From Long Term Classroom Programs and Medium / Short Classroom Program 4 in Top 10, 10 in Top 20, 43 in Top 100, 75 in Top 200, 159 in Top 500 Ranks & 3542 total selections in IIT-JEE 2012

ALL INDIA TEST SERIES

FIITJEE **JEE (Advanced), 2013**

FULL TEST – I

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 240**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-B**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (09 – 12) contains 4 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (13 – 18) contains 2 paragraphs. Based upon paragraph, 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+4 marks** for correct answer and **– 1 marks** for wrong answer.

2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 mark** will be awarded. There may be one or more than one correct choice. No marks will be given for any wrong match in any question. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

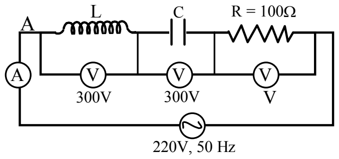
Physics PART – I

SECTION – A

Single Correct Choice Type

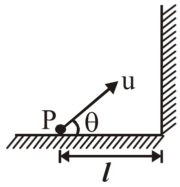
This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. In the circuit shown below, what will be the reading of the voltmeter and ammeter?



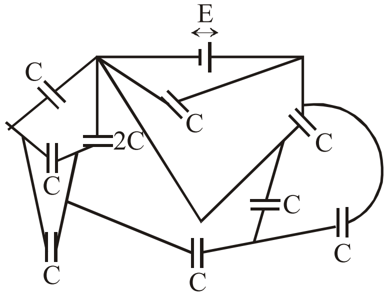
(A) 800 V, 2A (B) 300 V, 2A
(C) 220 V, 2.2A (D) 100 V, 2A

2. A ball of mass m is projected from a point P on the ground as shown in the figure. It hits a fixed vertical wall at a distance *l* from P. Choose the most appropriate option :



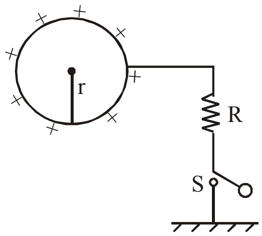
(A) the ball will return to the point P if *l* = half of the horizontal range.
(B) the ball will return to the point P if *l* ≤ half of the horizontal range.
(C) the ball can not return to the initial point if *l* > half of the horizontal range.
(D) the ball will return to the initial point, if the collision elastic and *l* < half of the range.

3 What is the equivalent capacitance across the battery?



(A) $\frac{79}{30}C$ (B) $\frac{59}{30}C$
(C) $\frac{41}{30}C$ (D) $\frac{21}{30}C$

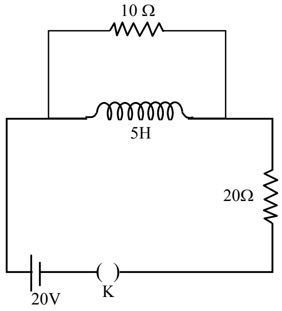
4. Initial charge on conducting sphere of radius r is Q_0. If S is closed at t = 0 then charge on the sphere at any time t is



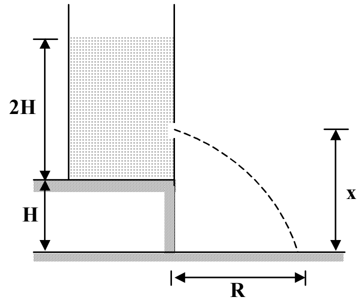
(A) $Q_0 e^{-t/rR}$ (B) $Q_0 e^{\frac{-t}{4\pi\varepsilon_0 R}}$
(C) $Q_0 e^{-\frac{t}{4\pi\varepsilon_0 Rr}}$ (D) none of these

Rough work

5. Two resistances of 10 Ω and 20 Ω and an ideal inductor of inductance 5H are connected to a 20V battery through a key K, as shown in figure. The key is closed at t = 0. What is the final value of current in the 10Ω resistor?
(A) (2/3) A
(B) (1/3) A
(C) (1/6) A
(D) zero

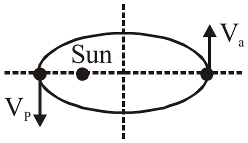


6. A tank is filled upto a height $2H$ with a liquid and is placed on a platform of height H from the ground. The distance x from the ground where a small hole is punched to get the maximum range R is
(A) H
(B) 1.25 H
(C) 1.5 H
(D) 2 H



7. The measure of radius of a sphere is (4.22 + 2%) cm. The volume of the sphere is
(A) $(315 \pm 6\%)\,\text{cm}^3$
(B) $(315 \pm 2\%)\,\text{cm}^3$
(C) $(315 \pm 4\%)\,\text{cm}^3$
(D) $(315 \pm 8\%)\,\text{cm}^3$

8. A planet moves around Sun in an elliptical orbit of eccentricity e. The ratio of the velocity at perigee V_p and at apogee V_a is given by
(A) $\frac{V_P}{V_a} = \frac{1+e}{1-e}$
(B) $\frac{V_P}{V_a} = \frac{1-e}{1+e}$
(C) $\frac{V_P}{V_a} = \sqrt{\frac{1+e}{1-e}}$
(D) $\frac{V_P}{V_a} = \sqrt{\frac{1-e}{1+e}}$

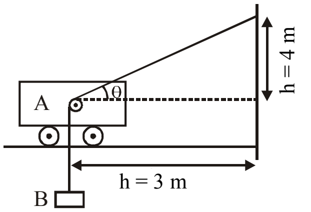


Rough work

Multiple Correct Answer(s) Type

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

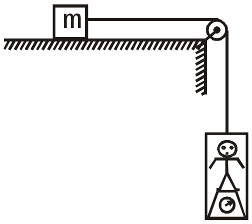
9. The string shown in the figure is passing over small smooth pulley rigidly attached to trolley *A*. If speed of trolley is constant and equal to V_A. Speed and magnitude of acceleration of block B at the instant shown in figure is



(A) $v_B = v_A$, $a_B = 0$ (B) $a_B = 0$

(C) $v_B = \frac{3}{5}v_A$ (D) $a_B = \frac{16v_A^2}{125}$

10. In the figure, a man of true mass *M* is standing on a weighing machine placed in a cabin. The cabin is joined by a string with a body of mass *m*. Assuming no friction, and negligible mass of cabin and weighing machine, the measured mass of man is (normal force between the man and the machine is proportional to the mass)



(A) measured mass of man is $\frac{Mm}{(M+m)}$ (B) acceleration of man is $\frac{mg}{(M+m)}$

(C) acceleration of man is $\frac{Mg}{(M+m)}$ (D) measured mass of man is M.

11. A charged particle of mass 2 kg and charge 2 C moves with a velocity $\vec{v} = 8\hat{i} + 6\hat{j}$ m/s in a magnetic field $\vec{B} = 2\hat{k}$ T. Then

(A) The path of particle may be $x^2 + y^2 = 25$. (B) The path of particle may be $x^2 + z^2 = 25$.

(C) The time period of particle will be 3.14 s. (D) None of these.

12. Choose the correct statement(s)

(A) The density of nuclear matter is independent of the size of the nucleus.

(B) The binding energy per nucleon, for nuclei of middle mass numbers, is about 8 MeV.

(C) A free neutron is unstable.

(D) A free proton is stable.

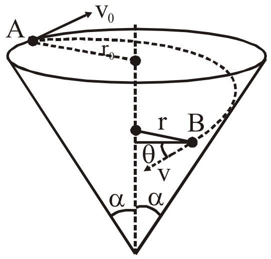
Rough work

Comprehension Type

This section contains 2 groups of questions. Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 13 to 15

A small particle of mass m is given an initial velocity v_0 tangent to the horizontal rim of a smooth cone at a radius r_0 from the vertical centerline as shown at point A. As the particle slides to point B, a vertical distance h below A and a distance r from the vertical centerline, its velocity v makes an angle θ with the horizontal tangent to the cone through B.



13. The value of θ is

(A) $\cos^{-1}\dfrac{v_0r_0}{\sqrt{v_0^2+2gh}(r_0-h\tan\alpha)}$

(B) $\cos^{-1}\dfrac{v_0r_0}{\sqrt{v_0^2+2gh}(r_0+h\tan\alpha)}$

(C) $\cos^{-1}\dfrac{v_0r_0}{\sqrt{v_0^2-2gh}(r_0-h\tan\alpha)}$

(D) $\cos^{-1}\dfrac{v_0r_0}{r_0\sqrt{v_0^2+2gh}}$

14. The speed of particle at point B

(A) $\sqrt{v_0^2+2gh}$

(B) $\sqrt{v_0^2-2gh}$

(C) $\sqrt{v_0^2+gh}$

(D) $\sqrt{2v_0^2+2gh}$

15. The minimum value of v_0 for which particle will be moving in a horizontal circle of radius r_0.

(A) $\sqrt{\dfrac{2gr_0}{\tan\alpha}}$

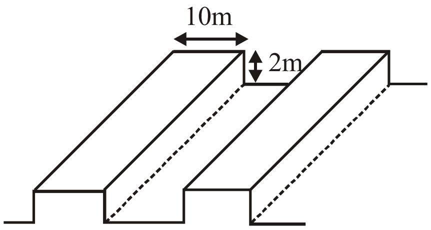
(B) $\sqrt{\dfrac{gr_0}{2\tan\alpha}}$

(C) $\sqrt{\dfrac{gr_0}{\tan\alpha}}$

(D) $\sqrt{\dfrac{4gr_0}{\tan\alpha}}$

Rough work

Paragraph for Question Nos. 16 to 18



The world is focusing its attention on renewable sources of energy like solar energy, wind energy, tidal energy and wave energy. These sources are non-polluting, do not cause the emission of greenhouse gases, or cause any large scale damage to the ecology or environment.

Waves on the surface of the ocean are a good source of power. To illustrate this, we calculate the mechanical energy carried by an average wave of crest 1m, wavelength 20 m and a period of 5 s. The wave profile is taken as approximately step-like, instead of a sinusoidal function.

A simple minded calculation gives us a contribution of 200 kW from the release of potential energy by such a wave over a 1 m wavefront.

16. The speed of the wave is
(A) 100 ms^{-1}
(B) 4 ms^{-1}
(C) 0.25 ms^{-1}
(D) none of these

17. Wave energy provides an inexpensive source of power. In the paragraph above, only the potential energy carried by the wave was calculated. The contribution to power due to kinetic energy, assuming that all the water in the crest is moving forward at the speed of the wave gives us, over a 1 m wavefront approximately, of the order of
(A) 10 W
(B) 100 W
(C) 10^3 W
(D) 10^4 W

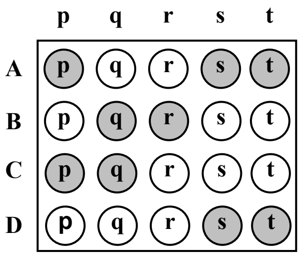
18. The momentum carried by the crest of the wave, per metre of the wavefront, is of the order of,
(A) 10^5 kg ms^{-1}
(B) 10^2 kg ms^{-1}
(C) 10 kg ms^{-1}
(D) 10^8 kg ms^{-1}

Rough work

SECTION - B

Matrix – Match Type

*This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*
If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



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1. For the following statements, except gravity and contact force between the contact surfaces, no other force is acting on the body.

Column A		Column B	
(A)	When a sphere is in pure–rolling on a fixed horizontal surface.	(p)	Upward direction
(B)	When a cylinder is in pure rolling on a fixed inclined plane in upward direction then friction force acts in	(q)	$v_{cm} > R\,\omega$
(C)	When a cylinder is in pure rolling down a fixed incline plane, friction force acts is	(r)	$v_{cm} < R\omega$
(D)	When a sphere of radius R is rolling with slipping on a fixed horizontal surface, the relation between v_{cm} and ω is	(s)	No frictional force acts.

2. Match the column I with column II
In simple harmonic motion: $x = 1.0 \sin [12\pi t]$ and mass of particle executing SHM, $m = 1/4$ kg

Column A		Column B	
(A)	Frequency with which kinetic energy oscillates = …	(p)	$\frac{1}{12}$
(B)	Speed of particle is maximum at time = ….	(q)	$18\pi^2$
(C)	Maximum potential energy = …	(r)	12
(D)	Force constant k = …	(s)	$36\pi^2$

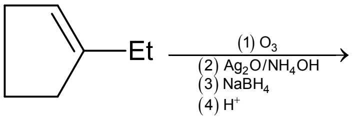
Rough work

Chemistry PART – II

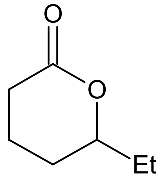
SECTION – A

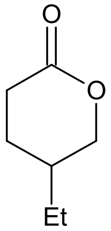
Straight Objective Type

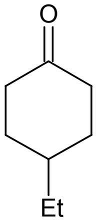
This section contains 8 multiple choice questions numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

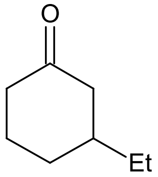
1. 
Et
(1) O3
(2) Ag2O/NH4OH
(3) NaBH4
(4) H+

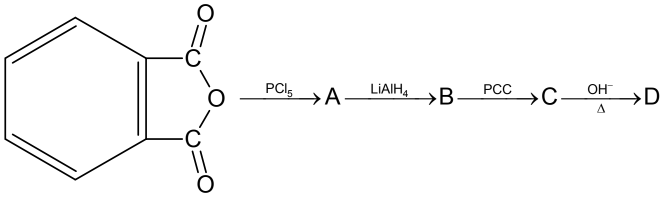
A, Product (A) is :

(A) 

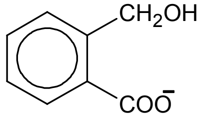
(B) 

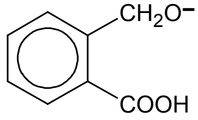
(C) 

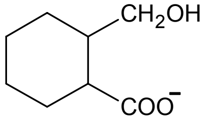
(D) 

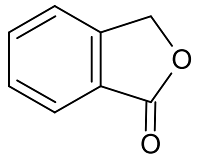
2. 
O
C
O
C
O
PCl5
A
LiAlH4
B
PCC
C
OH−
Δ
D

Product (D) is:

(A) 

(B) 

(C) 

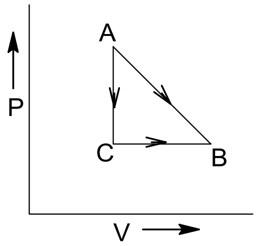
(D) 

3. The two forms of D-glucopyranose obtain from the solution of D-glucose are called
(A) Isomer
(B) Anomer
(C) Epimer
(D) Enantiomer

4. The vapour pressure of pure benzene and toluene are 160 and 60 torr respectively. The mole fraction of toluene in vapour phase in contact with equimolar solution of benzene and toluene is:
(A) 0.50
(B) 0.6
(C) 0.27
(D) 0.73

5. Consider the modes of transformations of a gas from state 'A' to state 'B' as shown in the following P – V diagram. Which one of the following is true?

(A) $\Delta H = q$ along $A \to C$
(B) ΔS is same along both $A \to B$ and $A \to C \to B$
(C) W is same along both $A \to B$ and $A \to C \to B$
(D) W > O along both $A \to B$ and $A \to C$



6. Select the group of species in which all show trigonal bipyramidal geometry:
(A) PF_5, IF_5, XeF_4
(B) ClO_4^-, IF_7, CO_3^{2-}
(C) I_3^-, XeF_2, SF_4
(D) XeF_6, PF_6^-, ICl_2^+

7. Crystal field stabilization energy for high spin d^4 octahedral complex is:
(A) $-1.8\ \Delta_o$
(B) $-1.6\ \Delta_o + P$
(C) $-1.2\ \Delta_o$
(D) $-0.6\ \Delta_o$

8. Solubility product of silver bromide is 5×10^{-13}. The quantity of potassium bromide (molar mass taken as 120 g mol^{-1}) to be added to 1 litre of 0.05 M solution of silver nitrate just to start the precipitation of AgBr is:
(A) 5×10^{-8} g
(B) 1.2×10^{-10} g
(C) 1.2×10^{-9} g
(D) 6.2×10^{-5} g

Rough Work

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

9. Which of the following statement(s) is/are correct?
(A) The coordination number of each type of ion in CsCl crystal is 8
(B) A metal that crystallizes in bcc structure has a coordination number of 12
(C) A unit cell of an ionic crystal shares some of its ions with other unit cells
(D) The length of the unit cell in NaCl is 552 pm
$\left(r_{Na^+} = 95\text{ pm}, r_{Cl^-} = 181\text{ pm}\right)$

10. Which of the following statements are correct for cis-1,2-dibromocyclopentane?
(A) It contains two chiral centres, but is optically inactive
(B) It can exist in two enatiomeric forms but cannot be optically active
(C) It is a meso compound
(D) It is with two chiral centres and is optically active

11. Which of the following pairs can be distinguished by using Lucas Test?
(A) $PhCH_2OH, CH_3CH_2OH$
(B) $PhCH_2OH$, PhOH
(C) $(CH_3)_2CHOH, CH_3CH_2CH_2OH$
(D) $CH_3CH_2CH_2OH, CH_3CH_2OH$

12. Which reagent does not give oxygen as one of the products during oxidation with ozone?
(A) SO_2
(B) $SnCl_2$ + HCl
(C) H_2S
(D) PbS

Rough Work

Comprehension Type

This section contains 2 groups of questions. Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 13 to 15

For an electrode reaction written as

$M^{n+} + ne^- \longrightarrow M$

$E_{red} = E^o_{red} - \frac{RT}{nF}\ln\frac{1}{\left[M^{n+}\right]}$ (Nernst equation)

$= E^o_{red} - \frac{0.0591}{n}\log\frac{1}{\left[M^{n+}\right]}$ at 298 K

For the cell reaction, $aA + bB \rightleftharpoons xX + yY$

$$E_{cell} = E^o_{cell} - \frac{RT}{nF}\ln\frac{[X]^x[Y]^y}{[A]^a[B]^b}$$

$$= E^o_{cell} - \frac{0.0591}{n}\log\frac{[X]^x[Y]^y}{[A]^a[B]^b} \text{ at 298 K}$$

For pure solids, liquids or gases at 1 atm, molar concentration = 1

Standard free energy change $\Delta G^o = -nE^o_{cell}F$ where n is the number of electrons transferred in the redox reaction of the cell, E^o_{cell} is the standard emf of the cell. F stands for 1 Faraday, i.e. 96500 C mol^{-1} (approx.).

Standard free energy change $\Delta G^o = \frac{-2.303RT}{nF}\log K_{eq}$. Where K_{eq} is the equilibrium constant at TK. K_{eq} can be calculated from E^o_{cell} by using the relation, $E^o_{cell} = \frac{0.0591}{n}\log K_{eq}$

13. The e.m.f. of the cell

$Zn\,|\,Zn^{+2}(0.01\,M)\,||\,Fe^{+2}(0.001\,M)\,|\,Fe$

at 298 K is 0.2905 V. The value of the equilibrium constant for cell reaction is:

(A) $e^{\frac{0.32}{0.0295}}$
(B) $10^{\frac{0.32}{0.0295}}$
(C) $10^{\frac{0.26}{0.0295}}$
(D) $10^{\frac{0.32}{0.0591}}$

14. On the basis of information available from the reaction

$\frac{4}{3}Al + O_2 \longrightarrow \frac{2}{3}Al_2O_3,\ \Delta G = -827\ kJ\ mol^{-1}$

The minimum emf required to carry out an electrolysis of Al_2O_3 is (F = 96500 mol^{-1})

(A) 2.14 V
(B) 4.28 V
(C) 6.42 V
(D) 8.56 V

15. E^o for the cell, $Zn\,|\,Zn^{+2}_{(eq)}\,||\,Cu^{+2}_{eq}\,|\,Cu$; is 1.1 V at 25°C. The equilibrium constant for the cell reaction $Zn + Cu^{+2}_{(aq)} \rightleftharpoons Cu + Zn^{+2}_{(eq)}$ is of the order of

(A) 10^{-37}
(B) 10^{37}
(C) 10^{-17}
(D) 10^{17}

Rough Work

Paragraph for Question Nos. 16 to 18

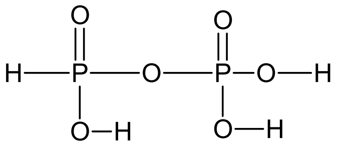
In oxoacids of phosphorus, P is tetrahedrally surrounded by other atoms. All these acids contain one P = O and P – OH bond. The oxoacids in which phosphorus has lower oxidation state (less than +5) contain, in addition to P = O and P – OH bonds, either P – P (e.g., in $H_4P_2O_6$) or P – H (e.g., in H_3PO_2) bonds but not both. These acids in +3 oxidation state of phosphorus tend to disproportionate to higher and lower oxidation states. For example, orthophosphorous acid (or phosphorus acid) on heating disproportionate to give orthophosphoric acid (or phosphoric acid) and phosphine.

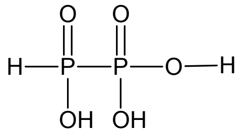
$$4H_3PO_3 \longrightarrow 3H_3PO_4 + PH_3$$

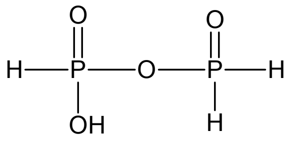
16. $H_3PO_2 + CuSO_4 \longrightarrow (X)$, a red ppt.
X is:
(A) Cu (B) Cu_2O
(C) CuO (D) Cu_2H_2

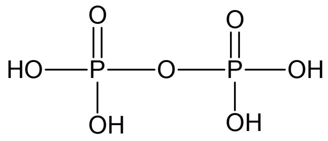
17. $P_4\,(\text{white}) + J\,(\text{an alkaline solution}) \longrightarrow K\,(\text{reducing gas}) + L$
L + dil. $H_2SO_4 \rightarrow$ N (ppt.) + M (oxyacids P)
N gives apple green colour in the flame.
Thus J, K, L, M and N respectively are:
(A) $Ba(OH)_2$, PH_3, $Ba(H_2PO_2)_2$, H_3PO_2, $BaSO_4$
(B) $Ca(OH)_2$, P_2H_4, $Ba(H_2PO_2)_3$, H_3PO_2, $CaSO_4$
(C) $Ba(OH)_2$, PH_3, $Ba(H_2PO_2)_3$, H_3PO_3, $BaSO_4$
(D) $Ba(OH)_2$, P_2H_4, $Ba(H_2PO_2)_2$, H_3PO_2, $BaSO_4$

18. Which of the following represents the isopolyacid of phosphorus?

(A)


(B)


(C)


(D)


Rough Work

SECTION-B
(Matrix Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

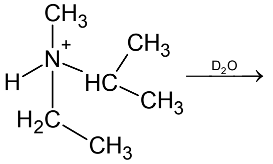
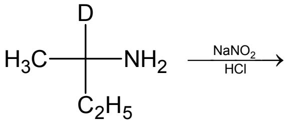
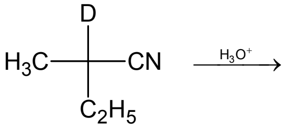
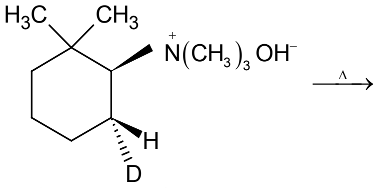
If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Acids given in Column – I are treated with OH^- and then with H^+, if required. The results are given in Column – II. Match correctly:

Column – I	**Column – II**
(A) 2-bormopropanoic acid	(p) Product is optically active
(B) 3-bromobutanoic acid	(q) Product shows geometrical isomerism
(C) 4-bromobutanoic acid	(r) Involves S_N2 attack
(D) 5-boromobutanoic acid	(s) Product contains a ring
	(t) Product contains – OH group

2. Match the reactions given in Column-I with the facts given in Column-II:

Column – I	**Column – II**
(A) 	(p) Develops a racemic mixture
(B)  (One enantiomer)	(q) An alkene is obtained
(C)  (One enantiomer)	(r) Configuration is retained
(D)  (One isomer)	(s) Product may contain deuterium
	(t) No stereogenic centre in the product

Rough Work

Mathematics

PART – III

SECTION – A

Straight Objective Type

This section contains 8 multiple choice questions numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. If a function y = f(x) is such that $f'(x) < 0$, then the number of integral values of 'a' for which the major axis of ellipse $f(a + 11)x^2 + f(a^2 + 2a + 5)y^2 = f(a + 11)f(a^2 + 2a + 5)$ becomes x–axis is

(A) 1	(B) 2
(C) 3	(D) 4

2. In a $\triangle ABC$, A, B, C are in AP and a, b, c are in GP then value of $a^3 + b^3 + c^3 - a^2b - b^2c - c^2a$ is

(A) 0	(B) 1
(C) 3	(D) 4

3. The four points A, B, C, D in space are such that angle ABC, BCD, CDA and DAB are all right angles, then

(A) A, B, C, D cannot be coplanar	(B) A, B, C, D are necessarily coplanar
(C) A, B, C, D may or may not be coplanar	(D) no such points A, B, C, D exist

4. b and c are arithmetic means between a and d (a > d > 0) and h and k are the geometric mean between a and d then

(A) bc is always greater than hk	(B) bc is always less than hk
(C) bc may be equal to hk	(D) none of these

5. If P be a point on ellipse $4x^2 + y^2 = 8$ with eccentric angle $\frac{\pi}{4}$. Tangent and normal at P intersects the axes at A, B, A′ and B′ respectively. Then the ratio of area of $\triangle APA'$ and area of $\triangle BPB'$ is

(A) 1	(B) 2
(C) 3	(D) 4

Rough work

6. If sin x + sin y $\geq$ cos α cos x $\forall$ x $\in$ R then sin y + cos α is equal to

(A) $\frac{1}{2}$
(B) 1
(C) 2
(D) –1

7. Let $I = \int_0^1 \frac{\sin x}{\sqrt{x}}\,dx$ and $J = \int_0^1 \frac{\cos x}{\sqrt{x}}\,dx$. Then which one of the following is true?

(A) $I > \frac{2}{3}$ and J > 2
(B) $I < \frac{2}{3}$ and J < 2
(C) $I < \frac{2}{3}$ and J > 2
(D) $I > \frac{2}{3}$ and J < 2

8. Tangent to hyperbola $xy = c^2$ at point P intersects the x–axis at T and the y–axis at T′. Normal to hyperbola at P intersects the x–axis at N and the y–axis at N′. If the area of the triangles PNT and PN′T′ are Δ and Δ' respectively then $\frac{1}{\Delta} + \frac{1}{\Delta'}$, is equal to

(A) c^2
(B) $\frac{2}{c^2}$
(C) $\frac{1}{c^2}$
(D) $\frac{c^2}{2}$

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

9. If $2\sin^2\left(\frac{\pi}{2}\cos^2 x\right) = 1 - \cos(\pi \sin 2x)$, $x \neq (2n+1)\frac{\pi}{2}$, n $\in$ I, then

(A) cos 2x is $\frac{3}{5}$
(B) cos 2x is $\frac{1}{2}$
(C) tan x is $\frac{1}{2}$
(D) tan x is $\frac{1}{3}$

Rough work

10. A circle having centre at C is made to pass through the point P(1, 2), touching the straight lines $7x - y = 5$ and $x + y + 13 = 0$ at A and B respectively, then
(A) area of quadrilateral ACBP is 100 sq. units (B) radius of smaller circle is $\sqrt{50}$
(C) area of quadrilateral ACBP is 200 sq. units (D) radius of smaller circle is 10

11. If $ax^2 + bx + c = 0$ has no real root and $a + b + c < 0$ then
(A) $4a - 2b + c > 0$ (B) $4a - 2b + c < 0$
(C) $13a + 5b + 2c < 0$ (D) $5b - 25a - c > 0$

12. Let $f(x) = (x + |x|)\,|x|$, then for all x
(A) f is continuous (B) f' is differentiable $\forall\, x \in R$
(C) f' is continuous (D) f'' is continuous

Comprehension Type

This section contains 2 groups of questions. Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 13 to 15

Read the following write up carefully and answer the following questions:
At times the methods of coordinates becomes effective in solving problems of properties of triangles, we may choose one vertex of the triangle and one side passing through this vertex as x–axis. Thus, without loss of generality, we can assume that every triangle ABC has a vertex B situated at B(0, 0), vertex C at (a, 0) and A as (h, k).

13. If in ΔABC, AC = 3, BC = 4 medians AD and BE are perpendicular, then area of triangle ABC must be equal to
(A) $\sqrt{7}$ (B) $\sqrt{11}$
(C) $2\sqrt{2}$ (D) $\sqrt{13}$

Rough work

14. Suppose the bisector AD of the interior angle A of ΔABC divides sides BC into segments BD = 4, DC = 2. Then we must have
(A) $b > c$ and $c < 4$
(B) $b \in (2, 6)$ and $c < 1$
(C) $b \in (2, 6)$ and $c \in (4, 12)$
(D) none of these

15. If altitude, CD = 7, AE = 6 and E divides BC given that $\frac{BE}{EC} = \frac{3}{4}$ then c must be
(A) $2\sqrt{3}$
(B) $5\sqrt{3}$
(C) $\sqrt{5}$
(D) $4\sqrt{3}$

Paragraph for Question Nos. 16 to 18

Read the following write up carefully and answer the following questions:

Let $f(x) = 12x^2\int_0^1 yf(y)\,dy + 20\int_0^1 xy^2f(y)\,dy + 4x$

16. The maximum value of f(x) is
(A) 8
(B) $\frac{1}{8}$
(C) 16
(D) $\frac{1}{16}$

17. The number of solutions of the equation $|f(|x|)| = e^{|x|}$
(A) 0
(B) 2
(C) 4
(D) 3

18. The range of $f(-2^x)$ is
(A) $(-\infty, 0)$
(B) $(0, \infty)$
(C) $\left(-\infty, \frac{1}{8}\right)$
(D) $\left(\frac{1}{8}, \infty\right)$

Rough work

SECTION – B

(Matrix Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:
If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Let $f(x) = \begin{cases} [x] & ; \ x \in [-2, 0) \\ |x| & ; \ x \in [0, 2] \end{cases}$; where [.] represent G.I.F. and g(x) = sec x, $x \in R - (2n+1)\frac{\pi}{2}$.

Match the following statements in column–I with their values in column–II in interval $\left(-\frac{3\pi}{2}, \frac{3\pi}{2}\right)$.

	Column – I		Column – II
(A)	Limit of fog exist at	(p)	-1
(B)	Limit of gof does not exist at	(q)	π
(C)	Points of discontinuity of fog is/are	(r)	$\frac{5\pi}{6}$
(D)	Points of differentiability of fog is/are	(s)	$-\pi$
		(t)	$\frac{\pi}{3}$

2. Match the following column–I with column–II.

	Column – I		Column – II
(A)	One ball is drawn from a bag containing 4 balls and is found to be white. The events that the bag contains 1 white, 2 white, 3 white and 4 white balls are equally likely. If the probability that all the balls are white is $\frac{p}{15}$ then the value of p is	(p)	9
(B)	From a set of 12 persons if the number of different selection of a committee, its chairperson and its secretary (possibly same as chairperson) is $13 \cdot 2^{10} m$ then m is	(q)	3
(C)	If x, y, z > 0 and x + y + z = 1, then the least value of $\frac{5x}{2-x} + \frac{5y}{2-y} + \frac{5z}{2-z}$ is	(r)	8
(D)	If $\sum_{K=1}^{12} 12K \cdot {}^{12}C_K \cdot {}^{11}C_{K-1}$ is equal to $\frac{12 \times 21 \times 19 \times 17 \times ..... \times 3}{11!} \times 2^{12} \times p$ the p is	(s)	6
		(t)	12

Rough work

From Long Term Classroom Programs and Medium / Short Classroom Program 4 in Top 10, 10 in Top 20, 43 in Top 100, 75 in Top 200, 159 in Top 500 Ranks & 3542 total selections in IIT-JEE 2012

ALL INDIA TEST SERIES

FIITJEE JEE(Advanced)-2013

ANSWERS, HINTS & SOLUTIONS

FULL TEST –I

(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	A	D
2.	C	A	A
3.	A	B	B
4.	C	C	A
5.	D	B	D
6.	C	C	B
7.	A	D	B
8.	A	C	B
9.	C, D	A, C, D	A, C
10.	A, C	A, C	A, B
11.	A, C	A, B, C	B, C, D
12.	A, B, C, D	A, B	A, C
13.	A	B	B
14.	A	A	C
15.	C	B	D
16.	B	D	B
17.	D	A	B
18.	A	D	A
1.	(A) → (s) (B) → (p) (C) → (p) (D) → (q, r)	(A) → (p, r, t) (B) → (q) (C) → (r, s) (D) → (r, s)	(A) → (p, q, r, s) (B) → (p) (C) → (q, s) (D)→ (p, r)
2.	(A) → (r) (B) → (q) (C) → (q) (D) → (s)	(A) → (p, q, s) (B) → (p, s) (C) → (r, s) (D) → (q, t)	(A) → (s) (B) → (t) (C) → (q) (D)→ (s)

Physics PART – I

SECTION – A

1. $E^2 = V_R^2 + (V_L - V_C)^2 = V_R^2 + 0$

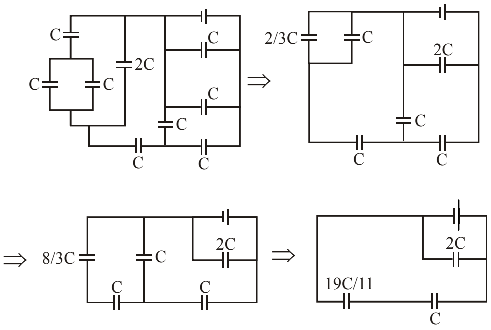
As, $E = V_R$

$\therefore\ V_R = V = 220$ V

$I = \frac{E}{R} = \frac{220}{100} = 2.2$ amp

3. Equivalent circuit can be drawn as

Equivalent capacitance = $\frac{79}{30}C$.



4. This is simply discharging of a capacitor.

$\therefore\ q = Q_0 e^{-t/CR}$ where $C = 4\pi\varepsilon_0 r$

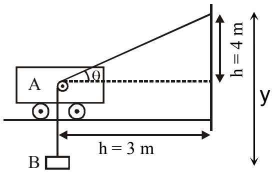
5. When the circuit will reach to steady state the inductor will given zero resistance. Hence the entire current will only pass through it.

6. $X = \frac{H + 2H}{2} = \frac{3H}{2}$

8. Here $V \propto 1/r$

$r \rightarrow$ distance between Sun and Planet.

9. $(y - h) + \sqrt{x^2 + h^2} = \ell$



$$\frac{dy}{dt} + \frac{x}{\sqrt{x^2 + h^2}}\frac{dx}{dt} = 0$$

$$\frac{dy}{dt} = -\frac{x}{\sqrt{x^2 + h^2}}\frac{dx}{dt}$$

$$\frac{dy}{dt} = -\frac{3}{5}v_A$$

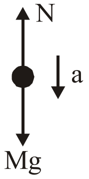
$$|u_B| = \frac{3}{5}v_A \qquad \ldots(i)$$

$$\frac{d^2y}{dt^2} = v_A^2\frac{h^2}{(x^2 + h^2)^{3/2}}$$

$$a_B = v_A^2\frac{16}{(5)^3}$$

$a_B = \frac{16}{125}v_A^2$ …(ii)

10. $Mg - T = Ma$ …(i)
$T = ma$ …(ii)
Solving (i) and (ii)
$a = \frac{Mg}{(M+m)}$
FBD of man
$Mg - N = Ma$
$N = \frac{Mmg}{(M+m)}$



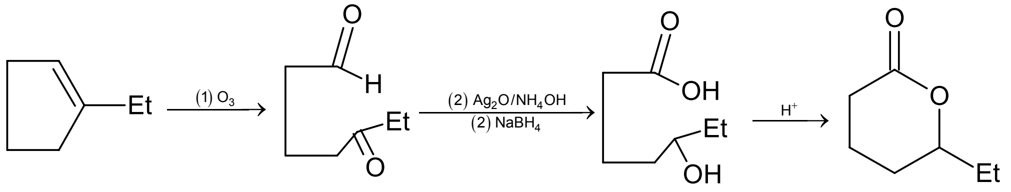
11. $T = \frac{2\pi m}{qB} = 3.14\text{ s}.$

Chemistry

PART – II

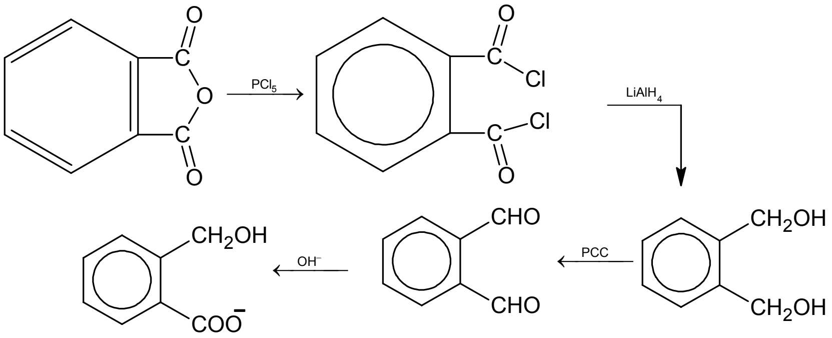
SECTION – A

1.



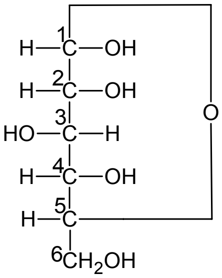
Et
(1) O_3
H
Et
O
(2) Ag_2O/NH_4OH
(2) $NaBH_4$
OH
Et
OH
H^+
O
Et

2.

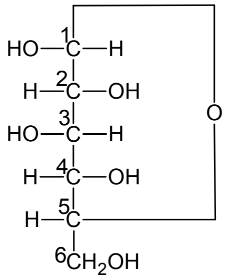


C
O
PCl_5
Cl
$LiAlH_4$
CH_2OH
CH_2OH
PCC
CHO
CHO
OH^-
CH_2OH
COO^-

3.



and



H—C—OH
HO—C—H
O
$^6CH_2OH$
1
2
3
4
5

Cyclic forms of diastereomers that differ only in the configuration of C1, are known as anomers.

The configuration differ only at carbon no. 1.

4. For equimolar solutions, $n_1 = n_2$

$\therefore x_1 = 0.5$ and 0.5

$P_B = x_B \times P_B^o = 0.5 \times 160 = 80$ mm

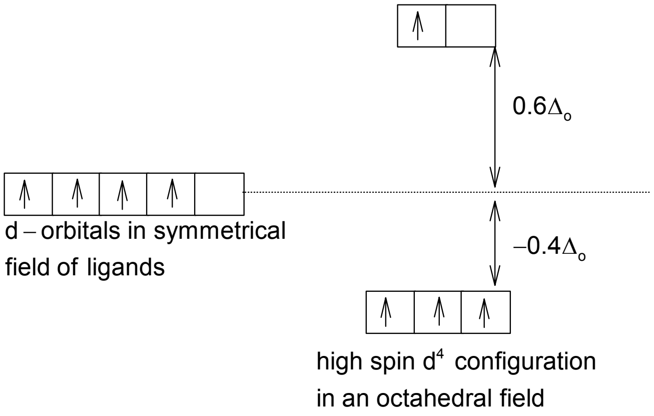
$P_T = x_T \times P_T^o = 0.5 \times 60 = 30$ mm

$P_{Total} = 80 + 30 = 110$ mm

Mole fraction of toluene in vapour phase = $\dfrac{P_T}{P_{Total}} = \dfrac{30}{110} = 0.27$

5. Entropy is a state function, i.e. the change entropy depends upon the initial and final states of the system and not on how that change is brought about.

7.


0.6Δo
d – orbitals in symmetrical field of ligands
–0.4Δo
high spin d4 configuration in an octahedral field

CFSE = 3(- 0.4) Δ_o + 0.6 Δ_o = - 1.2 Δ_o + 0.6 Δ_o = -0.6 Δ_o

8. Given $\left(K_{sp}\right)_{AgBr} = 5\times10^{-13}$

$KBr + AgNO_3 \longrightarrow AgBr + KNO_3$

Given, $[AgNO_3]$ = 0.05 M

$\Rightarrow \left[Ag^+\right] = \left[NO_3^-\right] = 0.05M$

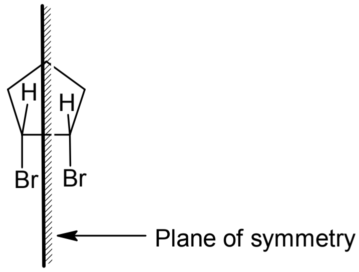
$\left[Ag^+\right]\left[Br^-\right] = \left(K_{sp}\right)AgBr \;\Rightarrow 0.05\times\left[Br^-\right] = 5\times10^{-13}$

$\Rightarrow \left[Br^-\right] = \dfrac{5\times10^{-13}}{0.05} = 1\times10^{-11}M$

$\therefore \left[Br^-\right] = \left[KBr\right] = 1\times10^{-11}M$

wt. of $KBr = 1\times10^{-11}\times120 = 1.20\times10^{-9}$ gm / litre

10.


H
H
Br
Br
Plane of symmetry

11. (A) $Ph-CH_2-OH \xrightarrow[\text{conc.HCl}]{\text{anh.ZnCl}_2} Ph-CH_2-Cl + Zn(OH)Cl(\text{immediate})$

(white turbidity)

$CH_3-CH_2-OH \xrightarrow{\text{Lucas reagent}} CH_3-CH_2-Cl + Zn(OH)Cl$ (slow)

(B) $Ph-CH_2-OH \xrightarrow[\text{reagent}]{\text{Lucas}} PhCH_2Cl + Zn(OH)Cl$ (immediate)

(White turbidity)

$Ph-OH \xrightarrow[\text{reagent}]{\text{Lucas}}$ No reaction under normal condition

(C) $(CH_3)_2CH-OH \xrightarrow[\text{reagent}]{\text{Lucas}} (CH_3)_2CH-Cl + Zn(OH)Cl$ (Moderate rate)

(White turbidity)

$CH_3-CH_2-CH_2-CH_2-OH \xrightarrow[\text{reagent}]{\text{Lucas}} CH_3-CH_2-CH_2-CH_2-Cl + Zn(OH)Cl$ (Slow)

(White turbidity)

12. $H_2S + O_3 \longrightarrow H_2O + S + O_2$

$PbS + 4O_3 \longrightarrow PbSO_4 + 4O_2$

$3SO_2 + O_3 \longrightarrow 3SO_3$

$3SnCl_2 + 6HCl + O_3 \longrightarrow 3SnCl_4 + 3H_2O$

13. $Zn + Fe^{+2} \longrightarrow Fe + Zn^{+2}$

$E = E^o - \frac{0.0591}{n}\log K_{eq}$

Given, E = 0.2905

$\Rightarrow 0.2905 = E^o - \frac{0.0591}{2}\log\frac{0.01}{0.001}$

$\Rightarrow$ 0.02905 + 0.0295 log10

= 0.2905 + 0.0295

= 0.32

$\therefore E^o = \frac{0.0591}{2}\log K_{eq}$

$\Rightarrow 0.32 = \frac{0.0591}{2}\log K_{eq}$

$\Rightarrow K_{eq} = 10^{\frac{0.32}{0.0295}}$

14. For 1 mole of O_2

$O_2 \longrightarrow 2O^{2-}\left(\text{i.e. } \frac{2}{3}\times 3O^{2-}\right)$

Or $\frac{4}{3}$ mol of Al to change into Al^{+3} ions.

n = 4

Thus, $\Delta G = -nEF$

$\Rightarrow E = -\frac{\Delta G}{nF} = \frac{+827000}{4\times 96500} = 2.14$ volt

15. $E^o_{cell} = \frac{0.059}{2}\log K_{eq} \Rightarrow \frac{1.1\times 2}{0.059} = 37.2881 = \log K_{eq}$

$\Rightarrow K_{eq} = 1.9\times 10^{37}$

16. Copper sulphate when reacts with hypophosphorus acid, gets reduced to cuprous hydride.

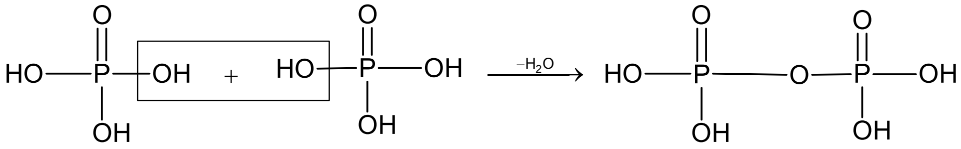
$4CuSO_4 + 3H_3PO_2 + 6H_2O \longrightarrow 2Cu_2H_2 + 3H_3PO_4 + 4H_2SO_4$

17. $\underset{(J)}{3Ba(OH)_2} + 2P_4 + 6H_2O \longrightarrow \underset{(L)}{3Ba(H_2PO_2)_2} + \underset{(K)}{2PH_3}$

$\underset{(L)}{Ba(H_2PO_2)_2} + H_2SO_4 \longrightarrow \underset{(N)}{BaSO_4} + \underset{(M)}{2H_3PO_2}$

gives apple green colour in the flame

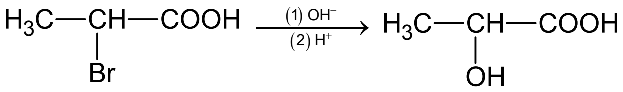
18. $H_4P_2O_7$ (pyrophosphoric acid) is a tetrabasic acid, i.e. 4-hydroxyl groups are present. It is prepared by removing one water molecule from two molecules of orthophosphoric acid. Each phosphorus atom lies in same tetrahedral environment, so called isopolyacid.



$$HO-\underset{OH}{\overset{O}{\overset{\|}{P}}}-\boxed{OH + HO}-\underset{OH}{\overset{O}{\overset{\|}{P}}}-OH \xrightarrow{-H_2O} HO-\underset{OH}{\overset{O}{\overset{\|}{P}}}-O-\underset{OH}{\overset{O}{\overset{\|}{P}}}-OH$$

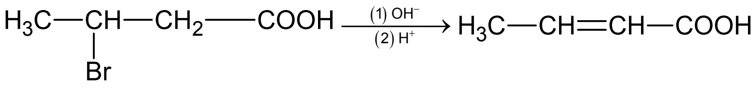
SECTION-B

1. (A)



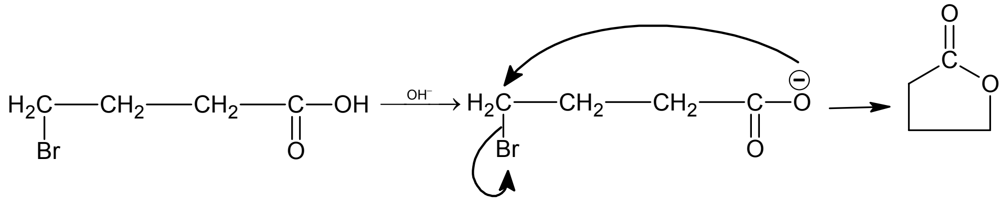
$$H_3C-\underset{Br}{CH}-COOH \xrightarrow[(2)\,H^+]{(1)\,OH^-} H_3C-\underset{OH}{CH}-COOH$$

(B)

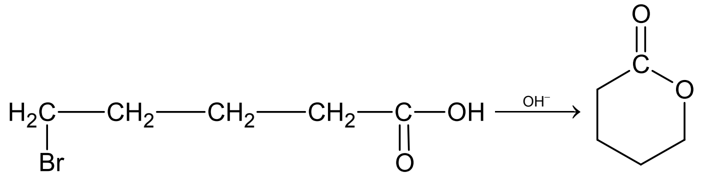


$$H_3C-\underset{Br}{CH}-CH_2-COOH \xrightarrow[(2)\,H^+]{(1)\,OH^-} H_3C-CH{=}CH-COOH$$

(C)

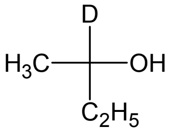


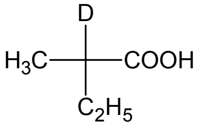
(D)

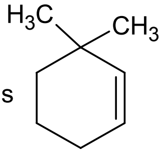


Reactions A, C, and D show S_N2 reactions.

2. In case of (A), compound given in (A) exchanges – H with – D and becomes racemic.
In case (B), compound in (B) reacts through a carbocation and gives racemic mixture.
In case of (C), no bond attached to the stereocentre breaks in reaction of (C), so retention.
In case of (D), compound in (D) gives Hoffmann elimination and it is an example of anti-elimination. Product does not have any stereogenic centre.

Reaction(B) gives  (d, ℓ – form)

Reaction(C) gives 

Reaction(D) gives  (No stereocentre)

Mathematics PART – III

SECTION – A

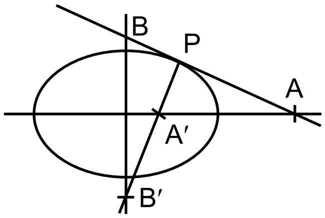
1. We must have $f(a^2 + 2a + 5) > f(a + 11)$
$\Rightarrow a^2 + 2a + 5 < a + 11$
$\Rightarrow a \in (-3, 2)$
$\therefore$ a can take values –2, –1, 0, 1

2. ΔABC is equilateral
$\Rightarrow a = b = c$

3. $AC^2 = AB^2 + BC^2$ ….. (1)
$BD^2 = BC^2 + CD^2$ ….. (2)
$CA^2 = CD^2 + DA^2$ ….. (3)
$DB^2 = DA^2 + AB^2$ ….. (4)
Equation (1) + (3) and (2) + (4) gives AC = BD
So, equation (1) and (2) give AB = CD and equation (2) and (3) give BC = AD
So Δ′s CBD and ADB are congruent $\Rightarrow \angle CBD = \angle ADB = 90^\circ - \angle ABD$
$\Rightarrow \angle CBD + \angle ABD = \angle CBA \Rightarrow$ DB lies in the plane of ΔABC, so the points are coplanar

4. Let $a - d = 3t$; then $bc = (d + zt)(d + t) = d^2 + 3td + 2t^2$
Also $\frac{a}{d} = 1 + \frac{3t}{d}$, so $hk = d^2\left[1 + \frac{3t}{d}\right] = d^2t + 3td < bc$
$\Rightarrow bc > hk$

5. Clearly $P \equiv (1, 2)$
Equation of tangent at P is $4x(1) + y(2) = 8$
$\Rightarrow A \equiv (2, 0)$ and $B \equiv (0, 4)$
Similarly normal at P is $2x - 4y = 6$
$\Rightarrow A'(-3, 0)$ and $B'\left(0, \frac{3}{2}\right)$



$$\therefore \text{Area } BPB' = \frac{1}{2}\begin{vmatrix} 0 & 4 & 1 \\ 1 & 2 & 1 \\ 0 & \frac{3}{2} & 1 \end{vmatrix} = \frac{5}{4} \text{ and Area } APA' = 5$$

$\therefore$ Ratio = 4

6. As $\sin x + \sin y \ge \cos\alpha \cos x \ \forall \ x \in R$
Let $x = -\frac{\pi}{2} \Rightarrow \sin y \ge 1 \Rightarrow \sin y = 1$
$\Rightarrow 1 + \sin x \ge \cos\alpha \cos x$
$\Rightarrow \cos\alpha \cos x - \sin x \le 1$
$\Rightarrow \sqrt{\cos^2\alpha + 1} = 1 \Rightarrow \cos\alpha = 0 \Rightarrow \sin y + \cos\alpha = 1 + 0 = 1$

7. $I = \int_0^1 \frac{\sin x}{\sqrt{x}} dx < \int_0^1 \frac{x}{\sqrt{x}} dx = \frac{2}{3}$

$\Rightarrow I < \frac{2}{3}$ and $J = \int_0^1 \frac{\cos x}{\sqrt{x}} < \int_0^1 x^{-1/2} dx = 2$

$\Rightarrow J < 2$

8. Equation of tangent $x + t^2 y = 2ct \Rightarrow T \equiv (2ct, 0)$ and $T' \equiv \left(0, \frac{2c}{t}\right)$

Equation of normal $t^3 x - ty = c\left(t^4 - 1\right)$; $N \equiv \left[c\left(t - \frac{1}{t^3}\right), 0\right]$; $N \equiv \left[0, c\left(\frac{1}{t} - t^3\right)\right]$

$\Rightarrow NT = \frac{c}{t^3} + ct;\ N'T' = ct^3 + \frac{c}{t}$

$\Rightarrow \Delta = \frac{1}{2}\left|\frac{c}{t^3} + ct\right|\frac{c}{t} \Rightarrow \frac{1}{\Delta} = \frac{2t^4}{c^2\left(1+t^4\right)}$ and $\Delta' = \frac{1}{2}\left|ct^3 + \frac{c}{t}\right|ct$

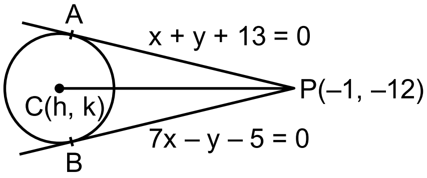
$\Rightarrow \frac{1}{\Delta'} = \frac{2}{c^2\left(1+t^4\right)} \Rightarrow \frac{1}{\Delta} + \frac{1}{\Delta'} = \frac{2}{c^2}$

9. We have $2\sin^2\left(\frac{\pi}{2}\cos^2 x\right) = 2\sin^2\left(\frac{\pi}{2}\sin 2x\right)$

$\Rightarrow \cos^2 x = \sin 2x \Rightarrow \cos x(\cos x - 2\sin x) = 0$

$\Rightarrow 1 - 2\tan x = 0$ as $\cos x \neq 0$

$\Rightarrow \tan x = \frac{1}{2}$ and $\cos 2x = \frac{3}{5}$



10. Clearly, the point lies on 7x – y = 5

Also, centre of the circle must lie on the bisectors of the lines

x + y + 13 = 0 and 7x – y – 5 = 0 given by

$\frac{x+y+13}{\sqrt{2}} = \pm\frac{7x-y-5}{\sqrt{50}} \Rightarrow x - 3y = 35$ and $3x + y + 15 = 0$

Let (h, k) be the centre of the circle, then h – 3k = 35 ….. (1)

and 3h + k = 15 ….. (2)

Clearly CB is perpendicular BP $\Rightarrow \frac{k-2}{h-1} \times 7 = -1 \Rightarrow h + 7k - 15 = 0$ ….. (3)

On solving, we get centres as $C_1 \equiv (29 - 2)$ and $C_2 \equiv (-6, 3)$

$\Rightarrow r_1^2 = 800$ and $r_1^2 = 50 \Rightarrow$ smaller circle has radius = $\sqrt{50}$

Therefore area of quadrilateral ACBP = $2\left[\frac{1}{2} \times \sqrt{50} \times \sqrt{200}\right]$ sq. units

11. Let $f(x) = ax^2 + bx + c$ and f(1) = a + b + c < 0 $\Rightarrow$ f(x) < 0 for all x $\in$ R $\Rightarrow$ f(–2) < 0 $\Rightarrow$ 4a – 2b + c < 0

Again f(3) + f(2) < 0 $\Rightarrow$ 13a + 5b + 2c < 0

Also f(–5) < 0 $\Rightarrow$ 25a – 5b + c < 0 $\Rightarrow$ 5b – 25a – c > 0

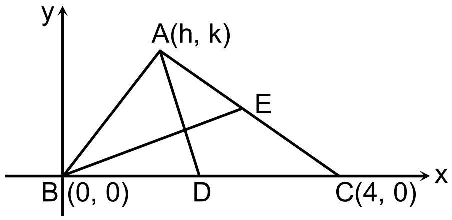
12. $f(x) = \begin{cases} (x-x)(-x) = 0 & ; \quad x < 0 \\ (x+x)x = 2x^2 & ; \quad x \geq 0 \end{cases}$

$\Rightarrow$ f is continuous and differentiable

Again $f'(x) = \begin{cases} 0 & ; \quad x < 0 \\ 4x & ; \quad x \geq 0 \end{cases}$

$\Rightarrow$ f′(x) is continuous but not differentiable at x = 0

13. Taking B as origin, BC as x–axis and A as (h, k) and C(4, 0)



We have D ≡ (2, 0) and E ≡ $\left(\frac{h+4}{2}, \frac{k}{2}\right)$

$\Rightarrow K^2 + (h + 4)(h - 2) = 0$ ….. (1)

Also AC = 3 $\Rightarrow (h - 4)^2 + k^2 = 9$ ….. (2)

And area = $\frac{1}{2} \times 4 \times K = 2K$

Solving (1) and (2), we get $h = \frac{3}{2}$ and $K = \frac{\sqrt{11}}{2}$

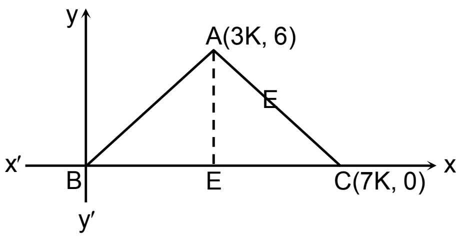
$\therefore$ ΔABC = $\sqrt{11}$

14. Let AD be angle bisector $\Rightarrow \frac{AB}{AC} = \frac{BD}{DC} \Rightarrow c = 2b$

Now b + c > a $\Rightarrow$ b + c > 6 $\Rightarrow$ b + 2b > 6 $\Rightarrow$ b > 2

Again $\frac{b^2 + 4b^2 - 6}{4b^2} < 1 \Rightarrow b < 6 \Rightarrow b \in (2, 6)$ and consequently $c \in (4, 12)$

15. $\frac{BE}{EC} = \frac{3}{4}$, take BE = 3K and EC = 4K



$\Rightarrow$ A must be (3K, 6)

Now equation of line BA is $y = \frac{6}{3K}x$

$\Rightarrow$ Ky – 2x = 0

Since perpendicular from c on AB = 7

$\Rightarrow \left|\frac{0 - 14K}{\sqrt{K^2 + 4}}\right| = 7 \Rightarrow K^2 = \frac{4}{3}$

Now $c^2 = (6-0)^2 + (3K-0)^2 = 36 + 9K^2 = 36 + 12$

$\Rightarrow c = \sqrt{48} = 4\sqrt{3}$

16–18. Let $12\int_0^1 yf(y)dy = a$ and $20\int_0^1 \left(y^2 f(y)\right)dy + 4 = b$

$\Rightarrow f(x) = ax^2 + bx \Rightarrow f(y) = ay^2 + by$

$\Rightarrow f(x) = 12x^2\int_0^1 y\left(ay^2 + by\right)dy + 20x\int_0^1 y^2\left(ay^2 + by\right)dy + 4x = 12x^2\left(\frac{a}{4} + \frac{b}{3}\right) + 20x\left[\frac{a}{5} + \frac{b}{4}\right] + 4x$

$\Rightarrow$ a = 3a + 4b $\Rightarrow$ a = –2b ….. (1)

and 4a + 5b + 4 = b $\Rightarrow$ a + b = –1 ….. (2)

$\Rightarrow$ a = –2, b = 1

$\therefore f(x) = -2x^2 + x$

SECTION – B

1. Clearly we have $f(x)=\begin{cases}-2 & ; \quad x\in[-2,\ 1) \\ -1 & ; \quad x\in[-1,\ 0) \\ x & ; \quad x\in[0,\ 2]\end{cases}$ and g(x) = sec x; $x \in R-(2x+1)\dfrac{\pi}{2}$

We have $\text{fog}(x)=\begin{cases}-2 & ; \quad \sec x\in[-2,\ -1) \\ -1 & ; \quad \sec x\in[-1,\ 0) \\ \sec x & ; \quad \sec x\in[0,\ 2]\end{cases}$

$$\therefore\ \text{fog}(x)=\begin{cases}-2 & ; \quad x\in\left[-\frac{4\pi}{3},\ -\frac{2\pi}{3}\right]\cup\left[\frac{2\pi}{3},\ \frac{4\pi}{3}\right]-\{-\pi,\ \pi\} \\ -1 & ; \quad x=-\pi,\ \pi \\ \sec x & ; \quad x\in\left[-\frac{\pi}{3},\ \frac{\pi}{3}\right]\end{cases}$$

Limit of fog exist at x = –π, π, –1, points of discontinuity of fog are –π, π and points of differentiability of fog are $-1,\ \dfrac{5\pi}{6}$

Again $g(f(x))=\begin{cases}\sec(-2) & ; \quad x\in[-2,\ -1)-\left\{-\frac{\pi}{2}\right\} \\ \sec(-1) & ; \quad x\in[-1,\ 0) \\ \sec x & ; \quad x\in[0,\ 2]-\left\{\frac{\pi}{2}\right\}\end{cases}$

Limit of g(f(x)) does not exist at x = –1

2. (A) Let E_i ; i = 1, 2, 3, 4 represents the events that the bag contains I white balls: Clearly $P(E_i)=\dfrac{1}{4}$. Let W be the event that the ball drawn is white then,

$$P(W)=\sum P(E_i)\cdot P\left(\frac{W}{E_i}\right)=\frac{1}{4}\left(\frac{1}{4}+\frac{2}{4}+\frac{3}{4}+\frac{4}{4}\right)=\frac{5}{8}$$

Now $P\left(\dfrac{E_4}{W}\right)=\dfrac{P(E_4)P(W/E_4)}{P(W)}=\dfrac{1/4}{5/8}=\dfrac{2}{5}=\dfrac{p}{15} \Rightarrow p = 6$

(B) Required number of ways

$= {}^{12}C_1+{}^{12}C_2\left({}^{2}C_1+2\cdot{}^{2}C_2\right)+{}^{12}C_3\left({}^{3}C_1+2\cdot{}^{3}C_2\right)+.....+{}^{12}C_{12}\left({}^{12}C_1+2\cdot{}^{12}C_2\right)$

=

$\left({}^{12}C_1+2\cdot{}^{12}C_2+3\cdot{}^{12}C_3+.....+12\cdot{}^{12}C_2\right)+2\left({}^{12}C_2\cdot{}^{2}C_2+{}^{12}C_3\cdot{}^{3}C_2+.....+{}^{12}C_2\cdot{}^{12}C_2\right)$

$=\displaystyle\sum_{r=1}^{12} r\cdot{}^{12}C_r+12\sum_{r=2}^{12}{}^{10}C_{r-2}=12\times 2^{11}+12\times 11\times 2^{10}$

$= 13\times 2^{10}\times 12 = 13\times 2^{10}\times m \Rightarrow m = 12$

(C) $\dfrac{5x}{2-x}+\dfrac{5y}{2-y}+\dfrac{5z}{2-z}=5\left[\dfrac{x}{2-x}+\dfrac{y}{2-y}+\dfrac{z}{2-z}\right]$

$=5\left[\dfrac{x-2+2}{2-x}+\dfrac{y-2+2}{2-y}+\dfrac{z-2+2}{2-z}\right]=5\left[-3+2\left[\dfrac{1}{2-x}+\dfrac{1}{2-y}+\dfrac{1}{2-z}\right]\right]$

Now apply A.M ≥ H.M on 2 – x, 2– y and 2 – z

$$\Rightarrow \frac{2-x+2-y+2-z}{3} \ge \frac{3}{\frac{1}{2-x}+\frac{1}{2-y}+\frac{1}{2-z}} \Rightarrow \frac{1}{2-x}+\frac{1}{2-y}+\frac{1}{2-z} \ge \frac{9}{5}$$

Hence $\frac{5x}{2-x}+\frac{5y}{2-y}+\frac{5z}{2-z} \ge 5\left[-3+2\cdot\frac{9}{5}\right]=3$

$\therefore$ Least value = 3

(D) $\sum_{K=1}^{n} 12\cdot K\ {}^{12}C_K\cdot\ {}^{11}C_{K-1} = 12^2\sum_{K=1}^{12}\left({}^{11}C_{K-1}\right)^2 = 12^2\cdot\frac{22!}{11!\ 11!}$

$= 12\cdot\frac{21\cdot19\cdot17.....3}{11!} - 2^{12}\cdot6 \Rightarrow p = 6$

From Long Term Classroom Programs and Medium / Short Classroom Program 4 in Top 10, 10 in Top 20, 43 in Top 100, 75 in Top 200, 159 in Top 500 Ranks & 3542 total selections in IIT-JEE 2012

ALL INDIA TEST SERIES

FIITJEE **JEE (Advanced), 2013**

FULL TEST – I

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 240**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 04)** contains 4 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.
   Section – A (05 – 09) contains 5 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.
2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 mark** will be awarded. There may be one or more than one correct choice. No marks will be given for any wrong match in any question. There is no negative marking.
3. **Section – C (01 – 08)** contains 8 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

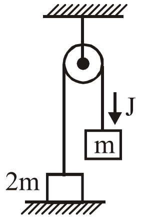
Physics PART – I

SECTION – A

Single Correct Choice Type

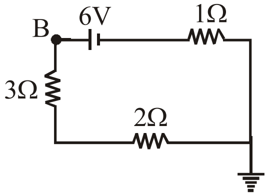
This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. In the given figure an impulse J is given to the block of mass m in the downward direction. As a result of the impulse



(A) both the blocks start moving with $\frac{J}{3m}$ in opposite directions
(B) both the blocks start moving with $\frac{J}{m}$ in opposite direction
(C) the centre of mass of the system is moving downwards
(D) the centre of mass of the system is not moving

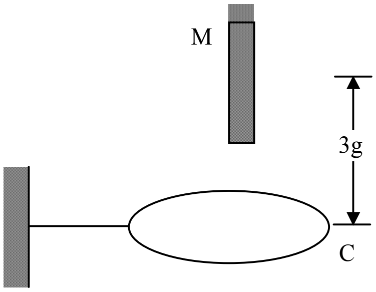
2. In the given electrical circuit electric Potential of point B is



(A) 6 VOLT (B) 5 VOLT
(C) 4 VOLT (D) 3 VOLT

3. Choose the incorrect statement about the coefficient of restitution
(A) it is defined as the ratio of relative velocity of separation to the relative velocity of approach
(B) it is defined only for two colliding bodies
(C) it is defined for colliding parts of the smooth body along the normal to the striking surface
(D) while calculating the velocity of approach and separation we take the velocities of centre of mass of the bodies

4. A bar magnet M is allowed to fall towards a fixed conducting ring C. If g is the acceleration due to gravity, v is the velocity of the magnet at t = 2s and s is the distance traveled by it in the same time then



(A) v > 2g (B) v < 4g
(C) s > 2g (D) s < 2g

Rough work

Multiple Correct Answer(s) Type

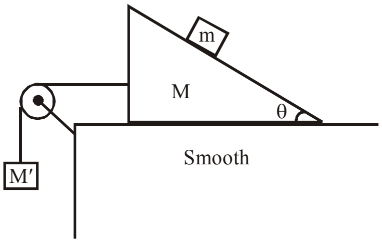
This section contains **5 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

5. Which of the following are true for a satellite in an orbit.
   (A) it is a freely falling body
   (B) its velocity is constant
   (C) it suffers no acceleration
   (D) it does not require energy for its motion in the orbit

6. The molar heat capacity for an ideal gas
   (A) is zero for an adiabatic process
   (B) is infinite for an isothermal process
   (C) depends only on the nature of the gas for a process in which either volume or pressure is constant
   (D) is equal to the product of the molecular weight and specific heat capacity for any process

7. A particle is projected at an angle $\theta = 30^\circ$ with the horizontal, with a velocity of 10 m/s then
   (A) after 2 s the velocity of particle makes an angle of 60° with initial velocity vector
   (B) after 1 s the velocity of particle makes an angle of 60° with initial velocity vector
   (C) the magnitude of velocity of particle after 1 s is 10 m/s
   (D) the magnitude of velocity of particle after 1 s is 5 m/s

8. The figure shows a block of mass *m* placed on a smooth wedge of mass *M*. Calculate the value of M′ and tension in the string, so that the block of mass *m* will move vertically downward with acceleration 10 m/s^2. (Take g = 10 m/s^2)

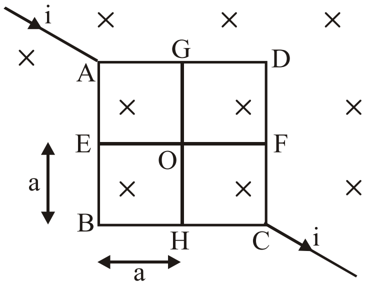


   (A) the value of M′ is $\frac{M\cot\theta}{1-\cot\theta}$
   (B) the value of M′ $\frac{M\tan\theta}{1-\tan\theta}$
   (C) the value of tension in the string is $\frac{Mg}{\tan\theta}$
   (D) the value of tension is $\frac{Mg}{\cot\theta}$

Rough work

9. In the figure, there is a uniform conducting structure in which each small square has side a. The structure is kept in uniform magnetic field B.

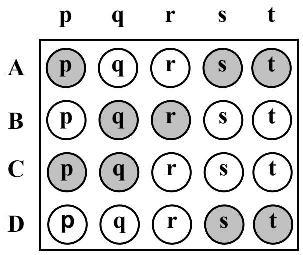
(A) The magnetic force on the structure is $2\sqrt{2}$iBa .
(B) The potential of point B = potential of point D.
(C) Potential of point O = potential of point B.
(D) The magnetic force on the structure is $\sqrt{2}$ iBa .



SECTION - B

Matrix – Match Type

*This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*
If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



1. A real object is being seen by optical component listing in column A and nature of image of this object is listing in column B :

Column A	Column B Nature of image
(A) Convex lens.	(p) Real.
(B) Convex mirror.	(q) Virtual.
(C) Concave lens.	(r) Erect.
(D) Concave mirror.	(s) Inverted.

2. Column A lists type of decay and the column B lists reason of decay (reason for instability of nucleus)

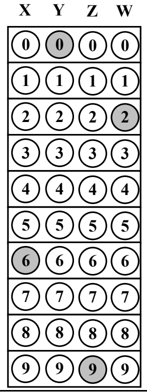
Column A	Column B
(A) γ–decay.	(p) Nucleus is too large.
(B) α–decay.	(q) Nucleus has too many neutrons relative to number of protons.
(C) β minus decay.	(r) Nucleus has excess energy.
(D) β plus decay.	(s) Nucleus has too many protons relative to number of neutrons.

Rough work

SECTION – C

Integer Answer Type

This section contains 8 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



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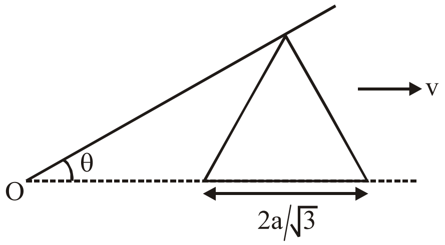
1. A body of mass m = 4 kg starts moving with velocity v_0 in a straight line is such a way that on the body work is being done at the rate which is proportional to the square of velocity as given by $P = \beta v^2$ where $\beta = \frac{0.693}{2}$. Find the time elapsed in seconds before velocity of body is doubled.

2. A sound source of frequency f_0 = 130 Hz is dropped from a height slightly greater than 250 m above the ground. At the same time a detector is thrown upwards with velocity u = 50 ms^{-1} along the same line. If the speed of sound is v = 300 ms^{-1}, if the frequency (in Hz) detected by the detector after t = 5 s is 39 × n, find the value of n (Take g = 10 ms^{-2})

3. There is an isolated planet having mass 2M and radius 2R, where M and R are the mass and radius of the earth. A simple pendulum having mass m and length 2R is made to small oscillations on the planet. The time period of SHM of pendulum is (0.7 K + 0.5) seconds. Find the value of K. (take π = 3.00, g = 10 m/s^2, $\sqrt{2} = 1.41$)

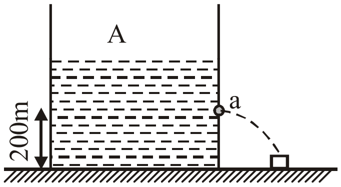
4. In the arrangement shown the rod is freely pivoted at point O and is in contact with the equilateral triangular block which can moves on the horizontal frictionless ground. As the block is given a speed v forward, the rod rotates about point O. Find the angular velocity of rod in rad/s at the instant when θ = 30º. [Take v = 20 m/s, a = 1 m]



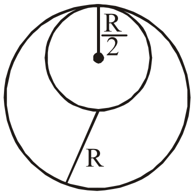
5. Radiation from hydrogen gas excited to first excited state is used for illuminating certain photoelectric plate. When the radiation from some unknown hydrogen like gas excited to the same level is used to expose the same plate, it is found that the de–Broglie wavelength of the fastest photoelectron has decreased 2.3 times. It is given that the energy corresponding to the longest wavelength of the Lyman series of the unknown gas is 3 times the ionization energy of hydrogen gas (13.6 eV). Find the work function of photoelectric plate in eV. (Take $(2.3)^2$ = 5.25.

Rough work

6. Water is filled in a uniform container of area of cross section A. A hole of cross section area a (<< A) is made in the container at a height of 20 m above the base. Water streams out and hits a small block placed at some distance from container. With what speed (in ms^{-1}) the block should be moved such that water streams always hits the block. (Given $\frac{a}{A} = \frac{1}{20}$). (Take g = 10 ms^{-2})

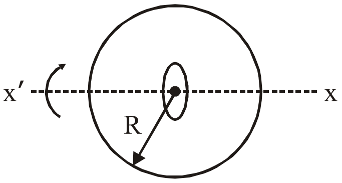


7. A spherical hole of radius $\frac{R}{2}$ is drilled from a planet of mass M as shown in the figure. If the gravitational acceleration at a point on the surface of the planet just above the hole is N × 1.1 m/s^2, find the value of N.
[Given : $G = 6.6 \times 10^{-11}$ $N.m^2/kg^2$, $R = 6 \times 10^6$ m, $M = 6 \times 10^{24}$ kg]



8. A non–conducting ring of radius R having uniformly distributed charge Q starts rotating about x–x′ axis passing through diameter with an angular acceleration α as shown in the figure. Another small conducting ring having radius a (a << R) is kept fixed at the centre of bigger ring is such a way that axis xx′ is passing through its centre and perpendicular to its plane. If the resistance of small ring is r = 1Ω, find the induced current in it in ampere.

(Given $q = \frac{16 \times 10^2}{\mu_0} C$, R = 1 m, a = 0.1 m, α = 8 rad/s^2)



Rough work

Chemistry

PART – II

SECTION – A

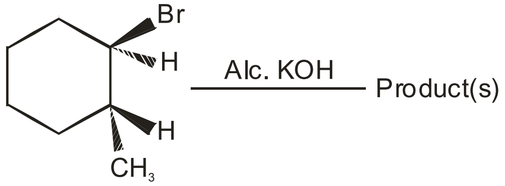
Straight Objective Type

This section contains 4 multiple choice questions numbered 1 to 4. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. A 75 gm $4\%\left(\frac{w}{w}\right)$ aqueous NaOH solution is distilled for some time. The water collected has a mass of 25 gms. To this distilled solution X gms of KOH(s) is added, so that molality of OH^- ion in the resulting solution becomes 5. Find X?

(A) 7 (B) 9

(C) 7.4 (D) 8.2

2. 

The above reaction follows bimolecular paths. Find the major product of the following :

(A) Saytzeff alkene (B) Hoffmann alkene

(C) alcohol (secondary) (D) alcohol (tertiary)

3. A 1.025 gm sample containing a weak acid HX (mol. wt = 82) is dissolved in 60 ml H_2O and titrated with 0.25 M NaOH solution. When half of the acid is neutralized the pH was found to be 5.0 and the pH at equivalence point is 9.0. Calculate the percentage of HX in the original sample. (Assume law of conservation of volume is obeyed)

(A) 40% (B) 80%

(C) 65% (D) 78%

4. The half life of a radioactive substance is 20 minutes. The approximate time interval $(t_2 - t_1)$ between the time t_2 when 2/3 of it has decayed and t_1 when 1/3 of it has decayed is :

(A) 14 min (B) 20 min

(C) 28 min (D) 17 min

Rough Work

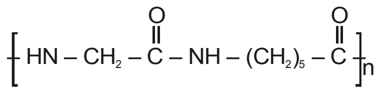
Multiple Correct Choice Type

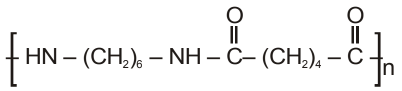
This section contains 5 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

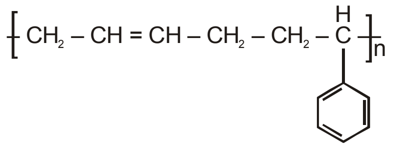
5. Find out which of the following statements are true :
(A) Bothe pH and POH decreases with rise in temperature for pure H_2O.
(B) pH decreases while POH increases with rise in temperature for pure H_2O.
(C) The pH scale shortens with increase in temperature.
(D) K_w increases with rise in temperature as dissociation of water is exothermic.

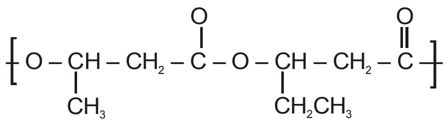
6. Which of the following statement(s) is(are) wrong ?
(A) Hg_2Cl_2 in soluble in cold H_2O.
(B) Hg_2Cl_2 dissolves in hot H_2O.
(C) Hg_2Cl_2 gives a white ppt with NH_4OH.
(D) Hg_2Cl_2 is used as a purgative.

7. Among the following, the heteropolymer is/are :

(A)

$\left[HN-CH_2-\overset{\overset{O}{\|}}{C}-NH-(CH_2)_5-\overset{\overset{O}{\|}}{C}\right]_n$

(B)

$\left[HN-(CH_2)_6-NH-\overset{\overset{O}{\|}}{C}-(CH_2)_4-\overset{\overset{O}{\|}}{C}\right]_n$

(C)


(D)

$\left[O-\underset{CH_3}{\underset{|}{CH}}-CH_2-\overset{\overset{O}{|}}{C}-O-\underset{CH_2CH_3}{\underset{|}{CH}}-CH_2-\overset{\overset{O}{\|}}{C}\right]$

8. The observed rate of a chemical reaction is substantially lower than the collision frequency. One or more of the following statements is/are true to account for this fact.
(A) the reactants do not have the required energy.
(B) the partners do not collide in the proper orientation.
(C) collision complex exists for a very short time.
(D) collision frequency overestimates the number of effective collisions.

9. 5 ml of 0.5 M K_2SO_4 is added to 10 ml of 1 M $BaCl_2$ solution. What will happen?
(A) Freezing point will increase
(B) Boiling point will increase
(C) Freezing point will decrease
(D) Boiling point will decrease

Rough Work

SECTION-B
(Matrix Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

---

1. Match the following and write the correct pairs.

	Column – I (Polymer)		Column – II
(A)	Terylene	(p)	Poly amide
(B)	Nylon-6,6	(q)	Addition polymer
(C)	Starch	(r)	Condensation polymer
(D)	Teflon	(s)	Polyester
		(t)	Natural polymer

2. Match the following and write the correct pairs.

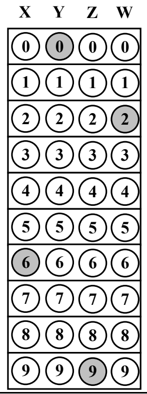
	Column – I		Column – II
(A)	H_3PO_3	(p)	Mono basic
(B)	H_3PO_4	(q)	Dibasic
(C)	$H_4P_2O_7$	(r)	Disproportionation
(D)	H_3PO_2	(s)	Oxidation state of P is +5
		(t)	sp^3 hybridization

Rough Work

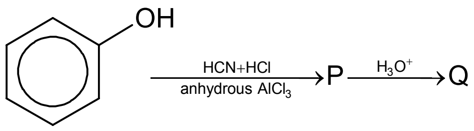
SECTION – C

Integer Answer Type

This section contains 8 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1.



Find the degree of unsaturation in P.

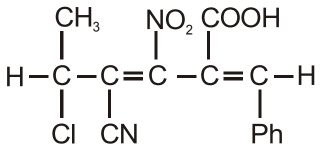
2. In the reaction $\underset{(CiS)}{[CoCl_2(NH_3)_4]^+} + Cl^- \rightarrow [CoCl_3(NH_3)_3] + NH_3$. How many isomers of the product (co-complex) is obtained.

3. One mole of Borax is dissolved in H_2O and the solution volume is made up to 2L. Calculate the minimum number of moles of NaOH required to neutralize the solution.

4. A compound AB has a rock salt structure with A : B = 1 : 1. The formula weight of AB is 6.023 Y amu. And the closest distance between A and B is $Y^{1/3}$ nm. The observed density of the lattice in kg/m³ is :

Rough Work

5.



$\mathrm{H-\underset{Cl}{\overset{CH_3}{C}}-\underset{CN}{C}=\overset{NO_2}{C}-\overset{COOH}{C}=\underset{Ph}{C}-H}$

Calculate the number of stereoisomer possible for the above compound.

6. A vessel fitted with a weightless, frictionless piston of 0.025 m², contains excess conc. Of HCl. The piston moved 1 m outward when 0.075 kg iron fillings were added at 300 K. The solution left behind was found to contain Fe(II). The approximate purity of the iron sample is x × 10. Find x ?

7. Number of B – O bonds in diborate ion $\left(B_2O_5\right)^{2-}$ is

8. Benzaldehyde, on reaction with aniline forms Schiff's base. The number of π bonds in Schiff's base is

Rough Work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains 4 multiple choice questions numbered 1 to 4. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Consider a point P(at^2, 2at) on the parabola $y^2 = 4ax$, A focal chord PS (S focus) is drawn to meet parabola again at Q. From Q, a normal is drawn to meet parabola again at R. From R, a tangent is drawn to the parabola to meet focal chord PSQ (extended) at T. The area of ΔQRT is

(A) $8a^2\left[t^2+\frac{1}{t^2}\right]^3$ (B) $a^2\left[t+\frac{1}{t}\right]^4$

(C) $\frac{8a^2}{3}\left[t+\frac{1}{t}\right]^3$ (D) $4a^2\left[t+\frac{1}{t}\right]^4$

2. Equation of plane which passes through the point of intersection of lines $\frac{x-1}{3}=\frac{y-2}{1}=\frac{z-3}{2}$ and $\frac{x-3}{1}=\frac{y-1}{2}=\frac{z-2}{3}$ and at greatest distance from the point (0, 0, 0) is

(A) $4x + 3y + 5z = 25$ (B) $4x + 3y + 5z = 50$

(C) $3x + 4y + 5z = 49$ (D) $x + 7y - 5z = 2$

3. If a > b > c and the system of equations $ax + by + cz = 0$, $bx + cy + az = 0$ and $cx + ay + bz = 0$ has a non–trivial solution, then the quadratic equation $ax^2 + bx + c = 0$ has

(A) at least one positive root (B) positive roots

(C) roots of opposite sight (D) image roots

4. Solution of the differential equation $\left(x\frac{dy}{dx}+y\right)=e^{xy-\ln x^2}\left(x\frac{dy}{dx}-y\right)$

(A) $\frac{y}{x}-e^{-xy}=c$ (B) $\frac{x}{y}+e^{-xy}=c$

(C) $\frac{y}{x}+e^{-xy}=c$ (D) $-\frac{x}{y}+e^{-xy}=c$

Rough work

Multiple Correct Choice Type

This section contains 5 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

5. All the three roots of $az^3 + bz^2 + cz + d = 0$ have negative real parts ($a, b, c, \in R$, $a \neq 0$) then
(A) $ab > 0$ (B) $bc > 0$
(C) $ad > 0$ (D) $a > 0$

6. If α and β^2 are the roots of $8x^2 - 10x + 3 = 0$ then the equation whose roots are $(\alpha + i\beta)^{100}$ and $(\alpha - i\beta)^{100}$ can be
(A) $x^2 + x + 1 = 0$ (B) $x^2 - x + 1 = 0$
(C) $x^3 - 1 = 0$ (D) $2x^2 + x + 1 = 0$

7. If function $f(x) = \begin{cases} |x-2| & ; \quad x \geq 1 \\ \dfrac{x^2}{5} - \dfrac{4x}{5} + \dfrac{8}{5} & ; \quad x < 1 \end{cases}$
(A) continuous at x = 1 (B) differentiable at x = 1
(C) not differentiable at x = 1 (D) differentiable at x = 2

8. Let $\vec{a}, \vec{b}, \vec{c}$ be three coplanar unit vectors such that $\vec{a} + \vec{b} + \vec{c} = \vec{0}$. If three vectors $\vec{p}, \vec{q}, \vec{r}$ parallel to $\vec{a}, \vec{b}, \vec{c}$ respectively and having integral but different magnitudes, then among the following options $|\vec{p} + \vec{q} + \vec{r}|$ can take a value equal to
(A) 1 (B) 0
(C) $\sqrt{3}$ (D) 2

9. Let 'z' be a complex number and 'a' be a real parameter such that $z^2 + az + a^2 = 0$, then
(A) locus of z is a pair of straight lines (B) locus of z is a circle
(C) $\arg(z) = \pm\dfrac{2\pi}{3}$ (D) $|z| = |a|$

Rough work

SECTION – B

(Matrix Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:
If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

---

1. Given pair of lines $2x^2 + 5xy + 2y^2 + 4x + 5y + a = 0$ and line $L \equiv bx + y + 5 = 0$

Column – I		Column – II	
(A)	If there exist 4 circles which touch pair of lines and the line L simultaneously then the value of b can be	(p)	$\frac{1}{2}$
(B)	If there exist 2 circles which touch pair of lines and the line L simultaneously then the value of b can be	(q)	2
(C)	If there exist no circle which touches pair of lines and the line L simultaneously then the value of b can be	(r)	5
(D)	If there exist infinite circles which touch pair of lines and the line L simultaneously then the value of b can not be	(s)	4
		(t)	1

2. Match the following column–I with column–II.

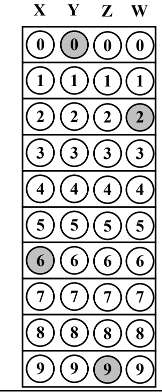
Column – I		Column – II	
(A)	Number of integral values of K such that all solutions (x, y) to the system of equation $x + 4y = 2K^2$ and $x + y = K$ are such that $x, y > 0$ is	(p)	0
(B)	Number of integers in the domain of function $g(x) = \ln(\cos^{-1} x)$ is	(q)	1
(C)	If $x > 0$; then the value of expression $\frac{(1+\sin^{-1}x)^{2010}(1+\cos^{-1}x)^{2011}(1+\tan^{-1}x)^{2012}}{(1+\operatorname{cosec}^{-1}x)^{2010}(1+\sec^{-1}x)^{2011}(1+\cot^{-1}x)^{2012}}$ is	(r)	2
(D)	If the function $f : R - \{-b\} \to R - \{1\}$ defined by $f(x) = \frac{x+a}{x+b}$, ($a \neq b$) is self inverse, then a + b can be	(s)	3
		(t)	4

Rough work

SECTION – C

Integer Answer Type

This section contains 8 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. If largest constant such that $\frac{Kabc}{a+b+c} \le (a+b)^2 + (a+b+4c)^2 \;\forall$ a, b, c > 0 is k then $\frac{K}{25}$ is equal to __________.

2. If y = f(x) satisfies f(x + 1) + f(z – 1) = f(x + z) $\forall$ x, z $\in$ R and f(0) = 0 and f′(0) = 4 then f(2) is equal to __________.

3. If $-\frac{\pi}{2} < \alpha_1 < \alpha_2 < \alpha_3 < \frac{\pi}{2}$, then number of values of $\theta \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$ satisfying $(\tan\theta - \tan\alpha_1)(\tan\theta - \tan\alpha_2)(\tan\theta - \tan\alpha_3) - \left(\sum(\tan\theta - \tan\alpha_i)\right)$ is __________.

4. A quadratic equation with integral coefficients has two prime numbers as its roots. If the sum of the coefficients of the equation is prime, then the sum of the roots is __________.

5. Let $I_1 = \int_0^1 \frac{e^x}{1+x}dx$ and $I_2 = \int_0^1 \frac{x^2}{e^{x^3}(2-x^3)}dx$. The $\frac{I_1}{I_2 e}$ is equal to __________.

6. In a right angled triangle ABC with C as a right angle, a perpendicular CD is drawn to AB. The radii of the circles inscribed into the triangles ACD and BCD are equal to 3 and 4 respectively. Then the radius of the circle inscribed into the ΔABC is __________.

7. If $f(x) + f\left(1 - \frac{1}{x}\right) = 1 + x \;\forall$ x $\in$ R – {0, 1}. The value of 4f(2) is equal to __________.

8. Given A = $\cos^2\theta(\cos^2\theta + 1) + 2\sin^2\theta$. Then for all θ, [A] can assume values whose sum is __________ (Where [.] denotes the greatest integer function).

Rough work

From Long Term Classroom Programs and Medium / Short Classroom Program 4 in Top 10, 10 in Top 20, 43 in Top 100, 75 in Top 200, 159 in Top 500 Ranks & 3542 total selections in IIT-JEE 2012

ALL INDIA TEST SERIES

FIITJEE JEE(Advanced)-2013

ANSWERS, HINTS & SOLUTIONS

FULL TEST –I

(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	B	C
2.	B	B	B
3.	D	B	A
4.	D	B	C
5.	A, D	A, C	A, C
6.	A, B, C, D	A, B, C	A, C
7.	B, C	A, B, D	A, C
8.	A, C	A, B, D	C, D
9.	A, B, C	B, C	A, C, D
1.	(A) → (p, q, r, s) (B) → (q, r) (C) → (q, r) (D) → (p, q, r, s)	(A) → (r, s) (B) → (p, r) (C) → (r, t) (D) → (q)	(A) → (s, t) (B) → (p, q) (C) → (r) (D)→ (p, q, r, s, t)
2.	(A) → (r) (B) → (p) (C) → (q) (D) → (s)	(A) → (q, r, t) (B) → (s, t) (C) → (s, t) (D) → (p, r, t)	(A) → (q) (B) → (r) (C) → (q) (D)→ (p, q, r, s, t)
1.	8	5	4
2.	4	2	8
3.	9	2	3
4.	5	5	5
5.	3	8	3
6.	1	8	5
7.	5	6	3
8.	8	7	3

Physics

PART – I

SECTION – A

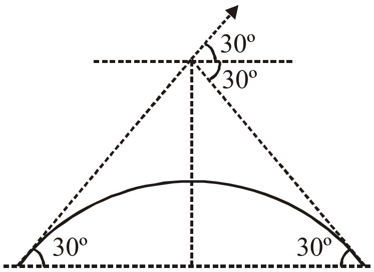
1. By conservation of momentum
$J = mV + 2\,mV$
$V = J/3m$.

2. $0 + 2 \times 1 + 3 \times 1 = V_B$
$\therefore\ V_B = 5$ volt

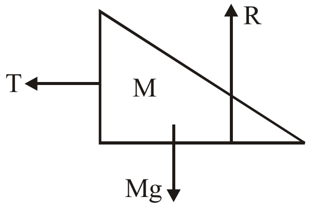
4. $S < \frac{1}{2}gt^2$
$\Rightarrow\ S < 2g$. (due to Lenz's Law).

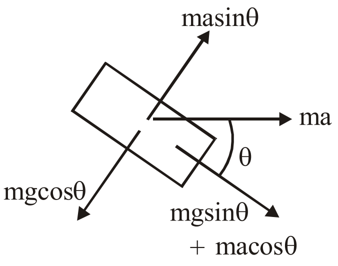
6. The molar heat capacity has the general definition
$$C = \frac{1}{n}\cdot\frac{\Delta Q}{\Delta T}$$
where n = number of moles, ΔQ = heat absorbed by the gas and ΔT = rise in temperature of gas. It is possible to obtain almost any set of values for ΔQ and ΔT by proper selection of a process.

7. $$T = \frac{2u\sin\theta}{g} = \frac{2\times 10\times\frac{1}{2}}{10} = 1 \text{ sec.}$$

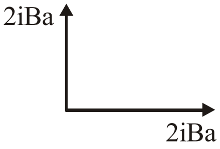


8. $$M'g - T = M'a \qquad \text{...(i)}$$
$$T = Ma \qquad \text{...(ii)}$$
$$M'g = a(M + M')$$
$$a = \frac{M'g}{(M+M')}$$
$$ma\sin\theta = mg\cos\theta$$
$$a = g\cot\theta$$
$$g\cot\theta = \frac{M'g}{(M+M')}$$
$$\cot\theta M + \cot\theta M' = M'$$
$$M' = \frac{M\cot\theta}{(1-\cot\theta)}$$
$$T = M\,a$$
$$= M.\,g\cot\theta$$
$$T = \frac{Mg}{\tan\theta}.$$





9. $F_R = 2\sqrt{2}\,iBa$.



SECTION –C

1. $P = \beta v^2$

$$\frac{mdv}{dt}.v = \beta v^2$$

$$\int_{v_0}^{2v_0} \frac{dv}{v} = \frac{\beta}{m}\int_0^t dt$$

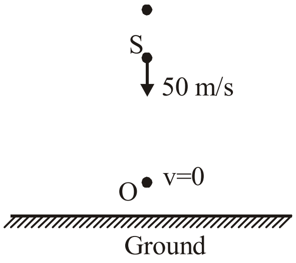
$$\ln 2 = \frac{\beta}{m}.t$$

$$t = \frac{m\ln 2}{\beta}$$

$$t = \frac{4\times 2}{0.693}\times 0.693$$

t = 8 seconds.

2. After 5 s, speed of detector = 50 – 10 × 5 = 0
and that of source = 0 + 10 × 5 = 50 m/s
and the source has fallen a distance $= \frac{1}{2}\times 10\times (5)^2 = 125\text{ m}$
and the detector has rises a distance $= 50\times 5 - \frac{1}{2}\times 10(5)^2 = 125\text{ m}$
So, $f' = 130\left(\frac{300-0}{300-50}\right)$ = 156 Hz.



3. $g = \frac{GM}{R^2}$

$$g' = \frac{G.2m}{4R^2}$$

$$g' = \frac{g}{2}$$

$$F = -mg'\sin\propto$$

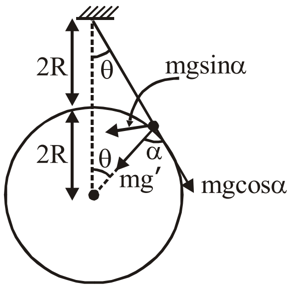
$$F = -\frac{mg}{2}.\sin 2\theta$$

As θ is much small

$$ma = -\frac{mg}{2}.2\theta$$

$$a = -g.\theta$$

$$a = -g.\frac{x}{2R}$$



$$\therefore \quad \omega = \sqrt{\frac{g}{2R}}\, f$$

$$T = 2\pi\sqrt{\frac{2R}{g}}$$

$$T = 2\times 3.14\sqrt{\frac{2\times 6400\times 10^3}{10}}$$

= 2 × 3 × 800 × 1.41

T = 6768 s.

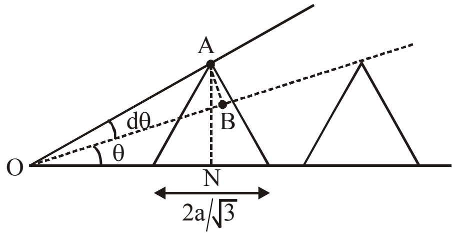
4. AB = v dt sin θ …(i)

(along the circular arc)

$$OA = \frac{AN}{\sin\theta}$$

ds = r dθ

given vdt sin θ = OA dθ



$$v dt \sin\theta = \frac{AN}{\sin\theta}.d\theta$$

$$v dt \sin\theta = \frac{a}{\sin\theta} d\theta$$

$$\frac{d\theta}{dt} = \frac{v}{a}\sin^2\theta$$

$$\frac{d\theta}{dt} = 5 \text{ rad/s.}$$

5. We have,

$10.2 = W + K_{max,\,1}$ …(i)

and $10.2\, Z^2 = W + K_{max,\,2}$ …(ii)

Also $\lambda_{de-Broglie} = \frac{h}{\rho} = \frac{h}{\sqrt{2mK}}$

$\therefore \quad \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{K_2}{K_1}} = 2.3 \quad \Rightarrow \quad K_2 = 5.25\, K_1$ …(iii)

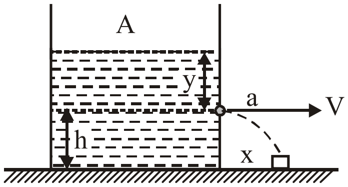
Also 10.2 Z^2 = energy corresponding to longest wavelength of the Lyman series = 3 × 13.6

⇒ Z = 2.

∴ From equations (i), (ii) and (iii)

W = 3 eV.

6. Velocity of efflux $v = \sqrt{2gy}$



Range $x = \sqrt{2gy}\times\sqrt{\frac{2h}{g}}$

The velocity of the block must be $\left(\frac{dx}{dt}\right)$.

$$\therefore \quad V_b = \frac{dx}{dt} = \sqrt{\frac{2h}{g}}\times\sqrt{2g}\times\frac{1}{2\sqrt{y}}\frac{dy}{dt}$$

$V_b = \frac{\sqrt{h}}{\sqrt{y}}.\frac{dy}{dt}$ …(i)

Using equation of continuity

$$\frac{Ady}{dt} = a\sqrt{2gy} \qquad \text{…(ii)}$$

equation (i) and (ii)

$$V_b = \sqrt{\frac{h}{y}} \times \frac{a}{A}\sqrt{2gy}$$

$$V_b = \sqrt{2gh} \times \frac{a}{A}$$

$$= 20 \times \frac{1}{20} = 1 \text{ ms}^{-1}.$$

7. If there were no hole

$$g_0 = \frac{GM}{R^2}$$

decrease in g due to hole (absent mass)

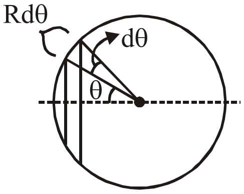
$$g_1 = \frac{GM/8}{\left(R/2\right)^2} = \frac{GM}{2R^2}$$

effective g = $g_0 - g_1$

$$= \frac{GM}{2R^2}$$

$$= 5.5 \text{ m/s}^2.$$

8. $$dq = \frac{q}{2\pi R}.Rd\theta = \frac{q}{2\pi}.d\theta$$



$$di = \frac{dq}{T} = \frac{qd\theta\omega}{2\pi 2\pi}$$

$$di = \frac{q\omega}{4\pi^2}.d\theta$$

$$dB = \frac{\mu_0 di(R\sin\theta)^2}{2R^3}$$

$$\int dB = \int_0^\pi \frac{\mu_0 \sin^2\theta}{2R}\left(\frac{q\omega}{4\pi^2}\right)d\theta$$

$$B = \frac{\mu_0 q\omega}{16\pi R}$$

$$\phi = B\pi a^2$$

$$\phi = \pi a^2.\frac{\mu_0 q\omega}{16\pi R}$$

$$\phi = \frac{\mu_0 q\omega a^2}{16R}$$

$$|\varepsilon| = \left|\frac{d\phi}{dt}\right|$$

$$|\varepsilon| = \frac{\mu_0 qa^2}{16R}\alpha .$$

$$= 8 \text{ volt}$$

$$i = \frac{8}{1} = 8 \text{ A}.$$

Chemistry

PART – II

SECTION – A

1. $W_{solute} = 3$ gms, $W_{solvent} = 50$ gm $= 75 - 25$

$$W_{OH^-} = \frac{3}{40} + \frac{x}{56}. \quad m = 5 = \frac{\left(3/40 + x/56\right)}{47} \times 1000$$

$X = 9$

2. Major product is formed via E_2.
H anti to halogen will be eliminated.

3. $n_{Hx} = n_{NaOH} = 0.25 \times V_{NaOH}$, $pH = pK_a = 5$ (acid buffer)

$$pH = 7 + \frac{1}{2}pK_a + \frac{1}{2}\log C = 9 \qquad \Rightarrow \log C = -1 \Rightarrow C = 10^{-1}$$

$$C = \frac{0.25V}{60 + V_{NaOH}} \Rightarrow V_{NaOH} = 40 \text{ ml}$$

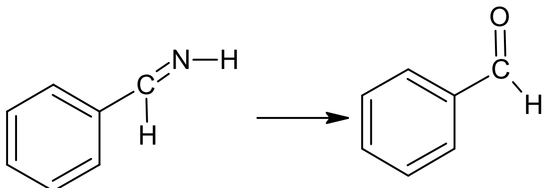
$n_{Hx} = 10$ mm $= 0.82$ gm

$$\% = \frac{0.82}{1.025} \times 100 = 80\%$$

4. Time required for equifractional change in a first order reaction is constant.

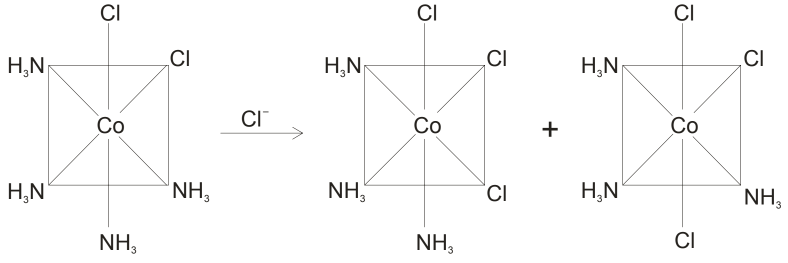
SECTION – C

1.



P Q

2.



(Fac) (Mer)

3.

$$\begin{array}{lllll} Na_2B_4O_7 & + \; H_2O & \rightarrow 2Na\left[B(OH)_4\right] & + \; 2H_3BO_3 \\ 1 \text{ mol} & & & 2 \text{ mol} \\ NaOH & + \; H_5BO_3 & \rightarrow \left[NaB(OH)_4\right] & \\ 2 \text{ mol} & 2 \text{ mol} & & \end{array}$$

4. $A = 2y^{1/3}$ nm. $M = 6.023 \times y \times 4$ amu

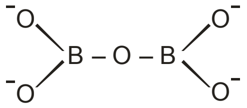
Density = m/a^3 $= \dfrac{6.023 \times 4 \times 1.66 \times 10^{-27}}{8y \times 10^{-27}}$ kg / m³

$$= \frac{40}{8} = 5 \text{ kg / m}^3$$

5. Two double bonds capable exhibiting geometrical and one chiral carbon molecule asymmetric.
$2^3 = 8$

6. $$w = \frac{Pvm}{RT} = 58.33 \text{ gm}$$

$$\% = \frac{58.33}{75} \times 100 = 77\%$$

7. 

Mathematics

PART – III

SECTION – A

1. PQ is a focal chord $Q\left(-\frac{1}{t}\right)=\left[\frac{a}{t^2},\ -\frac{2a}{t}\right]$

Normal drawn at P(t) meets the curve at Q $\left[-t,\ \frac{-2}{t}\right]$

$\therefore$ Normal drawn at $Q\left(-\frac{1}{t}\right)$ meets the parabola again at R $\left[2t+\frac{1}{t}\right]$

$R\left[a\left(2t+\frac{1}{t}\right)^2,\ 2a\left(2t+\frac{1}{t}\right)\right]$

Equation of tangent at R is $y\left(2t+\frac{1}{t}\right)=x+a\left[2t+\frac{1}{t}\right]^2$ ..... (1)

Equation of focal chord PQ is $(t^2-1)y=2t(x-a)$ ..... (2)

T is the point of intersection of line (1) and (2)

$\Rightarrow T\left[\frac{a}{3}\left(4t^2-\frac{1}{t^2}\right),\ \frac{2a}{3}\left(4t+\frac{1}{t}\right)\right]$

$\therefore$ Area of Δ TQR = $\frac{8a^2}{3}\left[t+\frac{1}{t}\right]^3$

2. Let a point (3λ + 1, λ + 2, 2λ + 3) of the first line also lies on the second line. Then

$\frac{3\lambda+1-3}{1}=\frac{\lambda+2-1}{2}=\frac{2\lambda+3-2}{3} \Rightarrow \lambda = 1$

Hence the point of intersection P of the two lines is (4, 3, 5). Equation of plane perpendicular to OP where OP is (0, 0, 0) and passing through P is 4x + 3y + 5z = 50

3. For non triangle solution $\Delta=\begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix}=0$

$\Rightarrow$ a + b + c = 0 $\Rightarrow$ '1' is a root of $ax^2 + bx + c = 0$

4. Clearly we have

$\frac{xdy+ydx}{e^{xy}}=\frac{xdy-ydx}{x^2}$

$\Rightarrow \int d(xy)e^{-xy}=\int d\left(\frac{y}{x}\right) \Rightarrow \frac{y}{x}+e^{-xy}=c$

5. Let the roots of $az^3 + bz^2 + cz + d = 0$, $z_1 = x_1$, z_2, $z_3 = x_2 \pm iy_2$

$\Rightarrow z_1 + z_2 + z_3 = -\frac{b}{a}$

$\Rightarrow$ ab > 0

Also $z_1 z_2 z_3 = x_1\left(x_2^2+y_2^2\right)=-\frac{d}{a}$

$\Rightarrow$ ad > 0

6. On solving we have $\alpha = \frac{1}{2}$ and $\beta^2 = \frac{3}{4} \Rightarrow \beta = \pm\frac{\sqrt{3}}{2}$

$\therefore$ New roots are ω and ω^2 which are roots of $x^3 - 1 = 0$ or $x^2 + x + 1 = 0$

7. Redefining the function, we get $f(x) = \begin{cases} \frac{x^2}{5} - \frac{4x}{5} + \frac{8}{5} & ; \quad x < 1 \\ 2 - x & ; \quad x \in [1,\ 2) \\ x - 2 & ; \quad x \geq 2 \end{cases}$

We have R.H.L at x = 1 is = $\lim_{h\to 0} 2 - (1+h) = 1$

L.H.L at x = 1 is = $\lim_{h\to 0} \frac{(1-h)^2}{5} - \frac{4(1-h)}{5} + \frac{8}{5} = 1$

$\therefore$ f(x) is continuous at x = 1

Now $f'(x) = \begin{cases} \frac{2x}{5} - \frac{4}{5} & ; \quad x < 1 \\ -1 & ; \quad 1 \leq x < 2 \\ 1 & ; \quad x \geq 2 \end{cases}$

R.H.D at x = 1 $\Rightarrow -1$

L.H.D at x = 1 $\Rightarrow -\frac{2}{5}$

$\therefore$ Not differentiable at x = 1

$\Rightarrow$ Not differentiable at x = 2

8. Let $\vec{a}$, $\vec{b}$, $\vec{c}$ lie in the xy plane

Let $\vec{a} = \hat{i}$, $\vec{b} = -\frac{1}{2}\hat{i} + \frac{\sqrt{3}}{2}\hat{j}$ and $\vec{c} = -\frac{1}{2}\hat{i} - \frac{\sqrt{3}}{2}\hat{j}$

$\therefore\ \left|\vec{p} + \vec{q} + \vec{r}\right| = \left|\lambda\vec{a} + \mu\vec{b} + \nu\vec{c}\right| = \left|\lambda\hat{i} + \mu\left(-\frac{1}{2}\hat{i} + \frac{\sqrt{3}}{2}\hat{j}\right) + \nu\left[-\frac{1}{2}\hat{i} - \frac{\sqrt{3}}{2}\hat{j}\right]\right|$

$= \sqrt{\left(\lambda - \frac{\mu}{2} - \frac{\nu}{2}\right)^2 + \frac{3}{4}(\mu - \nu)^2} = \sqrt{\lambda^2 + \mu^2 + \nu^2 - \lambda\mu - \lambda\nu - \mu\nu}$

$= \frac{1}{\sqrt{2}}\sqrt{(\lambda - \mu)^2 + (\mu - \nu)^2 + (\nu - \lambda)^2} \geq \frac{1}{\sqrt{2}}\sqrt{1 + 1 + 4} = \sqrt{3}$

$\therefore\ \left|\vec{p} + \vec{q} + \vec{r}\right|$ can take a value equal to $\sqrt{3}$ and 2.

9. $z^2 + az + a^2 = 0$

$\Rightarrow$ z = aω, aω^2 (where 'ω' is non real root of unity)

$\Rightarrow$ locus of z is a pair of straight lines and arg (z) = arg(a) + arg(ω) or arg(a) + arg(ω^2)

$\Rightarrow$ arg(z) = $\pm\frac{2\pi}{3}$ also, |z| = |a||ω| or |a| |ω^2| $\Rightarrow$ |z| = |a|.

SECTION – B

1. Clearly lines are $2x + y + 2 = 0$ and $x + 2y + 1 = 0$ and third line is $bx + y + 5 = 0$
For four circles three lines must not be concurrent $\Rightarrow b \neq 5$
For two circles exactly two lines should be parallel $\Rightarrow b = \frac{1}{2}$ and 2
For no circle three lines must be concurrent $\Rightarrow b = 5$
For infinite circles two lines must be identical $\Rightarrow b \in \phi$

2. (A) Solving $y = \frac{2K^2 - K}{3} > 0$ and $x = \frac{4K - 2K^2}{3} > 0 \Rightarrow K \in \left(\frac{1}{2}, 2\right)$
(B) Given $g(x) = \ln\left(\cos^{-1} x\right)$; As $0 \le \cos^{-1} x \le \pi \ \forall \ x \ [-1, 1]$
So domain of g(x) = [–1, 1]. Hence number of integers are two (i.e. –1 and 0)
(C) Clearly, domain of expression = {–1, 1}. As x > 0 given
So x = 1
Hence value of expression $\left(1 + \sin^{-1} x\right)^{2010} = 1$
(D) Here $f(x) = \frac{x + a}{x + b}$ ..... (1)
and $f^{-1}(x) = \frac{a - bx}{x - 1}$ ..... (2)
Given $f(x) = f^{-1}(x) \Rightarrow \frac{x + a}{x + b} = \frac{a - bx}{x - 1}$
$\Rightarrow (1 + b)x^2 + \left(b^2 - 1\right)x - x(1 + b) = 0 \ \forall \ x \in D_f$
Hence $b = -1$ and $a \in R$

SECTION – C

1. Using AM – GM inequality
$(a + b)^2 + (a + b + 4c)^2 = (a + b)^2 + (a + 2c + b + 2c)^2 \ge \left(2\sqrt{ab}\right)^2 + \left(2\sqrt{2ac} + 2\sqrt{2bc}\right)^2$
$= 4ab + 8ac + 8bc + 16c\sqrt{ab}$
$$\therefore \ \frac{(a + b)^2 + (a + b + 4c)^2}{abc}(a + b + c) \ge \frac{4ab + 8ac + 8bc + 16c\sqrt{ab}}{abc} \cdot (a + b + c)$$
$$= \left[\frac{4}{c} + \frac{8}{b} + \frac{8}{a} + \frac{16}{\sqrt{ab}}\right](a + b + c)\left[\frac{a}{2} + \frac{a}{2} + \frac{b}{2} + \frac{b}{2} + c\right] \ge 8 \times \left[5\sqrt[5]{\frac{1}{2a^2b^2c}}\right]\left(5\sqrt[5]{\frac{a^2b^2c}{2^4}}\right] = 100$$

2. Putting X = x + 1 and Z = z + 1
$\therefore f(X) + f(Z) = f(X + Z)$
$$\therefore \ f'(X) = \lim_{h \to 0} \frac{f(X + h) - f(X)}{h} = \lim_{h \to \infty} \frac{f(X) + f(h) - f(X)}{h} = \lim_{h \to 0} \frac{f(h) - f(0)}{h}$$
$= f'(0) = 4 \Rightarrow f'(X) = 4 \Rightarrow f(X) = 4X + c$
$\therefore f(x) = 4x \Rightarrow f(2) = 8$

3. Let $f(\theta) = \prod(\tan\theta - \tan\alpha_i) - \left(\sum\left(\tan\theta - \tan\alpha_i\right)\right)$
We have $f(\theta)_{\theta \to -\pi/2} \to -\infty$
Again $f\left(\alpha_1\right) > 0$, $f\left(\alpha_3\right) < 0$ and $f(\theta)_{\theta \to \pi/2} \to \infty$
$\Rightarrow$ There will be 3 such values of ‘θ’

4. Let the equation be $K(x - \alpha)(x - \beta) = 0$
$\therefore$ Sum of coefficient = $K(\alpha - 1)(\beta - 1)$ is prime
$\Rightarrow$ K is 1 and $\alpha - 1$ is 1
$\Rightarrow$ One root is 2 and $\beta - 1$ is 2
Hence roots are 2 and 3.

5. Let $t = x^3$ in I_2
We have $I_2 = \frac{1}{3}\int_0^1 \frac{1}{e^t(2-t)}dt = \frac{1}{3}\int_0^1 \frac{1}{e^{1-t}(1+t)}\,dt$
$\Rightarrow I_2 = \frac{1}{3e}\int_0^1 \frac{e^t}{(1+t)}dt = \frac{1}{3e}I_1 \Rightarrow \frac{I_1}{eI_2} = 3$

6. Let 3, 4 and r be radii of the circles inscribed into the Δ's ACD, BCD and ΔABC respectively, we get $\frac{r}{3} = \frac{AB}{AC} = \frac{c}{b} \Rightarrow b = \frac{3c}{r}$
Similarly ΔABC and ΔBCD are similar, we get $\frac{r}{4} = \frac{c}{a} \Rightarrow a = \frac{4c}{r}$
Now as $c^2 = a^2 + b^2$
$\Rightarrow c^2 = \frac{9c^2}{r^2} + \frac{16c^2}{r^2} \Rightarrow r = 5$

7. Putting x = 2, $\frac{1}{2}$ and – 1 successively
$f(2) + f\left(\frac{1}{2}\right) = 3$ ..... (1)
$f\left(\frac{1}{2}\right) + f(-1) = \frac{3}{2}$ ..... (2)
and $f(-1) + f(2) = 0$ ..... (3)
Solving, we get $f(2) = \frac{3}{4}$

8. On solving we have $A = \cos^4\theta + 1 - \cos^2\theta + 1$ = $\left(\cos^2\theta - \frac{1}{2}\right)^2 + \frac{7}{4} \Rightarrow A \in \left[\frac{7}{4}, 2\right]$

FIITJEE **JEE (Advanced), 2013**

From Long Term Classroom Programs and Medium / Short Classroom Program 4 in Top 10, 10 in Top 20, 43 in Top 100, 75 in Top 200, 159 in Top 500 Ranks & 3542 total selections in IIT-JEE 2012

ALL INDIA TEST SERIES

FULL TEST – II

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 252**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two section: **Section-A & Section-C**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) Section-A (01 – 08) contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 – 13) contains 5 multiple choice questions which have more than one correct answer. Each question carries **+3 marks** for correct answer. There is no negative marking.

Section-A (14 – 18) contains 2 paragraphs. Based upon paragraph, 2 and 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) Section-C (01 – 10) contains 10 Numerical based questions with answers as numerical value and each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

SECTION – A

Single Correct Choice Type

This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. A circuit has a self inductance of 1 henry and carries a current of 2A. To prevent sparking when the circuit is broken, a capacitor which can withstand 400 volts is used. The least capacitance of the capacitor connected across the switch must be equal to

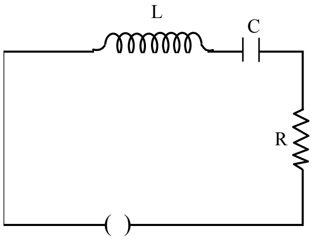
(A) 12.5 μF (B) 25 μF
(C) 50 μ F (D) 100 μF

2. A spherical conductor has a radius of R and charge Q. A spherical shell of thickness R and uniform charge Q, is kept so as to be concentric to the conductor and touching the conductor. The electric field at a distance of 1.5 R from the center of the sphere is

(A) $\frac{83Q}{504\pi\varepsilon_0 R^2}$ (B) $\frac{75Q}{504\pi\varepsilon_0 R^2}$
(C) $\frac{83Q}{252\pi\varepsilon_0 R^2}$ (D) $\frac{53Q}{252\pi\varepsilon_0 R^2}$

3. Figure shows a series LCR circuit connected to a variable frequency 200V source. L = 5H, C = 80 μF and R = 40 Ω. What is the source frequency which drives the circuit at resonance?

(A) 25 Hz (B) 25/π Hz
(C) 50 Hz (D) 50/π Hz

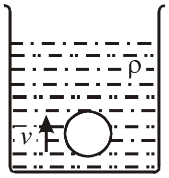


Rough work

4. A particle of mass m moves towards a smooth vertical wall with a speed u (relative to the ground) and collides elastically with the wall; the wall moving towards the particle with a speed 2u (also relative to the ground). Assuming that the wall is extremely massive, the impulse delivered to the particle equals

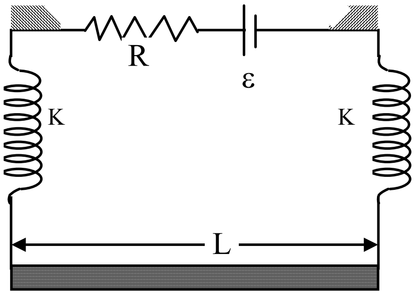
(A) 5 mu (B) 6 mu
(C) 4 mu (D) none of these.

5. An air bubble of radius r rises steadily through a liquid of density ρ at the rate of v. Neglecting density of air, the coefficient of viscosity of liquid is



(A) $\frac{2}{9}\frac{r^2\rho g}{v}$ (B) $\frac{1}{3}\frac{r^2\rho g}{v}$
(C) $\frac{1}{9}\frac{r^2\rho g}{v}$ (D) None of these

6. A perfectly conducting straight rigid rod of mass m and length L is suspended symmetrically from two identical perfectly conducting springs as shown in the figure. The springs stretch a distance of x_0 due to the weight of the wire. The circuit has a total resistance of RΩ. When the magnetic field perpendicular to the plane of the paper is switched on, springs are observed to extend further by the same distance. The magnetic field strength is

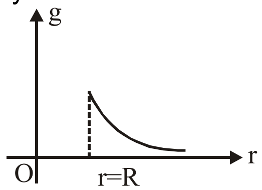


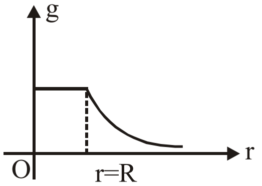
(A) $\frac{mgR}{\varepsilon L}$; directed outward from the plane of the paper
(B) $\frac{mgR}{2\varepsilon x_0}$; directed outward from the plane of the paper
(C) $\frac{mgR}{\varepsilon L}$; directed into the plane of the paper
(D) $\frac{mgR}{\varepsilon x_0}$; directed into the plane of the paper

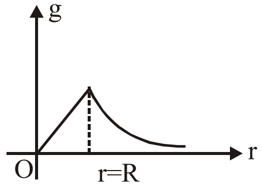
Rough work

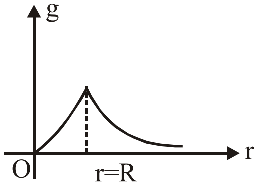
7. The dimension of ε_0E^2 (ε_o : permittivity of free space, E : electric field, J : dimension of energy) (Choose the most appropriate option)
(A) $J L^{-3}$
(B) $J L^{-1} T^{-2}$
(C) $ML^{-1}T^{-2}$
(D) (A) & (C)

8. The variation of gravitational intensity g for a uniform solid sphere of mass M and radius R is given by

(A)


(B)


(C)


(D)


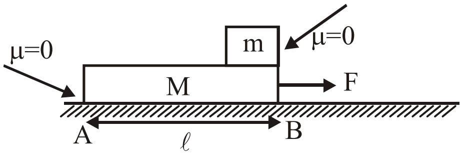
Multiple Correct Answer(s) Type

This section contains **5 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

9. A particle moves along positive branch of the curve $y = \frac{x}{2}$ where $x = \frac{t^3}{3}$, x and y are measured in metres and t in seconds, then
(A) the velocity of particle at t = 1 s is $\hat{i} + \frac{1}{2}\hat{j}$
(B) the velocity of particle at t = 1 s is $\frac{1}{2}\hat{i} + \hat{j}$
(C) the acceleration of particle at t = 1 s is $2\hat{i} + \hat{j}$
(D) the acceleration of particle at t = 2 s is $\hat{i} + 2\hat{j}$

Rough work

10. In the figure small block is kept on m then



(A) the acceleration of m w.r.t. ground is $\frac{F}{m}$

(B) the acceleration of m w.r.t. ground is zero

(C) the time taken by m to separate from M is $\sqrt{\frac{2\ell m}{F}}$

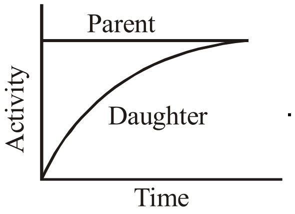
(D) the time taken by m to separate from M is $\sqrt{\frac{2\ell M}{F}}$

11. When a current–carrying coil is placed in a uniform magnetic field with its magnetic moment anti–parallel to the field.

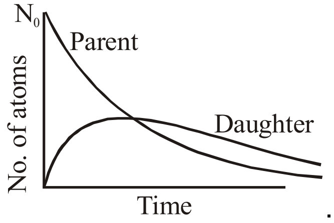
(A) Torque on it is maximum
(B) Torque on it is zero
(C) Potential energy is maximum
(D) Dipole is in unstable equilibrium.

12. A nucleus A decays into B with half life T_1 and B decays into C with half life T_2. Graph is drawn between number of atoms/activity versus time. Select the correct graph(s)

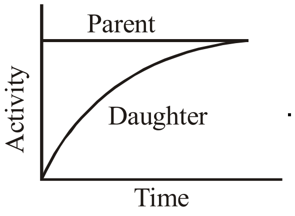
(A) When $T_1 >> T_2$



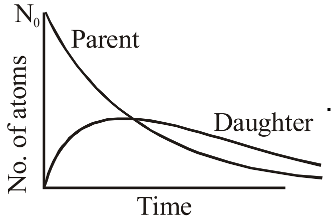
(B) When $T_1 >> T_2$



(C) When $T_1 < T_2$



(D) When $T_1 < T_2$



13. A lens of focal length ‘f’ is placed in between an object and screen at a distance ‘D’. The lens forms two real images of object on the screen for two of its different positions, a distance ‘x’ apart. The two real images have magnifications m_1 and m_2 respectively ($m_1 > m_2$). Then

(A) $f = \frac{x}{m_1 - m_2}$
(B) $m_1 m_2 = 1$
(C) $f = \frac{D^2 - x^2}{4D}$
(D) $D \geq 4f$.

Rough work

PARAGRAPH TYPE

This section contains **2 paragraphs.** Based upon the first paragraph 2 multiple choice questions and based upon the second paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices A), B), C) and D) out of **WHICH ONLY ONE IS CORRECT.**

Paragraph for Question Nos. 14 to 15

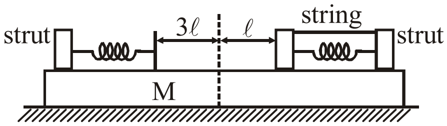
A coil having a resistance of 50.0Ω and an inductance of 0.5 H is connected to an AC source of 110 V, 50 Hz.

14. The impedance of the coil is (approximately)
    (A) 165Ω (B) 55Ω
    (C) 330Ω (D) none of these

15. The rms current in the circuit is
    (A) 1.5 A (B) 0.67 A
    (C) 1 A (D) 3 A

Rough work

Paragraph for Question Nos. 16 to 18



According to the principle of conservation of linear momentum if the external force acting on the system is zero, the linear momentum of the system will remain conserved. It means if the centre of mass of a system is initially at rest, it will remain at rest in the absence of external force, that is the displacement of centre of mass will be zero.

A plank of mass M is placed on a smooth horizontal surface. Two light identical springs each of stiffness K are rigidly connected to struts at the end of the plank as shown in the figure. When the springs are in their unextended position the distance between their free ends is 3ℓ. A block of mass m is placed on the plank and pressed against one of the springs so that it is compressed to ℓ. To keep the block at rest it is connected to the strut by means of a light string. Initially the system is at rest. Now the string is burnt.

16. The maximum displacement of plank is

(A) $\frac{5m\ell}{M}$ (B) $\frac{5m\ell}{M+m}$

(C) $\frac{3m\ell}{M+m}$ (D) $\frac{4m\ell}{M+m}$

17. Maximum velocity of plank is

(A) $\sqrt{\frac{Km}{(M+m)}}\ell$ (B) $\sqrt{\frac{m}{(M+m)}}\ell$

(C) $\sqrt{\frac{Km}{M(M+m)}}\ell$ (D) $\sqrt{\frac{Km}{(M+m)}}\ell$

18. Maximum kinetic energy of block m is

(A) $\frac{Km^2}{2M(M+m)}$ (B) $\frac{Km^2}{M(M+m)}$

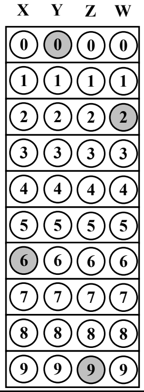
(C) $\frac{KM\ell^2}{2(M+m)}$ (D) none of these

Rough work

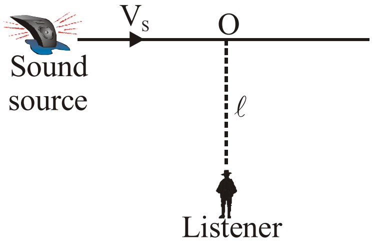
SECTION – C

Integer Answer Type

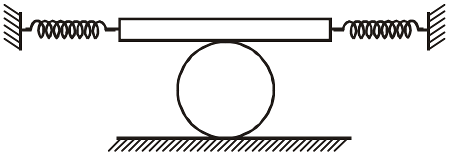
This section contains 10 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



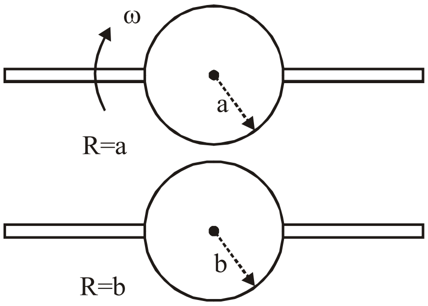
1. A source of sound with natural frequency F_0 moves uniformly along a line separated from a stationary listener by a distance $\ell = 42\sqrt{5}$ m. The velocity of source is equal to n = 0.5 fraction of velocity of sound. If the distance between source and listener at the moment when the listener receives actual frequency of the source is (21 × n) meter, find the value of n.



2. In the figure shown, mass of the plank is m and that of the solid cylinder is 8m. Springs are light. The plank is slightly displaced from equilibrium and then released. Find the period of small oscillations (in seconds) of the plank. There is no slipping at any contact point. The ratio of the mass of the plank and stiffness of the spring i.e. $\frac{m}{K} = \frac{2}{\pi^2}$.



3. Two uniform spheres shown in figure rotate separately on parallel axis. The upper sphere has angular speed ω_0 and lower sphere is at rest. Now the two spheres are moved together so that their surfaces touch. After a short time the two spheres now in contact are rotating without slipping. Find the final rate of rotation of upper sphere in rad/s. [given moment of inertia of upper sphere I_1 = 4 kg m^2, moment of inertia of lower sphere I_2 = 2 kg m^2, a = 2 m, b = 1 m, ω_0 = 12 rad/s].



Rough work

4 For an equilateral prism, it is observed that when a ray strikes grazingly at one face it emerges grazingly at the other. Find the refractive index of the prism

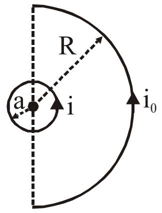
5. Consider a hydrogen like atom whose energy in n^{th} excited state is given by

$$E_n = -\frac{13.6}{n^2}Z^2$$

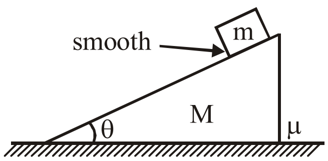
when this excited atom makes a transition from an excited state to ground state. The most energetic photons have energy $E_{max} = 52.224$ eV and the least energetic photons have energy $E_{min} = 1.224$ eV. Find the atomic number of atom.

6. A small current carrying loop having current i is placed in the plane of paper as shown. Another semicircular loop having current i_0 is placed concentrically in the same plane as that of small loop, the radius of semicircular loop is R (R >> a). Find the force applied by the smaller ring on bigger ring in newton.

(Given R = 1 m, $i = i_0 = \frac{40}{\sqrt{\mu_0}}$ A , a = 0.1 m)

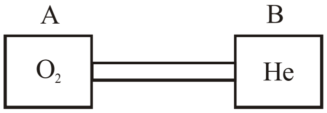


7. In figure if $\mu = 0.1$ is the coefficient of friction between the wedge and the horizontal surface then for what maximum value of m in kg, the wedge remains at rest [take M = 18 kg and $\theta = 45°$].



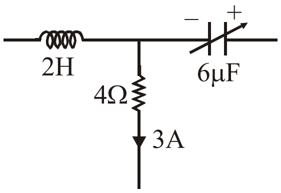
Rough work

8. Two containers A and B are connected by a conducting solid cylindrical rod of length $\frac{242}{7}$ cm and radius $\sqrt{8.3}$ cm. Thermal conductivity of the rod is 693 watt/mole–K. The container A contains two mole of oxygen gas and the container B contains four mole of helium gas. At time t = 0 temperature difference of the containers is 50ºC, after what time (in seconds) temperature difference between them will be 25ºC. Transfer of heat takes place through the rod only. Neglect radiation loss. Take R = 8.3 J/mole–K and $\pi = \frac{22}{7}$.



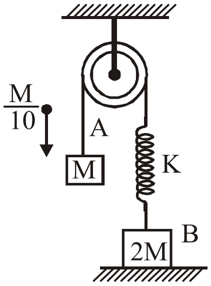
9. The figure shows part of a bigger circuit. The capacity of the capacitor is 6μF and decreasing at the constant rate 0.5 μF s^{-1}. The potential difference across the capacitor is changing as under

$$\frac{dV}{dt} = 2Vs^{-1},\ \frac{d^2V}{dt^2} = \frac{1}{2}V\,s^{-2}.$$



The current in the 4Ω resistor is decreasing at the rate of 1 μA s^{-1}. What is the potential difference (in micro volts) across the inductor at this moment ?

10. In the shown figure, a particle of mass $\frac{M}{10}$ strikes the block of mass M with velocity v_0 and gets attached to it. For what velocity v_0 (in ms^{-1}), the block B just able to leave the ground ?
(Given M = 100 gm, K = 880 N/m)



Rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains 8 multiple choice questions numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. $Ag\,|\,\underset{(1\,lit)}{Ag^{+}}(1\,M)\,||\,\underset{(1\,lit)}{Ag^{+}}(2\,M)\,|\,Ag$

0.5 F of electricity in anode and 1 F in the cathode is first passed making them independent electrolytic cell at 298 K. EMF of the cell after electrolysis will be:

(A) increased
(B) decreased
(C) no change
(D) time is also required to find it

2. For two gases A and B with molecular weights M_A and M_B. It is observed that at a certain temperature T, the average speed of A is equal to root mean square speed of B. Thus the average speed of A can be made equal to the average speed of B

State I : By keeping A at higher temperature than B.

State II : By keeping B at higher temperature.

State III : By keeping A at $\frac{8}{3\pi}$ times temperature of B.

Correct statement is/are:

(A) both State I and State II
(B) both State II and State III
(C) both State I and State III
(D) only State I

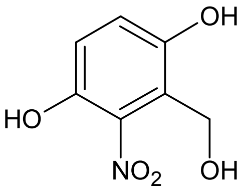
3. Consider the equilibrium:

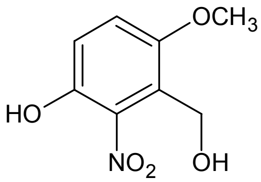
$2CO(g) + O_2 \rightleftharpoons 2CO_2(g) + \text{heat}$

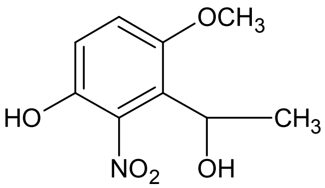
If O_2 is added and volume of the reaction vessel is increased, the equilibrium will

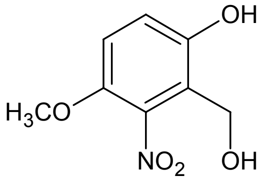
(A) shift in forward direction
(B) shift in backward direction
(C) remain unchanged
(D) be unpredictable

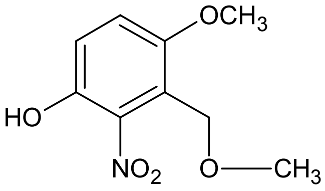
Rough Work

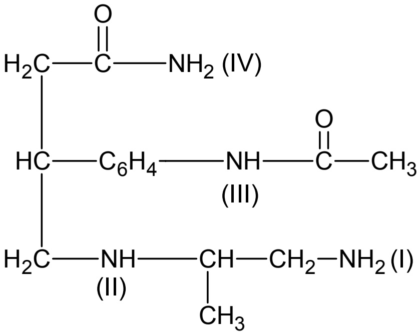
4.  $\xrightarrow[\text{(1 eq.)}]{CH_2N_2}$ A, A is :

(A) 

(B) 

(C) 

(D) 

5. 

Arrange the above mentioned nitrogen atoms of the compound in decreasing order of basic nature?

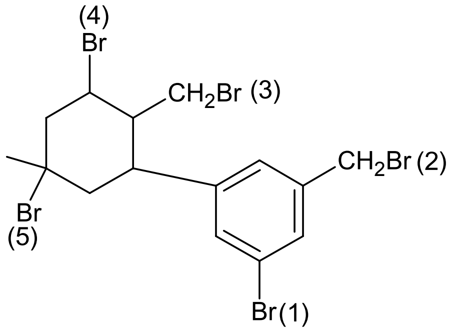
(A) I > II > IV > III
(B) II > I > IV > III
(C) II > I > III > IV
(D) I > IV > III > II

6. Which of the following compounds can form silicones on hydrolysis?

(A) $(CH_3)_2SiCl_2$
(B) $(SiH_3)_3N$
(C) $SiCl_4$
(D) All

Rough Work

7.



Arrange the above mentioned bromide atoms in decreasing order of their reactivity towards hydrolysis through S_N1 path

(A) 2 > 1 > 5 > 4 > 3 (B) 5 > 2 > 1 > 3 > 4

(C) 2 > 5 > 4 > 3 > 1 (D) 5 > 4 > 2 > 1 > 3

8. Gold number gives

(A) amount of gold in colloid

(B) weight in mg of colloid required to break gold sol.

(C) weight in mg of colloid to protect gold sol.

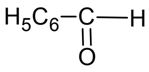
(D) amount of NaCl required to coagulate gold sol.

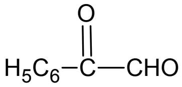
Rough Work

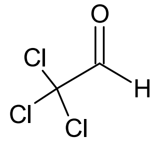
Multiple Correct Choice Type

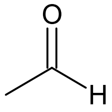
This section contains 5 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

9. Which of the following compounds will disproportionate on treating with conc. NaOH?

(A) 
$H_5C_6-C(=O)-H$

(B) 
$H_5C_6-C(=O)-CHO$

(C) 

(D) 

10. If electrolysis of 1 M $NiSO_4$ is carried with inert electrodes at pH = 7 at 25°C (the pressure of gases are taken 1 bar).

$E^o_{Ni^{2+}/Ni} = -0.25$ V $E^o_{H_2O/H_2} = -0.83$ V

The product of electrolysis at cathode and at anode (initially) are:

(A) Ni at cathode
(B) H_2 at cathode
(C) O_2 at anodes
(D) $S_2O_8^{2-}$ at anode

11. Which of the following is/are correct

(A) $[CrCl_2(CN)_2(NH_3)_2]$ and $[CrCl_3(NH_3)_3]$, both have d^2sp^3 hybridisation
(B) Magnetic moment of $[PdCl_4]^{2-}$ is zero
(C) $[Cu(NH_3)_4]^{2+}$, $[Pt(NH_3)_4]^{2+}$ and $[Ni(CN)_4]^{2-}$, all have dsp^2 hybridization of central metal
(D) It is difficult to substitute chelating ligands compared to similar monodentate ligands

12. Which of the following is/are correct?

(A) On strong heating $FeCl_3$ gives $FeCl_2$ and Cl_2
(B) Dilute $CuCl_2$ is blue due to formation of $\left[CuCl_4\right]^{2-}$
(C) PH_3 can be obtained by heating red P with NaOH
(D) PH_3, H_3PO_3 and H_3PO_2, all are reducing agents

13. $2X(g) + Y(g) + 3Z(g) \longrightarrow \text{Products}$

The rate equation of the above reaction is given by:

Rate = $K[X][Y]^o[Z]^2$

Choose correct statements:

(A) the rate of reaction becomes doubled by doubling the conc. of (X)
(B) rate of reaction decreases by reducing the conc. of (Y) to half of the original value
(C) the half life of (Z) increases by increasing its conc.
(D) if 75% of (X) undergoes reaction in 20 sec, 50% of (X) will react in 10 sec

Rough Work

PARAGRAPH TYPE

This section contains **2 paragraphs.** Based upon the first paragraph 2 multiple choice questions and based upon the second paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices A), B), C) and D) out of **WHICH ONLY ONE IS CORRECT.**

Paragraph for Question Nos. 14 to 15

There are 4 glass bottles containing water solutions. These bottles are not labeled. Bottles 1,2,3 Contained colourless solutions, while bottle 4 contained a blue solution. Each bottle is having any one solution among the following (Each bottle is having different solution).
Copper (III) sulphate
Sodium carbonates
Lead nitrate
Hydrochloric acid
By mixing samples of the contents of the bottles, in pairs, following observations are made:

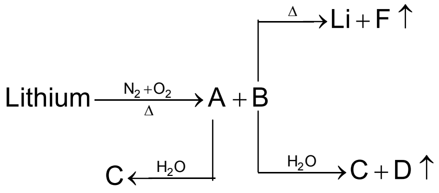
(1)	Bottle 1 + Bottle 2	White ppt.
(2)	Bottle 1 + Bottle 3	White ppt.
(3)	Bottle 1 + Bottle 2	White ppt.
(4)	Bottle 2 + Bottle 3	Colourless gas evolved
(5)	Bottle 2 + Bottle 4	No visible reaction
(6)	Bottle 3 + Bottle 4	Blue ppt.

14. Colourless solution present in Bottle 1 is :
(A) $CuSO_4$
(B) $Pb(NO_3)_2$
(C) HCl
(D) Na_2CO_3

15. Nature of gas evolved in observation (4) is:
(A) Acidic
(B) Neutral
(C) Basic
(D) Amphoteric

Rough Work

Paragraph for Question Nos. 16 to 18



Answer, the following questions:

16. Which of the following is compound (A)?

(A) Li_3N (B) Li_2O
(C) Li_2O_2 (D) LiO_2

17. The anion present in compound (C) is:

(A) O^{2-} (B) N^{3-}
(C) OH^- (D) NO_3^-

18. Which of the following is a property of gas F↑?

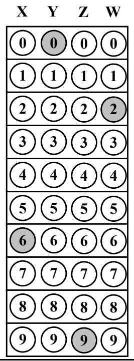
(A) It is paramagnetic in nature
(B) It's bond order is 3
(C) It does not contain lone pairs
(D) It contains two sigma and one pi bond per molecule

Rough Work

SECTION – C

Integer Answer Type

This section contains 10 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.

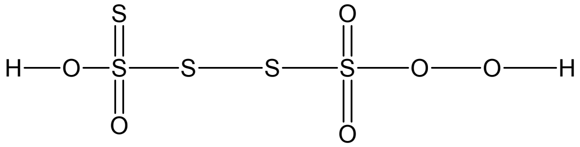


1. A compound (A) having molecular formula $C_7H_{11}Br$ is optically active. A reacts with HBr in the absence of peroxide to give isomeric products (B) and (C). Treating (A) with potassium-t-butoxide gives (D). (D) on reductive ozonolysis gives two moles of formaldehyde and one mole of 1, 3 cyclopentane dione. (A) in the presence of peroxide reacts with HBr to give (E). The total number of chiral carbon in one molecule of (E) is:

2. How many maximum number of e^- of an atom will have the following set of quantum numbers

$$n = 4, \ell = 0,1,2 \quad m = +2,-2, \qquad S = \pm\frac{1}{2}$$

3.



$$H{-}O{-}\underset{\underset{O}{\|}}{\overset{\overset{S}{\|}}{S}}{-}S{-}S{-}\underset{\underset{O}{\|}}{\overset{\overset{O}{\|}}{S}}{-}O{-}O{-}H$$

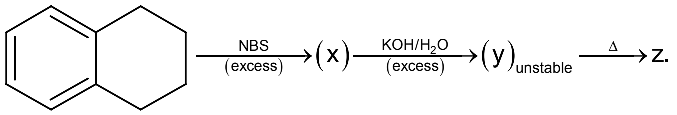
How many sp^3 hybridized atoms are present in one molecule of the above hypothetical compound?

4. A complex of potassium, iron and cyanide ions $K_x[Fe(CN)_y]$ is 100% ionized at 1 molal. If its elevation in boiling points is 2.08°C, find out the value of 'x' in the complex: (Given K_b = 0.52°C mol^{-1})

5. Phosphorus sulphide P_4S_3, a well known chemical used in match industry has how may P – S bonds?

Rough Work

6.


NBS
(excess)
(x)
KOH/H₂O
(excess)
(y)unstable
Δ
z.

The sp^2-hybridised carbon atoms present in one molecule of the end product z is:

7. Find 10 × $\log_{10}K$ for the reaction at 298 K.

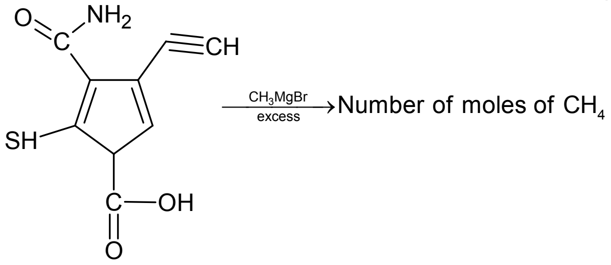
$$2H^+(aq) + D_2(g) \rightleftharpoons H_2(g) + 2D^+(aq)$$

Given $E^o_{D^+/D_2} = -2.955$ mv

Take $\left(\frac{RT2.303}{F}\right) = 0.0591$

8. Wavelength of the second line of Balmer series of a hydrogen like species is $\frac{4}{3R}$, what is the atomic number of the hydrogen like species? [R = Rydberg's constant)

9. What is the number of moles of CH_4 formed in the given reaction,


O
NH₂
C
CH
SH
C
OH
O
CH₃MgBr
excess
Number of moles of CH₄

10. No. of geometrical isomers for $[M(gly)Cl_2Br_2]^+$ is:

Rough Work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains 8 multiple choice questions numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. If k be a positive integer, then the number of values of k satisfying $\int_0^{\pi/2}\left[k^2\left(\cos 3x+\frac{1}{2}\cos x\right)+\sin x-2k\cos x\right]dx \le 1$, is

(A) 10 (B) 11

(C) 12 (D) none of these

2. If $I_1 = \int_{-100}^{101}\frac{dx}{(5+2x-2x^2)(1+e^{2-4x})}$ and $I_2 = \int_{-100}^{101}\frac{dx}{5+2x-2x^2}$, then $\frac{I_1}{I_2}$ is

(A) $\frac{1}{2}$ (B) 2

(C) 0 (D) none of these

3. If x f(x) = $3(f(x))^2+2$ then $\int\frac{2x^2-12xf(x)+f(x)}{(6f(x)-x)(x^2-(f(x)))^2}\,dx$ is equal to

(A) $\frac{1}{(6f(x)-x)^2}+c$ (B) $\frac{1}{x^2-f(x)}+c$

(C) $\frac{1}{x^2+xf(x)}+c$ (D) none of these

4. Let $f(x)=\lim_{h\to 0}\left(\frac{(\sin(x+h))^{\ln(x+h)}-(\sin x)^{\ln x}}{h}\right)$ then $f\left(\frac{\pi}{2}\right)$ is

(A) 0 (B) 1

(C) $\ln\left(\frac{\pi}{2}\right)$ (D) none of these

Rough work

5. Number of 4 digit number of the form N = $x_1\, x_2\, x_3\, x_4$ such that $2000 \le N \le 5000$, $4 \le x_2 < x_3 \le 8$ and N is multiple of 5 is/are

(A) 80 (B) 60
(C) 40 (D) 30

6. A biased coin is tossed repeatedly until a tail appears for the 1st time. The head is 2 times likely to appear as tail. The probability that the number of tosses required will be more than 6 given that in 1st three toss no tail has occured is/are

(A) $\frac{16}{81}$ (B) $\frac{32}{243}$
(C) $\frac{64}{729}$ (D) none of these

7. The product of all the even divisor of N = 9000 is

(A) 721×10^5 (B) 726×10^6
(C) 729×10^6 (D) none of these

8. Let the matrices $A = \begin{bmatrix} \sqrt{3} & -2 \\ 0 & 1 \end{bmatrix}$ and P be any orthogonal matrix such that Q = PAP′ and let $R = \left[r_{ij}\right]_{2\times2} = P'Q^8P$ then

(A) $r_{11} = 81$ (B) $r_{11} = 81\sqrt{3}$
(C) $r_{11} = 4\sqrt{3}$ (D) $r_{11} = -\sqrt{3}$

Multiple Correct Choice Type

This section contains 5 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

---

9. The radii of the escribed circle of ΔABC are r_1, r_2 and r_3 respectively (opposite to vertices A, B and C). If $r_1 + r_2 = 3R$ and $r_2 + r_3 = 2R$ then

(A) $\angle A = 90^\circ$ (B) $\angle B = 45^\circ$
(C) $\angle C = 60^\circ$ (D) right angle isoscelles triangle

Rough work

10. Let AB : y = x be a chord to the parabola $y^2 + 4x = 4$ and P be any variable point on the ellipse $x^2 + 9(y - 4)^2 - 9 = 0$. If Δ_1 and Δ_2 be the minimum and maximum area of triangle ABP respectively then

(A) $\Delta_2 = 2\sqrt{2}\left(4+\sqrt{10}\right)$
(B) $\Delta_2 - \Delta_1 = 8\sqrt{5}$
(C) $\frac{\Delta_2}{\Delta_1} = \frac{13+4\sqrt{10}}{3}$
(D) none of these

11. The all possible order pairs (a, b) that satisfy the relation

$(4-3i)a^2 + (3+2i)ab = 4b^2 - \frac{a^2}{2} + \left(3ab - 2b^2\right)i$ is/are

(A) (4, –3)
(B) (6, 9)
(C) (10, 15)
(D) none of these

12. Let $f(x) = \begin{cases} x+1 & , \quad 0 \le x \le 1 \\ 2x^2 - 6x + 6 & , \quad 1 \le x \le 2 \end{cases}$

And $g(t) = \int_{t-1}^{t} f(x)dx$, $t \in [1, 2]$. Which of the following is true statement

(A) f(x) is continuous and differentiable $\forall$ x $\in$ [0, 2]
(B) g(t) is maximum at t = $\frac{3}{2}$
(C) g(t) is minimum at t = 2
(D) all the above

13. A sq. matrix A of order 2 consisting element 0, 1, 2 and 4 then possible value of det(A) is/are

(A) 2
(B) 4
(C) 8
(D) none of these

Rough work

PARAGRAPH TYPE

This section contains **2 paragraphs.** Based upon the first paragraph 2 multiple choice questions and based upon the second paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices A), B), C) and D) out of **WHICH ONLY ONE IS CORRECT.**

Paragraph for Question Nos. 14 to 15

Read the following write up carefully and answer the following questions:

Let B_n denotes the event that n fair dice are rolled once with $P(B_n) = \frac{1}{2^n}$, $n \in N$. e.g. $P(B_1) = \frac{1}{2}$, $P(B_2) = \frac{1}{2^2}$, $P(B_3) = \frac{1}{2^3}$, ….. and $P(B_n) = \frac{1}{2^n}$. Hence B_1, B_2, B_3, ….. B_n are pairwise mutually exclusive and exhaustive events as $n \to \infty$. The event A occurs with atleast one of the event B_1, B_2, ….., B_n and denotes that the sum of the numbers appearing on the dice is S.

14. If even number of dice has been rolled, the probability that S = 4, is

(A) very closed to $\frac{1}{2}$	(B) very closed to $\frac{1}{4}$
(C) very closed to $\frac{1}{8}$	(D) very closed to $\frac{1}{16}$

15. Probability that greatest number on the dice is 4 if three dice are known to have been rolled, is

(A) $\frac{37}{216}$	(B) $\frac{64}{216}$
(C) $\frac{27}{216}$	(D) $\frac{31}{216}$

Rough work

Paragraph for Question Nos. 16 to 18

Read the following write up carefully and answer the following questions:
Tangents are drawn to the parabola $y^2 = 4x$ from the point P(6, 5) to touch the parabola at Q and R. C_1 is a circle which touches the parabola at Q and C_2 is a circle which touches the parabola at R. Both the circles C_1 and C_2 pass through the focus of the parabola.

16. Area of the ΔPQR equals
(A) 1/2 (B) 1
(C) 2 (D) 1/4

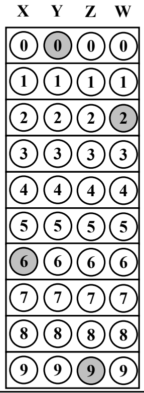
17. Radius of the circle C_2 is
(A) $5\sqrt{5}$ (B) $5\sqrt{10}$
(C) $10\sqrt{2}$ (D) $\sqrt{210}$

18. The common chord of the circles C_1 and C_2 passes through the
(A) incentre (B) circumcentre
(C) centroid (D) orthocentre of the ΔPQR

SECTION – C

Integer Answer Type

This section contains 10 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. If 3n be the sum of all possible integer values of ‘p’ for which $\left|x+\frac{1}{x}-3\right| = p-3$ has exactly two distinct solutions then the value of n is __________.

Rough work

2. For positive t, let α, β be the root of the quadratic equation $x^2 + t^2x - 2t = 0$. If minimum value of $\int_{-1}^{2}\left(\left(x+\frac{1}{\alpha^2}\right)\left(x+\frac{1}{\beta^2}+\frac{1}{\alpha\beta}\right)\right)dx$ is $\sqrt{p}+q$ where p is a rational number and $q \in N$, then the value of [p] + q is (where [.] denotes G.I.F)

3. A species has an initial population 4^{10}. At the end of the 1st day, the population increases by 50%. At the end of the 2nd day it decreases by the same percentage. If the process continues in the same pattern, and let 5x be the number of days required for population to be 3^{10}, then x is/are __________

4. The equation $2x^3 - 3x^2 + p = 0$ has 3 distinct real roots then [p] is __________. (Where [.] denotes the greatest integer function).

5. A plane P passes through the intersection of $\vec{r}\cdot\left(\hat{i}+\hat{j}+\hat{k}\right)+3=0$ and $\vec{r}\cdot\left(\hat{i}-\hat{j}+\hat{k}\right)=2$. If p divide the line segment joining (3, 0, 2) and (0, 3, –1) in the ratio 2 : 1 internally and the equation of plane is given by $\vec{r}\cdot\left(a\hat{i}-\hat{j}+b\hat{k}\right)=c$ when a, b, c $\in$ N than a + b + c is/are __________.

6. If the distance from (k, 0), k > 0 to the tangent to the parabola $y^2 = 4x$ at $\left(\frac{1}{4}, 1\right)$ is $2\sqrt{5}$ then the value of [k] is __________. (Where [.] denotes the greatest integer function)

7. Consider a polynomial P(x) of the least degree that has a maximum equal to 6 at x = 1, and a minimum equal to 2 at x = 3. Let P(2) + P'(0) is equal to n then $\left[\frac{n}{2}\right]$ is __________.

8. Let y = g(x) be the image of f(x) = x + sin x about the line x + y = 0. If the area bounded by y = g(x),
x-axis, x = 0 and x = 2π is A, then $\frac{A}{\pi^2}$ is __________.

9. If $I_n = \int_{0}^{\infty} e^{-x}(\sin x)^n dx$ (n > 1), then the value of $\frac{101\, I_{10}}{10\, I_8}$ is equal to __________.

10. If $|\vec{a}| = 2,\ |\vec{b}| = 3,$ and $|\vec{c}| = 4$ and maximum of $|\vec{a}-\vec{b}|^2+|\vec{b}-\vec{c}|^2+|\vec{c}-\vec{a}|^2$ = 10 p + q where
p, q $\in$ {0, 1, 2, 3, ….. 9} then |p – q| is ________

Rough work

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ANSWERS, HINTS & SOLUTIONS
FULL TEST – II
(PAPER-1)

ANSWERS KEY

	PHYSICS	CHEMISTRY	MATHEMATICS
Q. No.	ANSWER	ANSWER	ANSWER
1.	B	C	C
2.	B	B	A
3.	B	D	B
4.	B	C	A
5.	A	B	B
6.	A	A	D
7.	D	C	D
8.	C	C	A
9.	A, B	A, B	A, C
10.	B, D	A, C	A, B, C
11.	B, C, D	A, B, C, D	B, C
12.	A, D	A, D	B, C
13.	A, B, C, D	A, D	A, B, C
14.	A	B	D
15.	B	A	A
16.	B	B	A
17.	C	C	B
18.	C	B	C
1.	5	2	7
2.	4	4	4
3.	4	7	4
4.	2	3	0
5.	2	6	7
6.	8	8	4
7.	4	1	6
8.	3	2	2
9.	4	4	9
10.	1	4	1

Physics PART – I

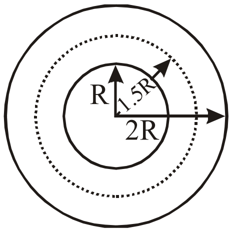
SECTION – A

1. $\varepsilon = L\frac{di}{dt}$

$400 = 1 \times \frac{2}{dt}$

$\Rightarrow$ dt = 5×10^{-3} sec.
Q = idt = $2 \times 5 \times 10^{-3}$
$\therefore$ Q = 10^{-2}
But Q = CV
10^{-2} = C × 400
$\therefore$ C = 25μF.

2. Total flux through this area is
= E.4π $(1.5R)^2$



$$\frac{q_{net}}{\varepsilon_0} = \frac{1}{\varepsilon_0}\left(Q + \frac{Q\left\{(1.5R)^2 - R^3\right\}}{\left\{(2R)^3 - R^3\right\}}\right)$$

$$= \frac{Q}{\varepsilon_0}\left(1 + \frac{19}{56}\right) = \frac{75Q}{56\varepsilon_0}$$

Gauss law E .4 π $(1.5R)^2$ = Q $(75/56\varepsilon_0)$

$$E = \frac{75Q}{504\pi\varepsilon_0 R^2}$$

3. $w_0 = \frac{1}{\sqrt{LC}} = \frac{1}{2\times10^{-2}}$

op, 2π f = 50

op, f = $\frac{25}{\pi}$Hz.

4. Use the definition of an elastic collision.

5. Buoyant force = Weight of liquid displaced = $\frac{4}{3}\pi r^2 \rho g$

Viscous force = Stoke's drag force = 6 πηrv

$\therefore$ $6\pi\eta rv = \frac{4}{3}\pi r^2\rho g$

6. $2(k2x_0) = mg + iBL$
$mg = 2kx_0$

$i = \frac{\varepsilon}{R}$

$\therefore$ $B = \frac{mgR}{\varepsilon L}$.

8. For a internal point

$g' = \frac{gr}{R}$

$\Rightarrow g' \propto r$
F as a external point
$g' = \frac{GM}{r^2} = g' \propto \frac{1}{r^2}$

9. $\frac{dx}{dt} = t^2$ …(i)

$y = \frac{1}{2}\frac{t^3}{3}$

$\frac{dy}{dt} = \frac{t^2}{2}$ …(ii)

t = 1, v_x = 1, v_y = $\frac{1}{2}$

$\vec{v} = \hat{i} + \frac{1}{2}\hat{j}$

$\frac{d^2x}{dt^2} = 2t$ …(iii)

$\frac{d^2y}{dt^2} = t$ …(iv)

at t = 1 s a_x = 2 and a_y = 1
$\therefore\ \vec{a} = 2\hat{i} + \hat{j}$

10. Acceleration of M, $a = \left(\frac{F}{M}\right)$

$\ell = \frac{1}{2}\frac{F}{M}.t^2$

$t = \sqrt{\frac{2M\ell}{F}}$.

11. $\vec{\tau} = \vec{M} \times \vec{B}$ and $U = -\vec{M}.\vec{B}$
here $\vec{M}$ and $\vec{B}$ are anti–parallel
$\therefore\ \vec{\tau} = \vec{O}$ and U = +MB (maximum)

13. v + u = D
and v – u = X
$\Rightarrow\ v = \frac{D+X}{2}, u = \frac{D-X}{2}$
and $f = \frac{D^2 - X^2}{4D}$
$m_1 = \frac{D+X}{D-X},\ m_2 = \frac{D-X}{D+X}$

14. - 15. The impedance is
$z = \sqrt{R^2 + \omega^2 L^2}$ and the rms
current is $i_{rms} = \frac{V_{rms}}{z}$.

16. Since the center of mass will remain at rest.

$$m(5\ell - x) = M.x$$

$$x = \frac{5m\ell}{(M+m)}.$$

17. $Mv_M - mv_m = 0$ …(i)

$\frac{1}{2}K\ell^2 = \frac{1}{2}Mv_M{}^2 + \frac{1}{2}mv_m^2$ …(ii)

Solving (i) and (ii)

$$v_M = \sqrt{\frac{Km}{M(M+m)}}\ell.$$

18. $$v_m = \frac{M}{m}\sqrt{\frac{Km}{M(M+m)}}\ell$$

$$= \sqrt{\frac{KM}{m(M+m)}}\ell$$

$$KE = \frac{1}{2}mv_m^2$$

SECTION – C

1. Let, $V_0 \rightarrow$ velocity of sound

when source is O at the velocity component of source towards listener is V_S cos 90 = 0

$$\therefore \quad F' = F_0\left(\frac{V_0}{V_0 - V_S\cos 90}\right) = F_S$$

time taken by sound to reach listener $= \frac{\ell}{V_0}$.

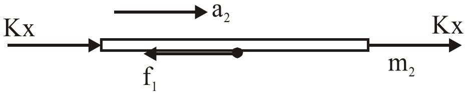
Distance moved by source in this time

$$= \left(\frac{\ell}{V_0}\right)V_S$$

$\therefore$ Distance between source and listener

$$= \sqrt{\ell^2 + n^2\ell^2} = \ell\sqrt{1+n^2}$$

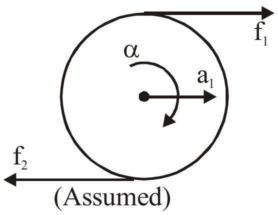
= 105 m. 2. If the plank is displaced slightly by x towards left, then



2 Kx – f_1 = m a_2 …(i)

$f_1 - f_2$ = 8 m a_1 …(ii)

$\tau_{cm} = I_{cm}\,\alpha$



or $\left(f_1 + f_2\right)R = \frac{(8m)R^2}{2}\alpha$

$(f_1 + f_2) = \frac{(8m)a_1}{2}$ …(iii)

From (ii) and (iii),

$$2f_1 = (8m)\times\frac{3a_1}{2}$$

or $f_1 = (8m)\times\frac{3a_1}{4}$

and $f_2 = 2\ ma_1$.
Hence, f_2 will be in forward direction.
Also, for no slipping, at the point of contact between plank and cylinder.

$$2a_1 = a_2 \qquad \ldots(iv)$$

$$f_1 = (8m)\times\left(\frac{3a_2}{8}\right) = (3m)a_2 \qquad \ldots(v)$$

from (i) and (v),

$$2Kx - (3m)\ a_2 = m\ a_2$$

$$a_2 = \frac{2K}{4m}x$$

or $\left(\frac{-d^2x}{dt^2}\right) = \left(\frac{2K}{4m}\right)x$

or $\frac{d^2x}{dt^2} = -\left(\frac{2}{4}\times\frac{\pi^2}{2}\right)x$

or $\omega^2 = \frac{\pi^2}{4}$

or $\omega = \frac{\pi}{2}$

or $\frac{2\pi}{T} = \frac{\pi}{2}$

or $T = 4$ seconds.

3. When the two disc come in contact, they exert equal and opposite forces.

$$\int Fadt = I_1(\omega_0 - \omega_1) \qquad \ldots(i)$$

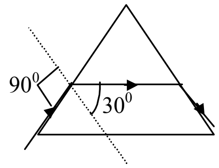
$$\int Fbdt = I_2\omega_2 \qquad \ldots(ii)$$

finally $\omega_1 a = \omega_2 b$

$$I_1(\omega_0 - \omega_1) = I_2\frac{a^2}{b^2}.\omega_1$$

$$\omega_1 = \frac{I_1\omega_0}{I_1 + \frac{a^2}{b^2}I_2} = 4\ \text{rad/s}.$$

4 $\mu = \frac{\sin 90^0}{\sin 30^0} = 2$



5. Max^n energy is liberated for transition

$$E_n \rightarrow E_1$$

and minimum energy for $E_n \rightarrow E_{n-1}$
Hence,

$$\frac{E_1}{n^2} - \frac{E_1}{12} = 52.224\,\text{eV}$$

and $\frac{E_1}{n^2} - \frac{E_1}{(n-1)^2} = 1.224\ \text{eV}$

Solving we get,

$E_1 = -54.4$ eV

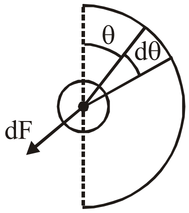
and $n = 5$

hence,

$$E_1 = -\frac{13.6Z^2}{12} = -54.4$$

$Z = 2$.

6. Magnetic field due to small ring at distance R from the centre $B = \frac{\mu_0}{4\pi}\frac{M}{R^3}$



where $M = i\,\pi\, a^2$

$$\therefore\quad B = \frac{\mu_0}{4\pi}\frac{i\pi a^2}{R^3} = \frac{\mu_0 i a^2}{4R^3}$$

$$dF = i_0 R d\theta \frac{\mu_0 i a^2}{4R^3}$$

$dF_x = dF\sin\theta$

$$= \frac{\mu_0 i.i_0 a^2 \sin\theta d\theta}{4R^2}$$

$$F_x = \frac{\mu_0 i\, i_0 a^2}{4R^2}\int_0^{\pi}\sin\theta\, d\theta$$

$$F_x = \frac{\mu_0 i\, i_0 a^2}{4R^2}\times 2$$

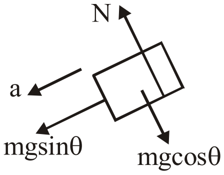
$$F_x = \frac{\mu_0 i\, i_0 a^2}{2R^2}$$

$F_y = 0$

$$\therefore\quad F_{net} = F_x = \frac{\mu_0 i\, i_0 a^2}{2R^2}$$

= 8 Newton.

7. F.B.D of m

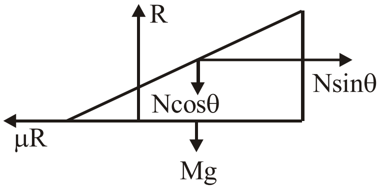


$N = mg\cos\theta$ ….(i)

$mg\sin\theta = ma$

$a = g\sin\theta$

F.B.D. of M



$R = N\cos\theta + Mg$

$\mu R = N\sin\theta$

$\mu.(N\cos\theta + Mg) = N\sin\theta$

$\mu Mg = N[\sin\theta - \mu\cos\theta]$

$\mu Mg = mg\cos\theta[\sin\theta - \mu\cos\theta]$

$$m = \frac{\mu M}{\cos\theta[\sin\theta - \mu\cos\theta]}$$

m = 4 kg.

8. Thermal resistance of the rod,

$$R = \frac{\ell}{kA}$$

When heat is transferred from first vessel to second, temperature of first vessel decreases while that of second vessel increases. Due to both there reasons, difference between temperature of vessels decreases.

Let at an instant t, the temperature difference between two vessels be θ.

$$H = \frac{\theta}{R} = \frac{KA\theta}{\ell}$$

$$dQ = Hdt = \frac{KA\theta}{\ell}dt \qquad \ldots(i)$$

Since gases are contained in two vessels, therefore, processes on gases in two vessels are isochoric.

Hence, decrease in temperature of gas in first vessel,

$$\Delta\theta_1 = \frac{dQ}{nC_V} = \frac{dQ}{2\times\frac{5R}{2}} = \frac{dQ}{5R}$$

Increase in temperature of gas in second vessel is

$$\Delta\theta_2 = \frac{dQ}{4\times\frac{3R}{2}} = \frac{dQ}{6R}$$

$\therefore$ Decrease in temperature difference $(-d\theta) = \Delta\theta_1 + \Delta\theta_2$

$$-d\theta = \frac{dQ}{R}\times\frac{11}{30}$$

or, $-d\theta = \frac{KA\theta\times 11}{30R\ell}dt$

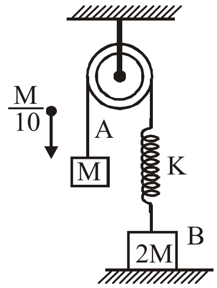
or $-\int_{50}^{25}\frac{d\theta}{\theta} = \frac{KA\times 11}{30\ell R}\int_0^t dt$

or, $\ell n2 = \frac{KA\times 11}{30\ell R}t$

or $t = \frac{.693\times 30\times 242\times 10^{-2}\times 8.3\times 7}{693\times 7\times 22\times 8.3\times 10^{-4}\times 11}$ = 3 seconds.

9. $V_L = \left|\left(\frac{di_R}{dt} - \frac{d^2q}{dt^2}\right)\right| = L\left|\frac{d}{dt}i_R - \left(C\frac{d^2V}{dt^2} + \frac{2dC}{dt}\frac{dV}{dt}\right)\right|$ = 4 μV.

10. From C.L.M.



$$\frac{M}{10}v_0 = \frac{11}{10}Mv \Rightarrow v = \frac{v_0}{11} \qquad \ldots(i)$$

For block B to leave ground

$K(x_0 + x) = 2\,Mg$ (where $x_0 = \frac{Mg}{K}$)

$$\therefore\ x = \frac{Mg}{K} \qquad \ldots(ii)$$

From COE

$$\frac{11}{10}Mgx - \left[\frac{1}{2}K(x_0+x)^2 - \frac{1}{2}Kx_0^2\right] = 0 - \frac{1}{2}\frac{11}{10}Mv^2$$

solving $v_0 = g\sqrt{\frac{88M}{K}}$

putting the value

$v_0 = 1\ ms^{-1}$.

Chemistry PART – II

SECTION – A

1. $E_{cell} = 0 - \frac{0.0591}{1}\log\frac{1}{2}$

After electrolysis $E_{cell} = 0 - \frac{0.0591}{1}\log\frac{(1-0.5)}{(2-1)}$

No change.

2. $\sqrt{\frac{8RT}{\pi M_A}} = \sqrt{\frac{3RT}{M_B}} \Rightarrow \frac{8}{\pi M_A} = \frac{3}{M_B}$

10. $H^+ + e^- \longrightarrow \frac{1}{2}H_2 \qquad E^o = 0.0V$

$E = E_{H^+/H_2} = -\frac{0.059}{1}\log\frac{1}{\left[H^+\right]}$

= - 0.059 × 7 = - 0.413

So, $E_{H^+/H_2} < E_{Ni^{2+}/Ni}$

Ni will deposit at cathode

At anode cell reaction

$4OH^- \longrightarrow 2H_2O + O_2 + 4e$

11. Both complexes have $Cr^{+3}(d^3)$, and coordination number is 6. Hence d^2sp^3

$Pd^{+2}(d^8)$ complexes with coordination number → 4 are square plannar and magnetic moment is zero.

12. $FeCl_3 \xrightarrow{\Delta} FeCl_2 + Cl_2$

Dilute $CuCl_2$ is blue due to $\left[Cu(H_2O)_4\right]^{2+}$. PH_3 is obtained be heating white P with NaOH.

All are reducing because of weak P – H bond.

15. Bottles 1,2,3,4 have $Pb(NO_3)_2$, HCl, Na_2CO_3 and $CuSO_4$

When mixing

Bottle 1 + Bottle 2 → $PbSO_4$

Bottle 1 + Bottle 3 → $PbCO_3$

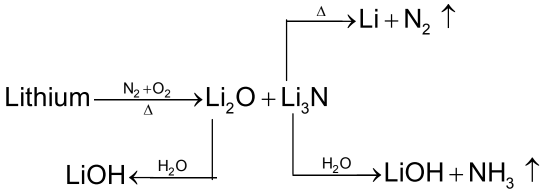
Bottle 1 + Bottle 4 → $PbSO_4$

Bottle 2 + Bottle 3 → CO_2

Bottle 2 + Bottle 4 → No visible reaction

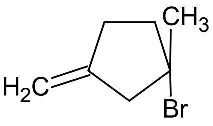
Bottle 3 + Bottle 4 → $CuCO_3$

18.

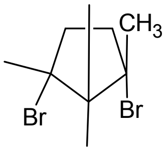


SECTION – C

1. A =

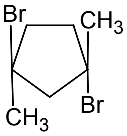


B =

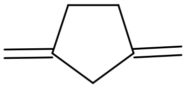


Inactive

C =


Br
CH3
CH3
Br

D =



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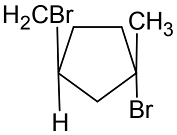
E =


H2CBr
CH3
H
Br

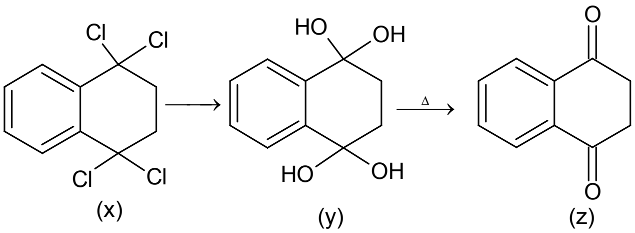
4. $\Delta T_b = K_b \times m \times i$

$2.08 = 0.52 \times 1 \times i$

$i = 4$

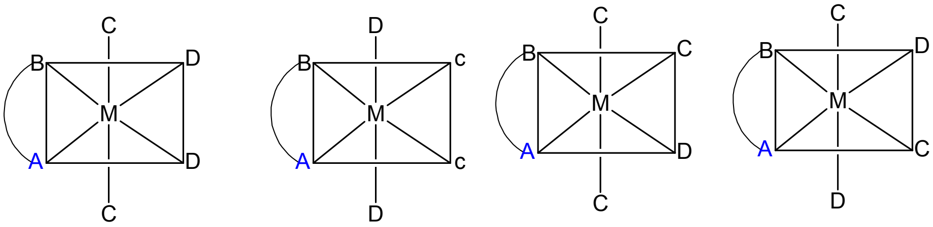
$K_3\left[Fe^{III}(CN)_6\right]$

6.


Cl
Cl
Cl
Cl
(x)
HO
OH
HO
OH
(y)
Δ
O
O
(z)

7. logK = 0.1

10. Glycinate is asymmetric bidentate ligand. AB type, so for $M(AB)C_2D_2$:


C
B
D
M
A
D
C
D
B
c
M
A
c
D
C
B
C
M
A
D
C
C
B
D
M
A
C
D

Mathematics

PART – III

SECTION – A

1. $$\left[k^2\left(\frac{\sin 3x}{3}+\frac{1}{2}\sin x\right)-\cos x-2k\sin x\right]_0^{\pi/2}\le 1$$

$$\left\{k^2\left(\frac{-1}{3}+\frac{1}{2}\right)-0-2k\right\}-\{-1\}\le 1$$

$$\frac{k^2}{6}-2k+1\le 1$$

$k\,(k - 12) \le 0$

$0 \le k \le 12$

$k = 1, 2, 3, 4, \ldots, 12.$

2. $$I_1 = \int_{-100}^{101}\frac{dx}{(5+2x-2x^2)(1+e^{2-4x})} = \int_{-100}^{101}\frac{dx}{\left(5+2(1-x)-2(1-x)^2\right)\left(1+e^{2-4(1-x)}\right)}$$

$$= 2I_1 = \int_{-100}^{101}\frac{dx}{5+2x-2x^2} = I_2$$

$$\Rightarrow \frac{I_1}{I_2} = \frac{1}{2}.$$

3. $$I=\int\frac{2x\left(x-6f(x)\right)+f(x)}{\left(6f(x)-x\right)\left(x^2-f(x)\right)^2}\,dx$$

$$I=-\int\frac{2x}{\left(x^2-f(x)\right)^2}\,dx+\int\frac{f(x)}{\left(6f(x)-x\right)\left(x^2-f(x)\right)^2}\,dx = \int\left(\frac{f'(x)-2x}{\left(x^2-f(x)\right)^2}\right)dx=\frac{1}{x^2-f(x)}+c$$

4. Let $g(x)=(\sin x)^{\ln x} \Rightarrow g'(x)=\lim\limits_{h\to 0}\left(\frac{\left(\sin(x+h)\right)^{\ln(x+h)}-(\sin x)^{\ln x}}{h}\right)$

$$\Rightarrow f(x)=g'(x)=g(x)\left(\frac{\ln(\sin x)}{x}+\cot x\ln x\right) \Rightarrow f\left(\frac{\pi}{2}\right)=g'\left(\frac{\pi}{2}\right)=0$$

5. $n(x_1) = 3$, $x_1 = 2, 3, 4$.

$4 \le x_2 < x_3 \le 8 \Rightarrow$ from 4, 5, 6, 7, 8

Selecting any 2 $\Rightarrow n(x_2, x_3) = {}^5C_2 = 10$ and $n(x_4) = 2$

$x_4 = 0, 5$

$\Rightarrow$ Number of such 4 digit numbers $3 \times 10 \times 2 = 60$

6. Let X denotes the number of toss required.

$$P(X\ge 4)=\left(\frac{2}{3}\right)^3\cdot\frac{1}{3}+\left(\frac{2}{3}\right)^4\cdot\frac{1}{3}+\left(\frac{2}{3}\right)^5\cdot\frac{1}{3}+\ \ldots\ldots\ \infty\ =\frac{\left(\frac{2}{3}\right)^3\cdot\frac{1}{3}}{1-\frac{2}{3}}=\frac{8}{27}$$

$$P(X \ge 7) = \left(\frac{2}{3}\right)^6 \cdot \frac{1}{3} + \left(\frac{2}{3}\right)^7 \cdot \frac{1}{3} + \text{.....} \infty = \left(\frac{\left(\frac{2}{3}\right)^6 \cdot \frac{1}{3}}{1-\frac{2}{3}}\right) = \left(\frac{2}{3}\right)^6$$

$$\text{Required probability} = \frac{\left(\frac{2}{3}\right)^6}{\left(\frac{2}{3}\right)^3} = \frac{8}{27}$$

8. $R = P'Q^8P = A^8$

$$A^2 = \begin{bmatrix} \sqrt{3} & -2 \\ 0 & 1 \end{bmatrix}\begin{bmatrix} \sqrt{3} & -2 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 3 & -2\sqrt{3}-2 \\ 0 & 1 \end{bmatrix}$$

$$A^3 = \begin{bmatrix} \sqrt{3} & -2 \\ 0 & 1 \end{bmatrix}\begin{bmatrix} 3 & -2\sqrt{3}-2 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} (\sqrt{3})^3 & -2(3)-2\sqrt{3}-2 \\ 0 & 1 \end{bmatrix}$$

$\Rightarrow$ If $[\lambda_{ij}]_{2\times2} = A^k$ then $\lambda_{11} = (\sqrt{3})^k \Rightarrow r_{11} = (\sqrt{3})^8 = 81$

9. $r_1 + r_2 = 3R \Rightarrow \left(\frac{\Delta}{s-a}\right) + \left(\frac{\Delta}{s-b}\right) = 3\left(\frac{abc}{4\Delta}\right)$

$\Rightarrow \frac{\Delta^2}{(s-a)(s-b)} = \frac{3ab}{4} \Rightarrow 4s(s-c) = 3ab$

$\Rightarrow \cos c = \frac{1}{2} \Rightarrow \angle c = 60^\circ$

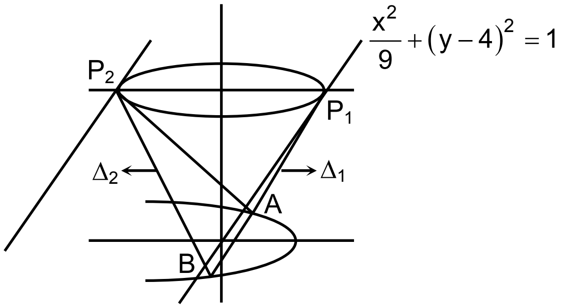
Also $r_2 + r_3 = 2R$

$\Rightarrow \left(\frac{\Delta}{s-b}\right) + \left(\frac{\Delta}{s-c}\right) = \frac{2abc}{4\Delta}$

$\Rightarrow 2s(s-a) = bc \Rightarrow \angle A = \frac{\pi}{2}$ and $\angle B = \frac{\pi}{6}$

10. $\Rightarrow \Delta_1 = 2\sqrt{2}(4-\sqrt{10})$

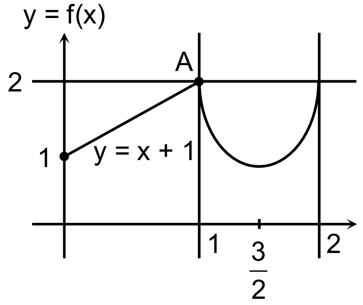
and $\Delta_2 = 2\sqrt{2}(4+\sqrt{10})$

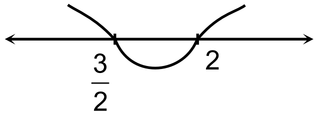


11. $(3a + 4b)(3a - 2b) = 0$ and $(3a - 2b)(a + b) = 0$

$\Rightarrow 3a = 2b$

12. f(x) is non differential at x = 1 (Point A in figure)
But f(x) is cont. $\forall\ x \in [0, 2]$
$\Rightarrow g'(t) = f(t) - f(t-1),\ t \in [1, 2]$
$= \left(2t^2 - 6t + 6\right) - \left((t-1)+1\right)$
$= 2t^2 - 7t + 6 = (2t-3)(t-2)$





$\Rightarrow$ Maximum when $t = \frac{3}{2}$ and minimum when t = 2.

14. $P\left(\frac{A}{B_E}\right) = \frac{P\left(A \cap B_E\right)}{P\left(B_E\right)}$, where A = sum is 4.

And $P\left(B_E\right) = P\left(B_2\right) + P\left(B_4\right) + ...$ $= \frac{1}{4} + \frac{1}{16} + \frac{1}{64} + ...\infty = \frac{\frac{1}{4}}{1-\frac{1}{4}} = \frac{1}{4}\cdot\frac{4}{3} = \frac{1}{3}$

$P\left(A \cap B_E\right) = P\left(A \cap B_2\right) + P\left(A \cap B_4\right) = P\left(B_2\right)P\left(\frac{A}{B_2}\right) + P\left(B_4\right)P\left(\frac{A}{B_4}\right)$

$= \frac{1}{4}\left(\frac{3}{36}\right) + \frac{1}{16}\left(\frac{1}{6^4}\right) = \frac{\left(4\cdot 3\cdot 6^2 + 1\right)}{16.6^4} = \frac{433}{16.6^4}$

Hence $P\left(\frac{A}{B_E}\right) = \frac{433}{16.6^4}\cdot 3 = \frac{433}{32\cdot 216} \cong \frac{1}{16}$

15. $n(S) = 6\cdot 6\cdot 6 = 6^3 = 216$
Now greatest number is 4, so atleast one of the dice shows up 4.
$\therefore\ n(A) = 4^3 - 3^3 = 37$
Hence $P(A) = \frac{37}{216}$

16-18. Equation of tangent of slope m to $y^2 = 4x$ is

$$y = mx + \frac{1}{m} \qquad ..... (1)$$

16. As (1) passes through P(6, 5), so $5 = 6m + \frac{1}{m}$

$\Rightarrow 6m^2 - 5m + 1 = 0 \Rightarrow m = \frac{1}{2}$ or $m = \frac{1}{3}$

Points of contact are $\left(\frac{1}{m_1^2}, \frac{2}{m_1}\right)$ and $\left(\frac{1}{m_2^2}, \frac{2}{m_2}\right)$

Hence R(4, 4) and Q(9, 6)

Area of $\Delta PQR = \frac{1}{2}\begin{vmatrix} 6 & 5 & 1 \\ 4 & 4 & 1 \\ 9 & 6 & 1 \end{vmatrix} = \frac{1}{2}$

17. $y = \frac{1}{2}x + 2 \Rightarrow x - 2y + 4 = 0$ ….. (2)

and $y = \frac{1}{3}x + 3 \Rightarrow x - 3y + 9 = 0$

Now equation of circle C_2 touching $x - 3y + 9 = 0$ at (9, 6), is

$(x-9)^2 + (y-6)^2 + \lambda(x-3y+9) = 0$

As above circle passes through (1, 0), so

$64 + 36 + 10\lambda = 0 \Rightarrow \lambda = -10$

Circle C_2 is $x^2 + y^2 - 28x + 18y + 27 = 0$ ….. (3)

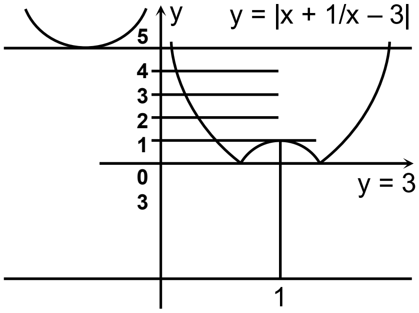
Radius of C_2 is $r_2^2 = 196 + 81 - 27 = 277 - 27 - 250 \Rightarrow r_2 = 5\sqrt{10}$

SECTION – C

1. $\Rightarrow p - 3 = 0, 2, 3, 4$

$\Rightarrow \Sigma p = 5 + 6 + 7 + 3 = 21$

$\Rightarrow n = 7$



2. $\left(x + \frac{1}{\alpha^2}\right)\left(x + \frac{1}{\beta^2}\right) + \frac{1}{\alpha\beta} = x^2 + \left(\frac{\alpha^2 + \beta^2}{(\alpha\beta)^2}\right)x + \frac{1}{(\alpha\beta)^2} + \frac{1}{\alpha\beta} = x^2 + \left(\frac{t^4 + 4t}{4t^2}\right)x + \frac{1}{4t^2} - \frac{1}{2t}$

Let I = $\int_{-1}^{2} x^2 dx + \frac{3}{2}\left(\frac{t^2}{4} + \frac{1}{t}\right) + 3\left(\frac{1}{4t^2} - \frac{1}{2t}\right)$

$\Rightarrow \frac{dI}{dt} = \frac{3}{2}\left(\frac{t}{2} - \frac{1}{t^2} - \frac{1}{t^3} + \frac{1}{t^2}\right) = 0 \Rightarrow t^4 = 2 \Rightarrow t = \pm(2)^{1/4}$

$\Rightarrow$ Min I(t) = $3 + \frac{3}{2}\left(\frac{\sqrt{2}}{4} + \frac{1}{2^{1/4}} + \frac{1}{2\sqrt{2}} - \frac{1}{2^{1/4}}\right) = 3 + \frac{3}{2}\cdot\frac{\sqrt{2}}{2} = 3 + \sqrt{\frac{9}{8}}$

$\Rightarrow \left[\frac{9}{8}\right] + 3 = 1 + 3 = 4$

3. The population after 2n days = $P\left(\left(\frac{3}{2}\cdot\frac{1}{2}\right)\cdot\left(\frac{3}{2}\cdot\frac{1}{2}\right)\cdot\text{..........n times}\right) = 3^{10}$

$\left(\frac{3}{4}\right)^n = \left(\frac{3}{4}\right)^{10} \Rightarrow n = 10 \Rightarrow$ Total number of days = 20 days

4. Let $f(x) = 2x^3 - 3x^2 + p$

$\Rightarrow f'(x) = 6x^2 - 6x = 0$ at x = 0, 1

$\Rightarrow f(0) > 0 \Rightarrow p > 0$

$f(1) < 0 \Rightarrow 2 - 3 + p < 0$

$\Rightarrow p < 1$

$\Rightarrow p \in (0, 1)$

$\Rightarrow [p] = 0$

5. Required plane is $p_1 + \lambda p_2 = 0$ and passes through (1, 2, 0)

$\Rightarrow p = \vec{r}\cdot\left(3\hat{i} - \hat{j} + 3\hat{k}\right) = 1\big) \Rightarrow$ a + b + c = 7

6. tangent at $\left(\frac{1}{4},\ 1\right)$ is $y = 2x + \frac{1}{2}$

$\Rightarrow k = \frac{19}{4}$

7. The polynomial is an everywhere differentiable function. Therefore, the points of extremum can only be roots of the derivative. Furthermore, the derivative of a polynomial is a polynomial. The polynomial of the least degree with roots $x_1 = 1$ and $x_2 = 3$ has the from

a(x – 1) (x – 3).

Hence P'(x) = a(x – 1) (x – 3) = a(x^2 – 4x + 3) since at the point x = 1, there must be P(1) = 6, we have

$$P(x) = \int_1^x P'(x)dx + 6 = a\int_1^x (x^2 - 4x + 3)dx + 6 = a\left(\frac{x^3}{3} - 2x^2 + 3x - \frac{4}{3}\right) + 6$$

The coefficient 'a' is determined from the condition P(3) = 2, whence a = 3.

Hence P(x) = $x^3 - 6x^2 + 9x + 2$

Now P(2) = 8 – 24 + 18 + 2 = 28 – 24 = 4

Also P'(x) = 3(x^2 – 4x + 3) $\Rightarrow$ P'(0) = 9

$\Rightarrow$ P(2) + P'(0) = 4 + 9 = 13

8. f(x) is an odd function

$\Rightarrow$ g(x) is $f^{-1}(x)$

$$\Rightarrow \text{Area} = \int_1^{2\pi} f^{-1}(y)dy = \int_0^{2\pi} f'(x)dx = \left[x\left(f(x)\right)\Big|_0^{2\pi} - \int_0^{2\pi}(x + \sin x)dx\right] = 2\pi^2.$$

9.
$$I_n = \left(\frac{e^{-x}(\sin x)^n}{-1}\right)_0^{\infty} + \int_0^{\infty} n(\sin x)^{n-1}\cos x e^{-x}dx$$

$$= 0 + n\left(\frac{(\sin x)^{n-1}\cos x e^{-x}}{-1}\right)_0^{\infty} + n\int_0^{\infty}\left[(\sin x)^{n-1}(-\sin x) + (\cos x)(n-1)\cos x(\sin x)^{n-2}\cos x\right]e^{-x}dx$$

$$= n\int_0^{\infty}\left(-(\sin x)^n + (n-1)\left(1 - \sin^2 x\right)(\sin x)^{n-2}\right)e^{-x}dx = \frac{n(n-1)}{n^2+1}I_{n-2}$$

$$101\frac{I_{10}}{I_8} = 101 \times \frac{10 \times 9}{10^2 + 1} = 90.$$

10.
$$|\vec{a} - \vec{b}|^2 + |\vec{b} - \vec{c}|^2 + |\vec{c} - \vec{a}|^2 = 2\left(a^2 + b^2 + c^2\right) - 2\left(\vec{a}\cdot\vec{b} + \vec{b}\cdot\vec{c} + \vec{c}\cdot\vec{a}\right)$$

$= 2(4 + 9 + 16) - 2\left(\vec{a}\cdot\vec{b} + \vec{b}\cdot\vec{c} + \vec{c}\cdot\vec{a}\right) = 58 - 2\left(\vec{a}\cdot\vec{b} + \vec{b}\cdot\vec{c} + \vec{c}\cdot\vec{a}\right)$.

Now $\left(\vec{a} + \vec{b} + \vec{c}\right)^2 \geq 0$

$\Rightarrow a^2 + b^2 + c^2 \geq -2\left(\vec{a}\cdot\vec{b} + \vec{b}\cdot\vec{c} + \vec{c}\cdot\vec{a}\right)$

$\Rightarrow -2\left(\vec{a}\cdot\vec{b} + \vec{b}\cdot\vec{c} + \vec{c}\cdot\vec{a}\right) \leq 29$

$\Rightarrow |\vec{a} - \vec{b}|^2 + |\vec{b} - \vec{c}|^2 + |\vec{c} - \vec{a}|^2 \leq 87.$

From Long Term Classroom Programs and Medium / Short Classroom Program 4 in Top 10, 10 in Top 20, 43 in Top 100, 75 in Top 200, 159 in Top 500 Ranks & 3542 total selections in IIT-JEE 2012

ALL INDIA TEST SERIES

FIITJEE **JEE (Advanced), 2013**

FULL TEST – II

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 237**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 06)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+5 marks** for correct answer and **– 2 marks** for wrong answer.
Section-A (07 – 12) contains 2 paragraphs. Based upon paragraph, 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct choice. No marks will be given for any wrong match in any question. There is no negative marking.

(iii) **Section-C (01 – 05)** contains 5 Numerical based questions with single digit integer as answer, ranging from 0 to 9 and each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

SECTION – A

Single Correct Choice Type

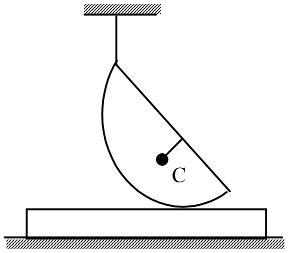
This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. In a series LCR circuit, if V is the root mean square (rms) value of the applied voltage. Across resistor (R) inductor (L) and capacitor (C) the rms values of the potential difference are V_R, V_L and V_C, respectively.

(A) $V = V_R + V_L + V_C$
(B) $V^2 = V_R^2 + V_L^2 + V_C^2$
(C) $V^2 = V_R^2 + (V_L - V_C)^2$
(D) $V^2 = V_L^2 + (V_R - V_C)^2$

2. Lower surface of a plank is rough and lies over a rough horizontal surface. Upper surface of the plank is smooth and has a smooth hemisphere placed over it through a light string as shown. After the string is burnt trajectory of C.M. of sphere is

(A) circle
(B) ellipse
(C) straight line
(D) none of these



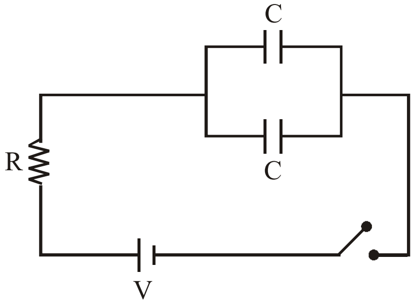
3. If switch S closed at t = 0 then work done by battery upto time t is equal to

(A) $\frac{CV^2}{2}\left(1 - e^{-\frac{2t}{CR}}\right)$

(B) $CV^2\left(1 - e^{-\frac{t}{2CR}}\right)$

(C) $CV^2\left(1 - e^{-\frac{t}{CR}}\right)$

(D) None



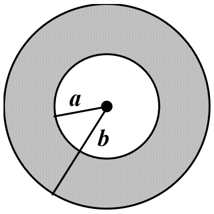
Rough work

4. Circular scale of a screw guage moves through 4 divisions of main scale in one rotation. If the number of divisions on the circular scale is 200 and each division of the main scale is 1 mm., the least count of the screw guage is

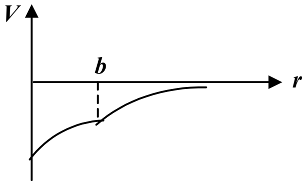
(A) 0.01 mm (B) 0.02 mm

(C) 0.03 mm (D) 0.04 mm

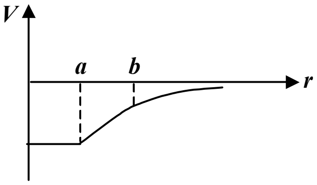
5. A sphere of mass *M* and radius *b* has a concentric cavity of radius *a* as shown in figure. The graph showing variation of gravitational potential *V* with distance *r* from the center of sphere is



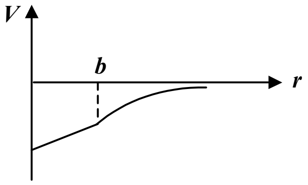
(A)



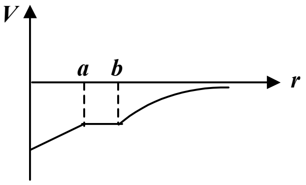
(B)



(C)



(D)



6. Let F_{pp}, F_{pn} and F_{nn} denote the magnitudes of the net force by a proton on a proton, by a proton on a neutron and by a neutron on a neutron respectively. Neglect gravitational force. When the separation is 1 fm,

(A) $F_{pp} > F_{pn} = F_{nn}$ (B) $F_{pp} = F_{pn} = F_{nn}$

(C) $F_{pp} > F_{pn} > F_{nn}$ (D) $F_{pp} < F_{pn} = F_{nn}$

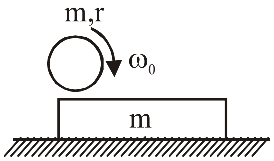
Rough work

Comprehension Type

This section contains 2 groups of questions. Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 7 to 9

In the figure shown a plank of mass m is lying at rest on a smooth horizontal surface. A disc of same mass m and radius r is rotated to an angular speed ω_0 and then gently placed on the plank. If we consider the plank and the disc as a system then frictional force between them is an internal force. Momentum of the system changes due to external force only. It is found that finally slipping cease. Assume that plank is long enough. μ is coefficient of friction between disc and plank.



7. Final velocity of the plank is

(A) $\frac{r\omega_0}{4}$ (B) $\frac{r\omega_0}{\sqrt{10}}$

(C) $\frac{r\omega_0}{2}$ (D) $\frac{r\omega_0}{2\sqrt{10}}$

8. Time when slipping ceases

(A) $\frac{r\omega_0}{2\mu g}$ (B) $\frac{r\omega_0}{\sqrt{10}\mu g}$

(C) $\frac{r\omega_0}{4\mu g}$ (D) $\frac{r\omega_0}{2\sqrt{10}\mu g}$

9. Magnitude of the change in angular momentum of the disc about center of mass of the disc

(A) $\frac{3}{4}mr^2\omega_0$ (B) $\frac{1}{4}mr^2\omega_0$

(C) zero (D) $\frac{1}{2}mr^2\omega_0$

Rough work

Paragraph for Question Nos. 10 to 12

As a charged particle q moving with a velocity $\vec{v}$ enters a uniform magnetic field $\vec{B}$, it experiences a force $\vec{f} = q(\vec{v} \times \vec{B})$. For θ = 0º or 180º, θ being the angle between $\vec{v}$ and $\vec{B}$, force experienced is zero and the particle passes undeflected. For θ = 90º, the particle moves along a circular arc and the magnetic force (qvB) provides the necessary centripetal force $\left(\frac{mv^2}{r}\right)$. For other values of θ ($\theta \neq$ 0º, 180º, 90º), the charged particle moves along a helical path which is the resultant motion of simultaneous circular and translational motions.

Suppose a particle, that carries a charge of magnitude q and has a mass 4×10^{-15} kg, is moving in a region containing a uniform magnetic field $\vec{B} = -0.4\hat{k}T$. At a certain instant, velocity of the particle is $\vec{v} = (8\hat{i} - 6\hat{j} + 4\hat{k}) \times 10^6$ m/s and force acting on it has a magnitude 1.6 N.

Answer the following:

10. Which of the three components of acceleration have non–zero values ?
    (A) x and y (B) y and z
    (C) z and x (D) x, y and z

11. Which of the following is correct?
    (A) Motion of the particle is non–periodic but y and z – position co–ordinates vary in a periodic manner
    (B) Motion of the particle is non–periodic but x and y – position co–ordinates vary in a periodic manner
    (C) Motion of the particle is non–periodic but x and z – position co–ordinates vary in a periodic manner
    (D) Motion of the particle is periodic and all the position co–ordinates vary in a periodic manner

12. If the co–ordinates of the particle at t = 0 are (2m, 1m, 0), co–ordinates at a time t = 3T, where T is the time period of circular component of motion, will be
    (A) (2m, 1m, 400m) (B) (0.142m, 120m, 0)
    (C) (2m, 1m, 1.884m) (D) (142m, 130m, 628m)

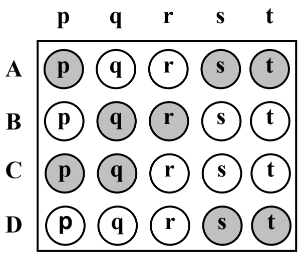
Rough work

SECTION - B

Matrix – Match Type

*This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



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1. Match the following.

Column A		Column B	
(A)	If the work done by force in cyclic path is zero, the force is	(p)	Non conservative
(B)	If the work done by a force in cyclic path is not zero, the force is	(q)	Negative
(C)	Work done by friction force can be	(r)	Conservative
(D)	Work done by spring force can be	(s)	Positive

2. Match the following.

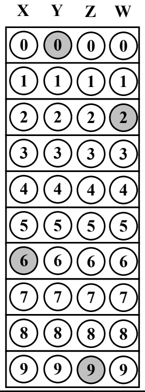
Column A		Column B	
(A)	Amplitude of constituent wave	(p)	0.06
(B)	Position of node at x = … m	(q)	0.5
(C)	Position of antinode at x = … m	(r)	0.25
(D)	Amplitude at $x = \left(\frac{3}{4}\right)$m	(s)	0.03

Rough work

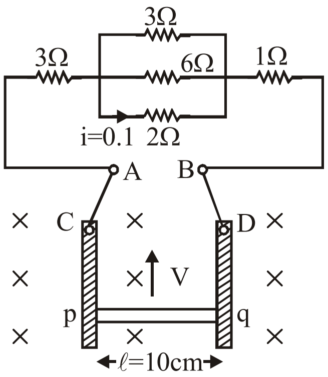
SECTION – C

Integer Answer Type

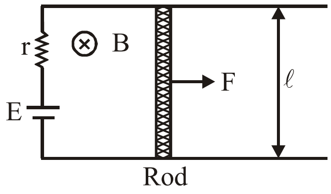
This section contains 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. A conducting rod Pq is sliding on two parallel conducting rods with constant velocity in a uniform magnetic field of induction B = 2 Wb/m^2 as shown in the figure. The rods are connected with a circuit. What should be velocity of rod Pq (in m/s) if current in 2Ω resistor is 0.1 A ?

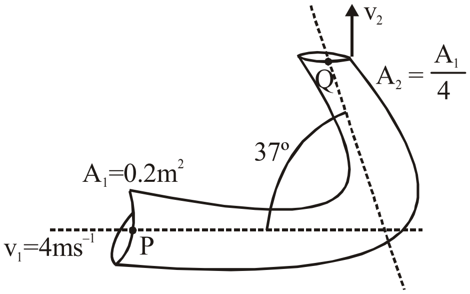


2. Two parallel conducting rails are connected to a source of emf E and internal resistance r. Another conducting rod of length ℓ having negligible resistance lies at rest and can slide without friction over the rails. A uniform magnetic field B is applied perpendicular to the plane of the rails. At t = 0, the rod is pulled along the rails by applying a force F. The velocity of the rod is observed to be $v = v_0 \cos(\omega t)$ then find the power (in watt) spent by the force over 1 cycle.
(Given B = 2 Tesla, $r = 2 \times 10^{-4}\Omega$, $v_0 = 2$ ms^{-1}, ℓ = 1cm)

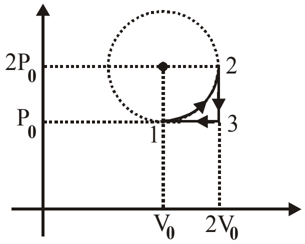


Rough work

3. Oil enters the bend of a pipe in the horizontal plane with velocity 4 ms^{-1} and pressure 280 × 10^{3} Nm^{-2} as shown in the figure. The pressure of oil at the point Q is 86λ. Find the value of λ. (KNm^{-2}).
(Take specific gravity of oil as 0.9 and sin 37° = 0.6)



4. One mole of ideal monoatomic gas is taken along a cyclic process as shown in the figure. Process 1 → 2 shown is 1/4th part of a circle as shown by dotted line process 2 → 3 is isochoric while 3 → 1 is isobaric. If efficiency of the cycle is n% where n is an integer. Find n.



5. A spring of force constant k = 300 N/m connects two blocks having masses 2 kg and 3 kg, lying on a smooth horizontal plane. If the spring block system is released from a stretched position, the number of complete oscillations in 1 minute is 6n. Find the value of n. Take $\pi = \sqrt{10}$.

Rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains 6 multiple choice questions numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Which test can distinguish 1,1 dichloroethane and 1,2 dichloroethane.

(A) (i) aq KOH, (ii) 2,4 - DNP (B) $NaHSO_3$

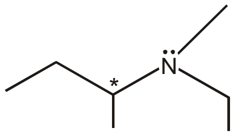
(C) Na_2CO_3 (D) $FeCl_3$ solution

2. Calculate the potential of an indicator electrode versus the standard hydrogen electrode, which originally contained 0.1 M MnO_4^- and 0.1 M H^+ and which was treated with Fe^{+2} necessary to reduce 90% of $KMnO_4$ to Mn^{+2}. $E^0_{MnO_4^-/Mn^{+2}} = 1.51$ v

(A) 1.3 (B) 1.43

(C) 1.48 (D) 1.4

3.



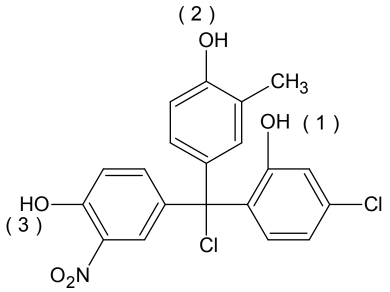
Let the starred carbon in the given amine has 'S' configuration. What is the isomeric relationship between the two forms of this compound that are inter converted by amine inversion.

(A) Diastereomers (B) Enantiomers

(C) Identical (D) Functional isomers

Rough Work

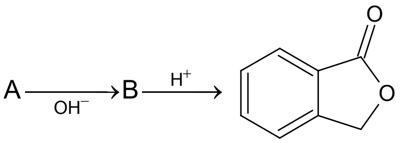
4.


(2)
OH
CH3
OH (1)
HO
(3)
Cl
Cl
O2N

Acidity of H is in the order

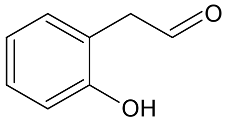
(A) 2 > 1 > 3 (B) 3 > 1 > 2
(C) 1 > 2 > 3 (D) 2 > 3 > 1

5.

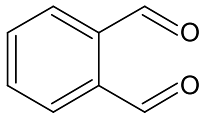


Possible structure for compound A is

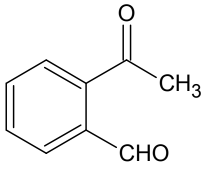
(A)



(B)

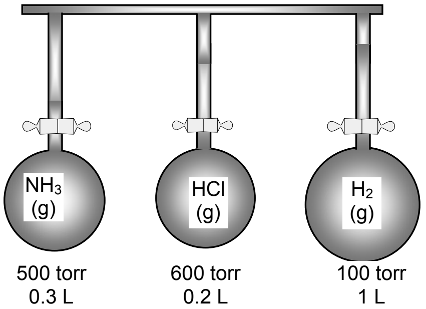


(C)



(D) None of these

6.


NH3 (g)
HCl (g)
H2 (g)
500 torr
0.3 L
600 torr
0.2 L
100 torr
1 L

What is the total pressure after all the stopcocks are opened at room temperature? (considering the volume of connecting tubes negligible

(A) 246.66 torr (B) 86.66 torr
(C) 100 torr (D) 1200 torr

Rough Work

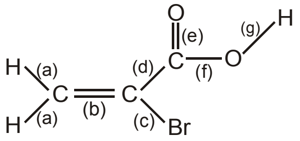
PARAGRAPH TYPE

This section contains 2 groups of questions. Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 7 to 9

Bond length is an important criterion in deciding the reactivity of organic entities. Bond length is affected by a number of factors like atomic size electronegativity, bond order and resonance.

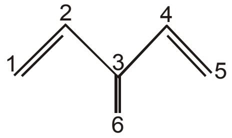
7.



For the given resonating structure of the molecule find the correct trend of bond length.

(A) e < b < g < a < f < d < c
(B) a < g < b < e < d < f < c
(C) g < a < e < b < f < d < c
(D) b < e < d < f < g < a < c

8.



Taking into account all the resonating structures of the above molecule, find which bond has highest bond order :

(A) $C_1 - C_2$
(B) $C_2 - C_3$
(C) $C_3 - C_6$
(D) (a) and (c) are having same bond order.

9. How many different Mn-O bond length(s) is/are there in $KMnO_4$ molecule.

(A) 1
(B) 2
(C) 3
(D) 4

Rough Work

Paragraph for Question Nos. 10 to 12

The solubility of an ionic compound depends upon lattice energy and hydration energy of that compound. Lattice energy involves the fact that how tightly are ions held together in ionic lattice whereas hydration energy involves the attraction of ions towards water molecule to get themselves hydrated. The dissolution occurs when hydrator energy predominates over lattice energy. The solubility also depends upon this difference. More is $\left(\Delta H_h - \Delta H_i\right)$ more is solubility.

10. Select the correct choice :
    (A) $KHCO_3$ is less soluble in water than $NaHCO_3$.
    (B) CaC_2O_4 is soluble in water and alkalies.
    (C) $Ca(HCO_3)_2$ an obtained in solid state.
    (D) BeF_2 is water soluble but CaF_2 is water insoluble.

11. Select the incorrect choice :
    (A) solubility of alkaline earth metal's carbonates, sulphates and chromates decreases from Be to Ba.
    (B) solubility of alkaline earth metal's hydroxides is less than alkali metal hydroxides.
    (C) solubility of alkaline earth metal's oxides increases from Be to Ba.
    (D) SO_2 on passing in lime water turns is milky.

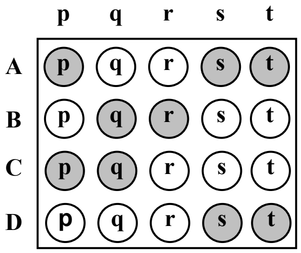
12. Report the correct order for lattice energy :
    (A) BeO > MgO > CaO (B) $BeF_2 < MgF_2 < CaF_2$
    (C) AgF < AgCl < AgBr (D) $Fe_2O_3 < FeO$

Rough Work

SECTION-B
(Matrix Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



1. Match the following

	Column – I		Column – II
(A)	$Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2 < Sr(OH)_2 < Ba(OH)_2$	(p)	Solubility in water
(B)	$BeCO_3 > MgCO_3 > CaCO_3 > SrCO_3 > BaCO_3$	(q)	Thermal stability
(C)	$Li(OH) < NaOH < KOH < RbOH < CsOH$	(r)	Hydration energy
(D)	$Li_2CO_3 < Na_2CO_3 < K_2CO_3 < Rb_2CO_3 < Cs_2CO_3$	(s)	Lattice Energy
		(t)	Basic strength in aqueous solution

2. Match the following

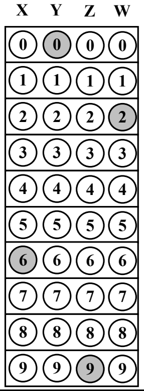
	Column – I (Using Pt electrode)		Column – II
(A)	Aqueous solution of HCl	(p)	O_2 evolved at anode
(B)	Aqueous solution of NaCl	(q)	H_2 evolved at cathode
(C)	Molten NaCl	(r)	Cl_2 evolved at anode
(D)	Aqueous solution of $AgNO_3$	(s)	Na deposited at cathode
		(t)	Ag deposited at cathode

Rough Work

SECTION – C

Integer Answer Type

This section contains 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. When CH_3CHO is treated with drops of concentration H_2SO_4 a pleasant smelting liquid paraldehyde results. The number of aldehyde molecules needed to from one molecule of paraldehyde is

2. If number of planes of symmetry in hexagonal unit cell is 'n' then the value of 'n' is:

3. If aqueous solution of NaCl is electrolyzed completely at 25°C, the total number of gases evolved is

4. 500 ml of 0.1 M $CaBr_2$(density of $CaBr_2$ solution = 1.02 gm/ml) is mixed with 500 ml of 0.2 M $AgNO_3$ (density of $AgNO_3$ solution = 1.034 gm/ml) solution. The mass of water in the mixture is 'x' gm. Then $\frac{x}{200}$ is

5. How many optically active alkanes are possible with molecular formula C_7H_{16}?

Rough Work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains 6 multiple choice questions numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Let g(x) = $f_n(x)$, where $f_2(x) = f(f(x))$, $f_3(x) = f(f(f(x)))$ ..... and $f(x) = x^3 - \frac{3}{2}x^2 + x + \frac{1}{4}$ then $\int\limits_{1/4}^{3/4} g(x)\,dx$ is

(A) $\frac{n}{2} + 2$ (B) $2^n + 1$

(C) $\frac{1}{4}$ (D) $\frac{3}{4}$

2. The area of the region bounded between the curves $y = e\left\|x\right|\ln\left|x\right\|$, $x^2 + y^2 - 2\left(|x| + |y|\right) + 1 \geq 0$ and x-axis where |x| ≤ 1, if α is the x-coordinate of the point of intersection of curves in 1st quadrant, is

(A) $4\left[\int\limits_0^{\alpha} ex\ln x\,dx + \int\limits_{\alpha}^{1}\left(1 - \sqrt{1-(x-1)^2}\right)dx\right]$ (B) $4\left[\int\limits_0^{\alpha} ex\ln x\,dx - \int\limits_{1}^{\alpha}\left(1 - \sqrt{1-(x-1)^2}\right)dx\right]$

(C) $2\left[-\int\limits_0^{\alpha} ex\ln x + \int\limits_{\alpha}^{1}\left(1 - \sqrt{1-(x-1)^2}\right)dx\right]$ (D) $2\left[\int\limits_0^{\alpha} ex\ln x + \int\limits_{\alpha}^{1}\left(1 - \sqrt{1-(x-1)^2}\right)dx\right]$

3. The value of $\lim\limits_{n\to\infty}\sum\limits_{r=1}^{n}\left(\sum\limits_{t=o}^{r-1}\frac{1}{5^n}\cdot {}^nC_r \cdot {}^rC_t \cdot 3^t\right)$ is equal to

(A) 4 (B) 3

(C) 1 (D) none of these

4. 8 spheres of radius 1 unit is kept on a table with their centres at the vertices of a regular octagon and each sphere touching its two neighbours. If a sphere is placed in the centre on the table touching all of the 8 sphers, then its radius is

(A) $\frac{1}{\sqrt{2}}$ (B) $1 - \frac{1}{\sqrt{2}}$

(C) $\sqrt{2}$ (D) $1 + \frac{1}{\sqrt{2}}$

Rough work

5. If f(x) = $(2x-3\pi)^{25}+\frac{4}{3}x+\cos x$ and g(x) is the inverse of f(x), then find $\frac{d}{dx}\left(g(x)\right)$ at x = 2π

(A) $\frac{7}{3}$
(B) $\frac{3}{7}$
(C) $\frac{30\pi^{25}+4}{3}$
(D) none of these

6. Three friends whose ages form a G.P. divide a certain sum of money in proportion to their ages. If they do that three years later, when the youngest is half the age of the oldest, then he will receive Rs. 150/– more than he gets now, and the middle friend will get Rs. 15 more than now, then the age of the youngest friend is

(A) 27
(B) 18
(C) 14
(D) 12

Comprehension Type

This section contains 2 groups of questions. Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 7 to 9

Read the following write up carefully and answer the following questions:

Let <a_n> and <b_n> be the arithmetic sequences each with common difference 2 such that $a_1 < b_1$ and let $c_n=\sum_{k=1}^{n}a_k$, $d_n=\sum_{k=1}^{n}b_k$. Suppose that the points $A_n(a_n, c_n)$, $B_n(b_n, d_n)$ are all lies on the parabola C : y = $px^2 + qx + r$ where p, q, r are the constants.

7. The value of p equals

(A) $\frac{1}{4}$
(B) $\frac{1}{3}$
(C) $\frac{1}{2}$
(D) 2

8. The value of q equals

(A) $\frac{1}{4}$
(B) $\frac{1}{3}$
(C) $\frac{1}{2}$
(D) 2

Rough work

9. If r = 0 then the value of a_1 and b_1 are

(A) $\frac{1}{2}$ and 1 (B) 1 and $\frac{3}{2}$

(C) 0 and 2 (D) $\frac{1}{2}$ and 2

Paragraph for Question Nos. 10 to 12

Read the following write up carefully and answer the following questions:
Let y = f(x) be a curve such that $x = 1 - 3t^2$, $y = t - 3t^3$, where t is a parameter and f(x) is not constantly zero $\forall$ t $\in$ R. The tangent drawn at P(t) to the curve makes an angle θ with positive direction of x-axis.

10. If the tangent at A $\equiv$ (–2, 2) meet the curve again at B then coordinates of point B is

(A) $\left(-3, -\frac{9}{2}\right)$ (B) $\left(-\frac{1}{3}, -\frac{2}{9}\right)$

(C) $\left(-\frac{1}{3}, \frac{2}{9}\right)$ (D) $\left(\frac{1}{3}, -\frac{2}{9}\right)$

11. The acute angle between the tangents at x = 0 to the curve y = f(x) is

(A) 0 (B) $\frac{\pi}{6}$

(C) $\frac{\pi}{4}$ (D) $\frac{\pi}{3}$

12. Let h(x) = |f(x)| + f(x) and g(x) = |f(x)| – f(x), then $\int_a^b h(x)dx$ is equal to

(A) $\int_b^a g(x)dx$ (B) $\int_a^b g(x)dx$

(C) $\int_b^a g(x)dx$ only if a, b $\in$ [0, 1] (D) none of these

Rough work

SECTION – B

(Matrix Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE** statement in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:
If the correct matches are A – p; B – q; C – p; and D – s; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	○	○
B	○	●	○	○	○
C	●	○	○	○	○
D	○	○	○	●	○

1. Match the following column–I with column–II.

	Column – I		Column – II
(A)	The equation of the right bisector plane of the segment joining (2, 3, 4) and (6, 7, 8) is	(p)	$\frac{13}{\sqrt{21}}$
(B)	The equation of the plane through the point (1, 2, –3) which is parallel to the plane $3x - 5y + 2z = 11$ is given by	(q)	$\frac{7}{\sqrt{21}}$
(C)	The distance of the point (2, 1, –1) from the plane $x - 2y + 4z = 9$ is	(r)	$\frac{20}{\sqrt{21}}$
(D)	The line $\frac{x-4}{1} = \frac{y-2}{1} = \frac{z-k}{2}$ lies completely on the plane $2x - 4y + z = 7$, then the value of $\frac{k}{\sqrt{21}}$ is	(s)	$x + y + z - 15 = 0$
		(t)	$3x - 5y + 2z + 13 = 0$

2. Match the following column–I with column–II.

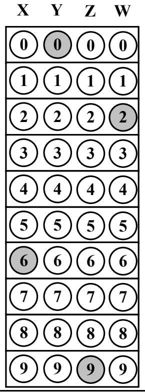
	Column – I		Column – II
(A)	The number of integers in the domain of $f(x) = \frac{1}{\sqrt{\ln \cos^{-1} x}}$, is	(p)	0
(B)	If the angle between the plane $x - 3y + 2z = 1$ and the line $\frac{x-1}{2} = \frac{y-1}{1} = \frac{z-1}{-3}$ is θ, then the value of cosec θ is	(q)	1
(C)	Let $J = \int_{-5}^{-4} (3 - x^2)\tan(3 - x^2)dx$ and $K = \int_{-2}^{-1} (6 - 6x + x^2)\tan(6x - x^2 - 6)dx$, then (J + K) equals	(r)	2
(D)	The value of a for the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ (a > b), if the extremities of the latus–rectum of the ellipse having positive ordinate lies on the parabola $x^2 = -2(y-2)$, is	(s)	4
		(t)	6

Rough work

SECTION – C

Integer Answer Type

This section contains 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. If the line $\frac{x-1}{2} = \frac{y+2}{3} = \frac{z-4}{6}$ intersect the xy, yz and zx planes at A, B and C respectively, and if volume of the tetrahedron OABD is V, where 'O' is origin and D is the image of C in the x–axis, then the value of [V] is __________. (Where [.] denote greatest integer function).

2. Let $1+\sum_{r=1}^{10}\left(3^r\cdot{}^{10}C_r + r\cdot{}^{10}C_r\right)$ = $2^{10}(\alpha\cdot 4^5+\beta)$ where $\alpha, \beta \in N$ and $f(x) = x^2 - 2x - k^2 + 1$.If α, β lies between the roots of $f(x) = 0$, then find the smallest positive integral value of k.

3. Let x be the 7th term from the beginning and y be the 7th term from the end in the expression of $\left(3^{1/3} + \frac{1}{4^{1/3}}\right)$. If $\frac{x}{y} = \frac{1}{12}$ then the value of n is __________.

4. Let z_1, z_2, z_3 be complex numbers of unit modulus such that $|z_1 - z_2|^2 + |z_1 - z_3|^2 = 4$ then $|z_2 + z_3|$ is equal to __________.

5. A student is allowed to select at most 'n' books from a collection of 2n + 1 books. If the total number of ways in which a student selects atleast one book is 63 then the value of n is __________.

Rough work

From Long Term Classroom Programs and Medium / Short Classroom Program 4 in Top 10, 10 in Top 20, 43 in Top 100, 75 in Top 200, 159 in Top 500 Ranks & 3542 total selections in IIT-JEE 2012

ALL INDIA TEST SERIES

FIITJEE JEE(Advanced)-2013

ANSWERS, HINTS & SOLUTIONS

FULL TEST – II

(Paper – 2)

ANSWERS KEY

	PHYSICS	CHEMISTRY	MATHEMATICS
Q. No.	ANSWER	ANSWER	ANSWER
1.	C	A	C
2.	C	D	C
3.	B	A	C
4.	B	B	D
5.	B	B	B
6.	D	B	B
7.	A	C	A
8.	C	A	C
9.	B	A	C
10.	A	D	B
11.	B	C	D
12.	C	A	B
1.	(A) → (r) (B) → (p) (C) → (q), (s) (D) → (q), (s)	(A) → (p, q, t) (B) → (p, r, s) (C) → (p, q, t) (D) → (q, t)	(A) → (s) (B) → (t) (C) → (p) (D)→ (q)
2.	(A) → (s) (B) → (q) (C) → (r) (D) → (q)	(A) → (q, r) (B) → (q, r) (C) → (r, s) (D) → (p, t)	(A) → (r) (B) → (r) (C) → (p) (D)→ (r)
1.	5	3	3
2.	4	7	5
3.	2	3	9
4.	4	5	0
5.	4	4	3

Physics PART – I

SECTION – A

3. $q = 2CV\left(1 - e^{-\frac{t}{2CR}}\right)$; $W_b = 2CV^2\left(1 - e^{-\frac{t}{2CR}}\right)$

4. LC = 4/200 = 0.02

5. Gravitational potential inside a shell = constant

6. In nuclear, nuclear force play major role. They are charge independent forces.

SECTION – C

1. Current is 2Ω = 0.1 A
current in circuit = 0.2 A
equivalent resistance about AB = 5Ω
$e = IR = 1$ volts
and also
$e = B\ell V$
$\therefore \quad V = \frac{e}{B\ell} = \frac{1}{2 \times 0.1} = 5\,m/s$.

2. Force on the rod
$F - F_m = ma$
$$F - \frac{B\ell}{r}(B\ell V - E) = ma$$
$$F + \frac{B\ell E}{r} - \frac{B^2\ell^2 V}{r} = \frac{mdV}{dt}$$
solving
$$F = -mV_0\omega\sin(\omega t) + \frac{B^2\ell^2}{r}V_0\cos\omega t - \frac{B\ell E}{r}$$
Power expended by force is
$$FV = -mV_0^2\omega\sin(\omega t)\cos(\omega t) + \frac{B^2\ell^2}{r}V_0^2\cos^2\omega t - \frac{B\ell E}{r}V_0\cos\omega t$$
Its average over the cycle is
$$\frac{B^2\ell^2V_0^2}{2r}.$$

3. Let A_1 and A_2 be the cross–sectional area of the pipe at points P and Q respectively.
Let v_1 and v_2 be the velocities of oil at the points P and Q respectively.
By conservation of mass,
$Q = A_1v_1 = A_2v_2$
$$\Rightarrow \quad v_2 = \left(\frac{A_1}{A_2}\right)(v_1) = 4v_1$$
Applying Bernoullis's equation between points P and Q, we have

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$$

$$P_2 = P_1 + \frac{1}{2}\rho(v_1^2 - v_2^2)$$

$$= P_1 + \frac{1}{2}\times 0.9[16 - 256]\times 10^3$$

$$= 280\times 10^3 + (-108)\times 10^3$$

$P_2 = 172 \times 10^3\ \text{Nm}^{-2}$

$P_2 = 172\ (\text{KN m}^{-2})$.

4. $$W_{net} = (2P_0v_0) - (P_0v_0) - \frac{\pi P_0 v_0}{4}$$

$$W_{net} = P_0v_0 - \frac{\pi P_0v_0}{4} = (4-\pi)\frac{P_0v_0}{4}$$; Put $\pi = 3.14$

$$W_{net} = \frac{0.86}{4}P_0v_0 = (0.22)\,(P_0v_0)$$

Now,

$$\left.\begin{aligned} T_1 &= \frac{P_0v_0}{R} \\ T_2 &= \frac{4P_0v_0}{R} \\ T_3 &= \frac{2P_0v_0}{R} \end{aligned}\right\} \text{ Thus, } \begin{aligned} \Delta U_{1\to 2} &= 1\times\frac{3R}{2}[T_2 - T_1] \\ \Delta U_{2\to 3} &= 1\times\frac{3R}{2}[T_3 - T_2] \\ \Delta U_{3\to 1} &= 1\times\frac{3R}{2}[T_1 - T_3] \end{aligned}$$

$$\Delta Q_{1\to 2} = (4.5)(P_0v_0) + (1.22)(P_0v_0) = (5.72)(P_0v_0)$$

$$\Delta Q_{2\to 3} = -3P_0v_0 + 0 = -3(P_0v_0)$$

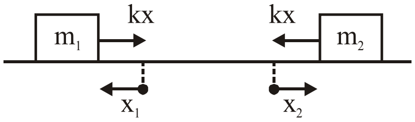
$$\Delta Q_{3\to 1} = -1.5\,(P_0v_0) - (P_0v_0) = -2.5(P_0v_0)$$

Thus efficiency $\eta = \dfrac{W_{net}}{+\text{ve heat}}$

$$\eta = \frac{0.22(P_0v_0)}{(5.72)\,(P_0v_0)} = 0.04$$

Thus efficiency is 4%

5. The total momentum of the system in the horizontal direction is conserved. We draw the F.B.D., assuming the displacement of the block to be x_1 and x_2 in opposite directions, and the total extension x is given by,



$x = x_1 + x_2$

and $m_1x_1 = m_2x_2$

$$\therefore\ m_1\frac{d^2x_1}{dt^2} = -k(x_1 + x_2)$$

and $$m_2\frac{d^2x_2}{dt^2} = -k(x_1 + x_2)$$

after suitably manipulating the equations,

we get,

$$\frac{d^2x_2}{dt^2} = -\frac{-k(m_1 + m_2)}{m_1m_2}.x$$

i.e. the frequency $= \frac{1}{2\pi}\sqrt{\frac{k(m_1 + m_2)}{m_1m_2}}$

$$= \frac{1}{2\pi}\sqrt{\frac{300(2+3)}{2\times 3}}$$

$$\simeq 2.5\text{Hz}.$$

$\therefore$ number of complete oscillations in 1 minute $= \frac{60}{2.5} = 24$.

Chemistry

PART – II

SECTION – A

1. Gem-dihalides on substitution by $\overset{\ominus}{O}H$ produces carbonyl compound, which will reacts with 2,4-DNP but 1,2-dichloroethane will give vic-diol.

2.
$$\begin{array}{lllll} MnO_4^- & + \; Fe^{+2} & +8H^{\oplus} \longrightarrow & Mn^{+2} & + \; Fe^{+3} \\ 0.1\,M & & & & \\ 0.01M & & & 0.09\text{ M} & \end{array}$$

$E^0_{R.P.\left(MnO_4^{-2}/Mn^{+2}\right)} > E^0_{R.P.\left(H^+/H_2\right)}$

So permanganate electrode behave as cathode.
$E_{cell} = 1.51 – 0 = 1.51$.
Using Nernst’s equation :- (n = 5)

$$E_{MnO_4^-/Mn^{+2}} = 1.51 + \frac{0.059}{5}\log\frac{\left[MnO_4^-\right]\left[H^+\right]^8}{\left[Mn^{+2}\right]}$$

= 1.51 + 0.11 = 1.4 V

3. Amine inversion will change the configuration of N only and not that of carbon.

5. Compound (A) will first undergo Cannizzaro reaction and the product B then will undergo esterification.

6. $\underset{\frac{500\times0.3}{760\times RT}}{NH_3} + \underset{\frac{600\times0.2}{760\times RT}}{HCl} \longrightarrow \underset{0\text{ Moles}}{NH_4Cl(s)}$ at room temperature.

$$\begin{array}{lll} \frac{150}{760RT} & \frac{120}{760RT} & \\ \frac{30}{760RT} & 0 & \frac{120}{760RT} \end{array}$$

Now total moles = $\frac{30}{760RT} + \frac{100\times1}{760RT}$

Total P = $\frac{130\times RT}{760RT\times1.5}$ (Total volume = 1. 5 Litre)

P in torr = $\frac{130}{1.5} = 86.66$ torr

SECTION – C

5. (S)-2,3-dimethylpentane, (R)-2,3-dimethylpentane, (S)-3-methylhexane and (R)-3-methylhexane.

Mathematics PART – III

SECTION – A

1. $$f(x)=\left(x-\frac{1}{2}\right)^3+\frac{1}{4}\left(x-\frac{1}{2}\right)+\frac{1}{2}$$

$$I=\int_{1/4}^{3/4} g(x)\,dx \ \text{ let } \ x=t+\frac{1}{2} \Rightarrow I=\int_{-1/4}^{1/4} g\left(t+\frac{1}{2}\right)dt$$

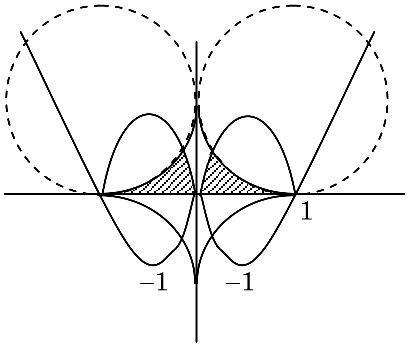
$$f\left(t+\frac{1}{2}\right)=t^3+\frac{1}{4}t+\frac{1}{2} \Rightarrow f\left(f\left(t+\frac{1}{2}\right)\right)=\left(t^3+\frac{1}{4}t\right)^3+\frac{1}{4}\left(t^3+\frac{1}{4}t\right)+\frac{1}{2}$$

$$\Rightarrow g\left(t+\frac{1}{2}\right)=p(t)+\frac{1}{2} \ \text{ where } p(-t)+p(t)=0$$

$$\Rightarrow I=\int_{-1/4}^{1/4}\frac{1}{2}dt=\frac{1}{4}$$

2. Required area is

$$2\left[\int_0^{\alpha} ex\ln x+\int_1^{\alpha}\left(1-\sqrt{1-(x-1)^2}\right)dx\right]$$



3. $$\lim_{n\to\infty}\sum_{r=1}^{n}\frac{1}{5^n}\cdot{}^nC_r\left(\sum_{t=o}^{r-1}{}^rC_t\cdot 3^t\right)=\lim_{n\to\infty}\sum_{r=1}^{n}\frac{1}{5^n}\cdot{}^nC_r\left(4^r-3^r\right)$$

$$=\lim_{n\to\infty}\frac{1}{5^n}\left(\sum_{r=1}^{n}{}^nC_r4^r-\sum_{r=1}^{n}{}^nC_r3^r\right)=\lim_{n\to\infty}\frac{1}{5^n}\left(5^n-4^n\right)=1.$$

4. In triangle OA_1A_2

$$\cos\left(\frac{\pi}{4}\right)=\frac{2R^2-4}{2R^2}=\frac{1}{\sqrt{2}}$$

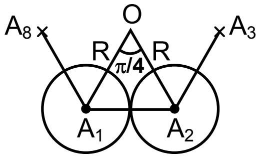
$$\Rightarrow R^2=4+2\sqrt{2}$$

Also

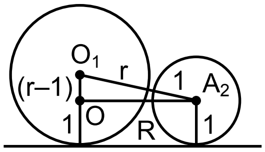
$$\Rightarrow (r+1)^2-(r-1)^2=4+2\sqrt{2}$$

$$\Rightarrow 4r=4+2\sqrt{2}$$

$$\Rightarrow r=\left(1+\frac{1}{\sqrt{2}}\right)$$



Vertex of octagen



5. $$f\left(\frac{3\pi}{2}\right)=2\pi$$

$\Rightarrow f'\left(\frac{3\pi}{2}\right)\cdot g'(2\pi) = 1$

$\Rightarrow f'(x) = 25(2)(2x-3\pi)^{24} + \frac{4}{3} - \sin x$

$\Rightarrow f'\left(\frac{3\pi}{2}\right) = \frac{7}{3} \Rightarrow g'(2\pi) = \frac{3}{7}$

6. Let the age of friends be a, ar, ar^2, r > 1 and money distributed is x, xr, xr^2 respectively.
$\Rightarrow (1 + r + r^2)x = (a(1 + r + r^2) + a)t$
Also after 3 years $ar^2 + 3 = 2(a + 3)$
$\Rightarrow a(r^2 - 2) = 3$
x + 105 = (a + 3)t and xr + 15 = (ar + 3)t (given)
$\Rightarrow (1 + r)x + 120 = (a(1 + r) + 6)t \Rightarrow 2(a + 3)t = r^2x - 120 = 2x + 210$
$\Rightarrow (r^2 - 2)x = 330$
Using $(r^2 - 2)x = 330$, $a(r^2 - 2) = 3 \Rightarrow x = 110a$
$\Rightarrow 110a + 105 = (a + 3)t \Rightarrow 5(22a + 21) = (a + 3)t$
and $110ar + 15 = (ar + 3)t \Rightarrow 5(22ar + 3) = (ar + 3)t$
$\Rightarrow \frac{22a+21}{22ar+3} = \frac{a+3}{ar+3} \Rightarrow 5ar = 7a + 6$
Where $5ar = 7a + 2(a(r^2 - 2))$ {Using $a(r^2 - 2) = 3$}
$\Rightarrow 2r^2 - 5r + 3 = 0 \Rightarrow r = \frac{3}{2}$. Hence a = 12 years

7. Given $c_n = a_1 + a_2 + a_3 + \ldots.. + a_n$
where $a_1, a_2, \ldots.., a_n$ are in A.P. with d = 2
and $d_n = b_1 + b_2 + b_3 + \ldots\ldots + b_n$
where $b_1, b_2, b_3, \ldots.., b_n$ are in A.P. with d = 2
Also (a_n, c_n) lies on $y = px^2 + qx + r$
Now $c_n = pa_n^2 + qa_n + r$ ….. (1)
$c_{n-1} = pa_{n-1}^2 + qa_{n-1} + r$ ….. (2)
∴ From (1) and (2), we get
$c_n - c_{n-1} = p\left(a_n^2 - a_{n-1}^2\right) + q\left(a_n - a_{n-1}\right)$
$\Rightarrow a_n = p\left(a_n + a_{n-1}\right)\left(a_n - a_{n-1}\right) + q\left(a_n - a_{n-1}\right)$
$a_n = \left(a_n - a_{n-1}\right)\left[p\left(a_n + a_{n-1}\right) + q\right]$ ….. (3)
$\left(a_n - a_{n-1} = d\right)$

10. $y = t(1 - 3t^2) \Rightarrow t = \frac{y}{x} \Rightarrow$ at A, t = – 1
Slope of tangent at A, $m = \frac{1-9t^2}{-6t} = -\frac{4}{3}$.
$\Rightarrow$ Equation of tangent at A $\Rightarrow 3y + 4x + 2 = 0$
Since tangent passes through the point $B(t_1)$ hence
$3(t_1 - 3t_1^3) + 4(1 - 3t_1^2) + 2 = 0$
$\Rightarrow (t_1 + 1)^2(3t_1 - 2) = 0 \Rightarrow t_1 = \frac{2}{3}$
$\Rightarrow B \equiv \left(-\frac{1}{3}, -\frac{2}{9}\right)$.

11. Slope of tangents at x = 0 and $m_1 = \frac{1}{\sqrt{3}}$ and $m_2 = -\frac{1}{\sqrt{3}}$

$\Rightarrow \tan\phi = \frac{\pi}{3}$.

SECTION – B

2. (A) We have $f(x) = \frac{1}{\sqrt{\ln\cos^{-1}x}}$

For domain of f(x), $\ln\left(\cos^{-1}x\right) > 0 \Rightarrow \cos^{-1}x > 1$ and $\cos^{-1}x \le \pi$

$\Rightarrow \cos\pi \le x \le \cos 1 \Rightarrow -1 \le x < \cos 1$

Hence number of integers in the domain of f(x) are 2 i.e., –1 and 0

(B) Vector normal to the plane is $\vec{n} = \hat{i} - 3\hat{j} + 2\hat{k}$ and vector along the line is $\vec{V} = 2\hat{i} + \hat{j} - 3\hat{k}$

Now $\sin\theta = \frac{\vec{x}\cdot\vec{v}}{|\vec{x}|\ |\vec{v}|} = \left|\frac{2-3-6}{\sqrt{14}\ \sqrt{14}}\right| = \left|\frac{7}{14}\right|$

Hence cosec θ = 2

(C) We have $J = \int_{-5}^{-4}\left(3-x^2\right)\tan\left(3-x^2\right)dx$. Put (x + 5) = t, we get

$$J = \int_0^1\left(3-(t-5)^2\right)\tan\left(3-(t-5)^2\right)dt = \int_0^1\left(-22+10t-t^2\right)\tan\left(-22+10t-t^2\right)dt$$

Now $K = \int_{-2}^{-1}\left(6-6x+x^2\right)\tan\left(6x-x^2-6\right)dx$. Put (x + 2) = z, we get

$$K = \int_0^1\left(6-6(z-2)+(z-2)^2\right)\tan\left(6(z-2)-(z-2)^2-6\right)dz$$

$$\int_0^1\left(22-10z+z^2\right)\tan\left(-22+10z-z^2\right)dz$$

Hence (J + K) = 0

SECTION – C

1. $A\left(-\frac{1}{3},\ -4,\ 0\right)$, $B\left(0,\ -\frac{7}{2},\ 1\right)$ and $C\left(\frac{7}{3},\ 0,\ 8\right)$.

Hence $V = \frac{56}{18}$

2. $1+\sum_{r=1}^{10}\left(3^r\cdot{}^{10}C_r + r\cdot{}^{10}C_r\right) = 4^{10} + 10 \times 2^9$

$\Rightarrow \alpha = 1$ and $\beta = 5$

$\Rightarrow k > 4$

3. $x = {}^nC_6\left(3^{1/3}\right)^{n-6}\left(4^{-1/3}\right)^6$

$y = {}^nC_{n-6}\left(3^{1/3}\right)^6\left(4^{-1/3}\right)^{x-6}$ and $\frac{x}{y} = \frac{1}{12} \Rightarrow (12)^{n-12/3} = (12)^{-1} \Rightarrow n = 9$

4. $z_2 + z_3 = 0$

5. Let $y = \sum_{r=0}^{n} {}^{2n+1}C_r = \sum_{r=n+1}^{2n+1} {}^{2n+1}C_r$

$\Rightarrow 2y = 2^{2n+1} \Rightarrow y = 2^{2n}$

$\Rightarrow n = 3$

From Long Term Classroom Programs and Medium / Short Classroom Program 4 in Top 10, 10 in Top 20, 43 in Top 100, 75 in Top 200, 159 in Top 500 Ranks & 3542 total selections in IIT-JEE 2012

ALL INDIA TEST SERIES

FIITJEE **JEE (Advanced), 2013**

FULL TEST – IV

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 210**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 10)** contains 10 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (11 to 15) contains 5 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

(ii) **Section-C (01 to 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
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Enrolment No. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

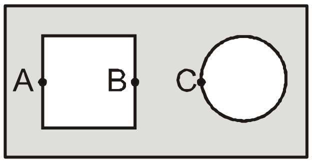
PART – I

SECTION – A

Single Correct Choice Type

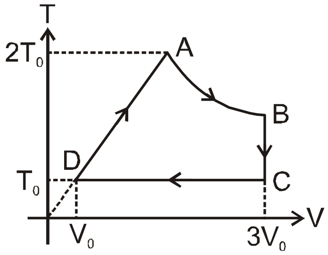
This section contains **10 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. Two large holes are cut in a metal sheet as shown. If this is heated, which distance will decrease :
(A) BC (B) AB
(C) AC (D) None of these



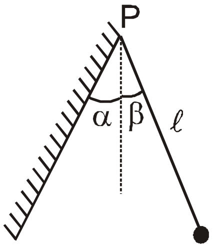
2. 2 gms steam at 100° is mixed with 5 gm ice at – 40°C in an ideal calorimeter. The final temperature of the system will be (Given L_v = 500 cal/gm; S_{ice} = 0.5 cal/gm°C, S_w = 1 cal/gm °C; L_f = 80 cal/gm) :
(A) 0°C (B) 100°C
(C) 80°C (D) 50°C

3. Consider the cyclic process ABCDA, as shown in figure, performed on a sample of n moles of an ideal gas. Net heat supplied to the gas during the process is $4nRT_0$. Then the work done during the process AB will be :
(A) $3nRT_0$
(B) nRT_0 (4 + ℓn3)
(C) nRT_0 (3 + ℓn3)
(D) nRT_0 (2 + ℓn3)



Rough work

4. A ball is hung vertically by a thread of length '' from a point 'P' of an inclined wall that makes an angle 'α' with the vertical. The thread with the ball is then deviated through a small angle 'β' ($\alpha > \beta$) and set free. Assuming the wall to be perfectly elastic, the period of such pendulum is :



(A) $2\sqrt{\frac{\ell}{g}}\left[\sin^{-1}\left(-\frac{\alpha}{\beta}\right)\right]$

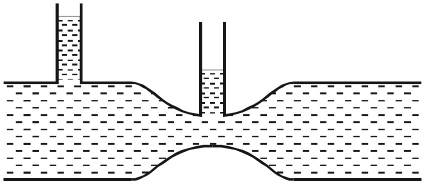
(B) $2\sqrt{\frac{\ell}{g}}\left[\frac{\pi}{2}+\sin^{-1}\left(\frac{\alpha}{\beta}\right)\right]$

(C) $\pi\sqrt{\frac{\ell}{g}}$

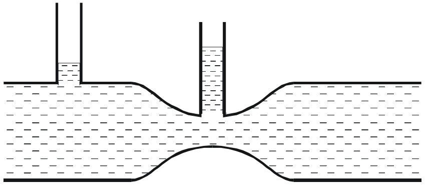
(D) $2\pi\sqrt{\frac{\ell}{g}}$

5. For a static fluid in a long horizontal pipe, the level in the vertical tubes is best represented by :

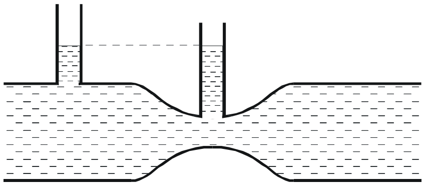
(A)



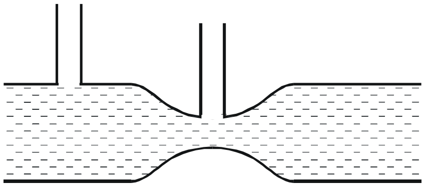
(B)



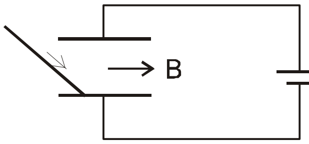
(C)



(D)



6. The collector plate in an experiment on photoelectric effect is kept vertically above the emitter plate. Light source is put on and a saturation photocurrent is recorded. A magnetic field is switched on which is in horizontal rightward direction :



(A) The photocurrent will increase
(B) The photocurrent may decrease
(C) The photocurrent will always remain same
(D) None of these

Rough work

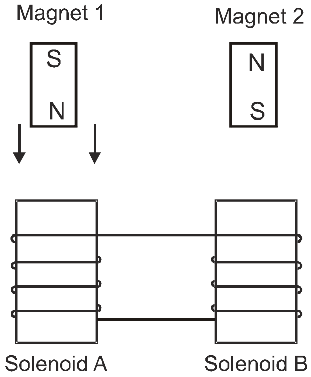
7. An uncharged capacitor of capacitance C is connected with an ideal cell. The emf of the cell is slowly increased from 0 to V (by some mechanism) . The total energy taken from the cell in the process of charging of the capacitor is (assume the resistance of the circuit is very small):

(A) $\frac{1}{2}CV^2$ (B) $2CV^2$

(C) $\frac{1}{4}CV^2$ (D) CV^2

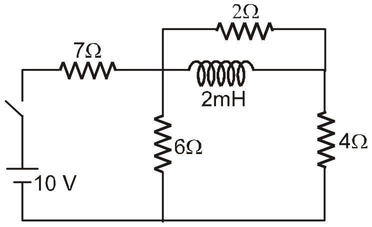
8. Two hollow-core solenoids, A and B, are connected by a wire and separated by a large distance, as shown in the diagram. Two bar magnets, 1 and 2, are suspended just above the solenoids. If the magnet 1 is dropped through solenoid A as shown, then the magnet 2 will simultaneously be

(A) Attracted by a magnetic force towards solenoid B
(B) Repelled by a magnetic force away from solenoid B
(C) Repelled by an electric force away from solenoid B
(D) Unaffected by solenoid B.

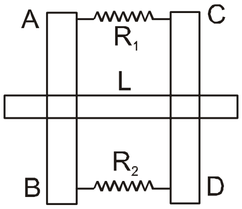


9. In the given circuit find the ratio of i_1 to i_2. Where i_1 is the initial (at t = 0) current, and i_2 is steady state (at t = ∞) current through the battery :

(A) 1.0 (B) 0.8
(C) 0.94 (D) 1.06



10. Two parallel vertical metallic rails AB and CD are separated by 1 m. They are connected at the two ends by resistance R_1 and R_2 as shown in the figure. A horizontal metallic bar L of mass 0.2 kg slides without friction, vertically down the rails under the action of gravity. There is a uniform horizontal magnetic field of 0.6T perpendicular to the plane of the rails. It is observed that when the terminal velocity of 4 m/s is attained, power dissipated in R_1 is 2 W. Then the power dissipated in R_2 at this moment will be :



(A) 2 W (B) 4 W
(C) 8 W (D) 6 W

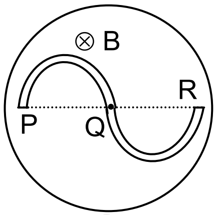
Rough work

Multiple Correct Answer(s) Type

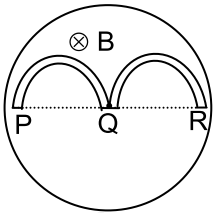
This section contains **5 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

11. In each of the following diagrams, the magnetic field in the circular region is inside the plane of the paper and is increasing with time. Four different shaped metallic conductors 'PQR' are placed as shown. The end P will be more positively charged compared to R in: (Q is the centre in options AB).

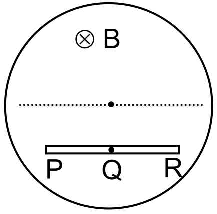
(A)



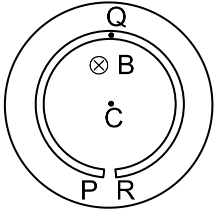
(B)



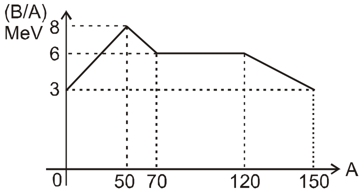
(C)



(D)



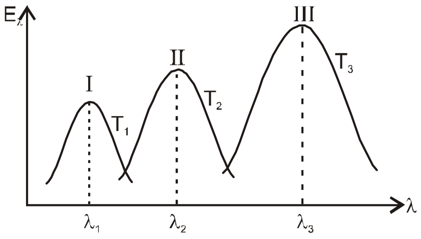
12. Assume that the nuclear binding energy per nucleon (B/A) versus mass number (A) is as shown in the figure. Consider a nucleus of A = 110. Fission of this nucleus results into 2 fragments. Which of the following could possibly be the mass number of the resulting nuclei?



(A) 55 and 55
(B) 70 and 40
(C) 100 and 10
(D) 90 and 20

Rough work

13. Three identical bodies are at temperature T_1, T_2 and T_3 having e_1, e_2 and e_3 as their respective emissivities. The thermal spectrum obtained for them is as shown in the diagram. Choose the correct order of temperatures and emissivities:



(A) $T_1 > T_2 > T_3$
(B) $T_1 < T_2 < T_3$
(C) $e_1 < e_2 < e_3$
(D) $e_1 > e_2 > e_3$

14. When photons of energy 4.25 eV strike the surface of a metal A, the ejected photoelectrons have maximum kinetic energy, T_A expressed in eV and de Broglie wavelength λ_A. The maximum kinetic energy of photoelectrons liberated from another metal B by photons of energy 4.70 eV is $T_B = (T_A - 1.50 \text{ eV})$. If the de Broglie wavelength of these photoelectrons is $\lambda_B = 2\lambda_A$, then :
(A) the work function of A is 2.25 eV
(B) the work function of B is 4.20 eV
(C) $T_A = 2.00$ eV
(D) $T_B = 2.75$ eV

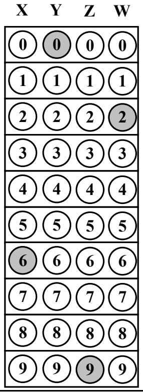
15. An ideal monoatomic gas undergoes a process in which $P = 3V^3$. Choose the correct statements.
(A) If volume increases then temperature will also increase
(B) If temperature of the gas decreases, then pressure must also decrease.
(C) For expansion, heat will have to be supplied to the gas.
(D) If temperature increases then work done by gas is positive.

Rough work

SECTION – C

Integer Answer Type

This section contains 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



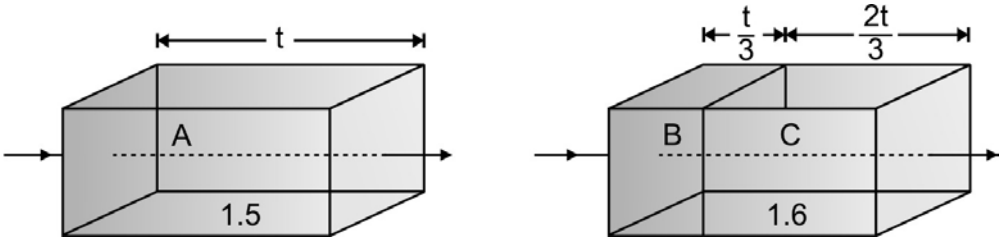
1. A string of length 2L, obeying Hooke's Law, is stretched so that its extension is L. The speed of the tranverse wave travelling on the string is v. If the string is further stretched so that the extension in the string becomes 4L. The speed of transverse wave travelling on the string will be $x\sqrt{2}\,v$. Calculate the value of x.

2. A train moves towards a stationary observer with a speed of 34 ms^{-1}. The train sounds a whistle and its frequency registered by the observer is f_1. If the train's speed is reduced to 17 ms^{-1}, the frequency registered is f_2. If the speed of sound is 340 ms^{-1}, then the ratio $\frac{f_1}{f_2}$ is $\frac{10+x}{18}$. Calculate the value of x.

3. A tuning fork A of frequency as given by the manufacturer is 512 Hz is being tested using an accurate oscillator. It is found that they produce 2 beats per second when the oscillator reads 514 Hz and 6 beats per second when it reads 510 Hz. The actual frequency of the fork in Hz is (510 + x). Calculate the value of x.

4. A person runs with a speed u towards a bicycle moving away from him with speed v. The person approaches his image in the mirror fixed at the rear bicycle with a speed of x(u – v). Calculate the value of x.

5. Two transparent slabs have the same thickness as shown. One is made of material A of refractive index 1.5. The other is made of two materials B and C with thickness in the ratio 1 : 2. The refractive index of C is 1.6. If a monochromatic parallel beam passing through the slabs has the same number of wavelengths inside both, the refractive index of B is $\frac{10+x}{10}$. Then x is:



Rough work

Chemistry PART – II

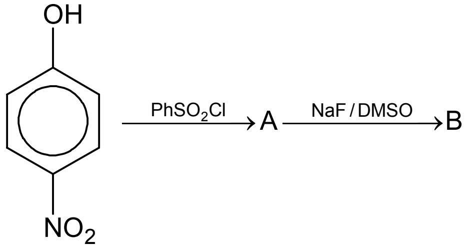
SECTION – A

Straight Objective Type

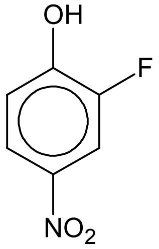
This section contains 10 multiple choice questions numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

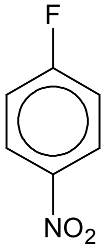
1. A compound (X) has the molecular formula C_3H_7NO gives Y on reaction with KOH and Br_2. Compound Y responds to mustard oil reaction. Y upon treatment with HNO_2 evolves N_2 and gives an alcohol Z which gives iodoform test. The compound X can be
(A) $C_2H_5CONH_2$ (B) CH_3CONH_2
(C) CH_3COONH_4 (D) C_2H_5NO

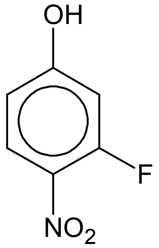
2. For the reaction sequence

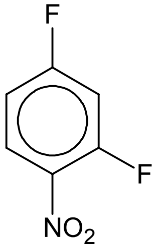


The compound B will be

(A)


(B)


(C)


(D)


3. In an experiment 11 g PCl_3 is made to react with 1.34 g of O_2 to yield $POCl_3$. If 11.2 g of $POCl_3$ were isolated. What is the percentage yield.
(A) 60 (B) 70
(C) 80 (D) 90

4. What is the molar mass of the gas if the density of a gas sample is 0.714 g/L at STP?
(A) 24 (B) 16
(C) 36 (D) 42

5. What is the root mean square speed of Argon atoms at 27°C.

(A) 200 m/s (B) 341 m/s
(C) 433 m/s (D) 510 m/s

6. Find the wavelength of light emitted by an electron during a transition from n = 3 to n = 1 level in the C^{+5} ion. Given Rh = 1.097×10^7 m^{-1}.

(A) 2.85 nm (B) 8.76 nm
(C) 6.40 nm (D) 12.0 nm

7. What is the shape of ClNO

(A) V- shaped (B) T – shaped
(C) Triangle (D) Linear

8. NCl_3 is hydrolysed by water to produce

(A) NH_2NH_2 and HCl (B) NH_2Cl + HOCl
(C) NH_4OH + HOCl (D) NH_2OH + HCl

9. Select the incorrect choice :

(A) solubility of alkaline earth metal's carbonates, sulphates and chromates decreases from Be to Ba.
(B) solubility of alkaline earth metal's hydroxides is less than alkali metal hydroxides.
(C) solubility of alkaline earth metal's oxides increases from Be to Ba.
(D) SO_2 on passing in lime water turns is milky.

10. The reduction potential of $Cu^+ | Cu$ half cell if SRP of $Cu^+ | Cu$ and SRP of $Cu^{2+} | Cu^+$ are 0.34 and 0.16 V respectively, will be

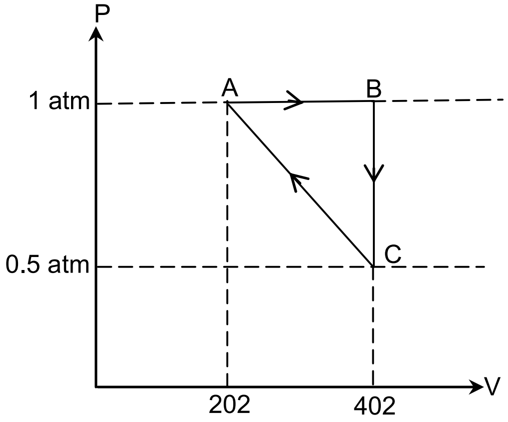
(A) 0.36 V (B) 0.43 V
(C) 0.68 V (D) 0.52 V

Rough Work

Multiple Correct Choice Type

This section contains 5 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

11. On the basis of the following graph (P-V) graph, choose the correct statements.



(A) The entropy change for the over all process is zero
(B) For the over all process Δ H > Δ E
(C) Total work done, W = q
(D) Total work = – 620.77 J

12. 150 ml $\frac{M}{10}$ Ba $(MnO_4)_2$ in acidic medium can oxidise completely.
(A) 150 ml of 1 M Fe^{+2}
(B) 50 ml of 1 M $FeCrO_4$
(C) 25 ml of 1 M $K_2Cr_2O_7$
(D) 100 ml of 2 M $C_2O_4^{-2}$ ions

13. Which of the following is/are produced during heating of Gypsum?
(A) CaO
(B) $Ca(OH)_2$
(C) $CaSO_4$
(D) Plaster of Paris

14. Which of the following solution will be acidic
(A) 0.1 M CH_3COONa
(B) 0.1 M $FeSO_4$
(C) 0.1 M $K_2SO_4Al_2(SO_4)_3.24H_2O$
(D) 0.1 M $(NH_4)_2SO_4$

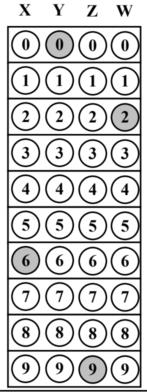
15. If temperature of a gas is raised, which of the following would be true?
(A) Fraction of the molecules possessing most probable velocity will increase
(B) Fraction of the molecules possessing most probable velocity will decrease
(C) Fraction of possessing very low velocity will decrease
(D) Fraction possessing very high velocity will increase

Rough Work

SECTION – C

Integer Answer Type

This section contains 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



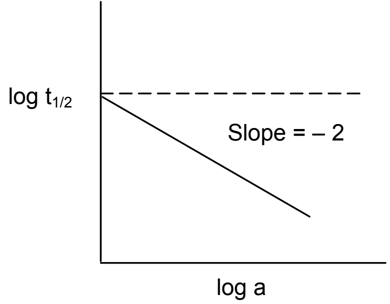
1. An organic compound (A) (m.f. $C_{10}H_{20}$) on reductive ozonolysis gives 2-methyl butanal. Then total no. of steroisomers possible for A is

2. If the half life of a radioactive sample is 2n years. Then the fraction of a sample which will remain decayed after n years is $\frac{1}{\sqrt{x}}$. Then the value of x will be

3. A mixture containing x millimoles of NaOH and y milli moles of Na_2CO_3 requires.
(A) 4 ml of 1 N HCl using phenolphthalien indicator
(B) 5 ml of 1 N HCl using methyl orange indicator
The value of x/y will be

Rough Work

4. A graph between log $t_{1/2}$ and log a (abscissa), a being the initial concentration of A in the reaction. A → Product is depicted in figure.



The rate law is $-\frac{d[A]}{dt} = k[A]^n$

The value of n will be

5. For the reaction $B^+ + H_2O \rightleftharpoons BOH + H^+$, kb for BOH is 1×10^{-6}. If the value of hydrogen constant is 1×10^{-x}. Then value of x is

Rough Work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains 10 multiple choice questions numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. If x = 2 is a real root of cubic equation $f(x) = 3x^3 + bx^2 + bx + 3 = 0$ then the value of $\lim\limits_{x \to \frac{1}{2}} \frac{e^{f(x)} - 1}{2x - 1} =$

(A) $\frac{27}{4}$ (B) $\frac{-27}{4}$
(C) $\frac{-27}{8}$ (D) $\frac{27}{8}$

2. If x ∈ [–20°, –5°] such that $f(x) = \tan(50° + x) + \cos(50° + x) + \cot(50° + x)$ then global maximum value of $f(x)$ is

(A) $\sqrt{\frac{121}{12}}$ (B) $\sqrt{\frac{123}{13}}$
(C) $\sqrt{\frac{121}{4}}$ (D) $\sqrt{\frac{119}{12}}$

3. The number of solution of equation |z| + |z – 1| + |z – 2| + |z – 3| = 4 and $z\bar{z} - z - \bar{z} = \frac{5}{4}$ where z is complex number is

(A) zero (B) one
(C) two (D) infinite

Rough work

4. Let us consider a real values bijective function g(x) such that $g'(x) = \sin^2(x + \pi/4) + 2\cos(x - \pi/4)$ and $g(\pi/4) = 3$ then value of $\left(g^{-1}\right)'$ (3) is

(A) 1 (B) 2
(C) 3 (D) none of these

5. $\int_0^{102} (x-1)(x-2)......(x-100)\left(\frac{1}{x-1} + \frac{1}{x-2} + ...\frac{1}{x-100}\right)dx$ = $\lfloor p - \lfloor q$ then p + q is equal to

(A) 203 (B) 201
(C) 202 (D) 204

6. Let ellipse $4x^2 + 16y^2 = 64$ and circle $x^2 + y^2 = r^2$ have common tangent touching at A and B respectively. Maximum length of AB can be

(A) 4 (B) 3
(C) 2 (D) 5

7. f(x) is defined for x > –1 and has a continuous derivate. If f satisfies f(0) = 1, f′(0) = 0; (1 + f(x)) f″(x) = 1 + x. If x is positive then f′(x) is

(A) always positive (B) always negative
(C) always non-negative (D) none of these

8. Let $f(x) = x^4 - x^3 - 16x^2 + 4x + 48$ then the value of P so that equation $f(|x| + p)$ = 0, have 8 real and distinct zeros

(A) P > –3 (B) P > 3
(C) P < –3 (D) – 3 < P < 3

9. a, b, c denote respectively the sides BC, CA, AB of a triangle ABC. Given that the quadratic equations $ax^2 + bx + c = 0$ and $15x^2 + 8x + 17 = 0$ have the same set of roots, the value of $\frac{r_1 + r_2 + r_3 - r}{R}$ where R denotes the circumradius, r denotes the radius of the incircle and r_1, r_2, r_3 denote the radii of the ex–circles of triangle ABC is

(A) 2 (B) 3
(C) 5 (D) 4

Rough work

10. T_1 and T_2 are the tangents to the hyperbola $x^2 - 2y^2 = 16$ that are perpendicular to the line $x - y + 10 = 0$. Find the perpendicular distance between T_1 and T_2

(A) 1 (B) 4

(C) 6 (D) none of these

Multiple Correct Answer(s) Type

This section contains **5 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

11. Consider the graph of the function $y = e^{\ln\left(\frac{x+3}{x+1}\right)}$ then which of the following is correct

(A) Range of the function is $(1,\infty)$ (B) $f(x)$ has no zeroes

(C) Graph lies completely above the x-axis (D) Domain of f is $(-\infty,-3)\cup(-1,\infty)$

12. $P(x)$ is a fourth degree polynomial such that

(1) $P(-x) = P(x) \forall x \in R$,

(2) $P(x) > 0 \ \forall x \in R$,

(3) $P(0) = 1$,

(4) $P(x)$ has exactly two local minima at x_1 and x_2 such that $|x_1 - x_2| = 2$.

The line $y = 1$ touches the curve at a certain point Q and the enclosed area between the line and the curve is $\frac{8\sqrt{2}}{15}$. Let $g(x) = Ax^2 + Bx + C$ $(A \neq 0)$ such that $\lim_{x\to 0}\frac{P(x) - g(x) - g(-x)}{x^2}$ is finite and is equal to the slope of the tangent of g(x) at $x = -1$. Also, P(x) and g(x) have common tangent at Q parallel to x-axis.

(A) the value of A is $-\frac{1}{2}$ (B) the value of B + C is $-\frac{1}{2}$

(C) the value of A + C is 1 (D) the value of A + B + C is –1

Rough work

13. Let S represents a circle of minimum radius in Argand plane which passes through z_1 and z_2, then

(A) Equation of S is $(z - z_1)(\overline{z} - \overline{z}_2) + (z - z_2)(\overline{z} - \overline{z}_1) = 0$

(B) Centre of S is represented by $(z_1 + 2z_2)$

(C) Radius of S is $\frac{|z_1 - z_2|}{2}$

(D) Let z be any complex number lying on circle S then $\frac{(z_2 - z)}{|z_2 - z|} = \pm\frac{(z - z_1)}{|z - z_1|}i$

14. Let $S_1 \equiv x^2 - 10x + y^2 + 16 = 0,$ and S_2 be the image of S_1 w.r.t. the line x – y = 0 and S_3 be the image of S_2 w.r.t. y = 0. Let S′ is the circle which cut all three circles orthogonally and S″ is the circle of minimum radius which contain all three circles then

(A) equation of circle S′ is $x^2 + y^2 = 16$
(B) equation of circle S″ is $x^2 + y^2 = 64$
(C) the radius of S′ is 4
(D) the radius of S″ is 8

15. A set of lines $x + y - 2 + \lambda_1 (2x + y - 3) = 0$ represents incident rays on an ellipse S = 0 and $2x + 3y - 23 + \lambda_2 (2x - y - 3) = 0$ represents the set of reflective rays from the ellipse where $\lambda_1, \lambda_2 \in R$. If P(3, 7) is a point on the ellipse normal at which meets the major axis at N.

(A) Eccentricity of ellipse is $\frac{\sqrt{5}}{2\sqrt{2}+1}$

(B) N divides line segment joining two foci in the ratio $2\sqrt{2}$: 1

(C) Area of triangle formed by point P and two foci 5

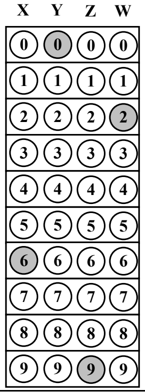
(D) Eccentricity of ellipse is $\frac{\sqrt{5}}{2\sqrt{2}-1}$

Rough work

SECTION – C

Integer Answer Type

This section contains 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. If circum radius of $\triangle ABC$ is 3 cm and its area is 6 cm^2 and DEF is triangle formed by foot of perpendicular drawn from A, B, C on sides BC, CA, AB respectively then perimeter of Δ DEF in cm is __________.

2. Let A and B are two sets such that
   $A = \{x : f(x) = [x^2]$, ([] denotes GIF) is discontinuous in [0, 2] }
   $B = \{x : f(x) = [\tan^2 x]\,[\cot^2 x]$ ([.] denotes GIF) is non differentiable in $(0, \pi)\}$
   If m be the total number of onto function from A to B then total number of divisors of m is __________.

3. If two lines $x + y = |a|$ and $ax = y + 1$ intersect at a point which lies in fourth quadrant then minimum length of focal chord of the parabola $y^2 = 4a^2x + 4\,|a - 1|\,x + 5$ is __________.

4. $\sum_{r=0}^{9} {}^{20}c_{2r}\ \ {}^{20}c_{2r+2} = \frac{a}{a+1}\left({}^{39}c_{21} - {}^{19}c_{10} \right)$
   and $xy = 4a$ then total number of ordered pair solution (x, y) where $x, y \in I^+$ is __________.

5. Let n be the number of triangles formed by the line segment of lengths 2, 3, 4, 5, 6, 7. If x and y are two positive integers whose LCM is (n + 2) then total no of ordered pair solution (x, y) will be __________.

Rough work

From Long Term Classroom Programs and Medium / Short Classroom Program 4 in Top 10, 10 in Top 20, 43 in Top 100, 75 in Top 200, 159 in Top 500 Ranks & 3542 total selections in IIT-JEE 2012

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FIITJEE JEE(Advanced)-2013

ANSWERS, HINTS & SOLUTIONS

FULL TEST –IV

(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	D	A	C
2.	B	B	A
3.	C	D	A
4.	D	B	D
5.	C	C	B
6.	B	A	C
7.	A	A	A
8.	A	C	C
9.	C	C	D
10.	D	D	B
11.	B, D	D	B, C, D
12.	A, B	A, B, C	A, B, D
13.	A, C	A, C, D	A, C, D
14.	A, B, C	B, C, D	A, B, C, D
15.	A, B, C, D	B, C, D	A, B, C
1.	2	6	4
2.	9	2	9
3.	6	3	3
4.	2	3	8
5.	3	8	9

Physics

PART – I

SECTION – A

1. On heating a metal sheet, distance between any two points increases.

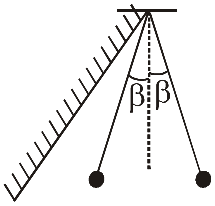
2. Heat taken by ice to convert to water at 100°C fully :
$5 \times (40) \times (0.5) + 5 \times 80 + 5 \times (100) \times (1) = 1000$ cal.
Heat given by steam to condense fully :
$2 \times 500 = 1000$ cal. Hence everything will be water at 100°C.

3. $W_{AB} + W_{BC} + W_{CD} + W_{DA} = \Delta Q$ $\{\because \Delta U = 0$ in cyclic process$\}$

$\Rightarrow W_{AB} + 0 + nRT_0 \ln\left(\frac{V_0}{3V_0}\right) + nR(2T_0 - T_0) = 4nRT_0$ $\{\because$ DA is isobaric process$\}$

get $W_{AB} = nRT_0 \ln 3 + 3nRT_0$

4. As $\alpha > \beta$, no collision will occur with the wall and the ball is doing SHM with amplitude β only.
$T = 2\pi\sqrt{\frac{\ell}{g}}$.

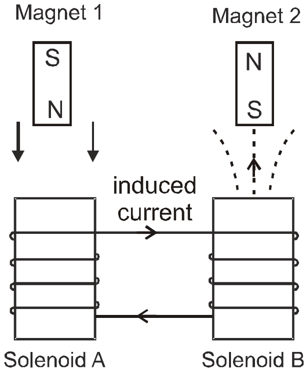


5. As the fluid is at rest; pressure at the same horizontal level in a connected fluid is same if it is at equilibrium.

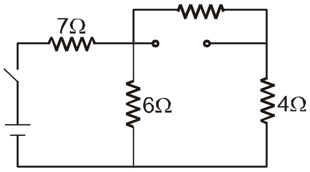
6. The magnetic field will make electrons revolve around the direction of B. It may cause some electrons not to reach the collector plate. If it is very strong; it will not let electrons reach the collector. As the magnitude is not given, hence photo current may decrease.

7. The work done by cell = $\int V\,dq = \int_0^V CV\,dV = \frac{1}{2}CV^2$.

8. As the magnet-1 falls into solenoid A, the magnetic flux associated with solenoid A increases. From Lenz's law, induced current in solenoid A will oppose this increase in magnetic flux. Hence direction of induced current in solenoids is as shown.
The nature of magnetic field produced by solenoid B is as shown. Therefore magnet 2 will be attracted by magnetic field due to solenoid B.



9. at t = 0
$\Rightarrow R_{eq.} = \frac{(4+2)\times 6}{6+6} + 7 = 3 + 7 = 10\ \Omega$

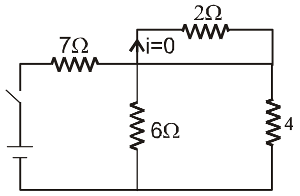


$\Rightarrow\ i_1 = \frac{10}{10} = 1$ A.

at $t = \infty$

$\Rightarrow\ 7 + \frac{4 \times 6}{6 + 4} = 9.4$

$\Rightarrow\ i_2 = \frac{10}{9.4}$ so $\frac{i_1}{i_2} = \frac{1}{(10/9.4)} = 0.94$

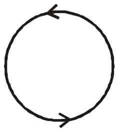


10. Power delivered by mg is converted to the heat dissipated in R_1 and R_2

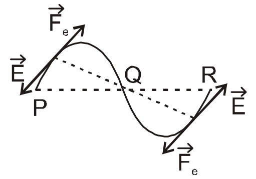
$\Rightarrow\ mgv = P_{R_1} + P_{R_2}$

solving, we get $P_{R_2} = 6W$

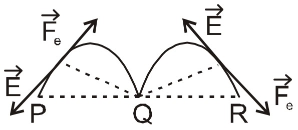
11. The changing magnetic field inside the plane produces electric lines of forces in anticlockwise direction.
There is no direct connection in the shown conductors, so electrons, experiencing electric force, try to accumulate as shown.



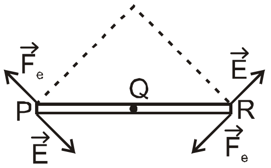
All electrons accumulate at Q symmetrically
$V_P = V_R$



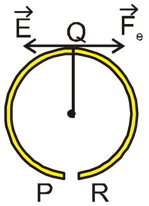
All electrons accumulate at R
$V_P > V_R$



electrons accumulate
at P $V_P < V_R$



electrons accumulate at R
$V_P > V_R$



12. Fission of a nucleus is feasible only if the binding energy of daughter nuclei is more than the parent nucleus.
A = 55 will have more BE than 110.
A = 70 will have same BE as 110 but A = 40 will have more B.E.
A = 100 will have same BE as 110 but A = 10 will have lesser B.E.
A = 90 will have same BE as 110 but A = 20 will have lesser B.E.

13. $\lambda \propto \frac{1}{T} \Rightarrow T_1 > T_2 > T_3$ as $\lambda_1 < \lambda_2 < \lambda_3$ (Wien's law)

Now as the area under the curve E_λ and λ gives the intensity; so

$\sigma Ae_3T_3^4 > \sigma Ae_2T_2^4$ {Areas of the bodies are same, given}

Now as $T_3 < T_2 \Rightarrow e_3 > e_2$.

14. hv = K.E. (T) + work function (W)

$\Rightarrow$ hv = T + W

$\Rightarrow$ 4.25 eV = $T_A + W_A$ (for Metal A)

$\Rightarrow$ 4.70 eV = $T_B + W_B$ (for Metal B)

Since $T_B = (T_A - 1.5)$ eV

Also $\lambda = h/p$

$$\Rightarrow \lambda = \frac{h}{\sqrt{2mT}} \quad \left\{\because \frac{p^2}{2m} = T = K.E.\right\}$$

$$\Rightarrow \frac{\lambda_A}{\lambda_B} = \sqrt{\frac{T_B}{T_A}}$$

Since $\lambda_A = \frac{1}{2}\lambda_B$

$\Rightarrow T_A = 4T_B$

$\Rightarrow T_B = T_A - 1.50$ gives

$T_B = 4T_B - 1.5$

$\Rightarrow T_B = 0.5$ eV

$\Rightarrow T_A = 2$ eV

$\Rightarrow W_A = 2.25$ eV

$\Rightarrow W_B = 4.20$ Ev

15. $P = V^3$, for ideal gas

PV = nRT

(A) relation between V and T

$V \times (3V^3) = nRT$

$$\Rightarrow V^4 = \left(\frac{nR}{3}\right)T \Rightarrow V^4 \propto T$$

(B) Relation between P and T

$$PV = nRT \Rightarrow P\left(\frac{P}{3}\right)^{1/3} = nRT$$

$\Rightarrow P^{4/3} \propto T$

(C) For expansion

V → increases

work-done : positive

internal energy : increases

Hence, heat will have to supplied to the gas.

(D) As $T \propto V^4$

with increase in temperature, volume increases

Hence work done is positive.

SECTION –C

1. $$v = \sqrt{\frac{T}{\mu}}$$

T can be calculated by using Hooke's Law and on stretching μ also changes.

2. $$f_1 = \left(\frac{340}{340 - 34}\right)f = \frac{10}{9}f$$

and $f_2 = \left(\frac{340}{340-17}\right)f = \frac{20}{19}f$

and $\frac{f_1}{f_2} = \frac{\frac{10}{9}}{\frac{20}{19}} = \frac{19}{18}$

3. For 1st reading of oscillator

$f_A = (514 \pm 2)$Hz

$\Rightarrow$ f_A = 516 Hz or 512 Hz

For 2nd reading of oscillator

$f_A = (510 \pm 6)$ Hz

$\Rightarrow$ f_A = 516 Hz or 504 Hz

$\Rightarrow$ A has a frequency of 516 Hz

4. Velocity of approach of man towards the bicycle = (u – v)
Hence velocity of approach of image towards bicycle is 2(u – v).

5. For A :

Total number of waves = $\frac{(1.5)t}{\lambda}$ ....(1)

$\because \begin{pmatrix}\text{Total number}\\ \text{of waves}\end{pmatrix} = \left(\frac{\text{optical path length}}{\text{wavelength}}\right)$

For B and C :

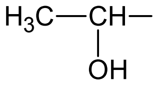
Total number of waves = $\frac{n_B\left(\frac{1}{3}\right)}{\lambda} + \frac{(1.6)\left(\frac{2t}{3}\right)}{\lambda}$ ....(2)

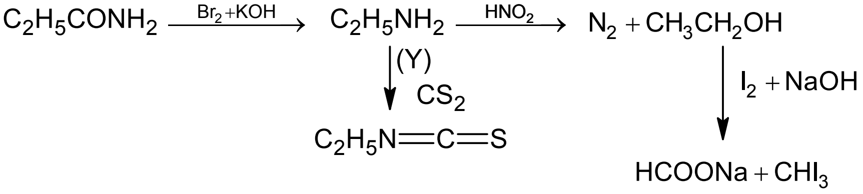
Equating (1) and (2)

$\Rightarrow n_B = 1.3$

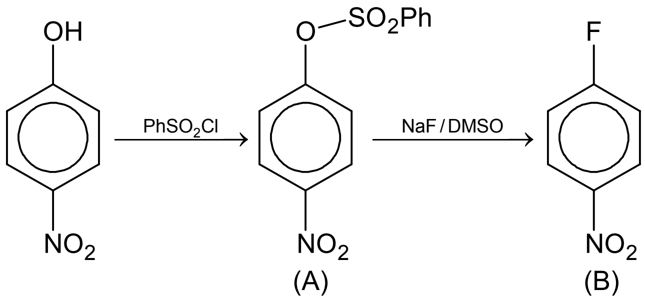
Chemistry PART – II

SECTION – A

1. Reaction of X with Br_2 + KOH suggests that X is an amide. Evolution of N_2 and formation of alcohol suggests that Y is a 1° aliphatic amine. Iodoform test of Z suggests that it is an alcohol containing  $H_3C-\underset{\displaystyle OH}{\underset{|}{CH}}-$ group.



$$\begin{tikzcd} C_2H_5CONH_2 \arrow[r, "Br_2+KOH"] & C_2H_5NH_2 \arrow[r, "HNO_2"] \arrow[d, "(Y)" ', "CS_2"] & N_2 + CH_3CH_2OH \arrow[d, "I_2+NaOH"] \\ & C_2H_5N{=}C{=}S & HCOONa + CHI_3 \end{tikzcd}$$

2. 

F^- is very reactive unsolvated which can displace $PhSO_3^-$ which being a good leaving group in presence of strong withdrawing group —NO_2.

3.
$$\begin{array}{lll} PCl_3 & + \ \frac{1}{2}O_2 \longrightarrow & POCl_3 \\ \frac{11}{137.3} & \frac{1.34}{32} & \\ =0.0801 & =0.0419 & 0.0801 \end{array}$$

Limiting reagent

Moles of $POCl_3$ formed = 0.0801

Mass of $POCl_3$ = 0.0801 × 153.3
= 12.3 g

Percentage yield = $\frac{11.2}{12.3}\times 100 = 91\%$

4. d = 0.714 g/L at STP

$\Rightarrow$ m = 0.714 g T = 273 K

P = 1 atm V = 1 L

$n = \frac{PV}{RT} = \frac{1\times 1}{0.0821\times 273} = 4.46\times 10^{-2}$

mass of this one litre sample is known from density

molar mass of the gas, M = $\frac{0.714}{4.46\times 10^{-2}} = 16 g/mole$

5. $U_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3\times 8.314\times 300}{0.03995}} = 432.78 \approx 433$

As molar mass of Ar = 39.95 g/mol
= 0.03995 kg/mol

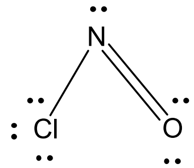
6. $\frac{1}{\lambda} = Z^2Rh\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$= 6^2 \times 1.097\times 10^7\left[\frac{1}{1^2} - \frac{1}{3^2}\right]$

$= 36\times 1.097\times 10^7\left[\frac{8}{9}\right] m^{-1}$

λ = 2.85 nm

7.



Central N-atom is bonded to two other atoms and has one l.p., the electron pair arrangement is trigonal planar. The $C\ell - N - O$ bond angle is about 120° (we expect it to be slightly less than 120 because of greater lp-bp-repulsions) and the molecule is V-shaped.

8. $NCl_3 + 4H_2O \longrightarrow NH_4OH + 3HOCl$

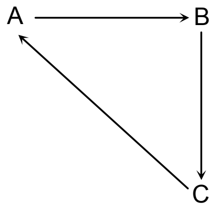
10.

$$\begin{array}{lll} Cu^{+2} + 2e^- \longrightarrow Cu, & & \Delta G_1 = -2F\times 0.34 \\ Cu^+ \longrightarrow Cu^{+2} + e^- & & \Delta G_2 = F\times 0.16 \\ \hline Cu^+ + e^- \longrightarrow Cu & & \end{array}$$

$\Delta G_3 = \Delta G_1 + \Delta G_2 = -0.52\ F$

$\Rightarrow E_{cu^+/Cu} = 0.52\ V$

11.



Thus it is a cyclic process.
Hence, $\Delta E = 0$, $\Delta H = 0$, $\Delta S = 0$
and $\Delta E = q + w$ (1st law)
$\therefore 0 = q + w$
or $q = -w$
Total work done = $W_{A\to B} + W_{B\to C} + W_{C\to A}$

$\therefore w = -P(V_B - V_A) + 0 + 2.303\ nRT \log\frac{V_C}{V_A}$

$= -(40 - 20) + 0 + 2.303 \times 1 \times 0.082 \times \log\frac{V_C}{V_A}$

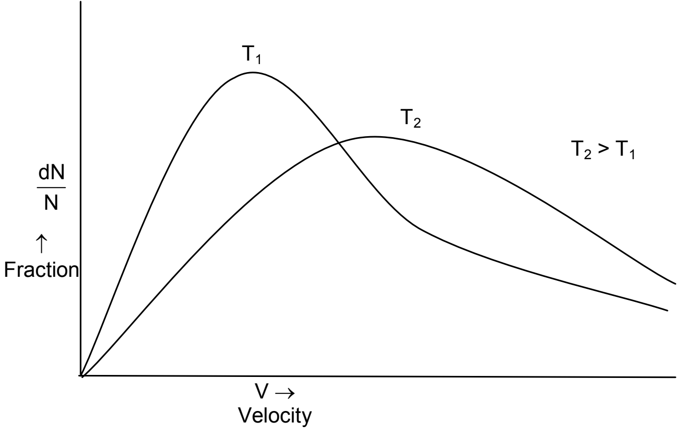
= – 6.13 litre-atmosphere
= – 620.77 J

12. Milli equivalent of $Ba(MnO_4)_2$ = Meq of Fe^{+2}
= Meq of $FeCrO_4$
= Meq of $K_2Cr_2O_7$

13. $$2[CaSO_4.2H_2O]\xrightarrow[-3H_2O]{120^0C}\underset{\text{Plaster of Paris}}{2CaSO_4.H_2O}\xrightarrow[-H_2O]{\Delta}2CaSO_4\xrightarrow[\text{strongly}]{\text{heated}}2CaO+2SO_2+O_2$$

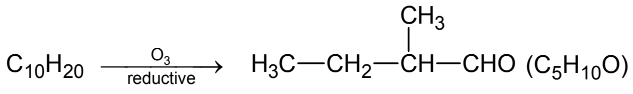
14. In case of B, C and D, the salt are of weak base and strong acid which undergo hydrolysis to give acidic solutions CH_3COONa however, on hydrolysis gives basic solution.

15. On increasing temperature, the Maxwell curve of distribution of molecular velocity is flattened and maximum is shifted to higher velocity.



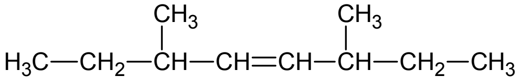
SECTION – C

1.



$$C_{10}H_{20}\xrightarrow[\text{reductive}]{O_3}H_3C-CH_2-\overset{\overset{\displaystyle CH_3}{|}}{C}H-CHO\ (C_5H_{10}O)$$

⇒ Structure of A



$$H_3C-CH_2-\overset{\overset{\displaystyle CH_3}{|}}{C}H-CH{=}CH-\overset{\overset{\displaystyle CH_3}{|}}{C}H-CH_2-CH_3$$

No. of stereoisomers of A = 6

3. $x \times 1 + y \times 1 = 4 \times 1$ Eq. (1)
$x \times 1 + 2y = 5 + 1$ Eq. (2)
From Eq. (1) and Eq. (2) we get
$y = 1$
$x = 3$
$\Rightarrow x / y = 3$

4. $t_{1/2} \propto \frac{1}{a^{1-n}}$
$\Rightarrow t_{1/2} = K\,a^{1-n}$
K^{-1} rate constant
$\text{Log } t_{1/2} = \log K + (1 - n) \log a$
$Y = C + mx$
Slope = $(1 - n) = -2$
$\Rightarrow n = 3$

5. $K_h = \frac{K_w}{K_b} = \frac{10^{-14}}{10^{-6}} = 10^{-8}$

Mathematics PART – III

SECTION – A

1. $3x^3 + bx^2 + bx + 3 = 0 \Rightarrow 3(x^3 + 1) + bx(x + 1) = 0$ has roots $-1, 2, \frac{1}{2}$.

So, $\lim\limits_{x\to\frac{1}{2}} \frac{e^{f(x)}-1}{2x-1} = \lim\limits_{x\to\frac{1}{2}} \frac{3x^2+bx^2+bx+3}{2x-1} = \lim\limits_{x\to\frac{1}{2}} \frac{3(x+1)(x-2)\left(x-\frac{1}{2}\right)}{2\left(x-\frac{1}{2}\right)} = \frac{3}{2}\times\frac{3}{2}\times\frac{-3}{2} = \frac{-27}{8}$

7. $f''(x) = \frac{1+x}{1+f(x)}$. Also $f''(x) > 0 \Rightarrow f'(x)$ is increasing $\Rightarrow f'(x) > f'(0) = 0\ \forall\ x > 0$

8. When $P < -3$, $F(x+p)$ will have 4 positive roots

9. We have $\frac{a}{15} = \frac{b}{8} = \frac{c}{17} \Rightarrow a = 15\lambda, b = 8\lambda, c = 17\lambda$ (λ being a positive constant)
Note that $a^2 + b^2 = c^2$
Triangle ABC is right angled
$R = \frac{1}{2}(17\lambda)$, Δ = area of $\Delta ABC = 60\lambda^2$
$s = 20\lambda$, $s - a = 5\lambda$, $s - b = 12\lambda$, $s - c = 3\lambda$
$r_1 + r_2 + r_3 - r = \frac{\Delta}{s-a}+\frac{\Delta}{s-b}+\frac{\Delta}{s-c}-\frac{\Delta}{s} = 12\lambda + 5\lambda + 20\lambda - 3\lambda = 34\lambda$
$\Rightarrow \frac{r_1+r_2+r_3-r}{R} = \frac{34\lambda}{17\lambda}\times 2 = 4$

10. Any line perpendicular to $x - y + 10 = 0$ is of the form $x + y = k$
If this line is a tangent to the hyperbola $x^2 - 2y^2 = 16$, $k^2 = 16(-1)^2 - 8 = 8$ (using $c^2 = a^2m^2 - b^2$)
$\therefore k = \pm 2\sqrt{2}$
$\therefore T_1$ and T_2 are $x + y + 2\sqrt{2} = 0$ and $x + y - 2\sqrt{2} = 0$
$\therefore$ Distance between them $= \frac{4\sqrt{2}}{\sqrt{2}} = 4$

11. $y = \frac{x+3}{x+1} > 0 \Rightarrow x < -3$ or $x > -1$
or $\begin{matrix} x \to -3 & & x \to \infty \\ y \to 0 & & y \to 1 \end{matrix}$
$(0,1) \cup (1,\infty)$

12. $P(x)$ is an even function.
$\therefore\ P(x) = ax^4 + bx^2 + 1$ and $P'(x) = 4ax^3 + 2bx = 2x\left(2ax^2 + b\right)$
It has two minima. Hence, a > and b < 0.
So, at $x = \pm\sqrt{\frac{-b}{2a}}, P(x)$ has minima.

$2\sqrt{\frac{-b}{2a}} = 2 \quad \Rightarrow b = -2a$

$\therefore$ Maximum at (0, 1).

Also, $\frac{8\sqrt{2}}{15} = 2\int_{0}^{\sqrt{\frac{-b}{a}}} \left(1-\left(ax^4+bx^2+1\right)\right)dx \quad \Rightarrow b = -1 \; a = \frac{1}{2}$

Now, $\lim\limits_{x\to 0} \frac{P(x)-\left(g(x)+g(-x)\right)}{x^2}$ is finite.

$\Rightarrow \; C = \frac{1}{2}, B = -1$

Also, y = 1 is tangent to $Ax^2 - x + \frac{1}{2} = f(x)$

$\Rightarrow \; Ax^2 - x + \frac{1}{2} = 1$ has equal roots

$\Rightarrow \; A = -\frac{1}{2}$

13. z_1 and z_2 are end points of diameter.

14. S' is radical circle of S_1, S_2 and S. S'' is circle of centre = radical centre and radius = 8 and $r_1 = 4$, r = 8

15. 2ae = 5, 2a = (2√2 + 1) √5, e ⇒ $\frac{\sqrt{5}}{2\sqrt{2}+1}$

Foci are $S_1(1, 1)$ and $S_2(4, 5)$ $\frac{S_1N}{S_2N} = \frac{PS_1}{PS_2} = \frac{\sqrt{40}}{\sqrt{5}} = 2\sqrt{2}$

SECTION – C

1. Perimeter of Δ DEF = a cos A + b cos B + c cos C
= R [sin 2A + sin 2B + sin 2C]
= R [4 sin A + sin B + sin C]
$= 4R\,\frac{abc}{8R^3} = \frac{abc}{2R^2} = \frac{2\Delta}{R} = 4\text{cm}.$

2. A = $A = \left\{1, \sqrt{2}, \sqrt{3}, 2\right\}$, $B = \left\{\frac{\pi}{4}, \frac{\pi}{2}, \frac{3\pi}{4}\right\}$ $\quad m = 3^4 - \left({}^3c_1\, 2^4 - {}^3c_2\right) = 36 = 2^2\, 3^2$ hence number of divisors of m is 9

4. $\frac{(1+x)^{20}+(1-x)^{20}}{2} = {}^{20}c_0 + {}^{20}c_2\, x^2 + {}^{20}c_4\, x^4 + \text{-----}\; {}^{20}c_{20}\, x^{20}$

$= {}^{20}c_0\;\, x^{20} + {}^{20}c_2\, x^{18} + {}^{20}c_4\, x^{16} + \text{-----}\; {}^{20}c_{20}$

So, $\sum\limits_{r=0}^{9} {}^{20}c_{2r}\;\, {}^{20}c_{2r+2}$ = coeff of x^{22} in $\frac{\left[(1+x)^{2n}+(1-x)^{2n}\right]}{4}$

⇒ a = 10 ⇒ xy = 40 has total order pair (x, y) solution = 4 × 2 = 8

From Long Term Classroom Programs and Medium / Short Classroom Program 4 in Top 10, 10 in Top 20, 43 in Top 100, 75 in Top 200, 159 in Top 500 Ranks & 3542 total selections in IIT-JEE 2012

ALL INDIA TEST SERIES

FIITJEE **JEE (Advanced), 2013**

FULL TEST – IV

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 198**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 to 14) contains 3 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (15 to 20) contains 6 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	$6.625 \times 10^{-34}\ \text{J}\cdot\text{s}$
		=	$6.625 \times 10^{-27}\ \text{erg}\cdot\text{s}$
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

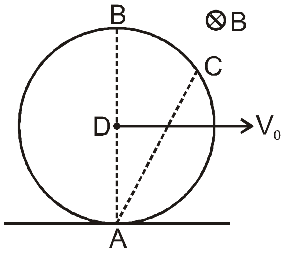
PART – I

SECTION – A

Single Correct Answer Type

This section contain **8 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

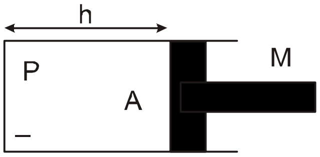
1. A conducting disc of radius R is rolling without sliding on a horizontal surface with a constant velocity of centre of mass, V_0. A uniform magnetic field of strength B is applied normal to the plane of the disc. Then the EMF induced between points B and C will be : (Take AB = 2R, D as centre and length AC = $\sqrt{3}R$).



(A) $\frac{3BV_0R}{2}$ (B) $\frac{5BV_0R}{2}$

(C) $\frac{BV_0R}{2}$ (D) $2BV_0R$

2. A cylindrical conducting piston of mass M slides smoothly inside a long cylinder closed at one end, enclosing a certain mass of a gas. The cylinder is kept with its axis horizontal. If the piston is disturbed from its equilibrium position, it oscillates simple harmonically. The period of oscillation will be (process is isothermal)

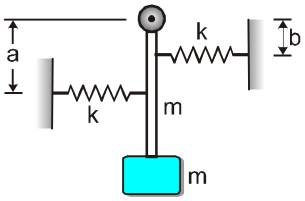


(A) $T = 2\pi\sqrt{\frac{Mh}{PA}}$ (B) $T = 2\pi\sqrt{\frac{MA}{Ph}}$

(C) $T = 2\pi\sqrt{\frac{M}{PAh}}$ (D) $T = 2\pi\sqrt{MPhA}$

Rough work

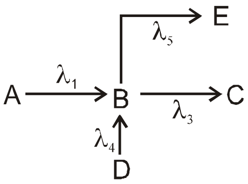
3. A rod of mass m and length L is hinged at its one end and carries a block of same mass m at its lower end. Two springs of same force constant k are installed at distances a = L/2 and b = L/4 respectively as shown in the figure. If the whole arrangement lies in the vertical plane, the frequency of small vibration is :



(A) $\frac{1}{2\pi}\sqrt{\frac{\frac{3mgL}{2}+\frac{5kL^2}{4}}{4mL^2}}$ (B) $\frac{1}{2\pi}\sqrt{\frac{3mgL+\frac{5kL^2}{4}}{\frac{4mL^2}{3}}}$

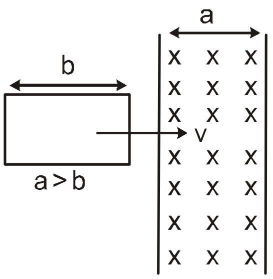
(C) $\frac{1}{2\pi}\sqrt{\frac{\frac{mgL}{2}+\frac{5kL^2}{16}}{\frac{mL^2}{3}}}$ (D) $\frac{1}{2\pi}\sqrt{\frac{\frac{3mgL}{2}+\frac{5kL^2}{16}}{\frac{4mL^2}{3}}}$

4. In radioactive chain reaction shown, initially at t = 0; only N_0 molecules of A are present. At some time t = t, number of molecules of A, B, C, D and E are N_1, N_2, N_3, N_4 and N_5 respectively. Then the activity of B at this time t is :



(A) $\lambda_1 N_1 + \lambda_4 N_4 - \lambda_5 N_2 - \lambda_3 N_2$
(B) $(\lambda_3 + \lambda_5)\ N_2$
(C) $\lambda_1 N_1 + \lambda_4 N_4 - \lambda_5 N_5 - \lambda_3 N_3$
(D) $(\lambda_1 + \lambda_4 - \lambda_3 - \lambda_5)N_2$

5. In the given arrangement, the loop is moved with constant velocity v in a uniform magnetic field B in a restricted region of width a. The time for which the emf is induced in the circuit is:

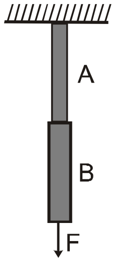


(A) $\frac{2b}{\nu}$ (B) $\frac{2a}{\nu}$

(C) $\frac{(a+b)}{\nu}$ (D) $\frac{2(a-b)}{\nu}$

Rough work

6. The wires A and B shown in the figure, are made of the same material and have unequal radii of cross-section r_A and r_B. When a constant force F is applied as shown, one of the wires breaks.
(A) A will break before B if $r_A > r_B$
(B) B will break before A if $r_A < r_B$
(C) Either A or B could break if $r_A = r_B$
(D) The lengths of A and B must be known to decide which wire will break



7. Two moving lumps of clay collide head on and stick together, the composite lump moving with a kinetic energy which is 80% less than the initial kinetic energy of the two initial lumps. If the final velocity of the lumps is 0.5 m/s, the relative velocity of the lumps before collision is
(A) at least 2 m/s (B) at most 2 m/s
(C) at least 1 m/s (D) at most 1 m/s

8. A uniform magnetic field $\vec{B} = B_0\hat{j}$ exists in space. A particle of mass *m* and charge *q* is projected in the negative *x*-direction with speed *v* from a point (*d*, 0, 0). The maximum value of *v* for which the particle does not hit the yz-plane is
(A) $\frac{Bqd}{m}$ (B) $\frac{2Bqd}{m}$
(C) $\frac{Bqd}{2m}$ (D) $\frac{Bqd}{3m}$

Rough work

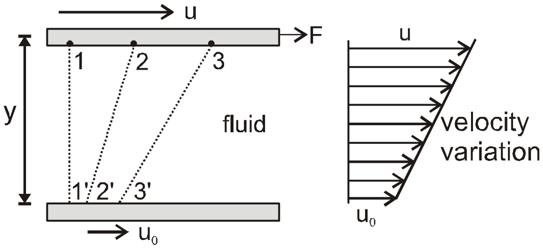
Comprehension Type

This section contains 3 groups of questions. Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Questions 9 and 10

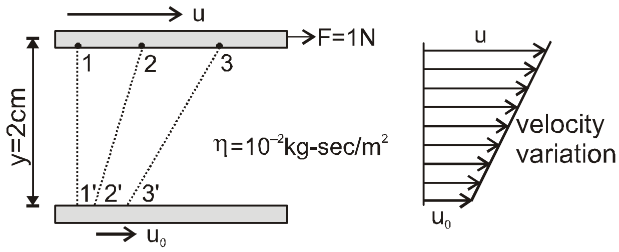
In the shown figure, both the plates are moving. The fluid between the plates moves such that fluid particles in contact of the plates move with same velocity as the plates. The fluid particles in the gap moves in a linear velocity distribution function. As per Newton law of viscosity, the tangential force F is given by

$$F = \eta A \frac{u - u_0}{y}$$



Where η = coefficient of viscosity = 10^{-2} kg -sec/m^3, A = Area of the plate = 1 m^2, y = distance between both the plates = 2 cm. The velocity gradient is given by $\frac{du}{dy}$.

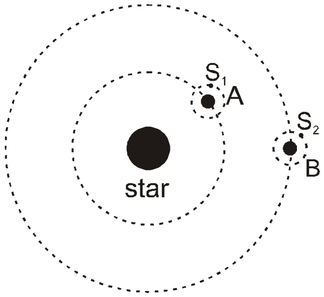
9. If the tangential force F = 1 Newton and u_0 = 1 m/s, then the velocity profile for the given figure is
   (A) u = 100 y
   (B) u = 200 y
   (C) u = 200 y + 1
   (D) u = 100 y + 1



10. In the previous question, the constant velocity of the upper plate would be :
    (A) 1 m/s
    (B) 2 m/s
    (C) 3 m/s
    (D) 4 m/s

Rough work

Paragraph for Questions 11 and 12



Consider a star and two planet system. The star has mass M. The planet A and B have the same mass m, radius a and they revolve around the star in circular orbits of radius r and 4r respectively (M > > m, r >> a). Planet A has intelligent life, and the people of this planet have achieved a very high degree of technological advance. They wish to shift a geostationary satellite of their own planet to a geostationary orbit of planet B. They achieve this through a series of high precision maneuvers in which the satellite never has to apply brakes and not a single joule of energy is wasted. S_1 is a geostationary satellite of planet A and S_2 is a geostationary satellite of planet B. Neglect interaction between A and B, S_1 and S_2, S_1 and B & S_2 and A.

11. The ratio of time of revolution of planet A and planet B about star is :

(A) $\frac{T_A}{T_B} = \frac{1}{8}$ (B) $\frac{T_A}{T_B} = 8$

(C) $\frac{T_A}{T_B} = 4$ (D) $\frac{T_A}{T_B} = \frac{1}{4}$

12. If the radius of the geostationary orbit in planet A is given by $r_G = r\left(\frac{m}{M}\right)^{1/3}$, then the time in which the geostationary satellite will complete 1 revolution is

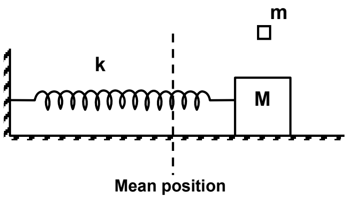
I. 1 planet year = time in which planet revolves around the star
II. 1 planet day = time in which planet revolves about its axis.

(A) I (B) II

(C) both I and II (D) neither I nor II.

Rough work

Paragraph for Questions 13 and 14



A horizontal spring block system executes SHM with amplitude A = 10 cm initial phase $\phi = 0$ and angular frequency ω. The mass of block is M = 13 kg and there is no friction between the block and the horizontal surface. The spring constant being 2500 N/m.

At t = t_1 sec [for which $\omega t_1 = \phi_1 = 30°$]. A mass m = 12 kg is gently put on the block. [Assume that collision between the block and the mass is perfectly inelastic and mass m remains stationary w.r.t. the block M always]

Read above passage carefully and answer the following questions.

13. The new angular frequency of the system will be

(A) 10 rad/sec (B) 15 rad/sec
(C) 20 rad/sec (D) none

14. The total energy of system after collision at any moment of time is

(A) 4 joule (B) 8 joule
(C) 12 joule (D) none of these

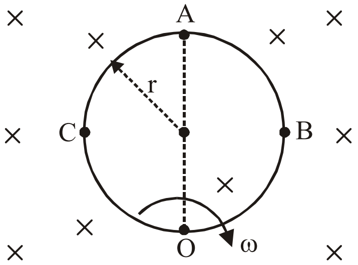
Rough work

Multiple Correct Answer(s) Type

The section contains **6 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct.**

15. A thin paper of thickness 0.02 mm having refractive index 1.45 is pasted across one of the slits in a Young's double slit experiment. The paper transmits 4/9 of light falling on it. (λ_{light} = 600 nm).
(A) Amplitude of light wave transmitted through the paper will be 2/3 times that of incident wave.
(B) The ratio of maximum and minimum intensity in the fringe pattern will be 25.
(C) The total number of fringe crossing the centre if an identical paper is pasted on the other slit is 15.
(D) The ratio of maximum and minimum intensity in the pattern will be 5.

16. In the figure, there is a conducting ring having resistance R placed in the plane of the paper in a uniform magnetic field B_0. The ring is rotating (in the plane of paper) about an axis passing through point O with constant angular speed ω in clockwise direction.
(A) Point A will be at higher potential than O.
(B) The potential of point B and C will be same.
(C) The current in ring will be zero.
(D) The current in the ring will be $\frac{2B_0\omega.r^2}{R}$.

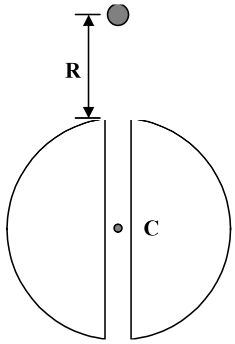


17. Which of the following will have a different time period (compared to the earth), if taken to the moon?
(A) A simple pendulum.
(B) A spring mass system oscillating vertically in the gravitational field.
(C) A torsion pendulum.
(D) An hourglass clock, which is essentially a vessel filled with a liquid, emptying through a hole in the bottom.

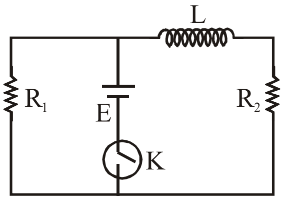
Rough work

18. Hydrogen atoms absorbs radiation of wavelength λ_0 and consequently emit radiations of 6 different wavelengths of which three wavelengths are shorter than λ_0.
(A) The final excited state of the atoms is n = 4
(B) The initial state of the atoms may be n = 2
(C) The initial state of the atoms may be n = 3
(D) There are three transitions belonging to Lyman series.

19. A particle is dropped from a height equal to the radius of the earth above the tunnel dug through the earth as shown in the figure.
R : Radius of earth.
M : Mass of earth.
(A) Particle will oscillate through the earth to a height R on both sides
(B) Particle will execute simple harmonic motion
(C) Motion of the particle is periodic
(D) Particle passes the centre of earth with a speed = $\sqrt{\frac{2GM}{R}}$



20. In the L–R circuit shown in the figure, the key K is closed at time t = 0.
(A) the current through R_1 decreases with time, t
(B) the drop across L increases with t
(C) the magnetic energy stored, in the steady state, equals $\frac{1}{2}L\frac{E^2}{R_2^2}$
(D) the total current through the battery is, in the steady state, $\frac{E}{R_1}+\frac{E}{R_2}$



Rough work

Chemistry

PART – II

SECTION – A

Straight Objective Type

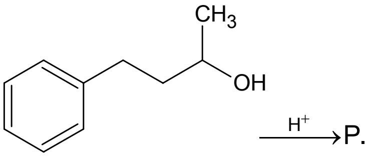
This section contains 8 multiple choice questions numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. In an amino acid the carboxylic acid group has $K_a = 10^{-4}$ and amino group has $K_b = 10^{-5}$. The isoelectric point of that amino acid is

(A) 4	(B) 5
(C) 6.5	(D) 4.5

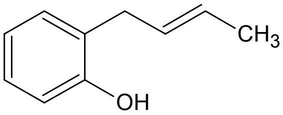
2. Why do mercury batteries and lead acid batteries maintain approximate constant voltage?
(A) They never run down
(B) No aqueous species appear in the equation for the overall cell reaction
(C) Their E° values are very high
(D) The concentration of reagents in the half cell reactions remain approximately constant

3.

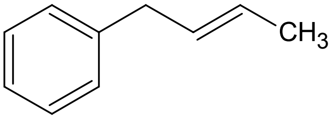


The product P is

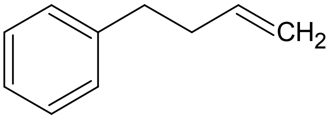
(A)



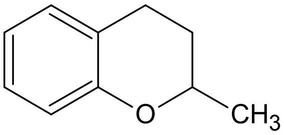
(B)



(C)



(D)



4. Which of the following quantities is proportional to the electron density at a point?

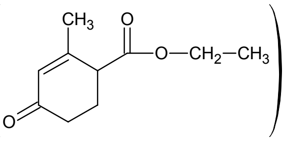
(A) the wave function	(B) the de-Broglie wavelength
(C) the square of wave function	(D) the reciprocal of the de Broglie wavelength

Rough Work

5. Which of the following will give maximum number of isomers?

(A) $\left[Co\left(NH_3\right)_4Cl_2\right]$ (B) $\left[Ni(en)\left(NH_3\right)_4\right]^{2+}$

(C) $\left[Ni\left(C_2O_4\right)(en)_2\right]$ (D) $\left[Cr(SCN)_2\left(NH_3\right)_4\right]^{2+}$

6. A compound Hagemann's Ester () can be prepared by treating a mixture of formaldehyde and ethylacetoacetate. Following steps are used

1. Itnramolecular aldol condensation.
2. Acid hydrolysis followed by decarboxylation
3. Michael addition
4. Aldol like condensation

What is the correct sequence of reactions:

(A) $1 \to 2 \to 3 \to 4$ (B) $4 \to 3 \to 1 \to 2$

(C) $4 \to 3 \to 2 \to 1$ (D) $2 \to 3 \to 4 \to 1$

7. Which of the following compounds on decomposition, releases two gases containing the same elements?

(A) $FeSO_4$ (B) $FeCO_3$

(C) $Fe(NO_3)_2$ (D) $Fe(ClO_3)_2$

8. If the energy of H-atom in the ground state is – E, the velocity of photo-electron emitted when a photon having energy E_p striked a stationary Li^{2+} ion in ground state, is given by:

(A) $V = \sqrt{\frac{2\left(E_p - E\right)}{m}}$ (B) $V = \sqrt{\frac{2\left(E_p + 9E\right)}{m}}$

(C) $V = \sqrt{\frac{2\left(E_p - 9E\right)}{m}}$ (D) $V = \sqrt{\frac{2\left(E_p - 3E\right)}{m}}$

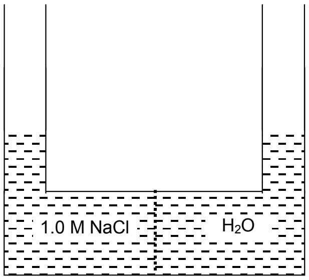
Rough Work

Comprehension Type

This section contains 3 groups of questions. Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 9 to 10

Read the paragraph carefully and answer the following questions:
Osmosis is a process of movement of solvent particles from a region of lower to higher concentration through semi permeable membrane. The pressure exerted by the liquids on semi permeable membrane at the time of equilibrium is called osmotic pressure. If the pressure more than osmotic pressure is applied at the more concentration side, reverse osmosis takes place, which is used for the purification of water



9. Select the correct statement for the above diagram
   (A) If semi permeable membrane is permeable to only H_2O, level of liquid in the left arm will decrease
   (B) If membrane is permeable to H_2O, Cl^- and Na^+ all, the level of liquid in two arms is different
   (C) In the reverse osmosis process water will move from NaCl side to H_2O side
   (D) all of these

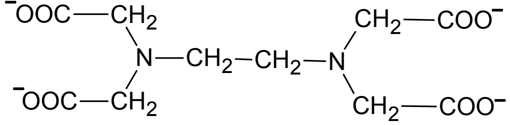
10. A water desalination plant is set up near a salt marsh containing water that is 0.1 NaCl. The minimum pressure (P) that must be applied at 27°C to purify the water by reverse osmosis is
    (A) $P \geq 4.926$ atm
    (B) $P \geq 2.46$ atm
    (C) $P \leq 2.46$ atm
    (D) $P \leq 4.926$ atm

Rough Work

Paragraph for Question Nos. 11 to 12

Read the paragraph carefully and answer the following questions:

EDTA is used as a complexing agent in chemical analysis. Solution of EDTA usually containing the disodium salt Na_2H_2 EDTA are also used to treat heavy metal poisoning. EDTA is a hexadentate ligand having the following structure.



Answer the following questions

11. A solution having equal moles of both reactant show the following equilibrium ($K_{eq}=10^{-3}$)

$$Pb^{2+}(aq) + H_2\,EDTA^{2-}(aq) \rightleftharpoons Pb\,EDTA^{2-}(aq) + 2H^{+}(aq)$$

If concentration of complex at equilibrium is 10^{-3} M find the concentration of Pb^{2+} at equilibrium maintained at pH = 3

(A) 10^{-9} (B) 10^{-6}
(C) 10^{-3} (D) None of these

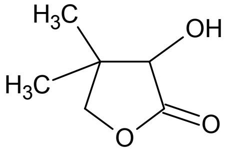
12. EDTA forms stable complexes with many metal ions due to

(A) High negative charge density (B) Chelation
(C) Low negative charge density (D) Because it is very weak field ligand

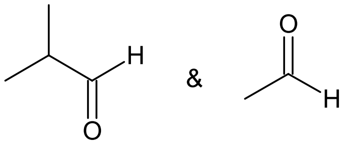
Rough Work

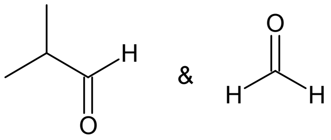
Paragraph for Question Nos. 13 to 14

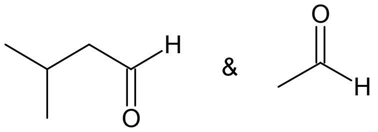
The aliphatic aldehyde 'P' and 'Q' react in the presence of aqueous K_2CO_3 to give compound 'R', which upon treatment with HCN provides compound 'S'. On acidification and heating, 'S' gives the product shown below:

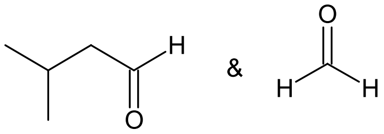


13. The compounds P and Q respectively are

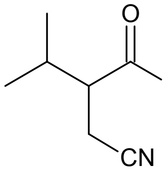
(A)


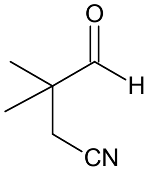
(B)


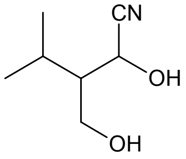
(C)


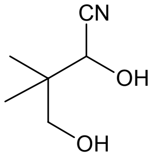
(D)


14. The compound S is

(A)


(B)


(C)


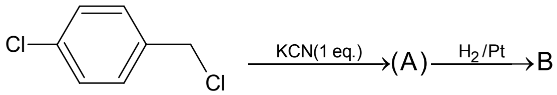
(D)


Rough Work

Multiple Correct Choice Type

This section contains 6 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

15.



Correct statement for product B is
(A) It is gives positive carbyl amine test
(B) It gives coupting reaction with diazonum salt
(C) It gives alcohol on treatment with nitrous acid
(D) It forms dibromo derivative with bromine water

16. Trans-2-butene $\xrightarrow{CF_3CO_3H} A \xrightarrow{H_3O^+} B \xrightarrow{HIO_4} C$

The incorrect statement is
(A) The product B is optically active
(B) Product C gives the iodoform test
(C) Product C does not gives iodoform test
(D) Product A is an alcohol

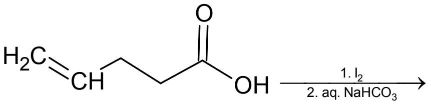
17. For which of the following species it is possible to solve equation analytically and obtain an equation for its electronic energy level
(A) He (B) Li^{2+}
(C) H_2 (D) H

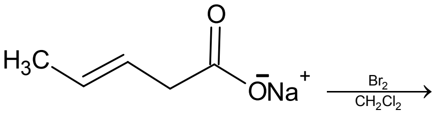
Rough Work

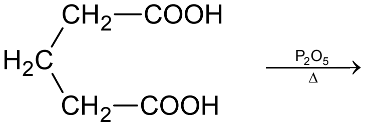
18. LiF and NaBr are ionic salts that both form a face centred cubic lattice. The ionic radii of Li^+, F^-, Na^+ and Br^- are 0.76, 1.33, 1.02 and 1.96 A^0 respectively, which of the following statement is / are true

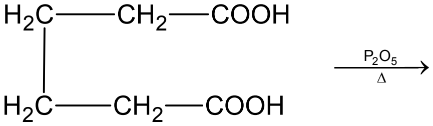
(A) The atomic radius of Na is smaller than 1.0 A^0
(B) The atomic radius of F is smaller than 1.33 A^0
(C) Each Li^+ ion in LiF has $8F^-$ ions as nearest neighbors
(D) The lattice energy of LiF is greater in magnitude than the lattice energy of NaBr

19. Which of the following reaction (s) can generate a five membered ring as the major product?

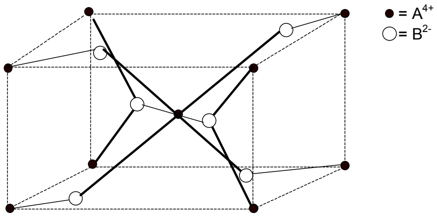
(A)

O
H_2C
CH
OH
1. I_2
2. aq. $NaHCO_3$

(B)

O
H_3C
$\bar{O}Na^+$
Br_2
CH_2Cl_2

(C)

CH_2—COOH
H_2C
CH_2—COOH
P_2O_5
Δ

(D)

H_2C——CH_2——COOH
H_2C——CH_2——COOH
P_2O_5
Δ

20. Consider the following solid:



(distarted cubic structure)

Identify the correct statements regarding the above crystalline solid:

(A) The coordination number of A^{4+} is 8
(B) The coordination number of B^{2-} is 3
(C) The formula of the solid is AB_2
(D) Effective number of A^{2+} ions per unit cell is 2

Rough Work

Mathematics PART – III

SECTION – A

Single Correct Choice Type

This section contains 8 multiple choice questions numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Consider P: $y^2 = 4ax$ and RH: $x^2 - y^2 = a^2$. Let S = {$m \in R$/m is the slope of the normal to P that touches the RH}. Then |S| is
(A) 0 (B) 2
(C) 4 (D) 6

2. Let x, y, $z \in R$. The number of integral values that x can take if x + y +z = 5 and $x^2 + y^2 + z^2 = 9$, is
(A) 0 (B) 1
(C) 2 (D) infinitely many

3. The number of solutions of the equations $2\sin^2 x + \sin^2 2x = 2$, $\sin 2x + \cos 2x = \tan x$ in $[0, 4\pi]$ satisfying the condition $2\cos^2 x + \sin x \le 2$ is
(A) 4 (B) 6
(C) 8 (D) 2

4. If |z| = 1 and $z \neq 0$, then the points $z + \frac{1}{z}$ lie on a
(A) straight line not through the origin (B) circle
(C) line segment lying on the x-axis (D) line segment lying on the y-axis

5. The vectors $\left(x^2-1\right)\bar{i} + 2\left(x^2-1\right)\bar{j} - 3\left(x^2-1\right)\bar{k}, \left(2x^2-1\right)\bar{i} + \left(2x^2+1\right)\bar{j} + x^2\bar{k}$, and $\left(3x^2+2\right)\bar{i} + \left(x^2+4\right)\bar{j} + \left(x^2+1\right)\bar{k}$ are non-coplanar. The number of real values that x cannot take is
(A) 0 (B) 1
(C) 2 (D) 4

Rough work

6. Let $f(x) = \left(a - x^n\right)^{1/n}$ and $g(x) = \dfrac{f\circ f\circ f\circ\ldots\ldots\circ f(x)}{2m \text{ times}}$. Then $\displaystyle\int \frac{dx}{\left(g(x)\right)^n\left(1+\left(g(x)\right)^n\right)^{1/n}}$ equals

(A) $\dfrac{n}{n-1}\left(1+\dfrac{1}{x^n}\right)^{\frac{n-1}{n}}+C$

(B) $\dfrac{1}{1-n}\left(1+x^{-n}\right)^{\frac{n-1}{n}}+C$

(C) $\dfrac{1}{1+n}\left(1+x^n\right)^{\frac{n+1}{n}}+C$

(D) $\dfrac{-1}{n}\left(1-x^n\right)^{\frac{n}{n+1}}+C$

7. If $y = f(x)$ and $z = g(x)$, then $\dfrac{d^2y}{dz^2}$ equals

(A) $\dfrac{g'f'' - f'g''}{(g')^2}$

(B) $\dfrac{g'f'' - f'g''}{(g')^3}$

(C) $\dfrac{g'f' - f''g''}{(g')^3}$

(D) $\dfrac{g'f'' + f'g''}{(g')^3}$

8. The function f(x) = $\begin{cases} \dfrac{a\,|x^2 - x - 6|}{6 + x - x^2}, x < 3 \\ b\displaystyle\lim_{x\to 3}\left(\dfrac{x\displaystyle\int_3^x t\,dt}{x-3}\right) \quad , x = 3 \\ \dfrac{x-[x]}{x-3}, x > 3 \end{cases}$

is continuous at x = 3. If f (3) ≠ 0, then {a, b} is (where [ ] denotes the greatest integer function)

(A) {3, 1}

(B) $\left\{\dfrac{1}{3}, 1\right\}$

(C) $\left\{1, \dfrac{1}{3}\right\}$

(D) $\left\{1, \dfrac{1}{9}\right\}$

Rough work

Comprehension Type

This section contains **3 paragraphs**. Based upon paragraph **2 multiple choice questions** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of **which ONLY ONE** is correct.

Paragraph for Question Nos. 9 to 10

Read the following write up carefully and answer the following questions:

Let S_r, $r \in N$, denote the sum of an infinite GP whose first term is $2r - 1$ and common ratio $\frac{1}{2r}$. Let $V_n = \sum_{r=1}^{n} S_r$ and $Q_n = \sum_{r=1}^{n} \frac{1}{S_r S_{r+1}}$.

9. $\lim_{n\to\infty} \frac{V_n}{n^2}$ equals

(A) 0 (B) −1

(C) 1 (D) 2

10. Consider the following statements:

I : $Q_1 > Q_2 > Q_3 > \ldots\ldots.$

II: $V_1 < V_2 < V_3 < \ldots\ldots..$

Then

(A) Only I is true (B) Only II is true

(C) Both I and II are true (D) Neither I nor II is true

Paragraph for Question Nos. 11 to 12

Read the following write up carefully and answer the following questions:

Consider the function $f : R \to R$ defined by $f(x) = a^{-x} + a^{|x|},\ a > 1$

11. The interval in which f(x) is monotonic decreasing, is

(A) (0, a) (B) $(-\infty, 0)$

(C) $(0, \infty)$ (D) (2, 2a)

Rough work

12. Area bounded by the given curve and the lines x = –1, x = 1 and y = 0, is

(A) $\frac{2a^2+3a+1}{\log_e a}$ (B) $\frac{3a^2-2a-1}{a\log_e a}$

(C) $\frac{3a-1}{a\log_e a}$ (D) $\frac{(3a-1)(2a-1)}{\log_e a}$

Paragraph for Question Nos. 13 to 14

Read the following write up carefully and answer the following questions:

Let S = set of triplets (A, B, C) where A, B, C are subsets of {1, 2, 3, ... n}. E_1 = event that a selected triplet at random from set S will satisfy $A\cap B\cap C = \phi$, $A \cap B \neq \phi$, $B \cap C \neq \phi$. E_2 = events that a selected triplet at random from set S will satisfy $A\cap B\cap C = \phi$, $A\cap B \neq \phi$ $B\cap C \neq \phi$, $A\cap C \neq \phi$. P (E) represents probability of an event E than

13. $P(E_1)$ is equal to

(A) $\frac{7^n-6^n+5^n}{8^n}$ (B) $\frac{7^n-2\times 6^n+5^n}{8^n}$

(C) $\frac{7^n-2\times 6^n}{8^n}$ (D) $\frac{7^n-2\times 6^n+5^n}{8^n}$

14. $P(E_2)$ is equal to

(A) $\frac{7^n-3\times 6^n+5^n}{8^n}$ (B) $\frac{7^n-3\times 6^n+3\times 5^n-4^n}{8^n}$

(C) $\frac{7^n-2\times 6^n+2\times 5^n-4^n}{8^n}$ (D) $\frac{7^n-6^n+5^n-4^n}{8^n}$

Rough work

Multiple Correct Answer(s) Type

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

15. The straight line $b^{1/3}y + a^{1/3}x + a^{2/3}b^{2/3} = 0$
(A) touches the parabola $y^2 = 4ax$
(B) touches the parabola $x^2 = 4by$
(C) intersects both the parabolas $y^2 = 4ax$ and $x^2 = 4by$ in real points
(D) touches $y^2 = 4ax$ and intersects $x^2 = 4by$

16. If x, y, a, b are real numbers such that $(x + iy)^{1/5} = a + ib$ and $p = \frac{x}{a} - \frac{y}{b}$, then
(A) a – b is a factor of p
(B) a + b is a factor of p
(C) a + ib is a factor of p
(D) a – ib is a factor of p

17. Let $0 < \theta < \frac{\pi}{4}$. Then,
(A) $\sum_{k=0}^{\infty} \sin^{2k}\theta = \sec^2\theta$
(B) $\sum_{k=0}^{\infty} \cos^{2k}\theta = \text{cosec}^2\theta$
(C) $\sum_{k=0}^{\infty} \tan^{2k}\theta = \frac{\cos^2\theta}{\cos 2\theta}$
(D) $\sum_{k=0}^{\infty} \tan^{2k}\theta + \sum_{k=0}^{\infty} \cot^{2k}\theta = 1$

18. A number is chosen at random from the set of integers {1, 2, 3, 4,……., n}. Let A denote the event that the number chosen is divisible by 4, B denote the event that the number chosen is divisible by 5 and C denote the event that the number chosen is divisible by 7. Then,
(A) A, B, C are always mutually independent
(B) A and B are always independent
(C) B and C are independent if n is of the form 35k (k positive integer)
(D) A and C are independent if n is of the form 28 λ (λ positive integer)

Rough work

19. Let A be the set of real values of x, and B be the set of real values of y, satisfying the equation $3^x + 3^y = 9$. Let a = [x], $x \in A$, and b = [y], $y \in B$. Then

(A) The roots of the equation $x^3 + 2x^2 - x - 2 = 0$ are x_1, x_2, x_3 such that $x_1, x_2, x_3 \in A$.

(B) The roots of the equation $x^3 - 2x^2 - x + 2 = 0$ are x_1, x_2, x_3 such that $x_1, x_2, x_3 \in B$.

(C) $a_{max} + b_{max} = 2$

(D) $17a_{max} - 12b_{max} = -5$

20. Let T be the Δ with vertices (0, 0), $(0, c^2)$ and (c, c^2) and let R be the region between y = cx and $y = x^2$ where c > 0 then

(A) Area of $(R) = \frac{c^3}{6}$

(B) Area of $R = \frac{c^2}{3}$

(C) $\lim\limits_{c \to 0^+} \frac{\text{Area}(T)}{\text{Area}(R)} = 3$

(D) $\lim\limits_{c \to 0^+} \frac{\text{Area}(T)}{\text{Area}(R)} = \frac{3}{2}$

Rough work

From Long Term Classroom Programs and Medium / Short Classroom Program 4 in Top 10, 10 in Top 20, 43 in Top 100, 75 in Top 200, 159 in Top 500 Ranks & 3542 total selections in IIT-JEE 2012

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FULL TEST –IV

(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	C	A
2.	A	B	C
3.	D	B	A
4.	B	C	C
5.	A	D	C
6.	C	C	B
7.	A	A	B
8.	A	C	D
9.	D	C	C
10.	C	A	B
11.	A	C	B
12.	C	B	B
13.	A	B	D
14.	B	D	B
15.	A, B, C	A,C	A, B
16.	A, B, C	A,C	A, B, C, D
17.	A, D	B,D	A, B, C
18.	A, B, D	B,D	C, D
19.	A, C, D	A, B, D	A, C
20.	C, D	B, C, D	A, C

Physics

PART – I

SECTION – A

1. A is at rest instantaneously (for no slipping at A)

$$V_B - V_A = \frac{1}{2} B \left(\frac{V_0}{R}\right) (2R)^2$$

$$V_C - V_A = \frac{1}{2} B \left(\frac{V_0}{R}\right) (\sqrt{3}\,R)^2$$

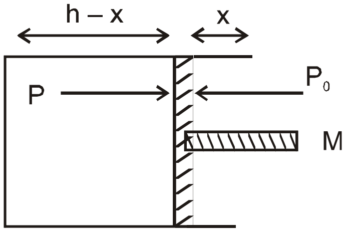
$$\Rightarrow \; V_B - V_C = \frac{1}{2}\, B \left(\frac{V_0}{R}\right) [R^2] = \frac{BV_0R}{2}$$

2. force = $(P - P_0)\,A = Ma$

by $P_1V_1 = P_2V_2$

$P_0hA = P(h - x)\,A$

$$\Rightarrow P = \frac{P_0h}{h - x}$$



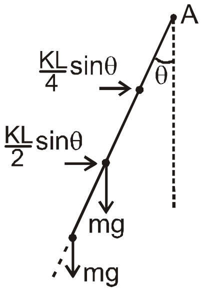
$$\text{So force} = \left(\frac{P_0h}{h - x} - P_0\right) \frac{A}{M} = a$$

$$a = \frac{P_0Ax}{M(h - x)} \Rightarrow \frac{P_0Ax}{Mh}; \text{ (for small x)}$$

$$T = 2\pi \sqrt{\frac{Mh}{P_0A}}$$

3. $\tau_{restoring}$ = (mg sinθ L + (mg sin θ $\frac{L}{2}$

$$+ \left(K\frac{L}{4}\sin\theta\right)\frac{L}{4} + \left(\frac{KL}{2}\sin\theta\right)\frac{L}{2}$$



$$\text{restoring} = \left[\frac{3mg}{2} + \frac{5KL^2}{16}\right]\theta \quad (\theta : \text{small})$$

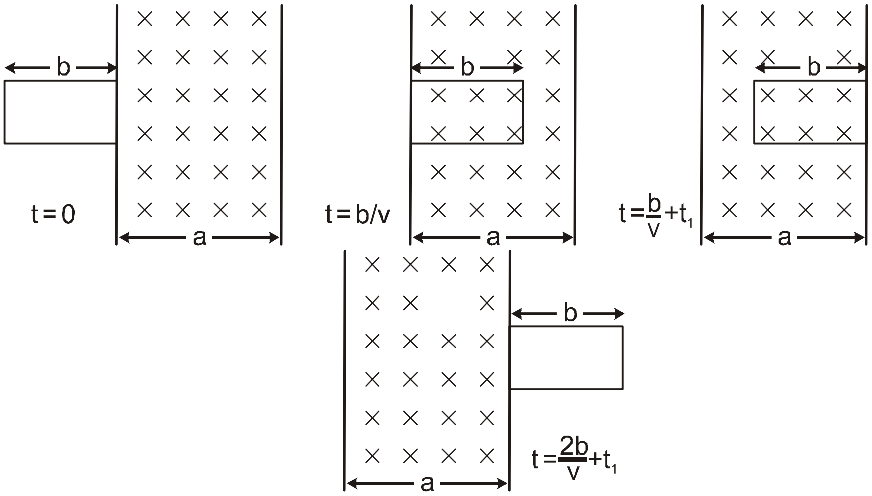
$$\text{frequency of oscillation)} = \frac{1}{2\pi}\sqrt{\frac{\frac{3mg}{2} + \frac{5kL^2}{16}}{I}}$$

$$\text{where } I = mL^2 + \frac{mL^2}{3} = \frac{4mL^2}{3}$$

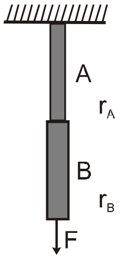
4. From law of radioactive decay.
Activity µ Number of nuclear of that nucleus present in the sample.
Activity does not depend upon the rate of the formation of nucleus.
In given reaction B decays into E and C.
Total activity of B = rate of decay of B into E + rate of decay of B into C = $I_5N_2 + I_3N_2$

5. The EMF will be induced in the loop, only when there is a change in the flux through the loop. When the loop was completely inside the field region, for some time (say t_1) there is no change in the flux, hence that time would not be included in the calculation.

The time for which EMF was induced = $\frac{b}{v}+\frac{b}{v}=\frac{2b}{v}$



6. That wire will break first whose stress reaches the breaking stress (for that material) first.



Stress = $\frac{F}{A}=\frac{F}{\pi r^2}$ where F is the tension in the wire. F is same in both the wires.

Thus stress $\propto \frac{1}{r^2}$ for the wire of smaller radius, the stress is more.

Thus the wire with smaller radius will break first.

If $r_A < r_B$, then wire A will break first.

If $r_A > r_B$, then wire B will break first.

If $r_A = r_B$, either of them could break.

8. As the magnetic field is uniform and the particle is projected in a direction perpendicular to the field, it will describe a circular path. The particle will not hit the yz-plane if the radius of the circle is smaller than d. For the maximum value of v, the radius is just equal to d. Thus $\frac{mv}{Bq}=d$.

$$\therefore \quad v=\frac{Bqd}{m}$$

9. $F = \eta A \; \frac{u-u_0}{y}$

$\Rightarrow \; u = \frac{F}{\eta A} y + u_0$

$\Rightarrow \; u = \frac{1}{10^{-2}\times 1} \; y + 1 \; = 100 \; y + 1$

10. The velocity of upper plate is same as that of the layer in contact with the plate i.e. layer at y = 2 cm.

u = 100 (0.02) + 1 = 3 m/s

11. $T^2 \propto r^3$ (Kepler's law)

$$\frac{T_A^2}{T_B^2} = \frac{r_A^3}{r_B^3} = \frac{r^3}{(4r)^3} = \frac{1}{64} \text{ Get } \frac{T_A}{T_B} = \frac{1}{8}$$

12. For geostationary satellite, time period = 1 planet day (by def.)
Let T = 1 planet day
T_0 = 1 planet year

Now $T^2 = \frac{4\pi^2}{Gm} r_G^3 = \frac{4\pi^2}{Gm} r^3 \left(\frac{m}{M}\right)$

$= \frac{4\pi^2}{GM} r^3 = T_0^3$ or $T = T_0$

13-14. $\omega = \sqrt{\frac{k}{M}}$, $\omega' = \sqrt{\frac{k}{M+m}} = \sqrt{\frac{2500}{25}}$ = 10 rad/sec

$\omega' = \omega\sqrt{\frac{M}{M+m}}$

$x_1 = A \sin \phi_1$

Potential energy stored in the spring at ($t = t_1$) = $\frac{1}{2}kx_1^2 = \frac{1}{2}M\omega^2 \sin^2 \phi_1$

Let v and v′ be the velocity of system just before collision and just after collision, so using COLM

$v' = \frac{Mv}{(M+m)} = \frac{MA\omega\cos\theta}{(M+m)}$

Total energy after collision = PE + KE = $\frac{1}{2}kx_1^2 + \frac{1}{2}(M+m)v'^2$

$= \frac{1}{2}MA^2\omega^2\left[\frac{M+m\sin^2\theta}{M+m}\right] = \frac{1}{2}kA^2\left[\frac{M+m\sin^2\theta}{M+m}\right]$ = 8 J

$$\frac{1}{2}(M+m)A'^2\omega'^2 = \frac{1}{2}MA^2\omega^2\left[\frac{M+m\sin^2\theta}{M+m}\right]$$

15. $\frac{I_{max}}{I_{min}} = \frac{(a_1+a_2)^2}{(a_1-a_2)^2}$

$\frac{a_1}{a_2} = \sqrt{\frac{I_1}{I_2}} = \sqrt{\frac{4}{9}} = \frac{2}{3}$

$\therefore \frac{I_{max}}{I_{min}} = 25$

If an identical paper is pasted across second slit shifted C.B.F. will back in central point.

shift $= (\mu - 1)\frac{tD}{d}$

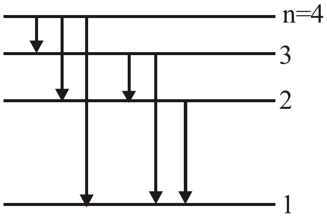
fringe width $= \frac{n\lambda D}{d}$

$\therefore n = \frac{\text{shift}}{\text{fringe width}} = \frac{(\mu-1)t}{\lambda} = 15$.

16. The change in magnetic flux is zero, hence the current in the ring will be zero.

17. Both (A) and (D) depend on g.

18. $\frac{n(n-1)}{2} = 6 \Rightarrow n = 4$



If the initial state were n = 3, in the emission spectrum, no wavelengths shorter than λ_0 would have occurred. This is possible if initial state were n = 2

$\therefore$ (A), (B) and (D)

19. From COE (A) is correct.

The force outside the earth varies as inverse square of the distance.

$\therefore$ motion is not simple harmonic. However, from symmetry of motion, the motion will be periodic.

$\therefore$ (C) is correct.

From COE

$$\frac{1}{2}mv^2 = -\frac{GMm}{2R} - \left(-\frac{3GMm}{2R}\right)$$

$$\Rightarrow \quad v = \sqrt{\frac{2GM}{R}}$$

$\therefore$ (A), (C) and (D) are correct.

20. The current through R_1 is constant.

Chemistry PART – II

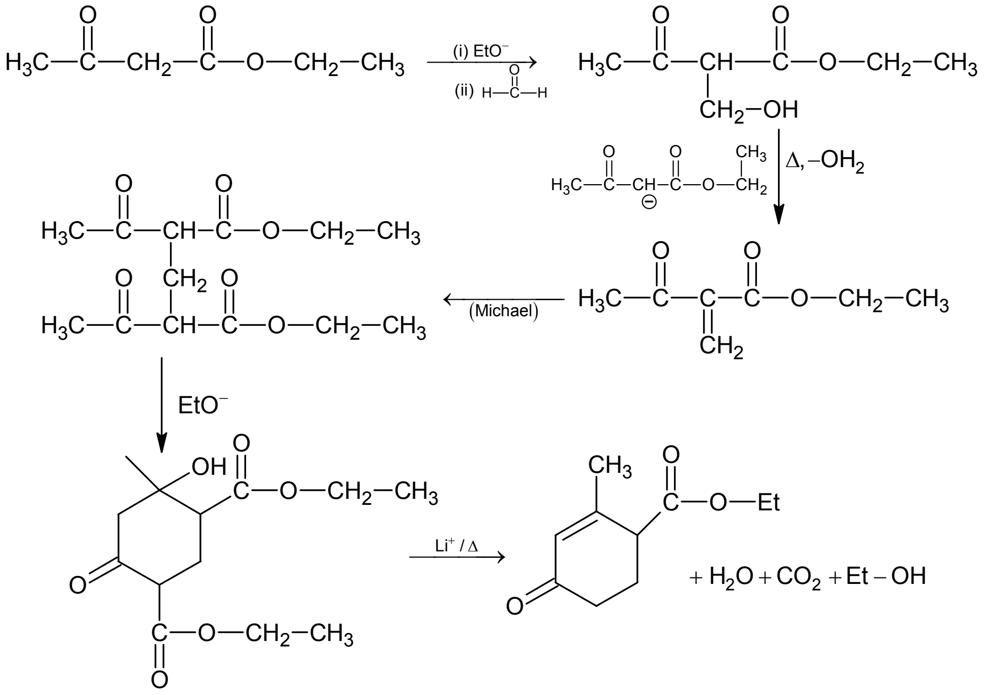
SECTION – A

1. pH at isoelectric point = $\dfrac{pKa_1 + pKa_2}{2} = \dfrac{4+9}{2} = 6.5$

2. Net reaction does not involve any aqueous species.

5. $\left[Cr(SCN)_2(NH_3)_4\right]^{2+}$, shows geometrical (or cis-trans) and linkage isomerism.

6.



7. $FeSO_4 \xrightarrow{\Delta} Fe_2O_3 + SO_3 + SO_2$

8. Energy of e^- in H-atom = - E

Energy of e^- in Li^{+2} = - 9E

Energy supplied by photon = $IE + \frac{1}{2}mv^2$

$IE = |E|$

$\therefore E_p = 9E + \frac{1}{2}mv^2$

$v = \sqrt{\dfrac{2(E_p - 9E)}{m}}$

9. In reverse osmosis water moves from more concentrated to less concentrated solution

10. π = iCRT, (i=2)

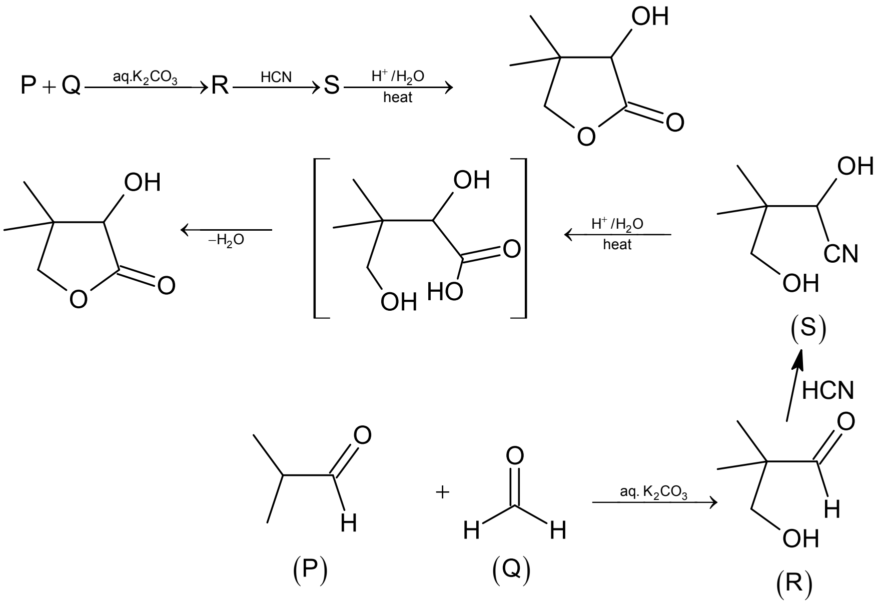
11. Let conc. of both reactants at equilibrium is x M

$$\text{Keq} = \frac{\left[\text{PbEDTA}^{2-}\right]\left[\text{H}^{+}\right]^{2}}{x^{2}}$$

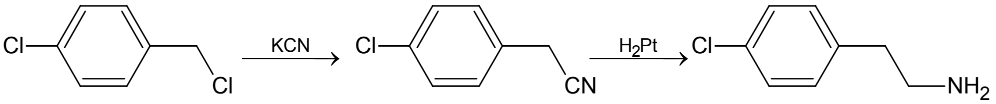
x = 10^{-3}

12. Chelation increases stability of complexes

14.


P + Q
aq.K₂CO₃
R
HCN
S
H⁺/H₂O
heat
OH
O
O
OH
−H₂O
OH
O
OH HO
H⁺/H₂O
heat
OH
CN
OH
(S)
HCN
O
H
O
H H
aq. K₂CO₃
O
H
OH
(P)
(Q)
(R)

15.

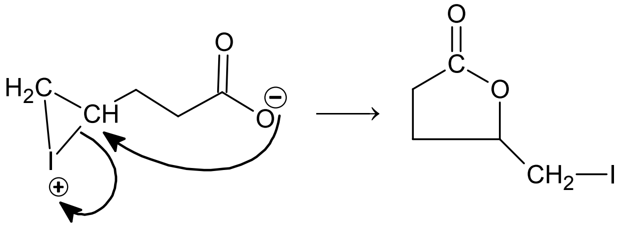

Cl
Cl
KCN
Cl
CN
H₂Pt
Cl
NH₂

16. Trans-2-butene $\xrightarrow{CF_3CO_3H}$ epoxide $\xrightarrow{H_3O^+}$ diol $\xrightarrow{HIO_4}$ $2CH_3CHO$

17. He and H_2 are not hydrogen like particles

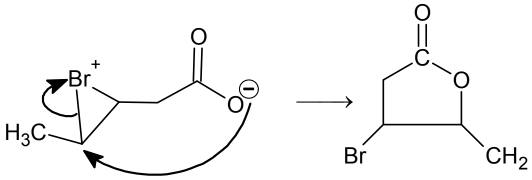
18. Radius of cation is smaller than parent atom and that of anion is more than parent atom

19. (A)


O
H₂C
CH
I
⊕
O
⊖
O
C
O
CH₂—I

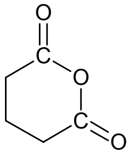
I_2 will attack the double bond to form a cyclic halonium ion. It then undergoes on intramolecular reaction. Formation of five membered ring is favoured because (i) attack by a nucleophile on a halonium ion normally takes place at the more substituted site.
(ii) Formation of five membered ring is more probable.

(B)



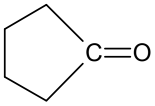
(C)

Option(C)gives



(D)

Option(D)gives



1, 4 and 1,5-dicarboxylic acids give anhydrides whereas 1,6 and 1, 7-diacids give ketones when heated with P_2O_5.

Mathematics PART – III

SECTION – A

1. Normal to $y^2 = 4ax$ with slope m is

$y = mx - 2am - am^3$ ..... (1)

(1) touches $x^2 - y^2 = a^2$ if

$(-2am - am^3)^2 = a^2 (m^2 - 1)$

i. e. if $m^6 + 4m^4 + 3m^2 + 1 = 0$ ..... (2)

(2) is a sixth degree equation in m with no odd power terms and whose coefficients are all positive.

$\Rightarrow$ (2) has no real root

$\therefore |S| = 0$

2. Given $x + y + z = 5 \rightarrow (1)$

and $x^2 + y^2 + z^2 = 9 \rightarrow (2)$

We have $yz = \frac{1}{2}\left[(y+z)^2 - (y^2 + z^2)\right]$

$= \frac{1}{2}\left[(5-x)^2 - (9 - x^2)\right]$ (using) (1) & (2))

$= x^2 - 5x + 8$

$\Rightarrow$ y, z must be the roots of the equation

$u^2 - (5-x)u + (x^2 - 5x + 8) = 0 \rightarrow (3)$

As y, z are real, we must have discriminant of (3) ≥ 0

$\Rightarrow (5 - x)^2 - 4 (x^2 - 5x + 8) \geq 0$

$\Rightarrow 3x^2 - 10x + 7 \leq 0$

$\Rightarrow (3x - 7) (x - 1) \leq 0$

$\Rightarrow x \in \left[1, \frac{7}{3}\right]$

$\Rightarrow$ Number of integer values that x can take is 2

3. $2 \sin^2 x + \sin^2 2x = 2$

$\Rightarrow -2(1 - \sin^2 x) + 4 \sin^2 x \cos^2 x = 0$

$\Rightarrow \cos^2 x.\cos 2x = 0 \rightarrow (1)$

$\sin 2x + \cos 2x = \tan x$

$\Rightarrow 2 \sin x \cos^2 x + \cos 2x \cos x = \sin x$

$\Rightarrow \sin x \cos 2x + \cos 2x \cos x = 0$

$\Rightarrow \cos 2x (\sin x + \cos x) = 0 \rightarrow (2)$

Common roots of (1) and (2) are given by $\cos 2x = 0$

$\Rightarrow x = \frac{(2n-1)\pi}{4}, n \in N$

In $[0, 4\pi]$ we have $x = \frac{n\pi}{4}$, where n = 1, 3, 5,……,15 $\rightarrow$ (3)

Now, $-2 \sin^2 x + \sin x \leq 0$

$\Rightarrow 2 \sin^2 x - \sin x \geq 0$

$\Rightarrow (\sin x) (2 \sin x - 1) \geq 0$

$\Rightarrow \sin x \in [-1, 0]$ or $\frac{1}{2} \leq \sin x \leq 1 \rightarrow (4)$

Among the 8 values given by (3), only 4 values, i.e., $x = \frac{5\pi}{4}, \frac{7\pi}{4}, \frac{13\pi}{4}, \frac{15\pi}{4}$ satisfy (4)

4. We have $w = z + \frac{1}{z}$

Take $z = e^{i\theta}$ ($\because |z| = 1$).

We have $w = e^{i\theta} + e^{-i\theta} = 2\cos\theta$

We know that w is real and $|w| \le 2$

5. The scalar triple product of the three given vectors is $\begin{vmatrix} x^2-1 & 2(x^2-1) & -3(x^2-1) \\ 2x^2-1 & 2x^2+1 & x^2 \\ 3x^2+2 & x^2+4 & x^2+1 \end{vmatrix}$

$$= (x^2-1)\begin{vmatrix} 1 & 2 & -3 \\ 2x^2-1 & 2x^2+1 & x^2 \\ 3x^2+2 & x^2+4 & x^2+1 \end{vmatrix} = (x^2-1)\begin{vmatrix} 1 & 2 & 0 \\ 2x^2-1 & 2x^2+1 & 5x^2 \\ 3x^2+2 & x^2+4 & 5x^2+7 \end{vmatrix} \text{ (using } C_3 \to C_3 + C_2 + C_1\text{)}$$

$$= (x^2-1)\begin{vmatrix} 1 & 0 & 0 \\ 2x^2-1 & -2x^2+3 & 5x^2 \\ 3x^2+2 & -5x^2 & 5x^2+7 \end{vmatrix} \text{ (using } C_2 \to C_2 - 2C_1\text{)}$$

$= (x^2-1)(15x^4 + x^2 + 21)$

Vector are non–coplanar ⇒ Scalar triple product $\ne 0 \Rightarrow x^2 - 1 \ne 0$ ($\because 15x^4 + x^2 + 21 \ne 0$) $\Rightarrow x \ne \pm 1$

6. We have $f(x) = (a - x^n)^{1/n}$ so that

$$f{\circ}f(x) = f\left((a-x^n)^{1/n}\right) = \left(a - \left((a-x^n)^{1/n}\right)^n\right)^{1/n} = \left(a - (a - x^n)\right)^{1/n}$$

$$\Rightarrow g(x) = \underbrace{f{\circ}f{\circ}.....f(x)}_{2m\,\text{times}} = x$$

$$\therefore \int \frac{dx}{(g(x))^n\left(1+(g(x))^n\right)^{1/n}} = \int \frac{dx}{x^n(1+x^n)^{1/n}} = \int \frac{dx}{x^{n+1}(1+x^{-n})^{1/n}} = -\int \frac{dt}{nt^{1/n}} \text{ (using } t = 1 + x^{-n}\text{)}$$

$$= -\frac{1}{n}\left(\frac{t^{-1/n+1}}{-\frac{1}{n}+1}\right) + c = \frac{1}{1-n}(1+x^{-n})^{1-\frac{1}{n}} + c$$

7. Given $y = f(x), z = g(x)$ we have

$$\frac{dy}{dz} = \frac{dy/dx}{dz/dx} = \frac{f'(x)}{g'(x)} \text{ and } \frac{d^2y}{dz^2} = \frac{d}{dx}\left(\frac{f'}{g'}\right)\frac{dx}{dz} = \frac{g'f'' - f'g''}{(g')^2}.\frac{1}{g'}$$

8. $f(x)$ is continuous at x = 3

$\Rightarrow f(3^-) = f(3) = f(3^+)$

Now $f(3^-) = \lim\limits_{x \to 3^-} \frac{a|x^2 - x - 6|}{6 + x - x^2} = \lim\limits_{x \to 3^-} \frac{-a(x^2 - x - 6)}{6 + x - x^2} = a$

$$f\left(3^+\right) = \lim_{x\to 3^+} \frac{x-[x]}{x-3} = \lim_{x\to 3^+} \frac{x-3}{x-3} = 1$$

$$f(3) = b\lim_{x\to 3}\left(\frac{x\int_3^x tdt}{x-3}\right)\left(\frac{0}{0}\text{form}\right) = b\lim_{x\to 3}\left(\frac{x^2+\int\limits_3^x tdt}{1}\right) = 9b$$

$\Rightarrow$ a = 9b = 1 $\Rightarrow$ b = $\frac{1}{9}$ and a = 1

9. $V_n = \sum_{r=1}^{n} S_r = 2\sum_{r=1}^{n} r = n(n+1)$

$\therefore \lim_{n\to\infty} \frac{V_n}{n^2} = \lim_{n\to\infty} \frac{n+1}{n} = 1$

10. (i) $V_n = n(n+1) \Rightarrow V_1 < V_2 < V_3 < \ldots$

$\Rightarrow$ Statement – 2 is true

(ii) $Q_n = \sum_{r=1}^{n} \frac{1}{S_r S_{r+1}} = \frac{1}{4}\sum_{r=1}^{n} \frac{1}{r(r+1)} = \frac{1}{4}\sum_{r=1}^{n}\left(\frac{1}{r} - \frac{1}{r+1}\right) = \frac{1}{4}\left(1 - \frac{1}{n+1}\right)$

$\Rightarrow Q_1 < Q_2 < Q_3 < \ldots\ldots\ldots$

$\Rightarrow$ Statement –1 is false

11. We have

$$f(x) = \begin{cases} 2a^{-x}, & x < 0 \\ a^{-x} + a^{x}, & x \geq 0 \end{cases}$$

Clearly, f(x) is continuous in R.

For $x > 0$, $f'(x) = -a^{-x}\log_e a + a^x \log_e a = (a^x - a^{-x})\log_e a = \left(\frac{a^{2x}-1}{a^x}\right)\log_e a > 0$ for $x > 0$

$\Rightarrow f(x)$ is monotonic increasing for x > 0

For x < 0, $f(x) = 2a^{-x} \Rightarrow f'(x) = -2a^{-x}\log_e a < 0$

$\Rightarrow f(x)$ is monotonic decreasing for x < 0

12. Required area $= \int\limits_{-1}^{0} 2a^{-x}dx + \int\limits_{0}^{1}\left(a^{-x} + a^{x}\right)dx = \left\{\frac{-2a^{-x}}{\log_e a}\right\}_{-1}^{0} + \left\{\frac{-a^{-x} + a^{x}}{\log_e a}\right\}_{0}^{1}$

$$= \frac{1}{\log_e a}\left[-2-(-2a)\right] + \frac{1}{\log_e a}\left[\left(\frac{-1}{a}+a\right)-0\right] = \frac{3a^2-2a-1}{a\log_e a}$$

15. The equation of the line is $b^{\frac{1}{3}}y + a^{\frac{1}{3}}x + a^{\frac{2}{3}}b^{\frac{2}{3}} = 0$

This can be written as $y = -\frac{a^{\frac{1}{3}}}{b^{\frac{1}{3}}}x - a^{\frac{2}{3}}b^{\frac{1}{3}} \Rightarrow m = \frac{-a^{\frac{1}{3}}}{b^{\frac{1}{3}}},\ c = -a^{\frac{2}{3}}b^{\frac{1}{3}}$

Consider the parabola $y^2 = 4ax$

$$\frac{a}{m}=\frac{a}{\frac{-a^{\frac{1}{3}}}{b^{\frac{1}{3}}}}=-\frac{ab^{\frac{1}{3}}}{a^{\frac{1}{3}}}=-a^{\frac{2}{3}}b^{\frac{1}{3}}=c$$

$\therefore$ Condition for tangency for the parabola $y^2 = 4ax$ is satisfied

$\therefore$ The given line touches $y^2 = 4ax$

Similarly the line touches $x^2 = 4by$

16. $(x+iy)^{\frac{1}{5}} = a+ib$

$\therefore$ $x + iy = (a + ib)^5 = a^5 + 5a^4 (ib) + 10a^3 (-b^2) + 10a^2 (-ib^3) + 5ab^4 + ib^5$

Equating the real and imaginary parts $x = a^5 - 10a^3b^2 + 5ab^4 \Rightarrow y = 5a^4b - 10a^2b^3 + b^5$

$p = \frac{x}{a} - \frac{y}{b} = (a^4 - 10a^2b^2 + 5b^4) - (5a^4 - 10a^2b^2 + b^4) = -4a^4 + 4b^4 = -4(a^4 - b^4)$

$= -4(a^2 - b^2)(a^2 + b^2) = -4(a + b)(a - b)(a + ib)(a - ib)$

$\therefore$ $a - b$, $a + b$, $a + ib$ and $a - ib$ are all factors of p.

17. Since $0 < \theta < \frac{\pi}{4}, 0 < \sin^2\theta, \cos^2\theta, \tan^2\theta < 1$

(A) $\sum_{k=0}^{\infty} \sin^{2k}\theta = \frac{1}{1-\sin^2\theta} = \sec^2\theta$

(B) $\sum_{k=0}^{\infty} \cos^{2k}\theta = \frac{1}{1-\cos^2\theta} = \operatorname{cosec}^2\theta$

(C) $\sum_{k=0}^{\infty} \tan^{2k}\theta = \frac{1}{1-\tan^2\theta} = \frac{\cos^2\theta}{\cos^2\theta - \sin^2\theta} = \frac{\cos^2\theta}{\cos 2\theta}$

(D) $\cot\theta > 1$ in $0 < \theta < \frac{\pi}{4}$. Hence, $\sum_{k=0}^{\infty} \cot^{2k}\theta$ does not exist.

19. $3^y = 9 - 3^x \Rightarrow 9 - 3^x > 0 \Rightarrow x < 2$

Similarly, $y < 2$

20. Area $(T) = \frac{c.c^2}{2} = \frac{c^3}{2}$

Area $(R) = \frac{c^3}{2} - \int_0^c x^2 dx$

$= \frac{c^3}{2} - \frac{c^3}{3} = \frac{c^3}{6}$

$$\lim_{c\to 0^+} \frac{\text{Area }(T)}{\text{Area }(R)} = \lim_{R\to 0^+} \frac{c^3}{2}.\frac{6}{c^3} = 3$$

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

FIITJEE **JEE (Advanced), 2014**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - I

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 10)** contains 10 multiple choice questions which have only one correct answer. Each question carries **+2 marks** for correct answer. There is no negative marking.

Section-A (11 to 15) contains 5 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-C (01 to 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	$6.625 \times 10^{-34}\ \text{J}\cdot\text{s}$
		=	$6.625 \times 10^{-27}\ \text{erg}\cdot\text{s}$
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Single Correct Choice Type

This section contains **10 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. Two balls are dropped from the same point after an interval of 1 second. Their separation 3 second after the release of the second ball. ($g = 10\ m/s^2$)
(A) 25 m (B) 30 m
(C) 35 m (D) 40 m

2. The upper half of an inclined plane of inclination θ is perfectly smooth while the lower half is rough. A block starting from rest at the top of the plane will come to rest at the bottom if the coefficient of friction between the block and the lower half of the plane is
(A) $\mu = 2\tan\theta$ (B) $\mu = \tan\theta$
(C) $\mu = \frac{2}{\tan\theta}$ (D) $\mu = \frac{1}{\tan\theta}$

3. A spring is compressed between two blocks of masses m_1 and m_2 placed on a horizontal frictionless surface. When the blocks are released. The blocks travel distance x_1 and x_2 respectively before coming to rest. The ratio x_1/x_2 is
(A) m_1/m_2 (B) m_2/m_1
(C) $\sqrt{\frac{m_1}{m_2}}$ (D) $\sqrt{\frac{m_2}{m_1}}$

4. If A is the areal velocity of planet of mass M, its angular momentum is
(A) M (B) 2MA
(C) A^2M (D) AM^2

5. A meteor of mass M breaks up into two parts. The mass of one part is m. For a given separation r the mutual gravitational force between the two parts will be maximum if
(A) $m = (M/2)$ (B) $m = (M/3)$
(C) $m = \frac{M}{\sqrt{2}}$ (D) $m = \frac{M}{2\sqrt{2}}$

Space for Rough work

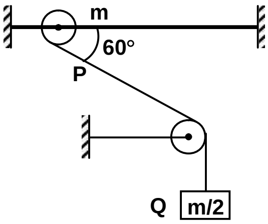
6. A wire breaks when subjected to a stress S. If ρ is the density of the material of the wire and g, the acceleration due to gravity, then the length of the wire so that it breaks by its own weight is
(A) ρgs
(B) ρg/s
(C) gs/ρ
(D) s/ρg

7. A cylinder has a radius r. To what height h should it be filled with water so that the thrust on its walls is equal to that on its bottom
(A) h = 2r
(B) h = r
(C) h = (r/2)
(D) h = (r/4)

8 A swimmer can swim in still water with a speed of $\sqrt{5}$ m/s. While crossing a river his average speed is 3 m/s. If he cross the river in the shortest possible time, what is the speed of flow of water?
(A) 2 m/s
(B) 4 m/s
(C) 6 m/s
(D) 8 m/s

9 A car starting from rest is accelerated at constant rate until it attains a constant speed v. It is then retarded at a constant rate until it comes to rest. Considering that the car moves with constant speed for half of the time of total journey, the average speed of the car for the journey is
(A) $\frac{v}{4}$
(B) $\frac{3v}{4}$
(C) $\frac{3v}{2}$
(D) Data insufficient

10. A smooth ring P of mass m can slide on a fixed horizontal rod. A string tied to the ring passes over a fixed pulley and carries a block Q of mass (m/2) as shown in the figure. At an instant, the string between the ring and the pulley makes an angle 60° with the rod.
The initial acceleration of the ring is



(A) $\frac{2g}{3}$
(B) $\frac{2g}{6}$
(C) $\frac{2g}{9}$
(D) $\frac{g}{3}$

Space for Rough work

Multiple Correct Answer(s) Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

11. A particle having mass m and positive charge q whirls along vertical circle of radius R. At the centre of circle, another positive charge 2q is fixed.
(A) The minimum velocity given at the lowest point to complete vertical circular motion is less than $\sqrt{5gR}$ for motion in gravity.
(B) For any value of velocity given in horizontal direction at the lowest point in gravity free space it will perform vertical circular motion.
(C) Tension in gravity free space cannot becomes zero at any point during motion.
(D) If the charge at the centre is removed and considering the motion in gravity tension will also be function of charge on particle.

12. The potential energy of a particle of mass 0.1 kg, moving along the x-axis, is given by U = 5x(x–4)J, where x is in meters. It can be concluded that
(A) The particle is acted upon by a variable force.
(B) The minimum potential energy during motion is –20 J
(C) The speed of the particle is maximum at x = 2m.
(D) The period of oscillation of the particle is (π/5) sec.

Space for Rough work

13. A cubical block is floating in a liquid with one third of it's volume immersed in the liquid. When the whole system accelerates upwards with acceleration of g/2.
(A) The fraction of volume immersed in the liquid will change.
(B) The buoyancy force on the block will change.
(C) The buoyancy force will increase by 50 percent.
(D) The pressure in the liquid will increased.

14. Two concentric metallic shell's of radius R and 2R, out of which the inner shell is having charge Q and outer shell is uncharged. If they are connected with a conducting wire. Then,
(A) Q amount of charge will flow from inner to outer shell.
(B) Q/e number of electrons will flow from outer to inner shell, where e charge on electron.
(C) $\frac{KQ^2}{4R}$ amount of heat is produced in the wire
(D) $\frac{KQ^2}{2R}$ amount of heat is produced in the wire.

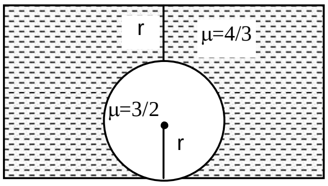
15. A sound wave of frequency n travels horizontally to the right. It is reflected from a large vertical plane surface moving to the left with a speed v. The speed of sound in the medium is c. Then,
(A) The number of waves striking the surface pre second is $\frac{n(c+v)}{c}$.
(B) The frequency of the reflected wave is $\frac{n(c+v)}{(c-v)}$
(C) The wavelength of the reflected wave is $\frac{c(c-v)}{n(c+v)}$
(D) The number of beats heard by a stationary listener to the left of the reflecting surface is $\frac{nv}{c-v}$

Space for Rough work

SECTION –C
Integer Answer Type

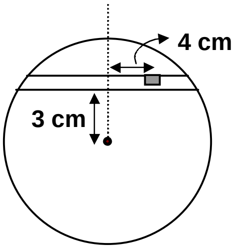
This section contains **5 questions.** The answer to each question is a **single digit integer**, ranging from 0 to 9 (both inclusive).

1. A glass sphere having refractive index (3/2) is having a small irregularity at its centre. It is placed in a liquid of refractive index $\frac{4}{3}$ such that surface of liquid is r high above sphere where r is radius of sphere. If irregularity is viewed from above normally, the distance is 26/K cm from centre where eye will observe the irregularity. Then find the value of K. (r = 20 cm)



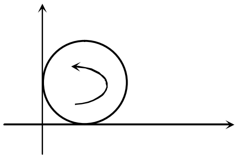
2. Two block of masses m and M are connected by means of a metal wire passing over a frictionless fixed pulley. The area of cross-section of the wire is 6.5×10^{-9} m^2 and its breaking stress is 2×10^9 Nm^{-2}. If m = 1 kg, if the maximum value of M is K × 1.86 kg for which the wire will not break. Find the value of K. (g = 10 m/s^2)

3. A small cubical block of mass 1 kg is placed inside a rough rectangular groove $\left(\mu = \frac{1}{2}\right)$ made in a circular table as shown in the figure. The table starts rotating with angular acceleration 1 rad/sec^2 in a horizontal plane about its axis. The time is $10\sqrt{K}$ sec after which the blocks will start motion with respect to table. Find the value of K. (Take g = 10 m/s^2) Assume the size of block slightly smaller then the width of groove.



4. Two particles of mass M = 3 kg each are kept on a horizontal circular platform on two mutually perpendicular radii at equal distance R = 1 m from the centre of the table. The particles are connected with a string, which is just taught when the platform is not rotating. Coefficient of friction between the platform and block is μ = 0.1. Then the maximum angular speed (ω in rad/sec) of platform about its centre so that the blocks remain stationary relative to platform. (take g = 10 m/s^2)

5. A uniform cylinder of radius R(= 3m) is spin about its axis at an angular velocity ω_0 (= $40\sqrt{\pi}$ rad/sec) and placed between two perpendicular wall. The coefficient of friction between the walls and cylinder is μ(= 2). Then, 25 K turns will the cylinder make before it stops. Find the value of K.



Space for Rough work

Chemistry PART – II

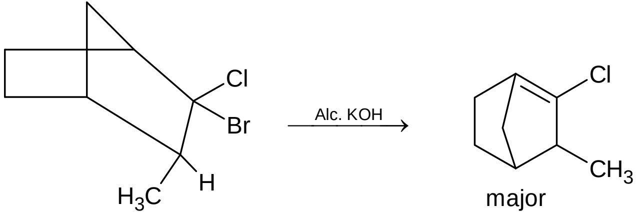
SECTION – A

Single Correct Choice Type

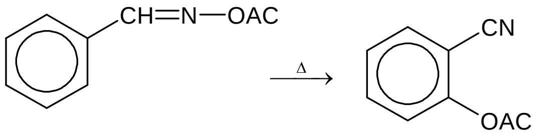
This section contains **10 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. Which of the following reactions product is correct, correspondingly?

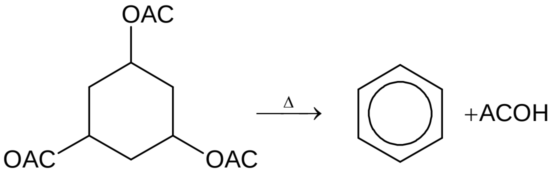
(A)


Cl
Br
H₃C
H
Alc. KOH
Cl
CH₃
major

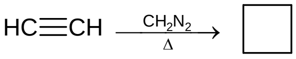
(B)


CH=N—OAC
Δ
CN
OAC

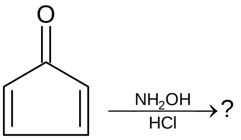
(C)


OAC
OAC
OAC
Δ
+ACOH

(D)

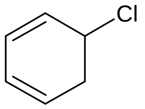

HC≡CH
CH₂N₂
Δ

2.

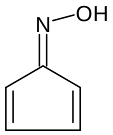


The major product of the following reaction is.....?

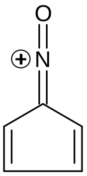
(A)



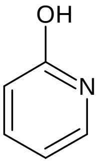
(B)



(C)

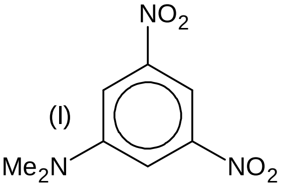


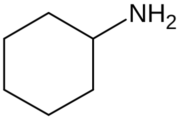
(D)

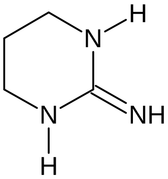


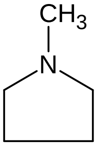
Space for Rough work

3. What is the correct order of basic strength of the following amines?

(I)


(II)


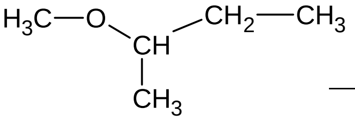
(III)


(IV)


(A) (II) > (IV) > (III) > (I)
(B) (IV) > (I) > (III) > (II)
(C) (IV) > (I) > (II) > (III)
(D) (III) > (IV) > (II) > (I)

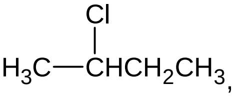
4. The complex $[Fe(H_2O)_5(NO)]^{2+}$ is formed in the ring test for nitrate when freshly prepared $FeSO_4$ solution is added to aqueous solution of NO_3^- followed by addition of conc. H_2SO_4. The complex is formed by charge transfer, which of the following change occurs?

(A) $Fe^{3+} \longrightarrow Fe^{2+};\ NO \longrightarrow NO^+$
(B) $Fe^{2+} \longrightarrow Fe^{3+};\ NO \longrightarrow NO^+$
(C) $Fe^{2+} \longrightarrow Fe^{+};\ NO \longrightarrow NO^+$
(D) $Fe^{2+} \longrightarrow Fe^{3+};\ NO^+ \longrightarrow NO$

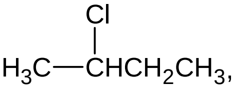
5.


$$\xrightarrow{PCl_5} CH_3 - Cl + A$$

(A) CH_3Cl is formed by S_N1 process.
(B) CH_3Cl is formed by S_N2 process

(C) A is


$H_3C-\overset{Cl}{\overset{|}{C}}HCH_2CH_3$, which is formed by S_N2 process

(D) A is


$H_3C-\overset{Cl}{\overset{|}{C}}HCH_2CH_3$, which is formed by S_N1 process

6. For the following equilibria in a close container

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

At a constant temperature, the volume of the container is halved suddenly. Which of the following is correct for K_p and α?

(A) Both K_p and α changes
(B) None of the K_p and α change
(C) K_p changes but α does not
(D) α - changes but K_p does not

Space for Rough work

7. Aluminum chloride exists as a dimer Al_2Cl_6 in solid state as well as in solution of non-polar solvents such as C_6H_6 . When dissolved in water, it gives

(A) $Al_2O_3 + 6HCl$	(B) $\left[Al\left(H_2O\right)_6\right]^{+} + 3Cl^{-}$
(C) $\left[\text{Al}\left(\text{OH}\right)_6\right]^{3-} + 6\text{HCl}$	(D) $Al^{3+} + 3Cl^{-}$

8. Resonance Energy of Toluene is 37.5 kcal/mol while that of Benzene is 36 kcal/mole then which of the following explains this difference

(A) Zeeman effect	(B) Electromeric effect
(C) Hyper-conjugation	(D) – I effect

9. The ortho and para-hydrogens possess:
(A) Same physical properties but different chemical properties.
(B) Different physical properties but same chemical properties.
(C) Same chemical and physical properties.
(D) Different physical and chemical properties.

10. During extraction of Fe
(A) Carbon is ultimately converted to CO_2 in combustion zone in blast furnace.
(B) CO_2 is one of the by-products of reduction zone of blast furnace.
(C) Cast iron is obtained from blast furnace.
(D) Uppermost zone of blast furnace is slag formation zone.

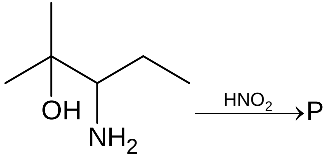
Space for Rough work

Multiple Correct Answer(s) Type

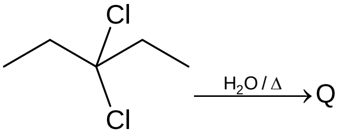
This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

11. Which of the following reaction products give haloform test?

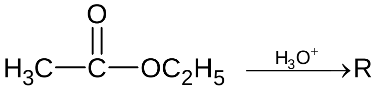
(A)



(B)

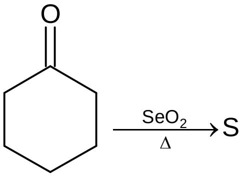


(C)

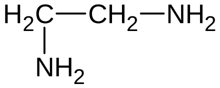


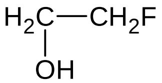
$H_3C-\overset{\overset{O}{||}}{C}-OC_2H_5 \xrightarrow{H_3O^+} R$

(D)



12. Which of the following statement(s) is/are correct?

(A) Anti conformation of  $H_2\underset{\underset{NH_2}{|}}{C}-CH_2-NH_2$ is always more stable than its Gauche conformation.

(B) Gauche conformation of  $H_2\underset{\underset{OH}{|}}{C}-CH_2F$ is more stable than anti-conformation at room temperature.

(C) On increasing temperature dipole moment of pure $Cl-CH_2-CH_2-Cl$ increases.

(D) In case of 1, 4 – dihydroxycyclohexane twist boat conformer is most stable.

13. Which of the following statement(s) is/are incorrect?

(A) Manganese salts give a violet borax bead test in reducing flame.

(B) From mixed salt of AgCl and AgI, NH_4OH solution dissolves only AgCl.

(C) Fe^{3+} ions given a deep green precipitate, on adding $K_4[Fe(CN)_6]$ solution.

(D) On strong heating $Na_2S_2O_3.5H_2O$, a polysulphide is resulted.

14. Which of the following is / are correct for amino acids?

(A) At pI, there is no net charge on amino acid.

(B) At pH > pI, there is net negative charge on amino acid.

(C) Amino acids are amphoteric in nature.

(D) They are highly soluble in benzene like organic solvents.

15. Which of the following is / are correct?

(A) All Arrhenius acids are also Bronsted acids.

(B) All Bronsted bases are also Arrhenius bases.

(C) All Bronsted bases are also Lewis bases.

(D) pH of 10^{-8} M HCl (aq) is 7.04 while that of 10^{-8} M NaOH (aq) is 6.96.

Space for Rough work

SECTION –C
Integer Answer Type

This section contains **5 questions.** The answer to each question is a **single digit integer**, ranging from 0 to 9 (both inclusive).

1. The osmotic pressure of 0.1 M monobasic acid solution is 0.11 RT at 'T Kelvin', what is its pH value?

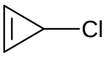
2. How many equivalents of HCHO are formed by oxidative cleavage of one equivalent of D-glucose by excess of HIO_4 in water?

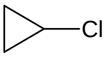
3. How many equivalents of base are consumed in the following reaction?

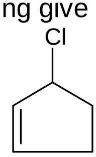
$$\underset{(1\text{ equivalent})}{CH_3CHO} \xrightarrow{Br_2/OH^-/\Delta} HCBr_3 + HCOO^-$$

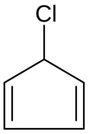
4. How many of the following salts are white and soluble in dilute HNO_3?
$BaCrO_4$, Hg_2CrO_4, ZnS, $BaSO_4$, BaS_2O_3, CH_3COOAg, $AgNO_2$

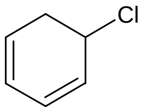
5. How many of the following give white precipitate with aqueous $AgNO_3$ solution?

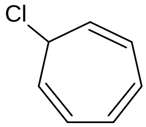


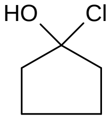


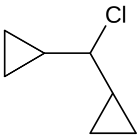












Space for Rough work

Mathematics

PART – III

SECTION – A

Single Correct Choice Type

This section contains **10 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. Number of solutions of the equation [y + [y]] = 2 cosx is, where y = $\frac{1}{3}$[sinx + [sinx + [sinx]]] and [.] denotes the greatest integer function
(A) 1
(B) 2
(C) 3
(D) none of these

2. The differential equation of the system of circles touching the x-axis at origin is
(A) $(x^2 - y^2)\frac{dy}{dx} - 2xy = 0$
(B) $(x^2 - y^2)\frac{dy}{dx} + 2xy = 0$
(C) $(x^2 + y^2)\frac{dy}{dx} - 2xy = 0$
(D) $(x^2 + y^2)\frac{dy}{dx} + 2xy = 0$

3. If α, β, γ, δ are the smallest positive angles in ascending order of magnitude which have their sines equal to the positive quantity k, then the value of 4 sin $\frac{\alpha}{2} + 3\sin\frac{\beta}{2} + 2\sin\frac{\gamma}{2} + \sin\frac{\delta}{2}$ is equal to
(A) $2\sqrt{1-k}$
(B) $2\sqrt{1+k}$
(C) $2\sqrt{k}$
(D) none of these

4. If equation $x^3 - x + a^2 - a + \frac{2}{3\sqrt{3}} < 0$ is true for atleast one positive x, then a belongs to
(A) (0, 1)
(B) $(1, \infty)$
(C) $(2, 3\sqrt{3})$
(D) none of these

Space for rough work

5. Number of solutions of the equation $\sqrt{3x-2}+\sqrt{4x+4}=\sqrt{5x+1}+\sqrt{4x-5}$ is
(A) 0
(B) 1
(C) 2
(D) 4

6. The value of $\lim\limits_{n\to\infty}\frac{1}{n^{n\lambda}}\left[(n+1)^{\lambda}(n+2)^{\lambda}...(n+n)^{\lambda}\right]^{1/n}$ is equal to
(A) $\left(\frac{4}{e}\right)^{\lambda}$
(B) $\left(\frac{1}{e}\right)^{\lambda}$
(C) $\left(\frac{3}{e}\right)^{\lambda}$
(D) $\left(\frac{2}{e}\right)^{\lambda}$

7. If $0 \le \arg z \le \frac{\pi}{4}$, then the least value of $\sqrt{2}\,|2z - 4i|$ is
(A) 6
(B) 1
(C) 4
(D) 2

8. If α, β, γ be the roots of the equation $2x^3 + 3x^2 - 12x + 3 = 0$ and $A(\alpha, \beta, \gamma)$, $B(\beta¸\ \gamma, \alpha)$, $C(\gamma, \alpha, \beta)$ represent vertices of a triangle ABC then the centroid of the triangle lies upon the line
(A) $x = y = z$
(B) $x = 2y = 3z$
(C) $x = -2y = 3z$
(D) $x = y = -2z$

9. If $a = \sqrt{\cot^{-1}x}$, $b = \cot^{-1}x$ and $c = (\cot^{-1}x)^2$ and $a > b > c$ then x lies in the interval
(A) $(0, 1)$
(B) $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$
(C) $(\cot 1, \infty)$
(D) $(-\cot 1, 1)$

10. Given a triangle ABC with circumcentre at origin. If $a \le 4 \sin A$ then for any point (a, y) inside the circumcircle of ΔABC
(A) $|xy| < 2$
(B) $2 < |xy| < 4$
(C) $\frac{1}{2} < |xy| < \frac{3}{4}$
(D) $|xy| > 4$

Space for rough work

Multiple Correct Answer(s) Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

11. If in a ΔABC a, b and $\angle A$ are given and C_1, C_2 are the possible values of the third side, then
(A) $C_1 + C_2 = 2b \cos A$
(B) $C_1 \cdot C_2 \ (b^2 - a^2)$
(C) $C_1^2 + C_2^2 - 2C_1C_2 \cos 2A = 4a^2 \cos^2 A$
(D) $C_1 + C_2 = 2a \cos B$

12. $\frac{1}{\sqrt{2}+\sqrt{5}} + \frac{1}{\sqrt{5}+\sqrt{8}} + \frac{1}{\sqrt{8}+\sqrt{11}} + \cdots$ n terms value of the above expression is
(A) $\frac{\sqrt{3n+2}-\sqrt{2}}{3}$
(B) $\frac{n}{\sqrt{2+3n}+\sqrt{2}}$
(C) less than n
(D) less than $\sqrt{\frac{n}{3}}$

13. If inside a big circle exactly 24 small circles, each of radius 2, can be drawn in such a way that each small circle touches the big circle and also touches both its adjacent small circles, then radius of the big circle is
(A) $2\left(1+\operatorname{cosec}\frac{\pi}{24}\right)$
(B) $\left(\frac{1+\tan\frac{\pi}{24}}{\cos\frac{\pi}{24}}\right)$
(C) $2\left(1+\operatorname{cosec}\frac{\pi}{12}\right)$
(D) $\frac{2\left(\sin\frac{\pi}{48}+\cos\frac{\pi}{48}\right)^2}{\sin\frac{\pi}{24}}$

14. If $x^2 + x + 1 - |[x]| = 0$ (where [.] denotes greatest integer function) then
(A) x = 1
(B) x = – 1
(C) exactly two value of x in [–2, – 1]
(D) none of these

15. If acosx + cotx + 1 = cosecx then the possible values of x can be
(A) $x = n\pi$, $a \in R$, $n \in I$
(B) $x = (4n+1)\frac{\pi}{2}$, $a \in R$, $n \in I$
(C) $x = \frac{1}{2}\sin^{-1}\left(\frac{4(a+1)}{a^2}\right)$, $a \in (-\infty, 2 - 2\sqrt{2}\,] \cup [2 + 2\sqrt{2}, \infty) - \{-1\}$
(D) none of these

Space for rough work

SECTION –C
Integer Answer Type

This section contains **5 questions.** The answer to each question is a **single digit integer**, ranging from 0 to 9 (both inclusive).

---

1. If $a = \sum_{r=1}^{\infty} \frac{1}{r^2},\ b = \sum_{r=1}^{\infty} \frac{1}{(2r-1)^2}$, then $\frac{3a}{b}$ is equal to _____

2. Let f : R → R defined by f(x) = sin x + x if $\int_0^{\pi} f^{-1}(x)dx = \frac{\pi^2}{2} - k$, then the value of k is _____

3. The figures 4, 5, 6, 7, 8 are written in every possible order. The number of numbers greater than 56000 is 15K then K is equal to _____

4. Let y = g(x) be the image of f(x) = x + sin x about the line x + y = 0. If the area bounded by y = g(x), x-axis, x = 0 and x = 2π is A, then $\frac{A}{\pi^2}$ is _____

5. If $|\vec{a}| = 2,\ |\vec{b}| = 3,$ and $|\vec{c}| = 4$ then $|\vec{a} - \vec{b}|^2 + |\vec{b} - \vec{c}|^2 + |\vec{c} - \vec{a}|^2 \le (12K + \lambda)$ then λ is equal to _____

Space for rough work

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From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS
CRT–I
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	C	D
2.	A	D	A
3.	B	D	B
4.	B	C	A
5.	A	B	B
6.	D	D	A
7.	B	C	C
8.	A.	C	A
9.	B	B	C
10.	C	B	A
11.	A, B, C	A, C	A, B, C
12.	A, B, C, D	B, C	A, B, C, D
13.	B, C, D	A, C	A, D
14.	A, B, C	A, B, C	B, C
15.	A, B, C	A, C	B, C
1.	2	2	4
2.	1	1	2
3.	5	4	6
4.	1	3	2
5.	2	6	3

Physics

PART – I

SECTION – A

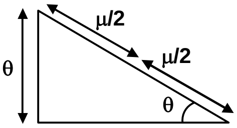
1. $U_{rel} = g \times t = 10 \times 1$

$= 10 \text{ m/s}$

$S_1 = \frac{1}{2}g(1) = 5\text{m}$

$S_{rel} = S_1 + u_{re\ell} + \frac{1}{2}a_{re\ell}t^2 = 5 + 10 \times 3 + 0 = 35 \text{ m}$

2. $\sin\theta = \frac{h}{\ell}$



$mgh = \mu \, mg \cos\theta(\ell/2)$

$\frac{h}{\ell} = \frac{\mu \cos\theta}{2}$

$\tan\theta = \frac{\mu}{2}$

3. Centre of mass does not move in the absence of external force so

$m_1x_1 = m_2x_2$

$\frac{x_1}{x_2} = \frac{m_2}{m_1}$

4. $A = \frac{dA_1}{dt} = \frac{r^2}{2}\frac{d\theta}{dt} = \frac{r^2}{2}\omega$

$L = Mr^2\omega$

$L = 2MA$

5. $F = \frac{Gm(M-m)}{r^2} = 0$

$\frac{dF}{dm} = \frac{G}{r^2}(M-2m) = 0$

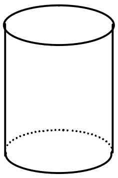
$M = 2m$

$m = (M/2)$

6. $\frac{\rho A\ell g}{A} = s$

$\ell = \frac{s}{\rho g}$

7. $\rho gh\pi r^2 = \int_0^h (2\pi r dh)\rho gh$



$\rho gh\pi r^2 = 2\pi r\rho g\frac{h^2}{2}$

$r = 2\frac{h}{2}$

$r = h$

8. Avg. speed $3 = \dfrac{\sqrt{(v_r t)^2 + (v_{mr} t)^2}}{t}$

$\Rightarrow v_r^2 + 5 = 9$

$\Rightarrow v_r = 2m/s$

9. $v_{avg} = \dfrac{\frac{1}{2} \times \frac{t}{2} \times v + \frac{1}{2} \times v}{t} = \dfrac{3v}{4}$

10. $\dfrac{m}{2}g - T = \dfrac{m}{2}a$ …(i)

T cos 60° = $\dfrac{ma}{\cos 60°}$ …(ii)

Solving (i) and (ii) acceleration of ring = $\dfrac{2g}{9}$

11. $mg - \dfrac{2kq^2}{R^2} + T = \dfrac{mv^2}{R}$ …(i)

$-mgR + \dfrac{1}{2}mu^2 = mgR + \dfrac{1}{2}mv^2$ …(ii)

if T = 0 $\Rightarrow u_{min} = \sqrt{5gR - \dfrac{2Kq^2}{mR}}$

12. $F = -\dfrac{dU}{dx} = -5(2x - 4)$

At mean position F = 0 ⇒ x = 2m

$U_{min} = -20$ J

$a = -50 \times 2(x - 2)$

$\omega = 10$ rad/sec

$T = \pi/5$ sec

13. If the volume immersed initially is (V/3). Then $\dfrac{V}{3}\rho g = mg$ …(i)

If the volume immersed when the system accelerates is V′ then

$V'\rho\left(g + \dfrac{g}{2}\right) - mg = \dfrac{mg}{2} \Rightarrow V' = \dfrac{V}{3}$

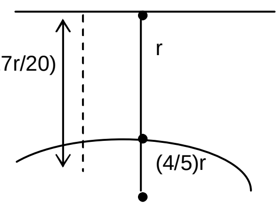
14. The potential of the two surface will be equal when the whole charge Q flows from inner to other shell.

SECTION –C

1. Consideration refraction at glass-water interface

$\dfrac{\mu_2}{v} - \dfrac{\mu_1}{u} = \dfrac{\mu_2 - \mu_1}{R}$

$\Rightarrow \dfrac{4}{3v} - \dfrac{3}{-2r} = \dfrac{(4/3) - (3/2)}{r}$



$\Rightarrow \dfrac{4}{3v} + \dfrac{3}{2r} = -\dfrac{1}{6r}$

$\therefore\ v = -\dfrac{r}{5}$

Now refraction at water air surface

$u = -\left(r + \dfrac{4}{5}r\right) = -\dfrac{9r}{5}$

$\dfrac{\mu_2}{v} - \dfrac{\mu_1}{u} = \dfrac{\mu_2 - \mu_1}{\infty}$

$\Rightarrow \dfrac{1}{v} + \dfrac{4\times 5}{3\times 9r} = \dfrac{1-(4/3)}{\infty}$

$\dfrac{1}{v} = -\dfrac{20}{27r}$

$v = -\dfrac{27r}{20}$

so height above centre $= 2r - \dfrac{27r}{20}$

$= \dfrac{40r - 27r}{20} = \dfrac{13}{20}r = 13$ cm.

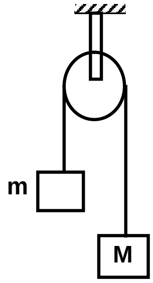
2. $Mg - T = Ma$ …(i)

$T - mg = ma$ …(ii)

$T = \dfrac{2Mmg}{(M+m)}$

$\Rightarrow \dfrac{T}{A} = \dfrac{2Mmg}{A(M+m)} = \dfrac{2mg}{A\left(1+\dfrac{m}{M}\right)} = 2\times 10^9$

$\Rightarrow M = 1.86$ Kg



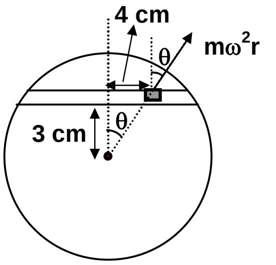
3. Relative motion between block and table will start when

$m\omega^2 r \sin\theta = \mu(mg + m\omega^2 r\cos\theta)$ …(i)

$\omega = \alpha t$ …(ii)

solving (i) and (ii)

$t = \sqrt{500} = 22.4$ sec .



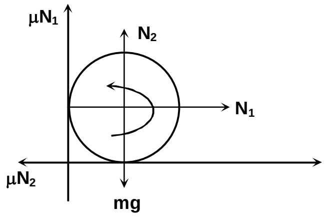
4. $\omega = \sqrt{\dfrac{\mu g}{R}} = 1$ rad/sec

5. $\mu N_1 + N_2 = mg$ . . . (1)

$N_1 = \mu N_2$ . . . (2)

$N_2 = \dfrac{mg}{\left(1+\mu^2\right)}$

$N_1 = \dfrac{\mu mg}{\left(1+\mu^2\right)}$



Torque about centre of mass

$\mu(N_1 + N_2)R = \frac{1}{2}mR^2\alpha$

$\alpha = \frac{2\mu(N_1 + N_2)}{mR} = \frac{2\mu(1+\mu)g}{(1+\mu^2)R}$

$\omega^2 = \omega_0^2 - 2\alpha\theta$

$\theta = \frac{\omega_0^2}{2\alpha}$

$\theta = \frac{\omega_0^2(1+\mu^2)R}{2\times 2\mu(1+\mu)g}$

Hence number of turns

$N = \frac{\theta}{2\pi} = \frac{\omega_0^2 R(1+\mu^2)}{4\mu(1+\mu)g.2\pi}$

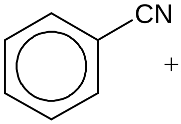
$N = \frac{\omega_0^2 R(1+\mu^2)}{8\mu\pi g(1+\mu)}$

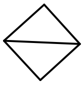
Chemistry

PART – II

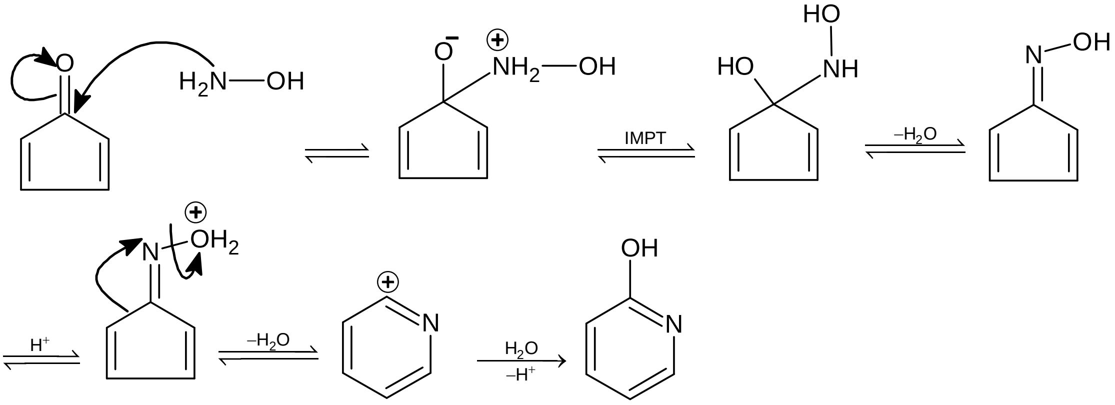
SECTION – A

1. In ‘A’ π bond is at bridge head which is not stabilized in the given structure;

In ‘B’ the product is  +ACOH ;

In ‘D’ the product is 

2.



5. CH_3Cl is formed by S_N2 while $CH_3CHClC_2H_5$ is formed by S_Ni.

6.

	$PCl_5(g) \rightleftharpoons$	$PCl_3(g) +$	$Cl_2(g)$
Let initially no. of moles	x	–	–
at equilibrium (volume V)	$x(1-\alpha)$	$x\alpha$	$x\alpha$

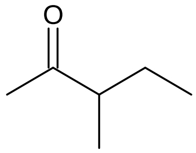
$K_c = \dfrac{x^2\alpha^2}{x(1-\alpha)V}$, also $K_p = K_c(RT)^{\Delta n_g}$

on reducing volume to $\dfrac{V}{2}$, initial concentration of PCl_5 doubles and its degree of dissociation is increased but K_p does not change, as it is characteristic constant for a reaction at constant temperature.

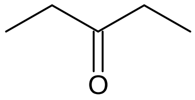
7. $Al_2Cl_6 + 12H_2O \longrightarrow 2H_3\left[Al(OH)_6\right] + 6HCl$;

10. In blast furnace,
In combustion zone, CO is produced ultimately which reduce Fe_2O_3 to Fe_3O_4 in reduction zone, which is uppermost zone.

11. P =

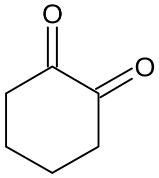


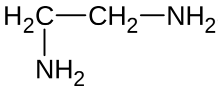
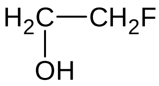
Q =



R = $CH_3COOH + C_2H_5OH$; $C_2H_5OH \xrightarrow{\text{Oxidation by } XO^-} CH_3CHO$

S =



12. Due to hydrogen bonding Gauche conformation of  $\underset{NH_2}{H_2C}-CH_2-NH_2$ and  $\underset{OH}{H_2C}-CH_2F$

are more stable than their anti-conformations.

In case of $ClCH_2CH_2Cl$, on increasing temperature, % of Gauche conformation increases. Hence dipole moment increases. In case of option (D) boat conformation is most stable.

13. Mn appears colourless in reducing flame in Borax Bead Test.

$Fe^{3+} + K_4\left[Fe(CN)_6\right] \longrightarrow \underset{\text{Prussian blue}}{Fe_4\left[Fe(CN)_6\right]_3} \downarrow + K^+$

$Na_2S_2O_3.5H_2O \xrightarrow{\Delta} Na_2S_5 + Na_2SO_4 + H_2O$

14. At pH = pI, amino acid exists as Zwitter Ion, they are highly soluble in polar solvents.

15. pH of 10^{-8} M HCl (aq) is 6.96 and pH of 10^{-8} M NaOH (aq) is 7.04

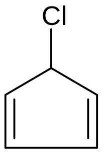
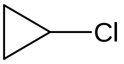
SECTION – C

1. π = CRT × i
hence i = 1.1; so α = 0.1
hence $[H^+] = c\alpha = 0.1 \times 0.1 = 10^{-2}$ M
pH = 2

2. It has only one CH_2OH group.

3. Three equivalents to remove three hydrogens from CH_3 group and one for attack on C of CHO group.

4. $BaCrO_4$ – Yellow, soluble in dil HNO_3
Hg_2CrO_4 – Red, soluble in conc. HNO_3
ZnS – White, soluble in Conc. HNO_3
$BaSO_4$ – White, insoluble in all mineral acids
BaS_2O_3, CH_3COOAg and $AgNO_2$ all are white solid and are soluble in dilute HNO_3 solution.

5. Except  and 

Mathematics PART – III

SECTION – A

1. [y + [y]] = 2 cosx $\Rightarrow$ [y] = cosx
$y = \frac{1}{3}$ [sinx + [sinx + [sinx]]] = [sinx]
$\Rightarrow$ [sinx] = cosx
Number of solution in [0, 2π] is 0
Hence total solution is 0.
$\therefore$ both are periodic with period 2π

2. $(x - 0)^2 + (y - k)^2 = k^2$
$\Rightarrow x^2 + (y - k)^2 = k^2$
$2x + 2(y - k)\frac{dy}{dx} = 0$
$\Rightarrow \frac{dy}{dx} = -\frac{x}{y-k}$
$y - k = -\frac{xdx}{dy}$
$k = y + \frac{xdx}{dy}$

$$\Rightarrow x^2 + \left(y - \left(y + \frac{xdx}{dy}\right)\right)^2 = \left(y + \frac{xdx}{dy}\right)^2$$

$$\Rightarrow x^2 + x^2\left(\frac{dx}{dy}\right)^2 = y^2 + x^2\left(\frac{dx}{dy}\right)^2 + \frac{2xydx}{dy}$$

$$x^2 = y^2 + \frac{2xydx}{dy}$$

$$(x^2 + y^2)\frac{dy}{dx} - 2xy = 0$$

3. Given $\alpha < \beta < \gamma < \delta$ also $\sin\alpha = \sin\beta = \sin\gamma = \sin\delta = k$
and $\alpha, \beta, \gamma, \delta$ are smallest positive angles
$\therefore \beta = \pi - \alpha, \gamma = 2\pi + \alpha, \delta = 3\pi - \alpha$
as $\sin\beta = \sin\alpha$ and $\beta > \alpha$
$\sin\beta = \sin\gamma$ and $\gamma > \beta$
$\sin\gamma = \sin\delta$ and $\delta > \gamma$
Putting these values in the given expansion, we have given expression

$$= 2\left(\sin\frac{\alpha}{2} + \cos\frac{\alpha}{2}\right) = 2\sqrt{1+\sin\alpha} = 2\sqrt{1+k}$$

4. $x^3 - x < -a^2 + a - \frac{2}{3\sqrt{3}}$
$f(x) = x^3 - x$
$f'(x) = 3x^2 - 1 = 0$
$x = \pm\frac{1}{\sqrt{3}}$
In positive region minimum value of $f(x) = \frac{1}{3\sqrt{3}} - \frac{1}{\sqrt{3}} = -\frac{2}{3\sqrt{3}}$
So, $-a^2 + a - \frac{2}{3\sqrt{3}} > -\frac{2}{3\sqrt{3}}$
$a^2 - a < 0$
$a \in (0, 1)$

5. $\underset{v}{\sqrt{3x-2}} + \underset{u}{\sqrt{4x+4}} = \underset{p}{\sqrt{5x+1}} + \underset{q}{\sqrt{4x-5}}$ …(1)
$u^2 - v^2 = x + 6 = p^2 - q^2$
$u - v = p - q$ …(2)
solving (1) and (2)
we get, $2\sqrt{4x+4} = 2\sqrt{5x+1}$
$\Rightarrow x = 3$

6. Limit be equal to y

$$\log y = \frac{1}{n}\lim_{n\to\infty}\left[\log\left(\frac{n+1}{n}\right)^{\lambda} + \log\left(\frac{n+2}{n}\right)^{\lambda} + \ldots\right]$$

$$= \frac{1}{n}\lim_{n\to\infty}\sum_{r=1}^{n}\left[\log\left(\frac{n+r}{n}\right)^{\lambda}\right] = \frac{1}{n}\lim_{n\to\infty}\sum_{r=1}^{n}\lambda\log\left(1+\frac{r}{n}\right) = \lambda\int_0^1 \log(1+x)dx$$

$= \lambda \,.\, 2\left[\log 2 - \frac{1}{2}\right] = \lambda[\log 4 - \log e] = \lambda \log\left(\frac{4}{e}\right)$

$\log y = \log\left(\frac{4}{e}\right)^{\lambda}$

7. $0 \le \arg z \le \frac{\pi}{4}$, represent the region of complex plane lying in the first quadrant and bounded by x-axis and the line y = x
$|2z - 4i| = 2|z - 2i|$
least value of $|z - 2i|$ is length of perpendicular from (0, 2) to y = x, which is $\sqrt{2}$
So the least value of $\sqrt{2}\,|2z - 4i|$ is 4

8. Let $f(x) = 2x^3 + 3x^2 - 12x + 3$
$\Rightarrow f(x) = 0$ has three real roots (α, β, γ)
$\alpha + \beta + \gamma = -\frac{3}{2}$
Centroid = $\left(\frac{\sum\alpha}{3}, \frac{\sum\alpha}{3}, \frac{\sum\alpha}{3}\right) = \left(-\frac{1}{2}, -\frac{1}{2}, -\frac{1}{2}\right)$ which lies on x = y = z.

9. If a > b > c and $a^2 = b = \sqrt{c}$ then $b < 1 \Rightarrow \cot^{-1}x < 1 \Rightarrow x > \cot 1$

10. $a \le 4\sin A \Rightarrow \frac{a}{\sin A} \le 4 \Rightarrow R \le 2$
so for any point (x, y) inside the circumcircle, $x^2 + y^2 < 4$
$\Rightarrow |xy| < 2$

11. a, b and ∠A are given in ΔABC,
$\therefore \cos A = \frac{b^2 + c^2 - a^2}{2bc}$
$\Rightarrow c^2 - 2bc\cos A + (b^2 - a^2) = 0$
$\Rightarrow c^2 - (2b\cos A)c + (b^2 - a^2) = 0$
which is quadratic in c and gives two values of c and let these are c_1 and c_2
$\therefore c_1 + c_2 = 2b\cos A$
and $c_1 \cdot c_2 = (b^2 - a^2)$
$c_1^2 + c_2^2 - 2c_1c_2\cos 2A$
$= (c_1 + c_2)^2 - 2c_1c_2(1 + \cos 2A)$
$= 4b^2\cos^2 A - 2(b^2 - a^2)(2\cos^2 A)$
$= 4b^2\cos^2 A - 4b^2\cos^2 A + 4a^2\cos^2 A$
$= 4a^2\cos^2 A$

12. $\frac{1}{\sqrt{2}+\sqrt{5}} + \frac{1}{\sqrt{5}+\sqrt{8}} + \frac{1}{\sqrt{8}+\sqrt{11}} + \cdots$ n terms
$= \frac{\sqrt{5}-\sqrt{2}}{3} + \frac{\sqrt{8}-\sqrt{5}}{3} + \frac{\sqrt{11}-\sqrt{8}}{3} + \cdots + \frac{\sqrt{5+(n-1)3} - \sqrt{2+(n-1)3}}{3}$
$= \frac{\sqrt{3n+2}-\sqrt{2}}{3} = \frac{3n+2-2}{3\left(\sqrt{3n+2}+\sqrt{2}\right)} = \frac{n}{\sqrt{3n+2}+\sqrt{2}}$

$$= \frac{n}{\sqrt{2+3n}+\sqrt{2}} < \frac{n}{\sqrt{3n}} < n$$

13. $\sin\frac{\pi}{24} = \frac{2}{R-2}$

$\Rightarrow R = 2\left(1+\text{cosec}\frac{\pi}{24}\right)$

(A) is true $\because \frac{\left(\sin\frac{\alpha}{2}+\cos\frac{\alpha}{2}\right)^2}{\sin A} = 1+\text{cosec}\alpha$

(D) is true

14. $x^2 + x + 1 = |[x]|$
Hence only 2 solutions exist
i.e. $x = -1$ and another lie $-2 < x < -1$

15. $\sin x + \cos x = 1 - a \sin x \cos x$
$\Rightarrow a^2 \sin^2x \cos^2x - 2(a + 1) \sin x \cos x = 0$
$\Rightarrow \sin 2x\left(\frac{a^2}{2}\sin 2x - 2(a+1)\right) = 0$
Hence $\sin 2x = 0\ \forall\ a \in R$
$\Rightarrow x = \frac{n\pi}{2}, n \in I$
And $\sin 2x = \frac{4(a+1)}{a^2} \Rightarrow a \in (-\infty, 2 - 2\sqrt{2}\,] \cup [2 + 2\sqrt{2}, \infty)$

SECTION – C

1. $a = \sum_{r=1}^{\infty}\frac{1}{r^2},\ b = \sum_{r=1}^{\infty}\frac{1}{(2r-1)^2}$

$a = \frac{1}{1^2}+\frac{1}{2^2}+\frac{1}{3^2}+\frac{1}{4^2}+...\infty$ and $b = \frac{1}{1^2}+\frac{1}{3^2}+\frac{1}{5^2}+\frac{1}{7^2}+...\infty$

$b = \left(\frac{1}{1^2}+\frac{1}{2^2}+\frac{1}{3^2}+\frac{1}{4^2}+...\infty\right)-\left(\frac{1}{2^2}+\frac{1}{4^2}+\frac{1}{6^2}+...\infty\right)$

$b = \left(\frac{1}{1^2}+\frac{1}{2^2}+\frac{1}{3^2}+\frac{1}{4^2}+...\infty\right)-\frac{1}{2^2}\left(1+\frac{1}{2^2}+\frac{1}{3^2}+...\infty\right)$

$b = a - \frac{1}{4}a$

$b = a\times\frac{3}{4}$

$\frac{a}{b} = \frac{4}{3}$

2. $\int_0^{\pi} f^{-1}(x)dx = \int_0^{\pi} t f'(t)dt$

$= \left[t\, f(t)\right]_0^{\pi} - \int_0^{\pi} (t + \sin t)\,dt$

$= \pi^2 - \frac{\pi^2}{2} - 1 - 1$

$= \frac{\pi^2}{2} - 2$

$\Rightarrow k = 2$

3. **Case I:** When we use 6, 7 or 8 at ten thousand place then number of numbers
$= 3 \times {}^4P_4 = 72$
Case II: When we use 5 at ten thousand place and 6, 7 or 8 at thousand place then number of numbers is
$= 1 \times 3 \times {}^3P_3 = 18$
hence the required numbers of numbers is 72 + 18 = 90

4. f(x) is an odd function
$\Rightarrow$ g(x) is $f^{-1}(x)$
$\Rightarrow$ Area = $\int_0^{2\pi} f^{-1}(y)\,dy = \int_0^{2\pi} x\, f'(x)\,dx$
$= \left[x(f(x))\Big|_0^{2\pi} - \int_0^{2\pi} (x + \sin x)\,dx \right] = 2\pi^2$

5. $|\vec{a} - \vec{b}|^2 + |\vec{b} - \vec{c}|^2 + |\vec{c} - \vec{a}|^2 = 2(a^2 + b^2 + c^2) - 2(\vec{a}\cdot\vec{b} + \vec{b}\cdot\vec{c} + \vec{c}\cdot\vec{a})$
$= 2(4 + 9 + 16) - 2(\vec{a}\cdot\vec{b} + \vec{b}\cdot\vec{c} + \vec{c}\cdot\vec{a})$
$= 58 - 2(\vec{a}\cdot\vec{b} + \vec{b}\cdot\vec{c} + \vec{c}\cdot\vec{a})$.
Now $(\vec{a} + \vec{b} + \vec{c})^2 \ge 0$
$\Rightarrow a^2 + b^2 + c^2 \ge -2(\vec{a}\cdot\vec{b} + \vec{b}\cdot\vec{c} + \vec{c}\cdot\vec{a})$
$\Rightarrow -2(\vec{a}\cdot\vec{b} + \vec{b}\cdot\vec{c} + \vec{c}\cdot\vec{a}) \le 29$
$\Rightarrow |\vec{a} - \vec{b}|^2 + |\vec{b} - \vec{c}|^2 + |\vec{c} - \vec{a}|^2 \le 87$

FIITJEE **JEE (Advanced), 2014**

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - I

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 08)** contains 8 multiple choice questions which have one or more correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 to 16) contains 4 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-A (17 – 20)** contains 4 Matching Lists Type questions: Each question has four statements in LIST I & 4 statements in LIST II. The codes for lists have choices (A), (B), (C), (D) out of which only one is correct. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

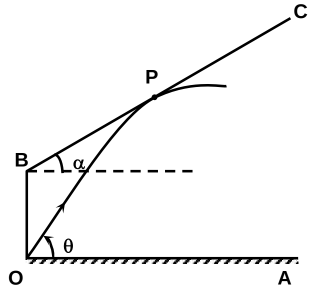
PART – I

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE OR MORE** is/are correct

1. A particle is projected from a point O in the horizontal surface OA with speed u and angle of projection θ. It just grazes the plane BC which makes an angle α with the horizontal. The time taken by the projectile to reach p from the instant of projection is



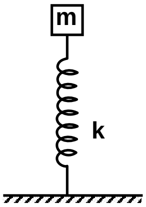
(A) $\dfrac{2u\sin\theta}{g\cos\alpha}$

(B) $\dfrac{u\sin\theta}{g\cos\alpha}$

(C) $\dfrac{u\sin(\theta-\alpha)}{g\cos\alpha}$

(D) None of these.

2. A block of mass m is attached to a spring of force constant k whose other end is fixed to a horizontal surface. Initially the spring is in its natural length and the block is released from rest. The average force acting on the surface by the spring till the instant when the block has zero acceleration for the first time is



(A) $\dfrac{mg}{\pi}$

(B) $\dfrac{2mg}{\pi}$

(C) $\dfrac{3mg}{\pi}$

(D) $\dfrac{4mg}{\pi}$

3. The gas inside a spherical bubble expands uniformly and slowly so that its radius increases from R to 2R. Let the atmospheric pressure be p_0 and surface tension be S. The work done by the gas in the process is

(A) $\dfrac{28\pi p_0R^3}{3} + 24\pi SR^2$

(B) $\dfrac{25\pi p_0R^3}{3} + 24\pi SR^2$

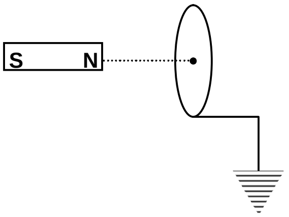
(C) $\dfrac{25\pi p_0R^3}{3} + \dfrac{23\pi SR^2}{2}$

(D) None of these

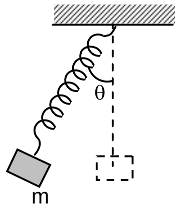
Space for Rough work

4. A block of mass M is hanging over a smooth and light pulley through a light string. The other end of the string is pulled by a constant force F. If kinetic energy of the block increases by 20 J in 1s. Then
(A) tension in the string is Mg.
(B) tension in the string is F
(C) Work done by the tension on the block is 20 J in 1 sec.
(D) Work done by the force of gravity is 20 J in 1 sec.

5. A circular ring is fixed in a gravity free space and one point of the ring is earthed. Now a magnet is placed along axis of the ring at a distance from its centre such that the nearer pole is north pole as shown in figure. A sharp impulse is applied on the magnet so that it starts to move towards the ring. Then,
(A) Initially magnet experiences an acceleration and then it retards to come to an instantaneous rest.
(B) Magnet starts to oscillate about centre of the ring
(C) Magnet continuous to move along the axis with constant velocity
(D) The magnet retards and comes to rest finally.



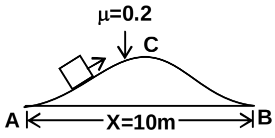
6. A block of mass m is suspended by means of an ideal spring of force constant k from ceiling of a car which is moving along a circular path of radius 'r' with acceleration 'a'. The time period of oscillation of the block when it is displaced along the spring, will be



(A) $2\pi\sqrt{\frac{mg+ma}{k}}$
(B) $2\pi\sqrt{\frac{m}{k\sqrt{g^2+a^2}}}$
(C) $2\pi\sqrt{\frac{m}{k}}$
(D) $2\pi\sqrt{\frac{m}{\sqrt{k^2+g^2+a^2}}}$

7. In the hydrogen atom spectrum λ_{3-1} and λ_{2-1} represent wavelengths emitted due to transition from second and first excited states to the ground state respectively. The value of $\frac{\lambda_{3-1}}{\lambda_{2-1}}$ is
(A) 27 / 32
(B) 32/27
(C) 4/9
(D) 9/4

8. A block of mass 1 kg is pulled along the curve path ACB by a tangential force as shown in figure. The work done by the frictional force when the block moves from A to B is
(A) 5 J
(B) 10 J
(C) 20 J
(D) none of these



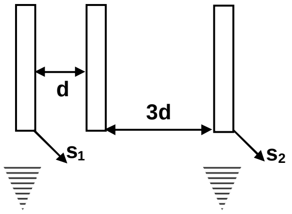
Space for Rough work

Paragraph Type

This section contains 8 **multiple choice questions** relating to **four paragraphs** with **two questions on each paragraph**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

Paragraph for Questions 9 and 10

Three metallic plates out of which middle is given charge Q as shown in the figure. The outer plates can be earthed with the help of switches S_1 and S_2. The area of each plates is same.
Answer the following question based on the following passage.

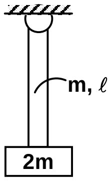


9. The charge appearing on the outer surface of extreme left plate is
   (A) –(Q/2)
   (B) (Q/2)
   (C) Q
   (D) –Q

10. The charge that will flow to earth when only switch S_1 is connected to earth is
   (A) –(Q/2)
   (B) (Q/2)
   (C) Q
   (D) –Q

Paragraph for Questions 11 and 12

A block of mass 2m is hanging at the lower end of a rope of mass m and length the ℓ, the other end being fixed to the ceiling. A pulse of wavelength λ_0 is produced at the lower end of the rope.



11. The wavelength of the pulse when it reaches the other end of the rope is
   (A) $\sqrt{3}\lambda_0$
   (B) $\sqrt{\frac{3}{2}}\lambda_0$
   (C) λ_0
   (D) $\frac{\lambda_0}{2}$

12. The speed of the pulse at the mid point of rope is
   (A) $\sqrt{\frac{5}{2}g\ell}$
   (B) $\sqrt{\frac{5}{3}g\ell}$
   (C) $\sqrt{\frac{2}{5}g\ell}$
   (D) $\sqrt{\frac{g\ell}{2}}$

Space for Rough work

Paragraph for Questions 13 and 14

A bike of length ℓ having its centre of mass at the middle is to turn with constant speed v [here v is the speed of centre of mass of the bike]. To turn, the front wheel is rotated by an angle θ. The coefficient of friction between the tyres and the road is μ. Assuming the bike to be vertical and it does not skid, answer the following questions.

13. The radius of curvature of the centre of mass of the bike is

(A) $\frac{\ell}{\tan\theta}\sqrt{4+\tan^2\theta}$ (B) $\frac{\ell}{\tan\theta}\sqrt{2+\tan^2\theta}$

(C) $\frac{\ell}{2\tan\theta}\sqrt{4+\tan^2\theta}$ (D) $\frac{\ell}{2\tan\theta}\sqrt{2+\tan^2\theta}$

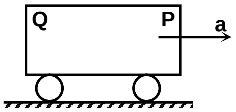
14. The friction force acting on the bike

(A) $\frac{2mv^2\tan^2\theta}{\ell\sqrt{4+\tan^2\theta}}$ (B) $\frac{2mv^2\tan^2\theta}{\ell\sqrt{2+\tan^2\theta}}$

(C) $\frac{mv^2\tan^2\theta}{\ell\sqrt{4+\tan^2\theta}}$ (D) $\frac{mv^2\tan^2\theta}{\ell\sqrt{4+\tan^2\theta}}$

Paragraph for Questions 15 and 16

A cylindrical vehicle containing a gas of mass m and molecular weight M moves along the axis of the cylinder with constant acceleration “a”. The temperature of the gas is maintained constant at T_0 and saturated vapour pressure at this temperature is P_0. Saturated vapour pressure is the pressure at which condensation starts. The cross sectional area of the cylinder is A and volume V. Now, answer the following questions neglecting gravity and assuming the pressure at the front face to be zero & varies linearly from P to Q.



15. The maximum value of “a” so that no condensation takes place

(A) $\frac{p_0A}{m}$ (B) $\frac{p_0A}{2m}$

(C) $\frac{2p_0A}{m}$ (D) $\frac{3p_0A}{2m}$

16. If $a = 5p_0A/m$, the mass of the gas condensed is

(A) m/2 (B) m/3

(C) 4m/5 (D) m/5

Space for Rough work

Matching list Type

This section contains **4 multiple choice questions**. Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

17. Match **List - I** with **List - II** and select the correct answer using the codes given below the lists:

List – I		**List – II**	
(P)	Isothermal process	(1)	Pressure = constant
(Q)	Adiabatic process	(2)	$dW = -dU$
(R)	Isochoric process	(3)	$dU = 0$
(S)	Isobaric process	(4)	$dQ = dU$

Codes:

	P	Q	R	S
(A)	2	3	1	4
(B)	3	2	4	1
(C)	4	1	2	3
(D)	2	3	4	1

18. Match **List - I** with **List - II** and select the correct answer using the codes given below the lists:

List – I		**List – II**	
(P)	Ultraviolet light	(1)	$N = 6 \rightarrow n = 3$
(Q)	Visible light	(2)	$N = 3 \rightarrow n = 1$
(R)	Infrared radiation	(3)	$N = 4 \rightarrow n = 2$
(S)	Micro waves	(4)	$N = 7 \rightarrow n = 6$

Codes:

	P	Q	R	S
(A)	2	3	1	4
(B)	1	4	2	3
(C)	4	1	2	3
(D)	2	3	4	1

Space for Rough work

19. Three concentric spherical metallic shells A, B, and C of radii a, b, and c (a<b<c) have charge densities of σ, $-\sigma$ and σ respectively. Match **List - I** with **List - II** and select the correct answer using the codes given below the lists:

	List – I		**List – II**
(P)	The potential at A	(1)	$\frac{\sigma}{\varepsilon_0}\left(\frac{a^2}{c}-\frac{b^2}{c}+c\right)$
(Q)	The potential at B	(2)	$\frac{\sigma}{\varepsilon_0}\left(\frac{a^2}{c}-b+c\right)$
(R)	The potential at C	(3)	$\frac{\sigma}{\varepsilon_0}$
(S)	The electric field at surface of A	(4)	$\frac{\sigma}{\varepsilon_0}\left(a-b-c\right)$

Codes:

	P	Q	R	S
(A)	2	3	1	4
(B)	1	4	2	3
(C)	4	1	2	3
(D)	2	3	4	1

20. Match **List - I** with **List - II** and select the correct answer using the codes given below the lists:

	List – I		**List – II**
(P)	Solid sphere is rolling without slipping. The ratio of rotational K.E. to the translational K.E.	(1)	$\frac{5}{7}$
(Q)	When ring and disc both rolling without slipping on the inclined plane the ratio of their times to reach bottom.	(2)	$\frac{2}{5}$
(R)	A solid sphere is rolling with slipping. The ratio of frictional force to normal reaction is (μ = 0.25)	(3)	$\frac{2}{\sqrt{3}}$
(S)	The ratio of translational kinetic energy to the total K.E. when sphere is rolling without slipping on the inclined plane.	(4)	$\frac{1}{4}$

Codes:

	P	Q	R	S
(A)	2	3	1	4
(B)	1	4	2	3
(C)	4	1	2	3
(D)	2	3	4	1

Space for Rough work

Chemistry PART – II

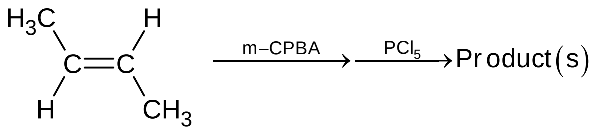
SECTION – A

Straight Objective Type

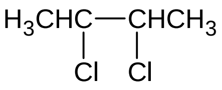
This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE OR MORE** is/are correct

1. Sometimes yellow turbidity appears while passing H_2S gas even in the absence of IInd group of basic radicals. Which of the following is/are not correct justification for the aforesaid observation?
(A) Sulphur is present in the mixture as impurity
(B) IV group radicals are precipitated as sulphides
(C) H_2S (g) is oxidized by some acid radicals
(D) IIIrd group radicals are precipitated as hydroxides

2.

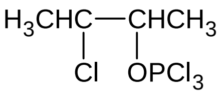


(A) The product is



$H_3CHC(Cl)-CHCH_3(Cl)$

(B) The product is



$H_3CHC(Cl)-CHCH_3(OPCl_3)$

(C) The product is optically active
(D) The product is optically inactive

3. Which of the following is / are correct matches?

	Column – I (Trend)		Column – II (Characteristic/Property)
(A)	$NaNO_3 > KNO_3 > RbNO_3$	(p)	Thermal stability
(B)	$MgO > SnO > B_2O_3$	(q)	Basic nature
(C)	$NaHCO_3 < KHCO_3 < RbHCO_3$	(r)	Solubility in H_2O
(D)	$AlF_3 > AlCl_3 > AlBr_3$	(s)	Melting point

4. For the cell:
$Tl(s) \,|\, Tl^{+}(0.001\,M) \,||\, Cu^{2+}(0.1\,M) \,|\, Cu(s)$;
E_{cell} = 0.83 V at 298 K. The cell potential can be increased by
(A) increasing $[Cu^{2+}]$ (B) increasing $[Tl^{+}]$
(C) decreasing $[Cu^{2+}]$ (D) decreasing $[Tl^{+}]$

Space for Rough work

5. Which of the following statement(s) is/are true?
(A) The equivalent conductance of strong and weak electrolytes increases on dilution.
(B) The increase in equivalent conductance of strong and weak electrolytes on dilution is due to increase in number of ions.
(C) If $CH_3COOH(aq)$ is separated from pure water by semipermeable membrane, then equivalent conductance of solution increases gradually and ultimately becomes constant.
(D) (B) and (C) both are incorrect.

6. 34.1 gm Pb_3O_4 is dissolved in 500 ml of 4M HNO_3, then (M_{Pb} = 206 gm/mole)
(A) There is no residue
(B) The weight of residue is 11.9 gm
(C) 300 ml of 6 M NaOH is required to neutralise excess of HNO_3
(D) Total 2.2 moles of NaOH are used after reaction of Pb_3O_4 with HNO_3

7. Which of the following statement(s) is/are correct?
(A) During electrophoresis, colloidal particles move under influence of electric field.
(B) Suspensions are opaque and they do not show Tyndell effect.
(C) Higher is the coagulating power of an electrolyte, higher is its coagulation value.
(D) 50 ml of standard gold sol needs 0.05 mg of gelation or 125 mg of starch, for its protection from coagulation by 1 ml, 10% NaCl solution, it means gold number of starch is more than that of gelation and is better protective agent than gelation.

8. A balloon blown up with 1 mole of a gas, has a volume of 480 ml to 5^oC. If the balloon is filled to $\left(\frac{7}{8}\right)$th of its maximum capacity, then which of the following options is/are correct?
(A) The balloon will burst at 30^oC
(B) The pressure of the gas inside the balloon at 5^oC is 47.5 atm
(C) The minimum temperature at which the balloon will burst is 44.71^oC
(D) The pressure of gas when balloon burst at minimum temperature is 50 atm

Space for Rough work

Paragraph Type

This section contains 8 **multiple choice questions** relating to **four paragraphs** with **two questions on each paragraph**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

Paragraph for Questions 9 and 10

Answer the questions followed by the given reaction sequence

$$\underset{\text{(white powder)}}{A} \xrightarrow{\Delta} \underset{\text{odorless colorless}}{B(g)} + C(s)$$

$$B(g) + Ca(OH)_2 \longrightarrow \underset{\text{milky white}}{D\downarrow} + H_2O$$

$$D(s) + B(g) \xrightarrow{H_2O} E$$

$$B(g) + K_2Cr_2O_7 \longrightarrow \text{No response}$$

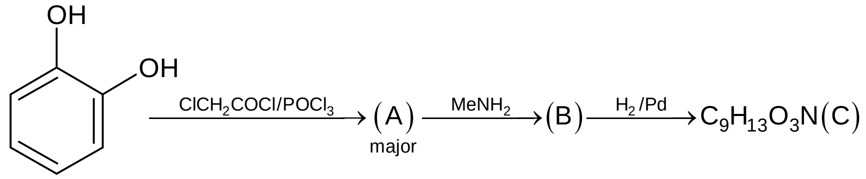
C(s) is white when cold and turns yellow when heated.

9. What is A?
(A) Li_2CO_3
(B) Mg_2CO_3
(C) Na_2CO_3
(D) $ZnCO_3$

10. C and E are respectively:
(A) MgO, $Ca(HCO_3)_2$
(B) Li_2O, $Ca(HCO_3)_2$
(C) ZnO, $Ca(HCO_3)_2$
(D) ZnO, $Mg(HCO_3)_2$

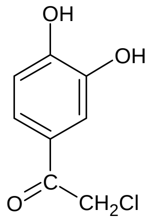
Space for Rough work

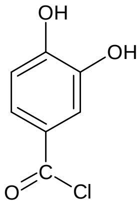
Paragraph for Question Nos. 11 to 12

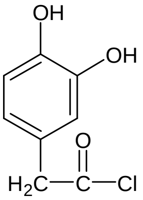

OH
OH
ClCH₂COCl/POCl₃
(A)
major
MeNH₂
(B)
H₂/Pd
C₉H₁₃O₃N(C)

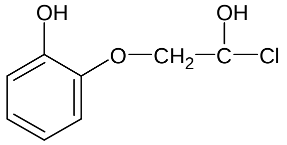
'A' also reacts with NaOI followed by the reaction with H^+ to give 3,4 – dihdyroxybenzoic acid.

11. What is A?

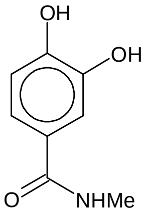
(A)

OH
OH
C
O
CH₂Cl

(B)


(C)

OH
OH
O
H₂C—C—Cl

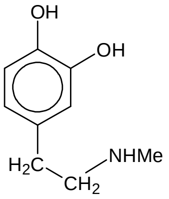
(D)

OH
OH
O—CH₂—C—Cl

12. Which of the following is correct?

(A) 'B' is


(B) 'C' is optically active which is derived from A

(C) no other side product is formed along with 'A'

(D) 'C' is

OH
OH
H₂C
CH₂
NHMe

Space for Rough work

Paragraph for Question Nos. 13 to 14

An organic compound (A) $C_3H_6Cl_2$ on reduction with red P and HI gives propane. (A) on hydrolysis by an alkali followed by oxidation gives (B) $C_3H_4O_4$, which on heating gives (C). Both (B) and (C) give effervescence with $NaHCO_3$. (B) on reacting with ethyl alcohol gives (D) $C_7H_{12}O_4$, a well known synthetic reagent.

Now answer the following questions

13. $\left(\text{D}\right)+\text{Benzaldehyde}\xrightarrow[\text{(ii) } H_3O^+]{\text{(i) Pyridine, } \Delta}\text{Major Prodcut}\left(\text{E}\right)$

The major product (E) is

(A) crotonic acid	(B) cinnamic acid
(C) benzoic acid	(D) Mandelic acid

14. Compound (C) $\xrightarrow{P_4O_{10}}$ Product (F)

Hence product F may be

(A) malonic anhydride	(B) ethanoic anhydride
(C) ethanal	(D) a lactone

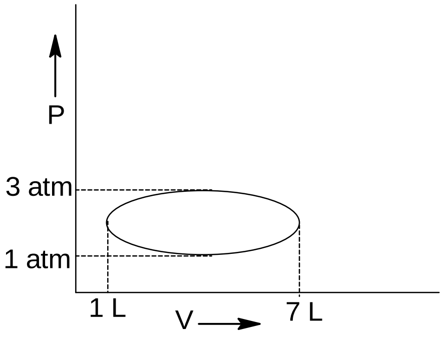
Space for Rough work

Paragraph for Question Nos. 15 to 16

The statement of the first law of thermodynamics given by Clausius, is: 'Die Energie der welt ist konstant'. That is, the energy of the universe is constant.
Mathematically it can be written as:
$\sum \Delta U = 0; \ \ (\text{universe})$
The first law predicts that energy added to or removed from a system must be accounted for, by a change in the internal energy ΔU. Energy is added to or removed from a system as work (w) or heat (q), in which case $\Delta U = q + w$;
for an infinitesimal process, this equation becomes $\delta U = \delta q + \delta w$
Heat and work represent ways that energy can be transferred from one system to another. q and w, both are path functions and both are interconvertible. Extent of work done can be calculated by
$w = -\int_{v_i}^{v_f} P_{ext} dV$.

15. Which of the following is correct statement?
    (A) The sum of the two path dependent thermodynamic properties, is always path dependent.
    (B) Work appears at the boundary of the system as well as inside the system.
    (C) Work and heat are completely interconvertible in real life systems.
    (D) None of the above.

16. Which of the following is correct?
    (A) Work done in a cyclic process is always zero.
    (B) A two litre container is filled with the gas at 10^{-3} atm pressure and the gas is allowed to diffuse into an empty and closed container of volume 4 litre. Then work done in the process is zero due to no opposing force.
    (C) PV work done in a cyclic process, which is represented as follows (for 1 mole ideal gas), 953 Joule



    (D) (B) and (C) both are correct.

Space for Rough work

Matching list Type

This section contains **4 multiple choice questions**. Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

17. Match the following column:

	List – I		**List – II**
(P)	$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$	(1)	Increase in volume favours forward reaction
(Q)	$2NO(g) \rightleftharpoons N_2(g) + O_2(g)$	(2)	Increase in pressure accelerate the forward reaction
(R)	$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$	(3)	$K_p = P_{total}$
(S)	$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$	(4)	At constant volume introduction of inert gas, has no effect.

Codes:

	P	Q	R	S
(A)	2	4	3	1
(B)	2	3	1	4
(C)	3	1	4	2
(D)	4	3	1	2

18. Match the following

	List – I (Species)		**List – II (Hybridisation of central atom)**
(P)	$(BN)_x$	(1)	sp^3
(Q)	$(BeCl_2)_n$; (n > 2)	(2)	sp^2
(R)	$[Cu(NH_3)_4]^{2+}$	(3)	dsp^2
(S)	MnO_4^-	(4)	d^3s

Codes:

	P	Q	R	S
(A)	3	4	1	2
(B)	2	1	3	4
(C)	3	1	4	2
(D)	4	3	1	2

Space for Rough work

19. Match the following

List – I (Thermodynamics process)		**List – II (ΔS_{System})**	
(P)	Isothermal reversible	(1)	$nc_v \ln\frac{T_2}{T_1}$
(Q)	Adiabatic irreversible	(2)	$nc_p \ln\frac{T_2}{T_1}$
(R)	Isochoric reversible	(3)	$nc_v \ln\frac{T_2}{T_1} + nR\ln\frac{V_2}{V_1}$
(S)	Isobaric reversible	(4)	$nR\ln\frac{V_2}{V_1}$

Codes:

	P	Q	R	S
(A)	3	4	1	2
(B)	2	1	3	4
(C)	3	1	4	2
(D)	4	3	1	2

20. Match the following

List – I (Species)		**List – II (relation)**	
(P)	CN^-, N_2	(1)	Isodiaphers
(Q)	F^{19}, K^{39}	(2)	Isobars
(R)	N^{15}, O^{15}	(3)	Isotones
(S)	C^{14}, N^{15}	(4)	Isoesters

Codes:

	P	Q	R	S
(A)	3	4	1	2
(B)	2	1	3	4
(C)	3	1	4	2
(D)	4	1	2	3

Space for Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE OR MORE** is/are correct

1. A non-zero vector $\vec{a}$ is parallel to the line of intersection of the plane P_1 determined by $\hat{i}+\hat{j}$ and $\hat{i}-2\hat{j}$ and plane P_2 determined by vector $2\hat{i}+\hat{j}$ and $3\hat{i}+2\hat{k}$, then angle between $\vec{a}$ and vector $\hat{i}-2\hat{j}+2\hat{k}$ is

(A) $\frac{\pi}{4}$ (B) $\frac{\pi}{2}$

(C) $\frac{\pi}{3}$ (D) none of these

2. Let f(x) be a function satisfying f′(x) = f(x) with f(0) = 1 and g be the function satisfying f(x) + g(x) = x, then the value of $\int_0^1 f(x)g(x)dx$

(A) $\frac{3-e^2}{2}$ (B) $\frac{e^2-3}{2}$

(C) $\frac{e^2}{2}$ (D) $\frac{e-2}{4}$

3. If three one by one squares are selected at random from the chessboard, then the probability that they form the letter 'L' is

(A) $\frac{196}{^{64}C_3}$ (B) $\frac{49}{^{64}C_3}$

(C) $\frac{36}{^{64}C_3}$ (D) $\frac{98}{^{64}C_3}$

Space for rough work

4. If $x^2 + 9y^2 + 25z^2 = xyz\left(\frac{15}{x}+\frac{5}{y}+\frac{3}{z}\right)$, the x, y, z are in

(A) A.P. (B) G.P.
(C) A.G.P. (D) H.P.

5. The number of ways of choosing triplet (x, y, z) such that $z \geq \max\{x, y\}$ and $x, y, z \in \{1, 2, \ldots, n, n + 1\}$ is

(A) ${}^{n+1}C_3 + {}^{n+2}C_3$ (B) $\frac{1}{6}n(n + 1)(2n + 1)$
(C) $1^2 + 2^2 + \ldots + n^2$ (D) $2({}^{n+2}C_3) - {}^{n+1}C_2$

6. A complex number z is rotated in anticlockwise direction by an angle α and we get z' and if the same complex number z is rotated by an angle α in clockwise direction and we get z'' then

(A) z', z, z'' are in G.P. (B) $z'^2 + z''^2 = 2z^2 \cos 2\alpha$
(C) $z' + z'' = 2z \cos \alpha$ (D) z', z, z'' are in H.P.

7. The equation of the circle which touches the axes of coordinates and the line $\frac{x}{3}+\frac{y}{4}=1$ and whose centre lies in the first quadrant is $x^2 + y^2 - 2cx - 2cy + c^2 = 0$ where c is

(A) 1 (B) 2
(C) 3 (D) 6

8. If $\cos\alpha = \frac{1}{2}\left(x+\frac{1}{x}\right)$ and $\cos\beta = \frac{1}{2}\left(y+\frac{1}{y}\right)$, (xy > 0) x, y, $\alpha, \beta \in R$ then

(A) $\sin(\alpha + \beta + \gamma) = \sin\gamma \ \forall \ \gamma \in R$ (B) $\cos\alpha \cos\beta = 1 \ \forall \ \alpha, \beta \in R$
(C) $(\cos\alpha + \cos\beta)^2 = 4 \ \forall \ \alpha, \beta \in R$ (D) $\sin(\alpha + \beta + \gamma) = \sin\alpha + \sin\beta + \sin\gamma \ \forall \ \alpha, \beta, \gamma \in R$

Space for rough work

Paragraph Type

This section contains 8 **multiple choice questions** relating to **four paragraphs** with **two questions on each paragraph**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

Paragraph for Questions 9 and 10

Read the following write up carefully and answer the following questions:
In an argand plane z_1, z_2 and z_3 are respectively the vertices of an isosceles triangle ABC with AC = BC and $\angle CAB = \theta$. If z_4 is incentre of triangle. Then

9. The value of $\left(\frac{AB}{IA}\right)^2\left(\frac{AC}{AB}\right)$

(A) $\frac{(z_2-z_1)(z_1-z_3)}{(z_4-z_1)^2}$ (B) $\frac{(z_2-z_1)(z_3-z_1)}{(z_4-z_1)}$

(C) $\frac{(z_2-z_1)(z_3-z_1)}{(z_4-z_1)^2}$ (D) none of these

10. The value of $(z_4-z_1)^2$ $(1 + \cos\theta)\sec\theta$ is

(A) $(z_2-z_1)(z_3-z_1)$ (B) $\frac{(z_2-z_1)(z_3-z_1)}{(z_4-z_1)}$

(C) $\frac{(z_2-z_1)(z_3-z_1)}{(z_4-z_1)^2}$ (D) $(z_2-z_1)(z_3-z_1)^2$

Space for rough work

Paragraph for Question Nos. 11 to 12

Read the following write up carefully and answer the following questions:

If the normal to the hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ at any point P (a cos θ, b tan θ) meets the transverse and conjugate axes in G and g respectively and if 'f' is the foot of perpendicular to the normal at P from the centre 'C' then

11. The length of PG^2 is

(A) $\frac{b^2}{a^2}\left(b^2\text{cosec}^2\theta+a^2\cot^2\theta\right)$
(B) $\frac{a^2}{b^2}\left(b^2\text{cosec}^2\theta+a^2\cot^2\theta\right)$
(C) $\frac{b^2}{a^2}\left(b^2\sec^2\theta+a^2\tan^2\theta\right)$
(D) $\frac{b^2}{a^2}\left(b^2\tan^2\theta+a^2\sec^2\theta\right)$

12. Minimum of PG is

(A) $\frac{b^2}{a}$
(B) $\left|\frac{a}{b}(a+b)\right|$
(C) $\left|\frac{b}{a}(a-b)\right|$
(D) $\left|\frac{a}{b}(a-b)\right|$

Paragraph for Question Nos. 13 to 14

Read the following write up carefully and answer the following questions:

If a cricket team of 11 players is to be selected from 8 batsman, 6 bowlers, 4 all rounder and 2 wicket keepers, then

13. The number of selections when atmost 1 all rounder and 1 wicket keeper will play, is

(A) ${}^4C_1 \cdot {}^{14}C_{10} + {}^2C_1 \cdot {}^{14}C_{10} + {}^4C_1 \cdot {}^2C_1\ {}^2C_1 \cdot {}^{14}C_9 + {}^{14}C_{11}$
(B) ${}^4C_1 \cdot {}^{15}C_{11} + {}^{15}C_{11}$
(C) ${}^4C_1 \cdot {}^{15}C_{10} + {}^{15}C_{11}$
(D) none of these

14. Number of selection when 2 particular batsmen don't want to play when a particular bowler will play, is

(A) ${}^{17}C_{10} + {}^{19}C_{11}$
(B) ${}^{17}C_{10} + {}^{19}C_{11} + {}^{17}C_{11}$
(C) ${}^{17}C_{10} + {}^{20}C_{11}$
(D) ${}^{19}C_{10} + {}^{19}C_{11}$

Space for rough work

Paragraph for Question Nos. 15 to 16

Read the following write up carefully and answer the following questions:
A curve y = f(x) passes through the point P(1, 1). The normal to the curve at P is a(y – 1) + (x – 1) = 0. If the slope of the tangent at any point on the curve is proportional to the ordinates of the point, then

15. The equation of the curve y = f(x) is

(A) $y = e^{a(x-1)}$
(B) $y = e^{a(x^2-1)}$
(C) $y = e^{a(1-|x|)}$
(D) $y = e^{a(|x|-1)}$

16. The area bounded by the curve y = f(x), y-axis and the normal to the curve at P is

(A) $\frac{1}{a}\left(a-\frac{1}{2}+e^{-a}\right)$
(B) $\frac{1}{a}\left(a+\frac{1}{2}+e^{-a}\right)$
(C) $\frac{1}{a}\left(a-\frac{1}{2}+e^{a}\right)$
(D) $\frac{1}{a}\left(a+\frac{1}{2}+e^{a}\right)$

Matching list Type

This section contains **4 multiple choice questions**. Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

17. Match the following List–I with List–II.

List – I		**List – II**	
(P)	The value of k for which $\lim\limits_{x\to 1}\operatorname{cosec}^{-1}\left(\frac{k^2}{\ln x}-\frac{k^2}{x-1}\right)$ exists is	1.	$\left(0, \frac{2}{3}\right)$
(Q)	The value of k for which $kx^2 - 2kx + 3x - 6$ is positive for exactly two integral values of x is	2.	[–1, 4]
(R)	The value of k for which the point (2k + 1, k – 1) is an interior point of the smaller segment of the circle $x^2 + y^2 - 2x - 4y - 4 = 0$ w.r.t. the chord x + y – 2 = 0 is	3.	$\left(-\frac{3}{4}, -\frac{3}{5}\right)$
(S)	The solution of the inequality $\log_{1/5}(2x + 5) + \log_5(16 - x^2) \le 1$ is	4.	$(-\infty, -\sqrt{2}) \cup (\sqrt{2}, \infty)$

Codes:

	P	Q	R	S
(A)	4	3	2	1
(B)	2	1	4	3
(C)	4	3	1	2
(D)	2	4	3	1

Space for rough work

18. If $\int_0^{\infty} e^{-x^2} dx = \frac{\sqrt{\pi}}{2}$, then match the following List–I with List–II.

	List – I		**List – II**
(P)	$\int_0^{\infty} e^{-2x^2} dx$	1.	$\sqrt{\pi}$
(Q)	$\frac{d}{dt}\int_0^{\infty} e^{-tx^2} dx$ at t = 1	2.	$\frac{3\sqrt{\pi}}{8}$
(R)	$\frac{d^2}{dt^2}\int_0^{\infty} e^{-tx^2} dx$ at t = 1	3.	$-\frac{\sqrt{\pi}}{4}$
(S)	$\int_{-\infty}^{\infty} e^{-x^2} dx$	4.	$\frac{\sqrt{\pi}}{2\sqrt{2}}$

Codes:

	P	Q	R	S
(A)	4	3	1	2
(B)	3	4	1	2
(C)	2	1	2	4
(D)	4	3	2	1

19. If in ΔABC, $r = 2$, $r_1 = 4$, $s = 12$ and $a < b < c$, then match the following List–I with List–II.

	List – I		**List – II**
(P)	Area of triangle is	1.	5
(Q)	R is equal to	2.	24
(R)	$\angle A$ of triangle is	3.	$\sin^{-1}\frac{4}{5}$
(S)	$\angle B$ of triangle is	4.	$\sin^{-1}\frac{3}{5}$

Codes:

	P	Q	R	S
(A)	4	2	3	1
(B)	2	1	4	3
(C)	3	4	1	2
(D)	2	1	3	4

Space for rough work

20. Match the following List–I with List–II.

	List – I		List – II
(P)	The normal chord at a point t on the parabola $y^2 = 4x$ subtends a right angle at the vertex, then t^2 is	1.	4
(Q)	The area of the triangle inscribed in the curve $y^2 = 4x$, the parameter of coordinates whose vertices are 1, 2 and 4 is	2.	2
(R)	The number of distinct normal possible from $\left(\frac{11}{4}, \frac{1}{4}\right)$ to the parabola $y^2 = 4x$ is	3.	3
(S)	The normal at (a, 2a) on $y^2 = 4ax$ meets the curve again at $(at^2, 2at)$, then the value of $\lvert t - 1 \rvert$ is	4.	6

Codes:

	P	Q	R	S
(A)	2	4	1	3
(B)	3	1	4	2
(C)	1	3	2	4
(D)	2	4	3	1

Space for rough work

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(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	A, B, D	B
2.	B	A, D	A
3.	B	B, C, D	A
4.	B	A, D	D
5.	D	A, D	B, C, D
6.	C	B, C, D	A, B, C
7.	A	A, B	A, D
8.	C	B, C	A, B, C, D
9.	B.	D	C
10.	C	C	A
11.	B	A	C
12.	A	B	A
13.	C	B	A
14.	A	B	A
15.	A	D	A
16.	C	C	A
17.	B	A	C
18.	A	B	D
19.	C	D	B
20.	D	D	D

Physics

PART – I

SECTION – A

2. $v_{max} = \omega \times mg/k$

$F_{av} = \frac{mv_{max}}{(T/4)} = \frac{2mg}{\pi}$

3. $W = \int_R^{2R}\left(p_0 + \frac{4S}{r}\right)4\pi r^2 dr = 4\pi p_0 \times \frac{7R^3}{3} + (4\pi)(4S) \times \frac{3R^2}{2}$

4. Work done by all the forces on the block equal to change in kinetic energy.

6. No effect of 'a' and 'g' on time period of spring pendulum.

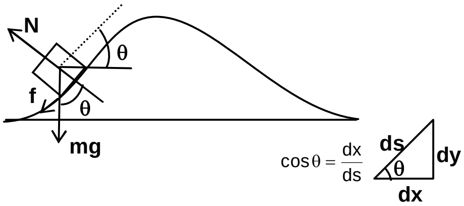
7. $\frac{1}{\lambda_{3-1}} = R\left(\frac{1}{1^2} - \frac{1}{3^2}\right) = \frac{8R}{9}$

$\frac{1}{\lambda_{2-1}} = R\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = \frac{3R}{4}$

$\Rightarrow \frac{\lambda_{3-1}}{\lambda_{2-1}} = \frac{27}{32}$

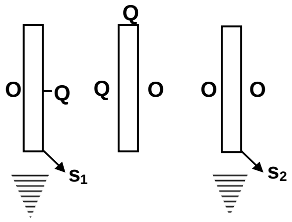
8. Work done by friction $= \int \vec{F} \cdot \vec{ds} = \int_0^x \mu mg\cos\theta \frac{dx}{\cos\theta}$

$= \mu mg\, x = 20$ J



9. Field inside the conductor is zero

10. Charge distribution is shown in figure.



11. $\frac{\lambda}{(\sqrt{3mg})/(m/\ell)} = \frac{\lambda_0}{\sqrt{2mg/(m/\ell)}}$

$\Rightarrow \lambda = \sqrt{\frac{3}{2}}\lambda_0$

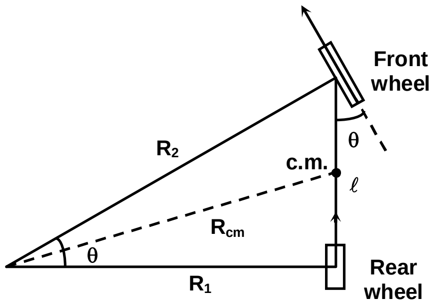
12. $v = \sqrt{\frac{\left(2m + \frac{m}{2}\right)g}{m/\ell}} = \sqrt{\frac{5}{2}g\ell}$

13-14. If the bike does not slip, path of both the wheel must be parallel with its direction as shown in the figure.

$R_1 = \ell/\tan\theta$

$$R_{cm} = \sqrt{\left(\frac{\ell}{2}\right)^2 + R_1^2} = \frac{\ell}{2\tan\theta}\sqrt{4+\tan^2\theta}$$

Net friction force $f = \frac{mv^2}{R_{cm}} = \frac{2mv^2\tan\theta}{\ell\sqrt{4+\tan^2\theta}}$



15. $p_0A = ma \Rightarrow a = p_0A/m$

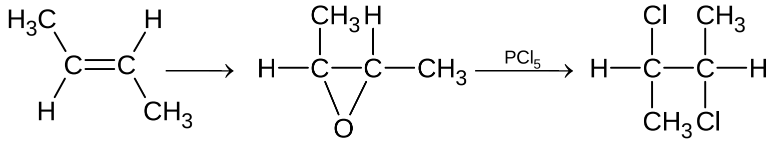
16. $p_0A = m'a \Rightarrow m' = m/5$
$\therefore\ m - m' = 4m/5$

Chemistry

PART – II

SECTION – A

2.



(anti conformer)

3. Thermal stability of nitrates of alkali metals increases down the group. MgO is basic; SnO is amphoteric and B_2O_3 is acidic oxides.

4. Cell reaction is:

$$Tl(s) + Cu^{2+}(aq) \rightleftharpoons Tl^{+}(aq) + Cu(s)$$

Reaction quotient $Q = \frac{[Tl^+]}{[Cu^{2+}]}$ and Nernst equation is $E_{cell} = E^0_{cell} - \frac{0.0591}{n}\log Q$; at 298 K

To increase E_{cell}, Q should be decreased. Which is decreased by decreasing $[Tl^+]$ and increasing $[Cu^{2+}]$.

5. Statement 'B' is true for weak electrolytes only and in case of 'C' osmosis never stops so dilution on solution side continues and no limiting value of equivalent conductance of solution is obtained.

6.

	$Pb_3O_4 +$	$4HNO_3 \longrightarrow$	$2Pb(NO_3)_2 +$	PbO_2	$+2H_2O$
Before reaction	0.05 mole	2 mole	–	–	
After reaction	–	1.8 mole	0.1 mole	0.05 mole residue	

$$2Pb^{2+} + 8NaOH \longrightarrow 2Na_2[Pb(OH)_4]$$

$$HNO_3 + NaOH \longrightarrow NaNO_3 + H_2O$$

Moles of NaOH used to neutralise excess of HNO_3 = 1.8 mole
Moles of NaOH used with $Pb(NO_3)_2$ = 0.4 mole
Total NaOH used = 2.2 mole.

7. Coagulation value $\propto \frac{1}{\text{Coagulating power}}$

Less is the gold number, better is the protection power.

8. Maximum capacity or volumes of balloon $= \frac{8}{7} \times 480 = 548.57$ ml

Also, V_1 = 480 ml, T_1 = 278 K, n = 1 mole

(A) The balloon will burst at a minimum temperature (T_2) when volume becomes 548.57 ml.
Using Charle's law

$$\therefore \frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{480}{278} = \frac{548.57}{T_2}$$

$\therefore T_2 = 317.71$ K

or $T_2 = 44.71^\circ$C

Hence (A) is incorrect but (C) is correct.

(B) Pressure of the gas at 5°C having 1 mole and V = 480 ml

PV = nRT

$$\therefore P \times \frac{480}{1000} = 1 \times 0.0821 \times 278$$

$\therefore P = 47.5$ atm

Hence (B) is also correct.

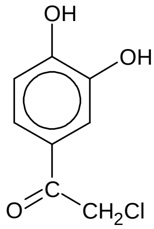
(D) Since V increase with increase in temperature from 5°C to 44.71°C, at which balloon bursts and therefore pressure remains constant. Thus pressure of gas inside the balloon when it bursts is 47.5 atm. Hence (D) is incorrect.

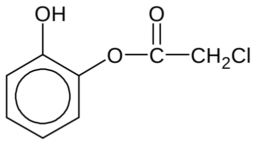
Hence (B, C) are correct.

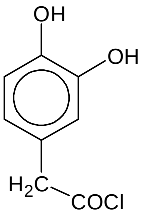
Solution for the Q. No. 9 & 10

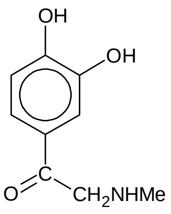
B is $CO_2(g) \Rightarrow$ the compound A is a $ZnCO_3$ and C is oxide of Zn, as it is white when cold and turn yellow on heating. D is $CaCO_3$ which form $Ca(HCO_3)_2$ which exist in solution only.

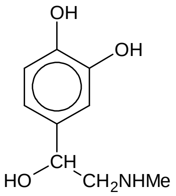
Solution for the Q. No. 11 & 12

Since 'A' react with NaOI, it must be  other side products are

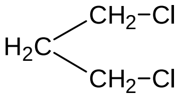


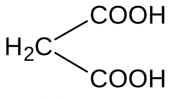
and less likely to be 

; B is  ;

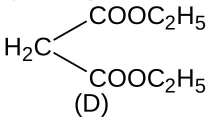
while 'C' is 

13. The above paragraph shows that compounds (A to D) are

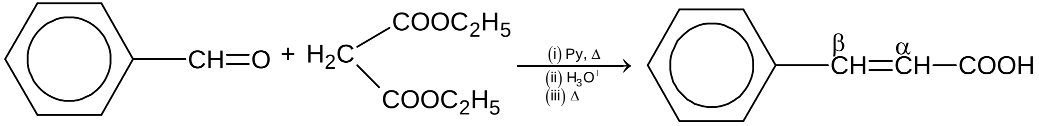

(A)


(B)

CH_3COOH
(C)


(D)

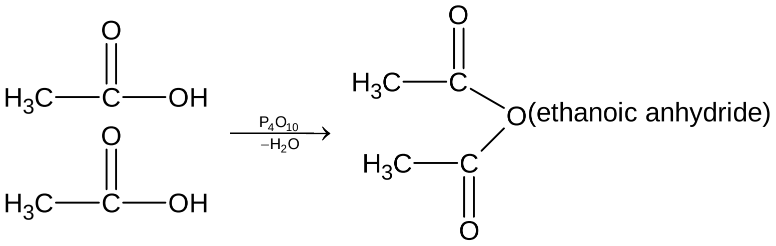
In above problem concerned reaction is:



Benzaldehyde (D) Cinnamic acid (E)

Hence (B) is correct.

14. Since compound (C) is CH_3COOH. So,



(F)

Hence (B) is correct.

15. (A) That is path independent e.g. $\Delta U = q + w$; U is state function, while q and w are path functions.
(B) Work is a type of energy in transit, i.e. which appears only on surface/boundaries.
(C) w & q are not completely interconvertible.

16. (A) Work is path function.
(B) Initially there is no opposing force but opposing force increases gradually due to diffused gas.
(C) W = πab; (area inside the curve)
a = 3 litre, b = 1 atm.

17. Le-chateliers principle is applicable and for (R) $P_{total} = P_{CO_2}$, which is equal to K_p for the given reaction.

20. Isodiaphers are those atoms for which (n-p) is equal. Isoesters are those species which contains equal number of atoms as well as equal number of electrons.

Mathematics PART – III

SECTION – A

1. Normal vector to plane P_1 $3\hat{k}$
Normal vector to plane P_2 $2\hat{i}-4\hat{j}-3\hat{k}$
$\vec{a}=\lambda\left(2\hat{i}+\hat{j}\right)$
angle between $\vec{a}$ and vector $\hat{i}-2\hat{j}+2\hat{k}$ is given by
$$\cos\theta = \frac{\lambda\left(2\hat{i}+\hat{j}\right)\cdot\left(\hat{i}-2\hat{j}+2\hat{k}\right)}{\lambda\sqrt{5}\sqrt{9}}=0$$
$$\Rightarrow \theta = \frac{\pi}{2}.$$

2. $f'(x) = f(x)$
Integrating $\log f(x) = x + k$
$f(x) = e^{x+k}$
$f(0) = 1$
$1 = e^0.e^k$
$k = 0$
$\therefore f(x) = e^x$
$g(x) = x - f(x) = x - e^x$
$$I=\int_0^1 e^x\left(x-e^x\right)dx = \int_0^1 e^x x\,dx - \int_0^1 e^{2x}dx$$
$$= e-(e-1)-\frac{e^2}{2}+\frac{1}{2}=\frac{3}{2}-\frac{e^2}{2}=\frac{3-e^2}{2}.$$

3. $n(S) = {}^{64}C_3$
Let 'E' be the even of selecting 3 squares which from the letter 'L'
No ways of selecting squares consisting of 4 unit squares = ${}^7C_1 \times {}^7C_1 = 49$
Each square with 4 unit squares forms 4L – shapes consisting of 3 unit squares
$\therefore n(E) = 7 \times 7 \times 4 = 196$
$$\therefore p(E) = \frac{196}{{}^{64}C_3}$$

4. $x^2 + 9y^2 + 25z^2 = 15yz + 5zx + 3xy$
$(x)^2 + (3y)^2 + (5z)^2 - (x)(3y) - (3y)(5z) - (x)(5z) = 0$
$$\frac{1}{2}\left[2(x)^2+2(3y)^2+2(5z)^2-2(x)(3y)-2(3y)(5z)-2(x)(5z)\right]$$
$$= \frac{1}{2}\left[(x-3y)^2+(3y-5z)^2+(x-5z)^2\right]=0$$
$x - 3y = 0,\ 3y - 5z = 0,\ x - 5z = 0$
$$\frac{1}{x}=\frac{1}{3y} \text{ and } \frac{5}{3y}=\frac{1}{z} \text{ and } \frac{1}{5z}=\frac{1}{x}$$
$$\frac{1}{x}+\frac{1}{z}=\frac{1}{3y}+\frac{5}{3y}=\frac{2}{y}$$
$\therefore \frac{1}{x}, \frac{1}{y}, \frac{1}{z}$ are in A.P. and x, y, z are in H.P.

5. When $z = n + 1$ we can choose x, y from $\{1, 2, \ldots, n\}$
$\therefore$ when $z = n + 1$, x, y can be chosen in n^2 ways and $z = n$, x, y can be chosen in $(n - 1)^2$ ways and so on
$\therefore\ n^2 + (n - 1)^2 + \ldots + 1^2 = \frac{1}{6}n(n + 1)(2n + 1)$
ways of choosing triplets
Alternatively triplets with $x = y < z$, $x < y < z$, $y < x < z$ can be chosen in
${}^{n+1}C_2$, ${}^{n+1}C_3$, ${}^{n+1}C_3$ ways.
There are
${}^{n+1}C_2 + 2({}^{n+1}C_3) = {}^{n+2}C_2 + {}^{n+1}C_3 = 2({}^{n+2}C_3) - {}^{n+1}C_2$.

6. $z' = ze^{i\alpha}$ … (1)
$z'' = ze^{-i\alpha}$ … (2)
$\therefore\ z'z'' = z^2 \Rightarrow z', z, z''$ are in G.P.
$\left(\frac{z'}{z}\right)^2 + \left(\frac{z''}{z}\right)^2 = 2\cos 2\alpha$
$\Rightarrow z'^2 + z''^2 = 2z^2 \cos 2\alpha$
$z' + z'' = 2z \cos \alpha$.

7. $\left|\frac{\frac{c}{3}}{\sqrt{\frac{1}{3^2} + \frac{1}{4^2}}}\right| = c \Rightarrow c = 6, 1.$

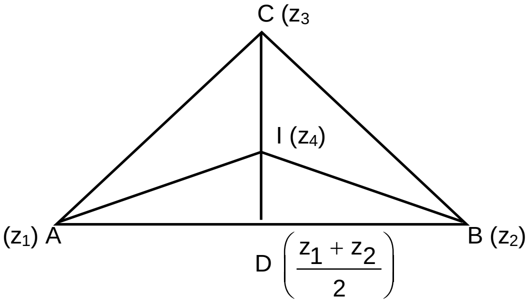
8. $\cos\alpha = \frac{1}{2}\left(x + \frac{1}{x}\right)$ and $\cos\beta = \frac{1}{2}\left(y + \frac{1}{y}\right)$
since $xy > 0 \Rightarrow x + \frac{1}{x} \geq 2$ or ≤ -2
$y + \frac{1}{y} \geq 2$ or ≤ -2
$\Rightarrow \cos\alpha = 1, \cos\beta = 1$ …(1)
or
$\cos\alpha = -1, \cos\beta = -1$ …(2)
$\therefore\ \cos\alpha \cos\beta = 1$
$(\cos\alpha + \cos\beta)^2 = 4$
$\Rightarrow \alpha + \beta$ is an even multiple of π.
$\Rightarrow \sin(\alpha + \beta + \gamma) = \sin(2n\pi + \gamma) = \sin\gamma$
Also, $\sin\alpha = \sin\beta = 0$

9. $\angle IAB = \frac{\theta}{2}$, $\angle IAC = \frac{\theta}{2}$

$$\frac{z_2 - z_1}{|z_2 - z_1|} = \frac{z_4 - z_1}{|z_4 - z_1|}e^{-\frac{i\theta}{2}}$$

$$\frac{z_3 - z_1}{|z_3 - z_1|} = \frac{z_4 - z_1}{|z_2 - z_1|}e^{-\frac{i\theta}{2}}$$

$$\frac{(z_2 - z_1)(z_3 - z_1)}{|z_2 - z_1||z_3 - z_1|} = \frac{(z_4 - z_1)^2}{|z_4 - z_1|^2}e^{\theta}$$



$$\therefore\ \frac{(z_2-z_1)(z_3-z_1)}{(z_4-z_1)^2}=\frac{AB\cdot AC}{(IA)^2}=\left(\frac{AB}{IA}\right)^2\left(\frac{AC}{AB}\right)$$

10. $\dfrac{(z_2-z_1)(z_3-z_1)}{(z_4-z_1)^2}=2\left(\dfrac{AD}{IA}\right)^2\left(\dfrac{AC}{AD}\right)$ (Since AB = 2AD)

$(z_4-z_1)^2$ (1 + cos θ) sec θ = $(z_2-z_1)(z_3-z_1)$

11. Equation of the tangent is

$\frac{x}{a}\sec\theta-\frac{y}{b}\tan\theta=1$

Normal is ax cos θ + by cot θ = $a^2 + b^2$

The normal at P meets the co-ordinate axes at $G\left(\frac{a^2+b^2}{a}\sec\theta,\ 0\right)$ and $g\left(0,\ \frac{a^2+b^2}{a}\tan\theta\right)$

$\therefore\ PG^2=\left(\frac{a^2+b^2}{a}\sec\theta-a\sec\theta\right)^2+(b\tan\theta-0)^2$

$PG^2=\frac{b^2}{a^2}\left(b^2\sec^2\theta+a^2\tan^2\theta\right)$

12. When tan θ = 0

$PG=\frac{b^2}{a}$

13. When 1 all rounder and 10 players from bowlers and batsman play number of ways
$= {}^4C_1\cdot{}^{14}C_{10}$
when 1 wicket keeper and 10 players from bowlers and batsman play number of ways
$= {}^2C_1\cdot{}^{14}C_{10}$
when 1 all rounder 1 wicket keeper and 9 from batsmen and bowlers play number of ways
$= {}^4C_1\cdot{}^2C_1\cdot{}^{14}C_9$
when all eleven players play from bowlers and batsmen then the number of ways
$= {}^{14}C_{11}$
∴ Total number of selections = ${}^4C_1\cdot{}^{14}C_{10}+{}^2C_1\cdot{}^{14}C_{10}+{}^4C_1\cdot{}^2C_1\cdot{}^{14}C_9+{}^{14}C_{11}$.

14. If 2 batsmen don't want to play then the rest of 10 players can be selected from 17 other players number of selection = ${}^{17}C_{10}$
If the particular bowler doesn't play then number of selection = ${}^{19}C_{11}$
∴ Total number of selection = ${}^{17}C_{10}+{}^{19}C_{11}$

15. Slope of tangent at any point P(x, y) is $\frac{dy}{dx}\propto y$

$\Rightarrow \frac{dy}{dx}=ky\Rightarrow y=e^{k(x-1)}$

Since a(y – 1) + (x – 1) = 0 is normal at (1, 1) ⇒ k = 1
Hence $f(x)=y=e^{a(x-1)}$

16. Area bounded = $\displaystyle\int_0^1\left(\frac{1}{a}-\frac{x}{a}+1-e^{a(x-1)}\right)dx=\frac{1}{a}\left(a-\frac{1}{2}+e^{-a}\right)$ sq. units.

17. (P) Limit is easily reducible to $\operatorname{cosec}^{-1}\left(\frac{k^2}{2}\right)$ by L'Hospital rule which exist if $\frac{k^2}{2} \geq 1$.

(Q) $kx^2 + (3 - 2k)x - 6 = (kx + 3)(kx - 2)$

$4 \leq -\frac{3}{k} \leq 5 \Rightarrow -\frac{3}{4} \leq k \leq -\frac{3}{5}$.

(R) $(2k + 1, k - 1)$ is an interior point

$(2k + 1)^2 + (k - 1)^2 - 2(2k + 1) - 4(k - 1) - 4 < 0$

$0 < k < \frac{6}{5}$ ….. (1)

Centre (1, 2) and point $(2k + 1, k - 1)$ must lie on opposite side of chord $x + y - z = 0$

$k < \frac{2}{3}$ ….. (2)

$0 < k < \frac{2}{3}$

(T) $x > -\frac{5}{2}, -4 < x < 4 \Rightarrow x \in \left(-\frac{5}{2}, 4\right)$

$\log_5\left(\frac{16 - x^2}{2x + 5}\right) \leq 1$

$\Rightarrow \frac{16 - x^2}{2x + 5} \leq 5^1$

$\Rightarrow x \in (-\infty, -9) \cup [-1, \infty)$

$\therefore x \in [-1, 4]$

18. $I = \int_0^\infty e^{-tx^2} dt$

$x\sqrt{t} = u$, then $dx = \frac{du}{\sqrt{t}}$

$I = \int_0^\infty e^{-u^2} \frac{du}{\sqrt{t}} = \frac{1}{\sqrt{t}} \int_0^\infty e^{-u^2} du = \frac{\sqrt{\pi}}{2\sqrt{t}}$

$\int_{-\infty}^{\infty} e^{-x^2} dx = 2\int_0^\infty e^{-x^2} dx = \sqrt{\pi}$.

19. $r_1r_2 + r_2r_3 + r_3r_1 = \frac{r_1r_2r_3}{r} = s^2 = 144$

$4(r_2 + r_3) + r_2r_3 = 2r_2r_3 = 144$

$\Rightarrow r_2r_3 = 72, r_2 + r_3 = 18 \Rightarrow r_2 = 6, r_3 = 12$

$\frac{r}{r_1} = \frac{s - a}{s} = \frac{1}{2} \Rightarrow a = 6$

Similarly b = 8, c = 10

$\Rightarrow$ ABC is right angle triangle.

Smallest angle is $\sin^{-1}\frac{3}{4}$

$\Delta = \frac{1}{2} \times 6 \times 8 = 24$ sq. units

R = 5

$|r_2 - r_3| = 6$

20. (P) Equation of normal is $y = -tx + 2at + at^3$ at P(t)
It intersect the curve again at point $Q(t_1)$ on the parabola such that

$$t_2 = -t - \frac{2}{t}$$

Again slope of OP is $\frac{2}{t} = M_{OP}$

Also, slope of OQ is $\frac{2}{t_1} = M_{OQ}$

Since $M_{OP} \cdot M_{OQ} = -1 = \frac{4}{tt_1}$

$\Rightarrow tt_1 = -4$

$$t\left(-t - \frac{2}{t}\right) = -4$$

$\Rightarrow t^2 = 2$

(Q) P(1, 2), Q(4, 4), R(16, 8)
Now, ar(ΔPQR) = 6 sq. units

(R) Equation of normal from any point $P(am^2, -2m)$ is
$y = mx - 2am - am^3$
It passes through $\left(\frac{11}{4}, \frac{1}{4}\right)$

$\Rightarrow 4m^3 + 8m - 11m + 1 = 0$
$\Rightarrow 4m^3 - 3m + 1 = 0$
Now, $f(m) = 4m^3 - 3m$
$\Rightarrow f'(m) = 12m^2 - 3 = 0$

$\Rightarrow m \pm \frac{1}{2}$

Since $f\left(\frac{1}{2}\right) f\left(-\frac{1}{2}\right) < 0$ has 3 normals are possible.

(T) Since, normal at $P(t_1)$ if meets the curve again at (t_2), then

$$t_2 = -t_1 - \frac{2}{t_1}$$

Such that here normal at P(1) meets the curve again at Q(t)

$\Rightarrow t = -1 - \frac{1}{2} = -3$

FIITJEE **JEE (Main), 2014**

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - I

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 02 and 09 to 30)** contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (03 to 08) contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

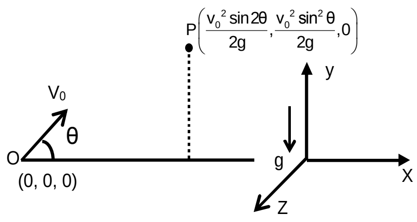
1. In a standard meter bridge experiment, to measure the specific resistance of a wire the following data are found:-
Length (L) $=(1\pm\cdot01)$m measured by a meter scale
Radius of wire = 1mm ±.01mm. (measured by screw gauge).
Resistance of wire (R) = (5±.01) Ω
The maximum possible error in the measurement of specific resistance is
(You may use the formula:- $\rho=\frac{\pi r^2}{L}R$)
(A) ·1μΩm (B) ·2μΩm
(C) ·5024μΩm (D) ·6024μΩm

2. A physical quantity P is related to four measurable quantities as $P=\frac{a^3b^2}{c^3d^{4.}}$. If the errors in measurement of a, b, c, d are 0.1%, 0.2%, 0.3%, 0.1% respectively, what is the maximum percentage error in measurement of P.
(A) 1% (B) 2%
(C) 3% (D) 4%

3. When N_0 molecules of a radioactive nuclide are taken at t = 0, the activity reduces to ‘A’ in time t_0. When $3N_o$ molecules of the same nuclide are taken, activity will become 3Ae in time t equal to :-
(A) t_0 (B) $t_0+\frac{1}{\lambda}$
(C) $t_0-\frac{1}{\lambda}$ (D) None of these
Where; λ is decay constant of the Nuclide

Space for rough work

4. A particle of mass m is projected from O with velocity $v_0 \cos\theta \hat{i} + v_0 \sin\theta \hat{j}$.
At the same instant, another particle of mass 2m is projected from point P with $v_0\hat{k}$. The velocity of 2nd particle w.r.t first particle after time $t = \frac{v_0 \sin\theta}{g}$ is



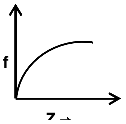
$P\left(\frac{v_0^2 \sin 2\theta}{2g}, \frac{v_0^2 \sin^2\theta}{2g}, 0\right)$
V0
θ
O
(0, 0, 0)
g
y
X
Z

(A) $v_0\hat{k} + gt\hat{j} + v_0 \cos\theta \hat{i}$ (B) $v_0\hat{k} - gt\hat{j} + v_0 \cos\theta \hat{i}$

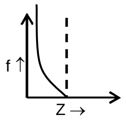
(C) $v_0\hat{k} - v_0 \cos\theta \hat{i}$ (D) None of the above

5. The plot of characteristics frequency 'f' in case of X – rays of K_γ wavelength, with the atomic number 'Z' of an element may be best represented by :-

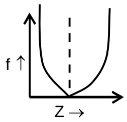
(A)



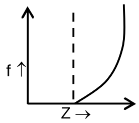
(B)



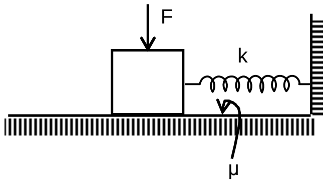
(C)



(D)



6. In the position shown, the spring is at its natural length. The block of mass m is given a velocity v_0 towards the vertical support at t = 0. The coefficient of friction between the block and the surface is given by: μ = αx, where α is a positive constant and x is the position of the block from its starting position. The block comes to rest for the first time at x =



(A) $v_0\sqrt{\frac{m}{k + \alpha mg}}$ (B) $v_0\sqrt{\frac{m}{k}}$

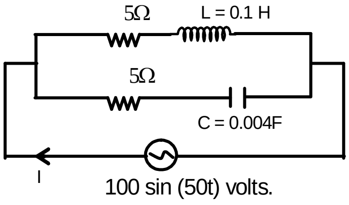
(C) $v_0\sqrt{\frac{m}{\alpha mg}}$ (D) none of the above.

Space for rough work

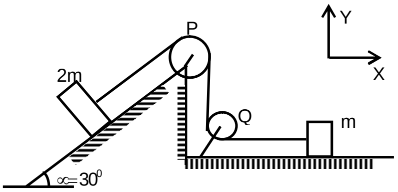
7. Two waves of Intensity I_1 and I_2 interfere. The maximum intensity produced to the minimum intensity are in the ration α. Then I_1/I_2 is equal to

(A) $\frac{\alpha - I}{\alpha + I}$, if $I_1 > I_2$
(B) $\frac{I + \alpha}{\alpha - I}$, if $I_1 > I_2$
(C) $\left(\frac{I + \sqrt{\alpha}}{\sqrt{\alpha} - 1}\right)^2$, if $I_1 < I_2$
(D) $\left(\frac{\sqrt{\alpha} - 1}{1 + \sqrt{\alpha}}\right)^2$ if $I_1 > I_2$

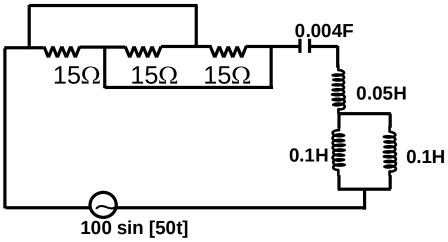
8. The current in the circuit at any time t is
(A) 20ampere.
(B) $20\sin\left[50t + \frac{\pi}{4}\right]$
(C) $20\sin\left[50t\ \frac{-\pi}{4}\right]$
(D) $20\sin(50t)$



9. All the surfaces & pulleys are frictionless in the shown arrangement. Pulleys P and Q are massless. The force applied by clamp on pulley P is
(A) $\frac{mg}{6}\left(-\sqrt{3}\hat{i} - 3\hat{j}\right)$
(B) $\frac{mg}{6}\left(\sqrt{3}\hat{i} + 3\hat{j}\right)$
(C) $\frac{mg}{6}\sqrt{2}$
(D) none of the above.

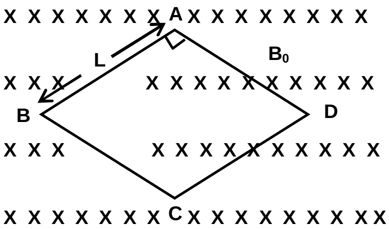


10. The power factor, ϕ, for the above circuit and the peak current, neglecting the mutual inductance of the coils, is :-
(A) $\frac{\pi}{4}, 10\sqrt{2}$ Ampere
(B) $\frac{-\pi}{4}, 10\sqrt{2}$ Ampere.
(C) 0, 20 Ampere
(D) $\frac{\pi}{4}$,10 Ampere



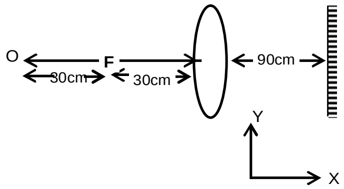
Space for rough work

11. A conducting square loop of length ‘L’ is placed in a magnetic field of Induction B_0. End ‘A’ and End ‘C’ are moved away from each other. So that finally the square loop becomes a straight line. The total charge flowing through the loop, if its resistance is ‘R’ then :



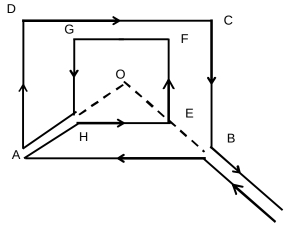
(A) $\frac{B_0L^2}{\pi R}$
(B) $< \frac{B_0L^2}{R}$
(C) $\frac{B_0L^2}{R}$
(D) $> \frac{B_0L^2}{R}$

12. A thin biconvex lens of focal length 30cm is Kept 90 cm away from a plane mirror kept parallel to the plane of the lens. A point object is placed on the optical axis of the lens 60cm away from the lens as shown in the figure. Now, if the point object is slowly moved towards the lens with a small velocity, the image of the object in the mirror.



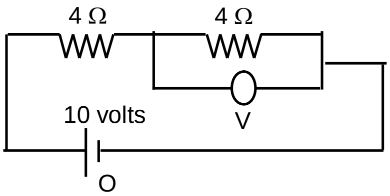
(A) Moves in the + ve x direction
(B) Moves in – ve x direction
(C) Does not move
(D) Data insufficient

13. ABCD is a square of side 4R and EFGH is a square loop of side 2R. The loop carries a current I. The magnetic field at the centre O of the loop



(A) $\frac{\mu_0 I}{2\pi R} \odot$
(B) $\frac{\mu_0 I}{2\pi R} \otimes$
(C) $\frac{\mu_0 I}{\sqrt{2}\pi R} \otimes$
(D) $\frac{\mu_0 I}{\sqrt{2}\pi R} \odot$

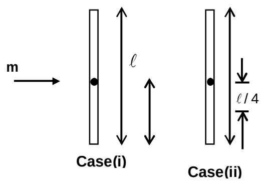
14. In the given circuit, if the voltmeter is ideal its reading is V_1 volts. If the voltmeter has a resistance of 100Ω, the reading is V_2. Then $|V_1 - V_2|$ is equal to:-



(A) Zero
(B) 0.3volts.
(C) 0.2volts
(D) 0.1volts

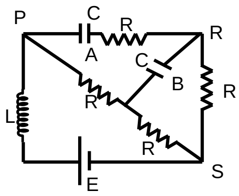
Space for rough work

15. Two identical rods each of mass m and length ℓ are placed on a smooth horizontal surface. In case (1) a particle of mass m moving with V_0 strikes the rod perpendicularly at its centre. In case (ii), another particle of mass m moving with V_0 strikes the rod perpendicularly at $\ell / 4$ from the centre. In both the cases, particles come to rest just after collision. The ratio of velocity of center of mass of rod in case (i) to that in case (ii) is



(A) 1:1 (B) 1:2
(C) 2:1 (D) 4:1

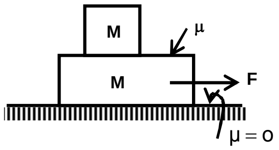
16. The charge on the capacitors A and B in steady state is :-



(A) $\frac{CE}{2}$,CE (B) $\frac{CE}{2}, \frac{CE}{2}$
(C) CE,$\frac{CE}{2}$ (D) CE,CE

17. In a region, uniform electric field exists as $\vec{E} = \left[10\hat{i} + 10\hat{j}\right] N/C.$ If the potential of origin is 0 volts, the potential of point (10m, 10m, 10m) is
(A) 20 volts (B) – 200 volts
(C) 10 volts (D) – 10 volts

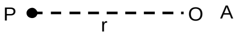
18. For $\mu = \frac{F}{Mg}$, the power applied by force F on the system as a function of time t is



(A) Zero (B) $\frac{F^2}{2M}t$
(C) $\frac{F^2}{M}t$ (D) none of the above

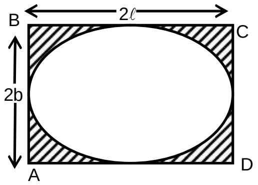
Space for rough work

19. There in a small source of heat radiations emitting energy at a constant rate of P watts. At a distance r from the source a small thin disc of mass 'M' surface area 'A' and specific heat capacity 'c' is kept. The time required to raise the temperature of the disc by T Kelvin is



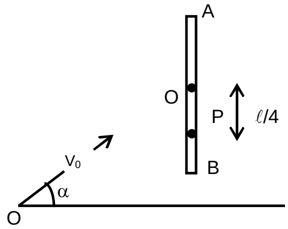
(A) $\frac{mcT}{P}$
(B) $\frac{4\pi r^2 mcT}{PA}$
(C) $\frac{\pi r^2 mcT}{PA}$
(D) data insufficient.

20. There is a thin plate ABCD with an elliptical hole as shown in the figure. The coefficient of linear expansion of the sheet is α. When the temperature of the plate is increased by T K, the area of the hole increases by an amount :-



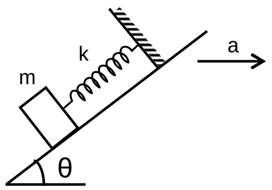
(A)$\pi\ell b\ \alpha T$
(B) $2\pi\ell b\alpha T$
(C) $3\pi\ell b\ \alpha T$
(D) Data insufficient.

21. A rod of mass M and length ℓ is falling vertically downwards. A particle of m is projected with V_0 at t = 0 at an angle α with horizontal and it strikes the rod perpendicularly at $P(\text{at } t = t_1)$ and comes to rest. The rod strikes the ground at $t = t_2$. The angular velocity of rod about its centre of mass (O)



(A) keeps on increasing from t_1 to t_2
(B) keeps on decreasing for t_1 to t_2
(C) remains constant and is non – zero for t = t_1 to t_2
(D) remains constant and is zero for $t = t_1$ to t_2

22. A spring block system (mass = m, spring constant k) is placed on a smooth inclined plane (θ = angle of inclination). The plane is accelerated horizontally with a such that the block does not loose contact with the plane. The time period of small oscillation of the block is



(A) $2\pi\sqrt{\frac{m}{k}}$
(B) $2\pi\sqrt{\frac{m\sin\theta}{k}}$
(C) $2\pi\sqrt{\frac{mg}{ka}}$
(D) none of the above.

Space for rough work

23. A spherical drop of radius r and density n is falling in air with terminal velocity. The density of air is n_0 and its coefficient of viscosity μ. The power developed of by gravity is

(A) $\frac{\pi r^5 n}{\mu}(n-n_0)g^2$ (B) $\frac{\pi r^5}{2\mu}n[n-n_0]$

(C) $\frac{27}{8\mu}r^5 n(n-n_0)g^2$ (D) $\frac{8\pi r^5}{27\mu}n[n-n_0]g^2$

24. A progressive mechanical longitudinal wave is represented by $y = A\sin(\omega t - kx + \pi)$

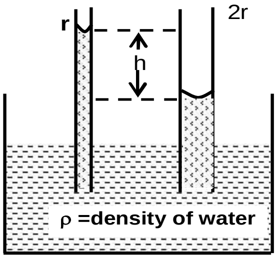
For $k = 100\text{cm}^{-1}$, phase difference between two particles at $x_1 = 2\text{cm}$ and $x_2 = 4\text{cm}$ at $t = 0$ is

(A) 1rad (B) 2rad
(C) 3rad (D) none of above.

25. In the given arrangement, two capillaries of glass having radii r and 2 r are dipped in pure water of density ρ, the surface tension of water is

(A) $2\rho hgr$ (B) ρhgr

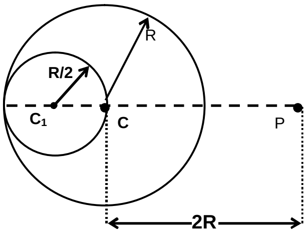
(C) $\frac{\rho hgr}{2}$ (D) None of these



26. A solid uniform sphere of mass M and radius R with centre C is isolated in space. If in the sphere a cavity of radius $\frac{R}{2}$ with centre C_1 is made, then the potential at a point P at a distance of 2R from centre C is

(A) $< -\frac{2GM}{5R}$ (B) $> -\frac{2GM}{5R}$

(C) $= -\frac{2GM}{5R}$ (D) None of these.



Space for rough work

27. Two concentric circles each of radius a (50m< a < 100m) lie in mutually perpendicular planes. A source of sound moves with constant speed on one circle and an observer with same speed on the other circle. If both cross each other simultaneously by at a point, then actual frequency (f_1) of sound and apparent frequency (f_2) received by observer are such that

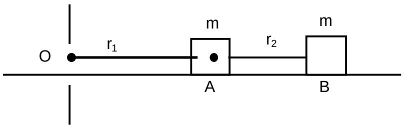
(A) $f_1 < f_2$ always (B) $f_1 = f_2$ always
(C) $f_1 > f_2$ always (D) none of above

28. A satellite of mass m is orbiting round the earth at a distance of 2R' from the centre of the earth. The amount of energy that must be given to the satellite in order to make its radius 6R must be :-

(A) less than $\frac{GM_em}{3R}$ (B) equal to $\frac{GM_em}{6R}$
(C) greater than $\frac{GM_em}{4R}$ (D) less than $\frac{GM_em}{4R}$

29. A person throws a ball (A) vertically upwards with 40 m/sec. After 4 sec, he throws another identical ball (B) upwards with same speed. If the collision between balls is head-on perfectly elastic, the speed of ball (A) just after collision is
(A) 0 (B) 10 m/sec
(C) 20 m/sec (D) 40 m/sec

30. Two blocks of mass m each are connected by a massless string while block A is connected to point O by another massless string. Both rotate with constant speed ω on the horizontal surface with O as centre. If T_1 is the tension in OA and T_2 is tension in string AB, then the relation between T_1 & T_2 is:-



(A) $T_1 = T_2$ (B) $T_1 > T_2$
(C) $T_1 < T_2$ (D) data insufficient

Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. In a mixture of C_6H_5Cl and $C_6H_5CH_3$. The $\chi_{C_6H_5Cl}$ is 0.5. The maximum % composition of C_6H_5Cl is the mixture is:
(A) 35% (B) 45%
(C) 55% (D) 65%

2. A gas under constant temperature was kept to the change in this manner that the density of gas increase twice of its original density so the diffusability of gas will be. (assuming pressure and volume varies remarkably)
(A) initially decreases and then increases (B) initially increases then decreases
(C) remain as it is (D) it is negative work done

3. The sum of angular node and angular momentum for ψ_{432} is
(A) $\frac{\sqrt{6}h+3\pi}{2\pi}$ (B) $\frac{\sqrt{3}h+\pi}{\pi}$
(C) $\frac{\sqrt{3}h+3\pi}{\pi}$ (D) $\frac{\sqrt{3}h+3\pi}{3\pi}$

4. On heating orthophosphoric acid at 250°C it gives (assuming no further reaction).
(A) Phosphorus acid (B) Hypophosphoric acid
(C) Pysophosphoric acid (D) Metaphosphoric acid

5. Inorganic benzene is $B_3N_3H_6$, if all the H are replaced by OH group and all the N by P atom. Then possibility of π bond
(A) B to O and O to P (B) B to O and P to O
(C) O to B and O to P (D) O to B and P to O

6. In NaOX, X can not be
(A) F_2 (B) Cl_2
(C) Br_2 (D) I_2

Space for rough work

7. $K_2Cr_2O_7$ when reacts with cold conc. H_2SO_4 gives red crystal of

(A) CrO_4^{-2} (B) CrO_3

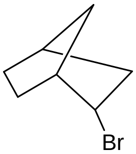
(C) $Cr_2(SO_4)_3$ (D) Cr_2O_3

8. Which of the following statement is incorrect about $[Cu(NH_3)_4]SO_4$

(A) It is paramagnetic in nature (B) the hybridization of the complex is dsp^2

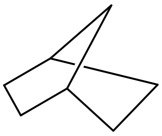
(C) The colour of the complex is blue (D) SO_4^{-2} behaves as ligand

9

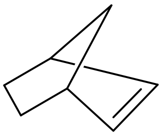


$\xrightarrow[NH_3]{NH_2^-}$ A (major prodcut), A is

(A)



(B)



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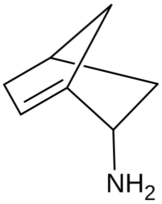
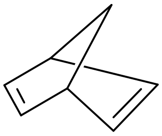
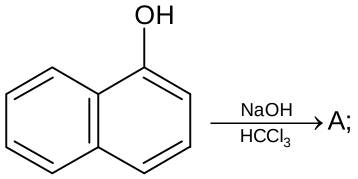


(D)

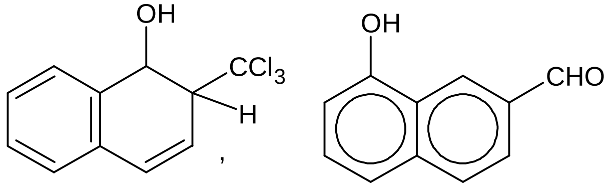


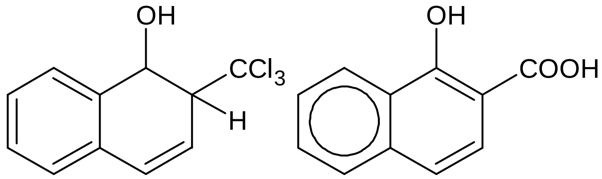
Space for rough work

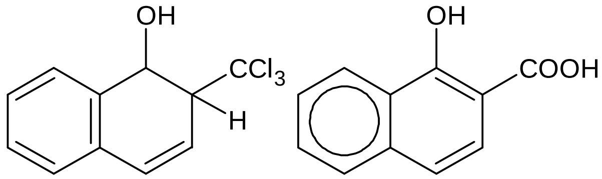
10. 

α – Naphthol

The intermediate of the reaction with the major product is

(A) 

(B) 

(C) 

(D) None of these

11. $Na_2S_2O_3$ when treated with $AgNO_3$ in presence of heat, gives black ppt. of
(A) $Ag_2S_2O_3$ (B) Ag_2O
(C) Ag_2S (D) Na_2S

12. Critical temperature (T_c) for 2 gases X and Y is T_{c1} and T_{c2} respectively, so the radius of X and Y are related as follow of $T_{c1} > T_{c2}$
(A) $r_x > r_y$ (B) $r_y > r_x$
(C) $r_y = r_x$ (D) $r_x + r_y = 0$

13. The coordination number of Wurtzite structure is
(A) 2 : 2 (B) 4 : 4
(C) 6 : 6 (D) 8 : 8

14. When equal conc. of aniline in added to acetone which of the following property of solution will not change
(A) Molarity (B) Boiling point
(C) Volality (D) Vapour pressure

Space for rough work

15. For a consecutive reaction
$A \rightarrow B \rightarrow C$ the $[B]_{max}$ will be

(A) $[B]_{max} = [A]_t \times \left[\frac{K_2}{K_1}\right]^{\frac{K_2}{K_1-K_2}}$

(B) $[B]_{max} = [A]_0 \times \left[\frac{K_2}{K_1}\right]^{\frac{K_2}{K_1-K_2}}$

(C) $[B]_{max} = [A]_t \times \left[\frac{K_1}{K2}\right]^{\frac{K_2}{K_1-K_2}}$

(D) $[B]_{max} = [A]_0 \times \left[\frac{K_1}{K_2}\right]^{\frac{K_2}{K_1-K_2}}$

16. In the reaction of solubility of $\left[Fe(H_2O)_6\right]^{3+} + H_2O \longrightarrow H_3O^+ + \left[Fe(H_2O)_5\,OH\right]^{+2}$
The complex formation takes place if

(A) high concentration of $\left[Fe(H_2O)_5\,OH\right]^{+2}$ is taken

(B) Ksp is positive

(C) low concentration of $\left[Fe(H_2O)_5\,OH\right]^{+2}$ is taken

(D) Ksp is negative

17. The pH of the solution of 0.1 M is acetic acid and 0.1 M benzoic acid is
(if $K_{a_{C_6H_5COOH}} = 6.5 \times 10^{-5}, K_{a_{CH_3COOH}} = 1.8 \times 10^{-5}$)

(A) 3.5
(B) 2.5
(C) 1.5
(D) 0.5

18. $A^{+a} + ae^- \rightleftharpoons A$ $\quad E_1^0$

$A^{b+} + be^- \rightleftharpoons A$ $\quad E_2^0$

For simultaneous reactions electrode potential is

(A) $E_3 = \frac{aE_1^0 + bE_2^0}{(a+b)}$

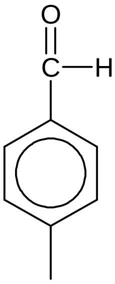
(B) $E_3 = \frac{aE_1^0 - bE_2^0}{(a+b)}$

(C) $E_3 = \frac{bE_2^0 - aE_1^0}{(a+b)}$

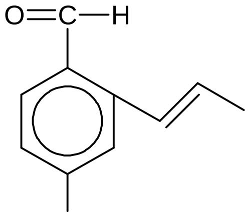
(D) $E_3 = \frac{aE_1^0 - bE_2^0}{(a-b)}$

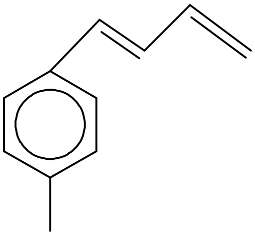
Space for rough work

19. An inorganic molecule X on heating gives green colouration and evolve O_2 gas the X is
(A) $K_2Cr(SO_4)_2$
(B) $K_2Cr_2O_7$
(C) $RbCrO_4$
(D) CrO_2Cl_2

20.


$+\ CH_2=CH-CH=PPh_3 \longrightarrow A$, A is

(A)


(B)


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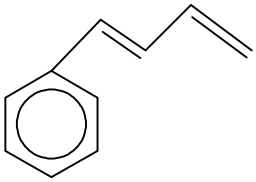
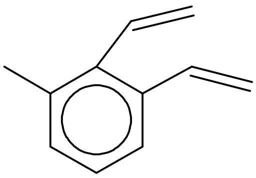


(D)


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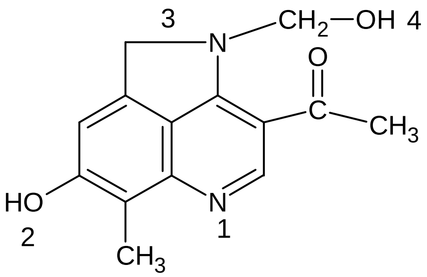
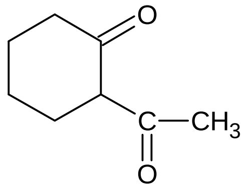
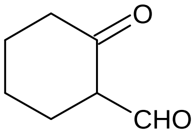
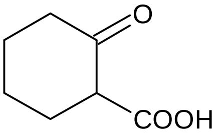


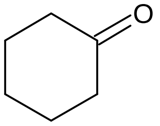
H^+ will attack on the basic site
(A) 1
(B) 2
(C) 3
(D) 4

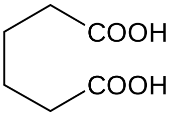
Space for rough work

22.  $\xrightarrow[(3)\ \Delta]{(1)\ NaOI,\ (2)\ H^+}$ Product is

(A) CHI_3 and 

(B) CHI_3 and 

(C) CHI_3 and 

(D) CHI_3 and 

23. Which of the following order is incorrect?
(A) $Na_2O < K_2O < Rb_2O$ (basic nature)
(B) $CH_4 > SiH_4 > GeH_4 > SnH_4$ (stability of hydride)
(C) $NH_3 < PH_3 < AsH_3$ (basic nature)
(D) $N_2O_5 < P_2O_5 < As_2O_5$ (acidic nature)

24. Select correct statement:
(A) Red oxide of lead is known as massicot
(B) Red oxide of lead is known as litharge
(C) Yellow oxide of lead is known as litharge
(D) Yellow oxide of lead is known as anarge

25. Most oxidizing agent is
(A) $\left[CeO_4\right]^{-2}$
(B) $\left[WO_4\right]^{-2}$
(C) $\left[CrO_4\right]^{-2}$
(D) $\left[MnO_4\right]^{-2}$

26. $\left[NiCl_4\left(NH_3\right)_2\right]^{-2}$ can show:
(A) Coordination isomerism
(B) Linkage isomerism
(C) Geometrical isomerism
(D) Hydration isomerism

Space for rough work

27. $As_2O_3 + H_2O \longrightarrow AsO_4^{-3} + H^+$, in the reaction n factor of As_2O_3 is

(A) 1 (B) 2
(C) 3 (D) 4

28. The mean free path (λ) of a gas sample is given by:

(A) $\lambda = \sqrt{2}\pi\sigma^2 N$ (B) $\lambda = \frac{1}{\sqrt{2}\pi\sigma^2 N}$
(C) $\lambda = \sqrt{2}\pi 4\sigma^2 N$ (D) $\lambda = \frac{\sqrt{2}}{\pi\sigma^2 N}$

29. The oxide of Alkali earth metal gives brick red coloured carbide with the formula. (M_2C), on reaction with carbon the metal oxide is:

(A) MgO (B) CaO
(C) BeO (D) SrO

30. Which of the following pair of metal form nitrite on reaction with Nitrogen?

(A) Li, Mg (B) Mg, Na
(C) Al, K (D) Al, Na

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Let $f(x) = \begin{cases} |x| & \text{for } 0 < |x| \le 3 \\ 1 & \text{for } x = 0 \end{cases}$, then at x = 0 f(x) has

(A) a local maximum
(B) no local maximum
(C) a local minimum
(D) no extremum

2. If three equations are consistent
$(a + 1)^3x + (a + 2)^3y = (a + 3)^3$
$(a + 1)x + (a + 2)y = a + 3$
$x + y = 1$, then a is equal to

(A) 1
(B) 2
(C) –2
(D) 3

3. The remainder on dividing $1234^{567} + 89^{1011}$ by 12 is

(A) 1
(B) 5
(C) 9
(D) none of these

4. If tan A, tan B are the roots of the quadratic equation $abx^2 - c^2x + ab = 0$ where a, b, c are sides of the ΔABC then $\sin^2 A + \sin^2 B + \sin^2 C$ is

(A) 1
(B) 2
(C) 3
(D) $\frac{3}{2}$

5. If $I_1 = \int_{-100}^{101} \frac{dx}{(5+2x-2x^2)(1+e^{2-4x})}$ and $I_2 = \int_{-100}^{101} \frac{dx}{5+2x-2x^2}$, then $\frac{I_1}{I_2}$ is

(A) $\frac{1}{2}$
(B) 2
(C) 0
(D) none of these

Space for rough work

6. Let f: R → R and g: R → R be two one-one and onto functions such that they are the mirror images of each other about the line y = 2. If h(x) = f(x) + g(x) then h(0) equals to

(A) 2
(B) 4
(C) 0
(D) none of these

7. If the straight line 3x + 4y = 24 intersects the axes at A and B and the straight line 4x + 3y = 24 intersects the axis at C and D then the number of parabolas possible to draw through A, B, C and D is

(A) 0
(B) 1
(C) 2
(D) 4

8. Two given circles of radii r_1 and r_2 touch each other externally. If $\frac{r_1}{r_2} = 3 + 2\sqrt{2}$ then the locus of the centre of a circle that touches both the circles externally is

(A) a straight line
(B) a pair of perpendicular straight lines
(C) either of two parabolas
(D) a rectangular hyperbola

9. In an equilateral triangle, inradius (r), circumradius (R) and exradius (r_1) are in

(A) A.P.
(B) G.P.
(C) H.P.
(D) none of these

10. $\lim\limits_{x\to\infty} \int_0^{x^2/2} \frac{t^2}{x^2(1+t^2)} dt$ is equal to

(A) $\frac{1}{4}$
(B) $\frac{1}{2}$
(C) 1
(D) none of these

11. The number of pairs (m, n) of integers such that $n^2 - 3mn + m - n = 0$ is

(A) 0
(B) 1
(C) 2
(D) none of these

12. The greatest possible number of points of intersection of 6 straight lines and 4 circles is

(A) 55
(B) 75
(C) 45
(D) 51

Space for rough work

13. If $\cos 3x + \sin\left(2x - \frac{7\pi}{6}\right) = -2$, then x is equal to (where $m \in I$)

(A) $\frac{\pi}{3}(6m-1)$
(B) $\frac{\pi}{3}(6m+1)$
(C) $\frac{\pi}{3}(2m+1)$
(D) none of these

14. If a, b, c > 0, then the minimum value of $(a + b + c)\left(\frac{1}{a}+\frac{1}{b}+\frac{1}{c}\right)$ must be

(A) 6
(B) 8
(C) 9
(D) 12

15. The value of $\int \frac{(x^2+1)}{(x^4-x^2+1)\cot^{-1}\left(x-\frac{1}{x}\right)}dx$ will be

(A) $\ln\left|\cot^{-1}\left(x-\frac{1}{x}\right)\right|+c$
(B) $-\ln\left|\cot^{-1}\left(x-\frac{1}{x}\right)\right|+c$
(C) $\ln\left|\cot^{-1}\left(x+\frac{1}{x}\right)\right|+c$
(D) none of these

16. The highest power of 3 contained in (70)! Must be equal to

(A) 16
(B) 24
(C) 32
(D) 48

17. If f(x) = sinx + cosax is periodic then a is

(A) 2
(B) π
(C) $\frac{\pi}{2}$
(D) $\sqrt{2}$

18. If A is a nilpotent matrix of index 2, then for any positive integer n, $A(I + A)^n$ is equal to

(A) A^{-1}
(B) A
(C) A^n
(D) I_n

Space for rough work

19. If in triangle ABC, $\angle C = 45^\circ$ then value of $\sin^2 A + \sin^2 B$ lies in the interval
(A) $[0, 1]$
(B) $(0, 1)$
(C) $\left(\frac{1}{2}, \quad \frac{1+\sqrt{2}}{\sqrt{2}}\right)$
(D) none of these

20. The curve $xy = c$ $(c > 0)$ and the circle $x^2 + y^2 = 1$ touch at two points, then distance between the points of contacts is
(A) 1
(B) 2
(C) $2\sqrt{2}$
(D) none of these

21. A seven digit number without repetition and divisible by 9 is to be formed by using 7 digits out of 1, 2, 3, 4, 5, 6, 7, 8, 9. The number of ways in which this can be done is;
(A) 9!
(B) 2 (7!)
(C) 4 (7!)
(D) none of these

22. Point of intersection of the lines $\text{Arg}(z - 1) = \frac{\pi}{4}$ and $z = it + (1 - t)$ is
(A) i
(B) 1
(C) $1 + i$
(D) none of these

23. If p and q be the longest and the shortest distances respectively of the point $(-7, 2)$ from any point (α, β) on the curve whose equation is $x^2 + y^2 - 10x - 14y - 51 = 0$ then G.M of p and q is
(A) $2\sqrt{11}$
(B) $5\sqrt{5}$
(C) 13
(D) none of these

24. If the sides of a right angled triangle are in G.P then the cosines of the acute angles of the triangle are
(A) $\frac{\sqrt{5}-1}{2}, \quad \frac{\sqrt{\sqrt{5}-1}}{2}$
(B) $\frac{-\sqrt{5}-1}{2}, \quad \frac{\sqrt{\sqrt{5}-1}}{2}$
(C) $\frac{1}{2}, \quad \frac{1}{4}$
(D) none of these

25. The number of real root(s) of the equation $x^2 \tan x = 1$ lie(s) between 0 and 2π is/are
(A) 1
(B) 2
(C) 3
(D) 4

Space for rough work

26. If α, β and γ are the roots of the equation $x^2(px + q) = r(x + 1)$. Then the value of determinant $\begin{vmatrix} 1+\alpha & 1 & 1 \\ 1 & 1+\beta & 1 \\ 1 & 1 & 1+\gamma \end{vmatrix}$ is

(A) $\alpha\beta\gamma$
(B) $1+\frac{1}{\alpha}+\frac{1}{\beta}+\frac{1}{\gamma}$
(C) 0
(D) none of these

27. If $f(x) = x^3 + ax^2 + bx + c$ has local maxima at certain $x \in R^+$ and minima at certain $x \in R^-$ then
(A) $b > 0, c > 0$
(B) $b > 0, c < 0$
(C) $b < 0$
(D) none of these

28. The number of solutions of $\log_e|x| = \sqrt{2-x^2}$ is
(A) 4
(B) 1
(C) 2
(D) 3

29. The value of $c\int_{1+c}^{a+c}[f(cx)+1]dx - \int_{c}^{ac} f(c^2+x)dx$ $(c \neq 0)$, is equal to
(A) 0
(B) $c(a - 1)$
(C) ac
(D) $a(c + 1)$

30. If z_1, z_2, z_3 are unimodular complex numbers then the greatest value of $|z_1 - z_2|^2 + |z_2 - z_3|^2 + |z_3 - z_1|^2$ equals to
(A) 3
(B) 6
(C) 9
(D) $\frac{27}{2}$

Space for rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students
from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

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CRT – I
(Main)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	D	A
2.	B	B	C
3.	C	C	C
4.	D	C	B
5.	D	C	A
6.	A	A	B
7.	C	B	C
8.	D	D	D
9.	B	B	A
10.	C	A	B
11.	C	C	C
12.	B	B	B
13.	D	B	B
14.	D	A	C
15.	A	B	B
16.	C	B	C
17.	B	B	A
18.	B	D	B
19.	B	B	C
20.	B	B	B
21.	C	C	C
22.	A	C	B
23.	D	D	A
24.	B	B	A
25.	B	C	B
26.	C	C	C
27.	D	D	C
28.	B	B	C
29.	C	C	B
30.	B	A	C

Physics

PART – I

1. $$\rho = \frac{3\cdot 14 \times 10^{-6} \times 5}{1}$$
$$= 15.7\mu \text{ ohm metre.}$$
$$\delta\rho = \rho\left[\frac{2\delta r}{r} + \frac{\delta L}{L} + \frac{\delta R}{R}\right] \text{ohm metre.}$$
$$= 15\cdot 7\mu\left[2 \times \frac{\cdot 01}{1} + \frac{\cdot 01}{1} + \frac{\cdot 01}{5}\right] \text{ ohm metre}$$
$$= 15.7\mu\left[\cdot 02 + \cdot 01 + \cdot 002\right] \text{ohm – metre}$$
$$= 15.7 \times \cdot 032\mu\,\Omega\text{ m}$$
$$= \cdot 5024\mu\,\Omega\text{ m}$$

2. $$100 \times \frac{\Delta P}{P} = 3 \times 0\cdot 1 + 2 \times 0\cdot 2 + 3 \times 0\cdot 3 + 4 \times 0\cdot 1$$
$$= \cdot 3 + \cdot 4 + \cdot 9 + \cdot 4 = 2\%$$

3. $$A = \lambda N_0 e^{-\lambda t_0}$$
$$3Ae = 3\lambda N_0 e^{-\lambda t}$$
$$\Rightarrow \frac{1}{e} = e^{\lambda(t - t_0)} = e^{-1}$$
$$t = t_0 - \frac{1}{\lambda}.$$

4. At $t = \dfrac{v_o \sin\theta}{g}, \overrightarrow{v_1} = v_0 \cos\theta\,\hat{i}$
$$\overrightarrow{v_2} = v_0\hat{k} - gt\hat{j}$$
$$\therefore \overrightarrow{v_2} - \overrightarrow{v_1} = v_0\hat{k} - gt\,\hat{j} - v_0\cos\theta\,\hat{i}$$

5. $$f = a^2(Z - b)^2.$$
$\therefore$ (D)

6. $$-v\frac{dv}{dx} = \frac{(k + \alpha mg)x}{m}$$
$$\Rightarrow -\int_{v_0}^{0} v\,dv = \left(\frac{k + \alpha mg}{m}\right)\int_{o}^{x_0} x\,dx$$
$$\Rightarrow x_0 = v_0\sqrt{\frac{m}{(k + \alpha mg)}}$$

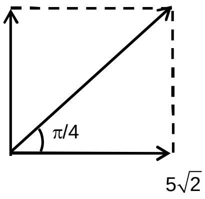
7. $$\frac{I_{max}}{I_{min}} = \frac{\left(\sqrt{I_1} + \sqrt{I_2}\right)^2}{\left(\sqrt{I_1} - \sqrt{I_2}\right)^2} = \alpha$$

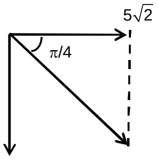
$$\frac{I_1}{I_2} = \left(\frac{\sqrt{\alpha}+1}{\sqrt{\alpha}-1}\right)^2 \text{ if } I_1 > I_2$$

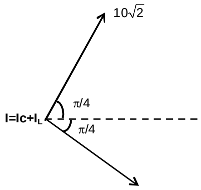
8. $I_c = \dfrac{100}{5\sqrt{2}}\sin\left(50t + \dfrac{\pi}{4}\right)$

$I_L = \dfrac{100}{5\sqrt{2}}\sin\left[50t - \dfrac{\pi}{4}\right]$

I = 20sin(50t)







9. 2mg sin30 – T = 2m(a)

T = ma

$\Rightarrow a = g/3 \;\&\; T = \dfrac{mg}{3}$

$\therefore$ Net force =

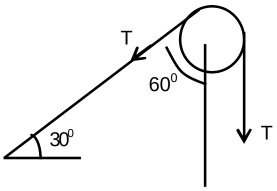
Result of these forces $= T\left(-\hat{j}\right) + T\cos 60^0\left(-\hat{j}\right) + T\sin 60\left(-\hat{i}\right)$

$= -\dfrac{\sqrt{3}}{2}T\hat{i} - \dfrac{3}{2}T\hat{j}$

$= \dfrac{mg}{6}\left(-\sqrt{3}\hat{i} - 3\hat{j}\right)$

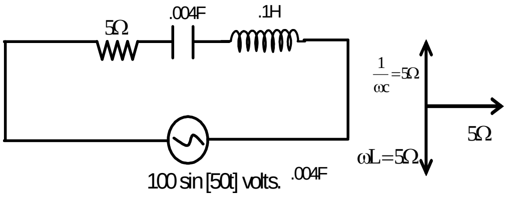
As net force in pulley = 0,

force by clamp $= \dfrac{mg}{6}\left(\sqrt{3}\hat{i} + 3\hat{j}\right)$



10. The circuit can be simplified as:

$\phi = 0^0$,peak current =20 Ampere.



12. When u decreases v increases. For plane mirror u decreases.

$\therefore$ the image in plane mirror moves towards the left.

13. $4 \times \dfrac{\mu_0 I}{4\pi}.\left[\sin 45^0 + \sin 45^0\right]\left[\dfrac{1}{R} - \dfrac{1}{2R}\right]$

$= \dfrac{\mu_0 I}{\pi}\left[\sqrt{2}\right]\left[\dfrac{1}{2R}\right] = \dfrac{\mu_0 I}{\sqrt{2}\pi R} \odot$

14. $V_1 = \dfrac{10}{4+4} \times 4$ volts = 5 volt

$$V_2 = \frac{10 \times \dfrac{100 \times 4}{100+4}}{4 + \dfrac{100 \times 4}{100+4}}$$

= 4.9 volts $\therefore \left|V_1 - V_2\right| = 0.1$ volt

15. In both cases
applying com,

$$mv_0 = Mv$$

$$\Rightarrow V = \frac{mv_0}{M}$$

$$\therefore \frac{V_1}{V_2} = 1:1$$

16. In steady state :-

$$V_P - V_Q = \frac{E}{2R} \times R = \frac{E}{2}$$

$$V_Q - V_S = \frac{E}{2R} \times R = \frac{E}{2}$$

$$V_S = V_R$$

$$V_P - V_R = E$$

$$\therefore Q_A = CE$$

$$Q_B = \frac{CE}{2}$$

17. $V_P - V_0 = -[10 \times 10 + 10 \times 10]$
= - 200 volts.

18. For the two blocks to move together

$$\mu_{min} = \frac{F}{(M+m)g} = \frac{F}{2Mg}$$

As $\mu > \mu_{min}$,
the two blocks move together.
$\therefore$ Velocity of the system (M+m) is

$$v = at = \left(\frac{F}{2M}\right)t$$

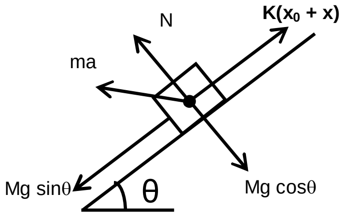
$$\Rightarrow P = Fv = F\frac{F}{2m}t = \frac{F^2}{2M}t.$$

19. $\frac{P}{4\pi r^2} \times Axt = mcT$

$$t = \frac{4\pi r^2 mcT}{PA}$$

20. $\Delta A = \pi \ell b(2\alpha)T$.

21. After collision,
the rod starts rotating about its centre of mass.
Now the torque of mg about the centre of mass = 0, hence ω is constant.



22. $x_0 \therefore$ elongation in equilibrium

$\therefore ma\cos\theta + mg\sin\theta = kx_0$ (1)

For x = elongation from equilibrium

net force $= mg\sin\theta + ma\cos\theta - k(x_0 + x)$

$= -kx$ (i)

$\therefore \text{acc} = -\dfrac{kx}{m}$

$\Rightarrow T = 2\pi\sqrt{\dfrac{m}{k}}$

23. $\dfrac{4}{3}\pi r^3[n - n_0]g = 6\pi\mu r V_T.$

$V_T = \dfrac{2r^2[n - n_0]}{9\mu}g$

$P_g = \dfrac{4}{3}\pi r^3 . n . g . \dfrac{2r^2(n - n_0)g}{9\mu}$

$= \dfrac{8\pi r^5 n}{27\mu}[n - n_0]g^2$ 55. $\Delta x = 2\text{cm} = 0.02\text{m}$

24. $\Delta\phi = k\Delta x = 100 \times .02$

= 2rad

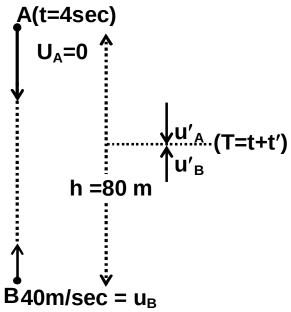
25. $P_0 - \dfrac{2T}{r} + \rho gh = P_0 - \dfrac{2T}{2r}$

$\Rightarrow T = \rho ghr.$

26. $\dfrac{-GM}{2R} + \dfrac{G\dfrac{M}{4}}{\dfrac{5R}{2}} = -\dfrac{2GM}{5R}$

27. The apparent frequency initially decreases & then increases in one time period.

28. $\Delta E = -\dfrac{GM_e m}{12R} + \dfrac{GM_e m}{4R} = \dfrac{GM_e m}{6R}$



29. $v^2 = u^2 + 2gh \Rightarrow 0^2 = (40^2) - 2(10)(h)$

$\Rightarrow h = 80\text{m}$

where h is maximum height reached by ball A

v = u – gt ⇒ t = 4 sec,

$t' = \dfrac{80}{u_A + u_B} = 2\sec$

$u'_A = gt' = 20\text{m/s}$

$u'_B = 40 - 2\times 10 = 20\text{m/s}$

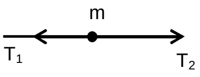
Thus the speed of each ball gets interchanged (for equal mass & elastic collision)

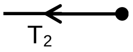
30. $T_1 - T_2 = m\omega^2 r_1$

$T_2 = m\omega^2 (r_1 + r_2)$

$\Rightarrow T_1 = m\omega^2 (2r_1 + r_2)$

Thus $T_1 > T_2$





Chemistry

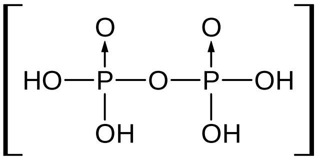
PART – II

1. M_{wt} C_6H_5Cl = 112.5
M_{wt} $C_6H_5CH_3$ = 92
Given:
$x_{C_6H_5Cl} = 0.5$
So mass% composition reaction of C_6H_5Cl is
% C_6H_5Cl = $\frac{112.5}{204.5} \times 100$ = 55%

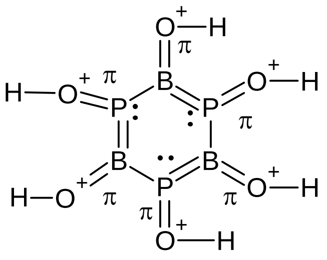
2. As density increases, volume of gas decreases so intermolecular forces increase and diffisubility decreases.

3. For $\Psi_{432} \Rightarrow$
n = 4, l = 3, m = 2
Angular momentum = $\frac{h}{2\pi}\sqrt{\ell(\ell+1)} = \frac{\sqrt{12}h}{2\pi} = \frac{\sqrt{3}h}{\pi}$
Angular node = ℓ = 3
So total node = $\frac{\sqrt{3}h}{\pi} + 3$ = $\frac{\sqrt{3}h + 3\pi}{\pi}$

4. $2H_3PO_4 \xrightarrow{250^\circ C} \underset{\text{Pyrophosphoric acid}}{H_4P_2O_7} + H_2O$



5.

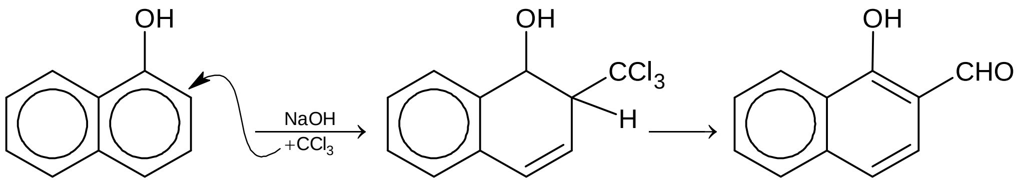


3 pπ—pπ back bonding between B and O and
3 pπ—dπ back bonding between P and O is possible.

7. $K_2Cr_2O_7 + 2H_2SO_4 \longrightarrow \underset{\substack{\text{Chromic anhydride} \\ \text{(Red Crystal)}}}{2CrO_3} + 2KHSO_4 + H_2O$

9. NH_2^- behaves as a base and E_2 elimination takes place.

10.



11. $\underset{}{Na_2S_2O_3 + AgNO_3} \longrightarrow \underset{(\text{white})}{Ag_2S_2O_3} \longrightarrow \underset{(\text{black ppt})}{Ag_2S}$

12. $T_c = \dfrac{8a}{27Rb}$ so $T_c \propto \dfrac{1}{b}$; and b = 4 × N_A × V ⇒ b ∝ r

13. AB type structure in which Zn^{+2} is tetrahedrally surrounded by S^{-} ion, S^{-2} is present in half of tetradedral acid.

14. It is an extensive property.

15. $$\frac{d[B]}{dt} = [A]_0\left[\frac{K_1}{K_2 - K_1}\right]\left(-K_1e^{-K_1t} + K_2e^{-K_2t}\right)$$

16. $$\text{ksp} = \frac{\left[Fe(H_2O)OH\right]^{+2}\left[H_3O^{+}\right]}{\left[Fe(H_2O)_6\right]^{+3}}$$, Ksp should be high.

17. $\left[H^{+}\right] = \sqrt{K_{a_1}C_1 + K_{a_2C_2}} \Rightarrow 2.5$

18. ΔG^0 (net) = $\Delta G_1^0 + \Delta G_2^0$

Total e^{-} exchanged = (a + b)

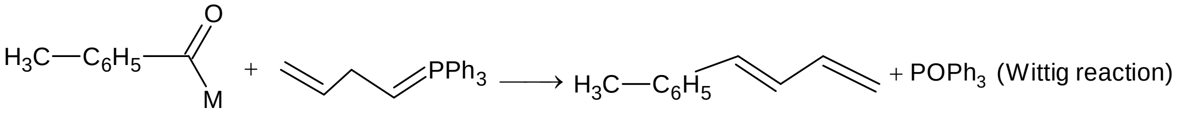
$\Delta G^0 = -nFE^0$

$-(a+b)FE_3^0 = -aFE_1^0 - bFE_2^0$

$$E_3^0 = \frac{aE_1^0 - bE_2^0}{(a-b)}$$

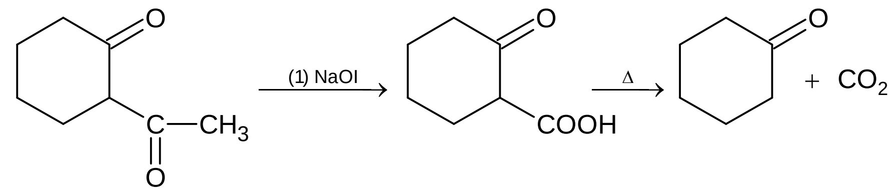
19. $K_2Cr_2O_7 \xrightarrow{\Delta} K_2CrO_4 + Cr_2O_3 + O_2$

20.



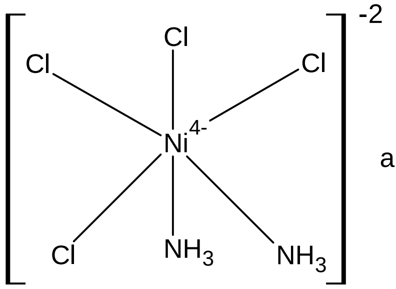
21. Nitrogen is less electronegative than oxygen and on 3rd reactive site it is sp^3 hybridised.

22.



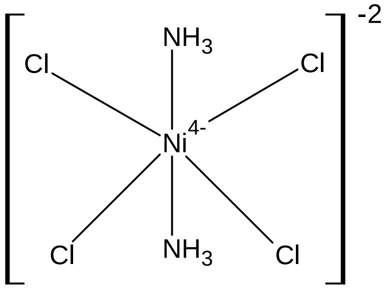
23. As metallic character increases down the group so acidic nature of oxide decreases.

26.



Cis

and



Trans

27. $As_2O_3 + 5H_2O \longrightarrow 2AsO_4^{-3} + 10H^+ + 4e^-$

29. $2BeO + 2C \xrightarrow{\Delta} Be_2C + 2CO$

30. Only lithium nitride with formula LiN_3 in first group and Mg with Mg_3N.

Mathematics PART – III

2. Since the equations are consistent

$\therefore$ D = 0

$$\begin{vmatrix} (a+1)^3 & (a+2)^3 & -(a+3)^3 \\ (a+1) & (a+2) & -(a+3) \\ 1 & 1 & -1 \end{vmatrix} = 0$$

Put u = (a + 1), v = a + 2, w = a + 3

u – v = –1, v – wz –1, w – u = 2

u + v + w = 3a + 6

$$\therefore \begin{vmatrix} u^3 & v^3 & w^3 \\ u & v & w \\ 1 & 1 & 1 \end{vmatrix} = 0$$

(u – v) (v – w) (w – u) (u + v + w) = 0

(–1) (–1) (2) (3a + 6) = 0

i.e. a = –2.

3. 1234 = 3n + 1, so 1234^{567} = 3m + 1,89 = 3k – 1, so 89^{1011} = 3p – 1.

Hence $1234^{567} + 89^{1011}$ = 3n 1234 is even,

So 1234^{567} = 4q. 89 = 4r + 1, so 89^{1011} = 4t + 1.

Hence $1234^{567} + 89^{1011}$ = 4l + 1. So it is 9x + 1.

4. Here, tan A + tan B = $\frac{c^2}{ab}$ and tan A . tan B = 1

tan A . tan B = 1 $\Rightarrow$ tan A = cot B $\Rightarrow$ A = 90^0 – B $\Rightarrow$ A + B = 90^0 $\Rightarrow$ C = 90^0

$\Rightarrow$ sin A = $\frac{a}{c}$, sin B = $\frac{b}{c}$

$\therefore \sin^2 A + \sin^2 B + \sin^2 C = \frac{a^2}{c^2}+\frac{b^2}{c^2}+1=2$

5. $I_1 = \int_{-100}^{101} \frac{dx}{(5+2x-2x^2)(1+e^{2-4x})} = \int_{-100}^{101} \frac{dx}{(5+2(1-x)-2(1-x)^2)(1+e^{2-4(1-x)})}$

$\Rightarrow 2I_1 = \int_{-100}^{101} \frac{dx}{5+2x-2x^2} = I_2$

$\Rightarrow \frac{I_1}{I_2} = \frac{1}{2}$.

6. Since f(x) and g(x) are one-one and onto and are also the mirror images of each other with respect to the line y = 2. It clearly indicates that h(x) = f(x) + g(x) will be a constant function and will always be equal to 4.

7. Equation of the curve passing through the points A, B, C, D is
$(3x + 4y - 24)(4x + 3y - 24) - \lambda xy = 0$
If it represents a parabola then the quadratic terms must form a perfect square.
$\Rightarrow \lambda = 1$ or 49.

8. Locus is a hyperbola with eccentricity = $\frac{r_1+r_2}{r_1-r_2}=\sqrt{2}$

9. In an equilateral triangle r = $\frac{R}{2}$

Also exradius $r_1 = 4R \sin\frac{A}{2} \cos\frac{B}{2} \cos\frac{C}{2} = 4R\ \frac{1}{2}.\frac{\sqrt{3}}{2}.\frac{\sqrt{3}}{2}=\frac{3}{2}R$

$\Rightarrow$ r, R, r_1 are in A.P.

10. $\lim\limits_{x\to\infty} \int_0^{x^2/2} \frac{t^2}{x^2(1+t^2)}dt = \frac{\infty}{\infty}$ form

$\Rightarrow \lim\limits_{x\to\infty} \frac{\int_0^{x^2/2} \frac{t^2}{(1+t^2)}dt}{x^2} = \lim\limits_{x\to\infty} \frac{\frac{x^4}{4+x^4}x}{2x} = \lim\limits_{x\to\infty} \frac{x^5}{2x^5+8} = \frac{1}{2}$.

11. $(3m + 1)(3n - 1) = 3n^2 - 1$, so if p divides 3n – 1, then it also divides $3n^2 - 1$
and hence also $(3n^2 - 1) - n(3n - 1) = n - 1$, and hence also (3n – 1) – 3(n – 1) = 2.
So 3n – 1 = 0, ± 1 or ± 2.
But n must be an integer, so 0, 1, – 2 do not work. – 1 gives n = 0 and hence m = 0, which is a solution. 2 gives n = 1 and hence m = 0, which is a solution.

12. Two lines can meet in a point

$\therefore\ {}^6C_2 = 15$

line and circle meet in two points = $({}^6C_1 \times {}^4C_1) \times 2 = 48$.

Two circles meet in 2 points = ${}^4C_2 \times 2 = 12$

total number of points = 48 + 15 + 12 = 75.

13. $1 + \cos 3x + 1 - \left[\cos\left(\frac{\pi}{2} + \left(2x - \frac{7\pi}{6}\right)\right)\right] = 0$

$$2\cos^2\frac{3x}{2} + 1 - \cos\left(2x - \frac{2\pi}{3}\right) = 0$$

$$2\cos^2\frac{3x}{2} + 2\sin^2\left(x - \frac{\pi}{3}\right) = 0$$

$$\cos\frac{3x}{2} = 0,\ \sin\left(x - \frac{\pi}{3}\right) = 0$$

$x = \frac{\pi}{3}$, π and $x = \frac{\pi}{3}, \frac{2\pi}{3}, \frac{7\pi}{3}, \ldots..$

$\therefore\ x = \frac{\pi}{3}$ is the common value which satisfies both

$\therefore\ x = 2n\pi + \frac{\pi}{3} = (6n + 1)\frac{\pi}{3}$

15. $\int \frac{(x^2+1)}{(x^4 - x^2 + 1)\cot^{-1}\left(x - \frac{1}{x}\right)}dx = \int \frac{\left(1 + \frac{1}{x^2}\right)}{\left(x^2 + \frac{1}{x^2} - 2 + 1\right)\cot^{-1}\left(x - \frac{1}{x}\right)}dx$

$= \int \frac{dt}{(t^2+1)\cot^{-1}t}$

Put $x - \frac{1}{x} = t \Rightarrow \left(1 + \frac{1}{x^2}\right)dx = dt$

$= \int \frac{-du}{u}$

Let $\cot^{-1} t = u$

$\Rightarrow -\frac{1}{(1+t^2)}dt = du$ $= -\ln|u| + c$

$= -\ln\left|\cot^{-1}\left(x - \frac{1}{x}\right)\right| + c$

16. $\left[\frac{70}{3}\right] + \left[\frac{70}{9}\right] + \left[\frac{70}{27}\right] = 23 + 7 + 2 = 32$

17. Let λ be the period of sinx + cosax then
$\sin(\lambda + x) + \cos a(\lambda + x) = \sin x + \cos ax$ for all x
In this identity, putting x = 0 and $x = -\lambda$, we het
$\sin\lambda + \cos a\lambda = 1$ and $1 = -\sin\lambda + \cos\lambda$
solving these equation, we get
$\sin\lambda = 0$ and $\cos a\lambda = 1$
hence $\lambda = n\pi$ and $a\lambda = 2m\pi$. Where m, n are non–zero integers
hence $\frac{a\lambda}{\lambda} = \frac{2m\pi}{n\pi}$
or $a = \frac{2m}{n}$ (since $\lambda \neq 0$)

18. $A^2 = 0, A^3 = A^4 = \ldots = A^n = 0$
then $A(I \pm A)^n = A(I + nA)$
$= A \pm nA^2 = A$.

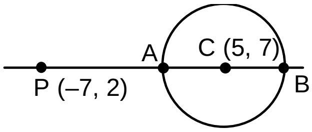
19. $\Delta = \sin^2 A + \sin^2(135° - A) = 1 + \sin^2 A - \sin^2(45° - A)$
$= 1 + \sin 45° \times \sin(2A - 45°) = 1 + \frac{1}{\sqrt{2}}.\sin\left(2A - 45^0\right)$
$= \Delta < \frac{\sqrt{2}+1}{\sqrt{2}}$ and $\Delta > \frac{1}{2}$
$0 < A < 135°$
$0 < 2A < 270°$
$-45° < 2A - 45° < 225°$
$-\frac{1}{\sqrt{2}} < \sin\left(2A - 45^0\right) < 1$
$\Rightarrow \frac{1}{2} < \sin^2 A + \sin^2 B < \frac{1+\sqrt{2}}{\sqrt{2}}$.

20. The curve xy = c and the circle $x^2 + y^2 = 1$ touches each other so
$x^2 + \frac{c^2}{x^2} - 1 = 0 \Rightarrow x^4 - x^2 + c^2 = 0$
will have equal roots so $(-1)^2 - 4c^2 = 0 \Rightarrow 4c^2 = 1$
$\Rightarrow c^2 = \frac{1}{4} \Rightarrow c = \frac{1}{2}$.
Roots of the equations $x^4 - x^2 + \frac{1}{4} = 0$ are $x = \pm \frac{1}{\sqrt{2}}$
$\Rightarrow y = \mp \frac{1}{\sqrt{2}}$.
Clearly distance between the points of contact = 2 units

21. Sum of 7 digits = a multiple of 9
Sum of number 1, 2, 3, 4, 5, 6, 7, 8, 9 = 45 so two left should also have sum of 9.
The pair of left numbers is (1, 8), (2, 7), (3, 6), (4, 5).
with each pair left number of 7 digit number = 7!
So with all 4 pairs = 4 × 7! .

22. Equation of Ist line is $y - 0 = 1(x - 1)$
$y = x - 1$
and equation of IInd line is $x + y = 1$.
Clearly point of intersection is (1, 0).

23. The centre c of the circle = (5, 7) and the radius



$= \sqrt{5^2 + 7^2 + 51} = 5\sqrt{5}$

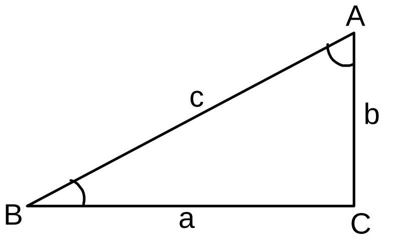
$PC = \sqrt{12^2 + 5^2} = 13$

$\Rightarrow q = PA = 13 - 5\sqrt{5}$ and $p = PB = 13 + 5\sqrt{3}$

$\therefore$ G.M of p and q = $\sqrt{pq} = \sqrt{\left(13 - 5\sqrt{5}\right)\left(13 + 5\sqrt{5}\right)}$

$= \sqrt{169 - 125} = 2\sqrt{11}$.

24. a, b, c are in G.P $\Rightarrow b^2 = ac$
and $c^2 = a^2 + b^2$
$\Rightarrow c^2 = a^2 + ac$



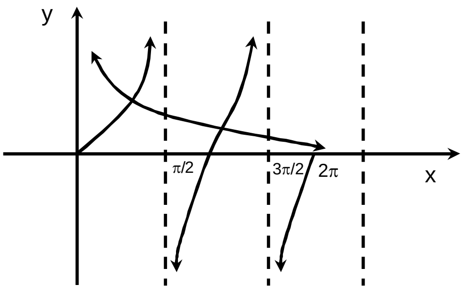
$\Rightarrow \left(\frac{a}{c}\right)^2 + \left(\frac{a}{c}\right) - 1 = 0$

$\Rightarrow \frac{a}{c} = \cos B = \frac{-1 \pm \sqrt{5}}{2}$

$\Rightarrow \cos B = \frac{\sqrt{5} - 1}{2}$ (B is acute)

$\cos A = \sin B = \sqrt{1 - \cos^2 B} = \frac{\sqrt{\sqrt{5} - 1}}{2}$

25. $y = \tan x = \frac{1}{x^2}$
From graph it is clear that it will have two real roots,



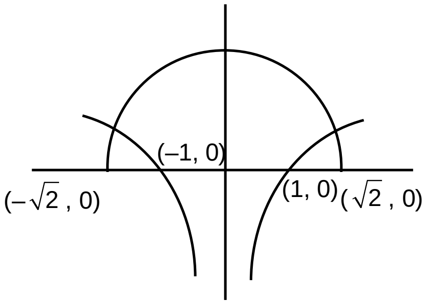
26. The given equation is $px^3 + qx^2 - rx - r = 0$. Its roots are given α, β, γ so we have

$\alpha + \beta + \gamma = \frac{-q}{p}$; $\alpha\beta + \beta\gamma + \gamma\alpha = -\frac{r}{p}$; $\alpha\beta\gamma = \frac{r}{p}$.

$D = \alpha\beta\gamma\left(1 + \frac{1}{\alpha} + \frac{1}{\beta} + \frac{1}{\gamma}\right) = \alpha\beta\gamma\left(\frac{\alpha\beta\gamma + \alpha\beta + \beta\gamma + \gamma\alpha}{\alpha\beta\gamma}\right) = 0.$

27. For local maxima at $x \in R^+$ and minima at certain $x \in R^-$ the roots of $f'(x) = 0$ are of opposite sign $\Rightarrow f'(0) < 0 \Rightarrow b < 0$.

28. Drawing the curves $y = \log_e |x|$
and $y = \sqrt{2 - x^2}$
So, number of solutions = 2



29. Putting $cx = c^2 + z$

$$c\int_{1+c}^{a+c} f(cx)dx = \int_{c}^{ac} f(c^2 + z)dz$$

So, the required value = $c\int_{1+c}^{a+c} dx = c(a-1)$

30. $|z_1 - z_2|^2 + |z_2 - z_3|^2 + |z_3 - z_1|^2$
$= 2(|z_1|^2 + |z_2|^2 + |z_3|^2) - (z_1\bar{z}_2 + \bar{z}_1z_2 + z_2\bar{z}_3 + \bar{z}_2z_3 + z_3\bar{z}_1 + \bar{z}_3z_1)$
$= 6 - (z_1\bar{z}_2 + \bar{z}_1z_2 + z_2\bar{z}_3 + \bar{z}_2z_3 + z_3\bar{z}_1 + \bar{z}_3z_1)$ ……(1)
Now $|z_1 + z_2 + z_3|^2 \geq 0$
$\Rightarrow |z_1|^2 + |z_2|^2 + |z_3|^2 + z_1\bar{z}_2 + \bar{z}_1z_2 + z_2\bar{z}_3 + \bar{z}_2z_3 + z_3\bar{z}_1 + \bar{z}_3z_1 \geq 0$
$\Rightarrow -(z_1\bar{z}_2 + \bar{z}_1z_2 + z_2\bar{z}_3 + \bar{z}_2z_3 + z_3\bar{z}_1 + \bar{z}_3z_1) \leq 3$ ……(2)
from (1) and (2)
maximum value = 6 + 3 = 9

FIITJEE **JEE (Advanced), 2014**

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - II

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 210**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 10)** contains 10 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (11 to 15) contains 5 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

(ii) **Section-C (01 to 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant R = $8.314\ J\ K^{-1}\ mol^{-1}$
= 0.0821 Lit atm $K^{-1}\ mol^{-1}$
= $1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

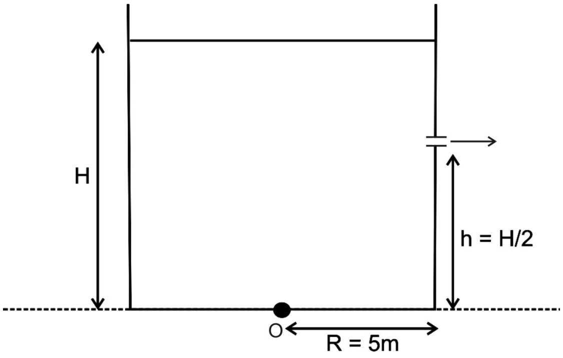
Single Correct Choice Type

This section contains **10 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. Two mutually perpendicular infinitely long straight conductors carrying uniformly distributed charges of λ_1 and λ_2 are at x = 0 along y–axis and at x = a parallel to z axis. Then:
(A) The force between them is infinite
(B) The force between them depends on 'a'
(C) The force between them is independent of 'a'
(D) The torque of force about x axis on any conductor is non zero

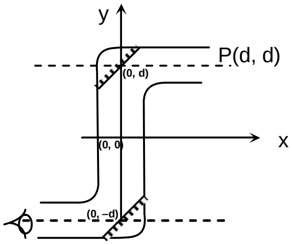
2. A block is attached to a horizontal spring of stiffness k. The other end of the spring is attached to a fixed wall. The entire system lie on a horizontal surface and the spring is in natural state. The natural length of the spring is ℓ_0. If the block is slowly lifted up vertically to a height $\frac{5}{12}\ell_0$ from its initial position, which of the following is not correct:
(A) The work done by the gravity $\frac{5}{12}\ell_0 mg$
(B) The work done by the spring force $-\frac{k\ell_0^2}{288}$
(C) The work done by the lifting force $\frac{5}{12}mg\ell_0 + \frac{k\ell_0^2}{288}$
(D) The sum of works done by all the forces on the block is zero

3. A small hole of area 1 cm^2 is punched on the side of a cylindrical vessel containing water upto a height H = 10 m as shown. The torque of normal force about 'Centre of the vessel O' immediately after making the hole would be :
Assume that tank does not topple.
(A) 10 Nm
(B) 30 Nm
(C) 50 Nm
(D) Zero



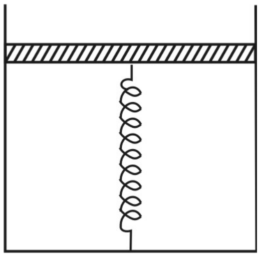
Space for rough work

4. Find the position coordinates of the image of the object P as seen through the periscope. The mirrors are inclined at 45° with x-axis and eye is placed at the level $y = -d$.

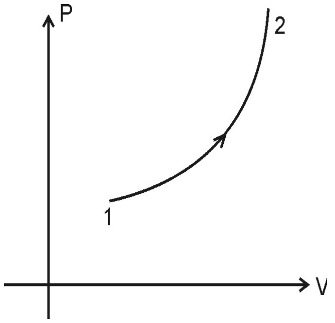


(A) (d, –d)
(B) (–d, +d)
(C) (2d, –d)
(D) (3d, –d)

5. The piston is massless and the spring is ideal and initially streched the piston cylinder arrangement encloses an ideal gas. If the gas is heated quasistatically the PV graph.



(A)



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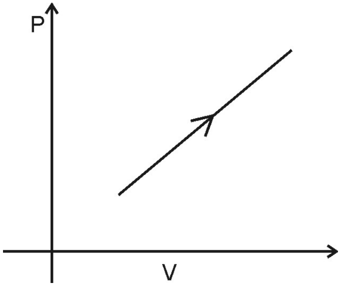

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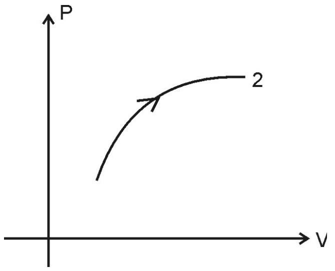

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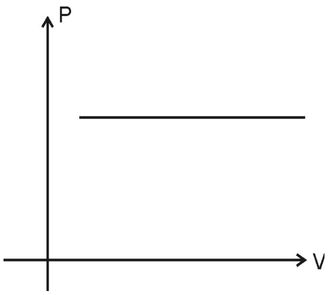
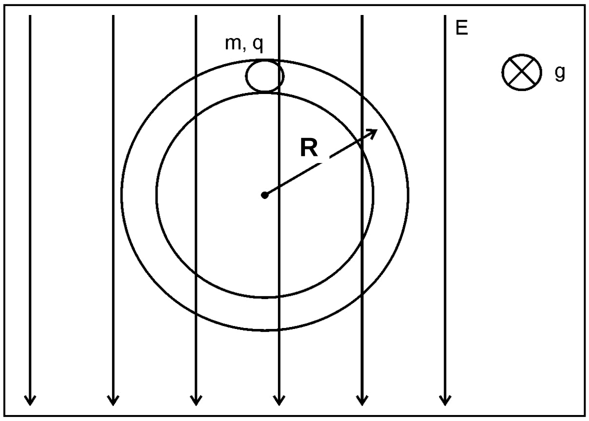


Space for rough work

6. When an excited H atom goes to ground state it emits a photon.
Statement 1 : Mass has changed into energy.
Statement 2 : K.E. has increased.
(A) Both 1 and 2 are true
(B) Both 1 and 2 are false
(C) Only 1 is true
(D) Only 2 is true

7. The smooth circular pipe is kept fixed in a horizontal plane. If mass m with change +q is slightly displaced from the position shown, then distance traveled by the ball when the magnitude of normal becomes minimum would be



(A) 0
(B) $R\cos^{-1} 1/3$
(C) $R\tan^{-1}\frac{\sqrt{5}}{2}$
(D) πR

8. When a tangential force of 0.02 N is applied on a large wooden plate of area 10 m^2 floating on the surface of river, plate moves with the speed 2 m/s on the river surface. The river is 1 m deep and the water in contact with the bed is stationary. Assuming constant speed gradient, coefficient of viscosity of water is
(A) 10^{-5} poise
(B) 10^{-2} poise
(C) 10^{-9} poise
(D) 10^{-15} poise

9. A car is moving towards an approaching bike. Bike is moving with velocity 30 m/s. Frequency of horn sounded by car is 100 Hz while it is observed by bike rider as 120 Hz. The actual duration of horn is 6 sec. The time the bike rider hears it, in seconds is (take velocity of sound in air as 330 m/s)
(A) 1 sec
(B) 10 sec
(C) 5 sec
(D) 12 sec

10. An empty plastic box of mass m is found to accelerate up at a rate of g/6 when placed deep inside water. Then the mass of sand be filled in it so that it may accelerate down at a rate of g/6 is
(A) $\frac{2}{5}m$
(B) $\frac{4}{5}m$
(C) $\frac{13}{5}m$
(D) $\frac{17}{5}m$

Space for rough work

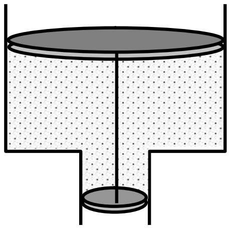
Multiple Correct Answer(s) Type

This section contains **5 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

11. A block of mass 2kg moves under the influence of external forces on a rough horizontal surface. At some instant, it has a velocity of 1 m/sec. due south and acceleration of 1 m/sec^2 due east. The force of friction acting on it is F.
(A) F acts due west
(B) F acts due north
(C) F acts in the south-west direction
(D) The magnitude of F can not be found from the given data.

12. In a certain series LCR A.C. circuit it is found that $X_L = 2X_C$ and phase difference between the current and voltage is $\pi/4$. If now capacitance is made 1/4th & the inductance and resistance are doubled then which are not correct.
(A) voltage will lead current by a phase of $\tan^{-1}(1/2)$.
(B) voltage will lag behind current by a phase of $\tan^{-1}(1/2)$.
(C) voltage will lag behind current by a phase of $\pi/4$.
(D) voltage and current will be in same phase.

13. A vertical cylinder contains ideal gas with the help of two pistons whose combined mass is M. Pistons are connected by an inextensible string. The difference in the area of pistons is A. Atmospheric pressure is P_0. Initially the system is in equilibrium as shown in the figure. Now heat is supplied to the system. Mark the correct statement(s).
(A) volume will increase
(B) Pressure will remain constant
(C) Temperature will increase
(D) Internal energy of gas will remain constant.



14. As shown in the fig. all surface are frictionless and block B is released from top of the incline A then
(A) Linear momentum of (A + B) will remain constant in all direction.
(B) Linear momentum of (A + B) will remain constant in horizontal direction.
(C) Linear momentum of A will remain constant in horizontal direction.
(D) Mechanical Energy of (A + B) system will remain constant

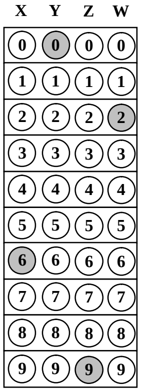
15. Choose the INCORRECT statement(s)
(A) The flux of electric field is equal to number of field lines crossing the surface
(B) The flux of electric field over a closed surface is always non-zero
(C) The flux of gravitational field over any closed surface can never be positive
(D) The flux is equal to $\phi = \vec{E}.\vec{S}$ where $\vec{E}$ is electric field and $\vec{S}$ is area of surface.

Space for rough work

SECTION –C

Integer Answer Type

This section contains 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



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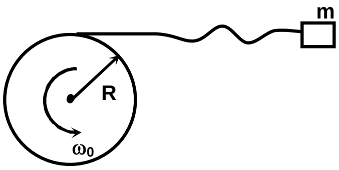
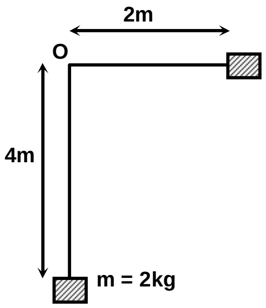
1. Disc of mass M = 10 kg and radius R = 50 cm is revolving about fixed vertical axis on smooth horizontal surface with angular velocity ω_0 = 4 rad/sec. A block of mass m = 5kg is connected to disc through slack string as shown in the diagram. Find the velocity of the block when string become taut.



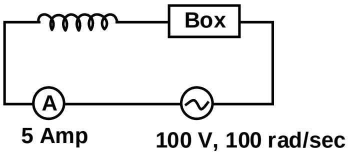
2. A block of mass 2 kg is tied to elastic thread of length 2 m and suspended to point O. Initially block is horizontal level to this point O. Now block is released and its speed is 5 m/s when thread is vertical. If the acceleration of the block at the lowest position is 2.5 K. Find the value of K.



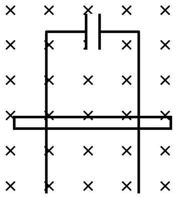
Space for rough work

3. A non conducting ring of mass m = 1 kg and radius R = 10 cm has a charge Q = 2 C uniformly distributed over its circumference. The ring is placed on rough horizontal surface such that plane of the ring is parallel to the surface. A vertical magnetic field $B = B_0t^2$ where $B_0 = 4T/sec^2$ is switched on. After 5 sec, after switching on the magnetic field the ring is just about to rotate about vertical axis through the centre. The coefficient of friction μ between the ring and the surface is found to be $x \times 10^{-1}$. Find the value of x.

4. In the circuit shown, the power factor of the circuit is 1, power factor of box is 4/5, source voltage is 100V and angular frequency ω = 100 rad/sec and current flowing in circuit is 5 amp. Value of inductance of inductor is $\frac{K}{20}$ henry then find value of K.



5. A capacitor of capacitance 100 μF is connected to smooth railing and connector of mass 1 kg and length 1 m, whole system is in vertical plane and a magnetic field of strength 100 T is applied perpendicular to plane of circuit as shown. Connector is released under gravity. The time (in sec) after which dielectric of capacitor will burn out is $k \times 10^3$ then find the value of k. Breaking strength of dielectric is 5×10^8 V/m. (d is the distance between plates of capacitor = 1 mm)



Space for rough work

Chemistry

PART – II

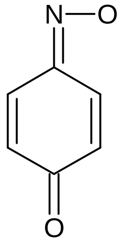
SECTION – A

Straight Objective Type

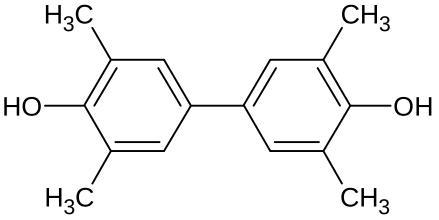
This section contains **10 multiple** choice questions numbered **1 to 10.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Which of the following will not show tautomerism:

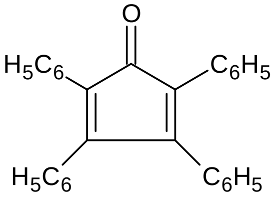
(A)



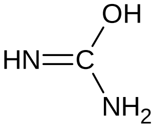
(B)



(C)



(D)



2. Which of the following reactions represent developing in photography?

(A) $AgNO_3 + NaBr \longrightarrow AgBr + NaNO_3$

(B) $AgBr + 2Na_2S_2O_3 \longrightarrow Na_3\left[Ag(S_2O_3)_2\right] + NaBa$

(C) $AgBr + h\upsilon \longrightarrow Ag\overset{\bullet}{Br}$

(D) $C_6H_4(OH)_2 + 2Ag\overset{\bullet}{Br} \longrightarrow C_6H_4O_2 + 2HBr + 2Ag$

3. In an adiabatic expansion of air (assume it a mixture of N_2 and O_2), the volume increases by 5% the percentage change in pressure is:

(A) 3%
(B) 4%
(C) 6%
(D) 7%

4. In the normal spinel having one eighth of the tetrahedral holes, occupied by one type of metal ion and one half of the octahedral holes occupied by another type of metal ion. Such a spinel is formed by Mg^{2+}, Al^{3+} and O^{2-}. If oxide ion is replaced by $X^{-8/3}$, the number of anionic vacancies per unit cell is;

(A) 1
(B) 2
(C) 3
(D) ¾

Rough Work

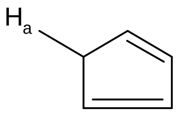
5. Caffeine is dissolved in a suitable solvent and the osmotic pressure (π) of solutions of various concentrations (g/cm^3) C is measured at 20°C. The slope of a plot of π against C is found to be 4.65×10^{-3}. The molecular weight of the caffeine (g/mol) is:

(A) 3×10^5	(B) 9×10^5
(C) 4.5×10^5	(D) 5.16×10^6

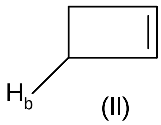
6. In which of the following molecule, the number of possible $\angle XAX$ angles is maximum in the anionic part of their solid state? [A : central atom, X : surrounding atom]

(A) PBr_5	(B) N_2O_5
(C) PCl_5	(D) Cl_2O_6

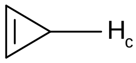
7. Arrange the following in increasing order of pk$_o$ values:



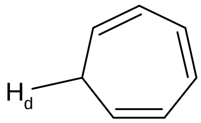
(I)



(II)



(III)



(IV)

(A) (I) < (II) < (III) < (IV)	(B) (I) < (II) < (IV) < (III)
(C) (IV) < (III) < (II) < (I)	(D) (III) <(IV) < (II) < (I)

8. HCl gas is passed through an aqueous solution of 0.1 M 1 – aminopropane ($PrNH_2$) till the pH reaches 9.71. Calculate the ratio of $[PrNH_2]/[PrNH_3]^+$ in this solution:

$$\left[K_a\left(PrNH_3^+\right) = 1.96 \times 10^{-11}\right]$$

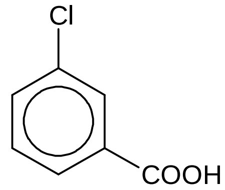
(A) 0.01	(B) 0.002
(C) 0.1	(D) 10^{-3}

Rough Work

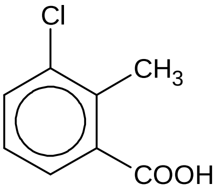
9. Compound$(A)\xrightarrow[\text{aq. NaOH}]{\text{dil}},\xrightarrow{H^+}\xrightarrow[Na_2Cr_2O_7]{\text{acidic}}\xrightarrow{\Delta}\text{Product}(C_8H_4O_3)$

The compound (A) is:

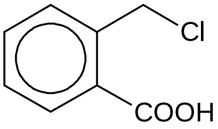
(A)



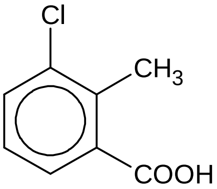
(B)



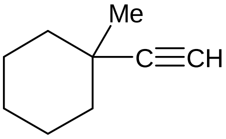
(C)



(D)



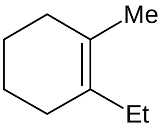
10.



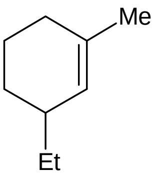
$\xrightarrow{H_2/Ni_2B(P-2)}(B)\xrightarrow{H^+}(C)$

Compound (C) is:

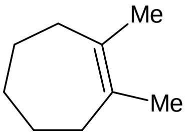
(A)



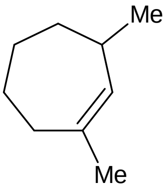
(B)



(C)



(D)



Rough Work

Multiple Correct Choice Type

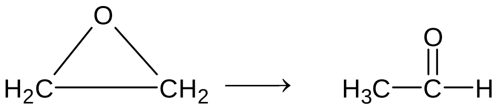
This section contains 5 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

11. Among the isomers of dimethylcyclohexane, the achiral ones are:
(A) 1, 2-trans and 1,3 – cis
(B) 1, 2-cis and 1. 3 – trans
(C) 1, 3 – trans and 1, 4 – trans
(D) 1, 2 and 1, 3 – trans

12. Select the correct statement (s) about the compound NO[BF_4]:
(A) Magnetic moment of the species is zero
(B) B—F bond energy is lower in this compound than in BF_3
(C) It has 5σ and 2π bond
(D) Nitrogen oxygen bond order is same as in N_2

13. The oxidation potential of hydrogen half-cell will be negative if:
(A) $p(H_2) = 1$ atm and $[H^+] = 1$ M
(B) $p(H_2) = 1$ atm and $[H^+] = 2$ M
(C) $p(H_2) = 0.2$ atm and $[H^+] = 1$ M
(D) $p(H_2) = 0.2$ atm and $[H^+] = 0.2$ M

14.



Given: For ethylene oxide ΔH_f^o and ΔS^o are –51 kJ mol^{-1} 243 $Jmol^{-1}K^{-1}$ respectively and acetaldehyde. ΔH_f^o and ΔS^o are –166 $KJmol^{-1}$ and 266 $Jmol^{-1}K^{-1}$ respectively, then select the correct statements:
(A) ΔH^o per the reation is –115 $KJmol^{-1}$
(B) $\Delta S^o = 0.0236\ KJmol^{-1}K^{-1}$
(C) Reaction is thermodynamically favourable
(D) Low temperature can favour formation of more product.

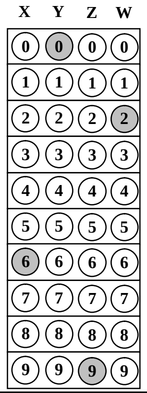
15. Which of the following is/are correct about:
Tetramminedithiocyanato – S – cobalt (III) tris (oxalate) cobaltate (III)?
(A) Formula of the complex is $[Co(SCN)_2(NH_3)_4][Co(ox)_3]$
(B) It is a chelating complex and show linkage isomerism
(C) It shows optical isomerism
(D) It shows geometrical isomerism

Rough Work

SECTION – C

Integer Answer Type

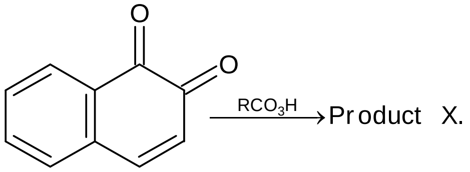
This section contains 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. AgNO$_3$ gives white precipitate with hypo changing to black after some time, the oxidation number of sulphur in the black precipitate is:

2. In the structure of (Sb$_2$F$_{11}$)$^-$, the total number of hybrid orbitals present per Sb – atom are

3. In the given reaction:



The number of sp^2 carbon is X are expressed as a two-digit number AB, the sum of AB is:

4. The emf of the cell: $M(s)|M_nX_n(0.01M)||M_nX_n\ (0.1M)/\ M_{cs})$ is found to be 0.0295V at 25°C. If M_nX_n is soluble salt. Find the value of n.

5. If the bond enthalpies of A$_2$, AB and B$_2$ are in the ratio. 1 : 1 : 0.5 and the enthalpy of formation of AB from A$_2$ and B$_2$ is –100 KJmol^{-1}, the bond enthalpy of A$_2$ is 504 kJ/mole. X will be y × 10^2 kJ/mole, the value of y is:

Rough Work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Let $\vec{u}$ be a vector on rectangular coordinate system with sloping angle 60º. Suppose that $|\vec{u}-\hat{i}|$ is geometric mean of $|\vec{u}|$ and $|\vec{u}-2\hat{i}|$ where $\hat{i}$ is the unit vector along x–axis then $|\vec{u}|$ has the value equal to $\sqrt{a}-\sqrt{b}$ where a, b $\in$ N, then the value of $(a+b)^3+(a-b)^3$ is
(A) 27 (B) 28
(C) $28\sqrt{3}$ (D) $27\sqrt{3}$

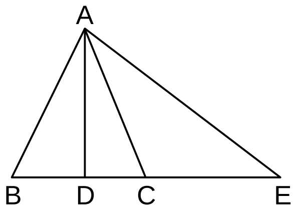
2. One of the roots of equation $2000x^6 + 100x^5 + 10x^3 + x - 2 = 0$ is of the form $\frac{m+\sqrt{n}}{r}$, where m is non–zero integer, and r and n are relatively prime natural number, then the value of (m + n + r) is
(A) 200 (B) 205
(C) 195 (D) 190

3. A perfectly rough plane is inclined at an angle α to the horizontal. Then the least eccentricity of an ellipse which can rest on the plane is
(A) $\sqrt{2\sin\alpha}$ (B) $\sqrt{\frac{2\sin\alpha}{1+\sin\alpha}}$
(C) $\sqrt{\frac{2\cos\alpha}{1+\sin\alpha}}$ (D) $\sqrt{\frac{2\sin\alpha}{1+\cos\alpha}}$

4. If the value of limit $\lim\limits_{x\to\infty}\sum\limits_{k=2}^{n}\cos^{-1}\left(\frac{1+\sqrt{k(k-1)(k+1)(k+2)}}{k(k+1)}\right)$ is equal to $\frac{120\pi}{k}$ then the value of k is
(A) 360 (B) 700
(C) 720 (D) 240

Space for rough work

5. In triangle ABC, |AB| = |AC| points D and E lie on ray BC such that |BD| = |DC| and |BE| > |CE|. Suppose that tan ∠EAC, tan ∠EAD and tan ∠EAB form a geometric progression, and that cot ∠DAE, cot ∠CAE and cot ∠DAB form an arithmetic progression. If |AE| = 10, then area of the triangle ABC is



(A) $\frac{50}{3}$
(B) 5
(C) $\frac{10}{3}$
(D) $\frac{25}{3}$

6. A circle C is tangent to the x and y–axis in first quadrant at the points P and Q respectively. BC and AD are parallel tangents to the circle with slope –1. If the points A and B are on the y–axis while C and D are on x–axis and area of figure ABCD is $900\sqrt{2}$ sq. units. The radius of the circle is

(A) $5\sqrt{2}$
(B) $6\sqrt{2}$
(C) 30
(D) 15

7. Let A be matrix $\begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix}$ then the matrix B = $A^{10} - A^9 + 2A^8 - A^7 + 4A^6 - 2A^5 + 4A^4 + A^3 - A^2 + A + I$ is

(A) A
(B) A + I
(C) I
(D) A – I

8. Tangents are drawn to the incircle of ∆ABC. Which are parallel to its sides, let p, q, r be the length of the tangents opposite to a, b, c respectively, then the value of $\frac{p}{a}+\frac{q}{b}+\frac{r}{c}$ is

(A) $\frac{1}{4}$
(B) $\frac{1}{2}$
(C) 1
(D) 2

9. A vector given by $\bar{A} = f(t)\hat{i} + g(t)\hat{j} + \hat{k}$ moves such that it is always parallel to the vector $\vec{B} = -f''(t)\hat{i} + f'(t)\hat{j} + \hat{k}$ then magnitude of $\vec{A}$ is

(A) constant
(B) a quadratic function of time
(C) a linear function of time
(D) a cubic function of time

10. Let $A = \begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix}$ such that |A| = 0. If a, b, c are distinct, then the sum of the coordinates of the fixed point through which the line ax + by + c = 0 passes is

(A) 2
(B) 3
(C) 4
(D) 5

Space for rough work

Multiple Correct Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

11. If a continuous function f(x) satisfies the relation $\int_0^x t\,f(x-t)dt = \int_0^x t\,g(t)dt + \sin x + \cos x - x - 1$ for all x then which of the following does not hold good?

(A) f(0) = 1
(B) f′(0) = 0
(C) f″(0) = 2
(D) $\int_0^x f(x)dx = e^{\pi}$

12. From an urn containing x white and y–x black balls, n balls have been lost, then probability of drawing a white ball

(A) before the loss is $\frac{x}{y}$
(B) after the loss is $\frac{x}{y}$ for n = 1
(C) after the loss is $\frac{x}{y}$ for n = 2
(D) after the loss is $\frac{x}{y}$ for n = 3

13. Let u, v, w, z be complex number such that |u| < 1, |v| = 1 and $w = \frac{v(u-z)}{\bar{u}z-1}$ then

(A) $|w| \le 1 \Rightarrow |z| \le 1$
(B) $|w| \ge 1 \Rightarrow |z| \ge 1$
(C) $|w| \le 1 \Rightarrow |z| \ge 1$
(D) $|w| \ge 1 \Rightarrow |z| \le 1$

14. The function defined as f(x) = $\lim_{n\to\infty}\begin{cases}\cos^{2n} x & \text{If } x < 0 \\ \sqrt[n]{1+x^n} & 0 \le x \le 1 \\ \frac{1}{1+x^n} & x > 1\end{cases}$ which of the following does not hold good

(A) continuous at x = 0, but discontinuous at x = 1
(B) continuous at x = 1, but discontinuous at x = 0
(C) continuous at both x = 1 and x = 0
(D) discontinuous at both x = 1 and x = 0

15. Let 2sin x + 3 cos y = 3, and 3 sin y + 2 cos x = 4 then

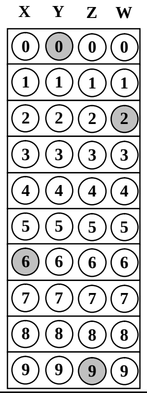
(A) $x + y = (4n+1)\frac{\pi}{2}$, $n \in I$
(B) $x + y = (2n+1)\frac{\pi}{2}$, $n \in I$
(C) x and y can be two non right angle of a 3–4–5 triangle with x > y
(D) x and y can be two non right angles of a 3–4–5 triangle with y > x

Space for rough work

SECTION – C

Integer Answer Type

This section contains **5 questions.** The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



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1. The value of $\lim\limits_{n\to\infty}\sum\limits_{r=n^2}^{(n+1)^2}\frac{1}{\sqrt{r}}$ is _____

2. If r_1, r_2 and r_3 are three values of r which satisfy the equation $\int\limits_0^{\pi/2}(\sin x + r\cos x)^3\,dx - \frac{4r}{\pi - 2}\int\limits_0^{\pi/2} x\cos x\,dx = 2$ then the value of $\frac{4}{7}\left(r_1^2 + r_2^2 + r_3^2\right)$ is equal to _____

3. Die A has four red faces and two white faces, die B has two red and four white faces. A fair coin is tossed. If it shows head, then die A is rolled thrice, otherwise die B is rolled thrice. If the first two throws of die shows red face, then the probability of getting red face in third throw is $\frac{a}{b}$ (in lowest terms) then $(a - 1)^{b-3}$ is equal to _____

4. The set of all points where f(x) is increasing in (a, b) ∪ (c, ∞) then [a + b + c] is (where [.] denotes the greatest integer function). Given that $f(x) = 2f\left(\frac{x^2}{2}\right) + f\left(6 - x^2\right)$ $\forall\, x \in R$ and $f''(x) > 0\ \forall\, x \in R$ _____

5. A circle of radius R is tangent to the hypotenuse, the incircle and one leg of an isosceles right angle triangle with inradius r = $1 + \sin\frac{\pi}{8}$. If the value of $Rr = \frac{a + \sqrt{a}}{b}$, where $\sqrt{a}$ is surd then (a + b) is equal to _____

Space for rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

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ANSWERS, HINTS & SOLUTIONS

CRT –II

(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	C	B
2.	A	D	A
3.	C	D	B
4.	D	A	C
5.	B	D	A
6.	D	C	D
7.	C	B	D
8.	B	C	C
9.	C	C	A
10.	A	C	A
11.	B, D	D	A, B, D
12.	A, B, C	A, B, C, D	A, B, C, D
13.	A, B, C	B	A, B
14.	B, D	A, B, C, D	A, B, C
15.	A, B, D	B, C, D	A, D
1.	1	2	2
2.	7	6	3
3.	4	1	4
4.	3	2	0
5.	1	4	6

Physics

PART – I

3. $F = v_e \dfrac{dm}{dt} = \rho A v^2$

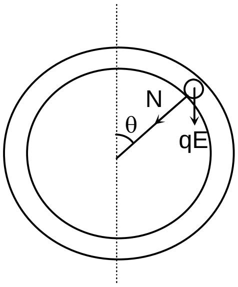
$\tau = \dfrac{(\rho A v^2)H}{2}$

7. $N_H + qE\cos\theta = \dfrac{mv^2}{R}$ …(i)

$N_H = 0$

($N_H \to$ horizontal component of normal force)

$qER(1 - \cos\theta) = \dfrac{1}{2}mv^2$



8. $$n = \frac{\left(\frac{F}{A}\right)}{\left(\frac{dv}{dx}\right)} = \frac{\frac{0.02}{10}}{\frac{2}{1}} = 10^{-3}\,kg/ms = 10^{-2}\,poise$$

9. Velocity of bike V_b = 30 m/ s

Let velocity of car be V_c

$f_{obs} = f_{actual} \times \dfrac{V_{so} + V_b}{V_{so} - V_c}$

$120\text{ Hz} = 100\text{ Hz} \times \dfrac{330 + 30}{330 - V_c}$

$\Rightarrow$ V_C = 30 m/s

Distance between initial and final pulse of horn

$= V_{so} \times \Delta t - V_C\,\Delta t$ {Δt is duration of emission of sound}

$= (330 - 30) \times 6 = 1800$ m

This wave train travels with 330 m/s and cross bike rider moving with velocity of 30 m/s towards it.

time taken $= \dfrac{\textit{length of wave train}}{V_{so} + V_b} = \dfrac{1800}{330 + 30} = \dfrac{180}{36} = 5$ sec

11. Kinetic friction acts opposite to relative velocity w.r.t. contact surface.

12. $X_L = 2X_C$

$X'_C = 4X_C$

$X'_L = 2X_L$

$\Rightarrow X'_L - X'_C = 2X_L - 4X_C = 2[X_L - 2X_C] = 0$

14. Since vertical Impulse is acting on A

Hence momentum of A & B will constant in horizontal direction only.

and M.E. of A & B will remain constant

SECTION –C

1. Angular momentum Conservation

$$\frac{1}{2}MR^2\omega_0 = \left(\frac{MR^2}{2} + mR^2\right)\omega'$$

$$\left(\frac{M}{M+2m}\right)\omega_0 = \omega'$$

$$U = \omega'R = \left(\frac{M}{M+2m}\right)\omega_0 R$$

2. M.E. Conservation

$$mg(4) - \frac{k}{2}x^2 = \frac{1}{2}mv^2$$

$kx = 55$

$-mg + kx = ma$

$55-20 = 2a$

$a = 17.5\ m/sec^2$

3. $\mu = \left(\frac{qBR}{mg}\right)t = 0.4$

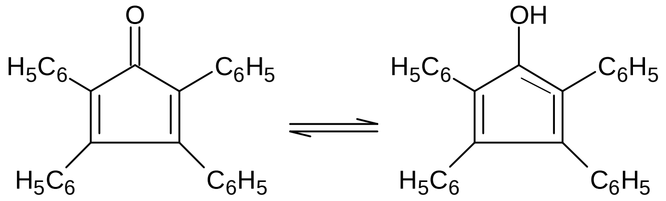
5. $t = \frac{dE\left[B^2\ell^2C + M\right]}{B\ell mg} = 1000\,sec = 1$

Chemistry

PART – II

SECTION – A

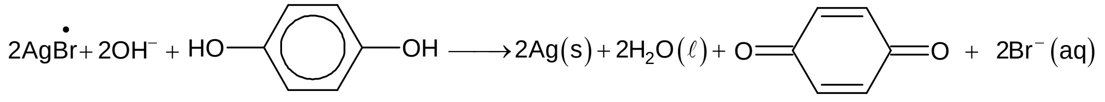
1. In (C), the tautomeric form will be



The tautomeric form, contains sp-hybridised carbon in ring, making it unstable.

∴ tautomerism is not shown by (C).

2.



Hydroquinol Hydroquinone

3. PV^{γ} = constant

$$P_1 \times \left(\frac{105V}{100}\right)^{\gamma} = \text{Constant}$$

$$\therefore \frac{P_1}{P} \times \left(\frac{105}{100}\right)^{\gamma} = 1$$

$$\text{or } \frac{P_1}{P} = \left[\frac{100}{105}\right]^{\frac{7}{5}}$$

(γ for N_2 or O_2 = 7/5)

$P_1 = 0.93P$,

∴ 7% decrease in pressure.

4. O^{2-} is replaced by $X^{-8/3}$, so formula of spinel is $MgAl_2X_3$ and deficiency by one anion.

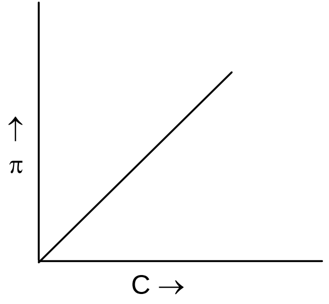
5.

$$\pi = \frac{W}{M} \times \frac{RT}{V}$$

$$\text{Slope} = \frac{RT}{M}$$

$$\Rightarrow M = \frac{0.082 \times 293}{4.65 \times 10^{-3} \times 10^{-3}}$$

$\Rightarrow 5.16 \times 10^{6}$ g



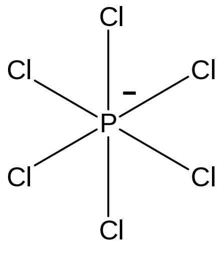
6.

$$PBr_5(s) \longrightarrow [PBr_4]^{+} + Br^{-}$$

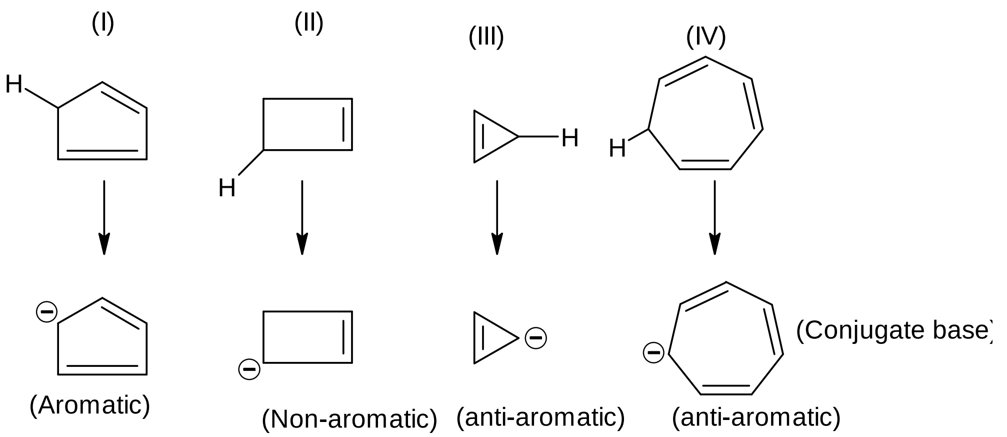
$$N_2O_5(s) \longrightarrow NO_2^{+} + NO_3^{-}\ (sp^2)$$

$$PCl_5(s) \longrightarrow PCl_4^{+} + PCl_6^{-}\ (sp^3d^2)$$

$$Cl_2O_6(s) \longrightarrow ClO_2^{+} + ClO_4^{-}\ (sp^3)$$



7.


(I)
(II)
(III)
(IV)
H
H
H
H
(Conjugate base)
(Aromatic)
(Non-aromatic)
(anti-aromatic)
(anti-aromatic)

(III) and (IV) both are anti-aromatic, but (IV) has more resonating structures than (III).
So, stability of conjugate bases: (I) > (II) > (IV) > (III)
And pk_a order is: (I) < (II) < (IV) < (III)

8. pH = 9.71, $\therefore \left[H^+\right] = 1.95 \times 10^{-10}$

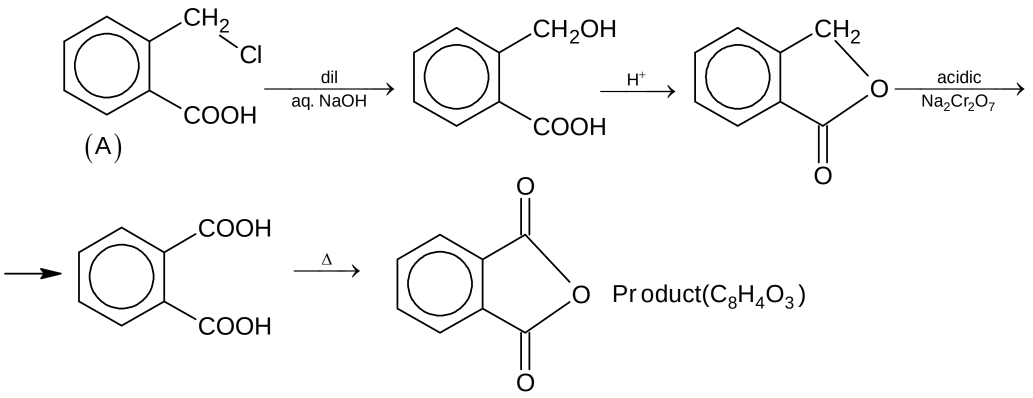
$$PrNH_2 + HCl \rightleftharpoons PrNH_3^+ + Cl^-$$

$$K_a = \frac{Pr\left[NH_2\right]\left[H^+\right]}{\left[PrNH_3^+\right]}$$

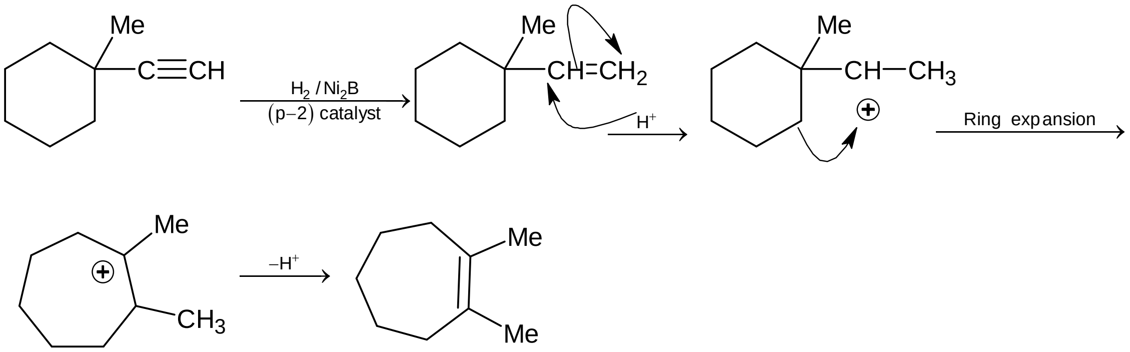
$$\frac{K_a}{\left[H^+\right]} = \frac{Pr\left[NH_2\right]}{\left[PrNH_3^+\right]}$$

$$\Rightarrow \frac{\left[PrNH_2\right]}{\left[PrNH_3^+\right]} = 0.1$$

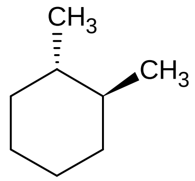
9.


CH2
Cl
COOH
(A)
dil
aq. NaOH
CH2OH
COOH
H+
CH2
O
O
acidic
Na2Cr2O7
COOH
COOH
Δ
O
O
O
Product(C8H4O3)

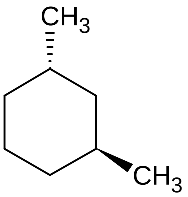
10.


Me
C≡CH
H2 / Ni2B
(p–2) catalyst
Me
CH=CH2
H+
Me
CH—CH3
Ring expansion
Me
CH3
–H+
Me
Me

11.



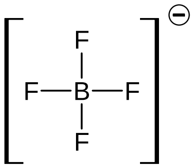
Trans - 1, 2 - dimethyl cyclohexane



Trans - 1, 3 - dimethyl cyclohexane

No plane of symmetry in both the above isomers, hence optically active.

12. $NO^{+}[BF_4]^{-}$



$$\left[\begin{array}{ccc} & F & \\ F- & B & -F \\ & F & \end{array}\right]^{\ominus}$$

No. of σ bonds in $[BF_4]^{-} = 4$

= B. O. of $NO^{+} = 3.0$, i.e. one sigma bond and two π bonds.

$\therefore$ It has 5 sigma and two ,π bonds.

$\Rightarrow$ NO^{+} is diamagnetic and BF_4^{-} is also diamagnetic

$\Rightarrow$ B—F bond energy is lower in BF_4^{-} than in BF_3, due to presence of back bonding in BF_3.

13. $$E_{2H^{+}/H_2} = E^{o}_{2H^{+}/H_2} - \frac{0.059}{2}\log_{10}\frac{p(H_2)}{[H^{+}]^{2}}$$

14. $\Delta H^{o} = \Delta H_f^{o}(\text{products}) - \Delta H_f^{o}(\text{reactants})$

$= -166 - (-51) = -115$ KJ mol^{-1}

$\Delta S^{o} = 266 - 243 = 23J = 0.023$ KJmol^{-1}K^{-1}

ΔH^{o} = –ve

ΔS^{o} = +ve

$\therefore \Delta G^{o} = \Delta H^{o} - T\Delta S^{o}$

ΔG^{o} will be –ve at all temperature and $\therefore$ the reaction is favour at temperature.

15. Formula of complex is : $[Co(SCN)_2(NH_3)_4]_3[Co(ox)_3]$

$\Rightarrow$ Linkage isomerism is due to presence of $SCN^{\ominus}$

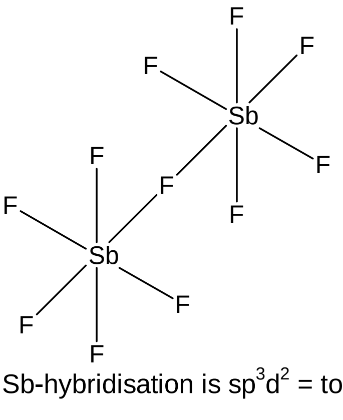
$\Rightarrow$ Optical isomerism is exhibited due to presence of $[Co(ox)_3]^{3-}$ which has asymmetric structure.

$\Rightarrow$ Geometrical isomerism is exhibited by $[Co(SCN)_2(NH_3)_4]^{+}$ part

SECTION – C

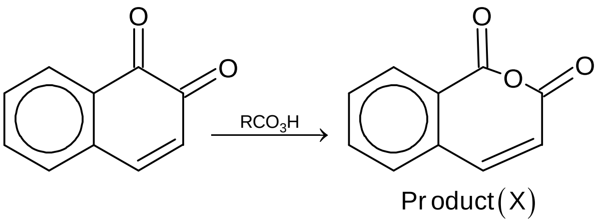
1. $$AgNO_3 + H_2S_2O_3 \longrightarrow \underset{(\text{Black ppt})}{Ag_2S}$$

2.



Sb-hybridisation is sp^3d^2 = total 6 hybrid orbitals per sb-atom.

3.



The number of sp^2 – carbon is X are 10, the sum 1 + 0 = 1

4. $nM_{(s)} + nX^- \longrightarrow M_nX_n + ne^-$ (L.H.S)

For, $M_nX_n + ne^- \longrightarrow nM + nX^-$ (R.H.S)

$\therefore \quad E = \frac{-0.059}{n}\log_{10}\frac{0.01}{0.1}$

$\therefore$ n = 2

5. $\frac{1}{2}A_2 + \frac{1}{2}B_2 \longrightarrow AB$

$\Delta H = \frac{1}{2}e_{A-A} + \frac{1}{2}e_{B-B} - e_{A-B}$

$-100 = \frac{x}{2} + \frac{0.5x}{2} - x$

$\therefore$ x = 400 KJmol^{-1}

x = 4 × 10^2 KJmol^{-1}

Mathematics PART – III

1. $\vec{u} = x\hat{i} + \sqrt{3}x\hat{j}$, |u| = 2x, x > 0

Now $|\bar{u}||\bar{u} - 2\hat{i}|^2 = |u - i|^2$

$2|x|\sqrt{(x-2)^2 + 3x^2} = \left((x-1)^2 + 3x^2\right)$

$\Rightarrow 4|x|\sqrt{x^2 - x + 1} = 4x^2 - 2x + 1$

Squaring, $16x^2(x^2 - x + 1) = 16x^4 + 4x^2 + 1 - 16x^3 - 4x + 8x^2$

$\Rightarrow 16x^2 = 12x^2 - 4x + 1$

$x = \dfrac{-4 \pm \sqrt{32}}{8} = \dfrac{-1 \pm \sqrt{2}}{2}$

$\Rightarrow x = \sqrt{2} - 1$

$\Rightarrow |\bar{u}| = \sqrt{2} - 1 = \sqrt{2} - \sqrt{1}$

$\Rightarrow$ a = 2, b = 1

2. $2000x^6 + 100x^5 + 10x^3 + x - 2 = 0$

$\Rightarrow 2000x^6 + \dfrac{x\left((10x^2)^3 - 1\right)}{10x^2 - 1} - 2 = 0$

$\Rightarrow \dfrac{x\left(1000x^6 - 1\right)}{10x^2 - 1} = -2\left(1000x^6 - 1\right)$

$\therefore 1000x^6 - 1 = 0$ or $\dfrac{x}{10x^2 - 1} = -2$

$\Rightarrow x = -(10x^2 - 1)$

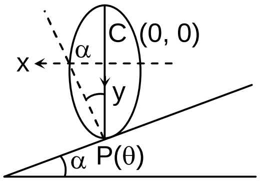
$\Rightarrow x^2 = \dfrac{1}{10}$ which is not possible

$\Rightarrow 20x^2 + x - 2 = 0$

$\Rightarrow x = \dfrac{-1 \pm \sqrt{161}}{40}$, m = –1, n = 161, r = 40

$\therefore$ (m + n + r) = 200

3. Let $P(a \cos \theta, b \sin \theta)$



Slope of $cp = \dfrac{b}{a}\tan\theta$

$\tan\alpha = \dfrac{a^2 - b^2}{2ab}\sin 2\theta$

$\Rightarrow \sin 2\theta = \dfrac{2ab}{a^2 - b^2}\tan\alpha$

Using $\sin 2\theta \le 1$ and $e^2 = 1 - \dfrac{b^2}{a^2}$

$\dfrac{2\frac{b}{a}}{1 - \frac{b^2}{a^2}}\tan\alpha \le 1 \Rightarrow \dfrac{2\sqrt{1 - e^2}}{e^2}\tan\alpha \le 1$

$\Rightarrow e^4 + 4e^2 \tan^2 \alpha - 4\tan^3 \alpha \ge 0$

$$e^2 \ge 2\tan\alpha(\sec\alpha - \tan\alpha) = \frac{2\sin\alpha}{1+\sin\alpha}$$

4. $T_k = \cos^{-1}\left(\frac{1}{k(k+1)} + \frac{\sqrt{(k-1)k(k+1)(k+2)}}{k(k+1)}\right)$

Let $x = \frac{1}{k}$, $y = \frac{1}{k+1}$

$\sqrt{1-y^2} = \sqrt{1-\frac{1}{(k+1)^2}} = \frac{\sqrt{(k+1)^2-1}}{k+1} = \frac{\sqrt{k(k+2)}}{k+1}$

$T_k = \cos^{-1}\left(\frac{1}{k+1}\right) - \cos^{-1}\frac{1}{k}$, substituting n = 2, 3, 4

$S = \lim\limits_{n\to\infty} \cos^{-1}\left(\frac{1}{n+1}\right) - \cos^{-1}\frac{1}{2} = \frac{\pi}{2} - \frac{\pi}{3} = \frac{\pi}{6}$

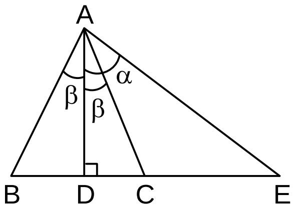
$S_n = \frac{\pi}{6} = \frac{120\pi}{k}$

$\Rightarrow$ k = 720

5. $\angle EAC = \alpha - \beta$

$\angle EAB = \alpha + \beta$

It is given that $\tan(\alpha - \beta)$, $\tan\alpha$ and $\tan(\alpha + \beta)$ form a G.P.



Thus $\tan^2\alpha = \tan(\alpha-\beta)\tan(\alpha+\beta) = \frac{\tan^2\alpha - \tan^2\beta}{1-\tan^2\alpha\tan^2\beta}$

$\tan\alpha = 1$, $\alpha = 45^\circ$, thus

AD = DE = $5\sqrt{2}$, so that area Δ(ABC) = $\frac{1}{2}BC\cdot AD = CD\cdot AD = 50\tan\beta$

Now, $\cot\alpha$, $\cot(\alpha-\beta)$, $\cot\beta$ form an A.P.

$2\cot(45^\circ - \beta) = 1 + \cot\beta \Rightarrow \cot\beta = 3$

$\Rightarrow \Delta(ABC) = \frac{50}{3}$

6. ABCD is a trapezium and its area = $\frac{1}{2}(a+b)h$

Where $\frac{a+b}{2} = EF$ (mid parallel)

Area = 2r(EF)

Now equation of EF is $y = -x + c$ ….. (1)

From equation (1) passes through (r, r)

$\Rightarrow c = 2r$

$x + y = 2r$, hence E = (2r, 0) and F(0, 2r)

$\therefore EF = \sqrt{4r^2 + 4r^2} = 2\sqrt{2}r$

$\therefore$ Area ABCD = $2r \cdot 2\sqrt{2}r = 4\sqrt{2}r^2$

$\therefore 4\sqrt{2}\,r^2 = 900\sqrt{2}$, $r^2 = 225 \Rightarrow r = 15$

7. $A^2 - 2A + 2I = 0$

Divide B by $A^2 - 2A + 21$

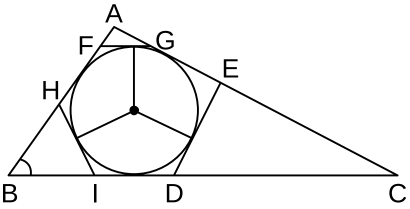
$\Rightarrow B = (A^2 - 2A + 21)(f(A)) + A - I$

$$\Rightarrow B = A - I = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$$

8. FG = p

DE = q

HI = r



In ΔAFG $\frac{P}{\sin A} = \frac{AG}{\sin B} = \frac{AF}{\sin C}$

$\Rightarrow AG = \frac{bp}{a}$, $AF = \frac{cp}{a}$

Now, incircle of ΔABC is the ex–circle opposite to A for ΔAFG the semi perimeter of ΔAFG is

$S_{\Delta AFG} = \frac{1}{2}\left(p + \frac{bp}{a} + \frac{cp}{a}\right) = \frac{Sp}{a}$

$\Rightarrow r = S_{\Delta AFG} \tan\frac{A}{2} = \frac{Sp}{a}\tan\frac{A}{2}$

Since r = (s – a) $\tan\frac{A}{2}$

$\Rightarrow s - a = \frac{sp}{a} \Rightarrow \frac{p}{a} = 1 - \frac{a}{s}$

Similarly $\frac{q}{b} = 1 - \frac{b}{s} \Rightarrow \frac{r}{c} = 1 - \frac{c}{s}$

9. Since the coefficient of $\hat{k}$ in both $\vec{A}$ and $\vec{B}$ are the same, the only way that $\vec{A}$ and $\vec{B}$ can be parallel is that $f(t) = -f''(t)$, $f'(t) = g(t)$

The first differential equation, $f''(t) = -f(t)$

$\Rightarrow f(t) = p \cos t + q \sin t$. $(p, q \in R) = \sqrt{p^2 + q^2}\sin(t + \phi)$, $\tan\phi = \frac{p}{q}$

$f_{max}(t) = M = \sqrt{p^2 + q^2}$

$|\vec{A}| = \sqrt{f^2(t) + g^2(t) + 1} = \sqrt{p^2 + q^2 + 1}$

$|\vec{A}|$ is constant

10. A upon simplification (a + b + c) (a – b) (b – c) (c – a)

The only way this can be 0 is (a + b + c) = 0

$\Rightarrow$ fixed point is (1, 1)

11. $\int_0^x t\, f(x - t)dt = \int_0^x f(t)dt + \sin x + \cos x - x - 1$

$\Rightarrow \int_0^x (x - t)f(t)dt = \int_0^x f(t)dt + \sin x + \cos x - x - 1$

$\Rightarrow \int_0^x f(t)dt - \int_0^x t\, f(t)dt = \int_0^x f(t)dt + \sin x + \cos x - x - 1$

Again differentiating

$x f(x) + f(x) + f(x) - xf'(x) - f(x) > f'(x) - \sin x - \cos x$

$f(x) = f'(x) - \sin x - \cos x$

Solving this linear differential equation

We get, $f(x)\, e^{-x} = e^{-x} \cos x + c$

If x = 0, f(0) = 0 $\Rightarrow f(x) = e^x - \cos x$

12. Let w be the event that the ball drawn is white

Then P(w) = $\frac{x}{y}$

When, ball is lost P(w) = $\frac{x}{y}\frac{x-1}{y-1}+\frac{y-x}{y}\frac{x}{y-1}=\frac{x}{y}$

When 2 balls is lost P(w) = $\frac{{}^{x}C_2}{{}^{y}C_2}\frac{x-2}{y-2}+\frac{{}^{x}C_1\ {}^{y-x}C_1}{{}^{y}C_2}\frac{x-1}{y-2}+\frac{y-\ {}^{x}C_2}{{}^{y}C_2}\frac{x}{y-2}=\frac{x}{y}$

Similarly for n = 3, P(w) = $\frac{x}{y}$

13. $|w|=\frac{|v||u-z|}{|\bar{u}z-1|}=\frac{|u-z|}{|\bar{u}z-1|}$

Let, $|w| \le 1$

$\Rightarrow |u-z| \le |\bar{u}z-1|$

$\Rightarrow (u-z)(\bar{u}-\bar{z}) \le (u\bar{z}-1)(\bar{u}z-1)$

$\Rightarrow (|u|^2-1)(|z|^2-1) \ge 1$

$\Rightarrow |z|^2-1 \le 0$

14. $f(0^-) = 0,\ f(0^+) = 1,\ f(0) = 1$

$\Rightarrow$ discontinuous at x = 0

$f(1^-) = 1,\ f(1) = 1,\ f(1^+) = 0$

$\Rightarrow$ discontinuous at x = 1

15. Squaring and adding

$\Rightarrow \sin(x+y) = 1$

$\Rightarrow x + y = (4n+1)\frac{\pi}{2},\ n \in I$

$\Rightarrow x + y = \frac{\pi}{2},\ y=\frac{\pi}{2}-x$

$\Rightarrow 5\sin x = 3$

$\Rightarrow \cos x = \frac{4}{5}$

Also, $\cos y = \frac{3}{5}$ and $\sin y = \frac{4}{5}$

Hence, y > x

SECTION – C

1. $f(x)=\frac{1}{\sqrt{n^2}}+\frac{1}{\sqrt{n^2+2}}+.....+\frac{1}{\sqrt{n^2+2n+1}}$

Terms of the sequence are decreasing and number of terms are (2n + 2)

$$\frac{2n+2}{\sqrt{n^2+2n+1}} \le f(x) \le \frac{2n+2}{\sqrt{n^2}}$$

Now $\lim\limits_{n\to\infty}\frac{2(n+1)}{\sqrt{n^2+2n+1}} = \lim\limits_{n\to\infty}\frac{2n\left(1+\frac{1}{n}\right)}{n\sqrt{1+\frac{2}{n}+\frac{1}{n^2}}}$

Similarly $\lim_{n\to\infty}\frac{2(n+1)}{\sqrt{n^2}} = \lim_{n\to\infty}\frac{2(n+1)}{n}=2$

2. $I_1 = \int_0^{\pi/2}(\sin x + r\cos x)^3\,dx = \int_0^{\pi/2}\sin^3 x + r^3\cos^3 x + 3r\sin^2 x\cos x + 3r^2\sin x\cos^2 x\,dx$

$= \frac{2}{3}+\frac{2r^3}{3}+r^2+r$

$I_2 = \int_0^{\pi/2} x\cos x dx = (x\sin x+\cos x)_0^{\pi/2} = \frac{\pi-2}{2}$

$I = I_1 + \frac{4r}{\pi-2}I_2 = 2$

$\Rightarrow 2r^3 + 3r^2 - 3r + 2 = 6$

$\Rightarrow 2r^3 + 3r^2 - 3r - 4 = 0$

$\sum r_1 = -\frac{3}{2}$, $\sum r_1r_2 = -\frac{3}{2}$, $\sum r_1^2 = \frac{21}{4}$

3. A → event that die A was used in first two throws
B → event that die B was used in first two throws
C → event that next throws gives red face
E → event that first two throws give red faces

$P\left(\frac{A}{E}\right) = \frac{\frac{1}{2}\times\left(\frac{4}{6}\right)^2}{\frac{1}{2}\times\left(\frac{4}{6}\right)^2+\frac{1}{2}\times\left(\frac{2}{6}\right)^2} = \frac{4}{5}$

$P\left(\frac{B}{E}\right) = \frac{1}{5} \Rightarrow P\left(\frac{C}{E}\right) = \frac{3}{5}$

a = 3, b = 5

4. $f(x) = 2f\left(\frac{x^2}{2}\right) + f(6-x^2)$

$\Rightarrow f'(x) = 2f'\left(\frac{x^2}{2}\right)x - 2xf'(6-x^2)$

$\Rightarrow f'(x) = 2x\left(f'\left(\frac{x^2}{2}\right) - f'(6-x^2)\right)$

$f'\left(\frac{x^2}{2}\right) > f'(6-x)^2$ (if $\frac{x^2}{2} > 6-x^2$)

∵ f′(x) is increasing

$\frac{x^2}{2} > 6-x^2 \Rightarrow x^2 > 4$

$\Rightarrow f'\left(\frac{x^2}{2}\right) - f'(6-x^2) > 0$ when x < –2 or x > 2

$\Rightarrow f'(x) > 0$, when $x \in (-2, 0) \cup (2, \infty)$

$\Rightarrow a + b + c = 0$

5. $R = 1 + \sin\theta,\ \theta = \frac{\pi}{8}$

$\Rightarrow c_1c_2 = R + r$

$\therefore\ \sin\theta = \frac{R-r}{R+r}$

$R\sin\theta + r\sin\theta = R - r$

$R(1 - \sin\theta) = r(1 + \sin\theta)$ (Put $R = 1 + \sin\theta$)

$\Rightarrow (1 + \sin\theta)(1 - \sin\theta) = r(1 + \sin\theta)$

$\Rightarrow r = 1 - \sin\theta$

$\Rightarrow Rr = 1 - \sin^2\theta = \cos^2\theta$

$\Rightarrow \cos 2\theta = \frac{1}{2}(1+\cos\theta) = \frac{1}{2}\left(1+\cos\frac{\pi}{4}\right) = \frac{2+\sqrt{2}}{4}$

$\Rightarrow a = 2,\ b = 4$

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

FIITJEE **JEE (Advanced), 2014**

CONCEPT RECAPITULATION TEST - II

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 198**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 to 14) contains 3 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (15 to 20) contains 6 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10$ m/s^2
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N-m^2
Density of water	$\rho_{water} = 10^3$ kg/m^3
Atmospheric pressure	$P_a = 10^5$ N/m^2
Gas constant	$R = 8.314$ J K^{-1} mol^{-1}

CHEMISTRY

Gas Constant	R	=	8.314 J K^{-1} mol^{-1}
		=	0.0821 Lit atm K^{-1} mol^{-1}
		=	1.987 ≈ 2 Cal K^{-1} mol^{-1}
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

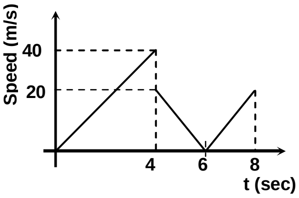
SECTION – A

Single Correct Choice Type

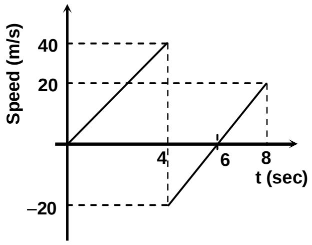
This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. A ball is dropped from a height of 80 m on a floor. At each collision, the ball losses half of its speed. Then the graph of speed versus time is

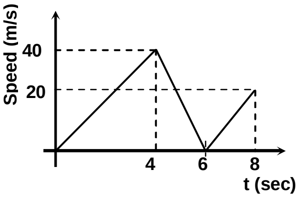
(A)



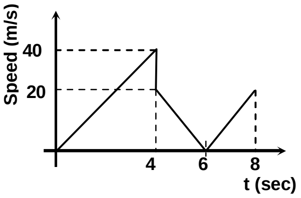
(B)



(C)



(D)

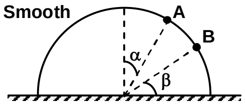


2. A projectile is required to hit a target whose co-ordinates relative to horizontal and vertical axes through the point of projection are (α, β). If the gun velocity is $\sqrt{2g\alpha}$. Then the condition when it is impossible to hit the target.

(A) $3\alpha > 4\beta$ (B) $4\beta > 3\alpha$
(C) $3\beta > 4\alpha$ (D) $4\alpha > 3\beta$

Space for Rough work

3. A particle moves from rest at A on the surface of a smooth circular cylinder of radius r as shown. At B its leaves the cylinder. Then the equation relating α and β is

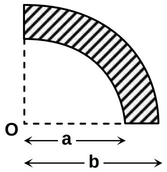


(A) $3\sin\alpha = 2\cos\beta$ (B) $2\sin\alpha = 3\cos\beta$
(C) $3\sin\beta = 2\cos\alpha$ (D) $2\sin\beta = 3\cos\alpha$

4. The gravitational field in a region is given by E = $\left(2\hat{i}+3\hat{j}\right)$ N/kg. The equation of the line on which no work is done by the gravitational when the particle is moved

(A) $2y + 3x = 5$ (B) $5y + 2x = 3$
(C) $3y + 2x = 5$ (D) $3y + 5x = 2$

5. The distance of centre of mass from O of a uniform plate having quarter circular inner and outer boundaries of radii a and b from centre O.

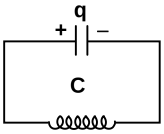


(A) $\frac{4}{3\pi}\left(\frac{b^3-a^3}{b^2-a^2}\right)$ (B) $\frac{4\sqrt{2}}{3\pi}\left(\frac{b^3+a^3}{b^2-a^2}\right)$
(C) $\frac{4}{\pi}\left(\frac{b^3+a^3}{b^2+a^2}\right)$ (D) $\frac{4\sqrt{2}}{3\pi}\left(\frac{b^3-a^3}{b^2-a^2}\right)$

6. Two concentric conducting spheres of radii R and 3R carrying charges Q and 2Q respectively. If the charge on inner sphere is doubled. The potential difference between inner and outer spheres will

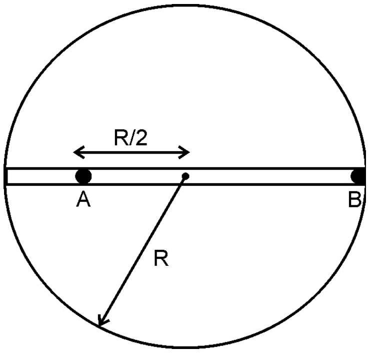
(A) becomes two times (B) becomes four times
(C) be halved (D) remains same

7. In an L-C circuit shown in the figure, C = 1F, L = 4H. At time t = 0, charge in the capacitor is 4C and it is decreasing at a rate of $\sqrt{5}$ C/s. Choose the correct statements.



(A) maximum charge in the capacitor can be 6C
(B) maximum charge in the capacitor can be 8C
(C) charge in the capacitor will be maximum after time $2\sin^{-1}(2/3)$ sec
(D) None of these

Space for Rough work



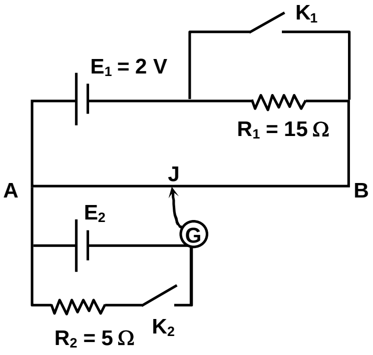
8. A massive planet of radius R has a diametrical hole as shown in figure, such that hole does not effect the spherecity of the planet. The planet has uniform density. Two equal mass A and B [m << M] are simultaneously released, from positions shown. If the collisions are elastic then the total distance traveled by mass A after being released at the time of 6th collision is : [M→mass of planet, m→ mass of A and B neglect the gravitational interaction between mass A and mass B.]
(A) 8.5 R (B) 5R
(C) 6.5 R (D) 9.5 R

Comprehension Type

This section contains 3 groups of questions. Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Questions 9 and 10

In the circuit shown AB is a 10 Ω uniform slide wire 50 cm long. E_1 is 2 V accumulator of negligible internal resistance R_1 and R_2 are 15 Ω and 5 Ω respectively. When k_1 and k_2 are both open, the galvanometer shows no deflection when AJ = 31.25. When k_1 and k_2 are both closed the balance length AJ = 5 cm

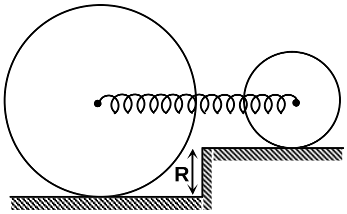


9. The emf of the cell E_2
(A) 0.5 V (B) 1 V
(C) 1.5 V (D) 2 V

10. The internal resistance of the cell E_2
(A) 7.5 Ω (B) 8 Ω
(C) 10 Ω (D) 2 Ω

Space for Rough work

Paragraph for Question Nos. 11 to 12



Two uniform circular disc of masses M and 4M and radii R and 2R respectively are connected by a massless spring of force constant k and placed in a vertical plane on consecutive steps of a stair as shown. Initially spring is compressed and system is released from rest. Assume that friction is enough to prevent slipping.

11. When spring is compressed by x, what is the friction force from stair on the mass 4M

(A) Kx/2 left	(B) kx/2 right,
(C) kx/3 left,	(D) kx/3 right

12. What is the angular frequency of oscillation of the system

(A) $\sqrt{\frac{5k}{6M}}$	(B) $\sqrt{\frac{5k}{4M}}$
(C) $\sqrt{\frac{k}{5M}}$	(D) none of these

Paragraph for Question Nos. 13 to 14

A ring of radius R is made of a thin wire of material of density ρ, having cross–section area a and Young's Modulus y. The ring rotates about an axis perpendicular to its plane and through its centre. Angular frequency of rotation is ω.

13. The tension in the ring will be

(A) $\frac{a\rho R^2\omega^2}{2}$	(B) $a\rho R^2\omega^2$
(C) $2a\rho R^2\omega^2$	(D) $\frac{a\rho R^2\omega^2}{4}$.

14. The ratio of kinetic energy to potential energy is

(A) $\frac{y}{\rho R^2\omega^2}$	(B) $\frac{2y}{\rho R^2\omega^2}$
(C) $\frac{y}{2\rho R^2\omega^2}$	(D) $\frac{y}{4\rho R^2\omega^2}$.

Space for Rough work

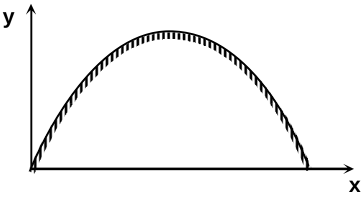
Multiple Correct Answer(s) Type

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

15. A reflecting surface is represented by the equation

$$y = \frac{2L}{\pi}\sin\left(\frac{\pi x}{L}\right),\ 0 \le x \le L$$

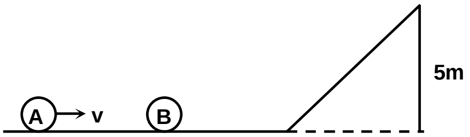
A ray travelling horizontally becomes vertical after reflection. The co-ordinate of the points where this ray is incident is



(A) $\left(\frac{L}{4}, \frac{\sqrt{2}L}{\pi}\right)$ (B) $\left(\frac{L}{3}, \frac{\sqrt{3}L}{\pi}\right)$

(C) $\left(\frac{3L}{4}, \frac{\sqrt{2}L}{\pi}\right)$ (D) $\left(\frac{2L}{3}, \frac{\sqrt{3}L}{\pi}\right)$

16. Two balls A and B of masses m and 2m respectively are lying on a smooth surface as shown in the figure. Ball A hits the ball B (which is at rest) with a velocity v = 16 m/s. Such that B just reaches the highest point of inclined plane. (g = 10 m/s^2)

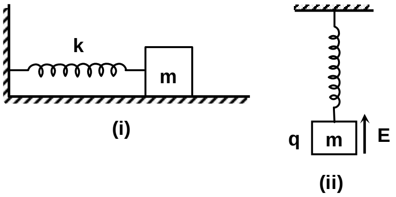


(A) e = 3/4 (B) e = 7/8

(C) $v_A = -4$ m/s (D) $v_A = 8$ m/s

where e is the coefficient of restitution and v_A is velocity of the ball A after collision.

17. A particle of mass m is executing SHM as shown in diagram (1) and (2). In diagram (2) particle contains charge q such that Eq = mg. If their velocities are same at mean position and let A_1 and A_2 be their amplitudes and T_1 and T_2 be their time periods respectively then



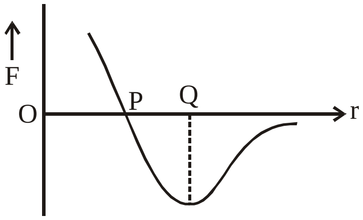
(A) $A_1 = A_2$ (B) $A_1 < A_2$

(C) $T_1 = T_2$ (D) $T_1 > T_2$

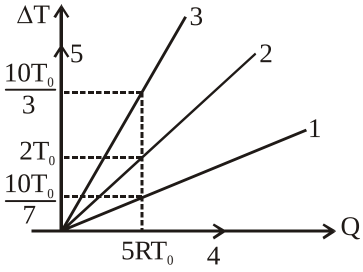
Space for Rough work

18. Two objects of mass m and 4 m are at rest at an infinite separation. They move towards each other under mutual attraction. If G is the universal gravitational constant. Then at separation r.
(A) The sum of energy of the two objects is negative.
(B) Their relative velocity of approach is $\left(\frac{10Gm}{r}\right)^{1/2}$ in magnitude
(C) The sum of kinetic energy of the objects is $\frac{4Gm^2}{r}$.
(D) The sum of angular momenta of both the objects is zero about any point.

19. Figure shows roughly how the force F between two adjacent atoms in a solid varies with separation 'r'
(A) OQ is equilibrium separation
(B) Hooke's law is obeyed around P
(C) The potential energy of the atom is the gradient of the graph at all points
(D) The energy to separate the atoms completely is obtained from the area enclosed below the axis or r.



20. Figure (Five straight lines numbered 1, 2, 3, 4 and 5) shows graph of change in temperature ΔT versus heat supplied Q for different processes performed on a gas of one mole.
(A) line 4 and 5 (coinciding with Q and ΔT axis respectively) represent isothermal and adiabatic processes respectively
(B) line 2 represents isochoric process for diatomic gas
(C) line 1 and 3 represent isobaric process for a diatomic gas and isochoric process for a monoatomic gas respectively
(D) line 2 represents isobaric process for a monoatomic gas.



Space for Rough work

Chemistry

PART – II

SECTION – A

Straight Objective Type

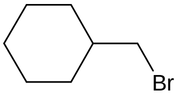
This section contains 8 multiple choice questions numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

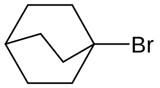
1. Which among the following is the strongest oxidizing agent?

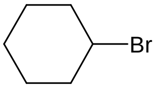
(A) IO_4^- (B) XeO_6^{4-}

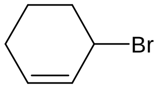
(C) PO_4^{3-} (D) SO_4^{2-}

2. The compound which undergoes S_N1 reaction most rapidly is:

(A)


(B)


(C)


(D)


3. At 20°C, the osmotic pressure of a solution of 100 ml of which contains 6.33 g of the colouring substance of the blood haematin is 243.4 kP_a. What is the molecular formula of the haematin; if the elementary composition of haematin is C = 64.4%, H = 5.2%, N = 3.8%, O = 12.6% and Fe 8.8%?

(A) $C_{34}H_{33}N_4O_5Fe$ (B) $C_{33}H_{32}N_4O_5Fe$

(C) $C_{34}H_{30}N_3O_5Fe$ (D) $C_{32}H_{28}N_4O_5Fe$

4. Calculate E^o for the reactions:

$ZnY^{2-} + 2e^- \rightleftharpoons Zn(s) + Y^{4-}$, where Y^{4-} is the completely deprotonated anion of EDTA, the formation constant for ZnY^{2-} is 3.2×10^{16} and E^o for $Zn \longrightarrow Zn^{2+} + 2e^-$ is 0.76V.

(A) - 1.25 V (B) 0.48 V

(C) + 0. 68 V (D) - 0.27 V

5. The freezing point of 0.20 M solution of weak acid HA is 272.5 K. The molality of the solution is 0.263 mol kg^{-1}. Find the pH of the solution on adding 0.25 M sodium acetate solution:

(K_f of water = 1.86 K $kgmol^{-1}$).

(A) 5.4 (B) 3.2

(C) 6.1 (D) 4.11

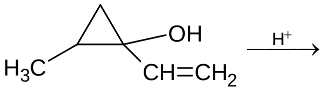
6. Aqueous solution of a (Y) salt is alkaline to litmus. On strong heating, it smells up to give a glassy material. When conc. H_2SO_4 is added to hot concentrated solution of (Y), white crystal of a weak acid separates out. Hence, the compound (Y) is:

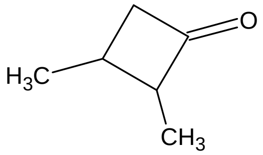
(A) $Na_2SO_4.10H_2O$ (B) $Ca_2P_6O_{11}.10H_2O$

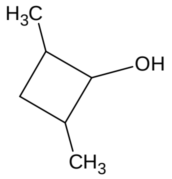
(C) $Na_2B_6O_{11}$ (D) $Na_2B_4O_7.10H_2O$

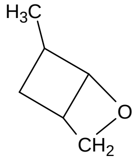
Rough Work

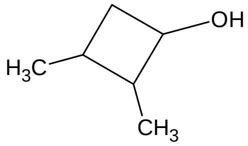
7. The major product of the following reaction is:

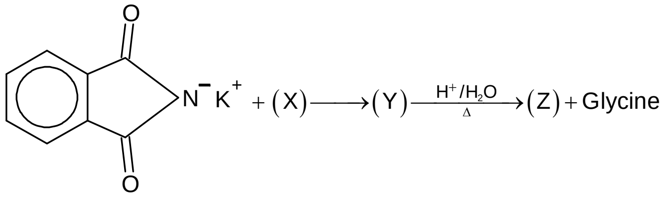

OH
H3C
CH=CH2
H+

(A)


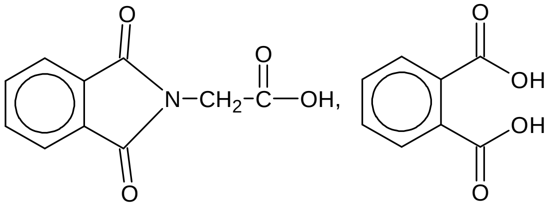
(B)


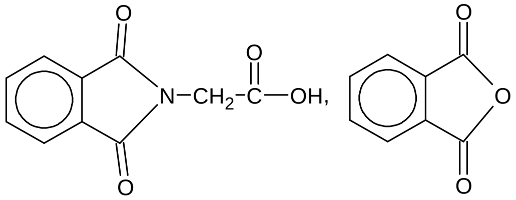
(C)


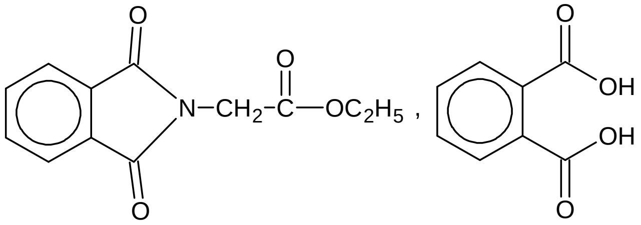
(D)


8.

O
N⁻ K⁺
O
+ (X) ⟶ (Y)
H+/H2O
Δ
(Z) + Glycine

Compound X, Y, Z are:

(A) Chloroacetic acid,

O
O
N−CH2−C—OH,
O
O
OH
OH
O

(B) Bromo acetic acid,

O
O
N−CH2−C—OH,
O
O
O
O

(C) Ethyl chloro acetic acid,

O
O
N−CH2−C—OC2H5 ,
O
O
OH
OH
O

(D) None of the above

Rough Work

Comprehension Type

This section contains 3 groups of questions. Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 9 to 10

Elements (A) burns in nitrogen atmosphere to give an ionic compound (B). Compound (B) gets hydrolysed by water giving (C) and (D). A solution of (C) becomes milky on passing carbon dioxide through it. Element (A) reacts quite readily with cold water liberating hydrogen gas and forming metal hydroxide.

9. Select the correct statement with respect to (D).
   (A) It is trigonal pyramidal in shape.
   (B) It can be obtained by the hydrolysis of calcium cyanamide, $CaCN_2$.
   (C) It gives precipitate with $HgCl_2$.
   (D) All of these

10. The compound (C) is:
   (A) $Mg(OH)_2$ (B) $Ba(OH)_2$
   (C) $Ca(OH)_2$ (D) Both (B) and (C)

Paragraph for Question Nos. 11 to 12

1 g of a weak monobasic acid (MW = 100) when dissolved in 100 g of liquid A (MW = 100) increases the boiling point from 80^o C to 81^o C at 760 mm of Hg. The vapour pressure of liquid A, at 90^o C is 850 mm of Hg. Degree of dissociation of the monobasic acid is 0.189 at 90^o C. Enthalpy of neutralization of a strong acid with strong base = - 57.3 kJ/equivalent.

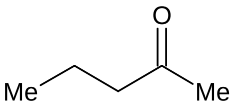
11. ΔH_v for the liquid A is (assuming it remain constant within the temperature range considered)
   (A) 11.99 kJ mol^{-1} (B) - 11.99 kJ mol^{-1}
   (C) 119.9 kJ mol^{-1} (D) - 119.9 kJ mol^{-1}

12. Degree of dissociation of the monobasic acid at 80^oC will be:
   (A) 0.2 (B) 0.158
   (C) 0.1158 (D) 0.52

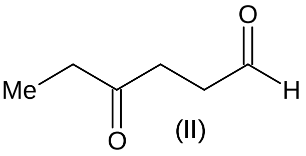
Rough Work

Paragraph for Question Nos. 13 to 14

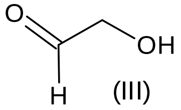
Compound (A) $C_{13}H_{24}O$ is a pheromone of codling moth. On hydrogenation, compound (A) absorbs two molar equivalents of H_2 and is converted to 3-ethyl-7-methyl decan-1-ol. On reductive ozonolysis, it gives the following compounds:



(I)



(II)



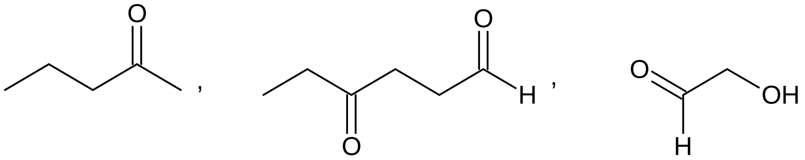
(III)

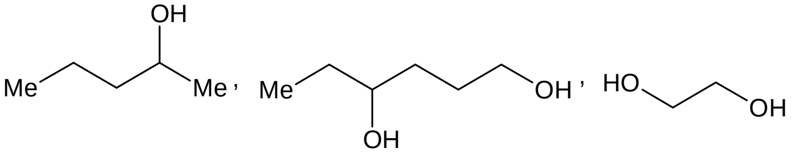
13. The number of stereoisomers of (A) is:

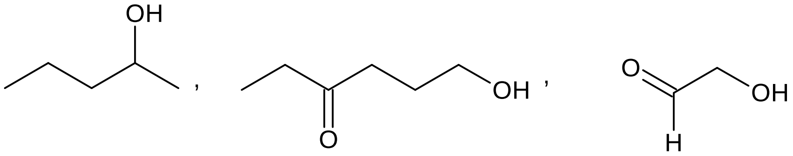
(A) 2 (B) 4

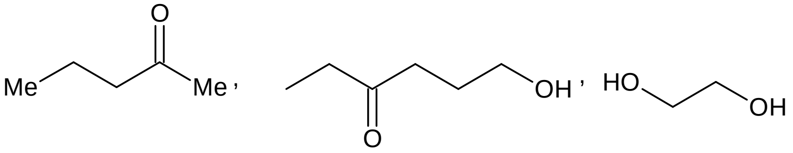
(C) 6 (D) 8

14. The products of (A) on ozonolysis followed by reduction with LAH are:

(A)


(B)

OH
Me
Me,
Me
OH,
OH
HO
OH

(C)


(D)

O
Me
Me,
OH,
O
HO
OH

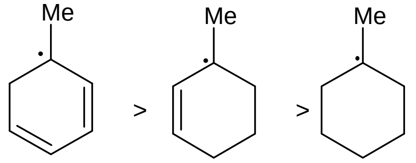
Rough Work

Multiple Correct Choice Type

This section contains 6 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

15. Which statements are correct about Lactose?
    (A) (C_1 - OH) of β-glucose is linked with (C_4) of galactose.
    (B) (C_1 – OH) of β-galactose is linked with (C_4) of β-glucose.
    (C) It exhibits mutarotation.
    (D) It is a reducing sugar.

16. Which of the following are correct?
    (A) Dipole moment of $NH_3 > NF_3$
    (B) Stability of free radical:



(I) (II) (III)

    (C) Basic strength : $CH_3O^- > OH^- > RS^-$
    (D) Basic strength : $I^- > Br^- > Cl^- > F^-$

17. A solution of colourless salt (X) on boiling with excess NaOH produces a non-flammable gas. The gas evolution ceases after sometime. Upon addition of Zn dust to the same solution, the gas evolution restarts. The colourless salt (s) X is (are):
    (A) NH_4NO_3
    (B) NH_4NO_2
    (C) NH_4Cl
    (D) $(NH_4)_2SO_4$

18. If the rms velocity of nitrogen and oxygen molecule are same at two different temeperature and same pressure; then:
    (A) Average speed of molecules is also same
    (B) Density (gm/l) of nitrogen and oxygen is also equal
    (C) Number of moles of each gas is also equal
    (D) Most probable velocity of molecules is also equal

19. Which of the following statement(s) is/are true?
    (A) In metal carbonyl complexes, d_{C-O} increases compared to that in CO molecule
    (B) The pair of compounds $[Cr(H_2O)_6]Cl_3$ and $[CrCl_3(H_2O)_3].3H_2O$ show hydrate isomerism
    (C) d_{z^2} orbital of central metal atom/ion is used in dsp^2 hybridization
    (D) Facial and meridional isomers associated with $[Ma_3b_3]^{n\pm}$ type complex compound, both are optically inactive

20. A 0.1 M sodium acetate solution was prepared having $K_h = 5.6 \times 10^{-10}$.
    (A) The degree of hydrolysis is 7.48×10^{-5}
    (B) The OH^- concentration is 7.48×10^{-3} M
    (C) The OH^- concentration is 7.48×10^{-6} M
    (D) The pH is approximately is 8.88

Rough Work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. If $6x^5 + 5x^3 + x^2 + 4x - 1 = a(x-1)^5 + b(x-1)^4 + c(x-1)^3 + d(x-1)^2 + e(x-1) + f$ then what is the value of a + 2b + 3c + 4d + 5e + 5f?

   (A) 780 (B) 820

   (C) 870 (D) 910

2. If $f(x) = \prod_{n=1}^{50} (x-n)^{n(51-n)}$; then $\frac{f(51)}{f'(51)}$

   (A) 4040 (B) $\frac{1}{1275}$

   (C) $\frac{1}{4040}$ (D) 1275

3. In a triangle ABC, area of triangle (Δ) and A are fixed. The angles B and C and length of sides a, b, c are variable quantities. If length of the side 'a' is minimum then

   (A) $c = \frac{\sqrt{2\Delta}}{\sin A}$ (B) $b = \sqrt{\frac{2\Delta}{\sin A}}$

   (C) $a = \frac{\sqrt{2\Delta}}{\sin A}$ (D) triangle is equilateral

4. If f(x) is differentiable function with f′(0) = 1 and
   cos 2x sin 2y(f(3x + 3y) + f(3x – 3y)) = sin 2x cos 2y(f(3x + 3y) – f(3x – 3y)) for all x, b ∈ R, then the equation of tangent to y = f(x) at $x = \frac{\pi}{2}$ is

   (A) $2x + 4y = 3\sqrt{3} - \pi$ (B) $2x - 4y = \pi - 3\sqrt{3}$

   (C) $2x - y = 3\sqrt{3} - \pi$ (D) none of these

Space for rough work

5. Let $a_1, a_2, \ldots\ldots a_n$ be the terms of a G.P. whose common ratio is r. Set S_k denotes the sum of first k terms of the G.P. then the value of $\sum\limits_{1\le i<j\le m} a_i a_j$ in terms of S_{m-1} and S_m is

(A) $r\, S_{m-1}\, S_m$ (B) $\frac{r}{1+r} S_{m-1} S_m$

(C) $\frac{S_{m-1} S_m}{1+r}$ (D) $S_{m-1}\, S_m$

6. $\lim\limits_{x\to 0} \frac{\sqrt[3]{1+3x}-1-x}{(1+x)^{101}-1-101x}$ has the value equal to

(A) $-\frac{3}{5050}$ (B) $-\frac{1}{5050}$

(C) $\frac{1}{5050}$ (D) $\frac{1}{4950}$

7. Let f(x) is a quadratic function such that f(0) = 1 and $\int \frac{f(x)dx}{x^2(x+1)^3}$ is a rational function. Then the value of $f'(0)$ is

(A) 2 (B) 3

(C) 4 (D) 5

8. Curves $ax^2 + 2hxy + by^2 - 2gx - 2fy + c = 0$ and $a'x^2 - 2hxy + (a' + a - b)y^2 - 2g'x - 2f'y + c = 0$ intersect at four concyclic points A, B, C and D. If P is the point $\left(\frac{g'+g}{a'+a}, \frac{f'+f}{a'+a}\right)$, the value of $\frac{PA^2+PB^2+PC^2}{PD^2}$ is

(A) 1 (B) 2

(C) 3 (D) 4

Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 9 to 10

Read the following write up carefully and answer the following questions:
While finding the sine of a contain angle x, an absent minded professor failed to notice that his calculator was not in the correct angular mode. However he was lucky to get right answer. The two least positive value of x for which the sine of x degree is the same as the sine of x radian found by him as $\frac{m\pi}{n-\pi}$ and $\frac{p\pi}{q+\pi}$, where m, n, p and q are positive integers. Suppose $\frac{mn}{pq}$ be denoted by quantity 'L'

9. The value of (m + n + p + q) is equal to

(A) 720 (B) 900
(C) 1080 (D) 1260

10. If x is measured in radians and $\lim_{x\to\infty}\left(\sqrt{Ax^2+Bx}-Cx\right)=2$, the value of $\frac{BC}{A}$ equals (A, B, C $\in$ R)

(A) 4 (B) 2
(C) $\frac{1}{2}$ (D) $\frac{1}{4}$

Paragraph for Question Nos. 11 to 12

Read the following write up carefully and answer the following questions:
Square ABCD has vertices A(1, 4), B(5, 4), C(5, 8) and D(1, 8) from a point P outside the square, a vertex of square is said to be visible if it can be connected to P by a straight line that does not pass through square. Thus from any point P, outside either two or three of the vertices of the square are visible. The visible area of P is the area of one triangle or the sum of the area of the two triangle formed by joining P to the two or three visible vertices of the square

11. Visible area of the point P with coordinate (2, –6) in square unit is

(A) 10 (B) 20
(C) –30 (D) 40

12. Visible area of the point Q(11, 0) in square unit is

(A) 20 (B) 30
(C) 40 (D) 50

Space for rough work

Paragraph for Question Nos. 13 to 14

Read the following write up carefully and answer the following questions:

Let $f(x)=\begin{cases} e^{\{x^2\}}-1 & x>0 \\ \dfrac{\sin x-\tan x+\cos x-1}{2x^2-\ln(2+x)+\tan x} & x<0 \\ 0 & x=0 \end{cases}$ (where {} represents fractional part function). Lines L_1 and L_2 represent tangent and normal to curve y = f(x) at x = 0. Consider the family of circles touching both the lines L_1 and L_2

13. Ratio of radii of two circles belonging to this family cutting each other orthogonally is

(A) $2+\sqrt{3}$ (B) $\sqrt{3}$

(C) $2+\sqrt{2}$ (D) $2-\sqrt{2}$

14. A circle having radius unity is inscribed in the triangle formed by L_1 and L_2 and a tangent to it. Then the minimum area of the triangle is

(A) $3+\sqrt{2}$ (B) $3-\sqrt{2}$

(C) $3+2\sqrt{2}$ (D) $3-2\sqrt{2}$

Multiple Correct Choice Type

This section contains **6 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

15. Consider the points $A(\vec{o})$, $B\left(3\hat{i}+f(t)\hat{j}+\hat{k}\right)$ and $C\left(2\hat{i}+f'(t)\hat{j}+2\hat{k}\right)$ and another point D are coplanar for all t ∈ R

(A) if D is $(\hat{i})$ then f(x) = ce^{2x}, c ∈ R (B) if D is $(\hat{i})$ then f(x) = c ln(2x), c ∈ R

(C) if D is $(\hat{i}+\hat{j})$ then f(x) = 2 + ce^{2x}, x ∈ R (D) if D is $(\hat{i}+\hat{j})$ then f(x) = 2 + c ln(2x), c ∈ R

16. Let $u_n=\int_0^{\pi/2}\cos^n x\cos nx\,dx$ it turns out that u_1, u_2, u_3, ... form a G.P. then

(A) the common ratio of G.P. is $\frac{1}{2}$ (B) the common ratio of G.P. is $\frac{1}{4}$

(C) then $u_n=\frac{\pi}{2^{2n}}$ (D) then $u_n=\frac{\pi}{2^{n+1}}$

Space for rough work

17. Consider the following three planes
$P_1 : x = y \sin\alpha + z \sin\beta$
$P_2 : y = z \sin\theta + x \sin\alpha$
$P_3 : z = x \sin\beta + y \sin\theta$
If P_1, P_2, P_3 intersect in the line $\frac{x}{\cos\theta} = \frac{y}{\cos\beta} = \frac{z}{\cos\alpha}$ then the value of $\alpha + \beta + \theta$ is equal to
(A) $\frac{\pi}{2}$
(B) $\frac{5\pi}{2}$
(C) $-\frac{3\pi}{2}$
(D) $\frac{7\pi}{2}$

18. Five points are selected on a circle of radius r, consider the centres of the five rectangular hyperbola each passing through four of these five points, then
(A) these centres lie on another hyperbola
(B) these centres lie on a circle of radius $\frac{r}{2}$
(C) these centres lie on a circle of radius 2r
(D) mean of these four points is mid–point of centres of circle and rectangular hyperbola

19. Which of the following condition must be satisfied so that two of the lines represented by the equation $ay^4 + by^3x + cy^2x^2 + dyx^3 + ax^4 = 0$ will bisect the angle between the other two?
(A) b + d = 0
(B) bd = 1
(C) c + 4a = 0
(D) c + 6a = 0

20. Let $P_k(k = 1, 2, \ldots\ldots n)$ be the nth root of unity. Let z = a + ib and $A_k = \text{Re}(z)\,\text{Re}(P_k) + i\{\text{Im}(z)\,\text{Im}(P_k)\}$ then which of the following is true
(A) A_k lies on ellipse
(B) A_k lies on hyperbola
(C) if S be the focus of locus of A_k then $\sum_{k=1}^{n} A_kS = na$
(D) if S be the focus of locus of A_k then $\sum_{k=1}^{n} (A_kS)^2 = \frac{n}{2}(3a^2 - b^2)$

Space for rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

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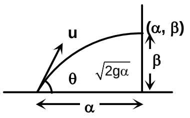
ANSWERS, HINTS & SOLUTIONS

CRT –II
(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	B	D
2.	B	D	B
3.	C	A	B
4.	C	A	B
5.	D	D	B
6.	A	D	B
7.	A	A	B
8.	A	C	C
9.	A	D	B
10.	A	D	A
11.	D	A	B
12.	A	B	A
13.	B	D	A
14.	A	B	C
15.	B, D	B, C, D	A, C
16.	B, C	A, B	A, D
17.	A, C	A, B	A, B, C
18.	B, C, D	A, B, D	B, D
19.	B, D	A, D	A, D
20.	A, B, C, D	A, C, D	A, C, D

Physics PART – I

2. $\beta = \alpha \tan\theta - \frac{1}{2} g \frac{\alpha^2}{u^2 \cos^2\theta}$



$$\beta = \alpha \tan\theta - \frac{1}{2} g \frac{\alpha^2}{2g\alpha}\left(1 + \tan^2\theta\right)$$

$$\tan^2\theta - 4\tan\theta + \left(1 + \frac{4\beta}{\alpha}\right) = 0$$

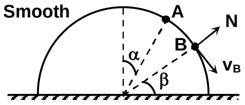
If particle will not hit the target.

$(b^2 - 4ac) < 0$

$$16 - 4\left(1 + \frac{4\beta}{\alpha}\right) < 0$$

$4\beta > 3\alpha$

3. At B, $mg \sin\beta = \frac{mv_B^2}{r}$ . . . (1)



Using energy considerations

$$\frac{1}{2}mv_B^2 = mgr(\cos\alpha - \sin\beta) \quad . . . (2)$$

From (1) and (2)

$mg \sin\beta = 2mg(\cos\alpha - \sin\beta)$

$2\cos\alpha = 3\sin\beta$

7. $i = \sqrt{5}A$

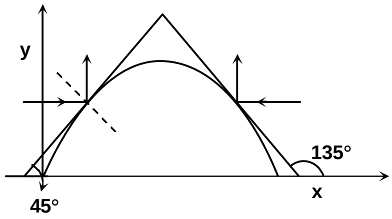
$$\frac{q_m^2}{2C} = \frac{q^2}{2C} + \frac{1}{2}Li^2 \Rightarrow q_{max} = 6\ C$$

8. Time period does not depend on amplitude SHM and both particle will exchange velocity at every collision.

15. The slope of curve at such a point will be ± 1

$$\therefore \quad \frac{dy}{dx} = 2\cos\left(\frac{\pi x}{L}\right) = \pm 1$$

$$\Rightarrow \quad x = \frac{L}{3} \text{ or } \frac{2L}{3}$$



16. $P_1 = m \times 16 + 2m \times 0 = 16m$

$P_f = mv_A' + 2mv_B'$

$\therefore \frac{1}{2} \times 2mv_B^2 = 2mgh$

$\Rightarrow v_B = 10\ \text{m/s}$

$16\ m = mv_A' + 2m \times 10$

$\Rightarrow v_A' = -4\text{m/s}$

$$e = \frac{v_B' - v_A'}{v_A - v_B} = \frac{10-(-4)}{16-0} = \frac{14}{16} = \frac{7}{8}$$

17. If v be the velocity at mean position in two cars then $\frac{1}{2}mv^2 = \frac{1}{2}KA_1^2 = \frac{1}{2}KA_2^2$

and $T_1 = T_2 = 2\pi\sqrt{\frac{m}{K}}$

$A_1 = A_2$

18. Initially potential and kinetic both energies zero and from conservation of mechanical energy total energy of the two object zero

Further, decrease in P.E. = increase in K.E.

$$\frac{G(m)(4m)}{r} = \frac{1}{2}\mu v_r^2$$

$$v_r = \sqrt{\frac{10Gm}{r}}$$

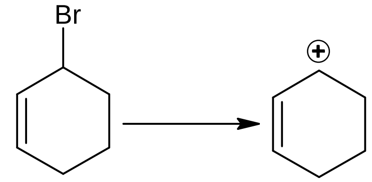
Total K.E. $= \frac{G(m)(4m)}{r} = \frac{4Gm^2}{r}$

Chemistry PART – II

SECTION – A

1. XeO_6^{4-} (perxenate ion) because oxidation state of Xe is +8 and it is highly unstable compound.

2.



Due to formation of resonance stabilized carbocation.

3. $\pi = CRT, So, C = \frac{\pi}{RT} = \frac{293.4}{8.31 \times 293} = 0.1\ mol/L$

If 100 ml contains 6.33 g of haematin.

$\therefore$ 1 L will contain 63.3 g of haematin.

Molecular mass of haematin = 633 u

Estimating the empirical formula of compound

$$C : H : N : O : F = \frac{64.6}{12} : \frac{5.2}{1} : \frac{8.8}{14} : \frac{12.6}{16} : \frac{8.8}{56}$$

$\approx 34 : 33 : 4 : 5 : 1$

So, empirical formula is $C_{34}H_{33}N_4O_5Fe$, whose mass corresponds to the molecular mass.

4. $$E^o_{Zn^{2+}/ZnY^{2-}/Y^{4-}} = E^o_{Zn^{2+}/Zn^{+}} + \frac{0.059}{2}\log K$$

$$K_f = \frac{\left[ZnY^{2-}\right]}{\left[Y^{4-}\right]} \Rightarrow K = \frac{1}{K_f}$$

$$E^o_{Zn^{2+}/ZnY^{2-}/Y^{4-}} = -0.76 + \frac{0.059}{2}\log_{10}\frac{1}{3.2 \times 10^{16}}$$

= - 1.25 V

5. $\Delta T_f = 0.5K = iK_f m$

$$\therefore i = \frac{\Delta T_f}{K_f m} = \frac{0.5}{1.86 \times 0.263} = 1.022$$

$$\begin{array}{llll} HA \longrightarrow & H^+ & + & A^- \\ 1 & 0 & & 0 \\ 1-\alpha & \alpha & & \alpha \end{array}$$

$i = 1 + \alpha \Rightarrow \alpha = 0.022$

$K_a = C\alpha^2 = 0.2 \times (0.022)^2 = 9.6 \times 10^{-5}$

$\Rightarrow pK_a = 4.0177$

On adding 0.25 M NaA, buffer is formed.

$$\therefore pH = pK_a + \log_{10}\frac{[Salt]}{[Acid]} = 4.0177 + 0.0969$$

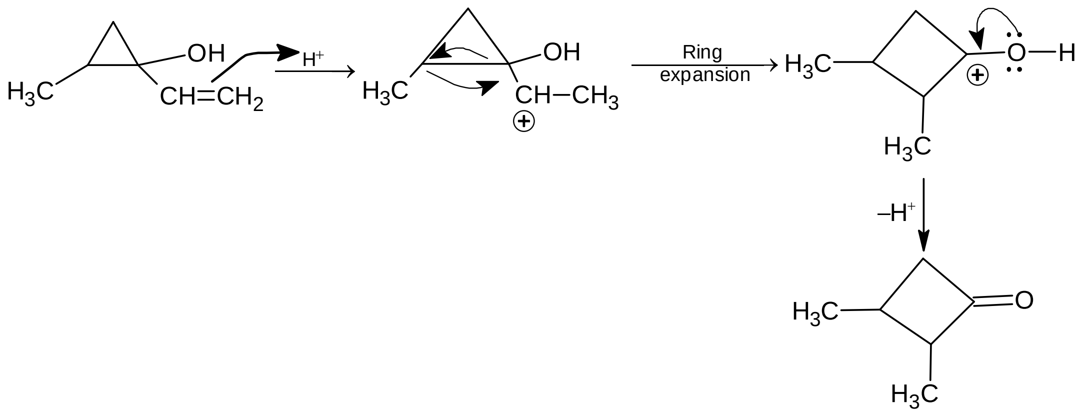
= 4.1146

6. $$Na_2B_4O_7 + 7H_2O \longrightarrow \underbrace{\underset{\text{Strong base}}{2NaOH} + \underset{\text{Weak acid}}{4H_3BO_3}}_{\text{Alkaline}}$$

$$Na_2B_4O_7 \xrightarrow{\Delta} \underbrace{2NaBO_2 + B_2O_3}_{\text{Glassy bead}}$$

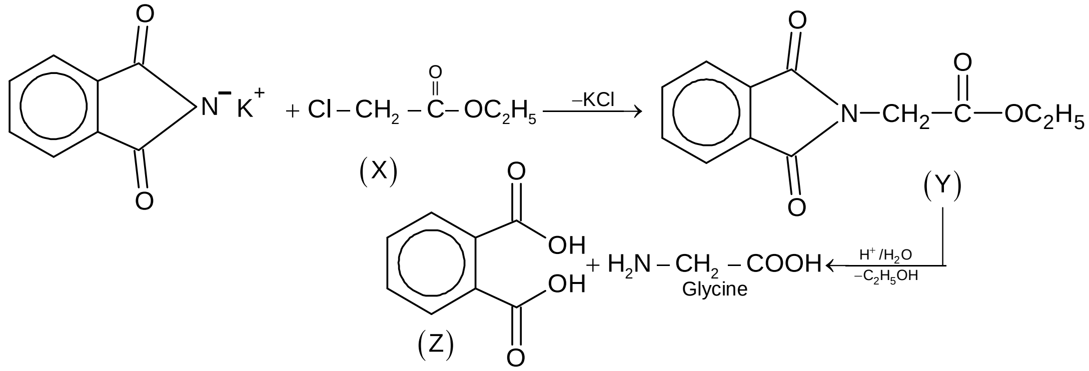
$$\underset{(\text{White crystals})}{Na_2B_4O_7} + H_2SO_4 + 5H_2O \longrightarrow Na_2SO_4 + 4H_3BO_3$$

7.



H₃C
OH
CH=CH₂
H⁺
H₃C
OH
CH–CH₃
⊕
Ring expansion
H₃C
⊕
O–H
H₃C
–H⁺
H₃C
O
H₃C

8.



O
N⁻ K⁺
O
+ Cl – CH₂ – C(=O) – OC₂H₅
(X)
–KCl
O
N–CH₂–C(=O)–OC₂H₅
O
(Y)
H⁺/H₂O
–C₂H₅OH
+ H₂N – CH₂ – COOH
Glycine
O
OH
OH
O
(Z)

9. $$\underset{(A)}{3M} + N_2 \xrightarrow{\text{Burning}} \underset{(B)}{M_3N_2}$$

$$\underset{(B)}{M_3N_2} + 6H_2O \longrightarrow \underset{(C)}{3M(OH)_2} + \underset{(D)}{2NH_3}$$

All statement with respect to NH_3 are correct.

10. Ba and Ca quite readily liberate hydrogen.

In cold water Mg decomposes water only on heating. So, element (A) may be Ca and Ba not Mg.

$\underset{(\text{Lime water})}{Ca(OH)_2}$ & $\underset{(\text{Baryta water})}{Ba(OH)_2}$, both givess milkiness with CO_2.

11. $$2.303\log\frac{P_2}{P_1} = \frac{\Delta H}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$\Delta H = 11.99\ kJmol^{-1}$$

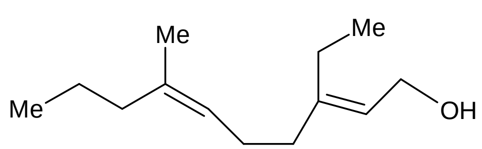
12 $$K_b = \frac{RT^2M}{1000\ \Delta H} = \frac{8.314\times(353)^2\times100}{1000\times11.99\times10^3} = 8.64\ \text{K kgmol}^{-1}$$

$$\Delta T_b = K_b(1+\alpha)m$$

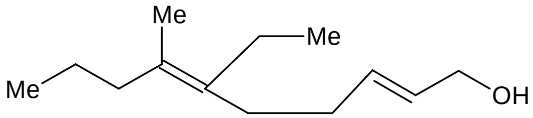
$$1 = 8.64\times(1+\alpha)\frac{1}{100}\times\frac{1000}{100}$$

$\alpha = 0.158$

13. Two structural isomers of (A) are:



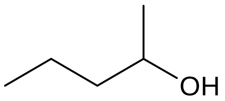
&



There are four geometrical isomers for each strucutre, i.e. total number of stereoiosmers = 8.

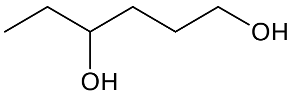
14. Convert aldehyde and ketone to alcohol

(1)



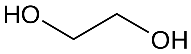
(5C −)

(2)



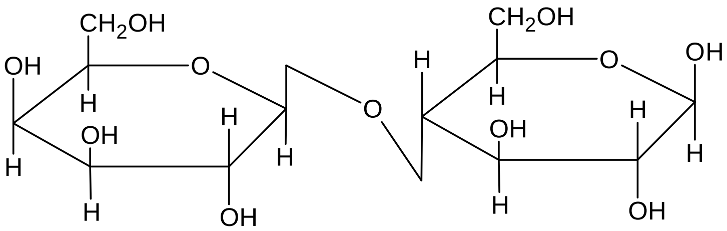
(6C −)

(3)

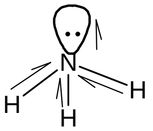


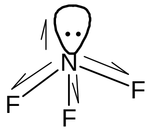
(2C −)

15.



16. (A)





$\mu_{NH_3} > \mu_{NF_3}$

(B) (I) is 3^o allylic with extended conjugation.
(II) is 3^o allylic, (III) is 3^o free radical.

(C) Correct order is: $RS^- < CH_3O^- < OH^-$ (Basic strength)

(D) Correct order is: $I^- < Br^- < Cl^- < F^-$ (Basic strength)

17. (A) $NH_4NO_3 + NaOH \longrightarrow NH_3 + NaNO_3 + H_2O$

$7NaOH + NaNO_3 + 4Zn \longrightarrow 4Na_2ZnO_2 + NH_3 + 2H_2O$

(B) $NH_4NO_2 + NaOH \longrightarrow NaNO_2 + NH_3 + H_2O$

$3Zn + 5NaOH + NaNO_3 \longrightarrow 3Na_2ZnO_2 + NH_3 + H_2O$

18. $$v_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3PV}{M}} = \sqrt{\frac{3P}{d}}$$

19. In metal carbonyls, $M \underset{\sigma}{\overset{\pi}{\rightleftharpoons}} CO$, the C – O bond length increases compared to that in CO molecules due to synergic bonding between metal and carbonyl ligand.

Facial and meridenal isomers $\left[Ma_3b_3\right]^{n+}$ contains plane of symmetry.

20. $CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$

$0.1(1-h) \qquad\qquad 0.1h \qquad 0.1\,h$

$K_h = \dfrac{(0.1h)(0.1h)}{0.1(1-h)} = 0.1\,h^2 \Rightarrow h = 7.48\times10^{-5}$

$\Rightarrow \left[OH^-\right] = Ch = 7.48\times10^{-5}\times10^{-1} = 7.48\times10^{-6}$

$\therefore \left[H^+\right] = \dfrac{K_W}{\left[OH^-\right]} = \dfrac{10^{-14}}{7.48\times10^{-5}} = 1.33\times10^{-9}$

And pH = 8.8 approx.

Mathematics PART – III

1. We express x in terms of a new variable y

$$x-1=\frac{1}{y} \Rightarrow x=\frac{y+1}{y}$$

$$\Rightarrow \frac{6(y+1)^5}{y^5}+\frac{5(y+1)^3}{y^3}+\frac{(y+1)^2}{y^2}+\frac{4(y+1)}{y}-1=\frac{a}{y^5}+\frac{b}{y^4}+\frac{c}{y^3}+\frac{d}{y^2}+\frac{e}{y}+f$$

Multiplying both side by y^6 we get $6y(y + 1)^5 + 5y^3(y + 1)^3 + y^4(y + 1)^2 + 4y^5(y + 1) – y^6$
$= ay + by^2 + cy^3 + dy^4 + ey^5 + fy^6$
Differentiating both side and then satisfying y = 1
Gives the value a + 2b + 3c + 4d + 5e + 6f = 910

2. $$f(x)=\prod_{n=1}^{50}(x-n)^{n(51-n)}$$

$$\ln(f(x))=\sum_{n=1}^{50}n(51-n)\ln(x-n)$$

Differentiating both side w.r.t. x

$$\frac{f'(x)}{f(x)}=\sum_{n=1}^{50}\frac{n(51-n)}{x-n}$$

$$\Rightarrow \frac{f'(51)}{f(51)}=1275$$

3. $a^2 = b^2 + c^2 – 2bc \cos A = (b – c)^2 + 2bc(1 – \cos A)$

$$\Delta=\frac{1}{2}bc\sin A \Rightarrow 2bc=\frac{4\Delta}{\sin A}$$

$$\Rightarrow a^2=(b-c)^2+\frac{4\Delta}{\sin A}(1-\cos A) = (b-c)^2+4\Delta\tan\frac{A}{2}$$

Since A and Δ are fixed hence a is minimum when b = c

Hence $2bc = 2b^2 = \frac{4\Delta}{\sin A}$

4. $$\frac{f(3x+3y)}{\sin(2x+3y)}=\frac{f(3x-3y)}{\sin(2x-2y)} \quad \forall x, y \in R$$

$$\Rightarrow f(x)=k\sin\left(\frac{2x}{3}\right)$$

$$\therefore f'(0)=\frac{2}{3}k=1 \Rightarrow k=\frac{3}{2}$$

$$\therefore f(x)=\frac{3}{2}\sin\left(\frac{2x}{3}\right) \Rightarrow f'\left(\frac{\pi}{2}\right)=\frac{3\sqrt{3}}{4}$$

Equation of tangent is $y-\frac{3\sqrt{3}}{4}=\frac{1}{2}\left(x-\frac{\pi}{2}\right)$

5. $$\sum_{1\le i<j\le m}a_ia_j = \frac{1}{2}\left\{\left(\sum_{i=1}^{m}a_i\right)^2-\sum_{i=1}^{m}a_i^2\right\}$$

$$= \frac{1}{2}\left\{\left(\frac{a_1\left(1-r^m\right)}{1-r}\right)^2 - \frac{a_1^2\left(1-r^{2m}\right)}{1-r^2}\right\}$$

$$= \frac{a_1^2}{2(1-r)}\left\{\frac{\left(1-r^m\right)^2}{1-r} - \frac{1-r^{2m}}{1+r}\right\}$$

$$= \frac{r}{1+r}\left\{\frac{a_1\left(1-r^{m-1}\right)}{1-r}\right\}\left\{\frac{a_1\left(1-r^m\right)}{1-r}\right\}$$

$$= \frac{r}{1+r}S_{m-1}S_m$$

6. Use L'Hospital's Rule twice

7. $g(x) = \int \frac{f(x)dx}{x^2(x+1)^3} = \int\left(\frac{A}{x} + \frac{B}{x^2} + \frac{C}{x+1} + \frac{D}{(x+1)^2} + \frac{E}{(x+1)^3}\right)dx$

$= A\ln x - \frac{B}{x} + c\ln(1+x) - \frac{D}{1+x} - \frac{E}{2(x+1)^2}$

Since g(x) is a rational function, hence logarithmic function must be absent

$\Rightarrow A = C = 0$

$g(x) = \int \frac{B}{x^2} + \frac{D}{(x+1)^2} + \frac{E}{(x+1)^3}\,dx$

$\Rightarrow f(x) = (B + D)x^3 + (3B + D + E)x^2 + 3Bx + B$

$\Rightarrow B + D = 0$, $f(0) = 1$ gives $B = 1 \Rightarrow D = -1$

$\therefore f(x) = (2 + E)x^2 + 3x + 1$

$f'(x) = 2(2 + E)x + 3$

$f'(0) = 3$

8. Denoting the two curve by S_1 and S_2 the equation of curve S passing through intersection of S_1 and S_2 can be $S = S_1 + \lambda S_2 = 0$. Since S is circle

$\Rightarrow$ Coefficient of x^2 = Coefficient of y^2, Coefficient of xy = 0 we get $\lambda = 1$

$S = (a' + a)(x^2 + y^2) - 2(g' + g)x - 2(f' + f)y + 2c = 0$

The centre is $\left(\frac{g'+g}{a'+a}, \frac{f'+f}{a'+a}\right)$ which is P

$PA^2 + PB^2 + PC^2 = 3(\text{Radius})^2 = 3(PD)^2$

9. $\sin x = \sin\frac{(\pi x)}{180} \Rightarrow \sin x = \sin\left(\pi - \frac{\pi x}{180}\right)$ or $\sin\left(2\pi + \frac{\pi x}{180}\right)$

$x = \pi - \frac{\pi x}{180}$, $x = 2\pi + \frac{\pi x}{180}$

$x = \frac{180\pi}{180+\pi}$, $x = \frac{360\pi}{180-\pi}$

On comparing, m = 360, n = 180, p = 180, q = 180

$\Rightarrow$ (m + n + p + q) = 900

10. $\lim\limits_{x\to\infty} \frac{\left(A - C^2\right)x^2 + Bx}{x\left(\sqrt{A + \frac{B}{x}} + C\right)} = 2$

For existence of limit $A = C^2$

Hence, $C = \sqrt{A}$, $\frac{B}{\sqrt{A}+C} = 2$

$\Rightarrow \frac{B}{C} = 4$

For $C = -\sqrt{A}$ limit does not exist

11. The visible are of P(2, –6) is the area of ΔABP ΔABP has base AB of length 4 and its height is the distance from AB to point P. Which is 10, since AB is parallel to x–axis.

Thus area = $\frac{1}{2}\times b\times h = 20$

12. Similarly area = ΔQBC = $\frac{1}{2}\times b\times h = \frac{1}{2}\times 4\times 4 = 8$

13. LHD = $\lim\limits_{h\to 0}\left(\frac{\frac{-\sinh+\tanh+\cosh-1}{2h^2-\ln(2-h)-\tanh}}{-h}\right)$

$= \lim\limits_{h\to 0}\frac{\frac{\sinh}{h}-\frac{\tanh}{h}+\frac{1-\cosh}{h^2}\times h}{2h^2-\ln(2-h)-\tanh} = 0$

RHD = $\lim\limits_{h\to 0}\frac{e^{h^2}-1-0}{h} = h\times\frac{e^{h^2}-1}{h} = 0$

$\Rightarrow L_1 \equiv y = 0,\ L_2 \equiv x = 0$

14. $\Delta = 2\times\frac{1}{2}\left(\cot\left(\frac{\pi}{4}-\frac{\theta}{2}\right)+\cot\frac{\theta}{2}+1\right)$

$= 1+\frac{2\sin\frac{\pi}{4}}{2\left(\sin\left(\frac{\pi}{4}-\frac{\theta}{2}\right)\right)\sin\frac{\theta}{2}}$

$= 1+\frac{\sqrt{2}}{\cos\left(\theta-\frac{\pi}{4}\right)-\cos\frac{\pi}{4}}$

$\Delta_{\min} = 1+\frac{\sqrt{2}}{1-\frac{1}{\sqrt{2}}} = \left(1+2\left(\sqrt{2}+1\right)\right) = 3+2\sqrt{2}$

15. Four point A, B, C, D are coplanar if three vector $\overrightarrow{AB}$, $\overrightarrow{AC}$, $\overrightarrow{AD}$ are coplanar or STP of there vectors is 0

$\overrightarrow{AB}\cdot\left(\overrightarrow{AC}\times\overrightarrow{AD}\right) = 0$

$\Rightarrow \begin{vmatrix} 1 & 0 & 0 \\ 3 & f(t) & 1 \\ 2 & f'(t) & 2 \end{vmatrix} = 0 \ \forall\ t \in R$

$\Rightarrow f'(t) = 2f(t)$

$\Rightarrow f(t) = ce^{2t}$

Similarly for $\vec{B}\left(\hat{i}+\hat{j}\right)$ differential equation will be $f'(t) - 2f(t) = -4$

On solving $f(x) = 2 + ce^{2x}$, $c \in R$

16. First use integrating by parts to show that

$$u_n = \int_0^{\pi/2} \cos^{n-1} x \sin x \sin nx \, dx$$

$$= \int_0^{\pi/2} \cos^{n-1} x \cos(n-1)x - \int_0^{\pi/2} \cos^n x \cos nx \, dx$$ (Use sin nx sin x = cos(n – 1)x – cos nx cos x)

$= u_{n-1} - u_n$

$$\Rightarrow \frac{u_n}{u_{n-1}} = \frac{1}{2}$$

We have, $u_1 = \frac{\pi}{4}$, $u_n = \frac{1}{2^{n-1}} \cdot \frac{\pi}{4} = \frac{\pi}{2^{n+1}}$

17. If three planes pass through the same line, their normal vector will be coplanar

$$\Rightarrow \begin{vmatrix} -1 & \sin\alpha & \sin\beta \\ \sin\alpha & -1 & \sin\theta \\ \sin\beta & \sin\theta & -1 \end{vmatrix} = 0$$

$\Rightarrow \sin^2\alpha + \sin^2\beta + \sin^2\theta + 2\sin\alpha\sin\beta\sin\theta = 1$ ..... (1)

Now the cross product $\hat{r}$ of normals of P_1, and P_2 will parallel to line

Direction ratio of $\hat{r} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -1 & \sin\alpha & \sin\beta \\ \sin\alpha & -1 & \sin\theta \end{vmatrix}$ = {(sin α sin θ + sin β), (sin α sin β + sin θ), (1– sin² α)}

$\hat{r}$ is parallel to given line

$$\Rightarrow \frac{\sin\alpha\sin\theta + \sin\beta}{\cos\theta} = \frac{\sin\alpha\sin\beta + \sin\theta}{\cos\beta} = \frac{1 - \sin^2\alpha}{\cos\alpha} = \lambda \quad ..... (2)$$

Using (1) and (2) we get

$\lambda \cos\alpha = \lambda \sin(\beta + \theta) \Rightarrow \sin(\beta + \theta) = \sin\left(\frac{\pi}{2} - \alpha\right) = \alpha + \beta + \theta = 2n\pi + \frac{\pi}{2}$ $(n \in z)$

18. Let the circle be $x^2 + y^2 = r^2$, and the five points be $P_i = (r\cos\theta_i, r\sin\theta_i)$, i = 1, 2, 3, 4, 5

Let (h_i, k_i) represent the centre of that rectangular hyperbola which passes through the four points $P_j(j \neq i)$ let (h_1, k_1) is centre of hyperbola which passes through P_2, P_3, P_4, P_5.

Now $\frac{h_1}{2} = \frac{r}{4}(\cos\theta_2 + \cos\theta_3 + \cos\theta_4 + \cos\theta_5)$, $\frac{k_1}{2} = \frac{r}{4}(\sin\theta_2 + \sin\theta_3 + \sin\theta_4 + \sin\theta_5)$

(As we know if a circle and rectangular hyperbola intersect at four point then their means is mid–point of centre of two curves)

$$2h_1 = r\sum_{i=1}^{5} \cos\theta_i - r\cos\theta_1$$

$$\Rightarrow 2k_1 = r\sum_{i=1}^{5} \sin\theta_i - r\sin\theta_1$$

However, r, $\left(\lambda = \sum_{i=1}^{5} \cos\theta_i\right)$ and $\left(\gamma = \sum_{i=1}^{5} \sin\theta_i\right)$ are fixed

$\Rightarrow 2h_1 = \lambda - r\cos\theta_1$, $2k_1 = \gamma - r\sin\theta$

$$\Rightarrow \left(h_1 - \frac{\lambda}{2}\right)^2 + \left(k_1 - \frac{\gamma}{2}\right)^2 = \left(\frac{r}{2}\right)^2$$

This equation is satisfied by all (h_i, k_i), i = 1, 2, 3, 4, 5

19. Divided the given equation by ax^4, and let $\frac{y}{x} = m$

Equation become $m^4 + \frac{b}{a}m^3 + \frac{c}{a}m^2 + \frac{d}{a}m + 1 = 0$ ..... (1)

Assuming that four slopes m_1, m_2, m_3, $m_4 \Rightarrow m_1 \cdot m_2 \cdot m_3 \cdot m_4 = 1$

Now it is given pair of these lines, bisect the angle between the other pair. So let, $m_1m_2 = -1$ $m_3m_4 = -1$ which means other two lines are also perpendicular

Equation (1) can be written as

$(m - m_1)(m - m_2)(m - m_3)(m - m_4) = (m - m_1)\left(m + \frac{1}{m_1}\right)(m - m_3)\left(m + \frac{1}{m_3}\right)$

$= (m^2 + \lambda m - 1)(m^2 + \mu m - 1)$ ..... (2)

Where $\lambda = \frac{1 - m_1^2}{m_1} \Rightarrow \mu = \frac{1 - m_3^2}{m_3}$

Comparing the coefficient (1) and (2)

$\lambda + \mu = \frac{b}{a}$, $\lambda\mu - 2 = \frac{c}{a}$, $\lambda + \mu = -\frac{d}{a}$ ..... (3)

Thus, $\frac{b}{a} = -\frac{d}{a} \Rightarrow b + d = 0$

Also, we have to use angle bisector fact

$\left|\frac{m_1 - m_3}{1 + m_1m_3}\right| = \left|\frac{m_3 + \frac{1}{m_1}}{1 - \frac{m_3}{m_1}}\right| \Rightarrow (m_1 - m_3)^2 = (1 + m_1m_3)^2$ ..... (4)

From (3), $\lambda\mu - 2 = \frac{c}{a} \Rightarrow \left(\frac{1 - m_1^2}{m_1}\right)\left(\frac{1 - m_3^2}{m_3}\right) - 2 = \frac{c}{a}$ ..... (5)

Using (4) and (5) we obtain $(c + 6a) = 0$

20. Since $P_k = e^{i\theta_k}$, $\theta_k = \frac{(2k)\pi}{n}$

Let $A_k = x_k + iy_k = a \cos \theta_k + ib \sin \theta_k$

$\Rightarrow \frac{x_k}{a} = \cos\theta_k$, $\frac{y_k}{b} = \sin\theta_k$, which implies that $\frac{x_k^2}{a^2} + \frac{y_k^2}{b^2} = 1$, A_k lies on ellipse

$\Rightarrow \sum_{k=1}^{n} A_kS = \sum_{k=1}^{n}(a - ex_k) = na - e\sum_{k=1}^{n} x_k = na$

$\Rightarrow \sum_{k=1}^{n}(A_kS)^2 = \sum_{k=1}^{n}(a - ex_k)^2 = na^2 - 2ae\sum_{k=1}^{n} x_k + e^2\sum_{k=1}^{n} x_k^2$

$= na^2 + a^2e^2\sum_{k=1}^{n}\cos^2\theta_k = na^2 + \frac{na^2e^2}{2} + \frac{1}{2}a^2e^2\sum_{k=1}^{n}\cos 2\theta_k$

$= na^2 + \frac{na^2}{2}\left(1 - \frac{b^2}{a^2}\right) = \frac{n}{2}(3a^2 - b^2)$

$(\because \sum_{k=1}^{n}\cos 2\theta_k = 0$ sum of roots of $z^{n/2} - 1 = 1)$

FIITJEE **JEE (Main), 2014**

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - II

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 03 and 10 to 12)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (04 to 09 and 13 to 30) contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

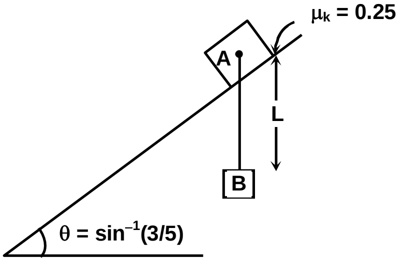
PART – I

SECTION – A

Single Correct Choice Type

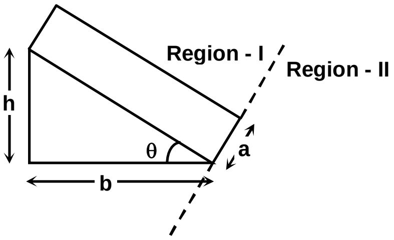
This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. Two similar blocks A and B are riveted rigidly with a rigid rod of length L such that block A can slide along an inclined plane as shown in the figure. If masses of the both blocks and the rod are each equal to m and kinetic friction between A and inclined plane is $\mu_k = 0.25$ then the magnitude of acceleration of centre of mass of the block rod system is



(A) 6 m/s^2 (B) 4 m/s^2
(C) 5 m/s^2 (D) 2 m/s^2

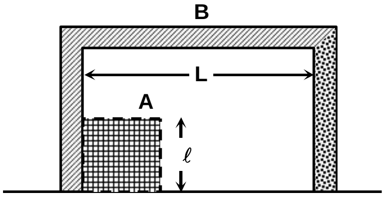
2. A wedge of mass M and dimensions as shown in the figure is lying completely inside a region (I) of zero pressure. The pressure inside region II is 1 Pa. The surfaces are smooth. The wedge is imparted an initial velocity v_0 so that it just travels a distance b inside region II before finally coming to rest. The value of v_0 is



(A) $\sqrt{\frac{abh}{M}}$ (B) $\frac{3}{4}\sqrt{\frac{abh}{M}}$
(C) $\frac{4}{3}\sqrt{\frac{abh}{M}}$ (D) $\sqrt{\frac{4}{3}\frac{abh}{M}}$

Space for Rough work

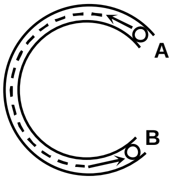
3. A block A of mass m and a box B of same mass are lying on a horizontal surface as shown in the above figure. The coefficient of kinetic friction between the block and horizontal surface is μ_A, while that between the box and surface is μ_B. Given that $\mu_B > \mu_A$. At t = 0, the position is as shown in the figure and both are simultaneously given a velocity v_0 to the right. The time after which block will collide with the right end of the box is

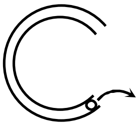


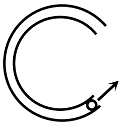
(A) $\sqrt{\frac{2(L-\ell)}{(\mu_B-\mu_A)g}}$
(B) $\sqrt{\frac{2(L-\ell)}{(\mu_B+\mu_A)g}}$
(C) $\sqrt{\frac{4(L+\ell)}{(\mu_B-\mu_A)g}}$
(D) $\sqrt{\frac{4(L-\ell)}{(\mu_B-\mu_A)g}}$

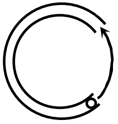
4. It is observed that only 0.39% of the original radioactive sample remains undecayed after eight hours. Hence choose the incorrect statement.
(A) The half life of that substance is 1 hr.
(B) The mean life of that substance is 1/ln 2 hr
(C) The decay constant of the substance is ln 2 hr^{-1}
(D) The half life of the substance is 1/2 hr

5. The figure shows a hollow circular tube fixed to a frictionless horizontal table. It is the top view of the arrangement. A ball is shot into end A of the tube to leave the other end B at high speed. The balls diameter is slightly less than the internal diameter of the tube. Which of the paths below will the ball follow on the table after it leaves the tube?



(A)


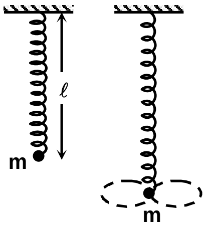
(B)


(C)


(D) None of these

Space for Rough work

6. A mass m on the end of an ideal spring stretches the spring to a length ℓ when at rest. The mass is now set into motion so that it executes up and down vibrations while swinging back and forth as a simple pendulum. The mass moves in a figure eight pattern in a vertical plane a shown in the figure. The force constant of the spring assuming small oscillations is

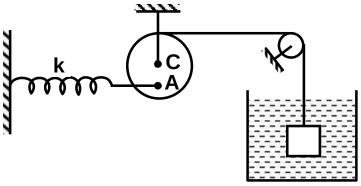


(A) $\frac{mg}{\ell}$ (B) $\frac{2mg}{k}$
(C) $\frac{4mg}{\ell}$ (D) $\frac{mg}{2\ell}$

7. When an ultrasonic waves travels from air into water,
(A) waves bends towards the normal
(B) frequency of waves changes from air to water.
(C) speed of ultrasonic wave is greater in water than that in air.
(D) speed of ultrasonic wave is less in water than that in air.

8. A narrow tunnel is made through the earth of mass M and radius R from the centre to the surface. The speed (in m/s) with which a particle should be projected from the centre of the earth through the tunnel so that it escapes to the space is
(A) $\sqrt{2gR}$ (B) $\sqrt{gR}$
(C) $\sqrt{3gR}$ (D) $2\sqrt{gR}$

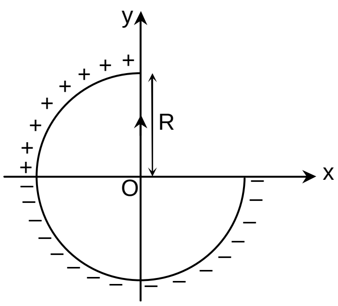
9. A cubical block of volume v and density 3ρ is placed inside a liquid of density ρ and attached to a spring of spring constant k as shown in the figure. Assuming ideal spring and pulley and spring is attached at A which is at R/2 from centre. The compression in the spring at equilibrium is



(A) $\frac{4\rho vg}{k}$ (B) $\frac{2\rho vg}{k}$
(C) $\frac{3\rho vg}{k}$ (D) $\frac{\rho vg}{k}$

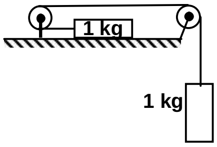
Space for Rough work

10. A conductor having uniform linear charge density λ is placed in circular form in 3 quadrants with different polarities as shown in the figure. Let $\vec{E}_0$ be the electric field at O. Then the angle made by $\vec{E}_0$ with the line along y-axis is



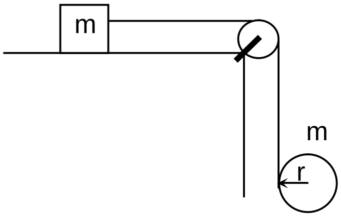
(A) $\tan^{-1}\left(\frac{1}{2}\right)$ (B) $\tan^{-1}(1)$
(C) $\tan^{-1}\left(\frac{1}{3}\right)$ (D) None

11. The pulley and the string are light and all the surfaces are frictionless. The system is initially held at rest and The string is just taut. The 1kg block on the plane is suddenly imparted a velocity of 5m/s to the left, and the system is simultaneously released. Find the displacement of the 1kg block (on the plane) after 3s. [Take g = 10 m/s^2]



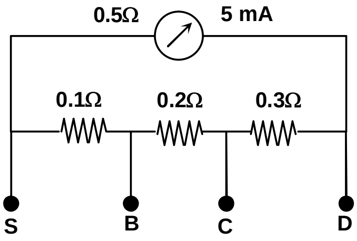
(A) 10 m (B) 20 m
(C) 30 m (D) 40 m

12. A light thread is wound on a disk of mass *m* and other end of thread is connected to a block of mass *m*, which is placed on a rough ground as shown in diagram. Find the minimum value of coefficient of friction for which block remain at rest:



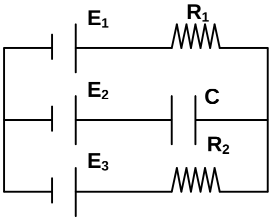
(A) $\frac{1}{3}$ (B) $\frac{1}{4}$
(C) $\frac{1}{2}$ (D) $\frac{1}{5}$

13. A milli ammeter of range 5 mA and resistance $0.5\,\Omega$ is joined in a circuit as shown. Find the value of current for which meter gives full scale deflection when A & B are used as Terminal:



(A) 50 mA (B) 5 mA
(C) 100 mA (D) 1 A

14. In the circuit shown, the batteries $E_1 = E_2 = 1$ V, $E_3 = 2.5$ V and the resistances $R_1 = 10\,\Omega$, $R_2 = 20\,\Omega$. The potential difference across the capacitor is

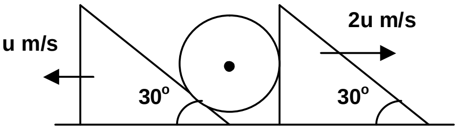


(A) 0.2 V (B) 0.4 V
(C) 0.5 V (D) 1.2 V

15. A horizontal spring mass system of mass M performs simple harmonic motion of amplitude a_0 and time period T_0. When the mass M passes through mean position another stationary mass M sticks to it and both move together. If a and T be new amplitude and time period. Then

(A) $a = \frac{a_0}{\sqrt{2}}$ (B) $a = a_0\sqrt{2}$
(C) $T = \frac{T_0}{\sqrt{2}}$ (D) None

16. System is shown in figure. Assume the cylinder remains in contact with the two wedges. The velocity of cylinder is

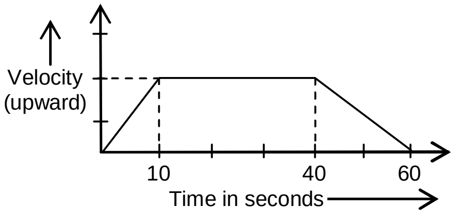


(A) $\sqrt{19 - 4\sqrt{3}}\,\frac{u}{2}$ m/s (B) $\frac{\sqrt{13}}{2}$v m/s
(C) $\sqrt{3}$v m/s (D) $\sqrt{7}$u m/s

17. Consider the following statements for a particle moving in an elliptic orbit under the influence of a central force:
(1) The radius vector covers equal area in equal time.
(2) The motion takes place in a plane.
(3) The angular momentum is constant of motion.
Which of options given above are correct?
(A) 1 & 2 only (B) 2 & 3 only
(C) 1 & 3 only (D) all

Space for Rough work

18. A person is standing on a weighing machine placed on the floor of an elevator. The motion of the elevator is shown in the adjacent diagram. The maximum and the minimum weights recorded are 66 kg and 57 kg. The magnitude of the upward accelerations is [Take g = 10 m/s^2.]



(A) 1 m/s^2 (B) 0.5 m/s^2
(C) 2 m/s^2 (D) 0.25 m/s^2

19. When a charge particle of charge $2\mu c$ and mass 1 gm is released at origin in gravity free space having $\vec{E} = E_0\hat{j}$ and $\vec{B} = -B_0\hat{j}$ (E_0 = 10^3 N/c and B0 = 5T). Then its speed

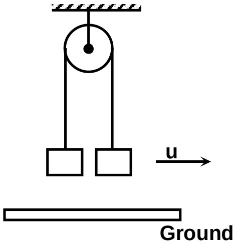
(A) depends only of X co-ordinate (B) depends only on Y co-ordinate
(C) depends only on z co-ordinate (D) depends only on X, Y, Z co-ordinate

20. A neutral metallic finite block is placed at large but finite distance from a large charged sheet in the middle space in front of sheet. Then the block will be

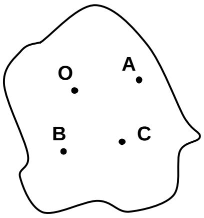
(A) Attracted towards the sheet (B) Repelled away from the sheet
(C) Depend on nature of charge on the sheet (D) Zero force on the block

21. Two equal masses hang on either side of a pulley at the same height from the ground. The mass on the right is given a horizontal speed, after some time.

(A) The mass on the left will be nearer to ground.
(B) The mass on the right will be nearer to ground.
(C) Both the masses will be at equal distance from the ground.
(D) Nothing can be said regarding their positions.



22. O is the centre of mass of a body of mass M as shown in the figure. A, B, C are three different point on the body. OB = 8 cm, OC = 10 cm, BC = 6 cm and OA = 10 cm. Which of the following can be written by using parallel axis theorem? I$_0$ is the moment of inertia about the axis passing through point O and perpendicular to plane of object.



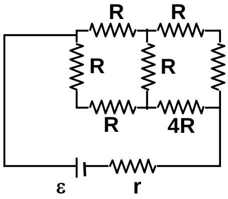
(A) $I_B = I_C + M(BC)^2$ (B) $I_C = I_B + M(BC)^2$
(C) $I_A = I_0 + M(OB)^2$ (D) None of these

Space for Rough work

23. A solid sphere of radius R, and dielectric constant 'k' has spherical cavity of radius R/4. A point charge q_1 is placed in the cavity. Another charge q_2 is placed outside the sphere at a distance of r from q. Then Coulombic force of interaction between them is found to be 'F_1'. When the same charges are separated by same distance in vacuum then the force of interaction between them is found to be F_2 then

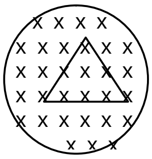
(A) $F_1 = F_2/k$
(B) $F_2 = F_1/k$
(C) $F_1 . F_2 = \frac{1}{k}$
(D) $F_1 = F_2$

24. The relation between R and r (internal resistance of the battery) for which the power consumed in the external part of the circuit is maximum.



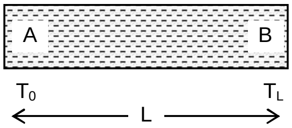
(A) $R = r$
(B) $R = \frac{r}{2}$
(C) $R = 2r$
(D) $R = 1.5\,r$

25. An equilateral triangular loop having a resistance R and length of each side 'ℓ' is placed in a magnetic field which is varying at $\frac{dB}{dt}$ = 1 T/s. The induced current in the loop will be



(A) $\frac{\sqrt{3}}{4}\frac{\ell^2}{R}$
(B) $\frac{4}{\sqrt{3}}\frac{\ell^2}{R}$
(C) $\frac{\sqrt{3}}{4}\frac{R}{\ell^2}$
(D) $\frac{4}{\sqrt{3}}\frac{R}{\ell^2}$

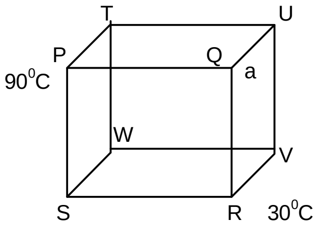
26. The temperature of a mono-atomic gas in an uniform container of length 'L' varies linearly from T_0 to T_L as shown in the figure. If the molecular weight of the gas is M_0, then the time taken by a wave pulse in travelling from end A to end B is



(A) $\frac{2L}{(\sqrt{T_L}+\sqrt{T_0})}\sqrt{\frac{3M}{5R}}$
(B) $\sqrt{\frac{3(T_L - T_0)}{5RM_0L}}$
(C) $\frac{2L}{(\sqrt{T_L}-\sqrt{T_0})}\sqrt{\frac{3M}{5R}}$
(D) $L\sqrt{\frac{M_0}{2R(T_L - T_0)}}$

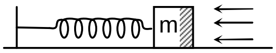
Space for Rough work

27. 12 identical rods made of same material are arranged in the form of a cube. The temperature of 'P' and 'R' are maintained at 90^0 C and 30^0C respectively. Then the temperature of point 'V', when steady state is reached,



(A) 65°C (B) 60°C
(C) 20°C (D) 50°C

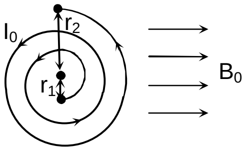
28. A spring block system with mass of block m and spring constant K (all the surfaces of block are perfectly reflecting and smooth) is placed on a smooth horizontal plane as shown in the diagram. A light beam of intensity I is switched on from rightwards. Find the amplitude of oscillations of the block.



(A) $\frac{I}{KC}$ (B) $\frac{2I}{KC}$
(C) $\frac{4I}{KC}$ (D) Zero

29. A rod of mass M and length L is placed on a smooth horizontal table and is hit by a ball moving horizontally and perpendicular to length of rod and sticks to it. Then conservation of angular momentum can be applied
(A) About any point on the rod (B) About a point at the centre of the rod
(C) About end point of the rod (D) None

30. Magnetic force on a spiral carrying current I_0 and placed in magnetic field B_0 parallel to the plane of spiral as shown in diagram, will be nearly (initial point, final point and centre lie on a line)



(A) Zero (B) $I_0B_0\left(r_2 - r_1\right)$
(C) $I_0B_0\left(r_2 + r_1\right)$ (D) $\frac{I_0B_0r_2}{r_1}$

Space for Rough work

Chemistry PART – II

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

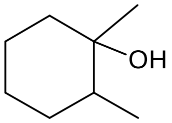
1. The pressure (P) and density (ρ) of a diatomic gas $\left(\gamma = \frac{7}{5}\right)$ changes from $P_1\ \rho_1$ to $P_2\rho_2$. If $\frac{\rho_1}{\rho_2} = 32,$ the value of $\frac{P_1}{P_2}$ is:

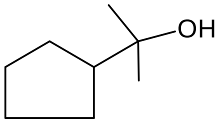
(A) 32
(B) $\frac{1}{32}$
(C) 128
(D) $\frac{1}{164}$

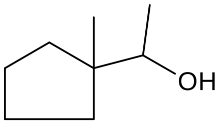
2. 0.2 mol of NH_4Cl are introduced into an empty container of 10 litre and heated to 327°C to attain equilibrium as $NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$, K_p = 0.36 atm^2. The quantity of solid NH_4Cl left is:

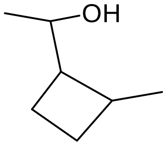
(A) 0.02 mole
(B) 0.078 mole
(C) 0.095 mole
(D) 0.035 mole

3. Which of the following alcohols will give same alkene on reaction with conc. H_2SO_4?


(I)


(II)

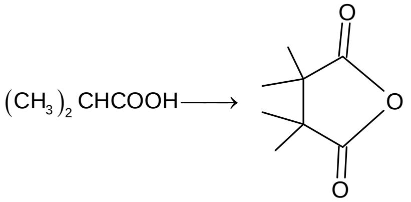

(III)


(IV)

(A) I and II
(B) II and III
(C) I, II and III
(D) II, III and IV

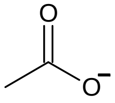
Space for Rough work

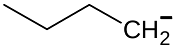
4. The correct set of reagents for the following conversion is:



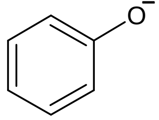
(A) P_4/I_2, Na, conc. H_2SO_4 (B) P_2O_5, $LiAlH_4$
(C) P_4/I_2, Na, P_2O_5/Δ (D) P_2O_5/Δ, H_2O, P_4/I_2, Na

5. Order of basic strength of the following compounds is:


(I)


(II)

$\bar{N}H_2$
(III)


(IV)

(A) IV > II > I > III (B) III > II > IV > I
(C) II > III > IV > I (D) II > III > I > IV

6. When K_2CrO_4 is added to $CuSO_4$ solution there is formation of $CuCrO_4$ and $CuCr_2O_7$. Formation of $CuCr_2O_7$ is due to:
(A) basic nature of $CuSO_4$ solution which converts CrO_4^{2-} to $Cr_2O_7^{2-}$
(B) acidic nature of $CuSO_4$ solution which converts CrO_4^{2-} to $Cr_2O_7^{2-}$
(C) $CuSO_4$ has a typical property of converting CrO_4^{2-} to $Cr_2O_7^{2-}$
(D) none of the above is correct

7. Amorphous boron is extracted from borax by following steps:
$\text{Borax} \xrightarrow{(X)} H_3BO_3 \xrightarrow{(Y)} B_2O_3 \xrightarrow{(Z)} \text{Boron}$
What are (X) and (Z)?
(A) H_2SO_4, Al (B) HCl, C
(C) HCl, Fe (D) H_2SO_4, Na

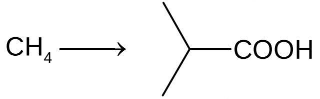
8. Heat of neutralisation of strong acid and strong base under 1 atm and 25^oC is – 13.7 kcal. If standard Gibbs energy change for dissociation of water to H^+ and OH^- is – 19.14 kcal, the change in standard entropy for dissociation of water in cal k^{-1} mol^{-1} is:
(A) 18.25 (B) 110.2
(C) - 18.25 (D) none of these

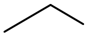
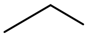
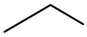
Space for Rough work

9. A metal crystallises in bcc lattice. The % of fraction of edge length not covered by atom is:
(A) 10.4%
(B) 13.4%
(C) 12.4%
(D) 11.4%

10. $E^0_{Al^{3+}/Al} = -1.66$ V and K_{sp} of $Al(OH)_3$ = 1.0×10^{-33}. The reaction potential of above couple at pH = 14 is:
(A) - 2. 31 V
(B) + 2.31 V
(C) + 1.01 V
(D) - 1.01 V

11. Which of the following is correct option of reagent for the given conversion?



(A) $Br_2 / h\nu$,  MgCl, $Br_2 / h\nu$, HCOOH
(B) $Cl_2 / h\nu$,  MgCl, $Br_2 / h\nu$, KCN / H_3O^+
(C) $Br_2 / h\nu$,  MgCl, $Br_2 / h\nu$, $NaNH_2$, HCN, H_3O^+
(D) $Cl_2 / h\nu, CH_3MgBr, Br_2 / h\nu, CH_3COOH$

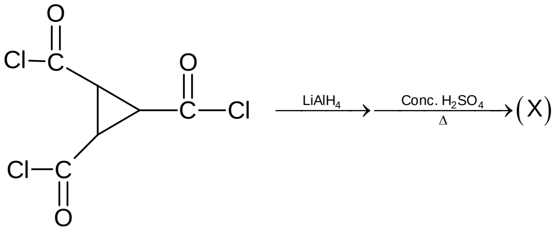
12. Which is correct statements about P_4O_6 and P_4O_{10}?
(A) Both form oxyacids H_3PO_3 and H_3PO_4 respectively.
(B) In P_4O_4 each P is joined to three O and in P_4O_{10} each P is joined to four O atoms.
(C) Both of these
(D) None of these

13. 50 mL of a solution of Na_2CO_3 neutralizes 49.35 mL of 4 N HCl. The reaction is represented as
$CO_3^{2-} + 2H^+ \longrightarrow CO_2 + H_2O$
The density of this Na_2CO_3 solution is 1.25 g mL^{-1}. The percentage of Na_2CO_3 in it is:
(A) 47.7
(B) 37.7
(C) 26.7
(D) 16.7

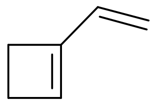
Space for Rough work

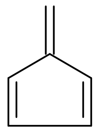
14. In the extraction of copper, the reaction which does not take place in Bessemer converter is:
(A) $2CuFeS_2 + O_2 \longrightarrow Cu_2S + 2FeS + SO_2$
(B) $2Cu_2O + Cu_2S \longrightarrow 6Cu + SO_2$
(C) $2Cu_2S + 3O_2 \longrightarrow 2Cu_2O + 2SO_2$
(D) $2FeS + 3O_2 \longrightarrow 2FeO + 2SO_2$

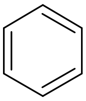
15. In the following compounds of manganese what is the distribution of electrons on d-orbitals of manganese?
(i) $[Mn(H_2O)_6]^{2+}$
(ii) $[Mn(CN)_6]^{4-}$
(A) $t_{2g}^3 e_g^2$ in both
(B) $t_{2g}^5 e_g^0$ in both
(C) $t_{2g}^3 e^2$ in (i) and $t_{2g}^5 e_g^0$ in (ii)
(D) $t_{2g}^5 e_g^0$ in (i) and $t_{2g}^3 e_g^2$ (ii)

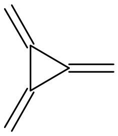
16.


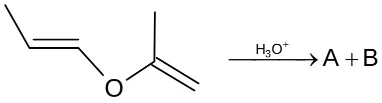
The final product (X) is:

(A)


(B)


(C)


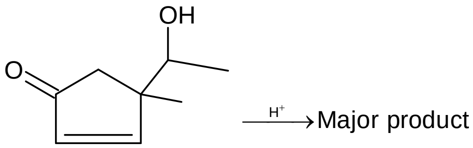
(D)


17.


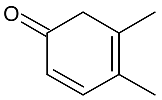
Compounds A and B can be differentiated by
(A) 2, 4-DNP
(B) Fehling solution
(C) Lucas reagent
(D) $NaHSO_3$

Space for Rough work

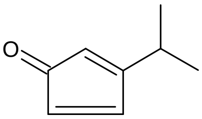
18.


OH
O
H⁺
Major product

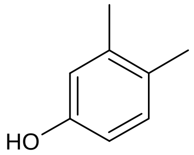
(A)



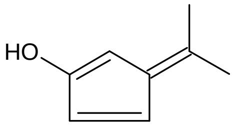
(B)



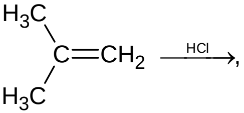
(C)



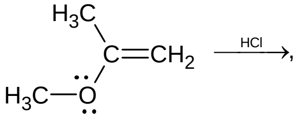
(D)



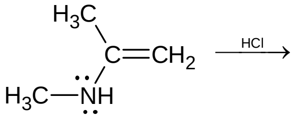
19. Arrange the following reactions ion decreasing order of electrophilic addition reaction:


H3C
C=CH2
H3C
HCl

(I)


H3C
C=CH2
H3C—O
HCl

(II)

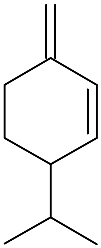

H3C
C=CH2
H3C—NH
HCl

(III)

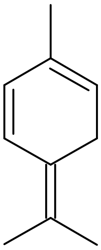
(A) I > II > III
(B) III > II > I
(C) II > III > I
(D) I = II = III

20. Reductive ozonolysis of alkene $C_{10}H_{14}$ gave $CH_3 - CO - CH_3$, $CH_3 - COCHO$ and $OCH - CH_2CO - CHO$ in 1 : 1 : 1 ratio. Which of the following is the most likely structure of alkene.

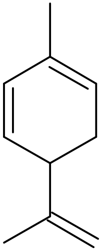
(A)



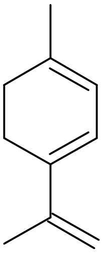
(B)



(C)



(D)



Space for Rough work

21. Temperature of 4 moles of an ideal gas is raised from 300 K to 350 K. What is value of $\Delta H - \Delta E$ for this process? (R = 8.314 J J $mol^{-1}K^{-1}$)

(A) 0	(B) 415 J
(C) 41.5	(D) 1660 J

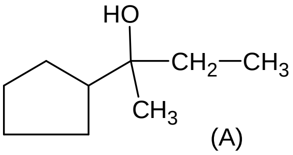
22. K_{sp} of CdS is 8.0×10^{-27} and that of H_2S is 1×10^{-22}. 1×10^{-14} M $CdCl_2$ solution is precipitated on passing H_2S when pH is about

(A) 4	(B) 6
(C) 5	(D) 7

23. For the following equilibrium reaction $N_2O_4(g) \rightleftharpoons 2NO_2(g)$, NO_2 is 50% of total volume at given temperature. Hence, vapour density of equilibrium mixture is:

(A) 34.5	(B) 25.0
(C) 23.0	(D) 20.0

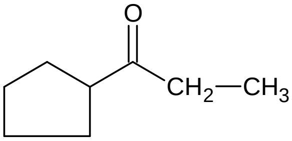
24. To synthesize



(A)

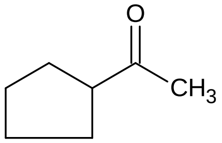
Which of the following reactants cannot be suitable:

(A)



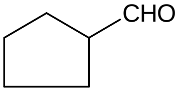
, CH_3MgBr

(B)

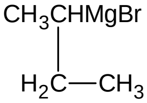


, CH_3CH_2MgBr

(C)

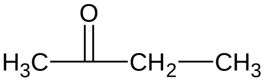


,

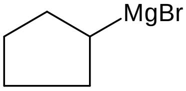


$CH_3CH(MgBr)CH_2CH_3$

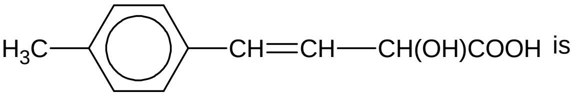
(D)



$H_3C-CO-CH_2-CH_3$,



25. The number of stereoisomers possible for the compound

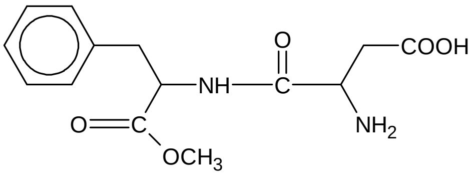


is

(A) 2	(B) 4
(C) 6	(D) 8

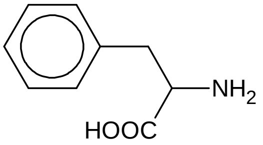
Space for Rough work

26. Aspartame, an artificial sweetener is peptide and has the following structure:

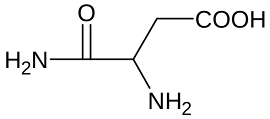


Free amino acids obtained by the hydrolysis of aspartame are

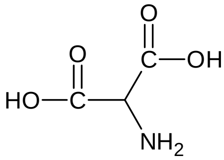
(A)



(B)



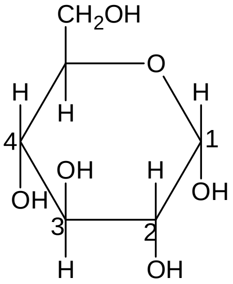
(C)



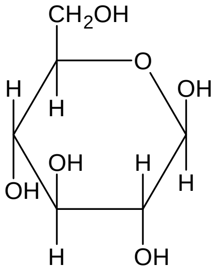
(D) Both (A) and (C)

27. Haworth projection of α-D-glucose is

(A)



(B)



(C) Both (A) and (B)

(D) None of these

28. Which of the following is having highest bondlength?

(A) NO^-
(B) NO^+
(C) CN^-
(D) CN^+

29. A 0.001 molal solution of $Pt(NH_3)_4Cl_4$ in aqueous solution decreases the freezing point by 0.0054^oC. If $K_f = 1.86$ K kg mol^{-1}. What is the formula of the complex:

(A) $[Pt(NH_3)_4Cl_4]$
(B) $[Pt(NH_3)_5Cl]Cl_3$
(C) $[Pt(NH_3)_4Cl_2]Cl_2$
(D) $[Pt(NH_3)_3Cl_3]Cl.NH_3$

30. Holm's signal can be given by using

(A) $CaC_2 + CaCN_2$
(B) $CaC_2 + Ca_3P_2$
(C) $CaC_2 + CaCO_3$
(D) $Ca_3P_2 + CaCN_2$

Space for Rough work

Mathematics PART – III

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. The points A(3, 4) and B(4, 3) lies on same or opposite side of the line ax + by + c = 0, (a, b, c $\in R^+$) in which origin lies and P_1 and P_2 are length of perpendicular from A and B to the line such that $2P_1 + 3P_2 = 10$ then the line ax + by + c = 0 touches the circle

(A) $(x - 18)^2 + (y - 17)^2 = 4$ (B) $\left(x+\frac{18}{5}\right)^2+\left(y-\frac{17}{5}\right)^2=4$

(C) $\left(x-\frac{18}{5}\right)^2+\left(y-\frac{17}{5}\right)^2=4$ (D) $(x - 3)^2 + (y - 6)^2 = 4$

2. If a hyperbola whose foci are (–2, 4) and (4, 6) touches y–axis then equation of hyperbola is

(A) $(3x+y-8)^2-\frac{(x-3y+14)^2}{4}=20$ (B) $\frac{(x+3y-7)^2}{2}-\frac{(x-3y+8)^2}{8}=1$

(C) $\frac{(3x+y-8)^2}{2}-\frac{(x-3y+14)^2}{8}=1$ (D) $\frac{(x-3y+14)^2}{2}-\frac{(3x+y-8)^2}{8}=20$

3. $f(x)=\frac{x^4-14x^2+25}{x-\frac{5}{x}+2}$, zeroes are of the form $a\pm\sqrt{b}$, a, b $\in$ z then a + b is equal to

(A) 5 (B) 6
(C) 7 (D) 8

4. The number 916238457 is an example of nine digit number which contain each of the digits 1 to 9 exactly one, it also has the property that the digit 1 to 5 occur in their natural order, while the digit 1 to 6 do not. Number of such numbers are

(A) 2268 (B) 2520
(C) 2975 (D) 1560

Space for rough work

5. Let z = 18 + 26i, where $z = a + ib$ ($a, b \in R$) is the cube root of z having least positive argument then the value of ab(a + b) is

(A) 18 (B) 12

(C) 10 (D) $\sqrt{10}$

6. A parabola touches two given straight lines originating from a given point. The locus of mid–point of portion of any tangent. Which is intercepted between the given straight line is

(A) parabola (B) ellipse

(C) straight line (D) hyperbola

7. z_1, z_2 and z_3 are three points on a circle centred at origin. A point z is chosen on the circle such that the line joining z and z_1 is perpendicular to the line joining z_2 and z_3. Which of the following is true?

(A) $zz_1 + z_2z_3 = 0$ (B) $z^2 - z_1^2 + z_2z_3 = 0$

(C) $z^2 + z_1^2 + z_2z_3 = 0$ (D) $zz_1 - z_2z_3 = 0$

8. Let $C_n = \int_{\frac{1}{n+1}}^{\frac{1}{n}} \frac{\tan^{-1}(nx)}{\sin^{-1}(nx)}\,dx$ then $\lim_{n\to\infty} n^2 \cdot C_n$ equals

(A) 1 (B) 0

(C) –1 (D) $\frac{1}{2}$

9. We have 21 identical balls available with us which we need to be distributed amongst 3 boys A, B and C such that A always gets an even number of balls. The number of possible ways of doing this is

(A) 112 (B) 120

(C) 126 (D) 132

10. The equation $x a^{1/x} + \frac{1}{x} a^x = 2a$, $a \ge 1$; $a, x \in R$ has

(A) only one solution as x = 1 (B) only positive solution as x = 1

(C) infinite solutions (D) none of these

Space for rough work

11. A card from a pack of 52 cards is lost. From the remaining cards two cards are drawn at random and are found to be spades. What is the probability that the missing card was a spade

(A) $\frac{1}{5}$ (B) $\frac{11}{50}$
(C) $\frac{6}{25}$ (D) $\frac{1}{4}$

12. The latus rectum of a conic section is the width of perpendicular line segment through the focus. The positive difference between the lengths of the latus rectum of $3y = x^2 + 4x - 9$ and $x^2 + 4y^2 - 6x + 16y = 24$ is

(A) $\frac{1}{2}$ (B) 2
(C) $\frac{3}{2}$ (D) $\frac{5}{2}$

13. Let A be a (n × n) matrix with $|A| = 4$, B is the adjoint of the matrix 2A such that $|B| = 1024$. What is the value of n?

(A) 3 (B) 4
(C) 5 (D) more than 5

14. Suppose that the domain of the function f(x) is set D and the range is the set R, where D and R are the subsets of real numbers. Consider the functions: f(2x), f(x + 2), 2f(x), $f\left(\frac{x}{2}\right)$, $\frac{f(x)}{2} - 2$. If m is the number of functions listed above that must have the same domain as f(x) and n is the number of functions that must have the same range as f(x) then the ordered pair (m, n) is

(A) (1, 5) (B) (2, 3)
(C) (3, 2) (D) (3, 3)

15. Let $\vec{a}_1, \vec{a}_2 \ldots\ldots \vec{a}_n$ be the sides of a regular polygon inscribed in a circle of unit radius. If $\left[\vec{a}_1 \times \vec{a}_2 + \vec{a}_2 \times \vec{a}_3 \ldots\ldots + \vec{a}_n \times \vec{a}_1\right] = \left[\vec{a}_1 \cdot \vec{a}_2 + \vec{a}_2 \cdot \vec{a}_3 + \ldots\ldots + \vec{a}_n \cdot \vec{a}_1\right]$ smallest possible value of n is

(A) 4 (B) 6
(C) 8 (D) 12

Space for rough work

16. Let us consider f(x) = 1 – x + [x] – [1 – x] and g(x) = 1 – x – $\lim\limits_{n\to\infty}(\cos^{2n+1}\pi x)$

(A) the graph of f(x) is a straight line passing through origin.
The graph of g(x) is straight line passing through origin
(B) the graph of both f(x) and g(x) is a straight line not passing through origin
(C) the graph of f(x) is a straight line passing through origin whereas for that of g(x) is not passing through origin
(D) will not be a straight line for either of the curve

17. Let f(x) = [x] + $\{x\}^2$: R → R, then area of figure bounded by y = $f^{-1}(x)$, y = 0 between the ordinates x = $\frac{1}{2}$ and x = 5 is (where [.] and {.} represent the greatest integers and fractional part functions respectively)

(A) $\frac{1}{3\sqrt{2}}\left[40\sqrt{2}+1\right]$
(B) $\frac{40}{3}$
(C) $\frac{40}{3\sqrt{2}}$
(D) $\frac{1}{3\sqrt{2}}\left(40\sqrt{2}-1\right)$

18. What is the minimum value of $\frac{\sec^4\alpha}{\tan^2\beta}+\frac{\sec^4\beta}{\tan^2\alpha}$ for α, B ≠ $\frac{k\pi}{2}$, k ∈ z?

(A) 2
(B) 4
(C) 8
(D) 16

19. Consider straight line ax + by = c where abc ∈ R^+ and a, b, c are distinct. This line meets the coordinate axes at P and Q respectively. If area of ΔOPQ, 'O' being origin does not depend upon a, b and c then

(A) a, b, c are in GP
(B) a, c b are in GP
(C) a, b, c are in AP
(D) a, c, b are in AP

20. In a ΔABC, a, c, ∠A are fixed. The third side may have two possible values say b_1 and b_2. It is given that $b_2 = 2b_1$. Then find the value of $\frac{c}{a}\sqrt{1+8\sin^2 A}$

(A) 1
(B) 2
(C) 3
(D) 4

21. If A is an invertible idempotent matrix and B = $7A^7 + 6A^6 + 5A^5 + \ldots + A$ then |B| is equal to

(A) 7
(B) 14
(C) 28
(D) 35

Space for rough work

22. Find the number of triangles formed by the lines represented by $x^3 - x^2 - x - 2 = 0$ and $x y^2 + 2 x y + 4 x - 2 y^2 - 4 y - 8 = 0$

(A) one	(B) two
(C) three	(D) none of these

23. Let $f(x) = \sin^3 x + \lambda \sin^2 x$ for $-\frac{\pi}{2} < x < \frac{\pi}{2}$ and $\lambda > 0$. The interval in which λ should lie in order that f(x) has exactly one minimum and one maximum is

(A) $0 < \lambda < \frac{3}{2}$	(B) $0 < \lambda < 1$
(C) $1 < \lambda < 2$	(D) $1 < \lambda < 3/2$

24. If $P(x) = ax^2 + bx + c$ leaves a remainder of 4 when divided by x, a remainder of 3 when divided by (x + 1) and a remainder of 1 when divided by (x – 1) then P(2) is

(A) 3	(B) 6
(C) –3	(D) –6

25. Let $L_1 : 2x + 3y + p - 3 = 0$ and $L_2 : 2x + 3y + p + 3 = 0$ be two lines and $p \in z$.
Let $C : x^2 + y^2 + 6x + 10y + 30 = 0$. If it is given that at least one of the lines L_1 L_2 is chord of C the probability that both are chords of C is

(A) $\frac{2}{7}$	(B) $\frac{3}{7}$
(C) $\frac{4}{11}$	(D) $\frac{5}{11}$

26. If $\lim_{n\to\infty} \frac{n \cdot 3^n}{n(x-2)^2 + n \cdot 3^{n+1} - 3^n} = \frac{1}{3}$ then the range of x is ($n \in N$)

(A) [2, 5]	(B) (1, 5)
(C) (–1, 5)	(D) $(-\infty, \infty)$

Space for rough work

27. The coordinate plane is constrained by the hyperbola $x^2 - y^2 = 4$ so that only the region exterior of the hyperbola is accessible what are the possible values of the ordinates of the center of a circular disc of radius 4 where centres lies on the y–axis?

(A) $\left(-\infty,\ -\sqrt{2}\right] \cup \left[\sqrt{2},\ \infty\right)$
(B) $\left(-\infty,\ -2\sqrt{3}\right] \cup \left[2\sqrt{3},\ \infty\right)$
(C) $\left(-\infty,\ -\sqrt{6}\right) \cup \left[\sqrt{6},\ \infty\right)$
(D) $\left(-\infty,\ -2\sqrt{6}\right] \cup \left[2\sqrt{6},\ \infty\right)$

28. If $\left|x^2 - \frac{\pi}{4} + \sin x - 2\right| = \left|x^2 - 2\right| + \left|\sin x\right| + \frac{\pi}{4}$ then

(A) $x \in \left(0,\ \sqrt{2}\right)$
(B) $x \in \left(-\sqrt{2},\ \sqrt{2}\right)$
(C) $x \in R$
(D) $x \in \left(-\sqrt{2},\ 0\right)$

29. A plane P makes intercepts with the axes, the sum of whose square is a constant equal to K^2. The foot of the perpendicular from the origin P is $(\lambda, \lambda, \lambda)$ the value of λ in terms of K is

(A) $\pm\frac{K}{3\sqrt{3}}$
(B) $\pm\frac{K}{2\sqrt{3}}$
(C) $\pm\frac{K}{\sqrt{3}}$
(D) $\pm\frac{2K}{\sqrt{3}}$

30. Let $f(x) = \ln\left(\frac{x^2 + e}{x^2 + 1}\right)$ then the range of $g(x) = \sqrt{\sin f(x)} + \sqrt{\cos f(x)}$ is

(A) $\left(1,\ 2^{3/4}\right]$
(B) $\left[1,\ 2^{1/2}\right)$
(C) $\left[1,\ 2^{2}\right]$
(D) $(1,\ 2)$

Space for rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

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3.	A	C	C
4.	A	C	B
5.	B	B	B
6.	C	B	C
7.	C	D	A
8.	C	B	D
9.	A	B	D
10.	C	A	A
11.	D	B	B
12.	A	C	A
13.	B	D	A
14.	C	A	B
15.	A	C	C
16.	D	C	D
17.	D	B	D
18.	A	C	C
19.	B	C	B
20.	A	B	C
21.	B	D	C
22.	B	C	D
23.	D	A	A
24.	B	C	D
25.	A	B	B
26.	A	D	C
27.	D	A	D
28.	B	A	D
29.	D	C	A
30.	C	B	A

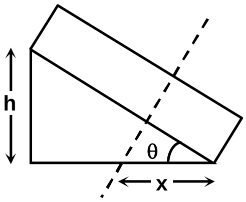
Physics

PART – I

SECTION – A

1. $\therefore$ Net force on the system is
$F = 3\,mg\sin\theta - \mu_k\,3\,mg\cos\theta$
$\therefore\ a_{cm} = \dfrac{3mg\sin\theta - 3\mu_k mg\cos\theta}{3m} = 4\ m/s^2$

2. Consider an arbitrary moment when the wedge has travelled a distance x into region II.
The area of the top surface inside the region II = ax sec θ
Force on it = ax sec θ ΔP = ax sec θ [ΔP =1]
Component of the force opposite velocity = ax sec θ. sin θ = ax tan θ.
If it further moves by dx then the work done = ax tanθ dx
$\therefore\ \dfrac{1}{2}mv_0^2 = a\tan\theta\int_0^b x\,dx$
$\Rightarrow\ v_0 = \sqrt{\dfrac{abh}{M}}$



3. $S_A = v_0t - \dfrac{1}{2}\mu_A g t^2$
$S_B = v_0t - \dfrac{1}{2}\mu_B g t^2$
$S_A - S_B = L - \ell \Rightarrow t = \sqrt{\dfrac{2(L-\ell)}{(\mu_B - \mu_A)g}}$

4. $N/N_0 = e^{-\lambda t}$

5. First law of motion.

6. For vertical oscillation time period
$T_1 = 2\pi\sqrt{\dfrac{m}{k}}$ . . . (1)
For the transverse oscillation period of simple pendulum $T_2 = 2\pi\sqrt{\dfrac{\ell}{g}}$
But $2T_1 = T_2 \Rightarrow k = \dfrac{4mg}{\ell}$

8. $-\dfrac{3GMm}{2R} + \dfrac{1}{2}mv^2 = 0$
$\Rightarrow\ v = \sqrt{3gR}$

9. Tension in the string $T = mg - F_B = 3\rho vg - \rho vg = 2\rho vg$
Balancing torque
$kxR/2 = TR$
$\Rightarrow\ x = 2T/k = 4\rho vg/k$

10. II and IV quadrant field will be added.

11. $v_P = \dfrac{1600 \times 10^{-6}}{4 \times 10^{-4}} = 4$ m/s

$v_Q = \dfrac{1600 \times 10^{-6}}{2 \times 10^{-4}} = 8$ m/s

$\rho_A - \rho_B = \dfrac{1}{2}\rho_A\left(v_Q^2 - v_P^2\right) = \rho gh$

h = 3.6 mm

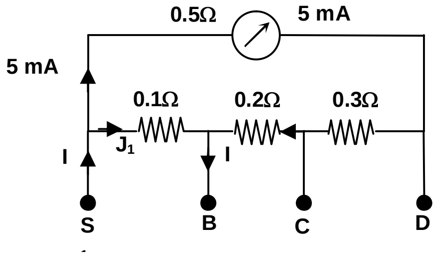
12. $mg - T = ma$ ----- (1)

$T_r = \dfrac{mr^2}{2} \times \dfrac{a}{r}$ ----- (2)

From (1) and (2), $a = \dfrac{2g}{3}$ & $T = \dfrac{mg}{3} = \mu mg$

$\mu = \dfrac{1}{3}$

13. $J_1 \times 0.1 = 5 \times I$
$J_1 = 50$ mA
$I = 50 + 5 = 55$ mA

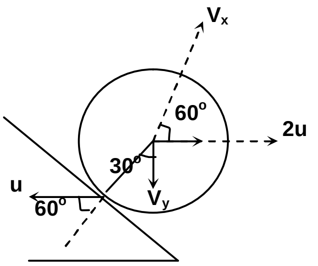


16. Let V_x and V_y be components of velocity. At contact point A and B,
the velocity along normal should be same.

$u\cos 60^\circ = V_y \cos 30^\circ - V_x \cos 60^\circ$ …. (1)

$v_x = 2u$

$v = \sqrt{V_x^2 + V_y^2}$

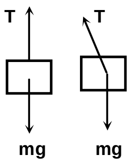


19. $qEy = \dfrac{1}{2}mv^2$

Magnetic force will not do any work.

20. Conceptual.

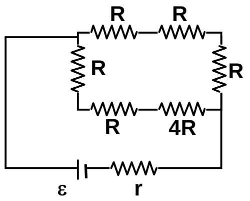
21. Now downward force on the right block is more.



22. $I_C = I_0 + M(OC)^2 = I_0 + M(OB^2 + BC^2) = I_B + M(BC)^2$

23. Coulombic force between them remains same.

24. Circuit is forming a wheatstone bridge $R_{eq} = 2R$
For maximum power transfer 2R = r.

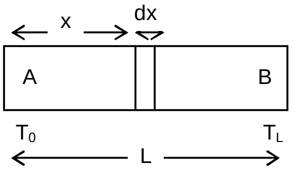


25. $\phi = \frac{\sqrt{3}}{4}\ell^2 B$

$\varepsilon = \left|\frac{d\phi}{dt}\right| = \frac{\sqrt{3}}{4}\ell^2\frac{dB}{dt}$

$i = \frac{\varepsilon}{R} = \frac{\sqrt{3}\ell^2}{4R}$

26. $C = \sqrt{\frac{\gamma RT}{M_0}} = \sqrt{\frac{5RT}{3M_0}}$

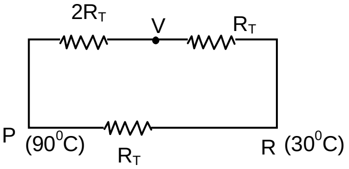


$dx = C.\ dt = \sqrt{\frac{5R}{3M_0}\left[T_0 + \left(\frac{T_L - T_0}{L}\right)x\right]}dt$

$t = \frac{2L}{(\sqrt{T_L} + \sqrt{T_0})}\sqrt{\frac{3M}{5R}}$

27. Equivalent circuit is

$\frac{90 - V}{2R_T} = \frac{20}{R_T} \Rightarrow V = 50^0C$



28. Leftward Force = $\frac{2I}{C} = \frac{\Delta P}{\Delta t}$

29. Conceptual, torque of pseudo force.

30. Effective length = $(r_2 + r_1)$

Chemistry

PART – II

SECTION – A

1. $P_1V_1^{\gamma} = P_2V_2^{\gamma}$

$$\Rightarrow \frac{P_1}{P_2} = \left(\frac{V_2}{V_1}\right)^{\gamma} = \left(\frac{\rho_1}{\rho_2}\right)^{\gamma} = (32)^{\frac{7}{5}}$$

$$= \left(2^5\right)^{\frac{7}{5}} = 2^7 = 128.$$

2.

$$\begin{array}{llll} & NH_4Cl \rightleftharpoons & NH_3(g) + & HCl \\ t = 0 & 0.20 & 0 & 0 \\ \text{At eqm.} & (0.2 - x) & x & x \end{array}$$

$K_P = P_{NH_3} \times P_{HCl} = P^2 \Rightarrow P = \sqrt{K_P}$

$= \sqrt{0.36} = 0.6$ atm.

NH_3 formed $= \frac{PV}{RT} = \frac{0.6 \times 10}{0.0821 \times 600}$

= 0.122 mole = moles of NH_4Cl decomposed.

$\therefore$ Moles of NH_4Cl left = 0.2 – 0.122 = 0.078.

7. $Na_2B_4O_7 + \underset{(X)}{H_2SO_4} \longrightarrow Na_2SO_4 + H_2B_4O_7$

$H_2B_4O_7 + 5H_2O \longrightarrow 4H_3BO_3$

$2H_3BO_3 \xrightarrow{\Delta} B_2O_3 + 3H_2O$

$B_2O_3 + \underset{(X)}{6Na} \longrightarrow 2B + 3Na_2O$

8. $\Delta G^o = \Delta H^o - T\Delta S^o$

$H_2O \rightleftharpoons H^+ + OH^-$ $\quad \Delta H^o = 13.7$ kcal

$$\Delta S^o = \frac{\Delta H^o - \Delta G^o}{T} = \frac{13.7 + 19.14}{298}$$

= 0.1102 kcal mol^{-1} = 110.2 cal k^{-1} mol^{-1}

9. In bcc, $r = \frac{\sqrt{3}\,a}{4}$

Edge length = a

$\therefore$ Edge length not covered by atom = a – 2r

$$= a - \frac{\sqrt{3}}{2} \times a = a\left(\frac{2-\sqrt{3}}{3}\right)$$

$\therefore$ percentage fraction not covered = $\frac{a\left[\frac{2-\sqrt{3}}{2}\right]}{a} \times 100 = 0.134 \times 100$ = 13.4%

10. $Al^{3+} + 3e \longrightarrow Al$ $\qquad K = \dfrac{1}{\left[Al^{3+}\right]}$

$Al(OH)_3 \rightleftharpoons Al^{3+} + 3OH^-$

$pH = 14$, $[H^+] = 1 \times 10^{-14}$

$(OH^-) = 1\ M$

$K_{sp} = [Al^{3+}][1]^3$

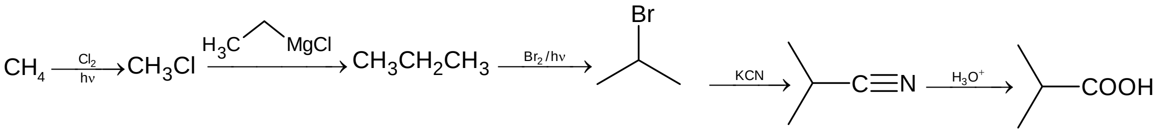
$\therefore \left(Al^{3+}\right) = 1 \times 10^{-33}\ M$

$$E = E^o - \frac{0.0591}{3}\log\frac{1}{\left[Al^{3+}\right]}$$

$$= -1.66 - \frac{0.0591}{3}\log 10^{33} = -1.66 - \frac{0.0591}{3} \times 33$$

$= -\ 2.31\ V$

11.


CH4
Cl2
hν
CH3Cl
H3C
MgCl
CH3CH2CH3
Br2/hν
Br
KCN
C≡N
H3O+
COOH

13. $$\frac{M_1V_1}{n_1}\left(CO_3^{2-}\right) = \frac{M_2V_2}{n_2}\left(H^+\right)$$

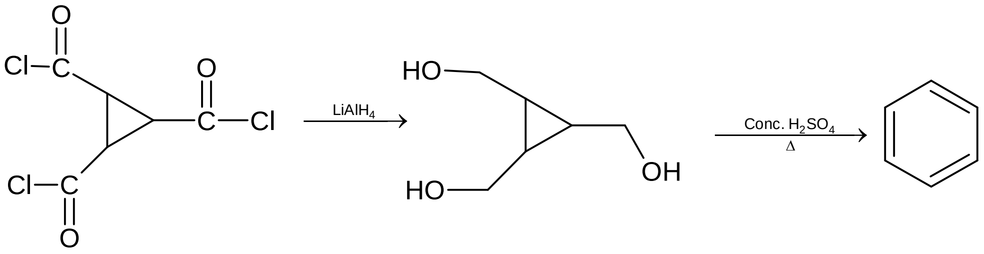
$$\Rightarrow \frac{M_1 \times 50}{1} = \frac{4 \times 49.35}{2} \qquad \therefore M_1 = 1.974$$

$$M = \frac{x \times d \times 10}{m_B} \Rightarrow 1.974 = \frac{x \times 1.25 \times 10}{106}$$

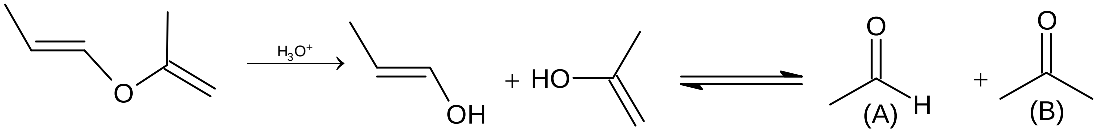
$\therefore x = 16.7$

15. H_2O is weak field ligand while CN^- is a strong field ligand. In complex (i), the distribution is $t_{2g}^3 e_g^{\ 2}$, i.e. all electrons are unpaired while in (ii) complex, the distribution is $t_{2g}^5 e_g^{\ 0}$, i.e. two t_{2g} orbitals are paired while one is unpaired.

16.

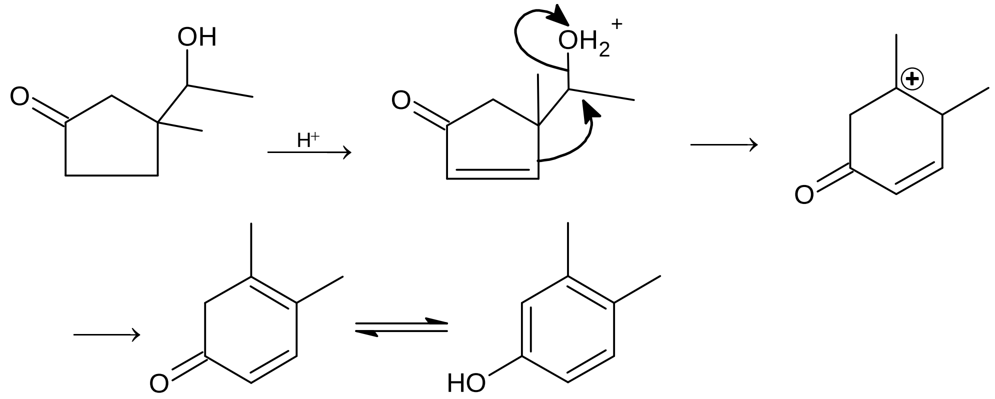

O
Cl
C
O
C
Cl
Cl
C
O
LiAlH4
HO
HO
OH
Conc. H2SO4
Δ

17.

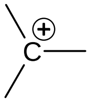

O
H3O+
OH
+ HO
O
H
(A)
+
O
(B)

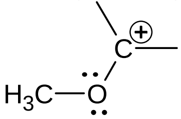
Aldehyde and ketone can be differentiated by Fehling's solution.

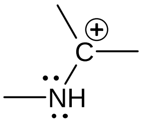
18.



19. The rate can be compared by stability of carbocation.


(I)


(II)


(III)

N has more tendency to donate electron than O.

21. $H = E + PV \Rightarrow H = E + nRT$
$H_2 = E_2 + nRT_2$
$H_1 = E_1 + nRT_1$
$(H_2 - H_1) = (E_2 - E_1) + nR(T_2 - T_1)$
$\Rightarrow \Delta H - \Delta E = nR\Delta T = 4 \times 8.314 \times 50$
$= 1660$ J

22. $H_2S \rightleftharpoons 2H^+ + S^{2-}$
$CdS \rightleftharpoons Cd^{2+} + S^{2-}$
$K_{sp_{CdS}} \rightleftharpoons [Cd^{2+}][S^{2-}]$
$\rightarrow 8 \times 10^{-27} = 1 \times 10^{-14}[S^{2-}]$
$\therefore [S^{2-}] = 8 \times 10^{-13}$ M
$K_{H_2S} = [H^+]^2[S^{2-}]$
$\Rightarrow [H^+]^2 \times 8 \times 10^{-13} = 1 \times 10^{-22}$
$\therefore [H^+]^2 = 1.25 \times 10^{-10}$
$[H^+] = 1.11 \times 10^{-5}$
$\therefore pH \approx 5$.

23. $N_2O_4(g) \rightleftharpoons 2NO_2(g)$
1 0
$(1-x)$ 2x
Total moles = 1 – x + 2x = 1 + x
Since PV = nRT, $V \propto n$
% of $NO_2 = \dfrac{2x}{(1+x)} \times 100 = 50$

$$\therefore x = \frac{1}{3}$$

$$(1+x) = \frac{D}{d} = \frac{\text{Theoretical VD}}{\text{Experimental VD}}$$

$$\Rightarrow \frac{4}{3} = \frac{46}{d} \Rightarrow d = \frac{46 \times 3}{4} = 34.5$$

28.

Species	NO^-	NO^+	CN^-	CN^+
Bond order	2	3	3	2

Bond order $\propto \dfrac{1}{\text{Bondlength}}$

Bondlength of $NO^- > CN^+$ due to greater number of antibonding electrons.

29. $\Delta T_f = i \times K_f \times m \Rightarrow 86 \times 0.001$

$\Rightarrow 0.0054 = i \times 1.86 \times 0.001$

$\therefore i = \dfrac{0.0054}{1.86 \times 0.001} = 2.9 \approx 3$

i.e. there are 3 ions in the solution of complex.
So, $[Pt(NH_3)_4Cl_2]Cl_2$ is the correct choice.

Mathematics PART – III

SECTION – A

1. $$\left|\frac{2(3a+4b+c)+3(4a+3b+c)}{\sqrt{a^2+b^2}}\right| = 10$$

$$\Rightarrow \left|\frac{18a+17b+5c}{\sqrt{a^2+b^2}}\right| = 10$$

$$\Rightarrow \left|\frac{\frac{18}{5}a+\frac{17}{5}b+c}{\sqrt{a^2+b^2}}\right| = 2$$

2. $b^2 = 4 \times 2 = 8,\ 2ae = \sqrt{40}$
$a^2e^2 = 10 = b^2 + a^2$
$\Rightarrow a^2 = 2$
Centre = (1, 5)
Equation of transverse axis $\equiv x - 3y + 14 = 0$
Equation of conjugate axis $\equiv 3x + y - 8 = 0$
Equation of hyperbola = $\dfrac{(3x+y-8)^2}{1} - \dfrac{(x-3y+14)^2}{4} = 20$

3. $$f(x) = \frac{x^4 - 14x^2 + 25}{x - \frac{5}{x} + 2} = \frac{x^2\left(x^2 + \frac{25}{x^2} - 14\right)}{x - \frac{5}{x} + 2}$$

$$= \frac{x^2\left(\left(x-\frac{5}{x}\right)^2-4\right)}{x-\frac{5}{x}+2} = x^2\left(x-\frac{5}{x}-2\right)$$

$\Rightarrow x^2 - 2x - 5 = 0$

$$x = \frac{2\pm\sqrt{4+20}}{2} = \frac{2\pm 2\sqrt{6}}{2} = 1\pm\sqrt{6}$$

4. 6 places can be selected in ${}^9C_6$ ways and 6 can be placed only at 5 places, except the right most of other 6 selected. Remaining numbers i.e. 7, 8, 9 in 3! ways

Hence number of ways = ${}^9C_6 \cdot 5 \cdot 3!$

5. $z = 18 + 26i$, $r = 10\sqrt{10}$, $\tan\theta = \frac{13}{9}$, $\theta \in \left(0, \frac{\pi}{2}\right] \Rightarrow \frac{\theta}{3} \in \left(0, \frac{\pi}{6}\right]$

$\therefore\ z^{1/3} = \left(10\sqrt{10}\left(\cos\theta + i\sin\theta\right)\right)^{1/3} = \sqrt{10}\left(\cos\frac{\theta}{3} + i\sin\frac{\theta}{3}\right)$

$\tan\theta = \frac{3t - t^3}{1-3t^2}$, $\left(t = \tan\frac{\theta}{3}\right)$

$\Rightarrow\ \tan\frac{\theta}{3} = \frac{1}{3}$

$z^{1/3} = 3 + i$, $a = 3$, $b = 1$

6. Let parabola is $y^2 = 4ax$

$\alpha = at_1t_2$, $\beta = a(t_1 + t_2)$, $Q = (at_1t_3, a(t_1 + t_3))$, $R \equiv (at_2t_3, a(t_2 + t_3))$

Let T = (h, k) then h = $\frac{at_3}{2}(t_1 + t_2) = \frac{\beta t_3}{2}$

$2k = a(t_1 + t_2) + 2at_3 = \beta + \frac{4ah}{\beta}$

The locus id $4ax - 2\beta y + \beta^2 = 0$

7. We observe that $\theta = \phi$

because of perpendicularity of two secant

Now $\angle SOR + \angle SOQ - \angle SOP = \pi$ $(\theta = \phi)$

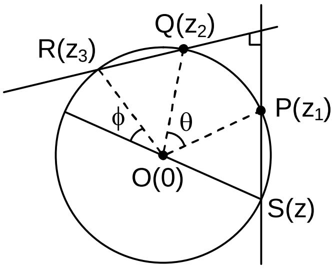
$\Rightarrow (\arg(z_3) - \arg(z) + (\arg(z_2) - \arg(z)) - (\arg(z_1) - \arg(z)) = \pi$

$\Rightarrow \arg(z_3) + \arg(z_2) = \pi + \arg(z_1) + \arg(z)$

$= \arg(z_2z_3) = \pi + \arg(zz_1)$

$\Rightarrow z_2z_3 = -zz_1$

$\Rightarrow zz_1 + z_2z_3 = 0$



8. $$C_n = \frac{1}{n}\int_{\frac{n}{n+1}}^{1} \frac{\tan^{-1}(t)}{\sin^{-1}(t)}dt$$

$$L = \lim_{n\to\infty} n^2 \cdot C_n = \lim_{n\to\infty} n\int_{\frac{n}{n+1}}^{1} \frac{\tan^{-1}t}{\sin^{-1}t}dt\ \ (\infty \times 0)$$

$$L = \lim_{n\to\infty} \frac{\displaystyle\int_{\frac{n}{(n+1)}}^{1} \frac{\tan^{-1} t}{\sin^{-1} t}\,dt}{\frac{1}{n}} \quad \text{(Applying Leibniz rule)}$$

9. We have to find non negative integral solution of equation 2x + y + z = 21
Note that x can take a maximum value of 10 and a minimum value of 0.
We rearrange equation so that we get an integer equation with y and z as variables, x as a constant
y + z = 21 – 2x
The number of non negative integer solution is ${}^{21-2x+2-1}C_1 = {}^{22-2x}C_1 = 22 - 2x$
We now add the number of solutions so obtained for all the possible values of x.
The total number of solution is therefore $\sum_{x=0}^{10}(22-2x) = 132$

10. As a > 0 ⇒ R.H.S. > 0 hence x > 0
Applying AM ≥ GM we get,

$$\frac{x a^{\frac{1}{x}} + \frac{1}{x}a^{x}}{2} \ge a^{\left(x+\frac{1}{x}\right)\frac{1}{2}}$$

L.H.S. $\ge 2\ a^{\frac{1}{2}\left(x+\frac{1}{x}\right)}$

But $x + \frac{1}{x} \ge 2\ \forall\ x > 0$

$\Rightarrow 2\ a^{\frac{1}{2}\left(x+\frac{1}{x}\right)} \ge 2\,a\ \forall\ a \ge 1 \Rightarrow$ L.H.S. ≥ 2 a and equality holds if x = 1.

11. The required probability is $p = \dfrac{\frac{1}{4}\times\frac{{}^{12}C_2}{{}^{51}C_2}}{\frac{1}{4}\times\frac{{}^{12}C_2}{{}^{51}C_2} + \frac{{}^{13}C_2}{{}^{51}C_2}} = \dfrac{11}{50}$

12. $(x+2)^2 = 3\left(y + \frac{13}{3}\right)$ = latus rectum = 3

Other conic is $\dfrac{(x-3)^2}{7^2} + \dfrac{(y+2)^2}{\left(\frac{7}{2}\right)^2} = 1$ which an ellipse is

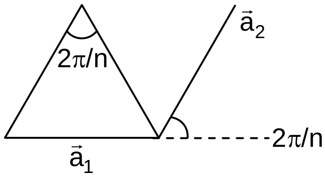
Latus rectum = $\dfrac{2b^2}{a} = \dfrac{2\cdot 49}{4\cdot 7} = \dfrac{7}{2}$

Positive difference $\dfrac{7}{2} - 3 = \dfrac{1}{2}$

13. B = adj (2A) ⇒ $|B| = |2A|^{n-1}$
$1024 = 4^{n-1}\ 2^{n(n-1)}$
$2^{10} = 2^{n^2+n-2}$
n = 3

14. 2f(x) and $\frac{f(x)}{2}$ have the same domain as f(x), f(2x) and f(x + 2), $f\left(\frac{x}{2}\right)$ have the range as f(x)
m = 2, n = 3
Verify by f(x) = $\sin^{-1}$ x, d : |x| ≤ 1, R : $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right)$

15. $|a_1 \times a_2| = |\vec{a}_1||\vec{a}_2|\sin\frac{2\pi}{n}$



$|\vec{a}_1 \cdot \vec{a}_2| = |\vec{a}_1||\vec{a}_2|\cos\frac{2\pi}{n}$

$n\sin\frac{2\pi}{n} = n\cos\frac{2\pi}{n}$

$\tan\left(\frac{2\pi}{n}\right) = 1 \Rightarrow \frac{2\pi}{n} = m\pi + \frac{\pi}{4}$

$n = \frac{8}{1+4m}$

Smallest possible value of n corresponds to m = 0 ⇒ n = 8

17. $f^{-1}(x) = [x] + \sqrt{\{x\}}$

$A = \int_{1/2}^{5} [x] + \sqrt{\{x\}}dx$

$= \int_{1/2}^{5} [x]dx + \int_{1/2}^{1} \sqrt{\{x\}}dx + 4\int_{0}^{2} \sqrt{\{x\}}dx = \frac{1}{3\sqrt{2}}\left(40\sqrt{2} - 1\right)$ sq. unit

18. $\tan^2 \alpha \to a$, $\tan^2 B \to b$

$$\frac{(a+1)^2}{b} + \frac{(b+1)^2}{a} = \left[\frac{a^2}{b} + \frac{1}{b} + \frac{b^2}{a} + \frac{1}{a}\right] + 2\left(\frac{a}{b} + \frac{b}{a}\right) \ge 4\left[\frac{a^2}{b}\cdot\frac{1}{b}\cdot\frac{b^2}{a}\cdot\frac{1}{a}\right]^{1/4} + 2\cdot 2\left[\frac{a}{b}\cdot\frac{b}{a}\right]^{1/2} = 8$$

19. $$A = \frac{1}{2}\begin{vmatrix} 0 & 0 & 1 \\ 0 & \frac{c}{b} & 1 \\ \frac{c}{a} & 0 & 1 \end{vmatrix} = \frac{1}{2}\left[0 - \frac{c^2}{ab}\right]$$

If A is independent of a, b, c then C^2 = ab a, c, b are G.P.

20. Using cosine rule $b^2 - 2bc\cos A + (c^2 - a^2) = 0$
$b_1 + b_2 = 2c\cos A$ $b_1b_2 = c^2 - a^2$
Using $b_2 = 2b_1$

$b_1 = \frac{2c}{3}\cos A$ and $b_1^2 = \frac{c^2 - a^2}{2}$

$\frac{4c^2}{9}\cos^2 A = \frac{c^2 - a^2}{2} \Rightarrow 9(c^2 - a^2) = 8c^2\cos^2 A$

$\Rightarrow \frac{c}{a}\sqrt{1 + 8\sin^2 A} = 3$

22. $x^3 - x^2 - x - 2 = 0 \Rightarrow (x - 2)(x^2 + x + 1) = 0 \Rightarrow x = 2$ … (1)

$x\,y^2 + 2\,x\,y + 4\,x - 2\,y^2 - 4\,y - 8 = 0 \Rightarrow (x - 2)\,(y^2 + 2\,y + 4) = 0 \Rightarrow x = 2$ … (2)
Both the equation represent same line. So number of triangle formed are zero.

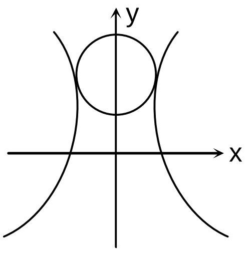
23. $f\,(x) = \sin^3 x + \lambda \sin^2 x$
$f'\,(x) = 3 \sin^2 x \cos x + 2\,\lambda \sin x \cos x$
for exactly one minimum and one maximum
$f'\,(x) = 0$ at two points in $\frac{-\pi}{2} < x < \frac{\pi}{2}$
therefore $f'\,(x) = 0 \Rightarrow \cos x = 0$ or, $\sin x\,(3 \sin x + 2\,\lambda) = 0 \Rightarrow \sin x = \frac{-2\lambda}{3}$ or $\sin x = 0$, $\cos x \neq 0$
$\Rightarrow -1 < \frac{-2\lambda}{3} < 1$
$\Rightarrow \lambda < \frac{3}{2}$ but $\lambda > 0 \Rightarrow 0 < \lambda < \frac{3}{2}$

24. $P(x) = ax^2 + bx + c$
$P(x) = Q_1(x) + 4 = Q_2(x + 1) + 3 = Q_3(x - 1) + 1$
$P(0) = c = 4$
$P(-1) = a - b + 4 = 3\ (b - a = 1)$
$P(1) = a + b + 4 = 1\ (b + a = 3)$
$b = -1,\ a = -2$
$P(x) = 2x^2 - x + 4$
$P(2) = -8 - 2 + 4 = -6$

25. Center (–3, –5)
Radius → 2
For L_1 to be a chord its distance from center must be less than radius
Since P is an integer p can take value $S_1 = \{17, 18, 31\}$
L_2 to be chord of a circle, P can take value from the set $S_2 = \{11, 12, \ldots.. 25\}$
$S_1 \cup S_2$ has 21 elements while
$S_1 \cup S_2$ has 9 elements
Required probability $\frac{9}{21}$ or $\frac{3}{7}$

26. $\lim\limits_{n\to\infty} \dfrac{1}{\dfrac{(x-2)^n}{3^n} + 3 - \dfrac{1}{n}}$ divided N and D by $3^n \cdot n$
$\lim\limits_{n\to\infty}$ to equal to $\frac{1}{3} \Rightarrow \lim\limits_{n\to\infty} \frac{1}{n} \to 0$
$\lim\limits_{n\to\infty} \left(\dfrac{x-2}{3}\right)^n \to 0 \Rightarrow -1 < x < 5$

27. Let the equations of circle be
$x^2 + (y - \lambda)^2 = 16$
$\lambda = \pm\ 2\sqrt{6}$



28. $|x + y + z| = |x| + |y| + |z|$
$\Rightarrow x^2 - 2 < 0, \sin x < 0$
$x \in \left(-\sqrt{2},\ 0\right)$

29. The normal to the plane will have direction cosine $\left(\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}\right)$ and the distance of this plane from the origin will be OP = $\sqrt{3}\lambda$
$\frac{x}{\sqrt{3}} + \frac{y}{\sqrt{3}} + \frac{z}{\sqrt{3}} = \sqrt{3}\lambda = x + y + z = 3\lambda$
Intercepts lengths $(3\lambda, 3\lambda, 3\lambda)$
$(3\lambda)^2 + (3\lambda)^2 + (3\lambda)^2 = k^2$
$\lambda = \pm\frac{k}{\sqrt{3}}$

30. $\frac{x^2 + e}{x^2 + 1} \in (1, e], f(x) = \ln\left(\frac{x^2 + e}{x^2 + 1}\right) \in \left(0, 1\right]$
$g(\theta) = \sqrt{\sin\theta} + \sqrt{\cos\theta}$ where $\theta \in (0, 1]$
$g'(\theta) = \frac{\cos\theta}{2\sqrt{\sin\theta}} - \frac{\sin\theta}{2\sqrt{\cos\theta}} = 0 \Rightarrow \theta = \frac{\pi}{4}$
$g(\theta)$ has an extremum point $\theta = \frac{\pi}{4}$
$g(0) = 1 \Rightarrow g(1) = \sqrt{\sin 1} + \sqrt{\cos 1}$
While $g\left(\frac{\pi}{4}\right) = 2^{3/4} \Rightarrow g(1) > g(0) = 1$
Since $g\left(\frac{\pi}{2}\right) = g(0) = 1$
$g(x) = \left(1, 2^{3/4}\right]$

FIITJEE **JEE (Advanced), 2014**

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - III

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 240**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 07)** contains 7 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (08 – 11) contains 4 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

Section-A (12 – 16) contains 2 paragraphs. Based upon paragraph, 2 and 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-C (01 – 07)** contains 7 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

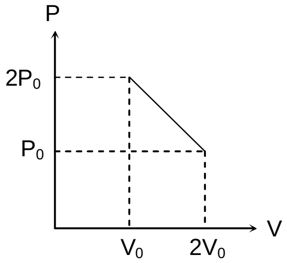
Physics PART – I

SECTION – A

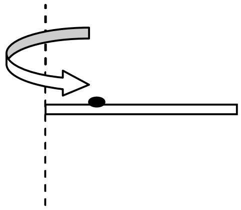
Straight Objective Type

This section contains **7 multiple choice questions** numbered 1 to 7. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

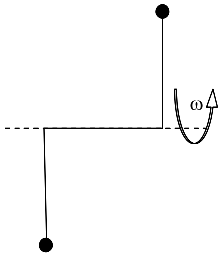
1. A diatomic gas expands from (V_0, $2P_0$) to ($2V_0$, P_0) as shown in the P-V graph. For this process choose the correct statement
(A) Specific heat is positive throughout the process
(B) Specific heat is negative throughout the process
(C) Specific heat is negative from $V = 3V_0/2$ to $V = 7V_0/4$
(D) Specific heat is negative from $V = 5V_0/4$ to $V = 3V_0/2$



2. A uniform straight rod of mass M is free to rotate about a vertical axis through one of its end perpendicular to its length. It is given an angular velocity ω_0 about the vertical axes. And insect of mass M/3 starts moving along the rod away from the axes of rotation with constant speed $L\omega_0$ relative to rod, where L is the length of the rod. By the time insect has reached to the other end, rod has turned through an angle equal to
(A) $\pi/4$ (B) $\pi/2$
(C) $3\pi/4$ (D) π



3. Three massless straight rigid rods, each of length L are rigidly joined to give shape as shown. Two particles each of mass M are fixed at ends as shown. Whole system is free to rotate about a fixed axes passing through the cross section of middle rod as shown in fig. in a gravity free space. What is the net torque acting by the fixed axes on the whole system
(A) Zero (B) $ML^2\omega^2$
(C) $2ML^2\omega^2$ (D) None of these



Space for rough work

4. Six resistor, each of resistance R, are connected at their ends so as form tetrahedral frame. Now two cells of negligible internal resistance, and emf E is connected to the combination. One cell between any two corners and other cell between rest two corners. Thermal power developed will be.

(A) $\frac{E^2}{R}$ (B) $\frac{2E^2}{R}$

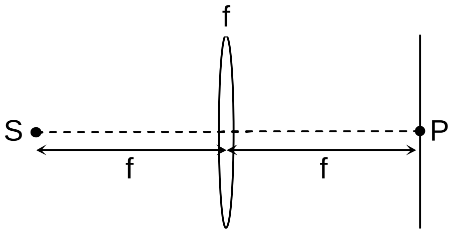
(C) $\frac{4E^2}{R}$ (D) $\frac{8E^2}{R}$

5. Two particles are thrown with same point with same velocity at some time interval. Horizontal component of projection velocity is u. What is Relative angular velocity of the line joining the two particles when they are at same horizontal level.

(A) $\frac{g}{u}$ (B) $\frac{g}{2u}$

(C) $\frac{2g}{u}$ (D) none of these

6. A monochromatic point light source S is placed at a distance 2f from a screen as shown. A convex lens of focal length f is placed in between source and screen as shown. Assume complete transmission of light through lens.



(A) Intensity at point P on the screen before and after placing lens will be same
(B) Intensity at point P on the screen after placing lens will become two times that of before placing lens
(C) Intensity at point P on the screen after placing lens will become four times that of before placing lens
(D) Intensity at point P on the screen before and after placing lens is not comparable

7. A block is suspended by an ideal spring constant K. If the block is pulled down by constant force F and if maximum displacement of block from it's initial position of rest is z, then
(A) z = F/K
(B) z = 2F/K
(C) work done by force F is equal to 2Fz.
(D) increase in potential energy of the spring is $\frac{1}{2}Kz^2$

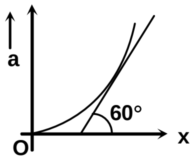
Space for rough work

Multiple Correct Choice Type

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

8. Two concentric coil of radii r_1 and r_2 ($r_1 < r_2$) carry currents i_1 and i_2 respectively. If the smaller coil is rotated slightly about one of its diameter it starts oscillating. Then choose the correct statements.
(A) The oscillations are simple harmonic in nature
(B) The frequency of oscillation is proportional to product i_1i_2.
(C) The frequency of oscillation is proportional to square root of r_2
(D) The frequency of oscillation is independent of radius r_1.

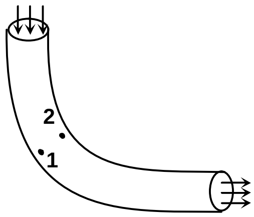
9. A particle starts moving with initial velocity 3 m/s along x-axis from origin. Its acceleration is varying with x in parabolic nature as shown in figure. At x = √3 m tangent to the graph makes an angle 60° with positive x-axis as shown in diagram. Then at x = √3



(A) $v = \sqrt{(\sqrt{3}+9)}$ m/s
(B) $a = 1.5\ \text{m/s}^2$
(C) $v = \sqrt{12}$ m/s
(D) $a = 3\ \text{m/s}^2$

10. A vertical capillary tube with inside radius 0.25 mm is submerged into water so that the length of its part protruding over the water surface is equal to 25 mm. surface tension of water is 73×10^{-3} N/m and angle of contact is zero degree for glass and water, acceleration due to gravity is 9.8 m/s^2. Then choose correct statement.
(A) R = 0.25 mm
(B) h = 59.6 mm
(C) R = 0.60 mm
(D) h = 25 mm
where R is radius of meniscus and h is height of water in capillary tube.

11. Ideal fluid flows along a tube of uniform cross section, located in a horizontal plane and bent as shown in figure. The flow is steady, 1 and 2 are two points in the tube. If P_1 and P_2 are pressure at the two points and v_1 and v_2 are the respective velocities, then



(A) $P_1 < P_2$
(B) $P_1 > P_2$
(C) $v_1 < v_2$
(D) $v_1 > v_2$

Space for rough work

Comprehension Type

This section contains **2 paragraphs**. Based upon one of paragraphs **2 multiple choice questions** and based on the other paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

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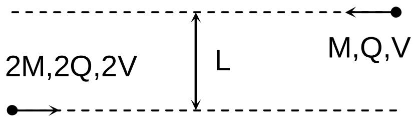
Paragraph for Question Nos. 12 to 13

Two particles approach each other from very large distance as shown. (consider gravitational force between the particle is negligible)

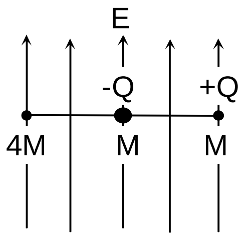


12. If the least separation between the particles is b, what is the speed of M in center of mass frame when particles are closest
    (A) LV/b,
    (B) 2LV/b,
    (C) 3LV/b,
    (D) 4LV/b

13. If $\frac{Q^2}{LMV^2} = 18\pi\varepsilon_0$, find the least separation between the particles
    (A) $\left(\frac{3+\sqrt{13}}{5}\right)L$
    (B) $\left(\frac{3+\sqrt{13}}{2}\right)L$
    (C) $\left(3+\sqrt{13}\right)L$
    (D) 2L

Space for rough work

Paragraph for Question Nos. 14 to 16



Two point masses of mass M and 4M are fixed to the end of a massless straight rod. Mass 4M is kept neutral but mass M is given charge +Q. In the middle of the rod another point mass M with charge –Q is fixed. The whole system is kept on a frictionless horizontal surface perpendicular to uniform horizontal electric field as shown.

14. Ratio of speed of 4M and M with charge –Q when both moving
(A) Varies with time (B) 1 : 1
(C) 3 : 1 (D) 1 : 4

15. Ratio of magnitude of acceleration of –Q and +Q
(A) Varies with time (B) 1 : 1
(C) 1 : 2 (D) 1 : 3

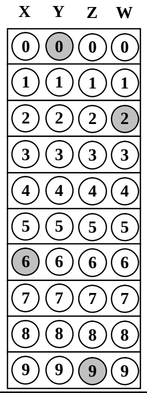
16. Ratio of acceleration of particle at t = 0 to instant when system passes through its stable equilibrium position
(A) Different for different particles (B) 2 : 1
(C) 1 : 2 (D) 1 : 1

Space for rough work

SECTION – C

Integer Answer Type

This section contains **7 questions.** The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



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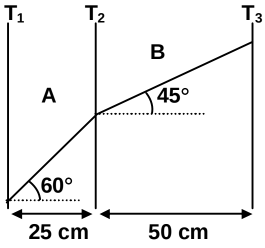
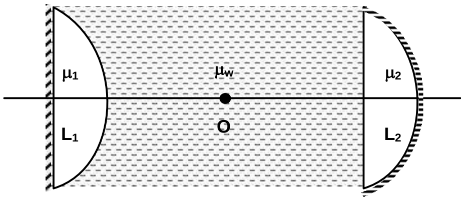
1. A Thread is passing through a hole at the centre of a frictionless table. At the upper end a block of mass 0.5 kg is tied and a block of mass 8 kg is ties at the lower end which freely hanging. The smaller mass is rotated on the table with a constant angular velocity about the axis passing through the hole so as to balance the heavier mass. If the mass of the hanging block is changed from 8 kg to 1 kg. The fractional change in the angular velocity of the smaller mass is $-\frac{K}{4}$, so that it balances the hanging mass again. Find the value of K.

2. Two conductors A and B each of cross section area 5 cm^2 are connected in series. Variation of temperature (in °C) along the length (in cm) is as shown in the figure. If thermal conductivity of A is 200 J/m-sec-°C and the heat current in the conductors is 0.173 J/s. The thermal conductivity of B is $K \times 50\sqrt{3}$ J/m-sec-°C. Find the value of K.

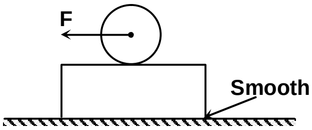


3. A cylindrical tube filled with water (μ_w = 4/3) is closed at its both ends by two silvered plano convex lenses as shown in the figure. Refractive index of lenses L_1 and L_2 are 2.0 and 1.5 while their radii of curvature are 5 cm and 9 cm respectively. A point object is placed some where at a point O on the axis of cylindrical tube. It is found that the object and image coincide each other. Then find the position of object w.r.t. lens L_1 is K × 2 cm. Find the value of K.

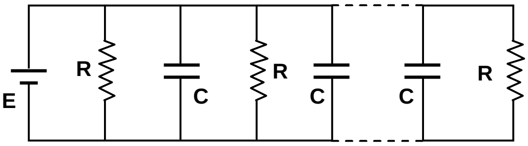


Space for rough work

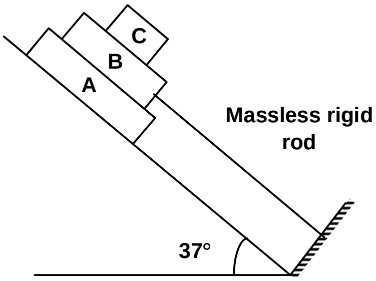
4. A disc of mass m and radius R is placed over a plank of same mass m. There is sufficient friction between the disc and the plank to prevent slipping. A force F is applied at the centre of the disc. Then, the Acceleration of the plank is $\frac{F}{Km}$. Find the value of K.



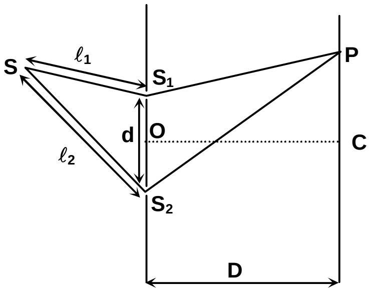
5. n resistances each of resistance R are joined with capacitors of capacity C (each) and a battery of emf E as shown in the figure. In steady state condition, find ratio of charge stored in the first and last capacitor.



6. In the shown figure m_A, m_B and m_C are the masses of the three blocks, the incline is frictionless m_A = 5 kg, m_B = 10 kg, m_C = 2kg. coefficient of friction between A and B is 0.5 and between B and C is 0.1. The frictional force on block A is 6K Newton. Find the value of K. (Take g = 10 m/s^2)



7. In a young double slit experiment. The two slits are illuminated by a monochromatic light source S of wavelength λ = 500 nm. Distance between slits and screen is D = 2m and distance between two slits $S_1S_2 = 10$ μm. ℓ_1 = 20 μm and ℓ_2 = μm, as shown in the figure. If maxima will appear on the screen is 20 K. Find the value of K.



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Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **7 multiple choice questions** numbered 1 to 7. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. For the reaction: $3Fe_2O_3(s) \rightleftharpoons 2Fe_3O_4(s) + \frac{1}{2}O_2(g)$,

$\Delta H^o_{298\ K} = 55.5$ kcal and $\Delta G^o_{298\ K} = 46.5$ kcal. What is the equilibrium constant K_p at 298 K for this reaction.

(A) 1.3×10^{-34}
(B) 1.3×10^{-35}
(C) 4×10^{-35}
(D) 8×10^{-35}

2. If the enthalpy of combustion of benzene, carbon and hydrogen are Q_1, Q_2 and Q_3 respectively, what will be the enthalpy of formation of benzene?

(A) $Q_1 + 6Q_2 + Q_3$
(B) $6Q_2 + Q_1 + 3Q_3$
(C) $6Q_2 - 3Q_3 - Q_1$
(D) $6Q_2 + 3Q_3 - Q_1$

3. $\text{Cyclo pentane} \xrightarrow{Cl_2, h\nu} [X] \xrightarrow[C_2H_5OH]{KOH} [Y] \xrightarrow[H_2O]{O_3/Zn} [Z]$

Here [Z] is:

(A) Pentanal
(B) Pentan – 2 – one
(C) Pentane – 3 – one
(D) Pentane 1, 5 dial

4. Two liquids A and B have $P^o_A : P^o_B$ = 1:3 at certain temperature. If the mole fraction ratio of $X_A : X_B = 1 : 3$, the mole fraction of A in vapour in equilibrium with the solution at a given temperature is:

(A) 0.1
(B) 0.2
(C) 0.5
(D) 1.0

5. $A \underset{K_b}{\overset{K_f}{\rightleftharpoons}} B$ is an exothermic reaction, then on increasing temperature,

(A) K_f/K_b, K_f and K_b all increases
(B) K_f, K_b increases and K_f/K_b decreases
(C) K_f decreases, K_b increases, K_f/K_b remains same
(D) K_f, K_b increases and K_f/K_b remains same

Space for rough work

6. Colourless, tetrahedral complexes among the following are:

(A) $K_3[Cu(CN)_4]$ (B) $Na_2[NiCl_4]$
(C) $K[BF_4]$ (D) $Ni(CO)_4$

7. ZnO is white when cold but yellow when hot because

(A) as ZnO is heated its oxidation state changes
(B) due to escape of oxide ions in the form of oxygen, the electrons left in the lattice causes colour to a appear
(C) due to metal deficiency on heating, holes transit, producing colours
(D) due to polarisation of oxide ions

Multiple Correct Choice Type

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

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8. During the purification of copper by electrolysis:

(A) the anode used is made of copper ore
(B) pure copper is deposited on the cathode
(C) the impurities such as Ag, Au are present in solution as ions
(D) concentration of $CuSO_4$ solution remains constant during dissolution of Cu

9. For the depression of freezing point experiment with non-volative solute, the correct statement(s) is/are:

(A) vapour pressure of pure solvent is more than that of solution
(B) vapour pressure of pure solvent is less than that of solution
(C) only solute molecules solidify at the freezing point
(D) only solvent molecules solidify at the freezing point

10. Select the false statement(s):

(A) Brownian motion and Tyndall effect are shown by true solutions
(B) Sorption process is a combination of adsorption and absorption process
(C) Hardy-Schulze law is related with coagulation of a sol.
(D) Higher is the gold number greater will be the protective power of a lyophilic colloid

11. Which of the following combinations in an aqueous medium will give a blue colour or precipitate?

(A) $Fe^{2+} + [Fe(CN)_6]^{3-}$ (B) $Fe^{3+} + [Fe(CN)_6]^{4-}$
(C) $Co^{2+} + SCN^-$ (D) $Fe^{3+} + SCN^-$

Space for rough work

Comprehension Type

This section contains **2 paragraphs**. Based upon one of paragraphs **2 multiple choice questions** and based on the other paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

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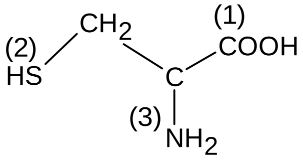
Paragraph for Question Nos. 12 to 13

Read the following paragraph and answer the questions given below:
The pK_a values for the amino acid cysteine are 1.8, 8.3 and 10.8



12. What is the correct assignment of pK_a values for the functional groups 1, 2 and 3:
(A) 1.8 for 1, 8.3 for 2 and 10.8 for 3 (B) 1.8 for 1, 8.3 for 3 and 10.8 for 2
(C) 8.3 for 1, 1.8 for 3 and 10.8 for 2 (D) 8.3 for 1, 1.8 for 2 and 10.8 for 3

13. What will the pH of cysteine at isoelectric point:
(A) 10.8 (B) 9.55
(C) 5.05 (D) 6.3

Paragraph for Question Nos. 14 to 16

Read the following paragraph and answer the questions given below:
(A) is one of the substance formed when SO_2 and PCl_5 react together. It is a fuming liquid which dissolves in water to give a pungent smelling aqueous solution which turns blue litmus red. 5.95 g of (A) were dissolved in water and the solution was made up to 1 dm^3. Dilute HNO_3 and excess of $AgNO_3$ solution was added to 100 cm^3 of this solution and the precipitate was collected dried & weighed. Dilute HCl followed by $BaCl_2$ solution was added to a second 100 cm^3 portion of solution. No precipitate formed, but on further addition of H_2O_2 solution to the mixture, a white precipitate was obtained. After collecting and drying, the precipitate was weighed.

14. The fuming liquid dissolves in water to give a pungent smelling liquid which turns blue litmus red. The fuming liquid is
(A) SO_2Cl_2 (B) $SOCl_2$
(C) HCl (D) SO_2

15. The weight of precipitate obtained in first case is
(A) 0.2 g (B) 1.435 g
(C) 0.05 g (D) none of these

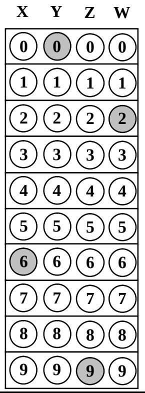
16. The weight of the precipitate obtained in second case is
(A) 0.05 g (B) 1.165 g
(C) 0.583 g (D) 0.595 g

Space for rough work

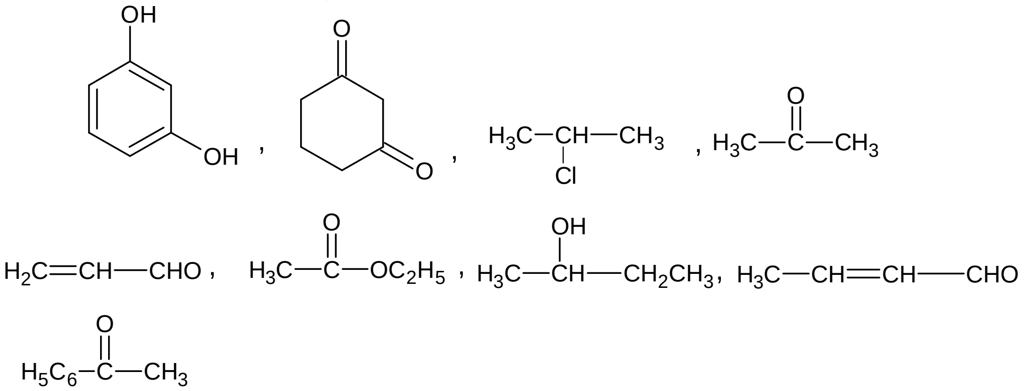
SECTION – C

Integer Answer Type

This section contains **7 questions.** The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. Consider the following compounds:



$H_3C-\underset{Cl}{\underset{|}{CH}}-CH_3$, $H_3C-\overset{O}{\overset{\|}{C}}-CH_3$

$H_2C{=}CH-CHO$, $H_3C-\overset{O}{\overset{\|}{C}}-OC_2H_5$, $H_3C-\overset{OH}{\overset{|}{CH}}-CH_2CH_3$, $H_3C-CH{=}CH-CHO$

$H_5C_6-\overset{O}{\overset{\|}{C}}-CH_3$

How many of these compounds would give iodoform test?

2. n-butane on monobromination gives three isomers. The number of product(s) obtained when the major product is heated with KOH in CH_3CH_2OH is/are……………..

Space for rough work

3. When a strong current of trivalent gaseous boron is passed through a germanium crystal, its density decreases due to part replacement of Ge by B and due to interstitial vacancies created by missing Ge atoms. When one gm of Ge is taken in the above experiment, the percentage of missing vacancies due to germanium, which are filled by B atoms is found to be 2.376 and boron atoms are found to be 150 ppm by weight. Assuming no volume change in lattice, find the percentage decrease in density of Ge crystal. (At. Wt. of Ge = 72.6, B = 11)

4. What is the minimum pH required to prevent the precipitation of ZnS in a solution that is 0.01 M $ZnCl_2$ and saturated with 0.10 M H_2S? [Given k_{sp} of ZnS = 10^{-21}, For H_2S $K_{a_1} \times K_{a_2} = 10^{-20}$].

5. What will be the simplest stoichiometric coefficient of Cu when it reacts with conc. HNO_3 yielding 3 : 1 ratio of NO_2 and NO.

6. 10 ml of mixture of CO, CH_4 and N_2 exploded with excess of oxygen gave a contraction of 6.5 ml. There was a further contraction of 7 ml when the residual gas was treated with KOH. What is the amount of CH_4 in the original mixture

7. What is ratio of P – O and P = O bonds in $H_4P_2O_7$?

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **7 multiple choice questions** numbered 1 to 7. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. In ΔABC, the ratio $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$ is not always equal to (All symbols used have usual meaning in a triangle)

(A) 2R, where R is circum-radius

(B) $\frac{abc}{2\Delta}$, where Δ is area of triangle

(C) $\frac{2}{3}\left(a^2+b^2+c^2\right)^{1/2}$

(D) $\frac{(abc)^{2/3}}{(h_1h_2h_3)^{1/3}}$ (where h_1, h_2, h_3 are lengths of altitudes)

2. Let α be a real value such that $0 \le \alpha \le \pi$. If f(x) = cos x + cos(x + α) + cos(x + 2α) takes some constant C for any real $x \in R$ then the value of [C + α] is equal to (Where [.] denotes the greatest integer function)

(A) 0	(B) 1
(C) –1	(D) 2

3. $\int \frac{\sin 2x + \sin 4x - \sin 6x}{1+\cos 2x + \cos 4x + \cos 6x}dx$ is equal to

(A) $\frac{1}{3}\ln\lvert\sec 3x\rvert + \frac{1}{2}\ln\lvert\sec 2x\rvert + \ln\lvert\sec x\rvert + c$	(B) $\frac{1}{3}\ln\lvert\sec 3x\rvert - \frac{1}{2}\ln\lvert\sec 2x\rvert - \ln\lvert\sec x\rvert + c$
(C) $C - \frac{1}{3}\ln\lvert\sec 3x\rvert + \frac{1}{2}\ln\lvert\sec 2x\rvert + \ln\lvert\sec x\rvert$	(D) $C - \frac{1}{3}\ln\lvert\sec 3x\rvert - \frac{1}{2}\ln\lvert\sec 2x\rvert - \ln\lvert\sec x\rvert$

Space for rough work

4. Let $\beta(x) = \int_0^{x\pi} \sqrt{1-\sin t}\,dt$. The value of $\beta(2) - \beta(1)$ is equal to

(A) $2\sqrt{3}$ (B) $3\sqrt{2}$
(C) 4 (D) 2

5. The centres of the three circles A, B, and C are collinear with the centre of circle B lying between the centres of circle A and C circles A and C both touch externally to circle B and the three circles share a common tangent line. Given that circle A has radius 12 and circle B has radius 42 the radius of circle C, is equal to

(A) 120 (B) 136
(C) 147 (D) 171

6. Let f(x) be a differentiable function in the interval [0, 2] then the value of $\int_0^2 f(x)dx$ is equal to

(A) f(c) where $c \in (0, 2)$ (B) 2f(c) where $c \in (0, 2)$
(C) f′(c) where $c \in (0, 2)$ (D) $\frac{1}{2}f(c)$ where $c \in (0, 2)$

7. Equation of the line in the plane x + 3y – z = 9, which is perpendicular to the line $\vec{r} = \hat{i} + \hat{j} + \hat{k} + \lambda(2\hat{i} + \hat{j} - \hat{k})$ and passing through a point where plane meets the given line, is

(A) $\frac{x-3}{2} = \frac{y-2}{1} = \frac{z}{5}$ (B) $\frac{x-3}{-2} = \frac{y-2}{-1} = \frac{z}{5}$
(C) $\frac{x-3}{-5} = \frac{y-2}{1} = \frac{z}{2}$ (D) $\frac{x-3}{1} = \frac{y-2}{5} = \frac{z}{2}$

Multiple Correct Choice Type

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

8. Let $f : R \to [-1, 1]$ be defined as f(x) = cos(sin x) then which of the following is/are correct?

(A) f is periodic with fundamental period 2π (B) range of f = [cos 1, 1]
(C) $\lim_{x\to\pi/2}\left(f\left(\frac{\pi}{2}-x\right)+f\left(\frac{\pi}{2}+x\right)\right) = 2$ (D) f is neither even nor odd function

Space for rough work

9. The sum of the first three numbers in an A.P. is 24 and their product is 384. Then which of the following hold(s) good?
(A) sum of n terms can be $2n(n + 1)$
(B) sum to n terms can be $2n(n + 3)$
(C) sum of n terms can be $14n - 2n^2$
(D) sum of the squares of the three numbers is 224

10. Suppose that f(x) is defined and positive for all real numbers x. If f(x) increases for $x < 0$ and decreases for all $x > 0$, and $g(x) = \frac{1}{f\left(\frac{1}{x}\right)}$ then
(A) g increases for all real x
(B) g increases for $x < 0$
(C) g decreases for $x > 0$
(D) g increases for $x > 0$

11. In ΔABC if $ac = 3$, $bc = 4$ and $\cos(A - B) = \frac{3}{4}$ then
(A) measure of angle A is $\frac{\pi}{2}$
(B) measure of angle B is $\frac{\pi}{2}$
(C) $\cot\frac{C}{2} = \sqrt{7}$
(D) circum–radius of ΔABC is $\frac{2}{7^{1/4}}$

Comprehension Type

This section contains **2 paragraphs**. Based upon one of paragraphs **2 multiple choice questions** and based on the other paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

Paragraph for Question Nos. 12 to 13

Read the following write up carefully and answer the following questions:
Let C be the curve $f(x) = (\ln x)^2 + 2\ln x$ and $A(a, f(a))$, $B(b, f(b))$ where $(a < b)$ are the points of tangency of two tangents drawn from origin to the curve C

12. The value of the product ab is equal to
(A) e
(B) $\frac{1}{e}$
(C) e^2
(D) 1

13. Number of values of x satisfying the equations $5x \cdot f'(x) - x \cdot \ln 10 - 10 = 0$ is equal to
(A) 0
(B) 1
(C) 2
(D) 3

Space for rough work

Paragraph for Question Nos. 14 to 16

Read the following write up carefully and answer the following questions:

Let f and g be two real valued differentiable function on R satisfying $\int_0^x g(t)dt = 3x + \int_x^0 \cos^2 t \cdot g(t)dt$ and

$$f(x) = \lim_{\alpha\to 0} \frac{1}{\alpha^4}\int_0^{\alpha} \frac{\left(e^{x+t} - e^x\right)\ln^2(1+t)}{2t^3 + 3}\, dt$$

14. f(ln 2) is greater than

(A) 0 (B) $\frac{1}{6}$

(C) $\frac{3}{20}$ (D) $\frac{4}{25}$

15. Range of g(x) is equal to

(A) $\left[\frac{3}{2}, 3\right]$ (B) $\left[\frac{1}{2}, 3\right]$

(C) $\left[\frac{3}{2}, \infty\right]$ (D) [–3, 3]

16. The value of definite integral $\int_0^{\pi/2} g(x)dx$ has in the interval

(A) $\left(\frac{2\pi}{3}, \frac{4\pi}{5}\right)$ (B) $\left(\frac{\pi}{2}, \frac{5\pi}{6}\right)$

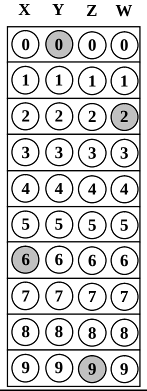
(C) $\left(\frac{3\pi}{4}, \frac{6\pi}{5}\right)$ (D) $\left(\pi, \frac{3\pi}{2}\right)$

Space for rough work

SECTION – C

Integer Answer Type

This section contains **7 questions.** The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. Let $\sum_{=1}^{\infty}\cot^{-1}\left(\frac{k^2}{8}\right) = -\frac{\pi}{\lambda}$, $\lambda \in$ I then the value of λ is equal to _____

2. Given that for a, b, c, d $\in$ R, if a sec(200º) – c tan(200º) = d and b sec(200º) + d tan(200º) = c then $\frac{a^2+b^2+c^2+d^2}{ac-bd} = p\ \text{cosec}(200^o)$ find the value of p _____

3. Given a triangle ABC with AB = 2 and AC = 1 internal bisector of $\angle$BAC intersect BC at D. If AD = BD and Δ is the area of triangle ABC then the value of $12\Delta^2$ is _____

4. A diagonal of rhombus ABCD is a member of both the family of lines $(x + y - 1) + \lambda_1(2x + 3y - 2) = 0$ and $(x - y + 2) + \lambda_2(2x - 3y + 5)$ where $\lambda_1, \lambda_2 \in$ R and one of the vertex of the rhombus is (3, 2). If area of the rhombus is $12\sqrt{5}$ square units then find the length of semi longer diagonal of the rhombus _____

5. Let f(x) be a function defined on R such that $f'(x) = f'(3 - x)\ \forall\ x \in [0, 3]$ with f(0) = –32 and f(3) = 46, then find the value of $\frac{1}{3}\int_0^3 f(x)dx$ _____

6. Consider an isosceles triangle with base a, vertical angle 20º and lateral side each being b. Then the value of $\frac{a^3+b^3}{ab^2}$ _____

7. Find the smallest integral value of P for which the function f(x) = 6Px – P sin 4x – 5x – sin 3x is monotonic increasing and has no critical point on R _____

Space for rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

FIITJEE **JEE(Advanced)-2014**

ALL INDIA TEST SERIES

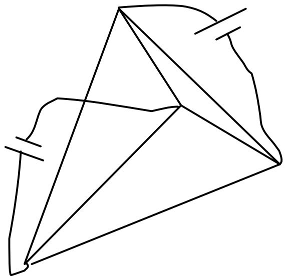
ANSWERS, HINTS & SOLUTIONS
CRT – III
(Paper-1)

	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	A	C
2.	A	D	D
3.	B	D	B
4.	C	A	C
5.	A	B	C
6.	C	C	B
7.	B	B	A
8.	A, D	A, B, D	B, C
9.	A, B	A, D	A, C, D
10.	C, D	A, D	B, C
11.	B, C	A, B, C	B, C, D
12.	B	A	D
13.	B	C	C
14.	B	B	B
15.	D	B	A
16.	C	B	C
1.	3	5	4
2.	4	3	2
3.	5	4	9
4.	4	1	5
5.	1	3	7
6.	5	2	3
7.	2	3	5

Physics

PART – I

4. Apply superposition of currents in each resistor due to each cell to get current in two resistors zero, E/R in rest four, current drawn from each cell is 2E/R



5. One particle t/2 before max height, other t/2 after max height
Relative velocity perpendicular to line joining them = gt
Relative separation = ut
Relative angular velocity = gt/ut = g/u

6. Intensity in absence of lens = $P/4\pi r^2$
So intensity at P before placing lens is ¼ of intensity at optical center of lens
After crossing lens light becomes parallel rays to intensity does not change further along that ray

7. apply work-energy theorem

$$mgz-\left[\frac{1}{2}K\left(\frac{mg}{K}+z\right)^2-\frac{1}{2}K\left(\frac{mg}{K}\right)^2\right]+Fz=0$$

$\Rightarrow$ z = 2F/K.

8. $\tau = MB\sin\theta$

$\Rightarrow \alpha \propto -\theta$

$\Rightarrow f \propto \sqrt{\frac{i_1 i_2}{r_2}}$

9. $a = kx^2$

$$\frac{da}{dx}=2kx \Rightarrow \tan 60^\circ = 2k\sqrt{3} \Rightarrow k=\frac{1}{2}$$

$$a=\frac{x^2}{2}$$

$$v\frac{dv}{dx}=\frac{x^2}{2} \Rightarrow \frac{v^2}{2}=\frac{x^3}{6}+C_1 \text{ at } x = 0,\ v = 3 \text{ m/s}$$

$$C_1=\frac{9}{2}$$

$$v^2=\frac{x^3}{3}+9$$

hence a = 1.5 and $v=\sqrt{\sqrt{3}+9}$

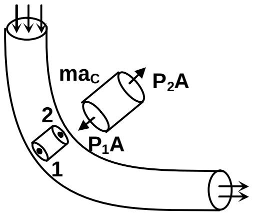
10. Capillary height $h=\frac{2T\cos\theta}{r\rho g}$

$\Rightarrow$ h = 59.6 mm

here 59.6 mm is greater than the protruding part hence water will rise in the capillary of insufficient height 25 mm.

Now, $R = \frac{2T}{hrg} = 0.6$ mm

11. Fluid particles passing through the bend are in circular motion. The centripetal acceleration is provided by the variation in pressure. In the section as shown



$P_1A - P_2A = ma_C$

$\Rightarrow P_1 > P_2$

applying Bernoulli theorem at 1 and 2

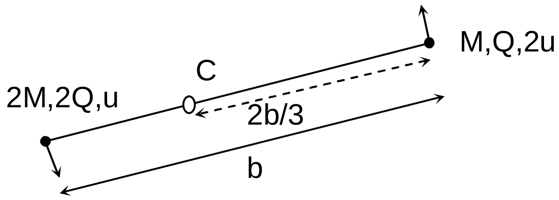
i.e., $P_1 + \frac{1}{2}\rho_1 v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$

$P_1 + \frac{1}{2}\rho_1 v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$ as $h_1 = h_2$

$\because \quad P_1 > P_2$

$v_1 < v_2$

12. In CM frame

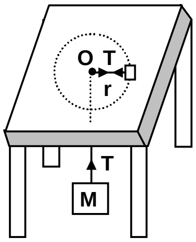


13. At closest approach velocity perpendicular to line joining particles
Conserve kinetic + electric potential energy from large separation to closest approach

16. System rotates about CM i.e. middle of 4M and M(–Q)
For problem 3, work done by electric field = QLE = ½ $I\omega^2$
Initial torque by electric field = QLE = $I\alpha$
$r\alpha/\omega^2 r$ = ½

SECTION–C

1. For circular motion of a body tied to a string on a horizontal plane



$\frac{mv^2}{r} = T$

here, $T = mg$

$\frac{mv_1^2/r_1}{mv_2^2/r_2} = \frac{M_1 g}{M_2 g}$

$\frac{v_1^2 r_2}{v_2^2 r_1} = \frac{8}{1}$ …(i)

Now as angular momentum is conserved about pt 0.

$mv_1 r_1 = mv_2 r_2$ …(ii)

from (i) and (ii) $\frac{r_1}{r_2} = 2$

further $\frac{\omega_2}{\omega_1} = \frac{v_2}{v_1} \times \frac{r_1}{r_2} = \left(\frac{r_1}{r_2}\right)^2$

$$\frac{\omega_2}{\omega_1} = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$$

$$\frac{\Delta\omega}{\omega} = \frac{\omega_2 - \omega_1}{\omega_2} = \frac{\omega_2}{\omega_1} - 1 = \frac{1}{4} - 1 = -\frac{3}{4}$$

2. $\frac{\Delta Q}{\Delta t} = K_A A \frac{dT}{dx}$

$\frac{dT}{dx}$ in conductor A = slope of graph = $\sqrt{3}$

Since both conductors are connected in series, same heat current will flow in A and B.

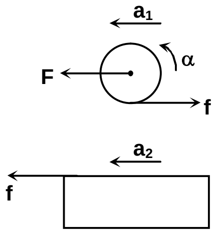
$K_B = \frac{\Delta Q}{\Delta t} \times \frac{1}{A\frac{dT}{dn}} = \frac{\Delta\theta}{\Delta t} \times \frac{1}{A\tan 45^\circ} = 200\sqrt{3}$ J/m-sec°C

3. For lens L_1, ray must move parallel to the axis after refraction $\frac{\mu_1}{\infty} + \frac{\mu_w}{x} = \frac{\mu_1 - \mu_\omega}{R_1} \Rightarrow x = 10$ cm

4. $f = ma_2$

$\alpha = \frac{\tau}{I} = \frac{2f}{mR}$

$\Rightarrow a_2 = F/4m, f = F/4$



5. In steady state potential difference across each capacitor = E

6. $m_{Ag}\sin\theta = 5 \times 10 \times \sin 37^\circ = 5 \times 10 \times \frac{3}{5} = 30$ N

$f_{max} = \mu_{AB}(m_C + m_B)g\cos\theta = 48$ N

hence f = 30 N

7. $|\sin\theta| \le 1$

$-1 \le 2\left[\frac{n}{40} - 1\right] \le 1$

or $20 \le n \le 60$

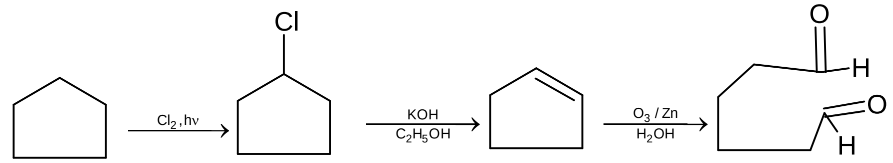
Hence number of maxima = 60 – 20 = 40

Chemistry

PART – II

1. $\Delta G^o = -RT\ln K_p$
$\Rightarrow 46.5 \times 1000 = -2 \times 298 \times \ln K_p$
$\Rightarrow K_p = 1.3 \times 10^{-34}$

2. $C_6H_6 + \frac{15}{2}O_2 \longrightarrow 6CO_2 + 3H_2O; Q_1$
$C + O_2 \longrightarrow CO_2; \quad Q_2$
$H_2 + \frac{1}{2}O_2 \longrightarrow H_2O; \quad Q_3$
Required equation: $6C(s) + 3H_2 \longrightarrow C_6H_6;\ \Delta H = 6Q_2 + 3Q_3 - Q_1$

3.


4. Mole fraction of A in vapour $Y_A = \frac{X_A P_A^o}{X_A P_A^o + X_B P_B^o}$
$\because \frac{X_A}{X_B} = \frac{1}{3} \& \frac{P_A^o}{P_B^o} = \frac{1}{3}$
$\Rightarrow Y_A = \frac{1}{1 + \frac{X_B}{X_A}\frac{P_B^o}{P_A^o}} = \frac{1}{1+3.3} = 0.1$

6. $[Cu(CN)_4]^{3-}$ is square planar and contains Cu (I) which is colourless
$[NiCl_4]^{2-}$ is tetrahedral and contains Ni(II) which is coloured.
$[BF_4]^-$ is tetrahedral and colourless

14. $\underset{(A)}{SO_2 + PCl_5 \longrightarrow SOCl_2} + POCl_3$
$\underset{(A)}{SOCl_2} + H_2O \longrightarrow SO_2 + \underset{(\text{pungent smelling})}{HCl}$

15. $M_{SOCl_2} = \frac{5.95}{119 \times 1} = 5 \times 10^{-2}\ mol/l$
$H_2O + SOCl_2 + 2AgNO_3 \longrightarrow 2AgCl + 2HNO_3 + SO_2$
Moles of AgCl formed = 2 × molarity of $SOCl_2$ in 100 ml = $2 \times 5 \times 10^{-2} \times \frac{100}{1000} = 10^{-2}$ moles
Wt. of AgCl = $143.5 \times 10^{-2} = 1.435$ g

16. IInd part was treated with dil. $HCl/BaCl_2/H_2O_2$.
$SOCl_2 + H_2O \longrightarrow SO_2 + 2HCl$
$H_2O_2 + SO_2 \longrightarrow SO_3 + H_2O$

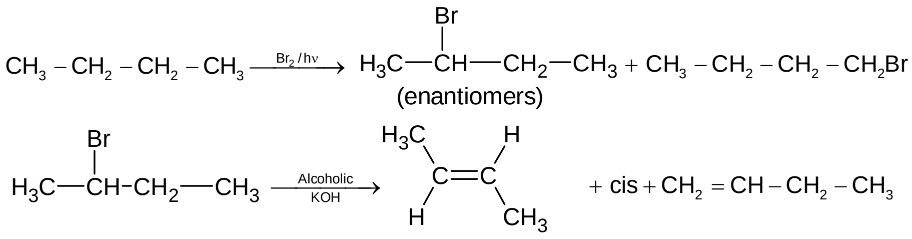
$$SO_3 + H_2O \longrightarrow H_2SO_4$$
$$BaCl_2 + H_2SO_4 \longrightarrow \underset{\text{ppt.}}{BaSO_4} + 2HCl$$

Mole of $BaSO_4$ formed = $5 \times 10^{-2} \times \frac{10}{100}$ in 100 ml solution

$\therefore$ Wt. of $BaSO_4$ formed = $5 \times 10^{-3} \times 233 = 1.165$ g.

SECTION – C

2.



$$CH_3-CH_2-CH_2-CH_3 \xrightarrow{Br_2/h\nu} H_3C-\overset{\overset{\displaystyle Br}{|}}{CH}-CH_2-CH_3 + CH_3-CH_2-CH_2-CH_2Br$$

(enantiomers)

$$H_3C-\overset{\overset{\displaystyle Br}{|}}{CH}-CH_2-CH_3 \xrightarrow[\text{KOH}]{\text{Alcoholic}}$$

$+ \text{cis} + CH_2 = CH-CH_2-CH_3$

3. Let x% be the decrease in density of Ge crystals. Let ‘a’ be the total no. of Ge atoms missing and ‘b’ be the no. of boron atoms replacing Ge atoms.

$\frac{b}{a} \times 100 = 2.376$ … (i)

$1 - \frac{72.6a}{N_{AV}} + \left(\frac{11b}{N_{AV}}\right) = 1 - 0.01x$

$\frac{72.6a}{N_{AV}} - \frac{11b}{N_{AV}} = 0.01x$ … (ii)

Also, b = $\frac{150N_{AV}}{10^6 \times 11} \times (1 - 0.01x)$ … (iii)

$\therefore$ Solving (i), (ii) and (iii)
x = 4%

4. $K_{sp} = [Zn^{2+}][S^{2-}]$

$[S^{2-}] = \frac{10^{-21}}{0.01} = 10^{-19}$

For $K_{a_1}.K_{a_2} = \frac{[H^+]^2[S^{2-}]}{[H_2S]}$

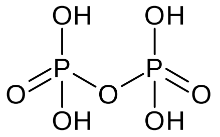
$10^{-20} = \frac{[H^+]^2 \times 10^{-19}}{0.1} \Rightarrow [H^+] = 0.1$

or pH = 1

5. $3Cu + 10HNO_3 \rightarrow 3Cu(NO_3)_2 + 3NO_2 + NO + 5H_2O$

6. Only CO and CH_4 react with O_2, N_2 remain uncreative

7.



$\frac{6}{2} = 3$

Mathematics PART – III

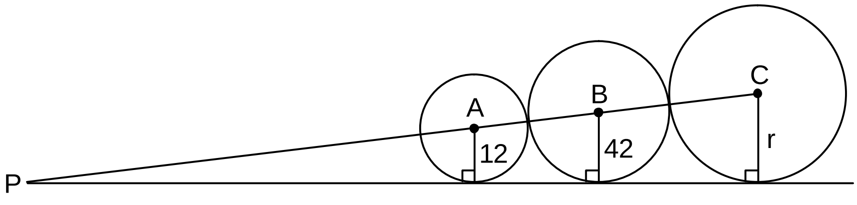
1. A, B, D are always true but C is true only if the triangle is equilateral

2. $f(x) = \cos x + \cos(x + 2\alpha) + \cos(x + \alpha) = (2\cos\alpha + 1)\cos(x + \alpha)$
As $\cos(x + \alpha)$ can take any real value from –1 to 1 $\forall\ x \in R$
But f(x) is constant so $(2\cos\alpha + 1) = 0$ must hold
$\Rightarrow \alpha = \frac{2\pi}{3}$ and C = 0
Hence $[C + \alpha] = \left[0 + \frac{2\pi}{3}\right] = 2$

3. $$\int \frac{2\sin 3x\cos x - 2\sin 3x\cos 3x}{2\cos^2 x + 2\cos x\cdot\cos 5x}dx$$
$$\int \frac{\sin 3x(\cos x - \cos 3x)}{\cos x(\cos x + \cos 5x)}dx$$
$$\int \frac{2\sin 3x\cdot\sin 2x\cdot\sin x}{2\cos x\cdot\cos 3x\cdot\cos 2x}dx$$
$$\int \tan 3x\cdot\tan 2x\cdot\tan x\,dx = \int(\tan 3x - \tan 2x - \tan x)dx$$

4. $$\beta(2) = \int_0^{2\pi}\sqrt{1-\sin t}\,dt$$
$$\beta(2) = \int_0^{\pi}\sqrt{1-\sin t}\,dt + \int_{\pi}^{2\pi}\sqrt{1-\sin t}\,dt$$
$$\beta(2) - \beta(1) = \int_{\pi}^{2\pi}\sqrt{1-\sin t}\,dt$$
Put t = π + x, $\beta(2) - \beta(1) = \int_0^{\pi}\sqrt{1+\sin x}\,dx$
$$= \int_0^{\pi}\left|\cos\frac{x}{2} + \sin\frac{x}{2}\right|dx = 2\left[\sin\frac{x}{2} - \cos\frac{x}{2}\right]_0^{\pi} = 4$$

5. We have $\sin\theta = \frac{12}{PA} = \frac{42}{PB} = \frac{r}{PC} = K(\text{Let})$



So K(PB – PA) = 42 – 12 = 30
K(AB) = 30
K[54] = 30
K = $\frac{30}{54} = \frac{5}{9}$

Now K(PC – PB) = r – 42
K(BC) = r – 42
K[r + 42] = r – 42
On solving r = 147

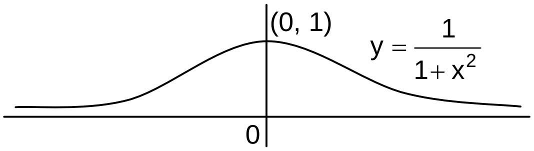
6. Let $g(t) = \int_0^t f(x)dx$
$g'(t) = f(t)$
Now apply Lagrange's mean value theorem in [0, 2], we get
$\frac{g(2) - g(0)}{2 - 0} = g'(c)$ where $c \in (0, 2)$
$\Rightarrow \int_0^2 f(x)dx = 2g'(c)$ where $c \in (0, 2)$

7. Vector perpendicular to $(2\hat{i} + \hat{j} - \hat{k})$ and $(\hat{i} + 3\hat{j} - \hat{k})$ is
$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 1 & -1 \\ 1 & 3 & -1 \end{vmatrix} = 2\hat{i} + \hat{j} + 5\hat{k}$$
Any general point on the line is $(1 + 2\lambda, 1 + \lambda, 1 - \lambda)$ at the point of intersection. This point satisfy equation of plane $(1 + 2\lambda) + 3(1 + \lambda) - (1 - \lambda) = 9$
$\Rightarrow \lambda = 1$
Point of intersection (3, 2, 0) and required line $\frac{x-3}{2} = \frac{y-2}{1} = \frac{z}{5}$

8. (A) f(x) = cos(sin x)
As $f(x + \pi) = \cos(\sin(\pi + x)) = \cos(-\sin x) = \cos(\sin x) = f(x)$
(B) As $-1 \le \sin x \le 1$
$\cos 1 \le \cos(\sin x) \le 1$
(C) $\lim_{x \to \pi/2} \left[f\left(\frac{\pi}{2} - x\right) + f\left(\frac{\pi}{2} + x\right) \right]$
$= \lim_{x \to \pi/2} 2\cos(\cos x) = 2$
(D) Clearly f(x) is even function

9. Let the number be (a – d), a, (a + d)
3a = 24
a = 8
Also (8 – d)(8)(8 + d) = 384
$d^2 = 16$
d = 4 or –4
Hence series is 4, 8, 12, …..
$\Rightarrow S_n = 2n(n + 1)$ or 12, 8, 4, …..
$\Rightarrow S_n = 14n - 2n^2$

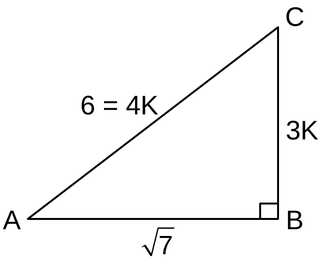
10. f(x) > 0 and f′(x) > 0 for x < 0
f′(x) < 0 for x > 0
Now $g(x) = \frac{1}{f\left(\frac{1}{x}\right)}$



$$g'(x) = \frac{-1}{f^2\left(\frac{1}{x}\right)} \times f'\left(\frac{1}{x}\right) \times \left(\frac{-1}{x^2}\right)$$

So for $x < 0 \Rightarrow g'(x) > 0$
$x > 0 \Rightarrow g'(x) < 0$

11. As ac = 3 and bc = 4



$$\frac{b}{a} = \frac{4}{3} \Rightarrow \frac{b-a}{b+a} = \frac{4-3}{4+3} = \frac{1}{7} \quad (\angle B > \angle A)$$

$$\tan\left(\frac{B-A}{2}\right) = \frac{b-a}{b+a}\cot\frac{C}{2}$$

$$\sqrt{\frac{1-\cos(B-A)}{1+\cos(B-A)}} = \frac{4-3}{4+3}\cot\frac{C}{2}$$

On solving $\cot\frac{C}{2} = \sqrt{7} \Rightarrow \cos C = \frac{3}{4}$

$\therefore$ cos C = cos(A – B) or cos C = cos(B – A)
C = A – B C = B – A
π – (A + B) = A – B π – (A + B) = B – A
$A = \frac{\pi}{2}$ (rejected) $B = \frac{\pi}{2}$

But $\frac{b}{a} = \frac{4}{3} \Rightarrow \frac{b}{4} = \frac{a}{3} = K$

Now ac = 3 $\Rightarrow 3\sqrt{7}K^2 = 3 \Rightarrow K = \frac{1}{7^{1/4}}$

$$R = 2K = \frac{2}{7^{1/4}}$$

12. $y = f(x) = (\ln x)^2 + 2\ln x$

$$\left.\frac{dy}{dx}\right|_{A(a,\, f(a))} = \frac{2\ln a}{a} + \frac{2}{a} = \frac{2}{a}(1+\ln a)$$

Also $\frac{dy}{dx} = \frac{f(a)-0}{a-0}$

$\frac{f(a)}{a} = \frac{2}{a}(1+\ln a) \Rightarrow f(a) = 2(1 + \ln a)$
So $(\ln a)^2 + 2\ln a = 2 + 2\ln a$
$(\ln a)^2 = 2 \Rightarrow a = e^{\sqrt{2}}$ or $e^{-\sqrt{2}}$
Hence $a = e^{-\sqrt{2}}$ and $b = e^{\sqrt{2}}$
So ab = 1

13. $5x \cdot f'(x) - x \cdot \ln 10 - 10 = 0$

$$5x\left[\frac{2\ln x}{x} + \frac{2}{x}\right] - x\ln 10 - 10 = 0$$

$10\ln x + 10 - x\ln 10 - 10 = 0$
$10\ln x = x\ln 10$

$$\frac{\ln x}{x} = \frac{\ln 10}{10},\ x > 0$$

As $y = \frac{\ln x}{x}$

$\Rightarrow\ y' = \dfrac{1-\ln x}{x^2}$ so two values of x are possible

14.-16 We have $f(x) = \lim\limits_{\alpha\to 0}\dfrac{e^x}{\alpha^4}\displaystyle\int_0^{\alpha}\frac{(e^t-1)\ln^2(1+t)}{(2t^3+3)}\,dt\ \left[\frac{0}{0}\text{ form}\right]$

$= \lim\limits_{\alpha\to 0}\dfrac{e^x(e^{\alpha}-1)\ln^2(1+\alpha)}{(2\alpha^3+3)4\alpha^3}$

$= e^x\lim\limits_{\alpha\to 0}\dfrac{e^{\alpha}-1}{\alpha}\cdot\dfrac{\ln^2(1+\alpha)}{\alpha^2}\cdot\dfrac{1}{4(2\alpha^3+3)}$

$= \dfrac{e^x}{12}$

14. Clearly f(ln 2) = $\dfrac{e^{\ln 2}}{12} = \dfrac{1}{6}$

15. We have $\displaystyle\int_0^x g(t)\,dt = 3x + \int_x^0 \cos^2 t\cdot g(t)\,dt$

On differentiating both side w.r.t x

$g(x) = 3 - \cos^2 x\ g(x)$

$g(x) = \dfrac{3}{1+\cos^2 x}$

Clearly $\dfrac{3}{2} \le \dfrac{3}{1+\cos^2 x} \le 3$

16. Let $I = \displaystyle\int_0^{\pi/2} g(x)\,dx$

$= \displaystyle\int_0^{\pi/2}\frac{3}{1+\cos^2 x}\,dx$

$= \displaystyle\int_0^{\pi/2}\frac{3\sec^2 x}{\tan^2 x+2}\,dx$

$= \dfrac{3\pi}{2\sqrt{2}}$

SECTION – C

1. $T_k = \tan^{-1}\left(\dfrac{8}{k^2}\right) = \tan^{-1}\left(\dfrac{2}{\frac{k^2}{4}}\right) = \tan^{-1}\left[\dfrac{2}{1+\left(\frac{k^2}{4}-1\right)}\right]$

$= \tan^{-1}\left[\dfrac{\left(\frac{k}{2}+1\right)-\left(\frac{k}{2}-1\right)}{1+\left(\frac{k}{2}+1\right)\left(\frac{k}{2}-1\right)}\right]$

$= \tan^{-1}\left[\dfrac{k}{2}+1\right] - \tan^{-1}\left[\dfrac{k}{2}-1\right]$

2. $\frac{a}{\cos(200^o)} - \frac{c\sin(200^o)}{\cos(200^o)} = d$ ….. (1)

$\frac{b}{\cos(200^o)} + \frac{d\sin(200^o)}{\cos(200^o)} = c$ ….. (2)

a = d cos(200º) + c sin(200º) ….. (3)

b = c cos(200º) – d sin(200º) ….. (4)

$\therefore\ a^2 + b^2 = c^2 + d^2$

$\therefore\ (a^2 + b^2 + c^2 + d^2) = 2(c^2 + d^2)$

$ac = dc\cos(200^o) + c^2\sin(200^o)$

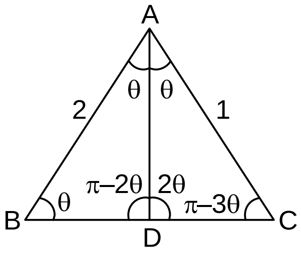
Also $bd = cd\cos(200^o) - d^2\sin(200^o)$

$ac - bd = (c^2 + d^2)\sin(200^o)$

So $\frac{a^2 + b^2 + c^2 + d^2}{ac - bd} = \frac{2(c^2 + d^2)}{(c^2 + d^2)\sin(200^o)} = 2\ \text{cosec}(200^o)$

$\therefore$ p = 2

3. Since $\frac{AB}{AC} = \frac{BD}{DC} = \frac{2}{1}$



Using since law in ΔABC we get

$\frac{1}{\sin\theta} = \frac{2}{\sin(\pi - 3\theta)} = \frac{2}{\sin 3\theta}$

$3 - 4\sin^2\theta = 2$

$\Rightarrow \sin^2\theta = \frac{1}{4} \Rightarrow \sin\theta = \frac{1}{2} \Rightarrow \theta = 30^o \Rightarrow 2\theta = 60^o$

Area of ΔABC = $\frac{1}{2} \times 2 \times 1 \times \sin 60^o = \frac{\sqrt{3}}{2}$

Hence $12\Delta^2 = 12 \times \frac{3}{4} = 9$

4. Since diagonal is a member of both the families so it will pass through (1, 0) and (–1, 1)

Equation of diagonal AC is x + 2y – 1= 0

Since one of the vertex (3, 2) which does not be on AC, so equation of BD is 2x – y = 4

Point of intersection of AC and BD is $P\left(\frac{9}{5}, -\frac{2}{5}\right)$

If vertex B is (3, 2) then vertex D is $\left(\frac{3}{5}, -\frac{14}{5}\right)$ also $BD = \frac{12\sqrt{5}}{5}$ (say d_1)

Area of rhombus = $\frac{1}{2} \times d_1 \times d_2$

$\frac{1}{2} \times \left(\frac{12\sqrt{5}}{5}\right) \times d_2 = 12\sqrt{5}$

$d_2 = 10$

5. We have f′(x) = f′(3 – x) on integrating w.r.t. x

f(x) = –f(3 – x) + c

Put x = 0

f(0) + f(3) = c

–32 + 46 = c

c = 14

Now let $I = \int_0^3 f(x)dx$ ….. (1)

$I = \int_0^3 f(3-x)dx$ ….. (2)

Adding (1) and (2), we get $2I = \int_0^3 (f(x)+f(3-x))dx = \int_0^3 14dx = 42$

6. $\frac{a^3+b^3}{ab^2} = \frac{\sin^3 20^o + \sin^3 80^o}{\sin 20^o \sin^2 80^o}$

$= \frac{3\sin 20^o - \sin 60^o + 3\sin 80^o - \sin 240^o}{4\sin 20^o \cos^2 10^o}$

$= \frac{3(\sin 20^o + \sin 80^o)}{4\sin 20^o \sin^2 80^o} = \frac{3\cos 30^o}{4\sin 40^o \sin 20^o \sin 80^o}$

$= \frac{3}{4}\frac{\cos 30^o}{\sin 20^o \sin(60^o - 20^o) s \sin(60^o + 20^o)}$

$= \frac{3}{4}\frac{\cos 30^o}{\frac{1}{4}\sin 60^o} = 3$

7. f′(x) = 6P – 4P cos 4x – 5 – 3 cos 3x > 0

2P > $\frac{5+3\cos 3x}{3-2\cos 4x}$

2P > max value of $\frac{5+3\cos 3x}{3-2\cos 4x}$

2P > $\frac{5+3}{3-2}$

P > 4

Smallest P is 5

FIITJEE **JEE (Advanced), 2014**

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - III

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 240**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section–C**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 – 12) contains 4 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

(ii) **Section-B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct choice. No marks will be given for any wrong match in any question. There is no negative marking.

(iii) **Section-C (01 – 06)** contains 6 Numerical based questions with single digit integer as answer, ranging from 0 to 9 and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

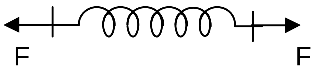
Physics

PART – I

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.



1. If an ideal spring is stretehed by a force F = 3N as shown then its length is observed to be 2m. If the value of F is 4N instead of 3N then which of the following cannot be it's length is second case?
(A) 2.4 m (B) 2.55 m
(C) 2.7 m (D) none of these

2. The potential energy U in joule of a perticle of mass 2 kg moving in X – Y plane follows the law U = 2x + 4y, where (x, y) are the co-ordinates (in metre) of the particle. If the particle is at rest at (4, 4) at time t = 0 then, [choose the incorrect statement]
(A) at t = $2\sqrt{2}$ sec, the paticle crosses the y-axis.
(B) at t = 2sec, the particle crosses the x-axis.
(C) The particle has kinetic energy of 40 Joule when it crosses y-axis.
(D) The kinetic energy of the particle when it crosses x-axis is 40 Joule.

3. A container of mass 'm' initially at rest and containing same mass of water in it, is being pulled vertically up by an ideal string exerting a constant force 'F' starting at t = 0. The water starts leaking out of the container with negligible relative speed. The velocity of the container at an instant t = t_0 when it becomes empty is 'v'. Then the value of t_0 is
(A) $\frac{mv}{F(\ell n2)-mg}$ (B) $\frac{mv}{F(\ell n2)+mg}$
(C) $\frac{2mv}{F(\ell n2)+2mg}$ (D) $\frac{mv}{2F(\ell n2)-mg}$

4. Three moles of an inert monoatomic gas is mixed with two moles of a diatomic gas and the mixture is heated by a process V = $\frac{k}{\sqrt{T}}$. Where V and T are volume and temeprature of the mixture and k is a constant. The molar heat capacity of this process for this mixture is
(A) $\frac{7R}{5}$ (B) $\frac{9R}{5}$
(C) $\frac{11R}{5}$ (D) none of these

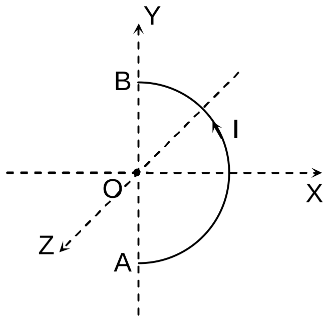
Space for rough work

5. A conducting sphere of radius R and charge Q is surrounded by a medium of resistivity 'ρ' at $t = 0$. Due to the medium the charge starts decreasing from it. At $t = t_1$ the charge on the sphere is found $\frac{Q}{4}$ then the value of t_1 is [Absolute permitivity of the vacuum is $\in_0$]

(A) $\frac{\rho \in_0 \ln 2}{2}$ (B) $\frac{\rho \in_0 \ln 2}{4}$

(C) $4\rho\in_0\ln 2$ (D) $2\rho\in_0\ln 2$

6. A conductor carrying current I is in the form of a semicircle AB of radius R and lying in xy-plane with it's centre at origin as shown in the figure. Which of the following is the magnitude of $\oint \vec{B}.\vec{d\ell}$ for the circle $3x^2 + 3z^2 = R^2$ in xz-plane due to current in curve AB?



(A) $\frac{\sqrt{3}}{2}\mu_0 I$ (B) $\left(\sqrt{3}+1\right)\frac{\mu_0 I}{2}$

(C) $\left(2-\sqrt{3}\right)\frac{\mu_0 I}{2}$ (D) zero

7. In a young's double slit interference experiment, the fringe pattern is observed on a screen placed at a distance D. The slits are separated by d (<<D) and are illuminated by coherent sources. The central maxima is formed at the geometrical centre on the screen with respect to the slits. If at a distance h from the central maximum on the screen the intensity is half of the maximum intensity then the value of λ may be

(A) $\frac{2hd}{3D}$ (B) $\frac{8hd}{19D}$

(C) $\frac{4hd}{13D}$ (D) $\frac{6hd}{11D}$

8. Momentum P of a particle is given as, $P = at + \frac{b+t^2}{c} + dt^3$, t represents time. If [X] represents dimensional expression of any physical quanity X then choose the correct.

(A) $[a] = [MLT^{-2}]$, $[b] = [M^oL^oT^2]$, $[d] = [MLT^{-3}]$ (B) $[a] = [MLT^{-2}]$, $[c] = [M^{-1}L^{-1}T^3]$, $[d] = [MLT^{-4}]$

(C) $[a] = [ML^{-1}T^2]$, $[c] = [MLT^{-3}]$, $[d] = [MLT^{-4}]$ (D) $[a] = [MLT^3]$, $[b] = [M^oL^oT^{-2}]$, $[c] = [M^{-1}L^{-1}T^3]$

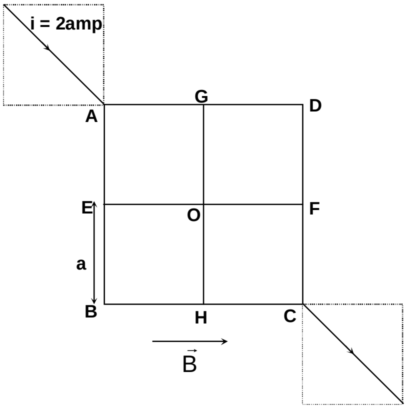
Space for rough work

Multiple Correct Choice Type

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

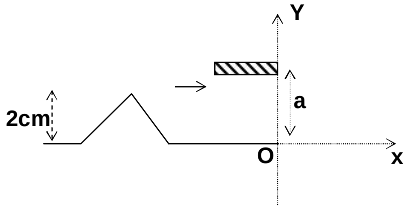
9. In the figure there is a uniform conducting structure in which each small square has side a =1m. The structure is kept in uniform magnetic field B = 2 Tesla along BC. Current of 2 amperes enters the structure at A and leaves at C. Find the correct option(s).

(A) The magnetic force on the structure is $8\sqrt{2}$N
(B) The potential of point B = potential of D.
(C) Potential of O = potential of D
(D) If r = 1Ω is the resistance of small side, the equivalent resistance across AC is $\frac{3}{2}\Omega$



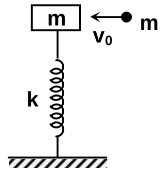
Space for rough work

10. In the figure, a wave pulse is moving on a string towards a loosely bound end and there is no loss of energy on reflection. A touch screen cell phone is kept parallel to x-axis. Cell phone is at a distance 'a' from the origin. For what value of 'a' will the cell phone screen get activated.



(A) 3 (B) 5.5
(C) 3.5 (D) 5

11. A vertical spring of spring constant k is compressed by x_0 by a block of mass m as shown in figure. Block is released from rest. Spring can be gently detached from block at any moment. At the instant of detachment, a particle of mass m moving with speed v_0 horizontally collides with the block perfectly inelastically.



(A) to have max. horizontal velocity of the block on the ground, spring can be detached at any moment.
(B) to have max. horizontal velocity of the block on the ground, spring should only be detached at it's natural length.
(C) to have max. mechanical energy of the block on the ground, spring can be detached at any moment
(D) to have max. mechanical energy of the block on the ground spring should be detached at it's natural length.

12. A cylindrical shell, a spherical shell and a solid sphere are allowed to roll on an inclined rough surface of co-efficient of friction μ and inclination θ. The correct statements are
(A) If cylindrical shell can roll on inclined plane, all other objects will also roll
(B) If all the objects have different mass and allowed to roll from same height, then K.E. of all the object will be different at the bottom of inclined plane.
(C) work done by the frictional force will be zero if object are rolling.
(D) frictional force will be equal for all the objects having same mass

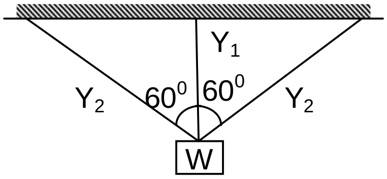
Space for rough work

SECTION – B

(Matching List Type)

This section contains **2 multiple choice questions.** Each question has matching lists. The codes for the Column(s) have choices (A), (B), (C) and (D) out of which only **ONE OR MORE** is/are correct

1. A load is supported using three wires of same cross section area as shown. Then for



	Column I		Column II
(A)	Equal tensile stress in all wires	(p)	$Y_2 = 2Y_1$
(B)	Equal tension in all wires	(q)	$Y_2 = 4Y_1$
(C)	Equal elastic potential energy in all wires	(r)	$Y_2 = 8Y_1$
(D)	Equal elastic potential energy per unit volume in all wires	(s)	$Y_2 = 16Y_1$
		(t)	Does not depend on ratio of $\frac{Y_1}{Y_2}$

2. A mono atomic ideal gas expands according to law PV^n = constant. ΔU is change in internal energy of the gas, ΔQ is heat absorbed by the gas. Match column for different values of n

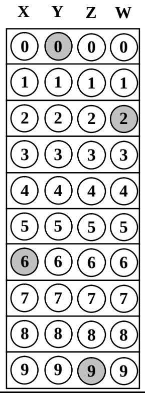
	Column I		Column II
(A)	n = 1.8	(p)	$\Delta Q > 0$
(B)	n = 1.5	(q)	$\Delta Q < 0$
(C)	n = 1.2	(r)	$\Delta U > 0$
(D)	n = 0.9	(s)	$\Delta U < 0$
		(t)	$\Delta U = 0$

Space for rough work

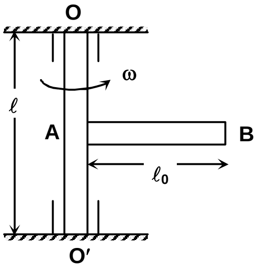
SECTION – C

Integer Answer Type

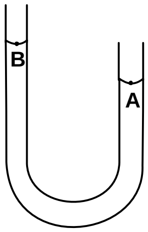
This section contains **6 questions.** The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. A horizontally uniform rod AB of mass m and length ℓ_0 rotates freely about a stationary vertical axis OO′ passing through the end A, which is located exactly midway between O and O′ and OO′ = ℓ. At what angular velocity (in units) of the rod is the horizontal component of the force acting on the lower end of the axis OO′ equal to zero. ($g = 10$ m/s^2, $\ell = 5$m, $\ell_0 = 3$m)



2. The difference in water levels in the two communicating capillary tubes of different diameter d = 1 mm and d = 1.5 mm is K × 2.38. Surface tension of water = 0.07 N/m and angle of contact between glass and water is 0°. Find the value of K.



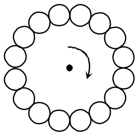
Space for rough work

3. As a result of isobaric heating by $\Delta T = 72$ K. One mole of a certain ideal gas receives heat $Q = 1.6$ kJ. Find the value of adiabatic exponent ν for the gas is $8/\lambda$. Find the value of λ.

4. A coil carrying a current $I = 10$ mA is placed in a uniform magnetic field so that its axis coincides with the field direction. The coil consist of only one turn and made up of copper. The diameter of the wire is 0.1 mm, the radius of the coil is $R = 3\pi$ cm. The value of external induction field will the coil rupture is 500K. Breaking stress of copper = 3×10^8 N/m^2. Then find the value of K.

5. A rubber ball of mass m and radius r is submerged into water of density ρ to the depth h and released. Then the height will the ball jump up above the surface of water is $\left(\rho\frac{2K}{3}\pi r^3 - m\right)\frac{h}{m}$. Find the value of K.

6. A metallic chain with a length ℓ and whose ends are joined together is fitted onto a wooden disc as shown in the figure. The disc rotates with a speed of n revolutions per second. Then the tension of the chain T if its mass = m is $Km\ell n^2$. Find the value of K.



Space for rough work

Chemistry PART – II

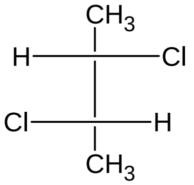
SECTION – A

Straight Objective Type

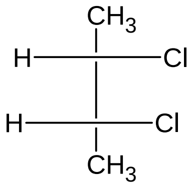
This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Heat of neutralization of HCl and NaOH is x kJ and that of CH_3COOH and NaOH is y kJ. What is heat of ionization of CH_3COOH
(A) (x – y) kJ (B) (y – x) kJ
(C) (x + y) kJ (D) - (x + y) kJ

2. If the optical rotation produced by



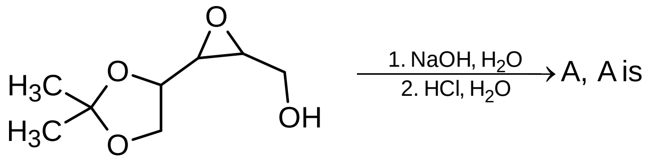
is +36°, then the optical rotation produce by



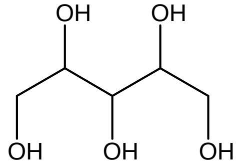
will be
(A) - 36^o (B) 0^o
(C) +36^o (D) Unpredictable

3. The IUPAC name for $[Pt(NH_3)_3(Br)(NO_2)(Cl)]Cl$ is
(A) Triamminechlorobromonitroplatinum (IV) chloride
(B) Triamminebromochloronitroplatinum (IV) chloride
(C) Triamminechlorobromoplatinum (IV) chloride
(D) Triamminechloronitrobromoplatinum (IV) chloride

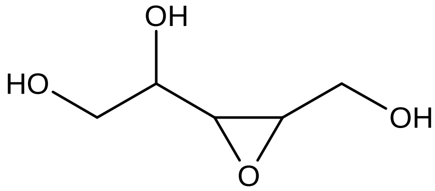
Space for rough work

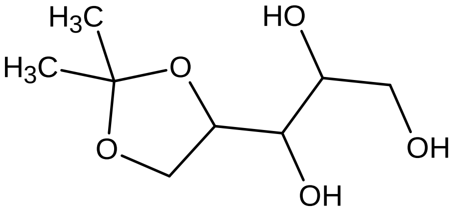
4. 

H_3C
H_3C
O
O
O
OH
1. NaOH, H_2O
2. HCl, H_2O
A, A is

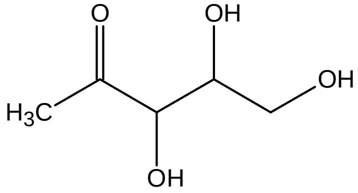
(A) 

OH
OH
OH
OH
OH

(B) 

(C) 

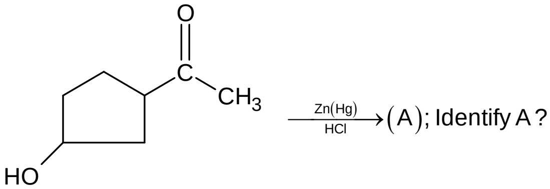
H_3C
H_3C
HO
O
O
OH
OH

(D) 

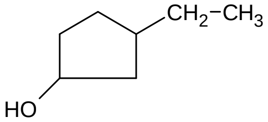
O
OH
OH
H_3C
OH

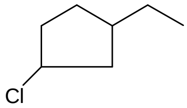
5. The solubility product constants of Ag_2CrO_4 and AgBr are 1.1×10^{-12} and 5.0×10^{-13} respectively. The ratio of molarities of their saturated solution is

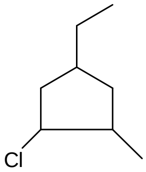
(A) 216.4 (B) 91.9
(C) 121.6 (D) 87.8

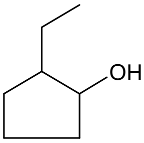
6. 

O
C
CH_3
HO
Zn(Hg)
HCl
(A); Identify A ?

(A) 

(B) 

(C) 

(D) 

Space for rough work

7. Element X crystallizes in a 12 coordination f.c.c lattice. On applying high temperature it changes to 8 coordination b.c.c. lattice. Find the ratio of the density of the crystal lattice before & after applying high temperature?

(A) 1:1 (B) 3:2

(C) $\sqrt{2}:\sqrt{3}$ (D) $2\left(\sqrt{2}\right)^3:\left(\sqrt{3}\right)^3$

8. When NaCl is heated in presence of sodium vapour it becomes yellow coloured due to

(A) Schottky defect (B) Frenkel defect

(C) Metal in excess defect (D) Metal in deficiency defect

Multiple Correct Choice Type

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

9. Ratio between potential energy, kinetic energy and total energy of electron in hydrogen atom are

(A) $\frac{KE}{PE}=-\frac{1}{2}$ (B) $\frac{E}{PE}=\frac{1}{2}$

(C) $\frac{KE}{E}=-\frac{1}{2}$ (D) $\frac{E}{PE+KE}=-1$

10. The dissociation of ammonium carbamate is represented by the following equation:

$NH_4CO_2NH_2(s) \rightleftharpoons 2NH_3(g)+CO_2(g)$

ΔH^o for the backward reaction is positive. The equation will shift from right to the left if there is

(A) an increase in temperature

(B) a decrease in pressure

(C) an increase in concentration of ammonia

(D) addition of inert gas at constant pressure into the reaction container

11. In a solid AB having NaCl structure, A atoms occupy the corners of the cubic unit cell. If all the face centred atoms along one of the axes are removed, then the resultant stoichiometry of the solid is not:

(A) AB_2 (B) A_2B

(C) A_4B_3 (D) A_3B_4

12. Choose the correct statements:

(A) $BaCl_2+AcOH+K_2CrO_4 \longrightarrow$ Yellow ppt. (B) $BaCO_3(s)+K_2CrO_4 \longrightarrow$ Yellow ppt.

(C) $BaCO_3(s)+K_2CrO_4+AcOH \longrightarrow$ No ppt. (D) $SrCO_3(s)+K_2CrO_4+AcOH \longrightarrow$ No ppt.

Space for rough work

SECTION – B

(Matching List Type)

This section contains **2 multiple choice questions.** Each question has matching lists. The codes for the Column(s) have choices (A), (B), (C) and (D) out of which only **ONE OR MORE** is/are correct

1. Match the organic compound in Column I with the type of isomerism shown by them:

Column – I	**Column – II**
(A) $CH_3-CH=CH-CH_2-Cl$	(p) Chain isomerism
(B) $CH_3-CH_2-CH_2-CH_2-O-CH_3$	(q) Tautomerism
(C) $CH_3-CH_2-CH_2-CH_2OH$	(r) Functional isomerism
(D) $CH_3-COOCH_3$	(s) Position isomerism
	(t) Metamerism

2.

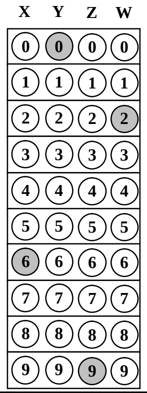
Column – I	**Column – II**
(A) $\left[Cu(NH_3)_4\right]^{2+}$	(p) Tetrahedral shape
(B) $\left[Co(ox)_3\right]^{3-}$	(q) Coloured complex and paramagnetic
(C) $[Ni(CO)_4]$	(r) Octahedral (sp^3d^2 hybridization)
(D) $\left[Ni(CN)_4\right]^{2-}$	(s) Square planar shape
	(t) Trigonal planar

Space for rough work

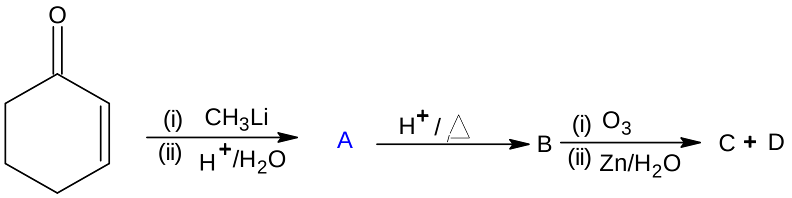
SECTION – C

Integer Answer Type

This section contains **6 questions.** The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. The first order gaseous decomposition of N_2O_4 in to NO_2 has a rate constant value $K = 4.5 \times 10^3\ s^{-1}$ at 1^oC and energy of activation 58 kJ mol^{-1}. What should be the rise in temperature in (^oC) to get the value of $K = 1.00 \times 10^4\ s^{-1}$. (log 2.2 = 0.3424)

2. 

How many moles of mild oxidizing agent are needed to oxidize the products formed?

3. How many secondary amines are possible with the formula $C_5H_{13}N$.

4. 10 ml of a solution of H_2SO_4 having pH = 5 is diluted to 10 litres by adding water, pH of final solution is....

5. At critical set of condition the value of compressibility factor is $\frac{1.5}{x}$, the value of 'x' is:

6. In analytical chemistry how many of these cations form black precipitate of sulphide:
$Ca^{2+}, Hg^{2+}, Pb^{2+}, Cu^{2+}, Zn^{2+}, As^{3+}, Cd^{2+}, Sb^{3+}, Ni^{2+}, Co^{2+}$

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. The value of the definite integral $\int_{-\infty}^{\ln 3}\{e^x\}\,dx$ equals (where {y} denote fractional part of y)

(A) 3 + ln 2 – 2 ln 3
(B) 3 – ln 3
(C) 2 ln 3 + ln 2
(D) 1

2. Let z_1 and z_2 be roots of the equation $z^2 + 8(i - 1)z + 63 - 16i = 0$ where $i^2 = -1$. The area of triangle formed by o, z_1 and z_2 (where o being origin) is equal to

(A) 24
(B) 26
(C) 28
(D) 30

3. Let ABC be a triangle whose vertices are A(–5, 5) and B(7, –1). If vertex c has on a circle whose director circle has equation $x^2 + y^2 = 100$, then locus of the orthocentre of triangle ABC is equal to

(A) $x^2 + y^2 + 4x - 8x - 30 = 0$
(B) $x^2 + y^2 - 4x + 8y - 30 = 0$
(C) $x^2 + y^2 - 4x - 8y - 30 = 0$
(D) $x^2 + y^2 + 4x + 8y - 30 = 0$

4. If the complex number z = x + iy moves in argand plane such that $1 \le |x + iy| \le 2$ and $x - y \le 0$ where x, y $\in$ R determines a region with area k then value of the definite integral $\int_0^{2k/3}\{\sin x\}\,dx$ is equal to (where {k} represents fractional part of k)

(A) 0
(B) 1
(C) 2
(D) 3

5. A circle passes through A(0, 4) and B(8, 0) has its centre on x–axis. If point C lies on the circumference of the circle and m is the greatest area of triangle ABC, then m is equal to

(A) $10\left(\sqrt{5}-1\right)$
(B) $10\left(\sqrt{5}+1\right)$
(C) $20\left(\sqrt{5}+1\right)$
(D) $20\left(\sqrt{5}-1\right)$

Space for rough work

6. If $M(x_0, y_0)$ is the point on the curve $3x^2 - 4y^2 = 72$ which is nearest to the line $3x + 2y + 1 = 0$ then the value of $(x_0 + y_0)$ is equal to

(A) 3	(B) –3
(C) 9	(D) –9

7. Area enclosed by the figure described by the equation $x^4 + 1 = 2x^2 + y^2$ is

(A) 3	(B) $\frac{8}{3}$
(C) $\frac{7}{3}$	(D) $\frac{10}{3}$

8. Let $f(x) = \left[\frac{\sin x}{x}\right] + \left[\frac{2\sin 2x}{x}\right] + ... + \left[\frac{10\sin 10x}{x}\right]$ where [y] is the greatest integer function. The value of $\lim\limits_{x\to 0} f(x)$ is equal to

(A) 55	(B) 164
(C) 165	(D) 375

Multiple Correct Choice Type

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

9. A circle 'S' is described on the focal chord of the parabola $y^2 = 4x$ as diameter. If the focal chord is inclined at an angle of 45º with axis of x, then which of the following is/are true
(A) radius of the circle is 4
(B) centre of the circle is (3, 2)
(C) the line $x + 1 = 0$ touches the circle
(D) the circle $x^2 + y^2 + 2x - 6y + 3 = 0$ is orthogonal to 'S'

10. If three planes $P_1 \equiv 2x + y + z - 1 = 0$, $P_2 \equiv x - y + z - 2 = 0$ and $P_3 \equiv \alpha x - y + 3z - 5 = 0$ intersect each other at point P on XOY plane and at point Q on YOZ plane, where O is the origin then identify the correct statement(s)
(A) the value of α is 4
(B) straight line perpendicular to plane P_3 and passing through P is $\frac{x-1}{4} = \frac{y+1}{-1} = \frac{z}{3}$
(C) the length of projection of $\overrightarrow{PQ}$ on x–axis is 1
(D) centroid of the triangle OPQ is $\left(\frac{1}{3}, -\frac{1}{2}, \frac{1}{2}\right)$

Space for rough work

11. PQ is a double ordinate of the parabola $y^2 = 4ax$. If the normal at P intersect the line passing through Q and parallel to x–axis at G then locus of G is a parabola with
(A) length of latus rectum equal to 4a (B) vertex at (4a, 0)
(C) directrix as the line $x - 3a = 0$ (D) focus at (5a, 0)

12. If α is a root of the equation $4x^2 + 2x - 1 = 0$ then the other root must be
(A) $3\alpha^3 - 4\alpha$ (B) $4\alpha^3 - 3\alpha$
(C) $2\alpha^2 - 1$ (D) all above

SECTION – B

(Matching List Type)

This section contains **2 multiple choice questions.** Each question has matching lists. The codes for the Column(s) have choices (A), (B), (C) and (D) out of which only **ONE OR MORE** is/are correct

1. Match the following Column–I with Column–II

	Column – I		**Column – II**
(A)	If $\lim\limits_{x\to 3} \frac{f(x)-3}{x-2} = 1$ then $\lim\limits_{x\to 3} f(x)$ is equal to	(p)	15
(B)	The number of order pairs of integers (x, y) satisfying the equation $x^2 + 6x + y^2 = 4$ is	(q)	11
(C)	Consider the graphs of y = sin x, y = cos x, y = tan x, y = cot x, y = sec x and y = cosec x Let $R = \left\{(x, y) \middle| 0 \le x \le \frac{\pi}{2},\ 0 \le y \le 100\right\}$ Number of points of R which be on atleast two of the graph, is	(r)	8
(D)	Suppose that $2 - \sqrt{95}$ is a root of $x^2 + ax + b = 0$ where b is negative real number and a is a integer. The largest possible value of a, is	(s)	7
		(t)	4

Space for rough work

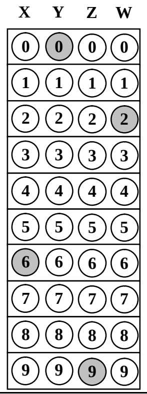
2. Match the following Column–I with Column–II

	Column – I		Column – II
(A)	Number of roots of the equation $\log_{\frac{6x-x^2}{11}}(-\cos x - \cos 3x) = \log_{\frac{6x-x^2}{11}}(-\cos 2x)$ in $[0,\ 2\pi]$ is equal to	(p)	1
(B)	If a_1 is the value of a for which $f(x) = x^2 + \frac{a}{x}$ has a local minima at x = 2 and a_2 is the value of a for which f(x) has a point of inflection at x = 1, then $\left(\frac{a_1 + a_2}{3}\right)$ is equal to	(q)	2
(C)	Number of points where the function $f(x) = \left\lvert \lvert x\rvert^2 - 2\lvert x\rvert - 3 \right\rvert$ is not differentiable is equal to	(r)	3
(D)	If $\lim\limits_{x \to 0} \int_0^x \frac{t^2 dt}{(x - \sin x)\sqrt{a+t}} = 1$ then the value of a is equal to	(s)	4
		(t)	5

SECTION – C

Integer Answer Type

This section contains **6 questions.** The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. The number of five digit numbers that can be formed using its digits 1, 2, 3, 4, 5, 6, 7, 8, 9 in which one digit appears once and two digits appear twice (e.g. 44533) is k then the value of $\frac{k}{1890}$ is equal to _____

Space for rough work

2. Let k be the coefficient of x^{18} in the polynomial $f(x) = (1+x)^{20} + x(1+x)^{19} + x^2(1+x)^{18} + ... + x^{18}(1+x)^2$ then the value of $\frac{k}{190}$ is equal to _____

3. Let P be the sum of integral values of b in the interval [1, 20] for which the equation $4^x + (1 - b)2^{x+1} + b = 0$ has roots of apposite sign, then the value of $\frac{p}{51}$ is equal to _____

4. Let O be the interior point of ΔABC such that $2\overrightarrow{OA} + 3\overrightarrow{OB} + 6\overrightarrow{OC} = 0$ where O is origin. If $\frac{\text{Area of } (\Delta ABC)}{\text{Area of } (\Delta AOB)} = \frac{m}{n}$, where m and n are relatively prime, then (m – n) is equal to _____

5. If the quadratic equation $x^2 + (2 - \tan\theta)x - (1 + \tan\theta) = 0$ has two integral roots, then sum of all possible values of θ in the interval $(0, 2\pi)$ is $k\pi$, then the value of k is equal to _____

6. Bag ‘A’ contains 9 green and 1 red ball, Bag ‘B’ contains 10 balls all of them being green, 9 balls are drawn randomly from Bag ‘A’ and put into bag ‘B’, and then 9 balls are randomly transferred from bag ‘B’ to bag ‘A’. If $\frac{p}{q}$ (in its lowest form) is the chance that the red ball is still there in the bag ‘A’ then the value of (q – p) is equal to _____

Space for rough work

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CRT – III

(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	B	A
2.	D	B	C
3.	A	B	C
4.	A	A	C
5.	D	B	B
6.	C	B	B
7.	C	D	B
8.	B	C	D
9.	A, B, C, D	A, B	A, B, C
10.	A, C	A, C	A, B, C, D
11.	A, D	A, B, C	A, B, C, D
12.	A, B, C	A, D	B, C
1.	(A) → (q) (B) → (q) (C) → (r) (D) → (s)	(A) → (p, s) (B) → (p, r, s, t) (C) → (p, r, s) (D) → (r)	(A) → (t) (B) → (r) (C) → (q) (D) → (s)
2.	(A) → (q), (s) (B) → (p), (s) (C) → (p), (s) (D)→ (p), (r)	(A) → (q, s) (B) → (q, r) (C) → (p) (D) → (s)	(A) → (s) (B) → (t) (C) → (r) (D) → (s)
1.	2	9	4
2.	2	3	7
3.	5	6	4
4.	5	7	5
5.	2	4	4
6.	1	5	9

Physics

PART – I

1. In first case, $3 = k(2 - \ell_0)$, If ℓ_0 is natural length of the spring

In second case $4 = k(\ell_1 - \ell_0)$, ℓ_1 is the length of the spring in second case

By solving the equations we have $\ell_0 = 8 - 3\ell_1$

but ℓ_0 is always greater than zero.

$\Rightarrow\ 8 - 3\ell_1 > 0$

$\Rightarrow\ \ell_1 < \frac{8}{3}$ so it cannot be 2.7 m.

2. $U = 2x + 4y$

$F = -\frac{\partial U}{\partial x}\hat{i} - \frac{\partial U}{\partial y}\hat{j} - \frac{\partial U}{\partial z}\hat{k} = \left(-2\hat{i} - 4\hat{j}\right)N$

At t = 0, at (4, 4), P = 24 J

Kinetic energy K = 0

Total energy, E = P + k + 24J and acceleration $\vec{a} = \left(-\hat{i} - 2\hat{j}\right)m/s^2$

To cross x-axis, along y, $4 = \frac{1}{2}a_y t_1^2 = \frac{1}{2}2t_1^2 \qquad \Rightarrow t_1 = 2sec$

To cross y-axis, along y, $4 = \frac{1}{2}a_x t_2^2 = \frac{1}{2}.1.t_2^2 \qquad \Rightarrow t_2 = 2\sqrt{2}$ sec

Also, Crossing the x-axis $\Rightarrow$ co-ordinates are $\left(4 - \frac{1}{2}a_x t_1^2, 0\right) = (2, 0)$

$\therefore$ P = 4J $\Rightarrow$ K = E – P = 20 J.

Crossing the y-axis $\Rightarrow$ co-ordinates are $\left(0, 4 - \frac{1}{2}a_y t_2^2\right) = (0, -4)$

$\therefore$ P = –16J, K = E – P = 40 J

3. If at t = t_0 container is empty then the rate by which water comes out is $\frac{m}{t_0}$. At any t, total mass

$m_1 = m + m - \frac{mt}{t_0}$

$\therefore\ F - m_1 g = m_1 a = m_1 \frac{dv}{dt}$

$\Rightarrow\ \int_0^v dv = \int_0^{t_0} \frac{F}{m_1}dt - \int_0^{t_0} g\,dt$

$\Rightarrow\ v = \int_0^{t_0} \frac{F}{2m - \frac{mt}{t_0}} - gt_0 = \frac{t_0 F}{m}.\ell n2 - gt_0$

$\Rightarrow mv = t_0\,[F\ell n2 - mg]$

$\Rightarrow\ t_0 = \frac{mv}{F(\ell n2) - mg}$ correct coice is (A)

4. $V = \frac{K}{\sqrt{T}}$, $T = \frac{PV}{nR}$ is put then PV^3 = constant (say k_1)

$\therefore\ \Delta W = PdV = \int \frac{k_1}{v^3} dv = \frac{-nR\Delta T}{2} = \frac{-5R\Delta T}{2}$

$\Delta\ U = nCv\Delta T = (n_1Cv_1 + n_2Cv_2)\Delta T = \left(3\,x\frac{3R}{2} + 2\,x\frac{5R}{2}\right)\Delta T = \frac{19}{2}R\Delta T$

$\Delta Q = \Delta U + \Delta W = \frac{14R\ \Delta T}{2} = 7R\Delta T$

$C_{(process)} = \frac{\Delta Q}{n\Delta T} = \frac{7R\Delta T}{5\Delta T} = \frac{7R}{5}$

5. Total flux coming out of the sphere is $\frac{Q}{\epsilon_0}$ and conductivity at that point, $\sigma = \frac{1}{\rho}$

The relation current density, $J = \sigma E$

$\therefore$rate of change of charge, $-\frac{dQ}{dt} = \vec{J}.\vec{A} = \sigma\vec{E}\cdot\vec{A} = \sigma$[Total flux]

$-\frac{dQ}{dt} = \sigma.\frac{Q}{\epsilon_0} = \frac{Q}{\rho\epsilon_0}$

Hence, $-\int_{Q}^{Q/4}\frac{dQ}{Q} = \int_{0}^{t_1}\frac{dt}{\rho\epsilon_0} \Rightarrow \ell n4 = \frac{t_1}{\rho\ \epsilon_0}\ \Rightarrow t_1 = \rho\epsilon_0\ \ \ell n4 = 2\rho\ \epsilon_0\ (\ell n2)$

6. If the loop is completed by wire of length 2R along y-axis i.e. the diametre of the semicircle then $\sum\vec{B}.\vec{d\ell} = \mu_0 I$ [Ampere's law]. And due to the diameter wire only,

$\left|\vec{B}\right|$ at all point on the circle $3x^2 + 3z^2 = R^2$, is $\frac{\mu_0 I}{4\pi r}[\sin\theta_1 + \sin\theta_2] = \frac{\mu_0 I}{4\pi\frac{R}{\sqrt{3}}}\left[\sin 60^o + \sin 60^o\right] = \frac{3\mu_0 I}{4\pi R}$

$\therefore\ \sum\vec{B}.\vec{d\ell}_{\text{(due to diameter wire only)}} = \frac{3\mu_0 I}{4\pi R}\times 2\pi\frac{R}{\sqrt{3}} = \frac{\sqrt{3}}{2}\mu_0 I$

Hence, $\sum\vec{B}.\vec{d\ell}$ due to semicircle = $\mu_0 I - \frac{\sqrt{3}\mu_0 I}{2} = \frac{\left(2-\sqrt{3}\right)\mu_0 I}{2}$

7. Intesnity, $I = 4I_0\cos^2\frac{\varphi}{2}$

$\therefore\ I_{max} = 4I_0$, For I to be $2I_0$.

Phase diff. $\varphi = (2n+1)\frac{\pi}{2}$, n = 0, 1, 2, 3......

$\therefore$ Path diff. = $\frac{\varphi}{2\frac{\pi}{\lambda}} = \frac{\lambda}{4}(2n+1)$; $\therefore\ \frac{hd}{D} = \frac{\lambda}{4}(2n+1)$

$\Rightarrow\ \lambda = \frac{4hd}{(2n+1)D} = \frac{4hd}{(\text{odd int eger})\,x\,D}$

8. $P = at + \frac{b+t^2}{c} + dt^3$

$[P] = [m.v] = [MLT^{-1}]$

$[a] = \frac{[P]}{[t]} = MLT^{-2}$

$[b] = [t^2] = M^0L^0T^2$

$\left[\frac{t^2}{c}\right] = [P] \Rightarrow [c] = \frac{[t^2]}{[P]} = M^{-1}L^{-1}T^3$

$[d] = \frac{[P]}{[t^3]} = MLT^{-4}$

11. To have max. M.E. on ground spring should be detached at a point where spring have minimum energy.

12. If $I = \frac{mR^2}{K}$, $\mu_{min} = \frac{\tan\theta}{1+K}$

K is minimum for cylindrical shell $\Rightarrow \mu_{min} = \frac{\tan\theta}{1+2} = \frac{1}{2}\tan\theta$ is maximum

$\therefore$ If shell can roll then other will also roll.

Force of frictional is static hence work done by force will zero w.r.t. ground.

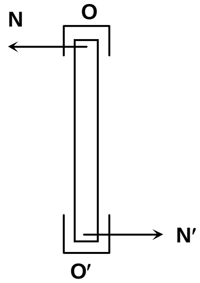
SECTION–B

1. Length of wire (Young's modulus Y_2). Cos 60^0 = length of wire (Young's modulus Y_1)
By symmetry and small deformation
Elongation in wire (Young's modulus Y_2) = Elongation in wire (Young's modulus Y_1).cos 60^0
4*Strain in wire (Young's modulus Y_2) = strain in wire (Young's modulus Y_1)

2. Degree of freedom f = 3
$\Delta U = ½ fnR(T_2 - T_1) = ½ f(P_2V_2 - P_1V_1) = ½ fP_1V_1\{(V_2/V_1)^{1-n} - 1\}$; > 0 for n < 1 and < 0 for n > 1
$\Delta W = (P_1V_1 - P_2V_2)/(n-1) = P_1V_1\{1 - (V_2/V_1)^{1-n}\}/(n-1)$;
$\Delta Q = \Delta U + \Delta W = P_1V_1\{(V_2/V_1)^{1-n} - 1\}\{ ½ f - 1/(n-1)\}$;

SECTION–C

1. About O



$N'\ell + \tau_{centrifugal} + \left(-mg\frac{\ell_o}{2}\right) = 0$

About O′

$N\ell + \tau_{centrifugal} + \left(-mg\frac{\ell_o}{2}\right) = 0$

$\tau_{centrifugal} = \int_0^{\ell} \frac{m\omega^2\ell}{2\ell_0} x dx = \frac{1}{4}m\omega^2\ell\ell_o$ (anticlockwise)

$\therefore \quad N'\ell + \frac{1}{4}m\omega^2\ell\ell_o - mg\frac{\ell_o}{2} = 0$

and $N\ell - \frac{1}{4}m\omega^2\ell\ell_o - mg\frac{\ell_o}{2} = 0$

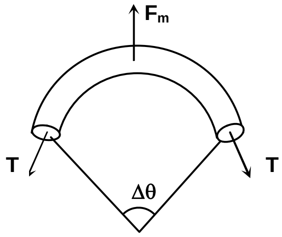
When N′ = 0, $\frac{1}{4}m\omega^2\ell\ell_o - mg\frac{\ell_o}{2} = 0$

$\Rightarrow \quad \omega = \sqrt{\frac{2g}{\ell}}$

2. $2T\cos\theta\left(\frac{1}{r_1}-\frac{1}{r_2}\right)=\rho gh$

3. $\nu = \frac{C_p}{C_v}$ $\left(C_p = \frac{\Delta Q}{\Delta T},\ C_v = \frac{\Delta U}{\Delta T}\right)$

4. $2T\sin\frac{\Delta\theta}{2}$ = Bi $(\Delta\theta R)$



$\Rightarrow$ T = IRB
also, $T = \pi r^2\sigma$
$\therefore\ B = \frac{\pi r^2\sigma}{IR}$

Chemistry

PART – II

SECTION – A

1. $HCl + NaOH \longrightarrow NaCl + H_2O$

   $H^+ + OH^- \longrightarrow H_2O; \quad x\ kJ$

   $CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$

   $CH_3COOH + OH^- \longrightarrow CH_3COO^- + H_2O; \quad y\ kJ$

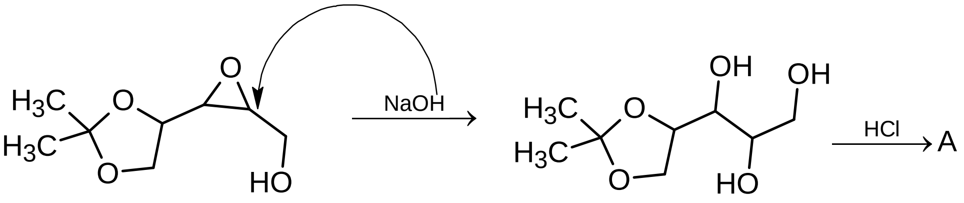
   Required equation:

   $CH_3COOH \longrightarrow CH_3COO^- + H^+$

   $\therefore \Delta H = (y - x) kJ$

2. Because it has one d and one ℓ centre.

4.



5. Solubility of Ag_2CrO_4 $S_1 = \sqrt[3]{\frac{K_{sp}}{4}}$

   $= 6.5 \times 10^{-5}$ M

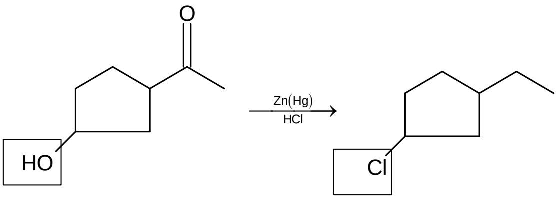
   Solubility of $AgBrS_2 = \sqrt{K_{sp}}$

   $= 7.07 \times 10^{-7}$ M

   Ratio = $\frac{S_1}{S_2} = \frac{6.5\times10^{-5}M}{7.07\times10^{-7}}$

   = 91.9

6. (B)



7. 12 coordination (f.c.c.) **:** 8 coordination (b.c.c.)

   $\frac{4\times M_x}{N_{av}\times a^3}$ **:** $\frac{2\times M_x}{N_{av}\times a^3}$ (Ratio of density)

   For f.c.c. lattice, $\Rightarrow a = \frac{4r}{\sqrt{2}}$

   For b.c.c. lattice, $4r = \sqrt{3}a \Rightarrow a = \frac{4r}{\sqrt{3}}$

Ratio of density = $\dfrac{\dfrac{4}{N_{av}}\times M_x}{\left(\dfrac{4r}{\sqrt{2}}\right)^3} : \dfrac{\dfrac{2}{N_{av}}\times M_x}{\left(\dfrac{4r}{\sqrt{3}}\right)^3}$

= 2 × $\left(\sqrt{2}\right)^3$: $\left(\sqrt{3}\right)^3$

9. Because magnitude of $KE = \dfrac{ze^2}{2r}$, $PE = \dfrac{-ze^2}{r}$ and $TE = \dfrac{-ze^2}{2r}$

10. According to Le Chatelier's principle.

11. A is present at corners and face centres and B in the tetrahedral voids.
So, along one axis two face centred atoms will be and if they are removed then A are present in the corner and centre of four faces.
So, total no. of atoms of A = 1 + 2 = 3
total no. of atoms of B = 4
Formula is A_3B_4

12. Ba^{2+} ions produce yellow ppt. with CrO_4^{2-}, which is not soluble in CH_3COOH.
$BaCO_3$ dissolves in CH_3COOH and produces Ba^{2+} ion which gives yellow ppt. with CrO_4^{2-} which is insoluble in CH_3COOH.
$SrCO_3$ is soluble in CH_3COOH and produces Sr^{2+} ion which does not give yellow ppt. of $SrCrO_4$ in CH_3COOH.

SECTION – C

1. $\log\left(\dfrac{10\times10^3}{4.5\times10^3}\right) = \dfrac{58\times10^3}{2.303\times8.314}\left(\dfrac{T_2-274}{274T_2}\right)$
$\Rightarrow T_2$ = 283 K = 10°C
$\therefore$ Rise in temperature = 10 – 1 = 9°C

2. CH_3COCHO, $OHCCH_2CH_2CHO$

4. $\left[H^+\right] = \dfrac{10\times10^{-5}}{10,000} = 10^{-8}$
$\left[H^+\right]_{total} = 10^{-8}\left(\text{from } H_2SO_4\right) + 10^{-7}\left(\text{from water}\right)$
= 1.1×10^{-7}
pH = 7 – log 1.1 = 6.94 ≈ 7

5. $T_c = \dfrac{8a}{27Rb}, V_c = 3b, P_c = \dfrac{a}{27b^2}$
$Z_c = \dfrac{P_cV_c}{RT_c} = \dfrac{3}{8} = \dfrac{1.5}{4}$

6. Black sulphides are Hgs, PbS, CuS, NiS, CoS.

Mathematics

PART – III

SECTION – A

1. $I = \int_{-\infty}^{0} e^x dx + \int_{0}^{\ln 2} (e^x - 1) dx + \int_{\ln 2}^{\ln 3} (e^x - 2) dx$

On solving = 3 + ln 2 – 2 ln 3

2. $z = -4(i-1) \pm \sqrt{-63-16i}$

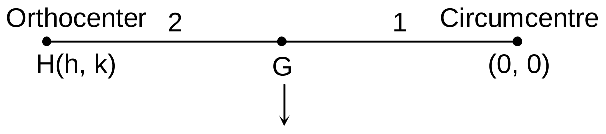
$z = -4(i - 1) \pm (1 - 8i)$

$z = 5 - 12i,\ 3 + 4i$

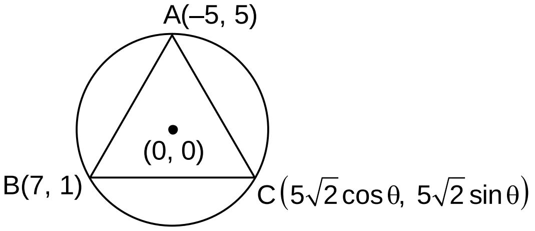
Hence area $(\Delta oz_1z_2) = \frac{1}{2}\begin{vmatrix} 0 & 0 & 1 \\ 5 & -12 & 1 \\ 3 & 4 & 1 \end{vmatrix} = \frac{1}{2} \times 56 = 28$

3. $\frac{h}{3} = \frac{2 + 5\sqrt{2}\cos\theta}{3}$

and $\frac{k}{3} = \frac{4 + 5\sqrt{2}\sin\theta}{3}$



$$\left(\frac{-5 + 7 + 5\sqrt{2}\cos\theta}{3},\ \frac{5 - 1 + 5\sqrt{2}\sin\theta}{3}\right)$$

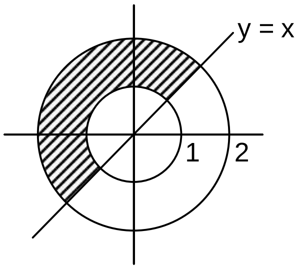


On eliminating θ, we get $(x - 2)^2 + (y - 4)^2 = 50$

$x^2 + y^2 - 4x - 8y - 30 = 0$

4. $k = \frac{\pi(2^2 - 1^2)}{2} = \frac{3\pi}{2}$

$\int_0^{\pi} \{\sin x\} dx = \int_0^{\pi} \sin x dx = 2$



5. $h^2 + 16 = (h - 8)^2$

$h^2 + 16 = h^2 - 16h + 64$

$h = 3$

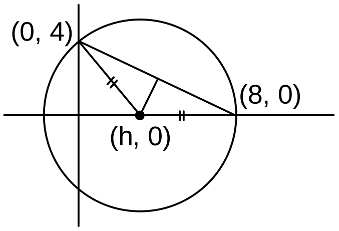
So centre is (3, 0) and r = 5

equation of circle $(x - 3)^2 + y^2 = 25$

Let C(3 + 5 cos θ, 5 sin θ)

$$\Delta = \frac{1}{2}\begin{vmatrix} 0 & 4 & 1 \\ 8 & 0 & 1 \\ 3 + 5\cos\theta & 5\sin\theta & 1 \end{vmatrix} = .10\left|(2\sin\theta + \cos\theta - 1)\right|$$

$A_{max} = 10(\sqrt{5} + 1)$



6. Slope of given line = $-\frac{3}{2}$

First of all we try to locate points on the curve at which tangents are parallel to given line
On differentiating $3x^2 - 4y^2 = 72$ w.r.t. x

$\frac{dy}{dx} = \frac{3x}{4y} = -\frac{3}{2}$ (Given) $\frac{x}{y} = -2$

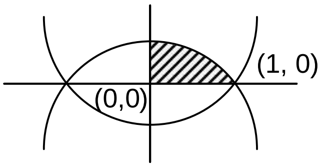
Put $x = -2y$ in $3x^2 - 4y^2 = 72$

We get (–6, 3) and (6, –3) and their distances from line are $\frac{11}{\sqrt{13}}$ and $\frac{13}{\sqrt{13}}$ respectively

So (–6, 3) is nearest
So $x_0 = -6 \Rightarrow y_0 = 3$ and $(x_0 + y_0) = -3$

7. $y^2 = (x^2 - 1)^2$
So $y = x^2 - 1$ or $y = 1 - x^2$

So required area = $4\int_0^1 (1 - x^2)dx = 4\left[x - \frac{x^3}{3}\right]_0^1 = \frac{8}{3}$



8. Given limit = $0 + (2^2 - 1) + (3^2 - 1) + ... + (10^2 - 1) = \sum_{n=2}^{10}(n^2 - 1)$

$= \frac{10 \times 11 \times 21}{6} - 1 - 9 = 375$

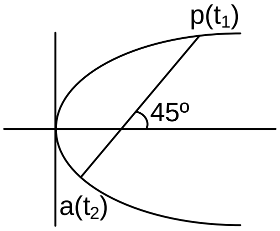
9. Circle on PQ as diameter

$\left(x - t_1^2\right)\left(x - t_2^2\right) + (y - 2t_1)(y - 2t_2) = 0$

$x^2 + y^2 - \left(t_1^2 + t_2^2\right)x - 2(t_1 + t_2)y + t_1^2 t_2^2 + 4t_1t_2 = 0$

Put $\frac{t_1 + t_2}{2} = 1$ and $t_1t_2 = -1$

Hence equation of circle become
$x^2 + y^2 - 6x - 4y - 3 = 0$ ..... (1)
With centre (3, 2) and radius 4
Equation (1) is not orthogonal to $x^2 + y^2 + 2x - 6y + 3 = 0$



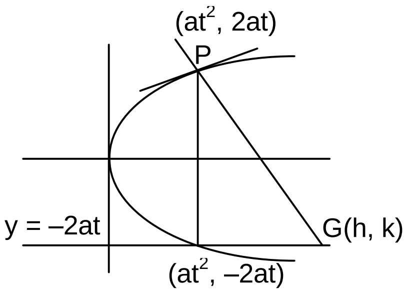
10. Three planes meet at two points it means they have infinite many solution, so

$\begin{vmatrix} 2 & 1 & 1 \\ 1 & -1 & 1 \\ \alpha & -1 & 3 \end{vmatrix} = 0$ on solving $\alpha = 4$

$P_1 : 2x + y + z = 1$
$P_2 : x - y + z = 2$
$P_3 : 4x - y + 3z = 5$

P on XOY plane ≡ (1, –1, 0) (Which can be obtained by putting z = 0 in any two equations)

Q on YOZ plane ≡ $\left(0, -\frac{1}{2}, \frac{3}{2}\right)$ (By putting x = 0 in any two equations)



11. N : $y + tx = 2at + at^3$
L : $y = -2at$
On solving together $-2at + tx = 2at + at^3$
$x = at^2 + 4a$
Hence $h = at^2 + 4a$ ..... (1)
$k = -2at$ ..... (2)
So $y^2 = 4a(x - 4a)$ (eliminating t)
Now verify alternatives

12. $4x^2 + 2x - 1 = 0$
$$x = \frac{-2 \pm \sqrt{4+16}}{8}$$
$$x = \frac{-2 \pm 2\sqrt{5}}{8} = \frac{-1 \pm \sqrt{5}}{4}$$
If $\alpha = \frac{\sqrt{5}-1}{4} = \sin 18^o$
$$\beta = -\left[\frac{\sqrt{5}+1}{4}\right] = -\cos 36^o$$
$\beta = -\cos 36^o = -\sin[90^o - 36^o] = -\sin 54^o = 4\sin^3 18^o - 3\sin 18^o = 4\alpha^3 - 3\alpha$
$\beta = -\cos 36^o = 2\cos^2 18^o - 1 = 2\alpha^2 - 1$

SECTION – B

1. (A) $\lim_{x \to 3} f(x) = 4$
(B) $x^2 + 6x + 9 + y^2 = 9 + 4$
$\therefore (x + 3)^2 + y^2 = 9 + 4$
$\therefore (x + 3)^2 = 9, y^2 = 4$ or $(x + 3)^2 = 4, y^2 = 9$
(C) Draw graph and check
(D) Let $\alpha = 2 - \sqrt{95}$ and β be other root
As $\alpha + \beta = -a$ (Given)
$\beta = -a - \alpha = -a - 2 + \sqrt{95}$
Also $\alpha\beta = b$
$\left(2 - \sqrt{95}\right)\left(-a - 2 + \sqrt{95}\right) = b$
But $b < 0$ (Given)
$\Rightarrow \left(-a - 2 + \sqrt{95}\right) > 0$
So $a < \sqrt{95} - 2$
Hence max of a = 7

2. (A) $\cos x + \cos 3x = \cos 2x$
$2\cos 2x \cos x - \cos 2x = 0$
$\cos 2x(2\cos x - 1) = 0$
$\cos x = \frac{1}{2} \therefore x = \frac{\pi}{3}$ or $\frac{5\pi}{3}$ or $\cos 2x = 0$
$\Rightarrow 2x = \frac{\pi}{2}$ or $\frac{3\pi}{2} \Rightarrow x = \frac{\pi}{4}, \frac{3\pi}{4}$
Roots are $\left\{\frac{\pi}{3}, \frac{5\pi}{3}\right\}$
$\Rightarrow$ 2 roots

(B) $f'(x) = 2x - \frac{a}{x^2}$

$f'(2) = 4 - \frac{a}{4} = 0$

$\Rightarrow$ a = 16 so $a_1 = 16$

Also $f''(x) = 2 + \frac{2a}{x^3}$

Also $f''(1) = 2 + 2a = 0$

a = –1 so $a_2 = –1$

Hence $\frac{a_1 + a_2}{3} = \frac{15}{3} = 5$

(C) Check by graph

(D) We have $\lim\limits_{x \to 0} \frac{\int_0^x \frac{t^2}{\sqrt{a+t}}dt}{\left(\frac{x - \sin x}{x^3}\right)x^3} = 1$

$6. \lim\limits_{x \to 0} \frac{x^2}{\sqrt{a+x}} \times \frac{1}{3x^2} = 1$ = $\frac{2}{\sqrt{a}} = 1$ so a = 4

SECTION – C

1. $^{9}C_3 \times {}^{3}C_2 \times \frac{5!}{2!2!1!}$

2. $f(x) = (1+x)^{20}\left[1 + \frac{x}{1+x} + \left(\frac{x}{1+x}\right)^2 + ... + \left(\frac{x}{1+x}\right)^{18}\right]$

$(1+x)^{21}\left[1 - \left(\frac{x}{1+x}\right)^{19}\right] = (1+x)^{21} - (1+x)^2 x^{19}$

Coefficient of x^{18} in f(x) = Coefficient of x^{18} in $(1 + x)^{21}$ = $^{21}C_{18}$ = 1330

3. Let $2^x = t$ (for x < 0, t < 1 and for x > 0, t > 1)
Now $g(t) = t^2 + 2(1 – b)t + b = 0$
Unity must be between the roots of this equation g(1) < 0
1 + 2(1 – b) + b < 0 $\Rightarrow$ b > 3
Possible values of b in [1, 20] are 4, 5, 6, ... 19, 20
So p = 204 = 4

4. Area of ΔABC = $\frac{1}{2}\left|\vec{a} \times \vec{b} + \vec{b} \times \vec{c} + \vec{c} \times \vec{a}\right|$

Now given $2\vec{a} + 3\vec{b} + 6\vec{c} = 0$

Cross with $\vec{a}$, $3\vec{a} \times \vec{b} + 6\vec{a} \times \vec{c} = 0$

or $\vec{a} \times \vec{b} = 2(\vec{c} \times \vec{a})$ ..... (1)

Again cross with $\vec{b}$

$2\vec{a} \times \vec{b} + 6\vec{c} \times \vec{b} = 0$

or $\vec{a} \times \vec{b} = 3(\vec{b} \times \vec{c})$

Area of ΔOAB = $\frac{1}{2}\left|\vec{a} \times \vec{b}\right|$

$$\frac{\text{Area of }\Delta ABC}{\text{Area of }\Delta AOB}=\frac{\frac{1}{2}|\vec{a}\times\vec{b}|\left(1+\frac{1}{2}+\frac{1}{3}\right)}{\frac{1}{2}|\vec{a}\times\vec{b}|}=\frac{11}{6}$$

So m = 11, n = 6 $\Rightarrow$ (m – n) = 5

5. $x^2 + (2 - \tan\theta)x - (1 + \tan\theta) = 0$

$\alpha + \beta = \tan\theta - 2$ ..... (1)

$\alpha\beta = -\tan\theta - 1$ ..... (2)

From equation (1) + (2)

$\alpha + \beta + \alpha\beta = -3$

$(\alpha + 1)(\beta + 1) = -2$

Hence either $\alpha + 1 = -2$ and $\beta + 1 = 1$

then $\alpha = -3$, $\beta = 0$

or $\alpha + 1 = -1$ and $\beta + 1 = 2$

$\alpha = -2$ and $\beta = 1$

If $\alpha = -3$, $\beta = 0$ then $\tan\theta = -1$

$\Rightarrow\ \alpha = \frac{3\pi}{4},\ \frac{7\pi}{4}$

If $\alpha = -2$, $\beta = 1$ then $\tan\theta = 1$

$\Rightarrow\ \theta = \frac{\pi}{4},\ \frac{5\pi}{4}$

Sum = $\frac{3\pi}{4}+\frac{7\pi}{4}+\frac{\pi}{4}+\frac{5\pi}{4}=4\pi$ = 4

6. $\frac{p}{q}=1-\frac{{}^{9}C_{8}\cdot{}^{1}C_{1}}{{}^{10}C_{9}}\times\frac{{}^{18}C_{9}}{{}^{19}C_{9}}=1-\frac{9}{19}=\frac{10}{19}$

So q – p = 19 – 10 = 9

FIITJEE **JEE (Main), 2014**

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - III

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 30)** contains 30 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity $g = 10\ m/s^2$

Planck constant $h = 6.6 \times 10^{-34}$ J-s

Charge of electron $e = 1.6 \times 10^{-19}$ C

Mass of electron $m_e = 9.1 \times 10^{-31}$ kg

Permittivity of free space $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$

Density of water $\rho_{water} = 10^3\ kg/m^3$

Atmospheric pressure $P_a = 10^5\ N/m^2$

Gas constant $R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant R = $8.314\ J\ K^{-1}\ mol^{-1}$
= 0.0821 Lit atm $K^{-1}\ mol^{-1}$
= $1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

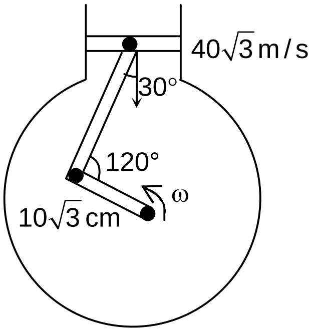
SECTION – A

Single Correct Choice Type

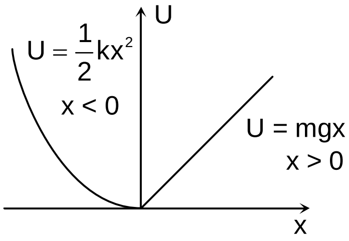
This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. An electron is released from rest at one point in a uniform electric field and travels a distance of 10 cm in 10^{-7} seconds. Potential difference across the points is
(A) 11.375 volts
(B) 10 volts
(C) 5 volts
(D) 5.7 volts

2. A snapshot of a petrol engine is given in which piston is moving downwards with velocity $40\sqrt{3}\,\text{m/s}$. Find the angular velocity of the shaft.
(A) 400 rad/s
(B) 300 rad/s
(C) 200 rad/s
(D) 500 rad/s

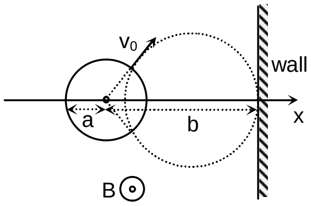


3. A particle of mass m moves in the potential shown in the figure. The particle has energy E. The period of the motion the particle is
(A) $2\pi\sqrt{\frac{m}{k}} + 2\sqrt{\frac{2E}{mg^2}}$
(B) $2\pi\sqrt{\frac{m}{k}} + \sqrt{\frac{2E}{mg^2}}$
(C) $\pi\sqrt{\frac{m}{k}} + 2\sqrt{\frac{2E}{mg^2}}$
(D) $\pi\sqrt{\frac{m}{k}} + \sqrt{\frac{2E}{mg^2}}$



Space for Rough work

4. A electron is projected normally from the surface of a sphere with speed v_0 in a uniform magnetic field perpendicular to the plane of the paper such that its strikes symmetrically opposite on the sphere with respect to the x-axis. Radius of the sphere is 'a' and the distance of its centre from the wall is 'b'. What should be magnetic field such that the charge particle just escapes the wall



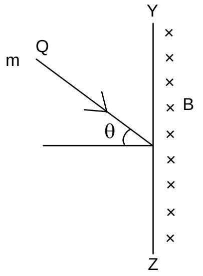
(A) $B = \frac{2bmv_0}{(b^2 - a^2)e}$

(B) $B = \frac{2bmv_0}{(a^2 - b^2)e}$

(C) $B = \frac{(a^2 - b^2)}{2bmv_0}$

(D) $B = \frac{me(b^2 - a^2)}{2bmv_0}$

5. A particle with positive charge Q and mass m enters a magnetic field of magnitude B, existing only to the right of boundary YZ. The direction of the motion of the particle is perpendicular to the direction of B. Let $T = 2\pi\left(\frac{m}{QB}\right)$. The time spent by the particle in the field will be



(A) $T\theta$

(B) $2T\theta$

(C) $T\left(\frac{\pi + 2\theta}{2\pi}\right)$

(D) $T\left(\frac{\pi - 2\theta}{2\pi}\right)$

6. If net external torque, about a point, acting on the system is zero, then we can surely say

(A) Kinetic energy of the system remains constant

(B) Mechanical energy of the system remains constant
(C) Torque of Internal forces is zero

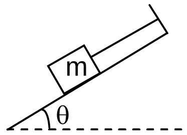
(D) Momentum of system will remain constant.

7. A horizontal spring mass system of mass M performs simple harmonic motion of amplitude a_0 and time period T_0. When the mass M passes through mean position, another stationary mass M sticks to it and both move together. If a and T be new amplitude and time period, then

(A) $a = \frac{a_0}{\sqrt{2}}$
(B) $a = a_0\sqrt{2}$
(C) $T = \frac{T_0}{\sqrt{2}}$
(D) None

Space for Rough work

8. A metal block of mass m is placed on a smooth metallic plane in support with string as shown in diagram. If, after long time due to corrosion, the contact surface becomes rough with coefficient of friction μ, then friction force acting on the block will be



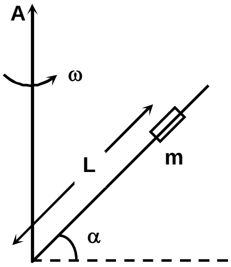
(A) $\mu mg\cos\theta$
(B) $mg\sin\theta$
(C) mg
(D) None

9. A uniform rod of mass 2M and length 2L is bent at its mid point to form an L shape. Then, moment of inertia of the system about an axis symmetrical to both straight parts of L shaped rod is

(A) $\frac{7}{5}ML^2$ (B) $\frac{1}{3}ML^2$
(C) $\frac{7}{24}ML^2$ (D) $\frac{ML^2}{2}$

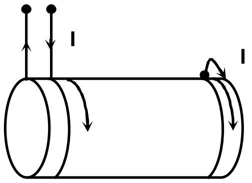
10. Which of the following is correct about principle of conservation of momentum?
(A) Conservation of momentum can be applied only in absence of external forces
(B) Conservation of momentum can be applied only during collisions of bodies
(C) Conservation of momentum can be applied in a process even in the presence of external forces
(D) Conservation of momentum is not applicable in rocket propulsion

11. A rod revolves with a constant angular velocity ω about a vertical axis A. The rod makes a fixed angle α with the horizontal. A body of mass m can slide along the rod and it has tendency to slide down, the angle of friction being β. The value of α so that "m" remains at rest (relative to the rod) is given by



(A) $\tan(\alpha-\beta)=\frac{\omega^2 L}{g}\cos\alpha$ (B) $\tan(\alpha+\beta)=\frac{\omega^2 L}{g}\cos\alpha$
(C) $\omega^2 L\sin(\alpha+\beta) = g\cos\beta$ (D) $\omega^2 L\sin(\alpha-\beta) = g\cos\alpha$

12. Two long cylindrical coils with uniform winding of the same length and nearly the same radius having inductances L_1 and L_2. The coils are coaxially inserted into each other and connected to a current source as shown in the figure. The inductance L of the composite system is



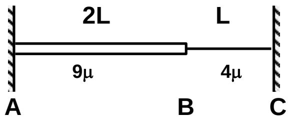
(A) $L_1 + L_2$
(B) $L_1L_2(L_1+L_2)$
(C) $L_1 + L_2 + \sqrt{L_1L_2}$
(D) $L_1 + L_2 + 2\sqrt{L_1L_2}$

Space for Rough work

13. A disturbance can be written as y(x, t) = $\left[e^{-(x/b)^2}e^{2xt/b}e^{-t^2}\right]^a$. The disturbance is
(A) not a travelling wave
(B) a travelling wave with speed v = a
(C) a travelling wave with speed v = a/b
(D) a travelling wave with speed v = b

14. Which of the following is cause of dispersion of a white light by a prism
(A) waves of different frequencies lose energy at different rates.
(B) waves of different amplitudes lose energy at different rate.
(C) waves of different frequencies travel through the medium at different speeds
(D) waves of different amplitudes travels through the medium with different wavelengths.

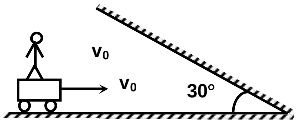
15. A thick rope of length 2L and linear mass density 9μ is joined at B to a thin rope of length L and linear mass density 4μ. The system is horizontally stretched by the two vertical wall A and C. Assuming B to be a node, find the minimum number of loops in the thick rope.



(A) 1
(B) 2
(C) 3
(D) 4

16. In an L-C-R series circuit, it is found that the power factor is maximum. Then the angular frequency of the emf source must be equal to
(A) $\frac{1}{\sqrt{LC}}$
(B) zero
(C) a very large number
(D) none of these

17. A car approaches an inclined wall (see in the figure) with speed v_0 an a horizontal road. When the horn of frequencies f_0 is sounded, the beat frequencies heard by the person on the car is (v = speed of sound)



(A) $\frac{v_0 f_0}{v - v_0}$
(B) $\frac{2v_0 f_0}{2v - v_0}$
(C) $\frac{v_0 f_0}{2(v - v_0)}$
(D) $\frac{2v_0 f_0}{v - v_0}$

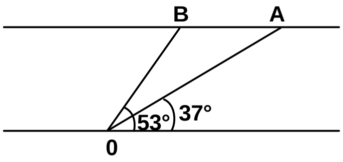
18. The speed of the colliding electron is increased in an X-ray tube, then
(A) the cutoff wavelength must increase
(B) the cutoff frequency must increase
(C) the intensity of the X-rays must increase.
(D) the types of characteristic X-rays must increase

Space for Rough work

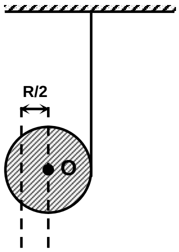
19. If white light is used in an YDSE setup, the nearest bright fringe from the central fringe will be
(A) white (B) violet
(C) red (D) yellow

20. A particle is placed in a cart. Initial location of the particle is taken as origin in ground frame. At t = 0, the cart starts moving along x-axis with uniform velocity 2m/s and at the same instant the particle starts moving with $2x\hat{j}$ relative to cart where x is x-coordinate of the cart. Which of the following is the radius of curvature of the trajectory of the particle in ground frame when it's tangential acceleration is equal to normal acceleration in magnitude?
(A) $\frac{1}{\sqrt{2}}$m (B) $\frac{2}{\sqrt{2}}$m
(C) $\frac{3}{2\sqrt{2}}$m (D) $\frac{4}{\sqrt{2}}$m

21. A boat crosses a 2.4km wide river to reach the a point A on the opposite bank, located at 37° with the flow, in 500s. The same boat takes the same time (500s) to reach another point B on the opposite bank located at 53° with the flow. the speed of flow of the river is
(A) 5 m/s
(B) 10 m/s
(C) 15 m/s
(D) none of these

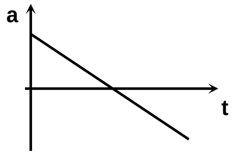


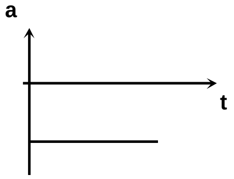
22. A disc of mass M and radius R is wounded by massless inextensible thread. One end of string is tied to ceiling and system is released. Then which of the followings are/is false.
(A) Tension in the thread mg/3
(B) acceleration of disc 2g/3
(C) angular momentum of disc is conserved about point of contact on rim with thread.
(D) angular momentum is conserved about any point on vertical line at distance x = R/2 from centre toward left.

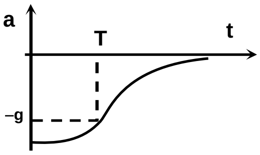


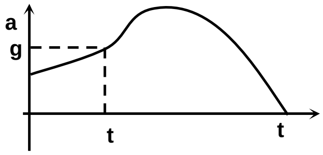
Space for Rough work

23. A ball is thrown vertically upward at time t = 0. Viscous force of air resistance is not negligible and the acceleration due to gravity is g. The ball reaches maximum height at t = T and then descends attaining terminal speed. Which graph shows the best variation with time t of the acceleration a of the ball.

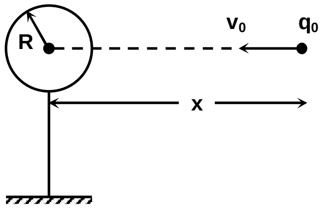
(A)


(B)


(C)


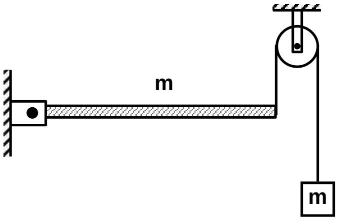
(D)


24. An uncharged sphere of radius R is connected by zero resistance wire to earth. A charged particle q_0 is moving towards centre of sphere with constant velocity v_0. Find current flowing in wire. When charged particle is at distance x. q_0 = 10 C, R = 1 m, v_0 = 10 m/s, x = 2 m.



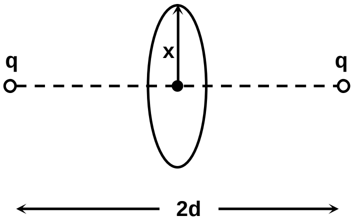
(A) 25 A
(B) 5A
(C) infinity
(D) zero.

25. A rod and a block are of same mass. Initially rod is in horizontal position. What will be acceleration of tip of the rod. When system is released from this position



(A) zero
(B) $\frac{3g}{4}$
(C) $\frac{3g}{8}$
(D) $\frac{3g}{2}$

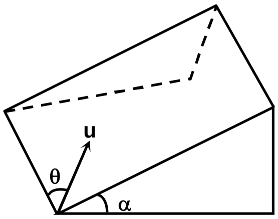
26. Two identical charges q are separated by distance 2d and fixed at this position. Third charge $-q_0$ is revolving in a circle of radius x in plane perpendicular to line joining charges and centre coincides with mid point of line joining charges. The value of x for which speed of particle is maximum is [Consider gravity free space.]



(A) $\frac{d}{\sqrt{2}}$
(B) $\sqrt{2}$ d
(C) d
(D) 2d

Space for Rough work

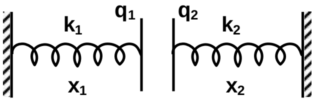
27. A particle is thrown at an angle θ with horizontal along the inclined plane of inclination α. Find the maximum height from the ground reached by particle



(A) $\dfrac{u^2 \sin^2 \theta}{2g}$
(B) $\dfrac{u^2 \sin^2 \theta \sin \alpha}{2g}$
(C) $\dfrac{u^2 \sin^2 \theta}{2g \sin \alpha}$
(D) $\dfrac{u^2 \sin^2 \theta \sin^2 \alpha}{2g}$

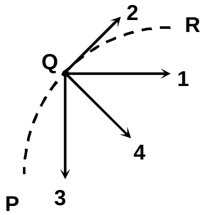
28. A charged particle of charge q is revolving in a circle of radius R of time period T = 9 sec. A point P at distance 2R from centre of circle in same plane record magnetic field. Find minimum time interval between two successive times at which magnetic field is zero at that point
(A) 9 sec
(B) 4.5 sec
(C) 3 sec
(D) magnetic field at point P will always have non-zero value.

29. Two plates of capacitors are provided charges q_1 and q_2 and connected with springs of constant k_1 and k_2 as shown in the diagram. Find the ratio of elongation in two springs (x_1/x_2). (springs are of dielectric material]



(A) $\dfrac{k_2}{k_1}$
(B) $\left(\dfrac{k_2}{k_1}\right)^2$
(C) 1
(D) $\left(\dfrac{k_1}{k_2}\right)^2$

30. A body moves along a path PQR from P to R shown as a dashed line in figure. When the particle is at Q, its speed is decreasing. The acceleration of the particle at Q is best represented by the
(A) 1
(B) 2
(C) 3
(D) 4



Space for Rough work

Chemistry

PART – II

SECTION – A

Straight Objective Type

This section contains 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. The correct order of leaving group for aromatic nucleophilic substitution is:

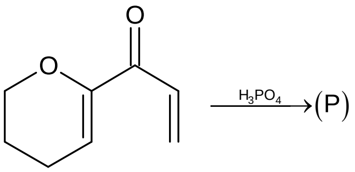
(A) $F^- > Cl^- > I^- > Br^- > NO_2^-$

(B) $F^- > NO_2^- > Cl^- > Br^- > I^-$

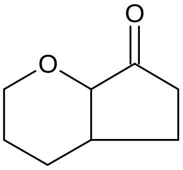
(C) $NO_2^- > Cl^- > Br^- > I^- > F^-$

(D) $I^- > Br^- > Cl^- > F^- > NO_2$

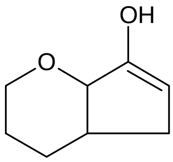
2.



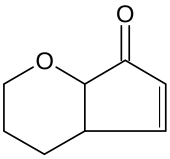
(A)



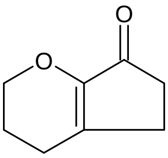
(B)



(C)

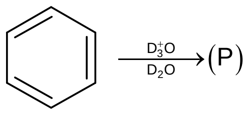


(D)



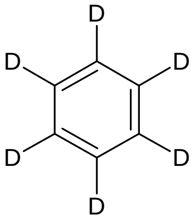
Rough Work

3.

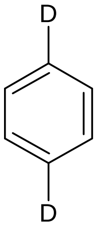


The product (P) formed finally is?

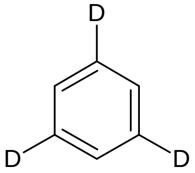
(A)



(B)



(C)



(D) None of these

4. 'Talc' is one of the very soft material and it is used in talcum powder having molecular formula $Mg_3Si_4O_{10}(OH)_2$. What type of silicate it is?
(A) Two dimensional sheet silicate
(B) Three dimensional sheet silicate
(C) Cyclic silicate
(D) Chain silicate

5. What is the false about H_2O_2?
(A) Acts both as oxidising and reducing agent.
(B) It is an antiseptic and germicide for working wounds, teeth and ears under the name perhydrol.
(C) H_2O_2 is prepared by adding ice cold dilute H_2SO_4(20%) on Na_2O_2.
(D) Two OH bonds of H_2O_2 lie in the same plane.

6. Hydrazine may be obtained from the reaction between ammonia and hydrogen peroxide:

$$2NH_3(g) + H_2O_2(\ell) \longrightarrow N_2H_4(\ell) \qquad \Delta_r H^o = -241.0 \text{ kJ/mol.}$$

What is the standard enthalpy change per mole for the decomposition of hydrazine to its elements into their standard state? Given the standard enthalpy changes of formation (in kJ/mol) are:

$NH_3(g)$ = - 46.1
$H_2O_2(\ell)$ = - 187.8
$H_2O\ (\ell)$ = - 285.8

(A) - 50.6 kJ/mol
(B) + 50.6 kJ/mol
(C) - 25.3 kJ/mol
(D) +25.3 kJ/mol

Rough Work

7. $(A) + X^- + K_2Cr_2O_7(s) + H_2SO_4(\text{conc.}) \xrightarrow{\Delta} \underset{(\text{Red vapour})}{B} + \underset{(\text{Reddish brown vapour})}{C(g)}$

$C + H_2O \longrightarrow \text{Brown red colouration} \xrightarrow{NaOH} (E) + (F)$

colourless solution

$B + NaOH \longrightarrow (D)$

Yellow solution

$(D) + Pb(OAc)_2 \xrightarrow{CH_3COOH} \text{Yellow solid}$

What is (D) in the above sequence?

(A) Na_2CrO_4
(B) $NaBrO_3$
(C) NOBr
(D) None of these

8. H_2S is bubbled into 0.2 M NaCN solution which is 0.02 M in each $[Cd(CN)_4]^{2-}$ and $[Ag(CN)_2]^-$. The H_2S produces 1×10^{-9} M sulphide ion in the solution.

Given: $K_{sp}Ag_2S = 1\times10^{-50}\ M^3; K_{sp}CdS = 7.1\times10^{-28}\ M^2$

$K_{instability}\left[Ag(CN)_2\right]^{-1} = 1\times10^{-20}\ M^2,\ K_{instability}\left[Cd(CN)_4\right]^{2-} = 7.8\times10^{-18}\ M$

Identify the correct statement:

(A) Ag_2S precipitates first from the solution.
(B) CdS precipitates first from the solution.
(C) None of them precipitates under the given conditions.
(D) Ag_2S precipitates at a sulphide concentration $1 \times 10^{+15}$ M.

9. Predict coordination number of the cation in the crystals of the following compounds:

1. MgO : $r_c = 0.65\ \text{Å}$; $r_a = 1.40\ \text{Å}$
2. MgS : $r_c = 0.65\ \text{Å}$; $r_a = 1.84\ \text{Å}$

(Where r_c and r_a represents the radius of cation and anion respectively).

(A) 6, 4
(B) 4, 6
(C) 3, 4
(D) 6, 8

10. The chlorate ion can disproportionate in basic solution according to reaction,

$2ClO_3^- \rightleftharpoons ClO_2^- + ClO_4^-$

What is the equilibrium concentration of perchlorate ions from a solution initially at 0.1 M in chlorate ions at 298 K?

Given: $E^o_{ClO_4^-/ClO_3^-} = 0.36$ V and $E^o_{ClO_3^-/ClO_2^-} = 0.33$ V at 298 K.

(A) 0.019 M
(B) 0.024 M
(C) 0.1 M
(D) 0.19 M

Rough Work

11. A d-Block element forms octahedral complex but its magnetic moment remains same either in strong field or in weak field ligand. Which of the following is/are correct?
(A) Element always forms colourless compound.
(B) Number of electrons in t_{2g} orbitals are higher than in e_g orbitals.
(C) It can have either d^3 or d^8 configuration.
(D) It can have either d^7 or d^8 configuration.

12. The Schrodinger wave equation for hydrogen atom is :

$$\psi(r)_{n,\ell} = \frac{1}{16\sqrt{4}}\left(\frac{1}{a_0}\right)^{3/2}\left[(\sigma-1)\left(\sigma^2-8\sigma+12\right)\right]e^{-\sigma/2}$$

Where a_0 and z are constant in which answer can be expressed and $\sigma = \frac{2r}{a_0}$. Then the minimum and maximum position of radial nodes from nucleus respectively are:

(A) a_0, $3a_0$	(B) $\frac{a_0}{2}, a_0$
(C) $\frac{a_0}{2}, 3a_0$ `	(D) $\frac{a_0}{2}, 4a_0$

13. Equivalent weight of H_3PO_2, when it disproportionate into PH_3 and H_3PO_3 is:
(Given M is the molecular mass of H_3PO_2)

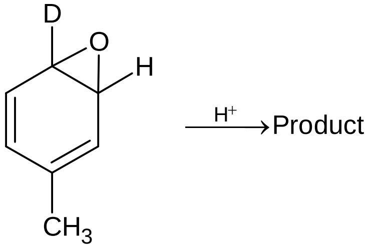
(A) M	(B) M/2
(C) M/4	(D) 3M/4

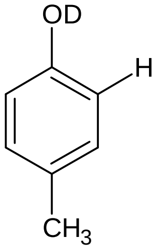
14. A complex of iron and cyanide ions is 100% ionized at 1 molal concentration. If its elevation in boiling point is 2.08^o, then the complex is (Given $K_b = 0.52^o$ C mol^{-1} kg)

(A) $Fe_4[Fe(CN)_6]_3$	(B) $K_3[Fe(CN)_6]$
(C) $K_4[Fe(CN)_6]$	(D) $Fe_3[Fe(CN)_6]_2$

Rough Work

15. What will the major product of the following reaction?



(A)


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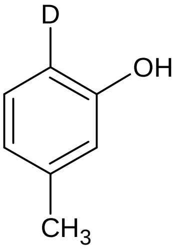

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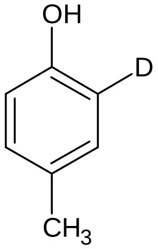
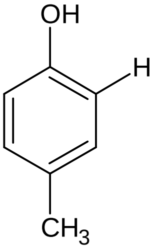


(D)


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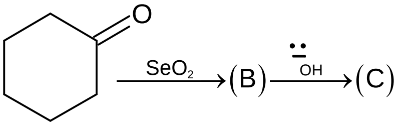
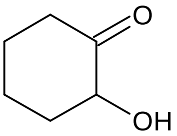


Compounds (B) and (C), respectively are:

(A)

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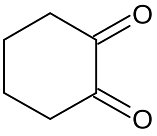

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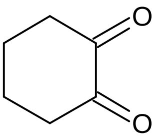
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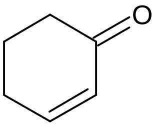

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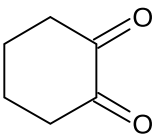
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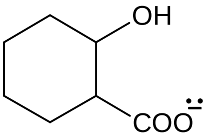

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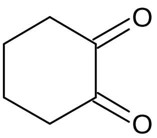
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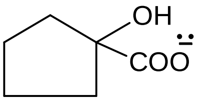


17. In the commercial electrochemical process for aluminium extraction, the electrolyte used is:
(A) $Al(OH)_3$ in NaOH solution
(B) An aqueous solution of $Al_2(SO_4)_3$
(C) A molten mixture of Al_2O_3 and Na_3AlF_6
(D) A molten mixture of Al_2O_3 and $Al(OH)_3$

Rough Work

18. DDT is:
(A) antibiotic
(B) a fertilizer
(C) a non-degradable pollutant
(D) dichlorodifluorotitanium

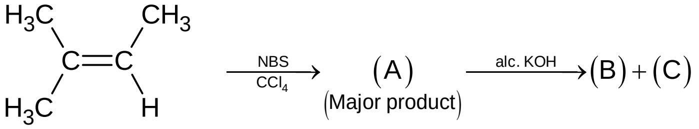
19. Which of the following colloidal solution is used in photography?
(A) Colloidal silver bromide
(B) Colloidal gold
(C) Colloidal silver
(D) Colloidal sulphur

20. The correct increasing order of thermal stabilities of
$\underset{(I)}{K_2CO_3}$ $\underset{(II)}{MgCO_3}$ $\underset{(III)}{CaCO_3}$ $\underset{(IV)}{BeCO_3}$
(A) I < II < III < IV
(B) IV < II < III < I
(C) IV < II < I < III
(D) IV < II < I < III

21. Which of the following molecular orbital have 2-nodal planes?
(A) π_{2px}
(B) π_{2py}
(C) π^*_{2px}
(D) σ_{1s}

22. The reaction, $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ is favoured in forward direction by:
(A) increasing the volume of the container.
(B) introducing PCl_5 at constant volume.
(C) adding inert gas at constant pressure
(D) all of the above

23. In the given reaction:

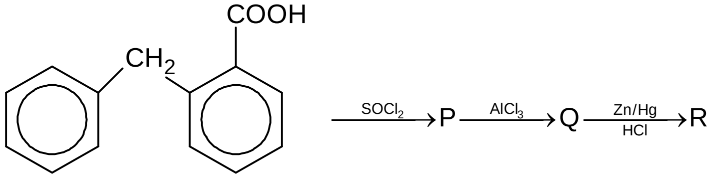


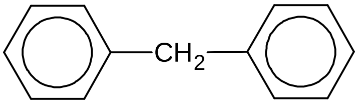
Which of the following is correct?
(A) Compounds (B) and (C) are stereoisomer and both are planar.
(B) Compounds (B) and (C) are not stereoisomer and both are planar.
(C) Compounds (B) and (C) are not stereoisomer and one of them is planar.
(D) Compounds (B) and (C) are stereoisomer and one of them is planar.

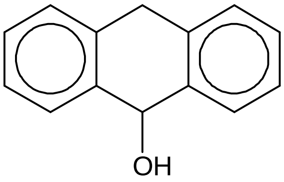
24. For a first order reaction which among the following is incorrect?
(A) $r \propto [\text{conc.}]^1$.
(B) $t_{1/2}$ is independent of initial concentration.
(C) Slope of graph of log(conc.) versus time in $-\frac{K}{2.303}$.
(D) $t_{1/2} \propto [\text{conc.}]^{1/2}$.

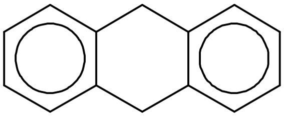
Rough Work

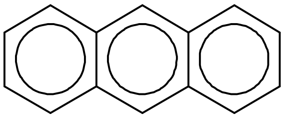
25. What is R in the following set of reactions?



(A)


(B)


(C)


(D)


26. Which of the following is not correct?

(A) $FeCl_3 + KCNS \longrightarrow$ Red colour

(B) $KI + PbCl_2 \longrightarrow$ Yellow ppt.

(C) $NH_4Cl +$ Nesseler's reagent $\longrightarrow$ Blue colour

(D) $DMG + Ni^{2+} + NH_4OH \longrightarrow$ Scarlet red ppt.

27. Nucleosides contain:

(A) pentose sugar
(B) purine pyrimidine
(C) phosphate
(D) both (A) and (B)

28. Which of the following is not a cross linked polymer?

(A) Alkyde resin
(B) Bakelite
(C) Vulcanised rubber
(D) Nylon-6

29. Acetonitrile on reduction gives:

(A) Propanamine
(B) Methanamine
(C) Ethanamine
(D) None of these

30. The fundamental unit of linear silicones is:

(A) SiO_4^{4-}
(B) $\left(R_2SiO\right)_n$
(C) $\left(RSiO_3\right)_n$
(D) none of these

Rough Work

Mathematics

PART – III

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Consider the circle c : $x^2 + y^2 = 1$ and the line L : $y = m(x + 2)$. If L intersect c at P and Q, then locus of middle point of PQ is

(A) $(x+1)^2 + y^2 = 1$ (B) $x^2 + (y - 1)^2 = 1$

(C) $(x - 1)^2 + y^2 = 1$ (D) $x^2 + (y + 1)^2 = 1$

2. Let f : (1, ∞) → (0, ∞) be a continuous decreasing function with $\lim\limits_{x\to\infty} \frac{f(4x)}{f(8x)} = 1$, then $\lim\limits_{x\to\infty} \frac{f(6x)}{f(8x)}$ is equal to

(A) $\frac{4}{8}$ (B) $\frac{4}{6}$

(C) $\frac{6}{8}$ (D) 1

3. If the equation $ax^2 - 6xy + y^2 + 2gx + 2fy + c = 0$ represents a pair of lines whose slopes are m and m^2, then sum of all possible values of a is

(A) 17 (B) –19

(C) 19 (D) –17

4. Let g : R → R be a differentiable function such that g(2) = –40 and g′(2) = –5 then

$$\lim_{x\to 0}\left(\frac{g(2-x^2)}{g(2)}\right)^{\frac{4}{x^2}}$$ is equal to

(A) e^{32} (B) $\sqrt{e}$

(C) $\frac{1}{\sqrt{e}}$ (D) e^{-5}

Space for rough work

5. Let f : [0, 1] → R be a differentiable function with f(0) = 0, then $\lim\limits_{n\to\infty} n^2 \int_0^{1/n} f(t)dt$ equals

(A) $\frac{1}{2}f'(0)$ (B) $f'(0)$

(C) $2f'(0)$ (D) 0

6. The values of parameter a such that the line $(\log_2(1 + 5a - a^2))\, x - 5y - (a^2 - 5) = 0$ is a normal to the curve xy = 1, may be in the interval

(A) $(-\infty, 0)$ (B) $(5, \infty)$

(C) $(0, 5)$ (D) $(-\infty, 0) \cup (5, \infty)$

7. A triangle has vertices A, B, C and their respective opposite sides have tangents a, b, and c. Then triangle is inscribed in a circle of radius R. If b = c = 1 and the altitude from A to side BC has length $\sqrt{\frac{2}{3}}$, then R is equal to

(A) $\frac{1}{\sqrt{3}}$ (B) $\frac{2}{\sqrt{3}}$

(C) $\frac{\sqrt{3}}{2}$ (D) $\frac{\sqrt{3}}{2\sqrt{2}}$

8. Let O be the centre of a circle of radius 1 P and Q are the points on the circle such that θ = ∠POQ is an acute angle and R is a point outside the circle such that OPRQ is a parallelogram. If the area of the part of the parallelogram that is outside the circle is f(θ), then $\lim\limits_{\theta\to 0} \frac{f(\theta)}{\theta}$ is equal to

(A) $\frac{3}{\pi}$ (B) $\frac{2}{\pi}$

(C) $\frac{1}{2}$ (D) 1

9. If $\sum_{r=1}^{10} r(r-1)\ {}^{10}C_r = k \cdot 2^9$, then k is equal to

(A) 10 (B) 45

(C) 90 (D) 100

Space for rough work

10. If A and B are square matrices of order 3 where $|A| = -2$ and $|B| = 1$ then $|(A^{-1})\ \text{adj}(B^{-1})\ \text{adj}(2A^{-1})|$ is equal to
(A) 8 (B) –8
(C) 1 (D) –1

11. P is a point on the line y + 2x = 1 and Q and R are two points on the line 3y + 6x = 6 such that the triangle PQR is an equilateral triangle. Area of this triangle is equal to
(A) $\frac{1}{15}$ (B) $\frac{1}{5\sqrt{3}}$
(C) $\frac{1}{3\sqrt{5}}$ (D) $\frac{1}{2\sqrt{15}}$

12. Let OABC be a tetrahedron (O beams the origin). If position vectors of A, B and C are $\hat{i}$, $\hat{i}+\hat{j}$ and $\hat{j}+\hat{k}$ respectively, then height of the tetrahedron (taking ABC as base) is equal to
(A) $\frac{1}{2}$ (B) $\frac{1}{\sqrt{2}}$
(C) $\frac{1}{2\sqrt{2}}$ (D) $\sqrt{2}$

13. A circle is inscribed in a right triangle ABC, right angled at C. The circle is tangent to the segment AB at D and length of segments AD and DB are 7 and 13 respectively. Area of triangle ABC is equal to
(A) 91 (B) 96
(C) 100 (D) 104

14. The vector equation of a curve in R^3 denoted by $\vec{r} = (t^2+t-2)\hat{i} + (t+2)\hat{j} + (t+3)^2\hat{k}$ denotes
(A) a plane passing through the origin (B) a plane passing through (0, 0, 1)
(C) a line parallel to the vector $\hat{i}+5\hat{j}-\hat{k}$ (D) a pair of lines intersecting at (0, 0, 1)

15. Rajdhani express stops at six intermediate stations between Kota and Mumbai. Five passengers board at Kota. Each passenger can get down at any station till Mumbai. The probability that all five passengers will get down at different stations, is
(A) $\frac{{}^6P_5}{6^5}$ (B) $\frac{{}^6C_5}{6^5}$
(C) $\frac{{}^7P_5}{7^5}$ (D) $\frac{{}^7C_5}{7^5}$

Space for rough work

16. Let $\vec{a}$ and $\vec{b}$ be two vectors such that $|\vec{a}| = 1$ and $\vec{a}\cdot\left(\vec{b}\times\left(\vec{a}\times\vec{b}\right)\right) = 8$. If angle between $\vec{a}$ and $\vec{b}$ is $\cos^{-1}\frac{1}{\sqrt{2}}$, then magnitude of $\vec{b}$ equals

(A) 2 (B) 4
(C) 8 (D) 16

17. An ellipse in the first quadrant is tangent to co–ordinate axes. If one focus is $F_1(3, 7)$ and other focus is $F_2(d, 7)$ then the value of $\sqrt{3d}$ is equal to

(A) 5 (B) 7
(C) 14 (D) 49

18. The minimum value of the function $f(x) = \int_0^x \frac{d\theta}{\cos\theta} + \int_x^{\pi/2} \frac{d\theta}{\sin\theta}$ where $x \in \left(0, \frac{\pi}{2}\right)$, is

(A) $2\ln\left(\sqrt{2}+1\right)$ (B) $\ln\left(2\sqrt{2}+2\right)$
(C) $\ln\left(2+\sqrt{3}\right)$ (D) $\ln\left(3+\sqrt{2}\right)$

19. Let $I(a) = \int_0^a \ln(\cot a + \tan x)\,dx$, where $a \in \left(0, \frac{\pi}{2}\right)$ then I(1) has value equal to

(A) ln (sin 1) (B) –ln (cos 1)
(C) ln (cosec 1) (D) ln (sec 1)

20. $\lim\limits_{x\to 0}\left(2^{x-1} + \frac{1}{2}\right)^{1/x}$ is equal to

(A) $\sqrt{2}$ (B) $\frac{1}{2}\ln 2$
(C) ln 2 (D) 2

21. Let $U_n = \frac{\underline{|n}}{\underline{|n+2}}$ where $n \in N$. If $S_n = \sum_{n=1}^{n} U_n$ then $\lim\limits_{n\to\infty} S_n$ is equal to

(A) 2 (B) 1
(C) $\frac{1}{2}$ (D) none exists

Space for rough work

22. Given $z = \left(1 + i\sqrt{3}\right)^{100}$ then $\frac{\text{Re}(z)}{\text{Im}(z)}$ is equal to

(A) 2^{100}
(B) 2^{50}
(C) $\frac{1}{\sqrt{3}}$
(D) $\sqrt{3}$

23. If $|z - 1| \le 2$ and $|wz - 1 - w^2| = a$ (where w n a cube root of unity) then complete set of values of a is

(A) $0 \le a \le 2$
(B) $\frac{1}{2} \le a \le \frac{\sqrt{3}}{2}$
(C) $\frac{\sqrt{3}}{2} - \frac{1}{2} \le a \le \frac{1}{2} + \frac{\sqrt{3}}{2}$
(D) $0 \le a \le 4$

24. The number of positive integral solution of $x^4 - y^4 = 3789108$ is

(A) 0
(B) 1
(C) 2
(D) 4

25. The total number of ways of selecting two numbers from a set {1, 2, 3, 4 ….. 3n} so that their sum is divisible by 3 is equal to

(A) $\frac{2n^2 - n}{2}$
(B) $\frac{3n^2 - n}{2}$
(C) $2n^2 - n$
(D) $3n^2 - n$

26. The sum of the coefficients of even power of x in the expansion of $(1 + x + x^2 + x^3)^5$ is

(A) 256
(B) 128
(C) 512
(D) 64

27. Consider $f(x) = x^3 + ax^2 + bx + c$, parameters a, b, c are chosen respectively by throwing a dice three times. Then probability that f(x) is an increasing functions is

(A) $\frac{5}{36}$
(B) $\frac{8}{36}$
(C) $\frac{4}{9}$
(D) $\frac{1}{3}$

Space for rough work

28. If a, b, c $\in R^+$ then the minimum value of $a(b^2 + c^2) + b(c^2 + a^2) + c(a^2 + b^2)$ is equal to

(A) abc
(B) 2abc
(C) 3abc
(D) 6abc

29. $\sum_{r=1}^{n} \tan^{-1}\left(\frac{2^{r-1}}{1+2^{2r-1}}\right)$ is equal to

(A) $\tan^{-1}(2^n)$
(B) $\tan^{-1}(2^n) - \frac{\pi}{4}$
(C) $\tan^{-1}(2^{n+1})$
(D) $\tan^{-1}(2^{n+1}) - \frac{\pi}{4}$

30. In ΔABC, $a^2 + c^2 = 2002b^2$ then $\frac{\cot A + \cot C}{\cot B}$ is equal to

(A) $\frac{1}{2001}$
(B) $\frac{2}{2001}$
(C) $\frac{3}{2001}$
(D) $\frac{4}{2001}$

Space for rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

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ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

CRT –III
(Main)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	B	A
2.	A	D	D
3.	C	A	B
4.	A	A	C
5.	C	D	A
6.	C	A	C
7.	A	A	D
8.	D	B	C
9.	B	A	B
10.	C	A	B
11.	A	B	C
12.	D	C	B
13.	D	D	A
14.	C	B	B
15.	C	C	C
16.	A	D	B
17.	B	C	B
18.	B	C	A
19.	B	A	C
20.	D	B	A
21.	A	C	C
22.	C	D	C
23.	C	D	D
24.	A	D	A
25.	C	C	B
26.	C	C	C
27.	A	D	C
28.	C	D	D
29.	A	C	B
30.	C	B	B

Physics

PART – I

1. V = Es ;

$$E = \frac{2sm}{qt^2}$$

$$\Rightarrow V = \frac{2s^2m}{qt^2} = 11.375 \text{ Volt}$$

.2

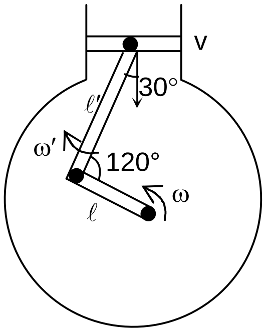
$$\frac{\ell}{\sin 30^\circ} = \frac{\ell'}{\sin 60^\circ}$$

$$\Rightarrow \ell' = \sqrt{3}\ell$$

$$\ell'\omega'\cos 30^\circ = v\cos 30^\circ$$

$$\ell\omega = \cos 60^\circ(v + \ell'\omega') = \cos 60^\circ(2v) = v$$

$$\omega = v/\ell = \frac{40\sqrt{3}}{0.1\sqrt{3}} = 400 \text{ rad/s}$$



3. for x<0

It will oscillate like SHM

Time period $T_1 = \pi\sqrt{\frac{m}{k}}$

For x>0

It will perform periodic motion under constant force

$$T_2 = 2\sqrt{\frac{2E}{mg^2}}$$

Hence time period $T = T_1 + T_2$

$$T = \pi\sqrt{\frac{m}{k}} + 2\sqrt{\frac{2E}{mg^2}}$$

4

$$ev_0B = \frac{mv_0^2}{R}$$

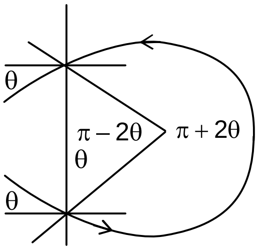
$$B = \frac{mv_0}{eR}$$

$$\sqrt{a^2 + R^2} = b - R$$

$$R = \frac{b^2 - a^2}{2b}$$

$$B = \frac{2bmv_0}{(b^2 - a^2)e}$$

5. Here the total time is given T
Time spent m the region is $(\pi + 2\theta)$
Hence total time spent
$= T\left(\dfrac{\pi + 2\theta}{2\pi}\right)$


θ
$\pi - 2\theta$
θ
$\pi + 2\theta$
θ

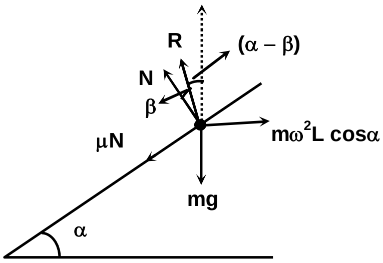
6. Torque of Internal force is always zero. All other quantities will vary.

8. Static friction depends on tendency.

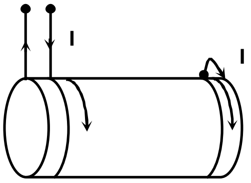
9. $\dfrac{ML^2}{12}\sin^2 60 \times 2 = \dfrac{3ML^2}{24}$

10. When impulse of external force is zero.

11. Balance forces.


R
$(\alpha - \beta)$
N
β
μN
$m\omega^2L\cos\alpha$
mg
α

12.



13. y(x, t) = $\left[e^{-\left(t-\frac{x}{b}\right)^2}\right]^a$ $\Rightarrow$ v = b

15. 2L = m × (λ_1/2) = $\dfrac{m}{2f}\sqrt{\dfrac{T}{9\mu}}$

L = n × (λ_2/2) = $\dfrac{n}{2f}\sqrt{\dfrac{T}{4\mu}}$

$\Rightarrow$ m = 3n = 3 × 1 = 3

16. cos ϕ = 1 $\Rightarrow$ ϕ = 0° $\Rightarrow$ ωL = 1/ωC

17. $f_B = f - f_0 = \left(\dfrac{v + v_0\sin 30^\circ}{v - v_0\sin 30^\circ}\right)f_0 - f_0$

$= \dfrac{2v_0f_0}{2v - v_0}$

18. $\frac{1}{2}mv^2 = h\nu$

19. $\beta = \lambda D/d$, λ is minimum for violet.

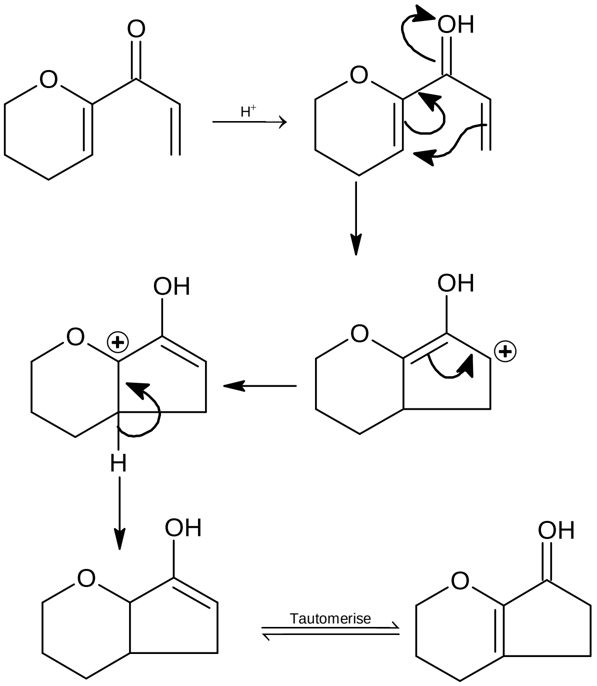
20. $\vec{V}_{PG} = \vec{V}_{PC} + \vec{V}_{CG} = 2x\hat{j} + 2\hat{i}$

Hence, for the paritcle,
$V_x = 2$m/s and $V_y = 2x = 4t$
$a_x = 0$ $a_y = 4$m/s^2
$x = 2t$, $y = 2t^2$
$\Rightarrow$ $a_{Total} = 4$m/s^2
(a) (along Y-axis)
and trajectory $\Rightarrow$ $y = 2.\frac{x^2}{4} = \frac{x^2}{2}$
when $\left|\vec{a}_\tau\right| = \left|\vec{a}_N\right|$, a cos θ = a sin θ ⇒ θ = 45º
So, $V_x = V_y = 2 \Rightarrow V = 2\sqrt{2}$
$\therefore$ $R_C = \frac{V^2}{a_N} = \frac{4\times 2}{4.\cos 45^o} = 2\sqrt{2}$ m = $\frac{4}{\sqrt{2}}$m

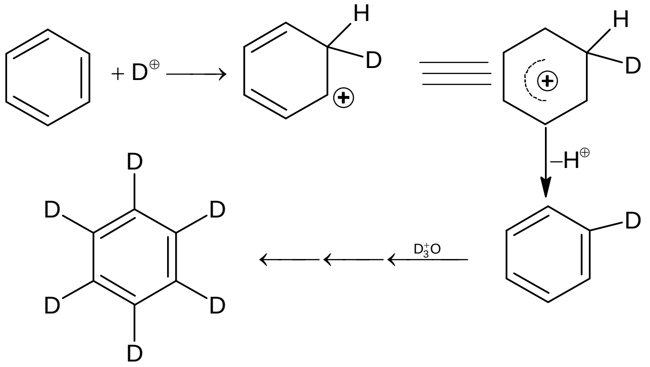
Chemistry

PART – II

2.

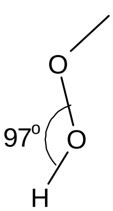


3.



4. Talc has empirical formula $Mg_2(Si_2O_5)_2Mg(OH)_2$ which $\left(Si_2O_5\right)_n^{2n-}$ units of two dimensional sheet silicates.

5.



It has half open book like structure having dihedral angle 97°

6. $\Delta_r H^o = \left(\left(2\times 46.1\right)+187.8-\left(2\times 285.8\right)+\Delta_r H^o\left(N_2H_4\right)\right) kJ/mol^{-1}$

$= -241.0\ kJ/mol^{-1}$

$\Delta H_{r^o}\left(N_2H_4\right) = 50.6\ kJ/mol$

Decomposition enthalpy = - 50.6 kJ/mol.

9. Radius ratio for MgO is = 0.464 which reflect the coordination number 6 and radius ratio for MgS is 0.353. Which reflect the coordination number 4.

10.
$$H_2O(\ell) + ClO_3^-(aq) \longrightarrow ClO_4^-(aq) + 2H^+(aq) + 2e^-$$
$$\underline{2H^+(aq) + ClO_3^-(aq) + 2e^- \longrightarrow ClO_2^-(aq) + H_2O(\ell)}$$
$$2ClO_3^-(aq) \longrightarrow ClO_2^-(aq) + ClO_4^-(aq)$$
$$E^o_{cell} = 0.33 - 0.36 = -0.03$$
$$E^o_{cell} = \frac{RT}{nF}\ln K \text{ (at equilibrium)}$$
$$-0.03 = \frac{0.059}{2}\log K$$
logK = - 1
K = 0.1

$$2ClO_3^- \rightleftharpoons ClO_4^- + ClO_2^-$$

Initially	.1	0	0
equilibrium	$.1-2x$	x	x

$$K = \frac{x^2}{(.1-2x)^2}$$
$$\frac{1}{10} = \frac{x^2}{(.1-2x)^2} \Rightarrow x = 0.019 \text{ M}$$

12. Probability of finding an electron is zero, i.e. $\psi^2 = 0$.
$$\left[\frac{1}{16\sqrt{4}}\left(\frac{1}{a_0}\right)^{3/2}\left[(\sigma-1)(\sigma^2-8\sigma+12)\right]e^{-\sigma/2}\right]^2 = 0$$
$$(\sigma-1)(\sigma^2-8\sigma-12) = 0$$
On solving for σ we get

σ = 1, 6, 2 and $\sigma = \frac{2r}{a_0}$

For σ = 1; $1 = \frac{2r}{a_0}$ $r \Rightarrow \frac{a_0}{2}$

$\sigma = 2;\ 2 = \frac{2r}{a_0}$ $r \Rightarrow a_0$

$\sigma = 6;\ \ 6 = \frac{2r}{a_0}$ $r = 3a_0$

13. n-factor of H_3PO_2 is 4/3 for the reaction.

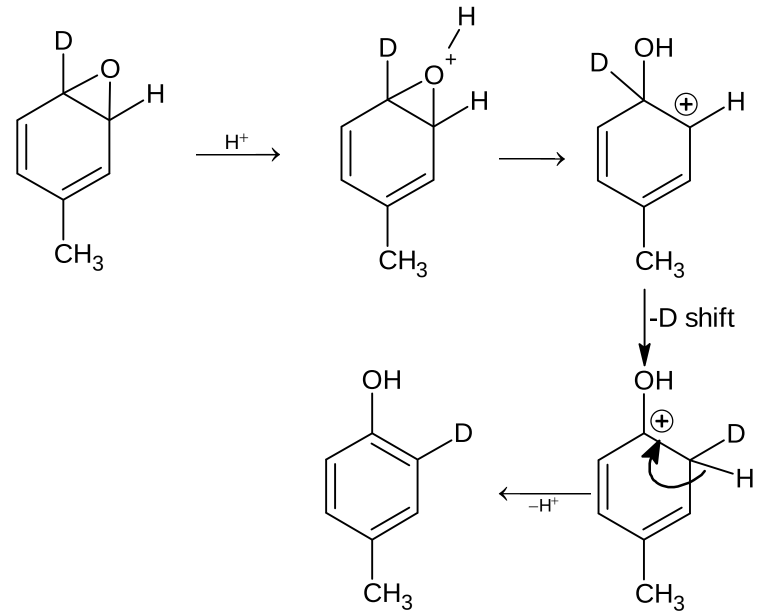
14. $\Delta T_b = K_b \times m \times i$

2.08 = 0.52 × 1 × i

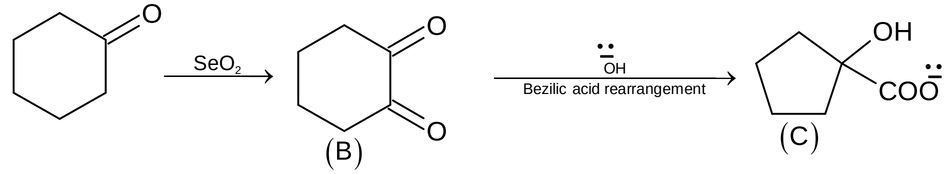
i = 4

This implies that the salt on dissociation gives 4 ions. Thus, the salt that gives four ions is $K_3[Fe(CN)_6]$.

15.


D
O
H
H^+
H
D
O
+
H
D
OH
⊕
H
CH$_3$
-D shift
OH
D
OH
⊕
D
H
$-H^+$
CH$_3$

16.


O
SeO$_2$
O
O
(B)
OH
Bezilic acid rearrangement
OH
COO
(C)

18. It is a non-degradable pollutant.

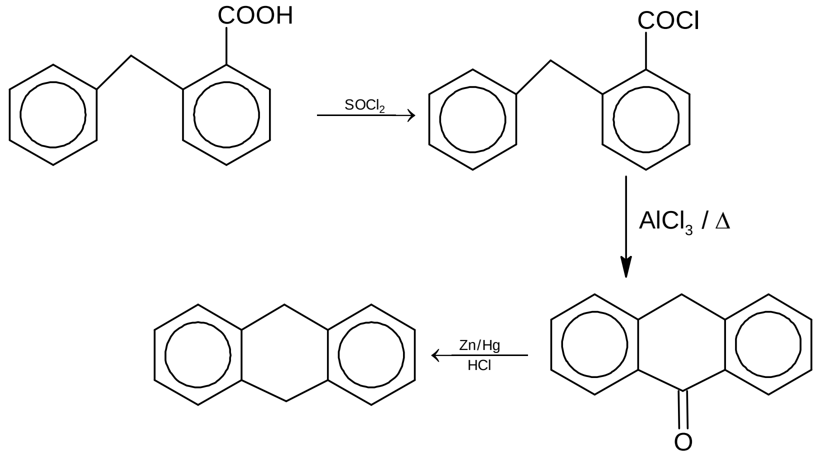
19. Colloidal silver bromide solution is used in photography.

20. Stability of carbonates increases down the group. Carbonates of alkali metals are more stable than those of alkali metals.

21. π_{2px} and π_{2py} have one nodal plane each. In $\sigma 1s$ there is no nodal plane and in case of π^*_{2px} there are two nodal planes.

22. Le-Chatellier's principle.

25.


COOH
SOCl$_2$
COCl
AlCl$_3$ / Δ
Zn/Hg
HCl
O

26. $NH_4Cl + \text{Nesseler's reagent} \longrightarrow \text{Brown colour of iodide million's base.}$

Mathematics

PART – III

1. Using T = S_1 take mid–point (h, k) then equation of PQ is
$xh + yk - (h^2 + k^2) = 0$ ….. (1)
$mx - y + 2m = 0$ ….. (2)
Compare (1) and (2) eliminate m

2. As f(x) is continuous decreasing function on (0, ∞), so $0 < f(8x) < f(6x) < f(4x)$
So $\lim\limits_{x\to\infty} 1 < \lim\limits_{x\to\infty} \frac{f(6x)}{f(8x)} < \lim\limits_{x\to\infty} \frac{f(4x)}{f(8x)}$
By squeeze play theorem $\lim\limits_{x\to\infty} \frac{f(6x)}{f(8x)} = 1$

3. The given lines will be parallel to lines $ax^2 - 6xy + y^2 = 0$
So, $\left(\frac{y}{x}\right)^2 - 6\left(\frac{y}{x}\right) + a = 0$
$m + m^2 = 6$ ….. (1)
Which gives m = –3 or 2
and $mm^2 = a$ ….. (2)
From (2) a = –27 or 8
Hence sum of all possible value of a = –19

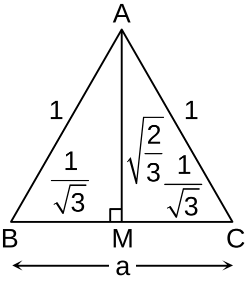
4. $$e^{\lim\limits_{x\to\infty} \frac{4}{x^2}}\left[\ln g(2-x^2) - \ln g(2)\right] \quad \left(\frac{0}{0} \text{ form}\right)$$
$$e^{\lim\limits_{x\to 0} \frac{\frac{g'(2-x^2)}{g(2-x^2)}\cdot(-2x)}{2x}} = e^{-\frac{g'(2)}{g(2)}} = e^{-\frac{1}{2}} = \frac{1}{\sqrt{e}}$$

5. $$I = \lim_{n\to\infty} \frac{\int_0^{1/n} f(t)\,dt}{\frac{1}{n^2}} \quad \left(\frac{0}{0} \text{ form}\right)$$
Using : L' Hospital and using Leibnitz rule
$$I = \lim_{n\to\infty} \frac{n^3 f\left(\frac{1}{n}\right)\left(-\frac{1}{n^2}\right)}{-2} = \lim_{n\to\infty} \frac{n}{2} f\left(\frac{1}{n}\right)$$
Put $n = \frac{1}{h}$ hence
$$I = \frac{1}{2} \times \lim_{h\to 0}\left(\frac{f(0+h) - f(0)}{h}\right) = \frac{1}{2} f'(0)$$

6. For xy = 1 ⇒ $\frac{dy}{dx} = -\frac{1}{x^2}$
Slope of normal to xy = 1 for $x^2 > 0$ $(x \ne 0)$
Slope of line (given) = $\frac{\log_2(1 + 5a - a^2)}{5} > 0$
So $1 + 5a - a^2 > 1$

$a^2 - 5a < 0$ hence $a \in (0, 5)$

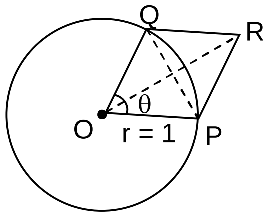
7. $a = \dfrac{2}{\sqrt{3}}$



$$\Delta = \frac{1}{2}ah = \frac{1}{2} \times \frac{2}{\sqrt{3}} \times \frac{\sqrt{2}}{\sqrt{3}} = \frac{\sqrt{2}}{3}$$

$$R = \frac{abc}{4\Delta} = \frac{2(1)(1)(3)}{\sqrt{3}(4)\sqrt{2}} = \frac{\sqrt{3}}{2\sqrt{2}}$$

8. Area of the parallelogram outside the circle
= Area of parallelogram – Area of sector OPQ
$= \left(\dfrac{1}{2}\sin\theta\right)2 - \dfrac{1}{2}\theta = \sin\theta - \dfrac{\theta}{2} = f(\theta)$



9. Using ${}^{n}C_r = \dfrac{n}{r} \cdot {}^{n-1}C_{r-1} = \dfrac{n(n-1)}{r(r-1)} \times {}^{n-2}C_{r-2}$ is equal to

10. We have $|(A^{-1})\ \text{adj}(B^{-1})\ \text{adj}(2A^{-1})| = \dfrac{1}{|A|} \cdot \dfrac{1}{|B|^2} \cdot \dfrac{64}{|A|^2} = \dfrac{64}{-2 \times 1 \times 4} = -8$

(By using $|A^{-1}| = \dfrac{1}{|A|}$ and $|\text{adj } B| = |B|^{n-1}$ where n is order of square matrix)

11. This distance between the given parallel lines (h) is $\dfrac{1}{\sqrt{5}}$

length of the side of triangle is = $\dfrac{2h}{\sqrt{3}}$

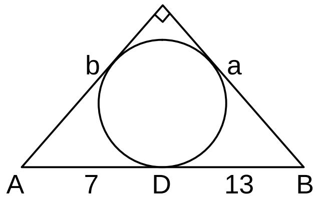
Area of triangle = $\dfrac{\sqrt{3}}{4} \times \dfrac{4h^2}{3} = \dfrac{h^2}{\sqrt{3}} = \dfrac{1}{5\sqrt{3}}$

12. The volume of tetrahedron = $\dfrac{1}{6}\left|\left[\overrightarrow{OA}\ \ \overrightarrow{OB}\ \ \overrightarrow{OC}\right]\right| = \dfrac{1}{6}\begin{vmatrix} 1 & 0 & 0 \\ 1 & 1 & 0 \\ 0 & 1 & 1 \end{vmatrix} = \dfrac{1}{6}$

Area of base = $\dfrac{1}{2}\left|\left(\hat{i} + \hat{j} - \hat{i}\right) \times \left(\hat{j} + \hat{k} - \hat{i}\right)\right| = \dfrac{1}{2}\left|\hat{i} \times \hat{k}\right| = \dfrac{1}{2}\left(\sqrt{2}\right) = \dfrac{1}{\sqrt{2}}$

Hence height = $\dfrac{3 \times \text{volume}}{\text{Area of base}} = \dfrac{3\sqrt{2}}{6} = \dfrac{1}{\sqrt{2}}$

13. C = 20
$\Delta = \dfrac{1}{2}ab$
S – a = 7
S – b = 13
a – b = 6 ….. (1)
$a^2 + b^2 = 400$



$(a - b)^2 + 2ab = 400$

$\Rightarrow ab = 182$

$\Delta = \frac{1}{2}ab = 91$

14. Let $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$

Comparing $x = t^2 + t - 2 \Rightarrow y = t + 2 \Rightarrow z = t^2 + 6t + 9$

Hence $z - x = 5t + 11 \Rightarrow z - x = 5(y - 2) + 11 \Rightarrow x + 5y - z + 1 = 0$

16. $\left[\vec{a} \quad \vec{b} \quad \vec{a}\times\vec{b}\right] = 8$

$\Rightarrow |\vec{a}\times\vec{b}|^2 = 8$

$|\vec{a}|^2 |\vec{b}|^2 \sin^2\theta = 8$

$|b|^2 = \frac{8}{1^2 \times \frac{1}{2}} = 16$

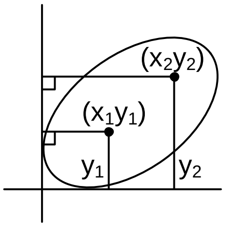
$|\vec{b}| = 4$

17. If $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, a > b

So $x_1x_2 = y_1y_2 = b^2$

3d = 49

$\sqrt{3d} = 7$



18. $f'(x) = \sec x - \operatorname{cosec} x$

$f'(x) = 0$ at $x = \frac{\pi}{4}$

Also $f''\left(\frac{\pi}{4}\right) > 0$ so f(x) is minimum at $x = \frac{\pi}{4}$

$$f\left(\frac{\pi}{4}\right) = \int_0^{\pi/4} \sec\theta\, d\theta + \int_{\pi/4}^{\pi/2} \operatorname{cosec}\theta\, d\theta = \ln\left(\frac{\sqrt{2}+1}{\sqrt{2}-1}\right) = 2\ln\left(\sqrt{2}+1\right)$$

19. $\int_0^a \ln(\cot a + \tan x)dx = \int_0^a \ln\left(\frac{\cos(a-x)}{\sin a \cdot \cos x}\right)dx$

$= \int_0^a \ln\cos(a-x)dx - \int_0^a \ln\sin a dx - \int_0^a \ln\cos x dx$

$I(a) = -\ln(\sin a)\cdot a$

$I(1) = -\ln(\sin a) = \ln|\operatorname{cosec} 1|$

20. Let $A = \lim_{x\to 0}\left(2^{x-1} + \frac{1}{2}\right)^{1/x}$ (1^∞ form)

$= e^{\lim_{x\to 0}\frac{1}{x}\left[2^{x-1}+\frac{1}{2}-1\right]} = e^{\lim_{x\to 0}\left(\frac{2^x-1}{2x}\right)} = e^{\frac{1}{2}\ln 2} = \sqrt{2}$

21. $U_n = \frac{1}{(n+1)(n+2)} = \frac{(n+2)-(n+1)}{(n+1)(n+2)} = \frac{1}{n+1} - \frac{1}{n+2}$

$S_n = \sum_{n=1}^{n}\left(\frac{1}{n+1} - \frac{1}{n+2}\right) = \frac{1}{2} - \frac{1}{n+2}$

Hence $\lim_{n\to\infty} S_n = \frac{1}{2}$

22. $z = \left(1+i\sqrt{3}\right)^{100}$

$= 2^{100}\left[\cos\frac{\pi}{3} + i\sin\frac{\pi}{3}\right]^{100}$

$= 2^{100}\left[\cos\frac{100\pi}{3} + i\sin\frac{100\pi}{3}\right]$

$= 2^{100}\left[-\cos\frac{\pi}{3} - i\sin\frac{\pi}{3}\right]$

$= 2^{100}\left[-\frac{1}{2} - i\frac{\sqrt{3}}{2}\right]$

$$\frac{\text{Re}(z)}{\text{Im}(z)} = \frac{-\frac{1}{2}}{-\frac{\sqrt{3}}{2}} = \frac{1}{\sqrt{3}}$$

23. $|wz - 1 - w^2| = a$
$|z + 1| = a$
$\Rightarrow |a - 1 + 2| = a$
$|z - 1| + 2 \geq a$
$0 \leq a \leq 4$

24. Since RHS is even. So LHS is also even integer so either both x and y should even or both should odd integer. Now
$x^4 - y^4 = (x - y)(x + y)(x^2 + y^2)$
$(x - y)$, $(x + y)$, $(x^2 + y^2)$ must be an even integer
Therefore $(x - y)(x + y)(x^2 + y^2)$ must be divisible by 8
But RHS is not divisible by 8
So given equation has no solution

25. Given numbers can be rearranged as
1, 4, 7 ….. 3n – 2 → (3λ – 2) type
2, 5, 8 ….. 3n – 1 → (3λ – 1) type
3, 6, 9 ….. 3n → 3λ type
This means either both the numbers should from (3λ type) or one number each from (3λ – 2) type and (3λ – 1) type
So total number of ways ${}^nC_2 + {}^nC_1 \times {}^nC_1 = \frac{n(n-1)}{2} + n^2 = \frac{3n^2 - n}{2}$

26. $(1 + x + x^2 + x^3)^5 = a_0 + a_1x + a_2x^2 + a_3x^3 + a_4x^4 + \ldots\ldots + a_{15}x^{15}$

Put x = 1 and x = –1 and add

$$4^5 = a_0 + a_1 + a_2 + a_3 + a_4 + \ldots\ldots + a^{15}$$

$$0 = a_0 - a_1 + a_2 - a_3 + a_4 - \ldots\ldots - a^{15}$$

$$4^5 = 2(a_0 + a_2 + a_4 + \ldots\ldots\ldots\ldots\ldots + a_{14})$$

$a_0 + a_2 + a_4 + \ldots\ldots\ldots\ldots\ldots + a_{14} = 512$

27. $f'(x) = 3x^2 + 2ax + b$

y = f(x) is increasing $\forall\ x \in R$

$f'(x) \geq 0\ \forall\ x \in R$

So $(2a)^2 - 4 \times 3 \times b \leq 0$

$a^2 - 3b \leq 0$

This is true for exactly 16 ordered pairs (a, b) $1 \leq a, b \leq 6$

So required probability = $\frac{16}{36} = \frac{4}{9}$

28. $$\frac{ab^2 + ac^2 + bc^2 + ba^2 + ca^2 + cb^2}{6} \geq (a^6b^6c^6)^{1/6}$$

So $a(b^2 + c^2) + b(c^2 + a^2) + c(a^2 + b^2) \geq 6abc$

29. $$\sum \tan^{-1}\left(\frac{2^r - 2^{r-1}}{1 + 2^r \cdot 2^{r-1}}\right)$$

$= \sum_{r=1}^{n}\left[\tan^{-1}(2^r) - \tan^{-1}(2^{r-1})\right]$

$= \tan^{-1}(2^n) - \tan^{-1}(1)$

$= \tan^{-1}(2^n) - \frac{\pi}{4}$

30. $$\frac{\cot A + \cot C}{\cot B} = \frac{\sin(A + C) \cdot \sin B}{\sin A \cdot \sin C \cdot \cos B}$$

$= \frac{\sin^2 B}{\sin A \cdot \sin C \cdot \cos B}$

$= \frac{4R^2b^2}{4R^2ac\cos B}$

$= \frac{b^2}{ac\cos B}$

$= \frac{2b^2}{2002b^2 - b^2} = \frac{2}{2001}$

FIITJEE

JEE (Advanced), 2014

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - IV

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 10)** contains 10 multiple choice questions which have only one correct answer. Each question carries **+2 marks** for correct answer. There is no negative marking.

Section-A (11 to 15) contains 5 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-C (01 to 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant R = $8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
= 0.0821 Lit atm $\text{K}^{-1}\ \text{mol}^{-1}$
= $1.987 \approx 2$ Cal $\text{K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

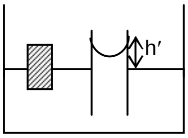
PART – I

SECTION – A

Single Correct Choice Type

This section contains **10 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. In a capillary tube placed inside the liquid of density (ρ)in a container, the rise of liquid is h. When block of density 'σ' is placed on the liquid as shown in figure, liquid in the tube is h′. If $\sigma < \rho$ then



(A) h′ = h (B) h′ < h
(C) h′ > h (D) insufficient data

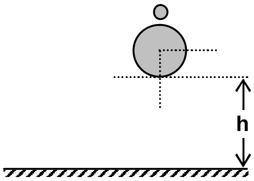
2. Two points A and B are at distances of 'a' and 'b' respectively from an infinite conducting plate having charge density σ. The work done in moving charge Q from A to B is

(A) $\frac{Q\sigma}{\varepsilon_0}(b-a)$ (B) $\frac{\sigma}{(b-a)}Q$
(C) $\frac{Q\sigma}{(b-a)\varepsilon_0}$ (D) none of these

3. A point charge of 0.1C is placed on the circumference of a non-conducting ring of radius 1m which is rotating with a constant angular acceleration of 1 rad/sec^2. If ring starts it's motion at t = 0 the magnetic field at the centre of the ring at t = 10 sec, is

(A) 10^{-6} T (B) 10^{-7} T
(C) 10^{-8} T (D) 10^{7} T

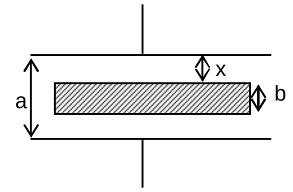
4. A small sphere and a big sphere are released from rest with a very small gap from height h as shown in the figure. The mass of bigger sphere is very large as compared to mass of smaller sphere. The height from the point of collision of smaller sphere with the bigger sphere to which the smaller sphere will rise if all the collisions are elastic

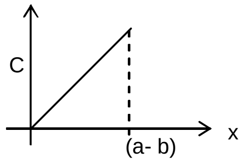


(A) 2h (B) 4h
(C) 6h (D) 9h

Space for Rough work

5. The distance between two parallel plates of a capacitor is a. A conductor of thickness b(b < a) is inserted between the plates as shown in the figure. The variation of effective capacitance between the surfaces of conductor and plate as a function of the distance (x) is best represented by



(A)


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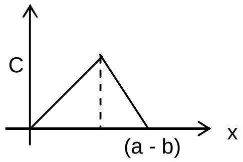

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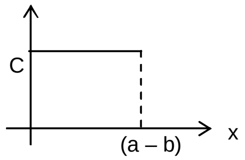
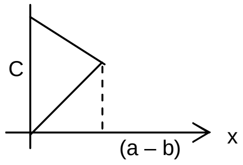
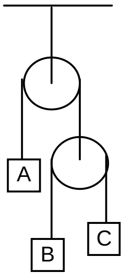


(D)


6. Three blocks A, B and C having masses m kg 2kg and 3 kg are attached by massless strings and ideal pulleys as shown in the figure. When the system is released from rest if the block 'A' remains stationary , the mass of block 'A' is



(A) 2.2 kg
(B) 2.6 kg
(C) 2.4 kg
(D) 4.8 kg

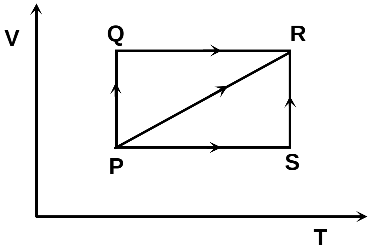
7. A block of mass 2 kg is attached to one end of a massless rod of length $\frac{1}{\pi}$m. The rod is fixed to a horizontal plane at the other end such that the block and rod are free to revolve on a horizontal plane. The coefficient of friction between the block and surface is 0.1. Block is made to rotate with uniform angular speed by applying a constant external force in tangential direction on the block. The work done by external force till the rod rotates by 90^0 is

(A) 0
(B) 10 joule
(C) $\frac{\pi}{2}$ joule
(D) 1 joule

Space for Rough work

8. One mole of a monoatomic gas is taken from P to R, via three paths PQR, PR and PSR. If work done by the gas in PQR is W_1, in PR work done is W_2 and in PSR work done is W_3, then

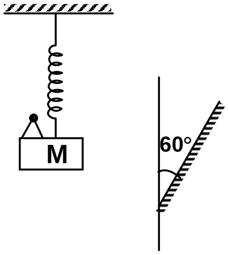
(A) $W_2 > W_3 > W_1$
(B) $W_1 > W_2 > W_3$
(C) $W_2 > W_1 > W_3$
(D) $W_3 > W_2 > W_1$



9. A block of wood of relative density 0.5 is placed 10 m inside a vessel containing water. The vessel is accelerated upward with an acceleration of 10 m/s^2. If the block is released at some instant, then the time taken by block to reach the surface of water from that instant is ($g = 10$ m/s^2)

(A) 0.5 sec
(B) 1 sec
(C) 2 sec
(D) none of these

10. An insect of negligible mass is sitting on a block of mass M, tied with a spring of force constant k. The block performs simple harmonic motion with amplitude A infront of a plane mirror placed as shown in the figure. The maximum speed of insect relative to its image will be



(A) $A\sqrt{\frac{k}{m}}$
(B) $\frac{A\sqrt{3}}{2}\sqrt{\frac{k}{m}}$
(C) $A\sqrt{3}\sqrt{\frac{k}{m}}$
(D) $A\sqrt{\frac{m}{k}}$

Space for Rough work

Multiple Correct Answer(s) Type

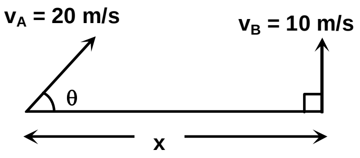
This section contains **5 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

11. When an electron of hydrogen like atom jumps from a higher energy level to a lower energy level. Then,
(A) angular momentum of the electron remains constant.
(B) kinetic energy increases.
(C) wavelength of de-Broglie wave, associated with motion of the electron, decreases.
(D) all of the above

12. If the filament current in Coolidge tube is increased by increasing the voltage in the filament circuit then
(A) λ_{min} remain same
(B) Max. K.E. of electron not affected.
(C) Intensity increases
(D) Intensity decreases

13. A parallel plate capacitor of plate area 0.2 m^2 and spacing 10^{-2} m is charged to 10^3 volt and then disconnected from the battery, and pulled apart to double the plate spacing
(A) work required to pull the plate is 8.8×10^{-5} J
(B) final voltage on the capacitor is 2×10^3 Volts.
(C) Final charge on the capacitor becomes two times of initial
(D) final charge becomes half of initial value.

14. Two particles A and B are projected simultaneously in the direction shown in the figure with velocities v_A = 20 m/s and v_B = 10 m/s respectively. They collide in air after 1/2 sec. Then



(A) the angle θ is 60°
(B) the distance x is $5\sqrt{3}$ m
(C) the angle θ is 30°
(D) The distance x is $15\sqrt{3}$ m

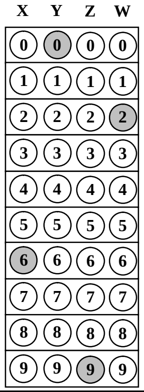
15. A uniform square plate of mass m and edge a initially at rest starts rotating about one of the edge under the action of a constant torque τ. Then at the end of the 5th sec after start
(A) angular momentum is equal to 5τ
(B) kinetic energy is equal to $\frac{75\tau^2}{ma^2}$
(C) angular momentum is equal to 2.5τ
(D) kinetic energy is equal to $\frac{75\tau^2}{2ma^2}$

Space for Rough work

SECTION –C

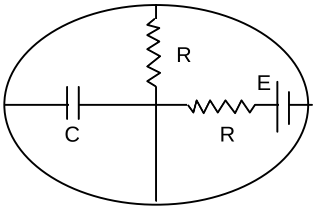
Integer Answer Type

This section contains 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. A light rod of length L, is hanging from the vertical smooth wall of a vehicle moving with acceleration $\sqrt{3}$ g having a small mass attached at it's one end is free to rotate about an axis passing through the other end. The minimum velocity given to the mass at it's equilibrium position so that it can complete vertical circular motion is $\sqrt{KgL}$. Find the value of K.

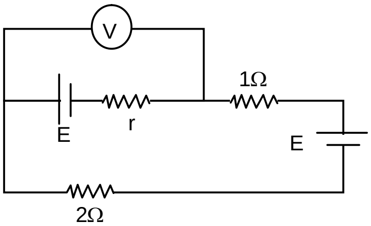
2. Find energy stored in the capacitor in it's steady state.



3. The potential difference between two points A and B which are separated by a distance of 1m along the field in a uniform electric field of $10NC^{-1}$ is 5K Volt. Find the value of K.

4. The power factor of a circuit in which a box having unknown electrical devices connected in series with a resistor of resistance 3Ω is 3/5. Find the reactance of the box in Ω.

5. In the given circuit the reading of ideal voltmeter is E/2. Find the internal resistance of the battery in Ω.



Space for Rough work

Chemistry

PART – II

SECTION – A

Straight Objective Type

This section contains **10 multiple choice** questions numbered **1 to 10.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. K_c for the reaction $[Ag(CN)_2]^{-1} \rightleftharpoons Ag^+ + 2CN^-$, the equilibrium constant at 25^oC is 4×10^{-19}, then the silver ion concentration in the solution which was originally 0.1 M in KCN and 0.03 M in $AgNO_3$ is
(A) 7.5×10^{18} (B) 7.5×10^{-18}
(C) 7.5×10^{19} (D) 7.5×10^{-19}

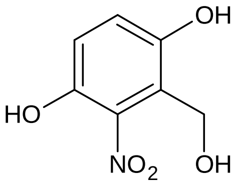
2. A gas in an open container is heated from 27^oC to 127^oC. The fraction of the original amount of gas left in the container would be:
(A) 3/4 (B) 1/2
(C) 2/3 (D) 7/8

3. Consider the equilibrium, $2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g) + \text{heat}$
If O_2 is added and volume of the reaction vessel is increased, the equilibrium will
(A) shift in forward direction (B) shift in backward direction
(C) remain unchanged (D) be unpredictable

4. If the energy of H-atom in the ground state is – E, the velocity of photo electron emitted when a photon having energy E_p striked a stationary Li^{2+} ion in ground state, is given by:
(A) $V = \sqrt{\frac{2(E_p - E)}{m}}$ (B) $V = \sqrt{\frac{2(E_p + 9E)}{m}}$
(C) $V = \sqrt{\frac{2(E_p - 9E)}{m}}$ (D) $V = \sqrt{\frac{2(E_p - 3E)}{m}}$

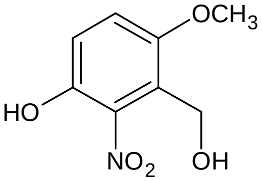
Rough Work

5.

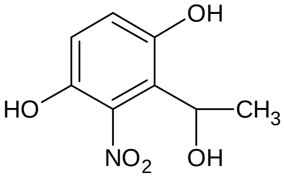


$\xrightarrow[(1\,eqv.)]{CH_2N_2}$ A, A is :

(A)



(B)



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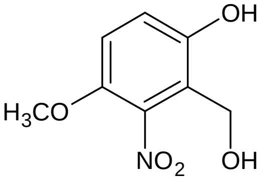
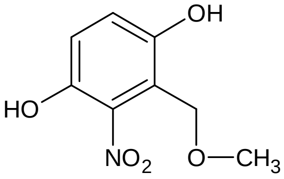
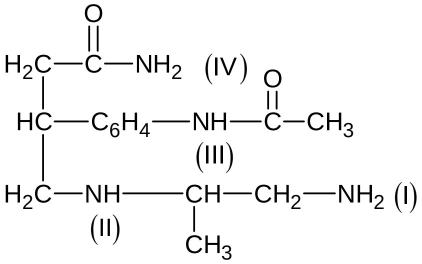


(D)



6.



Arrange the above mentioned nitrogen atoms of the compound in decreasing order of basic nature?

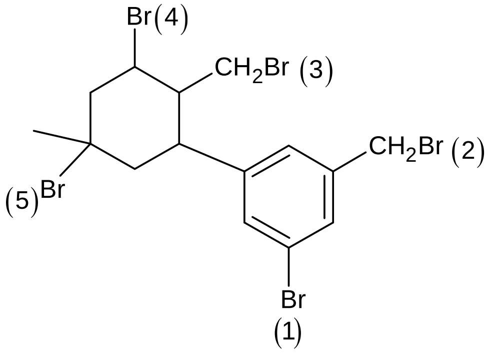
(A) I > II > IV > III
(B) II > I > IV > III
(C) II > I > III > IV
(D) I > IV > III > II

7. Which of the following compounds can form silicones on hydrolysis?

(A) $(CH_3)_2SiCl_2$
(B) $(SiH_3)_3N$
(C) $SiCl_4$
(D) All of the above

Rough Work

8.



Arrange the above mentioned bromine atoms in decreasing order of their reactivity towards hydrolysis through S_N1 path.

(A) 2 > 1 > 5 > 4 > 3
(B) 5 > 2 > 1 > 3 > 4
(C) 2 > 5 > 4 > 3 > 1
(D) 5 > 4 > 2 > 1 > 3

9. Which of the following compounds on decomposition, releases two gases containing the same elements?

(A) $FeSO_4$
(B) $FeCO_3$
(C) $Fe(NO_3)_2$
(D) $Fe(ClO_3)_2$

10. Gold number gives

(A) amount of gold in colloid.
(B) weight in mg of colloid required to break gold sol.
(C) weight in mg of colloid to protect gold sol.
(D) amount of NaCl required to coagulate gold sol.

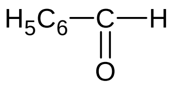
Rough Work

Multiple Correct Choice Type

This section contains **5 multiple choice** questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

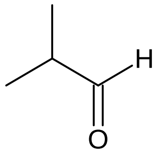
11. Which of the following compounds does not disproportionate on treating with conc. NaOH?

(A)

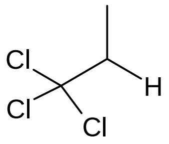


$H_5C_6-\underset{\underset{O}{\|}}{C}-H$

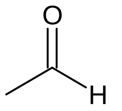
(B)



(C)



(D)



12. If electrolysis of 1 M $NiSO_4$ is carried with inert electrodes at pH = 7 at 25°C (the pressure of gases are taken 1 bar).

$\left(E^o_{Ni^{2+}/Ni} = -0.25\text{ V} \qquad E^o_{H_2O/H_2} = -0.83\text{ v}\right)$

The product of electrolysis at cathode and at anode (initially) are:

(A) Ni at cathode
(B) H_2 at cathode
(C) O_2 at anode
(D) $S_2O_8^{2-}$ at anode

13. Which of the following is/are correct:

(A) $[CrCl_2(CN)_2(NH_3)_2]$ and $[CrCl_3(NH_3)_3]$, both have d^2sp^3 hybridization.
(B) Magnetic moment of $[PdCl_4]^{2-}$ is zero.
(C) $[Cu(NH_3)_4]^{2+}$, $[Pt(NH_3)_4]^{2+}$ and $[Ni(CN)_4]^{2-}$, all have dsp^2 hybridization of central metal.
(D) It is difficult to substitute chelating ligands compared to similar monodentate ligands.

14. Which of the following is/are correct?

(A) On strong heating $FeCl_3$ gives $FeCl_2$ and Cl_2.
(B) Dilute $CuCl_2$ is blue due to formation of $[CuCl_4]^{2-}$.
(C) PH_3 can be obtained by heating red P with NaOH.
(D) PH_3, H_3PO_3 and H_3PO_2, all are reducing agents.

15. $2X(g) + Y(g) + 3Z(g) \longrightarrow \text{Products}$

The rate equation of the above reaction is given by:

Rate = $K[X][Y]^o[Z]^2$

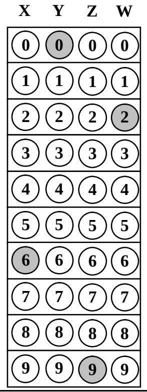
Choose the correct statements:

(A) The rate of reaction becomes doubled by doubling the conc. of (X).
(B) Rate of reaction decreases by reducing the conc. of (Y) to half of the original value.
(C) The half life of (Z) increases by increasing its conc.
(D) If 75% of (X) undergoes reaction in 20 sec., 50% of (X) will react in 10 sec.

Rough Work

SECTION – C
Integer Answer Type

This section contains 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.

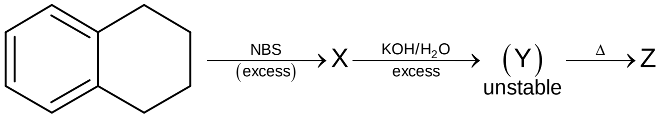


1. A compound (A) having molecular formula $C_7H_{11}Br$ is optically active. A reacts with HBr in the absence of peroxide to give isomeric products (B) and (C). Treating (A) with potassium-t-butoxide gives (D). (D) on reductive ozonolysis gives two moles of formaldehyde and one mole of 1, 3 cyclopentane dione. (A) in the presence of peroxide reacts with HBr to give (E). The total number of chiral carbon in one molecule of (E) is:

2. How many of the following nitrates give positive brown ring test as well as oxygen on heating?
KNO_3, $Pb(NO_3)_2$, NH_4NO_3, $Ca(NO_3)_2$, $Sr(NO_3)_2$, $Mg(NO_3)_2$, $NaNO_3$

3. How many (S = O) are present in $H_2S_2O_5$?

4. A complex of potassium, iron and cyanide ions $K_x[Fe(CN)_6]$ is 100% ionized at 1 molal. If its elevation in boiling points is 2.08°C, find out the value of 'x' in the complex.
(Given $K_b = 0.52^oC\ mol^{-1}\ kg$)

5.


The sp^2-hybridized carbon atoms present in one molecule of the end product Z is:

Rough Work

Mathematics

PART – III

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. The value of $\int_{-2}^{1}\left[x\left[1+\cos\left(\frac{\pi x}{2}\right)\right]+1\right]dx$, (where [.] denotes the greatest integer function), is

(A) 1
(B) $\frac{1}{2}$
(C) 2
(D) none of these

2. f(x) = $4x^3 - x^2 - 2x + 1$ and $g(x)=\begin{bmatrix}\min\{f(t):0\le t\le x\} & ; & 0\le x\le 1\\ 3-x & ; & 1<x\le 2\end{bmatrix}$ then $g\left(\frac{1}{4}\right)+g\left(\frac{3}{4}\right)+g\left(\frac{5}{4}\right)$ has the value equal to

(A) $\frac{7}{4}$
(B) $\frac{9}{4}$
(C) $\frac{13}{4}$
(D) $\frac{5}{2}$

3. If $x_1, x_2, x_3, \ldots, x_n$ are in A.P. whose common difference is α, then the value of $\sin\alpha(\sec x_1 \sec x_2 + \sec x_2 \sec x_3 + \ldots + \sec x_{n-1} \sec x_n)$ is

(A) $\frac{\sin(n-1)\alpha}{\cos x_1 \cos x_n}$
(B) $\frac{\sin n\alpha}{\cos x_1 \cos x_n}$
(C) $\sin(n-1)\alpha \cos x_1 \cos x_n$
(D) $\sin n\alpha \cos x_1 \cos x_n$

Space for rough work

4. In ΔABC, the median AD divides $\angle BAC$ such that $\angle BAD : \angle CAD = 2 : 1$. Then $\cos\left(\frac{A}{3}\right)$ is equal to

(A) $\frac{\sin B}{2\sin C}$ (B) $\frac{\sin C}{2\sin B}$

(C) $\frac{2\sin B}{\sin C}$ (D) none of these

5. The projection of the line $\frac{x+1}{-1} = \frac{y}{2} = \frac{z-1}{3}$ on the plane $x - 2y + z = 6$ is the line of intersection of this plane with the plane

(A) $2x + y + z = 0$ (B) $3x + y - z = 2$

(C) $2x - 3y + 8z = 3$ (D) none of these

6. If $|z_2 + iz_1| = |z_1| + |z_2|$, $|z_1| = 5$ and $|z_2| = 12$, then area of ΔABC, if affixes of A, B and C are z_1, z_2 and $\left[\frac{(z_2 - iz_1)}{(1-i)}\right]$ respectively, is

(A) $\frac{13}{2}$ (B) 0

(C) $\frac{169}{2}$ (D) $\frac{169}{4}$

7. A person buys eight packets of TIDE detergent. Each packet contains one coupon, which bears one of the letters of the word TIDE. If he shows all the letters of the word TIDE, he gets one free packet. If he gets exactly one free packet, then the number of different possible combinations of the coupons is

(A) ${}^7C_3 - 1$ (B) ${}^8C_4 - 1$

(C) ${}^8C_3$ (D) 4^4

8. If the chord of contact of tangents from a point P to a given circle passes through Q, then the circle on PQ as diameter

(A) cuts the given circle orthogonally (B) touches the given circle externally

(C) touches the given circle internally (D) none of these

Space for rough work

9. An ellipse is sliding along the co–ordinate axes. If at an instant, the foci of the ellipse are (1, 1) and (3, 3), then area of the director circle of the ellipse (in sq. units) is
(A) 2π (B) 4π
(C) 6π (D) 8π

10. The coefficient of the term independent of x in the expansion of $\left(\frac{x+1}{x^{2/3}-x^{1/3}+1}-\frac{x-1}{x-x^{1/2}}\right)^{10}$ is
(A) 210 (B) 105
(C) 70 (D) 112

Multiple Correct Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

11. $P(A)=\frac{3}{8}$; $P(B)=\frac{1}{2}$; $P(A\cup B)=\frac{5}{8}$, which of the following do/does hold good?
(A) $P\left(\frac{A^C}{B}\right)=2P\left(\frac{A}{B^C}\right)$ (B) $P(B)=P\left(\frac{A}{B}\right)$
(C) $15P\left(\frac{A^C}{B^C}\right)=8P\left(\frac{B}{A^C}\right)$ (D) $P\left(\frac{A}{B^C}\right)=P(A\cap B)$

12. Given that x + y + z = 15 when a, x, y, z, b are in A.P. and $\frac{1}{x}+\frac{1}{y}+\frac{1}{z}=\frac{5}{3}$ when a, x, y, z, b are in H.P. then
(A) G.M. of a and b is 3 (B) one possible value of a + 2b is 11
(C) A.M. of a and b is 6 (D) greatest value of a – b is 8

13. A quadrilateral is inscribed in parabola, then
(A) quadrilateral may be cyclic
(B) diagonals of the quadrilateral may be equation
(C) all possible pairs of adjacent sides may be perpendicular
(D) none of these

14. $f(x) = x^2 - 2ax + a(a + 1)$; $f : [a, \infty) \to [a, \infty)$. If one of the solutions of the equation $f(x) = f^{-1}(x)$ is 5049, then the other may be
(A) 5051 (B) 5048
(C) 5052 (D) 5050

Space for rough work

15. If $\int \frac{e^{x-1}}{(x^2-5x+4)}2x\,dx$ = A.F(x – 1) + B.F(x – 4) + C and $F(x)=\int \frac{e^x}{x}\,dx$, then

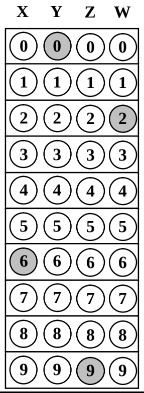
(A) $A=-\frac{2}{3}$ (B) $B=\left(\frac{4}{3}\right)e^3$

(C) $A=\frac{2}{3}$ (D) $B=\left(\frac{8}{3}\right)e^3$

SECTION – C

Integer Answer Type

This section contains **5 questions.** The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. The perpendicular from the origin to the tangent at any point on a curve is equal to the abscissa of the point of contact. Also curve passes through the point (1, 1). Then the length of intercept of the curve on the x–axis is _____

2. At the point P(a, a^n) on the graph of $y = x^n$ ($n \in N$) in the first quadrant a normal is drawn. The normal intersects the y–axis at the point (0, b). If $\lim_{a\to 0} b=\frac{1}{2}$, then n is equal to _____

3. $f : R \to R$, $f(x)=\frac{3x^2+mx+n}{x^2+1}$. If the range of this function is [–4, 3), then the value of |m + n| is _____

4. If $a_1, a_2, a_3, \ldots, a_{12}$ are in A.P. and $\Delta_1=\begin{vmatrix} a_1a_5 & a_1 & a_2 \\ a_2a_6 & a_2 & a_3 \\ a_3a_7 & a_3 & a_4 \end{vmatrix}$, $\Delta_2=\begin{vmatrix} a_2a_{10} & a_2 & a_3 \\ a_3a_{11} & a_3 & a_4 \\ a_3a_{12} & a_4 & a_5 \end{vmatrix}$ then $\Delta_1 : \Delta_2$ is equal to _____

5. Number of solution of the equation $\sin^4 x - \cos^2 x \sin x + 2\sin^2 x + \sin x = 0$ in $0 \le x \le 3\pi$ is _____

Space for rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students
from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

FIITJEE **JEE(Advanced)-2014**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

CRT –IV
(Paper-1)

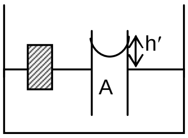
Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	B	C
2.	A	A	D
3.	B	D	A
4.	D	C	A
5.	C	C	A
6.	D	B	D
7.	D	A	A
8.	D	C	A
9.	B	A	D
10.	C	C	A
11.	B, C	C, D	A, B, D
12.	A, B, C	A, C	A, B, D
13.	A, B	A, B, C, D	A, B
14.	B, C	A, D	B, D
15.	A, D	A, D	A, D
1.	8	2	2
2.	0	3	2
3.	2	3	4
4.	4	3	1
5.	1	8	4

Physics

PART – I

1. There will be no change.

∴ $h' = h$



2. $\varepsilon = \dfrac{\sigma}{\varepsilon_0}$

$v_A - v_B = \dfrac{\sigma}{\varepsilon_0}(b) - \dfrac{\sigma}{\varepsilon_0}(a)$

∴ $W = Q(v_A - v_B) = \dfrac{Q\sigma}{\varepsilon_0}(b - a)$

3. $\omega = 0 + 1 \times 10 = 10$ rad/sec^2

∴ $v = r\omega = 1 \times 10 = 10$ m/s

$\bar{B} = \dfrac{\mu_0}{4\pi}\dfrac{q(\bar{v} \times \bar{r})}{r^3} \Rightarrow |\bar{B}| = \dfrac{\mu_0 qv}{4\pi r^2}$

$B = \dfrac{10^{-7} \times 0.1 \times 10}{(1)^2} = 10^{-7}$ T

4. conservation of momentum

$M\sqrt{2gh} - m\sqrt{2gh} = MV_1 + mV_2$ (1)

$-1 = \dfrac{V_1 - V_2}{2\sqrt{2gh}}$ (2)

$V_2 = 3\sqrt{2gh}$

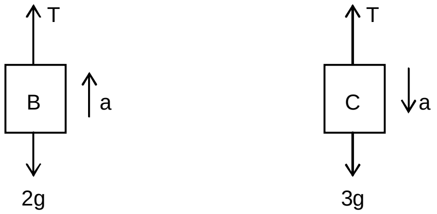
$h' = \dfrac{V_2^2}{2g} = 9h$

5. $\dfrac{1}{C} = \dfrac{1}{C_1} + \dfrac{1}{C_2}$

$= \dfrac{x}{\varepsilon_0 A} + \dfrac{a - b - x}{\varepsilon_0 A}$

$\Rightarrow C = \dfrac{\varepsilon_0 A}{a - b}$

6. FBD of ‘B’ and ‘C’

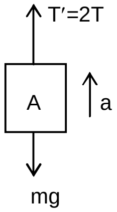


$\Rightarrow T - 2g = 2a$ . . . (i)

and $3g - T = 3a$ . . . (ii)

$T = \dfrac{12g}{5}$

for A



$\Rightarrow$ T = mg

$2 \times \frac{12g}{5} = mg \Rightarrow m = 4.8$ kg.

7. W = $\int_0^{\pi/2} f.Rd\theta = \frac{\mu mgR\pi}{2}$ = 1 joule.

9. a = $\frac{\rho v(g+a) - m(g+a)}{m}$ = 20 m/s^2

t = $\sqrt{\frac{2h}{a}}$ = 1 sec

11. Angular momentum = $\frac{nh}{2\pi}$

kinetic energy $\propto \frac{1}{n^2}$

De-broglie wavelength $\lambda = \frac{h}{mv}$ so as v increases λ decreases.

14. Relative velocity of B w.r.t. A along vertical direction should be zero

$20 \sin\theta = 10$

$\Rightarrow \sin\theta = 1/2$

x = 20 cos 30° × $\frac{1}{2}$ = $5\sqrt{3}$ m

15. Change in angular momentum = angular impulse

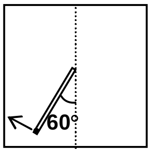
$L = 5\tau$

$I = \frac{ma^2}{3}$

$K = \frac{L^2}{2I} = \frac{75\tau^2}{2ma^2}$

Section -C

1. Conservation of energy $\frac{1}{2}mv^2 - mg\frac{\ell}{2} = mg\frac{\ell}{2} + m\sqrt{3}\left(2\ell\frac{\sqrt{3}}{2}\right)g$



$v = \sqrt{8g\ell}$

2. Potential across capacitor is zero, hence energy stored is zero.

3. $v_A - v_B = \int E.\,dx = 10\,(1)$

$= 10$ volt.

4. $Z = \sqrt{R^2 + X^2} = \sqrt{9 + X^2}$

but $\cos\phi = \frac{R}{Z} = \frac{3}{5}$

$X = 4\ \Omega$.

5. $\frac{E}{2} = E - ir$

$\Rightarrow\ i = \frac{E}{2r}$ . . . (i)

$2E = i(3 + r)$ . . . (ii)

$\Rightarrow r = 1\ \Omega$

Chemistry PART – II

SECTION – A

1. $K_c = 4 \times 10^{-19}$

$$Ag^+ + 2CN^- \rightleftharpoons \left[Ag(CN)_2\right]^{-1}$$

$$0.03 \quad 0.1 \qquad\qquad 0$$

$$\left[Ag(CN)_2\right]^{-1} \rightleftharpoons Ag^+ + 2CN^-$$

$$t = 0 \quad 0.3 \qquad 0 \quad 0.04$$

$$0.03 - x \qquad x \quad 0.04 + 2x$$

$$K_c = \frac{x(0.04+2x)^2}{[0.03-x]} = 4 \times 10^{-19}$$

$$0.04 + 2x \approx 0.04$$

$$0.03 - x \approx 0.03$$

$$K_c = \frac{x.(0.04)^2}{0.03} = 4 \times 10^{-19}$$

$x = 7.5 \times 10^{-18}$

2. $PV = nRT$

As PV constant

$n_1T_1 = n_2T_2$

$n_1 . 300 = n_2. 400$

$$n_2 = \frac{300}{400}n_1 = \frac{3}{4}n_1$$

4. Energy of $\overset{\ominus}{e}$ in H-atom = - E

Energy of $\overset{\ominus}{e}$ in Li^{+2} = - 9E

Energy supplied by photon = $IE + \frac{1}{2}mv^2$

$IE = |E|$

$$\therefore E_p = 9E + \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{2(E_p - 9E)}{m}}$$

9. $FeSO_4 \xrightarrow{\Delta} Fe_2O_3 + SO_3 + SO_2$

12. $H^+ + e^- \longrightarrow \frac{1}{2}H_2 \qquad E^o = 0.0\ v$

$$E = E_{H^+/H_2} = 0 - \frac{0.059}{1}\log\frac{1}{[H^+]}$$

$$= -0.059 \times 7 = -0.413$$

So, $E_{H^+/H_2} < E_{Ni^{2+}/Ni}$

Ni will deposit at cathode

$$2H_2O + 2e^- \longrightarrow H_2 + 2OH^-$$

$$E = -0.83 - \frac{0.059}{2}\log\left[OH^-\right]^2$$

$= -0.83 + 0.059 \times 7$

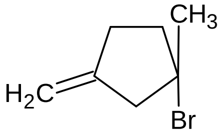
= - 0.417

13. Both have $Cr^{+3}(d^3)$, and C.N. is 6. Hence d^2sp^3.
    $Pd^{+2}(d^8)$ complexes with C.N. is 4 are square plannar and magnetic moment is zero.

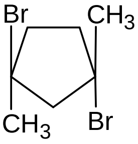
14. $FeCl_3 \xrightarrow{\Delta} FeCl_2 + Cl_2$
    Dil. $CuCl_2$ is blue due to $[Cu(H_2O)_4]^{2+}$ PH_3 is obtained by heating white P with NaOH
    All are reducing because of weak P – H bond.

SECTION – C

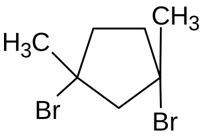
1. A =



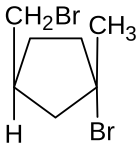
C =



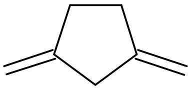
B =



E =



D =

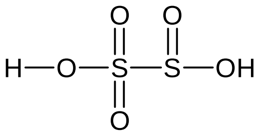


inactive

2. $KNO_3 \rightarrow KNO_2 + \frac{1}{2}O_2$
   $2Pb(NO_3)_2 \rightarrow 2\,PbO + 4NO_2 + O_2$
   $NH_4NO_3 \rightarrow N_2O + 2H_2O$
   $2Ca(NO_3)_2 \rightarrow 2SrO + 4NO_2 + O_2$
   $2Mg\left(NO_3\right)_2 \rightarrow 2MgO + 4NO_2 + O_2$

   $NaNO_3 = NaNO_2 + \frac{1}{2}O_2$
   $Ca\left(NO_3\right)_2$, $Sr\left(NO_3\right)_2$,
   $Pb(NO_3)_2$ do not respond to the test.

3.



$$H{-}O{-}\overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle O}{\|}}{S}}{-}\overset{\overset{\displaystyle O}{\|}}{S}{-}OH$$

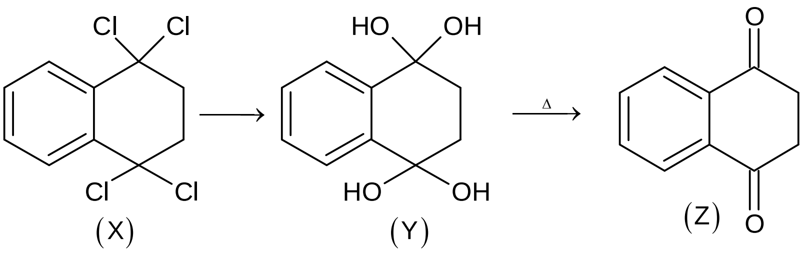
4. $\Delta T_b = K_b \times m \times i$

   2.08 = 0.52 × 1 × i

   i = 4

   $K_3\left[Fe'''(CN)_6\right]$

5.

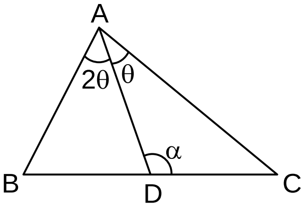

Cl
Cl
Cl
Cl
(X)
HO
OH
HO
OH
(Y)
Δ
O
O
(Z)

Mathematics PART – III

1. $I = \int_{-2}^{1}\left[x[1+(-1)]+1\right] dx + \int_{-1}^{1}[x[1+0]+1]dx$

2. Here, $g(x) = \begin{cases} f(x) & , \text{ if } 0 \le x < \frac{1}{2} \\ f\left(\frac{1}{2}\right) & , \text{ if } \frac{1}{2} \le x \le 1 \\ 3-x & , \text{ if } 1 < x \le 2 \end{cases}$

4. Let $\frac{A}{3} = \angle CAD = \theta$
By m – n theorem,
$(1 + 1) \cot \alpha = 1 \cot 2\theta – 1\cot \theta$



6. Here, $z_2 – z_3 = i(z_1 – z_3)$
$\Rightarrow \angle ACB = \frac{\pi}{2}$
$\Rightarrow AC = \frac{13}{\sqrt{2}}$; AC = BC

9. (0, 0) lies on the director circle

10. $\frac{x+1}{x^{2/3} - x^{1/3} + 1} - \frac{x-1}{x - x^{1/2}} = x^{1/3} - x^{-1/2}$

12. $x + y + z = 3\left(\frac{a+b}{2}\right); \frac{1}{x} + \frac{1}{y} + \frac{1}{z} = \frac{3\left(\frac{1}{a}+\frac{1}{b}\right)}{2}$

14. Here, $f^{-1}(x) = a + \sqrt{x-a}$

SECTION – C

1. Equation of tangent is $y - \beta = f'(\alpha)\{x - \alpha\}$
Also, $\alpha = \frac{\beta - \alpha f'(\alpha)}{\sqrt{f'(\alpha)^2 + 1}}$
Thus, $\frac{dy}{dx} = \frac{1}{2}\left(\frac{y^2 - x^2}{xy}\right)$
Thus, equation of curve is $x^2 + y^2 – 2x = 0$

2. Equation of normal is $y - a^n = -\frac{1}{na^{n-1}}(x - a)$

4. Here, $\Delta_1 = d(a_1 - a_2)(a_2 - a_3)(a_3 - a_1) = -2d^4$
Also, $\Delta_2 = -2d^4$

5. $\sin^2 x[\sin^2 x + \sin x + 2] = 0$
$\Rightarrow \sin x = 0$, where $x = 0, \pi, 2\pi, 3\pi$

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - IV

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 08)** contains 8 multiple choice questions which have one or more correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 to 16) contains 4 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-A (17 – 20)** contains 4 Matching Lists Type questions: Each question has four statements in LIST I & 4 statements in LIST II. The codes for lists have choices (A), (B), (C), (D) out of which only one is correct. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

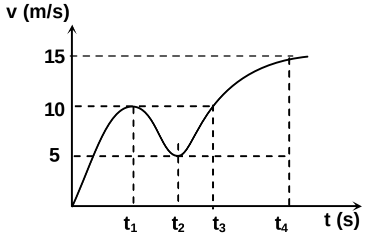
Physics PART – I

SECTION – A

Single Correct Answer Type

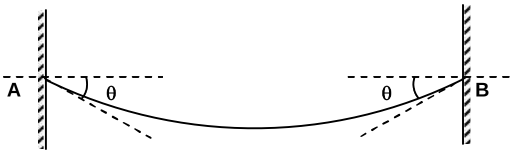
This section contain **8 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

1. Velocity time graph of a particle undergoing rectilinear motion is plotted as shown in the figure. Average acceleration of particle is zero between time intervals.



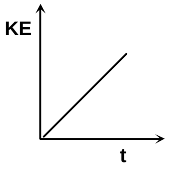
(A) 0 and t_1 (B) t_1 and t_2
(C) t_1 and t_3 (D) t_2 and t_4

2. A heavy string of mass m hangs between two fixed points A and B at the same level. The tangents to the string at A and B are at an angle θ with the horizontal as shown in the figure. The tension in the string at lowest point is



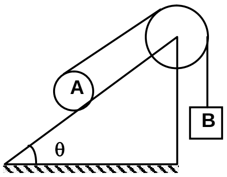
(A) $\frac{mg}{2\sin\theta}$ (B) $\frac{mg}{2\cos\theta}$
(C) $\frac{mg}{2\tan\theta}$ (D) $\frac{mg}{2\cot\theta}$

3. The kinetic energy of a body moving along a straight line varies with time as shown in the figure. The force acting on the body is



(A) zero
(B) constant
(C) directly proportional to velocity
(D) inversely proportional to velocity.

4. In the figure shown, a string is wound over a cylinder A. The other end of the string is attached to block B through a pulley. When the system is released the cylinder rolls down without slipping. The ratio of magnitude of vertical component of displacement of A and B in any time interval t is



(A) sinθ : 1 (B) sin θ : 2
(C) cos θ : 1 (D) cos θ : 2

Space for Rough work

5. Six stars of equal mass are moving about the centre of mass of the system such that they are always on the vertices of a regular hexagon of side length a. Their common time period will be

(A) $4\pi\sqrt{\dfrac{a^3}{Gm}}$ (B) $2\pi\sqrt{\dfrac{4\sqrt{3}a^3}{Gm\left(5\sqrt{3}+4\right)}}$

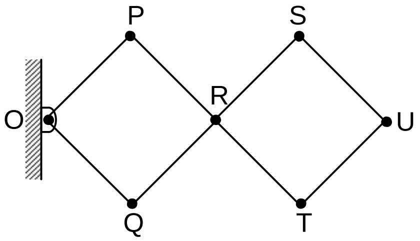
(C) $4\pi\sqrt{\dfrac{3a^3}{Gm}}$ (D) None of these

6. The end of a chain of length L and mass per unit length ρ, which is piled up on a horizontal platform is lifted vertically with a constant velocity u by a variable force F. Find F as a function of height x of the end above platform.

(A) $\rho\left(gx+2u^2\right)$ (B) $\rho\left(2gx+\rho u^2\right)$

(C) $\rho\left(gx+u^2\right)$ (D) $\rho\left(u^2-gx\right)$

7. In the arrangement of rigid links of equal length l, they can freely rotate about the joined ends as shown in the figure. If the end U is pulled horizontally with constant speed 20 m/s, find the approx. speed of end P when the angle SUT is 90°.



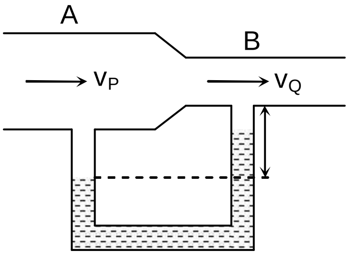
(A) 5 m/s

(B) 10 m/s

(C) 7.1 m/s

(D) 14.12 m/s

8. Air is blown through a pipe AB at a rate of 1600 cm^3/sec. The cross-section area of the broad portion of pipe is 4 cm^2 and that of narrow portion is 2 cm^2. The difference in water length is (ρ_{air} = 1.4 kg/m^3, ρ_{water} = 10^3 kg/m^3)



(A) 1.6 mm (B) 3 mm

(C) 3.6 mm (D) None

Space for Rough work

Comprehension Type

This section contains **4 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Questions 9 and 10

At certain pressure and 127^0 C temperature the mean kinetic energy of hydrogen molecules is 8×10^{-21} J. (Mass of hydrogen atom = 1.7×10^{-27} kg & atomic weight of nitrogen = 14). Then

9. Root mean square speed of hydrogen molecule at 27°C is

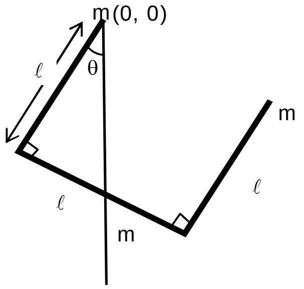
(A) 0.88×10^4 m/sec	(B) 1.88×10^4 m/sec.
(C) 1.88×10^3 m/sec.	(D) 2.88×10^3 m/sec

10. The rms speed of nitrogen molecules at 27^0C is

(A) 5.02×10^2 m/sec.	(B) 5.02×10^4 m/sec.
(C) 2.51×10^2 m/sec.	(D) 2.51×10^3 m/sec.

Paragraph for Questions 11 and 12

A 'U' shaped uniform rod of each of side having length 'ℓ' and mass 'm' is hinged from the one end of one of its limbs as shown.



11. The Y_{cm} of the given system is

(A) 2L/3	(B) –2L/3
(C) –L/8	(D) –L/3

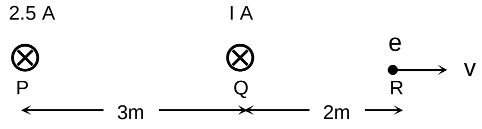
12. If the system is displace by small angle then time period of oscillation is

(A) $\pi\sqrt{\frac{3\ell}{5g}}$	(B) $2\pi\sqrt{\frac{6\ell}{5g}}$
(C) $\pi\sqrt{\frac{6\ell}{5g}}$	(D) $2\pi\sqrt{\frac{3\ell}{5g}}$

Space for Rough work

Paragraph for Questions 13 and 14

Two long parallel wires carrying currents 2.5 amp and I amp in the same direction as shown in figure. An electron moving with a velocity 4×10^5 m/sec. as shown in figure and experiences a force of magnitude 3.2×10^{-20} N at the point R. Then



13. The value of current I is
    (A) 2 amp.
    (B) 8 amp.
    (C) 4 amp.
    (D) 1 amp.

14. The position between PR at which a third long parallel wire carrying current 2.5 amp may be placed such that magnetic induction at R is zero.
    (A) at 1 m from R and the direction of current is inward.
    (B) at 1 m from R and the direction of current is outward
    (C) at 1 m from P and the direction of current is inward.
    (D) at 1 m from P and the direction of current is outward

Paragraph for Questions 15 and 16

A tube of length ℓ and radius R carries a steady flow of a fluid whose density is ρ and viscosity η. The velocity v of flow is given by $v = v_0[1 - (r^2/R^2)]$, where r is the distance of flowing fluid from the axis. Then

15. Kinetic energy of the fluid within the volume of the tube is
    (A) $\frac{1}{6}\pi\ell R^2\rho v_0^2$ (B) $\frac{1}{8}\pi\ell R^2\rho v_0^2$
    (C) $\frac{1}{4}\pi\ell R^2\rho v_0^2$ (D) $\frac{1}{3}\pi\ell R^2\rho v_0^2$

16. The difference of pressure at the ends of the tube is
    (A) $\frac{4\eta\ell v_0}{R^2}$ (B) $\frac{8\eta\ell v_0}{R^2}$
    (C) $\frac{2\eta\ell v_0}{R^2}$ (D) $\frac{\eta\ell v_0}{R^2}$

Space for Rough work

Matching list Type

This section contains **4 multiple choice questions**. Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

17. A block of mass m is placed on a rough horizontal surface having coefficient of friction μ. The magnitude of external horizontal force applied on the block gradually increases. The force exerted by the block on the surface is N. Match **List - I** with **List - II** and select the correct answer using the codes given below the lists:

List – I		List – II	
(P)	The magnitude of N	(1)	is less than or equal to $\tan^{-1}(\mu)$.
(Q)	N is less than of equal to	(2)	decreases gradually.
(R)	The angle made by N with horizontal.	(3)	$\sqrt{(mg)^2 + (\mu mg)^2}$
(S)	The angle made by N with vertical	(4)	increases gradually.

Codes:

	P	Q	R	S
(A)	2	3	1	4
(B)	1	4	2	3
(C)	4	3	2	1
(D)	2	3	4	1

18. Match **List - I** with **List - II** and select the correct answer using the codes given below the lists:

List – I		List – II	
(P)	For the propagation of mechanical Wave	(1)	have zero displacement simultaneously at some instant.
(Q)	In a stationary wave, all the particles between two nodes.	(2)	no material medium is required
(R)	In a transverse progressive wave, all the particles of the medium.	(3)	Material medium is required.
(S)	For the propagation of e.m. wave	(4)	have the same time period and amplitude of vibration through out the wave.

Codes:

	P	Q	R	S
(A)	2	3	1	4
(B)	1	4	2	3
(C)	4	1	2	3
(D)	3	1	4	2

Space for Rough work

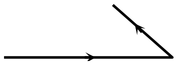
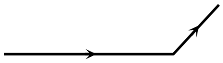
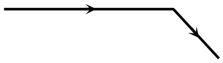
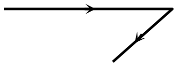
19. Match **List - I** with **List - II** and select the correct answer using the codes given below the lists:

List – I		**List – II**	
(P)	For a sustained interference pattern of light.	(1)	amplitude of waves from the two sources must be same.
(Q)	Newton’s corpuscular theory	(2)	could not explain the phenomenon of interference of light.
(R)	Huygens wave theory	(3)	coherent source is required.
(S)	For maximum contrast in the sustained interference pattern due to a YDSE.	(4)	could not explain photoelectric effect.

Codes:

	P	Q	R	S
(A)	2	3	1	4
(B)	1	4	2	3
(C)	3	2	4	1
(D)	2	3	4	1

20. Four rays of light parallel to optic axis and their path after passing through an optical system are shown in the following two columns. Match **List - I** with **List - II** and select the correct answer using the codes given below the lists:

List – I		**List – II**	
(P)		(1)	Convex lens
(Q)		(2)	Concave lens
(R)		(3)	Convex mirror
(S)		(4)	Concave mirror

Codes:

	P	Q	R	S
(A)	2	3	1	4
(B)	3	2	1	2
(C)	4	1	2	3
(D)	2	3	4	1

Space for Rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE** are correct.

1. Which of the following is correct for critical temperature?
   (A) It is highest temp. at which liquid and vapour can coexist.
   (B) Beyond the critical temp. there is no distinction between two phases and gas can not be liquiefied by compression.
   (C) At critical temp., the surface tension of the system is zero.
   (D) At critical temp. the gas and the liquid phases have the different critical densities.

2. The correct expression(s) for an adiabatic process is/are:
   (A) $\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$ (B) $\frac{P_2}{P_1} = \left(\frac{T_1}{T_2}\right)^{\frac{\gamma-1}{\gamma}}$
   (C) $P_1V_1^{\gamma} = P_2V_2^{\gamma}$ (D) $P_1V_1^{\gamma-1} = P_2V_2^{\gamma-1}$

3. A liquid is in equilibrium with its vapour at its boiling point. On an average the molecules in the two phases have equal.
   (A) Intermolecular forces (B) Potential energy
   (C) Kinetic energy (D) Both kinetic energy and potential energy.

4. Choose the correct statement(s):
   (A) $BeCO_3$ is kept in the atmosphere of CO_2 since it is last thermally stable.
   (B) Be dissolves in an alkali solution forming $[Be(OH)_4]^{-2}$.
   (C) BeF_2 forms complex ion with NaF in which Be goes with cation.
   (D) BeF_2 forms complex ion with NaF in which Be goes with anion.

Rough Work

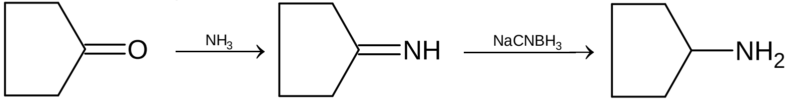
5. NH_3 can be obtained by
   (A) Heating of NH_4NO_3 or NH_4NO_2
   (B) Heating of NH_4Cl or $(NH_4)_2CO_3$
   (C) Heating of NH_4NO_3 with NaOH
   (D) Reaction of AlN or Mg_3N_2 or $CaCN_2$ with H_2O

6. Among the following, the ions having same magnetic moments are:
   (A) $[Ti(H_2O)_6]^{3+}$
   (B) $[Sc(H_2O)_6]^{3+}$
   (C) VO^{2+}
   (D) $[Mn(H_2O)_6]^{+3}$

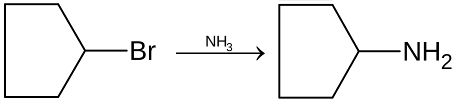
7. Which of the following reactions is feasible for the preparation of 1-propoxy-2-methyl propane.
   (A) Williamson's synthesis of ($Me_2CHCH_2ONa + MeCH_2CH_2Cl$)
   (B) Williamson's synthesis of ($Me_2CHCH_2Cl + MeCH_2CH_2ONa$)
   (C) Alkoxy mercuration-demercuration of ($Me_2CH = CH_2 + MeCH_2CH_2OH$)
   (D) Alkoxy mercuration-demercuration of propene with Me_2CHCH_2OH

8. Which of the following are correct reactions?

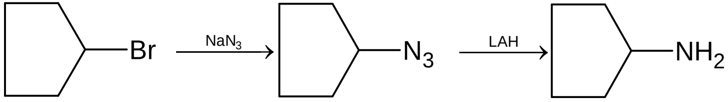
(A)



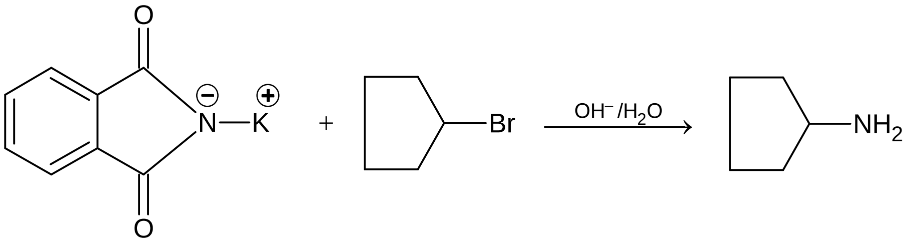
(B)



(C)



(D)



Rough Work

Comprehension Type

This section contains **4 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 9 to 10

There are 4 glass bottles containing water solutions. These bottles are not labelled. Bottles 1, 2, 3 contained colourless solutions, while Bottles 4 contained a blue solution. Each Bottle is having any one solution among the following (Each bottle is having different solution):
Copper (II) sulphate
Sodium carbonates
Lead nitrate
Hydrochloric acid
By mixing samples of the contents of the bottles in pairs, following observations are made:

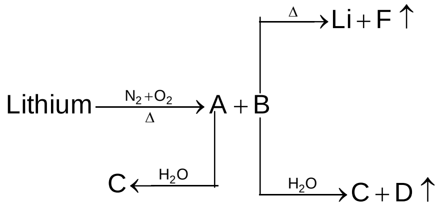
(1) Bottle 1 + Bottle 2	White ppt.
(2) Bottle 1 + Bottle 3	White ppt.
(3) Bottle 1 + Bottle 4	White ppt.
(4) Bottle 2 + Bottle 3	Colourless gas evolved
(5) Bottle 2 + Bottle 4	No visible reaction
(6) Bottle 3 + Bottle 4	Blue ppt.

9. Colourless solution present in Bottle 1 is:
(A) $CuSO_4$ (B) $Pb(NO_3)_2$
(C) HCl (D) Na_2CO_3

10. Chemical formula of white ppt. formed in observation (3) is:
(A) $PbCl_2$ (B) $PbCO_3$
(C) $CuCO_3$ (D) $PbSO_4$

Rough Work

Paragraph for Question Nos. 11 to 12



11. Which of the following is compound (A)?

(A) Li_3N (B) Li_2O
(C) Li_2O_2 (D) LiO_2

12. Which of the following is a property of gas F↑?

(A) It is paramagnetic in nature.
(B) It's bond order is 3.
(C) It does not contain lone pairs.
(D) It contains two sigma and one pi bond per molecule

Paragraph for Question Nos. 13 to 14

The contributions of both heat (enthalpy) and randomness (entropy) shall be considered to the overall spontaneity of a process. When deciding about the spontaneity of a chemical reaction or other process, we define a quantity called the Gibb's energy.

$$\Delta G = \Delta H - T\Delta S$$

Where ΔH = Enthalpy change, ΔS = entropy change.
If $\Delta G < 0$, process is spontaneous; $\Delta G = 0$, process is at equilibrium, $\Delta G > 0$, process is non-spontaneous.

13. For the change $H_2O(s)(273\text{ K, 2 atm})$

$$\downarrow$$

$$H_2O(\ell)(273\text{ K, 2 atm})$$

Choose the correct statement:

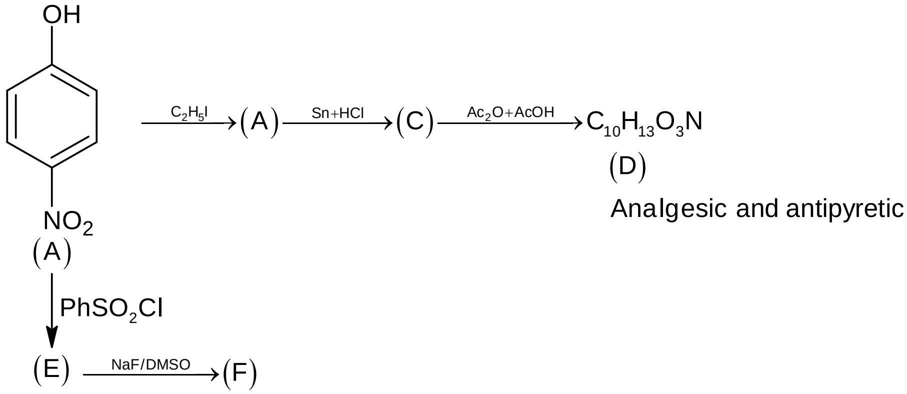
(A) $\Delta G = 0$ (B) $\Delta G < 0$
(C) $\Delta G > 0$ (D) None of the above

14. 5 mole of liquid water is compressed from 1 bar to 10 bar at constant temperature, change in Gibb's energy:
(ΔG) in joule is (density of water = 1000 kg/m^3)

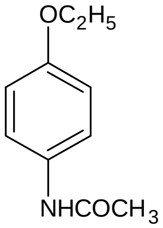
(A) 18 (B) 225
(C) 450 (D) 900

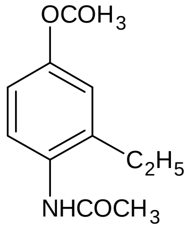
Rough Work

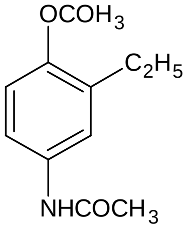
Paragraph for Question Nos. 15 to 16

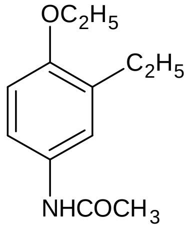

OH
NO$_2$
(A)
C_2H_5I
(A)
Sn+HCl
(C)
$Ac_2O+AcOH$
$C_{10}H_{13}O_3N$
(D)
Analgesic and antipyretic
$PhSO_2Cl$
(E)
NaF/DMSO
(F)

15. The compound (D) is:

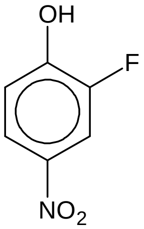
(A)

OC$_2$H$_5$
NHCOCH$_3$

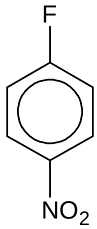
(B)

OCOH$_3$
C$_2$H$_5$
NHCOCH$_3$

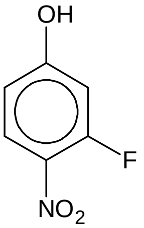
(C)

OCOH$_3$
C$_2$H$_5$
NHCOCH$_3$

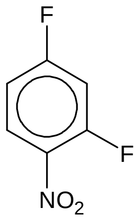
(D)

OC$_2$H$_5$
C$_2$H$_5$
NHCOCH$_3$

16. The compound (F) is:

(A)


(B)


(C)


(D)


Rough Work

(Matching List Type)

This section contains **4 multiple choice questions. Each question has matching lists.** The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

17. Match List I with List II and select the correct options given below:

	List – I		List – II
(P)	For spontaneous reaction	(1)	$\sum(BE)_R - \sum(BE)_P$
(Q)	For endothermic reaction	(2)	$\Delta H = \Delta E$
(R)	Bond dissociation energy	(3)	$\Delta G = -ve$
(S)	For solids and liquids in liquids in thermo-chemical reaction	(4)	$\sum H_P > \sum H_R$

Codes:

	P	Q	R	S
(A)	3	1	2	4
(B)	2	1	4	3
(C)	3	4	1	2
(D)	4	1	2	3

18. Match List I with List II and select the correct options given below:

	List – I		List – II
(P)	10 ml 0.1 M NaOH aq. solution is added to 10 0.1 M HCl aqueous soluntion	(1)	Salt of weak acid and strong base
(Q)	10 ml, 0.1 M NaOH aq. solution is added to 10 ml 0.1 M CH_3COOH aq. solution	(2)	Salt of weak base and strong acid
(R)	10 ml 0.1 M HCl aq. solution is added to 10 ml 0.1 M NH_3 aq. solution	(3)	pH of the solution will be 7
(S)	10 ml, 0.2 M HCl aq. solution to 10 ml, 0.1 M KOH aq. solution	(4)	pH of the solution will be 1.33

Codes:

	P	Q	R	S
(A)	3	1	2	4
(B)	2	1	4	3
(C)	4	1	3	2
(D)	4	1	2	3

Rough Work

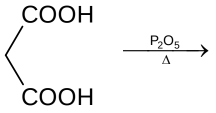
19. Match List I with List II and select the correct options given below:

	List – I		List – II
(P)	$B + N_2 \xrightarrow{\Delta}$	(1)	Inorganic graphite
(Q)	$Na_2B_4O_7(aq)$	(2)	Amphoteric
(R)	Al_2O_3	(3)	Basic
(S)	BBr_3	(4)	Lewis acid

Codes:

	P	Q	R	S
(A)	3	1	2	4
(B)	2	1	4	3
(C)	4	1	3	2
(D)	1	3	2	4

20. Match List I with List II and select the correct options given below:

	List – I		List – II
(P)	$\left(COOH\right)_2.2H_2O \xrightarrow[150^o C]{\Delta}$ $\left(I\right)$	(1)	$2CO_2 + H_2O$
(Q)	$\left(I\right) \xrightarrow[\text{or } H_2SO_4\text{, at } 90^o C]{\Delta a + 200^o C}$	(2)	$(COOH)_2$
(R)		(3)	$CO + CO_2 + H_2O$
(S)	$\left(I\right) \xrightarrow[KMnO_4]{\Delta}$	(4)	Carbon sulphoxide O = C = C = C = O

Codes:

	P	Q	R	S
(A)	3	1	2	4
(B)	2	1	4	3
(C)	2	3	4	1
(D)	4	1	2	3

Rough Work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE OR MORE** is/are correct

1. $\int e^{x^4}\left(x + x^3 + 2x^5\right)e^{x^2}dx$ is equal to

(A) $\frac{1}{2}xe^{x^2}e^{x^4} + c$
(B) $\frac{1}{2}x^2e^{x^4} + c$
(C) $\frac{1}{2}e^{x^2}e^{x^4} + c$
(D) $\frac{1}{2}x^2e^{x^2}e^{x^4} + c$

2. In triangle ABC, $\frac{a}{b} = \frac{2}{3}$ and $\sec^2 A = \frac{8}{5}$. Then the number of triangles satisfying these conditions is

(A) 0
(B) 1
(C) 2
(D) 3

3. If a team scores 200 runs for the loss of two wickets, the number of ways of distribution of runs in partnerships if there was a partnership of at least 50 runs for each wicket, is

(A) ${}^{52}C_2$
(B) ${}^{200}C_3$
(C) ${}^{50}C_2$
(D) ${}^{49}C_2$

4. If $\tan\theta_1$, $\tan\theta_2$, $\tan\theta_3$ are the real roots of the equation $x^3 - (a + 1)x^2 + (b - a)x - b = 0$, where $\theta_1 + \theta_2 + \theta_3 \in (0, \pi)$, then $\theta_1 + \theta_2 + \theta_3$ is equal to

(A) $\frac{\pi}{2}$
(B) $\frac{\pi}{4}$
(C) $\frac{3\pi}{4}$
(D) π

Space for rough work

5. If a, b, and c are in G.P. and x and y, respectively, be arithmetic means between a, b and b, c then

(A) $\frac{a}{x}+\frac{c}{y}=2$ (B) $\frac{a}{x}+\frac{c}{y}=\frac{c}{a}$

(C) $\frac{1}{x}+\frac{1}{y}=\frac{2}{b}$ (D) $\frac{1}{x}+\frac{1}{y}=\frac{2}{ac}$

6. A rod of length 2 units whose one end is (1, 0, –1) and other end touches the plane x – 2y + 2z + 4 = 0, then

(A) the rod sweeps the figure whose volume is π cubic units

(B) the area of the region which the rod traces on the plane is 2π

(C) the length of projection of the rod on the plane is $\sqrt{3}$ units

(D) the centre of the region which the rod traces on the plane is $\left(\frac{2}{3}, \frac{2}{3}, \frac{-5}{3}\right)$

7. $f(x)=\frac{\sqrt{x-2\sqrt{x-1}}}{\sqrt{x-1}-1}$ x, then

(A) f′(10) = 1 (B) $f'\left(\frac{3}{2}\right)=-1$

(C) domain of f(x) is $x \geq 1$ (D) range of f(x) is $(-2, -1] \cup (2, \infty)$

8. A point $P(\sqrt{3}, 1)$ moves on the circle $x^2 + y^2 = 4$ and after covering a quarter of the circle leaves it tangentially. The equation of line along which the point moves after leaving the circle is

(A) $y=\sqrt{3}x+4$ (B) $\sqrt{3}y=x+4$

(C) $y=\sqrt{3}x-4$ (D) $\sqrt{3}y=x-4$

Space for rough work

Comprehension Type

This section contains **4 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 9 to 10

Read the following write up carefully and answer the following questions:
Tangent to the parabola $y = x^2 + ax + 1$, at the point of intersection of y–axis also touches the circle $x^2 + y^2 = r^2$. Also no point of the parabola is below x–axis

9. The radius of circle when a attains its maximum value

(A) $\frac{1}{\sqrt{10}}$ (B) $\frac{1}{\sqrt{5}}$

(C) 1 (D) $\sqrt{5}$

10. The slope of the tangent when radius of the circle is maximum is

(A) –1 (B) 1

(C) 0 (D) 2

Paragraph for Question Nos. 11 to 12

Read the following write up carefully and answer the following questions:
Consider the equation $az + b\bar{z} + c = 0$, where a, b, c $\in$ **C** (set of complex number)

11. If $|a| = |b|$ and $\bar{a}c \neq b\bar{c}$, then z has

(A) infinite solutions (B) no solutions

(C) finite solutions (D) cannot say anything

12. If $|a| = |b| \neq 0$ and $\bar{a}c = b\bar{c}$, then $az + b\bar{z} + c = 0$ represents

(A) an ellipse (B) a circle

(C) a point (D) a straight line

Space for rough work

Paragraph for Question Nos. 13 to 14

Read the following write up carefully and answer the following questions:

If e^A is defined as $e^A = I + A + \frac{A^2}{2!} + \frac{A^3}{3!} + ... = \frac{1}{2}\begin{bmatrix} f(x) & g(x) \\ g(x) & f(x) \end{bmatrix}$ where $A = \begin{bmatrix} x & x \\ x & x \end{bmatrix}$ and 0 < x < 1, I is an identify matrix

13. $\int \frac{g(x)}{f(x)} dx$ is equal to

(A) $\log(e^x + e^{-x}) + c$ (B) $\log(e^x - e^{-x}) + c$
(C) $\log(e^{2x} - 1) + c$ (D) none of these

14. $\int (g(x)+1)\sin x dx$ is equal to

(A) $\frac{e^x}{2}(\sin x - \cos x) + c$ (B) $\frac{e^{2x}}{5}(2\sin x - \cos x) + c$
(C) $\frac{e^x}{5}(\sin 2x - \cos 2x) + c$ (D) none of these

Paragraph for Question Nos. 15 to 16

Read the following write up carefully and answer the following questions:

f(x) satisfies the relation $f(x) - \lambda \int_0^{\pi/2} \sin x \cos t \, f(t) dt = \sin x$

15. If f(x) = 2 has at least one real root, then

(A) $\lambda \in [1, 4]$ (B) $\lambda \in [-1, 2]$
(C) $\lambda \in [0, 1]$ (D) $\lambda \in [1, 3]$

16. If $\int_0^{\pi/2} f(x) dx = 3$, then the value of λ is

(A) 1 (B) $\frac{3}{2}$
(C) $\frac{4}{3}$ (D) none of these

Space for rough work

(Matching list Type)

This section contains **4 multiple choice questions.** Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

17. Match the following List–I with List–II.

	List – I		**List – II**
(P)	Four dice (six faced) are rolled. The number of possible outcomes in which at least one dice shows 2 is	1.	210
(Q)	Let A be the set of 4–digit number $a_1a_2a_3a_4$ where $a_1 > a_2 > a_3 > a_4$. Then n(A) is equal to	2.	750
(R)	The total number of three–digit numbers, the sum of whose digits is even, is equal to	3.	671
(S)	The number of four–digit numbers without repetition that can be formed from the digits 0, 1, 2, 3, 4, 5, 6, 7 so that each number contains digit 1 is	4.	450

Codes:

	P	Q	R	S
(A)	4	2	1	3
(B)	3	1	4	2
(C)	1	3	2	4
(D)	3	4	1	2

18. Match the following List–I with List–II.

	List – I		**List – II**
(P)	Diameter of the circle touching the line $(x - 1)\cos\theta + (y - 1)\sin\theta = 1$ for all values of θ	1.	2
(Q)	Radius of smallest circle which touches the circle $x^2 + y^2 = 1$ and $x^2 + y^2 - 6x - 8y + 21 = 0$	2.	1
(R)	Number of values of m for which the line $(y - 2) = m(x - 1)$ cuts the circle $x^2 + y^2 = 5$ at two real points	3.	4
(S)	Number of circle touching both the axes and the line $x + y = 4$	4.	infinite

Codes:

	P	Q	R	S
(A)	1	2	3	4
(B)	3	4	1	2
(C)	1	2	4	3
(D)	2	4	3	1

Space for rough work

19. Match the following List–I with List–II.

	List – I		**List – II**
(P)	Least value of the expression $2\log_{10} x - \log_x 0.01$ for x > 1 is	1.	2
(Q)	The number of solutions of $\log_4(x-1) = \log_2(x-3)$ is	2.	4
(R)	Least integral value of x which satisfies $\log_{x+1}\sqrt{2}x > \frac{1}{2}$ is	3.	1
(S)	Number of solutions of $[\log_e x] = \lvert x \rvert$ is (where [.] denotes the greatest integer function)	4.	0

Codes:

	P	Q	R	S
(A)	2	3	4	1
(B)	2	1	2	4
(C)	2	4	3	1
(D)	2	3	1	4

20. Match the following List–I with List–II.

	List – I		**List – II**
(P)	If f : (0, ∞) onto (0, ∞) be a derivable function for which there exists its primitive F such that $2(F(x) - f(x)) = f^2(x)$ for any real positive x, then $\lim\limits_{x\to\infty} \frac{f(x)}{x}$ is equal to	1.	$\frac{1}{3}$
(Q)	If f(x) is continuous and differentiable over [–2, 5] and $3 \le f'(x) \le 4$ for all x in (–2, 5), then value of f(5) – f(–2) may be	2.	1
(R)	If x is real, then the greatest value of the expression $\frac{x+2}{2x^2+3x+6}$ is	3.	2
(S)	If $y = e^{-x}\cos x$ and $y_4 + 2ky = 0$, where $y_4 = \frac{d^4y}{dx^4}$, then k is equal to	4.	22

Codes:

	P	Q	R	S
(A)	4	1	2	3
(B)	3	1	4	2
(C)	2	4	1	3
(D)	2	4	3	1

Space for rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

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JEE(Advanced)-2014

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

CRT –IV

(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	A, B, C	D
2.	C	A, C	C
3.	D	C	A
4.	B	A, B, D	B
5.	B	B, C, D	A, C
6.	C	A, C	A, C, D
7.	C	A, B	A, B, D
8.	C	A, B, C	B, D
9.	C	B	B
10.	A	D	C
11.	B	B	B
12.	B	B	D
13.	C	B	A
14.	B	D	B
15.	A	A	D
16.	C	B	C
17.	C	C	B
18.	D	A	C
19.	C	D	D
20.	B	C	C

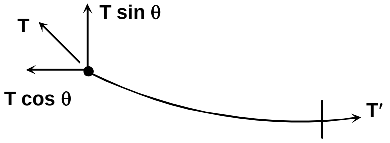
Physics

PART – I

2. $T \sin\theta = mg/2$

$T' = T\cos\theta$

$= \frac{mg}{2}\cot\theta = \frac{mg}{2\tan\theta}$



3. $\frac{1}{2}mv^2 = pt$ (P = const)

$\Rightarrow v = \sqrt{\frac{2Pt}{m}}$

$a = \frac{dv}{dt} = \sqrt{\frac{2P}{m}}\frac{1}{2\sqrt{t}}$

$F = ma = \sqrt{\frac{mP}{2t}} \propto \frac{1}{v}$

5. $\vec{F} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \vec{F}_4 + \vec{F}_5$

$\left|\vec{F}_2\right| = \left|\vec{F}_5\right|$ and $\left|\vec{F}_2\right| = \left|\vec{F}_4\right|$

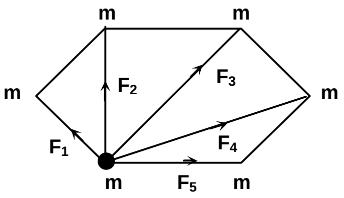
$\vec{F}_1 = \vec{F}_3 + 2F_2\cos 30° + 2F_1\cos 60°$

$F_3 = \frac{Gm^2}{4a^2}$; $F_2 = \frac{Gm^2}{3a^2}$; $F_1 = \frac{Gm^2}{a^2}$

$F = \frac{Gm^2}{a^2}\left(\frac{5}{4} + \frac{1}{\sqrt{3}}\right) = m\omega^2 a$

$\omega = \sqrt{\frac{Gm}{a^3}\left(\frac{5}{4} + \frac{1}{\sqrt{3}}\right)}$

$T = 2\pi\sqrt{\frac{4\sqrt{3}a^3}{Gm\left(5\sqrt{3} + 4\right)}}$



6. $\rho + \rho g(L - x) - \rho gL = \frac{d}{dt}(\rho xu)$

7. $v_{p_x} = 5$, $v_{p_y} = 5$

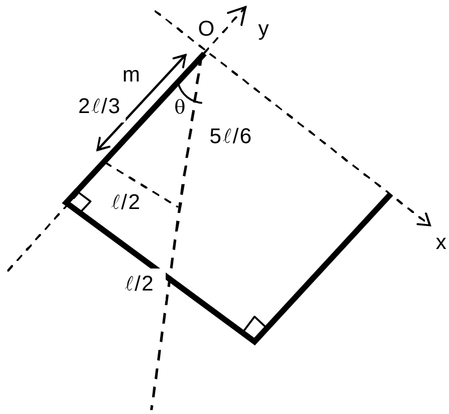
$5\sqrt{2}$ = 7.1 m/s approx.

8. $v_P = \frac{1600 \times 10^{-6}}{4 \times 10^{-4}}$ = 4 m/s

$v_Q = \frac{1600 \times 10^{-6}}{2 \times 10^{-4}}$ = 8 m/s

$P_A - P_B = \frac{1}{2}\rho_A\left(v_Q^2 - v_P^2\right) = \rho gh$

11-12. Let the point of suspension is origin(O), then C.M. lies on vertical line when it is in equilibrium position.



$x_{cm} = \frac{m(0)+m(L/2)+m(L)}{3m}$ = L/2 and

$y_{cm} = \frac{m(-L/2)+m(-L)+m(-L/2)}{3m} = \frac{-2L}{3}$

$\therefore \tan\theta = \frac{L/2}{2L/3} = 3/4 \Rightarrow \theta = \tan^{-1}(3/4)$ or 37^0

$d^2 = \left(\frac{2L}{3}\right)^2 + \left(\frac{L}{2}\right)^2$

$d = \frac{5L}{6}$

Moment of inertia $I = Mk^2 = 4m\left(\frac{\ell^2}{12}+\frac{\ell^2}{4}+\frac{\ell^2}{2}\right) - \frac{m\ell^2}{3} = 3m\ell^2$

(Assume full square and calculate moment of inertia about origin and subtract the moment of inertia of fourth rod.)

Time period of a physical pendulum $= 2\pi\sqrt{\frac{I}{mgd}} = 2\pi\sqrt{\frac{6\ell}{5g}}$ sec

13-14. $F = qvB\sin\theta = qvB$ $(\theta = 90°)$

So, $B = \frac{F}{qv} = \frac{3.2\times10^{-20}}{1.6\times10^{-19}\times4\times10^{3}} = 5\times10^{-7}$ T

Now, $\frac{\mu_0}{2\pi}\left[\frac{I_p}{5}+\frac{I_q}{2}\right] = 5\times10^{-7}$

$\Rightarrow$ I = 4 amp.

If the distance of point R from third current carrying current is X, then

$B_R = 0$

$\frac{\mu_0}{4\pi}\frac{2\times2.5}{|x|} + 5\times10^{-7} = 0$

so x = ± 1 m

16. $P(2\pi r)dr = 2\pi r\ell\eta\frac{dv}{dr} - 2\pi(r+dr)\,\ell\eta\,\frac{dv}{dr}$

$P(2\pi r)dr = -2\pi\,\ell\eta\left(\frac{dv}{dr}\right)dr$

$P(2\pi r) = -2\pi\,\ell\eta\left(\frac{-2v_0r}{R^2}\right)$

$P = \frac{2\eta\ell v_0}{R^2}$

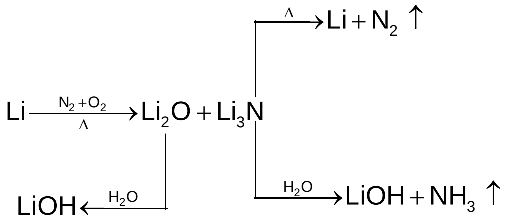
Chemistry PART – II

SECTION – A

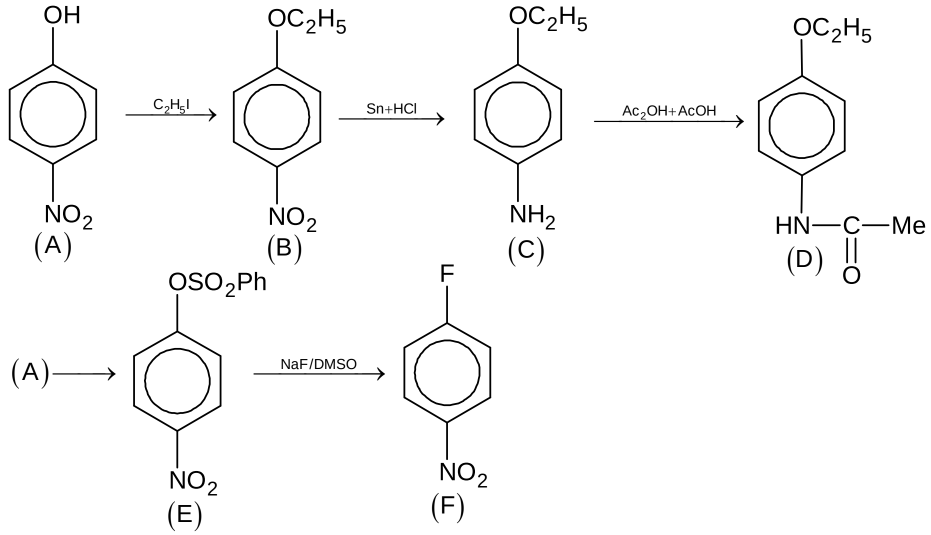
8. (D) is incorrect, since Gabriel method is used to prepare 1^o aliphatic amines.

10. Bottles 1, 2, 3, 4 have $Pb(NO_3)_2$, HCl, Na_2CO_3 and $CuSO_4$.
When mixing:
Bottle 1 + Bottle 2 → $PbCl_2$
Bottle 1 + Bottle 3 → $PbCO_3$
Bottle 1 + Bottle 4 → $PbSO_4$
Bottle 2 + Bottle 3 → CO_2
Bottle 2 + Bottle 4 → No visible reaction
Bottle 3 + Bottle 4 → $CuCO_3$

12.


Li
N₂+O₂
Δ
Li₂O + Li₃N
Δ
Li + N₂ ↑
H₂O
LiOH + NH₃ ↑
H₂O
LiOH

Solution for the Q. No. 15 & 16


OH
NO₂
(A)
C₂H₅I
OC₂H₅
NO₂
(B)
Sn+HCl
OC₂H₅
NH₂
(C)
Ac₂OH+AcOH
OC₂H₅
HN—C—Me
O
(D)
(A)
OSO₂Ph
NO₂
(E)
NaF/DMSO
F
NO₂
(F)

20. (P – 2) oxalic acid dehydrate, loses H_2O when treated at 105^oC.
(Q – 3) when heated at 200^oC or when refluxed with H_2SO_4 at 90^oC, it decomposes into CO_2, CO, HCOOH and H_2O.
(R – 4) malonic acid on heating with P_2O_5 loses H_2O and forms carbon suboxide.
(S – 1) oxalic acid is oxidised by $KMnO_4$ to CO_2.

Mathematics PART – III

HINTS AND SOLUTION

1. Put $x^2 = t$

$$I = \frac{1}{2}\int e^t \left[te^{t^2} + \left(e^{t^2} + 2t^2e^{t^2}\right)\right] dt$$

2. We have $\frac{a}{2} = \frac{b}{3} = k$ and $\sec^2 A = \frac{8}{5}$

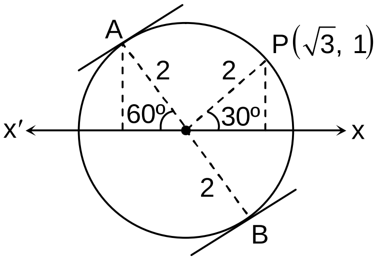
$\Rightarrow \cos^2 A = \frac{5}{8}$

$\Rightarrow c^2 = 10k^2,\ \frac{5}{2}k^2$

4. $$\tan\left(\theta_1 + \theta_2 + \theta_3\right) = \frac{\sum \tan\theta_1 - \prod \tan\theta_1}{1 - \sum \tan\theta_1 \tan\theta_2} = \frac{a + 1 - b}{1 - (b - a)} = 1$$

7. $$f(x) = \begin{cases} -x & \text{if } x \in [1, 2) \\ x & \text{if } x \in (2, \infty) \end{cases}$$

8. Clearly, A = (–2 cos 60º, 2 sin 60º)
B = (2 cos 60º, –2 sin 60º)
Tangent at A is x(–2 cos 60º) + y(2 sin 60º) = 4
and tangent at B is x(2 cos 60º) + y(–2 sin 60º) = 4



9. Since, parabola is above x–axis
$D = a^2 - 4 \le 0$
Thus, $a_{max} = 2$

10. Equation of tangent at (0, 1) to the parabola is y – 1 = a(x – 0)

11.-12. $az + b\bar{z} + c = 0$ ..... (1)
$\Rightarrow \bar{a}\bar{z} + \bar{b}z + \bar{c} = 0$ ..... (2)
Eliminating $\bar{z}$ from (1) and (2)
$\left(|b|^2 - |a|^2\right)z = c\bar{a} - b\bar{c}$
Adding (1) and (2) $(\bar{a} + b)\bar{z} + \left(a + \bar{b}\right)z + (c + \bar{c}) = 0$
This is of form $A\bar{z} + \bar{A}z + B = 0$

13.-14 Here, $e^A = \frac{1}{2}\begin{bmatrix} e^{2x} + 1 & e^{2x} - 1 \\ e^{2x} - 1 & e^{2x} + 1 \end{bmatrix}$
So, $f(x) = e^{2x} + 1$; $g(x) = e^{2x} - 1$

15.-16. $f(x) - \lambda \sin x \int_0^{\pi/2} \cos t\, f(t) dt = \sin x$

$\Rightarrow$ f(x) – P sin x = sin x
or f(x) = (P + 1) sin x

Where $P = \lambda \int_0^{\pi/2} \cos t\, f(t) dt$

$= \lambda \int_0^{\pi/2} \cos t (P+1) \sin t \, dt$

$= \frac{\lambda(P+1)}{2} \int_0^{\pi/2} \sin 2t \, dt$

$P = \frac{\lambda(P+1)}{2} \Rightarrow P = \frac{\lambda}{2-\lambda}$

$f(x) = \left(\frac{\lambda}{2-\lambda} + 1\right) \sin x = 2$

$\Rightarrow$ sin x = 2 – λ
$\Rightarrow$ $\lambda \in [1, 3]$

$\int_0^{\pi/2} \frac{2}{2-\lambda} \sin x \, dx = 3$

$\Rightarrow \lambda = \frac{4}{3}$

20. (P) $2(F(x) - f(x)) = f^2(x)$
$\Rightarrow f(x) - f'(x) = f(x) f'(x)$
$\Rightarrow f'(x) = \frac{f(x)}{1+f(x)} = 1 - \frac{1}{1+f(x)}$
$\Rightarrow$ f(x) is an increasing function
(Q) $21 \le f(5) - f(-2) \le 28$
(R) $y = \frac{x+2}{2x^2+3x+6}$
$\Rightarrow y \in \left[-\frac{1}{13}, \frac{1}{3}\right]$
(S) $y = e^{-x} \cos x$
$\Rightarrow y_1 = -e^{-x} \sin x - e^{-x} \cos x = -e^{-x} \sin x - y$
$y_2 = -e^{-x} \cos x + e^{-x} \sin x - y_1$
$\Rightarrow y_4 + 4y = 0$
$\Rightarrow k = 2$

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ALL INDIA TEST SERIES

FIITJEE **JEE (Main), 2014**

CONCEPT RECAPITULATION TEST - IV

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 30)** contains 30 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

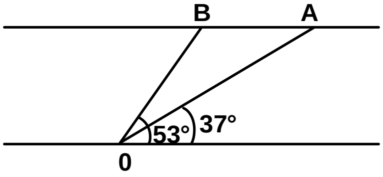
SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. The minimum and maximum magnitude which is possible by adding four forces of magnitudes 1N, 3N, 9N and 10N is
(A) 0 and 23 N
(B) 1N and 23 N
(C) 2N and 23 N
(D) 3N and 23 N

2. A boat crosses a 2.4km wide river to reach the a point A on the opposite bank, located at 37° with the flow, in 500s. The same boat takes the same time (500s) to reach another point B on the opposite bank located at 53° with the flow. Where should a landing point be chosen on the other bank so that the boat can cross in the minimum possible time?



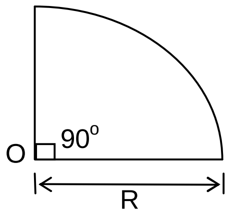
(A) 1.2 km downstream from O
(B) 2.4 km downstream from O
(C) 3.6 km downstream from O
(D) 7.2 km downstream from O

3. A particle is moving in x–y plane. At certain instant, the components of its velocity and acceleration are as follows. V_x = 3m/s, V_y = 4m/s, a_x = 2 m/s^2 and a_y = 1 m/s^2. The rate of change of speed at this moment is
(A) $\sqrt{10}\,m/s^2$
(B) $4\,m/s^2$
(C) 10 m/s^2
(D) 2 m/s^2

4. A body of mass 'm' is moving in a circle of radius with a constant speed 'v'. Let work done by the resultant force in moving the body over half circumference and full circumference is W and W' then
(A) $W = \frac{mv^2}{r}(\pi r),\ W' = \frac{mv^2}{r}(2\pi r)$
(B) $W = \frac{mv^2}{r}(2r),\ W' = \text{zero}$
(C) $W = \frac{mv^2}{r}(\pi r),\ W' = \text{zero}$
(D) W = 0, W' = 0

Space for Rough work

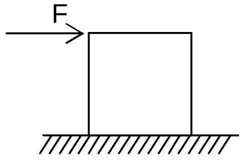
5. In the figure, one fourth part of uniform disc of radius ‘R’ is shown. The distance of the centre of mass of this object from centre ‘O’ is



(A) $\frac{4R}{3\pi}$ (B) $\frac{2R}{3\pi}$

(C) $\sqrt{2}\frac{4R}{3\pi}$ (D) $\sqrt{2}\frac{2R}{3\pi}$

6. A force F is applied on the top of a cube as shown in the figure. The coefficient of friction between the cube and ground is μ. If F is gradually increased the cube will topple before sliding if

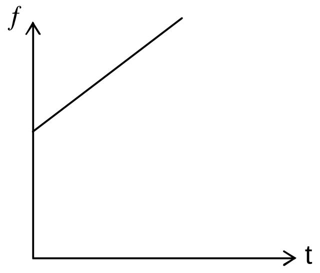


(A) $\mu > 1$ (B) $\mu < \frac{1}{2}$

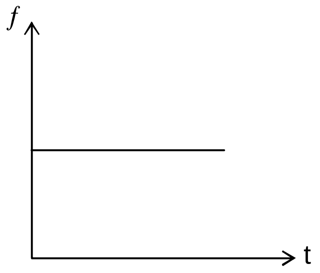
(C) $\mu > \frac{1}{2}$ (D) $\mu < 1$

7. An observer starts moving with uniform acceleration ‘a’ towards a stationary sound source of frequency f_o. As the observer approaches the source, the apparent frequency ‘f’ heard by the observer varies with time ‘t’ as

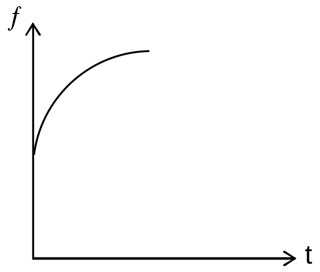
(A)



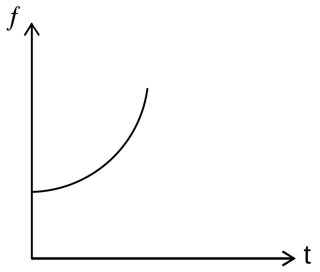
(B)



(C)

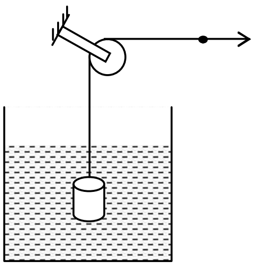


(D)

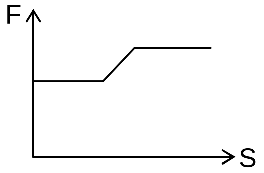


Space for Rough work

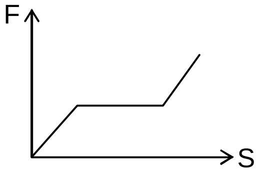
8. A metallic cylinder of radius r and height h is totally submerged in a liquid contained in a beaker as shown in the figure. If force F is pulling the string at a constant velocity v, the graph showing the variation of force F against displacement of cylinder is best represented by



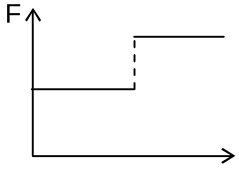
(A)



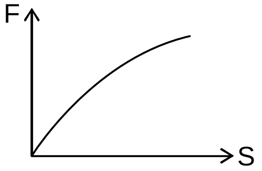
(B)



(C)



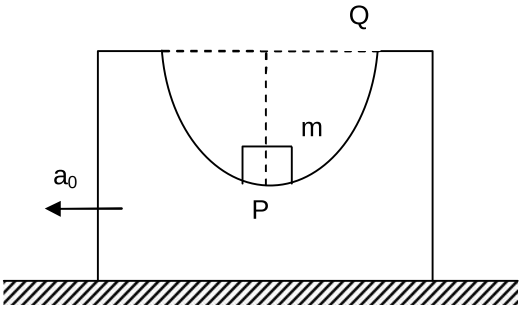
(D)



9. A particle starts moving with velocity $\vec{v} = \hat{i}$ (m/s), and acceleration $\vec{a} = \left(\hat{i} + \hat{j}\right)$ (m/s^2). Find the radius of curvature of the particle at t = 1sec.

(A) 5 m
(B) $5\sqrt{5}$ m
(C) $6\sqrt{5}$ m
(D) none

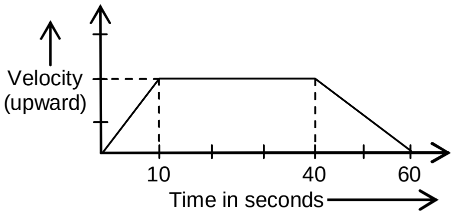
10. A block of mass m is lying at rest at point P of a wedge having a smooth semi-circular track of radius R. What should be the minimum value of a_0 so that the mass can just reach point Q.



(A) $\frac{g}{2}$
(C) g
(D) not possible

Space for Rough work

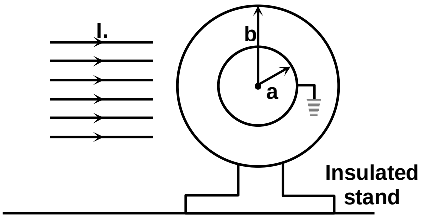
11. A person is standing on a weighing machine placed on the floor of an elevator. The motion of the elevator is shown in the adjacent diagram. The maximum and the minimum weights recorded are 66 kg and 57 kg. The true weight of the person is [Take $g = 10\ m/s^2$.]



(A) 60 kg
(B) 63 kg
(C) 61.5 kg
(D) 65 kg

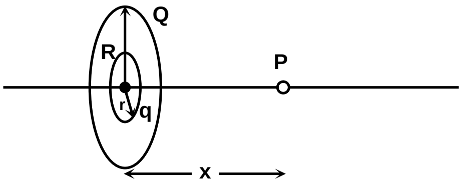
12. An x-ray tube is operating at 150 kV and 10 mA. If only 1% of the electric power supplied is converted into X-ray, the rate at which heat is produced in the target is
(A) 3.55 cal/sec
(B) 35.5 cal/sec
(C) 355 cal/sec
(D) 3550 cal/sec

13. A parallel beam of light of monochromatic radiation of cross-section area A ($<\pi b^2$), intensity I and frequency ν is incident on a solid, perfectly absorbing conducting sphere of work function ϕ_0 ($h\nu > \phi_0$) and radius b. The inner sphere of radius a is grounded by a conducting wire. Assume that for each incident photon one photoelectron is ejected. Current through the conducting wire just after the radiation is



(A) $\frac{IAe}{h\nu}\frac{b}{a}$
(B) $\frac{IAe}{2h\nu}$
(C) $\frac{2IAe}{h\nu}$
(D) $\frac{IAe}{h\nu}\frac{a}{b}$

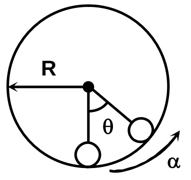
14. Two concentric rings of radius R = 8 cm and r = 2 cm having charge Q = 8 μC and q = –1 μC are placed as shown in diagram. Then electric field is zero at axis of rings



(A) $x = \pm 4\sqrt{3}$ cm
(B) $x = \pm 4$ cm
(C) $x = \pm 2$ cm
(D) $x = \pm 2\sqrt{3}$ cm

Space for Rough work

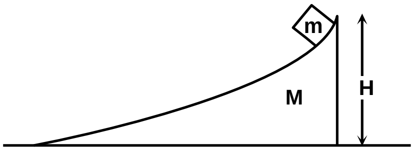
15. A small sphere of mass m and radius r is placed inside a hollow cylinder of radius R. Now cylinder rotating with some angular acceleration which slowly increases from zero to certain value α. There is no slipping between two surfaces during motion.



(A) Maximum angle formed by line joining centre will be $\theta = \sin^{-1}\left(\frac{2\alpha R}{5g}\right)$
(B) Angular velocity of sphere will be $\omega' = \frac{\omega r}{R}$ where ω is angular velocity of cylinder.
(C) sphere will keep rotating at lowest position.
(D) K.E. of sphere becomes constant when it reaches maximum height.

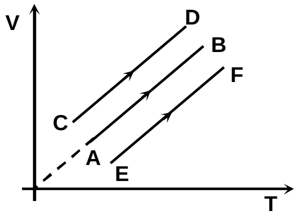
16. Suppose the potential energy between the electron and proton at a distance r is given by $-\frac{Ke^2}{3r^3}$. Application of Bohr's theory of hydrogen atom in this case shows that energy in the nth orbit is proportional to
(A) n^6 (B) n^{-3}
(C) n^{-2} (D) n^{-4}

17. Block of mass m is placed on a wedge of mass M at height H. All surfaces are smooth and system is released, then which of the following is incorrect.



(A) Work done by normal reaction on the wedge is positive and on block is negative.
(B) work done by normal reaction is zero for both the block and the wedge.
(C) change in gravitational potential energy is shared by the block and wedge in inverse ratio of their masses.
(D) Centre of mass will not change position.

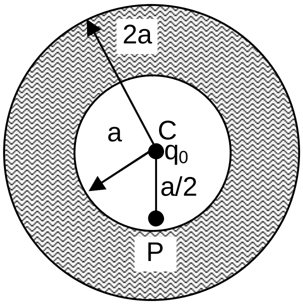
18. Following are some processes shown in V-T graph for ideal gas. Which of following is incorrect.



(A) in process CD pressure continuously increases.
(B) in process EF pressure continuously decreases.
(C) Pressure remains constant in all process AB, CD, EF.
(D) Internal energy of gas increases in all three processes.

Space for Rough work

19. A point positive charge q_0 is placed at a point C inside the cavity in spherical conductor as shown in figure. Find the potential at P.

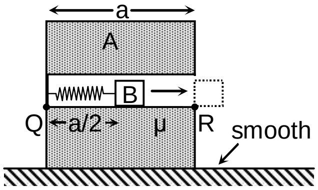


(A) $\frac{Kq_0}{2a}$
(B) $\frac{Kq_0}{a}$
(C) $\frac{2kq_0}{a}$
(D) $\frac{3Kq_0}{2a}$

$\left[\text{here}, k = \frac{1}{4\pi \in_0}\right]$

20. In screw gauge; 5 complete rotations of circular scale give 1.5 mm reading on linear scale. Circular scale has 50 divisions. Least count of the screw gauge is
(A) 0.006 mm
(B) 0.003 mm
(C) 0.015 mm
(D) 0.03 mm

21. A cubical block 'A' of mass m_1 and edge length 'a' lies on a smooth horizontal floor. It has a groove with a flat base with an open end. On the closed end of the groove there is a spring of natural length 'a' attached to it. A small block 'B' of mass m_2 is pushed into the groove compressing the spring by a/2. Coefficient of friction between B and groove is μ. System is now released from rest. Find speed of B as it comes out of A. Assume that B is always sliding against the surface of the groove. (m_1 = 3kg, m_2 = 1kg, a = 10 cm, k = 100N/m, μ = 0.13)



(A) 15 cm/s
(B) 10 cm/s
(C) 5 cm/s
(D) 20 cm/s

22. The end of capillary tube is immersed into a liquid. Liquid slowly rises in the tube up to a height. The capillary-fluid system
(A) will absorb heat
(B) will release heat
(C) will not be involved in any heat transfer
(D) nothing can be said

23. The radius of a planet is n times the radius of earth, R. A satellite revolves around it in a circle of radius 4nR with angular velocity ω. The acceleration due to gravity on planet's surface is
(A) $R\omega^2$
(B) $16\ R\omega^2$
(C) $32\ nR\omega^2$
(D) $64\ nR\omega^2$.

24. Some successive frequencies of an ideal organ pipe are measured as 150 Hz, 250 Hz, 350 Hz. Velocity of sound is 340 m/s.
(A) it must be an open organ pipe of length 3.4 m
(B) it must be an open organ pipe of length 6.8 m
(C) it must be an closed organ pipe of length 1.7 m
(D) it must be an closed organ pipe of length 3.4 m.

Space for Rough work

25. Two identical blocks are kept on a frictionless horizontal table and connected by a spring of stiffness 'k' and of original length ℓ_0. A total charge Q is distributed on the blocks such that maximum elongation of spring, at equilibrium, is equal to x. Value of Q is
(A) $2\ell_0\sqrt{4\pi\varepsilon_0 k(\ell_0 + x)}$ (B) $2x\sqrt{4\pi\varepsilon_0 k(\ell_0 + x)}$
(C) $2(\ell_0 + x)\sqrt{4\pi\varepsilon_0 kx}$ (D) $(\ell_0 + x)\sqrt{4\pi\varepsilon_0 kx}$.

26. At t = 0, light of intensity 10^{12} photons/s–m^2 of energy 6eV per photon start falling on a plate with work function 2.5 eV. If area of the plate is 2×10^{-4} m^2 and for every 10^5 photons one photoelectron is emitted, charge on the plate at t = 25 s is
(A) 8×10^{-15} C (B) 4×10^{-15} C
(C) 12×10^{-15} C (D) 16×10^{-15} C.

27. Two resistances are measured in Ohm.
$R_1 = 3\Omega \pm 1\%$
$R_2 = 6\Omega \pm 2\%$
When they are connected in parallel, the percentage error in equivalent resistance is
(A) $\frac{14}{3}\%$ (B) 1%
(C) 2% (D) $\frac{4}{3}\%$

28. If λ_{min} is minimum wavelength produced in X–ray tube and $\lambda_{K\alpha}$ is the wavelength of K_α line. As the operating voltage is increased
(A) $\lambda_{K\alpha}$ increases (B) $\lambda_{K\alpha}$ decreases
(C) $(\lambda_{K\alpha} - \lambda_{min})$ increases (D) $(\lambda_{K\alpha} - \lambda_{min})$ decreases.

29. The filament current in the electron gun of a Coolidge tube is increased while the potential difference used to accelerate the electron is decreased. As a result in the emitted radition.
(A) The intensity decreases while the minimum wavelength increases.
(B) The intensity increases while the minimum wavelength decreases.
(C) The intensity as well as the minimum wavelength increases.
(D) The intensity as well as the minimum wavelength decreases.

30. Monochromatic light of wavelength 900 nm is used in a young's double slit experiment. One of the slits is covered by a transparent sheet of thickness 1.8×10^{-5} m made of material of refractive index 1.6. How many fringes will shift due to introduction of the sheet.
(A) 18 (B) 12
(C) 10 (D) 6

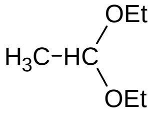
Space for Rough work

Chemistry PART – II

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. Compound  and $H_3C—CH_2—O—CH_2—CH_3$ can not be differentiated by

(p) (Acetal) (q)

(A) $H_3O^{\oplus}$, Na
(B) $H_3O^{\oplus}$, Tollens test
(C) $H_3O^{\oplus}$, Fehling test
(D) None of the above

2. If Ksp of AgX are in the order AgCl > AgBr > AgI, then what will be the order of $E^{\circ}_{X^-/AgX/Ag}$ for different half cells having different silver halides

(A) AgCl < AgBr < AgI
(B) AgCl > AgBr > AgI
(C) AgCl = AgBr = AgI
(D) E^0 is not related to Ksp

3. Which of the following compounds was unable to respond chromyl chloride Test?

(A) NaCl
(B) $SnCl_2$
(C) $SnCl_4$
(D) AuCl

4. The activation energy for the decomposition of hydrogen iodide at 581 K is 209.5 cal. Then the percentage of the molecules crossing over the barrier is:
Given that antilog (-1.07828) = 0.0835

(A) 83.5%
(B) 8.35%
(C) 40%
(D) 60%

5. A mixture of SO_3, SO_2 and O_2 gases is maintained at equilibrium in 10 litre flask at a temperature at which K_c for the reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ is 100. If number of moles of SO_2 and SO_3 are same at equilibrium, the number of moles of O_2 present is:

(A) 0.01
(B) 0.1
(C) 1
(D) 10

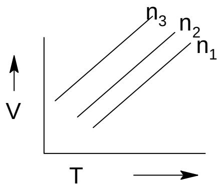
Space for Rough work

6. Two containers A and B (having same volume) containing N_2 at pressure P_1 and the temperature is maintained T_1, if these two are now connected with a narrow tube and one container is still at T_1 and other changes to T_2 then the new pressure in the vessel can be given as

(A) $2P_1/(T_1+T_2)$
(B) $2P_1T_2/(T_1+T_2)$
(C) $P_1T_2/2(T_1+T_2)$
(D) $T_1/2P_1T_2$

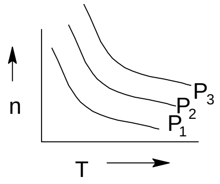
7. Which of the following curves does not represent the behaviour of an ideal gas

(A)



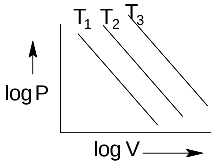
n_1, n_2 & n_3 are no. of moles of the gases

(B)



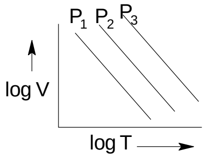
at constant V

(C)



at constant n

(D)



at constant P and constant n

8. A solution of A and B with 30 mole percent of A is in equilibrium with its vapour which contains 60 mole percent of A. Assuming ideality of the solution and the vapour. The ratio of vapour pressure of pure A to that of pure B will be

(A) 7:2
(B) 7:4
(C) 4:7
(D) 1:2

9. Potassium halide has unit cell length of 0.5 $\overset{\circ}{A}$ lesser than that for the corresponding Rb salt of the same halogen. What is the ionic radius of K^+ if that of Rb^+ is 1.58 $\overset{\circ}{A}$?

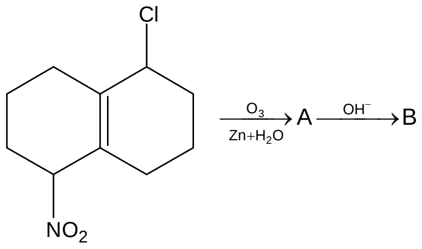
(A) 2.08 $\overset{\circ}{A}$
(B) 1.33 $\overset{\circ}{A}$
(C) 1.08 $\overset{\circ}{A}$
(D) 1.28 $\overset{\circ}{A}$

10. In the process of extraction of Al from bauxite coke powder is spreaded over the molten electrolyte to:

(A) Prevent the loss of heat by radiation from the surface
(B) Prevent the corrosion of graphite anode
(C) Prevent oxidation of molten aluminium by air
(D) Both (A) and (C)

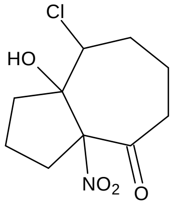
Space for Rough work

11.

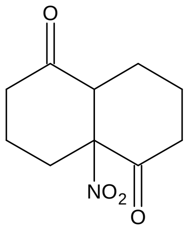

Cl
NO2
O3
Zn+H2O
A
OH⁻
B

The end product (B) would be

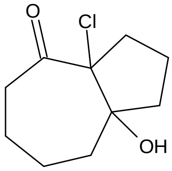
(A)



(B)

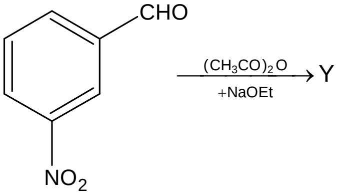


(C)



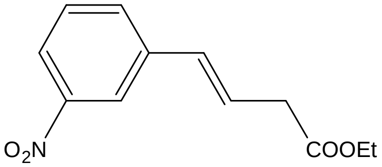
(D) Both A & B

12.

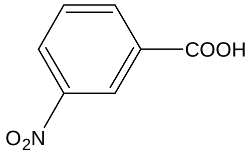

CHO
NO2
(CH3CO)2O
+NaOEt
Y

Y would be

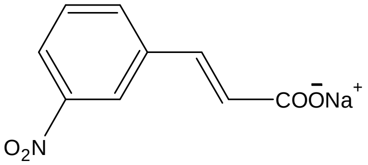
(A)



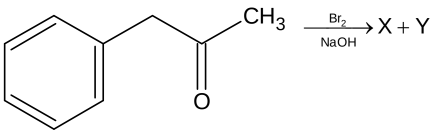
(B)



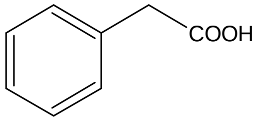
(C)



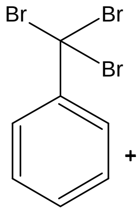
(D) None

13. 
CH3
O
Br2
NaOH
X + Y

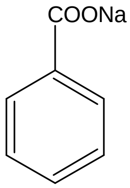
X and Y would be

(A) 

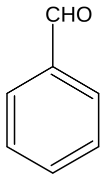
+ $CHBr_3$

(B) 

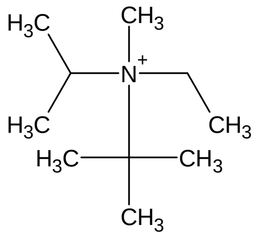
+ $CH_3CO\bar{O}Na^+$

(C) 

+ CH_3COONa

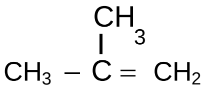
(D) 

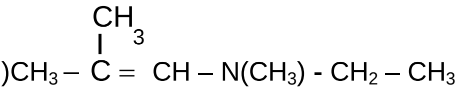
+ $CH_3CO\bar{O}Na^+$

14. 
H3C
CH3
N+
H3C
CH3
H3C
CH3
CH3
$\xrightarrow{\Delta, OH^-}$ A(alone), A is

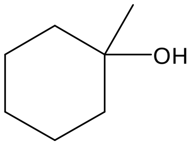
(A) $CH_2 = CH_2$

(B) $CH_3 - CH = CH_2$

(C) 
$CH_3 - \overset{\overset{\displaystyle CH_3}{|}}{C} = CH_2$

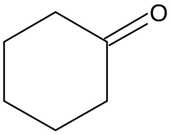
(D) 
$CH_3 - \overset{\overset{\displaystyle CH_3}{|}}{C} = CH - N(CH_3) - CH_2 - CH_3$

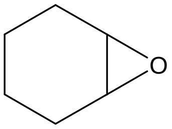
Space for Rough work

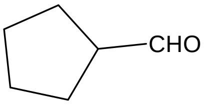
15. (A) $\xrightarrow[\text{(ii)}H_3O^+]{\text{(i)}CH_3MgI}$ 

$C_6H_{10}O$

The structure of the compound (A) is

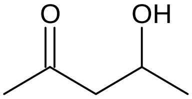
(A) 

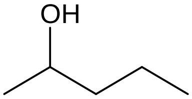
(B) 

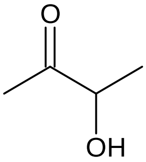
(C) 

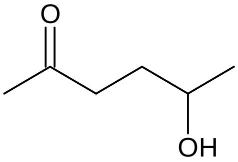
(D) All the above

16. Which one of the following will most readily be dehydrated in acidic condition?

(A) 

(B) 

(C) 

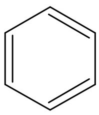
(D) 

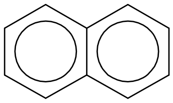
17. At Temperature T, a compound $AB_2(g)$ dissociates according to the reaction.
$2AB_2(g) \rightleftharpoons 2AB(g) + B_2(g)$ with a degree of dissociation ‘x’, which is small compared to unity. Then the expression for ‘x’ is: [k_p is equilibrium constant, P is total pressure].

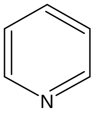
(A) $\left(2k_p/P\right)^3$
(B) $\left(2k_p/P\right)^2$
(C) $\left(2k_p/P\right)^{\frac{1}{3}}$
(D) $\left(2k_p/P\right)^{\frac{1}{2}}$

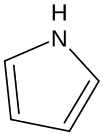
Space for Rough work

18. Which of the following is most reactive towards electrophilic aromatic substitution

(A) 

(B) 

(C) 

(D) 

19. Consider the reaction

$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)} + \text{Heat}$$

What will happen if 0.5 mole of Helium gas is introduced into the vessel so that the temperature and pressure remain constant?

(A) the equilibrium will shift to right
(B) the equilibrium will shift to left
(C) no change
(D) equilibrium constant will increase

20. The bond angle around central atom is highest in

(A) BBr_3
(B) CS_2
(C) SO_2
(D) SF_4

21. Acetone an heating with conc. H_2SO_4 mainly gives

(A) Mesitylene
(B) Mesityl oxide
(C) Toluene
(D) Xylene

22. Which is not dissolved by dil. HCl?

(A) ZnS
(B) MnS
(C) $BaSO_3$
(D) $BaSO_4$

Space for Rough work

23. When electricity is passed through aqueous solution of aluminium chloride, 13.5g of Al are deposited. The number of faradays of electricity passed must be

(A) 2	(B) 1.5
(C) 1.0	(D) 0.5

24. Which one of the following statement is incorrect?
(A) A solution freezes at lower temperature than the pure solvent.
(B) A solution boils at a higher temperature than the pure solvent.
(C) 0.1 M NaCl solution and 0.1M sugar solution have the same boiling point.
(D) Osmosis cannot take place without a semi permeable membrane.

25. The metallurgical process in which a metal is obtained in a fused state is called

(A) Smelting	(B) Roasting
(C) Calcination	(D) Froth floatation

26. Which one of the following doesn't react with NH_3?

(A) Benzaldehyde	(B) Acetone
(C) Formaldehyde	(D) Glucose

27. The pair of compound which cannot exist together in solution is

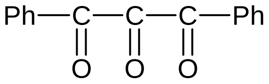
(A) $NaHCO_3$ and NaOH	(B) Na_2CO_3 and $NaHCO_3$
(C) Na_2CO_3 and NaOH	(D) $NaHCO_3$ and NaCl

28. X^+Y^- crystallises in a bcc lattice in which the radius of $X^+ = 0.4\overset{o}{A}$. If all the X^+ ions are removed and another cation Z^+ is inserted, what should be the maximum radius of the cation Z^+ to crystallise in a fcc lattice with Y^-:

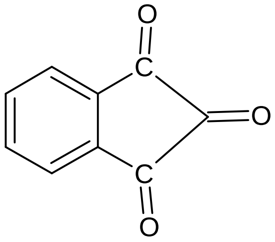
(A) $0.546\overset{o}{A}$	(B) $0.010\overset{o}{A}$
(C) $0.400\overset{o}{A}$	(D) $0.226\overset{o}{A}$

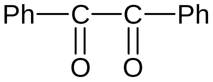
Space for Rough work

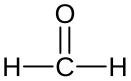
29. Which will form(s) stable gem-diol:

(I) 
$Ph-\underset{\underset{O}{\|}}{C}-\underset{\underset{O}{\|}}{C}-\underset{\underset{O}{\|}}{C}-Ph$

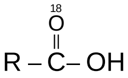
(II) CCl_3CHO

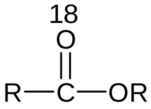
(III) 

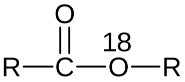
(IV) 
$Ph-\underset{\underset{O}{\|}}{C}-\underset{\underset{O}{\|}}{C}-Ph$

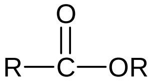
(V) 
$H-\overset{\overset{O}{\|}}{C}-H$

(A) I, II, III, V only
(B) I, II, III, IV only
(C) II, III, IV only
(D) II, III, IV, V only

30. The reaction of  $R-\overset{\overset{^{18}O}{\|}}{C}-OH$ with H^+/ROH will give:

(I) 
$R-\overset{\overset{^{18}O}{\|}}{C}-OR$

(II) 
$R-\overset{\overset{O}{\|}}{C}-\overset{18}{O}-R$

(III) 
$R-\overset{\overset{O}{\|}}{C}-OR$

(A) I, II only
(B) I, III only
(C) I, II and III only
(D) I only

Space for Rough work

Mathematics

PART – III

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. If the graph of the function $f(x) = \dfrac{a^x - 1}{x^n(a^x + 1)}$ is symmetrical about y–axis, then n equals

(A) 2 (B) $\dfrac{2}{3}$

(C) $\dfrac{1}{4}$ (D) $-\dfrac{1}{3}$

2. $\lim\limits_{x\to\infty} \dfrac{\cot^{-1}\left(x^{-a}\log_a x\right)}{\sec^{-1}\left(a^x \log_a a\right)}$ (a > 1) is equal to

(A) 2 (B) 1

(C) $\log_a 2$ (D) 0

3. If $f(x) = \begin{cases} \sin x & , \quad x < 0 \\ \cos x - |x - 1| & , \quad x \ge 0 \end{cases}$ then g(x) = f(|x|) is non–differentiable for

(A) no value of x (B) exactly one value of x

(C) exactly 3 values of x (D) none of these

4. The radius of a right circular cylinder increases at the rate of 0.1 cm/min, and the height decreases at the rate of 0.2 cm/min. The rate of change of the volume of the cylinder, in cm^3/min, when the radius is 2 cm and the height is 3 cm is

(A) -2π (B) $-\dfrac{8\pi}{5}$

(C) $-\dfrac{3\pi}{5}$ (D) $\dfrac{2\pi}{5}$

Space for rough work

5. If 3(a + 2c) = 4(b + 3d), then the equation $ax^3 + bx^2 + cx + d = 0$ will have
(A) no real solution
(B) at least one real root in (–1, 0)
(C) at least one real root in (0, 1)
(D) none of these

6. If f : R → R and g : R → R are two functions such that $f(x) + f''(x) = -x\,g(x)f'(x)$ and $g(x) > 0\ \forall\ x \in$ R, then the functions $f^2(x) + (f'(x))^2$ has
(A) a maxima at x = 0
(B) a minima at x = 0
(C) a point of inflection at x = 0
(D) none of these

7. The fuel charges for running a train are proportional to the square of the speed generated in km per hour, and the cost is Rs. 48 at 16 km per hour. If the fixed charges amount to Rs. 300 per hours, the most economical speed is
(A) 60 kmph
(B) 40 kmph
(C) 48 kmph
(D) 36 kmph

8. If the function $f(x) = \frac{t + 3x - x^2}{x - 4}$, where t is a parameter that has a minimum and maximum, then the range of values of t is
(A) (0, 4)
(B) (0, ∞)
(C) (–∞, 4)
(D) (4, ∞)

9. If $4\hat{i} + 7\hat{j} + 8\hat{k}$, $2\hat{i} + 3\hat{j} + 4\hat{k}$ and $2\hat{i} + 5\hat{j} + 7\hat{k}$ are the position vectors of the vertices A, B and C, respectively, of triangle ABC, the position vector of the point where the bisector of angle A meets BC, is
(A) $\frac{2}{3}\left(-6\hat{i} - 8\hat{j} - 6\hat{k}\right)$
(B) $\frac{2}{3}\left(6\hat{i} + 8\hat{j} + 6\hat{k}\right)$
(C) $\frac{1}{3}\left(6\hat{i} + 13\hat{j} + 18\hat{k}\right)$
(D) $\frac{1}{3}\left(5\hat{j} + 12\hat{k}\right)$

10. $\vec{a} = 2\hat{i} - \hat{j} + \hat{k}$, $\vec{b} = \hat{i} + 2\hat{j} - \hat{k}$, $\vec{c} = \hat{i} + \hat{j} - 2\hat{k}$. A vector coplanar with $\vec{b}$ and $\vec{c}$ whose projection on $\vec{a}$ is magnitude $\sqrt{\frac{2}{3}}$ is
(A) $2\hat{i} + 3\hat{j} - 3\hat{k}$
(B) $-2\hat{i} - \hat{j} + 5\hat{k}$
(C) $2\hat{i} + 3\hat{j} + 3\hat{k}$
(D) $2\hat{i} + \hat{j} + 5\hat{k}$

Space for rough work

11. If $|\vec{a}| = 2$, $|\vec{b}| = 3$ and $\vec{a}\cdot\vec{b} = 0$, then $\left(\vec{a}\times\left(\vec{a}\times\left(\vec{a}\times\left(\vec{a}\times\vec{b}\right)\right)\right)\right)$ is equal to

(A) $48\hat{b}$
(B) $-48\hat{b}$
(C) $48\hat{a}$
(D) $-48\hat{a}$

12. If $\vec{r} = x_1\left(\vec{a}\times\vec{b}\right) + x_2\left(\vec{b}\times\vec{a}\right) + x_3\left(\vec{c}\times\vec{d}\right)$ and $4\left[\vec{a}\ \vec{b}\ \vec{c}\right] = 1$, then $x_1 + x_2 + x_3$ is equal to

(A) $\frac{1}{2}\vec{r}\cdot\left(\vec{a}+\vec{b}+\vec{c}\right)$
(B) $\frac{1}{4}\vec{r}\cdot\left(\vec{a}+\vec{b}+\vec{c}\right)$
(C) $2\vec{r}\cdot\left(\vec{a}+\vec{b}+\vec{c}\right)$
(D) $4\vec{r}\cdot\left(\vec{a}+\vec{b}+\vec{c}\right)$

13. The point of intersection of the line passing through (0, 0, 1) and intersecting the lines $x + 2y + z = 1$, $-x + y - 2z = 2$ and $x + y = 2$, $x + z = 2$ with xy plane is

(A) $\left(\frac{5}{3}, -\frac{1}{3}, 0\right)$
(B) (1, 1, 0)
(C) $\left(\frac{2}{3}, -\frac{1}{3}, 0\right)$
(D) $\left(-\frac{5}{3}, \frac{1}{3}, 0\right)$

14. The lines which intersect the skew lines $y = mx$, $z = c$; $y = -mx$, $z = -c$ at the x–axis lies on the surface

(A) $cz = mxy$
(B) $xy = cmz$
(C) $cy = mxz$
(D) none of these

15. A light ray gets reflected from the line $x = -2$. If the reflected ray touches the circle $x^2 + y^2 = 4$ and point of incidence is (–2, –4), the equation of incident ray is

(A) $4y + 3x + 22 = 0$
(B) $3y + 4x + 20 = 0$
(C) $4y + 2x + 20 = 0$
(D) $y + x + 6 = 0$

Space for Rough work

16. If S_1 and S_2 are the foci of the hyperbola whose transverse axis length is 4 and conjugate axis length is 6, S_3 and S_4 are the foci of the conjugate hyperbola, then the area of the quadrilateral $S_1S_2S_3S_4$ is

(A) 24
(B) 26
(C) 22
(D) none of these

17. $\sum_{r=1}^{n} \sin^{-1}\left(\frac{\sqrt{r}-\sqrt{r-1}}{\sqrt{r(r+1)}}\right)$ is equal to

(A) $\tan^{-1}(\sqrt{n})-\frac{\pi}{4}$
(B) $\tan^{-1}(\sqrt{n+1})-\frac{\pi}{4}$
(C) $\tan^{-1}(\sqrt{n})$
(D) $\tan^{-1}(\sqrt{n+1})$

18. In triangle ABC, a = 5, b = 4 and c = 3. G is the centroid of the triangle. Circumradius of triangle GAB is equal to

(A) $2\sqrt{13}$
(B) $\frac{5}{12}\sqrt{13}$
(C) $\frac{5}{3}\sqrt{13}$
(D) $\frac{3}{2}\sqrt{13}$

19. 1, z_1, z_2, z_3, ….., z_{n-1} are the nth roots of unity, then the value of $\frac{1}{3-z_1}+\frac{1}{3-z_2}+.....+\frac{1}{3-z_{n-1}}$ is equal to

(A) $\frac{n\cdot 3^{n-1}}{3^n-1}+\frac{1}{2}$
(B) $\frac{n\cdot 3^{n-1}}{3^n-1}-1$
(C) $\frac{n\cdot 3^{n-1}}{3^n-1}+1$
(D) none of these

Space for Rough work

20. $\lim\limits_{n\to\infty}\sum\limits_{r=1}^{n}\frac{r}{1\times3\times5\times7\times.....\times(2r+1)}$ is equal to

(A) $\frac{1}{3}$
(B) $\frac{3}{2}$
(C) $\frac{1}{2}$
(D) none of these

21. If n integers taken at random are multiplied together then the probability that the last digit of the product is 1, 3, 7 or 9 is

(A) $\frac{2^n}{5^n}$
(B) $\frac{4^n-2^n}{5^n}$
(C) $\frac{4^n}{5^n}$
(D) none of these

22. The number of distinct real roots of $\begin{vmatrix}\sin x & \cos x & \cos x\\ \cos x & \sin x & \cos x\\ \cos x & \cos x & \sin x\end{vmatrix}=0$ in the interval $-\frac{\pi}{4}\le x\le\frac{\pi}{4}$ is

(A) 0
(B) 2
(C) 1
(D) 3

23. Area of the region bounded by the curves $y = 2^x$, $y = 2x - x^2$, $x = 0$ and $x = 2$ is given by

(A) $\frac{3}{\log 2}-\frac{4}{3}$
(B) $\frac{3}{\log 2}+\frac{4}{3}$
(C) $3\log 2-\frac{4}{3}$
(D) none of these

24. $\sim[(\sim p)\wedge q]$ is equal to

(A) $p \vee (\sim q)$
(B) $p \vee q$
(C) $p \wedge (\sim q)$
(D) $\sim p \wedge \sim q$

Space for Rough work

25. The angle of elevation of the top of the tower observed from each of the three points A, B, C on the ground, forming a triangle is the same angle α. If R is the circum–radius of the ΔABC, then the height of the tower is

(A) $R \sin \alpha$ (B) $R \cos \alpha$
(C) $R \cot \alpha$ (D) $R \tan \alpha$

26. The mean of two samples of size 200 and 300 were found to be 25, 10 respectively. Their standard deviations were 3 and 4 respectively. The variance of combined sample of size 500 is

(A) 64 (B) 65.2
(C) 67.2 (D) 64.2

27. If $I = \int_0^{\pi/2} \frac{dx}{\sqrt{1+\sin^3 x}}$, then

(A) $I \ge \frac{\pi}{2}$ (B) $I \ge \frac{\pi}{2\sqrt{2}}$
(C) $I \le \frac{\pi}{2\sqrt{2}}$ (D) none of these

28. The solution of $x = 1 + \left(xy\frac{dy}{dx}\right) + \frac{x^2y^2}{2!}\left(\frac{dy}{dx}\right)^2 + \frac{(xy)^3}{3!}\left(\frac{dy}{dx}\right)^3 + ...$ is

(A) $y = \ln x + c$ (B) $y = (\ln x)^2 + c$
(C) $y = \pm\sqrt{(\ln x)^2 + c}$ (D) none of these

29. A parabola $y = ax^2 + bx + c$ crosses the x–axis at $(\alpha, 0)$ and $(\beta, 0)$ both to the right of the origin. A circle also passes through these two points. The length of a tangent from the origin to the circle is

(A) $\sqrt{\frac{bc}{a}}$ (B) ac^2
(C) $\frac{b}{a}$ (D) $\sqrt{\frac{c}{a}}$

30. If $f(x) = 1 - x + x^2 - x^3 + ... - x^{15} + x^{16} - x^{17}$, then the coefficient of x^2 in $f(x - 1)$ is

(A) 826 (B) 816
(C) 822 (D) none of these

Space for rough work

FIITJEE

JEE(Advanced), 2014

FULL TEST – I

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 243**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-B**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 09)** contains 09 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (10 – 13) contains 4 Assertion-Reasoning (multiple choice questions) which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (14 – 19) contains 2 paragraphs. Based upon paragraph, 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-B (1 – 03)** contains 3 Matrix Match Type (4 × 4 Matrix) questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+6 marks** for all correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

ALL INDIA TEST SERIES

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

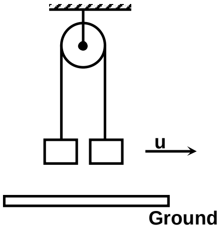
Physics PART – I

SECTION – A

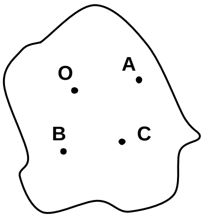
Single Correct Choice Type

This section contains **9 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

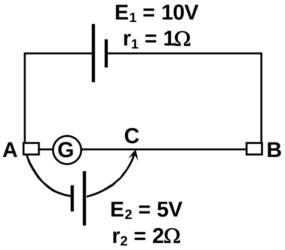
1. Two equal masses hang on either side of a pulley at the same height from the ground. The mass on the right is given a horizontal speed, after some time.
(A) The mass on the left will be nearer to ground.
(B) The mass on the right will be nearer to ground.
(C) Both the masses will be at equal distance from the ground.
(D) Nothing can be said regarding their positions.



2. O is the centre of mass of a body of mass M as shown in the figure. A, B, C are three different point on the body. OB = 8 cm, OC = 10 cm, BC = 6 cm and OA = 10 cm. Which of the following can be written by using parallel axis theorem? I_0 is the moment of inertia about the axis passing through point O and perpendicular to plane of object.
(A) $I_B = I_C + M(BC)^2$
(B) $I_C = I_B + M(BC)^2$
(C) $I_A = I_0 + M(OB)^2$
(D) None of these

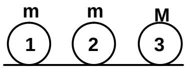


3. For the potentiometer arrangement shown in the figure, length of wire AB is 100 cm and its resistance is 9Ω. Find the length AC for which the galvanometer G will show zero deflection.
(A) 66.7 cm
(B) 60 cm
(C) 50 cm
(D) 33.3 cm



Space for rough work

4. Two balls marked 1 and 2 of the same mass m and a third ball marked 3 of mass M are arranged over a smooth horizontal surface as shown in the figure. Ball 1 moves with a velocity v_1 towards balls 2. All collisions are assumed to be elastic. If M < m the number of collisions between the balls will be



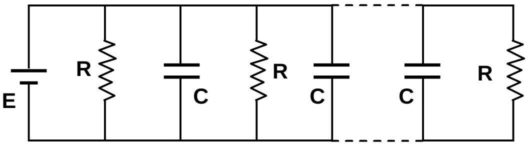
(A) 1 (B) 2
(C) 3 (D) 4

5. An electron and a proton are separated by a large distance and the electron approaches the proton with K.E. of 2 eV. If the electron is captured by the proton to form a hydrogen atom in the ground state, wavelength of photon emitted will be
(A) 793 Å (B) 1096 Å
(C) 704.5 Å (D) 1291.6 Å

6. A metallic surface is irradiated with monochromatic light of variable wavelength. Above a wavelength of 5000 Å, no photoelectrons are emitted from the surface. With an unknown wavelength, a stopping potential of 3 V is necessary to eliminate the photo current. The unknown wavelength is
(A) 2258Å (B) 4133 Å
(C) 3126 Å (D) 2679 Å

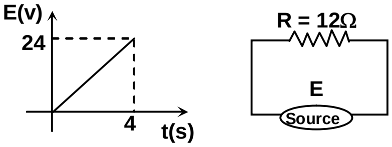
7. An electric bulb of 100 W – 300 V is connected with an A.C. supply of 500 V and 150/π Hz. The required inductance to save the electric bulb is
(A) 2H (B) $\frac{1}{2}$H
(C) 4 H (D) $\frac{1}{4}$H

8. n resistances each of resistance R are joined with capacitors of capacity C (each) and a battery of emf E as shown in the figure. In steady state condition ratio of charge stored in the first and last capacitor is



(A) n : 1 (B) (n – 1) : R
(C) $(n^2 + 1) : (n^2 – 1)$ (D) 1 : 1

9. A resistance R = 12 Ω is connected across a source of emf as shown in the figure. Its emf changes with time as shown in the graph. What is the heat developed in the resistance in the first four seconds?



(A) 72 J (B) 64 J
(C) 108 J (D) 100 J

Space for rough work

Assertion - Reasoning Type

This section contains 4 questions numbered 10 to 13. Each question contains **STATEMENT-1 (Assertion)** and **STATEMENT-2 (Reason)**. Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

10. STATEMENT-1: In a certain frame if the work done by all the real force is zero then the change in kinetic energy may not be zero.
and

STATEMENT-2: To apply work energy theorem in non inertial frames one must also consider the work done by the pseudo force.

(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

11. STATEMENT-1: If a block of mass M is made to slide along a circular path on a rough horizontal surface then frictional force must be acting in a centripetal direction.
and

STATEMENT-2: Kinetic friction acts always opposite to the direction of relative velocity.

(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

Space for rough work

12. STATEMENT-1: For expansion of one mole of a gas isobarically from one temperature to another, the ratio of ΔQ and ΔW is depends on γ
and

STATEMENT-2: Difference between C_P and C_V for all ideal gases is R.
(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

13. STATEMENT-1: Current in a phototube is independent of applied voltage.
and

STATEMENT-2: Saturation current in a phototube depends on intensity of incident light.
(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

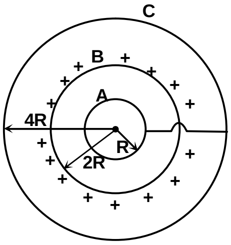
Space for rough work

Comprehension Type

This section contains 2 groups of questions. Each group has **3 multiple choice question** based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 14 to 16

Three concentric spherical conductors A, B and C of radii R, 2R and 4R respectively. A and C is shorted and B is uniformly charged (charge +Q)



14. Charge on conductor A is
(A) Q/3
(B) –Q/3
(C) 2Q/3
(D) None of these

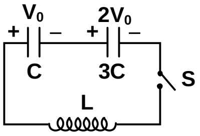
15. Potential at A is
(A) $\frac{Q}{4\pi\varepsilon_0 R}$
(B) $\frac{Q}{16\pi\varepsilon_0 R}$
(C) $\frac{Q}{20\pi\varepsilon_0 R}$
(D) None of these

16. Potential at B is
(A) $\frac{Q}{4\pi\varepsilon_0 R}$
(B) $\frac{Q}{16\pi\varepsilon_0 R}$
(C) $\frac{5Q}{48\pi\varepsilon_0 R}$
(D) None of these

Space for rough work

Paragraph for Question Nos. 17 to 19

Two capacitors of capacitance C and 3C are charged to potential difference V_0 and $2V_0$ respectively and connected to an inductor of inductance L as shown in the figure. Initially the current in the inductor is zero. Now the switch S is closed.



17. The maximum current in the inductor is

(A) $\frac{3V_0}{2}\sqrt{\frac{3C}{L}}$ (B) $V_0\sqrt{\frac{3C}{L}}$

(C) $2V_0\sqrt{\frac{3C}{L}}$ (D) $V_0\sqrt{\frac{C}{L}}$

18. Potential difference across capacitor of capacitance C when the current in the circuit is maximum

(A) $\frac{CV_0}{4}$ (B) $\frac{3CV_0}{4}$

(C) $\frac{5CV_0}{4}$ (D) None of these

19. Potential difference across capacitor of capacitance 3C when the current in the circuit is maximum

(A) $\frac{CV_0}{4}$ (B) $\frac{3CV_0}{4}$

(C) $\frac{5CV_0}{4}$ (D) None of these

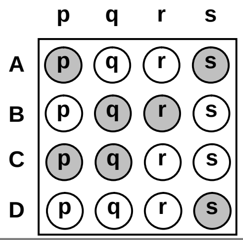
Space for rough work

SECTION - B

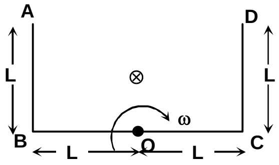
Matrix – Match Type

This section contains 3 questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in column I have to be matched with statements (p, q, r, s) in column II. The answers to these questions have to be appropriately bubbled as illustrated in the following example.

If the correct match are A-p, A-s, B-q, B-r, C-p, C-q and D-s, then the correctly bubbled 4 × 4 matrix should be as follows:

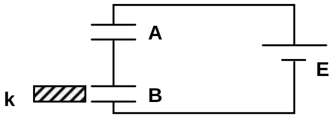


1. A frame ABCD is rotating with angular velocity ω about an axis which passes through the point O perpendicular to the plane of paper as shown in the figure. A uniform magnetic field $\vec{B}$ is applied into the plane of the paper in the region as shown. Match the following.



Column – I	Column – II
(A) Potential difference between A and O	(p) zero
(B) Potential difference between O and D	(q) $B\omega L^2/2$
(C) Potential difference between C and D	(r) $B\omega L^2$
(D) Potential difference between A and D	(s) constant

2. When a dielectric slab is inserted between the plates of one of the two identical capacitors shown in the figure, then match the following.



Column – I	Column – II
(A) Charge on A	(p) increases
(B) Potential difference across A	(q) decreases
(C) Potential difference across B	(r) remains constant
(D) Charge on B	(s) will change

3. Match the following.

Column – I	Column – II
(A) Concave mirror, real object	(p) real image
(B) Convex mirror, real object	(q) virtual image
(C) Concave lens, real object	(r) magnified image
(D) Convex lens, real object	(s) diminished image

Space for rough work

Chemistry

PART – II

SECTION – A

Straight Objective Type

This section contains **09 multiple choice questions** numbered 1 to 9. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Given the data at 25°C

$Ag + I^- \longrightarrow AgI + e^-$ $E^o = 0.152$ V

$Ag \longrightarrow Ag^+ + e$ $E^o = -0.800$ V

What is the value of $\log K_{SP}$ for AgI?
(2.303 RT/F = 0.059 V)

(A) - 37.83 (B) - 16.13
(C) - 8.12 (D) + 8.612

2. The oxidation of certain metal is found to obey the equation $A^2 = \alpha t + \beta$. Where A is the thickness of the metal oxide film at time t, α and β are constants. The order of this reaction is:

(A) 0 (B) 1
(C) -1 (D) 12

3. In an ionic compound AB the radii of A^+ and B^- ions are 1.0 pm and 2.0 pm respectively. The volume of the unit cell of the crystal AB will be

(A) 27 pm^3 (B) 64 pm^3
(C) 125 pm^3 (D) 216 pm^3

4. In the equilibrium : $BaF_2(s) \rightleftharpoons Ba^{2+}(aq) + 2F^-(aq)$, if $[Ba^{2+}]$ is increased two times, then $[F^-]$ in solution will:

(A) increase two times (B) increase four times
(C) decrease two times (D) decrease $\frac{1}{\sqrt{2}}$ times

5. Which of the following does not involve innershell hybridisation:

(A) $\left[Co(F)_6\right]^{3-}$ (B) $\left[Co(CN)_6\right]^{3-}$
(C) $\left[Fe(CN)_6\right]^{4-}$ (D) $\left[Ni(NH_3)_6\right]^{2+}$

Rough Work

6. Pick up the incorrect statement

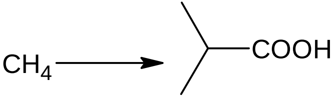
(A) Bond length N_2^+ > bond length N_2

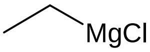
(B) Bond length of NO^+ < bond length of NO

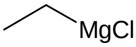
(C) Bond length of CN^- < bond length of CN

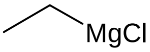
(D) Bond length of CO < bond length of CO^+

7. Which of the following is the correct option of reagent for the given conversion?



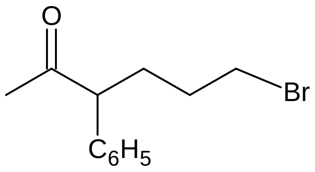
(A) $Br_2 / h\nu$, , $Br_2 / h\nu$, HCOOH

(B) $Cl_2 / h\nu$, , $Br_2 / h\nu$, KCN / H_3O^+

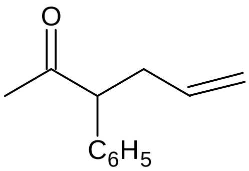
(C) $Br_2 / h\nu$, , $Br_2 / h\nu$, $NaNH_2$, HCN, H_3O^+

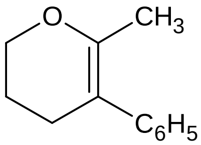
(D) $Cl_2 / h\nu$, CH_3MgBr, $Br_2 / h\nu$, CH_3COOH

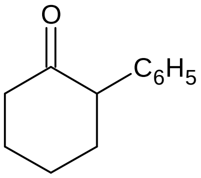
Rough Work

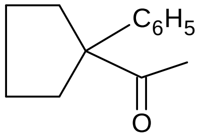
8. 

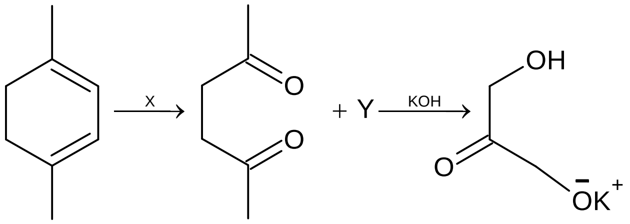
$\xrightarrow[\text{DMSO}]{CH_3CH_2ONa}$ Major product

(A) 

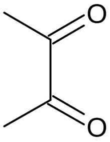
(B) 

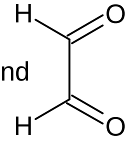
(C) 

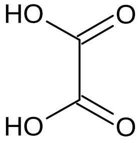
(D) 

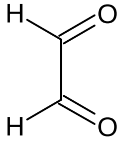
9. 
X
O
O
+ Y
KOH
OH
O
OK+

Identify 'X' and 'Y' of the above reaction:

(A) O_3 / Ag_2O and 

(B) O_3 / Zn – H_2O and 

(C) $KMnO_4$ and 

(D) $KMnO_4$ and 

Rough Work

Reasoning Type

This section contains 4 questions numbered 10 to 13. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

10. STATEMENT-1: $[Fe(CN)_6]^{3-}$ is weakly paramagnetic while $[Fe(CN)_6]^{4-}$ is diamagnetic

and

STATEMENT-2: Both $[Fe(CN)_6]^{3-}$ and $[Fe(CN)_6]^{4-}$ involve d^2sp^3 hybridisation. In rearranging electrons in d-orbitals one d-orbital is singly occupied in $[Fe(CN)_6]^{3-}$ and all d-orbitals are doubly occupied in $[Fe(CN)_6]^{4-}$.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

11. STATEMENT-1: $AlCl_3$ forms dimer Al_2Cl_6 but it dissolves in water forming $[Al(H_2O)_6]^{3+}$ and Cl^- ions.

and

STATEMENT-2: Aqueous solution of $AlCl_3$ is acidic due to hydrolysis.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

Rough Work

12. STATEMENT-1: In acidic medium Zn^{2+} is not precipitated by S^{2-} ions.

and

STATEMENT-2: Common ion effect reduces the concentration of S^{2-} ions to the minimum level.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

13. STATEMENT-1: In acidic medium, an amino acid migrates to cathode.

and

STATEMENT-2: Zwitter ion of the amino acid changes to cation in acidic medium thus migrates to cathode.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

Rough Work

Comprehension Type

This section contains 2 groups of questions. Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 14 to 16

Concrete is produced from a mixture of cement, water, sand and small stones. It consists primarily of calcium silicates and calcium aluminates formed by heating and grinding of clay and limestone. In later steps of cement production a small amount of gypsum, $CaSO_4.2H_2O$ is added to improve subsequent hardening of concrete. The use of elevated temperatures during the final production may lead to formation of unwanted hemihydrate, $CaSO_4.1/2H_2O$. Consider the following reaction:

$$CaSO_4.2H_2O(s) \longrightarrow CaSO_4.\frac{1}{2}H_2O(s) + \frac{3}{2}H_2O(g)$$

The following thermodynamic data apply at 25°C, standard pressure: 1 bar

Compound	$\Delta H^o_{f(kJ/mol)}$	$S^o(JK^{-1}\ mol^{-1})$
$CaSO_4.2H_2O(s)$	- 2021.0	194.0
$CaSO_4.\frac{1}{2}H_2O(s)$	- 1575.0	130.5
$H_2O(g)$	- 241.8	188.6

$R = 8.314\ JK^{-1}\ mol^{-1}$

14. ΔH^o for the formation of 1.00 kg of $CaSO_4.\frac{1}{2}H_2O(s)$ from $CaSO_4.2H_2O(s)$ is

(A) + 446 kJ (B) + 484 kJ
(C) - 446 kJ (D) - 484 kJ

15. Equilibrium pressure (in bar) of water vapour in closed vessel containing $CaSO_4.2H_2O(s)$, $CaSO_4.\frac{1}{2}H_2O(s)$, $H_2O(g)$ at 25°C

(A) 17.35×10^{-4} bar (B) 2.15×10^{-4} bar
(C) 8.10×10^{-3} bar (D) 7.00×10^{-4} bar

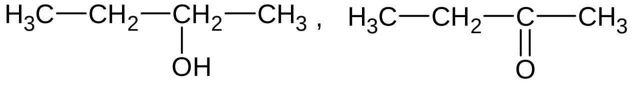
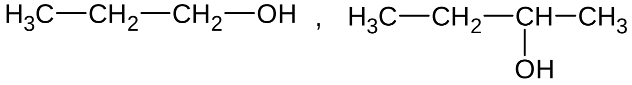
16. Temperature at which the equilibrium water vapour pressure is 1.00 bar

(A) 107°C (B) 380°C
(C) 215°C (D) 240°C

Rough Work

Paragraph for Question Nos. 17 to 19

A research scholar synthesised alcohol by hydration of 1-butene. He was unaware of the fact that the vessel he used had some coating of a metal and in addition to alcohol (b.p. 100^{o}C) he also got compound (X). X (b.p. 80^{o}C) formsbisulphate compound as well as 2,4-dinitrophenylhydrazo. He honour, was successful in the separation, based on physical and chemical properties. Read the above technical report and answer the following questions.

17. Which alcohol does research scholar want to sysnthesise and what is the other product?
(A) $CH_3-CH_2CH_2CH_2OH$, $CH_3CH_2-CH_2-CHO$
(B)

$H_3C-CH_2-\underset{\underset{OH}{|}}{CH_2}-CH_3$, $H_3C-CH_2-\underset{\underset{O}{\|}}{C}-CH_3$
(C)

$H_3C-CH_2-CH_2-OH$, $H_3C-CH_2-\underset{\underset{OH}{|}}{CH}-CH_3$
(D) $CH_3-CH_2-CH_2-CH_2-OH$, $CH_3-CH_2-CH=CH_2$

18. He also got yellow precipitate on heating with NaOH/I_2. This yellow ppt. is due to
(A) alcohol and side product both
(B) side product only
(C) alcohol only
(D) none of the above

19. Carbonyl compound can be converted into required alcohol by
(A) Clemmensen reduction
(B) Wolf-Kishner reduction
(C) $LiAlH_4$
(D) All of the above

Rough Work

SECTION-B
(Matrix Type)

This section contains 3 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

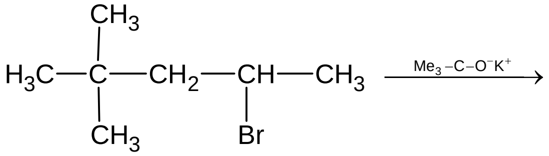
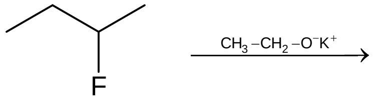
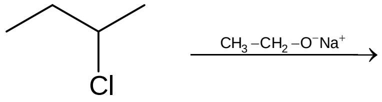
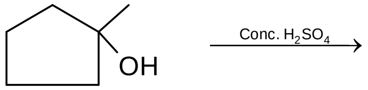
If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the Column – I with Column – II:

	Column – I		Column – II
(A)	0.1 M glucose sol.	(p)	Lowest freezing point
(B)	0.1 M sucrose sol.	(q)	Highest freezing point
(C)	0.1 M $BaCl_2$ sol.	(r)	Lowest osmotic pressure
(D)	0.1 M $Ca(NO_3)_2$ sol.	(s)	Highest atmospheric pressure

2. Match the Column – I with Column – II:

	Column – I		Column – II
(A)	 $H_3C-C(CH_3)_2-CH_2-CH(Br)-CH_3 \xrightarrow{Me_3-C-O^-K^+}$	(p)	p-Saytzeff's product
(B)		(q)	q-Carbocation
(C)		(r)	r-E_2 elimination
(D)		(s)	s-Hoffmann product

3. Match the reactions of metals with dilute HNO_3 (in Column – I) with the nitrogen compounds obtained by oxidation/reduction (in Column – II):

	Column – I		Column – II
(A)	Mg + dil. HNO_3	(p)	NO
(B)	Zn + dil. HNO_3	(q)	H_2
(C)	Sn + dil. HNO_3	(r)	N_2O
(D)	Pb + dil. HNO_3	(s)	NH_4NO_3

Rough Work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **9 multiple choice questions** numbered 1 to 9. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Consider two circles $x^2 + y^2 = 1$ and $(x - 1)^2 + (y - 1)^2 = 3$ then the point circle which is orthogonal to the given two circles can be

(A) $\left(x-\frac{1}{2}\right)^2+\left(y-\frac{1}{2}\right)^2=0$ (B) $\left(x-\frac{1}{\sqrt{2}}\right)^2+\left(y-\frac{1}{\sqrt{2}}\right)^2=0$

(C) $(x - 1)^2 + (y - 1)^2 = 0$ (D) none of these

2. Consider a 9 sided regular polygon then the probability that if 3 vertices are selected at random the triangle so formed will contain the centre of the polygon is

(A) $\frac{5}{14}$ (B) $\frac{1}{2}$

(C) $\frac{11}{14}$ (D) none of these

3. The range of m for which the line $z(1 - mi) - \bar{z}(1 + mi) = 0$ divides two chords drawn from point $z_1 = \sqrt{3} + i$ to the curve $|z| = 2$ in the ratio 1 : 2 is

(A) $\left(0, \sqrt{3}\right)$ (B) (1, 2)

(C) $\left(\frac{1}{\sqrt{3}}, 1\right)$ (D) none of these

4. Consider the equation $x^4 - ax^3 - bx^2 - cx - d = 0$, a, b, c, d $\in I^+$, $a \geq b \geq c \geq d$ then, the number of integral solutions are

(A) 0 (B) 4

(C) 2 (D) none of these

Space for rough work

5. Consider a function f : X → R such that $f(x)=\log_{|x-1|-|x+1|-\frac{1}{2}}\left[\left(x^2-x+\frac{1}{2}\right)^{x^2-3x+2}-1\right]$ then the exhaustive set X can be

(A) $\left[1,\ \frac{5}{4}\right]$

(B) $\left(-\infty,\ -\frac{1}{4}\right)$

(C) $\left(-\infty,\ -\frac{1}{4}\right)-\left\{-\frac{3}{4}\right\}$

(D) none of these

6. For the given curve, x = a cos t + $\frac{1}{2}$ a ln $\tan^2\frac{t}{2}$; y = a sin t the area bounded by the curve is

(A) $\frac{\pi}{2}a^2$

(B) πa^2

(C) $2\pi a^2$

(D) none of these

7. Consider a 3–D figure represented as $xyz^2 = 2$ then its minimum distance from origin is

(A) 2

(B) 4

(C) 8

(D) none of these

8. Consider curve, $r^2 = a \sin 2\theta$ then its orthogonal trajectory is

(A) $r^2 = c$

(B) $r^2 = c \sin \theta$

(C) $r^2 = c \cos 2\theta$

(D) none of these

9. If the equation $x^3+bx^2+cx+1=0$, $(b<c)$, has only one real root α. Then the value of $2\tan^{-1}(\operatorname{cosec}\alpha)+\tan^{-1}\left(2\sin\alpha\sec^2\alpha\right)$, is

(A) $-\pi$

(B) $-\frac{\pi}{2}$

(C) $\frac{\pi}{2}$

(D) π

Space for rough work

Reasoning Type

This section contains **4 questions** numbered 10 to 13. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

10. STATEMENT 1: Consider a function $f(z) = \frac{1}{1+z^2}$ where $z \in$ complex number then, f(z) is continuous inside a unit circle centred at origin.
STATEMENT 2: $|z| \neq 1$ if f(z) is continuous.
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

11. STATEMENT 1: f(z) = Re(z) is a function where $z \in$ complex number then f(z) is continuous but not differentiable
STATEMENT 2: $\lim\limits_{\substack{\Delta x \to 0 \\ \Delta y \to 0}} \frac{f(z+\Delta z) - f(z)}{\Delta z} = \lim\limits_{\substack{\Delta y \to 0 \\ \Delta x \to 0}} \frac{f(z+\Delta z) - f(z)}{\Delta z}$ for any point z
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

12. STATEMENT 1: If $y = \sin(m \sin^{-1} x)$ then $(1 - x^2)y_{n+2} - (2n + 1)xy_{n+1} + (n^2 - m^2)y_n = 0$ [y_n is nth derivative of y w.r.t. x]
STATEMENT 2: $\frac{d^n}{dx^n}[u(x)v(x)] = u_n v_0 + {}^nC_1 u_{n-1} v_1 + {}^nC_2 u_{n-2} v_2 + ... + {}^nC_n u_0 v_n$ [u_n, v_n denote nth derivative of u(x), v(x) w.r.t. x]
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

13. STATEMENT 1: Consider a curve defined as given $x = \frac{3at}{1+t^3}$, $y = \frac{3at^2}{1+t^3}$, $a > 0$ then $\left[a(4)^{1/3}, a(2)^{1/3}\right]$ is point where a vertical tangent exists
STATEMENT 2: A vertical tangent exists if $\frac{dy}{dx} = -1$
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

Space for rough work

Comprehension Type

This section contains **2 groups of questions.** Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 14 to 16

Read the following write up carefully and answer the following questions:

Let $\overrightarrow{OP_1}, \overrightarrow{OP_2}, \overrightarrow{OP_3}, \ldots\ldots, \overrightarrow{OP_n}$ be unit vectors in a plane. $P_1, P_2, P_3, \ldots\ldots P_n$ all lie on the same side of a line through O. $|\overline{OM}|$ denotes length of vector through O

14. $\overrightarrow{OP_v} \cdot \left(\overrightarrow{OP_3} + \overrightarrow{OP_4} + \overrightarrow{OP_5} + \ldots\ldots + \overrightarrow{OP_{k-1}}\right)$ $\left(\text{where } \overrightarrow{P_r} = \overrightarrow{P_2} + \overrightarrow{P_k}\right)$ is

(A) > 0 (B) < 0
(C) = 0 (D) none of these

15. If n is odd then, $\left|\overrightarrow{OP_1} + \overrightarrow{OP_2} + \ldots\ldots + \overrightarrow{OP_n}\right|$ is

(A) < 1 (B) < 0
(C) ≥ 1 (D) none of these

16. If $\vec{S} = \overrightarrow{OP_2} + \overrightarrow{OP_3} + \overrightarrow{OP_4} + \overrightarrow{OP_5} + \overrightarrow{OP_6}$ and $\vec{V} = \overrightarrow{OP_1} + \overrightarrow{OP_7}$ then least value of $|\vec{S}| + |\vec{V}|$ is

(A) 0 (B) 2
(C) 1 (D) none of these

Paragraph for Question Nos. 17 to 19

Read the following write up carefully and answer the following questions:

Let A be a n × n matrix. Suppose the linear transformation Y = AX transforms X into a scalar multiple of itself i.e. AX = Y = λX i.e. X is an invariant vector. Then the unknown scalar λ is known as an eigen value of matrix A and corresponding non zero vector X as eigen vector. Thus eigen values satisfy the equation AX = λX

17. $A = \begin{bmatrix} 8 & -4 \\ 2 & 2 \end{bmatrix}$ then possible eigen values is/are

(A) 4 (B) –4
(C) –6 (D) none of these

Space for rough work

18. The possible matrix X acting as eigen vector for $A = \begin{bmatrix} 8 & -4 \\ 2 & 2 \end{bmatrix}$ is

(A) $\begin{bmatrix} 1 \\ -1 \end{bmatrix}$
(B) $\begin{bmatrix} 2 \\ 1 \end{bmatrix}$
(C) $\begin{bmatrix} \frac{1}{2} \\ \frac{3}{2} \end{bmatrix}$
(D) none of these

19. Let, $A = \begin{bmatrix} 1 & 0 & -1 \\ 1 & 2 & 1 \\ 2 & 2 & 3 \end{bmatrix}$ then value of λ for which eigen vector so formed is orthogonal is

(A) –1
(B) 2
(C) 3
(D) none of these

SECTION – B

(Matching List Type)

This section contains **3 multiple choice questions.** Each question has matching Column(s). The codes for the Column(s) have choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. Match the following Column–I with Column–II

	Column – I		**Column – II**
(A)	A variable plane through a fixed point (1, 2, 3) cuts the coordinate axes in the point P, Q, R then locus of centre of sphere OPQR is (0 is origin)	(p)	$x^2 + y^2 + z^2 = \frac{4}{9}$
(B)	A sphere of radius 1 unit passes through O and cuts axis in P, Q, R then locus of centroid of ΔPQR is	(q)	$2xy - \frac{z^2}{2} = 0$
(C)	Consider a point P on OX, Q and OY so that angle OPQ is $\frac{\pi}{12}$, with PQ as a diameter is circle is so described such that its plane is parallel to z–axis. Now if length of PQ is varied then locus generated by circle is	(r)	$x + 2y + 2z = 9$
(D)	The equation of a plane tangent to the sphere $x^2 + y^2 + z^2 = 9$ which passes through the line of intersection of the planes $x + y = 6$, $x - 2z = 3$	(s)	$\frac{1}{x} + \frac{2}{y} + \frac{3}{z} = 2$

Space for rough work

2. Match the following Column–I with Column–II

	Column – I		Column – II
(A)	Consider real numbers x, y, z such that $x \ge y \ge z \ge \frac{\pi}{2}$, $x + y + z = \frac{\pi}{2}$ then the maximum value of cos x sin y cos z is	(p)	$\frac{1}{2}$
(B)	Consider a trigonometric equation as shown [$x \in [0, 2\pi]$] $3\cot^2 x + 8\cot x + 3 = 0$ then the sum of all x is	(q)	$\frac{2+\sqrt{3}}{8}$
(C)	Consider a ΔABC, points D, E, F are on sides BC, CA, AB respectively such that |DC| + |CE| = |EA| + |AF| = |FB| + |BD| then the minimum value of $\frac{\lvert DE\rvert + \lvert EF\rvert + \lvert FD\rvert}{\lvert AB\rvert + \lvert BC\rvert + \lvert CA\rvert}$ is	(r)	3
(D)	Let $x_1, x_2, \ldots\ldots x_{10}$ be real numbers in the interval $\left[0, \frac{\pi}{2}\right]$ such that $\sin^2 x_1 + \sin^2 x_2 + \ldots\ldots + \sin^2 x_{10} = 1$. If $\frac{\cos x_1 + \cos x_2 + \ldots\ldots + \cos x_{10}}{\sin x_1 + \sin x_2 + \ldots\ldots + \sin x_{10}} \ge \alpha$ then maximum value of α is	(s)	5π

3. Match the following Column–I with Column–II

	Column – I		Column – II
(A)	The product of the perpendiculars drawn from the foci upon a tangent made at the locus of points described by P(4 cos θ, 3 sin θ) is	(p)	$\frac{\sqrt{162}}{2}$
(B)	The length of the normal chord subtending an angle of 90º at the vertex of locus of P(t^2, 2t) where (t is a parameter)	(q)	9
(C)	Let P(2, 4) be a point and L : x = y then a circle is made with centre as Q [Image of P in L] and radius as 4. If a circle is so made such that it touches L in (1, 1) and its radical axis with S passes through P then its radius is	(r)	$\sqrt{\frac{5}{2}}$
(D)	The differential equation $\frac{dy}{dx} = \frac{2x}{3y}$ can represent hyperbolas of eccentricity as	(s)	$6\sqrt{3}$

Space for rough work

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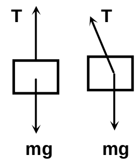
ANSWERS, HINTS & SOLUTIONS
FULL TEST –I
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	B	B
2.	B	C	A
3.	A	D	A
4.	B	D	A
5.	A	A	C
6.	A	D	B
7.	C	B	A
8.	D	B	C
9.	B	B	A
10.	A	A	A
11.	D	B	C
12.	B	B	D
13.	B	A	C
14.	A	B	A
15.	B	C	C
16.	C	A	C
17.	A	B	A
18.	C	A	B
19.	C	C	C
1.	(A) → (r, s), (B) → (r, s), (C) → (q, s), (D) → (p, s)	A → (q, r) B → (q, r) C → (p, s) D → (p, s)	(A) → (s), (B) → (p), (C) → (q), (D) → (r)
2.	(A) → (p, s), (B) → (p, s), (C) → (q, s), (D) → (p, s)	A → (r, s) B → (r, s) C → (p, r) D → (p, q)	(A) → (q), (B) → (s), (C) → (p), (D) → (r)
3.	(A) → (p, q, r, s), (B) → (q, s) (C) → (q, s), (D) → (p, q, r, s)	A → (q) B → (r) C → (s) D → (p)	(A) → (q), (B) → (s), (C) → (p), (D) → (r)

Physics

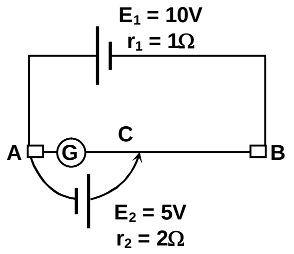
PART – I

1. Now downward force on the right block is more.



2. $I_C = I_0 + M(OC)^2 = I_0 + M(OB^2 + BC^2) = I_B + M(BC)^2$

3. Potential difference across AC is zero as



$I_{AC} = 0$

$5 - 2I = 0$

$I = 2.5$ A

Let the resistance of part BC be r

Applying KVL

$$10 + 5 - 2I - Ir - I = 0$$

$2.5r = 7.5 \Rightarrow r = 3\,\Omega$

As resistance of part AB = 9Ω

$\therefore$ Length AC = 66.7 cm

5. Initial energy of electron = 2eV

Energy after formation of hydrogen atom in the ground state = –13.6 eV.

Energy released = 2 – (–13.6) = 15.6 eV

$$\lambda = \frac{hc}{15.6} = 793\ \text{Å}$$

6. Threshold wavelength = 5000Å

Work function = $\frac{hc}{\lambda}$ = 2.48 eV

K.E. = eV = 3 eV

$$\lambda = \frac{hC}{5.48} = 2258\ \text{Å}$$

7. $P = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P^2} = \frac{300^2}{100} = 900\ \Omega$

$\therefore$ current $i = \frac{V}{R} = \frac{300}{900} = \frac{1}{3}$A

Let L be the required inductance, then

$$\frac{500}{z} = \frac{1}{3} \text{ or } \frac{500}{\sqrt{(900)^2 + x_2^2}} = \frac{1}{3}$$

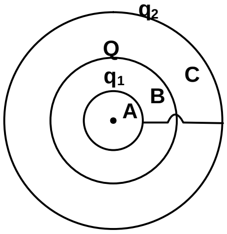
$X_L = 1200\Omega$

$$L = \frac{1200}{W} = \frac{1200}{2\pi f} = \frac{1200}{2\pi \times \frac{150}{\pi}} = 4H$$

8. In steady state potential difference across each capacitor = E

9. $H = \int_0^4 \frac{E^2}{R} dt = \int_0^4 \frac{(6t)^2 dt}{12} = 64$ J

14. $q_1 + q_2 = 0$



$v_A = \frac{kq_1}{R} + \frac{kQ}{2R} + \frac{kq_2}{4R}$

$v_C = \frac{kq_1}{4R} + \frac{kQ}{4R} + \frac{kq_2}{4R}$

$v_A = v_C$

$\Rightarrow$ $q_1 = -Q/3$ and $q_2 = Q/3$

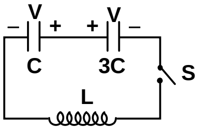
15. $v_A = k\left[\frac{-Q}{3R} + \frac{Q}{2R} + \frac{Q}{12R}\right] = \frac{Q}{16\pi\varepsilon_0 R}$

16. $v_B = k\left[\frac{-Q}{6R} + \frac{Q}{2R} + \frac{Q}{12R}\right] = \frac{5Q}{48\pi\varepsilon_0 R}$

17-19. When current is maximum $\frac{di}{dt} = 0$

$\therefore$ emf across L = 0 and potential difference across the capacitor will be same.

From conservation of charge



$3CV + CV = 6CV_0 - CV_0$

$\Rightarrow$ $V = \frac{5CV_0}{4}$

Loss in energy of capacitor = energy stored in inductor

$\Rightarrow$ $I_{max} = \frac{3V_0}{2}\sqrt{\frac{3C}{L}}$

Chemistry

PART – II

1. $Ag + I^- \longrightarrow AgI + e^-$ $\quad E^o = 0.152$ V

$Ag^+ + e^- \longrightarrow Ag$ $\quad E^o = -0.800$ V

$Ag^+ + I^- \longrightarrow AgI$ $\quad E_{cell} = 0.952$ V

At eqm, $E^o = \dfrac{2.303RT}{[Ag^+][I^-]} = \dfrac{1}{K_{SP}}$

$\therefore 0.952 = \dfrac{-2.303RT}{F}\log K_{SP} = -0.059\log K_{SP}$

$\therefore \log K_{SP} = -16.13$

2. $A^2 = \alpha t + \beta$

on differentiating the equation we get:

$-2AdA = \alpha dt$ or $\dfrac{-dA}{dt} = \dfrac{\alpha}{2A} = \dfrac{\alpha}{2}[A]^{-1}$

Hence order is -1.

3. $\dfrac{r_{A^+}}{r_{B^-}} = \dfrac{1}{2} = 0.5$. As it lies in the range 0.414 to 0.732. AB has octahedral structure like that of NaCl.

$\therefore a = 2(r_{A^+} + r_{B^-}) = 2(1+2) = 6$ pm

Volume = $a^3 = (6\text{ pm})^3 = 216\text{ pm}^3$

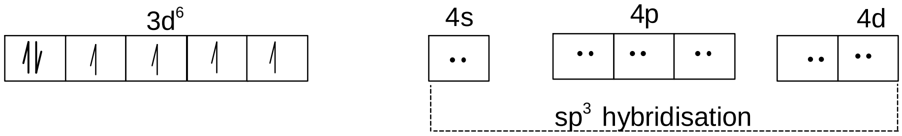
4. $BaF_2(s) \rightleftharpoons Ba^{2+}(aq) + 2F^-(aq)$

$K_{sp} = [Ba^{2+}][F^-]^2 \qquad \therefore F^- = \sqrt{\dfrac{K_{sp}}{[Ba^{2+}]}}$

Again $K_{sp} = 2\times[Ba^{2+}][F^-]^2$

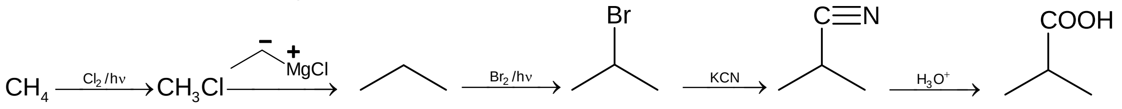
$\therefore [F^-] = \sqrt{\dfrac{K_{sp}}{2[Ba^{2+}]}}$

5. Co^{3+} $\quad 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6$

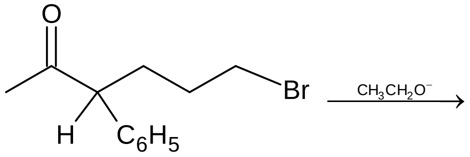


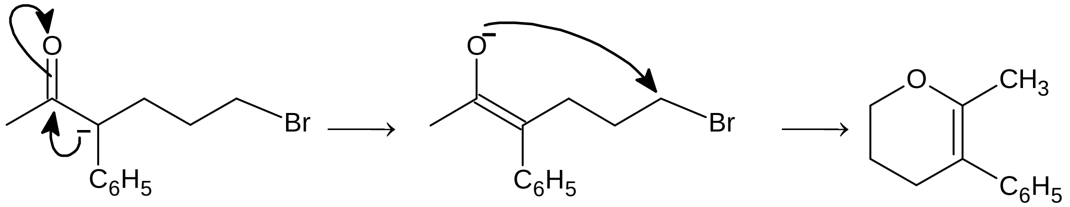
6. Bond order of $N_2, N_2^+, NO^+, NO, CN^-$ and CN are 3, 2.5, 3, 2.5, 3, 2.5 respectively. Higher is bond order smaller is bond length. Bond order of CO and CO^+ are 3 and 3.5.

7.

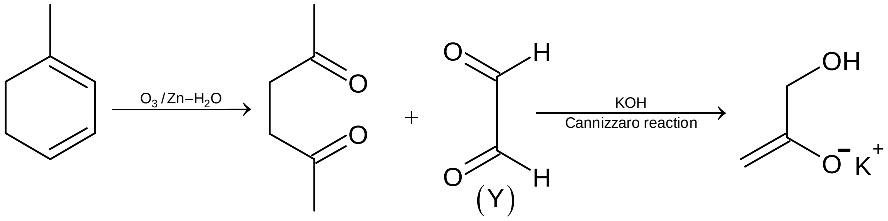


8.




O
Br
C_6H_5
O^-
Br
C_6H_5
O
CH_3
C_6H_5

9.


$O_3/Zn-H_2O$
O
O
O
H
O
H
(Y)
KOH
Cannizzaro reaction
OH
O^- K^+

14. $\Delta H^o = H\left[CaSO_4.\frac{1}{2}H_2O(s)\right] + H\left[\frac{3}{2}H_2O(g)\right]$

$-H\left[CaSO_4.2H_2O(s)\right] = 833$ kJ mol^{-1}

= + 484 kJ for 1 kg

15. $\Delta H^o = \Delta H^o - \Delta S^o$

= 17920 J mol^{-1}

$\Delta G^o = -2.303RT\log K_p$

$$\log K_p = \frac{\Delta G^o}{2.303RT} = 7.22\times10^{-4}\left(p_{H_2O}\right)^{\frac{3}{2}}$$

$p_{H_2O} = 8.1\times10^{-3}$ atm

16. $p_{H_2O} = 1, K_p = 1$

$\Delta G^o = 0$ at eqm.

$$\Delta H^o = T\Delta S^o \Rightarrow T = \frac{\Delta H^o}{\Delta S^o} = 380\text{ K}$$

= 107^{o}C

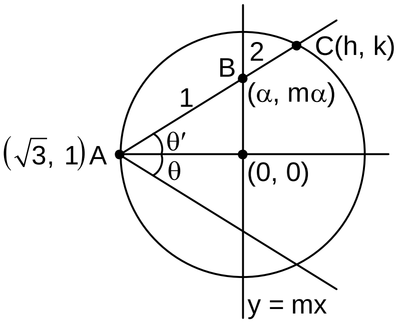
Mathematics

PART – III

1. $x^2 + y^2 - 2x - 2y - 1 = 0$
$x^2 + y^2 \qquad\qquad - 1 = 0$
Common chord is $-2x - 2y = 0 \Rightarrow 2x + 2y = 0$
$y = -x$
Points of intersection of circles are $\left(\pm\frac{1}{\sqrt{2}},\ \mp\frac{1}{\sqrt{2}}\right)$

2. $$P(E) = \frac{\sum\limits_{k=1}^{4} k}{{}^{8}C_2} = \frac{10\times 2}{8\times 7} = \frac{5}{14}$$

3. The line can be written as y = mx and curve as $x^2 + y^2 = 4$
Let, C(h, k) be a point on the circles and $A\left(\sqrt{3},\ 1\right)$ be given point then, $\frac{h+2\sqrt{3}}{3} = \alpha$



$\Rightarrow\ h = 3\alpha - 2\sqrt{3}$
$\frac{k+2}{3} = m\alpha$
$\Rightarrow k = 3m\alpha - 2$
Now, this point (h, k) lies on the circle
$\Rightarrow\ \left(3\alpha - 2\sqrt{3}\right)^2 + (3m\alpha - 2)^2 = 4$
$9\alpha^2 + 12 - 12\sqrt{3}\alpha + 9m^2\alpha^2 + 4 - 12m\alpha = 4$
$\Rightarrow\ 9\left(1+m^2\right)\alpha^2 - 12\alpha\left(\sqrt{3}+m\right) + 12 = 0$
$3\left(1+m^2\right)\alpha^2 - 4\alpha\left(\sqrt{3}+m\right) + 4 = 0$
$16\left(\sqrt{3}+m\right)^2 - 4\times 3\left(1+m^2\right)(4) > 0$
$\left(\sqrt{3}+m\right)^2 - 3\left(1+m^2\right) > 0$
$3 + m^2 + 2\sqrt{3}m - 3 - 3m^2 > 0$
$2\sqrt{3}m - 2m^2 > 0$
$2m^2 - 2\sqrt{3}m < 0$
$m \in \left(0,\ \sqrt{3}\right)$

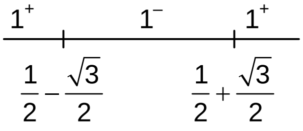
4. Suppose m is an integer root of $x^4 - ax^3 - bx^2 - cx - d = 0$ as $d \neq 0$
$\Rightarrow m \neq 0$
(I) $m > 0$
$m^4 - am^3 - bm^2 - cm = d$
$\Rightarrow d = m(m^3 - am^2 - bm - c)$
$\Rightarrow d \geq m$
Also, $m^4 - am^3 = bm^2 + cm + d$
$m^3(m - a) = bm^2 + cm + d$
$\Rightarrow m > a \Rightarrow$ contradiction
(II) $m < 0$
$m = -n$
$\Rightarrow n^4 + an^3 - bn^2 + cn - d = 0$

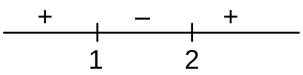
$n^4 + n^2(an - b) + (cn - d) > 0$
So, contradiction
Hence, equation has no integral solution

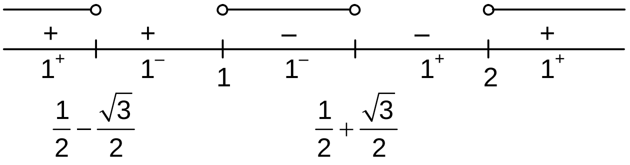
5. **(I)** $x^2 - x + \frac{1}{2}$

$\left(x - \frac{1}{2}\right)^2 + \frac{1}{4} = 1$

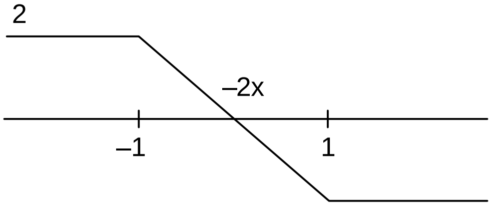
$\Rightarrow x = \frac{1}{2} \pm \frac{\sqrt{3}}{2}$


1^+
1^-
1^+
$\frac{1}{2} - \frac{\sqrt{3}}{2}$
$\frac{1}{2} + \frac{\sqrt{3}}{2}$




+
+
–
–
+
1^+
1^-
1
1^-
1^+
2
1^+
$\frac{1}{2} - \frac{\sqrt{3}}{2}$
$\frac{1}{2} + \frac{\sqrt{3}}{2}$

(II) $x^2 - 3x + 2$



(III) $|x - 1| - |x + 1| - \frac{1}{2}$

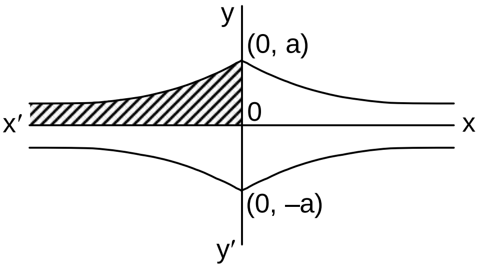
$\therefore$ set x can be $\left(-\infty,\ -\frac{1}{4}\right) - \left\{-\frac{3}{4}\right\}$

$-2x > \frac{1}{2}$	$-2x - \frac{1}{2} = 1$
$\Rightarrow x < -\frac{1}{4}$	$\Rightarrow x = -\frac{3}{4}$

6. Required area, $A = 4\int_0^{\pi/2} y \cdot \frac{dx}{dt} dt$

$= 4\int_0^{\pi/2} (a\sin t)\left(\frac{a}{\sin t}\cos^2 t\right) dt$

$= 4a^2 \int_0^{\pi/2} \cos^2 t\, dt = \pi a^2$



7. Distance from origin, $D = \sqrt{x^2 + y^2 + z^2}$ where P(x, y, z) is any point on the curve

$D^2 = x^2 + y^2 + z^2 = x^2 + y^2 + \frac{2}{xy} \geq 2xy + \frac{2}{xy} \geq 4$

$\Rightarrow$ D = 2 and occurs at point(s) $\left(1, 1, \sqrt{2}\right)$ and $\left(-1, -1, \sqrt{2}\right)$, $\left(1, 1, -\sqrt{2}\right)$, $\left(-1, -1, -\sqrt{2}\right)$

8. Differentiating w.r.t. ‘r’, $2r\,dr = 2a\cos 2\theta\, d\theta$, $a = \frac{r^2}{\sin 2\theta}$

$\Rightarrow r\,dr = \frac{r^2}{\sin 2\theta}\cos 2\theta\, d\theta$

$\Rightarrow r \cdot \frac{d\theta}{dr} = \tan 2\theta$

So, differential equation of orthogonal trajectory, $r \cdot \frac{d\theta}{dr} = -\cot 2\theta$

Solving $-\tan 2\theta \, d\theta = \frac{dr}{r}$

$\Rightarrow \ln(\cos 2\theta) = 2 \ln r + k \Rightarrow r^2 = c \cos 2\theta$

9. Let $f(x) = x^3 + bx^2 + cx + 1$. $f(0) = 1 > 0$, $f(-1) = b - c < 0$

So, $\alpha \in (-1, 0)$. So, $2\tan^{-1}(\operatorname{cosec}\alpha) + \tan^{-1}\left(2\sin\alpha \sec^2\alpha\right)$

$= 2\tan^{-1}\left(\frac{1}{\sin\alpha}\right) + \tan^{-1}\left(\frac{2\sin\alpha}{1-\sin^2\alpha}\right) = 2\left[\tan^{-1}\left(\frac{1}{\sin\alpha}\right) + \tan^{-1}(\sin\alpha)\right]$

$= 2\left(-\frac{\pi}{2}\right) = -\pi \quad (\text{as} \quad \sin\alpha < 0)$

10. $\frac{1}{1+z^2}$ is continuous every where except where $1 + z^2 = 0$

$\Rightarrow z = \pm i$ so when $|z| < 1$ then above points are excluded so f(z) is continuous

11. Continuity : for any point z, $\lim\limits_{z\to z_0} f(z) = \lim\limits_{z\to z_0} x = x_0 = f(z_0)$. Non differentiable : for any point z,

$f'(z) = \lim\limits_{\Delta z\to 0} \frac{f(z+\Delta z) - f(z)}{\Delta z} = \lim\limits_{\Delta z\to 0} \frac{\Delta x}{\Delta x + i\Delta y}$ now $\lim\limits_{\substack{\Delta x\to 0\\ \Delta y\to 0}} \frac{\Delta x}{\Delta x + i\Delta y} = 0$ and $\lim\limits_{\substack{\Delta y\to 0\\ \Delta x\to 0}} \frac{\Delta x}{\Delta x + i\Delta y} = 1$

12. $y_1 = \cos\left(m\sin^{-1}x\right) \cdot \frac{m}{\sqrt{1-x^2}}$

$\sqrt{1-x^2}\, y_1 = m\cos\left(m\sin^{-1}x\right)$

$\Rightarrow (1-x^2)y_2 - xy_1 + m^2 y = 0$

$\left[(1-x^2)y_{n+2} + n(-2x)y_{n+1} + \frac{n(n-1)}{2}(-2)y_n\right] - \left[xy_{n+1} + n.1.y_n\right] + m^2 y_n = 0$

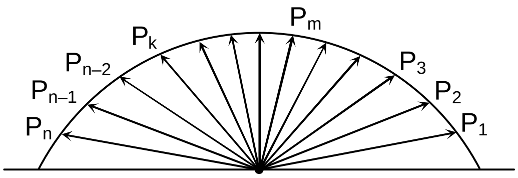
Simplifying we get, $(1-x^2)y_{n+2} - (2n+1)y_{n+1} - (n^2 - m^2)y_n = 0$

13. $\frac{dy}{dt} = \frac{3at\left(2-t^3\right)}{\left(1+t^3\right)^2}$

$\frac{dx}{dt} = 6a\frac{\left(\frac{1}{2} - t^3\right)}{\left(1+t^3\right)^2}$

Now $\frac{dy}{dx} \to \infty$ at $t \to (2)^{1/3}$

14.-16. Here, $\overrightarrow{P_v} = \overrightarrow{P_2} + \overrightarrow{P_K}$ so $\overrightarrow{P_v}$ will make acute angle with all the vectors from $\overrightarrow{P_2}$, $\overrightarrow{P_3}$, ..., $\overrightarrow{P_k}$



So, $\overrightarrow{OP_v}\cdot\left(\overrightarrow{OP_2}+\overrightarrow{OP_3}+.....+\overrightarrow{OP_{k-1}}\right)>0$

Again, if n is odd $\Rightarrow$ n = 2k – 1

$\overrightarrow{OP_1}+\overrightarrow{OP_{2k-1}}=\overrightarrow{OP_k}$

Now $\overrightarrow{OP_k}$ will make acute angle with all the vectors from $\overrightarrow{OP_1}$, $\overrightarrow{OP_2}$ ..... $\overrightarrow{OP_{2k-1}}$

$\overrightarrow{OP_k}\cdot\left(\overrightarrow{OP_1}+\overrightarrow{OP_2}+.....+\overrightarrow{OP_k}+\overrightarrow{OP_{k+1}}+.....+\overrightarrow{OP_{2k-1}}\right)\ge\overrightarrow{OP_k}\cdot\overrightarrow{OP_k}=1$

Now, $\overrightarrow{OP_k}\cdot\left(\overrightarrow{OP_1}+\overrightarrow{OP_2}+.....+\overrightarrow{OP_{2k-1}}\right)\le\left|\overrightarrow{OP_k}\right|\left|\overrightarrow{OP_1}+.....+\overrightarrow{OP_{2k-1}}\right| = \left|\overrightarrow{OP_1}+\overrightarrow{OP_2}+.....+\overrightarrow{OP_n}\right|$

Again, $\vec{V}$ makes acute angle with all the vectors $\overrightarrow{OP_1}$, $\overrightarrow{OP_2}$, ... $\overrightarrow{OP_7}$

So, $\left|\vec{V}+\vec{S}\right|=\left|\overrightarrow{OP_1}+\overrightarrow{OP_2}+.......+\overrightarrow{OP_7}\right|\ge 1\Rightarrow\left|\vec{V}\right|+\left|\vec{S}\right|\ge 1$

17. Eigen values are roots of the equation $A-\lambda X=0\Rightarrow(A-\lambda I)X=0$

$\Rightarrow |A-\lambda I|=0$

$$\Rightarrow\begin{vmatrix}8-\lambda & -4\\ 2 & 2-\lambda\end{vmatrix}=0$$

$\Rightarrow(\lambda-4)(\lambda-6)=0$

$\therefore\ \lambda=4,\ 6$

18. When $\lambda=6$

$$\begin{bmatrix}8-6 & -4\\ 2 & 2-6\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}=\begin{bmatrix}2 & -4\\ 2 & -4\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}=\begin{bmatrix}0\\ 0\end{bmatrix}$$

$\Rightarrow 2x_1-4x_2=0\Rightarrow x_1=2x_2$

$$\therefore\ X=C\begin{bmatrix}2\\ 1\end{bmatrix}$$

19. $|A-\lambda I|=0$

$$\Rightarrow\begin{vmatrix}1-\lambda & 0 & -1\\ 1 & 2-\lambda & 1\\ 2 & 2 & 3-\lambda\end{vmatrix}=0$$

$\Rightarrow\lambda^3-6\lambda^2+11\lambda-6=0\Rightarrow\lambda=1,\ 2,\ 3,$

For $\lambda=3$

$$X=C\begin{bmatrix}1\\ 1\\ -2\end{bmatrix}$$ which is orthogonal

SECTION – B

1. **(A)** Assume sphere as, $x^2+y^2+z^2+2ux+2vy+2wz=0$

Now P, Q, R are (–2u, 0, 0), (0, –2v, 0), (0, 0, –2w)

So, equation of plane is $\frac{x}{-2u}+\frac{y}{-2v}+\frac{z}{-2w}=1$

Since it passes through (1, 2, 3) $\frac{1}{-2u}+\frac{2}{-2v}+\frac{3}{-2w}=1$

If centre is $(x,y,z)\equiv(-u,-v,-w)$

$\therefore$ locus is $\frac{1}{x}+\frac{2}{y}+\frac{3}{z}=2$

(B) Assume equation of sphere as, $x^2+y^2+2ux+2vy+2wz=0$

It passes through $(\alpha, 0, 0)$, $(0, \beta, 0)$, $(0, 0\ \gamma)$

$\Rightarrow\ u = -\dfrac{\alpha}{2},\ v = -\dfrac{\beta}{2},\ \omega = -\dfrac{r}{2}$

Radius = 1 $\Rightarrow \sqrt{\left(\dfrac{\alpha}{2}\right)^2 + \left(\dfrac{\beta}{2}\right)^2 + \left(\dfrac{\gamma}{2}\right)^2} = 1$

$\alpha^2 + \beta^2 + \gamma^2 = 4$ if (x, y, z) are coordinates of centroid

$\Rightarrow\ x = \dfrac{\alpha}{3},\ y = \dfrac{\beta}{3},\ z = \dfrac{\gamma}{3}\ \therefore\ x^2 + y^2 + z^2 = \dfrac{4}{9}$

(C) $P \equiv (\alpha, 0, 0)$, $Q \equiv (0, \beta, 0)$, $\angle OPQ = 15^\circ$

$\Rightarrow \tan 15^\circ = \dfrac{\beta}{\alpha}$ ….. (1)

Now if sphere is made with PQ as diameter $(x - \alpha)x + (y - \beta)y + z^2 = 0$

$\Rightarrow x^2 + y^2 + z^2 = ax + by$ ….. (2)

A plane through PQ parallel to z–axis is

$\dfrac{x}{\alpha} + \dfrac{y}{\beta} = 1$ ….. (3)

Using (1), (2), (3) we get $x^2 + y^2 + z^2 = (\alpha x + \beta y)\left(\dfrac{x}{\alpha} + \dfrac{y}{\beta}\right)$

$\Rightarrow z^2 = xy(\tan 15^\circ + \cot 15^\circ) \Rightarrow\ 2xy - \dfrac{z^2}{2} = 0$

(D) Using family of planes any plane through line of intersection is $x + y - 6 + \lambda(x - 2z - 3) = 0$

Now, its distance from centre of sphere is radius $\dfrac{|-6 - 3\lambda|}{\sqrt{(1+\lambda)^2 + 1 + 4\lambda^2}} = 3$, $\lambda = 1,\ -\dfrac{1}{2}$

$\therefore$ Equation is $x + 2y + 2z = 9$; $2x + y - 2z = 9$

2. **(A)** Let $p = \cos x \sin y \cos z$. As, $\dfrac{\pi}{2} \ge y \ge z$, $\sin(y - z) \ge 0$

$p = \dfrac{1}{2}\cos z\left[\sin(x+y) - \sin(x-y)\right] \le \dfrac{1}{2}\cos^2 z$

As, $\sin(x - y) \ge 0$ and $\sin(x + y) = \cos z$

$p \le \dfrac{1}{4}(1 + \cos 2z) \le \dfrac{1}{4}\left(1 + \cos\dfrac{\pi}{6}\right) = \dfrac{2 + \sqrt{3}}{8}$

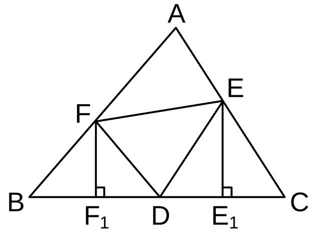
(B) The equation can be written as $3u^2 + 8u + 3 = 0 \Rightarrow u_1 = \dfrac{-8 + 2\sqrt{7}}{6}\ \Rightarrow\ u_2 = \dfrac{-8 - 2\sqrt{7}}{6}$

Clearly, u_1, u_2 are negative so $\dfrac{\pi}{2} < x_1,\ x_2 < \pi$

$\Rightarrow \pi < x_1 + x_2 < 2\pi$ as $\cot x \tan x = 1 = \cot x\ \cot\left(\dfrac{\pi}{2} - x\right) = \cot x \cdot \cot\left(\dfrac{3\pi}{2} - x\right)$

$\therefore\ x_1 + x_2 = \dfrac{3\pi}{2}$ and another pair, $x'_1 + x'_2 = \dfrac{7\pi}{2}\left[\pi < x'_1,\ x'_2 < 2\pi\right]$

$\therefore x_1 + x'_1 + x_2 + x'_2 = 5\pi$



(C) $|EF| \geq |E_1F_1| = a - [|BF| \cos B + |CF| \cos C]$
$|DE| \geq C - [|AE| \cos A + |BD| \cos B]$
$|FD| \geq b - [|CD| \cos C + |AF| \cos A]$
$|DC| + |CE| = |EA| + |AF| = |FB| + |BD| = \frac{1}{3}(a+b+c)$
$\therefore$ $|DE| + |EF| + |FD|$
$\geq a+b+c-\frac{1}{3}((a+b+c)(\cos A+\cos B+\cos C)) \geq \frac{1}{2}(a+b+c)$

So, minimum value is $\frac{1}{2}$

(D) $\sin^2 x_1 + \sin^2 x_2 + \ldots.. + \sin^2 x_{10} = 1$
$\cos x_i = \sqrt{\sum_{j=1} \sin^2 x_j}$

For each $1 \leq i \leq 10$ we have $\cos x_i = \sqrt{\sum_{j\neq i} \sin^2 x_j} \geq \frac{\sum_{j\neq i} \sin x_j}{3}$

$$\Rightarrow \sum_{i=1}^{10} \cos x_i \geq \sum_{i=1}^{10}\sum_{j\neq i} \frac{\sin x_j}{3} = \sum_{i=1}^{10} 9 \cdot \frac{\sin x_i}{3}$$

$$\Rightarrow \frac{\cos x_1 + \cos x_2 + \ldots.. + \cos x_{10}}{\sin x_1 + \sin x_2 + \ldots.. + \sin x_{10}} \geq 3$$

3. **(A)** Property of ellipse

(B) Normal chord is made between points $A(2,\ 2\sqrt{2})$ and $B(8,\ -4\sqrt{2})$ so its length is $6\sqrt{3}$

(C) $Q \equiv (4, 2)$, $S : (x-4)^2 + (y-2)^2 = 16$ then required circle is $(x-1)^2 + (y-1)^2 + \lambda(x-y) = 0$

Here, $\lambda = 9$ and radius = $\frac{\sqrt{162}}{2}$

(D) $x^2 = \frac{3y^2}{2} + c$

$e = \sqrt{\frac{5}{3}}$ (c > 0) and $e = \sqrt{\frac{5}{2}}$ (c < 0)

FIITJEE **JEE (Advanced), 2014**

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

FULL TEST – I

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 243**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-B**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 09)** contains 09 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (10 – 13) contains 4 Assertion-Reasoning (multiple choice questions) which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (14 – 19) contains 2 paragraphs. Based upon paragraph, 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-B (1 – 03)** contains 3 Matrix Match Type (4 × 4 Matrix) questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+6 marks** for all correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

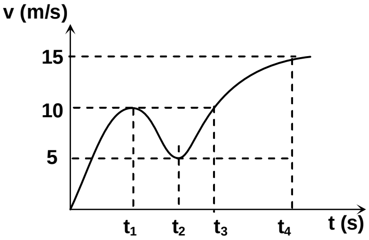
PART – I

SECTION – A

Single Correct Choice Type

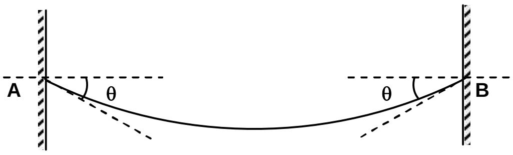
This section contains **9 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. Velocity time graph of a particle undergoing rectilinear motion is plotted as shown in the figure. Average acceleration of particle is zero between time intervals.



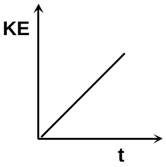
(A) 0 and t_1 (B) t_1 and t_2
(C) t_1 and t_3 (D) t_2 and t_4

2. A heavy string of mass m hangs between two fixed points A and B at the same level. The tangents to the string at A and B are at an angle θ with the horizontal as shown in the figure. The tension in the string at lowest point is



(A) $\frac{mg}{2\sin\theta}$ (B) $\frac{mg}{2\cos\theta}$
(C) $\frac{mg}{2\tan\theta}$ (D) $\frac{mg}{2\cot\theta}$

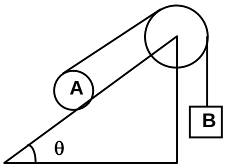
3. The kinetic energy of a body moving along a straight line varies with time as shown in the figure. The force acting on the body is



(A) zero
(B) constant
(C) directly proportional to velocity
(D) inversely proportional to velocity.

Space for rough work

4. In the figure shown, a string is wound over a cylinder A. The other end of the string is attached to block B through a pulley. When the system is released the cylinder rolls down without slipping. The ratio of magnitude of vertical component of displacement of A and B in any time interval t is

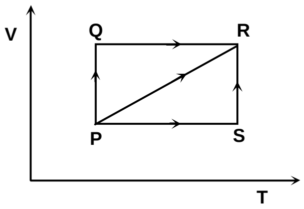


(A) $\sin\theta : 1$
(B) $\sin\theta : 2$
(C) $\cos\theta : 1$
(D) $\cos\theta : 2$

5. Six stars of equal mass are moving about the centre of mass of the system such that they are always on the vertices of a regular hexagon of side length a. Their common time period will be

(A) $4\pi\sqrt{\frac{a^3}{Gm}}$
(B) $2\pi\sqrt{\frac{4\sqrt{3}a^3}{Gm\left(5\sqrt{3}+4\right)}}$
(C) $4\pi\sqrt{\frac{3a^3}{Gm}}$
(D) None of these

6. One mole of a monoatomic gas is taken from P to R, via three paths PQR, PR and PSR. If work done by the gas in PQR is W_1, in PR work done is W_2 and in PSR work done is W_3, then

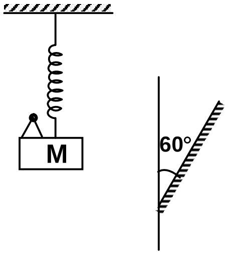


(A) $W_2 > W_3 > W_1$
(B) $W_1 > W_2 > W_3$
(C) $W_2 > W_1 > W_3$
(D) $W_3 > W_2 > W_1$

7. A block of wood of relative density 0.5 is placed 10 m inside a vessel containing water. The vessel is accelerated upward with an acceleration of 10 m/s^2. If the block is released at some instant, then the time taken by block to reach the surface of water from that instant is (g = 10 m/s^2)

(A) 0.5 sec
(B) 1 sec
(C) 2 sec
(D) none of these

Space for rough work



8. An insect of negligible mass is sitting on a block of mass M, tied with a spring of force constant k. The block performs simple harmonic motion with amplitude A infront of a plane mirror placed as shown in the figure. The maximum speed of insect relative to its image will be

(A) $A\sqrt{\frac{k}{m}}$ (B) $\frac{A\sqrt{3}}{2}\sqrt{\frac{k}{m}}$

(C) $A\sqrt{3}\sqrt{\frac{k}{m}}$ (D) $A\sqrt{\frac{m}{k}}$

9. Two concentric conducting spheres of radii R and 3R carrying charges Q and 2Q respectively. If the charge on inner sphere is doubled. The potential difference between inner and outer spheres will

(A) becomes two times (B) becomes four times

(C) be halved (D) remains same

Assertion - Reasoning Type

This section contains 4 questions numbered 10 to 13. Each question contains **STATEMENT-1 (Assertion)** and **STATEMENT-2 (Reason)**. Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

10. STATEMENT-1: The time period of a pendulum of infinite length whose bob hangs near the surface of the earth will be infinite.

and

STATEMENT-2: The time period of a pendulum of length L near the surface of the earth is $2\pi\sqrt{\frac{L}{g}}$, if L is reasonably small .

(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.

(C) Statement -1 is True, Statement-2 is False.

(D) Statement -1 is False, Statement-2 is True.

Space for rough work

11. STATEMENT-1: Action and reaction are always equal and opposite, they act on different bodies and they act along the same line (They are collinear)
and

STATEMENT-2: The summation of torques of internal forces in any rigid body is always zero.
(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

12. STATEMENT-1: An electromagnetic induction the Lenz law tells us only about the direction of induced emf while Faraday's law give us only the magnitude of emf.
and

STATEMENT-2: The direction of induced emf is such that it tends to oppose the cause of its production.
(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

13. STATEMENT-1: In X-rays the energy of K_α photon is lower than the energy of a K_β photon.
and

STATEMENT-2: The number of K_α photons is much larger than K_β photons.
(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

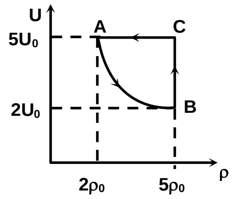
Space for rough work

Comprehension Type

This section contains 2 groups of questions. Each group has **3 multiple choice question** based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

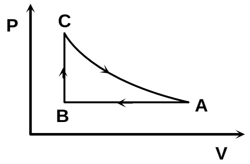
Paragraph for Question Nos. 14 to 16

Figure shows the variation of the internal energy U with the density ρ of one mole of ideal monoatomic gas for a thermodynamics cycle ABCA. Here process AB is a part of rectangular hyperbola

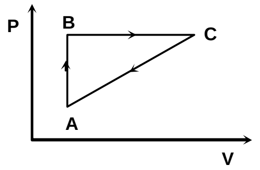


14. The P-V diagram of above process

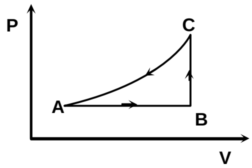
(A)



(B)



(C)



(D) None of these

15. The total amount of heat absorbed by the system for cyclic process is

(A) $\left(\frac{10}{3}\ln 2.5 - 2\right)U_0$

(B) $\left(\frac{10}{5}\ln 0.4 - 2\right)U_0$

(C) $50U_0$

(D) None of these

16. The work done in process AB is

(A) $-U_0$

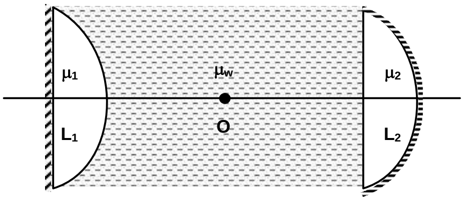
(B) $-2U_0$

(C) $-5U_0$

(D) none of these.

Space for rough work

Paragraph for Question Nos. 17 to 19



A cylindrical tube filled with water ($\mu_w = 4/3$) is closed at its both ends by two silvered plano convex lenses as shown in the figure. Refractive index of lenses L_1 and L_2 are 2.0 and 1.5 while their radii of curvature are 5 cm and 9 cm respectively. A point object is placed some where at a point O on the axis of cylindrical tube. It is found that the object and image coincide each other.

17. The position of object w.r.t. lens L_1 is

(A) 8 cm (B) 10 cm
(C) 12 cm (D) 14 cm

18. The position of object w.r.t. lens L_2 is

(A) 8 cm (B) 10 cm
(C) 12 cm (D) 14 cm

19. The length of the cylindrical tube is

(A) 16 cm (B) 18 cm
(C) 20 cm (D) 22 cm

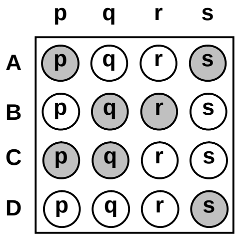
Space for rough work

SECTION - B

Matrix – Match Type

This section contains 3 questions. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in column I have to be matched with statements (p, q, r, s) in column II. The answers to these questions have to be appropriately bubbled as illustrated in the following example.

If the correct match are A-p, A-s, B-q, B-r, C-p, C-q and D-s, then the correctly bubbled 4 × 4 matrix should be as follows:



	p	q	r	s
A	●	○	○	●
B	○	●	●	○
C	●	●	○	○
D	○	○	○	●

1. Three concentric spherical metallic shells A, B, and C of radii a, b, and c (a<b<c) have charge densities of σ, –σ and σ respectively, then match the following:

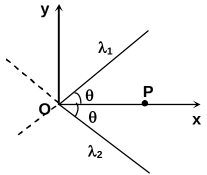
Column I		Column II	
(A)	The potential at A	(p)	$\frac{\sigma}{\varepsilon_0}\left(\frac{a^2}{c}-\frac{b^2}{c}+c\right)$
(B)	The potential at B	(q)	$\frac{\sigma}{\varepsilon_0}\left(\frac{a^2}{c}-b+c\right)$
(C)	The potential at C	(r)	$\frac{\sigma}{\varepsilon_0}$
(D)	The electric field at surface of A	(s)	$\frac{\sigma}{\varepsilon_0}(a-b-c)$

Space for rough work

2. For an atom having atomic number z.
Match the following:

Column I		Column II	
(A)	Radius of orbit	(p)	is proportional to z
(B)	Current associated due to orbital motion of electron	(q)	is inversely proportional to z.
(C)	Magnetic field at the centre due to orbital motion of electron	(r)	is proportional to z^2.
(D)	Velocity of an electron	(s)	is proportional to z^3

3. Two infinitely long line charges λ_1 and λ_2 are placed symmetric to x-axis as shown in the figure. Match the following for direction of electric field at point P on the x-axis.



Column I		Column II	
(A)	Both λ_1 and λ_2 are positive	(p)	positive x-axis
(B)	Both λ_1 and λ_2 are negative	(q)	positive y-axis
(C)	λ_1 is positive but λ_2 is negative	(r)	negative x-axis
(D)	λ_1 is negative but λ_2 is positive	(s)	negative y-axis

Space for rough work

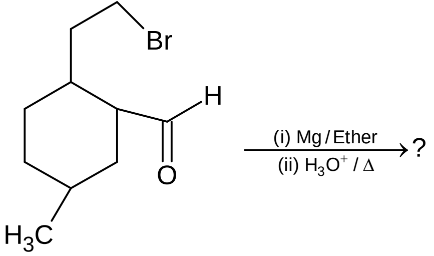
Chemistry PART – II

SECTION – A

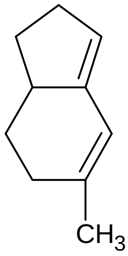
Straight Objective Type

This section contains 9 multiple choice questions numbered 1 to 9. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

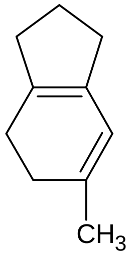
1. The final product in following reaction is



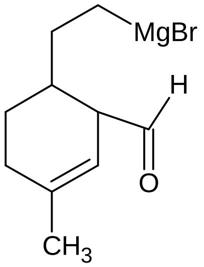
(A)



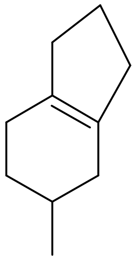
(B)



(C)

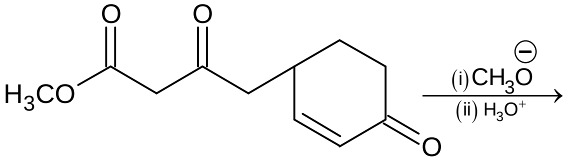


(D)

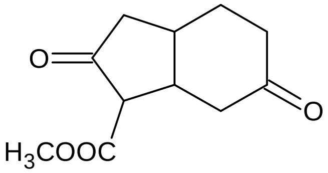


Rough Work

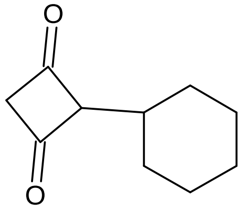
2. Find out major product of following reaction:



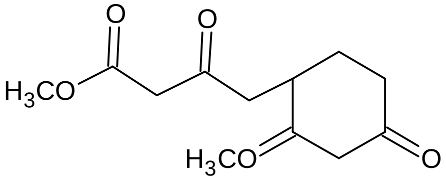
(A)



(B)



(C)



(D) None of these

3. At a given temp, total vapour pressure in Torr of a mixture of volatile components A and B is given by P = 120 – 75 × B.
Hence vapour pressures of pure A and B respectively (in Torr) are

(A) 120,75
(B) 120,195
(C) 120,45
(D) 75, 45

4. Equivalent conductance of saturated solution of $BaSO_4$ is 400 $ohm^{-1}cm^2eqv^{-1}$ and specific conductance is 8×10^{-5} $ohm^{-1}cm^{-1}$. Hence Ksp of $BaSO_4$ is

(A) 4×10^{-8} m^2
(B) 1×10^{-8} m^2
(C) 2×10^{-4} m^2
(D) 1×10^{-4} m^2

5. Number of natural life times (Tav) required for a first order reaction to achieve 99.9 level of completion is:

(A) 2.3
(B) 6.9
(C) 9.2
(D) 0.105

6. In $[B_4O_5(OH)_4]^{2-}$, the number of boron atoms having an octet of electron is:

(A) 0
(B) 1
(C) 2
(D) 4

Rough Work

7. Maximum percentage of available chlorine on the basis of $Ca(OCl)Cl.H_2O$ formula is

(A) 35 (B) 40

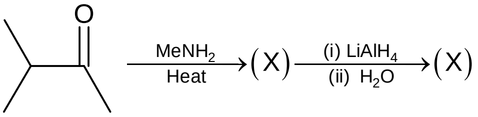
(C) 45 (D) 49

8. In which of the following pairs of molecules have bond order three and are isoelectronic?

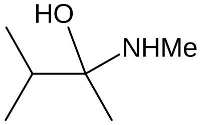
(A) NO^+ , CO^+ (B) CN^- , CO

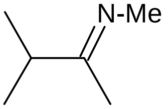
(C) CN^- , O_2^+ (D) CO, O_2^+

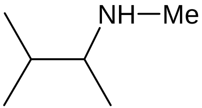
9. Consider the following sequence of reactions

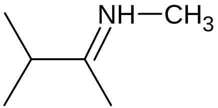


The final product (X) is

(A)


(B)


(C)


(D)


Rough Work

Reasoning Type

This section contains 4 questions numbered 10 to 13. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

10. STATEMENT-1: The equilibrium constant for a reaction having standard heat reaction ΔH^o increases with temperature.

and

STATEMENT-2: The temperature dependence of equilibrium constant is related to ΔS^o and ΔH^o for the reaction.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

11. STATEMENT-1: Isomerisation also results when $NaNH_2$ is used in dehydrbromination of 2, 2 dibromobutane forming 2-butyne as well as 1-butyne.

and

STATEMENT-2: All possible triple bond isomers are formed but $NaNH_2$ is such a strong base that it deprotonates the terminal alkyne removing it from the equilibrium.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

Rough Work

12. STATEMENT-1: Green solution of potassium magnate (VI) K_2MnO_4 turns purple and brown solid is precipitated when CO_2 bubbled into it.

and

STATEMENT-2: K_2MnO_4 changes to K_3MnO_8 by CO_2.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(C) Statement-1 is True, Statement -2 is False.

(D) Statement-1 is False, Statement-2 is True.

13. STATEMENT-1: Melting points of alkanes with even number of carbon atoms are higher than those of alkanes with odd number of carbon atoms.

and

STATEMENT-2: Alkanes with even number of carbon atom fit together better in crystal lattice.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(C) Statement-1 is True, Statement -2 is False.

(D) Statement-1 is False, Statement-2 is True.

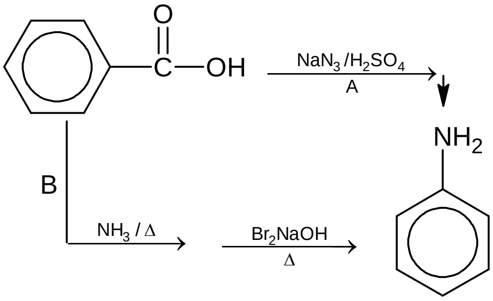
Rough Work

Comprehension Type

This section contains 2 groups of questions. Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 14 to 16

Benzoic acid can be converted into aniline by different reagents



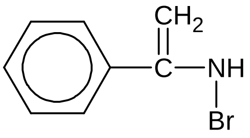
Following questions are based on the above reactions

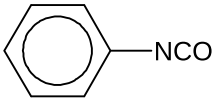
14. Consider the following facts about reaction (B)

Fact (P): It is intramolecular migration reaction

Fact (Q): It is degradation reaction.

Fact (R): It involves following intermediates.





Select correct facts

(A) P, Q	(B) Q and R
(C) P, R	(D) P, Q, R

15. Escaping gases in reaction (A) is/are:

(A) NH_3, CO_2	(B) N_2, NH_3
(C) N_2, CO_2	(D) CO_2 only

16. These reactions are called

	A	B
(A)	Hoffman	Schmidt
(B)	Schmidt	Hoffmann
(C)	HVZ	Hoffman
(D)	Hoffman	HVZ

Rough Work

Paragraph for Question Nos. 17 to 19

The following reaction was studied at 25°C in benzene solution containing 0.1 M pyridine.

$$\underset{(A)}{CH_3OH} + \underset{(B)}{\left(C_6H_5\right)_3 CCl} \longrightarrow \underset{(C)}{\left(C_6H_5\right)_3 COCH_3} + HCl$$

The following sets of data were observed.

Set	Initial concentration		Time	Final concentration (C)
	$[A]_o$	$[B]_o$		
I	0.10 M	0.05 M	25 min	0.0033 m
II	0.10 M	0.10 M	15 min	0.0039 m
III	0.20 M	0.10 M	7.5 min	0.0077 m

17. Rates $\frac{d[C]}{dt}$ in sets (I), II and III are respectively (in M min^{-1})

	I	II	III
(A)	1.30×10^{-4}	2.6×10^{-4}	1.02×10^{-3}
(B)	0.033	0.0039	0.0077
(C)	0.02×10^{-4}	0.04×10^{-4}	0.0077
(D)	None of these		

18. Rate law of above experiment is

(A) K[A][B]
(B) K$[A]^2$[B]
(C) K[A]$[B]^2$
(D) K$[A]^2[B]^4$

19. Rate constant of the above experiment is (in L^{2}m^{-2}min^{-1})

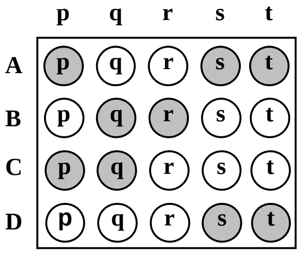
(A) 1.3×10^{-1}
(B) 2.6×10^{-2}
(C) 2.6×10^{-1}
(D) 1.3×10^{-2}

Rough Work

SECTION-B
(Matrix Type)

This section contains 3 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



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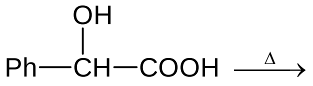
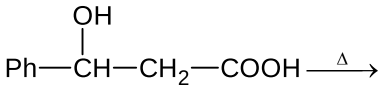
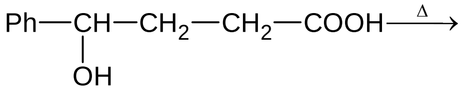
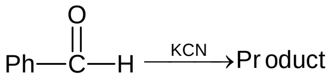
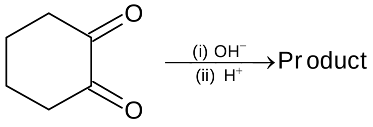
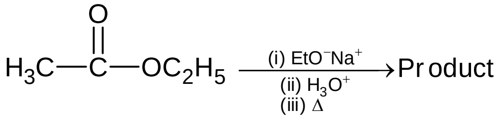
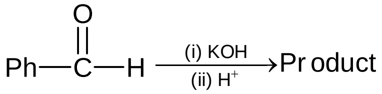
1. Match the following

(A)	 $Ph-\underset{}{\overset{OH}{\overset{\vert}{C}}}H-COOH \xrightarrow{\Delta}$	(p)	Cyclic
(B)	 $Ph-\overset{OH}{\overset{\vert}{C}}H-CH_2-COOH \xrightarrow{\Delta}$	(q)	Exibit geometrical isomerism.
(C)	 $Ph-\underset{OH}{\underset{\vert}{C}}H-CH_2-CH_2-COOH \xrightarrow{\Delta}$	(r)	Can be optically active
(D)	$HO-CH_2-OH \xrightarrow{\Delta}$	(s)	Lactonisation

2. Match the following

	Column – I		Column – II
(A)	 $Ph-\overset{O}{\overset{\Vert}{C}}-H \xrightarrow{KCN} Product$	(p)	Final product gives positive Tollen's test.
(B)	 $\xrightarrow[\text{(ii) } H^+]{\text{(i) } OH^-} Product$	(q)	Final product gives test with 2,4 – DNP
(C)	 $H_3C-\overset{O}{\overset{\Vert}{C}}-OC_2H_5 \xrightarrow[\text{(ii) } H_3O^+ \text{ (iii) } \Delta]{\text{(i) } EtO^-Na^+} Product$	(r)	Final product reacts with Na and liberates CO_2 gas
(D)	 $Ph-\overset{O}{\overset{\Vert}{C}}-H \xrightarrow[\text{(ii) } H^+]{\text{(i) } KOH} Product$	(s)	Final product reacts with Na and liberates H_2 gas.

3. Match the radicals of column – I with their group reagents in column II

	Column – I		Column – II
(A)	Pb^{2+}	(p)	H_2S
(B)	Co^{2+}	(q)	$(NH_4Cl + NH_4OH)$
(C)	Fe^{3+}	(r)	HCl
(D)	Ba^{2+}	(s)	$(NH_4)_2CO_3$

Rough Work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **9 multiple choice questions** numbered 1 to 9. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Consider a 9 sided regular polygon. If 5 vertices are selected at random then the minimum pairs of parallel lines formed from those 5 vertices is

(A) 0 (B) 1

(C) 2 (D) none of these

2. Consider a curve |x| + |y| = 1 such that lines y = mx, y = nx make points of intersection in the same quadrant. Let A, B be two such points lying in the same quadrant such that OA, AB, OB are in A.P. then the maximum angle θ is (0 is origin)

(A) $\frac{\pi}{6}$ (B) $\frac{\pi}{3}$

(C) $\frac{\pi}{4}$ (D) none of these

3. Let, a_1, a_2, a_3, ….. a_{23} be 23 integers (not necessarily distinct). Then, the prime number which always divides the sum of elements of atleast one subset of these numbers can be

(A) 23 (B) 29

(C) 31 (D) 37

4. Given that $|z_1|$, $|z_2|$, $|z_3|$, $|z_4|$ are non zero positive real numbers where z_1, z_2, z_3, z_4 are complex numbers then $\frac{1}{|z_1|}+\frac{1}{|z_2|}+\frac{4}{|z_3|}+\frac{16}{|z_4|}=\frac{k}{|z_1|+|z_2|+|z_3|+|z_4|}$ where k is

(A) 8 (B) 16

(C) 64 (D) none of these

Space for rough work

5. Let, $C_1 : r = ae^{\theta}$ and $C_2 : re^{\theta} = b$ be two curves then the angle between the curves is

(A) $\frac{\pi}{6}$ (B) $\frac{\pi}{3}$

(C) $\frac{\pi}{4}$ (D) $\frac{\pi}{2}$

6. Given the equation $f''(x) = 0$; f, f′, f″ are continuous in $a \le x \le b$ and curve $y = f(x)$ crosses the x–axis at least in 3 distinct points in [a, b] then which of the following represents the minimum number of roots in (a, b)

(A) 2 (B) 3

(C) 4 (D) none of these

7. The possible solution of the differential equation $y(y^2 - 2x^2)dx + x(2y^2 - x^2)dy = 0$ is

(A) $x^2y^2(x^2 + y^2) = c$ (B) $x^2(y^2 - x^2) = c$

(C) $x^2y^2(y^2 - x^2) = c$ (D) none of these

8. A circle with radius 'a' and centre on y-axis slides along y-axis and a variable line through (a, 0) cuts the circle at points P and Q, then the point of intersection of tangents to the circle at P and Q will lie in the region defined by

(A) $y^2 \ge 4a(x-a)$ (B) $y^2 \le 4ax$

(C) $x^2 + y^2 \le 4a^2$ (D) $x^2 - y^2 \ge a^2$

9. If f: [0, 1] → (0, ∞) such that $\int_0^1 f(x)dx = 1$, $\int_0^1 xf(x)dx = \alpha$ and $\int_0^1 x^2f(x)dx = \alpha^2$, then

(A) f(x) = 5 (B) f(2) = 8

(C) f(x) is not possible (D) f(x) = (2x – 1)

Space for rough work

Reasoning Type

This section contains **4 questions** numbered 10 to 13. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

---

10. STATEMENT 1: $2p^3 - (2x + 4\sin x - \cos x)p^2 - (x\cos x - 4x\sin x + \sin 2x)p + x\sin 2x = 0$ is a differential equation with a possible solution as $(2y - x^2 - c)(y + 2\cos x - c)$ $(2y + \sin x - c) = 0$; $\left[p = \dfrac{dy}{dx}\right]$

STATEMENT 2: Degree of differential equation is the power of the highest order derivative existing in the differential equation

(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

11. STATEMENT 1: Consider a polynomial such that $p(\lambda) = \dfrac{\lambda}{\lambda + 1}$, $\lambda \in I^+ \cup \{0\}$, $\lambda \le n$ then

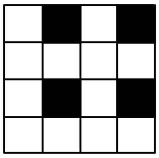
$p(n+1) = \dfrac{n}{n+2}$

STATEMENT 2: Let, $Q(x) = (x + 1)\,p(x) - x$ then $Q(x)$ vanishes for $x = 0, 1, 2, \ldots, n$ hence,
$(x + 1)\,p(x) - x = \alpha x(x - 1)(x - 2) \ldots (x - n)$

(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

12. STATEMENT 1: A rectangular floor is covered by two kinds of tiles 2 × 2 and 1 × 4. One tile is smashed and there is a tile of other kind available then, the floor cannot be covered by rearranging the tiles

STATEMENT 2: If we colour the floor as shown 4 × 1 tile covers 0 or 2 black squares. A 2 × 2 tile always covers one black square so, it is impossible to replace one type of tile for the other



(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

Space for rough work

13. STATEMENT 1: Consider an ellipse $ax^2 + 2hxy + by^2 = 1$ then its eccentricity (e) is $e^2 = \frac{\sqrt{(a-b)^2 + 4h^2}}{2(ab - h^2)}\left[(a+b) - \sqrt{(a-b)^2 + 4h^2}\right]$

STATEMENT 2: Any ellipse can be transformed to the principal axis as $\frac{x'^2}{\alpha^2} + \frac{y'^2}{\beta^2} = 1$ then associated eccentricity is $e^2 = \frac{\alpha^2 + \beta^2}{\alpha^2}$

(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

Comprehension Type

This section contains **2 groups of questions.** Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 14 to 16

Read the following write up carefully and answer the following questions:
Consider a function $f : R \to R$ such that $(f(x) + f(z))(f(y) + f(t)) = f(xy - zt) + f(xt + yz)$ where $x, y, z, t \in R$

14. For the function, $f : R \to R$, f(x) can be
(A) even (B) odd
(C) neither even nor odd (D) none of these

15. If $f : R \to R$ is the given function then in the interval $(0, \infty)$ f(x) is
(A) non decreasing (B) non increasing
(C) decreasing (D) none of these

16. The number of functions $f : R \to R$ which satisfy the given functional equation is
(A) 1 (B) 2
(C) 3 (D) none of these

Space for rough work

Paragraph for Question Nos. 17 to 19

Read the following write up carefully and answer the following questions:

Consider a parabola, $y^2 = 4ax$ then $y + tx = at^3 + 2at$ represents a normal at a point $(at^2, 2at)$. It can also be represented as $y - mx + am^3 + 2am = 0$ in its slope form.

Considering the above equation and assuming it passes through a point P(h, k) we can say that

$k - mh + am^3 + 2am = 0 \Rightarrow am^3 + m(2a - h) + k = 0$ from P(h, k) maximum 3 normals can be made to the parabola $y^2 = 4ax$

17. Consider a point $P(x_1, 0)$ lying inside the parabola $y^2 = 4ax$ then the interval of x_1 such that only one normal passes through P is

(A) (0, 8a) (B) (0, 2a)

(C) 0, 4a) (D) none of these

18. The number of points for the parabola $y^2 = 4ax$ from which 3 coincident normals can be drawn is

(A) 1 (B) 2

(C) 4 (D) none of these

19. The area of the region inside the parabola $y^2 = 4ax$ from which only one normal can be drawn is

(A) $\frac{352\sqrt{2}a^2}{15}$ (B) $32\sqrt{2}a^2$

(C) $\frac{48\sqrt{2}a^2}{5}$ (D) none of these

SECTION – B

(Matching List Type)

This section contains **3 multiple choice questions.** Each question has matching Column(s). The codes for the Column(s) have choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. Match the following Column–I with Column–II

	Column – I		Column – II
(A)	If 2 is the root of the equation $\lvert A - xI\rvert = 0$, (where A is a non singular matrix), $\frac{\lvert A\rvert}{2}$ a root of $\lvert B - xI\rvert = 0$, then B can be	(p)	e
(B)	If $e^{i\alpha}$ is the root of $\lvert A - yI\rvert = 0$ then a root of $\lvert \bar{A}' - xI\rvert = 0$ is (where A is a non singular matrix)	(q)	adj(A)
(C)	Let A_{ij} be a 2 × 2 non singular matrix where i, j ∈ N and $B = \begin{bmatrix} \lvert A_{11}\rvert \lvert A_{12}\rvert .... \lvert A_{1n}\rvert \\ 0 \quad \lvert A_{22}\rvert .... \lvert A_{2n}\rvert \\ 0 \quad 0 \quad \lvert A_{33}\rvert ... \lvert A_{3n}\rvert \\ ------------ \\ ------------ \\ 0 \; ------- \lvert A_{nn}\rvert \end{bmatrix}$ then $\lvert B - \lambda I\rvert = 0$ has root as	(r)	$\cos\alpha - i\sin\alpha$
(D)	Consider a matrix such that $\bar{A}' = A$ then the equation $\lvert A - xI\rvert = 0$ can have root as (where A is a non singular matrix)	(s)	$\lvert A_{11}\rvert$

Space for rough work

2. Match the following Column–I with Column–II

	Column – I		Column – II
(A)	If 32 $\sin^4\theta\cos^2\theta = \cos 6\theta - 2\cos 4\theta - \cos 2\theta + \lambda$ then λ is	(p)	$\frac{1}{8}$
(B)	Consider a tetrahedron with just one edge of length greater than 1 then its maximum volume is	(q)	$\frac{3}{2}$
(C)	Consider an acute angled triangle ABC such that $x_n = 2^{n-3}(\cos^n A + \cos^n B + \cos^n C) + \cos A \cos B \cos C$ where $n \in N$ then $x_1 + x_2 + x_3$ is atleast	(r)	$\frac{8}{9}$
(D)	Consider a ΔABC such that $\left(\cot\frac{A}{2}\right)^2 + \left(2\cot\frac{B}{2}\right)^2 + \left(3\cot\frac{C}{2}\right)^2 = \left(\frac{6}{7}\frac{S}{r}\right)^2$ where S and r are semi perimeter and inradius respectively, then $\frac{b}{c}$ is	(s)	2

3. Match the following Column–I with Column–II

	Column – I		Column – II
(A)	Consider an equation $8x^4 - 16x^3 + 16x^2 - 8x + a = 0$ then the sum of all the non real roots of the equation can be ($a \in R$)	(p)	9
(B)	If $x, y \in R^+$ such that $x + y = 2$ then the greatest value of $2x^3y^3(3x^3 + 3y^3)$ is	(q)	18
(C)	The number of all 7–digit numbers formed by using only the digits 5 and 7 & divisible by both 5 and 7 are	(r)	12
(D)	$X = \{8, 9, 10, \ldots\}$; $f : X \to X$ and $f(x + y) = f(xy)\ \forall\ x \geq 4$, $y \geq 4$; $f(8) = 9$ then $2f(9)$	(s)	2

Space for rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

FIITJEE **JEE(Advanced)-2014**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS
FULL TEST –I
(Paper-2)

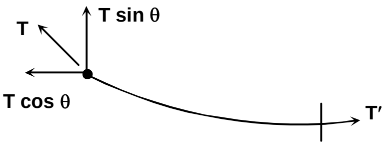
Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	D	B
2.	C	A	B
3.	D	C	A
4.	B	B	C
5.	B	B	D
6.	D	C	D
7.	B	D	C
8.	C	B	A
9.	A	C	C
10.	D	B	C
11.	B	A	D
12.	D	C	A
13.	B	A	C
14.	A	D	A
15.	A	C	A
16.	B	B	C
17.	B	A	B
18.	A	B	A
19.	B	C	A
1.	(A) → (s), (B) → (q), (C) → (p), (D) → (r)	(A → p, q, r), (B → q), (C → p, r, S), (D → p)	(A) → (q), (B) → (r), (C) → (s), (D) → (p)
2.	(A) → (q); (B) → (r); (C) → (s); (D) → (p)	(A → p, q, s), (B → r, s), (C → q), (D → r, s)	(A) → (s), (B) → (p), (C) → (q), (D) → (r)
3.	(A) → (p), (B) → (r), (C) → (s), (D) → (q)	(A → p, r), (B → q, p), (C → q), (D → q, s)	(A) → (s), (B) → (r), (C) → (p), (D) → (q)

Physics PART – I

2. $T \sin \theta = mg/2$

$T' = T \cos \theta$

$= \frac{mg}{2} \cot\theta = \frac{mg}{2\tan\theta}$



3. $\frac{1}{2}mv^2 = pt$ (P = const)

$\Rightarrow \quad v = \sqrt{\frac{2Pt}{m}}$

$a = \frac{dv}{dt} = \sqrt{\frac{2P}{m}}\frac{1}{2\sqrt{t}}$

$F = ma = \sqrt{\frac{mP}{2t}} \propto \frac{1}{v}$

5. $\vec{F} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \vec{F}_4 + \vec{F}_5$

$\left|\vec{F}_2\right| = \left|\vec{F}_5\right|$ and $\left|\vec{F}_2\right| = \left|\vec{F}_4\right|$

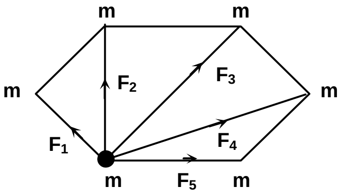
$\vec{F}_1 = \vec{F}_3 + 2F_2 \cos 30° + 2F_1 \cos 60°$

$F_3 = \frac{Gm^2}{4a^2}$; $F_2 = \frac{Gm^2}{3a^2}$; $F_1 = \frac{Gm^2}{a^2}$

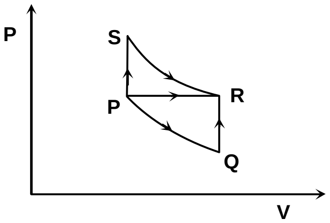
$F = \frac{Gm^2}{a^2}\left(\frac{5}{4} + \frac{1}{\sqrt{3}}\right) = m\omega^2 a$

$\omega = \sqrt{\frac{Gm}{a^3}\left(\frac{5}{4} + \frac{1}{\sqrt{3}}\right)}$

$T = 2\pi\sqrt{\frac{4\sqrt{3}a^3}{Gm\left(5\sqrt{3} + 4\right)}}$



6.



7. $a = \frac{\rho v(g+a) - m(g+a)}{m} = 20 \text{ m/s}^2$

$t = \sqrt{\frac{2h}{a}} = 1$ sec

10. Time period becomes $2\pi\sqrt{\frac{R}{g}}$. We can't neglect the roundness of earth for the pendulum of infinite length.

12. The –ve sign is $-\frac{d\phi}{dt}$ signifies the direction of induced emf.

14. process AB $U\rho$ = constant

$\frac{P}{\rho} = \frac{RT}{M}$ and $U \propto t$

$\Rightarrow$ P = const

Process BC $\rightarrow$isochoric

Process CA $\rightarrow$ isothermal

15. $Q = Q_{AB} + Q_{BC} + Q_{CA}$

$Q = -5U_0 + 3U_0 + \frac{10U_0}{3}\ln 2.5$

16. $W_{AB} = \Delta Q_{AB} - \Delta U_{AB} = -5U_0 - (-3U_0) = -2U_0$

17. For lens L_1, ray must move parallel to the axis after refraction $\frac{\mu_1}{\infty} + \frac{\mu_w}{x} = \frac{\mu_1 - \mu_\omega}{R_1} \Rightarrow x = 10$ cm

18. For lens L_2, image must form at centre of curvature of the curved surface after refraction through plane part.

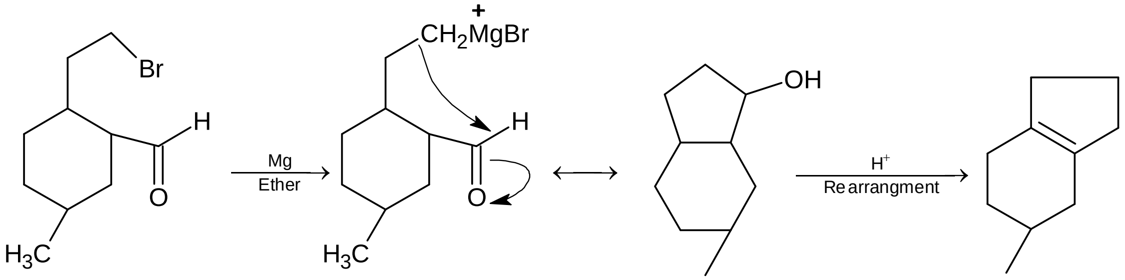
$\frac{\mu_2}{-R_2} + \frac{\mu_\omega}{x'} = 0$

$\Rightarrow$ $x' = 8$ cm

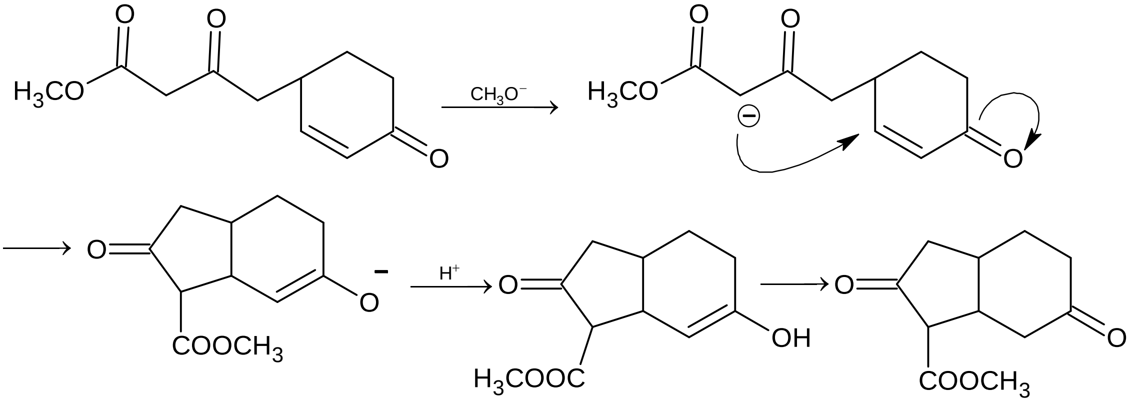
Chemistry

PART – II

1.


Br
H
O
H3C
Mg
Ether
CH2MgBr
+
H
O
H3C
OH
H+
Rearrangment

2.


O
O
H3CO
O
CH3O−
H3CO
O
O
O
O
COOCH3
O
H+
O
H3COOC
OH
O
COOCH3
O

3. $P = P_A^o X_A + P_B^o = P_A^o(1 - X_B) + P_B^o X_B$

$\Rightarrow P = P_A^o - \left(P_A^o - P_B^o\right) \times B$

Thus $P_A^o = 120$ Torr

$P_A^o - P_B^o = 75 \Rightarrow P_B^o = 45$ Torr

Hence C is correct answer.

4. $\Lambda^o_{BaSO_4} = \kappa \times \dfrac{1000}{\text{Conc}(\text{normality})}$

$\text{Normality} = \dfrac{\kappa \times 1000}{\Lambda^o_{BaSO_4}} = \dfrac{1000 \times 8 \times 10^{-5}}{400} = 2 \times 10^{-4}.$

$\text{Molarity} = \dfrac{\text{Normality}}{2} = 10^{-4}\,\text{M}\ (\text{Solubility})$

$\text{Ksp} = S^2 = 10^{-8}\ \text{M}^2.$

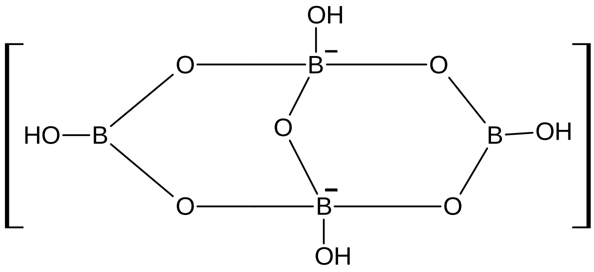
5. $T_{av} = \dfrac{1}{K}$

$T_{99.9} = 10 \times ty_2 = \dfrac{10 \times 0.693}{K} = \dfrac{6.93}{K}$

Number of natural life times = $\left(\dfrac{6.693}{K}\right) / \left(\dfrac{1}{K}\right)$

= 6.93

6.



7. $\underset{145}{Ca(OCl)Cl.H_2O} \longrightarrow \underset{71}{Cl_2}$

Percentage $= \frac{71}{145} \times 100 = 49$

Hence D is correct answer.

17. $\left[\frac{d(c)}{dt}\right]_I = \frac{0.0033}{25} = 1.32 \times 10^{-4} \text{m min}^{-1}$

$\left(\frac{d(c)}{dt}\right)_{II} = 2.6 \times 10^{-4} \text{ m min}^{-1}$

$\left(\frac{d(c)}{dt}\right)_{III} = 1.02 \times 10^{-3} \text{m min}^{-1}$

18. On comparing rates order w.r.t A = 2, and w.r.t. B = 1. Thus rate law = $K[A]^2[B]$

19. $\frac{dx}{dt} = K[A]^2[B]$

$K = \frac{(dx/dt)}{[A]^2[B]} = 0.26$

Mathematics PART – III

1. Total number of lines made = ${}^9C_2 = 36$
Now, these 36 lines are 9 sets each with 4 parallel members. With 5 vertices number of lines made
$= {}^5C_2 = 10$
Clearly, atleast 2 members belong to the same set
So, atleast one pair is parallel

2. $$\cos\theta = \frac{OA^2 + OB^2 - AB^2}{2OA\cdot OB}$$
$$= \frac{OA^2 + OB^2 - \left(\frac{OA+OB}{2}\right)^2}{2OA\cdot OB} = \frac{3}{8}\frac{\left(OA^2+OB^2\right)}{OA\cdot OB} - \frac{1}{4}$$
For maximum cos θ,
$$\frac{3}{8}\left(\frac{OA^2+OB^2}{OA\cdot OB}\right) - \frac{1}{2} \ge \frac{3}{8}\times\frac{2\cdot OA\cdot OB}{OA\cdot OB} - \frac{1}{4} = \frac{1}{2}$$
$$\Rightarrow \theta = \frac{\pi}{3}$$

3. $S_1 = a_1$
$S_2 = a_1 + a_2$
$S_3 = a_1 + a_2 + a_3$
$\vdots$
$S_n = a_1 + a_2 + \ldots.. + a_n$
If we divide all $S_1, S_2, \ldots.. S_n$ by 23 we get remainders 1, 2, 3, 4, ….., 22
So, two of these give same remainders S_p, S_q
$\Rightarrow S_p - S_q$ will be divisible by 23
$S_p - S_q = a_{p+1} + a_{p+2} + \ldots.. + a_q$

4. Using Cauchy we get, $\left(|z_1| + |z_2| + |z_3| + |z_4|\right)\left(\frac{1^2}{|z_1|} + \frac{1^2}{|z_2|} + \frac{2^2}{|z_3|} + \frac{4^2}{|z_4|}\right) \ge (1+1+2+4)^2 = 64$

5. Point of intersection is $\theta = \frac{1}{2}\ln\left(\frac{b}{a}\right)$
For C_1,
$\frac{dr}{d\theta} = ae^{\theta}$, now $\tan\phi_1 = r\frac{d\theta}{dr} = \left(ae^{\theta}\right)a^{-1}e^{-\theta} = 1$
$$\therefore \phi_1 = \frac{\pi}{4}$$
For C_2,
$\frac{dr}{d\theta} = -be^{-\theta} \Rightarrow \tan\phi_2 = \left(be^{-\theta}\right)\left(-\frac{1}{b}\right)e^{\theta} = -1$
$$\therefore \phi_2 = \frac{3\pi}{4}$$
$\therefore$ Angle of intersection is $\phi_2 - \phi_1 = \frac{3\pi}{4} - \frac{\pi}{4} = \frac{\pi}{2}$

6. Let c, d, e be the three points where y = f(x) crosses x–axis. Then, f(c) = f(d) = f(e) = 0
Assuming a < c < d < e < b. The function f satisfies Rolle's theorem in two intervals (c, d) and (d, e). Since f and f′ are continuous and f(c) = f(d) = 0
So, there exists, at least one point in the interval (c, d) and (d, e) such that derivative is zero
Let, $C_1 \in$ (c, d) such that $f'(C_1) = 0$ and $C_2 \in$ (d, e) such that $f'(C_2) = 0$. Now the function f′ satisfies Rolle's theorem since f′, f″ are continuous and $f'(C_1) = f'(C_2) = 0$
So, by Rolle's theorem, there exists a number C_3 in between C_1 and C_2 such that $f''(C_3) = 0$
⇒ Minimum one root C_3 of the equation f″(x) = 0 lies in the interval (a, b)

7. Dividing the given differential equation by $3xy(y^2 - x^2)$

$$\frac{y\left(y^2-2x^2\right)}{3xy\left(y^2-x^2\right)}dx+\frac{x\left(2y^2-x^2\right)}{3xy\left(y^2-x^2\right)}dy=0$$

$$\Rightarrow \frac{dx}{x}-\frac{xdx}{y^2-x^2}+\frac{ydy}{y^2-x^2}+\frac{dy}{y}=0$$

$$\Rightarrow d\left(\ln(xy)\right)+\frac{1}{2}\frac{d\left(y^2-x^2\right)}{y^2-x^2}=0$$

$$\Rightarrow d\left[\ln\left[x^2y^2\left(y^2-x^2\right)\right]\right]=0$$

$$\Rightarrow \ln\left[x^2y^2\left(y^2-x^2\right)\right]=c$$

$$\Rightarrow x^2y^2(y^2-x^2) = c$$

8. Let the circle be $x^2+\left(y-\alpha\right)^2=a^2$. Let the point of intersection of tangents at P and Q be (h, k).
Then equation of PQ, is $hx+\left(k-\alpha\right)\left(y-\alpha\right)-a^2=0$. As it passes through $\left(a,0\right)$, so,

$ha-\alpha\left(k-\alpha\right)-a^2=0$.

$\Rightarrow \alpha^2-k\alpha+a\left(h-a\right)=0.\ \ D\ge 0 \Rightarrow k^2-4a\left(h-a\right)\ge 0$

i.e. $y^2\ge 4a\left(x-a\right)$.

9. Consider $\int_0^1(\alpha-x)^2 f(x)dx=\int_0^1\left(\alpha^2f(x)-2\alpha xf(x)+x^2f(x)\right)dx = \alpha^2 - 2\alpha^2 + \alpha^2 = 0$
However f(x) assumes only positive values i.e. in (0, 1)
$\Rightarrow (\alpha - x)^2 (f(x)) > 0 \Rightarrow$ integral can't be zero

10. Differential equation can be written as, (p – x)(p – 2 sin x)(2p + cos x) = 0 which has solution as $(2y - x^2 - c)(y + 2\cos x - c)(2y + \sin x - c) = 0$

11. Put x = –1 we get $(-1 + 1)\, p(-1) + 1 = \alpha(-1)^{n+1}(n + 1)!$

$$\alpha=\frac{(-1)^{n+1}}{(n+1)!}$$

So, $p(x)=\dfrac{(-1)^{n+1}x(x-1).....(x-n)}{(n+1)!(n+1)}+\dfrac{x}{x+1}$

Clearly, $p(n+1)=\begin{cases}1, & \text{where 'n' is odd}\\ \dfrac{n}{n+2}, & \text{where 'n' is even}\end{cases}$

13. If e is the eccentricity then, $e^2 = \frac{\alpha^2 - \beta^2}{\alpha^2}$

Now, we know, $\frac{1}{\alpha^2} + \frac{1}{\beta^2} = a + b \Rightarrow \frac{1}{\alpha^2\beta^2} = ab - h^2$

$\Rightarrow \alpha^2 + \beta^2 = \frac{a+b}{ab-h^2}$, $\alpha^2\beta^2 = \frac{1}{ab-h^2}$

$\therefore \alpha^2 - \beta^2 = \sqrt{\frac{(a+b)^2 - 4(ab-h^2)}{(ab-h)^2}}$

$\frac{1}{\alpha^2} - \frac{1}{\beta^2} = \mp\sqrt{(a+b)^2 - 4(ab-h^2)}$

For an ellipse $\frac{2}{\alpha^2} = a + b - \sqrt{(a+b)^2 - 4(ab-h^2)}$

So, $e^2 = \frac{\sqrt{(a-b)^2 + 4h^2}}{2(ab-h^2)}\left[(a+b) - \sqrt{(a-b)^2 + 4h^2}\right]$

14. Put y = z = t = 0
f(0)[f(x) + f(0)] = f(0)
Put x = 0
$2f^2(0) = f(0)$
$\Rightarrow f(0) = 0, \frac{1}{2}$
If $f(0) = \frac{1}{2} \Rightarrow f(x) + \frac{1}{2} = 1$
$\Rightarrow f(x) = \frac{1}{2}$
If f(0) = 0, z = t = 0
$\Rightarrow$ f(x) f(y) = f(xy)
Let, x = y = 1 $\Rightarrow f^2(1) = f(1)$
$\Rightarrow$ f(1) = 0 or f(1) = 1
We have f(0) = 0, f(1) = 0, y = 1
f(x) = 0
Also, f(0) = 0, f(1) = 1, x = 0, y = t = 1
(f(0) + f(z)) (f(1) + f(1)) = f(–z) + f(z)
$\Rightarrow$ 2f(z) = f(–z) + f(z)
$\Rightarrow$ f(z) = f(–z)

15. If y = x in f(x) f(y) = f(xy)
$\Rightarrow f(x^2) = f^2(x) \geq 0$
Put x = t, y = z
$[f(x) + f(y)]^2 = f(x^2 + y^2)$
$\Rightarrow f(x^2 + y^2) = f^2(x) + f^2(y) + 2f(x)f(y) \geq f^2(x)$
$\Rightarrow f(x^2 + y^2) \geq f(x^2)$
$\Rightarrow$ f is non decreasing for positive x

16. Put y = z = t = 1
$\Rightarrow$ 2(f(x) + 1) = f(x – 1) + f(x + 1)
f(2) = 4, f(z) = 9, f(1) = 1, f(0) = 0
$f(n) = n^2$ (Possible function), if $f(n-1) = (n-1)^2$
2[f(n – 1) + 1] = f(n – 2) + f(n)

$\Rightarrow f(n) = n^2$

Now, for $x = \frac{p}{q}$ (rational number)

$f\left(\frac{p}{q}\right)f\left(q^2\right) = f(pq) \Rightarrow f\left(\frac{p}{q}\right)q^2 = p^2q^2$

$\Rightarrow f\left(\frac{p}{q}\right) = \left(\frac{p}{q}\right)^2$ (True for rational number)

Now, if $x \in R$, lets prove for positive x since if it is proved the function is even and will follow for negative x
Assume for $x > 0$, $f(x) < x^2$
So, now a rational number 'r' between $\sqrt{f(x)}$ and $x \Rightarrow \sqrt{f(x)} < r < x$
$\Rightarrow f(x) < r^2 < x^2$
[$f(r) = r^2$, f is non decreasing]
$\Rightarrow f(r) = r^2 \le f(x)$ [contradiction]
$\Rightarrow f(x) < x^2$ (impossible)
Similarly we can prove contradiction $f(x) > x^2$
So, only possibility $f(x) = x^2$ substituting $f(x) = x^2$ we get
$(f(x) + f(z)) (f(y) + f(t)) = f(xy – zt) + f(xt + yz)$
$(x^2 + z^2)(y^2 + t^2) = (xy – zt)^2 + (xt + yz)^2$ [Lagrange identity]
So, $f(x) = \frac{1}{2}$, $f(x) = 0$, $f(x) = x^2$ are the required solutions

17. $am^3 + m(2a – h) + k = 0$
$\Rightarrow am^3 + m(2a – x_1) = 0$
$\Rightarrow am^2 = x_1 – 2a$ {m = 0 (one possible value)}
$\Rightarrow m^2 = \frac{x_1 - 2a}{a}$, if $x \in (0, 2a)$
$\Rightarrow m^2 = (–)$ number, so non real roots

18. Let P(h, k) be the point $am^3 + m(2a – h) + k = 0$
Since, m_1, m_1, m_1 are the possible roots
$\Rightarrow 3m_1 = 0 \Rightarrow m_1 = 0$
If $m_1 = 0$ is the root then k = 0
$am^3 + m(2a – h) = 0$
$\Rightarrow m^2 = \frac{h-2a}{a} = 0 \Rightarrow h = 2a$
(2a, 0) is the only point

19. $A_1 = \int\limits_{2a}^{8a}\sqrt{\frac{4}{27a}}(x-2a)^{3/2}\,dx = \frac{2}{3\sqrt{3a}}\ \frac{2}{5}\left[(x-2a)^{5/2}\right]_{2a}^{8a}$

$= \frac{2}{3\sqrt{3a}}\ \frac{2}{5}(6a)^{5/2} = \frac{2}{3\sqrt{3a}} \times \frac{2}{5} \times 36a^2\sqrt{6a} = \frac{48\sqrt{2}a^2}{5}$

$A_1 = \int\limits_0^{8a}\sqrt{4ax}\,dx = 2\sqrt{a} \times \frac{2}{3}\left[x^{3/2}\right]_0^{8a} = \frac{4}{3}\sqrt{a}\ 8a\sqrt{8a} = \frac{64}{3}\sqrt{2}a^2$

Area = $2(A_2 – A_1) = 2 \times 16\sqrt{2}a^2\left[\frac{4}{3} - \frac{3}{5}\right] = 32\sqrt{2}a^2 \times \frac{11}{15} = \frac{352\sqrt{2}a^2}{15}$

SECTION – B

1. **(A)** |A – xI| = 0

There exists a non zero matrix X such that AX = xX

⇒ [(Adj A)A]X = x(adj A)X

⇒ |A|IX = x(adj A)X

⇒ |A|X = x(adj A)X

⇒ $\frac{|A|X}{x} = (\text{adj } A)X$

⇒ $(\text{adj } A)X = \frac{|A|X}{2}$

(B) $|\bar{A}' - \bar{\lambda}I| = |\overline{(A-\lambda I)'}| = |\overline{A-\lambda I}|$

∴ $|\bar{A}' - \bar{\lambda}I| = 0$ if and only if $|\overline{A-\lambda I}|$ = 0

⇒ $|\bar{A}' - \bar{\lambda}I| = 0$ if and only if $|\overline{A-\lambda I}|$ = 0

or $\bar{\lambda}$ is the root of $|\bar{A}' - xI| = 0$ if and only if λ is the root of |A – yI| = 0

∴ $e^{-i\alpha}$ is the required solution

(C) $$|B-\lambda I| = \begin{bmatrix} |A_{11}|-\lambda & |A_{12}|..........|A_{1n}| & \\ 0 & |A_{22}|-\lambda.....|A_{2n}| & \\ 0 & | & | \\ | & | & | \\ | & | & | \\ | & | & |A_{nn}|-\lambda \end{bmatrix} = 0$$

⇒ ($|A_{11}|$ – λ)($|A_{22}|$ – λ) ….. ($|A_{nn}|$ – λ) – 0

Clearly the elements of principal diagonal become the roots

(D) Let, AX = λX [X is a non zero matrix]

⇒ $\bar{X}'$ AX = $\bar{X}'$ λX = $\lambda\bar{X}' = A\bar{X}'IX$

$\bar{X}'AX$ and $\bar{X}'IX$ are both real

Also, $\bar{X}'X \neq 0$, $X \neq 0$

⇒ $\lambda = \bar{X}'AX/\bar{X}IX$ is real so λ can have real values

2. **(A)** z = cos θ + i sin θ, $z + \frac{1}{z} = 2\cos\theta$

$z - \frac{1}{z} = 2i\sin\theta$

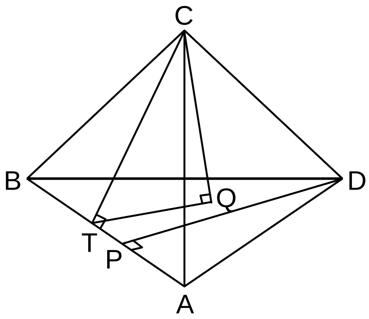
$z^p + \frac{1}{z^p} = 2\cos p\theta$

Now, $(2i\sin\theta)^4 (2\cos\theta)^2 = \left(z - \frac{1}{z}\right)^4 \left(z + \frac{1}{z}\right)^2 = \left(z^6 + \frac{1}{z^6}\right) - 2\left(z^4 + \frac{1}{z^4}\right) - \left(z^2 + \frac{1}{z^2}\right) + 4$

then, 2 cos 6θ – 2.2. cos 4θ – 2 cos 2 θ + 4

⇒ 2^4 i^4 $\sin^4$ θ 2^2 $\cos^2$ θ = 2(cos 6θ – 2 cos 4θ – cos 2θ + 2)

⇒ λ = 2



(B) Volume of tetrahedron = $\frac{1}{3}\times(\text{Ar}\Delta\text{ABD})\times\text{CQ}$

= $\frac{1}{3}\left(\frac{\text{AB}}{2}\right)\times\text{DP}\times\text{CQ}$

Let, CD be the largest side and AB = x ≤ 1
Let, T be closer to A than B

$\Rightarrow \text{BT} \ge \frac{x}{2}$

$\Rightarrow \text{CT}^2 = \text{BC}^2 - \text{BT}^2 \le 1-\frac{x^2}{4}$

$\Rightarrow \text{CT} \le \sqrt{1-\frac{x^2}{4}}$ (same for DP, CQ)

So, $V \le \frac{1}{3}\times\frac{x}{2}\times\left(1-\frac{x^2}{4}\right) = \frac{1}{24}x(4-x^2) \Rightarrow V_{\max} = \frac{1}{8}$

(C) By AM ≥ GM

$\cos^3 x + \frac{\cos x}{4} \ge \cos^2 x$ (x is an acute angle)

Now, setting x = A, B, C we get

$x_1 + x_3 \ge \cos^2 A + \cos^2 B + \cos^2 C + 2\cos A\cos B\cos C = 2x_2$

$\Rightarrow x_1 + x_2 + x_3 \ge 3x_2 = \frac{3}{2}$

(D) Let, $u = \cot\frac{A}{2}$, $v = \cot\frac{B}{2}$, $w = \cot\frac{C}{2} \Rightarrow u = \frac{S-a}{r}$, $v = \frac{S-b}{r}$, $w = \frac{S-c}{r}$

$\frac{S}{r} = \frac{(S-a)+(S-b)+(S-c)}{r} = u+v+w$

Now we can rewrite as $49[u^2 + 4v^2 + 9w^2] = 36(u + v + w)^2$

$\Rightarrow (3u - 12v)^2 + (4v - 9w)^2 + (18w - 2u)^2 = 0$

$\therefore u : v : w = 1 : \frac{1}{4} : \frac{1}{9}$

Multiplying by r we get $\frac{S-a}{36} = \frac{S-b}{9} = \frac{S-c}{4} = \frac{2S-b-c}{9+4}$

$= \frac{2S-c-a}{4+36} = \frac{2S-a-b}{36+9} \Rightarrow \frac{a}{13} = \frac{b}{40} = \frac{c}{45}$

3. **(A)** Put $x = y + \frac{1}{2}$ and substitute, $8y^4 + 4y^2 + a - \frac{3}{2} = 0$

Again, $z = y^2$ we get, $8z^2 + 4z + a - \frac{3}{2} = 0$

When $a \le \frac{3}{2}$ there are 2 non real roots and two real and $a > \frac{3}{2}$ we have 4 non real roots

$\therefore$ Sum = $\begin{cases} 1, & a \le \frac{3}{2} \\ 2, & a > \frac{3}{2} \end{cases}$

(B) $xy \le \left(\frac{x+y}{2}\right)^2 = 1 \Rightarrow 0 < xy \le 1$

$x^3y^3(x^3 + y^3) = 2(xy)^3((x + y)^2 - 3xy) = 2(xy)^3(4 - 3xy)$

Put z = xy

$$z^3(4-3z) \le \left(\frac{4-3z+3z}{4}\right)^4 = 1$$

$\therefore x^3y^3(x^3+y^3) \le 2$

(C) There are 9 possible numbers of the type 7775775, 7757575, 7575575 etc.

(D) We have f(9) = f(4 + 5) = f(4 . 5) = f(20) = f(16 + 4) = f(16 . 4) = f(64)

$\Rightarrow$ f(64) = f(8 . 8) = f(8 + 8) = f(16) = f(4 . 4) = f(4 + 4) = f(8) = 9

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

FIITJEE **JEE (Main), 2014**

ALL INDIA TEST SERIES

FULL TEST – I

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 03 and 10 to 12)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (04 to 09 and 13 to 30) contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant R = $8.314\ J\ K^{-1}\ mol^{-1}$
= 0.0821 Lit atm $K^{-1}\ mol^{-1}$
= $1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

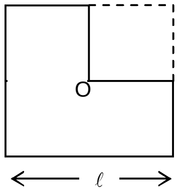
PART – I

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. One quarter of the plate is cut from a square plate as shown in the figure. If 'M' is the mass of the plate and 'ℓ' is the length of each side, then the moment of inertia of the plate about an axis passing through 'O' and perpendicular to the plate is

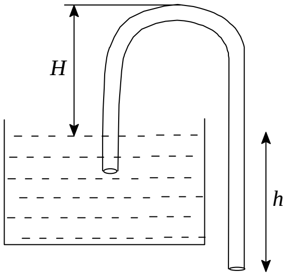


(A) $M\ell^2 / 8$ (B) $3M\ell^2/4$
(C) $M\ell^2/3$ (D) $3M\ell^2$

2. A block is suspended by an ideal spring constant K. If the block is pulled down by constant force F and if maximum displacement of block from it's initial position of rest is z, then
(A) $z = F/K$ (B) $z = 2F/K$
(C) work done by force F is equal to 2Fz.
(D) increase in potential energy of the spring is $\frac{1}{2}Kz^2$

3. A particle starts from rest and moves with an acceleration of $a = \{2 + |t - 2|\}$ m/s^2, the velocity of the particle at t = 4 sec is
(A) 2 m/s (B) 4 m/s
(C) zero (D) 12 m/s.

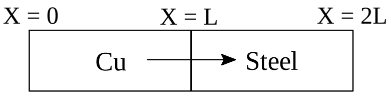
4. A large tank filled with water of density ρ and surface tension γ is being siphoned out using a glass capillary tube of cross-sectional radius *r*. If the siphon action starts without any external agent, then (angle of contact is zero).

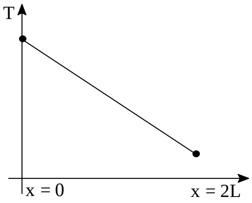


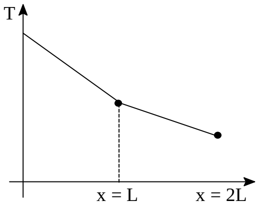
(A) $H < \frac{\gamma}{\rho g r}$ (B) $H < \frac{2\gamma}{\rho g r}$
(C) $H - h < \frac{2\gamma}{\rho g r}$ (D) $\sqrt{H^2 - h^2} < \frac{\gamma}{\rho g r}$

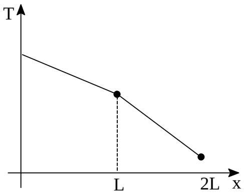
Space for Rough work

5. A copper rod and a steel rod of equal cross-sections and lengths (L) are joined side by side and connected between two heat baths as shown in the figure. If heat flows through them from x = 0 to x = 2L at a steady rate, and conductivities of the metals are K_{cu} & K_{steel} ($K_{cu} > K_{steel}$), then the temperature varies as: (convection and radiation are negligible)



(A)


(B)


(C)


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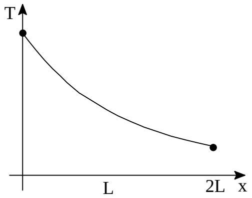
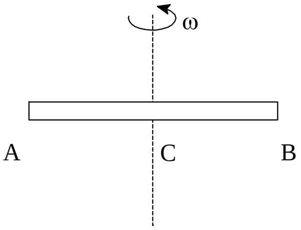


6. A non –conducting rod AB of length *l* has a total charge q. The rod is rotated about an axis passing through its center of mass with a constant angular velocity ω as shown in the figure. The magnetic moment of the rod is



(A) $\frac{q\omega l^2}{12}$

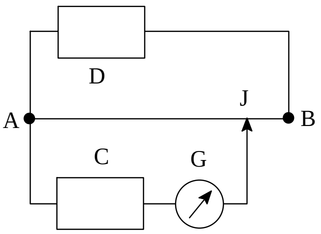
(B) $\frac{q\omega l^2}{3}$

(C) $\frac{q\omega l^2}{24}$

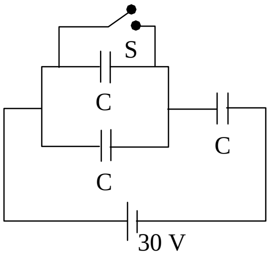
(D) $\frac{q\omega l^2}{6}$

Space for Rough work

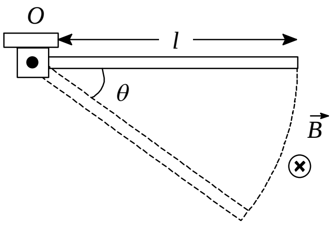
7. The figure shows a potentiometer arrangement. *D* is the driving cell, *C* is the cell whose e.m.f. is to be determined. *AB* is the potentiometer wire and *G* is a galvanometer. *J* is a sliding contact which can touch any point on *AB*. Which of the following are essential conditions for obtaining balance?
(A) The e.m.f. of *D* must be greater than the e.m.f. of *C*
(B) The positive terminals of D and C both must be joined to A
(C) The resistance of G must be less than the resistance of AB
(D) None of these



8. Three capacitors each having capacitance $C = 2\ \mu F$ are connected with a battery of e.m.f. 30 V as shown in the figure. When the switch *S* is closed. The amount of charge flown through the battery is
(A) 20 μC (B) 24 μC
(C) 10 μC (D) 40 μC



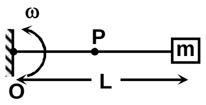
9. A conducting rod of length *l* is hinged at point *O*. It is free to rotate in a vertical plane. There exists a uniform magnetic field $\vec{B}$ in horizontal direction. The rod is released from the position shown in the figure. The potential difference between the two ends of the rod when it rotates through an angle θ is proportional to:
(A) ℓ^2 (B) $\ell^{3/2}$
(C) $\sin\theta$ (D) None of these



10. If $\vec{a}$ and $\vec{b}$ are two non parallel vectors then $\left[\vec{a}\times\left(\vec{a}\times\vec{b}\right)\right].\left[\vec{a}\times\vec{b}\right]$ is equal to
(A) a^3b^2 (B) $a^2\left(\vec{a}.\vec{b}\right)$
(C) zero (D) None of these

11. A boat goes downstream for half an hour and then goes upstream for half an hour. The total distance travelled by the boat in the ground frame for this is 20 km. Ii is known that speed of the boat relative to the river for the whole trip was constant and greater than the speed of the river. The distance travelled by the boat in the frame of the river for this is
(A) zero (B) 20 km
(C) 10 km (D) can't be determined

Space for Rough work

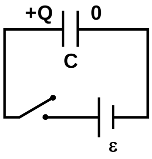


12. A particle of mass m is attached to a rod of length L and it rotates in a circle with a constant angular velocity ω. An observer P is rigidly fixed on the rod at a distance L/2 from the centre. The acceleration of m and the pseudo force on m from the frame of reference of P must be respectively

(A) zero, zero
(B) zero, $m\omega^2\frac{L}{2}$
(C) $\omega^2\frac{L}{2}$, $m\omega^2\frac{L}{2}$
(D) zero, $m\omega^2L$

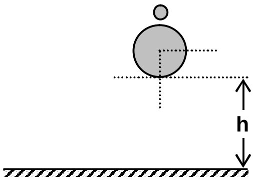
13. For a certain organ pipe open at both ends, the successive resonance frequencies are obtained at 510, 680 and 850 Hz. The velocity of sound in air is 340 m/s. The length of the pipe must be
(A) 2 m
(B) 0.5 m
(C) m
(D) 0.25 m

14. A short linear object of length 1 mm lies along the axis of a biconvex lens of focal length 5 cm at a distance of 15 cm. The length of the image will be approximately
(A) 1/16 mm
(B) 1/4 mm
(C) 1/2 mm
(D) 1/8 mm



15. The left plate of the capacitor shown in the figure above carries a charge +Q while the right plate is uncharged at t = 0. The total charge on the right plate after closing the switch will be

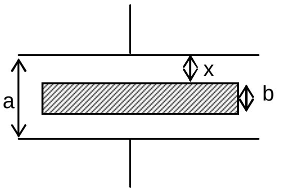
(A) $\frac{Q}{2} + C\varepsilon$
(B) $\frac{Q}{2} - C\varepsilon$
(C) $-\frac{Q}{2}$
(D) $- C\varepsilon$

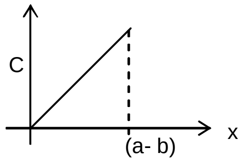


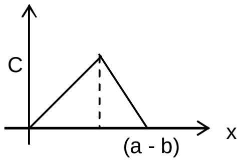
16. A small sphere and a big sphere are released from rest with a very small gap from height h as shown in the figure. The mass of bigger sphere is very large as compared to mass of smaller sphere the height from the point of collision of smaller sphere with the bigger sphere to which the smaller sphere will rise if all the collisions are elastic
(A) 2h
(B) 4h
(C) 6h
(D) 9h

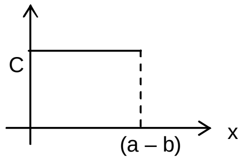
Space for Rough work

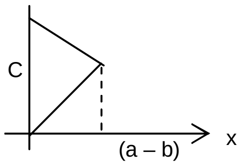
17. The distance between two parallel plates of a capacitor is a. A conductor of thickness b(b < a) is inserted between the plates as shown in the figure. The variation of effective capacitance between the surfaces of conductor and plate as a function of the distance (x) is best represented by



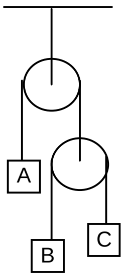
(A)


(B)


(C)


(D)


18. Three blocks A, B and C having masses m kg 2kg and 3 kg are attached by massless strings and ideal pulleys as shown in the figure. When the system is released from rest if the block 'A' remains stationary , the mass of block 'A' is



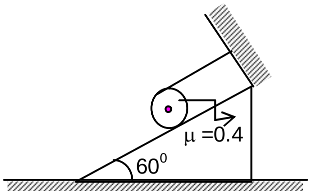
(A) 2.2 kg (B) 2.6 kg
(C) 2.4 kg (D) 4.8 kg

19. A block of mass 2 kg is attached to one end of a massless rod of length $\frac{1}{\pi}$m. The rod is fixed to a horizontal plane at the other end such that the block and rod are free to revolve on a horizontal plane. The coefficient of friction between the block and surface is 0.1. Block is made to rotate with uniform speed by applying a constant external force in tangential direction on the block. The work done by external force when the rod rotates by 90^0 is
(A) 0 (B) 10 joule
(C) $\frac{\pi}{2}$ joule (D) 1 joule

20. A solid sphere of radius R, and dielectric constant 'k' has spherical cavity of radius R/4. A point charge q_1 is placed in the cavity. Another charge q_2 is placed outside the sphere at a distance of r from q. Then Coulombic force of interaction between them is found to be 'F_1'. When the same charges are separated by same distance in vacuum then the force of interaction between them is found to be F_2 then
(A) $F_1 = F_2/k$ (B) $F_2 = F_1/k$
(C) $F_1 . F_2 = \frac{1}{k}$ (D) $F_1 = F_2$

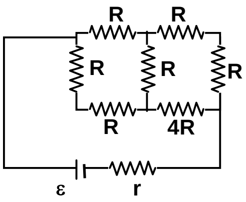
Space for Rough work

21. A solid cylinder is wrapped with a string and placed on an inclined plane as shown in the figure. Then the frictional force acting between cylinder and plane is



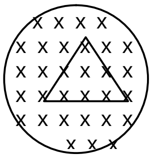
(A) zero
(B) 5 mg
(C) $\frac{7mg}{2}$
(D) $\frac{mg}{5}$

22. The relation between R and r (internal resistance of the battery) for which the power consumed in the external part of the circuit is maximum.



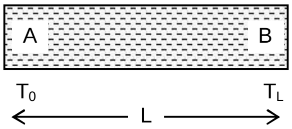
(A) R = r
(B) $R = \frac{r}{2}$
(C) R = 2r
(D) R = 1.5 r

23. An equilateral triangular loop having a resistance R and length of each side 'ℓ' is placed in a magnetic field which is varying at $\frac{dB}{dt}$ = 1 T/s. The induced current in the loop will be



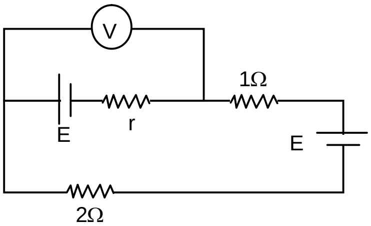
(A) $\frac{\sqrt{3}}{4}\frac{\ell^2}{R}$
(B) $\frac{4}{\sqrt{3}}\frac{\ell^2}{R}$
(C) $\frac{\sqrt{3}}{4}\frac{R}{\ell^2}$
(D) $\frac{4}{\sqrt{3}}\frac{R}{\ell^2}$

24. The temperature of a mono-atomic gas in an uniform container of length 'L′ varies linearly from T_0 to T_L as shown in the figure. If the molecular weight of the gas is M_0, then the time taken by a wave pulse in travelling from end A to end B is



(A) $\frac{2L}{(\sqrt{T_L}+\sqrt{T_0})}\sqrt{\frac{3M}{5R}}$
(B) $\sqrt{\frac{3(T_L-T_0)}{5RM_0L}}$
(C) $\frac{2L}{(\sqrt{T_L}-\sqrt{T_0})}\sqrt{\frac{3M}{5R}}$
(D) $L\sqrt{\frac{M_0}{2R(T_L-T_0)}}$

Space for Rough work



25. In the given circuit the reading of ideal voltmeter is E/2. The internal resistance of the battery is

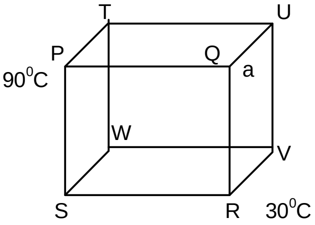
(A) $1\,\Omega$ (B) $\frac{2}{3}\Omega$

(C) $\frac{2}{5}\Omega$ (D) $\frac{5}{2}\Omega$

26. The specific heat capacity of a monoatomic gas for the process TV^2 = constant is (where R is gas constant)

(A) $\frac{R}{2}$ (B) 2R

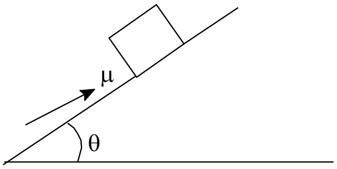
(C) $\frac{R}{3}$ (D) $\frac{R}{4}$



27. 12 identical rods made of same material are arranged in the form of a cube. The temperature of 'P' and 'R' are maintained at 90^0 C and 30^0C respectively. Then the temperature of point 'V', when steady state is reached,

(A) 65°C (B) 60°C

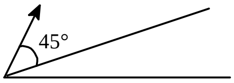
(C) 20°C (D) 50°C



28. A block is placed at the the bottom of an inclined plane and slided upwards with some initial speed. It slides up the incline, stops after time t_1, and slides back in a further time t_2. The angle of inclination of the plane with the horizontal is θ and the coefficient of friction is μ. Then

(A) $t_1 > t_2$ (B) $t_1 < t_2$

(C) $t_1 = t_2$ (D) $t_1 = t_2$ only if $\theta = \frac{\pi}{4}$



29. A projectile is thrown from the base of an inclined plane at an angle 45° with the plane. At what angle may it hit the plane again?

(A) 30° (B) 45°

(C) 60° (D) all of the above.

30. In an artificial satellite which of the following process of heat transfer will not take place?

(A) Conduction (B) Convection

(C) Radiation (D) All of the above

Space for rough work

Chemistry PART – II

SECTION – A
Straight Objective Type

This section contains 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Which one of the following is correct?
(A) If one component of a binary liquid-liquid solution deviate negatively from Raoult's law, then the solution will form minimum boiling point azeotrope.
(B) for a solution of two liquids (A and B), $V_{sol} > V_A + V_B$; then A and B can be separated by fractional distillation.
(C) Deep sea divers use a mixture of He and O_2 instead of air due to less solubility of He in blood in comparison to N_2, which cause the bends, i.e. pain due to bubbling of untreated gas dissolved in blood.
(D) All of the above.

2. A compound is composed of two elements A and B, element A constitute f.c.c. lattice, while B occupy all the tetrahedral voids, in this way another simple cubic is constituted by element B, inside the fcc unit cell of element A. If all the points/particles along any one edge of inner cube of every unit cell, are missing then what is the new empirical formula of the compound
(A) A_4B_6
(B) A_2B_8
(C) A_2B_3
(D) AB_4

3. Which of the following gives yellow precipitate with aq. $AgNO_3$?
(A) KIO_3
(B) KI
(C) CHI_3
(D) CH_2I_2

4. How many planes of symmetry and axis of symmetry are there in one molecule of PCl_3F_2, respectively?
(A) 4, 7
(B) 7, 13
(C) 7, 10
(D) 4, 10

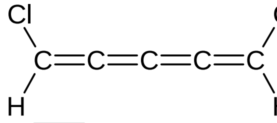
5. Two cylinders A and B of equal volumes are filled and equal masses of N_2 and O_2, respectively. Cylinder A is kept at 300 K while B is kept at 600 K, then (assume ideal behaviour of both gases)
(A) Average kinetic energy of N_2 (per mole) in A is equal to that of O_2 in B.
(B) Molecules in cylinder B move twice as fast as those in A.
(C) Pressure in flask A is less than that of B.
(D) Average velocity of N_2 is equal to rms velocity of O_2, in the given conditions.

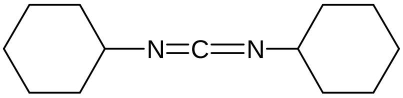
Space for Rough work

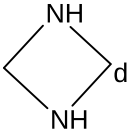
6. The ratio of time periods taken by electron in 1st and 3rd orbits of He^+ ion, for each revolution is.....
(A) 1 : 9
(B) 1 : 27
(C) 8 : 27
(D) 8 : 9

7. The equilibrium constant of mutarotation of α-D-glucose to β-D-glucose is 1.8. If specific rotation of α-D-glucose is 112^o and that of mixture is 59^o; what is specific rotation of β-D-glucose?
(A) -112^o
(B) -59^o
(C) $+29.6^o$
(D) -29.6^o

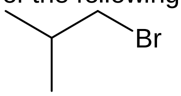
8. Which of the following is correct?
(A) cis-cycloalkane is always more stable than trans cycloalkane.

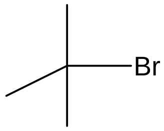
(B) 
$Cl(H)C{=}C{=}C{=}C{=}C(H)Cl$ does not show geometrical isomerism

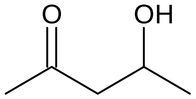
(C)  show geometrical isomerism.

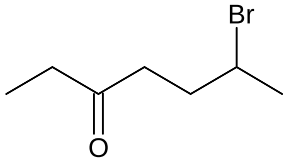
(D)  does not show any type of isomerism

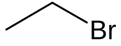
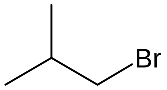
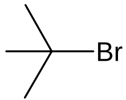
9. Which of the following will undergo $E1_{cB}$.?

(A) 

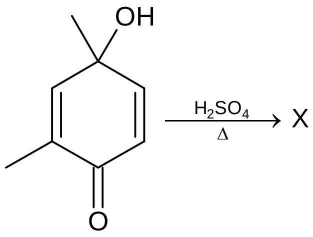
(B) 

(C) 

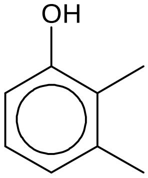
(D) 

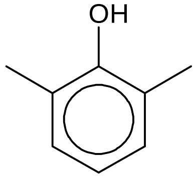
10. From which of the following halogen can be replaced by H_2O by S_N1?
(A) $CH_3 — Br$
(B) 
(C) 
(D) 

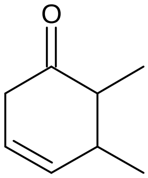
Space for Rough work

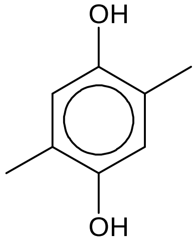
11. 

Product X is :

(A) 

(B) 

(C) 

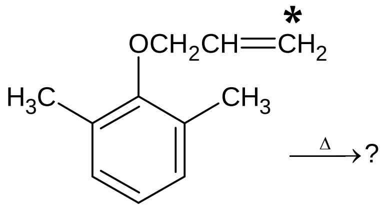
(D) 

12. Which of the following can not be used for protection of carbonyl group?
(A) $CH_2(OH)CH_2CHO$
(B) $CH_2(OH)—CH_2CH_2(OH)/H^+$
(C) $CH_2(OH)\ CH_2(OH)/H^+$
(D) $HS(CH_2)_3SH$

13. The configuration of the C-2 epimer of D-glucose is
(A) 2R, 3S, 4R, 5S
(B) 2R, 3S, 4R, 5R
(C) 2S, 3S, 4R, 5R
(D) 2S, 3R, 4R, 5S

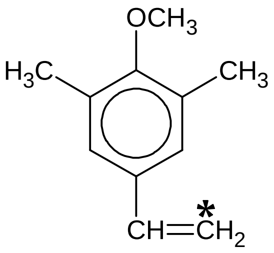
Space for Rough work

14.

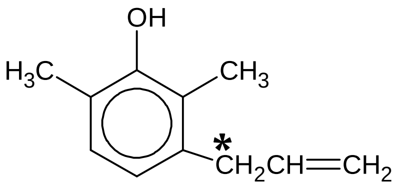


The product is

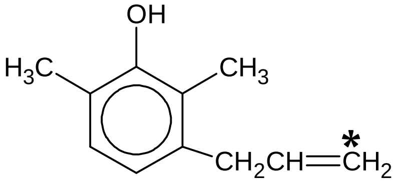
(A)



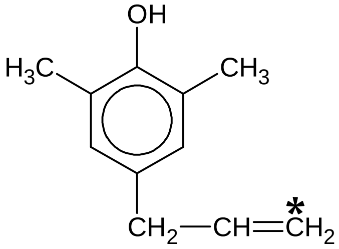
(B)



(C)



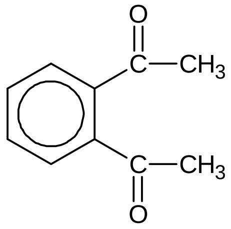
(D)



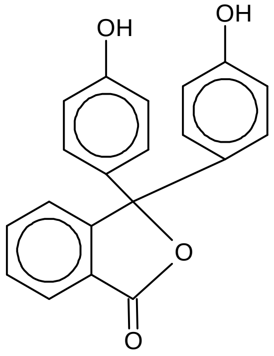
15. Acetophenone $\xrightarrow{HCO_3H}$ $\underset{(Major)}{A}$ $\xrightarrow{H_3O^+}$ $B + C$ $\xrightarrow{\text{Phthalic Anhydride}/H^+}$ Indicator (D) is

(A) PhOH

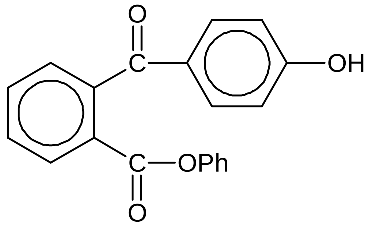
(B)



(C)



(D)



Space for Rough work

16. The complex $[Fe(H_2O)_5(NO)]^{2+}$ is formed in the ring test for nitrate when freshly prepared $FeSO_4$ solution is added to aqueous solution of NO_3^- followed by addition of conc. H_2SO_4. The complex is formed by charge transfer in which:
(A) Fe^{2+} charges to Fe^{3+}, NO to NO^+
(B) Fe^{3+} charge to Fe^{2+} and NO changes to NO^+
(C) Fe^{2+} changes to Fe^+ and NO changes to NO^+
(D) Fe^{2+} changes to Fe^{3+} and NO^+ changes to NO

17. Which of the following match is correct?

	Ore/ Minerals	**Element**
(A)	Bauxite	B
(B)	Magnetite	Mn
(C)	Bornite	B
(D)	Cerussite	Pb

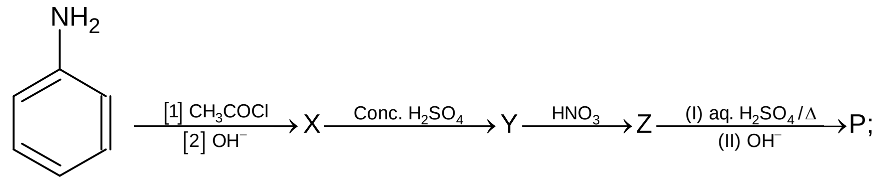
18. Which of the following is correct about Boron nitride $\{(BN)_x\}$?
(A) All the atoms of the ring are uncharged
(B) It is insulator, unlike graphite
(C) Inter-layer distance in its graphite like structures, is less than that of graphite
(D) Resonance energy of each hexagon of $(BN)_x$ is greater than that of Benzene.

19. Which of the following is true?
(A) Oxides of Ge, Sn and Pb are amphoteric in nature
(B) Producer gas is produdced in incomplete combustion of C by air ($O_2 + N_2$)
(C) SnO is much better reducing agent than PbO.
(D) All are correct

20. Which of the following can not be used as nitrating agent in Electrophilic Aromatic Substitution of benzene?
(A) N_2O_5/MeCN
(B) $C_2H_5ONO_2$
(C) $C_2H_5NO_2$
(D) $NO_2.SO_3$

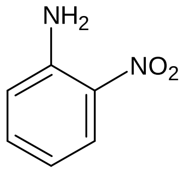
Space for Rough work

21.

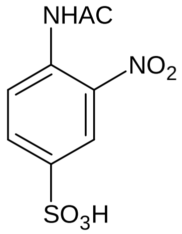

NH2
[1] CH3COCl
[2] OH⁻
X
Conc. H2SO4
Y
HNO3
Z
(I) aq. H2SO4 / Δ
(II) OH⁻
P;

What is the product 'P' of the above reaction

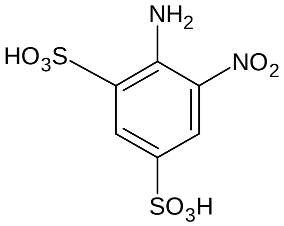
(A)



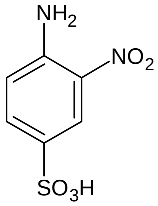
(B)


NHAC
NO2
SO3H

(C)


NH2
HO3S
NO2
SO3H

(D)


NH2
NO2
SO3H

22. Which of the following is tetrahedral and paramagnetic complex?

(A) $[NiCl_4]^{2-}$

(B) $[Ni(CN)_4]^{2-}$

(C) $[Cu(NH_3)_4]^{2+}$

(D) $[Ni(CO)_4]$

23. Which of the following statement is correct?

(A) Free energy (G) is a path function

(B) In the expression G = H – TS, TS is the part of the system's energy that is disordered, already.

(C) ΔG for a system is equal to $T\Delta S_{Total}$ in magnitude

(D) Statement A is incorrect but statement B and C are correct

Space for Rough work

24. All the elements A, B, C and D form homonuclear diatomic molecules and conform anion of type X^- also. In a series of experiments the following observations are made:

(i) $2B^- + C_2 \longrightarrow 2C^- + B_2$

(ii) $2A^- + C_2 \longrightarrow \text{no reaction}$

(iii) $2D^- + C_2 \longrightarrow 2C^- + D_2$

(iv) $2B^- + D_2 \longrightarrow B_2 + 2D^-$

Which of the following statement is correct?
(A) A_2 is the strongest oxidizing agent among all A_2, B_2, C_2 and D_2.
(B) Correct order of reduction potentials is $A_2 > C_2 > D_2 > B_2$.
(C) (A) and (B) are correct statements as well as it can also be concluded that B corrode at fastest rate among all the four elements.
(D) All the above statements are correct.

25. What is the solubility product of CaF_2 at room temperature, if $\overset{o}{\Lambda}_m\left(Ca^{2+}\right)$ = 1.04×10^{-2} Sm^2/mol

$\overset{o}{\Lambda}_m\left(F^-\right)$ = 4.8×10^{-3} Sm^2/mol

$\kappa_{CaF_2(\text{Saturated Solution}))} = 4.25 \times 10^{-3}\ S/m$ at room temperature.

$\kappa_{H_2O} = 2 \times 10^{-4} S/m$

(A) 4.05×10^{-4} M^3
(B) 2.025×10^{-4} M^3
(C) 3.32×10^{-11} M^3
(D) 4.05×10^{10} M^3

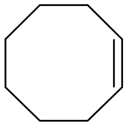
26. Some times yellow turbidity appears while passing H_2S gas even in the absence of II_{nd} group of basic radicals. This is because:
(A) Sulphur is present in the mixture as impurity.
(B) IV group radicals are precipitated as sulphides.
(C) The oxidation of H_2S gas by some acid radicals.
(D) III^{rd} group radicals are precipitated as hydroxides.

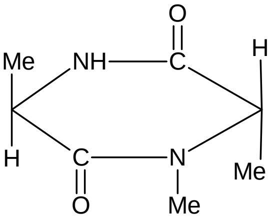
27. In low temperature range fraction of heat supplied to an ideal diatomic gas system, at constant pressure, which bring change in its internal energy is approx.......?
(A) 0.71
(B) 0.75
(C) 0.60
(D) 0.50

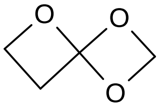
Space for Rough work

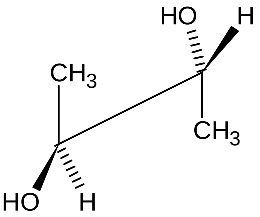
28. By which of the following methods, Cl_2 can be produced?
(A) By treating $KClO_3$ with iodine (I_2)
(B) By heating a mixture of NaBr and $NaBrO_3$ with HCl
(C) By treating $CaOCl_2$ and NaI mixture with HCl solution.
(D) By treating NaCl with H_2SO_4

29. Which of the following is optically active?

(A)


(B)


(C)


(D)


30. Which of the following will cause symmetric cleavage of B_2H_6?
(A) NH_3
(B) $N(CH_3)_3$
(C) $NH_2 - C_2H_5$
(D) $HN(CH_3)_2$

Space for Rough work

Mathematics

PART – III

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. For n ≥ 3 circles, the value of n for which the number of radical axis is equal to number of radical centres is
(A) 3 (B) 4
(C) 5 (D) none of these

2. Consider a circle, $x^2 + y^2 = 1$ and point $P(1, \sqrt{3})$ ·PAB is a secant drawn from P intersecting circle in A and B (distinct) then range of |PA| + |PB| is
(A) $[2, 2\sqrt{3}]$ (B) $(2\sqrt{3}, 4]$
(C) (0, 4] (D) none of these

3. Consider a curve |z – i| = 2 and a point $z_1 = 3 - i$, then the length of tangent made from the point (z_1) to the curve is
(A) 2 (B) 3
(C) 5 (D) none of these

4. The total number of 1 word, 2 word, 3 word sentences that can be formed using the letters of the word SAMSUNG is
(A) 8! (B) 18 × 7!
(C) 11 × 7! (D) none of these

5. Consider a line $z(i - 1) + \bar{z}(i + 1) = 0$ in the argand plane and a point $z_1 = 2 + 3i$ then the reflection of z_1 in the given line is
(A) 2 – 3i (B) –2 + 3i
(C) 3 + 2i (D) none of these

Space for Rough work

6. The sequence a_n is defined by $a_1 = \frac{1}{2}$, $a_{n+1} = a_n^2 + a_n$. Also, $S = \frac{1}{a_1+1} + \frac{1}{a_2+1} + ... + \frac{1}{a_{100}+1}$ then [S] (where [.] denotes the greatest integer function) is

(A) 1
(B) 2
(C) 3
(D) none of these

7. Consider a plane $\bar{r}\cdot\left(2\hat{i}+2\hat{j}-\hat{k}\right)=5$ which cuts a circular section from the sphere $|\bar{r}| = 9$ then the volume of the cone formed by taking circular cross section as base and vertex as centre of sphere is

(A) $\frac{3520\pi}{27}$
(B) $\frac{40}{9}\sqrt{11}\pi$
(C) $\frac{64}{9}\pi$
(D) none of these

8. Let, t_r = r! and S_n = $\sum_{r=1}^{n} r!$ then $\frac{S_n}{24} = a + \frac{\lambda}{24}$; a, $\lambda \in$ N where λ is

(A) 7
(B) 23
(C) 9
(D) none of these

9. If $z = \begin{bmatrix} O & I \\ I & O \end{bmatrix}$ where O, I are 2 × 2 null and identity matrix then det(|z|) is

(A) 1
(B) –1
(C) 0
(D) none of these

10. Given that $f(x) + f\left(\frac{1}{1-x}\right) = \frac{2(1-2x)}{x(1-x)}$, x $\in$ R, x $\neq$ 0, 1 then the given f(x) is

(A) one–one
(B) many one
(C) f(0) = 1
(D) none of these

11. The area between the curve $y^2(a + x) = (a - x)^3$ and its vertical asymptote is

(A) $\frac{\pi}{2}a^2$
(B) $2\pi a^2$
(C) $3\pi a^2$
(D) none of these

Space for Rough work

12. If the given curve satisfies the differential equation $e^y dx + (xe^y + 2y)dy = 0$ and also passes through (0, 0) then the possible equation of curve can be

(A) $xe^y + y = 0$ (B) $x + y^2e^y = 0$

(C) $x^2e^x + ye^y = 1$ (D) none of these

13. Let $\bar{v}$ be a unit vector which follows the equation, $\bar{v} \times \bar{b} = \bar{c}$. Also, $|\bar{b}| = 2$ and $|\bar{c}| = \sqrt{3}$ then

(A) $\bar{v} = -\bar{b} + \bar{b} \times \bar{c}$ (B) $\bar{v} = \frac{3}{4}(\bar{b} + 2\bar{b} \times \bar{c})$

(C) $\bar{v} = \frac{1}{4}(\bar{b} + \bar{b} \times \bar{c})$ (D) none of these

14. If the tangent to the curve $y = 1 - x^2$ at $x = \alpha(0 < \alpha < 1)$ meets the axes at P and Q. Also α varies, the minimum value of the area of the triangle OPQ is k times the area bounded by the axes and the part of the curve for which $0 < x < 1$, then k is

(A) $\frac{\sqrt{3}}{2}$ (B) $\frac{2}{\sqrt{3}}$

(C) $\frac{1}{2}$ (D) $\frac{3}{2}$

15. Consider a parabola $y^2 = \alpha x$ and a point $\left(-\frac{\alpha}{4}, 0\right)$ then midpoint of centres of the circles touching the tangents from given point and its chord of contact is

(A) $\frac{\alpha}{2}$ (B) $\frac{\alpha}{4}$

(C) $\frac{3\alpha}{2}$ (D) none of these

16. Consider a curve $(2x + y - 1)^2 = 5(x - 2y - 3)$ then the possible coordinates of foci are

(A) $\left(\frac{5}{4}, \frac{3}{4}\right)$ (B) $\left(\frac{3}{4}, -\frac{1}{2}\right)$

(C) $\left(\frac{5}{4}, \frac{3}{2}\right)$ (D) none of these

Space for Rough work

17. Consider the curves C_1: $x^2 + y^2 = 1$ and $C_2 : \frac{x^2}{\sin^2\theta} + \frac{y^2}{\cos^2\theta} = 1$. If a common tangent y = mx + c is drawn to C_1, C_2 then $\left(\frac{\pi}{4} < \theta < \frac{\pi}{2}\right)$

(A) $m \in \phi$
(B) c = 1
(C) $m = \frac{1}{\sqrt{2}}$
(D) none of these

18. Consider a parabola $x^2 = 4y$ and a hyperbola xy = 1. A tangent is drawn to parabola meets the hyperbola in A and B then locus of midpoint of AB is

(A) straight line
(B) parabola
(C) ellipse
(D) none of these

19. If the following represent the two lines with real point of intersection then $\alpha_1x + \alpha_2y = k_1$, $\beta_1x + \beta_2y = k_2$. Also, (α_1, α_2), (β_1, β_2) lie on $x^2 + y^2 = 1$ then

(A) $\alpha_1\beta_1 + \alpha_2\beta_2 \in [0, 2]$
(B) lines can represent asymptotes of rectangular hyperbola
(C) $\alpha_1\beta_1 + \alpha_2\beta_2 \in [-2, 0]$
(D) none of these

20. $g(n) = \int_0^{n^2+n+1} e^{x/2-[x/2]}\left(\frac{x}{2} - \left[\frac{x}{2}\right]\right) d(x-[x])$; $n \in N$ then g(n)

(A) has minimum value as $\frac{1}{4} + \sqrt{e}$
(B) has maximum value as $3 - \sqrt{e}$
(C) has minimum value as $\frac{3}{4} - \sqrt{\frac{e}{4}}$
(D) none of these

21. Consider a sequence f(x), $n \in I^+ \cup \{0\}$ defined by f(0) = 0, f(n + 1) = $\sqrt{6 + f(n)}$ then $\lim_{n\to\infty} f(n)$ is

(A) 1
(B) 2
(C) 3
(D) none of these

Space for Rough work

22. If $(a-a')^2+(b-b')^2+(c-c')^2=p$ and $(ab'-a'b)^2+(bc'-b'c)^2+(ca'-c'a)^2=q$, then the perpendicular distance of the line $ax+by+cz=1,\ a'x+b'y+c'z=1$ from origin, is

(A) $\sqrt{\frac{p}{q}}$
(B) $\sqrt{\frac{q}{p}}$
(C) $\frac{p}{\sqrt{q}}$
(D) $\frac{q}{\sqrt{p}}$

23. Consider a function, f : R → R such that $f(x + a) = \frac{1}{2}+\sqrt{f(x)-f^2(x)}$, a is a real constant. If f(x) is periodic then its period can be

(A) $\frac{a}{2}$
(B) a
(C) 2a
(D) none of these

24. Consider an identity matrix (n × n) I_n; $\lambda \in R^+$ then $|Adj(\lambda I_n)|$ is

(A) λ^{n-1}
(B) $\lambda^{n(n-1)}$
(C) λ^{n}
(D) $\lambda^{2(n-1)}$

25. Let $A_1, A_2, A_3, \ldots, A_7$ be skew symmetric matrices of same order then $1\cdot(A_1)^1 + 3\cdot(A_2)^3 + 5(A_3)^7 + \ldots + 13(A_7)^{13}$ is

(A) symmetric
(B) skew symmetric
(C) neither symmetric nor skew symmetric
(D) none of these

26. Given the expansion $(a + p)^{m-1} + (a + p)^{m-2}(a + q) + (a + p)^{m-3}(a + q)^2 + \ldots + (a + q)^{m-1}$ $[a \ne -q$ and $p \ne q]$ then coefficient of a^t is

(A) $\frac{{}^mC_t\left[p^t-q^t\right]}{p-q}$
(B) ${}^mC_t\frac{p^{m-t}-q^{m-t}}{p-q}$
(C) $\frac{{}^mC_t\left[p^t+q^t\right]}{p-q}$
(D) ${}^mC_t\frac{p^{m-t}+q^{m-t}}{p-q}$

Space for Rough work

27. Consider a curve C : $y^2 = 8x$ and line L : $2x + y = 3$. If three distinct points A, B, C are selected at random on L, then the maximum probability that the tangents drawn from A, B, C to $y^2 = 8x$ are mutually perpendicular is [For points A, B, C, $S_1 > 0$]

(A) 1
(B) $\frac{1}{3}$
(C) $\frac{2}{3}$
(D) none of these

28. Let F, F′, F″ be continuous in [0, ln 2] and f(0) = 0, f′(0) = 3, f(ln 2) = 6, f′(ln 2) = 4 and $\int_0^{\ln 2} e^{-2x} f(x)\,dx = 3$ then $\int_0^{\ln 2} e^{-2x} f''(x)\,dx$ is

(A) 10
(B) 13
(C) 12
(D) none of these

29. Consider circles S : $x^2 + y^2 = 1$ and S′ : $(x - 4)^2 + (y - 0)^2 = 9$. Now a circle is drawn touching S, S′ externally and also their direct common tangent then its radius is

(A) $3\left(4+2\sqrt{3}\right)$
(B) $\frac{3}{4}\left(4-2\sqrt{3}\right)$
(C) $4-2\sqrt{3}$
(D) none of these

30. Given that a, b, c are sides of the triangle ΔABC such that $z = \log_{2^a+2^{-a}}\left[4(ab+bc+ca)-(a+b+c)^2\right]$ then z has a real value if and only if

(A) a = b = 2c
(B) 3a = 2b = c
(C) a – b = 3c
(D) none of these

Space for Rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ANSWERS, HINTS & SOLUTIONS
FULL TEST –I
(Main)

S. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**A**	**C**	**C**
2.	**B**	**A**	**B**
3.	**D**	**B**	**B**
4.	**B**	**D**	**C**
5.	**C**	**C**	**C**
6.	**C**	**B**	**A**
7.	**A**	**D**	**A**
8.	**C**	**B**	**C**
9.	**B**	**C**	**B**
10.	**C**	**D**	**A**
11.	**B**	**D**	**C**
12.	**D**	**A**	**D**
13.	**C**	**C**	**C**
14.	**B**	**D**	**B**
15.	**B**	**C**	**D**
16.	**D**	**C**	**B**
17.	**C**	**D**	**A**
18.	**D**	**B**	**B**
19.	**D**	**D**	**B**
20.	**D**	**C**	**D**
21.	**D**	**A**	**C**
22.	**B**	**A**	**A**
23.	**A**	**D**	**C**
24.	**A**	**D**	**B**
25.	**A**	**C**	**B**
26.	**A**	**C**	**B**
27.	**D**	**A**	**B**
28.	**B**	**A**	**B**
29.	**D**	**B**	**B**
30.	**B**	**B**	**D**

Physics

PART – I

SECTION – A

1. For full square about an axis passing through 'O' $= \frac{M\ell^2}{6}$

   by symmetry for remaining portion it must be $\frac{3}{4}\left[\frac{M\ell^2}{6}\right] = \frac{M\ell^2}{8}$

2. apply work-energy theorem

   $$mgz - \left[\frac{1}{2}K\left(\frac{mg}{K}+z\right)^2 - \frac{1}{2}K\left(\frac{mg}{K}\right)^2\right] + Fz = 0$$

   $\Rightarrow$ z = 2F/K.

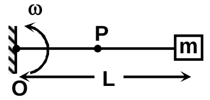
3. a = 2 + |t – 2|
   for $t \le 2$
   a = 2 – t + 2
   a = 4 – t
   dv = (4 – t)dt
   $v = 4t - t^2/2$
   at t = 2, v = 6 m/s.
   for t > 2
   a = 2 + t – 2 = t
   $\int_6^v dv = \int_2^t tdv$
   $v - 6 = \left[t^2/2\right]_2^t$
   $v = \frac{t^2}{2} + 4$
   at t = 4, v = 12 m/s.

10. $(\vec{a}\times\vec{b}) \perp [\vec{a}\times(\vec{a}\times\vec{b})]$. Dot product is zero.

11. Say speed of boat is v w.r.t. water and speed of river is C. Then, distance travelled in ground frame

    $= (c + v) \times \frac{1}{2}$ hour + $(v - c) \times \frac{1}{2}$ hour = v × 1 hour
    = distance travelled by boat w.r.t. river.

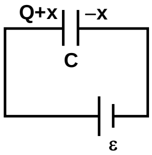
12. In the shown frame the particle appears to be at rest.
    ∴ Net force on it must be zero. Therefore pseudo force must be equal and opposite to the tension.'



13. Successive frequencies will differ by an amount v/2L

14. Linear magnification = v^2/u^2

15. Electric field between the capacitor plates = $\frac{\sigma_1}{2\varepsilon_0} + \frac{(-\sigma_2)}{2\varepsilon_0}$



$$E = \frac{Q+x}{2A\varepsilon_0} + \frac{x}{2A\varepsilon_0} = \frac{1}{2A\varepsilon_0}[Q+2x]$$

$\Rightarrow$ Potential different $E_d = \frac{d}{2A\varepsilon_0}[Q+2x] = \varepsilon$

$$\Rightarrow \varepsilon = \frac{Q+2x}{2C}$$

$$\Rightarrow -x = \frac{Q}{2} - C\varepsilon$$

16. conservation of momentum

$M\sqrt{2gh} - m\sqrt{2gh} = MV_1 + mV_2$ (1)

$-1 = \frac{V_1 - V_2}{2\sqrt{2gh}}$ (2)

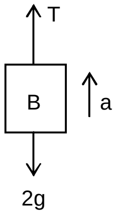
$V_2 = 3\sqrt{2gh}$

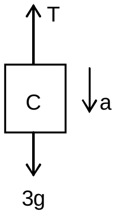
$h' = \frac{V_2^2}{2g} = 9h$

17. $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$

$= \frac{x}{\varepsilon_0 A} + \frac{a-b-x}{\varepsilon_0 A} \Rightarrow C = \frac{\varepsilon_0 A}{a-b}$

18. FBD of ‘B’ and ‘C’



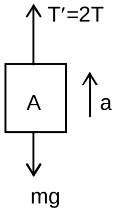


$\Rightarrow$ T – 2g = 2a . . . (i)

and 3g – T = 3a . . . (ii)

$T = \frac{12g}{5}$

for A



$\Rightarrow$ T = mg

$2 \times \frac{12g}{5} = mg \Rightarrow m = 4.8$ kg.

19. $W = \int_0^{\pi/2} f.Rd\theta = \frac{\mu mgR\pi}{2}$ = 1 joule.

20. Coulombic force between them remains same.

21. Let us assume cylinder is no moving then

$T + f_s = mg\sin\theta$

$T.R - f_s R = 0$

$\Rightarrow\ f_s = \frac{mg\sqrt{3}}{4}$.

but $(f_s)_{max} = \mu N = \mu mg\cos\theta$

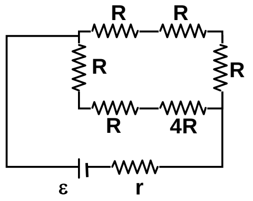
$= 0.4\ .\ mg \times \frac{1}{2} = \frac{mg}{5}$

$\therefore\ (f_s) < (f_s)_{max}$, our assumption is wrong. So, friction existing must be kinetic

$f_k = \mu mg\cos\theta = 0.4 \times mg \times \frac{1}{2} = \frac{mg}{5}$

22. Circuit is forming a wheatstone bridge $R_{eq} = 2R$

For maximum power transfer 2R = r.

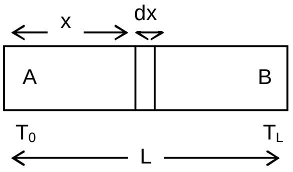


23. $\phi = \frac{\sqrt{3}}{4}\ell^2 B$

$\varepsilon = \left|\frac{d\phi}{dt}\right| = \frac{\sqrt{3}}{4}\ell^2\frac{dB}{dt}$

$i = \frac{\varepsilon}{R} = \frac{\sqrt{3}\ell^2}{4R}$

24. $C = \sqrt{\frac{\gamma RT}{M_0}} = \sqrt{\frac{5RT}{3M_0}}$



$dx = C.\,dt = \sqrt{\frac{5R}{3M_0}\left[T_0 + \left(\frac{T_L - T_0}{L}\right)x\right]}dt$

$t = \frac{2L}{(\sqrt{T_L} + \sqrt{T_0})}\sqrt{\frac{3M}{5R}}$

25. $\frac{E}{2} = E - ir$

$\Rightarrow\ i = \frac{E}{2r}$ . . . (i)

$2E = i(3 + r)$ . . . (ii)

$\Rightarrow r = 1\ \Omega$

26. dQ = dU + dW

$C = C_v + \frac{PdV}{ndT}$ …(i)

Differentiating $TV^2 = \text{constant}$

$\frac{dV}{dT} = -\frac{V}{2T}$ …(ii)

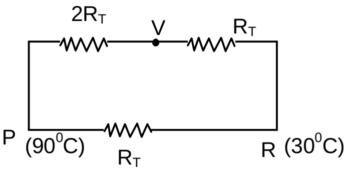
$PV = nRT$ …(iii)

solving eq. (i), (ii) and (iii)

$C = \frac{R}{2}$

27. Equivalent circuit is

$$\frac{90 - V}{2R_T} = \frac{20}{R_T} \Rightarrow V = 50^0C$$



Chemistry

PART – II

SECTION – A

2. 2B atoms (ions are missing from every unit cell).

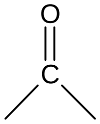
3. Only KI produces I^- ions in aq. solution.

6. Time period $\propto \frac{n^3}{z^3}$

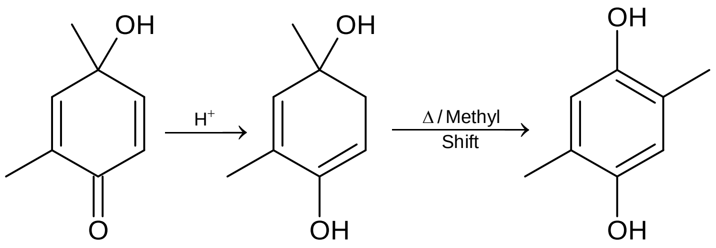
$\frac{T_1}{T_2} = \frac{n_1^3 \times z_2^3}{n_2^3 \times z_1^3}$; $z_1 = z_2$ for same element.

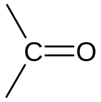
Hence, $\frac{T_1}{T_2} = \frac{1^3}{3^3} = \frac{1}{27}$

7. From K_{eq} value; % of β-D-glucose is 64.3.

9. Leaving group is at β position to anion stabilizing group (i.e.  group.)

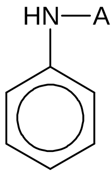
11.



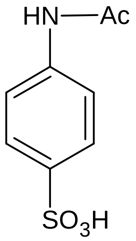
12. All others are used for this purpose and they form cyclic acetal or cyclic thioacetals at  group.

17. Bauxite is ($Al_2O_3.2H_2O$)
Magnetite is (Fe_3O_4)
Bornite is (Cu_3FeS_3)
Cerussite is ($PbCO_3$)

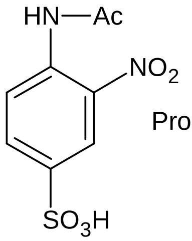
21. X =



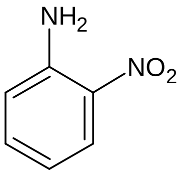
Y =



Z =



Product P =



22. $[NiCl_4]^{2-} \Leftarrow dsp^2$, square planer and diamagnetic

$\left[Cu(NH_3)_4\right]^{2+} \Leftarrow dsp^2$, square planer and paramagnetic

$\left[Ni(CO)_4\right] \Leftarrow$ is sp^3, tetrahedral but diamagnetic

25. $\kappa_{CaF_2} = \kappa_{CaF_2}$ (solution) - κ_{H_2O}
$= 4.05 \times 10^{-3}$ S/m

$$\text{Conc} = \frac{\kappa}{\Lambda_m} = 2.025 \times 10^{-4}\ \text{mol/dm}^3$$

$$K_{sp} = 4C^3 = 3.32 \times 10^{-11} M^3$$

27. Heat supplied at constant pressure in the range of temperature, ΔT is ΔH and change in internal energy is ΔU hence $\frac{\Delta U}{\Delta H} = \frac{1}{\gamma} = \frac{1}{1.4} = 0.71(\text{approx})$

28. (A) $2KClO_3 + I_2 \longrightarrow 2KIO_3 + Cl_2$

(B) $5NaBr + NaBrO_3 + 6HCl \longrightarrow 6NaCl + 3Br_2 + 3H_2O$

(C) $CaOCl_2 + 2NaI + 2HCl \longrightarrow I_2 + CaCl_2 + H_2O + NaCl$

(D) $NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$

29. A and C possesses plane of symmetry. While D possesses centre of symmetry.

Mathematics

PART – III

SECTION – A

1. $^nC_3 = {}^nC_2 \Rightarrow n = 5$

2. $\frac{|PA| + |PB|}{2} > [|PA| \cdot |PB|]^{1/2}$

   $|PA| + |PB| > 2|PT| = 2\sqrt{3}$
   Maximum length occurs when PAB passes through centre
   i.e. $|PA| + |PB| = 4$ (Maximum)
   So, range is $\left(2\sqrt{3},\ 4\right]$

3. Length of tangent is = $\sqrt{|z_1 - i|^2 - 4}$

   $= \sqrt{|3-2i|^2 - 4} = \sqrt{9+4-4} = 3$

4. Required number of sentences = $\left({}^6C_0 + {}^6C_1 + {}^6C_2\right) \times \frac{7!}{2!}$

5. The given line can be written as $y = x$
   Hence reflection is $3 + 2i$

6. $\frac{1}{a_{n+1}} = \frac{1}{a_n(a_n+1)} = \frac{1}{a_n} - \frac{1}{a_n+1}$

   $\Rightarrow S = \frac{1}{a_1} - \frac{1}{a_2} + ... + \frac{1}{a_{100}} - \frac{1}{a_{101}}$

   $= \frac{1}{a_1} - \frac{1}{a_{101}} = 2 - \frac{1}{a_{101}}$

   Since, $a_{101} > 1 \Rightarrow [S] = 1$

7. Height of the cone = $\frac{5}{3}$

   Radius of cone = $\sqrt{9^2 - \left(\frac{5}{3}\right)^2} = \frac{8}{3}\sqrt{11}$

   Volume = $\pi\left(\frac{8}{3}\sqrt{11}\right)^2\left(\frac{5}{3}\right) = \frac{3520}{27}\pi$

8. $4! = 24$
   $5! = 24 \times 5$
   $6! = 24 \times 5 \times 6$
   $1! + 2! + 3! = 9$
   So, $1! + 2! + 3! + ….. 100! = 9 + 24p$
   $\therefore \lambda = 9$

9. $|z| = O \times O - I \times I = -I^2$
   $\det(|z|) = |-I^2| = (-1)$

10. $f(x)+f\left(\frac{1}{1-x}\right)=\frac{2}{x}-\frac{2}{1-x}$ ….. (1)

Now replace x by $\frac{1}{1-x}$ we get $f\left(\frac{1}{1-x}\right)+f\left(1-\frac{1}{x}\right)=2(1-x)-2\left(1-\frac{1}{x}\right)=-2x+\frac{2}{x}$ ….. (2)

Replace x by $1-\frac{1}{x}$ we get $f\left(1-\frac{1}{x}\right)+f(x)=\frac{2x}{x-1}-2x$ ….. (3)

From equation (1) – (2), we get

Now, $f(x)-f\left(1-\frac{1}{x}\right)=2x-\frac{2}{1-x}$ ….. (4)

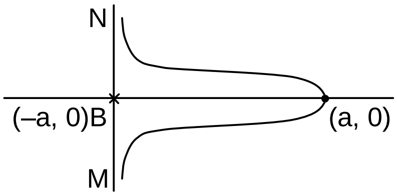
From equation (3) + (4), we get

Again, $2f(x)=\frac{2x}{x-1}-\frac{2}{1-x}$

$f(x)=\frac{x+1}{x-1}$ which is a one–one function

11. x = –a is the only asymptote to the given curve

$$A=2\int_{-a}^{a}y\,dx=3\pi a^2$$



12. M = e^y, N = $x \cdot e^y + 2y$

Now, $\frac{dM}{dy}$ (keeping x constant) = e^y

= $\frac{dN}{dx}$ (keeping y constant)

Hence, the given equation is exact

Now, $f=\int e^y dx+g(y)=x\cdot e^y+g(y)$

Differentiating w.r.t y we get, $x\cdot e^y+\frac{dg}{dy}=N=x\cdot e^y+2y$

i.e. $\frac{dg}{dy}=2y$

Integrating g(y) = $y^2 + c_1$

$\Rightarrow f = x\cdot e^y + y^2 + c_1$

So, desired solution is $x\cdot e^y + y^2 = 0$

13. $\bar{b}\times(\bar{v}\times\bar{b})=\bar{b}\times\bar{c}$

$4\bar{v}-(\bar{b}\cdot\bar{v})\bar{b}=\bar{b}\times\bar{c}$

$|\bar{v}\times\bar{b}|=|\bar{c}|$

$\Rightarrow |\bar{v}||\bar{b}|\sin\theta=|\bar{c}|$

$2|\bar{v}|\sin\theta=\sqrt{3}$

$\sin\theta=\frac{\sqrt{3}}{2}$

$\cos\theta = \frac{1}{2}$

$\Rightarrow 4\bar{v} - \left(2\times 1\times\frac{1}{2}\right)\bar{b} = \bar{b}\times\bar{c}$

$\bar{v} = \frac{1}{4}\left(\bar{b} + \bar{b}\times\bar{c}\right)$

14. Area under curve and axis = $\int_0^1 \left(1 - x^2\right)dx = \frac{2}{3}$ at point (α, $1 - \alpha^2$) tangent is

$[y - (1 - \alpha^2)] = -2\alpha(x - \alpha)$

$\Rightarrow 2\alpha x + y = \alpha^2 + 1 \Rightarrow P \equiv \left(\frac{\alpha^2 + 1}{2\alpha}, 0\right)$, $Q \equiv (0, \alpha^2 + 1)$

Hence, $Q \equiv \left(2,\ 1 + 4x_1 - x_1^2\right)$

$\therefore\ A = \left[\left(1 + 2x_1 - x_1^2\right) + \left(1 + 4x_1 - x_1^2\right)\right] = 1 - 3x_1 - x_1^2$

$\frac{dA}{dx_1} = -3 - 2x_1 \Rightarrow x_1 = -\frac{3}{2}$

15. $\left(-\frac{\alpha}{4}, 0\right)$ lies on directrix and centre be $(x_1, 0)$. Equation of one of the tangent is $x + y + \frac{\alpha}{4} = 0$ and chord is $x - \frac{\alpha}{4} = 0$, centre is $(x_1, 0)$

$\frac{\left|x_1 + \frac{\alpha}{4}\right|}{\sqrt{2}} = \frac{\left|x_1 - \frac{\alpha}{4}\right|}{1} \Rightarrow x_1^2 + \frac{\alpha^2}{16} + \frac{\alpha x}{2} = 2x_1^2 + \frac{\alpha^2}{8} - \alpha x$

$x_1^2 - \frac{3\alpha x}{2} + \frac{\alpha^2}{16} = 0 \Rightarrow x_1 + x_2 = \frac{3\alpha}{2} \Rightarrow \text{Midpoint} \equiv \left(\frac{3\alpha}{4}, 0\right)$

16. $2x + y - 1$ is the axis and $(1, -1)$ is the point of intersection with the tangent at the vertex, length of latus rectum is $\sqrt{5}$

So, coordinates can be (h, k)

$h = 1 \pm \left(\frac{\sqrt{5}}{4}\right)\left(-\frac{1}{\sqrt{5}}\right) = 1 \mp \frac{1}{4} = \frac{3}{4}, \frac{5}{4}$

$k = -1 \pm \left(\frac{\sqrt{5}}{4}\right)\left(\frac{2}{\sqrt{5}}\right) = -1 \pm \frac{1}{2} = -\frac{1}{2}, -\frac{3}{2}$

$\left(\frac{3}{4}, -\frac{1}{2}\right)$ and $\left(\frac{5}{4}, -\frac{3}{2}\right)$ are required points

17. For the common tangent $m^2 \sin^2\theta + \cos^2\theta = m^2 + 1$

$m^2(\sin^2\theta - 1) = 1 - \cos^2\theta$

$\Rightarrow m^2 = \frac{1 - \cos^2\theta}{\sin^2\theta - 1} = -\frac{\cos^2\theta}{\sin^2\theta} = -\cot^2\theta$

Clearly no such m is possible (when $\left(\frac{\pi}{4} < \theta < \frac{\pi}{2}\right)$)

18. Let midpoint is (h, k) then chord is $y = -\frac{h}{k}x + 2h$ and if it is a tangent then $x^2 = 4\left(-\frac{h}{k}x + 2h\right)$

D = 0

$\Rightarrow k^2 = -\frac{h}{2}$ (Parabola)

19. $\left|\alpha_1\beta_1 + \alpha_2\beta_2\right| \le \sqrt{\alpha_1^2 + \alpha_1^2}\sqrt{\beta_1^2 + \beta_2^2}$

$\Rightarrow \left|\alpha_1\beta_1 + \alpha_2\beta_2\right| \le 1$

20. $g(n) = \int\limits_0^{n^2+n+1} e^{\{x/2\}}\left\{\frac{x}{2}\right\}d\{x\}$

$= \left(n^2 + n + 1\right)\int\limits_0^1 e^{\{x/2\}}\left\{\frac{x}{2}\right\}dx$

$= \left(n^2 + n + 1\right)\int\limits_0^1 e^{x/2}\left(\frac{x}{2}\right)dx$

$= n^2 + n + 1[4 – 2e^{1/2}]$

So, minimum value is $12 - 6\sqrt{e}$

21. f(0) < f(1) now if suppose

$\Rightarrow$ f(n – 1) < f(n)

$\Rightarrow \sqrt{f(n-1)+6} < \sqrt{f(n)+6}$

$\Rightarrow$ f(n) < f(n + 1)

Also, f(0) < 3, let f(n) < 3

$\Rightarrow \sqrt{f(n)+6} < \sqrt{3+6}$

$\Rightarrow$ f(n + 1) < 3

So, f(n) is bounded above 3

22. Any plane containing the line is $p_1 + \lambda p_2 = 0$. It's distance (d) from origin $= \frac{|1+\lambda|}{\sqrt{\sum(a+\lambda a')^2}}$.

Let $d^2 = \phi = \frac{\lambda^2 + 2\lambda + 1}{A\lambda^2 + B\lambda + C}$ where $A = \sum a'^2,\ B = 2\sum aa'$ and $C = \sum a^2$.

$\Rightarrow (A\phi - 1)\lambda^2 + (B\phi - 2)\lambda + (C\phi - 1) = 0$. As $\lambda \in R$, $D \ge 0$

$\Rightarrow 0 \le \phi \le \frac{4(A+C-B)}{4AC - B^2} = \frac{p}{q}$. So, $d_{max} = \sqrt{\frac{p}{q}}$.

23. We have f(x + a) $\ge \frac{1}{2}$ and so f(x) $\ge \frac{1}{2}$ $\forall$ x $\in$ R.

Lets set, g(x) = f(x) – $\frac{1}{2}$ we have g(x) $\ge$ 0 $\forall$ x $\in$ R

$\Rightarrow g(x+a) = \sqrt{\frac{1}{4} - (g(x))^2}$

$\Rightarrow g^2(x+a) = \frac{1}{4} - g^2(x) = g(x+2a) = \frac{1}{4} - g^2(x+a)$

$\Rightarrow g^2(x+2a) = g^2(x)$
$\Rightarrow g(x + 2a) = g(x)$
$\Rightarrow f(x + 2a) = f(x)$

24. $(\lambda I_n)\,\text{Adj}(\lambda I_n) = |\lambda I_n|\, I$
$\Rightarrow \text{Adj}(\lambda I_n) = \lambda^{n-1} I_n$
$\Rightarrow |\text{Adj}(\lambda I_n)| = \lambda^{n(n-1)}$

25. $B = A_1 + 3(A_2)^3 + \ldots.. + 13(A_7)^{13}$
$B^T = -[A_1 + 3(A_2)^3 + \ldots.. + 13(A_7)^{13}] = -B$

26. $$f = (a+p)^{m-1}\left[1 + \frac{a+q}{a+p} + \left(\frac{a+q}{a+p}\right)^2 + \ldots.. + \left(\frac{a+q}{a+p}\right)^{m-1}\right]$$
Now coefficient of a^t is ${}^mC_t \dfrac{p^{m-t} - q^{m-t}}{p-q}$

27. Point of intersection of L and x = –2 is the required point

28. $$\int_0^{\ln 2} e^{-2x} f''(x)\,dx$$
$$= \left[e^{-2x} f'(x)\right]_0^{\ln 2} + 2\int_0^{\ln 2} e^{-2x} f'(x)\,dx$$
$$= \left[\frac{1}{4} f'(\ln 2) - 3\right] + 2\left[e^{-2x} f(x) + 2\int e^{-2x} f(x)\,dx\right]_0^{\ln 2} = 13$$

30. $|a - b| < c$
$|b - c| < a$
$|c - a| < b$
$$\Rightarrow \left.\begin{array}{l}(a-b)^2 < c^2 \\ (b-c)^2 < a^2 \\ (c-a)^2 < b^2\end{array}\right\} (a-b)^2 + (b-c)^2 + (c-a)^2 < a^2 + b^2 + c^2$$
$\Rightarrow a^2 + b^2 + c^2 < 2ab + 2bc + 2ca$
$\Rightarrow a^2 + b^2 + c^2 + 2ab + 2bc + 2ca < 4(ab + bc + ca)$
$\Rightarrow 4(ab + bc + ca) - (a + b + c)^2 > 0$
Also, $2^a + 2^{-a} \ge 2$
Hence, for all values of a, b, c the above z is defined.

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

FIITJEE **JEE (Advanced), 2014**

FULL TEST – II

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 246**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 06)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-A (07 – 10)** contains 4 multiple choice questions having one or more than one correct answer and each question carries **+4 marks** for correct answer and there is no negative marking.

(iii) **Section-A (11 – 14)** contains 4 Assertion-Reasoning (multiple choice questions) which have only one correct answer. Each question carries **+3 marks** each for correct answer and **– 1 mark** for wrong answer.

(iv) **Section-A (15 – 23)** contains 3 paragraphs. Based upon paragraph, 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10$ m/s^2
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N-m^2
Density of water	$\rho_{water} = 10^3$ kg/m^3
Atmospheric pressure	$P_a = 10^5$ N/m^2
Gas constant	$R = 8.314$ J K^{-1} mol^{-1}

CHEMISTRY

Gas Constant	R	=	8.314 J K^{-1} mol^{-1}
		=	0.0821 Lit atm K^{-1} mol^{-1}
		=	1.987 ≈ 2 Cal K^{-1} mol^{-1}
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

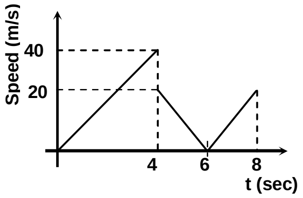
SECTION – A

Straight Objective Type

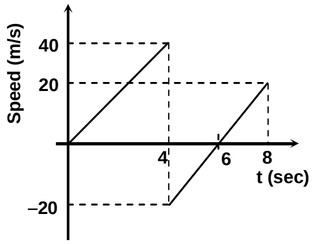
This section contains **6 multiple choice questions** numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. A ball is dropped from a height of 80 m on a floor. At each collision, the ball losses half of its speed. Then the graph between speed versus time is

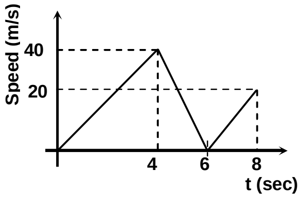
(A)



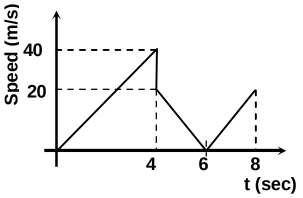
(B)



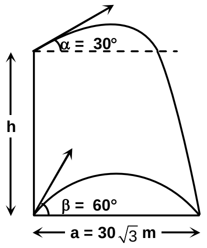
(C)



(D)



2. Shots are fired simultaneously from the top and bottom of a vertical cliff with elevation $\alpha = 30°$ and $\beta = 60°$ respectively and strikes the object simultaneously at the same point. If $a = 30\sqrt{3}$ m is the horizontal distance of the object from the cliff, then the height of the cliff is



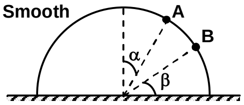
(A) 30 m
(B) 45 m
(C) 60 m
(D) 90 m

3. A projectile is required to hit a target whose co-ordinates relative to horizontal and vertical axes through the point of projection are (α, β). If the gun velocity is $\sqrt{2g\alpha}$. Then the condition when it is impossible to hit the target.

(A) $3\alpha > 4\beta$
(B) $4\beta > 3\alpha$
(C) $3\beta > 4\alpha$
(D) $4\alpha > 3\beta$

Space for rough work

4. A particle moves from rest at A on the surface of a smooth circular cylinder of radius r as shown. At B its leaves the cylinder. Then the equation relating α and β is



(A) $3\sin\alpha = 2\cos\beta$
(B) $2\sin\alpha = 3\cos\beta$
(C) $3\sin\beta = 2\cos\alpha$
(D) $2\sin\beta = 3\cos\alpha$

5. The gravitational field in a region is given by E = $\left(2\hat{i} + 3\hat{j}\right)$ N/kg. The equation of the line on which no work is done by the gravitational when the particle is moved

(A) 2y + 3x = 5
(B) 5y + 2x = 3
(C) 3y + 2x = 5
(D) 3y + 5x = 2

6. A rubber ball of mass m and radius r is submerged into water of density ρ to the depth h and released. Then to what height will the ball jump up above the surface of water?

(A) $\left(\rho\frac{4}{3}\pi r^3 - m\right)\frac{h}{m}$
(B) $\left(m - \rho\frac{4}{3}\pi r^3\right)\frac{h}{m}$
(C) $\left(\rho\frac{4}{3}\pi r^3 - m\right)\frac{h}{2m}$
(D) $\left(\rho\frac{4}{3}\pi r^3 + m\right)\frac{h}{m}$

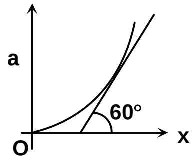
Multiple Correct Choice Type

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

7. In a YDSE set up the separation between the slits is 3×10^{-3} m. The distance between the slits and the screen is 1.5 m. Light of wavelength in the visible range (4000Å – 8000Å) is allowed to fall on the slits. The wave length in the visible region that will be present on the screen at a distance of 1.5×10^{-3} m from central maxima is

(A) 4285.7Å
(B) 5000 Å
(C) 6000 Å
(D) 7500Å

8. A particle starts moving with initial velocity 3 m/s along x-axis from origin. Its acceleration is varying with x in parabolic nature as shown in figure. At x = $\sqrt{3}$ m tangent to the graph makes an angle 60° with positive x-axis as shown in diagram. Then at x = $\sqrt{3}$

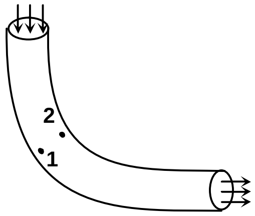


(A) $v = \sqrt{(\sqrt{3} + a)}$ m/s
(B) $a = 1.5$ m/s^2
(C) v = $\sqrt{12}$ m/s
(D) $a = 3$ m/s^2

Space for rough work

9. A vertical capillary tube with inside radius 0.25 mm is submerged into water so that the length of its part protruding over the water surface is equal to 25 mm. surface tension of water is 73×10^{-3} N/m and angle of contact is zero degree for glass and water, acceleration due to gravity is 9.8 m/s^2. Then choose correct statement.
(A) R = 0.25 mm (B) h = 59.6 mm
(C) R = 0.60 mm (D) h = 25 mm
where R is radius of meniscus and h is height of water in capillary tube.

10. Ideal fluid flows along a tube of uniform cross section, located in a horizontal plane and bent as shown in figure. The flow is steady, 1 and 2 are two points in the tube. If P_1 and P_2 are pressure at the two points and v_1 and v_2 are the respective velocities, then
(A) $P_1 < P_2$ (B) $P_1 > P_2$
(C) $v_1 < v_2$ (D) $v_1 > v_2$



Reasoning Type

This section contains **4 questions** numbered 11 to 14. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

11. STATEMENT-1: If the magnitude of momentum of a system of particle is zero, its kinetic energy may or may not be zero.
and
STATEMENT-2: the kinetic energy of a particle of mass m with momentum P is equal to $P^2/2m$
(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

Space for rough work

12. STATEMENT-1: For an ideal fluid flowing through a horizontal pipe of non-uniform cross section. The pressure decreases with the decrease in cross-section.
and
STATEMENT-2: for ideal flow through a pipe of non-uniform cross section, the speed decreases with the increase in cross-section.
(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

13. STATEMENT-1: The electric field inside the cavity of a charged conductor is zero when there is no charge in the cavity.
and
STATEMENT-2: The flux of electric field through Gaussian surface inside the cavity with no charge is zero.
(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

14. STATEMENT-1: Light of frequency f illuminating a long narrow slit produces a diffraction pattern. On increasing the frequency slightly the pattern contracts toward the centre.
and
STATEMENT-2: For the same size obstacles, light waves of small wavelength undergo more diffraction.
(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

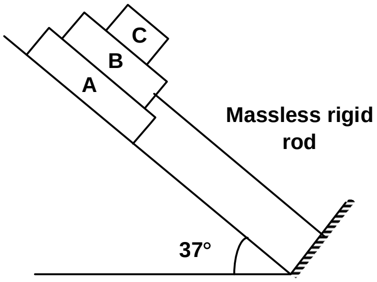
Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 15 to 17

In the shown figure m_A, m_B and m_C are the masses of the three blocks, the incline is frictionless m_A = 5 kg, m_B = 10 kg, m_C = 2kg. coefficient of friction between A and B is 0.5 and between B and C is 0.1 (Take g = 10 m/s^2)
On the basis of above data answer the following questions.



15. What is the frictional force on block A
    (A) 30 N (B) 48 N
    (C) 18 N (D) 78 N

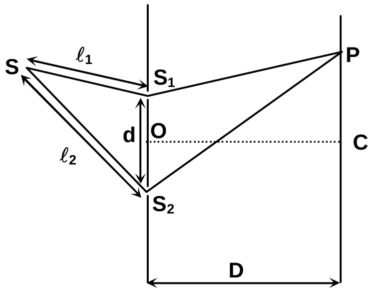
16. What is the frictional force on block C
    (A) 12 N (B) 1.6 N
    (C) 20 N (D) 13.6 N

17. What is the tension in the rod
    (A) 91.6 N (B) 31.6 N
    (C) 8.4 N (D) 90 N

Space for rough work

Paragraph for Question Nos. 18 to 20

In a young double slit experiment. The two slits are illuminated by a monochromatic light source S of wavelength λ = 500 nm. Distance between slits and screen is D = 2m and distance between two slits $S_1S_2 = 10$ μm. ℓ_1 = 20 μm and ℓ_2 = μm, as shown in the figure. Answer the following questions on the basis above data.



18. The value of θ relative to the central line OC, where maxima appear on the screen

(A) $\theta = \sin^{-1}\left[2\left(\frac{n}{40} - 1\right)\right]$
(B) $\theta = \sin^{-1}\left[2\left(\frac{n}{20} - 1\right)\right]$
(C) $\theta = \sin^{-1}\left[\left(\frac{n}{40} - 1\right)\right]$
(D) $\theta = \sin^{-1}\left[\left(\frac{n}{20} - 1\right)\right]$

19. How many maxima will appear on the screen

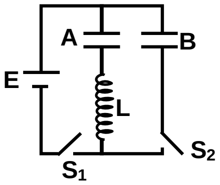
(A) 80
(B) 60
(C) 40
(D) 20

20. What should be minimum thickness of a slab of refractive index μ = 1.5 will be placed on the path of one ray so that minima occurs at C?

(A) 1000 nm
(B) 250 nm
(C) 1500 nm
(D) 500 nm

Space for rough work

Paragraph for Question Nos. 21 to 23



Two uncharged identical capacitors A and B, each of capacitance C, and an inductor of inductance L are arranged as shown in the adjacent figure. At t = 0, the switch S_1 is closed while switch S_2 remains open. At time t = $t_0 = \sqrt{LC}\frac{\pi}{2}$, switch S_2 is closed while switch S_1 is opened.

Read the above passage carefully and answer the following questions.

21. The charge on capacitor A after time t_0 is

(A) 2CE (B) $\frac{CE}{2}$

(C) CE (D) $\frac{CE}{4}$

22. The current flowing through the inductor at t = t_0 is

(A) $2CE\frac{1}{\sqrt{LC}}$ (B) 0

(C) $\frac{CE}{2}\times\frac{1}{\sqrt{LC}}$ (D) $CE\times\frac{1}{\sqrt{LC}}$

23. After switch S_2 is closed and S_1 is opened, the maximum value of current through the inductor is

(A) $\left(\sqrt{\frac{C}{L}}\right)E$ (B) $\left(\sqrt{\frac{C}{2L}}\right)E$

(C) $\left(\sqrt{\frac{3}{2}\frac{C}{L}}\right)E$ (D) $\left(\sqrt{\frac{5}{4}\frac{C}{L}}\right)E$

Space for rough work

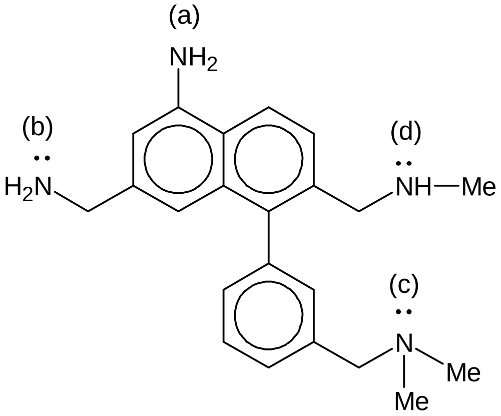
Chemistry PART – II

SECTION – A

Straight Objective Type

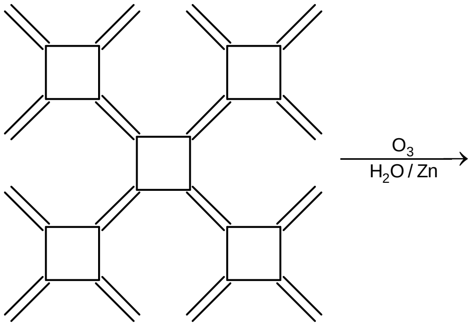
This section contains **6 multiple choice questions** numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Which of the N atoms is least basic in the given compound?



(A) a (B) b
(C) c (D) d

2. How many formaldehyde will be formed in the given reaction?



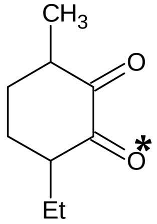
(A) 12 (B) 10
(C) 11 (D) 5

Space for rough work

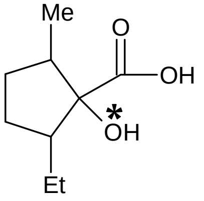
3. Select the incorrect statement about N_2F_4 and N_2H_4.
   (i) In N_2F_4, d orbitals are contracted by electronegative fluorine atoms, but d-orbitals contraction is not possible by H-atoms in N_2H_4.
   (ii) The N—N bond energy in N_2F_4 is more than N—N bond energy in N_2H_4
   (iii) The N—N bond length in N_2F_4 is more than that of in N_2H_4
   (iv) The N—N bond length in N_2F_4 is less than that of N_2H_4
   Choose the correct code:
   (A) (i), (ii), (iii)
   (B) (i) and (ii)
   (C) (ii) and (iv)
   (D) (ii) and (iii)

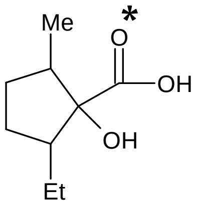
4. The radius of the Cl^- ion is 38% larger than that of the F^- ion but the radius of the Br^- ion is only 6.5% larger than that of the Cl^- ion. The relatively small difference in size between Cl^- and Br^- ion is due to the fact that
   (A) The Br^- ion contains ten 3d electrons, which fails to shield the nuclear charge effectively.
   (B) The Br^- ion contains ten 3d electrons, which shield the nuclear charge effectively.
   (C) The Br^- ion contains six 4p electrons which shield the nuclear charge effectively.
   (D) The Br^- ion contains ten 3d electrons and six 3p electrons, together they shield the nuclear charge effectively.

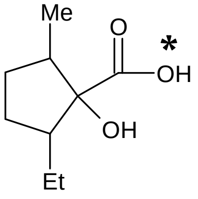
5. A cinema hall has equidistant rows 1m apart. The length of cinema hall is 287m and it has 287 rows. From one side of cinema hall, laughing gas N_2O is released and from the other side, weeping gas ($C_6H_5COCH_2Cl$) is released. In which rows, spectators will be laughing and weeping simultaneously?
   (A) 100th row from weeping gas side
   (B) 100th row from laughing gas side
   (C) 187th row from the weeping gas side
   (D) 185th row from the laughing gas side

6. 

$\xrightarrow[H_3O^+]{OH^-}(B)$, compound (B) is

   (A) 

   (B) 

   (C) 

   (D) All

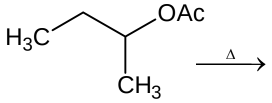
Multiple Correct Choice Type

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

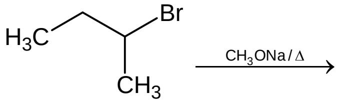
7. Which of the following statement(s) is/are correct?
   (A) For adiabatic expansion of an ideal gas, $TV^{\gamma-1} =$ constant.
   (B) Work done in reversible isothermal expansion is greater than that done in reversible adiabatic expansion for the same increase of volume.
   (C) Buffer capacity is maximum when concentration of weak acid and salt of its conjugate base is equal.
   (D) Equilibrium constant of an exothermic reaction decreases with increase of temperature generally.

8. In which of the following reaction product formation takes place by Hofmann rule?

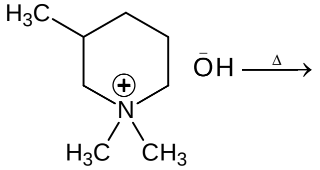
(A)



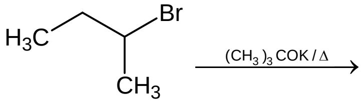
(B)



(C)



(D)



9. Select the correct statement(s):
   (A) Ionization energies of 5d elements are greater than those of 3d and 4d elements.
   (B) $[Fe(CN)_6]^{4-}$, $[Ni(CN)_4]^{2-}$ and $[Ni(CO)_4]$ all are diamagnetic.
   (C) Holme's signal can be given by using (Ca_3P_2 + CaC_2).
   (D) Nitrolim is a mixture of calcium cyanide and carbon.

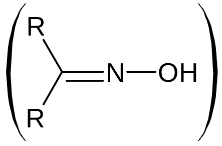
10. Nitrogen (I) oxide is produced by
    (A) thermal decomposition of ammonium nitrate
    (B) disproportionation of N_2O_4
    (C) thermal decomposition of ammonium nitrite
    (D) interaction of hydroxyl amine with nitrous acid

Space for rough work

Reasoning Type

This section contains **4 questions** numbered 11 to 14. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

11. STATEMENT-1: For π overlap the lobes of the atomic orbitals are perpendicular of the line joining the nuclei.
and
STATEMENT-2: In π molecular orbitals probability of finding electron is zero along the internuclear axis.
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

12. STATEMENT-1: Oximes 

are more acidic than hydroxylamine (NH_2OH).
and
STATEMENT-2: Conjugate base of oxime is resonance stablised.
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

Space for rough work

13. STATEMENT-1: In an atom, the velocity of electrons in the higher orbits keeps on decreasing.
and
STATEMENT-2: Velocity of electrons is inversely proportional to the radius of the orbit.
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

14. STATEMENT-1: BrO_3^- shows two reactions as

$$SeO_3^{--} + BrO_3^- + H^+ \longrightarrow SeO_4^- + Br_2 + H_2O$$

$$AsO_2^{--} + BrO_3^- + H^+ \longrightarrow Br^- + AsO_4^- + H_2O$$

and

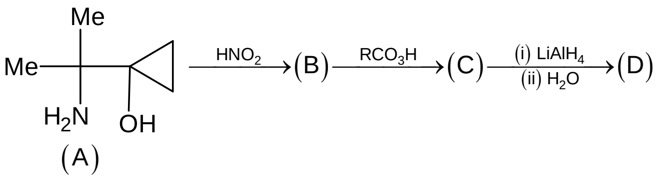
STATEMENT-2: The ratio of equivalent weights of BrO_3^- in two reaction 5/6
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

Space for rough work

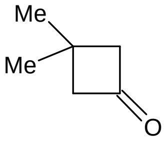
Comprehension Type

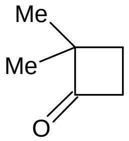
This section contains **3 groups of questions.** Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

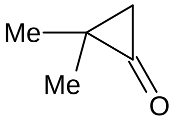
Paragraph for Question Nos. 15 to 17

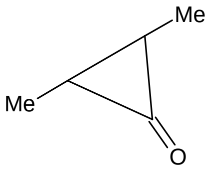

Me
Me
H₂N
OH
(A)
HNO₂
(B)
RCO₃H
(C)
(i) LiAlH₄
(ii) H₂O
(D)

15. The compound (B) is

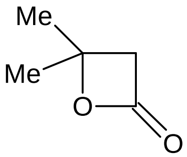
(A)


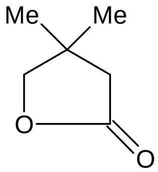
(B)


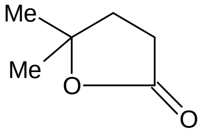
(C)


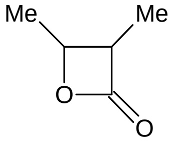
(D)


16. The compound (C) is

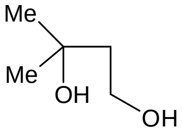
(A)


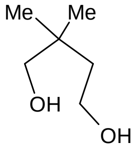
(B)


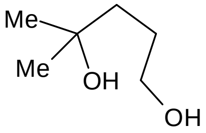
(C)


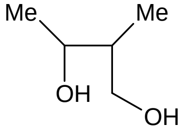
(D)


17. The compound (D) is

(A)


(B)


(C)


(D)


Space for rough work

Paragraph for Question Nos. 18 to 20

$Pb(IO_3)_2$ is a sparingly soluble salt ($K_{sp} = 2.7 \times 10^{-13}$). To 35 ml 0.15 M $Pb(NO_3)_2$ solution, 15 ml of 0.8 M KIO_3 solution is added and a precipitate of $Pb(IO_3)_2$ is formed.

18. Which is a limiting reagent of the reaction that takes place in the solution?
(A) $Pb(IO_3)_2$
(B) $Pb(NO_3)_2$
(C) KIO_3
(D) Both B and C

19. What will be the molarity of IO_3^- ions in the solution after completion of the reaction.
(A) 0.152
(B) 0.081
(C) 0.41
(D) 0.03

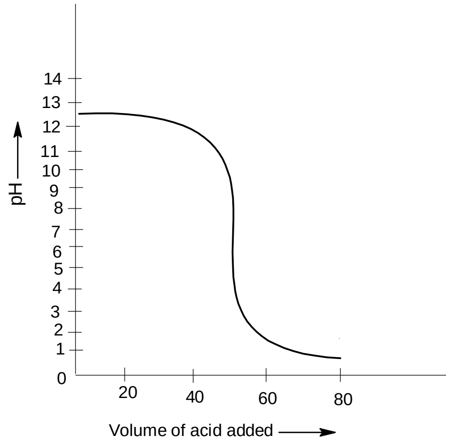
20. What will the molarity of Pb^{+2} ions in the solution after completion of the reaction
(A) 8.4×10^{-10}
(B) 1.6×10^{-10}
(C) 3.0×10^{-10}
(D) 6.1×10^{-10}

Space for rough work

Paragraph for Question Nos. 21 to 23

Read the following paragraph and answer the questions given below:

A titration curve graph of pH as a function of the volume of titrant, displays in detail how the pH changes over the course of an acid-base titration. Significantly, the pH changes most rapidly near the equivalence point. The exact shape of a titration curve depends on the relative strengths of acids and bases. Examine the titration curve below:



21. The suitable indicator for this titration will be

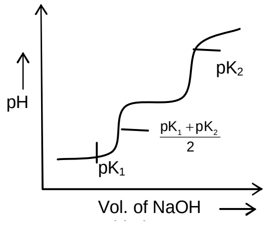
(A) bromomethyl blue
(B) methyl orange
(C) methyl red
(D) All of the above

22. The pH at equivalence point is

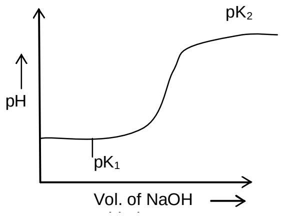
(A) 11
(B) 7
(C) 3
(D) 2

23. Which of the following curve indicates the titration of a weak diprotic acid by NaOH of equivalent strength?

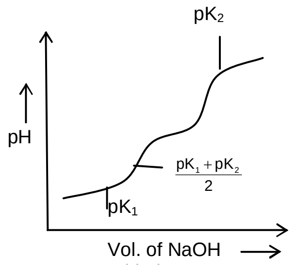
(A)



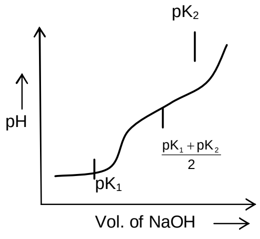
(B)



(C)



(D)



Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **6 multiple choice questions** numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. If the parabola $y = ax^2 + bx + c$ has vertex at (4, 2) and $a \in [1, 3]$, then difference between the extreme values of abc is equal to,

(A) 3600	(B) 144
(C) 3456	(D) none of these

2. Let $f : R \to R$, $f(x) = \begin{cases} |x-[x]|, & [x] \text{ is odd} \\ |x-[x+1]|, & [x] \text{ is even} \end{cases}$, where [.] denotes greatest integer function, then $\int_{-2}^{4} f(x)dx$ is equal to

(A) 5/2	(B) 3/2
(C) 5	(D) 3

3. If $\lim_{x\to 0}\int_0^x \frac{t^2dt}{(x-\sin x)\sqrt{a+t}} = 1$, then the value of a is

(A) 4	(B) 2
(C) 1	(D) none of these

4. Nine hundred distinct N-digit numbers are to be formed by using 6, 8 and 9 only. The smallest value of N for which this is possible, is

(A) 6	(B) 7
(C) 8	(D) 9

Space for rough work

5. If P, Q, R be midpoints of sides AB, BC and CA of ΔABC, then the ration of circumradius of ΔPQR to that of circumradius of ΔABC is
(A) 1 : 4 (B) 1 : 2
(C) 1 : 3 (D) none of these

6. The number of solutions of $\log_x 3 = 2x - 3$ is
(A) 3 (B) 1
(C) 2 (D) 0

Multiple Correct Choice Type

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

---

7. $f(x) = \cos \pi(|x| + [x])$, then
(A) f is continuous at $x = 1/2$ (B) f is continuous at $x = 0$
(C) f is differentiable in $(-1, 0)$ (D) f is differentiable in $(0, 1)$

8. Tangents are drawn to the circle $x^2 + y^2 = 50$ from a point 'P' lying on the x-axis. These tangents meet the y-axis at points 'P_1' and 'P_2'. Possible coordinates of 'P' so that area of triangle PP_1P_2 is minimum, is/are
(A) (10, 0) (B) $(10\sqrt{2}, 0)$
(C) (–10, 0) (D) $(-10\sqrt{2}, 0)$

9. Two particles start from the same point (2, –1), one moving 2 units along the line $x + y = 1$ and the other 5 units along $x - 2y = 4$. If the particles move towards increasing y, then their new position will be
(A) $(2 - \sqrt{2}, \sqrt{2} - 1)$ (B) $(2\sqrt{5} + 2, \sqrt{5} - 1)$
(C) $(2 + \sqrt{2}, \sqrt{2} + 1)$ (D) $(2\sqrt{5} - 2, \sqrt{5} - 1)$

10. If $\frac{x}{a} + \frac{y}{b} = 1$ is a tangent to the curve $x = 4t$, $y = \frac{4}{t}$, $t \in R$ then
(A) $a > 0, b > 0$ (B) $a > 0, b < 0$
(C) $a < 0, b > 0$ (D) $a < 0, b < 0$

Space for rough work

Reasoning Type

This section contains **4 questions** numbered 11 to 14. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

11. STATEMENT 1: $\pi^4 > 4^\pi$

STATEMENT 2: The function $y = x^x$ is decreasing $\forall\ x > \frac{1}{e}$

(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

12. If $P(\bar{B}) = \{P(A \cup B)\}^2$, then

STATEMENT 1: $P(A \cup B)$ is at least $\frac{\sqrt{5}-1}{2}$

STATEMENT 2: $A \cap (B \cap A) = A \cup (B \cap A)$

(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

13. STATEMENT 1: $a + b + c + d + e = 8$ and $a^2 + b^2 + c^2 + d^2 + e^2 = 16$, where a, b, c, d, e are positive non-negative real numbers, then $e \in \left[0, \frac{16}{5}\right]$

STATEMENT 2: $\left(\frac{a+b+c+d}{4}\right)^2 \le \frac{a^2+b^2+c^2+d^2}{4}$

(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

14. STATEMENT 1: Tangents at two distinct points of a cubic polynomial cannot coincide

STATEMENT 2: If P(x) is a polynomial of degree n ($n \ge 2$), then $P'(x) = k$ cannot hold for n or more distinct values of x

(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 15 to 17

Read the following write up carefully and answer the following questions:
A circle C whose radius is 1 unit, touches the x–axis at point A. The centre Q of C lies in first quadrant. The tangent from origin O to the circle touches it at T and a point P lies on it such that ΔOAP is a right angled triangle at A and its perimeter is 8 units

15. The length of QP is
(A) $\frac{1}{2}$ (B) $\frac{4}{3}$
(C) $\frac{5}{3}$ (D) none of these

16. Equation of circle C is
(A) $\{x-(2+\sqrt{3})\}^2+(y-1)^2=1$ (B) $\{x-(\sqrt{3}+\sqrt{2})\}^2+(y-1)^2=1$
(C) $(x-\sqrt{3})^2+(y-2)^2=1$ (D) none of these

17. If tangent OT cuts the two parallel tangents (one of them is OA) at O and R, then equation of circle circumscribing the Δ ORQ is
(A) $x^2+y^2-\sqrt{3}x-y=0$ (B) $x^2+y^2-\sqrt{3}x-2y=0$
(C) $x^2+y^2-2\sqrt{3}x-2y=0$ (D) none of these

Paragraph for Question Nos. 18 to 20

Read the following write up carefully and answer the following questions:
The vertices of a ΔABC lies on a rectangular hyperbola such that the orthocentre of the triangle is (3, 2) and the asymptotes of the rectangular hyperbola are parallel to the coordinate axis. If the two perpendicular tangents of the hyperbola intersect at the point (1, 1)

18. The equation of the asymptotes is
(A) $xy - 1 = x - y$ (B) $xy + 1 = x + y$
(C) $2xy = x + y$ (D) none of these

19. Equation of the rectangular hyperbola is
(A) $xy = 2x + y - 2$ (B) $2xy = x + 2y + 5$
(C) $xy = x + y + 1$ (D) none of these

20. Number of real normals that can drawn from the point (1, 1) to the rectangular hyperbola is
(A) 4 (B) 0
(C) 3 (D) 2

Space for rough work

Paragraph for Question Nos. 21 to 23

Read the following write up carefully and answer the following questions:
If $ax^2 + by^2 + 2hxy + 2gx + 2fy + c = 0$ represents an ellipse, then $h^2 < ab$ and $abc + 2fgh - af^2 - bg^2 - ch^2 \neq 0$. If for every point (x_1, y_1) satisfying above equation $(2h - x_1, 2k - y_1)$ also satisfy it, then (h, k) is centre of it. The length of semi major axis and minor axis is nothing but the maximum and minimum value of the distance of a point lying on the curve from its centre.

21. For the ellipse $2x^2 - 2xy + 4y^2 - (3 + \sqrt{2}) = 0$, the inclination of major axis of it with x-axis is

(A) $\frac{\pi}{12}$
(B) $\frac{\pi}{8}$
(C) $\frac{3\pi}{8}$
(D) $\frac{5\pi}{8}$

22. If the given ellipse is rotated so that it has its major axis coincident with x-axis, then its equation becomes

(A) $3(x^2 + y^2 - 1) = (y^2 - x^2 + 1)\sqrt{2}$
(B) $3(x^2 + y^2 - 1) = (y^2 - x^2 - 1)\sqrt{2}$
(C) $3(x^2 + y^2 - 1) = (y^2 - x^2 - 1)\sqrt{2}$
(D) $\sqrt{2}\,(x^2 - y^2 + 1) = 3(x^2 + y^2 - 1)$

23. The maximum area of the circle lying inside the given ellipse is

(A) π
(B) $\frac{\pi}{2}$
(C) $\pi\left(\frac{3+\sqrt{2}}{3-\sqrt{2}}\right)$
(D) $\pi\left(\frac{3-\sqrt{2}}{3+\sqrt{2}}\right)$

Space for rough work

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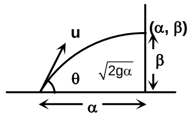
Q.NO	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	A	C
2.	C	A	D
3.	B	A	A
4.	C	A	B
5.	C	A	B
6.	A	A	C
7.	A, B, C, D	A, B, C, D	A, C, D
8.	A, B	A, C, D	A, C
9.	C, D	A, B, C	A, B
10.	B, C	A, D	A, D
11.	B	B	C
12.	B	A	B
13.	B	A	A
14.	C	C	A
15.	A	B	C
16.	B	C	D
17.	A	C	C
18.	A	B	B
19.	C	D	C
20.	D	C	D
21.	C	D	B
22.	D	B	D
23.	C	A	A

Physics PART – I

2. $(v_1\cos\alpha)t = (v_2\cos\beta)t = 30\sqrt{3}$ . . . (1)

$(v_1\sin\alpha)t - \frac{1}{2}gt^2 + h = (v_2\sin\beta)t - \frac{1}{2}gt^2$ . . . (2)

from (1) and (2)
$h = 60$ m



3. $\beta = \alpha\tan\theta - \frac{1}{2}g\frac{\alpha^2}{u^2\cos^2\theta}$

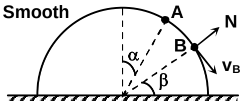
$\beta = \alpha\tan\theta - \frac{1}{2}g\frac{\alpha^2}{2g\alpha}\left(1+\tan^2\theta\right)$

$\tan^2\theta - 4\tan\theta + \left(1+\frac{4\beta}{\alpha}\right) = 0$

If particle will not hit the target.
$(b^2 - 4ac) < 0$

$16 - 4\left(1+\frac{4\beta}{\alpha}\right) < 0$

$4\beta > 3\alpha$



4. At B, $mg\sin\beta = \frac{mv_B^2}{r}$ . . . (1)

Using energy considerations

$\frac{1}{2}mv_B^2 = mgr(\cos\alpha - \sin\beta)$ . . . (2)

From (1) and (2)
$mg\sin\beta = 2mg(\cos\alpha - \sin\beta)$
$2\cos\alpha = 3\sin\beta$

7. Here the position y on the screen will correspond to maxima.

$y = \frac{n\lambda D}{d}$

$\lambda = \frac{30,000}{n}$ when n = 1, 2, 3, 4, …………..

8. $a = kx^2$

$\frac{da}{dx} = 2kx \Rightarrow \tan 60° = 2k\sqrt{3} \Rightarrow k = \frac{1}{2}$

$a = \frac{x^2}{2}$

$v\frac{dv}{dx} = \frac{x^2}{2} \Rightarrow \frac{v^2}{2} = \frac{x^3}{6} + C_1$ at x = 0, v = 3 m/s

$C_1 = \frac{9}{2}$

$v^2 = \frac{x^3}{3} + 9$

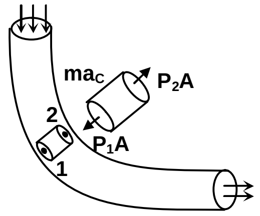
hence a = 1.5 and $v = \sqrt{\sqrt{3}+9}$

9. Capillary height $h = \frac{2T\cos\theta}{r\rho g}$ $\Rightarrow$ h = 59.6 mm

here 59.6 mm is greater than the protruding part hence water will rise in the capillary of insufficient height 25 mm.

Now, $R = \frac{2T}{hrg} = 0.6$ mm

10. 10. Fluid particles passing through the bend are in circular motion. The centripetal acceleration is provided by the variation in pressure. In the section as shown



$P_1A - P_2A = ma_C$

$\Rightarrow P_1 > P_2$

applying Bernoulli theorem at 1 and 2

i.e., $P_1 + \frac{1}{2}\rho_1 v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$

$$P_1 + \frac{1}{2}\rho_1 v_1^2 = P_2 + \frac{1}{2}\rho v_2^2 \text{ as } h_1 = h_2$$

$\because P_1 > P_2$

$v_1 < v_2$

15. $m_{Ag}\sin\theta$ = 5 × 10 × sin 37° = 5 × 10 × $\frac{3}{5}$ = 30 N

$f_{max} = \mu_{AB}(m_C + m_B)g\cos\theta = 48$ N

hence f = 30 N

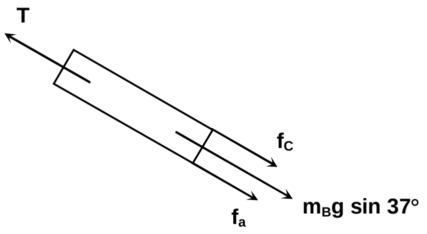
16. $m_C g\sin\theta = 2\times 10\times\frac{3}{5} = 12N$

$f_{max} = \mu m_c g\cos\theta = 0.1\times 2\times 10\times\frac{4}{5} = 1.6$ N

hence f = 1.6 N

17. $T = f_A + f_C + m_B g\sin 37°$

= 91.6 N



18. Optical path difference between the beans arriving at P

$\Delta x = (\ell_2 - \ell_1) + d\sin\theta$

for maxima

$(\ell_2 - \ell_1) + d\sin\theta = n\lambda$

$\sin\theta = \frac{1}{d}[n\lambda - (\ell_2 - \ell_1)]$

$\theta = \sin^{-1}\left[2\left(\frac{n}{40} - 1\right)\right]$

19. $\left|\sin\theta\right| \le 1$

$$-1 \le 2\left[\frac{n}{40} - 1\right] \le 1$$

or $20 \le n \le 60$

Hence number of maxima = 60 – 20 = 40

20. At C, phase difference

$$\phi = \frac{2\pi}{\alpha}(\ell_2 - \ell_1) = 80\,\pi$$

Hence for maximum intensity will appear at C.
Now for minimum intensity at C

$$(\mu - 1)t = \frac{\lambda}{2}$$

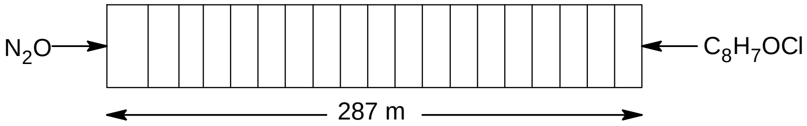
$$t = \frac{t}{2(\mu - 1)} = 500\ \text{nm}$$

Chemistry PART – II

3. Neither N nor F contain d-orbitals. Further in N_2F_4 N—N bond is shorter than in N_2H_4 due to s-character (Bent's Rule).

4. Due to poor shielding effect of 3d electron the size of Br^- ion nearly same as that of Cl^- ion.

5.



Molar mass of $C_8H_7OCl = 8 \times 12 + 7 \times 1 + 16 + 35.5 = 154.5$ g
Molar mass of $N_2O = 2 \times 14 + 16 = 44$g
According to Graham's Law of diffusion

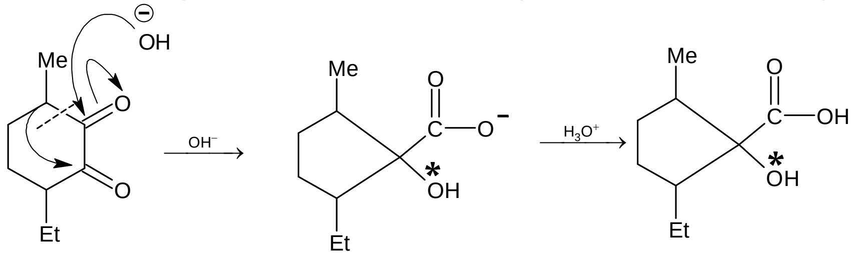
$$\frac{r_{N_2O}}{r_{C_8H_7OCl}} = \sqrt{\frac{M_{C_8H_7OCl}}{M_{N_2O}}} = \sqrt{\frac{154.5}{44}} = \sqrt{3.5} = 1.87 : 1$$

$$d_{N_2O} = \frac{1.87}{2.87} \times 287 = 187^{th} \text{ row from } N_2O \text{ side}$$

$$d_{C_8H_7OCl} = \frac{1.0}{2.87} \times 287 = 100^{th} \text{ row from weeping gas side}$$

Therefore, the spectator from the side of N_2O in the 187th row will be laughing and weeping simultaneously Alternatively, the spectator from the side of weeping gas in 100th row will laugh and weep.

6. OH^- attacks at the more reactive (C=O) group, (containing more EWG or less EDG) Et is more EDG than Me (due to +I effect here no H.C.). Therefore OH^- attack (C=O) with (Me) group.

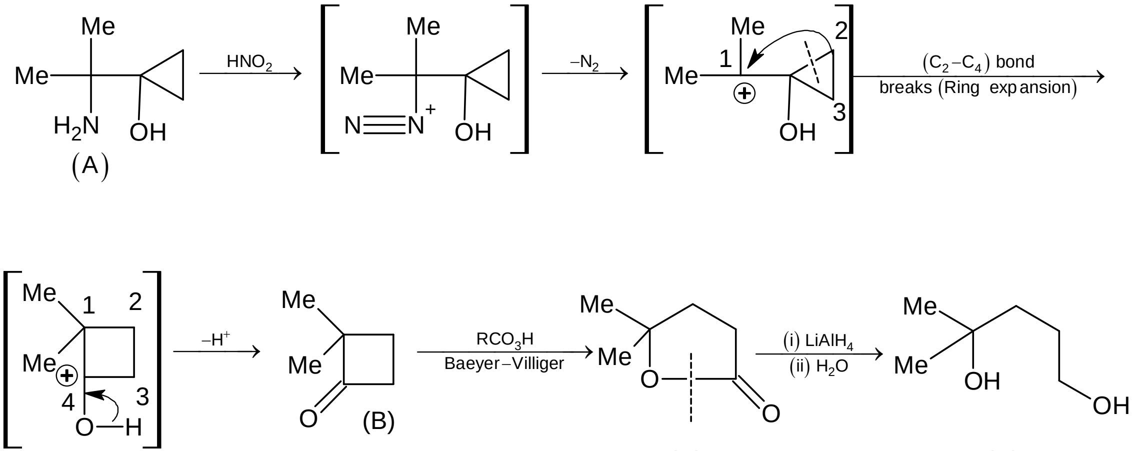


10. $NH_4NO_3(aq) \longrightarrow N_2O + H_2O$
$NH_2OH + HNO_2 \longrightarrow N_2O + 2H_2O$
Hence, (A) and (D) are the correct answers.

13. Velocity = $2.18 \times 10^6 \times \frac{Z}{n}$

14. (i) $E_{BrO_3^-} = M/5$
(ii) $E_{BrO_3^-} = M/6$
$\therefore$ ratio = 6/5

17.


Me
Me
H₂N
OH
(A)
HNO₂
Me
Me
N≡N⁺
OH
–N₂
Me
1
2
3
Me
OH
(C₂–C₄) bond
breaks (Ring expansion)
Me
1
2
Me
4
3
O—H
–H⁺
Me
Me
O
(B)
RCO₃H
Baeyer–Villiger
Me
Me
O
O
(i) LiAlH₄
(ii) H₂O
Me
Me
OH
OH

(C)
(Cyclic ester)

(Lactone)

(D)

18. $$\underset{\substack{0.8\times 15\\ =12}}{2KIO_3} + \underset{\substack{35\times 0.15\\ =5.25}}{Pb(NO_3)_2} \rightleftharpoons Pb(IO_3)_2 + 2KNO_3$$

1 mol of Pb(NO_3) reacts with 2 mol of KIO_3
5.25 m mol of Pb$(NO_3)_2$ reacts = 2 × 5.25
= 10.5 m mol
m mol of KIO_3 left = 12 – 10.5
= 1.5
Hence Pb$(NO_3)_2$ is the limiting reagent

19. $$\left[IO_3^-\right] = \frac{1.5\text{ m mol}}{(15+35)\text{ mL}} = 0.03\text{ M}$$

20. Due to common ion $\left(IO_3^-\right)$ left in the solution the solubility $Pb(IO_3)_2$ decreases.

$$S = \frac{K_{sp}}{(0.03)^2} = \frac{2.7\times 10^{-13}\times 10^4}{9}$$
$= 0.30 \times 10^{-9}$
$= 3.0 \times 10^{-10}$

21. pH range of all these indicators lies in between 2-12. Hence, all are suitable indicators.

22. Since curve is given for strong acid and strong base hence, pH at the end point is 7.

Mathematics PART – III

1. $y = ax^2 + bx + c$, vertex is (4, 2)

$\Rightarrow 4 = -\frac{b}{2a}$, $b = -8a$, $\frac{4ac - b^2}{4a} = 2 \Rightarrow c = 2 + \frac{b^2}{4a} = 2 + 16a$

Now $\Delta = abc = -8a^2(2 + 16a) = -16(a^2 + 8a^3)$

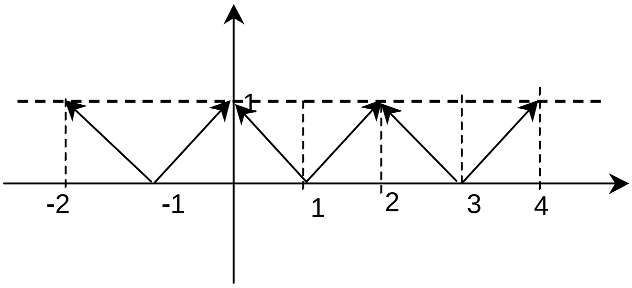
$\Rightarrow \frac{d\Delta}{da} = -16(2a + 24a^2) < 0 \ \forall \ a \in [1, 3]$

$\Rightarrow \Delta|_{max} = -144$, $\Delta|_{min} = -3600 \Rightarrow$ Difference = 3456

2. $x - [x] = \{x\}$

$x - [x + 1] = \{x\} - 1$

$\int_{-2}^{4} f(x)dx = 6.\frac{1}{2}(1.1) = 3$



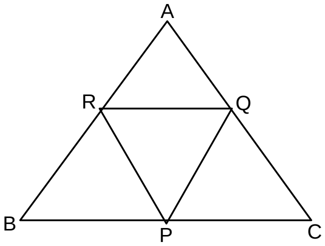
3. $\lim_{x\to 0} \int_0^x \frac{t^2 dt}{(x - \sin x)\sqrt{a+t}} = \lim_{x\to 0} \frac{\int_0^x \frac{t^2 dt}{\sqrt{a+t}}}{(x - \sin x)} = \lim_{x\to 0} \frac{x^2}{\sqrt{a+x}\,(1 - \cos x)}$

$= \lim_{x\to 0} \frac{x^2}{2\sin^2\frac{x}{2}.\sqrt{a+x}} = \frac{2}{\sqrt{a}} = 1$ (given)

$\Rightarrow a = 4$

4. $(3)^6 = 729 < 900$ and $(3)^7 = 2187 > 900$

5. Now by property of triangles



$RQ = \frac{1}{2}BC = \frac{a}{2}$

Similarly $PQ = \frac{c}{2}$, $PR = \frac{b}{2}$

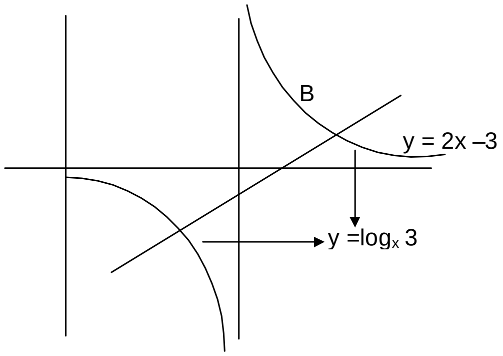
Area of $\Delta ABC = \frac{abc}{4R}$

That of $\Delta PQR = \frac{\frac{a}{2}\frac{b}{2}\frac{c}{2}}{4R'}$

Also area of ΔABC = 4 (area of ΔPQR)

$\Rightarrow \frac{abc}{32R'} = \frac{abc}{16R} = \left(\frac{R}{R'} = \frac{2}{1}\right)$

6. Clearly 2 solutions



7. $f(x) = \cos \pi(|x| + [x])$

$f(0) = 1,\ f(0 - 0) = \cos \pi(-1) = -1$

$f(1/2) = \cos \pi\left(\frac{1}{2}\right) = 0,\ f\left(\frac{1}{2} - 0\right) = \cos \pi\left(\frac{1}{2}\right) = 0$

$f\left(\frac{1}{2} + 0\right) = \cos \frac{\pi}{2} = 0$

for $x \in (0, 1)$ $f(x) = \cos \pi x$

for $x \in (-1, 0)$ $f(x) = \cos \pi(-x - 1) = -\cos \pi x$

8. $OP = 5\sqrt{2}\ \sec\theta$

$OP_1 = 5\sqrt{2}\ \text{cosec}\,\theta$

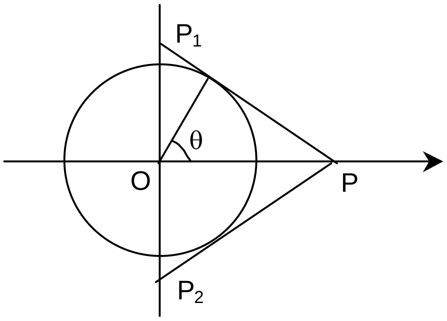
$\Delta PP_1P_2 = \frac{100}{\sin 2\theta}$

$(\Delta\ |\ PP_1P_2)_{\min} = 100$

$\Rightarrow \theta = \pi/4$

$\Rightarrow OP = 10$

$\Rightarrow P = (10, 0), (-10, 0)$



9. Let P(2, –1) goes 2 units along $x + y = 1$ upto A and 5 units along $x - 2y = 4$ up to B

Slope of PA = $-1 = \tan 135°$, slope of PB = $\frac{1}{2} = \tan\theta$

$\therefore \sin\theta = \frac{1}{\sqrt{5}}, \cos\theta = \frac{2}{\sqrt{5}}$

$\therefore A \equiv (x_1 + r\cos 135°, y_1 = r\sin 135°) = (2 + 2x - \frac{1}{\sqrt{2}}, -1 + 2 \times \frac{1}{\sqrt{2}}) = (2 - \sqrt{2}, \sqrt{2} - 1)$

$B \equiv (x_1 + r\cos\theta, y_1 + r\sin\theta) = (2 + 5 \times \frac{2}{\sqrt{5}}, -1 + \frac{5}{\sqrt{5}}) = (2\sqrt{5} + 2, \sqrt{5} - 1)$

10. Slope of tangent = $\frac{\frac{-1}{a}}{\frac{1}{b}} = -\frac{b}{a}$

$$\frac{dy}{dx} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}} = \frac{\frac{-4}{t^2}}{4} = -\frac{1}{t^2} < 0$$

So, $\frac{-b}{a} < 0 \Rightarrow \frac{b}{a} > 0$

12. $P\left(\frac{\bar{A}}{\bar{B}}\right) = \frac{1-P(A \cup B)}{P(\bar{B})} = \frac{1-x}{x^2} \le 1$

$\Rightarrow x^2 + x - 1 \ge 0$

$\Rightarrow x \ge \frac{\sqrt{5}-1}{2}$ or $x \le \frac{-1-\sqrt{5}}{2}$

$\therefore$ x is positive

$x \ge \frac{\sqrt{5}-1}{2}$

13. $\left(\frac{a+b+c+d}{4}\right)^2 \le \frac{a^2+b^2+c^2+d^2}{4}$

$\frac{(8-e)^2}{16} \le \frac{16-e^2}{4}$

$64 + e^2 - 16e \le 64 - 4e^2$

$5e^2 - 16e \le 0$

$0 \le e \le \frac{16}{5}$

14. Let A(a, P(a)), B(b, P(b)), then slope of AB = P′(a) = P′(b) from LMVT $\exists$ c $\in$ (a, b)
Where P′(c) = slope of AB

15. Given QT = QA = 1

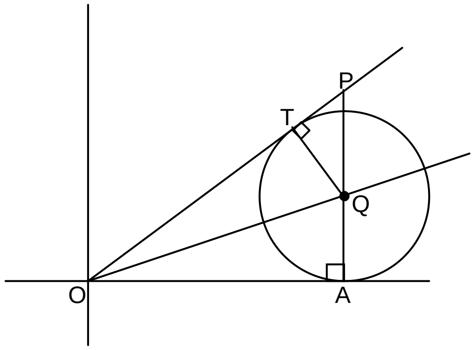
Let PQ = x, then $PT = \sqrt{x^2-1}$

Then Δ TQP and Δ APO are similar triangles

Then $OT = OA = \frac{x+1}{\sqrt{x^2-1}}$

$\Rightarrow 1 + x + \frac{2(x+1)}{\sqrt{x^2-1}} + \sqrt{x^2-1} = 8$

$\Rightarrow x = \frac{5}{3}$



16. From above, OA = 2 and AQ = 1
$\Rightarrow$ coordinate of Q $\equiv$ (2, 1)
$\Rightarrow$ equation is $(x - 2)^2 + (y - 1)^2 = 1$

17. ΔORQ is a right angled triangle. Then O and R are the extremities of the diameter then the coordinates of $R(2\sqrt{3},\ 2)$

$\Rightarrow$ Equation of circle $(x-0)(x-2\sqrt{3})+(y-0)(y-2)=0 \Rightarrow x^2+y^2-2\sqrt{3}x-2y=0$

18. Perpendicular tangents intersect on the director circle of hyperbola and director circle of rectangular hyperbola is a point circle. Hence centre of hyperbola is (1, 1) and equation of asymptotes are $(x - 1) = 0$ and $y - 1 = 0$

19. Equation of hyperbola is $xy - x - y + 1 + \lambda = 0$
It passes through (3, 2) hence $\lambda = -2$
Equation of hyperbola is $xy = x + y + 1$

20. From the centre of hyperbola we can draw two real normals to the rectangular hyperbola

21. Taking point $(r\cos\theta, r\sin\theta)$, we get
$$r^2 = \frac{3+\sqrt{2}}{3-\sqrt{2}\sin\left(2\theta+\frac{\pi}{4}\right)}$$
$$r_{max} = \sqrt{\frac{3+\sqrt{2}}{3-\sqrt{2}}}, \; r_{min} = 1$$
Max exist when $2\theta + \frac{\pi}{4} = \frac{\pi}{2} \Rightarrow \theta = \frac{\pi}{8}$

22. Required equation is $\frac{x^2}{\frac{3+\sqrt{2}}{3-\sqrt{2}}} + y^2 = 1$

23. Centre of circle be origin and its radius is the length of semi minor axis
Hence area = π

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

FIITJEE **JEE (Advanced), 2014**

FULL TEST – II

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 243**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-B**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 09)** contains 09 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (10 – 13) contains 4 Assertion-Reasoning (multiple choice questions) which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (14 – 19) contains 2 paragraphs. Based upon paragraph, 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-B (1 – 03)** contains 3 Matrix Match Type (4 × 4 Matrix) questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+6 marks** for all correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant R = $8.314\ J\ K^{-1}\ mol^{-1}$
= 0.0821 Lit atm $K^{-1}\ mol^{-1}$
= $1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

SECTION – A

Straight Objective Type

This section contains **9 multiple choice questions** numbered 1 to 9. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Two identical cylindrical vessels with their bases at the same level each contains a liquid of density ρ. The height of the liquid in one vessel is h_1 and that in other is h_2. The area of either base is A. Then the work done by gravity in equalizing the levels when the vessels are connected

(A) $\frac{1}{4}\rho gA\left(h_1 - h_2\right)^2$ (B) $\frac{1}{4}\rho gA\left(h_1^2 - h_2^2\right)$

(C) $\frac{1}{2}\rho gA\left(h_1 - h_2\right)^2$ (D) $\frac{1}{2}\rho gA\left(h_1^2 - h_2^2\right)$

2. An empty plastic box of mass m is found to accelerate up at a rate of g/6 when placed deep inside water. Then the mass of sand be filled in it so that it may accelerate down at a rate of g/6

(A) $\frac{5}{2}m$ (B) $\frac{2}{5}m$

(C) $\frac{2}{3}m$ (D) $\frac{3}{2}m$

3. The distance from the surface of the earth at which the acceleration due to gravity is the same below and above the surface of the earth

(A) $\left(\sqrt{5}+1\right)R_e$ (B) $\left(\frac{\sqrt{5}+1}{2}\right)R_e$

(C) $\frac{\left(\sqrt{5}-1\right)R_e}{2}$ (D) $\left(\sqrt{5}-1\right)R_e$

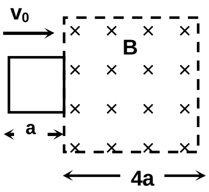
4. A ray is incident on a spherical body ($\mu = \sqrt{3}$) making an angle 60° with the normal drawn at the point of incidence. The ray after passing through sphere gets incident on the further surface of sphere and get reflected and refracted. Then the angle between the reflected and refracted rays at this surface is

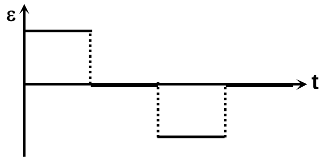
(A) 45° (B) 90°

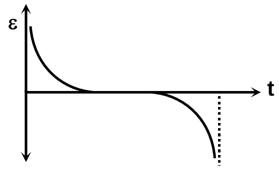
(C) 120° (D) 150°

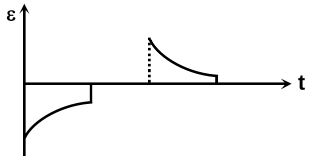
Space for rough work

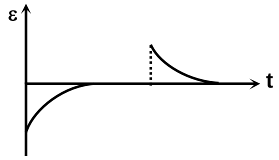
5. A square loop of side a is projected at t = 0, with speed v_0 into a region having uniform magnetic field B, with velocity perpendicular to the magnetic field. Which of the following plots correctly represents the variation of induced emf of loop with time



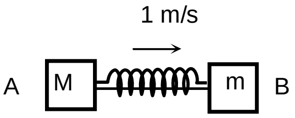
(A)


(B)


(C)


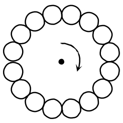
(D)


6. A block A of mass M = 2kg is connected to another block B of mass 1kg with a string and a spring of force constant k = 600 N/m as shown in the figure. Initially spring is compressed to 10 cm and whole system is moving on a smooth surface with a velocity v = 1 m/s. At any time thread is burnt, the velocity of block A, when B is having maximum velocity w.r.t. ground, is:



(A) 0
(B) 1 m/s
(C) 3 m/s
(D) none of these

7. A metallic chain with a length ℓ and whose ends are joined together is fitted onto a wooden disc as shown in the figure. The disc rotates with a speed of n revolutions per second. Then the tension of the chain T if its mass is m



(A) $m\ell n$
(B) $2m\ell n$
(C) $2m\ell n^2$
(D) $m\ell n^2$

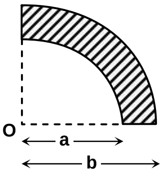
Space for rough work

8. An object of mass m is projected with momentum P at such an angle that its maximum height (H) is 1/4th of its horizontal range (R). Its minimum kinetic energy in its path will be

(A) $\frac{p^2}{8m}$ (B) $\frac{p^2}{4m}$

(C) $\frac{3p^2}{4m}$ (D) $\frac{p^2}{m}$

9. The distance of centre of mass from O of a uniform plate having quarter circular inner and outer boundaries of radii a and b from centre O.



(A) $\frac{4}{3\pi}\left(\frac{b^3-a^3}{b^2-a^2}\right)$ (B) $\frac{4\sqrt{2}}{3\pi}\left(\frac{b^3+a^3}{b^2-a^2}\right)$

(C) $\frac{4}{\pi}\left(\frac{b^3+a^3}{b^2+a^2}\right)$ (D) $\frac{4\sqrt{2}}{3\pi}\left(\frac{b^3-a^3}{b^2-a^2}\right)$

Reasoning Type

This section contains **4 questions** numbered 10 to 13. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

10. STATEMENT-1: In isothermal quasi-static process, heat is absorbed or given out by the system even though at every state the gas is at the same temperature as that of the surrounding reservoir.

and

STATEMENT-2: This is possible because of the infinitesimal difference in temperature between the system and surrounding.

(A) Statement-1 is True, Statement-2 is True; Statement -2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 is NOT a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

Space for rough work

11. STATEMENT-1: Only longitudinal waves can propagate in gases.

and

STATEMENT-2: The modulus of rigidity of gases is zero.

(A) Statement-1 is True, Statement-2 is True; Statement -2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 is NOT a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

12. STATEMENT-1: If the net external force on a system is zero, the net torque on the system is independent of origin.

and

STATEMENT-2: When the net force on a system is zero, net torque may or may not be zero.

(A) Statement-1 is True, Statement-2 is True; Statement -2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 is NOT a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

13. STATEMENT-1: In a photocell experiment, the stopping potential increases when the cathode is changed from cesium (Cs) metal to aluminium ($A\ell$).

and

STATEMENT-2: Stopping potential does not depend on the threshold wavelength.

(A) Statement-1 is True, Statement-2 is True; Statement -2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 is NOT a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

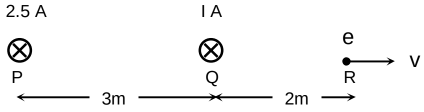
Space for rough work

Comprehension Type

This section contains **2 groups of questions.** Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 14 to 16

Two long parallel wires carrying currents 2.5 amp and I amp in the same direction as shown in figure. An electron moving with a velocity 4×10^5 m/sec. as shown in figure and experiences a force of magnitude 3.2×10^{-20} N at the point R. Then



14. The value of current I is
    (A) 2 amp.
    (B) 8 amp.
    (C) 4 amp.
    (D) 1 amp.

15. The position between PR at which a third long parallel wire carrying current 2.5 amp may be placed such that magnetic induction at R is zero.
    (A) at 1 m from R and the direction of current is inward.
    (B) at 1 m from R and the direction of current is outward
    (C) at 1 m from P and the direction of current is inward.
    (D) at 1 m from P and the direction of current is outward

16. The position not between PR but on the line joining PR at which a third long parallel wire carrying current 2.5 amp may be placed such that magnetic induction at R is zero.
    (A) at a distance of 1m from R and the direction of current is outward.
    (B) at a distance of 1 m from R and the direction of current is inward
    (C) at a distance of 1 m from P and the direction of current is outward
    (D) at a distance of 1 m from P and the direction of current is inward

Space for rough work

Paragraph for Question Nos. 17 to 19

A tube of length λ and radius R carries a steady flow of a fluid whose density is ρ and viscosity η. The velocity v of flow is given by $v = v_0[1 - (r^2/R^2)]$, where r is the distance of flowing fluid from the axis. Then

17. Volume of fluid flowing across the section of tube in unit time is

(A) $\frac{1}{4}\pi v_0 R^2$ (B) $\frac{1}{2}\pi v_0 R^2$

(C) $\pi v_0 R^2$ (D) $\frac{1}{8}\pi v_0 R^2$

18. Kinetic energy of the fluid within the volume of the tube is

(A) $\frac{1}{6}\pi \ell R^2 \rho v_0^2$ (B) $\frac{1}{8}\pi \ell R^2 \rho v_0^2$

(C) $\frac{1}{4}\pi \ell R^2 \rho v_0^2$ (D) $\frac{1}{3}\pi \ell R^2 \rho v_0^2$

19. The difference of pressure at the end of the tube is

(A) $\frac{4\eta \ell v_0}{R^2}$ (B) $\frac{8\eta \ell v_0}{R^2}$

(C) $\frac{2\eta \ell v_0}{R^2}$ (D) $\frac{\eta \ell v_0}{R^2}$

Space for rough work

SECTION – B

(Matching List Type)

This section contains **3 multiple choice questions.** Each question has matching Column(s). The codes for the Column(s) have choices (A), (B), (C) and (D) out of which **ONLY ONE or MORE is/are correct.**

1. Match the following:

Column – I	Column – II
(A) Linear combination of two SHM's	(p) T = $2\pi\sqrt{\frac{R}{g}}$ and not T = ∞
(B) $y = A \sin \omega_1 t + A \sin (\omega_2 t + \phi)$	(q) SHM for equal frequencies and amplitude
(C) Time period of a pendulum of infinite length.	(r) Superposition may not be a SHM always.
(D) Maximum value of time period of an oscillating pendulum.	(s) amplitude will be $\sqrt{2}$ A for $\omega_1 = \omega_2$ and phase difference of $\pi/2$.

2. Match the following:

Column – I	Column – II
(A) Characteristic X-ray	(p) Inverse photoelectric effect.
(B) X-ray production	(q) high potential difference
(C) Cut-off wavelength	(r) Moseley's law
(D) Continues X-ray	(s) Brems-strahung radiation.

3. Considering a projectile motion.

Column – I	Column – II
(A) Change in magnitude of momentum will be present	(p) At highest point parabolic path
(B) Maximum angular momentum about the point of throw	(q) 2mv sin θ between the point of throw and target.
(C) minimum velocity	(r) $L = \frac{2mv^3 \sin^2\theta \cos\theta}{g}$
(D) magnitude of change in momentum	(s) along vertical direction.

Space for rough work

Chemistry

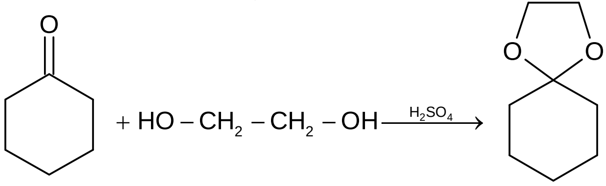
PART – II

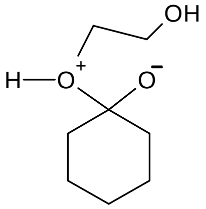
SECTION – A

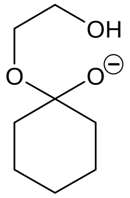
Straight Objective Type

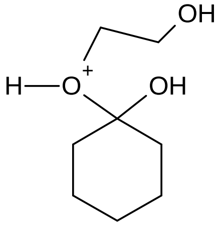
This section contains **9 multiple choice questions** numbered 1 to 9. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

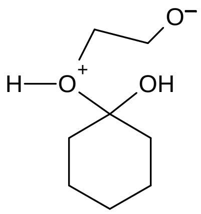
1. Which of the following is reactive intermediate for the following reaction?



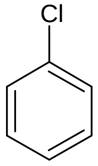
(A)


(B)


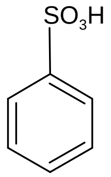
(C)


(D)


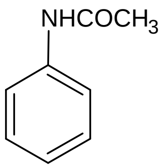
2. What is the expected order of reactivity of the following compounds in electrophilic nitration (more reactive, less reactive)?



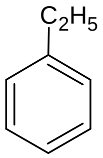
(I)



(II)



(III)



(IV)

(A) I > II > III > IV
(B) IV > I > II > III
(C) III > IV > I > II
(D) II > I > IV > III

Space for rough work

3. An electron is continuously accelerated in vacuum tube by applying potential difference. If its de-Broglie wavelength is decreased by 1%, the change in kinetic energy of the electron is nearly:
(A) decreased by 1.0%
(B) increased by 2.0%
(C) increased by 1.0%
(D) decreased by 2.0%

4. Quick lime; (CaO) is produced by heating limestone $CaCO_3$ to drive off CO_2 gas:

$$CaCO_3 \longrightarrow CaO(s) + CO_2(g)$$

$$\Delta H = 180 \text{ kJ mol}^{-1}$$

$$\Delta S = 150 \text{ JK}^{-1}$$

Assuming that variation of enthalpy change and entropy change with temperature to be negligible, which of the following is correct?
(A) Decomposition of $CaCO_3(s)$ is always non-spontaneous at room temperature.
(B) Decomposition of $CaCO_3(s)$ becomes spontaneous when temperature is less than 927°C.
(C) Decomposition of $CaCO_3(s)$ becomes non-spontaneous when temperature is greater than 1200°C.
(D) All of the above.

5. A doctor by mistake administers a dilute $Ba(NO_3)_2$ solution to a patient for radiographic investigations. Which of the following should be the best to prevent the absorption of soluble barium and subsequent barium poisoning?
(A) NaCl
(B) Na_2SO_4
(C) Na_2CO_3
(D) NH_4Cl

6. Match the products in the following reactions:

List – I	List – II
(1) $PCl_5 + H_2O \xrightarrow{1:1}$	(a) $N_3P_3Cl_6 + 12\ HCl$
(2) $PCl_5 + H_2O(\text{excess}) \longrightarrow$	(b) $[PCl_4]^+ [AlCl_4]^-$
(3) $PCl_5 + AlCl_3 \longrightarrow$	(c) $H_3PO_4 + HCl$
(4) $PCl_5 + NH_4Cl \longrightarrow$	(d) $POCl_3 + HCl$

(A) 1-d, 2-c, 3-b, 4-a
(B) 1-b, 2-b, 3-d, 4-a
(C) 1-d, 2-a, 3-b, 4-c
(D) 1-c, 2-b, 3-d, 4-a

7. The magnetic momentum of $K[Fe(CN)_5(NO)]$ is:
(A) 1.73 BM
(B) 2.84 BM
(C) 6.9 BM
(D) Zero

Space for rough work

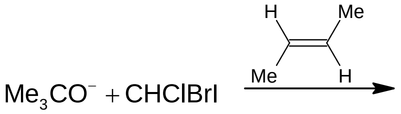
8. $\text{Glucose} \xrightarrow[(C_6H_5NHNH_2)]{\text{Phenylhydrazine}} X$

$\text{Fructose} \xrightarrow{\text{Phenylhydrazine}} Y$

X and Y are:
(A) Different osazones
(B) Same osazones
(C) Each molecule of glucose reacts with 4 molecules of phenylhydrazine
(D) Each molecule of fructose reacts with 2 molecules of phenylhydrazine

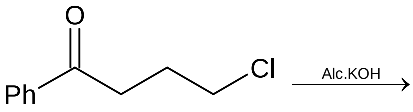
9. In which of the following α-elimination occurs:

(i)

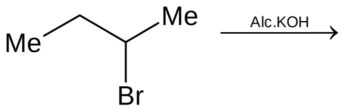


$Me_3CO^- + CHClBrI$

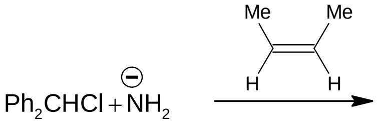
(ii)



(iii)



(iv)



$Ph_2CHCl + \overset{\ominus}{N}H_2$

(A) (i), (ii)
(B) (i), (iv)
(C) (ii), (iii)
(D) (ii), (iv)

Space for rough work

Reasoning Type

This section contains **4 questions** numbered 10 to 13. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

10. STATEMENT-1: Bond energy of Cl – Cl bond is more than F – F bond.

and

STATEMENT-2: Shorter the bond length more is the bond energy.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

11. STATEMENT-1: A gas can be easily liquefied at any temperature below its critical temperature.

and

STATEMENT-2: Liquification of a gas takes place when the average kinetic energy of the molecules is low.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

Space for rough work

12. STATEMENT-1: Para methoxy aniline undergoes faster diazotization than aniline.

and

STATEMENT-2: Electron releasing group stabilizes diazonium salts.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

13. STATEMENT-1: The carboxylic and amino group in amino acid neutralize each other in aqueous solution.

and

STATEMENT-2: Amino acid forms Zwitterion by losing a proton from $-$COOH group and accepting a proton from H_2O molecule.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

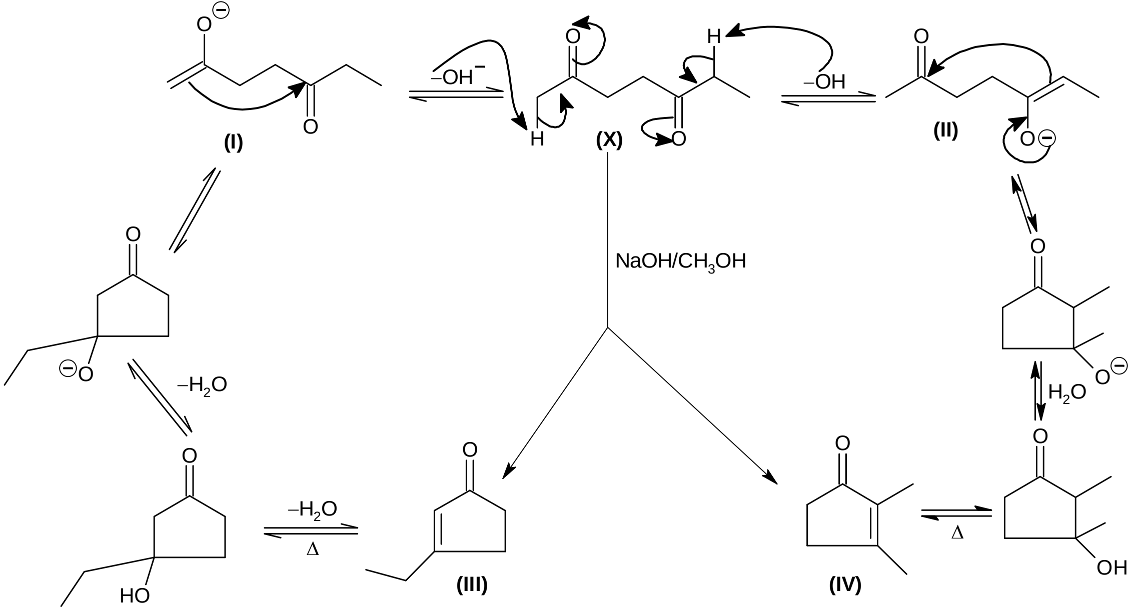
Space for rough work

Comprehension Type

This section contains **2 groups of questions.** Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 14 to 16

Consider the following mechanism of an aldol condensation reaction:



Answer the following questions based on the above mechanism and your knowledge about aldol condensation.

14. Which of the following statement regarding enolates I and II is true?
    (A) Enolate I is more stable than II, since it is formed by deprotonation of more acidic hydrogen.
    (B) Enolate I is more stable than II, since it is less substituted.
    (C) Enolate II is more stable than I, since it is formed by deprotonation of more stable than acidic hydrogen.
    (D) Enolate II is more stable than I, since it is more substituted.

15. If all the alpha hydrogen in X is replaced by deuterium "D" atom. Which of the following would be observed? (Assuming high concentration of base)
    (A) Rate of reaction would decrease since C – D bond is stronger than C – H bond.
    (B) Rate of reaction would increase since D is more acidic than H.
    (C) Rate of reaction would remains same since C – D bond is not broken in the rate determining step.
    (D) III would be formed more easily than IV.

16. How many different aldol products (excluding stereoisomers) are expected from intermolecular aldol condensation of X?

(A) 2	(B) 4
(C) 6	(D) 8

Paragraph for Question Nos. 17 to 19

The cell is $Mg | Mg^{+2} || Ag^{+} | Ag$

$E^{o}_{Ag^{+}|Ag} = 0.80V$

$E^{o}_{Mg|Mg^{2+}} = 2.37V$

17. The value of log K_c is:

(A) 107.45	(B) 80.5
(C) 67.15	(D) 53.725

18. The maximum work obtained by the cell is:

(A) 2×10^{2} kJ	(B) 3×10^{2} kJ
(C) 5×10^{2} kJ	(D) 6×10^{2} kJ

19. Calculate the E^{o} of cell.

(A) –3.17 V	(B) 3.17 V
(C) 1.57 V	(D) –1.57 V

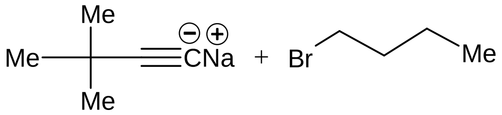
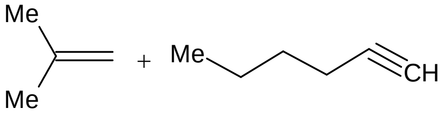
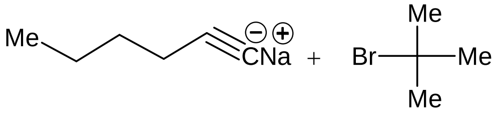
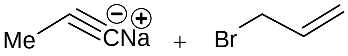
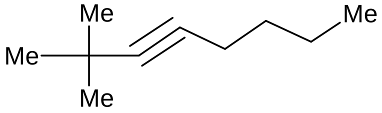
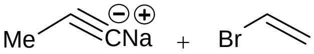
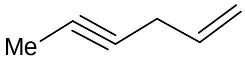
Space for rough work

SECTION – B

(Matching List Type)

This section contains **3 multiple choice questions.** Each question has matching Column(s). The codes for the Column(s) have choices (A), (B), (C) and (D) out of which **ONLY ONE or MORE is/are correct.**

1. Match the Column – I with Column – II:

	Column – I(Reaction)		**Column – II(Products)**
(A)		(p)	
(B)		(q)	No reaction
(C)		(r)	
(D)		(s)	

2. Match the Column – I with Column – II:

	Column – I(Orbitals)		**Column – II(Quantum No.)**
(A)	2s	(p)	$n = 2,\ \ell = 0,\ m = 0$
(B)	$2p_z$	(q)	$n = 2,\ \ell = 1,\ m = 0$
(C)	$4d_{x^2-y^2}$	(r)	$n = 4,\ \ell = 1,\ m = \mp 2$
(D)	$4d_{z^2}$	(s)	$n = 4,\ \ell = 2,\ m = 0$

3. Match the Column – I with Column – II:

	Column – I		**Column – II**
(A)	NO_2	(p)	Paramagnetic
(B)	NO	(q)	Dimerises on cooling
(C)	Cl_2O	(r)	Disproportionate either in cold or hot water
(D)	ClO_2	(s)	Act both oxidizing and reducing agent

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **9 multiple choice questions** numbered 1 to 9. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Consider a set {1, 2, 3, ..., 100}. The number of ways in which a number can be selected from the set so that it is of the form x^y, (where x, y, $\in$ N and $\geq$ 2), is
(A) 12 (B) 16
(C) 5 (D) 11

2. Solution set of $[\sin^{-1}x] > [\cos^{-1}x]$, where [.] denotes greatest integer function
(A) [sin 1, 1] (B) $\left[\frac{1}{\sqrt{2}},\ 1\right]$
(C) (cos 1, sin 1) (D) none of these

3. The equation $(1 + a^2)x^2 + 2a^2 x + a^2 + b^2 - 1 = 0$ has roots of opposite sign if a + ib lies
(A) on a straight line x + y = 1
(B) inside a circle of centre (0, 0) and radius 1
(C) on a parabola of vertex (0, 0) and focal length 1
(D) none of these

4. The complex number z satisfying $|(z - 2 + 3i)| = 6$ and $|z - 4 - i| = |z - 12 - i|$ are
(A) one (B) two
(C) three (D) none of these

5. $f(x) = \left(x^2 - 1\right)^{20}\left(x^2 + x + 1\right)$, then
(A) x = 1 is the point of local minima (B) x = –1/2 is the point of local minima
(C) x = 1 is the point of local maxima (D) x = –1 is the point of local maxima

Space for rough work

6. If the tangent at the point (a sec α, b tan α) to the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ meets the transverse axis at T, then the distance of T from a focus of hyperbola is

(A) $a(e \pm \cos \alpha)$
(B) ae
(C) $b(e + \cos \alpha)$
(D) $\sqrt{a^2e^2 + b^2 \cot^2 \alpha}$

7. A bag contains 17 markers with numbers 1 to 17. A marker is drawn at random and then replaced; a second marker is drawn then the probability that first number is even and second is odd, is

(A) $\frac{72}{712}$
(B) $\frac{72}{289}$
(C) $\frac{9}{34}$
(D) none of these

8. If in a triangle ABC, $\sum \sin\frac{A}{2} = \frac{6}{5}$ and $\sum I \ \ I_1$ = 9 (where I_1, I_2, I_3 are ex–centres and I is incentre), then circumradius R is equal to

(A) $\frac{15}{8}$
(B) $\frac{15}{4}$
(C) $\frac{15}{2}$
(D) $\frac{4}{15}$

9. If $y^r = \frac{n \ \ ! \ \ {}^{n+r-1}C_{r-1}}{r^n}$, where n = kr (k is constant), then $\lim_{n\to\infty} y$ is equal to

(A) (k + 1) log(1 + k) – k
(B) (k + 1) log(k – 1) + k
(C) (k + 1) log(k – 1) – k
(D) (k – 1) log(k – 1) + k

Reasoning Type

This section contains **4 questions** numbered 10 to 13. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

10. STATEMENT 1: Locus of P(z) is a straight line in the equation $z - tz_1 = (1 - t)z_2$, where z_1, z_2 are the points A and B respectively in an argand plane
STATEMENT 2: A point dividing the two fixed point in the ratio m : n is collinear with the line through the given points

(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

Space for rough work

11. STATEMENT 1: If $p < q$ and $px^2 + 4\mu xy + qy^2 + 4a(x + y + 1) = 0$ represents pair of straight lines for some $\mu \in R$ and $a \neq 0$, then $a \leq p$ or $a \geq q$
STATEMENT 2: The given equation has non-zero linear terms
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

12. STATEMENT 1: If $f(x) = ax^2 - bx + 2$; $a + b + 4 < 0$ then exactly one root lies between – 1 and 0
STATEMENT 2: $ab < 0$
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

13. STATEMENT 1: The order of the differential equation of family of circles touching a fixed straight line, which passes through origin is two
STATEMENT 2: General equation of circle has three parameters so if conditions are given then order is two always
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

Comprehension Type

This section contains **2 groups of questions.** Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 14 to 16

Read the following write up carefully and answer the following questions:
If (x_1, y_1) is the image (reflection) of the point (x, y) in the line $y = mx$, then

$$x_1 = \frac{1-m^2}{1+m^2}x + \frac{2m}{1+m^2}y \text{ and } y_1 = \frac{2m}{1+m^2}x + \frac{m^2-1}{1+m^2}y$$

$$\Rightarrow \begin{bmatrix} x_1 \\ y_1 \end{bmatrix} = \begin{bmatrix} \frac{1-m^2}{1+m^2} & \frac{2m}{1+m^2} \\ \frac{2m}{1+m^2} & \frac{m^2-1}{1+m^2} \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} \Rightarrow X_1 = AX \Rightarrow X = A^{-1}X_1 \Rightarrow \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} \frac{1-m^2}{1+m^2} & \frac{2m}{1+m^2} \\ \frac{2m}{1+m^2} & \frac{m^2-1}{1+m^2} \end{bmatrix} \begin{bmatrix} x_1 \\ y_1 \end{bmatrix}, \text{ (since } A^2 = I).$$

14. The image of the parabola $y^2 = x$ in the line $x + y + 4 = 0$ is
(A) $x^2 = -(y + 4)$
(B) $(x + 4)^2 = -(y + 4)$
(C) $(x + 4)^2 = -y$
(D) none of these

Space for rough work

15. A ray moving along the line px + qy = 1, after striking a mirror placed along the line y = 3, is reflected along the line
(A) px – qy = 1
(B) px – qy = 1 – q
(C) px – qy = 1 – 6q
(D) px – qy = 1 – 4q

16. A tangent is drawn to the circle $x^2 + y^2 + 4x + 6y - 7 = 0$ at the point (2, – 1). The image of the tangent in the line y = x + 2 touches the parabola
(A) $y^2 = 5x$
(B) $5y^2 = x$
(C) $y^2 = -5x$
(D) $5y^2 = -x$

Paragraph for Question Nos. 17 to 19

Read the following write up carefully and answer the following questions:
Consider a three dimensional Cartesian system with origin at O and three rectangular coordinate axes x, y and z-axis. Suppose that the distance between two points P and Q in the space having their coordinates (x_1, y_1, z_1) and (x_2, y_2, z_2) respectively be defined by the following formula
$d(P, Q) = |x_2 - x_1| + |y_2 - y_1| + |z_2 - z_1|$

Although the formula of distance between two points has been defined in a new way, yet the other definitions remain same (like section formula, direction cosines etc.). So, in general equations of straight line in space, plane in space remain unchanged. Now answer the following questions.

17. If l, m, n represent direction cosines (if we can call it) of a vector $\overrightarrow{OP}$, then which of the following relations holds?
(A) $l^2 + m^2 + n^2 = 1$
(B) l + m + n = 1
(C) |l + m + n| = 1
(D) |l| + |m| + |n| = 1

18. Locus of point P if d(O, P) = k, where k is a positive constant number, represents
(A) a sphere of radius k
(B) a set of eight planes forming an octahedron
(C) a set of eight planes forming hexagonal prism
(D) an infinite cylinder of radius k

19. Let OABC represents a regular tetrahedron with edge length 2a and vertices A, B, C lying on x, y and z-axis respectively. Let P be a point inside the region of the tetrahedron satisfying
$d(O, P) \le \min\{d(P, A), d(P, B), d(P, C)\}$. The maximum value of d(O, P) is
(A) a
(B) $\sqrt{2}$ a
(C) $\frac{2a}{3}$
(D) $\frac{4a}{3}$

Space for rough work

SECTION – B

(Matching List Type)

This section contains **3 multiple choice questions.** Each question has matching Column(s). The codes for the Column(s) have choices (A), (B), (C) and (D) out of which **ONLY ONE or MORE is/are correct.**

1. Match the following Column–I with Column–II

Column – I		Column – II	
(A)	$\int \frac{dx}{\left(a^2-x^2\right)^2}-\frac{1}{2a^2}\int \frac{dx}{a^2-x^2}$ is equal to	(p)	$\frac{x}{2a^2\left(a^2-x^2\right)}+c$
(B)	$\int \frac{dx}{x^2\sqrt{x^2-a^2}}$	(q)	$\frac{\sqrt{x^2-a^2}}{a^2x}$ + c
(C)	$\int \frac{\sqrt{a^2-x^2}}{x^2}dx$	(r)	$-\frac{\sqrt{a^2-x^2}}{x}+\cos^{-1}\frac{x}{a}+c$
(D)	$\int \frac{\sqrt{x^2-a^2}}{x}dx$	(s)	$\sqrt{x^2-a^2}-a\sec^{-1}\frac{x}{a}+c$

2. Match the following Column–I with Column–II

Column – I		Column – II	
(A)	Area bounded by the parabola y^2 = 4x and the line y = x is	(p)	$\frac{1}{2}$
(B)	$\int_0^{\pi/2}\left(\sin^5 x+\cos^5 x\right)dx$ is equal to	(q)	–22
(C)	If S = 0 be the equation of the hyperbola x^2 + 4xy + $3y^2$ – 4x + 2y + 1 = 0, then the value of k for which S + k = 0 represents its asymptotes is	(r)	$\frac{8}{3}$
(D)	The value of α for which $\alpha\hat{i}+2\hat{j}+\hat{k}$, lies in the plane containing three points $\hat{i}+\hat{j}+\hat{k}$, $2\hat{i}+2\hat{j}+\hat{k}$ and $3\hat{i}-\hat{k}$ is	(s)	$\frac{16}{15}$

3. Match the following Column–I with Column–II

Column – I		Column – II	
(A)	$3x^2$ + 2 (b^2 + 1)x + b^2 – 3b + 2 = 0 will have roots of opposite sign if b ∈	(p)	$\left(\frac{2}{3},\ 1\right)$
(B)	The probability of a problem being solved by 3 students are $\frac{1}{2}$, $\frac{1}{3}$ and α ∈ (0, 1). Then probability that problem will be solved ∈	(q)	[$2\sqrt{2}$, ∞)
(C)	If 3 real numbers satisfy the equation x + y + z = 5 and xy + yz + zx = 8, then z ∈	(r)	$\left[1,\ \frac{7}{3}\right]$
(D)	The range of |sec x| + |cosec x| is	(s)	(1, 2)

Space for rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

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FULL TEST – II
PAPER-2

Q.NO	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	C	A
2.	B	C	A
3.	C	B	B
4.	B	A	A
5.	C	B	A
6.	A	A	A
7.	D	A	B
8.	B	B	A
9.	D	B	A
10.	A	B	A
11.	A	A	B
12.	B	A	C
13.	C	C	C
14.	C	D	B
15.	B	C	C
16.	A	D	C
17.	B	A	D
18.	A	D	B
19.	A	B	A
1.	(A) → (q, r), (B) → (q, r, s) (C) → (p), (D) → (p)	(A) → (r), (B) → (p) (C) → (s), (D) → (q)	(A) → (p), (B) → (q) (C) → (r), (D) → (s)
2.	(A) → (r), (B) → (p, q, r, s) (C) → (q), (D) → (s)	(A) → (p), (B) → (q) (C) → (r), (D) → (s)	(A) → (r), (B) → (s) (C) → (q), (D) → (p)
3.	(A) → (s) (B) → (r) (C) → (p) (D) → (q)	(A) → (p, q, r, s) (B) → (p, q, s) (C) → (r) (D) → (p, r)	(A) → (s) (B) → (p) (C) → (r) (D) → (q)

Physics

PART – I

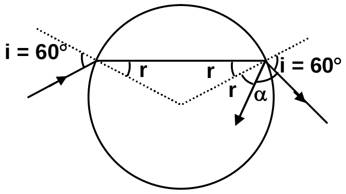
3. According to the question

$$\frac{g}{\left(1+\frac{h}{R_e}\right)^2} = g\left(1-\frac{h}{R_e}\right)$$

$$-\frac{h}{R_e}+1-\frac{h^2}{R_e^2}=0$$

$$h = \frac{\left(\sqrt{5}-1\right)R_e}{2}$$

4. From figure it is clear



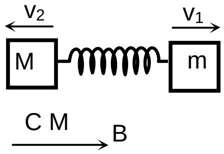
$\alpha = 180-(i+r)$

and $\mu = \frac{\sin i}{\sin r} \Rightarrow \sqrt{3} = \frac{\sin 60°}{\sin r}$

r = 30°

α = 90°

6.



16. F = qvB sin θ = qvB (θ = 90°)

So, B = $\frac{F}{qv}$ = $\frac{3.2\times10^{-20}}{1.6\times10^{-19}\times4\times10^{3}}$ = 5 × 10^{-7} T

Now, $\frac{\mu_0}{2\pi}\left[\frac{I_p}{5}+\frac{I_q}{2}\right]=5\times10^{-7}$

$\Rightarrow$ I = 4 amp.

If the distance of point R from third current carrying current is X, then

B_R = 0

$$\frac{\mu_0}{4\pi}\frac{2\times2.5}{|x|}+5\times10^{-7}=0$$

so x = ± 1 m

19. P(2πr)dr = 2πr$\ell\eta$ $\frac{dv}{dr}$ – 2π(r+dr) $\ell\eta$ $\frac{dv}{dr}$

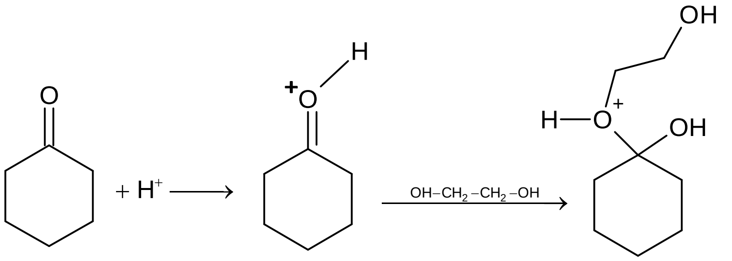
P(2πr)dr = – 2π $\ell\eta$ $\left(\frac{dv}{dr}\right)$dr

P(2πr) = $-2\pi\,\ell\eta\left(\frac{-2v_0r}{R^2}\right)$

P = $\frac{2\eta\ell v_0}{R^2}$

Chemistry PART – II

1.



2. (III) is most reactive (resonance activation) followed by N (inductive activation). (II) is more deactivated (resonance deactivation) followed by (I) (inductive deactivation).

3. $\lambda \propto \frac{1}{\sqrt{KE}}$

$= \sqrt{\frac{KE_1}{KE_2}} = \frac{\lambda_2}{\lambda_1}$

$= \frac{0.99\lambda_1}{\lambda_1}$

$KE_1 = (0.99)^2 KE_2$

$KE_2 \approx 1.02\ KE_1$

% change is KE = $\frac{KE_2 - KE_1}{KE_1} \times 100$

$\approx 2\%$

4. $\Delta H > 0,\ \Delta S > 0 \Rightarrow$ Reaction may be non-spontaneous at 25^oC

$\Delta G = \Delta H - T\Delta S$

$= 180 - 298 \times 150 \times 10^{-3}$

$= 135.3 > 0$

= Non-spontaneous

To make it spontaneous $(\Delta G < 0)$. We have to increase the temperature.

$T = \frac{\Delta H}{\Delta S} = \frac{180 \times 10^3}{150}$

$= 1200\ K = 927^oC$.

11. Above critical temperature (T_C), gas can not be liquified on cooling, the average energy of molecule decreases.

12. Positive charge on nitrogen of diazo group is stabilized by electron releasing group.

13. Within amino acid, proton is accepted from –COOH group by $–NH_2$ group to from "$^{-}COO - R - \overset{+}{N}H_3$".

14. More the number of alkyl substitute at double bond, greater its thermodynamic stability.

15. C – H bond is broken in non rate determining step, therefore, substitution of α-H by deuterium doesn't affect the rate of reaction.

16. There are total four types of α-H and two types of carbonyl, hence a total of eight aldol would be formed.

17. $E^o_{cell} = 2.37 + 0.8$

$= 3.17$ V

$$E^o = \frac{0.059}{2}\log K_c$$

$\log K_c = 107.45$

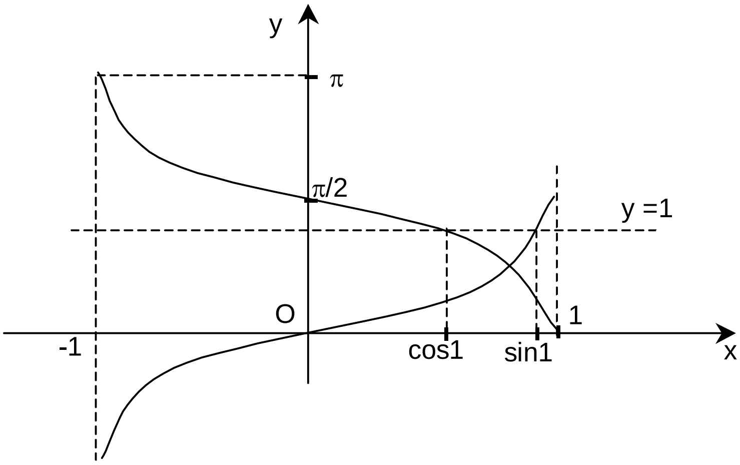
18. Maximum work = nFE

$= 6 \times 10^2$ kJ

Mathematics PART – III

1. Perfect square = $\left[\sqrt{100}\right] - 1 = 9$(excluding one)
Perfect cubes = $\left[100^{1/3}\right] - 1 = 3$
Perfect 4th powers = $\left[100^{1/4}\right] - 1 = 2$
Perfect 5th powers = $\left[100^{1/5}\right] - 1 = 1$
Perfect 6th powers = $\left[100^{1/6}\right] - 1 = 1$
Now, perfect 4th powers have already been counted in perfect squares and perfect 6th powers have been counted with perfect squares as well as with perfect cubes
Hence the total ways = 9 + 3 + 1 – 1 = 12

2. $[\sin^{-1}x] > [\cos^{-1}x] \Rightarrow x > 0$



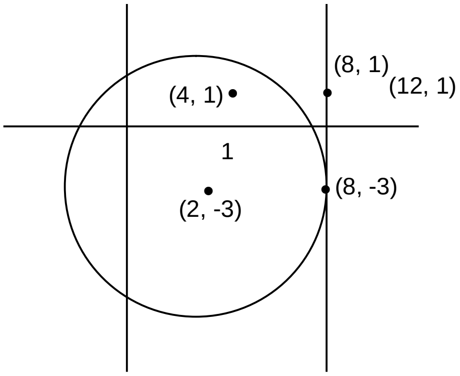
Clearly $[\cos^{-1}x] = \begin{cases} 1, & x \in [0, \cos 1] \\ 0, & x \in (\cos 1, 1] \end{cases}$

$[\sin^{-1}x] = \begin{cases} 0, & x \in [0, \sin 1) \\ 1, & x \in [\sin 1, 1] \end{cases}$

Hence $[\sin^{-1}x] > [\cos^{-1}x] \Rightarrow x \in [\sin 1, 1]$.

3. As roots are of opposite sign, product of roots < 0
$\Rightarrow a^2 + b^2 - 1 < 0$
$\Rightarrow a^2 + b^2 < 1$
$\Rightarrow |a + ib| < 1$
So, the point a + ib lies inside a circle of centre (0, 0) and radius 1.

4. $|z - 2 + 3i| = 6$ is a circle with centre (2, –3) and radius 6 and $|z - 4 - i| = |z - 12 - i|$ is the perpendicular bisector of (4, 1) and (12, 1) is a line parallel to axis imaginary.
Now this line
The line is tangent to circle at complex number $(8 - 3i)$.
Hence only one complex number satisfies the above equation.



6. Co–ordinates of point T $(a \cos \alpha, 0)$ so distance from focus of the point T is $a(e \pm \cos \alpha)$

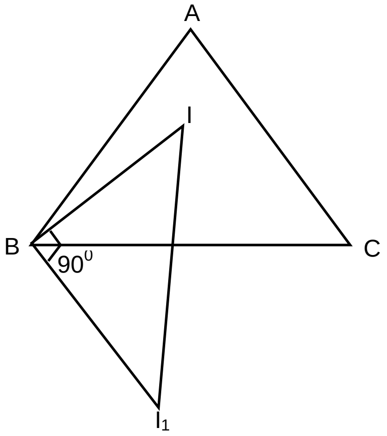
7. There are 8 even and 9 odd numbers. So probabilities of getting first even number is $\frac{8}{17}$ and probabilities of getting second odd number = $\frac{9}{17}$, so required probabilities = $\frac{8}{17} \times \frac{9}{17} = \frac{72}{729}$

8. $BI = r \operatorname{cosec} \frac{B}{2} = 4R \sin \frac{A}{2} \sin \frac{C}{2}$

$BI_1 = r_1 \sec \frac{B}{2} = 4R \sin \frac{A}{2} \cos \frac{C}{2}$

$\Rightarrow II_1 = \sqrt{(BI)^2 + (BI')^2} = 4R \sin \frac{A}{2}$

$\Rightarrow \sum II_1 = 4R \sum \sin\frac{A}{2} \Rightarrow R = \frac{15}{8}$



9. $y^r = \left(1+\frac{1}{r}\right)\left(1+\frac{2}{r}\right)\left(1+\frac{3}{r}\right)\text{.......}\left(1+\frac{n-1}{r}\right)$

$\Rightarrow \log y = \frac{1}{r}\sum_{p=1}^{n-1}\log\left(1+\frac{p}{r}\right)$

$\lim_{n\to\infty} \log y = \int_0^k \log(1+x)\ dx = (k + 1) \log(1 + k) – k$

11. $px^2 + 4\mu xy + qy^2 + 4a(x + y + 1) = 0$ represents pair of straight lines iff
$4apq + 16a^2\mu - 4a^2p - 4a^2q - 16a\mu^2 = 0$
$\Rightarrow 4\mu^2 - 4a\mu + ap + aq - pq = 0.$
For real μ, $16a^2 - 4.4(ap + aq - pq) \ge 0$
$\Rightarrow (a - p)(a - q) \ge 0 \Rightarrow a \le p$ or $a \ge q$

12. $f(x) = ax^2 - bx + 2$
$f(0) = 2$
$f(-1) = a + b + 2 < 0$ $(\because\ a + b + 4 < 0)$

$\therefore$ f(0) f(– 1) < 0
$\therefore$ One root lie between (– 1, 0)
Nothing can be said about ab

13. Here only one condition is given. So degree is 2.

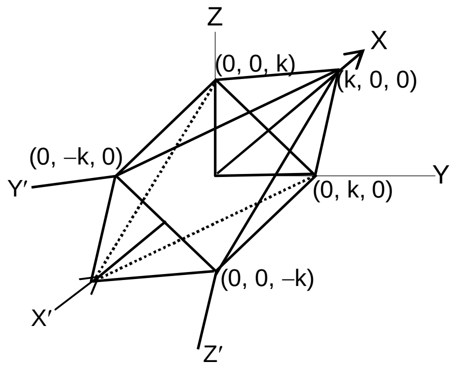
14. Any point on the parabola is (t^2, t). Shift the origin to (–4, 0) so that the line becomes X + y = 0 and the point (t^2, t) becomes $(4 + t^2, t)$ where X = x + 4. If (X_1, y_1) is the image of $(4 + t^2, t)$ in X + y = 0, then $\begin{bmatrix} X_1 \\ y_1 \end{bmatrix} = \begin{bmatrix} 0 & -1 \\ -1 & 0 \end{bmatrix}\begin{bmatrix} 4+t^2 \\ t \end{bmatrix}$
$\Rightarrow X_1 = -t,\ y_1 = -(4 + t^2)$ and in the original coordinates $x_1 = -4 - t,\ y_1 = -4 - t^2$
$\Rightarrow$ the equation of image is $(x + 4)^2 = -(y + 4)$.

15. Shift the origin to the point (0, 3) so that any point (x_1, y_1) on the reflected line is given by
$\begin{bmatrix} x_1 \\ y_1 - 3 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}\begin{bmatrix} \dfrac{1-q(h+3)}{p} \\ h \end{bmatrix}$ (since m = 0)
$\Rightarrow x_1 = \dfrac{1-q(h+3)}{p},\ y_1 - 3 = -h \Rightarrow px_1 = qy_1 + 1 - 6q$
and hence the reflected line is px − qy = 1 − 6q.

16. Equation of the tangent to the given circle at (2, – 1) is 2x + y – 3 = 0.
Shift the origin to the point (–2, 0) so that the two lines becomes y = X and 2X + y – 7 = 0. Any point on the line is (h, 7 – 2h) and its reflection in y = X is given by $\begin{bmatrix} X_1 \\ y_1 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}\begin{bmatrix} h \\ y-2h \end{bmatrix}$
$\Rightarrow X_1 = 7 - 2h,\ y_1 = h \Rightarrow X_1 = 7 - 2y_1$
$\Rightarrow x_1 + 2 = 7 - 2y_1$ and hence the reflection of the tangent is
$2y + x - 5 = 0$ or $y = \dfrac{x}{-2} - \dfrac{5}{4}(-2)$ which touch the parabola $y^2 = -5x$.

17. In the new definition $l = \dfrac{x}{|x|+|y|+|z|}$, etc.

18. d(O, P) = k
$\Rightarrow |x| + |y| + |z| = k$
which represents a set of 9 planes making intercepts of lengths k on positive as well negative sides of all three axes. See the adjacent figure.



19. The maximum value of d(O, P) = circumradius of sphere = a.

SECTION – B

1. **(A)** $I = \int \frac{dx}{a^2-x^2} = \frac{x}{a^2-x^2} - \int \frac{2xdx}{\left(a^2-x^2\right)^2}x = \frac{x}{a^2-x^2} + 2\int \frac{a^2-x^2-a^2}{\left(a^2-x^2\right)^2}dx$

$= \frac{x}{a^2-x^2} + 2I - 2a^2\int \frac{dx}{\left(a^2-x^2\right)^2}$

$\Rightarrow \int \frac{dx}{\left(a^2-x^2\right)^2} - \frac{1}{2a^2}\int \frac{dx}{a^2-x^2}$

$= \frac{x}{2a^2\left(a^2-x^2\right)} + c$.

(B) Put x = a sec θ

$\Rightarrow dx = a \sec\theta \tan\theta\, d\theta$

$\therefore I = \int \frac{a\sec\theta\tan\theta d\theta}{a^2\sec^2\theta\cdot a\tan\theta} = \frac{1}{a^2}\sin\theta + c = \frac{\sqrt{x^2-a^2}}{a^2x} + c$.

(C) Put x = a sinθ

$\Rightarrow dx = a \cos\theta\, d\theta$

$\therefore I = \int \frac{a\cos\theta a\cos\theta d\theta}{a^2\sin^2\theta} = \int \cot^2\theta d\theta = -\cot\theta - \theta + c$

$= -\frac{\sqrt{a^2-x^2}}{x} - \sin^{-1}\frac{x}{a} + c = -\frac{\sqrt{a^2-x^2}}{x} + \cos^{-1}\frac{x}{a} + c$.

(D) Put x = a sec θ

$\Rightarrow dx = a \sec\theta \tan\theta\, d\theta$

$\therefore I = \int \frac{a\tan\theta a\sec\theta\tan\theta d\theta}{a\sec\theta} = a\int \tan^2\theta d\theta$

$= a \tan\theta - a\theta + c$

$= \sqrt{x^2-a^2} - a\sec^{-1}\frac{x}{a} + c$.

2. **(A)** Required area = $2\int_0^4 \sqrt{x}dx - \frac{1}{2}\times 4\times 4$

$= \frac{4}{3}\left[x^{3/2}\right]_0^4 - 8 = \frac{8}{3}$

(B) $\int_0^{\pi/2}\left(\sin^5 x + \cos^5 x\right)dx$

$= 2\int_0^{\pi/2}\sin^5 x dx = 2\left[\frac{4}{5}\times\frac{2}{3}\right] = \frac{16}{15}$

(C) For equation S + k = 0 to represent pair of lines

$$\begin{vmatrix} 1 & 2 & -2 \\ 2 & 3 & 1 \\ -2 & 1 & 1+k \end{vmatrix} = 0$$

$\Rightarrow 3(1 + k) - 1 - 2(2 + 2k + 2) - 2(2 + 6) = 0$

$\Rightarrow k = -22$

(D) Let p.v. of given points be $A(\hat{i}+\hat{j}+\hat{k})$, $B(2\hat{i}+2\hat{j}+\hat{k})$ and $C(3\hat{i}-\hat{k})$, so that two vectors in the plane may be $\overrightarrow{AB}=\hat{i}+\hat{j}$ and $\overrightarrow{AC}=2\hat{i}-\hat{j}-2\hat{k}$

Thus, $\begin{vmatrix} \alpha & 2 & 1 \\ 1 & 1 & 0 \\ 2 & -1 & -2 \end{vmatrix} = 0$

$\Rightarrow -2\alpha - 2(-2) + (-1 - 2) = 0$

$\Rightarrow \alpha = \dfrac{1}{2}$

3. **(A)** The equation will have roots of opposite sign if it has real roots and product of roots is negative $4(b^2+1)^2 - 12(b^2-3b+2) \ge 0$ and $\dfrac{b^2-3b+2}{3} < 0$

$\Rightarrow 1 < b < 2$

(B) The probability of problem being solved is $1 - P(\bar{A})\cdot P(\bar{B})\cdot P(\bar{C})$

$= 1 - \left(1-\dfrac{1}{2}\right)\left(1-\dfrac{1}{3}\right)(1-\alpha)$

$= \dfrac{2}{3}+\dfrac{\alpha}{3} \in \left(\dfrac{2}{3},\ 1\right)$

(C) $x = 5 - (y + z)$
$yz + x(y + z) = 8$
$yz + (y + z)(5 - (y + z)) - 8 = 0$
$y^2 + y(z - 5) + (z^2 - 5z + 8) = 0$
For real solution, $(z - 5)^2 - 4(z^2 - 5z + 8) \ge 0$
$(z - 1)\left(z - \dfrac{7}{3}\right) \le 0$
$1 \le z \le \dfrac{7}{3}$

FIITJEE **JEE (Main), 2014**

ALL INDIA TEST SERIES

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

FULL TEST – II

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 30)** contains 30 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

SECTION – A

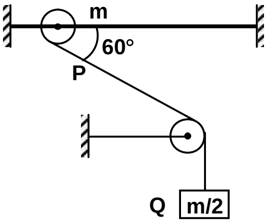
Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. A swimmer can swim in still water with a speed of $\sqrt{5}$ m/s. While crossing a river his average speed is 3 m/s. If he cross the river in the shortest possible time, what is the speed of flow of water?
(A) 2 m/s
(B) 4 m/s
(C) 6 m/s
(D) 8 m/s

2. A car starting from rest is accelerated at constant rate until it attains a constant speed v. It is then retarded at a constant rate until it comes to rest. Considering that the car moves with constant speed for half of the time of total journey, the average speed of the car for the journey is
(A) $\frac{v}{4}$
(B) $\frac{3v}{4}$
(C) $\frac{3v}{2}$
(D) Data insufficient

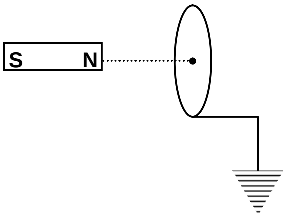
3. A smooth ring P of mass m can slide on a fixed horizontal rod. A string tied to the ring passes over a fixed pulley and carries a block Q of mass (m/2) as shown in the figure. At an instant, the string between the ring and the pulley makes an angle 60° with the rod.
The initial acceleration of the ring is
(A) $\frac{2g}{3}$
(B) $\frac{2g}{6}$
(C) $\frac{2g}{9}$
(D) $\frac{g}{3}$



4. A block of mass M is hanging over a smooth and light pulley through a light string. The other end of the string is pulled by a constant force F. If kinetic energy of the block increases by 20 J in 1s. Then
(A) tension in the string is Mg.
(B) tension in the string is F
(C) Work done by the tension on the block is 20 J in 1 sec.
(D) Work done by the force of gravity is 20 J in 1 sec.

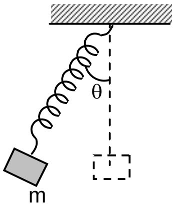
Space for Rough work

5. A circular ring is fixed in a gravity free space and one point of the ring is earthed. Now a magnet is placed along axis of the ring at a distance from its centre such that the nearer pole is north pole as shown in figure. A sharp impulse is applied on the magnet so that it starts to move towards the ring. Then,



(A) Initially magnet experiences an acceleration and then it retards to come to an instantaneous rest.
(B) Magnet starts to oscillate about centre of the ring
(C) Magnet continuous to move along the axis with constant velocity
(D) The magnet retards and comes to rest finally.

6. A block of mass m is suspended by means of an ideal spring of force constant k from ceiling of a car which is moving along a circular path of radius ‘r’ with acceleration ‘a’. The time period of oscillation of the block when it is displaced along the spring, will be



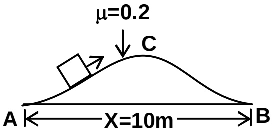
(A) $2\pi\sqrt{\dfrac{mg+ma}{k}}$ (B) $2\pi\sqrt{\dfrac{m}{k\sqrt{g^2+a^2}}}$

(C) $2\pi\sqrt{\dfrac{m}{k}}$ (D) $2\pi\sqrt{\dfrac{m}{\sqrt{k^2+g^2+a^2}}}$

7. In the hydrogen atom spectrum $\lambda_{3\text{-}1}$ and $\lambda_{2\text{-}1}$ represent wavelengths emitted due to transition from second and first excited states to the ground state respectively. The value of $\dfrac{\lambda_{3-1}}{\lambda_{2-1}}$ is

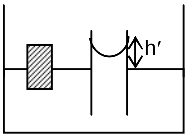
(A) 27 / 32 (B) 32/27
(C) 4/9 (D) 9/4

8. A block of mass 1 kg is pulled along the curve path ACB by a tangential force as shown in figure. The work done by the frictional force when the block moves from A to B is



(A) 5 J (B) 10 J
(C) 20 J (D) none of these

9. In a capillary tube placed inside the liquid of density (ρ)in a container, the rise of liquid is h. When block of density ‘σ’ is placed on the liquid as shown in figure, liquid in the tube is h′. If σ < ρ then



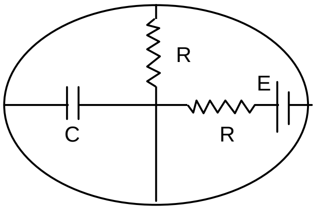
(A) h′ = h (B) h′ < h
(C) h′ > h (D) insufficient data

Space for Rough work

10. A light rod of length L, is hanging from the vertical smooth wall of a vehicle moving with acceleration $\sqrt{3}$ g having a small mass attached at it's one end is free to rotate about an axis passing through the other end. The minimum velocity given to the mass at it's equilibrium position so that it can complete vertical circular motion is

(A) $\sqrt{5gL}$ (B) $\sqrt{4gL}$
(C) $\sqrt{8gL}$ (D) none of these

11. Energy stored in the capacitor in it's steady state is



(A) CV (B) $\frac{CV}{2}$
(C) $\frac{1}{2}QV$ (D) zero

12. The potential difference between two points A and B which are separated by a distance of 1m along the field in a uniform electric field of $10NC^{-1}$ is

(A) zero (B) 100 volt
(C) 10 volt (D) 0.1 volt

13. The power factor of a circuit in which a box having unknown electrical devices connected in series with a resistor of resistance 3Ω is 3/5. The reactance of the box is

(A) $5\ \Omega$ (B) $5/3\ \Omega$
(C) $4\ \Omega$ (D) $4/3\ \Omega$

14. Two points A and B are at distances of 'a' and 'b' respectively from an infinite conducting plate having charge density σ. The work done in moving charge Q from A to B is

(A) $\frac{Q\sigma}{\varepsilon_0}(b-a)$ (B) $\frac{\sigma}{(b-a)}Q$
(C) $\frac{Q\sigma}{(b-a)\varepsilon_0}$ (D) none of these

15. A point charge of 0.1C is placed on the circumference of a non-conducting ring of radius 1m which is rotating with a constant angular acceleration of 1 rad/sec^2. If ring starts it's motion at t = 0 the magnetic field at the centre of the ring at t = 10 sec, is

(A) 10^{-6} T (B) 10^{-7} T
(C) 10^{-8} T (D) 10^{7} T

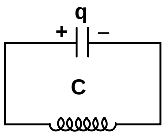
Space for Rough work

16. The wavelength corresponding to maximum spectral radiancy of a black body A is $\lambda_A = 5000$ Å. Consider another black body B whose surface area is twice of that of A and total radiant energy emitted by B is 16 times that emitted by A. The wavelength corresponding to maximum spectrum radiancy for B will be
(A) $5000\,(8)^{1/4}$ Å
(B) 2500 Å
(C) 10, 000 Å
(D) $\frac{5000}{(8)^{1/4}}$ Å

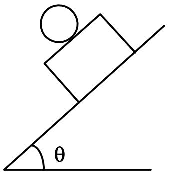
17. During an adiabatic process, the density of a gas is found to be proportional to cube of temperature. The degree of freedom of gas molecule is
(A) 6
(B) 5
(C) 4
(D) 3

18. Two fixed charges –2Q and Q are located at the point of co-ordinates (–3a, 0) and (3a, 0) respectively in (x – y) plane. Then all the points in x-y plane where potential is zero lies on a
(A) straight line parallel to x-axis
(B) straight line parallel to y- axis
(C) a circle of radius 4a
(D) circle of radius 2a

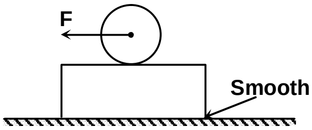
19. In an L-C circuit shown in the figure, C = 1F, L = 4H. At time t = 0, charge in the capacitor is 4C and it is decreasing at a rate of $\sqrt{5}$ C/s. Choose the correct statements.
(A) maximum charge in the capacitor can be 6C
(B) maximum charge in the capacitor can be 8C
(C) charge in the capacitor will be maximum after time $2\sin^{-1}(2/3)$ sec
(D) None of these



20. A plank of mass M is placed over smooth inclined plane and a sphere is also placed over the plank. Friction is sufficient between the sphere and the plank to prevent slipping. If the plank and the sphere are released from rest the frictional force on the sphere is
(A) up the plane
(B) down the plane
(C) zero
(D) horizontal

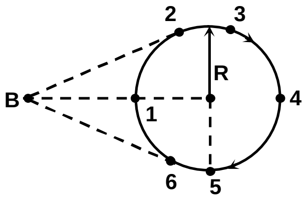


Space for Rough work



21. A disc of mass m and radius R is placed over a plank of same mass m. There is sufficient friction between the discs and the plank to prevent slipping. A force F is applied at the centre of the disc. Choose the correct statements.
(A) Acceleration of the plank is $\frac{F}{4m}$
(B) Acceleration of the plank is $\frac{F}{2m}$
(C) Force of friction between disc and plank is $\frac{F}{6}$
(D) Force of friction between disc and plank is $\frac{F}{2}$

22. A certain amount of ideal monoatomic gas undergoes, process given by $UV^{1/2} = C$ where U is the internal energy of the gas. The molar specific heat of the gas for the process will be
(A) R/2 (B) 3R
(C) 5R/2 (D) –R/2



23. An isotropic sound source A is moving in a circle of radius R with a small speed v. An observer B is hearing this sound (See figure). The intensity of the sound heard by B will be maximum when the source is at point.
(A) 1 (B) 2
(C) 6 (D) none of these

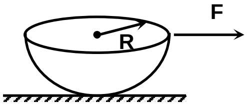
24. A stable species C can be obtained through unstable nuclides A and B. The half life period for conversion A → C is T and that for conversion B → C is 2T. Initially a sample contains N nuclides of A, N nuclides of B and no nuclides of C. After how much time will the nuclides of species C be equal to (27/16) N
(A) 2T (B) 3T
(C) 4T (D) 5T

25. A certain thermodynamic cycle comprises of two isothermal and two adiabatic processes. The highest temperature obtained in the entire cycle is 600 K while the lowest temperature is 300 K. When the cycle represented on a P-V curve the sense of the cycle is counter clockwise. The efficiency of the cycle is
(A) 50% (B) 75 %
(C) 25 % (D) None of these.

Space for Rough work

26. A man wearing spectacles with diverging lenses is viewing a distance object. The image formed on his retina will be
(A) real and erect. (B) real and inverted
(C) virtual and erect (D) virtual and inverted.

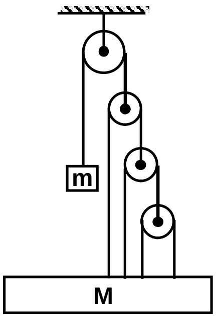
27. A thin uniform hemispherical bowl of mass m and radius R is lying on a smooth horizontal surface. A horizontal force F is now applied perpendicular to the rim of the bowl (see figure). The instantaneous angular acceleration of the bowl will be



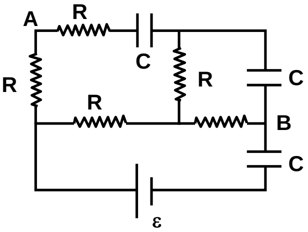
(A) $\frac{20}{3}\frac{F}{MR}$ (B) $\frac{10}{3}\frac{F}{MR}$
(C) $\frac{40}{3}\frac{F}{MR}$ (D) $\frac{5}{3}\frac{F}{MR}$

28. For a stone thrown from a tower of unknown height, the maximum range for a projection speed of 10 m/s is obtained for a projection angle of 30°. The corresponding distance between the foot of the tower and the point of landing of the stone is
(A) 10 m (B) 20 m
(C) $\left(20/\sqrt{3}\right)$ m (D) $\left(10/\sqrt{3}\right)$ m

29. Consider the system shown in the figure. the system is so arranged that both m and M are in pure translation. If at a certain instant M is moving down with a speed of 1 m/s then the speed of m will be
(A) 7 m/s (B) 8 m/s
(C) 1 m/s (D)15 m/s



30. Consider the circuit in the adjacent figure. What will be potential difference between A and B in the steady state
(A) ε (B) ε/2
(C) ε/3 (D) zero



Space for Rough work

Chemistry

PART – II

SECTION – A

Straight Objective Type

This section contains 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. For the equilibrium, $Ag^+ + 2NH_3 \rightleftharpoons [Ag(NH_3)_2]^+$ $K_1 = 1.8 \times 10^7$ and $Ag^+ + Cl^- \rightleftharpoons AgCl$;

$K_2 = 5.6 \times 10^9$ hence, for the equilibrium : $AgCl + 2NH_3 \rightleftharpoons Ag(NH_3)_2^+ + Cl^-$ equilibrium constant is :

(A) 0.32×10^{-2} (B) 0.31×10^{-21}
(C) 1.01×10^{17} (D) 1.01×10^{-17}

2. 2-Pentyne, on reduction with lithium in liq. NH_3 yields

(A) pentane (B) cis-2-pentene

(C) trans-2-pentene (D) 1-pentene

3. $A\left(C_7H_7Cl\right)\xrightarrow[\text{(ii) Sodalime}/\Delta]{\text{(i) KMnO}_4}$ Chlorobenzene. A forms only one nitro derivative. Hence A is,

(A) Benzyl chloride (B) p-Chlorotoluene

(C) o-Chlorotoluene (D) m-Chlorotoluene

4. Claisen rearrangement of allyl phenyl ether gives a mixture of
(A) o-, m-and p-allyl phenols. (B) o-and m-allyl phenols.
(C) m-and p-allyl phenols. (D) o-and p-allyl phenols.

5. If in diamond, there is a unit cell of carbon atoms as fcc and if carbon atom is sp^3 hybridized, what fractions of void are occupied by carbon atom.
(A) 25% tetrahedral (B) 50% tetrahedral
(C) 25% octahedral (D) 50% octahedral

Rough Work

6. Out of boiling point (I), entropy (II), pH (III) and standard e.m.f. of a cell (IV), intensive properties are -
(A) I, II
(B) I, II, III
(C) I, III,IV
(D) all of these

7. Which metal liberates H_2 with very dilute nitric acid:
(A) Zn
(B) Cu
(C) Mn
(D) Hg

8. Which of the following statements are not correct ?
(A) The number of α and β-particles emitted in neptunium series $({}^{237}_{93}Np \rightarrow {}^{209}_{83}Bi)$ are 7 and 4, respectively.
(B) The number of α and β-particles emitted in uranium series $({}^{238}_{92}U \rightarrow {}^{206}_{83}Pb)$ are 8 and 7, respectively.
(C) The number of α and β-particles emitted in actinium series $({}^{235}_{92}\text{U} \rightarrow {}^{207}_{83}\text{Bi})$ are 4 and 7, respectively.
(D) The half-life of a radioactive decay is given as $t_{1/2} = 0.693/\lambda$, where λ is decay constant

9. Reactivity of borazole is greater than that of benzene because:
(A) borazole is non-polar compound
(B) borazole is polar compound
(C) borazole has electron in it
(D) of localized electrons in it

10. When acetone and chloroform are mixed, hydrogen bonding takes place between them. Such a liquid pair will cause.
(A) No deviations from Raoult's law
(B) Negative deviations from Raoult's law
(C) Positive deviations from Raoul'ts law
(D) None

Rough Work

11. On heating ammonium dichromate, the gas evolved is
(A) Oxygen
(B) Ammonia
(C) Nitrous oxide
(D) Nitrogen.

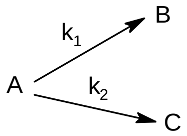
12. When ammonia is added to a cupric salt solution, the deep blue colour, so observed is due to the formation of
(A) $[Cu(OH)_4]^{2-}$
(B) $[Cu(NH_3)_4]^{2+}$
(C) $[Cu(OH)_2(NH_3)_2]$
(D) $[Cu(H_2O)_4]^{2+}$

13. Arrange the following in order of their decreasing thermal conductivity
(A) Al, Ag, Cu
(B) Cu, Ag, Al
(C) Ag, Cu, Al
(D) Al, Cu, Ag.

14. In a measurement of quantum efficiency of photo-synthesis in green plants, it was found that 10 quanta of red light of wavelength $6850\,\overset{o}{A}$ were needed to release one molecule of O_2. The average energy storage in this process is 112 kcal/mol O_2 evolved. What is the energy conversion efficiency in this experiment? Given 1 cal = 4.18 J, $N_A = 6 \times 10^{23}$, $h = 6.64 \times 10^{-34}$ JS.
(A) 23.5
(B) 26.9
(C) 66.34
(D) 73.1

15. The rate of effusion of two gases 'a' and 'b' under identical condition of temperature and pressure are in the ratio of 2 : 1. What is the ratio of rms velocity of their molecules if T_a and T_b are in the ratio of 2 : 1?
(A) 2 : 1
(B) $\sqrt{2} : 1$
(C) $2\sqrt{2} : 1$
(D) $1 : \sqrt{2}$

16. For first order parallel reaction k_1 and k_2 are 4 and 2 min^{-1} respectively at 300 K. If the activation energies for the formation of B and C are respectively 30,000 and 33,314 J/mol respectively. The Temperature at which B and C will be obtained in equimolar ratio is:



(A) 757.48 K
(B) 329.77 K
(C) 600 K
(D) None of these

Rough Work

17. One mole of SO_3 was placed in a two litre vessel at a certain temperature. The following equilibrium was established in the vessel.

$$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$$

The equilibrium mixture reacted with 0.2 mole $KMnO_4$ in acidic medium. Hence K_c is:

(A) 0.50 (B) 0.25
(C) 0.125 (D) none of these

18. A complex of iron and cyanide ions is 100% ionized at 1 molal. If its elevation in boiling point is 2.08^o, then the complex is: (Given $K_b = 0.52^oC\ mol^{-1}\ kg$)

(A) $Fe_4[Fe(CN)_6]_3$ (B) $K_3[Fe(CN)_6]$
(C) $K_4[Fe(CN)_6]$ (D) $Fe_3[Fe(CN)_6]_2$

19. Find the standard cell potential involving the cell reaction:

$In^{2+} + Cu^{+2} \longrightarrow In^{+3} + Cu^{+}$, at 298 K

Given: $E^0_{Cu^{+2}/Cu^{+}} = X_1V$, $E^0_{In^{+3}/In^{+}} = X_2V$ $E^o_{In^{+2}/In^{+}} = X_3V$

(A) $X_1 + X_3 - X_2$ (B) $(X_1 + X_3 - 2X_2)/3$
(C) $X_1 + X_3 - 2X_2$ (D) $X_1 + X_3 + 2X_2$

20. $SnCl_4$ is a covalent liquid because

(A) e^- clouds of the Cl^- ions are weakly polarized to envelop the cation
(B) electron clouds of the Cl^- ions are strongly polarized to envelop the cation
(C) its molecules are attracted to one another by strong vander Waal's forces
(D) Sn shows inert-pair effect

21. Boron nitride obtained by heating borazole is:

(A) white solid with a diamond like structure
(B) slippery white solid with layered structure similar to that of graphite
(C) covalent liquid and is structurally similar to carbon monoxide
(D) low melting solid with rock-salt like structure molecules

22. If a metal has low oxygen affinity then purification of metal may be carried out by

(A) Liquation (B) Distillation
(C) Zone refining (D) Cupellation

Rough Work

23. An original salt solution in acidic medium did not give any precipitate on passing H_2S gas. Such a solution was boiled, reboiled after dilution 3 times. To such a solutions two drops of conc. HNO_3 were added, then heated and water was added. To this resulting solution, NH_4Cl was first added followed by excess of NH_4OH. Finally a green ppt. was obtained. Hence the cation may be:
(A) Al^{+3} (B) Fe^{+2}
(C) Fe^{+3} (D) Cr^{+3}

24. Which of the following statement is wrong?
(A) d orbital taking part in dsp^2 is $d_{x^2-y^2}$
(B) d orbital taking part in sp^3d is d_{yz}
(C) d orbitals taking part in sp^3d^2 are $d_{x^2-y^2}$ and d_{z^2}
(D) d orbitals taking part in sp^3d^3 are d_{xy}, d_{z^2} and $d_{x^2-y^2}$

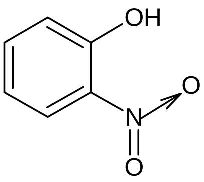
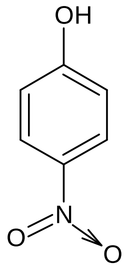
25. $H_3CCOOH \xrightarrow{Br_2/P} (Y) \xrightarrow[(ii)\ H_3O^+]{(i)\ KCN} (X)$
Here (X) is:
(A) Glycollic acid (B) α-hydroxypropionic acid
(C) succinic acid (D) malonic acid

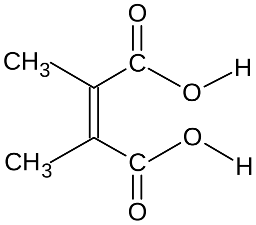
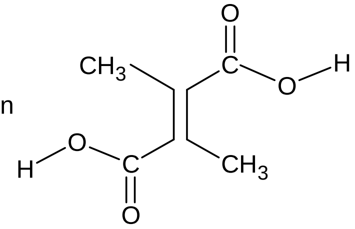
26. In order to distinguish between $C_2H_5NH_2$ and $C_6H_5NH_2$, which of the following reagents is useful
(A) Heinsberg reagent (B) p-napthol
(C) Benzene diazonium chloride (D) None of these

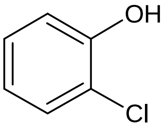
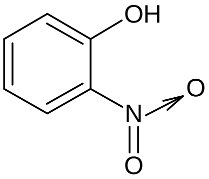
27. The weakest interparticle forces are present in
(A) thermosetting polymers (B) thermoplastic polymers
(C) fibres (D) elastomers

Rough Work

28. Which of the following statement is false ?

(A) 
has lower boiling point than


(B) 
is less stable than


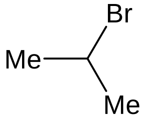
(C) 
has greater pKa than


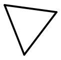
(D) H_3BO_3 in C_2H_5OH exists in the cage form due to intermolecular hydrogen bonding.

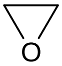
29. Which among the following compounds will not give effervescence with sodium bicarbonate?

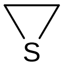
(A) C_6H_5COOH
(B) $C_6H_5SO_3H$
(C) C_6H_5OH
(D) picric acid

30. Which of the following is most reactive for S_N2 reaction?

(A) 

(B) 

(C) 

(D) 

Rough Work

Mathematics

PART – III

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Sum of all the roots of the equation $x^2 - 2x + |x - 1| - 5 = 0$ is
(A) 0 (B) 2
(C) 1 (D) 5

2. If z_1, z_2, z_3, z_4 are points on the circle $|z| = 1$ such that $z_1 + z_2 + z_3 + z_4 = 0$ and the value of the expression $|z_1 - z_2|^2 + |z_2 - z_3|^2 + |z_3 - z_4|^2 + |z_4 - z_1|^2$ is least then,
(A) $z_1 + z_3 = 0$ and $z_2 + z_4 = 0$ (B) $z_1 + z_2 = z_3 + z_4$
(C) z_1, z_2, z_3, z_4 must be real (D) $\frac{z_1}{z_3} = \frac{z_2}{z_4}$

3. If $T_r = \frac{r}{r^4 + 4}$ and $S_n = \sum_{r=1}^{n} t_r$, then the value of $37S_5 - \frac{7}{26}$ is equal to
(A) 13 (B) $\frac{25}{26}$
(C) $\frac{1}{2}$ (D) $\frac{7}{26}$

4. Number of distinct terms in the expansion of $(x + y + z + w)^{50}$ is equal to
(A) ${}^{53}C_3$ (B) 51
(C) 51^2 (D) ${}^{51}C_3$

5. If y = f(x) is symmetric about the lines $3x + 4y + 1 = 0$ and $4x - 3y - 7 = 0$, then it must be symmetric about
(A) (1, 1) (B) (1, –1)
(C) (0, 0) (D) (1, 0)

Space for rough work

6. If $\sqrt{1-x^6}+\sqrt{1-y^6}=a\left(x^3-y^3\right)$ and $\frac{dy}{dx}=f(x,\ y)\sqrt{\frac{1-y^6}{1-x^6}}$ then,

(A) $f(x,\ y)=\frac{y}{x}$
(B) $f(x,\ y)=\frac{x^2}{y^2}$
(C) $f(x,\ y)=\frac{2y^2}{x^2}$
(D) $f(x,\ y)=\frac{y^2}{x^2}$

7. If with standard notations t_1, t_2, t_3, t_4 are four co–normal points on the hyperbola $xy = c^2$ then the orthocentre of the triangle formed by joining the points t_1, t_2, t_3 is given by

(A) (0, 0)
(B) $\left(ct_4,\ \frac{c}{t_4}\right)$
(C) $\left(c\left(t_1+t_2+t_3\right),\ \frac{c}{t_1+t_2+t_3}\right)$
(D) $\left(\frac{c}{t_4},\ ct_4\right)$

8. If S be the focus of a parabola and PQ be the focal chord, such that SP = 3 and SQ = 6, then the length of latus rectum of the parabola is

(A) 4
(B) 2
(C) 8
(D) 16

9. If a circle having centre at $(\alpha,\ \beta)$ cut the circles $x^2 + y^2 - 2x - 2y - 7 = 0$ and $x^2 + y^2 + 4x - 6y - 3 = 0$ orthogonally, then $\left|\frac{3}{4}\alpha-\frac{\beta}{2}\right|$ is equal to

(A) 1
(B) $\frac{1}{2}$
(C) $\frac{1}{4}$
(D) 0

10. Two circles with radii 'r_1' and 'r_2', $r_1 > r_2 \geq 2$, touch each other externally. If 'θ' be the angle between the direct common tangents, then

(A) $\theta=\sin^{-1}\left(\frac{r_1+r_2}{r_1-r_2}\right)$
(B) $\theta=2\sin^{-1}\left(\frac{r_1-r_2}{r_1+r_2}\right)$
(C) $\theta=\sin^{-1}\left(\frac{r_1-r_2}{r_1+r_2}\right)$
(D) none of these

Space for rough work

11. A unit vector in xy – plane which makes an angle of 45° with the vector $\vec{i} + \vec{j}$ and an angle of 60° with the vector $\overrightarrow{3i} - \overrightarrow{4j}$ is

(A) $\vec{i}$

(B) $\dfrac{\vec{i} + \vec{j}}{\sqrt{2}}$

(C) $\dfrac{\vec{i} - \vec{j}}{\sqrt{2}}$

(D) none of these

12. Let $(1 + x)^n = 1 + nx + \dfrac{n(n-1)x^2}{2} + \ldots .\ x,\ n \in R$. Then the sum of the series

$3 + \dfrac{8}{3} + \dfrac{80}{3^3} + \dfrac{240}{3^4} + \ldots.$ is

(A) 9
(B) 27
(C) 12
(D) 101

13. There are three points (a, x), (b, y) and (c, z) such that the straight lines joining any two of them are not equally inclined to the coordinate axes where a, b, c, x, y, z ∈ R.

If $\begin{vmatrix} x+a & y+b & z+c \\ y+b & z+c & x+a \\ z+c & x+a & y+b \end{vmatrix} = 0$ and a + c = –b, then x, $-\dfrac{y}{2}$, z are in

(A) A.P.
(B) G.P.
(C) H.P.
(D) none of these

14. If at x = 1, y = 2x is tangent to the parabola $y = ax^2 + bx + c$, then respective values of a, b, c are

(A) $\dfrac{1}{2}, 1, \dfrac{1}{2}$

(B) $1, \dfrac{1}{2}, \dfrac{1}{2}$

(C) $\dfrac{1}{2}, \dfrac{1}{2}, 1$

(D) none of these

15. If $f'\left(x^2 - 4x + 3\right) > 0,\ \forall x \in (2,\ 3)$; then f(sin x) is increasing on

(A) $\bigcup\limits_{n \in I} \left(2n\pi, (4n+1)\dfrac{\pi}{2}\right)$

(B) $\bigcup\limits_{n \in I} \left((4n-1)\dfrac{\pi}{2}, 2n\pi\right)$

(C) R

(D) none of these

Space for rough work

16. Coordinates of the point on the straight line x + y = 4, which is nearest to the parabola $y^2 = 4(x - 10)$ is

(A) $\left(\frac{17}{2}, -\frac{9}{2}\right)$	(B) (2, 2)
(C) $\left(\frac{3}{2}, \frac{5}{2}\right)$	(D) none of these

17. If $\bar{a}, \bar{b}, \bar{c}$ be three vectors of magnitude $\sqrt{3}$, 1, 2 such that $\bar{a} \times (\bar{a} \times \bar{c}) + 3\bar{b} = 0$, if θ is the angle between $\bar{a}$ and $\bar{c}$, then $\cos^2\theta$ is equal to

(A) $\frac{3}{4}$	(B) $\frac{1}{2}$
(C) $\frac{1}{4}$	(D) none of these

18. If $\Delta(x) = \begin{vmatrix} e^x & \sin 2x & \tan x^2 \\ \ln(1+x) & \cos x & \sin x \\ \cos x^2 & e^x - 1 & \sin x^2 \end{vmatrix}$ = A + Bx + Cx^2 + ……., then B is equal to

(A) 0	(B) 1
(C) 2	(D) none of these

19. If the function f : [2, ∞) → [1, ∞) is defined by f (x) = $3^{x(x-2)}$, then $f^{-1}(x)$ is

(A) $1 + \sqrt{1 + \log_3 x}$	(B) $1 - \sqrt{1 + \log_3 x}$
(C) $1 + \sqrt{1 - \log_3 x}$	(D) does not exist

20. The number of real solutions of the equations $\tan^{-1}\sqrt{x^2 - 3x + 2} + \cos^{-1}\sqrt{4x - x^2 - 3} = \pi$

(A) one	(B) two
(C) zero	(D) infinite

21. Let x = $(5\sqrt{2} + 7)^{19}$, then x{x} ({.} denotes the fractional part of x) is equal to

(A) 2^{19}	(B) 3^{19}
(C) 0	(D) 1

Space for rough work

22. A flagstaff stands vertically on a pillar, the height of the flagstaff being double the height of the pillar. A man on the ground at a distance finds that both the pillar and the flagstaff subtend equal angles at his eyes. The ratio of the height of the pillar and the distance of the man from the pillar, is

(A) $\sqrt{3} : 1$ (B) $1 : 3$
(C) $1 : \sqrt{3}$ (D) $\sqrt{3} : 2$

23. $\frac{1}{x} = \frac{2e}{3!} + \frac{4e}{5!} + \frac{6e}{7!} + \ldots \infty$, then find $\int_0^x f(y)\log_y x \, dy$, $y > 1$

(A) $\frac{[f(e)]^2}{2}$ (B) $\frac{\left[f\left(\frac{1}{e}\right)\right]^2}{2}$
(C) $\frac{\left[f(e^2)\right]^2}{2}$ (D) none of these

24. If lines x = y = z, $x = \frac{y}{2} = \frac{z}{3}$ and third line passing through (1, 1, 1) form a triangle of area $\sqrt{6}$ units then point of intersection of third line with second line will be

(A) (1, 2, 3) (B) (2, 4, 6)
(C) $\left(\frac{4}{3}, \frac{8}{3}, \frac{12}{3}\right)$ (D) none of these

25. If $A(\bar{a})$, $B(\bar{b})$ and $C(\bar{c})$ be vertices of a triangle whose circumcentre is the origin, then orthocentre is given by

(A) $\frac{\bar{a}+\bar{b}+\bar{c}}{3}$ (B) $\frac{\bar{a}+\bar{b}+\bar{c}}{2}$
(C) $\bar{a}+\bar{b}+\bar{c}$ (D) none of these

26. Let f(x) = max{tan x, cot x}. Then number of roots of the equation f(x) = $\frac{1}{\sqrt{3}}$ in $(0, 2\pi)$ is

(A) 2 (B) 4
(C) 0 (D) infinite

Space for rough work

27. If S denote the sum to infinity and S_n the sum of n terms of the series $1+\frac{1}{3}+\frac{1}{9}+\frac{1}{27}+...$ such that $S - S_n < \frac{1}{300}$, then the least value of n is

(A) 4
(B) 5
(C) 6
(D) 7

28. If f(x) = $\int_0^4 e^{|t-x|}dt$ $(0 \le x \le 4)$, the maximum value of f(x) is

(A) $e^4 - 1$
(B) $2(e^2 - 1)$
(C) $e^2 - 1$
(D) none of these

29. Let x, y $\in$ [0, 10], then number of solutions (x, y) of the inequation $|\,3^{\sec^2 x-1}\sqrt{9y^2-6y+2} \le 1$ is

(A) 4
(B) 2
(C) 1
(D) infinite

30. A triangle is inscribed in a circle. The vertices of the triangle divide the circle in to three arcs of length 3, 4 and 5 units, then area of the triangle is equal to,

(A) $\frac{9\sqrt{3}\left(1+\sqrt{3}\right)}{\pi^2}$
(B) $\frac{9\sqrt{3}\left(\sqrt{3}-1\right)}{\pi^2}$
(C) $\frac{9\sqrt{3}\left(1+\sqrt{3}\right)}{2\pi^2}$
(D) $\frac{9\sqrt{3}\left(\sqrt{3}-1\right)}{2\pi^2}$

Space for rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students
from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS
FULL TEST – II
(Main)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	A	B
2.	B	C	A
3.	C	B	A
4.	B	D	A
5.	D	B	B
6.	C	C	B
7.	A	C	B
8.	C	C	C
9.	A.	B	B
10.	C	B	B
11.	D	D	D
12.	C	B	B
13.	C	C	A
14.	A	B	A
15.	B	C	B
16.	D	B	A
17.	A	C	A
18.	C	B	A
19.	A	C	A
20.	C	B	C
21.	A	B	D
22.	D	B	C
23.	A	D	D
24.	C	B	B
25.	D	D	C
26.	B	B	C
27.	B	D	C
28.	D	D	A
29.	C	C	A
30.	D	D	A

Physics PART – I

1. Avg. speed $3 = \frac{\sqrt{(v_r t)^2 + (v_{mr} t)^2}}{t}$

$\Rightarrow v_r^2 + 5 = 9$

$\Rightarrow v_r = 2 m/s$

2. $v_{avg} = \frac{\frac{1}{2} \times \frac{t}{2} \times v + \frac{1}{2} \times v}{t} = \frac{3v}{4}$

3. $\frac{m}{2}g - T = \frac{m}{2}a$ …(i)

$T \cos 60° = \frac{ma}{\cos 60°}$ …(ii)

Solving (i) and (ii) acceleration of ring = $\frac{2g}{9}$

4. Work done by all the forces on the block equal to change in kinetic energy.

6. No effect of 'a' and 'g' on time period of spring pendulum.

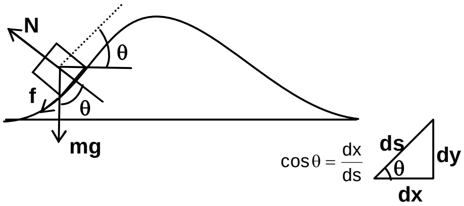
7. $\frac{1}{\lambda_{3-1}} = R\left(\frac{1}{1^2} - \frac{1}{3^2}\right) = \frac{8R}{9}$

$\frac{1}{\lambda_{2-1}} = R\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = \frac{3R}{4}$

$\Rightarrow \frac{\lambda_{3-1}}{\lambda_{2-1}} = \frac{27}{32}$

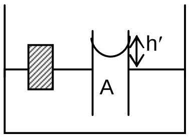
8. Work done by friction $= \int \vec{F} \cdot \vec{ds} = \int_0^x \mu mg \cos\theta \frac{dx}{\cos\theta}$

$= \mu mg\, x = 20$ J



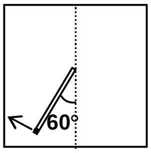
9. There will be no change.

∴ h′ = h



10. Conservation of energy $\frac{1}{2}mv^2 - mg\frac{\ell}{2} = mg\frac{\ell}{2} + m\sqrt{3}\left(2\ell\frac{\sqrt{3}}{2}\right)g$

$v = \sqrt{8g\ell}$



11. Potential across capacitor is zero, hence energy stored is zero.

12. $v_A - v_B = \int E.\,dx = 10\,(1)$

$= 10$ volt.

13. $Z = \sqrt{R^2 + X^2} = \sqrt{9 + X^2}$

but $\cos\phi = \frac{R}{Z} = \frac{3}{5}$

$X = 4\,\Omega$.

14. $\varepsilon = \frac{\sigma}{\varepsilon_0}$

$v_A - v_B = \frac{\sigma}{\varepsilon_0}(b) - \frac{\sigma}{\varepsilon_0}(a)$

$\therefore\; W = Q(v_A - v_B) = \frac{Q\sigma}{\varepsilon_0}(b - a)$

15. $\omega = 0 + 1 \times 10 = 10$ rad/sec^2

$\therefore\; v = r\omega = 1 \times 10 = 10$ m/s

$\bar{B} = \frac{\mu_0}{4\pi}\frac{q(\bar{v} \times \bar{r})}{r^3} \;\Rightarrow\; |\bar{B}| = \frac{\mu_0 qv}{4\pi r^2}$

$B = \frac{10^{-7} \times 0.1 \times 10}{(1)^2} = 10^{-7}$ T

16. $P = \sigma A T^4$

$\Rightarrow\; \frac{P_A}{P_B} = \frac{A_B}{A_A}\left(\frac{T_B}{T_A}\right)^4 \Rightarrow 16 = \frac{2}{1}\left(\frac{T_B}{T_A}\right)^4 \Rightarrow T_B = T_A(8)^{1/4}$

Since $\lambda_m T$ = constant, $\frac{\lambda_A}{\lambda_B} = \frac{T_B}{T_A} = (8)^{1/4}$

$\Rightarrow\; \lambda_B = \frac{\lambda_A}{(8)^{1/4}} = \frac{5000}{(8)^{1/4}}$ Å

17. For adiabatic process, $TV^{\gamma-1}$ = constant

$T\left(\frac{m}{\rho}\right)^{\gamma-1}$ = constant

$\frac{T}{\rho^{\gamma-1}}$ = constant

$\rho \propto T^{1/(\gamma-1)} \Rightarrow \frac{1}{\gamma - 1} = 3 \Rightarrow \gamma = 4/3$

$f = \frac{2}{\gamma - 1} = \frac{2}{\left(\frac{4}{3} - 1\right)} = 6$

18. P(x, y), A(–3a, 0), B = (3a, 0)

$V_{PA} = \frac{1}{4\pi\varepsilon_0}\frac{-2Q}{PA}$, $V_{PB} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{PB}$

According to equation

$$\frac{1}{4\pi\varepsilon_0}\left(\frac{-2Q}{PA}\right)+\frac{1}{4\pi\varepsilon_0}\frac{Q}{PB} = 0$$

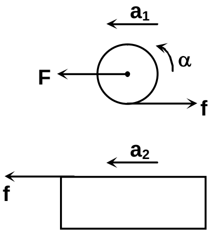
$$\frac{2}{PA}=\frac{1}{PB} \Rightarrow 4PB^2 = PA^2$$

$$(x - 5a)^2 + y^2 = (4a)^2$$

19. $i = \sqrt{5}A$

$$\frac{q_m^2}{2C}=\frac{q^2}{2C}+\frac{1}{2}Li^2 \Rightarrow q_{max} = 6\ C$$

21. $f = ma_2$



$$\alpha = \frac{\tau}{I}=\frac{2f}{mR}$$

$\Rightarrow a_2 = F/4m$, $f = F/4$

22. The process is equivalent to $TV^{1/2} = C$

Compare with $TV^{x-1} = C \Rightarrow x = 3/2$

$$\Rightarrow\ C = \frac{R}{\gamma-1}+\frac{R}{1-X} = \frac{R}{2/3}+\frac{R}{1-(3/2)} = \frac{3}{2}R-2R=-\frac{1}{2}R$$

23. Intensity will be highest at the nearest point.

28. $\tan\theta = \frac{u^2}{Rg} \Rightarrow R=\frac{u^2}{g\tan\theta}=\frac{100}{10\times\sqrt{3}}=\frac{10}{\sqrt{3}}$

Chemistry PART – II

14. $E = \frac{hc}{\lambda} = 2.9 \times 10^{-19}$ J

Total energy of 10 quanta = 10 × 2.9 × 10^{-19}J

Energy stored for process $= \frac{112 \times 4.18 \times 10^{3}}{6 \times 10^{23}} = 7.8 \times 10^{-19}$ J

% efficiency $= \frac{7.8 \times 10^{-19}}{29 \times 10^{-19}} \times 100$

= 26.9%

15. $\frac{r_a}{r_b} = \frac{2}{1} = \sqrt{\frac{M_b}{M_a}}$

$V_{rms} \propto \sqrt{\frac{T}{M}}$ (As $V_{rms} = \sqrt{\frac{3RT}{M}}$)

$\frac{V_{rms(a)}}{V_{rms(b)}} = \sqrt{\frac{T_a \times M_b}{T_b \times M_a}} = \frac{2}{1} \times \frac{\sqrt{2}}{1} = \frac{2\sqrt{2}}{1}$

16. $\ell n \frac{k_1'}{k_1} = \frac{E_1}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$ ... (i)

$\ell n \frac{k_2'}{k_2} = \frac{E_2}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$ ... (ii)

Eqn. (ii) – Eqn.(i)

$\ell n \frac{k_2' \times k_1}{k_2 \times k_1'} = \frac{(E_2 - E_1)}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$

(For equimolar formation of B and C, $k_2' = k_1'$)

$\ell n\left(\frac{k_1}{k_2}\right) = \left(\frac{8314}{8.314}\right)\left(\frac{T_2 - 300}{300 \times T_2}\right)$

$\ell n2 = = \left(\frac{8314}{8.314}\right)\left(\frac{T_2 - 300}{300 \times T_2}\right)$

T_2 = 329.77 K.

17. $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$

at equilibrium $(1-2x)$ $(2x)$ x

Only SO_2 will oxidized.

Equivalent of SO_2 = Equivalent of $KMnO_4$

2x × 2 = 0.2 × 5

2x = 0.5

$K_c = \frac{\left[\frac{0.5}{2}\right]^2\left[\frac{0.25}{2}\right]}{\left[\frac{0.5}{2}\right]^2} = 0.125$

18. $\Delta T_b = i \times k_b \times m$

2.08 = 0.52 × 1 × i

i = 4

It means salt on dissociation gives 4 ions. Thus the salt that gives 4 ions is $K_3[Fe(CN)_6]$.

19. $Cu^{+2} + e^{-} \longrightarrow Cu^{+};$ $E^{o} = X_1V$ $\Delta G_1^{o} = -FX_1$ ... (i)

$In^{+3} + 2e^{-} \longrightarrow In^{+1}$ $E^{o} = X_2V$ $\Delta G_2^{o} = -2FX_2$ ...(ii)

$In^{+2} + e^{-} \longrightarrow In^{+}$ $E^{o} = X_3V$ $\Delta G_3^{o} = -FX_3$ ... (iii)

From Eqn. (i) + (iii) – (ii)

$In^{+2} + Cu^{2+} \longrightarrow In^{+3} + Cu^{+}$ $\Delta G^{o} = -FE^{o}$

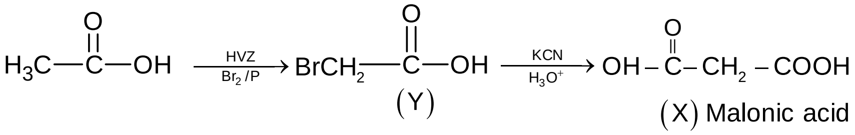
$\Delta G^{o} = -F\left(X_1 + X_3 - 2X_2\right) = -FE^{o}$

$E^{o} = \left(X_1 + X_3 - 2X_2\right)$

20. Due to Fajan's rule.

23. Green ppt. is – $Cr(OH)_3$

25.



$$H_3C-\overset{\overset{\displaystyle O}{||}}{C}-OH \xrightarrow[Br_2/P]{HVZ} \underset{(Y)}{BrCH_2-\overset{\overset{\displaystyle O}{||}}{C}-OH} \xrightarrow[H_3O^{+}]{KCN} \underset{(X)\text{ Malonic acid}}{OH-\overset{\overset{\displaystyle O}{||}}{C}-CH_2-COOH}$$

26. 1^{o} aromatic amine on diazotisation followed by coupling with β-napthol gives azo dye test.

28. (A) Viscosity α intermolecular attraction
α intermolecualr H-bonding tendency

(B) No intramoecular H-bonding in the cis-isomer due to loss in planarity as a result of steric and electronic repulsion.
$\therefore$ stability α symmetry.

(C) Even though o-nitrophenol shows intramolecular H-bonding but has greater – R and – I effect than –Cl.

(D) $H_3BO_3 + 3\ C_2H_5OH \rightarrow B(OC_2H_5)_3 + 3H_2O$.
$\therefore$ No cage lattice structure of H_3BO_3.

29. Because phenol is less acidic than H_2CO_3.

30. S is less electronegative and therefore more reactive towards S_N2.

Mathematics PART – III

1. Given equation can be written as $|x - 1|^2 + |x - 1| - 6 = 0$
$t^2 + t - 6 = 0$
$\Rightarrow t = 2$ or $-3 \Rightarrow |x - 1| = 2$
$\Rightarrow x - 1 = \pm 2$ or $x = 3, -1$

2. $|z_1 - z_2|^2 + |z_2 - z_3|^2 + |z_3 - z_4|^2 + |z_4 - z_1|^2$
$= 2(|z_1|^2 + |z_2|^2 + |z_3|^2 + |z_4|^2) + |z_1 + z_3|^2 + |z_2 + z_4|^2 \geq 8 + |z_1 + z_3|^2 + |z_2 + z_4|^2$

3. $$T_r = \frac{r}{r^4 + 4} = \frac{r}{(r^2+2)^2 - 4r^2} = \frac{r}{(r^2+2r+2)(r^2-2r+2)}$$
$$= \frac{1}{4}\left[\frac{1}{r^2-2r+2} - \frac{1}{r^2+2r+2}\right] = \frac{1}{4}\left[\frac{1}{(r-1)^2+1} - \frac{1}{(r+1)^2+1}\right]$$
$$\Rightarrow S_n = \frac{1}{4}\left[1 + \frac{1}{2} - \frac{1}{n^2+1} - \frac{1}{(n+1)^2+1}\right]$$
$$\Rightarrow S_5 = \frac{1}{4}\left[1 + \frac{1}{2} - \frac{1}{26} - \frac{1}{37}\right] = \frac{1}{4}\left[\frac{38\times 37 - 26\times 1}{26\times 37}\right] = \frac{1}{4}\times\frac{1380}{26\times 37} = \frac{345}{26\times 37}$$
$$\Rightarrow 37S_5 - \frac{7}{26} = \frac{338}{26} = 13$$

4. Number of terms = Number of non–negative integral solution of the equation p + q + r + s = 50
$= {}^{50+4-1}C_{50} = {}^{53}C_{50} = {}^{53}C_3$

5. If a function is symmetric about two mutually perpendicular lines, it must be symmetric about their point of intersection.

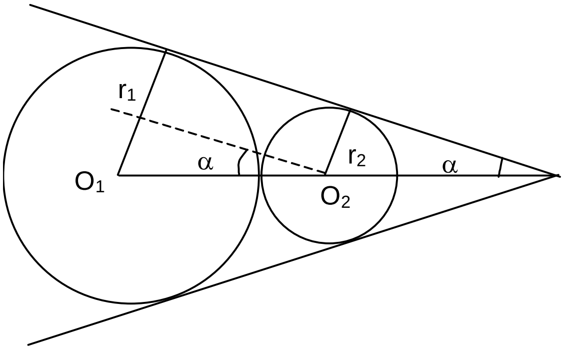
6. $$-\frac{x^5}{\sqrt{1-x^6}} - \frac{y^5}{\sqrt{1-y^6}}\frac{dy}{dx} = a\left(x^2 - y^2\frac{dy}{dx}\right)$$
$$\Rightarrow \left(ay^2 - \frac{y^5}{\sqrt{1-y^6}}\right)\frac{dy}{dx} = ax^2 + \frac{x^5}{\sqrt{1-x^6}}$$
$$\Rightarrow \frac{dy}{dx} = \frac{\sqrt{1-y^6}}{\sqrt{1-x^6}} \times \frac{x^2\left(a\sqrt{1-x^6} + x^3\right)}{y^2\left(a\sqrt{1-y^6} - y^3\right)} \qquad ..... (1)$$
Also, $\dfrac{(1-x^6)-(1-y^6)}{\sqrt{1-x^6}-\sqrt{1-y^6}} = a\left(x^3 - y^3\right)$ or $x^3 + y^3 = a\left(\sqrt{1-y^6} - \sqrt{1-x^6}\right)$
$$\Rightarrow a\sqrt{1-y^6} - y^3 = a\sqrt{1-x^6} + x^3$$
Hence, from equation (1), $\dfrac{dy}{dx} = \dfrac{\sqrt{1-y^6}}{\sqrt{1-x^6}} \times \dfrac{x^2}{y^2}$

7. For a triangle formed by joining any three co–normal points, orthocentre consides with the fourth point.

8. HM of SP and SQ = $\dfrac{2(3)(6)}{3+6} = 4$ = semi latus rectum.

9. If a circle cuts two circles orthogonally, radical axis of the two circles pass through the centre of the first circle
Here radical axis of given circles is $6x - 4y + 4 = 0$ or $3x - 2y + 2 = 0$
Hence $3\alpha - 2\beta + 2 = 0 \Rightarrow \frac{3}{4}\alpha - \frac{\beta}{2} = -\frac{1}{2}$

10. $\sin\alpha = \frac{r_1 - r_2}{r_1 + r_2}$
$\Rightarrow \theta = 2\sin^{-1}\left(\frac{r_1 - r_2}{r_1 + r_2}\right)$



11. Let $\vec{r} = a\vec{i} + b\vec{j} \Rightarrow a^2 + b^2 = 1$ …(1)
Also,
$\cos 45° = \frac{\vec{r}\cdot(\vec{i}+\vec{j})}{|\vec{r}||\vec{i}+\vec{j}|} \Rightarrow a + b = 1$ …(2)
$\cos 60° = \frac{\vec{r}\cdot(3\vec{i}-4\vec{j})}{|\vec{r}||3\vec{i}-4\vec{j}|} \Rightarrow 3a - 4b = \frac{5}{2}$ …(3)
There exists no real values of a and b satisfying (1), (2) and (3)
Hence no such unit vector exists

12. $(1 + x)^n = 3 + \frac{8}{3} + \frac{80}{3^3} + \frac{240}{3^4} + ... = 1 + nx + \frac{n(n-1)x^2}{2} + ...$
On comparison, $n = -3$ and $x = -\frac{2}{3}$

13. From the given conditions, $\frac{y-x}{b-a} \neq \pm1, \frac{z-y}{c-b} \neq \pm1, \frac{z-x}{c-a} \neq \pm 1$
$\Rightarrow x + a \neq y + b \neq z + c$ The determinant is a symmetric one. The determinant will be equal to zero if $x + a + y + b + z + c = 0$
but $a + b + c = 0$ (given)
$\Rightarrow x + y + z = 0$
$\Rightarrow x + z = 2\left(-\frac{y}{2}\right) \Rightarrow x, -\frac{y}{2}, z$ are in A.P.

14. For $x = 1$, $y = a + b + c$
Tangent at $(1, a + b + c)$ is $\frac{1}{2}(y + a + b + c) = ax + \frac{b}{2}(x + 1) + c$
Comparing with $y = 2x$, $c = a$, $b = 2(1 - a)$

]

15. $x \in (2, 3) \Rightarrow -1 < x^2 - 4x + 3 < 0$, so f(x) is increasing in (–1, 0)

$\Rightarrow$ f(sin x) is increasing on $\bigcup\limits_{n \in I}\left((4n-1)\frac{\pi}{2}, 2n\pi\right)$

16. Let point P on the straight line x + y = 4 be (m, 4 – m), this will be nearest to the parabola if ⊥ at this point to the straight line becomes normal to the parabola.
Let it is normal at $x - 10 = t^2$, y = 2t
Perpendicular to x + y = 4 at (m, 4 – m) is y – (4 – m) = (x – m) …..(1)
Normal at parabola at $(t^2 + 10, 2t)$ is $y + t(x - 10) = 12t + t^3$ …..(2)
(1) and (2) are same $\Rightarrow t = -1,\ m = \frac{17}{2}$ so required point is $\left(\frac{17}{2},\ -\frac{9}{2}\right)$

17. $\left|\bar{a} \times \left(\bar{a} \times \bar{c}\right)\right| = \left|3\bar{b}\right| = 3\left|\bar{b}\right|$

$\left|\bar{a}\right|.\left|\left(\bar{a} \times \bar{c}\right)\right| \sin\frac{\pi}{2} = 3.1 \Rightarrow 3 = \left|\bar{a}\right|.\left(\left|\left|\bar{a}\right|\ \ \left|\bar{c}\right|\right| \sin\theta\right)$

$\Rightarrow 3 = 3.2 \sin\theta \Rightarrow \sin\theta = \frac{1}{2} \Rightarrow \cos^2\theta = \frac{3}{4}$

18. $\Delta'(x) = \begin{vmatrix} e^x & 2\cos 2x & 2x\sec^2 x^2 \\ \ln(1+x) & \cos x & \sin x \\ \cos x^2 & e^x - 1 & \sin x^2 \end{vmatrix} + \begin{vmatrix} e^x & \sin 2x & \tan x^2 \\ \frac{1}{(1+x)} & -\sin x & \cos x \\ \cos x^2 & e^x - 1 & \sin x^2 \end{vmatrix} + \begin{vmatrix} e^x & \sin 2x & \tan x^2 \\ \ln(1+x) & \cos x & \sin x \\ -2x\sin x^2 & e^x & 2x\cos x^2 \end{vmatrix}$

= B + 2Cx + ….

Put x = 0, $B = \begin{vmatrix} 1 & 2 & 0 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{vmatrix} + \begin{vmatrix} 1 & 0 & 0 \\ 1 & 0 & -1 \\ 1 & 0 & 0 \end{vmatrix} + \begin{vmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 1 & 0 \end{vmatrix} = 0$

19. Let g(x) be the inverse of f, then f(g(x)) = x
$\Rightarrow 3^{g(x)(g(x)-2)} = x$
$\Rightarrow (g(x))^2 - 2g(x) - \log_3 x = 0$
$\Rightarrow g(x) = \frac{2 \pm \sqrt{4 + 4\log_3 x}}{2} = 1 \pm \sqrt{1 + \log_3 x}$
Since g : [1, ∞] → [2, ∞]
So $g(x) = 1 + \sqrt{1 + \log_3 x}$

20. Since $\sqrt{x^2 - 3x + 2} \ge 0 \Rightarrow 0 \le \tan^{-1}\sqrt{x^2 - 3x + 2} < \frac{\pi}{2}$

Since $\sqrt{4x - x^2 - 3} \ge 0 \Rightarrow 0 < \cos^{-1}\sqrt{4x - x^2 - 3} \le \frac{\pi}{2}$

$\Rightarrow 0 <$ L.H.S $< \pi \Rightarrow$ The given equation has no solution

21. Let $f = (5\sqrt{2} - 7)^{19}$
x – f = an integer ⇒ [x] + {x} – f = an integer
⇒ {x} – f = an integer, but – 1 < {x} – f < 1 ⇒ {x} = f
So, $x\{x\} = x.f = 1^{19} = 1$

23. $\frac{1}{x} = 2e\left[\frac{1}{3\ !}+\frac{2}{5\ !}+\frac{3}{7\ !}+...\infty\right] = 2eS$

$S = \sum_{r=1}^{\infty}\frac{r}{(2\ \ r+1)!} = \frac{1}{2}\sum_{r=1}^{\infty}\frac{(2\ \ r+1)-1}{(2\ \ r+1)!} = \frac{1}{2}\sum_{r=1}^{\infty}\left[\frac{1}{(2\ \ r)!}-\frac{1}{(2\ \ r+1)!}\right]$

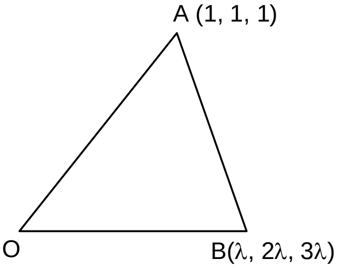
$= \frac{1}{2}\left[\frac{1}{2\ !}-\frac{1}{3\ !}+\frac{1}{4\ !}-\frac{1}{5\ !}+...\infty\right]$

$= \frac{1}{2}e^{-1} = \frac{1}{2\ \ e}$

$\Rightarrow \frac{1}{x} = 2eS = \frac{2\ \ e}{2\ \ e} = 1$

So, $\int_0^1 f\ \ (y)\log_y x\,dy = 0$

24. Let any point on second line be (λ, 2λ, 3λ)



$\cos\theta = \frac{6}{\sqrt{42}}$ $\sin\theta = \frac{6}{\sqrt{42}}$

$\Delta_{OAB} = \frac{1}{2}$ (OA).OB $\sin\theta = \frac{1}{2}\sqrt{3}\,.\lambda\sqrt{14} \times \frac{6}{\sqrt{42}} = \sqrt{6}$

$\Rightarrow \lambda = 2$

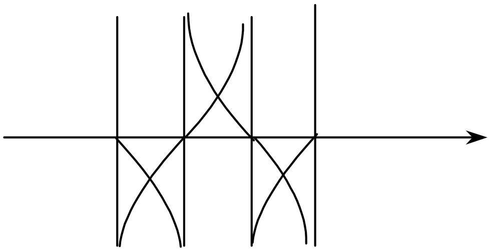
So, B is (2, 4, 6)

25. Centroid of triangle will be $\frac{\bar{a}+\bar{b}+\bar{c}}{3}$

Now line joining the orthocentre and the circumcentre is divided by centroid in 2 : 1 ratio internally, so orthocentre will be $\bar{a}+\bar{b}+\bar{c}$.

26. If we draw the graph of tan x and cot x, we observes that range of f (x) is [–1, 0) ∪ [1, ∞)

So f (x) = $\frac{1}{\sqrt{3}}$ does not have any root.



27. $S - S_n < \frac{1}{300}$

$\Rightarrow \frac{1}{1-\frac{1}{3}} - \frac{1-\frac{1}{3^n}}{1-\frac{1}{3}} < \frac{1}{300} \Rightarrow \frac{3}{2}\left[1-1+\frac{1}{3^n}\right] < \frac{1}{300}$

$\Rightarrow \frac{1}{3^n} < \frac{1}{300}\times\frac{2}{3} \Rightarrow \frac{1}{3^n} < \frac{1}{450} \Rightarrow 3^n > 450$

∴ Least value of n = 6

28. $f(x) = \int_0^x e^{|t-x|}dt + \int_x^4 e^{|t-x|}dt = \int_0^x e^{x-t}dt + \int_x^4 e^{t-x}dt = -e^{x-t}\Big|_0^x + e^{t-x}\Big|_x^4 = e^x + e^{4-x} - 2$

$f'(x) = e^x - e^{4-x} = 0 \Rightarrow x = 4 - x \Rightarrow x = 2$

$f(0) = f(4) = e^4 - 1$, $f(2) = 2(e^2 - 1)$, so maximum value of f(x) is $e^4 - 1$.

29. Given inequation can be rewritten as $3^{\sec^2 x}\sqrt{y^2 - \frac{2y}{3} + \frac{2}{9}} \le 1$

$\Rightarrow 3^{\sec^2 x}\sqrt{\left(y - \frac{1}{3}\right)^2 + \frac{1}{9}} \le 1$

Now, $3^{\sec^2 x} \ge 3$ and $\sqrt{\left(y - \frac{1}{3}\right)^2 + \frac{1}{9}} \ge \frac{1}{3}$

So, we should have $\sec^2 x = 1$, $y = \frac{1}{3}$

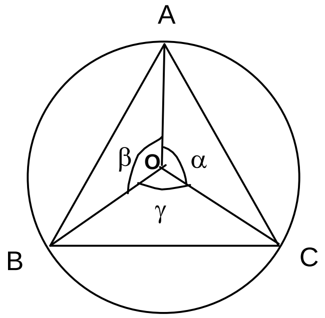
$\Rightarrow x = 0, \pi, 2\pi, 3\pi$

30. arc(AC) = 3, arc(AB) = 4, arc(BC) = 5

Let radius of the circle be ‘r’

$\Rightarrow r\alpha = 3 \Rightarrow \alpha = 3/r$, $\beta = 4/r$, $\gamma = 5/r$

Now, $3 + 4 + 5 = 2\pi r \Rightarrow r = 6/\pi \Rightarrow \frac{1}{r} = \frac{\pi}{6}$



$\Delta_{ABC} = \Delta_{OAC} + \Delta_{OAB} + \Delta_{OBC}$

$= \frac{1}{2}r^2\left(\sin\left(\frac{3}{r}\right) + \sin\left(\frac{4}{r}\right) + \sin\left(\frac{5}{r}\right)\right)$

$= \frac{1}{2}.\frac{36}{\pi^2}\left(\sin\left(\frac{\pi}{2}\right) + \sin\left(\frac{2\pi}{3}\right) + \sin\left(\frac{5\pi}{6}\right)\right)$

$= \frac{18}{\pi^2}\left(1 + \frac{\sqrt{3}}{2} + \frac{1}{2}\right) = \frac{9\sqrt{3}\left(1 + \sqrt{3}\right)}{\pi^2}$

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

FIITJEE **JEE (Advanced), 2014**

FULL TEST – IV

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 240**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-B**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (09 – 12) contains 4 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (13 – 18) contains 2 paragraphs. Based upon paragraph, 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+4 marks** for correct answer and **– 1 marks** for wrong answer.

2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 mark** will be awarded. There may be one or more than one correct choice. No marks will be given for any wrong match in any question. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant R = $8.314\ J\ K^{-1}\ mol^{-1}$
= 0.0821 Lit atm $K^{-1}\ mol^{-1}$
= $1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

SECTION – A

Single Correct Choice Type

This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. A longitudinal wave is represented by

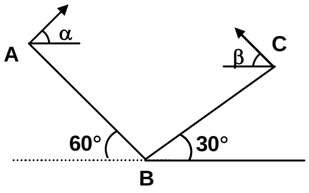
$$y = x_0 \text{ Sin } 2\pi\left(nt - \frac{x}{\lambda}\right)$$

The maximum particle velocity will be four times the wave velocity if

(A) $\lambda = \frac{\pi x_0}{4}$ (B) $\lambda = 2\pi x_0$

(C) $\lambda = \frac{\pi x_0}{2}$ (D) $\lambda = 4\pi x_0$

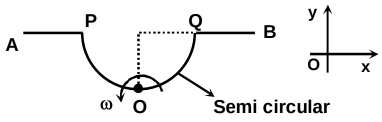
2. Two inclined planes AB and BC are at inclination of 60° and 30° as shown in the figure. The two projectiles of same mass are thrown simultaneously from A and C with speed 2 m/s and v_0 m/s respectively, they strike at B with same speed. If length of AB is $\frac{1}{\sqrt{3}}$ m and BC is 1 m, then find the value of v_0



(A) (1/2) m/s (B) 1 m/s

(C) 2 m/s (D) none of these

3. A conductor AB is rotated about O as shown in the figure such that its axis of rotation is parallel to the magnetic field $\vec{B} = B_0\hat{k}$ with uniform angular speed ω_0. The potential difference between points A and B is (given AP = QB)

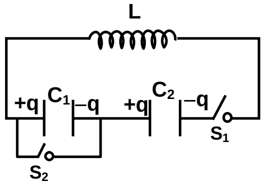


(A) $5B_0\omega R^2$ (B) $-5B_0\omega R^2$

(C) zero (D) None

Space for Rough work

4. Two capacitors $C_1 = C_2 = \frac{1}{\pi^2}\times 10^{-2}F$ and inductor $L = 2 \times 10^{-2}$ H are connected in series as shown in the figure. Initially charge on each capacitors are $4\sqrt{3}$ μC. At t = 0 switch S_1 is closed and t = 1/400 sec, switch S_2 is also closed. The maximum charge on capacitor C_2 during LC oscillation is



(A) 3 μC
(B) 6 μC
(C) $3\sqrt{3}$ μC
(D) $6\sqrt{3}$ μC

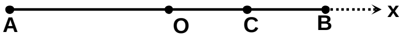
5. A light ray incident along vector $2\hat{i} + 4\hat{j} + \sqrt{5}\hat{k}$ strikes on the x-z plane from medium I of refractive index $\sqrt{3}$ and enters into medium II of refractive index is μ_2. The value of μ_2 for which the value of angle of refraction becomes 90°, is

(A) $\frac{4\sqrt{3}}{5}$
(B) $\frac{3\sqrt{3}}{5}$
(C) $\frac{2\sqrt{3}}{5}$
(D) $\frac{\sqrt{3}}{5}$

6. The energy of an electron in excited Hydrogen atom is –3.4 eV. Then according to Bohr's Theory the angular momentum of this electron in Js is

(A) 2.11×10^{-34}
(B) 3×10^{-34}
(C) 2×10^{-34}
(D) 0.5×10^{-34}

7. A particle of mass m is performing simple harmonic motion along line AB with amplitude 2a with centre of oscillation as O. At t = 0 particle is at point C (OC = a) and is moving towards B with velocity v = $a\sqrt{3}$ m/s. The equation of motion can be given by



OA=OB=2a
OC = a

(A) x = 2a (sin t + $\sqrt{3}$ cos t)
(B) x = 2a ($\sqrt{3}$ sin t + cos t)
(C) x = a (sin t + $\sqrt{3}$ cos t)
(D) x = a ($\sqrt{3}$ sin t + cos t)

8. Four identical samples of same polyatomic ideal gas undergo addition of same amount of heat under four different processes namely $PV^{1/2} = C$; $PV^{3/2} = C$; P = C and $PV^2 = C$. The final internal energy will be maximum for the sample which has undergone

(A) $PV^{1/2} = C$
(B) $PV^{3/2} = C$
(C) P = C
(D) $PV^2 = C$

Space for Rough work

Multiple Correct Answer(s) Type

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

9. A parallel plate capacitor with plate area A and separation d has charge Q. A slab of dielectric constant k is inserted in space between the plates almost completely fills the space. If E_0, U_0 and C_0 be the electric field, potential energy and capacitance before inserting the slab, then

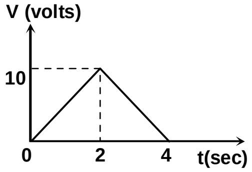
(A) the electric field after inserting the slab is $\frac{E_0}{k}$

(B) the capacitance after inserting the slab is $k\,C_0$

(C) the induced charge on the slab is $Q\left(1-\frac{1}{k}\right)$

(D) the energy stored in the capacitor becomes $\frac{U_0}{k}$, U_0 being the energy of the capacitor before inserting the slab

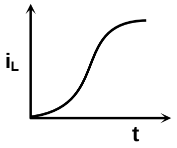
10. The potential difference across a 2H inductor as a function of time is shown in the figure. At time t = 0, current is zero. Choose the correct statement



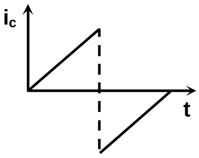
(A) Current at t = 2 sec is 5A

(B) Current at t = 2 sec is 10A

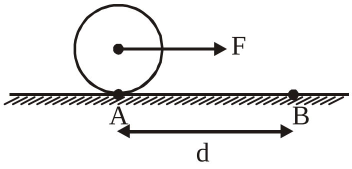
(C) Current vs time graph across inductor will be



(D) Current vs time graph across inductor will be



11. A uniform ring is connected to a light axle with light spokes so as to form a wheel. The wheel is placed on a horizontal surface with its plane vertical and a constant horizontal force F is applied to the axle. Surface AB is rough and surface right of B is smooth. The wheel does not slip when it moves from A to B. The wheel moves from A to B in time T.



(A) Rotational KE remains constant right of B

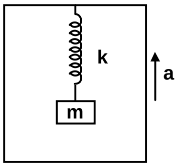
(B) Energy is dissipated from A to B

(C) Linear acceleration right of B is more than linear acceleration left of B

(D) The wheel undergoes constant non–zero acceleration to the right of B.

Space for Rough work

12. A spring mass system hanging from the ceiling of an elevator is at rest. The elevator starts accelerating upwards with acceleration 'a'. 'm' is the mass of block and 'k' is the spring constant of spring. Then Choose the correct alternative(s)



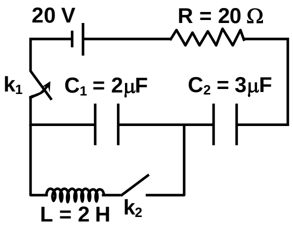
(A) Amplitude of oscillation is $\frac{ma}{k}$
(B) Amplitude of oscillation is $\frac{mg}{k}$
(C) Time period of oscillation is $2\pi\sqrt{\frac{m}{k}}$
(D) Time period of oscillations is $2\pi\sqrt{\frac{2m}{k}}$

Paragraph Type

This section contains 6 **multiple choice questions** relating to two paragraphs with **three questions on each paragraph**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

Paragraph for Questions 13 and 15

A circuit shown in the figure in which k_1 is closed and k_2 is open. Inductor L can be connected to capacitor C_1 by closing switch k_2 and opening k_1.



13. Let switch k_1 is closed and k_2 is opened for long time. The charge on capacitor C_2 will be
(A) 60 μC
(B) 12 μC
(C) 24 μC
(D) 8 μC

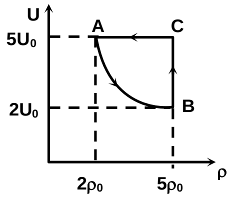
14. At t = 0, when capacitors are fully charged, switch k_1 is opened and switch k_2 is closed, so that inductor is connected in series with capacitor C_1. The maximum charge will appear on capacitor C_1 at time t is
(A) $\frac{\pi}{2000}$ sec
(B) $\frac{\pi}{1000}$ sec
(C) $\frac{\pi}{500}$ sec
(D) None

15. The maximum energy across inductor will be
(A) 0.144 mJ
(B) 0.288 mJ
(C) 0.072 mJ
(D) None of these

Space for Rough work

Paragraph for Questions 16 and 18

Figure shows the variation of the internal energy U with the density ρ of one mole of ideal monoatomic gas for a thermodynamics cycle ABCA. Here process AB is a part of rectangular hyperbola



16. The total amount of heat absorbed by the system for cyclic process is

(A) $\left(\frac{10}{3}\ln 2.5 - 2\right)U_0$ (B) $\left(\frac{10}{5}\ln 0.4 - 2\right)U_0$

(C) $50U_0$ (D) None of these

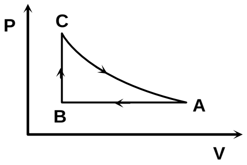
17. The work done in process AB is

(A) $-U_0$ (B) $-2U_0$

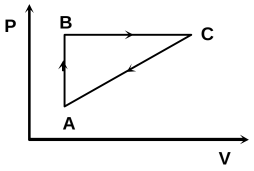
(C) $-5U_0$ (D) none of these.

18. The P-V diagram of above process

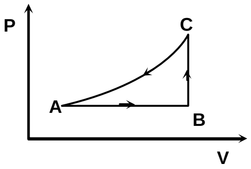
(A)



(B)



(C)



(D) None of these

Space for Rough work

SECTION - B

Matrix – Match Type

*This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

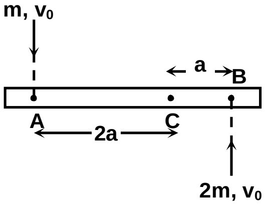
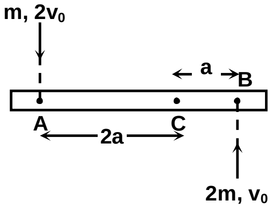
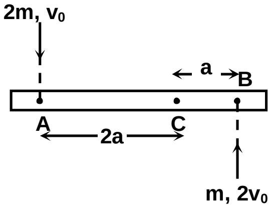
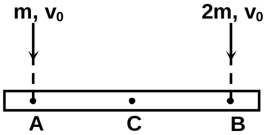
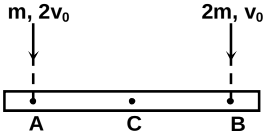
---

1. An electron in a hydrogen atom makes a transition $n_1 \rightarrow n_2$, where n_1 and n_2 are the principal quantum numbers of the two states. Assume Bohr model to be valid.

Column I		Column II	
(A)	The electron emits an energy of 2.55 eV	(p)	$n_1 = 2, n_2 = 1$
(B)	Time period of the electron in the initial state is eight time that in the final state.	(q)	$n_1 = 4, n_2 = 2$
(C)	Speed of electron become two times	(r)	$n_1 = 5, n_2 = 3$
(D)	Radius of orbit of electron becomes 4.77A°	(s)	$n_1 = 6, n_2 = 3$
		(t)	$n_1 = 8, n_2 = 4$

Space for Rough work

2. A rod of mass 6m and length 6a is kept at horizontal smooth surface. Two point masses of masses 2m and m respectively moving perpendicular to the rod, collide to the rod and stick to the rod after collision as shown in the column – II and stick to the rod. Point C represents centre of mass of the rod. AC = 2a and CB = a. v is the linear speed of the centre of mass of the system just after collision and ω is the angular speed of the system just after collision.

	Column – I		Column – II
(A)	$v = 0$	(p)	
(B)	$\omega = 0$	(q)	
(C)	$v \neq 0$	(r)	
(D)	$\omega \neq 0$	(s)	
		(t)	

Space for Rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. Boron cannot form which of the following anions:

(A) BF_6^{3-} (B) BH_4^-

(C) $B(OH)_4^-$ (D) BO_2^-

2. Which of the following resonating structures of 1-methoxy-1,3-butadiene is most stable:

(A) $\overset{(-)}{C}H_2 - CH = CH - CH = \overset{\oplus}{O} - CH_3$ (B) $CH_2 = CH - \overset{(-)}{C}H - CH = \overset{\oplus}{O} - CH_3$

(C) $CH_2 = CH - \overset{\oplus}{C}H - \overset{(-)}{C}H - O - CH_3$ (D) $CH_2 = CH - \overset{(-)}{C}H - \overset{\oplus}{C}H - O - CH_3$

3. A mixture of two salts is not water soluble but dissolves completely in dilute HCl to form a colourless solution. The mixture could be

(A) $AgNO_3$ and KBr (B) $BaCO_3$ & ZnS

(C) $FeCl_3$ and $CaCO_3$ (D) $Mn(NO_3)_2 + MgSO_4$

4. The weight of a residue obtained by heating 2.76 g of silver carbonate is :

(A) 2.76 g (B) 2.98 g

(C) 2.16 g (D) 2.44 g

Rough Work

5. The brown ring complex $[Fe(H_2O)_5NO]SO_4$ has oxidation number of Fe

(A) +1	(B) +2
(C) +3	(D) +4

6. Black Jack is an ore of:

(A) Cr	(B) Sn
(C) Zn	(D) Ni

7. The correct order of decreasing acidic strength of oxides is:

(A) $Li_2O > BeO > B_2O_3 > CO_2 > NO_2$	(B) $N_2O_3 > CO_2 > B_2O_3 > BeO > Li_2O$
(C) $CO_2 > N_2O_3 > B_2O_3 > BeO > Li_2O$	(D) $B_2O_3 > CO_2 > N_2O_3 > Li_2O > BeO$

8. $C_5H_{13}N$ reacts with HNO_2 to give an optically active alcohol. The compound is:

(A) Pentan-1-amine	(B) Pentan-2-amine
(C) N, N – dimethylpropan-2-amine	(D) N – Methylbutan-2-amine

Rough Work

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

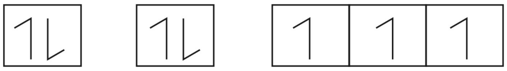
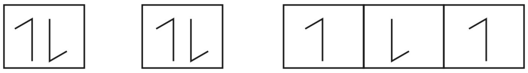
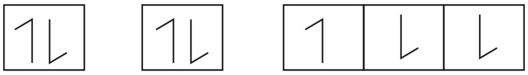
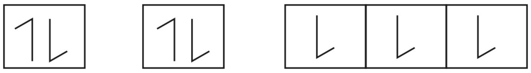
9. If P° and P_S are the V.P. of solvent and its solution respectively and N_1 and N_2 are the moles of solute and solvent then

(A) $(P° – P_S)/P° = N_1/(N_1 + N_2)$
(B) $(P° – P_s)/P_S = N_1/N_2$
(C) $(P° – P_S)/P° = N_1/N_2$
(D) None

10. Select the correct statements:

(A) For the reaction $H_{2(g)} + I_{2(g)} \underset{K_b}{\overset{K_f}{\rightleftharpoons}} 2HI\,(g)$; $\frac{d[H_2]}{dt} = K_b[HI]^2$ (Assuming the reactions to be elementary)
(B) At equilibrium net rate of change in conc. of H_2 is zero for $H_2 + I_2 \rightleftharpoons 2HI$
(C) The equilibrium constant for the reaction $H_{2(g)} + I_{2(g)} \underset{K_b}{\overset{K_f}{\rightleftharpoons}} 2HI$; is independent of temperature
(D) (A) is correct and (B) is wrong

11. Ground state of nitrogen atom can be represented by

(A) 
(B) 
(C) 
(D) 

12. Radioactive $\left(\overset{82}{Br}—\overset{82}{Br}\right)$ adds to 1-bromocyclohexene in CCl_4. The product is :

(A) 1, 1, 2 – tribromocyclohexane

(B) has radioactive bromine in vicinal position

(C) has radioactive bromine trans to each other

(D) has radioactive bromine cis to each other

Rough Work

Paragraph Type

This section contains 6 **multiple choice questions** relating to two paragraphs with **three questions on each paragraph**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

Paragraph for Question Nos. 13 to 15

A solid crystal is composed of X,Y and Z atoms, Z atoms (radius 200 pm) form cubic close packed structure, whereas X (radius 50 pm) and Y (radius 100 pm) occupy respective voids – Assume all the voids are occupied. Now answer the following questions.

13. If all the atoms along one body diagonal are removed, then the formula of the compound becomes :

(A) $X_8Y_4Z_5$ (B) $X_8Y_4Z_4$

(C) $X_6Y_3Z_3$ (D) $X_6Y_3Z_4$

14. Now in the crystal obtained in Q. No. 13 if all the atoms along another body diagonal are removed, then the formula of the compound becomes :

(A) $X_8Y_4Z_6$ (B) $X_8Y_6Z_5$

(C) $X_8Y_4Z_8$ (D) $X_8Y_6Z_7$

15. Which type of voids are occupied by X atoms:

(A) Tetrahedral void (B) Octahedral void

(C) Cubic void (D) All of these

Rough Work

Paragraph for Question Nos. 16 to 18

Buffer is a solution whose pH does not change significantly on addition of a small amount of acid or alkali or on dilution. Answer the following questions:

16. The amount of $(NH_4)_2SO_4$ to be added to 500 ml of 0.01 M NH_4OH solution (pKa for NH_4^+ is 9.26) prepare a buffer of pH 8.26 is :

(A) 0.05 mole
(B) 0.025 mole
(C) 0.10 mole
(D) 0.005 mole

17. The ratio of pH (approximately) of solution (I) containing 1 mole of CH_3COONa and 1 mole of HCl and solution (II) containing 1 mole of CH_3COONa and 1 mole of acetic acid in one litre is :

(A) 1 : 2
(B) 2 : 1
(C) 1 : 3
(D) 3 : 1

18. A weak acid HA after treatment with 12 ml of 0.1M strong base BOH has pH = 5. At the end point, the volume of same base required is 26.6 ml. K_a of acid is :

[Given : $\log\left(\frac{1.2}{1.46}\right) = -0.085$]

(A) 8.2×10^{-6}
(B) 8.2×10^{-5}
(C) 8.2×10^{-4}
(D) 8.2×10^{-7}

Rough Work

SECTION-B
(Matrix Type)

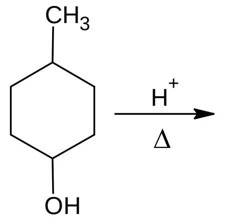
This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

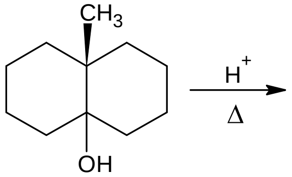
If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

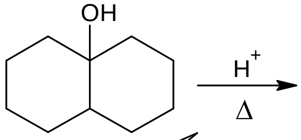
	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

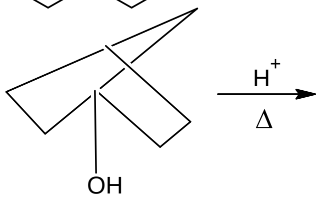
1. Match the Column – I with Column – II:

Column – I

(A)


(B)


(C)


(D)


Column – II

(p) Racemic mixture

(q) Major product consist of even number of α-hydrogen

(r) Will not undergo dehydration

(s) Major product consist of odd number of α-hydrogen

(t) Bridged carbocation is an intermediate

2. Match the Column – I with Column – II:

Column – I(Reaction)

(A) $[Co(NH_3)_4 (H_2O)_2] Cl_2$
(B) $[Pt (NH_3)_2 Cl_2]$
(C) $[Co(H_2O)_5 Cl] Cl$
(D) $[Ni(H_2O)_6] Cl_2$

Column – II(Products)

(p) Geometrical isomers
(q) Paramagnetic
(r) Diamagnetic
(s) Metal ion with +2 oxidation state
(t) On reaction with $AgNO_3$ forms 2 equivalents of AgCl

Rough Work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. OPQR is a square and M, N are the mid–points of the sides PQ and QR respectively. If the ratio of the areas of the square and the triangle OMN is k : 6, then $\frac{k}{4}$ is equal to

(A) 2 (B) 4
(C) 12 (D) 16

2. P is a point (a, b) in the first quadrant. If the two circles which pass through P and touch both the co–ordinate axes cut at right angles, then

(A) $a^2 - 6ab + b^2 = 0$ (B) $a^2 + 2ab - b^2 = 0$
(C) $a^2 - 4ab + b^2 = 0$ (D) $a^2 - 8ab + b^2 = 0$

3. If f(x) is a decreasing function then the set of values of 'k', for which the major axis of the ellipse $\frac{x^2}{f(k^2+2k+5)} + \frac{y^2}{f(k+11)} = 1$ is the x–axis, is

(A) $k \in (-2, 3)$ (B) $k \in (-3, 2)$
(C) $k \in (-\infty, -3) \cup (2, \infty)$ (D) $k \in (-\infty, -2) \cup (3, \infty)$

4. If $f(x) = 2\sin^2\theta + 4\cos(x+\theta)\sin x\sin\theta + \cos(2x+2\theta)$ then value of $f^2(x) + f^2\left(\frac{\pi}{4} - x\right)$ is

(A) 0 (B) 1
(C) –1 (D) x^2

5. If $\frac{a_0}{n+1} + \frac{a_1}{n} + \frac{a_2}{n-1} + ... + \frac{a_{n-1}}{2} + a_n = 0$, then the equation $a_0x^n + a_1x^{n-1} + a_2x^{n-2} + ... + a_{n-1}x + a_n = 0$ has

(A) exactly one root in (0, 1) (B) at least one root in (0, 1)
(C) no root in (0, 1) (D) at the most one root in (0, 1)

Space for rough work

6. If $f(x)=\sqrt{x}$, g(x) = $e^x - 1$, and $\int fog(x)dx = Afog(x)+B\tan^{-1}(fog(x))+C$, then A + B is equal to

(A) 1 (B) 2
(C) 3 (D) none of these

7. Area bounded by the curve y = $\ell n\, x + \tan^{-1} x$ and x–axis from x = 1 to x = 2, is

(A) $\frac{5}{2}\ell n\ 2-\frac{1}{2}\ell n\ 5+2\tan^{-1}2-\frac{\pi}{3}-1$ (B) $\frac{5}{2}\ell n\ 2-\frac{1}{2}\ell n\ 5+2\tan^{-1}2-\frac{\pi}{4}+1$
(C) $\frac{5}{2}\ell n\ 2-\frac{1}{2}\ell n\ 5+2\tan^{-1}2+\frac{\pi}{4}-1$ (D) $\frac{5}{2}\ell n\ 2-\frac{1}{2}\ell n\ 5+2\tan^{-1}2-\frac{\pi}{4}-1$

8. If gradient of a curve at any point P(x, y) is $\frac{x+y+1}{2y+2x+1}$ and it is passes through origin, then curve is

(A) $2(x+3y)=\ell n\left|\frac{3x+3y+2}{2}\right|$ (B) $x+3y=\ell n\left|\frac{3x+3y+2}{2}\right|$
(C) 3y + x = ℓn (3x + 2y + 1) (D) $6y-3x=\ell n\left|\frac{3x+3y+2}{2}\right|$

Multiple Correct Choice Type

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

9. If $\left(4+\sqrt{15}\right)^n = I+f$, where n is an odd natural number, I is an integer and 0 < f < 1, then

(A) I is natural number (B) I is an even integer
(C) (I + f)(1 – f) = 1 (D) 1 – f = $\left(4-\sqrt{15}\right)^n$

10. A bag initially contains one red and two blue balls. An experiment consisting of selecting a ball at random, noting its colour and replacing it together with an additional ball of the same colour. If three such trials are made, then

(A) probability that atleast one blue ball is drawn is $\frac{9}{10}$
(B) probability that exactly one blue ball is drawn is $\frac{1}{5}$
(C) probability that all the drawn balls are red given that all the drawn balls are of same colour is $\frac{1}{5}$
(D) probability that atleast one red ball is drawn is $\frac{3}{5}$

Space for rough work

11. If z is a complex number satisfying $|z - i\,\text{Re}(z)| = |z - \text{im}(z)|$ then z lies on
(A) $y = x$ (B) $y = -x$
(C) $y = x + 1$ (D) $y = -x + 1$

12. In a four – dimensional space where unit vectors along axes are $\hat{i}, \hat{j}, \hat{k}$ and $\hat{\ell}$ and $\vec{a}_1, \vec{a}_2, \vec{a}_3, \vec{a}_4$ are four non–zero vectors such that no vector can be expressed as linear combination of others and $(\lambda - 1)(\vec{a}_1 - \vec{a}_2) + \mu(\vec{a}_2 + \vec{a}_3) + \gamma(\vec{a}_3 + \vec{a}_4 - 2\vec{a}_2) + \vec{a}_3 + \delta\vec{a}_4 = \vec{o}$ then
(A) $\lambda = 1$ (B) $\mu = -\frac{2}{3}$
(C) $\gamma = \frac{2}{3}$ (D) $\delta = \frac{1}{3}$

Paragraph Type

This section contains 6 **multiple choice questions** relating to two paragraphs with **three questions on each paragraph**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

Paragraph for Question Nos. 13 to 15

Read the following write up carefully and answer the following questions:
The complex slope of a line passing through two points represented by complex numbers z_1 and z_2 is defined by $\frac{z_2 - z_1}{z_2 - z_1}$ and we shall denote by ω. If z_0 is complex number and c is a real number, then $\bar{z}_0 z + z_0 \bar{z} + c = 0$ represents a straight line. Its complex slope is $-\frac{z_0}{\bar{z}_0}$.

Now consider two lines $\alpha\bar{z} + \bar{\alpha}z + i\beta = 0$ ….. (i)
and $a\bar{z} + \bar{a}z + b = 0$ ….. (ii)
where α, β and a, b are complex constants and let their complex slopes be denoted by ω_1 and ω_2 respectively

13. If the lines are inclined at an angle of 120º to each other, then
(A) $\omega_2\bar{\omega}_1 = \omega_1\bar{\omega}_1$ (B) $\omega_2\bar{\omega}_1^2 = \omega_1\bar{\omega}_2^2$
(C) $\omega_1^2 = \omega_2^2$ (D) $\omega_1 + 2\omega_2 = 0$

Space for rough work

14. Which of the following must be true
(A) a must be purely imaginary (B) β must be purely imaginary
(C) a must be real (D) b must be imaginary

15. If line (i) makes an angle of 45º with real axis, then $(1+i)\left(-\frac{2\alpha}{\bar{\alpha}}\right)$ is
(A) $2\sqrt{2}$ (B) $2\sqrt{2}$ i
(C) 2(1 – i) (D) –2(1 + i)

Paragraph for Question Nos. 16 to 18

Read the following write up carefully and answer the following questions:
Let $a_1x + b_1y + c_1z + d_1 = 0$ and $a_2x + b_2y + c_2z + d_2 = 0$ be two planes, where $d_1, d_2 > 0$. Then origin lies in acute angle if $a_1a_2 + b_1b_2 + c_1c_2 < 0$ and origin lies in obtuse angle if $a_1a_2 + b_1b_2 + c_1c_2 > 0$. Further point (x_1, y_1, z_1) and origin both lie either in acute angle or in obtuse angle, if $(a_1x_1 + b_1y_1 + c_1z_1 + d_1)(a_2x_1 + b_2y_1 + c_2z_1 + d_2) > 0$. One of (x_1, y_1, z_1) and origin lie in acute angle and the other in obtuse angle, if $(a_1x_1 + b_1y_1 + c_1z_1 + d_1)(a_2x_1 + b_2y_1 + c_2z_1 + d_2) < 0$

16. Given the planes 2x + 3y – 4z + 7 = 0 and x – 2y + 3z – 5 = 0, if a point P is (1, –2, 3), then
(A) O and P both lie in acute angle between the planes
(B) O and P both lie in obtuse angle
(C) O lies in acute angle, P lies in obtuse angle
(D) O lies in obtuse angle, P lies an acute angle

17. Given the planes x + 2y – 3z + 5 = 0 and 2x + y + 3z + 1 = 0. If a point P is (2, –1, 2), then
(A) O and P both lie in acute angle between the planes
(B) O and P both lie in obtuse angle
(C) O lies in acute angle, P lies in obtuse angle
(D) O lies in obtuse angle, P lies an acute angle

18. Given the planes x + 2y – 3z + 2 = 0 and x – 2y + 3z + 7 = 0, if the point P is (1, 2, 2), then
(A) O and P both lie in acute angle between the planes
(B) O and P both lie in obtuse angle
(C) O lies in acute angle, P lies in obtuse angle
(D) O lies in obtuse angle, P lies an acute angle

Space for rough work

SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in ***Column I*** *are labelled A, B, C and D, while the statements in* ***Column II*** *are labelled p, q, r, s and t. Any given statement in* ***Column I*** *can have correct matching with* ***ONE OR MORE*** *statement(s) in* ***Column II.*** *The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

---

1. Match the following Column–I with Column–II

	Column – I		Column – II
(A)	If $\cos A = \dfrac{\sin B}{2\sin C}$, then ΔABC is	(p)	isosceles
(B)	If $\dfrac{\cos A + 2\cos C}{\cos A + 2\cos B} = \dfrac{\sin B}{\sin C}$, then ΔABC may be	(q)	obtuse angle
(C)	If $\dfrac{2\cos A}{a} + \dfrac{\cos B}{b} + \dfrac{2\cos C}{c} = \dfrac{a}{bc} + \dfrac{b}{ca}$, then ΔABC is	(r)	right angle
(D)	If $\dfrac{a^2 - b^2}{a^2 + b^2} = \dfrac{\sin(A - B)}{\sin(A + B)}$, then ΔABC may be	(s)	acute angle
		(t)	equilateral

2. Match the following Column–I with Column–II

	Column – I		Column – II
(A)	If set of all possible values of k for which every solution of the inequation $x^2 - (3k - 1)x + 2k^2 - 3k - 2 \geq 0$ is also a solution of the inequation $x^2 - 1 \geq 0$ is $[\ell, m]$, then $\ell + m$ is equal to	(p)	3
(B)	If a, b, c and d are four positive real numbers such that abcd = 1 and minimum value of (1 + a)(1 + b)(1 + c)(1 + d) is 16λ, then λ + 2 is equal to	(q)	1
(C)	If solution set of the inequality $5^{x+2} > \left(\dfrac{1}{25}\right)^{1/x}$ is (ℓ, ∞), then ℓ is equal to	(r)	4
(D)	Let $f(x) = x^3 + 3x + 1$. If g(x) is the inverse function of f(x) and $g'(5) = 6\lambda$, then 4λ is equal to	(s)	2
		(t)	0

Space for rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students
from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

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ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS
FULL TEST –IV
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	A	B
2.	C	B	C
3.	C	B	B
4.	D	C	B
5.	B	A	B
6.	A	C	D
7.	D	B	D
8.	B	B	D
9.	A, B, C, D	A, B	A, C, D
10.	A, C	A, B	A, B, C, D
11.	A, C, D	A, D	A, B
12.	A, C	A, B, C	A, B, D
13.	C	A	B
14.	C	D	B
15.	A	A	C
16.	A	B	B
17.	B	A	C
18.	A	A	A
1.	(A) → (q),(B) → (p, q, s, t), (C) → (p, q, s, t), (D) → (r, s)	A → (p, q) B → (p, q) C → (q) D → (r, t)	(A) → (p), (B) → (p, r) (C) → (r), (D) → (p, r)
2.	(A) → (q, r), (B) → (s), (C)→ (p, s, t), (D) → (p, q, r, t)	A → (p, q, s, t) B → (p, r, s) C → (q, s) D → (q, s, t)	(A) → (q), (B) → (p) (C) → (t), (D) → (r)

Physics

PART – I

1. Particle vel = $\frac{dx}{dt} = x_0\ 2\pi n \cos 2\pi\left(nt - \frac{x}{\lambda}\right)$

max particle vel = $x_0 2\pi n$ putting cos term = 1 wave vel = $\frac{\lambda}{T} = n\lambda$

for $x_0 2\pi n = 4n\lambda$

$\therefore\ \lambda = \frac{x_0\pi}{2}$

2. $\frac{1}{2}mv^2 + mg\frac{1}{\sqrt{3}}\sin 60° = \frac{1}{2}mv_0^2 + mg \times 1 \times \sin 30°$

$\Rightarrow\ v_0 = 2$ m/s

4. $\omega = \frac{1}{\sqrt{LC_{eq}}} = 100\pi$

$\Rightarrow\ T = 1/50$ sec

5. $\sin\theta_C = \mu_2/\mu_1$

$1 - \cos^2\theta_C = \left(\frac{\mu_2}{\mu_1}\right)^2$

$1 - (\hat{n}.\hat{p})^2 = \left(\frac{\mu_2}{\mu_1}\right)^2$

$1 - \left[\frac{4}{\sqrt{25}}\right]^2 = \left(\frac{\mu_2}{\mu_1}\right)^2 \Rightarrow \frac{\mu_2}{\mu_1} = \frac{3}{5} \Rightarrow \mu_2 = \frac{3\sqrt{3}}{5}$

6. $E_n = -3.4$ eV $E_n \alpha \frac{1}{n^2}$

$\therefore\ E_1 - 13.6$ eV

n = 2

Angular momentum = $\frac{nh}{2\pi} = \frac{2h}{2\pi} = \frac{h}{\pi} = 2.11 \times 10^{-34}$ Js

7. $v^2 = \omega^2(A^2 - x^2) = 3\omega^2 a^2 \Rightarrow \omega = \frac{v}{\sqrt{3}a} = 1$ rad/sec

$x = 2a\sin(\omega t + \phi)$, $v = 2a\omega\cos(\omega t + \phi)$

At t = 0, x = a & v = +ve

$\frac{1}{2} = \sin\phi$

$\Rightarrow\ \phi = n\pi + (-1)^n\frac{\pi}{6} = \begin{cases}\pi/6 \\ 5\pi/6\end{cases}$

v at $\phi = \pi/6$ = + ve and v at $\phi = 5\pi/6$ = –ve

So, $\phi = \pi/6$

$x = 2a\sin(\omega t + \phi) = 2a[\sin\omega t\cos\phi + \cos\omega t\sin\phi]$

$x = a(\sqrt{3}\sin t + \cos t)$

8. For a polytropic process

$$\frac{\Delta U}{\Delta Q}=\frac{\frac{R}{\gamma-1}}{\frac{R}{\gamma-1}+\frac{R}{1-x}}=\frac{1}{1+\frac{\gamma-1}{1-x}}$$

For polyatomic gas, $\gamma = 4/3$

$$\Rightarrow \frac{\Delta U}{\Delta Q}=\frac{1}{1+\frac{1}{3(1-x)}}$$

This is max at $x = 3/2$

9. Use the concept of capacitor.

10. Area in (v_L-t)graph = $L\Delta I$

$\Rightarrow 2(i_f - 0) = \frac{1}{2}\times 10\times 2$

$\Rightarrow i_f = 5A$

13 -15. For long time capacitor gets full charged and charge on each capacitor must be same.

$\frac{Q}{2}+\frac{Q}{3}=20$

$Q = 24\ \mu C$

$$\left[\omega=\frac{1}{\sqrt{LC}}=\frac{1}{\sqrt{2\times 2\times 10^{-6}}}=\frac{10}{2}=50\text{ rad/s}\right]$$

$Q(t) = 24 \sin \omega t\ \mu C$

$Q(t) = (24 \sin \omega t)\ \mu C$

$500t = \frac{\pi}{2}(-1)^n + \pi n$

$t = \frac{n\pi}{500}+(-1)^n\frac{\pi}{1000}$

$E_{max} = \frac{Q_0^2}{2C}=\frac{24\times 10^{-3}\times 24\times 10^{-6}}{2\times 2\times 10^{-6}}$ = 144×10^{-6} Joule = 0.144 mJ

16. $Q = Q_{AB} + Q_{BC} + Q_{CA}$

$Q = -5U_0 + 3U_0 + \frac{10U_0}{3}\ln 2.5$

17. $W_{AB} = \Delta Q_{AB} - \Delta U_{AB} = -5U_0 - (-3U_0) = -2U_0$

18. Process AB $U\rho$ = constant

$\frac{P}{\rho}=\frac{RT}{M}$ and $U \propto t$

$\Rightarrow$ P = const

Process BC → isochoric

Process CA → isothermal

SECTION - B

2. $I = \frac{1}{12} \times 6m \times 36a^2 + m4a^2 + 2ma^2 = 24a^2m$ for p, q, s & t

$p \Rightarrow \vec{v} = \frac{v_0}{9}\hat{j}$, $24ma^2\vec{\omega} = mv_0 2a\hat{k} + 2mv_0 a\hat{k} \Rightarrow \vec{\omega} = \frac{v_0}{6a}\hat{k}$

$q \Rightarrow \vec{v} = \vec{0}$, $24ma^2\vec{\omega} = 2mv_0 2a\hat{k} + 2mv_0 a\hat{k} \Rightarrow \vec{\omega} = \frac{v_0}{4a}\hat{k}$

$s \Rightarrow \vec{v} = \frac{v_0}{3}\left(-\hat{j}\right)$, $24ma^2\vec{\omega} = mv_0 2a\hat{k} + 2mv_0 a(-\hat{k}) \Rightarrow \vec{\omega} = \vec{0}$

$t \Rightarrow \vec{v} = \frac{4v_0}{9}\left(-\hat{j}\right)$, $24ma^2\vec{\omega} = 4mv_0 a\hat{k} + 2mv_0 a(-\hat{k}) \Rightarrow \vec{\omega} = \frac{v_0}{12a}\hat{k}$

$r \Rightarrow \vec{v} = \vec{0}$, $(18\,ma^2 + ma^2 + 2m4a^2)\,\vec{\omega} = 4mv_0 a\hat{k} + 2mv_0 a\hat{k} \Rightarrow \vec{\omega} = \frac{6v_0}{25a}\hat{k}$

Chemistry PART – II

SECTION - A

1. Due to non availability of d-orbitals, boron is unable to expand its octet. Therefore it cannot extend its covalency more than 4.

3. $BaCO_3 + 2HCl \rightarrow BaCl_2 + H_2O + CO_2$

   $ZnS + 2HCl \rightarrow ZnCl_2 + H_2S$

4. $2Ag_2CO_3 \xrightarrow{\Delta} 4\,Ag + 2CO_2 + O_2$

   552 gm $Ag_2CO_3 \rightarrow$ 432 g of Ag

   $\therefore$ 2.76 g $Ag_2CO_3 \rightarrow \frac{432}{552} \times 2.76 = 2.16g$

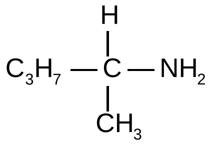
5. NO in iron complex has +1 oxidation number.

   Thus, $a + 5 \times (0) + 1 + 1 \times (-2) = 0$

   $\therefore a = +1$

6. It is called Zinc blend

7. From left to right in a period acidic character increases due to increase in electronegativity.

8. 

   $C_3H_7 - \overset{H}{\underset{CH_3}{C}} - NH_2$

9. Roult's law for ideal solutions can be represented in the above two given ways.

11. Hund's rule.

12. Addition of Br_2 in CCl_4 is anti addition.

13. In the original compound

    Z atoms → form CCP

    X atoms → present in tetrahedral void.

    $\left(\frac{rX}{rZ} = \frac{50}{200} = 0.25\right)$

    Y atoms → present in octahedral void

$$\left(\frac{rY}{rZ} = \frac{100}{200} = 0.5\right)$$

Assuming, all voids are occupied, formula of the original compound = $X_8Y_4Z_4$.

On removing atoms along one body diagonal,

We lose → 2Z atoms, 2X atoms, 1Y atom (body centre)

$\therefore$ The new formula becomes →$X_6\ Y_3Z_{3.75}$

Simplest formula → $X_8Y_4Z_5$

14. On removing atoms along another body diagonal, we lose

→ 2Z atoms

→2X atoms

$\therefore$ The new formula becomes = $X_4Y_3Z_{3.5}$

Simplest formula = $X_8Y_6Z_7$

16. pH = pKa + log $\frac{[\text{Base}]}{[\text{Salt}]}$

[Base] = $\frac{0.01\times 500}{500} = 0.01$

Let 'a' milli moles of $(NH_4)_2SO_4$

$[NH_4^+] = \frac{a\times 2}{500}$; $\because$ [Salt] = $[NH_4^+]$

pH = 9.26 + log $\left[\frac{0.01}{2a/500}\right]$

8.26 = 9.26 + log $\left[\frac{0.01\times 500}{2a}\right]$

a = 25

$\therefore$Moles of $(NH_4)_2SO_4$ added = 0.025

17. Solution (I) → $\begin{array}{cccc} CH_3COONa & +\ HCl & \longrightarrow CH_3COOH & +\ NaCl \\ 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 \end{array}$

$$\therefore\ [CH_3COOH] = \frac{\text{No. of moles}}{\text{Volume of solution}} = \frac{1}{1} = 1$$

$$[H^+] = C\propto = C\sqrt{\frac{K_a}{C}} = \sqrt{K_a.C} = \sqrt{K_a}$$

i.e. $pH_1 = -\frac{1}{2}\log K_a = \frac{1}{2}pK_a$

Solution (II) → $\begin{array}{ccc} CH_3COONa & + & CH_3COOH \\ 1 & & 1 \end{array}$

It is buffer.

$\therefore$ $pH_2 = pK_a + \log\left[\dfrac{CH_3COONa}{CH_3COOH}\right]$

$pH_2 = pK_a + \log\dfrac{1}{1}$

$pH_2 = pK_a$

$\therefore$ $\dfrac{pH_1}{pH_2} = \dfrac{1}{2}$

18.

$$\begin{array}{llllll} & & HA + & BOH & \rightleftharpoons BA & + H_2O \\ t = 0 & & a & 12 \times 0.1 & 0 & 0 \\ t = eq & & (a - 1.2) & 0 & 1.2 & 1.2 \end{array}$$

Meq of HA = Meq of BOH at end point

A = 26.6 × 0.1 = 2.66

$\therefore$ Meq of HA left = 2.66 – 1.2

Now, $pH = pK_a + \log\dfrac{[Salt]}{[Acid]left}$

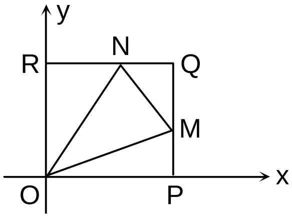
$5 = -\log K_a + \log\dfrac{1.2}{(2.66 - 1.2)}$

$K_a = 8.219\times10^{-6}$

Mathematics PART – III

SECTION – A

1. We can assume that OP and OR are x–axis and y–axis respectively.
Let OP = a, then ar(sq. OPQR) = a^2
coordinates of M and N are $\left(a, \frac{a}{2}\right)$ and $\left(\frac{a}{2}, a\right)$ respectively



$$\therefore\ \text{ar}(\Delta OMN) = \frac{1}{2}\begin{vmatrix} a & \frac{a}{2} \\ \frac{a}{2} & a \end{vmatrix} = \frac{3a^2}{8}$$

$\therefore\ \frac{8}{3} = \frac{k}{6}$

$\therefore$ k = 16

2. Equation of the two circles be $(x - r)^2 + (y - r)^2 = r^2$ i.e.
$x^2 + y^2 - 2rx - 2ry + r^2 = 0$ where r = r_1 and r_2. Condition of orthogonality gives
$2r_1r_2 + 2r_1r_2 = r_1^2 + r_2^2$
$\Rightarrow\ 4r_1r_2 = r_1^2 + r_2^2$
Circle passes through (a, b)
$\Rightarrow a^2 + b^2 - 2ra - 2rb + r^2 = 0$ i.e. $r^2 - 2r(a + b) + a^2 + b^2 = 0$
$r_1 + r_2 = 2(a + b)$ and $r_1r_2 = a^2 + b^2$
$\therefore\ 4(a^2 + b^2) = 4(a + b)^2 - 2(a^2 + b^2)$ i.e. $a^2 - 4ab + b^2 = 0$

3. f(x) is a decreasing function and for major axis to be x–axis
$f(k^2 + 2k + 5) > f(k + 11)$
$\Rightarrow k^2 + 2k + 5 < k + 11$
$\Rightarrow k \in (-3, 2)$

4. $f(x) = 2\sin^2\theta + 4\cos(x + \theta)\sin x\sin\theta + \cos(2x + 2\theta)$
$= 2\sin^2\theta + \cos(2x + 2\theta) + 2\cos(x + \theta)\cos(x - \theta) - 2\cos^2(x + \theta)$
$= 2\sin^2\theta + 2\cos^2(x + \theta) - 1 + 2\cos^2 x - 2\sin^2\theta - 2\cos^2(x + \theta)$
$= \cos 2x$
$\therefore\ f^2(x) = f^2\left(\frac{\pi}{4} - x\right) = \cos^2 2x + \sin^2 2x = 1$

5. Consider the function $f(x) = \frac{a_0x^{n+1}}{n+1} + \frac{a_1x^n}{n} + \frac{a_2x^{n-1}}{n-1} + ... + \frac{a_{n-1}x^2}{2} + a_nx$
Then f(0) = 0 and f(1) = 0
Hence f′(x) = 0 has at least one solution in (0, 1)

6. $\text{fog}(x) = \sqrt{e^x - 1}$
$\therefore\ I = \int\sqrt{e^x - 1}dx = \int\frac{2t^2}{t^2 + 1}dt$ (where $\sqrt{e^x - 1} = t$)
$= 2t - 2\tan^{-1}t + C = 2\sqrt{e^x - 1} - 2\tan^{-1}\left(\sqrt{e^x - 1}\right) + C = 2\text{fog}(x) - 2\tan^{-1}(\text{fog}(x)) + C$
$\therefore$ A + B = 2 + (–2) = 0

7. Area = $\int_1^2 \left(\ell n\, x + \tan^{-1} x\right)dx = x\ell n\, x\big|_1^2 - \int_1^2 1\, dx + x\tan^{-1} x\big|_1^2 - \int_1^2 \frac{x}{1+x^2}dx$

$= \frac{5}{2}\ell n\ 2 - \frac{1}{2}\ell n\ 5 + 2\tan^{-1} 2 - \frac{\pi}{4} - 1$

8. Let x + y = v

9. $I + f = \left(4 + \sqrt{15}\right)^n$

Let $g = \left(4 - \sqrt{15}\right)^n$, then 0 < g < 1

$I + f = {}^nC_0 4^n + {}^nC_1 4^{n-1}\sqrt{15} + {}^nC_2 4^{n-2} 15 + {}^nC_3 4^{n-3}\left(\sqrt{15}\right)^3 + ...$

$g = {}^nC_0 4^n - {}^nC_1 4^{n-1}\sqrt{15} + {}^nC_2 4^{n-2} 15 - {}^nC_3 4^{n-3}\left(\sqrt{15}\right)^3 + ...$

$\therefore\ I + f + g = 2\ \left({}^nC_0 4^n + {}^nC_2 4^{n-2} 15 + ...\right)$ = even integer

$\because$ 0 < f + g < 2

$\Rightarrow$ f + g = 1

$\Rightarrow$ 1 – f = g thus I is an odd integer 1 – f = g = $\left(4 - \sqrt{15}\right)^n$

(I + f)(1– f) = (I + f) g = 1

10. **(A)** P(E$_1$) = 1 – P(R R R) = $1 - \left[\frac{1}{3}\cdot\frac{2}{4}\cdot\frac{3}{5}\right]$

(B) P(E$_2$) = 3P(B R R) = $3\cdot\frac{2}{3}\cdot\frac{1}{4}\cdot\frac{2}{5} = \frac{1}{5}$

(C) P(E$_2$) = P(R R R/R R R $\cup$ B B B) = $\frac{P(R\ R\ R)}{P(R\ R\ R) + P(B\ B\ B)}$

But $P(B\ B\ B) = \frac{2}{3}\cdot\frac{3}{4}\cdot\frac{4}{5} = \frac{8}{20}\ \Rightarrow\ P(E_3) = \frac{0.1}{0.1 + 0.4} = \frac{1}{5}$

(D) $P(E_4) = 1 - P(B\ B\ B) = 1 - \frac{2}{5} = \frac{3}{5}$

11. |z – i Re (z)| = |z – Im (z)|

Let z = x + iy, then |x + iy – ix| = |x + iy – y|

i.e. $x^2 + (y - x)^2 = (x - y)^2 + y^2$

i.e. $x^2 = y^2$

i.e. $y = \pm x$

12. $(\lambda - 1)\left(\vec{a}_1 - \vec{a}_2\right) + \mu\left(\vec{a}_2 + \vec{a}_3\right) + \gamma\left(\vec{a}_3 + \vec{a}_4 - 2\vec{a}_2\right) + \vec{a}_3 + \delta\vec{a}_4 = \vec{o}$

i.e. $(\lambda - 1)\vec{a}_1 + (1 - \lambda + \mu - 2\gamma)\vec{a}_2 + (\mu + \gamma + 1)\vec{a}_3 + (\gamma + \delta)\vec{a}_4 = \vec{o}$

Since $\vec{a}_1,\ \vec{a}_2,\ \vec{a}_3,\ \vec{a}_4$ are linearly independent

$\therefore$ $\lambda = 1 = 0,\ 1 - \lambda + \mu - 2\gamma = 0,\ \mu + \gamma + 1 = 0,\ \gamma + \delta = 0$

i.e. $\lambda = 1,\ \mu = 2\gamma,\ \mu + \gamma + 1 = 0,\ \gamma + \delta = 0$

i.e. $\lambda = 1,\ \mu = -\frac{2}{3},\ \gamma = -\frac{1}{3},\ \delta = \frac{1}{3}$

13. $\omega_1 = \omega_2 e^{i\frac{4\pi}{3}}$

$\Rightarrow\ \omega_1^3 = \omega_2^3$

$\Rightarrow \omega_1^3\overline{\omega}_1^2\overline{\omega}_2^2 = \omega_2^3\overline{\omega}_1^2\overline{\omega}_2^2$

$\Rightarrow \omega_2\overline{\omega}_1^2 = \omega_1\overline{\omega}_2^2$

14. Since iβ is real
$\therefore$ β is purely imaginary

15. $-\frac{\alpha}{\alpha} = e^{\pm i\frac{\pi}{2}} = \pm i$

$\therefore (1+i)\left(-\frac{2\theta}{\alpha}\right) = \pm 2(-1+i)$

16. Equation of the second plane is –x + 2y – 3z + 5 = 0
2(–1) + 3, 2 + (–4)(–3) > 0
$\therefore$ origin lies in obtuse angle (2 × 1 + 3(–2) – 4 × 3 + 7)(–1 + 2(–2) – 3 × 3 + 5)
= (2 – 6 – 12 + 7)(–1 – 4 –9 + 5) > 0
$\therefore$ P lies in obtuse angle

17. 1 × 2 + 2 × 1 – 3 × 3 < 0
$\therefore$ Origin lies in acute angle
Also (2 + 2(–1) – 3(2) + 5)(2 × 2 – 1 + 3 × 2 + 1) = (–1)(10) < 0
$\therefore$ P lies in obtuse angle

18. 1 – 4 – 9 < 0
$\therefore$ Origin lies in acute angle
Further (1 + 4 – 6 + 2)(1 – 4 + 6 + 7) > 0
$\therefore$ The point P lies in acute angle

SECTION – B

1. **(A)** Since $\cos A = \frac{\sin B}{2\sin C}$, we have $\frac{b^2+c^2-a^2}{2bc} = \frac{b}{2c}$
or $b^2 + c^2 - a^2 = b^2$ or $c^2 = a^2$
Hence c = a and so the ΔABC is isosceles

(B) cos A (sin B – sin C) + (sin 2B – sin 2C) = 0
or cos A (sin B – sin C) + 2 sin (B – C) cos (B + C) = 0
or cos A (sin B – sin C) – 2 cos A sin (B – C) = 0
$\therefore$ either cos A = 0 ⇒ A = 90º
or (sin B – sin C) – 2(sin B cos C – cos B sin C) = 0

$\therefore (b-C) - 2\left[b\cdot\frac{a^2+b^2-c^2}{2ab} - c\cdot\frac{c^2+a^2-b^2}{2ca}\right]$

or $a(b - c) - 2(b^2 - c^2) = 0$
⇒ (b – c)[a – 2(b + c)] = 0
$\therefore$ b – c = 0 or b = c
$\therefore$ Isosceles

(C) Combine first and thiral and put the value of cos B

$\therefore \frac{2}{ac}\cdot(b) + \frac{1}{b}\frac{c^2+a^2-b^2}{2ca} = \frac{a^2+b^2}{abc}$

or $4b^2 + c^2 + a^2 - b^2 = 2a^2 + 2b^2$
$\therefore b^2 + c^2 + a^2$
$\therefore$ ∠A = 90º

(D) $\frac{\sin(A-B)}{\sin(A+B)} = \frac{k^2(\sin^2 A - \sin^2 B)}{k^2(\sin^2 A + \sin^2 B)}$ by sine formula

or $\frac{\sin(A-B)}{\sin C} = \frac{\sin(A-B)\sin(A+B)}{\sin^2 A + \sin^2 B}$

or $\sin(A-B)\left[\frac{1}{\sin C} - \frac{\sin C}{\sin^2 A + \sin^2 B}\right] = 0$

$\therefore$ Either sin (A – B) = 0

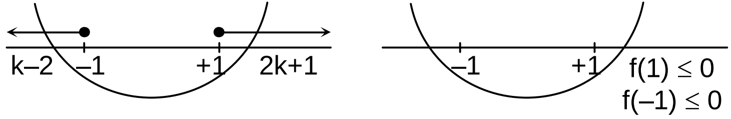
$\therefore$ A = B i.e. Δ is isosceles

or $\sin^2 A + \sin^2 B = \sin^2 C$ or $a^2 + b^2 = c^2$

$\therefore$ Δ is right angled

2. **(A)** $x^2 - (3k-1)x + 2k^2 - 3k - 2 \ge 0$

$\Rightarrow [x - (k-2)][x - (2k+1)] \ge 0$



f(1) ≤ 0

f(–1) ≤ 0

Hence 2k + 1 ≥ 1 and k – 2 ≤ –1

i.e. k ≥ 0 and k ≤ 1

$\therefore$ k $\in$ [0, 1]

$\therefore$ ℓ + m = 1

(B) $1 + a \ge 2\sqrt{a}$ (AM ≥ GM)

$1 + b \ge 2\sqrt{b}$

$1 + c \ge 2\sqrt{c}$

$1 + d \ge 2\sqrt{d}$

$\therefore$ $(1+a)(1+b)(1+c)(1+d) \ge 16\sqrt{abcd} = 16$

$\therefore$ Minimum value = 16

(C) $5^{x+2} > 5^{-\frac{2}{x}}$

$\Rightarrow x + 2 > -\frac{2}{x}$

$\Rightarrow \frac{x^2+2x+2}{x} > 0$

$\Rightarrow \frac{(x+1)^2+1}{x} > 0$

$\Rightarrow x \in (0, \infty)$

(D) $f(x) = x^3 + 3x + 1$ and g(x) is inverse of f(x)

f(1) = 5

$\therefore$ g(5) = 1

$\therefore g'(f(x)) = \frac{1}{f'(x)} = \frac{1}{(3x^2+3)}$

$\therefore g'(f(1)) = \frac{1}{3+3}$

$\Rightarrow g'(5) = \frac{1}{6}$

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

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JEE (Advanced), 2014

FULL TEST – IV

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 240**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 04)** contains 4 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.
   Section – A (05 – 09) contains 5 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 mark** will be awarded. There may be one or more than one correct choice. No marks will be given for any wrong match in any question. There is no negative marking.

3. **Section – C (01 – 08)** contains 8 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

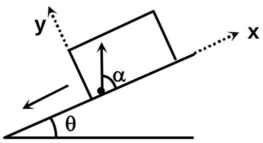
PART – I

SECTION – A

Single Correct Choice Type

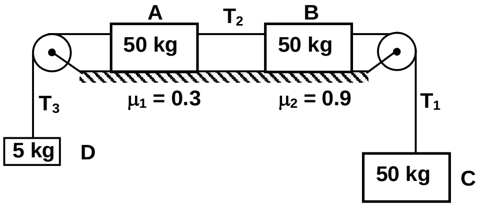
This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. A large empty container is sliding without friction down a smooth inclined plane of inclination θ. From a point on the bottom of container a particle is projected with speed u with respect to box at an angle α with the bottom of container. The velocity $\vec{v}$ of the particle relative to the box after time t is



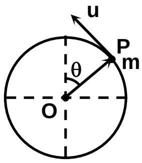
(A) $u\cos\alpha\ \hat{i} + (u\sin\alpha - gt)\hat{j}$
(B) $(u\cos\alpha - gt\sin\theta)\hat{i} + (u\sin\alpha - gt\cos\theta)\hat{j}$
(C) $u\cos\alpha\ \hat{i} + (u\sin\alpha - gt\cos\theta)\hat{j}$
(D) $u\cos\alpha\,\hat{i} + u\sin\alpha\,\hat{j}$

2. A block pulley arrangement is shown in the figure. If f_1 and f_2 represents frictional force acting on the block A and B respectively then choose the correct statement. (given g = 10 m/s^2)



(A) $T_1 = 100$ N, $T_2 = 10$ N
(B) $f_1 = 10$ N , $f_2 = 450$ N
(C) $T_2 = 50$ N, $T_3 = 50$ N
(D) $f_1 = 50$ N, $T_2 = 50$ N

3. A simple pendulum of bob of mass m and length ℓ has one of its ends fixed at the centre O of a vertical circle, as shown in the figure. If $\theta = 60°$ at the point P, the minimum speed u that should be given to the bob so that it completes vertical circle is



(A) $\sqrt{g\ell}$
(B) $\sqrt{2g\ell}$
(C) $\sqrt{\frac{5g\ell}{2}}$
(D) $\sqrt{\frac{3g\ell}{2}}$

Space for Rough work

4. A rod of mass m and length ℓ is lying along the y-axis such that one of its ends is at the origin. Suddenly an impulse is given to the rod such that immediately after the impulse, the end on the origin has a velocity $v_0\hat{i}$ and the other end has a velocity $2v_0\hat{i}$. The magnitude of angular momentum of the rod about the origin at this instant is

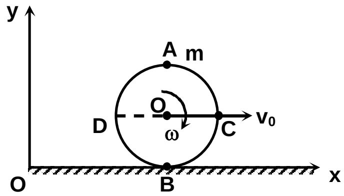
(A) $\frac{2}{3}mv_0\ell$ (B) $\frac{3}{2}mv_0\ell$

(C) $\frac{5}{6}mv_0\ell$ (D) $\frac{7}{8}mv_0\ell$

Multiple Correct Answer(s) Type

This section contains **5 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

5. A particle of mass 'm' is attached to the rim of a uniform disc of mass 'm' and radius R. The disc is rolling without slipping on a stationary horizontal surface, as shown in the figure. At a particular instant, the particle is at the top most position and centre of the disc has speed v_0 and its angular speed is ω. Choose the correct regarding the motion of the system (disc + particle) at that instant.



(A) $v_0 = \omega R$ (B) kinetic energy of the system is $\frac{11}{4}mv_0^2$

(C) speed of point mass m is less than $2v_0$ (D) $|\vec{v}_C - \vec{v}_B| = |\vec{v}_B - \vec{v}_D|$

6. Consider one dimensional collision between two identical particles A and B. B is stationary and A has momentum P before impact. During impact, B gives impulse $\vec{J}$ to A. Choose the correct alternative(s)

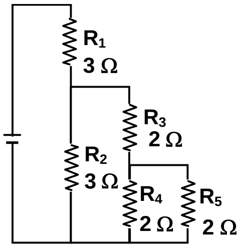
(A) the total momentum of the (A + B) system is P before and after the impact and (P – J) during the impact.

(B) During the impact, A give impulse $-\vec{J}$ to B.

(C) The coefficient of restitution is $\frac{2J}{P}-1$

(D) The coefficient of restitution is $\frac{J}{P}-1$

Space for Rough work



7. In the figure shown
(A) currents in R_4 and R_5 are equal
(B) current in R_2 and R_3 are equal
(C) current in R_1 is equal to the sum of currents in R_3, R_4 and R_5
(D) current in R_1 is equal to the sum of currents in R_2, R_4 and R_5

8. Energy liberated in the de–excitation of hydrogen atom from 3rd level to 1st level falls on a photo–cathode. Later when the same photo–cathode is exposed to a spectrum of some unknown hydrogen like gas, excited to 2nd energy level, it is found that the de–Broglie wavelength of the fastest photoelectrons, now ejected has decreased by a factor of 3. For this new gas, difference of energies of 2nd Lyman line and 1st Balmer line is found to be 3 times the ionization potential of the hydrogen atom. Select the correct statement(s) :
(A) The gas is lithium.
(B) The gas is helium.
(C) The work function of photo–cathode is 8.5 eV.
(D) The work function of photo–cathode is 5.5 eV.

9. The SI unit of inductance, ‘henry’ is the same as
(A) weber/ampere
(B) volt-second/ampere
(C) joule/(ampere)^2
(D) ohm-second

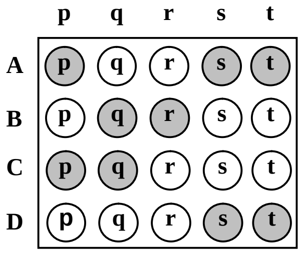
Space for Rough work

SECTION - B

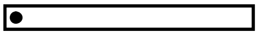
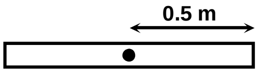
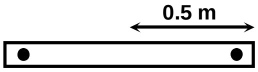
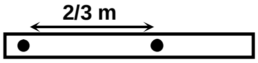
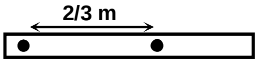
Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

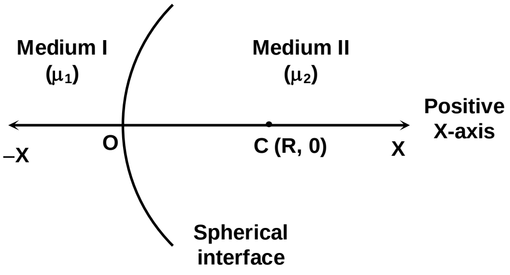


1. Longitudinal waves are produced in five identical rods in different situations. Their mode of vibration and fixed points (with bold point) are shown in the column II, and their frequencies are given in the column I, match the frequency in the column I with the appropriate situation in the column II. Each of the rods has length 1 m young's modulus of elasticity, 2×10^{12} N/m^2 and density 5×10^3 kg/m^3.

	Column-I		Column-II
(A)	10 KHz	(p)	 Second overtone
(B)	15 KHz	(q)	 Fundamental mode
(C)	25 KHz	(r)	 First harmonic
(D)	45 KHz	(s)	 Fundamental mode
		(t)	 Third harmonic

Space for Rough work

2. A spherical interface whose radius is R separates the two media, I and II as shown in the figure. The refractive index of medium I is μ_1 and that of medium II is μ_2. Now match the column I with column II [Consider the pole 'O' as the origin and principal axis as the x-axis]



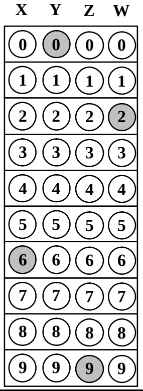
	Column I		Column II
(A)	Object is kept at point (–a, 0) and $\mu_1 < \mu_2$	(p)	Image may be real
(B)	Object is kept at point (–a, 0) and $\mu_1 > \mu_2$	(q)	Image may be virtual
(C)	Object is kept at point (+a, 0) and $\mu_1 < \mu_2$	(r)	The position of image may be in between the position of object and origin.
(D)	Object is kept at point (+a, 0) and $\mu_1 > \mu_2$	(s)	The position of image may be in between the position of object and centre of curvature of interface.

Space for Rough work

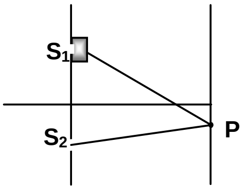
SECTION – C

Integer Answer Type

This section contains 8 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.

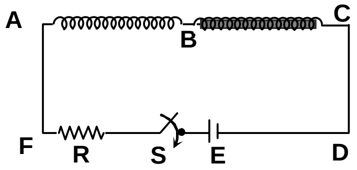


1. In a young's double slit experiment one of the slits is covered by a thin film of thickness t = 0.04 mm, and refractive index $\mu = 1.2 + \frac{9\times10^{-14}\text{m}^2}{\lambda^2}$, where, λ is the wave length in meter. A beam of light consisting two wavelengths λ_1 = 400 nm and λ_2 = 600 nm falls normally on the plane of the slits. Find the distance between two central maxima in milimeter. Distance of screen from slits is 400 times the separation between the slits.

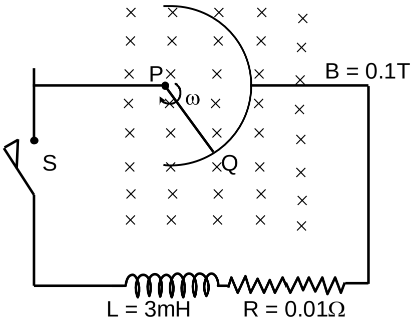


2. Two particles A and B are located at points (0, $-10\sqrt{3}$) and (0, 0) in xy plane. They start moving simultaneously at time t = 0 with constant velocities $\vec{v}_A = 5\hat{i}$ m/s and $\vec{v}_B = -5\sqrt{3}\hat{j}$ m/s, respectively. Time when they are closest to each other is found to be K/2 second. Find K. All distances are given in meter.

3. Two ideal solenoids of same dimensions. One is air cored with 600 turns while other is Aluminium cored with 200 turns (relative permeability of Aluminium is 3), are connected in a circuit as shown in the figure. The switch S is closed at t = 0. Find the ratio of potential difference across air-cored solenoid to that of Aluminium cored solenoid at any time t.



4. The circuit shows a resistance R = 0.01Ω and inductance L = 3mH connected to a conducting rod PQ of length ℓ = 2m which can slide on a perfectly conducting circular arc of radius ℓ with its centre at P. Assume that friction & gravity are absent and a constant uniform magnetic field B = 0.1T exists as shown in the figure. At t = 0, the circuit is switched on and simultaneously an external torque is applied on the rod so that it rotates about P with a constant angular velocity



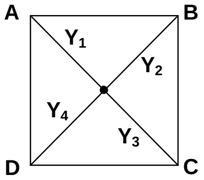
ω = 2 rad/sec. Find the magnitude of this torque (in N-m) at t = (0.3 ln2) second.

Space for Rough work

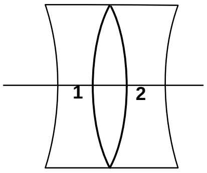
5. Two sound waves of frequencies 100 Hz and 102 Hz and having same amplitude 'A' are interfering. A stationary detector, which can detect waves of amplitude greater than or equal to A, So, in a given time interval of 12 seconds, find the total duration in which detector is active.

6. Two identical metallic sheets each behaves like a black body are kept parallel to each other with small separation between them in vacuum. Thermal energy is generated at a constant rate P in one of the sheets by a passing electricity in it. In steady state, temperature of the other sheet is found to be constant is 300K. Find the value of P in Kilo-Watt.
(Given area of the plates A = $\frac{10^3}{17\times 27}$ m^2 and $\sigma = \frac{17}{3}\times 10^{-8}$ w/m^{2}K^4)

7. In the adjacent figure, ABCD are four points in a smooth horizontal plane representing the four corners of a square of diagonal 20 cm. A very small object of mass 14 gm placed at the centre of the square connected to points A, B, C and D by four elastic strings of same dimensions but of different moduli of elasticity as shown in the figure. Natural length and cross-sectional area of each string are 10 cm and $\pi^2 \times 10^{-6}$ m^2 respectively. The mass is slightly displaced from equilibrium and then released to perform SHM along the diagonal AC. ($Y_1 = 9Y$, $Y_2 = 4Y$, $Y_3 = 16Y$ and $Y_4 = 4Y$, where $Y = 4.9 \times 10^9$ N/m^2). The time period of oscillation of object is k millisecond. The value of K is



8. Two identical equi-concave lenses made of glass of reflected index 1.5, placed in contact has power P. When a liquid of refractive index μ is filled in the gap between the concave lenses, the power becomes of initial value(P/3). The value of μ is $\frac{K}{3}$. Find the value of K.



Space for Rough work

Chemistry

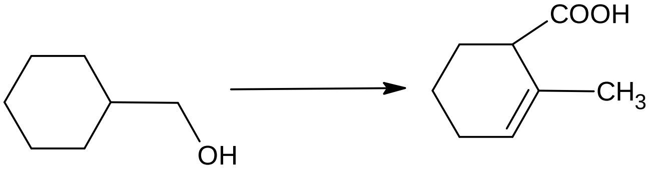
PART – II

SECTION – A

Straight Objective Type

This section contains **4 multiple** choice questions numbered **1 to 4.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. The correct order of reagents required to bring the following change is:



(A) H_3O^+ ; KCN ; NBS ; $K_2Cr_2O_7/H^+$ (B) $K_2Cr_2O_7/H^+$; Cl_2/KOH; CH_3MgBr ; H_3O^+

(C) conc. H_2SO_4 ; NBS ; KCN ; H_3O^+ (D) Conc. H_2SO_4 ; NBS ; CH_3MgBr ; $K_2Cr_2O_7/H^+$

2. 1 mole of a gas AB_3 present in 10 lt container at pressure 2.5 atm and 273 K temperature. On increasing the temperature to 546 K, AB_3 dissociates into $AB_2(g)$ and $B_2(g)$. If the degree of dissociation of AB_3 is 80%, then final pressure at 546 K is :

(A) 5 atm (B) 1.25 atm

(C) 10 atm (D) 6.25 atm

3. 1 mole of each of CaC_2, Al_4C_3, Mg_2C_3 reacts with excess water in separate open flasks work done during dissolution shows the order :

(A) $CaC_2 = Mg_2C_3 < Al_4C_3$ (B) $CaC_2 = Mg_2C_3 = Al_4C_3$

(C) $Mg_2C_3 < CaC_2 < Al_4C_3$ (D) $Mg_2C_3 < Al_4C_3 < CaC_2$

4. In which of the following pairs the two species are not isostructural?

(A) PCl_4^+ and $SiCl_4$ (B) PF_5 and BrF_5

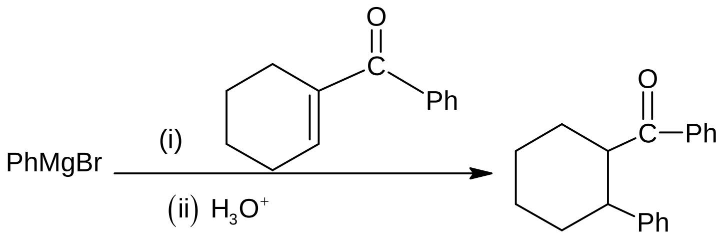
(C) AlF_6^{3-} and SF_6 (D) CO_3^{2-} and NO_3^-

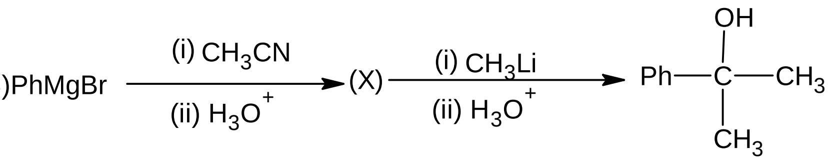
Rough Work

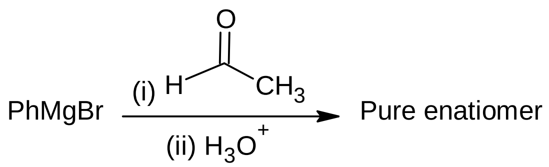
Multiple Correct Choice Type

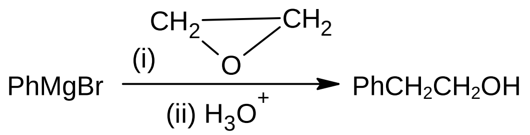
This section contains **5 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

5. Which of the following reactions are correctly matched with products (major)?

(A)

PhMgBr
(i)
O
C
Ph
(ii) H_3O^+
O
C—Ph
Ph

(B)

PhMgBr
(i) CH_3CN
(ii) H_3O^+
(X)
(i) CH_3Li
(ii) H_3O^+
OH
Ph—C—CH_3
CH_3

(C)

PhMgBr
O
(i) H
CH_3
(ii) H_3O^+
Pure enatiomer

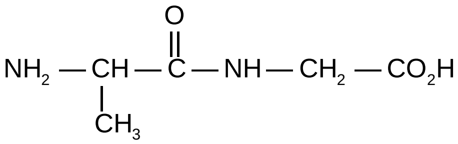
(D)

PhMgBr
CH_2
CH_2
(i)
O
(ii) H_3O^+
$PhCH_2CH_2OH$

6. For $I_2 + 2e^- \rightarrow 2I^-$, standard reduction potential = +0.54 volt.
For, $2Br^- \rightarrow Br_2 + 2e^-$, standard oxidation potential = – 1.09 volt
For, $Fe \rightarrow Fe^{2+} + 2e^-$, standard oxidation potential = +0.44 volt
Which of the following actions are spontaneous:
(A) $Br_2 + 2I^- \rightarrow 2Br^- + I_2$
(B) $Fe + Br_2 \rightarrow Fe^{2+} + 2Br^-$
(C) $Fe + I_2 \rightarrow Fe^{2+} + 2I^-$
(D) $I_2 + 2Br^- \rightarrow 2I^- + Br_2$

7. Which of the following will respond to positive chromyl chloride test?
(A) $CuCl_2$
(B) $ZnCl_2$
(C) $HgCl_2$
(D) AgCl

Rough Work

8.



$NH_2-CH(CH_3)-C(=O)-NH-CH_2-CO_2H$

Identify the amino acids obtained by hydrolysis of the above compound :

(A) Glycine

(B) Phenylalonine

(C) Alanine

(D) Glutamic acid

9. Which of the following reaction produces N_2 ?

(A) $NH_4ClO_4 \xrightarrow[\Delta]{}$

(B) $KIO_3 + N_2H_4 \xrightarrow{H^+}$

(C) $HN_3 + HNO_2 \rightarrow$

(D) $NH_2OH + CuO \rightarrow$

Rough Work

SECTION-B
(Matrix Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the Column – I with Column – II:

Column – I(Ionic solid)		**Column – II(their Properties)**	
(A)	ZnS	(p)	Limiting $\frac{r_+}{r_-} = 0.414$
(B)	NaCl	(q)	Frenkel Defect
(C)	CsCl	(r)	Crystallographic C.N = 4
(D)	CaF_2	(s)	Insoluble in water
		(t)	8 nearest neighbours of the cation

2. Match the Column – I with Column – II:

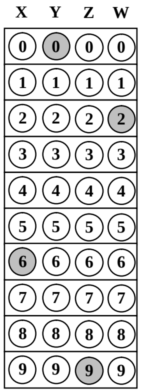
Column – I(compounds)		**Column – II(characteristics)**	
(A)	AsF_3	(p)	sp^2
(B)	$S_2O_3^{2-}$	(q)	sp^3
(C)	BF_3	(r)	Back bonding
(D)	$H_2C = SF_4$	(s)	sp^3d
		(t)	Coordinate bond

Rough Work

SECTION – C

Integer Answer Type

This section contains 8 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. The total number of cyclic, structural isomers for a compound with molecular formula C_5H_{10} is______.

2. The equivalent weight of $Zn(OH)_2$ in the following reaction is equal to its M/x :

   $Zn(OH)_2 + HNO_3 \rightarrow Zn(OH)(NO_3) + H_2O$

   X is equal to ___________.

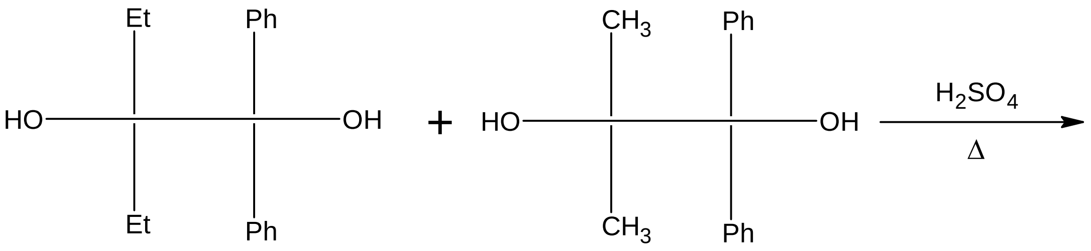
3. The number of ions formed when cuprammonium sulphate is dissolved in water is _______.

4. How many visible lines are emitted during transition from 5th orbit to ground state in hydrogen emission spectrum?

5. The half life of two samples of a substance is 50 sec and 200 sec at 0.4 M and 0.1M concentrations, respectively the order of reaction is __________.

Rough Work

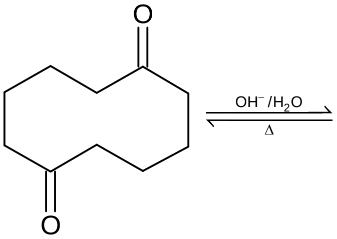
6.


Et
Ph
HO
OH
Et
Ph
+
CH3
Ph
HO
OH
CH3
Ph
H2SO4
Δ

How many products are obtained in the above reaction.

7. The total number of pi-bonds in pyrene responsible for its aromatic behaviour are:

8.



Double bond equivalent of final product is ....

Rough Work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **4 multiple choice questions** numbered 1 to 4. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. If a_1, a_2, a_3 ….. are in A.P. and $b_k = a_k + a_{k+1} + ….. + a_{k+n-1}$ (k = 1, 2, 3 …..), then $b_1 + b_2 + ….. + b_n$ is equal to

(A) $n(n + 1)a_n$
(B) $(n - 1)na_n$
(C) n^2a_n
(D) $(n + 1)^2a_n$

2. If for $|z - 1| = 1$, $z - 2 = kz \tan(\arg z)$, then k is equal to

(A) – 1
(B) i
(C) 1
(D) 2

3. Tangents PA and PB are drawn to the circle $x^2 + y^2 = 4$ from an external point P lying on the line y = x such that the angle θ between the tangents satisfies $\frac{\pi}{3} \le \theta \le \frac{2\pi}{3}$. The co-ordinates of the point P, if the perimeter of ΔPAB is maximum for all θ are

(A) $\left(2\sqrt{2},\ 2\sqrt{2}\right)$
(B) $\left(\frac{2\sqrt{2}}{\sqrt{3}},\ \frac{2\sqrt{2}}{\sqrt{3}}\right)$
(C) (2, 2)
(D) none of these

4. The reflection of the complex number $\frac{2+i}{3-i}$ in the straight line $z(1 + i) = \bar{z}(1 - i)$ is

(A) $\frac{2+i}{3+i}$
(B) $\frac{-2+i}{-3+i}$
(C) $\frac{2-i}{3-i}$
(D) $\frac{2+i}{-3+i}$

Space for rough work

Multiple Correct Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

5. Two players A and B toss a coin which has a probability p of showing head ($0 < p < 1$), in the cyclic order A, A, B, A, A, B, ….. till a head appears. Let x denotes the probability that A gets the head first and y that of B, then
(A) $x + y = 1$
(B) $x > y$ for all p
(C) $x > \frac{1}{2}$ for all p
(D) $y > \frac{1}{2}$ for all p

6. Let a, b, c be the sides of a triangle whose perimeter is P and area is A, then
(A) $P^3 \le 27(b + c - a)(c + a - b)(a + b - c)$
(B) $P^2 \le 3(a^2 + b^2 + c^2)$
(C) $a^2 + b^2 + c^2 \ge 4\sqrt{3}\ A$
(D) $P^4 < 256A^2$

7. A plane meets the co-ordinates axes in A, B, C such that the centroid of the triangle ABC is the point $(1, r, r^2)$. If all such planes must pass through the point (t, t, t) for all $r \in R - \{0\}$, then t can satisfy
(A) $0 \le t \le 4$
(B) $1 < t \le 4$
(C) $2 < t < 3$
(D) $0 < t \le 4, t \ne 3$

8. The value(s) of θ satisfying the equation $[\sin(\cot^{-1} \cos \tan^{-1} x)] = \sin \theta$, (where $x \in R$ and [.] denotes the greatest integer function) is/are
(A) 0
(B) $\frac{\pi}{2}$
(C) π
(D) $\frac{3\pi}{2}$

9. Let $f(x) = (ax + b)\cos x + (cx + d)\sin x$ and $f'(x) = x \cos x$ for all $x \in R$, then
(A) $a = -1$
(B) $b = 1$
(C) $c = 1$
(D) $d = -1$

Space for rough work

SECTION-B
(Matrix Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

---

1. Match the following Column–I with Column–II

	Column – I		Column – II
(A)	Two sides of a triangle are given by the roots of the equation $x^2 - 5x + 3 = 0$. If the angle between these sides is $\frac{\pi}{3}$, then the product of inradius and circumradius of the triangle is	(p)	12
(B)	In a triangle ABC, if the radii of ex-circles r_1, r_2 and r_3 are given by $r_1 = 8$, $r_2 = 12$ and $r_3 = 24$, then value of the side a is	(q)	15
(C)	Let a be a positive integer not exceeding 10, then the probability that the equation $x^2 - 2(a^2 - 1)x + 2a^2 - 7a + 3 = 0$ has one positive and one negative roots is	(r)	$\frac{3}{7}$
(D)	Let (α, β) be a point from which two perpendicular tangents can be drawn to the ellipse $4x^2 + 5y^2 = 20$. If $F = 4\alpha + 3\beta$, then the maximum value of F	(s)	$\frac{1}{5}$
		(t)	$\frac{2}{3}$

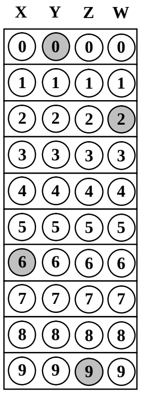
2. Match the following Column–I with Column–II

	Column – I		Column – II
(A)	The coefficient of two consecutive terms in the expansion of $(1 + x)^n$ will be equal, then n can be	(p)	9
(B)	If $15^n + 23^n$ is divided by 19, then n can be	(q)	10
(C)	$^{10}C_0\,^{20}C_{10} - ^{10}C_1\,^{18}C_{10} + ^{10}C_2\,^{16}C_{10} - \ldots$.. is divisible by 2^n, then n can be	(r)	11
(D)	If the coefficients of T_r, T_{r+1}, T_{r+2} terms of $(1 + x)^{14}$ are in A.P., then r is less than	(s)	12
		(t)	14

Space for rough work

SECTION – C

Integer Answer Type



This section contains **8 questions.** The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.

---

1. If the function $f(x) = 2x^3 – 9ax^2 + 12a^2x + 1$ has a local maximum at $x = x_1$ and a local minimum at $x = x_2$ such that $x_2 = x_1^2$, then a is equal to _____

2. If positive numbers x, y, z are in A.P., then the minimum value of $\frac{x+y}{2y-x}+\frac{y+z}{2y-z}$ is equal to _____

3. The number of odd proper divisors of 24300 is N + 11, then N is equal to _____

4. The number of solutions of the simultaneous complex equations $|z – 3 – i| = 2$ and $|z – 2 + i| + |z – 4 – 3i| = 6$ is _____

5. The number of normal(s) to hyperbola which can touch its conjugate is equal to _____

6. Let z be a complex number satisfying $|z – 3| \le |z – 1|$, $|z – 3| \le |z – 5|$, $|z – i| \le |z + i|$ and $|z – i| \le |z – 5i|$. The area of the region in which z can lie is equal to _____

7. For $y = \cot^{-1}\left(\frac{\log ex^2}{\log e/x^2}\right)+\tan^{-1}\left(\frac{3+2\ln x}{1-6\ln x}\right)$, the value of $\frac{d^2y}{dx^2}$ at x = 1, is equal to _____

8. For real valued function f(x), $f(x) + f(x + 4) = f(x + 2) + f(x + 6)$, $g(x) = \int_x^{x+8} f(x)\,dx$. Then $g'(x)$ is equal to _____

Space for rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

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ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS
FULL TEST –IV
(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	C	C
2.	C	D	B
3.	B	A	A
4.	C	B	D
5.	A, B, D	A, B, D	A, B, C
6.	B, C	A, B, C	B, C
7.	A, B, C, D	A, B	B, C
8.	B, C	A, C	A, C
9.	A, B, C, D	A, B, C	B, C
1.	(A)→ (q, r) (B)→ (s) (C)→ (p) (D)→ (t)	A → (q, r) B → (p) C → (t) D → (r, s)	(A) → (t), (B) → (p), (C) → (s), (D) → (q)
2.	(A) → (p, q) (B) → (q, r, s) (C) → (p, q, r) (D) → (q, r, s)	A → (q, r) B → (q, t) C → (p, r) D → (p, s)	(A) → (p, r), (B) → (p, r), (C) → (q), (D) → (q, r, s, t)
1.	5	5	2
2.	3	1	4
3.	3	2	6
4.	4	3	2
5.	8	2	4
6.	3	2	6
7.	1	7	0
8.	5	4	0

Physics

PART – I

2. $f_{max} = f_{1_{max}} + f_{2_{max}} = 150 + 450 = 600\text{N}$

Hence A and B have no acceleration but block C has a tendency to move down. Hence $T_1 = 500$ N, $f_2 = 450$ N, $T_2 = 50$ N, $T_3 = 50$ N, $f_1 = 0$ N

4. $\omega = \dfrac{v_0}{\ell}$ and $v_{cm} = \dfrac{3}{2}v_0$

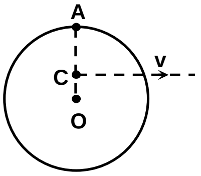
$$\Rightarrow \;L = M\left(\frac{\ell}{2}\right)\times\frac{3}{2}v_0 + \frac{M\ell^2}{12}\times\frac{v_0}{\ell}$$

$$= mv_0\ell\left[\frac{3}{4}+\frac{1}{12}\right] = \frac{5}{6}mv_0\ell$$

5. $K = K_D + K_P$

$$= \frac{1}{2}mv_0^2\left(1+\frac{1}{2}\right)+\frac{1}{2}m(2V_0)^2$$

$$= \frac{11}{4}mV_0^2$$



7. Use rules of combination of resistances and distribution of currents

8. $$E_0z^2\left(1-\frac{1}{9}\right)-E_0z^2\left(\frac{1}{4}-\frac{1}{9}\right) = 3E_0$$

$z = 2$

$\lambda_1/\lambda_2 = 3$

$$KE_1 = E_0\left(1-\frac{1}{9}\right)-\phi$$

$$KE_2 = E_0z^2\left(1-\frac{1}{4}\right)-\phi$$

$$KE \propto \frac{1}{\lambda^2} = 8.5\text{ eV.}$$

SECTION - B

1. Velocity of longitudinal wave = $\sqrt{\dfrac{2\times10^{12}}{5\times10^3}} = 20000$ m/s

In situation (p) $\dfrac{5\lambda}{4} = 1\text{m}$ ∴ $\lambda = \dfrac{4}{5}\text{m}$ ∴ $f = 25\text{ k}H_2$

In situation (q) $\dfrac{\lambda}{2} = 1\text{m}$ ∴ $\lambda = 2\text{m}$ ∴ $f = 10\text{ k}H_2$

In situation (r) $\dfrac{\lambda}{2} = 1\text{m}$ ∴ $\lambda = 2\text{m}$ ∴ $f = 10\text{ k}H_2$

In situation (s) $\dfrac{\lambda}{4} = \dfrac{1}{3}\text{m}$ ∴ $\lambda = \dfrac{4}{3}\text{m}$ ∴ $f = 15\text{ k}H_2$

In situation (t) $\dfrac{\lambda}{4} = \dfrac{1}{3}\text{m}$ ∴ $\lambda = \dfrac{4}{9}\text{m}$ ∴ $f = 45\text{ k}H_2$

SECTION –C

1. $\Delta x = (S_1P - t) + \mu_1 t - S_2P$

$0 = (S_1P - S_2P) + (\mu_1 - 1)t$

$\Rightarrow d \sin\theta = (\mu_1 - 1)t$

$$\frac{y_1 d}{D} = (\mu_1 - 1)t$$

$$\frac{y_2 d}{D} = (\mu_1 - 1)t$$

$$y_1 - y_2 = \frac{(\mu_1 - \mu_2)tD}{d}$$

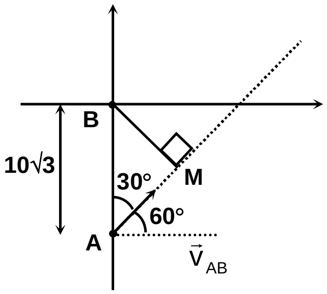
$= 5\text{mm}$

2. As observed by B motion of A is along AM and BM is the shortest distance between them. Relative displacement of A w.r.t to B is AM = AB cos 30°

$\vec{V}_{AB} = 5\hat{i} + 5\sqrt{3}\hat{j}$

Time taken (t) = $\dfrac{|\vec{S}_{AB}|}{|\vec{v}_{AB}|} = \dfrac{AM}{v_{AB}} = \dfrac{10\sqrt{3}\cos 30°}{10}$

$= 1.5$ sec



3. $L_1 = \dfrac{\mu_0 N_1^2 A}{\ell}$, $L_2 = \dfrac{\mu_0 N_2^2 A \mu_r}{\ell}$

Since $V = -L\dfrac{dI}{dt}$, So

$$\frac{V_1}{V_2} = \frac{L_1}{L_2} = \left(\frac{N_1}{N_2}\right)^2 \frac{1}{\mu_r} = \left(\frac{600}{200}\right)^2 \times \frac{1}{3} = 3$$

4. The half of the maximum current is equal to

$i_1 = \dfrac{B\omega\ell^2}{4R}$ at $t = \dfrac{L}{R}\ln 2$

The torque at this instant = $\dfrac{B^2\omega\ell^4}{8R} = 4$ N-m

5. $y_1 = A \sin\omega_1 t$

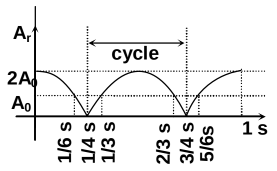
$y_2 = A \sin\omega_2 t$

$$y_r = 2A\cos\left\{\frac{(\omega_2 - \omega_1)}{2}t\right\}\left\{\sin\frac{(\omega_2 + \omega_1)}{2}t\right\}$$

Resultant amplitude $A_r = 2A_0|\cos(\Delta\omega)t/2|$

$$(\Delta\omega)\frac{t}{2} = \frac{\pi}{2} \Rightarrow t = \frac{1}{4}\text{s}$$

$$(\Delta\omega)\frac{t}{2} = \frac{\pi}{3} \Rightarrow t = \frac{1}{6}\text{s}$$



In one cycle of intensity of 1/2s, the detector remain idle for

$$2\left(\frac{1}{4}-\frac{1}{6}\right)s=\frac{1}{6}\text{sec}$$

$\therefore$ In ½ sec cycle, active time is $\left(\frac{1}{2}-\frac{1}{6}\right)$ = 1/3 sec

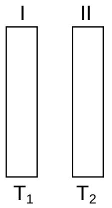
$\therefore$ In 12 sec interval, active time is $12\times\frac{(1/3)}{(1/2)}$ = 8 sec

6. P = $2\sigma AT_1^4-\sigma AT_2^4$ (steady state condition of sheet I) …(i)

and $2\sigma AT_2^4=\sigma AT_1^4$ (steady state condition of sheet II) …(ii)

$\Rightarrow$ P = $3\sigma AT_2^4$

= 3 kW



7. T = $\pi\left[\sqrt{\frac{m\ell}{9YA}}+\sqrt{\frac{m\ell}{16YA}}\right]$

$=\pi\left[\sqrt{\frac{m\ell}{YA}}\right]\left[\frac{1}{3}+\frac{1}{4}\right]$

$=\frac{7\pi}{12}\sqrt{\frac{m\ell}{YA}}$

m = 144 × 10^{-3} kg

ℓ = AO = BO = CO = DO = 10 × 10^{-2} m

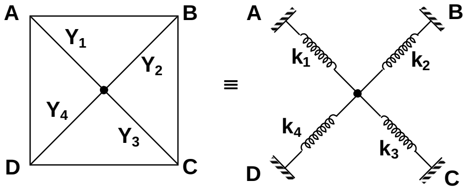
A = $\pi^2\times10^{-6}$ m^2

Y = 4.9 × 10^9

T = $\frac{7\pi}{12}\sqrt{\frac{144\times10^{-3}\times10\times10^{-2}}{\pi^2\times10^{-6}\times49\times10^8}}$ = $\frac{7\pi}{12}\times\frac{12}{\pi}\times\frac{1}{7}\sqrt{\frac{10^{-2}}{10^8}}$

= 1 × 10^{-3}

= 1 ms

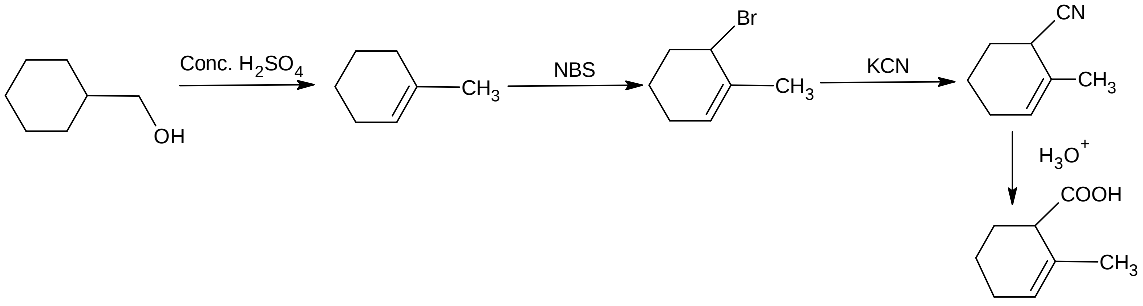


Chemistry

PART – II

SECTION – A

1.



2.

	$2AB_3(g)$	$\rightleftharpoons$	$2AB_2(g)$	+	B_2
t = 0	0.1 mol/lt		0		0
t = eq	0.1 – 0.08		0.08		0.04

Total no. of moles per litre (n/v) = 0.14

$$P = \frac{n}{V} \times R \times T = 0.14 \times 0.082 \times 546 = 6.25 \text{ atm}$$

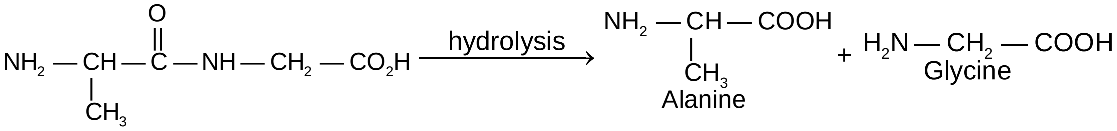
3. In Al_4C_3, three moles of CH_4 are formed.

4. PF_5 has sp^3d hybridization (trigonal bipyramid)
BrF_5 has sp^3d^2 hybridization (square pyramidal).

5. In case of (C) racemic mixture is obtained.

7. Fact → Chromyl chloride test is not given by chlorides of Hg, Sn, Ag, Pb and Sb.

8.



$$NH_2-\underset{\underset{CH_3}{|}}{CH}-\overset{\overset{O}{||}}{C}-NH-CH_2-CO_2H \xrightarrow{\text{hydrolysis}} \underset{\text{Alanine}}{NH_2-\underset{\underset{CH_3}{|}}{CH}-COOH} + \underset{\text{Glycine}}{H_2N-CH_2-COOH}$$

9.

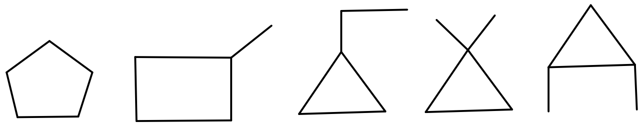
$$2NH_4ClO_4 \longrightarrow N_2 + Cl_2 + 2O_2 + 4H_2O$$

$$IO_3^- + N_2H_4 + 2H^+ \longrightarrow I^+ + N_2 + 3H_2O$$

$$HN_3 + HNO_2 \longrightarrow N_2 + N_2O + H_2O$$

$$2NH_2OH + 4CuO \longrightarrow N_2O + 2Cu_2O + 3H_2O$$

SECTION – C

1. 

2. $\text{E.W.} = \dfrac{\text{M.W}}{\text{acidity}}$

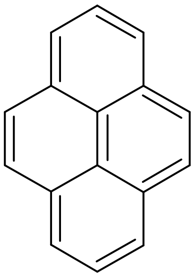
Zn(OH)$_2$ can replace only one OH.

3. $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4 \rightleftharpoons [\text{Cu}(\text{NH}_3)_4]^{2+} + \text{SO}_4^{2-}$

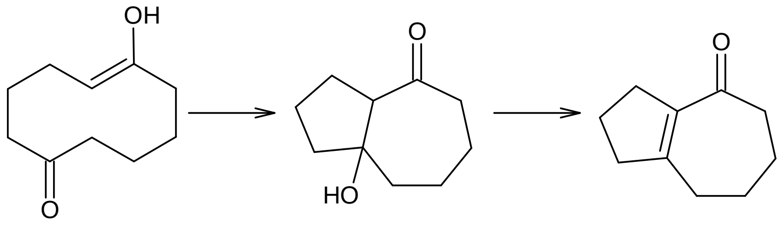
4. $\dfrac{(n_2 - n_1)(n_2 - n_1 + 1)}{2}$

5. $\text{rate} \propto \dfrac{1}{[A]}$

6. Pinacol-pinacolone reaction

7.  The central pi-bond is not in conjugation.

8.



Mathematics PART – III

SECTION – A

1. We have $b_k = \frac{n}{2}\left(a_K + a_{n+k-1}\right) = \frac{n}{2}\left[a_1 + (k-1)d + a_1 + (n+k-2)d\right]$

$= \frac{n}{2}\left[a_n + a_1 + 2(k-1)d\right]$ (d is the common difference)

$$\Rightarrow \sum_{k=1}^{n} b_k = \frac{n}{2}\left[na_n + na_1 + 2d\sum_{k=1}^{n}(k-1)\right] = \frac{n}{2}\left[na_n + na_1 + d(n-1)n\right]$$

$$= \frac{n^2}{2}\left[a_n + a_1 + (n-1)d\right] = \frac{n^2}{2}\left[a_n + a_n\right] = n^2 a_n$$

2. Here $z - 1 = e^{i\theta}$

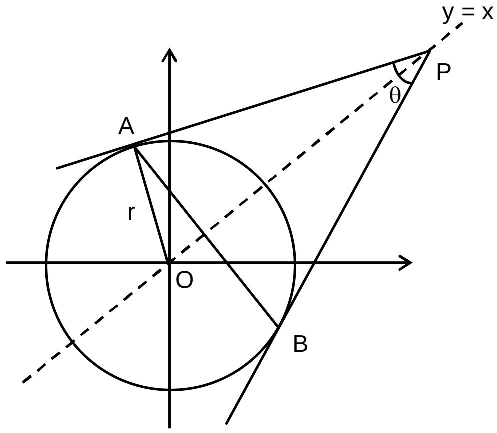
$$\Rightarrow z = 2\cos^2\frac{\theta}{2} + 2i\sin\frac{\theta}{2}\cos\frac{\theta}{2} = 2\cos\frac{\theta}{2}e^{i\theta/2}$$

and $z - 2 = z - 1 - 1 = e^{i\theta} - 1 = -1 + e^{i\theta} = -2\sin^2\frac{\theta}{2} + 2i\sin\frac{\theta}{2}\cos\frac{\theta}{2} = 2i\sin\frac{\theta}{2}e^{i\theta/2}$.

Hence $2i\sin\frac{\theta}{2}e^{i\theta/2} = k\cdot 2\cos\frac{\theta}{2}e^{i\theta/2}\tan\frac{\theta}{2}$

$\Rightarrow k = i$.

3. $\angle OAB = \angle APO = \frac{\theta}{2}$



$\therefore$ AP = BP = $r\cot\frac{\theta}{2}$ and

AB = $2r\cos\frac{\theta}{2}$.

$\therefore$ Perimeter of ΔAPB, $L = 2r\left(\cot\frac{\theta}{2} + \cos\frac{\theta}{2}\right)$

$$\frac{dL}{dr} = r\left(-\operatorname{cosec}^2\frac{\theta}{2} - \sin\frac{\theta}{2}\right) < 0$$

for all $\theta \in \left[\frac{\pi}{3}, \frac{2\pi}{3}\right]$.

$\therefore$ L is maximum when $\theta = \frac{\pi}{3}$ and then OP = $r\operatorname{cosec}\frac{\theta}{2}$ = 2r.

So, the co-ordinates of P are (2r cos 45°, 2r sin 45°).

4. The line is $z(1 + i) = \bar{z}(1 - i)$ or $z(-1 + i) + \bar{z}(-1 - i) = 0$.
If the reflection of a number ω in the line $a\bar{z} + \bar{a}z + b = 0$, $b \in R$ be ω', then
$\omega'\bar{a} + \bar{\omega}a + b = 0$

Now $\omega = \frac{2+i}{3-i} = \frac{(2+i)(3+i)}{10} = \frac{1+i}{2}$

So, $\omega'(-1+i) + \left(\frac{1-i}{2}\right)(-1-i) = 0$

$$\therefore\ \omega'(-1+i) = \frac{(1-i)(1-i)}{2} = 1$$

$$\Rightarrow \omega' = \frac{1}{-1+i} = \frac{-1-i}{2} = \frac{2+i}{-3+i}$$

5. x = P(A wins) = P(H) + P(TH) + P(TTTH) + P(TTTTH) + …..
$= p + qp + q^3p + q^4p + \ldots\ (q = 1 - p)$
$= (p + q^3p + q^6p + \ldots) + (qp + q^4p + q^7p + \ldots)$
$= \frac{p}{1-q^3} + \frac{pq}{1-q^3} = \frac{1+q}{1+q+q^2}$ and $y = 1 - x = \frac{q^2}{1+q+q^2}$
Now $0 < p < 1 \Rightarrow 0 < q < 1$, so, $1 + q > q^2 \Rightarrow x > y$
Also, $x > y \Rightarrow 2x > x + y = 1$ or $x > \frac{1}{2}$ thus $y < \frac{1}{2}$

6. In ΔABC, $b + c - a > 0$, $c + a - b > 0$, $a + b - c > 0$, so

$$\frac{(b+c-a)+(c+a-b)+(a+b-c)}{3} \ge \{(b+c-a)(c+a-b)(a+b-c)\}^{1/3}$$

$\Rightarrow P^3 \ge 27(b + c - a)(c + a - b)(a + b - c)$
Also,

$$\frac{(a+b+c)+(b+c-a)+(c+a-b)+(a+b-c)}{4} > \{(a+b+c)(b+c-a)(c+a-b)(a+b-c)\}^{1/4}$$

$\Rightarrow \frac{2P}{4} > (16A)^{1/4} \Rightarrow P > 4A^{1/4}$ or $P^4 > 256A$
Next, we know for a given parameter, equilateral triangle has the largest area, so the area of triangle
$A \le \frac{\sqrt{3}}{4}\left(\frac{p}{3}\right)^2$ (for equilateral triangle, a = b = c = p/3)
Now, $p^2 = (a + b + c)^2 = a^2 + b^2 + c^2 + 2(ab + bc + ca)$
$= 3(a^2 + b^2 + c^2) - 2(a^2 + b^2 + c^2 - ab - bc - ca)$
$\le 3(a^2 + b^2 + c^2)$ (equality holds iff a = b = c)
Thus $A \le \frac{\sqrt{3}}{4}\frac{a^2+b^2+c^2}{3} \Rightarrow a^2 + b^2 + c^2 \ge 4\sqrt{3}\,A$

7. Let the equation of the required plane be $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=1$
The points A, B, C are (a, 0, 0), (0, b, 0) and (0, 0, c) and the centroid of ΔABC is $\left(\frac{a}{3}, \frac{b}{3}, \frac{c}{3}\right)$
Thus $a = 3$, $b = 3r$, $c = 3r^2$, $r \ne 0$
So, the equation of plane is $\frac{x}{3}+\frac{y}{3r}+\frac{z}{3r^2}=1$
It passes through (t, t, t)
so, $(t - 3)r^2 + rt + t = 0$, clearly $t \ne 0$
for real r, $t^2 - 4(t - 3)t \ge 0$, $t \ne 3 \Rightarrow 0 < t \le 4$, $t \ne 3$
when t = 3, r = – 1, so $0 < t \le 4$

8. We have $\sin(\cot^{-1}\cos\tan^{-1}x) = \sin(\cot^{-1}\cos\theta)$, where $\theta = \tan^{-1}x$

$$= \sin\cot^{-1}\frac{1}{\sqrt{1+\tan^2\theta}} = \sin\cot^{-1}\frac{1}{\sqrt{1+x^2}} = \sqrt{\frac{1+x^2}{2+x^2}}$$

Now for all $x \in R$, $0 < \frac{1+x^2}{2+x^2} < 1$, then $[\sin(\cot^{-1} \cos \tan^{-1} x)] = \left[\frac{1+x^2}{2+x^2}\right] = 0$

$\therefore$ The equation is $\sin\theta = 0 \Rightarrow \theta = n\pi$, $n \in I$

9. We have $a \cos x - (ax + b) \sin x + c \sin x + (cx + d) \cos x = x \cos x \; \forall \; x \in R$
$\Rightarrow (a + d) \cos x + (c - b) \sin x - ax \sin x + (c - 1)x \cos x = 0$ is an identity
$\Rightarrow a + d = 0$, $c - b = 0$, $a = 0$, $c - 1 = 0 \Rightarrow a = d = 0$ and $b = c = 1$

SECTION – B

1. **(A)** Let the sides a and b are the roots of $x^2 - 5x + 3 = 0$, then $a + b = 5$ and $ab = 3$
Also, $\angle C = \frac{\pi}{3}$
$\therefore \; \frac{1}{2} = \frac{a^2 + b^2 - c^2}{2ab} \Rightarrow ab = (a + b)^2 - 2ab - c^2 \Rightarrow c = 4$
Now, $rR = \frac{abc}{2(a+b+c)} = \frac{3 \times 4}{2(5+4)} = \frac{2}{3}$
(B) We have $a = \frac{r_1(r_2 + r_3)}{\sqrt{r_1r_2 + r_2r_3 + r_3r_1}} = \frac{8 \times 36}{24} = 12$
(C) Given $1 \le a \le 10$
Also, for roots of opposite sign $2a^2 - 7a + 3 < 0$
or $\frac{1}{2} < a < 3 \Rightarrow a = 1$ or 2
$\therefore$ Desired probability $= \frac{2}{10} = \frac{1}{5}$
(D) (α, β) lies on the director circle of the ellipse i.e. on $x^2 + y^2 = 9$
So, we can assume $\alpha = 3 \cos\theta$, $\beta = 3 \sin\theta$.
Thus $F = 12 \cos\theta + 9 \sin\theta = 3(4 \cos\theta + 3 \sin\theta)$
$\Rightarrow -15 \le F \le 15$

2. **(A)** Let consecutive coefficients be ${}^nC_r$ and ${}^nC_{r+1}$. Then, $\frac{n!}{(n-r)!r!} = \frac{n!}{(n-r-1)!(r+1)!}$
$\Rightarrow \; \frac{1}{(n-r)(n-r-1)!r!} = \frac{1}{(n-r-1)!(r+1)r!}$
$\Rightarrow r + 1 = n - r$
$\Rightarrow n = 2r + 1$ hence, n is odd.
(B) $E = (19 - 4)^n + (19 + 4)^n$
$2[{}^nC_0 19^n + {}^nC_2 19^{n-2} 4^2 + \ldots.. + {}^nC_n 4^n]$ when n is even or
$2[{}^nC_0 19^n + {}^nC_2 \cdot 19^{n-2} \cdot 4^2 + \ldots.. + {}^nC_{n-1} 19 \cdot 4^{n-1}]$ when n is odd
$\Rightarrow$ E is divisible by 19 when n is odd
(C) ${}^{10}C_0 \, {}^{20}C_{10} - {}^{10}C_1 \, {}^{18}C_{10} + {}^{10}C_2 \, {}^{16}C_{10} - \ldots..$
$=$ Coefficient of x^{10} in $[{}^{10}C_0 (1 + x)^{20} - {}^{20}C_1 \times (1 + x)^{18} + {}^{10}C_2 (1 + x)^{16} - \ldots..]$
$=$ Coefficient of x^{10} in $[{}^{10}C_0 ((1 + x)^2)^{10} - {}^{10}C_1 \times ((1 + x)^2)^9 + {}^{10}C_2((1 + x)^2)^8 - \ldots..]$
$=$ Coefficient of x^{10} in $[(1 + x)^2 - 1]^{10}$
$=$ Coefficient of x^{10} in $[2x + x^2]^{10}$
$= 2^{10}$
(D) $T_r = {}^{14}C_{r-1} x^{r-1;} \; T_{r+1} = {}^{14}C_r x^r$; $T_{r+2} = {}^{14}C_{r+1} x^{r+1}$
By the given condition, $2 \; {}^{14}C_r = {}^{14}C_{r-1} + {}^{14}C_{r+1}$

$$\Rightarrow\ 2 = \frac{{}^{14}C_{r-1}}{{}^{14}C_r} + \frac{{}^{14}C_{r+1}}{{}^{14}C_r}$$

$$\Rightarrow\ 2 = \frac{r}{14-r+1} + \frac{14-(r+1)+1}{r+1}$$

$$\Rightarrow\ 2 = \frac{r}{15-r} + \frac{14-r}{r+1}$$

$\Rightarrow r = 9$

SECTION – C

1. $f'(x) = 6x^2 - 18ax + 12a^2 = 0 \Rightarrow x = a, 2a$.

Given $x_2 = x_1^2$, so a cannot be negative. If $a > 0$, then local minimum occurs at $x = 2a$ and local maximum at $x = a$. Thus $x_1 = a$ and $x_2 = 2a$

$\Rightarrow 2a = a^2 \Rightarrow a = 2$ (if $a = 0$, $f(x)$ is always increasing)

2. Since x, y, z are in A.P., $x + z = 2y$ and hence

$$\frac{x+y}{2y-x} + \frac{y+z}{2y-z} = \frac{x+y}{z} + \frac{y+z}{x} = \frac{y}{x} + \frac{y}{z} + \frac{x}{z} + \frac{z}{x}$$

$$= \frac{x}{z} + \frac{x+z}{2z} + \frac{x+z}{2x} + \frac{z}{x} = 1 + \frac{3}{2}\left(\frac{x}{z} + \frac{z}{x}\right)$$

$\geq 1 + 3$ [A. M. $\geq$ G.M.]

$\Rightarrow$ minimum value of the given expression is 4.

3. $24300 = 2^2\, 3^5\, 5^2$

Number of odd divisors = the number of terms in $(1 + 3 + 3^2 + 3^3 + 3^4 + 3^5)(1 + 5 + 5^2)$

$= 6 + 6 + 6 = 18$

This also includes the factor 1. So the number of proper odd divisors = 17

4. $|z - 3 - i| = 2$ represents a circle with centre $3 + i$ and radius 2

$|z - 2 + i| + |z - 4 - 3i| = 6$ represents an ellipse with centre $\left(\frac{2-i+4+3i}{2}\right) = 3 + i$ and major axis = 6

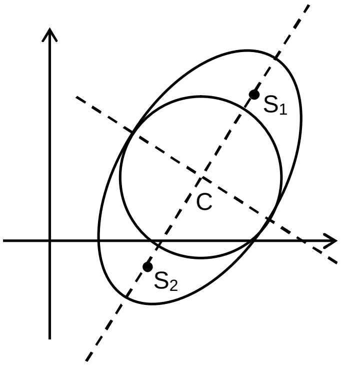
Also, the distance between foci = $2\sqrt{5}$

$\Rightarrow$ eccentricity = $\frac{2\sqrt{5}}{6} = \frac{\sqrt{5}}{3} < 1$

$\therefore$ Minor axis = $2 \times 3\sqrt{1 - \frac{5}{a}} = 4$

$\because$ diameter of circle = minor axis

So, the circle touches the ellipse internally



5. Normal to hyperbola at t is $y - \frac{c}{t} = t^2(x - ct)$ ….. (1)

It touches $xy = -c^2$

Solving with (1), we get $x\left\{\frac{c}{t} + t^2(x - ct)\right\} + c^2 = 0 \Rightarrow t^2x^2 + \left(\frac{c}{t} - ct^3\right)x + c^2 = 0$

For equal roots, we have $\left(\frac{1}{t} - t^3\right)^2 - 4t^2 = 0 \Rightarrow (1 - t^4)^2 - 4t^4 = 0$

$\Rightarrow t^4 - 1 - 2t^2 = 0$ or $t^4 - 1 + 2t^2 = 0$

$\Rightarrow t^2 = \dfrac{2 \pm \sqrt{8}}{2}$ or $\dfrac{-2 \pm \sqrt{8}}{2}$ $\Rightarrow t^2 = 1 + \sqrt{2}$ or $-1 + \sqrt{2}$

6. $|z - 3| \le |z - 1| \Rightarrow z + \bar{z} \ge 4 \Rightarrow x \ge 2$ ($\because z + \bar{z} = 2x$)
$|z - 3| \le |z - 5| \Rightarrow z + \bar{z} \le 8 \Rightarrow x \le 4$
$|z - i| \le |z + i| \Rightarrow i(z - \bar{z}) \le 0 \Rightarrow y \ge 0$ ($\because z - \bar{z} = 2iy$)
$|z - i| \le |z - 5i| \Rightarrow i(z - \bar{z}) \ge -6 \Rightarrow y \le 3$.
Clearly the region is a rectangle of area = 2 × 3 = 6

7. The given function is

$$y = \cot^{-1}\left(\frac{1+2\ln x}{1-2\ln x}\right) + \tan^{-1}\left(\frac{3+2\ln x}{1-6\ln x}\right).$$

Let $\tan\theta = 2\ln x$, $\tan\phi = 3$ so that

$$y = \cot^{-1}\left(\frac{\tan\frac{\pi}{4} + \tan\theta}{1 - \tan\frac{\pi}{4}\tan\theta}\right) + \tan^{-1}\left(\frac{\tan\phi + \tan\theta}{1 - \tan\phi\tan\theta}\right)$$

$$= \cot^{-1}\left(\tan\left(\frac{\pi}{4} + \theta\right)\right) + \tan^{-1}\left(\tan\left(\phi + \theta\right)\right)$$

$$= \frac{\pi}{2} - \left(\frac{\pi}{4} + \theta\right) + \phi + \theta = \frac{\pi}{4} + \phi = \frac{\pi}{4} + \tan^{-1}3 = \text{constant}$$

$\Rightarrow \dfrac{d^2y}{dx^2} = 0$.

8. We have f(x) + f(x + 4) = f(x + 2) + f(x + 6)
$\Rightarrow$ f(x + 2) + f(x + 6) = f(x + 4) + f(x + 8)
$\Rightarrow$ f(x) = f(x + 8), and hence g′(x) = f(x + 8) – f(x) = 0

FIITJEE **JEE (Main), 2014**

ALL INDIA TEST SERIES

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

FULL TEST – IV

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 03 and 10 to 12)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (04 to 09 and 13 to 30) contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

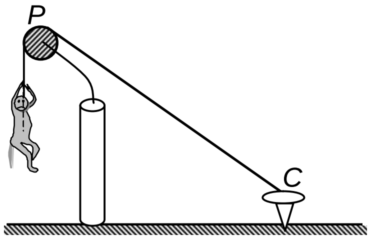
Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. Which of the following numbers has maximum number of significant figure?
(A) 1001
(B) 100.1
(C) 100.10
(D) 0.001001

2. Two boys are standing at the points A and B on the ground, where AB = a. The boy at B starts running in a direction perpendicular to AB with velocity v_1. The boy at A starts running simultaneously with velocity v and catches the other in time t then t is
(A) $\frac{a}{\sqrt{v^2+v_1^2}}$
(B) $\frac{a}{v+v_1}$
(C) $\frac{a}{v-v_1}$
(D) $\frac{a}{\sqrt{v^2-v_1^2}}$

3. One end of a massless rope, which passes over a massless and frictionless pulley P is tied to a hook C while the other end is free. Maximum tension that the rope can bear is 360 N with what value of minimum safe acceleration (in ms^{-2}) can a monkey of 60 kg move down on the rope
(A) 16
(B) 6
(C) 4
(D) 8



Space for Rough work

4. A particle moves on a rough horizontal ground with some initial velocity say v_0. If $(3/4)^{th}$ of its kinetic energy is lost due to friction in time t_0 then coefficient of friction between the particle and the ground is

(A) $\frac{v_0}{2gt_0}$ (B) $\frac{v_0}{4gt_0}$

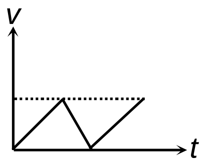
(C) $\frac{3v_0}{4gt_0}$ (D) $\frac{v_0}{gt_0}$

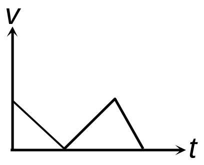
5. A block of mass m is placed on an another rough block of mass M and both are moving horizontally with same acceleration a due to a force which is applied on the lower block, then work done by lower block on the upper block in moving a distance s will be

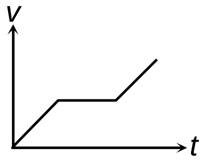
(A) Mas (B) $(m+M)$ as

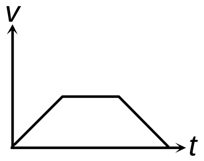
(C) $\frac{M^2}{m}$as (D) mas

6. A ball falls from some height above a horizontal surface. If the collision is elastic, the graph between speed (v) and time (t) upto the second collision looks like

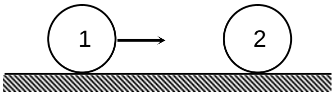
(A)


(B)


(C)


(D)


7. Ball 1 collides with an another identical ball 2 at rest as shown in figure. For what value of coefficient of restitution e, the velocity of second ball becomes two times that of 1 after collision?



(A) 1/3 (B) 1/2

(C) 1/4 (D) 1/6

Space for Rough work

8. The radius of a planet is R_1 and a satellite revolves around it in a circle of radius R_2. The time period of revolution of satellite is T. Acceleration due to the gravitation of the planet at its surface will be

(A) $\frac{4\pi^2 R_2^3}{T^2 R_1^2}$ (B) $\frac{R_2^3}{4\pi^2 T^2 R_1^2}$

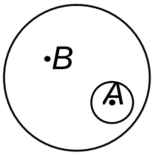
(C) $\frac{4\pi^2 R_1^3}{T^2 R_2^2}$ (D) $\frac{R_1^3}{4\pi^2 T^2 R_2^2}$

9. A spherical object of mass 1 kg and radius 1 m is falling vertically downward inside a viscous liquid in a gravity free space. At a certain instant the velocity of the sphere is 2 m/s. If the coefficient of viscosity of the liquid is $\frac{1}{18\pi}$ N-s/m^2, then velocity of ball will become 0.5 m/s after a time

(A) ln 4 s (B) 2 ln 4 s

(C) 3 ln 4 s (D) 2 ln 2 s

10. There is an air bubble of radius R inside a drop of water of radius 3R. Find the ratio of gauge pressure at point B to that at point A.



(A) $\frac{1}{2}$ (B) $\frac{1}{4}$

(C) $\frac{1}{3}$ (D) 1

11. A simple pendulum is suspended from the ceiling of an empty box falling in air near earth surface. The total mass of system is M. The box experiences air resistance $\vec{R} = -k\vec{v}$ where v is the velocity of box and k is a positive constant. After some time it is found that period of oscillation of pendulum becomes double the value when it would have suspended from a point on earth. The velocity of box at that moment (take g in air same as on earth's surface)

(A) $\frac{Mg}{4k}$ (B) $\frac{Mg}{k}$

(C) $\frac{Mg}{2k}$ (D) $\frac{2Mg}{k}$

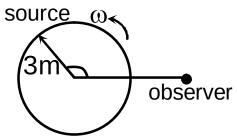
Space for Rough work

12. A uniform vertical electric field E is established in the space between two large parallel plates. A small conducting sphere of mass m is suspended in the field from a string of length L. If the spheres is given a positive charge q and the lower plate is charged positively, the period of oscillation of this pendulum is

(A) $2\pi\sqrt{\frac{L}{g}}$ (B) $2\pi\sqrt{\frac{L}{g+(qE/m)}}$

(C) $2\pi\sqrt{\frac{L}{g-(qE/m)}}$ (D) $2\pi\sqrt{\frac{L}{[g^2+(qE/m)^2]^{1/2}}}$

13. A source is moving on a circle of radius 3 m with constant angular velocity ω = 5 rad/s. If the observer is at a distance 5 m from the centre of circle, the time interval between maximum and minimum frequency received by the observer is



(A) $\frac{\pi}{5}$ (B) $\frac{2}{5}\cos^{-1}\left(\frac{3}{4}\right)$

(C) $\frac{2}{5}\cos^{-1}\left(\frac{3}{5}\right)$ (D) $\frac{2}{5}\sin^{-1}\left(\frac{3}{5}\right)$

14. A l cm long string fixed at both ends, sustains a standing wave such that all the points on the string having displacement amplitude 1 mm (less than maximum amplitude) are separated by d cm. The string is oscillating in its third overtone then

(A) $\frac{l}{d}=2$ (B) $\frac{l}{d}=3$

(C) $\frac{l}{d}=6$ (D) $\frac{l}{d}=8$

15. The air in a open pipe of length 36 cm long is vibrating with 2 nodes and 2 antinodes. The temperature of the air inside the pipe is 51^0C. What is the wavelength of waves produced in air outside the tube where the temperature of air is 16^0C?

(A) 32.1 cm (B) 68 cm

(C) 34 cm (D) 10.2 cm

Space for Rough work

16. A cubical vessel of edge 1 m and total thermal resistance (of its walls) is $\frac{1}{R}$ (where, R is universal gas constant) has a small hole in one of its walls. It is kept in a very big closed chamber whose temperature T_0 remains constant. In the chamber and vessel, a mono-atomic gas is filled at a same constant pressure P_0. At time t = 0, temperature of the gas in the vessel is T_1 (< $2T_0/3$). When temperature of the gas in the vessel becomes 0.8 T_0, rate of change of moles in it will be

(A) $\frac{1}{10}$
(B) $\frac{1}{6}$
(C) $-\frac{1}{10}$
(D) $-\frac{1}{6}$

17. One mole of an ideal gas is enclosed in a cylinder fitted with a frictionless piston and occupies a volume of 1.5 litre at a pressure of 1.2 atm. It is subjected to a process given by equation $T = \alpha V^2, \gamma$ (adiabatic constant) for the gas = 1.5. Choose the wrong statement.

Given $R\alpha = 80$ J mol^{-1} lit^{-2} (R = gas constant and α is constant)

(A) the P-V diagram of the process is a straight line.
(B) the work done by the gas in increasing the volume of the gas to 9 litre is 3150 J.
(C) the change in the internal energy of the gas is 12600 J.
(D) the heat supplied to the gas in the process is 15750 J.

18. A point charge is placed at a distance r from center of a conducting neutral sphere of radius R (r > R). The potential at any point P inside the sphere at a distance r_1 from point charge due to induced charge of the sphere is given by [$k = \frac{1}{4\pi\varepsilon_0}$]

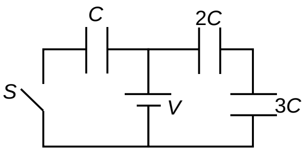
(A) kq/r_1
(B) kq/r
(C) $kq/r - kq/r_1$
(D) $-kq/R$

19. A charge q is placed at some distance along the axis of a uniformly charged disc of surface charge density σ. The flux due to the charge q through the disc is ϕ. The electric force on charge q exerted by the disc is

(A) $\sigma\varphi$
(B) $\frac{\sigma\varphi}{4\pi}$
(C) $\frac{\sigma\varphi}{2\pi}$
(D) $\frac{\sigma\varphi}{3\pi}$

Space for Rough work

20. In the given circuit diagram, find the heat generated on closing the switch S. (Initially the capacitor of capacitance C is uncharged)



(A) $\frac{3}{2}CV^2$ (B) CV^2

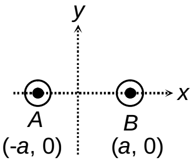
(C) $\frac{1}{2}CV^2$ (D) $2CV^2$

21. A spherical conductor A of radius r is placed concentrically inside a conducting shell B of radius R(R > r). A charge Q is given to A, and then A is joined to B by a metal wire. The charge flowing from A to B will be

(A) $Q\left(\frac{R}{R+r}\right)$ (B) $Q\left(\frac{r}{R+r}\right)$

(C) Q (D) zero

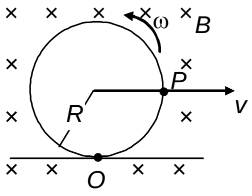
22. Two very long current carrying wires A and B carrying current I_0 (along z-axis) are placed at (–a, 0) and (a, 0) as shown. Find the value of magnetic field at (0, a)



(A) $\frac{\mu_0 I_0}{\sqrt{2}\pi a}$ (B) $\frac{\mu_0 I_0}{2\pi a}$

(C) $\frac{\mu_0 I_0}{4\pi a}$ (D) $\frac{\mu_0 I_0}{2\sqrt{2}\pi a}$

23. A metallic ring of radius R moves in a vertical plane in the presence of a uniform magnetic field B perpendicular to the plane of the ring. At any given instant of time its centre of mass moves with a velocity v while ring rotates in its COM frame with angular velocity ω as shown in the figure. The magnitude of induced e.m.f. between points O and P is

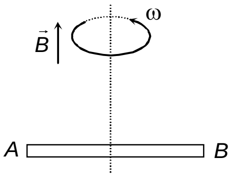


(A) zero (B) $vBR\sqrt{2}$

(C) vBR (D) 2 vBR

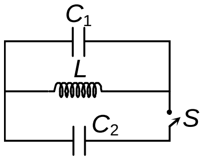
Space for Rough work

24. A conducting rod of length 2l is rotating with constant angular speed ω about its perpendicular bisector. A uniform magnetic field $\vec{B}$ exists parallel to the axis of rotation. The emf induced between two ends of the rod is



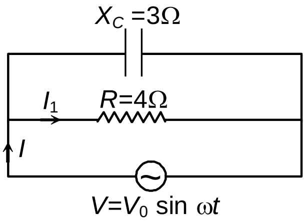
(A) $B\omega l^2$
(B) $\frac{1}{2}B\omega l^2$
(C) $\frac{1}{8}B\omega l^2$
(D) zero

25. At a moment (t = 0), when the charge on capacitor C_1 is zero, the switch is closed. If I_0 be the current through inductor at t = 0 , for t > 0 (initially C_2 is uncharged)



(A) maximum current through inductor equals $I_0/2$.
(B) maximum current through inductor equals $\frac{C_1 I_0}{C_1 + C_2}$.
(C) maximum charge on $C_1 = \frac{C_1 I_0\sqrt{LC_2}}{C_1 + C_2}$.
(D) maximum charge on $C_1 = C_1 I_0\sqrt{\frac{L}{C_1 + C_2}}$.

26. A capacitor and resistor are connected with an A.C. source as shown in figure. Reactance of capacitor is $X_C = 3\Omega$ and resistance of resistor is 4Ω. Phase difference between current I and I_1 is $\left[\tan^{-1}\left(\frac{3}{4}\right) = 37^\circ\right]$

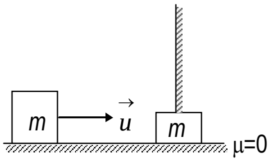


(A) 90°
(B) zero
(C) 53°
(D) 37°

Space for Rough work

27. In Young's double slit experiment the two slits act as coherent sources of equal amplitude A and wavelength λ. In another experiment with the same set-up the two slits are source of equal amplitude A and wavelength λ, but are incoherent. The ratio of the intensity of light at the midpoint of the screen in the first case to that is second case is
(A) 1 (B) 2
(D) 3 (D) 4

28. An object of mass m is moving with velocity $\vec{u}$ towards a plane mirror kept on a stand as shown in the figure. The mass of the mirror and stand system is m. A head-on elastic collision takes place between the object and the mirror stand, the velocity of image before and after the collision is



(A) $\vec{u}, 2\vec{u}$ (B) $-\vec{u}, -2\vec{u}$
(C) $-\vec{u}, 2\vec{u}$ (D) $\vec{u}, -2\vec{u}$

29. A silver sphere (work function 4.6 eV) is suspended in a vacuum chamber by an insulating thread. Ultraviolet light of wavelength 0.2 μm strike on the sphere. The maximum electric potential of the sphere will be (hc = 12400 eVÅ)
(A) 4.6 V (B) 6.2 V
(C) 1.6 V (D) 3.2 V

30. If light of wavelength of maximum intensity emitted from a surface at temperature T_1 is used to cause photoelectric emission from a metallic surface, the maximum kinetic energy of the emitted electron is 6 eV, which is 3 times the work function of the metallic surface. If light of wavelength of maximum intensity emitted from a surface at temperature $T_2\left(T_2 = 2T_1\right)$ is used, the maximum kinetic energy of the photoelectrons emitted is
(A) 2 eV (B) 4 eV
(C) 14 eV (D) 18 Ev

Space for Rough work

Chemistry

PART – II

SECTION – A

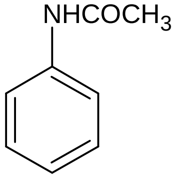
Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

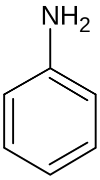
1. The ratio of difference of radius between 3rd and 2nd orbit of H-atom and Li^{+2} ion is:
(A) 3 : 1 (B) 1 : 1
(C) 1 : 3 (D) 2 : 3

2. The slag obtained during the extraction of copper pyrites is composed mainly of:
(A) $MgSiO_3$ (B) $CuSiO_3$
(C) $FeSiO_3$ (D) $CuFeS_2$

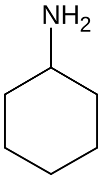
3. Rank in decreasing order of basicity:



(I)



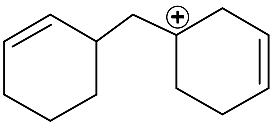
(II)

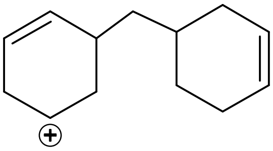


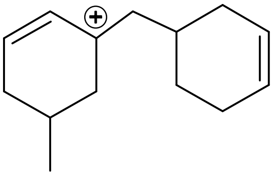
(III)

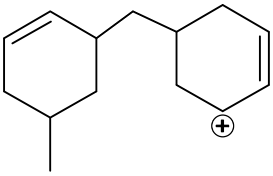
(A) III, I, II (B) III, II, I
(C) II, I, III (D) II, III, I

4. Which of the following is the most stabilized carbocation?

(A)


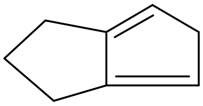
(B)


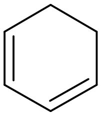
(C)


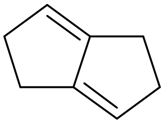
(D)


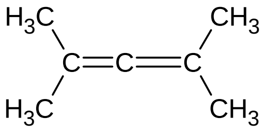
Space for Rough work

5. Which of the diene has highest heat of hydrogenation?

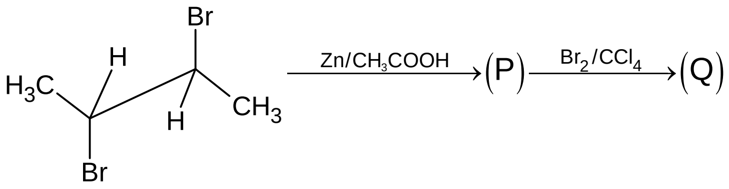
(A)


(B)


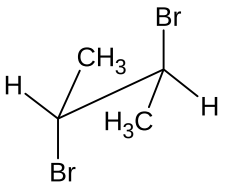
(C)


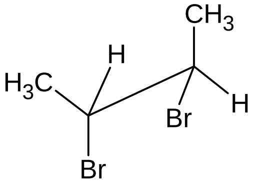
(D)

$(H_3C)_2C=C=C(CH_3)_2$

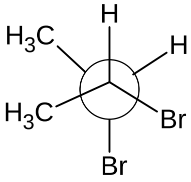
6. If the solubility of calcium phosphate [$Ca_3(PO_4)_2$] is s mol L^{-1}. The solubility product is equal to
(A) $6s^5$
(B) $72s^5$
(C) $54s^4$
(D) $108s^5$

7.


Q is major product?

(I)


(II)


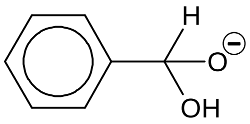
(III)


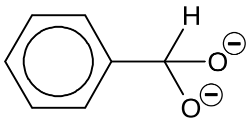
(A) I only
(B) II only
(C) III only
(D) I, II and III

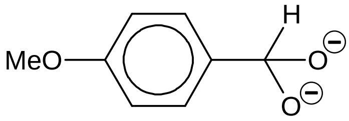
8. The reaction of NH_3 and Cl_2 is as follows
$aNH_3 + bCl_2 \longrightarrow cNH_4Cl + N_2$
The coefficient a, b and c are respectively.
(A) 8,4,6
(B) 8, 3, 2
(C) 3, 8, 6
(D) 8, 3, 6

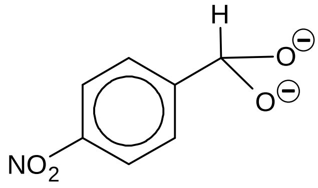
Space for Rough work

9. A crystal made up of A, B and C atoms, A occupy in all the tetrahedral voids and B occupied in octahedral void while 'C' forms face centred cubic. The molecular formula of the compound or crystal is:
(A) AB_2C (B) $A_2B_3C_8$
(C) $A_3B_8C_3$ (D) A_2BC

10. In a Cannizzaro reaction, the intermediate that will be best hydride donor is:
(A)


(B)


(C)


(D)


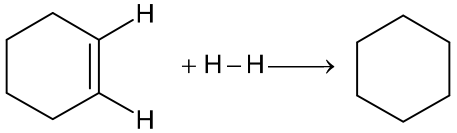
11. The number of revolutions made by an electron in Bohr's 2nd orbit of hydrogen atom in one second is (approx.)
(A) 8.3×10^{14} (B) 6.66×10^{15}
(C) 5.3×10^{6}` (D) none of these

12. Two non reacting gases A and B, having the mole ratio of 3 : 5 in a container, exert a pressure of 8 atm. If B is removed, what would be pressure of A only, T remaining constant.
(A) 3 atm (B) 4 atm
(C) 5 atm (D) None of these

13. A liquid is kept in a closed vessel. If a glass plate with a small hole in kept on top of the liquid surface, what would be the vapour pressure of the liquid in the vessel? (Neglect weight of glass)
(A) More than what would be if the glass plate were removed.
(B) Less than what would be if the glass plate were removed.
(C) Same as what would be if the glass plate were removed.
(D) Can not predicted.

14. Two mole of ideal gas at 300 K is expanded isothermally from an initial volume of 1 litre to 10 litre. The change in internal energy in the process is:
(A) 11.49 kJ (B) 2.73 kcal
(C) zero (D) All are incorrect

Space for Rough work

15. 

Bond energies of C – C, C = C, C – H and H – H are w, x, y and z kJ/mole respectively. What is the value of ΔH^o for above reaction?

(A) 2y – x – z) kJ
(B) (x + z – w – 2y) kJ
(C) (x + z – y) kJ
(D) (x + z – 2y) kJ

16. For a reaction

$3A + B \longrightarrow 2C$

$-\frac{d[A]}{dt} = K[A][B]$, the expression for $\frac{d[C]}{dt}$ will be:

(A) $\frac{2}{3}K[A][B]$
(B) $\frac{3}{2}K[A][B]$
(C) $\frac{1}{3}K[A][B]$
(D) $\frac{1}{2}K[A][B]$

17. For the reaction $SrCO_3(s) \rightleftharpoons SrO(s) + CO_2(g)$

the pressure of CO_2(g) depends on

(A) Amount of $SrCO_3$(s)
(B) Amount of SrO (s)
(C) Amounts of both $SrCO_3$(s) and SrO(s)
(D) Temperature of the system

18. On increasing temperature ionic product of water increases $\left[H_2O \rightleftharpoons H^+ + OH^-, K_W = 10^{-14} \text{ at } 25^oC\right]$ which of the following statement is correct regarding dissociation of water.

(A) water becomes basic on decreasing the temperature
(B) pH of water increase on increasing the temperature
(C) water will be neutral irrespective of temperature change
(D) pH cannot be predicted on given information

19. On adding few drops of dil. HCl to freshly precipitated ferric hydroxide, a red coloured colloidal solution is obtained. The phenomenon is known as:

(A) protective action
(B) flocculation
(C) coagulation
(D) peptisation

20. When sodium argentocyanide is treated with zinc dust, silver precipitates because

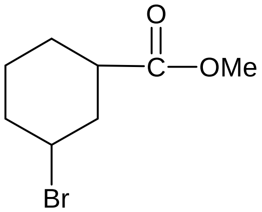
(A) Both Zn^{+2} and Ag^+ ions have d^{10} electronic configuration
(B) Zinc forms a complex readily with cyanide
(C) Zinc is more electropositive than silver
(D) Zinc is less electropositive than silver

21. Aqueous solution of carnalite gives a positive test for
(A) potassium ions only (B) chloride ions only
(C) magnesium and chloride ions (D) potassium, magnesium and chloride ions

22. Which compound is formed when excess of KCN is added to an aqueous solution of copper sulphate?
(A) $Cu(CN)_2$ (B) $K[Cu(CN)_2]$
(C) $K_4[Cu(CN)_6]$ (D) $K_3[Cu(CN)_4]$

23. In successive emission of α and β particles, how many α and β particles should be emitted for conversion $_{94}Pu^{241}$ to $_{92}U^{233}$?
(A) $2\alpha, 3\beta$ (B) $3\alpha, 2\beta$
(C) $2\alpha, 2\beta$ (D) none of them

24. The IUPAC name of the following compound

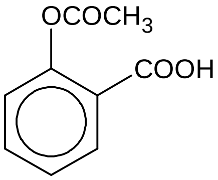


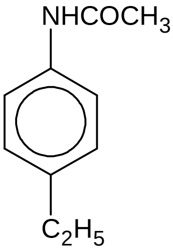
(A) 3-bromo-1-methoxy cyclohexanone (B) 4-bromo-1-methoxy cyclo hexanone
(C) methyl-3-bromo cyclo hexanoate (D) methyl-3-bromo cyclo hexane carboxylate

25. The excessive use of phosphates as water softners leads to aquatic pollution called
(A) eutrophication (B) phsophosylation
(C) deoxygenation (D) denitrification

Space for Rough work

26. Paracetamol is a common antipyretic, which is the correct formula among given options?

(A)


(B)


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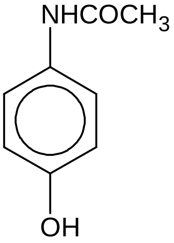
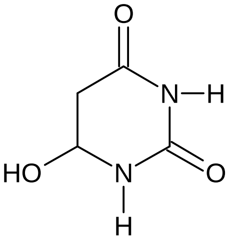
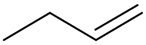


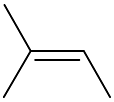
(D)


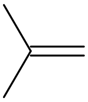
27. Consider the following statements about lactose:
1. Lactose on hydrolysis yields equimolar mixture of D-glucose and D-galactose.
2. Lactose is a poly-saccharide.
3. Lactose is a reducing sugar.
4. In lactose, the glycosidic linkage is between C-1 of galactose and C-4 glucose unit.

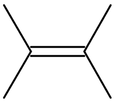
Which of the statements are correct?
(A) 1 and 3 only
(B) 1 and 4 only
(C) 2 and 3 only
(D) 1, 3 and 4 only

28. The correct order of reactivity of alkenes towards HBr is:

1.


2.


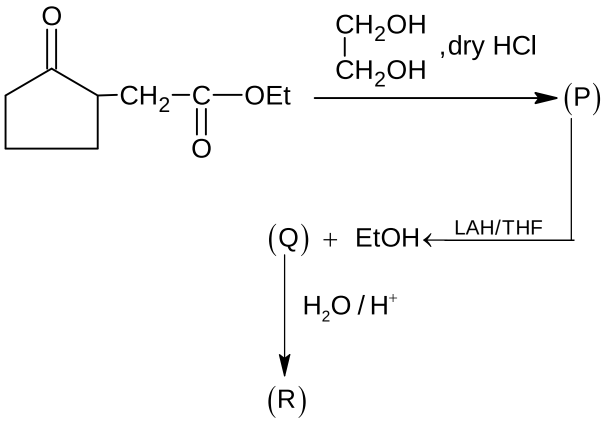
3.


4.


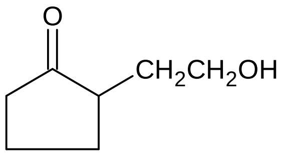
(A) 1 > 2 > 3 > 4
(B) 1 > 3 > 2 > 4
(C) 3 > 2 > 4 > 1
(D) 4 > 2 > 3 > 1

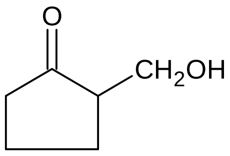
Space for Rough work

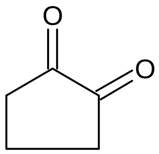
29.

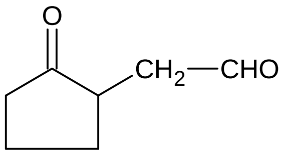

O
CH2–C–OEt
O
CH2OH
CH2OH
,dry HCl
(P)
LAH/THF
(Q) + EtOH
H2O / H+
(R)

What is the structure of (R)?

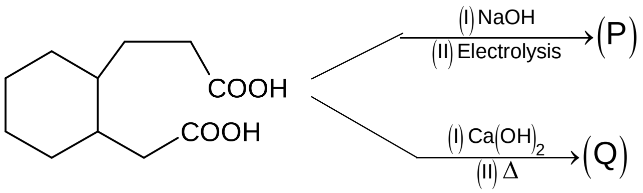
(A)


(B)


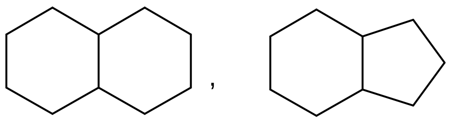
(C)


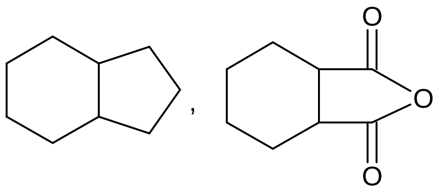
(D)


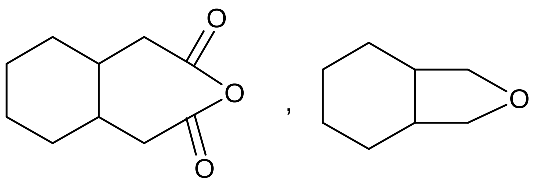
30.

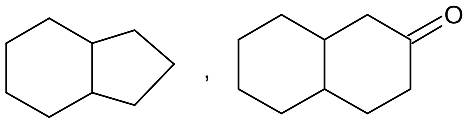

COOH
COOH
(I) NaOH
(II) Electrolysis
(P)
(I) Ca(OH)2
(II) Δ
(Q)

If P and Q are main products then P and Q are:

(A)


(B)


(C)


(D)


Space for Rough work

Mathematics

PART – III

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. Number of words can be formed using all the letters of the work 'HIPHIPHURRAY' in which all H's lie somewhere between R's is

(A) (198)7!
(B) (99)7!
(C) (99)8!
(D) (198)8!

2. Let a, b ($a \neq b$) are two non–zero complex numbers satisfying $|a^2 - b^2| = |\vec{a}^2 + \vec{b}^2 - 2\vec{a}\vec{b}|$ then

(A) $\frac{a}{b}$ is purely real
(B) $\frac{a}{b}$ is purely imaginary
(C) $|\arg(a) - \arg(b)| = \pi$
(D) $|\arg(a) - \arg(b)| = \frac{\pi}{4}$

3. Let I be the purchase value of an equipment and V(t) be the value after it has been used for t years. The value V(t) depreciates at a rate given by differential equation $\frac{dV(t)}{dt} = -K(T-t)$, where K > 0 is a constant and T is the total life in years of the equipment. Then the scrap value V(T) of the equipment is

(A) $I - \frac{KT^2}{2}$
(B) $I - \frac{K(T-t)^2}{2}$
(C) e^{-KT}
(D) $T^2 - \frac{1}{K}$

Space for Rough work

4. If $\left(\tan^{-1}x\right)^2+\left(\cot^{-1}x\right)^2=\frac{5\pi^2}{8}$, then x is equal to

(A) –1 (B) 0
(C) 1 (D) none of these

5. If the equation $\left|\left|x-1\right|-6\lim\limits_{t\to\infty}\left(\frac{\sqrt{2t^2-t-1}-\sqrt{t^2-t+1}}{t\left(\tan\frac{\pi}{8}\right)}\right)\right|=k$ has four distinct solutions then the number of integral values of k is

(A) 4 (B) 5
(C) 6 (D) none of these

6. If f(x + y) = f(x) + f(y) + |x|y + xy^2, ∀ x, y ∈ R and f′(0) = 0 then

(A) f(x) is twice differentiable at x = 0 (B) area bounded by f(x), x = 1, y = 0 is $\frac{1}{3}$
(C) f′(x) is continuous ∀ x ∈ R (D) f′(x) is differentiable ∀ x ∈ R

7. If f : [2, ∞[→ [8, ∞[is a surjective function defined by f(x) = x^2 – (p – 2)x + 3p – 2, p ∈ R then sum of values of 'p' is $m+\sqrt{n}$, m, n ∈ N then m + n is equal to

(A) 20 (B) 10
(C) 30 (D) 40

8. For x, y ∈ R, if $x^2 - 2xy + 2y^2 - 6y + 9 = 0$ then the value of (5x – 4y) is equal to

(A) 2 (B) 3
(C) 6 (D) 15

9. Let $f(x)=\begin{cases}2-x+a^2-9a-9, & x<2\\ 2x-3, & x\geq 2\end{cases}$ where a is a positive constant. It f(x) has local minimum at x = 2, then a lies in the interval

(A)]0, 1] (B) [10, ∞[
(C) [1, 10] (D) [2, 10[

Space for Rough work

10. If a, b $\in$ R and satisfy $a = b + \cfrac{1}{a + \cfrac{1}{b + \cfrac{1}{a + ...\infty}}}$, $b = a - \cfrac{1}{b + \cfrac{1}{a - \cfrac{1}{b + ...\infty}}}$ then $a^2 - b^2$ is equal to

(A) –1
(B) 2
(C) 1
(D) 0

11. The probability that a randomly selected calculator from a store is of brand 'r' is proportional to r(r = 1, 2, ….., 6). Further, the probability of a calculator of brand 'r' being defective is $\frac{7-r}{21}$, r = 1, 2, 3, 4, 5, 6. If probability that a calculator randomly selected from the store being defective is $\frac{p}{q}$, where p and q are co–prime then the value of (p + q) is

(A) 63
(B) 60
(C) 71
(D) 21

12. If P(r) be number of points (x, y), x, y $\in$ I which lie inside or on the curve $|xy| - r(|x| + |y|) + r^2 = 0$, r $\in$ N and if $\lim\limits_{n\to\infty}\left(\frac{\sum_{r=1}^{n-1}\sqrt{P(r)}}{an^3 + bn^2 + c}\right) = \frac{1}{2}$ then (a + b), is

(A) 1
(B) 2
(C) 3
(D) 4

13. It ax + b sec($\tan^{-1}$ x) = c and ay + b sec($\tan^{-1}$ y) = c, then $\frac{x+y}{1-xy}$ is equal to

(A) $\frac{2ac}{a-c}$
(B) $\frac{2ac}{a^2-c^2}$
(C) $\frac{a+c}{1-ac}$
(D) $\frac{ac}{a^2+c^2}$

Space for Rough work

14. Consider, $f(x)=\begin{cases}\dfrac{e^{(x-2)\ln\sqrt{5^x}+\frac{1}{3x}\log_2\left(\left(4^x\right)^3\right)}-e^2}{(x-2)\tan x}, & x>0\\ \lambda\dfrac{\left(\left(\sqrt{5}\right)^x-1\right)\left(e^{x^2+2}-e^2\right)}{(2\sin x-\sin 2x)}, & x<0\end{cases}$. If $\lim\limits_{x\to 0} f(x)$ exists then λ is equal to

(A) 1
(B) –1
(C) 2
(D) ln 5

15. The absolute value of the expression $\left(\dfrac{1+\sqrt{3}\tan 1^\circ}{\sqrt{3}+\tan 1^\circ}\right)\left(\dfrac{1-\sqrt{3}\tan 1^\circ}{\sqrt{3}-\tan 1^\circ}\right)\dfrac{\tan 89^\circ}{\cot 3^\circ}$ is equal to

(A) 0
(B) 1
(C) 2
(D) 3

16. The value of $\lim\limits_{x\to 0}\dfrac{1}{x}\int\limits_0^x (1+\sin 2t)^{1/t}\,dt$ is equal to

(A) 2
(B) 1
(C) e
(D) e^2

17. Let f be a polynomial function such that for all real x, $f(x^2+1)=x^4+5x^2+2$, then $\int f(x)\,dx$ is

(A) $\dfrac{x^3}{3}+\dfrac{3x^2}{2}-2x+c$
(B) $\dfrac{x^3}{3}+\dfrac{3x^2}{2}+2x+c$
(C) $\dfrac{x^3}{3}-\dfrac{3x^2}{2}-2x+c$
(D) $\dfrac{x^3}{3}-\dfrac{3x^2}{2}+2x+c$

18. If $f(x)=(x-1)^4(x-2)^3(x-3)^2(x-4)$, then the value of $\left(f'''(1)+f''(2)+f'(3)+f'(4)\right)$ is equal to

(A) 638
(B) $3(6^3)$
(C) 50
(D) 0

Space for Rough work

19. The first two terms of a geometric progression add up to 12. The sum of third and fourth terms is 48. If the terms are alternately positive and negative, then
(A) common ratio of G.P. is –2 (B) common ratio of G.P. is –3
(C) sixth term of G.P. is 128 (D) none of these

20. If P(x, y, z) is a point on the line segment joining Q(2, 3, 4) and R(3, 5, 6) such that the projection of the vector $\overrightarrow{OP}$ on the axes are $\frac{13}{5}, \frac{21}{5}, \frac{26}{5}$ respectively. The P divides QR in the ratio
(A) 2 : 3 (B) 3 : 1
(C) 1 : 3 (D) 3 : 2

21. Area of triangle whose vertices are (a, a^2), (b, b^2), (c, c^2) is $\frac{1}{2}$, and area of another triangle whose vertices are (p, p^2), (q, q^2) and (r, r^2) is 4, then the value of $\begin{vmatrix} (1+ap)^2 & (1+bp)^2 & (1+cp)^2 \\ (1+aq)^2 & (1+bq)^2 & (1+cq)^2 \\ (1+ar)^2 & (1+br)^2 & (1+cr)^2 \end{vmatrix}$, is
(A) 2 (B) 4
(C) 8 (D) 16

22. The line parallel to the x–axis and passing through the intersection of the lines ax + 2by + 3b = 0 and bx – 2ay – 3a = 0, where (a, b) $\neq$ (0, 0) is
(A) below the x–axis at a distance of $\frac{3}{2}$ from it (B) below the x–axis at a distance of $\frac{2}{3}$ from it
(C) above the x–axis at a distance of $\frac{3}{2}$ from it (D) above the x–axis of distance of $\frac{2}{3}$ from it

23. The locus of feet of perpendicular from either foci of the ellipse $(x - y + 1)^2 + (2x + 2y - 6)^2 = 20$ on any tangent will be
(A) $x^2 + y^2 + 2x + 4y + 5 = 0$ (B) $x^2 + y^2 + 2x + 4y - 5 = 0$
(C) $x^2 + y^2 - 2x - 4y - 5 = 0$ (D) $x^2 + y^2 - 2x - 4y + 5 = 0$

24. For $x \neq \frac{n\pi}{2}$, where n $\in$ I, the range of function
f(x) = sgn(sin x) + sgn(cos x) + sgn(tan x) + sgn(cot x) is
(A) {–2, 4} (B) {–2, 0, 4}
(C) {–4, 0, –2, 4} (D) {0, 2, 4}

Space for Rough work

25. If $\cos\theta = \frac{a}{b+c}$, $\cos\phi = \frac{b}{a+c}$, $\cos\psi = \frac{c}{a+c}$, where θ, ϕ, ψ ∈ (0, π) and a, b, c are sides of triangle ABC then $\tan^2\frac{\theta}{2} + \tan^2\frac{\phi}{2} + \tan^2\frac{\psi}{2}$ is equal to

(A) 1 (B) 2
(C) 3 (D) 4

26. Let A = {1, 2, 3, 4}. The number of different ordered pairs (B, C) that can be formed such that $B \subseteq A$, $C \subseteq A$ and $B \cap C = \phi$

(A) 3 (B) 9
(C) 27 (D) 81

27. If $\cos^2 x - (c - 1)\cos x + 2c \geq 6$ for every $x \in R$, then the true set of values of c is

(A) $[4, \infty[$ (B) $[2, \infty[$
(C) $]-\infty, -2]$ (D) $]-\infty, -4]$

28. If the equations $px^2 + qx + r = 0$ and $rx^2 + qx + p = 0$ $(p \neq r \neq 0)$ have a negative common root, then the value of (p – q + r) is equal to

(A) –1 (B) 1
(C) 2 (D) 0

29. If $f(x) = \left([\{x\}]\tan^{-1}\left(\frac{x^2 - 3x - 1}{x^2 - 3x + 5}\right) + 3 - x^7\right)^{\frac{1}{7}}$. Where [k] and {k} denotes greatest integer and fractional part functions of k respectively, then the value of $f^{-1}(50) - f(50) + f(f(100))$, is

(A) 0 (B) 25
(C) 50 (D) 100

30. In triangle ABC, if $a \sin A \sin B + b \cos^2 A = \sqrt{2}a$, then the value of $\left(\frac{b}{a}\right)$ is

(A) $\frac{1}{2}$ (B) 2
(C) $\sqrt{2}$ (D) 1

Space for rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

FIITJEE **JEE(Main), 2014**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – IV
(Main)

S. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	A	A
2.	D	C	B
3.	C	B	A
4.	A	C	A
5.	D	D	B
6.	A	D	C
7.	A	D	C
8.	A	D	B
9.	C	D	B
10.	B	D	C
11.	A	A	C
12.	C	A	B
13.	C	C	B
14.	D	C	A
15.	C	B	B
16.	C	A	D
17.	D	D	A
18.	C	C	B
19.	A	D	A
20.	C	C	D
21.	C	D	D
22.	B	D	A
23.	C	C	C
24.	D	D	B
25.	D	A	A
26.	C	C	D
27.	B	D	A
28.	C	C	D
29.	C	A	D
30.	C	D	C

Physics

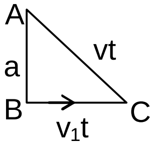
PART – I

SECTION – A

1. Zero after decimal point is also significant.

2. $a^2 + v_1^2t^2 = v^2t^2$

$$t = \frac{a}{\sqrt{v^2 - v_1^2}}$$



3. $600 - T = ma$

$$a_{min} = \frac{600 - 360}{60} = 4 \text{ m/s}^2$$

4. $$-\mu mgt_0 = \frac{mv_0}{2} - mv_0$$

$$\mu = \frac{v_0}{2gt_0}$$

5. Friction force on upper block is f = ma
So work done = ma × s

7. mu = m(v/2) + mv
⇒ v = (2/3)u

$$-e = \frac{\frac{u}{3} - \frac{2u}{3}}{u}$$

⇒ e = 1/3

8. $$T = \frac{2\pi R_2}{\sqrt{\frac{GM}{R_2}}}$$

$$\Rightarrow \frac{GM}{R_2^3} = \frac{4\pi^2}{T^2}$$

$$g = \frac{GM}{R_1^2} = \frac{4\pi^2 R_2^3}{T^2 R_1^2}$$

9. $$m\left(-\frac{dv}{dt}\right) = 6\pi\eta rv$$

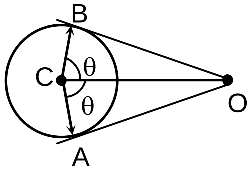
$$-\int_2^{0.5} \frac{dv}{v} = 6\pi\left(\frac{1}{18\pi}\right)\int_0^t dt$$

$$\ell n\frac{2}{0.5} = \frac{t}{3} \Rightarrow t = 3\ell n4 \text{ sec}$$

12. $T = 2\pi\sqrt{\frac{\ell}{g_{eff}}}$ **where g_{eff} =** $\frac{mg - qE}{m} = g - \frac{qE}{m}$

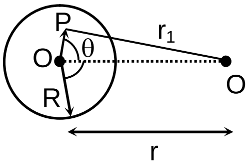
13. Maximum will be corresponding to source position A and minimum to source friction B.

So, time interval = $\frac{2\theta}{\omega} = \frac{2\cos^{-1}\left(\frac{3}{5}\right)}{5}$



18. $V_P = V_{pindued} + V_{Pq} = V_0$

$V_{pinduced} = \frac{kq}{r} - \frac{kq}{r_1}$



20. $v_i = \frac{1}{2}\frac{6}{5}CV^2$ …(i)

$q_i = \frac{6}{5}CV$ ….(ii)

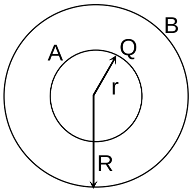
$q_f = \frac{11}{5}CV$ …(iii)

$U_f = \left(\frac{1}{2}\frac{6}{5}CV^2 + \frac{1}{2}CV^2\right)$

Charge flown from battery = CV
Work done = CV^2
Heat produced $\Delta H = \Delta U + \Delta W$

$= \left[\left(\frac{1}{2}\frac{6}{5}CV^2 + \frac{1}{2}CV^2\right) - \frac{1}{2}\frac{6}{5}CV^2\right] - CV^2 = -\frac{1}{2}CV^2$

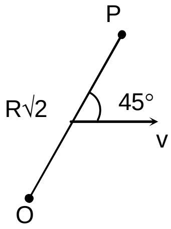
21. As A and B will be at same potential so charge flown equal to Q.



22. $B = \sqrt{B_A^2 + B_B^2} = \frac{\sqrt{2}\mu_0 I_0}{2\pi a\sqrt{2}} = \frac{\mu_0 I_0}{2\pi a}$

23. Using $e = \int \vec{B}\cdot\left(d\vec{\ell}\times\vec{v}\right)$

So, e = BvR



24. $e = \int_{-\ell/2}^{+\ell/2} B(x\omega)dx = 0$

25. $$\frac{1}{2}\frac{q^2}{(C_1 + C_2)} = \frac{1}{2}LI_0^2$$

$$q = \sqrt{L\left(C_1 + C_2\right)}I_0$$

$$q_1 = \frac{q}{C_1 + C_2}C_1 = C_1I_0\sqrt{\frac{L}{\left(C_1 + C_2\right)}}$$

27. $$\frac{I_{coherent}}{I_{incoherent}} = \frac{4I}{2I} = 2$$

29. Using Einstein equation

E = W + eV

$$\frac{12400\text{ ev}\overset{o}{A}}{0.2\times10^4\ \overset{o}{A}} = 4.6\text{ eV} + \text{eV}$$

V = 1.6 Volts

Chemistry

PART – II

SECTION – A

1. For H, $\Delta r_H = r_3 - r_2 = \frac{0.529}{1} \times [9-4]$

For $Li^{+2}, \Delta r_{Li^{+2}} = r_3 - r_2 = \frac{0.529}{3}[9-4]$

$\Rightarrow \frac{\Delta r_H}{\Delta r_{Li^{+2}}} = \frac{3}{1}$

2. $2Cu_2S + 3O_2 \longrightarrow 2Cu_2O + 2SO_2$

$Cu_2O + FeS \longrightarrow FeO + Cu_2S$

$2FeS + 3O_2 \longrightarrow 2FeO + 2SO_2$

$FeO + SiO_2 \longrightarrow FeSiO_3 \,(\text{Slag})$

4. This is a 3^o and resonance stabilized carbocation.

5. Cumulated diene is least stable, evolve max heat in the hydrogenation reaction.

11. Number of revolution made by an electron per sec

$$= \frac{v_n}{2\pi r_n} \approx \left(\frac{2\pi Ze^2}{nh \times 2\pi\left(\frac{n^2h^2}{4\pi mZe^2}\right)} \right)$$

$$= \frac{4\pi^2 mZ^2e^4}{n^3h^3} \approx \frac{4\pi^2me^4}{h^3}\left(\frac{Z^2}{n^3}\right)$$

$$= \frac{Z^2}{n^3} \times 6.66 \times 10^{15} \approx \frac{1}{8} \times 6.66 \times 10^{15}$$

$= 8.3 \times 10^{14}$

13. Vapour pressure depends on temperature not on size of container.

14. There is no intermolecular forces of attraction in ideal gases.

16. $3A + B \longrightarrow 2C$

$$r = \frac{1}{3}\frac{d[A]}{dt} = -\frac{d[B]}{dt} = \frac{1}{2}\frac{d[C]}{dt} = K'[A][B]$$

$$-\frac{d[A]}{dt} = 3K'[A][B] = K[A][B]$$

i.e. $K = 3K'$

So that $\frac{d[C]}{dt} = 2K'[A][B] = \frac{2}{3}K[A][B]$

17. $K_P = P_{CO_2}$, which will depends temperature of the system only.

18. Water will be neutral as $[H^+] = [OH^-]$

20. Zinc is more electropositive than silver therefore, it displaces less electropositive silver.

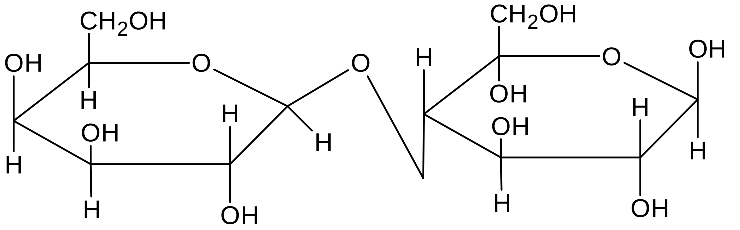
21. Carnalite is a double salt $KCl.MgCl_2.6H_2O$ which give test of K^+, Mg^{+2} and Cl^-.

22. $2Cu^{+2} + 2CN^- \longrightarrow 2Cu^+ + (CN)_2$

$Cu^+ + CN^- \longrightarrow CuCN \xrightarrow{3KCN} K_3[Cu(CN)_4]$

23. Mass number change only by α-particles and atomic number reduces by 2 unit by each α-particle and increase by 1 unit by β-particle.

27.

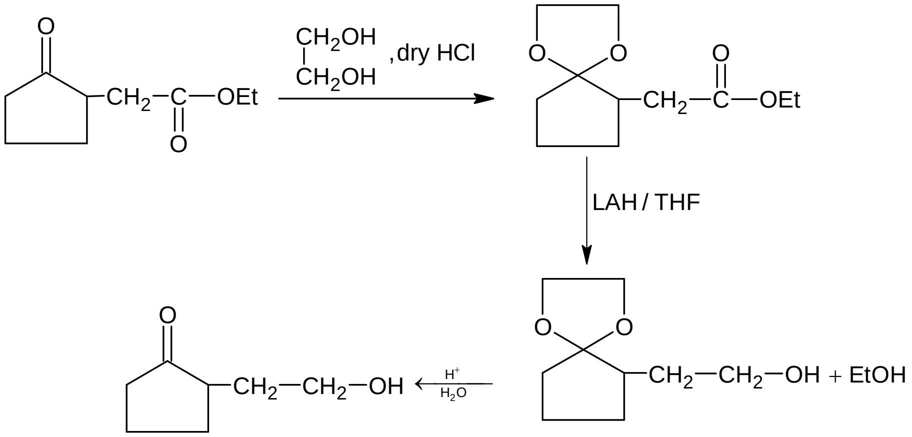

CH2OH
OH
O
H
OH
H
H
OH
H
O
H
CH2OH
O
OH
OH
OH
H
H
H
OH
H

Galactose unit

Glucose unit

28. The 1st step is electrophilic addition i.e. rate determining step, more stable will be the intermediate better will be the rate of reactions.

29.


O
CH2—C—OEt
O
CH2OH
CH2OH
,dry HCl
O
O
O
CH2—C—OEt
LAH / THF
O
O
CH2—CH2—OH + EtOH
H+
H2O
O
CH2—CH2—OH

Mathematics

PART – III

SECTION – A

1. $(HHH),(RR),\underbrace{(I,I),(P,P),AYU}_{x} = {}^{12}C_7 \cdot \frac{7!}{2!2!} \cdot 1 = (198)7!$

2. $|(a+b)(a-b)| = |a-b|^2 \Rightarrow |a + b| = |a - b|$

$\Rightarrow \left|\frac{a}{b}+1\right| = \left|\frac{a}{b}-1\right|$

$\Rightarrow \frac{a}{b}$ is perpendicular bisector of (–1, 0) and (1, 0)

$\therefore \frac{a}{b}$ is purely imaginary

3. $\frac{dV(t)}{dt} = -K(T-t)$

$\Rightarrow V(t) = \frac{K(T-t)^2}{2} + C$

At t = 0, V = I $\Rightarrow C = I - \frac{KT^2}{2}$

$\therefore$ Scrap value V(T) $\Rightarrow$ V(t = T) = C = $I - \frac{KT^2}{2}$

4. $2\left(\tan^{-1}x\right)^2 - \pi\left(\tan^{-1}x\right) - \frac{3\pi^2}{8} = 0$

$\Rightarrow \tan^{-1}(x) = -\frac{\pi}{4}$

$\therefore$ x = –1

5. $$\lim_{t\to\infty} \frac{\left(t^2-2\right)}{t^2\left(\sqrt{2-\frac{1}{t}-\frac{1}{t^2}}+\sqrt{1-\frac{1}{t}+\frac{1}{t^2}}\right)\left(\sqrt{2}-1\right)} = 1$$

Now ||x – 1| – 6| = k has four distinct solutions if k $\in$ (0, 6)
$\therefore$ Number of integral values of k is 5

6. $f(x) = \frac{x|x|}{2}$

7. **Case–I:** when $\frac{p-2}{2} \le 2 \Rightarrow p \le 6$ and f(2) = 8

$\therefore$ P = 2

Case–II: when $\frac{p-2}{2} > 2 \Rightarrow p > 6$

$-\frac{D}{4a} = 8 \Rightarrow -\frac{(p-2)^2 - 4(3p-2)}{4} = 8$

$\Rightarrow P = 8 + 2\sqrt{5}$

$\therefore$ $p = 8 + 2\sqrt{5}$ and $p = 8 - 2\sqrt{5}$ (rejected)

$\therefore$ Sum of values of p is $2 + 8 + 2\sqrt{5} = 10 + 2\sqrt{5} = 10 + \sqrt{20}$

$\therefore$ m + n = 30

8. We have $(x - y)^2 + (y - 3)^2 = 0$

$\therefore$ x = y = 3

9. We have f(x) > f(2) $\forall$ x < 2

$\Rightarrow \lim_{x \to 2^-} f(x) \ge f(2) = 1$

$\Rightarrow a^2 - 9a - 9 \ge 1$

$\Rightarrow a^2 - 9a - 10 \ge 0$

$\Rightarrow a \le -1$ or $a \ge 10$

But a is positive. Hence $a \ge 10$. That is $a \in [10, \infty[$

Note that when a = 10

$$f(x) = \begin{cases} 3 - x, & x < 2 \\ 2x - 3, & x \ge 2 \end{cases}$$

So that f is continuous at 2, f′(2) does not exist and f′(x) ≠ 0 $\forall$ x $\in$ R. Therefore, x = 2 is a critical point and f′(x) changes sign from negative to positive at x = 2

10. We have $a = b + \frac{1}{a + \frac{1}{a}}$

$\Rightarrow (a - b) = \frac{1}{a + \frac{1}{a}}$ and $b = a - \frac{1}{b + \frac{1}{b}}$

$\Rightarrow a - b = \frac{1}{b + \frac{1}{b}}$

$\therefore$ $a + \frac{1}{a} = b + \frac{1}{b}$ $\Rightarrow$ (ab – 1)(a – b) = 0

$\therefore$ ab = 1 $\because$ $a \ne b$

$\therefore$ $(a - b) = \frac{1}{a + b}$ $\Rightarrow a^2 - b^2 = 1$

11. Probability that calculator of brand r is selected and is defective

$= \sum_{1}^{6} (kr)\left(\frac{7 - r}{21}\right) = \frac{k}{21}\sum_{r=1}^{6}(7r - r^2) = \frac{8k}{3}$ ….. (1)

$\Rightarrow$ Let E_r denote the event that calculator of brand r is selected $P(E_r) = kr$

Since E_r(r = 1, 2, ….., 6) are mutually exclusive and exhaustive events we must have $\sum_{r=1}^{6} P(E_r) = 1 \Rightarrow \sum_{r=1}^{6} kr = 1 \Rightarrow k = \frac{1}{21}$

$\therefore$ required probability = $\frac{8k}{3} = \frac{8}{63} = \frac{p}{q}$

$\therefore$ (p + q) = 71

12. $P(r) = (2r + 1)^2$

$$\sum_{r=1}^{n-1}\sqrt{P(r)} = \sum_{r=1}^{n-1}(2r+1) = n^2 - 1$$

$$\therefore\ \frac{1}{2} = \lim_{n\to\infty}\frac{n^2-1}{an^3+bn^2+c}$$

$\Rightarrow$ a = 0, b = 2

So, (a + b) = 2

13. Let $\tan^{-1} x = \alpha$ and $\tan^{-1} y = \beta$ then $a \tan\alpha + b \sec\alpha = c$ and $a \tan\beta + b \sec\beta = c$

Obviously $a \tan\theta + b \sec\theta = c$ has roots $\tan\alpha$ and $\tan\beta$

$\Rightarrow (a^2 - b^2) \tan^2\theta - 2\,ac \tan\theta + c^2 - b^2 = 0$

$$\therefore\ \tan\alpha + \tan\beta = \frac{2ac}{a^2-b^2}\ \text{ and }\ \tan\alpha\tan\beta = \frac{c^2-b^2}{a^2-b^2}$$

$$\text{So}\ \frac{x+y}{1-xy} = \frac{2ac}{a^2-b^2}$$

14. $$\lim_{x\to o^+} e^2\frac{\left(5^{\left(\frac{x(x-2)}{2}\right)}-1\right)}{\frac{2x(x-2)}{2}\,\frac{\tan x}{x}} = \frac{1}{2}e^2\ln 5$$

$$\lim_{x\to o^-}\frac{\lambda\left(e^2\left(\left(\sqrt{5}\right)^x-1\right)\right)\left(e^{x^2}-1\right)}{x\frac{2\sin x}{x}\left(\frac{1-\cos x}{x^2}\right)x^2} = \lambda e^2\ln\sqrt{5} = \lambda\frac{e^2}{2}\ln 5$$

$\therefore \lambda = 1$

15. $$\left(\frac{1-3\tan^2 1^o}{3-\tan^2 1^o}\right)\frac{\cot 1^o}{\cot 3^o} = \left(\frac{1-3\tan^2 1^o}{3\tan 1^o-\tan^3 1^o}\right)\frac{1}{\cot 3^o} = \frac{1}{\tan 3^o\cot 3^o} = 1$$

16. $$\lim_{x\to 0}\frac{(1+\sin 2x)^{1/x}}{1} = e^2$$

17. $f(x) = x^2 + 3x - 2$

$$\therefore\ \int f(x)\,dx = \frac{x^3}{3}+\frac{3x^2}{2}-2x+c$$

18. $f(x) = (x - 1)^4 (x - 2)^3 (x - 3)^2 (x - 4)$

$f'''(1) = f''(2) = f'(3) = 0$

$$f'(x) = (x-1)^4(x-2)^3(x-3)^2\cdot 1+(x-1)^4(x-2)^3\cdot 2(x-3)(x-4)$$
$$+(x-1)^4\,3(x-2)^2(x-3)^2(x-4)+4(x-1)^3(x-2)^3(x-3)^2(x-4)$$

$\therefore f'(4) = 3(6^3)$

19. $a + ar = 12$ ..... (1)

$ar^2 + ar^3 = 48$ ..... (2)

$\therefore r^2 = 4 \Rightarrow r = -2,\ \because\ r \neq -1, 2$

20. $P\left(\frac{3k+2}{k+1}, \frac{5k+3}{k+1}, \frac{6k+4}{k+1}\right)$

$\therefore$ Hence $\frac{3k+2}{k+1} = \frac{13}{5} \Rightarrow k = \frac{3}{2}$

21. $\Delta = \begin{vmatrix} 1 & 2a & a^2 \\ 1 & 2b & b^2 \\ 1 & 2c & c^2 \end{vmatrix} \cdot \begin{vmatrix} 1 & p & p^2 \\ 1 & q & q^2 \\ 1 & r & r^2 \end{vmatrix} = 2 \cdot 2\Delta_1 \cdot 2\Delta_2 = 8\Delta_1\Delta_2 = 8 \cdot \frac{1}{2} \cdot 4 = 16$

22. $(a + b\lambda)x + (2b - 2a\lambda)y + (3b - 3\lambda a) = 0$

$\because a + b\lambda = 0 \Rightarrow \lambda = -\frac{a}{b}$

$\therefore y = -\frac{3}{2}$

23. $$\frac{\left(\frac{x-y+1}{\sqrt{2}}\right)^2}{10} + \frac{\left(\frac{x+y-3}{\sqrt{2}}\right)^2}{5/2} = 1$$

Here $a^2 = 10$ and $b^2 = 5/2$ and centre is (1, 2)

$\because$ Locus of feet of perpendicular lie on auxiliary circle of ellipse

$\therefore$ Equation of circle is $(x - 1)^2 + (y - 2)^2 = 10$

24. $$f(x) = \begin{cases} 4; & 0 < x < \frac{\pi}{2} \\ -2 & \frac{\pi}{2} < x < \pi \\ 0; & \pi < x < \frac{3n}{2} \\ -2 & \frac{3\pi}{2} < x < 2\pi \end{cases}$$

$\therefore$ Range of function = {0, –2, 4}

25. $$\sum \tan^2\left(\frac{\theta}{2}\right) = \sum \frac{1-\cos\theta}{1+\cos\theta} = \sum \left(\frac{1-\frac{a}{b+c}}{1+\frac{a}{b+c}}\right)$$

$$= \sum \left(\frac{b+c-a}{a+b+c}\right) = \frac{a+b+c}{a+b+c} = 1$$

26. $3^4 = 81$

27. We have, $\cos^2 x - (c - 1)\cos x + 2c - 6 \geq 0 \ \forall x \in R$

$\Rightarrow (\cos x - 2)(\cos x - (c - 3)) \geq 0$

$\therefore \cos x \leq c - 3$

$\Rightarrow c - 3 \geq 1 \Rightarrow c \geq 4$

28. $px^2 + qx + r = 0$
$rx^2 + qx + p = 0$ (on subtract)
$\therefore$ x = –1
So common root is – 1
$\therefore$ p – q + r = 0

29. [{x}] = 0

$$f(x) = (3 - x^7)^{\frac{1}{7}}$$

$$f(f(x)) = \left(\left(3 - (3 - x^7)^{\frac{1}{7}}\right)^7\right)^{\frac{1}{7}} = x$$

$f(f(x)) = x \Rightarrow f^{-1}(x) = f(x)$
$\therefore f^{-1}(50) = f(50)$ and f(f(100)) = 100
$\therefore f^{-1}(50) - f(50) + f(f(100)) = 100$

30. Put a = 2R sin A, b = 2R sin B
2R sin B ($\sin^2$ A + $\cos^2$ A) = $\sqrt{2}a$
$\therefore$ 2R sin B = $\sqrt{2}a$
$$\Rightarrow \left(\frac{b}{a}\right) = \sqrt{2}$$

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

FIITJEE

JEE (Advanced), 2014

FULL TEST – V

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 252**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two section: **Section-A & Section-C**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) Section-A (01 – 08) contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 – 13) contains 5 multiple choice questions which have more than one correct answer. Each question carries **+3 marks** for correct answer. There is no negative marking.

Section-A (14 – 18) contains 2 paragraphs. Based upon paragraph, 2 and 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) Section-C (01 – 10) contains 10 Numerical based questions with answers as numerical value and each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	g = 10 m/s^2
Planck constant	h = 6.6 $\times 10^{-34}$ J-s
Charge of electron	e = 1.6 $\times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N-m^2
Density of water	$\rho_{water} = 10^3$ kg/m^3
Atmospheric pressure	$P_a = 10^5$ N/m^2
Gas constant	R = 8.314 J K^{-1} mol^{-1}

CHEMISTRY

Gas Constant	R	=	8.314 J K^{-1} mol^{-1}
		=	0.0821 Lit atm K^{-1} mol^{-1}
		=	1.987 ≈ 2 Cal K^{-1} mol^{-1}
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

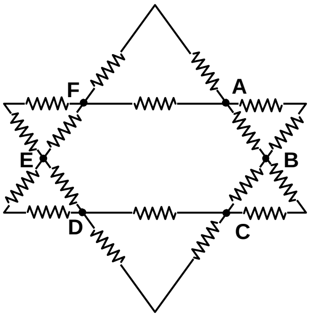
PART – I

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

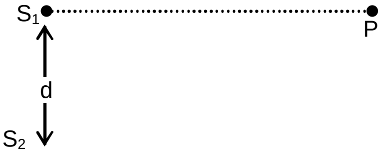
1. Resistance of each resistor is R. Then the equivalent resistance across A and B is



(A) $\frac{5}{9}R$ (B) $\frac{4}{9}R$

(C) $\frac{R}{9}$ (D) $\frac{7}{9}R$

2. Consider two coherent monochromatic (wavelength λ) sources S_1 and S_2 separated by distance d. The ratio of intensity of S_1 and that of S_2 (which is responsible for interference at point P, where detector is located) is 4. The distance of point P from S_1 is (if the resultant intensity at point P is equal to $\frac{9}{4}$ times of intensity of S_1)



[Given $\angle S_2 S_1 P$ is 90°] (d > 0, n is a positive integer)

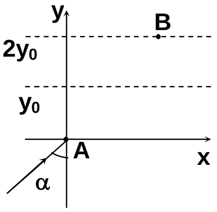
(A) $\frac{d^2 - n^2\lambda^2}{2n\lambda}$ (B) $\frac{d^2 + n^2\lambda^2}{2n\lambda}$

(C) $\frac{n\lambda d}{\sqrt{d^2 - n^2\lambda^2}}$ (D) $\frac{2n\lambda d}{\sqrt{d^2 - n^2\lambda^2}}$

Space for rough work

3. The refractive index of space changes with y, whose function is given as

$$\mu(y) = \begin{cases} 1 & \text{if} \quad y \le 0 \\ ky^2 & \text{if} \quad 0 \le y \le 2y_0 \\ \dfrac{\ell}{y^2} & \text{if} \quad 2y_0 \le y \le 4y_0 \end{cases}$$



where k and ℓ are positive constant. When a light ray is incident at point A as shown in figure. When the ray reaches to point B, it becomes parallel to xz-plane. Choose the correct statement.

(A) α is independent of k
(B) α is independent of ℓ
(C) α is independent of both k and ℓ
(D) none of these

4. The space has electromagnetic field which varies with time whose variation is given as

$$\vec{B} = \begin{cases} -B_0\hat{k} & \text{if} \quad 0 \le t \le \dfrac{\pi m}{qB_0} \\ -B_0\hat{j} & \text{if} \quad \dfrac{\pi m}{qB_0} \le t \le \dfrac{2\pi m}{qB_0} \\ 0 & \text{if} \quad \dfrac{2\pi m}{qB_0} \le t < \infty \end{cases} \quad \text{and} \quad \vec{E} = \begin{cases} 0 & \text{if} \quad 0 \le t \le \dfrac{2\pi m}{qB_0} \\ -E_0\hat{k} & \text{if} \quad \dfrac{2\pi m}{qB_0} \le t < \infty \end{cases}$$

A charge particle having mass m and positive charge q is given velocity $v_0\hat{i}$ at origin at t = 0 sec. The coordinate of point on xy plane when it is passing through xy plane again is

(A) $\left(\dfrac{2mv_0}{q}\sqrt{\dfrac{v_0}{E_0B_0}}, \dfrac{2mv_0}{qB_0}, 0\right)$
(B) $\left(\dfrac{2mv_0}{q}\sqrt{\dfrac{v_0}{E_0B_0}}, \dfrac{mv_0}{qB_0}, 0\right)$
(C) $\left(\dfrac{mv_0}{q}\sqrt{\dfrac{v_0}{E_0B_0}}, \dfrac{2mv_0}{qB_0}, 0\right)$
(D) $\left(\dfrac{mv_0}{q}\sqrt{\dfrac{v_0}{E_0B_0}}, \dfrac{mv_0}{qB_0}, 0\right)$

5. If the sound heard by observer, whose equation is given as
$y = 8\sin 10\pi t \cos 200\pi t$ at x = 0
The number of beat frequency heard by observer is 2k, then the value of k is
(A) 10
(B) 5
(C) 4
(D) none

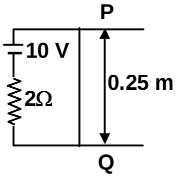
6. Two sound waves of frequencies 100 Hz and 102 Hz and having same amplitude 'A' are interfering. A detector which can detect waves of amplitude greater than or equal to A is kept at rest. In a time interval of 12 seconds, find the total duration in which detector is active.
(A) 2sec
(B) 4sec
(C) 6sec
(D) 8sec

Space for rough work

7. Two identical photons of energy E (4eV ≤ E ≤ 8eV) fall on two different metals whose work functions are in the ratio of 1 : 2. The ratio of the kinetic energies of the most energetic electrons coming from each metal is 2 : 1. Work function of one of the metal is 4 eV. What is the energy of photon in eV.

(A) 6eV	(B) 8 eV
(C) 4 eV	(D) 5 eV

8. A metal wire PQ slides on parallel metallic rails having separation 0.25 m, each having negligible resistance. There is a 2 Ω resistor and 10 V battery as shown in figure. There is a uniform magnetic field directed into the plane of the paper of magnitude 0.5T. A force of 0.5 N to the left is required to keep the slide wire PQ moving with constant speed to the right. With what speed is the wire PQ moving?



(A) 14 m/s	(B) 16 m/s
(C) 18 m/s	(D) 20 m/s

Multiple Correct Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

---

9. In the shown figure (1) and (2), capacitors are in the steady state. Charging batteries are removed and switches S_1 and S_2 are closed at time t = 0. The plot of ℓnI (I is the current in the resistor) in against time t in the resistors R_1 and R_2 are shown by the graphs 1 and 2 respectively in the figure (3). Choose the correct option(s).

(A) If $\varepsilon_1 = 2\varepsilon_2$, R_1 must be equal to $2R_2$	(B) If $R_1 = R_2$, C_1 must be less than C_2
(C) If $C_1 = C_2$, R_1 must be less than R_2	(D) R_1C_1 is equal to R_2C_2

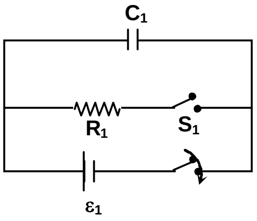


figure (1)

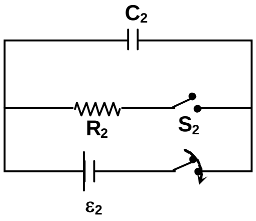


figure (2)

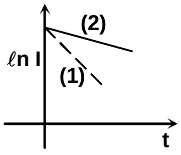
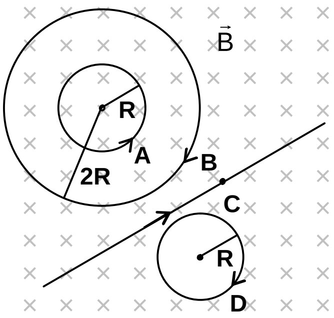
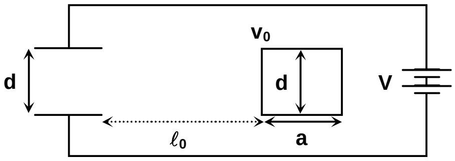


figure (3)

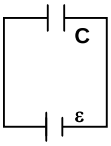
Space for rough work



10. Four particles A, B, C and D of masses m_A, m_B, m_C and m_D respectively, follow the paths shown in the figure, in a uniform magnetic field. Each particle moving with same speed. Q_A, Q_B, Q_C and Q_D are the specific charge of particles A, B, C and D respectively (assume that the motion of each particle is in the same plane perpendicular to the magnetic field).
(A) $Q_A < Q_B < Q_C < Q_D$
(B) $Q_D < Q_B < Q_C < Q_A$
(C) charge on the particle B and particle D is of same nature
(D) Work done by magnetic force on the particle C is minimum as compared to other particle



11. A parallel plates capacitor is made of square conducting plates of side a and the separation between plates is d. The capacitor is connected with battery of emf V volt as shown in the figure. There is a dielectric slab of dimension a × a × d with dielectric constant k. At t = 0, dielectric slab is given velocity v_0 towards capacitor as shown in the figure. (Neglect the effect of gravity and electrostatic force acting on the dielectric when dielectric is out side of capacitor. Also ignore any type frictional force acting on the dielectric during its motion) let the x be the length dielectric inside the capacitor at t = t sec. [$\ell_0 \gg a$]
(A) Motion of dielectric slab is periodic but not simple harmonic motion
(B) Motion of dielectric slab is simple harmonic motion
(C) At any time, the slope of graph of total energy verses x is twice the slope of graph of potential energy verses x.
(D) The value of maximum energy stored in the system is $\frac{1}{2}mv_0^2 + \frac{\varepsilon_0 a^2 V^2}{2d}(2k-1)$



12. A capacitor of capacitance ‘C’ is connected to a battery of emf ε as shown. After full charging a dielectric of same size as that of capacitor & dielectric constant k is inserted. Then choose the **INCORRECT** statement(s).
(Capacitor remains always connected to battery)
(A) electric field between plates of capacitor remains same
(B) charge on capacitor increases to 2kC ε
(C) energy stored in capacitor decreases
(D) electric field between plates of capacitor increases

Space for rough work

13. The equation of a process of diatomic gas is $P^2 = \alpha^2 V$ where α is a positive constant. Then choose the **INCORRECT** option(s).

(A) Work done by gas for a temperature change T is $\frac{2}{3}\alpha nRT$

(B) The change in internal energy is $\frac{5}{2}nRT$ for a temperature change T

(C) The specific heat for the process is $\frac{19}{9}R$

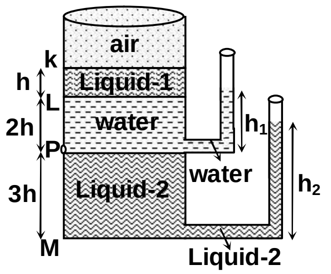
(D) The change in internal energy for a temperature change T is $\frac{5}{2}\alpha nRT$

Comprehension Type

This section contains **2 paragraphs**. Based upon one of paragraph **2 multiple choice questions** and based on the other paragraphs **3 multiple choice questions** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of **which ONLY ONE** is correct.

Paragraph for Question Nos. 14 and 15

A container contains three liquid as shown in the figure. The specific gravity of liquid I and liquid II are 0.8 and 1.2 respectively. The is small hole having area 10^{-6} m^2 at point P as shown in the figure. Initially hole is closed. The cross-sectional area of container is 50 cm^2. Assume all liquids are ideal and neglect any type of friction between liquid and container. Read the passage carefully and answer the following question(s) (given that g = 9.8 m/s^2 and h = 28 cm)



14. The value of h_2/h_1 is

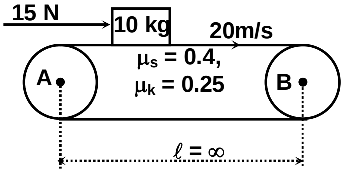
(A) 9/5
(B) 20/7
(C) 40/21
(D) 40/7

15. At some instant, hole is open, the speed of water coming out from hole just after the opening of hole is

(A) 7.84 m/s
(B) 3.92 m/s
(C) 1.96 m/s
(D) none of these

Space for rough work

Paragraph for Question Nos. 16 and 18



A block of mass 10 kg is put gently on a belt-conveyor system of infinite length at t = 0 sec, which is moving with constant speed 20 m/sec rightward at all time, irrespectively of any situation by means of a motor-system as shown in the figure.
tant force of magnitude 15 N is applied on the block continuously during its motion.

16. The nature of friction force acting on the block of mass 10 kg during its motion is
(A) kinetic only (B) Static only
(C) some time kinetic some time static (D) can't be predicted

17. Work done by the kinetic friction on the block of mass 10 kg is
(A) 1250 Joule (B) 2500 Joule
(C) –1250 Joule (D) none

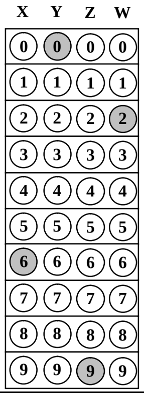
18. The magnitude of acceleration of the block of mass 10 kg at t = 6 sec is
(A) 4 m/s^2 (B) 3 m/s^2
(C) 2 m/s^2 (D) none

Space for rough work

SECTION – C

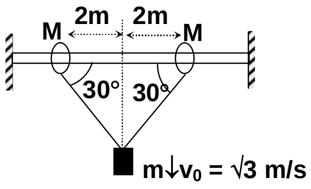
Integer Answer Type

This section contains **10 questions.** The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



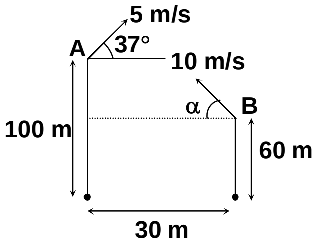
1. The xz plane is the boundary between two transparent medium. Medium –I with $y \geq 0$ has refractive index μ and medium –II with $y \leq 0$ has a refractive index 1. A ray of light in medium-I, given by vector $\vec{n} = \hat{i} - \sqrt{3}\hat{j}$ is incident on the plane of separation. If the reflected and refracted rays make an angle of 90° with each other, then the value of μ is $\sqrt{k}$. Find the value of k.

2. Two rings, each of mass M = 100 gm are constrained to move along a fixed horizontal rod. An ideal string is connected with rings and a small m = 200 gm is connected to the mid point of string. At any moment m is moving downward with velocity $\sqrt{3}$ m/s. The speed of ring of M at the same moment is



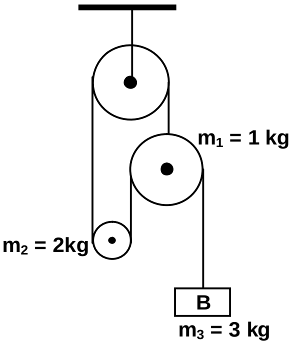
3. Pressure variation due a sonic wave propagating along positive x-direction is given by the equation $\Delta P(x) = \Delta P_0 \sin\left[2\pi(vt - x)\right]$. One end of an open organ pipe is closed by a cap and held at rest with its axis parallel to x-axis and the open end at the origin. What should be the minimum value of frictional force between the cap and the pipe so that pipe will remain closed. Given $\Delta P_0 = 2 \times 10^3$ N/m^2 and cross sectional area of the tube is equal to 5×10^{-4} m^2,

4. Two particle are projected simultaneously at point A and point B from two towers as shown in the figure. If they collide then the value of α is $(a \times 10 + b)$ in degree. Find the value of $(a - b)$. (Neglect any type of frictional force acting on the particles during motion. (take $g = 10$ m/s^2)(where a and b are positive integer, $a < 10$ and $b < 10$)

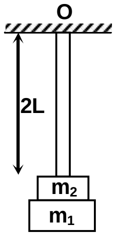


Space for rough work

5. In the given system which mass (in kg) will move with acceleration greater than acceleration due to gravity(g).



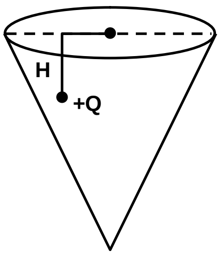
6. A string of negligible mass, natural length L has Young's modulus Y. The string hangs from roof with masses m_1 and m_2 as shown in the figure. If mass m_2 is removed gently, the mass m_1 is just able to bounce back upto point O. Find the ratio m_2/m_1. (string will not obstruct the motion of mass m_1 and system is initially in equilibrium).



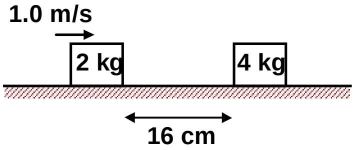
7. Use the following equation $(m)^{ft}(a - c)^2 = x\left[d - kx - \frac{mc}{t}\right]$; where k = spring constant, x = distance, m = mass, t = sec and a, c, d and f are some other physical quantities. If the dimensional formula of f is $[M^{\ell}L^{m}T^{-n}]$, then the value of $\ell + m + n$ is

Space for rough work

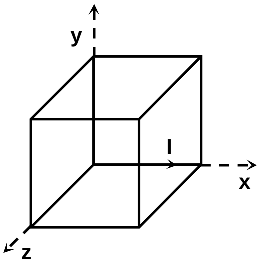
8. A charge +Q is located somewhere inside a vertical cone such that the depth of the charge from the free surface of the cone is H. It is found that the flux associated with the cone with the curved surface is $\frac{3Q}{5\varepsilon_0}$. If the charge is raised vertically through a height 2H, the flux associated with the cone with the curved surface is $\frac{\eta Q}{20\varepsilon_0}$. What should be the value of η?



9. The friction coefficient between the horizontal surface and each of the block shown in the figure is 0.2. The collision between the blocks is perfectly elastic. Find the separation (in cm) between them when they come to rest.
Take g = 10m/s^2.



10. A cubical frame having edge length a, each having a resistance R is placed in a gravity free space such that axes are along sides of cube. Now a cylindrical region of time varying magnetic field is created around the cube having axis in direction of vector $\left(\hat{i}+\hat{j}+\hat{k}\right)$. It was found that current through edge along x axis is $I = \left|\eta \frac{a^2}{R}\frac{dB}{dt}\right|$, where B is the instantaneous magnetic field. What should be the value of η?



Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

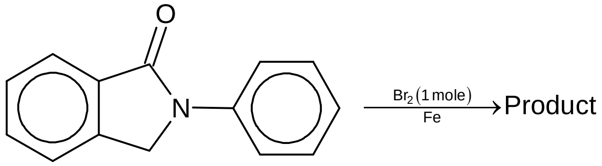
1. At 80°C the vapour pressure of pure liquid A is 520 mm Hg and that of pure liquid B is 1000 mm Hg. Liquid A and liquid B form an ideal solution. If the mixture of liquid A and liquid B boils at 80°C and 1 atm pressure, the mole fraction of A the liquid mixture is:

(A) 0.4 (B) 0.2
(C) 0.5 (D) 0.8

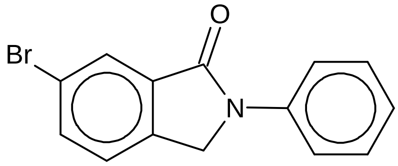
2. When 20 g of $CaCO_3$ were put into 10 litre flask and heated to 794°C, 40% of $CaCO_3$ decomposed at equilibrium. K_P for the decomposition of $CaCO_3$ is:

(A) 0.7 atm (B) 0.3 atm
(C) 1.05 atm (D) 2.5 atm

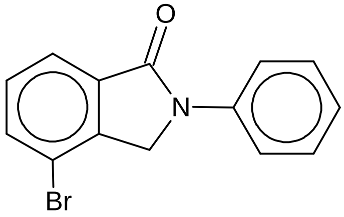
3. In the reaction given below, the major product formed is:



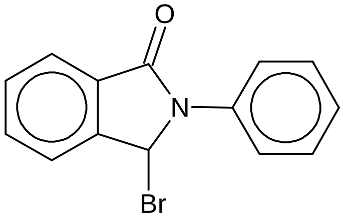
(A)



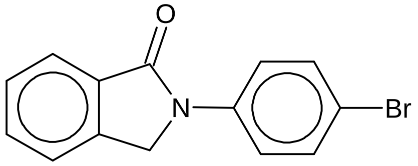
(B)



(C)



(D)

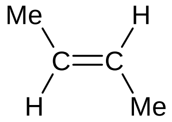


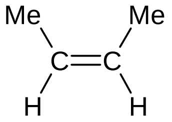
Space for rough work

4. In the following reactions:

$$Me{-}CH{=}CH{-}Me \xrightarrow[CCl_4]{Br_2} A \xrightarrow{2NaNH_2} B \xrightarrow{Na/Liq.NH_3} C$$

The product (C) is:

(A)


(B)


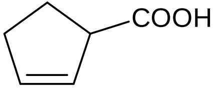
(C) $Me - CH_2 - CH_2 - Me$

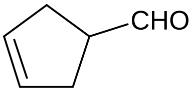
(D) $Me - C \equiv C - Me$

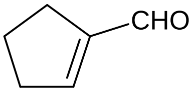
5. 50 ml of a mixture of NaOH and Na_2CO_3 solution titrated with $\frac{N}{10}$ HCl using phenolphthalein indicator required 50 ml HCl to decolourise phenolphthalein. At this stage methyl orange was added and addition of acid was continued. The second end point was reached after further addition of 10 ml of $\frac{N}{10}$ HCl. The amount of NaOH in the solution is:

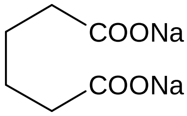
(A) 3.2 g
(B) 0.16 g
(C) 0.08 g
(D) 0.4 g

6. Cyclohexene on ozonolysis followed by reaction with zinc dust and water gives compound B. Compound B on further treatment with aqueous NaOH followed by heating yields compound C. The compound 'C' is:

(A)


(B)


(C)


(D)


7. Which among the following statement is incorrect?
(A) With excess ammonia, chlorine gives N_2 and NH_4Cl.
(B) With hot and conc. NaOH, Cl_2 gives a mixture of $NaClO_3$, NaCl and H_2O.
(C) HCl reacts with finely powdered iron to form ferric chloride.
(D) Bond dissociation energy of F – F is less than that of Cl – Cl.

8. Which of the following is used as a chain stopping unit in the preparation of linear polymer from the hydrolysis of $(CH_3)_2SiCl_2$?

(A) $(CH_3)_3SiCl$
(B) $(CH_3)_4Si$
(C) CH_3SiCl_3
(D) $SiCl_4$

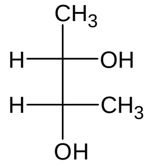
Space for rough work

Multiple Correct Choice Type

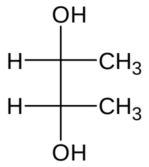
This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

9. Which of the following structures is/are meso-2,3-butanediol

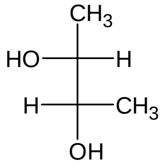
(A)



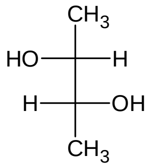
(B)



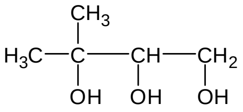
(C)



(D)



10. Which of the following compounds are formed by the oxidation of



$H_3C-\overset{CH_3}{\underset{OH}{C}}-\underset{OH}{CH}-\underset{OH}{CH_2}$

with HIO_4

(A) CH_3-CHO (B) CH_3COCH_3
(C) $H-COOH$ (D) $HCHO$

11. For the reaction $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$; the forward reaction at constant temperature is favoured by

(A) Adding inert gas at constant volume (B) Adding inert gas at constant pressure
(C) Adding Cl_2 at constant volume (D) Increasing volume of the container

12. Which of the following statements are correct:

(A) The flocculating value of PO_4^{3-} is less than that of SO_4^{2-}.
(B) Charcoal adsorbs gases with higher critical temperature more than gases with lower critical temperature.
(C) Chemisorption is multilayered.
(D) In the manufacture of NH_3 by Haber's process, molybdenum is used as promoter for the catalyst iron.

13. In which of the complex ions the central metal ion is dsp^2 hybridized?

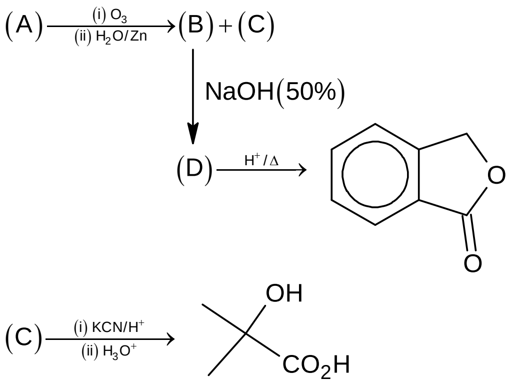
(A) $[Cu(NH_3)_4]^{2+}$ (B) $[Ni(CN)_4]^{2-}$
(C) $[CuCl_4]^{2-}$ (D) $[NiCl_4]^{2-}$

Space for rough work

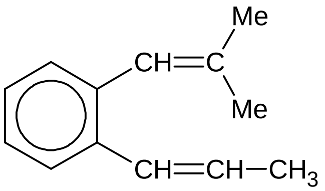
Comprehension Type

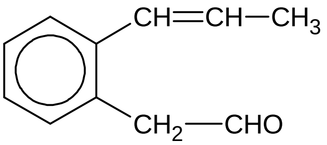
This section contains **2 paragraphs**. Based upon one of paragraph **2 multiple choice questions** and based on the other paragraphs **3 multiple choice questions** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of **which ONLY ONE** is correct.

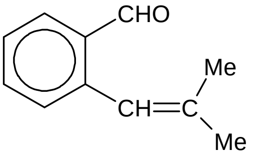
Paragraph for Question Nos. 14 to 15

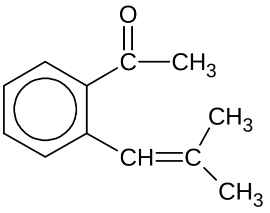

(A)
(i) O_3
(ii) H_2O/Zn
(B) + (C)
NaOH(50%)
(D)
H^+/Δ
O
O
(C)
(i) KCN/H^+
(ii) H_3O^+
OH
CO_2H

14. Structure of (A) is:

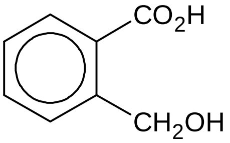
(A)

Me
CH=C
Me
CH=CH−CH_3

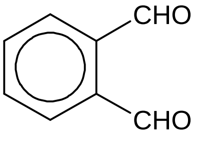
(B)

CH=CH−CH_3
CH_2—CHO

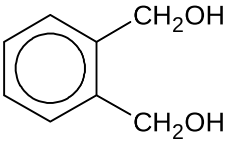
(C)

CHO
Me
CH=C
Me

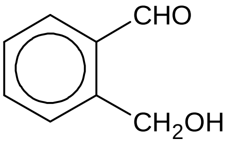
(D)

O
C—CH_3
CH_3
CH=C
CH_3

15. Structure of (B) is:

(A)


(B)


(C)

CH_2OH
CH_2OH

(D)


Space for rough work

Paragraph for Question Nos. 16 to 18

A white metal sulphide (A) gives (B) gas with rotten egg smell and (C) a colourless sulphate, when treated with dil. H_2SO_4. (B) reacts with $K_2Cr_2O_7/H^+$ to form (D), a white grey element. (D) burns in oxygen to yield (E), a colourless gas. If (B) is added in (E), it gives (D) and a colourless liquid which turns anhydrous $CuSO_4$ blue. (C) gives a precipitate with NaOH which dissolves in excess of NaOH.

16. The metal sulphide (A) is:
(A) CuS (B) ZnS
(C) NiS (D) MnS

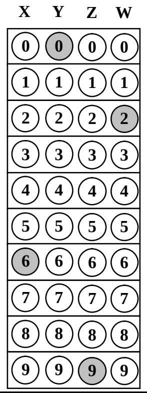
17. The compound (C) is:
(A) $CuSO_4$ (B) $MnSO_4$
(C) $ZnSO_4$ (D) $NiSO_4$

18. The colourless (E) is:
(A) H_2S (B) SO_3
(C) SO_2 (D) CO_2

SECTION – C

Integer Answer Type

This section contains **10 questions.** The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



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1. A compound AB has zinc blende structure with 'A' atoms at corners and face centre of the unit cell. If all the atoms present in one body diagonal are removed, the formula of the compound becomes A_xB_y. The sum (x + y) is:

2. Among the following, the number of compounds which undergo hydrolysis is
NCl_3, P_4O_{10}, $SiCl_4$, $BiCl_3$, XeF_4, $POCl_3$ and B_2H_6.

Space for rough work

3. The number of β-particles emitted by the conversion of ${}^{238}_{92}U$ to ${}^{206}_{82}Pb$ is

4. Total number of cyclic isomers of molecular formula C_4H_7Cl is

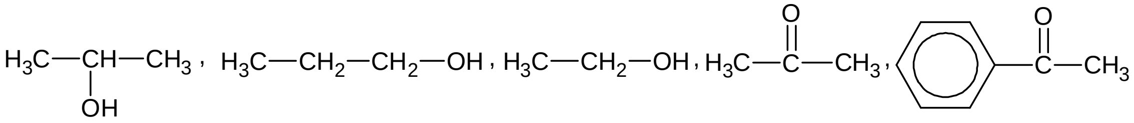
5. Total number of optically active isomers of molecular formula $C_5H_{12}O$ is

6. One mole of PCl_3 is dissolved in excess of water. Number of moles of NaOH required to neutralised this solution completely is

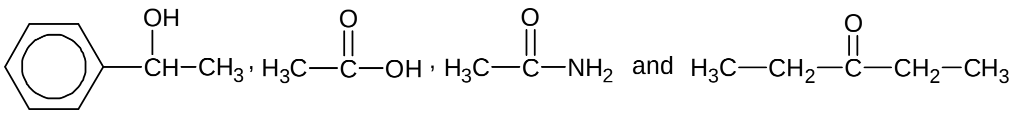
7. A hydrocarbon $C_xH_{12}(g)$ and $O_2(g)$ were taken in a closed flask at 400 K. When sparked they reacted to form $CO_2(g)$ and $H_2O(g)$ and no reactants left after the reaction. The pressure in the flask is increased by 20%. The value of 'x' is

8. The number of neutral oxides among the following oxides is
N_2O, NO, N_2O_3, NO_2, N_2O_5, CO, CO_2, SO_2 and CrO_3

9. Among the following the total number of compound which give positive iodoform test is:



$H_3C-\underset{OH}{CH}-CH_3$, $H_3C-CH_2-CH_2-OH$, H_3C-CH_2-OH, $H_3C-\overset{O}{\overset{\|}{C}}-CH_3$,



$H_3C-\overset{O}{\overset{\|}{C}}-OH$, $H_3C-\overset{O}{\overset{\|}{C}}-NH_2$ and $H_3C-CH_2-\overset{O}{\overset{\|}{C}}-CH_2-CH_3$

10. The number of compounds among the following in which the sulphur has +6 oxidation state is
$H_2S_2O_5$, $H_2S_2O_4$, $H_2S_2O_6$, H_2SO_5, $H_2S_2O_8$, $H_2S_2O_7$, H_2SO_4 and H_2SO_3

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. If $|z - 1| + |z + 3| \le 8$, then the range of values of $|z - 4|$ is
(A) (0, 7) (B) (1, 8)
(C) [1, 9] (D) [2, 5]

2. Two circles with radii $\sqrt{2}$ cm and 1 cm meet at a point A, whose centres lie on x-axis. The distance between their centres is 2 cm. The chord AC of the larger circle cuts the smaller circle at a point B and is bisected by that point. The length of chord AC is
(A) $\frac{\sqrt{5}}{2}$ cm (B) $\sqrt{\frac{7}{2}}$ cm
(C) $\frac{\sqrt{3}}{2}$ cm (D) $\sqrt{\frac{5}{2}}$ cm

3. Suppose P is an interior point of a ΔABC such that the ratio
$\frac{d(A,\ BC)}{d(P,\ BC)} = \frac{d(B,\ CA)}{d(P,\ CA)} = \frac{d(C,\ AB)}{d(P,\ AB)} = \frac{p_1}{p_2}$, then
(A) P is orthocenter and $p_1 : p_2 = 4 : 1$ (B) P is orthocenter and $p_1 : p_2 = 3 : 1$
(C) P is centroid and $p_1 : p_2 = 3 : 1$ (D) P is circumcentre and $p_1 : p_2 = 4 : 1$

4. Two triangles ABC and DEF are formed by three tangents and the corresponding three normals to a parabola $y^2 = 4ax$ respectively. The orthocenter of ΔABC has coordinates (–5, 4). Then, distance of orthocenter of ΔDEF from axis of parabola is
(A) 5 units (B) 2 units
(C) 4 units (D) cannot be determined

5. All the 7 digit numbers containing each of the digits 2, 3, 5, 6, 7, 8, 9 exactly once and not divisible by 5 are arranged in increasing order. The 2017th number in the list is
(A) 6298753 (B) 6325789
(C) 6352789 (D) none of these

Space for rough work

6. If P and Q are symmetric matrices and PQ = QP, then which of the following is/are true?
(A) $QP^{-1} = P^{-1}Q$
(B) PQ is skew symmetric
(C) $P^{-1}Q$ is symmetric
(D) both (a) and (c)

7. Let W_1 and W_2 are two distinct points in an argand plane. If $p|W_1| = q|W_2|$, then the point $\frac{pW_1}{qW_2} + \frac{qW_2}{pW_1}$ is a point on the
(A) line segment [–2, 2] of the real axis
(B) line segment [–2, 2] of the imaginary axis
(C) unit circle $|z| = 1$
(D) the line $\arg W = \tan^{-1} 2$

8. There are n urns $u_1, u_2, \ldots, u_n$. Each urn contains $2n+1$ balls. The i^{th} urn contains 2i number of balls $P(u_i)$, i.e., probability of selecting i^{th} urn is proportional to (i^2+2). If we randomly select one of the urns and draw one ball and probability of ball being white be $P(A)$, then $\lim_{n\to\infty} P(A)$ is
(A) $\frac{3}{4}$
(B) $\frac{1}{4}$
(C) $\frac{2}{3}$
(D) $\frac{3}{16}$

Multiple Correct Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

---

9. All values of $x \in \left(0, \frac{\pi}{2}\right)$ such that $\frac{\sqrt{3}-1}{\sin x} + \frac{\sqrt{3}+1}{\cos x} = 4\sqrt{2}$ are
(A) $\frac{\pi}{15}$
(B) $\frac{\pi}{12}$
(C) $\frac{11\pi}{36}$
(D) $\frac{3\pi}{10}$

10. Let a, b, c be distinct complex numbers with |a| = |b| = |c| = 1 and z_1, z_2 be the roots of the equation $az^2 + bz + c = 0$ with $|z_1| = 1$. Also let P and Q represents the complex numbers z_1 and z_2 in the complex plane with $\angle POQ = \theta$ where O is the origin then
(A) $b^2 = ac$, $\theta = \frac{2\pi}{3}$
(B) $\theta = \frac{2\pi}{3}$, $PQ = \sqrt{3}$
(C) $b^2 = ac$, $PQ = 2\sqrt{3}$
(D) $2b^2 = ac$, $\theta = \frac{\pi}{3}$

Space for rough work

11. If the sum of the first 100 terms of an AP is –1 and the sum of the even terms lying in the first 100 terms is 1, then
(A) common difference is $\frac{3}{50}$ (B) first term is $-\frac{149}{50}$
(C) common difference is $\frac{7}{50}$ (D) first term is $-\frac{151}{50}$

12. A line segment is divided so that the lesser part is to the greater part is equal to the greater part is to the whole. If R is the ratio of the lesser part to the greater part, then
(A) $R^2 + R - 1 = 0$ (B) $R^2 + R^{-1} = 2$
(C) $R^{(R^2+R^{-1})} + R^{-1} = 2$ (D) $R^2 + R + 1 = 0$

13. If ‘a’ and ‘b’ are two numbers such that $a^2 + b^2 = 7$ and $a^3 + b^3 = 10$, then
(A) greatest value of $|a + b|$ is 5 (B) greatest value of $(a + b)$ is 4
(C) least value of $(a + b)$ is 1 (D) least value of $|a + b|$ is 1

Comprehension Type

This section contains **2 paragraphs**. Based upon one of paragraph **2 multiple choice questions** and based on the other paragraphs **3 multiple choice questions** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of **which ONLY ONE** is correct.

Paragraph for Question Nos. 14 to 15

Read the following write up carefully and answer the following questions:
Dice A has four red and two white faces whereas dice B has two red and four white faces. A coin is tossed once. If it falls head, the game continues by throwing dice A, if it falls tail, dice B is to be used

14. The probability of getting a red face at any throw is
(A) $\frac{1}{3}$ (B) $\frac{1}{2}$
(C) $\frac{1}{4}$ (D) $\frac{25}{31}$

15. If red turns up at the first 5 thrown, what is the probability that dice A is being used?
(A) $\frac{32}{33}$ (B) $\frac{30}{31}$
(C) $\frac{1}{2}$ (D) $\frac{25}{31}$

Space for rough work

Paragraph for Question Nos. 16 to 18

Read the following write up carefully and answer the following questions:
P is variable point on the line L = 0. Tangents are drawn to the circle $x^2 + y^2 = 4$ from P to touch Q and R. The parallelogram PQSR is complicated

16. If $L \equiv 2x + y = 6$, then the locus of circumcentre of ΔPQR is

(A) $2x - y = 4$	(B) $y + 2x = 3$
(C) $x - 2y = 4$	(D) $x + 2y = 3$

17. If $L \equiv y = 4$ then the locus of the circumcentre of ΔPQR is

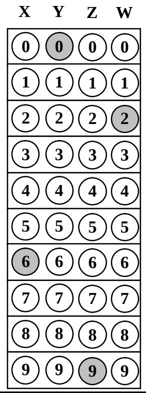
(A) $y = 2$	(B) $x = 2$
(C) $y = 4$	(D) $x = -4$

18. If P = (2, 3), then the circumcentre of ΔQRS is

(A) $\left(\frac{2}{13}, \frac{7}{26}\right)$	(B) $\left(\frac{2}{13}, \frac{3}{16}\right)$
(C) $\left(\frac{4}{13}, \frac{5}{26}\right)$	(D) none of these

SECTION – C

Integer Answer Type



This section contains **10 questions.** The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.

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1. Given that α, β, γ are the roots of cubic equation $x^3 - 3x^2 + 2x + \frac{2}{3} = 0$. The value of $\alpha^4 + \beta^4 + \gamma^4$ is equal to _____

Space for rough work

2. If the substitution x = cos θ reduces the differential equation $\left(1-x^2\right)\frac{d^2y}{dx^2}-x\frac{dy}{dx}+y=0$ to $\frac{d^2y}{d\theta^2}+Ay=0$ then (A^2 + 2) is equal to _____

3. $\lim_{x\to 0^+}\frac{x}{4}\left[\frac{16}{x}\right]$ is equal to _____ (where [.] denote greatest integer function)

4. In a triangle ABC, the least values of Π cosec$\left(\frac{A}{2}\right)$ and $\sum \text{cosec}^2 A$ are p and q respectively, then (p – q) is equal to _____

5. Let $\vec{r}\times\vec{a}=\vec{b}\times\vec{a}$ and $\vec{c}:\vec{r}=0$, where $\vec{a}\cdot\vec{c}\neq 0$, then $\vec{a}\cdot\vec{c}\left(\vec{r}\times\vec{b}\right)+\vec{b}\cdot\vec{c}\left(\vec{a}\times\vec{r}\right)$ is equal to _____

6. If $g(x)=\begin{vmatrix} 1 & x & x+1 \\ 2x & x(x-1) & x(x+1) \\ 3x(x-1) & x(x-1)(x-2) & x\left(x^2-1\right) \end{vmatrix}$, then g(200) is equal to _____

7. $13^{99}-19^{93}$ is divisible by 162, then the remainder is _____

8. Given $\left(2+6+10+14+......+2a\right)+\left(2+6+10+14+.......+2b\right)=\left(2+6+10+14+.......+2c\right)$, where $a+b+c=21$ and a > 6. Then $a-b$ is equal to _____

9. Seven digit numbers are formed using digits 1, 2, 3, 4, 5, 6, 7, 8, 9 without repetition. The probability of selecting a number such that product of any 5 consecutive digits is divisible by either 5 or 7 is p. Then 12p is equal to _____

10. If a singular matrix $A=\left[a_{ij}\right]_{2\times 2}$ always commute with $B=\begin{bmatrix} 1 & 1 \\ 2 & 1 \end{bmatrix}$ such that $\frac{a_{11}}{a_{12}}=\sqrt{k}$, then k is equal to _____

Space for rough work

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FULL TEST – V
PAPER-1

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	C	C
2.	A	A	B
3.	A	D	C
4.	A	A	C
5.	B	B	B
6.	D	C	D
7.	A	C	A
8.	B	A	A
9.	A, B, C	B, C	B, C
10.	B, C	B, C, D	A, B
11.	C, D	B, D	A, B
12.	B, C, D	A, B, D	A, B, C
13.	A, C, D	A, B	A, B, D
14.	C	C	B
15.	B	B	A
16.	C	B	B
17.	A	C	A
18.	D	C	D
1.	3	9	9
2.	1	7	3
3.	2	6	4
4.	5	7	4
5.	1	8	0
6.	3	5	0
7.	1	6	0
8.	8	3	2
9.	5	5	7
10.	0	4	2

Physics

PART – I

SECTION – A

2. $\frac{9}{4}$ intensity of S_1 = 9 times of intensity S_2

Intensity of maxima = $\left(\sqrt{I_1}+\sqrt{I_2}\right)^2$ = 9 I_2

$\Rightarrow$ $S_2P - S_1P = n\lambda$ for maxima

$\sqrt{d^2+x^2} - x = n\lambda$ $\quad$ $x = \frac{d^2-n^2\lambda^2}{2n\lambda}$

3. $\sin\alpha = \frac{\ell}{4y_0^2}$, $\alpha = \sin^{-1}\left(\frac{\ell}{4y_0^2}\right)$

4. $\frac{2mv_0}{qB_0} = \frac{1}{2}\left(\frac{qE_0}{m}\right)t^2$

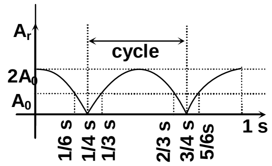
$\frac{4m^2v_0}{q^2E_0B_0} = t^2$

$x = v_0 \times \frac{2m}{q}\sqrt{\frac{v_0}{E_0B_0}}$

6. $y_1 = A\sin\omega_1 t$

$y_2 = A\sin\omega_2 t$

$y_r = 2A\cos\left\{\frac{(\omega_2-\omega_1)}{2}t\right\}\left\{\sin\frac{(\omega_2+\omega_1)}{2}t\right\}$



Resultant amplitude $A_r = 2A_0|\cos(\Delta\omega)t/2|$

$(\Delta\omega)\frac{t}{2} = \frac{\pi}{2} \Rightarrow t = \frac{1}{4}s$

$(\Delta\omega)\frac{t}{2} = \frac{\pi}{3} \Rightarrow t = \frac{1}{6}s$

In one cycle of intensity of 1/2s, the detector remain idle for

$2\left(\frac{1}{4}-\frac{1}{6}\right)s = \frac{1}{6}sec$

$\therefore$ In ½ sec cycle, active time is $\left(\frac{1}{2}-\frac{1}{6}\right)$ = 1/3 sec

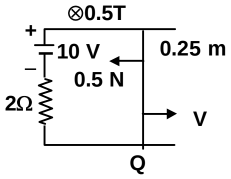
$\therefore$ In 12 sec interval, active time is $12\times\frac{(1/3)}{(1/2)}$ = 8 sec

7. Let ϕ_1 = 4eV, then ϕ_2 = 2eV

$(E - \phi)$ represent kinetic energy of most energetic electron.

$E - \phi_2 = 2(E - \phi_1)$

$\Rightarrow E = 6eV$

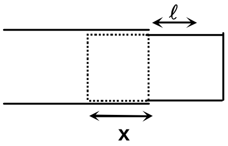


8. Induced e.m.f. = $B\ell v = 0.125$ V

$\text{current } I = \dfrac{10 - e}{R} = \dfrac{10 - 0.125\text{ V}}{2}$

$\text{Force } BI\ell = 0.5\left(\dfrac{10 - 0.125}{2}\right)0.25 = 0.5\text{N}$ (given)

Solving v = 16 m/s.



11. $C = \dfrac{\varepsilon_0(a - x)a}{d} + \dfrac{\varepsilon_0 xak}{d}$

$= \dfrac{\varepsilon_0 a[a - x + kx]}{d}$

$= \dfrac{\varepsilon_0 a}{d}\left[a + (k-1)x\right]$

$U = \dfrac{\varepsilon_0 aV^2}{2d}\left[a + (k-1)x\right]$

$F = \dfrac{dU}{dx} = \dfrac{\varepsilon_0 aV^2(k-1)}{2d}$

$v^2 = v_0^2 + 2Ax = v_0^2 + \dfrac{\varepsilon_0 aV^2(k-1)}{md}x$

$E = \dfrac{1}{2}mv_0^2 + \dfrac{\varepsilon_0 aV^2(k-1)x}{2d} + \dfrac{\varepsilon_0 aV^2}{2d}\left[a + (k-1)x\right]$

$E_{max} = \dfrac{1}{2}mv_0^2 + \dfrac{\varepsilon_0 a^2V^2(2k-1)}{2d}$

12. P.D. same & electric field same
Charge will be kC ε
Energy will be ½ kC ε^2

14. $P_0 + 0.8\,\rho_w gh + \rho_w g(2h) + 1.2\,\rho_w g(3h) = P_0 + 1.2\,\rho_w gh_2$

$\Rightarrow 1.2\,h_2 = h[0.8 + 2 + 3.6] = 6.4\,h \Rightarrow h_2 = \dfrac{6.4}{1.2}h$

$P_0 + 0.8\,\rho_w gh + \rho_w g(2h) = \rho_w gh_1 + P_0$

$\Rightarrow\ h_1 = h[0.8 + 2] \Rightarrow h_1 = 2.8\,h$

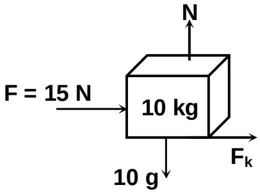
$h_2/h_1 = 40/21$

15. $P_0 + \dfrac{1}{2}\rho_w v^2 = P_0 + 0.8\rho_w gh + \rho_w g(2h)$

$\Rightarrow \dfrac{v^2}{2} = gh[0.8 + 2]$

$v = \sqrt{2 \times 9.8 \times 0.28 \times 2.8} = 3.92$ m/s

16-18. In the time interval t = 0 sec to t = t_0 sec, till the time. The relative velocity is not zero the nature of friction will be kinetic.



$\vec{u}_{AB} = 0\hat{i} - (20\hat{i}) = 20 \text{ m/sec}(\hat{i})$

N = 100 N ⇒ $F_k = 0.25 \times 100 = 25$ N

$\vec{a}_A = 4 \text{m/sec}^2 \left(\hat{i}\right)$, $\vec{a}_B = 0 \text{m/sec}^2 \left(\hat{i}\right)$

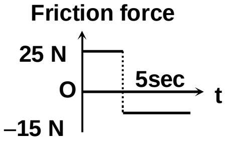
$\vec{a}_{AB} = \vec{a}_A - \vec{a}_B = 4 \text{m/sec}^2 \left(\hat{i}\right)$

$\vec{V}_{AB} = \vec{u}_{AB} + \vec{a}_{AB} t = \vec{0}$

⇒ t = 5 sec

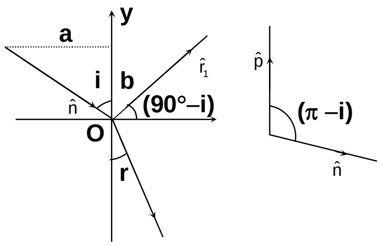
When the relative motion between block A and belt conveyor will be zero, the nature of friction will be static and its magnitude will equal to magnitude of unbalanced external force acting on the block A and its direction will be I the opposite direction of unbalanced external force.

$$\Rightarrow F_r = \text{Frictional force} = \begin{cases} 25\text{N}(\hat{i}) \Rightarrow \text{kinetic in nature} \\ 15\text{N}(-\hat{i}) \Rightarrow \text{Static in nature} \end{cases}$$



SECTION –C

1. $\hat{p} = \hat{j}$, $\hat{n} = a\hat{i} - b\hat{j} = \frac{1}{2}\hat{i} - \frac{\sqrt{3}}{2}\hat{j}$



$\hat{r}_1 = \hat{n} - 2(\hat{n} \cdot \hat{p})\hat{p}$

$= (a\hat{i} - b\hat{j}) - 2(-b)\hat{j} = a\hat{i} + b\hat{j}$

$\hat{n} \cdot \hat{p} = \cos(\pi - i) = -b$

$\cos i = b = \frac{\sqrt{3}}{2} \Rightarrow i = 30°$

$\mu = \cot i = \sqrt{3}$

4. For collision the relative velocity of A with respect to B should be along the line AB

6. Using condition of equilibrium

KL = $(m_1 + m_2)g$

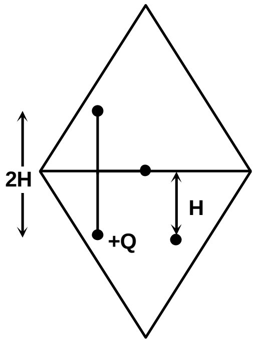
Using COME

$\frac{1}{2}KL^2 = m_1 g(2L)$

$\Rightarrow \quad m_1 = \frac{KL}{4g} = \frac{(m_1 + m_2)}{4}$

$\Rightarrow \quad 3m_1 = m_2 = m_2/m_1 = 3$

8. If we place another similar cone on this one, net flux = $\frac{Q}{\varepsilon_0}$



⇒ Flux with the upper cone = $\frac{Q}{\varepsilon_0} - \frac{3Q}{5\varepsilon_0} = \frac{2Q}{5\varepsilon_0} = \frac{8Q}{20\varepsilon_0}$. This must also be the flux associated with the lower cone when the charge is raised through a height 2H because of symmetry.

9. Velocity of first block before collision,

$v_1^2 = 1^2 - 2(2) \times 0.16$

$= 1 - 0.64$

$v_1 = 0.6$ m/s

By conservation of momentum, $2 \times 0.6 = 2\, v_1' + 4 v_2'$

also $v_2' - v_1' = v_1$ for elastic collision

It gives $v_2' = 0.4$ m/s

$v_1' = -0.2$ m/s

Now distance moved after collision

$s_1 = \frac{(0.4)^2}{2 \times 2}$ & $s_2 = \frac{(0.2)^2}{2 \times 2}$

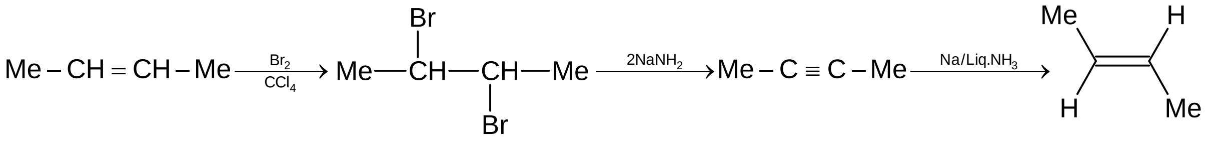
$\therefore$ $s = s_1 + s_2 = 0.05$ m = 5 cm.

10. By symmetry, no current will flow in arm along x-axis.

Chemistry PART – II

3. More activated ring undergo EAS.

4.



5. 1st titration

Meq. of NaOH $\frac{1}{2}$ Meq. of Na_2CO_3 = Meq. of HCl = $50 \times \frac{1}{10} = 5$

2nd titration

$\frac{1}{2}$ Meq. of Na_2CO_3 = Meq. of HCl = $10 \times \frac{1}{10} = 1$

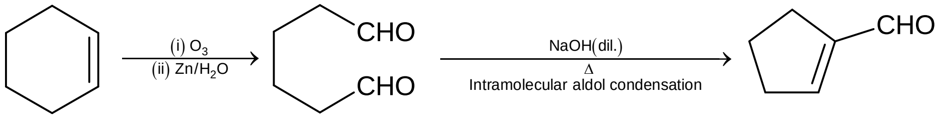
$\therefore$ Meq. of NaOH = 5 – 1 = 4

Wt. of NaOH $= \frac{\text{Meq. of NaOH} \times \text{Equivalent weight}}{1000}$

$= \frac{4 \times 40}{1000}$

= 0.16 g

6.



7. $8NH_3\,(\text{excess}) + 3Cl_2 \longrightarrow 6NH_4Cl + N_2$

$6NaOH(\text{hot and conc.}) + 3Cl_2 \longrightarrow 5NaCl + NaClO_3 + 3H_2O$

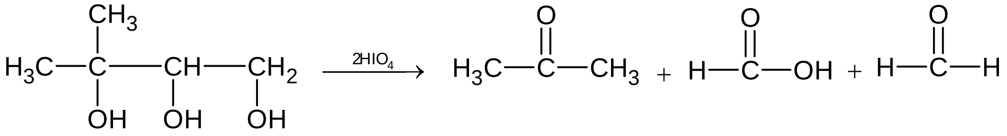
$Fe + 2HCl \longrightarrow FeCl_2 + H_2$

Liberation of H_2 prevents the formation of $FeCl_3$.
Bond dissociation of F – F is less than that of Cl – Cl.

8. $(CH_3)_3SiCl$ is used to stop the growth of polymerisation of linear polymer formed from the hydrolysis of $(CH_3)_2SiCl_2$.

9. Configuration of (B) is (2R, 3S)
Configuration of (C) is (2R, 3S)

10.



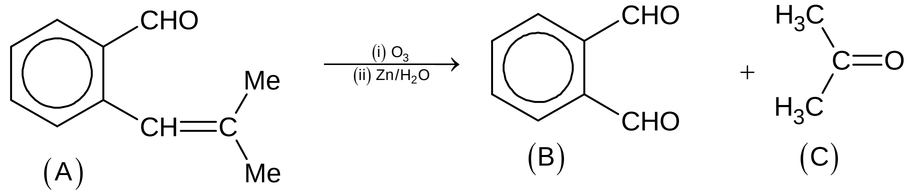
$$H_3C-\underset{OH}{\overset{CH_3}{C}}-\underset{OH}{CH}-\underset{OH}{CH_2} \xrightarrow{2HIO_4} H_3C-\overset{O}{\overset{\|}{C}}-CH_3 + H-\overset{O}{\overset{\|}{C}}-OH + H-\overset{O}{\overset{\|}{C}}-H$$

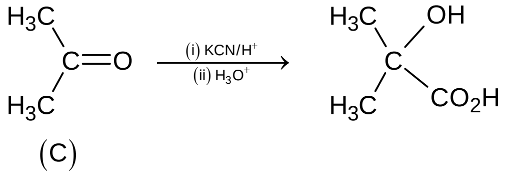
11.
1. Addition of inert gas at constant pressure shifts the equilibrium in that direction which has more number of gaseous moles.
2. Increasing the volume of the container shifts the equilibrium in that direction which has more number of gaseous moles.

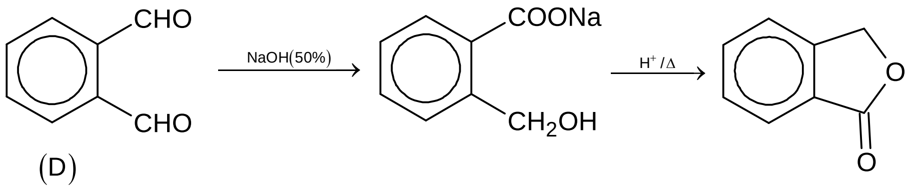
12. Chemisorption unimolecular layer.

13. $[Cu(NH_3)_4]^{2+} \rightarrow dsp^2$
$[Ni(CN)_4]^{2-} \rightarrow dsp^2$
$[CuCl_4]^{2-} \rightarrow sp^3$
$[NiCl_4]^{2-} \rightarrow sp^3$

14.–15.


CHO
Me
CH
C
Me
(A)
(i) O3
(ii) Zn/H2O
CHO
CHO
(B)
+
H3C
C=O
H3C
(C)


H3C
C=O
H3C
(C)
(i) KCN/H+
(ii) H3O+
H3C
OH
C
H3C
CO2H


CHO
CHO
(D)
NaOH(50%)
COONa
CH2OH
H+/Δ
O
O

16.–18.

$$\underset{\text{(White)}}{\underset{\text{(A)}}{ZnS}} + H_2SO_4 \longrightarrow \underset{\text{(C)}}{ZnSO_4} + \underset{\text{(B)}}{H_2S}$$

$$3H_2S + K_2Cr_2O_7 + 4H_2SO_4 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + \underset{\text{(D)}}{3S} + 7H_2O$$

$$\underset{\text{(D)}}{S} + O_2 \longrightarrow \underset{\text{(E)}}{SO_2}$$

$$2H_2S + SO_2 \longrightarrow 2H_2O + 3S$$

$$ZnSO_4 + 2NaOH \longrightarrow Zn(OH)_2 + Na_2SO_4$$

$$Zn(OH)_2 + 2NaOH \longrightarrow \underset{\text{(Soluble)}}{Na_2ZnO_2} + 2H_2O$$

SECTION – C

1. A present in corners and face centre.
B present in alternate tetrahedral voids.

No. of A per unit cell = $6\times\frac{1}{8}+6\times\frac{1}{2}=\frac{15}{4}$

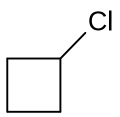
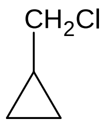
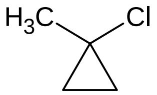
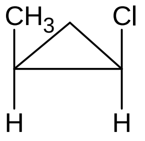
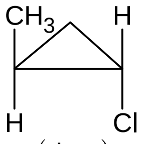
No. of B per unit cell = 4 – 1 = 3

$x : y = \frac{15}{4} : 3 = 5 : 4$

x + y = 5 + 4 = 9

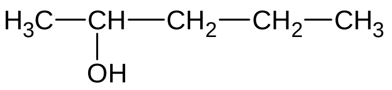
2. All the compounds undergo hydrolysis.

3. Let the number of α-particles emitted be x and the number of β-particles emitted be y.
4x = 238 – 206 = 32
x = 8
2x – y = 10
2 × 8 – y = 10
y = 6.

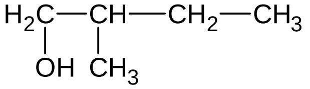
4.     

$(d+\ell)$ $(d+\ell)$

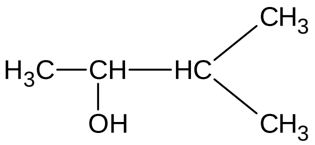
Total number of isomers = 7.

5. 

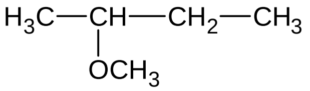
$$H_3C-\underset{\large OH}{\underset{|}{CH}}-CH_2-CH_2-CH_3 \quad (2)$$



$$H_2\underset{\large OH}{\underset{|}{C}}-\underset{\large CH_3}{\underset{|}{CH}}-CH_2-CH_3 \quad (2)$$



$$H_3C-\underset{\large OH}{\underset{|}{CH}}-HC(CH_3)_2 \quad (2)$$



$$H_3C-\underset{\large OCH_3}{\underset{|}{CH}}-CH_2-CH_3 \quad (2)$$

6. $PCl_3 + 3H_2O \longrightarrow \underset{(\text{dibasic})}{H_3PO_3} + 3HCl$

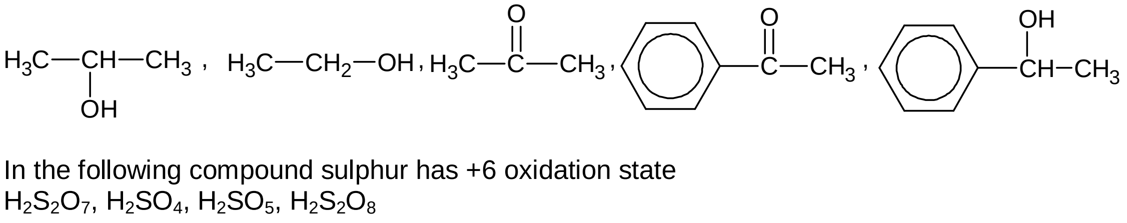
Number of moles required to neutralise H_3PO_3 = 2
Number of moles required to neutralise HCl = 3
Total number of moles of NaOH required to neutralise the solution = 5.

7. $C_xH_{12}(g) + \left(x + \frac{12}{4}\right)O_2(g) \longrightarrow xCO_2(g) + 6H_2O(g)$

Initial moles of gaseous reactant taken = 1 + (x + 3) = x + 4
Final moles of product formed = x + 6
Number of moles increased = 2
Pressure $\propto$ Number of moles.
% of pressure increased $= \frac{2}{(x+4)} \times 100$, $20 = \frac{2}{(x+4)} \times 100$, x = 6.

8. N_2O, NO and CO are neutral oxides remaining are acidic oxides.

9. The following compounds give positive iodoform test



10. In the following compound sulphur has +6 oxidation state
$H_2S_2O_7$, H_2SO_4, H_2SO_5, $H_2S_2O_8$

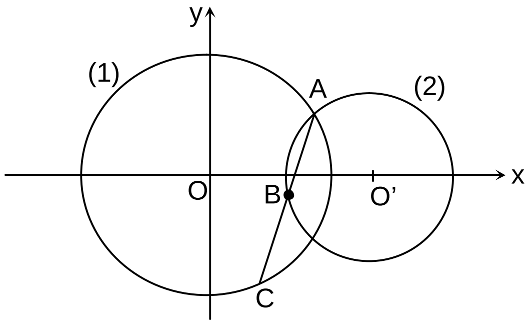
Mathematics PART – III

SECTION – A

2. Let origin be centre of larger circle and O’ be the centre of smaller circle.

Equation of (1): $x^2 + y^2 = 2$

Equation of (2): $(x-2)^2 + y^2 = 1$



$\therefore A\left(\frac{5}{4}, \frac{\sqrt{7}}{4}\right)$

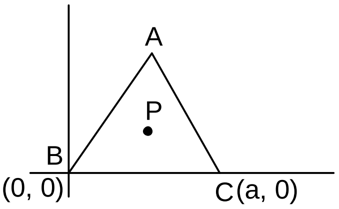
$x_B = \frac{x_A + x_C}{2}, \; y_B = \frac{y_A + y_C}{2}$

$\therefore x_C^2 + y_C^2 = 2$

$$\therefore \left(\frac{x_C + \frac{5}{4}}{2} - 2\right)^2 + \left(\frac{y_C + \frac{\sqrt{7}}{4}}{2}\right)^2 = 1$$

$\therefore AC = \sqrt{\frac{7}{2}}$

3. Let B (0, 0), C (a, 0), A (h, k) and $P(\alpha, \beta)$.



$\frac{d(A, BC)}{d(P, BC)} = \frac{k}{\beta}$

Equation of AC is $kx - (h-a)y - ka = 0$

$\therefore \frac{d(B, AC)}{d(P, AC)} = \frac{ka}{k\alpha - (h-a)\beta - ka}$

Equation of AB is $kx - hy = 0$

$\frac{d(C, AB)}{d(P, AB)} = \frac{ka}{k\alpha - h\beta}$

Solving, $\alpha = \frac{h+a}{3}, \; \beta = \frac{k}{3}$

4. Ortho–centres of triangles formed by three tangents and corresponding normals to a parabola are equidistant from axis of parabola.

5. Number beginning with 2 and not divisible by 5 is 6! – 120 = 600
Number beginning with 3 and not divisible by 5 = 600
Number beginning with 5 and not divisible by 5 = 720
Total = 1920
Number beginning with 6 2 and not divisible by 5 is 120 – 24 = 96
$\therefore$ Total = 2016
$\therefore$ 2017th number is 6325789

6. $(PQ)^T = Q^T P^T = QP = PQ$

PQ is symmetric

$$\therefore PQP^{-1} = QPP^{-1} = Q$$
$$\Rightarrow P^{-1}PQP^{-1} = P^{-1}Q$$
$$\Rightarrow QP^{-1} = P^{-1}Q$$
$$\left(P^{-1}Q\right)^T = Q^T\left(P^{-1}\right)^T = P^{-1}Q$$

8. $P(u_i) \propto i^2 + 2$

$$\Rightarrow P(u_i) = k\left(i^2+2\right)$$

u_1, u_2, …….., u_n are mutually exclusive events.

$$\therefore P(u_1) + P(u_2) + ... + P(u_n) = 1$$
$$\Rightarrow k\left[1^2 + 2 + 2^2 + 2 + 3^2 + 2 + ...n^2 + 2\right] = 1$$
$$\Rightarrow k = \frac{6}{n(n+1)(2n+1)+12n}$$

A → event of drawing a white ball

$$P(A) = k\left(1^2+2\right)\times\frac{2}{2n+1} + k\left(2^2+2\right).\frac{4}{2n+1} + k\left(3^2+2\right).\frac{6}{2n+1} + ... + k\left(n^2+2\right).\frac{2n}{2n+1}$$
$$= \frac{k}{2n+1}\left[1^2.2 + 2^2.4 + 3^2.6 + ... + n^2.2n + 2.2 + 4.2 + 6.2 + ... + 2n.2\right]$$
$$= \frac{2.k}{2n+1}\left[1^3 + 2^3 + 3^3 + ... + n^3 + 2(1+2+3+.....+n)\right]$$
$$= \frac{2k}{2n+1}\left[\frac{n^2(n+1)^2}{4} + n(n+1)\right]$$
$$= \frac{2.6\left[n^2(n+1)^2 + 4n(n+1)\right]}{4(2n+1)\left[n(n+1)(2n+1)+12n\right]}$$
$$\lim_{n\to\infty} P(A) = \lim_{n\to\infty}\frac{3\left(1+\frac{1}{n}\right)^2 + 4\left(\frac{1}{n^2}+\frac{1}{n^3}\right)}{\left(2+\frac{1}{n}\right)^2\left(1+\frac{1}{n}\right) + 12\left(\frac{2}{n^2}+\frac{1}{n^3}\right)} = \frac{3}{4}$$

9. $$\frac{\sin\frac{\pi}{12}}{\sin x} + \frac{\cos\frac{\pi}{12}}{\cos x} = 2$$

10. $|z_1| = |z_2| = 1$; $|z_1 + z_2| = 1$

$$\Rightarrow (z_1+z_2)(\bar{z}_1+\bar{z}_2) = 1$$

$|z_1 + z_2| = |z_1|\ |1 + e^{i\theta}| = 1$

$|z_2 - z_1| = |z_1|\ |e^{i\theta} - 1|$

11. $$\frac{100}{2}(x_1 + x_{100}) = -1$$
$$\frac{50}{2}(x_1 + d + x_{100}) = 1$$

12. Let y < x

$\Rightarrow \frac{y}{x} = \frac{x}{x+y}$

$\Rightarrow R = \frac{1}{1+R}$

13. (a + b) = x, then $x^3 - 21x + 20 = 0$
Which has roots 1, 4, –5

SECTION – C

8. $2(1+3+5+7+......+a)+2(1+3+5+7+......+b)=2(1+3+5+7+......+c)$

$\Rightarrow \left[2+\left(\frac{a+1}{2}-1\right)2\right]\frac{a+1}{2}+\left[2+\left(\frac{b+1}{2}-1\right)2\right]\frac{b+1}{2}=\left[2+\left(\frac{c+1}{2}-1\right)2\right]\frac{c+1}{2}$

$\Rightarrow (a+1)^2+(b+1)^2=(c+1)^2$

$\because a > 6$ and $a+b+c=21$

$\therefore$ a = 7, b = 5, c = 9

$\therefore a-b=2$

9. $p = \frac{{}^3C_1 \times {}^8P_6 + {}^3C_1 \times {}^8P_6 - {}^3P_2 \times {}^7P_5}{{}^9P_7} = \frac{7}{12}$

10. $\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}\begin{bmatrix} 1 & 1 \\ 2 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 2 & 1 \end{bmatrix}\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$

$\Rightarrow a_{11}+2a_{12}=a_{11}+a_{21}$ ..... (i)

$a_{11}+a_{12}=2a_{12}+a_{22}$ ..... (ii)

$a_{21}+2a_{22}=2a_{11}+a_{21}$

$a_{21}+a_{22}=2a_{12}+a_{22}$

$\therefore$ From (ii), $a_{11}=a_{22}$

$a_{21}=2a_{12}$

$\because a_{11}a_{22}=a_{21}a_{21} \Rightarrow (a_{11})^2=2(a_{12})^2$

$\Rightarrow a_{11}=\sqrt{2}a_{12}$

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

FIITJEE **JEE (Advanced), 2014**

FULL TEST – V

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 237**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 06)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+5 marks** for correct answer and **– 2 marks** for wrong answer.
Section-A (07 – 12) contains 2 paragraphs. Based upon paragraph, 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct choice. No marks will be given for any wrong match in any question. There is no negative marking.

(iii) **Section-C (01 – 05)** contains 5 Numerical based questions with single digit integer as answer, ranging from 0 to 9 and each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	g = 10 m/s^2
Planck constant	h = 6.6 $\times 10^{-34}$ J-s
Charge of electron	e = 1.6 $\times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N-m^2
Density of water	$\rho_{water} = 10^3$ kg/m^3
Atmospheric pressure	$P_a = 10^5$ N/m^2
Gas constant	R = 8.314 J K^{-1} mol^{-1}

CHEMISTRY

Gas Constant	R	=	8.314 J K^{-1} mol^{-1}
		=	0.0821 Lit atm K^{-1} mol^{-1}
		=	1.987 $\approx$ 2 Cal K^{-1} mol^{-1}
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

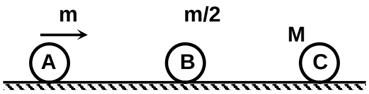
PART – I

SECTION – A

Straight Objective Type

This section contains **6 multiple choice questions** numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Three masses A, B and C are kept on the smooth horizontal surface as shown in the figure. A sharp impulse is given to the mass A, so that it starts moving towards B with speed v_0. What is the minimum value of m so that there is only one collision between masses A and B. (all collision are elastic)

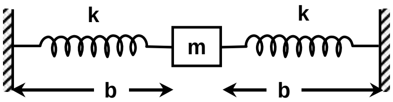


(A) M
(B) $\frac{10M}{3}$
(C) $\frac{8M}{3}$
(D) 2M

2. A freshly prepared sample contains 16×10^{20} radioactive nuclei, whose mean life is 10^{10} seconds. The activity of the sample just after 4 half lives time is

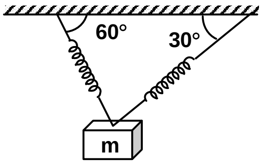
(A) $\frac{\ln^{2}}{16} \times 10^{10}$ dps
(B) 1×10^{10} dps
(C) $\frac{16}{\ln^{2}} \times 10^{10}$ dps
(D) 16×10^{10} dps

Space for rough work



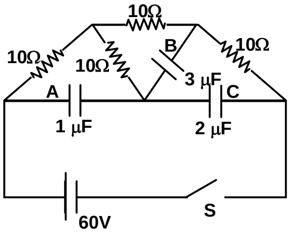
3. In the adjacent figure, a block of mass m is rigidly attached to two identical springs of stiffness k each. The other ends of the springs are connected to the fixed wall when the block is in equilibrium, length of each spring is b, which is greater than then the natural length ℓ of the spring The time period of the oscillation of the block if it is displaced by small distance x perpendicular to the length of the spring and released. (motion of the block is unaffected from gravity).

(A) $2\pi\sqrt{\dfrac{mb}{k(b-\ell)}}$
(B) $2\pi\sqrt{\dfrac{mb}{2k(b-\ell)}}$
(C) $2\pi\sqrt{\dfrac{m(b-\ell)}{kb}}$
(D) $2\pi\sqrt{\dfrac{m(b-\ell)}{2kb}}$



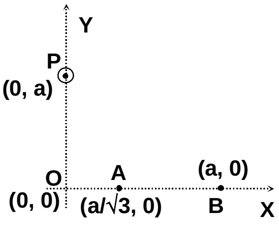
4. Block of mass m = 10 kg is suspended by two springs as shown in the diagram. Acceleration of block just after cutting the right spring is

(A) $\dfrac{5\sqrt{3}}{2}$ m/s^2
(B) 10 m/s^2
(C) $5\sqrt{3}$ m/s^2
(D) 5 m/s^2



5. In the adjacent figure the switch S is closed at t = 0. Q_A, Q_B and Q_C are charges on the capacitor A, Capacitor B and capacitor C in the steady state respectively. Choose the correct statement.

(A) $Q_A < Q_B < Q_C$
(B) $Q_A < Q_C < Q_B$
(C) $Q_C < Q_A < Q_B$
(D) $Q_C < Q_B < Q_A$



6. An infinite current carrying conductor, parallel to z-axis is situated at point P as shown in the figure to x-y plane. The find $\int_A^B \vec{B}\cdot\vec{d\ell}$?

(A) $\dfrac{\mu_0 i}{24}$
(B) $\dfrac{\mu_0 i}{16}$
(C) $\dfrac{\mu_0 i}{12}$
(D) $\dfrac{\mu_0 i}{8}$

Space for rough work

Comprehension Type

This section contains **2 groups of questions.** Each group has 3 multiple choice question based on a paragraphs. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Questions 7 and 9

An experiment is performed on thin lens in order to determine the radii R_1 and R_2 of the curvature of its two surfaces and the refractive index 'μ' of its glass.

Experiment I: A real object is placed 36 cm to the left of lens and a real image is formed 72 cm to the right of lens.

Experiment II: The lens is floated on the surface of mercury with surface having radius of curvature R_2 faces air. A real object is placed at 60 cm above it, and a real image is formed at 30 cm above it (assume mercury to be perfectly reflecting).

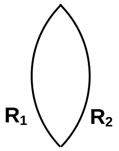
Experiment III: The lens is floated on the surface of mercury with surface having radius of curvature R_1 faces air. A real object is placed at 7.5 cm above it and real image is formed at $\frac{20}{3}$ cm above it. On the bases of Experiments I, II and III, answer the following questions.

7 The refractive index of material of lens is
(A) 1.6 (B) 1.75
(C) 2 (D) none

8 The magnitude of R_1 is
(A) 60 cm (B) 30 cm
(C) 120 cm (D) 45 cm

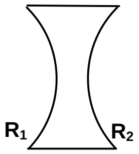
9 The lens can be best represented by

(A)



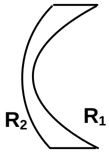
Biconvex

(B)



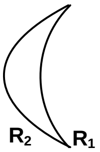
Biconcave

(C)



Convexo-concave

(D)

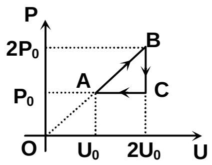


Concavo-convex

Space for rough work

Paragraph for Questions 10 and 12

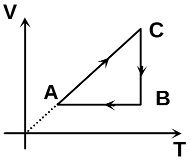
2 mole of an ideal monoatomic gas undergoes a cyclic process ABCA as shown in the figure. R is the universal gas constant. (given ln2 = 0.693)



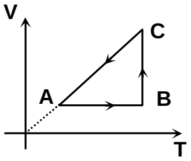
Answer the following questions.

10. Percentage efficiency of cycle is (approximately)
(A) 10.38%
(B) 13.38%
(C) 40.38%
(D) none of these

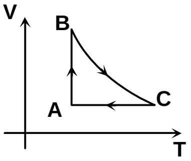
11. Graph of volume verses temperature of the cyclic process ABCA is
(A)



(B)

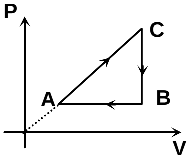


(C)

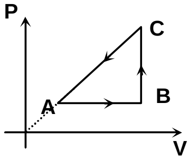


(D) none of these

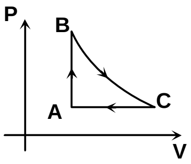
12. Graph of pressure verses volume of the cyclic process ABCA is
(A)



(B)



(C)



(D) none of these

Space for rough work

SECTION – B

(Matching List Type)

This section contains **2 multiple choice questions.** Each question has matching Column(s). The codes for the Column(s) have choices (A), (B), (C) and (D) out of which only **ONE OR MORE is/are correct.**

1. An electron in a hydrogen atom makes a transition $n_1 \rightarrow n_2$, where n_1 and n_2 are the principal quantum numbers of the two states. Assume Bohr model to be valid.

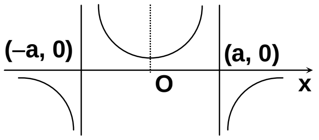
	Column I		**Column II**
(A)	The electron emits an energy of 2.55 eV	(p)	$n_1 = 2, n_2 = 1$
(B)	Time period of the electron in the initial state is eight times that in the final state.	(q)	$n_1 = 4, n_2 = 2$
(C)	Speed of electron become two times	(r)	$n_1 = 5, n_2 = 3$
(D)	Radius of orbit of electron becomes 4.77A°	(s)	$n_1 = 6, n_2 = 3$
		(t)	$n_1 = 8, n_2 = 4$

Space for rough work

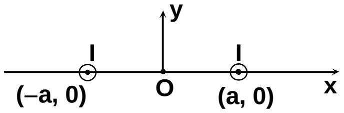
2. The **Column-I** is having the graph of either electrostatic field or its magnitude verses position on x-axis and magnetic field or its magnitude verses position on the x-axis for the system indicated in the **Column-II**. Match the following.

Column I **Column II**

(A)

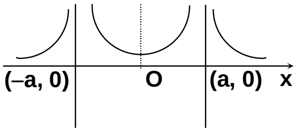


(p)

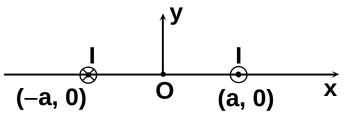


Two infinite wire are kept parallel to z-axis as shown in the figure, each carrying positive current I along positive z-axis

(B)

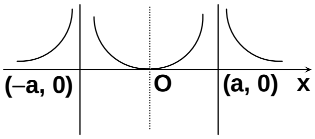


(q)

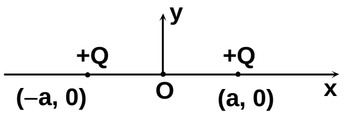


Two infinite wire are kept parallel to z-axis as shown in the figure, one is carrying current positive I along positive z-axis and other is carrying positive current I along negative z-axis

(C)

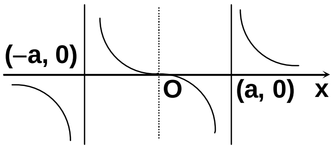


(r)

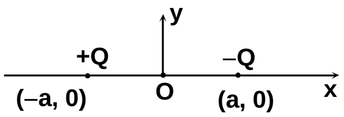


Two point charges, each of magnitude +Q are kept at points (–a, 0) and (a, 0)

(D)

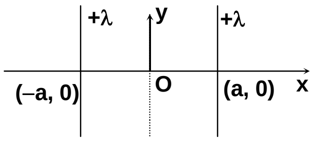


(s)



Two point charges, +Q and –Q are kept at points (–a, 0) and (a, 0) respectively

(t)



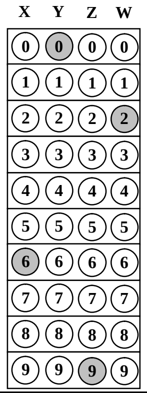
Two infinite non-conducting rod are kept parallel to the y-axis as shown in the figure, each carrying uniform charge density λ.

Space for rough work

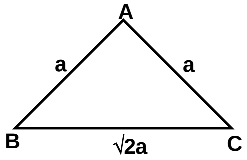
SECTION – C

Integer Answer Type

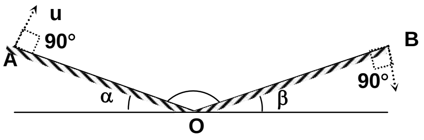
This section contains **5 questions.** The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. ABC is an isosceles triangular sheet of negligible thickness, made of isotropic material. Mass of the sheet is m. Its moment of inertia about axes perpendicular to its plane and passing through the points A and B are I_1 and I_2 respectively. [AB = AC = a and BC = $\sqrt{2}$a]. Find I_2/I_1.



2. Two inclined planes OA and OB of inclinations to the horizontal are α and β, each equal to 30° as shown in the figure. A particle is projected at an angle of 90° with plane OA from point A and its strikes the plane OB at point B normally. Then find the speed of projection in m/s. (given that OA = OB = 20 cm and g = 10 m/s^2)



3. If the sound heard by observer, whose equation is given as
$y = 8\sin 10\pi t \cos 200\pi t$ at x = 0
The number of beat frequency heard by observer is 2k, then find the value of k.

4. A certain amount of a mono-atomic ideal gas undergoes a process $\rho u^{\eta} = C$, where ρ is the density of the gas and u is the internal energy of the gas. It was found that the ratio $r = \frac{\Delta W}{\Delta Q}$ for the process was r = 2/3. What is the value of η?

5. Current in a X-ray tube operating at 40 kV is 10 mA. 1% of the total kinetic energy of electrons hitting the target is converted into X-rays. Then the heat produced in the target per second is 99n Joule

Space for rough work

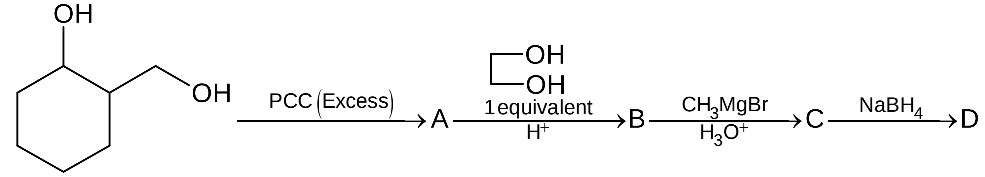
Chemistry PART – II

SECTION – A

Straight Objective Type

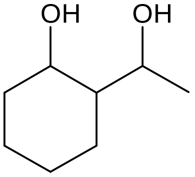
This section contains **6 multiple choice questions** numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1.

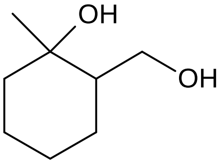

OH
OH
PCC (Excess)
A
OH
OH
1 equivalent
H+
B
CH3MgBr
H3O+
C
NaBH4
D

The product D is:

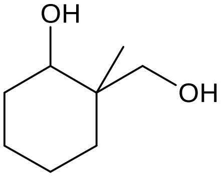
(A)



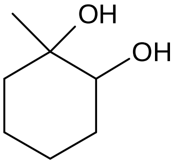
(B)



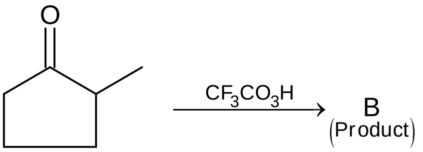
(C)



(D)

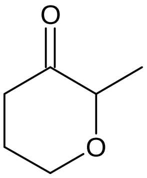


2. In the following reaction,

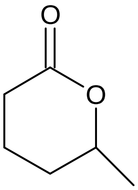

O
CF3CO3H
B
(Product)

The product (B) is:

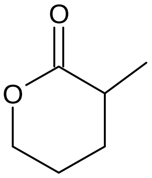
(A)



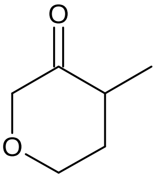
(B)



(C)



(D)



Space for rough work

3. The standard heat of combustion of $C_2H_2(g)$, C(graphite) and $H_2(g)$ are 310 Kcal, 94 Kcal and 98 Kcal respectively. The heat of formation of $C_2H_2(g)$ is:

(A) 24 Kcal	(B) 148 Kcal
(C) 26 Kcal	(D) 284 Kcal

4. 20 ml of $\frac{M}{10}\,NH_4OH$ solution is mixed with 16 ml of $\frac{M}{10}$ HCl solution. The pH of the resulting solution is:(pK_b of $NH_4OH = 4.74$)

(A) 9.26	(B) 6.85
(C) 4.74	(D) 8.65

5. Which of the following statement is incorrect?

(A) $HClO_4$ is a stronger acid than HClO	(B) HF is a stronger acid than HI
(C) BF_3 is a weaker Lewis acid than BCl_3	(D) NF_3 is a weaker Lewis base than NCl_3

6. Which of the following statement is incorrect?
(A) $LiHCO_3$ does not exist in the solid state.
(B) Potassium superoxide is paramagnetic in nature.
(C) Solubility of $Ba(OH)_2$ in water is more than the solubility of $Mg(OH)_2$.
(D) Li_2CO_3 is more stable than Rb_2CO_3.

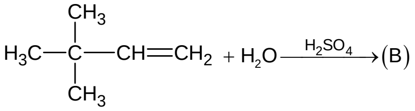
Comprehension Type

This section contains **2 groups of questions.** Each group has 3 multiple choice question based on a paragraphs. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos.7 to 9

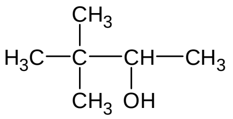
Acid catalysed hydration of alkene gives alcohol. The addition is in accordance with Markownikov's rule. Alcohols can also be prepared by the oxymercuration-demercuration of alkenes. When alkenes undergo hydroboration oxidation alcohol is formed. In oxymercuration-demercuration and hydroboration oxidation, the net result is the addition of H_2O to the double bond producing alcohol.

7. Which of the following is the major product (B) in the following reaction?



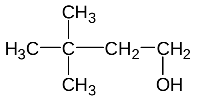
$$H_3C-C(CH_3)_2-CH=CH_2 + H_2O \xrightarrow{H_2SO_4} (B)$$

(A)



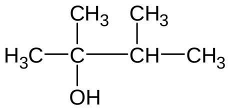
$$H_3C-C(CH_3)_2-CH(OH)-CH_3$$

(B)



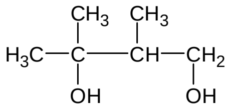
$$H_3C-C(CH_3)_2-CH_2-CH_2OH$$

(C)



$$H_3C-C(CH_3)(OH)-CH(CH_3)-CH_3$$

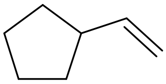
(D)



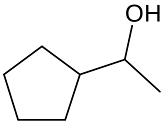
$$H_3C-C(CH_3)(OH)-CH(CH_3)-CH_2OH$$

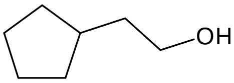
Space for rough work

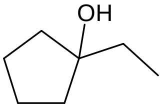
8. In the following reaction,

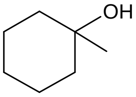
 $+ H_2O \xrightarrow{H_2SO_4} (A)$

The major product (A) is:

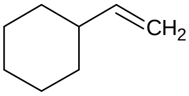
(A) 

(B) 

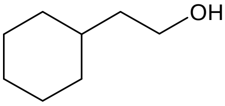
(C) 

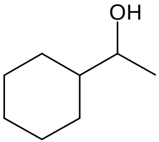
(D) 

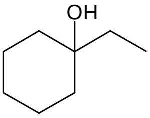
9. In the following reaction:

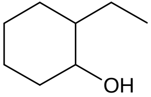
 $\xrightarrow[\text{(II) } H_2O_2 | OH^-]{\text{(I) } BH_3-THF} (B)$

The product (B) is:

(A) 

(B) 

(C) 

(D) 

Paragraph for Question Nos. 10 to 12

A solution is 0.1 M in each KCl, KBr and K_2CrO_4. To this solution solid $AgNO_3$ is gradually added. Assume no change in the volume of the solution.

Given $K_{sp}(AgCl) = 1.7 \times 10^{-10}$
$K_{sp}(AgBr) = 5 \times 10^{-13}$
and $K_{sp}(Ag_2CrO_4) = 1.9 \times 10^{-12}$

10. The sequence of ions precipitated follows the order?
(A) Cl^-, Br^-, CrO_4^{2-}
(B) Br^-, Cl^-, CrO_4^{2-}
(C) Cl^-, CrO_4^{2-}, Br^-
(D) CrO_4^{2-}, Cl^-, Br^-

11. The concentration of first ion when the second ion starts precipitating is about:
(A) 0.1 M
(B) 0.03 M
(C) 0.003 M
(D) 0.0003 M

12. The concentration of $[Ag^+]$ required to start the precipitation of AgBr is:
(A) 5×10^{-12} M
(B) 1.7×10^{-9} M
(C) 6×10^{-11} M
(D) 4×10^{-8} M

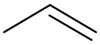
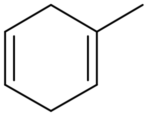
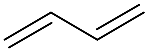
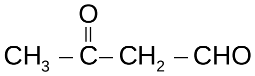
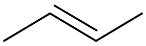
Space for rough work

SECTION – B

(Matching List Type)

This section contains **2 multiple choice questions.** Each question has matching Column(s). The codes for the Column(s) have choices (A), (B), (C) and (D) out of which only **ONE OR MORE is/are correct.**

1. Match the Column – I with Column – II:

Column – I(compounds)	**Column – II(Product(s) of reductive ozonolysis)**
(A) 	(p) OHC – CHO
(B) 	(q) $CH_3 – CHO$
(C) 	(r)  $CH_3 - \overset{\overset{\large O}{\|}}{C} - CH_2 - CHO$
(D) 	(s) HCHO
	(t) $OHC – CH_2 – CHO$

2. Match the Column – I with Column – II:

Column – I	**Column – II**
(A) KCl	(p) Antifluorite structure
(B) CsCl	(q) 4 : 4 coordination
(C) ZnS	(r) 6 : 6 coordination
(D) Na_2O	(s) 8 : 8 coordination
	(t) Rocksalt structure

Space for rough work

SECTION – C

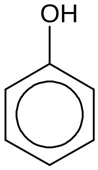
Integer Answer Type

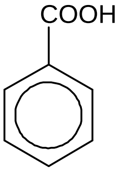
This section contains **5 questions.** The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.

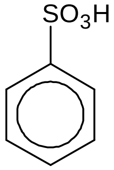
X	Y	Z	W
0	●	0	0
1	1	1	1
2	2	2	●
3	3	3	3
4	4	4	4
5	5	5	5
●	6	6	6
7	7	7	7
8	8	8	8
9	9	●	9

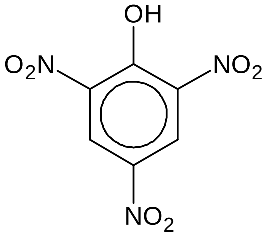
1. Total number of monochlorinated products of $CH_3 – CH_2 – CH_2 – CH_3$ is

2. How many of the following compounds will liberate CO_2 gas from $NaHCO_3$ solution?

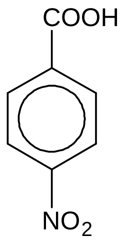




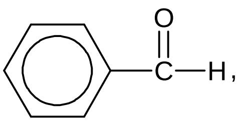


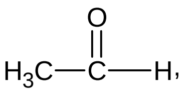


$CH_3 —CH_2—OH$

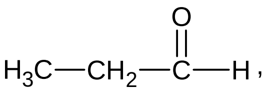


3. Among the following the number of compounds which react with Fehling solution is:

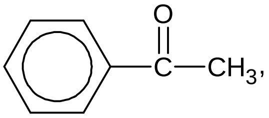


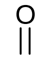


$H_3C—\overset{\overset{\large O}{||}}{C}—H$

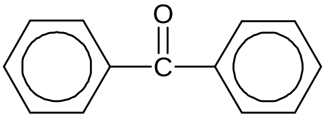


$H_3C—CH_2—\overset{\overset{\large O}{||}}{C}—H$





$H_3C—\overset{\overset{\large O}{||}}{C}—CH_3$



4. The number of geometrical isomers of the complex $[Pt(Py)(NH_3)BrCl]$ is?

5. 5 ml of a gaseous hydrocarbon (C_xH_y) was exploded with 30 ml of oxygen. The resulting gas on cooling to room temperature is found to measure 25 ml of which 10 ml are absorbed by NaOH and the remainder by pyrogallol. The value of x + y is?

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **6 multiple choice questions** numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. The differential equation $\left\{xy^3\left(1+\cos x\right)-y\right\}dx+xdy=0$ represents the curve $\frac{x^2}{ay^2}=\frac{x^3}{b}+x^2\sin x+cx\cos x-d\sin x+k$. Then $a+b+c+d$ is equal to

(A) 8 (B) 9
(C) 10 (D) 11

2. Let $f\left(x\right)=\int\frac{x-1}{x+1}\frac{dx}{\sqrt{x^3+x^2+x}}$ such that $f\left(1\right)=\frac{2\pi}{3}$. Then $f'\left(1\right)$ is equal to

(A) 0 (B) $\frac{\pi}{3}$
(C) $\frac{\pi}{4}$ (D) 2

3. If in the triangle ABC, $\frac{AB}{AC}=\frac{3}{4}$ and D is a point lying on BC such that AB $\perp$ AD and D divides BC externally in the ratio 3 : 2, then

(A) $\angle A = 30^\circ$ (B) $\angle A = 75^\circ$
(C) $\angle A = 45^\circ$ (D) $\angle A = 60^\circ$

4. There were two women participating in a chess tournament. Every participant played two games with every other participant. The number of games that the men played among themselves exceeds by 66 that of the games which the man played with the two women then total number of participants is

(A) 11 (B) 13
(C) 10 (D) 12

Space for rough work

5. If the equation $z^3+(3+i)z^2-3z-(m+i)=0$, where $m\in R$ has at least one real root, then m can have the value equal to

(A) 1
(B) 2
(C) 3
(D) 4

6. Find the value of $\sqrt{1+\frac{1}{1^2}+\frac{1}{2^2}}+\sqrt{1+\frac{1}{2^2}+\frac{1}{3^2}}+\sqrt{1+\frac{1}{3^2}+\frac{1}{4^2}}+.......+\sqrt{1+\frac{1}{2010^2}+\frac{1}{2011^2}}$

(A) $2011-\frac{1}{2011}$
(B) $2011+\frac{1}{2011}$
(C) $2011-\frac{1}{2010}$
(D) none of these

Comprehension Type

This section contains **2 groups of questions.** Each group has 3 multiple choice question based on a paragraphs. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 7 to 9

Read the following write up carefully and answer the following questions:

Let $h(x)=\sin^{-1}\frac{1-x^2}{1+x^2}$ and $g(x)=x^4-2x^3+x^2+4$.

$h(x)$ increases in $(-\infty, a_1)$

$h(x)$ decreases in (a_1, ∞)

$g(x)$ decreases in $(-\infty, a_1)$

$g(x)$ increases in (a_1, a_2)

$g(x)$ decreases in (a_2, a_3)

$g(x)$ increases in (a_3, ∞)

$l(AB)$ = portion of tangent at x = a_1 to the curve $g(x)$ intercepted between x = a_1 and x = a_3.

$l(CD)$ = portion of tangent at x = a_2 to the curve $g(x)$ intercepted between x = a_1 and x = a_3.

Join BC and AD with straight line

7. Let number of points of non differentiability of $y=|h(x)|$ be a_4. Then $a_1+a_2+a_3+a_4$ is equal to

(A) $\frac{9}{2}$
(B) $\frac{7}{2}$
(C) $\frac{11}{2}$
(D) 5

Space for rough work

8. Area of quadrilateral ABCD is

(A) $\frac{1}{16}$ (B) $\frac{1}{4}$

(C) $\frac{9}{16}$ (D) none of these

9. Area enclosed by $y = h(x)$ and x-axis is

(A) $1 + 2\ln 2$ (B) $\frac{\pi}{2} - \ln 2$

(C) $\frac{\pi}{4} + \ln 2$ (D) none of these

Paragraph for Question Nos. 10 to 12

Read the following write up carefully and answer the following questions:

Consider the equation $x^4 + 2ax^3 + x^2 + 2ax + 1 = 0$, where $a \in R$. Also, range of $f(x) = x + \frac{1}{x}$ is $(-\infty,\ -2] \cup [2,\ \infty)$

10. If equation has at least two distinct positive real roots, then all possible values of 'a' are

(A) $\left(-\infty,\ -\frac{1}{4}\right)$ (B) $\left(\frac{5}{4},\ \infty\right)$

(C) $\left(-\infty,\ -\frac{3}{4}\right)$ (D) none of these

11. If equation has at least two distinct negative real roots, then all possible values of 'a' are

(A) $\left(\frac{3}{4},\ \infty\right)$ (B) $\left(-\frac{5}{4},\ \infty\right)$

(C) $\left(-\infty,\ \frac{1}{4}\right)$ (D) none of these

12. If exactly two roots are positive and two roots are negative, then number of integral values of 'a' is

(A) 2 (B) 1

(C) 0 (D) 3

Space for rough work

SECTION – B

(Matching List Type)

This section contains **2 multiple choice questions.** Each question has matching Column(s). The codes for the Column(s) have choices (A), (B), (C) and (D) out of which only **ONE OR MORE is/are correct.**

1. If a, b, c are sides of a triangle and a^3, b^3, c^3 are roots of $x^3 - px^2 + qx - r = 0$. Then, match the following Column–I with Column–II

Column – I		Column – II	
(A)	$\sin^3 A + \sin^3 B + \sin^3 C - 3\sin A \sin B \sin C = 8\Delta^3$	(p)	p = 14, q = 5, r = 8
(B)	$a\sin^2 A + b\sin^2 B + c\sin^2 C = 14\Delta^2$	(q)	p = 36, q = 7, r = 27
(C)	$\sin A \sin B \sin C = 2\Delta^3$	(r)	p = 9, q = 7, r = 8
(D)	$a\cos 2A + b\cos 2B + c\cos 2C = 2\left(s - \Delta^2\right)$	(s)	$p = \frac{63}{2}$, q = 5, r = 27
		(t)	p = 1, q = 8, r = 8

2. Let $f(n, k)$ be the probability that when n coins are tossed, then k heads are obtained $(k \le n)$. Match the following Column–I with Column–II

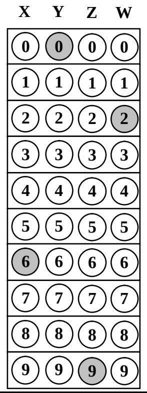
Column – I		Column – II	
(A)	$f(n, k)$ when no 2 heads are consecutive $(n \ge 2k - 1)$	(p)	$\frac{2^n - {}^{n+k+1}C_k}{2^n}$
(B)	$f(n, k)$ when k heads occur together	(q)	$\frac{2^n - {}^{n-k+1}P_1}{2^n}$
(C)	$f(n, k)$ when all k heads do not occur together	(r)	$\frac{{}^{n-k+1}C_k}{2^n}$
(D)	$f(n, k)$ when 2 heads are consecutive	(s)	$\frac{{}^{n-k+1}P_1}{2^n}$
		(t)	$1 - \frac{{}^{n-k+1}C_1}{2^n}$

Space for rough work

SECTION – C

Integer Answer Type

This section contains **5 questions.** The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. A semicircle is drawn outwardly on chord AB of the circle with centre O and unit radius. The perpendicular from O to AB meets the semicircle on AB at C. Then length of AB so that OC has maximum length is $\sqrt{K}$. Then K is equal to _____

2. In a ΔABC, $\angle$B = 60^o. Then, one of the roots of the equation $(a-c)^2 x^2 - b^2 x + ac = 0$, where a, b, c are the sides of the triangle, is equal to _____

3. The centre of a circle passing through foci of a hyperbola $\frac{x^2}{9} - \frac{y^2}{4} = 1$ and the points at which the tangent at the point (6, $2\sqrt{3}$) meets the tangents at the vertices is $\left(h, \frac{-k}{\sqrt{3}}\right)$, then k is equal to _____

4. There are 15 seats in the first row of a theatre of which 6 are to be occupied. The number of ways of arranging 15 person so that no two persons are side by side is k + 5, then digit in unit's place in k is equal to _____

5. The remainder when $6^{83} + 8^{83}$ is divided by 49 is equal to _____

Space for rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

FIITJEE

JEE(Advanced), 2014

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – V
PAPER-2

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	B	B
2.	B	B	A
3.	B	A	D
4.	D	D	B
5.	A	B	A
6.	A	D	A
7.	D	C	A
8.	A	D	A
9.	D	A	A
10.	B	B	C
11.	B	D	A
12.	C	A	C
1.	(A) → (q) (B) → (p, q, s, t) (C) → (p, q, s, t) (D) → (r, s)	(A) → (q, s) (B) → (r, t) (C) → (p, s) (D) → (q)	(A) → (p, q) (B) → (p, s) (C) → (p, r, t) (D) → (t)
2.	(A) → (s) (B) → (q, s) (C) → (p, r, t) (D) → (p, r, t)	(A) → (r, t) (B) → (s) (C) → (q) (D) → (p)	(A) → (r) (B) → (s) (C) → (q) (D) → (p)
1.	2	3	2
2.	2	4	1
3.	5	2	2
4.	3	3	5
5.	4	6	5

Physics

PART – I

SECTION – A

1. Let just after collision between A and B, v_1 and v_2 be the velocity of masses A and B respectively

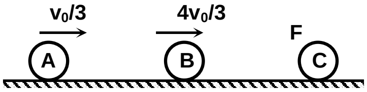
$v_0 = v_2 - v_1$ . . . (1)

$mv_0 = mv_1 + \frac{m}{2}v_2 \Rightarrow 2v_0 = 2v_1 + v_2$ . . . (2)

Using (1) and (2) we have

$v_1 = v_0/3,\ v_2 = 4v_0/3$

Now let v_3 and v_4 will be the velocity of mass B and respectively just after collision between B and C



Situation after collision between A and B

$4v_0/3 = [v_4 - v_3] \times M$ . . . (3)

$2mv_0/3 = mv_3/2 + Mv_4$ . . . (4)

Using M × (3) + (4)

$$\frac{2v_0}{3}[m - 2M] = \frac{1}{2}(m + 2M)v_3$$

$$v_3 = \frac{4v_0}{3}\left[\frac{m-2M}{m+2m}\right]$$

For only one collision between masses A and B

$v_3 > 0$ and $v_3 \geq v_0/3$

$\Rightarrow m > 2M$ and $m \geq 10M/3$

2. $\lambda N(t) = \lambda\left(\frac{1}{2}\right)^n N_0$

Where n is no of half lives

5. $Q_A = 20\ \mu C$
$Q_B = 60\ \mu C$
$Q_C = 80\ \mu C$

12. $U_0 = nc_vT_A = 2 \times \frac{3}{2}RT_A$

$$\Rightarrow T_A = \frac{U_0}{3R},\ T_B = T_C = \frac{2U_0}{3R}$$

$$V_A = V_B = \frac{nRT_A}{P_A} = \frac{2U_0}{3P_0},\ V_c = \frac{nRT_C}{P_C} = \frac{4V_o}{3P_0}$$

$$W_{cycle} = W_{AB} + W_{BC} + W_{CA}$$

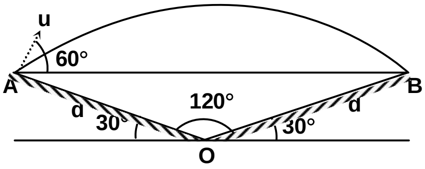
$$= \frac{0.772U_0}{3}$$

$$\%\eta = \frac{W_{cycle}}{\text{Heat supplied}} \times 100 = \frac{W_{cycle}}{Q_{BC} + Q_{AB}} \times 100$$

= 13.38%

SECTION - C

2. Since $\alpha = \beta$
AO = BO = 20 cm
$AB = \sqrt{d^2 + d^2 - 2d \cdot d\cos 120^\circ}$
$AB = \sqrt{3}d$
Now AB is the range of the projectile from A to B.



$$\sqrt{3}d = \frac{u^2 \sin 2\theta}{g}$$

$$\Rightarrow \sqrt{3}d = \frac{u^2\sqrt{3}}{2g}$$

Putting d = 0.2 m
u = 2 m/s

4. $\rho u^{\eta} = C$

$\Rightarrow V^{-1}T^{\eta} = C$

$\Rightarrow TV^{-1/\eta} = C$

$\Rightarrow PV^{1-(1/\eta)} = C$

Compare with $PV^x = C$

$$\Rightarrow x = 1 - \frac{1}{\eta}$$

Now, $\Delta Q \propto \left(\frac{R}{r-1} + \frac{R}{1-x}\right)$ and $\Delta W \propto \left(\frac{R}{1-x}\right)$

$$\Rightarrow \frac{\Delta W}{\Delta Q} = \frac{\left(\frac{R}{1-x}\right)}{\frac{R}{r-1} + \frac{R}{1-x}} = \left(\frac{r-1}{r-x}\right) = \frac{2}{3}$$

$$= \frac{\frac{5}{3} - 1}{\frac{5}{3} - x} = \frac{2}{3}$$

$$\Rightarrow x = 2/3 = 1 - \frac{1}{\eta}$$

$\Rightarrow \eta = 3$

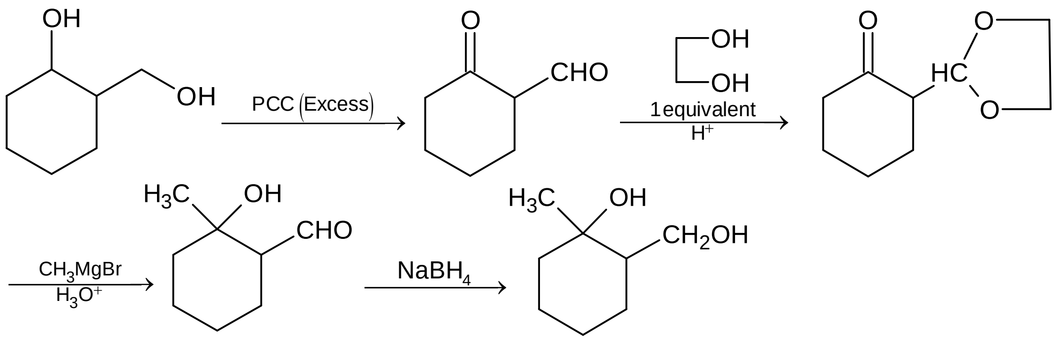
5. Power = 40 kV 10 mA = 400 W.
99 % of it is produced as heating power
Heating power = 396 W = 396 Joules per second.

Chemistry

PART – II

SECTION – A

1.


OH
OH
PCC (Excess)
O
CHO
OH
OH
1 equivalent
H+
O
O
HC
O
H3C
OH
CHO
CH3MgBr
H3O+
NaBH4
H3C
OH
CH2OH

2. Bayer-Villiger oxidation.

3. $2C + H_2(g) \longrightarrow C_2H_2(g)$

$\Delta H = 310 - [(2\times94)+98]$

= 24 kcal

4.

NH_4OH	$+$	HCl	$\longrightarrow NH_4Cl + H_2O$	
$20\times\frac{1}{10}=2$		$16\times\frac{1}{10}=1.6$	0	0
0.4		0	1.6	

The resulting solution is a basic buffer.

$pOH = pK_b + \log\frac{[Salt]}{[Base]}$

$= 4.74 + \log\frac{1.6}{0.4}$

= 4.74 + log4

= 4.74 + 0.6020

= 5.342

pH = 14 – 5. 342

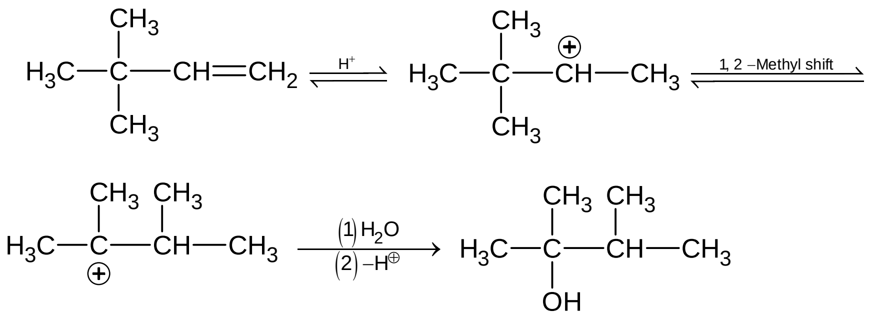
= 8.658

5. HF is a weaker acid than HI

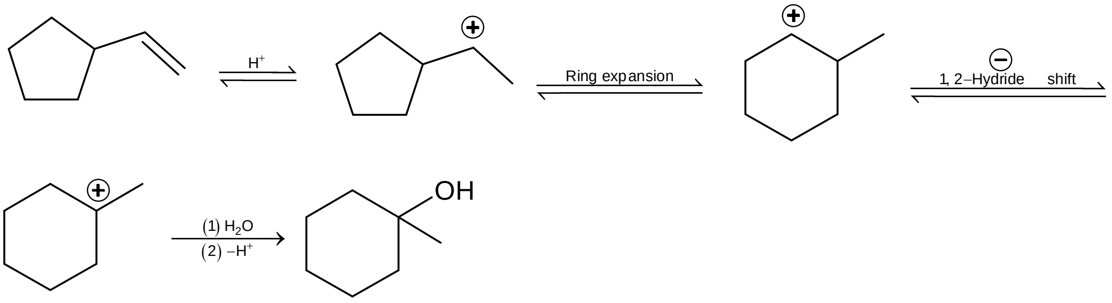
HF < HCl < HBr < HI

6. Li_2CO_3 is less stable than Rb_2CO_3.

7.



8.



9. Hydroboration-oxidation. Anti Markownikov's addition of H_2O.

10. $[Ag^+]$ to start the ppt. of Cl^-

$$=\frac{K_{sp}(AgCl)}{[Cl^-]}=\frac{1.7\times10^{-10}}{0.1}=1.7\times10^{-9}\text{ M}$$

$[Ag^+]$ to start the ppt. of Br^-

$$=\frac{K_{sp}(AgBr)}{[Br^-]}=\frac{5\times10^{-13}}{0.1}=5\times10^{-12}\text{ M}$$

$[Ag^+]$ to start the ppt. of CrO_4^{2-}

$$=\left[\frac{K_{sp}(Ag_2CrO_4)}{[CrO_4^{2-}]}\right]^{1/2}=\left[\frac{1.9\times10^{-12}}{0.1}\right]^{1/2}=4.36\times10^{-6}\text{ M}$$

Order of ppt. Br^-, Cl^-, CrO_4^{2-}.

11. When Cl^- starts precipitating

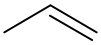
$$[Br^-]=\frac{K_{sp}(AgBr)}{[Ag^+]}=\frac{5\times10^{-13}}{1.7\times10^{-9}}=3\times10^{-4}\text{ M}$$

12. $[Ag^+]$ to start the ppt. of AgBr

$$=\frac{K_{sp}(AgBr)}{[Br^-]}=\frac{5\times10^{-13}}{0.1}=5\times10^{-12}\text{ M}$$

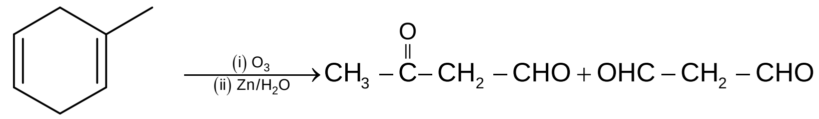
SECTION-B

1. (A)



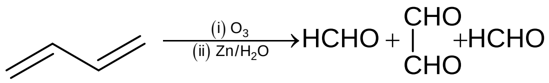
$$\xrightarrow[(ii)\ Zn/H_2O]{(i)\ O_3} CH_3-CHO+HCHO$$

(B)



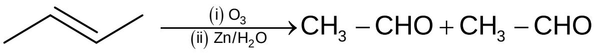
$$\xrightarrow[\text{(ii) Zn/H}_2\text{O}]{\text{(i) O}_3} CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CHO+OHC-CH_2-CHO$$

(C)



$$\xrightarrow[\text{(ii) Zn/H}_2\text{O}]{\text{(i) O}_3} HCHO+\begin{matrix}CHO\\|\\CHO\end{matrix}+HCHO$$

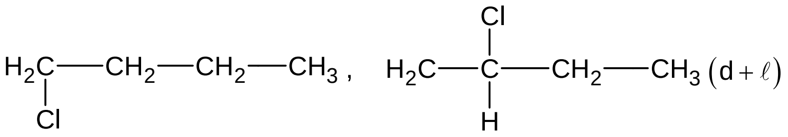
(D)



$$\xrightarrow[\text{(ii) Zn/H}_2\text{O}]{\text{(i) O}_3} CH_3-CHO+CH_3-CHO$$

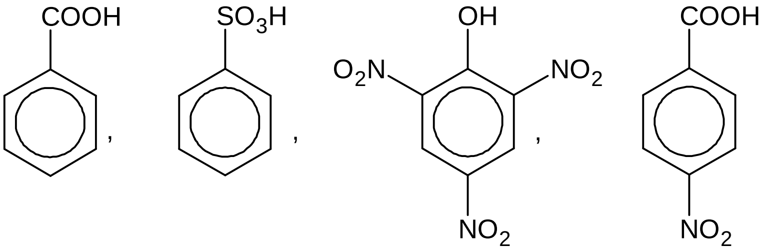
SECTION – C

1.

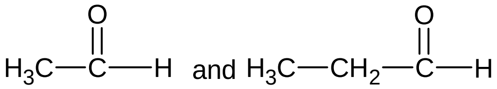


$$\underset{\underset{Cl}{|}}{H_2C}-CH_2-CH_2-CH_3,\quad H_2C-\overset{\overset{Cl}{|}}{\underset{\underset{H}{|}}{C}}-CH_2-CH_3\ (d+\ell)$$

2.

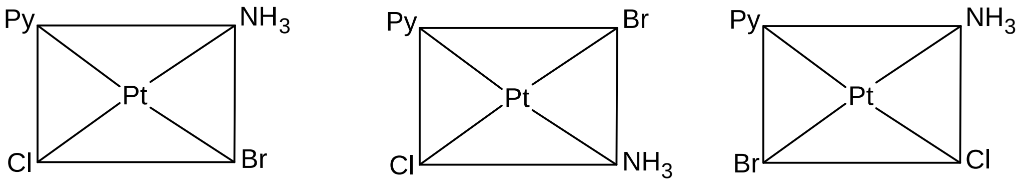


3.



$$H_3C-\overset{\overset{O}{\|}}{C}-H \text{ and } H_3C-CH_2-\overset{\overset{O}{\|}}{C}-H$$ react with Fehling solution.

4.



5.

$$C_xH_y+\left(x+\frac{y}{4}\right)O_2\longrightarrow xCO_2+\frac{y}{2}H_2O(\ell)$$

$$\begin{array}{lll} 5\text{ ml} & 30\text{ ml} & 0 \\ 0 & 30-5\left[x+\frac{y}{4}\right] & 5x \end{array}$$

5x = 10, x = 2

$$5\left(x+\frac{y}{4}\right)=15$$

y = 4

Formula of hydrocarbon = C_xH_y

x + y = 2 + 4 = 6.

Mathematics PART – III

SECTION – A

1. $\frac{dy}{dx}+y^3(1+\cos x)-\frac{y}{x}=0$

$\frac{1}{y^3}\frac{dy}{dx}-\frac{1}{y^2x}=-(1+\cos x)$

Let $\frac{-1}{y^2}=u$

$\therefore \frac{1}{2}\frac{du}{dx}+\frac{u}{x}=-(1+\cos x)$

$IF = e^{\int \frac{2}{x}dx} = x^2$

$\therefore ux^2=-2\int x^2(1+\cos x)dx$

$\Rightarrow \frac{x^2}{2y^2}=\frac{x^3}{3}+x^2\sin x+2x\cos x-2\sin x+k$

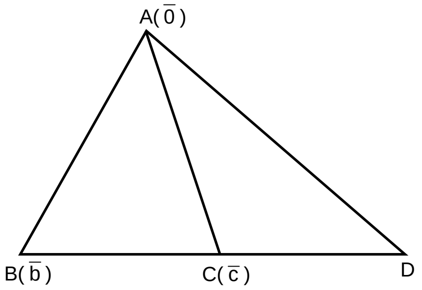
2. Put $x+\frac{1}{x}=t$

3. The p.v. of D = $3\vec{c}-2\vec{b}$

AD ⊥ AB $\Rightarrow \vec{b}\cdot\left(3\vec{c}-2\vec{b}\right) = 0$

$\Rightarrow \cos A = \frac{2|\vec{b}|}{3|\vec{c}|}=\frac{1}{2}$

$\Rightarrow A = 60^\circ$



4. Let number of men be ‘m’.

Number of games played by men among themselves is $2\times {}^{m}C_2 = m(m-1)$

Number of games which the men played with each of two women is 2m.

$\therefore m(m-1)-2(2m)=66$

$m^2-5m-66=0$

$m=11, \ -6$

$\therefore$ Total number of participants = 13 players

Number of games is $2\times {}^{13}C_2=156$

5. Let $z=\alpha$ (real root)

$\alpha^3+(3+i)\alpha^2-3\alpha-(m+i)=0$

$\alpha^3+3\alpha^2-3\alpha-m=0 \Rightarrow \alpha^2-1=0$

$\therefore$ m = 1, 5 $\Rightarrow \alpha=\pm 1$

6. $T_n = \sqrt{1+\frac{1}{n^2}+\frac{1}{(n+1)^2}} = \sqrt{\frac{n^4+2n^3+n^2+n^2+2n+1+n^2}{n^2(n+1)^2}} = \frac{n^2+n+1}{n(n+1)} = 1+\frac{1}{n(n+1)}$

7. $g'(x) = 4x^3-6x^2+2x$

$= 2x\left(2x^2-3x+1\right)$

$= 2x(2x-1)(x-1)$

$\therefore a_1 = 0,\ a_2 = \frac{1}{2},\ a_3 = 1$

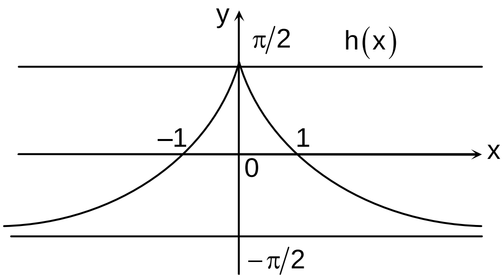
$g\left(\frac{1}{2}\right) = \frac{1}{16}-\frac{2}{8}+\frac{1}{4}+4 = \frac{1}{16}+4$

$\therefore BC = \frac{1}{16}$

$\therefore$ Area of ABCD is = $\frac{1}{16}\times 1 = \frac{1}{16}$

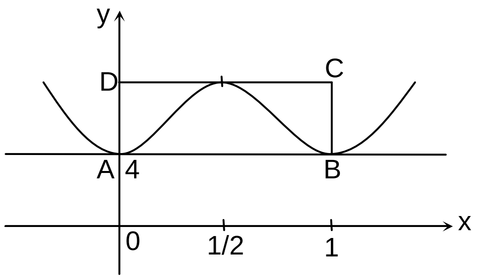
Area = $2\int_0^1 \sin^{-1}\left(\frac{1-x^2}{1+x^2}\right)dx$

Substitute $x = \tan\theta$ and integrate.



$a_4 = 3$

$g(x) =$



10. $\left(x+\frac{1}{x}\right)^2 + 2a\left(x+\frac{1}{x}\right) - 1 = 0$ ..... (1)

$\Rightarrow\ t^2+2at-1=0$ ..... (2)

$t \ge 2$ and $t \le -2$ (Given)

Equation (1) will have at least two positive roots, when at least one root of equation (2) will be greater than 2

11. Equation (1) will have at least two negative roots, when at least one roots of equation (2) will be less than –2

12. –2 and 2 must lie between roots

SECTION – B

1. $a^3+b^3+c^3 = p$

$a^3b^3+b^3c^3+c^3a^3 = q$

$a^3b^3c^3 = r$

(A) $\therefore \frac{a^3+b^3+c^3-3abc}{8R^3} = 8\Delta^3$

$\Rightarrow \frac{\left(p-3r^{\frac{1}{3}}\right)64\Delta^3}{8(abc)^3} = 8\Delta^3$

$\Rightarrow p = r+3r^{\frac{1}{3}}$

(B) $\dfrac{a^3+b^3+c^3}{4R^2}=14\Delta^2$

$$\frac{\left(a^3+b^3+c^3\right)\left(16\Delta^2\right)}{4(abc)^2}=14\Delta^2$$

$$\frac{p}{r^{\frac{2}{3}}}=\frac{14}{4}$$

$$p=\frac{14}{4}r^{\frac{2}{3}}$$

(C) $\dfrac{abc}{8R^3}=2\Delta^3$

$$\Rightarrow\frac{abc\left(\Delta^3\right)64}{8(abc)^3}=2\Delta^3$$

$$\Rightarrow\frac{8}{r^{\frac{2}{3}}}=2$$

$$\Rightarrow r^{\frac{2}{3}}=4$$

$$\Rightarrow r=8$$

(D) $a+b+c-2\left(a\sin^2 A+b\sin^2 B+c\sin^2 C\right)=2\left(s-\Delta^2\right)$

$$\left(a\sin^2 A+b\sin^2 B+c\sin^2 C\right)=\frac{2\Delta^2}{2}$$

$$\Rightarrow\frac{p}{r^{\frac{2}{3}}}.4\Delta^2=\Delta^2$$

$$\Rightarrow p=\frac{r^{\frac{2}{3}}}{4}$$

$$\Rightarrow p=1,\ \ r=8$$

2 **(A)** Let $(n-k)$ tail occur at any $n-k$ places
x T x T x T x T x T x ……… x T
Blank spaces between $(n-k)$ tails can be occupied by k heads.
Total probability = ${}^{n-k+1}C_k\left(\frac{1}{2}\right)^k\left(\frac{1}{2}\right)^{n-k}=\dfrac{{}^{n-k+1}C_k}{2^n}$

(B) Treating the k heads as one unit,
Probability = $\dfrac{{}^{n-k+1}C_1}{2^n}$

(C) and **(D)** follows from **(A)** and **(B)**

SECTION – C

1. Let OD = $\sqrt{a}$ and AD = $\sqrt{1-a}$
OC = OD + CD = $\sqrt{1-a}$

$OC^2 = \left(\sqrt{a}+\sqrt{1-a}\right)^2 = 1+2\sqrt{a(1-a}$

$a(1-a)$ should be maximum

$\Rightarrow$ at $a=\frac{1}{2}$, the above expression attains maximum value

$\therefore$ OD = $\frac{1}{\sqrt{2}}$

$\therefore$ AD = $\frac{1}{\sqrt{2}}$

AB = 2AD = $\sqrt{2}$

2. $\cos B = \frac{1}{2} = \frac{a^2+c^2-b^2}{2ac}$

$\Rightarrow (a-c)^2 - b^2 + ac = 0$

$\Rightarrow$ 1 satisfies the given equation

3. The portion of tangent intercepted between tangent at vertices subtends right angle at focus.
$\therefore$ Centre of circle is the midpoint of the portion of the tangents intercepted between the tangent at vertices

4. Let the six persons P_1, P_2, P_3, P_4, P_5 and P_6 be seated.

$\underset{x_1}{\_}P_1\underset{x_2}{\_}P_2\underset{x_3}{\_}P_3\underset{x_4}{\_}P_4\underset{x_5}{\_}P_5\underset{x_6}{\_}P_6\underset{x_7}{\_}$

x_1 is the number of seats to left of P_1, x_2 is the number of seats in between P_1 and P_2, ………, x_7 is the number of seats to right of P_6 such that $x_1+x_2+x_3+......+x_7=9$.

i.e., coefficient of x^9 in $\left(1+x+x^2+......\right)^2\left(x+x^2+x^3+......\right)^5 = {}^{15-6+1}C_6 = {}^{10}C_6$

$\because$ 6 persons can be arranged in 6! ways

$\therefore$ ${}^{10}P_6$ is the answer

5. $6^{83} + 8^{83} = (7+1)^{83} + (7-1)^{83}$
$= 2({}^{83}C_0\,(7)^{83} + {}^{83}C_2\,(7)^{81} + \ldots + {}^{83}C_{82}\,(7)^1)$
$= 7\lambda + 83 \times 7 \times 2$
$\Rightarrow$ Remainder is 5

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA TEST SERIES

FIITJEE **JEE (Main), 2014**

FULL TEST – V

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 30)** contains 30 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

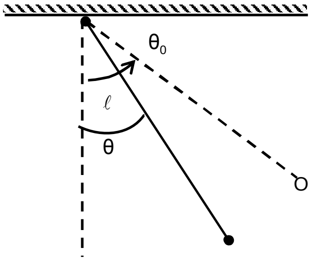
SECTION – A

Single Correct Choice Type

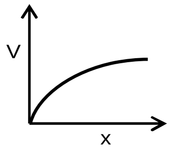
This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. The orbital radius of a hydrogen atom is 0.847 nm. The electron makes a transition from this state to a lower state. How many possible wavelengths are emitted?
(A) 1 (B) 2
(C) 3 (D) 4

2. A point mass is attached to an inextensible string of length ℓ. The particle is released from a position where the string is initially horizontal. At some time string makes an angle θ with vertical & let u be the speed of particle at that instant then
(A) $T\cos\theta = mg$ (T is tension in spring)
(B) $mg\cos\theta = T$
(C) T = 3mg cos θ
(D) T = 2mg cos θ



3. A particle starts from origin at t=0 according to law $x = A(1-e^{-\lambda t})$ graph between its velocity and displacement is

(A)


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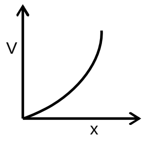

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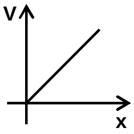

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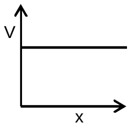
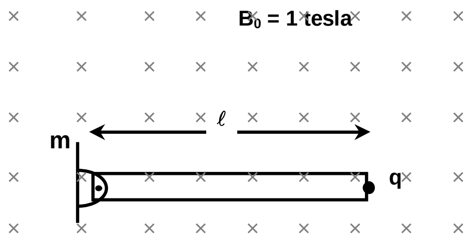


4. A constant and uniform magnetic field of strength, B = 1T is established in a cylindrical region of radius 10 cm. A rectangular conducting wire loop of size 30 cm × 30 cm is taken and moved so that all the magnetic field lines pass through this loop once. The resistance of the loop is 200 Ω. The net charge flowing through the loop is
(A) 4.5 C (B) 4.5×10^{-4}C
(C) $\frac{\pi}{2}$C (D) $\frac{\pi}{2}\times 10^{-4}$C

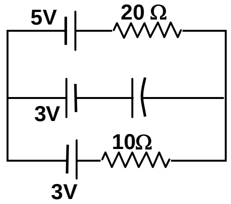
Rough Work

5. A uniform non conducting bar of mass 1 kg, length 1 m is hinged at one end so that it can rotate freely in vertical plane. A charge $\sqrt{\frac{3}{10}}C$ is placed on the other end. If the bar is released from horizontal position the force exerted on the hinge, when the rod becomes vertical, is

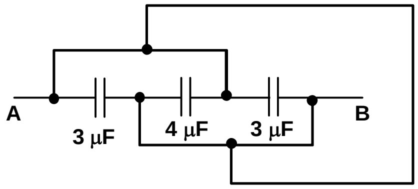


(A) $\frac{\mu_0 q}{4\pi\ell}\sqrt{\frac{3g}{\ell}}$ (B) $\frac{\mu_0 q}{2\pi\ell}\sqrt{\frac{3g}{\ell}}$
(C) $\frac{\mu_0 q}{4\pi}\sqrt{3g\ell}$ (D) $\frac{\mu_0 q}{2\pi}\sqrt{3g\ell}$

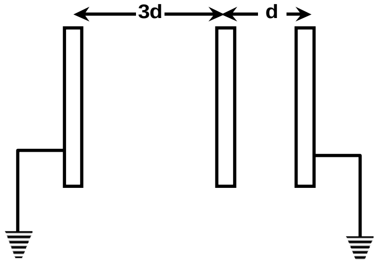
6. The capacitor is the ratio uncharged of the current through the 10 Ω resistance through the 20 Ω resistance is, initially,
(A) 3/2 (B) 6/5
(C) 1/1 (D) 2/3



7. The equivalent capacitance of the circuit between A and B is
(A) 10 μF
(B) 5 μF
(C) 15 μF
(D) 20 μF

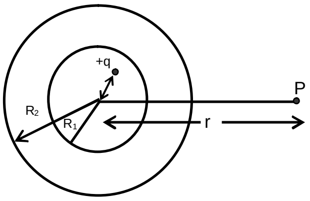


8. Three similar plates are arranged as shown in the figure. If area of each plate is A and a charge +Q is given to middle plate then potential of middle plate is
(A) $\frac{3}{4}\frac{Qd}{A\in_0}$ (B) $\frac{Qd}{4A\in_0}$
(C) $\frac{Qd}{3A\in_0}$ (D) $\frac{Qd}{2A\in_0}$



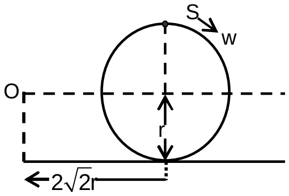
Rough Work

9. A conducting shell having inner radius R_1 and outer radius R_2 contains a charge + q which is placed at a distance x from its centre. Field at an exterior point P which is situated at a distance r from centre of shell $(r > R_2)$



(A) depends on x
(B) depends on R_1 and R_2
(C) depends only or r
(D) None.

10. Consider the situation shown in the figure. The source S emits a wave pulse having frequency f_0 when it is at highest point on the ring (which is performing pure rolling). The frequency of that pulse heard by an observer at O is



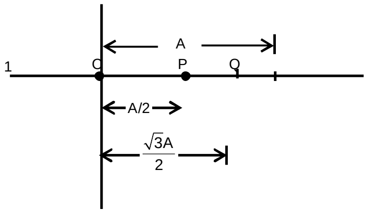
(A) $cfo/\left(3c+2\sqrt{2}c\right)$

(B) $3cfo/\left(3c+2\sqrt{2}c\right)$

(C) $cfo/\left(3c-2\sqrt{2}c\right)$

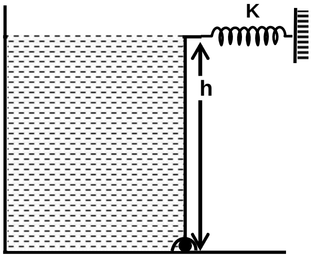
(D) $3fo/\left(3c-2\sqrt{2}c\right)$

11. A particle is performing simple harmonic motion with amplitude A and time period T. Time taken by particle in going from point P to Q is



(A) T/3
(B) T/6
(C) T/12
(D) T/18

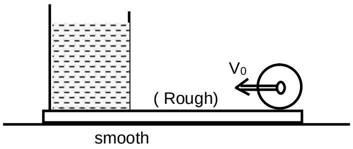
12. A plank of length h and width b (perpendicular to plane of paper is hinged at one end. The upper end is attached with a spring of spring constant k and water is filled up to high h. If plank is in equilibrium in vertical position then potential energy stored in spring is (ignore effect of atmospheric pressure)



(A) $\frac{b^2\rho^2g^2h^4}{18}$
(B) $\frac{b^2\rho^2g^2h^4}{36k}$
(C) $\frac{b^2\rho^2g^2h^4}{72k}$
(D) $\frac{b^2\rho^2g^2h^4}{128k}$

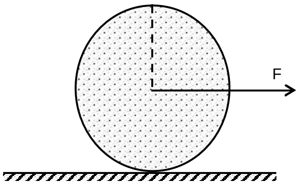
Rough Work

13. A beaker containing liquid is fixed on a long plank which is placed on a smooth ground. A disk is given a velocity V_0 on upper rough surface of plank. When pure rolling starts the surface of liquid is



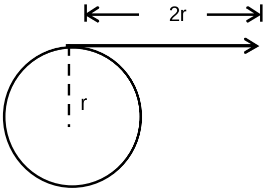
(A) horizontal
(B) curved
(C) inclined
(D) None of the above

14. A uniform disk of mass m is resting on a rough horizontal surface. A force F is applied at the centre of disc at t=0. If disc performs pure rolling then power developed by F at any time t is



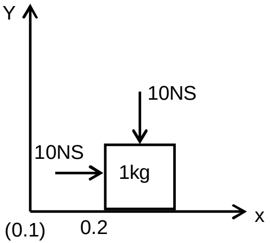
(A) $\frac{3F^2t}{2m}$ (B) $\frac{2F^2t}{3m}$
(C) $\frac{4F^2t}{3m}$ (D) $\frac{aF^2t}{43m}$

15. A uniform bar of mass m and length 2r is attached to ring of mass m and radius r. such that it is tangential to the ring and both are in same plane. Moment of inertia of this assembly about an axis passing through centre of ring and perpendicular to plane is -



(A) $\frac{10}{3}mr^2$ (B) $\frac{7}{3}mr^2$
(C) $\frac{11}{3}mr^2$ (D) $\frac{19}{3}mr^2$

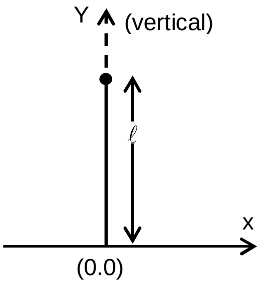
16. A block of mass 1kg is resting on a rough horizontal surface with coefficient of friction 0.2. If an impulse $\left(10\hat{i}-10\hat{j}\right)$ N - s is given to block then velocity of block just after the given impulse is



(A) 10 m/sec. (B) 0 m/sec.
(C) 8 m/sec. (D) 4m/sec.

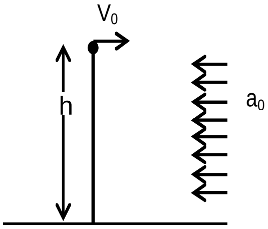
Rough Work

17. A mass m is attached to one end of a light rod. This assembly is placed on the origin as shown in the figure. If all surfaces are smooth then the position of lower end when the rod becomes horizontal after its upper end has been disturbed gently towards right is



(A) $\ell,0$
(B) $\frac{\ell}{2},0$
(C) $-\ell,0$
(D) $-\frac{\ell}{2},0$

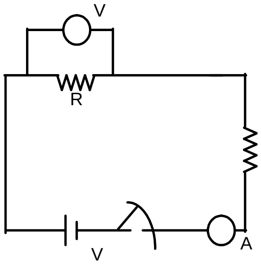
18. A particle is projected horizontally from a tower with velocity V_0. Wind is blowing in opposite direction and is providing a constant horizontal acceleration a_0. If particle strikes the ground vertically then height of building is



(A) $V_0^2 g / a_0$
(B) $\frac{V_0^2 g}{2a_0}$
(C) $\frac{2V_0^2 g}{a_0}$
(D) $\frac{V_0^2}{g}$

19. Two waves given by equations $y_1 = 3\sin(100t - 20x)$m and $y_2 = 4\cos(100t - 20x)$m interfere at a point then amplitude of the resultant wave is
(A) 7m
(B) 1m
(C) 25m
(D) 5m.

20. The potential deference across the resistor as measured by a voltmeter is 60 ± 1.5V and the current through the resistor as measured by an ammeter is (2 ± 0.01) A. what is the maximum % error in the measured value of R?



(A) 3%
(B) 1.5%
(C) 2.5%
(D) None of these

21. Which of the following is equal to the minimum kinetic energy needed by a hydrogen atom in ground state to produce a photon after collision with another identical hydrogen atom at rest?
(A) 6.8eV
(B) 3.4eV
(C) 20.4eV
(D) 2.04eV

Rough Work

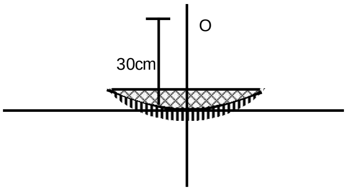
22. Suppose a parent nucleus decays into a daughter nucleus with a decay constant of λ_p and the daughter nucleus of λ_d. At any instant the ratio of parent to daughter nuclei is observed to be 2. What should be the ratio λ_p / λ_d if the number, of daughter nucleus is constant?

(A) 2
(B) $\frac{1}{2}$
(C) $\frac{1}{4}$
(D) 4.

23. The half life of a radioactive substance A is 2 hour and that of B 4 hour. What fraction of the original activity of an equi-molar mixture of A and B remains after 12 hour?

(A) $\frac{9}{64}$
(B) $\frac{5}{96}$
(C) $\frac{1}{16}$
(D) $\frac{1}{16\sqrt{2}}$

24. A concave mirror is placed in a medium of refractive index $\mu_1 = 1.2$. An object placed at 30 cm from pole of the mirror and is image coincide. Now a liquid of refractive index μ is placed in the concave mirror in the shaded region and it is found that object needs to be shifted by 7.5 cm below O for the object and image to coincide. The refractive index of the liquid μ is

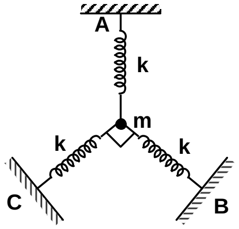


(A) $\frac{4}{3}$
(B) 1.2
(C) 1.6
(D) None of the above.

25. An object is placed at 30 cm from a convex lens of focal length 15cm. On the other side of the lens a convex mirror of focal length 12cm is placed so that the principal axis of both coincide. It is observed that the object and image coincide. What is the separation between the lens and mirror?

(A) 6cm
(B) 30cm
(C) both (A) and (B)
(D) none of the above

26. A particle of mass m is attached to three identical springs of spring constant k connected to the three vertices of an equilateral triangle ABC. The mass m is pressed against block C and released. The time period of small oscillations is



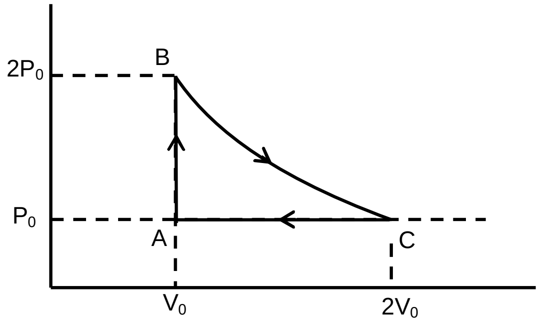
(A) $2\pi\sqrt{\frac{3m}{k}}$
(B) $2\pi\sqrt{\frac{m}{3k}}$
(C) $\frac{2\pi}{3}\sqrt{\frac{m}{k}}$
(D) $2\pi\sqrt{\frac{2m}{3k}}$

Rough Work

27. A tuning fork of frequency 330 Hz is observed to resonate with an open organ pipe. The length of the open pipe could be (speed of sound in air = 330 m/s)
(A) 1/2 m (B) 3/2 m
(C) 3/4 m (D) 1 m

28. An inductor of inductance $\frac{1}{\pi^2}$mH is connected in series with a capacitor of 2.5 μF charged to 30 V and the circuit is completed (t = 0). The time when the voltage across the capacitor becomes 15 V for the first time is
(A) $\frac{1}{12}\times10^{-4}$s (B) $\frac{1}{2}\times10^{-4}$s
(C) $\frac{1}{6}\times10^{-4}$s (D) $\frac{1}{8}\times10^{-4}$s

29. 1 mole of a mono atomic ideal gas undergoes a cyclic process shown in the diagram. The process BC is isothermal and the temperature at B is 800 K. The work done by the gas during the process ABC equals
(A) 1600 Rln2
(B) 3200 Rln2
(C) 800 Rln2
(D) zero



30. A calorimeter of water equivalent 20g is filled with 230 g water at 20°C. An unknown solid of mass 150g heated to a temperature of 75°C is put into the calorimeter and the system is thermally insulated from the surroundings. The final temperature of the system is found to be 25°C. The water equivalent of the solid is
(A) 150 g (B) 75g
(C) 45 g (D) 25 g

Rough Work

Chemistry

PART – II

SECTION – A

Straight Objective Type

This section contains **30 multiple choice** questions numbered **1 to 30.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Which of the following is resistant to hydrolysis at room temperature?
(A) SF_6
(B) $SiCl_4$
(C) PCl_5
(D) BCl_3

2. The complex ion which exhibits geometrical isomerism as well as optical isomerism is:
(A) $[Cr(NH_3)_4Cl_2]^+$
(B) $[Pt(NH_3)_2Cl_2]$
(C) $[Pt(NH_3)_2(Br_2)_2Cl_2]$
(D) $[Ca(EDTA)]^{2-}$

3. Select the reaction (s) which would liberate hydrogen gas?
(I) $SiH_4 + H_2O \longrightarrow ?$
(II) $Al + NaOH \longrightarrow ?$
(III) $Zn + H_2SO_4(\text{dilute}) \longrightarrow ?$
(IV) $XeF_6 + H_2O \longrightarrow ?$
(A) II, III
(B) I, II, III
(C) I, IV
(D) I, II, III, IV

4. The metal which is extracted by hydrometallurgy as well as pyrometallurgy is:
(A) Mg
(B) Fe
(C) Pb
(D) Cu

5. Which of the given set of compounds does not exist?
(A) H_2S, $PbCl_4$, FeI_3
(B) HgI_2, FeI_3, PbI_4
(C) PH_5, SCl_6, $BiCl_5$
(D) BiI_3, Al_2Br_6, Fe_2Cl_6

Rough Work

6. The correct order of increasing bond length is:

(A) $H_2 > H_2^+ > H_2^-$
(B) $H_2 < H_2^+ < H_2^-$
(C) $H_2 < H_2^+ = H_2^-$
(D) $H_2 < H_2^- < H_2^+$

7. $B_2H_6 + \underset{(\text{Lewis base})}{2L:} \longrightarrow 2BH_3L$

L : would be

(A) NH_3
(B) CH_3NH_2
(C) $(CH_3)_2NH$
(D) $(CH_3)_3N$

8. Which of the following reaction is exothermic in nature?

(A) $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + Cr_2O_3 + 4H_2O$
(B) $2Al + Fe_2O_3 \xrightarrow{\Delta} 2Fe + Al_2O_3$
(C) $2Na + 2H_2O \longrightarrow 2NaOH + H_2 \uparrow$
(D) All of these

9. Which of the following set of cations can not be precipitated by treatment with sodium thiosulphate solution?

(A) Ag^+
(B) Zn^{2+}
(C) Pb^{2+}
(D) Bi^{3+}

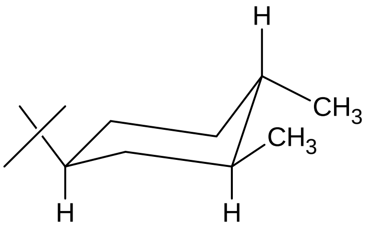
10. Select the reaction, which is not disproportionation reaction?

(A) $NH_4NO_3 \xrightarrow{\Delta} ?$
(B) $Na_2SO_3 \xrightarrow{\Delta} ?$
(C) $P_4 + NaOH \xrightarrow{\Delta} ?$
(D) $H_3PO_3 \xrightarrow{\Delta} ?$

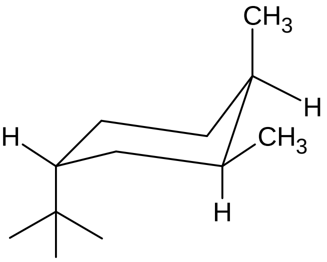
Rough Work

11. Which of the following conformations has maximum energy?

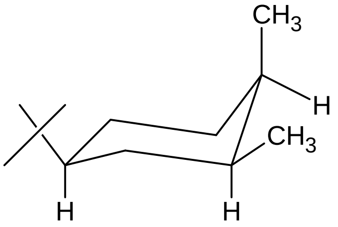
(A)



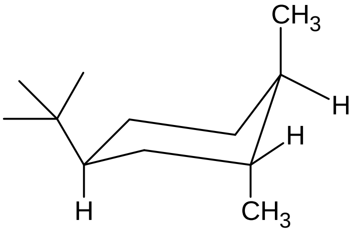
(B)



(C)

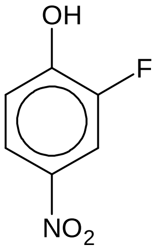


(D)

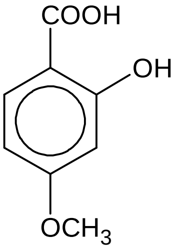


12. The most acidic compound among the following is:

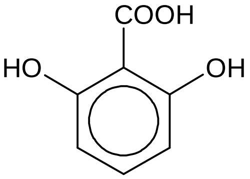
(A)



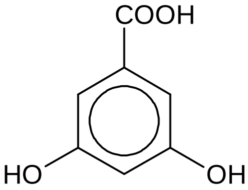
(B)


COOH
OH
OCH3

(C)

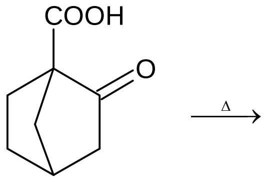


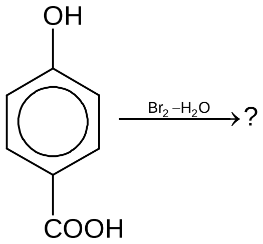
(D)



Rough Work

13. Which of the following reactions would produce a gas which turns lime water milky?

(A)


(B)

OH
Br_2-H_2O
?
COOH

(C) $MgCl_2.6H_2O \xrightarrow{\Delta}$

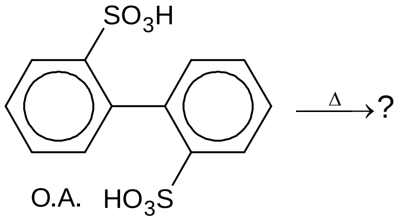
(D) All of these

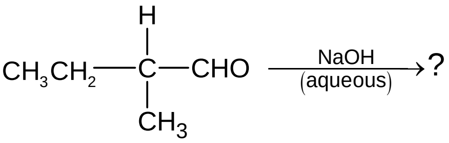
14. $CF_3I + NaOH(aqueous) \longrightarrow ?$

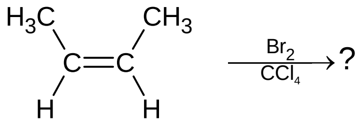
The major product formed is:

(A) CF_3OH
(B) $F_2C = CF_2$
(C) CHF_3
(D) $F_3C - OCF_3$

15. The reaction (s) which would yield racemic mixture is/are:

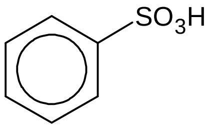
(A)

SO_3H
Δ
?
O.A.
HO_3S

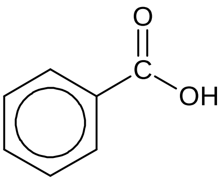
(B)

$CH_3CH_2-\overset{H}{\underset{CH_3}{C}}-CHO \xrightarrow[(aqueous)]{NaOH} ?$

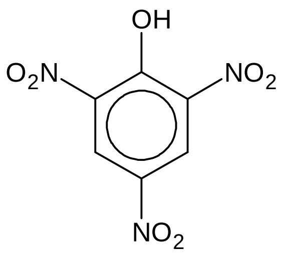
(C)

H_3C
CH_3
C=C
H
H
Br_2
CCl_4
?

(D) All of these

16. Which of the following would produce effervescence with sodium bicarbonate?

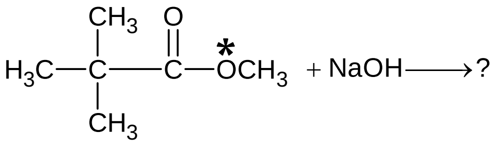
(A)


(B)


(C)

OH
O_2N
NO_2
NO_2

(D) All of these

Rough Work

17. 

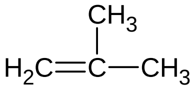
$$H_3C-\overset{\overset{\large CH_3}{|}}{\underset{\underset{\large CH_3}{|}}{C}}-\overset{\overset{\large O}{\|}}{C}-\overset{*}{O}CH_3 + NaOH \longrightarrow ?$$

The major product formed in the above reaction is:

(A) $CH_3\overset{*}{O}H$

(B) CH_3OH

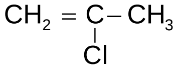
(C) $(CH_3)_3C-COONa$

(D) 

$$H_2C=\overset{\overset{\large CH_3}{|}}{C}-CH_3$$

18. PVC is the polymer of

(A) $CH_2=CH-CH_2Cl$

(B) 

$$CH_2=\underset{\underset{\large Cl}{|}}{C}-CH_3$$

(C) $CH_2=CH-Cl$

(D) $F_2C=CF_2$

19. Mutarotation is not exhibited by:

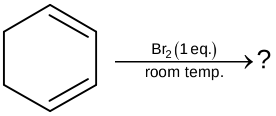
(A) α-D-glucopyranose

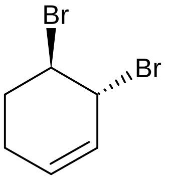
(B) Methyl α-D-glucopyranoside

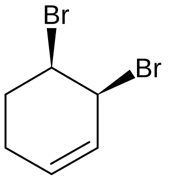
(C) α-D-fructofuranose

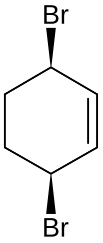
(D) All of these

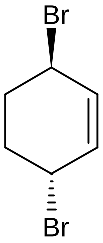
20. The product which is least expected to be produced in significant yield in the reaction given below, is:



(A) 

(B) 

(C) 

(D) 

21. A monoatomic ideal gas expands by doing q/2 work as a result of absorption of ‘q’ amount of heat. The molar heat capacity for the process is:

(A) R

(B) 2R

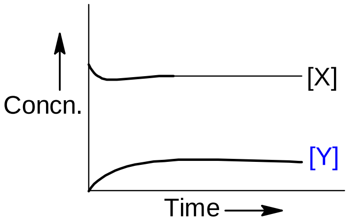
(C) 3R

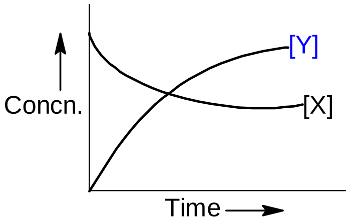
(D) 4R

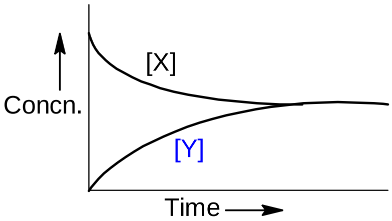
Rough Work

22. A metallic oxide contains 20% oxygen by mass. The equivalent weight of metal is:
(A) 40 (B) 32
(C) 16 (D) 48

23. The correct representation for the reaction $X \rightleftharpoons Y$, starting with X would be:

(A)


(B)


(C)


(D) Any of these

24. pH of aqueous solution of one of the following salts is independent of its concentration. The salt is:
(A) CH_3COONa (B) $C_6H_5NH_3Cl$
(C) $PbCl_2$ (D) CH_3COONH_4

25. The total volume of gases liberated at S.T.P. when a charge of 2F is passed through aqueous solution of sodium phosphate using inert electrode is:
(A) 44.8 L (B) 22.4 L
(C) 33.6 L (D) 11.2 L

26. Which of the following orbital has equal probability of finding an electron in any direction at a certain distance from the nucleus?
(A) s-orbital (B) p-orbital
(C) d-orbital (D) f-orbital

Rough Work

27. Which of the following reactions is not feasible?

(A) $Cu + H_2SO_4(\text{conc.}) \longrightarrow CuSO_4 + SO_2 + 2H_2O$

(B) $Cu + H_2SO_4(\text{dilute}) \longrightarrow CuSO_4 + H_2$

(C) $Mn + HNO_3(\text{very dilute}) \longrightarrow Mn(NO_3)_2 + H_2$

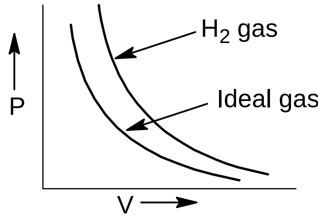
(D) $Al + Mn_3O_4 \longrightarrow Mn(NO_3)_2 + H_2$

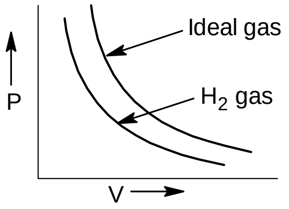
28. The total number of third nearest neighbours of Na^+ in NaCl lattice is:

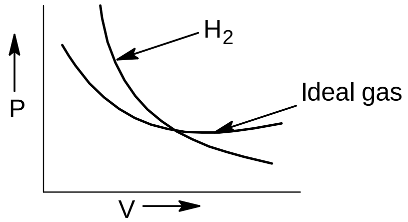
(A) $6Cl^-$ (B) $12Na^+$

(C) $8Cl^-$ (D) $24Cl^-$

29. The correct graph for H_2 gas is:

(A)


(B)


(C)


(D) All are correct

30. Which of the following binary liquid solutions would exhibit negative deviation from Raoult's law?

(A) Acetone + chloroform (B) Benzene + toluene

(C) Diethyl ether + acetone (D) Ethanol + acetone

Rough Work

Mathematics PART – II

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. The function $f(x) = \frac{x^2 - 3x + 2}{x^2 + 2x - 3}$
(A) has a maximum value at x = –3 (B) has a minimum value at x = 3
(C) is increasing in its domain (D) is decreasing in its domain

2. The total number of 4 digit numbers which have digits in decreasing order (from left to right) such that number is divisible by 4 is
(A) 110 (B) 118
(C) 112 (D) 111

3. If in a triangle R(b + c) = $a \cdot \sqrt{bc}$, then the triangle is
(A) equilateral (B) obtuse angled
(C) right angled (D) nothing can be said

4. A tangent is drawn to a parabola at the point (12, 6) to meet the directrix at $\left(2, \frac{8}{3}\right)$. If focus lies on x–axis, then equation of parabola is
(A) $y^2 = 4x$ (B) $y^2 = 4(x - 3)$
(C) $y^2 = 4(x + 3)$ (D) none of these

5. Total number of triangles formed by the curves $x^3 - x^2 - x - 2 = 0$ and $4x^2 + x^2y^2 + 2y^2 - 3xy^2 - 12x + 8 = 0$ is equal to
(A) 1 (B) 0
(C) 2 (D) 3

Space for rough work

6. For a acute angle triangle, the value of $\frac{\sin A}{A}+\frac{\sin B}{B}+\frac{\sin C}{C}$ is

(A) greater than $\frac{6}{\pi}$ (B) $\frac{6}{\pi}$
(C) less than $\frac{6}{\pi}$ (D) none of these

7. An ellipse has the point (1, –1) and (2, –1) as its focii and x + y = 5 as one of its tangents, then the coordinates of the point where this line touches the ellipse is

(A) $\left(\frac{34}{9}, \frac{11}{9}\right)$ (B) $\left(\frac{32}{9}, \frac{13}{9}\right)$
(C) $\left(\frac{34}{9}, \frac{79}{9}\right)$ (D) $\left(\frac{32}{9}, \frac{77}{9}\right)$

8. In the process of numbering the pages of a large book, the printer uses 1890 digits. The number of pages in the book is

(A) 600 (B) 666
(C) 659 (D) 660

9. If the middle term in the expansion of $(1 + x)^{2n}$ is the greatest term, then the value of [x] can be [.]

(A) {0, 2} (B) {1, 2}
(C) {0, 1} (D) {0, 1, 2}

10. The value of $\sum_{n=1}^{2008}\frac{\sqrt{n^4+2n^3+3n^2+2n+1}}{n(n+1)}$ is equal to

(A) $2008+\frac{2008}{2009}$ (B) $2007+\frac{2008}{2009}$
(C) $2008+\frac{2007}{2009}$ (D) $2008+\frac{2007}{2008}$

11. Number of solutions of the equation $\sin^{-1} x + \cos^{-1} (x^2) = \frac{\pi}{2}$ is/are

(A) 0 (B) 1
(C) 2 (D) infinite

Space for rough work

12. The range of $y = \sin^3 x - 6\sin^2 x + 11\sin x - 6$ is
(A) [–24, 2]
(B) [–24, 0]
(C) [0, 24]
(D) none of these

13. If p and q are prime numbers and the equation $x^2 - px + q = 0$ has distinct integral roots then which of the following statements are true
(I) the difference of roots is odd
(II) at least one root is prime
(III) $p^2 - q$ is prime
(IV) $p + q$ is prime
(A) I only
(B) II only
(C) II and III only
(D) all are true

14. Let x_1 and x_2 are two solutions of the equation $e^x \cos x = 1$, then the minimum number of the solutions of the equation $e^x \sin x = 1$ lying in between x_1 and x_2 can be
(A) 0
(B) 1
(C) 3
(D) none of these

15. The number of integral solutions of the equation $4\int_0^{\infty} \frac{\ln x}{x^2 + t^2} dt - \pi \ln 2 = 0$; x > 0 is/are
(A) 2
(B) 0
(C) 1
(D) 3

16. The complex number z which satisfy the equations |z| = 1 and $\left| \frac{z - \sqrt{2}(1+i)}{z} \right| = 1$ is
(A) z = 1
(B) z = (1 + i)
(C) $z = \frac{1+i}{\sqrt{2}}$
(D) $z = -\frac{(1+i)}{\sqrt{2}}$

17. The two adjacent sides AB and BC of a cyclic quadrilateral ABCD are 2 and 5 units respectively and the angle between them is 60º. If the area of quadrilateral is $4\sqrt{3}$ sq. units, then area of the circle circumscribing the quadrilateral ABCD is
(A) 48 π
(B) $\frac{19\pi}{3}$
(C) 12 π
(D) $\frac{19\pi}{12}$

Space for rough work

18. Let A = (2, 3, 5), B = (–4, 3, –1) and C = (3, 5, –2), then the equation of plane perpendicular to the plane ABC and passes through A, B is
(A) $2x - y + 2z + 13 = 0$ (B) $x + 2y - 2z + 3 = 0$
(C) $2x + y - 2z + 3 = 0$ (D) $2x - y + 2z - 11 = 0$

19. If A and B are two non singular matrices which commute then $(A(A + B)^{-1}B)^{-1}(AB)$ is equal to
(A) $A + B$ (B) $A^{-1} + B^{-1}$
(C) $A^{-1} + B$ (D) $A + B^{-1}$

20. Let P(x) be a polynomial of degree at most 5 which leaves remainders –1 and 1 upon division by $(x - 1)^3$ and $(x + 1)^3$ respectively then the number of real roots of P(x) = 0
(A) 1 (B) 3
(C) 5 (D) 2

21. If the equation $2x^2 + 2hxy + 6y^2 - 4x + 5y - 6 = 0$ represents a pair of straight lines, then the length of intercept on the x–axis cut by the lines is equal to
(A) 2 (B) 4
(C) $\sqrt{7}$ (D) 0

22. A polynomial is said to be a cyclotomic polynomial of degree n > 1 if it is of the form $x^n + x^{n-1} + \ldots + x + 1$. If $r_1, r_2, \ldots r_{100}$ are the roots of a cyclotomic polynomial of degree 100 then $(1 - r_1)(1 - r_2) \ldots (1 - r_{100})$ is equal to
(A) 100 (B) 101
(C) I (D) 0

23. If $\vec{a} = \hat{i} + \hat{j} + \hat{k}$, $\vec{a} \cdot \vec{b} = 1$ and $\vec{a} \times \vec{b} = \hat{j} - \hat{k}$, then $\vec{b}$ is equal to
(A) $2\hat{i}$ (B) $\hat{i} - \hat{j} + \hat{k}$
(C) $\hat{i}$ (D) $2\hat{j} - \hat{k}$

24. 5 different games are to be distributed among 4 children randomly. The probability that each child gets at least one game is
(A) $\frac{1}{4}$ (B) $\frac{15}{64}$
(C) $\frac{21}{64}$ (D) none of these

Space for rough work

25. If $\int\limits_{-\pi/4}^{3\pi/4} \frac{e^{\pi/4}dx}{(e^x + e^{\pi/4})(\sin x + \cos x)} = k \int\limits_{-\pi/2}^{\pi/2} \sec x dx$, then the value of k is

(A) $\frac{1}{2}$ (B) $\frac{1}{\sqrt{2}}$

(C) $\frac{1}{2\sqrt{2}}$ (D) $-\frac{1}{\sqrt{2}}$

26. If the lines $\frac{x-2}{1} = \frac{y-3}{1} = \frac{z-4}{\lambda}$ and $\frac{x-1}{\lambda} = \frac{y-4}{2} = \frac{z-5}{1}$ intersect at a point (α, β, γ), then

(A) $\lambda = -1$ (B) $\lambda = 2$

(C) $\lambda = -3$ (D) $\lambda = 1$

27. The value of $\int\limits_{-3}^{-1} (x+1)^4 (x+2)^3 (x+3)^4 \, dx$ is

(A) $\frac{7}{4}$ (B) $-\frac{3}{4}$

(C) 0 (D) none of these

28. The number of ways in which 9 identical balls can be placed in three identical boxes is

(A) 18 (B) 15

(C) 19 (D) 12

29. If $b_{n+1} = \frac{1}{1-b_n}$ $\forall$ $n \geq 1$ and $b_1 = b_3$ then $\sum\limits_{r=1}^{2001} b_r^{2001}$ is equal to

(A) 2001 (B) –2001

(C) 0 (D) none of these

30. The value of $\int\limits_{-1}^{0} \frac{x^2 + 2x}{\ln(x+1)} dx$ is equal to

(A) ln 2 (B) ln 4

(C) ln 3 (D) ln 6

Space for rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

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(Main)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	A	C
2.	C	C	B
3.	A	B	C
4.	D	D	B
5.	C	C	B
6.	A	B	A
7.	D	D	A
8.	B	D	B
9.	C	B	C
10.	B	A	D
11.	C	B	C
12.	C	C	B
13.	A	B	D
14.	B	C	B
15.	A	D	A
16.	C	D	C
17.	C	B	B
18.	B	C	C
19.	D	B	A
20.	A	B	A
21.	A	C	B
22.	B	B	B
23.	B	D	C
24.	C	D	B
25.	C	C	C
26.	D	A	A
27.	C	B	C
28.	C	C	D
29.	C	A	B
30.	D	A	C

Physics PART – I

1. Viscosity of gases increases & that of liquid decreases.

2. $T - mg\cos\theta = \frac{mu^2}{\ell}$

3. $x = 2t^2$

$\Rightarrow v\frac{dv}{dx} = 4 \Rightarrow v^2 = 8x$

So graph is parabolic

4. The galvanometer will not show any deflection.

5. When bar becomes vertical

$\omega = \sqrt{\frac{3g}{\ell}}$ so $V = \sqrt{3g\ell}$

$B = \frac{\mu_0}{4\pi}\frac{q\sqrt{3g\ell}}{\ell^2} = \frac{\mu_0 q}{4\pi\ell}\sqrt{\frac{3g}{\ell}}$

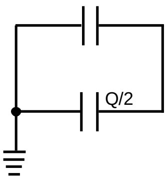
6. If $I_G = 0$ then it becomes a balanced whetstone bridge

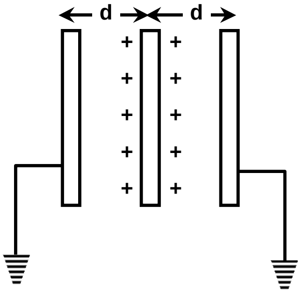
$\ell_1 = \frac{2}{3}\times 1m$

$= \frac{2}{3}\times 100 = \frac{200}{3}cm$

8. $E_1 = \frac{\sigma}{\epsilon_0} = \frac{Q}{2A\epsilon_0}$

$V = E_1 d = \frac{Qd}{2A\epsilon_0}$





9. Apply gaus theorem

$E\left(4\pi r^2\right) = \frac{q_{in}}{\epsilon_0}$

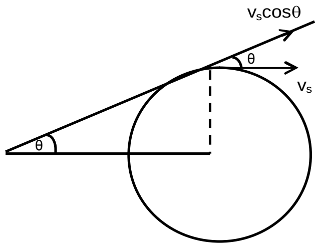
$\Rightarrow E = \frac{q}{4\pi\epsilon_0 r^2} \Rightarrow E \propto \frac{1}{r^2}$

$\Rightarrow$ field depends only on r.

10. $$\cos\theta = 2\sqrt{2}\frac{r}{\sqrt{8r^2 + r^2}}$$

$$\cos\theta = \frac{2\sqrt{2}}{3}$$

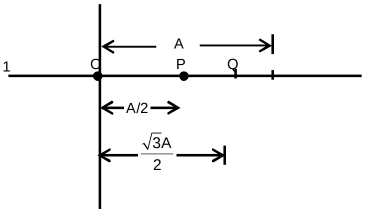
$$f^1 = \frac{cf_0}{c + v_s\cos\theta} = \frac{cf_o}{c + 2\omega\frac{r \times 2\sqrt{2}}{3}} = \frac{3cf_0}{3c + 4\sqrt{2}\omega r}$$



11. $$\frac{A}{2} = A\sin\omega t_1 \Rightarrow t_1 = \frac{\pi}{6\omega}$$

$$\frac{\sqrt{3}}{2}A = A\sin\omega t \Rightarrow t_2 = \frac{\pi}{3\omega}$$

$$t_2 - t_1 = \frac{\pi}{6\omega} = \frac{\pi \times T}{6 \times 2\pi} = T/12$$



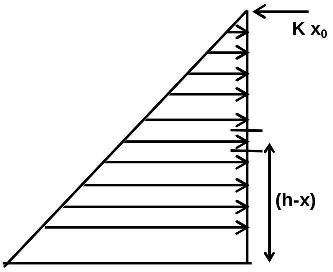
12. $$kx_0h = \int_o^h (bdx)\rho gx(h - x)$$

$$\Rightarrow kx_0h = b\rho g\int_0^h (hx - x^2)dx = b\rho g\left[h\frac{h^2}{2} - \frac{h^3}{3}\right]$$

$$\Rightarrow kx_0h = b\rho g\frac{h^3}{6} \Rightarrow `x_0 = \frac{b\rho gh^2}{6k}$$

$$PE = \frac{1}{2}kx_0^{\ 2} = \frac{1}{2}k\frac{b^2\rho^2g^2h^4}{36k^2}$$

$$= \frac{b^2\rho^2g^2h^4}{72k}$$



13. When pure rolling starts friction reduces to zero. So plank does not have any acceleration so surface is horizontal.

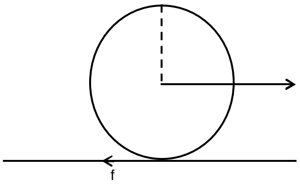
14. $$F - f = ma$$

$$fr = \frac{mr^2}{2}\frac{a}{r}$$

$$\Rightarrow F = \frac{3}{2}ma \qquad \Rightarrow a = \frac{2F}{3m}$$

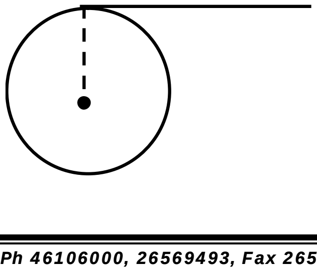
$$v_{cm} = \frac{2Ft}{3m}$$

$$P = \vec{F}\cdot\vec{V} = \frac{2F^2}{3m}.t$$



15. $$I = mr^2 + \frac{m(2r)^2}{12} + m\left(\sqrt{2}r\right)^2$$

$$\Rightarrow I = 3mr^2 + \frac{mr^2}{3} = \frac{10mr^2}{3}$$



16. $\Delta P = 10 - (10) \times 0.2$

$\Rightarrow 8 = 1 \times v$

$\Rightarrow v = 8 m / sec.$

17. As there does not exist any external horizontal force so X – coordinate of centre of mass will not charge

$\Rightarrow$ position of lower end is $(-\ell, 0)$

18. $\frac{1}{2}gt^2 = h \Rightarrow t = \sqrt{\frac{2h}{g}}$

$v_0 - a_0 t = 0 \Rightarrow \frac{v_0{}^2}{a_0} = \frac{2h}{g}$

$\Rightarrow h = \frac{V_0{}^2 g}{2a_0}$

19. The amplitude of the resultant wave is

$$\sqrt{3^2 + 4^2 + 2 \times 3 \times 4 \times \cos 90}$$
$$= 5m$$

20. $\frac{\Delta R}{R} = \frac{\Delta V}{V} + \frac{\Delta I}{I}$

$\Rightarrow \frac{\Delta R}{R} \times 100 = \frac{\Delta V}{V} \times 100 + \frac{\Delta I}{I} \times 100$

$= 3\%$

21. Minimum energy transferred in the form of proton $= -13.6\left(\frac{1}{2^2} - \frac{1}{1^2}\right) = \frac{3}{4} \times 13.6 ev.$

from COE $\frac{1}{2}mv^2 = \frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2 + \frac{3}{4} \times 13.6$

$\nu_{min} = \sqrt{\frac{3 \times 13.6}{m}}$

$KE_{min} = \frac{1}{2}mv_{min}^2 = \frac{3}{2} \times 13.6 = 20.4 eV.$

22. $\lambda_p N_p dt = \lambda_d n_d dt$

$\Rightarrow \frac{\lambda_p}{\lambda_d} = \frac{N_d}{N_p} = \frac{1}{2}.$

23. Activity $A = \frac{A_0}{2^{\left(t/\tau\frac{1}{2}\right)}}$

$\Rightarrow \frac{A}{A_0} = \frac{1}{32}$

24. $$\frac{1}{f_{eq}}=\frac{1}{f_1}+\frac{2}{f_2}=\frac{1}{15}+\frac{2\left({}^{m}\mu_{\ell}-1\right)}{R_1}.$$

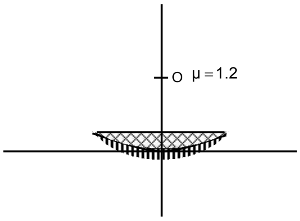
$$=\frac{1}{15}+\frac{{}^{m}\mu_{\ell}-1}{15}=\frac{{}^{m}\mu_{\ell}}{15}$$

$$\Rightarrow f_{eq}=\frac{15}{{}^{m}\mu_{\ell}}$$

and $f_{eq}=\frac{(30-7.5)}{2}=\frac{22.5}{2}$

This $\frac{22.5}{2}=\frac{15}{{}^{m}\mu_1}\Rightarrow{}^{m}\mu_1=\frac{4}{3}.$

Also ${}^{m}\mu_{\ell}=\frac{\mu_{\ell}}{\mu_m}=\Rightarrow\frac{4}{3}=\frac{\mu}{1.2}\Rightarrow\mu=\frac{4\times1.2}{3}=1.6$



25. For image to be coincident, either the rays should retrace or the image due to the lens should formed just at the pole of the mirror in thin case. The image formed due to lens is at 30 cm (2f) be from the lens. Thus either this image should be at centre of curvature of the convex mirror or at the pole of the mirror. Hence 6cm or 30 cm should be the separation between the lens and the mirror.

26. no of fringes shifted $=\frac{\Delta x}{\lambda}=\frac{(\mu-1)t}{\lambda}$

$$=\frac{0.48\times20\times10^{-6}}{4800\times10^{-10}}=20$$

27. frequency of vibration of wire will be equal to the frequency of the source hence f = 400Hz

28. $R=\frac{10}{5}=2\Omega$

I and V are in phase $\Rightarrow x_c=x_L$. and $Z=R$

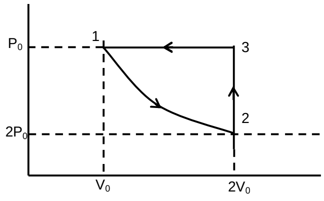
thus $I_{rms}=\frac{V_{rms}}{Z}=\frac{20}{2}=10A.$

29. $Q_{1\to2}=\Delta U_{1\to2}+\Delta W_{1\to2}$

$\Delta U_{1\to2}=0\Rightarrow Q_{1\to2}=nRT_1\ell n\frac{2V_0}{V_0}$

$Q_{1\to2}=nRT_1\ell n2$

Also, $T_3=400K.$ for $1\to3, V\propto T\Rightarrow T_1=\frac{T_3}{2}=200K.$



30. Some quantity of ice will melt and the equilibrium temperature will be 0^0c

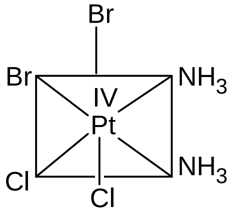
Chemistry PART – II

1. $SiCl_4 + 4H_2O \longrightarrow H_4SiO_4 + 4HCl$

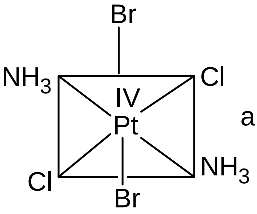
$PCl_5 + 4H_2O \longrightarrow H_3PO_4 + 5HCl$

$BCl_3 + 3H_2O \longrightarrow B(OH)_3 + 3HCl$

2.



(Optically active)
cis



(Optically inactive)
trans

and more stereo isomers are possible.

3. $SiH_4 + 4H_2O \longrightarrow SiO_2.2H_2O + 4H_2$

$2Al + 2NaOH + 2H_2O \longrightarrow 2NaAlO_2 + 3H_2$

$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$

$XeF_6 + 3H_2O \longrightarrow XeO_3 + 6HF$

6. B.O. of H_2 = I

B.O. of $H_2^+ = \frac{1}{2}$

7. With NH_3, CH_3NH_2 and $(CH_3)_2NH$, $(BH_2)(BH_2L_2)$ is formed.

9. Ag^+, Pb^{2+} and Bi^{3+} form corresponding thiosulphate.

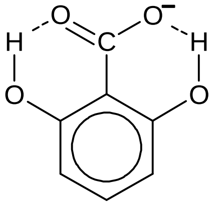
10. $P_4 + 3NaOH + 3H_2O \longrightarrow 3NaH_2PO_2 + PH_3$

$4Na_2SO_3 \xrightarrow{\Delta} 3Na_2SO_4 + Na_2S$

$4H_3PO_3 \xrightarrow{\Delta} 3H_3PO_4 + PH_3$

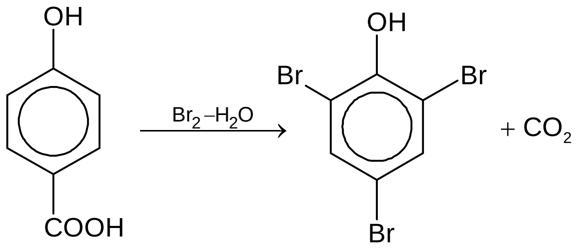
11. Due to maximum 1, 3-diaxial interaction.

12.

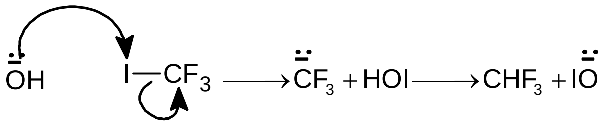


(highly stable anion).

13.

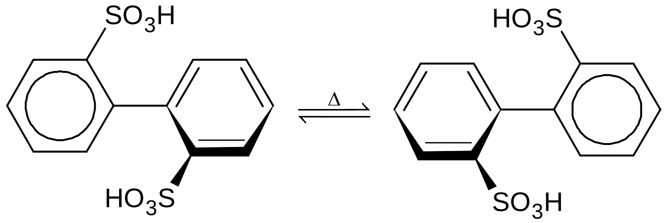


14.



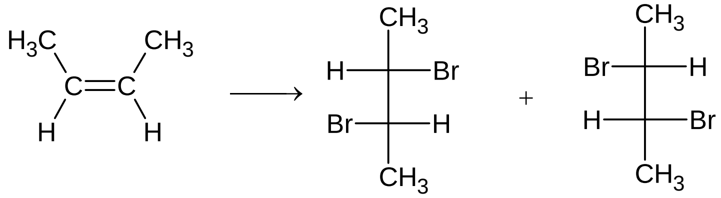
$$\ddot{\bar{O}}H \quad I-CF_3 \longrightarrow \ddot{\bar{C}}F_3 + HOI \longrightarrow CHF_3 + I\ddot{\bar{O}}$$

15. (A)



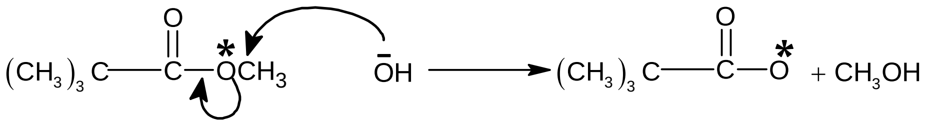
(B) Due to tautomerism the product will become racemic mixture.

(C)



16. All are stronger than carbonic acid.

17.



$$(CH_3)_3C-\overset{O}{\overset{||}{C}}-\overset{*}{O}CH_3 \quad \bar{O}H \longrightarrow (CH_3)_3C-\overset{O}{\overset{||}{C}}-\overset{*}{\bar{O}} + CH_3OH$$

20. 1, 2-addition does not yield syn-brominated product.

21. $C_V = \frac{3R}{2}$ (for monoatomic gas)

We know $q = \Delta E - W$

$$q = nC_V(\Delta T) - \left(-\frac{q}{2}\right)$$

$$n\Delta T = \frac{q}{2C_V}$$

$$\therefore C = \frac{q}{n\Delta T} = \frac{q}{q/2C_V} = 2C_V = 2\times\frac{3R}{2} = 3R$$

22.

$$\begin{array}{lll} M \quad + & O_2 \longrightarrow & \text{Metallic oxide}\left(O^{2-}\right) \\ 80\text{ gm} & 20\text{ gm} & 100\text{ gm} \end{array}$$

No. of equivalents of M = no. of equivalents of O_2

$$\Rightarrow \frac{80}{E} = \frac{20}{8}$$

$$\therefore E = \frac{80 \times 8}{20} = 32$$

24. pH of aqueous solution of salt of weak acid and weak base is given by

$$pH = 7 + \frac{1}{2}[pK_a - pK_b]$$

25. H_2 and O_2 are produced at cathode and anode respectively.

At cathode:

$$\underset{2F}{2H_2O + 2e^-} \longrightarrow \underset{1\,mol}{H_2} + 2OH^-$$

At anode:

$$2H_2O \longrightarrow \underset{\frac{1}{2}mol}{O_2} + 4H^+ + \underset{2F}{4e^-}$$

Total volume of gases = 22.4 L H_2

+11.2 L O_2

33.6 L

26. s-orbital is spherically symmetrical.

30. Due to strong H-bond between acetone and chloroform, vapour pressure is less than that of ideal solution.

Mathematics PART – III

1. $\frac{df(x)}{dx} > 0$

2. Last two digits should be 20, 32, 40, 52, 60, 64, 72, 76

3. $\frac{\sin B + \sin C}{2\sqrt{\sin B \cdot \sin C}} = \sin A$
$\Rightarrow$ LHS ≥ 1, RHS ≤ 1
$\Rightarrow$ sin B = sin C and sin A = 1

4. Line joining (12, 6) and $\left(2, \frac{8}{3}\right)$ will subtend a right angle at focus (a, 0)

5. $(x – 2)(x^2 + x + 1) = 0$, x = 2
$(x – 1)(x – 2)(y^2 + 4) = 0$, x = 1, x = 2
No triangle possible

6. Clearly $\frac{\sin A}{A} > \frac{2}{\pi}$

7. $ae = \frac{1}{2}$, $b^2 = 10$, $a^2 = \frac{41}{4}$

8. From 1 to 9, there are 9 × 1 = 9 digits
From 10 to 99, there are 90 × 2 = 180 digits and so on
So finally total digits will take 666 pages

9. $\frac{n}{n+1} < x < \frac{n+1}{n}$

10. $n^4 + 2n^3 + 3n^2 + 2n + 1 = n^2\left(n + \frac{1}{n} + 1\right)^2$

11. $\cos^{-1} x^2 = \cos^{-1} x$
$x^2 = x$, x = 0, 1

12. Put sin x = t

13. q = 2 and p = 3

14. Consider $f(x) = \cos x – e^{-x}$, apply Roll's theorem

15. $\int_0^{\infty} \frac{\ln x}{x^2 + t^2} dt = \frac{\pi \ln x}{2x}$

17. $\cos 60° = \frac{29 – AC^2}{20}$

$\Rightarrow AC^2 = 19$

$\Rightarrow R = \sqrt{\frac{19}{3}}$

18. $AC = BC = \sqrt{54}$
Mid–point of AB $\Rightarrow$ D = (–1, 3, 2)
dr's of DC = (4, 2, –4)
Equation of plane is $2x + y - 2z + 3 = 0$

20. $P'(x) = \alpha(x-1)^2(x+1)^2$

21. Put y = 0

22. $x^n + x^{n-1} + \ldots + x + 1 = (x - r_1)(x - r_2) \ldots (x - r_n)$
Put x = 1

23. Let $\vec{b} = \alpha\hat{i} + \beta\hat{j} + \gamma\hat{k}$

24. Total ways 4^5
Favourable = $4^5 - 4C_1 \cdot 3^5 + {}^4C_2 \cdot 2^5 - {}^4C_3 = 240$
$P(E) = \frac{240}{4^5} = \frac{15}{64}$

25. $I = \frac{1}{\sqrt{2}} \int_{-\pi/2}^{\pi/2} \frac{e^t dt}{(e^t + 1)\cos t}$

26. Lines will intersect if $\begin{vmatrix} 2-1 & 3-4 & 4-5 \\ 1 & 1 & \lambda \\ \lambda & 2 & 1 \end{vmatrix} = 0$
$\{\lambda = -1, 0\}$

27. y = x + 2

29. $b_1 = -\omega$ or $-\omega^2$
$b_2 = -\omega$ or $-\omega^2$
$b_3 = -\omega$ or $-\omega^2$

FIITJEE JEE MAINS MOCK TEST-1

Target IIT - JEE 2014

QP CODE: 120634.0

Time : 3 hours ***Maximum Marks : 360***

- ***Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.***
- ***You are not allowed to leave the examination hall before end of the test.***

Instructions

1. Immediately fill in the particulars on this page of the Test Booklet with *Blue / Black Ball Point Pen. Use of pencil is strictly prohibited.*

2. The Answer Sheet is kept inside this Test Booklet. When you are directed to open the Test Booklet, take out the Answer Sheet and fill in the particulars carefully.

3. The test is of **3 hours** duration.

4. The Test Booklet consists of **90** questions. The maximum marks are **360**.

5. There are ***three*** parts in the question paper A, B, C consisting of **Physics, Chemistry** and **Mathematics** having 30 questions in each part of equal weightage. Each question is allotted **4 (four)** marks for correct response.

6. *Candidates will be awarded marks as stated above in instruction No.5 for correct response of each question. ¼ (one fourth) marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.*

7. There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 6 above.

8. Use ***Blue / Black Ball Point Pen only*** for writing particulars / marking responses on ***Side-1*** and ***Side-2*** of the Answer Sheet. ***Use of pencil is strictly prohibited.***

9. No candidate is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. except the Admit Card inside the examination hall / room.

10. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator on duty in the Room / Hall. ***However, the candidates are allowed to take away this Test Booklet with them.***

11. **Do not fold or make any stray marks on the Answer Sheet.**

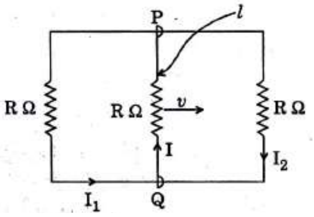
Name of the Candidate (in Capital Letters) :____________________________________

Enrolment Number :____

Batch :________________________ **Date of Examination :** ________________________

SECTION - 1
PHYSICS

1. A rectangular loop has a sliding connector PQ of length ℓ and resistance RΩ and it is moving with a speed v as shown. The set-up is placed in a uniform magnetic field going into the plane of the paper. The three currents I_1, I_2 and I are



(A) $I_1 = -I_2 = \frac{B\ell v}{R}, I = \frac{2B\ell v}{R}$

(B) $I_1 = I_2 = \frac{B\ell v}{3R}, I = \frac{2B\ell v}{3R}$

(C) $I_1 = I_2 = I = \frac{B\ell v}{R}$

(D) $I_1 = I_2 = \frac{B\ell v}{6R}, I = \frac{B\ell v}{3R}$

2. Let C be the capacitance of a capacitor discharging through a resistor R. Suppose t_1 is the time taken for the energy stored in the capacitor to reduce to half its initial value and t_2 is the time taken for the charge to reduce to one-fourth its initial value. Then the ratio t_1/t_2 will be

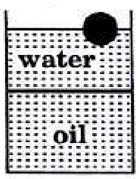
(A) 1

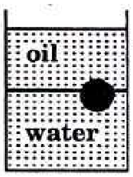
(B) $\frac{1}{2}$

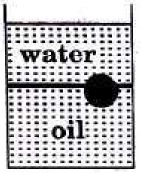
(C) $\frac{1}{4}$

(D) 2

3. A ball is made of a material of density ρ where $\rho_{oil} < \rho < \rho_{water}$ with ρ_{oil} and ρ_{water} representing the densities of oil and water, respectively. The oil and water are immiscible. If the above ball is in equilibrium in a mixture of this oil and water, which of the following pictures represents its equilibrium position?

(A)


(B)


(C)


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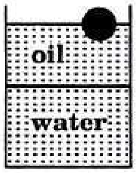
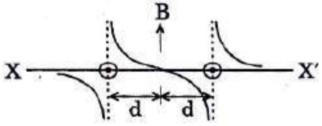
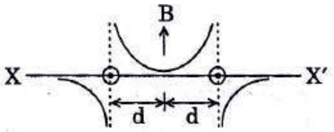


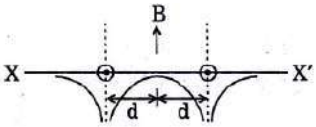
Space for rough work

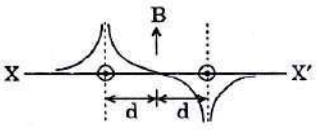
4. A particle is moving with velocity $\vec{v} = K(y\hat{i} + x\hat{j})$, where K is a constant. The general equal for its path is
(A) $y = x^2$ + constant
(B) $y^2 = x$ + constant
(C) xy = constant
(D) $y^2 = x^2$ + constant

5. Two long parallel wires are at a distance 2d apart. They carry steady equal current flowing out of the plane of the paper as shown. The variation of the magnetic field along the line XX′ is given by

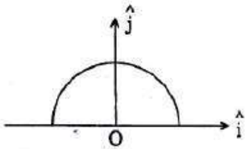
(A)


(B)


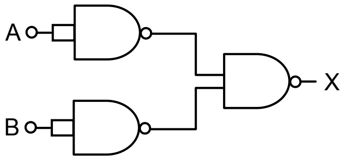
(C)


(D)


6. A thin semi-circular ring of radius r has a positive charge q distributed uniformly over it. The net field $\vec{E}$ at the centre O is
(A) $\frac{q}{4\pi^2\varepsilon_o r^2}\hat{j}$
(B) $-\frac{q}{4\pi^2\varepsilon_o r^2}\hat{j}$
(C) $-\frac{q}{2\pi^2\varepsilon_o r^2}\hat{j}$
(D) $\frac{q}{2\pi^2\varepsilon_o r^2}\hat{j}$



7. The combination of gates shown below yields
(A) OR gate
(B) NOT gate
(C) XOR gate
(D) NAND gate



8. A diatomic ideal gas is used in a car engine as the working substance. If during the adiabatic expansion part of the cycle, volume of the gas increases from V to 32V the efficiency of the engine is
(A) 0.5
(B) 0.75
(C) 0.99
(D) 0.25

Space for rough work

9. Let there be a spherically symmetric charge distribution with charge density varying as $\rho(r)=\rho_o\left(\frac{5}{4}-\frac{r}{R}\right)$ upto r = R and $\rho(r) = 0$ for r > R, where r is the distance from the origin. The electric field at a distance r(r < R) from the origin is given by

(A) $\frac{4\pi\rho_o r}{3\varepsilon_o}\left(\frac{5}{3}-\frac{r}{R}\right)$ (B) $\frac{\rho_o r}{4\varepsilon_o}\left(\frac{5}{3}-\frac{r}{R}\right)$

(C) $\frac{4\rho_o r}{3\varepsilon_o}\left(\frac{5}{4}-\frac{r}{R}\right)$ (D) $\frac{\rho_o r}{3\varepsilon_o}\left(\frac{5}{4}-\frac{r}{R}\right)$

10. The potential energy function for the force between two atoms in a diatomic molecule is approximately given by $U(x)=\frac{a}{x^{12}}-\frac{b}{x^6}$, where a and b are constants and x is the distance between the atoms. If the dissociation energy of the molecule is $D=[U(x=\infty)-U_{\text{at equilibrium}}]$, D is

(A) $\frac{b^2}{2a}$ (B) $\frac{b^2}{12a}$

(C) $\frac{b^2}{4a}$ (D) $\frac{b^2}{6a}$

11. Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle of 30° with each other. When suspended in a liquid of density 0.8 g cm^{-3}, the angle remains the same. If density of the material of the sphere is 16 g cm^{-3}, the dielectric constant of the liquid is

(A) 4 (B) 3

(C) 2 (D) 1

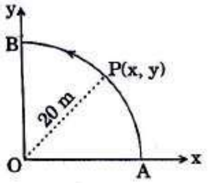
12. Two conductors have the same resistance at 0°C but their temperature coefficients of resistance are α_1 and α_2. The respective temperature coefficients of their series and parallel combinations are nearly

(A) $\frac{\alpha_1+\alpha_2}{2}, \alpha_1+\alpha_2$ (B) $\alpha_1+\alpha_2, \frac{\alpha_1+\alpha_2}{2}$

(C) $\alpha_1+\alpha_2, \frac{\alpha_1\alpha_2}{\alpha_1+\alpha_2}$ (D) $\frac{\alpha_1+\alpha_2}{2}, \frac{\alpha_1+\alpha_2}{2}$

Space for rough work

13. A point P moves in counter-clockwise direction on a circular path as shown in the figure. The movement of 'P' is such that it sweeps out a lengths $s = t^3 + 5$, where s is in metres an t is in seconds. The radius of the path is 20 m. The acceleration of 'P' when t = 2s is nearly

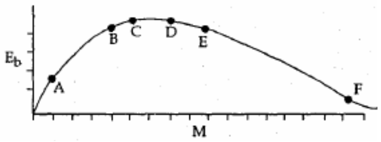


(A) 13 m/s^2 (B) 12 m/s^2
(C) 7.2 m/s^2 (D) 14 m/s^2

14. For a particle in uniform circular motion the acceleration $\vec{a}$ at a point P(R, θ) on the circle of radius R is (here θ is measured from the x-axis)

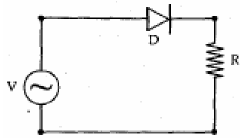
(A) $-\frac{v^2}{R}\cos\theta\hat{i} + \frac{v^2}{R}\sin\theta\hat{j}$ (B) $-\frac{v^2}{R}\sin\theta\hat{i} + \frac{v^2}{R}\cos\theta\hat{j}$
(C) $-\frac{v^2}{R}\cos\theta\hat{i} - \frac{v^2}{R}\sin\theta\hat{j}$ (D) $\frac{v^2}{R}\hat{i} + \frac{v^2}{R}\hat{j}$

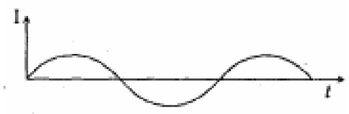
15. The above is a plot of binding energy per nucleon E_b, against the nuclear mass M; A, B,, C, D,, E, F correspond to different nuclei. Consider four reactions:

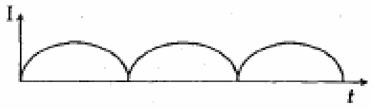


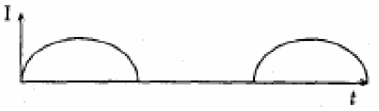
(i) $A + B \rightarrow C + \varepsilon$ (ii) $C \rightarrow A + B + \varepsilon$
(iii) $D + E + \varepsilon$ and (iv) $F \rightarrow D + E + \varepsilon$
where ε is the energy released? In which reactions is ε positive?
(A) (i) and (iv) (B) (i) and (iii)
(C) (ii) and (iv) (D) (ii) and (iii)

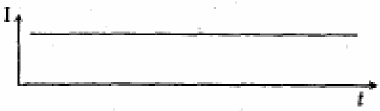
16. A p-n junction (D) shown in the figure can act as a rectifier. An alternating current source (V) is connected in the circuit.



(A)


(B)


(C)


(D)


Space for rough work

17. If x, v and a denote the displacement, the velocity and the acceleration of a particle executing simple harmonic motion of time period T, then, which of the following does not change with time?

(A) $a^2T^2 + 4\pi^2v^2$ (B) $\frac{aT}{x}$

(C) $aT + 2\pi v$ (D) $\frac{aT}{v}$

18. In an optics experiment, with the position of the object fixed, a student varies the position of a convex lens and for each position, the screen is adjusted to get a clear image of the object. A graph between the object distance u and the image distance v, from the lens, is plotted using the same scale for the two axes. A straight line passing through the origin and making an angle of 45° with the x-axis meets the experimental curve at P. The coordinates of P will be

(A) (2f, 2f) (B) $\left(\frac{f}{2}, \frac{f}{2}\right)$

(C) (f, f) (D) (4f, 4f)

19. A thin uniform rod of length ℓ and mass m is swinging freely about a horizontal axis passing through its end. Its maximum angular speed is ω. Its centre of mass rises to a maximum height of

(A) $\frac{1}{3}\frac{\ell^2\omega^2}{g}$ (B) $\frac{1}{6}\frac{\ell\omega}{g}$

(C) $\frac{1}{2}\frac{\ell^2\omega^2}{g}$ (D) $\frac{1}{6}\frac{\ell^2\omega^2}{g}$

20. Let $P(r) = \frac{Q}{\pi R^4}r$ be the charge density distribution for a solid sphere of radius R and total charge Q for a point 'p' inside the sphere at distance r_1 from the centre of the sphere, the magnitude of electric field is

(A) 0 (B) $\frac{Q}{4\pi\varepsilon_o r_1^2}$

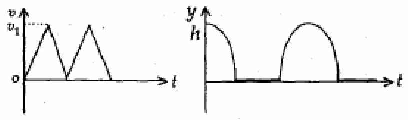
(C) $\frac{Qr_1^2}{4\pi\varepsilon_o R^4}$ (D) $\frac{Qr_1^2}{3\pi\varepsilon_o R^4}$

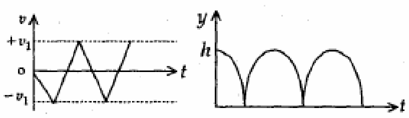
Space for rough work

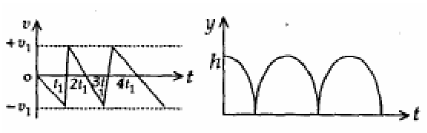
21. One kg of a diatomic gas is at a pressure of 8×10^4 N/m^2. The density of the gas is 4 kg/m^{-3}. What is the energy of the gas due to its thermal motion?
(A) 3×10^4 J (B) 5×10^4 J
(C) 6×10^4 J (D) 7×10^4 J

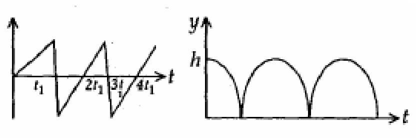
22. A motor cycle starts from rest and accelerates along a straight path at 2 m/s^2. At the starting point of the motor cycle there is a stationary electric sire. How far has the motor cycle gone when the driver hears the frequency of the siren at 94% of its value when the motor cycle was at rest? (speed of sound = 330 ms^{-1}).
(A) 49 m (B) 98 m
(C) 147 m (D) 196 m

23. Consider a rubber ball freely falling from a height h = 4.9 m onto a horizontal elastic plate. Assume that the duration of collision is negligible and the collision with the plate is totally elastic. Then the velocity as a function of time the height as function of time will be

(A)


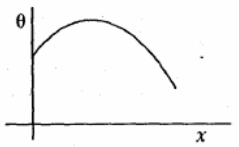
(B)


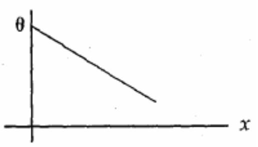
(C)


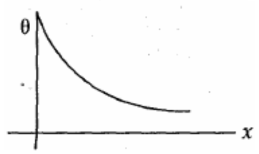
(D)


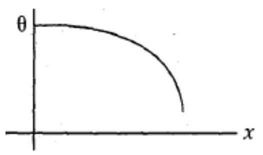
24. A charge Q is placed at each of the opposite corners of a square. A charge q is placed at each of the other two corners. If the net electrical force on Q is zero, then the Q/q equals
(A) $-2\sqrt{2}$ (B) -1
(C) 1 (D) $-\frac{1}{\sqrt{2}}$

25. A long metallic bar is carrying heat from one of its ends to the other end under steady-state. The variation of temperature θ along the length x of the bar from its hot end is best described by which of the following figure.

(A)


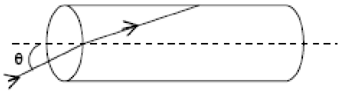
(B)


(C)


(D)


Space for rough work

26. A transparent solid cylindrical rod has a refractive index of $\frac{2}{\sqrt{3}}$. It is surrounded by air. A light ray is incident at the mid point of one end of the rod as shown in the figure. The incident angle θ for which the light ray grazes along the wall of the rod is



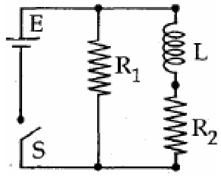
(A) $\sin^{-1}\left(\frac{1}{2}\right)$ (B) $\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$
(C) $\sin^{-1}\left(\frac{2}{\sqrt{3}}\right)$ (D) $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$

27. Three sound waves of equal amplitudes have frequencies (v – 1), v, (v + 1). They superpose to give beats. The number of beats produced per second will be
(A) 4 (B) 3
(C) 2 (D) 1

28. Two wires are made of the same material and have the same volume. However wire 1 has crossectional area A and wire-2 has cross-sectional area 3A. If the length of wire 1 increases by Δx on applying force F, how much force is needed to stretch wire 2 by the same amount?
(A) F (B) 4F
(C) 6F (D) 9F

29. In an experiment the angles are required to be measured using an instrument. 29 divisions of the main scale exactly coincide with the 30 divisions of the vernier scale. If the smallest division of the main scale is half-a-degree(=0.5o), then the least count of the instrument is
(A) one minute (B) half minute
(C) one degree (D) half degree

30. An inductor of inductance L = 400 mH and resistors of resistances R_1 = 2Ω and R_2 = 2Ω are connected to a battery of emf 12V as shown in the figure. The internal resistance of the battery is negligible. The switch S is closed at t = 0. The potential drop across L as a function of time is



(A) $6e^{-5t}$ V (B) $\frac{12}{t}e^{-3t}$ V
(C) $6(1 - e^{-1/02})$ V (D) $12e^{-5t}$ V

Space for rough work

SECTION - 2
CHEMISTRY

1. Knowing that the Chemistry of lanthanoids (Ln) is dominated by its +3 oxidation state, which of the following statement is incorrect ?
(A) Because of the large size of the Ln (III) ions the bonding in its compounds is predominantly ionic in character.
(B) The ionic sizes of Ln (III) decrease in general with increasing atomic number.
(C) Ln (III) compounds are generally colourless.
(D) Ln (III) hydroxides are mainly basic in character.

2. A liquid was mixed with ethanol and a drop of concentrated H_2SO_4 was added. A compound with a fruity smell was formed. The liquid was :
(A) CH_3OH (B) HCHO
(C) CH_3COCH_3 (D) CH_3COOH

3. In which of the following arrangements, the sequence is not strictly according to the property written against it?
(A) $CO_2 < SiO_2 < SnO_2 < PbO_2$: increasing oxidising power
(B) HF < HCl < HBr < HI: increasing acid strength
(C) $NH_3 < PH_3 < AsH_3 < SbH_3$: increasing basic strength
(D) B < C < O < N: increasing first ionization enthalpy.

4. Which of the following statements is incorrect regarding physiosorption ?
(A) It occurs because of van der Waal's forces.
(B) More easily liquefiable gases are adsorbed readily.
(C) Under high pressure it results into multi molecular layer on adsorbent surface.
(D) Enthalpy of adsorption ($\Delta H_{adsorption}$) is low and positive.

5. Given: $E^o_{Fe^{3+}/Fe} = -0.036\,V$,$E^o_{Fe^{2+}/Fe} = -0.439\,V$. The value of standard electrode potential for the change, $Fe^{3+}(aq) + e^- \longrightarrow Fe^{2+}(aq)$ will be :
(A) -0.072 V (B) 0.385 V
(C) 0.770 V (D) -0.270 V

6. Solid $Ba(NO_3)_2$ is gradually dissolved in a 1.0×10^{-4} M Na_2CO_3 solution. At what concentration of Ba^{2+} will a precipitate begin to form? (K_{sp} for $BaCO_3 = 5.1 \times 10^{-9}$).
(A) 4.1×10^{-5} M (B) 5.1×10^{-5} M
(C) 8.1×10^{-8} M (D) 8.1×10^{-7} M

Space for rough work

7. Which one of the following reactions of Xenon compounds is not feasible ?
(A) $XeO_3 + 6HF \longrightarrow XeF_6 + 3H_2O$
(B) $3XeF_4 + 6H_2O \longrightarrow 2Xe + XeO_3 + 12HF + 1.5O_2$
(C) $2XeF_2 + 2H_2O \longrightarrow 2Xe + 4HF + O_2$
(D) $XeF_6 + RbF \longrightarrow Rb[XeF_7]$

8. The set representing the correct order of ionic radius is :
(A) $Li^+ > Be^{2+} > Na^+ > Mg^{2+}$
(B) $Na^+ > Li^+ > Mg^{2+} > Be^{2+}$
(C) $Li^+ > Na^+ > Mg^{2+} > Be^{2+}$
(D) $Mg^{2+} > Be^{2+} > Li^+ > Na^+$

9. The bond dissociation energy of B – F in BF_3 is 646 kJ mol^{-1} whereas that of C-F in CF_4 is 515 kJ mol^{-1}. The correct reason for higher B-F bond dissociation energy as compared to that of C- F is :
(A) smaller size of B-atom as compared to that of C- atom
(B) stronger σ bond between B and F in BF_3 as compared to that between C and F in CF_4
(C) significant pπ - pπ interaction between B and F in BF_3 whereas there is no possibility of such interaction between C and F in CF_4 .
(D) lower degree of pπ - pπ interaction between B and F in BF_3 than that between C and F in CF_4 .

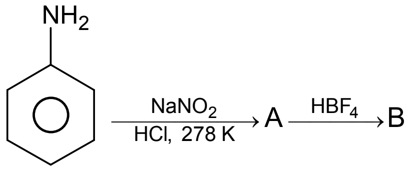
10. Which of the following pairs represents linkage isomers ?
(A) $[Cu(NH_3)_4][PtCl_4]$ and $[Pt(NH_3)_4][CuCl_4]$
(B) $[Pd(PPh_3)_2(NCS)_2]$ and $[Pd(PPh_3)_2(SCN)_2]$
(C) $[Co(NH_3)_5NO_3]SO_4$ and $[Co(NH_3)_5SO_4]NO_3$
(D) $[PtCl_2(NH_3)_4]Br_2$ and $[PtBr_2(NH_3)_4]Cl_2$

11. If 10^{-4} dm^3 of water is introduced into a 1.0 dm^3 flask at 300 K, how many moles of water are in the vapour phase when equilibrium is established ?
(Given : Vapour pressure of H_2O at 300 K is 3170 Pa; R = 8.314 J K^{-1} mol^{-1})
(A) 5.56×10^{-3} mol
(B) 1.53×10^{-2} mol
(C) 4.46×10^{-2} mol
(D) 1.27×10^{-3} mol

12. From amongst the following alcohols the one that would react fastest with conc. HCl and anhydrous $ZnCl_2$, is
(A) 2–Butanol
(B) 2–Methylpropan–2–ol
(C) 2–Methylpropanol
(D) 1–Butanol

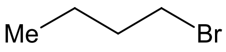
Space for rough work

13. In the chemical reactions,

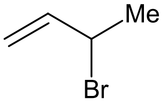

NH2
NaNO2
HCl, 278 K
A
HBF4
B

the compounds ‘A’ and ‘B’ respectively are
(A) nitrobenzene and fluorobenzene
(B) phenol and benzene
(C) benzene diazonium chloride and fluorobenzene
(D) nitrobenzene and chlorobenzene

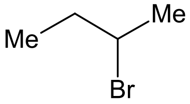
14. Consider the following bromides:



(A)



(B)



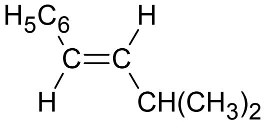
(C)

The correct order of S_N1 reactivity is
(A) B > C > A
(B) B > A > C
(C) C > B > A
(D) A > B > C

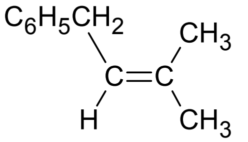
15. The main product of the following reaction is

$C_6H_5CH_2CH(OH)CH(CH_3)_2 \xrightarrow{\text{Conc.}H_2SO_4} ?$

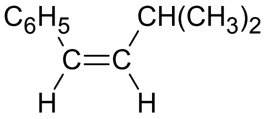
(A)


H5C6
H
C=C
H
CH(CH3)2

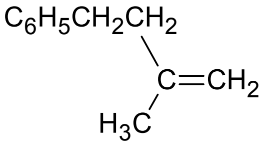
(B)


C6H5CH2
CH3
C=C
H
CH3

(C)


C6H5
CH(CH3)2
C=C
H
H

(D)


C6H5CH2CH2
C=CH2
H3C

16. The presence or absence of hydroxyl group on which carbon atom of sugar differentiates RNA and DNA?
(A) 2nd
(B) 3rd
(C) 4th
(D) 1st

Space for rough work

17. Trichloroacetaldehyde was subjected to Cannizzaro's reaction by using NaOH. The mixture of the products contains sodium trichloroacetate and another compound. The other compound is :
(A) trichloromethanol (B) 2, 2, 2-trichloropropanol
(C) chloroform (D) 2, 2, 2-trichloroethanol

18. 'a' and 'b' are van der Waals' constants for gases. Chlorine is more easily liquefied than ethane because
(A) a and b for Cl_2 < a and b for C_2H_6
(B) a for Cl_2 < a for C_2H_6 but b for Cl_2 > b for C_2H_6
(C) a for Cl_2 > a for C_2H_6 but b for Cl_2 < b for C_2H_6
(D) a and b for Cl_2 > a and b for C_2H_6

19. In context of the lanthanoids, which of the following statement is not correct ?
(A) All the members exhibit +3 oxidation state
(B) Because of similar properties the separation of lanthanoids is not easy.
(C) Availability of 4f electrons results in the formation of compounds in +4 state for all the members of the series.
(D) There is a gradual decrease in the radii of the members with increasing atomic number in the series.

20. Which of the following statements regarding sulphur is incorrect ?
(A) The vapour at 200^oC consists mostly of S_8 rings
(B) At 600^oC the gas mainly consists of S_2 molecules
(C) The oxidation state of sulphur is never less than +4 in its compounds
(D) S_2 molecule is paramagnetic.

21. Phenol is heated with a solution of mixture of KBr and $KBrO_3$. The major product obtained in the above reaction is
(A) 3-Bromophenol (B) 4-Bromophenol
(C) 2, 4, 6- Tribromophenol (D) 2-Bromophenol

22. The molecule having smallest bond angle is :
(A) NCl_3 (B) $AsCl_3$
(C) $SbCl_3$ (D) PCl_3

23. The incorrect expression among the following is:
(A) $\frac{\Delta G_{system}}{\Delta S_{total}} = -T$ (B) In isothermal process $W_{reversible} = -nRT\ln\frac{V_2}{V_1}$
(C) $\ln K = \frac{\Delta H^0 - T\Delta S^0}{RT}$ (D) $K = e^{-\Delta G^0/RT}$

Space for rough work

24. The density of a solution prepared by dissolving 120 g of urea (mol. Mass = 60 u) in 1000g of water is 1.15 g/mL. The molarity of this solution is:
(A) 0.50 M (B) 1.78 M
(C) 1.02 M (D) 2.05 M

25. How many chiral compounds are possible on monochlorination of 2–methyl butane ?
(A) 8 (B) 2
(C) 4 (D) 6

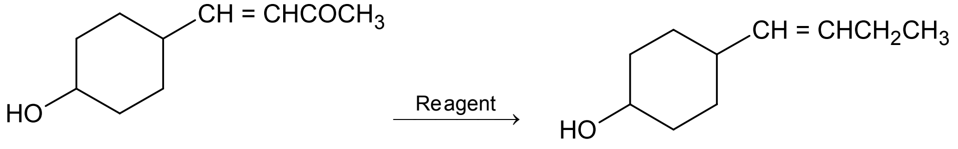
26. For a first order reaction, (A) → products, the concentration of A changes from 0.1 M to 0.025 M in 40 minutes. The rate of reaction when the concentration of A is 0.01 M is :
(A) 1.73×10^{-5} M/ min (B) 3.47×10^{-4} M/min
(C) 3.47×10^{-5} M/min (D) 1.73×10^{-4} M/min

27. Iron exhibits + 2 and +3 oxidation states. Which of the following statements about iron is incorrect ?
(A) Ferrous oxide is more basic in nature than the ferric oxide.
(B) Ferrous compounds are relatively more ionic than the corresponding ferric compounds
(C) Ferrous compounds are less volatile than the corresponding ferric compounds.
(D) Ferrous compounds are more easily hydrolysed than the corresponding ferric compounds.

28. K_f for water is 1.86 K kg mol^{-1}. If your automobile radiator holds 1.0 kg of water, how many grams of ethylene glycol ($C_2H_6O_2$) must you add to get the freezing point of the solution lowered to –2.8°C ?
(A) 72g (B) 93g
(C) 39g (D) 27g

29. Iodoform can be prepared from all except :
(A) Ethyl methyl ketone (B) Isopropyl alcohol
(C) 3–Methyl – 2– butanone (D) Isobutyl alcohol

30. In the given transformation, which of the following is the most appropriate reagent?



(A) NH_2NH_2, OH^- (B) Zn-Hg/HCl
(C) Na.Liq.NH_3 (D) $NaBH_4$

Space for rough work

SECTION - 3
MATHEMATICS

1. The real number k for which the equation, $2x^3 + 3x + k = 0$ has two distinct real roots in [0, 1]
   (A) lies between –1 and 0 (B) does not exist
   (C) lies between 1 and 2 (D) lies between 2 and 3

2. If $A = \sin^2 x + \cos^4 x$, then for all real x
   (A) $\frac{13}{16} \le A \le 1$ (B) $1 \le A \le 2$
   (C) $\frac{3}{4} \le A \le \frac{13}{16}$ (D) $\frac{3}{4} \le A \le 1$

3. If $P = \begin{bmatrix} 1 & \alpha & 3 \\ 1 & 3 & 3 \\ 2 & 4 & 4 \end{bmatrix}$ is the adjoint of a 3×3 matrix A and $|A| = 4$, then α is equal to:
   (A) 5 (B) 0
   (C) 4 (D) 11

4. $\lim\limits_{x \to 2} \left(\frac{\sqrt{1 - \cos\{2(x-2)\}}}{x-2} \right)$
   (A) equals $\sqrt{2}$ (B) equals $-\sqrt{2}$
   (C) equals $\frac{1}{\sqrt{2}}$ (D) does not exist

5. At present a firm is manufacturing 2000 items. It is estimated that the rate of change of production P w.r.t. additional number of workers x is given by $\frac{dP}{dx} = 100 - 12\sqrt{x}$. If the firm employs 25 more workers, then the new level of production of items is:
   (A) 3500 (B) 4500
   (C) 2500 (D) 3000

6. ABCD is a trapezium such that AB and CD are parallel and $BC \perp CD$. If $\angle ADB = \theta$, BC = p and CD = q, then AB is equal to
   (A) $\frac{p^2 + q^2}{p^2 \cos\theta + q^2 \sin\theta}$ (B) $\frac{(p^2 + q^2)\sin\theta}{(p\cos\theta + q\sin\theta)^2}$
   (C) $\frac{(p^2 + q^2)\sin\theta}{p\cos\theta + q\sin\theta}$ (D) $\frac{p^2 + q^2\cos\theta}{p\cos\theta + q\sin\theta}$

Space for rough work

7. The value of $\int_0^1 \frac{8\log(1+x)}{1+x^2}dx$ is

(A) $\frac{\pi}{8}\log 2$ (B) $\frac{\pi}{2}\log 2$

(C) $\log 2$ (D) $\pi \log 2$

8. A ray of light along $x+\sqrt{3}y=\sqrt{3}$ gets reflected upon reaching x-axis, the equation of the reflected ray is:

(A) $y=\sqrt{3}x-\sqrt{3}$ (B) $\sqrt{3}y=x-1$

(C) $y=x+\sqrt{3}$ (D) $\sqrt{3}y=x-\sqrt{3}$

9. The domain of the function $f(x)=\frac{1}{\sqrt{|x|-x}}$ is

(A) $(0,\infty)$ (B) $(-\infty,0)$

(C) $(-\infty,\infty)-\{0\}$ (D) $(-\infty,\infty)$

10. If z is a complex number of unit modulus and argument θ, then $\arg\left(\frac{1+z}{1+\bar{z}}\right)$ equals:

(A) θ (B) $\pi-\theta$

(C) $-\theta$ (D) $\frac{\pi}{2}-\theta$

11. If $\int f(x)\,dx=\psi(x)$, then $\int x^5 f(x^3)dx$ is equal to:

(A) $\frac{1}{3}x^3\psi(x^3)-\int x^2\psi(x^3)dx+C$ (B) $\frac{1}{3}\left[x^3\psi(x^3)-\int x^3\psi(x^3)dx\right]+C$

(C) $\frac{1}{3}\left[x^3\psi(x^3)-\int x^2\psi(x^3)dx\right]+C$ (D) $\frac{1}{3}x^3\psi(x^3)-3\int x^3\psi(x^3)dx+C$

12. Equation of the ellipse whose axes are the axes of coordinates and which passes through the point (–3, 1) and has eccentricity $\sqrt{\frac{2}{5}}$ is

(A) $5x^2+3y^2-48=0$ (B) $3x^2+5y^2-15=0$

(C) $5x^2+3y^2-32=0$ (D) $3x^2+5y^2-32=0$

Space for rough work

13. If the lines $\frac{x-2}{1}=\frac{y-3}{1}=\frac{z-4}{-k}$ and $\frac{x-1}{k}=\frac{y-4}{2}=\frac{z-5}{1}$ are coplanar, then k can have:
(A) exactly two values
(B) exactly three values
(C) any value
(D) exactly one value

14. The number of values of k for which the linear equations $4x+ky+2z=0; kx+4y+z=0;$ $2x+2y+z=0$ posses a non – zero solution is
(A) 2
(B) 1
(C) zero
(D) 3

15. Consider:
Statement – I : $(p\wedge \sim q)\wedge(\sim p\wedge q)$ is a fallacy.
Statement – II : $(p\rightarrow q)\leftrightarrow(\sim q\rightarrow\sim p)$ is a tautology.
(A) Statement – I is true; Statement – II is false.
(B) Statement – I is false; Statement – II is true.
(C) Statement – I is true; Statement – II is true; Statement – II is a correct explanation for Statement – I
(D) Statement – I is true; Statement – II is true; Statement – II is not a correct explanation for Statement – I.

16. If the equations $x^2+2x+3=0$ and $ax^2+bx+c=0, a,b,c\in R,$ have a common root, then a : b : c is:
(A) 1 : 3 : 2
(B) 3 : 1 : 2
(C) 1 : 2 : 3
(D) 3 : 2 : 1

17. If the mean deviation about the median of the numbers $\alpha, 2\alpha, ...50\alpha$ is 50, then $|\alpha|$ equals
(A) 3
(B) 4
(C) 5
(D) 2

18. The term independent of x in expansion of $\left(\frac{x+1}{x^{2/3}-x^{1/3}+1}-\frac{x-1}{x-x^{1/2}}\right)^{10}$ is
(A) 210
(B) 310
(C) 4
(D) 120

19. Let A and B be two symmetric matrices of order 3.
Statement – 1 A (BA) and (AB) A are symmetric matrices.
Statement – 2 AB is symmetric matrix if matrix multiplication of A and B is commutative.
(A) Statement – 1 is true, Statement – 2 is true; Statement – 2 is not a correct explanation for Statement – 1
(B) Statement – 1 is true, Statement – 2 is false
(C) Statement – 1 is false, Statement – 2 is true
(D) Statement – 1 is true, Statement – 2 is true; Statement – 2 is a correct explanation for Statement – 1

Space for rough work

20. If x, y, z are in A.P. and $\tan^{-1}x, \tan^{-1}y$ and $\tan^{-1}z$ are also in A.P., then:
(A) $6x = 3y = 2z$ (B) $6x = 4y = 3z$
(C) $x = y = z$ (D) $2x = 3y = 6z$

21. The intercepts on x-axis made by tangents to the curve, $y = \int_0^x |t| dt,\ x \in R$, which are parallel to the line $y = 2x$, are equal to
(A) ± 3 (B) ± 4
(C) ± 1 (D) ± 2

22. Let [.] denote the greatest integer function then the value of $\int_0^{1.5} x\left[x^2\right]dx$ is:
(A) 0 (B) $\frac{3}{2}$
(C) $\frac{3}{4}$ (D) $\frac{5}{4}$

23. The circle passing through (1, –2) and touching the axis of x at (3, 0) also passes through the point:
(A) $(5, -2)$ (B) $(-2, 5)$
(C) $(-5, 2)$ (D) $(2, -5)$

24. If $A(2, -3)$ and $B(-2, 1)$ are two vertices of a triangle and third vertex moves on the line $2x + 3y = 9$, then the locus of the centroid of the triangle is:
(A) $x - y = 1$ (B) $2x + 3y = 1$
(C) $2x + 3y = 3$ (D) $2x - 3y = 1$

25. If $y = \sec\left(\tan^{-1}x\right)$, then $\frac{dy}{dx}$ at $x = 1$ is equal to:
(A) 1 (B) $\sqrt{2}$
(C) $\frac{1}{\sqrt{2}}$ (D) $\frac{1}{2}$

Space for rough work

26. The expression $\frac{\tan A}{1-\cot A}+\frac{\cot A}{1-\tan A}$

(A) $\tan A+\cot A$ (B) $\sec A+\text{coesc}A$

(C) $\sin A\cos A+1$ (D) $\sec A\,\text{cosec}A+1$

27. If the trivial solution is the only solution of the system of equations

$x-ky+z=0$

$kx+3y-kz=0$ then the set of all values of k is:

$3x+y-z=0$

(A) $R-\{2,-3\}$ (B) $R-\{2\}$

(C) $R-\{-3\}$ (D) $\{2,-3\}$

28. A multiple choice examination has 5 questions. Each question has three alternative answers of which exactly one is correct. The probability that a student will get 4 or more correct answers just by guessing is:

(A) $\frac{11}{3^5}$ (B) $\frac{10}{3^5}$

(C) $\frac{17}{3^5}$ (D) $\frac{13}{3^5}$

29. Consider the differential equation $y^2dx+\left(x-\frac{1}{x}\right)dy=0$. If $y(1)=1$, then x is given by:

(A) $4-\frac{2}{y}-\frac{e^{\frac{1}{y}}}{e}$ (B) $3-\frac{1}{y}+\frac{e^{\frac{1}{y}}}{e}$

(C) $1+\frac{1}{y}-\frac{e^{\frac{1}{y}}}{e}$ (D) $1-\frac{1}{y}+\frac{e^{\frac{1}{y}}}{e}$

30. $\lim\limits_{x\to 0}\frac{(1-\cos 2x)(3+\cos x)}{x\tan 4x}$ is equal to:

(A) 1 (B) 2

(C) $-\frac{1}{4}$ (D) $\frac{1}{2}$

Space for rough work

FIITJEE JEE MAINS MOCK TEST-1

Target IIT - JEE 2014

QP CODE: 120634.0

ANSWERS

SECTION – I (Physics)

1.	**B**	2.	**C**	3.	**B**	4.	**D**
5.	**A**	6.	**C**	7.	**A**	8.	**B**
9.	**B**	10.	**C**	11.	**C**	12.	**D**
13.	**D**	14.	**C**	15.	**A**	16.	**C**
17.	**B**	18.	**A**	19.	**D**	20.	**C**
21.	**B**	22.	**B**	23.	**C**	24.	**A**
25.	**B**	26.	**D**	27.	**C**	28.	**D**
29.	**A**	30.	**D**				

SECTION – II (Chemistry)

1.	**C**	2.	**D**	3.	**C**	4.	**D**
5.	**C**	6.	**B**	7.	**A**	8.	**B**
9.	**C**	10.	**B**	11.	**D**	12.	**B**
13.	**C**	14.	**A**	15.	**A**	16.	**A**
17.	**D**	18.	**C**	19.	**C**	20.	**C**
21.	**C**	22.	**C**	23.	**C**	24.	**D**
25.	**B**	26.	**B**	27.	**D**	28.	**B**
29.	**D**	30.	**A**				

SECTION – III (Mathematics)

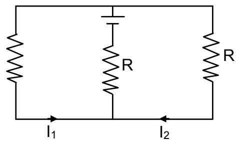
1.	**B**	2.	**D**	3.	**D**	4.	**D**
5.	**A**	6.	**C**	7.	**D**	8.	**D**
9.	**B**	10.	**A**	11.	**A**	12.	**D**
13.	**A**	14.	**A**	15.	**D**	16.	**C**
17.	**B**	18.	**A**	19.	**A**	20.	**C**
21.	**C**	22.	**C**	23.	**A**	24.	**B**
25.	**C**	26.	**D**	27.	**A**	28.	**A**
29.	**C**	30.	**B**				

Hints & Solutions

Physics

1. **B**

Sol. A moving conductor is equivalent to a battery of emf = $vB\ell$ (motion emf)



Equivalent circuit

$I = I_1 + I_2$

Applying Kirchoff's law

$I_1R + IR - vB\ell = 0$ …(1)

$I_2R + IR - vB\ell = 0$ …(2)

Adding (1) and (2)

$2IR + IR = 2vB\ell$

$$I = \frac{2vB\ell}{3R} \; ; \; I_1 = I_2 = \frac{vB\ell}{3R}$$

2. **C**

Sol. $$U = \frac{1}{2}\frac{q^2}{C} = \frac{1}{2C}(q_o e^{-t/T})^2 = \frac{q_0^2}{2C}e^{-2t/T} \text{ (where } \tau = CR)$$

$$U = U_1 e^{-2t_1/\tau}$$

$$\frac{1}{2}U_1 = U_1 e^{-2t_1/\tau} \; ; \; \frac{1}{2} = e^{-2t_1/\tau} \Rightarrow t_1 = \frac{T}{2}\ln 2$$

Now, $q = q_o e^{-t/T}$

$$\frac{1}{4}q_o = q_o e^{-t/2T}$$

$t_2 = T\ln 4 = 2T\ln 2$

$$\therefore \quad \frac{t_1}{t_2} = \frac{1}{4}$$

3. **B**

Sol. $\rho_{oil} < \rho < \rho_{water}$

Oil is the least dense of them so it should settle at the top with water at the base. Now the ball is denser than oil but less denser than water. So, it will sink through oil but will not sink in water. So it will stay at the oil-water interface.

4. **D**

Sol. $\vec{v} = Ky\hat{i} + x\hat{j}$

$\frac{dx}{dt} = Ky,\ \frac{dy}{dt} = Kx$

$\frac{dy}{dx} = \frac{dy}{dt} \times \frac{dt}{dx} = \frac{Kx}{Ky}$

ydy = xdx

$y^2 = x^2 + C$

5. **A**

Sol. The magnetic field in between because of each will be in opposite direction.

$B_{\text{in between}} = \frac{\mu_o i}{2\pi x}\hat{j} - \frac{\mu_o i}{2\pi(2d - x)}(-\hat{j})$

$= \frac{\mu_o i}{2\pi}\left[\frac{1}{x} - \frac{1}{2d - x}\right](-\hat{j})$

at x = d, $B_{\text{in between}} = 0$

for x < d, $B_{\text{in between}} = (\hat{j})$

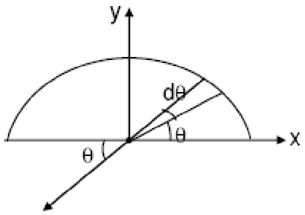
for x > d, $B_{\text{in between}} = (-\hat{j})$

towards x net magnetic field will add up and direction will be $(-\hat{j})$

towards x′ net magnetic field will add up and direction will be $(\hat{j})$

6. **C**

Sol. Linear charge density $\lambda = \left(\frac{q}{\pi r}\right)$



$E = \int dE \sin\theta(-\hat{j}) = \int \frac{K.dq}{r^2}\sin\theta(-\hat{j})$

$E = \frac{K}{r^2}\int \frac{qr}{\pi r} d\theta \sin\theta(-\hat{j})$

$= \frac{K}{r^2}\frac{q}{\pi}\int_0^{\pi} \sin\theta(-\hat{j}) = \frac{q}{2\pi^2\varepsilon_0 r^2}(-\hat{j})$

7. **A**

Sol. Truth table for given combination is

A	B	Y
0	0	1
1	0	1
0	1	1
1	1	1

This comes out to be truth table of OR gate.

8. **B**

Sol. The efficiency of cycle is

$\eta = 1 - \frac{T_2}{T_1}$

for adiabatic process

$TV^{\gamma-1}$ = constant

For diatomic gas $\gamma = \frac{7}{5}$

$$T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$$

$$T_1 = T_2\left(\frac{V_2}{V_1}\right)^{\gamma-1} \quad ; \quad T_1 = T_2(32)^{\frac{7}{2}-1}$$

$$= T_2(2^5)^{2/5} = T_2 \times 4$$

$$T_1 = 4T_2$$

$$\eta = \left(1-\frac{1}{4}\right) = \frac{3}{4} = 0.75$$

9. **B**

Sol. Apply shell theorem the total charge upto distance r can e calculated as followed

$$dq = 4\pi r^2.dr.\rho \;=\; 4\pi r^2.dr.\rho_o\left[\frac{5}{4}-\frac{r}{R}\right]$$

$$= 4\pi\rho_0\left[\frac{5}{4}r^2dr - \frac{r^3}{R}dr\right]$$

$$\int dq = q = 4\pi\rho_0\int_0^r\left(\frac{5}{4}r^2dr - \frac{r^3}{R}dr\right) \;=\; 4\pi\rho_0\left[\frac{5}{4}\frac{r^2}{3} - \frac{1}{R}\frac{r^4}{4}\right]$$

$$E = \frac{kq}{r^2}$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{1}{r^2}\cdot 4\pi\rho_0\left[\frac{5}{4}\frac{r^2}{3} - \frac{1}{R}\frac{r^4}{4}\right]$$

$$E = \frac{\rho_o r}{4\varepsilon_o}\left(\frac{5}{3}-\frac{r}{R}\right)$$

10. **C**

Sol. $U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$

$U(x=\infty) = 0$

as, $F = -\frac{dU}{dx} = -\left[\frac{12a}{x^{13}} + \frac{6b}{x^7}\right]$

at equilibrium, F = 0

$\therefore \quad x^6 = \frac{2a}{b}$

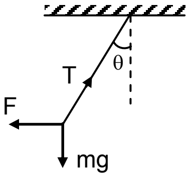
$\therefore \quad U_{\text{at equilibrium}} = \frac{a}{\left(\frac{2a}{b}\right)^2} - \frac{b}{\left(\frac{2a}{b}\right)} = \frac{-b^2}{4a}$

$\therefore \quad D = [U(x=\infty) - U_{\text{at equilibrium}}] = \frac{b^2}{4a}$

11. **C**

Sol. From F.B.D. of sphere, using Lami's theorem

$$\frac{F}{mg} = \tan\theta \qquad \ldots\text{(i)}$$



when suspended in liquid, as θ remains same,

$$\therefore \quad \frac{F'}{mg\left(1-\frac{\rho}{d}\right)} = \tan\theta \qquad \ldots\text{(ii)}$$

Using (i) and (ii)

$$\frac{F}{mg} = \frac{F'}{mg\,K\left(1-\frac{\rho}{d}\right)} \text{ where, } F' = \frac{F}{K}$$

$$\therefore \quad \frac{F}{mg} = \frac{F'}{mg\,K\left(1-\frac{\rho}{d}\right)}$$

or $$K = \frac{1}{1-\frac{\rho}{d}} = 2$$

12. **D**

Sol. Let R_0 be the initial resistance of both conductors

$\therefore$ At temperature θ their resistance will be

$R_1 = R_0(1 + \alpha_1\theta)$ and $R_2 = R_0(1 + \alpha_2\theta)$

for, series combination, $R_s = R_1 + R_2$

$R_{s0}(1+\alpha_1\theta)$ and $R_2 = (1+\alpha_1\theta) + R_0(1+\alpha_2\theta)$

where $R_{s0} = R_0 + R_0 = 2R_0$

$$\therefore \quad 2R_0(1+\alpha_s\theta) = 2R_0 + R_0\theta(\alpha_1+\alpha_2)$$

or $$\alpha_s = \frac{\alpha_1+\alpha_2}{2}$$

for parallel combination, $R_p = \dfrac{R_1R_2}{R_1+R_2}$

$$R_{p0}(1+\alpha_p\theta) = \frac{R_0(1+\alpha_1\theta)R_0(1+\alpha_2\theta)}{R_0(1+\alpha_1\theta)+R_0(1+\alpha_2\theta)}$$

where, $R_{p0} = \dfrac{R_0R_0}{R_0+R_0} = \dfrac{R_0}{2}$

$$\therefore \quad \frac{R_0}{2}(1+\alpha_p\theta) = \frac{R_0^2(1+\alpha\theta+\alpha_2\theta+\alpha_1\alpha_2\theta)}{R_0(2+\alpha_1\theta+\alpha_2\theta)}$$

as α_1 and α_2 are small quantities

$\therefore$ $\alpha_1\ \alpha_2$ is negligible

or $$\alpha_p = \frac{\alpha_1+\alpha_2}{2+(\alpha_1+\alpha)\theta} = \frac{\alpha_1+\alpha_2}{2}[1-(\alpha_1+\alpha_2)\theta]$$

as $(\alpha_1+\alpha_2)^2$ is negligible

$$\therefore \quad \alpha_p = \frac{\alpha_1+\alpha_2}{2}$$

13. **D**

Sol. $S = t^3 + 5$

$\therefore$ Speed, $v = \dfrac{ds}{dt} = 3t^2$

and rate of change of speed = $\dfrac{dv}{dt} = 6t$

$\therefore$ tangential acceleration at t = 2s, $a_t = 6 \times 2 = 12\ \text{m/s}^2$

At t = 2s, $v = 3(2)^2 = 12$ m/s

$\therefore$ centripetal acceleration, $a_c = \dfrac{v^2}{R} = \dfrac{144}{20}\ \text{m/s}^2$

$\therefore$ net acceleration = $\sqrt{a_t^2 + a_i^2}$

$\approx 14\ \text{m/s}^2$

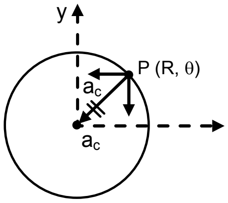
14. **C**

Sol. For a particle in uniform circular motion,

$$\vec{a} = \frac{v^2}{R} \text{ towards centre of circle}$$

$$\therefore \quad \vec{a} = \frac{v^2}{R}(-\cos\theta\hat{i} - \sin\theta\hat{j})$$

$$\text{or} \quad \vec{a} = \frac{v^2}{R}\cos\theta\hat{i} - \frac{v^2}{R}\sin\theta\hat{j}$$



15. **A**

Sol. 1^{st} reaction is fusion and 4^{th} reaction is fission.

16. **C**

Sol. Given figure is half wave rectifier.

17. **B**

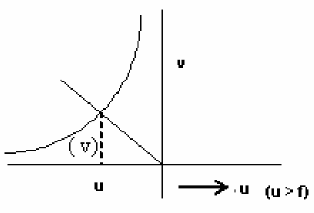
Sol. $\frac{aT}{x} = \frac{\omega^2 xT}{x} = \frac{4\pi^2}{T^2} \times T = \frac{4\pi^2}{T}$ = constant.

18. **A**

Sol. It is possible when object kept at centre of curvature.

u = v

u = 2f, v = 2f



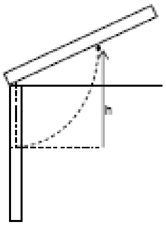
19. **D**

Sol. $T.E_i = T.E_f$

$$\frac{1}{2}I\omega^2 = mgh$$

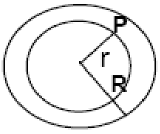
$$\frac{1}{2} \times \frac{1}{3}m\ell^2\omega^2 = mgh$$

$$\Rightarrow h = \frac{1}{6}\frac{\ell^2\omega^2}{g}$$



20. **C**

Sol. $$E4\pi r_1^2 = \frac{\int_0^{r_1} \frac{Q}{\pi R^4} r4\pi r^2 dr}{\varepsilon_0} \Rightarrow E = \frac{Qr_1^2}{4\pi\varepsilon_0 R^4}$$



21. **B**

Sol. Thermal energy corresponds to internal energy

Mass = 1 kg

Density = 8 kg/m^3

$$\Rightarrow \text{Volume} = \frac{\text{mass}}{\text{density}} = \frac{1}{8}\text{m}^3$$

Pressure = 8×10^4 N/m^2

$$\therefore \text{ Internal Energy} = \frac{5}{2}P \times V = 5 \times 10^4 \text{ J}$$

22. **B**

Sol. Motorcycle, u = 0, a = 2 m/s^2

Observer is in motion and source is at rest.

$$\Rightarrow \quad n' = n\frac{v - v_0}{v + v_s} \Rightarrow \frac{94}{100}n = n\frac{330 - v_0}{330} \Rightarrow 330 - v_0 = \frac{330 \times 94}{100}$$

$$\Rightarrow \quad v_0 = 330 - \frac{94 \times 33}{10} = \frac{33 \times 6}{10} m/s$$

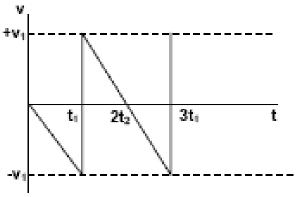
$$s = \frac{v^2 - u^2}{2a} = \frac{9 \times 33 \times 33}{100} = \frac{9 \times 1089}{100} \approx 98 \text{ m}$$

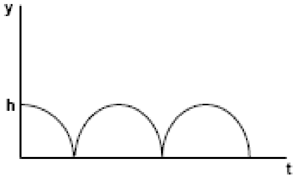
23. **C**

Sol. $h = \frac{1}{2}gt^2$, v = –gt and after the collision, v = gt

(parabolic) (straight line)

Collision is perfectly elastic then ball reaches to same height again and again with same velocity.



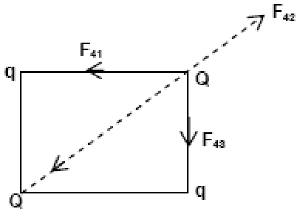


24. **A**

Sol. Three forces F_{41}, F_{42} and f_{43} acting on Q are shown

Resultant of $F_{41} + F_{43} = \sqrt{2}\,F_{each}$

$$= \sqrt{2}\,\frac{1}{4\pi\varepsilon_o}\frac{Qq}{d^2}$$



Resultant on Q becomes zero only when 'q' charges are of negative nature.

$$F_{4.2} = \frac{1}{4\pi\varepsilon_o}\frac{Q \times Q}{(\sqrt{2}d)^2}$$

$$\Rightarrow \quad \sqrt{2}\frac{dQ}{d^2} = \frac{Q \times Q}{2d^2}$$

$$\Rightarrow \quad \sqrt{2} \times q = \frac{Q \times Q}{2} \quad ; \quad \therefore \quad q = -\frac{Q}{2\sqrt{2}} \text{ or } \frac{Q}{q} = -2\sqrt{2}$$

25. **B**

Sol. We know that $\frac{dQ}{dt} = KA\frac{d\theta}{dx}$

In steady state flow of heat

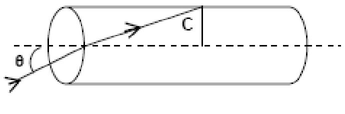
$$d\theta = \frac{dQ}{dt} \cdot \frac{1}{kA}dx$$

$$\Rightarrow \quad \theta_H - \theta = k'x \quad \Rightarrow \quad \theta = \theta_H - k'x$$

Equation $\theta = \theta_H - k'x$ represents a straight line.

26. **D**

Sol. $\text{Sin } C = \frac{\sqrt{3}}{2}$ …(1)



Sin r = sin (90 – C) = cos C = $\frac{1}{2}$

$$\frac{\sin\theta}{\sin r}=\frac{\mu_2}{\mu_1}$$

$$\sin\theta=\frac{2}{\sqrt{3}}\times\frac{1}{2}$$

$$\theta=\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$$

27. **C**

Sol. Maximum number of beats = $\nu + 1 - (\nu - 1) = 2$.

28. **D**

Sol. $A_1\ell_1=A_2\ell_2 \Rightarrow \ell_2=\frac{A_1\ell_1}{A_2}=\frac{A\times\ell_1}{3A}=\frac{\ell_1}{3}\Rightarrow\frac{\ell_1}{\ell_2}$ = 3

$$\Delta x_1=\frac{F_1}{A_\gamma}\times\ell_1 \qquad \ldots(i)$$

$$\Delta x_2=\frac{F_2}{3A_\gamma}\ell_2 \qquad \ldots(ii)$$

Here $\Delta x_1 = \Delta x_2$

$$\frac{F_2}{3A\gamma}\ell_2=\frac{F_1}{A\gamma}\ell_1$$

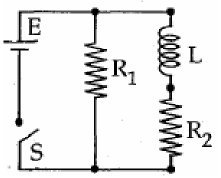
$$F_2=3F_1\times\frac{\ell_1}{\ell_2}=3F_1\times 3 = 9F$$

29. **A**

Sol. Least count = $\frac{\text{value of main scale division}}{\text{No. of divisions on vernier scale}}=\frac{1}{30}\text{MSD}=\frac{1}{30}\times\frac{1^o}{2}=\frac{1^o}{60}$ = 1 minute

30. **D**

Sol. $I_1=\frac{F}{R_1}=\frac{12}{2}=6A$



$$E=L\frac{dI_2}{dt}+R_2\times I_2$$

$$I_2=I_o(1-e^{-t/t_c}) \Rightarrow I_o=\frac{E}{R_2}=\frac{12}{2}=6A$$

$$t_c=\frac{L}{R}=\frac{400\times10^{-3}}{2}=0.2$$

$$I_2=6(1-e^{-t/0.2})$$

Potential drop across L = $E - R_2I_2 = 12 - 2 \times 6(1 - e^{-bt}) = 12\ e^{-5t}$

Chemistry

1. C

1. Ln^{3+} compounds are mostly coloured.

2. D

Sol. Esterification reaction is involved

$$CH_3COOH(\ell)+C_2H_5OH(\ell)\xrightarrow{H^+}CH_3COOC_2H_5(\ell)+H_2O(\ell)$$

3. C

Sol. Correct basic strength is $NH_3 > PH_3 > AsH_3 > BiH_3$

4. D

Sol Enthalpy of adsorption regarding physiosorption is not positive and it is negative.

5. C

Sol. $\because Fe^{3+} + 3e^{-} \longrightarrow Fe; E^{o} = -0.036\,V$

$\therefore \Delta G_1^{o} = -nFE^{o} = -3F(-0.036) = +0.108\ F$

Also $Fe^{2+} + 2e^{-} \longrightarrow Fe;\ E^{o} = -0.439\,V$

$\therefore \Delta G_2^{o} = -nFE^{o}$

$= -2F(-0.439) = 0.878F$

To find E^{o} for $Fe^{3+}(aq) + e^{-} \longrightarrow Fe^{2+}(aq)$

$\Delta G^{o} = -nFE^{o} = -1FE^{o}$

$\because G^{o} = G_1^{o} - G_2^{o}$

$\therefore\ G^{o} = 0.108F = 0.878F$

$\therefore -FE^{o} = +0.108F - 0.878F$

$\therefore E^{o} = 0.878 - 0.108 = 0.77\ V$

6. B

Sol. $Ba(NO_3)_2 + CaCO_3 \longrightarrow BaCO_3 + 2NaNO_3$

Here $\left[CO_3^{2-}\right] = [Na_2CO_3] = 10^{-4}$ M

$K_{SP} = [Ba^{2+}]\left[CO_3^{2-}\right] \Rightarrow 5.1 \times 10^{-9} = [Ba^{2+}](10^{-4}) \Rightarrow [Ba^{2+}] = 5.1 \times 10^{-5}$

At this value, just precipitation starts.

7. A

Sol. Remaining are feasible

8. B

Sol. Follow the periodic trends.

9. C

Sol. Option itself is the reason

10. B

Sol. NCS^{-} is ambidentate ligand and it can be linked through N (or) S

11. D

Sol. $n = \dfrac{PV}{RT}$

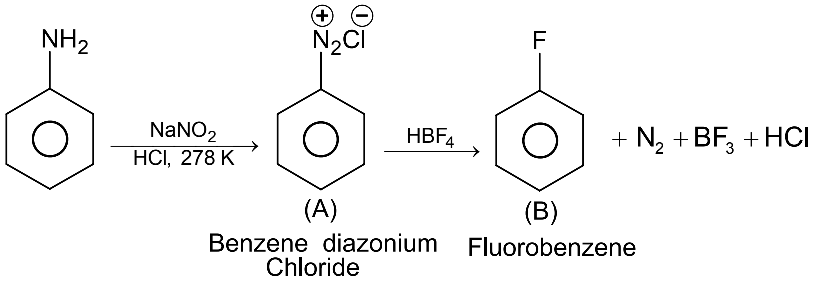
$$= \frac{3170 \times 10^{-5}\ \text{atm} \times 1L}{0.0821\,L\,\text{atm}\ K^{-1}\,\text{mol}^{-1} \times 300K} \approx 1.27 \times 10^{-3}\ \text{mol}$$

12. B

Sol. 3° alcohols react fastest with $ZnCl_2$/conc.HCl due to formation of 3° carbocation and 2–methyl propan–2–ol is the only 3° alcohol

13. C

Sol.

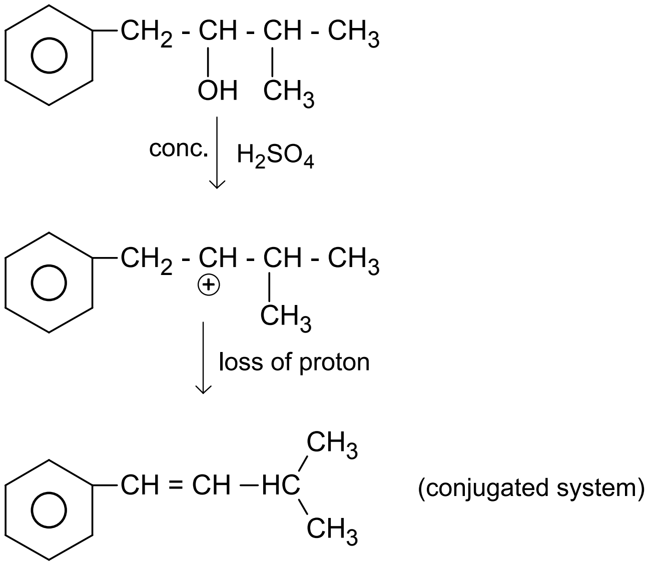

NH2
NaNO2
HCl, 278 K
N2Cl
HBF4
F
+ N2 + BF3 + HCl
(A)
Benzene diazonium Chloride
(B)
Fluorobenzene

14. A

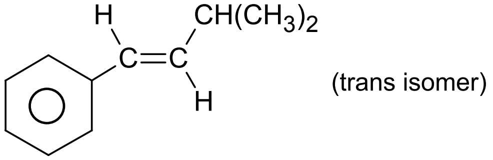
Sol. S_N1 proceeds via carbocation intermediate, the most stable one forming the product faster. Hence reactivity order for A, B, C depends on stability of carbocation

15. A

Sol.


CH2 - CH - CH - CH3
OH CH3
conc.
H2SO4
CH2 - CH - CH - CH3
CH3
loss of proton
CH = CH —HC
CH3
CH3
(conjugated system)

Trans isomer is more stable & main product here


H
CH(CH3)2
C=C
H
(trans isomer)

16. A

Sol. In RNA, the sugar is β - D – Ribose, whereas in DNA the sugar is β - D-2-deoxy Ribose.

17. D

Sol. $2CCl_3CHO \xrightarrow{OH^-} CCl_3COONa + CCl_3CH_2OH$

Cannizaro reaction is a disproportionation reaction. One aldehyde molecule is oxidized to salt of the carboxylic acid, other one is reduced to alcohol. So, the compound is CCl_3CH_2OH. IUPAC name is 2, 2, 2, -trichloro ethanol.

18. C

Sol. Ease of liquefication $\alpha \frac{a}{b}$

For ethane a = 5.49, b = 0.0638
For Cl_2 a = 6.49, b = 0.0562

19. C

Sol. The general o.s of lanthanides is +3, only few elements exhibit +4 o.s.

20. C
Sol. 'S' can exhibit a minimum oxidation state of -2.

21. C
Sol. In acidic medium, KBr + $KBrO_3$ in turn produces Br_2. Phenol reacts with $Br_2(aq)$ to give 2, 4, 6-trinitrophenol.

22. C
Sol. As the size of central atom increases lone pair bond pair repulsions increases so, bond angle decreases.

23. C
Sol. $\Delta G^0 = -RT\ln K$ and $\Delta G^0 = \Delta H^0 - T\Delta S^0$

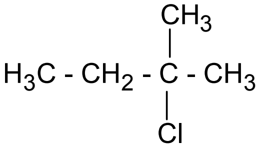
24. D
Sol. Total weight of solution = 1000 + 120 = 1120 g

$$\text{Molarity} = \frac{120}{60} \times \frac{1000}{1120/1.15} = 2.05\text{M}$$

25. B
Sol. $H_3C - CH_2 - CH(CH_3) - CH_3$ on monochlorination gives

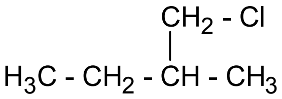
$H_2C(Cl) - CH_2 - CH(CH_3) - CH_3$
(I)
Achiral

$H_3C - CH(Cl) - CH(CH_3) - CH_3$
(II)
Chiral



$H_3C - CH_2 - \underset{Cl}{\overset{CH_3}{C}} - CH_3$

(III)
Achiral



$H_3C - CH_2 - \overset{CH_2 - Cl}{CH} - CH_3$

(IV)
Chiral

26. B
Sol. $k = \frac{2.303}{40} \log \frac{0.1}{0.025}$

$k = \frac{0.693}{20}$

For a 1st order reaction, rate = k(A), rate = $\frac{0.693}{20} \times 10^{-2}$ = 3.47×10^{-4}

27. D
Sol. FeO → More basic, more ionic, less volatile

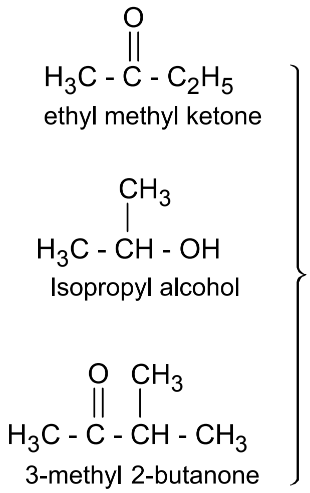
28. B
Sol. $\Delta T_f = K_f m$

$2.8 = 1.86 \times \frac{w}{62} \times \frac{1000}{1000}$

w = 93g

29. D

Sol. Iodoform is given by: 1) methyl ketones R – CO - CH_3
2) alcohols of the type R - CH(OH)CH_3
Where R can be hydrogen also



$H_3C-\overset{\overset{\displaystyle O}{\|}}{C}-C_2H_5$

ethyl methyl ketone

$H_3C-\overset{\overset{\displaystyle CH_3}{|}}{CH}-OH$

Isopropyl alcohol

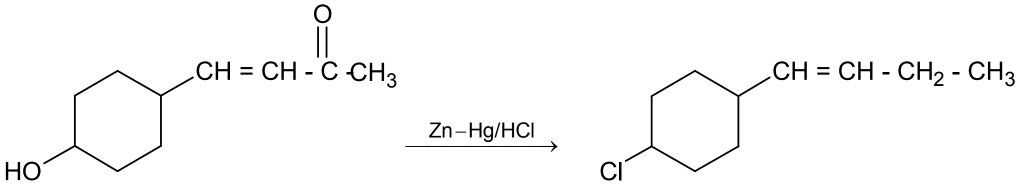
$H_3C-\overset{\overset{\displaystyle O}{\|}}{C}-\overset{\overset{\displaystyle CH_3}{|}}{CH}-CH_3$

3-methyl 2-butanone

can give iodoform test

30. A

Sol. ZnHg/HCl can't be used due to the presence of acid sensitive group i.e. OH



and Na/Liq. NH_3 and $NaBH_4$ convert – CO – into – CH(OH)–

Mathematics

1. Let $f(x)=2x^3+3x+k$

$f'(x)=6x^2+3$

$\Rightarrow f(x)$ is an increasing function

$\Rightarrow$ there exist no real values of k

3. As we know

$|\text{adj } A|=|A|^{n-1}$ where n is order of matrix A

$$\begin{vmatrix}1 & \alpha & 3\\ 1 & 3 & 3\\ 2 & 4 & 4\end{vmatrix}=(4)^2=(12-12)-\alpha(4-6)+3(4-6)=16$$

$2\alpha-6=16\Rightarrow\alpha=11$

5. $\dfrac{dp}{dx}=100-12\sqrt{x}\Rightarrow\int dp=\int\left(100-12\sqrt{x}\right)dx+c$

$P=100x-8x^{3/2}+C$

At $x=0,\ p=2000\quad\Rightarrow C=2000$

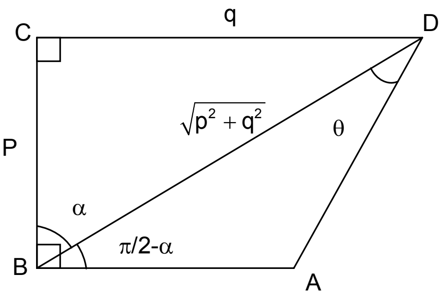
$P=100x-8x^{3/2}+2000$

When $x=25$

$P=100\times25-1000+2000$

$P = 3500$

6. In ΔADB, by sine rule



$$\frac{\sin\theta}{AB} = \frac{\sin\left(\frac{\pi}{2}+\alpha-\theta\right)}{\sqrt{p^2+q^2}}$$

$$AB = \frac{\sqrt{p^2+q^2}\sin\theta}{\cos\alpha\cos\theta+\sin\alpha\sin\theta}$$

In ΔBCD, $\sin\alpha = \frac{q}{\sqrt{p^2+q^2}}, \cos\alpha = \frac{p}{\sqrt{p^2+q^2}}$

$$AB = \frac{\left(p^2+q^2\right)\sin\theta}{p\cos\theta+q\sin\theta}$$

8. Given line is $\frac{x}{\sqrt{3}}+\frac{y}{1}=1$

Passing through $\left(\sqrt{3},\,0\right)$ and $\left(0,\,1\right)$, we know that image of (α,β) with respect to x axes is $(\alpha, -\beta)$

Reflected ray pass through $\left(\sqrt{3},\,0\right)$ and $\left(0,\,-1\right)$

$\Rightarrow \sqrt{3}y = x-\sqrt{3}$

10. Given $|z| = 1$ then

$z\bar{z} = 1$, so, $\bar{z} = \frac{1}{z}$

$\Rightarrow \text{Arg}\ \frac{z(1+z)}{(1+z)} = \text{Arg}(z)-\theta$

11. By Newton & libnitz rule

$f(x) = \psi'(x)$

Put $x^3 = t \ \Rightarrow \frac{dt}{dx} = 3x^2$

$= \frac{1}{3}\int t\ f(t)\ dt \quad = \frac{1}{3}\int t\ .\ \psi'(t)dt \quad = \frac{1}{3}\left[t\psi(t)-\int\psi(t)\ dt\right]$

$= \frac{1}{3}x^3\psi\left(x^3\right)-\int x^2\psi\left(x^3\right)dx$

13. If vector a = (1, 1, –k), b = (k, 2, 1) c = (1, –1, –1) are coplanar then $[abc] = 0$

$$\begin{vmatrix} 1 & 1 & -k \\ k & 2 & 1 \\ 1 & -1 & -1 \end{vmatrix} = 0$$

$k^2+3k = 0$

15.

p	q	$\sim q$	$p\wedge\sim q$	$\sim p$	$\sim p\wedge q$	$\left(p\wedge nq\right)\wedge\left(\sim p\wedge q\right)$
T	T	F	F	F	F	F
T	F	T	T	F	F	F
F	T	F	F	T	T	F

F	F	T	F	T	F	F

$p \to q$	$\sim q \to \sim p$	$(p \to q) \leftrightarrow [(\sim q) \to (\sim p)]$
T	T	T
F	F	T
T	T	T
T	T	T

16. $x^2 + 2x + 3 = 0$

$D = 2^2 - 3x4 = -ve$, then both roots are common and coefficient ratio are equal

$\therefore \quad a : b : c = 1 : 2 : 3$

18. $$\left(\frac{x+1}{x^{2/3} - x^{1/3} + 1} - \frac{x-1}{x - x^{1/2}}\right)^{10} = \left(\frac{\left(x^{1/3}\right)^3 + 1}{x^{2/3} - x^{1/3} + 1} - \frac{\left(x^{1/2}\right)^2 - 1}{x - x^{1/2}}\right)^{10}$$

$= \left(x^{1/3} - x^{-1/2}\right)^{10}$

For term independent of x , $\frac{10-r}{3} - \frac{r}{2} = 0$

r =4

${}^{10}C_4 = 210$

20. $2\tan^{-1} y = \tan^{-1} x + \tan^{-1} z \Rightarrow \tan^{-1}\frac{2y}{1-y^2} = \tan^{-1}\frac{x+z}{1-xz}$

$y^2 = xz$

also $2y = x + z$

$\therefore x = z = y \quad$ (x, y, z are in A.P. and G.P.)

21. By Newton & Libnitz rule

$\frac{dy}{dx} = |x| = 2 \quad \Rightarrow \quad x = \pm 2$

At $x = 2$, $y = 2 \Rightarrow$ equation of tangent $y - 2 = 2(x - 2)$

At $x = -2$, $y = -2 \Rightarrow$ equation of tangent $y + 2 = 2(x + 2)$

So, x intercept $= \pm 1$

23. By family of point circle & line $\Rightarrow S + \lambda L = 0$

$(x-3)^2 + y^2 + \lambda y = 0$

$\lambda = -5$

$x^2 + y^2 - 6x - 5y - 9 = 0$

Which is satisfied by (5, –2)

25. By Chain rule

$y = \sec\left(\tan^{-1} x\right)$

$\frac{dy}{dx} = \sec\left(\tan^{-1} x\right).\tan\left(\tan^{-1} x\right).\frac{1}{1+x^2}$

$\frac{dy}{dx}\Big|_{x=1} = \sqrt{2} \,.\, 1.\, \frac{1}{2} = \frac{1}{\sqrt{2}}$

26. $\frac{\tan^2 A}{\tan A - 1} + \frac{\cot A}{1 - \tan A} \Rightarrow \frac{\tan^2 A - 1 + 1}{\tan A - 1} - \frac{\cot A}{\tan A - 1}$

$= (\tan A + 1) + \frac{1 - \cot A}{\tan A - 1}$

$= \tan A + 1 + \frac{\sin A - \cos A}{(\sin A - \cos A)} . \frac{\cos A}{\sin A}$

$= \tan A + \cot A + 1$

$= \sec A. \operatorname{cosec} A + 1$

28. By Binomial Probability

$p = \frac{1}{3} \quad q = \frac{2}{3} \quad x = 5$

$p(x \geq 4) = P(x = 4) + P(x = 5)$

$= {}^5C_4 \left(\frac{1}{3}\right)^4 \left(\frac{2}{3}\right) + {}^5C_5 \left(\frac{1}{3}\right)^5$

$= \frac{1}{3^5}(10 + 1)$

$= \frac{11}{3^5}$

30. $\lim_{x \to 0} \frac{(1 - \cos 2x)(3 + \cos x)}{x \tan 4x}$

Divide by x^2 in Numerator and denominator

$$\lim_{x \to 0} \frac{2\left(\frac{\sin^2 x}{x^2}\right)(3 + \cos x)}{\frac{x \tan 4x}{x^2}}$$

$$\lim_{x \to 0} \frac{2\left(\frac{\sin x}{x}\right)^2 (3 + \cos x)}{4\left(\frac{\tan 4x}{4x}\right)}$$

$$= \frac{2 \times 1^2 \times (3 + 1)}{4 \times 1}$$

FIITJEE JEE MAINS MOCK TEST-2

Target IIT - JEE 2014
QP CODE: 120638.0

Time : 3 hours ***Maximum Marks : 360***

- ***Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.***
- ***You are not allowed to leave the examination hall before end of the test.***

Instructions

1. Immediately fill in the particulars on this page of the Test Booklet with *Blue / Black Ball Point Pen. Use of pencil is strictly prohibited.*

2. The Answer Sheet is kept inside this Test Booklet. When you are directed to open the Test Booklet, take out the Answer Sheet and fill in the particulars carefully.

3. The test is of **3 hours** duration.

4. The Test Booklet consists of **90** questions. The maximum marks are **360**.

5. There are ***three*** parts in the question paper A, B, C consisting of **Physics, Chemistry** and **Mathematics** having 30 questions in each part of equal weightage. Each question is allotted **4 (four)** marks for correct response.

6. *Candidates will be awarded marks as stated above in instruction No.5 for correct response of each question. ¼ (one fourth) marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.*

7. There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 6 above.

8. Use ***Blue / Black Ball Point Pen only*** for writing particulars / marking responses on ***Side-1*** and ***Side-2*** of the Answer Sheet. ***Use of pencil is strictly prohibited.***

9. No candidate is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. except the Admit Card inside the examination hall / room.

10. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator on duty in the Room / Hall. ***However, the candidates are allowed to take away this Test Booklet with them.***

11. **Do not fold or make any stray marks on the Answer Sheet.**

Name of the Candidate (in Capital Letters) :____________________________________

Enrolment Number :____

Batch :________________________ **Date of Examination :** ________________________

SECTION - 1
PHYSICS

1. A screw gauge gives the following reading when used to measure the diameter of a wire.
Main scale reading: 0 mm
Circular scale reading: 52 divisions
Given that 1 mm on main scale corresponds to 100 divisions of the circular scale.
The diameter of wire from the above date is
(A) 0.052 cm (B) 0.026 cm (C) 0.005 cm (D) 0.52 cm

2. Which of the following statements is false for a particle moving in a circle with a constant angular speed?
(A) The velocity vector is tangent to the circle.
(B) The acceleration vector is tangent to the circle.
(C) The acceleration vector points to the centre of the circle.
(D) The velocity and acceleration vectors are perpendicular to each other.

3. A mass M, attached to a horizontal spring, executes SHM with amplitude A_1. When the mass M passes through its mean position then a smaller mass m is placed over it and both of them move together with amplitude A_2. The ratio of $\left(\frac{A_1}{A_2}\right)$ is
(A) $\frac{M+m}{M}$ (B) $\left(\frac{M}{M+m}\right)^{1/2}$ (C) $\left(\frac{M+m}{M}\right)^{1/2}$ (D) $\frac{M}{M+m}$

4. A carnot engine, having an efficiency of $\eta = 1/10$ as heat engine, is used as a refrigerator. If the work down on the system is 10 J, the amount of energy absorbed from the reservoir at lower temperature is
(A) 99 J (B) 90 J (C) 1 J (D) 100 J

5. One mole of ideal monoatomic gas ($\gamma = 5/30$) is mixed with one mole of diatomic gas ($\gamma = 7/5$). What is γ for the mixture? γ denotes the ratio of specific heat at constant pressure, to that at constant volume.
(A) 3/2 (B) 23/15 (C) 35/23 (D) 4/3

Space for rough work

6. If M_o is the mass of an oxygen isotope $_8O^{17}$, M_p and M_N are the masses of a proton and a neutron respectively, the nuclear binding energy of the isotope is
(A) $(M_o - 8M_P)C^2$ (B) $(M_o - 8M_P - 9M_N)C^2$
(C) M_oC^2 (D) $(M_o - 17M_N)C^2$

7. Two thermally insulated vessels 1 and 2 are filled with air at temperatures (T_1, T_2), volume (V_1, V_2) and pressure (P_1, P_2) respectively. If the value joining two vessels is opened, the temperature inside the vessel at equilibrium will be
(A) $T_1 + T_2$ (B) $(T_1 + T_2)/2$
(C) $\dfrac{T_1T_2(P_1V_1 + P_2V_2)}{P_1V_1T_2 + P_2V_2T_1}$ (D) $\dfrac{T_1T_2(P_1V_1 + P_2V_2)}{P_1V_1T_1 + P_2V_2T_2}$

8. A spherical solid ball of volume V is made of a material of density ρ_1. It is falling through a liquid of density $\rho_2(\rho_2 < \rho_1)$. Assume that the liquid applied a viscous force on the ball that is proportional to the square of its speed v, i.e., $F_{viscous} = -kv^2(k > 0)$. The terminal speed of the ball is
(A) $\sqrt{\dfrac{Vg(\rho_1 - \rho_2)}{k}}$ (B) $\dfrac{Vg\rho_1}{k}$ (C) $\sqrt{\dfrac{Vg\rho_1}{k}}$ (D) $\dfrac{Vg(\rho_1 - \rho_2)}{k}$

9. In forced oscillation of a particle the amplitude is maximum for a frequency ω_1 of the force, while the energy is maximum for a frequency ω_2 of the force, then
(A) $\omega_1 = \omega_2$
(B) $\omega_1 > \omega_2$
(C) $\omega_1 < \omega_2$ when damping is small and $\omega_1 > \omega_2$ when damping is large
(D) $\omega_1 < \omega_2$

10. A sound absorber attenuates the sound level by 20 dB. The intensity decreases by a factor of
(A) 1000 (B) 10000 (C) 10 (D) 100

11. Energy required for the electron excitation in Li^{++} from the first to the third Bohr orbit is
(A) 36.3 eV (B) 108.8 eV (C) 122.4 eV (D) 12.1 eV

12. The electrostatic potential inside a charged spherical ball is given by $\phi = \alpha\rho^2 + b$ where r is the distance from the centre; a, b are constants. Then the charge density inside ball is
(A) $-6a\varepsilon_0 r$ (B) $-24\pi a\varepsilon_0 r$ (C) $-6a\varepsilon_0$ (D) $24\pi a\varepsilon_0 r$

Space for rough work

13. 100 g of water is heated from 30°C to 50°C. Ignoring the slight expansion of the water, the change in its internal energy is (specific heat of water is 4148 J/kg/K)
(A) 8.4 kJ (B) 84 kJ (C) 2.1 kJ (D) 4.2 kJ

14. The half life of a radioactive substance is 20 minutes. The approximate time interval $(t_2 - t_1)$ between the time t_2 when $\frac{2}{3}$ of it has decayed and time t_1 and $\frac{1}{3}$ of it had decayed is:
(A) 14 min (B) 20 min (C) 28 min (D) 7 min

15. A particle of mass m is attached to a spring (of spring constant k) and ha a natural angular frequency ω_0. An external fore F(t) proportional to $\cos\omega t$ $(\omega \neq \omega_0)$ is applied to the oscillator. The time displacement of the oscillator will be proportional to
(A) $\frac{m}{\omega_0^2 - \omega^2}$ (B) $\frac{1}{m(\omega_0^2 - \omega^2)}$ (C) $\frac{1}{m(\omega_0^2 + \omega^2)}$ (D) $\frac{m}{\omega_0^2 + \omega^2}$

16. A car is fitted with a convex side-view mirror of focal length 20 cm. A second car 2.8 m behind the first car is overtaking the first car at relative speed of 15 m/s. The speed of the image of the second car as
(A) $\frac{1}{15}$m/s (B) 10 m/s (C) 15 m/s (D) $\frac{1}{10}$m/s

17. The bob of a simple pendulum executes simple harmonic motion in water with a period t, while the period of oscillation of the bob is t_0 in air. Neglecting frictional force of water and given that the density of the bob is $\left(\frac{4}{3}\right) \times 1000$ kg/m³. What relationship between t and t_0 is true?
(A) $t = t_0$ (B) $t = t_0/2$ (C) $t = 2t_0$ (D) $t = 4t_0$

18. A carnot engine operating between temperatures T_1 and T_2 has efficiency $\frac{1}{6}$. When T_2 is lowered by 62 K, is efficiency increases to $\frac{1}{3}$. Then T_1 and T_2 are, respectively
(A) 372 K and 330 K (B) 330 K and 268 K
(C) 310 K and 248 K (D) 372 K and 310 K

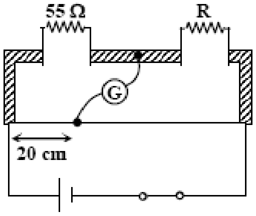
19. A resistor 'R' and 2μF capacitor in series is connected through a switch to 200 V direct supply. Across the capacitor is a neon bulb that lights up at 120 V. Calculate the value of R to make the bulb light up 5s after the switch has been closed. $(\log_{10} 2.5 = 0.4)$
(A) $1.7 \times 10^5\ \Omega$ (B) $2.7 \times 10^6\ \Omega$
(C) $3.3 \times 10^7\ \Omega$ (D) $1.3 \times 10^4\ \Omega$

Space for rough work

20. A current I flows in an infinitely long wire with cross section in the form of a semicircular ring of radius R. The magnitude of the magnetic induction along its axis is

(A) $\frac{\mu_0 I}{2\pi^2 R}$ (B) $\frac{\mu_0 I}{2\pi R}$ (C) $\frac{\mu_0 I}{4\pi^2 R}$ (D) $\frac{\mu_0 I}{\pi^2 R}$

21. Shown in the figure is a meter-bridge set up with null deflection in the galvanometer. The value of the unknown resistor R is



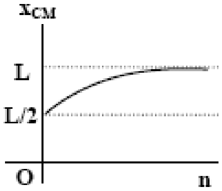
(A) 13.75 Ω (B) 220 Ω
(C) 110 Ω (D) 55 Ω

22. A uniform chain of length 2 m is kept on a table such that a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. What is the work done in pulling the entire chain on the table?

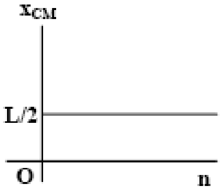
(A) 7.2 J (B) 3.6 J
(C) 120 J (D) 1200 J

23. A thin rod of length 'L' is lying along the x-axis with its ends at x = 0 and x = L. Its linear density (mass/length) varies with x as $k\left(\frac{x}{L}\right)^n$, where n can be zero or any positive number. If the position x_{CM} of the centre of mass of the rod is plotted against 'n', which of the following graphs best approximates the dependence of x_{CM} on n?

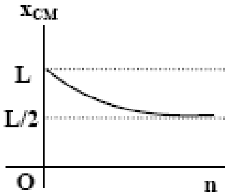
(A)



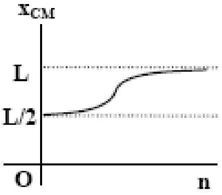
(B)



(C)



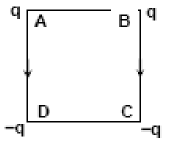
(D)



Space for rough work

24. A charged particle with charge q enters a region of constant, uniform and mutually orthogonal fields $\vec{E}$ and $\vec{B}$ with a velocity $\vec{v}$ perpendicular to both $\vec{E}$ and $\vec{B}$, and comes out without any change in magnitude or direction of $\vec{v}$. Then
(A) $\vec{v} = \vec{E} \times \vec{B} / B^2$ (B) $\vec{v} = \vec{B} \times \vec{E} / B^2$ (C) $\vec{v} = \vec{E} \times \vec{B} / E^2$ (D) $\vec{v} = \vec{B} \times \vec{E} / E^2$

25. Charges are placed on the vertices of a square as shown. Let E be the electric field and V the potential at the centre. If the charges on A and B are interchanged with those on D and C respectively, then
(A) $\vec{E}$ remains unchanged, V changes
(B) Both $\vec{E}$ and V change
(C) $\vec{E}$ and V remains unchanged
(D) $\vec{E}$ changes, V remains unchanged



26. A ball is released from the top of a tower of height h meters. It takes T seconds to reach the ground. What is the position of the ball in T/3 seconds?
(A) h/9 metres from the ground (B) 7h/9 metres from the ground
(C) 8h/9 metres from the ground (D) 17h/18 metres from the ground

27. If g_E and g_m are the accelerations due to gravity on the surfaces of the earth and the moon respectively and if Millikan's oil drop experiment could be performed on the two surfaces, one will find the ratio $\frac{\text{electronic charge on the moon}}{\text{electronic charge on the earth}}$ to be
(A) 1 (B) 0 (C) g_E/g_m (D) g_m/g_E

28. A machine gun fires a bullet of mass 40 g with a velocity 1200 ms^{-1}. The man holding it can exert a maximum force of 144 N on the gun. How many bullets can he fire per second at the most?
(A) one (B) four (C) two (D) three

29. In a Young's double slit experiment the intensity at a point where the path difference is $\frac{\lambda}{6}$ (λ being the wavelength of the light used) is I. If I_0 denotes the maximum intensity, $\frac{I}{I_0}$ is equal to
(A) $\frac{1}{\sqrt{2}}$ (B) $\frac{\sqrt{3}}{2}$ (C) 1/2 (D) 3/4

30. For a transistor amplifier in common emitter configuration having load impedance of 1 kΩ (h_{fe} = 50 and h_{oe} = 25) the current gain is
(A) –5.2 (B) –15.7 (C) –24.8 (D) –48.78

Space for rough work

SECTION - 2
CHEMISTRY

1. Two liquids X and Y form an ideal solution. At 300K, vapour pressure of the solution containing 1 mol of X and 3 mol of Y is 550 mm Hg. At the same temperature, if 1 mol of Y is further added to this solution, vapour pressure of the solution increases by 10 mm Hg. Vapour pressure (in mm Hg) of X and Y in their pure states will be, respectively :

(A) 200 and 300	(B) 300 and 400
(C) 400 and 600	(D) 500 and 600

2. On the basis of the following thermochemical data: ($\Delta_f G^o H^+(aq) = 0$)

$$H_2O(\ell) \longrightarrow H^+(aq) + OH^-(aq); \Delta H = 57.32\ kJ$$

$$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(\ell); \Delta H = -286.20\,kJ$$

The value of enthalpy of formation of OH^- ion at 25°C is:

(A) -22.88 kJ	(B) -228.88 kJ
(C) +228.88 kJ	(D) -343.52 kJ

3. The number of stereoisomers possible for a compound of the molecular formula
$CH_3 - CH = CH - CH(OH) - CH_3$ is:

(A) 3	(B) 2
(C) 4	(D) 6

4. The time for half life period of a certain reaction A → products is 1 hour. When the initial concentration of the reactant 'A', is 2.0 mol L^{-1}, how much time does it take for its concentration to come from 0.50 to 0.25 mol L^{-1} if it is a zero order reaction?

(A) 4 h	(B) 0.5 h
(C) 0.25 h	(D) 1 h

5. A solution containing 2.675 g of $CoCl_3.6\ NH_3$ (molar mass = 267.5 g mol^{-1}) is passed through a cation exchanger. The chloride ions obtained in solution were treated with excess of $AgNO_3$ to give 4.78 g of AgCl (molar mass = 143.5 g mol^{-1}). The formula of the complex is (At. Mass of Ag = 108 u)

(A) $[Co(NH_3)_6]Cl_3$	(B) $[CoCl_2(NH_3)_4]Cl$
(C) $[CoCl_3(NH_3)_3]$	(D) $[CoCl(NH_3)_5]Cl_2$

Space for rough work

6. Consider the reaction:

$$Cl_2(aq) + H_2S(aq) \longrightarrow S(s) + 2H^+(aq) + 2Cl^-(aq)$$

The rate equation for this reaction is rate = k $[Cl_2]$ $[H_2S]$

Which of these mechanisms is/are consistent with this rate equation ?

(i) $Cl_2 + H_2S \longrightarrow H^+ + Cl^- + Cl^+ + HS^-$ (slow)

$Cl^+ + HS^- \longrightarrow H^+ + Cl^- + S$ (fast)

(ii) $H_2S \rightleftharpoons H^+ + HS^-$ (fast equilibrium)

$Cl_2 + HS^- \longrightarrow 2Cl^- + H^+ + S$ (slow)

(A) ii only
(B) Both i and ii
(C) Neither i nor ii
(D) i only

7. If sodium sulphate is considered to be completely dissociated into cations and anions in aqueous solution, the change in freezing point of water (ΔT_f), when 0.01 mol of sodium sulphate is dissolved in 1 kg of water, is (K_f = 1.86 K kg mol^{-1})

(A) 0.0372 K
(B) 0.0558 K
(C) 0.0744 K
(D) 0.0186 K

8. 29.5 mg of an organic compound containing nitrogen was digested according to Kjeldahl's method and the evolved ammonia was absorbed in 20 mL of 0.1 M HCl solution. The excess of the acid required 15 mL of 0.1 M NaOH solution for complete neutralization. The percentage of nitrogen in the compound is

(A) 59.0
(B) 47.4
(C) 23.7
(D) 29.5

9. The energy required to break one mole of Cl–Cl bonds in Cl_2 is 242 kJ mol^{-1}. The longest wavelength of light capable of breaking a single Cl – Cl bond is

($c = 3 \times 10^8$ ms^{-1} and $N_A = 6.02 \times 1023$ mol^{-1})

(A) 594 nm
(B) 640 nm
(C) 700 nm
(D) 494 nm

10. Which one of the following has an optical isomer?

(A) $[Zn(en)(NH_3)_2]^{2+}$
(B) $[Co(en)_3]^{3+}$
(C) $[Co(H_2O)_4(en)]^{3+}$
(D) $[Zn(en)_2]^{3+}$

11. Aspirin is known as

(A) Acetyl salicylic acid
(B) Phenyl salicylate
(C) Acetyl salicylate
(D) Methyl salicylic acid

Space for rough work

12. Three reactions involving $H_2PO_4^-$ are given below :

(i) $H_3PO_4 + H_2O \longrightarrow H_3O^+ + H_2PO_4^-$ - (ii) $H_2PO_4^- + H_2O \longrightarrow HPO_4^{2-} + H_3O^+$

(iii) $H_2PO_4^- + OH^- \longrightarrow H_3PO_4 + O^{2-}$

In which of the above does $H_2PO_4^-$ act as an acid?

(A) (ii) only (B) (i) and (ii)

(C) (iii) only (D) (i) only

13. In aqueous solution the ionization constants for carbonic acid are
$K_1 = 4.2 \times 10^{-7}$ and $K_2 = 4.8 \times 10^{-11}$
Select the correct statement for a saturated 0.034 M solution of the carbonic acid.

(A) The concentration of CO_3^{2-} is 0.034 M.

(B) The concentration of CO_3^{2-} is greater than that of HCO_3^-.

(C) The concentration of H^+ and HCO_3^- are approximately equal.

(D) The concentration of H^+ is double that of HCO_3^-.

14. The correct order of increasing basicity of the given conjugate bases ($R = CH_3$) is

(A) $RCO\bar{O} < HC \equiv \bar{C} < \bar{R} < \bar{N}H_2$ (B) $\bar{R} < HC \equiv \bar{C} < RCO\bar{O} < \bar{N}H_2$

(C) $RCO\bar{O} < \bar{N}H_2 < HC \equiv \bar{C} < \bar{R}$ (D) $RCO\bar{O} < HC \equiv \bar{C} < \bar{N}H_2 < \bar{R}$

15. Which of the following on heating with aqueous KOH produces acetaldehyde?

(A) CH_3COCl (B) CH_3CH_2Cl

(C) CH_2ClCH_2Cl (D) CH_3CHCl_2

16. The Gibbs energy for the decomposition of Al_2O_3 at 500°C is as follows:

$$\frac{2}{3}Al_2O_3 \longrightarrow \frac{4}{3}Al + O_2, \Delta_r G = +966 \text{ kJ mol}^{-1}$$

The potential difference needed for electrolytic reduction of Al_2O_3 at 500°C is at least

(A) 4.5 V (B) 3.0 V

(C) 2.5 V (D) 5.0 V

17. At 25°C, the solubility product of $Mg(OH)_2$ is 1.0×10^{-11}. At which pH, will Mg^{2+} ions start precipitating in the form of $Mg(OH)_2$ from a solution of 0.001 M Mg^{2+} ions ?

(A) 9 (B) 10

(C) 11 (D) 8

18. The polymer containing strong intermolecular forces e.g. hydrogen bonding, is

(A) teflon (B) nylon 6,6

(C) polystyrene (D) natural rubber

Space for rough work

19. Sodium ethoxide has reacted with ethanoyl chloride. The compound that is produced in the above reaction is:
(A) 2-Butanone (B) Ethyl chloride
(C) Ethyl ethanoate (D) Diethyl ether

20. The reduction potential of hydrogen half cell will be negative if :
(A) $p(H_2) = 1$ atm and $[H^+] = 1.0$ M (B) $p(H_2) = 2$ atm and $[H^+] = 1.0$ M
(C) $p(H_2) = 2$ atm and $[H^+] = 2.0$ M (D) $p(H_2) = 1$ atm and $[H^+] = 2.0$ M

21. Boron cannot form which one of the following anions ?
(A) BH_4^- (B) $B(OH)_4^-$
(C) BO_2^- (D) BF_6^{2-}

22. Which one of the following order represents the correct sequence of the increasing basic nature of the given oxides?
(A) $MgO < K_2O < Al_2O_3 < Na_2O$ (B) $Na_2O < K_2O < MgO < Al_2O_3$
(C) $K_2O < Na_2O < Al_2O_3 < MgO$ (D) $Al_2O_3 < MgO < Na_2O < K_2O$

23. The magnetic moment (spin only) of $[NiCl_4]^{2-}$ is
(A) 5.46 BM (B) 2.83 BM
(C) 1.41 BM (D) 1.82 BM

24. Which of the following statement is wrong?
(A) Nitrogen cannot form $d\pi$ - $p\pi$ bond.
(B) Single N - N bond is weaker than the single P – P bond,
(C) N_2O_4 has two resonance structures
(D) The stability of hydrides increases from NH_3 to BiH_3 in group 15 of the periodic table

25. Ozonolysis of an organic compound gives formaldehyde as one of the products. This confirms the presence of:
(A) a vinyl group (B) an isopropyl group
(C) an acetylenic triple bond (D) two ethylenic double bonds

26. How many maximum number of products can be formed in the following reaction?

$$CH_3OC_2H_5 \xrightarrow{HI} \text{Products}$$

(A) 2 (B) 4
(C) 3 (D) 8

Space for rough work

27. In a face centred cubic lattice, atom A occupies the corner positions and atom B occupies the face centre positions. If one atom of B is missing from one of the face centred points, the formula of the compound is

(A) AB_2 (B) A_2B_3
(C) A_2B_5 (D) A_2B

28. The entropy change involved in the isothermal reversible expansion of 2 moles of an ideal gas from a volume of 10 dm^3 to a volume of 100 dm^3 at 27°C is :

(A) 35.8 J $mol^{-1}K^{-1}$ (B) 32.3 J $mol^{-1}K^{-1}$
(C) 42.3 J $mol^{-1}K^{-1}$ (D) 38.3 J $mol^{-1}K^{-1}$

29. Which of the following compounds can be detected by Molish's test ?

(A) Nitro compounds (B) Sugars
(C) Amines (D) Primary alcohols

30. The species which can best serve as an initiator for the cationic polymerization is :

(A) $LiAlH_4$ (B) HNO_3
(C) $AlCl_3$ (D) BuLi

Space for rough work

SECTION - 3
MATHEMATICS

1. The lines $L_1 : y - x = 0$ and $L_2 : 2x + y = 0$ intersect the line $L_3 : y + 2 = 0$ at P and Q respectively. The bisector of the acute angle between L_1 and L_2 intersect L_3 at R.

Statement – 1 : The ratio $PR : RQ$ equals $2\sqrt{2} : \sqrt{5}$.

Statement – 2 : In any triangle, bisector of an angle divides the triangle into two similar triangles.

(A) Statement – I is true, Statement – 2 is true; Statement – 2 is not a correct explanation for Statement – 1.
(B) Statement – 1 is true, Statement – 2 is false
(C) Statement – 1 is false, Statement – 2 is true.
(D) Statement – 1 is true, Statement – 2 is true; Statement – 2 is a correct explanation for Statement – 1

2. The number of values of k, for which the system of equations:

$(k + 1)x + 8y = 4k$

$kx + (k + 3)y = 3k - 1$ has no solution, is

(A) 2 (B) 3
(C) infinite (D) 1

3. The coefficient of x^7 in the expansion of $\left(1 - x - x^2 + x^3\right)^6$ is

(A) -132 (B) -144
(C) 132 (D) 144

4. Let T_n be the number of all possible triangles formed by joining vertices of an n – sided regular polygon. If $T_{n+1} - T_n = 10$ then the value of n is:

(A) 10 (B) 8
(C) 7 (D) 5

5. Statement – 1 : The number of ways of distributing 10 identical balls in 4 distinct boxes such that no box is empty is ${}^9C_3$

Statement – 2 : The number of ways of choosing any 3 places from 9 different places is ${}^9C_3$.

(A) Statement – 1 is true, Statement – 2 is true; Statement – 2 is not a correct explanation for Statement – 1.
(B) Statement – 1 is true, Statement – 2 is false.
(C) Statement – 1 is false, Statement – 2 is true.
(D) Statement – 1 is true, Statement – 2 is true; Statement – 2 is a correct explanation for Statement – 1.

Space for rough work

6. $\frac{d^2x}{dy^2}$ equals

(A) $-\left(\frac{d^2y}{dx^2}\right)^{-1}\left(\frac{dy}{dx}\right)^{-3}$ (B) $\left(\frac{d^2y}{dx^2}\right)\left(\frac{dy}{dx}\right)^{-2}$

(C) $-\left(\frac{d^2y}{dx^2}\right)\left(\frac{dy}{dx}\right)^{-3}$ (D) $\left(\frac{d^2y}{dx^2}\right)^{-1}$

7. All the students of a class performed poorly in Mathematics. The teacher decided to give grace marks of 10 to each of the students. Which of the following statistical measures will not change even after the grace marks were given?

(A) mode (B) variance

(C) mean (D) median

8. A man saves Rs. 200 in each of the first three months of his service. In each of the subsequent months his saving increases by Rs. 40 more than the saving of immediately previous month. His total saving from the start of service will be Rs. 11040 after

(A) 19 months (B) 20 months

(C) 21 months (D) 18 months

9. The area (in square units) bounded by the curves $y=\sqrt{x},\ 2y-x+3=0,$ x-axis and lying in the first quadrant is:

(A) 18 (B) $\frac{27}{4}$

(C) 9 (D) 36

10. If the angle between the line $x=\frac{y-1}{2}=\frac{z-3}{\lambda}$ and the plane $x+2y+3z=4$ is $\cos^{-1}\left(\sqrt{\frac{5}{14}}\right)$, then λ equals

(A) $\frac{3}{2}$ (B) $\frac{2}{5}$

(C) $\frac{5}{3}$ (D) $\frac{2}{3}$

11. If $\vec{a}=\frac{1}{\sqrt{10}}\left(3\hat{i}+\hat{k}\right)$ and $\vec{b}=\frac{1}{7}\left(2\hat{i}+3\hat{j}-6\hat{k}\right),$ then the value of $\left(2\vec{a}-\vec{b}\right).\left[\left(\vec{a}\times\vec{b}\right)\times\left(\vec{a}+2\vec{b}\right)\right]$ is

(A) –3 (B) 5

(C) 3 (D) –5

Space for rough work

12. Let A and B be two sets containing 2 elements and 4 elements respectively. The number of subsets of $A \times B$ having 3 or more elements is:
(A) 219 (B) 211
(C) 256 (D) 220

13. The two circle $x^2 + y^2 = \alpha x$ and $x^2 + y^2 = c^2 \left(c > 0\right)$ touch each other if
(A) $|\alpha| = c$ (B) $\alpha = 2c$
(C) $|\alpha| = 2c$ (D) $2|\alpha| = c$

14. The x-coordinate of the incentre of the triangle that has the coordinates of mid points of its sides as (0, 1) (1, 1) and (1, 0) is:
(A) $1 + \sqrt{2}$ (B) $1 - \sqrt{2}$
(C) $2 + \sqrt{2}$ (D) $2 - \sqrt{2}$

15. Consider the following statements
P : Suman is brilliant
Q : Suman is rich
R : Suman is honest
The negation of the statement "Suman is brilliant and dishonest if and only if Suman is rich" can be expressed as
(A) $\sim\left(Q \leftrightarrow \left(P \wedge \sim R\right)\right)$ (B) $\sim Q \leftrightarrow \sim P \wedge R$
(C) $\left(P \wedge \sim R\right) \leftrightarrow Q$ (D) $\sim P \wedge \left(Q \leftrightarrow \sim R\right)$

16. The shortest distance between line $y - x = 1$ and curve $x = y^2$ is
(A) $\frac{3\sqrt{2}}{8}$ (B) $\frac{8}{3\sqrt{2}}$
(C) $\frac{4}{\sqrt{3}}$ (D) $\frac{\sqrt{3}}{4}$

17. The sum of first 20 terms of the sequence 0.7, 0.77, 0.777,…………is:
(A) $\frac{7}{81}\left(179 + 10^{-20}\right)$ (B) $\frac{7}{9}\left(99 + 10^{-20}\right)$
(C) $\frac{7}{81}\left(179 - 10^{-20}\right)$ (D) $\frac{7}{9}\left(99 - 10^{-20}\right)$

Space for rough work

18. Statement – 1 : The point $A(1, 0, 7)$ is the mirror image of the point $B(1, 6, 3)$ in the line $\frac{x}{1}=\frac{y-1}{2}=\frac{z-2}{3}$

Statement – 2 : :The line: $\frac{x}{1}=\frac{y-1}{2}=\frac{z-2}{3}$ bisects the line segment joining $A(1, 0, 7)$ and $B(1, 6, 3)$.

(A) Statement – 1 is true, Statement – 2 is true; Statement – 2 is not a correct explanation for statement 1.
(B) Statement – 1 is true, Statement – 2 is false
(C) Statement – 1 is false, Statement – 2 is true
(D) Statement – 1 is true, Statement – 2 is true, Statement – 2 is a correct explanation for Statement – 1

19. If the vectors $\overrightarrow{AB}=3\hat{i}+4\hat{k}$ and $\overrightarrow{AC}=5\hat{i}-2\hat{j}+4\hat{k}$ are the sides of a triangle ABC, then the length of the median through A is :

(A) $\sqrt{33}$ (B) $\sqrt{45}$
(C) $\sqrt{18}$ (D) $\sqrt{72}$

20. If $\omega(\neq 1)$ is a cube root of unity, and $(1+\omega)^7=A+B\omega$. The (A, B) equals

(A) (1, 1) (B) (1, 0)
(C) (–1, 1) (D) (0, 1)

21. Let f be a function defined by $f(x)=(x-1)^2+1, (x\geq 1)$.

Statement – 1:
The set $\{x : f(x)=f^{-1}(x)\}=\{1, 2\}$

Statement – 2:
f is bijection and $f^{-1}(x)=1+\sqrt{x-1}, x\geq 1$

(A) Statement – 1 is true, Statement – 2 is true; Statement – 2 is a correct explanation for Statement – 1
(B) Statement – 1 is true, Statement – 2 is true; Statement – 2 is NOT a correct explanation for Statement – 1
(C) Statement – 1 is true, Statement – 2 is false
(D) Statement – 1 is false, Statement – 2 is true

22. Distance between two parallel planes $2x+y+2z=8$ and $4x+2y+4z+5=0$ is

(A) $\frac{7}{2}$ (B) $\frac{9}{2}$
(C) $\frac{3}{2}$ (D) $\frac{5}{2}$

Space for rough work

23. The lines $x + y = |a|$ and $ax - y = 1$ intersect each other in the first quadrant. Then the set of all possible values of a is the interval:
(A) $(0, \infty)$ (B) $(1, \infty)$
(C) $(-1, \infty)$ (D) $(-1, 1]$

24. The equation of the circle passing through the foci of the ellipse $\frac{x^2}{16} + \frac{y^2}{9} = 1$, and having centre at (0, 3) is:
(A) $x^2 + y^2 - 6y - 5 = 0$ (B) $x^2 + y^2 - 6y + 5 = 0$
(C) $x^2 + y^2 - 6y - 7 = 0$ (D) $x^2 + y^2 - 6y + 7 = 0$

25. The equation of the circle passing through the point (1, 0) and (0, 1) and having the smallest radius is
(A) $x^2 + y^2 - 2x - 2y + 1 = 0$ (B) $x^2 + y^2 - x - y = 0$
(C) $x^2 + y^2 + 2x + 2y - 7 = 0$ (D) $x^2 + y^2 + y - 2 = 0$

26. The equation of hyperbola whose foci are (–2, 0) and (2, 0) and eccentricity is 2 given by:
(A) $x^2 - 3y^2 = 3$ (B) $3x^2 - y^2 = 3$
(C) $-x^2 + 3y^2 = 3$ (D) $3x^2 + y^2 = 3$

27. Given : A circle, $2x^2 + 2y^2 = 5$ and a parabola, $y^2 = 4\sqrt{5}x$.
Statement – I : An equation of a common tangent to these curves is $y = x + \sqrt{5}$.
Statement – II : If the line, $y = mx + \frac{\sqrt{5}}{m}(m \neq 0)$ is their common tangent, then m satisfies $m^4 - 3m^2 + 2 = 0$
(A) Statement – I is true; Statement – II is false
(B) Statement – I is false; Statement – II is true
(C) Statement – I is true; Statement – II is true; Statement – II is a correct explanation for Statement – I
(D) Statement – I is true; Statement – II is true; Statement – II is not a correct explanation for Statement – I.

Space for rough work

28. Let a_n be the nth term of A.P. If $\sum_{r=1}^{100} a_{2r} = \alpha, \sum_{r=1}^{100} a_{2r-1} = \beta,$ then the common difference of the A.P. is

(A) $\alpha - \beta$
(B) $\frac{\alpha - \beta}{100}$
(C) $\beta - \alpha$
(D) $\frac{\alpha - \beta}{200}$

29. Statement – I

The value of the integral $\int_{\pi/6}^{\pi/3} \frac{dx}{1+\sqrt{\tan x}}$ is equal to $\frac{\pi}{6}$.

Statement – II

$\int_a^b f(x)\,dx - \int_a^b f(a+b-x)\,dx$

(A) Statement – I is true; Statement – II is false
(B) Statement – I is false; Statement – II is true
(C) Statement – I is true; Statement – II is true; Statement – II is a correct explanation for Statement – I
(D) Statement – I is true; Statement – II is true; Statement – II is not a correct explanation for Statement – I

30. Let for $a \neq a_1 \neq 0$,
$f(x) = ax^2 + bx + c,\ g(x) = a_1x^2 + b_1x + c_1$ and $p(x) = f(x) - g(x)$. If $p(x) = 0$ only for $x = -1$ and $p(-2) = 2$, then the value of $p(2)$ is:

(A) 3
(B) 9
(C) 6
(D) 18

Space for rough work

FIITJEE JEE MAINS MOCK TEST-2

Target IIT - JEE 2014

QP CODE: 120638.0

ANSWERS

SECTION – I (Physics)

1.	**A**	2.	**B**	3.	**C**	4.	**B**
5.	**A**	6.	**B**	7.	**C**	8.	**A**
9.	**A**	10.	**D**	11.	**B**	12.	**C**
13.	**A**	14.	**B**	15.	**B**	16.	**A**
17.	**C**	18.	**D**	19.	**B**	20.	**D**
21.	**B**	22.	**B**	23.	**A**	24.	**A**
25.	**D**	26.	**C**	27.	**A**	28.	**D**
29.	**D**	30.	**D**				

SECTION – II (Chemistry)

1.	**C**	2.	**B**	3.	**C**	4.	**C**
5.	**A**	6.	**D**	7.	**B**	8.	**C**
9.	**D**	10.	**B**	11.	**A**	12.	**A**
13.	**C**	14.	**D**	15.	**D**	16.	**C**
17.	**B**	18.	**B**	19.	**C**	20.	**B**
21.	**D**	22.	**D**	23.	**B**	24.	**D**
25.	**A**	26.	**B**	27.	**C**	28.	**D**
29.	**B**	30.	**C**				

SECTION – III (Mathematics)

1.	**B**	2.	**D**	3.	**B**	4.	**D**
5.	**D**	6.	**C**	7.	**B**	8.	**C**
9.	**C**	10.	**D**	11.	**D**	12.	**A**
13.	**A**	14.	**D**	15.	**A**	16.	**A**
17.	**A**	18.	**A**	19.	**A**	20.	**A**
21.	**A**	22.	**A**	23.	**B**	24.	**C**
25.	**B**	26.	**B**	27.	**D**	28.	**B**
29.	**B**	30.	**D**				

Hints & Solutions

Physics

1. **A**

Sol. Diameter of wire = $\frac{1}{100}\times 52$ = 0.52 mm = 0.052 cm

2. **B**

Sol. The acceleration vector is along the radius of circle.

3. **C**

Sol. Energy of simple harmonic oscillator is constant.

$$\Rightarrow \quad \frac{1}{2}M\omega^2A_1^2 = \frac{1}{2}(m+M)\omega^2A_2^2$$

$$\frac{A_1^2}{A_2^2} = \frac{M+m}{M}$$

$$\therefore \quad \frac{A_1}{A_2} = \sqrt{\frac{M+m}{M}}$$

4. **B**

Sol.

$$W = Q_2\left(\frac{T_1}{T_2}-1\right) \qquad \eta = 1-\frac{T_2}{T_1}$$

$$10 = Q_2\left(\frac{10}{9}-1\right) \qquad \frac{1}{10} = 1-\frac{T_2}{T_1} \Rightarrow \frac{T_2}{T_1} = 1-\frac{1}{10} = \frac{9}{10}$$

$$10 = Q_2\left(\frac{1}{9}\right) \qquad \Rightarrow \frac{T_1}{T_2} = \frac{10}{9}$$

Q_2 = 90 J

5. **A**

Sol. $Q = Q_1 + Q_2$

$$\frac{n_1+n_2}{\gamma_m-1} = \frac{n_1}{\gamma_1-1}+\frac{n_2}{\gamma_2-1}$$

$$\gamma_m = \frac{3}{2}$$

6. **B**

Sol. Binding energy = $(M_o - 8M_P - 9M_N)C^2$

7. **C**

Sol. The number of moles of system remains same

According to Boyle's law,

$P_1V_1 + P_2V_2 = P(V_1 + V_2)$

$$\therefore \quad T = \frac{T_1T_2(P_1V_1+P_2V_2)}{P_1V_1T_2+P_2V_2T_1}$$

8. **A**

Sol. $\rho_1Vg - \rho_2Vg = kv_T^2$

$$\Rightarrow \qquad V_T = \sqrt{\frac{Vg(\rho_1-\rho_2)}{k}}$$

9. **A**

Sol. Both amplitude and energy get maximized when the frequency is equal to the natural frequency. This is the condition of resonance.

$\omega_1 = \omega_2$

10. **D**

Sol. $B_1 = 10\log\left(\frac{I}{I_0}\right)$; $B_2 = \log\left(\frac{I'}{I_0}\right)$

given $B_2 - B_1 = 20$

$20 = 10\log\left(\frac{I'}{I}\right)$

$I' = 100I$

11. **B**

Sol. $E_n = -13.6\frac{Z^2}{n^2}$

$E_{Li}^{++} = -13.6 \times \frac{9}{1}$ = –122.4 eV

$E_{Li}^{++} = -13.6 \times \frac{9}{9}$ = –13.6 eV

ΔE = –13.6 – (–122.4)

= 108.8 eV

12. **C**

Sol. Potential inside (ϕ) = $ar^2 + b$

$\therefore\ E_r = -\frac{\delta v}{\delta r} = -2ar$

Electric field inside uniformly charged solid volume varies with ‘r’. So charge density is constant $\phi_{net} = (-2ar)4\pi r^2 = -8\pi ar^3$

$$-8\pi ar^3 = \frac{\sigma \times \frac{4}{3}\pi r^3}{\varepsilon_0}$$

$\therefore\ \sigma = -6a\varepsilon_0$

13. **A**

Sol. $\Delta Q = \Delta U + \Delta W$ (ignoring expansion)

$\Delta U = ms\Delta T$ = 0.1 × 4.184 × 20 = 8.368 kJ

14. **B**

Sol. $t_{\frac{t}{2}}$ = 20 minutes

$N = N_0 e^{-\lambda t_2}$; $\lambda t_1 = \ln 3$

$\frac{2}{3}N_o = N_0 e^{-\lambda t_2}$

$t_2 = \frac{1}{\lambda}\ln\frac{3}{2}$

$t_2 - t_1 = \frac{1}{\lambda}\left[\ln\frac{3}{2} - \ln 3\right] = \frac{1}{\lambda}\ln\left[\frac{1}{2}\right] = \frac{0.693}{\lambda}$

= 20 min

15. **B**

Sol. For forced oscillations, the displacement is given by

$x = A \sin(\omega t + \phi)$ with $A = \frac{F_0 / m}{\omega_0^2 - \omega^2}$

16. **A**

Sol. $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$-\frac{1}{v^2}\frac{dv}{dt} - \frac{1}{u^2}\frac{du}{dt} = 0$

$\frac{dv}{dt} = -\frac{v^2}{u^2}\left(\frac{du}{dt}\right)$

f = 20 cm

$\frac{1}{u} + \frac{1}{-280} = \frac{1}{20}$

$v_1 = -\left(\frac{280}{15 \times 280}\right)^2 \times 15 = \frac{1}{15} m/s$

17. **C**

Sol. $\frac{t}{t_0} = \sqrt{\frac{1}{\left(1 - \frac{\rho'}{\rho}\right)}} = \sqrt{\frac{1}{1 - \frac{1}{3}}}$

$\Rightarrow \frac{t}{t_0} = 2$

or, $t = 2t_0$

18. **D**

Sol. $\eta = \frac{T_1 - T_2}{T_1} = \frac{1}{6}$

$\eta_2 = \frac{T_1 - (T_2 - 62)}{T_1} = \frac{1}{3}$

$\Rightarrow \frac{T_1 - T_2}{T_1} + \frac{62}{T_1} = \frac{1}{3}$; $\frac{1}{6} + \frac{62}{T_1} = \frac{1}{3}$; $\frac{62}{T_1} = \frac{1}{6}$

$\therefore T_1 = 62 \times 6 = 372$ K

$\frac{T_1 - T_2}{T_1} = \frac{1}{6}$; $1 - \frac{T_2}{T_1} = \frac{1}{6}$; $\frac{T_2}{372} = \frac{5}{6}$

19. **B**

Sol. $V_c = E(1 - e^{-1/Rc})$

$1 - e^{-t/Rc} = \frac{120}{200} = \frac{3}{5}$

$\Rightarrow R = \frac{5}{1.84 \times 10^{-6}} = 2.7 \times 10^6\ \Omega$

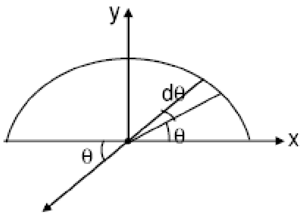
20. **D**

Sol. $d\vec{B} = \frac{\mu_0 di}{2\pi R}\left[-\cos\theta\hat{i} - \sin\theta\hat{j}\right]$

$di = \frac{T}{\pi R}Rd\theta \;=\; \frac{1}{\pi}d\theta$

$d\vec{B} = \frac{\mu_0 I}{2\pi^2 R}\left[-\cos\theta\hat{i} - \sin\theta\hat{j}\right]$

$\vec{B} = -\frac{\mu_0 I}{\pi^2 R}\hat{i}$



21. **B**

Sol. $\frac{55}{20} = \frac{R}{80} \Rightarrow R = \frac{55\times 8}{2}\; = 220\Omega$

22. **B**

Sol. Work done = mgh = 1.2 × 0.3 × 10 = 3.6 J

23. **A**

Sol. $$x_{cm} = \frac{\int dmx}{\int dm} = \frac{\int \lambda dx.x}{\int dm} = \frac{\int k\left(\frac{x}{L}\right)^n \cdot xdx}{\int k\left(\frac{x}{L}\right)^n dx} = \left[\frac{\frac{kx^{n+2}}{(n+2)L^n}}{\frac{kx^{n+1}}{(n+1)L^n}}\right]_0^L = \left[\frac{x(n+1)}{n+2}\right]_0^L$$

$x_{cm} = \frac{L}{2}, \frac{2L}{3}, \frac{3L}{4}, \frac{4L}{5}, \frac{5L}{6}, \ldots.$

24. **A**

Sol. $\vec{v}\times\vec{B} = -\vec{E}$

25. **D**

Sol. As $\vec{E}$ is a vector quantity.

26. **C**

27. **A**

28. **D**

Sol. Change in momentum for each bullet fires is

$= \frac{40}{1000}\times 1200\; = 48$ N

If a bullet fired exerts a force of 48 N on man's hand so ρ man can exert maximum force of 144 N, number of bullet that can be fired = 144/48 = 3 bullets.

29. **D**

Sol. $\frac{I}{I_{max}} = \cos^2\left(\frac{\phi}{2}\right)$

30. **D**

Sol. In CE configuration, $A_i = \frac{-h_{fe}}{1 + h_{oe}R_L}$

$= \frac{-50}{1 + 25\times 10^{-6}\times 1\times 10^3} = -48.78$

Chemistry

1. C

Sol. $P_T = P_x^o x_x + P_Y^o x_Y$

x_x = mol fraction of X

x_Y = mol fraction of Y

$\therefore$ 550 = $P_x^o\left(\frac{1}{1+3}\right)+P_Y^o\left(\frac{3}{1+3}\right)$

$=\frac{P_x^o}{4}+\frac{3P_Y^o}{4}$

$\therefore$ 550 (4) = P_x^o + $3P_Y^o$……..(1)

Further 1 mol of Y is added and total pressure increases by 10 mm Hg

$\therefore$ 550 + 10 = $P_x^o\left(\frac{1}{1+4}\right)+P_Y^o\left(\frac{4}{1+4}\right)$

$\therefore$ 560(5) = P_x^o + $4P_Y^o$……..(2)

By solving (1) and (2)

We get, P_x^o = 400 mg Hg

P_Y^o = 600 mm Hg

2. B

Sol. By adding the two given equations, we have

$$H_2(g)+\frac{1}{2}O_2(g)\longrightarrow H^+(aq)+OH^-(aq);\Delta H=-228.88\,kJ$$

Here ΔH_f^o of H^+(aq) = 0

$\therefore$ ΔH_f^o of OH^- = -228.88 kJ

3. C

Sol. About the double bond, two geometrical isomers are possible and the compound is having one chiral carbon.

4. C

Sol. For a zero order reaction $k=\frac{x}{t}$ ----- (1)

Where x = amount decomposed

k = zero order rate constant

$k=\frac{[A]_0}{2t_{\frac{1}{2}}}$ -----(2)

Since $[A_0]$ = 2M, $t_{1/2}$ = 1 hr; k = 1

$\therefore$ from equation (1)

$t=\frac{0.25}{1}$ = 0.25 hr

5. A

Sol. $CoCl_3.6NH_3 \longrightarrow xCl^- \xrightarrow{AgNO_3} x\,AgCl\downarrow$

n(AgCl) = xn($CoCl_3.6NH_3$)

$\frac{4.78}{143.5}=x\frac{2.675}{267.5}$ $\therefore$ x = 3

$\therefore$ The complex is $[Co(NH_3)_6]Cl_3$

6. D

Sol. Rate equation is to be derived wrt slow step

$\therefore$ from mechanism (i)

Rate = $k[Cl_2]\,[H_2S]$

7. B

Sol. Van't Hoff's factor (i) for Na_2SO_4 = 3

$\therefore \Delta Tf = (i)\, k_f\, m$

$= 3 \times 1.86 \times \frac{0.01}{1} = 0.0558$ K

8. C

Sol. Moles of HCl reacting with

ammonia = (moles of HCl absorbed) – (moles of NaOH solution required)

$= (20 \times 0.1 \times 10^{-3}) - (15 \times 0.1 \times 10^{-3})$

= moles of NH_3 evolved.

= moles of nitrogen in organic compound

$\therefore$wt. of nitrogen in org. comp = $0.5 \times 10^{-3} \times 14$

= 7×10^{-3} g

$$\%\,wt = \frac{7\times10^{-3}}{29.5\times10^{-3}}\times100 = 23.7\%$$

9. D

Sol. Energy required for 1 Cl_2 molecule = $\frac{242\times10^3}{N_A}$ Joules

This energy is contained in photon of wavelength 'λ'

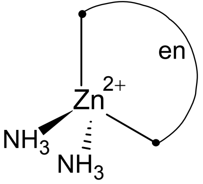
$$\frac{hc}{\lambda} = E \Rightarrow \frac{6.626\times10^{-34}\times3\times10^8}{\lambda} = \frac{242\times10^3}{6.022\times10^{23}}$$

$\lambda = 4947\ \overset{o}{A} = 494$ nm

10. B

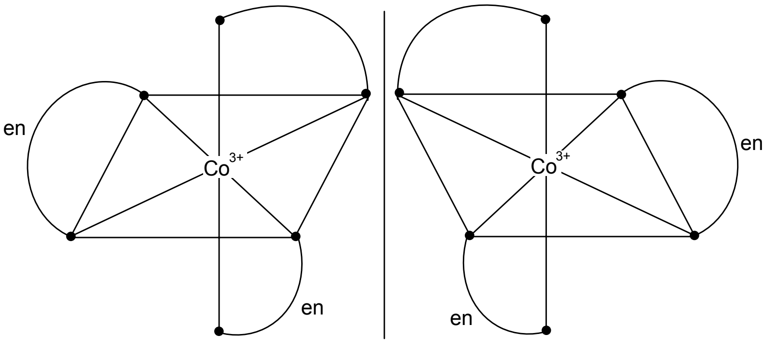
Sol. Only option (B) is having non–super imposable mirror image & hence one optical isomer.

(A)



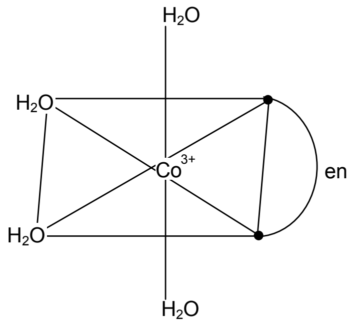
No optical isomer. It is tetrahedral with a plane of symmetry

(B)



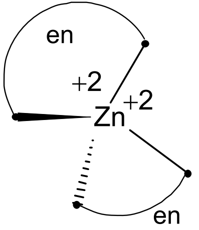
Optical isomer

(C)



Horizontal plane is plane of symmetry

(D)

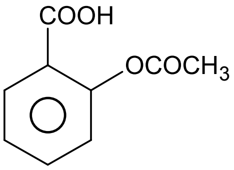


No optical isomer, it is tetrahedral with a plane of symmetry

11. A

Sol.

Aspirin is



12. A

Sol. (i) $\underset{\text{acid}}{H_3PO_4} + H_2O \longrightarrow H_3O^+ + \underset{\text{conjugate base}}{H_2PO_4^-}$

(ii) $\underset{\text{acid}}{H_2PO_4^-} + H_2O \longrightarrow \underset{\text{conjugate base}}{HPO_4^{-2}} + H_3O^+$

(iii) $\underset{\text{acid}}{H_2PO_4^-} + \underset{\text{acid}}{OH^-} \longrightarrow \underset{\text{conjugate base}}{H_3PO_4} + O^{-2}$

Only in reaction (ii) $H_2PO_4^-$ behaves as 'acid'.

13. C

Sol. $A \to \quad H_2CO_3 \rightleftharpoons H^+ + HCO_3^- \quad K_1 = 4.2 \times 10^{-7}$

$B \to \quad HCO_3^- \rightleftharpoons H^+ + CO_3^{-2} \quad K_2 = 4.8 \times 10^{-11}$

As $K_2 << K_1$

All major $[H^+]_{total} = [H^+]_A$

And from I equilibrium, $[H^+]_A = \left[HCO_3^-\right] = [H^+]_{total}$

$\left[CO_3^{-2}\right]$ is negligible compared to $\left[HCO_3^-\right]$ or $[H^+]_{total}$

14. D

Sol. Correct order of increasing basic strength is

$R–COO^- < CH \equiv C^- < NH_2^- < R^-$

15. D

Sol. $CH_3CHCl_2 \xrightarrow{KOH} CH_3CH(OH)_2 \xrightarrow{-H_2O} CH_3CHO$

16. C

Sol. $\Delta G = -nFE \quad \Rightarrow E = \frac{-\Delta G}{nF}$

$E = \frac{-966 \times 10^3}{4 \times 96500} = -2.5V$

$\therefore$ The potential difference needed for the reduction = 2.5 V

17. B

Sol. $Mg^{2+} + 2OH^- \rightleftharpoons Mg(OH)_2$

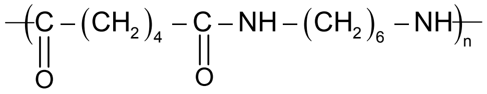
$K_{sp} = [Mg^{2+}]\,[OH^-]^2$

$\left[OH^-\right] = \sqrt{\frac{K_{sp}}{\left[Mg^{2+}\right]}} = 10^{-4}$

$\therefore$ p^{OH} = 4 and p^H = 10

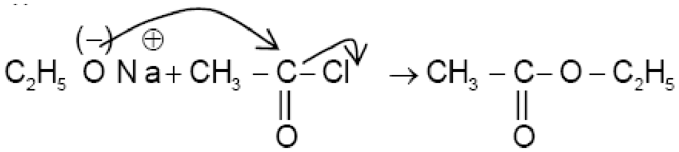
18. B

Sol. nylon 6,6 is a polymer of adipic acid and hexamethylene diamine



$-\!\!\left(\underset{\underset{O}{||}}{C} - (CH_2)_4 - \underset{\underset{O}{||}}{C} - NH - (CH_2)_6 - NH\right)\!\!_n-$

19. C

Sol.  Ethyl ethanoate

$C_2H_5\overset{(-)}{O}\overset{\oplus}{N}a + CH_3 - \underset{\underset{O}{||}}{C} - Cl \rightarrow CH_3 - \underset{\underset{O}{||}}{C} - O - C_2H_5$

20. B

Sol. $2H^+ + 2e^- \longrightarrow H_2(g)$

$E = E^o - \frac{0.059}{n}\log\left(\frac{P_{H_2}}{\left[H^+\right]^2}\right)$ (here E is –ve when P_{H_2} > $[H^+]^2$)

$= \frac{-0.0591}{2}\log_{10}\left(\frac{2}{1}\right) = \frac{-.0591}{2} \times .3010 =$ negative value

21. D

Sol. As Boron has only four orbitals in the valence shell (i.e 2s, $2p_x$, $2p_y$ & $2p_z$) it can show a maximum valency of four only.
Therefore $[BF_6]^{3-}$ is not possible.

22. D

Sol. Across a period metallic strength decreases & down the group it increases.

23. B

Sol. In $[NiCl_4]^{2-}$, n = 2

$\mu = \sqrt{n(n+2)}\,BM$

$= \sqrt{2(2+2)} = 2.82$ BM

24. D

Sol. Stability of hydrides decreases down the group from NH_3 to BiH_3 as M – H bond energy decreases.

25. A

Sol. Vinyl group
$(CH_2 = CH -)$
On ozonolysis give formaldehyde

26. B

Sol. The products are: CH_3OH, C_2H_5OH, CH_3I and C_2H_5I

27. C

Sol. Effective no. of A atoms = $\frac{1}{8} \times 8 = 1$

Effective no. of B atoms = $\frac{1}{2} \times 5$ (One is missing) = $\frac{5}{2}$

Therefore formula is $A_1B_{\frac{5}{2}} = A_2B_5$

28. D

Sol. For an ideal gas, for isothermal reversible process,

$\Delta S = 2.303nR \log\left(\frac{v_2}{v_1}\right)$

$= 2.303 \times 2 \times 8.314 \times \log\left(\frac{100}{10}\right)$

$= 38.3 \text{ J mol}^{-1}\text{K}^{-1}$

29. B

Sol. Molish's Test: when a drop or two of alcoholic solution of α –naphthol is added to sugar solution and then conc. H_2SO_4 is added along the sides of test tube, formation of violet ring takes place at the junction of two liquids.

30. C

Sol. Lewis acids can initiate the cationic polymerization.

Mathematics

2. Lines must be parallel but not coincident $\Rightarrow \frac{k+1}{k} = \frac{8}{k+3} \neq \frac{4k}{3k-1}$

then $\Rightarrow k = 3$

4. As we know, n sides polygon has ${}^{n}C_3$ number of triangles

${}^{n+1}C_3 - {}^{n}C_3 = 10$

$\Rightarrow n(n-1) = 20$

$\Rightarrow n^2 - n - 20 = 0$

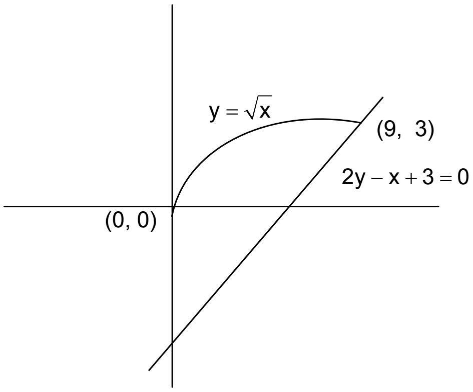
$\Rightarrow n = -4, 5$

7. Variance is independent of adding the sample data.

9. Area under y Axis = $\left|\int_{y_1}^{y_2} x\,dy\right|$

Area = $\int_0^3 \left(2y + 3 - y^2\right)\,dy$

= 9

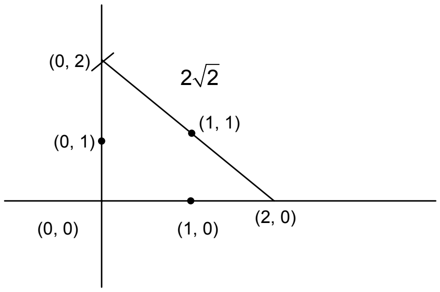


12. Clearly $A \times B$ contain 8 elements,
(we know that 2 sets having m, n elements then number of subset = 2^{mn})
So Total number of subsets of $A \times B$ is $2^8 = 256$
Out of which 8 singleton set and ${}^8C_2$ set contain 2 elements
So required number $= 2^8 - 1 - 8 -{}^8C_2 =$ 219

14. By using the formula $x_i = = \dfrac{x_1a + x_2b + x_3c}{a + b + c}$

$$x_i = \frac{2\times 0 + 2\times 2 + 0}{2 + 2 + 2\sqrt{2}} = \frac{4}{4 + 2\sqrt{2}} = \frac{2}{2 + \sqrt{2}} \times \frac{2 - \sqrt{2}}{2 - \sqrt{2}}$$

$$= 2 - \sqrt{2}$$



17. $.7 + .77 + .777 + ------$

$= \frac{7}{9}(.9 + .99 + .999 + ------) = \frac{7}{9}[1 - .1) + (1 - .01) + (1 - .001)$...............upto n times]

$= \frac{7}{9}\left(20 - \frac{1}{9} + 10^{-20}\right)$

$= \frac{7}{81}\left(179 + 10^{-20}\right)$

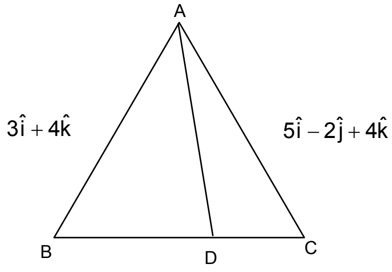
19. Let A as origin then $\overrightarrow{AB}$ and $\overrightarrow{AC}$ are position vector

$\overline{AD} = \dfrac{\overline{AB} + \overline{AC}}{2}$

$= \dfrac{8\hat{i} - 2\hat{j} + 8\hat{k}}{2}$

$= 4\hat{i} - \hat{j} + 4\hat{k}$

$\left|\overrightarrow{AD}\right| = \sqrt{33}$



22. Let d is distance between 2 parallel plane
$4x + 2y + 4z - 16 = 0$
$4x + 2y + 4z + 5 = 0$

$$d = \left|\frac{21}{\sqrt{4^2 + 2^2 + 4^2}}\right| = \frac{7}{2}$$

24. By using family of circle $S + \lambda L = 0$

foci are $\left(+\sqrt{7}, 0\right);\left(-\sqrt{7}, 0\right)$

equation of family of circle is $x^2 + y^2 - 7 + \lambda y = 0$

centre is $\left(0, \frac{-\lambda}{2}\right)$ which implies $\frac{-\lambda}{2} = 3$

$\lambda = -6$

equation of circle is $x^2 + y^2 - 7 - 6y = 0$

27. $x^2 + y^2 = 5/2, \quad y^2 = 4\sqrt{5}x$

$y = mx + \sqrt{\frac{5}{2}}\sqrt{1+m^2}, \; y = mx + \frac{\sqrt{5}}{m}$

$\therefore \sqrt{\frac{5}{2}}\sqrt{1+m^2} = \frac{\sqrt{5}}{m}$

$1 + m^2 = \frac{2}{m^2}$

$\Rightarrow m^4 + m^2 - 2 = 0$

$m^4 + 2m^2 - m^2 - 2 = 0$

$m^2\left(m^2 + 2\right) - 1\left(m^2 + 2\right) = 0$

$\left(m^2 + 2\right)\left(m^2 - 1\right) = 0$

$m^2 - 1 = 0$

$m = \pm 1$

$\therefore$ tangent is $y = x + \sqrt{5}$

$\therefore$ Statement I is true, II is true but II is not correct explanation

29. $I = \int_{\pi/6}^{\pi/3} \frac{\sqrt{\cos x}}{\sqrt{\cos x} + \sqrt{\sin x}}$ (i)

$I = \int_{\pi/6}^{\pi/3} \frac{\sqrt{\cos(\pi/2 - x)}}{\sqrt{\cos(\pi/2 - x)} + \sqrt{\sin(\pi/2 - x)}} dx$ (ii)

Applying property in Statement II

$I = \int_{\pi/6}^{\pi/3} \frac{\sqrt{\sin x}}{\sqrt{\sin x} + \sqrt{\cos x}} dx$ (iii)

Add (I) & (II)

$2I = \int_{\pi/6}^{\pi/3} I \, dx = [x]_{\pi/6}^{\pi/3}$

$2I = \pi/3 - \pi/6 = \frac{\pi}{6}$

$I = \frac{\pi}{12}$

$\therefore$ Statement I is False and Statement II is True

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Advanced), 2014**

PART TEST – III

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 240**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 07)** contains 7 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (08 – 11) contains 4 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

Section-A (12 – 16) contains 2 paragraphs. Based upon paragraph, 2 and 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-C (01 – 07)** contains 7 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

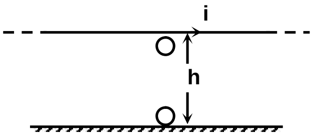
PART – I

SECTION – A

Single Correct Choice Type

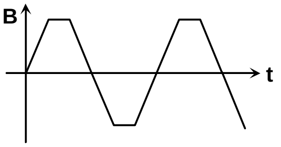
This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

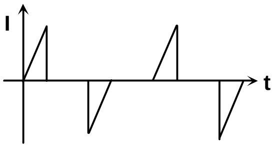
1. A small circular coil of radius 0.5 cm is held directly below a long straight wire carrying a current of 10.0 A. The plane of coil lies in the plane of paper. The coil is located 0.5 m above the top of a table. Now the coil is dropped from rest what is the magnitude of the average induced emf approximately in the coil from the time it is released to the moment it hits the top of the table. Assume that the magnetic field is nearly constant over the area of the coil and is equal to magnetic field at the centre of the coil. (g = 10 m/s^2

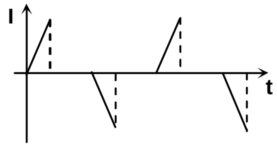


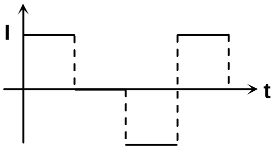
(A) 10^{-8} V
(B) 10^{-6} V
(C) 10^{-5} V
(D) 10^{-9} V

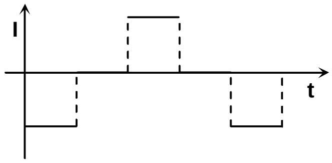
2. Magnetic field through the loop varies as shown in the figure. (Positive magnetic field implies magnetic field perpendicular to the plane of the loop and assume anticlockwise current as positive).



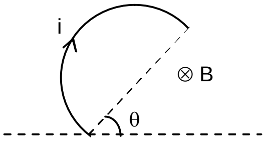
(A)


(B)


(C)


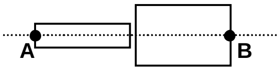
(D)


3. A semicircular ring of radius R carrying current i is placed in a magnetic field of intensity B so that plane of wire is perpendicular to magnetic field as shown. Net force acting on the ring is



(A) 2BiR
(B) 2BiRsin θ
(C) 2BiRcos θ
(D) BiR sin θ

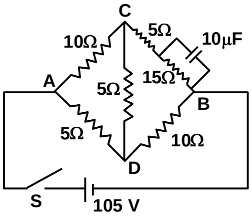
Space for rough work



4. A cylindrical element of resistivity ρ, radius r and length ℓ is connected in series with another cylindrical element of conductivity σ, radius 2r and length ℓ, such that axis of both the cylinders is along the same line as shown. The net resistance across A and B is

(A) $\left(\rho + \frac{1}{4\sigma}\right)\frac{\ell}{\pi r^2}$ (B) $\left(\rho + \frac{4}{\sigma}\right)\frac{\ell}{\pi r^2}$

(C) $\left(\frac{1}{\rho} + 4\sigma\right)\frac{\pi r^2}{\ell}$ (D) $\left(4\rho + \frac{1}{\sigma}\right)\frac{2\ell}{\pi r^2}$



5. In the circuit shown, switch S is closed at t = 0. The current in the branch BD at t = 0 for the given circuit in A is (Assume capacitor to be uncharged initially)

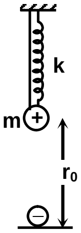
(A) 7 (B) 9

(C) 6 (D) 3

6. A galvanometer has sensitivity 35 kΩ/V and internal resistance 20 Ω. To convert it to an ammeter that reads 2A full scale a resistance of

(A) 2.9×10^{-4} Ω should be added in parallel. (B) 4 mΩ should be added in parallel.

(C) 2.9×10^{-4} Ω should be added in series. (D) 4 mΩ should be added in series.



7. A positively charged sphere of mass m = 5 kg is attached to one end of an ideal spring of spring constant k = 10^4 Nm^{-1} whose other end is fixed to a rigid support. The sphere is tied with a thread so that the spring is in its natural length. Another negatively charged sphere is fixed with floor, vertically below the positively charged sphere as shown. If initial separation between the spheres is 50 cm and magnitude of charge on each sphere is q = 100 μC. The maximum elongation of the spring when the thread is burnt is (g = 10 m/s^2)

(A) 10 cm (B) 15 cm

(C) 5 cm (D) 25 cm

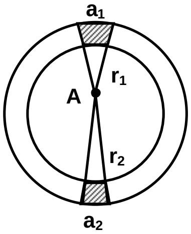
Space for rough work

Multiple Correct Answer(s) Type

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

---

8. A wire having uniform positive charge density λ, is bent in the form of a ring of radius R. Point A as shown in the figure is in the plane of the ring but not on the centre. Two elements of ring of lengths a_1 and a_2 subtend very small same angle at point A. They are at distances r_1 and r_2 from the point A respectively ($r_2 > r_1$). Then



(A) The ratio of charges of elements a_1 and a_2 is $\frac{q_1}{q_2} = \frac{r_1}{r_2}$

(B) The element a_1 produces greater magnitude of electric field at A than a_2 ($E_1 > E_2$)

(C) $V_1 = V_2$

(D) At point A net electric field is towards a_2.

9. A charged particle is released in a gravity free space with some initial velocity in a magnetic field $\vec{B} = B_x\hat{i} + B_y\hat{j}$. If at any instant velocity of the particle is $\vec{v} = v_x\hat{i} + v_y\hat{j}$

(A) $v_x^2 + v_y^2$ is always a constant.

(B) If at any instant acceleration vector of the particle is $\vec{a}$, then $\vec{a}\cdot\vec{v} = 0$

(C) Tangential acceleration of the particle is always zero.

(D) Component of acceleration along x-axis is always zero.

10. Current flows through a straight cylindrical conductor of radius r. The current is distributed uniformly over its cross-section. The magnetic field at a distance x from the axis of the conductor has magnitude B.

(A) B = 0 at the axis.
(B) $B \propto x$ for $0 \le x \le r$.
(C) $B \propto \frac{1}{x}$ for $x > r$
(D) B is maximum for x = r.

11. Select the correct statement(s) from the following.
The path of a charged particle moving with an initial velocity u

(A) parallel to the uniform electrostatic field is a straight line.

(B) perpendicular to the uniform electrostatic field is a parabola.

(C) parallel to the uniform magnetic field is a helix with its axis parallel to the direction of B.

(D) perpendicular to the uniform magnetic field is a circle in a plane normal to the field.

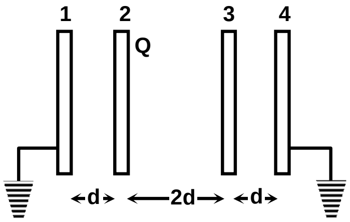
Space for rough work

Comprehension Type

This section contains **2 paragraphs.** Based upon the first paragraph 2 multiple choice questions and based upon the second paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices A), B), C) and D) out of **WHICH ONLY ONE IS CORRECT.**

Paragraph for Question Nos. 12 to 13

Four metallic plates are placed as shown in the figure. Plate 2 is given a charge Q whereas all other plates are uncharged. Plates 1 and 4 are earthed. The area of each plate is same.



12. The charge appearing on the right side of plate 3 is

(A) zero (B) +Q/4

(C) –3Q/4 (D) Q/2

13. The charge appearing on right side of plate 4 is

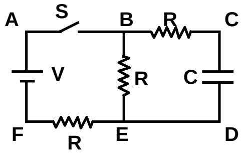
(A) zero (B) –Q/4

(C) –3Q/4 (D) –Q/2

Space for rough work

Paragraph for Question Nos. 14 to 16

In the circuit shown, the battery is ideal with emf V. The capacitor is initially uncharged. The switch S is closed at t = 0



14. The charge on the capacitor at time t is

(A) $\frac{VC}{2}\left(1-e^{-2t/3RC}\right)$ (B) $\frac{VC}{2}\left(1-e^{-t/3RC}\right)$

(C) $\frac{VC}{3}\left(1-e^{-2t/3RC}\right)$ (D) $\frac{VC}{3}\left(1-e^{-t/3RC}\right)$

15. The current in ED at time t is

(A) $\frac{V}{3R}e^{-2t/3RC}$ (B) $\frac{V}{2R}e^{-2t/3RC}$

(C) $\frac{V}{3R}e^{-t/3RC}$ (D) $\frac{V}{2R}e^{-t/3RC}$

16. The current in EB at time t is

(A) $\frac{V}{6R}\left(3e^{-2t/3RC}-1\right)$ (B) $\frac{V}{2R}$

(C) $\frac{Ve^{-2t/3RC}}{R}$ (D) $\frac{V}{6R}\left(e^{-2t/3RC}-3\right)$

SECTION –C

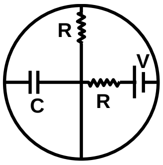
Integer Answer Type

This section contains **7 questions.** The answer to each question is a **single digit integer**, ranging from 0 to 9 (both inclusive).

1. Find the minimum number of capacitors of 2μF capacitance each, required to obtain a capacitance of 5μF.

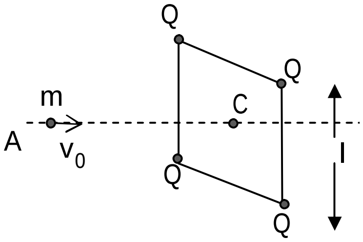
Space for rough work

2. Charge on capacitor in steady state is (in Volt)

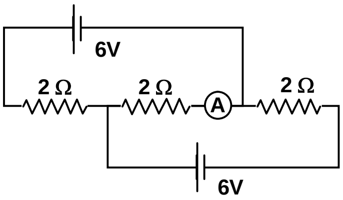


3. The resistance of a series combination of two resistances is S. When they are joined in parallel, the equivalent resistance is P. Find the minimum value of $\frac{S}{P}$.

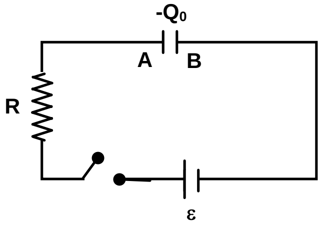
4. Four identical point charges are fixed at the four corners of a square of a side length l. Another charged particle of mass m and charge +q is projected towards centre of square from a large distance along the line perpendicular to plane of square. The minimum value of initial velocity v_0 required to cross the square is?
(m = 1 gm, l = $4\sqrt{2}$ m, Q = 1 μc, q = 0.5 μc)



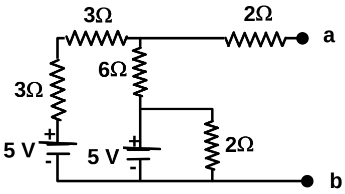
5. What is the reading of ideal ammeter (in A) in the circuit shown in the adjacent figure?



6. The figure shows a RC circuit with a parallel plate capacitor. Before switching on the circuit, plate A of the capacitor was given a charge $-Q_0$ while plate B had no net charge.
Now, at t = 0, the circuit is switched on. How much time (in seconds) will elapse before the net charge on plate A becomes zero. Take C = 1 μF, Q_0 = 1 mC, ε = 1000 V and R = $\frac{2\times10^6}{\ell n(3)}\Omega$



7. Determine the resistance (in Ω) to be connected across a and b in given circuit to dissipate maximum power through it.



Space for rough work

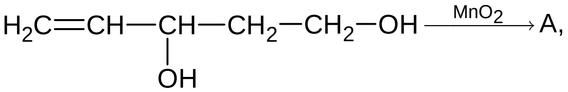
Chemistry

PART – II

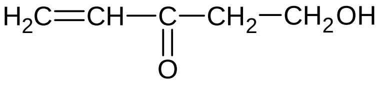
SECTION – A

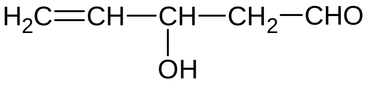
Single Correct Choice Type

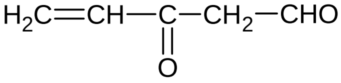
This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

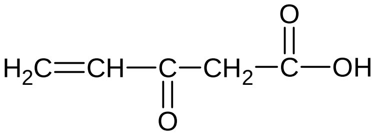
1.

$H_2C{=}CH{-}\underset{\substack{|\\OH}}{CH}{-}CH_2{-}CH_2{-}OH \xrightarrow{MnO_2} A,$

A is

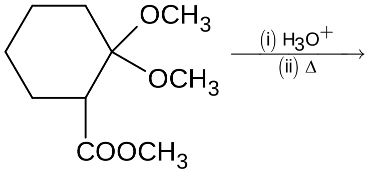
(A)

$H_2C{=}CH{-}\underset{\substack{||\\O}}{C}{-}CH_2{-}CH_2OH$

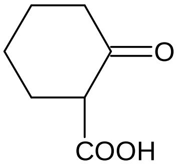
(B)

$H_2C{=}CH{-}\underset{\substack{|\\OH}}{CH}{-}CH_2{-}CHO$

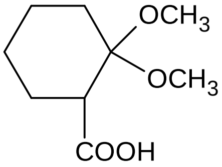
(C)

$H_2C{=}CH{-}\underset{\substack{||\\O}}{C}{-}CH_2{-}CHO$

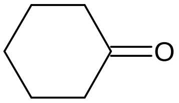
(D)

$H_2C{=}CH{-}\underset{\substack{||\\O}}{C}{-}CH_2{-}\overset{\substack{O\\||}}{C}{-}OH$

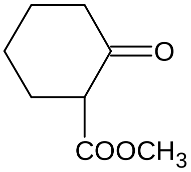
2. What is the final product of the following reaction?



(A)


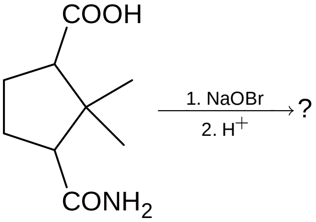
(B)


(C)


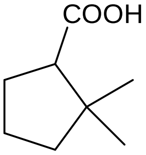
(D)


Space for rough work

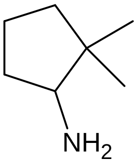
3. What is the final product of the following reaction?


COOH
CONH2
1. NaOBr
2. H+
?

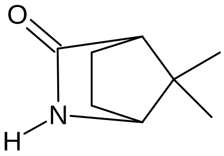
(A)



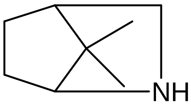
(B)



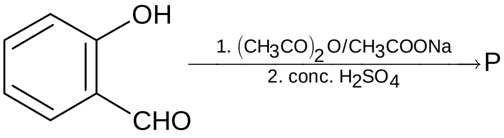
(C)



(D)

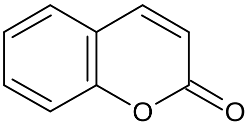


4.

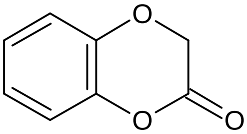

OH
CHO
1. (CH3CO)2O/CH3COONa
2. conc. H2SO4
P

What is the product P?

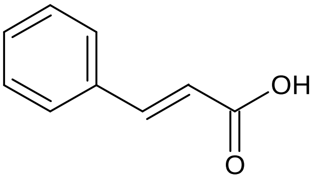
(A)



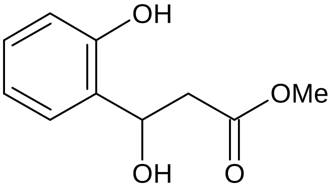
(B)



(C)

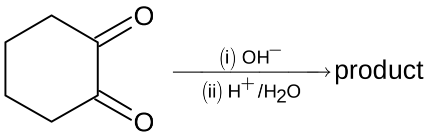


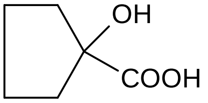
(D)

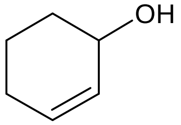


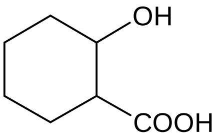
Space for rough work

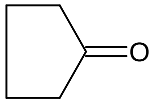
5. Predict the product in the following reaction:


O
O
(i) OH⁻
(ii) H⁺/H₂O
product

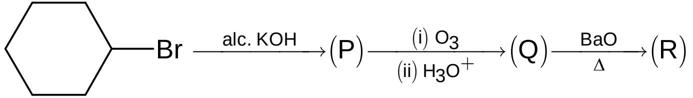
(A)


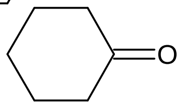
(B)


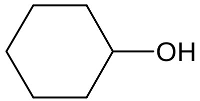
(C)


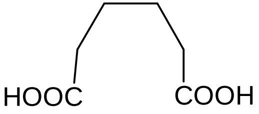
(D)


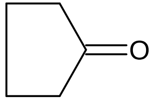
6. End product (R) of following sequence of reaction is


Br
alc. KOH
(P)
(i) O₃
(ii) H₃O⁺
(Q)
BaO
Δ
(R)

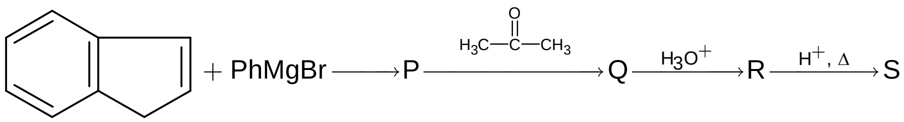
(A)


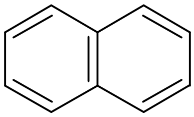
(B)


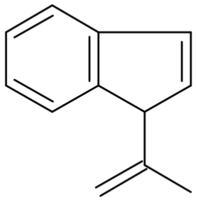
(C)


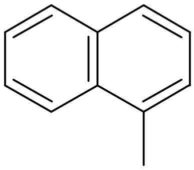
(D)


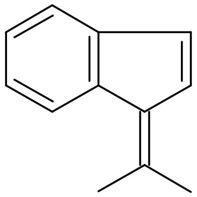
7. Identify S in the following reaction:


+ PhMgBr
P
O
H₃C—C—CH₃
Q
H₃O⁺
R
H⁺, Δ
S

(A)


(B)


(C)


(D)


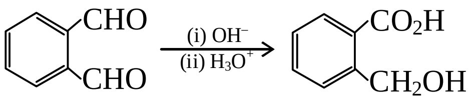
Space for rough work

Multiple Correct Answer(s) Type

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

8. Select the correct statement(s), among the following given statements
   (A) $CH_3CH_2CH_2I$ will react more readily than $(CH_3)_2CHI$ for SN^2 reactions
   (B) $CH_3CH_2CH_2Cl$ will react more readily than $CH_3CH_2CH_2Br$ for SN^2 reactions
   (C) $CH_3CH_2CH_2CH_2Br$ will react more readily than $(CH_3)_3C – CH_2Br$ for SN^2 reactions
   (D) $CH_3 – O – C_6H_5 – Br$ will react more readily than $NO_2 – C_6H_5 – CH_2Br$ for SN^2 reaction

9. Consider following reaction



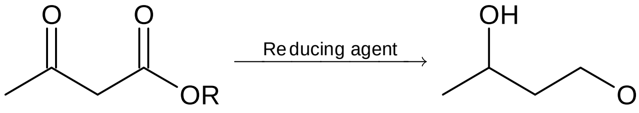
This:
(A) is a crossed Cannizzaro reaction.
(B) is intramolecular Cannizzaro reaction.
(C) causes substitution of H^- by OH^- in one–CHO group and is thus oxidised while second –CHO undergoes an addition of H^- and is thus reduced to alcohol.
(D) resembles aldol type condensation reaction.

10. Lucas test is used to make distinction between 1°, 2° and 3° alcohols:

$$\text{ROH} + \text{HCl(conc.)} \xrightarrow{\text{anhy. ZnCl}_2} \underset{\text{(White turbidity)}}{\text{RCl}\downarrow} + H_2O$$

This show that
(A) ROH behaves as a base
(B) Greater the value of pK_a(alcohol), greater the reactivity with conc. HCl & thus sooner the formation of white turbidity
(C) Alcohol which reacts fastest with Na metal, will give turbidity at fastest rate
(D) Alcohol which gives red colour during victor mayor test will give turbidity at slower rate in Lucas test than those giving blue or white colour during victor mayor test

11. Reducing agent(s) which can be used to carry out following conversion is/are



(A) $NaBH_4$ (B) $LiAlH_4$
(C) H_2/Ni (D) B_2H_6/THF

Space for rough work

Comprehension Type

This section contains **2 paragraphs.** Based upon the first paragraph 2 multiple choice questions and based upon the second paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices A), B), C) and D) out of **WHICH ONLY ONE IS CORRECT.**

Paragraph for Question Nos. 12 to 13

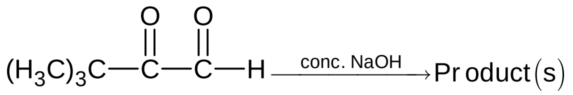
Aldehydes without α - hydrogen undergoes Cannizzaro reaction in the presence of conc. Alkali. Two molecule undergoes self oxidation and reduction to yield a mixture of alcohol and salt of carboxylic acid. Two different aldehydes without α hydrogen undergoes crossed Cannizzaro reaction. The rate of reaction is decided by the ease with which H^- is transferred.

12. $HCHO + PhCHO \xrightarrow{\text{50\% NaOH}} P + Q$

P and Q are

(A) HCOOH and PhCOONa
(B) HCOONa and PhCOOH
(C) CH_3OH and PhCOONa
(D) HCOONa and $PhCH_2OH$

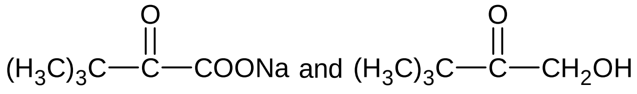
13.



$(H_3C)_3C-\overset{\overset{O}{\|}}{C}-\overset{\overset{O}{\|}}{C}-H \xrightarrow{\text{conc. NaOH}} \text{Product(s)}$

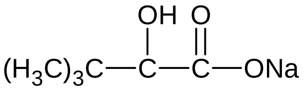
Choose the correct statements among the following statement:

(A) product are



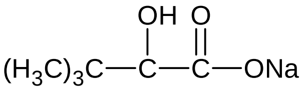
$(H_3C)_3C-\overset{\overset{O}{\|}}{C}-COONa$ and $(H_3C)_3C-\overset{\overset{O}{\|}}{C}-CH_2OH$

(B) Product is



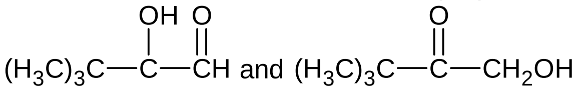
$(H_3C)_3C-\overset{\overset{OH}{|}}{C}-\overset{\overset{O}{\|}}{C}-ONa$ and reaction in disproportionation reaction

(C) Product is



$(H_3C)_3C-\overset{\overset{OH}{|}}{C}-\overset{\overset{O}{\|}}{C}-ONa$ but is not disproportionation reaction

(D) Product are



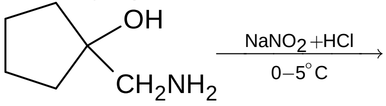
$(H_3C)_3C-\overset{\overset{OH}{|}}{C}-\overset{\overset{O}{\|}}{C}H$ and $(H_3C)_3C-\overset{\overset{O}{\|}}{C}-CH_2OH$

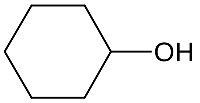
Space for rough work

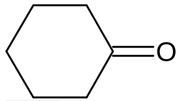
Paragraph for Question Nos. 14 to 16

Aliphatic primary amines react with nitrous acid ($NaNO_2$ + HCl) form alcohol as the major product. In addition to alcohol, alkenes and alkyl halide are also formed as minor products. Nitrous acid also react with secondary and tertiary amine, nature of reaction depends whether amine is aliphatic or aromatic.

14. The major product obtained in the following reaction will be



(A)


(B)


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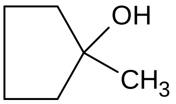
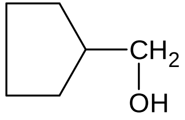
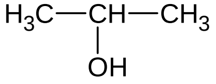
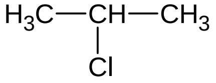


(D)


15. Which of the following product(s) will be obtained when n-propyl amine is treated with $NaNO_2$ and HCl?

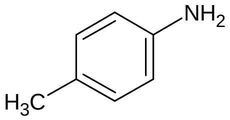
(A)

$H_3C-\underset{OH}{CH}-CH_3$

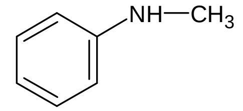
(B) $H_3C-CH=CH_2$

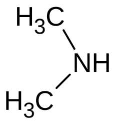
(C)

$H_3C-\underset{Cl}{CH}-CH_3$

(D) All of these

16. Which of the following amine evolve N_2 gas with $NaNO_2$/HCl temperature of reaction below 5°C?

(A)


(B)


(C)


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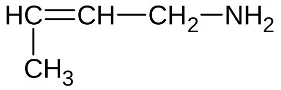
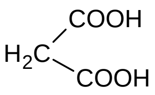

$\underset{CH_3}{HC}=CH-CH_2-NH_2$

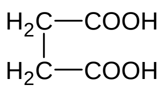
SECTION –C

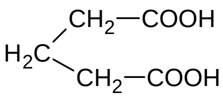
Integer Answer Type

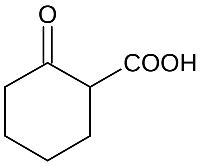
This section contains **7 questions.** The answer to each question is a **single digit integer**, ranging from 0 to 9 (both inclusive).

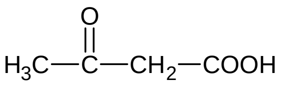
1. How many of the following acids easily undergo decarboxylation on heating?




$$\begin{array}{l} H_2C-COOH \\ \,\,| \\ H_2C-COOH \end{array}$$

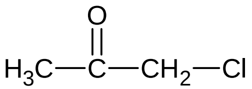





$H_3C-\overset{O}{\overset{||}{C}}-CH_2-COOH$

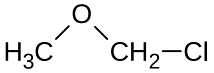
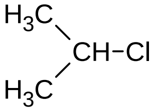
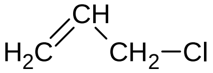
Space for rough work

2. How many of the following compounds are less reactive than

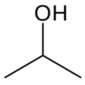
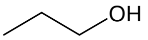
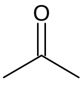
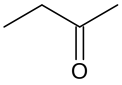
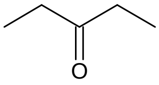
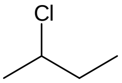
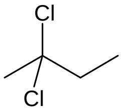
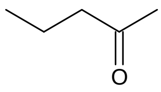


$H_3C-\overset{\overset{O}{\|}}{C}-CH_2-Cl$

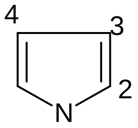
towards SN^2 reaction:

 ; H_3C-CH_2-Cl ;  ; 

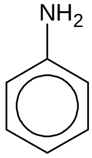
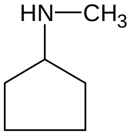
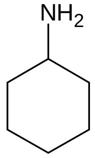
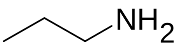
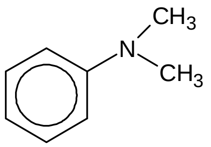
3. How many of the following compounds give positive haloform test?

 ;  ;  ;  ;  ;  ;  ; 

4. Which of the following mentioned position in the given compound is more reactive towards electrophilic substitutions?

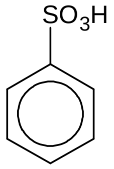
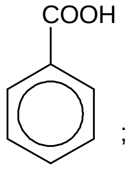
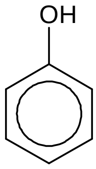
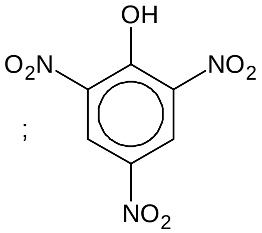


5. How many of the following give positive carbyl amine test?

 ;  ;  ;  ; 

6. How many moles of phenyl hydrazine react with glucose to form glucosazone?

7. How many of the following acid liberate CO_2 from $NaHCO_3$ solution?

 ;  ;  ; 

Space for rough work

Mathematics

PART – III

SECTION – A

Single Correct Choice Type

This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. If f(x) = $(-1)^{\left[\frac{2x}{\pi}\right]}$, g(x) = |sin x| – |cos x| and ϕ(x) = f(x) g(x) (where [.] denotes the greatest integer function) then the respective fundamental periods of f(x), g(x) and ϕ(x) are

(A) π, π, π (B) $\pi, 2\pi, \pi$

(C) $\pi, \pi, \frac{\pi}{2}$ (D) $\pi, \frac{\pi}{2}, \pi$

2. $\int_0^{\pi/2} \sin x \, \log(\sin x) dx$ is equal to

(A) $\log_e(e/2)$ (B) log2 – e

(C) $\log_e((2/e)$ (D) loge – 2

3. The value of $\int f''(x)F(x)dx - \int f(x)F''(x)dx$ is equal to

(A) f(x) F(x) – f″(x) F″(x) + c (B) f′(x) F(x) – f(x) F′(x) + c

(C) f(x) F′(x) – F(x) f′(x) + c (D) f′(x) F″(x) – F′(x) f″(x) + c

Space for rough work

4. If $f(x) = ax^2 + bx + c$ is such that $|f(x)| \le 1,\ \forall\ x \in [-1, 1]$ and $g(x) = |f(x)|,\ x \in [1, \infty]$, then $\int_1^2 g(x)dx$ is

(A) less than or equal to $\frac{11}{3}$ (B) greater than or equal to $\frac{1}{3}$

(C) less than or equal to $-\frac{5}{3}$ (D) lies between $-\frac{1}{3}$ to $\frac{5}{3}$

5. Let $f\left(-\frac{\pi}{2}\right) = -1$, $f(0) = 0$, $f\left(\frac{\pi}{2}\right) = 1$ be a continuous and twice differentiable function, then

(A) $|f''(x)| \le 1\ \forall\ x \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$ (B) $|f''(x)| = 1$ for atleast one $x \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$

(C) $|f''(x)| \ge 1\ \forall\ x \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$ (D) $|f''(x)| < 1$ for atleast one $x \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$

6. $\int \frac{x^3 - 1}{x^4\sqrt{6x^6 - 4x^3 + 2}}dx$ equals $(x > 0)$

(A) $\frac{\sqrt{6x^6 - 4x^3 + 2}}{12x^3} + c$ (B) $\frac{\sqrt{6x^6 - 4x^3 + 2}}{12x^2} + c$

(C) $\frac{\sqrt{6x^6 - 4x^3 + 2}}{6x^3} + c$ (D) $\frac{\sqrt{6x^6 - 4x^3 + 2}}{6x^2} + c$

7. The value of $\int_0^{\pi/3} \left[\sqrt{3}\tan x\right]dx$ (where [.] denotes the greatest integer function) is

(A) $\cot^{-1}\left(\frac{2}{\sqrt{3}}\right)$ (B) $\frac{5\pi}{6} - \tan^{-1}\left(\frac{2}{\sqrt{3}}\right)$

(C) $\frac{\pi}{6} - \tan^{-1}\left(\frac{2}{\sqrt{3}}\right)$ (D) none of these

Space for rough work

Multiple Correct Answer(s) Type

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

8. The value of $\lim\limits_{x\to -4} \dfrac{\tan \pi x}{x+4} + \lim\limits_{x\to\infty}\left(1+\dfrac{1}{x^2}\right)^x$ is

(A) greater than 3 (B) greater than 4
(C) greater than 5 (D) less than 6

9. If [x] represents the greatest integer less than or equal to x, then which of the following statement is true

(A) sin [x] = cos [x] has no solution
(B) sin [x] = tan [x] has infinitely many solutions
(C) sin [x] = cos [x] possess unique solution
(D) sin [x] = tan [x] for no value of x

10. Let f and g be functions from the interval $[0, \infty)$ to the interval $[0, \infty)$ f being an increasing function and g being a decreasing function. If f {g (0)} = 0, then

(A) $f\{g(x)\} \geq f\{g(0)\}$ (B) $g\{f(x)\} \leq g\{f(0)\}$
(C) f {g (1)} = 0 (D) none of these

11. If f(g(x)) is a one-one function, f: R → R and g: R → R, then

(A) g(x) must be one-one (B) f(x) must be one-one
(C) f(x) may not be one-one (D) g(x) may not be one-one

Space for rough work

Comprehension Type

This section contains **2 paragraphs.** Based upon the first paragraph 2 multiple choice questions and based upon the second paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices A), B), C) and D) out of **WHICH ONLY ONE IS CORRECT.**

Paragraph for Question Nos. 12 to 13

Read the following write up carefully and answer the following questions:

If f: R → R and f(x) = g(x) + h(x) where g(x) is a polynomial and h(x) is a continuous and differentiable bounded function on both sides, then f(x) is onto if g(x) is of odd degree and f(x) is into if g(x) is of even degree. To check whether f(x) is one-one we need to differentiate f(x). If f′(x) changes sign in domain of f then f is many-one else one-one

12. f: R → R and $f(x) = a_1x + a_3x^3 + a_5x^5 + ... + a_{2n+1}x^{2n+1} - \cot^{-1}x$ where $0 < a_1 < a_3 < ... < a_{2n+1}$, then the function f(x) is

(A) one-one into	(B) many-one onto
(C) one-one onto	(D) many-one into

13. f: R → R and $f(x) = \dfrac{x(x^4+1)(x+1)+x^4+2}{x^2+x+1}$, then f(x) is

(A) one-one into	(B) many-one onto
(C) one-one onto	(D) many-one into

Space for rough work

Paragraph for Question Nos. 14 to 16

Read the following write up carefully and answer the following questions:
Let the curve f(x, y) = 0, where $x = 1 - 3t^2$, $y = t - 3t^3$. If the tangent at the point P(t) is drawn, such that it makes an angle θ to the positive direction of x-axis.

14. For the point P(1), if m denotes the slope of the tangent then the value of $m + \sqrt{1+m^2}$ is
(A) 0 (B) 1
(C) 2 (D) 3

15. If the tangent at P(–1) meet the curve again at Q(t_1) then the coordinates of point Q be
(A) $\left(-3, -\frac{9}{2}\right)$ (B) $\left(-\frac{1}{3}, -\frac{2}{9}\right)$
(C) $\left(-\frac{1}{3}, \frac{2}{9}\right)$ (D) $\left(\frac{1}{3}, -\frac{2}{9}\right)$

16. If the tangent at P(1) meets the curve again at Q, then the angle between the tangent at P and Q is
(A) $\frac{\pi}{6}$ (B) $\frac{\pi}{4}$
(C) $\frac{\pi}{3}$ (D) $\frac{\pi}{2}$

Rough work

SECTION –C

Integer Answer Type

This section contains **7 questions.** The answer to each question is a **single digit integer**, ranging from 0 to 9 (both inclusive).

---

1. $\frac{1}{8}\int 7\left\{\frac{x^2(x^4-4x-3)}{(x^3-1)^2}\cos x-\frac{(x^4+1)}{(x^3-1)}\sin x\right\}dx$ is equal to ___________

2. I = $\int_0^{1.5}\left[x^2\right]dx$ where [.] is greatest integer function then the value of [I] is ________

3. If α is the absolute maximum value of the expression $\frac{3x^2+2x-1}{x^2+x+1}$ $\forall$ x $\in$ R, then [α] is _______, (where [.] denotes the greatest integer function)

4. The value of $\int_0^1 x\log x\,dx = -\frac{1}{k}$, then k is ___________

5. If f(x) = $3\sin\sqrt{\frac{\pi^2}{9}-x^2}+\left|\left|x\right|-\frac{3\sqrt{3}}{2}\right|$, then the maximum value of $\frac{f(x)}{\sqrt{3}}$ is ____________

6. If f(x) is a real valued function discontinuous only at x = 0; having local extrema at x = 0 and satisfying $(f(x))^2=4$ $\forall$ x, then the number of function f(x) is ____________

7. Let f: R → R and g: R → R be two one-one and onto functions such that they are the mirror images of each other about the line y = 2. If h(x) = f(x) + g(x) then h(0) equals to ____________

Rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ANSWERS, HINTS & SOLUTIONS

PART TEST-III

PAPER -1

ANSWERS KEY			
	PHYSICS	**CHEMISTRY**	**MATHEMATICS**
Q. No.	**ANSWER**	**ANSWER**	**ANSWER**
1.	**A**	**A**	**C**
2.	**D**	**C**	**C**
3.	**A**	**C**	**B**
4.	**A**	**A**	**A**
5.	**C**	**A**	**D**
6.	**A**	**D**	**C**
7.	**A**	**D**	**A**
8.	**A, B, C, D**	**A, C**	**A, C, D**
9.	**A, B, C**	**B, C**	**A, B**
10.	**A, B, C, D**	**A, B, D**	**A, B**
11.	**A, B, D**	**B, C, D**	**A, C**
12.	**B**	**D**	**C**
13.	**A**	**C**	**D**
14.	**A**	**B**	**D**
15.	**A**	**D**	**B**
16.	**D**	**D**	**D**
1.	**4**	**3**	**3**
2	**0**	**4**	**0**
3	**4**	**6**	**3**
4	**3**	**2**	**4**
5	**2**	**3**	**3**
6	**2**	**3**	**2**
7	**5**	**3**	**4**

Physics

PART – I

SECTION – A

1. $\varepsilon_{avg} = \dfrac{\pi r^2 \Delta B}{\Delta t}$

$\therefore \quad \varepsilon_{avg} = \pi r^2 \Delta B\sqrt{\dfrac{g}{2h}}$

3. Magnitude of net force = Bi (Separation between ends) = 2BiR

5. At t = 0 capacitor behaves as closed circuit,

$10I_1 + 5(2I_1 - I) - 5(I - I_1) = 0$ . .

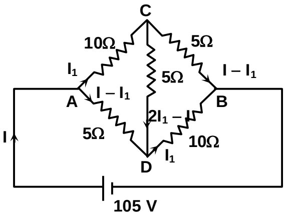
. (1)

$2I_1 + 2I_1 - I - I + I_1 = 0$

$\Rightarrow \quad I = 5I_1/2$

$5(I - I_1) + 10I_1 = 105$

$\Rightarrow \quad I_1 = 6A$



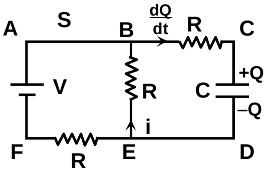
7. Energy is conserved.

14. Apply KVL in ABEFA and BCEDB to get

$Q = \dfrac{VC}{2}\left(1 - e^{-2t/3RC}\right)$

15. To calculate current in ED find dQ/dt

$\dfrac{dQ}{dt} = \dfrac{VC}{2} \times \dfrac{2}{3RC}e^{-2t/3RC} = \dfrac{V}{3R}e^{-2t/3RC}$



16. Apply KVL in EBCDE

$-iR - \dfrac{dQ}{dt}R - \dfrac{Q}{C} = 0 \Rightarrow i = -\dfrac{dQ}{dt} + \dfrac{Q}{RC}$

$\Rightarrow \quad i = \left[\dfrac{V}{3R}e^{-2t/3RL} + \dfrac{V}{2R}\left(1 - e^{-2t/3RC}\right)\right]$

$\Rightarrow \quad i = -\dfrac{V}{R}\left[\dfrac{1}{2} - \dfrac{e^{-2t/3RC}}{6}\right] = \dfrac{V}{6R}\left(e^{-2t/3RC} - 3\right)$

SECTION –C

2. There is no potential difference across the plates of capacitor so charge = 0

3. Use the expressions, $S = R_1 + R_2$ & $P^{-1} = R_1^{-1} + R_2^{-1}$

4. Particle will cross the square if it crosses the point of maximum potential between A and C–which is C itself.

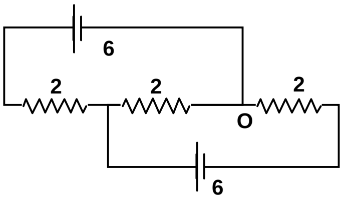
$\dfrac{1}{2}mv_0^2 = K + \dfrac{1}{4\pi\varepsilon_0}\dfrac{4Q^2q}{(l/\sqrt{2})}$

$K > 0 \Rightarrow V_0^2 = 8\sqrt{2}\left(\dfrac{1}{4\pi\varepsilon_0}\right)\left(\dfrac{Qq}{ml}\right)$

5. $$\frac{x+6-6}{2}+\frac{x+6-0}{2}+\frac{x-0}{2}=0$$

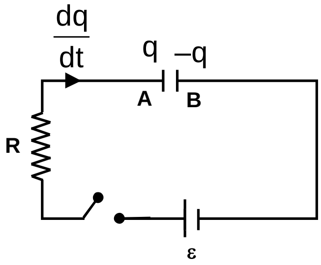
$\Rightarrow$ x = –2

$$\therefore \quad i=\frac{x+6-0}{2}=\frac{4}{2}=2$$



6. $$-\frac{q}{C}+\varepsilon-\frac{dq}{dt}R=0$$

$$\Rightarrow \int_{-Q_0/2}^{Q_0/2}\frac{dq}{q-C\varepsilon}=\int_0^t -\frac{dt}{RC}$$



7. Use Kirchhoff law to find current in external resistance & maximise power.

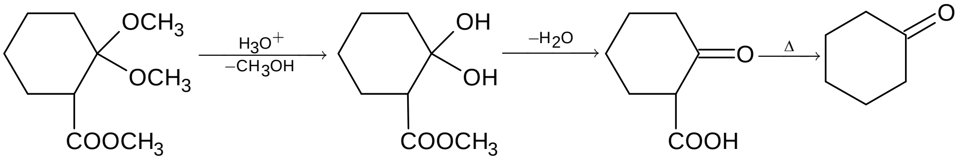
Chemistry

PART – II

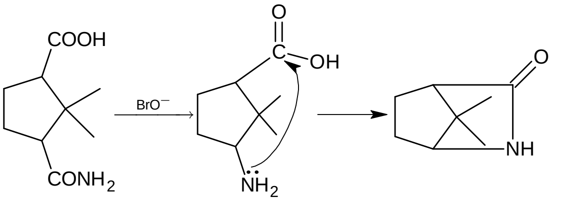
SECTION – A

1. MnO_2 oxidized allylic alcohol.

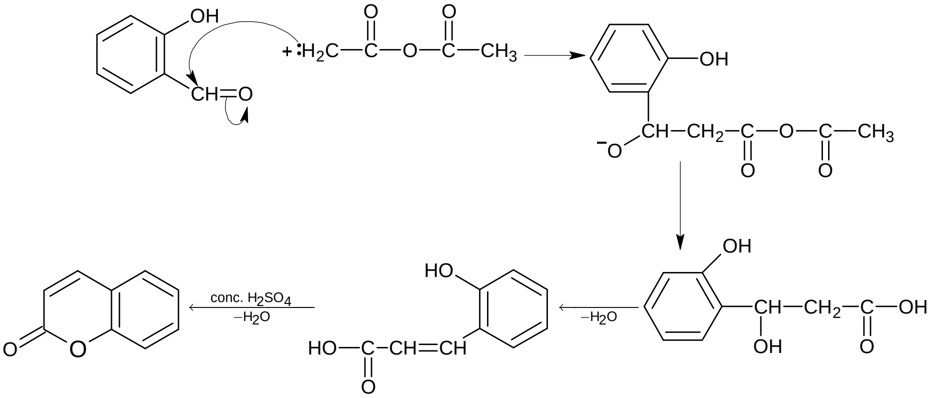
2.


OCH3
OCH3
COOCH3
H3O+
–CH3OH
OH
OH
COOCH3
–H2O
O
COOH
Δ
O

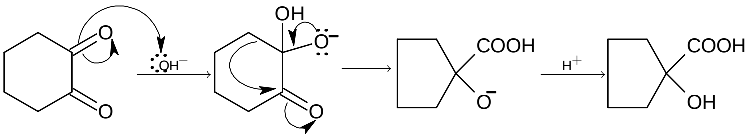
3.


COOH
CONH2
BrO–
O
C
OH
NH2
O
NH

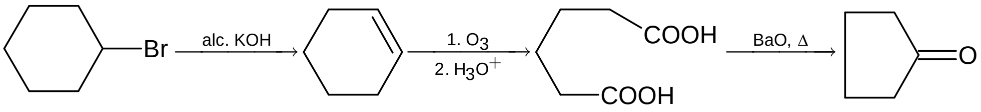
4.


OH
CH=O
H2C—C—O—C—CH3
O
O
OH
–O
CH—CH2—C—O—C—CH3
O
O
OH
CH—CH2—C—OH
OH
O
–H2O
HO
HO—C—CH=CH
O
conc. H2SO4
–H2O
O
O

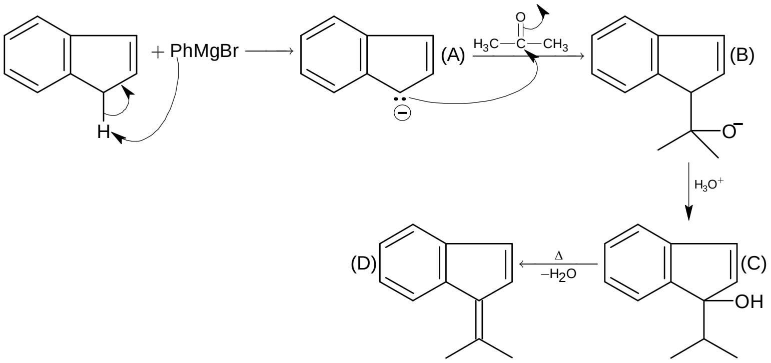
5.


O
O
OH–
OH
O–
O
COOH
O–
H+
COOH
OH

6.


Br
alc. KOH
1. O3
2. H3O+
COOH
COOH
BaO, Δ
O

7.


+ PhMgBr
H
(A)
H3C—C—CH3
O
(B)
O–
H3O+
(C)
OH
Δ
–H2O
(D)

11. $NaBH_4$ does not reduce ester.

Mathematics

PART – III

SECTION – A

1. Clearly $f(x+\pi) = f(x)$, $g(x+\pi) = g(x)$ and $\phi\left(x+\frac{\pi}{2}\right) = \{(-1)\,f(x)\}\{(-1)\,g(x)\} = \phi(x)$.

2. $\int\limits_0^{\pi/2} \sin x \,\log(\sin x)\,dx$

$$I = \frac{1}{2}\int\limits_0^{\pi/2} \sin x \,\log(\sin x)^2\,dx = \frac{1}{2}\int\limits_0^{\pi/2} \sin x\,\log\left(1-\cos^2 x\right)dx$$

$$= \frac{1}{2}\int\limits_0^{1}\log\left(1-t^2\right)dt,\ \text{ where } t = \cos x$$

$$= \frac{1}{2}\int\limits_0^{1}\left[-t^2 - \frac{\left(-t^2\right)^2}{2} - \frac{\left(-t^2\right)^3}{3} - \ldots\right]dt = -\left[\frac{1}{2.3}+\frac{1}{4.5}+\frac{1}{6.7}+\ldots\right] = \log_e 2 - 1 = \log_e\left(\frac{2}{e}\right).$$

3. $I = \int\left(f''(x)F(x) - f(x)F''(x)\right)dx = \int\left\{\left(f''(x)F(x)+f'(x)F'(x)\right)-\left(f(x)F''(x)+f'(x)F'(x)\right)\right\}dx$

$$= \int d\left(f'(x)F(x) - f(x)F'(x)\right) = f'(x)\,F(x) - f(x)\,F'(x) + c$$

4. $f(1) = a + b + c$, $f(-1) = a - b + c$, $f(0) = c$

$\Rightarrow a = \frac{1}{2}(f(-1) + f(1) - 2f(0))$, $b = \frac{1}{2}(f(1) - f(-1))$

$$\Rightarrow f(x) = \left(\frac{1}{2}\left(f(-1)+f(1)-2f(0)\right)\right)x^2 + \left(\frac{1}{2}\left(f(1)-f(-1)\right)\right)x + f(0)$$

$$= \frac{x(x-1)}{2}f(-1) - \left(x^2-1\right)f(0) + \frac{x(x+1)}{2}f(1)$$

$$\Rightarrow |f(x)| = \left|\frac{x(x-1)}{2}f(-1) + \left(1-x^2\right)f(0) + \frac{x(x+1)}{2}f(1)\right|$$

$2|f(x)| \le |x(x+1)| + 2|1-x^2| + |x(x-1)|$ $\quad\because\ |f(x)| \le 1;\ x \in [-1, 1]$

$\Rightarrow$ For $x \in [1, \infty] \Rightarrow 2|f(x)| \le x(x+1) + 2(x^2-1) + x(x-1)$

$\Rightarrow |f(x)| \le 2x^2 - 1\ \forall\ x \in [1, \infty)$

$\Rightarrow g(x) \le 2x^2 - 1$

$$\Rightarrow \int\limits_1^2 g(x)\,dx \le \int\limits_1^2\left(2x^2-1\right)dx = \frac{11}{3}.$$

5. Let $h(x) = f(x) - \sin x$

$\Rightarrow$ According to Rolle's theorem for $c \in \left(-\frac{\pi}{2},\ 0\right)$, $h'(c) = 0 \Rightarrow f'(c) = \cos c$

and $d \in \left(0,\ \frac{\pi}{2}\right)$, $h'(d) = 0 \Rightarrow f'(d) = \cos d$

let $h'(x) = f'(x) - \cos x$, $x \in [c, d]$.

According to Rolle's theorem $h''(x) = 0$, $x \in (c, d)$

$\Rightarrow f''(x) + \sin x = 0,\ x \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$

$\Rightarrow |f''(x)| = |\sin x| < 1$ for atleast one $x \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$.

6. $I = \int \frac{\frac{1}{x^4} - \frac{1}{x^7}}{\sqrt{\frac{2}{x^6} - \frac{4}{x^3} + 6}}\,dx$

Let $\frac{2}{x^6} - \frac{4}{x^3} + 6 = t^2$

$\Rightarrow I = \frac{1}{6}\int dt = \frac{1}{6}\sqrt{\frac{2}{x^6} - \frac{4}{x^3} + 6} + c = \frac{\sqrt{6x^6 - 4x^3 + 2}}{6x^3} + c$.

7. $\int_0^{\pi/6} 0dx + \int_{\pi/6}^{\tan^{-1}\left(\frac{2}{\sqrt{3}}\right)} 1dx + \int_{\tan^{-1}\left(\frac{2}{\sqrt{3}}\right)}^{\pi/3} 2dx = \frac{\pi}{2} - \tan^{-1}\left(\frac{2}{\sqrt{3}}\right) = \cot^{-1}\left(\frac{2}{\sqrt{3}}\right)$

8. $\lim_{x\to -4} \frac{\tan \pi x}{x+4} \qquad \left(\frac{0}{0}\right)$

$= \lim_{x\to -4} \frac{\pi \sec^2 \pi x}{1} = \pi$

$\lim_{x\to\infty}\left(1 + \frac{1}{x^2}\right)^x = \lim_{x\to\infty} e^{x\cdot\frac{1}{x^2}} = 1$

given limit = $\pi + 1$.

9. Since, according to option (A), we have

sin [x] = cos [x]

$\Rightarrow [x] = n\pi + \left(\frac{\pi}{4}\right) = \left(n + \frac{1}{4}\right)\pi$

Which is not possible, as LHS $\in$ I and RHS $\in Q^c$

Hence, sin [x] = cos [x] has no solution

However, sin [x] = tan [x]

$\Rightarrow [x] = n\pi,\ n \in I$

Which is possible when [x] = 0 and n = 0

$\therefore\ 0 \le x < 1$

10. ‘g’ is decreasing

$\Rightarrow g(1) \le g(0)$

Therefore f is increasing

$\Rightarrow f\{g(0)\} \ge f\{g(1)\}$

$\therefore\ 0 \ge f\{g(1)\}$, from the question. But, $f(x) \ge 0$, from the question

$\therefore\ f\{g(1)\} = 0$

As $x \ge 0$, $g(x) \le g(0)$

So, $f\{g(x)\} \le f\{g(0)\}$

As $x \ge 0$, $f(x) \ge f(0)$

So, $g\{f(x)\} \le g\{f(0)\}$

11. Since f(g(x)) is a one-one function

$\Rightarrow f(g(x_1)) \ne f(g(x_2))$ whenever $x_1 \ne x_2$

$\Rightarrow g(x_1) \neq g(x_2)$ whenever $x_1 \neq x_2$
$\Rightarrow g(x)$ must be one-one.
Let $f(x) = y$ is satisfied by $x = x_1$ and x_2
If $g(x)$ is such that its range has only one of x_1 and x_2, then $f(g(x))$ can be one-one even if $f(x)$ is many-one

12. $f(x)$ = odd degree polynomial + bounded function $\cot^{-1}x \in (0, \pi)$
also, $f'(x) > 0$.

13. $f(x) = x^4 + 1 + \frac{1}{x^2+x+1}$ = even degree polynomial + bounded function $\frac{1}{x^2+x+1} \in \left(0, \frac{4}{3}\right)$

$$f'(x) = \frac{4x^3\left(x^2+x+1\right)^2 - 2x - 1}{\left(x^2+x+1\right)^2}$$

$\Rightarrow f'(x) = 0$ has atleast one root which is repeated odd number of times or it has one root which is not repeated since numerator of $f'(x)$ is a polynomial of degree 7.
$\Rightarrow f(x) = 0$ has a point of extrema.

16. $P(1) \equiv (-2, -2)$

$\frac{dx}{dt} = -6t$, $\frac{dy}{dt} = 1 - 9t^2$

$\Rightarrow m_t = \frac{9t^2 - 1}{6t}$

at $t = 1$, $m_1 = \frac{4}{3}$

$\Rightarrow$ equation of tangent at P

$y + 2 = -\frac{4}{3}(x + 2) \Rightarrow (t + 1)^2 (3t - 2) = 0 \Rightarrow t = \frac{2}{3}$

$\Rightarrow Q \equiv \left(-\frac{4}{3}, -\frac{2}{9}\right)$

SECTION – C

1. $$\int_0^2 7\left\{\frac{x^2(x^4 - 4x - 3)}{(x^3-1)^2}\cos x - \frac{(x^4+1)}{(x^3-1)}\sin x\right\}dx$$

Substitute $y = \frac{x^4+1}{x^3-1}\cos x$

$$7\int_0^2 dy = y\Big|_0^2 = \frac{24}{7} \times 7 = 24.$$

2. $$I = \int_0^1 0dx + \int_1^{\sqrt{2}} dx + \int_{\sqrt{2}}^{1.5} 2dx = \left(\sqrt{2} - 1\right) + 2\left(1.5 - \sqrt{2}\right) = 2 - \sqrt{2}$$

$[I] = [0.41] = 0$

3. Let $y = \frac{3x^2 + 2x - 1}{x^2 + x + 1}$

$\Rightarrow (y - 3)x^2 + (y - 2)x + y + 1 = 0.$
As $x \in R$, $D \geq 0 \Rightarrow (y - 2)^2 - 4(y - 3)(y + 1) \geq 0$
$\Rightarrow 3y^2 - 4y - 16 \leq 0$
Clearly y lies between the roots.

Roots of the equation $3y^2 - 4y - 16 = 0$ are

$$y = \frac{4 \pm \sqrt{208}}{6} = \frac{2 \pm \sqrt{52}}{3}$$

$\therefore$ Absolute maximum of the expression = $\frac{2 + \sqrt{52}}{3} = \alpha$

$\Rightarrow [\alpha] = 3$

4. $$\int_0^1 x \log x \, dx = \int_0^1 \log x . x \, dx = \left| \log x . \frac{x^2}{2} \right|_0^1 - \int_0^1 \frac{1}{x} . \frac{x^2}{2} dx = -\frac{1}{4}$$

5. Let $p(x) = 3 \sin \sqrt{\frac{\pi^2}{9} - x^2}$ and $g(x) = \left| |x| - \frac{3\sqrt{3}}{2} \right|$.

$\Rightarrow$ p(x) and g(x) are even functions

and p(x) decreases in $x \in \left[0, \frac{\pi}{3}\right]$

and g(x) decreases in $x \in \left[0, \frac{3\sqrt{3}}{2}\right]$.

Hence p(x) and g(x) will be maximum at x = 0

$\Rightarrow$ maximum value of f(x) is $f(0) = 3\sqrt{3}$.

6. $$f(x) = \begin{cases} 2; & x = 0 \\ -2; & x \in R - 0 \end{cases} \quad f(x) = \begin{cases} -2; & x = 0 \\ 2; & x \in R - 0 \end{cases}$$

7. Since f(x) and g(x) are one-one and onto and are also the mirror images of each other with respect to the line y = 2. It clearly indicates that h(x) = f(x) + g(x) will be a constant function and will always be equal to 4.

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PART TEST – III

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 240**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 – 12) contains 4 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

(ii) **Section-B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. There is no negative marking.

(iii) **Section-C (01 – 06)** contains 6 Numerical based questions with single digit integer as answer, ranging from 0 to 9 and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

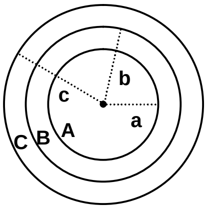
PART – I

SECTION – A

Single Correct Choice Type

This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. Three concentric charged metallic spherical shells A, B and C have radii a, b and c; charge densities σ, $-\sigma$ and σ; and potentials V_A, V_B and V_C respectively. Then which of the following relations is correct?

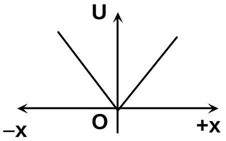


(A) $V_A = \dfrac{(a+b+c)\sigma}{\varepsilon_0}$ (B) $V_B = \dfrac{[(a^2/b)-b+c]\sigma}{\varepsilon_0}$

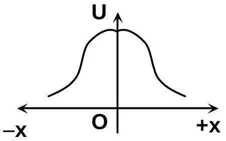
(C) $V_C = \dfrac{[(a^2+b^2)/c+c]\sigma}{\varepsilon_0}$ (D) $V_A = V_B = V_C = \dfrac{(a-b+c)\sigma}{\varepsilon_0}$

2. Four identical charges are placed at the four vertices of a square lying in YZ plane. A fifth charge is moved along X axis. The variation of potential energy (U) along X axis is correctly represented by

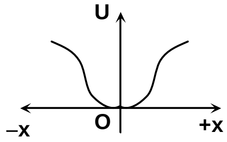
(A)



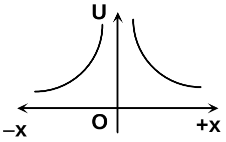
(B)



(C)



(D)

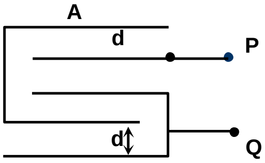


3. Two resistances 300 ohm and 400 ohm are connected in series with a 60 volt supply. A voltmeter connected across 400 ohm reads 30V. The same voltmeter when connected across the other resistance will read.

(A) 22.5 V (B) 50 V
(C) 30 V (D) 10 V

Space for rough work

4. The equivalent capacitance between P and Q in the figure is (area of each plate is A and separation between two consecutive plates is d)



(A) $\frac{A\varepsilon_0}{2d}$ (B) $\frac{3A\varepsilon_0}{2d}$

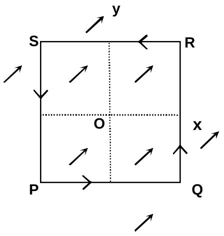
(C) $\frac{2A\varepsilon_0}{d}$ (D) $\frac{5}{3}\frac{A\varepsilon_0}{d}$

5. Two long parallel straight conductors carry currents i_1 and i_2 ($i_1 > i_2$). When the current are in the same direction, the magnetic field at a point midway between the wires is 20 μT. If the direction of i_2 is reversed, the field becomes 50 μT. the ratio of the currents i_1/i_2 is

(A) 5/2 (B) 7/3

(C) 4/3 (D) 5/3

6. A uniform constant magnetic field $\vec{B}$ is directed at an angle of 45° to the axis in the xy –plane. PQRS is a rigid, square wire frame carrying a steady current I_0, with its centre at the origin O. At time t = 0, the frame is at rest in the position as shown in figure, with its sides parallel to the x and y axes. Each side of the frame is of mass M and length L. The torque τ about O acting on the frame due to the magnetic field will be?



(A) $\frac{BI_0L^2}{\sqrt{2}}\left[+\hat{j}-\hat{i}\right]$ (B) $\frac{BI_0L^2}{\sqrt{2}}\left[-\hat{j}+\hat{i}\right]$

(C) $BI_0L^2\left[+\hat{j}-\hat{i}\right]$ (D) $BI_0L^2\left[-\hat{j}+\hat{i}\right]$

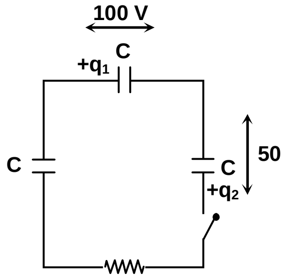
7. A coil is in the form of equilateral triangle of side 'a'. The current in the coil is I. The magnetic field at a distance 'a' equidistant' from all the vertices will be

(A) $\frac{\mu_0 I}{2\sqrt{3}\pi a}$ (B) $\frac{\sqrt{3}\mu_0 I}{2\pi a}$

(C) $\frac{\mu_0 I}{\sqrt{3}\pi a}$ (D) $\frac{\mu_0 I}{4\sqrt{3}\pi a}$

Space for rough work

8. Two capacitor each of capacitance C = 1 μF each charged to potential 100 V and 50 V respectively and connected across a uncharged capacitor 'C' = 1μF as shown in the figure if switch 'S' is closed then charge in the uncharged capacitor at equilibrium will be



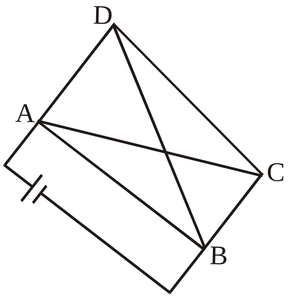
(A) $\frac{50}{3}$ μC
(B) 50 μC
(C) 25 μC
(D) $\frac{100}{3}$ μC

Multiple Correct Answer(s) Type

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

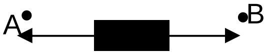
---

9. A wire frame in the form of a tetrahedron ABCD is connected to a dc source. The resistance of all the edges of the tetrahedron are equal. Choose the correct statement (s)
(A) the electric current through DC is zero
(B) if we remove anyone of the edges AD, AC, DB or BC, the change in current remain same
(C) the current through AB is maximum
(D) the change in current will be same if AB or DC is removed



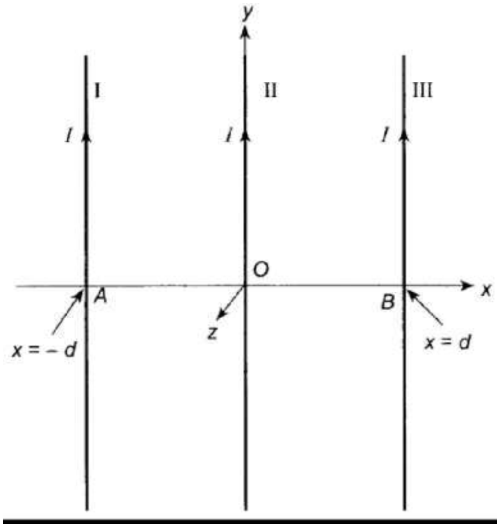
10. A parallel plate capacitor is charged to a certain voltage. Now, if the dielectric material (with dielectric constant k) is removed then.
(A) the capacitance increases by a factor k
(B) the electric field reduces by a factor k
(C) the voltage across the capacitor decreases by a factor k
(D) the charge stored in the capacitor increases by a factor k

Space for rough work



11. Two point charges $q_1 = +2\mu C$ and $q_2 = -4\mu C$ are placed at A and B respectively as shown. The distance between q_1 and q_2 is 4cm
(A) A line of force emanates from q_1 making a angle 90° with A B enters q_2 at angle 60°.
(B) The net electric flux will be zero over any surface that encloses a volume excluding A & B
(C) The electrostatic potential is zero at infinitely many points in space
(D) None of these

12. Three infinitely long thin wires, each carrying current I in the same direction are in the x – y plane in a gravity free space (see Fig.). The central wire is at x = 0 while the other two wires are at $x = \pm d$. The net magnetic field
(A) cannot be zero beyond B (i.e. $x > d$)
(B) cannot be zero beyond A (I,e. $x < -d$)
(C) will be zero between x = 0 and x = d
(D) will be zero between x = 0 and x = – d



Space for rough work

SECTION - B

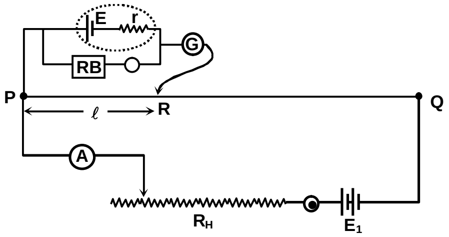
Matrix – Match Type

*This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

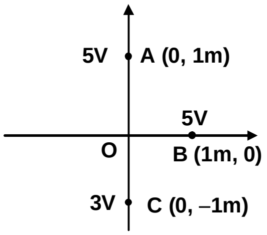
1. A potentiometer experiment setup is shown in the given diagram. P is the point when there is no deflection in the galvanometer. E_1 is the source. Match the following.



Column – I		Column – II	
(A)	If only emf of battery E_1 is increased	(p)	point P will shift to left
(B)	If only resistance of rheostat is increased	(q)	point P will shift to right
(C)	If resistance box is connected and increased.	(r)	point P will remain unchanged
(D)	If an identical battery is connected in parallel to E.	(s)	point P may shift to left or right

Space for rough work

2. An uniform electric field exists in straight line in the X–Y plane. The potential at different point in region are shown in the figure. Now match the following column if charge particles P (mass = 10^{-6} kg, charge $\sqrt{2}$ μC) and θ (mass = 10^{-6} kg. Charge = $-2\sqrt{2}$ μC are released from origin)



	Column A		Column B
(A)	Co-ordinate of position of particle P at time t = $2\sqrt{2}$ sec	(p)	($4\sqrt{2}$ m, $4\sqrt{2}$ m)
(B)	Co-ordinate of position of particle θat time t = 2 sec	(q)	($-4\sqrt{2}$ m, $-4\sqrt{2}$m)
(C)	Distance travelled by particle Q in 2 sec is	(r)	8 m
(D)	Distance travelled by particle P in 2 sec is	(s)	4 m

SECTION –C

Integer Answer Type

This section contains **6 questions.** The answer to each question is a **single digit integer**, ranging from 0 to 9 (both inclusive).

1. Three resistors of resistances 2 Ω, 3 Ω and 6 Ω are available to be connected across a battery of internal resistance 1Ω and emf. 4V by means of conducting wires. The maximum current (in amp) that can be drown through the cell by using all the given resistances is

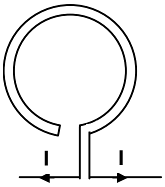
2. A capacitor of variable capacitance C = α t (where α is constant and 't' is time) is connected with a battery of emf E = βt. Rate of energy stored in capacitor is proportional to t^n. Then find the value of n. (t is time and α, β are constants)

Space for rough work

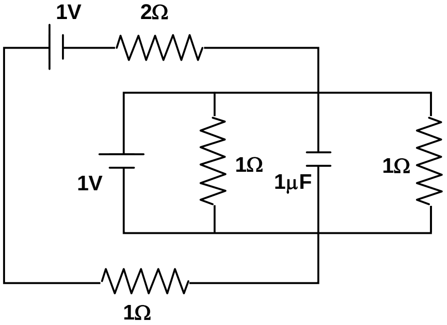
3. A wire of length L is wound on a spherical form, and a current I is passed through it. The coil is then placed in a uniform magnetic field of induction B. Find the number of turns so that the torque on it to be maximum.

4. A capacitor of variable capacitance C = α t (where α is constant and 't' is time) is connected with a battery of emf E = βt. Rate of energy stored in capacitor is proportional to t^n. Then find the value of n. (t is time and α, β are constants)

5. An electric current i is passed through a circular loop of folded copper wire as shown in the figure. Find the magnetic induction at the centre of the loop.



6. The charge on the capacitor in steady state is x μA. Calculate x.



Space for rough work

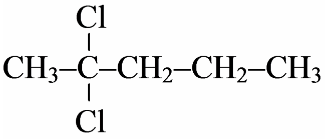
Chemistry PART – II

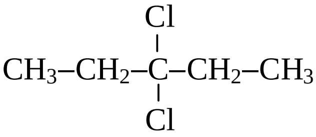
SECTION – A

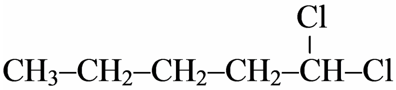
Single Correct Choice Type

This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. A compound (A) $C_5H_{10}Cl_2$ on hydrolysis gives (B) $C_5H_{10}O$. The compound (B) reacts with NH_2OH, to form oxime and gives positive iodoform test but does not give Fehling's test. The compound (A) is

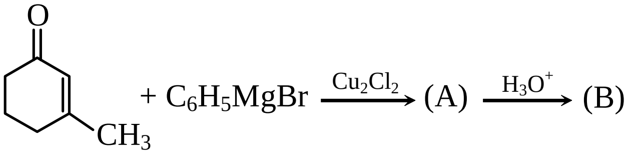
(A) 
$CH_3-\overset{Cl}{\underset{Cl}{C}}-CH_2-CH_2-CH_3$

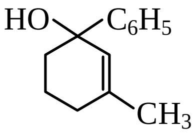
(B) 
$CH_3-CH_2-\overset{Cl}{\underset{Cl}{C}}-CH_2-CH_3$

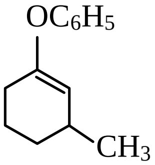
(C) 
$CH_3-CH_2-CH_2-CH_2-\overset{Cl}{CH}-Cl$

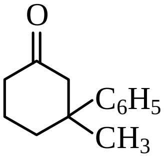
(D) None of these

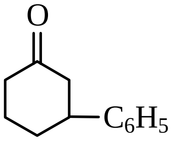
2. The major product (B) of the following reaction is



(A) 

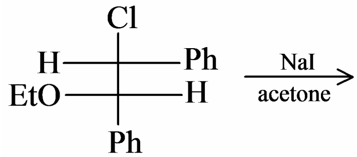
(B) 

(C) 

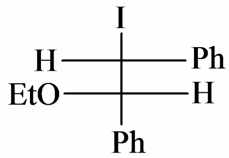
(D) 

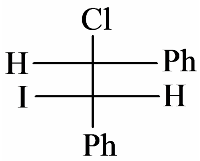
Space for rough work

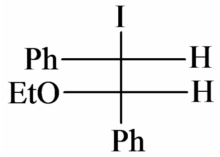
3. In the following reaction,

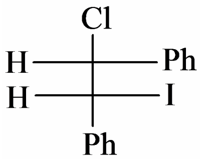


the structure of product is

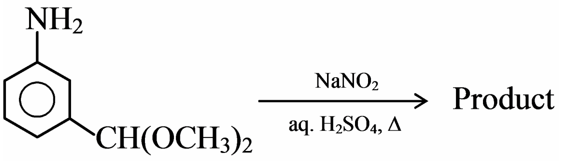
(A) 

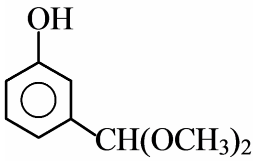
(B) 

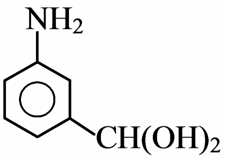
(C) 

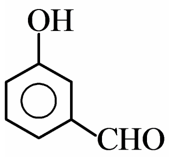
(D) 

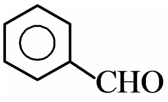
4. The major product of the following reaction is



(A) 

(B) 

(C) 

(D) 

5. The presence of carbon in an organic compound is detected by heating it with

(A) Sodium metal to convert it into NaCN.

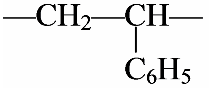
(B) CaO to convert it into CO which burns with a blue flame.

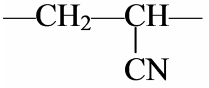
(C) CuO to convert it into CO_2 which turns lime water milky.

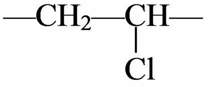
(D) Cu wire to give a bluish–green flame.

Space for rough work

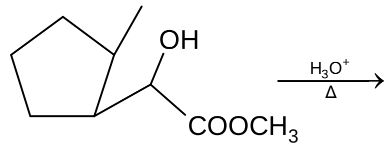
6. The repeat unit of polystyrene is

(A) 
$-CH_2-\underset{C_6H_5}{\underset{|}{C}}H-$

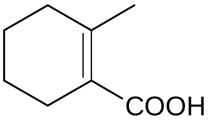
(B) 
$-CH_2-\underset{CN}{\underset{|}{C}}H-$

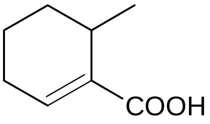
(C) 
$-CH_2-\underset{Cl}{\underset{|}{C}}H-$

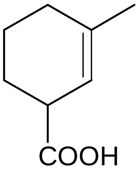
(D) $-CCl_2-CCl_2-$

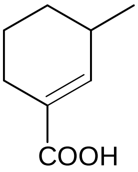
7. 

P; 'P' as a major product must be,

(A) 

(B) 

(C) 

(D) 

8. Benzene diazonium chloride on reaction with phenol in weakly basic medium gives ……………… and the reaction is ……………………

(A) diphenyl ether, nucleophilic addition
(B) p-hydroxy azobenzene, electrophilic substitution
(C) chlorobenzene, electrophilic addition
(D) benzene, elimination

Space for rough work

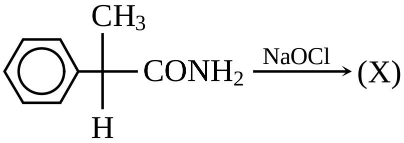
Multiple Correct Answer(s) Type

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

9. Which of the following statement(s) about D(+) glucose is/are true?
   (A) Naturally occurring glucose is dextrorotatory (B) It reduces ammoniacal $AgNO_3$ solution
   (C) On polymerisation it forms galactose (D) It forms cyanohydrin on reaction with HCN

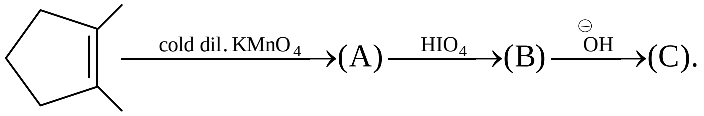
10. Which of the following statements is/are correct?
   (A) In S_N2 mechanism, the rate determining step involves two species
   (B) The S_N2 mechanism involves the formation of intermediate carbocation
   (C) The S_N2 mechanism is accompanied with Walden inversion
   (D) The S_N2 mechanisms may involve intramolecular rearrangement

11. Which of the following statements are true about the major product (X) in the reaction?

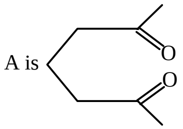


   (A) (X) is a cyclic amide
   (B) (X) has an asymmetric centre
   (C) (X) is a primary amine
   (D) (X) can also be obtained by treatment of NH_3 with $C_6H_5CH(CH_3)Br$

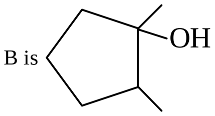
12. In a reaction sequence



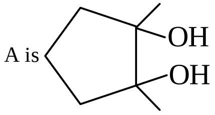
(A)



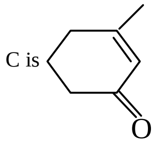
(B)



(C)



(D)



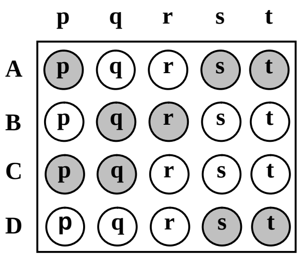
Space for rough work

SECTION - B

Matrix – Match Type

*This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



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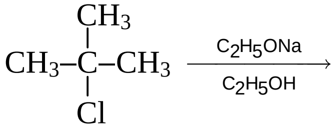
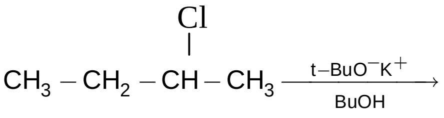
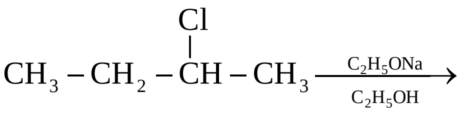
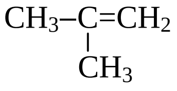
1. Match the following:

	Column - I (Substrate + reagent)		Column - II (Major product)
(A)	$CH_3–CH_2–CH_2–Cl \xrightarrow[C_2H_5OH]{C_2H_5ONa}$	(p)	$CH_3–CH_2–CH=CH_2$
(B)	 $CH_3–\underset{Cl}{\overset{CH_3}{C}}–CH_3 \xrightarrow[C_2H_5OH]{C_2H_5ONa}$	(q)	$CH_3–CH=CH–CH_3$
(C)	 $CH_3-CH_2-\overset{Cl}{CH}-CH_3 \xrightarrow[BuOH]{t-BuO^-K^+}$	(r)	$CH_3–CH=CH_2$
(D)	 $CH_3-CH_2-\overset{Cl}{CH}-CH_3 \xrightarrow[C_2H_5OH]{C_2H_5ONa}$	(s)	 $CH_3–\underset{CH_3}{C}=CH_2$
		(t)	$CH_2=CH–CH=CH_2$

2. Match the following:

	Column I		Column II
(A)	Hell–Volhard-Zelinsky reaction	(p)	Preparation of amines
(B)	Reformatsky reaction	(q)	Preparation of β–hydroxy aldehyde
(C)	Claisen condensation reaction	(r)	Preparation of β–hydroxy ester
(D)	Schmidt reaction	(s)	α–halogenation of carboxylic acid
		(t)	Preparation of β–keto ester

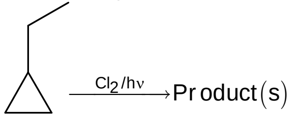
Space for rough work

SECTION –C

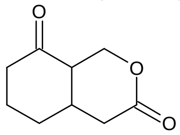
Integer Answer Type

This section contains **6 questions.** The answer to each question is a **single digit integer**, ranging from 0 to 9 (both inclusive).

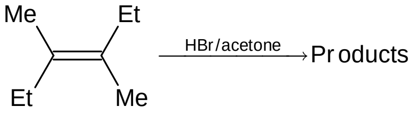
1. How many monochlorinated products (theoretically) of the following reaction is/are possible?


Cl2/hν
Product(s)

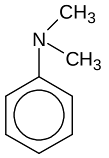
2. How many molecules of CH_3MgX are consumed in the reaction with one molecule of the following, in dry ether?

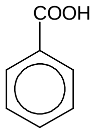


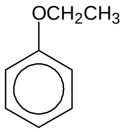
3. How many products will be formed in the following reaction?

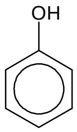

Me
Et
Et
Me
HBr/acetone
Products

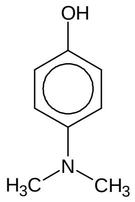
4. Amongst the following the total number of compounds soluble in aqueous NaOH is

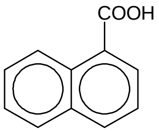




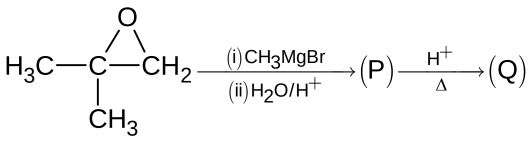






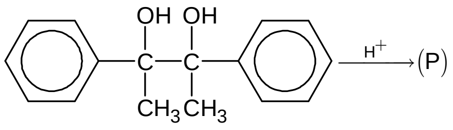


5.


O
H3C
C
CH2
CH3
(i) CH3MgBr
(ii) H2O/H+
(P)
H+
Δ
(Q)

How many hyperconjugating structures of "Q" are possible?

6.


OH OH
C
C
CH3 CH3
H+
(P)

How many α - H to carbonyl groups are there in the product "P"?

Space for rough work

Mathematics PART – III

SECTION – A
Single Correct Choice Type

This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. If f(x) = $(a^2 - 3a + 2)\left(\cos^2\frac{x}{4} - \sin^2\frac{x}{4}\right)$ + (a – 1)x + cos1 does not passes critical point then the possible value of a is/are

(A) $a \in (0, 1)$ (B) $a \in (0, 2)$
(C) $a \in (0, 4)$ (D) none of these

2. Let f(x) = $\frac{2}{\sqrt{3}}\tan^{-1}\left(\frac{2x+1}{\sqrt{3}}\right) - \ln\left(x^2+x+1\right) + \left(b^2 - 5b + 4\right)x + c$ be a decreasing function $\forall$ x $\in$ R, then the value of b is

(A) $\left(-2, \frac{2}{3}\right]$ (B) (0, 3)
(C) (3, 4) (D) (2, 3)

3. The area of the region described by a moving point P lying inside the circle $(x - a)^2 + y^2 = a^2$ above x-axis such that its distance from circle along the radius through P is greater than its distance from x-axis is

(A) $\frac{4a^2}{3}$ (B) $2a^2$
(C) a^2 (D) $\frac{2a^2}{3}$

4. If $y = \sqrt{a^2 - b^2\cos^2(\ln x)}$ then $x^2y^2\left(\frac{dy}{dx}\right)^2$ is equal to

(A) $a^2 - y^2$ (B) $a^2 + b^2 - y^2$
(C) $(a^2 - y^2)(b^2 - a^2 + y^2)$ (D) $(b^2 - y^2)(a^2 - b^2y^2)$

Rough work

5. $\lim\limits_{x\to 0} \dfrac{\sqrt[3]{1+\sin^2 x} - \sqrt[4]{1-2\tan x}}{\sin x + \tan^2 x}$ equals to

(A) -1 (B) 1

(C) $\frac{1}{2}$ (D) $-\frac{1}{2}$

6. If function f(x) satisfies $f'(x + k) + f'(x) = 0 \ \forall\ x \in R$ and $k \in \left(0, \frac{\pi}{2}\right)$, then the value of

$$\frac{\int_a^{2nk+a} \left|\sin\left(\frac{\pi x}{2k}\right)\right| f'(x)dx}{\int_0^{2k} \cos\left(\frac{\pi x}{2k}\right) f(x)dx}$$ is

(A) 0 (B) $n\pi$

(C) $-n\pi$ (D) $-\frac{n\pi}{2k}$

7. The domain of the function $f(x) = \cos^{-1}(\sec(\cos^{-1}x)) + \sin^{-1}(\text{cosec}(\sin^{-1}x))$ is

(A) $x \in R$ (B) $x = 1, -1$

(C) $-1 \le x \le 1$ (D) $x \in \phi$

8. Let f(x) be a polynomial one-one function such that $f(x)\, f(y) + 2 = f(x) + f(y) + f(xy) \ \forall\ x, y \in R - \{0\}$, $f(1) \ne 1$, $f'(1) = 3$. Let $g(x) = \frac{x}{4}(f(x)+3) - \int_0^x f(x)dx$, then

(A) g(x) = 0 has exactly one root for $x \in (0, 1)$ (B) g(x) = 0 has exactly two roots for $x \in (0, 1)$

(C) $g(x) \ne 0 \ \forall\ x \in R - \{0\}$ (D) $g(x) = 0 \ \forall\ x \in R - \{0\}$

Space for rough work

Multiple Correct Answer(s) Type

This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

---

9. Let $f(x) = \dfrac{\left(x+\frac{1}{x}\right)^6 - \left(x^6+\frac{1}{x^6}\right) - 2}{\left(x+\frac{1}{x}\right)^3 + \left(x^3+\frac{1}{x^3}\right)}$ then

(A) range of f(x) is $R - (-6, 6)$ (B) f(x) is increasing $\forall x \in (1, \infty)$

(C) f(x) is decreasing $\forall x \in (-\infty, -1)$ (D) range of f(x) is $R - \{0\}$

10. Let f(x) and g(x) are two periodical functions then which of the following may be periodic

(A) f(x) g(x) (B) f(x) + g(x)

(C) f(x) – g(x) (D) f(g(x))

11. If $f(x) = \int_1^x \frac{\ln t}{1+t}\,dt$, then

(A) $f\left(\frac{1}{x}\right) = -\int_1^x \frac{\ln t}{t(1+t)}\,dt$ (B) $f\left(\frac{1}{x}\right) = \int_1^x \frac{\ln t}{t(1+t)}\,dt$

(C) $f(x) + f\left(\frac{1}{x}\right) = 0$ (D) $f(x) + f\left(\frac{1}{x}\right) = \frac{1}{2}(\ln x)^2$

12. The point of inflection for the curve $y = \frac{x+1}{x^2+1}$ is

(A) $\left(-2-\sqrt{3},\ \frac{-\sqrt{3}-1}{4}\right)$ (B) $\left(-2+\sqrt{3},\ \frac{-1-\sqrt{3}}{4}\right)$

(C) $\left(-2+\sqrt{3},\ \frac{1+\sqrt{3}}{4}\right)$ (D) (1, 1)

Space for rough work

SECTION - B

Matrix – Match Type

*This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

---

1. Matching Column I with Column II:

	Column – I		Column – II
(A)	$\lim_{x\to 0}\left(\frac{ae^x - b}{x}\right) = 2$, then a + b is equal to	(p)	–1
(B)	$\lim_{x\to 0}(\cos 2kx)^{\cot^2(x/k)} = e^{-2}$, then k is	(q)	3
(C)	$\lim_{x\to 0}\left(1 + ax + bx^2\right)^{1/x} = e^2$, then b is	(r)	4
(D)	$\lim_{x\to 0^-}[x]\cos(2\pi[x])$ is equal to (where [.] denotes greatest integer function)	(s)	1

2. Matching Column I with Column II:

	Column – I		Column – II
(A)	The area of the figure bounded by y = x^2 and y = $\sqrt{x}$ is	(p)	4/3
(B)	$\int_0^4 \left\{\sqrt{x}\right\} dx$ has the value ({x} denotes fractional part of x}	(q)	5/3
(C)	The area of the region for which 0 < y < 3 – 2x – x^2 and x > 0 is	(r)	7/3
(D)	$\int_{-\pi/2}^{\pi/2} \sqrt{\cos x - \cos^3 x}\ dx$ equals	(s)	1/3

Space for rough work

SECTION –C

Integer Answer Type

This section contains **6 questions.** The answer to each question is a **single digit integer**, ranging from 0 to 9 (both inclusive).

---

1. The number of solutions of $x + \int_0^x \ln t\,dt = \frac{x^2}{3}$, $(x \in R^+)$ is __________

2. If $g : D \to R$ be a function such that $g(x) = \underbrace{\ln \ln \ln \ln ....\ln}_{\text{(n times)}}(4(x^2 + x + 1) + \sin(\pi x))$, $(n \in N)$, then the least value of n for which g becomes onto, is __________

3. The number of points of discontinuity of f (x) in [0, 2] where $f(x) = \begin{cases} [\cos \pi x], & x \le 1 \\ |2x - 3|[x - 2], & x > 1 \end{cases}$, ([.] denotes the greatest integer function), are __________

4. The area bounded by curves $y = \left[6 + x\left[\frac{1}{x}\right]\right]$, $y^2 - 18x + 18 = 0$ and $6x - 5y - 6 = 0$, (where [.] denotes the greatest integer function) is A, then $\frac{2A}{11}$ _________

5. The number of integral values of a ; $a \in (6, 100)$ for which the equation $[\tan x]^2 + \tan x - a = 0$ has real roots; where [.] denotes greatest integer function is _________

6. The value of $\frac{8\sqrt{2}}{\pi}\int_0^1 \left(\frac{1 - x^2}{1 + x^2}\right)\frac{dx}{\sqrt{1 + x^4}}$ is _________

Space for rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE(Advanced)-2014**

ANSWERS, HINTS & SOLUTIONS

PART TEST-III

PAPER -2

ANSWERS KEY

	PHYSICS	CHEMISTRY	MATHEMATICS
Q. No.	ANSWER	ANSWER	ANSWER
1.	B	A	A
2.	B	C	D
3.	A	A	D
4.	D	C	C
5.	B	C	C
6.	A	A	D
7.	A	B	B
8.	A	B	D
9.	A, B, C	A, B, D	A, B, C
10.	A, B, C, D	A, C	A, B, C, D
11.	A, B, C	B, C, D	B, D
12.	A, B, C, D	C, D	A, C, D
1.	(A) → (p) (B) → (q) (C) → (q) (D) → (s)	(A) → (r) (B) → (s) (C) → (p) (D) → (q)	(A) → (r) (B) → (p, s) (C) → (p, q, r, s) (D) → (p)
2.	(A) → (q) (B) → (p) (C) → (r) (D) → (s)	(A) → (s) (B) → (r) (C) → (t) (D) → (p)	(A) → (s) (B) → (r) (C) → (q) (D) → (p)
1.	2	6	2
2.	2	3	3
3.	1	4	3
4.	2	4	2
5.	0	9	7
6.	1	3	2

Physics PART – I

SECTION – A

2. Potential energy will be finite and maximum at x = 0.

5. $B_1 - B_2 = 20\ \mu T$, $B_1 + B_2 = 50\ \mu T$ and $B \propto i$

6. Use $\tau = \vec{M} \times \vec{B}$

7. Use symmetry arguments. Net $\vec{B}$ will be perpendicular to the plane of the loop

9. Use Kirchoff's law and concept of symmetry as well.

10. $\frac{v}{u} = 3$

$\frac{1}{v} - \frac{1}{u} = 1/f$

f = 30 cm

11. $\sin\beta / 2 = \sin\alpha / 2\sqrt{\frac{q_1}{q_2}}$

SECTION –C

1. $R_{eq} = 1\Omega$

$I_{max} = \frac{4v}{1+1} = 2\text{ Amp}$

2. $E = \frac{1}{2}CV^2 = \frac{1}{2}\alpha\beta t^3$

$\frac{dE}{dt}\alpha\ t^2$

3. Torque = NABI sin θ

Max Torque = NABI for $\theta = 90°$

For a coil of given length L

Radius = $L/2\pi N$

Area = π(radius) = $\pi \times \frac{L^2}{4\pi^2 N^2}$

Torque = $NBI\frac{\pi L^2}{4\pi^2 N^2}$

Torque $\alpha\ \frac{I}{N}$

$\therefore$ Smallest value of N for max Torque is n = 1

4. $E = \frac{1}{2}CV^2 = \frac{1}{2}\alpha\beta t^3$

$\frac{dE}{dt}\alpha\ t^2$

5. The two loops produce equal and opposite magnetic fields.

6. Capacitor is directly connected with 1 V cell in parallel to it

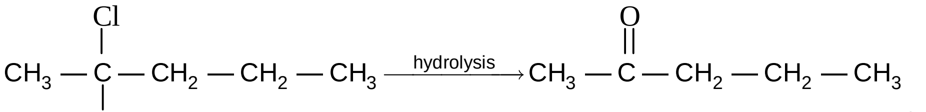
$\therefore$ Q = CV = 1 × 1 = 1 μC.

Chemistry

PART – II

SECTION – A

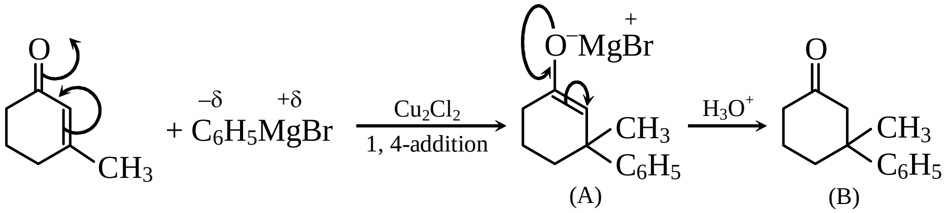
1.



$$CH_3-\underset{Cl}{\overset{Cl}{C}}-CH_2-CH_2-CH_3 \xrightarrow{\text{hydrolysis}} CH_3-\overset{O}{\overset{\|}{C}}-CH_2-CH_2-CH_3$$

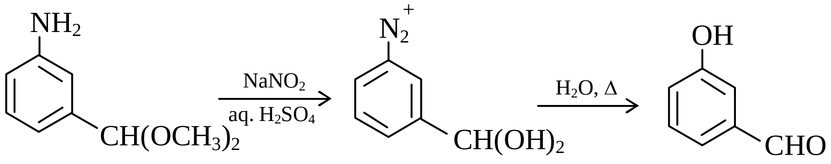
(gives positive iodoform test but does not give Fehling's test)

2.



3. Due to neighbouring group participation of OEt group.

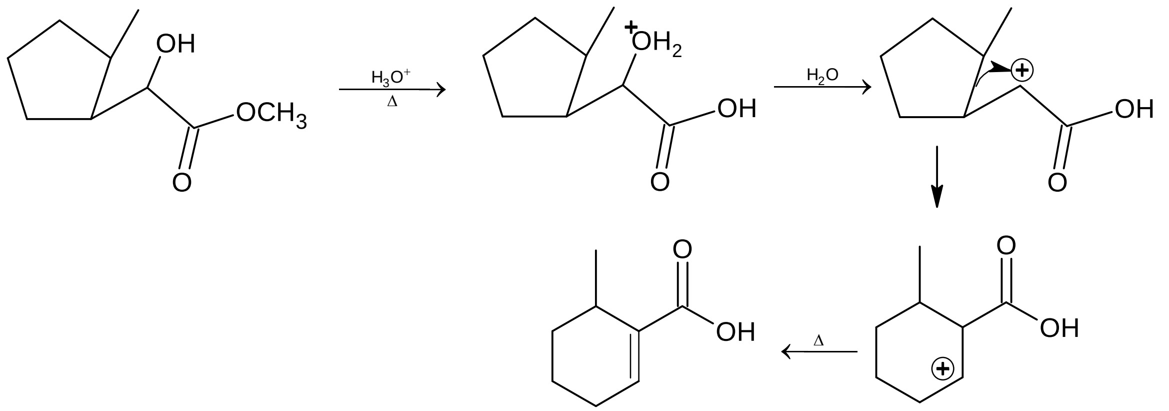
4.



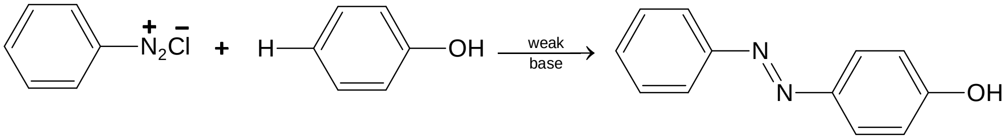
5. $2CuO + C \xrightarrow{\Delta} 2Cu + CO_2\uparrow$

6. In polystyrene the monomeric unit is styrene which is having the formula of $H_2C=CH—C_6H_5$.

7.

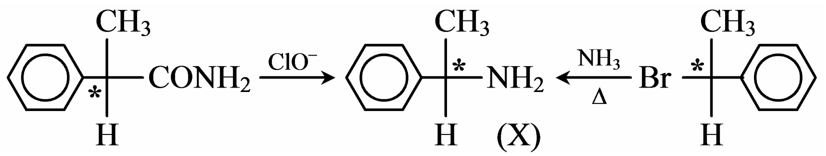


8.

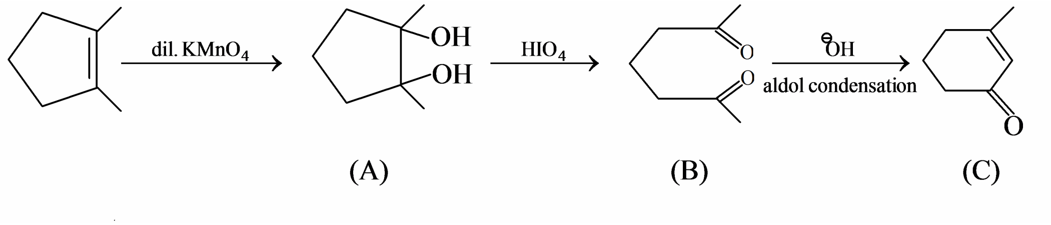


9. Galactose is empimer of D-(+)-glucose. It is monomer.

11.

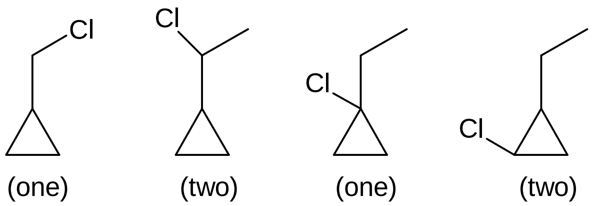

CH3
CONH2
H
ClO⁻
CH3
NH2
H
(X)
NH3
Δ
CH3
Br
H

12.


dil. KMnO4
OH
OH
HIO4
O
O
OH
aldol condensation
O
(A)
(B)
(C)

SECTION – C

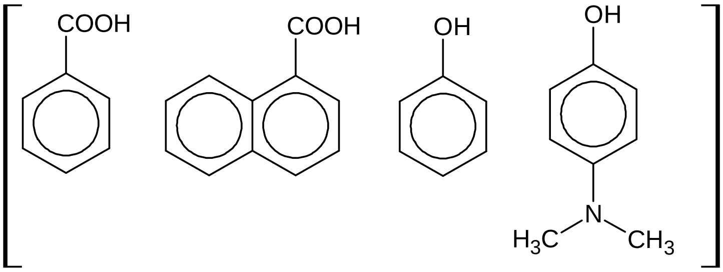
1.


Cl
Cl
Cl
Cl
(one)
(two)
(one)
(two)

2. One with keto and two with ester group (lactone).

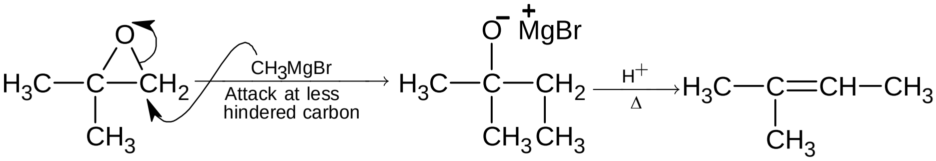
3. All are stereoisomers.

4.

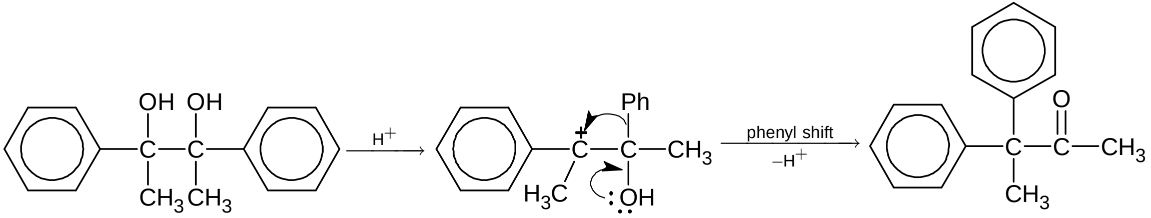

COOH
COOH
OH
OH
N
H3C
CH3

are soluble in alkalies.

5.


O
H3C—C—CH2
CH3
CH3MgBr
Attack at less hindered carbon
O⁻ MgBr⁺
H3C—C—CH2
CH3 CH3
H⁺
Δ
H3C—C=CH—CH3
CH3

6. Pinacol-Pinacolone rearrangement reaction.
The migratory aptitude is H > Ar > R.


OH OH
C—C
CH3 CH3
H⁺
Ph
C—C—CH3
H3C
OH
phenyl shift
–H⁺
O
C—C—CH3
CH3

Mathematics PART – III

SECTION – A

1. $f'(x) = -\frac{1}{2}\left(a^2 - 3a + 2\right)\sin\frac{x}{2} + (a-1) \neq 0$

$\Rightarrow (a - 1)\left(1 - \frac{(a-2)\sin x/2}{2}\right) \neq 0$

$\Rightarrow a \in (0, 1) \cup (1, 4)$

2. $f'(x) = \frac{-2x}{x^2 + x + 1} + b^2 - 5b + 4 < 0$

$\Rightarrow b^2 - 5b + 4 < \frac{2x}{x^2 + x + 1}$

$\Rightarrow b^2 - 5b + 4 < -2 \Rightarrow b \in (2, 3)$

3. PR $\leq$ PQ

$\Rightarrow (h - a)^2 + k^2 = (a - k)^2$

$\Rightarrow y \leq x - \frac{x^2}{2a}$

$\Rightarrow$ required area = $\int_0^{2a}\left(x - \frac{x^2}{2a}\right)dx = \frac{2a^3}{3}$

4. $y^2 = a^2 - b^2\cos^2(\ln x) \Rightarrow 2y\frac{dy}{dx} = 2b^2\cos(\ln x)\sin(\ln x)\cdot\frac{1}{x}$

$\therefore\ x^2y^2\left(\frac{dy}{dx}\right)^2 = b^4\cos^2(\ln x)\sin^2(\ln x) = b^4\left(\frac{a^2 - y^2}{b^2}\right)\left(1 - \frac{a^2 - y^2}{b^2}\right)$

5. Using approximations

$$L = \lim_{x\to 0}\frac{\frac{\sin^2 x}{3} + \frac{2\tan x}{4}}{\sin x + \tan^2 x} = \lim_{x\to 0}\frac{\frac{x^2}{3} + \frac{2x}{4}}{x + x^2} = \lim_{x\to 0}\frac{x\left(\frac{x}{3} + \frac{1}{2}\right)}{x(1 + x)} = \frac{1}{2}$$

6. $f'(x + 2k) = f'(x)$, hence $f'(x)$ is periodic with period as $2k$

$$\Rightarrow \int_a^{2nk+a}\left|\sin\left(\frac{\pi x}{2k}\right)\right|f'(x)dx = \int_0^{2nk}\left|\sin\left(\frac{\pi x}{2k}\right)\right|f'(x)dx$$

$$= n\int_0^{2k}\left|\sin\left(\frac{\pi x}{2k}\right)\right|f'(x)dx = \frac{-n\pi}{2k}\int_0^{2k}\cos\left(\frac{\pi x}{2k}\right)f(x)dx$$

7. $f(x) = \cos^{-1}(\sec(\cos^{-1}x)) + \sin^{-1}(\text{cosec}(\sin^{-1}x))$

$\Rightarrow -1 \leq \sec(\cos^{-1}x) \leq 1$ and $-1 \leq \text{cosec}(\sin^{-1}x) \leq 1$

$\Rightarrow \sec(\cos^{-1}x) = \pm 1$ and $\text{cosec}(\sin^{-1}x) = \pm 1$

$\Rightarrow \cos^{-1}x = 0, \pi$ and $\sin^{-1}x = \frac{\pi}{2}, -\frac{\pi}{2}$

$\Rightarrow x = \pm 1$ and $x = \pm 1 \Rightarrow$ domain is $x = \pm 1$

8. Put $x = y = 1 \Rightarrow f(1) = 2$

Put $y = \frac{1}{x} \Rightarrow f(x) + f\left(\frac{1}{x}\right) = f(x)\ f\left(\frac{1}{x}\right)$

$\Rightarrow f(x) = x^3 + 1$
$\Rightarrow g(x) = 0 \ \forall\ x \in R - \{0\}$

9. If we simplify, we get $f(x) = 3\left(x + \frac{1}{x}\right)$.

11. $$f\left(\frac{1}{x}\right) = \int_1^{1/x} \frac{\ln t}{(1+t)}dt = \int_1^x \frac{-\ln u}{\frac{1+u}{u}} \times \frac{-1}{u^2}du = \int_1^x \frac{\ln t}{t(1+t)}dt$$

Now, $$f(x) + f\left(\frac{1}{x}\right) = \int_1^x \frac{\ln t}{(1+t)}\left(1+\frac{1}{t}\right)dt = \int_1^x \frac{\ln t}{t}dt = \left[\frac{(\ln t)^2}{2}\right]_1^x = \frac{(\ln x)^2}{2}$$

12. $$\frac{dy}{dx} = \frac{-x^2 - 2x + 1}{\left(x^2+1\right)^2} \text{ and } \frac{d^2y}{dx^2} = \frac{2x^3 + 6x^2 - 6x - 2}{\left(x^2+1\right)^3}$$

$\frac{d^2y}{dx^2}$ is 0 at three points which are the roots of the equation $x^3 + 3x^2 - 3x - 1 = 0$

i.e. $-2 - \sqrt{3}$, $-2 + \sqrt{3}$, 1.

Checking the sign of $\frac{d^2y}{dx^2}$ in the neighbourhood of these points, all these are the point of inflection.

SECTION – B

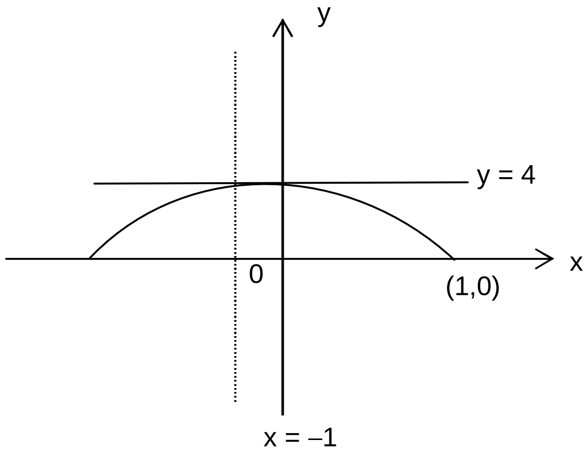
2. (A). Required area = $\int_0^1 \left(\sqrt{x} - x^2\right) dx = 1/3$

(B). $\int_0^4 \left\{\sqrt{x}\right\} dx = \int_0^4 \left(\sqrt{x} - \left[\sqrt{x}\right]\right) dx = \int_0^4 \sqrt{x}\, dx - \int_0^1 \left[\sqrt{x}\right] dx - \int_1^4 \left[\sqrt{x}\right] dx = 7/3$

(C). Area = $\int_0^1 \left(3 - 2x - x^2\right) dx$

$= \left[3x - x^2 - \frac{x^3}{3}\right]_0^1$

$= 5/3$



(D). $2\int_0^{\pi/2} \sqrt{\cos x}\ \sin x\, dx = 4/3$

SECTION–C

1. $t\ln t - t\Big|_0^x + x = \frac{x^2}{3} \Rightarrow \ln x = \frac{x}{3}$.

Now equation of tangent of the slope $\frac{1}{3}$ to the curve y = ln x at (3, ln 3) is

$y - \ln 3 = \frac{1}{3}(x-3) \Rightarrow y = \frac{1}{3}x + (\ln 3 - 1)$.

As, $\ln 3 - 1 > 0$, this tangent is above the line $y = \frac{x}{3}$.

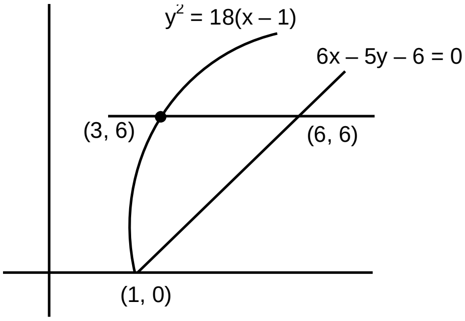
So the line $y = \frac{x}{3}$ will cut $y = \ln x$ at two distinct points.

2. $4x^2 + 4x + 4 + \sin(\pi x) = (2x+1)^2 + \sin(\pi x) + 3 \geq 2$.
Now as $1 < 2 < e$, the required value of n is 3.

3. The function is discontinuous at $x = 0, \frac{1}{2}$ and 2.

4. If $x > 1$
$y = 6$ …(1)
$y^2 = 18(x-1)$ …(2)
(1) and (2) intersect at (3, 6).
Intersection of $y^2 - 18x + 18 = 0$ and $6x - 5y - 6 = 0$ is (6, 6)

$$A = \int_1^3 \left\{\sqrt{18(x-1)} - \frac{6}{5}(x-1)\right\}dx + \int_3^6 \left\{6 - \frac{6}{5}(x-1)\right\}dx$$
= 11.



5. $[\tan x]^2 + \tan x - a = 0$
$\because [\tan x]^2$ and a are integral in nature $\Rightarrow$ tan x is integer.
$\Rightarrow$ equation reduces to $\tan^2 x + \tan x - a = 0$
$\Rightarrow \tan x(\tan x + 1) = a$
$\therefore$ a is product of consecutive integer
Here a = 12, 20, 30, 42, 56, 72, 90
$\Rightarrow$ a has 7 values.

6. Let $\cos\theta = \frac{\sqrt{1+x^4}}{1+x^2}$, we get

$$-\sin\theta\frac{d\theta}{dx} = \frac{2x^3}{(1+x^2)\left(1+x^4\right)} - \frac{2x\sqrt{1+x^4}}{(1+x^2)^2} = \frac{2x^3(1+x^2) - 2x(1+x^4)}{(1+x^2)^2\sqrt{1+x^4}}$$

$$= \frac{-2x(1-x^2)}{(1+x^2)^2\sqrt{1+x^4}} = \frac{1-x^2}{(1+x^2)\sqrt{1+x^4}}dx = \left(\frac{1+x^2}{2x}\right)\sin\theta\, d\theta$$

The factor on the right can be put in terms of θ as follows

$$\frac{1+x^2}{2x} = \frac{1+x^4+2x^2}{4x^2} = \left(\frac{\sqrt{1+x^4}}{2x}\right)^2 + \frac{1}{2} = \left(\left(\frac{1+x^2}{2x}\right)\cos\theta\right)^2 + \frac{1}{2}$$

$$\Rightarrow \left(1-\cos^2\theta\right)\left(\frac{1+x^2}{2x}\right)^2 = \frac{1}{2} \Rightarrow \frac{1+x^2}{2x} = \frac{1}{\sqrt{2}\sin\theta}$$

$\therefore$ the given integral becomes

$$\frac{8\sqrt{2}}{\pi}\int_0^{\pi/4}\frac{\sin\theta\, d\theta}{\sqrt{2}\sin\theta} = \frac{8\sqrt{2}}{\pi}\cdot\frac{1}{\sqrt{2}}\int_0^{\pi/4}d\theta = \frac{8\sqrt{2}}{\pi}\cdot\frac{1}{\sqrt{2}}\frac{\pi}{4} = 2$$

FIITJEE **JEE (Main), 2014**

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PART TEST – III

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 03 and 10 to 12)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (04 to 09 and 13 to 30) contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

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Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

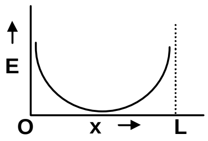
SECTION – A

Single Correct Choice Type

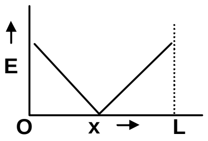
This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. Two identical point charges are placed at a separation of L. P is a point on the line joining the charges, at a distance x from any one charge. The field at P is E. E is plotted against x for values of x from close to zero to slightly less than L. Which of the following best represents the resulting curve?

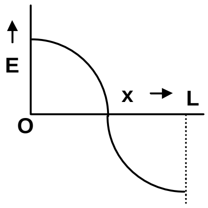
(A)



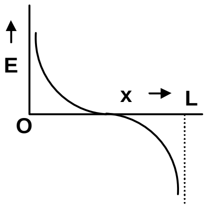
(B)



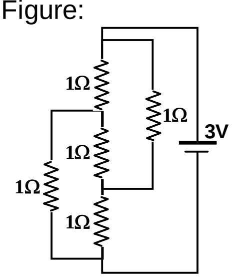
(C)



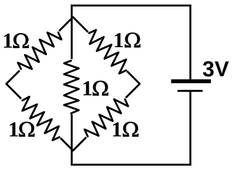
(D)



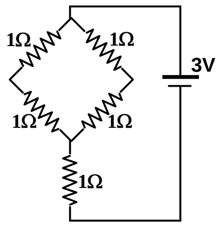
2. Figure shows three resistor configurations R1, R2 and R3 connected to 3V battery. If the power dissipated by the configuration R1, R2 and R3 is P1, P2 and P3, respectively, then
Figure:



R1



R2



R3

(A) P1 > P2 >P3
(B) P1 > P3 >P2
(C) P2 > P1 >P3
(D) P3 >P2 > P1

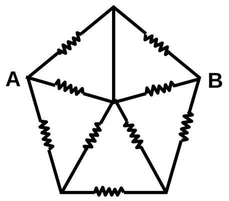
Space for rough work

3. A large sheet carries uniform surface charge density σ. A rod of length 2ℓ has a linear charge density λ on one half and $-\lambda$ on the other half. The rod is hinged at mid point O and makes θ with the normal to the sheet. The torque experienced by the rod is

(A) $\frac{\sigma\lambda\ell^2}{2\varepsilon_0}\cos\theta$ (B) $\frac{\sigma\lambda\ell}{2\varepsilon_0}\cos^2\theta$

(C) $\frac{\sigma\lambda\ell^2}{2\varepsilon_0}\sin\theta$ (D) $\frac{\sigma\lambda\ell}{2\varepsilon_0}\sin^2\theta$

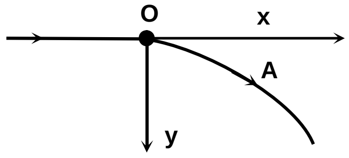
4. The effective resistance between A & B of the shown network. Where resistance of each resistor is R, is



(A) $\frac{8R}{11}$ (B) $\frac{6R}{11}$

(C) $\frac{6R}{5}$ (D) none of these

5. A positively charge moving along the positive x-direction with a speed v traces a non-linear trajectory OA in the x-y plane after passing O as shown in the figure. The combination of electric ($\vec{E}$) and magnetic field ($\vec{B}$) fields that would lead to the trajectory OA is (a, b, c are non-zero positive constants),



(A) $\vec{E} = 0$; $\vec{B} = a\hat{i} + c\hat{k}$ (B) $\vec{E} = a\hat{i}$; $\vec{B} = b\hat{j} + c\hat{k}$

(C) $\vec{E} = 0$; $\vec{B} = b\hat{j} + c\hat{k}$ (D) $\vec{E} = a\hat{i}$; $\vec{B} = b\hat{i} - c\hat{k}$

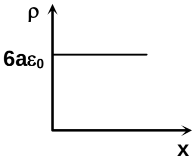
6. Current flows through a straight, thin-walled tube of radius r. The magnetic field at a distance x from the axis of the tube has magnitude B.

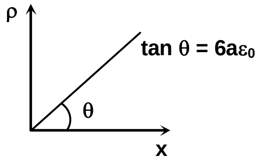
(A) $B \propto x$, for $0 < x < r$ (B) $B \propto 1/x$, for $0 < x < r$

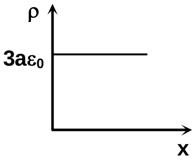
(C) $B = 0$, for $0 \le x < r$ (D) $B = 0$, only for $x = 0$

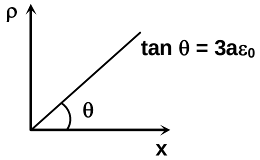
Space for rough work

7. The electric field in a certain region of space depends only on the x-coordinate as $E = 3ax^2$, where a is a constant. Then choose the correct curve, which is giving the variation of volume charge density (ρ) in the region as a function of x.

(A)


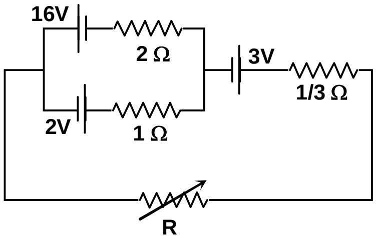
(B)


(C)


(D)


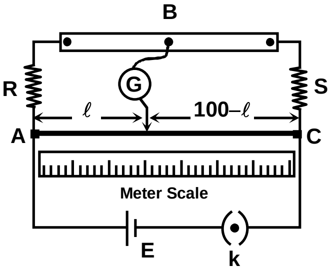
8. Three cells of emf 16V, 2V and 3V and internal resistance 2Ω, 1 Ω and ½ Ω respectively are connected with an unknown resistance R as shown in the figure. What is the value of R such that power developed through R is maximum in steady state condition.

(A) ½ Ω
(B) 1Ω
(C) 2 Ω
(D) Cannot be determined



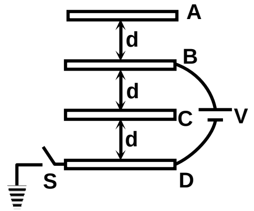
9. In a meter bridge, the null point is found at a distance of 40 cm from A. If now a resistance of 12 Ω is connected in parallel with S, the null point occurs at 60 cm from A. Determine the value of R.

(A) 15 Ω (B) 12 Ω
(C) 10 Ω (D) 5 Ω



Space for rough work

10. Find the charge flown when the switch S is closed.

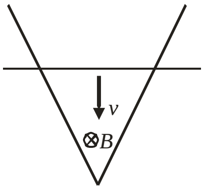


(A) zero
(B) $\frac{\varepsilon_0 A}{d}V$
(C) $\frac{3}{2}\frac{\varepsilon_0 A}{d}V$
(D) $\frac{\varepsilon_0 A}{2d}V$

11. A particle of mass m and charge q is located midway between two fixed charged particles each having a charge q and at a distance 2L apart so that distance of this charge from each charge located at end is L. Assuming that the middle charge moves along the line joining the fixed charges. The frequency of oscillation when it is displaced slightly is

(A) $\frac{q}{\pi\sqrt{m\pi\varepsilon_0 L^3}}$
(B) $\frac{q}{4\pi\sqrt{m\pi\varepsilon_0 L^3}}$
(C) $\frac{2q}{\pi\sqrt{m\pi\varepsilon_0 L^3}}$
(D) $\frac{q}{2\pi\sqrt{m\pi\varepsilon_0 L^3}}$

12. A wire is bent in form of a V shape and placed in a horizontal plane. There exists a uniform magnetic field B perpendicular to the plane of the wire. A uniform conducting rod starts sliding over the V shaped wire with a constant speed v as shown in the figure. If the wire has uniform resistance, the current in the rod will

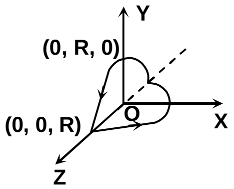


(A) Increase with time
(B) Decrease with time
(C) Remain constant
(D) Always be zero.

13. In non-uniform magnetic field in certain direction, current loop is placed
(A) net force and net torque on loop is zero.
(B) net force may be zero but net torque is non zero.
(C) net torque may be zero but net force is non zero.
(D) neither net force nor net torque is zero.

Space for rough work

14. A circular coil of radius R is folded across its diameter such that the planes of two half rings are perpendicular to each other as shown in the figure. If the current through the coil is I, calculate the magnetic dipole moment of the configuration so formed.

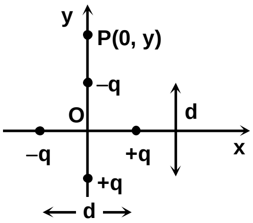


(A) $\frac{\pi R^2 I}{2}(\hat{i}+\hat{j})$
(B) $\frac{\pi R^2 I}{2}(\hat{i}+\hat{k})$
(C) $\frac{\pi R^2 I}{2}(\hat{j}+\hat{k})$
(D) $\frac{\pi R^2 I}{4}(\hat{i}+\hat{j})$

15. A particle of mass m and charge q moves at high speed along the x-axis. It is initially near x = $-\infty$ and it ends up near x = $+\infty$. A second charge Q is fixed at the point x = 0, y = –d. As the moving charge passes the stationary charge, its x component of velocity does not change appreciably, but it acquires a small velocity in y-direction. Determine the angle through which the moving charge is deflected

(A) $\theta = \tan^{-1}\left(\frac{qQ}{2\pi\varepsilon_0 dmv^2}\right)$
(B) $\theta = \sin^{-1}\left(\frac{qQ}{2\pi\varepsilon_0 dmv^2}\right)$
(C) $\theta = \tan^{-1}\left(\frac{qQ}{4\pi\varepsilon_0 dmv^2}\right)$
(D) $\theta = \sin^{-1}\left(\frac{qQ}{4\pi\varepsilon_0 dmv^2}\right)$

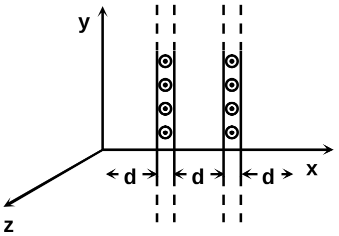
16. Two positive and two negative charges are kept in x-y plane in free space as shown in the figure. The magnitude of electric field due to the system of charges at a point P(0, y) will be ($y \gg d$)



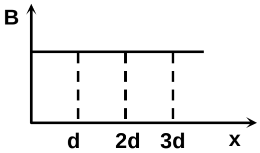
(A) $\frac{\sqrt{5}qd}{4\pi\varepsilon_0 y^3}$
(B) $\frac{2dq}{4\pi\varepsilon_0 y^3}$
(C) $\frac{dq}{4\pi\varepsilon_0 y^3}$
(D) $\frac{3dq}{4\pi\varepsilon_0 y^3}$

Space for rough work

17. Two large conducting planes perpendicular to x-axis are placed at (d, 0) and (2d, 0) as shown in the figure. Current per unit width in both the planes is same and current is flowing in the outward direction. The variation of magnetic field as function of $x(0 \leq x \leq 3d)$ is best represented by



(A)



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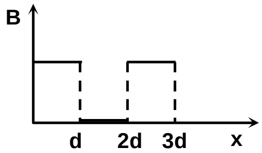
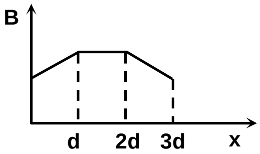
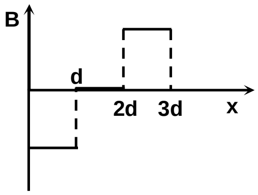


(C)



(D)



18. The current density in a wire of radius a varies with radial distance r as $J = \frac{J_0 r^2}{a}$, where J_0 is a constant. Choose the incorrect statement.

(A) Total current passing through the cross-section of the wire is $I = \frac{\pi J_0 a^3}{2}$

(B) Total current passing through the cross-section of the wire is $I = \frac{3\pi J_0 a^3}{2}$

(C) The field at a distance r > a is $B = \frac{\mu_0 J_0 a^3}{4r}$

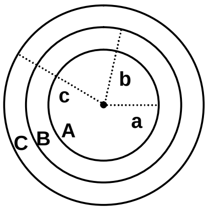
(D) The field at a distance r < a is $B = \frac{\mu_0 J_0 r^3}{4a}$

19. A washer is made of metal having resistivity $10^{-7}\Omega$M. The washer has inner radius 1 cm, outer radius 3 cm and thickness 1 mm. A magnetic field, oriented normal to the plane of the washer, has the time dependent magnitude $B = (2t)$ tesla/sec. Find the current (in ampere) around the washer.

(A) 2 Amp
(B) 4 Amp
(C) 6 Amp
(D) 8 Amp

Space for rough work

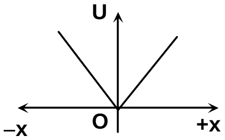
20. Three concentric charged metallic spherical shells A, B and C have radii a, b and c; charge densities σ, $-\sigma$ and σ; and potentials V_A, V_B and V_C respectively. Then which of the following relations is correct?



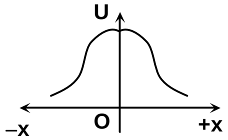
(A) $V_A = \frac{(a+b+c)\sigma}{\varepsilon_0}$
(B) $V_B = \frac{[(a^2/b)-b+c]\sigma}{\varepsilon_0}$
(C) $V_C = \frac{[(a^2+b^2)/c+c]\sigma}{\varepsilon_0}$
(D) $V_A = V_B = V_C = \frac{(a-b+c)\sigma}{\varepsilon_0}$

21. Four identical charges are placed at the four vertices of a square lying in YZ plane. A fifth charge is moved along X axis. The variation of potential energy (U) along X axis is correctly represented by

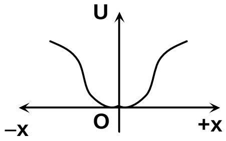
(A)



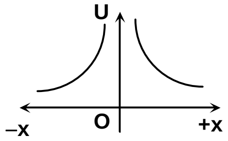
(B)



(C)



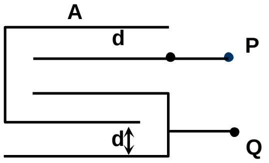
(D)



22. Two resistances 300 ohm and 400 ohm are connected in series with a 60 volt supply. A voltmeter connected across 400 ohm reads 30V. The same voltmeter when connected across the other resistance will read.

(A) 22.5 V
(B) 50 V
(C) 30 V
(D) 10 V

23. The equivalent capacitance between P and Q in the figure is (area of each plate is A and separation between two consecutive plates is d)

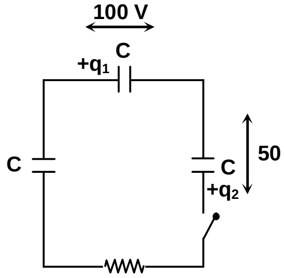


(A) $\frac{A\varepsilon_0}{2d}$
(B) $\frac{3A\varepsilon_0}{2d}$
(C) $\frac{2A\varepsilon_0}{d}$
(D) $\frac{5}{3}\frac{A\varepsilon_0}{d}$

Space for rough work

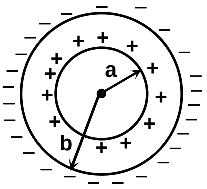
24. Two long parallel straight conductors carry currents i_1 and i_2 ($i_1 > i_2$). When the current are in the same direction, the magnetic field at a point midway between the wires is 20 μT. If the direction of i_2 is reversed, the field becomes 50 μT. the ratio of the currents i_1/i_2 is
(A) 5/2 (B) 7/3
(C) 4/3 (D) 5/3

25. Two capacitor each of capacitance C = 1 μF each charged to potential 100 V and 50 V respectively and connected across a uncharged capacitor 'C' = 1μF as shown in the figure if switch 'S' is closed then charge in the uncharged capacitor at equilibrium will be



(A) $\frac{50}{3}$ μC (B) 50 μC
(C) 25 μC (D) $\frac{100}{3}$ μC

26. There are two concentric spherical shells with inner shell having a positive charge q and outer shell having a charge –q. Now outer shell is supplied a charge –2q and inner shell is earthed. Calculate the ratio of initial and final capacities of the system. (If a = 3R, b = 5 R)



(A) 3/5 (B) 3
(C) 1 (D) 5/3

27. An infinite collection of current carrying conductor each carrying a current I outward perpendicular to paper are placed at x = a, x = 3a, x = 5a, ... ∞ on the x-axis. Another infinite collection of current carrying conductor each carrying current I inward perpendicular to paper are placed at x = 2a, x = 4a x = 6a, ... ∞ where a is a positive constant. Then the magnetic field at the origin due to the above collection of current carrying conductor is
(A) zero (B) $\frac{\mu_0 I}{4\pi a \ln 2}$
(C) ∞ (D) $\frac{\mu_0 I \ln 2}{2\pi a}$

Space for rough work

28. A number of resistors R_1, R_2, R_3, . . . are connected in series such that R_s is the equivalent resistance of series combination. A current I is flowing in the circuit due to a potential V applied across the circuit. V_1, V_2, V_3 . . . . are potential difference across R_1, R_2, R_3, . . . respectively. Choose the incorrect statement.

(A) Same current I will flow through each resistor

(B) $V_1 + V_2 + V_3 + \ldots = V$

(C) $V_1 = \left(\frac{R_1}{R_S}\right)V$, $V_2 = \left(\frac{R_2}{R_S}\right)V$, $V_3 = \left(\frac{R_3}{R_S}\right)V$ . . . .

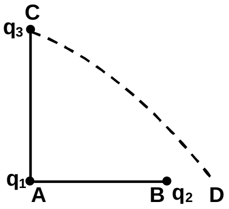
(D) $V_1 = \left(\frac{R_S}{R_1}\right)V$, $V_2 = \left(\frac{R_S}{R_2}\right)V$, $V_3 = \left(\frac{R_S}{R_3}\right)V$ . . . .

29. A soap bubble of radius R = 3 cm and thickness $t = 10^{-2}$ mm is charged to a potential of V = 0.3 volt. The bubble burst and falls as a spherical drop. Determine the potential of the drop.

(A) 3 volts. (B) 6 volts.

(C) 9 volts. (D) 12 volts.

30. Two charges q_1 and q_2 are placed 30 cm apart, as shown in the figure. A third charge q_3 is moved along the arc of a circle of radius 40 cm from C to D. The change in the potential energy of system is $\frac{kq_3}{4\pi\varepsilon_0}$, then the value of k is



(A) $8q_2$ (B) $8q_1$

(C) $6q_2$ (D) $6q_1$

Rough work

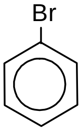
Chemistry PART – II

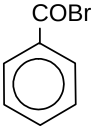
SECTION – A

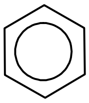
Straight Objective Type

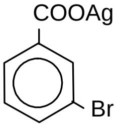
This section contains 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Silver benzoate reacts with bromine in acetone to form

(A)


(B)


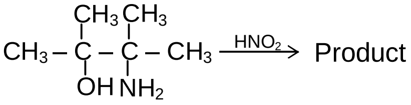
(C)


(D)


2. $RCOO^{-}Ag^{+} \xrightarrow{Br_2/CCl_4} R-Br + CO_2 + AgBr$, This is Borodine – Hunsdiecker reaction, Reaction intermediate in this reaction is

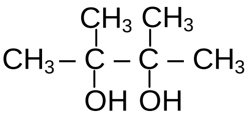
(A) Free radical
(B) Carbocation
(C) Carbene
(D) Carbanion

3. The product of the given reaction,

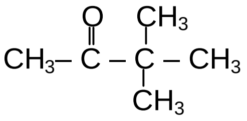


$CH_3-\overset{CH_3}{\underset{OH}{C}}-\overset{CH_3}{\underset{NH_2}{C}}-CH_3 \xrightarrow{HNO_2} \text{Product}$

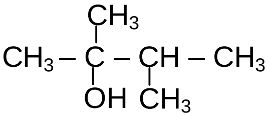
is

(A)


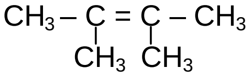
$CH_3-\overset{CH_3}{\underset{OH}{C}}-\overset{CH_3}{\underset{OH}{C}}-CH_3$

(B)


$CH_3-\overset{O}{\overset{\|}{C}}-\overset{CH_3}{\underset{CH_3}{C}}-CH_3$

(C)


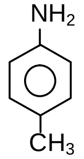
$CH_3-\overset{CH_3}{\underset{OH}{C}}-\underset{CH_3}{CH}-CH_3$

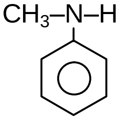
(D)


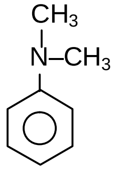
$CH_3-\underset{CH_3}{C}=\underset{CH_3}{C}-CH_3$

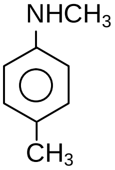
Space for rough work

4. Which of the following amine will show carbylamine reaction?

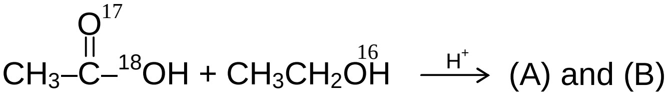
(A)


(B)


(C)


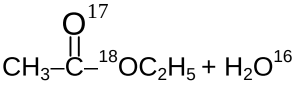
(D)


5. Consider the reaction,

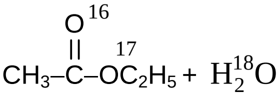


$$CH_3-\overset{\overset{O^{17}}{||}}{C}-{}^{18}OH + CH_3CH_2\overset{16}{O}H \xrightarrow{H^+} (A) \text{ and } (B)$$

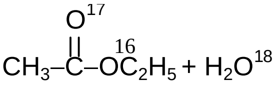
(A) and (B) respectively are

(A)


$CH_3-\overset{\overset{O^{17}}{||}}{C}-{}^{18}OC_2H_5 + H_2O^{16}$

(B)


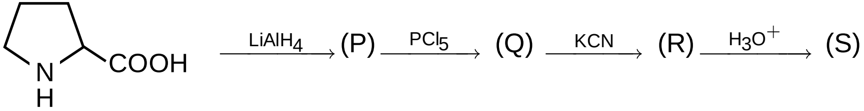
$CH_3-\overset{\overset{O^{16}}{||}}{C}-\overset{17}{O}C_2H_5 + H_2^{18}O$

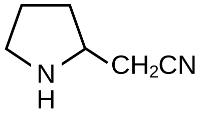
(C)


$CH_3-\overset{\overset{O^{17}}{||}}{C}-\overset{16}{O}C_2H_5 + H_2O^{18}$

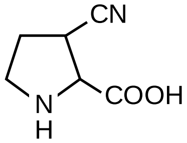
(D) Both (A) and (B)

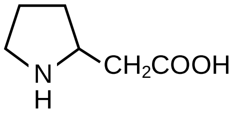
6. Predict the final product (S) formed in the following reaction sequence.


N
H
COOH
LiAlH4
(P)
PCl5
(Q)
KCN
(R)
H3O+
(S)

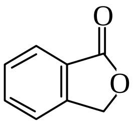
(A)


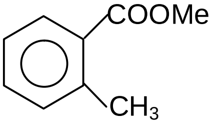
(B) $H_2N(CH_2)_3CH_2CH_2COOH$

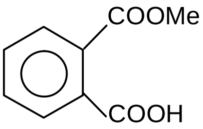
(C)


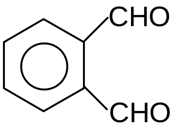
(D)


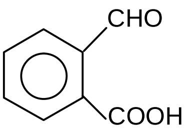
Space for rough work

7. Which of the following compound on treatment with aqueous alkali followed by acidification gives the lactone  ?

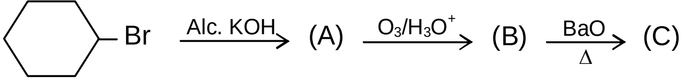
(A) 

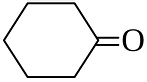
(B) 

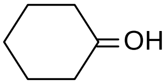
(C) 

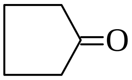
(D) 

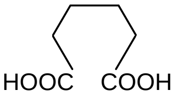
8. End product of following sequence of reaction is



(A) 

(B) 

(C) 

(D) 

9. Propyne and propene can be distinguished by

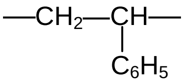
(A) conc. H_2SO_4
(B) Br_2 inCCl_4
(C) $AgNO_3$ [Ammonical]
(D) dil. $KMnO_4$

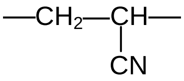
10. Identify the unknown products (A) and (B) in the given reaction:

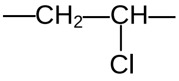
Glucose + $3C_6H_5NH–NH_2 \xrightarrow{H^{\oplus}/\Delta}$ Osazone + (A) + (B)

(A) $C_6H_5NH_2$ and NH_3
(B) $C_6H_5NH_2$ and NH_2OH
(C) $C_6H_5NH—NHOH$ and NH_3
(D) NH_2OH and H_2O

11. The repeat unit of polystyrene is

(A) 
$—CH_2—\underset{C_6H_5}{\underset{|}{CH}}—$

(B) 
$—CH_2—\underset{CN}{\underset{|}{CH}}—$

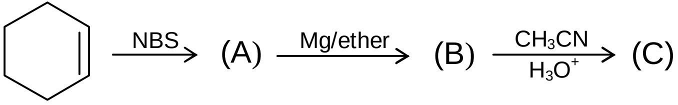
(C) 
$—CH_2—\underset{Cl}{\underset{|}{CH}}—$

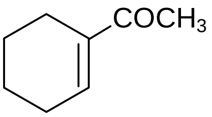
(D) $—CCl_2—CCl_2—$

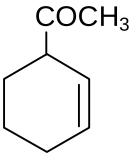
Space for rough work

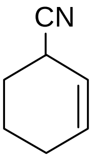
12. Buna–S rubber is a polymer of
(A) 1, 3-butadiene and styrene
(B) vinyl acetate
(C) Acrylonitrile
(D) none of these

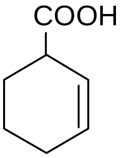
13. End product of the following sequence of reaction is:

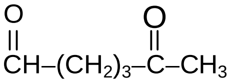

NBS
(A)
Mg/ether
(B)
CH_3CN
H_3O^+
(C)

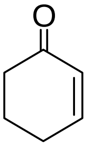
(A)


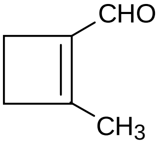
(B)


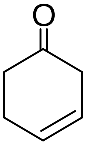
(C)


(D)


14.

$\overset{O}{\overset{\|}{C}}H\text{–}(CH_2)_3\text{–}\overset{O}{\overset{\|}{C}}\text{–}CH_3 \xrightarrow[\text{(ii) }\Delta]{\text{(i) dil. }OH^-}$ (A), compound (A) is

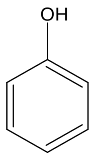
(A)


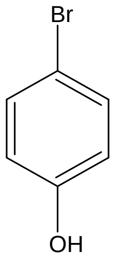
(B)


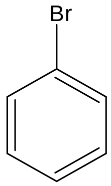
(C)


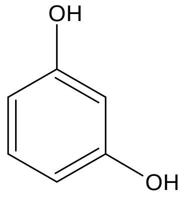
(D) None

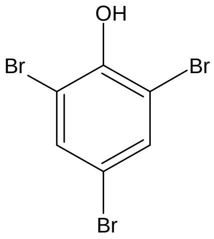
Space for rough work

15.  $+ Br_2 \xrightarrow[0^oC]{CS_2}$ A, A is

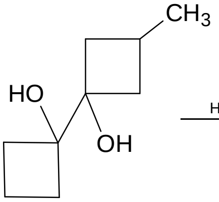
(A) 

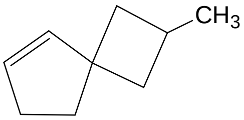
(B) 

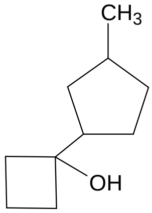
(C) 

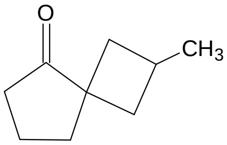
(D) 

16. The product in the following reaction is

 $\xrightarrow{H^+}$ Product

(A) 

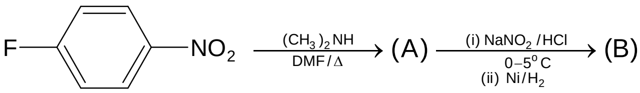
(B) 

(C) 

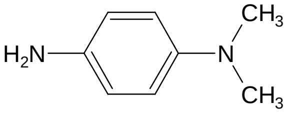
(D) None of the above

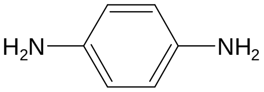
Space for rough work

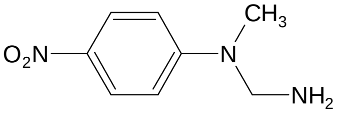
17.

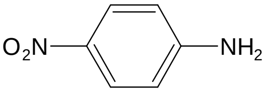

F
NO2
(CH3)2NH
DMF/Δ
(A)
(i) NaNO2/HCl
0–5°C
(ii) Ni/H2
(B)

The structure of (B) is

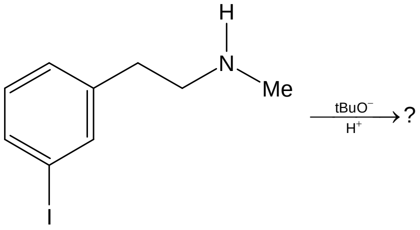
(A)

H2N
N
CH3
CH3

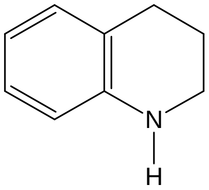
(B)


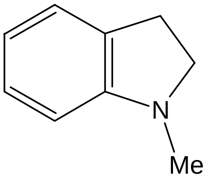
(C)

O2N
N
CH3
NH2

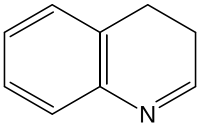
(D)


18.


H
N
Me
I
tBuO⁻
H⁺
?

(A)


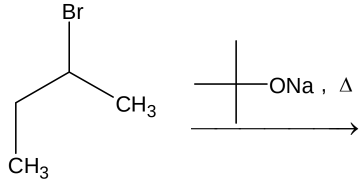
(B)


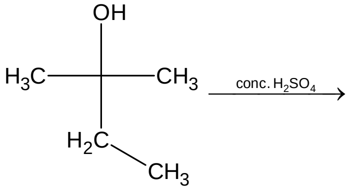
(C)


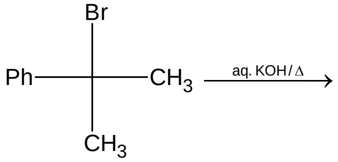
(D) All

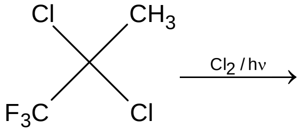
Space for rough work

19. In which reaction, product formation occurs by Saytzeff rule?

(1)


(2)


(3)


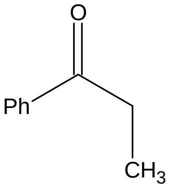
(4)


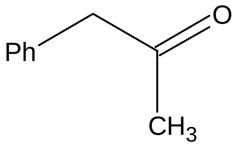
Select the correct alternative from the codes given below:
Codes:

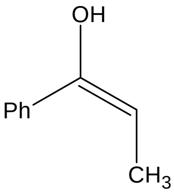
(A) 1, 2 and 3
(B) 2 and 3
(C) 1, 2 and 4
(D) 2, 3 and 4

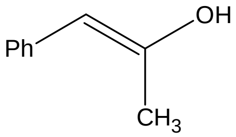
20.
$$Ph-C\equiv C-CH_3 \xrightarrow[H_2O]{Hg^{2+}/H^{+}} \underset{\text{(Major)}}{(W)}$$

(W) is

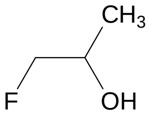
(A)


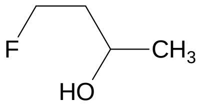
(B)


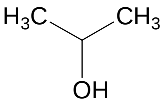
(C)


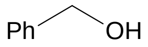
(D)


21. The order of reactivity of the following alcohols towards conc. HCl is


I


II


III

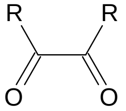

IV

(A) I > II > III > IV
(B) I > III > II > IV
(C) IV > III > II > I
(D) IV > III > I > II

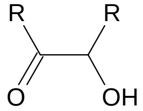
Space for rough work

22. Which of the following will be oxidized by HIO_4?

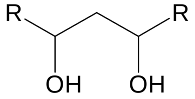
(1)



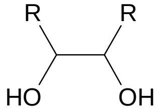
(2)



(3)



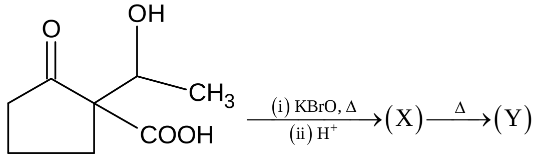
(4)



Select the correct answer using the codes below:

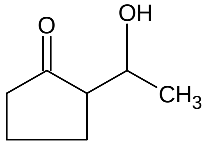
(A) 1, 2 and 3
(B) 1, 3 and 4
(C) 1, 2 and 4
(D) 2, 3 and 4

23.

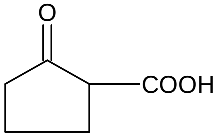


Hence the product (Y) in the above sequence of reaction is

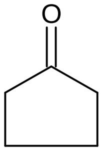
(A)



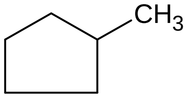
(B)



(C)



(D)

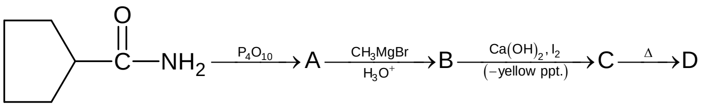


24. Osazone formation is used to characterize

(A) polymers
(B) sugars
(C) carboxylic acid
(D) alcohols

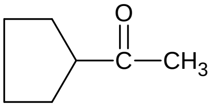
Space for rough work

25.

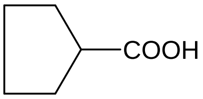

O
C
NH2
P4O10
A
CH3MgBr
H3O+
B
Ca(OH)2, I2
(−yellow ppt.)
C
Δ
D

D is

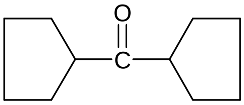
(A)



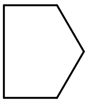
(B)



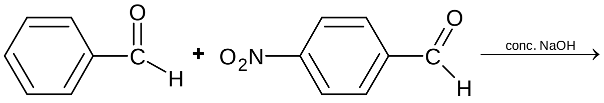
(C)



(D)

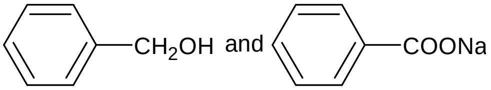


26.

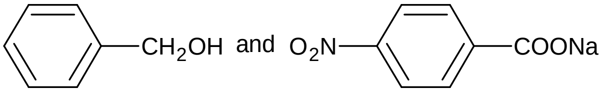

O
C
H
+
O2N
O
C
H
conc. NaOH

The products likely to be obtained are

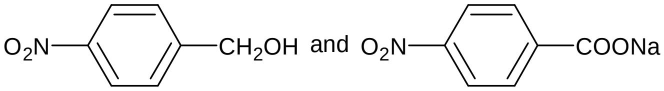
(A)


CH2OH
and
COONa

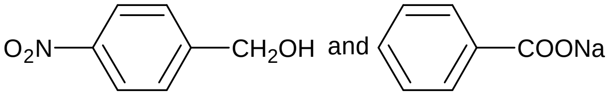
(B)


CH2OH
and
O2N
COONa

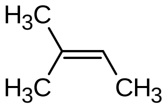
(C)

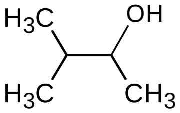

O2N
CH2OH
and
O2N
COONa

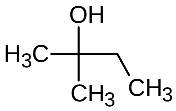
(D)

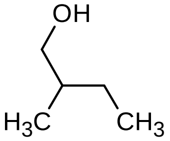

O2N
CH2OH
and
COONa

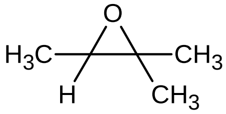
Space for rough work

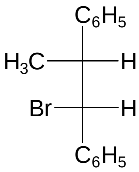
27. 
$\xrightarrow[\text{(ii)}H_2O_2/OH^-]{\text{(i) }B_2H_6,\text{THF}, \Delta}$ P. Then 'P' is

(A) 

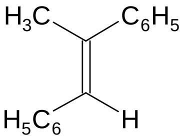
(B) 

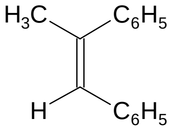
(C) 

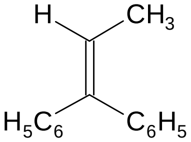
(D) 

28. 
$\xrightarrow[E_2]{\text{alc. KOH}}$ A (major)

A is

(A) 

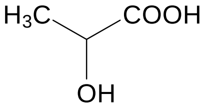
(B) 

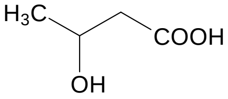
(C) 

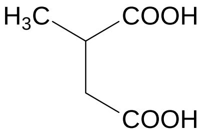
(D) All of the above

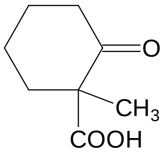
Space for rough work

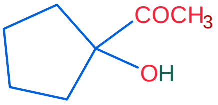
29. Which compound will lose its chirality when it is heated?

(A) 

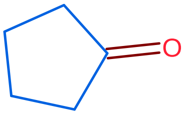
(B) 

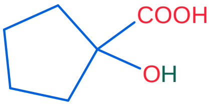
(C) 

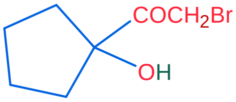
(D) 

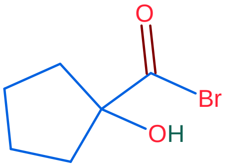
30.  $\xrightarrow{\text{NaOBr}}$ Product

The product is

(A) 

(B) 

(C) 

(D) 

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. If $f(2010) = \pi/2, f(x) = f(2x)\ \forall x \in R$ and $f(x)$ is continuous for $x \in R$, then the value of $\lim\limits_{x\to 0}\dfrac{\cos(f(x)) - \sqrt[3]{\cos(f(x))}}{\sin^2 x}$ is

(A) 1/4
(B) 1
(C) 0
(D) none of these

2. $\left|\left[\displaystyle\int_2^3 \frac{dx}{\sqrt{1+x^3}}\right]\right|$ is equal to (where [.] denotes the greatest integer function, |.| denotes absolute value function)

(A) 0
(B) 1
(C) 2
(D) 3

3. If $\displaystyle\int \frac{x\tan^{-1}x}{(1+x^2)^{3/2}}dx = \frac{k_1\tan^{-1}x - k_2}{\sqrt{1+x^2}} + c$

where k_1, k_2 are polynomial function of variable x and c is any real constant then value of $\displaystyle\int_0^2 \max\{k_1, k_2\}dx$ is

(A) $\frac{-2}{3}$
(B) $\frac{2}{3}$
(C) $\frac{-3}{2}$
(D) $\frac{-1}{2}$

4. The domain of the function $\sqrt{1-f(x)}$ where $f^3(x) = 1 - x^3 - 3xf(x)$. $x \in R$ is $(f(1) \neq -1)$

(A) R
(B) R – {0}
(C) $R^+ \cup \{0\}$
(D) R^-

Rough work

5. The left hand derivative of $f(x)=\begin{cases}|x-a|([x]-x), & x\neq a\\ 0 & x=a\end{cases}$ at x = a where a is an integer and [.] represent greatest integer function.
(A) $(1-a)^{-1}(-1)^{1-a}$
(B) $(1-a)^{1}(-1)^{1-a}$
(C) $(1-a)^{-1}(-1)$
(D) 1

6. f : R → R; f (x) = sin x + x, then the value of $\int_0^{\pi}\left(f^{-1}(x)\right)dx$ is equal to
(A) π^2
(B) $\frac{\pi^2}{2}-2$
(C) $\frac{\pi^2}{2}+2$
(D) can't be evaluated

7. If f: R → R is an invertible function such that f(x) and f^{-1} (x) are symmetric about the line y = – x, then
(A) f(x) is odd
(B) f(x) and $f^{-1}(x)$ may not be symmetric about the line y = x
(C) f(x) may not be odd
(D) none of these

8. If f(x + y + z) = f(x) + f(y) + f(z) with f(1) = 1 and f(2) = 2 and x, y, z ∈ R, then evaluate $\lim_{n\to\infty}\frac{\sum_{r=1}^{n}(4r)f(3r)}{n^3}$ is equal to
(A) 4
(B) 1
(C) 2
(D) 5

9. $\int_0^{\frac{\pi}{4}} e^{\tan x}(\cos x+\sec x\tan x)dx$ = k, then $[k^2]$ is
(A) 1
(B) 2
(C) 3
(D) 4

Rough work

10. f(x) is a polynomial function and $[f(\alpha)]^2 + [f'(\alpha)]^2 = 0$ then find $\lim\limits_{x\to\alpha}\frac{f(x)}{f'(x)}\left[\frac{f'(x)}{f(x)}\right]$ where [.] denotes greatest integer function

(A) 0 (B) 1
(C) –1 (D) none of these

11. The shortest distance between the curve $y = e^x$ and the line y = x is

(A) $\sqrt{2}$ units (B) $\frac{1}{2}$ units
(C) 2 units (D) $\frac{1}{\sqrt{2}}$ units

12. If $g(x) = \max|y^2 - xy|$ $(0 \le y \le 1)$ then minimum value of g(x) (for real x) is

(A) $\frac{1}{4}$ (B) $3-\sqrt{8}$
(C) $3+\sqrt{8}$ (D) $\frac{1}{2}$

13. sinax + cosax and |sinx| + |cosx| are periodic functions of same fundamental period if |a| equals

(A) 1 (B) 2
(C) 3 (D) 4

14. A polynomial P(x) with integral coefficients takes the value 5 at four distinct integral values of x. The number of integral solutions of the equation P(x) – 3 = 0 is

(A) 0 (B) 1
(C) 2 (D) 3

15. If $\int \frac{(x^2-1)}{(x^4+3x^2+1)\tan^{-1}\left(\frac{x^2+1}{x}\right)}dx = k\log\left|\tan^{-1}\frac{x^2+1}{x}\right| + c$, then k is equal to

(A) 0 (B) 1
(C) 2 (D) 3

Rough work

16. Range of $f(x) = \cos^{-1}x + 2\sin^{-1}x + 3\tan^{-1}x$ is

(A) $\left[-\frac{3\pi}{4}, \frac{7\pi}{4}\right]$
(B) $\left[-\frac{5\pi}{2}, \frac{7\pi}{2}\right]$
(C) $\left[-\frac{3\pi}{2}, \frac{5\pi}{2}\right]$
(D) none of these

17. Number of solutions of $\tan^{-1}|x| - \cos^{-1} x = 0$ is/ are

(A) 2
(B) 1
(C) 0
(D) none of these

18. $\int \frac{(x^2-1)}{(x^2+1)\sqrt{x^4+1}}dx$ is equal to

(A) $\sec^{-1}\left(\frac{x^2+1}{\sqrt{2}\,x}\right)+c$
(B) $\frac{1}{\sqrt{2}}\sec^{-1}\left(\frac{x^2+1}{\sqrt{2}\,x}\right)+c$
(C) $\frac{1}{\sqrt{2}}\sec^{-1}\left(\frac{x^2+1}{\sqrt{2}}\right)+c$
(D) none of these.

19. $\int_0^{\infty}\left[\frac{3}{x^2+1}\right]dx$ is equal to ([.] denotes the G.I.F)

(A) $\sqrt{2}$
(B) $\sqrt{2}+1$
(C) $\frac{3}{\sqrt{2}}$
(D) infinite

20. The domain of the function $f(x) = \sqrt{3-2^x-2^{1-x}} + \sqrt{\sin^{-1}x}$ is

(A) (0, 1)
(B) [0, 1)
(C) [0, 1]
(D) (0, 1]

Rough work

21. Let f(x) be a real valued bijective function such that $f'(x) = \sin^2\{\sin(x+1)\}$ and f(0) = 3. The value of $\left(f^{-1}\right)'(3)$ will be

(A) $\frac{1}{\cos^2(\cos 4)}$
(B) 2 cos (sin 4) sin4
(C) $\frac{1}{\sin^2(\sin 1)}$
(D) $\frac{1}{\cos^2(\sin 1)}$

22. The number of inflection points of a function given by a third degree polynomial is exactly
(A) 2
(B) 1
(C) 3
(D) 0

23. The integral $\int \frac{\sin 2x\left(1-\frac{3}{2}\cos x\right)}{e^{\sin^2 x+\cos^3 x}}dx$ is equal to

(A) $e^{\sin^2 x+\cos^3 x} + c$
(B) $-e^{-\left(\sin^2 x+\cos^3 x\right)} + c$
(C) $e^{\left(\sin^2 x+\cos^{3/2} x\right)^2} + c$
(D) none of these

24. $\lim\limits_{x\to 0}\frac{1-\cos^{12}(x^6)}{\sin x\sin 2x\sin 3x....\sin 12x}$ is equal to

(A) $\frac{1}{(12)!}$
(B) $\frac{1}{2(11)!}$
(C) $\frac{1}{72}$
(D) $\frac{1}{6\times(11)!}$

Rough work

25. $\lim\limits_{x\to 0}\left\{\frac{\sin x}{x}\right\}^{\frac{1}{\left\{\frac{\tan x}{x}\right\}}}$ is equal to (where {x} = fractional part of x)

(A) 0 (B) $\frac{1}{e}$

(C) $\frac{1}{\sqrt{e}}$ (D) 1

26. Let $f(x) = \sqrt{ax^3 + bx^2 + cx + d}$ have local minima and maxima at x = –2 and x = 2 respectively. If 'a' is the root of the equation $x^2 - x - 6 = 0$, then which of the following is/are correct

(A) a = –2 or 3, b = 0,c = 24, d > 32 (B) a = –2, b = 0, c = 24, d < 32

(C) a = 3, b = 0, c = 24, d > 32 (D) a = –2, b = 0, c = 24, d > 32

27. If f(x) = g(x) + g(2b – x), $-b \le x \le 3b$ and g(x) exist $\forall x \in [-b, 3b]$, then

(A) x = b is never a critical point for f(x) (B) f(x) is symmetric about the line x = b

(C) f(x) is symmetric about the line x = 2b (D) none of these.

28. $\int_0^1 \left(1 + (2008)x^{2008}\right)e^{x^{2008}}\,dx$ equals

(A) e^{-1} (B) $e^{-1/4}$

(C) $e^{1/2}$ (D) e

29. The value of the definite integral $\int_0^1 e^{-x^2}\,dx + \int_1^{1/e}\sqrt{-\ln x}\,dx$

(A) e^{-1} (B) $e^{-5/4}$

(C) $e^{3/2}$ (D) e^2

30. $\lim\limits_{n\to\infty}\left(\frac{1^1\cdot 2^2\cdot 3^3.........(n-1)^{n-1}\cdot n^n}{n^{1+2+3+........+n}}\right)^{\frac{1}{n^2}}$ equals

(A) e^{-1} (B) $e^{-1/4}$

(C) $e^{5/2}$ (D) e

Rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students
from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

FIITJEE

JEE(Main)-2014

ALL INDIA INTEGRATED TEST

ANSWERS, HINTS & SOLUTIONS

PART TEST–III

(Main)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	D	A	C
2.	C	A	A
3.	C	B	C
4.	A	A	C
5.	D	C	D
6.	C	D	B
7.	B	C	A
8.	B	C	A
9.	C	C	C
10.	A	A	B
11.	D	A	D
12.	C	A	B
13.	C	B	D
14.	A	A	A
15.	A	A	B
16.	A	C	A
17.	D	A	B
18.	B	B	B
19.	B	B	C
20.	B	A	C
21.	B	C	C
22.	A	C	B
23.	D	C	B
24.	B	B	B
25.	A	C	C
26.	A	B	D
27.	D	A	B
28.	D	B	D
29.	A	B	A
30.	A	B	B

Physics

PART – I

SECTION – A

1. Field will be in opposite direction in the two halves and infinite at x close to zero & L.

2. Calculate net resistance, power = E^2/R_{net}

5. Force due to $\vec{B}$ should be in $-\hat{j}$ direction and due to $\vec{E}$ should be in $\hat{i}$ direction.

6. Use Ampere’s circuital law

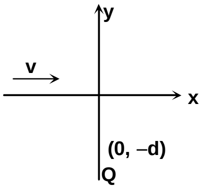
7. Use Gauss Law

8. Calculate equivalent internal resistance by using series and parallel grouping of cells.

9. Solve as balanced Wheatstone bridge and resistance of wire will be proportional to lengths.

14. $\vec{\mu} = \left(\frac{\pi R^2}{2} I\right)\hat{i} + \left(\frac{\pi R^2}{2} I\right)\hat{j} \;= \frac{\pi R^2 I}{2}(\hat{i}+\hat{j})$

15. $v_x = v$ = constant



$q\int E\cos\theta dt = mv_y$

or $q\int E\cos\theta \frac{dA}{2\pi dv} = mv_y$

$v_y = \frac{q}{2\pi mdv}\int E\cos\theta dA$

from Gauss’ law

$\int E\cos\theta dA = \frac{q}{\varepsilon_0}$ Integration for the whole cylindrical surface of radius d and extending from $x \to -\infty$ to $x \to +\infty$

Deflection $\theta = \tan^{-1}\left(\frac{qQ}{2\pi\varepsilon_0 dmv^2}\right)$

16. $\vec{E} = -\frac{kqd}{y^3}\hat{i} - \frac{2kqd}{y^3}\hat{j}$

29. $Q = 4\pi\varepsilon_0 RV$

$4\pi R^2 t = \frac{4}{3}\pi r^3$

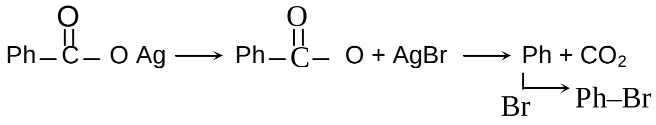
$V_{required} = \frac{Q}{4\pi\varepsilon_0 r}$ = 3 volts.

Chemistry

PART – II

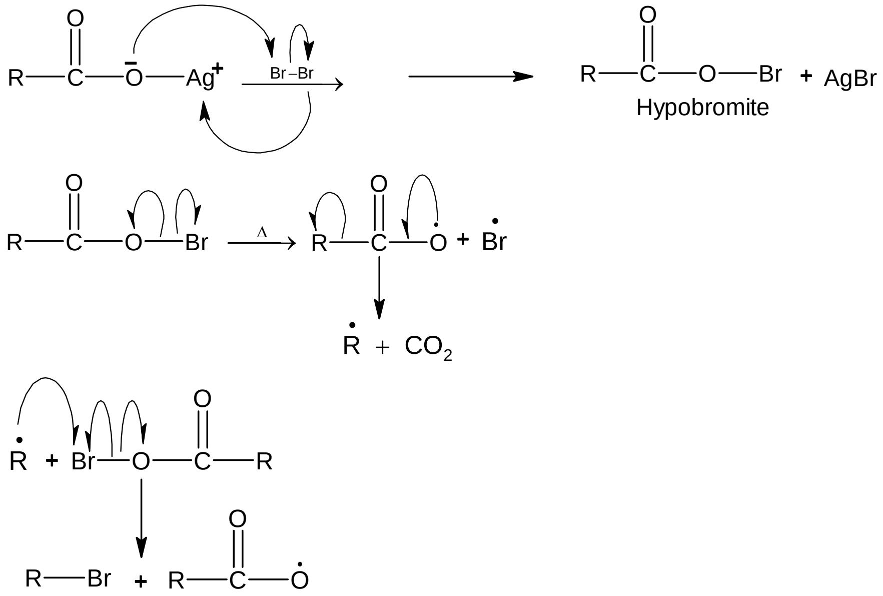
SECTION – A

1. This is Hundsdicker reaction.

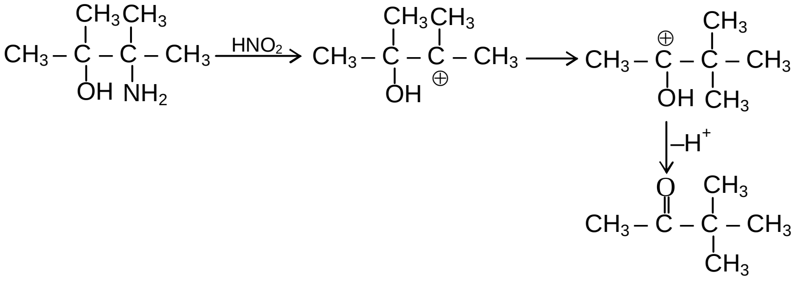


$$Ph-\overset{O}{\overset{||}{C}}-O\,Ag \longrightarrow Ph-\overset{O}{\overset{||}{C}}-O + AgBr \longrightarrow Ph + CO_2,\quad Br \longrightarrow Ph-Br$$

2.

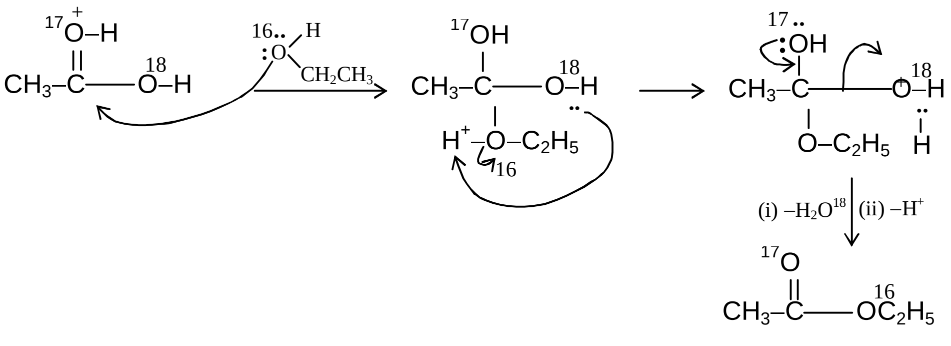


3.

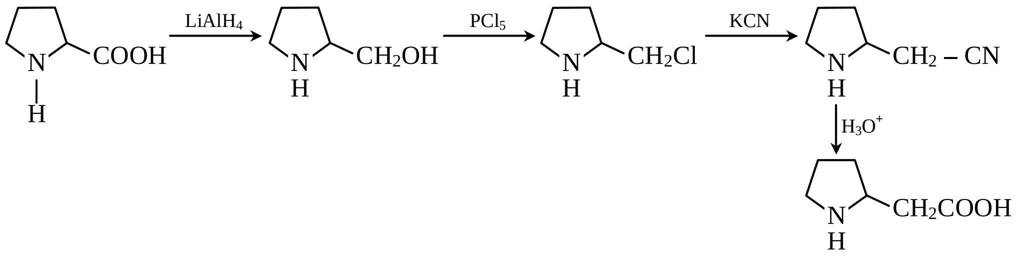


4. Carbylamine reaction is given by primary amines only.

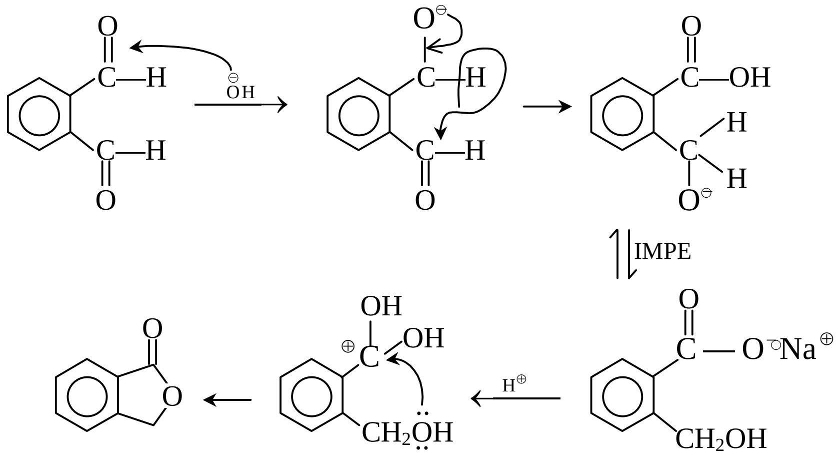
5.



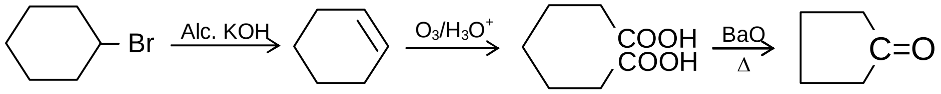
6.


COOH
LiAlH4
CH2OH
PCl5
CH2Cl
KCN
CH2 – CN
H3O+
CH2COOH

7.


OH
IMPE
O–Na+
H+
CH2OH

8.

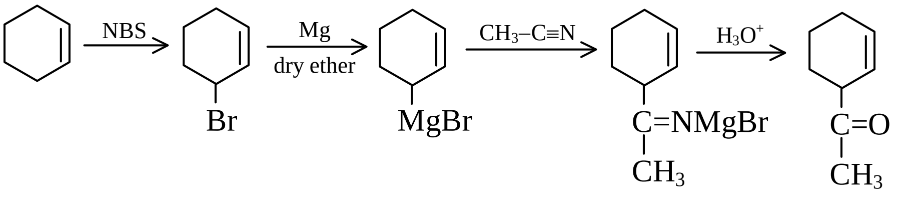

Br
Alc. KOH
O3/H3O+
COOH
COOH
BaO
Δ
C=O

9. Test of terminal alkynes.

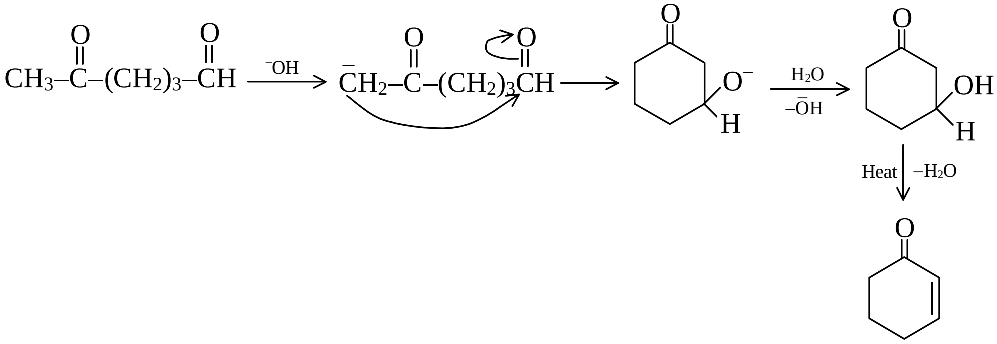
11. In polystyrene the monomeric unit is styrene which is having the formula of $H_2C=CH—C_6H_5$.

12. n $CH_2=CH–CH=CH_2$ + n $C_6H_5–CH=CH_2$ (styrene) → $[CH_2–CH=CH–CH_2–CH(C_6H_5)–CH_2]_n$
(1,3-butadiene) (Buna–S)

13.

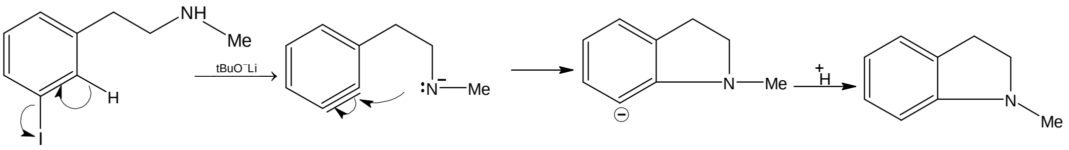

NBS
Br
Mg
dry ether
MgBr
CH3–C≡N
C=NMgBr
CH3
H3O+
C=O
CH3

14.


CH3–C–(CH2)3–CH
–OH
CH2–C–(CH2)3CH
O–
H
H2O
–OH
OH
Heat
–H2O

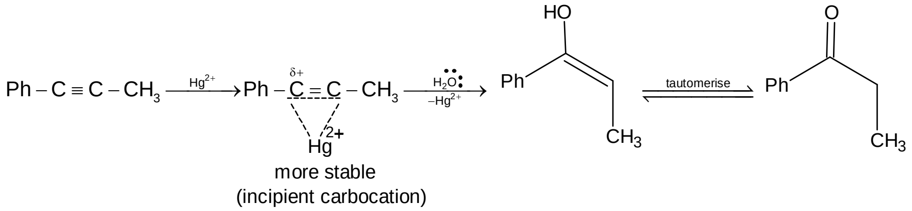
15. Due to the presence of CS_2, only monobromination takes place as CS_2 decrease the electrophilicity of Br_2 and also minimize phenol ionization.

18.


NH
Me
H
I
tBuO⁻Li
:N̄—Me
N—Me
$\overset{+}{H}$
N
Me

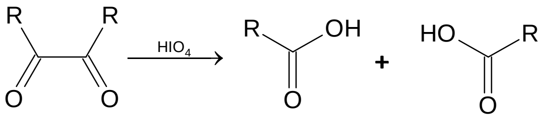
19. (1) proceeds through E2 path while (2) and (3) proceeds through E1 path and (4) proceeds through E1CB path.
Hence, only 2 and 3 takes place through Saytzeff rule.

20.

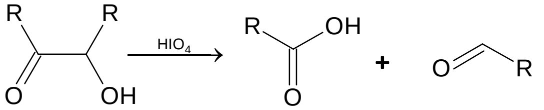

Ph – C ≡ C – CH3
Hg2+
Ph – C = C – CH3
δ+
Hg2+
more stable
(incipient carbocation)
H2O:
–Hg2+
HO
Ph
CH3
tautomerise
O
Ph
CH3

22.

(1)

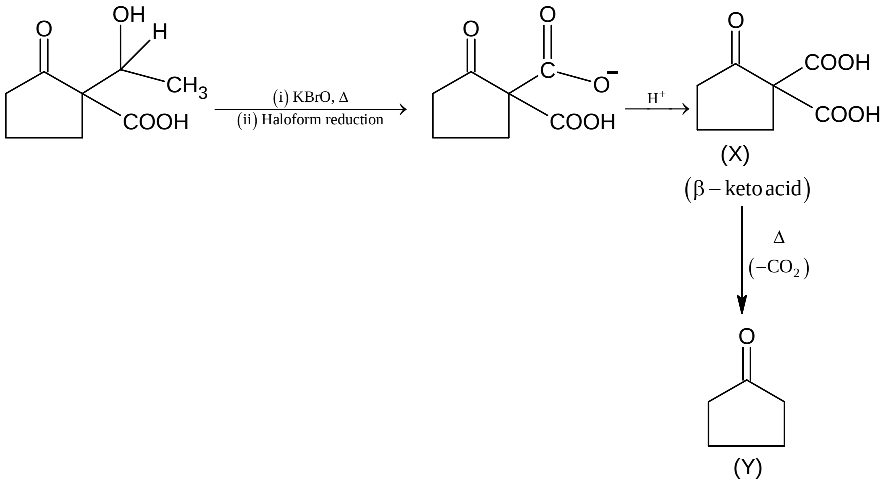

R
R
O
O
HIO4
R
OH
O
+
HO
R
O

(2)


R
R
O
OH
HIO4
R
OH
O
+
O
R

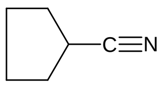
(4) $R-CHOH-CHOH-R \xrightarrow{HIO_4} R-CH=O + R-CH=O$

23.

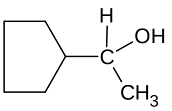

O
OH
H
CH3
COOH
(i) KBrO, Δ
(ii) Haloform reduction
O
O
C
O⁻
COOH
H+
O
COOH
COOH
(X)
(β – keto acid)
Δ
(–CO2)
O
(Y)

25.

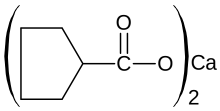
(A) -



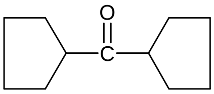
(B) -



(C) -

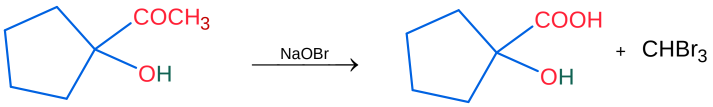


(D) -



26. This is an example of Cross – Cannizzaro reaction. The molecule first attacked is converted to sodium salt of benzoic acid in a Cannizzaro reaction. The presence of $-NO_2$ group activates the benzene ring towards nucleophilic attack. Therefore nitrobenzaldehyde is preferentially attacked.

30.



Haloform reaction

Mathematics PART – III

SECTION – A

1. $f(2x) = f(x) = f(x/2) = f(x/4) = \ldots = f\left(\frac{x}{2^{n-1}}\right) = f\left(\frac{x}{2^n}\right)$

consider $f(x) = f\left(\frac{x}{2^n}\right)$

$\lim\limits_{n\to\infty} f(x) = \lim\limits_{n\to\infty} f\left(\frac{x}{2^n}\right)$

$\Rightarrow f(x) = f(0)\ \forall\ x \in R$

(since f(x) is given to be a continuous function)

$\Rightarrow f(x) = f(2010) = \frac{\pi}{2}$

$\Rightarrow \lim\limits_{x\to 0} \frac{\cos\frac{\pi}{2} - \sqrt[3]{\cos\frac{\pi}{2}}}{\sin^2 x} = 0$

2. $\frac{1}{(1+x)^2} \le \frac{1}{\sqrt{1+x^3}} \le \frac{1}{1+x}$ for $x \in [2, 3]$

$\Rightarrow \int_2^3 \frac{1}{(1+x)^2}dx \le \int_2^3 \frac{dx}{\sqrt{1+x^3}} \le \int_2^3 \frac{dx}{1+x}$

$\frac{1}{12} \le \int_3^2 \frac{dx}{\sqrt{1+x^3}} \le \ln\frac{4}{3} < 1$

$\Rightarrow \left[\left[\int_2^3 \frac{dx}{\sqrt{1+x^3}}\right]\right] = 0$

3. $\int \frac{x\tan^{-1}x}{(1+x^2)^{3/2}}dx$. Let $\tan^{-1}x = t \Rightarrow \frac{dx}{1+x^2} = dt$

$= \frac{x - \tan^{-1}x}{\sqrt{1+x^2}} + c$ now compare it with RHS $k_1 = -1$, $k_2 = -x$ hence $\int_0^2 \max\{-1, -x\}dx = \frac{-3}{2}$

4. $(f(x))^3 + (x)^3 + (-1)^3 - 3(-1)(x)(f(x)) = 0$

$\Rightarrow (f(x) + x + (-1))\left(f^2(x) + x^2 + (-1)^2 - xf(x) + x + f(x)\right) = 0$

Using $a^3 + b^3 + c^3 - 3abc = (a+b+c)(a^2+b^2+c^2-ab-bc-ca)$

$f^2(x) + x^2 + (-a)^2 - xf(x) + x + f(x)$

$= \frac{1}{2}\left\{(f(x)-x)^2 + (x+1)^2 + (f(x)+1)^2\right\} \ge 0$

Equality occurs at $f(x) = x = -1 \Rightarrow f(1) = -1$

But it is given that $f(1) \ne -1$

Only solution is $f(x) = 1 - x$

domain of $\sqrt{1-f(x)} = \sqrt{x}$ is $x \in R^+ \cup \{0\}$

5. when $x \to a^-$

$[x] - x \to -1$

and $f(x)\big|_{\text{at } x=a^-} = x - a, f'(x)\big|_{\text{at } x=a^-} = 1$

6. $\int\limits_0^x f^{-1}(x)\,dx = \int\limits_{f^{-1}(0)}^{f^{-1}(x)} t f'(t)\,dt = t f(t)\Big|_{f^{-1}(0)}^{f^{-1}(x)} - \int\limits_{f^{-1}(0)}^{f^{-1}(x)} f(t)\,dt$ (by substituting x = f (t))

$\Rightarrow \int\limits_0^{\pi} f^{-1}(x)\,dx = \pi^2 - \int\limits_0^{\pi}(x + \sin x)\,dx = \frac{\pi^2}{2} - 2$

7. Since f (x) and f′ (x) are symmetric about the line y = – x.

If (α, β) lies on y = f (x) then $(-\beta, -\alpha)$ on $y = f^{-1}(x)$

$\Rightarrow (-\alpha, -\beta)$ lies on y = f (x)

⇒ y = f (x) is odd.

8. f(3) = 3f(1) = 3, f(4) = f(2 + 1 + 1) = 2 + 1 + 1 = 4 and so one.

In general, we get f(r) = r for $r \in N$

$\Rightarrow \lim\limits_{n\to\infty} \frac{\sum\limits_{r=1}^{n}(4r)f(3r)}{n^3} = \lim\limits_{n\to\infty} \frac{12n(n+1)(2n+1)}{6n^3} = 4$

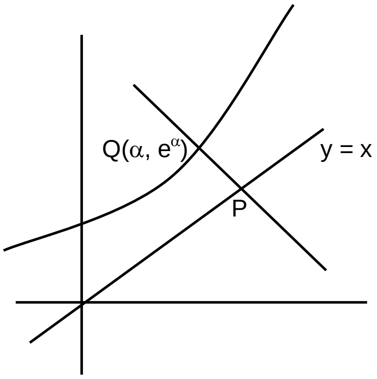
9. $\int e^{g(x)}\left[g'(x)f(x) + f'(x)\right]dx$

10. Clearly α is repeated root of f(x) = 0

$\lim\limits_{x\to\alpha} \frac{f(x)}{f'(x)}\left(\frac{f'(x)}{f(x)} - \left\{\frac{f'(x)}{f(x)}\right\}\right) \Rightarrow \lim\limits_{x\to\alpha}\left(1 - \frac{f(x)}{f'(x)}\left\{\frac{f'(x)}{f(x)}\right\}\right)$ = 1–0=1

$\left(\lim\limits_{x\to\alpha}\frac{f(x)}{f'(x)} = 0 \;\&\; \left\{\frac{f'(x)}{f(x)}\right\} \text{is bounded function}\right)$

11. We know the shortest and greatest distance between two curves always lie along the common normal. Let the normal to the $y = e^x$ at $Q(\alpha, e^{\alpha})$ meets the line y = x at P.



$\frac{dy}{dx} = e^x$

$\therefore -1 = \left(-\frac{1}{\frac{dy}{dx}}\right)_{x=\alpha} \Rightarrow -e^{-\alpha} = -1$

$\Rightarrow \alpha = 0$

$\therefore Q \equiv (0, 1)$

$\therefore$ normal = y – 1 = – 1(x – 0) ⇒ x + y – 1 = 0

$\therefore P = \left(\frac{1}{2}, \frac{1}{2}\right)$

$\therefore PQ = \sqrt{\frac{1}{4} + \frac{1}{4}} \Rightarrow \frac{1}{\sqrt{2}}$

12. $y^2 - xy = \left(y - \frac{x}{2}\right)^2 - \frac{x^2}{4} \Rightarrow y^2 - xy$ is decreasing to $y \le \frac{x}{2}$ and increasing to $y \ge \frac{x}{2}$.

Thus the largest value of $y^2 - xy$ must be at $y = 0, \frac{x}{2}$ or 1

The values are 0, $\frac{x^2}{4}$, $|1 - x| \Rightarrow$ for $x \notin (0, 1)$ $g(x) \ge \frac{1}{4}$

and for $x \in (0, 1)$ $g(x) = \max\left(\frac{x^2}{4}, 1 - x\right)$

also, $x^2 + 4x - 4 = 0 \Rightarrow x = -2 \pm \sqrt{8} \Rightarrow g(x) = 1 - x$ for $x \le \sqrt{8} - 2$ and $\frac{x^2}{4}$ for $x \ge \sqrt{8} - 2$

$\Rightarrow g(x)$ is minimum at $x = \sqrt{8} - 2$ and minimum value is $3 - \sqrt{8}$

13. $f(x) = |\sin x| + |\cos x|$ has period $\frac{\pi}{2}$

$g(x) = \sin ax + \cos ax$

$g(x) = \sqrt{2}\sin\left(ax + \frac{\pi}{4}\right)$

$g(x)$ has period $\frac{2\pi}{|a|} = \frac{\pi}{2}$

$|a| = 4 \qquad a = 4$

14. $P(x) - 5 = (x - a)(x - b)(x - c)(x - d)q(x)$
$\Rightarrow |P(x) - 5| = |x - a||x - b||x - c||x - d||qx|$
$\ge |(1)(-1)(2)(-2)(1)| \ge 4$
$\Rightarrow P(x) \ge 5 + 4$ or $\le 5 - 4 \Rightarrow P(x) \ge 9$ or ≤ 1.

15. Dividing the numerator and denominator by x^2, the given integral becomes

$$\int \frac{\left(1 - \left(\frac{1}{x^2}\right)\right)dx}{\left[\left(x + \left(\frac{1}{x}\right)\right)^2 + 1\right]\tan^{-1}\left(x + \left(\frac{1}{x}\right)\right)}$$

Let $x + \frac{1}{x} = \tan v = \int \frac{dv}{v} = \log|v| + c$

$= \log\left|\tan^{-1}\left(\frac{x^2 + 1}{x}\right)\right| + c$. Hence $k = 1$

16. $f(x) = \frac{\pi}{2} + \sin^{-1} x + 3\tan^{-1} x$

As $\sin^{-1}x + 3\tan^{-1}x$ is increasing in its domain $x \in [-1, 1]$
so, $[f(-1), f(1)]$

$f(-1) = \frac{\pi}{2} - \frac{\pi}{2} - \frac{3\pi}{4} = -\frac{3\pi}{4}$

$f(1) = \frac{\pi}{2} + \frac{\pi}{2} + \frac{3\pi}{4} = \frac{7\pi}{4}$.

17. As clear from the graph of $\tan^{-1}|x|$ and $-\cos^{-1} x$, there is only one solution.

18. $I = \int \dfrac{x^2\left(1-\dfrac{1}{x^2}\right)dx}{x^2\left(x+\dfrac{1}{x}\right)\left(x^2+\dfrac{1}{x^2}\right)^{1/2}}$

Let $x+\dfrac{1}{x}=p \Rightarrow \left(1-\dfrac{1}{x^2}\right)dx = dp$

$I = \int \dfrac{dp}{p\sqrt{p^2-2}} = \dfrac{1}{\sqrt{2}}\sec^{-1}\dfrac{p}{\sqrt{2}} = \dfrac{1}{\sqrt{2}}\sec^{-1}\left(\dfrac{x^2+1}{\sqrt{2}\,x}\right)+c$

19. $\int\limits_0^{\infty}\left[\dfrac{3}{x^2+1}\right]dx = \int\limits_0^{\frac{1}{\sqrt{2}}} 2dx + \int\limits_{\frac{1}{\sqrt{2}}}^{\sqrt{2}} 1\cdot dx + \int\limits_{\sqrt{2}}^{\infty} 0\cdot dx = \dfrac{3}{\sqrt{2}}$

20. $3-2^x-2^{1-x} \ge 0$ & $\sin^{-1}x \ge 0$
$\Rightarrow 1 \le 2^x \le 2$ & $x \in [0, 1]$
$\Rightarrow 0 \le x \le 1$ & $x \in [0, 1]$
$\Rightarrow x \in [0, 1]$

21. Let $f^{-1}(x) = g(x)$
$f(g(x) = x$

$g'(x) = \dfrac{1}{f'(g(x))} = \dfrac{1}{f'(g(3))} = \dfrac{1}{f'(0)} = \dfrac{1}{\sin^2(\sin 1)}$.

22. $f(x) = Ax^3 + Bx^2 + Cx + D$
$f'(x) = 3Ax^2 + 2Bx + C$
$f''(x) = 6Ax + 2B$
$\Rightarrow$ $f''(x)$ changes its sign only at one point i.e. $x = -B/3A$

23. Put $\sin^2 x + \cos^3 x = t$.

24. $\lim\limits_{x\to 0}\dfrac{(1-\cos x^6)(1+\cos x^6+\cos^2 x^6+.....\cos^{11}x^6)}{\dfrac{\sin x \sin 2x \sin 3x....\sin 12x}{(x.2x.3x....12x)}\cdot(x.2x.3x....12x)}$

$= \dfrac{1}{2\times(12)!}\times 12 = \dfrac{1}{2(11)!}$.

25. $\lim\limits_{x\to 0}\left\{\dfrac{\sin x}{x}\right\}^{\frac{1}{\left\{\frac{\tan x}{x}\right\}}} = \lim\limits_{x\to 0}\left(\dfrac{\sin x}{x}\right)^{\frac{1}{\frac{\tan x}{x}-1}} = e^{-\frac{1}{2}}$

26. Let $g(x) = ax^3+bx^2 + cx + d$
$g'(x) = 3ax^2+2bx+c$
have zeroes $x = 2, -2$
Now a is a root of $x^2-x-6=0$
$\Rightarrow a = 3$ or -2
When $a = 3$, $c = -36$ and $a = -2$, $c = 24$

Now $g(-2) > 0$
$-9a - 2c + d > 0$
$D > 32$

27. $f'(b) = 0$ and $f(b + x) = f(b - x)$

28. $$I = \int_0^1 e^{x^{2008}} dx = x.e^{x^{2008}}\Big|_0^1 - \int_0^1 2008x^{2008}.e^{x^{2008}} dx$$

$$\Rightarrow \int_0^1 \left(1 + (2008)x^{2008}\right)e^{x^{2008}} dx = e$$

29. $$f(x) = e^{-x^2}$$
$$\ell n f(x) = -x^2$$
$$-\ell n f(x) = x^2$$
$$\sqrt{-\ell n f(x)} = x$$
$$\int_0^1 f(x)dx + \int_1^{1/e} f^{-1}(x)dx$$
$$= 1\times\frac{1}{e} - 0\times 1 = \frac{1}{e}.$$

30. $$y = \underset{n\to\infty}{\mathrm{Lt}}\left\{\left(\frac{1}{n}\right)\left(\frac{2}{n}\right)^2\left(\frac{3}{n}\right)^3 ....\left(\frac{n}{n}\right)^n\right\}^{\frac{1}{n^2}}$$

$$\log y = \frac{\sum_{r=1}^{n} r\log(r/n)}{n^2}$$
$$= \int_0^1 x \log x \, dx$$
$$y = e^{-\frac{1}{4}}$$

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Advanced), 2014**

PART TEST – IV

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 210**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 10)** contains 10 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (11 to 15) contains 5 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

(ii) **Section-C (01 to 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

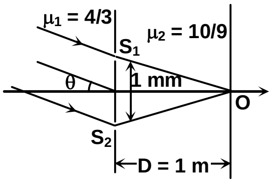
PART – I

SECTION – A

Single Correct Choice Type

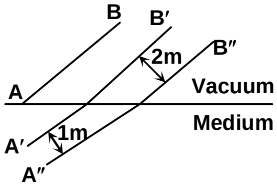
This section contains **10 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. In YDSE experiment shown in the figure, a parallel beam of light of wavelength (λ = 0.3 mm) in medium μ_1 is incident at an angle $\theta = 30°$ as shown. ($S_1O = S_2O$). If the intensity due to each light wave at point O is I_0 then the resultant intensity at point O will be



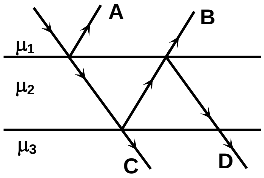
(A) zero
(B) $2I_0[1 + \cos(40\pi/9)]$
(C) $3I_0$
(D) I_0

2. Plane wavefronts are incident on a medium as shown in the figure. The refractive index of the medium is



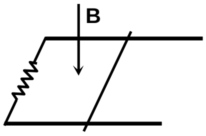
(A) 2
(B) 4
(C) 1.5
(D) can't be predicted.

3. A ray of light is incident on a thin film as shown in the figure. A and B are two reflected rays from first surface and C & D are two final transmitted rays. Rays B and D undergo a phase change π. Choose the correct relation among refractive indices is



(A) $\mu_2 > \mu_3 > \mu_1$
(B) $\mu_3 > \mu_2 > \mu_1$
(C) $\mu_3 > \mu_1 > \mu_2$
(D) None of these

4. Two parallel rails of negligible resistances are fixed on a horizontal surface. One end of the rails are connected by a resistance R as shown in the figure. There is a uniform magnetic field B perpendicular to the plane of the rails. A sliding wire of negligible resistance, length ℓ and mass m can slide on the rails. The coefficient of friction between the rails and wire is μ. The minimum force required to move the wire with uniform velocity v is



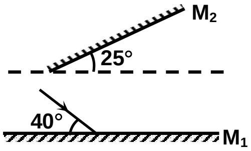
(A) $\mu mg + \frac{B^2a^2}{R}v$
(B) $\frac{B^2a^2}{R}v$
(C) $\frac{\mu mg}{\sqrt{\mu^2+1}} + \frac{B^2a^2}{R}\frac{v}{\sqrt{\mu^2+1}}$
(D) None of these

Space for rough work

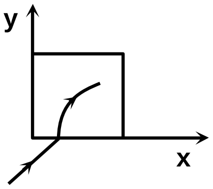
5. The minimum angle of deviation of a prism of refractive index μ is equal to its refracting angle. The refracting angle of prism is
(A) $2\cot^{-1}(\mu/2)$ (B) $2\tan^{-1}(\mu/2)$
(C) $2\sin^{-1}(\mu/2)$ (D) $2\cos^{-1}(\mu/2)$

6. A ray of light moving along the vector $\left(\hat{i}-2\hat{j}\right)$ undergoes refraction at an interface of two media, which is x-z plane. The refractive index for y > 0 is 2 while for y < 0 it is $\sqrt{5}/2$. The unit vector along the refracted ray is
(A) $\frac{-3\hat{i}-5\hat{j}}{\sqrt{34}}$ (B) $\frac{-\left(4\hat{i}-5\hat{j}\right)}{5}$
(C) $\frac{-3\hat{i}-4\hat{j}}{5}$ (D) $\frac{4\hat{i}-3\hat{j}}{5}$

7. By what angle should M_2 be rotated, so that the light ray after reflection from both the mirrors become horizontal
(A) 95° clockwise (B) 75° anticlockwise
(C) 5° anticlockwise (D) 15° anticlockwise

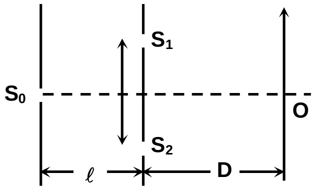


8. A ray of light is incident on a medium having variable refractive index. In which of the following variation of μ will the ray follow the path shown in the figure.
(A) $\mu = ax + b$ (a, b are positive)
(B) $\mu = a - bx$ (a, b are positive)
(C) $\mu = ay + b$ (a, b are positive)
(D) $\mu = a + by^2$ (a, b are positive)



9. A plano convex lens of refractive index 1.5 and radius of curvature 30 cm is silvered on its flat surface. Where should an object be placed relative to the silvered lens so as to form a real image of the same size as the object?
(A) 10 cm (B) 20 cm
(C) 30 cm (D) 60 cm

10. The figure shows a schematic diagram for Young's double slit experiment. Given $d \ll \ell$, $d \ll D$, $\lambda/D \ll 1$. Which of the following is a right statement about the wavelength of light used?
(A) Larger the wavelength, larger will be the fringe width.
(B) If white light is used, violet colour forms its first maxima closest to the central maxima.
(C) The central maxima of all wavelength coincide.
(D) All of the above

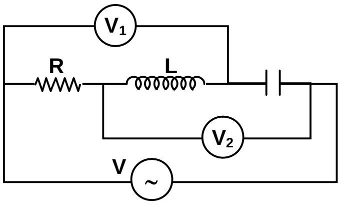


Space for rough work

Multiple Correct Answer(s) Type

This section contains **5 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

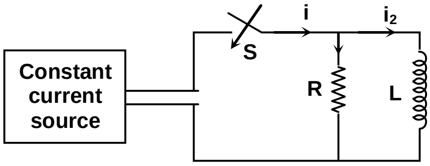
11. In the RLC series circuit shown, the reading of voltmeters are $V_1 = 150$ V, $V_2 = 50$ V and the source has emf 130 V.
(A) power factor of circuit will be 12/13
(B) value of $V_L = 90$ V
(C) value of $V_C = 40$ V
(D) value of $V_L = 50$ V



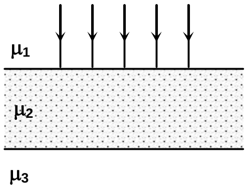
12. In β-decay, the Q value of the process is E. Then
(A) K.E. of β-particle cannot exceed E
(B) K.E. of antineutrino emitted lies between zero and E
(C) N/Z ratio of the nucleus is altered
(D) mass number (A) of the nucleus is altered

13. If the potential energy is taken zero at ground state of hydrogen atom in place of infinity then
(A) total energy of atom will change
(B) Binding energy of atom in ground state will remain unchanged
(C) kinetic energy of electron in ground state will get changed
(D) Energy of photon generated because of de excitation of atom from first excited state will remain unchanged

14. In the circuit shown switch S is close at t = 0. There after the constant current source by varying its emf maintains a constant current i out of its upper terminal. Then which of following are/is correct.
(A) Current at t = 0 is maximum from resistor and it decreases to zero after long time
(B) Current at t = 0 is zero and it increases to maximum value.
(C) Rate of growth of current in inductor is equal to rate of decay of current in inductor
(D) Current in inductor and resistor are equal at instant $t = \frac{L}{R}\ln 2$



15. Consider a case of thin film interference as show. Thickness of film is equal to wavelength of light in μ_2.
(A) Reflected light will be maxima if $\mu_1 < \mu_2 < \mu_3$
(B) Reflected light will be maxima if $\mu_1 < \mu_2 > \mu_3$
(C) Transmitted light will be maxima if $\mu_1 > \mu_2 > \mu_3$
(D) Transmitted light will be maxima if $\mu_1 > \mu_2 < \mu_3$



Space for rough work

SECTION –C

Integer Answer Type

This section contains **5 questions.** The answer to each question is a **single digit integer**, ranging from 0 to 9 (both inclusive).

1. A non conducting ring of mass m = 1 kg and radius R = 10 cm has a charge Q = 2 C uniformly distributed over its circumference. The ring is placed on rough horizontal surface such that plane of the ring is parallel to the surface. A vertical magnetic field $B = B_0t^2$ where $B_0 = 4T/sec^2$ is switched on. After 5 sec, after switching on the magnetic field the ring is just about to rotate about vertical axis through the centre. The coefficient friction μ between the ring and the surface is found to be $x \times 10^{-}$. Find the value of x.

2. A solenoid has an inductance of 10 H and resistance R = 5Ω, it is connected to 10 V battery. It take for the magnetic energy to reach ¼ of its maximum value is xln2. Then value of x is

3. A thin prism P_1 of angle 4° and made from glass of refractive index 1.54 is combined with another thin prism P_2 made from glass of refractive index 1.72 so that ray undergoes no diviation. The angle of prism P_2 in degree is

4. Young's double slit experiment is performed with light consisting of two wavelengths λ_1 = 6000Å and λ_2 = 4800Å. It is observed that the maximum of the 16th order corresponding to λ_1 = 6000 Å coincides with the maximum of the nth order corresponding to λ_2 = 4800 Å. The value of n is 10K. Find K.

5. Find the effective value or rms value of an alternating current (in ampere) that changes according to the law (all quantities are in S.I. unit and symbols have their usual meaning
   I = 10, when 0 < t < T/8 I = 0, when T/8 < t < T/2
   I = –10, when 5T/8 < t < T/2 I = 0, when 5T/8 < t < T

Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which only one is correct.

1. Which one of the following is true for Schottky defect in crystals?
   (A) Schottky defects increases the density of the crystal.
   (B) Schottky defect is found in crystal having large $\frac{r^+}{r^-}$ ratio.
   (C) Schottky defects are non thermodynamic defects.
   (D) Schottky defect is shown by highly ionic compounds having high coordination number.

2. The number of P–O–P bonds in cyclic trimetaphosphoric acid is
   (A) Zero (B) Two
   (C) Three (D) Four

3. In the coagulation of a positive sol, the flocculation powers of Cl^-, SO_4^{2-}, PO_4^{3-} and $[Fe(CN)_6]^{4-}$ are in the order of
   (A) $Cl^- > SO_4^{2-} > [Fe(CN)_6]^{4-} > PO_4^{3-}$ (B) $Cl^- > PO_4^{3-} > SO_4^{2-} > [Fe(CN)_6]^{4-}$
   (C) $[Fe(CN)_6]^{4-} > PO_4^{3-} > SO_4^{2-} > Cl^-$ (D) $Cl^- > SO_4^{2-} > PO_4^{3-} > [Fe(CN)_6]^{4-}$

4. E° values of Mg^{2+}/Mg is –2.37 volts of Zn^{+2}/Zn is –0.76 volt and Fe^{+2}/Fe is –0.44 volt. Which of the following statements is correct?
   (A) Zn oxidize Fe (B) Zn will reduce Fe^{2+}
   (C) Zn will reduce Mg^{2+} (D) Mg oxidizes Fe

Rough work

5. Lowering of vapour pressure ΔP_1 of aqueous solution of acid HA_1 and ΔP_2 of aqueous solution of acid HA_2 are related as $\Delta P_1 > \Delta P_2$. Correct relation is (Assume same concentration for both acids)
(A) $pK_{a_1} > pK_{a_2}$
(B) $pK_{a_1} < pK_{a_2}$
(C) $pK_{a_1} = pK_{a_2}$
(D) none of these

6. Which equation does not involve the reduction of a transition metal compound?
(A) $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$
(B) $TiO_2 + 2C + 2Cl_2 \longrightarrow TiCl_4 + 2CO$
(C) $Cr_2O_3 + 2Al \longrightarrow 2Cr + Al_2O_3$
(D) $TiCl_4 + 4Na \longrightarrow Ti + 4NaCl$

7. The aqueous solution of a certain compound (X), when added to a copper sulphate solution, a brown precipitate is obtained which turns white on addition of excess of $Na_2S_2O_3$ solution. Its aqueous solution, when added to Ag^+ ion solution, a yellow curdy precipitate is obtained which is insoluble in ammonium hydroxide. Hence, compound (X) is
(A) NaBr
(B) KBr
(C) KI
(D) $PbCrO_4$

8. A solution containing 0.319 g of complex $CrCl_3.6H_2O$ was passed through cation exchanger and the solution given out was neutralized by 28.5 ml of 0.125 M NaOH. What is the correct formula of complex?
(A) $[Cr(H_2O)_6]Cl_3$
(B) $[Cr(H_2O)_5Cl]Cl_2.H_2O$
(C) $[Cr(H_2O)_3Cl_3].3H_2O$
(D) $[Cr(H_2O)_4Cl_2]Cl.2H_2O$

9. Which of the following complexes is an inner d- orbital complex?
(A) $[Co(F)_6]^{-3}$
(B) $[Fe(F)_6]^{-3}$
(C) $[Cr(NH_3)_6]^{3+}$
(D) $[Co(H_2O)_6]^{3+}$

10. Ferric ion forms a prussian blue coloured ppt. due to formation of
(A) $KMnO_4$
(B) $K_4[Fe(CN)_6]$
(C) $Fe_4[Fe(CN)_6]_3$
(D) $Fe(OH)_3$

Rough work

Multiple Correct Answers Type

This section contains **5 multiple correct** answer(s) type questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE** is/are correct.

11. 1 mole benzene $(p^0_{\text{benzene}} = 42\ \text{mm})$ and 2 mole toluene $(p^0_{\text{benzene}} = 36\ \text{mm})$ will have:
(A) total vapour pressure 38 mm
(B) mole fraction of vapours of benzene above liquid mixture is $\frac{7}{19}$
(C) mole fraction of vapours of benzene above liquid mixture is $\frac{1}{3}$
(D) mole fraction of vapours of toluene above liquid mixture is $\frac{8}{19}$

12. In the equation, $X + CN^- + H_2O + O_2 \longrightarrow [X(CN)_2]^- + 4OH^-$; 'X' can be
(A) Au
(B) Ag_2S
(C) Sb
(D) As

13. 4.5g of Al (atomic mass = 27 amu) is deposited at cathode from Al^{+3} solution by a certain quantity of charge. The correct statement/s is are:
(A) The volume of H_2 produced at 0°C and 1atm pressure from H^+ ions in solution by the same quantity of charge will be 5.6 *l*.
(B) The volume of H_2 produced at 0°C and 1atm pressure from H^+ ions in solution by the same quantity of charge will be 22.4 *l*.
(C) The number of moles of Al deposited will be 0.166 moles.
(D) The number of faraday used for reduction of 1 mole of Al^{+3} is $\frac{3}{18}$F.

14. Which of the following statements are true regarding tetrahedral voids in fcc lattice?
(A) Tetrahedral voids formed by one corner spheres and three face spheres.
(B) Two tetrahedral voids can exist on one diagonal body line in fcc cubic.
(C) Tetrahedral voids are equal to number of spheres involved in body.
(D) Volume of tetrahedral voids are half of the octahedral voids.

15. Which of the following is/are the mixed salts?
(A) Rochelle's salt (sodium potassium tartrate)
(B) Bleaching powder
(C) Calcium hypochlorite
(D) Mohr's salt

Rough work

SECTION – C

(Integer Answer Type)

This section contains **5 questions.** The answer to each of the questions is a **single digit integer,** ranging from 0 to 9. The bubble corresponding to the correct is to be darkened in the ORS.

1. Freezing point of 0.2 M KCN solution is –0.7°C. On adding 0.1 mole of $Hg(CN)_2$ to one litre of the 0.2 M KCN solution, the freezing point of the solution becomes –0.53°C due to the reaction $Hg(CN)_2 + mCN^- \rightarrow Hg\ (CN)_{m+2}^{m-}$. What is the value of m assuming molality = molarity?

2. In the electrolysis of KI, I_2 is formed at the anode by the reaction;

   $2I^- \longrightarrow I_2 + 2e^-$

   After the passage of current of 0.5 ampere for 9650 seconds, I_2 formed required 40 ml of 0.1 M $Na_2S_2O_3{\cdot}5H_2O$ solution in the reaction;

   $I_2 + 2S_2O_3^{2-} \longrightarrow S_4O_6^{2-} + 2I^-$

   What is the current efficiency?

3. What is the oxidation number of Fe in violet coloured complex $Na_4\left[Fe\left(CN\right)_5\left(NO\right)S\right]$?

4. An alloy of copper, silver and gold is found to have cubic lattice in which Cu atoms constitute CCP. If Ag atoms are located at the edge centres and Au atom is present at body centre, the alloy will have the formula $Cu_xAg_yAu_z$. What is the value of X?

5. If $E^0_{Fe^{2+}/Fe} = 5V$ and $E^0_{Fe^{3+}/Fe^{2+}} = 2V$ then $E^0_{Fe^{3+}/Fe}$ will be.

Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. One Indian, four American men and their wives are to be seated randomly around a circular table. Then the conditional probability that the Indian men is seated adjacent to his wife given that each American man is seated adjacent to his wife is

(A) $\frac{1}{2}$ (B) $\frac{1}{3}$

(C) $\frac{2}{5}$ (D) $\frac{1}{5}$

2. A point P lying inside the curve y = $\sqrt{2ax - x^2}$ is moving such that its shortest distance from the curve at any position is greater than its distance from x-axis. The point P enclose a region whose area is equal to

(A) $\frac{\pi a^2}{2}$ (B) $\frac{a^2}{3}$

(C) $\frac{2a^2}{3}$ (D) $\left(\frac{3\pi - 4}{6}\right)a^2$

3. I write a letter to my friend and don't receive a reply. It is known that one out of m letters does not reach its destination. Then probability that my friend received the letter (it is certain that my friend would have replied, if he did receive my letter)

(A) $\frac{2m-1}{m-1}$ (B) $\frac{m-1}{2m-1}$

(C) $\frac{m+1}{2m+1}$ (D) none of these

4. If P(α, β, γ) be a vertex of an equilateral triangle PQR where vertex Q and R are (–1, 0, 1) and (1, 0, –1) respectively then P will lie on the plane

(A) x + y + z + 6 = 0 (B) 2x + 4y + 32 + 10 = 0

(C) x – y + z + 12 = 0 (D) x + y + z + 3$\sqrt{2}$ = 0

Rough work

5. $\vec{a}$ and $\vec{b}$ are non-zero non-collinear vectors such that $|\vec{a}| = 2$, $\vec{a}\cdot\vec{b}=1$ and angle between $\vec{a}$ and $\vec{b}$ is $\frac{\pi}{3}$. If $\vec{r}$ is any vector satisfying $\vec{r}\cdot\vec{a}=2$, $\vec{r}\cdot\vec{b}=8$, $(\vec{r}+2\vec{a}-10\vec{b})(\vec{a}\times\vec{b}) = 4\sqrt{3}$ and is equal to $\vec{r}+2\vec{a}-10\vec{b}=\lambda(\vec{a}\times\vec{b})$, then λ =

(A) $\frac{1}{2}$ (B) 2

(C) $\frac{1}{4}$ (D) 4

6. If p, q, r are in A.P., then the determinants $\begin{vmatrix} a^2+2^{n+1}+2p & b^2+2^{n+2}+3q & c^2+p \\ 2^n+p & 2^{n+1}+q & 2q \\ a^2+2^n+p & b^2+2^{n+1}+2q & c^2-r \end{vmatrix}$ is equal to

(A) 1 (B) 0

(C) $a^2b^2c^2 - 2^n$ (D) $(a^2 + b^2 + c^2) - 2^n q$

7. The area bounded by the curve $y=\frac{3}{|x|}$ and y + |2 – x| = 2 is

(A) $\frac{4-\ln 27}{2}$ (B) 2 – ln 3

(C) 2 + ln 3 (D) none of these

8. Cards are drawn one by one at random from a well shuffled pack of 52 cards until 2 spades are obtained for the first time. The probability that 20 draws are required for this is

(A) $\frac{{}^{39}C_{18}}{{}^{52}C_{19}}\cdot\frac{{}^{13}C_2}{33}$ (B) $\frac{{}^{39}C_{18}\cdot{}^{13}C_1}{{}^{52}C_{19}}\cdot\frac{12}{33}$

(C) $\frac{{}^{40}C_{19}}{{}^{52}C_{19}}\cdot\frac{12}{13}$ (D) none of these.

9. Let a plane passes through origin and is parallel to line $\frac{x-1}{2}=\frac{y+3}{-1}=\frac{z+1}{-2}$ such that the distance between plane and line is 5/3, then the equation of plane is

(A) 2x + 2y – z = 0 (B) x – 2y – 2z = 0

(C) x + 2y + 2z = 0 (D) 2x – 2y + z = 0

Rough work

10. Given $q^2 - pr < 0$, $p > 0$, then the value of $\Delta = \begin{vmatrix} p & q & px+qy \\ q & r & qx+ry \\ px+qy & qx+ry & 0 \end{vmatrix}$ is

(A) 0
(B) positive
(C) negative
(D) $q^2 + pr$

Multiple Correct Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

---

11. A fair coin is tossed n times. Let x = number of times head occurs. If P(x = 4), P (x = 5) and P (x = 6) are in A.P then the value of n can be

(A) 7
(B) 10
(C) 12
(D) 14

12. If p_1, p_2, p_3 denotes the distance of the plane $2x - 3y + 4z + 2 = 0$ from the planes $2x - 3y + 4z + 6 = 0$, $4x - 6y + 8z + 3 = 0$ and $2x - 3y + 4z - 6 = 0$ respectively, then

(A) $p_1 + 8p_2 - p_3 = 0$
(B) $p_3 = 16p_2$
(C) $8p_2 = p_1$
(D) $p_1 + 2p_2 + 3p_3 = \sqrt{29}$

13. The lines whose vector equations are $\vec{r} = 2\vec{i} - 3\vec{j} + 7\vec{k} + \lambda\left(2\vec{i} + p\vec{j} + 5\vec{k}\right)$ and $\vec{r} = \vec{i} + 2\vec{j} + 3\vec{k} + \mu\left(3\vec{i} - p\vec{j} + p\vec{k}\right)$ are perpendicular for all values of λ and μ, if

(A) p = –6
(B) p = –1
(C) p = 1
(D) p = 6

14. The vectors $\vec{a}, \vec{b}$ and $\vec{c}$ are of the same length and taken pair wise they form equal angles. If $\vec{a} = \hat{i} + \hat{j}$ and $\vec{b} = \hat{j} + \hat{k}$, the coordinates of $\vec{c}$ can be

(A) (1, 0, 1)
(B) (-1, 1, 2)
(C) $\left(-\frac{1}{3}, \frac{4}{3}, -\frac{1}{3}\right)$
(D) $\left(\frac{1}{3}, 0, \frac{2}{3}\right)$

Rough work

15. For a, b, c non zero real numbers, $\begin{vmatrix} bc & ca & ab \\ ca & ab & bc \\ ab & bc & ca \end{vmatrix} = 0$, then

(A) $\frac{1}{a}+\frac{1}{b}+\frac{1}{c}=0$

(B) $\frac{1}{a}+\frac{1}{b\omega}+\frac{1}{c\omega^2} = 0$

(C) $\frac{1}{a}+\frac{1}{b\omega^2}+\frac{1}{c\omega} = 0$

(D) $\frac{1}{a\omega}+\frac{1}{b\omega^2}+\frac{1}{c} = 0$

SECTION – C

Integer Answer Type

This section contains **5 questions.** The answer to each question is a **single digit integer**, ranging from 0 to 9 (both inclusive).

1. If the least value of the area bounded by the line y = mx + 1 and the parabola $y = x^2 + 2x - 3$ is α where m is a parameter then the value of $\frac{6\alpha}{32}$ is _____

2. A, B, C and D cut a pack of 52 cards successively in the order given. If the person who cuts a spade first receives Rs. 350 and if the expectation of A is λ then $\left[\frac{\lambda}{64}\right]$ is equal to (where [.] denotes greatest integer function) _____

3. Angle θ is made by line of intersection of planes $\vec{r}\cdot(\hat{i}+2\hat{j}+3\hat{k})=0$ and $\vec{r}\cdot(3\hat{i}+3\hat{j}+\hat{k})=0$ with $\hat{j}$, where $\cos\theta = \sqrt{\frac{\lambda}{3}}$, then λ is _____

4. The shortest distance between $(1-x)^2 + (x-y)^2 + (y-z)^2 + z^2 = \frac{1}{4}$ and 4x + 2y + 4z + 7 = 0 in 3 – dimensional coordinate system is equal to _____

5. If A′ denotes the transpose of matrix A, A′A = I and |A| = 1 then |A – I| must be equal to (where A is matrix of order 3) _____

Rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

FIITJEE

JEE(Advanced)-2014

ALL INDIA INTEGRATED TEST

ANSWERS, HINTS & SOLUTIONS

PART TEST – IV

(Paper – 1)

ANSWERS KEY

	PHYSICS	CHEMISTRY	MATHEMATICS
Q. No.	ANSWER	ANSWER	ANSWER
1.	D	D	C
2.	A	C	C
3.	B	C	B
4.	C	B	D
5.	D	B	B
6.	D	B	B
7.	A	C	A
8.	B	A	B
9.	D	C	A
10.	D	C	C
11.	A, B, C	A, B	A, D
12.	A, B, C	A, B	A, B, C, D
13.	A, B, D	A, C	B, D
14.	A, C, D	A, B	A, C
15.	A, D	A, B	A, B, C, D
1.	4	2	2
2.	2	8	2
3.	3	2	2
4.	2	4	2
5.	5	4	0

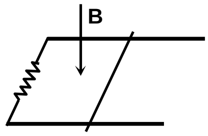
Physics

PART – I

1. $\Delta\phi = \frac{2\pi}{\lambda} d\sin\theta = \frac{10\pi}{3}$

   $I = I_0 + I_0 + 2I_0 \cos[2\pi + (4\pi/3)] = I_0$

4. $F\cos\theta = \frac{B^2a^2v}{R} + \mu(mg - F\sin\theta)$

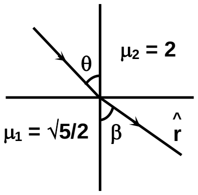


   $F(\cos\theta + \mu\sin\theta) = \frac{B^2a^2v}{R} + \mu mg$

   For F to be minimum, $\tan\theta = \mu$

   $F_{min} = \frac{\mu mg}{\sqrt{\mu^2+1}} + \frac{B^2a^2}{R}\frac{v}{\sqrt{\mu^2+1}}$

6. $-(\hat{i} - 2\hat{j})\hat{j} = |\hat{i} - 2\hat{j}||\hat{i}|\cos\theta$



   $\Rightarrow \sin\theta = 1/\sqrt{5}$

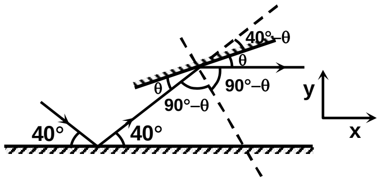
   $2 \times \frac{1}{\sqrt{5}} = \frac{\sqrt{5}}{2}\sin\beta \Rightarrow \sin\beta = 4/5$

   $\Rightarrow \cos\beta = 3/5 \Rightarrow \hat{r} = \frac{4}{5}\hat{i} - \frac{3}{5}\hat{j}$

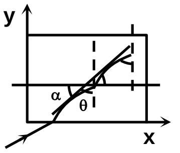
7. $\theta = 40° - \theta \Rightarrow \theta = 20$

   ⇒ 5° clockwise or 95 clockwise.

   In this case the ray will become horizontal and will be reflected along $-\hat{i}$



8. In both C and D μ increases a y is increases. In only B μ decreases as x increased.



9. $f_{lens} = \frac{R}{\mu - 1} = 60$ cm

10. $\beta = \lambda D/d \Rightarrow \beta \propto \lambda$

    The position of the central maxima is independent of wavelength used.

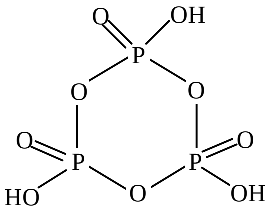
    $\gamma_n = \frac{n\lambda D}{d} \quad \therefore \quad \gamma_n \propto \lambda$

Section –C

1. $\mu = \left(\frac{qBr}{mg}\right)t = 4$

Chemistry PART – II

SECTION – A

2.


There are three P–O–P bonds.]

3. Hardy–Schulze rule

4. For $Zn + 2Fe^{+2} \rightarrow Zn^{+2} + 2Fe$ $E^{o}_{cell} = -0.44 + 0.76 = +ve$ and hence, the reaction is spontaneous.

5. Lowering, $\Delta P \propto$ 'a' number of solute particles.
Hence, HA_1 is stronger acid than HA_2 (Given $\Delta P_1 > \Delta P_2$) and $pK_{a_1} < pK_{a_2}$.

6. $$\underset{(+4)}{TiO_2} \longrightarrow \underset{(+4)}{TiCl_4}$$
No change in oxidation number takes place.

7. (X) is KI.
$$I^- + Ag^+ \longrightarrow \underset{\substack{\text{(Yellow ppt.)} \\ \text{(insoluble in } NH_4OH)}}{AgI}$$
$$CuSO_4 + \underset{(X)}{2KI} \longrightarrow CuI_2 + K_2SO_4$$
$$2CuI_2 \longrightarrow \underset{\text{Brown ppt.}}{Cu_2I_2} \downarrow + I_2$$
$$Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + 2NaI$$
Hence, (C).

8. Milliequivalents of NaOH = 28.5 × 0.125 = 3.5625 milliequivalents
Milliequivalents of NaOH $\equiv$ Milliequivalents of salt
$$3.5625 = \frac{0.319}{[52 + 6 \times 18 + 35.5 \times 3] \times 1000 \times \text{charge}}$$
Charge = +3
So, formula $= [Cr(H_2O)_6]^{3+} + 3Cl^-$, i.e. $[Cr(H_2O)_6]Cl_3$

10. $$4Fe^{3+} + K_4[Fe(CN)_6] \longrightarrow \underset{\text{Prussian blue}}{Fe_4[Fe(CN)_6]_3}$$

11. $P_{total} = P^0_B X_B + P^0_T X_T$

= $42\times\frac{1}{3}+36\times\frac{2}{3}$ = 38 mm.

$P_MY_B = P_B^0 \times X_B$; Where Y_B is the mole fraction of Benzene is vapour phase.

$38\times Y_B = 14$

$Y_B = \frac{14}{38} = \frac{7}{19}$.

12. In the given reaction 'X' can be Au and Ag_2S.

$4Au + 8CN^- + 2H_2O + O_2 \longrightarrow 4Au(CN)_2^- + 4OH^-$

$2Ag_2S + 8CN^- + 2H_2O + O_2 \longrightarrow 4Ag(CN)_2^- + 4OH^- + 2S$

13. $Al^{+3} + 3e^- \to Al$

Number of moles of Al produced = $\frac{4.5}{27} = 0.166$

Number of moles of electrons used = 3 × 0.166

$H^+ + e^- \to \frac{1}{2}H_2$

Number of moles of H_2 produced = $\frac{1}{2}\times 3\times 0.166$

Volume of H_2 produced = 1.5 × 0.166 × 22.4 *l* = 5.57 = 5.6 *l*

15. Rochelle salt (sodium potassium tartrate) and bleaching powder (calcium chloride hypochlorite) are mixed salts. Calcium hypochlorite is a simple salt. Mohr's salt [$FeSO_4.(NH_4)_2SO_4.6H_2O$] is a double salt.

SECTION – C

1. $0.7 = 2 \times K_f \times 0.2 \Rightarrow K_f = \frac{0.7}{0.4} = \frac{7}{4}$

$$\begin{array}{ccccc} Hg(CN)_2 & + & mCN^- & \longrightarrow & Hg\ (CN)_{m+2}^{m-} \\ 0.1 & & 0.2 & & 0 \\ 0 & & (0.2 - 0.1m) & & 0.1 \end{array}$$

Now, Molarity of K^+ = 0.2 M

Molarity of CN^- = (0.2 – 0.1m) M

Molarity of complex = 0.1 M

0.53 = K_f (0.2 + 0.2 – 0.1m + 0.1) = K_f (0.5 – 0.1m)

$\Rightarrow$ 0.53 = $\frac{7}{4}$ (0.5 – 0.1m) $\Rightarrow$ 2.1 = 3.5 – 0.7m

$\Rightarrow$ 0.7m = 1.4 $\Rightarrow$ m = **2**.

2. Number of moles of hypo = $\frac{MV}{1000} = \frac{0.1\times 40}{1000} = 4 \times 10^{-3}$

$\therefore$ Number of moles of $I_2 = 2 \times 10^{-3}$

Mass of $I_2 = 2 \times 10^{-3} \times 254$ g

$$w = \frac{i \times t \times E}{96500}$$

$$2 \times 10^{-3} \times 254 = \frac{i \times 9650 \times 127}{96500}$$

$$i = 0.04 \text{ ampere}$$

Current efficiency = $\frac{0.04}{0.50} \times 100$ = **8%**.

5. $Fe^{2+} + 2e^- \longrightarrow Fe(s);\ E^0 = 8V \quad ...(1)$

$Fe^{3+} + e^- \longrightarrow Fe^{2+};\quad E^0 = 2V \quad ...(2)$

Equation (1) + (2):

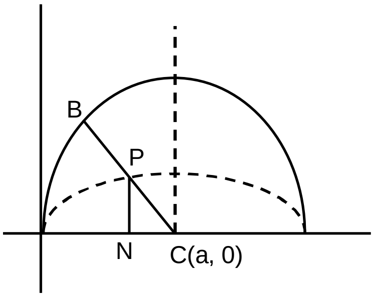
$Fe^{3+} + 3e^- \longrightarrow Fe(s);\ E^0 = xV(\text{let})$

Hence, 3x = 2 × 5 + 2
X = 4

Mathematics PART – III

1. E: Indian is seated adjacent to his wife
A: American are seated adjacent to their wives
$P\left(\frac{E}{A}\right) = \frac{2}{5}$

2. $y = \sqrt{2ax - x^2} \Rightarrow (x - a)^2 + y^2 = a^2$
Let P(h, k) be a point then BP > PN
For the boundary condition BP = PN = k
Now $AP = a - k = \sqrt{(h-a)^2 + k^2} \Rightarrow k = h - \frac{h^2}{2a}$
$\therefore$ boundary of the region is $y = x - \frac{x^2}{2a}$
required area $= 2\int_0^a \left(x - \frac{x^2}{2a}\right)dx = \frac{2a^2}{3}$.



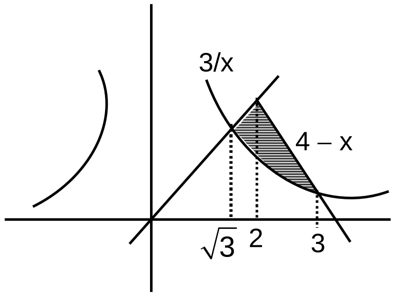
3. $$\frac{\frac{m-1}{m}\times\frac{1}{m}}{\frac{1}{m}\times 1 + \frac{m-1}{m}\times\frac{1}{m}} = \frac{m-1}{2m-1}$$

4. $QR = 2\sqrt{2} \Rightarrow OP = 6$.

5. Let $\vec{r} = \alpha\vec{a} + \beta\vec{b} + \lambda(\vec{a}\times\vec{b})$
$\Rightarrow 4\alpha + \beta = 2$
also $\alpha + \beta = 8$
$\therefore \alpha = -2, \beta = 10$
also $\lambda = 2$
now $\vec{r} + 2\vec{a} - 10\vec{b} = 2(\vec{a}\times\vec{b}) = 2$.

6. Applying $R_1 \to R_1 - R_3$ and $2q = p + r$
$$\begin{vmatrix} 2^{n+1} - 2^n + p & 2^{n+2} - 2^{n+1} + q & p + r \\ 2^n + p & 2^{n+1} + q & p + r \\ a^2 + 2^n + p & b^2 + 2^{n+1} + 2q & c^2 - r \end{vmatrix} = \begin{vmatrix} 2^n + p & 2^{n+1} + q & p + r \\ 2^n + p & 2^{n+1} + q & p + r \\ a^2 + 2^n + p & b^2 + 2^{n+1} + 2q & c^2 - r \end{vmatrix} = 0.$$

7. Area $= \int_{\sqrt{3}}^{2} x - \frac{3}{x} + \int_{2}^{3}\left(4 - x - \frac{3}{x}\right)dx = \frac{4 - \ln 27}{2}$.



8. 20 cards are required for 2 spades means in 19 draws there is only one spade and 20th card is a spade.
$\Rightarrow$ The order 18 cards are drawn from non–spades card and 1 card is drawn from 13 spades.
$\therefore$ Required probability $= \dfrac{{}^{39}C_{18}\cdot{}^{13}C_1}{{}^{52}C_{19}}\cdot\dfrac{12}{33}$.

9. Let the equation of plane passing through origin is $lx + my + nz = 0$
where l, m, n are direction cosines, then $l^2 + m^2 + n^2 = 1$ …(i)
The given line is parallel to the plane, then $2l - m - 2n = 0$ …(ii)
The distance between line and plane is 5/3, then $l - 3m - n = 5/3$ …(iii)
From (i), (ii) and (iii), we get equation of plane are
$x - 2y + 2z = 0$ and $2x + 2y - z = 0$.

10. Applying $R_3 \to R_3 - xR_1 - yR_2$

$$\Delta = \begin{vmatrix} p & q & px+qy \\ q & r & qx+ry \\ 0 & 0 & -\left(px^2+2qxy+ry^2\right) \end{vmatrix}$$

$(q^2 - pr)(px^2 + 2qxy + ry^2) < 0$.

11. $2P(x = 5) = P(x = 4) + P(x = 6)$

$2 = \dfrac{{}^nC_4}{{}^nC_5} + \dfrac{{}^nC_6}{{}^nC_5} \Rightarrow n = 7, 14$

12. Since all planes are parallel

$P_1 = \dfrac{4}{\sqrt{29}}$, $p_2 = \dfrac{1}{2\sqrt{29}}$, $p_3 = \dfrac{8}{\sqrt{29}}$

13. Given lines are perpendicular if $2\vec{i} + p\vec{j} + 5\vec{k}$ and $3\vec{i} - p\vec{j} + p\vec{k}$ are perpendicular.
$\Rightarrow 2.3 + p(-p) + 5p = 0 \Rightarrow p = -1, 6$

14. Let $\vec{c} = c_1\hat{i} + c_2\hat{j} + c_3\hat{k}$. Then $|\vec{c}| = \sqrt{2} = \sqrt{c_1^2 + c_2^2 + c_3^2}$ (1)

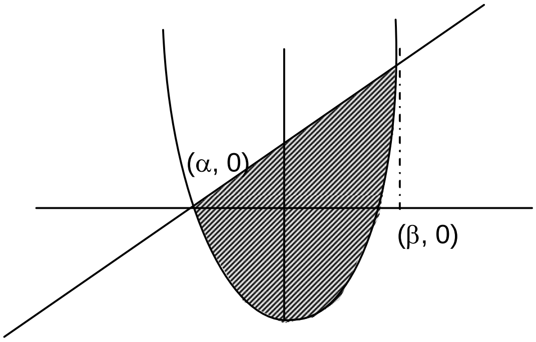
And $= \dfrac{\vec{a}\cdot\vec{b}}{|\vec{a}||\vec{b}|} = \dfrac{1}{2} \Rightarrow \dfrac{1}{2} = \dfrac{\vec{a}\cdot\vec{c}}{|\vec{a}||\vec{c}|} = \dfrac{c_1 + c_2}{\sqrt{2}.\sqrt{2}} \Rightarrow c_1 + c_2 = 1$

and $\dfrac{1}{2} = \dfrac{\vec{b}.\vec{c}}{|\vec{b}||\vec{c}|} = \dfrac{c_2 + c_3}{2} \Rightarrow c_2 + c_3 = 1$

From (1)
$2 = (1 - c_2)^2 + c_2^2 + (1 - c_2)^2$
$\Rightarrow 3c_2^2 - 4c_2 = 0$
$\Rightarrow c_2 = 0$ or $c_2 = \dfrac{4}{3}$

Therefore, the points are (1, 0, 1) and $\left(-\dfrac{1}{3}, \dfrac{4}{3}, -\dfrac{1}{3}\right)$

SECTION – C



1. A = $\int_{\alpha}^{\beta}(y_1 - y_2)$ dx where α, β are the roots of $x^2 + 2x - 3 = mx + 1$, on solving we will get

$\frac{1}{6}(m^2 - 4m + 20)^{3/2}$: Hence $\alpha = \frac{32}{3}$

$\Rightarrow \frac{6\alpha}{32} = 2.$

2. E = even of any one cutting a spade in one cut

$n(E) = {}^{13}C_1$

$n(S) = {}^{52}C_1$

$P(E) = 1/4 = p, P(\bar{E}) = q$

Probability of a winning = p + qqqp + qqqqqqp+ ……∞

$= \frac{p}{1-q^3} = \frac{64}{175}$

$\lambda = 350 \times \frac{64}{175} = 128$

$\left[\frac{\lambda}{64}\right] = 2$

4. Let a = 1 – x

b = x – y

c = y – z

d = z

then a + b + c + d = 1 and $a^2 + b^2 + c^2 + d^2 = \frac{1}{4}$

$\Rightarrow (a-b)^2 + (a-c)^2 + (a-d)^2 + (b-c)^2 + (b-d)^2 + (c-d)^2 = 0$

$\Rightarrow a = b = c = d$

$\therefore x = \frac{3}{4}, y = \frac{1}{2}, z = \frac{1}{4}$

So the distance from the point $\left(\frac{3}{4}, \frac{1}{2}, \frac{1}{4}\right)$

from the plane 4x + 2y + 4z + 7 = 0 is $\frac{3+1+1+7}{6} = 2$

5. $|A - I| = |A - I||A'|$

$|AA' - A|$ $(|AB| = |A|\,|B|)$

$|I - A'| = -|A' - I| = -|A - I|' = -|A - I|$

$\Rightarrow |A - I| = 0$

FIITJEE **JEE (Advanced), 2014**

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ALL INDIA INTEGRATED TEST SERIES

PART TEST – IV

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 198**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 to 14) contains 3 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (15 to 20) contains 6 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant R = $8.314\ J\ K^{-1}\ mol^{-1}$
= 0.0821 Lit atm $K^{-1}\ mol^{-1}$
= $1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

SECTION – A

Single Correct Choice Type

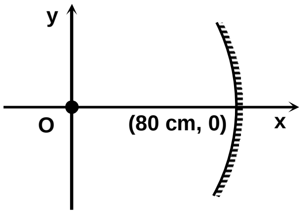
This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. A man in a boat is looking at the bottom of a lake of depth H. What will be he apparent depth of the lake if the line of vision of man forms an angle r with the vertical

(A) $(H/\mu)\sec r$ (B) H/μ

(C) $\frac{H}{\mu}\frac{\cos^2 r}{1-\left(\sin^2 r/\mu^2\right)^{3/2}}$ (D) None of these

2. In a three dimensional coordinate system (OXYZ), a concave mirror of radius of curvature 40 cm is placed at x = 80 cm. An object placed at origin is given a velocity $\vec{v}_0 = \left(9\hat{i}+6\hat{j}+3\hat{k}\right)$ cm/s. Find out the magnitude of velocity of its image.



(A) $\sqrt{46}$ cm/s (B) $\sqrt{6}$ cm/s

(C) $\frac{\sqrt{14}}{3}$ cm/s (D) None of these

3. It is desired to have a combination of two lenses placed very close to each other such that effective focal length of the combination for all the colours is same then

(A) Both must be biconvex lenses
(B) Both must be biconcave lenses
(C) At least one lens must be plano-concave lens
(D) If one lens is a converging lens then the other must be a diverging lens

4. For an equilateral prism, it is observed that when a ray strikes grazingly at one face it emerges grazingly at the other. Its refractive index will be

(A) $\frac{\sqrt{3}}{2}$ (B) $\frac{2}{\sqrt{3}}$

(C) 2 (D) Data not sufficient

Space for rough work

5. In a standard Young's double slit experiment performed with light of a single wavelength, it is observed that the difference between the intensity at the maximum and the minimum is (1/3) of the maximum intensity. If this is due to a difference in the amplitude of the light waves emerging from each slit, the ratio of the amplitudes is

(A) 3 : 2
(B) $\sqrt{3} : \sqrt{2}$
(C) 2 : 1
(D) none of these

6. If a physical quantity A associated with a hydrogen atom satisfies:

$\frac{A}{\sqrt{r}}$ = constant, where r is the radius of the electronic orbit of the hydrogen atom (not necessarily in the ground state), then A could be

(A) wavelength of emitted radiation from the state
(B) frequency emitted radiation from the state
(C) Angular momentum of a revolving electron in the state
(D) Energy of the emitted radiation from the state

7. In a series LCR circuit, the frequencies f_1 and f_2 at which the current amplitude falls to $1/\sqrt{2}$ of the current amplitude at resonance are separated by frequency interval

(A) R/L
(B) $2\pi\sqrt{LC}$
(C) $\sqrt{LC}$
(D) RC

8. Two indentical glass plates are kept close and parallel to each other. Each glass plate reflectes 20 percent of light incident on it and rest is transmitted. The ratio of the minimum and maximum intensities in the interference pattern formed by the two beams obtained after one reflection at each plate is

(A) $\frac{1}{25}$
(B) $\frac{1}{49}$
(C) $\frac{1}{64}$
(D) $\frac{1}{81}$

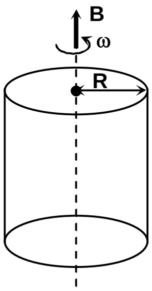
Space for rough work

Linked Comprehension Type

This section contains 3 paragraphs. Based upon each paragraph, 2 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which ***ONLY ONE*** *is correct.*

Paragraph for Questions 9 and 10

A very long solid conducting cylinder of radius R is placed in a constant and uniform magnetic field B which is parallel to the axis of the cylinder. Now the cylinder is rotated with a constant angular velocity ω as shown in the figure. Electronic charge and mass can be taken as e and m respectively.



9. The electric field inside the cylinder as a function of radial distance r is

(A) $E(r) = \left(\omega B - \frac{m\omega^2}{e}\right)r$ (B) $E(r) = \frac{m\omega^2}{e}r$

(C) $E(r) = \omega Br$ (D) $E(r) = \left(\omega B + \frac{m\omega^2}{e}\right)r$

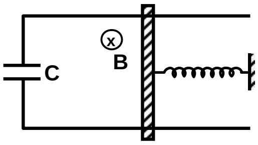
10. The potential difference between the axis of the cylinder and circumference is

(A) $\Delta V = \left(\omega B - \frac{m\omega^2}{e}\right)\frac{R^2}{2}$ (B) $\Delta V = \frac{m\omega^2 R^2}{2}$

(C) $\Delta V = \frac{\omega BR^2}{2}$ (D) $\Delta V = \left(\omega B + \frac{m\omega^2}{e}\right)\frac{R^2}{2}$

Space for rough work

Paragraph for Question Nos. 11 to 12



A straight resistanceless conductor of mass m is placed on two parallel resistance less smooth rails as shown in the figure. Distance between both the rails is ℓ. Leftmost ends of both the rails is shorted with the help of a capacitor C. The conductor is joined to a non-conducting ideal spring of spring constant k which is fixed to a rigid support. The whole system is placed in a static magnetic field B which is directed into the plane of the paper.
Now the conductor is shifted to right by a distance x_0 to compress the spring and the conductor is released from the position.

11. Find the least time to reach the conductor to its original position, where the spring was undeformed.

(A) $\frac{\pi}{2}\sqrt{\frac{m - CB^2\ell^2}{k}}$
(B) $\frac{\pi}{2}\sqrt{\frac{m}{k}}$
(C) $\frac{\pi}{2}\sqrt{\frac{CB^2\ell^2}{k}}$
(D) $\frac{\pi}{2}\sqrt{\frac{m + CB^2\ell^2}{k}}$

12. Find the maximum speed of the conductor.

(A) $x_0\sqrt{\frac{k}{m + CB^2\ell^2}}$
(B) $x_0\sqrt{\frac{k}{m - CB^2\ell^2}}$
(C) $x_0\sqrt{\frac{k}{m}}$
(D) $x_0\sqrt{\frac{k}{CB^2\ell^2}}$

Space for rough work

Paragraph for Question Nos. 13 to 14

Uranium ${}^{238}_{92}U$ is an unstable nucleus. It decays to Thorium ${}^{238}_{92}Th$, which is again an unstable nuclei which further decays to ${}^{234}_{91}Pa$. Such decay is called successive disintegration. Let ${}^{238}_{92}U$ is called as A of decay constant λ_1 and ${}^{234}_{90}Th$ is called as B of decay constant λ_2 and stable nuclei ${}^{234}_{91}Pa$ is named as C. Here A is called parent nucleus and B is called daughter nucleus of A. Any two adjacent nuclei may be consider parent or daughter nuclei. Suppose N_1, N_2 and N_3 are number of nuclei A, B and C respectively at time t which undergoes decay. Then we can write

$$A \xrightarrow{\lambda_1} B \xrightarrow{\lambda_2} C$$

Rate of disintegration of A = $\frac{dN_1}{dt} = -\lambda_1 N_1$

Rate of disintegration of B = $-\lambda_2 N_2$ and net rate of formation of B = $\frac{dN_2}{dt} = \lambda_1 N_1 - \lambda_2 N_2$

Rate of formation of nuclei C is equal to $\frac{dN_3}{dt} = \lambda_2 N_2$

If at t = 0, there are N_0 number of nuclei of A, where as nuclei B and C are absent in the sample answer the following questions

13. Number of nuclei of B at any time t is

(A) $\frac{N_0\lambda_1}{\lambda_2 - \lambda_1}\left(e^{\lambda_1 t} - e^{\lambda_2 t}\right)$ (B) $\frac{N_0\lambda_2}{\lambda_2 - \lambda_1}\left(e^{-\lambda_1 t} - e^{-\lambda_2 t}\right)$

(C) $\frac{N_0\lambda_1}{\lambda_2 - \lambda_1}\left(e^{-\lambda_1 t} - e^{-\lambda_2 t}\right)$ (D) $\frac{N_0\lambda_2}{\lambda_2 - \lambda_1}\left(e^{-\lambda_1 t} + e^{-\lambda_2 t}\right)$

14. Number of nuclei of nuclei C at time t is

(A) $N_0\left[1 + \frac{\lambda_1}{\lambda_2 - \lambda_1}e^{-\lambda_2 t} - \frac{\lambda_2}{\lambda_2 - \lambda_1}e^{-\lambda_1 t}\right]$ (B) $N_0\left[\frac{\lambda_1}{\lambda_2 - \lambda_1}e^{-\lambda_2 t} - \frac{\lambda_2}{\lambda_2 - \lambda_1}e^{-\lambda_1 t}\right]$

(C) $N_0\frac{\lambda_1}{\lambda_2 - \lambda_1}\left(e^{-\lambda_2 t} - e^{-\lambda_1 t}\right)$ (D) $N_0\left[\frac{\lambda_1}{\lambda_2 - \lambda_1}e^{-\lambda_2 t} - \frac{\lambda_2}{\lambda_2 - \lambda_1}e^{-\lambda_1 t} - 1\right]$

Multiple Correct Answer(s) Type

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.

15. Choose correct statement regarding X-ray

(A) If the target material in a Coolidge tube is changed keeping the acceleration voltage constant, the minimum wavelength of the X-rays produced will change.
(B) X-ray do not get deflected on application of electric or magnetic fields.
(C) X-ray can ionize a gas.
(D) X-ray can be reflected, refracted, diffracted and polarized under suitable condition.

Space for rough work

16. Choose the correct statement(s)
(A) The density of nuclear matter is independent of the size of the nucleus.
(B) The binding energy per nucleon, for nuclei of middle mass numbers, is about 8 MeV.
(C) A free neutron is unstable.
(D) A free proton is stable.

17. A lens of focal length 'f' is placed in between an object and screen at a distance 'D'. The lens forms two real images of object on the screen for two of its different positions, a distance 'x' apart. The two real images have magnifications m_1 and m_2 respectively ($m_1 > m_2$). Then
(A) $f = \frac{x}{m_1 - m_2}$ (B) $m_1m_2 = 1$
(C) $f = \frac{D^2 - x^2}{4D}$ (D) $D \geq 4f$.

18. A thin paper of thickness 0.02 mm having refractive index 1.45 is pasted across one of the slits in a Young's double slit experiment. The paper transmits 4/9 of light falling on it.
(λ_{light} = 600 nm).
(A) Amplitude of light wave transmitted through the paper will be 2/3 times that of incident wave.
(B) The ratio of maximum and minimum intensity in the fringe pattern will be 25.
(C) The total number of fringe crossing the centre if an identical paper is pasted on the other slit is 15.
(D) The ratio of maximum and minimum intensity in the pattern will be 5.

19. A neutron having kinetic energy E collides head on with a stationary hydrogen atom in ground state, which is initially at rest but free to move. Assume the mass of the neutron to be equal to that of H atom. Use the energy of the nth state for H atom as E_1 = – 13.6eV; E_2 =–3.4eV; E_3 = –1.5eV. (whether collision is elastic or inelastic, depends on the energy of the neutron, and in case of elastic collision they can be treated as ordinary particles) now choose the correct options:
(A) The collision will be perfectly elastic if E is less than 20.4 eV.
(B) If E = 24.2 eV, the H atom may get excited to n = 4.
(C) If E < 20.4eV the kinetic energy of the neutron will become zero after the collision.
(D) If E > 20.4eV the kinetic energy of the neutron will become zero after the collision.

20. A ray of light travelling in air falls on the surface of water in such a way that the reflected ray is completely plane polarised. The refractive index of water for the given ray is 4/3. Choose the correct option/options.
(A) The maximum angular deviation of the ray is 74°
(B) The minimum angular deviation of the ray is 16°
(C) The maximum angular deviation of the ray is 106°
(D) The minimum angular deviation of the ray 106°

Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **8 multiple choice** questions numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which only one is correct.

1. A crystal is made of particles A, B and C. A forms FCC packing B occupies all octahedral voids of A and C occupies all tetrahedral void of A. If all the particles along one body diagonal are removed them the formula of the crystal would be

(A) ABC_2	(B) A_2BC_2
(C) $A_8B_4C_5$	(D) $A_5B_4C_8$

2. Blister copper is

(A) ore of Cu	(B) pure Cu
(C) alloy of Cu	(D) Cu containing 2% impurity

3. H_2SO_4 is added while preparing a standard solution of Mohr' salt to prevent

(A) hydration	(B) reduction
(C) hydrolysis	(D) complex formation

4. In the reaction, the products P and Q are

$$Au + HCl + HNO_3 \rightarrow P + Q + H_2O$$

(A) $HAuCl_4$, NO_2	(B) $AuCl_3$, NO_2
(C) $AuCl_3$, N_2O_4	(D) $HAuCl_4$, N_2O_5

5. Which of the following can be separated by H_2S in dil HCl?

(i) $Bi^{3+}Mn^{2+}$	(ii) $Al^{3+}Hg^{2+}$
(iii) $Zn^{2+}Cu^{2+}$	(iv) $Ni^{2+}Cu^{2+}$
(A) (i) and (ii)	(B) (i) and (iii)
(C) (i), (ii), (iii)	(D) All

Rough work

6. The vapour pressure of a solution of 6.69 gm of $Ca(NO_3)_2$ in 100 gm water is 746.9 torr at 373 K. What is degree of dissociation of the salt?
(A) 0.68 (B) 0.32
(C) 0.18 (D) 0.46

7. Consider the given data:

Half – cell reaction standard reduction potential	E° (volts)
1. $Cr_2O_7^{-2} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	1.33V
2. $Cr^{3+} + 3e^- \rightleftharpoons Cr$	-0.74V
3. $Cu^+ + e^- \rightleftharpoons Cu$	0.52 V
4. $Cu^{2+} + 2e^- \rightleftharpoons Cu$	0.34 V

The numerical value of the standard cell potential for the reaction
$2Cr_{(s)} + 3Cu^{2+}_{(aq)} \rightleftharpoons 2Cr^{3+}_{(aq)} + 3Cu_{(s)}$ is
(A) - 1.08 volts (B) - 0.40 volts
(B) 1.08 volts (D) 2.50 volts

8. The product of reaction of an aqueous solution of Bi^{3+} salt with sodium thiosulphate gives
(A) Bi_2S_3 (B) $Na_3[Bi(S_2O_3)_3]$
(C) $Na[Bi(S_2O_3)_2]$ (D) $[Bi_2(S_2O_3)_2]Cl_2$

Rough work

Linked Comprehension Type

This section contains 3 paragraphs. Based upon each paragraph, 2 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which ***ONLY ONE*** *is correct.*

Paragraph for question Nos 9 to 10

The electrical energy produced by a galvanic cell is given by the product of its electromotive force and the quantity of electricity which passes. Till about the middle of the nineteenth century it was generally believed that electrical energy of a reversible cell originated from the decrease in the enthalpy ($-\Delta H$) of the cell reaction. This view received support from the fact that the enthalpy change of the reaction

$$Zn(s) + Cu^{2+}(aq) \longrightarrow Zn^{2+}(aq) + Cu(s)$$

taking place in the Daniell cell is about 210,000 joules which is very close to the electrical energy of the cell viz., 212,300 joules, as calculated above. However, towards the close of the century, it was pointed out by Gibbs, and independently by Helmholtz, that the electrical energy of a reversible cell originates from the free energy decrease ($-\Delta G$) of reaction occurring in the cell. Suppose in a particular cell reaction, n is the number of electrons liberated at one electrode (or taken up at the other electrode), then evidently, n faradays (nF coulombs) of electricity will be generated in the complete cell reaction. If, for the sake of simplicity, the EMF of the cell, viz., E_{cell} is denoted by E, then

Electrical energy produced by the cell = nFE

Hence, $-\Delta G = nFE$

Read the following paragraph and answer the questions given below:

9. In the Daniell cell, the EMF is 1.10 volts. The cell reaction involves liberation as well as taking up of 2 moles of electrons. What will be the electrical energy generated in the cell for the complete cell reaction

(A)106, 150 joule (B) 212, 300 joule

(C) 53, 075 joule (D) None of these

10. For the Daniel cell involving the cell reaction,

$Zn(s) + Cu^{2+}(aq) \longrightarrow Zn^{2+}(aq) + Cu(s)$

The standard free energies of formation of Zn(s), Cu(s), $Cu^{2+}(aq)$ and $Zn^{2+}(aq)$ are 0, 0, 64.4 kJ mol^{-1} and -154.0 kJ mol^{-1}, respectively. Calculate the standard EMF of the cell.

(A) 1.13 volt (B) 2.10 volt

(C) 0.5 volt (D) 1.95 volt

Rough work

Paragraph for question Nos 11 to 12

Addition of non-volatile solute always lowers the vapour pressure of solvent, therefore, it will be in equilibrium with solid phase at a lower pressure and hence at a lower temperature, the difference between the freezing points of the pure solvent and its solution is called depression of freezing point. The depression in freezing point when 1 mol of solute is dissolved in 1000 gm of solvent is called molal freezing point depression constant (K_f). The value of K_f for H_2O is 1.86 K mol^{-1}kg. To understand this, a solution of 25% (w/w) $MgCl_2$ containing impurity of the chloride of a trivalent metal M having atomic mass 43.5 gm (24% by weight of $MgCl_2$) has been prepared. In this solution $MgCl_2$ is completely dissociated. On the other hand only 50% dissociation of MCl_3 takes place and molality is approximately equal to molarity.

Read the following paragraph and answer the questions given below:

11. Depression in freezing point of the solution is
(A) 17.36 K (B) 13.02 K
(C) 14.88 K (D) 12.42 K

12. If the solution is cooled to –21.7°C, what weight of ice will be formed?
(A) 15 gm (B) 60 gm
(C) 40 gm (D) 51 gm

Paragraph for Question Nos. 13 to 14

One pungent colourless gas “A” and another colourless gas “B” both are soluble in water, produce a solid substance “C”. At high temperature when gas “A” is passed through heated sodium a solid substance “D” and H_2 gas is produced. When aqueous solution of “B” is added to a solution of $AgNO_3$ a white precipitate of “E” is obtained.

Read the above paragraph carefully and answer the questions given below it:

13. Pungent colourless gas A is:
(A) HCl (B) NH_3
(C) PH_3 (D) H_2S

14. After the reaction of A and B, compound C is formed; compound C is
(A) NH_2NH_2 (B) NH_4Cl
(C) $H_2S + Cl_2$ (D) PH_4Cl

Rough work

Multiple Correct Answers Type

This section contains **6 multiple correct** answer(s) type questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE** is/are correct.

15. Cataphoresis is the process used for the coagulation of colloids. It can be used for
(A) colloids having positive charge (B) colloids having negative charge
(C) lyophilic colloids (D) All of the above

16. The solid compound SiO_2 exist in the forms of
(A) crystalline in quartz (B) amorphous in quartz
(C) amorphous in silica glass (D) crystalline in silica glass

17. Given $E^o_{Ag^+|Ag} = 0.80V, E^o_{Mg^{2+}|Mg} = -2.37V, E^o_{Cu^{2+}|Cu} = 0.34V, E^o_{Hg^{2+}|Hg} = 0.79V$. Which of the following statement(s) is/are incorrect?
(A) $AgNO_3$ can be stored in copper vessel.
(B) $Cu(NO_3)_2$ can be stored in magnesium vessel.
(C) $CuCl_2$ can be stored in silver vessel.
(D) $HgCl_2$ can be stored in copper vessel.

18. Identify the correct statement(s)
(A) 1 M NaCl has higher freezing point than 1 M glucose solution.
(B) 1 M NaCl solution has almost same boiling point as 1 M KCl solution, assuming 100% ionisation.
(C) Apparent molecular weight of NaCl will be less than 58.5 in water because it undergoes dissociation.
(D) *i* = 1 when acetic acid is dissolved in benzene.

19. Which of the following is/are true?
(A) All halogens exist as diatomic gaseous molecules at ordinary temperature
(B) bromine dissolves in chloroform imparting blue colour
(C) chlorine monoxide is evolved when $KClO_3$ is treated with conc. H_2SO_4
(D) chloride ion is confirmed by chromyl chloride test

20. Which of the following is/are correct for lyophillic aquasols?
(A) Its surface tension is lower than that of H_2O.
(B) Its viscosity is higher than that of water.
(C) Colloidal silver
(D) Colloidal antimony

Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Two squares are chosen from the squares of an ordinary chess board. It is given that the selected square do not belong to the same row or column. The probability that the chosen squares are of same column is equal to

(A) $\frac{25}{49}$ (B) $\frac{32}{49}$

(C) $\frac{25}{64}$ (D) $\frac{1}{2}$

2. Area bounded by the curve y = sinx, y = cosx, $x = -\frac{\pi}{3}$, $x = 2\pi$

(A) $4\sqrt{2} - \left(\frac{\sqrt{3}+1}{2}\right)$ (B) $\sqrt{2} + \left(\frac{\sqrt{3}+1}{2}\right)$

(C) $\sqrt{2} - \left(\frac{\sqrt{3}+2}{2}\right)$ (D) $4\sqrt{2} + \left(\frac{\sqrt{3}+1}{2}\right)$

3. If f(x) = x – 1 and g(x) = |f(|x|) – 2|, then the area bounded by y = g(x) and the curve $x^2 - 4y + 8 = 0$ is equal to

(A) $\frac{4}{3}\left(4\sqrt{2}-5\right)$ (B) $\frac{4}{3}\left(4\sqrt{2}-3\right)$

(C) $\frac{8}{3}\left(4\sqrt{2}-3\right)$ (D) $\frac{8}{3}\left(4\sqrt{2}-5\right)$

Rough work

4. Let $\vec{a} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$, $\vec{b} = b_1\hat{i} + b_2\hat{j} + b_3\hat{k}$ and $\vec{c} = c_1\hat{i} + c_2\hat{j} + c_3\hat{k}$ be three non-zero vectors such that $\vec{c}$ is a unit vector perpendicular to vectors $\vec{a}$ and $\vec{b}$. If the angle between $\vec{a}$ and $\vec{b}$ is $\frac{\pi}{6}$, then $\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}^2$ is equal to

(A) 0 (B) 1

(C) $\frac{1}{4}|\vec{a}|^2|\vec{b}|^2$ (D) $\frac{3}{4}|\vec{a}|^2|\vec{b}|^2|\vec{c}|^2$

5. Shortest distance between the lines $\vec{r} = (\hat{i} + 2\hat{j} - 2\hat{k}) + \lambda(\hat{j} + \hat{k})$ and $\vec{r} = (\hat{i} - \hat{j} - \hat{k}) + \mu(\hat{j} + \hat{k})$; $\lambda, \mu \in R^+$ is

(A) $\frac{1}{2\sqrt{3}}$ (B) $\sqrt{\frac{2}{3}}$

(C) $\sqrt{2}$ (D) $\frac{4}{\sqrt{3}}$

6. The area bounded by the curve $y = \frac{3}{|x|}$ and $y + |2 - x| = 2$ is

(A) $\frac{4 - \ln 27}{2}$ (B) $2 - \ln 3$

(C) $2 + \ln 3$ (D) none of these

7. The probability that the length of a randomly chosen chord of a circle lies between $\frac{2}{3}$ and $\frac{5}{6}$ of its diameter is

(A) $\frac{5}{16}$ (B) $\frac{1}{16}$

(C) $\frac{1}{4}$ (D) $\frac{5}{12}$

Rough work

8. If p, q, r are in A.P., then the determinants $\begin{vmatrix} a^2+2^{n+1}+2p & b^2+2^{n+2}+3q & c^2+p \\ 2^n+p & 2^{n+1}+q & 2q \\ a^2+2^n+p & b^2+2^{n+1}+2q & c^2-r \end{vmatrix}$ is equal to

(A) 1 (B) 0
(C) $a^2b^2c^2 - 2^n$ (D) $(a^2 + b^2 + c^2) - 2^nq$

Comprehension Type

This section contains **3 paragraphs.** Based upon the paragraph 2 multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE IS CORRECT.**

Paragraph for Question Nos. 09 to 10

Read the following write up carefully and answer the following questions:
Two lines whose equations are $\frac{x-3}{2} = \frac{y-2}{3} = \frac{z-1}{\lambda}$ and $\frac{x-2}{3} = \frac{y-3}{2} = \frac{z-2}{3}$ lie in the same plane, then

9. Point of intersection of the lines lies on
(A) $3x + y + z = 20$ (B) $3x + y + z = 25$
(C) $3x + 2y + z = 24$ (D) none of these

10. Equation of plane containing both lines is
(A) $x + 5y - 3z = 10$ (B) $x + 6y + 5z = 20$
(C) $x + 6y - 5z = 10$ (D) none of these

Paragraph for Question Nos. 11 to 12

Read the following write up carefully and answer the following questions:
A 3 × 3 determinant has its entries 1 or –1. The number of such determinant is $2^9 = 512$. We will call a 3 × 3 determinant with entries 1 or –1 as minus special if product of elements of any rows or any column is –1 for example $\begin{vmatrix} 1 & -1 & 1 \\ 1 & 1 & -1 \\ -1 & 1 & 1 \end{vmatrix}$ is a minus special determinant.

11. The number of n × n minus special determinant must be
(A) 2^{n-1} (B) $2^{(n-1)^2}$
(C) 2^{n+1} (D) $\frac{13n^2 - 37n + 26}{n}$

12. The minimum value of 3 × 3 minus special determinant is
(A) –2 (B) –4
(C) –6 (D) 0

Rough work

Paragraph for Question Nos. 13 to 14

Read the following write up carefully and answer the following questions:
If $A_1, A_2, \ldots, A_n$ are mutually exclusive and exhaustive events and A is an event which together with one of $A_1, A_2, \ldots, A_n$, then $P(A) = P(A_1).P(A/A_1) + P(A_2) . P(A/A_2) + \ldots + P(A_n) . P(A/A_n)$.

13. A ball is drawn from a box containing 8 white and 12 green balls and kept aside. The probability that another ball drawn is green is

(A) $\frac{4}{5}$ (B) $\frac{2}{3}$

(C) $\frac{1}{5}$ (D) $\frac{3}{5}$

14. A lot contains 20 articles. The probabilities that the lot contains exactly 2 and 3 defective articles are 0.4 and 0.6 respectively. Articles are drawn from the lot at random one by one without replacement and tried till all the defective are found. Then the probability that the testing producer ends at the 12th testing is

(A) $\frac{1}{19}$ (B) $\frac{98}{1900}$

(C) $\frac{101}{1900}$ (D) $\frac{99}{1900}$

Multiple Correct Choice Type

This section contains **6 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

15. If A and B are two independent events such that $P(A) = \frac{1}{2}$, $P(B) = \frac{1}{5}$, then

(A) $P(A \cup B) = \frac{3}{5}$ (B) $P(A/B) = \frac{1}{2}$

(C) $P(A/A \cup B) = \frac{5}{6}$ (D) $P\left(\frac{A \cap B}{\bar{A} \cap \bar{B}}\right) = 0$

16. If A and B are two events such that $P(A) = \frac{1}{2}$ and $P(B) = \frac{2}{3}$, then

(A) $P(A \cup B) \geq \frac{2}{3}$ (B) $P(A \cap B') \leq \frac{1}{3}$

(C) $\frac{1}{6} \leq P(A \cap B) \leq \frac{1}{2}$ (D) $\frac{1}{6} \leq P(A' \cap B') \leq \frac{1}{2}$

Rough work

17. Let $\vec{a}, \vec{b}, \vec{c}$ are 3 vectors such that $\vec{a}\cdot\vec{a} = \vec{b}\cdot\vec{b} = \vec{c}\cdot\vec{c}$ and $|\vec{a}-\vec{b}|^2 + |\vec{b}-\vec{c}|^2 + |\vec{c}-\vec{a}|^2 = 27$ then
(A) $\vec{a}, \vec{b}, \vec{c}$ are necessarily coplanar
(B) $\vec{a}, \vec{b}, \vec{c}$ represents sides of a triangle in magnitude of direction
(C) $\vec{a}\cdot\vec{b}+\vec{b}\cdot\vec{c}+\vec{c}\cdot\vec{a}$ has the least value
(D) $\vec{a}, \vec{b}, \vec{c}$ represents mutually orthogonal vectors

18. Let E and F are independent event then
(A) E, F are mutually exclusive
(B) E, $\bar{F}$ are independent
(C) $\bar{E}$, $\bar{F}$ are independent
(D) $P\left(\frac{E}{F}\right)+P\left(\frac{\bar{E}}{F}\right)=1$

19. Let PN be the perpendicular from the point P(1, 2, 3) to xy–plane. If OP makes an angle α with positive direction of the z–axis and ON makes an angle β with the +ve direction of x–axis, where O is the origin (α and β are acute angle), then
(A) $\sin\alpha\sin\beta = \frac{2}{\sqrt{14}}$
(B) $\cos\alpha\cos\beta = \frac{1}{\sqrt{14}}$
(C) $\tan\alpha = \frac{\sqrt{5}}{3}$
(D) $\tan\beta = 2$

20. Let $\vec{a}$ and $\vec{b}$ are two given perpendicular vectors, which are non–zero. A vector $\vec{r}$ satisfying the equation $\vec{r}\times\vec{b} = \vec{a}$, can be
(A) $\vec{b} - \frac{\vec{a}\times\vec{b}}{|\vec{b}|^2}$
(B) $2\vec{b} - \frac{\vec{a}\times\vec{b}}{|\vec{b}|^2}$
(C) $|\vec{a}|\vec{b} - \frac{\vec{a}\times\vec{b}}{|\vec{b}|^2}$
(D) $|\vec{b}|\vec{b} - \frac{\vec{a}\times\vec{b}}{|\vec{b}|^2}$

Rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

ANSWERS, HINTS & SOLUTIONS

PART TEST – IV

(Paper – 2)

ANSWERS KEY

	PHYSICS	CHEMISTRY	MATHEMATICS
Q. No.	ANSWER	ANSWER	ANSWER
1.	C	D	A
2.	B	D	D
3.	D	C	A
4.	C	A	C
5.	D	D	D
6.	C	A	A
7.	A	B	C
8.	D	A	B
9.	A	B	B
10.	A	A	C
11.	D	A	B
12.	A	A	B
13.	C	B	D
14.	A	B	D
15.	B, C, D	A, B	A, B, C, D
16.	A, B, C, D	A, C	A, B
17.	A, B, C, D	A, B, D	A, B, C
18.	A, B, C	B, C	B, C, D
19.	A, C	D	A, C, D
20.	A, B	A, B	A, B, C, D

Physics

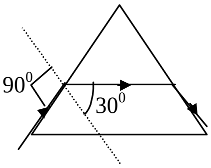
PART – I

2. $v_{Ix} = -\frac{v^2}{u^2} v_{0x}$

$v_{IY} = -\frac{v}{u} v_{OY}$, $v_{iZ} = -\frac{v}{u} v_{OZ}$

3. $\frac{\omega}{f} + \frac{\omega'}{f'} = 0$

4. $\mu = \frac{\sin 90^0}{\sin 30^0} = 2$



5. $I_{max} - I_{min} = \frac{1}{3} I_{max} \Rightarrow I_{min} = \frac{2}{3} I_{max}$

Further, $\frac{I_{max}}{I_{min}} = \left(\frac{A_1 + A_2}{A_1 - A_2}\right)^2$

6. $A = C\sqrt{r}$

from Bohr's theory mvr = constant

and $v \propto \frac{1}{\sqrt{r}}$

$\therefore L \propto vr$

$\therefore$ A is angular momentum

7. $Q = \frac{\omega_0 L}{R} = \frac{\omega_0}{2\Delta\omega}$

$\therefore$ $2\Delta\omega = R/L = f_1 - f_2$

8. $\frac{I_{min}}{I_{max}} = \frac{(A_1 - A_2)^2}{(A_1 + A_2)^2} = \left[\frac{0.2 - 0.16}{0.2 + 0.16}\right]^2 = \left(\frac{1}{9}\right)^2 = \frac{1}{81}$

9-10. Consider the force on electron $e\omega rB - eE = m\omega^2 r$

$\therefore$ $E = \left(\omega B - \frac{m\omega^2}{e}\right) r$

$\therefore$ $\Delta V = \left(\omega B - \frac{m\omega^2}{e}\right)\frac{R^2}{2}$

Considering a Gaussian surface of cylindrical shape having length ℓ, inner radius r and outer radius (r + dr)

$(E + dE)2\pi r\ell - (E)2\pi r\ell = \frac{\rho 2\pi r\ell dr}{\varepsilon_0}$

$\frac{\rho}{\varepsilon_0} = \frac{dE}{dr} = \omega B - \frac{m\omega^2}{e}$

$\therefore$ $\rho = \omega\left(B - \frac{m\omega}{e}\right)\varepsilon_0$

11-12. From conservation of energy

$$\frac{q^2}{2C}+\frac{1}{2}mv^2+\frac{1}{2}kx^2=E\text{, where } q = CB\ell v$$

$$\frac{dq}{dt}=CB\ell\frac{dv}{dt}$$

After differentiating

$$\frac{d^2x}{dt^2}=-\frac{dv}{m+CB^2\ell^2}x$$

$$\therefore\quad x = x_0\cos\left(\sqrt{\frac{k}{m+CB^2\ell^2}}\right)t$$

$$v=\frac{dx}{dt}\text{ and } q = CB\ell v$$

17. $v + u = D$

and $v - u = X$

$$\Rightarrow\quad v=\frac{D+X}{2},u=\frac{D-X}{2}$$

and $f=\dfrac{D^2-X^2}{4D}$

$$m_1=\frac{D+X}{D-X},\ m_2=\frac{D-X}{D+X}$$

18. $$\frac{I_{max}}{I_{min}}=\frac{(a_1+a_2)^2}{(a_1-a_2)^2}$$

$$\frac{a_1}{a_2}=\sqrt{\frac{I_1}{I_2}}=\sqrt{\frac{4}{9}}=\frac{2}{3}$$

$$\therefore\quad \frac{I_{max}}{I_{min}}=25$$

If an identical paper is pasted across second slit shifted C.B.F. will back in central point.

$$\text{shift}=(\mu-1)\frac{tD}{d}$$

fringe width $=\dfrac{n\lambda D}{d}$

$$\therefore\quad n=\frac{\text{shift}}{\text{fringe width}}=\frac{(\mu-1)t}{\lambda}=15$$

19. Energy available for excitation = E/2

$\therefore$ if E < 20.4 eV excitation will not take place.

For E < 20.4 eV collistion is perfectly elastic and neutron must come to rest.

Chemistry PART – II

SECTION – A

1. Number of ‘A’ particles per unit cell $= \frac{1}{8} \times 8 + \frac{1}{2} \times 6 = 4$
Number of octahedral voids = Number of B particles = 4
Number of tetrahedral voids = Number of C particles = 2 × 4 = 8
Hence formula = $A_4B_4C_8$ = ABC_2
When all particles along one body diagonal are removed two A atoms from corners are removed.
Hence new ‘A’ particles $= \frac{1}{8} \times 6 + \frac{1}{2}6 = \frac{3}{4} + 3 = \frac{15}{4}$
Number of B particles = 3
Number of C particles = 6
Hence new formula = $A_{\frac{15}{4}}B_3C_6$
$A_5B_4C_8$

2. 98% pure copper is called blister copper.

3. $FeSO_4 + 2H_2O \longrightarrow Fe(OH)_2 + H_2SO_4$
Addition of H_2SO_4 to this solution reverses the hydrolysis of $FeSO_4$.

4. The reaction is $Au + 4HCl + 3HNO_3 \rightarrow HAuCl_4 + 3NO_2 + 3H_2O$

5. Solution Bi^{3+} will form black precipitate where as Mn^{2+} does not in acidic medium due to higher K_{sp} value.
Hg^{2+} gets precipitate as HgS but Al^{3+} does not.
Cu^{2+} gets precipitated as CuS(black) whereas Zn^{2+} and Ni^{2+} does not precipitated in acidic medium.

6. $\underset{1-\alpha}{Ca(NO_3)_2} \rightleftharpoons \underset{\alpha}{Ca^{2+}} + \underset{2\alpha}{2NO_3}$

$$\frac{P^{\circ} - P}{P^{\circ}} = \left(\frac{6.69/164}{\frac{6.69}{164} + \frac{100}{18}}\right)i$$

$$\frac{760 - 746.9}{760} = i(0.00729)$$

$$i = \frac{1 + 2\alpha}{1 - \alpha} = 2.364$$

$\alpha = 0.68$

7. The half – cell reactions of the given cell will be
$Cr \longrightarrow Cr^{3+} + 3e \quad E^{\circ} = 0.74\ V$
$Cu^{2+} + 2e \longrightarrow Cu \quad E^{\circ} = 0.34V$
$\therefore E_{Cell} = 0.74 + 0.34 = 1.08V$

8. $3Na_2S_2O_3 + BiCl_3 \longrightarrow Na_3[Bi(S_2O_3)_3] + 3NaCl$

$$[Bi(S_2O_3)_3]^{3-} + 3H_2O \longrightarrow Bi_2S_3 + 3H_2SO_4$$

9. $\Delta G = -nFE$
$= -2 \times 96500 \times 1.1$
$= -212300$ J

10. $(\Delta G°)_R = (G°)_P - (G°)_R$

$= -154 - 64.4 = -218.4$ kJ.

$\Delta G° = -nFE°$

$-218.4 \times 10^3 = -2 \times 96500 \times E°$

$E° = 1.13$ V.

11. Let the solution is 100 gm
$\therefore$ 25 gm is impure $MgCl_2$ ($MgCl_2$ + MCl_3)
$\therefore$ 6 gm is MCl_3

$$\Delta T_f = i \times k_f \times m$$

$$= 1.86 \times \left[\left(i \times \frac{w_B}{M_B}\right)_{MgCl_2} + \left(i \times \frac{w_B}{M_B}\right)_{MCl_3}\right] \times \frac{1000}{w_A}$$

$$= 1.86 \times \left[\left(3 \times \frac{19}{95}\right) + \left(2.5 \times \frac{6}{150}\right)\right] \times \frac{1000}{75}$$

$$= 1.86 \times (0.6 + 0.1) \times \frac{1000}{75}$$

ΔT_f = **17.36 K**

12. At –21.7°C amount of solvent can be calculated as

$$21.7 = 1.86 \times \left[\left(3 \times \frac{19}{95}\right) + \left(2.5 \times \frac{6}{150}\right)\right] \times \frac{1000}{w_A}$$

$w_A = 60$ gm
$\therefore$ Amount of ice formed = 75 – 60 = **15 gm**.

15. Cataphoresis is the process used for coagulation of colloids in which +ve particles move towards –ve pole and –ve particles move towards +ve pole in the presence of electric field.

16. SiO_2 has different molecular arrangements in different forms.

18. More is value of *i* lesser will be freezing point of solution and *i* = $\frac{\text{Molecular wt. theoretical}}{\text{Molecular wt. experimental}}$

19. The first statement is false because F_2 and Cl_2 are gases, Br_2 is liquid while I_2 is a solid. Bromine dissolves in chloroform imparting reddish-brown colour. Chlorine dioxide is evolved when $KClO_3$ is treated with conc. H_2SO_4

20. Surface tension of lyophilic aquasols is lower than that due to force of attraction between dispersed phase and dispersion medium.
Its viscosity is higher due to force of attraction between dispersed phase and dispersion medium.

Mathematics PART – III

1. Let the first chosen square is white. Then the total number of squares which do not belong to the same row/column are 49 of them 25 are white and 24 are black.

Thus corresponding probability = $\frac{1}{2}.\frac{25}{49}$

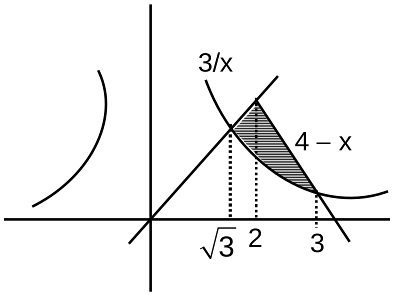
If first square is black, then corresponding probability = $\frac{1}{2}.\frac{25}{49}$

Thus required probability = $\frac{1}{2}.\frac{25}{49}+\frac{1}{2}.\frac{25}{49}=\frac{25}{49}$

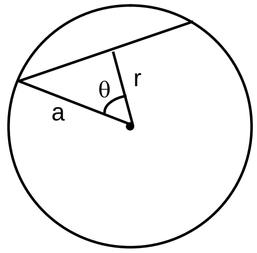
2. $A = \int\limits_{-\pi/3}^{2\pi} |\sin x - \cos x|\,dx \Rightarrow 4\sqrt{2}+\frac{\sqrt{3}+1}{2}$.

4. The given determinant is equal to $\begin{vmatrix} |\vec{a}|^2 & \vec{a}\cdot\vec{b} & 0 \\ \vec{a}\cdot\vec{b} & |\vec{b}|^2 & 0 \\ 0 & 0 & 1 \end{vmatrix} = \frac{1}{4}|\vec{a}|^2|\vec{b}|^2$.

6. Area = $\int\limits_{\sqrt{3}}^{2} x - \frac{3}{x} + \int\limits_{2}^{3}\left(4 - x - \frac{3}{x}\right)dx = \frac{4-\ln 27}{2}$.



7. If l is the length of chord, r the distance of the mid point of chord from the centre and a is radius of given circle.



r = a cos θ

l = 2a sin θ

$\frac{2}{3}\,2a < 2a\sin\theta < \frac{5}{6}\,2a$

$\frac{\sqrt{11}}{6}a < r < \frac{\sqrt{5}}{3}a$

∴ The given condition is satisfied if the mid point of the chord lies within the region between the concentric circles of radius $\frac{\sqrt{11}}{6}$ and $\frac{\sqrt{5}}{3}$.

$P = \frac{5}{9}-\frac{11}{36}=\frac{1}{4}$.

$\left(\frac{\text{Area of circular angular}}{\text{Area of given circle}}\right)$

8. Applying $R_1 \to R_1 - R_3$ and $2q = p + r$

$$\begin{vmatrix} 2^{n+1} - 2^n + p & 2^{n+2} - 2^{n+1} + q & p + r \\ 2^n + p & 2^{n+1} + q & p + r \\ a^2 + 2^n + p & b^2 + 2^{n+1} + 2q & c^2 - r \end{vmatrix} = \begin{vmatrix} 2^n + p & 2^{n+1} + q & p + r \\ 2^n + p & 2^{n+1} + q & p + r \\ a^2 + 2^n + p & b^2 + 2^{n+1} + 2q & c^2 - r \end{vmatrix} = 0.$$

9. Point of intersection is (5, 5, 5).

10. Equation of plane containing both the lines

$$\begin{vmatrix} x - 3 & y - 2 & z - 1 \\ 2 & 3 & 4 \\ 3 & 2 & 3 \end{vmatrix} = 0 \Rightarrow x + 6y - 5z = 10.$$

11. $({}^nC_1 + {}^nC_3 + {}^nC_5 + \ldots)^{n-1} = 2^{(n-1)^2}$

12. $$\begin{vmatrix} 1 & -1 & 1 \\ 1 & 1 & -1 \\ -1 & 1 & 1 \end{vmatrix} = -4$$

13. Required probability = $\frac{8}{20} . \frac{12}{19} + \frac{12}{20} . \frac{11}{19} = \frac{3}{5}$

14. Required probability = $\frac{2}{5} \cdot \frac{{}^2C_1 \cdot {}^{18}C_{10}}{{}^{20}C_{11}} \cdot \frac{1}{9} + \frac{3}{5} \cdot \frac{{}^3C_2 \cdot {}^{17}C_9}{{}^{20}C_{11}} \cdot \frac{1}{9} = \frac{99}{1900}$

15. A, B, C, D are independent events

$\therefore$ $P(A \cap B) = \frac{1}{2} \times \frac{1}{5} = \frac{1}{10}$ and $P(A/B) = P(A) = \frac{1}{2}$

Also $P(A \cup B) = P(A) + P(B) - P(A \cap B) = \frac{1}{2} + \frac{1}{5} - \frac{1}{10} = \frac{3}{5}$

Now $P(A/A \cup B) = \frac{P\{A \cap (A \cup B)\}}{P(A \cup B)} = \frac{P(A)}{P(A \cup B)} = \frac{1/2}{3/5} = \frac{5}{6}$.

16. $P(A \cup B) = P(A) + P(B) - P(A \cap B) = \frac{1}{2} + \frac{2}{3} - P(A \cap B) = \frac{7}{6} - P(A \cap B)$

$0 \le P(A \cap B) \le \frac{1}{2}$.

17. Clearly $\vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + \vec{c} \cdot \vec{a} = -\frac{9}{2}$

$|\vec{a} + \vec{b} + \vec{c}|^2 = |\vec{a}|^2 + |\vec{b}|^2 + |\vec{c}|^2 + 2(\vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + \vec{c} \cdot \vec{a})$

$\therefore$ $\vec{a} + \vec{b} + \vec{c} = 0 |\vec{a} + \vec{b} + \vec{c}|^2 \ge 0$.

19. Let OP = r

$\Rightarrow 1 = r \sin \alpha \cos \beta$ …(i)

$2 = r \sin \alpha \sin \beta$ …(ii)

$3 = r \cos \alpha$ …(iii)

Squaring and adding, we get

$r^2 = 14$

$\Rightarrow r = \pm\sqrt{14}$ …(iv)

Using (i), (ii), (iii) and (iv), we get the required result.

20. Since $\vec{a}$, $\vec{b}$ and $\vec{a}\times\vec{b}$ are non–coplanar.

So $\vec{r} = x\vec{a} + y\vec{b} + z(\vec{a}\times\vec{b})$

$\therefore\ \vec{r}\times\vec{b} = \vec{a} \Rightarrow x\vec{a}\times\vec{b} + z\left\{(\vec{a}\cdot\vec{b})\vec{b} - (\vec{b}\cdot\vec{b})\vec{a}\right\} = \vec{a}$

$\Rightarrow -\left(1 + z\left|\vec{b}\right|^2\right)\vec{a} + x\vec{a}\times\vec{b} = 0$ $\left[\text{since } \vec{a}\cdot\vec{b} = 0\right]$

$\therefore$ x = 0 and $z = -\dfrac{1}{\left|\vec{b}\right|^2}$

Thus $\vec{r} = y\vec{b} - \dfrac{\vec{a}\times\vec{b}}{\left|\vec{b}\right|^2}$, where y is the parameter.

FIITJEE **JEE (Main), 2014**

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ALL INDIA INTEGRATED TEST SERIES

PART TEST – IV

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 03 and 10 to 12)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (04 to 09 and 13 to 30) contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

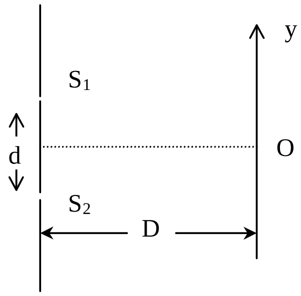
Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. Two mirrors, one concave and the other convex, are placed 60 cm apart with their reflecting surfaces facing each other. An object is placed 30 cm from the pole of either of them on their axis. If the focal lengths of both the mirrors are 15cm, the position of the image formed by reflection, first at the convex and then at the concave mirror, is
(A) 19.09 cm from the pole of the convex mirror
(B) 19.09 cm from the pole of the concave mirror
(C) 11.09 cm from the pole of the concave mirror
(D) 11.09 cm from the pole of the convex mirror

2. An alternating voltage $E = E_0 \sin \omega t$, is applied across a coil of inductor L. The current flowing through the circuit at any instant t is
(A) $\frac{E_0}{\omega L} \sin(\omega t + \pi/2)$ (B) $\frac{E_0}{\omega L} \sin(\omega t - \pi/2)$
(C) $E_0 \omega L \sin(\omega t - \pi/2)$ (D) $E_0 \omega L \sin(\omega t + \pi/2)$

3. Consider a usual set up of Young's double slit experiment with slits of equal intensity as shown in the figure. Take 'O' as origin and the Y axis as indicated. If average intensity between $y_1 = -\frac{\lambda D}{4d}$ and $y_2 = +\frac{\lambda D}{4d}$ equals 'n' times the intensity of maxima, then 'n' equals



(A) $\frac{1}{2}\left(1+\frac{2}{\pi}\right)$ (B) $2\left(1+\frac{2}{\pi}\right)$
(C) $\left(1+\frac{2}{\pi}\right)$ (D) $\frac{1}{2}\left(1-\frac{2}{\pi}\right)$

Space for rough work

4. One of the combination from the fundamental physical constants is hc/G. The unit of this expression is

(A) kg^2 (B) m^3
(C) s^{-1} (D) none of the above

5. Let $[\varepsilon_0]$ denote the dimensional formula of the permittivity of vacuum. If M = mass, L = length, T = time and I = electric current. Then

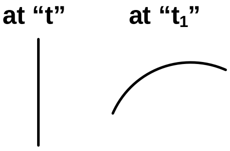
(A) $[\varepsilon_0] = [M^{-1}L^{-3}T^2I]$ (B) $[\varepsilon_0] = [M^{-1}L^{-3}T^4I^2]$
(C) $[\varepsilon_0] = [M^{-1}L^2T^{-1}I^{-2}]$ (D) $[\varepsilon_0] = [M^{-1}L^2T^{-1}I]$

6. A coil of resistance R and inductance L is connected across an a.c. power supply of r.m.s. voltage V. The average power dissipated in the coil is,

(A) V^2/R (B) $\frac{V^2R}{(R^2+\omega^2L^2)}$
(C) $\frac{V^2}{\sqrt{(R^2+\omega^2L^2)}}$ (D) zero

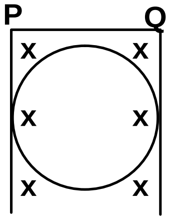
7. The figure shows a plane wave front at a time ‘t’ and at a time ‘t_1’

In the time interval (t_1 – t) the wave front must have passed through



(A) a prism (B) a prism and a convex lens
(C) a convex lens (D) a plane mirror and a concave lens

8. A vertical ring of radius r and resistance R falls vertically. It is in contact with two vertical rails which are joined at the top. The rails are without friction and resistance. There is a horizontal uniform magnetic field of magnitude B perpendicular to the plane of the ring and the rails. When the speed of the ring is v, the current in the section PQ is



(A) zero (B) $\frac{2Brv}{R}$
(C) $\frac{4Brv}{R}$ (D) $\frac{8Brv}{R}$

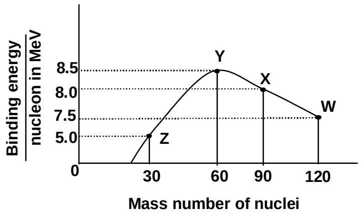
Space for rough work

9. An electric lamp designed for operation on 110 V AC is connected to a 220 V AC supply, through a choke coil of inductance 2H, for proper operation. The angular frequency of the AC is $100\sqrt{10}$ rad/s. If a capacitor is to be used in place of the choke coil, its capacitance must be

(A) 1 μF (B) 2 μF
(C) 5 μF (D) 10 μF

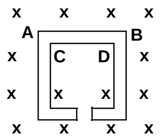
10. Binding energy per nucleon v_s mass number curve for nuclei is shown in the figure W, X, Y and Z are four nuclei indicated on the curve. The process that would release energy is

(A) Y → 2Z (B) W → X + Z
(C) W → 2Y (D) X → Y + Z



11. A wire is bent to form the double loop shown in the figure. There is a uniform magnetic field directed into the plane of the loop. If the magnitude of this field is decreasing, current will flow from

(A) A to B and C to D (B) B to A and D to C
(C) A to B and D to C (D) B to A and C to D



12. A cubical room is formed with 6 plane mirrors. An insect moves along the diagonal of the floor with uniform speed. The speed of its image in two adjacent walls is $20\sqrt{2}$ cm/s. Then the speed of the image formed on the roof is

(A) 20 cm/s (B) 40 cm/s
(C) $20\sqrt{2}$ cm/s (D) $10\sqrt{2}$ cm/s

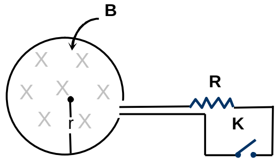
13. A prism of refractive index $\sqrt{2}$ refracting angle A produces minimum deviation D_m of a ray on one face at an angle of incidence 45° . The values of A and D_m are respectively.

(A) 45°, 45° (B) 45°, 60°
(C) 60°, 30° (D) 60°, 45°

Space for rough work

14. Which of the following statement is correct?
(A) The rest mass of a stable nucleus is less than the sum of the rest masses of its separated nucleons.
(B) The rest mass of a stable nucleus is greater than the sum of the rest masses of separated nucleons.
(C) In nuclear fission, energy is released by fusing two nuclei of medium mass (approximately 100 amu)
(D) In nuclear fission, energy is released by fragmentation of a very heavy nucleus.

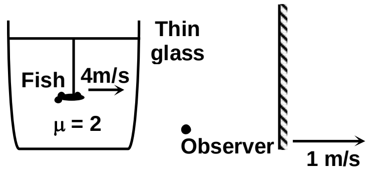
15. Shown in the figure is a circular loop of radius r and resistance R. A variable magnetic field of induction B = e^{-t} is established inside the coil. If the key (K) is closed at t = 0, the electrical power developed at the instant is equal to



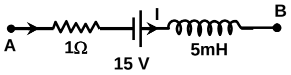
(A) $\frac{\pi r^2}{R}$
(B) $\frac{10r^3}{R}$
(C) $\frac{\pi^2 r^4 R}{5}$
(D) $\frac{\pi^2 r^4}{4R}$

16. In a YDSE apparatus, two films of thickness t_A and t_B, having refractive indices μ_A and μ_B are placed in front of slits A and B respectively. If $t_A\mu_A = t_B\mu_B$ the central maximum will
(A) not shift
(B) shift towards A if $t_A < t_B$
(C) shift towards B if $t_A < t_B$
(D) shift towards A if $t_A > t_B$

17. Velocity of image of fish in the mirror with respect to ground is
(A) zero
(B) 2 m/s towards mirror.
(C) 2 m/s away from mirror
(D) 4 m/s towards mirror.



18. The network shown in figure is a part of a complete circuit. If at a certain instant the current (I) is 5A, and is decreasing at a rate of 10^3 A/s. Then $V_B - V_A$ is equal to



(A) 15V
(B) 25V
(C) 20V
(D) 10 V

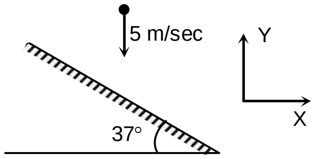
Space for rough work

19. Nuclei of radioactive element A are produced at any time t. the element A has decay constant λ. Let N be number of nuclei if element A at any time t. At time t = t_0, dN/dt is minimum. Then the numbers of nuclei of element A at time t = t_0 is

(A) $\frac{t_0 - \lambda t_0^2}{\lambda^2}$ (B) $\frac{2t_0 - \lambda t_0^2}{\lambda^2}$

(C) $\frac{t_0 - \lambda t_0^2}{\lambda}$ (D) $\frac{2t_0 - \lambda t_0^2}{\lambda}$

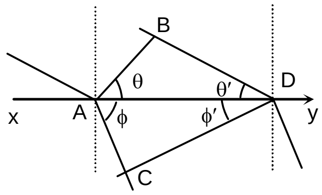
20. An object O is just about to strike a perfectly reflecting inclined plane of inclination 37° its velocity is 5 m/sec. Find the velocity of its image.



(A) $3\hat{i} + 4\hat{j}$ (B) $4\hat{i} + 3\hat{j}$

(C) $4.8\hat{i} + 14\hat{j}$ (D) $1.4\hat{i} + 4.8\hat{j}$

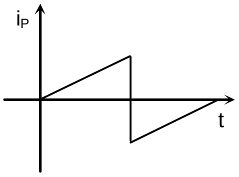
21. A wave front AB moving in air is incident on a plane glass surface XY, as given in the figure, its position CD after refraction through glass slab is shown along with normal drawn at A and d. the refractive index of glass w.r.t. air is given by



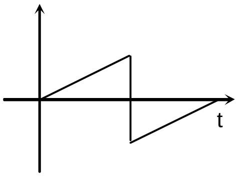
(A) $\frac{\sin\theta}{\sin\theta'}$ (B) $\frac{\sin\theta}{\sin\phi'}$

(C) $\frac{\sin\phi}{\sin\theta}$ (D) $\frac{AB}{CD}$

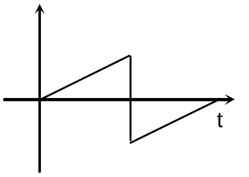
22. Nature of induced emf in secondary coil due to current in primary coil.



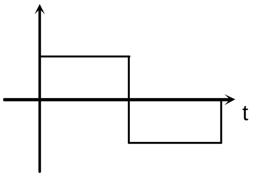
(A)



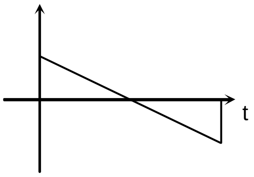
(B)



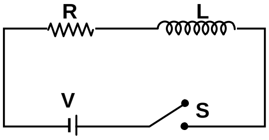
(C)



(D)



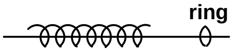
Space for rough work



23. A resistor and inductor are connected in series through a battery. The switch is closed at time t = 0. Then what is the magnitude of current flowing when rate of increase of magnetic energy in the inductor is maximum

(A) $I = \frac{V}{R}$ (B) $I = \frac{V}{2R}$

(C) $I = \frac{V}{4R}$ (D) $I = \frac{V}{R}\ln 2$



24. The diagram shows a solenoid carrying time varying current $I = I_0 t$ (I_0 is constant) on the axis of this solenoid a conducting ring is being placed as shown in the figure. The mutual inductance of the ring and the solenoid is M and self inductance of the ring is L. If the resistance of the ring is R then the maximum current which can flow through the ring is:

(A) $(2M+L)\frac{I_0}{R}$ (B) $\frac{MI_0}{R}$

(C) $(2M-L)\frac{I_0}{R}$ (D) $(M+L)\frac{I_0}{R}$

25. A student constructs a series RLC circuit. White operating the circuit at a frequency f he uses an AC voltmeter and measures the potential difference across each device as $(\Delta V_R)_{max}$ = 8.8 V, $(\Delta V_L)_{max}$ = 2.6 V, and $(\Delta V_C)_{max}$ = 7.4 V. Inductor in the circuit is connected next to capacitor. What result student will obtain for a measurement of combined potential difference $(\Delta V_L + \Delta V_C)_{max}$ across the inductor and capacitor.

(A) 10.0 V (B) 7.8 V

(C) 7.4V (D) 4.8 V

26. A radioactive isotopes is being produced at a constant rate X. Half life of substance is Y. After same time the no of radioactive nuclei become constant. The value of constant is

(A) $\frac{XY}{\ln(2)}$ (B) XY

(C) (ln2)XY (D) $\frac{X}{Y}$

27. In a black body radiation certain temperature T_1, the wave length having maximum intensity of radiation equal 9000 A^0. when the temperature is increased from T_1 to T_2 the total radiation increases 16 times. The peak radiation at T_2 is found to be capable of ejecting photoelectrons. The maximum kinetic energy of photoelectrons is the same as the energy of photon that one gets when one of electron in the M-shall of hydrogen atom jumps to L-shell, the work function of the metal will be

(A) 0.88 eV (B) 1.5 eV

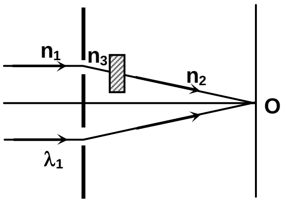
(C) 2.0 eV (D) 1.2 eV

Space for rough work

28. The energy of tungsten atom with a vacancy in L shell is 11.3 keV. Wavelength of k_α photon for tungsten is 21.3 pm. If a potential difference of 62 kV is applied across the X-ray tube following characteristic.

(A) K, L series
(B) only k_α and L series
(C) only L series
(D) none of these

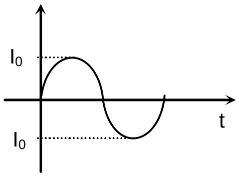
29. In the figure shown YDSE, a parallel beam of light is incident on the slit from a medium of reflective index n_1. The wavelength of light in the medium λ_1. A transparent slab of thickness 't' and refractive index n_3 is put infront of one slit. The medium between the screen and the plane of the slits is n_2. The phase difference between the light waves reaching point O (Symmetrical relative to the slits) is



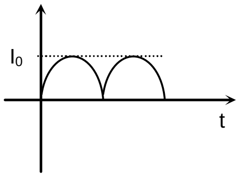
(A) $\frac{2\pi}{n_1\lambda_1}(n_3 - n_2)t$
(B) $\frac{2\pi}{\lambda_1}(n_3 - n_2)t$
(C) $\frac{2\pi n_1}{n_2\lambda_1}\left(\frac{n_3}{n_2} - 1\right)t$
(D) $\frac{2\pi n_1}{\lambda_1}(n_3 - n_1)t$

30. If I_1, I_2, I_3 and I_4 are the respective rms values of the time varying current as shown in four cases I, II, III, IV. Then identify the correct relations:

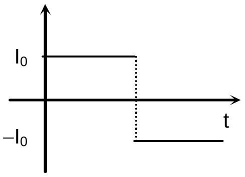
(I)



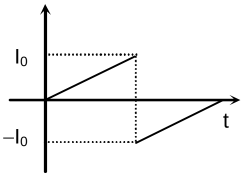
(II)



(III)



(IV)



(A) $I_1 = I_2 = I_3 = I_4$
(B) $I_3 > I_1 = I_2 > I_4$
(C) $I_3 > I_4 > I_2 = I_1$
(D) $I_3 > I_2 > I_1 > I_4$

Rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Before adding the reagents of group (III) of basic radicals, the solution is heated with some concentrated HNO_3 in order to
(A) lower the pH
(B) oxidize Cr^{3+} to $Cr_2O_7^{2-}$
(C) oxidize Fe^{2+} to Fe^{3+}
(D) increase $[NO_3^-]$

2. When heated above 916°C, iron changes its crystal structure from bcc to ccp structure without any change in the radius of atom. The ratio of density of the crystal before heating and after heating is:
(A) 1.089
(B) 0.918
(C) 0.725
(D) 1.231

3. The aqueous solution of each of the following salt is coloured except
(A) $TiCl_4$
(B) $FeCl_3$
(C) $CuCl_2$
(D) $MnCl_2$

4. If all Fe^{2+} ions are replaced by Sr^{4+} ions in 0.1 mole of $Fe_{0.9}O$, then number of vacancies created are
(A) 0.035 N_A
(B) 0.01 N_A
(C) 0.07 N_A
(D) 0.1 N_A
(N_A is Avogadro number.)

5. In diamond, the lattice is fcc with C atoms occupying lattice points as well as some of the voids. Which of the following statement(s) is/are correct about the diamond structure?
(I) In the diamond lattice, half of the tetrahedral voids are occupied.
(II) Percentage space occupied (packing efficiency) is 74%.
(III) In the diamond lattice all octahedral voids are occupied.
(A) Only I
(B) Only III
(C) I, II and III
(D) Only II

Rough work

6. Na_2CO_3 cannot be used in place of $(NH_4)_2CO_3$ for the precipitation of group V cations, because
(A) Na^+ interferes in the detection of group V
(B) concentration of CO_3^{2-} is very low
(C) Na^+ will react with the acid radicals
(D) Mg^{2+} will precipitate as $MgCO_3$

7. When $K_4[Fe(CN)_6]$ is added to $FeCl_3$, the complex formed is
(A) $Fe_3[Fe(CN)_6]_4$
(B) $K_2Fe[Fe(CN)_6]$
(C) $Fe_4[Fe(CN)_6]_3$
(D) $K_2Fe[Fe(CN)_6]_2$

8. When excess of $SnCl_2$ is added to a solution of $HgCl_2$, a white precipitate that turn grey, is obtained. The grey colour is due to the formation of
(A) Hg_2Cl_2
(B) $SnCl_4$
(C) Sn
(D) Hg

9. For an ideal binary liquid solution with $P_A^0 > P_B^0$, which relation between χ_A (mole fraction of A in liquid phase) and Y_A (mole fraction of A in vapour phase) is correct? (χ_B & Y_B are the mole fractions of B in liquid and vapour phase respectively)
(A) $\frac{Y_A}{Y_B} < \frac{\chi_A}{\chi_B}$
(B) $\chi_A > \chi_B$
(C) $Y_A < Y_B$
(D) $\frac{Y_A}{Y_B} > \frac{\chi_A}{\chi_B}$

10. The ratio of van't Hoff factor, if PBr_5 and PCl_5 are assumed to be soluble in water and remains same as in solid state, is
(A) 2
(B) 1
(C) 1.5
(D) 2.5

11. Insulin $(C_2H_{10}O_5)_n$ is dissolved in a suitable solvent and the osmotic pressure (π) of solution of various concentration (Kg/m^3) is measured at 20°C. The slope of a plot of π against C is found to be 4.65×10^{-3} (SI units). The molecular weight of the insulin (in Kg) is
(A) 4.8×10^5
(B) 9×10^5
(C) 3×10^5
(D) 5.24×10^5

12. When 0.1 mole of AgCl is dissolved in 1L of water then relative lowering of vapour pressure is 3.6×10^{-7}. The solubility product of AgCl is
(A) 10^{-10}
(B) 2×10^{-10}
(C) 2×10^{-9}
(D) Can not calculate

Rough work

13. The weight of a non-volatile solute (molecular weight = 40), required to be dissolved in 114 g octane, to reduce its vapour pressure to 80% is
(A) 5 g (B) 10 g
(C) 15 g (D) 20 g

14. Which is not a π-bonded complex?
(A) Zeises salt (B) Ferrocene
(C) Dibenzene chromium (D) Tetraethyl lead

15. The equilibrium constant of the following redox reaction at 298 K is 1×10^8.

$$2Fe^{3+}(aq.) + 2I^-(aq.) \rightleftharpoons 2Fe^{2+}(aq.) + I_2(s)$$

If the standard reduction potential of iodine becoming iodide is + 0.54 V. What is the standard reduction potential of Fe^{3+}/Fe^{2+}?
(A) + 1.006 V (B) –1.006 V
(C) + 0.776 V (D) –0.776 V

16. A cell assembled of two hydrogen electrodes at 1 atm pressure. The positive electrode is in contact with a solution of 10^{-4} M hydrogen ions. The emf of the cell is 0.118 V at 25°C. The concentration of hydrogen ions at negative electrode is
(A) 10^{-6} M (B) 10^{-4} M
(C) 10^{-2} M (D) None of the above

17. On passing CrO_2Cl_2 vapours in water and then adding $(CH_3COO)_2Pb$, the precipitate formed is
(A) $PbCrO_4$ (B) $PbCl_2$
(C) $CrCl_3$ (D) $PbSO_4$

18. From the following reaction,

$$A^+ + e^- \longrightarrow A \qquad E^o = 2\text{ V}$$

$$B^+ + e^- \longrightarrow B \qquad E^o = 4\text{ V}$$

$$C^+ + e^- \longrightarrow C \qquad E^o = 5\text{ V}$$

Which cell will have maximum standard electrode potential?
(A) B½B^+ 1½½ A^+ ½A (B) A½A^+ 1½½C^+ ½C
(C) A½A^+ 1½½ B^+½B (D) B½B^+ 1½½ C^+ ½C

19. A constant current of 2 ampere was passed for 16 minutes when 250 ml, 0.2 M $CuSO_4$(aq) solution was electrolysed using a platinum anode and Cu cathode. Then at what temperature the solution will freeze, after passage of current? ($K_f(H_2O)$ = 1.86 unit)
(A) 0.67°C (B) –0.67°C
(C) –1.86°C (D) +1.86°C

Rough work

20. When phosphorus is heated with conc. HNO_3, it reduces the acid to
(A) NO (B) NO_2
(C) N_2O_3 (D) N_2O_5

21. Heating ammonium dichromate yields a gas, which is also obtained by
(A) Mg_3N_2 in H_2O (B) Heating NH_4NO_3
(C) Heating NH_4NO_2 (D) Na_2O_2 in H_2O

22. Which of the following statement is incorrect?
(A) Silver glance mainly contains silver sulphide
(B) Zinc blende mainly contains zinc chloride
(C) Gold is found in native state
(D) Copper pyrites also contains Fe_2S_3

23. In which one case of the following oxides, carbon is not used as a reducing agent (in metallurgical process)?
(A) Fe_2O_3 (B) PbO
(C) SnO_2 (D) Al_2O_3

24. $NH_3 + O_2 \xrightarrow[\Delta]{Pt} X + H_2O$;

$X + O_2 \longrightarrow Y$;

$Y + O_2 + H_2O \longrightarrow Z$;

X, Y and Z are respectively
(A) N_2O, NO_2, HNO_3 (B) NO_2, NO, HNO_3
(C) NO, NO_2, HNO_3 (D) N_2O, NO, HNO_3

25. In the manufacture of steel from pig iron by Bassemer process, the furnace called Baseemer converter is lined with silica bricks when:
(A) the impurity is mainly phosphorus (B) the impurity is mainly manganese
(C) the impurity is mainly silicon (D) the impurity is mainly sulphur

26. To a metal nitrate, when KI solution is added, a brownish black precipitate is produced at first, on adding excess of KI orange solution is produced. Identify the metal ion.
(A) Hg^{2+} (B) Bi^{3+}
(C) Cu^{2+} (D) Pb^{2+}

27. In nitroprusside ion, the iron and NO exist as Fe(II) and NO^+ rather than Fe(III) and NO. These forms can be differentiated by
(A) Estimating the concentration of iron (B) Measuring the concentration of CN^-
(C) Measuring the solid state magnetic moment (D) Thermally decomposing the compound

Rough work

28. The stability of lyophilic colloids is due to
(A) charge on their particles
(B) large size of their particles
(C) smaller size of their particles
(D) a layer of medium of dispersion on their particles

29. Which of the following give HIO_3 on hydrolysis?
(A) ICl_3 (B) IF_5
(C) IF_7 (D) ICl

30. Which of the following is correct about P_4O_{10}?
(A) It is an anhydride of H_3PO_3.
(B) All the P atoms are sp^3d hybridized.
(C) There are 10 (P — O — P) linkage in one molecule.
(D) Total number of sp^3 hybridized atoms per molecules is 10.

Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. A nine digit number is formed using 1, 2, 3, ….., 9 without repetition. The probability of forming a number such that product of any of its five consecutive digits is divisible by 3 or 5

(A) $\frac{1}{63}$ (B) $\frac{17}{18}$

(C) $\frac{62}{63}$ (D) none of these

2. The area of the region bounded between the curves $y = e\left||x|\ln|x|\right|$, $x^2 + y^2 - 2(|x| + |y|) + 1 \geq 0$ and x-axis where $|x| \leq 1$, if α is the x-coordinate of the point of intersection of curves in 1st quadrant, is

(A) $4\left[\int_0^{\alpha} ex\ln x\,dx + \int_{\alpha}^{1}\left(1 - \sqrt{1-(x-1)^2}\right)dx\right]$ (B) $4\left[\int_0^{\alpha} ex\ln x\,dx - \int_{1}^{\alpha}\left(1 - \sqrt{1-(x-1)^2}\right)dx\right]$

(C) $2\left[-\int_0^{\alpha} ex\ln x + \int_{\alpha}^{1}\left(1 - \sqrt{1-(x-1)^2}\right)dx\right]$ (D) $2\left[\int_0^{\alpha} ex\ln x + \int_{\alpha}^{1}\left(1 - \sqrt{1-(x-1)^2}\right)dx\right]$

3. If $\bar{a}, \bar{b}, \bar{c}$ are non-coplanar and $\bar{d}$ is any unit vector the expression $\left|(\bar{a}\cdot\bar{d})(\bar{b}\times\bar{c}) + (\bar{b}\cdot\bar{d})(\bar{c}\times\bar{a}) + (\bar{c}\cdot\bar{d})(\bar{a}\times\bar{b})\right|$ is independent of the vector

(A) $\bar{a}$ (B) $\bar{b}$

(C) $\bar{c}$ (D) $\bar{d}$

4. If A and B are square matrices such that $A^{2006} = O$ and AB = A + B, then det B equals to

(A) 0 (B) 1

(C) – 1 (D) none of these

Rough work

5. Solution of the differential equation $y\,(2x^4 + y)\,\frac{dy}{dx} = (1 - 4xy^2)\,x^2$ is given by

(A) $3\,(x^2y)^2 + y^3 - x^3 = c$
(B) $xy^2 + \frac{y^3}{3} - \frac{x^3}{3} + c = 0$
(C) $\frac{2}{5}yx^5 + \frac{y^3}{3} = \frac{x^3}{3} - \frac{4xy^3}{3} + c$
(D) none of these

6. Let A, B and C are any three points on the ellipse $36x^2 + \frac{y^2}{192} = 1$, then the maximum area of the triangle ABC is

(A) 1
(B) 2
(C) 3
(D) 4

7. The length of the perpendicular from (1, 0, 2) on the line $\frac{x+1}{3} = \frac{y-2}{-2} = \frac{z+1}{-1}$ is

(A) $\frac{3\sqrt{6}}{2}$
(B) $\frac{6\sqrt{3}}{5}$
(C) $3\sqrt{2}$
(D) $2\sqrt{3}$

8. The value of the determinant $\begin{vmatrix} 1 & e^{i\pi/3} & e^{i\pi/4} \\ e^{-i\pi/3} & 1 & e^{2i\pi/3} \\ e^{-i\pi/4} & e^{-2i\pi/3} & 1 \end{vmatrix}$ where $i = \sqrt{-1}$ is

(A) $2 + \sqrt{2}$
(B) $-(2+\sqrt{2}\,)$
(C) $-2 + \sqrt{3}$
(D) $2\sqrt{3}$

9. The area of the region containing the points satisfying $|y| + \frac{1}{2} \le e^{-|x|}$, $\max(|x|, |y|) \le 2$ is

(A) $2\log\left(\frac{e}{2}\right)$
(B) $2\log\left(\frac{2e}{3}\right)$
(C) $3\log\left(\frac{e}{2}\right)$
(D) $3\log\left(\frac{2e}{3}\right)$

10. A point P(x, y) moves is such a way that [x + y + 1] = [x] (where [ ] denotes g.i.f) and $x \in (0, 2)$. Then the area representing all the possible positions of P equals

(A) $\sqrt{2}$ sq units
(B) $2\sqrt{2}$ sq units
(C) $4\sqrt{2}$ sq units
(D) None of these

Rough work

11. If the general solution for the differential equation $\frac{dy}{dx}=\frac{y}{x}+\phi\left(\frac{x}{y}\right)$ is y = $\frac{x}{\ln(cx)}$, then function $\phi\left(\frac{x}{y}\right)$ is

(A) $-\frac{x^2}{y^2}$ (B) $-\frac{y^2}{x^2}$

(C) $\frac{y^2}{x^2}$ (D) $\frac{x^2}{y^2}$

12. The length of the projection of the line segment joining P(–1, 2, 0) and Q(1, – 1, 2) on the plane 2x – y – 2z = 4 is

(A) 4 (B) 1

(C) 17 (D) none of these

13. Two persons Ram and Shyam agree to meet at a place between 11 to 12 noon. The first one to arrive waits for 20 minute and then leave. If the time of their arrive be independent and at random, then the probability that ram and Shyam meet is

(A) $\frac{1}{3}$ (B) $\frac{2}{3}$

(C) $\frac{4}{9}$ (D) $\frac{5}{9}$

14. If one of the roots of the equation $\begin{vmatrix} 7 & 6 & x^2-13 \\ 2 & x^2-13 & 2 \\ x^2-13 & 3 & 7 \end{vmatrix}$ = 0 is x = 2, then sum of all other five roots is

(A) $2\sqrt{15}$ (B) – 2

(C) $\sqrt{20}+\sqrt{15}-2$ (D) none of these

15. $\vec{a}$ and $\vec{c}$ are unit vectors and $|\vec{b}|$ = 4. If the angle between $\vec{b}$ and $\vec{c}$ is $\cos^{-1}\left(\frac{1}{4}\right)$ and $\vec{a}\times\vec{b}$ = $2\vec{a}\times\vec{c}$ then $\vec{b}=\lambda\vec{a}+2\vec{c}$ where λ is equal to

(A) $\pm\frac{1}{4}$ (B) $\pm\frac{1}{2}$

(C) ± 1 (D) ± 4

Rough work

16. If A = $\begin{bmatrix} ab & b^2 \\ -a^2 & -ab \end{bmatrix}$ and $A^n = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$, then minimum value of n is

(A) 2
(B) 4
(C) 6
(D) 3

17. Solution of differential equation $xdy - (y + xy^3(1 + \log x))dx = 0$

(A) $\frac{-x^2}{y^2} = \frac{2x}{3}\left(\frac{2}{3} + \log x\right) + c$
(B) $\frac{x^2}{y^2} = \frac{2x^2}{3}\left(\frac{2}{3} + \log x\right) + c$
(C) $\frac{-x^2}{y^2} = \frac{2x^3}{3}\left(\frac{2}{3} + \log x\right) + c$
(D) none of these

18. If y_1 and y_2 be solution of differential equation $\frac{dy}{dx} + Py = Q$, where P and Q are function of x alone and $y_2 = y_1 z$ then (where a is arbitrary constant)

(A) $z = 1 + ae^{-\int \frac{Q}{y_1}dx}$
(B) $z = 1 - ae^{-\int \frac{Q}{y_1}dx}$
(C) $z = 1 + ae^{\int \frac{Q}{y_1}dx}$
(D) $z = 1 - ae^{\int \frac{Q}{y_1}dx}$

19. If $\vec{p}, \vec{q}$ are two non collinear vectors such that $(b - c)\vec{p} \times \vec{q} + (c - a)\vec{p} + (a - b)\vec{q} = 0$, where a, b, c are length of sides of triangle then triangle is

(A) right angled
(B) obtuse angled
(C) equilateral
(D) isosceles

20. A draws two card at random from a pack of 52 cards. After returning them to the pack and shuffling it, B draws two card at random. The probability that there is exactly one common card is

(A) $\frac{25}{546}$
(B) $\frac{50}{663}$
(C) $\frac{23}{663}$
(D) none of these

21. Area bounded by $y = f^{-1}(x)$ and tangent and normal drawn to it at the points with abscissae π and 2π, where $f(x) = \sin x - x$ is

(A) $\frac{\pi^2}{2} - 1$
(B) $\frac{\pi^2}{2} - 2$
(C) $\frac{\pi^2}{2} - 4$
(D) $\frac{\pi^2}{2}$

Rough work

22. Area enclosed by ellipse $x^2 + \sin^4\alpha\, y^2 = \sin^2\alpha$, $\alpha \in \left(0, \frac{\pi}{2}\right)$ is

(A) 2π (B) π
(C) 1 (D) none of these

23. $\bar{a}, \bar{b}, \bar{c}$ are the edges of a cube of unit length and $\bar{r}$ be any unit vector inside the cube then $|\bar{a} \times \bar{r}|^2 + |\bar{b} \times \bar{r}|^2 + |\bar{c} \times \bar{r}|^2$ is

(A) 0 (B) 1
(C) 2 (D) 3

24. Let X = {1, 2, ,3, ….., 9} and Y = {1, 2, 3…,9} be two sets and one number is selected from each set, then the probability that sum of the numbers selected is 11

(A) $\frac{1}{81}$ (B) $\frac{3}{8}$
(C) $\frac{2}{81}$ (D) $\frac{1}{9}$

25. If $\begin{bmatrix} \frac{1}{25} & 0 \\ x & \frac{1}{25} \end{bmatrix} = \begin{bmatrix} 5 & 0 \\ -a & 5 \end{bmatrix}^{-2}$, then the value of x is

(A) $\frac{a}{125}$ (B) $\frac{2a}{25}$
(C) $\frac{2a}{125}$ (D) none of these

26. If A = $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$, then $A^2 + 5A$ =

(A) A (B) 2A
(C) 5A (D) 6A

Rough work

27. The solution of differential equation $2x^3y\,dy + (1 - y^2)(x^2y^2 + y^2 - 1)dx = 0$
(A) $x^2y^2 = (cx + 1)(1 - y^2)$ (B) $x^2y^2 = (cx + 1)(1 + y^2)$
(C) $x^2y^2 = (cx - 1)(1 - y^2)$ (D) none of these

28. The numbers of unit vectors perpendicular to $\bar{a} \equiv (1, 1, 0)$ and $\bar{b} \equiv (0, 1, 1)$ is
(A) 1 (B) 3
(C) infinite (D) 2

29. If the plane ax + by + cz = 1 meets the coordinate axes in A, B and C then the centroid of the ΔABC is
(A) (3a, 3b, 3c) (B) $\left(\frac{a}{3}, \frac{b}{3}, \frac{c}{3}\right)$
(C) $\left(\frac{1}{3a}, \frac{1}{3b}, \frac{1}{3c}\right)$ (D) $\left(\frac{3}{a}, \frac{3}{b}, \frac{3}{c}\right)$

30. The degree and order of differential equation of family of circle touching a parabola $y^2 = 4\lambda x$ ($\lambda \in$ R) at its vertex is
(A) degree = 2, order = 1 (B) degree = 1, order = 2
(C) degree = 1, order = 0 (D) none of these

Rough work

From Classroom/Integrated School Programs 7 in Top 20, 23 in Top 100, 54 in Top 300, 106 in Top 500 All India Ranks & 2314 Students
from Classroom /Integrated School Programs & 3723 Students from All Programs have been Awarded a Rank in JEE (Advanced), 2013

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ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS
PART TEST–IV
(Main)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	C	C
2.	B	B	C
3.	A	A	D
4.	A	A	A
5.	B	A	A
6.	B	D	C
7.	B	C	A
8.	D	D	B
9.	C	D	A
10.	C	A	D
11.	C	D	B
12.	C	A	A
13.	C	B	D
14.	A	D	B
15.	D	C	D
16.	B	A	A
17.	A	A	C
18.	A	B	A
19.	B	B	C
20.	D	C	B
21.	B	C	B
22.	C	B	B
23.	B	D	C
24.	B	C	D
25.	D	B	C
26.	A	B	D
27.	A	C	C
28.	C	D	D
29.	A	B	C
30.	B	D	D

Physics

PART – I

SECTION – A

1. use $\frac{1}{v}+\frac{1}{u}=\frac{2}{R}$. Image after 1st reflection will act as object for 2nd reflection.

2. In inductor current lags voltage by $\pi/2$

3. $$n(4I_0)=\frac{\int_{y=-\frac{\lambda D}{4d}}^{y=\frac{\lambda D}{4d}} 4I_0\cos^2\frac{\pi dy}{\lambda D}dy}{\int_{-\frac{\lambda D}{4d}}^{\frac{\lambda d}{4d}} dy}$$

4. $$E=\frac{hc}{\lambda}=\frac{GM^2}{L}$$

$\Rightarrow$ dimensions of $\frac{hc}{G}=\frac{LM^2}{L}=M^2$

5. $\langle P\rangle = V_{RMS}I_{RMS}\cos\phi$

11. Use Lenz's Rule

12. Speed of image = speed of object in all the mirrors

13. Use $\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

15. $\varepsilon = -\frac{d\phi}{dt}$ and $P = \frac{\varepsilon^2}{R}$

16. For CBF $\Delta P = 0 = t_A(\mu_A - 1) - t_B(\mu_B - 1) + \frac{dy}{D}$

18. $V_A - iR + 15 + (5\times10^{-3})\times10^3 = V_B$

Chemistry PART – II

SECTION – A

2. $$\frac{d_{bcc}}{d_{ccp}} = \frac{\text{packing efficiency of bcc}}{\text{packing efficiency of ccp}} = \frac{67.92}{74.02} = 0.918$$

3. Except Ti(+IV) in $TiCl_4$ all other metal ions Fe^{3+} in $FeCl_3$, Cu^{2+} in $CuCl_2$ and Mn^{2+} in $MnCl_2$ contains unpaired electrons and are coloured.

4. Fe^{2+} = 0.07 mole in 0.1 mol of $Fe_{0.9}O$
So to balance charge, some of the place has been left vacant as Fe^{2+} is replaced by Sr^{4+}.
0.07 × 2 = x × 4
$x = \frac{0.07 \times 2}{4} = 0.035$
Vacant place = 0.07 – 0.035 = 0.035 N_A

5. In diamond, all the carbon atoms are tetrahedrally bonded to one another so octahedral voids cannot be occupied. Also, the lattice points and the holes are occupied by carbon atoms. As a result the packing efficiency is less than 74%.

7. $$4FeCl_3 + 3K_4[Fe(CN)_6] \longrightarrow \underset{\text{Prussian blue}}{Fe_4[Fe(CN)_6]_3} + 12KCl$$

8. $$SnCl_2 + HgCl_2 \longrightarrow SnCl_4 + \underset{(\text{white})}{Hg_2Cl_2} \downarrow$$
$$Hg_2Cl_2 + SnCl_2 \longrightarrow \underset{(\text{grey})}{Hg} \downarrow + SnCl_4$$

9. $$\frac{Y_A}{Y_B} = \frac{P_A / P_T}{P_B / P_T} = \frac{\chi_A . P_A^0}{\chi_B . P_B^0}$$
$$\Rightarrow \frac{Y_A}{\chi_A} = \frac{Y_B}{\chi_B}\left(\frac{P_A^0}{P_B^0}\right)$$
Because $\frac{P_A^0}{P_B^0} > 1$

Hence $\frac{Y_A}{Y_B} > \frac{\chi_A}{\chi_B}$

10. $$PBr_5(s) \longrightarrow [PBr_4]^+(s) + Br^-(s); \quad [i = 2]$$
$$2PCl_5(s) \longrightarrow [PCl_6]^- + [PCl_4]^+; \quad [i = 1]$$
$$\text{ratio} = \frac{2}{1} = 2$$

11. $$\pi = \frac{CRT}{M}$$

$$\frac{RT}{M} = 4.65 \times 10^{-3}$$

$$8.314 \times \frac{293}{M} = 4.65 \times 10^{-3}$$

$M = 5.24 \times 10^5$

12. $3.6 \times 10^{-7} = \dfrac{2s}{55.55}$

(Let solubility is ‘s’)

Solubility = 10^{-5}

13. $P_S = \dfrac{80P^o}{100}$, W_B = ?, M_B = 40, W_A = 114 g, M_A = 114 g

$\Delta P = 0.2\ P^0$

Hence, $0.2 = \dfrac{W_B / 40}{(W_B / 40) + 1}$

Hence W_B = 10 gm

15. $E^o = \dfrac{0.059}{n} \log_{10} K$

$= \dfrac{0.059}{2} \log_{10} 10^8$

= 0.236

$E^o_{Cell} = E^o_{Reduced\ species} - E^o_{Oxidised\ species}$

$0.236 = E^o_{Fe^{3+}/Fe^{2+}} - 0.54$

$E^o_{Fe^{3+}/Fe^{2+}} = 0.776V$

16. $Pt \mid H_2 \mid H^+ \parallel H^+ \mid H_2 \mid Pt$

$1\,atm \quad x \quad 10^{-4} \quad 1\,atm$

$H_2(g) \longrightarrow 2H^+ + 2e^-$; at anode

x

$2H^+ + 2e^- \longrightarrow H_2(g)$; at cathode

$10^{-4}M$

$$E_{cell} = \frac{0.0591}{2} \log \frac{(10^{-4})^2}{x^2}$$

$x = 10^{-6}$ M = $[H^+]$

19. Copper deposited = 0.01 mole; Cu^{2+} already present = 0.05 mole.

Total solute remaining = 0.04 + 0.05 = 0.09 mole in 250 ml (250 gm) H_2O.

$\Delta T_f = K_f.m = 1.86 \times \dfrac{0.09}{0.25} = 0.67$

$T_f = -0.67$

21. $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + Cr_2O_3 + 4H_2O$

$NH_4NO_2 \xrightarrow{\Delta} N_2 + 2H_2O$

22. Zinc blende is ZnS and not $ZnCl_2$.

23. Aluminium will react with carbon to form aluminium carbide.

26. $Bi^{3+} + KI \longrightarrow \underset{\text{(brownish black)}}{BiI_3 \downarrow}$

$BiI_3 \xrightarrow{KI} \underset{\left(\substack{\text{orange yellow}\\\text{solution}}\right)}{[BiI_4]^-}$

27. Nitroprosside ion is $[Fe(CN)_5NO]^{2-}$. If the central atom is present here in Fe^{2+} form, its effective atomic number will be 26 – 2 + 6 × 2 = 36.
It does not have unpaired electron, so this anionic complex is diamagnetic. If the nitroprusside ion is having Fe^{3+} and NO, the electronic distribution will be such that it will have one unpaired electron and the complex will be paramagnetic. Thus magnetic moment measurement established that in nitroprusside ion, the Fe and NO exist Fe^{II} and NO^+ rather the Fe^{III} and NO.

29. $ICl_3 \xrightarrow{\text{hydrolysis}} HIO_2 + HCl$

$IF_5 \xrightarrow{\text{hydrolysis}} HIO_3 + HF$

$IF_7 \xrightarrow{\text{hydrolysis}} HIO_4.2H_2O + HF$

$ICl \xrightarrow{\text{hydrolysis}} HOI + HCl$

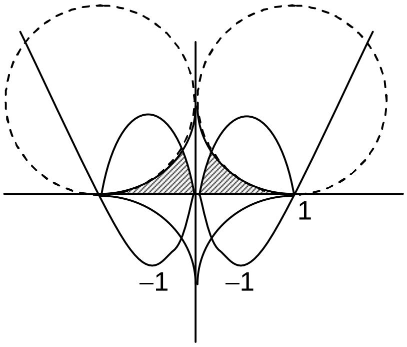
30. P_4O_{10} is anhydride of H_3PO_4.
All P atom are sp^3 hybridized.
There are 6 (P — O — P) linkage in one molecule.

Mathematics PART – III

SECTION – A

1. There should not be a gap of 5 or more than 5 between any two numbers from the set {3, 5, 6, 9}.
This gap can occur only when these numbers can occupy first four and last four position.
Hence number of favourable ways = 9! – 2(4! × 5!)
Total number of cases are 9!
Hence probability = $1 - \frac{2\times 4! \times 5!}{9!} = \frac{62}{63}$

2. Required area is
$$2\left[\int_0^{\alpha} ex\ln x + \int_1^{\alpha}\left(1-\sqrt{1-(x-1)^2}\right)dx\right]$$



3. Let $\bar{d} = x\left(\bar{b}\times\bar{c}\right)+y\left(\bar{c}\times\bar{a}\right)+z\left(\bar{a}\times\bar{b}\right)$

Where $x = \frac{\vec{a}\cdot\vec{d}}{\left[\bar{a}\bar{b}\bar{c}\right]}$, $y = \frac{\bar{b}\cdot\bar{d}}{\left[\bar{a}\bar{b}\bar{c}\right]}$, $z = \frac{\bar{c}\cdot\bar{d}}{\left[\bar{a}\bar{b}\bar{c}\right]}$

$\Rightarrow \left[\bar{a}\bar{b}\bar{c}\right]\bar{d} = \left(\bar{a}\cdot\bar{d}\right)\left(\bar{b}\times\bar{c}\right)+\left(\bar{b}\cdot\bar{d}\right)\left(\bar{c}\times\bar{d}\right)+\left(\bar{c}\cdot\bar{d}\right)\left(\bar{a}\times\bar{b}\right) \Rightarrow |\bar{d}| = 1.$

4. AB = A + B
$\Rightarrow$ B = AB – A
= A (B – I)
$\Rightarrow$ det (B) $\equiv$ det A · det (B – I) = 0
$\Rightarrow$ det (B) = 0.

5. Given equation can be written as
$2x^2y\,(x^2dy + 2xy\,dx) + y^2\,dy - x^2\,dx = 0$
or $2x^2yd\,(x^2y) + y^2\,dy - x^2\,dx = 0$
Integrating, we get
$3\,(x^2y)^2 + y^3 - x^3 = c$

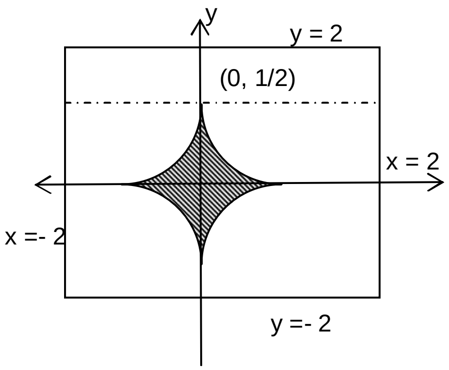
6. Area of the triangle inscribed in the ellipse is maximum if difference of the eccentric angles of the point A, B, C is $\frac{2\pi}{3}$.

So maximum area of the inscribed triangle is $\frac{3\sqrt{3}}{4}\cdot\frac{1}{6}\cdot 8\sqrt{3} = 3$ sq units.

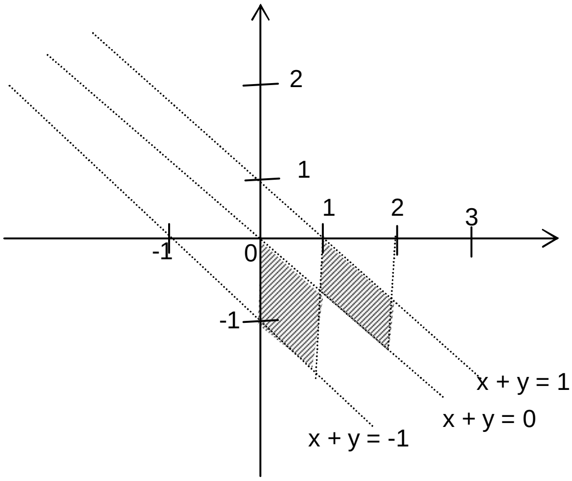
7. PM = $\sqrt{\left(1-\frac{1}{2}\right)^2+\left(0-1\right)^2\left(2+\frac{3}{2}\right)^2} = \frac{3\sqrt{6}}{2}$

8. Take $e^{-i\pi/3}$ common from R_2 and multiply in C_2.

9. **A**



10. If $x \in (0, 1)$
Then $-1 \le x + y < 0$
and if $x \in (1, 2)$
$0 \le x + y < 1$
Required area = $4\left(\frac{1}{2}\cdot 1\cdot \sqrt{2}\sin\frac{\pi}{4}\right)$ = 2 sq units.



11. Writing y = vx in the given equations, we get

$$x\frac{dv}{dx} = \phi\left(\frac{1}{v}\right)$$

and $\log c + \log x = \frac{1}{v}$

$$\Rightarrow -v^2 = x\frac{dv}{dx}$$

$$\Rightarrow \phi\left(\frac{1}{v}\right) = -v^2$$

$$\Rightarrow \phi\left(\frac{x}{y}\right) = -\frac{y^2}{x^2}.$$

12. D.C of the line PQ are $\left(\frac{2}{\sqrt{17}}, \frac{-3}{\sqrt{17}}, \frac{2}{\sqrt{17}}\right)$ and those of the normal to the given plane are $\left(\frac{2}{3}, \frac{-1}{3}, \frac{-2}{3}\right)$.

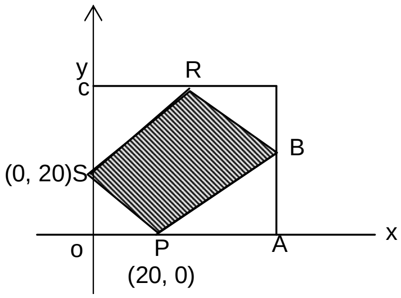
If θ is the angle between these two lines, then $\cos\theta = \frac{1}{\sqrt{17}}$

$\Rightarrow$ the angle ϕ between PQ and the plane is given by $\cos\phi = \frac{4}{\sqrt{17}}$.

Length PQ = $\sqrt{17}$.

Hence the length of the projection of PQ on the plane = $\sqrt{17}\cdot\frac{4}{\sqrt{17}}=4$.

13. Let Ram arrives x minutes and Shyam y minutes after 11 noon. So they will be able to meet if $|x - y| \le 20$. Thus
Favourable cases = Area OPQBRSO
Total ways = Area OABC
$\frac{2000}{3600}=\frac{5}{9}$.



14. Let $x^2 - 13 = t$, then
$t^3 - 67t + 126 = 0$
$\Rightarrow t = -9, 2, 7 \Rightarrow x = \pm 2, \pm\sqrt{20}, \pm\sqrt{15}$

15. $\vec{a}\times\vec{b}-2\vec{a}\times\vec{c}=\vec{0}=\vec{a}\times\left(\vec{b}-2\vec{c}\right)=\vec{0}\Rightarrow\vec{a}$ and $\vec{b}-2\vec{c}$ are collinear

$\Rightarrow\ b-2\vec{c}=\lambda\vec{a}\Rightarrow|\vec{b}-2\vec{c}|=\lambda^2\,|\vec{a}|^2\Rightarrow|\vec{b}|^2+4|\vec{c}|^2-4\vec{b}\cdot\vec{c}=\lambda^2\,|\vec{a}|^2$

$\Rightarrow 16 + 4 - 4\ (4)\ (1)\ .\ \frac{1}{4} = \lambda^2\ (1)$

$\Rightarrow \lambda = \pm 4$.

16. $A^2 = \begin{bmatrix} ab & b^2 \\ -a^2 & -ab \end{bmatrix}\begin{bmatrix} ab & b^2 \\ -a^2 & -ab \end{bmatrix}=\begin{bmatrix} a^2b^2-a^2b^2 & ab^3-ab^3 \\ -a^3b+a^3b & -a^2b^2+a^2b^2 \end{bmatrix}=\begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$

$\therefore$ Minimum value of n = 2

17. $-d\left(\frac{x}{y}\right)=xy\left(1+\log x\right)dx$

$\int -\frac{x}{y}d\left(\frac{x}{y}\right)=\int x^2\left(1+\log x\right)dx$ gives solution.

18. y_1 is solution of $\frac{dy}{dx}+Py=Q$ is $\frac{dy_1}{dx}+Py_1=Q$ …(1)
again $y_2 = y_1z$ is solution of (1)
then $\frac{d}{dx}(y,\ z)+P(y,\ z) = Q$ …(2)
(2) – (1) × z
$\Rightarrow z = 1 + ae^{-\int\frac{Q}{y_1}dx}$.

20. $P = \frac{{}^{52}C_1\,{}^{5}C_2\,2!}{\left({}^{52}C_2\right)^2}=\frac{50}{663}$

21. Required area A = $\int_{\pi}^{2\pi}\left(\left(\sin x-x\right)+2\pi\right)dx=\frac{\pi^2}{2}-2$ sq. units.

22. Area = $\pi ab = \pi \sin\alpha \,\mathrm{cosec}\alpha = \pi$.

23. $\left|\bar{r}\times\bar{a}\right|^2+|\bar{r}\times\bar{b}|^2+|\bar{r}\times\bar{c}|^2 = \sin^2\alpha + \sin^2\beta + \sin^2\gamma = 2$

24. n(S) = 81, E = sum of number is 11
n (E) = 9 ⇒ P(E) = 9/81 = 1/9.

25. Pre-multiply the given equation by $\begin{bmatrix}5 & 0\\ -a & 5\end{bmatrix}$, we get

$$\begin{bmatrix}5 & 0\\ -a & 5\end{bmatrix}\begin{bmatrix}\frac{1}{25} & 0\\ x & \frac{1}{25}\end{bmatrix}=\begin{bmatrix}5 & 0\\ -a & 5\end{bmatrix}^{-1}$$

$$\Rightarrow \begin{bmatrix}5 & 0\\ -a & 5\end{bmatrix}\begin{bmatrix}5 & 0\\ -a & 5\end{bmatrix}\begin{bmatrix}\frac{1}{25} & 0\\ x & \frac{1}{25}\end{bmatrix}=\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}$$

$$\Rightarrow \begin{bmatrix}1 & 0\\ -\frac{2a}{5}+25x & 1\end{bmatrix}=\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}$$

$$\Rightarrow 25x - \frac{2a}{5} = 0.$$

26. ∵ A is a unit matrix
so $A^2 = A$.

27. $2x^3y\,dy + (1-y^2)(x^2y^2 + y^2 - 1)dx = 0$

$$\frac{2y}{(1-y^2)^2}\frac{dy}{dx}+\frac{y^2}{1-y^2}\frac{1}{x}=\frac{1}{x^3}$$

Put $\frac{y^2}{1-y^2}=u \Rightarrow \frac{2y}{(1-y^2)^2}\frac{dy}{dx}=\frac{du}{dx}$

$$\Rightarrow \frac{du}{dx}+\frac{u}{x}=\frac{1}{x^3}$$

$u.x = \int\frac{1}{x^2}xdx+c \Rightarrow x^2y^2 = (cx-1)(1-y^2)$.

28. $\bar{a}\times\bar{b}=\hat{i}-\hat{j}+\hat{k}$

$\therefore\ \bar{c}=\pm\frac{\hat{i}-\hat{j}+\hat{k}}{\sqrt{3}}$.

30. Equation of circle will be $(x + r)^2 + y^2 = r^2$.

FIITJEE **JEE (Main), 2015**

ALL INDIA TEST SERIES

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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CONCEPT RECAPITULATION TEST - I

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 02 and 09 to 30)** contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (03 to 08) contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 marks** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

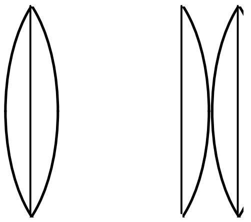
1. Number of amplitude modulation broadcast stations that can be accommodated in a 100 KHz bandwidth if the highest frequency modulating a carrier is 5 KHz
(A) 10
(B) 100
(C) 1000
(D) 10,000

2. Regarding transistor what is not correct.
(A) For transistor to act an amplifier EB junction should be forward biased and CB junction should be reverse biased
(B) $I_E = I_B + I_C$ in any configuration and for any transistor.
(C) $\alpha = \frac{\beta}{1+\beta}$ where α and β transistor parameter
(D) $\beta = \frac{\alpha}{1+\alpha}$.

3. A particle of charge q and mass m is projected from a large distance towards another identical charged particle at rest with velocity v_0. The distance of closest approach will be (Assume negligible gravitational attraction)
(A) $\frac{q^2}{2\pi\varepsilon_0 m v_0^2}$
(B) $\frac{q^2}{\pi\varepsilon_0 m v_0^2}$
(C) $\frac{2q^2}{\pi\varepsilon_0 m v_0^2}$
(D) $\frac{q^2}{4\pi\varepsilon_0 m v_0^2}$

Space for Rough work

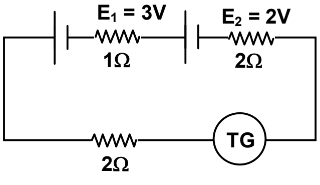
4. A thin equiconvex lens of focal length f is cut into two symmetric plano-convex lenses, and the lenses are placed with their curved faces towards each other, with a common optic axis. If the refractive index μ of the material of the lens is 1.45, the focal length of the combination is (assuming no reflection at the boundaries) :
(A) f
(B) –f
(C) 0.9 f
(D) + f/0.9



5. In an npn transistor amplifier circuit when working in common emitter configuration when the input signal changes by 0.02 V, the base current changes by 10 μA and the collector 1 μA. If the load in the collector circuit is 10 KΩ for this the power given.
(A) 10^4
(B) 2×10^4
(C) 5×10^4
(D) 5×10^3

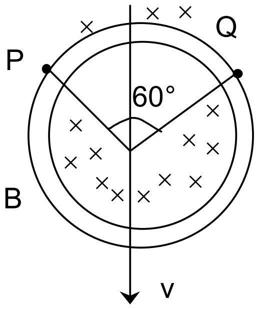
6. Two nicols A and B are placed in the path of a beam of unpolarised light. In between these two a third nicol C is placed such that its principal section is at an angle of 30° with that of A. The percentage of intensity of incident unpolarized light that emerges from C to B.
(A) 2.8%
(B) 9.4%
(C) 15.3%
(D) 10.2%

7. Two cells are connected with 2Ω resistance and a TG(tangent galvanometer). If the deflection in TG is 30°. Then the resistance of the coil.
Given that coil has 5 turns and radius = 0.08 and
$B_H = 5 \times 10^{-5}$T
(A) 1.5 Ω
(B) 3.5 Ω
(C) 5.5 Ω
(D) 7.5 Ω



Space for Rough work

8. A conducting ring of radius a falls vertically downward with a velocity v in a magnetic field B. The potential difference between two points P and Q located symmetrically on both sides of the vertical has the value



(A) 0
(B) $\frac{Bv_0a}{2}$
(C) $\frac{\sqrt{3}}{2}Bv_0a$
(D) Bv_0a

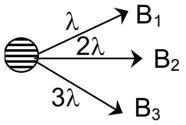
9. In problem 8, the current flowing in the upper arc PQ of the loop is given by (resistance per unit length is λ)

(A) 0
(B) $\frac{3Bv_0a}{2\pi\lambda}$
(C) $\frac{3\sqrt{3}}{2\pi\lambda}Bv_0a$
(D) $\frac{3}{\pi\lambda}Bv_0a$

10. A parallel beam of light of all wavelengths greater than 3000 A^0 falls on a double slit in a Young's double slit experiment. It is observed that the wavelengths 3600 A^0 and 6000 A^0 are absent at a distance of 31.5 mm from the position of the central maximum, and the orders of the interference at this point for the two wavelengths differ by 7. If the distance between the slits and the screen is 1m, the separation between the two slits is

(A) 0.08 mm
(B) 0.13 mm
(C) 0.2mm
(D) 0.1mm

11. A certain radioactive material can undergo three different types of decay, each with a different decay constant λ, 2λ and 3λ. Then, the effective decay constant λ_{eff} is given by



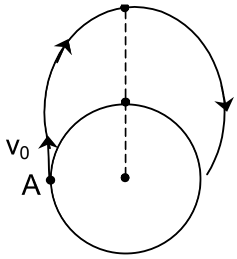
(A) $\frac{1}{\lambda_{eff}} = \frac{1}{\lambda} + \frac{1}{2\lambda} + \frac{1}{3\lambda}$
(B) $\lambda_{eff} = \lambda + 2\lambda + 3\lambda$
(C) $\lambda_{eff} = \frac{\lambda + 2\lambda + 3\lambda}{3}$
(D) $\frac{1}{\lambda_{eff}} = \frac{1}{3}\left(\frac{1}{\lambda} + \frac{1}{2\lambda} + \frac{1}{3\lambda}\right)$

Space for Rough work

12. A thin walled cylindrical metal vessel ($\alpha = 10^{-3}K^{-1}$) contains a liquid ($\gamma_r = 10^{-3}K^{-1}$). If the vessel and its contents are now heated by 10 K the pressure due to the liquid at the bottom

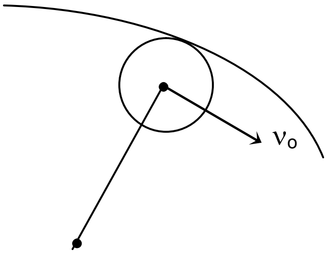
(A) increases by 2 % (B) decreases by 1 %
(C) remains unchanged (D) decreases by 2%

13. A projectile projected tangentially from the surface of a planet of radius R from a point A, follows the indicated trajectory during its motion. If it is at a height of 3R at the farthest point of its trajectory, then the velocity of projection at A, v_0 is given by (acceleration due to gravity on surface = g)



(A) $v_0 = \sqrt{1.5gR}$ (B) $v_0 = \sqrt{0.5gR}$
(C) $v_0 = \sqrt{1.6gR}$ (D) $v_0 = \sqrt{2gR/3}$

14. A small uniform sphere of diameter d is rolling without slipping with in another static hollow sphere of inner diameter 6d, the velocity of the centre of mass of the inner sphere being v_0 in magnitude. The angular velocity of the smaller sphere about an axis passing through its C.M. perpendicular to its direction of motion is



(A) $\frac{2v_0}{5d}$ (B) $\frac{2v_0}{d}$
(C) $\frac{12v_0}{5d}$ (D) $\frac{14v_0}{5d}$

15. 1 mole of H_2 and 1 mole of He at a pressure of P_0 & $2P_0$ respectively and a temperature T_0 are kept in two different containers. The ratio of their rms velocities is $C_{H_2} : C_{He}$ =

(A) $\sqrt{10} : \sqrt{3}$ (B) 1 : 1
(C) 5 : 3 (D) $2 : \sqrt{2}$

Space for Rough work

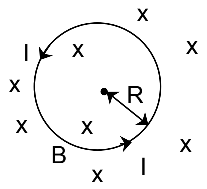
16. The wavelength of the K_α line for an element is measured to be $\lambda = 1.55\ A^0$. The element has Z (atomic number) equal to
(A) 28 (B) 27
(C) 29 (D) 30

17. An equimolar mixture of a monoatomic and a diatomic ideal gas is suddenly compressed to $\frac{1}{8}^{th}$ of its original volume. The ratio of final temperature to the initial temperature.
(A) $8^{0.53}$ (B) $8^{0.5}$
(C) $8^{1.53}$ (D) $8^{2/3}$

18. The material of an electromagnet should have following properties, except
(A) high retentivity
(B) high value of saturation magnetisation
(C) low coercivity
(D) low hystersis loss

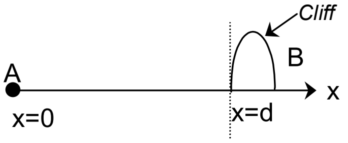
19. According to electromagnetic theory statement that is not correct.
(A) $\vec{E}$ and $\vec{B}$ vectors vibrate sinusoidally in the same phase
(B) $\vec{E}$ and $\vec{B}$ vectors vibrate sinusoidally in the opposite phase
(C) $\vec{E}$ and $\vec{B}$ vectors contribute to energy equally
(D) $\vec{E}$ and $\vec{B}$ vectors vibrate orthogonally with the same frequencies

20. A current (I) carrying circular wire of radius R is placed in a magnetic field B perpendicular to its plane. The change in tension T of the wire is
(A) BIR (B) $2\pi BIR$
(C) πBIR (D) 2BIR



Space for Rough work

21. The velocity of sound varies according to the relation :
$c(x) = c_0(1 + 0.1x/d)$ between a source located at x = 0 and a cliff located at x = d. The time taken for sound to travel from A to B and return back to A is given by



(A) $\frac{2d}{c_0}$
(B) $\frac{2d}{c_0(1+\frac{0.1}{2})}$
(C) $\frac{2d}{c_0 \times 1.1}$
(D) $\frac{20d}{c_0}\ln(1.1)$

22. A charged particle of mass m and charge e moves in a circular path of radius r under the action of a constant magnetic field B acting perpendicular to the plane of its orbit. If Bohr's postulate is valid for this system, then the radius of the path, r is given by
(A) $r \propto n^2$
(B) $r \propto 1/n$
(C) $r \propto e^{-n}$
(D) $r \propto \sqrt{n}$
where n is the quantum number of the orbit.

23. The molar heat capacity of a diatomic ideal gas undergoing the process :
$PV^{1/4}$ = constant is
(A) $\frac{17}{6}R$
(B) $\frac{2}{5}R$
(C) $\frac{23}{6}R$
(D) 0

24. A wheel of radius r rolls without slipping on a flat surface, with its centre of mass undergoing a linear deceleration a. Then,
(A) a non -zero toque is acting on the wheel about its CM.
(B) the net torque acting on the wheel may be zero or non-zero
(C) the net torque acting on the wheel is zero
(D) the net torque acting on the wheel cannot be calculated as the data is insufficient.

Space for Rough work

25. A capacitor C and a resistance R are connected in a circuit in series with each other, so that the capacitor discharges through R. If the temperature coefficient of the resistance is positive, as the temperature increases the time constant of the circuit
(A) increases
(B) decreases
(C) remains uncharged
(D) may increase or decrease depending on other factors

26. A particle A having charge q is placed at a distance d from another particle B having an equal charge q an dielectric slab of thickness t is placed midway between the two. Electrostatic force on A due to B
(A) decreases
(B) increases
(C) remains constant
(D) may increase or decrease depending upon the magnitudes of the charges

27. A radioactive element A decays into another element B with a decay constant 4λ, which then decays into a third element C (decay constant = 9λ). If all the atoms in the beginning consisted of atoms of type A only, then the ratio of the number of atoms of A to that of type B (i.e. N_A/N_B) when the number of atoms of B is at a maximum (N_B is maximum) is
(A) $\frac{3}{2}$
(B) $\frac{9}{4}$
(C) $\frac{1}{1}$
(D) $\frac{\ln 3}{\ln 2}$

28. If planck's constant (h) were to be doubled while other fundamental quantities like and charge mass electron. remaining constant the force acting on the electron in the nth orbit of a hydrogen atom will
(A) increases 4 times
(B) decrease 1/8 of its value
(C) remains unchanged
(D) decreases 1/16 of its original value

29. A positron -electron pair form a hydrogen like system. Applying Bohr's theory to this system and ignoring any relativistic effects, the distance (a) between the positron and electron in the ground state is given by
(A) $a > 0.53\ A^0$
(B) $a < 0.53\ A^0$
(C) $a = 0.53\ A^0$
(D) $a = 1.06\ A^0$

30. Two identical spherical stars each having a mass equal to that of the sun move in a common circular orbit of radius equal to the earth's orbital radius, under their mutual gravitational interaction. Their time period of rotation equals
(A) 2yr
(B) 1 yr
(C) $2\sqrt{2}$ yr
(D) $\sqrt{2}$ yr

Space for Rough work

Chemistry

PART – II

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. A gas in an open container is heated from 27°C to 127°C. The fraction of the original amount of remaining in the container will be:
(A) $\frac{3}{4}$ (B) $\frac{1}{4}$
(C) $\frac{1}{2}$ (D) $\frac{1}{8}$

2. Which one has peroxide linkage
(A) $S_2O_8^{2-}$ (B) $S_2O_6^{2-}$
(C) $S_2O_7^{2-}$ (D) $S_2O_3^{2-}$

3. The number of electrons gained in the following reaction $Fe_2(SO_4)_3 \longrightarrow Fe^{2+} + SO_2$ is
(A) 2 (B) 1
(C) 6 (D) 8

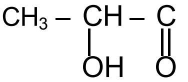
4. The values of observed and calculated molecular weights of silver nitrate are 92.64 and 170 respectively. The degree of dissociation of silver nitrate is
(A) 60% (B) 83.5%
(C) 46.7% (D) 60.23%

5. The pH of pure water at 25°C and 35°C are 7 and 6 respectively. The heat of formation of water from H^+ and OH^- are
(A) 84.55 kcal mol^{-1} (B) – 84.55 kcal $mole^{-1}$
(C) 74.55 kcal mol^{-1} (D) – 74.55 kcal $mole^{-1}$

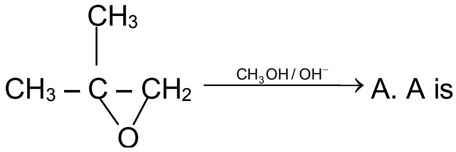
6. In a face centred cubic arrangement of A and B atoms whose A atoms are at the corner of the unit cell and B atoms are at the face centres. One of the A atom is missing from one corner in unit cell. The simplest formula of the compound is:
(A) A_7B_3 (B) AB_3
(C) A_7B_{24} (D) $A_{7/8}B_3$

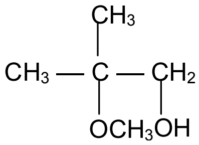
Space for Rough work

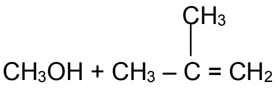
7. In which one of the following reactions, we will get only one crossed Aldol product,
(A) C_6H_5CHO, $(CH_3)_2CO$ (B) C_6H_5CHO, CH_3CHO
(C) C_6H_5CHO, $(C_2H_5)_2CO$ (D) CH_3CHO, CH_3CH_2CHO

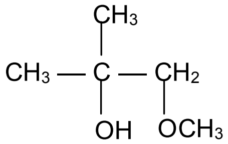
8. 
$CH_3-\underset{OH}{\underset{|}{CH}}-\underset{O}{\underset{||}{C}}-CH_3$. This compound
(A) Can react with Schiff's Reagent (B) Can react with Tollen's Reagent
(C) Both (A) and (B) (D) None

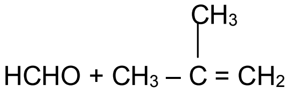
9. The isomeric monosubstitution products theoretically possible for the structure
$CH_2=CH-CH_2-CH_2-CH=CH_2$ are
(A) 3 (B) 2
(C) 4 (D) 6

10. 

(A) 

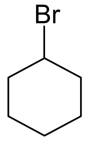
(B) 
$CH_3OH + CH_3-\overset{CH_3}{\overset{|}{C}}=CH_2$

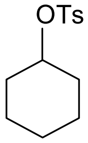
(C) 

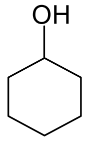
(D) 
$HCHO + CH_3-\overset{CH_3}{\overset{|}{C}}=CH_2$

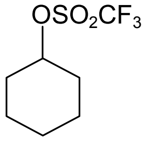
11. $HO-CH_2-CH_2-X + HC\equiv C^{-}Na^{+} \longrightarrow A + B$
A & B can be
(A) $HO-CH_2-CH_2-C\equiv CH$, NaX (B) Acetylene + $NaO-CH_2-CH_2-X$
(C) Ethanol + $XC\equiv CNa^{+}$ (D) Ethylhalide + $HOC\equiv CNa^{+}$

12. Which of the following will be most reactive towards the nucleophilic substitution.

(A) 

(B) 

(C) 

(D) 

Space for Rough work

13. The correct order of hybridisation in the following species SO_2, ClO_3^-, XeF_4 is
(A) sp^3, sp^2, sp^3d (B) sp^2, sp^2, sp^3d^2
(C) sp^2, sp^3, sp^3d^2 (D) sp, sp^3, sp^3d^2

14. The species with maximum magnetic moment is
(A) $K_4[Ni(CN)_6]$ (B) $K_4[Fe(CN)_6]$
(C) $K_3[Co(CN)_6]$ (D) $[Cu(NH_3)_4]SO_4$

15. The increasing order of dipole moment is
(A) $CH_3I < CH_3Br < CH_3Cl < CH_3F$ (B) $CH_3F < CH_3Cl < CH_3Br < CH_3I$
(C) $CH_3I < CH_3Br < CH_3F < CH_3Cl$ (D) $CH_3I < CH_3F < CH_3Br < CH_3Cl$

16. 17g of hydrogen peroxide is present in 1120 ml of solution. This solution is called
(A) 5 volume solution (B) 10 volume solution
(C) 15 volume solution (D) 16 volume solution

17. The density of a gas at 27°C and 1 atm is d. Pressure remaining constant, at which of the following temperature will its density become 0.75d.
(A) 20°C (B) 30°C
(C) 36°C (D) 127°C

18. Radioactivity of radioactive element remains 1/10 of the original radioactivity after 2.303 seconds. The half life period (in seconds) is
(A) 2.303 (B) 0.693
(C) 0.2303 (D) 0.0693

19. Assuming complete dissociation predict which of the following will have pH = 12.
(A) 500 ml 0.005 M NaOH (B) 1000 ml 0.005 M $Ca(OH)_2$
(C) 100 ml 0.05 M $Ca(OH)_2$ (D) 50 ml 0.05 M NaOH

20. The percentage of metal in its oxide is 60. The percentage of bromine in metal bromide (oxidation state of metal remains the same) will be
(A) ~ 87 (B) ~ 97
(C) ~ 77 (D) ~ 80

Space for Rough work

21. 50g of $CaCO_3$ when treated with 60 ml of 20 N HCl at 300 K and 4 atm produces
(A) 22 g CO_2 (B) 44g CO_2
(C) 11g CO_2 (D) 88 g CO_2

22. A certain weak acid has a dissociation constant of 10^{-5}. The equilibrium constant for its reaction with a strong base is
(A) 10^{-9} (B) 10^{+14}
(C) 10^{9} (D) 10^{-5}

23. The set representing the correct order of 1st ionisation potential is
(A) Cu > Ag > Au (B) Au >Ag > Cu
(C) Ag > Cu > Au (D) Au > Cu > Ag

24. Acetophenone on reaction with p -nitroperbenzoic acid gives
(A) phenyl propionate (B) phenyl acetate
(C) methyl benzoate (D) benzophenone

25. The number of monochloro derivaties of 2-methoxy propane are possible are
(A) 2 (B) 1
(C) 3 (D) 4

26. The increasing order of bond angle in the following species is
(A) $F_2O < Cl_2O < H_2O$ (B) $Cl_2O < H_2O < F_2O$
(C) $F_2O < H_2O < Cl_2O$ (D) $H_2O < F_2O < Cl_2O$

27. 0.10g of a sample containing $CuCO_3$ and some inert impurity was dissolved in dilute sulphuric acid and volume made up to 50 ml. This solution was added into 50 ml of 0.04 M KI solution where copper precipitates as CuI and I^- is oxidised into I_3^-. A 10 ml portion of this solution is taken for analysis filtered and made up free I_3^- and then treated with excess of acidic permanganate solution. Liberated iodine required 20 ml of 2.5 mM sodium thiosulphate solution to reach the end point. Determine the wt. percentage of $CuCo_3$ in the original sample.
(A) 7.41 (B) 74.1
(C) 61.75 (D) None of these

Space for Rough work

28. Urea (H_2NCONH_2) is manufactured by passing $CO_2(g)$ through ammonia solution followed by crystallization. CO_2 for the above reaction is prepared by combustion of hydrocarbon. If combustion of 236 kg of a saturated hydrocarbon (C_nH_{2n+2}) produces as much CO_2 as required for production of 999.6 kg urea then M. F. of hydrocarbon is:

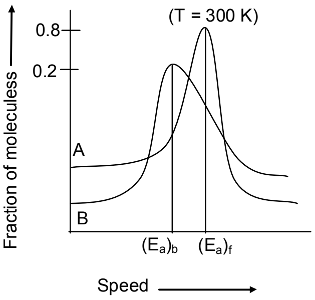
(A) $C_{10}H_{22}$
(B) $C_{12}H_{26}$
(C) $C_{13}H_{28}$
(D) C_8H_{18}

29. For the reaction at 300 K

$$A \rightleftharpoons B \qquad \Delta H = -2400 \text{ cal mol}^{-1}$$

Frequency factor for both forward and backward reaction is equal. The $[K_{eq}]_{400\text{ K}}$ is $4e^{-0.5n.}$

The value of 'n' is (Assume ΔH independent of temperature)



(A) 1
(B) 2
(C) 4
(D) 6

30. Which of the following statement is not true?

(A) O-F bond length in OF_2 is less than O-F bond length in O_2F_2.
(B) In HCO_3^-, all C – O bond length are not identical.
(C) In diborane, two different B – H bond lengths are observed although the hybridization of both boron atoms are same.
(D) In hydrazine, the N – N bond length is larger than normal N – N bond length.

Space for Rough work

Mathematics PART – III

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. Let y = f(x) be a curve passing through (e, e^e), which satisfy the differential equation (2ny + xy ln x) dx – x ln x dy = 0, x > 0, y > 0. It g(x) = $\lim\limits_{n\to\infty} f(x)$ then $\int_{1/e}^{e} g(x)dx$ equals to

(A) e (B) 1
(C) 0 (D) none of these

2. The smaller area enclosed by y = f(x), when f(x) is a polynomial of least degree satisfying $\lim\limits_{x\to0}\left(1+\frac{f(x)}{x^3}\right)^{1/x} = e$ and the circle $x^2 + y^2 = 2$ above the x-axis is

(A) $\frac{\pi}{2}$ (B) $\frac{3}{5}$
(C) $\frac{\pi}{2}-\frac{3}{5}$ (D) $\frac{\pi}{2}+\frac{3}{5}$

3. For x ∈ R and a continuous function f, let $I_1 = \int_{\sin^2 t}^{1+\cos^2 t} x f\{x(2-x)\}dx$, $I_2 = \int_{\sin^2 t}^{1+\cos^2 t} f\{x(2-x)\}dx$. Then $\frac{I_1}{I_2}$ is

(A) 0 (B) 1
(C) 2 (D) 3

Space for rough work

4. If xf(x) = 3(f(x))^2 + 2, then $\int \frac{2x^2 - 12xf(x) + f(x)}{(6f(x) - x)(x^2 - f(x))^2}dx$ equals to

(A) $\frac{1}{x^2 - f(x)} + c$ (B) $\frac{1}{x^2 + f(x)} + c$

(C) $\frac{1}{x - f(x)} + c$ (D) $\frac{1}{x + f(x)} + c$

5. If $f\left(2x + \frac{y}{8}, 2x - \frac{y}{8}\right) = xy$, then f(m, n) + f(n, m) = 0

(A) only when m = n (B) only when m ≠ n

(C) only when m = –n (D) for all m and n

6. If period of $\sin^{2m}\sqrt{k}x$, $m \in N$ is π then $\lim\limits_{n\to\infty} k^n$ is equal to

(A) 0 (B) ∞

(C) 1 (D) none of these

7. A function g(x) is defined as $g(x) = \frac{1}{4}f(2x^2 - 1) + \frac{1}{2}f(1 - x^2)$ and f′(x) is an increasing function then g(x) is increasing in the interval

(A) $\left(-\sqrt{\frac{2}{3}}, \sqrt{\frac{2}{3}}\right)$ (B) $\left(-\sqrt{\frac{2}{3}}, 0\right) \cup \left(\frac{\sqrt{2}}{3}, \infty\right)$

(C) (–1, 1) (D) none of these

8. If sin θ and –cos θ are the roots of the equation ax^2 – bx – c = 0, where a, b, c are the sides of a triangle ABC, then cos B is equal to

(A) $1 - \frac{c}{2a}$ (B) $1 - \frac{c}{a}$

(C) $1 + \frac{c}{2a}$ (D) $1 + \frac{c}{3a}$

Space for rough work

9. The equation $\int_0^x (t^2 - 8t + 13)dt = x\sin\left(\frac{a}{x}\right)$ has a solution if $\sin\frac{a}{6}$ is equal to

(A) 1 (B) $\frac{1}{2}$

(C) $\frac{1}{\sqrt{2}}$ (D) 0

10. If $\vec{x}$ and $\vec{y}$ are two non-collinear vectors and a triangle ABC with side lengths a, b, c satisfying

$(20a - 15b)\vec{x} + (15b - 12c)\vec{y} + (12c - 20a)(\vec{x} \times \vec{y}) = \vec{0}$. Then triangle ABC is

(A) an acute angle triangle (B) an obtuse angle triangle

(C) a right angle triangle (D) an isosceles triangle

11. The Cartesian equation of the plane $\vec{r} = (1 + \lambda - \mu)\hat{i} + (2 - \lambda)\hat{j} + (3 - 2\lambda + 2\mu)\hat{k}$ is

(A) $2x + y = 5$ (B) $2x - y = 5$

(C) $2x + z = 5$ (D) $2x - z = 5$

12. If the ellipse $\frac{x^2}{4} + y^2 = 1$ meets the ellipse $x^2 + \frac{y^2}{a} = 1$ in four distinct points and $a = b^2 - 5b + 7$, then b does not lie in the interval

(A) [4, 5] (B) $(-\infty, 2) \cup (3, \infty)$

(C) $(-\infty, 0)$ (D) [2, 3]

13. Portion of asymptote of hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ (between centre and the tangent at vertex) in the first quadrant is cut by the line $y + \lambda(x - a) = 0$ (λ is a parameter) then

(A) $\lambda \in R$ (B) $\lambda \in (0, \infty)$

(C) $\lambda \in (-\infty, 0)$ (D) $\lambda \in R - \{0\}$

14. A focal chord of parabola $y^2 = 4x$ is inclined at an angle of $\frac{\pi}{4}$ with positive x-direction, then the slope of normal drawn at the ends of chord will satisfy the equation

(A) $m^2 - 2m - 1 = 0$ (B) $m^2 + 2m - 1 = 0$

(C) $m^2 - 1 = 0$ (D) $m^2 + 2m - 2 = 0$

Space for rough work

15. The range of values of a such that the angle θ between the pair of tangents drawn from (a, 0) to the circle $x^2 + y^2 = 1$ lies in the interval $\left(\frac{\pi}{3}, \pi\right)$ is

(A) $(-2, -1) \cup (1, 2)$ (B) $\left(-\sqrt{2}, 0\right) \cup \left(0, \sqrt{2}\right)$

(C) $\left(-\sqrt{3}, -\sqrt{2}\right)$ (D) $\left(-\sqrt{3}, -\sqrt{2}\right) \cup \left(\sqrt{2}, \sqrt{3}\right)$

16. The equation of the parabola to which the line $m^2(y - 10) - mx - 1 = 0$ is a tangent for any real value of m is

(A) $x^2 = -4y$ (B) $x^2 = -4(y - 10)$

(C) $y^2 = 4(x - 4)$ (D) $x^2 = y - 10$

17. Consider a curve $ax^2 + 2hxy + by^2 - 1 = 0$ and a point P not on the curve. A line drawn from the point P intersects the curve at the points Q and R. If the product PQ·PR is independent of the slope of the line, then the curve is

(A) a pair of straight lines (B) a circle

(C) a parabola (D) an ellipse or a hyperbola

18. In a ΔABC if A = (1, 2) and internal angle bisectors through B and C are y = x and y = –2x. The in radius r of ΔABC is

(A) $\frac{1}{\sqrt{3}}$ (B) $\frac{1}{\sqrt{2}}$

(C) $\frac{2}{3}$ (D) none of these

19. If $0 \le [x] < 2$; $-1 \le [y] < 1$ and $1 \le [z] < 3$ (where [.] denotes the greatest integer function) then the maximum value of determinant $\begin{vmatrix} [x]+1 & [y] & [z] \\ [x] & [y]+1 & [z] \\ [x] & [y] & [z]+1 \end{vmatrix}$ is

(A) 2 (B) 6

(C) 4 (D) none of these

Space for rough work

20. If min{$x^2 + (a - b)x + 1 - a - b$} > max{$-x^2 + (a + b)x - (1 + a + b)$}, then
(A) $a^2 + b^2 < 2$ (B) $a^2 + b^2 < 4$
(C) $a^2 + b^2 > 4$ (D) $a + b > ab$

21. If m and x are two real numbers, then the real value of $e^{2mi\cot^{-1}x}\left(\frac{xi+1}{xi-1}\right)^m$ is equal to
(A) cos x + i sin x (B) $\frac{m}{2}$
(C) 1 (D) $\frac{m}{2}+1$

22. If {x} represents the fractional part of x, then $\left\{\frac{5^{200}}{8}\right\}$ is
(A) $\frac{1}{4}$ (B) $\frac{1}{8}$
(C) $\frac{3}{8}$ (D) $\frac{5}{8}$

23. If $\frac{a_2a_3}{a_1a_4} = \frac{a_2+a_3}{a_1+a_4} = 3\left(\frac{a_2-a_3}{a_1-a_4}\right)$, then a_1, a_2, a_3, a_4 are in
(A) A.P. (B) G.P.
(C) H.P. (D) none of these

24. n-similar balls each of weight w when weighed in pairs the sum of the weights of all the possible pairs is 120 when they are weighed in triplets the sum of the weights comes out to be 480 for all possible triplets, then n is
(A) 20 (B) 10
(C) 16 (D) 28

Space for rough work

25. If $\vec{a}, \vec{b}, \vec{c}$ are unit vectors such that $\left|\vec{a}+2\vec{b}+3\vec{c}\right| = \sqrt{3+2\sqrt{2}}$. Angle between $\vec{a}$ and $\vec{b}$ is α, between $\vec{a}$ and $\vec{c}$ is β and angle between $\vec{b}$ and $\vec{c}$ varies in $\left[\frac{\pi}{2}, \frac{2\pi}{3}\right]$, then the greatest value of 4 cos α + 6 cos β is
(A) $2\sqrt{2}+5$ (B) $-2\sqrt{2}+5$
(C) $2\sqrt{2}-5$ (D) $2\sqrt{2}$

26. If two events A and B are such that $P(A^c) = 0.3$, $P(B) = 0.4$ and $P(A \cap B^c) = 0.5$ then $P\left(\frac{B}{A \cup B^C}\right)$ is equal to
(A) 0.9 (B) 0.5
(C) 0.6 (D) 0.25

27. ABC is a triangular park with AB = AC = 100m. A block tower is situated at the midpoint of BC. The angles of elevation of the top of the tower at A and B are $\cot^{-1}(3.2)$ and $\text{cosec}^{-1}(2.6)$ respectively. The height of the tower is
(A) 16 m (B) 25 m
(C) 50 m (D) none of these

28. If $aN = \{ax \mid x \in N\}$ and $bN \cap cN = dN$, where $b, c \in N$, then
(A) d = bc (B) c = bd
(C) b = cd (D) none of these

29. If the normal to the curve y = f(x) at x = 0, be given by the equation 3x – y + 3 = 0, then the value of $\lim\limits_{x\to 0} x^2\left\{f\left(x^2\right)-5f\left(4x^2\right)+4f\left(7x^2\right)\right\}^{-1}$ is equal to
(A) $\frac{1}{3}$ (B) $-\frac{1}{3}$
(C) $-\frac{1}{5}$ (D) $\frac{1}{4}$

30. Let P (n) be the statement $2^n < n!$ where n is a natural number, then P (n) is true for
(A) all n (B) all n > 2
(C) all n > 3 (D) none of these

Space for rough work

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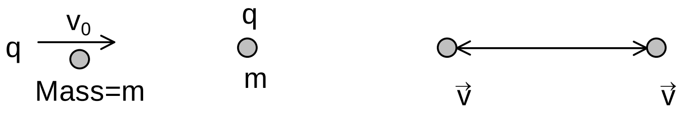
3.	**B**	**D**	**B**
4.	**A**	**B**	**A**
5.	**C**	**B**	**D**
6.	**B**	**C**	**C**
7.	**B**	**B**	**B**
8.	**D**	**B**	**C**
9.	**A**	**A**	**A**
10.	**C**	**C**	**C**
11.	**B**	**B**	**C**
12.	**D**	**D**	**D**
13.	**C**	**C**	**B**
14.	**B**	**D**	**B**
15.	**D**	**C**	**A**
16.	**C**	**A**	**B**
17.	**B**	**D**	**B**
18.	**A**	**B**	**B**
19.	**B**	**B**	**C**
20.	A	**A**	**B**
21.	D	**A**	**C**
22.	**D**	**C**	**B**
23.	**C**	**D**	**C**
24.	**A**	**B**	**B**
25.	**A**	**C**	**C**
26.	**C**	**C**	**D**
27.	**B**	**B**	**B**
28.	**D**	**B**	**D**
29.	**A**	**B**	**B**
30.	**A**	**D**	**C**

Physics PART – I

SECTION – A

1. No. of stations = $\frac{\text{Total Bandwidth}}{\text{BW per statation}} = \frac{100\times10^3}{10\times10^3}$ = 10.

3. B,



Applying conservation of momentum : 2mv = mv_0 . .. (i)

conservation of energy : $2 \times \frac{1}{2}mv^2 + \frac{1}{4\pi\varepsilon_0}\frac{q^2}{d} = \frac{1}{2}mv_0^2$ . . . (ii)

(I) ⇒ $v = v_0/2$, putting in (2), we get,

$d = \frac{q^2}{\pi\varepsilon_0 m v_0^2}$

4. the powers of the lenses add, and the power of each half is one half of that of the entire lens.

5. $\beta = \frac{\partial I_C}{\partial_B} = 100$, $R_i = \frac{\partial V_B}{\partial I_B}$

power gains = $\beta^2\frac{R_L}{R_i} = 5\times10^4$

6. $I_A = \frac{I_0}{2}$

$I_C = \frac{I_0}{2}\cos30^\circ = \frac{I_0}{2}\frac{3}{4} = \frac{3I_0}{8}$

$I_B = I_C\cos^2 60^\circ = \frac{3I_0}{8}\cos^2 60^\circ = \frac{3}{32}I_0$

$\frac{I_B}{I_C} = \frac{3}{32} = 9.4\%$

7. $i = \frac{5}{5+R}$

$B = B_H \tan\theta$

$\frac{\mu_0 Ni}{2r} = B_H\tan\theta$

$i = \frac{2rB_H}{\mu_0 N}\tan\theta = \frac{5}{5+R}$

Solving R = 3.5 Ω

9. Since the current flowing through a loop is determined by the net emf acting in the loop, which again is zero n this case - as the flux doesn't change.

10. At x = 31.5 mm, both 3600 A^0 and 6000 A^0 produce minima. If the slit separation is d, then,

$$\frac{xd}{D\lambda_1} = n_1 + \frac{1}{2}, \qquad \frac{xd}{D\lambda_2} = n_2 + \frac{1}{2}$$

or , $\frac{xd}{D}\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right) = n_1 - n_2 = 7$

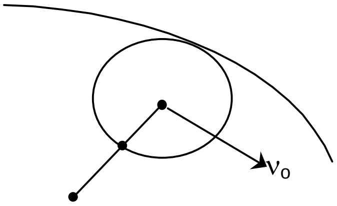
Substituting the values, D = 1m, λ_1 = 3600 A^0, λ_2 = 6000 A^0
we get d = 0.2 mm.

11. $\frac{dN_A}{dt} = (-\lambda N_A) + (-2\lambda.N_A) + (-3\lambda.N_A)$
$= -6\,\lambda.\ N_A$

12. The mass of the liquid does not change, the area on which it exerts its weight increases by $2 \times 10^{-3} \times 10$ or 2×10^{-2}
or 2 %, the pressure decreases by 2 %.

13. At the farthest point X,
$mv_0R = mv_x\,4R$
$\frac{1}{2}m\,v_x^2 - \frac{GMm}{4R} = \frac{1}{2}mv_0^2 - \frac{GMm}{R}$
$\Rightarrow\ v_0 = \sqrt{1.6gR}$.

14. The angular velocity ω of the sphere about an axis through its C.M. is $\frac{v_0}{d/2} = \frac{2v_0}{d}$, it does not depend on whether the axis is accelerated or not.



15. Their average translational K.E. is $\frac{3}{2}k_B$ T, k_B → Boltzmann's constant

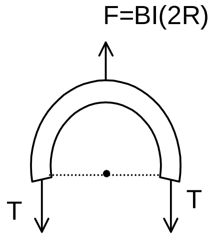
$\frac{1}{2}m_{H_2}C_{H_2}^2 = \frac{1}{2}m_{He}C_{He}^2 = \frac{3}{2}k_BT$
$C_{H_2} : C_{He} = \sqrt{m_{He}} : \sqrt{m_{H_2}} = \sqrt{4} : \sqrt{2} = 2 : \sqrt{2}$

16. Using $E_{k\alpha} = \frac{3}{4}13.6\text{ eV }(Z-1)^2$ & $\lambda_{k\alpha} = \frac{12400}{E_{k\alpha}}A^0$

17. For the mixture, $\gamma = \frac{C_P^{(1)} + C_P^{(2)}}{C_V^{(1)} + C_V^{(2)}} = \frac{\frac{7}{2}R + \frac{5}{2}R}{\frac{5}{2}R + \frac{3}{2}R} = \frac{3}{2}$

Applying $TV^{\gamma-1}$ = constant, the temperature increases by a factor of $\sqrt{8}$.

20. (A), Consider a semicircular portion of the wire
$2T = BI.\ 2R$
$\Rightarrow\ T = BIR$



21. Time to reach B from A = $t_{AB} = \int_{x=0}^{d} \frac{dx}{c(x)}$

$= \frac{d}{0.1c_0} \ln(1.1)$; total time = $2t_{AB}$

22. For the system,
$\frac{mv^2}{r} = Bev$
$mvr = \frac{nh}{2\pi}$
$\Rightarrow\ r = \sqrt{\frac{nh}{Be}}$.

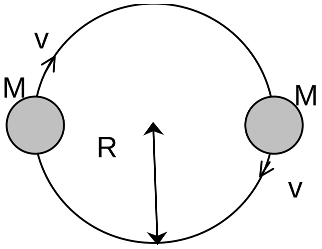
23. $pV^{1/4}$ = constant
$\Rightarrow\ \frac{RT}{V}v^{1/4}$ = constant
or $TV^{-3/4}$ = constant
$dT\,V^{-3/4} - \frac{3}{4}dV.V^{-7/4}.T = 0$
or $\frac{dV}{dt} = \frac{4}{3}\frac{V}{T}$
$C = \frac{dQ}{dT} = \frac{dU}{dT} + P\frac{dV}{dT} = C_v + p.\frac{4}{3}\frac{V}{T} = \frac{5}{2}R + \frac{4}{3}R = \frac{23}{6}R$.

25. Time constant = RC, increases with temperature

27. $\frac{dN_B}{dt} = \lambda_A N_A - \lambda_B N_B = 4\lambda N_A - 9\lambda N_B = 0$ (N_B is maximum)
$\therefore\ \frac{N_A}{N_B} = \frac{9}{4}$

29. For the position -electron system, the mass of the position = mass of the electron, much less than that of a proton . the distance in the ground state > a_B (hydrogen atom) A careful calculation shows $a \neq 1.06\ A^0$ (= 2 a_B)

30. (A), $M\frac{v^2}{R} = \frac{GM^2}{4R^2}$



$$v^2 = \frac{GM}{4R}$$

Time period, $T = \frac{2\pi R}{v} = \frac{2\pi R}{\sqrt{GM/4R}}$

$$= \frac{2\pi}{\sqrt{GM}} \times 2 \times R^{3/2}$$

If $M = M_{sun}$, $R = R_{earth\text{ - }sun,}$ Kepler's 3rd law gives us,

$$T_{earth} = \frac{2\pi}{\sqrt{GM_{sun}}} \times R_{earth-sun}^{3/2} = 1 \text{ yr.}$$

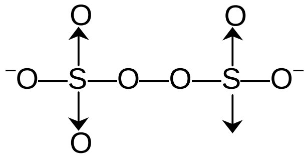
$$\therefore \quad T = \frac{2\pi}{\sqrt{GM_{sun}}} \times 2 \times R_{earth-sun}^{3/2} = 2 \times 1 \text{ yr} = 2\text{yr .}$$

Chemistry

PART – II

SECTION – A

2.



$${}^{-}O-\underset{\underset{O}{\downarrow}}{\overset{\overset{O}{\uparrow}}{S}}-O-O-\underset{\downarrow}{\overset{\overset{O}{\uparrow}}{S}}-O^{-}$$

4. i for $AgNO_3 = \dfrac{\text{normal molecular weight}}{\text{observed molecular weight}} = 1 + \alpha$

$\alpha = \dfrac{170}{92.64} - 1 = 0.835 = 83.5\%$

5. At 25°C $[H^+] = 10^{-7}$; $\therefore K_w = 10^{-14}$

At 35°C $[H^+] = 10^{-6}$; $\therefore K_w = 10^{-12}$

Now using,

$$2.303 \log \frac{K_{W_2}}{K_{W_1}} = \frac{\Delta H}{R}\left(\frac{T_2 - T_1}{T_1T_2}\right)$$

We get, $\Delta H = 84.55$ kcal/mole

Thus $H_2O \rightleftharpoons H^+ + OH^-$ $\qquad \Delta H = 84.55$

$\therefore H^+ + OH^- \rightleftharpoons H_2O$ $\qquad \Delta H = -84.55$ kcal/mole

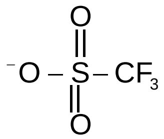
6. No. of atoms of A from corners of unit cell = $\dfrac{7}{8}$

No. of atoms of B from faces of unit cell = 3

Thus A : B : $\dfrac{7}{8}$: 3 (or) 7 : 24

$\therefore$ (C)

12.



$${}^{-}O-\underset{\underset{O}{\|}}{\overset{\overset{O}{\|}}{S}}-CF_3$$ is the best leaving group as it is the weakest base

14. Because it has maximum no. of unpaired electrons

16. Weight of H_2O_2 in 1 ml = $\dfrac{17}{1120}$

Moles of H_2O_2 in 1 ml = $\dfrac{17}{1120} \times \dfrac{1}{34}$

Moles of O_2 liberated = $\dfrac{17}{1120} \times \dfrac{1}{34} \times \dfrac{1}{2}$

Volume of O_2 liberated = $\dfrac{17}{1120} \times \dfrac{1}{34} \times \dfrac{1}{2} \times 22400 = 5$ ml

17. PM = dRT or $d \propto \frac{1}{T}$

$$\frac{d_1}{d_2} = \frac{T_2}{T_1} = \frac{d}{0.75d} = \frac{T_2 + 273}{27 + 273}$$

$\therefore T_2$ = 127°C

18. $$\frac{0.693}{t_{1/2}} = \frac{2.303}{t}\log\frac{A_0}{A_t}$$

Putting the values we get

$t_{1/2} = 0.693$

19. pH = 12, pOH = 2 $\Rightarrow [OH^-] = 10^{-2}$ M

20. % of M in $M_xO_y = \frac{xM \times 100}{xM + 16y} = 60 \therefore xM = 24y$

% M in $M_xBr_{2y} = \frac{xM}{xM + 160y} \times 100 = \frac{24y}{24y + 160y} \times 100 \approx 13$

$\therefore$ % of bromine in $M_xBr_{2y} \cong 87$

21. Equivalents of $CaCO_3 = \frac{50 \times 2}{100} = 1$

Equivalent of HCl = $\frac{60 \times 20}{1000} = 1.2$

$\therefore$ Equivalent of CO_2 = 1, moles of CO_2 = 0.5 (n-factor = 2)

$\therefore$ mass of CO_2 = 22g

22. $$HA + OH^- \underset{Kh}{\overset{Ka}{\rightleftharpoons}} A^- + H_2O$$

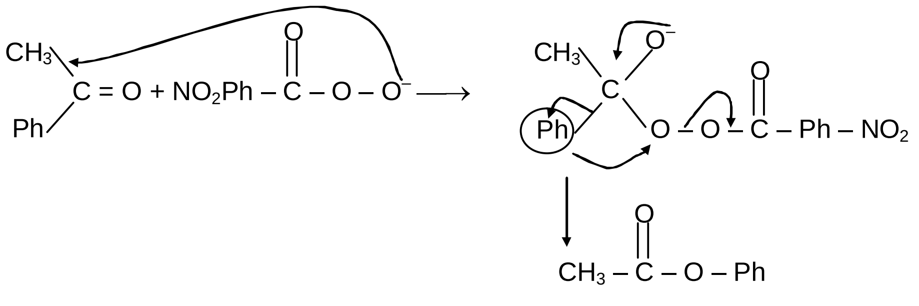
$K_h = \frac{K_w}{K_a} = \frac{10^{-14}}{10^{-5}} = 10^{-9}$

$K_a = K_h^{-1} = 10^9$

23. Ag has a lower ionisation potential than Cu because of larger size. But in Au due poor shielding effect of f-electrons the nuclear charge is not shielded and so I.P. is high

$\therefore$ Au > Cu > Ag

24.



27. m moles of KI = 50 × 0.04 = 2
m.eq. of $Na_2S_2O_3$ reacted with 10 ml solution = $20 \times 2.5 \times 10^{-3}$
$= 50 \times 10^{-3}$
m.eq. of I^- left unreacted in 100 ml solution = $50 \times 10^{-3} \times \frac{100}{10} = 0.5$
m. moles of I^- reacted with $CuCO_3$ = 2 – 0.5 = 1.5
$\because 2Cu^{++} + 5I^- \longrightarrow 2CuI + I_3^-$
m.moles of Cu^{++} = $\frac{2}{5} \times 1.5 = 0.6$
wt. of $CuCO_3$ = $0.6 \times 10^{-3} \times 123.5$
= 0.0741
wt. of $CuCO_3$ = $\frac{0.0741}{0.1} \times 100 = 74.1$

28. $2NH_2 + CO_2 \longrightarrow NH_2 - CO - NH_2 + H_2O$
moles of urea = $\frac{999.6 \times 10^3}{60}$ = 16.66×10^3
$\therefore$ moles of CO_2 = 16.66×10^3
$C_nH_{2n+2} + O_2 \longrightarrow nCO_2 + H_2O$
$\frac{16.66 \times 10^3}{n} \times \left[12n + (2n+2)\right] = 236 \times 10^3$
$\Rightarrow n \cong 12$
so, M. F. of hydrocarbon is $C_{12}H_{26}$

29. K_{eq}(300 K) $\frac{K_f}{K_b} = \frac{A.e^{-(E_a)_f/RT}}{A.e^{-(E_a)_b/RT}} = \frac{0.8}{0.2} = 4$
$\therefore \ln \frac{k_2}{k_1} = \frac{\Delta H}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$
$\ln\left(\frac{4}{k_2}\right) = 1$
$\frac{4}{k_2} = e \Rightarrow k_2 = 4e^{-1}$

30. In hydrazine ($NH_2 – NH_2$) bond order is one, whereas in nitrogen gas bond order is three.

Mathematics PART – III

SECTION – A

1. $f(x) = e^x (\ln x)^{2n}$

$\lim\limits_{n\to\infty} f(x) = 0$, if $x \in \left(\frac{1}{e}, e\right)$

$\therefore \int\limits_{1/e}^{e} g(x)dx = 0$

2. Clearly $f(x) = x^4$

$\therefore$ Required area = $2\int\limits_0^1\left(\sqrt{2-x^2} - x^4\right)dx = \frac{\pi}{2} + \frac{3}{5}$

3. $I_1 = \int\limits_{\sin^2 t}^{1+\cos^2 t} x f\{x(2-x)\}dx = 2I_2 - I_1$

$\Rightarrow \frac{I_1}{I_2} = 1$

4. $f'(x) = \frac{f(x)}{6f(x) - x}$

$\therefore I = -\int \frac{2x - f'(x)}{\left(x^2 - f(x)\right)^2} dx = \frac{1}{x^2 - f(x)} + c$

5. $2x + \frac{y}{8} = \alpha$, $2x - \frac{y}{8} = \beta$

$\therefore f(\alpha, \beta) = \alpha^2 - \beta^2$

$\therefore f(m, n) + f(n, m) = 0$

6. $\frac{\pi}{\sqrt{k}} = \alpha \Rightarrow k = 1 \Rightarrow \lim\limits_{n\to\infty} k^n = 1$

7. $g'(x) = x(f'(2x^2 - 1) - xf'(1 - x^2))$

If, $x > 0 \Rightarrow x \in \left(\sqrt{\frac{2}{3}}, \infty\right)$

If, $x < 0 \Rightarrow x \in \left(-\sqrt{\frac{2}{3}}, 0\right)$

$\therefore x \in \left(-\sqrt{\frac{2}{3}}, 0\right) \cup \left(\frac{\sqrt{2}}{3}, \infty\right)$

8. $\sin\theta - \cos\theta = \frac{b}{a}$

$\sin\theta\cos\theta = \frac{c}{a}$

$\therefore b^2 = a^2 - 2ac$

$\therefore \cos B = \frac{a^2 + c^2 - b^2}{2ac} = 1 + \frac{c}{2a}$

9. $\frac{x^3}{3} - 4x^2 + 13x = x\sin\left(\frac{a}{x}\right)$

$\Rightarrow \frac{1}{3}\left\{(x-6)^2 + 3\right\} = \sin\frac{a}{x}$

$\therefore \sin\frac{a}{6} = 1$

10. $\because \vec{x}, \vec{y}$ and $\vec{x} \times \vec{y}$ are linearly independent

$\therefore$ 20a – 15b = 15b – 12c = 12c – 20a = 0

$\therefore c^2 = a^2 + b^2$

11. $\vec{r} = \left(\hat{i} + 2\hat{j} + 3\hat{k}\right) + \lambda\left(\hat{i} - \hat{j} - 2\hat{k}\right) + \mu\left(-\hat{i} + 2\hat{k}\right)$

$\vec{a} = \hat{i} + 2\hat{j} + 3\hat{k}$

$\vec{b} = \hat{i} - \hat{j} - 2\hat{k}$

$\vec{c} = -\hat{i} + 2\hat{k}$

$\therefore$ Vector equation of plane is $\left(\vec{r} - \vec{a}\right)\left(\vec{b} \times \vec{c}\right) = 0$

$\Rightarrow$ 2x + z = 5

12. $\therefore$ a > 1

$\therefore b^2 - 5b + 7 > 1$

$\therefore b \in (-\infty, 2) \cup (3, \infty)$

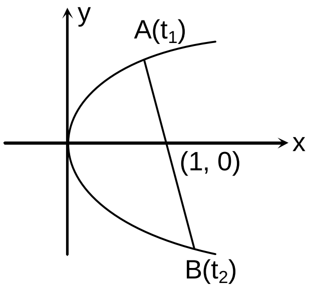
13. Clearly, $-\lambda < 0$, $\lambda > 0$

14. $m_{AB} = \frac{2}{t_1 + t_2} = 1$

$t_1 + t_2 = 2$

$t_1 t_2 = -1$

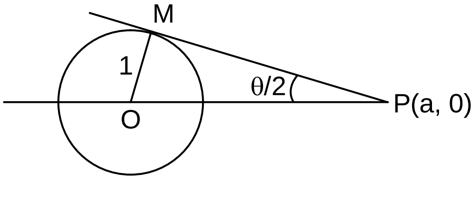
$\therefore$ Required equation is $m^2 + 2m - 1 = 0$



15. $\frac{\pi}{3} < \theta < \pi$

$\Rightarrow \frac{\pi}{6} < \frac{\theta}{2} < \frac{\pi}{2} \Rightarrow \frac{1}{2} < \frac{1}{a} < 1 \Rightarrow 1 < a < 2$

$\therefore a \in (-2, -1) \cup (1, 2)$



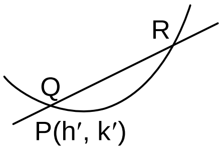
16. $x = m(y - 10) - \frac{1}{m}$

$x - h = m(y - k) + \frac{a}{m}$

$\therefore$ h = 0, k = 10, a = –1

$\therefore (x - 0)^2 = -4(y - 10)$

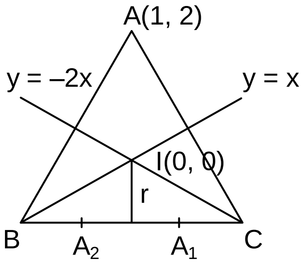
17. $\therefore \frac{x - h'}{\cos\theta} = \frac{y - k'}{\sin\theta} = r$



$\therefore PQ \cdot PR = \frac{ah'^2 + 2hh'k' + bk'^2}{a\cos^2\theta + 2h\sin\theta\cos\theta + b\sin^2\theta}$

$\therefore$ a = b, h = 0

18. $A_1 = (2, 1)$



$A_2 = \left(-\frac{11}{5}, \frac{2}{5}\right)$

Equation of BC: x – 7y + 5 = 0

$\therefore r = ID = \left|\frac{5}{\sqrt{1 + 49}}\right| = \frac{1}{\sqrt{2}}$

19. $R_1 \to R_1 - R_2$, $R_2 \to R_2 - R_3$

$\Delta = [x] + [y] + [z] + 1$

$\therefore \Delta_{max} = 1 + 0 + 2 + 1 = 4$

20. $-\left\{\frac{(a - b)^2 - 4(1 - a - b)}{4 \times 1}\right\} > -\left\{\frac{(a + b)^2 - 4(1 + a + b)}{4 \times (-1)}\right\}$

$\Rightarrow a^2 + b^2 < 4$

21. Put, $\cot^{-1} x = \theta$

$\therefore e^{2i\cot^{-1}x} = \cos 2\theta + i\sin 2\theta = \frac{xi - 1}{xi + 1}$

$\Rightarrow e^{2mi\cot^{-1}x}\left(\frac{xi + 1}{xi - 1}\right)^m = 1$

22. $\frac{5^{200}}{8} = \frac{(1 + 24)^{100}}{8}$

$\therefore \left\{\frac{5^{200}}{8}\right\} = \frac{1}{8}$

23. $\frac{1}{a_4} - \frac{1}{a_3} = \frac{1}{a_2} - \frac{1}{a_1}$ ….. (1)

$3\left(\frac{1}{a_3} - \frac{1}{a_2}\right) = \frac{1}{a_4} - \frac{1}{a_1}$ ….. (2)

$\therefore$ From (1) and (2), we get $\frac{1}{a_2} - \frac{1}{a_1} = \frac{1}{a_3} - \frac{1}{a_2} = \frac{1}{a_4} - \frac{1}{a_3}$

$\therefore a_1, a_2, a_3, a_4$ are in H.P.

24. $^nC_2 = \dfrac{n(n-1)}{2}$ = Number of possible pairs of n objects

Total weight of $\dfrac{n(n-1)}{2}$ pairs are $\dfrac{n(n-1)}{2} \times 2 \times w = n(n-1)w$ units

$\therefore$ n(n – 1)w = 120 ..... (1)

Similarly, total weight of all triplets = 480

$\therefore \dfrac{n(n-1)(n-2)3w}{6} = 480$ ….. (2)

$\therefore$ From (1) and (2), we get n = 10

25. $\left|\vec{a} + 2\vec{b} + 3\vec{c}\right|^2 = 3 + 2\sqrt{2}$

4 cos α + 6 cos β = –11 + $2\sqrt{2}$ – 12 cos γ (γ is angle between $\vec{b}$ and $\vec{c}$)

$\therefore$ 4 cos α + 6 cos $\beta \in \left[-11 + 2\sqrt{2}, -5 + 2\sqrt{2}\right]$

26. $P\left(\dfrac{B}{A \cup B^C}\right) = \dfrac{P(A \cap B)}{P(A \cup B^c)} = \dfrac{0.2}{0.8} = \dfrac{1}{4}$

27. Let $\alpha = \underline{|MAP} = \cot^{-1}(3.2)$

and $\beta = \underline{|MBP} = \text{cosec}^{-1}(2.6)$

$\Rightarrow$ cotα = 3.2 and cosecβ = 2.6

Let height of the tower = h

$\Rightarrow$ MP = h.

Now BM = MP cotβ = h cotβ

$= h\sqrt{\text{cosec}^2\beta - 1} = h\sqrt{(2.6)^2 - 1} = (2.4)h$

and AM = MP cotα = h cotα = h(3.2) = 3.2 h

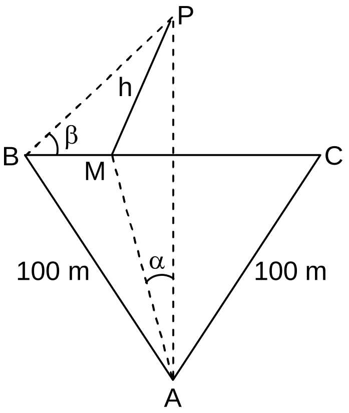
Hence, from ΔABM

$AB^2 = AM^2 + BM^2$

$(100)^2 = (3.2h)^2 + (2.4h)^2$

$h^2 = \dfrac{100^2}{10.24 + 5.76} = \dfrac{100^2}{16}$

$h = \dfrac{100}{4} = 25$.



28. We have,

bN = {bx | x $\in$ N } = the set of positive integral multiples of b

cN = {cx | x $\in$ N } = the set of positive integral multiple of c

$\therefore$ bN $\cap$ cN = the set of positive integral multiples of L.C.M of b and c

$\Rightarrow$ d = L.C.M. of b and c

29. $f'(0) = -\dfrac{1}{3}$

$\therefore$ Required limit = $\lim\limits_{x \to 0} \dfrac{2x}{2xf'(x^2) - 40xf'(4x^2) + 56xf'(7x^2)} = -\dfrac{1}{3}$

30. P(1), P(2) and P (3) are not true

P (4) is true and $2^k < k!$

$\Rightarrow 2.2^k < 2k! \le (k + 1)k!$ for $k \ge 1$

CONCEPT RECAPITULATION TEST - I

Paper 1

ALL INDIA TEST SERIES

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 10)** contains 10 multiple choice questions which have one or more than one correct answer. Each question carries **+3 marks** for correct answer. There is no negative marking.

(ii) **Section-C (01 – 10)** contains 10 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014: 2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

(One or More than One Options Correct Type)

This section contains **10 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** are correct.

1. Initially two particles *A* and *B* are present at (0, 0) and (*d*, 0) respectively. They start moving with speed $v_A = v\hat{i} + v\hat{j}$ and $v_B = -v\hat{j}$. If *R* is magnitude of relative separation between them and T_0 be the time when separation between them is minimum, then

(A) $T_0 = \frac{d}{5v}$
(B) $R_{\min} = \frac{2d}{\sqrt{5}}$
(C) Graph of *R* versus time is straight line
(D) Graph of *R* versus time is circle.

2. Four forces act on a point object. The object will be in equilibrium if

(A) all of them are in the same plane
(B) they are opposite to each other in pair
(C) the sum of *x*, *y* and *z* components of force is zero separately
(D) they form a closed figure of 4 sides

3. A person of mass 70 kg jump from a 3.0 m height. Then

(A) impulse on the man by ground will be 539 N-s
(B) average force on man if he land with stiffed leg and body moves by 1.0 cm during impact is 2.1×10^5 N
(C) average force on man feet by ground if he land with bent legs and body moves by 50 cm is 4.2×10^3 N
(D) average force on man feet by ground if he land with bent legs and body moves by 50 cm is (4.9×10^3 N)

4. A mass *m* of radius *r* is rolling horizontally without any slip with a linear speed *v*. It then rolls up to a height given by $\frac{3}{4}\frac{v^2}{g}$

(A) the body is identified to be a disc or a solid cylinder
(B) the body is a solid sphere
(C) MOI of the body about instantaneous axis of rotation is $\frac{3}{2}mr^2$
(D) MOI of the body about instantaneous axis of rotation is $\frac{2}{5}mr^2$

Space for Rough work

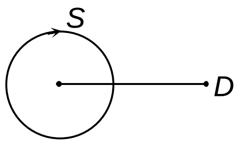
5. A particle initially at rest is displaced by applying a non conservative force F in a uniform gravitational field. In the process following physical quantities associated with the particle are measured

$\Delta U =$ change in gravitational potential energy
$\Delta K =$ change in kinetic energy
$\Delta W_1 =$ work done by the force F
$\Delta W_2 =$ work done by the gravitational force

(A) $\Delta W_2 = -\Delta U$ (B) $\Delta K = \Delta W_1 + \Delta W_2$
(C) $\Delta K + \Delta U = \Delta W_1 + \Delta W_2$ (D) $\Delta W_1 = \Delta W_2$

6. An object is floating in a liquid, kept in a container. The container is placed in a lift. Choose the correct option(s)
(A) Buoyant force increases as lift accelerates up
(B) Buoyant force decreases as lift accelerates up
(C) Buoyant force remains constant as lift accelerates
(D) The fraction of solid submerged into liquid does not change

7. A source of sound moves along a circle of radius 2 m with constant angular velocity 40 rad/s. Frequency of the source is 300 Hz. A detector is kept at some distance from the circle in the same plane of the circle (as shown in figure). Which of the following is not the possible value of frequency registered by the detector? (Speed of sound = 320 m/s)



(A) 250 Hz (B) 360 Hz
(C) 410 Hz (D) 220 Hz

8. Two gases have same initial pressure, volume and temperature. They expand to same final volume, one adiabatically and the other isothermally.
(A) the final temperature is greater for isothermal process
(B) the final temperature is lesser for isothermal process
(C) the work done by the gas is greater for isothermal process
(D) the work done by the gas is greater for adiabatic process

Space for Rough work

9. A charged particle q is placed at a distance d from the centre of conducting sphere of radius $R(<d)$, then in static condition at the centre of sphere

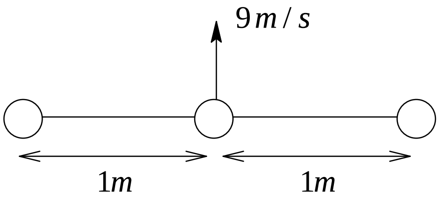
(A) magnitude of electric field due to induced charge is $\frac{kq}{d^2}$

(B) magnitude of electric field due to induced charge is $\frac{kq}{R^2}$

(C) magnitude of electric field due to induced charge is zero

(D) magnitude of electric field due to charge q is $\frac{kq}{d^2}$ (where $k = 1/4\pi\varepsilon_0$)

10. Three identical small balls of same mass 1 kg are placed on a horizontal smooth table. The velocity give to middle ball parallel to the surface is 9 m/s. Then:



(A) the speed of colliding balls just before collision is 5 m/s
(B) the speed of any of the balls when they collide is 9 m/s
(C) the tension in the string connected between balls just before the two balls collide is 5 newton
(D) the tension in the string connected between balls just before the two balls collide is 9 newton

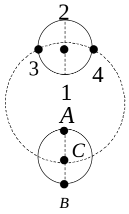
Space for Rough work

SECTION – C

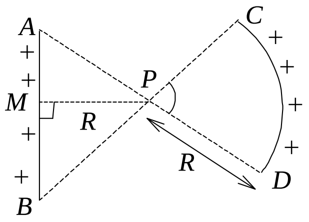
(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

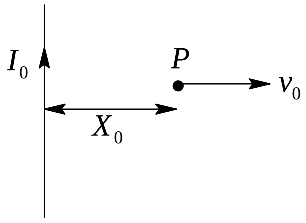
1. A ball translates on a horizontal circular path as shown in the figure. When the ball reaches the diametrically opposite point. The position of point A in shown by point 1, 2, 3 and 4. Find the correct position of point A:



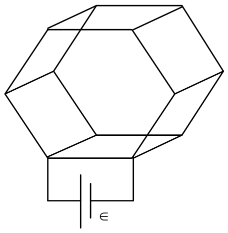
2. A rod of finite length having linear charge density λ subtends an angle of $15°$ at a point P which is also the centre of curvature of a circular arc having same linear charge density λ as shown in figure. If the net electric field at the origin is $\frac{bK\lambda}{R}$. Find the value of b:



3. A charge particle having specific charge α is initially located at point P at a distance of X_0 from an infinite current carrying wire as shown in figure. The maximum distance from the wire the charge will go, if it is given velocity v_0 perpendicular to the wire is $X_0 e^{\frac{b\pi v_0}{\alpha\mu_0 I_0}}$. Find the value of b:

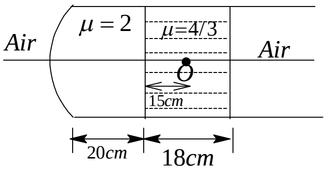


4. An electrical network is formed by two hexagon and joining grid points with wires. The resistance of each side and the connecting wires is R. An ideal battery of emf E is joined as shown in figure. Find the current passing through the battery. Consider the wire connected with the cell is ideal. [take $E = 11$ Volt ; $R = 6\,ohm$]

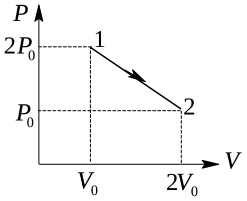


Space for Rough work

5. A point object is placed at the midpoint in water having boundary width of 30 cm and other medium having refractive index 2 is having boundary width 20 cm as shown in figure. The position of image of object O as seen from air through the curved part is 10k. Find the value of k……….

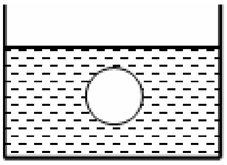


6. An ideal gas undergoes a process shown in the P-V diagram. If the change in heat content of the gas in this process is $\frac{K}{2}P_0V_0$. Then find the value of K:

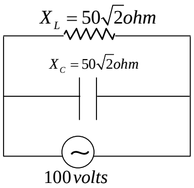


7. A source of sound of frequency 1000 Hz is moving towards a stationary wall with velocity 30 m/s and observer is also moving behind the source with the same velocity. If the frequency band width detected by the observer is $K \times 10^2$. There find the value of k:

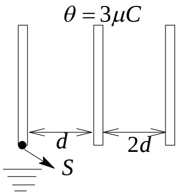
8. A vessel containing liquid of density ρ is accelerated horizontally with acceleration $10\,m/s^2$ in a gravity free space. A small sphere of density 2ρ is released from rest with respect to the vessel. Find the initial acceleration of the sphere with respect to the vessel:



9. In an AC circuit capacitive reactance of capacitor is $X_C = 50\sqrt{2}\Omega$ and inductive reactance of inductor is $X_L = 50\sqrt{2}ohm$. If the source voltage is 100 volts. Then find the current passing through the source.



10. Out of the three conducting identical plates, middle flat is given charge $3\mu C$ and other two plates are not having any charge. If switch S is closed. Find the charge passing through switch S. (in μC):



Space for Rough work

Chemistry PART – II

SECTION – A

(One or More than One Options Correct Type)

This section contains **10 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** are correct.

1. Dacron is a copolymer of ethylene glycol and
(A) Phthalic acid
(B) Adipic acid
(C) Benzoic acid
(D) Terephthalic acid

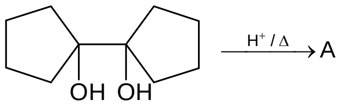
2. Select the correct statement/s to the following decay chain:
$A \xrightarrow{-\alpha} B \xrightarrow{-\beta} C \xrightarrow{-\beta} D$
(A) A and D are isotopes
(B) B, C, D are isobars
(C) A and B are isodiaphers
(D) A and C are isotones

3. In isothermal expansion of a gas:
(A) Kinetic energy of gas molecules remain same
(B) Kinetic energy of gaseous molecule decreases
(C) Pressure of gas decrease
(D) Kinetic energy of gaseous molecule increases

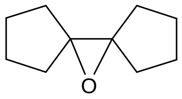
4. 5.3% (w/v) Na_2CO_3 solution and 6.3%(w/v) $H_2C_2O_4.2H_2O$ solution have same:
(A) Molality
(B) Molarity
(C) Normality
(D) Mole fraction

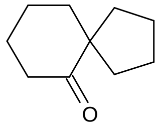
5. Given that
$E^o_{Ni^{2+}/Ni} = -0.25V,\ E^o_{Cu^{2+}/Cu} = +0.34V$
$E^o_{Ag^+/Ag} = +0.80V,\ E^o_{Zn^{2+}/Zn} = -0.76V$
Which of the following redox process will not take place in specified direction?
(A) $Ni^{2+}(aq) + Cu(s) \longrightarrow Ni(s) + Cu^{2+}(aq)$
(B) $Cu(s) + 2Ag^+(aq) \longrightarrow Cu^{2+}(aq) + 2Ag(s)$
(C) $Cu(s) + 2H^+(aq) \longrightarrow Cu^{2+}(aq) + H_2(g)$
(D) $Zn(s) + 2H^+(aq) \longrightarrow Zn^{2+}(aq) + H_2(g)$

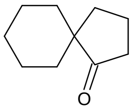
Space for Rough work

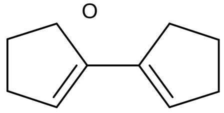
6. 

The product 'A' is

(A) 

(B) 

(C) 

(D) 

7. $CH_3CHO \xrightarrow[\text{(ii) } H_2O]{\text{(i) } CH_3MgBr} (A) \xrightarrow{H_2SO_4 / \Delta} (B) \xrightarrow{HBO} (C)$

(A) and (C) are related as:

(A) Identical
(B) Position isomers
(C) Functional isomer
(D) Optical isomers

8. Select molecules in which all π-orbitals are in same plane

(A) C_6H_6
(B) $O = C = C = C = O$
(C) $CH_2 = C = CH_2$
(D) $CH_2 = CH - CH = CH_2$

9. Select correct statement (s)

(A) Bond length of $NO^+ > NO$
(B) Bond order of $NO^+ > NO$
(C) Bond energy of $NO > NO^+$
(D) NO is paramagnetic but NO^+ is diamagnetic

10. Which of the following properties is/are same in:

(I) $[CrCl_6]^{3-}$ (II) $[Cr(H_2O)_6]^{3+}$ (III) $[Cr(NH_3)_6]^{3+}$ (IV) $[Cr(NH_3)_6]^{3-}$

(A) Magnetic moment
(B) EAN of central metal
(C) Magnitude of splitting energy
(D) Colour

Space for Rough work

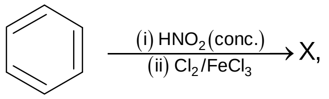
SECTION –C
Integer Answer Type

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. For the complex compound $\left[Pt(NH_3)(NO_2)Py(ONO)\right]$, total number of geometrical isomers will be:

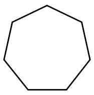
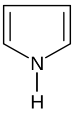
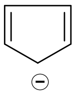
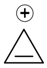
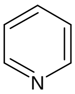
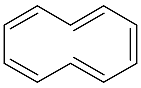
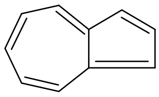
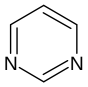
2. Find the total number of acidic radicals which produce volatile product with dilute HCl:
$SO_4^{2-}, I^-, NO_2^-, NO_3^-, SO_3^{2-}, HCO_3^-$

3. Total number of stereoisomers of 1, 2-Dibromo-3-chlorocyclo propane.

4. 

The number of possible isomers of 'X' is?

5. Number of aromatic compounds among the following:

,
,
,
,
,
,
,
, graphite, diamond.

6. Molality of a 5M solution of H_2SO_4 having density 1.115 gm/ml.

7. Total number of electron in phosphorus which have zero value of at least one quantum number.

8. The pressure necessary to obtain 50% dissociation of PCl_5 at 400 K is numerically equal to ……….times of Kp.

9. Number of S—S bonds in cyclic trimer of SO_3

10. Number of unpaired electrons in compound $[Mn(CN)_6]^{3-}$ is:

Space for Rough work

Mathematics PART – III

SECTION – A

(One or More than One Options Correct Type)

This section contains **10 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** are correct.

1. If x_1, x_2, x_3, x_4 are four positive real numbers such that

$$x_1 + \frac{1}{x_2} = 4,\ x_2 + \frac{1}{x_3} = 1,\ x_3 + \frac{1}{x_4} = 4 \text{ and } x_4 + \frac{1}{x_1} = 1, \text{ then}$$

(A) $x_1 = x_3$ (B) $x_2 = x_4$
(C) $x_1x_2 = 1$ (D) $x_3x_4 = 1$

2. If the normals at (x_i, y_i) i = 1, 2, 3, 4 to the rectangular hyperbola $xy = 2$ meet at the point (3, 4), then

(A) $x_1 + x_2 + x_3 + x_4 = 3$ (B) $y_1 + y_2 + y_3 + y_4 = 4$
(C) $x_1x_2x_3x_4 = -4$ (D) $y_1y_2y_3y_4 = 4$

3. In a triangle ABC with sides a, b and c, a semicircle touching the sides AC and CB is inscribed whose diameter lies on AB, then the radius of the semicircle is

(A) $\frac{a}{2}$ (B) $\frac{2abc}{s(a+b)}\sin\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2}$

(C) $\frac{2\Delta}{a+b}$ (D) $\frac{2abc}{s(a+b)}\cos\frac{A}{2}\cos\frac{B}{2}\cos\frac{C}{2}$

4. An urn contains fair tickets with numbers 112, 121, 211, 222 and one ticket is drawn. Let A_i (i = 1, 2, 3) be the event that the ith digit of the number of ticket drawn is 1 then

(A) $P(A_1) = P(A_2) = P(A_3) = \frac{1}{2}$ (B) $P(A_1 \cap A_2) = P(A_1)\,P(A_2)$

(C) A_1, A_2, A_3 are pair wise independent events (D) $P(A_1 \cap A_2 \cap A_3) \neq P(A_1)\,p(A_2)\,P(A_3)$

Space for rough work

5. Suppose that the complex number z lies on the curve such that $\frac{z-4}{z-2i}$ is purely imaginary. If the complex number z_1 represents the mid-point of chord OA of this curve, O being the origin, then z_1 necessarily satisfies

(A) $\frac{z_1-2}{z_1-i}=ik$, $k \in R-\{0\}$ (B) $\frac{z_1}{z_1-2-i}=ik$, $k \in R-\{0\}$

(C) $\frac{z_1-2}{2z_1-i}=k$, $k \in R-\{0\}$ (D) $|z_1|=\frac{\sqrt{5}}{2}$

6. $\int_{-\alpha}^{\alpha} e^x+\cos x \ln\left(x+\sqrt{1+x^2}\right)dx > \frac{3}{2}$, then α can be

(A) 1 (B) 2
(C) 3 (D) 4

7. Let f(x) = $x^3 - x^2 + x + 1$ and $g(x)=\begin{cases}\max.\, f(t) & ;\ 0 \le t \le x\ ;\ 0 \le x \le 1\\ 3-x & ;\ 1< x \le 2\end{cases}$ then

(A) g(x) is discontinuous at x = 1 (B) g(x) is continuous at x = 1
(C) g(x) is differentiable at x = 1 (D) g(x) is non-differentiable at x = 1

8. Which of the following set of values of x satisfies the equation
$2^{\left(2\sin^2 x-3\sin x+1\right)}+2^{\left(2-2\sin^2 x+3\sin x\right)}=9$

(A) $x=n\pi\pm\frac{\pi}{6}$, $n \in I$ (B) $x=n\pi\pm\frac{\pi}{3}$, $n \in I$

(C) $x = n\pi$, $n \in I$ (D) $x=2n\pi+\frac{\pi}{2}$, $n \in I$

9. Consider all the strings of n-digits which can be formed using the numbers from the set {0, 1, 2, 3} (may be starting with zero also). If E_n denotes the number of strings containing even number of zeros and O_n denotes the strings containing odd number of zeros then

(A) $E_n + O_n = 4^n$ (B) $E_n=\frac{4^n+2^n}{2}$

(C) $O_n=\frac{4^n-2^n}{2}$ (D) $E_n = O_n$

Space for rough work

10. The solution of $\left(\frac{dy}{dx}\right)\left(x^2y^3+xy\right)=1$ is

(A) $\frac{1}{x}=2-y^2+c\cdot e^{-y^2/2}$ (B) $\frac{1}{x}=2+y^2+c\cdot e^{-y^2/2}$

(C) $\frac{2}{x}=1-y^2+e^{-y/2}$ (D) $\frac{1-2x}{x}=-y^2+c\cdot e^{-y^2/2}$

SECTION – C

(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive)

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1. Three circles lie on a plane so that each of them externally touches the other two. Two of them has radius 3, the third having radius unity. If A, B and C are the points of tangency of those circles and the area of the triangle ABC is $\frac{a\sqrt{b}}{c}$ then value of c – a – b is, where a, b and c are positive integers _____

2. The number of polynomials of the form $x^3 + ax^2 + bx + c$ which are divisible by $x^2 + 1$ where $a, b, c \in \{1, 2, 3, \ldots, 10\}$ is 10k, then k is _____

3. OABC is a tetrahedron in which O is the origin and position vector of points A, B, C are $\hat{i}+2\hat{j}+3\hat{k}$, $2\hat{i}+\alpha\hat{j}+\hat{k}$ and $\hat{i}+3\hat{j}+2\hat{k}$ respectively. An integral value of α for which shortest distance between OA and BC is $\sqrt{\frac{3}{2}}$ is _____

4. If $f(x)+f\left(\frac{1}{1-x}\right)=\frac{2(1-2x)}{x(1-x)}$, where x is a real number $x \neq 0$, $x \neq 1$, then the value of f(2) must be _____

Space for rough work

5. If $x^5 - x^3 + x = a$, when $x > 0$, then the maximum value of $2a - x^6$ is equal to _____

6. If $x^4 + 3\cos(ax^2 + bx + c) = 2(x^2 - 2)$ has two solutions with a, b, c $\in (2, 5)$ then the maximum value of $\frac{ac}{b^2}$ is _____

7. If $f(x) = (x-1)^{100}(x-2)^{2(99)}(x-3)^{3(98)} \ldots\ldots (x-n)^{100}$, let $k = \frac{f'(101)}{f(101)}$, then $\left(\frac{k}{50} - 97\right)$ is _____

8. The minimum value of $\frac{(a^2 + b^2 + c^2)}{d^2}$ in any quadrilateral, where a, b, c and d are sides of quadrilateral, is k then 6k is equal to _____

9. The number of integral values of parameter α, so that the point $(\alpha, (1 + \alpha^2)^{-1})$ does not lie outside the triangle formed by the lines $L_1 : 15y = x + 1$, $L_2 : 78y = 118 - 23x$ and $L_3 : y + 2 = 0$, is equal to _____

10. Let $f(x) = \sin x - a \sin 2x - \frac{1}{3}\sin 3x + 2ax$, increases throughout the number line then minimum prime value of a is equal to _____

Space for rough work

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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FIITJEE

JEE(Advanced)-2015

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS
CRT– I
(Paper-1)

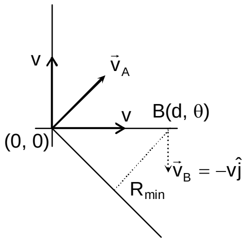
Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**A, B**	**D**	**A, B, C, D**
2.	**C, D**	**A, B, C**	**A, B, C**
3.	**A, B, D**	**A, C**	**C, D**
4.	**A, C**	**B, C**	**A, B, C, D**
5.	**A, B**	**A, C**	**A, B**
6.	**A, D**	**B**	**A, B, C, D**
7.	**C, D**	**B**	**B, D**
8.	**A, C**	**A, D**	**A, D**
9.	**A, D**	**B, D**	**A, B, C**
10.	**B, D**	**A, B**	**A, D**
1.	**2**	**3**	**0**
2.	**0**	**3**	**1**
3.	**2**	**4**	**3**
4.	**3**	**3**	**3**
5.	**4**	**7**	**1**
6.	**3**	**8**	**1**
7.	**2**	**9**	**4**
8.	**5**	**3**	**2**
9.	**0**	**0**	**4**
10.	**3**	**2**	**2**

Physics

PART – I

SECTION – A

1. Using concept of relative velocity we can solve



3. Use $v^2 = u^2 + 2as$
And impulse = change in momentum

4. Use $v = \sqrt{\dfrac{2gh}{\beta}}$
where, $\beta = 1 + \dfrac{I}{Mr^2}$

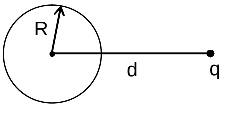
5. Use work energy theorem

6. Buoyant force $F_B = V\rho_e g_{eff}$
If lift accelerates
$g_{eff} = g + a$

7. Use, $\nu_{app} = \nu_v \left(\dfrac{v - v_0}{v - v_s}\right)$
v = speed of sound

8. for isothermal process, PV = constant
For adiabatic process, PV^γ = constant

9. Electric field at centre = 0
So, charge q will produce same electric field as induced charge on sphere at centre so A & D



10. Using conservation linear moment and conservation mechanical energy.

SECTION – C

1. For translation position of A will be 2.

2. formula for rod and are both are
$$\frac{k\lambda}{d}(\sin\alpha + \sin\beta)\hat{i} + \frac{k\lambda}{d}(\cos\alpha - \cos\beta)\hat{j}$$
So, $\vec{E} = \vec{0}$ and b = 0

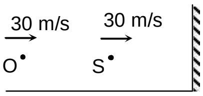
6. work done = $\frac{3}{2}P_0V_0$

$$\Delta U = \frac{P_2V_2 - P_1V_1}{\gamma - 1}$$

$$\Delta Q = \frac{3}{2}P_0V_0$$

$\therefore$ k = 3

7. $f_1 = f$



$$f_w = \frac{C}{C-30}f = \frac{330}{300}\times 1000 \text{ Hz}$$

$$f_2 = \frac{C+v_0}{C}f_w = \frac{360}{330}\times\frac{330}{300}\times 1000 = 1200 \text{ Hz}$$

Frequency Band width = $f_2 - f_1$ = 200 Hz

8. $$F_{net} = F_{pseudo} - F_{Buoyant} = V\times 2\rho\times 10 - v\rho\times 10 = v\rho\times 10$$

$$a = \frac{F_{net}}{n} = \frac{v\rho\times 10}{v\times 2\rho} = 5 \text{ m/s}$$

9. $$I_L = \frac{100}{50\sqrt{2}} = \sqrt{2} \text{ A}$$

$$I_C = \frac{100}{50\sqrt{2}} = \sqrt{2}$$

$$I_{source} = I_L - I_C = 0$$

Chemistry PART – II

SECTION – A

1. Dacron is a copolymer of ethylene glycol and terephthalic acid

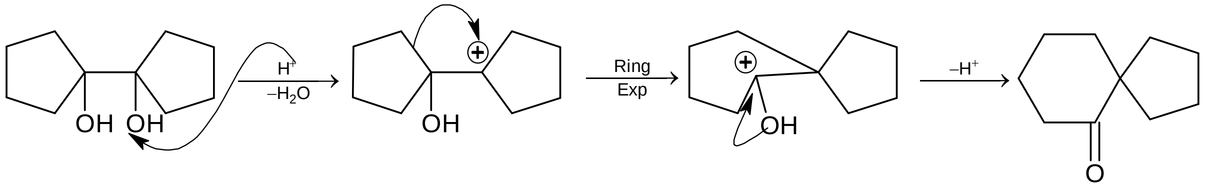
2. $${}^{A}_{Z}A \xrightarrow{-\alpha} {}^{A-4}_{Z-2}B \xrightarrow{-\beta} {}^{A-4}_{Z-1}C \xrightarrow{-\beta} {}^{A-4}_{Z}D$$
α - emission gives isodiapher.

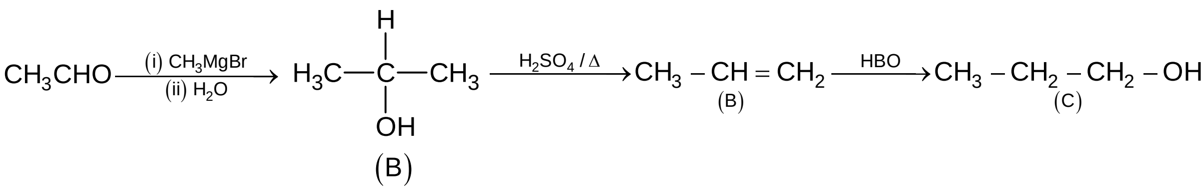
3. From kinetic theory of gases
K. E. $\propto$ T

4.
$$M_{Na_2CO_3} = \frac{W_B \times 1000}{m_B \times V} = \frac{5.3 \times 1000}{106 \times 100} = 0.5$$
$$N_{Na_2CO_3} = \frac{W_B \times 1000}{E_B \times V} = \frac{5.3 \times 1000}{53 \times 100} = 1$$
n-factor =2

$$M_{H_2C_2O_4.2H_2O} = \frac{W_B \times 1000}{m_B \times V} = \frac{6.3 \times 1000}{126 \times 100} = 0.5$$
$$N_{H_2C_2O_4.2H_2O} = \frac{N_B \times 1000}{E_B \times V} = \frac{6.3 \times 1000}{63 \times 100} = 1$$
n-faction = 2

5. $E^o_{redox\ change}$ will be negative for non-spontaneous reaction
$$Ni^{2+}(aq) + Cu(s) \longrightarrow Ni(s) + Cu^{2+}(aq)$$
$$E^o = E^o_{Ni^{2+}/Ni} - E^o_{Cu^{2+}/Cu} = -0.25 - 0.34 = -0.59V(-ve,\ non-spontaneous)$$
$$Cu(s) + 2H^+(aq) \longrightarrow Cu^{2+}(aq) + H_2(g)$$
$$E^o = E^o_{H^+/H_2} - E^o_{Cu^{2+}/Cu} = 0 - 0.34 = -0.34V(-ve,\ non-spontaneous)$$

6.


7.

$$CH_3CHO \xrightarrow[(ii)\ H_2O]{(i)\ CH_3MgBr} \underset{(B)}{H_3C-\underset{OH}{\overset{H}{C}}-CH_3} \xrightarrow{H_2SO_4/\Delta} \underset{(B)}{CH_3-CH=CH_2} \xrightarrow{HBO} \underset{(C)}{CH_3-CH_2-CH_2-OH}$$

8. Compounds have all ‘c’ atom sp^2 hybridised are coplanar.

9. B. O. of NO = 2.5, paramagnetic
NO^+ = 3.0, diamagnetic

10. Cr^{3+}, d^3 configuration shows same number paired e^- and EAN but strength of all ligands are different so does not slow same colour and splitting.

SECTION –C

1. [Mabcd] type square planar complex has 3 G. I.

2. $NO_2^- + HCl \longrightarrow HNO_2 + Cl^-$

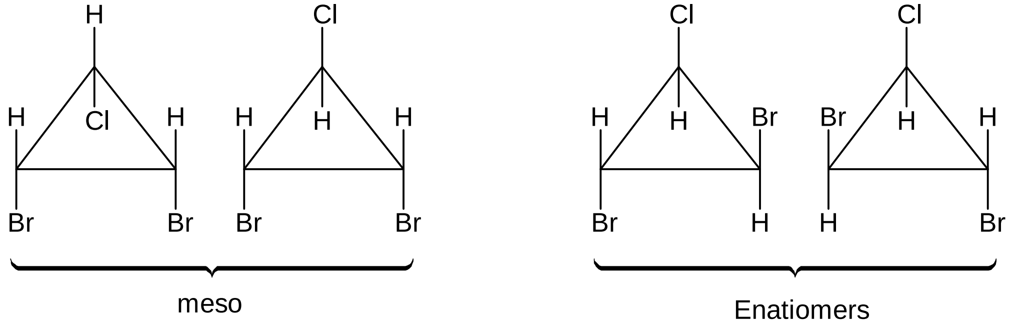
$3HNO_2 \longrightarrow HNO_3 + 2NO + H_2O$

$2NO + O_2 \longrightarrow 2NO_2 \uparrow$

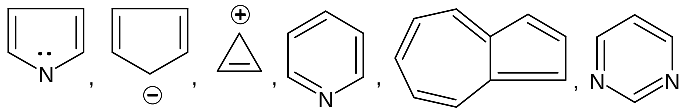
$SO_3^{2-} + HCl \longrightarrow H_2O + 2Cl^- + SO_2 \uparrow$

$HCO_3^- + HCl \longrightarrow H_2O + CO_2 \uparrow + Cl^-$

3.



5. Aromatic compounds


, graphite

A layer of graphite (graphene) contains infinite lattice of fused aromatic rings. All the valencies are satisfied (except at the edges) and no bonds are needed between layers. (Planar layered structure of fused aromatic rings).

6. 5M → 5 mol $H_2SO_4 = 5 \times 98 = 490$ gm of H_2SO_4

→ 1000 ml of solution $= 1000 \times 1.115 = 1115$ gm solution

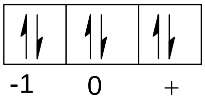
$\therefore$ wt. of solvent = 1115 – 490 = 625 gm

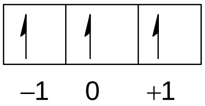
$$m = \frac{\text{moles of solute}}{\text{wt. of solvent (in kg)}} = \frac{5}{625 \times 10^3} = 8 \text{ mol/kg}$$

7. $_{15}P \longrightarrow 1s^2, 2s^2, 2p^6, 3s^2 3p^3$

For 's' $\ell = 0$, m = 0, $e^- = 6$

For 'p', $\ell = 1$, m = → -1, → +1, → 0





$= 2e^-$ $= 1e^-$

Total e^- = 6 + 2 + 1 = 9

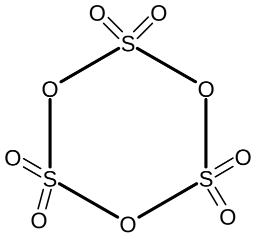
8. $$\underset{\substack{a\\a-ax}}{PCl_5} \rightleftharpoons \underset{\substack{0\\a\alpha}}{PCl_3} + \underset{\substack{0\\a\alpha}}{Cl_2} \quad \alpha=0.50$$

$$K_p = \frac{\alpha^2 P}{1-\alpha^2} \Rightarrow \frac{K_p}{P} = \frac{0.5\times0.5}{0.75}$$

$$\Rightarrow \frac{P}{K_P} = 3$$

$\therefore$ P = 3 × K_P

9.

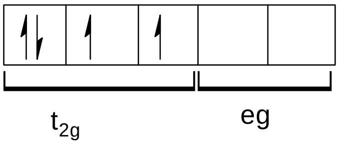


10. $\left[Mn(CN)_6\right]^{3-}$

x + 6(–1) = –3

$\therefore$ x = +3

$Mn^{3+} \longrightarrow [Ar]3d^4 4S^0$



As CN^- is strong ligand hence due to splitting it will from low spin complex.

Mathematics

PART – III

SECTION – A

1. $4 = x_1 + \frac{1}{x_2} \geq 2\sqrt{\frac{x_1}{x_2}}$

$1 = x_2 + \frac{1}{x_3} \geq 2\sqrt{\frac{x_2}{x_3}}$

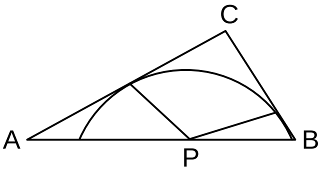
$4 = x_3 + \frac{1}{x_4} \geq 2\sqrt{\frac{x_3}{x_4}}$

$1 = x_4 + \frac{1}{x_1} \geq 2\sqrt{\frac{x_4}{x_1}} \Rightarrow 16 = \left(x_1 + \frac{1}{x_2}\right)\left(x_2 + \frac{1}{x_3}\right)\left(x_3 + \frac{1}{x_4}\right)\left(x_4 + \frac{1}{x_1}\right) \geq 2^4$

2. Any point on xy = 2 is $P\left(\sqrt{2}t, \frac{\sqrt{2}}{t}\right)$

Normal at P is $\left(y - \frac{\sqrt{2}}{t}\right) = t^2\left(x - \sqrt{2}t\right)$

3. $\Delta_{ABC} = \Delta_{BPC} + \Delta_{APC}$



$\Delta = \frac{1}{2}ar + \frac{1}{2}br$

$r = \frac{2\Delta}{a+b}$

$\cos\frac{A}{2}\cos\frac{B}{2}\cos\frac{C}{2} = \sqrt{\frac{s(s-a)}{bc}} \cdot \sqrt{\frac{s(s-b)}{ac}} \cdot \sqrt{\frac{s(s-c)}{ab}} = \frac{s\Delta}{abc}$

4. $P(A_1 \cap A_2) = \frac{1}{4}$, $P(A_1) = \frac{2}{4}$

$P(A_2) = \frac{1}{2}$. Thus $P(A_1 \cap A_2) = P(A_1)\, P(A_2)$

5. $\frac{z-4}{z-2i} + \frac{\bar{z}-4}{\bar{z}+2i} = 0$ which is a circle $x^2 + y^2 - 4x - 2y = 0$

$xx_1 + yy_1 - 2(x + x_1) - (y + y_1) = x_1^2 + y_1^2 - 4x_1 - 2y_1$

It passes through (0, 0), so, the locus of (x_1, y_1) is $x^2 + y^2 - 2x - y = 0$.

So, $z_1 = x_1 + iy_1$, lies on this circle for which the points (2, 0) and (0, 1) are extremities of a diameter. Also (0, 0) and (2, 1) represent extremities of another diameter

6. $I = \int_{-\alpha}^{\alpha} e^x dx + \int_{-\alpha}^{\alpha} \cos x \ln\left(x + \sqrt{1+x^2}\right)dx$

$\Rightarrow e^{\alpha} - e^{-\alpha} > \frac{3}{2}$

7. $f(t) = t^3 - t^2 + t + 1$

$f'(t) > 0$

$\therefore \max.\{f(t): 0 \leq t \leq x\} = f(x)$

8. Put $2^{\left(2\sin^2 x-3\sin x+1\right)}=t$

9. $E_n = 3^n + {}^nC_2 \cdot 3^{n-2} + {}^nC_4 \cdot 3^{n-4} + \ldots$
$O_n = {}^nC_1 \cdot 3^{n-1} + {}^nC_3 \cdot 3^{n-3} + \ldots$
Adding and subtracting, we get $E_n + O_n = (3 + 1)^n = 4^n$, $E_n - O_n = (3 - 1)^2 = 2^n$

Adding and subtracting again, we get $2E_n = 4^n + 2^n \Rightarrow E_n = \frac{4^n+2^n}{2}$

$2O_n = 4^n - 2^n \Rightarrow O_n = \frac{4^n-2^n}{2}$

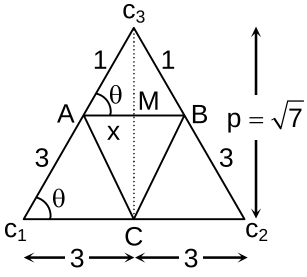
10. $\frac{dx}{dy} = x^2y^3 + xy$

$\frac{dx}{dy} - xy = x^2y^3$

$-\frac{1}{x^2}\frac{dx}{dy} + \frac{y}{x} = -y^3$

Put $\frac{1}{x} = t$

SECTION – C



1. $\cos\theta = \frac{3}{4} = \frac{x}{1}$

$\Rightarrow x = \frac{3}{4} \quad \Rightarrow AB = \frac{3}{2}$

$p = \sqrt{4^2 - 3^2} = \sqrt{7}$ and $c_3M = \frac{\sqrt{7}}{4}$

$\Rightarrow CM = \sqrt{7} - \frac{\sqrt{7}}{4} = \frac{3\sqrt{7}}{4}$

2. $x^2 + 1 = (x + i)(x - i)$
$b = 1, a = c$
Number of ways of choosing a, b, c = 10 = 10 × 1
$\therefore k = 1$

3. Unit vector $(\hat{n})$ perpendicular to $\overrightarrow{OA}$ and $\overrightarrow{CB}$

$$\hat{n} = \frac{\overrightarrow{CB}\times\overrightarrow{OA}}{\left|\overrightarrow{CB}\times\overrightarrow{OA}\right|} = \frac{(3\alpha-7)\hat{i}-4\hat{j}+(5-\alpha)\hat{k}}{\sqrt{(3\alpha-7)^2+16+(5-\alpha)^2}}$$

As $\overrightarrow{CB}\times\overrightarrow{OA} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & \alpha-3 & -1 \\ 1 & 2 & 3 \end{vmatrix}$ = $\left|\overrightarrow{BA}\cdot\hat{n}\right| = \left|\frac{(7-3\alpha)-4(2-\alpha)+2(5-\alpha)}{\sqrt{(3\alpha-7)^2+16+(5+\alpha)^2}}\right|$

Shortest distance = $\left|\overrightarrow{BA}\cdot\vec{n}\right|$

4. Replacing x by $\frac{1}{(1-x)}$, we obtain $f\left(\frac{1}{1-x}\right)+f\left(1-\frac{1}{x}\right) = -2x+\frac{2}{x}$

Again, replacing x by $1-\frac{1}{x}$

5. We have $a = \dfrac{x(x^6+1)}{x^2+1}$

$\Rightarrow x^6 + 1 = a\left(\dfrac{x^2+1}{x}\right) \geq 2a$

$\Rightarrow 2a - x^6 \leq 1$

6. $\Rightarrow (x^2 - 1)^2 = -3\{1 + \cos(ax^2 + bx + c)\}$ solution exists when L.H.S. = R.H. S. = 0
$\Rightarrow x = \pm 1$ and $\cos(ax^2 + bx + c) = -1$
When $x = 1$, $x = -1$
$\Rightarrow a + b + c = 3\pi$, $a - b + c = \pi$
$\Rightarrow b = \pi$ and $a + c = 2\pi$

7. $f(x) = \prod_{i=1}^{100} (x-i)^{i(101-i)}$

$\ln(f(x)) = \sum_{i=1}^{100} i(101-i)\ln(x-i)$

$\Rightarrow \dfrac{1}{f(x)} \cdot f'(x) = \sum_{i=1}^{100} \dfrac{i(101-i)}{(x-i)}$

8. For any quadrilateral,
$a + b + c > d$.
Now, $(a - b)^2 + (b - c)^2 + (c - a)^2 \geq 0$
$\Rightarrow a^2 + b^2 + c^2 \geq (ab + bc + ca)$
$\Rightarrow 3(a^2 + b^2 + c^2) \geq 3(ab + bc + ca)$
$\Rightarrow 3(a^2 + b^2 + c^2) \geq a^2 + b^2 + c^2 + 2(ab + bc + ca)$
$\Rightarrow 3(a^2 + b^2 + c^2) \geq (a + b + c)^2$
$\Rightarrow 3(a^2 + b^2 + c^2) > d^2$
$\Rightarrow \dfrac{(a^2+b^2+c^2)}{d^2} > \dfrac{1}{3}$.

$\therefore$ The minimum value of $\left(\dfrac{a^2+b^2+c^2}{d^2}\right)$ is $\dfrac{1}{3}$

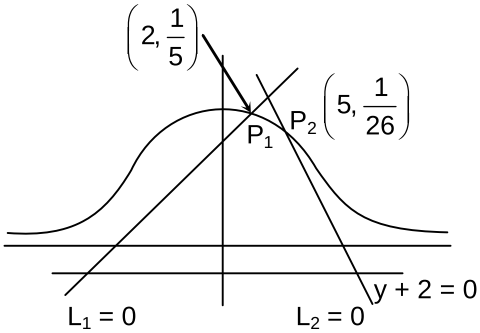
9. As $P(\alpha, (1 + \alpha^2)^{-1})$ lie on $y = \dfrac{1}{1+x^2}$

$\therefore$ On solving $y = \dfrac{1}{x^2+1}$ with L_1, we get

$\left(2, \dfrac{1}{5}\right)$ ….. (1)

and with line L_2, we get $P_2\left(5, \dfrac{1}{26}\right)$ ….. (2)

$\therefore$ Equation (1) and (2), we get $2 \leq \alpha \leq 5$


$\left(2, \frac{1}{5}\right)$
P_2 $\left(5, \frac{1}{26}\right)$
P_1
y + 2 = 0
$L_1 = 0$
$L_2 = 0$

10. $f'(x) = \cos x - 2a\cos 2x - \cos 3x + 2a \geq 0 \ \forall\ x \in R$
$\Rightarrow 2\sin^2 x(\cos x + a) \geq 0$
$\Rightarrow a \geq -\cos x \geq 1$

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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ALL INDIA TEST SERIES

FIITJEE # JEE (Advanced), 2015

CONCEPT RECAPITULATION TEST - I

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 10)** contains 10 multiple choice questions which have one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (11 to 16) contains 3 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (17 – 20) contains 4 Matching Lists Type questions: Each question has four statements in LIST I & 4 statements in LIST II. The codes for lists have choices (A), (B), (C), (D) out of which only one is correct. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

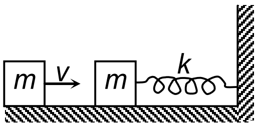
(Only One Option Correct Type)

This section contains **10 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

1. Which of the following is the most accurate instrument for measuring length?
   (A) vernier calipers having 20 divisions on the sliding scale which coincide with 19 divisions on the main millimeter scale
   (B) a screw gauge having pitch 1 mm and 50 divisions on the circular scale
   (C) a vernier scale of least count 0.01 mm
   (D) a screw gauge of least count 0.001 mm

2. A ball is thrown from the ground to clear a wall 3 m high at a distance of 6 m and falls 18 m away from the wall, the angle of projection of ball is
   (A) $\tan^{-1}\left(\frac{3}{2}\right)$ (B) $\tan^{-1}\left(\frac{2}{3}\right)$
   (C) $\tan^{-1}\left(\frac{1}{2}\right)$ (D) $\tan^{-1}\left(\frac{3}{4}\right)$

3. A block of mass m moving with velocity v strikes elastically another identical mass connected to a spring as shown in figure. The maximum compression produced in the spring (Assume surfaces to be smooth) is



   (A) $\sqrt{\frac{mv^2}{2k}}$ (B) $\sqrt{\frac{mv^2}{k}}$
   (C) $\sqrt{\frac{mv^2}{3k}}$ (D) none of these

Space for Rough work

4. A cube of side l and mass M is placed on rough horizontal surface and the friction is sufficient so that it will not move, if a constant force F = Mg is applied horizontally l/4 above the surface. Then the torque due to normal force about center of the cube is equal to

(A) $\frac{Mgl}{2}$
(B) $\frac{Mgl}{4}$
(C) $\frac{Mgl}{8}$
(D) zero

5. The work done to take a particle of mass m from surface of the earth to a height equal to 2R is (R is radius of earth)

(A) 2 mgR
(B) $\frac{mgR}{2}$
(C) 3 mgR
(D) $\frac{2mgR}{3}$

6. A spherical object of mass 1 kg and radius 1 m is falling vertically downward inside a viscous liquid in a gravity free space. At a certain instant the velocity of the sphere is 2 m/s. If the coefficient of viscosity of the liquid is $\frac{1}{18\pi}$ N-s/m^2, then velocity of ball will become 0.5 m/s after a time

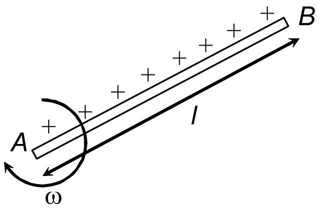
(A) ln 4 s
(B) 2 ln 4 s
(C) 3 ln 4 s
(D) 2 ln 2 s

7. Two straight long conductors AOB and COD are perpendicular to each other and carry currents i_1 and i_2. The magnitude of the magnetic induction at a point P at a distance a from the point O in a direction perpendicular to the plane ACBD is

(A) $\frac{\mu_0}{2\pi a}(i_1 + i_2)$
(B) $\frac{\mu_0}{2\pi a}(i_1 - i_2)$
(C) $\frac{\mu_0}{2\pi a}(i_1^2 + i_2^2)^{1/2}$
(D) $\frac{\mu_0}{2\pi a}\frac{i_1 i_2}{(i_1 + i_2)}$

Space for Rough work

8. A non-conducting rod AB of length l has a positive linear charge density λ. The rod is rotated about point A with an angular velocity ω in the plane of paper. The magnetic moment of the rod is



(A) $\frac{\lambda\omega l^3}{2}$ (B) $\frac{2\lambda\omega l^3}{3}$

(C) $\frac{3\lambda\omega l^3}{2}$ (D) $\frac{\lambda\omega l^3}{6}$

9. A bird is flying over a swimming pool at a height of 2m from the water surface. If the bottom is perfectly plane reflecting surface and depth of swimming pool is 1 m, then the distance of final image of bird from the bird itself is ($\mu_w = 4/3$)

(A) $\frac{11}{3}$m (B) $\frac{23}{3}$m

(C) $\frac{11}{4}$m (D) $\frac{11}{2}$m

10. The mean lives of a radioactive sample are 30 years and 60 years for α-emission and β-emission respectively. If the sample decays both by α-emission and β-emission simultaneously, the time after which, only one-fourth of the sample remain is

(A) 10 years (B) 20 years

(C) 40 years (D) 45 years

Space for Rough work

Comprehension type (Only One Option Correct)

This section contains **3 paragraphs**, each describing theory, experiments, data etc. Six questions relate to the three paragraphs with **two questions on each paragraph**. Each question has **only one** correct answer among the four given options (A), (B), (C) and (D).

Paragraph for Questions 11 & 12

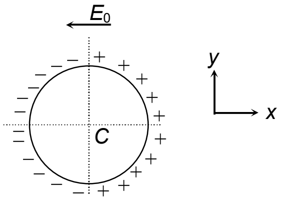
The position vector of a body of mass m = 4 kg is given as $\vec{r} = \hat{i}(t^2 - 4t) + \hat{j}(-t^3)$, where $\vec{r}$ is in metres and t in seconds.

11. The magnitude of torque with respect to origin, acting on the particle at t = 1s will be
(A) zero (B) 48 Nm
(C) 64 Nm (D) 80 Nm

12. Work done by force acting on it in first two seconds will be
(A) 32 J (B) 256 J
(C) 320 J (D) 288 J

Paragraph for Questions 13 & 14

A uniform ring of mass m and radius R can rotate freely about an axis passing through centre C and perpendicular to plane of paper. Half of ring is positively charge and other half is negatively charge. Uniform electric field E_0 is switched on along –ve x-axis (Axis are shown in figure)
[magnitude of charge density λ]



13. The dipole moment of ring is
(A) $2\lambda R^2$ (B) $4\lambda R^2$
(C) $2\pi\lambda R^2$ (D) $4\pi\lambda R^2$

14. If ring is slightly disturb from given position, find the angular speed of ring when it rotate by $\pi/2$.
(A) $2\sqrt{\frac{\lambda E_0}{m}}$ (B) $\sqrt{\frac{\lambda E_0}{m}}$
(C) $\sqrt{\frac{8\lambda E_0}{m}}$ (D) none

Space for Rough work

Paragraph for Questions 15 & 16

An ammeter and a voltmeter are connected in series to a battery with emf E = 6 volt and negligible resistance. When a resistance R = 3Ω is connected in parallel to voltmeter, reading of ammeter increases three times while that of voltmeter reduces to one third.

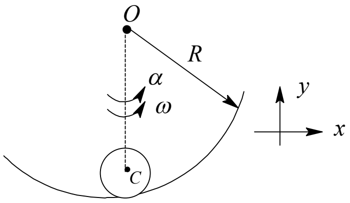
15. Reading of voltmeter after the connection of resistance is
(A) 1 Volt (B) 3 Volt
(C) 9/2 Volt (D) 3/2 Volt

16. Reading of ammeter before the connection of the resistance is
(A) $\frac{3}{4}$A (B) $\frac{6}{7}$A
(C) $\frac{3}{16}$A (D) 1 A

(Matching List Type)

This section contains **4 multiple choice questions. Each question has matching lists.** The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

17. Line joining the centre of path and cylinder is having angular velocity ω and angular acceleration α at the given instant: Match the statements from List I with those in List II and select the correct answer using the code given below the lists.



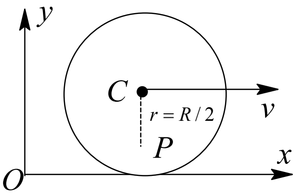
	List-I		List-II
(P)	Rotational component of kinetic energy of cylinder	1.	$(R-r)\alpha\hat{i}+(R-r)\omega^2\hat{j}$
(Q)	Kinetic energy of cylinder	2.	$\frac{\omega^2R(R-r)}{r}\hat{j}$
(R)	Acceleration of centre of cylinder	3.	$\frac{1}{4}m(R-r)^2\omega^2$
(S)	Acceleration of point of contact	4.	$\frac{3}{4}m(R-r)^2\omega^2$

Codes:

	P	Q	R	S
(A)	3	4	1	2
(B)	2	4	1	3
(C)	1	2	3	4
(D)	4	1	2	3

Space for Rough work

18. A disc of mass m and radius R is rolling without slipping on a horizontal fixed rough surface with tramlational velocity v as shown in the figure. Here $\vec{L}_o, \vec{L}_p$ and k_o, k_p represents the angular momentum and kinetic energy about point O and P respectively: Match the physical quantities from List I with those in List II and select the correct answer using the code given below the lists.

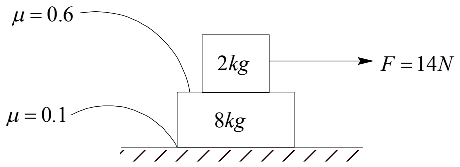


	List-I		List-II
(P)	$\vec{L}_o$	1.	$\frac{3}{4}mVR\left(-R\right)$
(Q)	$\vec{L}_p$	2.	$\frac{3}{4}mVR^2$
(R)	K_o	3.	$\frac{3}{2}mVR\left(-\hat{k}\right)$
(S)	K_p	4.	$\frac{3}{8}mv^2$

Codes:

	P	Q	R	S
(A)	4	2	1	3
(B)	2	4	1	3
(C)	3	1	2	4
(D)	4	1	2	3

19. A block of mass 2kg is kept over a block of mass 8 kg as shown in the figure. A force $F = 14N$ acts on the upper block. Match the physical quantities from List I with those in List II and select the correct answer using the code given below the lists. All values are in S.I. units:



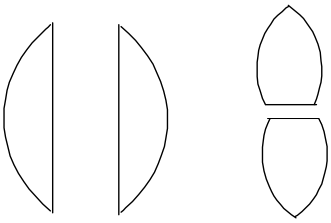
	List-I		List-II
(P)	Acceleration of block 2 kg	1.	10
(Q)	Acceleration of block 8 kg	2.	1
(R)	Friction action between the blocks	3.	12
(S)	Friction acting between lower block and ground	4.	$\frac{1}{4}$

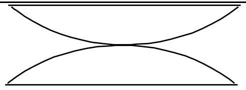
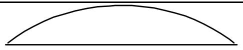
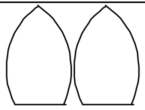
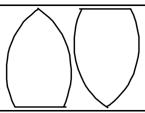
Codes:

	P	Q	R	S
(A)	4	2	1	3
(B)	2	4	1	3
(C)	1	2	3	4
(D)	2	4	3	1

Space for Rough work

20. A thin biconvex lens of small aperture and having focal length 30 cm is cut tow ways as shown in the figure. The focal length of different combination given in List-I with their value in List-II. Match the statements from List I with those in List II and select the correct answer using the code given below the lists.



	List-I		**List-II**
(P)		1.	Infinite
(Q)		2.	30 cm
(R)		3.	60 cm
(S)		4.	15 cm

Codes:

	P	Q	R	S
(A)	4	2	1	3
(B)	2	3	4	1
(C)	1	2	3	4
(D)	2	4	3	1

Space for Rough work

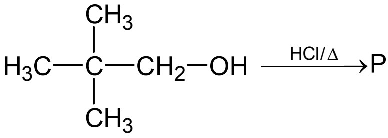
Chemistry PART – II

SECTION – A

(Only One Option Correct Type)

This section contains **10 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

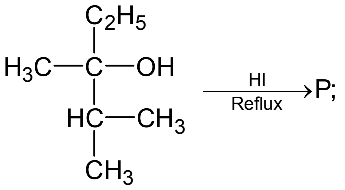
1. Which of the following is not matched correctly?

(A) 

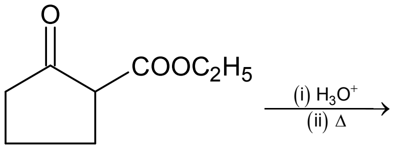
$(CH_3)_3C-CH_2-OH \xrightarrow{HCl/\Delta}$ P; Reaction through S_N1 and rearrangement.

(B) $CH_3-CH_2-OH \xrightarrow{SOCl_2}$ P; Reaction through S_Ni.

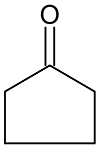
(C) $CH_3-CH_2-OH \xrightarrow[Reflux]{HI}$ P;Reaction through S_N2 reaction.

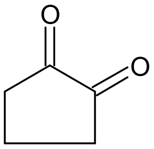
(D) 

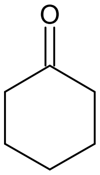
$H_3C-C(C_2H_5)(OH)-CH(CH_3)-CH_3 \xrightarrow[Reflux]{HI}$ P;

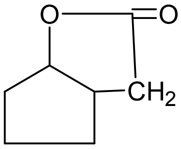
2. 

The major product is

(A) 

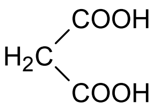
(B) 

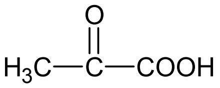
(C) 

(D) 

Space for Rough work

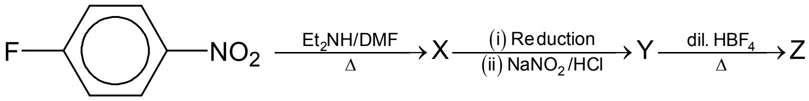
3. $CH_3-COOH\xrightarrow[\text{Red P}]{Br_2(1eq)}(A)\xrightarrow{KCN}(B)\xrightarrow{H_2O/H^+}(C)\xrightarrow{\Delta}(D)$, Product D is

(A) 
COOH
H₂C
COOH

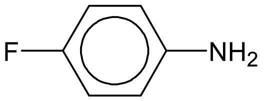
(B) 
$H_3C-\overset{O}{\overset{||}{C}}-COOH$

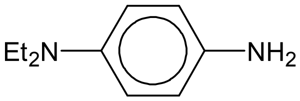
(C) CH_3COOH

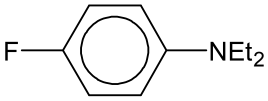
(D) CH_4

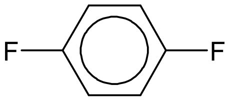
4. 
F
NO₂
Et₂NH/DMF
Δ
X
(i) Reduction
(ii) NaNO₂/HCl
Y
dil. HBF₄
Δ
Z

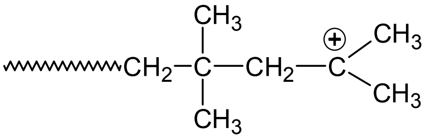
What is 'Z'?

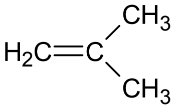
(A) 

(B) 

(C) 

(D) 

5. The monomer of the polymer: 
$\sim\sim CH_2-\underset{CH_3}{\overset{CH_3}{C}}-CH_2-\overset{\oplus}{C}(CH_3)_2$ is

(A) 
CH₃
H₂C=C
CH₃

(B) $(H_3C)_2C{=}C(CH_3)_2$

(C) $H_3CHC{=}CHCH_3$

(D) $H_3C-CH{=}CH_2$

6. State of hybridization of sulphur, carbon-1 and carbon-2 in $F_3S\underset{1}{C}\underset{2}{C}F_3$ respectively are"

(A) sp^3, sp^3, sp^3
(B) sp^3, sp^2, sp^3
(C) sp^3d, sp, sp^3
(D) sp^3, sp, sp^3

Space for Rough work

7. A XF_4 type molecule have μ = 0, which additional information is required to conform the geometry of molecule
(A) All the X—F bond length are identical
(B) Molecule has same F—X—F bond angle between any two adjacent F
(C) Number of lone pair of electron on central atom ≤ 2
(D) Planarity of molecule

8. Solid AB haz ZnS type structure. If the radius of A^+ ion is 22.5 pm then radius of B^- ion will be:

(A) 100 pm	(B) 200 pm
(C) 150 pm	(D) 95 pm

9. $2Zn + O_2 \longrightarrow 2ZnO;\ \Delta G^o = -616\ J$

$2Zn + S \longrightarrow 2ZnS;\ \Delta G^o = -293\ J$

$2S + 2O_2 \longrightarrow 2SO_2(g);\ \Delta G^o = -408\ J$

ΔG^o for the following reaction:

$2ZnS + 3O_2 \longrightarrow 2ZnO + 2SO_2,$ would be:

(A) –731 J	(B) –1317 J
(C) +731 J	(D) +1317 J

10. A gas shows heating effect on sudden expansion. It shows that:
(A) the gas is nobel
(B) the gas is ideal
(C) the inversion temperature of the gas is very low
(D) its Vanders Waal's constant 'b' is high

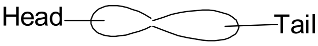
Space for Rough work

Comprehension Type (Only One Option Correct)

This section contains **3 paragraphs** each describing theory, experiment, data etc. **Six questions** relate to four paragraphs with two questions on each paragraph. Each question of a paragraph has **only one correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 11 to 12

Hybridisation is a process of mixing of atomic orbitals to give mixed or hybrid orbitals. Hybrid orbitals have equal energy and their hypothetical shape may be given as



Five d-orbitals are non-degenerate, they are divided into two different set of orbitals

$e_g \rightarrow d_{x^2-y^2}, d_{z^2}$

$t_{2g} \rightarrow d_{xy}, d_{y^2}, d_{zx}$

Hybridisation involving d-orbitals are dsp^2, sp^3d, dsp^3, sp^3d^2, d^2sp^3, sp^3d^3

11. Which of the following orbitals are involved in sp^3d^2 hybridisation?
(A) d_{xy}, d_{yz}
(B) $d_{x^2-y^2}, d_{xy}$
(C) $d_{x^2-y^2}, d_{z^2}$
(D) d_{z^2}, d_{xy}

12. Which of the following d – orbitals are involved in sp^3d^3 hybridisation?
(A) $d_{x^2-y^2}, d_{z^2}, d_{xy}$
(B) d_{xy}, d_{yz}, d_{zx}
(C) $d_{x^2-y^2}, d_{xy}, d_{xz}$
(D) d_{z^2}, d_{y^2}, d_{zx}

Space for Rough work

Paragraph for Question Nos. 13 to 14

If a cell has cell potential 'E' and standard cell potential 'E^o', then free energy change of cell process may be calculated as,
$\Delta G = -W = -nFE$ and $\Delta G^o = -W_{max} = -nFE^o$
Where 'n' is the number of electrons involved in overall all process . According to Gibs-Helmholtz equation:

$$\Delta G = \Delta H - T\Delta S$$

$$\Delta G = \Delta H + T\left(\frac{d\Delta G}{dT}\right)_P$$

Temperature coefficient of cell 'μ' will be equal to $\left(\frac{dE}{dT}\right)_P$

13. ΔG^o for the Daniell cell
$Zn(s)|ZnSO_4||CuSO_4|Cu(s)$
$E^o_{Zn^{2+}/Zn} = -0.76V; E^o_{Cu^{2+}/Cu} = +0.34$ V
Will be:
(A) –312.3 KJ (B) –212.3 KJ
(C) –123.2 KJ (D) –323.1 KJ

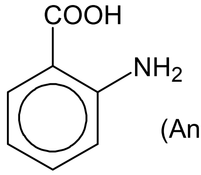
14. The temperature coefficient of a cell whose cell reaction is
$Pb(s) + HgCl_2(aq) \longrightarrow PbCl_2(aq) + Hg(\ell)$
$\left(\frac{dE}{dT}\right)_P = 1.5 \times 10^{-4}$ vK^{-1} at 298 K
The change in entropy in JK^{-1} mol^{-1} for the given cell reaction will be
(A) 14.475 (B) 57.9
(C) 28.95 (D) 86.82

Space for Rough work

Paragraph for Question Nos. 15 to 16

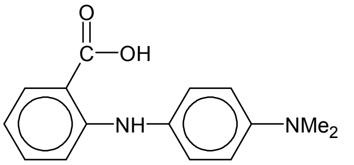
Methyl red is commonly used as indicator for acid base titrations. It is prepared by treating $NaNO_2$/HCl with anthranilic acid and the resulting solution is mixed with N, N-dimethyl aniline and shaked well the solution for some minute to get 'Methyl Red".

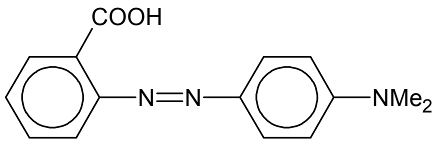
Given

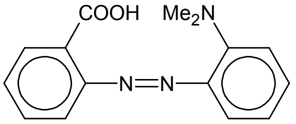


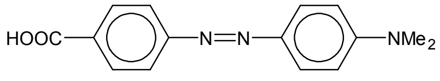
(Anthranilic Acid)

15. Which is most likely to be "Methyl Red"?

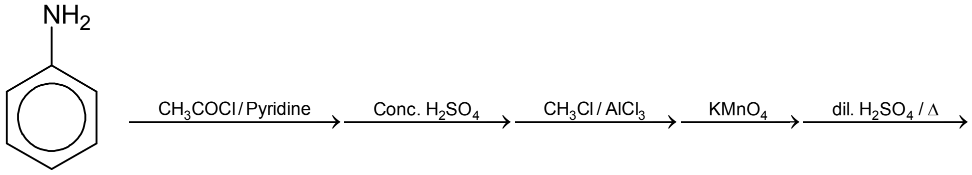
(A)

O
C—OH
NH
NMe2

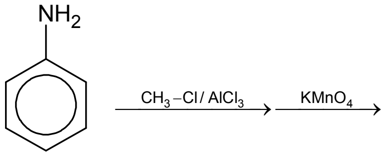
(B)

COOH
N=N
NMe2

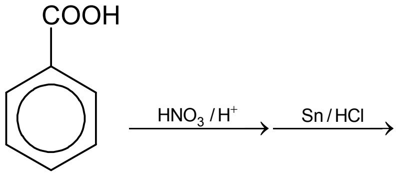
(C)

COOH
Me2N
N=N

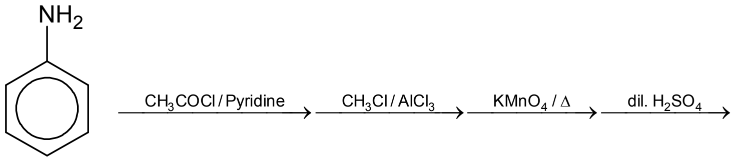
(D)

HOOC
N=N
NMe2

16. Which method can be prepare o-amino benzoic acid, the main raw material?

(A)

NH2
CH3COCl/Pyridine
Conc. H2SO4
CH3Cl/AlCl3
KMnO4
dil. H2SO4/Δ

(B)

NH2
CH3–Cl/AlCl3
KMnO4

(C)

COOH
HNO3/H+
Sn/HCl

(D)

NH2
CH3COCl/Pyridine
CH3Cl/AlCl3
KMnO4/Δ
dil. H2SO4

Space for Rough work

(Matching List Type)

This section contains **4 multiple choice questions. Each question has matching lists.** The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

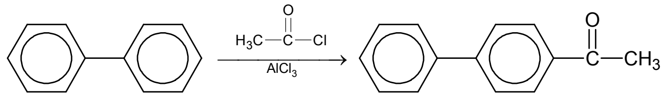
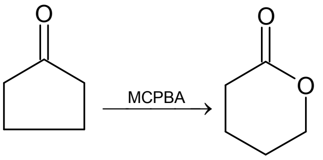
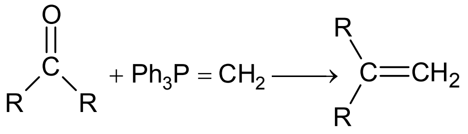
17. Match the list- I with list – Ii

	List– I		**List – II**
(P)	Calomel	(1)	Reference
(Q)	Glass	(2)	Redox
(R)	Hydrogen	(3)	Membrane
(S)	Quinohydrone	(4)	Gas

Codes:

	P	Q	R	S
(A)	1	3	4	2
(B)	3	1	2	4
(C)	1	2	4	3
(D)	1	4	2	3

18. Match List – I with List – II.

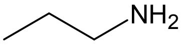
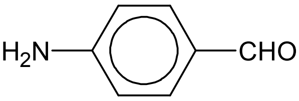
	List – I **Transformation**		**List – II** **Name**
(P)		(1)	Hofmann Isocyanide
(Q)		(2)	Wittin Reaction
(R)		(3)	Bayer-Villiger oxidation
(S)	$Ph-NH_3 \xrightarrow{CHCl_3/KOH} Ph-NC$	(4)	Friedel Craft's Acylation

Codes:

	P	Q	R	S
(A)	4	3	2	1
(B)	3	1	4	2
(C)	1	2	3	4
(D)	1	3	2	4

Space for Rough work

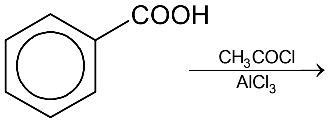
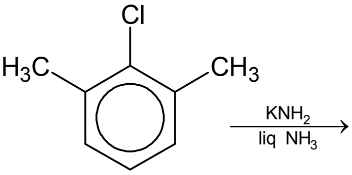
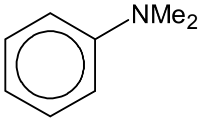
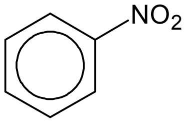
19. Match the list- I with list – II

	List– I		**List – II**
(P)	$H_3C—C\equiv CH$	(1)	Positive test with Fehling's solution
(Q)	HCOOH	(2)	Positive test with Tollen's reagent
(R)		(3)	Decolourise Br_2 water
(S)		(4)	Isocyanide test

Codes:

	P	Q	R	S
(A)	2,3	1,2	4	2,4
(B)	1, 2, 3	1,2	2	4
(C)	2	1, 2	1, 2, 3, 4	4
(D)	1	4	2	3

20. Match the list- I with list – II

	List– I		**List – II**
(P)		(1)	O, P – directing compound
(Q)		(2)	Activated compound
(R)		(3)	No reaction
(S)		(4)	Deactivated compound

Codes:

	P	Q	R	S
(A)	2	1, 2	3, 4	4
(B)	4	1, 2, 3	1, 2	4
(C)	1, 2	3, 4	1, 2	2, 3
(D)	1	2, 3	2	1, 4

Space for Rough work

Mathematics

PART – III

SECTION – A

(Only One Option Correct Type)

This section contains **10 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

1. $\tan^{-1}(\sin x) = \sin^{-1}(\tan x)$ holds true for

(A) $x \in R$

(B) $2n\pi - \frac{\pi}{2} \le x \le 2n\pi + \frac{\pi}{2}$; $(n \in z)$

(C) $x \in n\pi$, $(n \in z)$

(D) $x \in \{0, z^+\}$

2. Let P(x) be a polynomial with degree 2009 and leading co-efficient unity such that P(0) = 2008, P(1) = 2007, P(2) = 2006, ….. P(2008) = 0 and the value of P(2009) = $(\underline{|n})-a$ where n and a are natural number than value of (n + a) is

(A) 2008

(B) 2009

(C) 2010

(D) 2011

3. Let $f(x) = x^3 + x^2 + 100x + 7\sin x$, then equation $\frac{1}{y-f(1)}+\frac{2}{y-f(2)}+\frac{3}{y-f(3)}=0$ has

(A) no real root

(B) one real root

(C) two real roots

(D) more than two real roots

4. Let $(1+x)^n = \sum_{r=0}^{n} C_r x^r$ and $u_n = \sum_{r=0}^{n} (-1)^r \frac{C_r}{x+r}$ at x = 2. Then the sum to infinity of $u_1 + u_2 + u_3 + \ldots$ is

(A) 0

(B) $\frac{1}{2}$

(C) 1

(D) 2

Space for rough work

5. Consider the system of equations ax + by = 0 and cx + dy = 0 where a, b, c, d $\in$ {1, 2}. The probability that the system of equations has a unique solution is
(A) $\frac{3}{8}$
(B) $\frac{5}{16}$
(C) $\frac{9}{16}$
(D) $\frac{5}{8}$

6. If circumcentre of an equilateral triangle inscribed in $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ with vertices having eccentric angles α, β, γ respectively is (x_1, y_1) then $\sum\cos\alpha\cos\beta+\sum\sin\alpha\sin\beta$ is
(A) $\frac{9x_1^2}{2a^2}+\frac{9y_1^2}{2b^2}-\frac{3}{2}$
(B) $\frac{x_1^2}{2a^2}+\frac{y_1^2}{2b^2}-\frac{5}{2}$
(C) $\frac{x_1^2}{9a^2}+\frac{y_1^2}{9b^2}-\frac{5}{9}$
(D) $\frac{x_1^2}{a^2}+\frac{y_1^2}{b^2}-\frac{1}{2}$

7. In a ΔABC, CD is the bisector of the angle C. If $\cos\frac{C}{2}$ has the value $\frac{1}{3}$ and CD = 6, then $\frac{ab}{a+b}$ is equal to
(A) 3
(B) 6
(C) 9
(D) 18

8. Let $S(x)=\int\frac{dx}{e^x+8e^{-x}+4e^{-3x}}$, $R(x)=\int\frac{dx}{e^{3x}+8e^x+4e^{-x}}$ and M(x) = S(x) – 2R(x).
If $M(x)=\frac{1}{2}\tan^{-1}\left(f(x)\right)+c$ where c is an arbitrary constant then $f\left(\log_e 2\right)$ is equal to
(A) $\frac{1}{2}$
(B) $\frac{3}{2}$
(C) $\frac{5}{2}$
(D) $\frac{7}{2}$

Space for rough work

9. f(x) is a differentiable function satisfying the relation $f(x) = x^2 + \int_0^x e^{-t} f(x-t)\,dt$, then $\sum_{k=1}^{9} f(k)$ is equal to

(A) 960 (B) 1060
(C) 1224 (D) 1260

10. The solution of differential equation $x^2(x\,dy + y\,dx) = (xy - 1)^2\,dx$ is (where c is an arbitrary constant)

(A) $xy - 1 = cx$ (B) $xy - 1 = cx^2$
(C) $\frac{1}{xy-1} = \frac{1}{x} + c$ (D) none of these

Comprehension type (Only One Option Correct)

This section contains **3 paragraphs**, each describing theory, experiments, data etc. Six questions relate to the three paragraphs with **two questions on each paragraph**. Each question has **only one** correct answer among the four given options (A), (B), (C) and (D).

Paragraph for Question Nos. 11 to 12

Read the following write up carefully and answer the following questions:
Let each of the circles
$S_1 = x^2 + y^2 + 4y - 1 = 0$
$S_2 = x^2 + y^2 + 6x + y + 8 = 0$
$S_3 = x^2 + y^2 - 4x - 4y - 37 = 0$
touches the other two. Let P_1, P_2, P_3 be the point of contact of S_1 and S_2, S_2 and S_3, S_3 and S_1 respectively. Let T be the point of concurrence of the tangents at P_1, P_2, P_3 to the circles. C_1, C_2, C_3 are the centres of S_1, S_2, S_3 respectively

11. P_2 and P_3 are reflections of each other in the line

(A) $y = x$ (B) $y = x + 1$
(C) $2x - y + 3 = 0$ (D) $2x + y + 9 = 0$

12. The area of the quadrilateral $TP_2C_3P_3$ is

(A) 11 sq. units (B) 25 sq. units
(C) 15 sq. units (D) 9 sq. units

Space for rough work

Paragraph for Question Nos. 13 to 14

Read the following write up carefully and answer the following questions:
If f(x) is a differentiable function wherever it is continuous and $f'(c_1) = f'(c_2) = 0$, $f''(c_1)f''(c_2) < 0$, $f(c_1) = 5$, $f(c_2) = 0$ and $(c_1 < c_2)$

13. If f(x) is continuous in $[c_1, c_2]$ and $f''(c_1) - f''(c_2) > 0$, then minimum number of roots of $f'(x) = 0$ in $[c_1 - 1, c_2 + 1]$ is
(A) 2 (B) 3
(C) 4 (D) 5

14. If f(x) is continuous in $[c_1, c_2]$ and $f''(c_1) - f''(c_2) > 0$, then minimum number of roots of $f(x) = 0$ in $[c_1 - 1, c_2 + 1]$ is
(A) 2 (B) 3
(C) 4 (D) 5

Paragraph for Question Nos. 15 to 16

Read the following write up carefully and answer the following questions:
Define a function ϕ: N → N as follows: $\phi(1) = 1, \phi(p^n) = p^{n-1}(p-1)$ if p is prime and $n \in N$ and $\phi(mn) = \phi(m)\,\phi(n)$, if m and n are relatively prime natural numbers then

15. $\phi(8n + 4)$ where $n \in N$ is equal to
(A) $2\phi(4n + 2)$ (B) $\phi(2n + 1)$
(C) $2\phi(2n + 1)$ (D) $4\phi(2n + 1)$

16. The number of natural numbers 'n' such that $\phi(n)$ is odd is
(A) 1 (B) 2
(C) 3 (D) 4

Space for rough work

(Match List Type)

This section contains 4 multiple choice questions. Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

17. Match the following List–I with List–II

List – I		List – II
(P)	Let $f(x) = x^2 + xg'(1) + g''(2)$ and $g(x) = x^2 + xf'(2) + f''(3)$, then $f'(1) - f'(2)$ is equal to	1. 2
(Q)	If $f(x - y)$, $f(x)\cdot f(y)$ and $f(x + y)$ are in A.P., for all x, y and $f(0) \neq 0$, then $f'(2) + f'(-2)$ is equal to	2. 1
(R)	If $f(x) = x^3 + x^2\cdot f'(1) + xf''(2) + f'''(3)$ for all x, then $f(0) + f(3) + 1$ is equal to	3. 4
(S)	Let $f(x) = x^n$, n being a positive integer, then value of n for which the equality $f'(a + b) = f'(a) + f'(b)$ is valid for all a, b > 0 is	4. 0

Codes:

	P	Q	R	S
(A)	4	3	2	1
(B)	3	4	2	1
(C)	3	4	2	1
(D)	1	2	3	4

18. A function F is defined by $F(x) = \int_1^x \frac{e^t}{t}dt$ ∀ x > 0. Now express the functions in List–I in terms of F, then match the following List–I with List–II

List – I		List – II
(P)	$\int_1^x \frac{e^t}{t+2}dt$	1. $F(x) - \frac{e^x}{x} + e$
(Q)	$\int_1^x \frac{e^{3t}}{t}dt$	2. $xe^{\frac{1}{x}} - e - F\left(\frac{1}{x}\right)$
(R)	$\int_1^x \frac{e^t}{t^2}dt$	3. $e^{-2}[F(x + 2) - F(3)]$
(S)	$\int_1^x e^{\frac{1}{t}}dt$	4. $F(3x) - F(3)$

Codes:

	P	Q	R	S
(A)	4	3	2	1
(B)	3	4	1	2
(C)	3	4	2	1
(D)	1	2	3	4

Space for rough work

19. Match the following List–I with List–II

	List – I		List – II
(P)	An urn contains five balls, two balls are drawn and are found to be white. If probability of all the balls in urn are white is k, then	1.	$k = \frac{31}{91}$
(Q)	Out of 15 consecutive integers three are selected at random, then the probability of the sum is divisible by 3 is k, then	2.	$k = \frac{3}{16}$
(R)	If 3 cards are placed at random and independently in 4 boxes lying in a straight line. Then the probability of the cards going into 3 adjacent boxes is k, then	3.	$k = \frac{7}{8}$
(S)	A box contains 4 balls which are either red or black, 2 balls are drawn and found to be red if these are replaced, then the probability that next draw will result in a red ball is k, then	4.	$k = \frac{1}{2}$

Codes:

	P	Q	R	S
(A)	4	1	3	2
(B)	1	2	3	4
(C)	3	4	2	1
(D)	4	1	2	3

20. Match the following List–I with List–II

	List – I		List – II
(P)	$\sin\left[\frac{\pi}{900}\left\{\sum_{r=1}^{10}(r-\omega)(r-\omega^2)\right\}\right]$ is equal to	1.	0
(Q)	if root of $t^2 + t + 1 = 0$ be α, β, then $\alpha^4 + \beta^4 + \alpha^{-1}\beta^{-1}$ is equal to	2.	4
(R)	if $\left[\frac{1+\cos\theta+i\sin\theta}{\sin\theta+i(1+\cos\theta)}\right]^4 = \cos n\theta + i\sin n\theta$, then n is equal to	3.	i
(S)	if $z_r = \cos\frac{\pi}{3^r} + i\sin\frac{\pi}{3^r}$ (where $r = 1, 2, 3, ...$), then value of $z_1z_2z_3$ ….. ∞ is equal to	4.	1

Codes:

	P	Q	R	S
(A)	4	1	3	2
(B)	1	4	2	3
(C)	2	3	4	1
(D)	4	1	2	3

Space for rough work

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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JEE(Advanced)-2015

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS
CRT– I
(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**D**	**A**	**C**
2.	**B**	**A**	**C**
3.	**B**	**C**	**C**
4.	**B**	**C**	**B**
5.	**D**	**A**	**D**
6.	**C**	**D**	**A**
7.	**C**	**D**	**C**
8.	**D**	**A**	**B**
9.	**D**	**A**	**A**
10.	**C**	**C**	**C**
11.	**D**	**C**	**A**
12.	**B**	**B**	**C**
13.	**B**	**B**	**C**
14.	**C**	**C**	**A**
15.	**D**	**B**	**C**
16.	**C**	**A**	**B**
17.	**A**	**A**	**C**
18.	**C**	**A**	**B**
19.	**D**	**A**	**D**
20.	**B**	**B**	**D**

Physics

PART – I

SECTION – A

2. $6 = V\cos\theta\, t$ ...(1)

$3 = V\sin\theta\, t - \frac{1}{2}gt^2$ ...(2)

$24 = \frac{V^2\sin 2\theta}{g}$ ...(3)

Solving the equation we will get the result

3. $\frac{1}{2}kx^2 = \frac{1}{2}mv^2$

$x = \sqrt{\frac{mv^2}{k}}$

4. $F = \mu mg$ use concept of toppling

5. Use concept of conservation of energy $E_i = E_f$

6. $a = \frac{mg - F_v}{m}$

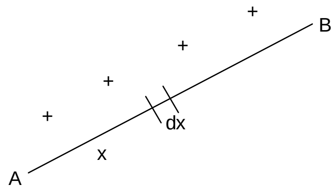
$v = u + at$

7. Use $B = \frac{\mu_0}{4\pi}\cdot\frac{2i}{r}$

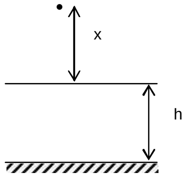
8. $\vec{M} = iA$

$A = \pi x^2, i = \frac{\lambda dx}{t}, t = \frac{2\pi}{\omega}$

Place the value in M = iA



9. $x + \frac{h}{\mu} =$ distance of final image of bird from bird itself

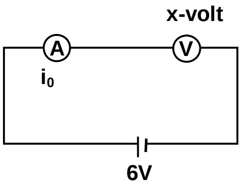


11. $\vec{r} = \hat{i}(t^2 - 4t) + \hat{j}(-t^3)$

Differentiation twice to get $\vec{a} = \hat{i}(2) - 6t\,\hat{j}$

$\vec{\tau} = \vec{r}\times\vec{F}$

12. $\omega = \int F\cdot dr$



15. $(6 - x)\, i_0R_A$ and $\left(6 - \frac{x}{3}\right) = (3i_0)R_A$

$\Rightarrow \dfrac{6 - x}{6 - \frac{x}{3}} = \dfrac{1}{3}$

$\Rightarrow x = \dfrac{9}{2}\text{V}$

$\Rightarrow$ after connection = $\dfrac{3}{2}$V

16. $i_0 \times R_V = x$ and $(3i_0)\left(\dfrac{3R_v}{3 + R_v}\right) = \dfrac{x}{3}$

$\Rightarrow i_0 = \dfrac{3}{16}\text{A}$

17. (P) $V_{cm} = (R - r)\omega$

$\therefore$ rotational $E = \dfrac{1}{4}m(R - r)^2\,\omega^2$

(Q) total kinetic energy = $\dfrac{1}{2}mv_{cm}^2 + \dfrac{1}{2}I_{cm}\omega^2 = \dfrac{3}{4}m(R - r)^2\,\omega^2$

(R) $\vec{a}_{cm} = (R - r)\alpha\,\hat{i} + (R - r)\omega^2\hat{j}$

18. $\vec{L}_{\text{any point}} = \vec{L}_{\text{cm, that point}} + \vec{L}_{\text{about CM}}$

(P) → $\dfrac{3}{2}mvr\left(-\hat{k}\right)$

(Q) → (1)

$K = \dfrac{1}{2}mv_{cm}^2 + \dfrac{1}{2}I_{cm}\omega^2$

$\Rightarrow$ (R) → $\dfrac{3}{4}mv^2$

19. Slipping between 2 and 8

(P) $a_{2\,kg} = \dfrac{14 - 12}{2} = 1$

(Q) $a_{8\,kg} = \dfrac{12 - 10}{8} = \dfrac{1}{4}$

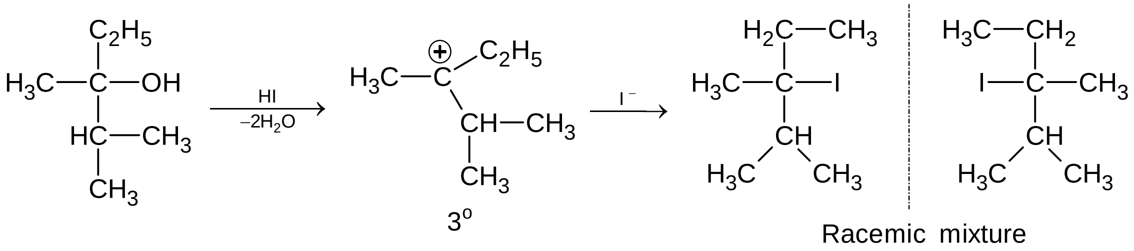
(R) $0.6 \times 2 \times 10 = 12$

20. Basic combination of lenses.

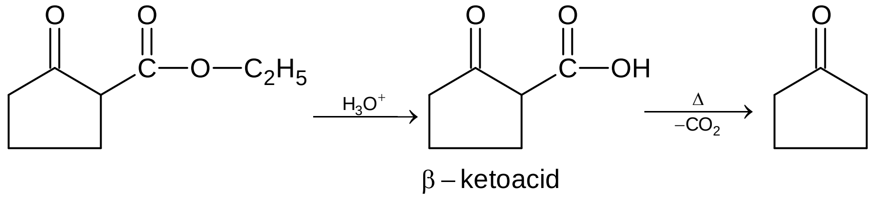
Chemistry PART – II

SECTION – A

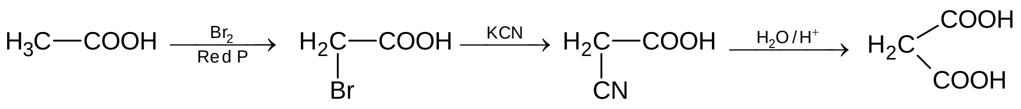
1.


HI
−2H₂O
3°
I⁻
Racemic mixture

2.

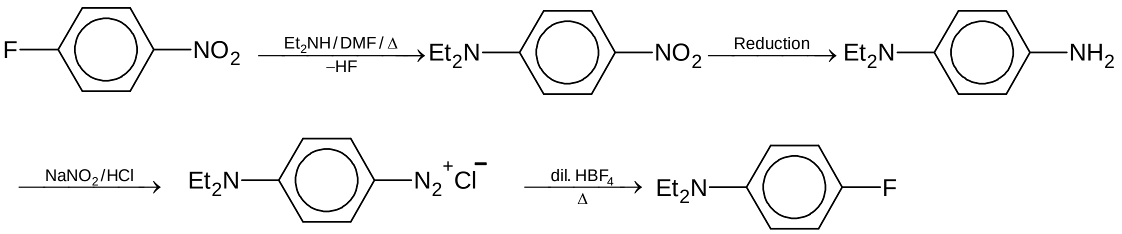

H₃O⁺
Δ
−CO₂
β – ketoacid

3.

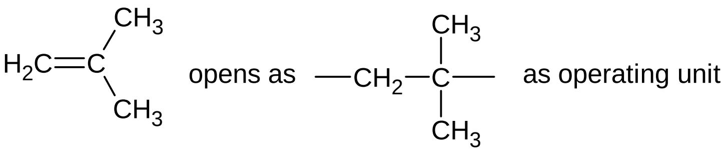

Br₂
Red P
KCN
H₂O / H⁺

$\xrightarrow[-CO_2]{\Delta} CH_3COOH + CO_2 \uparrow$

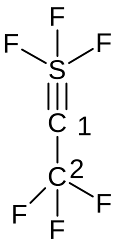
4.


Et₂NH / DMF / Δ
−HF
Reduction
NaNO₂ / HCl
dil. HBF₄
Δ

5.


opens as
as operating unit

6.



7. XF_4-type molecule have zero dipole moment when it is either tetrahedral or square planar.

8. $\frac{r_{A^+}}{r_{B^-}} = 0.225 \Rightarrow \frac{22.5}{r_{B^-}} = 0.225$

$\Rightarrow r_{B^-} = 100$ pm

9. $\Delta G^o = 2\Delta G^o_{ZnO} + 2\Delta G^o_{SO_2} - 2\Delta G^o_{ZnS}$

= (–616–408)–(–293) = –731 J

10. Expansion of real gas above its inversion temperature shows heating effect.

11. $sp^3d^2 \rightarrow$ it involves $d_{x^2-y^2}$ and d_{z^2} orbitals in hybridisation.

12. $sp^3d^3 \rightarrow$ It involves d_{xy}, d_{yz}, d_{zx} d-orbtials in hybridisation.

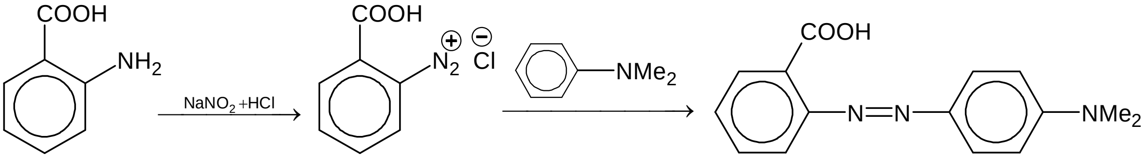
13. $\Delta G^o = -nFE^o$

$= -2 \times 96500 \times 1.10 = -212.3$ KJ

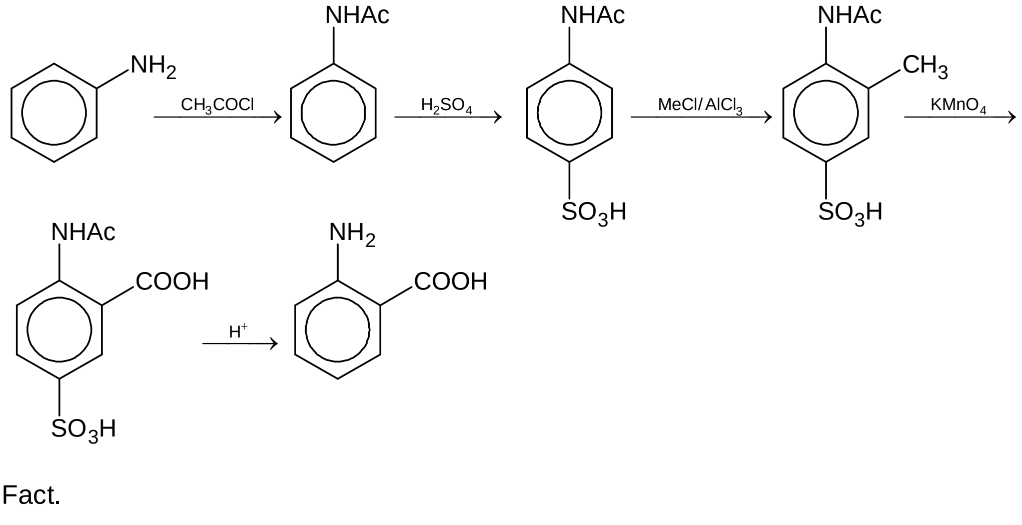
14. $\left(\frac{dE}{dT}\right)_P = \frac{\Delta S}{nF}$

$\Rightarrow 1.5 \times 10^{-4} = \frac{\Delta S}{2 \times 96500} \Rightarrow \Delta S = 28.95\ JK^{-1}\ mol^{-1}$

15.


COOH
NH2
NaNO2+HCl
COOH
N2 Cl
NMe2
COOH
N=N
NMe2

16.


NH2
CH3COCl
NHAc
H2SO4
NHAc
SO3H
MeCl/AlCl3
NHAc
CH3
SO3H
KMnO4
NHAc
COOH
SO3H
H+
NH2
COOH

17. Fact.

19. Read the text.

20. –COOH, $-NO_2$ groups are deactivating groups and $-CH_3$, $-NMe_2$ are activating group. Friedel Craft's acylation not take place with the deactivated benzene compound $\overset{-}{N}H_2$ is nucleophile.

Mathematics

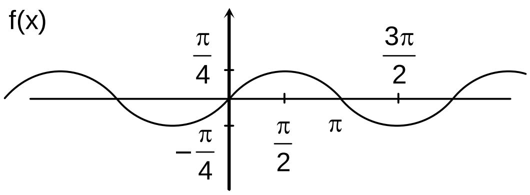
PART – III

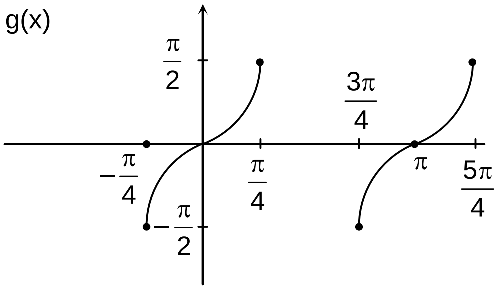
SECTION – A

1. At $x = 0, \pm\pi, \pm 2\pi$
LHS = RHS
Now let $f(x) = \tan^{-1}(\sin x)$ and $g(x) = \sin^{-1}(\tan x)$

$$f'(x) = \frac{\cos x}{1+\sin^2 x} \text{ and } g'(x) = \frac{\sec^2 x}{\sqrt{1-\tan^2 x}} \geq \frac{\cos x}{\sqrt{1-\tan^2 x}} \geq \frac{\cos x}{1+\sin^2 x} = f'(x)$$

Hence, $f'(x) \leq g'(x)\ \forall\ x \in$ domain. So f(x) and g(x) are equal only at $x = n\pi$





2. $P(x) - 2008 + x = x(x-1)(x-2)(x-3)\ \ldots..\ (x-2008)$
Put x = 2009

3. $\therefore f'(x) = 3x^2 + 2x + 100 + 7\cos x$
$= 3x^2 + 2x + 93 + 7(1 + \cos x)$

$$= 3\left\{\left(x+\frac{1}{3}\right)^2\right\} + \frac{278}{3} + 7(1+\cos x) > 0$$

$\therefore$ f(x) is increasing function $\Rightarrow f(1) < f(2) < f(3)$
(Let $a < b < c$)
Now $g(y) = (y-b)(y-c) + 2(y-c)(y-a) + 3(y-a)(y-b) = 0$
$\therefore g(a) > 0, g(b) < 0$ and $g(c) > 0$

4. $$\because \frac{C_0}{x} - \frac{C_1}{x+1} + \frac{C_2}{x+2} - \frac{C_3}{x+3} + \ldots.. + (-1)^n \frac{C_n}{x+n} = \frac{n!}{x(x+1)(x+2)\ldots..(x+n)}$$

$$\therefore \text{At } x = 2,\ u_n = \frac{C_0}{2} - \frac{C_1}{3} + \frac{C_2}{4} - \frac{C_3}{5} + \ldots.. = \frac{1}{(n+1)(n+2)} = \frac{1}{n+1} - \frac{1}{n+2}$$

Hence, $s_n = u_1 + u_2 + u_3 + \ldots.. + u_n = \left[\frac{1}{2} - \frac{1}{n+2}\right]$

5. (1) ad = 1, bc = 4
(2) ad = 1, bc = 2
(3) ad = 2, bc = 1
(4) ad = 2, bc = 4
(5) ad = 4, bc = 1
(6) ad = 4, bc = 2

6. Centroid = circumcentre = $(x_1, y_1) = \left[\frac{\sum a\cos\alpha}{3}, \frac{\sum b\sin\alpha}{3}\right]$

$$\left(\frac{9x_1^2}{a^2} + \frac{9y_1^2}{b^2} - 3\right) = 2\left(\sum \cos\alpha\cos\beta + \sum \sin\alpha\sin\beta\right)$$

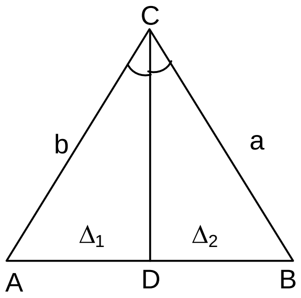
7. $\Delta = \Delta_1 + \Delta_2$

$\Delta = \frac{1}{2}\text{ab sin c} = \text{ab sin}\frac{C}{2}\cos\frac{C}{2}$

$\Delta_1 + \Delta_2 = \frac{1}{2}6b\sin\frac{C}{2} + \frac{1}{2}6a\sin\frac{C}{2}$

$\Delta = \Delta_1 + \Delta_2$

$\frac{1}{a} + \frac{1}{b} = \frac{1}{9} \Rightarrow \frac{ab}{a+b} = 9$



8. $M(x) = \int \frac{e^x\left(e^{2x}-2\right)}{e^{4x}+8e^{2x}+4}dx$

Put $e^x = t$

9. $f(x) = x^2 + \int_0^x e^{-t}f(x-t)dt = x^2 + \int_0^x e^{-(x-t)}f(t)dt = x^2 + e^{-x}\int_0^x e^t f(t)dt$

$\therefore e^x f(x) = x^2e^x + \int_0^x e^t f(t)dt$

Differentiating both sides w.r.t. x

$e^x f(x) + e^x f^1(x) = 2xe^x + x^2e^x + e^x f(x)$

$\therefore f^1(x) = 2x + x^2$

$\therefore f(x) = x^2 + \frac{x^3}{3} + c$

10. Given differential equation can be written as

$\frac{xdy + ydx}{(xy-1)^2} = \frac{dx}{x^2}$

Integrating both sides

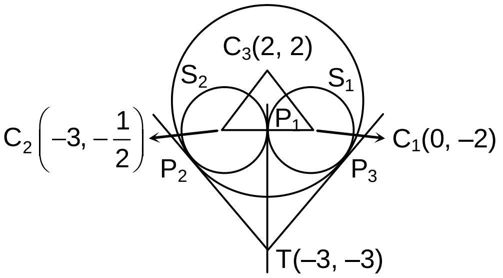
$-\frac{1}{(xy-1)} = -\frac{1}{x} + c \Rightarrow \frac{1}{xy-1} = \frac{1}{x} + c$

11.-12. Shown in figure

$P_1(-2, -1)$

$P_2(-4, -1)$

$P_3(-1, -4)$



13. $f''(c_1) > f''(c_2)$

$f''(c_1) > 0$ and $f''(c_2) < 0$

$\Rightarrow$ at $x = c_1$, f has local minimum and at $x = c_2$, f has local maximum

14. See above solution

15. $\phi(8n + 4) = \phi(4(2n + 1)) = \phi(4)\,\phi(2n + 1) = \phi(2^2)\,\phi(2n + 1) = 2\phi(2n + 1)$

16. $\phi(p^n)$ is odd $\Rightarrow p^{n-1}(p - 1)$ is odd

$\therefore$ p is prime, the only value p can take is p = 2
$\therefore$ $\phi(2^n)$ is odd

17. (P) $f'(x) = 2x + g'(1)$, $f''(x) = 2$
$g'(x) = 2x + f'(2)$, $g''(x) = 2$
at x = 1, $f'(1) = 2 + g'(1)$ and $g'(1) = 2 + f'(2)$
$\Rightarrow f'(1) = 4 + f'(2)$
(Q) $\therefore 2f(x)\,f(y) = f(x - y) + f(x + y)$ ….. (1)
Replacing x by y and y by x, then
$2f(y)\,f(x) = f(y - x) + f(y + x)$ ….. (2)
From equation (1) and (2), we get $f(x - y) = f(y - x)$
Put y = 0, then differentiate
(R) $f'(x) = 3x^2 + 2xf'(1) + f''(2)$
$\Rightarrow f'(1) = 3 + 2f'(1) + f''(2)$
$\Rightarrow f'(1) + f''(2) = -3$
$\Rightarrow$ and $f''(x) = 6x + 2f'(1)$
$\therefore f''(2) = 12 + 2f'(1)$
$\therefore -2f'(1) + f''(2) = 12$
(S) $n(a + b)^{n-1} = na^{n-1} + nb^{n-1}$

18. (P) Put t + 2 = z
(Q) Put 3t = z
(R) Integrate by part
(S) Put $\frac{1}{t} = z$

19. (P) $P\left(\frac{A_4}{B}\right) = \dfrac{\frac{1}{4}\times 1}{\frac{1}{4}\times\frac{1}{10}+\frac{1}{4}\times\frac{3}{10}+\frac{1}{4}\times\frac{6}{10}+\frac{1}{4}\times 1} = \frac{1}{2}$

(Q) Required probability = $\dfrac{3\times {}^{5}C_3 + 5^3}{{}^{15}C_3} = \dfrac{31}{91}$

(R) Required probability = $\dfrac{3!(2)}{4\times 4\times 4} = \dfrac{3}{16}$

(S) $P(A) = \sum_{i=1}^{3} P(E_i)\cdot P\left(\frac{A}{E_i}\right) = \frac{1}{3}\times 1 + \frac{1}{3}\times\frac{1}{2} + \frac{1}{3}\times\frac{1}{6} = \frac{5}{9}$

Thus, $P\left(\frac{E_1}{A}\right) = \dfrac{\frac{1}{3}\times 1}{\frac{5}{9}} = \frac{3}{5}$, $P\left(\frac{E_2}{A}\right) = \dfrac{\frac{1}{3}\times\frac{1}{2}}{\frac{5}{9}} = \frac{3}{10}$ and $P\left(\frac{E_3}{A}\right) = \dfrac{\frac{1}{3}\times\frac{1}{6}}{\frac{5}{9}} = \frac{1}{10}$

20. (P) $\sum_{r=1}^{10}(r - \omega)(r - \omega^2) = \sum_{r=1}^{10}\left\{r^2 - r(-1) + 1\right\}$
(Q) $\alpha^4 + \beta^4 + \alpha^{-1}\beta^{-1} = \omega^4 + \omega^8 + \omega^{-1}\omega^{-2} = \omega + \omega^2 + 1 = 0$
(R) $N^T = 1 + \cos\theta + i\sin\theta = 2\cos\frac{\theta}{2}\left[\cos\frac{\theta}{2} + i\sin\frac{\theta}{2}\right] = 2\cos\frac{\theta}{2}\cdot e^{i\theta/2}$

$D^r = -i^2\sin\theta + i(1 + \cos\theta) = i$ [conjugate of N^r] = $i2\cos\frac{\theta}{2}\cdot e^{-i\theta/2}$

(S) $\frac{\pi}{3} + \frac{\pi}{3^2} + \frac{\pi}{3^3} + \ldots..\ \infty = \frac{\pi}{2}$

FIITJEE **JEE (Main), 2015**

ALL INDIA TEST SERIES

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CONCEPT RECAPITULATION TEST - II

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 03 and 10 to 12)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (04 to 09 and 13 to 30) contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. There are some passengers inside a stationary railway compartment. The centre of mass of the compartment itself (without the passengers) is C_1, while the centre of mass of the 'compartment plus passengers' system is C_2. If the passengers move about inside the compartment,
(A) both C_1 and C_2 will move with respect to the ground
(B) neither C_1 nor C_2 will move with respect to the ground
(C) C_1 will move but C_2 will stationary with respect to the ground
(D) C_2 will move but C_1 will be stationary with respect to the ground

2. A false balance has equal arms. An object weighs x when placed in one pan and y in the other pan. The true weight of the object is equal to
(A) $\sqrt{xy}$
(B) $\frac{x+y}{2}$
(C) $\frac{x^2+y^2}{2}$
(D) $\frac{\sqrt{x^2+y^2}}{2}$

3. Two identical cylindrical vessels with their bases at the same level, each contains a liquid of density ρ. The height of the liquid in one vessel is h_1 and that in the other h_2. The area of either base is A. The work done by gravity in equalizing the levels when the vessels are inter connected is
(A) $A\rho g\left(\frac{h_1-h_2}{2}\right)$
(B) $A\rho g\left(\frac{h_1-h_2}{2}\right)^2$
(C) $A\rho g\left(\frac{h_1-h_2}{4}\right)$
(D) $A\rho g\left(\frac{h_1-h_2}{4}\right)^2$

4. Dimensional formula for Plank's constant is identical to that of
(A) Torque
(B) Power
(C) Linear momentum
(D) Angular momentum

Space for Rough work

5. A wheel of radius r rolls without slipping with a speed v on a horizontal road. When it is at a point A on the road, a small blob of mud separates from the wheel at its highest point and lands at point B on the road

(A) $AB = v\sqrt{\frac{r}{g}}$ (B) $AB = 2v\sqrt{\frac{r}{g}}$

(C) $AB = 4v\sqrt{\frac{r}{g}}$ (D) $AB = 8v\sqrt{\frac{r}{g}}$

6. A particle moves along the parabolic path $y = ax^2$ in such a way that the x-component of the velocity remains constant, say c. The acceleration of the particle is

(A) $ac\hat{k}$ (B) $2ac^2\hat{j}$

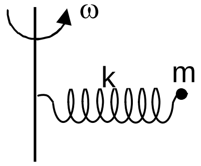
(C) $ac^2\hat{k}$ (D) $a^2c^2\hat{j}$

7. A radioactive nucleus of mass number A, initially at rest, emits an α particle with speed v. The recoil speed of the daughter nucleus is

(A) $\frac{4v}{A-4}$ (B) $\frac{4v}{A}$

(C) $\frac{(A-4)v}{A}$ (D) $\frac{(A-4)v}{4}$

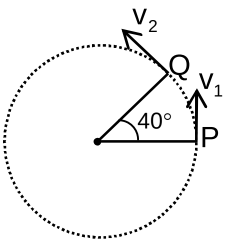
8. A particle of mass m is fixed to one end of a light spring of force constant k and unstretched length l. The system is rotated about the other end of the spring with an angular velocity ω, in gravity free space. The increase in length of the spring will be



(A) $\frac{ml\omega^2}{k}$ (B) $\frac{ml\omega^2}{k-m\omega^2}$

(C) $\frac{ml\omega^2}{k+m\omega^2}$ (D) None of these

9. A particle is moving in a circle of radius r centred at O with constant speed v. The change in velocity in moving from P to Q ($\angle$POQ = 40°) is



(A) 2vcos40° (B) 2vsin40°

(C) 2vcos20° (D) 2vsin20°

Space for Rough work

10. The electric potential (in volt) in a region is given by

$$V = 6x - 8xy^2 - 8y + 6yz - 4x^2$$

Then electric force acting on a point charge of 2C placed at the origin will be

(A) 2 N (B) 6 N
(C) 8 N (D) 20 N

11. Two containers of equal volume contain identical gases at pressures P_1 and P_2 and absolute temperatures T_1 and T_2 respectively. The vessels are joined and the gas reaches a common pressure P and a common temperature T. Then

(A) $P = \left(\frac{P_1}{T_1} + \frac{P_2}{T_2}\right)T$ (B) $P = \frac{1}{2}\left(\frac{P_1}{T_1} + \frac{P_2}{T_2}\right)T$

(C) $P = \left(\frac{P_1T_2 + P_2T_1}{T_1^2 + T_2^2}\right)T$ (D) $P = \left(\frac{P_1T_2 + P_2T_1}{T_1^2 - T_2^2}\right)T$

12. The half life period of a radioactive element X is same as the mean life time of another radioactive element Y. Initially both of them have same number of atoms. Then,

(A) X and Y have the same decay rate initially.
(B) X and Y decay at the same rate always.
(C) Y will decay at a faster rate than X.
(D) X will decay at a faster rate than Y.

13. The temperature of source and sink of a Carnot Engine are 327°C and 27°C respectively. The efficiency of the engine is

(A) $1 - \left(\frac{27}{327}\right)$ (B) $\frac{27}{327}$

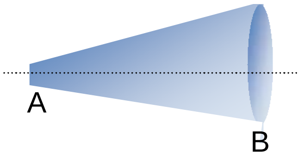
(C) 0.5 (D) 0.7

14. For a gas $\frac{R}{C_P} = \frac{2}{3}$. Possibly the gas is

(A) diatomic (B) monatomic
(C) a mixture of diatomic and monatomic (D) polyatomic

Space for Rough work

15. A wire has a non-uniform cross-section as shown in the figure. A steady current is flowing through it. Then the drift speed of the electrons
(A) is constant throughout the wire
(B) decreases from A to B
(C) increases from A to B
(D) varies randomly



16. Which of the following is most suitable for the core of the electromagnets?
(A) Air
(B) Steel
(C) Soft iron
(D) Cu-Ni alloy

17. A black body radiates power P and maximum energy is radiated by it around a wavelength λ_0. The temperature of the black body is now changed such that it radiates maximum energy around the wavelength $\frac{3\lambda_0}{4}$. The power radiated by it now is
(A) $\frac{256}{81}P$
(B) $\frac{16}{9}P$
(C) $\frac{64}{27}P$
(D) $\frac{4}{3}P$

18. The plane of the dip circle is set in the geographical meridian and apparent dip is θ_1. It is then set in a vertical plane perpendicular to the geographical meridian, the apparent dip becomes θ_2. The angle of declination α at that place is given by
(A) $\tan\alpha = \sqrt{\tan\theta_1 \tan\theta_2}$
(B) $\tan\alpha = \sqrt{\tan^2\theta_1 + \tan^2\theta_2}$
(C) $\tan\alpha = \frac{\tan\theta_1}{\tan\theta_2}$
(D) $\tan\alpha = \frac{\tan\theta_2}{\tan\theta_1}$

19. According to Faraday's law of electromagnetic induction
(A) the direction of induced current is such that it opposes the cause producing it.
(B) the magnitude of induced emf produced in a coil is directly proportional to the rate of change of magnetic flux.
(C) The direction of induced emf is such that it opposes the cause producing it.
(D) None of the above.

Space for Rough work

20. If ϕ is phase difference between current and voltage, the wattless component of current is
(A) I cosϕ (B) I sinϕ
(C) I tanϕ (D) I $\cos^2\phi$

21. A particle is vibrating in S.H.M. Its velocities are v_1 and v_2 when the displacements from the mean position are y_1 and y_2, respectively, then its time period is
(A) $2\pi\sqrt{\dfrac{y_1^2+y_2^2}{v_1^2+v_2^2}}$ (B) $2\pi\sqrt{\dfrac{v_1^2+v_2^2}{y_1^2+y_2^2}}$
(C) $2\pi\sqrt{\dfrac{v_2^2-v_1^2}{y_1^2-y_2^2}}$ (D) $2\pi\sqrt{\dfrac{y_1^2-y_2^2}{v_2^2-v_1^2}}$

22. The first overtone of an open pipe has frequency n. The first overtone of a closed pipe of the same length will have frequency
(A) $\dfrac{n}{2}$ (B) 2n
(C) $\dfrac{3n}{4}$ (D) $\dfrac{4n}{3}$

23. **Statement-1:** The resolving power of a telescope is more if the diameter of the objective lens is more.
Statement-2: Objective lens of large diameter collects more light.
(A) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is true, Statement-2 is true; Statement-2 is **not** a correct explanation for Statement-1.
(C) Statement-1 is true; Statement-1 is false.
(D) Statement-1 is false; Statement-1 is true.

24. Light of wavelength 6328 Å is incident normally on a slit having a width of 0.2 mm. the distance of the screen from the slit is 0.9 m. The angular width of the central maximum is
(A) 0.09 degree (B) 0.72 degree
(C) 0.18 degree (D) 0.36 degree

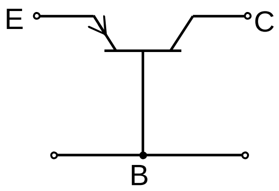
25. A clear sheet of polaroid is placed on the top of similar sheet so that their axes make an angle $\sin^{-1}\left(\dfrac{3}{5}\right)$ with each other. The ratio of intensity of the emergent light to that of unpolarised incident light is
(A) 16 : 25 (B) 9 : 25
(C) 4 : 5 (D) 8 : 25

Space for Rough work

26. The vernier constant of a travelling microscope is 0.001 cm. If 49 main scale divisions coincide with 50 main scale divisions, then the value of 1 main scale division is

(A) 0.1 mm
(B) 0.5 mm
(C) 0.4 mm
(D) 1 mm

27. For circuit shown in figure I_E = 4 mA, I_B = 40μA. What are the values of α and I_C?



(A) 0.99, 3.96 mA
(B) 1.01, 4.04 mA
(C) 0.97, 4.04 mA
(D) 0.99, 4.04 Ma

28. The average value of electric energy density in an electromagnetic wave is (E_0 is peak value)

(A) $\frac{1}{2}\varepsilon_0 E_0^2$
(B) $\frac{E_0^2}{2\varepsilon_0}$
(C) $\varepsilon_0 E_0^2$
(D) $\frac{1}{4}\varepsilon_0 E_0^2$

29. A body is projected away from the earth with a speed 3v, where v, is the escape velocity. The speed of the body at infinity will be

(A) v_e
(B) $\sqrt{2}v_e$
(C) $2v_e$
(D) $2\sqrt{2}v_e$

30. A vessel of cross-sectional area A contains a liquid to a height H_1. If a hole having cross-sectional area a is made at the bottom of the vessel, then the time taken by the liquid level to decrease from H_1 and H_2 is

(A) $\frac{A}{a}\sqrt{\frac{g}{2}}\left[\sqrt{H_1}-\sqrt{H_2}\right]$
(B) $\frac{A}{a}\sqrt{\frac{2}{g}}\left[\sqrt{H_1}-\sqrt{H_2}\right]$
(C) $\frac{a}{A}\sqrt{\frac{g}{2}}\left[\sqrt{H_1}-\sqrt{H_2}\right]$
(D) $\frac{a}{A}\sqrt{\frac{2}{g}}\left[\sqrt{H_1}-\sqrt{H_2}\right]$

Space for Rough work

Chemistry PART – II

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. Which of the following tests you would perform to identify the functional group present in salicylic acid?
(A) $FeCl_3$ and $NaHCO_3$ test (B) $FeCl_3$ and NaOH test
(C) $FeCl_3$ and 2, 4-dinitrophenylhydrazine test (D) $FeCl_3$ and Schiff's reagent test

2. A metal oxide is yellow when hot and white when cold. The metal oxide is
(A) CuO (B) ZnO
(C) PbO (D) All

3. A metal chloride solution on mixing with K_2CrO_4 solution gives a yellow ppt. insoluble in acetic acid. The metal may be.
(A) Mercury (B) Zinc
(C) Silver (D) Lead

4. Enthalpy of dissociation of water in kJ mol^{-1} is
(A) +13.7 (B) +57.3
(C) +18.0 (D) $+18 \times 4.2$

5. For the preparation of iodoform from acetone; we require
(A) KI (B) KI_3
(C) KOI (D) KIO_3

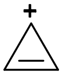
6. Cl_2 gas passed through Lassaigne's extract containing CCl_4. If the extract contains both NaBr and NaI then which colour will appear in the CCl_4 layer?
(A) Violet colour (B) Brown colour
(C) Green colour (D) Yellow colour

Space for Rough work

7. Which one of the following does not involve peptisation?
(A) $Fe(OH)_3$ precipitate shaken with a small amount of dil. HCl
(B) $Fe(OH)_3$ precipitate shaken with $FeCl_3$ solution
(C) $AuCl_3$ solution shaken with $SnCl_2$ solution
(D) $AgNO_3$ solution shaken with KI solution

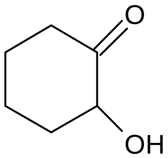
8. The increasing order of stability of the following carbocation is

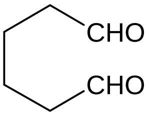
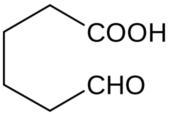
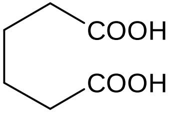
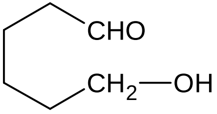
$CH_3-\overset{+}{C}H_2$ (I) $\quad CH_3-\overset{+}{C}=CH_2$ (II)

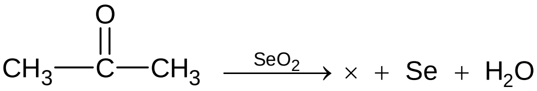

III

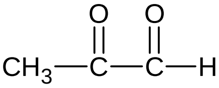
$H_2\overset{+}{C}-CH=CH_2$ (IV)

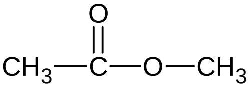
(A) IV < I < III < II
(B) II < I < IV < III
(C) I < II < III < IV
(D) III < I < IV < II

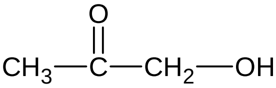
9. The product obtained when  is oxidized with HIO_4 is

(A) 
(B) 
(C) 
(D) 

10. 
$CH_3-\overset{\overset{O}{||}}{C}-CH_3 \xrightarrow{SeO_2} \times + Se + H_2O$ here, X is:

(A) 
$CH_3-\overset{\overset{O}{||}}{C}-\overset{\overset{O}{||}}{C}-H$

(B) 
$CH_3-\overset{\overset{O}{||}}{C}-O-CH_3$

(C) 
$CH_3-\overset{\overset{O}{||}}{C}-CH_2-OH$

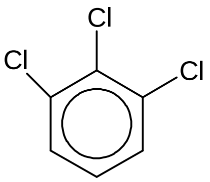
(D) None of the above

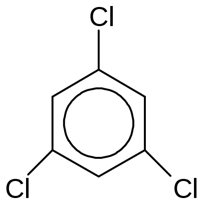
11. The weight of a molecule of the compound $C_{60}H_{122}$ is
(A) 1.4×10^{-21} g
(B) 1.09×10^{-21} g
(C) 5.025×10^{23} g
(D) 16.023×10^{23} g

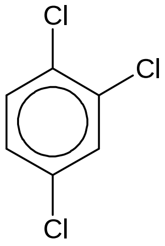
Space for Rough work

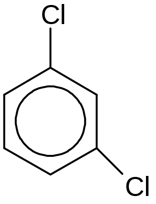
12. Benzoic acid undergoes dimerisation in benzene solution. The van't Hoff factor (i) is
(A) $i = (1 - x)$
(B) $i = (1 + x)$
(C) $i = (1 - x/2)$
(D) $i = (1 + x/2)$

13. Which of the following has maximum dipole moment?

(A)


(B)


(C)


(D)


14. The ONO bond angle is maximum in
(A) NO_3^-
(B) NO_2^-
(C) NO_2
(D) NO_2^+

15. Calculate the partial pressure of carbon monoxide from the following data

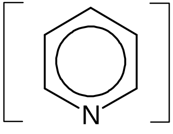
$$CaCO_3(s) \xrightarrow{\Delta} CaO(s) + CO_2(g); \quad K_p = 8 \times 10^{-2}$$

$$CO_2(g) + C(s) \longrightarrow 2CO(g); \quad K_p = 2$$

(A) 0.2
(B) 0.4
(C) 1.6
(D) 4

16. The diagonal partner of element B is
(A) Li
(B) Al
(C) Si
(D) Mg

17. Hybridization of the nitrogen atom and electron geometry around nitrogen atom in pyridine



is

(A) Sp^2, planar triangular
(B) Sp^3, pyramidal
(C) Sp^3, tetrahedral
(D) Sp^2, v-shape

Space for Rough work

18. The energy of the second Bohr orbit of the hydrogen atom is –328 kJ mol^{-1}; hence the energy of fourth Bohr orbit would be
(A) –1312 kJ mol^{-1}
(B) –82 kJ mol^{-1}
(C) –41 kJ mol^{-1}
(D) –164 kJ mol^{-1}

19. The ionic radii of isoelectronic species N^{3-}, O^{2-} and F^- in Å are in the order
(A) 1.36, 1.40, 1.71
(B) 1.36, 1.71, 1.40
(C) 1.71, 1.40, 1.36
(D) 1.71, 1.36, 1.40

20. What will be the correct order of vapour pressure of water, acetone and ether at 30ºC. Given that among these compounds, water has maximum boiling point and ether has minimum boiling point?
(A) Water < ether < acetone
(B) Water < acetone < ether
(C) Ether < acetone < water
(D) Acetone < ether < water

21. Conjugate base of H_2 is
(A) H_3^+
(B) H_3^-
(C) H^+
(D) H^-

22. How many ml of 0.05 M $KMnO_4$ (acid) are required to oxidize 2.0 gram of $FeSO_4$ in dilute solution?
(A) 52.63
(B) 42.63
(C) 12.63
(D) 21.36

23. If the bond lengths of $C \equiv C$, $C \equiv N$ are x and y Å respectively $N \equiv N$ bond length is given by
(A) $x + 2y$
(B) $\frac{x-2y}{2}$
(C) $x + y$
(D) $2y - x$

24. Which of the following complex species does not involve inner orbital hybridization?
(A) $[CoF_6]^{3-}$
(B) $[Co(NH_3)_6]^{3+}$
(C) $[Fe(CN)_6]^{3-}$
(D) $[Cr(NH_3)_6]^{3+}$

Space for Rough work

25. For the reaction,

$$A(g) + 2B(g) \longrightarrow 2C(g) + 3D(g)$$

The value of ΔH at 27ºC is 19.0 K cal. The value of ΔE for the reaction would be (given R = 2.0 cal K^{-1} mol^{-1})

(A) 20.8 Kcal (B) 19.8 Kcal
(C) 18.8 Kcal (D) 17.8 Kcal

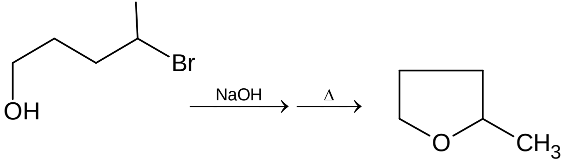
26. For the reaction

$$C_2H_6(g) \rightleftharpoons C_2H_4(g) + H_2(g)$$

The k_p = 0.05 atm. The value of ΔG^o of the reaction at 627ºC would be

(A) 11.19 kJ mol^{-1} (B) 22.40 kJ mol^{-1}
(C) 33.57 kJ mol^{-1} (D) 27.98 kJ mol^{-1}

27. The following reaction described as:



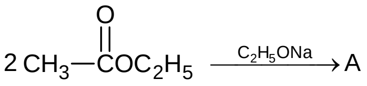
(A) S_N1 reaction with racemisation
(B) Intramolecular S_N2 reaction with Walden inversion
(C) Intramolecular S_N2 reaction with retention of configuration
(D) Intramolecular S_N1 reaction with racemisation

28. 75% of the first order reaction was completed in 32 min. 50% of the reaction was completed in

(A) 24 min (B) 8 min
(C) 16 min (D) 4 min

29. pH of a solution produced when an aqueous solution of pH 6 is mixed with an equal volume of an aqueous solution of pH 3 is about

(A) 4.5 (B) 4.0
(C) 4.3 (D) 3.3

30. 
$2\,CH_3-\overset{\overset{O}{||}}{C}OC_2H_5 \xrightarrow{C_2H_5ONa} A$, which is true about A.

(A) A forms oxime (B) A shows tautomerism
(C) A shows idoform test (D) All of them

Space for Rough work

Mathematics

PART – III

SECTION – A

Straight Objective Type

This section contains 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. The value of $\int\limits_{-1}^{1} \tan^{-1}\left[x^2+\frac{1}{2}\right]dx + \int\limits_{-1}^{1} \cot^{-1}\left[x^2-\frac{1}{2}\right]dx$ is equal to (where [.] denotes greatest integer function)

(A) $\frac{3\pi}{4}\left(1-\frac{1}{\sqrt{2}}\right)$ (B) $\frac{3\pi}{4}\left(1+\frac{1}{\sqrt{2}}\right)$

(C) $\frac{\pi}{4}\left(1-\frac{1}{\sqrt{2}}\right)$ (D) none of these

2. The number of ordered pairs of positive integers (m, n) satisfying $m \le 2n \le 60$, $n \le 2m \le 60$ is

(A) 240 (B) 480

(C) 900 (D) none of these

3. Let ‘P’ be a point which does not lie outside the triangle ABC, $A \equiv (3, 2)$, $B \equiv (0, 0)$, $C \equiv (0, 4)$ and satisfies $d(P, A) \ge$ maximum $\{d(P, B), d(P, C)\}$, then maximum distance of P from side BC where d(P, A) gives the distance between P and A, is

(A) $\frac{3}{4}$ (B) $\frac{4}{3}$

(C) 3 (D) 0

4. The m^{th} term of an arithmetic progression is x and the n^{th} term is y. Then the sum of the first (m + n) terms is

(A) $\frac{m+n}{2}\left[(x+y)+\frac{x-y}{m-n}\right]$ (B) $\frac{m+n}{2}\left[(x-y)+\frac{x+y}{m-n}\right]$

(C) $\frac{1}{2}\left[\frac{x+y}{m+n}+\frac{x-y}{m-n}\right]$ (D) $\frac{1}{2}\left[\frac{x+y}{m+n}-\frac{x-y}{m-n}\right]$

Space for rough work

5. Let the $f(x) = \sin^{-1}\left(\frac{1+x^2}{2x}\right)$ is

(A) Continuous but not differentiable at x = 1 (B) Differentiable at x = 1
(C) Neither continuous nor differentiable at x = 1 (D) Continuous everywhere

6. $\lim\limits_{n\to\infty} \frac{5^{n+1}+3^n-2^{2n}}{5^n+2^n+3^{2n+3}}$ is equal to

(A) 5 (B) 3
(C) 1 (D) zero

7. If the point $P(x_1+t(x_2-x_1), y_1+t(y_2-y_1))$ divides the join of $A(x_1, y_1)$ and $B(x_2, y_2)$ internally then

(A) t < 0 (B) 0 < t < 1
(C) t > 1 (D) t = 1

8. If x_1, x_2, x_3 as well as y_1, y_2, y_3 are in G. P with the same common ratio, then the points $(x_1, y_1), (x_2, y_2)$ and (x_3, y_3)

(A) Lie on a straight line (B) Lie on an ellipse
(C) Lie on a circle (D) are vertices of a triangle

9. If in a ΔABC, cos A + 2 cos B + cos C = 2, then a, b, c are in

(A) AP (B) HP
(C) GP (D) none of these

10. If $f(x) = \int_0^1 \frac{x^2+t^2}{2-t}$ dt, then the curve y = f(x) represents a

(A) Straight line (B) Parabola
(C) Hyperbola (D) None of these

11. Let P and Q be points (4, –4) and (9, 6) of the parabola $y^2 = 4a(x - b)$. Let R be a point on the arc of the parabola between P and Q. Then the area of ΔPRQ is largest when

(A) ∠PRQ = 90° (B) The point R is (4, 4)
(C) The point R is $\left(\frac{1}{4}, 1\right)$ (D) none of these

Space for rough work

12. For what values of a, m and b, Lagrange's mean value theorem is applicable to the function f(x) for $x \in [0, 2]$, f(x) = $\begin{cases} 3 & x = 0 \\ -x^2 + a & 0 < x < 1 \\ mx + b & 1 \le x \le 2 \end{cases}$

(A) a = 3, m = – 2, b = 0
(B) a = 3, m = – 2, b = 4
(C) a = 3, m = 2, b = 0
(D) No such a, m, b exist

13. Eccentricity of the hyperbola whose asymptotes are given by 3x + 2y – 5 = 0 and 2x – 3y – 5 = 0 is

(A) $\sqrt{2}$
(B) $\frac{3}{2}$
(C) 2
(D) $\frac{5}{3}$

14. Consider the ellipse $\frac{x^2}{3} + \frac{y^2}{1} = 1$. Let P, Q, R, S be four points on this ellipse such that the normals drawn from these points are concurrent at (2, 2) then the centre of the conic (apart from the given ellipse) on which these 4 points lie is

(A) P, Q, R, S lie only on the given ellipse and on no other conic
(B) (3, –1)
(C) (3, 1)
(D) (0, 0)

15. Let f(x) = $\int_0^x \cos\left(\frac{t^2 + 2t + 1}{5}\right) dt$, 0 < x < 2. Then f(x)

(A) increases monotonically
(B) decreasing monotonically
(C) has one point of local maximum
(D) has one point of local minimum

16. If $I = \int \frac{x^5 dx}{\sqrt{1 + x^3}}$, then I is equal to

(A) $\frac{2}{9}(1 + x^3)^{\frac{5}{2}} + \frac{2}{3}(1 + x^3)^{\frac{3}{2}} + c$
(B) $\frac{2}{9}(1 + x^3)^{\frac{3}{2}} - \frac{2}{3}(1 + x^3)^{\frac{1}{2}} + c$
(C) $\log\left|\sqrt{x} + \sqrt{1 + x^3}\right| + c$
(D) $x^2 \log(1 + x^3) + c$

Space for rough work

17. If w is an imaginary cube root of unity, then value of the expression
$2(1 + w)(1 + w^2) + 3(2 + w)(2 + w^2) + ... + (n + 1)(n + w)(n + w^2)$ is

(A) $\frac{1}{4}n^2(n+1)^2+n$ (B) $\frac{1}{4}n^2(n+1)^2-n$

(C) $\frac{1}{4}(n+1)^2-n$ (D) none of these

18 If z be a complex number satisfying $|z|^2+2(z+\bar{z})-5=0$, then complex number z + 3 + 2i will lie on

(A) Circle with centre 1 – 2i radius 4 (B) Circle with centre 1 + 2i radius 4

(C) Circle with centre 1 + 2i radius 3 (D) Circle with centre 1 – 2i radius 3

19. If one of the roots of the equation $\begin{vmatrix} 7 & 6 & x^2-13 \\ 2 & x^2-13 & 2 \\ x^2-13 & 3 & 7 \end{vmatrix}=0$ is x = 2, then sum of all other five roots is

(A) $2\sqrt{15}$ (B) –2

(C) $\sqrt{20}+\sqrt{15}-2$ (D) none of these

20. f: R → R, f(x) is differentiable such that $f(f(x)) = k(x^5 + x)$, $(k \neq 0)$, then f(x) is always

(A) Increasing (B) Decreasing

(C) Either increasing or decreasing (D) Non-monotonic

21. Let $\vec{a}$ and $\vec{b}$ are two perpendicular unit vectors. If $\vec{c}$ is another unit vector equally inclined at angle θ to the vectors $\vec{a}$ and $\vec{b}$, then the set of exhaustive values of θ in $[0, 2\pi]$ is

(A) $\left(0,\frac{\pi}{2}\right)$ (B) $\left[0,\frac{\pi}{4}\right]$

(C) $\left(\frac{\pi}{2},\frac{3\pi}{4}\right)$ (D) $\left[\frac{\pi}{4},\frac{3\pi}{4}\right]$

22. Let A, B, C be point with position vectors $r_1=2\hat{i}-\hat{j}+\hat{k},\ r_2=\hat{i}+2\hat{j}+3\hat{k}$ and $r_3=3\hat{i}+\hat{j}+2\hat{k}$ relative to the origin 'O'. The shortest distance between point B and plane OAC is

(A) 10 (B) 5

(C) $\sqrt{\frac{5}{7}}$ (D) $2\sqrt{\frac{5}{7}}$

Space for rough work

23. The maximum number of regions in which 10 circles can divide a plane is
(A) 512 (B) 1024
(C) 2048 (D) None of these

24. If [x] and {x} denotes the greatest integer and fractional part function, then the number of real x, satisfying the equation (x – 2)[x] = {x} – 1, is
(A) 0 (B) 1
(C) 2 (D) infinite

25. Let g(x) = ax + b, where a < 0 and g is defined from [1, 3] to [0, 2] then the value of $\cot\left(\cos^{-1}(|\sin x| + |\cos x|) + \sin^{-1}(-|\cos x| - |\sin x|)\right)$ is equal to
(A) g(1) (B) g(2)
(C) g(3) (D) g(1) + g(3)

26. Consider the 12 face diagonals of a rectangular block. How many pairs of them are skew lines?
(A) 24 (B) 30
(C) 48 (D) 60

27. Suppose M = {(x, y)| |xy| = 1, x > 0} and N = {(x, y)| $\tan^{-1} x + \tan^{-1} y = \pi$} which of the following statements is true?
(A) $M \cup N$ = {(x, y)| |xy| = 1}
(B) $M \cup N = M$
(C) $M \cup N = N$
(D) $M \cup N$ = {(x, y)| |xy| = 1, x, y are non negative simultaneously}

28. Let F(x) be such that $F\left(\frac{1-x}{1+x}\right) = x$ for all $x \neq -1$ which of the following statements is true?
(A) F(–2 – x) = –2 – F(x) (B) $F(-x) = F\left(\frac{1-x}{1+x}\right)$, $x \neq 1$
(C) $F\left(\frac{1}{x}\right) = F(x)$, $x \neq 0$ (D) F(F(x)) = –x

29. Which of the following is logically equivalent to $p \rightarrow (p \vee q)$?
(A) $\sim p \wedge (p \vee q)$ (B) $q \rightarrow (p \rightarrow q)$
(C) $\sim p \wedge \sim q$ (D) none of these

30. The mean of the 200 observation is 48 and their standard deviation is 3. Then sum of the squares of all the observations
(A) 46200 (B) 42600
(C) 62400 (D) none of these

Space for rough work

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3.	B	D	C
4.	D	B	A
5.	C	C	C
6.	B	A	D
7.	A	C	B
8.	B	B	A
9.	D	B	A
10.	D	A	B
11.	B	A	C
12.	C	C	B
13.	C	A	A
14.	B	D	B
15.	B	B	C
16.	C	C	B
17.	A	A	A
18.	C	B	C
19.	B	C	B
20.	B	B	C
21.	D	D	D
22.	C	A	D
23.	A	D	B
24.	D	A	D
25.	D	D	C
26.	B	B	B
27.	A	B	B
28.	D	C	A
29.	D	D	B
30.	B	D	D

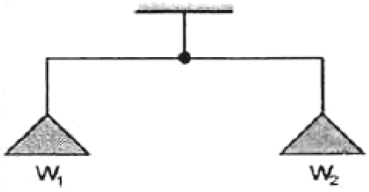
Physics

PART – I

SECTION – A

1. Since the compartment (including passengers) is stationary, so the combined centre of mass of compartment and passengers is fixed i.e. C_2 is fixed. When the passengers move here and there in the compartment then in an attempt to keep C_2 fixed C_1 has to move.

2. Since the balance has equal arms and it is a false balance, so the pans must be having different weights. Let w_1 and w_2 be the weights of left pan and right pan respectively. Let w be the true weight of object. When placed in left pan it weights x i.e. a total weight of $w + w_1$ on left balances a total weight of $w_2 + x$ on the right pan.



$\Rightarrow$ $w + w_1 = w + x$ ....(1)

Similarly it weighs y when placed in right pan i.e.

$y + w_1 = w + w_2$ ....(2)

From (1)

$w_1 - w_2 = x - w$ ....(3)

From (2)

$w_1 - w_2 = w - y$ ....(4)

$\Rightarrow x - w = w - y$

$\Rightarrow w = \dfrac{x+y}{2}$

3. The center gravity of liquid in the first column is $\dfrac{h_1}{2}$ and that in the second column is $\dfrac{h_2}{2}$.

Let litial Potential Energy be U_i

$$\Rightarrow U_i = (Ah_1\rho)g\left(\frac{h_1}{2}\right) + (Ah_2\rho)g\left(\frac{h_2}{2}\right)$$

$$\Rightarrow U_i = \frac{1}{2}A\rho g(h_1^2 + h_2^2)$$

When the water column in the two equavalises then equivalent height is $\dfrac{h_1+h_2}{2}$ and the center of gravity in both the columns is $\dfrac{h_1+h_2}{4}$. If U_f be the final potential energy in both the columns then

$$U_f = 2\left[A\left(\frac{h_1+h_2}{2}\right)\rho\left(\frac{h_1+h_2}{4}\right)g\right]$$

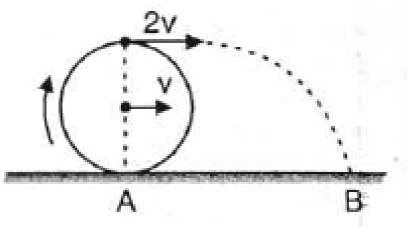
$$\Rightarrow U_f = \frac{1}{4}A\rho g(h_1+h_2)^2$$

Since work done is equal to the decrease in potential energy,

So, $w = U_i - U_f$

$$\Rightarrow w = A\rho g\left(\frac{h_1-h_2}{2}\right)^2$$

5. From the concepts of projectile motion,



$2r = \frac{1}{2}gt^2$

Since x = AB = (2v)t

$\Rightarrow t = \sqrt{\frac{4r}{g}}$

$\Rightarrow AB = 4v\sqrt{\frac{r}{g}}$

6. $y = ax^2$

$\Rightarrow \frac{dy}{dt} = \dot{y} = (2ax)\dot{x} = 2acx \qquad \left\{\because \frac{dx}{dt} = \dot{x} = c\right\}$

Further $a = \frac{d^2y}{dt^2} = \ddot{y} = 2ac\dot{x} = 2ac^2$

7. $(0)A = 4v + (A-4)V$

$\Rightarrow V = -\frac{4v}{A-4}$

Negative sign indicates the recoil speed.

8. Let the extension produced in the spring due to rotation be x.
Then, for the body to be in equilibrium

$F_{spring} = F_{centrifugal}$

$\Rightarrow kx = m(\ell + x)\omega^2$

$\Rightarrow x = \frac{m\ell\omega^2}{k - m\omega^2}$

10. $\vec{E} = \vec{\nabla}V$

$\Rightarrow \vec{E} = -\left(\hat{i}\frac{\partial U}{\partial x} + \hat{j}\frac{\partial U}{\partial y} + \hat{k}\frac{\partial U}{\partial z}\right)$

$\frac{\partial U}{\partial x} = 6 - 8y^2 - 8x$

$\frac{\partial U}{\partial y} = -16xy - 8 + 6z$

$\frac{\partial U}{\partial z} = 6y$

At (0, 0, 0)

$\frac{\partial U}{\partial x} = 6, \ \frac{\partial U}{\partial y} = -8, \ \frac{\partial U}{\partial z} = 0$

$\Rightarrow |\vec{E}|_{(0,0,0)} = -6\hat{i} + 8\hat{j}$

$\Rightarrow |\vec{E}| = 10NC^{-1}$

$\Rightarrow |\vec{F}| = q|\vec{E}|$

$\Rightarrow |\vec{F}| = 20\,N$

11. Since $P_1V = n_1RT_1$
and $P_2V = n_2RT_2$
After joining the vessels we have
$P(2V) = (n_1 + n_2)RT$

$$\Rightarrow P(2V) = \left(\frac{P_1V}{RT_1} + \frac{P_2V}{RT_2}\right)RT$$

$$\Rightarrow P = \frac{1}{2}\left(\frac{P_1}{T_1} + \frac{P_2}{T_2}\right)T$$

12. $$\frac{0.693}{\lambda_X} = \frac{1}{\lambda_Y}$$

$\Rightarrow \lambda_Y > \lambda_X$

Since, $\left(-\frac{dN}{dt}\right)_X = \lambda_X N$

And $\left(-\frac{dN}{dt}\right)_Y = \lambda_Y N$

$$\Rightarrow \left(-\frac{dN}{dt}\right)_Y > \left(-\frac{dN}{dt}\right)_X$$

Decay rate of Y > Decay rate of X.

15. $$v_d = \frac{1}{neA}$$

16. Soft iron has highest susceptibility.

17. $\lambda_m T$ = constant

$$\Rightarrow T = \frac{4}{3}T_0$$

Since, $P \propto T^4$ (from Stefan's Law)

$$\Rightarrow P_{new} = \frac{256}{81}P$$

18. $$\tan\theta_1 = \frac{\tan\theta}{\cos\alpha}$$

and $\tan\theta_2 = \frac{\tan\theta}{\cos(90° - \alpha)} = \frac{\tan\theta}{\sin\alpha}$

$$\Rightarrow \cos\alpha = \frac{\tan\theta}{\tan\theta_1} \quad ....(1)$$

and $\sin\alpha = \frac{\tan\theta}{\tan\theta_2}$ ....(2)

Dividing (2) by (1), we have

$$\tan\alpha = \frac{\tan\theta_1}{\tan\theta_2}.$$

19. A and C are statements of Lenz's Law. B is the correct option.

20. $I_v \sin\phi$ component of current gives no power consumption and hence is called wattless current.

21. $v^2 = \omega^2(a^2 - x^2)$

$\Rightarrow v_1^2 = \omega^2(a^2 - y_1^2)$ ....(1)

$\Rightarrow v_2^2 = \omega^2(a^2 - y_2^2)$ ....(2)

From (1) and (2), we get

$$T = 2\pi\sqrt{\frac{y_1^2 - y_2^2}{v_2^2 - v_1^2}}$$

22. $n = 2\left(\frac{v}{2\ell}\right)$

$$n' = 3\left(\frac{v}{4\ell}\right) = \frac{3n}{4}$$

23. Resolving power of telescope = $\frac{a}{1.22\lambda}$

where a is the diameter of objective lens and λ is the wavelength of light used. On increasing a, more light is collected by objective lens and so, the image formed is more bright. Thus, resolving power of telescope increases.

24. $\beta = \frac{\lambda D}{d}$

So, angular with, 2θ is

$$2\theta = \frac{2\beta}{D} = \frac{2\lambda}{d}$$

$$\theta = \frac{6328 \times 10^{-10}}{0.2 \times 10^{-3}}$$

$\Rightarrow \theta = 3164 \times 10^{-6}$ radian

$\Rightarrow \theta = 3164 \times 10^{-6} \times \frac{180}{\pi}$ degree

$\Rightarrow \theta = 0.18$ degree

$\Rightarrow 2\theta = 0.36$ degree.

25. If I is the intensity of the incident unpolarised light, the intensity transmitted by the first is $\frac{I}{2}$. This is the intensity of incident light on the second polaroid. Intensity transmitted by the second polaroid is $\left(\frac{I}{2}\right)\cos^2\theta$, where θ is the angle between the axes. Here $\sin\theta = \frac{3}{5}$, cos θ is therefore $\frac{4}{5}$.

$$\frac{I}{2}\cos^2\theta = \frac{I}{2} \times \left(\frac{4}{5}\right)^2 = \frac{8}{25}I$$

$\frac{8}{25}$ is the required ratio.

26. 50 VSD = 49 MSD

1 VSD = $\frac{49}{50}$MSD

$\Rightarrow$ VC = 1 MSD – 1 VSD

$\Rightarrow VC = 1MSD - \frac{49}{50}MSD$

$\Rightarrow$ $VC = \frac{1}{50}$ MSD

$\Rightarrow$ 1 MSD = 50 (VC) = 50 (0.001 cm)

$\Rightarrow$ 1 MSD = 0.05 cm = 0.5 mm

$\Rightarrow$ 1 MSD = 0.5 mm

27. $I_C = I_E - I_B = 4\text{ mA} - 40\ \mu\text{A} = (4 - 0.04) = 3.96\text{ mA}$

$$\alpha = \frac{I_C}{I_E} = \frac{3.96}{4} = 0.99$$

28. Electric energy density

$$u_0 = \frac{1}{2}\varepsilon_0 E_{rms}^2$$

Since, $E_{rms} = \frac{E_0}{\sqrt{2}}$

$$\Rightarrow u_0 = \frac{1}{4}\varepsilon_0 E_0^2$$

29. By the Law of conservation of energy

$(U + K)_{surface} = (U + K)_{\infty}$

$$\Rightarrow \frac{-GMm}{R} + \frac{1}{2}m(3v_1)^2 = 0 + \frac{1}{2}mv^2$$

$$\Rightarrow -\frac{GM}{R} + \frac{9v_e^2}{2} = \frac{1}{2}v^2$$

Since, $v_e^2 = \frac{2GM}{R}$

$$\Rightarrow -\frac{v_e^2}{2} + \frac{9v_e^2}{2} = \frac{1}{2}v^2$$

$$\Rightarrow v^2 = 8v_e^2$$

$$\Rightarrow v = 2\sqrt{2}v_e$$

30. Let h be the height of the water level at any instant. Then the rate of decrease of water level is $-\frac{dh}{dt}$. Therefore

$$-A\frac{dh}{dt} = av = a\sqrt{2gh}$$

$$\Rightarrow -\frac{dh}{dt} = \frac{a}{A}\sqrt{2gh}$$

$$\Rightarrow -\int_{H_1}^{H_2}\frac{dh}{h^{1/2}} = \left(\frac{a}{A}\sqrt{2g}\right)\int_0^1 dt$$

$$\Rightarrow -2\left[h^{1/2}\right]_{H_1}^{H_2} = \left(\frac{a}{A}\sqrt{2g}\right)t$$

$$\Rightarrow 2\left[\sqrt{H_1} - \sqrt{H_2}\right] = \left(\frac{a}{A}\sqrt{2g}\right)t$$

$$\Rightarrow t = \frac{A}{a}\sqrt{\frac{2}{g}}\left[\sqrt{H_1} - \sqrt{H_2}\right]$$

Chemistry PART – II

SECTION – A

1. Salicylic acid contains – OH group and – COOH group. Therefore $FeCl_3$ and $NaHCO_3$ tests are used.

2. ZnO gives yellow colour on heating and white on cooling.

3. $PbCl_2 + K_2CrO_4 \longrightarrow \underset{\text{yellow ppt.}}{PbCrO_4} + 2KCl$

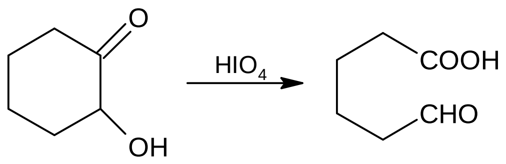
4. Dissociation of $H_2O(H_2O \rightleftharpoons H^+ + \bar{O}H)$ is opposite to neutralization. Hence, enthalpy of dissociation is equal to enthalpy of neutralization but has opposite sign.

5. For preparation of iodoform reagent which can supply I^+ is require i.e. KOI or KOH/I_2.

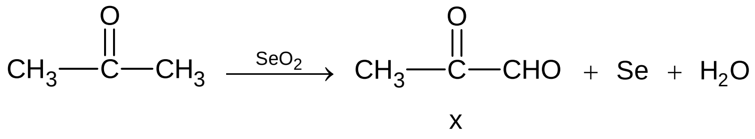
6. I^- ion is more easily oxidized than Br^- ion and hence violet colour due to I_2 appears first.

7. $AuCl_3$ is reduced by $SnCl_2$ to form colloidal sol of gold.
There is no peptisation involved.

8. In accordance with Huckel rule, carbocation (III) is aromatic and hence most stable. Carbocation (IV) is stabilized by resonance and hence more stable than carbocation (I and II). In carbocation (II), +ve charge is present on a more electronegative sp-hybridized carbon while in carbocation (I), it is present on a less electronegative sp^2-hybridised carbon and hence carbocation (I) is more stable than carbocation (II). Thus, the overall stability increases in the order : II < I < IV < III.

9. 

10. SeO_2 oxidizes – CH_2 – next to carbonyl group to another $-\overset{\overset{O}{||}}{C}-$ group.

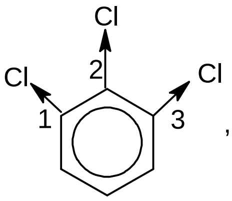


$$CH_3-\overset{\overset{O}{||}}{C}-CH_3 \xrightarrow{SeO_2} \underset{x}{CH_3-\overset{\overset{O}{||}}{C}-CHO} + Se + H_2O$$

11. 1 Mole of $C_{60}H_{122} = 60 \times 12\text{ g} + 122 \times 1\text{ g} = 842\text{ g}$
$= 6.022 \times 10^{23}$ molecules
Weight of 1 molecule = $(842/\ 6.022 \times 10^{23})$ gram.

12. $2C_6H_5COOH \rightleftharpoons (C_6H_5COOH)_2$
Before asso. 1 mol
After asso. 1 – x x/2
Total = 1 – x + x/2 = 1 – x/2

$$i = \frac{1-\frac{x}{2}}{1} = 1-\frac{x}{2}$$

13. 

, resultant bond moment of C_1 – Cl and C_3 – Cl bonds adds up to the bond moment of C_2 – Cl. Hence, it has maximum value.

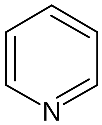
14. NO_2^+ has no unshared electron. It has only bond pairs in two directions. Hence, shape is linear $O{=}\overset{+}{N}{=}O$ with bond angle = 180º.

15. For reaction (i), $K_p = P_{CO_2} = 8 \times 10^{-2}$ (given)

For reaction (ii), $K_p = \frac{P_{CO}^2}{P_{CO}} = 2$ (given)

$\therefore \quad 2 = \frac{P_{CO}^2}{8 \times 10^{-2}}$ or $P_{CO} = 0.4$

16. Boron is diagonally related to Si.

17. In 

, N is linked to two c-atoms and has one lone pair. Hence, electron geometry is triangular planar and hybridization is Sp^2.

18. $E_2 = -\frac{k}{2^2} = -328 \text{ kJ mol}^{-1}$

$K = 1312 \text{ kJ mol}^{-1}$

$E_4 = -\frac{k}{4^2}$

$= -\frac{1312}{16} = -82 \text{ kJ mol}^{-1}$

19. Among isoelectronic ions, size increases the –ve charge increases.
i.e. $F^- < O^{2-} < N^{-3}$

20. Greater the boiling point, less is the vapour pressure. Hence, the correct order of vapour pressure wil be
Water < acetone < ether

21. Conjugate base = conjugate acid – H^+
$= H_2 - H^+ = H^-$.

22. The redox changes are

$Mn^{7+} + 5e^- \longrightarrow Mn^{2+}$

$Fe^{2+} \longrightarrow Fe^{3+} + 1e^-$

Equivalent weight of $FeSO_4 = \frac{152}{1}$

Milli equivalent of $KMnO_4$ = Meq. Of $FeSO_4$

$$\therefore\ 0.05\times5\times V=\frac{2}{152/1}\times1000$$

$$\Rightarrow\ V=52.63\text{ ml}$$

23. $$\frac{r}{2}C_2+\frac{r}{2}N_2=r_{CN}$$

$$\Rightarrow\ \frac{X}{2}+\frac{r}{2}N_2=y\ \Rightarrow\ \frac{r}{2}N_2=y-\frac{x}{2}$$

$$\Rightarrow\frac{r}{2}N_2=\frac{2Y-X}{2}$$

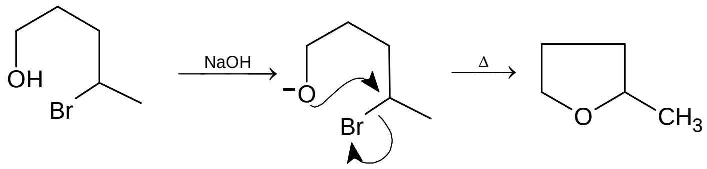
$$\Rightarrow\ r_{N_2}=2y-x$$

24. Outer elect. Configuration of Co atom = $3d^7 4s^2$
Outer elect. Configuration of Co^{3+} ion = $3d^6$
As F^- is a weak ligand, it cannot cause forcible pairing of electrons within the 3d level. Hence sp^3d^2 hybridization will result outer orbital complex.

25. $\Delta n(g) = n_p - n_r = 5 - 3 = 2$
$\Delta H = \Delta E + \Delta n_g RT$
$\Delta E = \Delta H - \Delta n_g RT$
$= 19-(2\times2\times10^{-3}\times300)$
$= 19 - 1.2 = 17.8$ K cal.

26. $\Delta G^o = -RT \ln K_p = -(8.314\ J\ k^{-1}\ mol^{-1})\ (900\ K)$
$(2.303)\log(0.05) = 22400\ J\ mol^{-1}$.

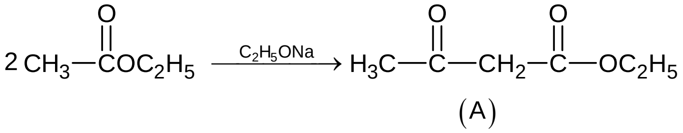
27.



28. 75% of reaction is completed in two half-lives.

29. In the final solution, $[H^+] = (10^{-6} + 10^{-3})/2$
$=0.5005\times10^{-3}=5.005\times10^{-4}$
$pH=-\log[H^+]=-\log(5.005\times10^{-4})$
$=4-0.6994\approx3.3$

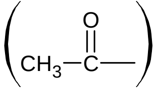
30.



$$2\,CH_3-\overset{\overset{\large O}{||}}{C}OC_2H_5\xrightarrow{C_2H_5ONa}H_3C-\overset{\overset{\large O}{||}}{C}-CH_2-\overset{\overset{\large O}{||}}{C}-OC_2H_5$$

(A)

(A) forms oxime due to keto group, shows tautomerism, also shows idoform test due to



$$\left(CH_3-\overset{\overset{\large O}{||}}{C}-\right)$$ group.

Mathematics PART – III

SECTION – A

1. $\frac{1}{2} \le x^2 + \frac{1}{2} < \frac{3}{2}$ $\qquad -\frac{1}{2} \le x^2 - \frac{1}{2} < \frac{1}{2}$

$\left[x^2 + \frac{1}{2}\right] = 0, 1$ $\qquad \left[x^2 - \frac{1}{2}\right] = -1, 0$

$\left[x^2 + \frac{1}{2}\right] = 1$ $\qquad \left[x^2 - \frac{1}{2}\right] = -1$

$1 \le x^2 + \frac{1}{2} < 2$ $\qquad -1 \le x^2 - \frac{1}{2} < 0$

$\frac{1}{2} \le x^2 < \frac{3}{2}$ $\qquad -\frac{1}{2} \le x^2 < \frac{1}{2}$

$\frac{1}{\sqrt{2}} \le |x| < \sqrt{\frac{3}{2}}$ $\qquad |x| < \frac{1}{\sqrt{2}}$

$$I = \int_{-\sqrt{\frac{3}{2}}}^{-\frac{1}{\sqrt{2}}} \tan^{-1} 1 dx + \int_{\frac{1}{\sqrt{2}}}^{\sqrt{\frac{3}{2}}} \tan^{-1} 1 dx + \int_{-\frac{1}{\sqrt{2}}}^{\frac{1}{\sqrt{2}}} \cot^{-1}(-1) dx = \frac{\pi}{4} \times \left(\frac{\sqrt{3}-1}{\sqrt{2}}\right) + \frac{\pi}{4} \frac{\sqrt{3}-1}{\sqrt{2}} + \frac{3\pi}{4} \times \left(\frac{1+1}{\sqrt{2}}\right)$$

$$= \frac{\pi}{4\sqrt{2}}\left[2\sqrt{3} - 2 + 6\right] = \frac{\pi}{2\sqrt{2}}\left(\sqrt{3} + 2\right) = \frac{\pi}{2\sqrt{2}}\left(\sqrt{3} + 2\right)$$

2. $m \le 2n \le 60 \Rightarrow n \le 2m \le 60$

For m = 1; $1 \le 2n \le 60$ and $n \le 2 \le 60 \Rightarrow \frac{1}{2} \le n \le 2 \Rightarrow n = 1, 2$

For m = 2; $2 \le 2n \le 60$ and $n \le 4 \le 60 \Rightarrow 1 \le n \le 4 \Rightarrow n = 1, 2, 3, 4$

For m = 3; $3 \le 2n \le 60$ and $n \le 6 \le 60 \Rightarrow \frac{3}{2} \le n \le 6 \Rightarrow n = 2, 3, 4, 5, 6$

m = 4 n = 2, 3, 4, 5, 6, 7, 8
m = 5 n = 3, 4, …….. 10
m = 6 n = 3, 4 ………12
Total order pair =

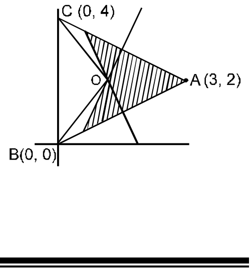
$$\underbrace{\overset{m=1}{2} + \overset{m=2}{4}} + \underbrace{\overset{m=3}{5} + \overset{m=4}{7}} + \underbrace{\overset{m=5}{8} + \overset{m=6}{10}} + \underbrace{\overset{m=6}{11} + \overset{m=8}{13}} + \overset{m=9}{14} + \ldots\ldots. + \underbrace{\overset{m=13}{20} + \overset{m=14}{22}} + \underbrace{\overset{m=15}{23} + \overset{m=16}{23}}$$

$$\underbrace{22+22} + \underbrace{21+21} + \underbrace{20+20} + \underbrace{19+19} + \underbrace{18+18} + \underbrace{17+17} + \underbrace{16+16}$$

$$= \underbrace{6 + 12 + 18 + \ldots\ldots\ldots\ldots + 42}_{7 \text{ terms}} + 46 + 2(22 + 21 + \ldots\ldots. + 16)$$

$$= \frac{7}{2} \times (6 + 42) + 46 + 2 \times \frac{7}{2} \times (22 + 16) = 7 \times 24 + 46 + 7 \times 38 = 480$$

3. In the figure O is circumcentre and shaded region shows location of P
Distance of P from side BC is maximum if P is at A



4. Let first term is a then $x = a + (m - 1)d$, $y = a + (n - 1)d$ and $s = \frac{m+n}{2}[2a+(m+n-1)d]$

$(x + y) = 2a + (m + n - 2)d$ and $(x - y) = (m - n)d$

$\Rightarrow d = \left(\frac{x-y}{m-n}\right) \Rightarrow (x + y) = 2a + (m + n - 1)d - \left(\frac{x+y}{m-n}\right)$

$S = \left(\frac{m+n}{2}\right)\left[(x+y)+\frac{x-y}{m-n}\right]$

5. $\sin^{-1}\left\{\frac{1}{2}\left(\frac{1}{x}+x\right)\right\}$ check $f(1^-) = \sin^{-1}1^+$, $f(1) = \sin^{-1}1$, $f(1^+) = \sin^{-1}1^-$

Hence function is discontinuous so non differentiable

6. $\lim\limits_{n\to\infty}\frac{5.5^n+3^n-4^n}{5^n+2^n+27\times 9^n} = 0$, divide numerator and denominator by highest power i.e. (9^n)

7. $P(x_1 + t\,(x_2 - x_1), y_1 + t(y_2 - y_1)$

$x = \frac{t\,x_2+(1-t)x_1}{t+1-t} \Rightarrow y = \frac{t\,y_2+(1-t)y_1}{t+1-t}$

For internal division

$t > 0$ and $(1 - t) > 0 \Rightarrow 0 < t < 1$

8.

x_1	x/r	y_1	y/r
x_2	x	y_2	y
x_3	xr	y_3	yr

Slope of line joining (x_1, y_1) and (x_2, y_2)

$m = \frac{y-y/r}{x-x/r} \Rightarrow$ Slope of line joining (x_2, y_2) and $(x_3, y_3) \Rightarrow m = \frac{yr-y}{xr-x} = \frac{r(y-y/r)}{r(x-x/r)}$

Slope is same hence (x_1, y_1), (x_2, y_2) and (x_3, y_3) are in straight line

9. $\cos A + 2\cos B + \cos C = 2$

$\cos A + \cos C = 2(1 - \cos B)$

$2\cos\frac{A+C}{2}.\cos\frac{A-C}{2} = 2\times 2\sin^2\frac{B}{2}$

$\sin\frac{B}{2}\cos\frac{A-C}{2} = 2\sin^2\frac{B}{2}$, $\cos\left(\frac{A}{2}-\frac{C}{2}\right) = 2\sin\frac{B}{2}$, $\cos\frac{A}{2}\cos\frac{C}{2}+\sin\frac{A}{2}\sin\frac{C}{2} = 2\sin\frac{B}{2}$

$\sqrt{\frac{s(s-a)}{bc}}\sqrt{\frac{s(s-c)}{ab}}+\sqrt{\frac{(s-b)(s-c)}{bc}}\sqrt{\frac{(s-a)(s-b)}{ab}} = 2\sqrt{\frac{(s-a)(s-c)}{ac}}$

$a + c = 2b$ i.e. a, b, c, in AP

10 $f(x) = \int_0^1 \frac{x^2+t^2}{2-t}\,dt = \int_0^1\left(\frac{x^2}{2-t}-t-2+\frac{4}{2-t}\right)dt$

$= \left(-(x^2+4)\ell n|2-t| - \frac{t^2}{2} - 2t\right)\Big|_0^1 = (x^2 + 4)\,\ell n2 - \frac{1}{2} - 2$

i.e. $y = x^2\ \ell n2 + 4\ \ell n2 - \frac{5}{2}$ which is a parabola

11. Since $(4, -4)$ and $(9, 6)$ lie on $y^2 = 4a(x - b)$

$\therefore 4 = a(4 - b)$ and $9 = a(9 - b)$

$\therefore$ a = 1 and b = 0

$\therefore$ The parabola is $y^2 = 4x$

Let the point R be $(t^2, 2t)$

$$\therefore \text{ Area of } \Delta PRQ = \frac{1}{2}\begin{vmatrix} 4 & -4 & 1 \\ 9 & 6 & 1 \\ t^2 & 2t & 1 \end{vmatrix} = \frac{1}{2}\begin{vmatrix} 4 & -4 & 1 \\ 5 & 10 & 0 \\ t^2-4 & 2t+4 & 0 \end{vmatrix} = \frac{1}{2}\begin{vmatrix} 5 & 10 \\ t^2-4 & 2t+4 \end{vmatrix}$$

$$= \frac{1}{2}(10t + 20 - 10t^2 + 40) = -5t^2 + 5t + 30 = -5(t^2 - t + \frac{1}{4}) + 30 + \frac{5}{4} = -5\left(t - \frac{1}{2}\right)^2 + \frac{125}{4}$$

$\therefore$ Area in largest when $t = \frac{1}{2}$

$\therefore$ Coordinates of the point R are $(\frac{1}{4}, 1)$

12. $f(x) = \begin{cases} 3 & x = 0 \\ a - x^2 & 0 < x < 1 \\ mx + b & 1 \le x \le 2 \end{cases}$

For Lagrange's mean value theorem f(x) must be continuous in [0, 2] and differentiable in (0, 2)

Hence, a = 3, m + b = 2

$f'(x) = \begin{cases} -2x & 0 < x < 1 \\ m & 1 < x \le 2 \end{cases}$

$\Rightarrow$ m = – 2 and hence b = 4

13. It is rectangular hyperbola $\Rightarrow e = \sqrt{2}$

14. Normal to ellipse is $ax\sec\theta - by\operatorname{cosec}\theta = a^2 - b^2$

15. $f'(x) = \cos\left(\frac{x^2 + 2x + 1}{5}\right) = \cos\left(\frac{(x+1)^2}{5}\right)$

Since $0 \le x \le 2$, $\frac{1}{5} \le \frac{(x+1)^2}{5} \le \frac{9}{5}$

$\cos\frac{(x+1)^2}{5} = 0$ only when $\frac{(x+1)^2}{5} = \frac{\pi}{2}$

$f'(x) > 0$ if $0 < x < \sqrt{\frac{5\pi}{2}} - 1$

$f'(x) < 0$ if $\sqrt{\frac{5\pi}{2}} - 1 < x < 2$

$\therefore x = \sqrt{\frac{5\pi}{2}} - 1$ is a point of local maximum

16. $I=\int\frac{x^5dx}{\sqrt{1+x^3}}$

$1 + x^3 = t^2$

$3x^2\, dx = 2t\, dt$

$$I=\frac{2}{3}\int\frac{(t^2-1)t\,dt}{t}=\frac{2}{3}\int(t^2-1)dt=\frac{2}{3}\left[t^3\times\frac{1}{3}-t\right]+c$$

$$=\frac{2}{9}\left[t^3-3t\right]+c=\frac{2}{9}t^3-\frac{2}{3}t+c=\frac{2}{9}(1+x^3)^{3/2}-\frac{2}{3}(1+x^3)^{1/2}+c$$

17. $\sum_{r=1}^{n}(r+1)(r+\omega)\,(r+\omega^2)=\sum_{r=1}^{n}(r^3+1)=\frac{1}{4}n^2(n+1)^2+n$

18. $z\bar{z}+\alpha\bar{z}+\bar{\alpha}z+\beta=0$

$z\bar{z}+2z+2\bar{z}-5=0$

$z_0=-2 \qquad r=\sqrt{4+5}$

$r = 3$

$|z+2|=3$

19. $7\,\{7(x^2-13)-6\}-\{14-2(x^2-13\}+(x^2-13)\,\{6-(x^2-13)^2\}=0$

$\alpha+\beta+\gamma+\delta+\phi+2=0$

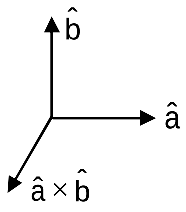
20. $f(f(x)) = k(x^5 + x)$ $(k \neq 0)$

$f'(f(x))\,.\,f'(x) = k(5x^4 + 1) \Rightarrow$ Can be + or –

But it may not be –ve. Because if f(x) ↑ ing then $f'(f(x)).f'(x) > 0$

and If f(x) ↓ ing then $f'(f(x)).f'(x) > 0$ i.e. f(x) is either ↑ ing or ↓ ing (also $k > 0$)

21. Let $\vec{c}$ makes an angle β from $\hat{a}\times\hat{b}$ then $\cos^2\theta + \cos^2\theta + \cos^2\beta = 1$



$2\cos^2\theta = 1 - \cos^2\beta$

$0\le 1-\cos^2\beta\le 1$

$0\le 2\cos^2\theta\le 1\Rightarrow 0\le\cos^2\theta\le\frac{1}{2}\Rightarrow-\frac{1}{\sqrt{2}}\le\cos\theta\le\frac{1}{\sqrt{2}}$

$\theta\in\left[\frac{\pi}{4},\frac{3\pi}{4}\right]$

22. A = (2, –1, 1), B = (1, 2, 3), C = (3, 1, 2)

$\overrightarrow{OA}=2\hat{i}-\hat{j}+\hat{k}$

$\overrightarrow{OC}=3\hat{i}+\hat{j}+2\hat{k}$

$$\overrightarrow{OA}\times\overrightarrow{OC}=\begin{vmatrix}\hat{i}&\hat{j}&\hat{k}\\2&-1&1\\3&1&2\end{vmatrix}=-3\hat{i}-\hat{j}+5\hat{k}$$

∴ Equation of plane OAC: $3x + y - 5z = d$

Put (0, 0, 0), d = 0

∴ Plane is $3x + y - 5z = 0$

Shortest distance = $\frac{|3\times1+2-5\times3|}{\sqrt{9+1+25}}=\frac{10}{\sqrt{35}}=2\sqrt{\frac{5}{7}}$

23. Initially there is one plane
When C_1 is introduced: 1 part is increased
When C_2 is introduced: 2 part is increased
When C_3 is introduced: 4 part is increased
When C_4 is introduced: 8 part is increased
$\therefore$ Total number of parts = 1 + 1 + 2 + 4 + 8 + 16 + ... $= 1 + \frac{1(2^{10} - 1)}{2 - 1}$ = 1024

24. for $x \geq 2$, LHS is always non negative and RHS is always –ve
Hence, for $x \geq 2$ no solution
If $1 \leq x < 2$ $(x - 2) = (x - 1) - 1 = x - 2$ which is an identity
For $0 \leq x < 1$, LHS is '0' and RHS is (–)ve $\Rightarrow$ no solution
$x < 0$, LHS is (+)ve, RHS is (–)ve $\Rightarrow$ no solution

25. Consider F(x) = $\cot\left(\cos^{-1}(|\sin x| + |\cos x|) + \sin^{-1}(-|\cos x| - |\sin x|)\right)$
But $|\sin x| + |\cos x| \in [1, \sqrt{2}]$
$\therefore$ F(x) = $\cot(\cos^{-1}(1) + \sin^{-1}(-1)) = \cot\left(0 - \frac{\pi}{2}\right)$ = 0 = g(3) (As F(x) = 0, $\forall$ x $\in$ DF)

26. Consider a fixed face diagonal. It is parallel to corresponding one on the opposite face. It intersects the other diagonal of the same face and one diagonal on each of the four neighbouring faces. The other five face diagonals form five pairs of skew lines with the fixed one. By symmetry, each of the twelve faces diagonals. The total count of pair of skew lines is 12 × 5 = 60 but this must be halved since each pair is counted twice.

27. Clearly N = ϕ
Now M consists of the curve xy = 1 and xy = –1 in the first and fourth quadrant
Hence, $N \subset M$

28. $y = \frac{1 - x}{1 + x}$, $F(y) = x = \frac{1 - x}{1 + x}$
$F(-2 - x) = -\left(\frac{3 + x}{1 + x}\right) = -2 - F(x)$
$F(F(x)) = -x$, $F\left(\frac{1}{x}\right) = F(x)$

29. $p \to (p \vee q)$ and $q \to (p \to q)$ both are tautologies, while formulae
$\sim p \wedge (p \vee q)$ and $\sim p \wedge \sim q$ are not

30. $\bar{x} = 48$, n = 200 standard deviation = 3
Variance = $\frac{\sum x^2}{n} - \left(\frac{\sum x}{n}\right)^2$
$$9 = \frac{\sum x^2}{200} - (48)^2$$
$$\sum x^2 = 46200$$

FIITJEE

JEE (Advanced), 2015

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - II

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 10)** contains 10 multiple choice questions which have only one correct answer. Each question carries **+2 marks** for correct answer. There is no negative marking.

Section-A (11 to 15) contains 5 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-C (01 to 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

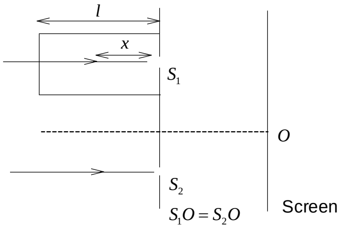
Physics

PART – I

SECTION – A

Single Correct Choice Type

This section contains **10 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE option is correct**.



1. In the figure shown, a parallel beam of light is incident on the plane of the slits of a Young's double slit experiment. Light incident on the slit, S, passes through a medium of variable refractive index $\mu = 1 + ax$ (where x is distance from the plane of slits as shown) upto a distance 'l' before falling on S_1. Rest of the space is filled with air. If at 'O' a minima is formed, then the minimum value of the positive constant a is:

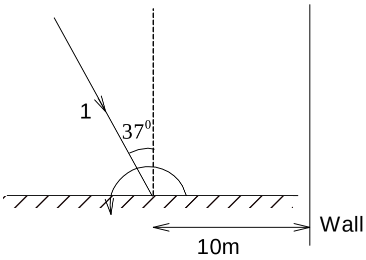
(A) $\frac{\lambda}{l}$
(B) $\frac{\lambda}{l^2}$
(C) $\frac{l^2}{\lambda}$
(D) $\frac{l^2}{2\lambda}$

2. The fundamental frequency of a sonometer wire of length l is f_0. A bridge is now introduced at a distance Δl from the centre of the wire $(\Delta l << l)$. The number of beats heard if both sides of the bridges are set into vibration in their fundamental modes are

(A) $\frac{8f_0\Delta l}{l}$
(B) $\frac{f_0\Delta l}{l}$
(C) $\frac{2f_0\Delta l}{l}$
(D) $\frac{4f_0\Delta l}{l}$

Space for Rough work

3. A light ray 1 is incident on a plane mirror M. The mirror is rotated in the direction as shown in fig. by an arrow at frequency $\frac{9}{\pi}$rps . The light reflected by the mirror is received on the wall W at a distance 10 m from the axis of rotation. When the angle of incidence is 37^0, the speed of the spot on the wall is:



(A) $10\,m/s$ (B) $1000\,m/s$
(C) $500\,m/s$ (D) $100\,m/s$

4. The photon radiated from hydrogen corresponding to 2^{nd} line of Lyman series is absorbed by a hydrogen like atom x in 2^{nd} excited state. As a result the hydrogen like atom 'x' makes a transition to nth orbit. Then

(A) $x = He^{+}, n = 4$ (B) $x = Li^{++}, n = 6$
(C) $x = He^{+}, n = 6$ (D) $x = Li^{++}, n = 9$

5. If a tuning fork of frequency (f_0) 340 Hz tolerance $\pm 1\%$ is used in resonance column method . The first and the second resonance are measured at $l_1 = 24.0$ cm and $l_2 = 74.0$ cm. The maximum permissible error in speed of sound is:

(A) 1.2 % (B) 1.8 %
(C) 1 % (D) 0.8 %

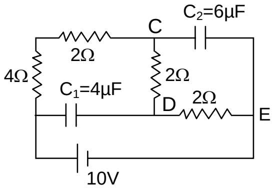
6. Axis of a solid cylinder of infinite length and radius R lies along y – axis it carries a uniformly distributed current 'I' along + y direction. Magnetic field at a point $\left(\frac{R}{2}, y, \frac{R}{2}\right)$ is

(A) $\frac{\mu_0 I}{4\pi R}\left(\hat{i} - \hat{k}\right)$ (B) $\frac{\mu_0 I}{2\pi R}\left(\hat{j} - \hat{k}\right)$
(C) $\frac{\mu_0 I}{4\pi R}\hat{j}$ (D) $\frac{\mu_0 I}{4\pi R}\left(\hat{i} + \hat{k}\right)$

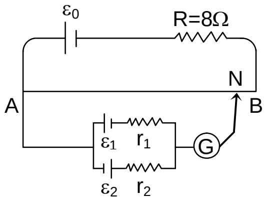
Space for Rough work

7. Find the potential difference across C_2 : When steady state reached.

(A) 6 V (B) 4 V
(C) Zero (D) 2 V



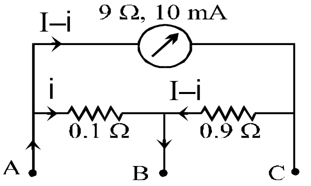
8. A battery of emf $\varepsilon_0 = 12V$ is connected across a 4m long uniform wire having resistance 4Ω/m. The cells of small emfs $\varepsilon_1 = 2V$ and $\varepsilon_2 = 4V$ having internal resistance 2Ω and 6Ω respectively, are connected as shown in the figure. If galvanometer shows no deflection at the point N, the distance of point N from the point A is equal to :



(A) $\frac{1}{6}$m (B) $\frac{1}{3}$m
(C) 25cm (D) 50cm

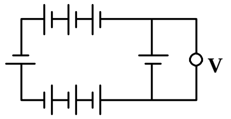
9. A milliameter of range 10 mA and resistance 9Ω is joined in a circuit as shown. The meter gives full-scale deflection for current I when A and B are used as its terminals, i.e., current enters at A and leaves at B (C is left isolated). The value of I is

(A) 100 mA (B) 900 mA
(C) 1 A (D) 1.1 A



10. In the circuit shown alongside, each battery is 5V and has an internal resistance of 0.2 ohm. The reading in the ideal voltmeter V is.

(A) 0 V (B) 1 V
(C) 2 V (D) 3 V



Space for Rough work

Multiple Correct Answer(s) Type

This section contains **5 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** are correct.

11. The instantaneous velocity v of a particle is related to its displacement x according to the relation $v = ax + b$, where $a > 0$ and $b \le a/7$. Which of the following statement(s) is (are) true if $x = 0$ at $t = 0$.

(A)The displacement of the particle at time t is $x = \frac{b}{a}(e^{at} - 1)$

(B)The particle will experience a retardation if $b < 0$

(C)The particle will be at rest at time $t = 0$

(D)The acceleration of the particle is constant

12. An moving body may have

(A)Varying speed without having varying velocity

(B)Varying velocity without having varying speed

(C)Nonzero acceleration without having varying velocity

(D)Nonzero acceleration without having varying speed

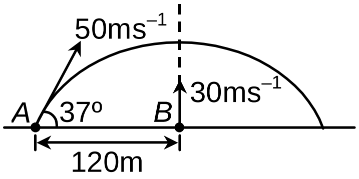
13. Balls A and B are thrown from two points lying on the same horizontal plane separated by a distance 120 m. Which of the following statement(s) is(are) correct.

(A) The balls can never meet

(B) The balls can meet if the ball B is thrown 1st later

(C) The balls can meet if the balls are thrown at the same time

(D) The two balls meet at a height of 45 m



14. Which of the following statements are correct

(A) Work by kinetic function on an object can be zero

(B) Work by static friction on an object can be non zero

(C) Work by normal force on an object can be non zero

(D) Work by force which is always perpendicular to its acceleration is zero

15. A 1.5kg box is initially at rest on a horizontal surface when at $t = 0$, a horizontal force $\vec{F} = 1.8t\,\hat{i}$ N (with t in sec), is applied to the box. The acceleration of the box as a function of time t is given by

$$\begin{cases} \vec{a} = 0, \text{ for } 0 \le t \le 2.8\,\text{sec} \\ \vec{a} = (1.2t - 2.4)\hat{i} \text{ for } t > 2.8\,\text{sec} \end{cases}$$

(A) The coefficient of static friction between the box and the surface is 0.24

(B) The friction force on the box at $t = 2\,\text{sec}$ is 3.6 N

(C) The coefficient of kinetic friction between the box and surface is 0.24

(D) The friction force on the box at $t = 4\,\text{sec}$ is 3.6 N

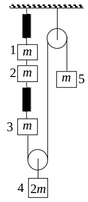
Space for Rough work

SECTION –C

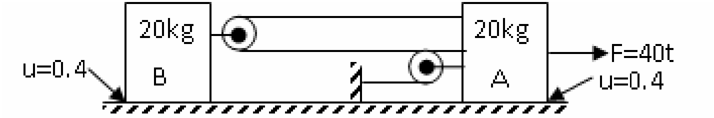
Integer Answer Type

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

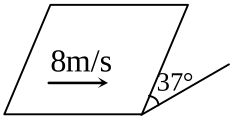
1. All the strings, springs and pulleys shown in figure are ideal. Initially the system is in equilibrium and blocks are at rest. Now, the upper spring is cut. The acceleration of block 1 just after cutting the upper spring is found y×g m/s^2. Find y?



2. Two identical blocks each having a mass of 20 kg is connected to each other by a light inextensible string as shown and is placed over a rough surface. Pulleys are connected to the blocks. The acceleration of block B after 1 sec is y/13 m/s^2 , after the application of the time varying force of 40t N, where t is in sec.

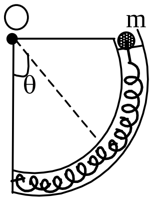


3. A ball is projected on a smooth inclined plane in a direction perpendicular to line of greatest slope with velocity of 8m/s. It's speed (in m/s) after 1 sec is 2K then value of K will be.



4. A train of length *l* = 350 m starts moving rectilinearly with constant acceleration *a* = 3×10^{-2} m/s^2. After 30 s the headlight of the train is switched on (event 1). After 60s from this event the tail signal light is switched on (event 2). The distance (in m) between these events in the reference frames fixed to the earth is 121K then what will be value of K.

5. A particle of mass m is released in a circular tube of radius *R.* If a spring of constant *K* is placed in the tube as shown in figure and angle made by radius vector with vertical when particle will come at instant rest is 60°, then the value of *K* is $\frac{(6mg)\lambda}{\pi^2 R}$ then find the value of λ:



Space for Rough work

Chemistry

PART – II

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

1. Which of the following property is not common in both VBT as well as MOT?
(A) LCAO
(B) Losing of nature of atomic orbital
(C) Mixing of atomic orbital
(D) Wave nature of electron

2. Which of the following method is not used to convert $\underset{1^{o}}{ROH} \rightarrow RBr$?
(A) $ROH \xrightarrow{HBr}$
(B) $ROH \xrightarrow{NaBr}$
(C) $ROH \xrightarrow[Conc.H_2SO_4]{NaBr}$
(D) $ROH \xrightarrow[H_3PO_4]{NaBr}$

3. The Molecularity of a reaction is :
(A) Always two
(B) Same as its order
(C) Different than the order
(D) May be same or different as compared to order

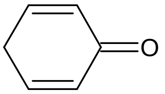
4. During micelle formation hydrocarbon part is directed towards
(A) centre
(B) periphery
(C) randomly
(D) Alternatively

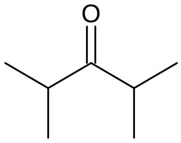
5. Which of the following is having maximum hydration energy?
(A) V^{3+}
(B) Fe^{2+}
(C) Cr^{3+}
(D) Cu^{2+}

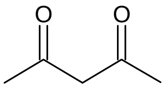
6. Which of the following is an application of Bohr's theory in an orbit?
(A) frequency of an electron
(B) nodal plane
(C) no. of waves
(D) probability of finding of electron

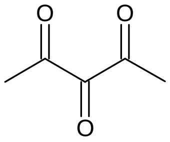
Space for Rough work

7. In which of the following ΔG_f is maximum in acidic medium?

(A) 

(B) 

(C) 

(D) 

8. $\underset{3^o}{RX}\xrightarrow{(X)}RH$

Reagent (X) cannot be used in the above conversion

(A) $LiAlH_4$ (B) $NaBH_4$
(C) Raney Ni (D) All

9. Which type of nuclear spin isomer of hydrogen exist at the temperature at which sulphonation of phenol gives major para substituted product

(A) Ortho (B) Para
(C) both (D) cant be defined

10. VBT can't explain the geometry of

(A) $[Cr(NH_3)_6]^{3+}$ (B) $[Co(NH_3)_6]^{3+}$
(C) $[Cu(NH_3)_4]^{2+}$ (D) $[Zn(NH_3)_4]^{2+}$

Space for Rough work

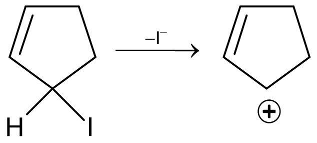
Multiple Correct Choice Type

This section contains 5 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

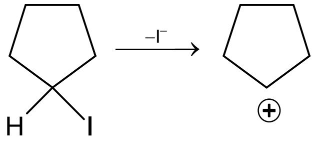
11. Which of the following ions can be separated by using NH_4Cl and NH_4OH?
(A) Fe^{3+} and Cr^{3+}
(B) Cr^{3+} and Co^{2+}
(C) Cr^{3+} and Al^{3+}
(D) Al^{3+} and Ba^{2+}

12. Which of the following has/have three isomers (including geometrical optical, ionisation, hydrated, linkage isomerism)?
(A) $[Zn(NH_3)(H_2O)(Cl)(Br)]$
(B) $[Cr(NH_3)_4(H_2O)_2]Br$
(C) $[Cr(NH_3)_5Cl]NO_2$
(D) $K_3[Co(C_2O_4)_3]$

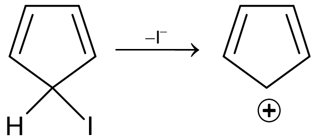
13. Consider the following reactions

(I) :


(X)

(II) :


(Y)

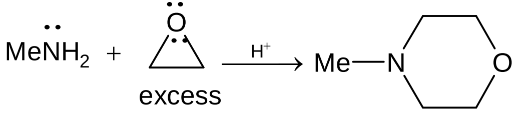
(III) :


(Z)

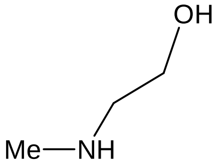
Select correct statement (s)
(A) All the carbocations (X), (Y) and (Z) are secondary
(B) X is stabilised by conjugation with the double bond and is formed fastest
(C) Z is least stable and formed slowest
(D) Z is conjugated cyclic system with four π electrons and thus is anti aromatic

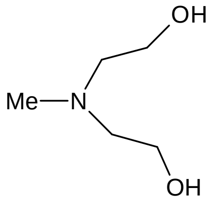
Space for Rough work

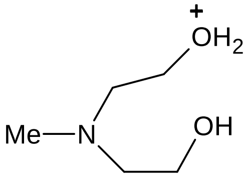
14. In the following reaction

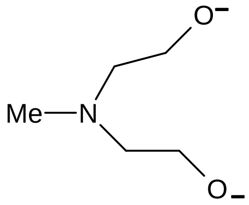

MeNH2
+
O
excess
H+
Me—N
O

Intermediates can be

(A)


(B)


(C)


(D)


15. Which of the folllowing possess two lone pairs at central atom and square planar shape?

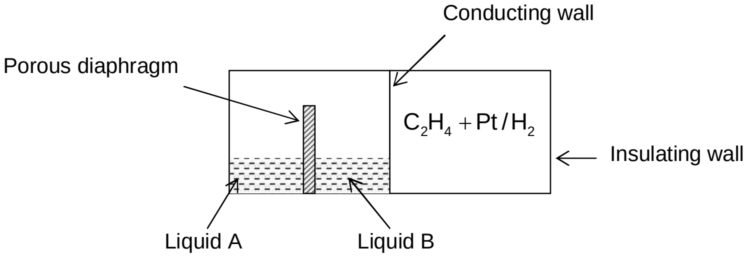
(A) SF_4
(B) XeO_4
(C) XeF_4
(D) ICl_4^-

Space for Rough work

SECTION –C
Integer Answer Type

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1.



In how many cases mixing of liquid (A) and liquid (B) is more effective if liquid (A) is H_2O and liquid (B) can be HCl, CH_3CH_2OH, HNO_3 and CH_3OCH_3

2. The electron in the ground state for a H-atom absorbs a photon of wavelength 97.20 nm and it reaches to maximum level 'n' then when it returns from this level to ground state. Maximum numbers of lines can be obtained in its spectrum?

3. The emf of the cell,
$M(s)|M_nX_n(0.01M) \,||\, M_nX_n(0.1M)/M(s)$ is found to be 0.0295 V at 25°C. If M_nX_n is a soluble salt, find the value of n.

4. How many complexes will show optical but not geometrical isomerism?
$\left[Pt(en)_2Cl_2\right]^{2+}$, $\left[Pt(Py)NH_3ClBr\right]$
$\left[Pt(en)(ox)Cl_2\right]$, $\left[Pt(en)_3\right]^{4+}$

5. 25 ml of 11.2 volume H_2O_2 solution is titrated with 25 ml $KMnO_4/H^+$. If 1L same $KMnO_4$ is used to oxidize 1 mole of an element X so that it is converted into a single species in which 'X' contains a single electron. If this single species is irradiated with light radiation of 114 $\overset{o}{A}$ so that electron is excited into a particular energy level. Determine no. of transitions possible from this energy level to ground state

Space for Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. The minimum value of the function f(x) = $x^{\frac{3}{2}} + x^{\frac{-3}{2}} - 4\left(x + \frac{1}{x}\right)$ for all permissible real x, is

(A) –10	(B) –6
(C) –7	(D) –8

2. The value of the definite integral $\int_{e}^{e^{2010}} \frac{1}{x}\left(1 + \frac{1 - \ln x}{\ln x \ln\left(\frac{x}{\ln x}\right)}\right)dx$, equals

(A) 2009 – ln(2010 – ln 2010)	(B) 2010 – ln(2009 – ln 2009)
(C) 2009 – ln(2010 – ln 2009)	(D) 2010 – ln(2010 – ln 2010)

3. Let z_1, z_2 and z_3 be three points on |z| = 1 and $z_1 + z_2 + z_3 = 0$. If θ_1, θ_2 and θ_3 be the arguments of z_1, z_2, z_3 respectively then $\cos(\theta_1 - \theta_2) + \cos(\theta_2 - \theta_3) + \cos(\theta_3 - \theta_1)$ is equal to

(A) 0	(B) $-\frac{3}{2}$
(C) –1	(D) $\frac{3}{2}$

4. A point (x, y) where function f(x) = [sin [x]] in (0, 2π) is not continuous, is (where [.] denotes greatest integer ≤ x)

(A) (3, 0)	(B) (2, 0)
(C) (1, 0)	(D) (4, –1)

Space for rough work

5. The solution of differential equation $2x^3y\,dy + (1 - y^2)(x^2y^2 + y^2 - 1)\,dx = 0$
(A) $x^2y^2 = (cx + 1)(1 - y^2)$ (B) $x^2y^2 = (cx + 1)(1 + y^2)$
(C) $x^2y^2 = (cx - 1)(1 - y^2)$ (D) None of these

6. Let S be the array of integral points (x, y, z) with x = 0, 1, 2; y = 0, 1, 2, 3 and z = 0, 1, 2, 3, 4. If two points are chosen from S, then the probability that their mid point is in S is
(A) $\frac{4}{59}$ (B) $\frac{2}{59}$
(C) $\frac{52}{177}$ (D) None of these

7. The number of ways in which 15 boys and 2 girls can sit in a row such that between the girls at the most 2 boys sit is
(A) 17! – (12! × 3!) (B) 17! – ($^{12}C_3$ × 3!)
(C) 17! – ($^{12}C_3$ × 15!) (D) 17! – (91 × 2! × 15!)

8. If $\vec{a}$, $\vec{b}$ and $\vec{c}$ are three mutually perpendicular unit vectors and $\vec{d}$ is a unit vector which makes equal angle with $\vec{a}$, $\vec{b}$ and $\vec{c}$, then $|\vec{a} + \vec{b} + \vec{c} + \vec{d}|^2$ is equal to
(A) 4 (B) $4 \pm \sqrt{3}$
(C) $4 \pm 2\sqrt{3}$ (D) None of these

9. The line $\frac{x}{k} = \frac{y}{2} = \frac{z}{-12}$ makes an isosceles triangle with the planes $2x + y + 3z - 1 = 0$ and $x + 2y - 3z - 1 = 0$ then value of k is
(A) 71 (B) –72
(C) 73 (D) 74

10. If $f(x) = 4x^3 - x^2 - 2x + 1$ and $g(x) = \begin{cases} \text{Min}\{f(t) : 0 \le t \le x\} & ; 0 \le x \le 1 \\ 3 - x & ; 1 < x \le 2 \end{cases}$ then
$g\left(\frac{1}{4}\right) + g\left(\frac{3}{4}\right) + g\left(\frac{5}{4}\right)$ has the value equal to
(A) $\frac{7}{4}$ (B) $\frac{9}{4}$
(C) $\frac{13}{4}$ (D) $\frac{5}{2}$

Space for rough work

Multiple Correct Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

11. The circles $x^2 + y^2 - 4x - 81 = 0$, $x^2 + y^2 + 24x - 81 = 0$ intersect each other at points A and B. A line through point A meet one circle at P and a parallel line through B meet the other circle at Q. Then the locus of the mid point of PQ is
(A) $(x + 5)^2 + (y + 0)^2 = 25$
(B) $(x - 5)^2 + (y - 0)^2 = 25$
(C) $x^2 + y^2 + 10x = 0$
(D) $x^2 + y^2 - 10x = 0$

12. Let S be the set of real values of parameter λ for which the equation $f(x) = 2x^3 - 3(2 + \lambda)x^2 + 12\lambda x$ has exactly one local maximum and exactly one local minimum. Then S is a subset of
(A) $(-4, \infty)$
(B) $(-3, 3)$
(C) $(3, \infty)$
(D) $(-\infty, 0)$

13. A and B are the points (2, 0) and (0, 2) respectively. The coordinates of the point P on the line $2x + 3y + 1 = 0$ is/are
(A) $(7, -5)$ if $|PA - PB|$ is maximum
(B) $\left(-\frac{1}{5}, -\frac{1}{5}\right)$ if $|PA - PB|$ is maximum
(C) $(7, -5)$ if $|PA - PB|$ is minimum
(D) $\left(-\frac{1}{5}, -\frac{1}{5}\right)$ if $|PA - PB|$ is minimum

14. If $x^2 - 3x + 2$ be a factor of the expression $x^4 - px^2 + q$, then
(A) roots of equation $x^4 - px^2 + q = 0$ are $\pm 1, \pm 2$
(B) roots of equation $x^4 - px^2 + q = 0$ are $1, 2, a + ib, a - ib$ (a, b R $b \neq 0$)
(C) value of p is 5
(D) value of q is 4

15. If $f(x) = ae^{2x} + be^x + cx$ satisfies the condition $f(0) = -1$, $f'(\log 2) = 31$ and $\int_0^{\ell n\, 4} (f(x) - cx)\, dx = \frac{39}{2}$, then
(A) $a = 5$
(B) $b = -6$
(C) $c = 2$
(D) $a = 3$

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive)

1. A straight line passing through origin O meets the lines 4x + 2y = 3 and 2x + y + 6 = 0 at the points P and Q respectively, then the point O divides the segment PQ in the ratio 1 : k then k is equal to _____

2. The number of real solutions of $\cos^{-1}x + \cos^{-1}2x = -\pi$ is _____

3. If trace (A) > 0 and abc = 1 where $A = \begin{bmatrix} a & b & c \\ b & c & a \\ c & a & b \end{bmatrix}$ and AA′ = I, then the value of $a^3 + b^3 + c^3$ is _____

4. Let f: $[0, \infty) \to R$ be a continuous strictly increasing function such that $f^3(x) = \int_0^x t f^2(t)\,dt\ \forall x \geq 0$ then value of f(6) is _____

5. The hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ passes through the point of intersection of the lines $x - 3\sqrt{5}\,y = 0$ and $\sqrt{5}\,x - 2y = 13$ and the length of its latus rectum is 4/3 units. Then the value of $9e^2 - 1$ where e is the eccentricity of the hyperbola is _____

Space for rough work

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ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

CRT –II
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	A	A
2.	A	D	A
3.	B	D	B
4.	D	A	D
5.	A	C	C
6.	A	A	C
7.	B	A	D
8.	C	A	C
9.	C	A	D
10.	A	C	D
11.	A,B	B, D	A, C
12.	B,D	B, C	C, D
13.	C,D	A, B, C, D	A, D
14.	A,B,C	A, B, C	A, C, D
15.	A,B,D	C, D	A, B
1.	2	1	4
2.	6	3	0
3.	5	2	4
4.	2	1	6
5.	6	3	9

Physics

PART – I

SECTION – A

1. Optical path length of ray entering through S_1

$$x_1 = \int_0^L \mu dx = L + \frac{aL^2}{2}$$

Path difference of ray from S_1 and $S_2 = \Delta x = \frac{aL^2}{2}$

For minima at O

$$\frac{aL^2}{2} = \frac{\lambda}{2}$$

2. Fundamental frequency $f_0 = \frac{v}{2L}$

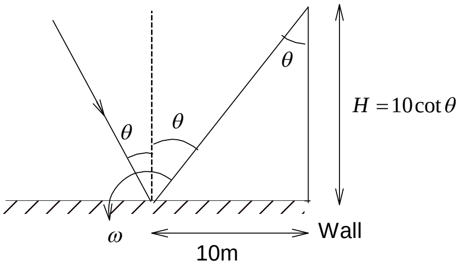
Beat frequency = $f_1 - f_2$

$$= \frac{v}{2\left(\frac{L}{2} - \Delta L\right)} - \frac{v}{2\left(\frac{L}{2} + \Delta L\right)}$$

$$= \frac{v}{2}\left[\frac{2}{(L - 2\Delta L)} - \frac{2}{(L + 2\Delta L)}\right]$$

$$= 2f_0 L\left[\frac{4\Delta L}{L^2 - 4\Delta L^2}\right] \approx \frac{8f_0 \Delta L}{l}$$

3. When mirror rotates, by ω, reflected ray rotates by $2\omega = 36$ rad/s.



speed of spot = $\frac{dH}{dt} = \frac{d[10\cot\theta]}{dt}$

$$= \left[-10\,\text{cosec}^2\theta \frac{d\theta}{dt}\right]$$

$$= \left[\frac{-10}{(0.6)^2} \times 36\right]$$

= 1000 m/s

4. Energy of nth state in H-atom is same as energy if 3nth state in Li^{++}.

5. $v = 2f_0 (l_2 - l_1)$

$$\left(\frac{\Delta v}{v}\right)_{max} = \frac{\Delta f_0}{f_0} + \frac{\Delta l_2 + \Delta l_1}{l_2 - l_1}$$

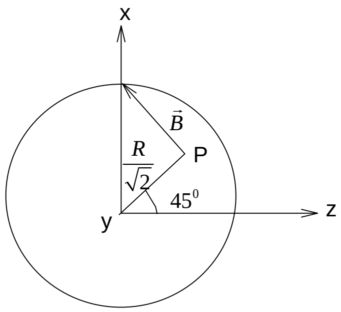
$$= \frac{1}{100} + \frac{0.1 + 0.1}{74 - 24}$$

$$= 1.2\%$$

6. Magnitude of field at Point $P\left(\frac{R}{2}, y, \frac{R}{2}\right)$ is

$$B = \frac{\mu_0 Ir}{2} = \frac{\mu_0 I}{2\pi R^2} \times \frac{R}{\sqrt{2}} = \frac{\mu_0 I}{2\sqrt{2}\pi R}$$

Unit vector in the direction of field, $\hat{B} = \frac{\hat{i} - \hat{k}}{\sqrt{2}}$



7. $i = \frac{10}{10} = 1A$; $V = iR = 1 \times 4 = 4V$

8. $\left(2 - \frac{6}{8} \times 2\right) = \left(\frac{12}{8+16}\right) 4x \Rightarrow$ x = 25 cm.

9. Ammeter and 0.9 Ω is in series

$10 \times 10^{-3}(9.9) = i \times 0.1 =$ $i = 0.99$

So current = 0.99 + 0.01 = 1 Amp.

Chemistry

PART – II

SECTION – A

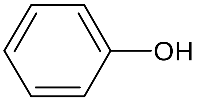
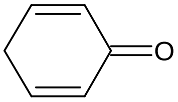
1. VBT and MOT both consider wave nature of e^-.

2. H_3PO_4 can act as a dehydrating agent.

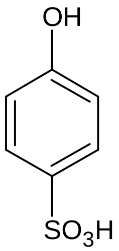
4. Hydrocarbon part is hydrophobic part

5. $\left[Cr(H_2O)_6\right]^{3+}$ has maximum CFSE

6. $\upsilon = \dfrac{v}{2\pi r}$ and both v and r can be determined by Bohr's theory .

7.  is aromatic hence ΔG_f of  is maximum in acidic medium.

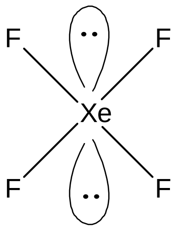
8. $RX \xrightarrow{LiAlH_4} Alkene$

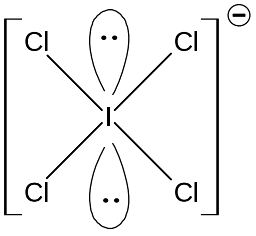
9.  is major at high T, at high temperature para hydrogen convert into ortho hydrogen.

10. $\left[Cu(NH_3)_4\right]^{2+}$ has square planar shape

12. (C) : $[Cr(NH_3)_5Cl]NO_2$
: $[Cr(NH_3)_5NO_2]Cl$
: $[Cr(NH_3)_5ONO]Cl$

15.





SECTION –C

1. In H_2O and CH_3CH_2OH mixing shows +ve deviation while in other cases it shows –ve deviation.

2. Electron will reach n = 4, so the maximum possible transitions for single electron are 4 → 3, 3 → 2, 2 → 1.

3. $$nM \longrightarrow M^{n^+}_{n_A} + ne^- \qquad (\text{at anode})$$
$$M^{n^+}_{n_c} + ne^- \longrightarrow 2M \qquad (\text{at cathode})$$
Net all reaction: $M^{n^+}_{n_c} \longrightarrow M^{n^+}_{n_A}$
$$\therefore 0.0295 = \frac{0.059}{n}\log\frac{\left[M^{n^+}_{n_C}\right]}{\left[M^{n^+}_{n_A}\right]}$$
$\therefore$ n = 2

4. $\left[Pt(en)_3\right]^{4+}$ is optically active but does not show geometrical isomerism.

5. $$\underset{(H_2O_2)}{N_1V_1} = \underset{KMnO_4/H^+}{N_2V_2}$$
2 x 25 = N x 25

N = 2

Again $\underset{KMnO_4/H^+}{N_1V_1}$ = gm eq. of (X)

$\therefore$ 2 x 1 = gm eq. of (X)

and n factor of x = 2

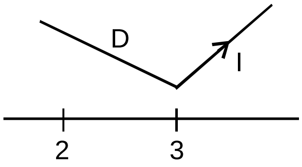
Since X is converted into single e species Hence X is Li^{2+} and light radiation of 114 $\overset{o}{A}$ corresponds to 108.77 eV.

$\therefore$ e is excited into 3rd energy level and total 3 transitions are possible.

Mathematics

PART – III

SECTION – A



1. $f(x) = x^{\frac{3}{2}} + x^{\frac{-3}{2}} - 4\left(x + \frac{1}{x}\right)$

$f(x) = \left(\sqrt{x} + \frac{1}{\sqrt{x}}\right)^3 - 3\left(\sqrt{x} + \frac{1}{\sqrt{x}}\right) - 4\left[\left(\sqrt{x} + \frac{1}{\sqrt{x}}\right)^2 - 2\right]$

Let $\sqrt{x} + \frac{1}{\sqrt{x}} = t$ (x > 0)

Let $g(t) = t^3 - 3t - 4t^2 + 8$

Now $g(t) = t^3 - 4t^2 - 3t + 8$ where $t \in [2, \infty)$

$g'(t) = 3t^2 - 8t - 3 = (t - 3)(3t + 1)$; $g'(t) = 0 \Rightarrow t = 3$ ($t \neq -1/3$)

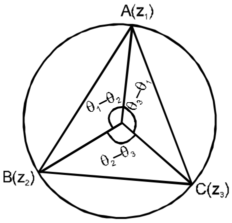
$g''(t) = 6t - 8$

$g''(3) = 10 > 0 \Rightarrow g(3)$ is minimum

$g(3) = 27 - 9 - 36 + 8 = -10$

2. Substituting lnx = t, we get $\int_1^{2010} \left(1 + \frac{1-t}{t(t-(\ln t))}\right)dt = 2009 + \int_1^{2010-\ln 2010} \frac{-1}{u}du$ ($u = t - \ln t$)

$= 2009 - \ln(2010 - \ln 2010)$



3. Since, $|z_1| = |z_2| = |z_3| = 1$ and $z_1 + z_2 + z_3 = 0$

∴ Triangle ABC is an equilateral triangle

$\therefore \theta_1 - \theta_2 = \theta_2 - \theta_3 = \theta_3 - \theta_1 = \frac{2\pi}{3}$

$\therefore \cos(\theta_1 - \theta_2) + \cos(\theta_2 - \theta_3) + \cos(\theta_3 - \theta_1) = -\frac{3}{2}$

4. In $(0, 2\pi)$ check for 1, 2, 3, 4, 5, 6 function is not continuous for 4

Hence, (x, y) is (4, –1)

5 $2x^3ydy + (1 - y^2)(x^2y^2 + y^2 - 1)\,dx = 0$, Let $1 - y^2 = t \Rightarrow 2y\,dy = -dt$

$-x^3\,dt + t(x^2(1 - t) - t)\,dx = 0 \Rightarrow -x^3dt + tx^2dx - t^2x^2dx - t^2dx = 0$

$x^2(t\,dx - x\,dt) = t^2(x^2 + 1)\,dx \Rightarrow \frac{tdx - xdt}{t^2} = \left(\frac{x^2+1}{x^2}\right)dx \Rightarrow d\left(\frac{x}{t}\right) = \left(1 + \frac{1}{x^2}\right)dx$

Integrate $\frac{x}{t} = x - \frac{1}{x} + c \Rightarrow x = \frac{x^2-1}{x}(1-y^2) + c(1-y^2)$

$x^2 = (x^2 - 1)(1 - y^2) + xc(1 - y^2) \Rightarrow 0 = -x^2y^2 - 1 + y^2 + xc - xcy^2$

$\Rightarrow x^2y^2 = (cx - 1)(1 - y^2)$

6. Total number of coordinates in S = 3 × 4 × 5 = 60

∴ Total no. of way of selecting two points = ${}^{60}C_2$

Now the selection of (x_1, y_1, z_1) and (x_2, y_2, z_2) should be in such a way that

$x_1 + x_2$, $y_1 + y_2$ and $z_1 + z_2$ are even

Now x_1, x_2, may be

∴ Favourable points = 5 × 8 × 13 = 520

$\therefore$ Probability = $\frac{520}{30 \times 59} = \frac{52}{177}$

7. Number of ways = total – those in which at least three boys between the girls = $\underline{|17} - a$

Now, x G_1 y G_2 z
$x + y + z = 15$
Min x = 0 max x = 12
Min y = 3 max y = 15
Min z = 0 max z = 12
Total solution = coefficient of x^{15} in $(x^0 + \ldots.. x^{12})(x^3 + x^4 + \ldots.. + x^{15})(x^0 + \ldots.. + x^{12})$

$$= \ldots..\ x^{12} \text{ in } (1 + x + \ldots..\ x^{12})^3 = \ldots..\ x^{12} \text{ in } \left(\frac{1-x^{13}}{1-x}\right)^3 = \ldots..\ x^{12} \text{ in } (1-x^{13})^3(1-x)^{-3}$$

$$= {}^{12+3-1}C_2 = {}^{14}C_2$$

$\therefore\ a = {}^{14}C_2 \times \underline{|2} \times \underline{|15}$ ways = $\underline{|17} - 91 \times \underline{|2}\ \underline{|15}$

8. Let $\vec{d}$ makes angle α from $\vec{a}, \vec{b}$ and $\vec{c}$ then $\cos^2\alpha + \cos^2\alpha + \cos^2\alpha = 1$

($\because\ \vec{a}, \vec{b}, \vec{c}$ mutually perpendicular)

$$\Rightarrow \cos\alpha = \pm\frac{1}{\sqrt{3}}$$

$$|\vec{a}+\vec{b}+\vec{c}+\vec{d}|^2 = |\vec{a}|^2 + |\vec{b}|^2 + |\vec{c}|^2 + |\vec{d}|^2 + 2(\vec{a}\cdot\vec{b} + \vec{a}\cdot\vec{c} + \vec{a}\cdot\vec{d} + \vec{b}\cdot\vec{c} + \vec{b}\cdot\vec{d} + \vec{c}\cdot\vec{d})$$

$$= 1 + 1 + 1 + 1 + 2\,(0 + 0 + \cos\alpha + 0 + \cos\alpha + \cos\alpha) = 4 + 6\cos\alpha = 4 \pm 2\sqrt{3}$$

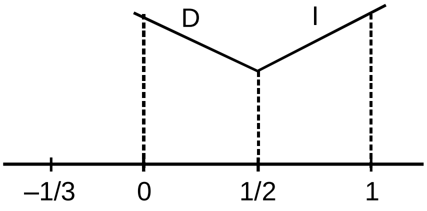
9. The line makes equal angle with planes hence with normal

i.e. $\dfrac{\vec{a}\cdot\vec{n}_1}{|\vec{a}||\vec{n}_1|} = \dfrac{\vec{a}\cdot\vec{n}_2}{|\vec{a}||\vec{n}_2|}$

$$\vec{a} = k\hat{i} + 2\hat{j} - 12\hat{k},\ \vec{n}_1 = 2\hat{i} + \hat{j} + 3\hat{k},\ \vec{n}_2 = \hat{i} + 2\hat{j} - 3\hat{k}$$

$$\frac{2k + 2 - 36}{\sqrt{14}} = \frac{k + 4 + 36}{\sqrt{14}} \Rightarrow k = 74$$

10. $f'(x) = 12x^2 - 2x - 2$
$= 2[6x^2 - x - 1]$
$= 2(3x + 1)(2x - 1)$



11. $S_1: x^2 + y^2 - 4x - 81 = 0$ $\quad$ $S_2: x^2 + y^2 + 24x - 81 = 0$
$S_1 - S_2 = 0$ $\quad$ $28x = 0$
x = 0 equation of AB $\quad$ Now let A ≡ (0, a) ∴ A is on x = 0
Now put A in S_1 or S_2 $\quad$ $0 + a^2 + 0 - 81 = 0$
a = ± 9 $\quad$ A = (0, 9), B = (0, –9)
Now PA, $y - 9 = mx \Rightarrow y = mx + 9$ $\quad$ $\Rightarrow$ BQ, $y + 9 = mx \Rightarrow y = mx - 9$
Now let $P(x_1, y_1)$ and $Q(x_2, y_2)$

Now solve S_1 and PA then $x_1 = \dfrac{-18m - 24}{m^2 + 1}$ and $y_1 = \dfrac{-9m^2 - 24m + 9}{m^2 + 1}$

Now solve S_2 and BQ then $x_2 = \dfrac{18m + 4}{m^2 + 1}$ and $y_2 = \dfrac{9m^2 + 4m - 9}{m^2 + 1}$

Let mid pt of PQ is (h, k) then $x_1 + x_2 = 2h$ and $y_1 + y_2 = 2k$

$$x_1 + x_2 = \frac{-20}{m^2 + 1} = 2h$$

$\frac{h}{k} = \frac{1}{m}$

$y_1 + y_2 = \frac{-20m}{m^2+1} = 2k \Rightarrow \frac{-20}{\left(\frac{k}{h}\right)^2 + 1} = 2h$

$h(h^2 + k^2 + 10h) = 0$

12. For one local max and min $f'(x) = 0$ will have two real and unequal roots
$f'(x) = 6x^2 - 6(2 + \lambda)x + 12\lambda \Rightarrow D = (2 + \lambda)^2 - 8\lambda > 0 \Rightarrow (\lambda - 2)^2 > 0 \Rightarrow \lambda \in R - \{2\}$

13 P lies on the line $2x + 3y + 1 = 0$ ….. (1)
|PA – PB| is maximum if P, A, B are collinear.
Equation of the line AB is $x + y = 2$ ….. (2)
P is the point of intersection of (1) and (2) which is (7, – 5)
Equation of perpendicular bisector of AB is
$y = x$ ….. (3)
For minimum value of |PA – PB|, P is the point of intersection of (1) and (3) which is $\left(-\frac{1}{5}, -\frac{1}{5}\right)$

14. Since $x^2 - 3x + 2$ is factors of $x^4 - px^2 + q$, then roots of $x^2 - 3x + 2 = 0$
i.e. 2, 1 are also roots of $x^4 - px^2 + q = 0$
but if a is roots of $x^4 - px^2 + q = 0$, then –a is also
roots of $x^4 - px^2 + q = 0$ are ±1, ±2
and $1 - p + q = 0$ and $16 - 4p + q = 0$, p = 5 and q = 4

15. $f(x) = ae^{2x} + be^x + cx$
Since $f(0) = a + b$ i.e. $a + b = -1$ ….. (1)
$f'(x) = 2ae^{2x} + be^x + c$
$\therefore f'(\log 2) = 2ae^{2\log 2} + be^{\log 2} + c$
$= 8a + 2b + c = 8a + 2b + c = 31$ ….. (2)

$$\int_0^{\ell n 4} (ae^{2x} + e^x + cx - cx)\, dx = \int_0^{\ell n 4} (ae^{2x} + be^x)\, dx$$

$$= \left(\frac{ae^{2x}}{2} + be^x\right)\Bigg|_0^{\log 4} = \frac{a\, e^{2\ell n 4}}{2} + be^{\ell n 4} - \frac{a}{2} - b = 8a + 4b - \frac{a}{2} - b = \frac{15a}{2} + 3b = \frac{39}{2}$$

i.e. $15a + 6b = 39$ ….. (3)
From (1), (2) and (3) we get $9a = 45$
$\therefore$ a = 5, b = – 6 and c = 3

SECTION – C

1. Straight line from Origin is $y = mx$

$4x + 2y = 3$, $y = mx$, $x_1 = \frac{3}{(2m+4)}$, $y_1 = \frac{3m}{(2m+4)}$

$2x + y + 6 = 0$, $y = mx$, $x_2 = \frac{-6}{(m+2)}$, $y_2 = \frac{-6m}{(m+2)}$

$$O = \frac{\frac{-6m}{(m+2)} + \frac{3mk}{2(m+2)}}{k+1} \Rightarrow O = \frac{\frac{-6}{m+2} + \frac{3k}{2(m+2)}}{k+1} = \frac{-6 + \frac{3k}{2}}{k+1} = 0 \Rightarrow \frac{3}{2}k = 6,\ k = \frac{12}{3} = 4$$

2. $\cos^{-1} x + \cos^{-1} 2x = -\pi$, $\cos^{-1} x \in [0, \pi]$
$\cos^{-1} x + \cos^{-1} 2x = -\pi \Rightarrow$ no solution

3. abc = 1, trace A = a + b + c > 0

$$I = \begin{bmatrix} a & b & c \\ b & c & a \\ c & a & b \end{bmatrix}\begin{bmatrix} a & b & c \\ b & c & a \\ c & a & b \end{bmatrix} = \begin{bmatrix} a^2+b^2+c^2 & ab+bc+ca & ac+ab+bc \\ ab+bc+ca & b^2+c^2+a^2 & bc+ca+ab \\ ca+ab+bc & bc+ca+ab & c^2+a^2+b^2 \end{bmatrix}$$

$\therefore\ a^2 + b^2 + c^2 = 1,\ ab + bc + ca = 0$
$(a + b + c)^2 = a^2 + b^2 + c^2 + 2(ab + bc + ca) = 1$
$\therefore\ a + b + c = 1$
$\therefore\ a^3 + b^3 + c^3 = 3abc + (a + b + c)(a^2 + b^2 + c^2 - ab - bc - ca) = 3 + 1(1 - 0) = 4$

4. $f^3(x) = \int_0^x t \cdot f^2(t)dt$ ….. (1)

Differentiate with respect to x

$3f^2(x) \cdot f'(x) = x \cdot f^2(x) \Rightarrow f'(x) = \frac{x}{3}$

$\Rightarrow f(x) = \frac{x^2}{6} + C$ ….. (2)

But from (1) $f^3(0) = 0 \Rightarrow f(0) = 0$

$\therefore$ From (2) C = 0 $\therefore\ f(x) = \frac{x^2}{6} \Rightarrow f(6) = \frac{6^2}{6} = 6$

5. The line $x - 3\sqrt{5}\,y = 0$ and $\sqrt{5}\,x - 2y = 13$ intersect at the point. Since the given hyperbola passes through this point,

$\frac{(3\sqrt{5})^2}{a^2}\ \frac{1}{b^2} = 1$ or $\frac{45}{a^2} - \frac{1}{b^2} = 1$ ….. (1)

Also length of the latus rectum = $\frac{2b^2}{a} = \frac{4}{3}$ (given) ….. (2)

From (1) and (2) we get $\frac{45}{a^2} - \frac{3}{2a} = 1$

$\Rightarrow a = 6$ or $-\frac{15}{2}$

$\Rightarrow a > 0$ therefore we have a = 6

$\Rightarrow b^2 = 4$

$\therefore\ e^2 = \frac{10}{9}$ hence $9e^2 - 1 = 10 - 1 = 9$

FIITJEE **JEE (Advanced), 2015**

CONCEPT RECAPITULATION TEST - II

Paper 2

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

ALL INDIA TEST SERIES

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 08)** contains 8 multiple choice questions which have one or more than one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 to 16) contains 4 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (17 – 20) contains 4 Matching Lists Type questions: Each question has four statements in LIST I & 4 statements in LIST II. The codes for lists have choices (A), (B), (C), (D) out of which only one is correct. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

SECTION – A

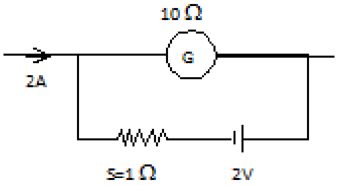
Multi Correct Choice Type

This section contains **8 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** are correct.

1. Suppose the potential energy between electron and proton at a distance r is given by $\frac{-ke^2}{3r^3}$. Application of Bohr's theory to hydrogen atom in this case shows that
(A) Energy in the nth orbit is proportional to n^6
(B) Energy is proportional to $m^{-3}.(m: \text{mass of electron})$
(C) Energy of the nth orbit is proportional to n^{-2}
(D) Energy is proportional to m^3 (m = mass of electron)

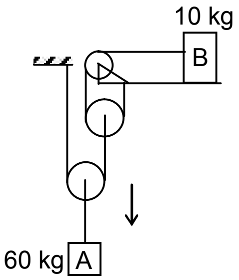
2. During an experiment an ideal gas is found to obey a condition $\frac{P^2}{\rho}$ = constant (ρ = density of gas). The gas is initially at temperature T_0, pressure P_0 and density ρ_0. The gas expands such that density changes to $\frac{\rho_0}{2}$. Then which of the following is/are correct:
(A) The pressure of the gas changes to $\sqrt{2}P_0$
(B) The temperature of the gas changes to $\sqrt{2}T_0$
(C) The graph of the above process on the P – T diagram is parabola.
(D) The graph of the above process on the P – T diagram is hyperbola.

3. The galvanometer shown in the figure has resistance 10Ω. It is shunted by a series combination of a resistance S = 1Ω and an ideal cell of emf 2V. A current 2A passes as shown. Then choose the correct statement(s).
(A) The reading of the galvanometer is 1A
(B) The reading of the galvanometer is zero
(C) The potential difference across the resistance S is 1.5 V
(D) The potential difference across the resistance S is 2V

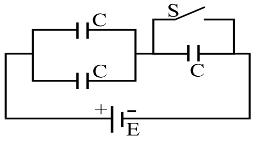


Space for Rough work

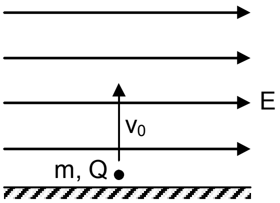
4. Figure shows two blocks A and B connected to an ideal pulley string system. In this system when bodies are released then:
(A) Acceleration of block A is 1 m/s^2
(B) Acceleration of block B is 2 m/s^2
(C) Tension in string connected to block B is 40 N
(D) Tension in string connected to block B is 80 N



5. In the circuit shown, each capacitor has a capacitance C. The emf of the cell is E. If the switch S is closed
(A) positive charge will flow out of the positive terminal of the cell
(B) positive charge will enter the positive terminal of the cell
(C) The amount of charge flowing through the cell will be CE.
(D) The amount of charge flowing through the cell will be 4/3 CE.



6. A point-like body of mass m and of charge Q is initially at rest on the horizontal tabletop as shown in the figure and is given a v_0 vertical, upward speed. There is a horizontal electric field E. Acceleration due to gravity = g.



(A) Maximum height attained $= \dfrac{v_0^2}{2g}$

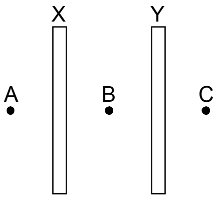
(B) Particle will collide with the table at horizontal distance $\dfrac{2QEv_0^2}{mg^2}$

(C) At the highest point acceleration will be only in horizontal direction.

(D) Particle will collide with the table at an angle $\tan\theta = \dfrac{mg}{2QE}$ with horizontal.

Space for Rough work

7. X and Y are large parallel conducting plates close to each other. Each face has an area A. X is given a charge Q, Y is without any charge. Point A, B and C are shown.



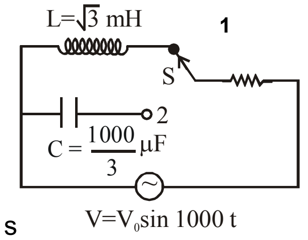
(A) Electric field at B is $\dfrac{Q}{2\varepsilon_0 A}$

(B) Electric field at B is $\dfrac{Q}{\varepsilon_0 A}$

(C) The fields at A, B and C are of same magnitude

(D) The fields at A and C are in opposite direction.

8. In the given AC circuit, when switch S is at position 1, the source emf leads current by $\frac{\pi}{6}$. Now, if the switch is at position 2, then



(A) current leads source emf by $\frac{\pi}{4}$

(B) current leads source emf by $\frac{\pi}{3}$

(C) source emf leads current by $\frac{\pi}{4}$

(D) source emf leads current by $\frac{\pi}{3}$

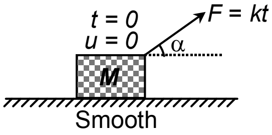
Space for Rough work

Comprehension Type

This section contains **4 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

Paragraph for Questions 09 & 10

A block of mass *M* is kept on a smooth horizontal floor. A variable force *F* = *kt* is acting on the block at an angle of α with the horizontal. At initial moment the block is at rest (the situation shown in the figure below). The block leaves the contact with floor at time $t = t_0$



9. The value of t_0 is

(A) $\frac{Mg}{k\cos\alpha}$ (B) $\frac{Mg}{k\sin\alpha}$

(C) $\frac{Mg\tan\alpha}{k}$ (D) $\frac{Mg\cot\alpha}{k}$

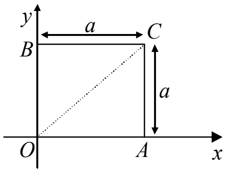
10. The displacement of the block till time $t = t_0$ is

(A) $\frac{M^2g^3\cot\alpha\,\mathrm{cosec}^2\alpha}{6k^2}$ (B) $\frac{M^2g^3\cot\alpha\,\mathrm{cosec}^2\alpha}{2k^2}$

(C) $\frac{M^2g^3\tan\alpha\,\sec^2\alpha}{6k^2}$ (D) $\frac{M^2g^3\tan\alpha\,\sec^2\alpha}{2k^2}$

Paragraph for Questions 11 & 12

A force acting on a particle depends on the particles position in the x-y plane. This force is given by the expression $\overline{F} = x^2y^2\hat{i} + x^2y^2\hat{j}(N)$. The particle is moved in the x-y plane along various paths as shown in the figure.



11. Work done by the force along the path *OAC* is

(A) $\frac{a^5}{3}$J (B) $\frac{a^4}{9}$J

(C) $\frac{2a^5}{5}$J (D) zero

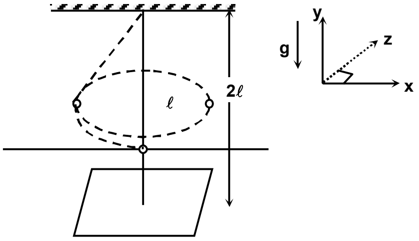
12. Work done by the force along the path *OC* is

(A) $\frac{a^5}{3}$J (B) $\frac{3a^5}{8}$J

(C) $\frac{2a^5}{5}$J (D) $-\frac{a^5}{3}$J

Space for Rough work

Paragraph for Questions 13 & 14



A pendulum bob has mass m. The length of pendulum is ℓ. It is initially at rest. A particle P of mass m/2 moving horizontally along –ve x-direction with velocity $\sqrt{2g\ell}$ collides with the bob and comes to rest. When the bob comes to rest momentarily, another particle Q of mass m moving horizontally along z-direction collides with the bob and sticks to it. It is observed that the bob now moves along a horizontal circle. The floor is a horizontal surface at a distance 2ℓ below the point of suspension of the pendulum.

13. Tension in string immediately after the first collision is

(A)2mg	(B)mg
(C) $\frac{3}{2}$ mg	(D) $\frac{5}{2}$ mg

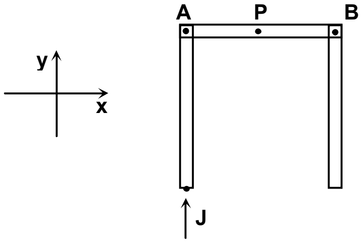
14. The height of circular path above the floor is

(A) $\frac{3\ell}{2}$	(B) $\frac{4\ell}{3}$
(C) $\frac{5\ell}{4}$	(D) data not sufficient

Space for Rough work

Paragraph for Questions 15 & 16

A uniform wire frame of linear mass density λ having three sides each of length 2a is kept on a smooth horizontal surface. An impulse J is applied at one end as shown in the figure. P is the midpoint of AB. Now answer the following question.



15. The angular velocity of system just after the impulse

(A) $\frac{3J}{22\lambda a^2}$
(B) $\frac{J}{22\lambda a^2}$
(C) $\frac{2J}{22\lambda a^2}$
(D) $\frac{4J}{22\lambda a^2}$

16. The velocity of point P just after the impulse is

(A) $\frac{J}{\lambda a}\hat{j}$
(B) $\frac{J}{6\lambda a}\hat{j}$
(C) $\frac{J}{\lambda a}\left(\frac{2}{11}\hat{i}+\frac{1}{6}\hat{j}\right)$
(D) $\frac{J}{\lambda a}\left(\frac{1}{11}\hat{i}+\frac{1}{6}\hat{j}\right)$

Space for Rough work

(Match list Type)

This section contains **4 multiple choice questions.** Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

17. In L – C – R series circuit suppose ω_r is the resonance frequency, then match the following table

	List-I		**List-II**
(P)	If $\omega > \omega_r$	1.	Current will lead the voltage
(Q)	If $\omega = \omega_r$	2.	Voltage will lead the current
(R)	If $\omega = 2\omega_r$	3.	$X_L = 2X_C$
(S)	If $\omega < \omega_r$	4.	Current and voltage are in phase

Codes:

	P	Q	R	S
(A)	4	2	1	3
(B)	2	4	2	1
(C)	1	2	3	4
(D)	2	4	3	1

18. A ray of light falls normally on an equilateral prism of refractive index $\mu = \sqrt{3}$. Match the following table :

i_1 = Angle of incidence
i_2 = Angle of emergence from second surface of prism
r_1 = Angle of refraction at the first surface of prism
r_2 = Angle of incidence at second surface of prism

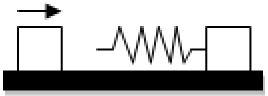
	List-I		**List-II**
(P)	Angle i_1	1.	0°
(Q)	Angle r_1	2.	90°
(R)	Angle i_2	3.	60°
(S)	Angle r_2	4.	None

Codes:

	P	Q	R	S
(A)	4	2	1	3
(B)	2	3	4	1
(C)	1	2	3	4
(D)	1	1	4	3

Space for Rough work

19. In the arrangement shown in fig. match the following:

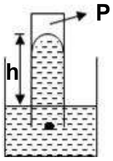


	List-I		List-II
(P)	Velocity of centre of mass	1.	2 SI unit
(Q)	Velocity of combined mass when compression in the spring is maximum	2.	1 SI unit
(R)	Maximum compression in the spring	3.	4 SI unit
(S)	Maximum potential energy stored in the spring	4.	0.5 SI unit

Codes:

	P	Q	R	S
(A)	4	2	1	3
(B)	2	3	4	1
(C)	2	2	2	1
(D)	1	2	2	1

20. A tube is inverted in a mercury vessel as shown in fig. P is the pressure inside the tube above the mercury level as shown.



	List-I		List-II
(P)	If P is increased, then height h	1.	Increase
(Q)	If P is increased, then pressure at O	2.	Decreases
(R)	If P is increased, then pressure at 1 cm above O	3.	Remains same
(S)	If the vessel is moved upwards with acceleration (a<g), then height h	4.	Increase or decreases depending on the size of the tube

Codes:

	P	Q	R	S
(A)	4	2	1	3
(B)	2	3	3	2
(C)	1	2	3	4
(D)	2	4	3	1

Space for Rough work

Chemistry

PART – II

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE** or **MORE** than is/are correct.

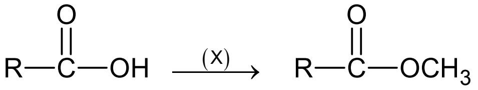
1. Select pair(s) in which both produces same coloured ppt. with CrO_4^{2-} ion

(A) Ba^{2+}, Sr^{2+}
(B) Pb^{2+}, Ba^{2+}
(C) Ag^{+}, Ba^{2+}
(D) Ag^{+}, Hg_2^{2+}

2. Which of the following property (s) is/are related to solution of rosy red complex of Ni^{2+} and dimethyl glyoximate ligand?

(A) Geometry around Ni is square planar and diamagnetic in nature
(B) Complex is stabilized by internal hydrogen bonding
(C) it is an organometallic complex
(D) Five member chelate ring is formed when each molecule of dimethyl glyoximate is bonded with metal ion.

3. In the given reaction



$$R-\overset{\overset{\displaystyle O}{||}}{C}-OH \xrightarrow{(X)} R-\overset{\overset{\displaystyle O}{||}}{C}-OCH_3$$

X will be

(A) CH_2N_2
(B) CH_3OH/H^{+}
(C) MeCOOH
(D) Me_2SO_4

4. In a cell, Zn(s) | Zn^{2+} ||H^{+} | H_2 (pt)
the addition of H_2SO_4 to the cathode compartment will

(A) Decrease E
(B) Increase E
(C) Shift equilibrium to left
(D) Shift equilibrium to right

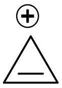
Space for Rough work

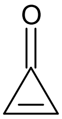
5. Select the correct staement (s) among the following
(A) Increase in concentration of reactant increases the rate of zero order reaction
(B) Rate constant K is equal to collision frequency A, if $E_a = 0$
(C) Rate constant K is equal to collision frequency A if $E_a = \infty$
(D) Graph of $\log_{10}K$ vs 1/T is straightline

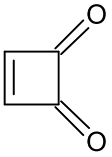
6. Self reduction is not used in the extraction of
(A) Lead
(B) Manganese
(C) Copper
(D) Iron

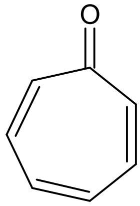
7. The Cl_2 evolve at anode during electrolysis of fused $MgCl_2$ which produces 13 g Mg. (Atomic mass of Mg = 24.3) is
(A) 11.98 lit
(B) 0.535 mole
(C) 37.98 gm
(D) 1.068 mole

8. Which are aromatic compounds?

(A)


(B)


(C)


(D)


Space for Rough work

Comprehension Type

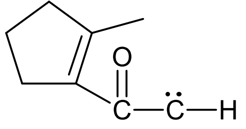
This section contains **4 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

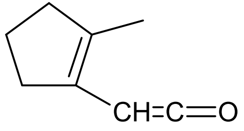
Paragraph for Question Nos. 9 to 10

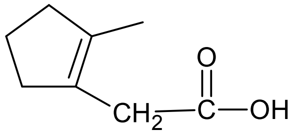
An organic compound (X) is subjected to reductive ozonolysis to give a product (A) which on heating with dil. NaOH gives another product (B). Compound (B) on heating with sodium hypoiodite followed by acidification produces (C). Compound (C) on treatment with $SOCl_2$ and then with diazomethane followed by hydrolysis gives a product which on heating gives 1, 2-dimethyl cyclopentene.
Now answer the following questions.

9. Organic compound (X) in the above passage is:
(A) 1,2-dimethyl cyclopentene
(B) 1,2-dimethyl hexene
(C) 1,2-dimethyl cyclohexene
(D) 2,5-dimethyl-3-hexene.

10. Intermediate species formed in the reaction of (C) with $SOCl_2/CH_2N_2/H_2O/\Delta$ is:

(A) 

(B) 

(C) 

(D) All of these

Space for Rough work

Paragraph for Question Nos. 11 to 12

$$\begin{tikzcd}
\text{A} \arrow[r, "N_2", "\text{Burn}"'] & \text{B} \arrow[r, "H_2O"] & \text{C} + \text{D(gas)} \arrow[d, "CO_2"] \\
 & & \text{Milkyness(E)}
\end{tikzcd}$$

$ACl_X \longrightarrow$ green colour in flame.

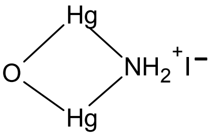
11. What is “A”?

(A) Ca (B) Mg
(C) Ba (D) None

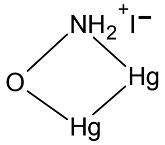
12. $KI(\text{excess}) + HgI_2 \longrightarrow F \xrightarrow[KOH]{D} G$

G is

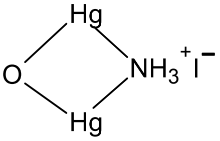
(A)



(B)



(C)



(D) None

Space for Rough work

Paragraph for Question Nos. 13 to 14

Redox reactions play a vital role in chemistry and biology. The values of E^o_{red} of two half cell reactions decide which way the reaction is expected to proceed. A simple example is Daniel cell in which zinc goes into solution and copper gets deposited. Given below are a set of half-cell reactions (acidic medium) along with their E^o values.

$$I_2 + 2e^- \longrightarrow 2I^-; \quad E^o = 0.54V$$
$$Cl_2 + 2e^- \longrightarrow 2Cl^-; \quad E^o = 1.36V$$
$$Mn^{3+} + e^- \longrightarrow Mn^{2+}; \quad E^o = 1.50V$$
$$Fe^{3+} + e^- \longrightarrow Fe^{2+}; \quad E^o = 0.77V$$
$$O_2 + 4H^+ + 4e^- \to 2H_2O; \ E^o = 1.23V$$

13. Fe^{3+} is stable but Mn^{3+} is not stable in acidic solution because:
(A) O_2 oxidises Mn^{2+} to Mn^{3+}
(B) O_2 oxidises both Mn^{2+} and Fe^{2+} into Mn^{3+} and Fe^{3+} respectively.
(C) Fe^{3+} oxidises H_2O to O_2
(D) Mn^{3+} oxidises H_2O to O_2.

14. Among the following identify the correct statement:
(A) Chloride ion is oxidized by O_2
(B) Fe^{2+} ion is oxidized by iodine
(C) Iodide ion is oxidized by chlorine
(D) Mn^{2+} is oxidized by chlorine.

Space for Rough work

Paragraph for Question Nos. 15 to 16

When 20.02 g of a white solid (X) is heated, 4.4 g of an acid gas (A) and 1.8 g of a neutral gas (B) are evolved leaving behind a solid residue (Y) of weight 13.8 g (A) turns lime water milky and (B) condenses into a liquid which changes anhydrous copper sulphate blue. The aqueous solution of Y is alkaline to litmus and gives 19.7 g of white precipitate (Z) with barium chloride solution. (Z) gives carbon-dioxide with an acid.

15. The white solid 'X' is:
(A) metal sulphate
(B) metal chloride
(C) metal carbonate
(D) metal bicarbonate

16. Atomic weight of the metal is:
(A) 23 g/mole
(B) 39.0 g/mole
(C) 6 g/mole
(D) 24 g/mole

Space for Rough work

(Match list Type)

This section contains **4 multiple choice questions.** Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

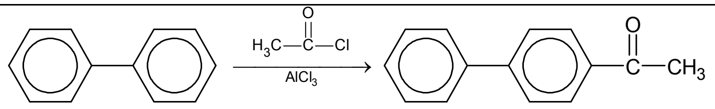
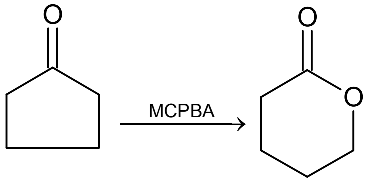
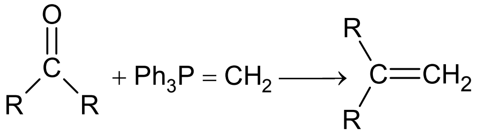
17. Match the List – I with List – II.

List I (Molecule)	**List II (Shape)**
(P) N_2O	(1) Angular
(Q) F_2O	(2) Tetrahedral
(R) BF_4^-	(3) Planar triangular
(S) CH_3^+	(4) Linear

Codes:

	P	Q	R	S
(A)	1	2	3	4
(B)	2	1	3	4
(C)	2	1	4	3
(D)	4	1	2	3

18. Match **List-I** with **List-II**.

List – I Transformation		**List – II Name**	
(P)		(1)	Carbyl amine reaction
(Q)		(2)	Wittin Reaction
(R)	 $R_2C{=}O + Ph_3P = CH_2 \longrightarrow R_2C{=}CH_2$	(3)	Bayer-Villiger oxidation
(S)	$Ph-NH_2 \xrightarrow{CHCl_3/KOH} Ph-NC$	(4)	Friedel Craft's Acylation

Codes:

	P	Q	R	S
(A)	1	2	3	4
(B)	2	1	3	4
(C)	2	1	4	3
(D)	4	3	2	1

Space for Rough work

19. Match **List-I** with **List-II**.

List-I		List-II	
(P)	$Fe(NO_3)_2$ (aq)	(1)	Only cationic hydrogen
(Q)	$KClO_4$ (aq)	(2)	Only anionic hydrolysis
(R)	HCOONa (aq)	(3)	Both cationic as anionic hydrolysis
(S)	NH_4CN (aq)	(4)	No hydrolysis

Codes:

	P	Q	R	S
(A)	1	2	3	4
(B)	1	4	2	3
(C)	2	1	4	3
(D)	4	3	2	1

20. Identify the correct matching from the codes given below

Reaction	**Product**
(P) $\text{Borax} \xrightarrow{\Delta}$	(1) $H_2B_4O_7$
(Q) $\text{Borax} + NH_4Cl \xrightarrow{\Delta}$	(2) $NaBO_2 + B_2O_3$
(R) $\text{Borax} \xrightarrow{HCl}$	(3) BN
(S) $\text{Borax} + H_2O$	(4) H_3BO_3

Codes:

	P	Q	R	S
(A)	1	2	3	4
(B)	2	1	3	4
(C)	2	3	4	1
(D)	4	3	2	1

Space for Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE or MORE** than is/are correct

1. Number of ways in which 200 people can be divided in 100 couples is

(A) $\frac{(200)!}{2^{100}(100)!}$ (B) 1.3.5. 199

(C) $\left(\frac{101}{2}\right)\left(\frac{102}{2}\right)......\left(\frac{200}{2}\right)$ (D) $\frac{(200)!}{(100)!}$

2. Consider the quadratic equation (a + c – b) x^2 + 2cx + (b + c – a) = 0 where a, b, c are distinct real number and a + c – b $\neq$ 0. If both the roots of the equation are rational then the numbers which must be rational are

(A) a, b, c (B) $\frac{c}{a-b}$

(C) $\frac{b+c-a}{a+c-b}$ (D) $\frac{b^2}{c-a}$

3. If a, b, c are first three terms of a G.P. if the harmonic mean of a and b is 12 and arithmetic mean of b and c is 3, then

(A) no term of this G.P. is square of an integer (B) arithmetic mean of a, b, c is 3

(C) b = ± 6 (D) common ratio of this G.P. is 2

Space for rough work

4. If the normal at any given point P on ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ meets its auxiliary circle at Q and R such that $\angle QOR = 90^\circ$, where O is centre of ellipse, then

(A) $2(a^2 - b^2)^2 = a^4 \sec^2\theta + a^2b^2 \operatorname{cosec}^2\theta$
(B) $a^4 + 5a^2b^2 + 2b^4 = a^4\tan^2\theta + a^2b^2\cot^2\theta$
(C) $a^4 + 5b^2a^2 + 2b^4 \ge 2a^3b$
(D) $a^4 + 2b^4 \ge 5a^2b^2 + 2a^3b$

5. If $\begin{vmatrix} x^2-5x+3 & 2x-5 & 3 \\ 3x^2+x+4 & 6x+1 & 9 \\ 7x^2-6x+9 & 14x-6 & 21 \end{vmatrix} = ax^3 + bx^2 + cx + d$ then which of the following are correct?

(A) a = 0
(B) b = 0
(C) c = 0
(D) d = 0

6. Let $(1 + x^2)^2 (1 + x)^n = A_0 + A_1 x + A_2 x^2 + \ldots\ldots$ If A_0, A_1, A_2 are in A.P. then the value of n is

(A) 2
(B) 3
(C) 5
(D) 7

7. A line passes through the points whose position vectors are $\hat{i} + \hat{j} - 2\hat{k}$ and $\hat{i} - 3\hat{j} + \hat{k}$. The position vector of a point on it at a unit distance from the first point is/are

(A) $\frac{1}{5}(5\hat{i} + \hat{j} - 7\hat{k})$
(B) $\frac{1}{5}(5\hat{i} + 9\hat{j} - 13\hat{k})$
(C) $\frac{1}{5}(6\hat{i} + \hat{j} - 7\hat{k})$
(D) $\frac{1}{5}(4\hat{i} + 9\hat{j} - 13\hat{k})$

8. Let $u = \int_0^\infty \frac{dx}{x^4 + 7x^2 + 1}$ and $v = \int_0^\infty \frac{x^2\,dx}{x^4 + 7x^2 + 1}$ then

(A) v > u
(B) 6 v = π
(C) 3u + 2v = $5\pi/6$
(D) u + v = $\pi/3$

Space for rough work

Comprehension Type

This section contains **4 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

Paragraph for Question Nos. 9 to 10

Read the following write up carefully and answer the following questions:
Continuous probability distributions, a continuous distribution is one in which the variate may take any value between certain limits a and b, a < b. Suppose that the probability of the variate X falling in the infinitesimal interval $x - \frac{1}{2}dx$ to $x + \frac{1}{2}dx$ is expressible as f(x) dx, where f(x) is a continuous function of x

Symbolically, $P(x - \frac{1}{2}dx \le X \le x + \frac{1}{2}dx) = f(x)\,dx$ where f(x) is called the probability density function (abbreviated as p.d.f.) or simply density function. The continuous curve y = f(x) is called probability curve; and when this is symmetrical, the distribution is said to be symmetrical. Clearly, the probability density function possesses the following properties

(i) $f(x) \ge 0$ for every x in the interval [a, b], a < b

(ii) $\int_a^b f(x)\,dx = 1$, a, b > 0 since the total area under the curve is unity

(iii) Furthermore, we define for any [c, d], where c, d ∈ [a, b], c < d;

$$P(c \le X \le d) = \int_c^d f(x)\,dx \quad ..... (1)$$

We define F(x), the cumulative distribution function (abbreviated as c.d.f.) of the random variate X where $F(x) = P(X \le x)$

$$\text{or } F(x) = \int_a^x f(x)\,dx \quad ..... (2)$$

9. If $f(x) = \begin{cases} 2x & ; \quad 0 \le x \le 1 \\ 0 & ; \quad x > 1 \end{cases}$ then the probability that $x \le \frac{1}{2}$ is

(A) $\frac{1}{2}$ (B) $\frac{1}{4}$
(C) $\frac{3}{4}$ (D) $\frac{1}{8}$

10. Suppose the life in hours (x) of a certain kind of radio tube has the probability density function $f(x) = \frac{100}{x^2}$ when x > 100 and zero when x < 100. Then the probability that none of three such tubes in a given radio set will have to be replaced during the first 150 hours of operation, is

(A) $\frac{1}{27}$ (B) $\frac{8}{27}$
(C) $\frac{1}{225}$ (D) $\frac{26}{27}$

Space for rough work

Paragraph for Question Nos. 11 to 12

Read the following write up carefully and answer the following questions:
Let f be a function defined so that every element of the co-domain has at most two pre-images and there is at least one element in the co-domain which has exactly two pre-images we shall call this function as "two-one" function. A two-one function is definitely a many one function but vice-versa is not true. For example, $y = |e^x - 1|$ is a "two-one" function. $y = x^3 - x$ is a many one function but not a "two-one" function. In the light of above definition answers the following questions:

11. In the following functions which one is a "two-one" function

(A) $y = |\ell n|x||$ (B) $y = x^2 \sin x$
(C) $y = x^3 + 3x + 1$ (D) $y = x^4 - x + 1$

12. Let f(x) = {x} be the fractional part function. For what domain is the function "two-one"?

(A) $\left[\frac{1}{2}, \frac{5}{2}\right]$ (B) $\left[-\frac{1}{2}, \frac{3}{2}\right)$
(C) [1, 2) (D) none of these

Paragraph for Question Nos. 13 to 14

Read the following write up carefully and answer the following questions:
If $y = \int_{u(x)}^{v(x)} f(t)\,dt$, let us define $\frac{dy}{dx}$ in a different manner as $\frac{dy}{dx} = v'(x)\, f^2(v(x)) - u'(x)\, f^2(u(x))$ and the equation of the tangent at (a, b) as $y - b = \left(\frac{dy}{dx}\right)_{(a,\, b)} (x - a)$

13. If $y = \int_{x}^{x^2} t^2\, dt$, then equation of tangent at x = 1 is

(A) $y = x + 1$ (B) $x + y = 1$
(C) $y = x - 1$ (D) $y = x$

14. If $F(x) = \int_{1}^{x} e^{t^2/2} (1 - t^2)\, dt$, then $\frac{d}{dx}F(x)$ at x = 1 is

(A) 0 (B) –1
(C) 1 (D) 2

Space for rough work

Paragraph for Question Nos. 15 to 16

Read the following write up carefully and answer the following questions:
In reducing a given equation to the standard forms $(\sin x = \sin\alpha \text{ etc})$ we apply several trigonometric or algebraic transformations. As a result of which the canonical form finally obtained may not be equivalent to the original equation resulting either in loss of solutions or in the appearance of fake solutions

15. The solution set of the equation $\sqrt{5-2\sin x} = 6\sin x - 1$ is
(A) $n\pi + (-1)^n \sin^{-1}\left(-\frac{2}{9}\right)$ or $x = n\pi + (-1)^n \frac{\pi}{6}$ (B) $n\pi + (-1)^n \frac{\pi}{6}$
(C) $n\pi + (-1)^n \sin^{-1}\left(\frac{2}{9}\right)$ (D) Null set

16. The equation $2\cot 2x - 3\cot 3x = \tan 2x$ has
(A) two solutions in $\left(0, \frac{\pi}{3}\right)$ (B) one solution in $\left(0, \frac{\pi}{3}\right)$
(C) no solution in $(-\infty, \infty)$ (D) none of these

(Match list Type)

This section contains **4 multiple choice questions.** Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

17. Matching the following List-I with List-II.

	List – I	List – II	
(P)	The least positive integral solution of $x^2 - 4x > \cot^{-1} x$	1.	1
(Q)	The least positive integral value of a for which $f(x) = 2e^x - ae^{-x} + (2a+1)x - 3$ is increasing	2.	2
(R)	Let f: R → R be such that f(a) = 1, f′(a) = 2, then $\lim\limits_{x\to 0}\left(\frac{f^2(a+x)}{f(a)}\right)^{\frac{1}{x}} = e^k$, then k is equal to	3.	5
(S)	Number of integral values of x which satisfy equation $\sin^{-1}((3-x)(x-1)) + \sin^{-1}(2-\lvert x\rvert) = \pi/2$ is/are	4.	4

Codes:

	P	Q	R	S
(A)	3	1	2	4
(B)	1	2	3	4
(C)	4	3	2	1
(D)	3	1	4	2

Space for rough work

18. Matching the following List-I with List-II.

List – I		List – II	
(P)	If $y = 2x + c - 4$ is a normal to the parabola $y^2 = 4x$, then value of '$-c$' is	1.	12
(Q)	If the mid point of a chord of the ellipse $\frac{x^2}{16} + \frac{y^2}{25} = 1$ is (0, 3), then length of the chord is $\frac{4k}{5}$, then $k + 4$ is equal to	2.	8
(R)	The product of the lengths of the perpendiculars from the two focii on any tangent to the hyperbola $\frac{x^2}{25} - \frac{y^2}{3} = 1$ is $\sqrt{k}$, then k is	3.	3
(S)	The line $x + y = a$ touches the hyperbola $x^2 - 2y^2 = 18$, if a is equal to $\pm b$, then value of $\lvert b \rvert$ is	4.	9

Codes:

	P	Q	R	S
(A)	1	2	3	4
(B)	2	1	3	4
(C)	2	1	4	3
(D)	4	3	2	1

19. Matching the following List-I with List-II.

List – I		List – II	
(P)	If the sum of unit vectors is a unit vector, then magnitude of difference is $\sqrt{x}$, then the value of x is	1.	$\frac{1}{2}$
(Q)	If $f(x) = \sin x, \forall x \in \left[0, \frac{\pi}{2}\right]$, $f(x) + f(\pi - x) = 2, \forall x \in \left(\frac{\pi}{2}, \pi\right]$ and $f(x) = f(2\pi - x), \forall x \in (\pi, 2\pi)$, then the area enclosed by $y = f(x)$ and the x-axis is $k\pi$ sq. units. Then k is	2.	2
(R)	Let f and g be differentiable function satisfying $g'(a) = 2$, $g(a) = b$ and $g = f^{-1}$ then $f'(b)$ is equal to	3.	3
(S)	The derivative of $\tan^{-1}\left(\frac{\sqrt{1+x^2}-1}{x}\right)$ w.r.t $\tan^{-1}\left(\frac{2x\sqrt{1-x^2}}{1-2x^2}\right)$ at $x = 0$ is	4.	$\frac{1}{4}$

Codes:

	P	Q	R	S
(A)	1	2	3	4
(B)	3	2	1	4
(C)	3	1	4	2
(D)	4	3	2	1

Space for rough work

20. Matching the following List-I with List-II

	List – I	List – II	
(P)	If a, b, c $\in$ N and a, b, c $\le$ 100, then probability that a, b, c are individually divisible by both 2 and 3	1.	$\frac{5}{28}$
(Q)	Probability that in a year of 22nd century chosen at random there will be 53 Sundays	2.	$\frac{31}{32}$
(R)	If a unbiased coin is tossed 5 times then probability of getting at least 1 head is	3.	$\frac{5}{12}$
(S)	If $P(A\cup B)=\frac{3}{4}, P(A\cap B)=\frac{1}{4}$, $P(\bar{A})=\frac{2}{3}$, then $P(\bar{A}\cap B)$ is	4.	$\frac{4}{1155}$

Codes:

	P	Q	R	S
(A)	4	1	3	2
(B)	1	2	3	4
(C)	3	4	2	1
(D)	4	1	2	3

Space for rough work

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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ANSWERS, HINTS & SOLUTIONS

CRT –II
(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A, B	A, B, D	A, B, C
2.	B, D	A, B, D	B, C
3.	B, D	A, B, D	A, B
4.	B, D	B, D	A, D
5.	A,D	B, D	A, B, C
6.	A,B,D	B, D	A, B
7.	A,C,D	A, B, C	A, B
8.	A	A, B, C, D	B, C, D
9.	B	C	B
10.	A	D	B
11.	A	C	D
12.	C	A	B
13.	C	D	C
14.	C	C	A
15.	A	D	B
16.	D	B	C
17.	A	D	D
18.	C	D	C
19.	C	B	B
20.	B	C	D

Physics

PART – I

SECTION – A

1. $$|F| = \frac{dU}{dr} = \frac{ke^2}{r^4}$$

$$F = \frac{mv^2}{r}$$

$$\Rightarrow \frac{ke^2}{r^4} = \frac{mv^2}{r} \quad ...(1)$$

and $mvr = \dfrac{nh}{2\pi} \quad ...(2)$

From (1) and (2) $r = \dfrac{ke^2 4\pi^2}{n^2}\dfrac{m}{n^2} = \dfrac{Am}{n^2}$

T.E. = $\dfrac{1}{2}P.E = \dfrac{1}{2} \times \dfrac{ke^2}{3\left(\dfrac{Am}{n^2}\right)^3}$

$T.E. \propto n^6,\ T.E. \propto m^{-3}$

2. $$\frac{P^2}{\rho} = \text{constant}$$

$$\Rightarrow \frac{P^2(nRT)}{MP} = \text{constant}$$

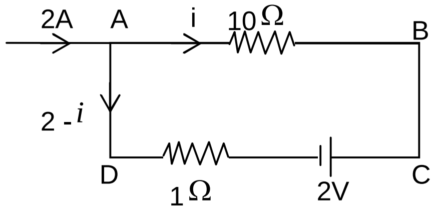
$$\Rightarrow PT = \text{constant}$$

3. In loop ABCDA

$10i + 2 - (2 - i) = 0$

$i = 0$

Potential difference across S → $(2 - i)1 = 2V$



8. $\omega L/R = \tan\pi/6 \Rightarrow R = 3\Omega$

$\tan\phi = 1/\omega CR = 1$

$\Rightarrow \phi = \pi/4$, leading P.D.

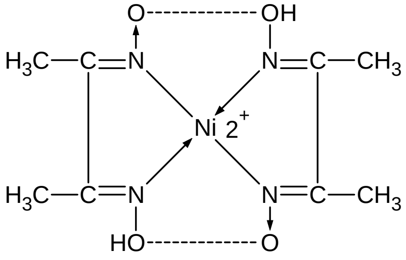
Chemistry

PART – II

SECTION – A

1.
$$\left.\begin{array}{l} Ba^{2+} \xrightarrow{CrO_4^{2-}} BaCrO_4 \\ Pb^{2+} \xrightarrow{CrO_4^{2-}} PbCrO_4 \\ Sr^{2+} \xrightarrow{CrO_4^{2-}} SrCrO_4 \end{array}\right\} \text{Yellow ppt.}$$

$$\left.\begin{array}{l} 2Ag^{+} \xrightarrow{CrO_4^{2-}} Ag_2CrO_4 \\ Hg_2^{2+} \xrightarrow{CrO_4^{2-}} Hg_2CrO_4 \end{array}\right\} \text{Red ppt.}$$

2.


[Ni(dmg)$_2$]

4. $$Zn(s) + 2H^{+}(aq) \rightleftharpoons Zn^{2+}(aq) + H_2 \quad ....(1)$$

$$E = E^{0}_{cell} - \frac{0.059}{n}\log\frac{[Zn^{2+}][H_2]}{[H^{+}]^{2}} \quad .....(2)$$

Equilibrium (1) will shift in forward direction and cell potential E will increase.

5. Rate of zero order reactions is independent of the concentration of reaction

In this equation K = $Ae^{-E_a/RT}$

K = A when E_a = 0

$$\log K = \log A - \frac{E_a}{2.303RT}$$

Plot of log K against 1/T is straight line with negative slope.

7. At anode At cathode

$2Cl^{-} \longrightarrow Cl_2 + 2e^{-}$ $Mg^{2+} + 2e^{-} \longrightarrow Mg$

(No. of gm equivalent of Mg at cathode) = (No of gm equivalent of Cl_2 at Anode)

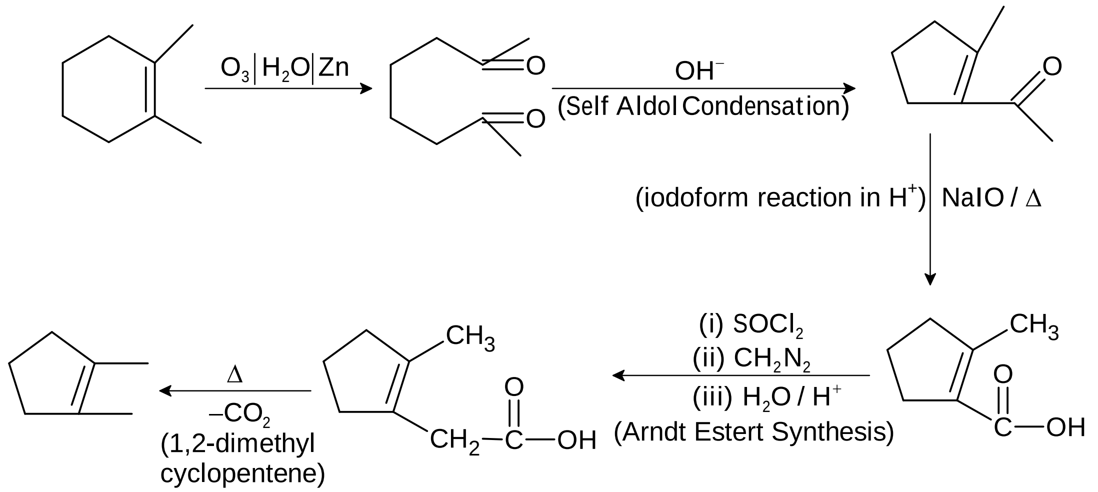
$$\frac{13}{24.3/2} = \frac{W_{Cl_2}}{35.5}$$

$W_{Cl_2} = 37.98$ gm

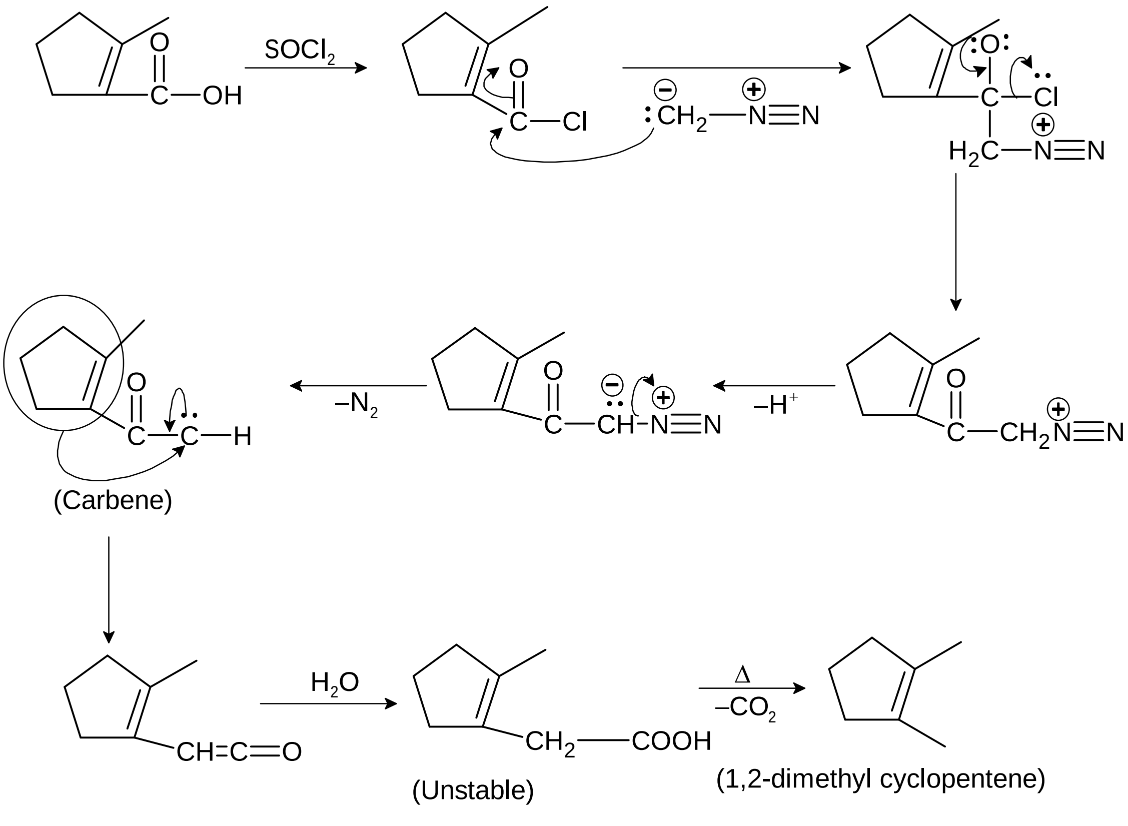
or $n_{Cl_2} = 0.535$

V_{Cl_2} = 11.98 lit at NTP

9.


O3|H2O|Zn
O
O
OH⁻
(Self Aldol Condensation)
O
(iodoform reaction in H⁺) NaIO / Δ
CH3
O
C—OH
(i) SOCl2
(ii) CH2N2
(iii) H2O / H⁺
(Arndt Estert Synthesis)
CH3
O
CH2—C—OH
Δ
–CO2
(1,2-dimethyl
cyclopentene)

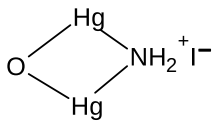
10.


O
C—OH
SOCl2
O
C—Cl
:CH2—N≡N
:O:
C—Cl
H2C—N≡N
O
C—CH2N≡N
–H⁺
O
C—CH—N≡N
–N2
O
C—C—H
(Carbene)
CH=C=O
H2O
CH2—COOH
(Unstable)
Δ
–CO2
(1,2-dimethyl cyclopentene)

11. $\underset{(A)}{Ba} \xrightarrow[\text{Burning}]{N_2} \underset{(B)}{Ba_3N_2} \xrightarrow{H_2O} Ba(OH)_2 + NH_3\,(D)$

$BaCl_2 \longrightarrow$ green flame

12. $HgI_2 \xrightarrow{KI} K_2HgI_4 \xrightarrow[KOH]{NH_3}$



13. Reaction of Mn^{3+} with H_2O is spontaneous.

14. Reduction potential of I_2 is less than Cl_2.

Solution for the Q. No. 15 to 16.

(i) A turns lime water milky so 'A' may be CO_2 or SO_2
(ii) B condenses into liquid turning anhydrous $CuSO_4$ to blue, so 'B' is H_2O.
(iii) Y gives alkaline solution and its solution forms white ppt. Z with $BaCl_2$ and Z on heating with acid gives CO_2 so, Z is $BaCO_3$ and Y is metal carbonate.
(iv) Since, Y and A are formed from 'X' and thus X is metal bicarbonate.
(v) $\underset{20.02\,g}{X} \longrightarrow \underset{4.4\,g}{A} + \underset{1.8\,g}{B} + \underset{13.8\,g}{Y}$
(vi) The above data reveal that,

$$\underset{(X)}{2MHCO_3} \longrightarrow \underset{(A)}{CO_2} + \underset{(B)}{H_2O} + \underset{(Y)}{M_2CO_3}$$

4.4 of CO_2 is obtained by 20.02 g of $MHCO_3$
44 g CO_2 is obtained by 200.2 g of $MHCO_3$
Molecular weight of $MHCO_3 = \frac{200.2}{2} = 100.1$
$\therefore$ Atomic wt. of M ≈ 39.0 g/mole
Thus metal is potassium.

17. BF_4^- has sp^3 hybridisation, CH_3^+ is sp^2, F_2O is sp^3 with two lone pairs on O. Also N_2O is linear.

Mathematics PART – III

SECTION – A

1. $$\frac{(200)!}{\underbrace{2!\,.\,2!\,.....2!}_{100\text{ times}}\,(100)!} = \frac{(200)!}{100!\,.\,2^{100}} = 1.3.5\,........\,.\,199$$

$$\frac{(200)!}{100!\,.\,2^{100}} = \left(\frac{101}{2}\right)\left(\frac{102}{2}\right).......\left(\frac{200}{2}\right)$$

2. Since, f(–1) = 0 the other root is $-\frac{b+c-a}{a+c-b} \in Q$

Which can be written as $-\dfrac{\frac{c}{a-b}-1}{\frac{c}{a-b}+1}$

Hence, $\frac{c}{a-b} \in Q$

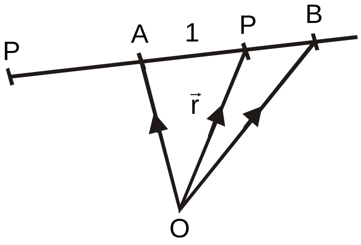
3. a, b, c are in GP
$\frac{2ab}{a+b} = 12$, $\frac{b+c}{2} = 3$
$\frac{2a\,.\,ar}{a+ar} = 12$, $ar + ar^2 = 6$
$ar = 6(1 + r)$, $ar(1 + r) = 6$
i.e. $6(1 + r)^2 = 6$, i.e. $(1 + r)^2 = 1$
$\therefore$ $1 + r = \pm 1$ i.e. r = 0 or r = –2
$\therefore$ r = –2
If r = –2, then a = 3
$\therefore$ The GP is 3, –6, 12, –24, 48
Clearly no term of the series is square of an integer AM of a, b, c is = $\frac{3-6+12}{3} = 3$

4. Homogenizing auxiliary circle with normal at P
$$x^2 + y^2 = \frac{a^2(ax\sec\theta - by\,\text{cosec}\theta)^2}{(a^2-b^2)^2}$$
$$\angle QOR = 90^o \Rightarrow -1 + \frac{a^4\sec^2\theta}{(a^2-b^2)^2} - 1 + \frac{a^2b^2\,\text{cosec}^2\theta}{(a^2-b^2)^2} = 0$$
$2(a^2 - b^2)^2 = a^4\sec^2\theta + a^2b^2\,\text{cosec}^2\,\theta$
$a^4 - 5a^2b^2 + 2b^4 = a^4\tan^2\theta + a^2b^2\cot^2\theta \ge 2a^3b.$

5. $$f(x) = \begin{vmatrix} x^2-5x+3 & 2x-5 & 3 \\ 3x^2+x+4 & 6x+1 & 9 \\ 7x^2-6x+9 & 14x-6 & 21 \end{vmatrix}$$
$f'(x) = 0$
$\Rightarrow$ f(x) is a constant polynomial and $f(0) \neq 0$
$\Rightarrow d \neq 0$

6. $(1 + x^2)^2 (1 + x)^n = (1 + 2x^2 + x^4) ({}^nC_0 + {}^nC_1 x + {}^nC_2 x^2 + ...)$
$= {}^nC_0 + {}^nC_1 x + ({}^nC_2 + 2\cdot{}^nC_0) x^2 + ...$
Hence, $A_0 = 1$; $A_1 = {}^nC_1$; $A_2 = {}^nC_2 + 2$ which are in A.P.

7. $\overrightarrow{OP} = \vec{r} = \overrightarrow{OA} \pm \dfrac{\overrightarrow{AB}}{|\overrightarrow{AB}|}$



$= \hat{i} + \hat{j} - 2\hat{k} \pm \dfrac{\overrightarrow{OB} - \overrightarrow{OA}}{|\overrightarrow{OB} - \overrightarrow{OA}|}$

$= \hat{i} + \hat{j} - 2\hat{k} \pm \dfrac{-4\hat{j} + 3\hat{k}}{|-4\hat{j} + 3\hat{k}|}$

$= \hat{i} + \hat{j} - 2\hat{k} \pm \dfrac{1}{5}(-4\hat{j} + 3\hat{k})$

$= \dfrac{1}{5}(5\hat{i} + \hat{j} - 7\hat{k}), \dfrac{1}{5}(5\hat{i} + 9\hat{j} - 13\hat{k})$

8. Put x = 1/t in u or v $\Rightarrow$ u = v
Now consider u + v

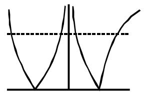
9. $P\left(x \le \dfrac{1}{2}\right) = \displaystyle\int_{x=0}^{1/2} f(x)\,dx = \int_0^{1/2} 2x\,dx = \left[x^2\right]_0^{1/2} = \frac{1}{4}$

10. Probability that life of a radio tube is less than or equal to 150 hours
$= \displaystyle\int_0^{150} f(x)\,dx = \int_{100}^{150} \frac{100}{x^2}\,dx = -\frac{100}{x}\Bigg|_{100}^{150} = -100\left[\frac{1}{150} - \frac{1}{100}\right] = \frac{1}{3}$

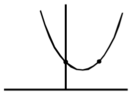
$\therefore$ Probability that life is greater than 150 hrs $= \dfrac{2}{3}$

$\therefore$ Probability that none of these have life less than on equal to 150 hrs $= \dfrac{2}{3} \times \dfrac{2}{3} \times \dfrac{2}{3} = \dfrac{8}{27}$ h

11. $y = |\ell n|x||$ has graph here an element in co-domain can have 4 pre-images

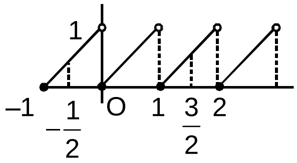


$y = x^2 \sin x$ is zero for infinitely many values of x
$y = x^3 + 3x + 1$ is M.I. and hence one-one function
$y = x^4 - x + 1$ has graph



$\therefore y = x^4 - x + 1$ is two-one

12. From graph it is clear that any horizontal lines cuts the graph at either one or two points between $\left[-\dfrac{1}{2}, \dfrac{3}{2}\right)$



13. At x = 1, y = 0
$\dfrac{dy}{dx} = 2x\cdot(x^4)^2 - (x^2)^2 = 2 - 1 = 1$
$\therefore$ Equation of tangent y – 0 = 1 (x – 1), y = x – 1

14. $F(x) = \int_1^x e^{t^2/2}(1-t^2)\,dt$

$F'(x) = \left(e^{\frac{x^2}{2}}(1-x^2)\right)^2$

$\therefore F'(1) = e^{1/2}.0 = 0$

15. Let $\sin x = t$; $t \in [-1, 1]$

$\sqrt{5-2t} = 6t-1 \ge 0$ i.e. $t \ge \frac{1}{6}$

So, $t \in \left[\frac{1}{6}, 1\right]$

Now squaring, $\sqrt{5-2t} = (6t-1)$, $t = \frac{1}{2}, -\frac{2}{9}$, $t = -\frac{2}{9}$ not possible $\left(\because t \in \left[\frac{1}{6}, 1\right]\right)$

So, $t = \frac{1}{2}$, $\sin x = \frac{1}{2} = \sin\frac{\pi}{6}$, $x = n\pi + (-1)^n \frac{\pi}{6}$

16. $2\frac{\cos 2x}{\sin 2x} - 3\frac{\cos 3x}{\sin 3x} = \frac{\sin 2x}{\cos 2x}$

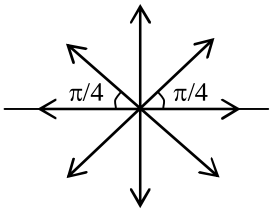
$2\frac{(2\cos^2 x - 1)}{2\sin x \cos x} - 3\frac{4\cos^3 x - 3\cos x}{3\sin x - 4\sin^3 x} = \frac{2\sin x \cos x}{2\cos^2 x - 1}$

Now Let $\cos^2 x = t$ in above i.e. $t \in (0,1) - \left\{\frac{1}{2}\right\}$

Now we have $2t - 1 - 3t\frac{4t-3}{4t-1} = \frac{2t(1-t)}{2t-1}$

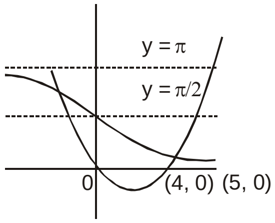
Solving $t = \pm 1$ but $t \in (0,1) - \left\{\frac{1}{2}\right\}$

So there is no t, so there is no x



These positions can't be the answer

17. (P) Form the graph it is clear that $x = 5$ is the least positive integral value for which $x^2 - 4x > \cot^{-1} x$.



(Q) $f'(x) = 2e^x + ae^{-x} + 2a + 1$

$= e^{-x}(2e^{2x} + (2a+1)e^x + a)$

$= 2e^{-x}(e^{2x} + (a + 1/2)e^x + a/2)$

$= 2e^{-x}(e^x + a)(e^x + 1/2)$

For $f(x)$ to be increasing $f'(x) \ge 0\ \forall\ x \in R$

or $e^x + a \ge 0\ x \in R$

or $a \ge 0$

(R) $\lim_{x\to 0}\left(\frac{f^2(a+x)}{f(a)}\right)^{\frac{1}{x}} = e^{\lim_{x\to 0}\left(\frac{f^2(a+x)-f(a)}{xf(a)}\right)} = e^{\lim_{x\to 0}\frac{f^2(a+x)-(f(a))^2}{x}} = e^4$

$\therefore k = 4$

(S) $\sin^{-1}(-x^2 + 4x - 3) = \cos^{-1}(2 - |x|)$

$0 \le -x^2 + 4x - 3 \le 1 \Rightarrow x \in [1, 3]$ ..... (1)

Also, $0 \le 2 - |x| \le 1 \Rightarrow x \in [-2, -1] \cup [1, 2]$ ..... (2)

From (1) and (2) $x \in \{1, 2\}$

18. (P) Equation of any normal to $y^2 = 4x$ is $y = -tx + 2t + t^3$
Comparing it with $y = 2x + c - 4$
$t = -2$ and $2t + t^3 = c - 4$
$\therefore c = 4 - 4 - 8 = -8$
$\therefore -c = 8$

(Q) Equation of the chord whose mid point is (0, 3) is $\frac{3y}{25} - 1 = \frac{9}{25} - 1$

i.e. $y = 3$ it intersects the ellipse $\frac{x^2}{16} + \frac{y^2}{25} = 1$ at $\frac{x^2}{16} = 1 - \frac{9}{25} = \frac{16}{25}$

$x = \pm \frac{16}{5}$

$\therefore$ Length of the chord $= \frac{32}{5}$

Thus $\frac{4k}{5} = \frac{32}{5}$ $\therefore k = 8$

(R) The product of the lengths of the perpendiculars from the two focii on any tangent to the hyperbola $\frac{x^2}{25} - \frac{y^2}{3} = 1$ is 3
$\therefore 3 = \sqrt{k}$, hence $k = 9$

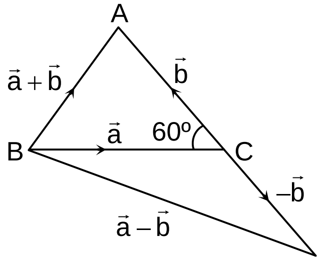
(S) Since, $x + y = a$ touches the hyperbola
$x^2 - 2y^2 = 18$
$\therefore x^2 - 2(a - x)^2 = 18$ has equal roots
i.e., $x^2 - 4ax + 18 + 2a^2 = 0$ has equal roots
$\therefore 16a^2 - 4(18 + 2a^2) = 0$
$8a^2 - 72 = 0 \Rightarrow a = \pm 3$
$\therefore |b| = 3$

19. (P) From figure $\vec{a} \wedge \vec{b} = \frac{2\pi}{3}$

and $\left|\vec{a} - \vec{b}\right|^2 = 2^2 - 1$

$\left|\vec{a} - \vec{b}\right| = \sqrt{3} = \sqrt{x}$

$\therefore x = 3$



(Q) $f(x) = \sin x$, $f(x) + f(\pi - x) = 2$

$f(x) = 2 - f(\pi - x) = 2 - \sin(\pi - x) = 2 - \sin x$, where $x \in \left(\frac{\pi}{2}, \pi\right]$

$f(x) = f(2\pi - x) = 2 - \sin(2\pi - x)$, where $x \in \left(\frac{3\pi}{2}, 2\pi\right]$

$$f(x) = \begin{cases} \sin x & , \quad x \in \left[0, \frac{\pi}{2}\right] \\ 2 - \sin x & , \quad x \in \left(\frac{\pi}{2}, \pi\right] \\ 2 + \sin x & , \quad x \in \left(\pi, \frac{3\pi}{2}\right] \\ -\sin x & , \quad x \in \left(\frac{3\pi}{2}, 2\pi\right] \end{cases}$$

Area = $\int_{0}^{\pi/2} \sin x dx + \int_{\pi/2}^{\pi} 2 - \sin x dx + \int_{\pi}^{3\pi/2} (2+\sin x) dx + \int_{3\pi/2}^{2\pi} (-\sin x) dx$

= $1 + 2 \times \frac{\pi}{2} - 1 + 2 \cdot \frac{\pi}{2} - 1 + 1 = 2\pi$ sq. units

(R) Since g = f^{-1} so fog(x) = x
Therefore f′(g(x)) g′(x) = 1
f′(g(a)) g′(a) = 1
$\Rightarrow$ f′(b) 2 = 1 $\Rightarrow$ f′(b) = $\frac{1}{2}$

(S) Putting x = tan θ

$$\frac{\sqrt{1+x^2}-1}{x} = \frac{\sec\theta - 1}{\tan\theta} = \tan\frac{\theta}{2}$$

This $u = \tan^{-1}\frac{\sqrt{1+x^2}-1}{x} = \frac{\theta}{2} = \frac{1}{2}\tan^{-1} x$

Putting x = sin θ, $v = \tan^{-1}\frac{2x\sqrt{1-x^2}}{1-2x^2} = 2\sin^{-1} x$

$$\frac{du}{dv} = \frac{\frac{1}{2}\frac{1}{1+x^2}}{\frac{2}{\sqrt{1-x^2}}} \Rightarrow \left.\frac{du}{dv}\right]_{x=0} = \frac{1}{4}$$

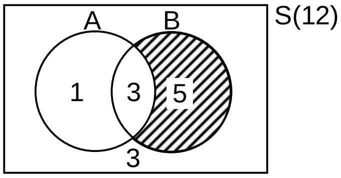
20. (P) We have to select 3 no. from {1, 2, ...100}
Number division by 6 are 6, 12 96

$\text{Prob} = \frac{^{16}C_3}{^{100}C_3} = \frac{4}{1155}$

(Q) 22^{nd} century 2200, 2201 2299
2200 leap year (L), 2201 Non leap year (N)
In 22^{nd} century: 25 L and 75 N, $P(L) = \frac{1}{4}$ $P(N) = \frac{3}{4}$
For L: 366 days; $\frac{366}{7} = 52 + \frac{2}{7}$
For N: 365 days; $\frac{365}{7} = 52 + \frac{1}{7}$
Now P(53 Sunday) = P(L) P(53S/L) + P(N)·P(53 Sun/N) $= \frac{1}{4}\times\frac{2}{7} + \frac{3}{4}\times\frac{1}{7} = \frac{5}{28}$

(R) P(at least one head) = 1 – P (no head) = $1 - {}^{5}C_5\left(\frac{1}{2}\right)^5\left(\frac{1}{2}\right)^0 = 1 - \frac{1}{32} = \frac{31}{32}$

(S) $P(A \cup B) = \frac{3}{4} = \frac{9}{12}$, $P(A \cap B) = \frac{1}{4} = \frac{3}{12}$
$P(\bar{A}) = \frac{8}{12}$; $P(A) = \frac{4}{12}$, $P(\bar{A} \cap B) = \frac{5}{12}$



FIITJEE **JEE (Main), 2015**

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - III

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 30)** contains 30 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

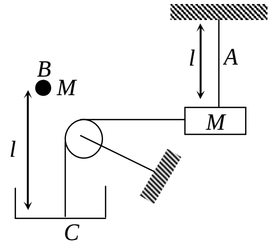
Physics PART – I

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

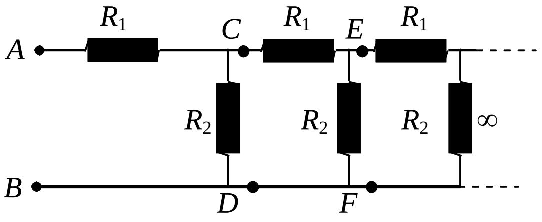
1. In the figure shown, pan *C* is massless. All strings and pulleys are ideal. Block *B* is dropped from a height *l* on pan *C*. Collision between block *B* and pan *C* is perfectly inelastic. Just after collision tension in string *A* differ from tension in string *A* before collision by a magnitude of



(A) Mg (B) $\frac{Mg}{2}$

(C) $\frac{Mg}{4}$ (D) 2Mg

2. An infinite grid is made using resistor R_1 and R_2 as shown. The potential difference between *A* and *B* is *V*, between *C* and *D* is $\frac{V}{3}$, between *E* and *F* is $\frac{V}{9}$ i.e. potential difference becomes one third after each pair. The value of $\frac{R_1}{R_2}$ is

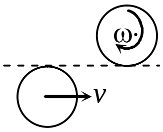


(A) 1 (B) $\frac{4}{3}$

(C) $\frac{2}{3}$ (D) 2

Space for rough work

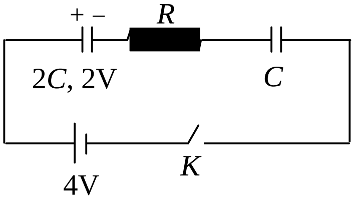
3. A uniform disc of mass m and radius R is rotating with angular velocity ω on a smooth horizontal surface. Another identical disc is moving translationally with velocity v as shown.



When they touch each other, they stick together. The angular velocity of centre of mass of the system after contact will be

(A) zero
(B) $\frac{2v - R\omega}{6R}$
(C) $\frac{v}{R}$
(D) $\frac{\omega}{6}$

4. A capacitor of capacitance $2C$ is charged to a potential 2V and then connected to an uncharged capacitor of capacitance C with a resistance R to a battery of emf 4V as shown.
The key is closed at t = 0. The charge on uncharged capacitor as a function of time will be



(A) $4CV\left(1 - e^{\frac{-t}{2RC}}\right)$
(B) $\frac{4CV}{3}\left(1 - e^{\frac{-t}{2RC}}\right)$
(C) $4CV\left(1 - e^{\frac{-3t}{2RC}}\right)$
(D) $\frac{4CV}{3}\left(1 - e^{\frac{-3t}{2RC}}\right)$

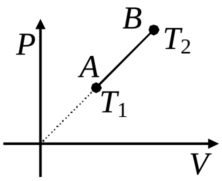
5. A series circuit consisting of a capacitor and a coil with active resistance is connected to a source of harmonic voltage whose frequency can be varied, keeping the voltage amplitude constant. At frequencies ω_1 and ω_2, the current amplitudes are n times less than the resonance amplitude. Then resonance frequency will be

(A) $\frac{\omega_1 + \omega_2}{2}$
(B) $\omega_1 + \omega_2$
(C) $\omega_1 - \omega_2$
(D) $\sqrt{\omega_1\omega_2}$

6. If the tension in the string changes by 21%, the fundamental frequency of string changes by 15 Hz. Which of the following statement is correct?
(A) original fundamental frequency is nearly 150 Hz
(B) velocity of propagation changes by 4.5%
(C) velocity of propagation changes by 10%
(D) fundamental wavelength changes by 15%

Space for rough work

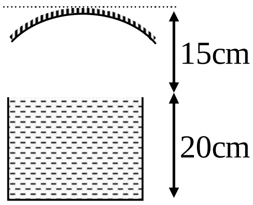
7. Two moles of an ideal monatomic gas are taken from state *A* to state *B* through a process as shown in figure. The work done by the gas in the process is



(A) $R(T_2 - T_1)$
(B) $2R(T_2 - T_1)$
(C) $\frac{1}{2}R(T_2 - T_1)$
(D) $\frac{1}{4R}(T_2 - T_1)$

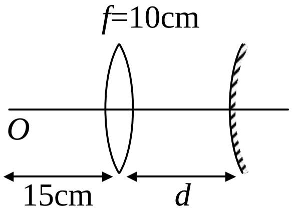
8. When an ideal gas undergoes an isothermal expansion, the pressure of the gas decreases due to
(A) decrease in change in momentum per collision
(B) decrease in frequency of collision with the container
(C) both decrease in frequency of collision and change in momentum per collision
(D) none of these

9. A vessel is filled with water $\left(\mu = \frac{4}{3}\right)$ upto a height 20 cm. A concave mirror of radius of curvature 40 cm is placed 15 cm above the water level. The position of final image of an object placed 20 cm below the water surface will be



(A) 45 cm below the water surface
(B) 60 cm above the water surface
(C) 45 cm above the water surface
(D) 60 cm below the water surface

10. An object is placed in front of convex lens of focal length (*f* = 10 cm). The distance *d* for which image of the object will concide with the object (irrespective of focal length of the mirror)



(A) 30
(B) 20
(C) 0
(D) 15

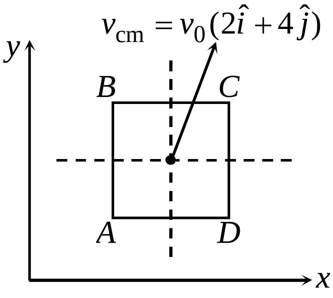
11. The probability that a radioactive nucleus will survive 10 times longer than its half life, is
(A) 2^{-20}
(B) 2^{-10}
(C) $\left(\frac{1}{2}\right)^5$
(D) data insufficient

Space for rough work

12. In a screw gauge, there are 100 divisions in circular scale and each main scale division is of 1 mm. When there is no gap between the jaws, 97th divisions coincides with the main scale zero and zero of main scale is not visible. While measuring the diameter of a ball, the circular scale is between 3 mm mark and 4 mm mark such that the 76th division of circular scale coincides with the reference line. Select the correct alternative

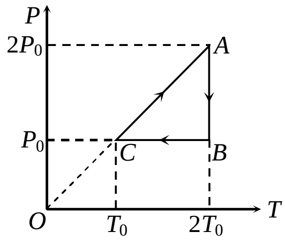
(A) the least count of the micrometer is 0.01 cm
(B) the zero error is – 0.04 mm
(C) the diameter of the ball is 3.79 cm
(D) the main scale reading is 4 mm

13. A uniform solid square plate *ABCD* of mass m and side *a* is moving in *x – y* horizontal smooth plane. The velocity of centre of mass is $v_0(2\hat{i}+4\hat{j})$ m/s. The end *A* of square plate is suddenly fixed by a pin, find the new velocity of centre of mass of square



(A) $v_0(2\hat{i}+4\hat{j})$
(B) $\frac{3v_0}{4}(-\hat{i})+\frac{3v_0}{4}\hat{j}$
(C) $\frac{3v_0}{2}\hat{i}-\frac{3v_0}{2}\hat{j}$
(D) $3v_0\hat{i}-3v_0\hat{j}$

14. Three moles of an ideal gas goes to a cyclic process shown in figure. The work done by the gas during the process is



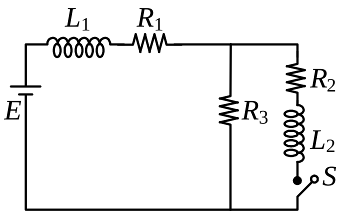
(A) $2.36RT_0$
(B) $0.58RT_0$
(C) $1.16RT_0$
(D) $-0.58RT_0$

15. A uniform ring of mass '*m*' and radius '*R*' is projected horizontally with velocity v_0 on a rough horizontal floor, so that it starts off with a purely sliding motion and it acquires a purely rolling motion after moving a distance *d*. If the coefficient of friction between the ground and ring is μ, then work done by the friction in the process is

(A) $-\mu mgd$
(B) $-\frac{1}{4}mv_0^2$
(C) μmgd
(D) $-\frac{1}{8}mv_0^2$

Space for rough work

16. In the circuit shown in figure, the switch '*S*' is closed at *t* = 0. After closing the switch, in steady state, the value of current in the resistor R_3



(A) increases
(B) decreases
(C) remains constant
(D) becomes zero

17. A particle is moving in *x* – *y* plane with a constant speed v_0 such that its *y* displacement is given by $y = \alpha e^{\frac{-2v_x}{\sqrt{3}v_0}}$. Where v_x is component of velocity along *x* axis. *y* displacement of the particle when slope of tangent on its path is $-\frac{1}{\sqrt{3}}$, is

(A) αe^{-1}
(B) αe^{-2}
(C) zero
(D) $\alpha^2 e$

18. A uniform string of large length *L* of uniform cross section, mass per unit length λ and free at both ends is revolving round the earth at equator in vertical position in such a way that its position relative to the earth is always the same and its lower end is slightly above the earth's surface. If the string is pulled down by a small distance *x*, then work done by gravity is

(A) $GM\lambda x\left(\frac{R}{R+L}\right)$
(B) $\frac{GM\lambda xL}{R(R+L)}$
(C) $\frac{GM\lambda x^2}{R(R+L)}$
(D) $\frac{GM\lambda L^2}{R(R+L)}$

19. A particle on a spring executes SHM. If the mass of the particle and the amplitude are both doubled then the magnitude of the maximum acceleration of the particle will change by a factor of

(A) 4
(B) $\sqrt{8}$
(C) 2
(D) 1

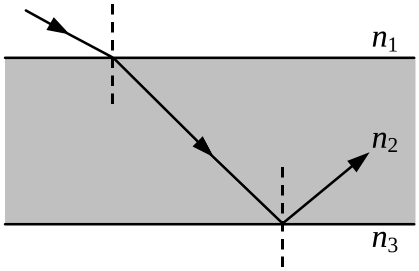
20. Two waves travel down the same string. The waves have the same velocity, frequency (f_0), and wavelength but different phase constants ($\phi_1 > \phi_2$) and amplitudes ($A_1 > A_2$)
According to the principle of superposition, the resultant wave has an amplitude *A* such that

(A) $A = A_1 + A_2$
(B) $A = A_1 - A_2$
(C) $A_1 \le A \le A_2$
(D) $A_1 - A_2 \le A \le A_1 + A_2$

Space for rough work

21. You are provided with three similar, but slightly different, tuning forks. When *A* and *B* are both struck, a beat frequency of f_{AB} is heard. When *B* and *C* are both struck, a beat frequency of f_{BC} is heard. It was noticed that $f_{AB} < f_{BC}$
A and C are simultaneously struck. What will be the observed beat frequency?
(A) $|f_{AB} + f_{BC}|$
(B) $|f_{AB} - f_{BC}|$
(C) either $|f_{AB} + f_{BC}|$ or $|f_{AB} - f_{BC}|$ will be heard
(D)both $|f_{AB} + f_{BC}|$ and $|f_{AB} - f_{BC}|$ will simultaneously be heard

22. Light traveling through three transparent substances follows the path shown in figure. Arrange the indices of refraction in order from smallest to largest. Note that total internal reflection does occur on the bottom surface of medium 2



(A) $n_1 < n_2 < n_3$
(B) $n_2 < n_1 < n_3$
(C) $n_1 < n_3 < n_2$
(D) $n_3 < n_1 < n_2$

23. Light shines through a spherical air bubble underwater. What type of optical device does the bubble act like?
(A) Converging
(B) Diverging
(C) Planar
(D) none of these

24. For fun, a student constructs a three-slit interference experiment. If the light from each of the three slits arrives in phase at the central maximum, then how will the intensity I compare to the intensity I_0 from a single slit?
(A) $I = I_0$
(B) $I = 3I_0$
(C) $I = 6I_0$
(D) $I = 9I_0$

25. An ideal gas has an initial pressure of 3 units and an initial volume of 4 units. The table gives the final pressure and volume of the gas (in same unit) in five processes. Which processes start and end on the same isotherm?

	a	b	c	d	e
P	12	6	5	4	2
V	1	2	7	3	12

(A) a, b, d
(B) a, b, d, e
(C) only c
(D) d, e

Space for rough work

26. If two moles of diatomic gas and one mole of mono atomic gas are mixed then the ratio of specific heats is

(A) $\frac{7}{3}$ (B) $\frac{5}{4}$

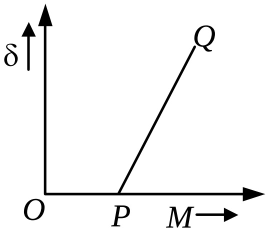
(C) $\frac{19}{13}$ (D) $\frac{15}{19}$

27. The K_α wavelength of an element with atomic number $Z = 17$ is given by λ.
What is the atomic number of an element with a K_α wavelength of 4λ?

(A) 4 (B) 5

(C) 7 (D) 9

28. For a small angled prism, angle of prism A, the angle of minimum deviation (δ) varies with the refractive index of the prism as shown in the graph



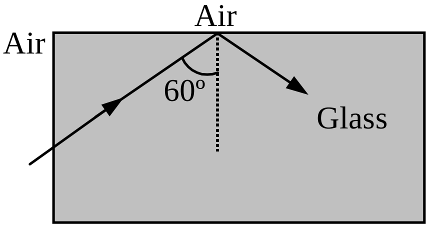
(A)point P corresponds to $\mu > 1$

(B)slope of the line $PQ = A/2$

(C)slope = A

(D)none of the above statements is true

29. A light ray from air is incident (as shown in figure) at one end of a glass fiber (refractive index $\mu = 1.5$) making an incidence angle of 60º on the lateral surface, so that it undergoes a total internal reflection. How much time would it take to traverse the straight fiber of length 1 km



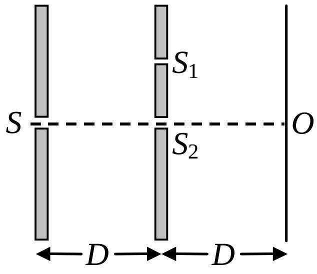
(A) 3.33 μ sec

(B) 6.67 μ sec

(C) 5.77 μ sec

(D) none of these

30. Two ideal slits S_1 and S_2 are at a distance d apart, and illuminated by light of wavelength λ passing through an ideal source slit S placed on the line through S_2 as shown. The distance between the planes of slits and the source slit is D. A screen is held at a distance D from the plane of the slits. The minimum value of d for which there is darkness at O is



(A) $\sqrt{\frac{3\lambda D}{2}}$ (B) $\sqrt{\lambda D}$

(C) $\sqrt{\frac{\lambda D}{2}}$ (D) $\sqrt{3\lambda D}$

Space for rough work

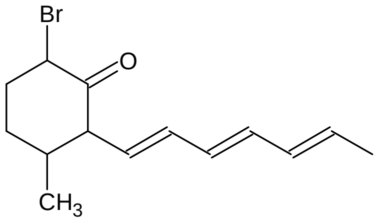
Chemistry PART – II

SECTION – A

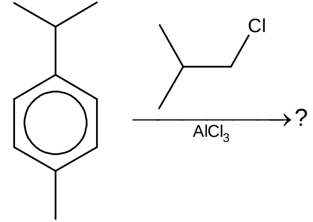
Straight Objective Type

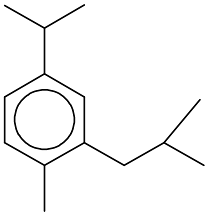
This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

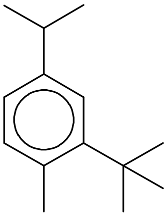
1. The basicity of Aliphatic Amines in gas phase is
(A) 1° amine > 2° amine > 3° amine
(B) 3° amine > 2° amine > 1° amine
(C) 2° amine > 1° amine > 3° amine
(D) 2° amine > 3° amine > 1° amine

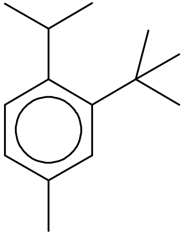
2.


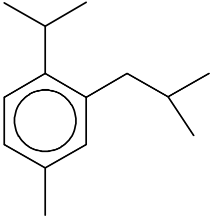
How many stereo isomers are possible for above compound?
(A) 14
(B) 16
(C) 12
(D) 18

3. The major product of the given reaction is


(A)


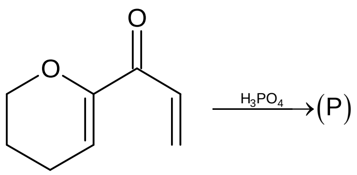
(B)


(C)


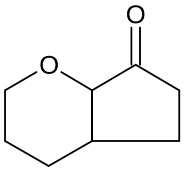
(D)


Space for rough work

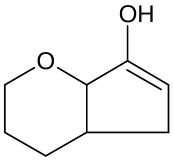
4.



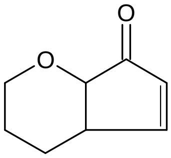
(A)



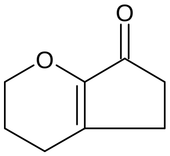
(B)



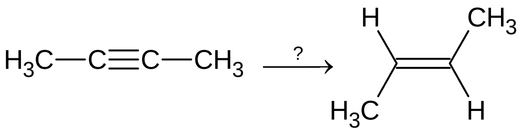
(C)



(D)



5.


H₃C—C≡C—CH₃
?
H
CH₃
H₃C
H

(A) NH_2-NH_2 | OH^-

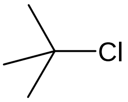
(B) H_2 | Ni

(C) H_2 | Pd – $BaSO_4$

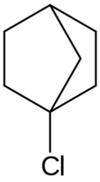
(D) H_2 | Ll. liq NH_2

6. Which of the following halide readily undergo S_N1 reaction?

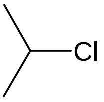
(A)



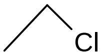
(B)



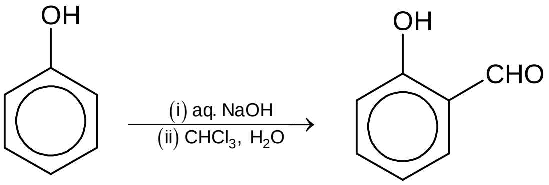
(C)



(D)



7.


OH
(i) aq. NaOH
(ii) CHCl3, H2O
OH
CHO

The intermediate involved is:

(A) $:CH_2$ (B) $:CCl_2$

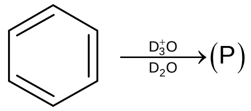
(C) $\overset{\oplus}{C}H_3$ (D) $\overset{\oplus}{C}Cl_2$

8. When accetaldehyde is heated with Fehling's solution. It gives a precipitate of

(A) Cu (B) CuO

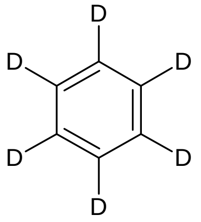
(C) Cu_2O (D) $Cu + Cu_2O + CuO$

9.

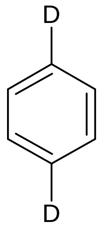


The product (P) formed finally is?

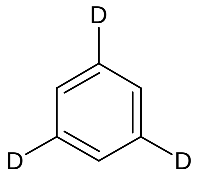
(A)



(B)

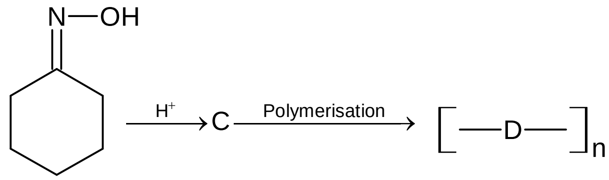


(C)



(D) None of these

10.


N—OH
H+
C
Polymerisation
[—D—]n

What is D?

(A) Nylon-66 (B) Nylon – 6

(C) Bekalite (D) Buna – 9

11. The electronic configuration of four elements are
(1) [Xe]$6s^1$
(2) [Xe]$4f^{14}$, $5d^1$, $6s^2$
(3) [Ar]$4s^2 4p^5$
(4) [Ar]$3d^7$, $4s^2$
Which one of the following statements about these elements is not correct?
(A) 1 is strong reducing agent.
(B) 2 is a d-block element.
(C) 3 has high electron affinity.
(D) The compound formed between 1 and 3 is ionic.

12. The IP_1' IP_2, IP_3, IP_4 and IP_5 of an element are 7.1, 14.3, 34.5, 46.8, 162.2 eV respectively. The element is likely to be

(A) Na	(B) Si
(C) F	(D) Ca

13. H_2S is bubbled into 0.2 M NaCN solution which is 0.02 M in each $[Cd(CN)_4]^{2-}$ and $[Ag(CN)_2]^-$. The H_2S produces 1×10^{-9} M sulphide ion in the solution.
Given: $K_{sp} Ag_2S = 1 \times 10^{-50}\ M^3; K_{sp} CdS = 7.1 \times 10^{-28}\ M^2$
$K_{instability}\left[Ag(CN)_2\right]^{-1} = 1 \times 10^{-20}\ M^2, K_{instability}\left[Cd(CN)_4\right]^{2-} = 7.8 \times 10^{-18}\ M$
Identify the correct statement:
(A) Ag_2S precipitates first from the solution.
(B) CdS precipitates first from the solution.
(C) None of them precipitates under the given conditions.
(D) Ag_2S precipitates at a sulphide concentration $1 \times 10^{+15}$ M.

14. Extraction of Ag from commercial lead is done by

(A) Parke's Process	(B) Clarke's Process
(C) Kroll's Process	(D) Electrolytic Process

15. Most stable polymeric hydride among the following is:

(A) CaH_2	(B) MgH_2
(C) BaH_2	(D) SrH_2

Space for rough work

16. $NaOH + O_3 \longrightarrow X + \text{products}$

X is

(A) Na_2O (B) NaO_3

(C) NaO_2 (D) Na_2O_2

17. Arrange the bond angle order for Cl_2O, ClO_2, F_2O, Br_2O:

(A) $OF_2 > OCl_2 > OBr_2 > ClO_2$ (B) $OF_2 < OCl_2 < OBr_2 < ClO_2$

(C) $ClO_2 < OF_2 < OCl_2 < OBr_2$ (D) $OF_2 < OCl_2 < ClO_2 < OBr_2$

18. A d-Block element forms octahedral complex but its magnetic moment remains same either in strong field or in weak field ligand. Which of the following is/are correct?

(A) Element always forms colourless compound.

(B) Number of electrons in t_{2g} orbitals are higher than in e_g orbitals.

(C) It can have either d^3 or d^8 configuration.

(D) It can have either d^7 or d^8 configuration.

19. Among the following complexes which will be attracted by magnetic field?

$\underset{(I)}{\left[Ni(CN)_4\right]^{2-}}$, $\underset{(II)}{\left[NiCl_4\right]^{2-}}$, $\underset{(III)}{\left[Ni(CO)_4\right]}$, $\underset{(IV)}{\left[Ni(H_2O)_6\right]^{2+}}$

(A) (I) only (B) (I) and (IV)

(C) (II), (III) and (IV) (D) (II) and (IV)

20. H_2S gas on passing through $CdSO_4$ solution will give

(A) Black ppt (B) Yellow ppt

(C) Organge ppt (D) No ppt

21. The vapour density of a mixture containing NO_2 and N_2O_4 is 27.6. The mole fraction of N_2O_4 in the mixture is

(A) 0.1 (B) 0.2

(C) 0.5 (D) 0.8

22. Calculate the maximum number of electrons which may have magnetic quantum number m = + 1 and spin quantum number s = +1/2 in chromium.

(A) 0 (B) 1

(C) 4 (D) 3

23. 36.5% HCl has density equal to 1.2 g ml^{-1}. The molarity (M) and molality (m), respectively are

(A) 15.7, 15.7 (B) 12, 12

(C) 15.7, 12 (D) 12, 15.7

Space for rough work

24. $3KClO_3 + 3H_2SO_4 \longrightarrow 3KHSO_4 + HClO_4 + 2ClO_2 + H_2O$

Equivalent weight of $KClO_3$ is

(A) $\frac{M}{4}$ (B) $\frac{M}{2}$

(C) $\left(M + \frac{M}{2}\right)$ (D) $\left(\frac{M}{4} + \frac{M}{2}\right)$

25. An ideal gas obeying kinetic theory of gases can be liquefied, if

(A) It's temperature is more than critical temperature T_c.

(B) Its pressure is more than critical pressure P_c.

(C) It's pressure is more than P_c at a temperature less than T_C.

(D) It cannot be liquefied at any value of P and T

26. A sample of Argon gas at 1 atm pressure and 27°C expands reversibly and adiabatically from 1.25 dm^3 to 2.5 dm^3. Calculate the enthalpy. Change in this process. C_{vm} for Argon is 12.48 $Jk^{-1}mol^{-1}$

(A) –114.52 J (B) –110.32 J

(C) –100.42 J (D) –126.42 J

27. In reduction

$\underset{(g)}{CH_3COCH_3} \rightleftharpoons \underset{(g)}{CH_3CH_3} + CO(g)$, if the initial pressure of $CH_3COCH_3(g)$ is 150 mm and at equilibrium the mole fraction of CO(g) is $\frac{1}{3}$, then the value K_p is

(A) 50 mm (B) 100 mm

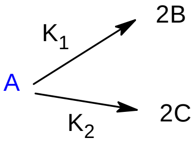
(C) 33.3 mm (D) 75 mm

28. Calculate pH of saturated solution of $Mg(OH)_2$, K_{sp} for $Mg(OH)_2$ is 8.9×10^{-12}

(A) 9.4 (B) 11.2

(C) 10.4 (D) 9.8

29. For a hypothetical elementary reaction:



Where $\frac{K_1}{K_2} = \frac{1}{2}$

Initially only 2 moles of A are present. The total no. of moles of A, B and C at the end of 75% reaction are

(A) 2 (B) 3

(C) 4 (D) 3.5

30. A crystal is made of particles X and Y. X forms f_{cc} packing and Y occupies all the octahedral voids. If all the particles along one body diagonal are removed then the formula of the crystal would be:

(A) X_4Y_3 (B) X_5Y_4

(C) X_4Y_5 (D) None of these

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. If α, β are the roots of the equation $x^2 + px + q = 0$ and also of the equation $x^{2n} + p^n x^n + q^n = 0$ and if $\frac{\alpha}{\beta}, \frac{\beta}{\alpha}$ are the roots of the equation $x^n + 1 + (x + 1)^n = 0$ then n must be an

(A) even integer
(B) odd integer
(C) irrational number
(D) none of these

2. A pole 50m high stands on a building 250 m high to an observer at a height of 300 m, the building and the pole subtend equal angles. The distance of the observer from the top of the pole is

(A) 25 m
(B) 50 m
(C) $25\sqrt{3}$m
(D) $25\sqrt{6}$m

3. Let $P = \prod_{n=1}^{\infty}\left(10^{\frac{1}{2^{n-1}}}\right)$ then $\log_{0.01}(P)$ is

(A) 0
(B) –1
(C) 1
(D) none of these

4. The greatest value of the function $y = \frac{x}{ax^2 + b}$ (a, b > 0)

(A) $\frac{1}{\sqrt{ab}}$
(B) $\frac{1}{2\sqrt{ab}}$
(C) $\sqrt{ab}$
(D) $2\sqrt{ab}$

Space for rough work

5. If a variable takes the values 0, 1, 2, ….., n with frequencies 1, ${}^nC_1$, ${}^nC_2$, …, ${}^nC_n$, then the A.M. is

(A) n
(B) $\frac{2^n}{n}$
(C) n + 1
(D) $\frac{n}{2}$

6. The greatest coefficient in the expansion of $(a + b + c + d)^{15}$ is

(A) $\frac{15!}{(3!)^2(4!)^3}$
(B) $\frac{15!}{(3!)(4!)^3}$
(C) $\frac{15!}{(3!)^3(4!)^2}$
(D) none of these

7. Let S be the set of all triangles and R^+ be the set of positive real numbers, then the function, f: $S \to R^+$, $f(\Delta)$ = area of Δ, where $\Delta \in S$ is

(A) injective but not surjective
(B) surjective but not injective
(C) injective as well as surjective
(D) neither injective nor surjective

8. Tangents are drawn to $x^2 + y^2 = 16$ from P(0, h). These tangents meet x-axis at A and B. If the area of PAB is minimum, then value of h is

(A) $12\sqrt{2}$
(B) $8\sqrt{2}$
(C) $4\sqrt{2}$
(D) $\sqrt{2}$

9. If $\alpha + \beta = 3\pi$ then the chord joining the points α and β for the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ passes through

(A) focus
(B) centre
(C) one of the end points of the transverse axis
(D) one of the end points of the conjugates axes

10. For a given non-zero value of m each of the lines $\frac{x}{a} - \frac{y}{b} = m$ and $\frac{x}{a} + \frac{y}{b} = m$ meets the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ at a point, sum of the ordinates of these points, is

(A) $\frac{a(1+m^2)}{m}$
(B) $\frac{b(1-m^2)}{m}$
(C) 0
(D) $\frac{a+b}{2m}$

Space for rough work

11. Two points P and Q are given in the rectangular cartesian co-ordinates on the curve $y = 2^{x+2}$, such that $\overrightarrow{OP} \cdot \hat{i} = -1$ and $\overrightarrow{OQ} \cdot \hat{i} = 2$ where $\hat{i}$ is a unit vector along the x-axis. Then the magnitude of $\overrightarrow{OQ} - 4\overrightarrow{OP}$ is

(A) 8 (B) 10
(C) 12 (D) 16

12. The image of A(p, q) in the line y = –x is B and the image of B in the line y = x is C then the mid point of AC is

(A) (p + q, p + q) (B) $\left(\frac{p+q}{2}, \frac{p+q}{2}\right)$
(C) (p – q, q – p) (D) (0, 0)

13. Let PQR be a triangle let P be the point (1, 2), y = x is the perpendicular bisector of PQ and x – 2y + 1 = 0 is the angel bisector of $\angle$R. If equation of QR is given by $\lambda x + \mu y - 5 = 0$, then the value of $\lambda + \mu$ is

(A) 1 (B) 2
(C) 3 (D) 4

14. If the tangents are drawn from any point on the line x + y = 3 to the circle $x^2 + y^2 = 9$, then the chord of contact passes through the point

(A) (3, 5) (B) (3, 3)
(C) (5, 3) (D) none of these

15. A is a point (a, b) in the first quadrant. If the two circles which passes through A and touches the coordinate axes cut at right angles then

(A) $a^2 - 6ab + b^2 = 0$ (B) $a^2 + 2ab - b^2 = 0$
(C) $a^2 - 4ab + b^2 = 0$ (D) $a^2 - 8ab + b^2 = 0$

16. If P be a point on the parabola $y^2 = 3(2x - 3)$ and M is the foot of perpendicular drawn from P on the directrix of the parabola, then length of each sides of an equilateral triangle SMP (where S is the focus of the parabola), is

(A) 2 (B) 4
(C) 6 (D) 8

17. If the chord of contact of tangents from a point P to the parabola $y^2 = 4ax$ touches the parabola $x^2 = 4by$, then locus of P is

(A) circle (B) parabola
(C) ellipse (D) hyperbola

Space for rough work

18. A tangent to the ellipse $\frac{x^2}{25}+\frac{y^2}{16}=1$ at any points meet the line x = 0 at a point Q. Let R be the image of Q in the line y = x, then circle whose extremities of a diameter are Q and R passes through a fixed point, the fixed point is

(A) (3, 0)	(B) (5, 0)
(C) (0, 0)	(D) (4, 0)

19. Number of distinct normal lines that can be drawn to ellipse $\frac{x^2}{169}+\frac{y^2}{25}=1$ from the point P(0, 6) is

(A) 1	(B) 2
(C) 3	(D) 4

20. The conditional $(p \wedge q) \Rightarrow p$ is

(A) a tautology	(B) a contradiction
(C) neither a tautology nor a contradiction	(D) none of these

21. If f(x) = (x – 1)(x – 2)(x – 3)(x – 4), then out of the three roots of f′(x) = 0

(A) three are positive	(B) three are negative
(C) two are complex	(D) none of these

22. Let f(x) g(y) = g′(y) – f′(x) g(y) $\forall$ x, y $\in$ R and g′(0) = 1, g(0) = 1, f′(0) = –5, then

(A) f(0) = 8	(B) f(1) = e
(C) g(1) = e	(D) g(–1) = e^{-1}

23. At an election, a voter may vote for any number of candidates not greater than the number to be elected, there are 10 candidates and 4 are to be elected. The number of ways in which a voter can vote for atleast one candidate is

(A) 385	(B) 1110
(C) 5040	(D) 4050

24. The number of 5 digit numbers that can be made using the digits 1 and 2 and in which at least one digit in different, is

(A) 30	(B) 31
(C) 32	(D) 35

Space for rough work

25. If two numbers a and b are chosen from the set of integers 1, 2, 3, 4, ….., 39 then, the probability that the equation 7a – 9b = 0 is satisfied, is

(A) $\frac{1}{247}$ (B) $\frac{2}{247}$

(C) $\frac{4}{741}$ (D) $\frac{5}{741}$

26. Two numbers are selected randomly from set S = {1, 2, 3, 4, 5, 6} without replacement one by one the probability that minimum of the two number is less than 4, is

(A) $\frac{1}{15}$ (B) $\frac{14}{15}$

(C) $\frac{1}{5}$ (D) $\frac{4}{5}$

27. If $\int \frac{dx}{\sqrt{\sin^3 x \cos x}} = g(x) + c$, then g(x) is equal to

(A) $-\frac{2}{\sqrt{\cos x}}$ (B) $-\frac{2}{\sqrt{\tan x}}$

(C) $\frac{2}{\sqrt{\cot x}}$ (D) $\frac{2}{\sqrt{\tan x}}$

28. The number of real solution of $6^x + 1 = 8^x - 27^{x-1}$ is/are

(A) exactly one (B) exactly two

(C) more than two (D) none of these

29. The value of $\theta \in (0, 2\pi)$ for which the equation is $2\sin^2\theta - 5\sin\theta + 2 > 0$, is

(A) $\left(0, \frac{\pi}{6}\right) \cup \left(\frac{5\pi}{6}, 2\pi\right)$ (B) $\left(\frac{\pi}{8}, \frac{5\pi}{6}\right)$

(C) $\left(0, \frac{\pi}{8}\right) \cup \left(\frac{\pi}{6}, \frac{5\pi}{6}\right)$ (D) $\left(\frac{41\pi}{48}, \pi\right)$

30. If f: R → R and g: R → R are two function such that $f(x) + f''(x) = -xg(x)f'(x)$ and $g(x) > 0\ \forall\ x \in R$ then $f^2(x) + (f'(x))^2$ has

(A) maxima at x = 0 (B) min at x = 0

(C) point of inflexion at x = 0 (D) none of these

Space for rough work

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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CRT – III
(Main)

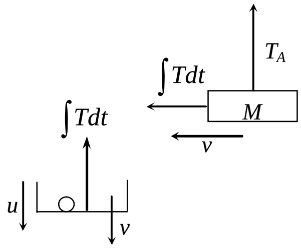
	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	B	A
2.	B	B	D
3.	B	B	B
4.	D	D	B
5.	D	D	D
6.	A	A	B
7.	A	B	B
8.	B	C	C
9.	A	A	B
10.	A	B	C
11.	B	B	B
12.	C	B	D
13.	B	B	B
14.	C	A	B
15.	B	B	C
16.	B	B	C
17.	A	B	D
18.	B	B	C
19.	D	D	C
20.	A	B	A
21.	C	B	A
22.	A	D	C
23.	A	D	A
24.	D	C	A
25.	A	D	C
26.	C	A	D
27.	D	D	B
28.	C	C	B
29.	D	D	A
30.	C	B	A

Physics

PART – I

SECTION – A

1. $-\int T dt = Mv - Mu$ and $\int T\,dt = Mv$

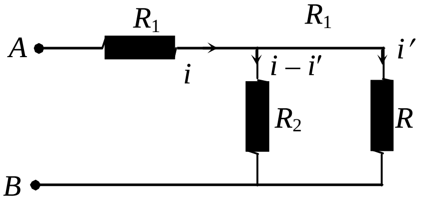


$$v = \frac{u}{2}$$

$$T_{A\ new} = Mg + M\frac{v^2}{l} = Mg + M\frac{u^2}{4l} = \frac{3Mg}{2}$$

$$T_{A\ old} = Mg$$

2. Let equivalent resistance between *A* and *B* is *R*.



$$iR = V, \quad i'R = \frac{V}{3} \quad \Rightarrow \quad i' = \frac{i}{3}$$

$$\frac{V}{3} = \frac{2i}{3}R_2$$

$$R = 2R_2$$

$$iR_1 = \frac{2V}{3}$$

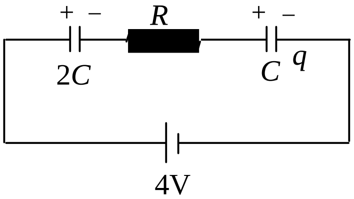
$$\frac{R_1}{R_2} = \frac{4}{3}$$

3. Conserving angular momentum

$$mvR - \frac{3mR^2\omega}{2} = 3mR^2\omega'$$

$$\Rightarrow \quad \omega' = \frac{2v - 3R\omega}{6R}$$

4. Let at any time a charge *q* flows through the circuit. The circuit is as shown



$$\text{Time constant } (\tau) = \frac{2RC}{3}$$

$$\therefore \quad q = \frac{4CV}{3}\left(1 - e^{\frac{-3t}{2RC}}\right)$$

5. $$I_{M_1} = \frac{V_M}{\sqrt{R^2 + \left(\omega_1 L - \frac{1}{\omega_1 C}\right)^2}}$$

Similarly, $$I_{M_2} = \frac{V_M}{\sqrt{R^2 + \left(\omega_2 L - \frac{1}{\omega_2 C}\right)^2}}$$

Since, both I_{M_1} and I_{M_2} are *n* times less than resonance current amplitude,

$\therefore \quad I_{M1} = I_{M2}$

$$\therefore \quad \frac{V_M}{\sqrt{R^2 + \left(\omega_1 L - \frac{1}{\omega_1 C}\right)^2}} = \frac{V_M}{\sqrt{R^2 + \left(\omega_2 L - \frac{1}{\omega_2 C}\right)^2}}$$

or $\quad \omega_1 L - \frac{1}{\omega_1 C} = \frac{1}{\omega_2 C} - \omega_2 L$

or $\quad \frac{\omega_1^2 LC - 1}{\omega_1 C} = \frac{1 - \omega_2^2 LC}{\omega_2 C}$

or $\quad \omega_1\omega_2 LC(\omega_1 + \omega_2) - (\omega_1 + \omega_2) = 0$

or $\quad 1 - \omega_1\omega_2 LC = 0$

$\therefore \quad \omega_1\omega_2 = \frac{1}{LC} = \omega_0^2$

$\therefore \quad \omega_0 = \sqrt{\omega_1\omega_2}$

6. $f_0 = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$

$\frac{df_0}{f_0} = \frac{1}{2}\frac{dT}{T}$

$f_0 = 2 \times 15 \frac{T}{21} \times 100 = 150 \text{ Hz.}$

7. $W = \int P dV$ and $P \propto V$

9. The object distance for the mirror

$= -\left(15 + \frac{20}{4/3}\right) = -30 \text{ cm}$

For mirror,

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$\Rightarrow \quad \frac{1}{v} + \frac{1}{-30} = \frac{1}{-20} \Rightarrow v = -60 \text{ cm}$

The distance from water surface equals 60 – 15 = 45 cm

12. Least count = $\frac{\text{Pitch}}{\text{Number of divisions on circular scale}}$

= $\frac{1\text{mm}}{100} = 0.01\text{mm} = 0.001\text{cm}$

Zero error = – 0.03 mm

Measurement = 3.76 – (– 0.03) = 3.79 mm

13. $\vec{r}_{cm} = \frac{a}{2}\hat{i} + \frac{a}{2}\hat{j}$ (considering *A* to be origin *AD* to *x*-axis and *AB* to be *y*-axis)

$\vec{L}_i = m\vec{r}_{cm} \times \vec{v}_{cm} = m\left(\frac{a}{2}\hat{i} + \frac{a}{2}\hat{j}\right) \times v_0(2\hat{i} + 4\hat{j})$

$= mav_0(2\hat{k} - \hat{k}) = mav_0\hat{k}$

$$L_f = \left[\frac{m}{12}(a^2 + a^2) + m\frac{a^2}{2}\right]\omega = \left(\frac{ma^2}{6} + \frac{ma^2}{2}\right)\omega$$

From conservation of angular momentum about point *A*

$$L_f = L_i$$

$$\frac{2}{3}ma^2\omega = mav_0$$

$$\Rightarrow \quad \omega = \frac{3v_0}{2a}$$

$$\left|\vec{v}_{cm}\right| = \omega\frac{a}{\sqrt{2}} = \frac{3v_0}{2a}\frac{a}{\sqrt{2}} = \frac{3v_0}{2\sqrt{2}}$$

14. If V_0 be volume of the gas at *C*, $P_0V_0 = 3RT_0$

$$\begin{aligned} W &= 3R(2T_0)\ln 2 - P_0V_0 \\ &= 6RT_0 \ln 2 - 3RT_0 \\ &= 3RT_0[2 \times 0.693 - 1] \\ &= 3RT_0[1.386 - 1] \\ &= 1.16RT_0 \end{aligned}$$

15. $mv_0R = I\omega + mvR$

$$= mR^2\left(\frac{v}{R}\right) + mvR$$

$$v = \frac{v_0}{2}$$

$$K_i = \frac{1}{2}mv_0^2$$

$$K_f = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = \frac{1}{2}m\left(\frac{v_0}{2}\right)^2 + \frac{1}{2}mR^2\frac{v_0^2}{4R^2}$$

$$= \frac{1}{4}mv_0^2$$

So $W_f = -\frac{1}{4}mv_0^2$

16. Initial current in R_3, $i_i = \frac{E}{R_1 + R_3}$

Final current $i_f = \frac{E}{R_1 + \frac{R_2R_3}{R_2 + R_3}} \times \frac{R_2}{R_2 + R_3}$

$$= \frac{R_2E}{R_1(R_2 + R_3) + R_2R_3}$$

$$i_f = \frac{E}{\frac{R_1R_3}{R_2} + R_1 + R_3}$$

As $i_f < i_i$, so current in the resistor R_3 will decrease.

17. $\frac{dy}{dx} = -\frac{1}{\sqrt{3}} = \frac{v_y}{v_x}$

So $v_x = -v_y\sqrt{3}$

$v_x^2 + v_y^2 = v_0^2$

$3v_y^2 + v_y^2 = v_0^2$

$v_y = \pm\frac{v_0}{2}$

$v_x = \mp\frac{\sqrt{3}v_0}{2}$

So $y = \alpha e^{\frac{-2}{\sqrt{3}v_0}\times\frac{\sqrt{3}v_0}{2}}$

$y = \alpha e^{-1}$

18. If the string is pulled down by distance *x*, it is equivalent that a mass of λx is removed from the upper end of the string and is connected to the lower end

So $W_g = -\Delta U = U_i - U_f$

$W_g = \frac{-GM(\lambda x)}{R+L} - \left(\frac{-GM\lambda x}{R}\right)$

$= GM\lambda x\left[\frac{1}{R} - \frac{1}{R+L}\right]$

19. $a_{max} = \omega^2 A = \frac{K}{m}A$

If mass and amplitude both are doubled maximum acceleration will not change.

20. Resultant wave amplitude is given by

$A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos(\varphi_1 - \varphi_2)}$

Value of $\cos(\phi_1 - \phi_2)$ lies between 1 and – 1

Hence $A_1 - A_2 \le A \le A, + A_2$

24. If three waves meet in same phase then the resultant amplitude will be algebraic addition of all three amplitudes

$R = 3A$

$A \to$ Amplitude of superimposed wave

$R \to$ Amplitude of resultant wave

than $I = 9I_0$ as $[I \propto R^2]$

25. If process starts and ends on same isotherm then product of *P* and *V* must be constant hence process *a*, *b*, *d* will be on same isotherm.

26. $\gamma_{mix} = \frac{n_1Cp_1 + n_2Cp_2}{n_1Cv_1 + n_2Cv_2}$

$= \frac{2\times\frac{7}{2}R + 1\times\frac{5}{2}R}{2\times\frac{5}{2}R + 1\frac{3}{2}R} = \frac{19}{13}$

27. $\frac{I}{\lambda_{K\alpha}} = R(Z-1)^2\left(\frac{1}{1^2}-\frac{1}{2^2}\right)$ .....(i)

$\frac{I}{\lambda'_{K\alpha}} = R(Z'-1)^2\left(\frac{1}{1^2}-\frac{1}{2^2}\right)$ ....(ii)

Solving (i) and (ii) $Z' = 9$

28. $\delta = A(\mu - 1)$ Slope of line will be A.

30. $\Delta x = \frac{\lambda}{2}$ $(SS_1 + S_1O) - (SO) = \frac{\lambda}{2}$

$$2\sqrt{D^2 + d^2} - 2D = \frac{\lambda}{2}$$

$$2D\left[1 + \frac{d^2}{2D^2} - 1\right] = \frac{\lambda}{2}$$

$$d = \sqrt{\frac{\lambda D}{2}}$$

Chemistry

PART – II

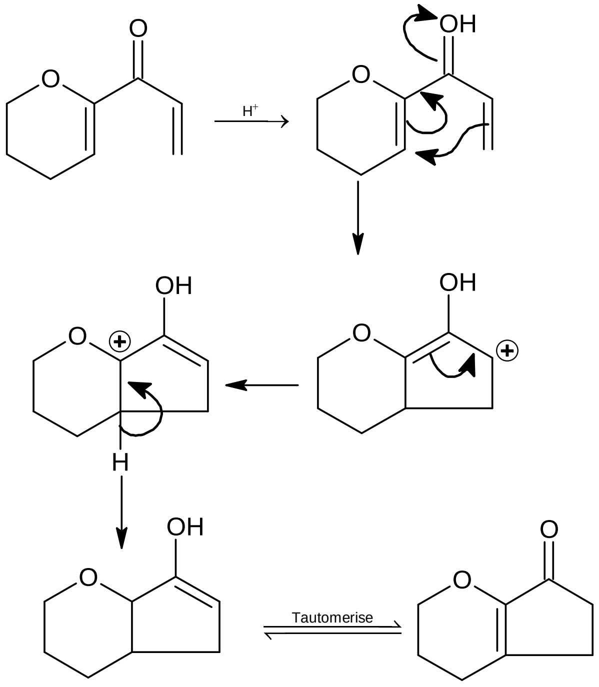
SECTION – A

1. In gas phase inductive effect play a key role.

2. Geometrical isomers = 8 = 2^n
Optical isomer = 8 = 2^3 = 8
= 16

3. Due to bulky effect.

4.


O
O
H^+
OH
O
OH
O
OH
O
H
OH
O
Tautomerise
O
O

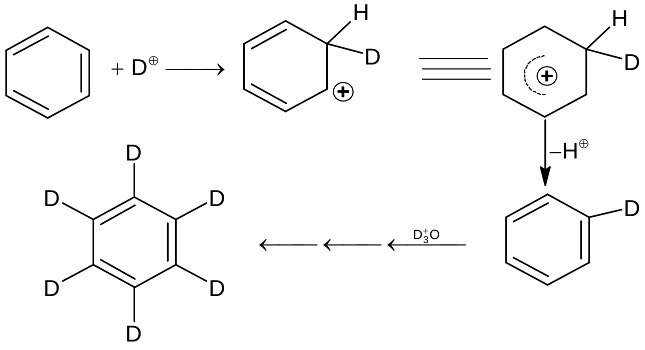
5. Birch reduction.

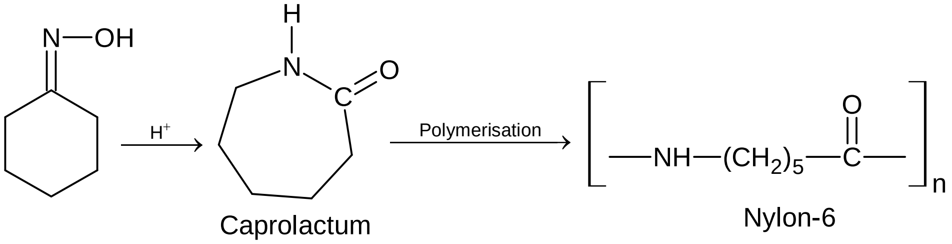
6. 3^o carbocation is more stable.

7. $:CCl_2$ intermediate.

8. $CH_3CHO + 2CuO \longrightarrow CH_3COOH + \underset{\text{Red ppt.}}{Cu_2O} \downarrow$

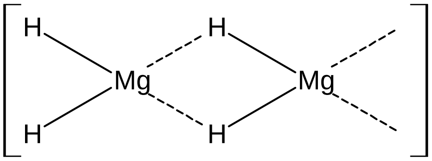
9.


$+ D^\oplus$
H
D
H
D
$-H^\oplus$
D
D_3^+O
D
D
D
D
D
D

10. 

11. It is belong to f-block – Lu element.

12. $IP_4 - IP_5$ required more energy, So IVA group elements.

15. 

16. $3NaOH + 2O_3 \longrightarrow 2NaO_3 + NaOH.H_2O(s) + \frac{1}{2}O_2$

17.

	Cl_2O,	ClO_2,	F_2O,	Br_2O
B.A	110	118	105	112

19. (II) and (IV) have unpaired electron.

20. $H_2S + CdSO_4 \longrightarrow \underset{\text{Yellow ppt}}{CdS}$

21. Let 1 mole of mixture has x mole N_2O_4
$2 \times 27.6 = x(92) + (1 - x)\,46$
$x = 0.2$

22.

	2p	3p	3d
$m =$	$+1$	$+1$	$+1$
$s =$	$+1/2$	$+1/2$	$+1/2$

23. $$M = \frac{\%\text{ by weight} \times 10 \times d}{M.w} = \frac{36.5 \times 10 \times 1.2}{36.5} = 12\text{ M}$$

$$m = \frac{36.5 \times 1000}{36.5 \times (100 - 36.5)} = \frac{1000}{63.5} = 15.7\text{ m}$$

24. $ClO_3^- \longrightarrow ClO_4^- + 2e^-\ (x = 2)\text{oxidation}$

x = 5, x = 7

$e^- + ClO_3^- \longrightarrow ClO_2\ (x = 1)\text{reduction}$

x = 5, x = 4

$$E_W = M + \frac{M}{2}$$

25. Ideal gas has no force of attraction and has negligible volume. Hence it can't be liquefied at any T and P.

26. $\Delta H = nxC_p \times \Delta T$ $\qquad$ $C_p = C_v + K$

$n = \frac{PV}{RT} = 0.05$ $\qquad$ $C_p = 20.794\ JK^{-1}$

For reversible adiable $(TV)^{r-1} = \text{constant}$

$T_2V_2^{r-1} = T_1V_1^{r-1}$ $\qquad$ r = 1.66 for argon

$T_2 = 189.85$ k $\qquad$ $\Delta T = -110.15$

Thus $\Delta H = 0.05 \times 20.794 \times -110.15) = -114.52$ J

27.

$$\begin{array}{lccc} & CH_3COCH_3 \rightleftharpoons & CH_3CH_3(g) + & CO(g) \\ \text{At } t=0 & 150 & 0 & 0 \\ \text{At } t=t & 150-x & x & x \end{array}$$

$$\frac{x}{150+x} = \frac{1}{3}$$

x = 75 mm.

28. $Mg(OH)_2 \rightleftharpoons \underset{s}{Mg^{2+}} + \underset{2s}{2OH^-}$

$4s^3 = 8.9 \times 10^{-12}$,

$s = 1.3 \times 10^{-4}$ m

$\therefore$ [OH] = $2 \times 1.305 \times 10^{-4}$

pOH = 3.58832

pH = 10.4168

29. 1 mole of A will form 2 moles of B and C after completion of reaction when 75%. A converted into B and C then total no. of moles

$0.5 + (2 \times 1.5) = 3.5$ moles

30. Along one body diagonal 2X atoms from 2 corners, one Y particle (at the centre of cube) will be removed.

So effective no. of X particle in a unit cell = $4 - 2 \times \frac{1}{8} = \frac{15}{4}$

And effective no. of Y particle in a unit cell = 4 – 1 = 3

$X : Y = \frac{15}{4} : 3$

5 : 4

Mathematics PART – III

SECTION – A

1. $\alpha^n + \beta^n = -p^n$ ….. (1)

Again since $\frac{\alpha}{\beta}$ is a root of equation

$x^n + 1 + (x + 1)^n = 0$

$\left(\frac{\alpha}{\beta}\right)^n + 1 + \left(\frac{\alpha}{\beta} + 1\right)^n = 0$

$\alpha^n + \beta^n + (\alpha + \beta)^n = 0$

$\alpha^n + \beta^n = -(\alpha + \beta)^n = -(-p)^n$ ….. (2)

From equation (1) and (2), we get

$-p^n = -(-p)^n \Rightarrow p^n = (-p)^n$

$\Rightarrow p^n = (-1)^n p^n \Rightarrow (-1)^n = 1$

$\Rightarrow$ n is an even integer

2. From the figure, OM is bisector of angle $\angle BOP$ of triangle OBP

$\therefore \frac{250}{50} = \frac{OB}{OP}$

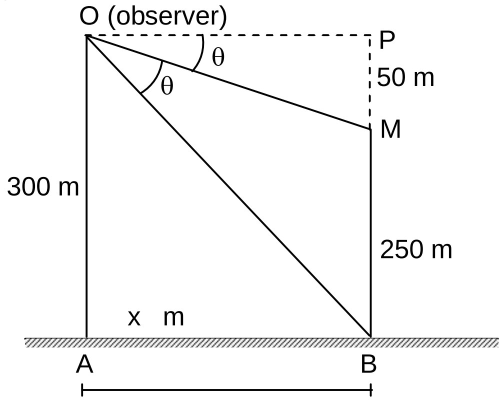
$\Rightarrow 5 = \frac{\sqrt{300^2 + x^2}}{x}$

$\Rightarrow 25x^2 - x^2 = (300)^2$

$\Rightarrow 24x^2 = (300)^2$

$\Rightarrow x^2 = \frac{300 \times 300}{24} = 3250 = 25 \times 25 \times 6$

$\Rightarrow x = 25\sqrt{6}.$



3. $P = 10^1 \cdot 10^{\frac{1}{2}} \cdot 10^{\frac{1}{2^2}} \cdot 10^{\frac{1}{2^3}}$ …..

$P = 10^{1+\frac{1}{2}+\frac{1}{2^2}+\frac{1}{2^3}+.....\infty} = 10^{\frac{1}{1-\frac{1}{2}}} = 10^2 = 100$

$\log_{0.01}P = \log_{0.01}(100) = -1$

4. $\frac{ax^2 + b}{2} \le \sqrt{ax^2b} = |x|\sqrt{ab}$

Consequently, for all x > 0

$y = \frac{x}{ax^2 + b} \le \frac{x}{2x\sqrt{ab}} = \frac{1}{2\sqrt{ab}}$

5. $\bar{x} = \frac{0.1 + 1\cdot{}^nC_1 + 2\,{}^nC_2 + 3\,{}^nC_3 + \cdots + n\,{}^nC_n}{1 + {}^nC_1 + {}^nC_2 + \cdots + {}^nC_n} = \sum_{r=0}^{n} r\,{}^nC_r = \frac{\sum_{r=1}^{n} r\frac{n}{r}\,{}^{n-1}C_{r-1}}{\sum_{r=0}^{n} {}^nC_r}$

$= \frac{n\sum_{r=1}^{n} {}^{n-1}C_{r-1}}{\sum_{r=0}^{n} {}^nC_r} = \frac{n2^{n-1}}{2^n} = \frac{n}{2}$

6. Greatest coefficient is $\frac{n!}{(q!)^{m-r}\left((q+1)!\right)^{r}} = \frac{15!}{(3!)(4!)^{3}}$

I^n = 15 and m = 4, q = 3 and r = 37

$\because$ 15 = 4 × 3 – 13

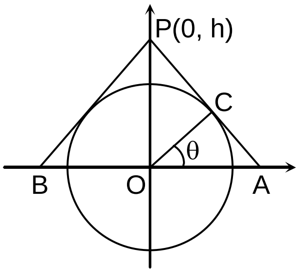
7. Two triangles may have equal areas

$\therefore$ f is not one-one

Since each positive real number can represent area of a triangle

$\therefore$ f is onto

8. Area of ΔPAB = $\frac{32}{\sin 2\theta}$



$(\Delta PAB)_{min}$ when $2\theta = \frac{\pi}{2}$

$\Rightarrow \theta = \frac{\pi}{4}$

$\Rightarrow$ h = OC cosec θ = $4\sqrt{2}$

9. Equation of chord joining α and β is $\frac{x}{a}\cos\left(\frac{\alpha-\beta}{2}\right) - \frac{y}{b}\sin\left(\frac{\alpha+\beta}{2}\right) = \cos\left(\frac{\alpha+\beta}{2}\right)$

$\therefore \alpha + \beta = 3\pi$

$\frac{x}{a}\cos\left(\frac{\alpha-\beta}{2}\right) + \frac{y}{b} = 0$

It passes through the centre (0, 0)

10. Ordinate of the point of intersection of the line $\frac{x}{a} - \frac{y}{b} = m$ and the hyperbola, given by

$\left(\frac{x}{a} - \frac{y}{b}\right)\left(\frac{x}{a} - \frac{y}{b} + \frac{2y}{b}\right) = 1$ i.e. $m\left(m + \frac{2y}{b}\right) = 1$

i.e. $y = \frac{b\left(1-m^2\right)}{2m}$

Similarly ordinate of the point of intersection of the line $\frac{x}{a} + \frac{y}{b} = m$ and the hyperbola is given by

$y = \frac{b\left(m^2-1\right)}{2m}$

Sum of the ordinates is zero

11. Let $P(x_1, y_1)$, $Q(x_2, y_2)$ be the given points on $y = 2^{x+2}$

$\therefore$ $y_1 = 2^{x_1+2}$ and $y_2 = 2^{x_2+2}$

$\overrightarrow{OP}\cdot\hat{i}$ = projection of $\overrightarrow{OP}$ on x-axis = $x_1 = -1 \Rightarrow y_1 = 2$

and $\overrightarrow{OQ}\cdot\hat{i}$ = projection of $\overrightarrow{OQ}$ on x-axis = $x_2 = 2 \Rightarrow y_2 = 16$

$\therefore$ $\overrightarrow{OP} = -\hat{i} + 2\hat{j}$, $\overrightarrow{OQ} = 2\hat{i} + 16\hat{j}$

$\therefore$ $\overrightarrow{OQ} - 4\overrightarrow{OP} = 6\hat{i} + 8\hat{i}$

$\therefore$ $\left|\overrightarrow{OQ} - 4\overrightarrow{OP}\right| = \left|6\hat{i} + 8\hat{j}\right| = 10$

12. The point B is (–q, –p) and the point C is (–p, –q) mid-point of AC is (0, 0)

13. The point Q is (2, 1)

Image of P(1, 2) in the line x – 2y + 1 = 0 is given by $\frac{x-1}{1}=\frac{y-2}{-2}=\frac{4}{5}$

$\therefore$ Ordinate of the point are $\left(\frac{9}{5},\frac{2}{5}\right)$

Since this point lies on QR

$\therefore$ Equation of QR is 3x – y – 5 = 0

$\therefore \lambda + \mu = 2$

14. Let $(\alpha, 3-\alpha)$ be any point on x + y = 3

$\therefore$ Equation of chord of contact is $\alpha x + (3-\alpha)y = 9$

i.e. $\alpha(x-y) + 3y - 9 = 0$

The chord passes through the point (3, 3) for all values of α

15. Equation of the two circles be $(x-r)^2 + (y-r)^2 = r^2$ i.e. $x^2 + y^2 - 2rx - 2ry + r^2 = 0$ where $r = r_1$ and r_2 condition of orthogonally gives $2r_1r_2 + 2r_1r_2 = r_1^2 + r_2^2$

$\Rightarrow 4r_1r_2 = r_1^2 + r_2^2$, circle passes through (a, b)

$\Rightarrow a^2 + b^2 - 2ra - 2rb + r^2 = 0$

i.e. $r^2 - 2r(a+b) + a^2 + b^2 = 0$

$\therefore 4(a^2 + b^2) = 4(a+b)^2 - 2(a^2 + b^2)$

$\Rightarrow a^2 - 4ab + b^2 = 0$

16. $y^2 = 6\left(x-\frac{3}{2}\right)$

Equation of directrix x = 0

Let coordinate P be $\left(\frac{3}{2}+\frac{3}{2}t^2, 3t\right)$

$\therefore$ Coordinate of M are (0, 3t)

$\therefore MS = \sqrt{9+9t^2}$

$MP = \frac{3}{2}+\frac{3}{2}t^2$

$\therefore 9 + 9t^2 = \left(\frac{3}{2}+\frac{3}{2}t^2\right)^2 = \frac{9}{4}\left(1+t^2\right)^2$

$\therefore 4 = 1 + t^2$

$\Rightarrow$ Length of side = 6

17. $yy_1 = 2a(x + x_1)$

$x^2 = 4by = 4b\left[\left(\frac{2a}{y_1}\right)(x+x_1)\right]$

$\Rightarrow y_1x^2 - 8ab\,x - 8ab\,x_1 = 0$

D = 0 gives xy = –2ab

18. Equation of the tangent to the ellipse at P(5 cos θ, 4 sin θ) is $\frac{x\cos\theta}{5}+\frac{y\sin\theta}{4}=1$
It meets the line x = 0 at Q(0, 4 cosec θ)
Image of in the line y = x is R(4 cosec θ, 0)
Equation of the circle is x(x – 4 cosec θ) + y(y – 4 cosec θ) = 0
i.e. $x^2 + y^2 - 4(x + y)\operatorname{cosec}\theta = 0$
∴ Each member of the family passes through the intersection of $x^2 + y^2 = 0$ and x + y = 0
i.e. The point (0, 0)

19. Equation of normal at (13 cos θ, 5 sin θ) of $\frac{x^2}{169}+\frac{y^2}{25}=1$
$(y-5\sin\theta)=\frac{13\sin\theta}{5\cos\theta}(x-13\cos\theta)$ it passes through (0, 6) then cos θ(15 + 72 sin θ) = 0
⇒ cos θ = 0, $\sin\theta=-\frac{5}{24}$
$\Rightarrow\ \pi+\sin^{-1}\left(\frac{5}{24}\right)$

21. Given, f(x) = (x – 1)(x – 2)(x – 3)(x – 4)
Consider the interval [1, 2]
Since, f(x) is a polynomial function, it is continuous in [1, 2] and differentiable in (1, 2)
Also, f(1) = 0 = f(2)
By Rolle's theorem these exists a point x = c in (1, 2) such that f′(c) = 0 i.e. these exists a root of f′(x) = 0 in the interval (1, 2) which is positive
Similarly, two positive roots of f′(x) = 0 exist in the open interval (2, 3) and (3, 4)
Hence, the three roots of f′(x) are positive

22. f(x) g(y) + f′(x) g(y) = g′(y)
⇒ (f(x) + f′(x)) g(y) = g′(y)
⇒ f(x) + f′(x) = $\frac{g'(y)}{g(y)}$ = constant ….. (1)
Put y = 0 ⇒ $\frac{g'(0)}{g(0)}=\frac{1}{1}$
Now from equation (1), we get f(x) + f′(x) = 1 and $\frac{g'(y)}{g(y)}=1$
⇒ g(y) = e^y

23. $^{10}C_1 + {}^{10}C_2 + {}^{10}C_3 + {}^{10}C_4 = 10+45+120+210=385$

24. Total number of numbers without restriction two numbers have all the digits equal
Hence, the required number of numbers = $2^5 - 2 = 30$

25. Given 7a – 9b = 0 ⇒ b = $\frac{7}{9}$a
So, the number of pairs (a, b) can be (9, 7), (18, 14) (27, 21) and (36, 28)
Required probability = $\frac{4}{^{39}C_2}=\frac{4}{741}$

26. Two numbers are selected from {1, 2, 3, 4, 5, 6}

$\therefore$ n(S) = 6 × 5 (as one by one with out replacement) favourable events = minimum of the two numbers is less than 4

$\therefore$ n(E) = 6 × 4

As for the minimum of the two is less then 4, we can select one from {1, 2, 3, 4} and other from {1, 2, 3, 4, 5, 6}

$\therefore$ Required probability = $\frac{n(E)}{n(S)} = \frac{24}{30} = \frac{4}{5}$

27. $\int \frac{dx}{\sqrt{\sin^4 x \cot x}} = \int \frac{dx}{\sin^2 x\sqrt{\cot x}} = \int \frac{\operatorname{cosec}^2 x}{\sqrt{\cot x}} dx$

Put cot x = t^2

cosec^2 x dx = –2t dt

$= -\int \frac{2t}{t} dt = -2t + c = -2\sqrt{\cot x} + c = -\frac{2}{\sqrt{\tan x}} + c$

28. Let $a = 2^x$, $b = -3^{x-1}$, c = –1

$\Rightarrow a^3 + b^3 + c^3 = 3abc$

Now, $a^3 + b^3 + c^3 - 3abc = \frac{1}{2}(a+b+c)\Sigma(a-b)^2$ factorizing and get a + b + c = 0 as a ≠ b ≠ c

Hence, the given equation is; $2^x - 3^{x-1} - 1 = 0$

By trial x = 1 and 2 are solution of this

Now, $2^x = 3^{x-1} + 1$ has no other solution

Number of real solution exactly two

29. $2\sin^2\theta - 5\sin\theta + 2 > 0$

$\sin\theta < \frac{1}{2}$ $(\because -1 \le \sin\theta \le 1)$

$\theta \in \left(0, \frac{\pi}{6}\right) \cup \left(\frac{5\pi}{6}, 2\pi\right)$

30. Let $h(x) = f^2(x) + (f'(x))^2$

$\Rightarrow h'(x) = -2x(f'(x))^2 g(x)$

$\Rightarrow$ x = 0 is the point of maximum

FIITJEE

JEE (Advanced), 2015

CONCEPT RECAPITULATION TEST - III

Paper 1

ALL INDIA TEST SERIES

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

Time Allotted: 3 Hours **Maximum Marks: 234**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 – 12) contains 4 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

Section-A (13 to 18) contains 3 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-C (01 – 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant R = $8.314\ J\ K^{-1}\ mol^{-1}$
= 0.0821 Lit atm $K^{-1}\ mol^{-1}$
= $1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. A spaceship is sent to investigate a planet of mass M and radius R. While hanging motionless in space at a distance 5R from the centre of the planet, the ship fires an instrument package of mass m (m < < mass of spaceship) with speed v_0 at an angle θ w.r.t. radial line between the centre of planet and spaceship. For what value of θ, the package will just graze the surface of the planet. Given $v_0 = \sqrt{\frac{GM}{5R}}$

(A) 30^o
(B) 60^o
(C) 37^o
(D) none of these

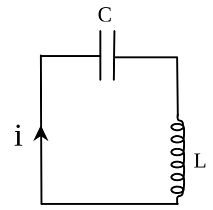
2. A charge distribution generates a radial electric field $\vec{E} = \frac{a}{r^2} e^{-\frac{r}{b}} \hat{r}$

Where a and b are constants. The total charge giving rise to this electric field is
(A) $4\pi\varepsilon_0 a$
(B) $4\pi\varepsilon_0 b$
(C) $4\pi\varepsilon_0 ab$
(D) 0

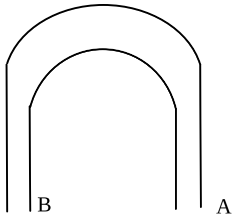
3. Suppose an electrostatic potential has a maximum at point A and a minimum at point B. Choose the correct alternative:
(A) point A is stable equilibrium point for both positive and negative charge
(B) point B is stable equilibrium point for both positive and negative charge
(C) point A is stable equilibrium point for positive and point B is stable equilibrium point for negative charge
(D) point B is stable equilibrium point for positive and point A is stable equilibrium point for negative charge

Space for rough work

4. Choose the correct alternatives for the circuit shown in figure.
(A) The total energy is stored only in the electric field and is changing
(B) The total energy is stored only in the magnetic field and is changing
(C) The total energy is stored in both electric and magnetic field and is changing
(D) The total energy is stored in both electric and magnetic field and is constant

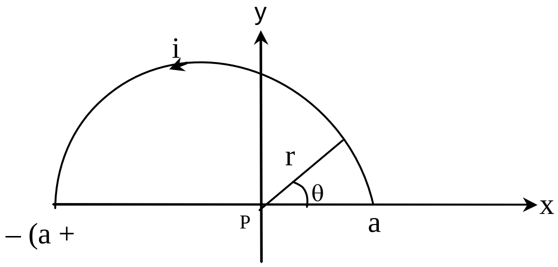


5. A glass rod of rectangular cross section is bent into the shape as shown in figure. The inner and outer contours of the curved portion of the rod have fixed radii R and R + a respectively. The refractive index of the glass is 1.5. For a given $R >> \lambda$, what is the maximum value of 'a' for which all the light entering at A will merge at B?



(A) R
(B) 0.5 R
(C) $\frac{R}{3}$
(D) 2 R

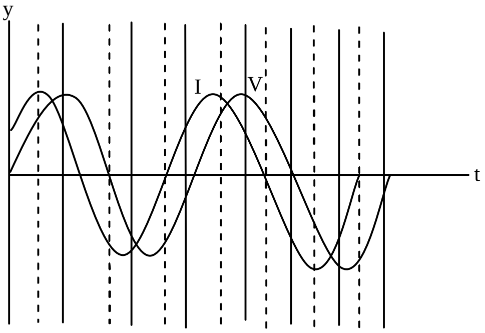
6. A wire segment is bent into the shape of an Archimedes spiral as shown in figure. The equation of the curve is, $r(\theta) = a + \frac{b}{\pi}\theta$ for $0 \le \theta < \pi$. The magnetic field at P is



(A) $\frac{\mu_0 i}{2r}\hat{k}$
(B) $\frac{\mu_0 i}{(2a+b)}\hat{k}$
(C) $\frac{\mu_0 i}{4b}\ln\left(1+\frac{b}{a}\right)\hat{k}$
(D) $\frac{\mu_0 i}{2b}\ln\left(1+\frac{b}{a}\right)\hat{k}$

Space for rough work

7. The graph shows current and voltage vs time in a driven RLC circuit at particular driving frequency. At this frequency the circuit is dominated by
(A) Inductance
(B) Capacitance
(C) Both (A) & (B)
(D) None of these



8. The volume of one mole of an ideal gas with adiabatic exponent γ is varied according to the law $V = \frac{a}{T}$, where a is a constant. Find the amount of heat obtained by the gas in this process if the gas temperature increased by ΔT.

(A) $\frac{2R\Delta T(2-\gamma)}{\gamma-1}$
(B) $\frac{R\Delta T(2-\gamma)}{\gamma-1}$
(C) $\frac{R\Delta T(2-\gamma)}{2(\gamma-1)}$
(D) $\frac{3R\Delta T(2-\gamma)}{2(\gamma-1)}$

Multiple Correct Choice Type

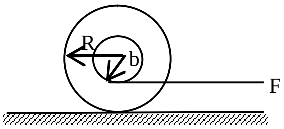
This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

9. A drum of mass m_1 and radius r_1 rotates freely with initial angular velocity ω_0. A second drum with mass m_2 and radius r_2 $(r_2 > r_1)$ is mounted on same axle and is at rest although it is free to rotate. A thin layer of sand with mass m is distributed on inner surface of smaller drum. At t = 0, small perforations in the inner drum are opened. The sand starts to fly out at a constant rate λ kg/sec and sticks to the outer drum. Ignore the transit time of the sand. Choose the correct alternatives.

(A) Angular speed of outer drum at time t is $\frac{\lambda t\omega_0}{m_2 + \lambda t}\left(\frac{r_1}{r_2}\right)^2$
(B) Difference in final angular speeds of two drums is 0.
(C) Difference in final angular speeds of two drums is $\left(\frac{m\left(r_2^2 - r_1^2\right) + m_2 r_2^2}{\left(m + m_2\right)r_2^2}\right)\omega_0$
(D) Angular speed of inner drum remains constant.

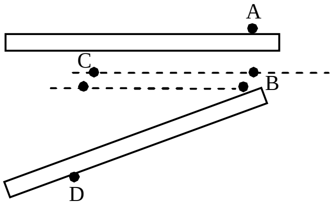
Space for rough work

10. A Yo-Yo of mass m has an axle of radius b and a spool of radius R. The Yo-Yo is placed upright on a table and string is pulled with a horizontal force $\vec{F}$ to the right as shown in figure.



The static friction coefficient between Yo-Yo and table is μ_s. Now there are two cases.
case (a): The string is pulled very gently?
case (b): The string is jerked hard?
The Yo – Yo will rotate:
(A) Clockwise in case (a),
(B) Anticlockwise in case (a)
(C) Clockwise in case (b)
(D) Anticlockwise in case (b)

11. Holding the upper plate at + 5V relative to the ground of the lower plate, what is true about the electric potential at the following locations.



(A) V(A) > V(B)
(B) V(B) $\cong$ V(C)
(C) V(D) > V(A)
(D) V(C) > V(D)

12. The equation of a transverse wave travelling along a string is given by $y = 0.4\sin\left[\pi\left(0.5x - 200t\right)\right]$ where y and x are measured in cm and t in seconds. Suppose that you clamp the string at two points L cm apart and you observe a standing wave of the same wavelength as above transverse wave. For what values of L less than 10 cm is this possible?

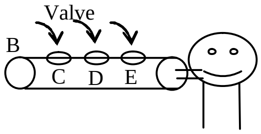
(A) 2 cm	(B) 4 cm
(C) 9 cm	(D) 8 cm

Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

Paragraph for Questions 13 & 14



A flutes can be regarded as a tube open at both ends. It will emit a musical note if the flutist excites a standing wave in the air the column inside the tube. Speed of sound in air = 344 m/s.
$BC \cong CD \cong DE \cong 0.035m.$

13. The lowest musical note that can be played on flutes is C (261.7 H_2). What must be length of the tube? Assume that air column is vibrating in its fundamental mode.
(A) 0.251 m (B) 0.355 m
(C) 0.657 m (D) 0.87 m

14. In order to produce higher musical notes, the flutist, opens valves along the tube. Since the holes in these valves are large, an open valve has same effect as shorting tube. The flutist opens one valve to play C, two valves to play D, etc. find frequency of flutes when valve C is opened keeping D and E are closed. Assume flute vibrates in its fundamental mode.
(A) 276.5 hz (B) 305.5 hz
(C) 150.5 hz (D) 450.5 hz

Paragraph for Questions 15 & 16

A Rydberg hydrogenic atom is one in which the electron possess a very large quantum number e.g. n = 100. Take the electron charge to be – e (e > 0). The binding energy of Rydberg electron may be taken as $E_b = 10^{-3}$eV, $e = 1.6 \times 10^{-19}$C

15. What angular frequency of a photon can ionize such an atom?
(A) 10^{16} rad/s (B) 10^{10} rad/s
(C) 10^{8} rad/s (D) 10^{9} rad/s

16. Now consider the electron in the Rydberg hydrogenic atom to be unbounded and force for all pratical purpose. Supposing such Rydberg atoms are infected uniformly into an oscillatory electric field $F_0 \cos\omega t\ \hat{k}$. Provided by an electromagnetic wave, let the speed of the electron at time of infection (t = 0), be v = 0. Find maximum speed of electron.
(A) $\frac{eF_0}{2m\omega}$ (B) $\frac{eF_0}{3m\omega}$
(C) $\frac{eF_0}{5m\omega}$ (D) $\frac{eF_0}{m\omega}$

Space for rough work

Paragraph for Questions 17 & 18

When two slabs of N-type and P-type semiconductor are put in contact, the relative affinities of the materials cause electrons to migrate out of N-type material across the function to P-type material. This leaves behind a volume in the N-type material that is positively charged and orates a negatively charged volume in P-type material.
Let us model this as two infinite slabs of charge, both of thickness a with the function lying on the plane z = 0.
The N-type material lies in the range 0 < z < a and has uniform charge density $-\rho_0$. Thus:

$$\rho(x,y,z)=\rho(z)=\begin{cases}+\rho_0 & 0<z<a\\ -\rho_0 & -a<z<0\\ 0 & |z|>a\end{cases}$$

The give answer of questions

17. Find electric field in religion –a < z < 0

(A) $\dfrac{\rho_0(a+z)}{\varepsilon_0}\hat{k}$ (B) $\dfrac{-2\rho_0(a+z)}{\varepsilon_0}\hat{k}$

(C) 0 (D) $\dfrac{-\rho_0(a-z)}{\varepsilon_0}\hat{k}$

18. Magnitude of potential difference between points z = –a to z = a

(A) $\dfrac{\rho_0 a^2}{4\varepsilon_0}$ (B) $\dfrac{+3\rho_0 a^2}{2\varepsilon_0}$

(C) $\dfrac{+\rho_0 a^2}{\varepsilon_0}$ (D) $\dfrac{\rho_0 a^2}{6\varepsilon_0}$

Space for rough work

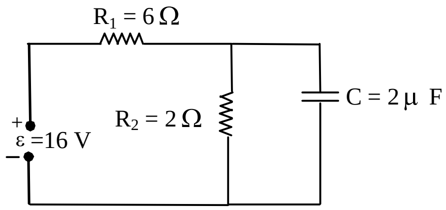
SECTION – C

(One Integer Value Correct Type)

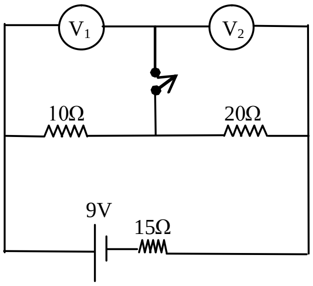
This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive)

1. A parallel plate capacitor of capacitance C is connected to a battery of emf ε until fully charged. It is then disconnected from battery and the plates are moved by a distance x so that potential difference between the plates is increased by four times. What is the volume of the dielectric (in m^3) necessary to fill the region between the plates.
Given C = 8.85 μF, x = 3 mm

2. Find maximum charge store on capacitor in μC.



3. In the circuit shown in the figure the emf of battery is 9v and its internal resistance is 15Ω. The two identical voltmeters can be considered ideal. Let V_1 and V_1^1 reading of 1st voltmeter when switch is open and closed respectively. Similarly, V_2 and V_2^1 be the reading of 2nd voltmeter when switch is open and closed respectively. Then find value of $\frac{V_2^1 - V_2}{V_1 - V_1^1} = ?$



4. A cube with sides of length $60\left(\sqrt{2}+1\right)$ cm and mass M is moving with an initial speed v_0 along a frictionless table. When it reaches the end of the table, it is caught abruptly by a short lip. What is the minimum speed v_0 in m/s such that it falls of the table?

5. Two beetles A and B hold the ends of a slightly stretched rubber band laid out on a horizontal table top. The initial positions of A and B are (0, 16 m) and (0, –4 m). A knot tied on the band is initially located at the origin. The beetle A starts running in +Y direction at constant acceleration and B moves in +X direction at constant speed of $2\sqrt{5}$ m/s. If the knot passes through point (8, 4), find the acceleration of A.

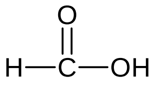
Space for rough work

Chemistry PART – II

SECTION – A

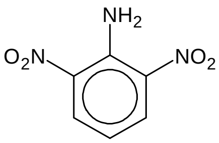
Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

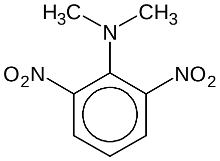
1. 
$H-\overset{\overset{O}{||}}{C}-OH$, CH_3COOH can be separated by

(A) $NaHCO_3$
(B) Tollen's reagent
(C) Neutral $FeCl_3$
(D) All of these

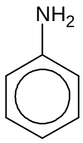
2. Write the basicity order for following compounds



(I)



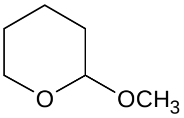
(II)

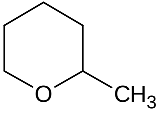


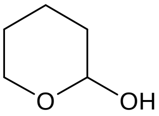
(III)

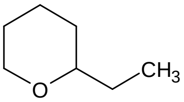
(A) III > II > I
(B) II > I > III
(C) II > III > I
(D) III > I > II

3. Which one of the following gives positive test with Fehling solution?

(A) 

(B) 

(C) 

(D) 

4. The radioactive decay ${}_{83}Bi^{211} \longrightarrow {}_{81}Tl^{207}$, takes place in 100 L closed vessel at 27°C. Starting with 2 moles of ${}_{83}Bi^{211}$ $\left(t_{1/2} = 130\ \text{sec}\right)$. The pressure development in the vessel after 520 sec will be

(A) 1.875 atm
(B) 0.2155 atm
(C) 0.4618 atm
(D) 4.618 atm

Space for rough work

5. The forward rate constant for the elementary reversible gaseous reaction

$C_2H_6 \rightleftharpoons 2CH_3$ is $1.57 \times 10^{-3} s^{-1}$ at 100 K

What is the rate constant for the backward reaction at this temperature if 10^{-4} moles of CH_3 and 10 moles of C_2H_6 are present in a 10 litre vessel at equilibrium

(A) 1.57×10^{6} L $mol^{-1}s^{-1}$
(B) 1.57×10^{10} L $mol^{-1}s^{-1}$
(C) 1.57×10^{11} L mol^{-1} s^{-1}
(D) 1.57×10^{7} L mol^{-1} s^{-1}

6. A mixture of nitrogen and water vapours is admitted to a flask at 760 torr which contains sufficient solid drying agent after long time the pressure reached a steady value of 722 torr. If the experiment is done at 27°C and drying agent increase in weight by 0.9 gm, what is the volume of flask? Neglect any possible vapour pressure of drying agent and volume occupied by drying agent.

(A) 443.34 L
(B) 246.3 L
(C) 12.315 L
(D) 24.63 L

7. Among KO_2, AlO_2^-, BaO_2 and NO_2^+, unpaired electron is present in

(A) NO_2^+ and BaO_2
(B) KO_2 and AlO_2^-
(C) KO_2 only
(D) BaO_2 only

8. Which of the following sentence is wrong about H_2O and HF

(A) Both the compounds resemble each other in solubility.
(B) Heat of formation of HF and H_2O are close to each other.
(C) Like H_2O, H_2F_2 is a weak acid and both are ionising solvents.
(D) The boiling points of HF and H_2O are high due to hydrogen bonding

Space for rough work

Multiple Correct Choice Type

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct

9. Which of the following order is wrong with respect to alkali metals?
   (A) In gaseous state the order of reactivity is Li < Na < K < Rb < Cs.
   (B) conducting power $Cs^+ > Li^+ > K^+ > Na^+ > Rb^+$ (in aqueous Solution).
   (C) density order Li > Na > K > Rb > Cs.
   (D) In gaseous sate the order of reactivity is Li > Na > K > Rb > Cs.

10. Among the following statements, the correct statements are:
    (A) Calamine and cerrusite are carbonate ores
    (B) Rutile and cuprite are oxide ores
    (C) Zinc blende and pyrites are sulphides ores
    (D) malachite and azurite are sulphate ores of Cu

11. Which of the following is correct for an ideal solution?
    (A) $\Delta H_{mix} = 0$ and $\Delta V_{mix} = 0$
    (B) $\Delta V_{mix} = 0$ and $\Delta S_{mix} > 0$
    (C) $\Delta H_{mix} > 0$ and $\Delta S_{mix} > 0$
    (D) $\Delta G_{mix} = 0$ and $\Delta S_{mix} > 0$

12. Which of the following statements are correct
    (A) Benzene is more reactive than pyridine towards electrophilic aromatic substitution
    (B) Benzene is less reactive than pyrrole towards electrophilic aromatic substitution
    (C) Pyridine is more reactive than benzene towards nucleophilic aromatic substitution
    (D) Pyridine is more reactive than Benzene towards electrophilic aromatic substitution

Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

Paragraph for Question Nos. 13 to 14

The cell potential (E_{cell}) of a reaction is related as $\Delta G = -nFE_{cell}$
For reversible reaction
at constant pressure $d(\Delta G) = -(\Delta S).dT$

$$\Delta G = \Delta H = T.\Delta S$$

$$\Delta G = \Delta H + T\left(\frac{d(\Delta G)}{dT}\right)_P$$

$\left[\frac{dE_{cell}}{dT}\right]_P$ is known as temperature coefficient of the e.m.f of the cell.

13. The temperature coefficient of the e.m.f of cell $\left(\frac{dE}{dT}\right)_P$ is given by

(A) $\frac{nF}{\Delta S}$
(B) $\frac{\Delta S}{nF}$
(C) $\frac{\Delta S}{nFT}$
(D) $-nFE$

14. At 300 K, ΔH for the reaction $Zn(s) + AgCl_{(s)} \longrightarrow ZnCl_2(aq) + 2Ag(s)$ is –218 kJ/mol. While the e.m.f. of the cell was 1.015 V. Then the value of $\left(\frac{dE}{dT}\right)_P$ for the cell is:

(A) $-4.2 \times 10^{-4}\ VK^{-1}$
(B) $-3.81 \times 10^{-4}\ VK^{-1}$
(C) $0.11\ VK^{-1}$
(D) $7.62 \times 10^{-4}\ VK^{-1}$

Space for rough work

Paragraph for Question Nos. 15 to 16

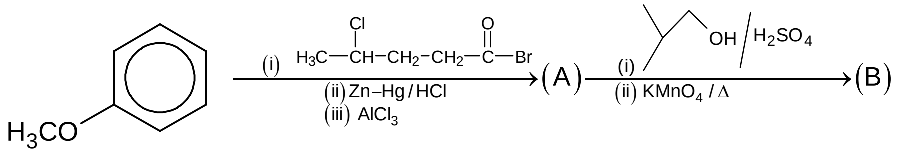
An unknown mixture contains one or two of the following: $CaCO_3$, $BaCl_2$, $AgNO_3$, Na_2SO_4, $ZnSO_4$ and NaOH. The mixture is completely soluble in water and solution gives pink colour with phenolphthalein. When dilute hydrochloride acid is gradually added to the solution, a precipitate is formed which dissolves with further addition of the acid.

15. Which of the following combination of compounds is soluble in water?
(A) $BaCl_2$ and $AgNO_3$
(B) $AgNO_3$ and NaOH
(C) $BaCl_2$ and Na_2SO_4
(D) $ZnSO_4$ and excess NaOH

16. The aqueous solution of mixture gives white precipitate with dil HCl which dissolves in excess of dil. HCl. It confirms
(A) $BaCl_2$ + NaOH
(B) Na_2SO_4 + NaOH
(C) $ZnSO_4$ + NaOH
(D) $AgNO_3$ + NaOH

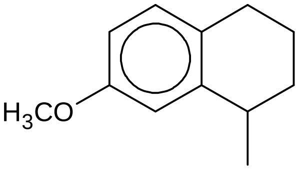
Space for rough work

Paragraph for Question Nos. 17 to 18

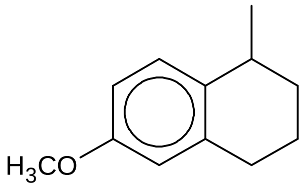

H$_3$CO
(i) H$_3$C—CH(Cl)—CH$_2$—CH$_2$—C(=O)—Br
(ii) Zn–Hg / HCl
(iii) AlCl$_3$
(A)
(i) OH / H$_2$SO$_4$
(ii) KMnO$_4$ / Δ
(B)

17. In the above sequence of reactions compound A is:

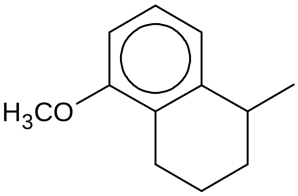
(A)



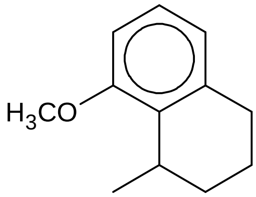
(B)



(C)

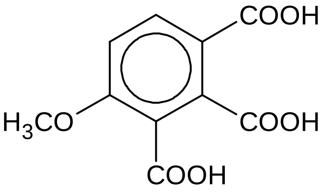


(D)

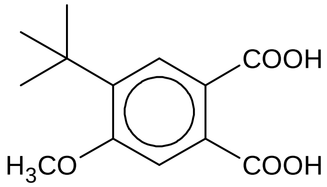


18. In the above sequence of reactions compound B is:

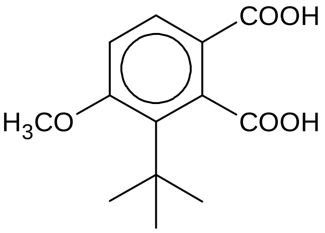
(A)



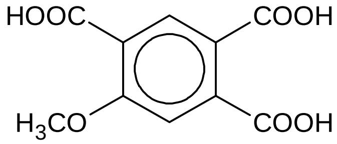
(B)



(C)



(D)



Space for rough work

SECTION – C

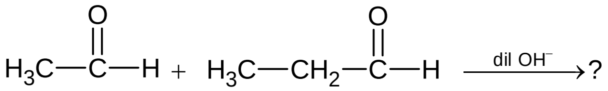
(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive)

1. If the lowest energy X-rays having $\lambda = 3.055 \times 10^{-8}$ m, estimate the minimum difference in energy between two Bohr's orbits such that an electronic transition would correspond to the emission of an X-ray. Assuming that the electrons in other shells exert no influence, at what Z (minimum) would transition from the second energy level to the first result in the emission of an X-ray?

2. A vessel of 250 litre was filled with 0.01 mole of Sb_2S_3 and 0.01 mole of H_2 to attain the equilibrium at 440°C as
$Sb_2S_3(s) + 3H_2(g) \rightleftharpoons 2Sb(s) + 3H_2S(g)$. In a separate experiment this H_2S is sufficient to precipitate 1.19 g PbS from Pb^{2+} solution. Then calculate K_c of the above reaction.

3. In metaborate structural arrangement, the number of B – O – B bonds is/are:

4. 
$$H_3C-\overset{\overset{O}{||}}{C}-H + H_3C-CH_2-\overset{\overset{O}{||}}{C}-H \xrightarrow{\text{dil } OH^-} ?$$
The number of possible products is/are:

5. $A \xrightarrow{\text{Hydrolysis}} B \xrightarrow{Na} C \xrightarrow{CH_3-CH_2-Cl} D \xrightarrow[HgSO_4]{H_2SO_4} E$
E is 2-butanone then 'A' has how many π bonds?

Space for rough work

Mathematics

PART – III

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. If a_1 is the greatest value of f(x), where $f(x) = \left(\frac{1}{2+[\sin x]}\right)$ (where [.] denotes the greatest integer function) and $a_{n+1} = \frac{(-1)^{n+2}}{(n+1)} + a_n$, then $\lim\limits_{n\to\infty} a_n$ is

(A) 1
(B) e^2
(C) ln 2
(D) none of these

2. If n be a positive integer such that $\sin\left(\frac{\pi}{2n}\right) + \cos\left(\frac{\pi}{2n}\right) = \frac{\sqrt{n}}{2}$, then

(A) $6 \le n \le 8$
(B) $4 < n \le 8$
(C) $4 \le n \le 8$
(D) $4 < n < 8$

3. Let f(x) = tan x and g(f(x)) = $f\left(x - \frac{\pi}{4}\right)$, where f(x) and g(x) are real values functions for all possible value of x, then f(g(x)) is

(A) $\tan\left(\frac{x-1}{x+1}\right)$
(B) tan (x – 1) – tan (x + 1)
(C) $\frac{f(x)+1}{f(x)-1}$
(D) $\frac{x-\frac{\pi}{4}}{x+\frac{\pi}{4}}$

Space for rough work

4. For which of the hyperbola, we can have more than one pair of perpendicular tangents?
(A) $\frac{x^2}{4}-\frac{y^2}{9}=1$ (B) $\frac{x^2}{4}-\frac{y^2}{9}=-1$
(C) $x^2 - y^2 = 4$ (D) $xy = 4$

5. A ray of light passing through the point P(1, 2) is reflected at a point Q on the x-axis and then passes through (5, 3), then the equation of reflected ray is
(A) $5x - 4y = 13$ (B) $5x - 4y = -3$
(C) $4x + 5y = 14$ (D) $4x - 5y = -6$

6. On the line segment joining (1, 0) and (3, 0) an equilateral triangle is drawn having its vertex in the fourth quadrant, then radical centre of the circles described on its sides as diameter is
(A) $\left(3, -\frac{1}{\sqrt{3}}\right)$ (B) $\left(3, -\sqrt{3}\right)$
(C) $\left(2, -\frac{1}{\sqrt{3}}\right)$ (D) $\left(2, -\sqrt{3}\right)$

7. Let P and Q be points (4, –4) and (9, 6) of the parabola $y^2 = 4a(x - b)$. Let R be a point on the arc of the parabola between P and Q, then the area of ΔPRQ is largest when
(A) $\angle PRQ = 90^\circ$ (B) the point R is (4, 4)
(C) the point R is $\left(\frac{1}{4}, 1\right)$ (D) the point R is $\left(1, \frac{1}{4}\right)$

8. If f(x) is a decreasing function then the set of values of 'k' for which the major axis of the ellipse $\frac{x^2}{f\left(k^2+2k+5\right)}+\frac{y^2}{f\left(k+11\right)}=1$ is the x-axis, is
(A) $k \in (-2, 3)$ (B) $k \in (-3, 2)$
(C) $k \in (-\infty, -3) \cup (2, \infty)$ (D) $k \in (-\infty, -2) \cup (3, \infty)$

Space for rough work

Multiple Correct Choice Type

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct

9. If $\int \frac{\left(x^{-7/6} - x^{5/6}\right)}{x^{1/3}\left(x^2+x+1\right)^{1/2} - x^{1/2}\left(x^2+x+1\right)^{1/3}} dx = -P\left\{\frac{Z^3}{3} + \frac{3z^Q}{1} + \frac{3z^2}{T} + \log|z|\right\} + R$ where $z = \left(x + \frac{1}{x} + 1\right)^{1/6} - 1$, then

(A) P = 6
(B) Q – P = 4
(C) T + Q = 3
(D) Q – P + T = 5

10. If $\int e^{\tan^2 x} \sin 4x dx = -k \cos^4 x e^{\tan^2 x} + c$, then k is less than

(A) 3
(B) 4
(C) 5
(D) none of these

11. Let $f(t) = \int\limits_{-\frac{\pi}{2}}^{t} \frac{\sin^3 x}{\sqrt[3]{\cos^2 x}} dx$, then

(A) $f\left(\frac{\pi}{2}\right) = 0$
(B) $f(0) = -\frac{18}{7}$
(C) $f\left(\frac{\pi}{2}\right) = -\frac{18}{7}$
(D) none of these

12. If f(x) = $ax^2 + bx + c = 0$ has real roots and its coefficients are odd positive integers then

(A) f(x) = 0 always has irrational roots
(B) discriminant is a perfect square
(C) if ac = 1, then equation must have exactly one root 'α' such that [α] = –1 (where [.] G.I.F)
(D) Equation f(x) = 0 has rational roots

Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

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Paragraph for Question Nos. 13 to 14

Read the following write up carefully and answer the following questions:
Let S be the set of points $\{(x, y): 0 \le x \le 3,\ 0 \le y \le 4$, where $x, y \in I\}$. Two distinct points are randomly chosen from S. It is given that mid-point of the line segment joining $A(x_1, y_1)$ and $B(x_2, y_2)$ is

$$\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right)$$

13. The probability that the mid-point of the line segment of the two points chosen belongs to S, is

(A) $\frac{21}{95}$ (B) $\frac{42}{95}$

(C) $\frac{36}{95}$ (D) none of these

14. If two points chosen are (x_1, y_1) and (x_2, y_2), then the probability that $x_1 \ne x_2$ and $y_1 = y_2$ with $\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right) \in S$, is

(A) $\frac{8}{95}$ (B) $\frac{12}{95}$

(C) $\frac{14}{95}$ (D) none of these

Space for rough work

Paragraph for Question Nos. 15 to 16

Read the following write up carefully and answer the following questions:
Equation of the form P(sin x ± cos x, sin x cos x) = 0 where P(y, z) is a polynomial, can be valued by the change cos x ± sin x = t; 1 ± 2 sin x cos x = t^2. Reduce the given equation into $P\left(t, \frac{t^2-1}{2}\right)=0$

15. If sin x + cos x = 1 + sin x cos x, then x is equal to

(A) $\frac{\pi}{2}+2n\pi$ or $2n\pi$, $n \in I$
(B) $\frac{\pi}{4}+2n\pi$ or $(2n + 1)\pi$, $n \in I$
(C) $2n\pi$, $n \in I$
(D) none of these

16. If $\sin^4 x + \cos^4 x = \sin x \cos x$, then x is equal to

(A) $(6n+1)\frac{\pi}{6}$
(B) $n\pi$
(C) $(4n+1)\frac{\pi}{4}$
(D) none of these

Paragraph for Question Nos. 17 to 18

Read the following write up carefully and answer the following questions:
Consider $f(x)=\frac{(x-\alpha)(x-\beta)}{(x-\gamma)(x-\delta)}$ where $0 < \alpha < \beta < \gamma < \delta$

17. Number of local maxima of f(x) will be
(A) 0
(B) 1
(C) 2
(D) can't be determined

18. Function f: D → R, (where D is the domain and R is the set of real numbers), will be
(A) one-one
(B) many one
(C) bijective
(D) none of these

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive)

1. Let p(x) be a polynomial of degree 11 such that $p(x) = \frac{1}{1+x}$ for x = 0, 1, 2, ….., 11 then p(12) is _____

2. If the coefficient of the second, third and fourth terms in the expansion of $(1 + x)^n$ are in A.P. then n is _____

3. A tangent is drawn to the curve $y = \frac{8}{x^2}$ in xy-plane at the point $A(x_0, y_0)$ where $x_0 = 2$, and the tangent cuts the x-axis at a point B. Then $\overrightarrow{AB} \cdot \overrightarrow{OB}$ (where O is origin) is equal to _____

4. Let $f(x) = 30 - 2x - x^3$, then find the number of positive integral values of x which satisfies f(f(f(x))) > f(f(–x)) _____

5. If x + sin y = 2010 and x + 2010 cos y = 2009, $0 < y \le \frac{\pi}{2}$ then find the value of $\frac{[x+y]}{1005}$ (where [.] denotes the greatest integer function) _____

Space for rough work

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CRT–III
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	B	C
2.	D	C	D
3.	D	C	A
4.	D	C	B
5.	B	D	A
6.	C	D	C
7.	B	C	C
8.	B	A	B
9.	A, C, D	B, C, D	A, C
10.	A, D	A, B, C	A, B, C
11.	A, B, D	A, B, D	A, B
12.	A, B, D	A, B, C	A, C
13.	C	B	A
14.	A	B	D
15.	A	D	A
16.	D	C	C
17.	A	A	B
18.	C	B	B
1.	4	2	0
2.	8	1	7
3.	1	3	3
4.	4	4	2
5.	8	2	2

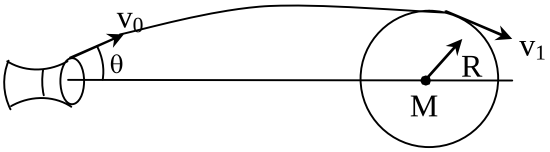
Physics PART – I

SECTION – A

1. Angular momentum conservation about the centre of the planet,

$$mv_0 \cdot 5\,R\sin\theta = mv_1R$$

$$v_1 = 5\,v_0\sin\theta \text{ -------(1)}$$



Energy conservation gives,

$$\frac{1}{2}mv_0^2 - \frac{GMm}{5R} = \frac{1}{2}mv_1^2 - \frac{GMm}{R} \text{ ------(2)}$$

Solve equation (1) and (2),

$$\theta = 37°$$

2. Assume a Gaussian surface to be a sphere of radius r and take limit as $r \to \infty$. The flux,

$$\int \vec{E}.d\vec{A} = \frac{q}{\varepsilon_0}$$

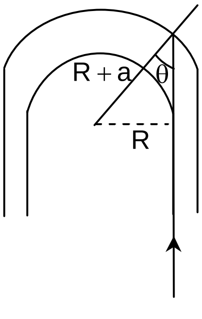
$$\int E.dA = \frac{q}{\varepsilon_0}$$

$$\lim_{r\to\infty}\frac{a}{r^2}e^{-r/b}\cdot 4\pi r^2 = \frac{q}{\varepsilon_0}$$

$$4\pi a\cdot\lim_{r\to\infty}e^{-r/b} = \frac{q}{\varepsilon_0}$$

q = 0

5. The smallest angle of incoming beam should be greater than critical angle of the medium.
The smallest angle incoming beam should be greater than critical angle of the medium.



$$\sin\theta \ge \sin\theta_c$$

$$\frac{R}{R+a} \ge \frac{1}{\mu}$$

$$a \le (\mu - 1)R$$

$$a_{max} = \frac{R}{2}$$

6. $$d\vec{B} = \frac{\mu_0 i}{4\pi}\,\frac{d\vec{\ell}\times\hat{r}}{r^2} = \frac{\mu_0 i}{4\pi r^2}\left(dr\hat{\ell}_r + rd\theta\hat{\ell}_\theta\right)\times\left(-\hat{\ell}_r\right) = \frac{\mu_0 i}{4\pi r^2}r\,d\theta\,\hat{k}$$

Where $\hat{\ell}_r$ and $\hat{\ell}_\theta$ are unit vectors along radial and azimuthal directions

$$d\vec{B} = \frac{\mu_0 i}{4\pi}\,\frac{d\theta}{r}\hat{k}$$

$$B = \int d\vec{B} = \int_0^\pi \frac{\mu_0 i}{4\pi}\,\frac{d\theta}{\left(a + \frac{b}{\pi}\theta\right)}\hat{k}$$

$$= \frac{\mu_0 i}{4b}\,\ln\left(1 + \frac{b}{a}\right)\hat{k}$$

7. Since current leads the voltage
Hence circuit is capacitive.

8. For 1 mole gas,
PV = RT

$PV^2 = aR = \text{constant}$

Compare with $PV^x = \text{constant}$

$x = 2$

molar heat capacity of gas $C = \frac{R}{\gamma - 1} + \frac{-R}{x - 1}$

$$C = \frac{R}{\gamma - 1}(2 - \gamma)$$

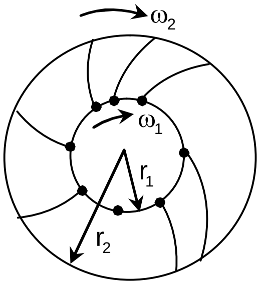
$$\Delta Q = nC\Delta T = \frac{R\Delta T}{\gamma - 1}(2 - \gamma)$$

9. As the sand leaves the inner drum through the open holes, it does not exert any force of the drum, angular momentum remains conserved.
At time t,

$$m_1 r_1^2 \omega_0 = (m_1 - \lambda t) r_1^2 \omega_0 + (m_2 + \lambda t) r_2^2 \omega_2$$

$$\omega_2 = \frac{\lambda t r_1^2 \omega_0}{(m_2 + \lambda t) r_2^2}$$

The speed of inner drum does not change.



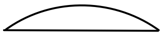
10. In first case, we can write torque equation about bottom point because it coincides with instantaneous axis of rotation while in second case, you will write torque equation of centre of mass.

11. $V(A) \cong 5V$

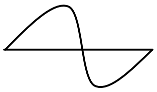
$V(B) \cong V(C) \cong 2.5V$

$V(D) \cong 0$

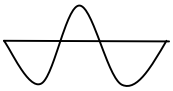
12. $K = 0.5\pi = \frac{2\pi}{\lambda} \Rightarrow \lambda = 4\text{cm}$



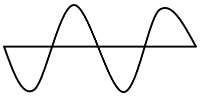
$\Rightarrow L = \frac{\lambda}{2} = 2\text{cm}$



$\Rightarrow L = \lambda = 4\text{cm}$



$\Rightarrow L = \frac{3\lambda}{2} = 6\text{cm}$



$\Rightarrow L = 2\lambda = 8\text{cm}$

13. $\frac{\lambda}{2} = \ell = \frac{v}{2f} = \ell \cong 0.657\text{m}$

14. $f = \frac{nv}{2\ell}$

$n = 1$

V = 344

$\ell = 0.657 - 0.035$

f = 276.5 hz

15. Hf > E_b

$6.6 \times 10^{-34} \frac{\omega}{2\pi} > 10^{-3} \times 1.6 \times 10^{-19}$

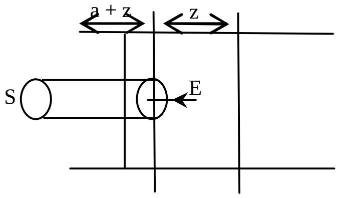
$\omega > 1.6 \times 10^{12}$ rad/s

16. $a = \frac{F_0}{m} \cos \omega t$

$v = \frac{-eF_0}{m\omega} \sin \omega t$

$\left| v_{max} \right| = \frac{eF_0}{m\omega}$

17. Here z is co-ordinate



$EA = \frac{-\rho_0 (a+z) A}{\varepsilon_0}$

$E = \frac{-\rho_0 (a+z)}{\varepsilon_0}$

18. $\int dv = -\int \vec{E} \cdot d\vec{r} = -\left[\int_a^0 \frac{\rho_0 (a+z)}{\varepsilon_0} dz + \int_0^a \frac{-\rho_0 (a-z)}{\varepsilon_0} dz \right]$

$= \frac{\varepsilon_0 a^2}{\varepsilon_0}$

SECTION – C

1. Initially,

$C = \frac{\varepsilon_0 A}{d}$ -----(1)

$V_0 = Ed$ ------(2)

and $V_f = Ed_f$

$4V_0 = E(d+x)$

$4Ed = E(d+x)$

$d = \frac{x}{3}$

Volume = A(d + x)

$= \frac{Cd}{\varepsilon_0} \cdot (d+x)$

$= \frac{4x^2 C}{9\varepsilon_0}$

2. $$V = \frac{\varepsilon}{1 + \frac{R_1}{R_2}}$$

$$Q = CV = \frac{C\varepsilon}{1 + \frac{R_1}{R_2}}$$

3. When switch is open

$$V_1 + V_2 = 6V$$

$$V_1 = V_2 = 3V$$

When switch is closed

$$V_1^1 = 2V; V_2^1 = 4V$$

$$\frac{V_2^1 - V_2}{V_1 - V_1^1} = \frac{4-3}{3-2} = 1$$

4. If length of side = 2a = $60\left(\sqrt{2}+1\right)$ cm

angular momentum conservation,

$$Mav_0 = I\,\omega$$

$$\omega = \frac{Mav_0}{I} .....(1)$$

$$\frac{1}{2}I\omega^2 \geq Mga\left(\sqrt{2}-1\right)......(2)$$

$$I = I_{cm} + M\left(a\sqrt{2}\right)^2$$

$$= \frac{8Ma^2}{3} ....(3)$$

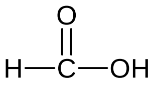
Solve these equation,

$$v_0 \geq 4 \text{ m/s}$$

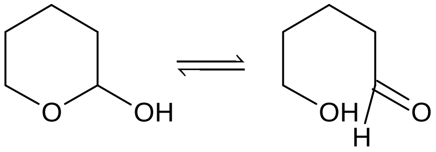
Chemistry

PART – II

SECTION – A

1. Tollen's reagent gives +ve test for  $H-\overset{\overset{\displaystyle O}{||}}{C}-OH$ not CH_3COOH.

2. Due to steric hindrance in II the loan pair e^- are not involved in resonance in I electron withdrawing effect of NO_2 is high.

3. 

4. $_{83}Bi^{211} \longrightarrow {}_{81}Tl^{207} + {}_2He^4$;
total time = n × half life
moles of substance left after n halve.
$= \frac{\text{initial moles}}{2^n} = \frac{2}{2^4} = 0.125$
moles of He produced
= 2 – 0.125 = 1.875
Pressure developed due to
He = $\frac{1.875 \times 0.0821 \times 300}{100}$
= 0.4618 atm

5. $K_{eq} = \frac{K_f}{K_b} = \frac{[CH_3]^2}{[C_2H_6]}$, $[CH_3] = 10^{-5}$m

$$\frac{1.57 \times 10^{-3}}{K_b} = \frac{[10^{-5}]^2}{1},\ K_b = 1.57 \times 10^{7}\,L\ mol^{-1}s^{-1}$$

6. $P_{H_2O} = 760 - 722 = \frac{38}{760}$atm;

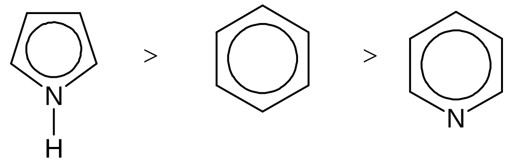
$n_{H_2O} = \frac{0.9}{18}$

$V = \frac{0.9}{18} \times \frac{0.0821 \times 300}{38} \times 760$;
V = 24.63 L

7. KO_2 has only unpaired e^- remaining all are diamagnetic.

8. Both compounds resemble each other in solubility.

12. Order of reactivity towards E. A. substitution



13. From equation above $\Delta S = \dfrac{-d(\Delta G)}{dT}$

$$\Delta S = \frac{-d(-nFE)}{dT} = nF\frac{dE}{dT}(or)\left(\frac{dE}{dT}\right)_P = \frac{\Delta S}{nF}$$

14. $\Delta H = nF\left(\dfrac{dE}{dT}\right)_P T - nFE_{cell}$

$$-218 \times 1000 = 2 \times 96500 \times 300\left(\frac{dE}{dT}\right)_P - 2\times 96500\times 1.015$$

$$\left(\frac{dE}{dT}\right)_P = -3.81\times 10^{-4}\,VK^{-1}$$

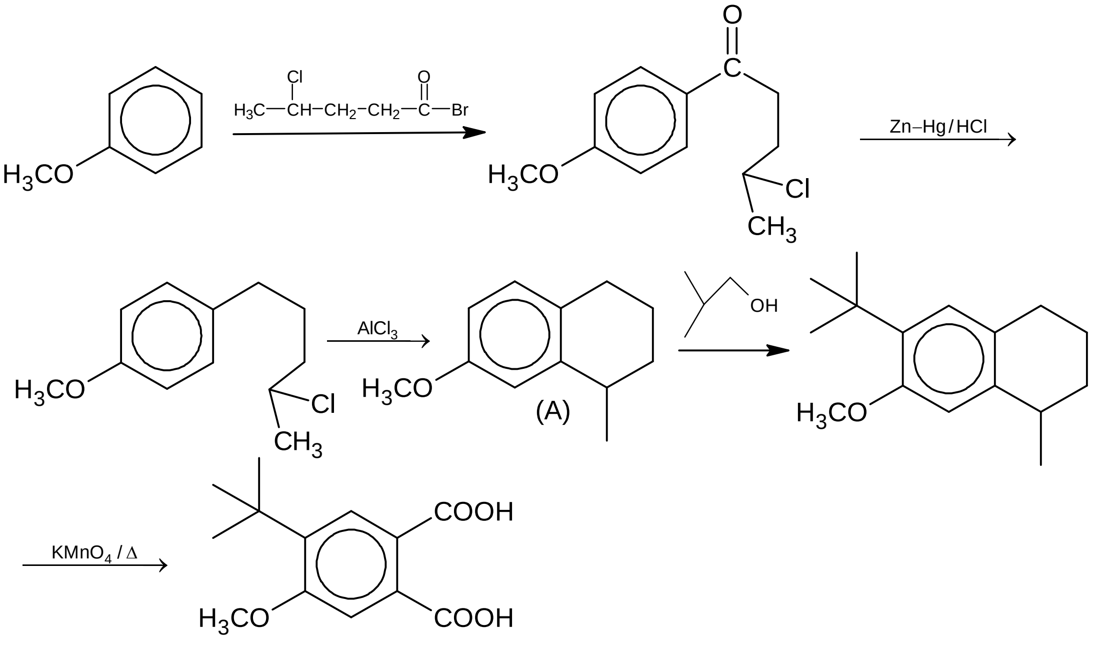
16. Mixture contains NaOH + $ZnSO_4$

$$NaOH + ZnSO_4 \longrightarrow \underset{soluble}{Na_2ZnO_2} + Na_2SO_4 + 2H_2O$$

$$Na_2ZnO_2 + 2HCl \longrightarrow 2NaCl + Zn(OH)_2 \downarrow$$

$$Zn(OH)_2 + 2HCl \longrightarrow \underset{soluble}{ZnCl_2} + 2H_2O$$

18.


H3CO
Cl
O
H3C—CH–CH2–CH2–C—Br
O
C
H3CO
Cl
CH3
Zn–Hg/HCl
H3CO
Cl
CH3
AlCl3
H3CO
(A)
OH
H3CO
KMnO4 / Δ
COOH
H3CO
COOH

SECTION –C

1. $\Delta E = \dfrac{hc}{\lambda} = \dfrac{(6.63\times 10^{-34} J.s)(3\times 10^{8} m/s)}{3.055\times 10^{-8} m}$

$= 6.52 \times 10^{-18}$ J.

$\Delta E_H = \frac{3}{4}\left(2.176 \times 10^{-18} J\right)$

$= 1.63 \times 10^{-18}$

$\Delta E = \Delta E_H(Z)^2$

$Z^2 = \frac{\Delta E}{\Delta E_H} = \frac{\left(6.52 \times 10^{-18}\right)}{\left(1.63 \times 10^{-18}\right)} = 4$

$Z = 2$

2. $Sb_2S_3(s) + 3H_2(g) \rightleftharpoons 2Sb(s) + 3H_2S(g)$

$0.01 - x \qquad 0.01 - 3x \qquad 2x \qquad 3x$

$3x = 0.005$

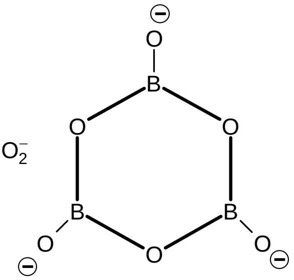
$H_2S + Pb^{2+} \longrightarrow PbS + 2H^+$

no. of moles of PbS formed = $\frac{1.19}{238} = 0.005$ moles

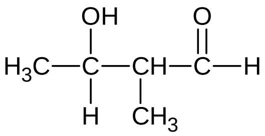
at equilibrium $[H_2] = \left[\frac{0.005}{250}\right]$

$K_c = \left[\frac{0.005}{0.005}\right]^3 = 1$

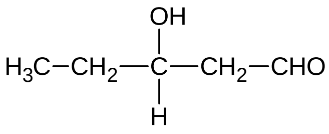
3. Metaborate BO_2^-



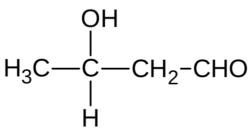
4.



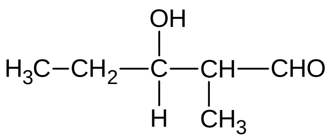
$H_3C-\underset{H}{\overset{OH}{C}}-\underset{CH_3}{CH}-\overset{O}{\overset{\|}{C}}-H$



$H_3C-CH_2-\underset{H}{\overset{OH}{C}}-CH_2-CHO$

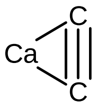


$H_3C-\underset{H}{\overset{OH}{C}}-CH_2-CHO$



$H_3C-CH_2-\underset{H}{\overset{OH}{C}}-\underset{CH_3}{CH}-CHO$

5. $A = CaC_2$

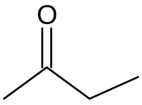


B = $HC\equiv CH$

C = $HC\equiv CNa$

D = $HC\equiv C-CH_2-CH_3$

E =



Mathematics PART – III

SECTION – A

1. $a_1 = 1$

$a_2 = 1 - \frac{1}{2}$

$a_3 = 1 - \frac{1}{2} + \frac{1}{3}$

$\vdots$

$a_\infty = 1 - \frac{1}{2} + \frac{1}{3} - \frac{1}{4} + ... = \ln 2$

2. Given, $\sin\left(\frac{\pi}{2n}\right) + \cos\left(\frac{\pi}{2n}\right) = \frac{\sqrt{n}}{2}$

$\Rightarrow \sin^2\left(\frac{\pi}{2n}\right) + \cos^2\left(\frac{\pi}{2n}\right) + 2\sin\left(\frac{\pi}{2n}\right)\cos\left(\frac{\pi}{2n}\right) = \frac{n}{4}$

$\Rightarrow 1 + \sin\left(\frac{\pi}{n}\right) = \frac{n}{4} \Rightarrow \sin\left(\frac{\pi}{n}\right) = \frac{n-4}{4}$

For n = 2, the given equation is not satisfied considering n > 1 and $n \neq 2$, $0 < \sin\left(\frac{\pi}{n}\right) < 1$

$\Rightarrow 0 < \frac{n-4}{4} < 1 \Rightarrow 4 < n < 8$

3. $g(f(x)) = \tan\left(x - \frac{\pi}{4}\right) = \frac{\tan x - 1}{\tan x + 1}$

$\Rightarrow g(x) = \frac{x-1}{x+1}$

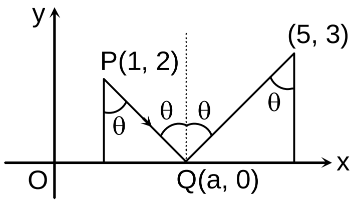
$f(g(x)) = \tan\left(\frac{x-1}{x+1}\right)$

4. Locus of point of intersection of perpendicular tangents is director circle for $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ equation of director circle is $x^2 + y^2 = a^2 - b^2$ which is real if a > b

5. Image of P in x-axis is (1, –2)

$\therefore$ Equation of reflected ray is $(y - 3) = \frac{5}{4}(x - 5)$

$\Rightarrow 5x - 4y = 13$

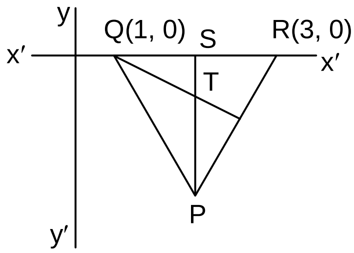


6. Radical centre of the circles described on the sides of a triangle as diameters is the orthocentre of the triangle

$\therefore$ OS = 2

$ST = -QS\tan\frac{\pi}{6} = -\frac{1}{\sqrt{3}}$

$\therefore$ Quadrants of T is $\left(2, -\frac{1}{\sqrt{3}}\right)$



7. $\therefore$ Since, (4, –4) and (9, 6) lie on $y^2 = 4a(x - b)$
$\therefore$ $4 = a(4 - b)$ and $9 = a(9 - b)$
$\therefore$ $a = 1$ and $b = 0$
$\therefore$ The parabola is $y^2 = 4x$
Let the points R be $(t^2, 2t)$

$$\therefore \text{ Area of } \Delta PRQ = \frac{1}{2}\begin{vmatrix} 4 & -4 & 1 \\ 9 & 6 & 1 \\ t^2 & 2t & 1 \end{vmatrix} = -5\left(t - \frac{1}{2}\right)^2 + \frac{125}{4}$$

$\therefore$ Area in largest when $t = \frac{1}{2}$

$\therefore$ Coordinate of the point R is $\left(\frac{1}{4}, 1\right)$

8. f(x) is a decreasing function and for major axis to be x-axis
$f(k^2 + 2k + 5) > f(k + 11)$
$\Rightarrow k^2 + 2k + 5 < k + 11$
$\Rightarrow k \in (-3, 2)$

9.
$$\frac{x^{-7/6} - x^{5/6}}{x^{1/3}\left(x^2 + x + 1\right)^{1/2} - x^{1/2}\left(x^2 + x + 1\right)^{1/3}} = \frac{x^{-7/6} - x^{5/6}}{x^{5/6}\left(x + \frac{1}{x} + 1\right)^{1/2} - x^{5/6}\left(x + \frac{1}{x} + 1\right)^{1/3}}$$

$$= \frac{\frac{1}{x^2} - 1}{\left(x + \frac{1}{x} + 1\right)^{1/2} - \left(x + \frac{1}{x} + 1\right)^{1/3}} \quad \text{put } Z = \left(x + \frac{1}{x} + 1\right)^{1/6} - 1$$

After solving we get, P = 6, T = 2 and Q = 1

10. $\int e^{\tan^2 x} \sin 4x\,dx$
Applying integration by parts
$$e^{\tan^2 x}\int \sin 4x\,dx - \int\left(e^{\tan^2 x} \times 2\tan x \sec^2 x \int \sin 4x\,dx\right)dx$$
$$= -\frac{1}{4}\cdot e^{\tan^2 x}\cdot \cos 4x + \frac{1}{2}\int e^{\tan^2 x}\tan x \sec^2 x\left[2\left\{2\cos^2 x - 1\right\}^2 - 1\right]dx \text{ continue solving like this}$$

11. Put z = cos x, dz = –sin x dx
$$f(t) = \int_{-\frac{\pi}{2}}^{t} \frac{\sin^3 x}{\sqrt[3]{\cos^2 x}}\,dx = -\int_{-\frac{\pi}{2}}^{t}\left(1 - z^2\right)z^{-\frac{2}{3}}\,dz$$

12. If a, b and c are odd integers then discriminant = $b^2 - 4ac \neq$ perfect square
$\Rightarrow$ Roots are always irrational
If $ac = 1 \Rightarrow a = 1$, $c = 1$ and $b \geq 3$
$\because$ a, b and c = odd
$\therefore$ $c(a - b + c) < 0 \Rightarrow f(0)\,f(-1) < 0$
$\Rightarrow \alpha \in (-1, 0)$

13.-14. Total points generated = 20
Two points can be selected in ${}^{20}C_2 = 190$ ways
(i) Number of points with all coordinates odd = 4
(ii) Number of points with x odd, y even = 6

(iii) Number of points with x even, y odd = 4
(iv) Number of points with both even = 6

$\therefore$ Required number of points = ${}^4C_2 + {}^6C_2 + {}^4C_2 + {}^6C_2 = 42$

(1) Required probability = $\frac{42}{190} = \frac{21}{95}$

(2) ($x_1 \neq x_2$ and $y_1 = y_2$) = 2 × 5 = 10

Required probability = $\frac{10}{190} = \frac{1}{19}$

15. sin x + cos x = 1 + sin x cos x

$\Rightarrow\ t = 1 + \frac{t^2 - 1}{2}$ (Let sin x + cos x = t)

$2t = 2 + t^2 - 1 \Rightarrow t^2 - 2t + 1 = 0$

$(t - 1)^2 = 0 \Rightarrow t = 1$

$\therefore$ sin x + cos x = 1

$\cos\left(x - \frac{\pi}{4}\right) = \frac{1}{\sqrt{2}}$

$x - \frac{\pi}{4} = 2n\pi \pm \frac{\pi}{4}$

$x = 2n\pi \pm \frac{\pi}{4}$

$\Rightarrow x = 2n\pi$ or $x = 2n\pi + \frac{\pi}{2}$, $n \in I$

16. $\sin^4 x + \cos^4 x = \sin x \cos x$

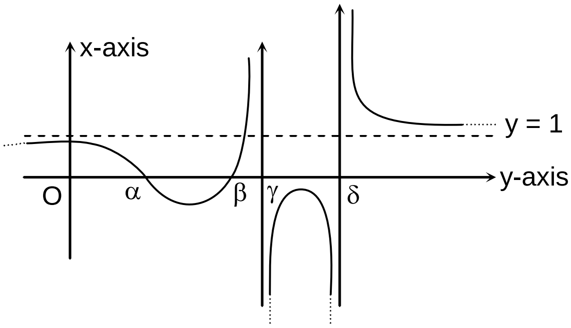
$(\sin^2 x + \cos^2 x)^2 - 2\sin^2 x \cos^2 x = \sin x \cos x$

$1 - 2p^2 = p$ ($\because$ sin x cos x = p)

$(p + 1)(2p - 1) = 0$

sin x cos x = –1	2 sin x cos x –1 = 0
sin x cos x = –1	sin 2x = 1
sin 2x = –2 (not possible)	$2x = 2n\pi + \frac{\pi}{2} \Rightarrow x = (4n + 1)\frac{\pi}{4}$

17.-18. Graph of $f(x) = \frac{(x - \alpha)(x - \beta)}{(x - \gamma)(x - \delta)}$



SECTION – C

1. Let g(x) = (x + 1) p(x) – 1 ….. (1)

g(0) = g(1) = g(2) = ….. = g(11) = 0

$\therefore$ g(x) = kx(x – 1)(x – 2) ….. (x – 11) ….. (2)

Also, g(–1) = –1

$\therefore\ k = -\frac{1}{\underline{|12}}$

Now, from equation (1) and (2), we get

$$\left(x+1\right)p\left(x\right)-1=-\frac{1}{\underline{|12}}x\left(x-1\right)\left(x-2\right).....\left(x-11\right)$$

$\therefore$ p(12) = 0

2. $^nC_1, {}^nC_2, {}^nC_3$ an in A.P.

$$\frac{2n\left(n-1\right)}{2}=n+\frac{n\left(n-1\right)\left(n-2\right)}{6}$$

$\Rightarrow$ n = 2 or 7

Since $^nC_3$ demands that n should be $\geq$ 3 then n can not be 2

$\therefore$ n = 7

3. $x_0 = 2 \Rightarrow y_0 = \frac{8}{4} = 2$

$\therefore$ Equation of the tangent is $y = -2x + 6$ which cuts x-axis at (3, 0)

Hence B $\equiv$ (3, 0)

$\therefore \overrightarrow{AB} = (3-2)\hat{i} + (0-2)\hat{j}$ and $\overrightarrow{OB} = 3\hat{i}$

$\therefore \overrightarrow{AB}\cdot\overrightarrow{OB} = 3$

4. $f'(x) = -2 - 3x^2 < 0 \Rightarrow f(x)$ is decreasing

$\because f(f(f(x))) > f(f(-x))$

$\Rightarrow f(f(x)) < f(-x) \Rightarrow f(x) > -x$

$\Rightarrow 30 - 2x + x^3 > -x \Rightarrow x^3 + x - 30 < 0$

$\Rightarrow (x-3)(x^2 + 3x + 10) < 0 \Rightarrow x < 3$

Positive values of integer x = 1, 2

5. $$\begin{array}{l} x+\sin y = 2010 \\ \underline{x+2010\cos y = 2009} \\ \sin y - 2010\cos y = 1 \end{array}$$ substracting

$\Rightarrow$ sin y = 1 + 2010 cos y

Possible if $y = \frac{\pi}{2} \because 0 \leq y \leq \frac{\pi}{2}$

$\therefore$ x = 2010 – 1 = 2009

$$\therefore \frac{[x+y]}{1005} = \frac{\left[2009+\frac{\pi}{2}\right]}{1005} = 2$$

FIITJEE **JEE (Advanced), 2015**

CONCEPT RECAPITULATION TEST - III

Paper 2

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

ALL INDIA TEST SERIES

Time Allotted: 3 Hours **Maximum Marks: 234**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 – 12) contains 4 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

Section-A (13 to 18) contains 3 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-C (01 – 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

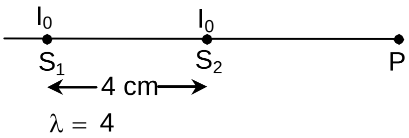
PART – I

SECTION – A

Straight Objective Type

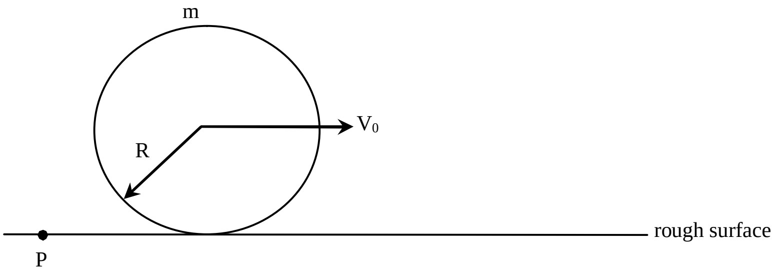
This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. Two coherent sources S_1 and S_2 are situated as shown in figure. Here S_1 is fixed but S_2 is performing SHM with amplitude 2 cm. Initially S_2 is at right extreme. At time $t = \frac{\pi}{2\omega}$ (where ω = angular frequency of SHM):



(A) Phase difference between waves produce by S_1 and S_2 at point P is $\frac{\pi}{2}$.
(B) Intensity at point P is $7I_0$.
(C) Intensity at point P is $4I_0$
(D) Intensity at point P is zero

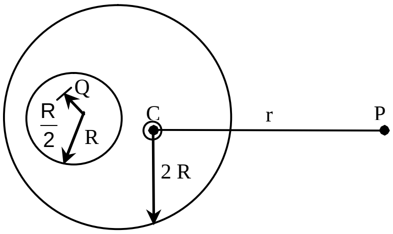
2. A disc of mass m and radius R is projected with initially velocity V_0 and initial angular velocity zero on rough surface. Then, which of the following is **INCORRECT**.



(A) Angular momentum of disc about point P is conserved
(B) Friction force will be zero after pure rolling start
(C) Final angular velocity of disc will be $\frac{V_0}{R}$
(D) Final velocity of centre of mass will be $\frac{2V_0}{3}$

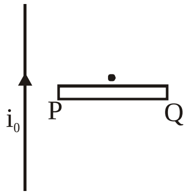
Space for rough work

3. There is a conductor with cavity of radius R as shown in figure. A point charge Q is placed at R/2 distance from centre of cavity. A point P is at r distance from centre of conductor. Then, which of the following is **INCORRECT**.



(A) charge density at inner surface of cavity will be non uniform
(B) charge density at surface of conductor will be uniform
(C) electric field at point P is $\frac{Q}{4\pi\varepsilon_0 r^2}$
(D) force on charge Q is zero.

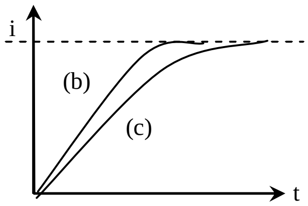
4. A metal rod PQ (carrying current from P to Q) is placed perpendicular to the infinite long wire carrying current i_0. If this arrangement lies in a horizontal plane; then the rod PQ will rotate:



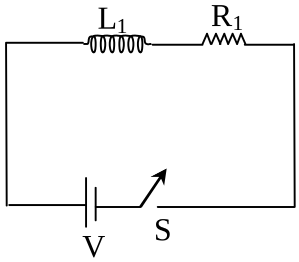
(A) clockwise
(B) anticlockwise
(C) along PQ
(D) does not rotate

Space for rough work

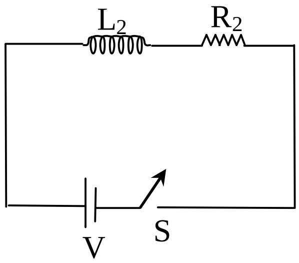
5. Current growth in two L – R circuits (2) and (3) is shown in figure (1) after switch S closed. Then



(1)



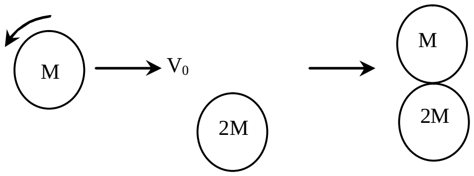
(2)



(3)

(A) $R_1 > R_2$
(B) $R_1 = R_2$
(C) $L_1 > L_2$
(D) $L_1 = L_2$

6. A uniform disc of mass m and diameter 2 R moves forward towards another uniform disc of mass 2 m & diameter 2 R on a frictionless surface as shown in figure



When the first disc contacts the second, they stick to each other and move as a single object. Then, find the **incorrect** option.

(A) the velocity of combined disc after the collision is $\frac{V_0}{3}$.

(B) the angular velocity of combined disc after the collision is $\frac{\omega_0}{3}$.

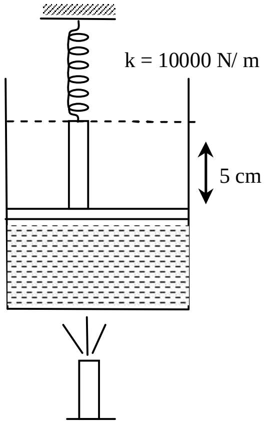
(C) If $\omega_0 = \frac{8}{3}\frac{V_0}{R}$, the combined disc will not rotate

(D) If combined disc does not rotate, the energy loss is $\frac{19}{9}MV_0^{\,2}$.

Space for rough work

7. Two strings with linear mass densities $\mu_1 = 0.1$ kg/m and $\mu_2 = 0.3$ kg/m are joined seamlessly. They are under tension of 20 N. A travelling wave of triangular shape is moving from lighter to heavier string.
   (A) The reflection coefficient at interface is zero
   (B) The reflection coefficient at interface is $2-\sqrt{3}$
   (C) The transmission coefficient at interface is 1
   (D) The transmission coefficient at interface is $\sqrt{3}+5$

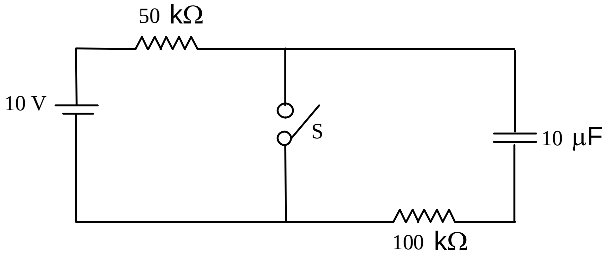
8. Consider a piston – cylinder arrangement with spring in its natural length. Due to heat transfer, the gas expands until the piston hits the stop. The mass of piston is 10 kg and area is 78 cm^2. Initial and final specific internal energies are 214 and 337 k J / kg. Then, find the **incorrect** option.
   (A) Initial pressure of gas is 112 k Pa
   (B) Work done by gas on the piston is 56.5 J
   (C) Work done by gas on the piston is 100 J
   (D) Heat transfer for 0.5 gas is 118 J



Multiple Correct Choice Type

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

9. In the circuit shown, the switch S has been closed for a long time. At time t = 0, the switch is opened. It remains open for a long time T, after which it is closed again.



   (A) voltage drop across 100 k Ω resister is $10e^{-t/1.5}$V for t < T
   (B) voltage drop across 100 k Ω resister is $\frac{20\,e^{-t/1.5}}{3}$ V for t < T
   (C) voltage drop across 100 k Ω resister is $100\left(e^{T-t} - e^{(T-3t)/3}\right)$ for t > T
   (D) The time constant of the circuit is 1.5 sec for t > T

Space for rough work

10. Which type of electrostatic field $\bar{E}$ is not possible?
(A) $\bar{E} = y\hat{i}$
(B) $\bar{E} = x\hat{j}$
(C) $\bar{E} = y\hat{i} + x\hat{j}$
(D) $x^2\left(3y\hat{i} + x\hat{j}\right)$

11. The threshold wavelength for photoelectric emission from a material is $5200\,\text{Å}$, photoelectrons will be emitted when this material is illuminated with monochromatic radiation from a
(A) 50 W infrared lamp
(B) 100 W infrared lamp
(C) 50 W ultraviolet lamp
(D) 100 W ultraviolet lamp

12. A very large number of fine smoke particles each of mass m_1 are trapped inside a small glass container, which contains an ideal gas of molecular mass m_2 at constant pressure P and density d. On viewing the particles through a powerful microscope, the ratio of the rms speed of the smoke particles to that of the gas molecules is K.
(A) smoke particles are in random translatory motion
(B) $m_1 = K^2 m_2$
(C) $m_2 = K^2 m_1$
(D) rms speed of the smoke particles will change if (p : d) changes.

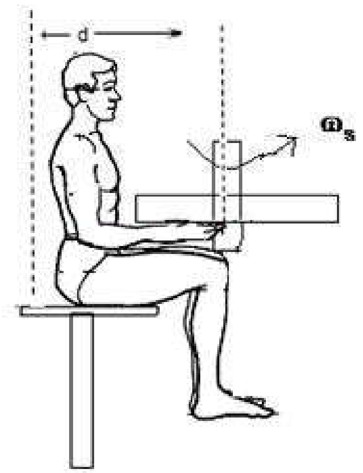
Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

Paragraph for Questions 13 & 14

A person is sitting on a stool that is initially not rotating and is holding a spinning wheel. The moment of inertia of the person and stool about a vertical axis passing through the centre of stool is I_{sp}. The moment of inertia of the wheel about an axis, perpendicular to the plane of the wheel, passing through the centre of mass of the wheel is $I\omega = \left(\frac{1}{4}\right) I_{SP}$. The mass of wheels m_ω. Suppose that the person holds the wheel as shown in the sketch such that the distance of an axis passing through the centre of mass of wheel to the axis of rotation of stool is d and $m_\omega d^2 = \frac{1}{3} I_\omega$. Suppose the wheel is spinning initially at an angular velocity ω_s. The person then turns the spinning wheel upside down. You may ignore any frictional torque in the bearing of the stool.



13. What is angular speed of person and stool after the spinning wheel is turned upside down?

(A) $\frac{3}{4} w_s$ (B) $\frac{3}{2} w_s$

(C) $\frac{3}{8} w_s$ (D) $\frac{3}{7} w_s$

14. Linear impulse given by person to wheel.

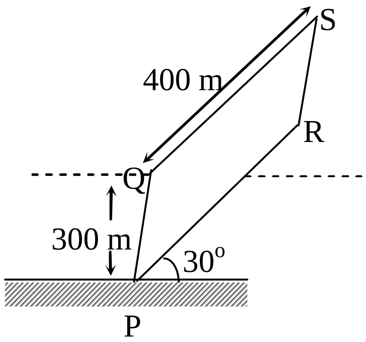
(A) $\frac{3}{4} m_\omega d w_s$ (B) $\frac{3}{2} m_\omega d w_s$

(C) $\frac{3}{8} m_\omega d w_s$ (D) $\frac{3}{7} m_\omega d w_s$

Space for rough work

Paragraph for Questions 15 & 16

A rectangular plank of sides 300 m x 400 m is placed over a horizontal plane at an inclination of 30^o as shown in the figure. (Take $g = 10$ m/s^2)



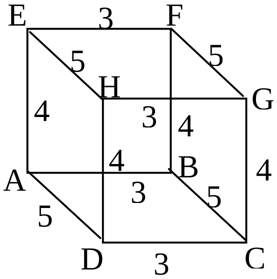
15. A particle is projected from one base corner at an angle of 30^o with the plank but in a vertical plane which carries line of maximum possible length of plank with speed 10 m/s. Then, if time after which particle strikes the plank is T sec, find $T\sqrt{21}$.
    - (A) 5 sec
    - (B) $2\sqrt{7}$ sec
    - (C) $\frac{2}{\sqrt{3}}$ sec
    - (D) None

16. If a particle was projected with speed 10 m/s from one base corner at an angle 30^o with the plank, but in a vertical plane which carries a line over the plank with least possible slope, then time after which particle lands over the plank is
    - (A) 1 sec
    - (B) $\frac{2}{\sqrt{3}}$ sec
    - (C) 2 sec
    - (D) Never

Space for rough work

Paragraph for Questions 17 & 18

An insect which can crawl only, but can not fly, has to reach from one corner to diagonally opposite corner inside a room ABCDEFGH.



17. Find the minimum path length which the insect may select to reach the target point [AD = 5 m, DH = 4 m, DC = 3 m]

(A) 10 m
(B) $\sqrt{90}$ m
(C) $5\sqrt{2}$ m
(D) $\sqrt{74}$ m

18. If while crawling over wall velocity of insect is 2 m/hr and over the floor it is 4 m/hr, then find the minimum possible time insect may take to reach the target point.

(A) More than 3.37 hours
(B) 3.37 hours
(C) Less then 3.37 hours
(D) Less than 1 hour

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive)

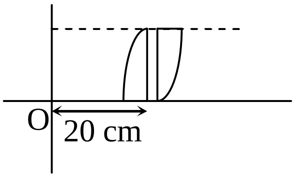
1. If two spherical bubbles of same radius 2 m. and same liquid coalesece to form a common plane surface, then find the gap between the centres of the bubbles.

2. If the no. of times the electron goes round the first Bohr orbit of hydrogen atom in 1S is $P \times 10^{15}$ per second then find approximate value of $\frac{2P}{13}$.

3. A uniformly charged non conducting disc of radius 2 m, mass 1 kg and charges Q = 4C is lying over smooth horizontal plane. The space carries a uniform vertical magnetic field of 1 Tesla find the angular velocity of disc just after reversal in direction of magnetic field.

4. Sound wave travels through air between two points A & B located at a gap of 30 m. if temperature between them varies linearly from -173^0 C to 127^oC. Time taken by sound signal to move from A to B is $K\sqrt{\frac{M}{\gamma R}}$ where γ is adiabatic exponent of air and M its molecular weight. Then find value of K.

5. A biconvex thin lens of focal length 30 cm and aperture diameter 10 cm is broken into four identical pieces. Two of the pieces are placed in a coordinate system as shown in the diagram. Find the magnitude of the y coordinate of the image if an object is placed at origin.



Space for rough work

Chemistry PART – II

SECTION – A

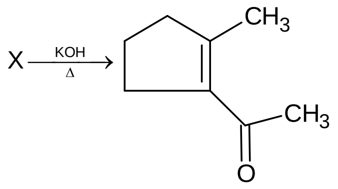
Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. Write the order of reactivity of halogens towards electrophilic addition reactions of alkenes through cyclohalonium intermediate:

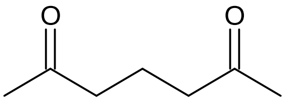
(A) $F_2 > Cl_2 > Br_2 > I_2$
(B) $I_2 > Br_2 > Cl_2 > F_2$
(C) $I_2 > Br_2 > F_2 > Cl_2$
(D) $Br_2 > Cl_2 > I_2 > F_2$

2.

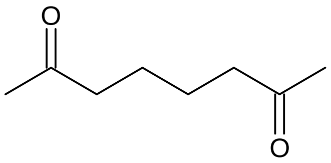


Find out the structure of ‘X’

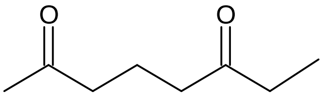
(A)



(B)

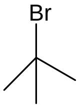


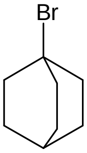
(C)

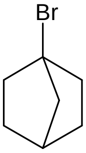


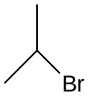
(D) None of these

3. Which is the correct order of following compounds towards nucleophilc substitution via 1st order mechanism?


(I)


(II)


(III)


(IV)

(A) I > IV > II > III
(B) I > II > III > IV
(C) I > IV > III > II
(D) II > I > III > IV

Space for rough work

4. Determine which reagent is in excess and by how much if 100 g P_4O_6 is treated with 100g $KMnO_4$ in HCl solution to form H_3PO_4 and $MnCl_2$?

(A) P_4O_6, 12.05g	(B) $KMnO_4$, 12.05g
(C) P_4O_6, 13.01g	(D) $KMnO_4$, 13.01g

5. The equilibrium pressure of $NH_4CN(s) \rightleftharpoons NH_3(g) + HCN(g)$ is 0.298 atm. Calculate K_P. If $NH_4CN(s)$ is allowed to decompose in presence of NH_3 at 0.25 atm. Calculate partial pressure of HCN at equilibrium.

(A) $K_P = 0.022\ atm^2$, 0.0694 atm	(B) $K_P = 0.022\ atm^2$, 0.0492 atm
(C) $K_P = 0.022\ atm^2$, 0.0542 atm	(D) $K_P = 0.022\ atm^2$, 0.0601 atm

6. $AgBr(s) + 2S_2O_3^{2-}(aq.) \rightleftharpoons Ag(S_2O_3)_2^{3-}(aq) + Br^-(aq.)$

Given $K_{sp(AgBr)} = 5 \times 10^{-13}$, $K_{f\left(Ag(S_2O_3)_2^{3-}\right)} = 5 \times 10^{13}$

What is the molar solubility of AgBr in 0.1 M $Na_2S_2O_3$?

(A) 0.5 M	(B) 0.45 M
(C) 0.045 M	(D) None of these

7. Energy of d-orbitals in square pyramidal geometry

(A) $d_{xz} \simeq d_{yz} < d_{z^2} < d_{xy} < d_{x^2-y^2}$	(B) $d_{xz} \simeq d_{yz} < d_{xy} < d_{z^2} < d_{x^2-y^2}$
(C) $d_{xz} < d_{yz} \simeq d_{xy} < d_{x^2-y^2} < d_{z^2}$	(D) $d_{xz} < d_{yz} \simeq d_{xy} < d_{x^2-y^2} < d_{z^2}$

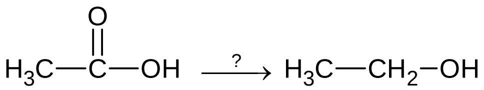
8. When alkali metals dissolved in liq. NH_3 it turns blue colour solution and after some time it disappears. Then

(A) The solution acts as good conductor.
(B) The solution shows diamagnetic nature.
(C) The solution acts as strong oxidising agent.
(D) The solution liberates H_2 gas.

Space for rough work

Multiple Correct Choice Type

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct

9.


$$H_3C-\overset{\overset{\displaystyle O}{||}}{C}-OH \xrightarrow{?} H_3C-CH_2-OH$$

For above reaction, the reagent used is:
(A) $LiAlH_4$ (B) $NaBH_4$
(C) B_2H_6 (D) Ni/H_2

10. Which of the following possess two lone pairs at central atom and has square planar shape?
(A) SF_4 (B) XeO_4
(C) XeF_4 (D) ICl_4^-

11. In co-ordination compounds, the valence bond theory does not explain:
(A) Magnetic moment (B) Colour property
(C) Square planar geometry of Cu^{2+} complex (D) Square planar geometry of Pt^{2+}, Pd^{2+}

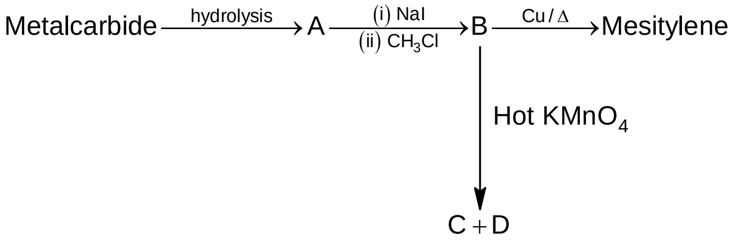
12. 1 atm pressure is equal to:
(A) 760 torr (B) 1.01325×10^5 pascal
(C) 1.01325×10^5 N/m^2 (D) 1.01325 bar

Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

Paragraph for Question Nos. 13 to 14



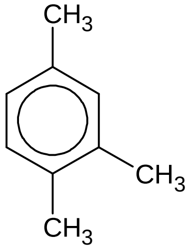
$$\begin{tikzcd} \text{Metalcarbide} \arrow[r, "\text{hydrolysis}"] & A \arrow[r, "\text{(i) NaI}", "\text{(ii) CH}_3\text{Cl}"'] & B \arrow[r, "\text{Cu}/\Delta"] \arrow[d, "\text{Hot KMnO}_4"] & \text{Mesitylene} \\ & & C + D & \end{tikzcd}$$

'C' gives effervescence with $NaHCO_3$

13. 'B' is
    (A) $HC\equiv CH$
    (B) $H_3C-CH_2-C\equiv C-H$
    (C) $H_3C-C\equiv C-H$
    (D) $H_3C-C\equiv C-CH_3$

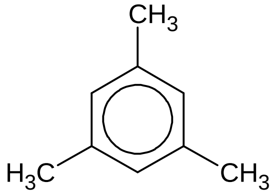
14. Mesitylene and 'D' respectively are:

(A)



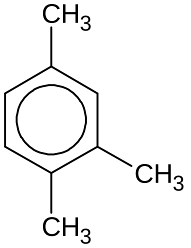
, CH_3COOH

(B)



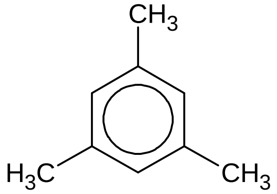
, CO_2

(C)



, CO_2

(D)

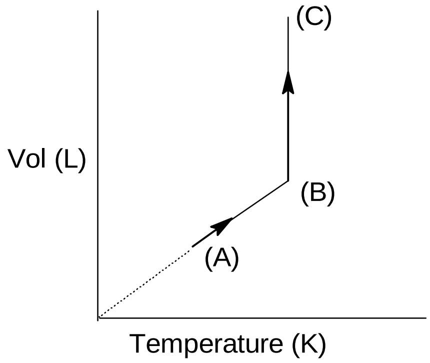


, HCOOH

Space for rough work

Paragraph for Question Nos. 15 to 16

A triatomic linear (neglect vibration degree of freedom) ideal gas of two mole is taken through a reversible process starting from 'A' as shown in figure



The volume ratio $\frac{V_B}{V_A} = 4$ and if the temperature at A is –73°C

15. Work done by the gas in AB process is
(A) 3.32 kJ (B) - 3.32 kJ
(C) 9.97 kJ (D) - 9.97 kJ

16. Total enthalpy change in the process (A →C) is:
(A) 3000 R (B) 4200 R
(C) 2100 R (D) 0

Space for rough work

Paragraph for Question Nos. 17 to 18

Many bond angles can be explained by either electronegativity (or) size arguments. Molecules with larger difference in electronegativity values between central and outer atoms have smaller bond angles.

17. Which has the smallest bond angle (X—O—X) in the given molecules?

(A) OSF_2	(B) $OSCl_2$
(C) $OSBr_2$	(D) OSI_2

18. Consider the following iodides:

PI_3	AsI_3	SbI_3
102^o	100.2^o	99^o

The bond angle is maximum in PI_3 which is

(A) due to small size of phosphorus	(B) due to more bp–bp repulsion in PI_3
(C) due to less electronegativity of ‘P’	(D) None of the above

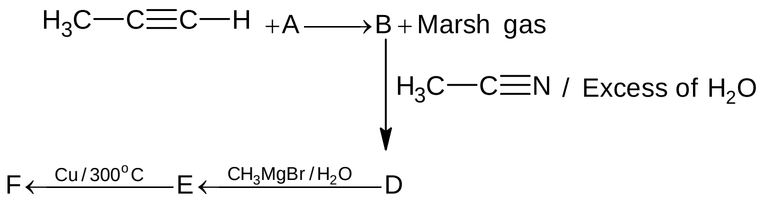
Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive)

---

1. 
$H_3C—C\equiv C—H + A \longrightarrow B + \text{Marsh gas}$
$H_3C—C\equiv N$ / Excess of H_2O
$F \xleftarrow{Cu/300^oC} E \xleftarrow{CH_3MgBr/H_2O} D$

No. of π bonds present in F

2. $C_6H_{14}O$ is an 3^o alcohol (A) which on Cu/300°C gives an alkene (having four hyperconjugative structures) which reacts with NBS in presence of light gives Bromo substituted compound (B). B again reacts with Benzene in presence of $AlCl_3$ gives final product C. 'C' reacts with strong oxidising agent such as $KMnO_4$ to give CO_2 as one of the products. What is the number of 1^o carbons present in (A).

3. Ammonium nitrate on strong heating, is decomposed to give a gas (A) and water. It is neutral gas. (A) on heating at 1300°C gives two gases (B) and (C). (B) reacts with $FeSO_4$ solution to form brown coloured compound (D). Number of unpaired electrons present in (D):

4. In Goldschmidt aluminothermic process, thermite mixture contains how many parts of Fe_2O_3 along with one part of aluminium?

5. At 48°C, the vapour pressure of pure CS_2 is 850 torr. A solution of 2.0 g of sulphur in 100 g of CS_2 has a vapour pressure 844.9 torr. Determine the atomicity of sulphur molecule.

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. Let a, b and c be non-zero real numbers, such that $\int_0^1 (1+\cos^8 x)(ax^2+bx+c)dx = \int_0^2 (1+\cos^8 x)(ax^2+bx+c)dx$ then, the equation $ax^2 + bx + c = 0$ has

(A) no roots in (0, 2)
(B) atleast one root in (1, 2)
(C) a double root in (0, 2)
(D) two imaginary roots

2. The value of b, such that the equation $\frac{b\cos x}{2\cos 2x - 1} = \frac{b+\sin x}{(\cos^2 x - 3\sin^2 x)\tan x}$ posses solutions, belong to the set

(A) $\left(-\infty, \frac{1}{2}\right)$
(B) $\left(\frac{1}{2}, \infty\right)$
(C) $(-\infty, \infty)$
(D) $\left(-\infty, \frac{1}{2}\right) \cup (1, \infty)$

3. Two forces whose magnitudes are 2 gm wt and 3 gm wt act on a particle in the directions of the vectors $2\hat{i}+4\hat{j}+4\hat{k}$ and $4\hat{i}-4\hat{j}+2\hat{k}$ respectively. If the particle is displaced from the origin to the point (1, 2, 2), then work done is

(A) 6 gm-cm
(B) 4 gm-cm
(C) 5 gm-cm
(D) none of these

Space for rough work

4. If a, b, c, d be in G.P. then $(a^2 + b^2 + c^2)(b^2 + c^2 + d^2)$ is
(A) ab + bc + cd (B) $(ab + bc + cd)^2$
(C) $(ab - bc - cd)^2$ (D) 0

5. The value of 'a' for which $ax^2 + \sin^{-1}(x^2 - 2x + 2) + \cos^{-1}(x^2 - 2x + 2) = 0$ has a real solution, is
(A) $\frac{\pi}{2}$ (B) $-\frac{\pi}{2}$
(C) $\frac{2}{\pi}$ (D) $-\frac{2}{\pi}$

6. Let $f(x) = \begin{cases} x^p \sin\left(\frac{1}{x}\right) & , \quad x \neq 0 \\ 0 & , \quad x = 0 \end{cases}$, then f(x) is continuous but not differentiable at x = 0 if
(A) $p < 0$ (B) $p = 0$
(C) $0 < p \le 1$ (D) $p \ge 1$

7. If $A_1, A_3, \ldots.. A_{2n-1}$ are n skew–symmetric matrices of same order then $B = \sum_{r=1}^{n}(2r-1)(A_{2r-1})^{2r-1}$ will be
(A) symmetric (B) skew–symmetric
(C) neither symmetric nor skew–symmetric (D) data is inadequate

8. In an acute angled triangle ABC, vertex A is (1, 2). Let H is the orthocentre and M is the mid point of side BC. On the line HM, a point T is taken such that HM = MT and equation of lines BT and CT are x – 2y + 3 = 0 and x + y + 1 = 0 respectively. Find equation of circumcircle of ΔABC.
(A) $(x+1)\left(x+\frac{5}{8}\right)+(y-2)\left(y-\frac{2}{3}\right)=0$ (B) $(x+1)\left(x+\frac{5}{8}\right)+(y+2)\left(y+\frac{2}{3}\right)=0$
(C) $(x-1)\left(x-\frac{5}{8}\right)-(y-2)\left(y-\frac{2}{3}\right)=0$ (D) $(x-1)\left(x+\frac{5}{8}\right)+(y-2)\left(y-\frac{2}{3}\right)=0$

Space for rough work

Multiple Correct Choice Type

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct

9. Let $\tan^{-1}\left(\tan\frac{5\pi}{4}\right) = \alpha$, $\tan^{-1}\left(-\tan\frac{2\pi}{3}\right) = \beta$. Then

(A) $\alpha > \beta$
(B) $4\alpha - 3\beta = 0$
(C) $\alpha + \beta = \frac{7\pi}{12}$
(D) $\alpha + \beta = \pi$

10. If $f(x) = \left|\left(x + \frac{1}{2}\right)[x]\right|$, $x \in [-2, 2]$ (where [.] denotes the G.I.F.), then f(x) is discontinuous at x is equal to

(A) –2
(B) 2
(C) 0
(D) 1

11. If D_1 and D_2 are diagonal matrices of order 3, then

(A) D_1D_2 is a diagonal matrix
(B) $D_1D_2 = D_2D_1$
(C) $D_1^2 + D_2^2$ is a diagonal matrix
(D) none of these

12. Let $u_n = \int_0^{\pi/2} \cos^n x \cos nx \, dx$ it turns out that $u_1, u_2, u_3, ...$ form a G.P. then

(A) the common ratio of G.P. is $\frac{1}{2}$
(B) the common ratio of G.P. is $\frac{1}{4}$
(C) then $u_n = \frac{\pi}{2^{2n}}$
(D) then $u_n = \frac{\pi}{2^{n+1}}$

Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

---

Paragraph for Question Nos. 13 to 14

Read the following write up carefully and answer the following questions:
If the three equation $x^2 + ax + 12 = 0$, $x^2 + bx + 15 = 0$ and $x^2 + (a + b)x + 36 = 0$ have a common possible root

13. Then value of a and b are
(A) $a = \pm 7, b = \pm 8$ (B) $a = \pm 8, b = \pm 7$
(C) $a = 0, b = 0$ (D) none of these

14. Then the common possible roots are
(A) ± 1 (B) ± 2
(C) ± 3 (D) ± 4

Paragraph for Question Nos. 15 to 16

Read the following write up carefully and answer the following questions:
P: $y^2 = 8x$ and E: $\frac{x^2}{4} + \frac{y^2}{15} = 1$ are equation of parabola and ellipse respectively

15. Equation of a tangent common to both the parabola P and ellipse E is
(A) $x - 2y + 8 = 0$ (B) $x + y + 9 = 0$
(C) $x + 2y - 8 = 0$ (D) $x - 2y - 8 = 0$

16. Equation of the normal at the point of contact of the common tangent, which (i.e. tangent) makes an acute angle with positive direction of x-axis to the parabola P, is
(A) $2x + y = 24$ (B) $2x + y + 24 = 0$
(C) $2x + y = 48$ (D) $2x + y + 48 = 0$

Space for rough work

Paragraph for Question Nos. 17 to 18

Read the following write up carefully and answer the following questions:
Let f(x) = |ln|{x} – 1|| $\forall$ x $\in$ [2, 3) and g(x) = f′(x). If h′(x) = $f^2(x) + g^2(x)$ such that h(2) = –3, then (where {x} denotes fractional part of x)

17. h(x) + g(x) = 0 has
(A) at least one root in [2, 3)
(B) exactly one root in [2, 3)
(C) non real root in [2, 3)
(D) can’t say

18. h′(x) + g′(x) = 0 has
(A) at least one root in [2, 3)
(B) exactly one root in [2, 3)
(C) no real root in [2, 3)
(D) can’t say

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive)

---

1. If $\int \frac{\cos x\left(1+4\cos 2x\right)}{\sin x+4\sin x\cos^2 x}dx=\frac{1}{2}\ln\left|h\left(x\right)\right|+\frac{1}{2}\ln\left|f\left(x\right)\right|+c$ then, $\left|f\left(\frac{\pi}{2}\right)\cdot h\left(\frac{\pi}{2}\right)\right|$ is equal to _____

2. If $\int\limits_0^{x^2} f\left(t\right)dt = x\cos\pi x$ and $\int\limits_0^{f(x)} t^2 dt = x\cos\pi x$ then $\frac{f'\left(4\right)}{16}$ is equal to _____

3. Let f: R $\to$ R be a twice differentiable function satisfying f″(x) – 5f′(x) + 6f(x) $\geq$ 0 $\forall$ x $\geq$ 0 if f(0) = 1, f′(0) = 0. If f(x) satisfies f(x) $\geq$ ah(bx) – bh(ax); $\forall$ x $\geq$ 0, then the value of (a + b) h(0) is equal to _____

4. Let f(x) be a differentiable function such that f′(x) + f(x) = $4xe^{-x}$ · sin 2x and f(0) = 0 if $\lim\limits_{n\to\infty}\sum\limits_{k=1}^{n} f\left(k\pi\right)=\frac{-p\pi e^{\pi}}{\left(e^{\pi}-1\right)^2}$ then p is equal to _____

5. If the range of the function $\cos^{-1}\left|1-x^2\right|$ is $\left[a, \frac{\pi}{b}\right]$ then find the value of b _____

Space for rough work

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CRT–III
(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	D	B
2.	C	B	A
3.	D	A	A
4.	A	C	B
5.	B	A	B
6.	B	C	C
7.	B	A	B
8.	C	A	D
9.	B, C	A, C, D	B, C
10.	A, B	C, D	B, C, D
11.	C, D	B, C, D	A, B, C
12.	A, C, D	A, B, C, D	A, D
13.	C	C	A
14.	C	B	C
15.	A	C	A
16.	A	B	A
17.	D	A	B
18.	C	B	C
1.	2	3	1
2.	1	4	1
3.	4	3	5
4.	2	3	2
5.	5	8	2

Physics

PART – I

SECTION – A

1. $$\Delta\phi = \frac{2\pi}{\lambda}\Delta X$$
$$\Delta\phi = \frac{2\pi}{16}\times 4 = \frac{\pi}{2}$$
$$I = 4I_0\cos^2\frac{\pi}{4} = 2I_0$$

2. $$mV_0R = \frac{3}{2}mR^2\omega$$
$$\omega = \frac{2V_0}{3R}$$
$$V_{cm} = R\omega = \frac{2V_0}{3}$$

3. Electric field lines kill off on surface of conductor

4. Torque will be in clockwise sense.

5. Since maximum current passing through two circuits is same and equal to V/R_1 in (b) and V/R_2 in (c) then $R_1 = R_2$
Current growth equation of L – R circuit is :
$$i = i_0\left(1 - e^{-t/\tau}\right)$$
$$i = i_0\left(1 - e^{\frac{-tR}{L}}\right)$$
Now, $\frac{di}{dt} = \frac{i_0R}{L}e^{-tR/L}$
At t = 0 slope of I vs t curve:
$$\frac{di}{dt} = \frac{i_0R}{L}$$
From graph (a) : slope of curve (b) > slope of curve (c)
$$\frac{R_1}{L_1} > \frac{R_2}{L_2}$$
Since, $R_1 = R_2$
$L_1 < L_2$

6. Momentum conservation.
$$MV_0 = 2MV$$
$$V = \frac{V_0}{3}$$
Angular momentum conservation about centre of mass,
$$\frac{1}{2}MR^2\cdot\omega_0 - \frac{4}{3}MV_0R = \left[\frac{MR^2}{2} + M\left(\frac{4}{3}R\right)^2 + \frac{1}{2}(2M)R^2 + 2M\left(\frac{2}{3}R^2\right)\right]\omega$$
$$\omega = \frac{3}{25}\omega_0 - \frac{8}{25}\frac{V_0}{R}$$

For $\omega = 0$

$$\omega_0 = \frac{8V_0}{3R}$$

The energy loss,

$$\Delta E = E_i - E_f$$

$$= \frac{1}{2}MV_0{}^2 + \frac{1}{2}\left(\frac{MR^2}{2}\right)\cdot\omega^2 - \frac{1}{2}(3M)V^2 = \frac{19}{9}MV_0{}^2$$

7. $V_1 = \sqrt{\frac{T}{\mu_1}} = 10\sqrt{2}$

$$V_2 = \sqrt{\frac{T}{\mu_2}} = \frac{10\sqrt{2}}{\sqrt{3}}$$

Reflection coefficient

$$R = \frac{V_2 - V_1}{V_1 + V_2} = 2 - \sqrt{3}$$

Transmission coefficient,

$$T = \frac{2V_2}{V_1 + V_2} = \sqrt{3} - 1$$

8. Initially,

$$P_{gas} = P_0A + mg = 112.5 \text{ kPa}$$

$$w = \int_0^x P_{gas}A\,dx$$

$$= \int_0^x (P_0A + mg + kx)dx = 56.5 \text{ J}$$

$$Q = m\Delta u + w = 118 \text{ J}$$

9. When the switch ‘S’ is opened,

$$\tau = RC = 1.5\,\text{sec}$$

Voltage across the capacitor,

$$V_c = 10\left(1 - e^{-t/1.5}\right) \text{ for } t < T$$

The current, $i = \frac{dQ}{dt} = C\ \frac{dV_c}{dt}$

$$= \frac{200}{3}\times 10^{-6}\left(e^{-t/1.5}\right) \text{ for } t < T$$

Voltage drop across 100 k μ resister,

$$V = iR = \frac{20}{3}e^{-t/1.5} \text{ for } t < T$$

After t = T,

$$\tau = 100\ \text{k}\Omega \times 10\ \mu\text{F} = 1 \text{ sec}$$

Voltage across capacitor,

$$V_c = V_o t^{-\left[(t-T)/\tau\right]} = 10\left(1 - e^{-(T/1.5)}\right), e^{-\left[(t-T)/1\right]}$$

The charge on capacitor,

$$Q = V_c \cdot C$$

The current through 100 k μ resistor,

$$i = -C\frac{dV_c}{dt} = 10^{-3}\left(1 - e^{-T/1.5}\right)\left(1 - e^{-(t-T)/1}\right)$$

10. If $\frac{\partial}{\partial y}\left(\frac{\partial V}{\partial x}\right) = \frac{\partial}{\partial x}\left(\frac{\partial V}{\partial y}\right)$ then $\bar{E}$ exists.

11. For emission of photoelectrons, $\lambda_{\text{incident}} < 5200\,\overset{o}{A}$.

12. $m_1 V_1^2 = m_2 V_2^2 = 3KT$

$$= \frac{3RT}{N_A} = \frac{3PM}{N_A d}$$

13. Angular momentum conservation about axel of stool.

$$I_\omega w_s = I_{sp} w_f + I_\omega (w_f - w_s) + m_\omega d^2 wf$$

$$w_f = \frac{3}{8} w_s$$

14. Linear impulse $= \Delta p = mv_{cm} - 0$

$$= \frac{3}{8} m_\omega d w_s$$

15. Slope will be now different such that

$$\sin\theta = \frac{200}{500} = \frac{2}{5}$$

So, $\cos\theta = \sqrt{\frac{21}{25}}$

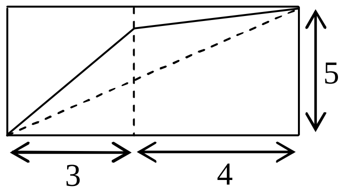
Hence, T = $\frac{2u\sin 30^o}{g\cos\theta}$

16. For minimum slope, line will be PQ, i.e. a horizontal line

Hence, time = $\frac{2u\sin 30^o}{g}$ = 1 sec.

17. $\sqrt{7^2 + 5^2} = \sqrt{74}$

18. Snell's law
For minimum time it will follow a path which could have been followed by a light ray under refraction, but not the previous one. Definitely time taken would be less than what could have been over straight path.



SECTION – C

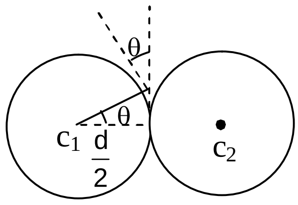
1. $4T \,.\, \cos\theta \,.\, dl = 2T \,.\, dl$

$$\cos\theta = \frac{1}{2}$$

$$\theta = 60^o$$

So, $\frac{d}{2} = R\cos 60 = \frac{R}{2}$

$c_1c_2 = d = R = 2$ m



2. $$f_n = \frac{1}{\frac{2\pi r_n}{v_n}} = \frac{v_n}{2\pi r_n}$$

$$f_1 = \frac{2.18\times10^6}{2\times3.14\times0.529\times10^{-10}}\ \text{sec}^{-1}$$

$$= 6.56\times10^{15}\ \text{sec}^{-1}$$

$$P = 6.56$$

$$\frac{2P}{13} = 1 \text{ approximately.}$$

3. $$dQ = 2\pi x dx.\frac{Q}{\pi R^2},\ E_x = \frac{-x}{2}\frac{2B}{t}$$

$$\Delta L = \int \tau\ dt\ \Rightarrow IW\ = \int_0^R \frac{x}{2}\frac{2B}{t}\ .\ 2\pi x dx\frac{Q}{\pi R^2}dt$$

$$\frac{MR^2}{2}\omega = \frac{QBR^2}{2} \Rightarrow \omega = \frac{QB}{M} = 4$$

4. $$V_{avg}\ = \frac{v_1+v_2}{2}$$ Since variation is linear, $t = \frac{t}{V_{avg}} = 2\sqrt{\frac{M}{\gamma R}}$

$$= \sqrt{\frac{\gamma R}{M}}\left(\frac{\sqrt{T_1}+\sqrt{T_2}}{2}\right)$$

5. $$\frac{1}{f}+\frac{1}{f} = 30,\ f = 60$$

$$\frac{1}{v_1}-\frac{1}{-20} = \frac{1}{60} \Rightarrow\ v_1 = -30,\ \frac{1}{v}-\frac{1}{-30} = \frac{1}{60}$$

$$\frac{I}{0} = m = \frac{v}{v_1} = \frac{-60}{-30} = 2$$

$$\Rightarrow\ \frac{I}{-5} = 2\ \Rightarrow\ I = -10$$

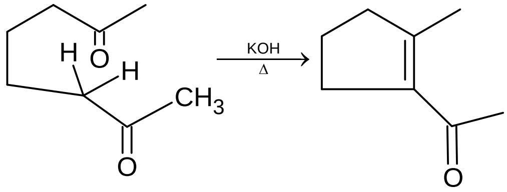
y coordinate = -5

Chemistry PART – II

SECTION – A

1. Normally not possible to F_2 because it is highly exothermic with I_2 reversible reaction takes place due to more E.N of Cl_2 compare to Br_2. It does not give e^- pair to carbocation.

2.



3. II, III are unstable because of their rigid frame work, to stabilize themselves by collapsing to the stable intermediate planer state. II is more stable than III because the greater rigidity about bridge head carbon with a one-carbon than with a two – carbon bridge.

4.
$$5e^- + Mn^{7+} \longrightarrow Mn^{2+}$$
$$\left(P^{3+}\right)_4 \longrightarrow 4P^{5+} + 8e^-$$

Meq. Of $KMnO_4 = \dfrac{100\times 5\times 1000}{158} = 3164.56$

Meq. Of $P_4O_6 = \dfrac{100\times 8\times 1000}{219.9} = 3638.02$

Meq. Of P_4O_6 in excess = 473.46

$\therefore\ \dfrac{w\times 8\times 1000}{219.9} = 473.46 \quad W_{P_4O_6}$ in excess $= 13.01g$

5.
$$NH_4CN(s) \rightleftharpoons NH_3(g) + HCN(g)$$
P P

At eq.

$\therefore$ Total pressure = 2P = 0.298 atm

p = 0.149

Also $K_P = P^1_{NH_3} \times P^1_{HCN} = 0.149 \times 0.149 = 0.022\ atm^2$

Now $P_{NH_3} = 0.25\ atm$

$$NH_4CN(s) \rightleftharpoons NH_3(g) + HCN(g)$$

Initial 0.25 0

At eq $0.25 + P^1$ P^1

$K_{P\,=\,P}{}^{1}\ (0.25 + P^1)$

$P^1 = 0.0694$ atm

6.
$$\begin{array}{ll} AgBr(s) \rightleftharpoons Ag^+(aq.) + Br^-(aq.) & K_1 = K_{sp} \\ Ag^+(aq) + 2S_2O_3^{2-}(aq.) \rightleftharpoons Ag(S_2O_3)_2^{3-}(aq.) & K_2 = K_f \\ \hline AgBr + 2S_2O_3^{2-}(aq.) \rightleftharpoons Ag(S_2O_3)_2^{3-} + Br^- & K = K_{sp}\times K_f = 25 \end{array}$$

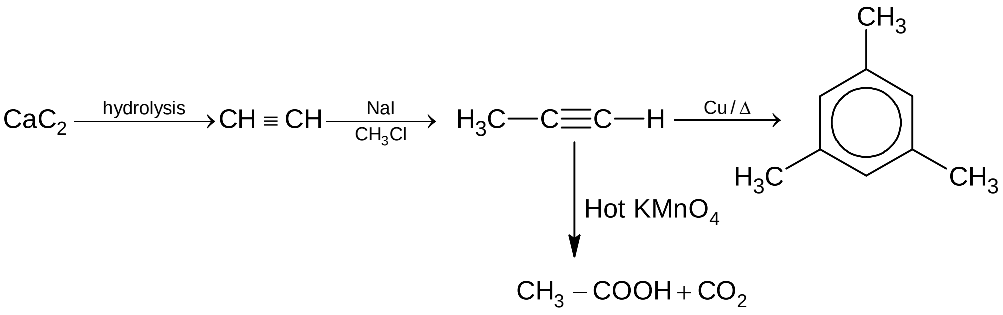
$$K = \frac{x^2}{(0.1-2x)^2} \Rightarrow \frac{x^2}{(0.1-2x)^2} = 25$$
$$\Rightarrow x = 0.045\ M.$$

8. $M \longrightarrow M^+ + e^-$

$$M^+ + e^- + (x+y)NH_3 \longrightarrow \underset{\text{solvated metal}}{M(NH_3)_x} + \underset{\text{solvated } e^-}{\left[e^-(NH_3)_y\right]}$$
$$\downarrow \text{on stand}$$
$$M-NH_2$$

11. V. B.T does not explain colour, Cu^{2+}, Pt^{2+}, Pd^{2+} square planar geometries with proper reason.

14.


CaC2
hydrolysis
CH ≡ CH
NaI
CH3Cl
H3C—C≡C—H
Cu / Δ
CH3
H3C
CH3
Hot KMnO4
CH3 – COOH + CO2

15. W = –P.ΔV = –nRΔT = – 2 × 8.314 × 600 = – 9.97 kJ

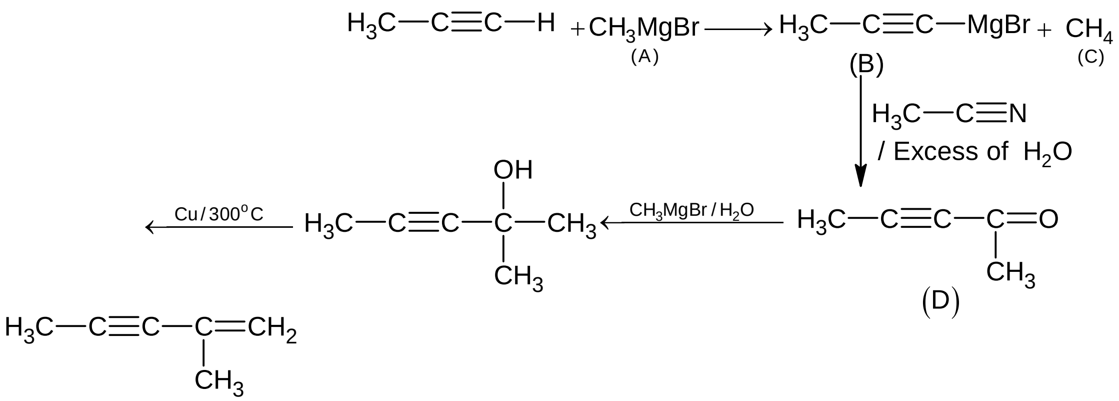
16. $\Delta H_{Total} = \Delta H_{AB} + \Delta H_{BC}$
$= nC_{p,m}\Delta T + 0$
$= 2 \times \frac{7}{2} \times R \times (800-200)$
= 4200 R

17. Due to high electronegativity of ‘F’ bp–bp repulsion is minimum in OSF_2. Steric effect may also be the explanation.

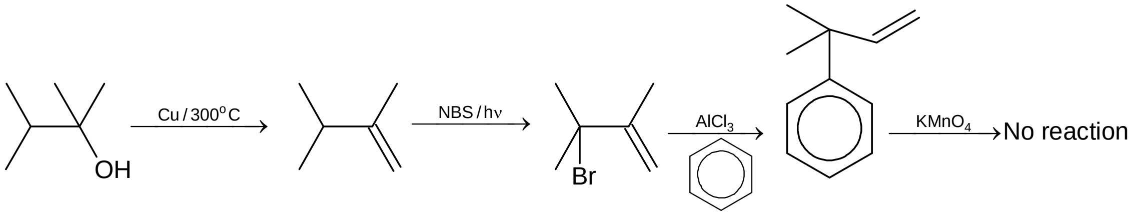
18. Among P, As and Sb, P is most electronegative and so it exerts the strongest pull on shared electrons causing more bp–bp repulsion.

SECTION – C

1.


H3C—C≡C—H
+CH3MgBr
(A)
H3C—C≡C—MgBr
(B)
+ CH4
(C)
H3C—C≡N
/ Excess of H2O
H3C—C≡C—C=O
CH3
(D)
CH3MgBr / H2O
OH
H3C—C≡C—C—CH3
CH3
Cu / 300°C
H3C—C≡C—C=CH2
CH3

2.



Due to absence of Benzoic hydrogens.

3. $\mathrm{NH_4NO_3} \xrightarrow{\Delta} \underset{(A)}{\mathrm{N_2O}} + 2\mathrm{H_2O}$

$\mathrm{N_2O} \xrightarrow{1300^{o}\mathrm{C}} 2\underset{(B)}{\mathrm{NO}} + \underset{(C)}{\mathrm{N_2}}$

$\mathrm{NO} + \mathrm{FeSO_4} \longrightarrow \underset{\text{Brown Compound}}{\underset{(D)}{\mathrm{FeSO_4.NO}}}$

5. $$\frac{P^{o} - P}{P} = \frac{n}{N} = \frac{W}{W \times N}$$

$$= \frac{850 - 844.9}{844.9} = \frac{2 \times 76}{M \times 100}$$

$M \approx 252$

$N = \dfrac{252}{32} \approx 8$

Mathematics

PART – III

SECTION – A

1. Consider $f\left(x\right)=\int\limits_0^x\left(1+\cos^8 x\right)\left(ax^2+bx+c\right)dx$

Obviously, f(x) is continuous in [1, 2] and differentiable in (1, 2). Also f(1) = f(2)
By Rolle's theorem, there exist one point
$k \in (1, 2)$ such that $f'(k) = 0$ ….. (1)
Now, $f'(k) = (1 + \cos^8 k)(ak^2 + bk + c) = 0$
$\Rightarrow ak^2 + bk + c = 0$ $(1 + \cos^8 k \neq 0)$
$\therefore$ x = k is root of $ax^2 + bx + c = 0$ where $k \in (1, 2)$
Here, atleast one root $\in (1, 2)$

2. $\because$ $2 \cos 2x – 1 = 2(\cos^2 x – \sin^2 x) – (\sin^2 x + \cos^2 x) = \cos^2 x – 3 \sin^2 x$
The given equation reduces to b sin x = b + sin x, then

$$\sin x=\frac{b}{b-1}$$

$$\Rightarrow\ -1\le\sin x\le 1$$

$$\Rightarrow\ -1\le\frac{b}{b-1}\le 1$$

$$\Rightarrow\ \frac{b}{b-1}\ge -1$$

and $\dfrac{b}{b-1}\le 1$

$$\Rightarrow\ b<\frac{1}{2}$$

$$\Rightarrow\ b\in\left(-\infty,\frac{1}{2}\right)$$

3. The vectors representing forces are 2 × unit vector along $(2\hat{i}+4\hat{j}+4\hat{k})$
and 3 × unit vector along $(4\hat{i}-4\hat{j}+2\hat{k})$

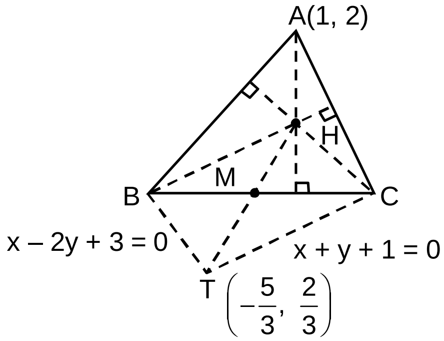
i.e., $\dfrac{1}{3}(2\hat{i}+4\hat{j}+4\hat{k})$ and $\dfrac{1}{2}(4\hat{i}-4\hat{j}+2\hat{k})$

$\therefore$ The resultant is $\dfrac{1}{3}(8\hat{i}-2\hat{j}+7\hat{k})$

The displacement is given by the vector $\hat{i}+2\hat{j}+\hat{k}$

Hence the work done $=\dfrac{1}{3}(8\hat{i}-2\hat{j}+7\hat{k})\cdot(\hat{i}+2\hat{j}+2\hat{k})=6$ gm-cm

4. Let r be the common ration of the given G.P., then $b = ar$, $c = ar^2$, and $d = ar^3$
Then $(a^2 + b^2 + c^2)(b^2 + c^2 + d^2)$
$= (a^2 + a^2r^2 + a^2r^4)(a^2r^2 + a^2r^4) + a^2r^6$
$= a^2(1 + r^2 + r^4)\, a^2r^2(1 + r^2 + r^4)$
$= a^4r^2(1 + r^2 + r^4)^2$
$= (a^2r + a^2r^3 + a^2r^5)^2$
$= (a\cdot ar + ar\cdot ar^2 + ar^2\cdot ar^3)^2$
$= (ab + bc + cd)^2$



8. M is mid point of BC and HT
$\therefore$ BTCH is a parallelogram
$\because$ CH is perpendicular BA and CH is parallel BT
$\therefore$ BT is perpendicular AB
Similarly CT is perpendicular AC
Now, a circle drawn taking AT as diameter will pass through B and C
i.e. points A, B, T, C are concyclic points
$\therefore$ Required circle $(x-1)\left(x+\frac{5}{8}\right)+(y-2)\left(y-\frac{2}{3}\right)=0$

12. First use integrating by parts to show that

$$u_n = \int_0^{\pi/2} \cos^{n-1} x \sin x \sin nx \, dx$$

$= \int_0^{\pi/2} \cos^{n-1} x \cos(n-1)x - \int_0^{\pi/2} \cos^n x \cos nx \, dx$ (Use sin nx sin x = cos(n – 1)x – cos nx cos x)

$= u_{n-1} - u_n$

$\Rightarrow \frac{u_n}{u_{n-1}} = \frac{1}{2}$

We have, $u_1 = \frac{\pi}{4}$, $u_n = \frac{1}{2^{n-1}} \cdot \frac{\pi}{4} = \frac{\pi}{2^{n+1}}$

13.-14. Let α be the common root of the three equations are their other roots be β, γ, δ respectively
$\therefore \alpha + \beta = -a, \alpha\beta = 12$
$\alpha + \gamma = -b, \alpha\gamma = 15$
$\alpha + \delta = -(a + b), \alpha\delta = 36$
$\therefore (\alpha + \beta) + (\alpha + \gamma) = -(a + b) = \alpha + \delta$
$\therefore \alpha + \beta + \gamma = \delta$ ….. (1)
Again $\alpha(\beta + \gamma + \gamma) = 12 + 15 + 36 = 63$
or $\alpha(2\delta - \alpha) = 63$ by (1)
or $2\alpha\delta = \alpha^2 = 63$ or $72 - \alpha^2 = 63$
$\because \alpha\delta = 36$
$\therefore \alpha^2 = 9; \alpha = 3, -3$
$\alpha = 3 \Rightarrow \beta = 4, \gamma = 5, \delta = 12$
$\alpha = -3 \Rightarrow \beta = -4, \gamma = -5, \delta = -12$
$\therefore a = -(\alpha + \beta) = 7, -7; b = -(\alpha + \gamma) = 8, -8$

15. Equation of any tangent to the parabola $y^2 = 8x$ is $y = mx + \frac{2}{m}$

Since, it touches $\frac{x^2}{4} + \frac{y^2}{15} = 1$ ($\because c^2 = a^2m^2 + b^2$)

$\left(\frac{2}{m}\right)^2 = 4m^2 + 15 \Rightarrow m = \pm\frac{1}{2}$

Hence, equations of tangent are $x \pm 2y + 8 = 0$

16. When $m = \frac{1}{2}$ then slope of normal is –2 and equation of the normal to the parabola is
$y = -2x - 2(2)(-2) - 2(-2)^3$ ($\because y = mx - 2am - am^3$)
$\Rightarrow y = -2x + 8 + 16 \Rightarrow 2x + y = 24$

SECTION – C

1. $$\frac{\cos x\left(1+4\cos 2x\right)}{\sin x\left(1+4\cos^2 x\right)} = \frac{\cos x\left[1+4\left(1-2\sin^2 x\right)\right]}{\sin x\left[1+4-4\sin^2 x\right]} = \frac{\cos x\left(5-8\sin^2 x\right)}{\sin x\left(5-4\sin^2 x\right)} = \frac{\cos x}{\sin x} - \frac{4\sin x}{\left(5-4\sin^2 x\right)}$$

Put t = sin x; dt = cos x dx

2. $$\int_0^{x^2} f\left(t\right)dt = x\cos \pi x$$

$2x \cdot f\left(x^2\right) = \cos \pi x - \pi x \sin \pi x$

Put x = 2

4f(4) = 1

$f\left(4\right) = \frac{1}{4}$

And f(x), $\int_0^{f(x)} t^2 dt = x\cos \pi x$

$\{f(x)^2 \cdot f'(x) = \cos \pi x - \pi x \sin \pi x$

Put x = 4

3. $f''(x) - 5f'(x) + 6f(x) \geq 0 \Rightarrow f''(x) - 2f'(x) \geq 3(f'(x) - 2f(x))$

$\Rightarrow g'(x) \geq 3g(x)$; where $g(x) = f'(x) - 2f(x)$

Multiply by e^{-3x} and then we can write it as

$\Rightarrow \frac{d}{dx}\left(g\left(x\right)e^{-3x}\right) \geq 0 \Rightarrow y = g(x)e^{-3x}$ is non decreasing

$\because x \geq 0$ (Given)

$\Rightarrow g(x)e^{-3x} \geq g(0)\ e^{-0} \Rightarrow g(x)\ e^{-3x} \geq -2 \Rightarrow g(x) \geq -2e^{3x}$

$\because g(x) = f'(x) - 2f(x),\ g(0) = f(0) - 2f(0) = 0 - 2$

$\Rightarrow f'(x) - 2f(x) \geq -2e^{3x}$

Multiply it by e^{-2x} and than we can write it as

$\Rightarrow \frac{d}{dx}\left(f\left(x\right)e^{-2x} + 2e^{x}\right) \geq 0 \Rightarrow f(x)\ e^{-2x} + 2e^{x} \geq 3$

$\because x \geq 0,\ e^{x} \geq 1$ ….. (1)

$\Rightarrow$ We have $e^{-2x} f(x) + 2e^{x} \geq 3$

or $f(x) \geq 3e^{2x} - 2e^{3x}$ ….. (2)

$f(x) \geq ah(bx) - bh(ax)$ ….. (3)

From equation (2) and (3), we get a = 3, b = 2

$\therefore (a + b)\ h(0) = (3 + 2)\ e^{0} = 5$

4. $$\frac{dy}{dx} + y = 4xe^{-x}\sin 2x$$

Integrating factor = e^{x}

$\therefore$ Equation becomes $ye^{x} = 4\int x\sin 2x dx$

$\Rightarrow ye^{x} = (\sin 2x - 2x\cos 2x) + c$

$\because f(0) = 0 \Rightarrow c = 0$

$\therefore y = f(x) = (\sin 2x - 2x\cos 2x)e^{-x}$

$f(k\pi) = e^{-k\pi}(0 - 2k\pi(1))$

$f(k\pi) = -2k\pi\ e^{-k\pi}$

$$\lim_{n\to\infty}\sum_{k=1}^{n} f\left(k\pi\right) = -2\pi\left(1\cdot e^{-\pi} + 2e^{-2\pi} + 3e^{-3\pi} + \text{..... upto } \infty\right) = \frac{-2\pi e^{\pi}}{\left(e^{\pi} - 1\right)^2}$$

FIITJEE

JEE (Main), 2015

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - IV

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 30)** contains 30 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. An object of mass m is moving in a uniform circular motion in the xy plane. The circle has radius R and the object is moving around the circle with speed v. The motion is projected onto the x axis where it appears as simple harmonic motion according to $x(t) = R\cos(\omega t + \phi)$, here ω is equal to
   (A) v/R (B) m^2R
   (C) R/v (D) $v/(R\sin\omega t)$

2. In a standing wave on a string, the spacing between nodes is Δx. If the tension in the string is doubled but the frequency of the standing waves is fixed, then the spacing between the nodes will change to
   (A) $\sqrt{2}\,\Delta x$ (B) Δx
   (C) $\Delta x/2$ (D) $\Delta x/\sqrt{2}$

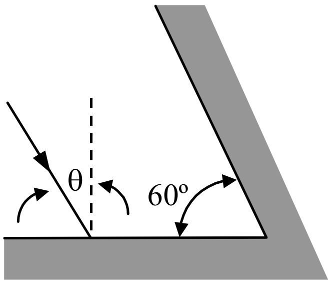
3. A 10 cm long rubber band obeys Hooke's law. When the rubber band is stretched to a total length of 12 cm the lowest resonant frequency is f_0. The rubber band is then stretched to a length of 13 cm. The lowest resonant frequency will now be
   (A) higher than f_0
   (B) the same as f_0
   (C) lower than f_0
   (D) changed, but the direction of the change depends on the elastic constant and the original tension

4. Objects A and B are initially in thermal equilibrium. Objects A and C are originally not in thermal equilibrium, but the two are placed in thermal contact and quickly reach thermal equilibrium. After doing this
   (A) B and C will also be in thermal equilibrium
   (B) B and C could be in thermal equilibrium, but might not be
   (C) B and C cannot be in thermal equilibrium
   (D) none of these

Space for Rough work

5. Four different containers each hold 0.5 moles of one of the following gases. Which gas is at the highest temperature?
(A) 8.0 L of helium gas at 120 kPa
(B) 6.0 L of neon gas at 160 kPa
(C) 4.0 L of argon gas at 250 kPa
(D) 3.0 L of krypton gas at 300 kPa

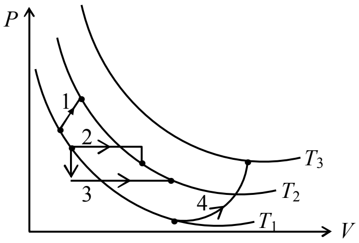
6. A ray of light strikes one of two mirrors that meet at a 60° angle as shown in figure. As the angle of incidence θ is increased, the angle between that final reflected ray and the incident ray
(A) increases
(B) decreases
(C) remains the same
(D) the question cannot be answered without solving each incident angle individually



7. Which of these statements is most correct?
(A) diffraction occurs only for transverse waves
(B) diffraction is proof that light can behave like a wave
(C) diffraction explains rainbows
(D) red sunsets are a diffraction phenomena

8. A gas mixture consists of molecules of type 1, 2 and 3 with molecular masses $m_1 > m_2 > m_3$. Which gas has maximum average translational kinetic energy?
(A) 1
(B) 2
(C) 3
(D) all has same average KE

9. The figure here shows four paths traversed by a gas on a P – V diagram. Which path has max change in internal energy of gas?
(A)1
(B)2
(C)3
(D)4



10. A carnot engine operates between the temperature T_H = 850 K and T_L = 300 K. The engine performs 1200 J of work each cycle which takes 0.25 sec. How much energy is delivered as heat to the low temperature reservoir each cycle?
(A) 655 J
(B) 1855 J
(C) 1200 J
(D) 600 J

Space for Rough work

11. Of the following quantities, which one has dimensions different from the remaining three
(A) energy per unit volume
(B) force per unit area
(C) product of voltage and charge per unit volume
(D) angular momentum per unit mass

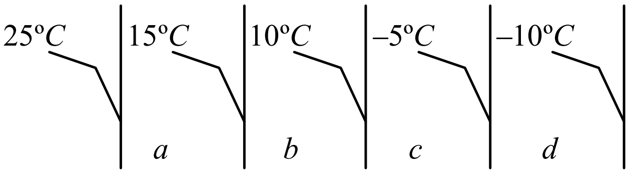
12. The resistance R = V/i where V = 100 ± 5 volts and i = 10 ± 0.2 amperes. What is the total error in R
(A) 5% (B) 7%
(C) 5.2% (D) 5/2%

13. A ray of light travels from an optically denser to rarer medium. The critical angle for the two media is C. The maximum possible deviation of the ray will be
(A) $\left(\frac{\pi}{2} - C\right)$ (B) 2C
(C) $\pi - 2C$ (D) $\pi - C$

14. 150, 225, 300, 375, is a series of resonant frequency. Which frequency is missing lower than 400H_z
(A) 250 (B) 350
(C) 75 (D) 200

15. The following four waves are sent along four wires with the same linear mass densities. Which string has maximum tension
(A) $y_1 = 3 \sin(9x - 3t)$ (B) $y_2 = 6 \sin(2x - t)$
(C) $y_3 = 1 \sin(4x - t)$ (D) $y_4 = 2 \sin(x - 2t)$

16. The figure shows the face and interface temperature of a composite slab consisting of four materials, of identical thickness, through which the heat transfer is steady. Which material has maximum thermal conductivity



(A) a
(B) b
(C) c
(D) d

Space for Rough work

17. The wavelength of radiation emitted is λ_0, when an electron jumps from the third to the second orbit of hydrogen atom. For the electron jump from the fourth to second orbit of the hydrogen atom, the wavelength of radiation emitted will be

(A) $\frac{16}{25}\lambda_0$ (B) $\frac{20}{27}\lambda_0$
(C) $\frac{27}{20}\lambda_0$ (D) $\frac{25}{16}\lambda_0$

18. A radioactive substance disintegrates as follows $_{92}X^{234} \rightarrow {}_{87}Y^{222}$. The number of α and β-particles that are emitted in this process are

(A) 3, 5 (B) 5, 3
(C) 3, 3 (D) 3, 1

19. Suppose the daughter nucleus in a nuclear decay is itself radioactive. If λ_d and λ_m denote the decay constants of daughter and mother nuclei and N_d and N_m the numbers of daughter and mother nuclei present at a time, then the number of daughter nuclei becomes constant when

(A) $\lambda_m N_m = \lambda_d N_d$ (B) $\lambda_m N_d = \lambda_d N_m$
(C) $N_m - N_d = \lambda_m - \lambda_d$ (D) $N_m + N_d = \lambda_m + \lambda_d$

20. Consider the fission reaction, $_{92}U^{236} \rightarrow X^{117} + Y^{117} + n + n$ two nuclei of same mass number 117 are found plus two neutrons. The binding energy per nucleon of X and Y is 8.5 MeV whereas of U^{236} is 7.6 MeV. The total energy liberated will be about

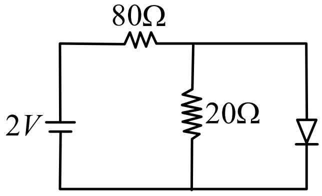
(A) 2 MeV (B) 20 MeV
(C) 200 MeV (D) 2000 MeV

21. Energy released in the fission of a single $_{92}U^{235}$ nucleus is 200 MeV. The fission rate of $_{92}U^{235}$ fuelled reactor operating at a power level of 5 watt is

(A) 1.56×10^{10}/sec (B) 1.56×10^{11}/sec
(C) 1.56×10^{20}/sec (D) 1.56×10^{-17}/sec

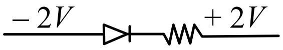
22. In the circuit shown, the current through the ideal diode is

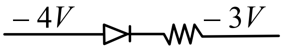
(A) 75 mA
(B) 20 mA
(C) 100 mA
(D) 25 mA

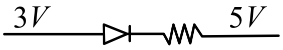


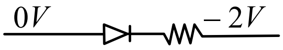
Space for Rough work

23. The forward biased diode is

(A) 

(B) 

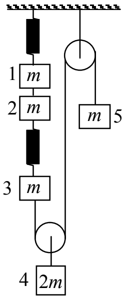
(C) 

(D) 

24. At $t = 0$, a particle is at rest at $x = 0$ where x is the position of the particle with respect to origin. The acceleration of the particle depends on its position as $a = \frac{3x^2}{2}$. The velocity of the particle at t = 1s will be

(A) 8 m/s
(B) 4 m/s
(C) 2 m/s
(D) 0

25. All the strings, springs and pulleys shown in figure are ideal. Initially the system is in equilibrium and blocks are at rest. Now, the upper spring is cut. The acceleration of block 1 just after cutting the upper spring will be



(A) $\frac{g}{3}$
(B) $\frac{g}{2}$
(C) 2g
(D) $\frac{2g}{3}$

26. A water tank having a uniform cross-sectional area A has an orifice of area of cross-section a at the bottom through which water is discharging. There is constant inflow of Q into the tank through another pipe. If $a\sqrt{2g} = K$, the time taken for the water level to rise from h_1 to h_2 will be

(A) $t = \frac{A}{K^2}\left[K\left(\sqrt{h_1} - \sqrt{h_2}\right) - Q\ln\left(\frac{Q - K\sqrt{h_2}}{Q - K\sqrt{h_1}}\right)\right]$

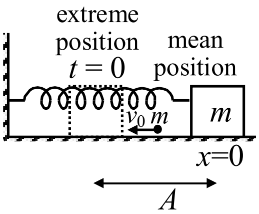
(B) $t = \frac{3A}{K^2}\left[K\left(\sqrt{h_1} - \sqrt{h_2}\right) - Q\ln\left(\frac{Q - K\sqrt{h_2}}{Q - K\sqrt{h_1}}\right)\right]$

(C) $t = \frac{2A}{K^2}\left[K\left(\sqrt{h_1} - \sqrt{h_2}\right) - Q\ln\left(\frac{Q - K\sqrt{h_2}}{Q - K\sqrt{h_1}}\right)\right]$

(D) $t = \frac{A}{2K^2}\left[K\left(\sqrt{h_1} - \sqrt{h_2}\right) - Q\ln\left(\frac{Q - K\sqrt{h_2}}{Q - K\sqrt{h_1}}\right)\right]$

Space for Rough work

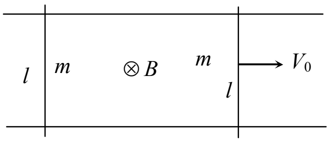
27. A block of mass m is performing SHM with an amplitude A, on a frictionless surface. When it is at extreme position, a bullet of mass m moving with a velocity v_0 collides and gets embedded into it at a time t = 0 $(mv_0^2 = 2kA^2)$ then the displacement x at any time t will be



(A) $x = -\sqrt{2}A\sin\left(\sqrt{\frac{k}{2m}}t + \pi/4\right)$
(B) $x = -\sqrt{2}A\sin\sqrt{\frac{k}{2m}}t$
(C) $x = -\sqrt{2}A\sin\left(\sqrt{\frac{k}{2m}}t + \frac{\pi}{3}\right)$
(D) $x = -A\sin\sqrt{\frac{k}{m}}t$

28. An electron of KE 100eV collides with stationary helium ion He^+ in its ground state and excites it to a higher energy level. After collision He^+ ion emits two photons in succession with wavelength 1085Å and 304Å. Then the KE of electron after collision will be (Neglect the recoil speed of He^+)
(A) 47.7 eV
(B) 94.4 eV
(C) 20.2 eV
(D) 10.1 eV

29. Two parallel conducting rails, separated by a distance l, are placed horizontally in a region of uniform magnetic field $\vec{B}$, perpendicular to the plane of the rails as shown in the figure. Two conducting wires, each of length l are placed so as to slide on parallel conducting rails without friction. One of the wires is given a velocity v_0 parallel to the rails. Loss in kinetic energy of the system till the steady state is achieved will be



(A) Zero
(B) $\frac{3}{4}mv_0^2$
(C) $\frac{3}{8}mv_0^2$
(D) $\frac{1}{4}mv_0^2$

30. A round metal hoop is suspended on the edge by a hook. The hoop can oscillate side to side in the plane of the hoop, or it can oscillate back and forth in a direction perpendicular to the plane of the hoop. For which mode will the frequency of oscillation be larger?
(A) oscillations in the plane of the hoop
(B) oscillations perpendicular to the plane of the hoop
(C) the frequency of oscillation will be the same in either mode
(D) none of these

Space for Rough work

Chemistry PART – II

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. Minerals kinoite is a silicate anion having chain of three SiO_4 tetrahedra. If in kinoite the three SiO_4 tetrahedra shares corners with adjacent tetrahedra then the overall charge on silicate anion is:
(A) – 4 (B) – 8
(C) – 6 (D) – 2

2. When compounds

$Cu(NO_3)_2$	$Hg(NO_3)_2$	$NaNO_3$	$AgNO_3$
I	II	III	IV

are heated (upto 500°C) seperately then a brown gas is formed in case of
(A) I and II (B) II and III
(C) II, III and IV (D) I, II and IV

3. Consider the following order:
(I) Thermal stability: $BeSO_4 < MgSO_4 < CaSO_4 < SrSO_4 < BaSO_4$.
(II) Bond angle: $OCl_2 > SF_2 > ASH_3 > H_2Se$
(III) Bond order of O_2^+, NO and N_2^- is 2.5.
(IV) NCl_3 on hydrolysis gives HOCl but BCl_3 gives HCl.
Identify which of the above four statements are correct.
(A) I, II, III and IV (B) II, III and IV
(C) I, II and IV (D) I and II

4. Identify the following statements as True (indicated by T) or False (indicated by F)
(I) Dipole moment order of $NH_3 > SbH_3 > AsH_3 > PH_3$
(II) F_2 on reaction with water produces HF, O_2 and O_3
(III) Number of S—S bonds in $H_2S_nO_6$ are n–2
(IV) PH_3 can be produced by hydrolysis of Ca_3P_2
(A) TFTT (B) TTFF
(C) TFFT (D) TTFT

5. Identify the incorrect statement for XeF_6
(A) XeF_6 reacts with excess H_2O to form XeO_3.
(B) XeF_6 may act as a fluoride donor during reaction with group I element.
(C) XeF_6 on reaction with small amount of H_2O form $XeOF_4$
(D) None of the above

Space for Rough work

6. For complex $[Co(NH_3)_5CO_3]ClO_3$, what is the spin only magnetic moment, oxidation number coordination number and d-electrons on transition metal.
(A) $\sqrt{3}$ BM, 0, 7, 2
(B) $\sqrt{15}$ BM, 3, 6, 0
(C) 0 BM, 3, 6, 6
(D) $\sqrt{15}$ MB, 2, 7, 3

7. Identify the incorrect statement
(A) $HgCl_2$ is prepared by heating mercury in chlorine.
(B) HgO decomposes on heating whereas Al_2O_3 has high thermal stability
(C) Mac-Aurthor's process is used to extract platinum
(D) NO_2 undergoes disproportionation reaction under alkaline medium.

8. Identify the incorrect:
(A) $Ni^{+2}(aq) + \text{dimethylglyoxime}(aq) + NH_3(aq) \longrightarrow \text{Red ppt/colour}$
(B) $Hg^{2+}(aq) + SCN^{-}(aq) + CO^{2+}(aq) \longrightarrow \text{Blue ppt/colour}$
(C) When $Mn(NO_3)_2$ (aq) is treated with sodium bismuthate in presence of concentration HNO_3 a purple coloured solution is obtained.
(D) None of these

9. Which of the following have same number of p-electrons as the 4d-electrons of Palladium?
(A) Si
(B) S
(C) P
(D) None of these

10. If the longest wavelength in Balmer series of Li^{2+} is 'x' then the value of shortest wavelength of He^{+} Paschen series will be
(A) $\frac{36x}{5}$
(B) $\frac{20x}{36}$
(C) $\frac{45x}{16}$
(D) $\frac{36x}{20}$

11. The ratio of rms velocity of N_2, average velocity of H_2 and most probable velocity of CO at 27°C is
(A) $\sqrt{\frac{3}{28}} : \sqrt{\frac{4}{\pi}} : \sqrt{\frac{1}{14}}$
(B) 1.224 : 1.128 : 1
(C) 0.33 : 1.113 : 0.27
(D) Both (A) and (C)

12. Element 'X' having atomic mass equal to 109.75 g crystallises in face centred cubic (fcc) structure. If the density of crystal is 9.0 g/cm^3 then the edge length of the unit is
(A) 450 pm
(B) 750 pm
(C) 900 pm
(D) 600 pm

Space for Rough work

13. In solubility of hydroxide $A(OH)_2$ in a buffer of pH = 11 is found to be 0.0416 g/L. Molar solubility of $A(OH)_2$ in pure water would be (in mol/lit). Use molecular weight of $A(OH)_2$ as 104 g/mol

(A) 10^{-3}	(B) 2.16×10^{-3}
(C) 10^{-4}	(D) 2.16×10^{-4}

14. Consider following equilibrium at 400 K and 50 atm

$$3A \rightleftharpoons 2B + 2C + D$$

If the equilibrium pressure of A is 5 atm then K_c will be:

(A) 38.32	(B) 19.16
(C) 9.58	(D) 28.74

15. For adiabatic reversible expansion, initial pressure and temperature are respectively 1 atm and 27°C. If final pressure is 0.25 atm then final temperature will be: (Assume the gas is monoatomic)

(A) –100°C	(B) –50°C
(C) –25°C	(D) 0°C

16. For the combustion of C_6H_{10} with required amount of oxygen. Which of the following is correct? {consider the state of each reactant and product same as at room temperature}.

(A) $\Delta H > \Delta E$	(B) $\Delta H = \Delta E$
(C) $\Delta H < \Delta E$	(D) None of these

17. 10 g sample of compound 'X' undergoes a first order reaction. If $t_{1/2}$ for this reaction is 20 min then the time needed to consume T_g of sample is

(A) 40 min	(B) 32 min
(C) 34.75 min	(D) 38 min

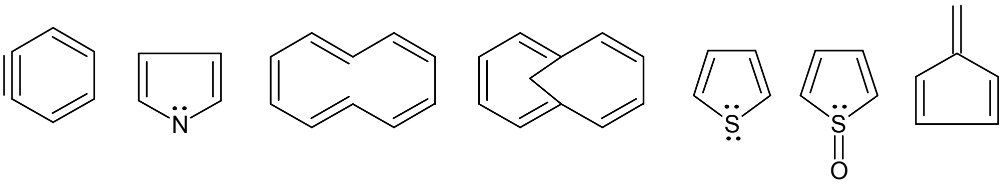
18. Identify the incorrect statement regarding adsorption of gas on solid surface.
(A) Adsorption can be endothermic
(B) Physisorption may get transformed into a Chemisorption at high temperature.
(C) Chemisorption is very slow as compared to physisorption because chemisorption have higher activation energy.
(D) Chemisorption is more exothermic than physisorption

19. Elevation in boiling point of aqueous glucose solution is 0.104 K. Osmotic pressure for same aqueous glucose solution was found to be 7.38 atm at 300 K. The density of aqueous glucose solution is:
Take R = 0.082 L. atm. Mol^{-1} K^{-1} and K_b = 0.52 K Kg mol^{-1}

(A) 1.036 g mL^{-1}	(B) 1.054 g mL^{-1}
(C) 1.00 g mL^{-1}	(D) None of these

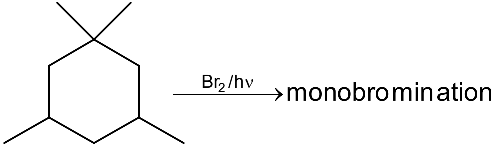
Space for Rough work

20. Identify the total number or aromatic compound from following:



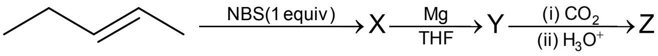
(A) Six
(B) Five
(C) Four
(D) Three

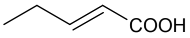
21. The number of monobromination product(s) in the following reaction is:

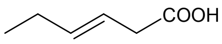

Br2/hν
monobromination

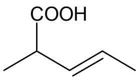
(A) 5
(B) 7
(C) 6
(D) 8

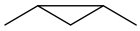
22. Identify the major produt (Z) in the following reaction sequence.


NBS(1 equiv)
X
Mg
THF
Y
(i) CO2
(ii) H3O+
Z

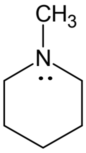
(A) 

(B) 

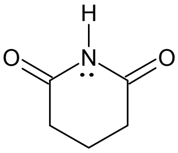
(C) 

(D) 

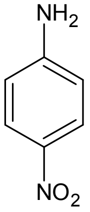
23. Arrange the following compounds in decreasing order of their basicity:



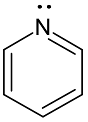
I



II



III

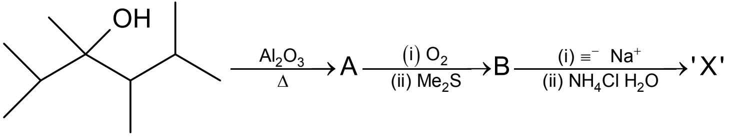


IV

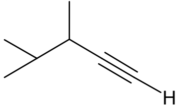
(A) I > IV > II > III
(B) I > III > IV > II
(C) I > IV > III > II
(D) I > III > II > IV

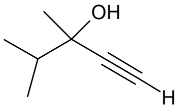
Space for Rough work

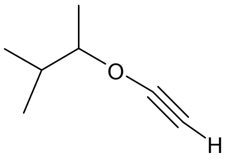
24. In the following reaction sequence:


OH
Al2O3
Δ
A
(i) O2
(ii) Me2S
B
(i) ≡⁻ Na⁺
(ii) NH4Cl H2O
'X'

The major product 'X' is

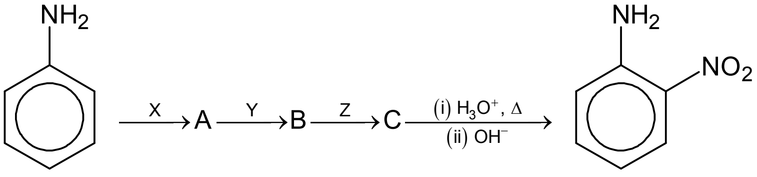
(A)


(B)


(C)


(D) Both B and C

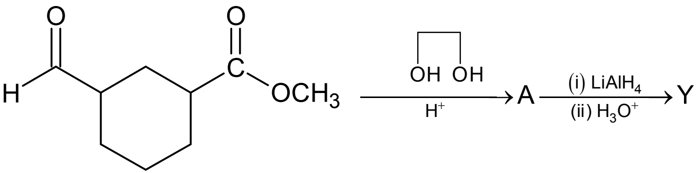
25. For the following reaction sequence

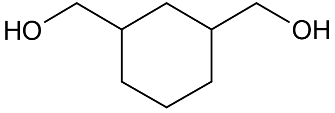

NH2
X
A
Y
B
Z
C
(i) H3O⁺, Δ
(ii) OH⁻
NH2
NO2

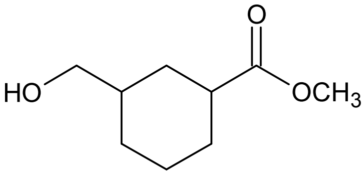
Identify the correct sequence of reagents X, Y and Z

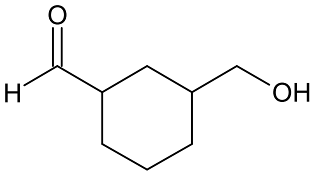
	X	Y	Z
(A)	Conc. HNO_3	CH_3COCl/base	Conc. H_2SO_4
(B)	CH_3COCl, Base	Conc. HNO_3	Conc. H_2SO_4
(C)	Conc. H_2SO_4	CH_3COCl, base	Conc. HNO_3
(D)	CH_3COCl, base	Conc. H_2SO_4	Conc. HNO_3

26. In the following reaction identify the major product 'X':


O
O
H
C
OCH3
OH OH
H⁺
A
(i) LiAlH4
(ii) H3O⁺
Y

(A)


(B)


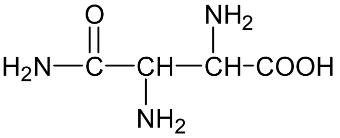
(C)


(D) Both (B) and (C)

Space for Rough work

27. Identify incorrect statement regarding Hunsdieker reaction:
(A) It can be given by silver salt of carboxylic acid
(B) Major product of reaction is halide of corresponding carboxylic acid
(C) It follows radical mechanism
(D) None of the above

28. What will be the net change on following amino acid at pH = 3



$$H_2N-\overset{\overset{O}{||}}{C}-\underset{\underset{NH_2}{|}}{CH}-\overset{\overset{NH_2}{|}}{CH}-COOH$$

(A) +2
(B) +3
(C) –1
(D) Zero

29. When C_4H_{10} undergoes chlorination by reaction with $Cl_2(g)$ in presence of ultraviolet light then how many stereoisomers are possible for dichloroderivatives.
(A) Two
(B) Three
(C) Four
(D) Five

30. The expression of K_p for the following reaction will be:

$$KMnO_4(aq) + H_2C_2O_4(aq) + HCl(aq) \rightleftharpoons MnO(s) + CO_2(g) + H_2O(\ell) + KCl(aq)$$

P_{CO_2} is partial pressure of carbon dioxide

(A) $Kp = P_{CO_2}$
(B) $K_p = \left(P_{CO_2}\right)^2$
(C) $Kp = \left(P_{CO_2}\right)^5$
(D) $K_P = \left(P_{CO_2}\right)^{10}$

Space for Rough work

Mathematics

PART – III

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. $\lim\limits_{x\to 0}\dfrac{\tan x\cos(\sin x)-\sin(\sin x)}{\cos(\tan x)\tan x-\sin(\tan x)}$ is

(A) $-\dfrac{1}{2}$ (B) -1

(C) $\dfrac{1}{2}$ (D) 1

2. If $f\left(\sqrt{3-x}\right)=\dfrac{1}{\sqrt{x}}$ is true for exhaustive domain of 'f', then domain of f(x) is

(A) $\left(-\sqrt{3},\ \sqrt{3}\right)$ (B) $\left[0,\ \sqrt{3}\right]$

(C) $\left(0,\ \sqrt{3}\right]$ (D) $\left[0,\ \sqrt{3}\right)$

3. If α is a root of $z^5+z^3+z+3=0$ then

(A) $|\alpha|\ge 1$ (B) $|\alpha|<1$

(C) α lies on or outside the circle $|z|=\dfrac{1}{2}$ (D) α lies inside the unit circle $|z|=1$

4. In a quadrilateral ABCD with sides a, b, c, d the range of $\dfrac{a^2+b^2+c^2}{d^2}$ is

(A) $\left(\dfrac{1}{3},\infty\right)$ (B) $\left(\dfrac{2}{3},\infty\right)$

(C) $(1,\infty)$ (D) $(0,\infty)$

5. If a_i is negative or positive according as i is odd or even and equation $x^4+a_1x^3+a_2x^2+a_3x+5=0$ has four real roots then minimum values of a_1a_3 is equal to

(A) 20 (B) 40

(C) 80 (D) 160

Space for rough work

6. Let a function f(x) has the property $f(x+2)=\dfrac{f(x)-5}{f(x)-3}$, then which of the following must equal to f(2014)

(A) f(2004) (B) f(2010)
(C) f(2006) (D) f(2018)

7. $\lim\limits_{x\to n^-}\dfrac{e^{\{x\}}-\{x\}-1}{\{x\}^2}$ (where n ∈ I), is

(A) e (B) $e-\dfrac{1}{2}$
(C) e – 2 (D) none of these

8. From (1, 2), tangents are drawn to the curve $y^2 - 2x^3 - 4y + 8 = 0$. Then
(A) sum of x–coordinates of points of contact is zero
(B) sum of x–coordinates of points of contact is 6
(C) sum of y–coordinates of points of contact is zero
(D) sum of y–coordinates of points of contact is 4

9. If $\left|\int_a^b f(x)dx\right| = \int_a^b |f(x)|dx \ (a \ne b)$ also f(x) ≠ 0 for any x ∈ (a, b) and $g(x)=\int_0^x f(x)dx$, then $\int_a^b f(x)g(x)dx$ when a and b are positive

(A) cannot be positive (B) cannot be negative
(C) can be less than –1 (D) nothing can be said

10. Three straight lines are drawn through a point 'P' lying in the interior of the ΔABC and parallel to its sides. The areas of the three resulting triangles with P as the vertex are s_1, s_2 and s_3 then area of ABC is equal to

(A) $\left(\sqrt{s_1}+\sqrt{s_2}+\sqrt{s_3}\right)^2$ (B) $(s_1 + s_2 + s_3)$
(C) $\sqrt{s_1s_2+s_2s_3+s_3s_1}$ (D) $s_1 + s_2 + s_3 + 2\left(\sqrt{s_1s_2}+\sqrt{s_2s_3}\right)$

11. Let a real valued differentiable function f(x) be strictly monotonic on [a, b], then

(A) $\int_a^b\left[(f(x))^2-(f(b))^2\right]dx = \int_{f(a)}^{f(b)} 2x\left(b-f^{-1}(x)\right)dx$

(B) $\int_a^b\left[(f(x))^2-(f(a))^2\right]dx = \int_{f(a)}^{f(b)} 2x\left(b-f^{-1}(x)\right)dx$

(C) $\int_a^b\left[f(x)-f(a)\right]^2 dx = \int_{f(a)}^{f(b)} x\left(b-f^{-1}(x)\right)^2 dx$

(D) none of these

Space for rough work

12. If $z_0 = \frac{1+i}{2}$, then the value of the product $\left(1+z_0\right)\left(1+z_0^2\right)\left(1+z_0^{2^2}\right)..........\left(1+z_0^{2^n}\right)$ must be

(A) $2^{2^{n+1}}$
(B) $\left(1+i\right)\left(1-\frac{1}{2^{2^n}}\right)$, if $n \geq 1$
(C) $\frac{5}{4}\left(1+i\right)$, if $n = 1$
(D) 0

13. Let N be any four digit number say $x_1\,x_2\,x_3\,x_4$. Then maximum value of $\frac{N}{x_1+x_2+x_3+x_4}$ is equal to

(A) 1000
(B) $\frac{1111}{4}$
(C) 800
(D) none of these

14. $\int \frac{e^{\cot x}}{\sin^2 x}$ [2 ln cosec x + sin 2x] dx is equal to

(A) $-2e^{\cot x}$ ln (cosec x) + c
(B) $e^{\cot x}$ ln x + c
(C) $e^{\cot x}$ (ln (cosec x) + c
(D) none of these

15. Let P be any moving point on the circle $x^2 + y^2 - 2x = 1$. AB be the chord of contact of this point w.r.t the circle $x^2 + y^2 - 2x = 0$. The locus of the circumcentre of the triangle CAB, (C being centre of the circles) is

(A) $2x^2 + 2y^2 - 4x + 1 = 0$
(B) $x^2 + y^2 - 4x + 2 = 0$
(C) $x^2 + y^2 - 4x + 1 = 0$
(D) $2x^2 + 2y^2 - 4x + 3 = 0$

16. ABCD is a quadrilateral with side lengths AB = 4, BC = 10, CD = 6 and AD = 6, and diagonal BD = 8 units. If the incircles of triangles ABD and BCD touch BD at P and Q respectively, then area of quadrilateral C_1PC_2Q (where C_1 and C_2 are incentres of triangle ABD and BCD respectively), is

(A) $3+\frac{\sqrt{15}}{2}$ sq. units
(B) 3 sq. units
(C) $\frac{\sqrt{15}}{6}$ sq. units
(D) none of these

Space for rough work

17. Let S = {1, 2, 3, ….. n} be a set and two numbers x and y are drawn with replacement from S. Let P_k be the probability that $x^2 - y^2$ is divisible by k and [x] denotes greatest integer less than or equal to x. The value of P_2 is equal to

(A) $\frac{1}{2}$

(B) $\left(\frac{\left[\frac{n}{2}\right]}{n}\right)^2$

(C) $1 - 2.\frac{\left[\frac{n}{2}\right]}{n} + 2\left(\frac{\left[\frac{n}{2}\right]}{n}\right)^2$

(D) $1 - \frac{2 - \left[\frac{n}{2}\right]}{n} - 2\left(\frac{\left[\frac{n}{2}\right]}{n}\right)^2$

18. A eccentric person starts writing numbers from 1 to n in a row such that i^{th} number is written i^2 times. The 500th digit from the starting in such a number is

(A) 0
(B) 1
(C) 2
(D) 3

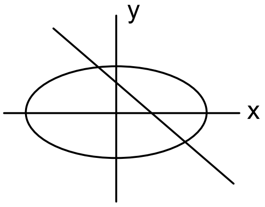
19. The value of a for which $4^{\sin x} + a2^{\sin x} - 1 \le 0 \ \forall \ x \in R$ is

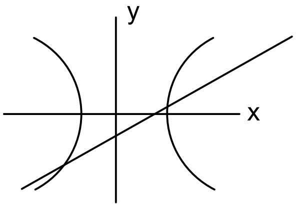
(A) $a \ge -\frac{3}{2}$
(B) $a \le -\frac{3}{2}$
(C) $a \le 2$
(D) No such value exists

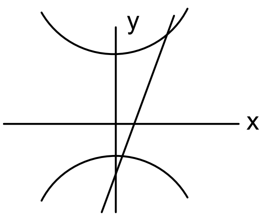
20. The number of tangents which can be drawn to the ellipse $16x^2 + 25y^2 = 400,$ such that sum of perpendicular distance from the foci to any tangent is 8, is

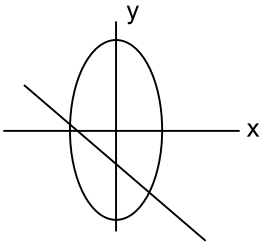
(A) 1
(B) 2
(C) 4
(D) none of these

21. Let $a, b \in R$ where $ab \ne 0$, then the graph of the straight line $ax - y + b = 0$ and the conic section $bx^2 + ay^2 = ab$ can be

(A)


(B)


(C)


(D)


Space for rough work

22. The differential equation of a curve, passing through $\left(0, -\frac{\pi}{4}\right)$ and $(t, 0)$ is $\cos y\left(\frac{dy}{dx}+e^{-x}\right)+\sin y\left(e^{-x}-\frac{dy}{dx}\right)=e^{e^{-x}}$, the value of $t.e^{e^{-t}}$ is

(A) –1 (B) 1
(C) 2 (D) –2

23. If $(1, 2, p)$, $(2, 2p, -6)$ and $(\alpha^2-2\alpha, 1, 1)$ are the ordered triplets of form (x, y, z) which satisfies all the equations. $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=1$, $\frac{x}{b}+\frac{y}{c}+\frac{z}{a}=1$ and $\frac{x}{c}+\frac{y}{a}+\frac{z}{b}=1$ then α can be

(A) 2 (B) –2
(C) –4 (D) 6

24. If $f(x)$ is a continuous and differentiable function such that $f(t_k)=1$ for $k=1, 2, ...n$, where $t_k=\sum_{r=1}^{k}\frac{1}{r(r+1)(r+2)}$ then

(A) $f\left(\frac{1}{4}\right)=1$ (B) $f\left(\frac{1}{2}\right)=1$
(C) $f'\left(\frac{1}{2}\right)=0$ (D) $f'\left(\frac{1}{4}\right)=1$

25. The sum of the real values that the function $f(x)=\frac{x^2-3x+2}{x^2+x-6}$ can not take is

(A) 2 (B) – 3
(C) $\frac{6}{5}$ (D) $\frac{4}{5}$

26. Let z_1, z_2, z_3 be the coordinates of vertices A, B, C of the triangle ABC. If $W_1=z_1-z_2$, $W_2=z_3-z_2$ and $\angle A=90°$, then

(A) $R_e\left(\frac{W_2}{W_1}\right)=2$ (B) $R_e(W_1\bar{W}_2)=|W_1|^2$
(C) $R_e(W_1\bar{W}_2)=|W_2|^2$ (D) $R_e\left(\frac{W_1}{W_2}\right)=1$

Space for rough work

27. Let $\cos\alpha$ is a root of the equation $169x^2 - 26x - 35 = 0$, $-1 < x < 0$, then $\sin 2\alpha$ is

(A) $\frac{144}{169}$ (B) $-\frac{144}{169}$

(C) $\frac{120}{169}$ (D) $-\frac{131}{169}$

28. Let $(1+x+x^2)^n = a_0 + a_1x + a_2x^2 ....a_{2n}x^{2n}$, where n is odd integer

$S_1 = a_0 + a_4 + a_8 + ...$

$S_2 = a_1 + a_5 + a_9 + ...$

$S_3 = a_2 + a_6 + a_{10} + ...$

$S_4 = a_3 + a_7 + a_{11} + ...$

(A) $S_1 = 2S_3$ (B) $S_2 = S_4$

(C) $S_2 + S_4 = 0$ (D) $S_1 = S_2 = S_3$ or $S_1 = S_3 = S_4$

29. Let $f(n)$ be the sum of first n terms of sequence 0, 1, 1, 2, 2, 3, 3, 4, 4 ….., then

(A) $f(n) = \frac{n^2}{6}$ {n is even number)

(B) $f(n) = \frac{n^2 - 1}{6}$ {n is odd number)

(C) $f(n+m) - f(n-m) = nm$, where $n, m \in I^+ (n > m)$

(D) $f(n+m) - f(n-m) = \frac{4nm+1}{1}$, where $n, m \in I^+ (n > m)$

30. If $\vec{A}, \vec{B}, \vec{C}$ and $\vec{D}$ are four non-zero vectors in the same plane no two of which are collinear then which of the following hold(s) good?

(A) $(\vec{A}\times\vec{B}).(\vec{C}\times\vec{D}) = 0$ (B) $(\vec{A}\times\vec{C}).(\vec{B}\times\vec{D}) = 0$

(C) $(\vec{A}\times\vec{B})\times(\vec{C}\times\vec{D}) = \vec{0}$ (D) $(\vec{A}\times\vec{C})\times(\vec{B}\times\vec{D}) \neq \vec{0}$

Space for rough work

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CRT –IV
(Main)

S. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	B	A
2.	B	D	D
3.	D	A	A
4.	B	D	A
5.	C	B	C
6.	C	C	C
7.	B	C	C
8.	D	D	D
9.	D	B	B
10.	A	C	A
11.	D	D	B
12.	B	C	C
13.	A	B	A
14.	C	B	A
15.	C	A	A
16.	C	C	A
17.	B	C	C
18.	D	A	B
19.	A	B	B
20.	C	B	B
21.	B	A	B
22.	B	C	B
23.	D	C	B
24.	D	B	A
25.	C	D	C
26.	C	C	B
27.	A	D	C
28.	A	A	D
29.	D	C	C
30.	A	D	C

Physics

PART – I

SECTION – A

1. Angular frequency of SHM is equal to angular velocity of particle $\omega = V/R$.

2. $V = n\lambda \quad \sqrt{\frac{T}{M}} = n(2\Delta x) \Rightarrow \sqrt{T} \propto \Delta x$

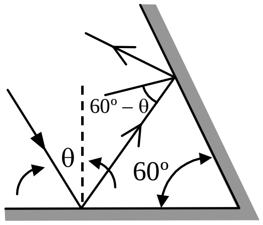
If tension is twice then Δx will increase to $\sqrt{2}\ \Delta x$.

3. $f_0 = \frac{1}{2l}\sqrt{\frac{T}{M}}$ [M = mass/length]

for elastic wire $T = Kx$
$x \rightarrow$ elongation from natural length
Hence frequency depends on K and original tension.

5. Temperature is maximum for which product of P and V is maximum as no. of moles is same for each containers
$PV = nRT$
$T \propto PV$
Hence option (c) is true.

6. $S = [\pi - 2\theta] + [\pi - 2(60 - \theta)]$
$= 2\pi - 2\theta - 120 + 2\theta = \text{constant}$
Angle of incidence and final reflected ray does not depend on θ.



8. It only depends on temperature. In a mixture all gases has same temperature.

9. $\Delta U = nC_V\Delta T$ From graph
Maximum change in internal [$T_3 > T_2 > T_1$] energy is in process 4.

10. $n = \left(1 - \frac{300}{850}\right) = \frac{11}{17}$

Work done in each cycle is

$n = \frac{W}{Q_{in}} \quad Q_{in} = \frac{1200}{11} \times 17$

$Q_{rej} = Q_{in} - W = \frac{1200 \times 17}{11} - 1200$

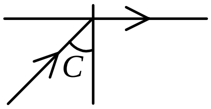
$= \frac{1200 \times 6}{11} = 654.54$

11. Quantities in option *a*, *b*, *c* has dimensions of [$M' L^{-1}T^{2}$] but angular momentum per unit mass has dimension [$M^{o} L^{2}T^{-1}$].

12. $\frac{\Delta R}{R}\times 100 = \frac{\Delta V}{V}\times 100 + \frac{\Delta I}{I}\times 100$

$= \frac{5}{100}\times 100 + \frac{0.2}{10}\times 100$

Total percentage error = 7%

13. 

$S = 2\pi - \left(\frac{\pi}{2} + C\right)$

$= \frac{\pi}{2} - C$

14. Series of resonant frequency must be integral multiple of fundamental frequency. This series is integral multiple of 75 H_2. Hence missing frequency is 75 H_2.

15. $V = \sqrt{\frac{T}{\mu}}$ $V \propto \sqrt{T}$

String with maximum tension will have maximum velocity.

V_1 = 3 m/sec, V_2 = 2m/s, V_3 = 4m/s

$V_4 = \frac{1}{2}$ m/s. Hence third string will have maximum tension.

16. $\frac{dQ}{dt} = KA\frac{\Delta\theta}{\Delta x}$

Rate of heat transfer, cross section area and thickness is same for all slab therefore

$K \propto \frac{1}{\Delta\theta}$

Slab which has minimum difference of temperature across interface will have maximum thermal conductivity.

Hence (c) option is true.

19. The number of mother nuclei decaying in a short time interval dt is = $N_m\lambda_m dt$. But death of a mother nucleus implies the birth of a daughter nucleus.

The number of daughter nuclei decaying in the same time interval is = $N_d\lambda_d dt$.

The number of daughter nuclei will remain constant when $N_m\lambda_m dt = N_d\lambda_d dt$

or $N_m\lambda_m = N_d\lambda_d$

21. Let fission rate be n per second; then

$n \times 200 \times 10^6 \times 1.6 \times 10^{-19} = 5 \times 1$

$\therefore \quad n = \frac{5}{3.2\times 10^{-11}} = 1.56\times 10^{11}$ / sec

22. $I = \frac{2}{80} = 25$ mA

24. The acceleration of particle at $t = 0$ is 0.

25. After the upper spring is cut, the block 1 and 2 will move with same acceleration.

$\therefore \quad a = 2g$

26. $$\frac{dV}{dt} = (Q - av)$$

$$\frac{Adh}{dt} = (Q - av)$$

$$\int_{h_1}^{h_2} \frac{Adh}{Q - K\sqrt{h}} = \int_0^t dt$$

$$t = \frac{2A}{K^2}\left[K\left(\sqrt{h_1} - \sqrt{h_2}\right) - Q\ln\left(\frac{Q - K\sqrt{h_2}}{Q - K\sqrt{h_1}}\right)\right]$$

27. $\frac{1}{2}KA^2 + \frac{1}{2}2m\frac{V_0^2}{4} = \frac{1}{2}KA'^2$ (by energy and momentum considerations)

$$KA^2 + \frac{1}{2}mV_0^2 = KA'^2 \Rightarrow A' = \sqrt{2}A$$

$$A' = \sqrt{2}A \Rightarrow \varphi = \frac{5\pi}{4}$$

$$x = A'\sin(\omega' t + \varphi)$$

$$\omega' = \sqrt{\frac{K}{2m}}$$

$$x = -\sqrt{2}A\sin\left(\sqrt{\frac{K}{2m}}t + \frac{\pi}{4}\right)$$

28. $\lambda_1 = 1085\text{Å}$ & $\lambda_2 = 304\text{Å}$

$E_1 = \frac{hc}{\lambda_1} = 11.5\text{eV}$ $E_2 = \frac{hc}{\lambda_2} = 40.8\text{eV}$

KE of electron after collision
= 100 – 52.3 = 47.7 eV

29. Net force on the system is zero hence momentum is conserved so
$mv_0 = 2mv$
Both wires will have same velocity when steady state will be achieved.

$$\Delta K = \frac{1}{4}mv_0^2$$

30. $T = 2\pi\sqrt{\frac{I}{mgl}} \Rightarrow f = \frac{1}{2\pi}\sqrt{\frac{mgl}{I}}$

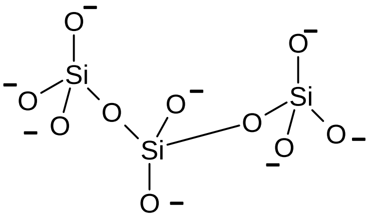
I is moment of inertia about axis passing from suspension point.

$f \propto \frac{1}{\sqrt{I}}, \in I$ about axis side to side in plane of loop is more hence *f* is greater in first case.

Chemistry PART – II

SECTION – A

1\.



Structure of silicate anion $\left(Si_3O_{10}^{8-}\right)$ in mineral kinoite.

2. NO_2 is a brown coloured gas:

$$Ca\left(NO_3\right)_2 \xrightarrow{\Delta} CuO\downarrow + 2NO_2\uparrow + \frac{1}{2}O_2\uparrow$$

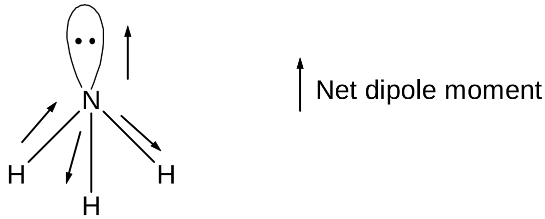
$$Hg\left(NO_3\right)_2 \xrightarrow{\Delta} Hg\downarrow + 2NO_2\uparrow + O_2\uparrow$$

$$NaNO_3 \xrightarrow[\text{below } 500^oC]{\Delta} NaNO_2\downarrow + \frac{1}{2}O_2\uparrow$$

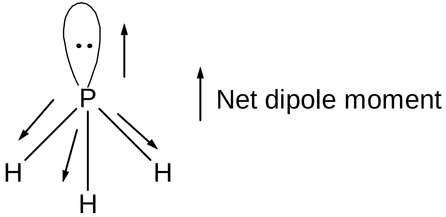
$$AgNO_3 \xrightarrow{\Delta} Ag\downarrow + NO_2\uparrow + \frac{1}{2}O_2\uparrow$$

3. Bond order of O_2^+ is 2.5
Bond order of NO is 2.5
Bond order of N_2^- is 2.5
Bond order can be calculated using molecular orbital diagrams.

4\.



Bond angle around central atom decrease down the group. Also electronegativity of N > P > As > Sb and electronegativity of H > P > As > Sb. Electronegative of P is very close that of H.



$Ca_3P_2 + 6H_2O \longrightarrow 3Ca(OH)_2 + 2PH_3$

$2F_2 + 2H_2O \longrightarrow 4HF + O_2$

$3F_2 + 3H_2O \longrightarrow 6HF + O_3$

5. XeF_6 may act as fluoride donor when it reacts with non metal fluorides.

$$XeF_6 + SbF_3 \rightleftharpoons SbF_6^- + XeF_5^+$$

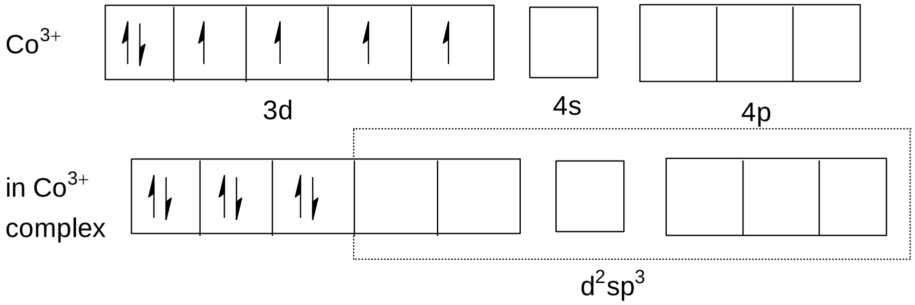
$$XeF_6 + \text{excess } H_2O \longrightarrow XeO_3 + 6HF$$

$$XeF_6 + H_2O \longrightarrow XeOF_4 + 2HF$$

6. $$\left[\underset{\underset{x}{\downarrow}}{Co}\ \underset{\underset{0}{\downarrow}}{(NH_3)_5}\ \underset{\underset{-2}{\downarrow}}{CO_3}\right]\underset{\underset{-1}{\downarrow}}{ClO_3}$$

x + 0 × 5 + (–2) × 1 = + 1

x = + 3



Coordination number = 6

No. of unpaired e^- (n) = 0

$\therefore\ \mu = \sqrt{n(n+2)} = 0$

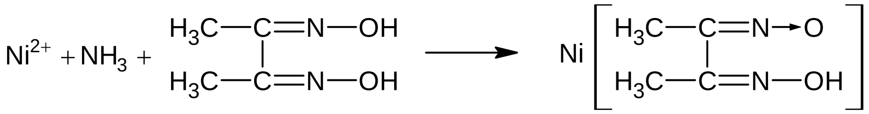
Number of 'd' electron = 6

7. $Hg + X_2 \longrightarrow HgX_2$ (where X = F, Cl, Br or I)

Mac-Aurthor's process is used in extraction of gold and silver

$4M + 8NaCN + 2H_2O + O_2 \longrightarrow 4Na\left[M(CN)_2\right] + 4NaOH$ Where, M = Ag, Au.

8.



$$Ni^{2+} + NH_3 + \begin{array}{l} H_3C{-}C{=}N{-}OH \\ \qquad\ \ | \\ H_3C{-}C{=}N{-}OH \end{array} \longrightarrow Ni\left[\begin{array}{l} H_3C{-}C{=}N{\to}O \\ \qquad\ \ | \\ H_3C{-}C{=}N{-}OH \end{array}\right]$$

Red precipitate

$$Hg^{2+} + Co(SCN)_2(aq) \longrightarrow \underset{\text{Blue precipitate}}{Hg(SCN)_2} + CO^{2+}$$

$$3Mn(NO_3)_2(aq) + 5NaBiO_3(aq) + 9HNO_3(aq) \longrightarrow \underset{(\text{Purple})}{3HMnO_4(aq)} + 3H_2O(\ell) + 5Bi(NO_3)_3$$

9. Pd ⇒ $4d^{10}5s^0$ ⇒ 10 α electron

S ⇒ $1s^2 2s^2 2p^6 3s^2 3p^4$ ⇒ 10 p electrons

10. Longest wavelength of Li^{2+}, Balmer series ⇒ $n_1 = 2$, $n_2 = 3$

$$\frac{1}{x} = R_H \times 3^2\left[\frac{1}{2^2} - \frac{1}{3^2}\right] \quad \left[\because \frac{1}{\lambda} = R_H Z^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]\right]$$

$$\frac{1}{x} = R_H \times 9\left[\frac{9-4}{36}\right] \qquad ....(1)$$

Shortest wavelength of He$^+$ Paschen series ⇒

$n_1 = 3$, $n_2 = \infty$

$$\frac{1}{\lambda} = R_H \times 2^2\left[\frac{1}{3^2} - \frac{1}{\infty^2}\right] \qquad .....(2)$$

From equation (1) and (2)

$$\frac{\lambda}{x} = \frac{R_H \times 9 \times \frac{5}{36}}{R_H \times 4 \times \frac{1}{9}} = \frac{5\times 9}{4\times 4} = \frac{45}{16}$$

$$\lambda = \frac{45x}{16}$$

11.

$$V_{rms} = \sqrt{\frac{3RT}{M}} \qquad V_{avg} = \sqrt{\frac{8RT}{\pi M}} \qquad V_{m.p} = \sqrt{\frac{2RT}{M}}$$

For N_2 at 27°C   For H_2 at 27°C   For CO at 27°C

$$V_{rms} = \sqrt{\frac{3RT}{28}} \qquad V_{avg} = \sqrt{\frac{8RT}{2\pi}} \qquad V_{mp} = \sqrt{\frac{2RT}{28}}$$

$$V_{rms} : V_{avg} : V_{mp} = \sqrt{\frac{3}{28}} : \sqrt{\frac{4}{\pi}} : \sqrt{\frac{1}{14}}$$

= 0.33 : 1.128 : 0.267

12. Mass of each atom = $\frac{\text{Atomic wt.}}{N_A} = \frac{109.75}{6.022\times 10^{23}} = 1.82\times 10^{-22}$

In FCC number of atom/unit cell = 4

Mass of unit cell = $4 \times 1.82 \times 10^{-22} = 7.29 \times 10^{-22}$ g

$$9\text{g/cm}^3 = \text{density} = \frac{\text{mass}}{\text{volume}} = \frac{7.29\times 10^{-22}\text{g}}{a^3}$$

$$a^3 = \frac{7.29\times 10^{-22}\text{g}}{9\text{g/cm}^3} = 81\times 10^{-24}\text{cm}^3$$

a = 900 pm

13. $A(OH)_2 \rightleftharpoons A^{2+} + 2OH^-$

$$\frac{0.0416\text{g/L}}{104\text{g/mol}}$$

$$\left[A^{2+}\right] = 4\times 10^{-4}\text{g/mol}$$

$$\left[OH^-\right] = 10^{-pOH} = 10^{-3}$$

$$K_{sp} = \left[A^{2+}\right]\left[OH^-\right]^2$$

$$= \left(4\times 10^{-4}\right)\left(10^{-3}\right)^2 = 4 \times 10^{-10}$$

$K_{sp} = 4s^3$ for $A(OH)_2$

$$S = \sqrt[3]{\frac{Ksp}{4}} = \sqrt[3]{\frac{4\times10^{-10}}{4}} = 2.16\times10^{-3}$$

14.

	$3A \rightleftharpoons$	$2B$	$+$	$2C$	$+$	D
Initial	P^o	0		0		0
Equilibrium	$P^o - 2x$	$2x$		$2x$		x

Equilibrium pressure = $P^o - 2x + 2x + 2x + x$

$50 = P^o + 3x$ ……….(1)

From question $5 = P^o - 2x$ ………..(2)

From equation (1) and (2)

$55 = 5x$

$x = 11$

$$K_p = \frac{P_B^2.P_C^2.P_D}{P_A^3} = \frac{(22)^2(22)^2 11}{5^3}$$

= 20614.5

$K_p = K_c (RT)\Delta n$

$$K_c = \frac{K_p}{(RT)^{\Delta n}} = \frac{20614.5}{(0.082\times400)^2}$$

= 19.16

15. Adiabatic reversible expansion

$$T_1^{\gamma}P_1^{1-\gamma} = T_2^{\gamma}P_2^{1-\gamma}$$

$$T_2^{\gamma} = T_1^{\gamma}\left(\frac{P_1}{P_2}\right)^{1-\gamma}$$

For mono atomic gas $\gamma = 1.66$

$T_2 = 172.88$

$T_2 = -100.27°C$

16. $$C_6H_{10}(\ell) + 8\frac{1}{2}O_2(g) \longrightarrow 6CO_2(g) + 5H_2O(\ell)$$

$\Delta H = \Delta E + \Delta ng\ RT$

$\Delta H = \Delta E + (6 - 8.5)\ RT$

$\Delta H = \Delta E - 2.5\ RT$

17. $$t = \frac{2.303}{k}\log\frac{a_o}{a_t}$$

$$k = \frac{0.693}{t_{1/2}} = \frac{0.693}{20}$$

$$t = \frac{2.303}{\frac{0.693}{20}}\times\log\frac{10}{10^{-7}}$$

= 34.75 min

18. Adsorption of gas on solid is always exothermic.

19. $m = \frac{\Delta T_b}{K_b} = \frac{0.104K}{0.52K\ Kg\ Mol^{-}} = 0.2\ mol\ Kg^{-1}$

$\pi = MRT \Rightarrow M = \frac{\pi}{RT}$

$= \frac{7.38\ \ atm}{\left(0.082\ L\ atm\ mol^{-1}\ K^{-1}\right)\left(300\ K\right)}$

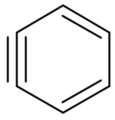
= 0.3 mol L^{-1}

Assuming volume of water does not change significantly on addition of glucose
In 1 L solution ⇒ 0.3 mol glucose and 1 kg water

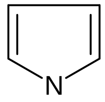
$\text{density} = \frac{\text{mass of solution}}{\text{volume of solution}}$

$= \frac{0.3\ mol \times \left(180g\ mol^{-1}\right) + 1000g}{1000\ mL}$

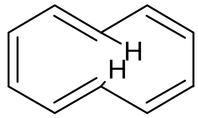
= 1.054 g mL

20. 

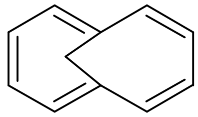
$8\pi e^-$. satisfying $(4n + 2)\pi e^-$ rule ⇒ only $6\pi e^-$ are in one plane and in cyclic conjugate. Therefore, aromatic.



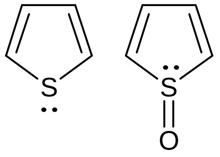
$6\pi e^-$ satisfying $(4n+2)\pi e^-$ rule ⇒ aromatic

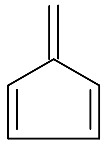


Due to repulsion between internal hydrogen atom ⇒ non aromatic

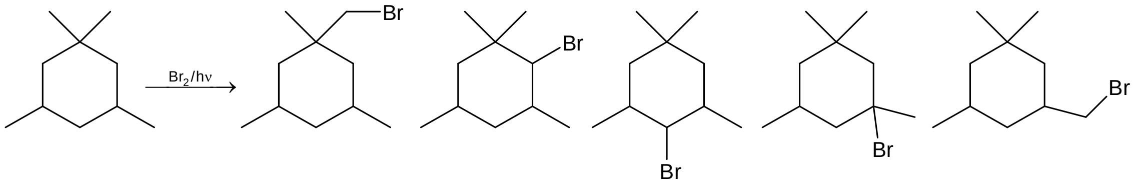


$10\pi e^-$ satisfies $(4n + 2)\pi e^-$ rule ⇒ aromatic

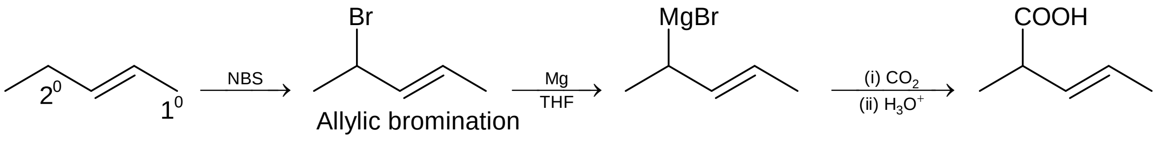




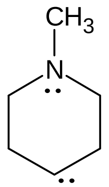
Non aromatic because cyclic delocalisation of πe^- is abscent.

21. 

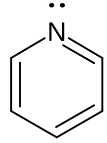
Five products

22. 

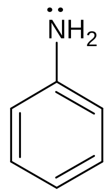
23.



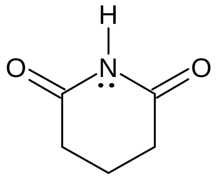
Aliphatic tertiary amine, nitrogen electron pair is not in conjugation.



Nitrogen is sp^2 hybridised. Nitrogen electron pair is not in conjugation.

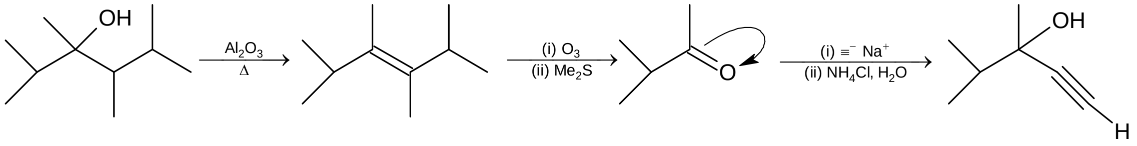


Nitrogen electron lone pair is in conjugation with phenyl ring.

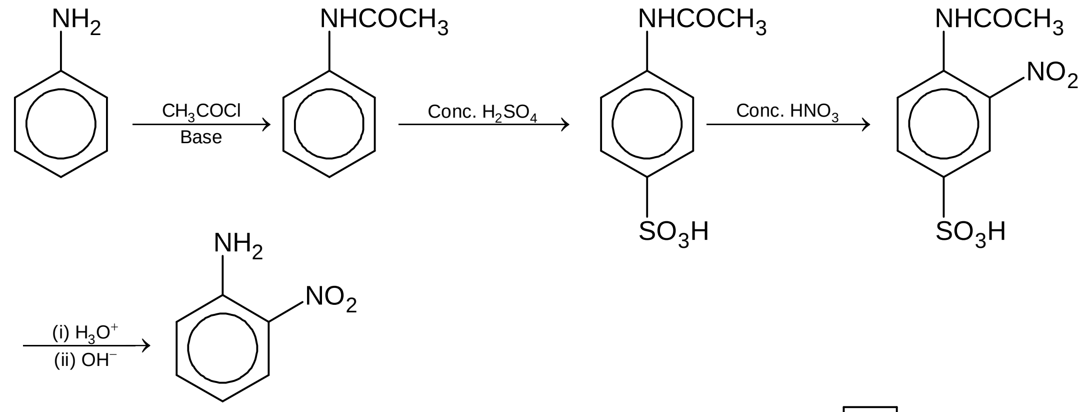


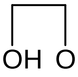
Nitrogen e$^-$ lone pair is in conjugate with two C=O groups leading to two equivalent resonative structures.

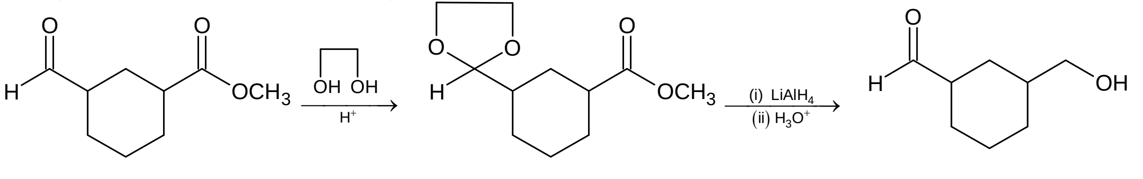
24.


OH
Al2O3
Δ
(i) O3
(ii) Me2S
O
(i) ≡⁻ Na⁺
(ii) NH4Cl, H2O
OH
H

25.


NH2
CH3COCl
Base
NHCOCH3
Conc. H2SO4
NHCOCH3
SO3H
Conc. HNO3
NHCOCH3
NO2
SO3H
(i) H3O⁺
(ii) OH⁻
NH2
NO2

26. LiAlH$_4$ can reduce both aldehyde as well as ester group into. But use  protects aldehyde group and hence only ester group is reduced.

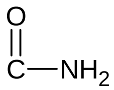

O
H
O
OCH3
OH OH
H⁺
O
O
H
O
OCH3
(i) LiAlH4
(ii) H3O⁺
O
H
OH

27. Hunsdieker reaction

$R-COOAg + Br_2 \longrightarrow R-Br + CO_2\uparrow + AgBr\downarrow$

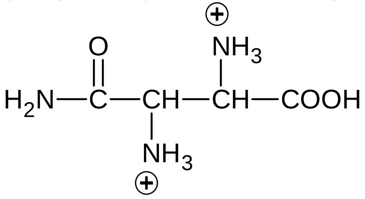
Free radical mechanism is followed.

28. At pH = 3, condition is highly acidic so all NH_2 group will get protonated. Protonation of



$-\overset{O}{\overset{\|}{C}}-NH_2$

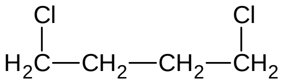
group is very difficult. So at pH = 3 structure will be



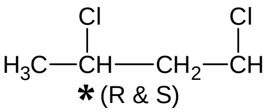
$$H_2N-\overset{O}{\overset{\|}{C}}-\underset{\underset{\oplus}{NH_3}}{\underset{|}{CH}}-\overset{\overset{\oplus}{NH_3}}{\overset{|}{CH}}-COOH$$

29.

$H_3C-CH_2-CH_2-CHCl_2$

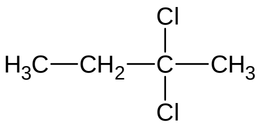


$$H_2\overset{Cl}{\overset{|}{C}}-CH_2-CH_2-\overset{Cl}{\overset{|}{C}}H_2$$

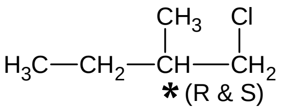


$$H_3C-\overset{Cl}{\overset{|}{CH}}-CH_2-\overset{Cl}{\overset{|}{CH}}$$

$*$ (R & S)

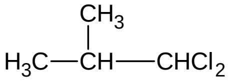


$$H_3C-CH_2-\underset{\underset{Cl}{|}}{\overset{Cl}{\overset{|}{C}}}-CH_3$$

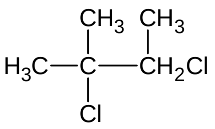


$$H_3C-CH_2-\overset{CH_3}{\overset{|}{CH}}-\overset{Cl}{\overset{|}{C}}H_2$$

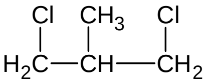
$*$ (R & S)



$$H_3C-\overset{CH_3}{\overset{|}{CH}}-CHCl_2$$



$$H_3C-\underset{\underset{Cl}{|}}{\overset{CH_3}{\overset{|}{C}}}-\overset{CH_3}{\overset{|}{C}}H_2Cl$$



$$H_2\overset{Cl}{\overset{|}{C}}-\overset{CH_3}{\overset{|}{CH}}-\overset{Cl}{\overset{|}{C}}H_2$$

$*$ Indicate chiral carbon

30. Balanced chemical equation is

$$2KMnO_4(aq) + 5H_2C_2O_4(aq) + 2HCl(aq) \rightleftharpoons 2MnO(s) + 10CO_2(g) + 6H_2O(\ell) + 2KCl(aq)$$

K_p depends only on partial pressure of gaseous species

$\therefore\ K_p = \left(P_{CO_2}\right)^{10}$

Mathematics PART – III

SECTION – A

1. $\lim\limits_{x\to 0}\dfrac{\sin(x-\sin x)}{\sin(x-\tan x)} = \lim\limits_{x\to 0}\dfrac{x-\sin x}{x-\tan x} = -\dfrac{1}{2}$

2. $\because f\left(\sqrt{3-x}\right)$ exists for $\sqrt{3-x} \ge 0$

   i.e. Domain of 'f' is $[0, \infty)$

   But, for $x > 0 \Rightarrow 0 \le \sqrt{3-x} < \sqrt{3}$

3. Suppose $|\alpha|<1$, we have

   $|-3| = |\alpha^5+\alpha^3+\alpha| \le |\alpha|^5+|\alpha|^3+|\alpha| < 1+1+1$

   $\Rightarrow 3 < 3$ A contradietion

   Thus $|\alpha| \ge 1 \Rightarrow \alpha$ lies either on or outside the unit circle

4. Here $a > 0, b > 0, c > 0, d > 0$

   $\Rightarrow a^2+b^2+c^2 \ge ab+bc+ca$

   $\Rightarrow 3(a^2+b^2+c^2) \ge (a+b+c)^2 > d^2$

   $\Rightarrow \dfrac{a^2+b^2+c^2}{d^2} > \dfrac{1}{3}$

5. Clearly from Descarte's rule of sign equation has 4 positive real roots lets say α, β, γ, and δ

   $\Rightarrow \sum\alpha = -a_1;\ \sum\alpha\beta = -a_2;\ \sum\alpha\beta\gamma = -a_3$ and $\alpha\beta\gamma\delta = 5$

   using AM $\ge$ GM $\Rightarrow \dfrac{\alpha+\beta+\gamma+\delta}{4}.\dfrac{\alpha\beta\gamma+...}{4} \ge \sqrt[4]{\alpha\beta\gamma\delta}.\sqrt[4]{\alpha^3\beta^3\gamma^3\delta^3} = \alpha\beta\gamma\delta = 5$

   $\Rightarrow -\dfrac{a_1}{4}.\dfrac{-a_3}{4} \ge 5 \Rightarrow a_1a_3 \ge 80$

8. Curve is $(y-2)^2 = 2x^3 - 4$ ..... (1)

   $\dfrac{dy}{dx} = \dfrac{3x^2}{y-2}$

   $\therefore$ Equation of tangent at (x_1, y_1)

   $y - y_1 = \dfrac{3x_1^2}{y_1-2}(x-x_1)$

   As it passes through (1, 2)

   $\Rightarrow 2 - y_1 = \dfrac{3x_1^2}{y_1-2}(1-x_1)$

   or $(y_1-2)^2 = 3x_1^2(x_1-1)$

   or $2x_1^3 - 4 = 3x_1^3 - 3x_1^2$ [As (x_1, y_1) lies on the curve]

or $x_1^3 - 3x_1^2 + 4 = 0$
or $(x_1 + 1)(x_1 - 2)^2 = 0$
$\therefore x_1 = -1$ or 2
But $x_1 \neq = -1$ (it is clear from equation (1))
$\therefore x_1 = 2$
$\therefore y_1 = 2 \pm 2\sqrt{3}$
Points of contact are $(2, 2 + 2\sqrt{3})$ and $(2, 2 - 2\sqrt{3})$
$\therefore$ Sum of x–coordinates of points of contact is 4
$\therefore$ Sum of y–coordinates of points of contact is 4

9. If $\left|\int_a^b f(x)dx\right| = \int_a^b |f(x)|dx$

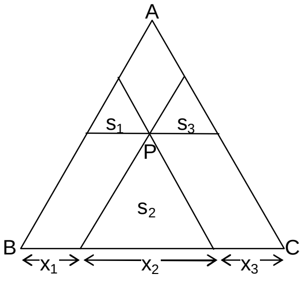
$\Rightarrow$ f(x) is either positive in (a, b)
or f(x) is negative in (a, b) and also b > a
Also $g'(x) = f(x)$
When $f(x) > 0 \Rightarrow g'(x) > 0 \Rightarrow$ g(x) is increasing function
When $f(x) < 0 \Rightarrow g'(x) < 0 \Rightarrow$ g(x) is decreasing function
Also g(0) = 0

$$\int_a^b f(x)g(x)dx = \int_a^b g(x)g'(x)dx$$

$= \dfrac{(g(b))^2 - (g(a))^2}{2}$ which will be positive for 0 < a < b

10. $\dfrac{s_1}{\Delta} = \dfrac{x_1^2}{a^2}$ or $\sqrt{\dfrac{s_1}{\Delta}} = \dfrac{x_1}{a}$

Similarly $\sqrt{\dfrac{s_2}{\Delta}} = \dfrac{x_2}{a}$ and $\sqrt{\dfrac{s_3}{\Delta}} = \dfrac{x_3}{a}$



11. Let $f^{-1}(x) = t \Rightarrow f(t) = x$

$$\int_{f(a)}^{f(b)} 2x\left(b - f^{-1}(x)\right)dx = \int_a^b 2f(t).(b-t).f'(t)dt = b\,[(f(t))^2]_a^b - \int_a^b t.2f(t).f'(t)\,dt$$

$= \int_a^b \left[(f(x))^2 - (f(a))^2\right]dx$

12. $(1+z_0)\left(1+z_0^{2^1}\right)\left(1+z_0^{2^2}\right) . \left(1+z_0^{2^n}\right) = \dfrac{1-z_0^{2^{n+1}}}{1-z_0} = \dfrac{1-\left(z_0^2\right)^{2^n}}{1-z_0} = (1+i)\left(1-\dfrac{1}{2^{2^n}}\right)$, if n > 1;

If n = 1, $(1+z_0)\left(1+z_0^2\right) = \dfrac{5}{4}(1+i)$

17. If one number is drawn from the set {1, 2, 3…….n} the probability α that it is divisible by 2 is given by $\alpha = \dfrac{\left[\frac{n}{2}\right]}{n}$

$\Rightarrow$ P (the number is not divisible by 2) = $1 - \alpha$
Now, $x^2 - y^2 = (x - y)(x + y)$
$\therefore P_2 = \alpha.\alpha + (1 - \alpha)(1 - \alpha) = 1 - 2\alpha + 2\alpha^2$

18. To exhaust all single digit numbers he must have written $\sum_{i=1}^{g} i^2 = 285$ digits, to exhaust 10 he must write 2×10^2 more digits i.e. 485 digits. So 500th digit will occur when he is writing 11

19. Taking $2^{\sin x} = t \Rightarrow \frac{1}{2} \le t \le 2$

$$a \le \frac{1-t^2}{t} \Rightarrow a \le \min\left(\frac{1-t^2}{t}\right) \Rightarrow a \le -\frac{3}{2}$$

20. If p_1 and p_2 are length of perpendiculars from foci to any tangent then $p_1p_2 = b^2 = 16$ and $p_1 + p_2 = 8 \Rightarrow p_1 = p_2 = 4$
Hence only two tangents are possible

21. Option (B) is correct because in this case $a > 0, b < 0$ (Let $b = -c$)

$$\Rightarrow -cx^2 + ay^2 = -ac \Rightarrow \frac{x^2}{a} - \frac{y^2}{c} = 1$$

22.
$$(\cos y - \sin y)\frac{dy}{dx} + (\cos y + \sin y)e^{-x} = e^{e^{-x}}$$
$$\cos y + \sin y = u$$
$$\Rightarrow \frac{du}{dx} + e^{-x}u = e^{e^{-x}} \Rightarrow ue^{-e^{-x}} = x$$
$$\Rightarrow e^{-e^{-t}} = t \text{ (Putting (t, 0))}$$
$$\Rightarrow t.e^{e^{-t}} = 1$$

23. Fro more than one triplet satisfying all three equations we have

$$\begin{vmatrix} \frac{1}{a} & \frac{1}{b} & \frac{1}{c} \\ \frac{1}{b} & \frac{1}{c} & \frac{1}{a} \\ \frac{1}{c} & \frac{1}{a} & \frac{1}{b} \end{vmatrix} = 0$$

$\Rightarrow a = b = c$
$\Rightarrow (x + y + z) = a$ satisfying the triplets
We get $a = 10,\ p = 7 \Rightarrow \alpha^2 - 2\alpha - 8 = 0$
$\alpha = -2$ and 4

24. If $f(x)$ is continuous then $\lim_{k\to\infty} f(t_k) = f\left(\lim_{k\to\infty}(t_k)\right) = f\left(\frac{1}{4}\right) = 1$ (Where $\lim_{k\to\infty} t_k = \frac{1}{4}$)

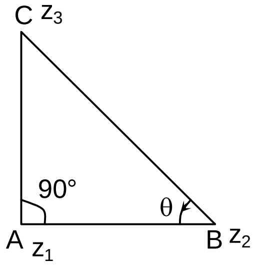
Also as graph is smooth $f'\left(\frac{1}{4}\right) = 0$

25. $f(x) = \frac{x-1}{x+3} \forall x \neq 2 \Rightarrow$ f(x) can not take the value 1 and f(2).

26. $\frac{W_2}{|W_2|} = \frac{W_1}{|W_1|} e^{-i\theta}$

$\Rightarrow \frac{W_2}{W_1} = \frac{|W_2|}{|W_1|} e^{-i\theta} = 1 - i\tan\theta$

$W_1\overline{W}_2 = \frac{W_1}{W_2}|W_2|^2 = |W_1|\ |W_2|e^{i\theta} = \left(|W_1|^2 + i|W_1|\ |W_2|\sin\theta\right)$



27. $(13x-1)^2 = 36$

$13x - 1 = \pm 6$

$x = \frac{7}{13}$

$x = -\frac{5}{13}$

$\Rightarrow \cos\alpha = -\frac{5}{13}$

$\Rightarrow \sin\alpha = \pm\frac{12}{13}$

$\Rightarrow \sin 2\alpha = \pm\frac{120}{169}$

28. $(1+x+x^2)^n = a_0 + a_1x + a_2x^2 + \ldots + a_{2n}x^{2n}$ ..... (1)

$\Rightarrow a_0 + a_2 + a_4 \ldots = \frac{3^n+1}{2}$

$a_1 + a_3 + a_5 \ldots = \frac{3^n-1}{2}$

Put $x = i$ in equation (1) where $i = \sqrt{-1}$
If $n = 4m+1$
$\Rightarrow a_1 - a_3 + a_5 \ldots = 1$
$a_0 - a_2 + a_4 \ldots = 0$

So, $a_1 + a_5 + a_9 \ldots = \frac{3^n+1}{4} = S_2$

$a_3 + a_7 + a_{11} \ldots = \frac{3^n-3}{4} = S_4$

Similarly if $n = 4m+3$

Then, $S_2 = \frac{3^n-3}{4}$ and $S_4 = \frac{3^n+1}{4}$

29. If n is even

$f(n) = 2\left(1 + 2 + \ldots \frac{n-2}{2}\right) + \frac{n}{2} = \frac{n^2}{4}$

If n is odd then $f(n) = f(n-1) + \frac{n-1}{2} = \frac{(n-1)^2}{4} + \frac{n-1}{2} = \frac{n^2-1}{4}$

$f(n+m)-f(n-m)=\frac{(n+m)^2-(n-m)^2}{4}$ if both even

$=\frac{(n+m)^2-1-(n-m)^2+1}{4}$ it both odd = nm

30. Obviously $\vec{A}\times\vec{C}$ and $\vec{B}\times\vec{D}$ will be non-zero collinear vectors

$\Rightarrow$ $(\vec{A}\times\vec{C}).(\vec{B}\times\vec{D})\neq 0$ and similarly $(\vec{A}\times\vec{B}),(\vec{C}\times\vec{D})$ will be non-zero collinear vectors

Hence $(\vec{A}\times\vec{B})\times(\vec{C}\times\vec{D})=0$

FIITJEE

JEE (Advanced), 2015

CONCEPT RECAPITULATION TEST - IV

Paper 1

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

ALL INDIA TEST SERIES

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 10)** contains 10 multiple choice questions which have one or more than one correct answer. Each question carries **+3 marks** for correct answer. There is no negative marking.

(ii) **Section-C (01 – 10)** contains 10 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10 \text{ m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3 \text{ kg/m}^3$
Atmospheric pressure	$P_a = 10^5 \text{ N/m}^2$
Gas constant	$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
		=	$0.0821 \text{ Lit atm K}^{-1} \text{ mol}^{-1}$
		=	$1.987 \approx 2 \text{ Cal K}^{-1} \text{ mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

(One or More than One Options Correct Type)

This section contains **10 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** are correct.

1. A particle is released at x = 1 in a force field $\vec{F}(x) = \left(\frac{2}{x^2} - \frac{x^2}{2}\right)\hat{x}$, $x \geq 0$. Which of the following statements is/are true?
(A) $\vec{F}(x)$ is conservative
(B) Angular momentum of the particle about the origin is const.
(C) The particle moves towards $x = \sqrt{2}$
(D) The particle moves towards the origin

2. Light from a monochromatic source is incident normally on a small photo sensitive surface S having work function ϕ. If power of the source is W and a is the distance between the source and S, then
(A) the number of photons striking the surface per unit time will be $\left(\frac{w\lambda S}{4\pi hca^2}\right)$
(B) the maximum energy of the emitted electrons will be $\frac{1}{\lambda}(hc - \lambda\phi)$
(C) the stopping potential needed to stop the most energetic photons will be $\frac{1}{e\lambda}(hc - \lambda\phi)$
(D) photo emission occurs only if $0 \leq \lambda \leq \frac{hc}{\phi}$

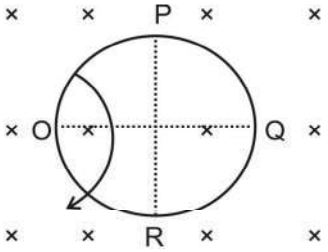
3. In a one-dimensional collision between two identical particles A and B, B is stationary and A has momentum P before impact. During impact, B gives impulse J to A.
(A) The total momentum of 'A plus B' system is P before and after the impact and (P – J) during the impact
(B) During the impact, A gives impulse J to B
(C) The coefficient of restitution is $\frac{2J}{P} - 1$
(D) The coefficient of restitution is $\frac{J}{P} - 1$

Space for Rough work

4. The electric potential decreases uniformly from 120V to 80V as one moves from y-axis from y = –2 cm to y = +2 cm. Then at origin

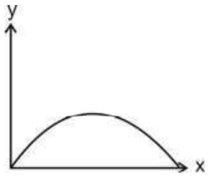
(A) Electric field must be equal $20\frac{V}{cm}$
(B) Electric field may be equal to $20\frac{V}{cm}$
(C) Electric potential must be 100V
(D) Electric potential may be 60V

5. A conducting ring of radius 'a' is rotated about a point O on its periphery as shown in the figure in a plane perpendicular to uniform magnetic field $\vec{B}$ which exists everywhere. The rotation velocity is w, then:



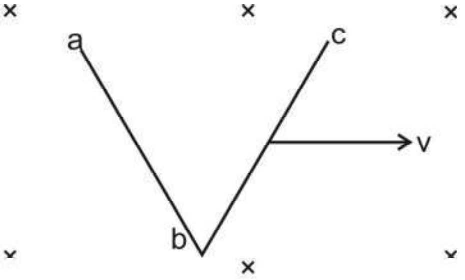
(A) $v_P - v_0 > 0$ and $v_R - v_0 < 0$
(B) $v_p = v_R > v_0$
(C) $v_0 > v_p = v_Q$
(D) $v_Q - v_p = v_p - v_0$

6. A reflecting surface is represented by equation $Y = \frac{2L}{\pi}\sin\left(\frac{\pi x}{L}\right)$. A ray travelling horizontally becomes vertical after refection. The coordinates of the point(s). Where this ray is incident :



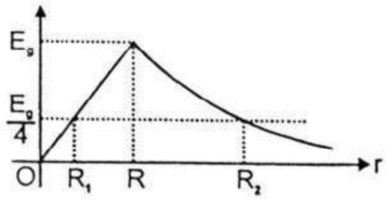
(A) $\left(\frac{L}{4}, \frac{\sqrt{2}L}{\pi}\right)$
(B) $\left(\frac{L}{3}, \frac{\sqrt{3}L}{\pi}\right)$
(C) $\left(\frac{3L}{4}, \frac{\sqrt{2}L}{\pi}\right)$
(D) $\frac{2L}{3}, \frac{\sqrt{3}L}{\pi}$

7. A V-shaped conducting wire is moved inside a magnetic field as shown in figure. Magnetic field is perpendicular to paper inwards. Then :
(A) $V_a = V_c$
(B) $V_a > V_c$
(C) $V_a > V_b$
(D) $V_c > V_b$



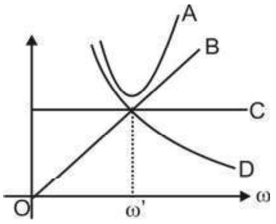
Space for Rough work

8. The variation of gravitational field intensity with distance from the centre of a body is shown in the graph from which one can conclude that

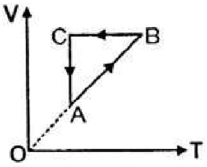


(A) Variation of gravitational field intensity is due to the spherical mass body of radius R
(B) $E_g \propto r$ for r < R
(C) the separation of two points having field $\frac{E_g}{4}$ may be $\frac{9R}{4}$
(D) the separation of two points R_1 is R is R/4

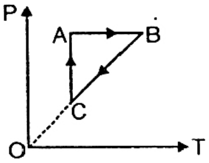
9. For an LCR circuit
(A) A and B represent R and Z respectively
(B) A and B represent Z and R respectively
(C) A, B, C and D represent Z, X_L, R and X_c respectively
(D) for $\omega = \omega'$, the phase difference between current and voltage becomes zero



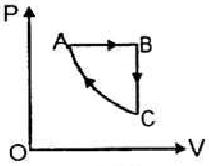
10. An ideal gas undergoes at thermodynamics cycle as shown in figure. Which of the following graphs represents the same cycle?



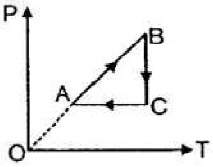
(A)



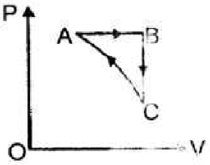
(B)



(C)



(D)



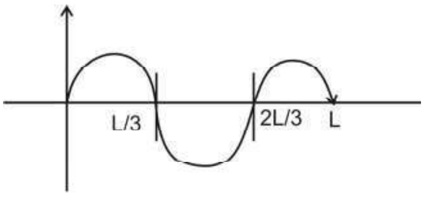
Space for Rough work

SECTION – C
(One Integer Value Correct Type)

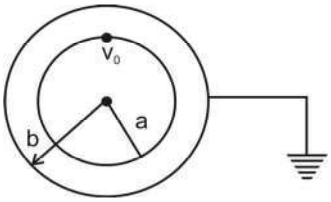
This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. A travelling pulse is given by f(x, t) = A $\exp\left(\frac{2abxt - a^2x^2 - b^2t^2}{c^2}\right)$, Where A, a, b, c are positive constants of appropriate dimensions, the speed of the pulse is nb/2a, n =

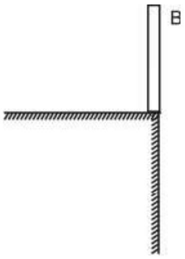
2. A free particle of mass 'm' is confined to a region of length L. The de-Broglie wave associated with the particle is sinusoidal in nature as given in figure the energy of the particle is $\frac{n^2h^2}{8mL^2}$, n =



3. A concentric spherical volume of inner radius a and outer radius 'b' is filled with a material of finite conductivity specified by $\sigma(r) = \frac{A}{r^2}$ where A is a positive constant of appropriate dimensions.
The outer surface is grounded and the inner surface is maintained at potential V_0. The resistance of this configuration is (b–a)/nπA, n = _________.



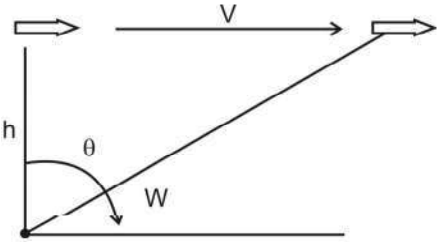
4. A rod of length 5m is placed at the edge of a smooth table as shown in figure. It is hit horizontally at point B. If the displacement of centre of mass in 1S is $5\sqrt{2}$ m, then the angular velocity of the rod is 5n rad/s, n = : (Given : g = 10 m/s^2)



5. Two consequent plane waves of light of equal amplitude and each of wavelength $20\pi\times10^{-8}$m propagating at an angle of $\frac{\pi}{1080}$ rad with respect to each other, fall almost normally on screen the fringe width (in mm) on the screen is 108/100n, n = ____________.

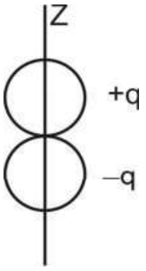
Space for Rough work

6. A directed beam from a small but powerful searchlight placed on the ground tracks a small plane flying horizontally at a fixed height 'h' above the ground with a uniform velocity V as shown in figure below.

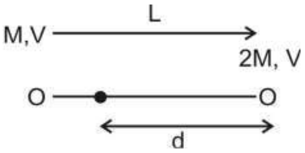


If the searchlight starts rotating with an instantaneous velocity ω_0 at t = 0, when the plane was directly overhead, then at a large time t, instantaneous angular velocity w(f) is given by $n\frac{w_0}{1+w_0^2t^2}$, n = ____________

7. An electric dipole is constructed by fixing two circular charged rings, each of radius a, with an insulating contact, one of these rings has a total charge +Q and the other has total charge –Q. If the charge is distributed uniformly along each ring, the dipole moment about the point of contact will be $n\,Qa\hat{Z}/4$, n = __________.



8. A dumbbell is placed in water of density ρ. It is observed that by attaching a mass m to the rod, the dumbbell floats with rod horizontal on the surface of water and each sphere exactly half submerged as shown in figure.



The volume of the mass m is negligible the value of length L is $nd\frac{(\rho V-3M)}{(\rho V-2M)}$,

n = _______________.

9. A small sphere of mass m and radius r rolls without slipping on the inside a large hemisphere of radius R. The axis of symmetry of the hemisphere is vertical. It starts at the top from rest. The small sphere will exert a normal force on the hemisphere at its bottom equal to $n\frac{17}{14}mg$, n = ________.

10. An electron of mass 'm' and charge 'e' initially at rest gets accelerated by a constant electric field E. The rate of change of De Broglie wavelength of this electron at time 't' is $\left(-\frac{h}{eE}t^{-n}\right)$; where n equals to_______.

Space for Rough work

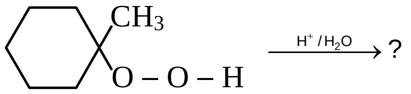
Chemistry PART – II

SECTION – A

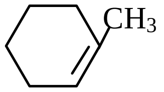
(One or More than One Options Correct Type)

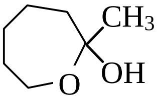
This section contains **10 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** are correct.

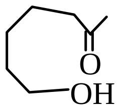
1. The product of the following reaction,

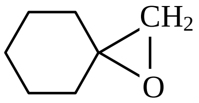

CH3
O – O – H
H+ /H2O
?

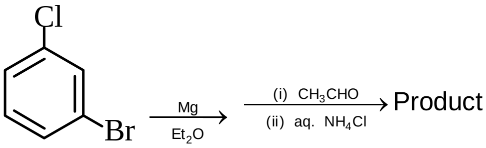
would be

(A) 

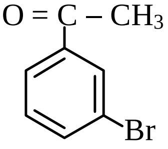
(B) 

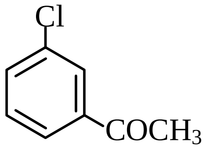
(C) 

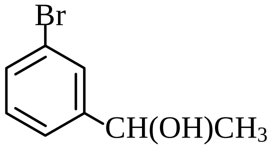
(D) 

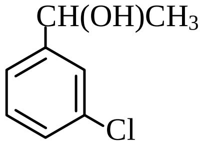
2. 
Cl
Br
Mg
Et2O
(i) CH3CHO
(ii) aq. NH4Cl
Product

The product of above reaction is

(A) 

(B) 

(C) 

(D) 

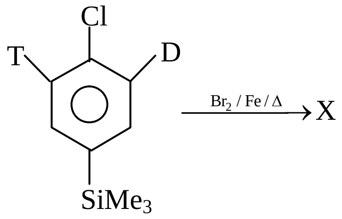
3. When 150 ml of ozonized oxygen was passed through red hot tube, the volume increased by 10 ml then the volume percentage of ozone in the sample is

(A) 25%	(B) 51%
(C) 13.33%	(D) 17.84%

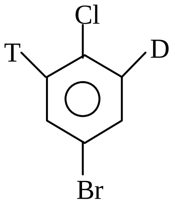
Space for Rough work

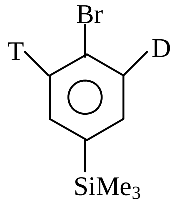
4. The volume of water needed to dissolve 1 mg of $PbSO_4$ ($K_{sp} = 1.44 \times 10^{-8}$ M^2) at 25°C is approximately (molar mass of Pb = 207)

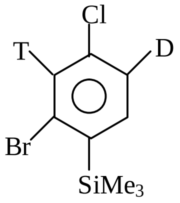
(A) 10 ml (B) 27 ml
(C) 43 ml (D) 80 ml

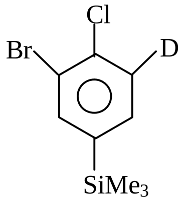
5. 

The product of the reaction (X) will be

(A) 

(B) 

(C) 

(D) 

6. Which of the following is a salt of sulphurous acid?

(A) $NaHSO_4$ (B) $Na_2S_2O_3$
(C) $Na_2S_4O_6$ (D) Na_2SO_3

7. Which of the following is/are true for 3–Methyl butanone

(A) This compound is an isomer of 4–penten–1–ol
(B) It may be prepared by acidic Hg^{2+} catalyzed hydration of 3–methyl–1–butyne
(C) It may prepared by CrO_3 oxidation of 2–methyl–2–butanol
(D) It can not give positive iodoform test.

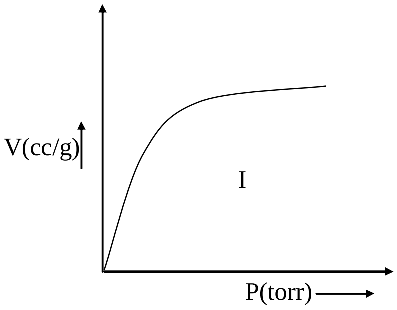
8. In blast furnace a charge of oxide ore, limestone and coke is feed for metallurgical extraction of iron. The correct statements regarding the process is/are

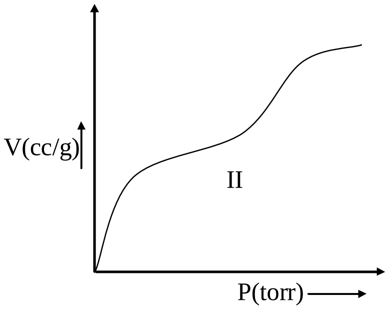
(A) at the top of furnace the reducing agent is CO
(B) at the top of furnace the reducing agent is C
(C) at the top of furnace the reducing agent is CO_2
(D) at the bottom of furnace the reducing agent is C

Space for Rough work

9. The correct facts regarding shape and hybridization of complexes $[CuCl_5]^{3-}$ and $[Ni(CN)_5]^{3-}$ will be
(A) both have similarly hybridized states on central metal ion
(B) both have different shapes
(C) both have different hybridized states on central metal ion
(D) both have similar shapes

10. On the basis of following graphs between volumes of gas adsorbed and pressure of gas





which of the following is/are correct ?
(A) graph I is of chemisorption
(B) graph II is of physiosorption
(C) graph II is of chemisorption
(D) graph I is of physiosorption

Space for Rough work

SECTION – C
(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. $A \xrightarrow[H_2SO_4]{NaCl} B\uparrow \xrightarrow{NaOH}$ yellow solution $\xrightarrow[2.\ H_2O_2]{1.\ H^+}$ Blue solution.
   (red vapours)
   The blue colour obtained at the end of reaction is due to salt formation. The oxidation number of the metal in the salt is

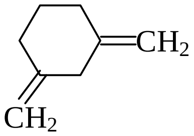
2. Find the quantum numbers of the excited state of electrons in He^+ ion which on transition to ground state and first excited state emit two photons of wavelengths, 30.4 nm and 108.5 nm respectively. ($R_H = 1.09678 \times 10^7\ m^{-1}$)

3. Electron is now a day considered as probability wave function with quantized angular momentum and energy. The angular momentum of e^- in 1s orbital is.

4. The number of atomic orbitals involved in the hybridization at central metal ion of $K_3[Fe(CN)_6]$ are

5. In an acidic buffer the ratio [acid]/[salt] is 0.5. If the concentration of acid make twice of its initial value then what is value of 10ΔpH. [log 2 = 0.3]

Space for Rough work

6. How many stereoisomers are obtained on complete hydrogenation of  ?

7. 20 ml solution containing mixture of NaOH and Na_2CO_3 require 60 ml of 0.5 N H_2SO_4 for the end point using phenolphthalein as indicator. After this when same solution was titrated using methyl orange indicator. A further 20 ml of 0.5 N H_2SO_4 was needed for the second end point. Calculate the molarity of NaOH.

8. A solution containing 2.68×10^{-3}mol of A^{n+}ions requires 1.61×10^{-3}mol of MnO_4^- for the complete oxidation of A^{n+} to AO_3^- in acidic medium. What is the value of n?

9. 0.15 mole of pyridinium chloride has been added into $500 cm^3$ of 0.2M pyridine solution. What is the pH of the resulting solution assuming no change in volume. (K_b for pyridine $= 1.5 \times 10^{-9}$)

10. A solution of 6.2 g ethylene glycol in 55 g H_2O is cooled to $-3.72^0 C$. What is the weight (in grams) of the ice separated from the solution?
($K_f H_2O = 1.86 k\, mole^{-1} kg$)

Space for Rough work

Mathematics PART – III

SECTION – A

(One or More than One Options Correct Type)

This section contains **10 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** are correct.

1. If curve $A \equiv \{z : |z-3|+|z+3| = 8\}$, where $B \equiv \{z : |z-3| = k\}$, $k \in R^+$ touches A internally and $C \equiv \{z : ||z-3|-|z+3|| = 4\}$, then
   (A) B also touches C internally
   (B) A and C intersect orthogonally
   (C) $k \in \{1\}$
   (D) $1 < k < 2$

2. If f(x) is a polynomial of degree three with leading coefficient as unity such that f(1) = 1; f(3) = 9 and f'(1) = 2, then
   (A) $f'(x) = 2x$ has at least one root between (1, 3)
   (B) $f''(x) = 2$ has at least one root between (1, 7/3)
   (C) product of roots of f(x) = 0 is 4
   (D) sum of root of f(x) = 0 is 3

3. The inequality $\sin|z| > 0$ may represent, where z is complex number
   (A) an interior region of circle where centre is origin and whose radius is π
   (B) a parabola whose vertex in (0, 0)
   (C) a region between two concentric circles cantered at (0, 0) and having radii 2π and 3π
   (D) an ellipse of semi axes are π and 2π

4. A straight line touches the rectangular hyperbola $9x^2 - 9y^2 = 8$ and parabola $y^2 = 32x$ then equation of line is (are)
   (A) $9x + 3y - 8 = 0$
   (B) $9x - 3y + 8 = 0$
   (C) $9x + 3y + 8 = 0$
   (D) $9x - 3y - 8 = 0$

5. Which of the following is true about matrix?
   (A) if A is a non–singular square matrix of order $n \times n$ and k is scalar $(k, n) \neq (0, 1)$ then $|\text{adj}(kA)|$ is equal to $k^{n^2-n}|A|^{n-1}$
   (B) let A and B be 3×3 order matrices. If $|A| = 0$, $AB = O$ and $AC = O$ then $B = C$
   (C) A and B are two square matrixes of order $n \times n$ such that $AB = O$ and A is non-singular then B must be null matrix
   (D) if AB is non–singular and A, B are square matrixes. Then A and B both must be non–singular matrices

Space for rough work

6 For a given parabola $y^2 = 4ax$, two variable chords PQ and RS at right angles are drawn through the fixed point $A(x_1, y_1)$ inside the parabola, making variable angles θ and α with x-axis. If r_1, r_2, r_3, r_4 are distances of P, Q, R and S from A, then the value of $\frac{1}{r_1r_2}+\frac{1}{r_3r_4}$

(A) independent of θ (B) independent of α

(C) depends upon both θ and α (D) is a constant

7. Consider the equation $\tan(5\pi\cos\theta) = \cot(5\pi\sin\theta)$ for $\theta \in (0, 2\pi)$, then

(A) number of real solution is 28 (B) number of real solution is 14

(C) $\sin\theta + \cos\theta = \frac{2n+1}{10}$ (D) $\sin\theta - \cos\theta = \frac{2n+1}{10}$

8. A is non singular square matrix of $(n\times n)$ such that $A^2 = -A$, then det (adj (A^n)) is

(A) 1, if n is even (B) –1, if n is odd

(C) 1 if n is odd (D) –1 if n is even

9. Which of the following when simplified reduces to unity?

(A) $\log_3 \log_{27} \log_4 64$ (B) $2\log_{18}\left(\sqrt{2}+\sqrt{8}\right)$

(C) $\log_2\sqrt{10}+\log_2\left(\frac{2}{\sqrt{5}}\right)$ (D) $-\log_{\sqrt{2}-1}\left(\sqrt{2}+1\right)$

10. If $\int\frac{dx}{p^2\sin^2x+r^2\cos^2x}=\frac{1}{12}\tan^{-1}\left(3\tan x\right)+c$, then the value of p sin x + r cos x can be

(A) $\frac{6}{\sqrt{5}}$ (B) $\sqrt{5}$

(C) $6\sqrt{5}$ (D) –4

SECTION – C

(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. If $(x-a)(x-a^2)<0$ has exactly one integral solution of x for $a \in I^+$, then a possible integral value of x is _______

2. If $|z_1-1|=1$ and $|z_2-4i|=1$, then the difference between maximum and minimum values of $|z_1-z_2|$ is _____

Space for rough work

3. Two points A and B lie on the curve $y = x^2$ such that $\overrightarrow{OA}.\hat{i} = 1, \overrightarrow{OB}.\hat{j} = 4$, where O is origin and A and B lies in first and second quadrant respectively. Then $\overrightarrow{OA}.\overrightarrow{OB}$ equals _____

4. If $\log_{245} 175 = a, \log_{1715} 875 = b$, then the value of $\frac{1-ab}{a-b}$ is _____

5. A circular section is formed by a thread of fixed length then $\frac{\text{maximum area of section formed by thread}}{\text{maximum area of rectange formed by thread}}$ is equal to _____

6. For all positive real number x and y, such that x + y = 1, the maximum value of $36\left(x^4y + xy^4\right)$ is _____

7. The number of solutions (x, y, z) to the system of equations

$$x + 2y + 4z = 9$$
$$4yz + 2xz + xy = 13$$
$$xyz = 3$$

such that at least two of x, y, z are integers is _____

8. If number of points common between $||x| - |y|| = 1$ and $2a|x||y| + 1 = 2|x| + a|y|$ are 8 then value of 3a (where $a < 1$) is _____

9. The value of the expression $\lim\limits_{y\to\infty}\left[(8y+3)(y+1)(y+2)(y+3)(2y+3)(4y+5)(2y+7)\right]^{1/7} - 2y$ is of the form $\frac{A}{B}$. Then the value $\left[\frac{A}{B}\right]$ (where [.] denotes the greatest integer function), is _____

10. If the number of the positive integral solutions of the equation $\left[\frac{x}{9}\right] = \left[\frac{x}{11}\right]$ is *n*, then $\frac{n}{3}$ is _____ (where [.] denotes the greatest integer function)

Space for rough work

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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FIITJEE **JEE(Advanced)-2015**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

CRT – IV

(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**A, B, C**	**C**	**A, B, C**
2.	**A, B, C, D**	**D**	**A, B**
3.	**B, C**	**C**	**A, C**
4.	**B, C**	**B**	**B, C**
5.	**B, D**	**A**	**A, C, D**
6.	**B, D**	**D**	**A, B, D**
7.	**A, C, D**	**A, B**	**B, C**
8.	**A, B, C**	**A, D**	**A, C**
9.	**C, D**	**B, C**	**B, D**
10.	**A, B**	**A, B**	**A, B, D**
1.	**2**	**6**	**3**
2.	**3**	**5**	**4**
3.	**4**	**0**	**2**
4.	**6**	**6**	**5**
5.	**5**	**3**	**1**
6.	**1**	**3**	**3**
7.	**8**	**1**	**5**
8.	**2**	**2**	**2**
9.	**2**	**5**	**3**
10.	**2**	**5**	**8**

Physics

PART – I

SECTION – A

1. $\int \vec{F}.dx$ is independent of path.

2. A, B, C, D

Energy received at photo sensitive surface per unit time = $\frac{WS}{4\pi a^2}$

$\therefore$ number of photons = energy per unit time + energy of a photon.

3. Conservation of momentum and impulse momentum theorem $\int F dt = \Delta P$

4. $\vec{E} = -\left(\frac{\delta v}{\delta x}\hat{i} + \frac{\delta v}{\delta y}\hat{j} + \frac{\delta v}{\delta z}\hat{k}\right)$

6. $\frac{dy}{dx} = 2\cos\left(\frac{\pi x}{L}\right) = \pm 1$

$\frac{\pi x}{L} = \frac{\pi}{3}, \frac{2\pi}{3}$

$x = \left(\frac{L}{3}\right), \frac{2L}{3}$

7. $\varepsilon_{ind} = \int\left(\vec{v} \times \vec{B}\right).d\ell$

8. $\underset{inside}{g} = \frac{Gm_e}{R^3} r \le R_e$

$\underset{out}{g} = \frac{Gm_e}{r^2}$

$R \ge R_e$

9. For RLC circuit

$Z = \sqrt{R^2 + \left(x_c - x_L\right)^2}$

$X_z = \omega L$

$x_C = \frac{1}{\omega C}$

Ab = $\omega = \omega'$, $x_L = x_C \Rightarrow z = R$

Hence phase difference between current and voltage = 0

SECTION – C

1. $f(x,t) = e^{-\left(\frac{ax-bt}{c}\right)^2}$

$$v = \frac{b}{A}$$

2. $K = \frac{P^2}{2m} = \frac{\left(\frac{h}{\lambda}\right)^2}{2m}$

$$K = \frac{h^2}{8L^2m}.9$$

3. $R = \int \frac{r^2}{A}\frac{dr}{a\pi r^2}\ \Big|\rho = \frac{1}{\sigma}$

$$\frac{(b-a)}{4\pi A}$$

4. $u_{cmx} = 5\ m/s$

So impulse = 5m,

$$5m.\frac{\ell}{2} = \frac{m\ell^2}{12}\omega$$

$$\omega = \frac{30}{L}$$

5. $\frac{\lambda D}{d} = \beta$

6. X = h tanθ

$$\frac{dx}{dt} = h\sec^2\theta\frac{d\theta}{dt}$$

$$\frac{d\theta}{dt} = \frac{v}{h\left(1+\tan^2\theta\right)}$$

$$= \frac{v}{h\left(1+\frac{v^2t^2}{h^2}\right)} = \frac{vh}{\left(h^2+v^2t^2\right)}$$

Put $\frac{v}{h} = \omega$

get n = 1

7. $\vec{b} = (q.2a)\hat{z}$

8. $F_3\left(d.v + d.\frac{v}{2}\right)\ dv = \left(3m + m\right)g$

$t_{xy} = 0$

$3mg\frac{L}{3} + mgd = dv\frac{L}{2}$

$L\left(mg + \frac{dv}{2}\right) = mgd$

$L = \frac{mgd}{\left(\frac{dv}{2} - mg\right)} = 2d.\frac{\left(dv - 3mg\right)}{\left(dv - 2mg\right)}$

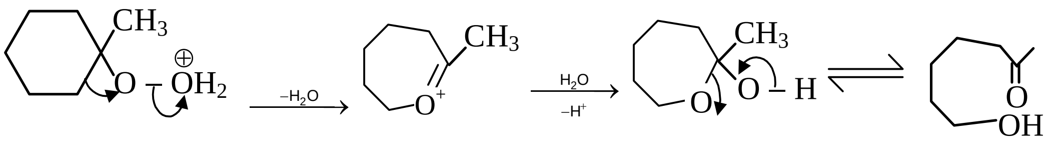
10. $\lambda = \frac{h}{p} = \frac{h}{eBt} \Rightarrow \frac{d\lambda}{dt} = -\frac{h}{eE}t^{-1}$

Chemistry

PART – II

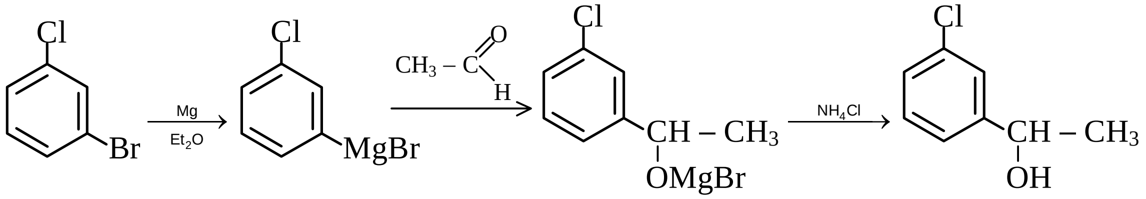
SECTION – A

1.



Hemiketal

2. Aryl chlorides do not form Grignard reagents in ether and THF is necessary as solvent, while aryl bromide and iodide readily react in ether solution.
The aqueous NH_4Cl is used to prevent the possibility of dehydration of alcohol which might occur if acid is used.



3. Let *x* ml ozone be present in 150 ml of ozonized oxygen.
$2O_3 \xrightarrow[\text{tube}]{\text{heated}} 3O_2$
x ml   3/2 *x* ml
Increasement in volume due to decomposition of ozone = 0.5 *x* = 10 ml
$\therefore$ *x* = 20 ml

Therefore, percentage of ozone in ozonized oxygen = $\frac{20}{150} \times 100 = 13.33\%$

4. Solubility of $PbSO_4 = \sqrt{K_{sp}} = \sqrt{1.44 \times 10^{-8}} = 1.2 \times 10^{-4}$ M
Solubility of PbSỌor$_4$ = $1.2 \times 10^{-4} \times 303 \times 10^3 = 36.36$ mg litre^{-1}
$\therefore$ Volume of water needed to dissolve 1 mg of $PbSO_4 = \frac{1000}{36.36} = 27.5$ ml

5. The reaction is known as bromodesilylation.

6. Sulphurous acid is actually aqueous solution of SO_2
$2NaOH + SO_2 \longrightarrow Na_2SO_3 + H_2O$

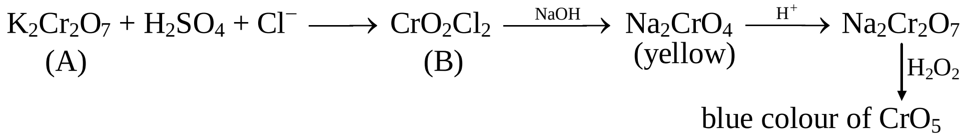
8. Both C and CO act as reducing agent. Being gas CO reduction is achieved at the top of furnace at lower temperature of 250°C.

9. $[CuCl_5]^{3-}$ is d_zsp^3 hybridized and trigonal bipyramidal in shape while $[Ni(CN)_5]^{3-}$ is $d_{x^2-y^2}sp^3$ hybridized and square pyramidal in shape.

10. As chemisorption is monolayer phenomenon while physiosorption is multilayered adsorption.

SECTION – C

1.



$$\underset{(A)}{K_2Cr_2O_7} + H_2SO_4 + Cl^- \longrightarrow \underset{(B)}{CrO_2Cl_2} \xrightarrow{NaOH} \underset{(yellow)}{Na_2CrO_4} \xrightarrow{H^+} Na_2Cr_2O_7 \; \Big\downarrow {\scriptstyle H_2O_2} \; \text{blue colour of } CrO_5$$

2. $\frac{1}{\lambda} = R_H Z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

For $n_1 = 1$, $n_2 = ?$

$$\frac{1}{30.4 \times 10^{-9}} = 1.09678 \times 10^7 \times 4\left[\frac{1}{1^2} - \frac{1}{n_2^2}\right]$$

$\therefore$ **$n_2 = 2$**

For $n_1 = 2$ (first excited state), $n_2 = ?$

$$\frac{1}{108.5 \times 10^{-9}} = 1.09678 \times 10^7 \times 4\left[\frac{1}{2^2} - \frac{1}{n_2^2}\right]$$

$\therefore$ **$n_2 = 5$**

3. $L = \sqrt{\ell(\ell+1)}\ \frac{h}{2\pi}$

as for 1 s orbital $\ell = 0$ $\therefore L = 0$

4. This octahedral complex involve d^2sp^3 hybridization which is hybrid of 6 atomic orbitals.

5. $pH = pK_a + \log\frac{[S]}{[A]}$

$pH = pK_a + \log 2$

now acid added so that $\frac{[S]}{[A]} = 1$

$pH' = pK_a + \log 1$

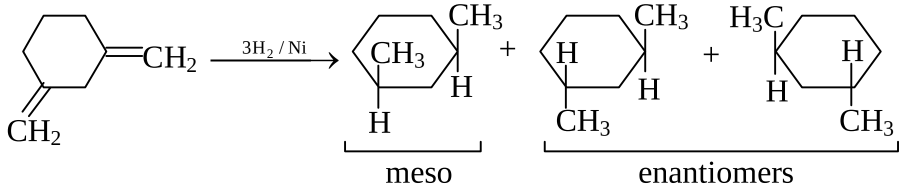
$pH' = pK_a$

$\therefore \Delta pH = pK_a + \log 2 - pK_a$

$= \log 2 = 0.3$

$\therefore 10\ \Delta pH = 3.$

6.



7. Let the 20 ml alkali solution
→ x m mole NaOH
→ y m mole Na_2CO_3

Using phenolphthalein indicator
nf of NaOH = 1
nf of Na_2CO_3 = 1
No. of meq. of base = $1 \times x + 1 \times y = x + y$
Meq. of acid = $60 \times 0.5 = 30$
Meq. of acid = Meq. base
$x + y = 30$
using methylorange indicator
No. of meq. of base Na_2CO_3 = $1 \times y = 4$
Meq. of acid = $20 \times 0.5 = 10$
$y = 10$
$x = 20$
Molarity of NaOH = $\frac{20}{20} = 1$

8. $MnO_4^- \longrightarrow Mn^{2+}$ n- factor = 5
Equivalents of $MnO_4^- = 1.61 \times 10^{-3} \times 5 = 8.05 \times 10^{-3}$
Equivalents of $A^{n+} = 8.05 \times 10^{-3}$
N –factor of $AO_3^- = 5 - n$
$\therefore (5-n) \times 2.68 \times 10^{-3} = 8.05 \times 10^{-3}$
$5 - n = 3$
$n = 2$

9. $[\text{Pyridinium Chloride}] = \frac{0.15 \times 1000}{500} = 0.3M$ $[\text{Pyridine}] = 0.2M$
A mixture of pyridine and its salt pyridinium chloride forms a basic buffer and therefore
$$pOH = -\log K_b + \log\frac{[\text{Salt}]}{[\text{Base}]}$$
$$pOH = -\log(1.5 \times 10^{-9}) + \log\frac{0.30}{0.20}$$
$$pOH = -\log 1.5 - \log 10^{-9} + \log 1.5$$
$pOH = 9$
$pH = 14 - 9$
$pH = 5$

10. No of mole of solute $(n_B) = \frac{6.2}{62} = 0.1$
$\Delta Tf = Kf \times m$
$$3.72 = 1.86 \times \frac{0.1 \times 1000}{w_A}$$
$$W_A = \frac{1.86 \times 0.1 \times 1000}{3.72}$$
$W_A = 50$
Weight of ice separated from solution $= 55 - 50 = 5$ grams

Mathematics PART – III

SECTION – A

1. Con-focal conics; therefore orthogonal intersection and circle touches at vertices

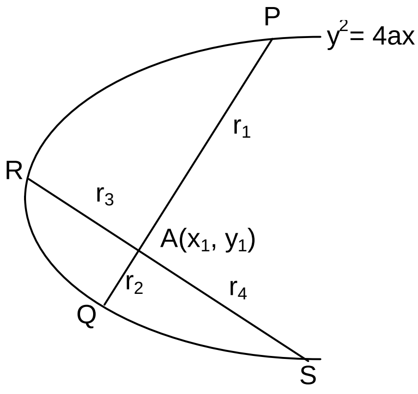
2. $\because f(x) - x^2 = (x-1)^2(x-3)$

3. $\sin|z| > 0$
$|z| \in (0, \pi)$ or $(2\pi, 3\pi)$ or $(4\pi, 5\pi)$
$\Rightarrow 0 < |z| < \pi,\ 2\pi < |z| < 3\pi$ so on

4. Let equation be $y = mx + c$ since it touches the hyperbola $c^2 = \frac{8}{9}(m^2 - 1)$
Also it touches the parabola $y^2 = 32x$, we get $c = \frac{8}{m}$
$\Rightarrow \frac{8}{9}(m^2-1) = \frac{64}{m^2} \Rightarrow (m^2 - 9)\ (m^2 + 8) = 0 \Rightarrow m \pm 3 \quad c = \pm\frac{8}{3}$
Requires equation are $9x - 3y + 8 = 0,\ 9x + 3y + 8 = 0$

5. $|\text{adj}(kA)| = |kA|^{n-1} = k^{n^2-n}\,|A|^{n-1}$ (A) is correct
(B) Order of C is unknown. Order of C not necessarily 3×3 hence B, C need not be equal
$\therefore$ (B) is incorrect
Since AB = O and A is non-singular
$\Rightarrow A^{-1}(AB) = A^{-1}O \Rightarrow IB = O \Rightarrow B = O$
(C) is correct
Now $|AB| \neq 0 \Rightarrow |A| \neq 0$ and $|B| \neq 0$
$\therefore$ A an B both are non-singular
$\Rightarrow$ (D) is correct

6. Let two perpendicular chords through A(x_1, y_1) be PQ and RS



Equation of PQ is $\frac{x - x_1}{\cos\theta} = \frac{y - y_1}{\sin\theta} = r$
Where tan θ = slope of PQ
Any point on this line may be taken as
(x_1 + r cos θ, y_1 + r sin θ)
As the point lies on $y^2 = 4ax$,
$\therefore\ (y_1 + r\sin\theta)^2 = 4a(x_1 + r\cos\theta)$
$\Rightarrow\ r^2\sin^2\theta + 2y_1\sin\theta.r - 4a\cos\theta r + y_1^2 - 4ax_1 = 0$

$\therefore\ r_1r_2 = \frac{(y_1^2 - 4ax_1)}{\sin^2\theta}$

Similarly $r_3r_4 = \frac{(y_1^2 - 4ax_1)}{\sin^2\alpha}$ where tan α = slope of RS
Since PQ is perpendicular to RS,

$\therefore$ $\alpha = 90 + \theta$ or $\theta - 90$

In either case; $\sin^2 \alpha = \cos^2 \theta$

Now $\frac{1}{r_1 r_2} + \frac{1}{r_3 r_4} = \frac{\sin^2\theta + \cos^2\theta}{\left(y_1^2 - 4ax_1\right)} = \frac{1}{\left(y_1^2 - 4ax_1\right)}$ which is constant

7. Since $\tan(5\pi \cos\theta) = \cot(5\pi \sin\theta)$

Or $\sin\theta + \cos\theta = \frac{2n+1}{10}$, $n \in I$

$\Rightarrow -1 < \frac{2n+1}{10\sqrt{2}} < 1 \Rightarrow -\left(\frac{10\sqrt{2}+1}{2}\right) < n < \left(\frac{10\sqrt{2}-1}{2}\right)$

Hence total number of solution is 14

8. $A^2 = -A \Rightarrow |A|^2 = -|A|$ if n is odd

$\Rightarrow |A| = -1$, $A^n \text{ adj } A^n = |A^n| I$

$\Rightarrow |A^n| \, |\text{Adj } A^n| = |A^n I|$

$\Rightarrow |\text{Adj } A^n| = 1$

Similarly when n is even $|A| = 1$

$\Rightarrow |\text{Adj } A^n| = 1$

9. $\log_3 \log_{27} \log_4 64 = -1$

$2\log_{18}\left(\sqrt{2} + \sqrt{8}\right) = \log_{\left(3\sqrt{2}\right)}\left(\sqrt{2} + 2\sqrt{2}\right) = \log_{3\sqrt{2}}\left(3\sqrt{2}\right) = 1$

$\log_2 \sqrt{10} + \log_2\left(\frac{2}{\sqrt{5}}\right) = \log_2\left(\sqrt{10} \times \frac{2}{\sqrt{5}}\right) = \log_2\left(2\sqrt{2}\right) = \frac{3}{2}$

$-\log_{\sqrt{2}-1}\left(\sqrt{2}+1\right) = 1$

10. $\int \frac{dx}{p^2 \sin^2 x + r^2 \cos^2 x} = \frac{1}{12}\tan^{-1}(3\tan x) + c$

$\int \frac{\sec^2 x}{p^2 \tan^2 x + r^2} dx$ ($p \tan x = t$, $p \sec^2 x \, dx = dt$)

$\frac{1}{p}\int \frac{dt}{t^2 + r^2} = \frac{1}{pr}\tan^{-1}\left(\frac{t}{r}\right) + c = \frac{1}{pr}\tan^{-1}\left(\frac{p\tan x}{r}\right) + c$

$\therefore$ $pr = 12$, $\frac{p}{r} = 3 \Rightarrow p = 6, r = 2$

$\therefore$ $-6 < 6 \sin x + 2 \cos x < 6$ when $\sin x = \pm 1$

SECTION – C

1. When $a = 2$, $x = 3$

2. Centres are (0, 4), (1, 0) and radii are each unity

$\Rightarrow$ The shortest distance = distance b/w centres – (sum of radii) $= \sqrt{17} - 2$

Maximum distance = distance b/w centres + (sum of radii) $= \sqrt{17} + 2$

$\therefore$ Diff. = 4

3. Let $\overrightarrow{OA} = x_1 i + x_1^2 j$, $\overrightarrow{OB} = x_2 i + x_2^2 j$

$\overrightarrow{OA} i = 1 \Rightarrow x_1 i \,.\, i + x_1^2 j \,.\, i = 1$

$\Rightarrow x_1 = 1 \quad \therefore y_1 = x_1^2 = 1$

$\overrightarrow{OB} \,.\, j = 4 = (x_2 i + x_2^2 j) \,.\, j = 4$

$\Rightarrow x_2^2 = 4 \Rightarrow x_2 = -2$ ($\because$ B lies in II quad.)

$\overrightarrow{OA}.\overrightarrow{OB} = (i + j).(-2i + 4j) = -2 + 4 = 2$

4. $175 = 5^2.7,\ 245 = 5.7^2,\ 875 = 5^3.7,\ 1715 = 5.7^3$

Let $\alpha = \log 5, \qquad \beta = \log 7$

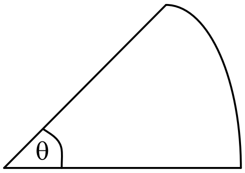
$$a = \frac{\log 175}{\log 245} = \frac{2\alpha + \beta}{\alpha + 2\beta}$$

$$b = \frac{\log 875}{\log 1715} = \frac{3\alpha + \beta}{\alpha + 3\beta}$$

$$\frac{1 - ab}{a - b} = \frac{(\alpha + 2\beta)(\alpha + 3\beta) - (2\alpha + \beta)(3\alpha + \beta)}{(2\alpha + \beta)(\alpha + 3\beta) - (\alpha + 2\beta)(3\alpha + \beta)}$$

$$= \frac{5(\beta^2 - \alpha^2)}{\beta^2 - \alpha^2} = 5$$

5. Let length $= \ell$ radius of sector $= r$, angle $= \theta$



$$\theta = \frac{\ell - 2r}{r}$$

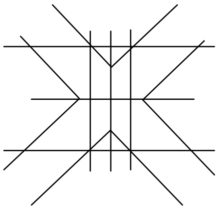
$$A = \frac{1}{2}r^2.\theta = \frac{1}{2}r^2\left(\frac{\ell - 2r}{r}\right) = \frac{1}{2}\left(\ell r - 2r^2\right)$$

$$\frac{dA}{dr} = \frac{\ell - 4r}{2} = 0 \qquad r = \frac{\ell}{4}, \quad \frac{d^2A}{dr^2} = -2 < 0$$

$$A_{\max} = \frac{r}{2}\left(4r - 2r\right) = r^2 = \ell^2/16$$

Max. area of rectangle $= \left(\dfrac{\ell}{4}\right)^2 = \dfrac{\ell^2}{16}$

8. Shown in the figure



10. $\left[\dfrac{x}{9}\right] = \left[\dfrac{x}{11}\right] = I$

$\Rightarrow I \le \dfrac{x}{9} < I + 1, I \le \dfrac{x}{11} < I + 1,$ Solution is possible only when $11I < 9I + 9$

$\Rightarrow 0 \le I < \dfrac{9}{2}$

Total number of solution $\displaystyle\sum_{I=0}^{4}(9 - 2I) - 1 = 24$

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ALL INDIA TEST SERIES

FIITJEE JEE (Advanced), 2015

CONCEPT RECAPITULATION TEST - IV

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 10)** contains 10 multiple choice questions which have one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (11 to 16) contains 3 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (17 – 20) contains 4 Matching Lists Type questions: Each question has four statements in LIST I & 4 statements in LIST II. The codes for lists have choices (A), (B), (C), (D) out of which only one is correct. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant R = $8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
= $0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
= $1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

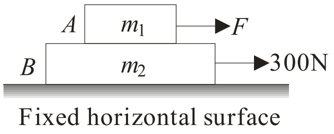
SECTION – A

(Only One Option Correct Type)

This section contains **10 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

1. Electrons in a sample of gas containing hydrogen like atom (Z = 3) are in fourth excited state. When photons emitted only due to transition from third excited state to second excited state are incident on a metal plate photoelectrons are ejected. The stopping potential for these photoelectrons is 3.95 eV. Now, if only photons emitted due to transition from fourth excited state to third excited state are incident on the same metal plate, the stopping potential for the emitted photoelectrons will be approximately equal to:
(A) 0.85 eV (B) 0.75 eV
(C) 0.65 eV (D) None of these

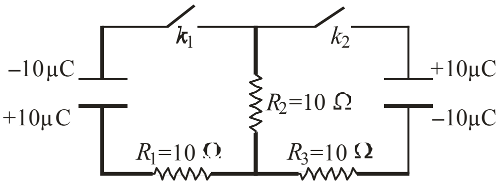
2. The coefficient of friction between block *A* of mass m_1 = 5 kg and block *B* of mass m_2 = 10 kg is μ = 0.5. There is no friction force between block *B* and fixed horizontal surface. A force of 300 N acts on block *B* in horizontal direction and a horizontal force of magnitude *F* acts on block *A* as shown, both towards right. Initially there is no relative motion between the blocks. The minimum value of *F* such that relative motion starts between *A* and *B* is:
(A) 200N (B) 187.5N
(C) 150 N (D) 0



3. A proton moves in the positive *z*-direction after being accelerated from rest through a potential difference *V*. The proton then passes through a region with a uniform electric field *E* in the positive *x*-direction and a uniform magnetic field *B* in the positive *y*-direction, but the proton's trajectory is not affected. If the experiment were repeated using a potential difference of 2V, the proton would then be:
(A) deflected in positive *x*-direction (B) deflected in negative *x*-direction
(C) deflected in positive *y*-direction (D) deflected in negative *y*-direction

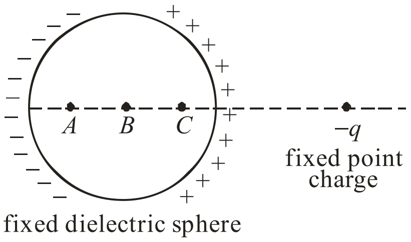
Space for Rough work

4. In the circuit shown initially both keys are open and capacitance of both capacitors is 1 μF. Charges on each capacitor are as shown. Now both the keys k_1 and k_2 are simultaneously closed. Just after closure of both keys, the current through resistance R_2 is:



(A) 1 ampere
(B) 0.5 ampere
(C) 1.5 ampere
(D) zero

5. A negative point charge is brought near an uncharged solid dielectric sphere. Positive induced charges appear on the side of the sphere nearest to the point charge, negative induced charges on the opposite side. *A*, *B* and *C* are three points on diameter of the sphere that also passes through the point charge. Comparing only at points *A*, *B* and *C* on the dielectric sphere, the potential is:



(A) Largest at *C*
(B) Largest at *A*
(C) Largest at *B*
(D) The same every where

6. A uniform thin, rod *AB* of length *L* and mass *m* is undergoing fixed axis rotation about end *A*, such that end *A* remains stationary as shown. The kinetic energy of section *AP* of rod is equal to kinetic energy of section *BP* of rod at an instant. Then the ratio of length *AP* and length *AB*, that is, $\frac{AP}{AB}$:

(A) $\frac{1}{2}$
(B) $\frac{1}{2^{1/3}}$
(C) $\frac{1}{\sqrt{2}}$
(D) $\frac{1}{2\sqrt{2}}$

Space for Rough work

7. In displacement method, the distance between object and screen is 96 cm. The ratio of length of two images formed by a convex lens placed between them is 4:
(A) Ratio of the length of object to the length of shorter image is 2.
(B) Distance between the two positions of the lens is 40 cm.
(C) Focal length of the lens is 64 cm.
(D) When the shorter image is formed, distance of the lens from the shorter image is 64 cm.

8. An unstable radioactive element *A* decays into a unstable daughter element *B* which in turn decays into stable grand-daughter element *C*. At time *t* = 0, the element *A* consists of N_0 atoms while number of atoms of element *B* and element *C* are zero. The decay constant λ of *A* and *B* are same. Based on this situation choose the incorrect statement from the following:
(A) At the instant activity of element *B* is zero, the number of atoms of element *B* are maximum.
(B) The maximum number of atoms of element *B* present at any moment is less than $\frac{N_0}{2}$.
(C) At the instant activity of element *B* is maximum, the activity of element *A* and element *B* are equal.
(D) The activity of stable element *C* increases with time.

9. Which of the following statements is/are incorrect:
(A) A positively charged particle having non-zero initial velocity may move from region of lower electric potential towards region of higher electric potential.
(B) Whenever a charged solid conductor is grounded, the net charge on conductor must become zero.
(C) Even though the plates of a parallel plate capacitor are oppositely charged, the net electrostatic potential energy stored inside the capacitor is positive.
(D) As the inter-plate distance of a parallel plate capacitor is slowly reduced to half its initial value, the electric field inside the capacitor may remain same.

Space for Rough work

10. Which of the following statements is/are correct:
(A) If distance x between two particles at any time t is increasing then the distance between particles will be least if and only if $\frac{dx}{dt} = 0$.
(B) For a particle moving with constant acceleration, the rate of change of speed with time must be a constant.
(C) The magnitude of average velocity of a particle moving along a straight line between time $t = 0$ to $t = T$ may be greater than speed of particle at time $t = T$.
(D) Several stone are projected from top of a tower with same speeds but at different angles of projection. The velocities of all these stone just before reaching the ground are equal.

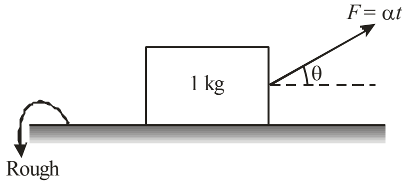
Comprehension type (Only One Option Correct)

This section contains **3 paragraphs**, each describing theory, experiments, data etc. Six questions relate to the three paragraphs with **two questions on each paragraph**. Each question has **only one** correct answer among the four given options (A), (B), (C) and (D).

Paragraph for Questions 11 & 12

A variable force $F = \alpha t$ is acting on block of mass 'm' at an angle θ with horizontal as shown.

(given $m = 1$ kg, $\alpha = 3$ N/sec, $\mu_S = 0.75$, $\mu_K = \frac{1}{3}$, sin 53 = $\frac{4}{5}$). Give answer of following.



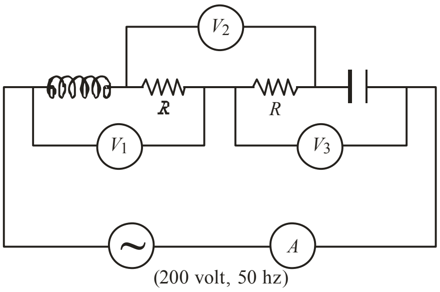
11. Minimum time after which block starts moving:
(A) 1 sec
(B) 2 sec
(C) 3 sec
(D) Data insufficient as α is not mentioned

12. Speed of block when it leaves the horizontal surface for $\theta = 37°$ approximately:
(A) 20 m/s
(B) 25 m/s
(C) 28 m/s
(D) 26 m/s

Space for Rough work

Paragraph for Questions 13 & 14

In the shown *AC*, *L*-*C*-*R* series circuit reading of ideal voltmeter V_1 and V_3 are 300 volt each and reading of hot wire ammeter *A* is 10 amp then give the answer of followings.



13. Reading of V_2 will be:

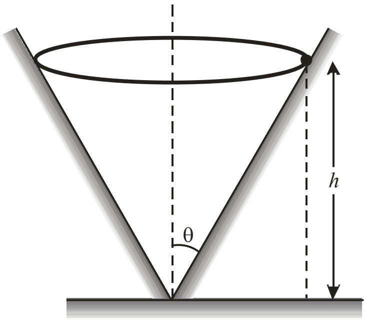
(A) 600 volt	(B) 300 volt
(C) 400 volt	(D) 200 volt

14. Value of resistance '*R*' will be:

(A) 10 Ω	(B) 20 Ω
(C) 30 Ω	(D) data insufficient

Paragraph for Questions 15 & 16

A particle of mass '*m*' is moving in horizontal circle inside a smooth inverted vertical cone above height '*h*' from apex. Half angle of cone is 'θ' then give the answer of following.



15. Normal force by surface of cone is :

(A) mg cos θ	(B) mg sec θ
(C) mg sin θ	(D) mg cosec θ

16. Time period of one revolution if θ increases keeping '*h*' constant :

(A) will remain same	(B) will decrease
(C) will increase	(D) increase then decrease

Space for Rough work

(Matching List Type)

This section contains **4 multiple choice questions. Each question has matching lists.** The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

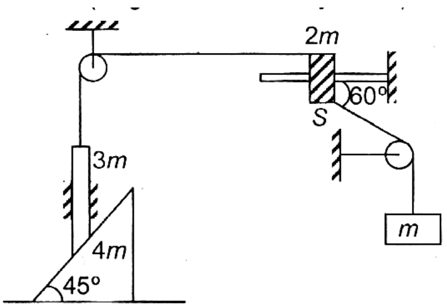
17. Match the statements from List I with those in List II and select the correct answer using the code given below the lists.

	List-I		**List-II**
(P)	Floating of a block in liquid	(1)	Work energy theorem
(Q)	The expression for buoyant force	(2)	Mass conservation
(R)	Equation of continuity	(3)	Equilibrium of a body
(S)	Bernoulli's theorem	(4)	Archimedes' principle

	P	Q	R	S
(A)	1	2	3	4
(B)	2	1	4	3
(C)	4	1	3	2
(D)	3	4	2	1

Space for Rough work

18. Consider an arrangement shown in the figure. The rod of mass 3m is constrained to move in the vertical direction only. The wedge of 4m moves in the horizontal direction. The slider S of mass 2m moves on a fixed horizontal rod. At a particular instant system is released and the string connecting the slider S to the making angle 60^0 with the rod. (Neglect friction everywhere) Match the statements from List I with those in List II and select the correct answer using the code given below the lists.

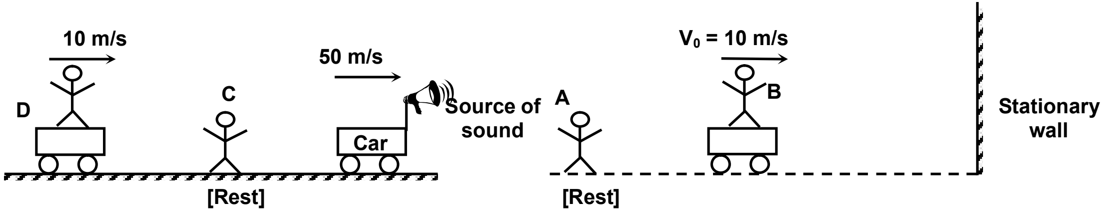


	List– I		List - II
(P)	If net force on the block of m at this instant is $\frac{5amg}{37}$, then a =	(1)	3
(Q)	If net force on the wedge is $\frac{5bmg}{37}$, then b =	(2)	1
(R)	If contact force between wedge and rod is $\frac{5\sqrt{2}cmg}{37}$, then c =	(3)	2
(S)	If tension in the string between blocks having mass m and 2m is $\frac{21dmg}{37}$, then d =	(4)	8

	P	Q	R	S
(A)	1	2	3	4
(B)	2	4	4	3
(C)	4	1	3	2
(D)	3	4	1	2

Space for Rough work

19. A source of sound, emitting frequency of 3000 Hz, moving towards a stationary reflecting wall with speed 50 m/s. There are four observers A, B, C and D as shown in the figure. (Detectors A & C are at rest and detectors B & D are moving with speed 10 m/s towards right. Speed of sound is 350 m/s) Match the statements from List I with those in List II and select the correct answer using the code given below the lists.



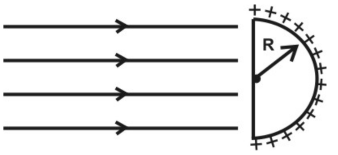
List-I contains detectors and List-II contains the beat frequency observed by the detectors. Match the List-I with List-II.

List-I		List-II	
(P)	Detector A	(1)	200 Hz
(Q)	Detector B	(2)	Zero
(R)	Detector C	(3)	900 Hz
(S)	Detector D	(4)	875 Hz

	P	Q	R	S
(A)	1	2	3	4
(B)	2	1	4	3
(C)	4	1	3	2
(D)	3	4	1	2

Space for Rough work

20. A semi circular disc of mass M and radius R with linear charge density λ on its curved circumference is hinged at its centre and placed in a uniform electric field as shown in the figure



Match the statements from List I with those in List II and select the correct answer using the code given below the lists.

List – I		List – II	
(P)	The net force acting on the ring is	(1)	$\pi\sqrt{\dfrac{M}{\lambda E}}$
(Q)	If the ring is slightly rotated about O and released, find its time period of oscillation	(2)	$\pi R\lambda E$
(R)	The work done by an external agency to rotate it through an angle α is	(3)	$E-\dfrac{2K\lambda}{R}$
(S)	Magnitude of electric field at 'O' will be	(4)	$4\lambda ER^2\sin^2\left(\dfrac{\alpha}{2}\right)$

	P	Q	R	S
(A)	1	2	3	4
(B)	2	4	1	3
(C)	2	1	4	3
(D)	3	4	1	2

Space for Rough work

Chemistry PART – II

SECTION – A

(Only One Option Correct Type)

This section contains **10 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

1. The solution of weak acid $H_2N_2O_2$ decomposes spontaneously at room temperature. The gaseous product obtained is
(A) NO (B) N_2O
(C) N_2 (D) NO_2

2. The correct statement for different solvents at constant temperature is
(A) The higher is the molar mass of solvent larger is K_b.
(B) The higher is the molar mass of solvent smaller is K_b.
(C) The higher is the molar mass of solvent larger is K_f.
(D) The higher is the molar mass of solvent smaller is K_f.

3. The incorrect statement amongst the following is?
(A) Black phosphorous is thermodynamically most stable allotrope of phosphorous
(B) Fe(III) is thermodynamically more stable than Fe(II)
(C) Graphite is thermodynamically more stable than diamond
(D) White phosphorous is kinetically least stable allotrope of phosphorous and so is graphite in comparison to diamond
(Note: All comparisons are in their respective standard states)

4. A certain amount of $N_2O_4(g)$ is enclosed in a closed container at 127°C when following equilibrium got set up at a total pressure of 10 atm.
$N_2O_4(g) \rightleftharpoons 2NO_2(g)$
If the concentration of $NO_2(g)$ in the equilibrium mixture be 8×10^5 ppm, the K_c (in mol L^{-1}) for the above reaction at 127°C is equal to
(A) 3.189 (B) 2.051
(C) 0.974 (D) 1.842

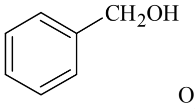
5. A metal M and its compounds can give the following observable changes in sequence of reactions.
$$M \xrightarrow[HNO_3]{dil} \begin{bmatrix} \text{colourless} \\ \text{solution} \end{bmatrix} \xrightarrow[NaOH]{dil} \begin{bmatrix} \text{white} \\ \text{ppt} \end{bmatrix} \xrightarrow[NaOH]{excess} \begin{bmatrix} \text{colourless} \\ \text{solution} \end{bmatrix} \xrightarrow{H_2S} \begin{bmatrix} \text{white} \\ \text{ppt} \end{bmatrix}$$
The metal M is
(A) Mg (B) Pb
(C) Zn (D) Sn

Space for Rough work

6. What is not correct about E_1CB reaction?
(A) Mechanism is followed when substrate is having excessive acidic proton while leaving group is a bad leaving group
(B) the rds is unimolecular and the intermediate is carbanionic
(C) the overall order of reaction is one
(D) the rate law of the reaction is as follows:
Rate $\propto \frac{[S]^2}{[B^-]}$, where S is the substrate and B^- is the base

7. $Fe_2O_{3(s)} + 3CO(g, 1\ atm) \longrightarrow 2Fe_{(s)} + 3CO_2\ (g, 1\ atm)$, $\Delta G_{25^\circ} = -10\ kJ$
The ΔG for the reaction
$2Fe_{(s)} + 3CO_2\ (g, 2\ atm) \longrightarrow Fe_2O_{3(s)} + 3CO\ (g, 20\ atm)$
at the temperature 25°C is equal to
(A) +17.11 kJ (B) –7.11 kJ
(C) +27.11 kJ (D) – 5.70 kJ

8. Consider the following alcohols: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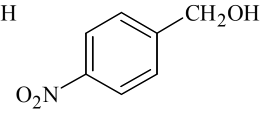
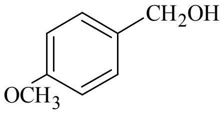
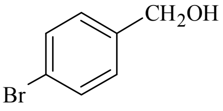

II


III


IV

The order of decreasing reactivities of these alcohols towards substitution with HBr is:
(A) III > I > IV > II (B) III > I > II > IV
(C) I > III > IV > II (D) I > III > II > IV

9. Which of the following is a pyrosilicate.
(A) $Sc_2Si_2O_7$ (B) Zn_2SiO_4
(C) $Ca_2Si_3O_9$ (D) $Be_3Al_2Si_6O_{18}$

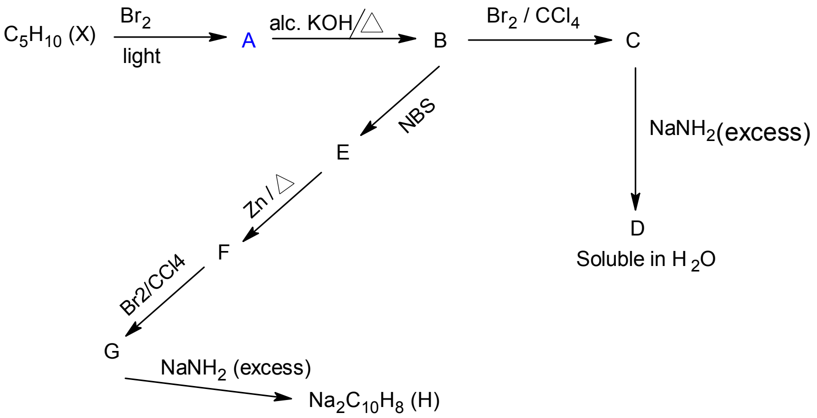
10. Boric acid is a weak acid but it behaves as a strong acid in presence of
(A) Glycerol (B) Borazole
(C) $FeCl_3$ (D) $AlCl_3$

Space for Rough work

Comprehension Type

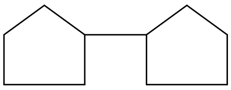
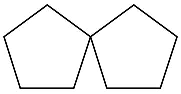
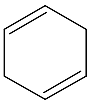
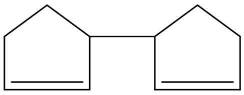
This section contains **3 paragraphs** each describing theory, experiment, data etc. **Six questions** relate to four paragraphs with two questions on each paragraph. Each question of a paragraph has **only one correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 11 to 12


C5H10 (X)
Br2
light
A
alc. KOH/△
B
Br2 / CCl4
C
NBS
E
NaNH2(excess)
D
Soluble in H 2O
Zn / △
F
Br2/CCl4
G
NaNH2 (excess)
Na2C10H8 (H)

X is a saturated hydrocarbon which gives only one monobromination product:

11. What is correct about D?
(A) D is an alkadiene
(B) D is an alkyne
(C) D is an aromatic ionic compound
(D) D can exist as two stereo isomeric forms

12. 'F' is:
(A) 
(B) 
(C) 
(D) 

Space for Rough work

Paragraph for Question Nos. 13 to 14

In coordination chemistry there are a variety of methods applied to find out the structures of complexes. One method involves treating the complex with known reagent and from the nature of reaction, the formula of the complex can be predicted. An isomer of the complex $Co(en)_2(H_2O)Cl_2Br$, on reaction with concentrated H_2SO_4 (dehydrating agent) suffers loss in weight and on reaction with $AgNO_3$ solution it gives a white precipitate which is soluble in NH_3(aq).

13. The correct formula of the complex is

(A) $[CoClBr(en)_2]H_2O$	(B) $[CoCl(en)_2(H_2O)]BrCl$
(C) $[CoBr(en)_2(H_2O)]Cl_2$	(D) $[CoBrCl(en)_2]Cl.H_2O$

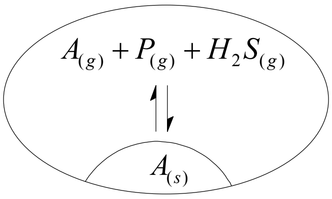
14. If one mole of original complex is treated with excess $Pb(NO_3)_2$ solution, then the number of moles of white precipitate formed under cold conditions will be

(A) 0.5	(B) 1.0
(C) 0.0	(D) 3.0

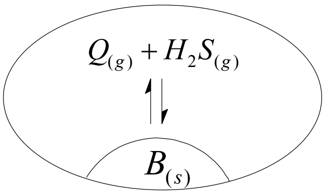
Space for Rough work

Paragraph for Question Nos. 15 to 16

Two identical bulbs contain an excess of solid A (volatile) and solid B (non-volatile) respectively.



I



II

At 25°C equilibrium gets established as shown above. At equilibrium; total pressure inside both bulbs is 10 mm whereas partial pressure of H_2S inside bulb I & II is 4 and 5 mm of Hg respectively.

Equilibria shown for bulb –I is a mix of

$A_{(s)} \xrightleftharpoons{\text{Decomosition}} P_{(g)} + H_2S_{(g)}$

$A_{(s)} \xrightleftharpoons{\text{Sublimation}} A_{(g)}$

Equilibrium shown for bulb –II

$B_{(s)} \xrightleftharpoons{\text{Decomosition}} Q_{(g)} + H_2S_{(g)}$

15. If some A(g) is removed from bulb–I at equilibrium:
    (A) decomposition equilibrium will shift forward
    (B) sublimation equilibrium will shift forward
    (C) both decomposition and sublimation equilibrium will shift forward
    (D) no change will happen in the state of equilibrium

16. If a mixture of excess solids A & B is kept at 25°C in a sealed container, the pressure developed inside the container at equilibrium will be:
    (A) 2.5 mm of Hg (B) 3.9 mm of Hg
    (C) 14.8 mm of Hg (D) 8.4 mm of Hg

Space for Rough work

(Matching List Type)

This section contains **4 multiple choice questions. Each question has matching lists.** The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

17. Match the following:-

	List-I (Binary liquid mixture in ether)		**List -II** (method used for separation)
(P)	Aniline + N-methyl aniline	(1)	(i) addition of $[Ag(NH_3)_2]^+$ (ii) filtration (iii) treating precipitate with dil HCl
(Q)	Phthalimide + benzyl amine	(2)	(i) addition of $C_6H_5SO_2Cl$ & aq NaOH (ii) Treating aqueous layer with dil HCl, con. HCl and Distilled over NaOH
(R)	1-propanol **+** propanone	(3)	(i) addition of NaOH (ii) treating aqueous layer with HCl
(S)	1-Butyne + 2-butyne	(4)	(i) addition of saturated $NaHSO_3$ (ii) filtration (iii) heating precipitate with dil HCl

	P	**Q**	**R**	**S**
(A)	3	2	4	1
(B)	4	3	2	1
(C)	2	3	4	1
(D)	3	4	2	1

18. Match the following:

	List – I		**List – II** (Nature of oxide product)
(P)	$NH_4NO_3 \xrightarrow[\Delta]{\text{gently}}$	(1)	Acidic & diamagnetic
(Q)	$NH_3 + O_2 \xrightarrow[\Delta]{Pt}$	(2)	Acidic & paramagnetic
(R)	$Cu + \underset{(Conc)}{HNO_3} \rightarrow$	(3)	Neutral & paramagnetic
(S)	$HNO_3 \xrightarrow[\Delta]{P_4O_{10}}$	(4)	Neutral & diamagnetic

	P	**Q**	**R**	**S**
(A)	1	2	3	4
(B)	3	4	1	2
(C)	4	2	1	3
(D)	4	3	2	1

Space for Rough work

19. Match the column.

List – I		**List – II**	
(P)	$CH_3COCH_2COOC_3H_7$	(1)	Gives positive iodoform test.
(Q)	$CH_3CH_2CH_2CHO$	(2)	Gives 2, 4–DNP derivative.
(R)	$CH_3CH(OH)CH=CH_2$	(3)	Decolourises Baeyer's reagent.
(S)	$C_2H_5OC(CH_3)=CH_2$	(4)	Do not give positive iodoform test.
		(5)	Can not show tautomerism.

	P	**Q**	**R**	**S**
(A)	2, 4	2, 4	3, 5	4, 5
(B)	2, 4	4	1,5	3, 4
(C)	2, 4	2, 4	1, 3, 5	3, 4, 5
(D)	2, 4	2	1, 3, 5	4, 5

20. Match the following:

	List – I		**List - II**
(P)	Plot of log $t_{1/2}$ vs log $[A_0]$ is a straight line with a slope of '-1'	(1)	Zero order
(Q)	Plot of log $t_{1/2}$ vs log $[A_0]$ is a straight line with a slope of '1'	(2)	2^{nd} order
(R)	Plot of log K_p vs 1/T is a straight line with a negative slope	(3)	ΔH^0 is negative
(S)	Plot of log K_p vs 1/T is a straight line with a positive slope	(4)	ΔH^0 is positive

	P	**Q**	**R**	**S**
(A)	1	2	3	4
(B)	2	1	3	4
(C)	1	2	4	3
(D)	2	1	4	3

Space for Rough work

Mathematics PART – III

SECTION – A

(Only One Option Correct Type)

This section contains **10 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

1. If $f(x)=\begin{cases} -x^2, & x\ge 0 \\ (a^2-2a)+(b^2-2)x, & x<0 \end{cases}$ and $x=0$ is point of maxima, then

(A) $a\in(0,\ 2)$ for $b\in\left(-\sqrt{2},\ \sqrt{2}\right)$
(B) $a\in[0,\ 2]$ for $b\in R-\left[-\sqrt{2},\ \sqrt{2}\right]$
(C) $a\in\{0,\ 2\}$ for $b\in R-\left(\sqrt{2},\ \sqrt{2}\right)$
(D) $a\in R-(0,\ 2)$ for $b\in R-\left[-\sqrt{2},\ \sqrt{2}\right]$

2. If $P_n=1+\cos 2^{n-1}\theta-\sin 2^{n-1}\theta$ and $Q_n=1+\tan 2^{n-1}\theta$ such that $(P_1Q_0)\times(P_2Q_1)\times.........(P_nQ_{n-1})=1$, then θ may be

(A) $\frac{\pi}{64}$
(B) $\frac{\pi}{256}$
(C) $\frac{\pi}{33}$
(D) $\frac{\pi}{31}$

3. If $h(x)=f(x)+g(1-x)$ is an increasing function from $[0,\ \infty)$ to $[0,\ \infty)$ such that $g'(1-x)=f''(x)$ and $f'(0)=0$, then

(A) $g'(1-x)\le 0$ for $x\ge 0$
(B) $g'(1-x)\ge 0$ for $x\ge 0$
(C) $g'(1-x)\le 0$ for $x\le 0$
(D) $g'(1-x)\ge 0$ for $x\le 0$

4. If $f(x)=x+1$, $g^{-1}(x)=x^3+x+1$ and $g(f(x))=h(x)$, then $\lim\limits_{x\to 1}\frac{h^{-1}(x)-h^{-1}(1)}{x-1}$ is equal to

(A) 2
(B) 4
(C) 1
(D) 8

5. If $f(x)=\tan x+\tan^2 x\tan 2x$ and $g(n)=\sum\limits_{r=0}^{r=n} f(2^r)$, then $g(2013)-\tan\left(2^{2014}\right)$ is equal to

(A) 0
(B) $\tan 1$
(C) $-\tan 1$
(D) 1

Space for rough work

6. If XY-plane is rotated about origin by an angle α in a.c.w. manner $\left(0 < \alpha < \frac{\pi}{2}\right)$, then the equation of line $\frac{x}{a} + \frac{y}{b} = 1$ is changed by $x\cos\alpha + y\sin\alpha = p$. Then, correct statement is

(A) $a = p\cos\alpha$, $b = p\sin\alpha$ (B) $a = p\sec\alpha$, $b = p\operatorname{cosec}\alpha$

(C) $\sqrt{\frac{1}{p^2} + \frac{2}{ab}} = \left|\frac{1}{a} + \frac{1}{b}\right|$ (D) $\frac{2}{p^2} = \frac{1}{a^2} + \frac{1}{b^2}$

7. If $y = \cfrac{x}{x^2 + \cfrac{x}{x^2 + \cfrac{x}{x^2 + ...\infty}}}$ and $\int \frac{\left(y - x^2\right)dx}{\left(x^2 + y\right)\left(x + y^2\right)} = f\left(y\right) + c$, then f′(y) for $x = 1$ is equal to

(A) 1 (B) $\frac{\sqrt{5} - 1}{2}$

(C) $\frac{\sqrt{5} + 1}{2}$ (D) $\frac{2 - \sqrt{5}}{2}$

8. Suppose f and g are functions having second derivatives f" and g" everywhere, if f(x) g(x) = 1 for all x and f ' (x) and g' are never zero, then $\frac{f''(x)}{f'(x)} - \frac{g''(x)}{g'(x)}$ equals

(A) $\frac{f'(x)}{f(x)}$ (B) $2\frac{f'(x)}{f(x)}$

(C) $-\frac{2g'(x)}{g(x)}$ (D) $-\frac{2f'(x)}{f(x)}$

9. Let A be the point of intersection of the curve $y = \log_{\frac{1}{3}}\left(x - \frac{1}{3}\right) + \log_3 \sqrt{9x^2 - 6x + 1}$ and the circle $x^2 + y^2 = 17$. B is also a point on the curve but lies inside the given circle such that its abscissa is an integer, then max {AB} is

(A) 2 units (B) 3 units

(C) 4 units (D) none of these

10. If S_n denotes the sum of first n terms of an AP and $a_n = \frac{S_{3n}}{S_{2n} - S_n}$, then $\underset{n\to\infty}{\text{Lt}} \sum_{r=1}^{2n} \frac{a_r}{n}$ is equal to

(A) 2 (B) 4

(C) 6 (D) 8

Space for rough work

Comprehension type (Only One Option Correct)

This section contains **3 paragraphs**, each describing theory, experiments, data etc. Six questions relate to the three paragraphs with **two questions on each paragraph**. Each question has **only one** correct answer among the four given options (A), (B), (C) and (D).

Paragraph for Question Nos. 11 to 12

Read the following write up carefully and answer the following questions:

$$\int_a^b f(x)d(\alpha(x)) - \int_a^b \alpha(x).d(f(x)) = \alpha(b)f(b) - \alpha(a).f(a)$$

11. $\int_0^6 (x^2 + [x])d(|3 - x|)$ (where [.] denotes greatest integer function) is equal to

(A) 126	(B) 63
(C) 72	(D) 36

12. $\int_{-2}^{3} [|x|]d(|x|)$, (where [.] denote greatest integer function) is equal to

(A) 1	(B) 2
(C) 4	(D) none of these

Paragraph for Question Nos. 13 to 14

Read the following write up carefully and answer the following questions:
Let f(x, y) be defined $\forall$ x, y ϵ N such that

(i) $f(x, x+1) = \frac{1}{3}$, $\forall$ x ϵ N

(ii) f(x, y) = f(x, z) + f(z, y) – 2f(x, z) f(z, y), for all z such that x < z < y; x, y, z ϵ N

13. $\lim\limits_{n\to\infty}$ f(1, n) is equal to

(A) 0	(B) $\frac{1}{2}$
(C) $\frac{2}{3}$	(D) $\frac{1}{3}$

14. f(2, 5) is equal to

(A) $\frac{13}{27}$	(B) $\frac{8}{27}$
(C) $\frac{1}{27}$	(D) $\frac{1}{3}$

Space for rough work

Paragraph for Question Nos. 15 to 16

Read the following write up carefully and answer the following questions:

Locus of the centre of a circle touching the circle $x^2 + y^2 - 4y - 2x = \frac{7}{4}$ internally and tangents on which from (1, 2) is making an angle 60° with each other is director circle (*C*) of a variable ellipse E. On this basis given answers to the following questions

15. The equation of the director circle (C) is

(A) $(x-2)^2+(y-1)^2=\sqrt{3}$
(B) $(x-1)^2+(y-2)^2=3$
(C) $(x+1)^2+(y-2)^2=\sqrt{3}$
(D) $(x-1)^2+(y+2)^2=3$

16. Locus of focus of variable ellipse (E) when major axis is parallel to x-axis, is

(A) $\left\{(x, y)/\sqrt{\frac{3}{2}}<|x-1|<\sqrt{3} \text{ and } y=2\right\}$
(B) $\{(x, y)/0<|x|<\sqrt{3} \text{ and } y=2\}$
(C) $\{(x, y)/0<|x+1|<\sqrt{3} \text{ and } y=2\}$
(D) $\left\{(x, y)/\sqrt{\frac{3}{2}}<|x-1|<\sqrt{3} \text{ and } y=2\right\}$

(Match List Type)

This section contains **4 multiple choice questions.** Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

17. Match the following List-I with List-II

	List – I	List – II	
(P)	If $f(x)=\int_{\pi/3}^{x}\frac{\sin t}{t}dt$ for $\frac{\pi}{2}\le x\le\pi$, then $\frac{\pi}{2}f\left(\frac{\pi}{2}\right)-\int_{\pi/3}^{\pi/2}f(x)dx$	1.	$\frac{2}{3}$
(Q)	If $x+y+z=4$ and $x^2+y^2+z^2=6$, then least value of x is	2.	2
(R)	If all the two digit numbers from 19 to 92 are written consecutively to form the number N = 19202122……9192, the largest power of 3 that divides N is	3.	$\frac{1}{2}$
(S)	If $z\in C$ such that $\lvert z-1\rvert+\lvert z+3\rvert\le 8$, then minimum value of $\frac{1}{\sqrt{3}}\lvert z+1\rvert$ is equal to	4.	1

Codes:

	P	Q	R	S
(A)	3	1	4	2
(B)	1	2	3	4
(C)	4	3	2	1
(D)	3	1	2	4

Space for rough work

18. Match the following List-I with List-II

List – I		**List – II**	
(P)	If the expression $\sin^2(\theta) + \sin^2(120° + \theta) + \sin^2(120° - \theta)$ remains constant, $\forall \theta \in R$, then the value of the constant is	1.	$\frac{2}{3}$
(Q)	If the sum of the solutions of the equation $2e^{2x} - 5e^{x} + 4 = 0$ is ln k then k equals	2.	1
(R)	If $\frac{\tan\theta}{\tan\theta - \tan 3\theta} = \frac{1}{3}$, find the value of $\frac{\cot\theta}{\cot\theta - \cot 3\theta}$	3.	$\frac{3}{2}$
(S)	If 3 $\tan(\theta - 30°) = \tan(\theta + 120°)$ then the value of $\cos 2\theta$ equals	4.	2

Codes:

	P	Q	R	S
(A)	4	3	2	1
(B)	3	4	1	2
(C)	3	4	2	1
(D)	1	2	3	4

19. Match the following List-I with List-II

List – I		**List – II**	
(P)	The distance of the point of intersection of the planes $\vec{r}\,.(2\hat{i} + \hat{j}) = 0$, $\vec{r}\,.(4\hat{j} + 3\hat{k}) = 24$, and $\vec{r}\,.(12\hat{i} - 7\hat{k}) = 24$ from the origin	1.	256
(Q)	The value of λ such that the planes $x - 2y - z = 10$, $3x + 3y + \sqrt{\lambda}\, z = 8$ and $2x - y + 2z = k$ are not able to make faces of a tetrahedron	2.	36
(R)	The product of distances of any vertex from the remaining vertices of a nine-sided regular polygon inscribed in a circle or radius $\sqrt{2}$ units	3	81
(S)	If on the complex plane the numbers $72 + 56i\sqrt{3}$, $a + b\, i\sqrt{3}$ (a, b $\in$ R, b > 0) and 0 represent vertices of an equilateral triangle then the value of $(a + b)^2$	4.	144

Codes:

	P	Q	R	S
(A)	2	3	1	4
(B)	1	2	3	4
(C)	4	3	2	1
(D)	2	3	4	1

Space for rough work

20. Match the following List-I with List-II

List – I		List – II	
(P)	If angles A, B of ΔABC are roots of equation $\sqrt{3}\tan^2\frac{\theta}{2} - \sqrt{3}\lambda\tan\frac{\theta}{2} + (\sqrt{3} - \lambda) = 0$, then C can $\left(\frac{2}{\sqrt{3}} < \lambda < \sqrt{3}\right)$ be equal to	1.	$\frac{\pi}{6}$
(Q)	If $\frac{\sin A}{A} > \frac{2}{\pi}$ where A is a angle of ΔABC then A cannot be	2.	$\frac{\pi}{3}$
(R)	In a ΔABC if $\sin A\cos B + \cos A\sin B\sin C = 1$, then angle C can be	3.	$\frac{\pi}{2}$
(S)	If $16\cos^4 x + k^2 - 2k = 8\cos^2 x - 2$ then possible values of $\frac{\pi k}{6}$ is	4.	$\frac{2\pi}{3}$

Codes:

	P	Q	R	S
(A)	1	2	3	4
(B)	2	4	3	1
(C)	2	4	1	3
(D)	4	3	2	1

Space for rough work

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Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	B	B
2.	D	A	C
3.	B	B	A
4.	D	C	B
5.	B	C	C
6.	B	D	C
7.	A	C	C
8.	D	A	B
9.	B	A	B
10.	C	A	C
11.	B	C	B
12.	C	D	B
13.	D	D	B
14.	A	A	A
15.	D	B	B
16.	C	C	D
17.	D	C	A
18.	B	D	B
19.	B	C	D
20.	C	D	B

Physics

PART – I

SECTION – A

1. $hv = 13.6\,(3)^2 \left[\frac{1}{4^2} - \frac{1}{5^2}\right] = 2.75$ eV

for $n = 4$ to $n = 3$

$hv = (13.6) \times (3)^2 \left[\frac{1}{3^2} - \frac{1}{4^2}\right] = 5.95$ eV

for shorter wavelength

$3.95 = 5.95 - \phi \Rightarrow \phi = 2\text{eV}$

for longer wavelength $eV_S = 2.75 - 2 = 0.75$ eV.

2. If $F = 0$

Then assuming no relative motion acceleration of $A + B = \frac{300}{15} = 20\ \text{m/s}^2$

$\Phi 20\ \text{m/s}^2 > \mu g$

where $\mu = 0.5$ and $g = 10\ \text{m/s}^2$

$\therefore$ relative motion shall exist. Hence $F = 0$ N.

3. The electrostatic force on proton is along positive x-axis and the magnetic force is along negative x-axis. Initially net force on charge q is zero. Since the velocity of proton is increased in repeat experiment, the magnetic force on proton shall increase and the proton would then be deflected in negative x-direction.

4. The reference potential at point A and B be o and x respectively.

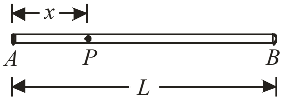
Applying Kirchoff laws

$$\frac{20 - x}{R_1} + \frac{10 - x}{R_2} + \frac{0 - x}{R_3} = 0$$

or $x = 10$ V thus $i = 0$.

6. The electric field of the negatively charged sphere is not entirely canceled inside the dielectric. This field points toward the sphere and so a positive particle placed inside the dielectric would tend to move toward the sphere. This means that the potential on the negative side of the dielectric is higher than that on the positive side.

7. The KE of given section AP and PB will be equal if MI of each section AP and section PB about A is same.



$I_{AP} = (\lambda x)\frac{x^2}{3}$ $I_{PB} = I_{AB} - I_{AP} = (\lambda L)\frac{L^2}{3} - (\lambda x)\frac{x^2}{3}$

$\therefore\ I_{AP} = I_{PB} \Rightarrow \frac{\lambda x^3}{3} = \frac{\lambda L^3}{3} - \frac{\lambda x^3}{3}$

or $x^3 = \frac{L^3}{2}$ or $x = \frac{L}{2^{1/3}}$

8. For first & second position $\frac{-y}{x} = \frac{I_1}{O}$, $\frac{-x}{y} = \frac{I_2}{O}$

$\Rightarrow \frac{y^2}{x^2} = \frac{I_1}{I_2} = 4$

$\Rightarrow \frac{y}{x} = 2$ and $y + x = 96$

$\Rightarrow y = 64,\ x = 32$

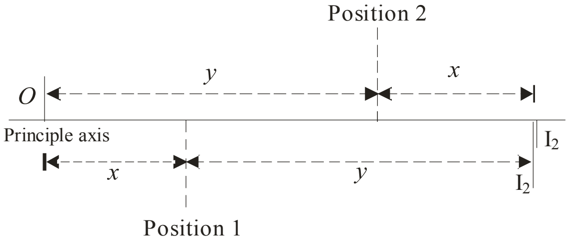
$\frac{O}{I_2} = \left|\frac{-y}{x}\right| = 2 \Rightarrow$ *A* is True

Distance between two position of lens = $y - x = 32$ cm $\Rightarrow$ *B* is True

Focal length of lens $f = \frac{xy}{x+y} = \frac{64 \times 32}{64 + 32}$

$= \frac{64}{3} \Rightarrow$ *C* is True

Distance of lens from shorter image = $x = 32$ cm $\Rightarrow$ *D* is True



9. $N_A = N_0 e^{-\lambda t}$

$\frac{dN_B}{dt} = \lambda N_A - \lambda N_B$

$e^{\lambda t}\left(\frac{dN_B}{dt} + \lambda N_B\right) = \lambda N_0 e^{-\lambda t} \cdot e^{\lambda t}$

$e^{\lambda t} \cdot N_B = \lambda N_0 \cdot t$

$N_B = \lambda N_0 t e^{-\lambda t}$

$\frac{dN_B}{dt} = \lambda N_0 \left[e^{-\lambda t} - \lambda e^{-\lambda t} t\right]$

If $\frac{dN_B}{dt} = 0$ then $(N_B)_{\text{maximum}}$ i.e. at $t = \left(\frac{1}{\lambda}\right)$

$-\frac{dN_A}{dt} = \lambda N_0 e^{-\lambda t}$

$\frac{d^2N_B}{dt^2} = \lambda N_0\left[-\lambda e^{-\lambda t} - \lambda e^{-\lambda t} + \lambda^2 e^{-\lambda t} \cdot t\right] = 0$ for $\frac{dN_B}{dt}$ to be maximum

That is $t = \frac{2}{\lambda}$ activity of *A* and *B* will be same

12. $\alpha t \cos\theta \le \mu_S N$ for no relative motion

$\alpha t \cos\theta \le \frac{3}{4}(10 - \alpha t \sin\theta)$

$\alpha t(\cos\theta + \frac{3}{4}\sin\theta) \le 0$

$t_1 = \frac{10}{4\cos\theta + 3\sin\theta}$ to start motion

$t_{\min} = \frac{10}{5}$ as $(4\cos\theta + 3\sin\theta)_{\max} = 5$ for $\theta = 37°$

$a = \alpha t\cos\theta - \mu_k(10 - \alpha t\sin\theta) = \alpha t(\cos\theta + \mu_S\sin\theta) - \mu_k 10$

$$v = \left|\frac{\alpha t^2}{2}(\cos\theta + \mu_k\sin\theta) - \mu_k 10t\right|_{t_1}^{t_2}$$

$$v = \left[\frac{\alpha(t_2^2 - t_1^2)}{2}(\cos\theta + \mu_k\sin\theta) - \mu_k 10(t_2 - t_1)\right]$$

$$= \frac{(t_2 - t_1)}{2}[\alpha(t_1 + t_2)(\cos\theta + \mu_k\sin\theta) - 2\mu_k 10]$$

$$= \frac{\left(\frac{50}{9} - 2\right)}{2}\left[3\times\left(\frac{50}{9} - 2\right)\left(\frac{4}{5} + \frac{1}{3}\times\frac{3}{5}\right) - \frac{20}{3}\right]$$

$$= \frac{16}{9}\left[\frac{68}{3}\times 1 - \frac{20}{3}\right]$$

$$= \frac{16}{9}\times\frac{48}{3} = \frac{928}{27}$$

$$V = \frac{256}{9}\text{ m/s}$$

$\alpha t_2\sin\theta = 10$

$$t_2 = \frac{10}{\alpha\sin\theta} = \left(\frac{50}{9}\right)$$

$t_1 = 2$

14. $I_{rms}(X_L^2 + R^2)^{1/2} = 300 = I_{rms}(X_C^2 + R^2)^{1/2}$

give $X_C = X_L$

so $I_{rms} = \frac{\varepsilon_{rms}}{2R} \Rightarrow 10 = \frac{200}{2R} \Rightarrow R = 10\ \Omega$

$X_C^2 + 10^2 = 30^2$

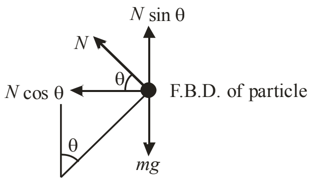
$X_C = 20\sqrt{2}\ \Omega$

so $V_{C\max} = I_{\max}\cdot X_C$

$= 10\sqrt{2}\times 20\sqrt{2}$

$= 400$ volt

16. $N\sin\theta = mg$



$\Rightarrow N\cos\theta = \frac{mv^2}{R}$

$\tan\theta = \frac{gR}{v^2} = v = \sqrt{gR\cot\theta}$

$v = \sqrt{gh}$ as h increases v increases.

$T = \frac{2\pi R}{v} = \frac{2\pi h\tan\theta}{\sqrt{gh}} = 2\pi\tan\theta\sqrt{\frac{h}{g}}$ as θ increases T increases.

17. 3y defination

18. By NLM

$N\sin\theta = 4\,ma_4$ ...(1)

$3mg - N\cos\theta - T_1 = 3\,ma_2$ ...(2)

$T_1 - T_2\cos 60 = 2\,ma_2$ ...(3)

$T_2 - mg = ma_1$ ...(4)

$a_3 = a_4 = a_2$

$a_2\cos 60 = a_1$

$$b = mg + \frac{5mg}{37} = \frac{42mg}{37}$$

$$3mg - N\cos\theta - \frac{mg}{2} = \frac{21ma}{4}$$

$$\frac{5mg}{2} = \frac{37\,ma}{4}$$

$$a = \left(\frac{10g}{37}\right)$$

$$\text{So, } T_2 - \frac{mg}{2} = 2mg + \frac{mg}{2} = \frac{9ma_2}{4}$$

19. $\Delta f_A = 0$

$$\Delta f_B = \frac{2v_0}{c - v_s} f_0 = \frac{2\times 10}{300} \times 3000 = 200\,\text{Hz}$$

$$\Delta f_C = \frac{2cv_s}{c^2 - v_s^2} f_0 = \frac{2\times\times 350\times 50}{400\times 300} \times 3000 = 875\,\text{Hz}$$

$$\Delta f_D = = \frac{360\times 2\times 50}{400\times 300} \times 3000 = 900\,\text{Hz}$$

20. $\int df = \int E\lambda R d\theta \cos\theta$

$R = \lambda RE\left(= \sin\theta\right]$

$= 2\lambda RE$

$t = \int E\lambda R d\theta . R\sin\theta$

$$= E\lambda R^2 \left(-\cos\theta\right]_{\left(\frac{\pi}{2}-\alpha\right)}^{\frac{\pi}{2}+\alpha}$$

$$= E\lambda R^2\left[-\cos\left(\frac{\pi}{2}+\alpha\right) - \left(-\cos\left(\frac{\pi}{2}-\alpha\right)\right)\right]$$

$$t_{net} = E\lambda R^2\left(2\sin\alpha\right]$$

$$\frac{MR^2}{2}\beta = -2E\lambda^2\alpha$$

$$\beta = \left(-\frac{2E\lambda^2}{MR^2}\right)\alpha$$

$$w = \sqrt{\frac{4EA}{m}}$$

$$w = 2\lambda ER^2\int_0^{\alpha}\sin\alpha d\alpha = td\alpha$$

$$w = 2\lambda ER^2\left(1 - \cos\alpha\right]$$

Chemistry

PART – II

SECTION – A

1. Hyponitrous acid is hydrate of nitrous oxide.

2. As most liquids follow Trouton's rule which provides constant value of $\Delta S^{o}_{vap} \approx 90$ J/K.

So $K_b = \frac{RMT_0^2}{1000 \times \Delta H_V^0} = \frac{RMT_0}{1000 \times \Delta S_V^0}$

as R and ΔS_V^0 are constant so K_b is proportional to MT_0 (T_0 increases along with M) while, ΔS_f^0 may vary with a good deal particularly when M is very high.

3. $2Fe^{3+} + Fe \longrightarrow 3Fe^{2+}$, $\Delta G° = -ve \because E^{o}_{cell} = +ve$

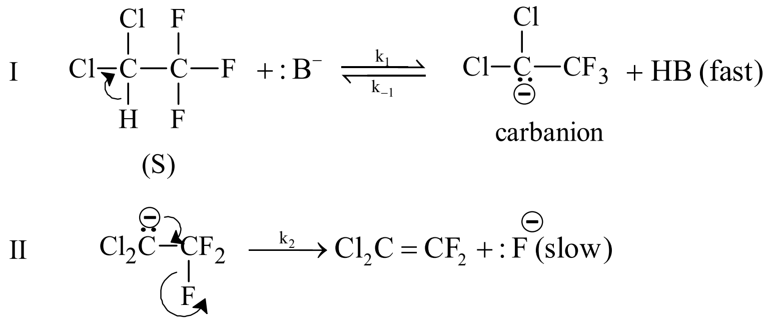
4. $p_{NO_2} = \frac{8 \times 10^5}{10^6} \times 10 = 8$ atm, $\therefore p_{N_2O_4} = 2$ atm

$K_p = \frac{p^2_{NO_2}}{p_{N_2O_4}} = \frac{8^2}{2} = 32$ atm

$K_c = \frac{32}{0.0821 \times 400} = 0.974$ mol L^{-1}

($\Delta n_g = 1$)

6.



Rate = k_2 [Carbanion]
Also,

$K_c = \frac{k_1}{k_{-1}} = \frac{[Carbonion][HB]}{[S]\,[:B^-]}$

$\therefore$ [Carbanion] = $\frac{k_c[S][B^-]}{[HB]}$, so

Rate = $k_2k_c\frac{[S][B^-]}{[HB]}$ Rate $\propto [S]\,[B^-]\,[HB]^{-1}$

7. $Fe_2O_{3(s)} + 3CO(1\text{ atm}) \longrightarrow 2Fe_{(s)} + 3CO_2\ (1\text{ atm})$,
ΔG_{25^oC} given for reaction is $\Delta G^o_{25^oC}$ as all the species are in their standard states.
So, for the reaction
$2Fe_{(s)} + 3CO_2\ (2\text{ atm}) \longrightarrow Fe_2O_{3(s)} + 3CO\ (20\text{ atm})$,
$\Delta G^o_{25^oC}$ will be equal to + 10 kJ

$$Q = \frac{P_{CO}^3}{P_{CO_2}^3} = \frac{(20)^3}{2^3} = 10^3$$

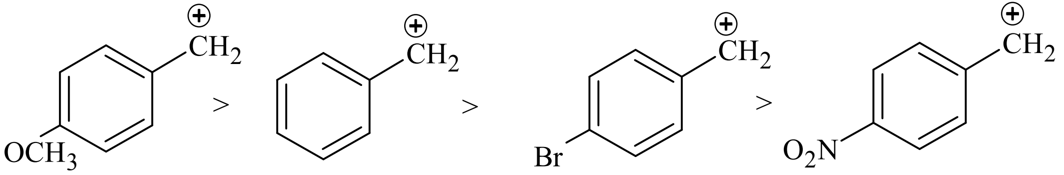
$\Delta G = \Delta G° + 2.303\ RT \log Q$

$= 10 + 2.303 \times 8.314 \times 10^{-3} \times 298 \log 10^3$

$= 10 + 17.11$

$= 27.11$ kJ

8. Substitution of —OH by Br atom takes place by carbocationic intermediate formation in rds. The stability of carbocation involved is as follows:


⊕
CH2
>
OCH3
⊕
CH2
>
⊕
CH2
>
Br
⊕
CH2
O2N

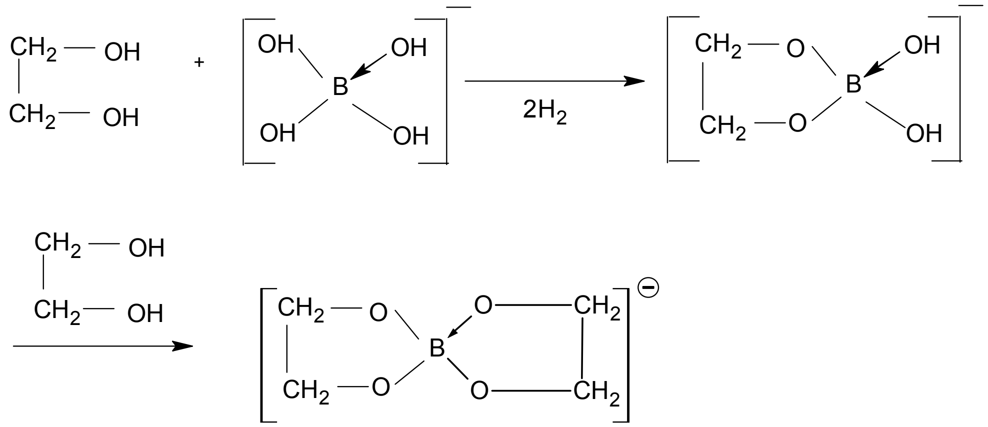
9. $Sc_2Si_2O_7$ is a pyrosilicate

Silicates containing $Si_2O_7^{6-}$ ios are pyrosilicate

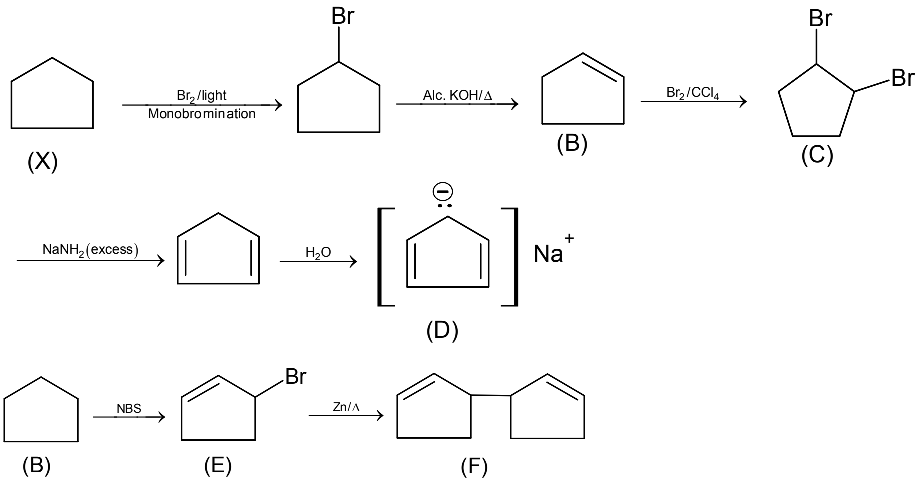
Zn_2SiO_4 orthosilicate

$Ca_3Si_3O_9$ and $Be_3Al_2Si_6O_{18}$ are cyclic silicates

10. $B(OH)_3 + H_2O \rightleftharpoons B(OH)_4^- + H^+$


CH2 — OH
CH2 — OH
+
OH
OH
B
OH
OH
2H2
CH2 — O
OH
B
CH2 — O
OH
CH2 — OH
CH2 — OH
CH2 — O
O
CH2
B
CH2 — O
O
CH2
⊖

11.


Br2/light
Monobromination
Br
Alc. KOH/Δ
Br2/CCl4
Br
Br
(X)
(B)
(C)
NaNH2(excess)
H2O
⊖
Na+
(D)
NBS
Br
Zn/Δ
(B)
(E)
(F)

13. As it suffers loss in weight with H_2SO_4, ionization sphere contains H_2O molecule. As complex also gives white ppt. with $AgNO_3$, the ionization sphere should contain Cl^- ion. So formula of the complex may be $[CoBrCl(en)_2]Cl.H_2O$.

14. Only one Cl^- ion is ionisable from the complex. So, 1 mole of complex will generate half mole of $PbCl_2$ precipitate.

15. Equilibria shown for bulb –I is a mix of

$$A_{(s)} \xrightleftharpoons{\text{Decomosition}} P_{(g)} + H_2S_{(g)} \qquad K_p = 4^2 = 16$$

$$A_{(s)} \xrightleftharpoons{\text{Sub lim ation}} A_{(g)} \qquad K_p = 2$$

16.

$$\begin{matrix} A_{(s)} \xrightleftharpoons{\text{Decomosition}} & P_{(g)} & + & H_2S_{(g)} & \qquad K_p = 16 \\ & x & & x & \end{matrix}$$

$$\begin{matrix} B_{(s)} \xrightleftharpoons{\text{Decomosition}} & Q_{(g)} & + & H_2S_{(g)} & \qquad K_p = 25 \\ & y & & y & \end{matrix}$$

$$16 = x(x+y), \qquad 25 = y(x+y)$$

$$\text{Total pressure} = 2x + 2y + \text{V.P. of } A_{(g)} = 14.8\,\text{mm}$$

19. 2, 4–DNP test is given by aldehydes and simple ketones, Baeyer's test is used to identify C–C unsaturation and iodoform test is given by methyl ketones or alcohols containing $CH_3CH(OH)$– group. No condition for tautomerism in (D) and (D) but (A) can not give idoform test due to active methylene group.

Mathematics PART – III

SECTION – A

1. If $f(a) > f(a-h)$ and $f(a) > f(a+h)$ for $h > 0$ and $h \to 0$, then $x = a$ is a point of maxima

2. $$\cos\frac{x}{2}\cos\frac{x}{2^2}.........\cos\frac{x}{2^n} = \frac{\sin x}{2^n \sin\frac{x}{2^n}}$$

3. $$\because h'(x) = f'(x) - g'(1-x) \ge 0$$
$$\Rightarrow f'(x) - f''(x) \ge 0$$
$$\Rightarrow \frac{d}{dx}\left(e^{-x}f'(x)\right) \le 0$$
$\Rightarrow e^{-x}f'(x)$ is decreasing function
$\Rightarrow e^{-x}f'(x) \le e^{-0}f'(0)$ for $x \ge 0$
$$\Rightarrow f'(x) \le 0\ \forall x \ge 0$$
$$\therefore g'(1-x) \le 0\ \forall x \ge 0$$

4. $$f^{-1}(x) = x - 1$$
$$\Rightarrow h^{-1}(x) = x^3 + x$$
$$\therefore \frac{d}{dx}\left(h^{-1}(x)\right) = 3x^2 + 1$$

5. $$\because f(x) = \tan 2x - \tan x$$
$$\Rightarrow f\left(2^n\right) = \tan 2^{n+1} - \tan 2^n$$
$$\Rightarrow g(n) = \tan 2^{n+1} - \tan 1$$
$$g(2013) - \tan 2^{2014} = -\tan 1$$

6. Since distance from origin is unchanged
So, $p = \dfrac{1}{\sqrt{\dfrac{1}{a^2} + \dfrac{1}{b^2}}} \Rightarrow \dfrac{1}{p^2} = \dfrac{1}{a^2} + \dfrac{1}{b^2}$
$$\Rightarrow \frac{1}{p^2} + \frac{2}{ab} = \left(\frac{1}{a} + \frac{1}{b}\right)^2$$

7. $$y = \frac{x}{x^2 + y} \Rightarrow y^2 + x^2y - x = 0$$
$$\therefore \frac{dy}{dx} = \frac{-(2xy-1)}{\left(x^2 + 2y\right)} = \frac{-\left(2x \times \dfrac{x}{x^2+y} - 1\right)}{x^2 + y + y} = \frac{-\left(2x^2 - x^2 - y\right)}{\left(x^2 + y\right)\left(\dfrac{x}{y} + y\right)}$$

$$\frac{1}{y}\frac{dy}{dx}=\frac{-\left(x^2-y\right)}{\left(x^2+y\right)\left(x+y^2\right)}\Rightarrow\frac{d}{dx}(\ln y)=\frac{y-x^2}{\left(x^2+y\right)\left(x+y^2\right)}$$

$$\Rightarrow \ln y+c=\int\frac{\left(y-x^2\right)dx}{\left(x^2+y\right)\left(x+y^2\right)}$$

$\therefore f'(y)=\frac{1}{y}$ and for $x=1$, $y^2+y-1=0\Rightarrow y=\frac{-1+\sqrt{5}}{2}$

8. $\frac{f''(x)}{f'(x)}-\frac{g''(x)}{g'(x)}$ = $\frac{\frac{d}{dx}(f'(x)/g'(x))}{\frac{f'(x).g'(x)}{(g'(x))^2}}$ = $\frac{g'}{f'}.\frac{d}{dx}\left(\frac{f'}{g'}\right)=\frac{2f'(x)}{f(x)}[\because f(x).g(x)=1]$

9. y = $\log_{1/3}\left(x-\frac{1}{3}\right)+\log_3\sqrt{9x^2-6x+1}$ = $\log_{1/3}\left(x-\frac{1}{3}\right)+\log_3|3x-1|$ = 1

Since, $x>\frac{1}{3}$, maximum {AB} = 3

10. a_n = $\frac{\frac{3n}{2}\left[2a+(3n-1)d\right]}{\frac{2n}{2}\left[2a+(2n-1)d\right]-\frac{n}{2}\left[2a+(n-1)d\right]}=3;$

$\therefore \ \underset{n\to\infty}{\text{Lt}}\sum_{r=1}^{2n}\frac{1}{n}.3=6$

11. $\int_0^6\left(x^2+[x]\right)d|3-x|=\int_0^3\left(x^2+[x]\right)d(3-x)+\int_3^6\left(x^2+[x]\right)d(x-3)=-\int_0^3\left(x^2+[x]\right)dx+\int_3^6\left(x^2+[x]\right)$

$\Rightarrow\int_0^6\left(x^2+[x]\right)d|3-x|=-\int_0^3x^2dx+\int_3^6x^2dx-\int_0^3[x]dx+\int_3^6[x]dx$

$=-\frac{x^3}{3}\Big]_0^3+\frac{x^3}{3}\Big]_0^6-\int_0^3[x]dx+3\int_0^3[x+3]dx=-9+(72-9)-\int_0^3[x]dx+\int_0^3[x]dx+3\int_0^1 3dx$

= 72 – 18 + 9 = 72 – 9 = 63.

12. $\int_{-2}^3[|x|]d|x|=\int_{-2}^0[-x]d(-x)+\int_0^3[x]dx$

$=-\int_{-2}^0[-x]dx+\int_0^3[x]dx=\int_2^0[x]dx+\int_0^3[x]dx=\int_2^3[x]dx=2(3-2)=2$

13.-14. $f(1,n)=\frac{1}{3^{n-2}}f(1,2)+\frac{1}{3^{n-2}}+\frac{1}{3^{n-3}}+...+\frac{1}{3}=\frac{1}{2}\left(1-\left(\frac{1}{3}\right)^{n-1}\right)$

15. Let r and R be radius of required & given circle respectively & let centre is (h, k)

By given condition $\sqrt{(h-1)^2+(k-2)^2}$ = R – r

Now, $\frac{r}{AB}$ = sin 30°

r = AB/2 = (R – r)/2 (AB = R – r)

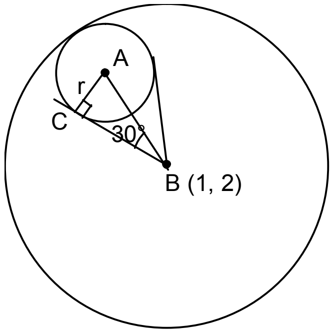
$\Rightarrow r = \frac{R}{3}$

$\Rightarrow \sqrt{(h-1)^2+(k-2)^2} = R - \frac{R}{3} = \frac{2R}{3}$

Now, R = $\frac{3\sqrt{3}}{2}$

$\Rightarrow \sqrt{(h-1)^2+(k-2)^2} = \frac{2}{3}\times\frac{3\sqrt{3}}{2} = \sqrt{3}$

$\therefore$ Locus is $(x - 1)^2 + (y - 2)^2 = 3$ which is C



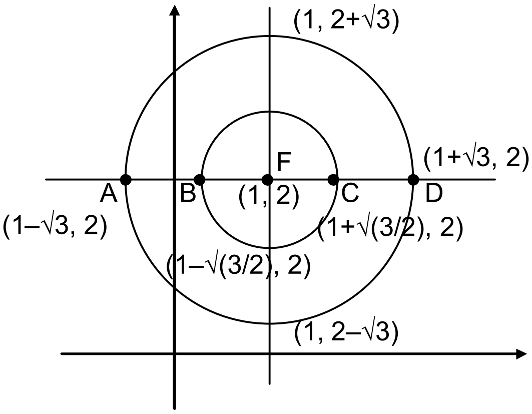
16. When major axis of ellipse (E) is parallel to x-axis then equation of E will be

$$\frac{(x-1)^2}{a^2}+\frac{(y-2)^2}{b^2}=1 \quad \text{.....(1)}$$

Such that $a^2 + b^2 = 3$

In this case one focus will lie in between F and D and other in between A and F.

i.e., $0 < |x-1| < \sqrt{3}$ and y = 2



17. (P) $\because xf(x) - \int f(x)dx = \int \frac{\sin x}{x}\times x dx$

(Q) $\because y + z = 4 - x$

and $y^2 + z^2 \geq \left(\frac{(y+z)^2}{2}\right)$

$\Rightarrow 6 - x^2 \geq \left(\frac{(4-x)^2}{2}\right)$

$\Rightarrow \frac{2}{3} \leq x \leq 2$

(R) Sum of digits in N = 705 is divisible by 3^1 but not 3^2

(S) Locus of z is an ellipse where a = 4 and $b = 2\sqrt{3}$

i.e. $|z+1|_{\min} = 2\sqrt{3}$

$\Rightarrow \frac{1}{\sqrt{3}}|z+1| = 2$

18. (P) LHS = $\sin^2\theta + 1 - [\cos^2(120° + \theta) - \sin^2(120° - \theta)]$

$= \sin^2\theta + 1 - [(\cos 240°)(\cos 2\theta)] = \sin^2\theta + 1 + \frac{1}{2}\cos 2\theta = \sin^2\theta + 1 + \frac{1}{2}\left(1 - 2\sin^2\theta\right) = \frac{3}{2}$

(Q) $2e^{2x} - 5e^x + 4 = 0$

Let roots be x_1 and x_2, product of the roots be

$e^{x_1} \cdot e^{x_2} = 2$, $e^{x_1 + x_2} = 2$

$x_1 + x_2 = \ln = 2$

(R) $a, b \in R$ $p_1 = p_2 = 4$ $3 \tan p_1 + p_2 = 8 = \tan p_1 p_2 = b^2 = 16$ $- \tan 3 p_2$

p_1 $2 \tan 16x^2 + 25y^2 = 400, + \tan 3\theta = 0 \Rightarrow \frac{\tan 3\theta}{\tan\theta} = -2$

Now $\frac{\cot\theta}{\cot\theta - \cot 3\theta} = \frac{1}{1 - \tan\theta - \cot 3\theta} = \frac{1}{1 - \frac{\tan\theta}{\tan 3\theta}} = \frac{1}{1 + \frac{1}{2}} = \frac{2}{3}$

Alternatively: Prove that $\frac{\tan\theta}{\tan\theta - \tan 3\theta} + \frac{\cot\theta}{\cot\theta - \cot 3\theta} = 1$ now proceed

(S) $\frac{2\sin(\theta - 30^0)}{2\sin(\theta + 120^o)} \cdot \frac{\cos(\theta + 120^o)}{\cos(\theta - 30^o)} = \frac{1}{3}$

$\frac{2\sin(2\theta - 90^0) - \sin 150^o}{\sin(2\theta + 90^o) + 150^o} = \frac{1}{3}$ or $\frac{\cos 2\theta - \frac{1}{2}}{\cos 2\theta + \frac{1}{2}} = \frac{1}{3}$ or $\frac{\cos 2\theta - \frac{1}{2}}{\cos 2\theta + \frac{1}{2}} = \frac{1}{3}$

$\Rightarrow 3\cos 2\theta - \frac{3}{2} = \cos 2\theta + \frac{1}{2}$

$2\cos 2\theta \Rightarrow \cos 2\theta = 1$

19. (P) $2x + y = 0$, $4y + 3z = 24$ and $12x - 7z = 24$. Solving we get the point intersection as $(-12, 24, -24)$ whose distance from origin is 36

(Q) For no unique solution $\Delta = 0 \Rightarrow \begin{vmatrix} 1 & -2 & -1 \\ 3 & 3 & \sqrt{\lambda} \\ 2 & -1 & 2 \end{vmatrix} = 0$

$\Rightarrow -1(-9) - \sqrt{\lambda}\,(3) + 2\,(9) = 0 \Rightarrow \sqrt{\lambda} = 9 \Rightarrow \lambda = 81$

(R) Let the centre be at origin and the vertex at $(\sqrt{2}, 0)$. The remaining vertices will be corresponding to the complex numbers $\sqrt{2}\alpha, \sqrt{2}\alpha^2, \sqrt{2}\alpha^3, \ldots, \sqrt{2}\alpha^8$ $\left(\alpha = \cos\frac{2\pi}{9} + i\sin\frac{2\pi}{9}\right)$.

The product of distances

$= |\sqrt{2} - \sqrt{2}\alpha||\sqrt{2} - \sqrt{2}\alpha^2| \ldots = (\sqrt{2})^8 |1 - \alpha||1 - \alpha^2| \ldots || - \alpha^8| = 16 \times 9 = 144$

(S) $a + b\sqrt{3}i = (72 + 56\sqrt{3}i) \,.\, e^{i\pi/3} = (36 + 28\sqrt{3}i)\,(1 + \sqrt{3}i)$

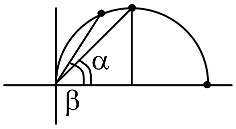
$\Rightarrow a = 36 - 84 = -48$, $b = 36 + 28 = 64$. $(a + b)^2 = 256$

20. (P) $\sqrt{3}\tan^2\frac{\theta}{2}-\sqrt{3}\lambda\tan\frac{\theta}{2}+(\sqrt{3}-\lambda)=0$

$$\cot\frac{c}{2}=\frac{\tan\frac{A}{2}+\tan\frac{B}{2}}{1-\tan\frac{A}{2}\tan\frac{B}{2}}=\frac{\lambda}{1-\left(1-\frac{\lambda}{\sqrt{3}}\right)}=\sqrt{3}$$

$$\Rightarrow C=\frac{\pi}{3}$$

(Q) Clearly from figure, $\tan\beta>\tan\alpha,\frac{\sin A}{A}>\frac{\sin\frac{\pi}{2}}{\frac{\pi}{2}}$ if $\left(A<\frac{\pi}{2}\right)$



(R) $\sin A\cos B+\cos A\sin B\sin C\le\sin A\cos B+\cos A\sin B$

$$\Rightarrow 1\le\sin(A+B)\Rightarrow\sin(A+B)=1\text{ or }C=\frac{\pi}{2}$$

(S) $16\left(\cos^2 x-\frac{1}{4}\right)^2+(k-1)^2=0$, $x=n\pi\pm\frac{\pi}{3}$

FIITJEE **JEE (Main), 2015**

FULL TEST – I

ALL INDIA TEST SERIES

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 03 and 10 to 12)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (04 to 09 and 13 to 30) contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant R = $8.314\ J\ K^{-1}\ mol^{-1}$
= 0.0821 Lit atm $K^{-1}\ mol^{-1}$
= $1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. A projectile is fired with velocity v at angle of θ with horizontal. What would be the radius of curvature of path at instant when rate of change of speed of projectile is minimum.

(A) $\frac{v^2\cos^2\theta}{g}$ (B) $\frac{v^2}{g\cos\theta}$

(C) $\frac{v^2\cos\theta}{g}$ (D) $\frac{v^2}{g\cos^2\theta}$

2. Position of particle is given by $x = t^3 - 4t^2 + 5t + 9$. What would be the distance travelled by particle from instant t = 0 to instant when particle changes its direction of velocity for last time.

(A) 1.85 m (B) 2.15 m

(C) 2m (D) 2.85 m

3. If a particle have velocity and acceleration given

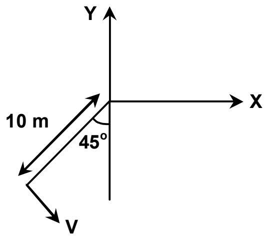
$\left(3\hat{i}+4\hat{j}\right)ms^{-1}, \left(4\hat{i}+3\hat{j}\right)ms^{-2}$ respectively.

What would be the rate of change of speed at that instant?

(A) 4.8 ms^{-2} (B) 5 ms^{-2}

(C) 3 ms^{-2} (D) 4 ms^{-2}

4. A ball of mass 1 kg attached with string of length 10 m is free to rotate in horizontal plane is subjected to constant force of $-\sqrt{2}\left(\hat{i}+\hat{j}\right)$N. What should be the velocity of projection at position shown in figure. Such that it complete full revolution.

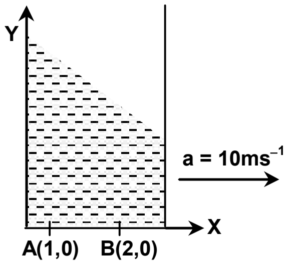


(A) 10 ms^{-1} (B) $2\sqrt{5}$ ms^{-1}

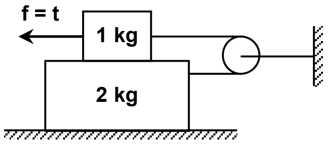
(C) $4\sqrt{5}$ ms^{-1} (D) 6 ms^{-1}

Space for Rough work

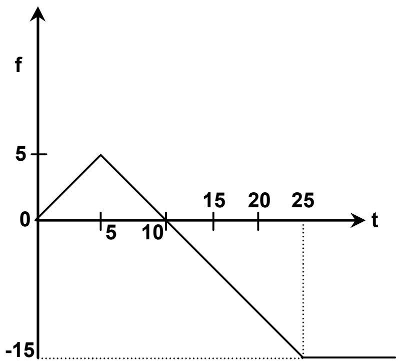
5. Fluid of density 10^3 kg/m^3 is kept in container. Container is moving with acceleration of 10 ms^{-2} find the magnitude of pressure difference between A and B as shown in figure.
(A) 10^4 (B) 0
(C) $\sqrt{2}\times 10^4$ (D) 2×10^4



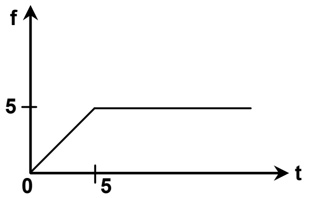
6. Coefficient of friction between all the surfaces is 0.5. Which diagram would describe the friction between ground and 2 kg block when f = t. N is applied on 1 kg block. It is given that string is not taut initially



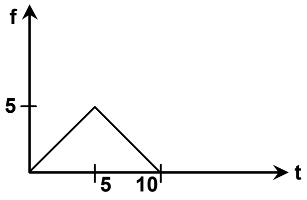
(A)



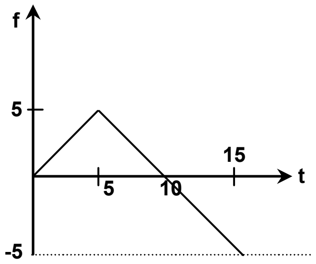
(B)



(C)

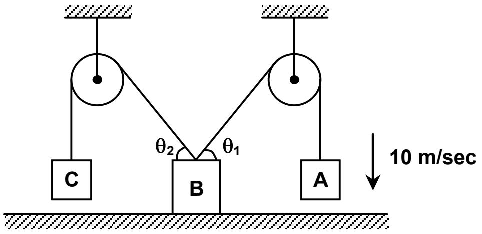


(D)



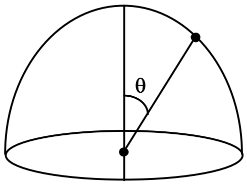
Space for Rough work

7. If v_A = 10 m/sec what would be the velocity of C. $\theta_1 = 30^0$, $\theta_2 = 60^o$. If B is very heavy and remains on ground.



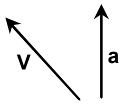
(A) $\frac{10}{\sqrt{3}}$ m/sec
(B) $10\sqrt{3}\ \text{ms}^{-1}$
(C) $10\ \text{ms}^{-1}$
(D) $5\sqrt{3}\ \text{ms}^{-1}$

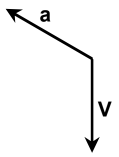
8. A ball of mass m kept at top slide freely on frictionless hemispherical surface. At what minimum angle θ net force acting on ball would be equal to mg

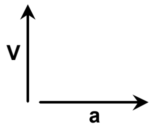


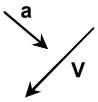
(A) $\cos^{-1}(2/3)$
(B) $\cos^{-1}(1/2)$
(C) 0^o
(D) 30^o

9. From the given velocity acceleration diagram identify in which case object is slowing and turning to the left.

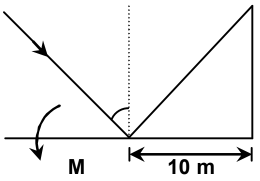
(A)


(B)


(C)


(D)


10. A light ray is incident on a plane mirror M. The mirror is rotated in direction as shown in figure by an arrows at frequency (9/π) revolution/sec. The light reflected by the mirror is received on the wall W at a distance of 10 m from axis of rotation. speed of the spot on wall when angle of incident = 37^o is



(A) 10 m/sec
(B) 1000 m/sec
(C) 360 m/sec
(D) 500 m/sec

Space for Rough work

11. A ray of light moving along the vector $\left(\hat{i}-2\hat{j}\right)$ undergoes refraction at an interference of two media which is x-z plane μ for y > 0 is 2 while Y < 0 it is $\frac{\sqrt{5}}{2}$. The unit vector along which the refracted ray moves is

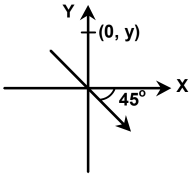
(A) $\frac{\left(-3\hat{i}-5\hat{j}\right)}{\sqrt{34}}$

(B) $\frac{-4\hat{i}-3\hat{j}}{5}$

(C) $\left(-\frac{3\hat{i}-4\hat{j}}{5}\right)$

(D) $\left(\frac{4\hat{i}-3\hat{j}}{5}\right)$

12. A dipole is placed at origin of co-ordinate system as shown in figure. Electric field at point P (0, y) is given as



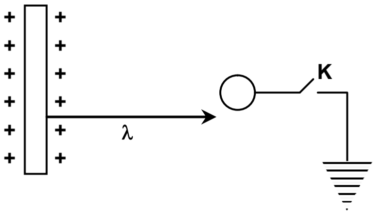
(A) $\frac{K\rho}{\sqrt{3}y3}\left(-\hat{i}-\hat{j}\right)$

(B) $\frac{K\rho}{y^3}\left(-\hat{i}+\sqrt{2}\hat{j}\right)$

(C) $\frac{K\rho}{y^3}\left(-\hat{i}-2\hat{j}\right)$

(D) $\frac{K\rho}{\sqrt{2}y^3}\left(-\hat{i}-2\hat{j}\right)$

13. Figure shows a large conducting sheet having charge density σ on both sheet. The surface potential of sheet is V_0. A sphere of radius r is placed at a distance λ (λ >> r) from the sheet. When the key is closed charge q appears on the surface. The values σ on sheet is given by



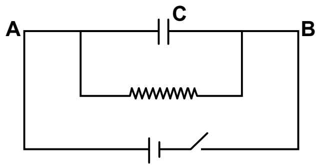
(A) $\left(\frac{q+4\pi\varepsilon_0 rV_0}{4\pi r\ell}\right)$

(B) $\left(\frac{4\pi\varepsilon_0 rV_0+q}{2\pi r\ell}\right)$

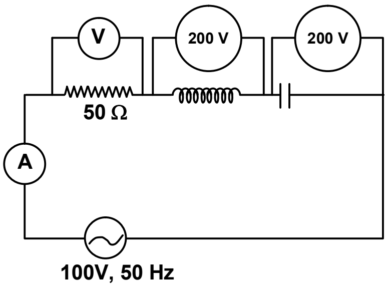
(C) $\left(\frac{4\pi\varepsilon_0 rV_0-q}{2\pi r\ell}\right)$

(D) Zero

Space for Rough work



14. The resistance between A and B of given circuit at t = 0 and t = ∞ will be (it the switch is closed at t = 0).
(A) ∞ at both t
(B) O at both t
(C) O and R respectively
(D) R at both t



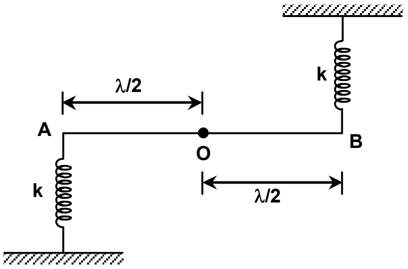
15. In series LCR circuit voltmeter and ammeter reading are
(A) V = 250 V, I = 4A
(B) V = 150 V, I = 2A
(C) V = 1000V, I = 5A
(D) V = 100 V, I = 2A

16. A radioactive substance X decays into another substance Y. Initially angle X was present. λ_x and λ_y are distingration constant of x and y. N_x and N_y are the number of nuclei of x and y at any time t. Number of nuclei N_y will be maximum when
(A) $\frac{N_y}{N_x - N_y} = \frac{\lambda_y}{\lambda_x - \lambda_y}$
(B) $\frac{N_x}{N_x - N_y} = \frac{\lambda_x}{\lambda_x - \lambda_y}$
(C) $\lambda_y N_y = N_x \lambda_x$
(D) $\lambda_x N_x = \lambda_x N_y$

17. A capillary tube is immersed vertically in water and the height of the water column is x. When this arrangement is taken into a mine of depth d, the height of the water column is y. If R is the radius of the earth, the ratio $\frac{x}{y}$ is
(A) $\left(1 - \frac{d}{R}\right)$
(B) $\left(1 + \frac{d}{R}\right)$
(C) $\left(\frac{R-d}{R+d}\right)$
(D) $\left(\frac{R+d}{R-d}\right)$

Space for Rough work

18. The ends of a rod of length λ and mass m are attached to two identical springs as shown in figure. The rod is free to rotate about its centre O. The rod is depressed slightly at end A and released. The time period of the resulting oscillation is



(A) $2\pi\sqrt{\frac{m}{2k}}$ (B) $2\pi\sqrt{\frac{2m}{k}}$

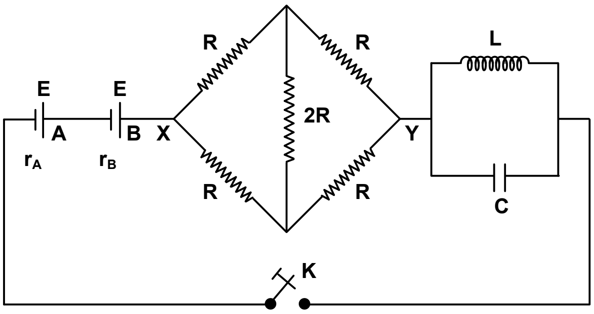
(C) $\pi\sqrt{\frac{2m}{3k}}$ (D) $\pi\sqrt{\frac{3m}{2k}}$

19. The period of oscillation of a simple pendulum of length L suspended from the roof of a vehicle which moves without friction down an inclined plane of inclination α, is given by

(A) $2\pi\sqrt{\frac{L}{g\cos\alpha}}$ (B) $2\pi\sqrt{\frac{L}{g\sin\alpha}}$

(C) $2\pi\sqrt{\frac{L}{g}}$ (D) $2\pi\sqrt{\frac{L}{g\tan\alpha}}$

20. In the circuit shown in figure, A and B are two cells of the same emf E and of internal resistances r_A and r_B respectively. L is an ideal inductor and C is an ideal capacitor. The key K is closed. When the current in the circuit becomes steady, what should be the value of R so that the potential difference across the terminals of cell A is zero



(A) $R = r_A - r_B$ if $r_A > r_B$

(B) $R = \sqrt{r_A r_B}$

(C) $R = \frac{1}{2}(r_A + r_B)$

(D) For no value of R will the potential difference between the terminals of cell A be equal to zero

Space for Rough work

21. A uniform metal rod is moving with a uniform velocity v parallel to a long straight wire carrying a current I. The rod is perpendicular to the wire with its ends at distance r_1 and r_2 (with $r_2 > r_1$) from it. The emf induced in the rod is

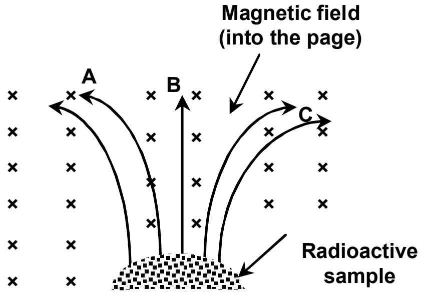
(A) Zero
(B) $\frac{\mu_0 Iv}{2\pi}\log_e\left(\frac{r_2}{r_1}\right)$
(C) $\frac{\mu_0 Iv}{2\pi}\log_e\left(\frac{r_1}{r_2}\right)$
(D) $\frac{\mu_0 Iv}{4\pi}\left(1-\frac{r_1}{r_2}\right)$

22. When a centimeter thick surface is illuminated with light of wavelength λ, the stopping potential is V. When the same surface is illuminated by light of wavelength 2λ, the stopping potential is V/3. The threshold wavelength for the surface is

(A) $\frac{4\lambda}{3}$
(B) 4λ
(C) 6λ
(D) $\frac{8\lambda}{3}$

23. The radiations emitted from a radioactive material separate into three distinct groups A, B and C when a magnetic field is directed into the plane of the paper. The names of radiations A, B and C, respectively, are (see figure)

(A) α, β and γ
(B) α, γ and β
(C) β, α and γ
(D) γ, α and β



24. The radioactivity of a sample is X at a time t_1 and Y at a time t_2. If the mean life of the specimen is τ, the number of atoms that have disintegrated in the time interval $(t_2 - t_1)$ is

(A) $X t_1 - Y t_2$
(B) $X - Y$
(C) $(X - Y)/\tau$
(D) $(X - Y)\tau$

25. A block of silver of mass 4 kg hanging from a string is immersed in a liquid of relative density 0.72. If relative density of silver is 10, then tension in the string will be: [Take $g = 10\ m/s^2$]

(A) 37.12 N
(B) 42 N
(C) 73 N
(D) 21 N

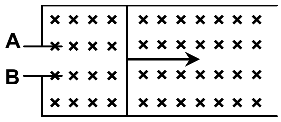
Space for Rough work

26. An electron is accelerated from rest through potential difference V. Then electron experience force f in uniform magnetic field on increasing the p.d. to v′ force became 2f. (V'/V) is equal to
(A) 1/4
(B) 2
(C) 1/2
(D) 4

27. Magnetic flux linked with a stationary loop of resistance R varies with time T as ϕ = at (T –t) amount of heat generated in loop during that time is:
(A) $\frac{aT}{3R}$
(B) $\frac{a^2T^2}{3R}$
(C) $\frac{a^2T^2}{R}$
(D) $\frac{a^2T^3}{3R}$

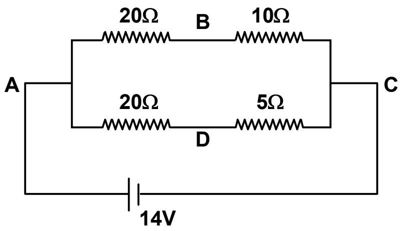
28. A large tank filled with water to height h is to be emptied through a hole at bottom ratio of time taken to value of water level from $\left(n \text{ to } \frac{n}{2}\right)$ & $\left(\frac{n}{2} \text{to } 0\right)$ is
(A) $\sqrt{2}$
(B) $\frac{1}{\sqrt{2}}$
(C) $\sqrt{2}-1$
(D) $\frac{1}{\sqrt{2}-1}$

29. A conductivity rod of length = 1.0 m is moving with uniform speed v = 20m/sec in field of 4.0T. C = 10 μt is connected as shown in figure



(A) q_A = +80 μC, q_B = –80 μC
(B) q_A = –80 μC, q_B = +80 μC
(C) q_A = –40 μC, q_B = + 40 μC
(D) q_A = +40 μC, q_B = –40 μC

30. What resistor should be connected in parallel with 20Ω resistor in ADC branch so that potential difference between B & D may be zero.



(A) 20 Ω
(B) 10Ω
(C) 5Ω
(D) 15Ω

Space for Rough work

Chemistry

PART – II

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. The Vander Waal's equation of corresponding states for 1 mole of gas is:
[Where P_c = critical pressure, T_c = critical temperature, V_c = critical volume]

$$\left[\pi = \frac{P}{P_c},\ \phi = \frac{V}{V_c} \text{ and } \theta = \frac{T}{T_c}\right]$$

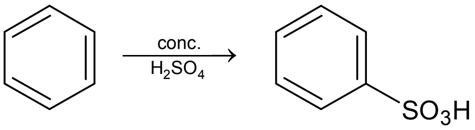
(A) $\left[\pi - \frac{3}{\phi}\right](3\phi - 1) = 8R\theta$
(B) $\left[\pi + \frac{3}{\phi}\right](3\phi - 1) = 8R\theta$
(C) $\left[\pi + \frac{3}{\phi}\right](3\phi + 1) = 8R\theta$
(D) $\left[\pi - \frac{\phi}{3}\right](3\phi - 1) = 8R\theta$

2. Given that $E^0_{Fe^{+2}|Fe} = -0.44V$; $E^0_{Fe^{+3}|Fe^{+2}} = 0.77$. If Fe^{+2}, Fe^{+3} and Fe solid are kept together then

(A) $\left[Fe^{+3}\right]$ increase
(B) $\left[Fe^{+3}\right]$ decrease
(C) Fe^{+2}/Fe^{+3} remain unchanged
(D) $\left[Fe^{+2}\right]$ decrease

Space for Rough work

3



Mark out the incorrect statement:
(A) Hexa deutarated benzene gets sulphonated slower than simple benzene
(B) Electrophile in the reaction is SO_3
(C) Dilution of acid during reaction promotes reversal (desulphonating)
(D) Polysulphonation is hard to proceed

4. To maintain the pH of 7.4 for blood at normal condition which is 2M in H_2CO_3 (at equilibrium). What volume of 5M $NaHCO_3$ solution is required to mix with 10ml of blood?
$K(H_2CO_3) = 7.8 \times 10^{-7}$
(A) 78.36 ml
(B) 102 ml
(C) 52.71 ml
(D) 89.01 ml

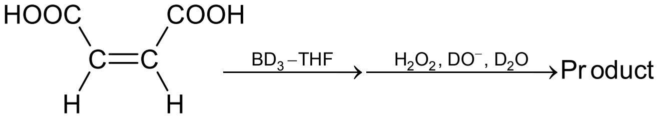
5. For fairly concentrated solution of a weak electrolyte A_xB_y, having concentration 'C' the degree of dissociation is given by:
(A) $\alpha = \sqrt{k_{eq}xy/c}$
(B) $\alpha = \sqrt{K_{eq}c/xy}$
(C) $\alpha = \sqrt{K_{eq}/c(x+y)}$
(D) $\alpha = K_{eq}/\left[c^{x+y-1}.x^x.y^y\right]^{1/x+y}$

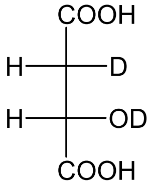
6. XeF_6 dissolves in anhydrous HF to give a good conductivity solution which contains:
(A) $H^{\oplus}$ and XeF_7^- ion
(B) HF_2^- and $XeF_5^{\oplus}$
(C) $HXeF_6^{\oplus}$ and F^- ion
(D) None

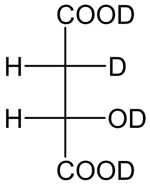
Space for Rough work

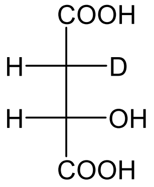
7. When the concentration of A is 0.1 M, it decomposes to give ‘x’ by a first order process with a rate constant of $6.93 \times 10^{-2}\text{min}^{-1}$. The reactant ‘A’ in the presence of catalyst gives ‘Y’ by a second order mechanism with a rate constant of $0.2\ \text{min}^{-1}\text{M}^{-1}$. In order that half life of both the process is 10 min. One should start the initial concentration of A as:
(A) 0.01M
(B) 5.0 M
(C) 10.0 M
(D) 0.5 M

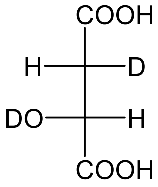
8. According to Arrhenius equation, the rate constant (K) and energy of activation (E) of a reaction are related by:
(A) $A = Ke^{-E/RT}$
(B) $K = Ae^{E/RT}$
(C) $K = Ae^{-E/RT}$
(D) $K = -Ae^{E/RT}$

9. 
HOOC
COOH
C=C
H
H
BD₃–THF
H₂O₂, DO⁻, D₂O
Product

(A) 
COOH
H
D
H
OD
COOH

(B) 
COOD
H
D
H
OD
COOD

(C) 
COOH
H
D
H
OH
COOH

(D) 
COOH
H
D
DO
H
COOH

10. In alkaline medium, H_2O_2 acts as an oxidising agent in its reaction with:
(A) $Cr_2(SO_4)_3$
(B) Ag_2O
(C) $K_3[Fe(CN)_6]$
(D) $K_2Cr_2O_7$

Space for Rough work

11.

(a)	KNO_2	(p)	$pH = \frac{1}{2}\left(pka + pka_2\right)$
(b)	$Ph\overset{\oplus}{N}H_2Cl^-$	(q)	$pH = \frac{1}{2}\left(pkw + pka - pkb\right)$
(c)	$NaHCO_3$	(r)	$pH = \frac{1}{2}\left(pkw - pkb - \log c\right)$
(d)	NH_4CN	(s)	$pH = \frac{1}{2}\left(pkw + pka + \log c\right)$

For abcd correct order of matching is
(A) pqrs
(B) qprs
(C) rspq
(D) srpq

12. In which of the following case, increase in concentration of ion cause increase in E_{cell}?
(A) $Pt(H_2)\,|\,H^{\oplus}(aq)$
(B) $Ag, AgCl\,|\,Cl^-(aq)$
(C) $Pt\,|\,\text{quinhydron}\,|\,H^-$
(D) $Ag\,|\,Ag^{\oplus}(aq)$

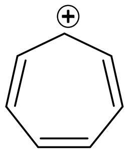
13. Mark out the correct order of nucleophilicity in DMF:
(A) $\overset{\ominus}{C}H_3 > \overset{\ominus}{O}H > \overset{\ominus}{N}H_2 > \overset{\ominus}{F} > \overset{\ominus}{I}$
(B) $\overset{\ominus}{C}H_3 > \overset{\ominus}{O}H > \overset{\ominus}{N}H_2 > \overset{\ominus}{I} > \overset{\ominus}{F}$
(C) $\overset{\ominus}{I} > \overset{\ominus}{F} > \overset{\ominus}{O}H > \overset{\ominus}{N}H_2 > \overset{\ominus}{C}H_3$
(D) $\overset{\ominus}{C}H_3 > \overset{\ominus}{N}H_2 > \overset{\ominus}{O}H > \overset{\ominus}{F} > \overset{\ominus}{I}$

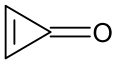
14. Mark out the right combination of cell and conditious for spontenety
(A) $\underset{P_1}{Pt(H_2)}\,|\,\underset{1M}{HCl}\,|\,\underset{P_2}{Pt(H_2)};\ P_1 > P_2$
(B) $Zn\,|\,Zn^{2+}(C_1)\,||\,Zn^{+2}(C_1)\,|\,Zn;\ C_1 > C_2$
(C) $Pt(Cl_2,\ 1\,atm)\,|\,Cl^-(C_1)\,||\,Cl^-(C_2)\,|\,Pt(Cl_2, 1\,atm);\ C_2 > C_1$
(D) $Pt(H_2,\ 1\,atm)\,|\,HCl(C_1)\,||\,HCl(C_2)\,|\,Pt(H_2), 1\,atm;\ C_1 > C_2$

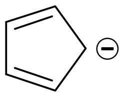
15. The dissolution of $Al(OH)_3$ by a solution of NaOH results in the formation of
(A) $[Al(H_2O)_4(OH)_4]^+$
(B) $[Al(H_2O)_3(OH)_3]$
(C) $[Al(H_2O)_2(OH)_4]^-$
(D) $[Al(H_2O)_6(OH)_3]$

Space for Rough work

16. Which of the following is polar and aromatic?

(A)


(B)


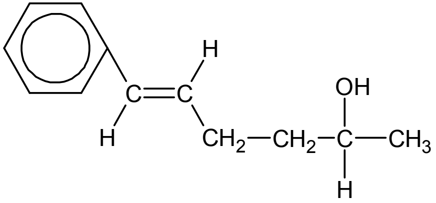
(C)


(D) None

17. The species that undergo disproportion in alkaline medium:

(A) Cl_2
(B) MnO_4^-
(C) HNO_3
(D) ClO_4^-

18. The compound, whose stereo chemical formula is written below, exhibits are geometrical isomers & y optical isomers



The value of x & Y are:

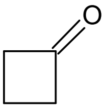
(A) 4 & 4
(B) 2 & 2
(C) 2 & 4
(D) 4 & 2

19. $Z-CH=CH_2 \xrightarrow{HBr} Z-CH_2-CH_2-Br$

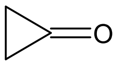
Which of the following is Z?

(A) —Cl
(B) $—SO_3H$
(C) $—OCH_3$
(D) $—CH_3$

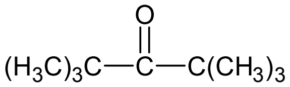
20. Rank the following in the order of increasing value of the equilibrium constant for hydration:



(I)



(II)



$(H_3C)_3C-\overset{\overset{\displaystyle O}{||}}{C}-C(CH_3)_3$

(III)

(A) I < II < III
(B) III < I < II
(C) II < I < III
(D) II < III < I

Space for Rough work

21. To a one liter solution of 0.1 N HCl, 0.025 mol of NH_4Cl are added. Assuming 80% dissociation of the solutes, the freezing point of the solution is (K_f = 1.85 deg/molal)
(A) –0.33°C
(B) –0.85°C
(C) –0.23°C
(D) –0.416°C

22. The suggested mechanism for reaction:

$$CHCl_3 + Cl_2 \longrightarrow CCl_4 + HCl$$

$$Cl_2 \underset{K_2}{\overset{K_1}{\rightleftharpoons}} 2Cl^{\bullet}$$

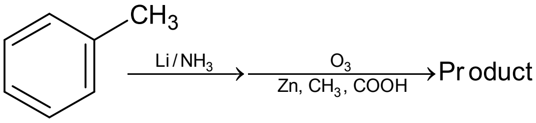
$$CHCl_3 + Cl^{\bullet} \xrightarrow{K_3} HCl + \overset{\bullet}{C}Cl_3\,(\text{slow})$$

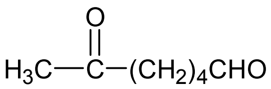
$$\overset{\bullet}{C}Cl_3 + \overset{\bullet}{C}l \xrightarrow{K_4} CCl_4$$

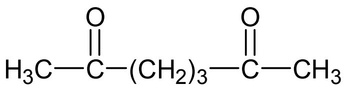
The experimental mechanism for reaction:
(A) $R = K_3[CHCl_3][Cl_2]$
(B) $R = K_3K_2[CHCl_3][Cl_2]^{1/2}$
(C) $R = K_3K_1[CHCl_3][Cl]$
(D) $R = K_3(K_{eq})^{1/2}[CHCl_3][Cl_2]^{1/2}$

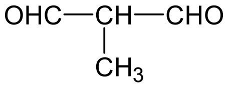
23. A catalyst increases the rate of reaction at 27°C by 10 times. By what amount it is decreasing E_a at the same temperature.
(A) 2 kJ/mol
(B) 1.3 kJ/mol
(C) 5.7 kJ /mol
(D) 21 kJ/mol

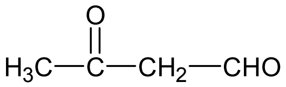
24.



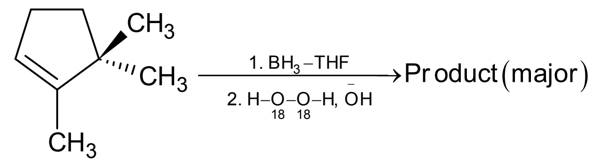
(A)

$H_3C-\overset{\overset{\displaystyle O}{\|}}{C}-(CH_2)_4CHO$

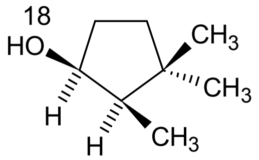
(B)

$H_3C-\overset{\overset{\displaystyle O}{\|}}{C}-(CH_2)_3-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$

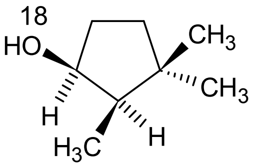
(C)

$OHC-\underset{\underset{\displaystyle CH_3}{|}}{CH}-CHO$

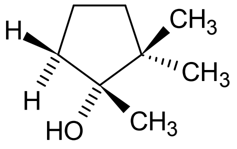
(D)

$H_3C-\overset{\overset{\displaystyle O}{\|}}{C}-CH_2-CHO$

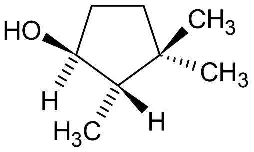
Space for Rough work

25. 
CH3
CH3
CH3
1. BH3-THF
2. H-O-O-H, OH
18 18
Product (major)

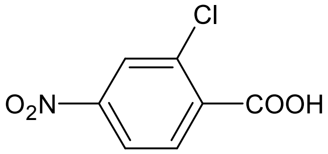
(A) 
18
HO
CH3
CH3
H
H
CH3

(B) 
18
HO
CH3
CH3
H
H3C
H

(C) 
H
CH3
CH3
H
HO
CH3

(D) 
HO
CH3
CH3
H
H3C
H

26. Which of the following is the best synthesis of 2-chloro-4-nitro benzoic acid?



(A) (i) Heat benzoic acid with $HNO_3 + H_2SO_4$
(i) Cl_2, $FeCl_3$, Δ
(B) (i) Toluene + ($HNO_3 + H_2SO_4$)
(ii) $K_2Cr_2O_7$, H_2O, H_2SO_4, Δ
(iii) Cl_2, $FeCl_3$
(C) (i) Heat chlorobenzene with ($HNCO_3 + H_2SO_4$)
(ii) CH_3Cl, $AlCl_3$
(ii) $K_2Cr_2O_7$, H_2O, H_2SO_4, Heat
(D) (i) Toluene + ($HNO_3 + H_2SO_4$)
(ii) Cl_2, $FeCl_3$, Heat
(iii) $K_2Cr_2O_7$, H_2O, H_2SO_4, heat

Space for Rough work

27. When a certain volume, V_1 ml of a gaseous hydrocarbon is exploded with excess of oxygen and the product coded to room temperature, the observed concentration in volume was 1.5 V_1 ml. A further contraction of $2V_1$ ml was observed on exposure of product to alkali. Formulae of hydrocarbon is

(A) C_2H_4	(B) C_2H_2
(C) C_2H_6	(D) C_3H_4

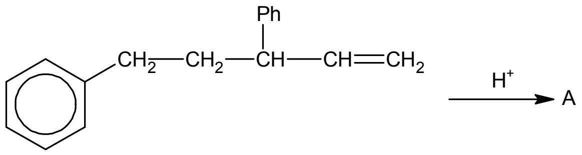
28. The de-broglie wavelength of an electron that has been accelerated through a potential difference of 100V is:

(A) 0.12264nm	(B) 1.226m
(C) 1.226nm	(D) 0.012264nm

29. The correct order of increasing $C-O$ bond length of CO, CO_3^{2-}, CO_2 is:

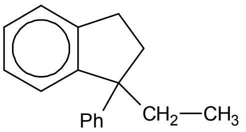
(A) $CO_3^{2-} < CO_2 < CO$	(B) $CO_2 < CO_3^{2-} < CO$
(C) $CO < CO_3^{2-} < CO_2$	(D) $CO < CO_2 < CO_3^{2-}$

30.

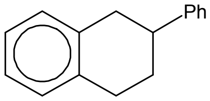


Product A is:

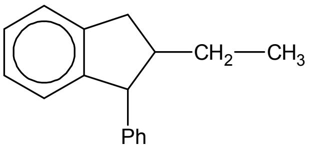
(A)



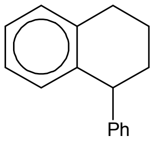
(B)



(C)



(D)



Space for Rough work

Mathematics PART – III

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. For the system of equations

$$\log_{10}\left(x^3 - x^2\right) = \log_5 y^2$$
$$\log_{10}\left(y^3 - y^2\right) = \log_5 z^2$$
$$\log_{10}\left(z^3 - z^2\right) = \log_5 x^2$$

Which of following is/are true?
(A) there are infinite number of solution
(B) there is unique solution with x, y, z $\in$ Q
(C) there are exactly two solution with x, y, z $\in$ Q
(D) there is no solution

2. Three points A, B and C are considered on a parabola. The tangents to the parabola at these points form triangle MNP (NP being tangent at A, PM at B and MN at C). If the line through B and parallel to axis of parabola intersect AC at L then quadrilateral LMNP
(A) is always a parallelogram
(B) can never be parallelogram
(C) is parallelogram only when ordinates of A, B, C are in AP
(D) has exactly two sides parallel to each other, always

3. Let $f(x) = \dfrac{e^{\tan x} - e^x + \ln(\sec x + \tan x) - x}{\tan x - x}$ be a continuous function at x = 0. The value of f(0) equals

(A) $\frac{1}{2}$ (B) $\frac{2}{3}$
(C) $\frac{3}{2}$ (D) 2

Space for rough work

4. Let α, β, γ are the roots of the equation , $8x^3 + 1001x + 2008 = 0$. The value of $(\alpha + \beta)^3 + (\beta + \gamma)^3 + (\gamma + \alpha)^3$ is
(A) 251 (B) 751
(C) 735 (D) 753

5. Number of four digit numbers of the form N = abcd which satisfy following three condition (i) $4000 < N < 6000$ (ii) N is a multiple of 5 (iii) $3 \le b < c \le 6$ is equal to
(A) 12 (B) 18
(C) 24 (D) 48

6. A coin that comes up head with probability $p > 0$ and tails with probability $1 - p > 0$ independently on each flip, is flipped eight times. Suppose the probability of three heads and five tails is equal to $\frac{1}{25}$ of the probability of five heads and three tails. The value of p is
(A) $\frac{5}{6}$ (B) $\frac{2}{3}$
(C) $\frac{1}{6}$ (D) $\frac{3}{4}$

7. The power of 'x' which has the greatest coefficient in the expansion of $\left(1+\frac{x}{2}\right)^{10}$ is
(A) 2 (B) 3
(C) 4 (D) 5

8. The first two terms of a G.P. add up to 12. The sum of the 3rd and 4th term is 48. If the term of the G.P. are alternatively positive and negative, then the first term is
(A) –4 (B) –12
(C) 12 (D) 14

9. If a curve is represented parametrically by the equations $x = 4t^3 + 3$ and $y = 4 + 3t^4$ and $\frac{\left(\frac{d^2x}{dy^2}\right)}{\left(\frac{dx}{dy}\right)^n}$ is a constant then the value of n, is
(A) 3 (B) 4
(C) 5 (D) 6

Space for rough work

10. The minimum value of the function $f(x) = x^{3/2} + x^{-3/2} - 4\left(x + \frac{1}{x}\right)$ for all permissible real x, is
(A) –10
(B) –6
(C) –7
(D) –8

11. The complete set of value of 'a' for which there exists at least one line that is tangent to the graph of the curve y = x^3 – ax at one point and normal to the graph at another point is given by
(A) $a \in \left(-\infty, -\frac{4}{3}\right]$
(B) $a \in \left[-\frac{4}{3}, \infty\right)$
(C) $a \in \left[\frac{4}{3}, \infty\right)$
(D) $a \in \left(-\infty, \frac{4}{3}\right]$

12. In ΔABC, if $\frac{\sin A}{c \sin B} + \frac{\sin B}{c} + \frac{\sin C}{b} = \frac{c}{ab} + \frac{b}{ac} + \frac{a}{bc}$, then the value of A is (All symbols have there usual meaning)
(A) 120°
(B) 90°
(C) 60°
(D) 30°

13. If $A = \begin{bmatrix} 0 & 2b & c \\ a & b & -c \\ a & -b & c \end{bmatrix}$ is orthogonal matrix, then |abc| is equal to
(A) $\frac{1}{2}$
(B) $\frac{1}{3}$
(C) $\frac{1}{6}$
(D) 1

14. If $A = \left[a_{ij}\right]_{n \times n}$, where $a_{ij} = i^{100} + j^{100}$, then $\lim_{n \to \infty} \left(\frac{\sum_{i=1}^{n} a_{ii}}{n^{101}} \right)$ equals
(A) $\frac{1}{50}$
(B) $\frac{1}{101}$
(C) $\frac{2}{101}$
(D) $\frac{3}{101}$

Space for rough work

15. If $a^2 + b^2 + c^2 + ab + bc + ca \le 0\ \forall\ a, b, c \in R$, then value of the determinant

$$\begin{vmatrix} (a+b+2)^2 & a^2+b^2 & 1 \\ 1 & (b+c+2)^2 & b^2+c^2 \\ c^2+a^2 & 1 & (c+a+2)^2 \end{vmatrix}$$ is equal to

(A) 65
(B) $a^2 + b^2 + c^2 + 31$
(C) $4(a^2 + b^2 + c^2)$
(D) 0

16. If z is a complex number satisfying the equation $|z - (1 + i)|^2 = 2$ and $w = \frac{2}{z}$, then the locus traced by 'w' in the complex plane is
(A) $x - y - 1 = 0$
(B) $x + y - 1 = 0$
(C) $x - y + 1 = 0$
(D) $x + y + 1 = 0$

17. The angle between pair of tangents drawn to the curve $7x^2 - 12y^2 = 84$ from M(1, 2) is
(A) $2\tan^{-1}\frac{1}{2}$
(B) $2\tan^{-1} 2$
(C) $2\left(\tan^{-1}\frac{1}{3} + \tan^{-1}\frac{1}{2}\right)$
(D) $2\tan^{-1} 3$

18. Tangents PA and PB are drawn to the circle $x^2 + y^2 = 8$ from any arbitrary point p on the line
$x + y = 4$. The locus of the midpoint of chord of contact AB is
(A) $x^2 + y^2 + 2x + 2y = 0$
(B) $x^2 + y^2 - 2x - 2y = 0$
(C) $x^2 + y^2 - 2x + 2y = 0$
(D) $x^2 + y^2 + 2x - 2y = 0$

19. Let A(5, 12), B($-13\cos\theta$, $13\sin\theta$) and C($13\sin\theta$, $-13\cos\theta$) are vertices of ΔABC where $\theta \in R$. The locus of the orthocentre of ΔABC is
(A) $x - y + 7 = 0$
(B) $x - y - 7 = 0$
(C) $x + y - 7 = 0$
(D) $x + y + 7 = 0$

20. The range of the $f(x) = \sqrt{\cos^{-1}\left(\sqrt{\log_4 x}\right) - \frac{\pi}{2} + \sin^{-1}\left(\frac{1+x^2}{4x}\right)}$ is equal to
(A) $\left(0, \frac{\pi}{2} + \sqrt{\frac{\pi}{2}}\right]$
(B) $\left[\frac{\pi}{2}, \frac{\pi}{2} + \sqrt{\frac{\pi}{2}}\right]$
(C) $\left[\frac{\pi}{6}, \frac{\pi}{2}\right]$
(D) $\left\{\frac{\pi}{6}\right\}$

Space for rough work

21. If $\lim\limits_{n\to\infty} \frac{n\cdot 3^n}{n(x-2)^n + n\cdot 3^{n+1} - 3^n} = \frac{1}{3}$ where n ∈ N, then the number of integer(s) in the range 'x' is

(A) 3
(B) 4
(C) 5
(D) infinite

22. For any natural number m, $\int \left(x^{7m} + x^{2m} + x^m\right)\left(2x^{6m} + 7x^m + 14\right)^{1/m} dx$ (where x > 0), equals

(A) $\frac{\left(7x^{7m} + 2x^{2m} + 14x^m\right)^{\frac{m+1}{m}}}{14(m+1)} + c$
(B) $\frac{\left(2x^{7m} + 14x^{2m} + 7x^m\right)^{\frac{m+1}{m}}}{14(m+1)} + c$
(C) $\frac{\left(2x^{7m} + 7x^{2m} + 14x^m\right)^{\frac{m+1}{m}}}{14(m+1)} + c$
(D) $\frac{\left(7x^{7m} + 2x^{2m} + x^m\right)^{\frac{m+1}{m}}}{14(m+1)} + c$

23. Let f: (0, ∞) → R be a continuous function such that $F(x) = \int_0^x t f(t)\,dt$. If $F(x^2) = x^4 + x^5$, then $\sum\limits_{r=1}^{12} f\left(r^2\right)$ is equal to

(A) 216
(B) 219
(C) 222
(D) 225

24. The area of the region bounded by the curve $C : y = \frac{x+1}{x^2+1}$ and the line L : y = 1, is

(A) $1 - \frac{1}{2}\ln 2 + \frac{\pi}{4}$
(B) $\ln 2 - \frac{\pi}{4} + 1$
(C) $\frac{1}{2}\ln 2 + \frac{\pi}{4} - 1$
(D) $\ln 2 - \frac{\pi}{2} + 1$

25. If $\frac{dy}{dx} = \left(e^y - x\right)^{-1}$ where y(0) = 0, then y is expressed explicitly as

(A) $\frac{1}{2}\ln\left(1 + x^2\right)$
(B) $\ln(1 + x^2)$
(C) $\ln\left(x + \sqrt{1 + x^2}\right)$
(D) $\ln\left(x + \sqrt{1 - x^2}\right)$

Space for rough work

26. If $\vec{a}, \vec{b}, \vec{c}$ are non-zero vectors then value of the scalar $\left(\left(\vec{a}\times\vec{b}\right)\times\vec{a}\right)\left(\left(\vec{b}\times\vec{a}\right)\times\vec{b}\right)$ equals

(A) $-\left(\vec{a}\cdot\vec{b}\right)\left|\vec{a}\times\vec{b}\right|^2$
(B) $\vec{a}^2\left|\vec{a}\times\vec{b}\right|^2$
(C) $\left|\vec{b}\right|^2\left|\vec{a}\times\vec{b}\right|^2$
(D) $\left(\vec{a}\cdot\vec{b}\right)\left|\vec{a}\times\vec{b}\right|^2$

27. The distance between the line x = 2 + t, y = 1 + t, $z=-\frac{1}{2}-\frac{t}{2}$ and the plane $\vec{r}\left(\hat{i}+2\hat{j}+6\hat{k}\right)=10$, is

(A) $\frac{1}{6}$
(B) $\frac{1}{\sqrt{41}}$
(C) $\frac{1}{7}$
(D) $\frac{9}{\sqrt{41}}$

28. Let a relation R in the set N of natural numbers be defined as (x, y) $\in$ R if and only if $x^2 - 4xy + 3y^2 = 0\ \forall\ x, y \in N$. The relation R is

(A) reflexive
(B) symmetric
(C) transitive
(D) an equivalence relation

29. The top of a hill observed from the top and bottom of a building of height h is at angles of θ and ϕ respectively. The height of the hill is

(A) $\frac{h\cot\phi}{\cot\phi-\cot\theta}$
(B) $\frac{h\cot\theta}{\cot\theta-\cot\phi}$
(C) $\frac{h\tan\theta}{\tan\theta-\tan\phi}$
(D) none of these

30. Mean deviation about mean from the following data

x_i : 3 9 17 23 27
f_i : 8 10 12 9 5 is

(A) 7.15
(B) 7.09
(C) 8.05
(D) none of these

Space for rough work

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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ALL INDIA TEST SERIES

FIITJEE **JEE(Main)-2015**

ANSWERS, HINTS & SOLUTIONS
FULL TEST – I
(Main)

S. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	A	B
2.	B	B	A
3.	A	C	C
4.	A	A	D
5.	A	D	C
6.	A	B	A
7.	A	D	B
8.	A	C	B
9.	B	B	C
10.	D	A	A
11.	D	D	C
12.	D	B	B
13.	A	D	C
14.	C	A	C
15.	D	C	A
16.	C	B	A
17.	A	A	C
18.	C	B	B
19.	A	B	A
20.	A	B	D
21.	B	D	C
22.	B	D	C
23.	B	C	B
24.	D	D	C
25.	A	D	C
26.	D	D	A
27.	D	B	D
28.	C	A	A
29.	A	D	B
30.	A	A	B

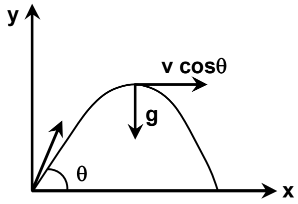
Physics

PART – I

SECTION – A

1. Rate of change of speed is minimum at highest point. Since at highest position.

$$R = \frac{(v\cos\theta)^2}{g} = \frac{v^2\cos^2\theta}{g}$$



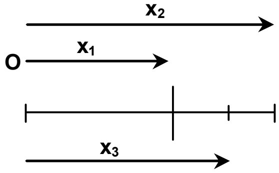
2. $x = t^3 - 4t^2 + 5t + 9$

$$V = \frac{dx}{dt} = (3t^2 - 8t + 5)$$

V = 0 at t = 1, $\frac{5}{3}$ sec.

x_1 (t = 0) = 9m; x_2 (t = 1) = 11 m, x_3 (t = 5/3) ≈ 10.85

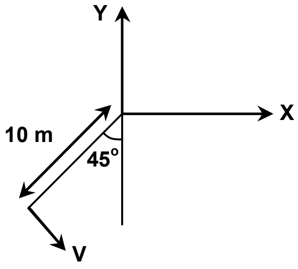
d = (x_2 –x_2) + (x_2 – x_3) = 2.15 m



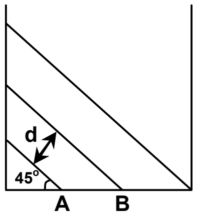
3. $$\frac{d|\vec{v}|}{dt} = a_t = \frac{\vec{a}.\vec{v}}{|\vec{v}|} = \frac{24}{5} = 4.8\ ms^{-2}$$

4. Situation is same as the motion in vertical circle with initial situation |a| = 2 equivalent to lowest point.

$$V = \sqrt{5a\ell} = \sqrt{5\times2\times10} = 10\,ms^{-1}$$



5. $|P_A - P_B| = d \times g_{effective} \times \rho = 10^4$ N/m^2



6. Friction would change the diagram with time as tension in string would increase. So, (a) is correct option.

7. $V_B \cos\theta_1 = 10$; $v_B \cos\theta_2 = v_c$; $v_c = \frac{10}{\cos\theta_1}\cos\theta_2 = \frac{10}{\sqrt{3}}$ m/sec.

8. Net force would be equal to figure mg when contact force with hemispherical ball is zero. $\theta = \cos^{-1}(2/3)$

9. Angle between $\vec{V}\,\&\,\vec{a}$ is obtuse and centripetal acceleration is directed towards left.

10. I = 10 tan (90 – θ)

$$\frac{dI}{dt} = 10\,\text{cosec}^2\theta \times \omega$$

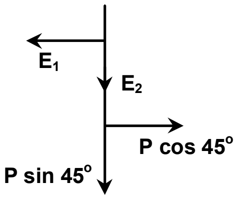
= 500 m/sec

11. $$\frac{\sin i}{\sin r} = \frac{\sqrt{5}}{2\sqrt{2}}$$

$$\left[\sin r = \frac{4}{5}\right]$$

12. $$E_1 = -\frac{KP\cos 45^\circ}{Y^3}$$

$$E_2 = \frac{2KP\sin 45^\circ}{Y^3}$$



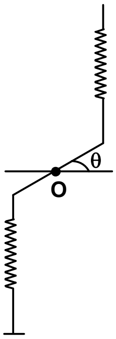
13. $$V_0 - \frac{\sigma\ell}{\varepsilon_0} + \frac{q}{4\pi\varepsilon_0 R} = 0$$

14. Initially capacitor will offer zero resistance at steady state it will behave like open circuit.

15. By KVL & KCL

16. $$\frac{dN_y}{dt} = \lambda_x N_x - \lambda_y N_y$$

17. $$X = 2T\cos\theta$$
$$Y = 2\tan\theta$$
$$\frac{X}{Y} = \frac{(R-d)}{R}$$



18. Torque about O

$$-(\lambda/2)\,(\lambda/2)\,\theta + k\,(\lambda/2)\,(\lambda/2)\,\theta = \frac{M\ell^2}{12}\alpha$$

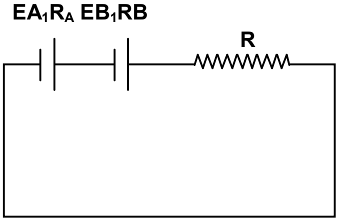
$$\frac{K}{2}\theta = \frac{M\ell^2}{612}\alpha$$

$$\omega^2 = \frac{6K}{M}$$

$$T = 2\pi\sqrt{\frac{M}{6K}}$$

19. $T = 2\pi\sqrt{\frac{\ell}{g\cos\alpha}}$

20. At steady state current through capacitor is zero and potential difference across inductor is zero. Circuit will be like $i = \frac{E}{r_A}$.



$2r_A = r_A + r_B + R$

$R = r_A - r_B$ since $R > 0$.

21. $B = \frac{\mu_0 i}{2\pi x}$

$d\varepsilon = Bd\ell v$

$\varepsilon = \frac{\mu_0 iv}{2\pi}\int_{r_2}^{r_1}\frac{dx}{x} = \left(\frac{\mu_0 iv}{2\pi}\ell n\frac{r_2}{r_1}\right)$

22. $$\begin{bmatrix} \frac{hc}{\lambda} & = \omega_f + ev \\ \frac{hc}{2\lambda} & = \omega_f + \frac{eV}{3} \end{bmatrix}$$

$\omega_f = \frac{hc}{4\lambda}, \lambda_0 = 4\lambda$

23. r particle will go undefected since it does not have α, β particle will deflect in opposite directions

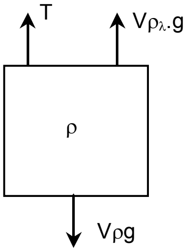
24. $X = \lambda N_1$

$Y = \lambda N_2$

$(N_1 - N_2) = \frac{(x-y)}{\lambda} = (x-y)\tau$

25. $T + V\rho_\lambda.g = 40$

So T = 37.12 N



26. $V_2 = 2V_1; K_2 = 4K_1$

27. $|E| = (aT - 2at)$

$H = \int E^2/R\,dt$

28. $-\frac{dh}{dt} \propto \sqrt{h}$

29. $E = BV\ell = 80\,V$

30. Condition of balanced bridge.

Chemistry

PART – II

SECTION – A

1. $\pi P_c = P \qquad \phi V_c = V \qquad \theta T_c = T$

$$\pi . \frac{a}{27b^2} = P \qquad \phi .3b = V \qquad \theta . \frac{8a}{27Rb} = T$$

$$\left[\pi - \frac{3}{\phi}\right](3\phi - 1) = 8\theta R$$

4. $[H_2CO_3] = 2M$
$V_{blood} = 10$ ml
$[NaHCO_3] = 5$ M
Let V ml 8 $NaHCO_3$ is mixed
$\therefore$ total V = (10 + V) ml
$\therefore [H_2CO_3]_{mix} = \frac{2 \times 10}{(v+10)}$
$[NaHCO_3] = \frac{5 \times V}{(v+10)}$
$\therefore$ pH = pKa + $\log\frac{[salt]}{[acid]}$
$\Rightarrow 7.4 = -\log(7.8 \times 10^{-7}) + \log\frac{5V}{20}$
$\Rightarrow$ V = 78.36 ml

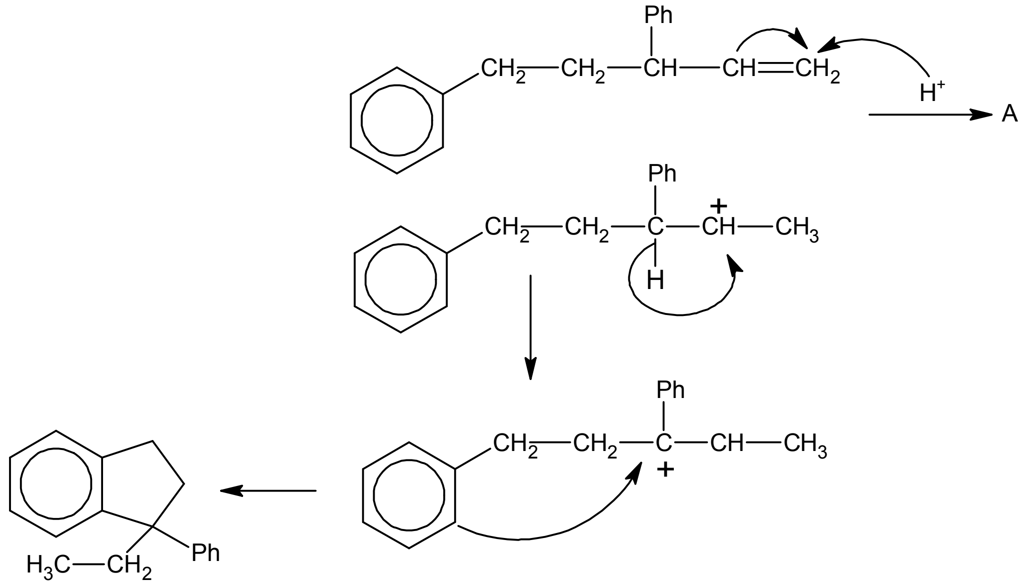
8. For a chemical reaction with rise in temperature by 10°, the rate of reaction is nearly doubled. The temperature dependence of the rate of a chemical equation can be explained by Arrhenius equation:
$K = Ae^{-E/RT}$

18. Number of G.I. = $2^4 = 2^1 = 2$
Number of OI = $2^4 = 2^1 = 2$
n = number of stereocentres

28. $P = \sqrt{2 \times 9.11 \times 10^{-31}(KJ) \times 1.602 \times 0^{-17}}$
$= 5.4 \times 10^{-24}$ kgms^{-1}
$\lambda = \frac{h}{p} = \frac{6.6 \times 10^{-31} JS}{5.4 \times 10^{-24} \, kgms^{-1}} = 0.1226$

29. Bond length $\alpha \frac{1}{\%\pi \text{ characater}}$

30.



Mathematics

PART – III

SECTION – A

1. For x > 1, let $f(x) = 5^{\log_{10}(x^3 - x^2)}$

The there equation are $f(x) = y^2$, $f(y) = z^2$ and $f(z) = x^2$

$\because x^3 - x^2 = x^2(x - 1)$ is increasing, f is an increasing function

If, say x > y then y < z and z < x, yielding a contradiction

Thus we can only have that x = y = z and so $\log_{10}(x^3 - x^2) = \log_5 x^2$

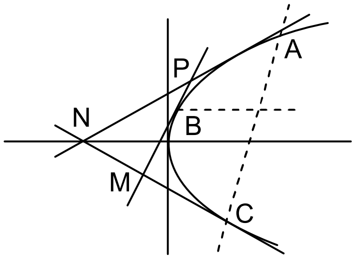
Let $2t = \log_5 x^2 \Rightarrow t > 0$, $x^2 = 5^{2t} \Rightarrow x = 5^t$

$\Rightarrow 5^{3t} - 5^{2t} = 10^{2t} \Rightarrow 5^t - 1 = 4^t \Rightarrow 5^t - 4^t = 1$

$\because 5^t - 4^t = 4^t\left(\left(\frac{5}{4}\right)^t - 1\right)$ is an increasing function of t

$\Rightarrow$ This equation has unique solution i.e. t = 1, x = y = z = 5

2. $A(at_1^2, 2at_1)$, $B(at_2^2, 2at_2)$, $C(at_3^2, 2at_3)$



$P(at_1t_2, a(t_1 + t_2))$

$N(at_1t_3, a(t_1 + t_3))$

$M(at_2t_3, a(t_2 + t_3))$

Equation of AC $y(t_1 + t_3) = 2x + 2at_1t_3$

Line through B parallel to x-axis $y = 2at_2$

$L \equiv (a(t_1t_2 + t_2t_3 - t_1t_3), 2at_2)$

Mid-point of L and N $\equiv \left(a\frac{(t_1t_2 + t_2t_3)}{2}, \frac{a(t_1 + 2t_2 + t_3)}{2}\right)$

Mid-point of PM $\equiv \left(a\left(\frac{t_1t_2 + t_2t_3}{2}\right), \frac{a(t_1 + 2t_2 + t_3)}{2}\right)$. Hence, parallelogram

3. For continuity $k = f(0) = \lim\limits_{x\to 0} f(x) = \lim\limits_{x\to 0} \dfrac{e^{\tan x} - e^{x}}{\tan x - x} + \lim\limits_{x\to 0} \dfrac{\ln(\sec x + \tan x) - x}{\left(\dfrac{\tan x - x}{x^3}\right)\cdot x^3}$

$$= \lim_{x\to 0} \frac{e^{x}\left(e^{\tan x - x} - 1\right)}{\tan x - x} + 3\lim_{x\to 0} \frac{\ln(\sec x + \tan x) - x}{x^3}$$

$$= 1 + 3\lim_{x\to 0} \frac{\sec x - 1}{3x^2} = 1 + \frac{1}{2} = \frac{3}{2}$$

4. $\alpha + \beta + \gamma = 0,\ \alpha\beta\gamma = -\dfrac{2008}{8}$

Now, let $\alpha + \beta = A$, $\beta + \gamma = B$, $\gamma + \alpha = C$
$\therefore\ A + B + C = 2(\alpha + \beta + \gamma) = 0$
Hence, $A^3 + B^3 + C^3 = 3ABC$
$\therefore\ (\alpha + \beta)^2 + (\beta + \gamma)^3 + (\gamma + \alpha)^3 = 3(\alpha + \beta)(\beta + \gamma)(\gamma + \alpha) = -3\alpha\beta\gamma$

5. $N = \begin{array}{|c|c|c|c|}\hline a & b & c & d \\ \hline\end{array}$

a can be chosen in 2 ways i.e. 4 or 5
b and c can be chosen in 6 ways i.e. 34, 35, 36, 45, 46, 56
d can be 0 or 5
Hence, total number = 2 × 6 × 2 = 24

6. ${}^{8}C_3 \cdot p^3 (1-p)^5 = \dfrac{1}{25} \cdot {}^{8}C_5 p^5 (1-p)^3$

$\Rightarrow 1 - p = \dfrac{p}{5} \Rightarrow p = \dfrac{5}{6}$

7. $\dfrac{{}^{10}C_r}{2^r} > \dfrac{{}^{10}C_{r-1}}{2^{r-1}}$ and $\dfrac{{}^{10}C_r}{2^r} > \dfrac{{}^{10}C_{r+1}}{2^{r+1}}$

$\Rightarrow \dfrac{8}{3} < r < \dfrac{11}{3}$ $\therefore$ r = 3

8. Let G.P. is a, ar, ar^2 …..
Now, a + ar = 12 and $ar^2 + ar^3 = 48$
$\Rightarrow r^2 = 4 \Rightarrow r = -2$ and hence a = –12

9. $\dfrac{dx}{dy} = \dfrac{\frac{dx}{dt}}{\frac{dy}{dt}} = \dfrac{12t^2}{12t^3} = \dfrac{1}{t}$

Now, $\dfrac{d^2x}{dy^2} = \dfrac{d}{dy}\left(\dfrac{dx}{dy}\right) = \dfrac{d}{dt}\left(\dfrac{1}{t}\right)\dfrac{dt}{dy} = -\dfrac{1}{t^2}\dfrac{1}{12t^3} = -\dfrac{1}{12t^5}$

$\therefore\ \dfrac{\frac{d^2x}{dy^2}}{\left(\frac{dx}{dy}\right)^n} = \dfrac{-\frac{1}{12t^5}}{\frac{1}{t^n}} = \dfrac{-t^{n-5}}{12}$ = constant $\Rightarrow$ n = 5

10. Write $f(x)=\left(\sqrt{x}+\frac{1}{\sqrt{x}}\right)^3-3\left(\sqrt{x}+\frac{1}{\sqrt{x}}\right)-4\left[\left(\sqrt{x}+\frac{1}{\sqrt{x}}\right)^2-2\right]$

Let $\sqrt{x}+\frac{1}{\sqrt{x}}=t$ (x > 0)
Let $g(t) = t^3 - 3t - 4t^2 + 8$
$g'(t) = (t - 3)(3t + 1) = 0 \Rightarrow t = 3$
$g''(3) > 0 \Rightarrow g(3) = -10$

11. Tangent at $(t, t^3 - at)$ is given by $y = (3t^2 - a)x - 2t^3$
This line cuts the curve again at $x = -2t$, where slope of tangent is $12t^2 - a$
As required $(12t^2 - a)(3t^2 - a) = -1$
$\Rightarrow 36t^4 - 15t^2a + a^2 + 1 = 0$
For positive root, $a > 0$ and discriminant ≥ 0
i.e. $a > 0$ and $225a^2 - 144(a^2 + 1) = 9(3a - 4)(3a + 4) \geq 0$
$\Rightarrow a \in \left[\frac{4}{3}, \infty\right)$

12. We have $\frac{\sin A}{C\sin B}=\frac{a}{bc}$
$\therefore\ \frac{\sin B}{c}+\frac{\sin C}{b}=\frac{c}{ab}+\frac{b}{ac} \Rightarrow \frac{b\sin B+c\sin C}{bc}=\frac{c^2+b^2}{abc}$
$\Rightarrow a=\frac{b^2+c^2}{b\sin B+c\sin C}=\frac{b(2R\sin B)+c(2R\sin C)}{b\sin B+c\sin C}$
$\Rightarrow a = 2R \Rightarrow \angle A=\frac{\pi}{2}$

13. The roots of A are unit orthogonal vectors
$\Rightarrow \vec{R}_1\cdot\vec{R}_2=0 \Rightarrow 2b^2 = c^2$
$\vec{R}_2\cdot\vec{R}_3=0 \Rightarrow a^2 - b^2 - c^2 = 0$
$\vec{R}_3\cdot\vec{R}_3=1 \Rightarrow a^2 + b^2 + c^2 = 1$
$\Rightarrow a^2 = \frac{1}{2},\ b^2 = \frac{1}{6},\ c^2 = \frac{1}{3} \Rightarrow |abc| = \frac{1}{6}$

14. $\sum_{i=1}^{n} a_{ii} = a_{11}+a_{22}+.....+a_{nn}$

$$\lim_{n\to\infty}\frac{\sum_{i=1}^{n}a_{ii}}{n^{101}}=\lim_{n\to\infty}\frac{2\left(1^{100}+2^{100}+3^{100}+.....+n^{100}\right)}{n^{101}}=2\lim_{n\to\infty}\frac{1}{n}\sum_{r=1}^{100}\left(\frac{r}{n}\right)^{100} = 2\int_a^1 x^{100}dx=\frac{2}{101}$$

15. We have $a^2 + b^2 + c^2 + ab + bc + ca \leq 0$
$\Rightarrow (a + b)^2 + (b + c)^2 + (c + a)^2 \leq 0$
$\Rightarrow a + b = 0,\ b + c = 0,\ c + a = 0$
$\Rightarrow a = b = c$
Now, $\begin{vmatrix}4 & 0 & 1\\ 1 & 4 & 0\\ 0 & 1 & 4\end{vmatrix}=65$

16. $|z-(1+i)|^2 = 2$

$\Rightarrow (x-1)^2 + (y-1)^2 = 2$

$\Rightarrow x^2 + y^2 = 2(x+y)$ ..... (1)

Let $w = h + ik = \dfrac{2}{z} = \dfrac{2}{x+iy} = \dfrac{2(x-iy)}{x^2+y^2}$, so

$h = \dfrac{2x}{x^2+y^2}, k = \dfrac{-2y}{x^2+y^2}$

$\Rightarrow h-k = \dfrac{2(x+y)}{x^2+y^2} = 1$ (from 1)

$\therefore$ Locus of w is $x - y = 1$

17. Point M lies on director circle of hyperbola, hence angle between the tangents is $\dfrac{\pi}{2}$

as $\tan^{-1}\dfrac{1}{3} + \tan^{-1}\dfrac{1}{2} = \tan^{-1}1 = \dfrac{\pi}{4} \Rightarrow 2\left(\tan^{-1}\dfrac{1}{3} + \tan^{-1}\dfrac{1}{2}\right) = \dfrac{\pi}{2}$

18. Let p(a, 4 – a)

The equation of chord of contact AB is

$xa + y(4-a) = 8$ ..... (1)

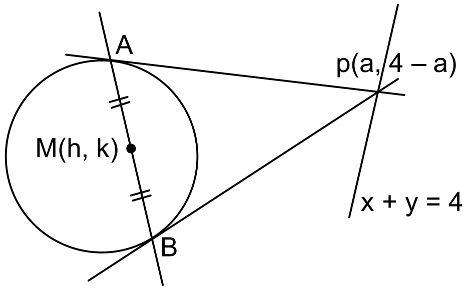
Equation of chord AB with M(h, k) as midpoint

$hx + ky = h^2 + k^2$ ..... (2)

(1) and (2) are same

$\Rightarrow \dfrac{a}{h} = \dfrac{4-a}{k} = \dfrac{8}{h^2+k^2}$

$\Rightarrow x^2 + y^2 - 2x - 2y = 0$



19. Circum-centre is (0, 0)

Centroid (G) is $\left(\dfrac{5-13\cos\theta+13\sin\theta}{3}, \dfrac{12+13\sin\theta-13\cos\theta}{3}\right)$

Centroid divides line joining orthocentre and circum-centre in ration 2 : 1

$\therefore \dfrac{5-13\cos\theta+13\sin\theta}{3} = \dfrac{2\times0+1\times h}{3}$ and $\dfrac{12+13\sin\theta-13\cos\theta}{3} = \dfrac{2\times0+1\times k}{3}$

$\Rightarrow \sin\theta - \cos\theta = \dfrac{h-5}{13}$ and $\sin\theta - \cos\theta = \dfrac{k-12}{13}$

Hence, locus is $x - y + 7 = 0$

20. Domain of f(x) is x = 1 so, $f(1) = \sqrt{0} + \sin^{-1}\dfrac{2}{4} = \dfrac{\pi}{6}$

21. $\lim\limits_{n\to\infty} \dfrac{n\cdot3^n}{n(x-2)^n + n\cdot3^{n+1} - 3^n} = \dfrac{1}{3}$, so $\lim\limits_{n\to\infty} \dfrac{1}{\left(\dfrac{x-2}{3}\right)^n + 3 - \dfrac{1}{n}} = \dfrac{1}{3}$

$-1 < \dfrac{x-2}{3} < 1 \Rightarrow -1 < x < 5$

Hence, possible number of integers in the range = 5

22. $I = \int\left(x^{7m-1} + x^{2m-1} + x^{m-1}\right)\left(2x^{7m} + 7x^{2m} + 14x^m\right)^{1/m}dx$

Put $2x^{7m} + 7x^{2m} + 14x^{m} = t^{m}$

$$I = \frac{1}{14}\int t^{m-1}\left(t^{m}\right)^{1/m} dt = \frac{t^{m+1}}{14(m+1)} + c$$

23. $F\left(x^2\right) = \int\limits_0^{x^2} t\,f(t)\,dt = x^4 + x^5$ ..... (1)

On differentiating $2x(x^2)f(x^2) = 4x^3 + 5x^4$

$\Rightarrow f\left(x^2\right) = 2 + \frac{5}{2}x$ ..... (2)

$\therefore \sum\limits_{r=1}^{12} f\left(r^2\right) = \sum\limits_{r=1}^{12}\left(2 + \frac{5}{2}r\right) = 216$

Hence, $\sum\limits_{r=1}^{12} f\left(r^2\right) = 219$

24. On solving $C : y = \frac{1+x}{1+x^2}$ and the line L : y = 1 gives x = 0, 1

Required area = $\int\limits_0^1\left(\frac{x+1}{x^2+1} - 1\right)dx = \frac{1}{2}\ln\left(x^2+1\right) + \tan^{-1}x - x\Big|_0^1 = \frac{1}{2}\ln 2 + \frac{\pi}{4} - 1$

25. $\frac{dx}{dy} = e^y - x \Rightarrow \frac{dx}{dy} + x = e^y$

Hence, integrating factor = e^y

Solution is $xe^y = \frac{1}{2}e^{2y} + c$

$\Rightarrow y = \ln\left(x + \sqrt{x^2+1}\right)$

26. $\left(\left(\vec{a}\times\vec{b}\right)\times\vec{a}\right)\left(\left(\vec{b}\times\vec{a}\right)\times\vec{b}\right) = \left(\left(\vec{a}\cdot\vec{a}\right)\vec{b} - \left(\vec{b}\cdot\vec{a}\right)\vec{a}\right)\left(\left(\vec{b}\cdot\vec{b}\right)\vec{a} - \left(\vec{a}\cdot\vec{b}\right)\vec{b}\right)$

= $\left(\vec{a}^2\,\vec{b}^2\right)\vec{a}\cdot\vec{b} - \vec{a}^2\cdot\vec{b}^2\left(\vec{a}\cdot\vec{b}\right) - \left(\vec{a}\cdot\vec{b}\right)\vec{a}^2\cdot\vec{b}^2 + \left(\vec{a}\cdot\vec{b}\right)^3 = -\left[\left(\vec{a}\cdot\vec{b}\right)\vec{a}^2\cdot\vec{b}^2 - \left(\vec{a}\cdot\vec{b}\right)^3\right]$

= $-\left(\vec{a}\cdot\vec{b}\right)\left[\vec{a}^2\cdot\vec{b}^2 - \left(\vec{a}\cdot\vec{b}\right)^2\right]$ = $-\left(\vec{a}\cdot\vec{b}\right)\left|\vec{a}\times\vec{b}\right|^2$

27. Line is $\frac{x-2}{1} = \frac{y-1}{1} = \frac{z+\frac{1}{2}}{-\frac{1}{2}} = t$ (Let)

Plane : x + 2y + 6z – 10 = 0

Vector along line : $\vec{V} = \hat{i} + \hat{j} - \frac{1}{2}\hat{k}$

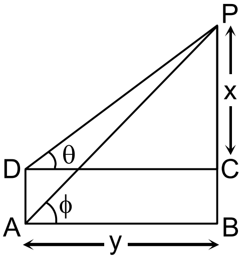
Vector normal to the plane $\vec{n} = \hat{i} + 2\hat{j} + 6\hat{k}$

$\vec{V}\cdot\vec{n} = 0 \Rightarrow$ line is parallel to plane

Distance of $\left(2, 1, -\frac{1}{2}\right)$ from the plane x + 2y + 6z – 10 = 0 is $\frac{9}{\sqrt{41}}$

28. R is reflexive

29. Let AD be the building of height h and BP be the hill.



Then $\tan\phi = \dfrac{h+x}{y}$ and $\tan\theta = \dfrac{x}{y}$

$\Rightarrow \tan\phi = \dfrac{h+x}{x\cot\theta} \Rightarrow x = \dfrac{h\cot\phi}{\cot\theta - \cot\phi}$

$\Rightarrow h + x = \dfrac{h\cot\theta}{\cot\theta - \cot\phi}$

30. Mean deviation calculation about mean

x_i	f_i	f_ix_i	$\lvert x_i - 15\rvert$	$f_i\lvert x_i - 15\rvert$
3	8	24	12	96
9	10	90	6	60
17	12	204	2	24
23	9	207	8	72
27	5	135	12	60
$N = \sum f_i = 44$		$\sum f_ix_i = 660$	$\sum f_i\lvert x_i - 15\rvert = 312$	

Mean = $\bar{X} = \dfrac{1}{N}\left(\sum f_ix_i\right) = \dfrac{660}{44} = 15$

Mean deviation = M.D. = $\dfrac{1}{N}\sum f_i\lvert x_i - 15\rvert = \dfrac{312}{44} = 7.09$

FIITJEE **JEE (Advanced), 2015**

FULL TEST – I

Paper 1

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

ALL INDIA TEST SERIES

Time Allotted: 3 Hours **Maximum Marks: 240**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 04)** contains 4 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (05 – 08) contains 4 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

   Section-A (09 to 11) contains 1 paragraph having 3 questions. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct matching. No marks will be given for any wrong matching in any question. There is no negative marking.

3. **Section-C (01 – 06)** contains 6 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck’s constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

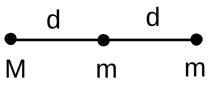
PART – I

SECTION – A

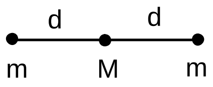
(Only One Option Correct Type)

This section contains **4 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

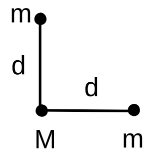
1. Three particles, two with mass m and one with mass M, might be arranged in any of the four configurations shown below. Rank the configurations according to the magnitude of the gravitational force on M, from least to greatest (i.e., in increasing order).



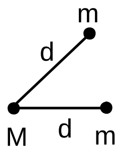
(1)



(2)



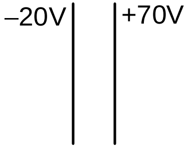
(3)



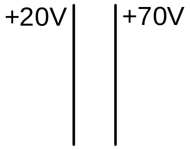
(4)

(A) 1, 2, 3, 4
(B) 2, 1, 3, 4
(C) 2, 1, 4, 3
(D) 2, 3, 4, 2

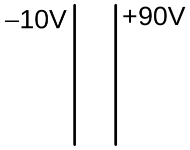
2. The diagram shows four pairs of large parallel conducting plates. The plates are separated by equal distance in all cases. The value of the electric potential is given for each plate. Rank the pairs according to the magnitude of the electric field between the plates, least to greatest.



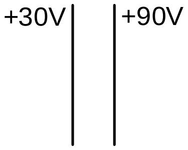
1



2



3



4

(A) 1, 2, 3, 4
(B) 4, 3, 2, 1
(C) 2, 3, 1, 4
(D) 2, 4, 1, 3

Space for Rough work

3. An observer 'O' at an accelerated trolley observes a projectile Q of mass 5 kg moving under uniform gravitational field of earth acting towards negative z-axis. He observes the momentum $\vec{P}$ of the projectile Q as $\vec{P} = 15t\hat{i} - 10t^2\hat{j} - 50t\hat{k}$ (kg m/s), where t denotes time in second. Find the acceleration of the trolley at t = 2 sec. (Take g = 10 m/s^2)

(A) $6\hat{i} - 8\hat{j} - 20\hat{k}$ m/s^2
(B) $3\hat{i} - 8\hat{j}$ m/s^2
(C) $-3\hat{i} - 8\hat{j}$ m/s^2
(D) $-3\hat{i} + 8\hat{j}$ m/s^2

4. A plane thick wall having uniform surface temperature along planes are 0°K and T_0°K (T_0 = 300K) at x = 0 and x = x_0 respectively. Thermal conductivity varies linearly with temperature

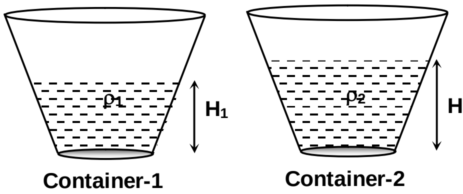
$K = K_0 (1 + T)$ The temperature of wall at the plane x = $2x_0$ is approximately: (where T is in kelvin)

(A) 300K
(B) 400K
(C) 425K
(D) 450K

(One or More than One Options Correct Type)

This section contains **4 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** are correct.

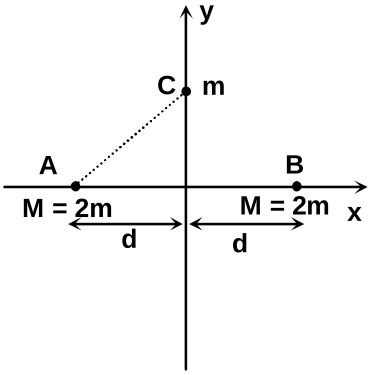
5. Two identical containers contains liquid of same mass m but different densities as shown in the figure given $\rho_1 > \rho_2$. P_1 and P_2 are pressures at the bottoms of the container-1 and container -2 respectively and F_1 and F_2 are the forces exerted by the liquid on the walls of container-1 and container -2 respectively. (Neglect the atmospheric pressure)

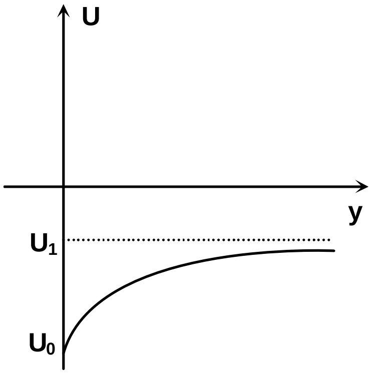


(A) $P_1 > P_2$
(B) $P_1 < P_2$
(C) $F_1 > F_2$
(D) $F_1 < F_2$

Space for Rough work

6. Two point masses, each of mass M are kept at rest at points A and B respectively. A third point m is released from infinity with a negligible speed, so that it can move along y-axis under the influence of mutual gravitational attraction on it due to point masses kept at A and B respectively as shown in the figure -1. Figure –2 represents the potential energy of system (includes m, M at A and M at B) with position of m at y-axis. (Neglect any other forces other than gravity) (given $Gm^2/d = 12$ Joule(m = 6 kg). Choose the correct option(s)





(A) Point mass m will perform periodic motion
(B) $U_1 = -24$ Joule
(C) Maximum speed of particle is 24 m/s
(D) Maximum speed of particle is 4 m/s

7. Choose the correct statements:
(A) The de broglie wavelength of electron, which are accelerated by an electric potential V is $\lambda = \frac{h}{\sqrt{2m_e eV}}$
(B) Wave velocity of the matter field is one half of the particle velocity
(C) Wave velocity of the matter field is equal to the particle velocity
(D) None of these

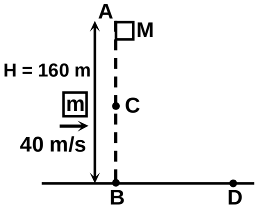
8. Equation of a travelling wave is $y = 5e^{(-ax^2 - bt^2 - 2\sqrt{ab}xt)}$ when x & y is in meter and t is in sec.
$a = 25\ m^{-2}$ and $b = 9\ sec^{-2}$
(A) Travelling wave is propagated along (+) x direction.
(B) Travelling wave is propagated along (–) x direction.
(C) Speed of wave is 3/5 m/sec.
(D) Maximum displacement of particle is 5 m.

Space for Rough work

Comprehension type (Only One Option Correct)

This section contains **1 paragraph**, describing theory, experiments, data etc. Three questions relate to the one paragraph. Each question has **only one** correct answer among the four given options (A), (B), (C) and (D).

Paragraph for Questions 09 & 11



A body of mass 150 gm is dropped from point A, takes time t_1 seconds to reach the point B at the ground. Once more, the same body is dropped from point A and when body traverses half the distance, a bullet of mass 50 gm, moving horizontally with speed 40 m/s hits the falling body at point C and sticks to it. The total time of flight of the body in this case is t_2 seconds and body strikes the ground at point D. The air drag should be neglected [Take g = 10 m/s^2]. Read above passage carefully and answer the following questions.

9. The ratio of t_1/t_2 is
   (A) $\sqrt{2} : 3$ (B) $2\sqrt{2} : 3$
   (C) $3\sqrt{2} : 4$ (D) $\sqrt{2} : 4$

10. Distance between B and D is
   (A) 160 m (B) 80 m
   (C) 40 m (D) 20 m

11. Speed of the body just before striking at point D is
   (A) $5\sqrt{26}$ m/s (B) $10\sqrt{26}$ m/s
   (C) $15\sqrt{26}$ m/s (D) $20\sqrt{26}$ m/s

Space for Rough work

SECTION - B

Matrix – Match Type

*This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

---

1. An electron in a hydrogen atom makes a transition $n_1 \rightarrow n_2$, where n_1 and n_2 are the principal quantum numbers of the two states. Assume Bohr model to be valid.

Column I		**Column II**	
(A)	The electron emits an energy of 2.55 eV	(p)	$n_1 = 2, n_2 = 1$
(B)	Time period of the electron in the initial state is eight times that in the final state.	(q)	$n_1 = 4, n_2 = 2$
(C)	Speed of electron become two times	(r)	$n_1 = 5, n_2 = 3$
(D)	Radius of orbit of electron becomes 4.77A°	(s)	$n_1 = 6, n_2 = 3$
		(t)	$n_1 = 8, n_2 = 4$

Space for Rough work

2. A triangular wave pulse on a string, is moving in the positive x-direction with speed '*v*'. The tension in string is F and linear mass density is μ. At t = 0 shape of pulse is give by:

$$y(x,0)=\begin{cases} 0 & \text{if} \quad x<-L \\ h(L+x)/L & \text{if} \quad -L<x<0 \\ h(L-x)/L & \text{if} \quad 0<x<L \\ 0 & \text{if} \quad x>L \end{cases}$$

Match the column **I** to that in column **II**

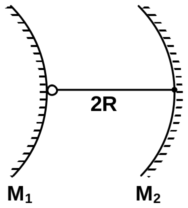
Column I		**Column II**	
(A)	for $-\infty < x \le vt - L$	(p)	Slope of string is negative
(B)	for $vt - L \le x \le vt$	(q)	Instantaneous power transmitted is non zero constants.
(C)	for $vt \le x \le vt + L$	(r)	Particle velocity is positive
(D)	for $vt + L \le x < \infty$	(s)	Particle velocity is negative
		(t)	Slope of string is zero

SECTION – C

(One Integer Value Correct Type)

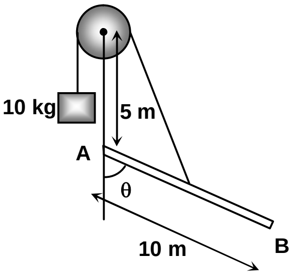
This section contains **6 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. Two spherical mirror, one of convex and other concave, each of same radius of curvature R are arranged coaxially at a distance 2R from each other. A small circle of radius a is drawn on the convex mirror near the pole as shown in figure. The radii of 3rd image (taking the first reflection at the concave mirror, then the successive reflection at the convex mirror and finally the third successive reflection at concave mirror again) of the circle is $\left(\frac{a}{40+x}\right)$, then value of x is



Space for Rough work

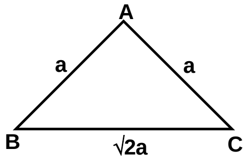
2. A uniform rod AB of mass 5 kg and length 10m is hinged at A. A block of mass 10 kg is hanging with a string and other end of the string is attached to a middle point of the rod passes over a smooth pulley as shown in the figure. Find the value of $\cos(\theta/2)$.



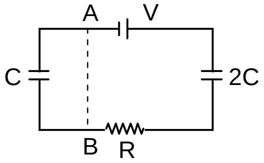
3. Pressure variation due a sonic wave propagating along positive x-direction is given by the equation $\Delta P(x) = \Delta P_0 \sin\left[2\pi(\nu t - x)\right]$. One end of an open organ pipe is closed by a cap and held at rest with its axis parallel to x-axis and the open end at the origin. The minimum value of frictional force (in Newton) between the cap and the pipe so that pipe will remain closed, is
(Given $\Delta P_0 = 2 \times 10^3$ N/m^2 and cross sectional area of the tube is equal to 5×10^{-4} m^2)

4. Two sound waves of frequencies 100 Hz and 102 Hz and having same amplitude 'A' are interfering. A stationary detector, which can detect waves of amplitude greater than or equal to A, In a given time interval of 12 seconds, find the total duration in which detector is active.

5. ABC is an isosceles triangular sheet of negligible thickness, made of isotropic material. Mass of the sheet is m. Its moment of inertia about axes perpendicular to its plane and passing through the points A and B are I_1 and I_2 respectively. [AB = AC = a and BC = $\sqrt{2}$a]. Find I_2/I_1.



6. If the heat dissipated in the circuit after a zero resistance wire is connected across the pairs A & B, is $\frac{2CV^2}{n}$, the value of n is



Space for Rough work

Chemistry PART – II

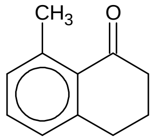
SECTION – A

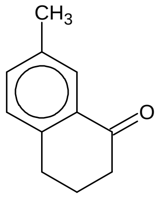
(Only One Option Correct Type)

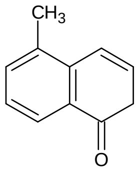
This section contains **4 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

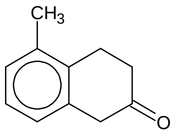
1. Calcium cyanamide is treated with ethyl chloride to give a product which on acidic hydrolysis followed by heating gives another product (A). Product (A) is treated with excess of CH_3I followed by heating with moist Ag_2O gives the product (B). Product (B) on heating strongly gives (C) which is
(A) Ethanol
(B) Ethene
(C) Isobutene
(D) Tetra allyl ammonium iodide

2. Toluene on heating with succinic anhydride in the presence of anhydrous $AlCl_3$ followed by reduction with Zn(Hg)/conc. HCl gives a product which on heating with thionyl chloride followed by heating with anhydrous $AlCl_3$ in CS_2 gives dominantly the ultimate product (P). Hence ultimate product (P) is

(A)


(B)


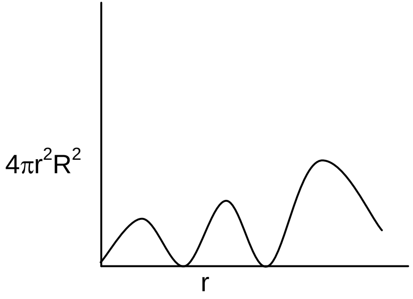
(C)


(D)


Space for Rough work

3. At cinema hall has equidistant rows 1m apart the length of cinema hall is 287 m and it has 287 rows. From one side of cinema hall, laughing gas N_2O is released and from the other side, weeping gas ($C_6H_5COCH_2Cl$) is released. In which rows, spectators will be laughing and weeping simultaneously?
(A) 100th row from weeping gas side
(B) 100th row from laughing gas side
(C) 187th row from the weeping gas side
(D) 185th row from the laughing gas side

4. An electron is in excited state in hydrogen atom. The orbital, in which electron is present, is shown the curve. The value of quantum numbers of electron in this exited state are



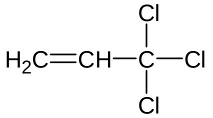
(A) n = 2, $\ell = 0$, m = 0, s = +1/2 or –1/2
(B) n = 2, $\ell = 1$, m = 0, s = +1/2 or –1/2
(C) n = 3, $\ell = 0$, m = 0, s = +1/2 or –1/2
(D) n = 3, $\ell = 0$, m = 0, s = +1/2 or –1/2

Space for Rough work

(One or More than One Options Correct Type)

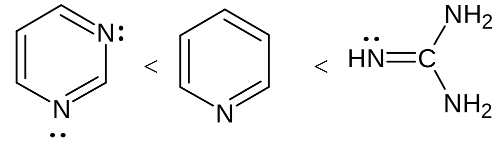
This section contains **4 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** are correct.

5. Identify the correct statement?

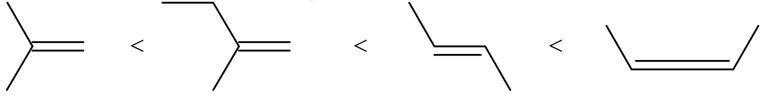
(A) 

$\mathrm{H_2C{=}CH{-}\overset{Cl}{\underset{Cl}{C}}{-}Cl}$

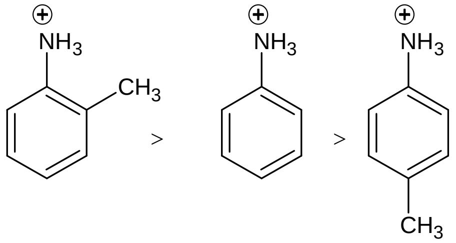
has greater ionization potential due to reverse hyper conjugation and –I effect.

(B) 

is the order of basic strength

(C) 

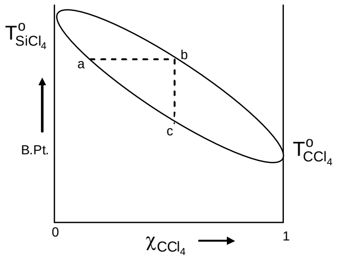
is the order of heat of combustion of the compounds.

(D) 

is the correct order of acidic strength

Space for Rough work

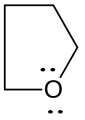
6. The diagram given below depicts the boiling point as the function of composition of the mixture of CCl_4 and $SiCl_4$ which of the following statements about the diagram is/are true?



(A) The point a represent the composition of solution and the point b that of the vapour in equilibrium.
(B) The proportion of CCl_4 in the solution is smaller than that in the vapour in equilibrium.
(C) bc represents the condensation of the vapour.
(D) The point c represents the composition of solution and the point b that of the vapour in equilibrium.

7. Assuming the bond direction to be Z-axis, which of the overlapping of atomic orbitals of two atoms A and B will result in bonding; (I)s orbital of A and P_x orbital of B, (II)s orbital of A and P_z orbital of B, ((III) P_y orbital of A and P_z orbital of B, (IV)s orbitals of A and B:
(A) I
(B) II
(C) III
(D) IV

8. Which of the following orders is are correct?
(A) $CH_3NH^- < CH_3O^- < CH_3CH_2^-$ (increasing basicity)
(B) $CH_3C \equiv C^- < CH_3CH = CH^- < CH_3CH_2CH_2^-$ (Increasing basicity)
(C) $CH_3OCH_3 < CH_3CH_2OH < CH_3CH_2OH_2^{\oplus}$ (Increasing acidity)
(D)



$> H_5C_2-\ddot{\underset{\cdot\cdot}{O}}-C_2H_5$

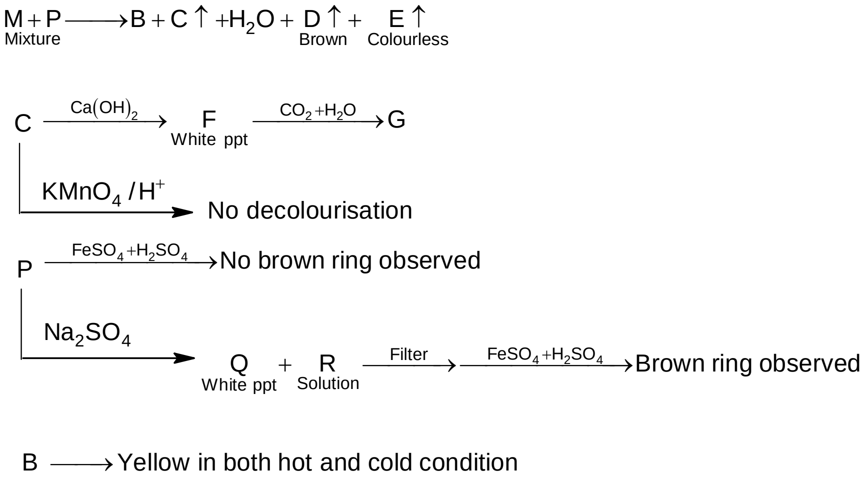
(Solubility in water)

Space for Rough work

Comprehension type (Only One Option Correct)

This section contains **1 paragraph**, describing theory, experiments, data etc. Three questions relate to the one paragraph. Each question has **only one** correct answer among the four given options (A), (B), (C) and (D).

Paragraph for Questions 09 & 11



$$\underset{\text{Mixture}}{M+P} \longrightarrow B + C\uparrow + H_2O + \underset{\text{Brown}}{D\uparrow} + \underset{\text{Colourless}}{E\uparrow}$$

$$C \xrightarrow{Ca(OH)_2} \underset{\text{White ppt}}{F} \xrightarrow{CO_2+H_2O} G$$

$$C \xrightarrow{KMnO_4/H^+} \text{No decolourisation}$$

$$P \xrightarrow{FeSO_4+H_2SO_4} \text{No brown ring observed}$$

$$P \xrightarrow{Na_2SO_4} \underset{\text{White ppt}}{Q} + \underset{\text{Solution}}{R} \xrightarrow{\text{Filter}} \xrightarrow{FeSO_4+H_2SO_4} \text{Brown ring observed}$$

$$B \longrightarrow \text{Yellow in both hot and cold condition}$$

9. What is the composition of original mixture?
(A) $ZnCO_3 + Zn(NO_3)_2$
(B) $Na_2CO_3 + NaNO_3$
(C) $PbCO_3 + Pb(NO_3)_2$
(D) $CuCO_3 + Cu(NO_3)_2$

10. What is F?
(A) $ZnSO_4$
(B) $PbSO_4$
(C) $CaSO_4$
(D) $CaCO_3$

11. $NO + E \longrightarrow$ Gas D

$D + H_2O \longrightarrow$ Product

(A) HNO_3
(B) $HNO_2 + HNO_3$
(C) $N_2O_5 + N_2O_3$
(D) HNO_2

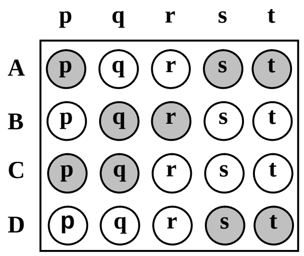
Space for Rough work

SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in ***Column I*** *are labelled A, B, C and D, while the statements in* ***Column II*** *are labelled p, q, r, s and t. Any given statement in* ***Column I*** *can have correct matching with* ***ONE OR MORE*** *statement(s) in* ***Column II.*** *The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



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1. Match column I with column II such that reagent present in column II cannot be used for distinguishing pair given in column I.

Column – I		Column – II	
(A)	Phenol and benzene	(p)	Br_2 water
(B)	CH_3CHO and $(Me_3C)_2CO$	(q)	Na
(C)	HCOOH and CH_3CHO	(r)	Na_2CO_3
(D)	Phenol and ethanol	(s)	$[Ag(NH_3)_2]$ OH
		(t)	$NaHCO_3$

2. Match column (I) with column (II).

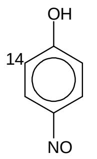
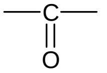
Column – I		Column – II	
(A)	$\left[CuCl_5\right]^{3-}$	(p)	Orbital involvd is $d_{x^2-y^2}$
(B)	$\left[Cu\left(NH_3\right)_4\right]^{2+}$	(q)	Orbital involved is d_{z^2}
(C)	$\left[FeF_6\right]^{3-}$	(r)	Orbital involved is d_{xy}
(D)	$\left[Ni\left(CO\right)_4\right]$	(s)	Tetrahedral
		(t)	Square planner

Space for Rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **6 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. How many tautomeric structures are possible for the compound  which have got a  $-\underset{\underset{O}{\|}}{C}-$ group.

2. If a solid A^+B^- having ZnS structure is heated so that the ions along two of the axis passing through the face centre particles are lost and bivalent ion (Z) enters here to maintain the electrical neutrality, so that the new formula unit becomes $A_xB_yZ_c$, report the value of x + y + c.

3. The area and circumference of n^{th} orbit of a H atom are 549 $\overset{o}{A}^2$ and 83.05 $\overset{o}{A}$ respectively. The maximum number of lines that can be produced when the electron falls from this orbit to 2th orbit is

4. Calculate the $\left(\frac{pH}{1.428}\right)$ at equilibrium point when a solution of 10^{-6} M acetic acid treated with a solution of 10^{-6} NaOH, K_a for acid = 1.9×10^{-5} (Answer given in whole integer).

5. Dissolved O_2 in water is determined by using a redox reaction:

$$\begin{array}{l} 2Mn^{+2}(aq) + 4OH^-(aq) + O_2(g) \\ \qquad\qquad\Big\downarrow \\ 2MnO_2(s) + 2H_2O(\ell) \end{array}$$

How many equivalent of O_2 will be required to react with 1 mole of Mn^{+2}?

6. At high temperature, the following equilibrium exist in a mixture of carbon, oxygen and their compound:

$$C(s) + O_2(g) \rightleftharpoons CO_2(g)\, Keq_1 = 10^{-2}$$

$$2C(s) + O_2(g) \rightleftharpoons 2CO(g)\, Keq_2 = 10^{-3}$$

$$C(s) + CO_2(g) \rightleftharpoons 2CO(g)\, Keq_3 = X$$

$$2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g)\, Keq_4 = Y$$

What will be the ratio of X and Y?

Mathematics PART – III

SECTION – A

(Only One Option Correct Type)

This section contains **4 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

1. If a, b, c are three distinct non-zero complex numbers such that |a| = |b| = |c| and the equation
$az^2 + bz + c = 0$ has a root whose modulus is 1 than
(A) $b^2 = ac$ (B) $c^2 = ab$
(C) $a^2 = bc$ (D) none of these

2. If f: [0, 1] → [0, ∞) is differentiable function with decreasing first derivative, such that f(0) = 0 and f′(x) > 0 then
(A) $\int_0^1 \frac{dx}{f^2(x)+1} > \frac{f(1)}{f'(1)}$ (B) $\int_0^1 \frac{dx}{f^2(x)+1} < \frac{f(1)}{f'(1)}$
(C) $\int_0^1 \frac{dx}{f^2(x)+1} > \frac{\tan^{-1}(f(1))}{f'(1)}$ (D) $\int_0^1 \frac{dx}{f^2(x)+1} = \frac{f(1)}{f'(1)}$

3. Let P(x) is polynomial of degree n, having n real and distinct non zero roots. Q(x) is another polynomial of degree m such that Q′(x) = 0 has at least one real root not equal to any of the root of P(x) = 0. If n, m > 2 then which of the following statements is correct
(I) : $x^2P''(x) + 3xP'(x) + P(x) = 0$ has n real roots
(II) : $P'(x)Q'(x) + P(x)Q''(x) = 0$ has at least one real root
(A) only (I) (B) only (II)
(C) both (I) and (II) (D) neither (I) nor (II)

4. Let a ∈ [0, 4]. The maximum area bounded by the curves y = 1 – |x – 1| and y = |2x – a| is
(A) $\frac{1}{3}$ (B) $\frac{1}{4}$
(C) $\frac{1}{2}$ (D) none of these

Space for rough work

(One or More than One Options Correct Type)

This section contains **4 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** are correct.

5. Let f, g and h are function differentiable on some open interval around 0 and satisfy the equations $f' = 2f^2gh + \frac{1}{gh}, f(0) = 1$, $g' = fg^2h + \frac{4}{fh}, g(0) = 1$ and $h' = 3fgh^2 + \frac{1}{fg}, h(0) = 1$. The function f is given by

(A) $f(x) = 2^{-1/12}\left(\frac{\sin\left(6x + \frac{\pi}{4}\right)}{\cos^2\left(6x + \frac{\pi}{4}\right)}\right)^{1/6}$

(B) $f(x) = 2^{-1/6}\left(\frac{\sin\left(6x + \frac{\pi}{4}\right)}{\cos^2\left(6x + \frac{\pi}{4}\right)}\right)^{1/12}$

(C) f(x) = $(\sec 12x)^{1/12}$ $(\sec 12x + \tan 12x)^{1/4}$

(D) f(x) = $(\sec 12x)^{1/4}$ $(\sec 12x + \tan 12x)^{1/12}$

6. Let PA and PB are two tangents drawn from point P, outside the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, (a > b). If H_1 and H_2 are reflections of F_1 and F_2 respectively in the tangents PA and PB, then which of the following option(s) are correct

(A) $\angle PH_2F_1 = \angle PF_2H_1$

(B) mid-points of line joining F_1H_1 lies on a circle of radius a

(C) ΔPF_2H_1 and ΔPF_1H_2 are similar

(D) ΔPF_2H_1 and ΔPF_1H_2 are congruent

7. Let f, g and h are quadratic polynomials such that f(x) f(x + 1) = g(h(x)). If α_1, β_1 are roots of f(x) = 0, α_2, β_2 are roots of g(x) = 0 and α_3, β_3 are roots of h(x) = 0 then which of the following is/are true?

(A) $\alpha_1 + \beta_1 = \alpha_2 + \beta_2$

(B) $\alpha_1 + \beta_1 = \alpha_3 + \beta_3$

(C) $\alpha_1\beta_1 = \alpha_2\beta_2$

(D) $\alpha_1\beta_1 = \alpha_3\beta_3$

8. For any real number $\lambda \geq 1$. let $f(\lambda)$ denote the real solution of the equation $x(1 + \ln x) = \lambda$ then

(A) $f(\lambda)$ is strictly increasing function in its domain

(B) $\lim_{\lambda \to \infty} f(\lambda) = \infty$

(C) if h(x) = x(1 + ln x), h: [1, ∞) → [1, ∞) then $f(\lambda)$ is inverse function of h(x)

(D) $\lim_{\lambda \to \infty} \frac{f(\lambda)\ln\lambda}{\lambda} = 1$

Space for rough work

Comprehension type (Only One Option Correct)

This section contains **1 paragraph**, describing theory, experiments, data etc. Three questions relate to the one paragraph. Each question has **only one** correct answer among the four given options (A), (B), (C) and (D).

Paragraph for Questions 09 & 11

Read the following write up carefully and answer the following questions:
Dot product of two vectors $\vec{A} = (a_1, a_2, a_3)$ and $\vec{B} = (b_1, b_2, b_3)$ is defined as $\vec{A}\cdot\vec{B} = a_1b_1 + a_2b_2 + a_3b_3$. Also, $\vec{A}\cdot\vec{B} = a_1b_1 + a_2b_2$ for $\vec{A} = (a_1, a_2)$ and $\vec{B} = (b_1, b_2)$. Using these definition of dot product and algebra it can easily be proved that following equations/in-equations holds true

(I) $\vec{A}\cdot\vec{B} = \vec{B}\cdot\vec{A}$ (II) $\vec{A}\left(\vec{B}+\vec{C}\right) = \vec{A}\cdot\vec{B} + \vec{A}\cdot\vec{C}$ (III) $c\left(\vec{A}\cdot\vec{B}\right) = \left(c\vec{A}\right)\cdot\vec{B} = \vec{A}\cdot\left(c\vec{B}\right)$

9. If the dot product of two vectors $\vec{A} = (a_1, a_2)$ and $\vec{B} = (b_1, b_2)$ is defined as $\vec{A}\cdot\vec{B} = 2a_1b_1 + a_2b_2 + a_1b_2 + a_2b_1$. And other algebraic operations vectors remains as usual then

(A) (II) holds true
(B) (II) and (III) do not hold true
(C) all of (I), (II), (III) do not hold true
(D) none of these

10. If the dot product of two vectors $\vec{A} = (a_1, a_2)$ and $\vec{B} = (b_1, b_2)$ is defined as $\vec{A}\cdot\vec{B} = \sqrt{a_1b_1} + \sqrt{a_2b_2} + 2\sqrt{a_2b_1} + 2\sqrt{a_1b_2}$ and modulus of $\vec{A}$ is defined as $\left|\vec{A}\right| = a_1 + a_2$, then which of the following is always true for a_i, $b_i > 0$, $\forall$ i = 1, 2, 3

(A) $\left|\vec{A}\cdot\vec{B}\right| = \left|\vec{A}\right|\cdot\left|\vec{B}\right|$
(B) $\left|\vec{A}\cdot\vec{B}\right| > \frac{3}{2}\left|\vec{A}\right| + \left|\vec{B}\right|$
(C) $\left|\vec{A}\cdot\vec{B}\right| \le \frac{3}{2}\left(\left|\vec{A}\right| + \left|\vec{B}\right|\right)$
(D) $\left|\vec{A}\cdot\vec{B}\right| = \frac{3}{2}\left|\vec{A}\right|$

11. If however dot product of two vectors $\vec{A} = (a_1, a_2, a_3)$ and $\vec{B} = (b_1, b_2, b_3)$ in defined as $\vec{A}\cdot\vec{B} = \left|\sum_{i=1}^{3} a_ib_i\right|$, while all other algebraic operations remains as usual, then

(A) (I) is not true
(B) (II) is not true
(C) all (I), (II), (III) are true
(D) (II) and (III) are true

Space for rough work

SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in ***Column I*** *are labelled A, B, C and D, while the statements in* ***Column II*** *are labelled p, q, r, s and t. Any given statement in* ***Column I*** *can have correct matching with* ***ONE OR MORE*** *statement(s) in* ***Column II.*** *The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

---

1. Parabola $y^2 = 4ax$ is given. Three normals are drawn from any point (N) inside the parabola. Tangents drawn at the intersection points (P, Q, R) of parabola and normals form an equilateral triangle (ΔABC). Then match the following Column-I with Column-II

Column – I		**Column – II**	
(A)	Circumcentre of ΔABC	(p)	$\left(3a, 2a\sqrt{3}\right)$
(B)	Co-ordinates of N	(q)	(5a, 0)
(C)	Co-ordinate of a point at a distance 'a' along negative x-axis from one of the intersection point (P, Q, R) is	(r)	(0, 0)
(D)	Co-ordinates of intersection points	(s)	(–a, 0)
		(t)	$\left(3a, -2a\sqrt{3}\right)$

2. Match the following Column-I with Column-II

Column – I		**Column – II**	
(A)	If $f(x) + f''(x) = -x\, g(x) f'(x)$ and $g(x) > 0$ $x \in R$ then $(f(x))^2 + [f'(x)]^2$ has k as its maxima. Then k is	(p)	0
(B)	If $f^2(x) + f(x) = g(x)$ and g(x) is always increasing then the minimum value that f(x) can attain so that f(x) also increasing is k. Then (2(k + 1)) is	(q)	1
(C)	If $g(x) = f(x)\int_0^x f(t)\,dt$ is non-increasing function and f(x) is continuous in R then f(1) is	(r)	2
(D)	If f(x) is differentiable function and $f(x) = x^2 + \int_0^x e^{-t} f(x-t)\,dt$ then $f(-1) = \frac{k}{3}$ then k is	(s)	–1
		(t)	3

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **6 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. If $\lim\limits_{r\to\infty} \dfrac{r^C \int_0^{\pi/2} x^r \sin x dx}{\int_0^{\pi/2} x^r \cos x dx} = L$, then value of $\pi L - C$ is equal to _____ ($C \in R$, $L > 0$)

2. Let f: R → R, satisfy the equation $(x - y)f(x + y) - (x + y)f(x - y) = 4xy(x^2 - y^2)\ \forall\ x, y \in R$. If $f(1) = -2$, then the absolute value of difference between maximum and minimum value of f(x) on the interval $x \in \left[-\sqrt{3}, \sqrt{3}\right]$ is _____

3. The number of all the pairs of natural numbers (x, y) which satisfy the equation
$2x(xy - 2y - 3) = (x + y)(3x + y)$ is _____

4. The number of distinct solutions $x \in [0, \pi]$ which satisfy the equation $8 \cos x \cos 4x \cos 5x = 1$ is k then $\dfrac{k}{2}$ is equal to _____

5. n biased coins, with m^th coin having probability of throwing head equal to $\dfrac{1}{(2m+1)}$ (m = 1, 2, ….., n), are tossed once. The probability of getting an odd numbers of heads, if results for each coin are independent, is $\dfrac{\alpha n}{\beta n + \gamma}$ then $\alpha + \beta + \gamma$ is equal to _____

6. Consider the parabola $y = ax - bx^2$. If the least positive value of a for which there exist $\alpha, \beta \in R - \{0\}$ such that both the point (α, β) and (β, α) lies on the given parabola is k then [k] is equal to _____

Space for rough work

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ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST– I
(PAPER-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**B**	**B**	**A**
2.	**D**	**B**	**B**
3.	**D**	**A**	**C**
4.	**C**	**C**	**A**
5.	**A, D**	**A, B, D**	**A, C**
6.	**B, D**	**A, B, C**	**A, B, C, D**
7.	**A, C**	**B, D**	**A, C, D**
8.	**B, C, D**	**B, C, D**	**A, B, C, D**
9.	**B**	**C**	**A**
10.	**D**	**D**	**C**
11.	**B**	**A**	**B**
1.	(A) → (q) (B) → (p, q, s, t) (C) → (p, q, s, t) (D) → (r, s)	(A → s, t) (B → p, q, r, t) (C → p, s) (D → q, s, t)	(A) → (s) (B) → (q) (C) → (s) (D) → (p, r, t)
2.	(A) → (t) (B) → (q, s) (C) → (p, q, r) (D) → (t)	(A → q) (B → p, t) (C → p, q) (D → s)	(A) → (p) (B) → (q) (C) → (p) (D) → (r)
1.	**1**	**4**	**3**
2.	**1**	**7**	**4**
3.	**2**	**3**	**3**
4.	**8**	**5**	**5**
5.	**2**	**2**	**4**
6.	**3**	**1**	**3**

Physics

PART – I

SECTION – A

3. $\vec{F}_{net} = \frac{d\vec{p}}{dt} = 15\hat{i} - 20t\hat{j} - 50\hat{k} = \vec{F}_{real} + \vec{F}_{pseudo}$ and $\vec{F}_{real} = mg(-\hat{k}) = -50\hat{k}$ N

4. $Q = KA\frac{dT}{dx}$

$$\frac{Q}{A}\int_0^x dx = K_0\int_0^T (1+T)dT$$

$$\frac{Q}{A}x = K_0\left(T + \frac{T^2}{2}\right)_0^T$$

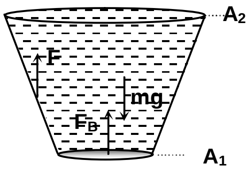
by solving

$$\frac{Q}{A}x = K_0\left(T + \frac{T^2}{2}\right)$$

So, $\frac{Q}{A}x_0 = K_0\left(300 + \frac{(300)^2}{2}\right)$

So, at $x = 2x_0$ temperature $T \approx 425$ K

5. $m = V\rho = \left[A_1 + A_2 + \sqrt{A_1A_2}\right]H\rho$



$$\rho H = \frac{m}{\left[A_1 + A_2 + \sqrt{A_1A_2}\right]}$$

$A_2\uparrow \Rightarrow \rho H\downarrow$

$P_1 = \rho_1 g H_1$

$P_2 = \rho_2 g H_2 \Rightarrow P_1 > P_2$

$F = mg - F_B = mg - PA_1$

$F_1 = mg - A_1P_1,$

$F_2 = mg - A_1P_2$

6. $U = \frac{-2GMm}{\sqrt{d^2+y^2}} + \frac{-GM^2}{2d}$

$$= \frac{-2GMm}{\sqrt{d^2+y^2}} - \frac{2Gm^2}{2d}$$

$$= -2Gm^2\left[\frac{2}{\sqrt{d^2+y^2}} + \frac{1}{d}\right]$$

$$= |\Delta U| = \frac{1}{2}mv^2$$

7. $v = \lambda f = \frac{h}{p} \times \frac{E}{h} = \frac{E}{P} = \frac{P}{2m} = \left(\frac{v_{\text{Particle}}}{2}\right)$

8. $y = 5e^{-(\sqrt{a}\,x + \sqrt{b}\,t)^2}$

09-11. h = 160 m

$$t_{1_0} = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2 \times 160}{10}} = 4\sqrt{2}\,\text{sec}$$

Velocity of system after collision in vertical direction, v_{10} = 30 m/s;

Velocity of system after collision in horizontal direction, v_{2_0} = ¼ × 40 = 10 m/s

$$v_{1_0}'^2 = 900 + 2 \times 10 \times 80 \Rightarrow v_{1_0}' = 50\text{ m/s}$$

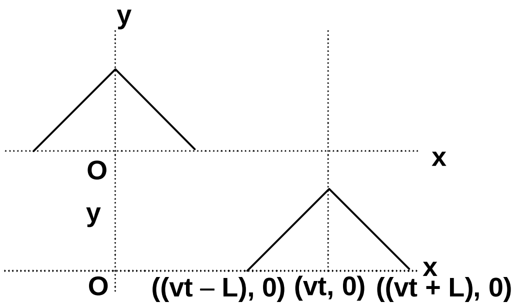
$$t_{2_0} = \frac{50 - 30}{10} = 2\text{ sec}$$

$$t_{1_0} = 4\text{ sec}$$

SECTION - B

2. Shape of sting at *t* = 0 is given by.

$$y(x,t) = \begin{cases} 0 & \text{if} \quad -\infty < x \le vt - L \\ h(L + x - vt)/L & \text{if} \quad vt - L \le x \le vt \\ h(L - x + vt)/L & \text{if} \quad vt \le x \le vt + L \\ 0 & \text{if} \quad vt + L \le x < \infty \end{cases}$$



SECTION – C

2. $10g\sin\frac{\theta}{2} = 5g\sin\theta$

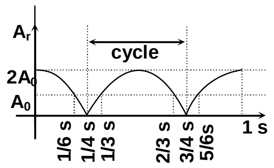
$$10\sin\frac{\theta}{2} = 5\,(2\sin\theta/2\cos\theta/2)$$

$$\cos\theta/2 = 1$$

4. $y_1 = A\sin\omega_1 t$

$y_2 = A\sin\omega_2 t$

$$y_r = 2A\cos\left\{\frac{(\omega_2 - \omega_1)}{2}t\right\}\left\{\sin\frac{(\omega_2 + \omega_1)}{2}t\right\}$$



Resultant amplitude $A_r = 2A|\cos(\Delta\omega)t/2|$

$$(\Delta\omega)\frac{t}{2} = \frac{\pi}{2} \Rightarrow t = \frac{1}{4}s$$

$$(\Delta\omega)\frac{t}{2} = \frac{\pi}{3} \Rightarrow t = \frac{1}{6}s$$

In one cycle of intensity of 1/2s, the detector remain idle for

$$2\left(\frac{1}{4} - \frac{1}{6}\right)s = \frac{1}{6}\text{sec}$$

$\therefore$ In ½ sec cycle, active time is $\left(\frac{1}{2}-\frac{1}{6}\right)$ = 1/3 sec

$\therefore$ In 12 sec interval, active time is $12\times\frac{(1/3)}{(1/2)}$ = 8 sec

6. $V_1=\frac{(2C)V}{3C}=\frac{2}{3}V$

$U_1=\frac{1}{2}C\frac{4}{9}V^2=\frac{2CV^2}{9}$

$V_2=\frac{V}{3}$

$U_2=\frac{1}{2}(2C)\frac{V^2}{9}=C\frac{V^2}{9}=\frac{CV^2}{9}$

Initial total energy = $\frac{CV^2}{3}$

Final total energy = $\frac{1}{2}(2C)V^2=CV^2$

Charge flow through the battery $=2CV-\frac{2}{3}CV=\frac{4}{3}CV$

$\Rightarrow$ $W_{battery}=\frac{4}{3}CV^2$

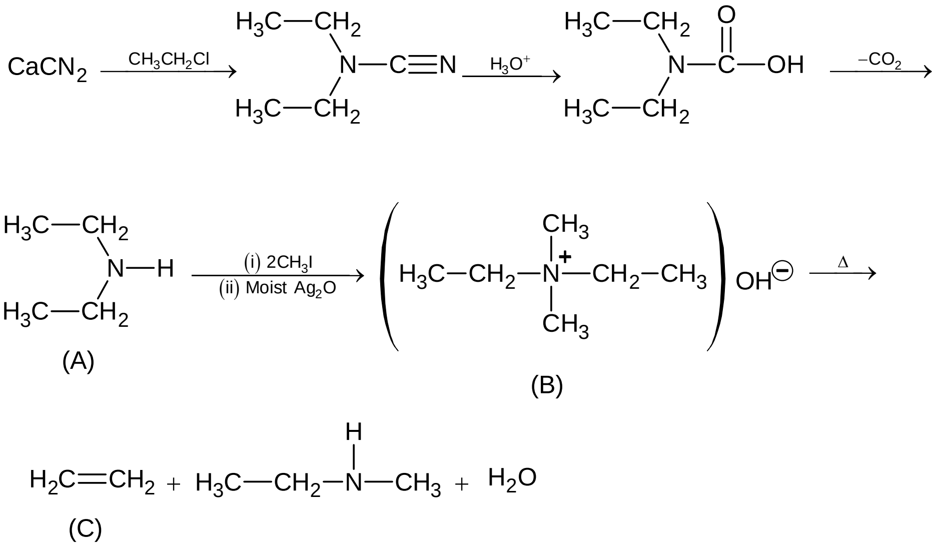
$\Rightarrow$ Heat dissipated $=\frac{4CV^2}{3}-\frac{2CV^2}{3}=\frac{2}{3}CV^2$

Chemistry

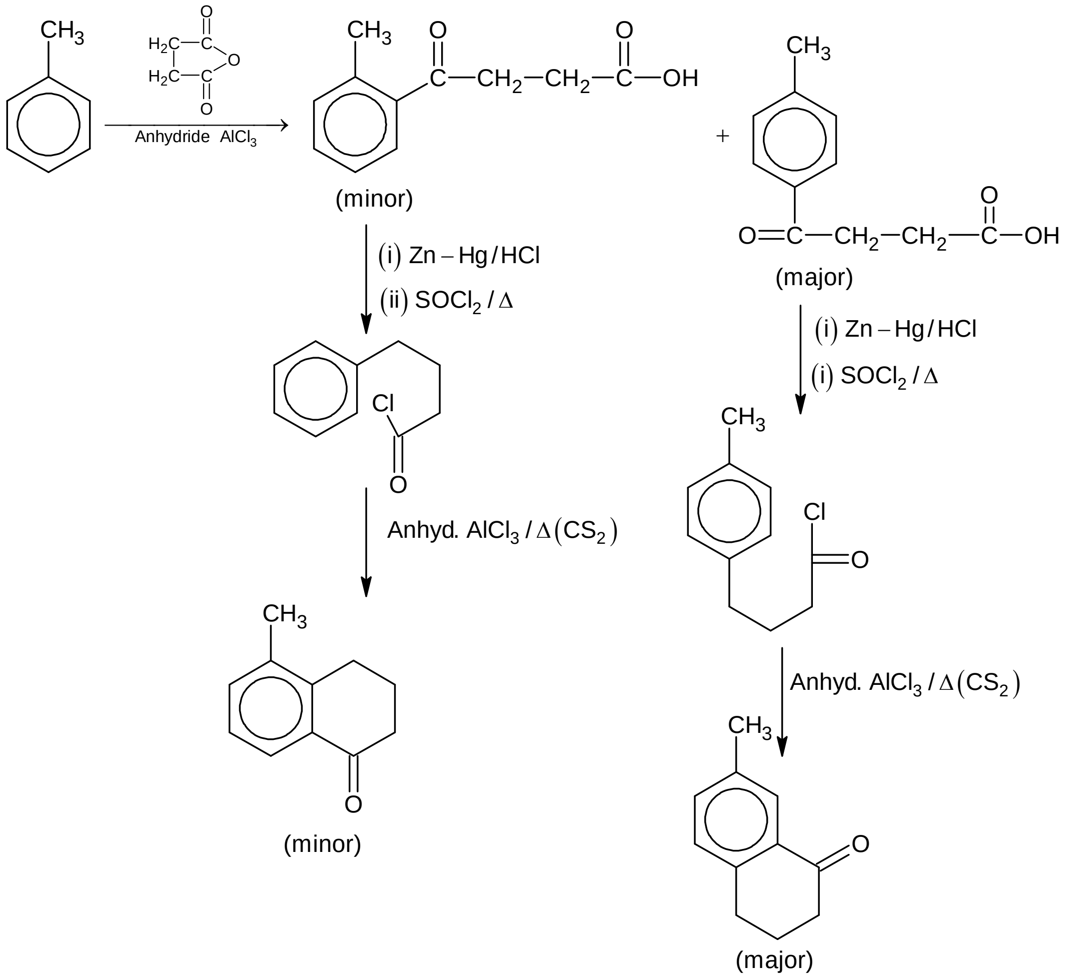
PART – II

SECTION – A

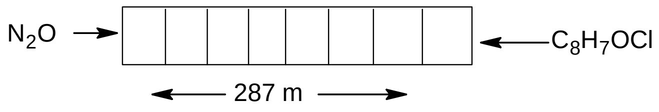
1.


CaCN2
CH3CH2Cl
H3C—CH2
N—C≡N
H3C—CH2
H3O+
H3C—CH2
O
N—C—OH
H3C—CH2
−CO2
H3C—CH2
N—H
H3C—CH2
(A)
(i) 2CH3I
(ii) Moist Ag2O
CH3
H3C—CH2—N+—CH2—CH3
CH3
OH⊖
Δ
(B)
H
H2C═CH2 + H3C—CH2—N—CH3 + H2O
(C)

2.


CH3
Anhydride AlCl3
(minor)
(i) Zn – Hg/HCl
(ii) SOCl2 / Δ
Cl
O
Anhyd. AlCl3 / Δ(CS2)
(minor)
+
O=C—CH2—CH2—C—OH
(major)
(i) Zn – Hg/HCl
(i) SOCl2 / Δ
Anhyd. AlCl3 / Δ(CS2)
(major)

3.


N2O
C8H7OCl
287 m

Molar weight of C_8H_7OCl = 8 × 12 + 7 × 1 + 16 + 35.5
= 154.5 g

Molar weight of N_2O = 2 × 14 + 16 = 44 g

According to Graham's Law of diffusion

$$\frac{r_{N_2O}}{r_{C_8H_7OCl}} = \sqrt{\frac{M_{C_8H_7OCl}}{M_{N_2O}}} = \sqrt{\frac{154.5}{44}} = \sqrt{3.5} = 1.87:1$$

$$d_{N_2O} = \frac{1.87}{2.87} \times 287 = 187^{th} \text{ row from } N_2O \text{ side.}$$

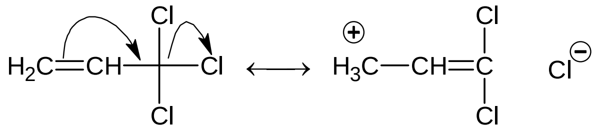
$$d_{C_8H_7OCl} = \frac{1.0}{2.87} \times 287 = 100^{th} \text{ row from weeping gas side.}$$

Therefore, the spectator from the side of N_2O in the 187^{th}. Row will be laughing and weeping simultaneously. Alternatively, the spectator from the side of weeping gas in 100^{th} row will laugh and weep.

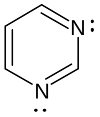
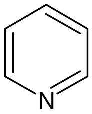
4. The given orbital diagram has two radial nodes, i.e. $n - \ell - 1 = 2$

$\therefore$ The orbital, in which electron is present is 3s.

5. (A)



These occurs decrease in electron density and hence the ionization potential increases.

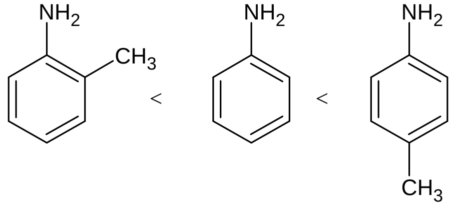
(B) Basic strength $\propto$ electron density over one N-atom  has lesser electron density over one N-atom than in 

(C) Heat of combustion $\propto \frac{1}{\text{Stability}}$

stability $\propto$ No. of α –H

and if no. of α–H of same stability $\propto$ ease of hyperconjugation.

(D) Conjugate acid of weaker base is stronger acid. Basic strength



6. B. pt. of CCl_4 < that of $SiCl_4$. The vapour must always be richer in more volatile component. Hence, the upper curve represents the composition of the vapour and the lower curve represents the composition of the solution at corresponding B. pt.

8. The correct basic order for (a) option

$$CH_3\overset{\ominus}{O} > CH_3\overset{\ominus}{N}H > CH_3\overset{\ominus}{C}H_2$$

(-ve) charge on most electronegative atom	(-ve) charge on least electronegative atom

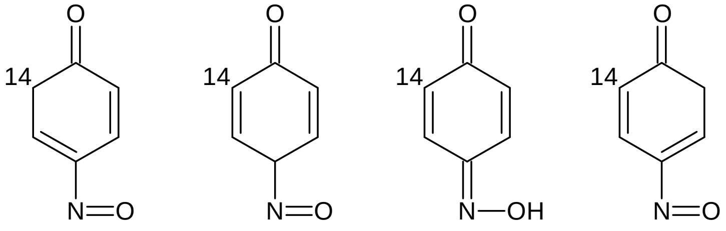
and it can also explain by its conjugate rest all option are correct.

Solution for the Q. No. 9 to 11.

M – $PbCO_3$
P – $Pb(NO_3)_2$
B – PbO
C – CO_2
D – NO_2
E – O_2
F – $CaCO_3$
G – $Ca(HCO_3)_2$
Q – $PbSO_4$
R – $NaNO_3$

SECTION –C

1.



2. $Z_{B^-} = 4 - 2 = 2$

$Z_{A^+} = 4$

$Z_{C^{-2}} = 1$

$\therefore A_4B_2Z_1$

$x + y + z = 7$

3. $\pi r^2 = 5.49\ \overset{o}{A}{}^2$

$2\pi r = 83.05\ \overset{o}{A}$

then $r = 13.22\ \overset{o}{A}$

$\because\ r = \dfrac{0.529 \times n^2}{Z}$

$\therefore\ 13.22 = \dfrac{0.529 \times n^2}{Z}$

$n = 5$

Number of maximum lines possible = 3

4.
$$\begin{array}{lcccc} & CH_3COOH + & NaOH \longrightarrow & CH_3COONa + & H_2O \\ \text{Int. No. of mole} & 10^{-6}V & 10^{-6}V & 0 & 0 \\ \text{at } t = t \text{ sec} & 0 & 0 & 10^{-6}V & \end{array}$$

$[CH_3COONa] = \dfrac{10^{-6}V}{2V}$

$= 5 \times 10^{-7} < 10^{-6}$.

$\left[OH^-\right] = \sqrt{\dfrac{K_w \times C}{K_a}}$

$= \sqrt{\dfrac{10^{-4} \times 10^{-7} \times 5}{1.9 \times 10^{-5}}}$

$= 2.63 \times 10^{-8} < 10^{-6}$

so $pOH = -\log(2.63 \times 10^{-8} + 10^{-7})$

$pH = 7$

$\Rightarrow \dfrac{pH}{1.42} = 5$

5. $Mn^{+2} \longrightarrow MnO_2 + 2e^-$

$4e^- + O_2 \longrightarrow 2H_2O$

1 Eq of Mn^{+2} = 1 Eq of O_2

(n = 2) (n = 4)

½ mole of Mn^{+2} = 1 Eq. of O_2

2 mole of Mn^{+2} = 4 Eq. of O_2

6. $$2C(s)+O_2(g) \rightleftharpoons 2CO(g) \qquad Keq = 10^{-3}$$

$$\underline{CO_2(g) \rightleftharpoons C(s)+O_2(g) \quad Keq = 10^{2}}$$

$$C(s)+CO_2(g) \rightleftharpoons 2CO(g) \qquad Keq = 10^{-1} = X$$

$$\underline{C(s)+O_2(g) \rightleftharpoons 2C(s)+CO_2(g) \quad Keq = 1/x = 10^{-1}}$$

$$2CO(g)+O_2(g) \rightleftharpoons 2CO_2(g) \quad Keq = 10^{-1} = Y$$

Hence X : Y = 1 : 1

Mathematics PART – III

SECTION – A

1. Let z_1, z_2 be the two roots with $|z_1| = 1$

$\because\ z_1z_2 = \dfrac{c}{a} \Rightarrow |z_2| = \left|\dfrac{c}{a}\right|\dfrac{1}{|z_1|} = 1$

$\Rightarrow\ z_1\bar{z}_1 = z_2\bar{z}_2 = 1$

$\because\ z_1 + z_2 = -\dfrac{b}{a}$ and $|b| = |a|$

$\Rightarrow |z_1 + z_2|^2 = 1$

$\Rightarrow (z_1 + z_2)(\bar{z}_1 + \bar{z}_2) = 1 \Rightarrow (z_1 + z_2)\left(\dfrac{1}{z_1} + \dfrac{1}{z_2}\right) = 1$

$\Rightarrow (z_1 + z_2)^2 = z_1z_2 \Rightarrow b^2 = ac$

2. For $x \in [0, 1]$, $f'(x) \ge f'(1)$ ($\because$ $f'(x)$ is decreasing)

$\Rightarrow\ \dfrac{f'(x)}{f^2(x)+1} \ge \dfrac{f'(1)}{f^2(x)+1}$

$\Rightarrow\ \displaystyle\int_0^1 \frac{f'(x)}{f^2(x)+1}dx \ge f'(1)\int_0^1 \frac{dx}{f^2(x)+1}$

$\Rightarrow\ \tan^{-1} f(x)\Big|_0^1 \ge f'(1)\displaystyle\int_0^1 \frac{dx}{f^2(x)+1}$

$\Rightarrow\ \displaystyle\int_0^1 \frac{dx}{f^2(x)+1} \le \frac{\tan^{-1} f(1)}{f'(1)}$

$\because\ \tan^{-1}\alpha < \alpha\ \forall\ \alpha > 0 \Rightarrow \dfrac{\tan^{-1} f(1)}{f'(1)} < \dfrac{f(1)}{f'(1)}$

$\Rightarrow\ \displaystyle\int_0^1 \frac{dx}{f^2(x)+1} < \frac{f(1)}{f'(1)}$

3. $\because$ P(x) = 0 has n real roots

$\Rightarrow$ x P(x) = 0 has n + 1 real roots

$\Rightarrow \dfrac{d}{dx}\left(xP(x)\right) = 0$

$\Rightarrow$ x P′(x) + P(x) = 0 has n real roots

$\Rightarrow$ x(x P′(x) + P(x)) = 0 has n + 1 real roots

$\Rightarrow \dfrac{d}{dx}\left(x^2P'(x) + xP(x)\right) = 0$ has n real roots

i.e. x^2 P″(x) + 3x P′(x) + P(x) = 0 has n real roots $\Rightarrow$ (I) is true

Let one of the roots of P(x) = 0 is α, and one root of Q′(x) = 0 is β as given, $\alpha \neq \beta$

$\because$ P′(x) Q′(x) + P(x) Q″(x) = 0

$\Rightarrow \dfrac{d}{dx}\left(P(x)Q'(x)\right) = 0$

Consider f(x) = P(x) Q′(x)

f(α) = 0, f(β) = 0

Hence, by Rolles theorem $\dfrac{d}{dx}\left(P(x)Q'(x)\right) = 0$ has at least one real root lying between α and β

4. **Case-I:**

If a $\in$ [0, 1], the curves intersect at $\left(\dfrac{a}{3}, \dfrac{a}{3}\right)$ and (a, a). The bounded region is contained in the triangle with vertices (0, 0), $\left(\dfrac{1}{2}, 0\right)$ and (1, 1) with area = $\dfrac{1}{4}$

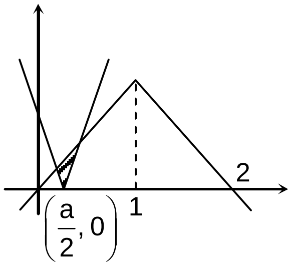
Hence, area can not exceed $\dfrac{1}{4}$

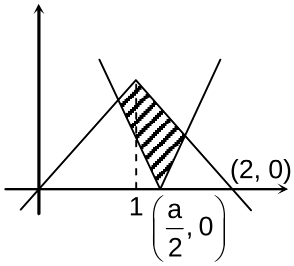
Case-II:

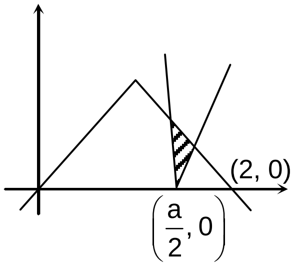
If a $\in$ [1, 3]. In this case the bounded region is a quadrilateral with four vertices $\left(\dfrac{a}{3}, \dfrac{a}{3}\right)$, $\left(\dfrac{a}{2}, 0\right)$, $\left(\dfrac{a+2}{3}, \dfrac{4-a}{3}\right)$ and (1, 1). In this case area bounded = $1 - \dfrac{1}{2}\cdot\dfrac{a}{3}\cdot\dfrac{a}{2} - \dfrac{1}{2}\left(\dfrac{4-a}{3}\right)\left(2-\dfrac{a}{2}\right)$

= $\dfrac{1}{3} - \dfrac{(a-2)^2}{6} \le \dfrac{1}{3}$

Case-III: If a $\in$ [3, 4]. This case is symmetric with case-I







5. Multiplying the first DE by gh, the second by fh and the third by fg, and adding the equations gives

$(fgh)' = 6(fgh)^2 + 6$

Let f(x) g(x) h(x) = k(x)

We have $k'(x) = 6(k(x))^2 + 6$

Integrating and using k(0) = 1 gives

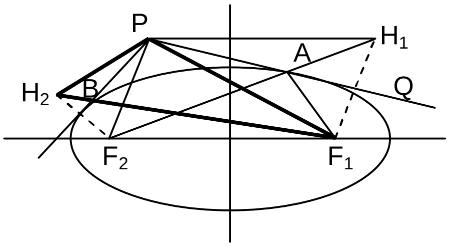
k(x) = $\tan\left(6x + \dfrac{\pi}{4}\right)$

Now 1st DE $\Rightarrow \dfrac{f'(x)}{f(x)} = 2k(x) + \dfrac{1}{k(x)}$

$\Rightarrow \dfrac{f'(x)}{f(x)} = 2\tan\left(6x + \dfrac{\pi}{4}\right) + \cot\left(6x + \dfrac{\pi}{4}\right)$

Integrating and using f(0) = 1 gives option A and C

6. By reflection property of ellipse $\angle PAF_2 = \angle QAF_1$
$\because$ H_1 is reflection of F_1 $\therefore$ $\angle QAH_1 = \angle QAF_1$
Now $PH_2 = PF_2$, $PH_1 = PF_1$
and $F_2H_1 = F_2A + AF_1 = 2a$
and $F_1H_2 = F_1B + BH_2 = F_1B + F_2B = 2a$
Hence, ΔPF_2H_1 and ΔPF_1H_2 are congruent as all three sides are equal
This leads to all the options



7. Let $f(x) = a(x - \alpha_1)(x - \beta_1)$
$\Rightarrow f(x)\, f(x + 1) = a^2(x - \alpha_1)(x - \beta_1 + 1)(x - \beta_1)(x - \alpha_1 + 1)$
$= a^2(x^2 + x - \alpha_1 x - \beta_1 x + \alpha_1\beta_1 - \alpha_1)(x^2 + x - \alpha_1 x - \beta_1 x + \alpha_1\beta_1 - \beta_1)$
$\Rightarrow f(x)\, f(x + 1) = a^2[(x^2 - (\alpha_1 + \beta_1 - 1)\, x + \alpha_1\beta_1) - \alpha_1] \times [(x^2 - (\alpha_1 + \beta_1 - 1)\, x + \alpha_1\beta_1) - \beta_1]$
Hence, $g(x) = a^2(x - \alpha_1)(x - \beta_1)$ and $h(x) = x^2 - (\alpha_1 + \beta_1 - 1) + \alpha_1\beta_1$

8. Consider $h(x) = x(1 + \ln x)$, $h: [1, \infty) \to [1, \infty)$
Clearly h(x) to increasing function in its domain
$\because$ $f(\lambda)$ denotes the solution of $x(1 + \ln x) = \lambda$
$\therefore$ $f: [1, \infty) \to [1, \infty)$, f is inverse function of h(x)
As $\lim\limits_{\lambda\to\infty} h(\lambda) = \infty \Rightarrow \lim\limits_{\lambda\to\infty} f(\lambda) = \infty$

$$f'(\lambda) = \frac{1}{h'(x)\big|_{x=f(\lambda)}} \Rightarrow f'(\lambda) = \frac{1}{2 + \ln x}\bigg|_{x=f(\lambda)} = \frac{1}{2 + \ln(f(\lambda))}$$

Now consider $L = \lim\limits_{\lambda\to\infty} \dfrac{f(\lambda)\ln\lambda}{\lambda} = \lim\limits_{\lambda\to\infty} \dfrac{f(\lambda)\ln\lambda}{f(\lambda)\left(1 + \ln(f(\lambda))\right)} = \lim\limits_{\lambda\to\infty} \dfrac{\ln\lambda}{1 + \ln(f(\lambda))}$

By L'Hospitals Rule $L = \lim\limits_{\lambda\to\infty} \dfrac{1/\lambda}{f'(\lambda)f(\lambda)} = \lim\limits_{\lambda\to\infty} \dfrac{f(\lambda)}{\lambda f'(\lambda)} = \lim\limits_{\lambda\to\infty} \dfrac{2 + \ln f(\lambda)}{1 + \ln f(\lambda)}$

$$\Rightarrow L = \lim_{\lambda\to\infty} \left(\frac{\dfrac{2}{\ln f(\lambda)} + 1}{\dfrac{1}{\ln f(\lambda)} + 1} \right) = 1$$

9. (I) holds true obviously
For (II): $\vec{A}\left(\vec{B} + \vec{C}\right) = (a_1, a_2)(b_1 + c_1, b_2 + c_2)$
$= 2a_1(b_1 + c_1) + a_2(b_2 + c_2) + a_1(b_2 + c_2) + a_2(b_1 + c_1)$
$= (2a_1b_1 + a_2b_2 + a_1b_2 + a_2b_1) + (2a_1c_1 + a_2c_2 + a_1c_2 + a_2c_1)$
$= \vec{A}\cdot\vec{B} + \vec{A}\cdot\vec{C}$
Similarly it can be checked that (III) also holds true

10. $\vec{A}\cdot\vec{B} = \sqrt{a_1b_1} + \sqrt{a_2b_2} + 2\sqrt{a_2b_1} + 2\sqrt{a_1b_2}$

$$\Rightarrow\ \vec{A}\cdot\vec{B} \le \left(\frac{a_1+b_1}{2}\right)+\left(\frac{a_2+b_2}{2}\right)+\left(a_2+b_1\right)+\left(a_1+b_2\right)\ \le \frac{3}{2}\left(\left(a_1+a_2\right)+\left(b_1+b_2\right)\right)$$

$$\Rightarrow\ \vec{A}\cdot\vec{B} \le \frac{3}{2}\left(\left|\vec{A}\right|+\left|\vec{B}\right|\right)$$

11. $\vec{A}\cdot\vec{B} = \left|a_1b_1+a_2b_2+a_3b_3\right| = \vec{B}\cdot\vec{A}$

Hence, (I) holds true

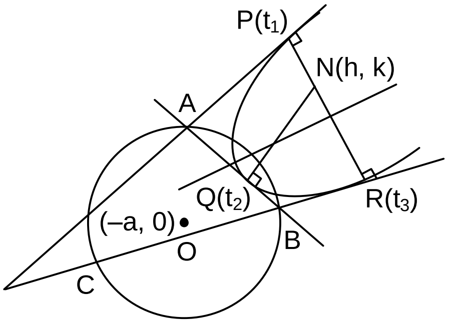
$\vec{A}\left(\vec{B}+\vec{C}\right) = \left|a_1\left(b_1+c_1\right)+a_2\left(b_2+c_2\right)+a_3\left(b_3+c_3\right)\right| = \left|\left(a_1b_1+a_2b_2+a_3b_3\right)+\left(a_1c_1+a_2c_2+a_3c_3\right)\right|$

$\ne \left|a_1b_1+a_2b_2+a_3b_3\right|+\left|a_1c_1+a_2c_2+a_3c_3\right|$

$\Rightarrow$ (II) Don't hold true

Similarly (III) can be checked

SECTION – B



1. Normal $y + tx = at^3 + 2at$

$\Rightarrow at^3 + (2a - h)t - k = 0$

$\Rightarrow t_1 + t_2 + t_3 = 0 \Rightarrow t_3 = -(t_1 + t_2)$ ….. (1)

$\Rightarrow t_1t_2 + t_2t_3 + t_3t_1 = \dfrac{2a-h}{a}$ ….. (2)

Also, $t_1t_2t_3 = \dfrac{k}{a}$ ….. (3)

$\Rightarrow \Delta ABC$ is equilateral

So, $G \equiv H \equiv O$

$G \equiv \left(\frac{a}{3}\left(t_1t_2+t_2t_3+t_3t_1\right), \frac{a}{3}\left(t_1+t_2+t_2+t_3+t_3+t_1\right)\right)$

$G \equiv \left(\frac{a}{3}\left(t_1t_2+t_2t_3+t_3t_1\right), 0\right)$ ….. (4)

$H \equiv \left(-a, \frac{a}{3}\left(t_1+t_2+t_3+t_1t_2t_3\right)\right)$ ….. (5)

Comparing (4) and (5), $t_1t_2t_3 = 0$ and from (3), $k = 0$

From equation (2), we get $\dfrac{2a-h}{a}\times\dfrac{a}{3} = -a$

$2a - h = -3a$

$h = 5a$

$\Rightarrow O \equiv$ circumcentre of $\Delta ABC = (-a, 0)$

Image of O will lie on circle

$\therefore\ N \equiv (5a, 0)$

$\Rightarrow$ One of the intersection point lie on vertex ($\because\ k = 0$)

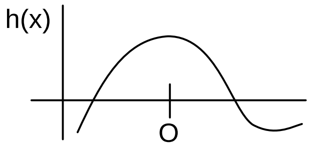
So, $t_2 = 0$

$\Rightarrow at^3 + (2a - 5a)t = 0$

$\Rightarrow t^3 - 3t = 0 \Rightarrow t(t^2 - 3) = 0$

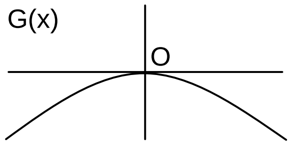
$t = 0, \pm\sqrt{3}$

$\therefore$ Intersection points $\Rightarrow P \equiv \left(3a, 2a\sqrt{3}\right)$, $Q \equiv (0, 0)$, $R \equiv \left(3a, -2a\sqrt{3}\right)$



2. (A) $(f(x))^2 + [f'(x)]^2 = h(x)$
$h'(x) = 2f(x)\,f'(x) + 2f'(x)\,f''(x)$
$= 2f'(x)\,(f(x) + f''(x))$
$= 2f'(x)\,\{-x\,g(x)\,f'(x)\}$
$= -2x(f'(x))^2\,g(x)$
So, $h'(x) < 0$ of $x > 0$ and $h'(x) > 0$ for $x < 0$
Then, $x = 0$ is a maxima

(B) $f^2(x) + f(x) = g(x)$
$2f(x)\,f'(x) + f'(x) = g'(x)$ and $g'(x) = f'(x)\,\{2f(x) + 1\}$
So, $g'(x) \geq 0$ as g(x) is increasing and for $f'(x) \geq 0$
$2f(x) + 1 \geq 0$
Hence, $f(x) \geq -\frac{1}{2}$



(C) Let $G(x) = \left[\int_0^x f(t)\,dt\right]^2$ ….. (1)

$G'(x) = 2f(x)\int_0^x f(t)\,dt$ and $\frac{G'(x)}{2} = g(x)$

and $G'(0) = 0 = g(0)$
Also, g(x) is non-increasing
Hence, $g(x) \geq 0\ x \in (-\infty, 0)$, $g(x) \leq 0\ x \in [0, \infty)$
i.e., $G'(x) \geq 0$ for $x \leq 0$, $G'(x) \leq 0$ for $x \geq 0$ and $G(0) = 0$
But G(x) (from equation (1)) ≥ 0
Hence, $G(x) = 0\ x \in R$

$\int_0^x f(t)\,dt = 0\ \ x \in R$

i.e., $f(x) = 0\ x \in R$
Hence, $f(1) = 0$

(D) $f(x) = x^2 + \int_0^x e^{-t} f(x-t)\,dt$ ….. (1)

$f(x) = x^2 + e^{-x}\int_0^x e^t f(x-x+t)\,dt$

$f(x) = x^2 + e^{-x}\int_0^x e^t f(t)\,dt$

$f'(x) = 2x + e^{-x}\left[e^x f(x)\right] - e^{-x}\int_0^x e^{tf} f(t)\,dt$

$f'(x) = 2x + f(x) - \int_0^x e^{-(x-t)} f(t)\,dt = 2x + f(x) + x^2 - f(x)$

$f'(x) = 2x + x^2$

$f(x) = x^2 + \frac{x^3}{3} + c$ and from equation (1) $f(0) = 0$

Hence, $c = 0$

i.e., $f(x) = x^2 + \frac{x^3}{3}$

$f(-1) = 1 - \frac{1}{3} = \frac{2}{3}$, $\frac{k}{3} = \frac{2}{3}$ $\therefore$ k = 2

SECTION – C

1. Let $f(r) = \int_0^{\pi/2} x^r \sin x dx$

Now, $\int_0^{\pi/2} x^r \cos x dx = \frac{x^{r+1}}{r+1}\cos x\Big|_0^{\pi/2} + \int_0^{\pi/2} \frac{x^{r+1}}{r+1}\sin x dx$

$\Rightarrow \int_0^{\pi/2} x^r \cos x dx = \frac{f(r+1)}{(r+1)}$

So, we have $\lim_{r\to\infty} \frac{r^C f(r)(r+1)}{f(r+1)} = L$

Now, consider $f(r) < \int_0^{\pi/2} x^r dx = \frac{\left(\frac{\pi}{2}\right)^{r+1}}{r+1}$

Also as $\sin x > \frac{2x}{\pi}$ $\forall$ $x \in \left(0, \frac{\pi}{2}\right)$

$f(r) > \int_0^{\pi/2} \frac{2}{\pi} x^{r+1} dx = \frac{\left(\frac{\pi}{2}\right)^{r+1}}{r+2}$

$\Rightarrow \frac{r}{r+2} < r\left(\frac{2}{\pi}\right)^{r+1} f(r) < \frac{r}{r+1}$

Hence, $\lim_{r\to\infty} \frac{f(r)}{f(r+1)} = \lim_{r\to\infty} \frac{r\left(\frac{2}{\pi}\right)^{r+1} f(r)}{(r+1)\left(\frac{2}{\pi}\right)^{r+2} f(r+1)} \times \frac{2(r+1)}{\pi r} = \frac{2}{\pi}$

Now, $\lim_{r\to\infty} r^C (r+1)\frac{f(r)}{f(r+1)} = L \Rightarrow \lim_{r\to\infty} \frac{2}{\pi} r^C (r+1) = L$

For positive L we should have C = –1 and L = $\frac{2}{\pi}$

2. Let x + y = α and x – y = $\beta \Rightarrow x = \frac{\alpha+\beta}{2}$ and $y = \frac{\alpha-\beta}{2}$

Given equation $\Rightarrow \beta f(\alpha) - \alpha f(\beta) = (\alpha^2 - \beta^2)\alpha\beta \Rightarrow \frac{f(\alpha)}{\alpha} - \alpha^2 = \frac{f(\beta)}{\beta} - \beta^2$

Hence, $\frac{f(x)}{x} - x^2 = k$ (k is some real constant)
$\Rightarrow f(x) = x^3 + kx$
$f(1) = -2 \Rightarrow k = -3$, $f(x) = x^3 - 3x$
$f'(x) = 3(x-1)(x+1)$ on the interval $x \in \left[-\sqrt{3}, \sqrt{3}\right]$ extreme value are –2 and 2

3. The given equation can be re-written as quadratic in y
$y^2 + (8x - 2x^2)y + (3x^2 + 6x) = 0$
Its discriminant to equal to

$= (64x^2 - 32x^3 + 4x^4) - 4(3x^2 + 6x) = 4x(x^3 - 8x^2 + 13x - 6)$
$= 4x(x - 6)(x - 1)^2$
For solutions in integers this discriminant should by perfect square this happens if and only if
$z^2 = x(x - 6) = (x - 3)^2 - 9$
$9 = (x - 3)^2 - z^2 = (x + z - 3)(x - z - 3)$ for name integer z
Checking all factorisations $9 = (-9) \times (-1) = (-3) \times (-3) = (-1) \times (-9) = 9 \times 1 = 3 \times 3 = 1 \times 9$
This gives all possible pairs (x, y) as (x, y) = (–2, 0), (–2, 24), (0, 0), (8, 4), (8, 60), (6, 12)
Therefore exactly three pairs of natural number (x, y) are possible

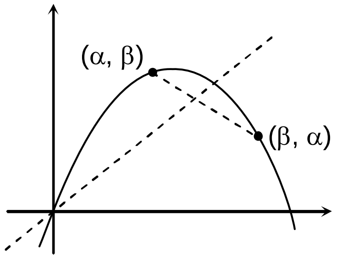
4. As no multiple of π nor any odd multiple of $\frac{\pi}{4}$ satisfies the equation we can multiply both sides by sin x cos 2x, which gives
$\sin 8x \cos 5x = 2 \sin 4x \cos 4x \cos 5x = 4 \sin 2x \cos 2x \cos 4x \sin 5x$
$= (\sin x \sin 2x)(8 \cos x \cos 4x \cos 5x) = \sin x \cos 2x$
$\Rightarrow \sin 13x + \sin 3x = \sin 3x - \sin x$
$\Rightarrow \sin 13x = \sin (-x)$
$\Rightarrow 13x = n\pi + (-1)^n (-x)$
Which gives 10 solutions $\frac{\pi}{12}, \frac{5\pi}{12}, \frac{7\pi}{12}, \frac{11\pi}{12}, \frac{\pi}{7}, \frac{2\pi}{7}, \frac{3\pi}{7}, \frac{4\pi}{7}, \frac{5\pi}{7}, \frac{6\pi}{7}$

5. Let $H_i \equiv$ the event of getting a head on i^{th} coin
$H \equiv$ getting odd number of heads on throwing n coins once

Coin Number:	1	2	3	4	……..	m	…..	n	
$P(H_i)$	$\frac{1}{3}$	$\frac{1}{5}$	$\frac{1}{7}$	$\frac{1}{9}$		$\frac{1}{(2m+1)}$	…..	$\frac{1}{(2n+1)}$	….. (1)
$P(\bar{H}_i)$	$\frac{2}{3}$	$\frac{4}{5}$	$\frac{6}{7}$	$\frac{8}{9}$	……..	$\frac{2m}{(2m+1)}$	…..	$\frac{2n}{(2n+1)}$	….. (2)

Now, P(H) = sum of series which has each term consisting of product of an odd number of terms from (1) and even number of terms from (2) such that total number of factors in each term is n
Consider the product $\left(\frac{2}{3} - \frac{1}{3}\right)\left(\frac{4}{5} - \frac{1}{5}\right)\left(\frac{6}{7} - \frac{1}{7}\right)\ldots\ldots\left(\frac{2n}{2n+1} - \frac{1}{2n+1}\right) = \frac{1}{2n+1}$
LHS = $P(\bar{H}) - P(H) = \frac{1}{2n+1}$
Also, $P(\bar{H}) + P(H) = 1$
$\Rightarrow P(H) = \frac{n}{2n+1}$
$\Rightarrow \alpha = 1, \beta = 2, \gamma = 1, \alpha + \beta + \gamma = 4$

6. (α, β) and (β, α) will lie on some line $y = -x + \lambda$
Solving line and parabola $-(-x + \lambda) = ax - bx^2$
$\Rightarrow bx^2 - (1 + a)x + \lambda = 0$ ….. (1)
Again, $y = a(\lambda - y) - b(\lambda - y)^2$
$\Rightarrow by^2 + y(1 + a - 2b\lambda) + (b\lambda^2 - a\lambda) = 0$ ….. (2)
Both (1) and (2) has same roots which are α and β
Hence, $1 + a - 2b\lambda = -(1 + a) \Rightarrow \lambda = \frac{1+a}{b}$



Now, for α, β to exist disc of (1) > 0
$\Rightarrow (1 + a)^2 - 4b\lambda > 0$
$\Rightarrow (a - 3)(a + 1) > 0$
$\Rightarrow a \in (-\infty, -1) \cup (3, \infty)$

FIITJEE JEE (Advanced), 2015

ALL INDIA TEST SERIES

FULL TEST – I

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 240**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 04)** contains 4 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (05 – 08) contains 4 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

   Section-A (09 to 11) contains 1 paragraph having 3 questions. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct matching. No marks will be given for any wrong matching in any question. There is no negative marking.

3. **Section-C (01 – 06)** contains 6 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

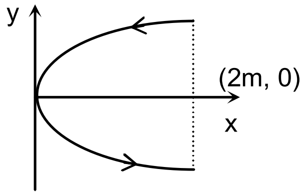
Physics PART – I

SECTION – A

(Only One Option Correct Type)

This section contains **4 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

1. A conducting wire is bent in the form of a parabola $y^2 = 2x$ carrying a current $i = 2A$ as shown in the figure. The wire is placed in a uniform magnetic field $\vec{B} = -4\hat{K}$. The magnetic force on the wire is

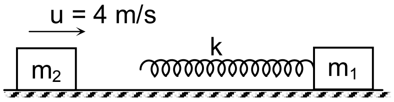


(A) $-16\hat{i}$
(B) $32\hat{i}$
(C) $-32\hat{i}$
(D) $16\hat{i}$

2. If M = mass, L = length, T = time and I = electric current, then the dimensional formula of resistance R will be given by

(A) $[R] = [M^1L^2T^{-3}I^{-2}]$
(B) $[R] = [M^1L^2T^{-3}I^2]$
(C) $[R] = [M^1L^2T^3I^{-2}]$
(D) $[R] = [M^1L^2T^3I^2]$

3. A block of mass m_1 = 3 kg is connected with ideal spring of spring constant k = 30000 N/m and kept at horizontal frictionless surface as shown in the figure. The block m_2 = 1 kg is moving with velocity u = 4 m/s towards block m_1. v_1 and v_2 are the final speed of the block m_1 and m_2 respectively.

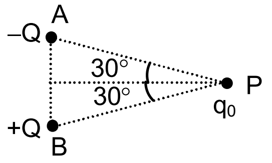


Choose the correct statement(s)

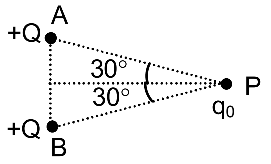
(A) $v_1 = v_2$ = 1m/s
(B) The maximum compression in the spring is 2 cm
(C) The maximum compression in the spring is 4 cm
(D) none

Space for Rough work

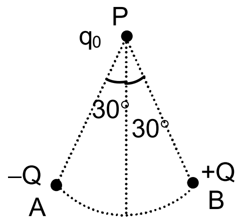
4 The diagram shows four systems of charged particles. Each system contains two charged particles at point A and point B as shown in the figure. A third positive point charge q_0 is kept at point P in each system. The direction of electrostatic force experienced by the charge q_0 will be



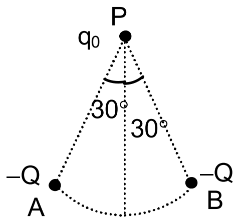
System -1; AP = BP = r and AB is a straight line



System -2; AP = BP = r and AB is a straight line



System -3; AP = BP = r and AB is a circular arc of radius r and centre at O



System -4; AP = BP = r and AB is a circular arc of radius r and centre at O

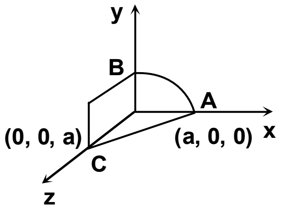
	System -1	**System-2**	**System-3**	**System-4**
(A)	↑	→	←	↓
(B)	↓	←	→	↑
(C)	↑	→	→	↓
(D)	↑	→	←	↑

Space for Rough work

(One or More than One Options Correct Type)

This section contains **4 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** are correct.

5. In the given figure a wire loop has been bent so that it has three segments. Segment AB is a quater circle in xy plane, segment BC is L–shaped wire in yz-plane, and segment CA is straight line in xz plane. Here are three choices for a magnetic field through the loop.



(1) $\vec{B}_1 = 3\hat{i} + 7\hat{j} - 5t\hat{k}$

(2) $\vec{B}_2 = 5t\hat{i} - 4\hat{j} - 15\hat{k}$

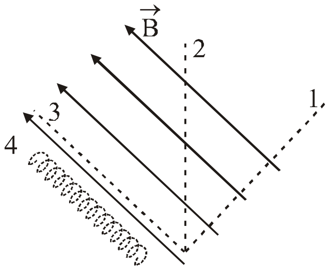
(3) $\vec{B}_3 = 2\hat{i} - 5t\hat{j} - 12\hat{k}$

If the induced current in the loop due to $\vec{B}_1, \vec{B}_2$ and $\vec{B}_3$ are i_1, i_2 and i_3 respectively then:

(A) $i_1 < i_2$ (B) $i_1 > i_3$
(C) $i_3 > i_2 > i_1$ (D) $i_1 = i_2 = i_3$

6. The surface tension phenomenon is the result of the tendency of a system to keep total
(A) density of the system is minimum (B) potential energy minimum
(C) volume of the system is minimum (D) surface area of the system is minimum

7. Radiation coming from a radioactive substance is passed through a cloud-chamber in which strong constant magnetic field is switched on in the direction shown in figure. Figure shows path followed by few particles coming from radioactive substance (shown by dotted lines) Neglect the interaction between different particles. Tick the correct statements :



(A) Path 1 can be followed by γ-radiation only
(B) Path 3 can be followed by γ-radiation only
(C) Path 4 can be followed by α-radiation only
(D) Path 4 can be followed by β-radiation

Space for Rough work

8. A particle of mass 'm' starts from origin and move in x-y plane velocity of particle is given by

$$\vec{v} = k_1 i + k_2\sqrt{1-\alpha y}\,\hat{j}$$

where k_1, k_2 & α are constant and 'y' is y-coordinate of position of particle. Choose the correct statements :

(A) Average force acting on particle $\frac{m\alpha k_2^2}{2}$

(B) Force acting on particle decreases first then increases

(C) Path of particle will be hyperbolic.

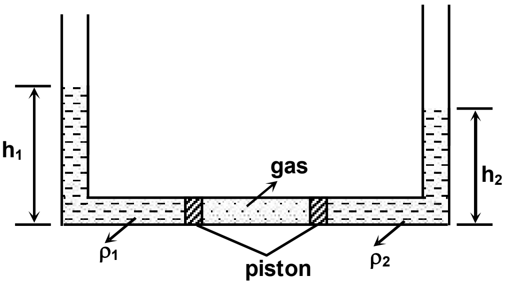
(D) Radius of curvature of the path followed by particle will decrease first then increase.

Comprehension type (Only One Option Correct)

This section contains **1 paragraph**, describing theory, experiments, data etc. Three questions relate to the one paragraph. Each question has **only one** correct answer among the four given options (A), (B), (C) and (D).

Paragraph for Questions 09 & 11

Figure shows a tube whose two limbs are vertical and one is horizontal of sufficient length. An ideal gas is enclosed between two massless non conducting movable piston of cross-sectional area 10 cm^2. A liquid of density ρ_1 = 1000 kg/m^3 and ρ_2 = 2000 kg/m^3 are poured in the vertical limbs of height of h_1 = 2m and h_2. Now gas is slowly heated. Consider the wall of tube is insulated.



9. Ratio of h_1 and h_2 at any instant will be

(A) $\frac{1}{2}$ (B) $\frac{2}{1}$

(C) $\frac{3}{2}$ (D) not constant

10. If due to heating separation between piston is increased by 3m then displacement of piston on left will be

(A) 2m (B) 1m

(C) 2.5 m (D) 1.5 m

11. Find the work done by gas

(A) 70 Joule (B) 390 Joule

(C) 90 Joule (D) 350 Joule

Space for Rough work

SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in ***Column I*** *are labelled A, B, C and D, while the statements in* ***Column II*** *are labelled p, q, r, s and t. Any given statement in* ***Column I*** *can have correct matching with* ***ONE OR MORE*** *statement(s) in* ***Column II.*** *The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

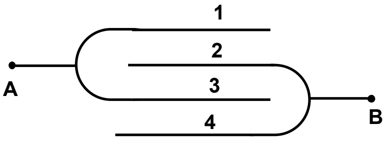
If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

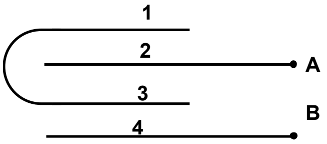
1. Terminal A is connected to positive terminal of battery and B is connected to negative terminal of plate and it send same charge Q in all four combination. Each plate have same area and separation between two consecutive plate is same.

Column I

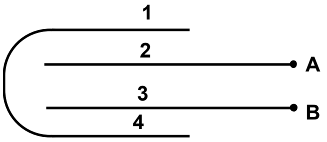
(A)



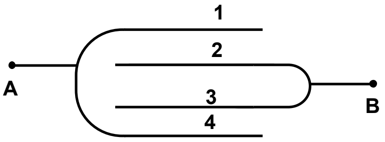
(B)



(C)



(D)



Column II

(p) Top surface of plate 1 have zero charge

(q) Upper surface of plate 4 have –Q charge

(r) Same charge Appear on both surface of plate 2

(s) Bottom surface of plate 4 have zero charge

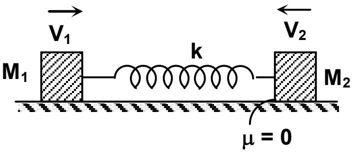
(t) Total charge on plate 2 is Q

Space for Rough work

2. Column I shows four physical situation and relates these with column II.

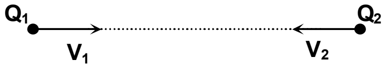
Column I

(A)



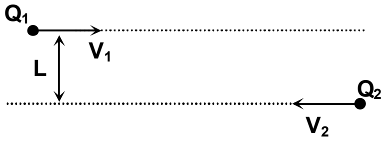
Blocks are given velocities as shown on smooth horizontal surface

(B)



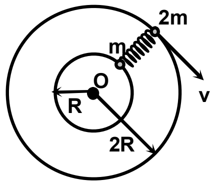
Two positive charge particles are given velocities towards each other in a gravity free space as shown.

(C)



Two positive charge particles are given velocities along different line towards each other in a gravity free space as shown.

(D)



Beads are free to move on a smooth circular rings placed on a smooth horizontal table.

Column II

(p) Mechanical energy is conserved

(q) Momentum is conserved

(r) K.E. of centre of mass will remain constant

(s) At maximum or minimum separation K.E. in centre of mass frame will be zero or minimum.

(t) Angular momentum is conserved about any point in inertial frame

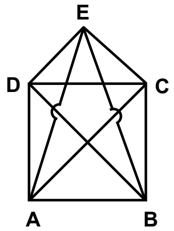
Space for Rough work

SECTION – C

(One Integer Value Correct Type)

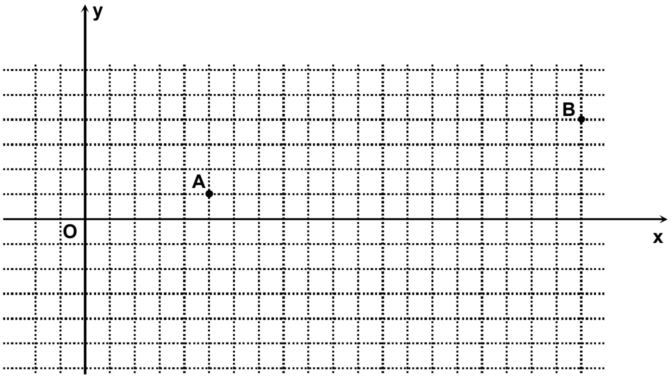
This section contains **6 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. In the given circuit the resistance of each sides and diagonals is $R\left(=\frac{35}{2}\Omega\right)$. The equivalent resistance across the points A and B is (given ABCD is a square)



2. If the sound heard by observer, whose equation is given as
$y = 8\sin 10\pi t \cos 200\pi t$ at $x = 0$
The number of beat frequency heard by observer is 2k, then the value of k is

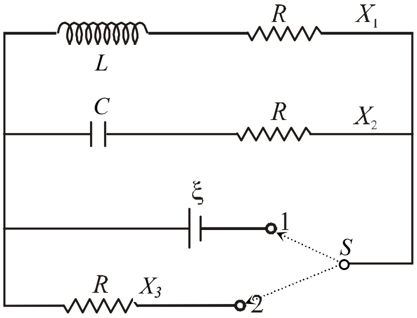
3. Point B is the image of point A due to reflection from mirror (which is either spherical concave mirror, or spherical convex mirror or plane mirror), whose principal axis is x-axis.



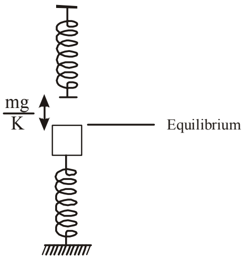
One square in x-axis represents 5 cm and one square on y-axis represents 1mm. The co-ordinate of centre of curvature of mirror is $(x_1, 0)$ and co ordinate of pole of mirror is $(x_2, 0)$ respectively. If $|x_1| + |x_2| = 5K$ cm, then find the value of K.

Space for Rough work

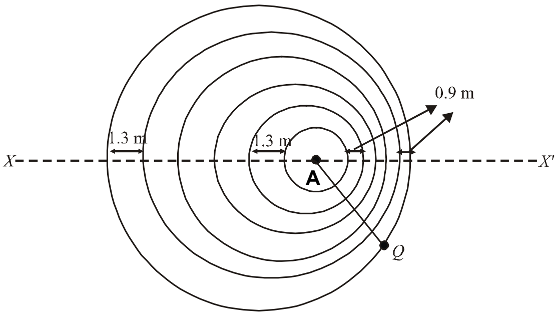
4. Figure shows a circuit containing three resistor X_1, X_2 & X_3 having resistance R each, an inductor, capacitor and an emf source having inductance 'L', capacitance C & emf ξ respectively (Given $R=\sqrt{\frac{L}{C}}$). The switch is first connected to position-1. When charge on capacitor becomes half of it maximum possible value then switch S is connected to position-2. Current in resistance X_3 just after shifting the switch from position-1 to position-2, is
(given L = 5mH, C = 2μF, R = 10 Ω, ξ = 5V)



5. In the figure shown a block of mass m is attached in a light spring of spring constant K and an identical spring hangs from ceiling. Initially lower spring is compressed in a state with compression equal to $\frac{3mg}{K}$ from natural length of spring when block is released it strikes upper spring and sticks to it. Amplitude of oscillation (in cm) is given mg = 10 N and $K=100\sqrt{7}$ N/m



6. Figure shows wave fronts coming form a source at equal interval of $\frac{10}{3}$ milli second. Frequency of wave emitted by source is 300 Hz. XX' is line along common diameter of wave fronts passing through 'A'. Distance between two consecutive wave fronts along line XX' is 0.9 m and 1.3 m in the right and left of point A respectively. At some instant source is at point A. Detector is placed at point 'Q'. AQ makes an angle 60° with line XX' If frequency of wave received by detector is f Hz, then $\frac{f}{110}$ (in Hz) is equal to



Space for Rough work

Chemistry

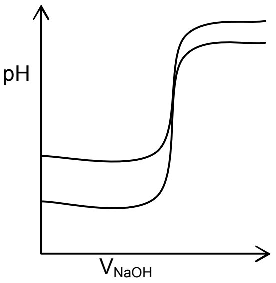
PART – II

SECTION – A

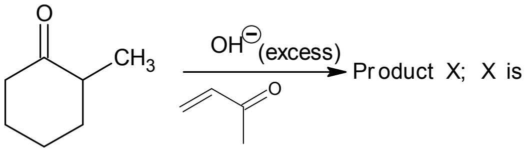
(Only One Option Correct Type)

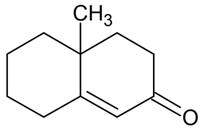
This section contains **4 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

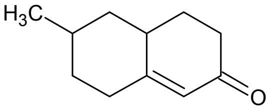
1. True or False
   (a) In any strong acids solution, the concentration of $[OH^-]$ will be zero.
   (b) If ΔG° of a reaction is positive, then the reaction will not proceed at all, in the forward direction for any concentration of reactants and products.
   (c) When titration curves are drawn for
   (i) 1 M HCl (50 mL) with 1 M NaOH and
   (ii) 0.01 M HCl (50 mL) with 0.01 M NaOH on the same graph paper they look like

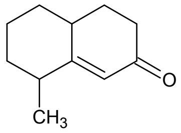


(A) TTF (B) FFT
(C) FTF (D) TFT

2. 

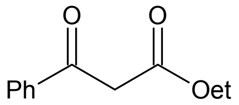
(A) 

(B) 

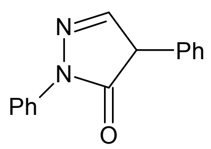
(C) 

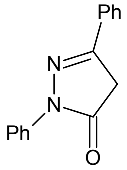
(D) None of these

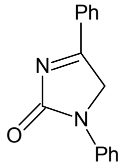
Space for Rough work

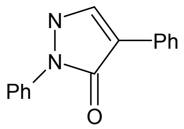
3. 

$\xrightarrow{PhNHNH_2}$ Product X; X is

(A) 

(B) 

(C) 

(D) 

4. Which of the following statement is false?
(A) In $XeOF_4$, the central atom Xe doesn't lie on the plane of the square
(B) In PF_2Cl_3, both the F-atoms lie on the axial bond
(C) In PCl_5, the axial bond length is longer than the equatorial bond length
(D) The dipole moment of CH_3F is greater than CH_3Cl

Space for Rough work

(One or More than One Options Correct Type)

This section contains **4 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** are correct.

5. Which of the following is correct for lyophilic aquasols?
(A) Its surface tension is lower than that of H_2O
(B) Its viscocity is higher than that of water
(C) Colloidal silver
(D) Colloidal antimony

6. Which of the following metals can be obtained by reducing its metal oxide using aluminium?
(A) Ca
(B) Fe
(C) Mg
(D) Cr

7. Select wrong statements
(A) Phenol reacts with Na_2CO_3 and librates CO_2 gas
(B) Phenol turn blue litmus to red
(C) Reactivity of methanol with sodium metal is more than that of isopropyl alcohol
(D) Methanol gives iodoform test

8. Borax bead test is given by
(A) Co^{2+}
(B) Zn^{2+}
(C) Cu^{2+}
(D) Ni^{2+}

Space for Rough work

Comprehension type (Only One Option Correct)

This section contains **1 paragraph**, describing theory, experiments, data etc. Three questions relate to the one paragraph. Each question has **only one** correct answer among the four given options (A), (B), (C) and (D).

Paragraph for Questions 09 & 11

Electrolysis is the process in which electrical energy is converted to chemical energy. In electrolytic cell, oxidation takes place at anode and reduction at cathode. Electrode process depends on the nature of electrode used for electrolysis. Amount of substance liberated at an electrode is directly proportional to the amount of charge passed through it. The mass of substance liberated at electrode is calculated by using the following relation:

$$m = \frac{ItE}{96500}$$

Here, E represents the equivalent mass and 96500 C is called the Faraday constant. Faraday (96500C) is the charge of 1 mole electron, i.e., 6.023 × 10^{23} electrons. This much charge is used to liberate one gram equivalent of any substance at each electrode.

9. The platinum electrodes were immersed in a solution of cupric sulphate ($CuSO_4$) and electric current is passed through the solution. After some time, it was observed that the colour of copper sulphate disappeared with evolution of a gas at the electrode. The colourless solution contains:
(A) platinum sulphate (B) copper nitrate
(C) copper sulphate (D) sulphuric acid

10. The passage of current liberates H_2 at cathode and Cl_2 at anode. The solution is:
(A) copper chloride in water (B) NaCl in water
(C) mercuric chloride in water (D) $AuCl_3$ in water

11. Calculate the volume of gas liberated at the anode at S.T.P. during the electrolysis of a $CuSO_4$ solution by a current of 1 A passed for 16 minutes and 5 seconds:
(A) 224 mL (B) 56 mL
(C) 112 mL (D) 448 mL

Space for Rough work

SECTION - B

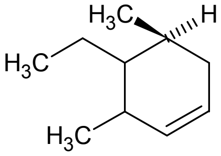
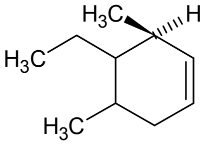
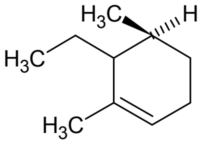
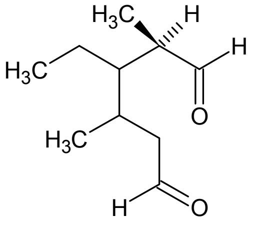
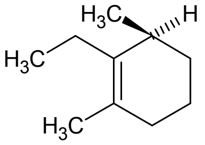
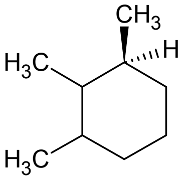
Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in ***Column I*** *are labelled A, B, C and D, while the statements in* ***Column II*** *are labelled p, q, r, s and t. Any given statement in* ***Column I*** *can have correct matching with* ***ONE OR MORE*** *statement(s) in* ***Column II.*** *The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

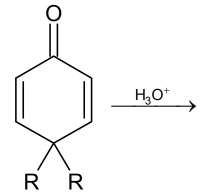
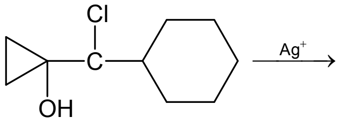
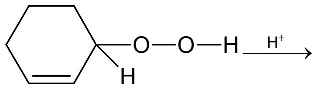
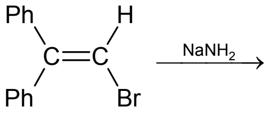
	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the following:

	Column – I		Column – II
(A)	When reacts with Br_2/CCl_4, diastereomer will be formed	(p)	
(B)	When reacts with O_3/H_2O, dicarboxylic acid will be formed	(q)	
(C)	Optically active compound	(r)	
(D)	When undergo reductive ozonolysis following product will be formed 	(s)	
		(t)	

Space for Rough work

2. Match the following:

	Column – I		**Column – II**
(A)		(p)	Final major product has a six membered ring
(B)		(q)	One of the group will undergo migration
(C)		(r)	Aldol condensation is one of the step
(D)		(s)	Final compound has three degree of unsaturation
		(t)	Contain at least one π bond.

Space for Rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **6 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. Two aqueous solutions are put in an evacuated chamber. When equilibrium is obtained, it is found that one solution contains 0.01% of CH_3COOH and other 0.014% of urea by weight, if degree of dissociation is 'α' then what is the value of 10α?

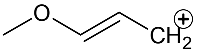
2. Metal element 'M' of radius 50 nm is crystallized in FCC format and make cubical crystal such that face of unit cells aligned with face of cubical crystal. If total number of metal atoms of 'M' at face of cubical crystal is 6×10^{30} then area of one face of cubical crystal is $A \times 10^{16}$ m^2, the value of A is

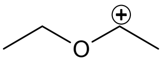
3. A 10 L box contains 41.4 gram of a mixture of gases C_xH_8 and C_xH_{12}. The total pressure of 44°C in flask is 1.56 atm. Analysis revealed that the gas mixture has 87% total C and 13% total H. Find out the value of x.

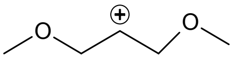
4. In the reaction $A + B \rightleftharpoons AB$, if the concentration of A and B is increased by a factor of 2, it will cause the equilibrium concentration of AB to change to…………..

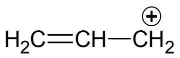
5. A solution of $SrCO_3$ is saturated with respect to SrF_2. Ksp = 7.9×10^{-10}. If the fluoride ion concentration is found to be 4.0×10^{-2}. Then the carbonate ion is found to be 1.4×10^{-x} M. Find the value of x.

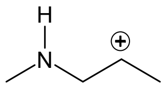
6. Which of the following carbocation have stability greater than an isopropyl cation $(CH_3)_2CH^+$

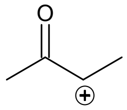

(i)

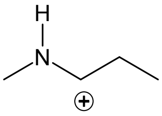

(ii)


(iii)


$H_2C{=}CH{-}\overset{\oplus}{C}H_2$
(iv)


(v)


(vi)


(vii)

Space for Rough work

Mathematics PART – III

SECTION – A

(Only One Option Correct Type)

This section contains **4 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

1. If f: R → R is a continuous function satisfying f(0) = 1 and f(2x) – f(x) = x ∀ x ∈ R and $\lim\limits_{x\to\infty}\left(f(x)-f\left(\frac{x}{2^n}\right)\right)=P(x)$ then P(x) is

(A) a constant function
(B) a linear polynomial in x
(C) a quadratic polynomial in x
(D) a cubic polynomial in x

2. If f(x) is continuous function such that f(x) > 0 ∀ x ≥ 0 and $\left(f(x)\right)^{2014}=1+\int\limits_0^x f(t)dt$ then the value of $(f(2014)^{2013}$ is equal to

(A) 2013
(B) 2014
(C) 2015
(D) 2016

3. An exam consist of 3 problems selected randomly from a collection of 2n problems, where n is an integer greater then 1. For a student to pass, he needs to solve correctly at least two of the three problems. If the student knows to solve exactly half of 2n problems, then the probability that the student pass the exam is

(A) $\frac{1}{2}$
(B) $\frac{1}{3}$
(C) $\frac{3}{4}$
(D) cannot be determined

4. If the radius of in-circle and radii of ex-circles of a triangle are consecutive terms of a geometric progression then the largest angle of the triangle will be

(A) 60°
(B) 90°
(C) 120°
(D) none of these

Space for rough work

(One or More than One Options Correct Type)

This section contains **4 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** are correct.

5. A point Q moves on the positive y-axis and a point P follows the point Q such that the motion of P is always towards Q and distance between P and Q is always equal to some constant K > 0. If initially Q is at origin and P is at (K, 0) then

   (A) the differential equation representing the curve traced by P is $\frac{dy}{dx} = \frac{\sqrt{K^2 - x^2}}{-x}$

   (B) y-axis is asymptote to the curve traced by P

   (C) the equation of curve traced by P is $y = -K\ln\left(\frac{K + \sqrt{K^2 - x^2}}{x}\right) - \sqrt{K^2 - x^2}$

   (D) the curve traced by P will has x-axis as asymptote

6. If a function y = f(x) is such that f′(x) is continuous function and satisfies

   $(f(x))^2 = K + \int_0^x \left((f(t))^2 + (f'(t))^2\right)dt$, $K \in R^+$, then

   (A) f(x) is increasing function ∀ $x \in R$
   (B) f(x) is bounded function
   (C) f(x) is neither even nor odd
   (D) if K = 100 then f(0) = 10

7. Consider parabola $P_1 \equiv y = x^2$ and $P_2 \equiv y^2 = -8x$ and the line $L \equiv \ell x + my + n = 0$. Which of the following holds true (a point (α, β) is called rational point if α and β are rational)

   (A) if ℓ, m, n are odd integers then the line L can not intersect parabola P_1 in a rational point

   (B) line L will be tangent to P_1 if m, $\frac{\ell}{2}$, n are in G.P.

   (C) if line L is common tangent to P_1 and P_2 then $\ell + m + n = 0$

   (D) if line L is common chord of P_1 and P_2 then $\ell - 2m + n = 0$

8. If H_n denotes the number of ways in which n horses participating in a race can reach the finishing line, when one or more horses can reach the finishing line at the same time, then

   (A) $H_2 = 3$
   (B) $H_3 = 13$
   (C) $H_4 = 75$
   (D) $H_3 = 10$

Space for rough work

Comprehension type (Only One Option Correct)

This section contains **1 paragraph**, describing theory, experiments, data etc. Three questions relate to the one paragraph. Each question has **only one** correct answer among the four given options (A), (B), (C) and (D).

Paragraph for Questions 09 & 11

Read the following write up carefully and answer the following questions:

A plane p contains the line L$_1$: $\frac{y}{b}+\frac{z}{c}=1$, x = 0 and is parallel to the line L$_2$: $\frac{x}{a}-\frac{z}{c}=1$, y = 0

9. Equation of plane p is

(A) $\frac{x}{a}-\frac{y}{b}+\frac{z}{c}+1=0$ (B) $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}-1=0$

(C) $\frac{x}{a}+\frac{y}{b}-\frac{z}{c}-1=0$ (D) $\frac{x}{a}-\frac{y}{b}-\frac{z}{c}+1=0$

10. If the shortest distance between L$_1$ and L$_2$ is $\frac{1}{4}$ then the value of $\frac{1}{a^2}+\frac{1}{b^2}+\frac{1}{c^2}$ equals

(A) 16 (B) 64

(C) 128 (D) 192

11. Distance of image of A(a, 0, 0) in the plane p from $M\left(-\frac{5}{3},\frac{8}{3},\frac{11}{3}\right)$, where a = b = c = 1, is equal to

(A) 1 (B) 2

(C) 3 (D) 4

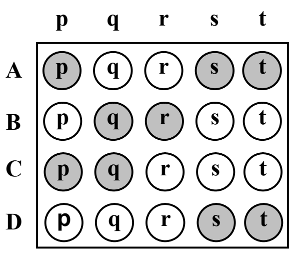
Space for rough work

SECTION - B

Matrix – Match Type

*This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the following Column-I with Column-II

	Column – I		Column – II
(A)	$f(x) = x[x]$ (where [.] denotes the greatest integer function and |.| denotes modulus function)	(p)	f(x) is continuous and differentiable everywhere on real domain
(B)	$f(x) = x\|x\|$	(q)	f(x) is continuous and differentiable at $x = 0$
(C)	$f(x) = x + \|x\|$	(r)	f(x) is continuous but not differentiable at $x = 0$
(D)	$f(x) = x + [x]$	(s)	f(x) is either discontinuous or non-differentiable for more than one $x \in R$
		(t)	f(x) is a periodic function

2 Match the following Column-I with Column-II

	Column – I		Column – II
(A)	Values of k for which the origin and the radical centre of three circles described on there sides $3x - 4y + 5 = 0$, $x + y + 5 = 0$ and $4x + 3y - 10 = 0$ of Δ as diameter lies opposite to the line $4x - ky + 1 = 0$	(p)	2
(B)	Values of λ for which the pair of lines $x^2 + 2\lambda xy + 2y^2 = 0$ and $(1 + \lambda)x^2 - 8xy + y^2 = 0$ are equally inclined to each other	(q)	3
(C)	Find the points on the axis of parabola $y^2 - 3x + 6y + 15 = 0$ such that three distinct normals can be drawn	(r)	–2
(D)	Let A and P represents the area and perimeter of the triangle formed by the common tangents to the circles $x^2 + y^2 - 6x = 0$ and $x^2 + y^2 + 2x = 0$. Then value of $\frac{A}{\sqrt{3}}, \frac{P}{\sqrt{3}}$	(s)	6
		(t)	4

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **6 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. Let $f(x) = x^{\alpha} + 3x^{\beta}$ with $\alpha > 1$, $\beta > 1$. The value of 'a' for which the area of the figure bounded by the graph of $y = f(x)$ and straight lines $x = 0$, $x = 1$ and $y = f(a)$ have the greatest value is A and the value for which area is minimum is B. Find the value of A + 2B _____

2. Let $S = \frac{1^2}{1.3} + \frac{2^2}{3.5} + \frac{3^2}{5.7} + ... + \frac{500^2}{999.1001}$. If where [.] denotes the greatest integer function then the number of total divisors of [S] is _____

3. If $\int_0^{\pi} \left(\sin x - ax(\pi - x)\right)^2 dx$ is minimum for $a = \frac{120}{\alpha\pi^{\beta}}$ then the value of $\alpha + \beta$ is _____

4. Consider the polynomials $P(x) = x^6 - x^5 - x^3 - x^2 - x$ and $Q(x) = x^4 - x^3 - x^2 - 1$. Given that z_1, z_2, z_3 and z_4 are the roots of the equation $Q(x) = 0$. The value of $P(z_1) + P(z_2) + P(z_3) + P(z_4)$ is _____

5. Let $\vec{A} = \hat{i} - 2\hat{j} + 3\hat{k}$, $\vec{B} = 2\hat{i} + \hat{j} - \hat{k}$, $\vec{C} = \hat{j} + \hat{k}$. If the vector $\vec{B} \times \vec{C}$ can be expressed as a linear combination $\vec{B} \times \vec{C} = x\vec{A} + y\vec{B} + z\vec{C}$ where x, y, z are scalar, then find the value of x + y + z _____

6. If w is the imaginary cube root of unity, then the number of ordered pairs of integers (a, b) such that $|aw + b| = 1$ is _____

Space for rough work

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

FIITJEE **JEE(Advanced)-2015**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS
FULL TEST– I
(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**B**	**B**	**B**
2.	**A**	**A**	**B**
3.	**B**	**B**	**A**
4.	**A**	**D**	**B**
5.	**A, B**	**A, B**	**A, B, C**
6.	**B, D**	**B, D**	**A, C¸D**
7.	**A, D**	**A, D**	**A, B, C, D**
8.	**A, D**	**A, C, D**	**A, B, C**
9.	**B**	**D**	**D**
10.	**A**	**B**	**B**
11.	**B**	**B**	**C**
1.	**(A) → (p, r, s) (B) → (p, q, r, s, t) (C) → (p, s, t) (D) → (p, s)**	**(A → p, q, r, s) (B → p, q) (C → p, q, r, s, t) (D → q)**	**(A) → (r, s) (B) → (p, q) (C) → (r) (D) → (s)**
2.	**(A) → (p, q, r, s, t) (B) → (p, q, r, s, t) (C) → (p, q, r, s, t) (D) → (p, q, r, s, t)**	**(A → p, q, t) (B → p, q, s, t) (C → q, r, t) (D → p, q, t)**	**(A) → (q, s, t) (B) → (p, r) (C) → (s, t) (D) → (q, s)**
1.	**6**	**4**	**3**
2.	**5**	**2**	**4**
3.	**8**	**5**	**6**
4.	**0**	**2**	**6**
5.	**5**	**3**	**1**
6.	**3**	**4**	**6**

Physics

PART – I

SECTION – A

7. γ-radiation being neutral is not deflected by magnetic field α & β particle may follow helical path or straight line depending upon velocity of particle & magnetic field.

8. Comparing the eqn. with velocity of projectile

$$\vec{v} = u\cos\theta i + \sqrt{u^2\sin^2\theta - 2gy}\,\hat{j}$$

Acceleration of particle $a_y = \frac{\alpha k_2^2}{2}, a_x = 0$

$\therefore$ Motion will be projectile motion and hence the result.

$\therefore$ Force acting on particle will be constant & equal to $\frac{m\alpha k_2^2}{2}$

$\therefore$ $< F > = \frac{m\alpha k_2^2}{2}$

9. $(h_1\rho_1 g)A = (h_2\rho_2 g)A$

$$\frac{h_1}{h_2} = \frac{2}{1}$$

10. $(h_1 + x_1)\rho_1 g = (h_2 + x_2)\rho_2 g$

$x_1/x_2 = 2$ …(i)

$x_1 + x_2 = 3$ …(ii)

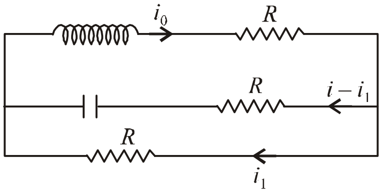
$x_1 = 2$ m

11. $W_1 = \int dW_1 = \int_2^4 (p_0 + x\rho_1 g)Adx = 260$ J

$W_2 = \int dW_2 = \int_1^2 (p_0 + x\rho_2 g)Adx = 130$ J

$W = W_1 + W_2 = 390$ J

SECTION – C



4. $R = \sqrt{\frac{L}{C}} \Rightarrow RC = L/R$ i.e. time constants of RC & LR circuit are same.

After switching from 1 to 2

$$i_0 = \frac{\xi}{2R}$$

from loop rule,

$$-(i_0 - i_1)R + \varepsilon/2 + i_1 R = 0$$

$$\Rightarrow \quad i_1 = \frac{2i_0R - \xi}{4R} = 0$$

5. $$mgx_2 + \frac{1}{2}kx_2^2 + \frac{1}{2}kx_2^2$$

$$= \frac{1}{2}k\left(\frac{3mg}{k}\right)^2 - mg\left(\frac{3mg}{k}\right)$$

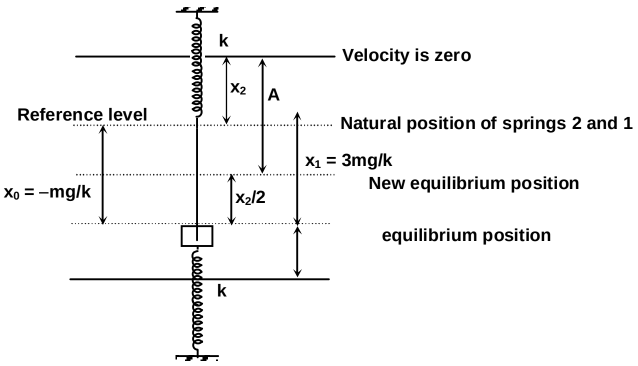
$$kx_1^2 + mgx_2 = \frac{9m^2g^2}{2k} - \frac{3m^2g^2}{k} = \frac{3m^2g^2}{2k}$$

$$2k^2x_2^2 + 2mgkx_2 - 3m^2g^2 = 0$$

$$x_2 = \frac{-2mgk \pm \sqrt{4m^2g^2k^2 + 24m^2g^2k^2}}{4k^2}$$

$$= \frac{-2mgk \pm 2mgk\sqrt{7}}{4k^2} = \frac{mg}{2k}[\sqrt{7} - 1]$$

$$A = \frac{x_0}{2} + x_2 = \frac{mg\sqrt{7}}{2k} = \frac{10 \times \sqrt{7}}{2 \times 100\sqrt{7}} = \frac{1}{20}m = 5cm$$


k
Velocity is zero
x₂
A
Reference level
Natural position of springs 2 and 1
x₁ = 3mg/k
New equilibrium position
x₀ = –mg/k
x₂/2
equilibrium position
k

6. $\lambda_0 - V_st = x_1$

$\lambda_0 + V_s t = x_2$

$V_s = \frac{x_2 - x_1}{2T} = 60$ m/s & $\lambda_0 = \frac{x_1 + x_2}{2} = 1.1$ m

Speed of sound $V = n \times \lambda_0 = 330$ m/s

Frequency detected at point Q

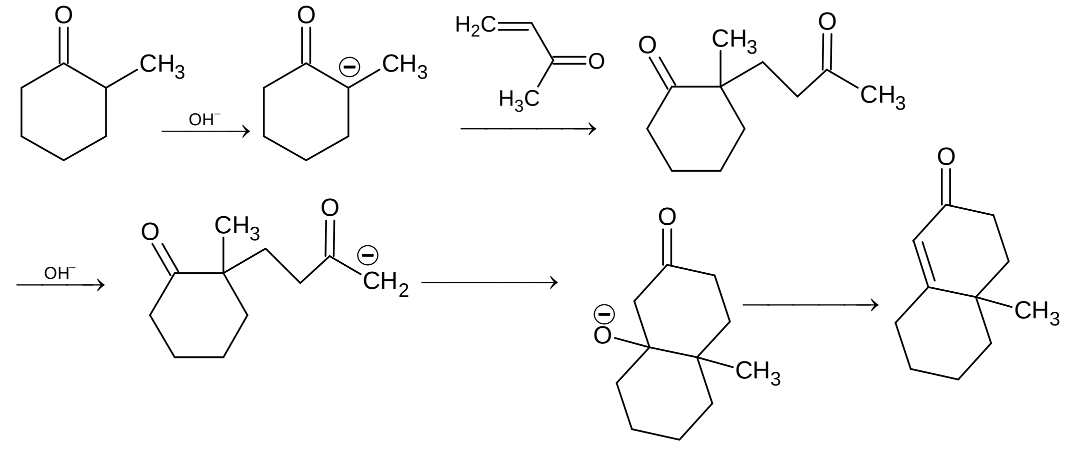
$$n = \frac{V}{V - V_s} \times 300\,Hz = 330\,Hz$$

Chemistry

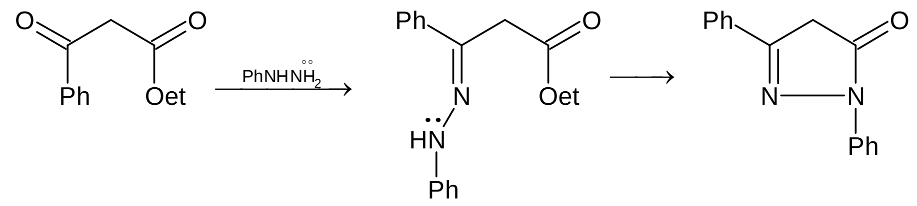
PART – II

SECTION – A

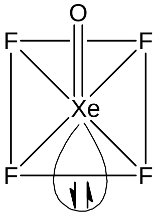
2.


O
CH3
OH⁻
O
CH3
H2C
O
H3C
O
CH3
O
CH3
OH⁻
O
CH3
O
CH2
O
O
CH3
O
CH3

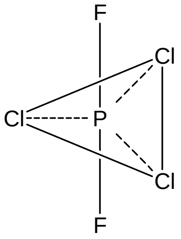
3.



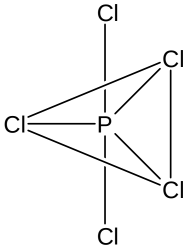
4. $XeOF_4$ is square pyramidal in shape



Due to lone pair-bond pair repulsion the four F atoms move away from lone pair resulting in the movement of Xe towards lone pair.



The most electronegative substituent lies at the axial position to minimize bond pair-bond pair repulsion.



PCl_5 shows sp^3d hybridisation with the involvement of axial dz^2 orbital. Since the axial Cl is at 90° hence suffers relatively greater repulsion increasing the axial bond length.

The size of F is smaller than Cl leading smaller C–F bond length decreasing the dipole moment.

5. Surface tension of lyophilic aquasols is lower than that due to force of attraction between dispered phase and dipersion medium.
Its viscocity is higher due to force of attraction between phase and disperesion medium.

8. White salts or ions giving colourless beads do not give borax bead test.

9. $Cu^{2+} + 2e \longrightarrow Cu$
Hence SO_4^{-2} ions are left which form H_2SO_4 with H^+ from H_2O.

11. At anode: $2OH^- \longrightarrow H_2O + \frac{1}{2}O_2 + 2e^-$

Equivalent volume $V_e = \frac{22.4}{2\times 2} = 5.6$ litre

$\therefore\ V = \frac{ItV_e}{96500} = \frac{1\times 965\times 5.6\times 10^3}{96500}$ = **56 ml**.

SECTION –C

1. At equilibrium relative lowering of vapour pressure of both the solution is same. Then

$\frac{(1+\alpha)0.01}{60} = \frac{0.014}{60}$

$(1 + \alpha) = 1.4$

$\alpha = 0.4$

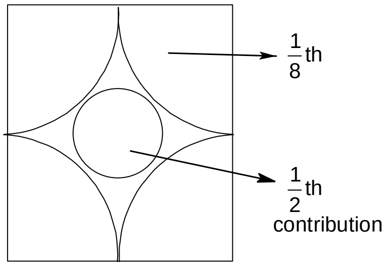
so

$10\alpha = 4$

2. Consider the unit cell face

So, atoms on face will be

$= \frac{1}{8}\times\frac{1}{4}+\frac{1}{2}\times 1 = 1$ atom



No. of atoms at one face of crystal

$= \frac{1}{6}\times 6\times 10^{30} = 10^{30}$ atm

No. of unit cells at one face of crystal = $6\times 10^{30}/6$

So no. of unit cells at edge of crystal = $\sqrt{10^{30}}$ = 10^{15}

Now edge length of one unit cell = $\frac{4}{\sqrt{2}}\times 50\times 10^{15}$ n

So area of face of crystal = $\left(\frac{4}{\sqrt{2}}\times 50\times 10^{15}\right)$nm^2

$= \frac{16}{2}\times 25\times 10^2\times 10^{30}$

$= 2\times 10^{34}$ nm^2

$= 2\times 10^{-18+34}$ m^2

$= 2\times 10^{16}$ m^2

3. Given P = 1.56 atm, V = 10 L

T = 317 K, R = 0.083 L

Total moles (n) = $\frac{PV}{RT} = \frac{1.56\times 10}{0.082\times 31\%} = 0.6$ mol

Let C_xH_8 be a mol, therefore moles of C_xH_{12} = (0.6 – a) mol. Mass of C in a mol of C_xH_{12} = 129 x gm.

Mass of C in (0.6 – a) mol of C_xH_{12} = 12 (0.6 – a) gram

Total mass of C in mixture = 12ax + 12x (0.6 – a)g

= 41.4 g

% of C in mixture = $\frac{7.2x}{41.4}\times 100$

Given % of C = 87%

Or

$\frac{720x}{41.4}=87$

x = 5

4. For $A+B \rightleftharpoons AB$

$$K=\frac{[AB]}{[A][B]}$$

When $2A+2B \rightleftharpoons 2AB$

Now eq. conc. will be 2 times of AB

5. $SrF_2 \rightleftharpoons Sr^{+2}(aq)+2F^-(aq)$

$$Ksp=\left[Sr^{+2}\right]\left[F^-\right]^2$$

$$\left[Sr^{+2}\right]=\frac{Ksp}{\left[F^-\right]^2}=\frac{7.9\times 10^{10}}{\left[4.0\times 10^{-2}\right]^2}=4.938\times 10^{-7}M$$

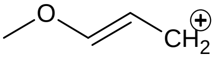
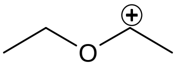
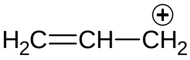
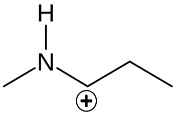
This concentration of Sr^{+2} ions should also satisfy the other expression for $SrCO_3$

$$SrCO_3(s) \rightleftharpoons Sr^{+2}(aq)+CO_3^{-\,-}(aq)$$

$$Ksp=\left[Sr^{+2}\right]\left[CO_3^{-\,-}\right]$$

$$\left[CO_3^{-\,-}\right]=\frac{Ksp}{\left[Sr^{+2}\right]}=\frac{7.0\times 10^{-10}}{4.938\times 10^{-7}}$$

= 1.4×10^{-3}

6.    $H_2C{=}CH{-}\overset{\oplus}{C}H_2$ 

Mathematics

PART – III

SECTION – A

1. Write the functional equation as $f(x)-f\left(\frac{x}{2}\right)=\frac{x}{2}$

$\Rightarrow f\left(\frac{x}{2}\right)-f\left(\frac{x}{4}\right)=\frac{x}{4}$

$\Rightarrow f\left(\frac{x}{4}\right)-f\left(\frac{x}{8}\right)=\frac{x}{8}$

– – – – – – – – – – –

– – – – – – – – – – –

$$f\left(\frac{x}{2^{n-1}}\right)-f\left(\frac{x}{2^n}\right)=\frac{x}{2^n}$$

Adding up we obtain $f(x)-f\left(\frac{x}{2^n}\right)=x\left(\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+.....+\frac{1}{2^n}\right)$

Hence, $\lim\limits_{n\to\infty}\left(f(x)-f\left(\frac{x}{2^n}\right)\right)=x$

2. Differentiating the given equation 2014 $(f(x))^{2013}$ $f'(x)$ = $f(x)$

$\Rightarrow$ 2014 $(f(x))^{2012}$ $f'(x)$ = 1

Integrate $\frac{2014}{2013}(f(x))^{2013}=x+c$

$\because$ f(0) = 1 $\Rightarrow$ $c=\frac{2014}{2013}$

Hence, $(f(x))^{2013}=\frac{2013}{2014}x+1$

$\Rightarrow$ $(f(2014))^{2013}$ = 2013 + 1 = 2014

3. Let $A_i \equiv$ the event that student correctly solves exactly i of the three proposed problems (Where i = 0, 1, 2, 3)

Required probability = P(A) = $P(A_2 \cup A_3) = P(A_2) + P(A_3)$

$\because$ Student know how to solve exactly half the problem

$P(A_0) = P(A_3)$ and $P(A_1) = P(A_2)$

Also, $P(A_0) + P(A_1) + P(A_2) + P(A_3) = 1$

$\Rightarrow$ P(A) = $P(A_2) + P(A_3) = \frac{1}{2}$

4. Let r to in-radius and r_1, r_2, r_3 are ex-radii of circle touching the sides BC, CA and AB respectively of ΔABC

If $\Delta$is area of triangle and s is semi-perimeter, $\Delta = rs = r_1(s-a) = r_2(s-b) = r_3(s-c)$

$$\Rightarrow \frac{1}{r_1}+\frac{1}{r_2}+\frac{1}{r_3}=\frac{s-a}{\Delta}+\frac{s-b}{\Delta}+\frac{s-c}{\Delta}=\frac{s}{\Delta}=\frac{1}{r}$$

So, that r is the smallest term in G.P. Suppose that $A \le B \le C$

then $r_1 = s\tan\frac{A}{2} \le r_2 = s\tan\frac{B}{2} \le r_3 = s\tan\frac{C}{2}$

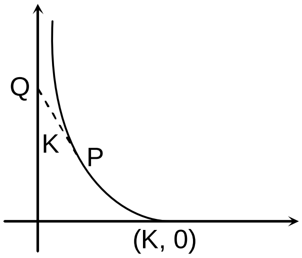
Hence, there is a number t > 1 for which $r_1 = tr$, $r_2 = rt^2$, $r_3 = rt^3$

and $(s-b) = t(s-c)$, $(s-a) = t^2(s-c)$, $s = t^3(s-c)$

By Herons formula $t^3r(s-c) = r_3(s-c) = rs = \Delta = \sqrt{s(s-a)(s-b)(s-c)}=\sqrt{t^6(s-c)^4}=t^3(s-c)^2$

Hence, r = s – c, and so $\tan\frac{C}{2}=\frac{r}{(s-c)}=1 \Rightarrow C = 90^o$

5. If the curve traced by P is y = f(x) then $\frac{dy}{dx}$ = slope of line joining P and Q as P is always moving towards Q



Let Q $\equiv$ (0, β) and P(x, y), $(0-x)^2 + (\beta-y)^2 = k^2$

$\Rightarrow \beta - y = \sqrt{K^2-x^2}$

$$\frac{dy}{dx}=\frac{\beta-y}{0-x}=\frac{\sqrt{K^2-x^2}}{-x}$$

Solving the differential equation with initial condition f(K) = 0 gives

$$y = -K\ln\left(\frac{K+\sqrt{K^2-x^2}}{x}\right) - \sqrt{K^2-x^2}$$

6. Differentiating the given equation $2f(x)\,f'(x) = (f(x))^2 + (f'(x))^2 \Rightarrow (f(x) - f'(x))^2 = 0$
$\Rightarrow f'(x) = f(x) \Rightarrow f(x) = ce^x$
$\because f(0) = \sqrt{K} \Rightarrow c = \sqrt{K} \Rightarrow f(x) = \sqrt{K}e^x$

7. Point of intersection of P_1 and L is given by $mx^2 + \ell x + n = 0$
Line is tangent if $\ell^2 = 4mn \Rightarrow m, \frac{\ell}{2}, n$ are in G.P.
If point of intersection is rational (let $x = \frac{p}{q}$) where p and q are co-prime
Then $mp^2 + lpq + nq^2 = 0$ ..... (1)
Now, if one of p and q is even and other is odd then (1) can not hold as sum of an even and an odd integer can't be zero
If p, q are odd then (1) can not hold true as sum of three odd numbers can't be zero
Common tangent to P_1 and P_2 is $2x - y - 1 = 0$
Common chord of P_1 and P_2 is $2x + y = 0$

8. The sequence of two horses reaching the finishing line can be 2 or 1 + 1
$\Rightarrow$ Number of ways = 1 + 2! = 3
The sequence of three horses reaching the finishing line and number of ways are shown below
$3 \Rightarrow 1$ way
$2 + 1 \Rightarrow {}^3C_2 = 3$ ways
$1 + 2 \Rightarrow {}^3C_2 = 3$ ways
$1 + 1 + 1 \Rightarrow 3! = 6$ ways
Hence $H_3 = 1 + 3 + 3 + 6 = 13$
The sequence of 4 horses reaching the finishing line and number of ways are shown below
$4 \Rightarrow 1$ way
$2 + 1 + 1 \Rightarrow \left(\frac{4!}{2!\,1!\,1!\,2!}\right) \times 3!$ ways
$3 + 1 \Rightarrow {}^4C_3$ ways
$1 + 3 \Rightarrow {}^4C_1$
$2 + 2 \Rightarrow {}^4C_2$
$1 + 1 + 1 + 1 \Rightarrow 4!$
Hence, $H_4 = 1 + 4 + 4 + 6 + 36 + 24 = 75$

9.-11. Equations of lines L_1 and L_2 can be obtained in symmetric form
L_1: $\frac{x}{0} = \frac{y-b}{-b} = \frac{z}{c}$
L_2: $\frac{x-a}{a} = \frac{y}{0} = \frac{z}{c}$

Equation of plane p: $\begin{vmatrix} x & y-b & z \\ 0 & -b & c \\ a & 0 & c \end{vmatrix} = 0$

$\Rightarrow \frac{x}{a} - \frac{y}{b} - \frac{z}{c} + 1 = 0$
Lines L_1 and L_2 in vector form
$L_1 \equiv \vec{r} = \vec{p}_1 + \lambda\vec{q}_1 \Rightarrow \vec{r} = b\hat{j} + \lambda\left(-b\hat{j} + c\hat{k}\right)$ and $L_2 \equiv \vec{r} = \vec{p}_2 + \lambda\vec{q}_2 \Rightarrow \vec{r} = a\hat{i} + 4\left(a\hat{i} + c\hat{k}\right)$

Shortest distance = $\frac{\left[\vec{p}_1 - \vec{p}_2 \;\; \vec{q}_1 \;\; \vec{q}_2\right]}{\left|\vec{q}_1 \times \vec{q}_2\right|} = \frac{\begin{vmatrix} -a & b & 0 \\ 0 & -b & c \\ a & 0 & c \end{vmatrix}}{\sqrt{(bc)^2 + (ac)^2 + (ab)^2}} = \frac{1}{4}$

$\Rightarrow \left|\frac{2abc}{\sqrt{(bc)^2 + (ca)^2 + (ab)^2}}\right| = \frac{1}{4} \Rightarrow \frac{1}{a^2} + \frac{1}{b^2} + \frac{1}{c^2} = 64$

SECTION – B

1. (A) f(x) = x[x]

f(x) is continuous at x = 0, but not differentiable at x = 0

f(x) is discontinuous at integers

(B) f(x) = x|x|

$$f(x) = \begin{cases} x^2 & , \quad x \ge 0 \\ -x^2 & , \quad x < 0 \end{cases}$$

f(x) is continuous and differentiable everywhere

(C) f(x) = x + |x| = $\begin{cases} 2x & , \quad x \ge 0 \\ 0 & , \quad x < 0 \end{cases}$

f(x) is continuous everywhere but not differentiable at x = 0

(D) f(x) = x = [x]

f(x) is discontinuous at integers

2. (A) Given lines are

$3x - 4y + 5 = 0$ ….. (1)
$4x + 3y - 10 = 0$ ….. (2)
$x + y + 5 = 0$ ….. (3)

Radical centre of three circles described on sides of Δ as diameter = orthocentre
As two lines are perpendicular to each other
So, orthocentre is point of intersection of (1) and (2)
Solving (1) and (2) x = 1, y = 2
So, radical centre (1, 2)
4x – ky + 1 = 0 is the given line (0, 0) 0 + 0 + 1 > 0
So, for radical centre to be on opposite side 4 – 2k + 1 < 0
5 – 2k < 0

$\Rightarrow k > \frac{5}{2}$

(B) $x^2 + 2\lambda xy + 2y^2 = 0$

Equation of angle bisectors $\frac{x^2 - y^2}{-1} = \frac{xy}{\lambda}$ ….. (1)

$(1 + \lambda)x^2 - 8xy + y^2 = 0$

Equation of angle bisectors $\frac{x^2 - y^2}{\lambda} = \frac{xy}{-4}$ ….. (2)

For equally inclined lines (1) and (2) must represent same

So, $-\frac{1}{\lambda} = \frac{\lambda}{-4} \Rightarrow \lambda^2 = 4, \lambda = \pm 2$

(C) $y^2 - 5x + 6y + 15 = 0$

$$y^2 + 6y + 9 = 5\left(x - \frac{6}{5}\right)$$

$$(y+3)^2 = 5\left(x - \frac{6}{5}\right)$$

$Y^2 = 4aX,\ a = \frac{5}{4}$

$X = x - \frac{6}{5}$

For three normals to be distinct

$X - 2a > 0$

$x - \frac{6}{5} > \frac{5}{2}$

$x > \frac{5}{2} + \frac{6}{5}$

$x > \frac{37}{10}$

(D) $x^2 + y^2 - 6x = 0$

$x^2 + y^2 + 2x = 0$

The triangle formed by common tangents is ΔABC

Let $C \equiv (h, k)$, $\frac{CD}{CE} = \frac{1}{3}$

$h = \frac{3+3}{-2} = -3$

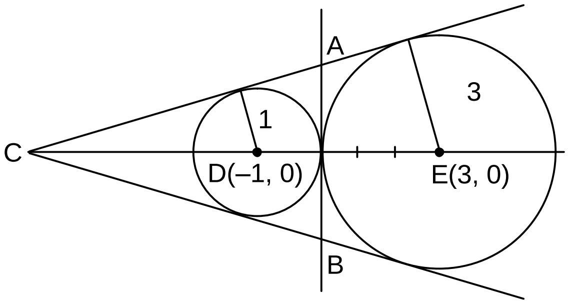
$k = 0$

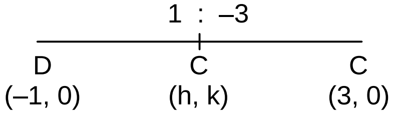
So, $C \equiv (-3, 0)$

Equation of line thru Q, $y = m(x + 3)$

$\Rightarrow mx - y + 3m = 0$

This represents two tangents with two difference values of m





Length of perpendicular from D = Radius $\frac{|-m + 3m|}{\sqrt{m^2+1}} = 1$

$4m^2 = m^2 + 1$

$3m^2 = 1$

$m = \pm\frac{1}{\sqrt{3}}$

So, equation of tangents $y = \frac{x}{\sqrt{3}} + \sqrt{3}$ and $y = \frac{-x}{\sqrt{3}} - \sqrt{3}$

$\Rightarrow A \equiv \left(0, \sqrt{3}\right)$, $B \equiv \left(0, -\sqrt{3}\right)$, $C \equiv (-3, 0)$

$\Rightarrow AB = BC = CA = 2\sqrt{3}$

So, $P = 6\sqrt{3}$, $A = \frac{\sqrt{3}}{4} \times \left(2\sqrt{3}\right)^2 = 3\sqrt{3}$

$\frac{P}{\sqrt{3}} = 6$, $\frac{A}{\sqrt{3}} = 3$

SECTION – C

1. $f(x) = x^{\alpha} + 3x^{\beta}$
$f'(x) = \alpha\, x^{\alpha-1} + 3\beta x^{\beta-1}$
$\Rightarrow f'(x) > 0\ \forall\ x \in (0, 1)$
$f''(x) = \alpha(\alpha - 1)x^{\alpha-2} + 3\beta(\beta - 1)x^{\beta-2}\ \forall\ x \in (0, 1)$
$\Rightarrow f''(x) > 0\ \forall\ x \in (0, 1)$
Hence, f(x) is monotonically increasing and concave upwards curve
$B = \frac{0+1}{2}$, A = 1

2. $$T_r = \frac{r^2}{(2r-1)(2r+1)} = \frac{1}{4}\left(\frac{r}{2r-1} + \frac{r}{2r+1}\right)$$
$$\therefore\ S = \frac{1}{4}\sum_{r=1}^{500}\left(\frac{r}{2r-1} + \frac{r}{2r+1}\right)$$
$$\Rightarrow\ 4S = \sum_{r=1}^{500}\left(\frac{r}{2r-1} + \frac{r}{2r+1}\right) = \frac{1}{1} + \left(\frac{1}{3} + \frac{2}{3}\right) + \left(\frac{2}{5} + \frac{3}{5}\right) + \left(\frac{3}{7} + \frac{4}{7}\right) + \ldots.. + \frac{500}{999} + \frac{500}{1001}$$
$$\because\ \frac{r}{2r+1} + \frac{r+1}{2r+1} = 1$$
Combining all such terms, we get $4S = 1 + 499 + \frac{500}{1001} = \frac{501000}{1001}$
$S = \frac{125250}{1001}\ \Rightarrow [S] = 125$
Number of divisors = 4

3. $$I(a) = a^2\int_0^{\pi} x^2(\pi - x)^2\,dx - 2a\int_0^{\pi} x(\pi - x)\sin x\,dx + \int_0^{\pi}\sin^2 x\,dx$$
$$\Rightarrow I(a) = \frac{\pi^5}{30}a^2 - 8a + \frac{\pi}{2}$$
$$I(a) = \frac{\pi^5}{30}\left(a - \frac{120}{\pi^5}\right)^2 + \frac{\pi}{2} - \frac{480}{\pi^5}$$
Hence, I(a) is minimum for $a = \frac{120}{\pi^5}\ \Rightarrow \alpha = 1, \beta = 5$

4. Dividing P(x) by Q(x) gives $P(x) = Q(x)(x^2 + 1) + x^2 - x + 1$
then $\sum_{i=1}^{4} P(z_i) = \left(\sum_{i=1}^{4} z_i\right)^2 - 2\sum z_i z_j - \sum_{i=1}^{4} z_i + 4$
Use the formula for sum and products of the roots to obtain $\sum_{i=1}^{4} P(z_i) = 1 + 2 - 1 + 4 = 6$

5 $\vec{B} \times \vec{C} = x\vec{A} + y\vec{B} + z\vec{C}$
Taking dot product with $\vec{B} \times \vec{C}$
$$\left(\vec{B} \times \vec{C}\right)\left(\vec{B} \times \vec{C}\right) = x\left[\vec{A}\ \vec{B}\ \vec{C}\right]\ \Rightarrow\ x = \frac{\vec{B}^2 \cdot \vec{C}^2 - \left(\vec{B} \cdot \vec{C}\right)^2}{\left[\vec{A}\ \vec{B}\ \vec{C}\right]}$$

Similarly taking dot with $\vec{C}\times\vec{A}$ gives $y = \dfrac{\left(\vec{B}\times\vec{C}\right)\left(\vec{C}\times\vec{A}\right)}{\left[\vec{A}\ \vec{B}\ \vec{C}\right]}$

and dot with $\vec{A}\times\vec{B}$ gives $z = \dfrac{\left(\vec{B}\times\vec{C}\right)\cdot\left(\vec{A}\times\vec{B}\right)}{\left[\vec{A}\ \vec{B}\ \vec{C}\right]}$

$\because\ \left[\vec{A}\ \vec{B}\ \vec{C}\right] = 12$

$\Rightarrow \vec{B}^2\cdot\vec{C}^2 - \left(\vec{B}\cdot\vec{C}\right) = 12$

$\Rightarrow x = 1$

$\Rightarrow\ y = \dfrac{1}{2}$ and $z = -\dfrac{1}{2}$

6 $\because$ $|aw + b| = 1$
$\Rightarrow |aw + b|^2 = 1 \Rightarrow (aw + b)\left(a\vec{w} + b\right) \Rightarrow a^2 - ab + b^2 = 1$
$\Rightarrow (a - b)^2 + ab = 1$
When $(a - b)^2 = 0$ and $ab = 1$ then (1, 1), (–1, –1)
When $(a - b)^2 = 1$ and $ab = 0$ then (0, 1), (1, 0), (0, –1), (–1, 0)
Hence, total six ordered pairs

FIITJEE **JEE (Main), 2015**

FULL TEST – II

ALL INDIA TEST SERIES

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 30)** contains 30 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

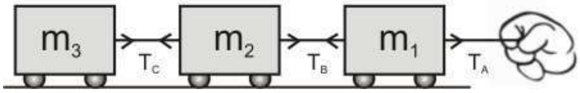
1. The physical quantity, electric potential (V) has dimensions [$M^a\ L^b\ T^c\ A^d$] and capacitance (c) has dimensions [$M^eL^fT^gA^h$]. Then a + b + c + d + e + f + g + h is :
(A) zero
(B) 1
(C) 2
(D) None of these

2. Mark the CORRECT statement:
(A) Two vectors are equal to each other only if their corresponding components are equal
(B) The cross product of two parallel vectors can be NON-zero
(C) The direction of a zero vector can be determined
(D) If we multiply $\vec{A}$ by the scalar-1, we obtain the vectors $-\vec{A}$, which is a vector with the opposite magnitude but the same direction as $\vec{A}$

3. The acceleration of a particle moving only on a horizontal x-y plane is given by a = $2t\hat{i} + 3t\hat{j}$, where a is in meters per second squared and t is in seconds. At t = 0 the particle has the velocity vector $\vec{V} = (5.00\,m/s)\hat{i} + (2.00m/s)\hat{j}$ and position vector $\vec{r} = (10.00m)\hat{i} + (10.0m)\hat{j}$. At t = 6s, the position vector of the particle is :
(A) $(112m)\hat{i} + (130m)\hat{j}$
(B) $(102m)\hat{i} + (120m)\hat{j}$
(C) $(256m)\hat{i} + (238m)\hat{j}$
(D) None of these

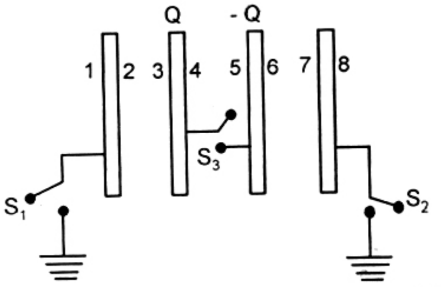
Space for Rough work

4. A child's toy consists of three cars that are pulled in tandem on small friction less rollers (Fig. A). The cars have masses m_1, m_2 and m_3 ($m_1 < m_2 < m_3$). If they are pulled to the right with a horizontal force P, mark the INCORRECT statement (T = Tension in the string):



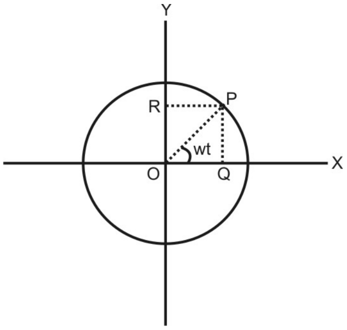
(A) $T_A > T_B > T_C$, (B) $T_A < 2T_B$
(C) $T_B < 2T_C$ (D) $T_A > 3T_C$

5. Four conducting plates are arranged with equal spacing and surfaces of all the plates are marked as 1, 2, 3, 4, 5, 6, 7 and 8 as shown. Two middle plates are given charged +Q and –Q, after which S_1 and S_2 are closed. The charge distribution on the surfaces of conducting plates from 1 to 8 in order is:



(A) O, –Q, +Q, O, O, –Q, Q, O
(B) O, –Q/3, Q/3, 2Q/3, –2Q/3, –Q/3, O
(C) O, O, O, Q, –Q, O, O, O
(D) O, –2Q/3, 2Q/3, Q/3, –Q/3, –2Q/3, 2Q/3, O

6. Consider a particle P moving on a circle of radius 'A' with a constant angular speed 'w'. RP and PQ are ⊥ to X and Y axes respectively:



(A) The x-coordinate of the particle at time t is $A \sin \omega t$
(B) The particle has a non-zero displacement in a time interval $2\pi/\omega$
(C) R and Q execute simple harmonic motion and their phases differ by $\pi/2$
(D) If the radius of the circle is doubled, the phase difference between R and Q would also double

Space for Rough work

7. An infinite non conducting uniformly charged sheet has a hole of radius ‘R’ in it (change density = σ). An electron is placed on an axis passing through the centre of hole and perpendicular to the plane of sheet at a distance ‘R’ from the centre. The speed with which the electron reaches the centre is ....

(σ > 0) Given : electric field on the axis of a uniformly charged disc of radius ‘r’

$$E(x) = \frac{\sigma}{2\in}\left[1 - \frac{x}{\sqrt{x^2 + r^2}}\right]$$

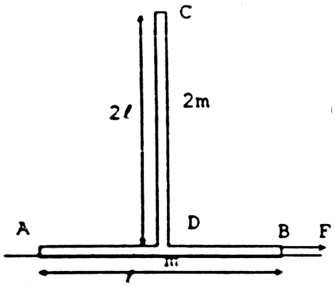
(A) $\sqrt{\frac{\sigma eR}{m\varepsilon_0}}$

(B) $\sqrt{\frac{2\sigma eR}{m\varepsilon_0}}$

(C) $\sqrt{\frac{(\sqrt{2}-1)\sigma eR}{m\varepsilon_0}}$

(D) $\sqrt{\frac{\sqrt{2}\sigma eR}{m\varepsilon_0}}$

8. Two thin rigid rods, AB (mass m, length ℓ) and CD (mass 2m, length 2ℓ) are connected to make a ‘T’ as shown in figure. The assembly is kept vertical on a frictionless horizontal surface and is restrained to fall sidewise. What is the least value of F to be applied horizontally at B, such that B is able to leave contact with the surface :



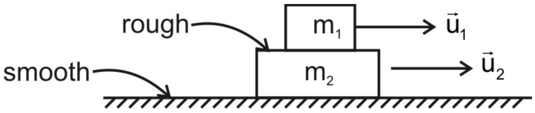
(A) 3mg

(B) (9/4) mg

(C) $\frac{3\sqrt{3}}{2}mg$

(D) $\frac{3}{2}mg$

9. In a two block system shown in the figure, the two blocks have velocities in same horizontal direction. Mark the CORRECT statement about ‘the velocity of the centre of mass’ of the system with respect to a stationary frame:



(A) $\vec{V}_{cm}$ is a function of time and will become $\vec{O}$ at some instant(s)

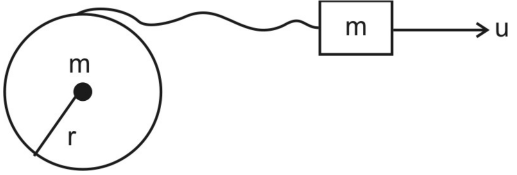
(B) $\vec{V}_{cm}$ is non-zero at all times

(C) $\vec{V}_{cm}$ is $\vec{O}$ at all times

(D) $\vec{V}_{cm}$ may be $\vec{O}$ at some instant(s)

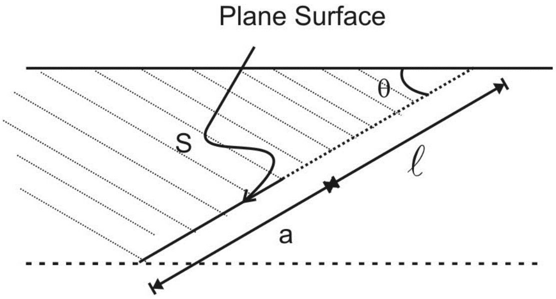
Space for Rough work

10. A block of mass m is attached to a pulley disc of same mass and radius 'r' by means of a block strings a shown. The pulley is hinged about its centre on a horizontal table and the block is projected with an initial velocity of 3 m/s. Its velocity when the string becomes taut will be:



(A) 3 m/s
(B) 2 m/s
(C) 1 m/s
(D) 2.5 m/s

11. Consider a plane surface of length 'a' and width 'b' which is inside a liquid of density ρ. Find the force on the entire surface due to the liquid in S.

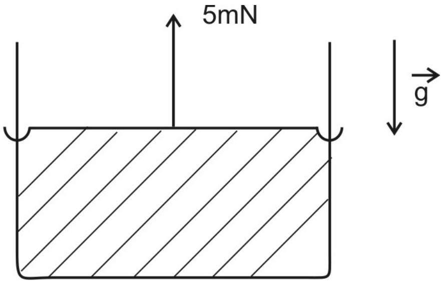


(A) $\frac{\rho gab}{2}[a+2\ell]\sin\theta$
(B) $\frac{\rho gab}{2}[a+\ell]\sin^2\theta$
(C) $\frac{\rho gab}{2}[a+\ell]\sin^2\theta$
(D) $\frac{\rho gab}{4}[a+2\ell]\sin^2\theta$

12. A pressure meter attached to a closed water tap reads 1 bar. When the tap speed is 10 ms^{-1} and the reading of the pressure meter is
(A) 1.5×10^5 Pa
(B) 3×10^5Pa
(C) 0.5×10^5 Pa
(D) 10^5 Pa

Space for Rough work

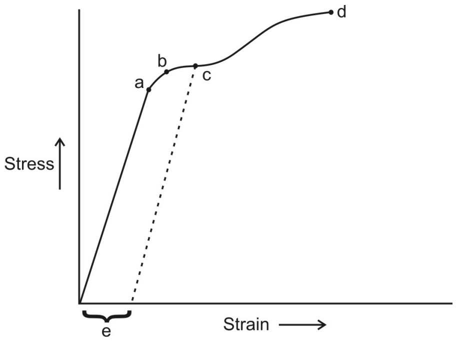
13. A film of the liquid is supported in a vertical rectangular area, the top border of which is a sliding wire. An external force of 5 mN acts on the sliding wire of length 50 mm and linear mass density of 1.75×10^{-3} kg/m. Find the surface tension of the liquid:



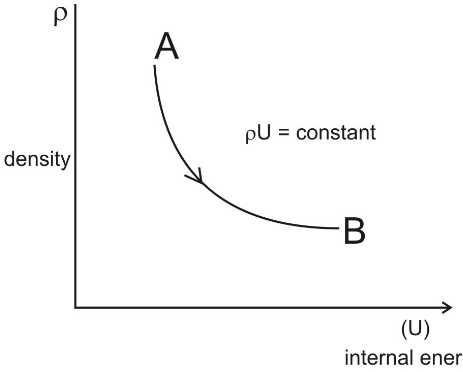
(A) 0.083 N/m
(B) 0.041 N/m
(C) 0.1 N/m
(D) 0.05 N/m

14. The magnitude of gravitational potential energy of the sun-earth system is u with zero potential energy at infinity separation. The kinetic energy of the earth with respect to the sum is K.
(A) U < K
(B) U > K
(C) U = K
(D) None of these

15. Mark the CORRECT option, for stress-strain curve of a metal wire:
(A) Curve ab represents elastic behaviour and e denotes fracture
(B) ONLY curve ac represents elastic behaviour
(C) Curve bd represents plastic behaviour and e represents permanent set
(D) Point d represents fracture point and the gap between b and d is respectively large for brittle materials



16. Mark the CORRECT option for a gas:
(A) Heat is expelled by gas
(B) Heat is absorbed by gas
(C) Process A→B is adiabatic
(D) Temperature of the gas decreases from A to B



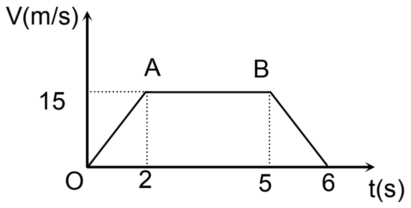
Space for Rough work

17. A musical instrument has a string which is timed to frequency 400 Hz and has a length of 0.5m. What is the third longest wavelength of resonance that reaches the ear of the listener? (V_{air} = 343 m/s):
(A) 0.572 m
(B) 0.286 m
(C) 1.7515 m
(D) 1.29 m

18. The most probable speed of a gas with temperature 'T' and molar Mass 'M' is $\sqrt{\frac{ART}{M}}$, A is a dimensionless constant and R is universal gas constant in JK^{-1} mol^{-1}. Four equal charges $A\times10^{-6}$C each are fixed at the four corners of a square of side 5 cm. Find the coulomb force experienced by one of the charges due to the other three :
(A) 20 N
(B) 27.5 N
(C) 44.6 N
(D) 61.9 N

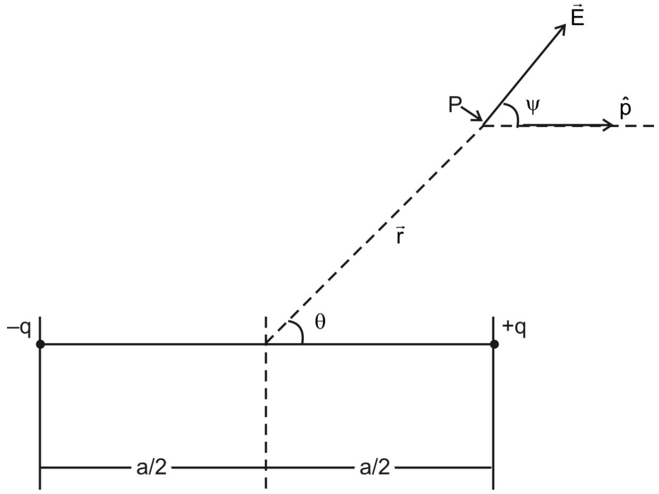
19. One cannot see through fog, because:
(A) Fog absorbs the light
(B) Light suffers total reflection at droplets
(C) Refractive index of the fog is infinity
(D) Light is scattered by droplets

20. The speed time graph of a car is given below the car weights 1 Mg.
(A) Distance travelled in first two seconds is 30 m
(B) Acceleration of the car at t = 4s is 7.5 m/s^2
(C) Braking force applied at the end of 5s to bring the Car to a stop within 1s is 15 KN
(D) (A), (B) and (C) are WRONG



Space for Rough work

21. Electric field due to a 'short' electric dipole at a point P as shown is at an angle ψ with respect to $\vec{p}$. Then



(A) $\psi = \theta + \tan^{-1}\left(\frac{\tan\theta}{\sqrt{2}}\right)$
(B) $\psi = \theta + \tan^{-1}\left(\frac{\tan\theta}{2}\right)$
(C) $\psi = \theta + \tan^{-1}\left(\frac{\tan\theta}{2\sqrt{2}}\right)$
(D) $\psi = \theta + \tan^{-1}\left(\frac{\tan\theta}{\sqrt{5}}\right)$

22. Mark the INCORRECT statement:
(A) By convention, the charge on a plastic rod rubbed with fur is negative and the charge on a glass rod rubbed with silk is positive.
(B) The ratio of electric force and gravitational force between a proton and electron is $\frac{ke^2}{Gmemp} \cong 2.4 \times 10^{39}$
(C) Conservation of total charge of an isolated system is a property dependent on the scalar nature of charge.
(D) Quantisation of electric charge is a basic unexplained law of nature, interestingly; there is no analogues law of quantisation of mass.

Space for Rough work

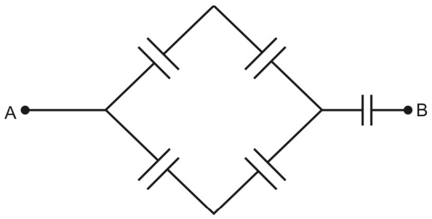
23. A substance when placed in a non-uniform magnetic field is attracted towards stronger magnetic field. That substance CAN be:
(A) Paramagnetic
(B) Diamagnetic
(C) Either Paramagnetic OR diamagnetic
(D) Neither Paramagnetic NOR diamagnetic

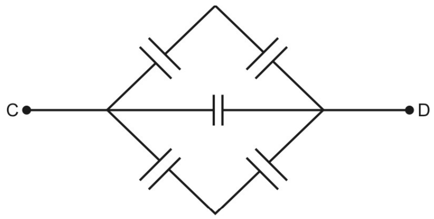
24. Mark the CORRECT option:
(A) A vertical plane containing the vertical axis (orthogonal to ground) and the longitude is called the geographic meridian
(B) Geographic meridian and magnetic meridian for earth are always same at a point
(C) The dip circle is simply a compass needle pivoted about a fixed vertical axis and free to move in a horizontal plane
(D) There is a bar magnet busied deep inside earth's interior which gives rise to earth's magnetic field

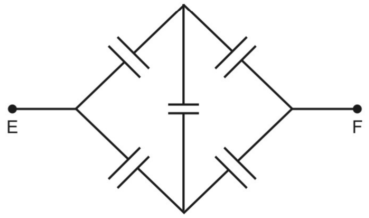
25. Two resistors R and 2R are connected in parallel in an electric circuit. The thermal energy developed in R and 2R are in the ratio:

(A) 1 : 2	(B) 2 : 1
(C) 1 : 4	(D) 4 : 1

26. Consider the circuits drawn below:





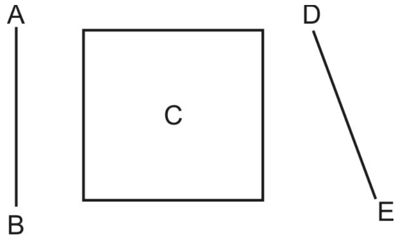


All the capacitors are identical, then

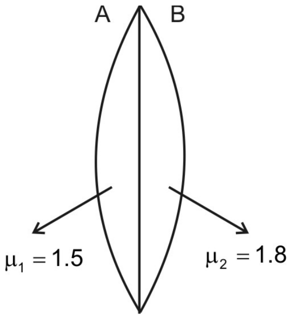
(A) $C_{CD} > C_{EF} = C_{AB}$	(B) $C_{CD} > C_{EF} > C_{AB}$
(C) $C_{CD} > C_{AB} > C_{EF}$	(D) $C_{EF} > C_{CD} > C_{AB}$

Space for Rough work

27. A wave front AB passing through a system C averages as DE. The system 'C' CAN be
(A) a slit
(B) a biprism
(C) a prism
(D) a glass slab



28. A convex lens is made of two different materials having radius of curvature of surface A and surface B as 25 cm and 24 cm respectively. The effective focal length of lens is
(A) 75/4 cm
(B) 75 cm
(C) 50 cm
(D) 30 cm



29. Hydrogen atom is its ground state is excited by means of monochromatic radiation of wavelength 970.6Å. How many different wavelengths are possible in the resulting EMISSION spectrum? [hc = 1.986×10^{-25} J-m] :
(A) 3 (B) 4
(C) 5 (D) 6

30. Attenuation, when referring to communication systems, is :
(A) The process of mixing low frequency signal and a high frequency signal
(B) The weakening of a signal as it propagates through a medium
(C) The process of increasing the amplitude of a signal
(D) The process of recovering a low frequency signal from a high frequency signal

Space for Rough work

Chemistry PART – II

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. A particular 100-octane aviation gasoline used 1.00 cm^3 of tetraethyl lead $(C_2H_5)_4Pb$ of density 1.66 g/cc, per litre of product. This compound is made as follows.
$4C_2H_5Cl + 4NaPb \longrightarrow (C_2H_5)_4Pb + 4NaCl + 3Pb$. How many gram of ethyl chloride is needed to make enough tetraethyl lead for 1 L of gasoline.
(A) 1.33g (B) 2.66 g
(C) 9.2g (D) 0.33g

2. The treatment of $CH_3CH = CHCH_3$ with $NaIO_4$ produces
(A) CH_3CHO only (B) CH_3COOH only
(C) CH_3CHO & CH_3COOH (D) $CH_3COCH_3 + HCOOH$

3. Among the following, which exhibits aromaticity?
(A) Cyclopentadienyl cation (B) Cyclopentadienyl radical
(C) Cycloheptatrienyl radical (D) Cycloheptatrienyl cation

4. S_N1 characteristics would be exhibited in the hydrolysis of
(A) chlorobenzene (B) 1-chloronapthalene
(C) propenyl chloride (D) 2-chloro-1-propene

5. The ease of dehydration of the following alcohols with H_2SO_4 is
(I) $CH_3CH_2CH(OH)CH_2CH_2CH_3$ (II) $(CH_3)_2C(OH)CH_2CH_2CH_3$
(III) $CH_3CH_2CH(OH)CH(CH_3)_2$ (IV) $(CH_3)_2C(OH)CH(CH_3)_2$

(A) III > IV > II > I (B) III > II > IV > I
(C) II > III > I > IV (D) II > III > IV > I

Space for Rough work

6. The solubility product of A_2X_3 is 1.08×10^{-23}. Its solubility will be

(A) 1×10^{-3}	(B) 1×10^{-6}
(C) 1×10^{-4}	(D) 1×10^{-5}

7. When dilute H_2SO_4 is electrolysed between Pt electrodes, the gas liberated at the anode will be

(A) SO_2	(B) SO_3
(C) O_2	(D) H_2

8. 0.7 g of $Na_2CO_3 .xH_2O$ were dissolved in water and the volume was made to 100 mL. 20 mL of this solution required 19.8 mL of N/10 HCl for complete neutralization. The value of x is

(A) 7	(B) 2
(C) 3	(D) 5

9. The product of reaction of an aq. solution of Bi^{3+} salt with sodium thiosulphate gives

(A) Bi_2S_3	(B) $Na_3[Bi(S_2O_3)_3]$
(C) $Na[Bi(S_2O_3)_2]$	(D) $[Bi_2(S_2O_3)_2]Cl_2$

10. The basic ionisation constant for hydrazine, N_2H_4 is 9.6×10^{-7}. What would be the percent hydrolysis of 0.1 N_2H_5Cl?

(A) 0.016%	(B) 3.2%
(C) 1.6%	(D) 0.032%

Space for Rough work

11. Which of the following combinations will act as a buffer
(A) NH_3 + HCl (molar ratio 2:1)
(B) HC_2H_3O, NaOH (Molar ratio 1:2)
(C) HCl + NaCl
(D) NaOH + $HC_2H_3O_2$ (1:1 molar ratio)

12. Gaseous cyclobutane isomerizes to butadiene in a first order process which has a k value at 153°C of $3.3 \times 10^{-4} s^{-1}$. How many minutes would it take for the isomerisation to proceed 40% to completion at this temperature?
(A) 26 min
(B) 52 min
(C) 13 min
(D) None of these

13. Current efficiency is defined as the extent of a desired electrochemical reaction divided by the theoretical extent of the reaction times 100%. What is the current efficiency of an electrodeposition of Cu metal in which 9.8 g Cu is deposited by passage of 3A current for 10000 seconds.
(A) 0.9%
(B) 49.9%
(C) 99.1%
(D) 51.1%

14. A 10 L cylinder of oxygen at 4 atm pressure and 17°C developed a leak. When the leak was repaired, 2.5 atm of O_2 remained in the cylinder, still at 17°C. The no. of moles of gas escaped.
(A) 1.2 mol
(B) 0.30 mol
(C) 0.63 mol
(D) 2.4 mol

15. Arrange the following in decreasing order of basicity
(I) Aniline (II) p-nitro aniline (III) N, N dimethyl aniline (IV) N, N, 2,6 tetramethylaniline

(A) I > II > IV > III
(B) III > IV > I > II
(C) III > I > IV > II
(D) IV > III > I > II

Space for Rough work

16. Which of the following is not linear
(A) $Ag(NH_3)_2^+$ (B) $HgCl_2$
(C) $PbCl_2$ (D) CS_2

17. The order of enol content in the following compounds is

CH_3COCH_2COOEt	$(EtOCO)_2CH_2$	$PhCOCH_2COCH_3$	$PhCOCH_2COOEt$
(I)	(II)	(III)	(IV)

(A) II > I > III > IV (B) IV > III > II >I
(C) III > IV > I > II (D) III > I > IV > II

18. All the halobenzenes are separately treated with HNO_3/H_2SO_4. The quantity of o-product should be maximum when the substance is
(A) Flurobenzene (B) Chlorobenzene
(C) Bromobenzene (D) Iodobenzene

19. The minimum number of carbon atoms for an alkene hydrocarbon to exhibit optical isomerism is
(A) 5 (B) 6
(C) 9 (D) None of these

20. Bicyclohexane was found to undergo two parallel 1st order rearrangements. At 730 K the first order rate constant for the formation of cyclohexene was 1.26×10^{-4} s^{-1} and for the formation of methyl cyclopentene the rate constant was 3.8×10^{-5} s^{-1}. What was the percentage distribution of methyl cyclopentene.
(A) 77% (B) 23%
(C) 66% (D) 34%

21. $\Delta T_f / K_f$ has the same value of 1 mol kg^{-1} for 8% AB_2 and 10% A_2B by mass of solvent, both AB_2 and A_2B being non electrolytes.
Atomic masses of A and B will be respectively.
(A) 20, 40 (B) 20, 50
(C) 40, 20 (D) 50, 40

22. What will happen when D-(+)-glucose is treated with methanolic HCl followed by Tollen's reagent?
(A) A black ppt. will be formed. (B) A green colour will appear.
(C) A red ppt. will be formed. (D) No characteristic colour or ppt. will be formed.

Space for Rough work

23. The r^+ / r^- ratio of ZnS is 0.402. Which of the following is the incorrect statement?
(A) ZnS is 4 : 4 coordination compound.
(B) ZnS does not crystallize in rock salt type lattice because r^+ / r^- is too small to avoid overlapping of S^{2-}.
(C) Zn^{2+} ion is too small to fit precisely into the tetrahedral voids of S^{2-} ions.
(D) Zn^{2+} ion is too large to fit into tetrahedral voids of S^{2-} ions.

24. The wavenumber of last line of Lyman series of hydrogen spectrum is 109674 cm^{-1}. The wave number of $H\alpha$ line in Balmer series He^+ is?
(A) 438696 cm^{-1}
(B) 106974 cm^{-1}
(C) 30465 cm^{-1}
(D) 60930 cm^{-1}

25. Consider the following statements
(I) NO^+ is more stable towards dissociation into atoms than NO.
(II) CO^+ is less stable towards dissociation into atoms than CO.
Then which of the following is correct?
(A) I only
(B) II only
(C) I & II both
(D) None of these

26. Below critical micelle concentration (CMC) sodium oleate in aqueous solution:
(A) exists largely as micelles of anions.
(B) dissolve substances like grease, fat etc. colloidally.
(C) increases the viscocity of water abruptly.
(D) behaves as strong electrolyte.

Space for Rough work

27. Given that:

$S^o_{H_2} = 131\ JK^{-1}\ mol^{-1}$

$S^o_{Cl_2} = 223\ JK^{-1}\ mol^{-1}$

and $S^o_{HCl} = 187\ JK^{-1}\ mol^{-1}$

The standard entropy change in formation of 1 mole of HCl (g) from H_2(g) and Cl_2(g) will be:

(A) 20 J K^{-1} (B) 10 J K^{-1}
(C) 187 J K^{-1} (D) 374 J K^{-1}

28. The hybridization of P in PO_4^{3-} is the same as that of:

(A) N in NO_3^- (B) S in SO_3
(C) I in ICl_2^+ (D) I in ICl_4^-

29. Among the following compounds which exist as solid at room temperature?

(A) XeF_6 (B) OF_2
(C) SF_4 (D) SF_6

30. Magnesium is mainly extracted by

(A) Carbon reduction method
(B) self reduction method
(C) the method of electrolysis
(D) leaching with aq. solution of NaCN followed by reduction

Space for Rough work

Mathematics PART – III

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. If the lines represented by $x^2 - 2pxy - y^2 = 0$ are rotated about origin through an angle θ, one in clockwise direction and other in anticlockwise direction, then equation of the bisectors of the angle between the lines in the new position is
(A) $px^2 + 2xy + py^2 = 0$ (B) $px^2 - 2xy + py^2 = 0$
(C) $px^2 - 2pxy - py^2 = 0$ (D) $px^2 + 2xy - py^2 = 0$

2. Let $D_0 = \begin{vmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{vmatrix}$ and let D_1 denote the determinant formed by the co-factor of elements of D_0 and D_2 denote the determinant formed by co-factor of D_1 and so on. If D_n denotes the determinant formed by the co-factor of D_{n-1}, then the value of determinant D_n is
(A) $(D_0)^{2n}$ (B) $D_0^{2^n}$
(C) $D_0^{n^2}$ (D) D_0^2

3. The maximum value of $f(x) = \int_0^1 t\sin(x + \pi t)dt$ is
(A) $\frac{1}{\pi}\sqrt{\pi^2 + 4}$ (B) $\frac{1}{\pi^2}\sqrt{\pi^2 + 4}$
(C) $\sqrt{\pi^2 + 4}$ (D) $\frac{1}{2\pi^2}\sqrt{\pi^2 + 4}$

Space for rough work

4. Number of integers in the range of 'a' so that the equation $x^3 - 3x + a = 0$ has all its roots real and distinct, is
(A) 2 (B) 3
(C) 4 (D) 5

5. f(n) = $\cot^2\frac{\pi}{n} + \cot^2\frac{2\pi}{n} + ... + \cot^2\frac{(n-1)\pi}{n}$, (n > 1, n $\in$ N) then $\lim_{n\to\infty}\frac{f(n)}{n^2}$ is equal to
(A) $\frac{1}{2}$ (B) $\frac{1}{3}$
(C) $\frac{2}{3}$ (D) 1

6. Given two circles $x^2 + y^2 + 3\sqrt{2}(x+y) = 0$ and $x^2 + y^2 + 5\sqrt{2}(x+y) = 0$, let the radius of a circle which touches the two circles and their common diameter be $\frac{2\lambda - 1}{\lambda}$ then λ equals
(A) 10 (B) 8
(C) 7 (D) 5

7. Let ABCD be a tetrahedron with AB = 41, BC = 36, CA = 7, DA = 18, DB = 27 and DC = 13, then square of the distance between mid-points of AB and CD equals
(A) 1096 (B) 548
(C) 274 (D) 137

8. In triangle ABC, if 2b = a + c and A – C = 90º, then sin B equals
(A) $\frac{\sqrt{7}}{5}$ (B) $\frac{\sqrt{5}}{8}$
(C) $\frac{\sqrt{7}}{4}$ (D) $\frac{\sqrt{5}}{3}$

9. The graph of $f(x) = x^2$ and $g(x) = cx^3$ intersect at two points. If area of region bounded between f(x) and g(x) over the interval $\left[0, \frac{1}{c}\right]$ is equal to $\frac{2}{3}$ then the value of $\left(\frac{1}{c} + \frac{1}{c^2}\right)$ is
(A) 20 (B) 2
(C) 6 (D) 12

Space for rough work

10. The value of sec 40º + sec 80º + sec 160º will be
(A) 4 (B) –4
(C) 6 (D) 8

11. Consider the chords of the parabola $y^2 = 4x$ which touches the hyperbola $x^2 - y^2 = 1$, the locus of the point of intersection of the tangents drawn to the parabola at the extremities of such chords is a conic section having latus rectum λ, the value of λ is
(A) 1 (B) 2
(C) 3 (D) 4

12. The area of the region bounded by lines y = x, y = 0 and $x = \sin^{-1}(a^4 + 1) + \cos^{-1}(a^4 + 1) - \tan^{-1}(a^4 + 1)$ is
(A) $\frac{\pi^2}{8} - \frac{a^2}{4}$ (B) $\frac{\pi^2}{8} - \frac{a^2}{2}$
(C) $\frac{\pi^2}{16}$ (D) $\frac{\pi^2}{32}$

13. If $ax^3 + by^3 + cx^2y + dxy^2 = 0$, represents three distinct straight lines, such that each line bisects the angle between the other two, then which of the following is true
(A) 3b + c = 0 (B) 3a + d = 0
(C) d + 3a = 0 (D) b + 3c = 0

14. The number of integral value of n (where $n \geq 2$) such that the equation $2n\{x\} = 3x + 2[x]$ has exactly 5 solution (where [.] denotes the greatest integer function and {x} is fractional part of x) is
(A) 2 (B) 3
(C) 4 (D) 0

15. The rth, sth, tth terms of an A.P. are 6, 8 and 12 respectively. If $f(x) = tx^2 + 2rx - 2s$ then f(x) = 0 has
(A) both roots are negative (B) both roots greater then 2
(C) one root negative other greater than 1 (D) exactly one root $\in (0, 1)$

16. Let $a, b, c, d \in R$ be such that $a^2 + b^2 + c^2 + d^2 = 25$, then
(A) $ab + bc + cd + ad \leq \frac{25}{2}$ (B) $ab + bc + cd + ad \leq 25$
(C) $ab + bc + cd + ad \leq 5$ (D) $ab + bc + cd + ad \leq \frac{5}{2}$

Space for rough work

17. Let $f\left(x\right)=\begin{cases}3\sin x+a^2-10a+30 & x\notin Q\\ 4\cos x & x\in Q\end{cases}$ which one of the following statements is correct?

(A) f(x) is continuous for all x when a = 5
(B) f(x) must be discontinuous for all x, when a = 5
(C) f(x) is continuous for all $x = 2n\pi - \tan^{-1}\left(\frac{3}{4}\right)$, $n \in$ **I**, when a = 5
(D) f(x) is continuous for all $x = 2n\pi - \tan^{-1}\left(\frac{4}{3}\right)$, $n \in$ **I**, when a = 5

18. Number of ways in which 5 alike red balls and 6 alike green balls can be arranged so that exactly two pairs of green balls are together is

(A) 72 (B) 90
(C) 144 (D) 100

19. If $|z-2+i|=|z|\left|\sin\left(\frac{\pi}{4}-\arg z\right)\right|$, then locus of z is

(A) pair of straight line (B) circle
(C) parabola (D) ellipse

20. If x, y, z are real variables such that 3 tan x + 4 tan y + 5 tan z = 20, then the minimum value of $\tan^2 x + \tan^2 y + \tan^2 z$ is

(A) 10 (B) 15
(C) 8 (D) 12

21. If $\theta=\frac{2\pi}{2009}$ then $\cos\theta\cos 2\theta\cos 3\theta \ldots\ldots \cos 1004\theta$ is equal to

(A) 0 (B) $\frac{1}{2^{2008}}$
(C) $\frac{1}{2^{1004}}$ (D) $-\frac{1}{2^{1004}}$

Space for rough work

22. $\int \frac{x\,dx}{\sqrt{1+x^2+\sqrt{\left(1+x^2\right)^3}}}$ is equal to

(A) $\frac{1}{2}\ell n\left(1+\sqrt{1+x^2}\right)+c$

(B) $\frac{-2}{3\left(1+\sqrt{1+x^2}\right)^{3/2}}+c$

(C) $2\left(1+\sqrt{1+x^2}\right)+c$

(D) $2\sqrt{1+\sqrt{1+x^2}}+c$

23. There exist two points P and Q on the hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ such that OP $\perp$ OQ (where O is origin), then number of points in the xy plane from where pair of perpendicular tangents can be drawn to the hyperbola is

(A) 0

(B) 1

(C) 2

(D) infinite

24. The shortest distance between the lines 2x + y + z – 1 = 0 = 3x + y + 2z – 2 and x = y = z is

(A) $\frac{1}{\sqrt{2}}$

(B) $\sqrt{2}$

(C) $\frac{3}{\sqrt{2}}$

(D) $\frac{\sqrt{3}}{2}$

25. If $A=\alpha\begin{bmatrix} 1 & 1+i \\ 1-i & -1 \end{bmatrix}$ ($\alpha \in$ R) is a unitary matrix then α^2 is

(A) $\frac{1}{2}$

(B) $\frac{1}{3}$

(C) $\frac{1}{4}$

(D) $\frac{2}{9}$

Space for rough work

26. Solution of equation (2 + x) dy – y dx = 0 represents a curve passing through a fixed point p, then are of equilateral triangle with p as one vertex and x + y = 0 as its one side is

(A) $2\sqrt{3}$ (B) $\sqrt{3}$

(C) $\frac{2}{\sqrt{3}}$ (D) $\frac{4}{\sqrt{3}}$

27. The term independent of x in the expansion of $\left(\frac{1}{x^2}+\frac{1}{x}+1+x+x^2\right)^5$ is

(A) 381 (B) 441

(C) 439 (D) 359

28. If the standard deviation of the data 1, 3, 5, 7, ….., 2013 is d, then [d] is (where [.] denotes the greatest integer function)

(A) 580 (B) 581

(C) 582 (D) 583

29. If number of different reflexive relation on set A is equal to number of different symmetric relation on set A, then n(A) is equal to

(A) 1 (B) 3

(C) 1 and 3 (D) 3 and 7

30. If $(\sin^{-1} x + \sin^{-1} y)(\sin^{-1} z + \sin^{-1} w) = \pi^2$, then the value of $\begin{vmatrix} x^{n_1} & y^{n_2} \\ z^{n_3} & w^{n_2} \end{vmatrix}$ can not be equal to (where $n_1, n_2, n_3, n_4 \in N$)

(A) –2 (B) 0

(C) 1 (D) 2

Space for rough work

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4.	D	C	B
5.	B	B	B
6.	C	D	B
7.	C	C	D
8.	B	B	C
9.	B	A	C
10.	B	D	C
11.	A	A	A
12.	C	A	D
13.	B	C	A
14.	B	C	B
15.	C	D	D
16.	B	C	B
17.	B	C	C
18.	B	D	B
19.	D	B	C
20.	C	A	C
21.	B	C	C
22.	C	D	D
23.	A	D	A
24.	A	C	A
25.	B	C	B
26.	B	D	C
27.	C	B	A
28.	A	C	B
29.	D	A	B
30.	B	C	C

Physics

PART – I

SECTION - A

1. Q = C.V. , [Q] = T'A'
So, a + b + c + d + e + f + g + h = 2

3. $\vec{r}(t) = \vec{r}(0) + \int_{t=0}^{t=t} \vec{v}.dt$, $\vec{v}(t) = \int_{t=0}^{t=t} \vec{a}.dt + \vec{v}(0)$

$$\int_{t=0}^{t=t} \vec{v}.dt = \int_{0}^{t} \left[\left(t^2 + 5\right)\hat{i} + \left(\frac{3t^2}{2} + 2\right)\hat{j}\right]dt$$

$$= \left[\frac{t^3}{3} + 5t\right]\hat{i} + \left[\frac{t^3}{2} + 2t\right]\hat{j}$$

$$\vec{r}(t) = \left[\frac{t^3}{3} + 5t + 10\right]\hat{i} + \left[\frac{t^3}{2} + 2t + 10\right]\hat{j}$$

4. $|\vec{a}_1| = |\vec{a}_2| = |\vec{a}_3| = \dfrac{T_A}{(m_1 + m_2 + m_3)} = \dfrac{T_B}{m_3 + m_2} = \dfrac{T_c}{m_3}$

$\Rightarrow T_A > T_B > T_C$

$T_A = T_B\left[1 + \dfrac{m_1}{m_2 + m_3}\right]$ and $\dfrac{m_1}{m_2 + m_3} < 1$

So, $T_A < 2T_B$

$T_B = T_C\left[1 + \dfrac{m_2}{m_3}\right]$ and $\dfrac{m_2}{m_3} < 1$

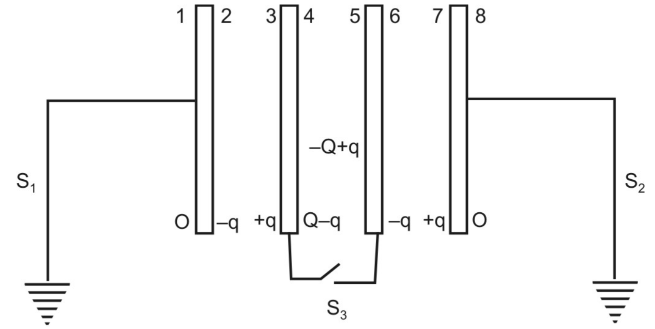
So, $T_B < 2T_C$

Now, $T_A = T_C\left[1 + \dfrac{m_1 + m_2}{m_3}\right]$

And, $m_1 + m_2 < m_3 + m_3 \Rightarrow \dfrac{m_1 + m_2}{m_3} < 2$

Or $T_A < 3T_C$

5. 'T' total charge in the system (initially) = zero We know that when two or more charged conducting plates are peaced parallel to each other, the outermost surfaces get equal charges 'p' can be proved using gauss's law) Where, $P = \dfrac{T}{2}$; So, P = 0



Since the middle plates are not connected total change on than would be conserved the charges on the plates after S_1 and S_2 are connected are shown in the figure. Again, we utilize the fact that the facing surfaces must carry opposite charges. Finally the potential difference between surface 1 and 8 must be zero. The electric field is non-zero between the conducting plates and zero inside them.

$$d\left(\frac{q}{A\varepsilon_0}\right)-\left(\frac{Q-q}{A\varepsilon_0}\right)d+d\left(\frac{q}{A\varepsilon_0}\right)=0$$

d = spacing between the plates A = Area of the plate

$\Rightarrow q = Q/3$

6. x = A cos wt

R = Δ sin wt : Q = A cos wt = A sin $\left(\frac{\pi}{2}-wt\right)$

7. Electric field at a distance x-on the axis
= Electric field due to an infinite sheet
– Electric field due to a uniformly charged disc of radius 'R'

$$=\frac{\sigma}{2\varepsilon_0}-\frac{\sigma}{2\varepsilon_0}\left[1-\frac{x}{\sqrt{x^2+r^2}}\right]$$

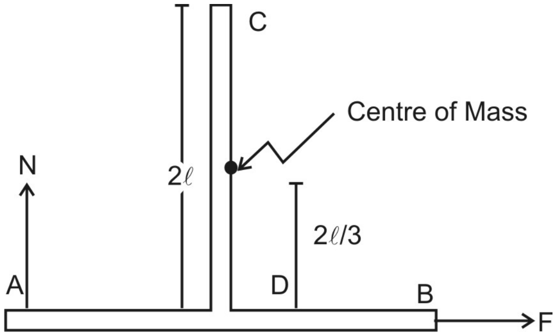
$$E=\frac{\sigma}{2\varepsilon_0}\frac{x}{\sqrt{x^2+R^2}}$$

$$F=qE=-\frac{\sigma ex}{2\varepsilon_0\sqrt{x^2+R^2}}$$

$$\Rightarrow mu\frac{du}{dx}=-\frac{\sigma ex}{2\in_0\sqrt{x^2+R^2}}$$

$$u=\sqrt{\frac{\left(\sqrt{2}-1\right)\sigma eR}{m\varepsilon_0}}$$

8. When the point B is about to leave ground the normal reaction to the rigid rod passes through A. Gravity would not cause a torque about centre of mass. Also, the torques must balance just before B leaves ground.



$$F\left(\frac{2\ell}{3}\right)=3mg\left(\frac{\ell}{2}\right)$$

$$F=\frac{9mg}{4}$$

9. $\vec{V}_{cm}$ of the system is non-zero initially and would remain so because $\vec{F}_{ext}=0$ at all times.

10. Initial angular momentum = mvr

Final angular momentum = $\left(\frac{mr^2}{2}\right)w + m(wr)r$

$\because$ T_{ext} = 0 : L is conserved

Mur = $\frac{3}{2}mwr^2$

Or, $wr = \frac{2u}{3}$

Velocity of mass m first after the string is taut = wr = 2m/s

11. Force on inclined surface in liquid

= Pressure at the centroid of the surface × area of surface

$= \left[\rho g\left(l + \frac{a}{2}\right)\sin\theta\right]ab$

12. $P_1 = \frac{1}{2}\rho u^2 + P_2$

$10^5 Pa = \frac{1}{2} \times 10^3 \times (10)^2 + P^2$

$P_2 = \frac{1}{2} \times 10^5 Pa$

13. $\gamma = \frac{P - \mu dg}{2d}$

P = 5mN, μ = 1.75×10^{-3} kg/m, d = 50 mn

14. Potential energy = – 2 × kinetic energy

Magnitude of potential energy = 2 × K.E.

Clearly, U > K

16. Volume of the gas is increasing (assuming its mass remains constant) and volume of the gas is directly proportional to T.

nC_v (dT) = (dV) $\frac{k}{m}$ or $V \propto T$

The process is isobaric and exchange of heat is given by nC_p (dT)

17. $\lambda_3 = \frac{2\ell}{3} = \frac{1}{3}m$

Wave speed on the string = $\nu\lambda_1$ (lowest resonant node) u_{string} = 400 m/s

When a wave passes from one medium to another (the air) of differing wave speed, the frequency remains the same.

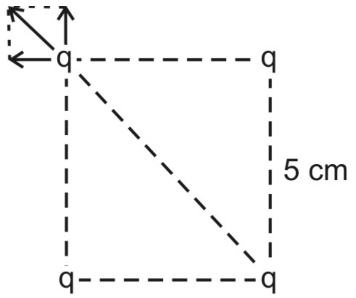
Now, $\lambda_{air} = \lambda_{string}\frac{v_{air}}{v_{string}}$

$= \frac{343}{400} \times \frac{1}{3}m$

18. $$F_q = kq^2\left[\frac{\sqrt{2}}{\left(5\times10^{-2}\right)^2}+\frac{1}{\left(5\sqrt{5}\times10^{-2}\right)}\right]$$

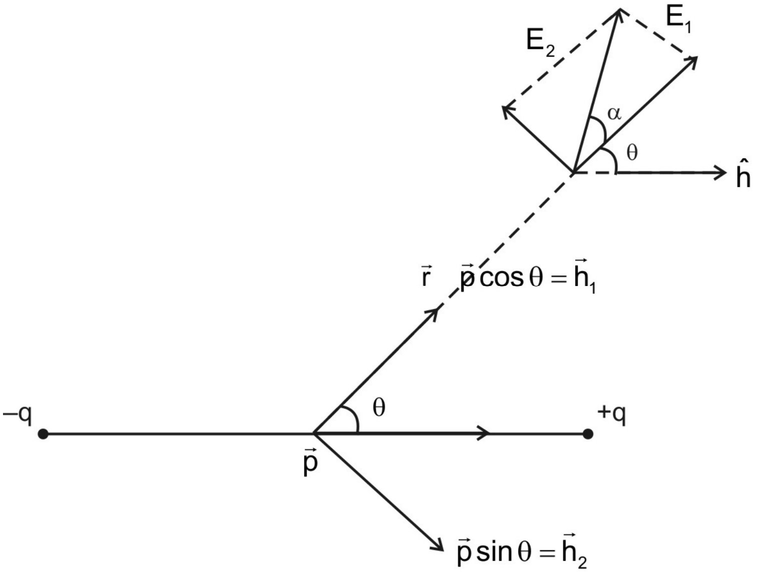
$$=\frac{9\times10^{9}\times4\times10^{-12}}{25\times10^{-4}}\left[\sqrt{2}+\frac{1}{2}\right]\text{N}$$

$$= 27.5 \text{ N}$$



20. Distance travelled in first two seconds = 15 m
Acceleration of the Car at t = 4s is zero
Braking force = Ma
= 1 Mg×15 m/s^2
= 15 KN

21. $$E_1 = \frac{2k\left(p\cos\theta\right)}{|\vec{r}|^3};E_2 = \frac{k\left(p\sin\theta\right)}{|\vec{r}|^3}$$


E_2
E_1
α
θ
$\hat{h}$
$\vec{r}$
$\vec{p}\cos\theta = \vec{h}_1$
$-q$
θ
$+q$
$\vec{p}$
$\vec{p}\sin\theta = \vec{h}_2$

$$\frac{E_2}{E_1} = \tan\alpha = \frac{\tan\theta}{2}$$

$$\text{or } \alpha = \tan^{-1}\left\{\frac{\tan\theta}{2}\right\}$$

$$\text{or } \psi = \theta + \tan^{-1}\left\{\frac{\tan\theta}{2}\right\}$$

25. $$\frac{P_1}{P_2} = \frac{H_1}{H_2} = \frac{\left(V^2/R_1\right)}{\left(V^2/R_2\right)} = \frac{R_2}{R_1} = \frac{2R}{R} = \frac{2}{1}$$

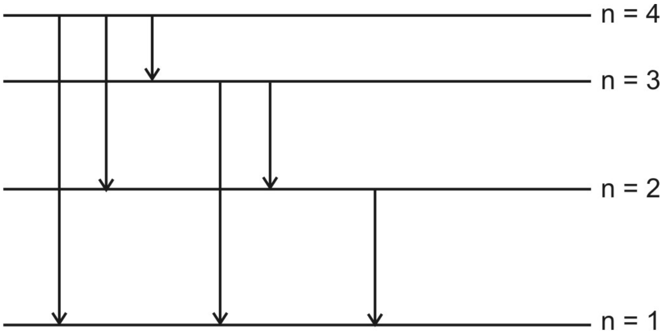
26. $C_{AB} = C/2$; $C_{CD} = 2C$; $C_{EF} = C$

27. A slit would have produced a spherical wave front. A biprism and a glass slab would produce a parallel wave front.

28. $\frac{1}{f_1} = (1.5-1)\left\{\frac{1}{25}\right) = \frac{1}{50};\ \frac{1}{f_2} = (1.8-1)\left\{\frac{1}{24}\right) = \frac{1}{30}$

$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{8}{150} = \frac{4}{75}; F = \frac{75}{4}\text{cm}$

29. $E = \frac{hc}{\lambda} = 12.79\text{eV}$



$E_n = E_1 + E = -0.81\text{eV}$

$E_n = -\frac{13.6}{n^2} = -0.81\text{eV}; n \simeq 4$

Chemistry

PART – II

SECTION – A

1. The mass of 1 cc of $(C_2H_5)_4Pb$ is = 1 × 1.66 = 1.66 g and this is the amount needed per litre.

No. of moles of $(C_2H_5)_4Pb$ needed = $\frac{1.66}{323}$ = 0.00514 ml

1 mole of $(C_2H_5)_4Pb$ requires 4 × (0.00514) = 0.0206 ml of C_2H_5Cl

$\therefore$ Mass of C_2H_5 Cl = 0.0206 × 64.5 = 1.33 g

2. The sp^3 bound leaving groups can be directly displaced by the nucleophile or the leaving group can ionise off to form a carbocation (S_N1) >C = C – L. However, sp^2 bound leaving groups are very difficult to ionise Halogen attached to allylic system are activated towards S_N1 due to stability of allyl carbocation.

4. Aromatic stabilisation occurs in rings that have an unbroken loop of p-orbitals. Any cyclic compound will be stable especially when the ring contains (4n + 2) π-electron.

5. The alcohols II & III are 3° but III gives more substituted C = C, I & IV are both 2° but IV can give a more substituted C = C.

6.
$$A_2X_3 \rightleftharpoons \underset{2S}{2A^{3+}} + \underset{3S}{3X^{2-}}$$

$K_{sp} = [2S]^2\,[3S]^3$
$= 2^2.\,3^3.\,S^5$

$$\Rightarrow S = \sqrt[5]{\frac{1.08\times10^{-23}}{108}} = \sqrt[5]{1\times10^{-25}} = 1\times10^{-5}$$

7.
$$H_2SO_4 \rightleftharpoons 2H^+ + SO_4^{2-}$$

$$H_2O \rightleftharpoons H^+ + OH^-$$

At anode: $2OH^- \longrightarrow H_2O + O + 2e^-$

$$O + O \longrightarrow O_2$$

OH^- ions are discharged at anode as OH^- ions have lower discharge potential then SO_4^{2-}.

8. Meq. of $Na_2CO_3.xH_2O$ in 20 mL = 19.8 × $\frac{1}{10}$

$\therefore$ Meq. of $Na_2CO_3.xH_2O$ in 100 ml = 19.8 × $\frac{1\times5}{10}$

$$\frac{0.7}{\frac{M}{2}}\times1000 = 19.8\times\frac{5}{10}$$

$\therefore$ M = 141.41
$\therefore$ 23 × 2 + 12 + 3 × 16 + 18x = 141.41
$\therefore$ x = 2

9. $3Na_2S_2O_3 + BiCl_3 = Na_3[Bi(S_2O_3)_3] + 3NaCl$
$Bi_2(S_2O_3)_3 + 3H_2O = Bi_2S_3 + 3H_2SO_4$

10. $N_2H_5^+ + H_2O \rightleftharpoons N_2H_4 + H_3O^+$

$$K_h = \frac{[N_2H_4][H_3O^+]}{[N_2H_5^+]} = \frac{k_w}{k_b} = \frac{10^{-14}}{9.6\times10^{-7}} = \frac{x^2}{0.1} = 1.04 \times 10^{-8}$$

$\therefore$ x = 3.2×10^{-5}

$$\% \text{ hydrolysis} = \frac{3.2\times10^{-5}}{0.1}\times100 = 0.032\ \%$$

11. $NH_3 + H^+ Cl \longrightarrow NH_4^+ Cl$

Solution contains NH_4Cl in contact with NH_3 (excess) & hence buffer

12. 2.303 log $C/C_0 = -$ kt

40% to completion means 60% unreacted

2.303 log 0.6 = $-(3.3 \times 10^{-4})$t

$\therefore$ t = 26 min

13. $9.8 \text{ g Cu} = \frac{9.8}{63.5}\times2 = 0.308 \text{ mol } e^-$

$10000 \times 3\times\frac{1}{96500} = 0.311 \text{ mol } e^-$

If 0.311 mol electrons provided by the current 0.308 mol was used to deposit copper.

The current efficiency is $\frac{0.308}{0.311}\times100 = 99.1\%$

14. Moles escaped = original – final moles

$$= \frac{4\times10}{0.082\times290} - \frac{2.5\times10}{0.082\times290} = 0.630 \text{ mol}$$

20. $$\frac{1.26\times10^{-4}}{(1.26\times10^{-4})+(3.8\times10^{-5})} = 77\% \text{ cyclohexene}$$

$\therefore$ methyl cyclopentene = (100 – 77) = 23%

21. Let x and y be the molar mass of A & B respectively then

$$\frac{\Delta T_f}{K_f} = m = 1 = \frac{8\times1000}{(x+2y)\times100} = \frac{80}{x+2y} \quad \ldots (1)$$

$$\& \frac{\Delta T_f}{K_f} = m = 1 = \frac{10\times1000}{(2x+y)\times100} = \frac{100}{2x+y} \quad \ldots (2)$$

Solving (1) & (2) x = 40; y = 20.

22. Reaction of D-(+)-glucose with methanolic HCl leads to the formation of methyl glucoside (C, - OH group is methylated) which, being acetal is not hydrolysable by base, so it will not respond Tollen's reagent.

23. For precise fitting of Zn^{2+} ions into tetrahedral voids of S^{2-} ions packing r^+ / r^- ratio must be 0.225.

24. $\bar{\nu} = RZ^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

For last line of Lyman series of H-specturm; $Z = 1$, $n_1 = 1$, $n_2 = \infty$.
For $H\alpha$ line in Balmer series of He^+; $Z = 2$, $n_1 = 2$, $n_2 = 3$.

25. NO^+ has lost an antibonding electron where as CO^+ has lost bonding electron.

26. Below CMC no micellization takes place. Sodium oleate ionizes almost completely in aqueous solution.

27. $\frac{1}{2}H_2(g) + \frac{1}{2}Cl_2(g) \longrightarrow HCl(g)$ … (1)

$\Delta S^\circ = \sum S^\circ(\text{product}) - \sum S^\circ(\text{reactants})$

$= S^\circ_{HCl} - \left[\frac{1}{2}S^\circ_{H_2} + \frac{1}{2}S^\circ_{Cl_2}\right]$

$= 187 - \frac{1}{2}[131 + 223] = 10\ JK^{-1}$

28. In PO_4^{3-}, P shows sp^3 hybridization.
In NO_3^-, N shows sp^2 hybridization'
In ICl_2^+, I shows sp^3 hybridization.

29. $OF_2 \rightarrow$ Pale yellow.
SF_6 & $SF_4 \rightarrow$ Gas.

Mathematics PART – III

SECTION – A

1. Bisectors of the lines in both the cases will remain unchanged

2. $D_1 = D_0^2$, $D_2 = D_1^2 = D_0^4, \ldots\ldots D_n = D_0^{2^n}$

3. $f(x) = \left[\frac{-t}{\pi}\cos(x+\pi t)\right]_0^1 + \frac{1}{\pi}\int_0^1 \cos(x+\pi t)\,dt$

$= \frac{1}{\pi}\cos x - \frac{2}{\pi^2}\sin x$

$f_{\max} = \sqrt{\frac{1}{\pi^2} + \frac{4}{\pi^4}} = \frac{\sqrt{\pi^2+4}}{\pi^2}$

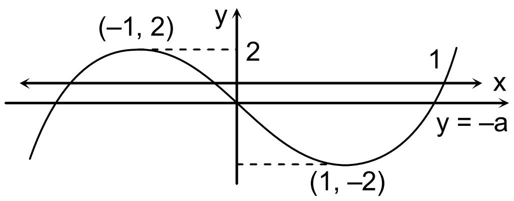
4. $y = x^3 - 3x$

$y = -a$

$\frac{dy}{dx} = 3x^2 - 3$

$\Rightarrow x = 1$ or -1

For three different roots $-a \in (-2, 2)$



5. $x = -i\cot\frac{k\pi}{n}$, $k \in \{1, 2, 3, \ldots\ldots, n-1\}$

Then $\frac{x}{1} = \frac{\cos k\frac{\pi}{n}}{i\sin\frac{k\pi}{n}}$

$\Rightarrow \left(\frac{x+1}{x-1}\right) = \cos\frac{2k\pi}{n} + i\sin\frac{2k\pi}{n}$

$\Rightarrow \left(\frac{x+1}{x-1}\right)^n = \cos 2k\pi + i\sin 2k\pi = 1$

$\Rightarrow (x+1)^n - (x-1)^n = 0$

$\Rightarrow {}^nC_1x^{n-1} + {}^nC_3x^{n-3} + \ldots\ldots = 0$

Roots of above equation are $-i\cot\frac{k\pi}{n}$, $k \in \{1, \ldots\ldots n-1\}$

$\therefore \sum_{k=1}^{n-1}\left(-i\cot\frac{k\pi}{n}\right)^2 = \left(\sum_{k=1}^{n-1}\left(-i\cot\frac{k\pi}{n}\right)\right)^2 - 2\cdot\sum\sum_{1\le p<q\le n-1}\left(-i\cot\frac{p\pi}{n}\right)\times\left(-i\cot\frac{q\pi}{n}\right) = 0 - 2\frac{{}^nC_3}{{}^nC_1}$

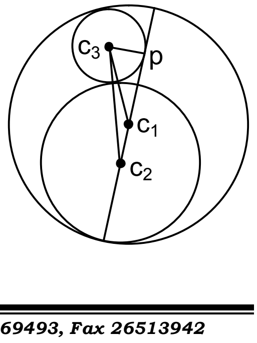
$\Rightarrow f(n) = \frac{(n-1)(n-2)}{3}$

6. $c_1 : \left(\frac{-5}{\sqrt{2}}, \frac{-5}{\sqrt{2}}\right)$

$r_1 = 5$

$c_2 : \left(\frac{-3}{\sqrt{2}}, \frac{-3}{\sqrt{2}}\right)$

$r_2 = 3$



r be radius of third circle and its centre be at c_3, then

$$(c_2c_3)^2 = (pc_3)^2 + \left(c_1c_2 + \sqrt{\left((c_1c_3)^2 - (pc_3)^2\right)}\right)^2$$

$$\Rightarrow (r_2 + r)^2 = r^2 + \left(r_1 - r_2 + \sqrt{(r_1 - r)^2 - r^2}\right)^2$$

$$\Rightarrow r = \frac{4r_1r_2(r_1 - r_2)}{(r_1 + r_2)^2} = \frac{15}{8}$$

$\Rightarrow \lambda = 8$

7. D be the origin and $\overline{DA} = \bar{a}$, $\overline{DB} = \bar{b}$ and $\overline{DC} = \bar{c}$

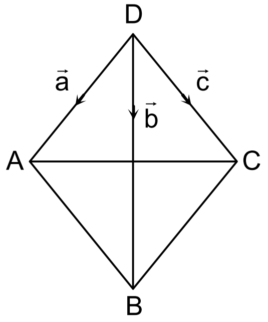
$|\bar{a} - \bar{b}| = 41$, $|\bar{b} - \bar{c}| = 36$, $|\bar{c} - \bar{a}| = 7$

distance between mid-points of AB and CD

$$d^2 = \left(\frac{\bar{a} + \bar{b} - \bar{c}}{2}\right)^2 = \frac{1}{4}\left(|\bar{a}|^2 + |\bar{b}|^2 + |\bar{c}|^2 + 2\bar{a}\cdot\bar{b} - 2\bar{a}\cdot\bar{c} - 2b\cdot\bar{c}\right)$$

$= \frac{1}{4}\left(|a|^2 + |b|^2 - |c|^2 - |\bar{a} - \bar{b}|^2 + |\bar{a} - \bar{c}|^2 + |\bar{b} - \bar{c}|^2\right)$

$= 137$



8. $2b = a + c \Rightarrow 2\sin B = \sin A + \sin C$

$$\Rightarrow 2\left(2\sin\frac{B}{2}\cdot\cos\frac{B}{2}\right) = 2\sin\frac{A+C}{2}\cdot\cos\frac{A-C}{2}$$

$$\Rightarrow \sin\frac{B}{2} = \frac{1}{2\sqrt{2}},\ \cos\frac{B}{2} = \frac{\sqrt{7}}{2\sqrt{2}} \Rightarrow \sin B = \frac{\sqrt{7}}{4}$$

9. Obviously for $c \in (0, 1)$, f(x) lies above the g(x), also $x^2 = cx^3$

$\Rightarrow x = 0,\ x = \frac{1}{c}$

Hence, $\int_0^{1/c}\left(x^2 - cx^3\right)dx = \frac{1}{12c^3} = \frac{2}{3}$

$\Rightarrow c = \frac{1}{2}$

10. sec 40º, sec 80º, sec 160º are the roots of $\frac{8}{t^3} - \frac{6}{t} + 1 = 0$

or $t^3 - 6t^2 + 8 = 0$

Sum of roots = 6

11. The chord of contact from (h, k) to $y^2 = 4x$ is $ky = 2(x + h)$. If it touches the hyperbola

$\Rightarrow 4h^2 + k^2 = 4$ locus is $\frac{x^2}{1} + \frac{y^2}{4} = 1$

12. $x = \sin^{-1}(a^4 + 1) + \cos^{-1}(a^4 + 1) - \tan^{-1}(a^4 + 1)$ is defined at a = 0 only

$\Rightarrow x = \frac{\pi}{4}$

$\therefore$ Area A = $\frac{1}{2}\cdot\frac{\pi}{4}\cdot\frac{\pi}{4} = \frac{\pi^2}{32}$

13. This can happen, if three lines are real and distinct as well as angle between any two adjacent sides is $\frac{2\pi}{3}$

$\Rightarrow$ $f(m) = bm^3 + dm^2 + cm + a = 0$ has three distinct real roots (where $m = y/x$)

And $\frac{m_1 - m_2}{1 + m_1m_2} = \frac{m_2 - m_3}{1 + m_2m_3} = \frac{m_3 - m_1}{1 + m_1m_3} = \pm\sqrt{3}$

$\Rightarrow 3 + m_1m_2 + m_2m_3 + m_3m_1 = 0$ and $3bm^2 + 2dm + c = 0$ has roots α, β with $f(\alpha)\, f(\beta) < 0$

$\Rightarrow 3b + c = 0$

14. $2n\{x\} = 3x + 2[x]$

$\Rightarrow \{x\} = \frac{5[x]}{2n - 3}$ as $0 \le \{x\} < 1$

$\Rightarrow 0 \le [x] \le \frac{2n - 3}{5}$ $\{n \ge 2\}$

It has 5 solution, $[x] = 0, 1, 2, 3, 4$, only if $4 < \frac{2n - 3}{5} \le 5$

$\Rightarrow \frac{23}{2} < n \le 14 \Rightarrow 12, 13, 14$

15. Let a is first term and d is common difference of the A.P.

$a + (r - 1)d = 6$, $a + (s - 1)d = 8$, $a + (t - 1)d = 12$

Solving, we get $2r + t = 3s$ also $f(x) = tx^2 + 2rx - 2s$

$\Rightarrow f(0) = -2s$, $f(1) = s$

$\Rightarrow f(0)\, f(1) = -2s^2 < 0$ hence, exactly one root in (0, 1)

16. $(a - b)^2 + (b - c)^2 + (c - d)^2 + (d - a)^2 \ge 0$

$\Rightarrow 2(a^2 + b^2 + c^2 + d^2) \ge 2(ab + bc + cd + ad)$

$\Rightarrow ab + bc + cd + ad \le 25$

17. f(x) is continuous where $3 \sin x + a^2 - 10a + 30 = 4 \cos x$

or $a^2 - 10a + 30 = 4 \cos x - 3 \sin x$

LHS ≥ 5, RHS ≤ 5

$\Rightarrow (a - 5)^2 + 5 = 4 \cos x - 3 \sin x$

$\Rightarrow a = 5$, $x = 2n\pi - \tan^{-1}\left(\frac{3}{4}\right)$, $n \in I$

18. Required ways = ${}^6C_2 \cdot {}^4C_2 = 90$

19. $z = x + iy$

$\Rightarrow \sqrt{(x - 2)^2 + (y + 1)^2} = \frac{1}{\sqrt{2}}|x - y|$

20. Let $\vec{a} = 3\hat{i} + 4\hat{j} + 5\hat{k}$

$\vec{b} = \tan x\hat{i} + \tan y\hat{j} + \tan z\hat{k}$

$\left(\vec{a} \cdot \vec{b}\right)^2 \le |\vec{a}|^2 |\vec{b}|^2$

$\Rightarrow \tan^2 x + \tan^2 y + \tan^2 z \ge 8$

21. $P = \cos\theta \cos 2\theta \cos 3\theta \,\ldots\ldots\, \cos 1004\theta$
$Q = \sin\theta \sin 2\theta \,\ldots\ldots\, \sin 1004\theta$
Then $2^{1004} PQ = \sin 2\theta \sin 4\theta \,\ldots\ldots\, \sin 2008\theta$
$= (\sin 2\theta \,\ldots\ldots\, \sin 1004\theta)[\sin(2\pi - 1003\theta) \sin(2\pi - 1001\theta) \,\ldots\ldots\, \sin(2\pi - \theta)]$
$= (\sin 2\theta \sin 4\theta \,\ldots\ldots\, \sin 1004\theta)(-\sin 1003\theta) \,\ldots\ldots\, (-\sin\theta) = Q$
$\Rightarrow p = \frac{1}{2^{1004}}$

22. $1 + x^2 = t^2 \Rightarrow x\,dx = t\,dt$
$I = \int \frac{t\,dt}{\sqrt{t^2 + t^3}} = \int \frac{dt}{\sqrt{1+t}} = 2\sqrt{1+t} + c = 2\sqrt{1+\sqrt{1+x^2}} + c$

23. If OP $\perp$ OQ for P and Q on the hyperbola then $b > a$
Director circle of the hyperbola is $x^2 + y^2 = a^2 - b^2$, that exist only when $a > b$

24. Any plane through first line can be written as $3x + y + 2z - 2 + \lambda(2x + y + z - 1) = 0$
It is parallel to $x = y = z$ if $\lambda = -\frac{3}{2}$
Thus, plane parallel to 2nd line is $-y + z - 1 = 0$

25. $A^* = \overline{\left(A^+\right)}$. If $AA^* = I$, then A is unitary

26. Solution is $y = m(x + 2)$
Fixed point p is $(-2, 0)$
Area = $\frac{2}{\sqrt{3}}$

27. $\left(\frac{1}{x^2} + \frac{1}{x} + 1 + x + x^2\right)^5 = \frac{1}{x^{10}}\left(1 - x^5\right)^5 (1 - x)^{-5}$
Now, coefficient of x^{10} in $(1 - x^5)^5 (1 - x)^{-5}$ is = ${}^{14}C_4 - {}^{5}C_1 \times {}^{9}C_4 + {}^{5}C_2 \times {}^{4}C_4 = 381$

28. Mean = 1007
Variance $\sigma^2 = \frac{1}{1007}\left(1^2 + 3^2 + \ldots.. + 2013^2\right) - 1007^2 = 338016$
$\therefore\ d = \sigma = \sqrt{338016} = 581.39$

29. Let $n(A) = n$
Then $2^{n^2 - n} = 2^{\frac{n^2 + n}{2}}$
$\Rightarrow n = 3$

30. $(\sin^{-1} x + \sin^{-1} y)(\sin^{-1} z + \sin^{-1} w) = \pi^2$ is possible only when $x = y = z = w = 1$ or -1 then
$\begin{vmatrix} x^{n_1} & y^{n_2} \\ z^{n_3} & w^{n_2} \end{vmatrix} = 0, 2 \text{ or } -2$

FIITJEE **JEE (Advanced), 2015**

FULL TEST – II

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 246**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 07)** contains 7 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (08 – 11) contains 4 multiple choice questions which have one or more than one correct answer. Each question carries **+3 marks** for correct answer. There is no negative marking.

   Section-A (12 – 16) contains 2 paragraphs. Based upon paragraph, 2 and 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.
2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct matching. No marks will be given for any wrong matching in any question. There is no negative marking.
3. **Section-C (01 – 06)** contains 6 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

ALL INDIA TEST SERIES

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

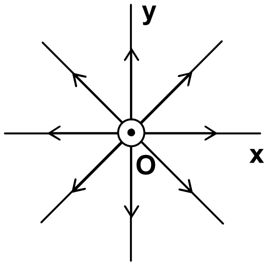
SECTION – A

Straight Objective Type

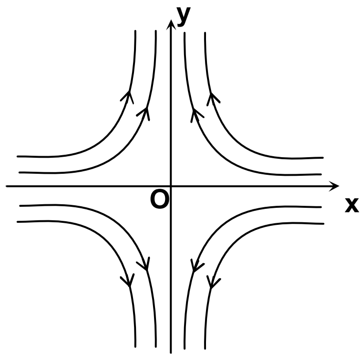
This section contains **7 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

1. Electric field at point P in a region whose coordinates are (x, y, z) is give by : $\vec{E} = E_0 \frac{(-y\hat{i} + x\hat{j})}{x^2 + y^2}$ where E_0 is constant. Which of the following can best represent the Electric field lines corresponding to this field?

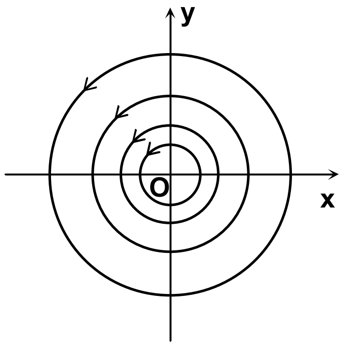
(A)



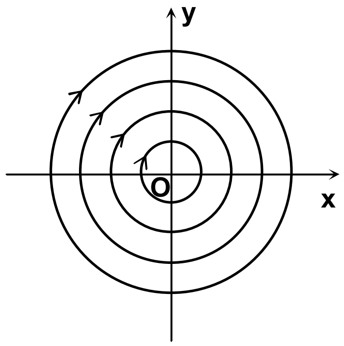
(B)



(C)

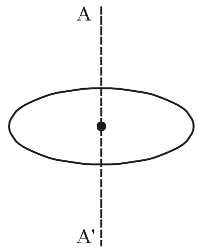


(D)



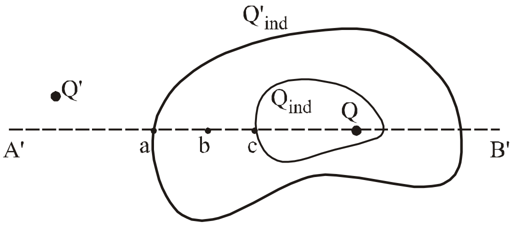
Space for Rough work

2. Net charge distributed on a ring shown in figure is zero. AA' is axis of ring. Then choose the correct statement



(A) Electrostatic field at all points an axis AA' will be zero.
(B) Component of Electrostatic field along axis must be zero.
(C) Component of Electrostatic field perpendicular to the axis must be zero
(D) Electrostatic potential must be zero at all point inside ring in the plane of ring

3. Figure shows a irregular shape conductor with irregular cavity inside it. A charge Q is placed inside cavity and a charge Q' is placed outside conductor. Let Q'_{ind} be charge induced at outside surface of conductor and Q_{ind} be the charge induced at inside surface of cavity. $A'B'$ is an arbitrary line passing through charge Q and a, b, c be the points on line as shown in figure. Let $\vec{E}, \vec{E}', \vec{E}_{ind}$ and $\vec{E}'_{ind}$ represent electric field at different points due to charge Q, Q' Q_{ind}, & Q'_{ind} respectively. If V_a, V_b and V_c represent potential at point a, b, and c. Choose the incorrect statement



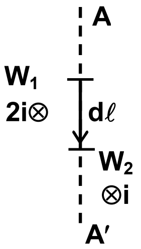
(A) $V_a = V_b = V_c$

(B) $V_b = \int_{-\infty}^{\vec{r}_b} (\vec{E} + \vec{E}' + \vec{E}_{ind} + \vec{E}'_{ind}).\vec{dr}$, where $\vec{r}_b$ = position vector of point b

(C) $V_b = \int_{-\infty}^{\vec{r}_b} (\vec{E}' + \vec{E}'_{ind}).\vec{dr}$

(D) At point 'b', $\vec{E}' = 0$

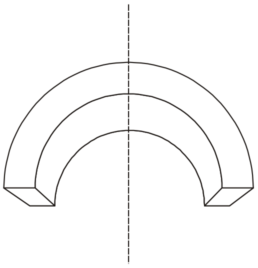
Space for Rough work



4. Two wires W_1 & W_2 carry current '2i' and i respectively directed into the plane of paper as shown in figure. AA' is line at some distance from wire. Let $\vec{B}$ be the net magnetic field due to wires. The magnitude of $\int_{-\infty}^{\infty} \vec{B}.d\vec{\ell}$ will be equal to

(A) $\mu_0 i/2$ (B) $\mu_0 i/4$

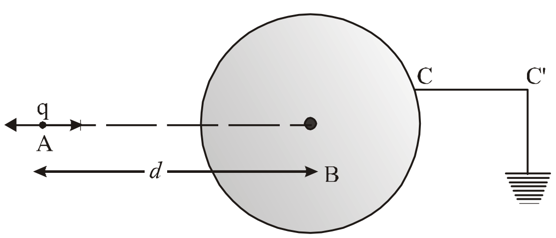
(C) $\mu_0 i/8$ (D) zero



5. A conducting rod of square cross section is bent in a semi circular shape of radius 'r' as shown in figure. Length of side of cross section is equal to 'a'. Resistivity of material is 'ρ'. The resistance of rod across its end will be

(A) $\dfrac{\pi\rho}{a\ln(1+a/r)}$ (B) $\dfrac{2\pi\rho}{a\ln(1+a/r)}$

(C) $\dfrac{\pi\rho(r+a)}{a^2}$ (D) $\dfrac{2\pi r\rho}{a^2}$



6. A charge 'q' is undergoing S.H.M. about point 'A' along the line AB at distance 'd' from the center B of a conducting sphere of radius R. Amplitude oscillation of charge is 'a' angular frequency is 'ω'. The sphere is grounded through conducting wire CC'. Choose the correct statement

(A) If a < < d then the maximum value of current in wire CC' will be $q\omega\left(\dfrac{Ra}{d^2}\right)$

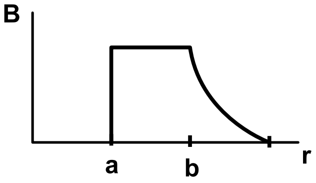
(B) If a < < d then the maximum value of current in wire CC' will be $\left(\dfrac{q\omega Ra^2}{d^3}\right)$

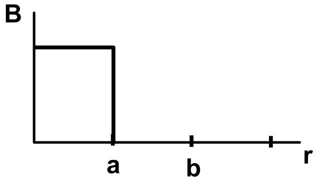
(C) If a < < d then the maximum value of current in wire CC' will be $q\omega\left(\dfrac{2Ra}{d^2}\right)$

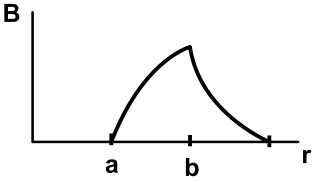
(D) If a < < d then the maximum value of current in wire CC' will be $\left(\dfrac{2q\omega Ra^2}{d^3}\right)$

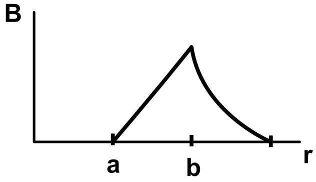
Space for Rough work

7. A hollow cylindrical conductor (inner radius = a, outer radius = b) carries a current i uniformly spread over its cross section. Which graph below correctly gives B as a function of the distance r from the center of the cylinder?

(A)


(B)


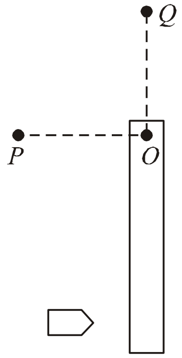
(C)


(D)


(Multiple Correct Choice Type)

This section contains **4 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** are correct.

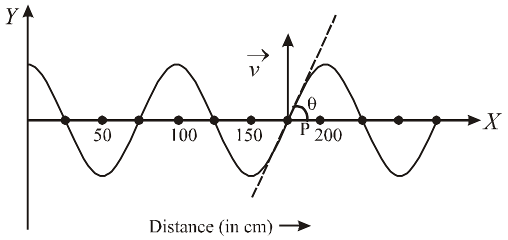
8. A rod is free to rotate in horizontal plane about one of its end hinged at point 'O' as shown in figure. Point P & Q are fixed points located in horizontal plane in such away that PO is perpendicular to rod & QO is along length of rod. A bullet hits the rod perpendicularly at some distance from point 'O' and gets imbedded into it. Then :



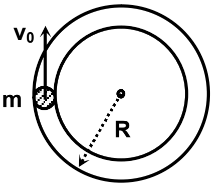
(A) Linear momentum of rod + bullet system will decrease after collision.
(B) Linear momentum of rod + bullet system may increase
(C) Angular momentum of rod + bullet system about point 'P' will not change before & after collision.
(D) Angular momentum of rod + bullet system about 'Q' may increase after collision.

Space for Rough work

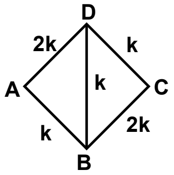
9. Shape of string transmitting wave along x-axis at some instant is shown
Velocity of point P is v = 4π cm/s□ and
$\theta = \tan^{-1}(0.004\pi)$
(A) Amplitude of wave is 2 mm
(B) Velocity of wave is 10 m/s
(C) Max acceleration of particle is $80\ \pi^2$ cm/sec^2
(D) Wave is traveling in –ve x-direction



10. A small ball of mass m is placed in a circular tube of mass M and radius R in gravity free space. Friction is absent between tube and ball. Ball is given a velocity v_0 as shown. Then,
(A) Path of ball from centre of mass of system will be circular.
(B) Path of ball from centre of mass of system will be elliptical
(C) Radius of curvature of ball at the time of projection of ball is $\dfrac{MR}{m+M}$
(D) Normal force between tube and ball if M = 2m, at the time of projection of ball is $\dfrac{2mV_0^2}{3R}$



11. A system of rods is assembled such that each rod has a length ℓ and cross-sectional areas S. The mode of heat transfer is conduction and the system is in steady state. The temperature of Junction A is T and that of C is 2T. Now answer the following question.
(A) Temperature of junction B is 1.6 T.
(B) Temperature of junction D is 1.4 T.
(C) The rate of heat flow along BD is $\dfrac{1}{5}\dfrac{kTS}{\ell}$.
(D) The rate of heat flow along BD is $\dfrac{21}{5}\dfrac{kTS}{\ell}$.

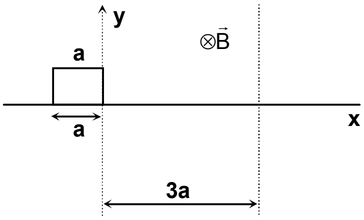


Space for Rough work

Comprehension Type

This section contains **2 paragraphs.** Based upon one of the paragraphs **2 multiple choice questions** and based on the other paragraph **3 multiple choice question** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph for Questions 12 & 13

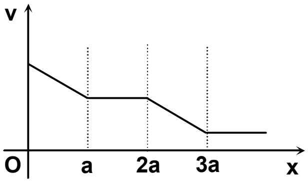


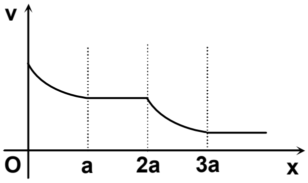
A square wire loop having side a, mass m and resistance R is moving along positive x-axis with speed v_0 enters into uniform steady magnetic field $\vec{B} = B_0(-\hat{k})$ at t = 0 sec as shown in the figure.

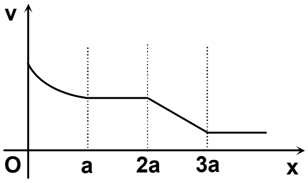
The magnitude of v_0 is sufficient so that the loop comes out from region of magnetic field with v_1. Neglect any type of energy loss other than heat loss in resistances of wires of square (given $v_0 = \dfrac{3B^2a^3}{mR}$)

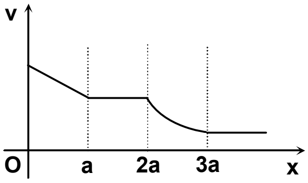
Read above passage carefully and answer the following questions.

12. The plot of speed of square versus position x will be represented by

(A)


(B)


(C)


(D)


13. The total amount of heat loss in the resistance will be

(A) $\frac{5}{9}mv_0^2$

(B) $\frac{4}{9}mv_0^2$

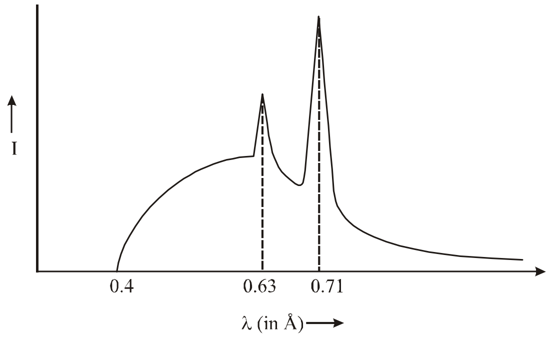
(C) $\frac{2}{9}mv_0^2$

(D) $\frac{mv_0^2}{9}$

Space for Rough work

Paragraph for Questions 14 & 16

Figure shows intensity versus wavelength graph of X-rays coming from Coolidge-tube with molybdenum as anticathode:



The two peaks shown in graph correspond to K_α & K_β X-rays

14. Wavelength of L_α X-rays from Coolidge tube will be (approximately)
(A) 5.60Å (B) 4.26 Å
(C) 0.33 Å (D) 1.34 Å

15. Voltage applied across Coolidge tube in (approximately)
(A) 20 kV (B) 16 kV
(C) 31 kV (D) 18 kV

16. In the potential difference across the Coolidge tube is increased such that the cut off wavelength of x-ray becomes 0.2 Å. Find the value of $\lambda_\beta - \lambda_\alpha$ in this condition.
(A) 0.02 Å (B) 0.04 Å
(C) 0.06 Å (D) 0.08 Å

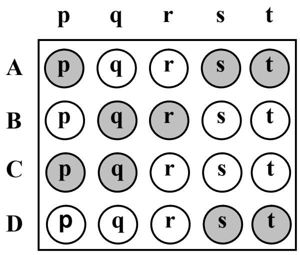
Space for Rough work

SECTION - B

Matrix – Match Type

*This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



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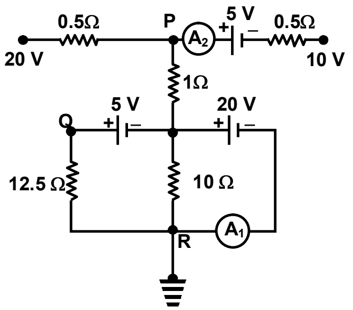
1. In the adjacent circuit shown, all ammeters and batteries are ideal. Internal resistances of all the batteries are negligible. Point R is grounded. Then, match the following.



Column – I		Column – II	
(A)	Potential of point P	(p)	6 SI unit
(B)	Potential of point Q	(q)	25 SI unit
(C)	Reading of ammeter A_1	(r)	18 SI unit
(D)	Reading of ammeter A_2	(s)	47 SI unit

Space for Rough work

2. A lens is made up of a material of refractive index μ which is completely immersed in a medium of refractive index μ_0. The power of lens is P. Match the properties in column I with the corresponding type(s) of lens in column II

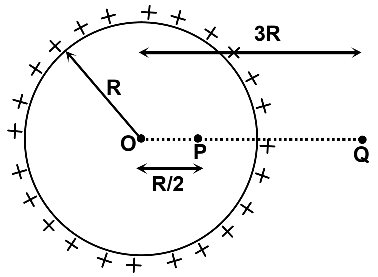
Column I		Column II	
(A)	$P \geq 0$ and $\mu > \mu_0$	(p)	Bi-convex
(B)	$P \geq 0$ and $\mu < \mu_0$	(q)	Bi-concave
(C)	$P \leq 0$ and $\mu > \mu_0$	(r)	Convexo concave
(D)	$P \leq 0$ and $\mu < \mu_0$	(s)	Concavo convex
		(t)	Plano convex

SECTION – C

(Integer Answer Type)

This section contains **6 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. Conducting shell of radius R carrying charge Q, another charge Q is placed at 3R distance from centre of shell. If the potential at point P due to charge on shell is $\frac{11}{3n}\frac{KQ}{R}$, Then the value of n is

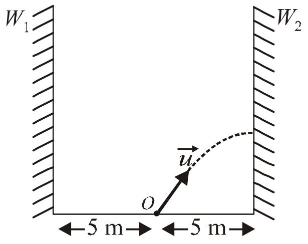


2. A liquid is kept in a cylindrical vessel. When the vessel is rotated about its axis, the liquid rises at its sides. If the radius of the vessel is 0.05 m and the speed of rotation is 2 revolutions per second, the difference in the heights (in cm) of the liquid at the centre and at the sides of the vessel is (take g = 10 ms^{-2} and $\pi^2 = 10$)

Space for Rough work

3. When a resistance R is connected in series with an element A, the electric current is found to be lagging behind the voltage by V angle 30° When the same resistance is connected in series with element B, current leads by 60°. When R, A, B are connected in series, the current new leads voltage by θ. Which is equal to $\tan^{-1}(K/\sqrt{3})$, then the value of K is (assume same AC source is used in all cases)

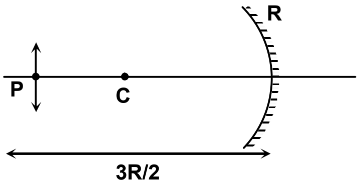
4. A ball of mass *m* = 2kg thrown from ground form point '*O*' between two walls, W_1 & W_2 at a distance 5 cm from '*O*' an shown in figure. Had the wall w_2 not been there range of ball would have been 20 m. Horizontal component of velocity of ball at the time of projection was 5 m/s. All collisions are elastic. Average force acting on one of the walls (in newton) is



5. A small object at P oscillates infront of a concave mirror as shown in the figure perpendicular to principal axis according to equation.

$y = 4\sin\left(\omega t + \frac{\pi}{3}\right)$ cm,

y is the displacement of particle perpendicular to principal axis. The amplitude (in cm) of image is



6. A particle moves in a circle with a uniform speed, when it goes from a point A to a diametrically opposite point B, the momentum of the particle changes by $\vec{P}_A - \vec{P}_B = 2\text{kgm/s}(\hat{j})$ and the centripetal force acting on it changes by $\vec{F}_A - \vec{F}_B = 8\text{N}(\hat{i})$ where $\hat{i}, \hat{j}$ are unit vectors. Then the angular velocity (in rad/s) of the particle is

Space for Rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **7 multiple choice** questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONLY ONE** option is correct.

1. At what $\frac{\left[\mathrm{Br}^{-}\right]}{\sqrt{\left[\mathrm{CO}_3^{2-}\right]}}$ does the following cell have its reaction at equilibrium?

$Ag(s)\ |Ag_2CO_3(s)|\ Na_2CO_3(aq)|\ |KBr(aq)|\ AgBr(s)|\ Ag(s)$

$K_{sp} = 8 \times 10^{-12}$ for Ag_2CO_3 and $K_{sp} = 4 \times 10^{-13}$ for AgBr

(A) $\sqrt{1}\times10^{-7}$ (B) $\sqrt{2}\times10^{-7}$

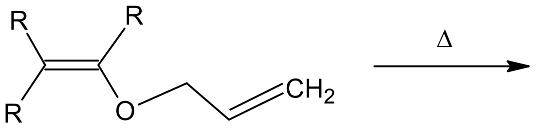
(C) $\sqrt{3}\times10^{-7}$ (D) $\sqrt{4}\times10^{-7}$

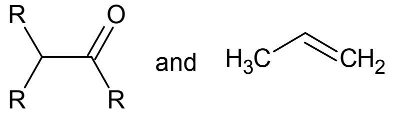
2. A human body excretes [removes by waste discharges, sweating etc] certain material by a law similar to radio activity. If technitium is injected in some form in the human body, the body excrets half of the amount in 24 hours. A patient is given an injection confainingTc^{99}. This isotope is radioactive with a half life 6 hrs. The activity from the body just after the injection is 6 μC. How many hours will elapse before the activity falls to 3 μCi?

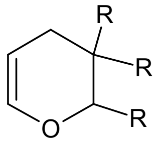
(A) 24 hours (B) 6 hours

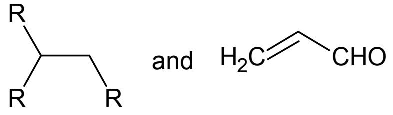
(C) 4.8 hours (D) 12 hours

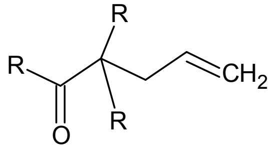
3. Find the product of the following reaction



(A)


(B)


(C)


(D)


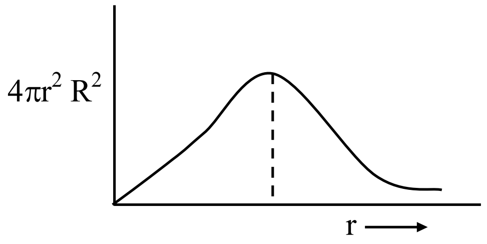
4. A big RED spherical balloon (radius = 6a) is filled up with gas. On this balloon six small GREEN spherical balloons (radius = a) are stuck on the surface in a specific manner. As RED balloon is slowly deflated, a point comes when all these six GREEN balloons touch and green balloons arrange themselves in a 3-D closed packing arrangement. At that stage the radius of the RED balloon would have reduced by approximately.

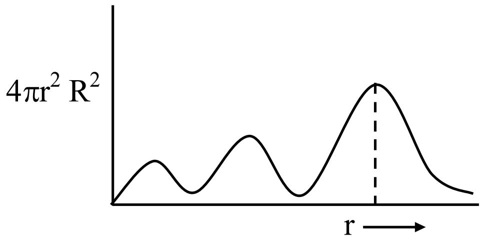
(A) 14.5 times (B) 1.414 times

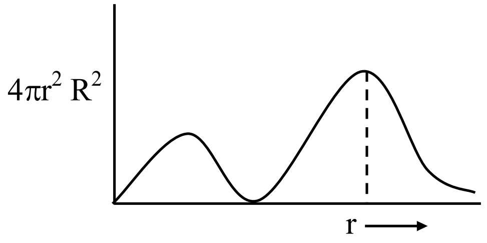
(C) 6.0 times (D) 2.42 times

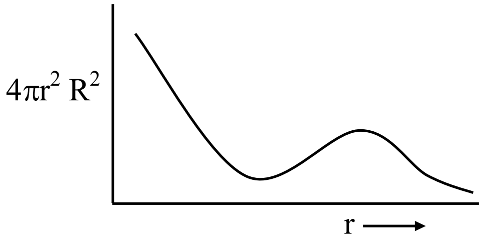
Rough Work

5. Which of the following graphs represents the radial charge density for the electron of outer most sub shell of Cu^{+2}?

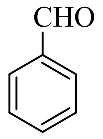
(A)


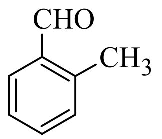
(B)


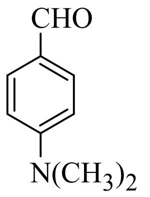
(C)


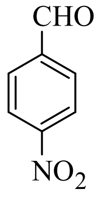
(D)


6. The order of reactivity towards Perkin reaction of the following aromatic aldehydes is


(a)


(b)


(c)


(d)

(A) (d) > (a) > (b) > (c)
(B) (c) > (a) > (b) > (d)
(C) (b) > (c) > (a) > (d)
(D) (d) > (a) > (c) > (b)

7. Which of the following represents the correct order for the wavelength of absorption in the visible region for the following

$\underset{(I)}{[Ni(NO_2)_6]^{4-}}$ $\underset{(II)}{[NiF_6]^{4-}}$ $\underset{(III)}{[Ni(H_2O)_6]^{2+}}$ $\underset{(IV)}{[Ni(NH_3)_6]^{2+}}$

(A) I > IV > III > II
(B) II > IV > III > I
(C) II > III > IV > I
(D) I > III > II > IV

Rough Work

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

8. A + B $\longrightarrow$ C + D is a stoichiometrically balanced reaction. The initial rate of the reaction is doubled if the initial concentration of A is doubled, but is quadrupled if the initial concentration of B is doubled.
Select the correct statement(s)
(A) The reaction is first order in B and second order in A
(B) The reaction is first order in A and second order in B
(C) The reaction can not be a single-step reaction
(D) The overall order of the reaction is 3

9. In which of the following cases will a violet colouration be observed
(A) An alkaline solution of sodium nitroprusside is treated with a solution of Na_2S
(B) A solution of sodium cobaltinitrite is treated with KCl
(C) A solution of $Mn(NO_3)_2$ is treated with sodium bismuthate or red lead in the presence of concentrated HNO_3
(D) A solution of sodium nitroprusside in aqueous, NaOH is heated ith Na_2SO_3

10. $CH_3-CH=NH\xrightarrow{?}CH_3CH_2-NH_2$ for this conversion suitable reagent
(A) $Na-Hg/H_2O$
(B) H_2/Pd
(C) $LiAlH_4/Et_2O$
(D) $NaBH_4/EtOH$

11. $X+H_2SO_4\rightarrow Y$ (a colourless gas with pungent smell)
$Y+K_2Cr_2O_7+H_2SO_4\rightarrow$ Green solution
(A) X is SO_3^{2-}
(B) X is CO_3^{-2}
(C) Y is H_2S
(D) Y is SO_2

Rough Work

Comprehension Type

This section contains **2 paragraphs.** Based upon the first paragraph 2 multiple choice questions and based upon the second paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices A), B), C) and D) out of **WHICH ONLY ONE IS CORRECT.**

Paragraph for Question Nos. 12 to 13

The process of eudiometry is used to calculate the volume of the various reacting gases present together in a closed vessel, it is done by sparking the content and noting the volume change or pressure change depending upon the conditions mentioned. Various reagents like alkaline pyrogallol, turpentine oil, caustic potash, conc. H_2SO_4 are used to absorb the selective gases like O_2, O_3, CO_2 and H_2O (v) respectively.
A 2.0 mole mixture of H_2(g), O_2(g) and He(g) are placed together in a closed container at pressure equal to 50 atm. An electric spark is passed and pressure is noted as 12.5 atm after cooling the content to original temp. (room temp). Oxygen gas is introduced for pressure to change to 25 atm, keeping volume and temp constant. Again electrical spark is passed and pressure drops to 10 atm under original temp. conditions.

12. The moles of He(g) present in the mixture sample is
(A) 0.2 (B) 0.1
(C) 0.5 (D) 1.4

13. The mole fraction of H_2(g) present in the initial mixture is:
(A) 0.05 (B) 0.7
(C) 0.5 (D) 1.25

Rough Work

Paragraph for Question Nos. 14 to 16

An unknown organic compound (A) with the molecular formula $C_9H_{12}O$ does not decolourize Br_2 in CCl_4, reacts with sodium to give a colourless, odourless gas and can be oxidised by hot alkaline $KMnO_4$ to give benzoic acid. Then, following test were performed on the compound (A) is given sequence:

Test (a): The colour of the solution changes from orange to green when $K_2Cr_2O_7$ is added to it.

Test (b): The compound can be resolved.

Test (c): No yellow precipitate of CHI_3 is formed when reacted with I_2 and OH^-.

Test (d): Oxidation of the compound with CrO_3 in pyridine gives another compound that gives Tollen's test.

14. Which of the following would be the structure of compound if test (a) is negative?
(A) $PhCH(OH)CH_2CH_3$
(B) $PhC(OH)(CH_3)_2$
(C) $PhCH_2CH(OH)CH_3$
(D) $PhCH(CH_3)CH_2OH$

15. Which of the following would not be the structure of compound (A) after test (b)?
(A) $PhCH(OH)CH_2CH_3$
(B) $PhCH_2CH(OH)CH_3$
(C) $PhCH_2CH_2CH_2OH$
(D) $PhCH(CH_3)CH_2OH$

16. The structure assigned to compound (A) after the test (d) would be
(A) $PhCH(OH)CH_2CH_3$
(B) $PhCH_2CH(OH)CH_3$
(C) $PhCH(CH_3)CH_2OH$
(D) $PhC(OH)(CH_3)_2$

Rough Work

SECTION-B
(Matrix-Match Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

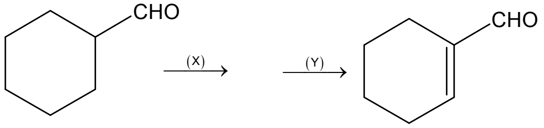
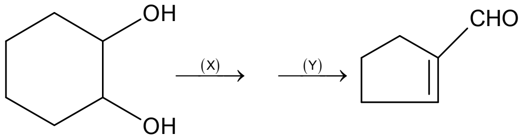
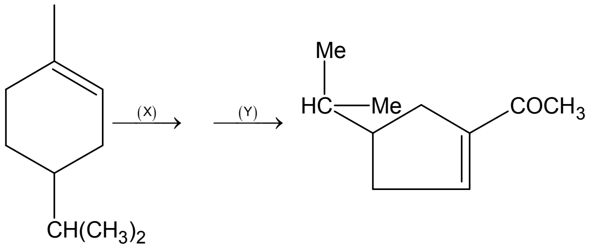
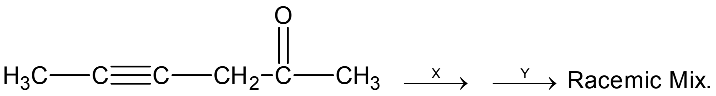
	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the following metals given in **Column I** with the appropriate metal extraction process(es) listed below in **Column II**.

Column – I	**Column – II**
(A) Silver	(p) Fused salt electrolysis
(B) Lead	(q) Cyanide process
(C) Iron	(r) Carbon monoxide reduction
(D) Magnesium	(s) Self reduction
	(t) Frothflotation

Rough Work

2. Column – I contain reaction and Column – II consist of reagent used in these reaction. Match the following.

	Column – I	Column – II
(A)		(p) X = Na/liq. NH_3 Y = cold dil. $KMnO_4/OH^-$
(B)		(q) X = Br_2, $CHCl_3$ Y = CH_3ONa/CH_3OH
(C)	 CH(CH₃)₂ (X) (Y) Me HC—Me COCH3	(r) X = O_3/H_2O, Zn Y = NaOH/Δ
(D)	 $H_3C-C\equiv C-CH_2-\overset{O}{\overset{\|}{C}}-CH_3 \xrightarrow{X} \xrightarrow{Y}$ Racemic Mix.	(s) X = HIO_4 Y = NaOH/Δ
		(t) X= H_2/Pd Y=Zn-Hg/ conc. HCl

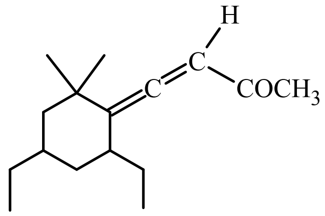
Rough Work

SECTION –C
Integer Answer Type

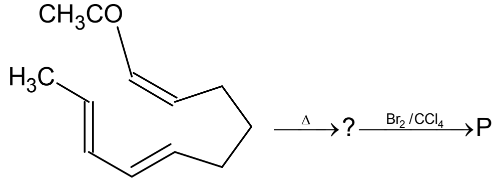
This section contains **6 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. How many of the following reactions are addition-elimination reactions of carbonyl compounds?
   (I) Cyanohydrin formation
   (II) Acetal formation
   (III) Semicarbazone formation
   (IV) Aldol formation
   (V) Hemiacetal formation
   (VI) Oximeformation
   (VII) Ketal formation
   (VIII) Imine formation
   (IX) 2,4-DNPderivative formation

2. Total number of stereoisomers of the compound given below is x



And number of chiral carbons are there in the product 'P'is y



then the value of (x+y)/2 is?

3. A 50 ml 1.92% (W/V) solution of a metal ion M^{n+} (atomic weight = 60) was treated with 5.332 g hydrazinehydrate (90% pure) and mixture was saturated with CO_2 gas when entire metal gets precipitated as a complex $[M(H_2N - NHCOO)_n]$. The complex was filtered off and the filtrate was titrated with $\frac{M}{10}$ KIO_3 in the presence of conc. HCl according to the following equation:

$$N_2H_4 + IO_3^- + 2H^+ + 2Cl^- \longrightarrow ICl + 3H_2O + N_2 \uparrow$$

The volume of $\frac{M}{10}$ KIO_3 solution needed for the end point to arrive was 480 ml. Find the value of n.

Rough Work

4. How many statements are true in the given question of about?

(i) orthoboric acid It is a strong tribasic acid.

(ii) orthoboric acid does not act as a proton donor but behaves like a Lewis acid by accepting OH^- ion.

(iii) orthoboric acid is prepared by the action of mineral acid on borax solution.

(iv) orthoboric acid has a layer structure in which hydrogen bonds unite $B(OH)_3$ units.

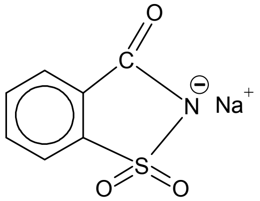
(v) If the number of revolutions made by electron in1.0 s in H atom in its nth orbit is twice of the number of revolution made by electron in 1.0 s in the 2nd orbit of H–atom, then n is 1.

(vi) Forms a colourless solution with coloured precipitate(r)$CrCl_3(s)$ + dil $HNO_3(aq)$

(vii) Forms a coloured solution with no precipitate(s)$K_2CrO_4(aq) + Ba(NO_3)_2(aq)$

(viii) F > N > C > Si >Ca - metallic character

(ix) Saccharin ($pK_a = 2$) is an artificial zero calorie sweetner added to toothpaste



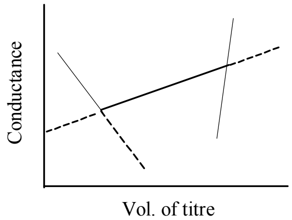
Sodium Saccharin Structure .Two flasks A&B both contain 18.3 gm of Saccharin dissolved in 100 ml solution. 2 grams of solid NaOH is added to A and 4 grams of solid NaOH is added to B. This resulted in the formation of the above structure in both flasks. The difference in pH of the two flasks after the experiment is: 6

(x) C > Si > P > N - electron affinity

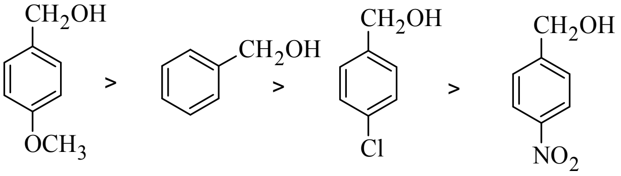
(xi) O > N > F > C - second ionisation potential

(xii) $I_2 < F_2 < Br_2 < Cl_2$ Bond energy ORDER

(xiii) mixture of HCl and CH_3COOH titrated against NaOH the correct graphical representation is

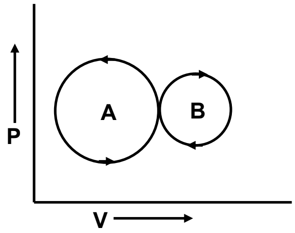


(xiv) The CORRECT ORDER OF basic character of the following alcohols is

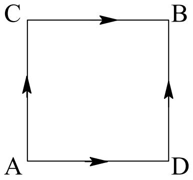


Rough Work

5. In the given graph, the area of circle A and B are 40 unit and 36 unit respectively, total work done 'X' unit.



When a system is taken from state A to B along path ACB, as shown in the figure, 5 unit of heat flows into the system and the system does 3 unit of work. If 'y'unit heat flows into the system along the path ADB, and the work done by the system is 2 unit ?



Then the value of x + y is

6. Alkaline hydrolysis of chloral hydrate produces a compound (A) which is used as a solvent and preservative for anatomical specimens and also has anesthetic properties. (A) is prone to aerial oxidation in presence of sunlight to give a poisonous compound (B) which may be made non poisonous by adding dilute solution of ethanol which converts it into a non poisonous compound (C). How many moles of CH_3MgBr will be added to (C) followed by acidic hydrolysis to give alcohol?

Rough Work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains 7 multiple choice questions numbered 1 to 7. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. The number of 6-digit numbers whose digits are selected from set {5, 6, 7, 8, 9} such that any digit that appears in the number appears at least twice is

(A) 1100
(B) 1200
(C) 1400
(D) 1405

2. The equation of common tangent to the curve |z – 2i| = 2 and |z – 1 – 3i| + |z + 1 – 3i| = $2\sqrt{2}$ is

(A) $z+\bar{z}=4$
(B) $z-\bar{z}=8i$
(C) $z+\bar{z}=8$
(D) $z-\bar{z}=4i$

3. Let $f(n)=\sum_{r=0}^{n}\sum_{k=r}^{n}{}^{k}C_{r}$ then total number of divisors of f(9) is equal to

(A) 5
(B) 6
(C) 7
(D) 8

4. Let $2\left(1+x^{3}\right)^{100}=\sum_{i=0}^{100}\left\{a_{i}x^{i}-\cos\left(\frac{\pi}{2}(x+i)\right)\right\}$. If $\sum_{i=0}^{50}a_{2i}=2^{k}$ then the value of k is

(A) k = 100
(B) k = 200
(C) k = 310
(D) k = 410

5. Let M = {(x, y) : $y \ge x^2$} and N = {(x, y) : $x^2 + (y - a)^2 \le 1$}. The necessary and sufficient condition for $M \cap N = N$ is

(A) $a \ge \frac{5}{4}$
(B) $a = \frac{5}{4}$
(C) $a \in R^+$
(D) $a \in (0, 1)$

Space for rough work

6. The value of the ratio $\dfrac{\int_0^{\pi} x^3 \log_e(\sin x)dx}{\int_0^{\pi} x^2 \log_e(\sqrt{2}\sin x)dx}$ is

(A) $\frac{\pi}{2}$ (B) $\frac{2\pi}{3}$

(C) $\frac{3\pi}{4}$ (D) $\frac{3\pi}{2}$

7. A parabola $y = ax^2 + bx + c$ crosses the x-axis at $(\alpha, 0)$ and $(\beta, 0)$ both to the right of the origin. A circle also passes through these two points the length of tangent from the origin to the circle is

(A) $\sqrt{\frac{a}{b}}$ (B) $\sqrt{\frac{c}{a}}$

(C) $\sqrt{bc}$ (D) $\frac{b^2}{c^2}$

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

8. Positive integers are written on all the faces of a cube, one on each. At each corner (vertex) of the cube, the product of the numbers on the faces that meet at the corner is written. The sum of the numbers written at all the corner is 2004. If T denotes the sum of the number on all the faces, the possible value of T are

(A) 174 (B) 175

(C) 339 (D) 505

9. If the equation $x^2 + (a - 2)x + 1 = 3|x|$ has exactly three distinct real solutions in x, the value of a is/are

(A) 1 (B) 2

(C) 3 (D) 4

Space for rough work

10. In an acute triangle ABC, O is circumcentre, H is orthocentre and G is the centroid. Let OD be perpendicular to BC and HE be perpendicular to CA, with D on BC, E on CA. Let F be the mid-point of AB. Suppose the area of triangle ODC, HEA and GFB are equal the possible value of angle C is

(A) $\frac{\pi}{3}$ (B) $\frac{\pi}{4}$

(C) $\frac{\pi}{6}$ (D) $\frac{\pi}{2}$

11. A player throws an ordinary dice, whenever he throws 1, he gets an additional throw. Then probability to get sum of score n is

(A) $\frac{1}{5}\left(\frac{6^4-1}{6^4}\right)$ is n = 5 (B) $\frac{1}{5}\left(\frac{6^5-1}{6^5}\right)$ if n = 6

(C) $\frac{1}{30}\left(\frac{6^5-1}{6^5}\right)$ if n = 7 (D) 0 if n = 1

Comprehension Type

This section contains 2 paragraphs. Based upon one of paragraphs 2 multiple choice questions and based on the other paragraph 3 multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

Paragraph for Question Nos. 12 to 13

Read the following write up carefully and answer the following questions:
A trapezium ABCD, in which AB is parallel to CD, is inscribed in a circle with centre O. Suppose the diagonal AC and BD of trapezium intersect at M and OM = 2

12. If $\angle AMB = 60^\circ$ then difference between length of parallel sides is

(A) $\sqrt{3}$ (B) 2

(C) $2\sqrt{3}$ (D) 4

13. If $\angle AMD$ is 60° then difference between length of parallel sides is

(A) 2 (B) $\sqrt{3}$

(C) $2\sqrt{3}$ (D) $4\sqrt{3}$

Space for rough work

Paragraph for Question Nos. 14 to 16

Read the following write up carefully and answer the following questions:
An ellipse whose major axis is parallel to x-axis such that segment of a focal chord are 1 and 2 units. The line $\frac{x}{a}+\frac{y}{b}+\frac{1}{c}=0$ are the chords of the ellipse such that a, c, b are in H.P. and are bisected by the point at which they are concurrent, the equation of auxiliary circle is $2x^2 + 2y^2 + 4px + 4qy - 16p + 1= 0$ then

14. The centre of ellipse is

(A) (1, –1) (B) (1, 1)

(C) $\left(\frac{1}{2},\frac{1}{2}\right)$ (D) $\left(-\frac{1}{2},-\frac{1}{2}\right)$

15. Equation of director circle is

(A) $x^2 + y^2 - x - y - \frac{37}{6}=0$ (B) $x^2 + y^2 + x + y + \frac{37}{6}=0$

(C) $x^2 + y^2 + x + y - \frac{37}{6}=0$ (D) $x^2 + b^2 - x - y + \frac{37}{6}=0$

16. Eccentricity of ellipse is

(A) $\frac{1}{3}$ (B) $\frac{1}{\sqrt{3}}$

(C) $\sqrt{\frac{2}{3}}$ (D) $\frac{2}{3}$

Space for rough work

SECTION-B
(Matrix-Match Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the following Column-I with Column-II

	Column – I		Column – II
(A)	The number of all triples (a, b, c) such that all three term a, b, c are in harmonic progression in which a = 20 and b divides c (where a, b, c are strictly increasing positive integers)	(p)	66
(B)	The number of solutions of m + n + p = 10, (m, n, p are non-negative integers)	(q)	20
(C)	The number of ordered pair (a, b) satisfying the equation ab + b – a + 1 = 0 are where a, b $\in$ I	(r)	4
(D)	The number of ordered pairs (x, y) of real numbers such that $(x + iy)^{20} = x - iy$ is (where $i = \sqrt{-1}$)	(s)	5
		(t)	22

2. Match the following Column-I with Column-II

	Column – I		Column – II
(A)	Let $f(x) = x^4 + ax^3 + bx^2 + cx + d$ (where a, b, c, d are real coefficient) and f(x) = 0 has real roots, If $\lvert f(i)\rvert = 1$ and a = b = c = d = k then k can be (where $i = \sqrt{-1}$)	(p)	0
(B)	If $x^5 = 1$ $(x \neq 1)$ then $\frac{x}{1+x^2} + \frac{x^2}{1+x^4} + \frac{x^3}{1+x} + \frac{x^4}{1+x^3}$ equals	(q)	1
(C)	Let $f(x) = \ln\left[\cos\lvert x\rvert + \frac{1}{2}\right]$ (where [.] denotes the greatest integer function), then $\int_{x_1}^{x_2}\left(\lim_{n\to\infty}\left(\frac{(f(x))^n}{x^2 + \tan^2 x}\right)\right)dx$ is (where $x_1, x_2 \in \left[-\frac{\pi}{6}, \frac{\pi}{6}\right]$)	(r)	2
(D)	Let ABCD be a cyclic quadrilateral inscribed in a circle of radius 2, such that BD = $2\sqrt{3}$, AB = 1. If $\angle$BAD is acute and AD = $a + b\sqrt{5}$, then the value of a + b is equal to	(s)	3
		(t)	4

Space for rough work

SECTION – C

(Integer Answer Type)

This section contains **6 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

1. Let X be the set of all positive integers greater then or equal to 8 and let f : X → X be a function such that f(x + y) = f(xy) for all $x \geq 4$, $y \geq 4$. If f(8) = 9 then f(9) is equal to _____

2. If f(x) and g(x) be two function such that $f''(x) = 2f'(x) - 2f(x)$, $g(x) = f'(x) - f(x)$. Let F(x) be defined as $F(x) = [f^2(x) + g^2(x)][f^2(-x) + g^2(-x)]$. If F(0) = 1 then the value of F(1) is _____

3. Let $f(x) = \tan^{-1}(\cot x - 2\cot 2x)$ and $\sum_{r=1}^{5} f(r) = a - b\pi$ where $a, b \in N$, then the value of b is _____

4. The least possible area of convex quadrilateral having two vertices on two branches of hyperbola xy = 2 and other two vertices on the two branches of xy = –2 is _____

5. Consider two polynomial f(x) and g(x) given by $f(x) = \sum_{r=0}^{200} \beta_r x^r$ and $g(x) = \sum_{r=0}^{200} \alpha_r x^r$ such that $\beta_r = 1$ $\forall\ 100 \leq r \leq 200$ and f(x + 1) = g(x). Let $A = \sum_{r=100}^{200} \alpha_r$, then the remainder when A is divided by 15 is equal to _____

6. Consider a square ABCD of diagonal length $2\sqrt{3}$. The square is folded along the diagonal AC so that the plane of ΔABC is perpendicular to the plane of ΔADC. The shortest distance between AB and CD is _____

Space for rough work

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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ALL INDIA TEST SERIES

FIITJEE JEE(Advanced)-2015

ANSWERS, HINTS & SOLUTIONS
FULL TEST–II
(PAPER-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	B	D
2.	B	C	B
3.	D	D	D
4.	A	A	A
5.	A	A	A
6.	A	A	D
7.	C	C	B
8.	B, C, D	B, C, D	A, B, C, D
9.	A, B, C, D	A, C	A, C
10.	A, C, D	A, B, C, D	A, B
11.	A, B, C	A, D	A, B, C, D
12.	A	B	C
13.	B	B	C
14.	A	B	D
15.	C	C	C
16.	D	C	B
1.	(A)$\rightarrow$ (r), (B)$\rightarrow$ (q), (C)$\rightarrow$ (p), (D)$\rightarrow$ (p)	(A $\rightarrow$ q) (B $\rightarrow$ s) (C $\rightarrow$ r) (D $\rightarrow$ p)	(A) $\rightarrow$ (s) (B) $\rightarrow$ (p) (C) $\rightarrow$ (r) (D) $\rightarrow$ (t)
1.	(A) $\rightarrow$ (p, s, t), (B) $\rightarrow$ (q, r), (C) $\rightarrow$ (q, r), (D) $\rightarrow$ (p, s, t)	(A) $\rightarrow$ (q), (B) $\rightarrow$ (s), (C) $\rightarrow$ (r), (D) $\rightarrow$ (p)	(A) $\rightarrow$ (p) (B) $\rightarrow$ (r) (C) $\rightarrow$ (p) (D) $\rightarrow$ (r)
1.	5	4	9
2.	2	7	1
3.	2	n = 3	5
4.	5	9	8
5.	2	8	1
6.	4	3	2

Physics

PART – I

SECTION – A

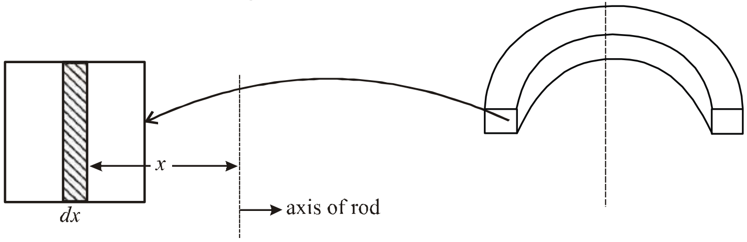
1. Electric field is tangential direction at all points $(\vec{E}.\hat{r}=0)$ and decreasing with increase in r. (r = magnitude of radius vector of a point)

2. Since, Electrostatic potential is zero at all points on axis,
So, along axis $\frac{\partial v}{\partial r}=0 \Rightarrow E_r = 0$

3. $V_a = V_b = V_c$ because electric field inside conductor is zero.
$V_b = \int_{\infty}^{\vec{r}_b} (\vec{E}+\vec{E}'+\vec{E}_{ind}+\vec{E}_{ind}).\vec{dr} = \int_{-\infty}^{\vec{r}_b} (\vec{E}'+\vec{E}'_{ind}).\vec{dr}$, because $\vec{E}'+\vec{E}'_{ind}=0$ for all points inside conductor or outside the conductor.

4. An infinite wire can be taken as half of closed loop.
Hence $\int_{-\infty}^{\infty} \vec{B}\cdot d\vec{\ell} = \frac{\mu_0 i}{2}$

5. Let us consider a strip of thickness dx at a distance 'x'



$$dR = \frac{\rho.\pi x}{a dx}$$

$$\frac{1}{R_{eff}} = \int \frac{1}{dR} = \frac{a}{\pi\rho}\int_{r}^{r+a}\frac{dx}{x} \Rightarrow R_{eff} = \frac{\pi\rho}{a\ln\left(1+\frac{a}{r}\right)}$$

6. $V_A + V_{ind} = 0 \Rightarrow K.\frac{q}{(d-a\sin\omega t)} + \frac{Kq_{ind}}{R} = 0$
$\Rightarrow q_{ind} = -\frac{R.q}{(d-a\sin\omega t)} \Rightarrow \frac{dq_{ind}}{dt} = \frac{Rqa\omega\cos\omega t}{(d-a\sin\omega t)^2}$

8. Force applied by hinge on rod may be towards P, away from P or zero depending upon distance from point 'O'. Accordingly linear momentum of rod + bullet system may decrease increase or remains constant respectively. Similarly angular momentum of system about 'Q' may decrease, increase or remain constant respectively.

9. $\lambda = 1$ m
$v_{max} = A\omega = 4\pi$
$\therefore \quad v = \frac{\partial y/\partial t}{\partial y/\partial x} = \frac{4\pi\times10^{-2}}{4\pi\times10^{-3}} = 10 m/s$
A = 2 × 10^{-3}m also $\nu = \frac{v}{\lambda} = 10 Hz$ and $a_{max} = A\omega^2 = 80\pi cm/s^2$

10. From centre of mass of system ball and centre of tube moves in circular path.

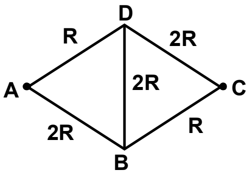
Radius of curvature of ball at the time of projection of ball is $\frac{MR}{m+M}$

Normal force between tube and ball if M = 2m, at the time of projection of ball is

$$V_{cm} = \frac{mV_0}{m+M}$$

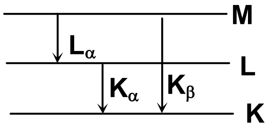
$$N = m\left(\frac{(V_0 - V_{cm})^2}{r_1}\right)$$

11. Equivalent circuit is



14. $$\frac{1}{\lambda_{k\beta}} = \frac{1}{\lambda_{k\alpha}} + \frac{1}{\lambda_{L\alpha}}$$

$$\Rightarrow \lambda_{L\alpha} = \frac{\lambda_{k\alpha} \cdot \lambda_{k\beta}}{\lambda_{k\alpha} - \lambda_{k\beta}} = 5.60\text{Å}$$



15. $$eV = \frac{hc}{\lambda_{\text{cut off}}} \Rightarrow V = \frac{hc}{e\lambda_{\text{cut off}}} = \frac{6.626\times10^{-34}\times3\times10^8}{1.6\times10^{-19}\times0.4\times10^{-10}} = 31\times10^3\ \text{V}$$

SECTION - B

1. Using Kirchof's first law at point P

SECTION – C

1. $V_O = V_P$

$$\frac{KQ}{R} + \frac{KQ}{3R} = V_{shell} + \frac{2Kq}{5R}$$

$$V_{shell} = \frac{KQ}{R}\left[1 + \frac{1}{3} - \frac{2}{5}\right]$$

$$= \frac{KQ}{R}\left[\frac{4}{3} - \frac{2}{5}\right]$$

$$= \frac{KQ}{R}\left[\frac{20-9}{15}\right] = \frac{11}{15}\frac{KQ}{R}$$

2. Using Bernoulli's theorem

$$\frac{1}{2}\rho v^2 = p = \rho gh \quad \text{or} \quad h = \frac{v^2}{2gh} \quad \text{..... (1)}$$

Put : V = rω = r (2πν) in (1)

5. $$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} - \frac{1}{(3R/2)} = -\frac{2}{R}$$

$$\frac{1}{v} = -\frac{2}{R} + \frac{2}{3R} = -\frac{4}{3R}$$

$$v = -\frac{3R}{4}$$

$$m = -\frac{v}{u} = -\frac{\left(-\frac{3R}{4}\right)}{\left(-\frac{3R}{2}\right)} = -\frac{2}{4} = -\frac{1}{2}$$

amplitude of image = $4\left(-\frac{1}{2}\right) = 2$

Chemistry

PART – II

SECTION – A

1. $Ag\,|\,Ag_2CO_3(s)\,|\,Na_2CO_3(aq.)\,||\,KBr(aq.)\,|\,AgBr(s)\,|\,Ag(s)$

$\text{Anode}: 2Ag(s)+CO_3^{2-}\longrightarrow Ag_2CO_3(s)+2e^-$

$\text{Cathode}: AgBr(s)+e^-\longrightarrow Ag(s)+Br^-(aq.)$

$CO_3^{2-}(aq.)+2AgBr(s)\longrightarrow 2Br^-(aq.)+Ag_2CO_3(s)$

$$E_{cell}=E^o_{cell}-\frac{0.059}{2}\log\frac{\left[Br^-\right]^2}{\left[CO_3^{2-}\right]}$$

At eqm.

$$0=E^o_{cell}-\frac{0.059}{2}\log\frac{\left[Br^-\right]^2}{\left[CO_3^{2-}\right]}$$

$$0=E^o_{cell}-0.059\log\frac{\left[Br^-\right]}{\sqrt{\left[CO_3\right]^{2-}}}$$

$$0.059\log\frac{\left[Br^-\right]}{\sqrt{\left[CO_3^{2-}\right]}}=E^o_C-E^o_A$$

$$E^o_{Ag/AgCl/Cl^-}=E^o_{Ag^+/Ag}+0.059\log K_{spAgBr}$$

$$E^o_{Ag/Ag_2CO_3/CO_3^{2-}}=E^o_{Ag^+}+0.059\log\frac{K_{sp}\ Ag_2CO_3}{K_{sp}\ AgBr}$$

$$\log\frac{\left[Br^-\right]}{\sqrt{CO_3^{2-}}}=\log\frac{K_{sp}\ AgBr}{K_{sp}\ Ag_2CO_3}$$

$$\frac{Br^-}{\sqrt{\left[CO_3^{2-}\right]}}=\frac{4\times10^{-13}}{\sqrt{8\times10^{-12}}}=\sqrt{2}\times10^{-7}$$

2. $\lambda_1N+\lambda_2N=\lambda N$

$\lambda_1=\frac{\ln2}{24}\qquad\qquad\lambda_2=\frac{\ln2}{6}$

$\lambda N_o=6$

$\lambda N_oe^{-\lambda t}=3$

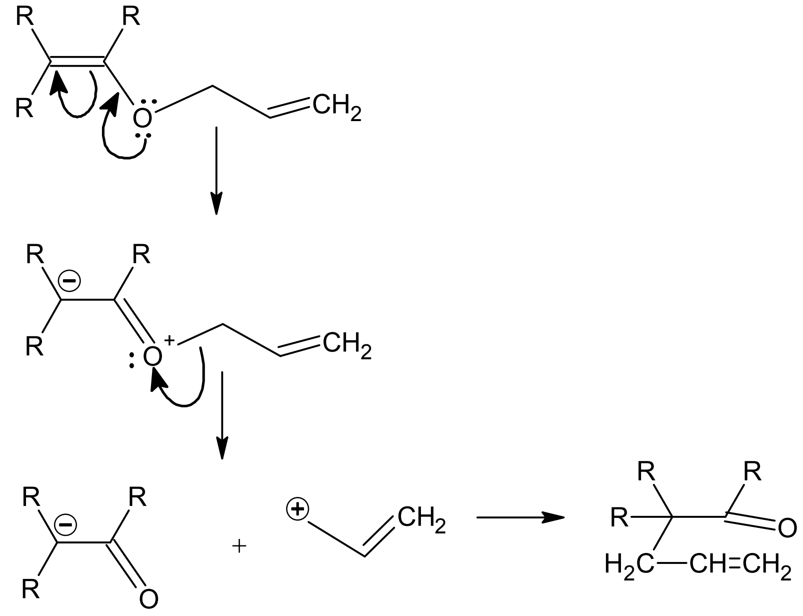
$e^{\lambda t}=2$

$\lambda t=\ln2$

$\left(\frac{\ln2}{24}+\frac{\ln2}{6}\right)t=\ln2$

t = 4.8 hours

3.



4. $\frac{r^+}{r^-} = 0.414$ for octahedral void fitted with our red spherical balloon.

$\frac{r^+}{\alpha} = 0.414$

$r^+ = 0.414\alpha$

Initial r^+ radius = 0.6α

Final r^+ radius = 0.414α

$\frac{\text{Initial r}}{\text{Final r}} = \frac{6\alpha}{0.414\alpha} = 14.5$

5. The number of maxima in the radial charge density curve is (n – *l*)
For 3d electron, n = 3 and d = 2
Hence, n – *l* = 3 – 2 = 1
There will be only one maximum in the curve for 3 d electron.

6. In Perkin reaction, the carbanion attacks the carbonyl carbon of aromatic aldehyde to produce finally the unsaturated acid
The electron withdrawing groups increase reactivity of aldehydes in this reaction by increasing the electron deficiency of carbonyl atom. Thus $-NO_2$ increases the reactivity and the groups like $-N(CH_3)_2$ and $-CH_3$ decreases the reactivity.

7. The order of ligand strength in the spectrochemical series $F^- < H_2O < NH_3 < NO_2^-$. A strong ligand causes a larger degree of splitting resulting in high value of E (energy). Therefore corresponding low value of λ $\left[E = \frac{hc}{\lambda}\right]$

Protonation occurs on the OH which can produce more stable carbocation and while rearrangement phenyl has higher migratory aptitude over o-substituted phenyl.

Solutions for Q. No. 12 to 13

Let the no. of moles of H_2, O_2 and He are x, y and z respectively
$\therefore$ x + y + z = 2.0
Pressure exerted by 2 moles of gaseous mixture is 50 atm.
After the first electric spark decrease in pressure = 50 – 12.5 = 37.5 atm
$\therefore$ decrease in no. of moles of gaseous mixture is 1.5
But from the given information limiting reagent in first step is O_2

$\therefore$ from $H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(\ell)$

$\therefore$ H_2 and O_2 reacted are in the ratio of 2 : 1
$\therefore$ 0.5 mole of O_2 should be reacted with 1.0 mole of H_2
$\therefore$ No. of mole of O_2 in the mixture (y) = 0.5
When again O_2 is passed, pressure increased from 12.5 to 25.0 atm
$\therefore$ Change in pressure = 12.5 atm

$\therefore$ No. of moles of O_2 added = $\frac{12.5 \times 2}{50} = 0.5$ mole

Now H_2 will be completely reacted
No. of moles H_2 actually left after first electric spark = x – 1

$$\begin{array}{lll} H_2 & + \frac{1}{2}O_2 & \longrightarrow H_2O \\ (x-1) & \left(\frac{x-1}{2}\right) & \end{array}$$

Now change in pressure in 25 – 10 = 15 atm

$\therefore$ change in no. of moles is $\frac{15 \times 2}{50} = 0.6$

$\therefore$ $(x-1) + \left(\frac{x-1}{2}\right) = 0.6$

$\Rightarrow x = 1.4$
$\therefore$ no. of moles of H_2 = 1.4
$\therefore$ no. of moles of He = 2.0 – (1.4 + 0.5) = 0.1

$\therefore$ mole fraction of H_2 = $\frac{1.4}{2.0}$ = 0.7

14. Possible structure after test (a) would be that of a 1° or a 2° alcohol and not that of 3° alcohol.

15. Only non-resolvable compound is a 1° alcohol out of the given choices.

16. Oxidation of compound with CrO_3 in pyridine gives a compound, that gives Tollen's test. This implies that it is a primary alcohol.

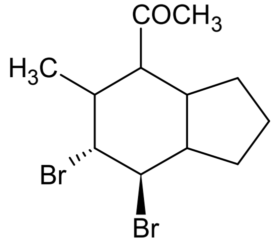
SECTION-B

1. Silver→ Ore is dissolved by complex formation using $\bar{C}N$ in presence of air followed by precipitation with zinc.
   Lead → Involves roasting of PbS followed by self reduction.
   Iron → Involves calcination followed by carbonmonoxide reduction.
   Magnesium → Involves calcination (of $MgCl_2.6H_2O$ in presence of dry HCl gas) followed by fused salt electrolysis.

SECTION –C

2.

P =



3. $n_{M^{n+}} = \frac{1.92}{2\times 60}\text{mol} = 0.016\text{ mol.}$

$n_{\text{hydrazinehydrate}} = = \frac{0.9\times 5.332}{50}\text{mol} = 0.096\text{ mol.}$

$n_{\text{eqKIO3}} = 4\times\frac{1}{10}\text{N}\times 0.48\text{L} = 0.192 \simeq n_{\text{eqhydrazine}}$ reacted with KIO_3

$\therefore n_{\text{hydrazine}}$ left after reaction with $M^{n+} = \frac{0.192}{4}\text{mol} = 0.048\text{ mol}$

$\therefore n_{\text{hydrazine}}$ reacted with $M^{n+} = (0.096 - 0.048)\text{ mol} = 0.048\text{ mol}$

$$\frac{n_{M^+}}{n_{\text{hydrazine}}} = \frac{1}{n} = \frac{0.016}{0.048} = \frac{1}{3}$$

4. F T T T T F F F T T F T T T

(IX) A is a buffer solution; pH of A = $pK_a = 2$

B is an aqueous solution of SacNa; pH of B = $\frac{1}{2}\left(pK_w + pK_a + \log c\right) = 8$

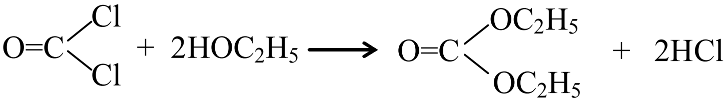
5. Total work done = Area of circle A (anticlockwise) – Area of circle B (clockwise)
= 40 – 36 = 4 unit
heat flows into the system along the path ADB, = 5 – 3+2 = 4 unit

6. $CCl_3\text{–}CH(OH)_2 + NaOH \longrightarrow CHCl_3 + HCOO^-Na^+ + H_2O$

Chloral hydrate (A)

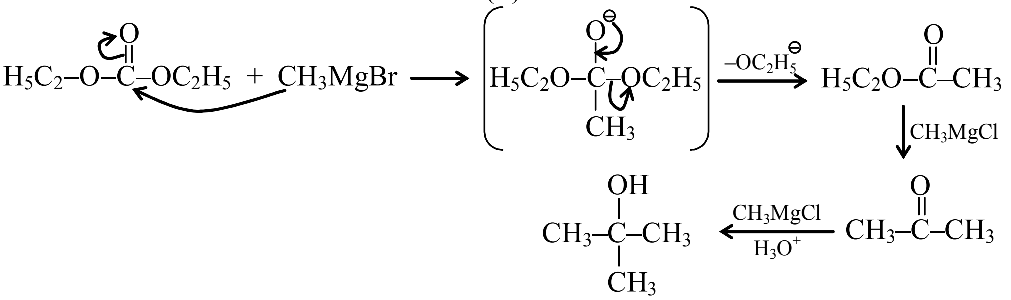
$CHCl_3 + \frac{1}{2}O_2 \xrightarrow{h\nu} COCl_2 + HCl$

(A) (phosgene)
(B)



$$O{=}C(Cl)_2 + 2HOC_2H_5 \longrightarrow O{=}C(OC_2H_5)_2 + 2HCl$$

(diethyl carbonate)
(C)



Mathematics PART – III

SECTION – A

1. Possibilities:

(i) three digit occur twice = ${}^{5}C_3 \cdot \frac{6!}{2!2!2!} = 900$ ways
(ii) two digit occur three times = 200 ways
(iii) one digit occur four times and other twice = 300 ways
(iv) all digits are same = 5
$\Rightarrow$ Total possibilities = 1405

2. $|z - 2i| = 2$ represent a circle with centre (0, 2), radius 2 unit and $|z - 1 - 3i| + |z + 1 - 3i| = 2\sqrt{2}$ represent an ellipse they touch each other at (0, 4)

3. Let $f(n) = \sum_{r=0}^{n} {}^{n+1}C_{r+1} = 2^{n+1} - 1$

f(9) = 1023 = 3.11.31
Total divisors are = 8

4. $$2\left(1+x^3\right)^{100} = \left[a_0 + a_1x + a_2x^2 + ... + a_{100}x^{100}\right] - \left[\cos\frac{\pi}{2}x + \cos\left(\frac{\pi}{2}x + \frac{\pi}{2}\right) + ... + \cos\left(\frac{\pi}{2}x + 100\frac{\pi}{2}\right)\right]$$

Replacing x by –x and adding

$$\left(1+x^3\right)^{100} + \left(1-x^3\right)^{100} = \left[a_0 + a_2x^2 + ... + a_{100}x^{100}\right] - \left(\cos\frac{50\pi}{2}\cos\frac{\pi x}{2}\right)$$

Put x = 1 $\Rightarrow 2^{100} = \sum_{i=0}^{50} a_{2i} \Rightarrow$ k = 100

5. The desired condition is to have the circle N inside the convex region of the parabola $y = x^2$ clearly $a \ge 1$, otherwise circle will cross x-axis also for circle to be inside the parabola the number of points of intersection must be less than or equal to 2

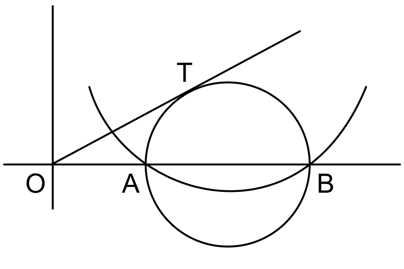
$\Rightarrow$ Equation $y + (y - a)^2 = 1$, has one or less than one solution
$\Rightarrow D \le 0$
$\Rightarrow a \ge \frac{5}{4}$

6. $I_N = \int_0^{\pi} x^3 \log_e(\sin x)\,dx = \int_0^{\pi} (\pi - x)^3 \log_e(\sin x)\,dx$

$= \frac{3\pi}{2}\int_0^{\pi} x^2 \log_e\sqrt{2}\,dx + \frac{3\pi}{2}\int_0^{\pi} x^2 \log_e(\sin x)\,dx = \frac{3\pi}{2} I_D$

$\Rightarrow \frac{I_N}{I_D} = \frac{3\pi}{2}$

7. $OT^2 = OA \cdot OB$



8. Let ABCDPQRS be a cube, the numbers a, b, c, d, e, f be written on the faces

$\Rightarrow$ ade + abe + abf + adf + cde + bce + bcf + cdf = 2004

$\Rightarrow (e + f)(a + c)(b + d) = 2^2 \cdot 3 \cdot 167$

Possible combination are $4 \cdot 3 \cdot 167$, $2 \cdot 6 \cdot 167$, $2 \cdot 3 \cdot 334$, $2 \cdot 2 \cdot 501$

T = a + b + c + d + e + f = 174, 175, 339, or 505

9. If $x \ge 0$, $x^2 + (a - 5)x + 1 = 0$

$x < 0$, $x^2 + (a + 1)x + 1 = 0$

Equation has exactly three distinct solution if (1)

Either $(a - 5)^2 > 4$ and $(a + 1)^2 = 4$

Or $(a - 5)^2 = 4$ and $(a + 1)^2 > 4$

10. $\Delta ODC = \Delta HEA = \Delta GFB$

$$\Rightarrow \frac{1}{2}R^2 \sin A \cos A = 2R^2 \sin C \cos C \cos^2 A = \frac{1}{3}R^2 \sin A \sin B \sin C$$

First two equality gives, tan A = 4 sin C cos C

From first and last, $3 \cos A = 2 \sin^2 C (1 + 4 \cos^2 C) \cos A$

$\Rightarrow 3 = 2 \sin^2 C (1 + 4 \cos^2 C)$

$$\Rightarrow \sin C = \frac{\sqrt{3}}{2} \text{ or } \frac{1}{\sqrt{2}}$$

11. Score of 5 can be obtained as 5 or (1, 4) or (1, 1, 3) or (1, 1, 1, 2)

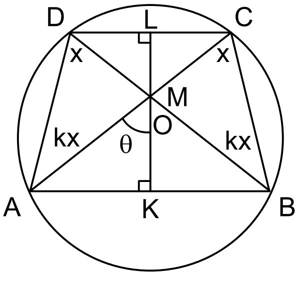
$$\text{P (scoring 5)} = \frac{1}{6} + \frac{1}{6^2} + \frac{1}{6^3} + \frac{1}{6^4} \text{ similarly}$$

$$\text{P (scoring 6)} = \frac{1}{6} + \frac{1}{6^2} + \frac{1}{6^3} + \frac{1}{6^4} + \frac{1}{6^5}$$

$$\text{P (scoring 7)} = \frac{1}{6^2} + \frac{1}{6^3} + \frac{1}{6^4} + \frac{1}{6^5} + \frac{1}{6^6}$$

P (scoring 1) is impossible event

12.-13. Let OM = d



$\Delta MDC \sim \Delta AMB$

$AK^2 + OK^2 = AO^2 = DO^2 = DL^2 + OL^2$

$\Rightarrow k^2x^2 \sin^2 \theta + (kx \cos \theta - d)^2 = x^2 \sin^2 \theta + (x \cos \theta + d)^2$

$\Rightarrow (k^2 - 1)x^2 = 2xd (k + 1) \cos \theta$ as $k + 1 > 0$

$\Rightarrow (k - 1)x = 2d \cos \theta$

Now, AB – CD = 2(AK – LD) = $2(k - 1)x \sin \theta = 2d \sin 2\theta$

If $\angle AMB = 60^\circ$, $\theta = 30^\circ$

If $\angle AMD = 60^\circ$, $\theta = 60^\circ$ in either case $\sin 2\theta = \frac{\sqrt{3}}{2}$

AB – CD = $2\sqrt{3}$

14.-16. a, c, b are in H.P.

$$\Rightarrow \frac{2}{c} = \frac{1}{a} + \frac{1}{b}$$

Line $\frac{x}{a} + \frac{y}{b} + \frac{1}{c} = 0$ passes through a fixed point $\left(-\frac{1}{2}, -\frac{1}{2}\right)$

So centre of ellipse is $\left(-\frac{1}{2}, -\frac{1}{2}\right)$

Which is also centre of auxiliary circle

$\Rightarrow p = \frac{1}{2}$, $q = \frac{1}{2}$ radius of auxiliary circle = 2

$\therefore$ Length of major axis = 4 also it segment of focal chord are 1, 2

$\Rightarrow \frac{1}{1}+\frac{1}{2}=\frac{4}{b^2} \Rightarrow b^2=\frac{8}{3}$

Director circle $\left(x+\frac{1}{2}\right)^2+\left(y+\frac{1}{2}\right)^2=\frac{8}{3}+4$

SECTION – B

1. (A) 20, b, c are in H.P.

$\Rightarrow \frac{1}{20}+\frac{1}{c}=\frac{2}{b}$

This can be written as (40 – b)(c + 20) = 800 we must have 20 < b < 40 or 0 < 40 – b < 20, consider factorisation of 800 in which one term is less that 20

$(40-b)(c+20) = 800 = 1 \times 800 = 2 \times 400 = 4 \times 200 = 5 \times 160 = 8 \times 100 = 10 \times 80 = 16 \times 50$

Thus pair (b, c) = (39, 780), (38, 380), (36, 180), (35, 140), (32, 80), (30, 60), (24, 30) but b divides c

$\Rightarrow$ Only 5 triples satisfy required requirement

(B) Solutions of m + n + p = 10, are ${}^{3+10-1}C_{3-1}$

(C) ab + b – a + 1 = 0

$\Rightarrow (a+1)(b-1) = -2$

$\Rightarrow (a+1, b-1) \in \{(1, -2), (-1, 2), (2, -1), (-2, 1)\}$

$\Rightarrow (a, b) \in \{(0, -1), (-2, 3), (1, 0), (-3, 2)\}$

(D) Let z = x + iy then $(x+iy)^{20} = x - iy$

$\Rightarrow |z|^{20} = |z| \Rightarrow |z|(|z|^{19}-1) = 0$

$\Rightarrow |z| = 1$ or 0

$\Rightarrow |z| = 0$

$\therefore$ Ordered pair (0, 0)

Let $z \neq 0$ then $(x+iy)^{20}(x+iy) = x^2+y^2$

$\Rightarrow z^{21} = |z|^2 = 1 \Rightarrow z^{21}-1 = 0$, which are 21 roots

2. (A) $f(x) = x^4 + ax^3 + bx^2 + cx + d$

$\alpha, \beta, \gamma, \delta$ are real roots of equation f(x) = 0

$\Rightarrow f(x) = (x-\alpha)(x-\beta)(x-\gamma)(x-\delta)$

$\Rightarrow |f(i)| = 1 \Rightarrow (1+\alpha^2)(1+\beta^2)(1+\gamma^2)(1+\delta^2) = 1$ this is possible if $\alpha = \beta = \gamma = \delta = 0$

$\Rightarrow a = b = c = d = 0$

(B) $x^5 - 1 = 0$

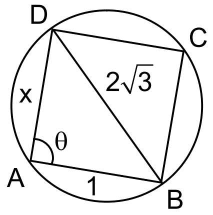
$\Rightarrow (x-1)(x^4+x^3+x^2+x+1) = 0$

$$\Rightarrow \frac{x}{1+x^2}+\frac{x^2}{1+x^4}+\frac{x^3}{1+x}+\frac{x^4}{1+x^3}=\frac{x}{1+x^2}+\frac{x^2}{1+x^4}+\frac{x^3}{x^5+x}+\frac{x^4}{x^5+x^3}$$

$$= \frac{x}{1+x^2}+\frac{x^2}{1+x^4}+\frac{x^2}{1+x^4}+\frac{x}{1+x^2} = 2\left(\frac{x}{1+x^2}+\frac{x^2}{1+x^4}\right) = \frac{2\left(x+x^5+x^2+x^4\right)}{1+x^2+x^4+x^6}=2$$

(C) $\left[\cos|x|+\frac{1}{2}\right]>0 \Rightarrow \cos|x|+\frac{1}{2}\geq 1$ and $-\frac{1}{2}\leq \cos|x|+\frac{1}{2}\leq\frac{3}{2}$

$\Rightarrow \left[\cos|x|+\frac{1}{2}\right]=1 \Rightarrow f(x) = 0 \Rightarrow \int_{x_1}^{x_2} f(x)=0$



(D) Let AD = x, $\angle BAD = \theta$

In ΔABD, $\frac{BD}{\sin\theta} = 2R$

$\Rightarrow \sin\theta = \frac{2\sqrt{3}}{4} \Rightarrow \theta = 60^\circ$

Using cosine rule $\cos 60^\circ = \frac{x^2 + 1 - BD^2}{2x}$

$\Rightarrow BD = \frac{1+3\sqrt{5}}{2}$

$\therefore a = \frac{1}{2}$, $b = \frac{3}{2}$

SECTION – C

1. $f(9) = f(4 + 5) = f(4.5) = f(20)$
$= f(16 + 4) = f(16.4) = f(64)$
$= f(8.8) = f(8 + 8) = f(16)$
$= f(4.4) = f(4 + 4) = f(8)$

2. $g(x) = f'(x) - f(x)$ ….. (1)
$g'(x) = f'(x) - 2f(x)$ ….. (2)
$F'(x) = (2f(x)f'(x) + 2g(x)g'(x))(f^2(-x) + g^2(-x)) + (f^2(x) + g^2(x))(-2f(-x)f'(-x) - 2g(-x)g'(-x))$ ….. (3)
Using (1) and (2) in equation (3), we get $F'(x) = 0$
$\Rightarrow$ F(x) is constant function $\Rightarrow F(0) = 1 = F(1)$

3. $f(x) = \tan^{-1}(\tan x)$
$\sum_{r=1}^{5} f(r) = f(1) + f(2) + f(3) + f(4) + f(5) = 1 + 2 - \pi + 3 - \pi + 4 - \pi + 5 - 2\pi = 15 - 5\pi$
a = 15, b = 5

4. Minimum area will be in case of square with vertices
$(-\sqrt{2}, \sqrt{2})$, $(\sqrt{2}, \sqrt{2})$, $(\sqrt{2}, -\sqrt{2})$ and $(-\sqrt{2}, -\sqrt{2})$
$\therefore$ Minimum area = 8s

5. $\sum_{r=0}^{200} \alpha_r x^r = \sum_{r=0}^{200} \beta_r (1+x)^r$

$\alpha_0 + \alpha_1 x + ... + \alpha_{200} x^{200} = \beta_0 + \beta_1(1+x) + ... + \beta_{200}(1+x)^{200}$

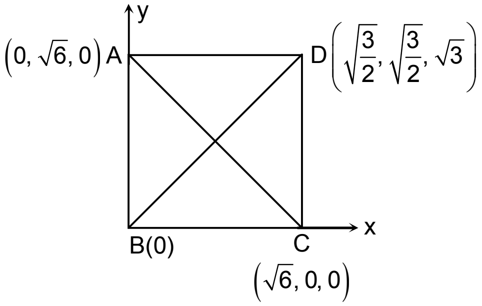
$= \beta_0 + \beta_1(1+x) + ... + \beta_{99}(1+x)^{99} + \frac{(1+x)^{201} - (1+x)^{100}}{x}$

Equating coefficient of $x^{100}, x^{101}, ….., x^{200}$ respectively we get
$\alpha_{100} = {}^{201}C_{101}$, $\alpha_{101} = {}^{201}C_{102}$, ….., $\alpha_{200} = {}^{201}C_{201}$

$\Rightarrow A = \sum_{r=100}^{200} \alpha_r = \alpha_{100} + \alpha_{101} + ... + \alpha_{200} = 2^{200}$

When 2^{200} is divided by 15 we get remainder 1

6. Take B as the origin, BC and BA as x and y axis and z axis perpendicular to the plane of ABC


y
$(0, \sqrt{6}, 0)$ A
D $\left(\sqrt{\frac{3}{2}}, \sqrt{\frac{3}{2}}, \sqrt{3}\right)$
x
B(0)
C
$(\sqrt{6}, 0, 0)$

$\Rightarrow \overrightarrow{BA} = \sqrt{6}\hat{j}$, $\overrightarrow{CD} = \left(\sqrt{\frac{3}{2}} - \sqrt{6}\right)\hat{i} + \sqrt{\frac{3}{2}}\hat{j} + \sqrt{3}\hat{k}$

$\Rightarrow \vec{n} = \overrightarrow{BA} \times \overrightarrow{CD} = 3\hat{k} + 3\sqrt{2}\hat{i} = 3(\sqrt{2}\hat{i} + \hat{k})$

The minimum distance d = $\left|\overrightarrow{BC} \cdot \frac{\vec{n}}{|\vec{n}|}\right| = \frac{2}{\sqrt{3}} \cdot \sqrt{3} = 2$

FIITJEE JEE (Advanced), 2015

FULL TEST – II

Paper 2

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

ALL INDIA TEST SERIES

Time Allotted: 3 Hours **Maximum Marks: 246**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 07)** contains 7 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (08 – 11) contains 4 multiple choice questions which have one or more than one correct answer. Each question carries **+3 marks** for correct answer. There is no negative marking.

   Section-A (12 – 16) contains 2 paragraphs. Based upon paragraph, 2 and 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct matching. No marks will be given for any wrong matching in any question. There is no negative marking.

3. **Section-C (01 – 06)** contains 6 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

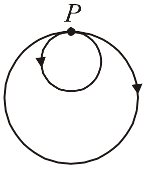
PART – I

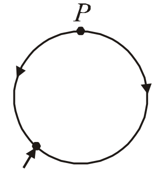
SECTION – A

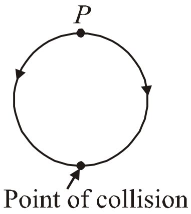
(Straight Objective Type)

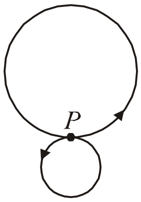
This section contains **7 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

1. A neutral particle at rest in a uniform magnetic field, decays into two charged particles of different masses at point P as shown in the figure. The energy released goes to their kinetic energy and particles move in the plane of the paper. Magnetic field is into the plane of paper. Select the diagram which describes path followed by the particles most appropriately.

(A)


(B)


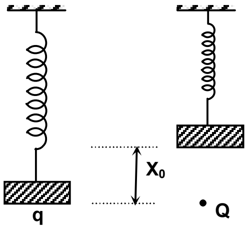
(C)


(D)


2. Choose the correct statement about centre of mass.
   (A) For calculation of any quantity associated with extended body we can assume total mass of body to be concentrated at centre of mass of the body.
   (B) Centre of mass of a body moves in the same way as if all external forces are acting on it and total mass of body is concentrated at it.
   (C) Torque of centrifugal force about centre of mass on rigid body undergoing rotational motion is always zero.
   (D) All above

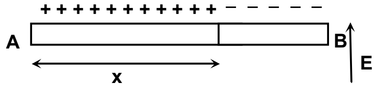
Space for Rough work

3. A block of mass m carrying charge q is suspended through non conducting spring in equilibrium spring elongation is x_0. Now another charge is moves very slowly from infinity until it is in the original position of suspended block. In this process spring acquire its natural length. Work done by external agent.



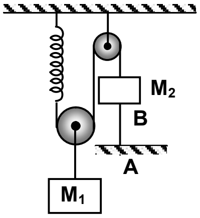
(A) $\frac{3}{2}(mgx_0)$
(B) $\frac{1}{2}(mgx_0)$
(C) $\frac{5}{2}(mgx_0)$
(D) (mgx_0)

4. Rod of mass m and length ℓ carrying one charge in length x and negative charge remaining portion. Linear charge density λ is same for both charges. Rod is hinged at end A. A uniform E perpendicular to rod is switched on and rod remain in equilibrium. Find value of x. (consider gravity g is absent)



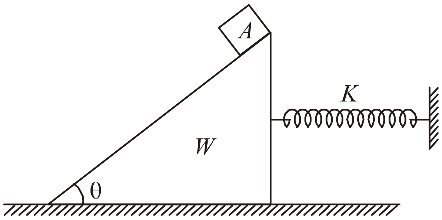
(A) $x = \frac{\ell}{2\sqrt{2}}$
(B) $x = \frac{\ell}{\sqrt{2}}$
(C) $x = \ell$
(D) $x = \frac{3\ell}{\sqrt{2}}$

5. Initially spring is relaxed and $m_1$is released from rest. When m_1 come to rest for a moment string AB is cut at the same amount. Find the acceleration of m_2 just after cutting thread.



(A) $a = \left[\frac{m_1}{m_2} - 1\right]g$
(B) $a = \left[\frac{2m_1}{m_2} - 1\right]g$
(C) $a = \left[\frac{m_1}{2m_2} - 1\right]g$
(D) $a = \left[\frac{3m_1}{m_2} - 1\right]g$

Space for Rough work



6. In the adjacent figure, a block 'A' of mass m is kept on a wedge 'W' of mass 'M', which is lying at rest on a smooth horizontal surface and is connected to a rigid support through a light spring of spring constant 'K'. Initially block and wedge are at rest and spring is at relaxed state. The system (block + wedge) is set free. Calculate maximum possible compression in the spring. All surfaces are frictionless and inclination of wedge is θ.

(A) $\frac{m^2g}{K(M+m\sin^2\theta)}$
(B) $\frac{2Mmg}{K(M+m\sin^2\theta)}$
(C) $\frac{mg\sin2\theta}{K}$
(D) $\frac{2mg\cos\theta}{K}$

7. If an electric dipole is rotating about its centre with uniform angular velocity in anticlockwise direction in a uniform magnetic field which is in the direction of angular velocity then :

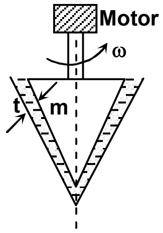
(A) Net magnetic force as well as torque due to the magnetic field on the dipole is zero
(B) Net magnetic force as well as torque due to the magnetic field on the dipole is non-zero
(C) Net magnetic force on dipole is zero but net torque due to the magnetic field on dipole is non-zero
(D) Net magnetic force on dipole is not zero but net torque due to the magnetic field on dipole is zero.

Space for Rough work

(Multiple Correct Choice Type)

This section contains **4 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** are correct.

8. The shown figure, there is a conical shaft rotating on a bearing of very small clearance t. The space between the conical shaft and the bearing, is filled with a viscous fluid having coefficient of viscosity η. The shaft is having radius R and height h. If the external torque applied by the motor is τ and the power delivered by the motor is P working in 100% efficiency to rotate the shaft with constant ω. Then



(A) $P = \dfrac{\pi\omega^2\eta R^3\sqrt{R^2+h^2}}{2t}$ (B) $\tau = \dfrac{\pi\omega\eta R^3\sqrt{R^2+h^2}}{2t}$

(C) $P = \dfrac{\pi\omega^2\eta R^3 h}{2t}$ (D) $\tau = \dfrac{\pi\omega\eta R^3 h^2}{2t\sqrt{R^2+h^2}}$

9. A metal wire of length L, area of cross section A and Young modulus Y is stretched by a variable force F such that F is always slightly greater than the elastic forces of resistance in the wire. When the longation of the wire is ℓ, then choose the correct option(s).

(A) the work done by F is $\dfrac{1}{2}\dfrac{YA}{L}\ell^2$

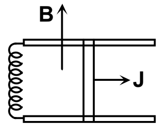
(B) the elastic potential energy stored in the wire is $\dfrac{1}{2}\dfrac{YA}{L}\ell^2$

(C) no heat is produced during the elongation

(D) the work done by F is $\dfrac{YA}{L}\ell^2$

Space for Rough work

10. Two parallel resistance less rails are connected by an inductor of inductance L at one end as shown in the figure. A magnetic field B exists in the space which is perpendicular to the plane of the rails. Now a conductor of length ℓ and mass m is placed transverse on the rails and given an impulse J towards the rightward direction. Then choose the correct option(s).



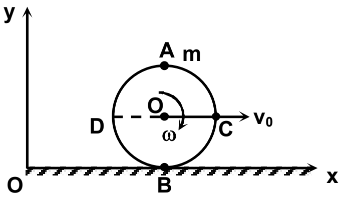
(A) Velocity of the conductor is half of the initial velocity after a displacement of the conductor $d = \sqrt{\frac{3J^2L}{4B^2\ell^2m}}$.

(B) Current flowing through the inductor at the instant when velocity of the conductor is half of the initial velocity is $i = \sqrt{\frac{3J^2}{4Lm}}$

(C) Velocity of the conductor is half of the initial velocity after a displacement of the conductor $d = \sqrt{\frac{3J^2L}{B^2\ell^2m}}$

(D) Current flowing through the inductor at the instant when velocity of the conductor is half of the initial velocity is $i = \sqrt{\frac{3J^2}{mL}}$

11. A particle of mass 'm' is attached to the rim of a uniform disc of mass 'm' and radius R. The disc is rolling without slipping on a stationary horizontal surface, as shown in the figure. At a particular instant, the particle is at the top most position and centre of the disc has speed v_0 and its angular speed is ω. Choose the correct regarding the motion of the system (disc + particle) at that instant.



(A) $v_0 = \omega R$

(B) kinetic energy of the system is $\frac{11}{4}mv_0^2$

(C) speed of point mass m is less than $2v_0$

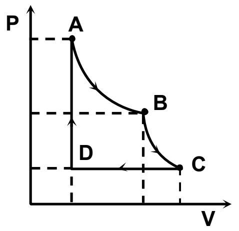
(D) $|\vec{v}_C - \vec{v}_B| = |\vec{v}_B - \vec{v}_D|$

Space for Rough work

Comprehension Type

This section contains **2 paragraphs.** Based upon one of the paragraphs **2 multiple choice questions** and based on the other paragraph **3 multiple choice question** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

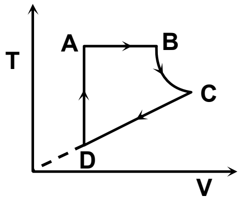
Paragraph for Questions 12 & 13

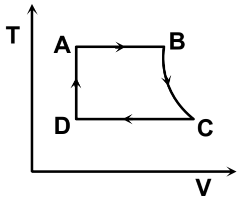


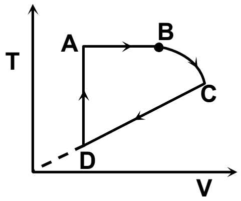
Two moles of a diatomic gas are carried through the cycle ABCDA shown in the figure PV diagram as shown in figure. The segment AB represents an isothermal expansion, the segment BC an adiabatic expansion. The pressure and temperature at A are 5 atm and 600 K respectively. The volume at B is twice that at A. The pressure at D is 1 atm.

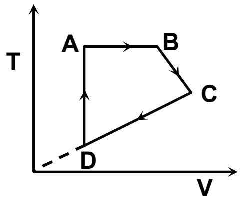
12. What is the pressure at B?
    (A) 2.5 atm (B) 3 atm
    (C) 3.5 atm (D) None of these

13. Find the T versus V graph of the above cyclic process.

(A)


(B)


(C)


(D)


Space for Rough work

Paragraph for Questions 14 & 16

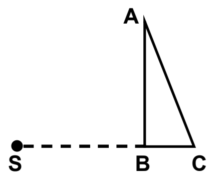
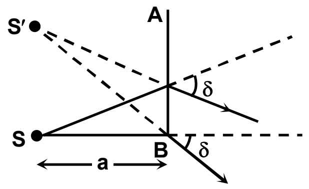


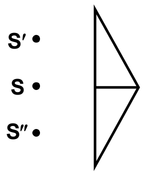
Image formation from a thin prism: For a thin prism, at near normal incidence, the angle of deviation does not vary considerably with angle of incidence and consequently we may write angle of deviation as $\delta = (\mu - 1)A$, where A is the angle of the prism and μ is the refractive index of the material of the prism. Consider a thin prism ABC and a source of light S. Suppose we want to trace the image of source S, for sake of simplicity we draw a simple ray diagram as shown in the figure.



Suppose we take S as the origin, S′ as the image of S and the horizontal and vertical lines passing through S as x and y axis, and the distance SB as a (SB is horizontal). Now using geometry and using the fact that angle CAB is small, we can find the co-ordinates of S′. Now answer the following questions.

14. The x-coordinate of S′ will be
(A) zero
(B) a/2
(C) 2a
(D) a

15. The y-coordinate of S′ will be
(A) $(\mu - 1)Aa$
(B) $\frac{1}{2}(\mu - 1)Aa$
(C) $2(\mu - 1)Aa$
(D) $\frac{3}{2}(\mu - 1)Aa$



16. If an identical prism is joined at the base of the first prism as shown in figure and a new image S″ is formed due to it. Then the separation between S′ and S″ will be
(A) $(\mu - 1)Aa$
(B) $2(\mu - 1)Aa$
(C) $\frac{(\mu - 1)Aa}{4}$
(D) $\frac{3(\mu - 1)Aa}{4}$

Space for Rough work

SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in ***Column I*** *are labelled A, B, C and D, while the statements in* ***Column II*** *are labelled p, q, r, s and t. Any given statement in* ***Column I*** *can have correct matching with* ***ONE OR MORE*** *statement(s) in* ***Column II.*** *The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

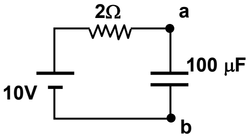
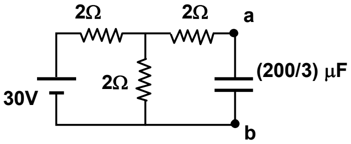
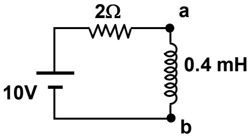
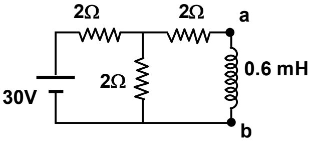
	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. An electron in a hydrogen atom makes a transition $n_1 \rightarrow n_2$, where n_1 and n_2 are the principal quantum numbers of the two states. Assume Bohr model to be valid.

Column I		**Column II**	
(A)	The electron emits an energy of 2.55 eV	(p)	$n_1 = 2, n_2 = 1$
(B)	Time period of the electron in the initial state is eight times that in the final state.	(q)	$n_1 = 4, n_2 = 2$
(C)	Speed of electron become two times	(r)	$n_1 = 5, n_2 = 3$
(D)	Radius of orbit of electron becomes 4.77A°	(s)	$n_1 = 6, n_2 = 3$
		(t)	$n_1 = 8, n_2 = 4$

Space for Rough work

2. Choose the correct equation of current in the Column- II as a function of t through the circuit element 'ab' of the circuits in the column – I

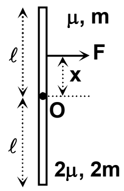
List – I		List – II
(A)		(p) $i = (5A)\left[1 - e^{-\frac{t}{(2\times10^{-4}\ \text{sec})}}\right]$
(B)		(q) $i = (5A)\left[1 - e^{-\frac{t}{(4\times10^{-4}\ \text{sec})}}\right]$
(C)		(r) $i = (5A)e^{-\frac{t}{(2\times10^{-4}\ \text{sec})}}$
(D)		(s) $i = (5A)e^{-\frac{t}{(4\times10^{-4}\ \text{sec})}}$

SECTION – C

(Integer Answer Type)

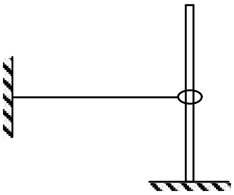
This section contains **6 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. Two rods of same length ℓ but there masses and coefficient of friction with table are m, 2m and μ, 2μ respectively are joint at point O as shown in the figure. Find the position x from joint of two rod where force should apply perpendicular to the length of the rod to drag the rod with constant velocity is $\frac{K}{10}\ell$. Find the value of K.

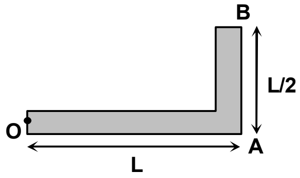


Space for Rough work

2. A string of length 0.4 m and mass 10^{-2} kg is tightly clamped at its one end and other end is free to move as shown in the figure. The tension in the string is 1.6 N identical pulses are produced at one end at equal intervals at time Δt. The minimum value of Δt which allows constructive interference between successive pulses is

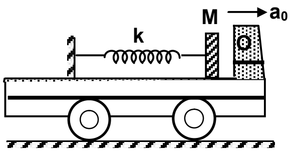


3. A uniform rod OAB is bent in L shape to form right angle at A. Length of OA is L and that of AB is $\frac{L}{2}$ respectively as shown in figure. The rod is hinged at the end O and is free to rotate in a vertical plane about O. It is set free from rest, when larger section of it is in horizontal position. Maximum angular acceleration of rod is $\frac{\sqrt{65}}{K}\frac{g}{L}$. The value of K is

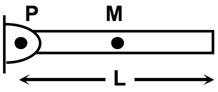


4. For an equilateral prism, it is observed that when a ray strikes grazingly at one face it emerges grazingly at the other. Its refractive index will be

5. A block of mass (M = 1 kg) is kept on smooth floor of a truck. One end of a spring of force constant 100 N/m^2 is attached to the block and other end is attached to the body of truck as shown in the figure. At t = 0, truck begin to move with constant acceleration 2 m/s^2. The amplitude of oscillation of block relative to the floor of truck is $\lambda/100$. Find the value of λ



6. A uniform rod of mass M is released from horizontal position as shown in the figure. The rod is free to rotate about a horizontal frictionless axis passing through hinge P. The reaction from the hinge just after the release is Mg/K. Find the value of K.

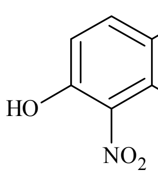


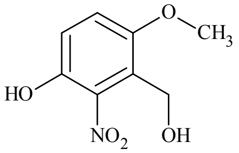
Space for Rough work

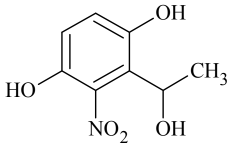
Chemistry PART – II

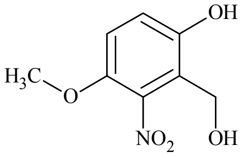
SECTION – A
Straight Objective Type

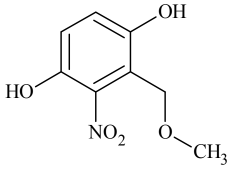
This section contains **7 multiple choice** questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONLY ONE** option is correct.

1.  $\xrightarrow[(1eqv)]{CH_2N_2}$ A. A is

(A) 

(B) 

(C) 

(D) 

2. Choose the correct statement(s) from among the following

(A) The corrected pressure $\left(P + \frac{an^2}{v^2}\right)$ in vander waals' equation (symbols have their usual meanings) is the pressure which the gas would exert if it was ideal.

(B) Above their respective Boyle's temperature, N_2 shows throughout positive deviation ($z > 1$) while O_2 shows negative deviation ($z < 1$) followed by positive deviation ($z > 1$).

(C) A gas shows negative deviation when long range attractive intermolecular forces are dominating

(D) The intercept of PV vs. P isotherm of any gas at 27°C is equal to 24.6 L atm.

3. The ZnS (zinc blende) structure is cubic. The unit cell may be described as a face-centred sulfide ion lattice with zinc ions in the tetrahedral voids. Then among the following which is incorrect:

(A) The nearest neighbours of Zn^{2+} are four

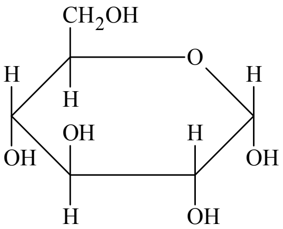
(B) The angle made by the lines connecting any Zn^{+2} to any two of its neighbours is $109^{o}28'$.

(C) The nearest neighbours of S^{-2} are four

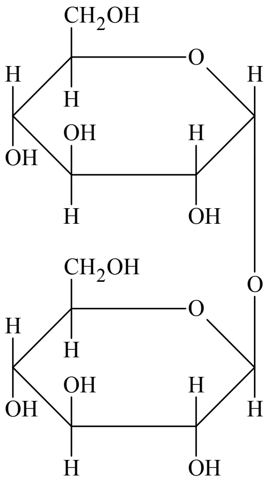
(D) The nearest neighbours of S^{-2} are eight

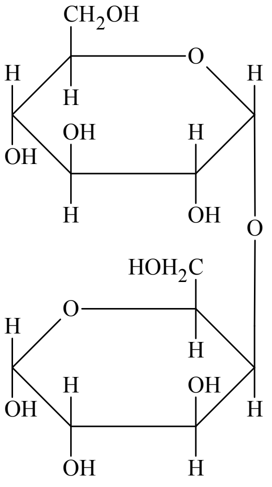
Rough Work

4. Some organic compounds are given below

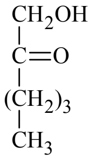


I





II III



IV

Select the correct statement about the above compounds from the following

(A) Compounds I and III would reduce Fehling's solution and will also mutarotate

(B) Compound IV will not reduce Tollen's reagent and will not mutarotate

(C) Compound II will not be reducing but mutarotating

(D) The product(s) of the acid catalysed hydrolysis of both II and III will be reducing but not mutarotating

5. $Mg_3N_2 \xrightarrow{H_2O} A_{(g)} \xrightarrow[\Delta]{CuO} B + C_{(g)} + H_2O$

$C_{(g)}$ can be obtained by heating

(A) NH_4NO_3 (B) $(NH_4)_2SO_4$

(C) NH_4ClO_4 (D) $NaNO_2$ + Zn + NaOH (Conc.)

6. Which of the following statements are incorrect?

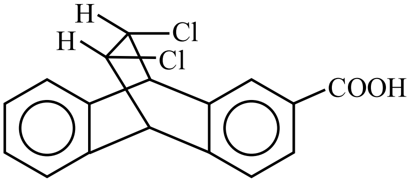
(A) Sulfate and thiosulphate ions are isostructural.

(B) Thiosulphate on reaction with HCl precipitates sulphur along with SO_2 evolution.

(C) In $S_2O_3^{2-}$ the oxidation states of the two 'S' atoms are -2 and +6.

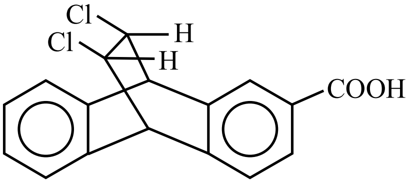
(D) Both SO_4^{2-} and $S_2O_3^{2-}$ can decolourise I_2.

7. Difference in P^{Ka} values of compounds A and B can be best explained by



(A)

$P^{Ka} = 6.07$



(B)

$P^{Ka} = 5.67$

(A) Inductive effect (B) Electromeric effect

(C) Field effect (D) Resonance effect

Rough Work

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

8. Which of the following statements are correct?
(A) Nylon 6 and Nylon 66 are examples of condensation polymerization
(B) D-glucose and D-galactose are epimers
(C) Polyethene is produced via addition polymerization
(D) Teflon has a low coefficient of friction

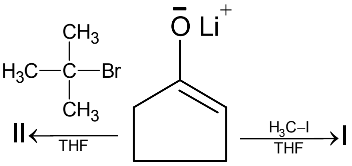
9. Consider the reaction

$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)} + \text{Heat}$$

What will happen if 0.5 mole of Helium gas is introduced into the vessel so that the temperature and pressure remain constant?
(A) the equilibrium concentration of SO_2 increases
(B) the equilibrium will shift to left
(C) the equilibrium concentration of O_2 increases
(D) equilibrium constant will increase

10. The standard enthalpy of formation of CO_2 will be given by :
(A) standard enthalpy of combustion of diamond
(B) standard enthalpy of combustion of graphite
(C) standard enthalpy of combustion of CO
(D) sum of standard enthalpy of formation and standard enthalpy of combustion of CO.

11. The lithium enolate base formed from cyclopentanone reacts with alkyl halides, often in different ways. As shown here, methyl iodide and *tert*-butyl bromide react to give different organic products, I and II, together with lithium halides. What are the products from these reactions?



(A) I is 1-methoxycyclopentane
(B) II is 1-t-butoxycyclopentane
(C) I is 2-methylcyclopentanone
(D) II is a mixture of cyclopentanone and 2-methylpropene

Rough Work

Comprehension Type

This section contains **2 paragraphs.** Based upon the first paragraph 2 multiple choice questions and based upon the second paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices A), B), C) and D) out of **WHICH ONLY ONE IS CORRECT.**

Paragraph For Question No.12 and 13

Heat of neutralization is defined as the enthalpy change when 1 mole of acid/base is completely neutralization by base/acid in dilute solution.

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l); \Delta_r H^0 = -55.84\,kJ/mol$$

$\Delta H^0_{ionization}$ of aqueous solution of strong acid and strong base is zero.

When a dilute solution of a weak acid or base is neutralized, the enthalpy of neutralization is some what less because of the absorption of heat in the ionization of the weak acid or base, for weak acid/base $\Delta H^0_{neutralisation} = \Delta H^0_{ionization} + \Delta_r H^0 \left(H^+ + OH^- \rightarrow H_2O\right)$

12. What is ΔH^0 for complete neutralization of strong diacidic base $A(OH)_2$ by HNO_3 ?

(A) –55.84 kJ (B) –111.68 kJ
(C) 55.84 kJ (D) 111.68 kJ

13. Under the same conditions how many mL of 0.1 M NaOH and 0.05 M H_2A (strong diprotic acid) solution should be mixed for a total volume of 100 mL produce the highest rise in temperature.

(A) 25 : 75 (B) 50 : 50
(C) 75 : 25 (D) 66.66 : 33.33

Rough Work

Paragraph For Question No.14 and 16

A green ore (A) of a metal present as a double/mixed compound is treated with HCl and then H_2S is passed in the solution. A black precipitate (B) is obtained, that is insoluble in yellow ammonium sulphide. The precipitate is dissolved in HNO_3 and then excess of NH_4OH is added. The solution becomes coloured but this colour is discharged upon addition of KCN in excess due to the formation of compound (C). The solution of (A) in H_2O liberates a colourless and odourless gas on reaction with dilute H_2SO_4 and solution of (A) gives white precipitate on addition of $BaCl_2$ solution.

14. The green ore (A) is
(A) $CuSO_4.Cu(OH)_2$
(B) $CuCO_3.Cu(OH)_2$
(C) $PbSO_4.Pb(OH)_2$
(D) $PbCO_3.Pb(OH)_2$

15. The compound (C) and its structure is
(A) $[Cu(CN)_4]^{2-}$, tetrahedral
(B) $[Cu(CN)_4]^{2-}$, square planar
(C) $[Cu(CN)_4]^{3-}$, tetrahedral
(D) $[Cu(CN)_4]^{3-}$, square planar

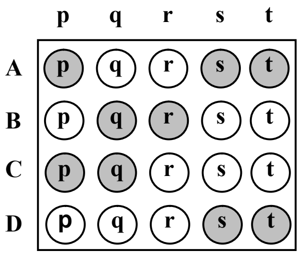
16. The procedure used to estimate the metal ion of ore (A) gravimetrically, is
(A) treatment of ore with excess KCN.
(B) treatment of solution of ore with Ag metal.
(C) treatment of ore with excess ammonia.
(D) treatment of ore with excess KSCN.

Rough Work

SECTION-B
(Matrix-Match Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



1.

Column – I (Compounds)	**Column – II (Magnetic moment)**
(A) $[Fe(H_2O)_5NO]SO_4$	(p) $\sqrt{24}$ B.M.
(B) $K_2[Fe(CN)_5NO]$	(q) $\sqrt{8}$ B.M.
(C) $[Mn(CN)_6]^{3-}$	(r) Zero B.M.
(D) $[Co(SCN)_6]^{3-}$	(s) $\sqrt{15}$ B.M.
	(t) $\sqrt{3}$ B.M.

2.

Column – I	**Column – II**
(A) N_2O_3	(p) Contains N – O – N linkage
(B) N_2O_4	(q) Neutral oxide
(C) N_2O_5	(r) Colored
(D) N_2O	(s) mixed Anhydride
	(t) Basic oxide

Rough Work

SECTION –C

Integer Answer Type

This section contains **6 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

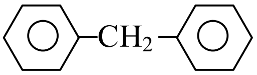
1. How many optically active isomers are possible for $CH_3CH(Br)CH(Br)CH(Br)CH_3$?

2. A certain saturated hydrocarbon effuses about half as fast as H_2O vapour. Number of carbons in the formula of this hydrocarbon are?

3. 2.505 g of hydrated dibasic acid requires 35 ml of 1N NaOH solution for complete neutralization. When 1.01 g of the hydrated acid is heated to constant weight 0.72 g of the anhydrous acid is obtained. The degree of hydration (number of water molecules) of the hydrated dibasic acid is approximately ______.

4. The number of mole of bromine required for complete bromination of 276 g of salicylic acid in aqueous medium are___________.

5. 1 g of an acid $C_6H_{10}O_4$ requires 0.768 g of KOH for complete neutralization. Determine the basicity of acid.

6. The structural formula of diphenyl methane $(C_{13}H_{12})$ is 

   How many structural isomers are possible when one of the hydrogens is replaced by a chlorine atom?

Rough Work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains 7 multiple choice questions numbered 1 to 7. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. A gun can hit the target A with probability $\frac{27}{28}$ and target B with probability $\frac{1}{28}$, it has 47 bullets, each of which can be fired either at A or at B and each bullet may hit the target, independently of the other bullet, with probability $\frac{1}{3}$. How many bullets must be fired at A to hit the target with maximum probability
(A) 20 (B) 25
(C) 30 (D) 35

2. A polynomial P(x) of nth degree satisfies $P(k) = 2^k$ for k = 0, 1, 2,.., n, then the value of P(n + 1) is
(A) 2^n (B) 2^{n+1}
(C) $2^{n+1} - 1$ (D) 2^{n+2}

3. The number of all polynomial whose coefficients are all ±1, that have only real roots are
(A) 6 (B) 8
(C) 10 (D) 12

4. For positive integer n, define $f(n) = 1^n + 2^{n-1} + 3^{n-2} + \ldots.. + (n-2)^3 + (n-1)^2 + n$ then the minimum of $\frac{f(n+1)}{f(n)}$ is
(A) 3 (B) $\frac{8}{3}$
(C) 2 (D) 1

Space for rough work

5. The value of $\int \sqrt{\frac{(1-\sin x)(2-\sin x)}{(1+\sin x)(2+\sin x)}}dx$ is

(A) $\ln\left(\frac{t-\sqrt{3}}{t+\sqrt{3}}\right)+2\tan^{-1}t+c$
(B) $\ln\left(\frac{t+\sqrt{3}}{t-\sqrt{3}}\right)+\tan^{-1}t+c$
(C) $\sqrt{3}\ln\left(\frac{t+\sqrt{3}}{t-\sqrt{3}}\right)+\tan^{-1}\frac{2t}{1-t^2}+c$
(D) $\sqrt{3}\ln\left(\frac{t-\sqrt{3}}{t+\sqrt{3}}\right)+2\tan^{-1}t+c$

(where t = $\sqrt{\frac{2-\sin x}{2+\sin x}}$)

6. Let x be $\left(\sqrt{108}+10\right)^{1/3}-\left(\sqrt{108}-10\right)^{1/3}$ then x is equal to

(A) 10
(B) 8
(C) 4
(D) 2

7. A circle of radius 320 units is touches internally a circle of radius 1000. The smaller circle touches a diameter of larger circle at the point p, least distance of the point p from the circumference of the larger circle is

(A) 300
(B) 360
(C) 400
(D) 420

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

8. The roots of a quadratic equation ax^2 + bx + c = 0 are $\alpha = z^2+z^4+.....+z^{2n}$ and $\beta = z+z^3+.....+z^{2n-1}$ where $z = e^{i\left(\frac{2\pi}{2n+1}\right)}$, n ∈ z$^+$ then

(A) $\alpha + \beta = 1$
(B) $\alpha \cdot \beta = 1$
(C) equation can be written as $x^2+x+\frac{1}{4}\sec^2\left(\frac{\pi}{2n+1}\right)=0$
(D) $\alpha + \beta = -1$

Space for rough work

9. Let $f_1(x) = x$, $f_2(x) = 1 - x$, $f_3(x) = \frac{1}{x}$, $f_4(x) = \frac{1}{1-x}$, $f_5(x) = \frac{x}{x-1}$, $f_6(x) = \frac{x-1}{x}$ suppose that $f_6(f_m(x)) = f_4(x)$ and $f_n(f_4(x)) = f_3(x)$ then

(A) m = 5
(B) n = 5
(C) m = 6
(D) n = 6

10. If a continuous function f(x) satisfy the relation $\int_0^x t f(x-t)dt = \int_0^x t\, f(t)dt + \sin x + \cos x - x - 1$, for all real number x, then which of the following does not hold good

(A) f(0) = 1
(B) f′(0) = 0
(C) f″(0) = 2
(D) $\int_0^\pi f(x)dx = e^\pi$

11. Let, f(0, ∞) → R be a strictly increasing function such that $f(x) > -\frac{1}{x}$ ∀ x > 0 and $f(x)f\left(f(x)+\frac{1}{x}\right) = 1$ ∀ x > 0, then

(A) $f(1) = \frac{1-\sqrt{5}}{2}$
(B) $f(1) = \frac{1+\sqrt{5}}{2}$
(C) $f(x) = \frac{1-\sqrt{5}}{2x}$
(D) $f(x) = \frac{(1+\sqrt{5})x}{2}$

Space for rough work

Comprehension Type

This section contains 2 paragraphs. Based upon one of paragraphs 2 multiple choice questions and based on the other paragraph 3 multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

---

Paragraph for Question Nos. 12 to 13

Read the following write up carefully and answer the following questions:
A line through the origin has the vector equation $\overline{r} = \lambda\overline{s}$, λ is a scalar parameter. Consider a family of line L with $\overline{s} = \left(\cos\theta + \sqrt{3}\right)\hat{i} + \left(\sqrt{2}\sin\theta\right)\hat{j} + \left(\cos\theta - \sqrt{3}\right)\hat{k}$ then

12. The line through origin and making acute angle $\frac{\pi}{6}$ with family of lines of the L–family are in the form of
(A) $\mu(i - j)$
(B) $\mu(i - k)$
(C) μ (i + j)
(D) $\mu(i + k)$

13. If the lines in L meet the plane x – z = $4\sqrt{3}$ at P. If θ varies and P describes a circle on the plane with centre on M then radius of this circle is
(A) 2
(B) $\sqrt{2}$
(C) 4
(D) $2\sqrt{2}$

Space for rough work

Paragraph for Question Nos. 14 to 16

Read the following write up carefully and answer the following questions:
While finding sine of a certain angle x, an absent minded professor failed to notice that his calculator was not in correct angular mode. However he was lucky to get the right answer. The two least positive value of x for which the sine of x degree is the same as sine of x radians were found by him as $\frac{m\pi}{n-\pi}$ and $\frac{p\pi}{q+\pi}$ where m, n, p, q are positive integers suppose $\frac{mn}{pq}$ be denoted by L, then

14. The value of m + n + p + q is equal to
(A) 720 (B) 900
(C) 1080 (D) 1260

15. If x measured in radian and $\lim_{x\to\infty}\left(\sqrt{Ax^2+Bx}-Cx\right)=L$, the value of $\frac{BC}{A}$ equals (A, B, C $\in$ R)
(A) 4 (B) 2
(C) $\frac{1}{2}$ (D) none of these

16. Assume that f is differentiable for all x, the sign of f is a follows
$f'(x) > 0$ on $(-\infty, -4)$
$f'(x) < 0$ on $(-4, 6)$
$f'(x) > 0$ on $(6, \infty)$
Let g(x) = f(10 – 2x) the value of g′(L) is
(A) positive (B) negative
(C) zero (D) the function g is not differentiable

Space for rough work

SECTION-B
(Matrix-Match Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:
If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the following Column-I with Column-II

	Column – I		Column – II
(A)	Real value of x satisfying $\left(\sqrt{x^2-5x+6}+\sqrt{x^2-5x+4}\right)^{x/2}+\left(\sqrt{x^2-5x+6}-\sqrt{x^2-5x+4}\right)^{x/2}$ $= 2^{\frac{x+4}{4}}$ is	(p)	0
(B)	Integral value of 'a' for which the equation $(x^2 + x + 2)^2 - (a - 3)(x^2 + x + 2)(x^2 + x + 1) + (a - 4)(x^2 + x + 1)^2 = 0$ has at least one real root is	(q)	1
(C)	If P_r is the coefficient of x^r in the expansion of $(1+x)^2\left(1+\frac{x}{2}\right)^2\left(1+\frac{x}{2^2}\right)^2\left(1+\frac{x}{2^3}\right)^2$ ..... then P_1 is equal to	(r)	2
(D)	If the number of positive integral solution of x + y + z = n be denoted by P_n and $\Delta=\begin{vmatrix} P_n & P_{n+1} & P_{n+2} \\ P_{n+1} & P_{n+2} & P_{n+3} \\ P_{n+2} & P_{n+3} & P_{n+4} \end{vmatrix}$ then $\lvert\Delta\rvert$ is equal to	(s)	4
		(t)	6

2. Match the following Column-I with Column-II

	Column – I		Column – II
(A)	Let $z = (\cos 12^\circ + i \sin 12^\circ + \cos 48^\circ + i \sin 48^\circ)^6$, then Im(z) is	(p)	0
(B)	Let f(x) be a continuous and differentiable function in (a, b). If $\lim\limits_{x\to a^+} f(x)=\infty$, $\lim\limits_{x\to b^-} f(x)=-\infty$ and $f'(x) + (f(x))^2 = -1$ then minimum value of $\frac{b-a}{\pi}$ is	(q)	1
(C)	The number of solution of $\tan\left(\frac{\pi}{4}+\frac{1}{2}\cos^{-1}x\right)+\tan\left(\frac{\pi}{4}-\frac{1}{2}\cos^{-1}x\right)=1$ is	(r)	3
(D)	The value of $\frac{1}{21}\left(\tan^2\frac{\pi}{7}+\tan^2\frac{2\pi}{7}+\tan^2\frac{3\pi}{7}\right)\left(\cot^2\frac{\pi}{7}+\cot^2\frac{2\pi}{7}+\cot^2\frac{3\pi}{7}\right)$ is	(s)	4
		(t)	5

Space for rough work

SECTION – C

(Integer Answer Type)

This section contains **6 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

1. Let f(x) is a quadratic function such that f(0) = 1 and $\int \frac{f(x)dx}{x^2(x+1)^3}$ is a rational function, then the value of $f'(0)$ is _____

2. If $0 \le [x] < 2$, $-1 \le [y] < 1$ and $1 \le [z] < 3$, (where [.] denotes the greatest integer function) then the maximum value of the determinant $\begin{vmatrix} [x]+1 & [y] & [z] \\ [x] & [y]+1 & [z] \\ [x] & [y] & [z]+1 \end{vmatrix}$ is _____

3. Let $\alpha = \sin^{-1}\left(\frac{36}{85}\right)$, $\beta = \cos^{-1}\frac{4}{5}$, $\gamma = \tan^{-1}\left(\frac{8}{15}\right)$ and $A = \frac{\cot\alpha + \cot\beta + \cot\gamma}{\cot\alpha \cdot \cot\beta \cdot \cot\gamma}$, $B = \tan\alpha \cdot \tan\beta + \tan\beta \cdot \tan\gamma + \tan\gamma \cdot \tan\alpha$ then A + B is _____

4. Let $f(x) = x^3 + 3x^2 - 6x + 11$, $g(x) = \ln|x|$. If $A = f(g'(-1))$, $B = g(f'(-1))$, $C = \int_{-2}^{1} f'(x)g'(f(x))dx$, $D = \frac{d}{dt}\int_{1}^{t^2} g(x)dx$ evaluated at t = 3 and A(B + C) – D = kln(3) then the value of k is _____

5. Let $\bar{r}_1, \bar{r}_2, ..., \bar{r}_n$ be the sides of a regular polygon inscribed in a circle of limit radius if $\left|\bar{r}_1 \times \bar{r}_2 + \bar{r}_2 \times \bar{r}_3 + ... + \bar{r}_n \times \bar{r}_1\right| = \left|\bar{r}_1 \cdot \bar{r}_2 + \bar{r}_2 \cdot \bar{r}_3 + ... + \bar{r}_n \cdot \bar{r}_1\right|$ then smallest possible value of n is _____

6. A ray of light emerging from the point p(0, 4) along the tangent of the ellipse $\frac{x^2}{25} + \frac{y^2}{16} = 1$ and strike a circle of radius $\sqrt{65}$ units and reflected from it. The reflected ray entering inside the ellipse through the focus (–3, 0) and strike lower surface of ellipse and gets reflected from it. If the reflected ray returns to the point p(0, 4), then ordinate of the centre of circle is _____

Space for rough work

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FULL TEST–II

(PAPER-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	C	B
2.	B	A	C
3.	A	D	D
4.	B	A	B
5.	A	C	D
6.	C	D	D
7.	D	C	C
8.	A, B	A, B, C, D	C, D
9.	A, B, C	A, B, C	B, C
10.	A, B	B, D	A, B, D
11.	A, B, D	C, D	A, C
12.	*A*	B	B
13.	A	B	D
14.	A	B	B
15.	A	C	A
16.	B	D	C
1.	(A) → (q), (B) → (p, q, s, t), (C) → (p, q, s, t), (D) → (r, s)	(A) – (s), (B) – (r), (C) – (q), (D) – (p)	(A) → (p, q, s) (B) → (t) (C) → (s) (D) → (q)
2.	(A) →(r), (B) → (r), (C) → (p), (D) → (p)	(A – r), (B – s), (C – p,), (D – q)	(A) → (p) (B) → (q) (C) → (p) (D) → (t)
1.	3	2	3
2.	2	5	4
3.	7	2	2
4.	2	6	7
5.	5	2	8
6.	4	4	5

Physics

PART – I

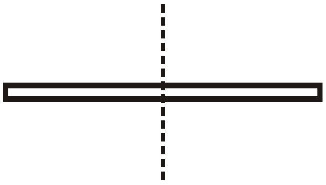
SECTION – A

1. Momenta and charged are equal and opposite, so sense of the motions are opposite.

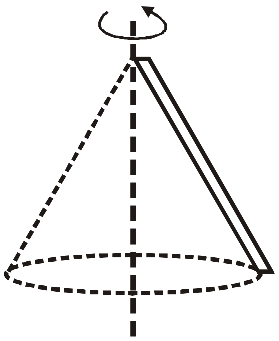
$\therefore R = \frac{Mv}{qB} \Rightarrow$ their radii are equal.

2. We can not assume total mass to be concentrated at centre of mass for calculation of all the thing e.g. for calculation of moment of inertia, calculation of torque of centrifugal force on a rod about hinge as shown.

(i)



(ii)



6. $Kx = (m + M)\, a + ma' \cos\theta$

Block: $a' + a\cos\theta = g\sin\theta$

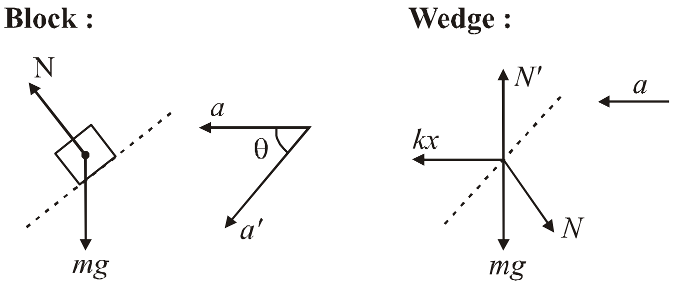
...(ii)

From (i) & (ii)

$$a = \frac{Kx - mg\sin\theta\cos\theta}{M + m\sin^2\theta} = K_1x - K_2$$

$\Rightarrow$ Max. compression

$$= \frac{2mg\sin\theta\cos\theta}{K}$$



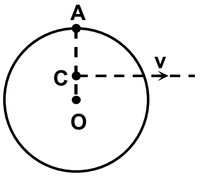
Block + Wedge

7. Net magnetic moment of loop formed is zero, hence torque due to magnetic field is zero.

11. $K = K_D + K_P$

$$= \frac{1}{2}mv_0^2\left(1+\frac{1}{2}\right)+\frac{1}{2}m(2V_0)^2$$

$$= \frac{11}{4}mV_0^2$$

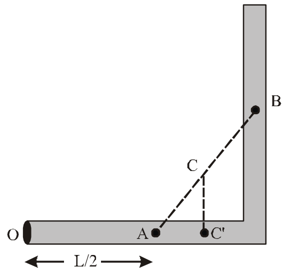


SECTION – C

3. Let A, B, and C be C.M. of larger section , smaller section and total rod

$$CC' = \frac{L}{12},\ AC' = \frac{L}{6}$$

$$OC = \left\{\left(\frac{L}{2}+\frac{L}{6}\right)^2 + \left(\frac{L}{12}\right)^2\right\}^{\frac{1}{2}} = \frac{\sqrt{65}}{12}L$$



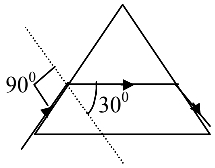
Moment of inertia about '*O*'

$I = \frac{7}{8}ML^2 \Rightarrow$ Maximum torque of about '*O*'

$$\tau_{max} = \frac{3Mg}{2}\times(OC)$$

$$\alpha_{max} = \frac{\tau_{max}}{I} = \frac{\sqrt{65}}{7}\left(\frac{g}{L}\right)$$

4. $\mu = \frac{\sin 90^0}{\sin 30^0} = 2$



5. $kx_0 = ma_0$

6. $\alpha = \tau/I = \left(Mg\frac{L}{2}\Big/\frac{ML^2}{3}\right) = \frac{3}{2}\frac{g}{L}$

$\Rightarrow\ a_{cm} = \alpha L/2 = 3g/4 = \frac{Mg-N}{M}$

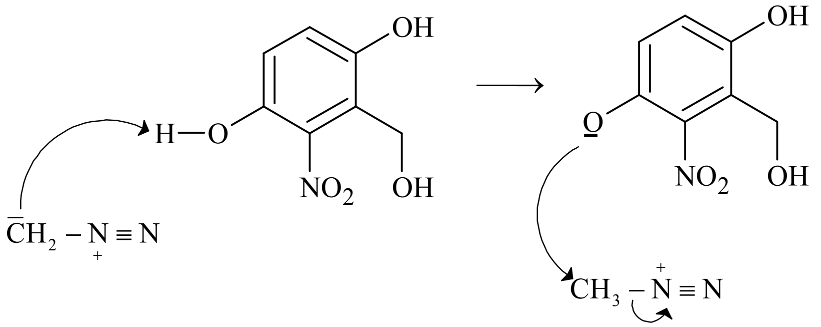
$\Rightarrow\ N = \frac{Mg}{4}$

Chemistry

PART – II

SECTION – A

1. Diazomethane being a base will pick up the hydrogen which is most acidic. The H of the OH group ortho to –NO_2 group is most acidic


OH
H—O
NO2
OH
$\bar{C}H_2 - \overset{}{\underset{+}{N}} \equiv N$
OH
O
NO2
OH
$CH_3 - \overset{+}{N} \equiv N$

2. Choice (B) is incorrect as all the gases above their respective Boyle's temperature show throughout +ve deviation.

4. All reducing sugars are mutarotating. Although IV is an α-hydroxy ketone and hence reducing but it can't mutarorate as it is not a carbohydrate/can't form ring. In II the glycosidic bond is in between two anomeric carbons and hence ring opening can't occur. Thus non-reducing as well as non-mutarotating.

5. $$Mg_3N_2 + 6H_2O \longrightarrow 3Mg(OH)_2 + \underset{(A)}{2NH_3}$$

$$2NH_3 + 3CuO \longrightarrow 3Cu + \underset{(C)}{N_2} + 3H_2O$$

$$NaNO_2 + Zn + NaOH \longrightarrow Na_2ZnO_2 + NH_3 + H_2O$$

Ammonium salts containing anions which are oxidizing in nature, on heating liberates $N_{2(g)}$ instead of NH_3.

9. At constant pressure, the addition of inert gas shifts the equilibrium towards larger no. of moles.

14. Since, it liberates a gas on reaction with dilute H_2SO_4, it cannot be a sulphate salt, it would be a carbonate salt. Malachite ore of copper, $CuCO_3$. $Cu(OH)_2$ is green in colour.

15. $$\underset{\text{Blue colour}}{\left[Cu(NH_3)_4\right]^{2+}} + 2KCN \longrightarrow \underset{\text{Yellow ppt}}{Cu(CN)_2 \downarrow} + 2K^+ + 4NH_3$$

$$2Cu(CN)_2 \downarrow \xrightarrow{\text{decomposes}} \underset{\text{White ppt}}{2CuCN \downarrow} + (CN)_2 \uparrow$$

$$CuCN \downarrow + 3KCN \longrightarrow \underset{\text{Colourless}}{\left[Cu(CN)_4\right]^{3-}} + 3K^+$$

Cu^{+1} has a d^{10} configuration, so it is tetrahedral in shape with sp^3 hybridization.

16. Gravimetric estimation of Cu^{2+} would be possible only when the given procedure gives an insoluble compound on treatment with a given reagent.

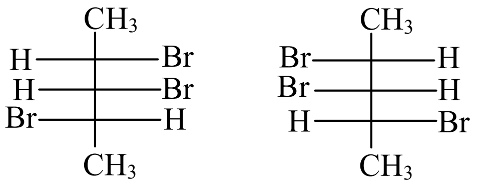
$$Cu^{2+} + 2KSCN \longrightarrow \underset{\text{Black ppt}}{Cu(SCN)_2} \downarrow + 2K^{+}$$

$$2Cu(SCN)_2 \downarrow \xrightarrow{\text{decomposes}} \underset{\text{White ppt}}{2CuSCN} \downarrow + (SCN)_2 \uparrow$$

With other reagents, either there is no reaction or even if it reacts, then the product is a soluble compound.

SECTION –C

1. Only two optically active isomers are possible.



2. $$\frac{r_{C_nH_{2n+2}}}{r_{H_2O}} = \frac{1}{2} = \sqrt{\frac{M_{H_2O}}{M_{C_nH_{2n+2}}}}$$

$\therefore\ M_{C_nH_{2n+2}} = 4 \times 18 = 72$

$\therefore\ 12 \times n + 1 \times (2n + 2) = 72$

$\therefore\ 14n + 2 = 72$

$\therefore\ n = 5$

3. Let formula of hydrated dibasic acid be $H_2A\ .x\ H_2O$

Equivalent of dibasic acid = Equivalent of NaOH

$$\frac{2.505 \times 2}{M} = \frac{35}{1000} \times 1$$

$$M = \frac{2.505 \times 2 \times 1000}{35 \times 1} = 143.14$$

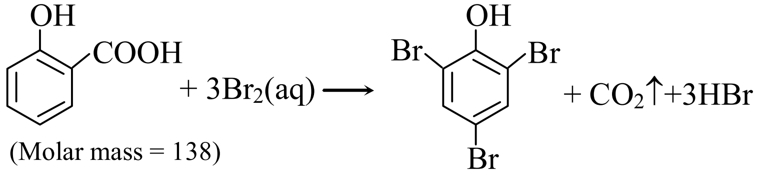
$$H_2A.xH_2O \xrightarrow{\Delta} H_2A + xH_2O$$

Mole of H_2O formed $=$ x $\times$ mole of hydrated dibasic acid

$$\frac{(1.01 - 0.72)}{18} = x \times \frac{1.01}{143.14}$$

$x = 2.28$

degree of hydration is ≈ 2.

4.


(Molar mass = 138)

Moles of salicylic acid $= \frac{276}{138} = 2$

Moles of Br_2 required = 3 × 2 = 6.

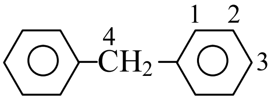
5. Let basicity of acid be n.

Equivalent of acid = Equivalent of KOH

$$\frac{1 \times n}{146} = \frac{0.768}{56}$$

$$n = \frac{0.768 \times 146}{56} = 2$$

6. Three in the ring and fourth on the CH_2 group as shown



Mathematics PART – III

SECTION – A

1. Let x bullet are fired at A
E_1 – the target is at A, E_2 – the target at B
E – the target is hit
$P(E_1) = \frac{27}{28}$, $P(E_2) = \frac{1}{28}$, $P\left(\frac{E}{E_1}\right)$ = probability that target is hit when x bullet are fired at A
$= 1 - \left(\frac{1}{3}\right)^x$
$P\left(\frac{E}{E_2}\right) = 1 - \left(\frac{1}{3}\right)^{47-x}$
$P(E) = P(E_1)\cdot P\left(\frac{A}{E_1}\right) + P(E_2)\cdot P\left(\frac{A}{E_2}\right) = \frac{27}{28}\cdot\left(1-\left(\frac{1}{3}\right)^x\right) + \frac{1}{28}\left(1-\left(\frac{1}{3}\right)^{47-x}\right)$
$= 1 - \frac{27}{28}\cdot 3^{-x} - \frac{1}{28}\cdot 3^{x-47}$
$\therefore \frac{d}{dx}(P(E)) = \frac{27}{28}3^{-x}\ln 3 - \frac{1}{28}3^{x-47}\ln 3$
$\frac{d^2}{dx^2}(P(E)) = -\frac{27}{28}(\ln 3)^2 3^{-x} - \frac{1}{28}(\ln 3)^2 3^{x-47} < 0$
For maximum P(E) $\Rightarrow \frac{d}{dx}(P(E)) = 0 \Rightarrow 27 \cdot 3^{-x} = 3^{x-47} \Rightarrow x = 25$

2. For $0 \le r \le n$, the polynomial ${}^xC_r = \frac{x(x-1).....(x-r+1)}{r!}$ is of degree r
$\Rightarrow Q(x) = {}^xC_0 + {}^xC_1 + ... + {}^xC_n$ is polynomial of degree n
$Q(k) = 2^k$ for k = 0, 1, 2, ….., n
$\Rightarrow P(x) = Q(x)\ \forall\ x$ then
$\Rightarrow P(n+1) = Q(n+1) = 2^{n+1} - 1$

3. If a polynomial $a_0x^n + a_1x^{n-1} + ... + a_n$ is such a polynomial,
We can assume $a_0 = 1$, let $r_1, r_2, ..., r_n$ are its roots
$\Rightarrow r_1^2 + r_2^2 + ... + r_n^2 = a_1^2 - 2a_2$, $r_1^2 r_2^2 ..... r_n^2 = a_n^2$
$\Rightarrow$ AM $\ge$ GM $\Rightarrow \frac{a_1^2 - 2a_2}{n} \ge (a_n)^{2/n}$
$\because a_1, a_2 = \pm 1$, we must have $a_2 = -1$, and $n \le 3$
$\Rightarrow$ Polynomials are
$\pm(x-1), \pm(x+1), \pm(x^2+x-1), \pm(x^2-x-1), \pm(x^3+x^2-x-1), \pm(x^3-x^2-x+1)$

4. For n = 1, 2, 3, 4, 5, 6, $\frac{f(n+1)}{f(n)} = 3, \frac{8}{3}, \frac{22}{8}, \frac{65}{22}, \frac{209}{65}, \frac{732}{209}$
The minimum of these is $\frac{8}{3}$, for n > 6, $\frac{f(n+1)}{f(n)} > 3 > \frac{8}{3}$

5. Let 1 + sin x = y

$I=\int \frac{1}{y}\sqrt{\frac{3-y}{1+y}}dy$ again let $\frac{3-y}{1+y}=t^2$

$I = 8\int \frac{t^2}{\left(t^2-3\right)\left(t^2+1\right)}dt=\sqrt{3}\ln\frac{t-\sqrt{3}}{t+\sqrt{3}}+2\tan^{-1}t+c$

6. Let $a=\left(\sqrt{108}+10\right)^{1/3}$, $b=\left(\sqrt{108}-10\right)^{1/3}$

$a – b = x$, $a^3 – b^3 = 20$, $ab = 2$

$x^3 = (a – b)^3 = a^3 – b^3 – 3ab(a – b) = 20 – 6x$

$\Rightarrow x^3 + 6x – 20 = 0$

$\Rightarrow$ x = 2 is only one real solution

7. $c_1c_2 = 1000 – 320 = 680$

$c_1p = \sqrt{\left(c_1c_2\right)^2-\left(320\right)^2}=600$, $PQ = r_1 – c_1p = 1000 – 600 = 400$

8. $S = \alpha + \beta = –1$

$P = \alpha\beta = z^3\left(\frac{z^{2n}-1}{z^2-1}\right)^2=\frac{z}{\left(z+1\right)^2}=\frac{1}{z+\frac{1}{z}+2}=\frac{1}{4}\sec^2\left(\frac{\pi}{2n+1}\right)$

9. $f_6\left(f_m\left(x\right)\right)=f_4\left(x\right)=\frac{1}{1-x}$

$f_6\left(f_m\left(x\right)\right)=\frac{f_m\left(x\right)-1}{f_m\left(x\right)}=\frac{1}{1-x}$

Let $f_m(x) = k \Rightarrow f_m\left(x\right)=\frac{x-1}{x}=f_6\left(x\right) \Rightarrow m = 6$

Assign, $f_n(f_4(x)) = f_3(x) = \frac{1}{x}$

$\Rightarrow f_n\left(\frac{1}{1-x}\right)=\frac{1}{x} \Rightarrow$ let $\frac{1}{1-x} = t \Rightarrow x = \frac{t-1}{t}$ hence, n = 5

10. Given equation can be written as $\int_0^x xf\left(t\right)dt-\int_0^x t\,f\left(t\right)dt=\int_0^x f\left(t\right)dt+\sin x+\cos x-x-1$ differentiating

$x\,f\left(x\right)+\int_0^x f\left(t\right)dt-x\,f\left(x\right)=f\left(x\right)+\cos x-\sin x-1$ again differentiating

$f(x) = f'(x) – \sin x – \cos x$ which is linear differential equation of 1st order whose solution gives

$ye^{–x} = –e^{–x}\cos x + c$

$x = 0, y = 0 \Rightarrow c = 1$

$f(x) = e^x – \cos x$

11. Let f(1) = t

Put x = 1 in $f\left(x\right)f\left(f\left(x\right)+\frac{1}{x}\right)=1$ ….. (1)

We get

$tf(t + 1) = 1 \Rightarrow t \neq 0$ and $f(t + 1) = \frac{1}{t}$

Put x = t + 1 in equation (1), we get $f\left(\frac{1}{t}+\frac{1}{t+1}\right)=t=f\left(1\right)$

$\Rightarrow \frac{1}{t}+\frac{1}{t+1}=1 \Rightarrow t=\frac{1\pm\sqrt{5}}{2}$

But for $t=\frac{1+\sqrt{5}}{2}$, t > 1 – f(1) < f(1 + t) = $\frac{1}{t}<1$ a contradiction

12. Let M (line be $\bar{r}=\mu(ai+bj+ck)$ then acute angle between L and M is

$$\cos\alpha=\frac{(a+c)\cos\theta+\sqrt{2}b\sin\theta+(a-c)\sqrt{3}}{2\sqrt{2}\sqrt{a^2+b^2+c^2}}$$

$\alpha=\frac{\pi}{6}$, a + c = 0, b = 0, c = –a

$\bar{M}=\mu(i-k)$

13. M meets the given plane in $P_1, \left(2\sqrt{3}, 0, -2\sqrt{3}\right)$ line L meets the plane in

$P\left(2\cos\theta+2\sqrt{3}, 2\sqrt{2}\sin\theta, 2\cos\theta-2\sqrt{3}\right)$

Thus $(PP_1)^2 = 8$

$\Rightarrow$ P describes a circle of radius $2\sqrt{2}$

14. In radians we can say

$$\sin x=\sin\frac{\pi x}{180}=\sin\left(\pi-\frac{\pi x}{180}\right) \text{ or } \sin\left(2\pi+\frac{\pi x}{180}\right)$$

$$x=\frac{180\pi}{180+\pi} \text{ or } x=\frac{360\pi}{180-\pi}$$

On comparing with $\frac{p\pi}{q+\pi}$ and $\frac{m\pi}{n-\pi}$

We have, m = 360, n = 180, p = 180, q = 180

$\therefore$ m + n + p + q = 900

15. $$\lim_{x\to\infty}\frac{\left(A-C^2\right)x^2+Bx}{x\left[\sqrt{A+\frac{B}{x}}+C\right]}=2$$ for existence of limit $A = C^2$

Hence, $\frac{BC}{A}=\frac{B}{C}$ (using $A = C^2$)

$\therefore\ L=\frac{B}{\sqrt{A}+C}=2$

If $C=-\sqrt{A}$ then limit does not exist hence $C=\sqrt{A}$

$\therefore\ \frac{B}{C}=4$

16. $g'(x) = -2f'(10-2x) \Rightarrow g'(L = 2) = -2f'(6) = 0$

SECTION – B

1. (A) $\left(\sqrt{x^2-5x+6}+\sqrt{x^2-5x+4}\right)^{x/2}=A$

$\left(\sqrt{x^2-5x+6}-\sqrt{x^2-5x+4}\right)^{x/2}=B$

Now, A + B = $2^{\frac{x+4}{4}} = 2\cdot 2^{\frac{x}{4}}$, AB = $2^{\frac{x}{2}}$

$\Rightarrow$ A – B = 0 $\Rightarrow$ A = B

Since power of A and B are same

$\Rightarrow$ x = 0, $\sqrt{x^2-5x+4}=0 \Rightarrow x = 0, 4, 1$

(B) Equation can be written as $\left(\frac{x^2+x+2}{x^2+x+1}\right)^2-(a-3)\left(\frac{x^2+x+2}{x^2+x+1}\right)+(a-4)=0$

$t=\frac{x^2+x+2}{x^2+x+1}$ as $t\in\left(1,\frac{7}{3}\right]$

Equation reduces to $t^2 - (a-3)t + (a-4) = 0$ at least one root of equation lies in $\left(1,\frac{7}{3}\right]$

t = a – 4, 1

$\Rightarrow$ One root lies in $\left(1,\frac{7}{3}\right] \Rightarrow 1<a-4\le\frac{7}{3} \Rightarrow a\in\left(5,\frac{19}{3}\right]$

(C) $(1+x)^2\left(1+\frac{x}{2}\right)^2.....\left(1+\frac{x}{2^3}\right)^2.....=P_0+P_1x+.....+P_rx^r.....$ ..... (1)

Replace x by $\frac{x}{2}$

$$\left(1+\frac{x}{2}\right)^2\left(1+\frac{x}{2^2}\right)^2.....\left(1+\frac{x}{2^n}\right)^2=P_0+P_1\left(\frac{x}{2}\right)+.....+P_rx^n+.....$$

Equating the coefficient of x^r

$\Rightarrow P_r=\frac{2^2\left(P_{r-1}+P_{r-2}\right)}{2^r-1}$ putting x_0 in (1), we get $P_0 = 1$

$\Rightarrow P_1=2+1+\frac{1}{2}+\frac{1}{2^2}+.....=4$

(D) x + y + z = n, x ≥ 1, y ≥ 1, z ≥ 1 number of solution is $P_n={}^{n-1}C_{n-3}$

$$\Delta=\begin{vmatrix}{}^{n-1}C_{n-3} & {}^{n}C_{n-2} & {}^{n+1}C_{n-1}\\ {}^{n}C_{n-2} & {}^{n+1}C_{n-1} & {}^{n+2}C_{n}\\ {}^{n+1}C_{n-1} & {}^{n+2}C_{n} & {}^{n+3}C_{n+1}\end{vmatrix}=\frac{1}{8}\begin{vmatrix}(n-1)(n-2) & n(n-1) & n(n+1)\\ n(n-1) & n(n+1) & (n+1)(n+2)\\ n(n+1) & (n+2)(n+1) & (n+3)(n+2)\end{vmatrix}$$

On applying $C_3 \to C_3 - C_2$, $C_1 \to C_1 - C_2$ and $C_1 \to C_1 + C_3$ = $\frac{1}{2}\begin{vmatrix}1 & n(n-1) & n\\ 0 & 2n & 1\\ 0 & 2(n+1) & 1\end{vmatrix}=-1$

$\therefore$ |Δ| = 1

2. (A) z = (2 cos 30° · cos 18° + i·2 sin 30° · cos 18°)^6

= $2^6 \cos^6 18°$ (cos 180° + i sin 180°) = $-2^6\cos^6 18°$

(B) $f'(x) + f^2(x) = -1 \Rightarrow \frac{dy}{dx}+y^2=-1 \Rightarrow y = \tan(c-x)$

$\therefore$ We must have c – a = $(2n+1)\frac{\pi}{2}$ and c – b = $(2n-1)\frac{\pi}{2}$ for some n ∈ I

$\therefore \min\left(\frac{b-a}{\pi}\right)=1$

(C) Let $\cos^{-1}x = \theta$ then $\tan\left(\frac{\pi}{4}+\frac{\theta}{2}\right)+\tan\left(\frac{\pi}{4}-\frac{\theta}{2}\right)=1$

$\Rightarrow$ 2 sec θ = 1

$\Rightarrow \sec = \frac{1}{2}$ no solution

(D) $\theta = \frac{\pi}{7} \Rightarrow 7\theta = \pi \Rightarrow 4\theta = \pi - 3\theta \Rightarrow \tan 4\theta = -\tan 3\theta$

$\Rightarrow t^3 - 21t^2 + 35t - 7 = 0,\ t = \tan^2\theta$

Above equation has the roots $\tan^2\frac{\pi}{7},\ \tan^2\frac{2\pi}{7},\ \tan^2\frac{3\pi}{7}$ and sum of roots = 21

Replacing t = $\frac{1}{r}$

$7r^3 - 35r + 21r - 1 = 0$ has three roots

$\cot^2\frac{\pi}{7}, \cot^2\frac{2\pi}{7}, \cot^2\frac{3\pi}{7}$ and sum of roots = 5

SECTION – C

1. Let $g(x) = \int \frac{f(x)dx}{x^2(x+1)^3}$ ..... (1)

$= \int\left(\frac{A}{x} + \frac{B}{x^2} + \frac{C}{x+1} + \frac{D}{(x+1)^2} + \frac{E}{(x+1)^3}\right)dx$

$= A\ln x - \frac{B}{x} + C\ln(1+x) - \frac{D}{1+x} - \frac{E}{2(x+1)^2}$

Since g(x) is a rational function hence A = C = 0

$g(x) = \int\left(\frac{B}{x^2} + \frac{D}{(x+1)^2} + \frac{E}{(x+1)^3}\right)dx$ ..... (2)

Comparing (1) and (2), we get $f(x) = (B + D)x^3 + (3B + D + E)x^2 + 3Bx + B$

$\Rightarrow$ f(x) is quadratic

$\Rightarrow B + D = 0,\ f(0) = 1$ gives $B = 1 \Rightarrow D = -1$

$\therefore f(x) = (2 + E)x^2 + 3x + 1$

$f'(0) = 3$

2. $\begin{vmatrix} 1 & 0 & -1 \\ 0 & 1 & -1 \\ [x] & [y] & [z]+1 \end{vmatrix}$ $R_1 \to R_1 - R_3, R_2 \to R_2 - R_3$ on solving [x] + [y] + [z] + 1, taking maximum value, we get 4

3. $\alpha + \beta + \gamma = \tan^{-1}\left(\frac{36}{77}\right) + \tan^{-1}\left(\frac{3}{4}\right) + \tan^{-1}\left(\frac{8}{15}\right) = \frac{\pi}{2}$

$\Rightarrow \sum\cot\alpha = \prod\cot\alpha$ and hence $A = \frac{\sum\cot\alpha}{\prod\cot\alpha} = 1$

and $\sum\tan\alpha\tan\beta = 1 \Rightarrow A + B = 2$

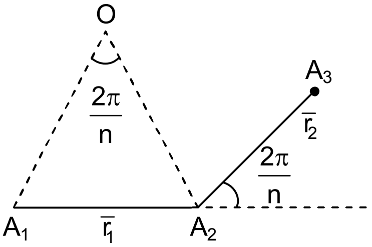
4. A = f(–1) = 19

B = g(–9) = 2 ln 3

C = $\int_{-2}^{1} \frac{3(x^2 + 2x - 2)}{x^3 + 3x^2 - 6x + 11}dx = \ln 9 - \ln 27 = -\ln 3$

$$D = \frac{d}{dt}\int_1^{t^2} g(x)dx = 6g(9) = 12 \ln 3$$

$A(B + C) - D = 7 \ln 3 \Rightarrow k = 7$

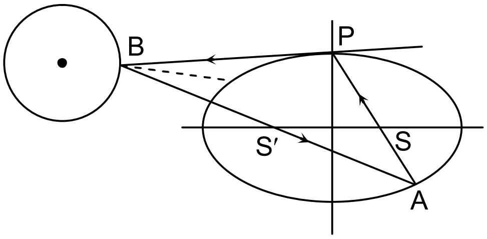


5. $|r_1 \times r_2| = |r_1||r_2|\sin\frac{2\pi}{n}$

$|r_1 \cdot r_2| = |r_1||r_2|\cos\frac{2\pi}{n}$

The given equality reduces to $\tan\frac{2\pi}{n} = 1$

$\Rightarrow \frac{2\pi}{n} = m\pi + \frac{\pi}{4} \Rightarrow n = \frac{8}{1+4m}\,(m \in z)$, least n = 8



6. Using reflection property of ellipse equation of reflected ray SP is
4x + 3y = 12 ….. (1)
Solving equation (1) with ellipse, we get
$A \equiv \left(\frac{75}{17}, -\frac{32}{17}\right)$
Equation of reflected ray BS′ is
16x + 63 + 48 = 0 ….. (2)
Equation of incident ray PB is
y = 4 ….. (3)
Equation of bisector of (2) and (3) with negative slope gives normal to circle at 3 which is
4x + 32y – 53 = 0
Point B is $\left(-\frac{75}{4}, 4\right)$, using parametric equation of line ordinate of centre is 5

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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ALL INDIA TEST SERIES

FULL TEST – IV

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 03 and 10 to 12)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (04 to 09 and 13 to 30) contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10 \text{ m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3 \text{ kg/m}^3$
Atmospheric pressure	$P_a = 10^5 \text{ N/m}^2$
Gas constant	$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
		=	$0.0821 \text{ Lit atm K}^{-1} \text{ mol}^{-1}$
		=	$1.987 \approx 2 \text{ Cal K}^{-1} \text{ mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

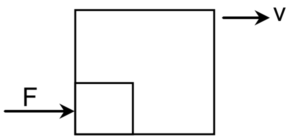
1. The unit vector perpendicular to $\hat{i}-2\hat{j}+\hat{k}$ and $3\hat{i}+\hat{j}-2\hat{k}$ is

(A) $\frac{5\hat{i}+3\hat{j}+7\hat{k}}{\sqrt{83}}$
(B) $\frac{3\hat{i}+5\hat{j}+7\hat{k}}{\sqrt{83}}$
(C) $\frac{5\hat{i}+3\hat{j}-7\hat{k}}{\sqrt{83}}$
(D) $\frac{3\hat{i}-5\hat{j}+7\hat{k}}{\sqrt{83}}$

2. A ball is projected at an angle 60^o with the horizontal with speed 30 m/s. After certain time it makes an angle 45^o with the horizontal. The speed of ball at that moment is

(A) 30 m/s
(B) $15\sqrt{2}$ m/s
(C) $\frac{15}{\sqrt{2}}$ m/s
(D) $30\sqrt{2}$ m/s

3. A block of mass 1 kg rests inside a cubical vessel, as shown in the figure which is moving with a velocity of $v=\sqrt{29}\,t$ m/s, where t is in sec. All the surfaces are smooth. The block is at rest w.r.t. the cube, the total force exerted by the cube on the block



(A) $\sqrt{129}$ N
(B) $\sqrt{130}$ N
(C) 10 N
(D) $\sqrt{29}$ N

4. A ball falls vertically on to a floor, with momentum p, and then bounces repeatedly, the coefficient of restitution is e. The total momentum imparted by the ball to the floor is

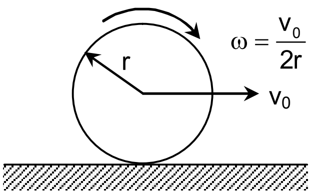
(A) $p(1+e)$
(B) $\frac{p}{(1-e)}$
(C) $p\frac{(1+e)}{(1-e)}$
(D) $p\left(1-\frac{1}{e}\right)$

Space for Rough work

5. A particle of mass 4m which is at rest explodes into three fragments. Two of the fragments each of mass m are found to move with a speed v each in mutually perpendicular directions along x and y axis. Calculate momentum of the fragment 2m after explosion, the energy released in the process of explosion.

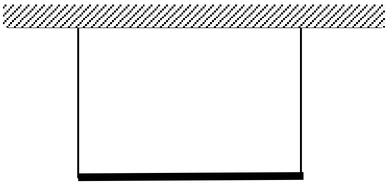
(A) $2m\left(\frac{v}{2}\hat{i}-\frac{v}{2}\hat{j}\right), \frac{3}{2}mv^2$
(B) $-2m\left(\frac{v}{2}\hat{i}+\frac{v}{2}\hat{j}\right), \frac{3}{2}mv^2$
(C) $-2m\left(\frac{v}{2}\hat{i}+\frac{v}{2}\hat{j}\right), \frac{3}{4}mv^2$
(D) $-2m\left(\frac{v}{2}\hat{i}-\frac{v}{2}\hat{j}\right), \frac{3}{4}mv^2$

6. A solid sphere of mass M and radius r slips on a rough horizontal surface. At some instant, it has translational velocity v_0 and angular velocity $\omega\left(=\frac{v_0}{2r}\right)$ about its center as shown in figure. The translational velocity after the sphere starts pure rolling motion is



(A) $\frac{v_0}{7}$
(B) $\frac{2v_0}{7}$
(C) $\frac{5v_0}{7}$
(D) $\frac{6v_0}{7}$

7. A uniform rod of length l and mass M is suspended from two inextensible string as shown in figure. Tension in left string at the instant, when right string snaps, is



(A) $\frac{mg}{2}$
(B) mg
(C) $\frac{mg}{4}$
(D) $\frac{mg}{8}$

Space for Rough work

8. In a certain region at space gravitational field is given by $I = -\frac{k}{r}$. Taking the reference point to be at r = r_0 with V = V_0, the potential $V_{(r)}$ is given by

(A) $V_{(r)} = K \ln\frac{r}{r_0} + V_0$ (B) $V_{(r)} = K \ln\frac{r}{r_0} - V_0$

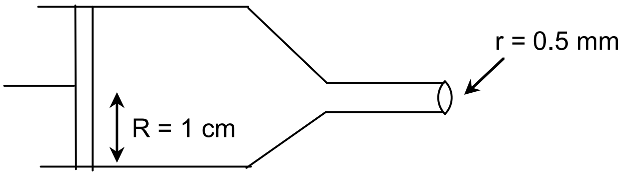
(C) $V_{(r)} = K \ln\frac{r_0}{r} + V_0$ (D) $V_{(r)} = K \ln\frac{r_0}{r} - V_0$

9. A planet of mass m moves along an ellipse around the sun so that its maximum and minimum distances from the sun are equal to R and r respectively. The angular momentum of this planet relative to the centre of the sun (mass M) is

(A) $2\sqrt{\frac{GMmrR}{r+R}}$ (B) $2R\sqrt{\frac{GMmR}{r+R}}$

(C) $2m\sqrt{\frac{GMrR}{r+R}}$ (D) $m\sqrt{\frac{2GMrR}{r+R}}$

10. A piston of a syringe pushes a liquid with a speed of 1 cm/sec. The radii of the syringe tube and the needle are R = 1 cm and r = 0.5 mm respectively. The velocity of the liquid coming out of the needle is



(A) 2 cm/sec. (B) 20 cm/sec.
(C) 10 cm/sec. (D) 400 cm/sec.

11. Two cylinders A and B fitted with pistons contain equal amounts of an ideal diatomic gas at 300 K. The piston A is free to move while that of B is held fixed. The same amount of heat is given to the gas in each cylinder. If the rise in temperature of the gas in A is 30 K, then the rise in temperature of the gas in B is
(A) 30 K (B) 18 K
(C) 50 K (D) 42 K

12. In a room where temperature is 30°C, a body cools from 61°C to 59°C in 4 minutes. The time taken by the body to cool from 51°C to 49°C will be
(A) 4 min (B) 6 min
(C) 5 min (D) 8 min

Space for Rough work

13. The motion of a particle varies with time according to the relation

$$y = a(\sin\omega t + \cos\omega t)$$

(A) the motion is oscillatory but not SHM
(B) the motion is SHM with amplitude a
(C) the motion is SHM with amplitude $a\sqrt{2}$
(D) the motion is SHM with amplitude 2a

14. If x, v and a denote the displacement, the velocity and the acceleration of a particle executing SHM of time period T, then which of the following does not change with time?

(A) $3a^2T^2 + 4\pi^2v^2$
(B) $\frac{aT}{x}$
(C) $aT + 2\pi v$
(D) $\frac{aT}{v}$

15. A sound wave of wavelength λ travels towards horizontally with a velocity v. It strikes and reflects from a vertical plane surface, traveling at a speed v_0 towards the left. The number of positive crests striking in a time interval of 3 sec. on the wall is

(A) $\frac{3(v+v_0)}{\lambda}$
(B) $\frac{3(v-v_0)}{\lambda}$
(C) $\frac{(v+v_0)}{3\lambda}$
(D) $\frac{(v-v_0)}{3\lambda}$

16. A section of an infinite rod of charge having linear charge density λ which is constant for all points on the line. Electric field E at a distance r from the line is

(A) $\frac{\lambda}{\pi\varepsilon_0 r}$
(B) $\frac{\lambda}{2\pi\varepsilon_0 r}$
(C) $\frac{\lambda}{4\pi\varepsilon_0 r}$
(D) $\frac{2\lambda}{\pi\varepsilon_0 r}$

17. Potential in the x-y plane is given as $V = 5(x^2 + xy)$ volts. The electric field at the point (1,-2) will be

(A) $3\hat{j}$ V/m
(B) $-5\hat{j}$ V/m
(C) $5\hat{j}$ V/m
(D) $-3\hat{j}$ V/m

Space for Rough work

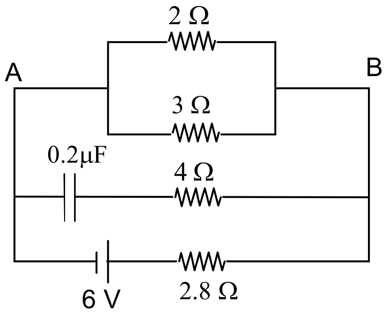
18. What is the mechanical work done in pulling the slab out of the capacitor after disconnecting it from the battery?

(A) $\frac{1}{2}E^2C(\varepsilon_r - 1)$ (B) E^2C

(C) $E^2C(\varepsilon_r - 1)$ (D) none of these

19. Calculate the steady-state current in the 2Ω resistor shown. The internal resistance of the battery is negligible and the capacitance of the capacitor is 0.2 μF.

(A) 0.6 A
(B) 0.7 A
(C) 0.8 A
(D) 0.9 A



20. In the secondary circuit of a potentiometer a cell of internal resistance 1.5 Ω gives a balancing length of 52 cm. To get a balancing length of 40 cm, how much resistance is to be connected across the cell?

(A) 5 Ω. (B) 6 Ω.

(C) 7 Ω. (D) 4 Ω.

21. The mass of the three wire of copper are in the ratio 1 : 3 : 5, and their lengths are in ratio 5 : 3 : 1. The ratio of their electrical resistance is

(A) 1 : 3 : 5 (B) 5 : 3 : 1

(C) 1 : 15 : 125 (D) 125 : 15 : 1

22. A point P lies on the axis of a flat coil carrying a current. The magnetic moment of the coil is μ. The distance of P from the coil is d, which is large compared to the radius of the coil. The magnetic field at P has magnitude

(A) $\frac{\mu_0}{2\pi}\left(\frac{\mu}{d^3}\right)$ (B) $\frac{\mu_0}{4\pi}\left(\frac{\mu}{d^3}\right)$

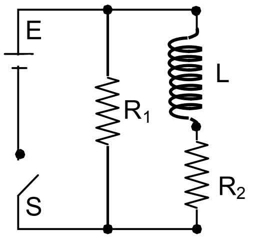
(C) $\frac{\mu_0}{6\pi}\left(\frac{\mu}{d^2}\right)$ (D) $\frac{\mu_0}{8\pi}\left(\frac{\mu}{d^2}\right)$

Space for Rough work

23. A winding wire which is used to frame a solenoid can bear a maximum 10 A current. If length of solenoid is 80 cm, then length of its winding wire is (B = 0.2 T, r = 3 × 10^{-2}m)

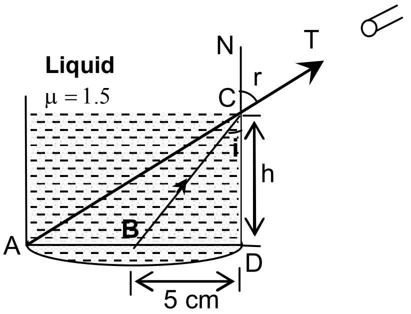
(A) 1.2×10^{2} m
(B) 4.8×10^{2} m
(C) 2.4×10^{3} m
(D) 6×10^{3} m

24. An inductor of inductance L = 400 mH and resistors of resistance R_1 = 2 Ω and R_2 = 2 Ω are connected to a battery of emf 12 V as shown in the figure. The internal resistance of the battery is negligible. The switch S is closed at t = 0. The potential drop across L as a function of time is



(A) $6e^{-5t}$ V
(B) $\frac{12}{t}e^{-3t}$ V
(C) $6\left(1-e^{-t/0.2}\right)$ V
(D) $12e^{-5t}$ V

25. A person looking through a telescope T just sees the point A on the rim at the bottom of a cylindrical vessel when the vessel is empty. When the vessel is completely filled with a liquid $(\mu = 1.5)$, he observes a mark at the centre, B, of the bottom without moving telescope or the vessel. What is the height of the vessel if the diameter of its cross-section is 10 cm?



(A) 5.5 cm
(B) 6.6 cm
(C) 7.5 cm
(D) 8.45 cm

26. The focal length of a plano convex lens when curved surface is silvered and the object is in front of plane surface is

(A) $\frac{R}{2\mu}$
(B) $\frac{2R}{\mu}$
(C) $-\frac{R}{2\mu}$
(D) $-\frac{2R}{\mu}$

Space for Rough work

27. At what distance from the objective should an object be placed to focus it properly so that the final image is formed at the least distance of clear vision?
(A) 1.1 cm (B) 2.2 cm
(C) 3.3 cm (D) 4.4 cm

28. The wavelength of 10 keV electron beam is 0.1227 A^o. when these waves are diffracted from a metal foil having d = 0.55 A^o the first maxima would occur at an angle θ where $\sin\theta$ is
(A) 0.1116 (B) 0.2218
(C) 0.4464 (D) 0.8928

29. The wavelength of the photoelectric threshold for silver is λ_0. The energy of the electron ejected from the surface of silver by an incident light of wavelength $\lambda(\lambda < \lambda_0)$ will be
(A) $hc(\lambda_0 - \lambda)$ (B) $\frac{hc}{\lambda_0 - \lambda}$
(C) $\frac{h}{c}\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$ (D) $hc\left(\frac{\lambda_0 - \lambda}{\lambda_0\lambda}\right)$

30. If resistivity of pure silicon is $3000\Omega m$ and the electron and hole mobilities are $0.12\ m^2V^{-1}s^{-1}$ and $0.045\ m^2V^{-1}s^{-1}$ respectively. The resistivity of a specimen of the material when 10^{19} atoms of phosphorous are added per m^3 is
$\left(\text{Given } e = 1.6\times10^{-19}c,\ \rho=3000\Omega m,\ \mu_e = 0.12\ m^2V^{-1}s^{-1},\ \mu_h = 0.045\ m^2V^{-1}s^{-1}\right)$
(A) 2.21 Ωm (B) 3.21 Ωm
(C) 4.21 Ωm (D) 5.21 Ωm

Space for Rough work

Chemistry PART – II

SECTION – A

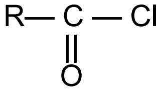
Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

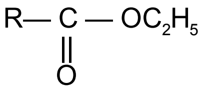
1. In the given reaction,

$$(A) + \underset{(excess)}{RMgX} \xrightarrow{H^+/H_2O} 3^\circ \text{ Alcohol}$$

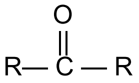
(A) cannot be

(A) 

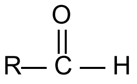
$R—\underset{\underset{O}{||}}{C}—Cl$

(B) 

$R—\underset{\underset{O}{||}}{C}—OC_2H_5$

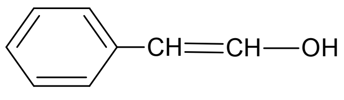
(C) 

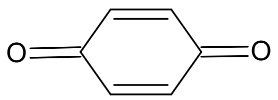
$R—\overset{\overset{O}{||}}{C}—R$

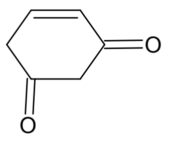
(D) 

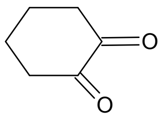
$R—\overset{\overset{O}{||}}{C}—H$

2. Tautomerism is not exhibited by

(A) 

(B) 

(C) 

(D) 

3. Match the following:

	Column-I		**Column-II**
(A)	Boric acid	(P)	sp^2 hybridised boron
(B)	Diborane	(Q)	Ring having 6π e^- delocalised
(C)	Borazine	(R)	Reacts with water
(D)	Boron Nitride	(S)	Bond having partial double bond character
		(T)	sp^3 hybridised boron

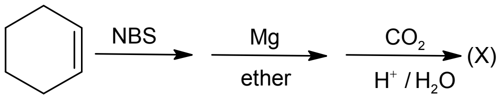
(A)	A→PRS	B→RT	C→PQRS	D→PQRS
(B)	A→PR	B→PR	C→PQR	D→PQR
(C)	A→RS	B→RT	C→PQRS	D→PQRS
(D)	A→RST	B→PRS	C→PQR	D→PRS

Space for Rough work

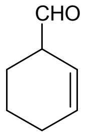
4. $I_2(s)\ |\ I^-$ (0.1M) half cell is connected to a H^+ (aq) | H_2 (1 bar) | Pt half cell and e.m.f. is found to be 0.7714V. If $E^{o}_{I_2/I^-} = 0.535V$, Then the pH of H^+/H_2 half cell is :

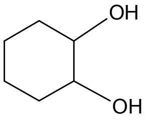
(A) 1 (B) 3
(C) 5 (D) 7

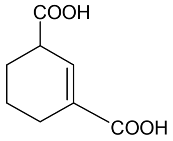
5. In the given reaction

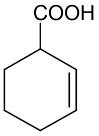


(X) will be :

(A)


(B)


(C)


(D)


6. Equivalent mass of As_2S_3 and $KMnO_4$ during the formation of H_3AsO_4, H_2SO_4 and Mn^{2+} ions are respectively :

(A) M/2, M/5 (B) M/6, M/5
(C) M/28, M/5 (D) M /14, M/3

7. What will be the maximum value of Σ (n + ℓ + m) for all unpaired electrons of chlorine in its second excited state ?

(A) 25 (B) 20
(C) 28 (D) 27

8. A gaseous compound A reacts by three independent first order processes with rate constant
2×10^{-3}, 3×10^{-3} and 1.93×10^{-3} sec^{-1} for products B, C and D respectively. If initial pressure of pure A was 8 atm taken in the closed container. Then the partial pressure of B (in atm) after 100 sec from starting:

(A) 0.288 (B) 0.577
(C) 1.154 (D) 2.15

Space for Rough work

9. Which of the following statements for crystals having frenkel defect is not correct?
(A) Frenkel defects are observed where the difference in sizes of cations and anions is large
(B) The density of crystals having frenkel defect is lesser than that of a pure perfect crystal
(C) In an ionic crystal having frenkel defect may also contain schottky defect
(D) Usually alkali halides do not have frenkel defect

10. Which of the following is true in respect of chemical adsorption?
(A) $\Delta H < 0, \Delta S > 0, \Delta G > 0$
(B) $\Delta H > 0, \Delta S > 0, \Delta G < 0$
(C) $\Delta H < 0, \Delta S < 0, \Delta G < 0$
(D) $\Delta H > 0, \Delta S < 0, \Delta G > 0$

11. 0.1 M NaCl and 0.05 M $BaCl_2$ solutions are separated by a semi-permeable membrane in a container. For this system, choose the correct answer :
(A) There is no movement of any solution across the membrane
(B) Water flows from $BaCl_2$ solution toward NaCl solution
(C) Water flows from NaCl solution towards $BaCl_2$ solution
(D) Osmotic pressure of 0.1M NaCl is lower than the osmotic pressure of $BaCl_2$

12. Glucose reacts with acetic anhydride to form :
(A) hexaacetate
(B) tetraacetate
(C) monoacetate
(D) pentaacetate

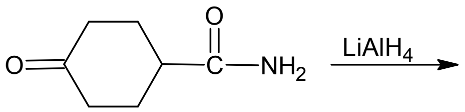
13. Among the following the coloured compound is :
(A) CuCl
(B) $K_3[Cu(CN)_4]$
(C) CuF_2
(D) $[Cu(CH_3CN)_4]\ BF_4$

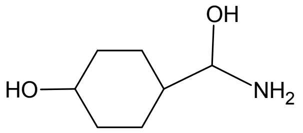
14. Identify the incorrect statement :
(A) Liquid oxygen is an important constituent of rocket fuel
(B) When SO_2 gas is passed through cupric chloride solution, then the solution becomes colourless and a white precipitate is formed
(C) Radon is formed from the decay of Radium
(D) Hydrofluoric acid is preserved in glass bottles

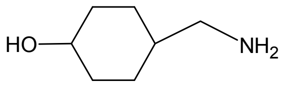
15. Which of the following ores is best concentrated by froth floatation process:
(A) Malachite
(B) Cassiterite
(C) Galena
(D) Magnetite

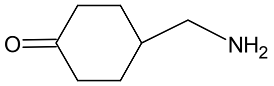
Space for Rough work

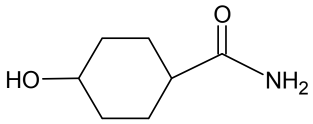
16. The IUPAC name of $[Ni(NH_3)_4][NiCl_4]$ is:
(A) Tetrachloronickel (II) tetra ammine nickel (II)
(B) Tetraammine nickel (II) tetra chloronickelate (II)
(C) Tetraamminenickel (II) tetrachloronickel (II)
(D) Tetrachloronickel (II) tetra amminenickelate (O)

17. 

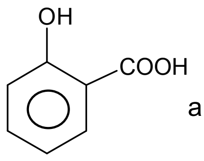
(A) 

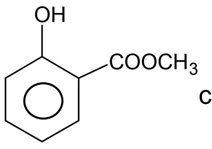
(B) 

(C) 

(D) 

18. Which of the following is not correctly matched ?
(A) Phenol + $CHCl_3$ + NaOH $\xrightarrow{heat}$ Salicylaldehyde
(B) Phenol + Phthalic anhydride $\xrightarrow[H_2SO_4]{heat}$ Phenetole
(C) $C_6H_5-\overset{+}{N}\equiv NCl^- \xrightarrow[H_2O]{H_3PO_2} C_6H_6$
(D) $C_6H_6 + CH_3COCl \xrightarrow[AlCl_3]{anhyd} C_6H_5COCH_3 + HCl$

19. 

and 

can be differentiated by :

(A) NaOH	(B) Na metal
(C) $NaHCO_3$	(D) $FeCl_3$

20. The monomers of Buna-S polymers are :

(A) Vinyl chloride and Vinylidene	(B) Styrene and butadiene
(C) Acrylonitrile and butadiene	(D) Isobutylene and isoprene

Space for Rough work

21. In the reaction, $4A + 2B + 3C \rightarrow A_4B_2C_3$, what will be the number of moles of product formed, starting from 1 mol of A, 0.6 mol of B and 0.72 mol of C?
(A) 0.25
(B) 0.3
(C) 0.24
(D) 2.32

22. The incorrect statement among the following is
(A) In $T\ell I_3$ the oxidation state of $T\ell$ is +3.
(B) B_2O_3 reacts with P_2O_5 to form BPO_4.
(C) $B(OH)_3$ solution is acidic in nature.
(D) Borax solution can be used as a buffer.

23. Sodium oxide Na_2O is a crystalline solid. It does not have.
(A) Antiflourite structure
(B) Na^+ ions are present at body diagonals
(C) Na^+ ions are present at tetrahedral voids
(D) O^{2-} ions are present at octahedral voids

24. The oxidation number of carbon in $H — C \equiv N$ and $H – N \overset{\rightarrow}{=} C$ are respectively :
(A) +2, +3
(B) +2, +4
(C) +2, +2
(D) +3, +3

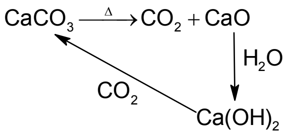
25. 0.56 litre each of three samples of H_2O_2 labelled as 10 vol, 15 vol and 20 vol are mixed. The resultant normality of H_2O_2 solution is :
(A) 1.68
(B) 2.68
(C) 4.5
(D) 8.0

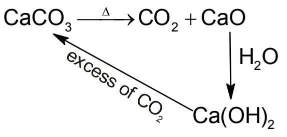
26. Calculate the vapour pressure of water at 300K if its heat of vaporisation is 540 cal/gm
(A) 3.162 mm
(B) 0.3192 mm
(C) 31.92 mm
(D) 319.2 mm

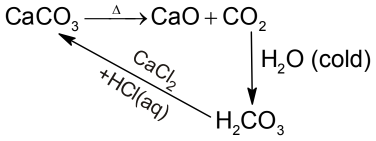
27. Select the incorrect statement :
(A) O_3 and O^{2-} both are diamagnetic
(B) Out of O_2, O_2^+, O_3 , least O – O bond length is in O_2^+
(C) Out of O_2, O_2^+, O_2^-, only O_2 is paramagnetic
(D) Out of O_2, O_2^+, O_2^-, maximum spin magnetic moment have O_2

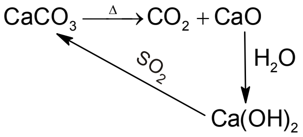
Space for Rough work

28. Which systematic diagram represents the correct sequence of reaction?

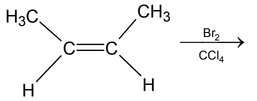
(A)

$CaCO_3 \xrightarrow{\Delta} CO_2 + CaO$
H_2O
CO_2
$Ca(OH)_2$

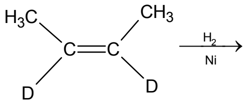
(B)

$CaCO_3 \xrightarrow{\Delta} CO_2 + CaO$
H_2O
excess of CO_2
$Ca(OH)_2$

(C)

$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$
H_2O (cold)
$CaCl_2$
+HCl(aq)
H_2CO_3

(D)

$CaCO_3 \xrightarrow{\Delta} CO_2 + CaO$
H_2O
SO_2
$Ca(OH)_2$

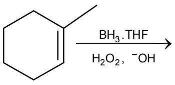
29. How many of the following addition reactions are syn addition reaction:

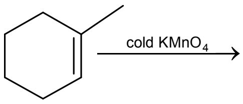
(a)

H3C
CH3
H
H
Br2
CCl4

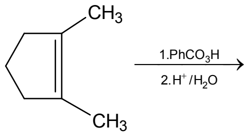
(b)

H3C
CH3
D
D
H2
Ni

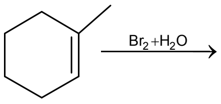
(c) $CH_3-C\equiv C-CH_3 \xrightarrow[BaSO_4]{H_2,Pd}$

(d) $CH_3-C\equiv C-CH_3 \xrightarrow{Na,\ liq.NH_3}$

(e)

BH3.THF
H2O2, ⁻OH

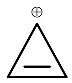
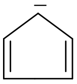
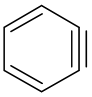
(f)


(g)

CH3
CH3
1.PhCO3H
2.H⁺/H2O

(h)


(A) 3
(B) 6
(C) 5
(D) 4

30.

	Column-I		Column-II
(A)		(P)	Hyperconjugation
(B)		(Q)	All carbon atom are sp^2 hybridized
(C)		(R)	Aromatic
(D)	$(CH_3)_3-C^{\oplus}$	(S)	Diamagnetic

(A) A→PQR B→PQR C→PQR D→PQR
(B) A→QRS B→QRS C→RS D→PQR
(C) A→QRS B→QRS C→QRS D→P,S
(D) A→QRS B→QS C→QR D→P,S

Space for Rough work

Mathematics PART – III

SECTION – A
Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. A and B throw a pair of dice alternately till one of them wins. If A wins by throwing 7 while B wins by throwing 5 as a sum respectively, then the probability that one of the dice shows 3 on the last throw if A starts the game is

(A) $\frac{11}{36}$ (B) $\frac{11}{28}$
(C) $\frac{7}{22}$ (D) none of these

2. The sum of rational term(s) in $\left(\sqrt{3}+\sqrt[3]{2}+\sqrt[4]{5}\right)^8$ is equal to

(A) 3150 (B) 336
(C) 3486 (D) 3592

3. $e^{|\sin x|}+e^{-|\sin x|}+4a=0$ will have exactly four different solutions in [0, 2π] if

(A) $a \in \left[-\frac{e}{4},-\frac{1}{4}\right]$ (B) $a \in R$
(C) $a \in \left[\frac{-1-e^2}{4e},\infty\right)$ (D) none of these

4. If $2^{\frac{2\pi}{\sin^{-1}x}}-2(a+2)2^{\frac{\pi}{\sin^{-1}x}}+8a<0$ for at least one real x, then

(A) $a \in \left[-\infty,\frac{1}{8}\right)\cup(2,\infty)$ (B) $a \in R-\{2\}$
(C) a < 2 (D) $\frac{1}{8} \le a < 2$

Space for rough work

5. Let f(x) = $\sin x\left(\cos x+\sqrt{\cos^2 x+\cos^2\theta}\right)$, where ‘$\theta$’ is a given constant, then maximum value of f(x) is

(A) $\sqrt{1+\cos^2\theta}$ (B) $|\cos\theta|$

(C) $|\sin\theta|$ (D) $\sqrt{1+\sin^2\theta}$

6. The number of integral values of K for which the equation 7 cos x + 5 sin x = 2k + 1 has a solution

(A) 5 (B) 6

(C) 7 (D) 8

7. If $\sin^{-1} x + \sin^{-1} y + \sin^{-1} z = \pi$, then $x^4 + y^4 + z^4 + 4x^2y^2z^2 = k(x^2y^2 + y^2z^2 + z^2x^2)$, where k is equal to

(A) 1 (B) 2

(C) 4 (D) none of these

8. If the variable takes values 0, 1, 2, 3, ….., n with frequencies proportional to
$^nC_0$, $^nC_1$, $^nC_2$, ….., ^nC_n respectively, the variance is

(A) $\frac{n}{3}$ (B) $\frac{2n}{5}$

(C) $\frac{n}{4}$ (D) none of these

9. Let a relation R in the set N of natural numbers be defined as $(x, y) \Leftrightarrow x^2 - 8xy + 7y^2 = 0$ $\forall$ x,
y $\in$ N. The relation R is

(A) reflexive (B) symmetric

(C) transitive (D) none of these

10. Suppose $f(x) = x^3 + ax^2 + 2bx + c$, where a, b, c are chosen respectively by throwing a dice three times. Then the probability that f(x) is a decreasing function for some x is

(A) $\frac{1}{3}$ (B) $\frac{13}{36}$

(C) $\frac{2}{9}$ (D) none of these

Space for rough work

11. A line intersects the ellipse $\frac{x^2}{4a^2}+\frac{y^2}{a^2}=1$ at A and B and the parabola $y^2 = 4a(x + 2a)$ at C and D. The line segment AB subtends a right angle at the centre of the ellipse. Then, the locus of the point of intersection of tangents to the parabola of C and D is

(A) $y^2 - a^2 = \frac{5}{4}(x-4a)^2$
(B) $y^2 - 2a^2 = 10(x - 4a)^2$
(C) $y^2 + a^2 = \frac{5}{2}(x-4a)^2$
(D) $y^2 + 4a^2 = 5(x + 4a)^2$

12. If $f(x)=\frac{9^x}{9^x+9}$, then $f\left(\frac{1}{2015}\right)+f\left(\frac{2}{2015}\right)+f\left(\frac{3}{2015}\right)+.....+f\left(\frac{4029}{2015}\right)$ is equal to

(A) 1007
(B) $\frac{4029}{2}$
(C) 2014
(D) 2015

13. If $p_i=\frac{|x-a_i|}{x-a_i}$, (where i = 1, 2, 3, ….., p) and $a_1 > a_2 > a_3$ ….. a_p, then $\lim\limits_{x\to a_q}\left(p_1p_2 \,.....\, p_p\right)$, $1 \le q \le p$ is equal to

(A) $(-1)^{q+1}$
(B) $(-1)^{q-1}$
(C) $(-1)^q$
(D) does not exist

14. $\int\sqrt{x-3}\left(\sin^{-1}(\ln x)+\cos^{-1}(\ln x)\right)dx$ is equal to

(A) $\frac{\pi}{3}(x-3)^{3/2}+C$
(B) 0
(C) DNE
(D) none of these

15. If $x\in\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$, then the value of $\tan^{-1}\left(\frac{\tan x}{4}\right)+\tan^{-1}\left(\frac{3\sin 2x}{5+3\cos 2x}\right)$ is

(A) 2x
(B) 3x
(C) $\frac{x}{2}$
(D) x

Space for rough work

16. P is any point on the circum-circle of ΔABC other than the vertices. H is the orthocentre of ΔABC, M is the mid-point of PH and D is the mid-point of BC. Then,
(A) DM is parallel to AP
(B) DM is perpendicular to AP
(C) AP is opposite side of DM
(D) none of these

17. Let $f(x) = (x - 3)^3 x^n$, $n \in N$. Then, f(x) has a
(A) minimum at x = 0, if n is even
(B) maximum at x = 0, if n is even
(C) maximum at $x = 3\ \forall\ n \in N$
(D) none of these

18. If a function y = f(x) is defined as $y = \frac{1}{t^2 - t - 6}$ and $t = \frac{1}{x-2}$, $t \in R$. Then, f(x) is discontinuous at
(A) $2, \frac{2}{3}, \frac{7}{3}$
(B) $2, \frac{3}{2}, \frac{7}{3}$
(C) $2, \frac{3}{2}, \frac{5}{3}$
(D) none of these

19. $\int \left(1 + x - x^{-1}\right) e^{x + x^{-1}} dx$ is equal to
(A) $x \cdot e^{x+x^{-1}}$
(B) $-x \cdot e^{x+x^{-1}} + c$
(C) $(x+1)e^{x+x^{-1}} + c$
(D) $(x-1)e^{x+x^{-1}} + c$

20. The co-ordinates of four vertices of a quadrilateral are (–2, 4), (–1, 2), (1, 2) and (2, 4) taken in order. The equation of the line passing through the vertex (–1, 2) and dividing the quadrilateral in two equal areas is
(A) x + 1 = 0
(B) x + y = 1
(C) x – y + 3 = 0
(D) none of these

21. $\sum_{r=0}^{n} (-1)^r\ {}^nC_r \frac{1 + r\log_e 10}{\left(1 + \log_e 10^n\right)^r}$ equals
(A) 1
(B) –1
(C) n
(D) none of these

22. If a, b, c are distinct positive numbers such that b + c – a, c + a – b and a + b – c are positive, then the expression (b + c – a)(c + a – b)(a + b – c) – abc is
(A) positive
(B) negative
(C) non-positive
(D) non-negative

Space for rough work

23. PSQ is a focal chord of a parabola whose focus is S and vertex is A. PA, QA are produced to meet the directrix in R and T. Then angel ∠RST is equal to
(A) 90º (B) 60º
(C) 45º (D) 30º

24. If z_1 and z_2 are lying on $|z - 3| \le 4$ and $|z - 1| + |z + 1| = 3$ respectively. Then, $A = |z_1 - z_2|$ satisfies
(A) $0 \le A < \frac{15}{2}$ (B) $0 < A \le \frac{15}{2}$
(C) $0 \le A \le \frac{17}{2}$ (D) $0 < A < \frac{17}{2}$

25. If four points be taken on a rectangular hyperbola such that the chord joining any two is perpendicular to the chord joining the other two, and if α, β, γ, δ be the inclinations to either asymptote of the straight line joining these points to the centre, then $\tan\alpha \tan\beta \tan\gamma \tan\delta$ is equal to
(A) 1 (B) 2
(C) –2 (D) –1

26. The sum of squares of the perpendiculars drawn from the points (0, 1) and (0, –1) to any tangent to a curve is 2. Then, the equation of the curve is
(A) $2y = c(x + 2)$ (B) $y = c(x \pm 1)$
(C) $y = c(x + 2)$ (D) $y = c(x \pm 2)$

27. The area of the region bounded by the curves $y = x^2$, $y = |2 - x^2|$ and $y = 2$ which lies to the right of the line x = 1, is
(A) $\left(\frac{12-20\sqrt{3}}{2}\right)$ sq. units (B) $\left(\frac{20-\sqrt{2}}{3}\right)$ sq. units
(C) $\left(\frac{20-12\sqrt{2}}{3}\right)$ sq. units (D) $\left(\frac{12-20\sqrt{2}}{3}\right)$ sq. units

Space for rough work

28. If A, B, C are angles of a triangle, then $\begin{vmatrix} e^{2iA} & e^{-iC} & e^{-iB} \\ e^{-iC} & e^{2iB} & e^{-iA} \\ e^{-iB} & e^{-iA} & e^{2iC} \end{vmatrix}$ is equal to

(A) 4 (B) 0
(C) –4 (D) –1

29. Two persons who are 500 m apart, observe the direction and the angle of elevation of a balloon at the same instant. One finds the elevation to be $\frac{\pi}{3}$ and direction being South-West, while the other finds the elevation to be $\frac{\pi}{4}$ and direction being west. Height of the balloon is

(A) $500\sqrt{\frac{3}{4-\sqrt{6}}}$ m (B) $250\sqrt{\frac{3}{4+\sqrt{6}}}$ m
(C) $250\sqrt{\frac{3}{4-\sqrt{6}}}$ m (D) $500\sqrt{\frac{3}{4+\sqrt{6}}}$ m

30. Let p and q be two statements, then $\sim(\sim p \wedge q) \wedge (p \vee q)$ is logically equivalent to

(A) q (B) $p \wedge q$
(C) p (D) $p \vee \sim q$

Space for rough work

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Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	D	B
2.	B	B	D
3.	A	A	D
4.	C	B	A
5.	B	D	A
6.	D	C	D
7.	C	A	B
8.	A	C	C
9.	D	B	A
10.	D	C	A
11.	D	B	D
12.	B	D	B
13.	C	C	D
14.	B	D	C
15.	A	C	D
16.	B	B	B
17.	B	D	B
18.	A	B	B
19.	D	C	A
20.	A	B	C
21.	D	C	D
22.	A	A	B
23.	C	D	A
24.	D	C	C
25.	D	B	A
26.	C	C	B
27.	A	C	C
28.	B	A	C
29.	D	D	A
30.	D	C	C

Physics PART – I

SECTION – A

1. $\vec{A}\times\vec{B}$ is a vector perpendicular to both $\vec{A}$ and $\vec{B}$

Now, $\vec{A}\times\vec{B}=\left(\hat{i}-2\hat{j}+\hat{k}\right)\times\left(3\hat{i}+\hat{j}-2\hat{k}\right)$

$3\hat{i}+5\hat{j}+7\hat{k}$

Now, $\hat{n}=\dfrac{\vec{A}\times\vec{B}}{\left|\vec{A}\times\vec{B}\right|}$

$=\dfrac{3\hat{i}+5\hat{j}+7\hat{k}}{\sqrt{3^2+5^2+7^2}}$

$=\dfrac{3\hat{i}+5\hat{j}+7\hat{k}}{\sqrt{83}}$

2. Horizontal velocity remains same

$30^o\cos 60^o = v\cos 45^o$

$\Rightarrow v = 15\sqrt{2}$ m/s

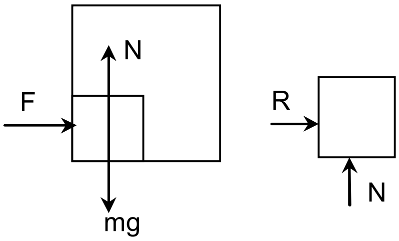
3. $v=\sqrt{29}\ t$

$a=\dfrac{dv}{dt}=\sqrt{29}$

$R = ma = \sqrt{29}$ N

$F_{net}=\sqrt{N^2+R^2}$

$=\sqrt{(10)^2+(29)}=\sqrt{129}$ N



4. Δp after 1st impact $= ep-(-p)$

$= p(1+e)$

Similarly Δp after 2nd impact = $ep(1+e)$

So, $p_{net}=p(1+e)\left[1+e+e^2+........\right]$

$=\dfrac{p(1+e)}{(1-e)}$

5. Force of explosion is internal and system is initially at rest

Let the velocities of the first two fragments are $v\hat{i}$ & $v\hat{j}$ and that of the fragment 2m be $v_1\hat{i}+v_2\hat{j}+v_3\hat{k}$,

So, $\vec{p}_1+\vec{p}_2+\vec{p}_3=0$

$\Rightarrow mv\hat{i}+mv\hat{j}+2m\left(v_1\hat{i}+v_2\hat{j}+v_3\hat{k}\right)=0$

$\Rightarrow v_1=-\dfrac{v}{2},\ v_2=-\dfrac{v}{2}$ and $v_3=0$

$$\vec{p}_3 = -2m\left(\frac{v}{2}\hat{i} + \frac{v}{2}\hat{j}\right)$$

So, $K_f = \frac{1}{2}mv^2 + \frac{1}{2}mv^2 + \frac{1}{2}(2m)\left(v_1^2 + v_2^2 + v_3^2\right)$

$= \frac{3}{2}mv^2$

Energy released in explosion

$\Delta E = K_f - K_i$

$= \frac{3}{2}mv^2 - 0 = \frac{3}{2}mv^2$

6. Angular momentum about point of contact will be conserved

$L_i = L_f$

$$\left(\frac{2}{5}Mr^2\right)\frac{v_0}{2r} + Mrv_0 = \left(\frac{2}{5}Mr^2\right)\frac{v}{r} + Mrv$$

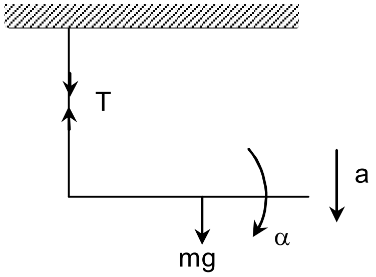
$\Rightarrow v = \frac{6}{7}v_0$

7. $mg - T = ma$ and

$\frac{mgl}{2} = I\alpha = \frac{ml^2}{3} \times \frac{a}{\left(\frac{l}{2}\right)}$

$\Rightarrow a = \frac{3g}{4}$

So, $T = \frac{mg}{4}$



8. $I = -\frac{K}{r} = -\frac{dV}{dr}$

$\Rightarrow \int_{V_0}^{V} dV = K\int_{r_0}^{r} \frac{dr}{r}$

$\Rightarrow V = K\ln\frac{r}{r_0} + V_0$

9. By conservation of angular momentum,

$mv_1R = mv_2r$

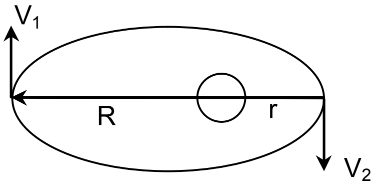
$\Rightarrow v_1R = v_2r$

By conservation of energy,

$-\frac{GMm}{R} + \frac{1}{2}mV_1^2 = -\frac{GMm}{r} + \frac{1}{2}mV_2^2$

$\Rightarrow V_1 = \sqrt{\frac{2GMr}{R(R+r)}}$

Now, $mv_1R = m\sqrt{\frac{2GMrR}{r+R}}$



10. By equation of continuity

$$Av = av'$$

$$\Rightarrow v' = \left(\frac{A}{a}\right)v = \left(\frac{\pi R^2}{\pi r^2}\right)\times v$$

$$\Rightarrow v' = 400 \text{ cm/sec.}$$

11. For cylinder A ;

$$\Delta Q = nC_p\Delta T_1$$

For cylinder B, $\Delta Q = nC_v\Delta T_2$

Hence, $nC_p\Delta T_1 = nC_v\Delta T_2$

$$(C_v + R)30 = C_v\Delta T_2$$

For diatomic gas,

$$C_v = \frac{5}{2}R$$

$$\Rightarrow \Delta T_2 = 42 \text{ K}$$

12. $\frac{dT}{dt} \propto \Delta\theta$ $\frac{d\theta}{dt} \propto (\theta - \theta_0)$

$\Rightarrow dT = K\Delta\theta dt$

In first case,

$dT = 61 - 59 = 2^\circ C$; $\Delta\theta = 30^\circ C$, dt = 4 min.

For second case, dT = 2°C; $\Delta\theta = 20^\circ C$

$$K = \frac{dT}{\Delta\theta dt} = \frac{2}{30\times 4} = \frac{1}{60}$$

$$dt = \frac{dT}{K\Delta\theta} = \frac{2}{\frac{1}{60}\times 20} = 6 \text{ min.}$$

13. $y = a(\sin\omega t + \cos\omega t)$

$$= a\sqrt{2}\left(\sin\omega t\frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}}\cos\omega t\right)$$

$$= a\sqrt{2}\sin\left(\omega t + \frac{\pi}{4}\right)$$

The motion is SHM with amplitude $a\sqrt{2}$

14. $\frac{aT}{x} = \frac{\omega^2 xT}{x} = \frac{4\pi^2}{T^2}\times T$

$$= \frac{4\pi^2}{T} = \text{Constt.}$$

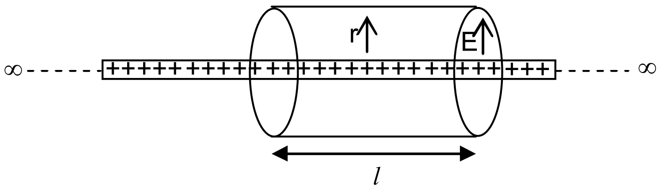
15. Relative velocity is $(v + v_0)$

Opponent frequency is $\frac{(v + v_0)}{\lambda}$

The no. of positive crests striking per sec. is same as frequency.

In 3 sec. $3\left(\frac{v + v_0}{\lambda}\right)$

16. From symmetry, $\vec{E}$ due to a uniform linear charged can only be radially directed. As a Gaussian surface, we can choose a circular cylinder of radius r and length. L, closed at each end by plane caps normal to the axis.



$\varepsilon_o \oint \vec{E}.\, d\vec{s} = q_{in}$

$\varepsilon_o \left[\int \vec{E}.d\vec{s} + \int \vec{E}.d\vec{s} \right] = q_{in}$

Cylindrical Plane Surface

$\varepsilon_o E(2\pi r l) + E.ds\ \cos 90^o = \lambda l$

$E = \dfrac{\lambda l}{\varepsilon_o 2\pi r l} = \dfrac{\lambda}{2\pi\varepsilon_0 r}$

The direction of $\vec{E}$ is radially outwards for a line of positive charge.

17. $E_x = -\dfrac{\partial V}{\partial x} = -(10x + 5y) = -10 + 10 = 0$

$E_y = -\dfrac{\partial V}{\partial y} = -5x = -5$

$\therefore \vec{E} = -5\hat{j}$ V/m.

18. Work done = change in potential energy

$= U_2 - U_1$

$U_1 = (1/2)E^2C$

$U_2 = \dfrac{1}{2}\dfrac{(EC)^2}{C'} = \dfrac{1}{2}\dfrac{E^2C^2}{C}\varepsilon_r = (1/2)E^2C\varepsilon_r$

$\therefore$ Work done = $(1/2)E^2C(\varepsilon_r - 1)$.

19. The resistance of the parallel combination of 2Ω and 3Ω resistors is given by $\dfrac{1}{R} = \dfrac{1}{2} + \dfrac{1}{3} = \dfrac{5}{6} \Rightarrow R = 1.2\Omega$

This resistance is in series with 2.8Ω giving a total effective resistance $= 1.2 + 2.8\Omega = 4\Omega$.

In the steady state, charge on the capacitor C has stablised and hence no current passes through 4Ω resistor which is in series with the capacitor.

Thus the current through the circuit = 6/4 = 1.5 A,

$V_{AB} = 1.5 \times 1.2 = 1.8V$, I through 2Ω resistor = 1.8/2 = 0.9 A.

20. $r = 1.5\Omega,\ l_1 = 52\text{cm},\ l_2 = 40\text{cm}$

$\dfrac{r}{R} = \dfrac{l_1 - l_2}{l_2}$

resistance R = $\dfrac{r l_2}{(l_1 - l_2)}$

$$= \frac{1.5 \times 40}{(52 - 40)}$$

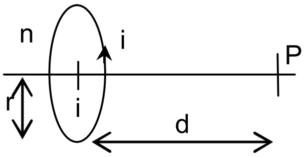
$$= \frac{1.5 \times 40}{12} = 5\Omega$$

21. $$R = \frac{\rho l}{A} = \frac{\rho l^2}{Al} = \frac{\rho l^2}{V} = \frac{\rho l^2}{m/d} = \frac{\rho d l^2}{m}$$

or $R \propto \frac{l^2}{m}$

$$R_1 : R_2 : R_3 = \frac{l_1^2}{m_1} : \frac{l_2^2}{m_2} : \frac{l_3^2}{m_3} = \frac{25}{1} : \frac{9}{3} : \frac{1}{5} = 125 : 15 : 1$$

22. The magnetic field at P due to the flat coil of n turns, radius r, carrying current i is



$$B = \frac{\mu_0}{2} . \frac{nir^2}{\left(d^2 + r^2\right)^{3/2}} \cong \frac{\mu_0}{2} . \frac{nir^2}{d^3} (d >> r)$$

$$= \frac{\mu_0}{2\pi} . \frac{n\left(\pi r^2\right)i}{d^3} = \frac{\mu_0}{2\pi} . \frac{\mu}{d^3} .$$

23. $B = \frac{\mu_0 Ni}{l}$ where N = Total number of turns, l = length of the solenoid

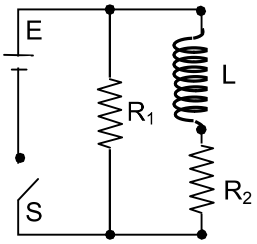
$$\Rightarrow 0.2 = \frac{4\pi \times 10^{-7} \times N \times 10}{0.8}$$

$$\Rightarrow N = \frac{4 \times 10^4}{\pi}$$

Since N turns are made from the winding wire so length of the wire $(L) = 2\pi r \times N [2\pi r = \text{ length of each turns}]$

$$\Rightarrow L = 2\pi \times 3 \times 10^{-2} \times \frac{4 \times 10^4}{\pi} = 2.4 \times 10^3 \text{m}$$

24. $$I_1 = \frac{E}{R_1} = \frac{12}{2} = 6A$$



$$E = L\frac{dI_2}{dt} + R_2 \times I_2$$

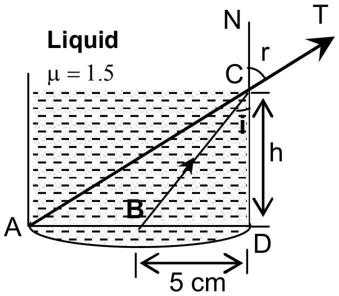
$$I_2 - I_0\left(1 - e^{-t/t_0}\right) \Rightarrow I_0 = \frac{E}{R_2} = \frac{12}{2} = 6A$$

$$t_0 = \frac{L}{R} = \frac{400 \times 10^{-3}}{2} 0.2$$

$$I_2 = 6\left(1 - e^{-t/0.2}\right)$$

Potential drop across L = E - $R_2 I_2 = 12 - 2 \times 6\left(1 - e^{-bt}\right) = 12\ e^{-5t}$

25. It is mentioned in the problem that on filling the vessel with the liquid, point B is observed for the same setting; this means that the image of point B, is observed at A, because of refraction of the ray at C. For refraction at C,



$$\frac{\sin r}{\sin i} = {}_a\mu_l = 1.5$$

Now,

$$\sin r = \frac{AD}{AC} = \frac{10}{\sqrt{10^2 + h^2}}$$

Where h is the height of vessel.

$$\sin i = \frac{BD}{BC} = \frac{5}{\sqrt{5^2 + h^2}}$$

$$\therefore \frac{10}{\sqrt{100 + h^2}} \cdot \frac{\sqrt{25 + h^2}}{5} = 1.5$$

$$\therefore \frac{25 + h^2}{100 + h^2} = \frac{9}{16}$$

$$\therefore 400 + 16h^2 = 900 + 9\,h^2$$

$$\therefore 7h^2 = 500$$

$$\therefore h = 8.45 \text{ cm}$$

26. In this case

$$\frac{1}{f_L} = (\mu - 1)\left(\frac{1}{\infty} - \frac{1}{-R}\right) = \frac{(\mu - 1)}{R}$$

and $F_M = \frac{(-R)}{2}$

so $P_L = \frac{1}{f_L} = \frac{(\mu - 1)}{R}$

and $P_M = -\frac{1}{f_M} = \frac{2}{R}$

and hence power of system

$$P = P_L + P_M + P_L = 2P_L + P_M$$

$$\Rightarrow P = \frac{2(\mu - 1)}{R} + \frac{2}{R} = \frac{2\mu}{R}$$

$$\therefore F = -\frac{1}{P} = -\frac{R}{2\mu}$$

i.e. the lens will be equivalent to a converging mirror of focal length $(R/2\mu)$

27. For eyepiece,

$v_E = -25$ cm, $f_E = +5$ cm

$\Rightarrow u_E = -4.17 \text{ cm} \simeq -4.2 \text{ cm}$

$L = v_0 + |u_E| = 12.2$ cm here $v_0 = 8$ cm

$f_0 = +1 \text{ cm} \Rightarrow u_0 = -1.1 \text{ cm}$

28. Wavelength associated with a particle is given by

$$\lambda = \frac{h}{\sqrt{2mE}}$$

$$\lambda = \frac{h}{\sqrt{2meV}} = \sqrt{\frac{150}{V}} A^o \quad \left(\text{for electron M = } 9.11 \times 10^{-31} \text{kg}\right)$$

$$\lambda = \sqrt{\frac{150}{10 \times 10^3}} = 0.122 \text{ A}^o$$

For minima

$$d\sin\theta = n\,\lambda$$

For first minima n = 1

$$0.55 \sin\theta = 0.122$$

$$\sin\theta = \frac{0.122}{0.55} = 0.2218$$

29. $$hv = hv_0 + E$$

$$E = hv - hv_0$$

But $v = \frac{c}{\lambda}$

$$E = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right) = hc\left(\frac{\lambda_0 - \lambda}{\lambda_0 \lambda}\right)$$

30. The resistivity of pure Si is given by

$$\rho = \frac{1}{\sigma} = \frac{1}{e(n_e\mu_e + n_h\mu_h)} = \frac{1}{en_1(\mu_e + \mu_h)}$$

$$\text{or } n_i = \frac{1}{e\rho(\mu_e + \mu_h)} = \frac{1}{1.6 \times 10^{-19} \times 3000(0.12 + 0.045)}$$

$$= 1.26 \times 10^{16} m^{-3}$$

When 10^{19} atoms of phosphorous (donor atoms of valence five) are added per m^3, the semiconductor becomes n – type semiconductor.

$$\therefore n_e - n_h \approx n_e = N_d = 10^{19} \quad \because n_h = 1.26 \times 10^{16}$$

$$\text{Resitivity } \rho = \frac{1}{n_e\mu_e e} = \frac{1}{1.6 \times 10^{-19} \times 10^{19} \times 0.12} = 5.21\,\Omega\text{m}$$

Chemistry

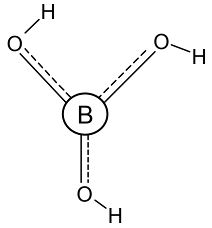
PART – II

SECTION – A

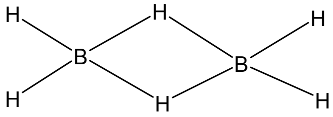
1. Aldehyde form 2° alcohol with RMgX.

2. It does not have α-hydrogen atom connected to sp^3 carbon.

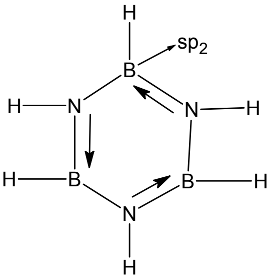
3. H_3BO_3 →



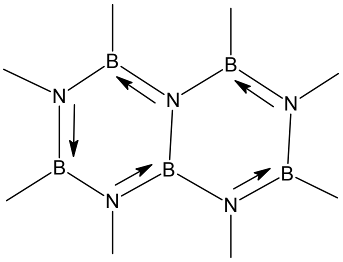
B_2H_6 →



Borazine →


H
sp2
B
H
N
N
H
H
B
B
H
N
H

BN→


B
B
N
N
N
B
B
B
N
N

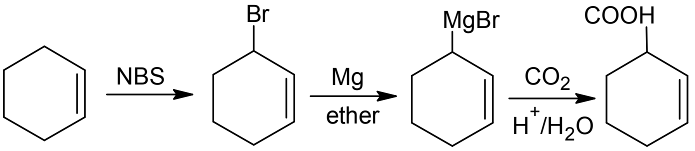
4. The cell reaction is

$H_2(g) + I_2(g) \rightleftharpoons 2H^+(aq) + 2I^-_{(aq)}$

$$0.7714 = 0.535 - \frac{0.0591}{2}\log\frac{\left[H^+\right]^2\left[I^-\right]^2}{p_{H_2}}$$

pH = 3

5.


NBS
Br
Mg
ether
MgBr
CO2
H+/H2O
COOH

6. $As_2S_3 \rightarrow H_3AsO_4 + H_2SO_4$

$(As^{3+})_2 \rightarrow 2As^{5+} + 4e^-$

$(S^{2-})_3 \rightarrow 3S^{6+} + 24e^-$

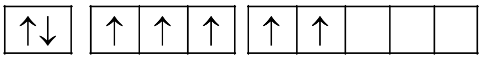
$As_2S_3 \rightarrow 2As^{5+} + 3S^{6+} + 28e^-$

E = M/28

$Mn^{7+} + 5e^- \rightarrow Mn^{2+}$ ∴ E = M/5

7. $Cl_{17} \rightarrow 3s^2\ 3p^5$
Cl_{17} (1^{st} excited state) $3s^2\ 3p^4\ 3d^1$
Cl_{17} (2^{nd} excited state)

$3s^2$ $3p^3$ $3d^2$



n –	3	3	3	3	3
ℓ –	1	1	1	2	2
m_ℓ –	-1	$+1$	0	$+2$	$+1$

Σ (n + ℓ + m) = 25

8. The overall rate constant, $K = K_1 + K_2 + K_3 = 6.93 \times 10^{-3}$

$$t_{1/2} = \frac{0.693}{6.93 \times 10^{-3}} = 100\,\text{sec}$$

After half life, total pressure, P = 4 atm

Now, $\frac{P_B}{P} = \frac{K_1}{K}$

$$P_B = \frac{2 \times 10^{-3} \times 4}{6.93 \times 10^{-3}} \Rightarrow 1.154\ \text{atm}$$

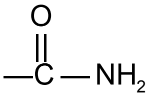
11. In osmois water flows from hypotonic solution towards hypertonic solution through SPM

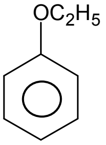
12. In glucose there are 5 – OH groups

13. In CuF_2, Copper is in +2 oxidation state

14. Hydro fluoric acid is not preserved in glass bottles because it reacts with silicon dioxide of glass

15. Galena is sulphide ore

17. $LiAlH_4$ does not reduce 
$-\overset{\overset{\large O}{\|}}{C}-NH_2$

18. Phenetole is 

21.

	4A	+	2B	+	3C →	$A_4B_2C_3$
Given	1 mole		0.6 mol		0.72 mol	?

In the above, C is the limiting reagent hence it will give least product on complete consumption.
$\because$ 3 mol C give 1 mol product
$\therefore$ 0.72 mol C give 0.24 mol product

22. (A) Oxidation state of $T\ell$ in $T\ell I_3$ is +1

(B) $B_2O_3 + P_2O_5 \longrightarrow 2BPO_4$

(C) $B(OH)_3 + H_2O \rightleftharpoons [B(OH)_4]^- + H^+$

(D) $Na_2B_4O_7 + 7H_2O \longrightarrow 2\underset{\text{Salt}}{Na[B(OH)_4]} + \underset{\text{Weak acid}}{2HBO_3}$

23. Na_2O has antiflourite structure in which O^{2-} ions are present at ccp and Na^+ ions are occupy all the tetrahedral voids which are located at body diagonals.

24. In both oxidation state of carbon is +2.

25. Vol. Strength of $H_2O_2 = 5.6 \times N$

$$\therefore \text{ Normality of 10 vol} = \frac{10}{5.6}N$$

$$\text{Normality of 20 vol} = \frac{20}{5.6}N$$

$$\text{Normality of 15 vol} = \frac{15}{5.6}N$$

$$\therefore \text{ Total equivalent of } H_2O_2 = \frac{0.56\times10}{5.6}+\frac{0.56\times15}{5.6}+\frac{0.56\times20}{5.6} = 1 + 1.5 + 2.0 = 4.5$$

$$\therefore N_{H_2O_2} = \frac{4.5}{3\times0.56} = 2.68$$

26. By using the formula

$$2.303\log\frac{P_2}{P_1} = \frac{\Delta H}{R}\left[\frac{T_2-T_1}{T_1T_2}\right]$$

For water boiling point = 373 K and thus P = 760 mm
Also $\Delta H = 540 \times 18$ cal/mol

$$2.303\log\frac{760}{P_1} = \frac{540\times18}{2}\times\left[\frac{373-300}{373\times300}\right]$$

$P_1 = 31.92$ mm

27. O_2, O_2^+ and O_2^- all are paramagnetic in nature.

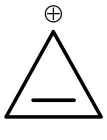
28. $$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$$

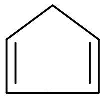
$$CaO + H_2O \longrightarrow Ca(OH)_2$$

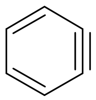
$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3$$

$$2CaCO_3 + 2H_2O + \underset{\text{excess}}{2CO_2} \longrightarrow 2Ca(HCO_3)_2$$

29. Option (b), (c), (e) & (f) shows syn addition.

30.  → sp^2 carbon, aromatic and diamagnetic

 → sp^2 carbon, aromatic and diamagnetic

 → sp^2 carbon, aromatic and diamagnetic

Mathematics PART – III

SECTION – A

1. $P(\text{A wins}) = \frac{9}{14}$; $P(\text{B wins}) = \frac{5}{14}$

$$P(\text{required}) = \frac{9}{14}\times\frac{2}{6}+\frac{5}{14}\times\frac{2}{4}=\frac{11}{28}$$

2. General term in the expansion of $\left(\sqrt{3}+\sqrt[3]{2}+\sqrt[4]{5}\right)^8$ is $\frac{8!}{x!\,y!\,z!}\left(\sqrt{3}\right)^x\left(\sqrt[3]{2}\right)^y\left(\sqrt[4]{5}\right)^z$

(Where x + y + z = 8)

For rational term(s), we have the following cases:

(i) x = 2, y = 6, z = 0

(ii) x = 4, y = 0, z = 4

(iii) x = 0, y = 0, z = 8

(iv) x = 8, y = 0, z = 0

3. Let, $t = e^{|\sin x|} \in [1, e]$

$\Rightarrow t^2 + 4at + 1 = 0$

This should have two distinct roots in [1, e]

4. $$\left(2^{\frac{\pi}{\sin^{-1}x}}-4\right)\left(2^{\frac{\pi}{\sin^{-1}x}}-2a\right)<0$$

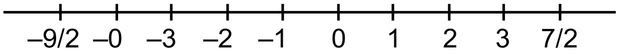
$$2^{\frac{\pi}{\sin^{-1}x}} \in \left(0, \frac{1}{4}\right] \cup [4, \infty)$$

5. Here, $f^2(x)\cot^2 x - 2f(x)\cot x + f^2(x) - \cos^2\theta = 0$ for which $D \ge 0$

6. $y = 7\cos x + 5\sin x = 8\left(\frac{7}{8}\cos x+\frac{5}{8}\sin x\right) = 8\sin(\alpha + x)$

$$\Rightarrow \sin(\alpha + x) = \frac{2k+1}{\pm 8}$$

$$-1\le\frac{2k+1}{8}\le 1.\ -1\le\frac{-2k+1}{8}\le 1,\ -\frac{9}{2}\le k\le\frac{7}{2}$$



Hence number of integral values are 8

7. Here, $x\sqrt{1-y^2}+y\sqrt{1-x^2} = z$

8. $$\text{Variance} = \frac{\sum_{r=0}^{n} r^2\cdot {}^nC_r}{\sum_{r=0}^{n} {}^nC_r} - \left(\frac{\sum_{r=0}^{n} r\cdot {}^nC_r}{\sum_{r=0}^{n} {}^nC_r}\right)^2$$

10. For f(x) to be strictly decreasing $f'(x) = 3x^2 + 2ax + 2b < 0$ for some x
i.e., f(x) must have distinct real roots
Thus, $D > 0 \Rightarrow a^2 > 6b$
This includes 12 cases for
(a, b), i.e., (3, 1), (4, 1), (4, 2), (5, 1), (5, 2), (5, 3), (5, 4), (6, 1), (6, 2), (6, 3), (6, 4), (6, 5)
Thus, $P(\text{required}) = \frac{1}{3}$

11. Let P(h, k) be the point of intersection
Then, equation of chord of contact is $ky - 2ax = 2a(h + 4a)$
Homogenising it with ellipse, $\frac{x^2}{4a^2} + \frac{y^2}{a^2} - \left\{\frac{ky - 2ax}{2a(h+4a)}\right\}^2 = 0$
represents pair of straight lines from origin to AB which are perpendicular to each other

12. Here, $f(x) + f(2 - x) = 1$

13. Here, L.H.L. = $(-1)^{q-1}$ and R.H.L. = $(-1)^q$

14. Since the given function is not defined for any real number so its domain is ϕ so that the integration will not exist

16. Let $\vec{a}, \vec{b}, \vec{c}$ and $\vec{p}$ be position vectors of A, B, C and P respectively
Then, P.V. of orthocentre H = $\vec{a} + \vec{b} + \vec{c}$
P.V. of $M = \frac{\vec{a} + \vec{b} + \vec{c} + \vec{p}}{2}$
$\overrightarrow{DM} = \frac{\vec{a} + \vec{p}}{2}$
$\Rightarrow \overrightarrow{DM} \cdot \overrightarrow{PA} = 0$

17. Here, $f'(x) = x^{n-1}(x - 3)^2 [x(n + 3) - 3n]$
$\Rightarrow f'(x) = 0$ at $x = 0, 3, \frac{3n}{n+3}$

18. Here, t is not defined at x = 2 and y is not defined at t = –2, 3
Now, t = –2 at $x = \frac{3}{2}$ and t = 3 at $x = \frac{7}{3}$

19. $\int (1 + x - x^{-1}) e^{x+x^{-1}} dx = \int e^{x+x^{-1}} dx + \int x\left(1 - \frac{1}{x^2}\right) e^{x+x^{-1}} dx$
$= \int e^{x+x^{-1}} dx + x \cdot e^{x+x^{-1}} - \int e^{x+x^{-1}} dx = x \cdot e^{x+x^{-1}} + c$

20. Let points be A(–2, 4), B(–1, 2), C(1, 2) and D(2, 4)
Let BE be required line such that DE = λ
Then area of quadrilateral BCDE = $\frac{1}{2} \times$ Area of trapezium ABCD

21. Let $\log_e 10 = x$. Then, $\sum_{r=0}^{n}(-1)^r\ {}^nC_r \frac{1+rx}{(1+nx)^r}$

$= \sum_{r=0}^{n}(-1)^r \cdot {}^nC_r\left(\frac{1}{1+nx}\right)^r - \frac{nx}{1+nx}\sum_{r=1}^{n}(-1)^{r-1} \cdot {}^{n-1}C_{r-1}\left(\frac{1}{1+nx}\right)^{r-1}$

$= \left(1-\frac{1}{1+nx}\right)^n - \frac{nx}{1+nx}\left(1-\frac{1}{1+nx}\right)^{n-1} = 0$

22. Here, $\frac{(b+c-a)+(c+a-b)}{2} > \{(b+c-a)(c+a-b)\}^{1/2}$

$\frac{(c+a-b)+(a+b-c)}{2} > \{(c+a-b)(a+b-c)\}^{1/2}$

and $\frac{(a+b-c)+(b+c-a)}{2} > \{(a+b-c)(b+c-a)\}^{1/2}$

Multiplying, $abc > (a + b - c)(b + c - a)(c + a - b)$

23. Let P and Q be $\left(at_1^2, 2at_1\right)$ and $\left(at_2^2, 2at_2\right)$ respectively for the parabola $y^2 = 4ax$

Then, $t_1t_2 = -1$

Also, R and T are $\left(-a, -\frac{2a}{t_1}\right)$ and $\left(-a, -\frac{2a}{t_2}\right)$ respectively

$\Rightarrow$ Slope of $RS = \frac{1}{t_1}$ and slope of $TS = \frac{1}{t_2}$

24. Here, $|z - 3| \le 4$ is circle with centre at (3, 0) and radius 4
$|z - 1| + |z + 1|$ is ellipse with foci at (–1, 0) and (1, 0) and length of major axis 3

25. Let the four points be $\left(ct_1, \frac{c}{t_1}\right), \left(ct_2, \frac{c}{t_2}\right), \left(ct_3, \frac{c}{t_3}\right)$ and $\left(ct_4, \frac{c}{t_4}\right)$

$\Rightarrow \tan\alpha = \frac{1}{t_1^2};\ \tan\beta = \frac{1}{t_2^2};\ \tan\gamma = \frac{1}{t_3^2};\ \tan\delta = \frac{1}{t_4^2}$

Also, $\frac{1}{t_1t_2t_3t_4} = -1$

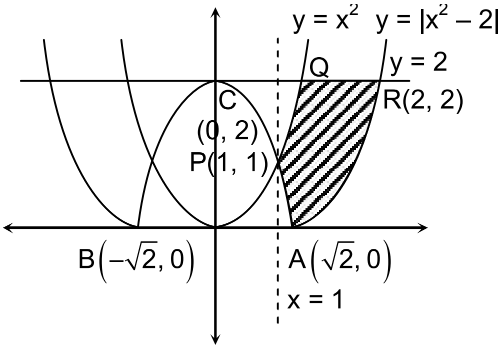
26. Equation of tangent to curve at (x, y) is $Y - y = \frac{dy}{dx}(X - x)$

Let, lengths of perpendiculars be D_1 and D_2
Then $D_1^2 + D_2^2 = 2$

$\Rightarrow \left(\frac{dy}{dx}\right)^2\left(x^2-1\right) - 2xy\left(\frac{dy}{dx}\right) + y^2 = 0$

$\Rightarrow \frac{dy}{dx} = \frac{xy \pm y}{x^2-1}$

27. Required area
= Area of region APQA + Area of region AQRA
$$= \int_{1}^{\sqrt{2}} \left\{x^2 - \left(2 - x^2\right)\right\} dx + \int_{\sqrt{2}}^{2} \left(4 - x^2\right) dx$$



28. Here, A + B + C = π
$\Rightarrow e^{-i(B+C)} = -e^{iA}; e^{-i(C+A)} = -e^{iB}; e^{-i(A+B)} = -e^{iC}$

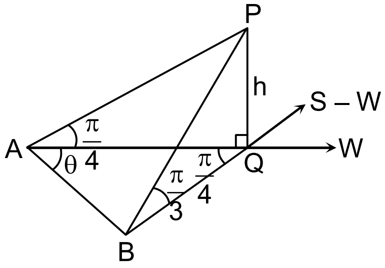
Now taking e^{iA}, e^{iB} and e^{iC} common from R_1, R_2 and R_3 = $-\begin{vmatrix} e^{iA} & -e^{iB} & -e^{iC} \\ -e^{iA} & e^{iB} & -e^{iC} \\ -e^{iA} & -e^{iB} & e^{iC} \end{vmatrix}$

29. Here, AQ = h

$BQ = \frac{h}{\sqrt{3}}$

Using cosine rule in ΔAQB

$h = 500\sqrt{\frac{3}{4-\sqrt{6}}}$ m



FIITJEE **JEE (Advanced), 2015**

FULL TEST – IV

Paper 1

ALL INDIA TEST SERIES

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

Time Allotted: 3 Hours **Maximum Marks: 243**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 06)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (07 – 09) contains 3 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

   Section-A (10 – 14) contains 2 paragraphs. Based upon paragraph, 2 and 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.
2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct matching. No marks will be given for any wrong matching in any question. There is no negative marking.
3. **Section-C (01 – 05)** contains 5 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

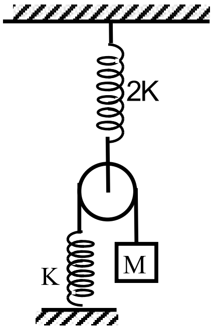
PART – I

SECTION – A

Straight Objective Type

This section contains **6 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

1. Find the angular frequency of oscillation of the show system (the pulley is massless).



(A) $\sqrt{\frac{K}{M}}$ (B) $\sqrt{\frac{K}{3M}}$

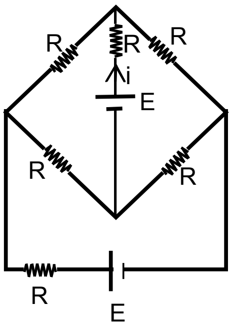
(C) $\sqrt{\frac{K}{2M}}$ (D) $\sqrt{\frac{2K}{3M}}$

2. An object is placed at a distance of 20 cm from an equi-concave lens of focal length 30 cm whose one side is silvered. If a virtual image is formed at 20/3 cm from the lens then what is the radius of curvature of the curved surface?

(A) 30 cm (B) 40 cm

(C) 60 cm (D) 15 cm

3. Find the current i in the circuit.



(A) $i = \frac{E}{2R}$ (B) $i = \frac{E}{R}$

(C) $i = \frac{E}{4R}$ (D) $i = \frac{2E}{R}$

Space for Rough work

4. Four particles each of mass 'm' are located at equal distance from each other. If the separation between any two particles is a then their gravitational potential energy is:

(A) $\frac{-4Gm^2}{a}$ (B) $\frac{-Gm^2}{8a}$

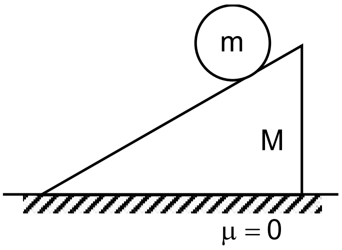
(C) $\frac{-Gm^2}{6a}$ (D) $\frac{-6Gm^2}{a}$

5. A parallel beam of light is incident on a perfectly absorbing small cube of side a. The beam is directed along one of the body diagonals of the cube and has sufficiently large aperture. What is the total radiation force experienced by the cube. I is the intensity of radiation.

(A) $a^2\frac{I}{c}$ (B) $3a^2\frac{I}{c}$

(C) $\sqrt{3}a^2\frac{I}{c}$ (D) $\sqrt{2}a^2\frac{I}{c}$

6. A cylinder is released from top of an inclined plane which itself rests on a smooth horizontal surface. The initial velocity of the cylinder as well as the incline is zero. (Assume no slipping in each case where the incline is rough).



(A) As the cylinder reaches the bottom most point, the inclined plane will acquire a greater speed if it were rough as compared to the case if it were smooth.
(B) As cylinder reaches the bottom-most point of the inclined plane it will acquire a greater speed if it were smooth as compared to the case when it were rough.
(C) The cylinder will have a lower kinetic energy i the case when the inclined plane is rough as compared to the case when it is smooth.
(D) Inclined plane will have a higher kinetic energy in the case when it is rough as compared to the case when it is smooth.

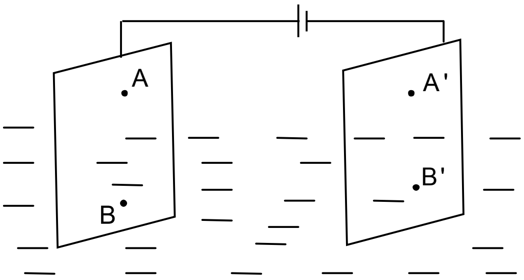
Space for Rough work

Multi Correct Choice Type

This section contains **3 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** is/are correct.

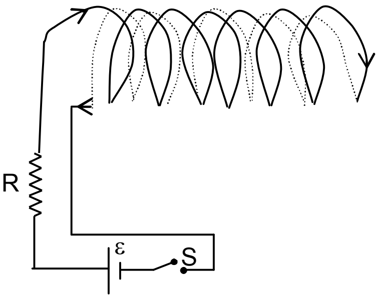
7. Four stationary observers have positions (a, 0), (0, a), (–a, 0) and (0, –a) respectively. A moving source, moving along +x-axis is crossing origin at t = 0. Which of the followings are correct at t = 0?
(A) Wavelength is same for all the observers.
(B) Speed of wave is same for all observers.
(C) Frequency is same for all observers.
(D) Frequency observed is more than emitted by source for three observers.

8. A parallel plate capacitor is dipped in an insulated liquid, vertically so that half of capacitor is in liquid. Plates of capacitor are joined to an ideal battery of emf ε, A, B, A', B' are four points on plate at facing surface as shown. Which of the following is/are correct?



(A) $V_A - V_{B'} = V_A - V_{A'}$
(B) $V_B - V_{B'} = V_B - V_{A'}$
(C) Electric field around A in air = Electric field around B' in liquid.
(D) Electric field around B in liquid = Electric field around B' in liquid.

9. Two identical solenoids each of self inductance L are joined and placed coaxially and overlapping in such a way that they carry equal and opposite currents. This arrangement is joined to a resistance R and battery of emf ε. Switch is closed at t = 0. Identify the correct statements:



(A) Energy stored in the magnetic field increases with time.
(B) Time constant of the circuit is $\frac{2L}{R}$.
(C) Time constant of the circuit is zero.
(D) Power delivered by battery remains constant.

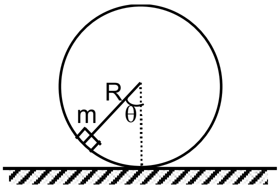
Space for Rough work

Comprehension type (Only One Option Correct)

This section contains **2 paragraphs.** Based upon one of paragraphs **2 multiple choice questions** and based on the other paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

Paragraph for Question Nos. 10 and 11

A particle of mass m is fixed on a massless ring which rests on a sufficiently rough surface so as to prevent slipping. The system is released from the shown configuration. Then:



10. Immediately after releasing from the shown configuration what is the angular acceleration of the ring?

(A) $\frac{g\sin\theta}{4R\sin^2\left(\frac{\theta}{2}\right)}$ (B) $\frac{g\sin\theta}{2R}$

(C) $\frac{g\sin\theta}{R}$ (D) $\frac{g\sin\theta}{R(1-\cos\theta)}$

11. If α be the λ anticlockwise angular acceleration immediately after release from the shown position, then what is the normal reaction immediately after release:

(A) $N = mg - mR\alpha\cos\theta$ (B) $N = mg$

(C) $N = m[g - R\alpha\sin\theta]$ (D) None of these

Space for Rough work

Paragraph for Question Nos. 12 and 14

A large cylindrical chamber has a massless piston fitted at the top. An acoustic source is situated at the centre of the bottom of the cylinder, while an observer is situated at the bottom circumference (inside the chamber). The observer is moving directly towards the source with constant velocity and hears a frequency f.

12. If the chamber were to be isobarically heated then the observed frequency will be
(A) same as f
(B) higher than f
(C) lower than f
(D) data insufficient

13. If the chamber were to be isochorically cooled then the observed frequency will be:
(A) same as f
(B) higher than f
(C) lower than f
(D) Date insufficient

14. If the chamber were to be isothermally heated then, the observed frequency will be:
(A) same as f
(B) higher than f
(C) lower than f
(D) Data insufficient

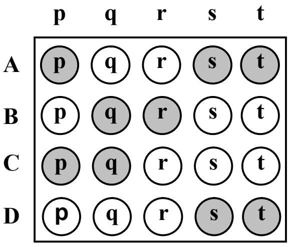
Space for Rough work

SECTION - B

Matrix – Match Type

*This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

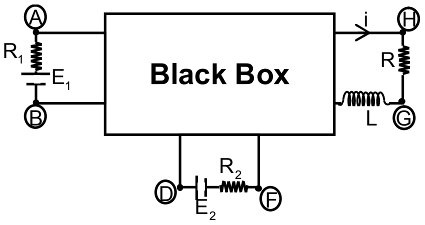
If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



1. Initially there are N_0 number of radioactive nuclei of species A while zero nuclei of species B and C. A decays to B with a decay constant λ_1 and B decays to C with a decay λ_2. C is not radioactive. Then match the column:

	Column I		Column II
(A)	$N_B + N_C$	(p)	Continuously increases.
(B)	N_B	(q)	Continuously decreases.
(C)	$N_A + N_C$	(r)	First increases then decreases.
(D)	$N_A + N_B$	(s)	First decreases then increases.
		(t)	Remains constant.

2. A black box having 6 points (A, B, D, F, G, H) contains a network of capacitors, real inductors (with resistance) and resistors. There is no battery inside the black box. E_1 and E_2 are the EMFs of ideal batteries. If we choose $E_1 = E_2 = 1$ volt, then steady state current i is 5A. If we choose $E_1 = 2$ volt and $E_2 = 1$ volt, the steady state current i = 7A. Now match the column:



	Column I		Column II
(A)	$E_1 = 3$ volt, $E_2 = 1$ volt	(p)	i = 10A
(B)	$E_1 = 1$ volt, $E_2 = 2$ volt	(q)	i = 11A
(C)	$E_1 = 1$ volt, $E_2 = 3$ volt	(r)	i = 8A
(D)	$E_1 = 4$ volt, $E_2 = 1$ volt	(s)	i = 9A
		(t)	i = 20 A

Space for Rough work

SECTION – C

(One Integer Value Correct Type)

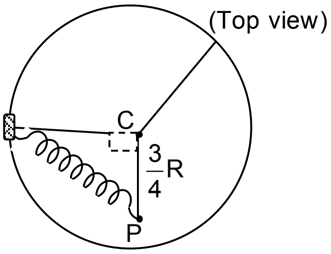
This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. A hydrogen atom in ground state absorbs a photon of energy corresponding to energy difference of first orbit and fourth orbit. After this, electron de-excite from excited state. As a result what maximum number of photons may be obtained?

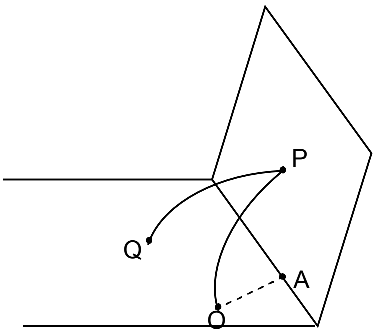
2. A capillary tube is a glass cylinder of radius r = 1 mm. It is dipped vertically in a liquid of surface tension T, $T = 80 \times 10^{-3}$ N/m, and angle of contact θ = 60°, liquid has normal capillary rise in the tube [mass of the tube and its material volume is negligible. Then force required to hold the tube is $P \times 10^{-4}$ N. Calculate P.

3. Two bodies A and B are joined through a conducting rod of high thermal conductivity with insulated cover. A and B are thermally insulated from surrounding. Initial temperature of A and B is 100°C and 20°C respectively. After one hour temperature of A is 80°C and B is 40°C. After further one hour temperature of B is x × 10°C, calculate x?

4. A ring of radius (R = 10 cm) is fixed in a horizontal plane. A sleeve of mass m = 300 gm can move on circumference of ring without friction. Sleeve is joined to a spring of spring constant $K = 200\frac{N}{m}$ and natural length R, other end is fixed at P $\left[CP = \frac{3}{4}R\right]$. Sleeve is released from rest. Calculate the net normal force (in N) exerted by ring on sleeve just after releasing. [$g = 10\ m/s^2$]



5. A ball is thrown form ground towards a vertical wall in such a way that motion plane of ball makes an angle of 30° with normal to wall. Distance of point of projection form wall is $4\sqrt{3}$ m. Collision between ball and wall is elastic. At what distance (in metre) from point of projection ball falls.



Space for Rough work

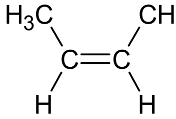
Chemistry PART – II

SECTION – A

Straight Objective Type

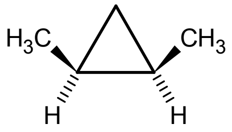
This section contains **6 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

1. The major product formed in the following reaction:

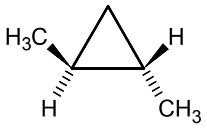


$+ :CH_2(\text{singlet}) \longrightarrow$

(A)

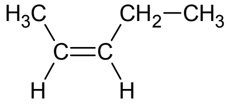


(B)

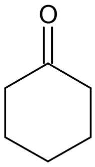


(C) 50 : 50 mixture of above two compounds

(D)

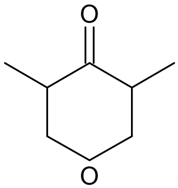


2.

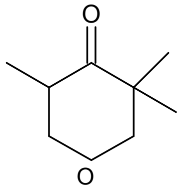


$\xrightarrow[\text{KH-excess}]{\text{MeI excess}}$ 81% yield, product of the reaction is

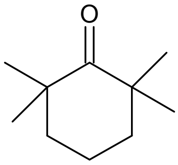
(A)



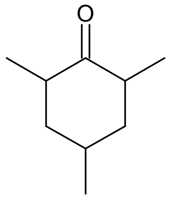
(B)



(C)



(D)



Space for Rough work

3. Which of the following exhibits aromaticity?
(A) Cyclopentadienyl cation
(B) Cyclopentadienyl radical
(C) Cycloheptatrienyl radical
(D) Cycloheptatrienyl cation

4. $\Delta H < \Delta E$ for the reaction:
(A) $N_2(g) + 3H_2(g) \longrightarrow 3H_2(g)$
(B) $Ag_2O(s) \longrightarrow 2Ag(s) + \frac{1}{2}O_2(g)$
(C) $C(s) + \frac{1}{2}O_2(g) \longrightarrow CO(g)$
(D) $C(s) + O_2(g) \longrightarrow CO_2(g)$

5. Which of the following is isoelectronic and isostructural?
$NO_3^-, CO_3^{2-}, ClO_3^-, SO_3$
(A) NO_3^-, CO_3^{2-}
(B) SO_3, NO_3^-
(C) ClO_3^-, CO_3^{2-}
(D) CO_3^{2-}, ClO_3^-

6. A particular 100-octane aviation gasoline used 1.00 cm^3 of tetraethyl lead $(C_2H_5)_4Pb$ of density 1.66g/cc, per litre of product. This compound is made as follows.
$4C_2H_5Cl + 4NaPb \longrightarrow (C_2H_5)_4Pb + 4NaCl + 3Pb$. How many gram of ethyl chloride is needed to make enough tetraethyl lead for 1 L of gasoline.
(A) 1.33g
(B) 2.66 g
(C) 9.2g
(D) 0.33g

Space for Rough work

Multi Correct Choice Type

This section contains **3 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** is/are correct.

7. The d-orbitals involved in sp^3d^2 or d^2sp^3 hybridisation of the central metal ion are:

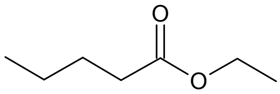
(A) $\mathbf{d}_{x^2-y^2}$ (B) d_{xy}

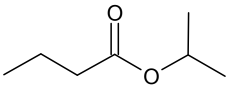
(C) d_{yz} (D) $\mathbf{d}_{z^2}$

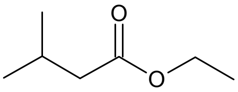
8. Which of the following statement(s) is/are correct when a soid mixture of NaCl and $K_2Cr_2O_7$ is gently warmed with conc. H_2SO_4?

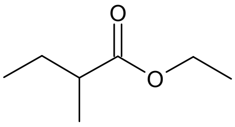
(A) A deep red vapour is evolved
(B) The vapour when passed into NaOH solution gives a yellow soluton of Na_2CrO_4
(C) Chlorine gas is evolved
(D) Chromyl chloride is formed

9. Which of the following compound/s shall undergo condensation by reacting with NaOEt/EtOH.

(A)


(B)


(C)


(D)


Space for Rough work

Comprehension type (Only One Option Correct)

This section contains **2 paragraphs.** Based upon one of paragraphs **2 multiple choice questions** and based on the other paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

Paragraph for Question Nos. 10 and 11

Variation of equilibrium constant K with temperature is given by Van't Hoff equation

$$\ln K = \frac{\Delta S_r^o}{R} - \frac{\Delta H_r^o}{RT}$$

From this equation, ΔH_r^o can be calculated if equilibrium constant K_1 and K_2 at two temperature T_1 and T_2 are known.

$$\log\left(\frac{K_2}{K_1}\right) = \frac{\Delta H_r^o}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

10. For an isomerization X (g) $\rightleftharpoons$ Y (g), the temperature dependency of equilibrium constant is given by

$$\ln K = 2 - \frac{1000}{T}$$

the value of ΔS_r^o at 300 K is

(A) 2R
(B) 2/R
(C) 1000 R
(D) None of these

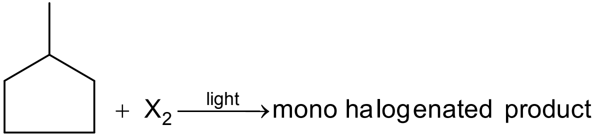
11. Select the correct statement

(A) value of K_c always increases with increasing temperature
(B) for exothermic reaction value of K_c increase with decreasing in temperature
(C) for endothermic reaction value of K_c increases with decreasing in temperature
(D) for exothermic reaction slope is $\left(\log K \text{ vs } \frac{1}{T}\right)$ negative

Space for Rough work

Paragraph for Question Nos. 12 to 14

Consider the following reaction



$+ X_2 \xrightarrow{\text{light}}$ mono halogenated product

12. Which halogen will give the best yield of a single mono halogenation products
(A) F_2 (B) Cl_2
(C) Br_2 (D) I_2

13. How many mono halo derivatives are possible (excluding stereo-isomers)?
(A) 3 (B) 4
(C) 5 (D) 6

14. Among the following halogens which one is least reactive towards halogenation reaction?
(A) F_2 (B) Cl_2
(C) Br_2 (D) I_2

Space for Rough work

SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in ***Column I*** *are labelled A, B, C and D, while the statements in* ***Column II*** *are labelled p, q, r, s and t. Any given statement in* ***Column I*** *can have correct matching with* ***ONE OR MORE*** *statement(s) in* ***Column II.*** *The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the following:

	Column – I		Column – II
(A)	Chalcopyrite → copper (pure)	(p)	Froth floatation
(B)	Zinc blende → zinc (pure)	(q)	Hall process
(C)	Bauxite → aluminium (pure)	(r)	Roasting
(D)	Galena → lead (pure)	(s)	Self reduction
		(t)	Basemerisation

2. Match the following:

	Column – I		Column – II
(A)	$K_P > Q_p$	(p)	Non-spontaneous
(B)	$\Delta G^\circ < RT\log_e Q_p$	(q)	Equilibrium
(C)	$K_P = Q_p$	(r)	Spontaneous and endothermic
(D)	$T > \frac{\Delta H}{\Delta S}$	(s)	Spontaneous
		(t)	Spontaneous and exothermic

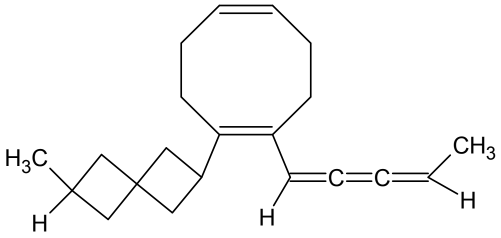
Space for Rough work

SECTION – C

(One Integer Value Correct Type)

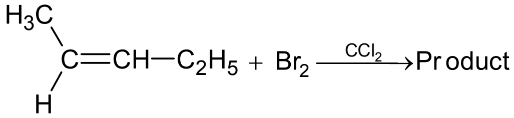
This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. Number of stereo centres in a given molecule?



2. Number of stereoisomers in given molecules [Ma_3b_2C].

3. Number of possible products formed in given reaction



$$H_3C(H)C{=}CH{-}C_2H_5 + Br_2 \xrightarrow{CCl_2} Product$$

4. The conductivity of 0.001 M Na_2SO_4 solution is 2.6×10^{-4} S cm^{-1} and increases to 7.0×10^{-4} S cm^{-1} and increases to 7×10^{-4} S cm^{-1}, when the solution is saturated with $CaSO_4$. The molar conductivity of Na^+ and Ca^{2+} are 50 and 120 S cm^2 mol^{-1}, respectively. Neglect conductivity of used water the solubility product of $CaSO_4$ is $y \times 10^{-x}$ M^2. What is the value of x.

5. ${}_{90}Th^{234}$ disintegrate to give ${}_{82}Pb^{206}$ as the final product. Total number of β particles emitted out during this process are:

Space for Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **6 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

1. The locus of a point which moves so that the distance between the feet of perpendiculars drawn from it to the lines $3x^2 - 6xy + y^2 = 0$ is $3\sqrt{3}$ is a circle with radius

(A) $2\sqrt{15}$	(B) 15
(C) $6\sqrt{5}$	(D) none of these

2. The sum to (n + 1) terms of the series $\cos\alpha + n\cos2\alpha + \frac{n(n-1)}{2!}\cos3\alpha + ...$ is

(A) $2^n \sin^n\frac{\alpha}{2}\cos(2+n)\frac{\alpha}{2}$	(B) $2^n \cos^n\frac{\alpha}{2}\cos(2+n)\frac{\alpha}{2}$
(C) $2^n \cos(2+n)\frac{\alpha}{2}$	(D) none of these

3. A tangent is drawn to the curve $x^2 + 2x - 4ky + 3 = 0$ at a point whose abscissa is 3. The tangent is perpendicular to the line $x - 2y + 3 = 0$. Then the area bounded by the curve, this tangent, the x-axis and the ordinate $x = -1$, is

(A) $\frac{108}{47}$ sq. units	(B) $\frac{109}{48}$ sq. units
(C) $\frac{111}{47}$ sq. units	(D) $\frac{104}{40}$ sq. units

Space for rough work

4. Given an ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ (a > b). A circle is drawn which passes through the foci and the extremities of the minor axis of this ellipse and let this circle be the auxiliary circle for a second ellipse whose vertices are the foci of the given ellipse. If any tangent to the second ellipse meets its auxiliary circle at two points such that it subtends a right angle at the origin, then the locus of the point of tangency, is (if eccentricity of both the ellipse are same)
(A) $x^2 + 2y^2 = a^2$ (B) $2x^2 + y^2 = a^2$
(C) $2x^2 + y^2 = a^2$ (D) $x^2 + y^2 = 2a^2$

5. The value of $\lim\limits_{x\to\infty}\frac{2(x)^{1/2}+3(x)^{1/3}+4(x)^{1/4}+.....+n(x)^{1/n}}{(2x-3)^{1/2}+(2x-3)^{1/3}+.....+(2x-3)^{1/n}}$ is
(A) 0 (B) 2
(C) $\sqrt{2}$ (D) $\frac{1}{\sqrt{3}}$

6. $\int e^{x^4}\left(x+x^3+2x^5\right)e^{x^2}dx$ is equal to
(A) $\frac{1}{2}xe^{x^2}e^{x^4}+c$ (B) $\frac{1}{2}x^2e^{x^4}+c$
(C) $\frac{1}{2}e^{x^2}e^{x^4}+c$ (D) $\frac{1}{2}x^2e^{x^2}e^{x^4}+c$

Multi Correct Choice Type

This section contains **3 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** is/are correct.

7. If $f(x)=\begin{vmatrix}(1-x)^a & (1+x)^b & 1\\ 1 & (1-x)^a & (1+x)^b\\ (1+x)^b & 1 & (1-x)^a\end{vmatrix}$, then
(A) constant term of f(x) = a + b (B) constant term of f(x) = 0
(C) coefficient of x in f(x) is zero (D) none of these

Space for rough work

8. If $f(a) = \int_0^1 \frac{x^{\cos a} - 1}{\ln x} dx$, 'a' being a real number other than an odd multiple of π, then

(A) f(a) = ln(cos a)
(B) f(a) = ln(1 + cos a)
(C) $f'(a) = \tan\frac{a}{2}$
(D) $f'(a) = -\tan\frac{a}{2}$

9. If $f(x) = x^3 - x^2 + 100x + 2002$, then

(A) f(1000) > f(1001)
(B) $f\left(\frac{1}{2000}\right) > f\left(\frac{1}{2001}\right)$
(C) f(x – 1) > f(x – 2)
(D) f(2x – 3) > f(x)

Comprehension type (Only One Option Correct)

This section contains **2 paragraphs.** Based upon one of paragraphs **2 multiple choice questions** and based on the other paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

Paragraph for Question Nos. 10 and 11

Read the following write up carefully and answer the following questions:
Consider a triangle ABC, where x, y, z are the length of perpendicular drawn from the vertices of the triangle to the opposite sides a, b, c respectively. Let the letters R, r, s, Δ denote the circumradius, in-radius, semi-perimeter and area of the triangle respectively

10. If $\frac{bx}{c} + \frac{cy}{a} + \frac{az}{b} = \frac{a^2 + b^2 + c^2}{k}$, then the value of k is

(A) R
(B) s
(C) 2R
(D) $\frac{3}{2}R$

11. If cot A + cot B + cot C = $k\left(\frac{1}{x^2} + \frac{1}{y^2} + \frac{1}{z^2}\right)$, then the value of k is

(A) R^2
(B) rR
(C) Δ
(D) $a^2 + b^2 + c^2$

Space for rough work

Paragraph for Question Nos. 12 and 14

Read the following write up carefully and answer the following questions:
If the locus of the circumcentre of variable triangle having sides x-axis, x = 3 and px + qy = 4, where (p, q) lies on the parabola $x^2 = 4ay$ is a curve C, then

12. Co-ordinates of the vertex of this curve C is

(A) $\left(\frac{9}{4}, -\frac{81}{8}a\right)$ (B) $\left(-\frac{9}{4}, -\frac{81}{8}a\right)$

(C) $\left(\frac{9}{4}, -\frac{9}{8}a\right)$ (D) $\left(-\frac{9}{4}, \frac{81}{8}a\right)$

13. The curve C is symmetric about the line

(A) $x = -\frac{9}{4}$ (B) $x = \frac{9}{4}$

(C) $y = -\frac{9}{4}$ (D) $y = \frac{9}{4}$

14. The length of smallest focal chord of this curve C is

(A) $\frac{1}{2a}$ (B) $\frac{1}{4a}$

(C) $\frac{1}{12a}$ (D) $\frac{1}{16a}$

Space for rough work

SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in ***Column I*** *are labelled A, B, C and D, while the statements in* ***Column II*** *are labelled p, q, r, s and t. Any given statement in* ***Column I*** *can have correct matching with* ***ONE OR MORE*** *statement(s) in* ***Column II.*** *The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the following Column-I with Column-II

	Column – I		Column – II
(A)	If A is an idempotent matrix and I is an identity matrix of the same order, then the value of n, such that $(A + I)^n = I + 127A$ is	(p)	9
(B)	If $(I – A)^{-1} = I + A + A^2 + ….. + A^7$, then $A^n = O$ where n is	(q)	10
(C)	If A is a matrix such that $a_{ij} = (i + j)(i – j)$ then A is singular if order of matrix is	(r)	7
(D)	If a non-singular matrix A is symmetric and A^{-1} is also symmetric, then order of A can be	(s)	8
		(t)	6

2. 'n' whole numbers are randomly chosen and multiplied then match the following Column-I with Column-II

	Column–I		Column–II
(A)	The probability that the last digit is 1, 3, 7 or 9 is	(p)	$\frac{8^n + 4^n}{10^n}$
(B)	The probability that the last digit is 2, 4, 6 or 8 is	(q)	$\frac{5^n - 4^n}{10^n}$
(C)	The probability that the last digit is 5 is	(r)	$\frac{4^n}{10^n}$
(D)	The probability that the last digit is zero is	(s)	$\frac{10^n - 8^n - 5^n + 4^n}{10^n}$
		(t)	$\frac{8^n - 4^n}{10^n}$

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. Let the circle $(x - 1)^2 + (y - 2)^2 = 25$ cuts a rectangular hyperbola with transverse axis along $y = x$ at four point A, B, C and D having coordinates (x_i, y_i), (where i = 1, 2, 3, 4) respectively, O being the centre of the hyperbola. If $\ell = x_1 + x_2 + x_3 + x_4$, $m = x_1^2 + x_2^2 + x_3^2 + x_4^2$, $n = y_1^2 + y_2^2 + y_3^2 + y_4^2$, then find value of $n - m - 4\ell$ _____

2. If $x \in [0, 2\pi]$ for which $2\cos x \le \left|\sqrt{1+\sin 2x} - \sqrt{1-\sin 2x}\right| \le \sqrt{2}$ has solution set $x \in \left[\frac{\lambda\pi}{4}, \frac{\mu\pi}{4}\right]$, then $\mu - \lambda$ is _____

3. Given $(1 - 2x + 5x^2 + 10x^3)(1 + x)^n = 1 + a_1x + a_2x^2 + \ldots..$ and that $a_1^2 = 2a_2$, then the value of n is _____

4. If $f(x) = a_0 + a_1x + a_2x^2 + \ldots.. + a_nx^n + \ldots..$ and $\frac{f(x)}{1-x} = b_0 + b_1x + b_2x^2 + \ldots.. + b_nx^n + \ldots..$ If $a_0 = 1$ and $b_1 = 3$ and $b_{10} = k^{11} - 1$, then k is _____ (Given that $a_0, a_1, a_2, \ldots..$ are in G.P.)

5. For $\tan^{-1}\left\{\frac{\cos 2\alpha \sec 2\beta + \cos 2\beta \sec 2\alpha}{\lambda}\right\} = \tan^{-1}\left\{\tan^2(\alpha+\beta)\tan^2(\alpha-\beta) + \tan^{-1}1\right\}$ the value of λ is _____

Space for rough work

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ANSWERS, HINTS & SOLUTIONS
FULL TEST– IV
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	A	C
2.	C	C	B
3.	A	D	B
4.	D	A	A
5.	C	A	C
6.	B	A	D
7.	B, D	A, D	B, C
8.	A, B, C, D	A, B, D	B, D
9.	C, D	A, B, C	B, C
10.	A	A	C
11.	C	B	C
12.	C	C	C
13.	B	B	B
14.	A	A	A
1.	A → p B → r C → s D → q	A → p, r, s, t B → p, r C → q D → p, r, s	(A) → (r) (B) → (s) (C) → (p, r) (D) → (p, q, r, s, t)
2.	A → s B → r C → q D → q	A → s B → p C → q D → q	(A) → (r) (B) → (t) (C) → (q) (D) → (s)
1.	3	3	4
2.	5	3	6
3.	5	4	6
4.	5	6	2
5.	8	7	2

Physics PART – I

SECTION – A

1. If the pulley comes down by a displacement x then the block comes down by 3x and the string connecting the block has tension Kx.

$$\Rightarrow -Kx = M \times \frac{3d^2x}{dt^2}$$

or $\omega = \sqrt{\frac{K}{3M}}$.

2. $\frac{1}{v} + \frac{1}{u} = \frac{1}{F_{eff}}$

$\Rightarrow \frac{1}{20/3} + \frac{1}{-20} = \frac{1}{F_{eff}}$ or F_{eff} = +10 cm

Now $\frac{1}{F_{eff}} = \frac{1}{f_m} - \frac{2}{f_0}$

or $\frac{1}{10} = \frac{1}{f_m} + \frac{2}{30}$

or $\frac{1}{f_m} = \frac{1}{10} - \frac{2}{30} = \frac{1}{30}$

or f_m = 30 cm or R = +60 cm.

3. Use KCL/KVL or suppose the current due to each battery. (Forms wheatstones by removing 1 battery at a time).

4. There is a tetrahedral configuration with a total of 6 interactions.

5. Say the beam is incident along $\hat{I} = \frac{\hat{i} + \hat{j} + \hat{k}}{\sqrt{3}}$ and the normal of one of the faces is $\hat{N} = \hat{i}$ then its projection area is $A\hat{N}.\hat{I} = \frac{a^2}{\sqrt{3}}$. There are three such faces on which the radiation falls.

$\Rightarrow$ Total projection area = $\sqrt{3}a^2$

$\Rightarrow$ Force = $\frac{I}{c}.\sqrt{3}a^2$.

6. Mechanical energy and momentum both have to be conserved. In case of rough incline, the sphere will also have some rotational KE. Thus lesser energy available as translational KE of incline as well as the cylinder.

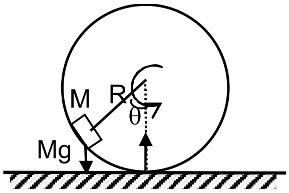
7. Speed is characteristic of the medium is same for all observers. Here wavelength is different for different directions and thus frequency.
For observer (a, 0), (0, a) and (0, –a) observed frequency is more than emitted taking into account time lag.

8. Potential difference between plates is same as ε.
$V_A - V_B = \varepsilon = E.d$ in both air and liquid.
$V_A = V_B$ and $V_A' = V_B'$
Complete plate is at same potential.

9. Since coils carry current in opposite sense magnetic field is always zero in solenoid even if current is there. Thus net inductance = 0, it is simply ε and R joined in series.

10. Instantaneous axis has zero.
instantaneous acceleration $\omega = 0$
Taking τ about bottom most point:
$Mg\,R\sin\theta = m(2R\sin\theta/2)^2\,\alpha$.
Solving we get,

$$\alpha = \frac{g\sin\theta}{4R\sin^2\left(\frac{\theta}{2}\right)}$$



11. $mg - N = mR\alpha\sin\theta$
$\eta N = m(g - R\alpha\sin\theta)$

12-14. Use Doppler's effect, the speed of sound increases with increase in temperature.

SECTION - B

1. $N_A + N_B + N_C = N_0$.
B will first have more production rate than decay and finally there will be no B.

2. In steady state all capacitors G have as open circuits and inductors as short circuits.
$\Rightarrow$ purely resistive network:
Assume, $i = aE_1 + bE_2$
We get, a = 2, b = 3.
$\Rightarrow i = 2E_1 + 3E_2$.

SECTION – C

1. There is only a single atom, thus maximum number of photons obtained are
$4 \rightarrow 3$, $3 \rightarrow 2$ and $2 \rightarrow 1$.

2. Surface tension force is acting downward at both inner and outer surface at contact point on the tube.
$F = 2\pi rT\cos\theta + 2\pi rT\cos\theta = 4\pi rT\cos\theta$

3. $(T_A - T_B) = T_0e^{-\alpha t}$
Same fractional change takes same time, where $T_0 = 80°C$ is initial temperature difference. Since in fixed one hour temperature loss of A = temperature gain of B, means heat capacities are same, means they will always undergo same loss and same gain. After one hour temperature difference become half = $40°C = \frac{1}{2}(80°)$. In further one hour temperature difference becomes further half.

$T_A + T_B = 120°C$

$T_A - T_B = \left(\frac{1}{2}\right)^2 \times T_0 = 20°\,C$

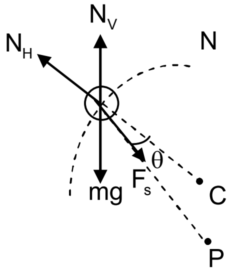
$\Rightarrow T_B = 50°C \;\Rightarrow x = 5$

4. Vertical component of normal reaction balances mg and horizontal component of normal reaction balances component of spring force towards centre.

$N_v = mg$

$N_H = F_s \cos\theta = \frac{kR}{4} \times \frac{4}{5} = \frac{k}{5}R$

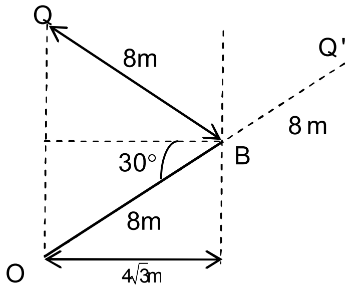
$N = \sqrt{N_v^2 + N_H^2} = 5\ N.$



5. Ball collide at highest point of projectile Motion, after collision, motion is mirror image of motion that would have been without collision.

Top view of motion is as shown in diagram OQ is required distance.

OQ = 2 (OB) sin 30° = 8 m



Chemistry

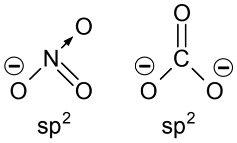
PART – II

SECTION – A

1. Singlet carbene gives *syn* addition on alkene. *syn* addition on cis alkene gives meso compound.

4. $\Delta H = \Delta E + \Delta nRT$, $\Delta H < \Delta E$ if $\Delta n < 0$

5.



6. The mass of 1 cc of $(C_2H_5)_4Pb$ is = 1 × 1.66 = 1.66g and this is the amount needed per litre.

No. of moles of $(C_2H_5)_4Pb$ needed = $\frac{1.66}{323}$ = 0.00514 ml

1 mole of $(C_2H_5)_4Pb$ requires 4 × (0.00514) = 0.0206 ml of C_2H_5Cl

∴ Mass of C_2H_5 Cl = 0.0206 × 64.5 = 1.33 g

8. When a solid mixture of NaCl, $K_2Cr_2O_7$ and conc. H_2SO_4 is heated, the products obtained are

$$4KCl + K_2Cr_2O_7 + 6H_2SO_4 \longrightarrow \underset{\text{Red vapour}}{2CrO_2Cl_2 \uparrow} + 6KHSO_4 + 3H_2O$$

$$CrO_2Cl_2 + 4NaOH \longrightarrow \underset{\text{Yellow solution}}{Na_2CrO_4} + 2NaCl + 2H_2O$$

9. Claisen condensation can be shown only when at least 2 α H are there.

SECTION-B

2. (A) $K_P > Q$ the reaction will proceed in forward direction spontaneously.

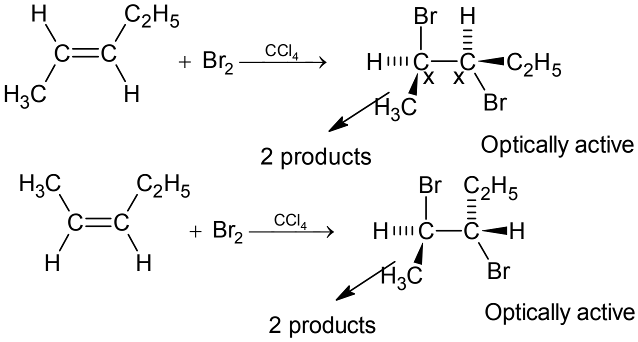
(B) $\Delta G^o < RT\log_e Q$ then $\Delta G = +ve$ then non spontaneous.

(C) $K_P = Q \rightarrow$ equilibrium

(D) $\Delta G = \Delta H - T.\Delta S$

SECTION – C

3.



total = 2 + 2 = 44. Conductivity of Na_2SO_4 = 2.6 × 10^{-4}

$$\Lambda_m(Na_2SO_4) = \frac{1000 \times 2.6 \times 10^{-4}}{0.001} = 260 \text{ S cm}^2$$

$$\Lambda_m(SO_4^{2-}) = \Lambda_m(Na_2SO_4) - 2\Lambda_m(Na^+)$$

= 260 – 2 × 50 = 160 S cm^2 mol^{-1}

Coductivity of $CaSO_4$ solution

$= 7 \times 10^{-4} - 2.6 \times 10^{-4} = 4.4 \times 10^{-4}\ S\ cm^{-1}$

$\Lambda_m\left(CaSO_4\right) = \Lambda_m\left(Ca^{2+}\right) + \Lambda_m\left(SO_4^{2-}\right)$

$= 120 + 160 = 280\ S\ cm^2\ mol^{-1}$

Solubility, S = $\dfrac{1000 \times K}{\Lambda_m} = \dfrac{1000 \times 4.4 \times 10^{-4}}{280}$

$= 1.57 \times 10^{-3}$ cm

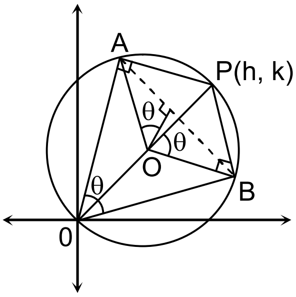
$K_{sp} = \left[Ca^{2+}\right]\left[SO_4^{2-}\right]_{total} = \left(0.00157\right)\left(0.00157 + 0.001\right)$

$= 4 \times 10^{-6}\ M^2$

$= y \times 10^{-x}\ M^2$

Mathematics PART – III

SECTION – A



1. Here, $\tan\theta = \sqrt{\frac{3}{2}}$
Thus, locus of P is
$x^2 + y^2 = 180$
Hence, radius = $6\sqrt{5}$

2. Sum = $\text{Re}(e^{i\alpha}(1 + e^{i\alpha})^n)$

3. For the given curve, $\left.\frac{dy}{dx}\right|_{x=3} = \frac{2}{k} = -2 \Rightarrow k = -1$
$\Rightarrow$ The curve is, $x^2 + 2x + 4y + 3 = 0$
and the tangent is $4x + 2y - 3 = 0$

4. Equation of first ellipse is $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$
Vertices of second ellipse are $(\pm ae, 0)$
$\Rightarrow$ Equation of second ellipse is $x^2 + \sqrt{2}y^2 = \frac{a^2}{2}$
$\Rightarrow$ Equation of tangent to it at (h, k) is $xh + \sqrt{2}yk = \frac{a^2}{2}$
Homogenising $x^2 + y^2 - b^2 = 0$ with this straight line $x^2 + y^2 - b^2\left[\frac{2}{a^2}\left(xh + \sqrt{2}yk\right)\right]^2 = 0$
These are perpendicular, hence $h^2 + 2x^2 = \frac{a^4}{2b^2} = a^2$
$\Rightarrow$ Locus of (h, k) is $x^2 + 2y^2 = a^2$

5. Given, $\lim\limits_{x\to\infty} \frac{2(x)^{1/2} + 3(x)^{1/3} + 4(x)^{1/4} + \ldots.. + n(x)^{1/n}}{(2x-3)^{1/2} + (2x-3)^{1/3} + \ldots.. + (2x-3)^{1/n}}$

$= \lim\limits_{h\to 0} \frac{2(h)^{-1/2} + 3(h)^{-1/3} + \ldots.. + n(h)^{-1/n}}{h^{-1/2}(2-3h)^{1/2} + h^{-1/3}(2-3h)^{1/3} + \ldots.. + h^{-1/n}(2-3h)^{1/n}}$ [Put $x = \frac{1}{h}$]

$= \lim\limits_{h\to 0} \frac{2 + 3h^{\left(\frac{1}{2}-\frac{1}{3}\right)} + 4h^{\left(\frac{1}{2}-\frac{1}{4}\right)} + \ldots.. + nh^{\left(\frac{1}{2}-\frac{1}{n}\right)}}{(2-3h)^{1/2} + h^{\left(\frac{1}{2}-\frac{1}{3}\right)}(2-3h)^{1/3} + \ldots.. + h^{\left(\frac{1}{2}-\frac{1}{n}\right)}(2-3h)^{1/n}}$

$= \frac{2 + 0 + 0 + \ldots.. + 0}{2^{1/2} + 0 + 0 + \ldots..} = \sqrt{2}$

6. Substitute $x^2 = t$

$$\Rightarrow I = \frac{1}{2}\int e^{t^2}\left(1+t+2t^2\right)e^t dt = \frac{1}{2}\int e^t\left[t\,e^{t^2}+\left(e^{t^2}+2t^2\,e^{t^2}\right)\right]dt$$

$$= \frac{1}{2}\int e^t\left[f(t)+f'(t)\right]dt = \frac{1}{2}e^t\left(te^{t^2}\right)+c = \frac{1}{2}e^{x^2}\left(x^2\,e^{x^4}\right)+c$$

7. Let, $f(x) = A + Bx + Cx^2 + Dx^3 + \ldots..$

Now, $f(0) = 0$ and $f'(0) = 0$

8. Here, $f'(a) = \int_0^1 \frac{x^{\cos a}\ln x(-\sin a)}{\ln x}dx = -\int_0^1 x^{\cos a}\sin a\,dx = -\tan\left(\frac{a}{2}\right)$

$$\Rightarrow f(a) = -\int\frac{\sin a}{1+\cos a}da = \ln(1+\cos a)$$

9. Here, $f'(x) = 3x^2 - 2x + 100 > 0$

$\Rightarrow f(x)$ is increasing

10. Here, $\frac{bx}{c}-\frac{cy}{a}-\frac{az}{b} = b\sin B + c\sin C + a\sin A = \frac{b^2+c^2+a^2}{2R}$

$\Rightarrow k = 2R$

11. $\cot A + \cot B + \cot C = \frac{R}{abc}\left(b^2+c^2-a^2+c^2+a^2-b^2+a^2+b^2-c^2\right)$

$$= \frac{R}{abc}\left(a^2+b^2+c^2\right) = \Delta\left(\frac{1}{x^2}+\frac{1}{y^2}+\frac{1}{z^2}\right)$$

$\Rightarrow k = \Delta$

12.-14. Let (h, k) be the circumcircle of ΔABC

Then, $h = \frac{4+3p}{2p}$; $k = \frac{4-3p}{2q}$

$\Rightarrow p = \frac{4}{2h-3}$; $q = \frac{4h-12}{k(2h-3)}$

This (p, q) lies on $x^2 = 4ay$

$\Rightarrow$ Locus of (h, k) is $\frac{1}{2a}\left(y+\frac{9}{8}a\right) = \left(h-\frac{9}{4}\right)^2$

SECTION – B

1. (A) A is idempotent, $A^2 = A^3 = A^4 = \ldots.. = A$

$(A + I)^n = I + {}^nC_1A + {}^nC_2A^2 + \ldots.. + {}^nC_nA^n = I + {}^nC_1A + {}^nC_2A + \ldots.. + {}^nC_nA$

$= I + \left({}^nC_1 + {}^nC_2A^2 + \ldots.. + {}^nC_n\right)A = I + \left(2^n - 1\right)A$

$\Rightarrow 2^n - 1 = 127 \Rightarrow n = 7$

(B) $(I - A)(I + A + A^2 + \ldots.. + A^7) = (I + A + A^2 + \ldots.. + A^7) - (A + A^2 + \ldots.. A^8)$

$= I - A^8 = I$ (if $A^8 = 0$)

(C) A is skew symmetric $\Rightarrow |A| = |A^T| = (-1)^n|A|$

$\Rightarrow |A|\left(I-(-1)^n\right) = 0$ as n is odd, hence $|A| = O \Rightarrow A$ is singular

(D) A is symmetric then A^{-1} is also symmetric for matrix of any order

2. (A) Required event will occur if last digit in all the numbers is 1, 3, 7 or 9. Thus, required probability = $\frac{4^n}{10^n}$

(B) Required probability = P (last digit is 1, 2, 3, 4, 6, 7, 8, 9) – P (last digit is 1, 3, 7, 9) = $\frac{8^n - 4^n}{10^n}$

(C) P (1, 3, 5, 7, 9) – P (1, 3, 7, 9) = $\frac{5^n - 4^n}{10^n}$

(D) P (required) = P (0, 5) – P (5) = $\frac{\left(10^n - 8^n\right) - \left(5^n - 4^n\right)}{10^n} = \frac{10^n - 8^n - 5^n + 4^n}{10^n}$

SECTION – C

1. Let hyperbola be $xy = c^2$. Then points of intersection is $\left(ct, \frac{c}{t}\right)$

$\Rightarrow c^2t^4 - 2ct^3 - 20t^2 - 4ct + c^2 = 0$

If t_1, t_2, t_3 and t_4 are its roots

Then, $\sum t_1 = \frac{2}{c}$; $\sum t_1t_2 = -\frac{20}{c^2}$; $\sum t_1t_2t_3 = \frac{4}{c}$ and $t_1t_2t_3t_4 = 1$

$\Rightarrow \ell = 2, m = 44, n = 56$

2. Let, $y = \left|\sqrt{1+\sin 2x} - \sqrt{1-\sin 2x}\right| \Rightarrow y^2 = 2 - 2|\cos 2x|$

If $x \in \left[0, \frac{\pi}{4}\right]$ or $\left[\frac{3\pi}{4}, \frac{5\pi}{4}\right]$ or $\left[\frac{7\pi}{4}, 2\pi\right]$, cos 2x is non-negative

$\Rightarrow y = 2|\sin x| \Rightarrow \cos x \le |\sin x|$ except for x in $\left[0, \frac{\pi}{4}\right]$ and $\left[\frac{7\pi}{4}, 2\pi\right]$

So, it holds for $\left[\frac{3\pi}{4}, \frac{5\pi}{4}\right]$ in which $\sin x \le \frac{1}{\sqrt{2}}$

If $x \in \left(\frac{\pi}{4}, \frac{3\pi}{4}\right)$ or $\left(\frac{5\pi}{4}, \frac{7\pi}{4}\right)$ then $\cos 2x < 0 \Rightarrow y = 2|\cos x|$

So, both inequalities hold

Thus, solution set is $x \in \left[\frac{\pi}{4}, \frac{7\pi}{4}\right]$

$\Rightarrow \mu - \lambda = 6$

3. Here, $(1 - 2x + 5x^2 + 10x^3)\left({}^nC_0 + {}^nC_1x + {}^nC_2x^2 + ...\right) = 1 + a_1x + a_2x^2 + ...$

$\Rightarrow a_1 = n - 2;\ a_2 = \frac{n(n-1)}{2} - 2n + 5$

Since, $a_1^2 = 2a_2 \Rightarrow n = 6$

4. $f(x)(1 - x)^{-1} = f(x)(1 + x + x^2 + ...) = b_0 + b_1x + b_2x^2 + ...$

$\Rightarrow (a_0 + a_1x + a_2x^2 + ... + a_nx^n + ...)(1 + x + x^2 + ... + x^n + ...) = b_0 + b_1x + b_2x^2 + ...$

Comparing coefficient of x^n on both sides, $a_0 + a_1 + a_2 + ... + a_{n-1} + a_n = b_n$

Comparing coefficient of x^{n-1} on both sides, $a_0 + a_1 + a_2 + ... + a_{n-1} = b_{n-1}$

$\Rightarrow b_n - b_{n-1} = a_n$

Also, $b_0 = a_0$ and $b_1 = a_0 + a_1$

$\Rightarrow b_0 = 1;\ a_1 = 2$

$\Rightarrow b_{10} = a_0 + a_1 + a_2 + \ldots.. + a_{10} = 2^{11} - 1$

5. Here, R.H.S. = $\tan^{-1}\left\{\dfrac{\tan^2(\alpha+\beta)\tan^2(\alpha-\beta)+1}{1-\tan^2(\alpha+\beta)\tan^2(\alpha-\beta)}\right\}$

$= \tan^{-1}\left\{\dfrac{\sin^2(\alpha+\beta)\sin^2(\alpha-\beta)+\cos^2(\alpha+\beta)\cos^2(\alpha-\beta)}{\cos^2(\alpha+\beta)\cos^2(\alpha-\beta)-\sin^2(\alpha+\beta)\sin^2(\alpha-\beta)}\right\}$

$= \tan^{-1}\left\{\dfrac{(\cos 2\beta-\cos 2\alpha)^2+(\cos 2\alpha+\cos 2\beta)^2}{2\cos 2\alpha\cos 2\beta}\right\}$

$= \tan^{-1}\left\{\dfrac{\cos 2\alpha\sec 2\beta+\cos 2\beta\sec 2\alpha}{2}\right\}$

$\Rightarrow \lambda = 2$

FIITJEE **JEE (Advanced), 2015**

ALL INDIA TEST SERIES

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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FULL TEST – IV

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 243**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 06)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (07 – 09) contains 3 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

   Section-A (10 – 14) contains 2 paragraphs. Based upon paragraph, 2 and 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.
2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct matching. No marks will be given for any wrong matching in any question. There is no negative marking.
3. **Section-C (01 – 05)** contains 5 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Enrolment No. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

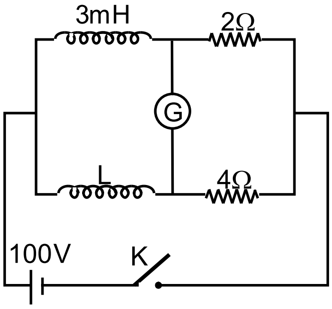
SECTION – A

Straight Objective Type

This section contains **6 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

1. A capacitor of capacitance C is connected between every two vertices of a cube (including the body diagonals and the face diagonals). The effective capacitance of the system across any edge is:
(A) C (B) 3C
(C) 2C (D) 4C

2. In the shown circuit, the switch is closed at t = 0. What should be the value of L if the galvanometer shows zero deflection?
(A) 3 mH
(B) 4 mH
(C) 6 mH
(D) 1.5 mH

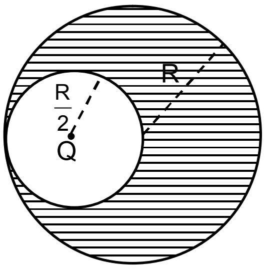


3. Two balls moving in a gravity free space collide with each other inelastically then choose the correct statement: $(0 < e < 1)$
(A) An any inertial frame the total pre collision kinetic energy is same.
(B) An any inertial frame the total post collision kinetic energy is same.
(C) The total velocity of separation of the balls will be different inertial frames.
(D) The loss in kinetic energy during collision is same in every inertial frame.

4. If I is the intensity at the central maximum of YDSE then what is the intensity at $y = \frac{\beta}{4}$?
(β is fringe width)
(A) $\frac{I}{4}$ (B) $\frac{I}{2}$
(C) 0 (D) $\frac{I}{3}$

Space for Rough work

5. An uncharged conducting sphere of radius R, has a hollow cavity sphere of radius $\frac{R}{2}$, as shown. Which of the following is/are correct about electrostatic energy?



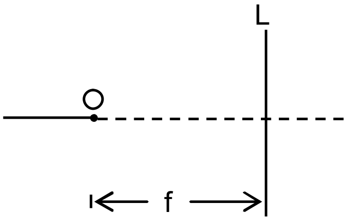
(A) Interaction energy of induced charges with charge placed at centre of cavity is $-\left(\frac{1}{4\pi\varepsilon_0}\right)\left(\frac{Q^2}{R}\right)$

(B) Interaction energy of induced charges with charge placed at centre of cavity is $\frac{1}{4\pi\varepsilon_0}\left(\frac{Q^2}{R}\right)$

(C) Electrostatic energy outside sphere is $\frac{1}{4\pi\varepsilon_0}\left(\frac{Q^2}{9R}\right)$

(D) Electrostatic energy outside sphere is $\left(\frac{1}{4\pi\varepsilon_0}\right)\left(\frac{Q^2}{R}\right)$.

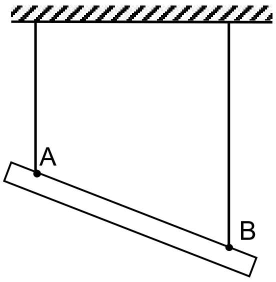
6. A self luminous point object is placed at focus of a thin lens. Which of the following is INCORRECT about shape of wave fronts?
(A) Before lens it is spherical if lens is converging.
(B) Before lens it is spherical if lens is diverging.
(C) After lens it is spherical if lens is converging.
(D) After lens it is spherical if lens is diverging.



Multi Correct Choice Type

This section contains **3 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** is/are correct.

7. Two vertical strings of different lengths are joined to a uniform rod at points A and B, rod is at rest. Now the string joining B is burnt. Which of the following are correct just after this?
(A) acceleration of COM of rod is vertical.
(B) acceleration of COM of rod is along rod.
(C) acceleration of particle at A is zero.
(D) acceleration of particle at A is horizontal.



8. A charged particle is projected in combined electric and magnetic field. Electric field is uniform along x-axis and magnetic field which is non-uniform but not time varying also along x-axis. Initial velocity of particle is $\left(10\hat{i}+10\hat{j}\right)$m/s. After certain time x component of velocity is 20 m/s. Which of the following is correct at that time?
(A) Velocity of particle is $\left(20\hat{i}+10\hat{j}\right)$ m/s.
(B) Speed of particle is $10\sqrt{5}$ m/s.
(C) With given information we cannot calculate y component and z component of velocities.
(D) $V_y^2+V_z^2=100\,m^2/s^2$.

9. In a photo electric effect frequency of incident radiation is halved. As a result, what is possible?
(A) Kinetic energy of most energetic electrons, becomes less than half, if electrons are emitted.
(B) Kinetic energy of most energetic electrons becomes more than half, if electrons are emitted.
(C) Kinetic energy of most energetic electrons becomes half, if electrons are emitted.
(D) May be no photo electrons are obtained.

Space for Rough work

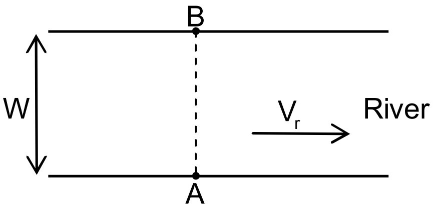
Comprehension type (Only One Option Correct)

This section contains **2 paragraphs.** Based upon one of paragraphs **2 multiple choice questions** and based on the other paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

Paragraph for Question Nos. 10 and 11

A boatman starts from point A and always heads boat towards point B (i.e. V_{br} is always towards B).

V_{br} is the velocity of the boat in still water and W is the width of the river. It is given that $V_{br} > V_r$.

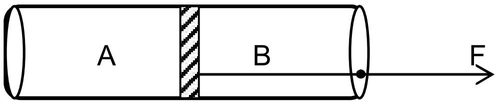


10. What is the time taken by the boat to cross the river?
    (A) $\frac{WV_r}{V_{br}^2}$
    (B) $\frac{W}{V_{br} - V_r}$
    (C) $\frac{WV_r}{V_{br}^2 - v_r^2}$
    (D) $\frac{W}{\sqrt{V_{br}^2 - V_r^2}}$

11. If the boat is observed from the ground frame as it tries to reach point B:
    (A) Its speed appears to increase with time
    (B) Its speed appears to be constant with time
    (C) Its speed appears to decrease with time
    (D) None of the above.

Space for Rough work

Paragraph for Question Nos. 12 and 14



A ***diathermic*** piston free to move without friction divides an adiabatic cylinder in two equal parts. The two parts contain equal amount of ideal gas. Piston is joined to a string which comes out passing through right boundary. [Assume that no matter and energy flows through hole that passes the string]. Now the string is pulled slowly to right.

12. Temperature of gas A
(A) increases (B) Decrease
(C) first decrease then increase (D) first increase then decrease

13. Temperature of gas B
(A) increases (B) Decrease
(C) first decrease then increase (D) first increase then decrease

14. Work done by gas A is
(A) negative (B) positive
(C) zero (D) none of the above

Space for Rough work

SECTION - B

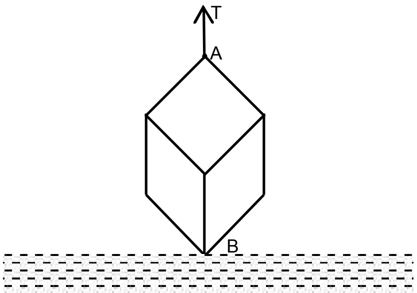
Matrix – Match Type

*This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. A cube of volume 1 m^3 and specific gravity 2 is very slowly being lowered in to a lake with help of a massless string tied to one of its vertices as shown.
Initially the vertex B is just touching the surface of water and finally, vertex A is just beneath the surface of water. For the process of immersion, match the columns: (Ignore change in KE of water). (g = 10 ms^{-2}).



Column I		Column II	
(A)	Work done by gravity on water + cube system.	(p)	$\frac{3\sqrt{3}}{2}\times 10^4$ Joule.
(B)	Work done by tension on the cube.	(q)	$\frac{-3\sqrt{3}}{2}\times 10^4$ Joule.
(C)	Work done by gravity on water.	(r)	$\frac{-\sqrt{3}}{2}\times 10^4$ Joule.
(D)	Work done by gravity on the cube.	(s)	$2\sqrt{3}\times 10^4$ Joule.
		(t)	$40\sqrt{3}\times 10^4$ Joule.

2. Match the columns according to the particle released in the reaction:

Column I		Column II	
(A)	${}^{14}_{6}C \to {}^{14}_{7}N + e^- + \_\_\_\_\_$	(p)	Neutrino
(B)	${}^{23}_{12}Mg \to {}^{23}_{11}Na + e^+ + \_\_\_\_\_$	(q)	Anti Neutrino
(C)	${}^{81}_{36}Kr + e^- \to {}^{81}_{35}Br + \_\_\_\_\_$	(r)	Deutron
(D)	${}^{137}_{55}Cs \to {}^{137}_{56}Ba + e^- + \_\_\_\_\_$	(s)	α-particle.
		(t)	β-particle

Space for Rough work

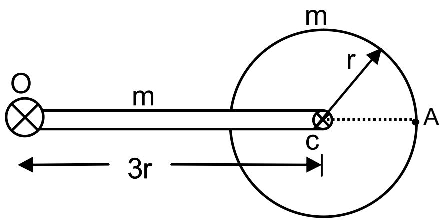
SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

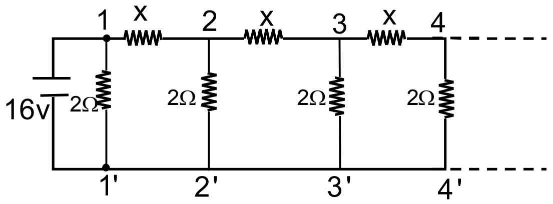
1. In a different type of Vernier calliper without zero error, five vernier division is equal to four main scale division. One main scale division is equal to 2 mm
Readings for a rod are.
Main scale reading = 8
Vernier scale reading = 3
If length of the rod is = [14 + x × 0.4] mm, what is the value of x?

2. A uniform rod of mass m and length 3r is free to rotate about a horizontal axis through O. A disc of mass m, radius r, is free to rotate about another horizontal axis fixed to other end of the rod (say C). [r = 1.2 m]. The system is released from rest when rod is horizontal. What is the velocity of particle at A (in m/s) when rod becomes vertical?

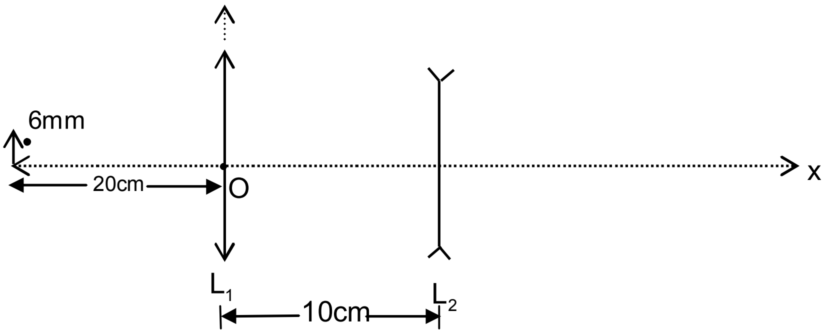


Space for Rough work

3. There is infinite ladder of network as shown. 1 and 1' are joined to ideal battery of emf 16 V. The potential difference across 4 and 4' is found to be 2V. What is the equivalent resistance between 1 and 1' (Voltage across the successive 2Ω resistance decreases by a factor of 2 as we move towards right)



4. A convex lens L_1 and a concave lens L_2 are arranged with separation 10 cm as shown. Their focal lengths are respectively 20 cm and 10 cm. optical centre of L_1 is treated as origin and optical axis as x-axis as shown. A self luminous point object is placed at [–20 cm, (6 mm)] Y coordinate of the final image in mm is?



5. Position vector of a particle is given as

$\vec{r} = A\cos^2\omega t\hat{i} + B\sin^2\omega t\hat{j}$, [A = 6 and B = 8]

Find the amplitude of motion.

Space for Rough work

Chemistry

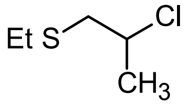
PART – II

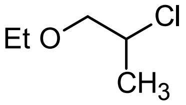
SECTION – A

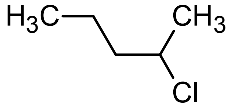
Straight Objective Type

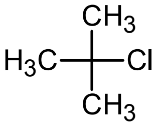
This section contains **6 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

1. Which will show greater degree of retention on hydrolysis?

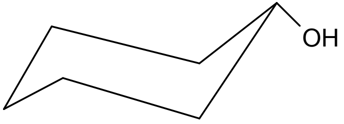
(A)


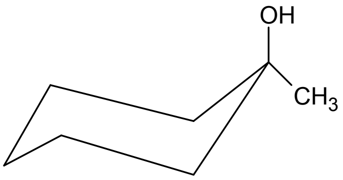
(B)


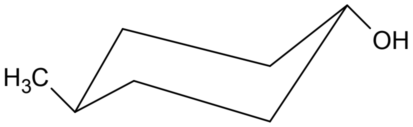
(C)


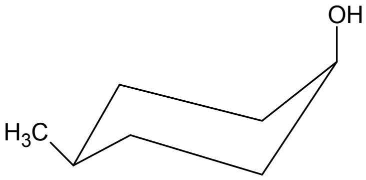
(D)

$H_3C-\overset{CH_3}{\underset{CH_3}{C}}-Cl$

2. Which of the following react with HBr at faster rate?

(A)


(B)


(C)


(D)


3. The value of universal gas constant R depends on

(A) Temperature of gas
(B) Volume of gas
(C) Number of moles of gas
(D) Units volume and pressure

Space for Rough work

4. When iodine is dissolved in aqueous potassium iodide, the shape of the species formed is:
(A) Linear (B) Angular
(C) Triangular (D) See-saw

5. Among the following complexes
(i) [Ru(bipyridyl)$_3$)$^+$
(ii) [Cr(EDTA)]$^+$
(iii) trans-[CrCl$_2$(Oxalate)$_2$]$^{3-}$
(iv) cis-[CrCl$_2$(ox)$_2$]$^{3-}$
The ones that shows chirality are
(A) (i),(ii), (iv) (B) (i), (ii), (iii)
(C) (ii), (iii), (iv) (D) (i), (iii), (iv)

6. The difference nth and (n + 1)th Bohr's radius of H-atoms is equal to (n-1)th Bohr's radius. Hence the value of 'n' is:
(A) 1 (B) 2
(C) 3 (D) 4

Space for Rough work

Multi Correct Choice Type

This section contains **3 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** is/are correct.

7. A binary solution of liquid A and B will show positive deviation from Roult's law if it fulfils the following condition:
(A) $P_A > X_A P_A^o$ and $P_B > X_B P_B^o$
(B) The intermolecular forces of A–B < A–A, B–B
(C) ΔH mixing is positive
(D) Δ V mixing is negative

8. For the reaction: $Cl_2(g) + 3F_2(g) \rightleftharpoons 2ClF_3(g)$; $\Delta H = -329KJ$ dissociation of $ClF_3(g)$ will be favoured by:
(A) Increasing the temperature
(B) Increasing the volume of the container
(C) Adding of F_2 gas
(D) Adding of inert gas at constant pressure

9. Select the correct statement(s):
(A) When $T \to \infty$ or $E_a \to o$ then K = A
(B) A positive catalyst can change ΔH of the reaction
(C) A mixture of reactants may be thermodynamically unstable but kinetically stable
(D) A negative catalyst increase the activation energy of the reaction

Space for Rough work

Comprehension type (Only One Option Correct)

This section contains **2 paragraphs.** Based upon one of paragraphs **2 multiple choice questions** and based on the other paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

Paragraph for Question Nos. 10 and 11

Read the following paragraph and answer the questions given below:
A proper control by pH is very essential for many industrial as well as biological processes. Solutions with a definite pH can be prepared from single salts or mixtures of acids/bases and their salts. We also require solutions which resist change in pH and hence have a reserve value. Such solutions are called buffer solutions. Henderson gave a theoretical equal for preparing acidic buffers of definite pH. The equation is:

$$pH = pK_a + \log\frac{[\text{Salt}]}{[\text{Acid}]}$$

A similar equation is used for basic buffers. The pH of aqueous solution of single salts is calculated by using an expression whose exact form depends on the nature of the salt. Considering all that in mind, answer the following questions:

10. Calculate pH of a mixture containing 100 ml of 0.10 M NaOH mixed with 100 ml of 0.05 M CH_3COOH solution
(A) 10.4
(B) 11.7
(C) 12.4
(D) 13.4

11. Calculate pH if 100 ml of 0.1 M NaOH is mixed with 100 ml of 0.1 M CH_3COOH solution [K_a (CH_3COOH) = 1.8×10^{-5}) log 1.8 = 0.255]
(A) 8.71
(B) 7
(C) 6.25
(D) 9.37

Space for Rough work

Paragraph for Question Nos. 12 and 14

Molar conductivity ($\wedge_m$) is defined as conducting power of the ions produced by 1 mole of an electrolyte in a solution. $\wedge_m$ = k/c where κ is conductivity (in S cm^2 mol^{-1}) and c is molar concentration (in mole/cm^3) the molar conductivity of 0.04 M solution of $CaCl_2$ is 200 S cm^2 mol^{-1} at 298 K. A cell with electrode that are 2.0 cm^2 in surface area and 0.50 cm apart is filled with $CaCl_2$ solution.

12. Conductance of $CaCl_2$ solution is:

(A) 8×10^{-3} S	(B) 32 S
(C) 0.032 S	(D) None of these

13. How much current will flow when the potential difference between the two electrode is 5.0 V?

(A) 156.25 A	(B) 0.16 A
(C) 160 A	(D) None of these

14. The cell constant of the following cell will be

(A) 0.4	(B) 0.8
(C) 0.25	(D) 0.6

Space for Rough work

SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in ***Column I*** *are labelled A, B, C and D, while the statements in* ***Column II*** *are labelled p, q, r, s and t. Any given statement in* ***Column I*** *can have correct matching with* ***ONE OR MORE*** *statement(s) in* ***Column II.*** *The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the contents of Column – I with contents of Column – II for 1 mole of gas.

	Column – I		Column – II
(A)	Raw egg $\longrightarrow$ Boiled egg	p.	$\Delta H = +\text{Ve}$
(B)	$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$	q.	$\Delta S = +\text{Ve}$
(C)	$\underset{\text{solid}}{P_{(\text{white})}} \longrightarrow \underset{\text{solid}}{P_{(\text{red})}}$	r.	$\Delta G = -\text{Ve}$
(D)	$Pd + H_2 \rightleftharpoons$ adsorbed gas	s.	Allotropic change
		t.	$\Delta S = -\text{Ve}$

2. Match the contents of Column – I with contents of Column – II for 1 mole of gas.

	Column – I		Column – II
(A)	Tetragonal	(p)	$a \neq b \neq c$
(B)	Monoclinic	(q)	$\alpha \neq \beta \neq \gamma \neq 90^\circ$
(C)	Rhombohedral	(r)	$a \neq b \neq c, \alpha \neq \beta \neq \gamma \neq 90^\circ$
(D)	Triclinic	(s)	$a = b \neq c, \alpha \neq \beta \neq \gamma \neq 90^\circ$
		(t)	$a = b = c, \alpha \neq \beta \neq \gamma \neq 90^\circ$

Space for Rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. An α-particle moving with velocity $\frac{1}{30}$th times of velocity of light. If uncertainty in position is $\frac{3.31}{\pi}$ pm, then minimum Uncertainty in kinetic energy is y × 10^{-16}J. Calculate value of 'y'.

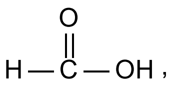
2. The vander Waal's constants for a gas are a = 3.6 atm L^2 mol^{-2}, b = 0.6L mol^{-1}, If R = 0.08 L $atmk^{-1}$ mol^{-1}. If the Boyle's temperature (K) is T_b of this gas, then what is the value of $\frac{T_b}{15}$?

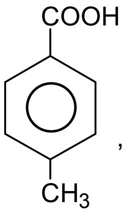
3. Amongst the following, the total number of compounds whose aqueous solution turns red litmus paper blue is NaCN, KCl, CH_3COONH_4, NaH_2PO_4, $ZnCl_2$, Na_3PO_4, $Fe(NO_3)_3$, Na_2CO_3, NH_4Cl, $NaHCO_3$, $Na_2C_2O_4$, Na_2HPO_4 .
Given :

Acid	Ka_1	Ka_2	Ka_3
H_3PO_4	10^{-3}	10^{-8}	10^{-12}
H_2CO_3	10^{-6}	10^{-1}	-
$H_2C_2O_4$	10^{-2}	10^{-5}	-

4. $\Delta G°$ for the hypothetical reaction x + y $\rightleftharpoons$ z is – 4.606 kcal. The equilibrium constant of the reaction at 227° is (x × 10^2). Find the value of x.

5. Find out number of compounds which are more acidic than benzoic acid from the following


$H-\overset{O}{\overset{\|}{C}}-OH$, $H_2C_2O_4$,



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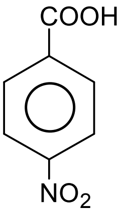

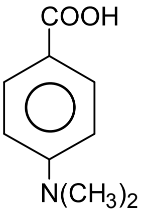

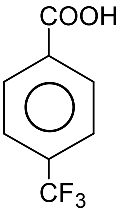

Space for Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **6 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

1. A straight line 'L' cuts the lines AB, AC and AD of a parallelogram ABCD at points B_1, C_1 and D_1 respectively. If $\overrightarrow{AB_1} = \lambda_1 \overrightarrow{AB}$, $\overrightarrow{AD_1} = \lambda_2 \overrightarrow{AD}$ and $\overrightarrow{AC_1} = \lambda_3 \overrightarrow{AC}$, then $\frac{1}{\lambda_3}$ is equal to

(A) $\frac{1}{\lambda_1} + \frac{1}{\lambda_2}$ (B) $\frac{1}{\lambda_1} - \frac{1}{\lambda_2}$

(C) $-\lambda_1 + \lambda_2$ (D) $\lambda_1 + \lambda_2$

2. If $f(x) = \begin{bmatrix} \cos x & -\sin x & 0 \\ \sin x & \cos x & 0 \\ 0 & 0 & 1 \end{bmatrix}$ then det $(f(\theta + \phi))$ is

(A) 0 (B) 1

(C) –1 (D) $\cos^2\theta - \sin^2\phi$

3. Let $\vec{a}, \vec{b}$ and $\vec{c}$ be three non zero and non coplanar vectors and $\vec{p}, \vec{q}$ and $\vec{r}$ be three vectors given by $\vec{p} = \vec{a} + \vec{b} - 2\vec{c}$; $\vec{q} = 3\vec{a} - 2\vec{b} + \vec{c}$ and $\vec{r} = \vec{a} - 4\vec{b} + 2\vec{c}$. If the volume of the parallelepiped determined by $\vec{a}, \vec{b}$ and $\vec{c}$ is v_1 and that of the parallelepiped determined by $\vec{p}, \vec{q}$ and $\vec{r}$ is v_2 then $v_2 : v_1$ is

(A) 1 : 5 (B) 5 : 1

(C) 15 : 1 (D) 1 : 15

4. The point A divides the join of P(–5, 1) and Q(3, 5) in ratio K : 1. The two values of K for which area of ΔABC, where B is (1, 5) and C is (7, –2), is equals to 2 units in magnitude are K or $\frac{31}{K+2}$ then K is

(A) 2 (B) 3

(C) 5 (D) 7

Space for rough work

5. If $\frac{\sin x}{a} = \frac{\cos x}{b} = \frac{\tan x}{c} = k$, then $bc + \frac{1}{ck} + \frac{ak}{1+bk}$ is equal to

(A) $k\left(a + \frac{1}{a}\right)$ (B) $\frac{1}{k}\left(a + \frac{1}{a}\right)$

(C) $\frac{1}{k^2}$ (D) $\frac{a}{k}$

6. The area (Δ) and an angle (θ) of a triangle are given. When the side opposite to the given angle is minimum, then the lengths of the remaining two sides are

(A) $\sqrt{\frac{2\Delta}{\sin\theta}}, \sqrt{\frac{3\Delta}{\sin\theta}}$ (B) $\sqrt{\frac{2\Delta}{\sin\theta}}, \sqrt{\frac{2\Delta}{\sin\theta}}$

(C) $\sqrt{\frac{4\Delta}{\sin\theta}}, \sqrt{\frac{2\Delta}{\sin\theta}}$ (D) $\sqrt{\frac{6\Delta}{\sin\theta}}, \sqrt{\frac{6\Delta}{\sin\theta}}$

Multi Correct Choice Type

This section contains **3 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** is/are correct.

7. Given a real valued function f such that $f(x) = \begin{cases} \frac{\tan^2\{x\}}{x^2 - [x]^2} & \text{for } x > 0 \\ 1 & \text{for } x = 0 \\ \sqrt{\{x\}\cot\{x\}} & \text{for } x < 0 \end{cases}$ (where [.] denotes the greatest integer function and {x} is fractional part of x), then

(A) $\lim_{x\to 0^+} f(x) = 1$ (B) $\lim_{x\to 0^-} f(x) = \cot 1$

(C) $\cot^{-1}\left(\lim_{x\to 0^-} f(x)\right)^2 = 1$ (D) $\tan^{-1}\left(\lim_{x\to 0^+} f(x)\right) = \frac{\pi}{4}$

8. The equation $x^{\left[(\log_3 x)^2 - \left(\frac{9}{2}\right)\log_3 x + 5\right]} = 3\sqrt{3}$ has

(A) at least 1 real solution (B) exactly three real solution

(C) exactly 1 irrational solution (D) complex roots

9. Which of following functions have the maximum value unity?

(A) $\sin^2 x - \cos^2 x$ (B) $\sqrt{\frac{6}{5}}\left(\frac{1}{\sqrt{2}}\sin x + \frac{1}{\sqrt{3}}\cos x\right)$

(C) $\cos^6 x + \sin^6 x$ (D) $\cos^2 x + \sin^4 x$

Space for rough work

Comprehension type (Only One Option Correct)

This section contains **2 paragraphs.** Based upon one of paragraphs **2 multiple choice questions** and based on the other paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

Paragraph for Question Nos. 10 and 11

Read the following write up carefully and answer the following questions:

Let f(x) be a non-positive continuous function and $F(x) = \int_0^x f(t)dt \;\; \forall\, x \geq 0$ and $f(x) \geq cF(x)$ where $c > 0$ and let g: [0, ∞) → R be a function such that $\frac{dg(x)}{dx} < g(x) \;\; \forall\, x > 0$ and g(0) = 0

10. The total number of root(s) of the equation f(x) = g(x) is/are

(A) ∞	(B) 1
(C) 2	(D) 0

11. The number of solution(s) of the equation $|x^2 + x - 6| = f(x) + g(x)$ is/are

(A) 2	(B) 1
(C) 0	(D) 3

Paragraph for Question Nos. 12 and 14

Read the following write up carefully and answer the following questions:

If 4-letter words are formed using the letters of the word 'MORADABAD', then

12. The probability that at least two letters are repeated is

(A) $\frac{120}{313}$	(B) $\frac{133}{313}$
(C) $\frac{123}{310}$	(D) none of these

13. The probability that D comes in the 4-letter word is

(A) $\frac{209}{313}$	(B) $\frac{120}{313}$
(C) $\frac{189}{310}$	(D) none of these

14. The probability that D comes exactly once in the 4-letters word is

(A) $\frac{73}{313}$	(B) $\frac{144}{310}$
(C) $\frac{146}{313}$	(D) none of these

Space for rough work

SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in ***Column I*** *are labelled A, B, C and D, while the statements in* ***Column II*** *are labelled p, q, r, s and t. Any given statement in* ***Column I*** *can have correct matching with* ***ONE OR MORE*** *statement(s) in* ***Column II.*** *The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	● p	○ q	○ r	● s	● t
B	○ p	● q	● r	○ s	○ t
C	● p	● q	○ r	○ s	○ t
D	○ p	○ q	○ r	● s	● t

1. Match the following Column-I with Column-II

	Column – I		Column – II
(A)	The number of solutions of the equation $\lvert\cot x\rvert = \cot x + \frac{1}{\sin x}(0 < x < \pi)$ is	(p)	No solution
(B)	If $\sin\theta + \sin\phi = \frac{1}{2}$ and cos θ + cos ϕ = 2, then value of $\cot\left(\frac{\theta+\phi}{2}\right)$ is	(q)	$\frac{1}{3}$
(C)	The value of $\sin^2\alpha + \sin\left(\frac{\pi}{3}-\alpha\right)\sin\left(\frac{\pi}{3}+\alpha\right)$ is	(r)	1
(D)	If tan θ = 3 tan ϕ, then maximum value of $\tan^2(\theta - \phi)$ is	(s)	2
		(t)	$\frac{3}{4}$

2. Match the following Column-I with Column-II

	Column – I		Column – II
(A)	$\int \frac{x^4-1}{x^2\sqrt{x^4+x^2+1}}dx$	(p)	$\ln\left(\frac{(x^2+1)+\sqrt{x^4+1}}{x}\right)+C$
(B)	$\int \frac{x^2-1}{x\sqrt{1+x^4}}dx$	(q)	$C+\frac{1}{\sqrt{2}}\ln\left(\frac{\sqrt{x^4+1}-\sqrt{2}x}{(x^2-1)}\right)$
(C)	$\int \frac{1+x^2}{(1-x^2)\sqrt{1+x^4}}dx$	(r)	$C-\tan^{-1}\left(\sqrt{\sqrt{1+\frac{1}{x^4}}-1}\right)$
(D)	$\int \frac{dx}{(1+x^4)\sqrt{\sqrt{1+x^4}-x^2}}$	(s)	$\frac{\sqrt{x^4+x^2+1}}{x}+C$
		(t)	$\ln\left(\frac{(x^2+1)-\sqrt{x^4+1}}{x}\right)+C$

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. If $x = \frac{4}{9}$ satisfies the in-equation $\log_a(x^2 - x + 2) > \log_a(-x^2 + 2x + 3)$, then sum of all possible distinct values of [x] is (where [.] denotes the greatest integer function) is _____

2. Let $\vec{v} = 2\hat{i} + \hat{j} - \hat{k}$ and $\vec{w} = \hat{i} + 3\hat{k}$. If $\vec{u}$ is a unit vector and P is the maximum value of the scalar triple product $[\vec{u}\ \vec{v}\ \vec{w}]$, then the value of $p^2 - 50$ is _____

3. If $\int \frac{e^x(2-x^2)}{(1-x)\sqrt{1-x^2}}dx = \mu e^x\left(\frac{1+x}{1-x}\right)^{\lambda} + c$, then 2(λ + μ) is equal to _____

4. If A, B and C are the angles of a triangle and $\begin{vmatrix} \sin 2A & \sin C & \sin B \\ \sin C & \sin 2B & \sin A \\ \sin B & \sin A & \sin 2C \end{vmatrix} = \lambda \sin A \sin B \sin C$, then λ is _____

5. The number of solutions of the equation $\log_{|x-1|}|x^2 - 1| = [|\sin x| + |\cos x|]$ (where [.] denotes the greatest integer function) is _____

Space for rough work

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FULL TEST– IV
(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	D	A	A
2.	C	B	B
3.	D	D	C
4.	B	A	D
5.	A	A	B
6.	C	D	B
7.	A, D	A, B, C	A, C, D
8.	B, C, D	A, B, D	A, B, C
9.	A, D	A, C, D	A, B, C, D
10.	C	B	B
11.	C	A	C
12.	A	C	B
13.	A	B	A
14.	B	C	C
1.	A → p B → q C → r D → s	A → (p, q, r) B → (p, q, r) C → (p, s) D → (p, r, t)	(A) → (r) (B) → (p) (C) → (t) (D) → (q)
2.	A → q B → p C → p D → q	A → (p) B → (t) C → (s) D → (r)	(A) → (s) (B) → (p) (C) → (q) (D) → (r)
1.	8	5	0
2.	9	5	9
3.	1	6	3
4.	3	1	0
5.	5	4	1

Physics PART – I

SECTION – A

1. There are 8 points in space and every pair connected through C. Without loss of generality we can choose 6 of them exactly at the mid-point of the remaining two: (1, 2, 3, 4, 5 and 6 are at same potential).

   Acceleration $C_{eff} = \frac{C}{2}\times 6 + C = 4C$.

2. For zero P.D. across galvanometer.

   $i_1R_1 = i_2R_2$

   and $L_1\frac{di_1}{dt} = L_2\frac{di_2}{dt}$

   Now, $i_2 \propto di_2$

   and $i_1 \propto di_1$

   $\Rightarrow \frac{L_1}{L_2} = \frac{R_1}{R_2} \Rightarrow \frac{3}{L} = \frac{2}{4}$

   or L = 6 mH.

3. For any system of particles,

   $KE = \frac{1}{2}MV_{CM}^2 + \frac{1}{2}\sum M_i V_{iCM}^2$

   First term of RHS is frame dependent, second term is not frame dependent.
   Loss in KE is any frame is same as loss of KE in C.M. frame. The first term doesn't change during collision.

4. $I' = I\cos^2(D\phi/2)$

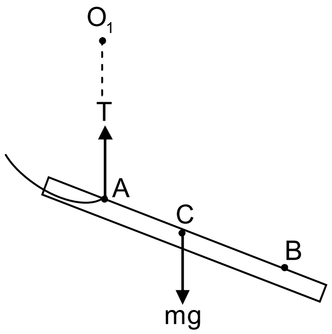
   $D\phi = \frac{2\pi}{\lambda}.Dx = \frac{2\pi}{\lambda}.\frac{dy}{D} = \frac{2\pi y}{\beta} = \frac{2\pi}{\beta}.\frac{\beta}{4} = \frac{\pi}{2}$

   $\Rightarrow I' = I\cos^2\left(\frac{\pi}{4}\right) = \frac{I}{2}$

5. Charge –Q is uniformly distributed at inner surface of cavity and +Q is uniformly distributed at outer surface. Outside energy is same as shell.

6. For a point source wave front is always spherical, after passing through lens shape becomes plane in case of convex lens as object lies on focus, but in case of concave lens it remains spherical with greater curvature.

7. FBD of rod just after the string is burnt is shown. Net force is vertical so the acceleration is vertical. Motion of point A is circular. Initial angular velocity is zero thus the radial acceleration which is vertical is zero.



8. Force of electric field is always along x-axis but force of magnetic field is always in y-z plane. Speed in y-z plane remains constant as magnetic field does not change speed.

9. $k_{max} = h\nu - \phi$

$k'_{max} = \frac{h\nu}{2} - \phi$

electrons are ejected only if $\frac{h\nu}{2} > \phi$

and $k'_{max} = \frac{k_{max}}{2} - \frac{\phi}{2} < \frac{k_{max}}{2}$

10. Considering the velocities in river frame, point B appears to move left with a velocity V_r while boat has a velocity V_{br} always towards A.

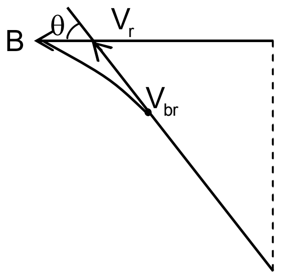
Velocity of approach = $V_{br} - V_r \cos\theta$

$$\Rightarrow \int_0^T (V_{br} - V_r \cos\theta)dt = W \quad ....(1)$$

Also:

$$V_r T = \int_0^T V_{br} \cos\theta dt \quad ....(2)$$

($\because$ equating x-coordinate).



From (1) and (2):

$$\Rightarrow \ V_{br}T - \frac{V_r^2}{V_{br}}T = W$$

or $T = \frac{WV_{br}}{V_{br}^2 - V_r^2}$

11. As time passes, θ decreases, initial θ is 90°. The net speed is given by:

$$V_b = \sqrt{V_{br}^2 + V_r^2 + 2V_rV_{br}\cos(180° - \theta)}$$

$= \sqrt{V_{br}^2 + V_r^2 - 2V_rV_{br}\cos\theta}$.

12-14. [A and B are always at same temperature as piston is diathermic].

For whole gas system $\Delta Q = 0$, ΔW = –Ve(as work done by gas in right is more –ve than +ve work done by gas in left) $\Rightarrow \Delta U$ = +Ve

SECTION – B

1. C.M. of the cube comes down through a height of √3 m while C.M. of displaced water goes up by a height of $\frac{\sqrt{3}}{2}$ m.

$\Rightarrow$ Loss in PE of cube = 2000 × 10 × $\sqrt{3}$ Joule.

$= 2\sqrt{3} \times 10^4$ Joule.

Gain in PE of water = $1000 \times 10 \times \frac{\sqrt{3}}{2} = \frac{\sqrt{3}}{2} \times 10^4$ Joule.

Using work energy theorem:

$W_T + W_{Gravity} = 0$

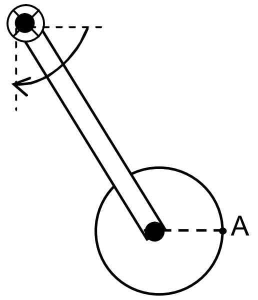
or $W_T = -W_{\text{Gravity}} = \Delta PE = \left(\frac{\sqrt{3}}{2} - 2\sqrt{3}\right) \times 10^4 = \frac{-3\sqrt{3}}{2} \times 10^4$ Joule.

SECTION – C

2. Motion of disc is only a pure translational motion, as torque on disc about C is always zero, even if C is accelerated. When rod becomes vertical, A remains horizontally to the right of C. Velocity of whole disc is same as C. Net velocity of disc be V.
Loss in potential energy = Gain in kinetic energy

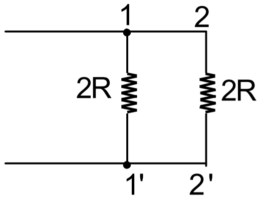
$$mg\left(\frac{3r}{2}\right) + mg3r = \frac{1}{2}\left[\frac{m(3r)^2}{3}\right]\left(\frac{V}{3r}\right)^2 + \frac{1}{2}mV^2$$

$$\Rightarrow V = \sqrt{\frac{27}{4}gr} = 9 \text{ m/s.}$$



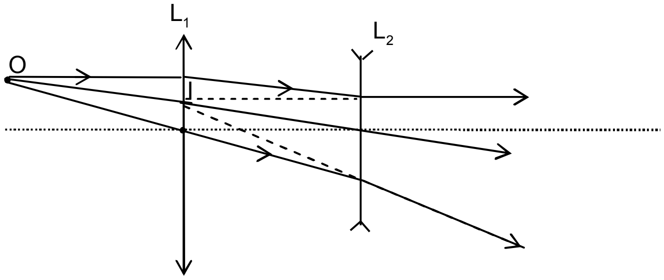
3. $V_{22'} = \eta V_{11'}$
$V_{33'} = \eta V_{22'} = \eta^2 V_{11'}$
So on, $V_{44'} = \eta^3 V_{11'}$

$$\Rightarrow 2 = \eta^3(16) \Rightarrow \eta = \frac{1}{2}$$



It means potential get equally divided in consecutive sections.
The equivalent arrangement is

4. After crossing L_1, rays become parallel and crossing L_2 the rays diverge to create image point at it's focal plane which is x = 0. Ray crossing optical centre of L_2 passes undeviated and y coordinate of this ray is focal plane of L_2 gives y coordinate of image, which is $\frac{1}{2}(6\text{mm}) = 3\text{mm}$.



5. $$\vec{r} = A\left(\frac{1+\cos^2\omega t}{2}\right)\hat{i} + B\left(\frac{1-\cos^2\omega t}{2}\right)\hat{j}$$

$$= \frac{A}{2}\hat{i} + \frac{B}{2}\hat{j} + \left(\frac{A}{2}\hat{i} - \frac{B}{2}\hat{j}\right)\cos\omega t = \vec{r}_0 + \vec{\alpha}\sin(\omega t + \frac{A}{2})$$

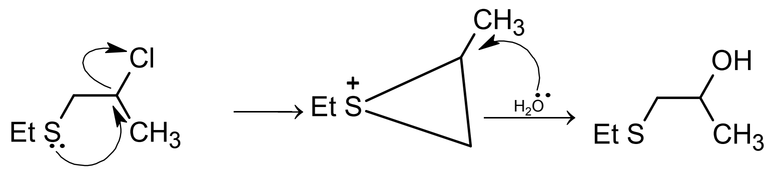
Amplitude is $|\vec{\alpha}| = \frac{\sqrt{A^2 + B^2}}{2} = 5$.

Chemistry

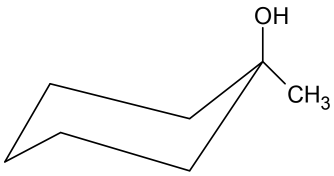
PART – II

SECTION – A

1.



2.



Give 3° carbocation as intermediate while other gives 2° carbocation.

4. $KI + I_2 \longrightarrow KI_3$

6. $r = \frac{0.529 \times n^2}{1} A^\circ$

$\therefore$ 0.529 $[(n + 1)^2 – n^2]$ = 0.529 $(n - 1)^2$
on solving, n = 4

13. $\kappa = \Lambda_m.C = \frac{\Lambda_m \times M}{1000} = \frac{200 \times 0.04}{1000}$

$= 8 \times 10^{-3}\ S\ cm^{-1}$

$\kappa = G\left(\frac{\ell}{A}\right) \Rightarrow 8 \times 10^{-3} = G\left(\frac{0.50}{2}\right)$

G = 0.032 S, V = IR $\Rightarrow$ I/G
I = 5 × 0.032 = 0.16 A

SECTION –C

1. $d(kE) = mv.dv = mv\frac{h}{4\pi m\Delta x}$

$$= \frac{3 \times 10^8}{3} \times \frac{6.62 \times 10^{-34}}{4 \times \pi \times \frac{3.31}{\pi} \times 10^{-12}}$$

$= 5 \times 10^{-16} J$

2. $T_B = \frac{a}{Rb} = \frac{3.6}{0.08 \times 0.6} = 75k$

$\frac{75}{15} = 5K$

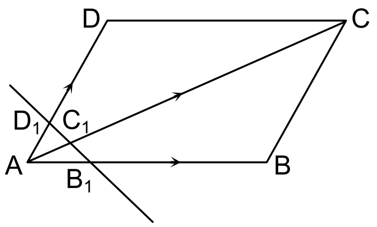
3. NaCN, Na_3PO_4, Na_2CO_3, $NaHCO_3$, $Na_2C_2O_4$, Na_2HPO_4

4. $\Delta G^\circ = – 2.303\ RT \log K$

5. Fact

Mathematics PART – III

SECTION – A



1. Let $\overrightarrow{AB} = \vec{a}$, $\overrightarrow{AD} = \vec{b}$, then $\overrightarrow{AC} = \vec{a} + \vec{b}$

Given, $\overrightarrow{AB_1} = \lambda_1\vec{a}$, $\overrightarrow{AD_1} = \lambda_2\vec{b}$, $\overrightarrow{AC_1} = \lambda_3\left(\vec{a} + \vec{b}\right)$

$\overrightarrow{B_1D_1} = \overrightarrow{AD_1} - \overrightarrow{AB_1} = \lambda_2\vec{b} - \lambda_1\vec{a}$

Since, vectors $\overrightarrow{D_1C_1}$ and $\overrightarrow{B_1D_1}$ are collinear

$\overrightarrow{D_1C_1} = k\overrightarrow{B_1D_1}$

$\Rightarrow \lambda_3\left(\vec{a} + \vec{b}\right) - \lambda_2\vec{b} = k\left(\lambda_2\vec{b} - \lambda_1\vec{a}\right)$

$\Rightarrow \lambda_3 = -k\lambda_1$ and $\lambda_3 - \lambda_2 = k\lambda_2$

$\Rightarrow k = \dfrac{-\lambda_3}{\lambda_1} = \dfrac{\lambda_3 - \lambda_2}{\lambda_2} \Rightarrow \lambda_1\lambda_2 = \lambda_1\lambda_3 + \lambda_2\lambda_3$

$\Rightarrow \dfrac{1}{\lambda_3} = \dfrac{1}{\lambda_1} + \dfrac{1}{\lambda_2}$

2. $$\det\det\left(f(\theta+\phi)\right) = \begin{vmatrix} \cos(\theta+\phi) & -\sin(\theta+\phi) & 0 \\ \sin(\theta+\phi) & \cos(\theta+\phi) & 0 \\ 0 & 0 & 1 \end{vmatrix} = \cos^2(\theta+\phi) + \sin^2(\theta+\phi) = 1$$

3. Given $\vec{p} = \vec{a} + \vec{b} - 2\vec{c}$

$\vec{q} = 3\vec{a} - 2\vec{b} + \vec{c}$

and $\vec{r} = \vec{a} - 4\vec{b} + 2\vec{c}$

Given $v_1 = \left[\vec{a}\vec{b}\vec{c}\right]$ ..... (1)

$$v_2 = \left[\vec{p}\vec{q}\vec{r}\right] = \begin{vmatrix} 1 & 1 & -2 \\ 3 & -2 & 1 \\ 1 & -4 & 2 \end{vmatrix}\left[\vec{a}\vec{b}\vec{c}\right]$$

$v_2 = 15\left[\vec{a}\vec{b}\vec{c}\right]$ ..... (2)

From (1) and (2) $v_2 : v_1 = 15 : 1$

4. $\dfrac{1}{2}\begin{vmatrix} 1 & 5 & 1 \\ 7 & -2 & 1 \\ \alpha & \beta & 1 \end{vmatrix} = 2$ where (α, β) divides PQ in K : 1

5. $$\frac{\cos x \tan x}{k^2} + \frac{1}{\tan x} + \frac{\sin x}{1+\cos x} = \frac{\sin x}{k^2} + \frac{\cos x(1+\cos x) + \sin^2 x}{\sin x(1+\cos x)} = \frac{a}{k} + \frac{1}{\sin x} = \frac{a}{k} + \frac{1}{ak}$$

6. Let θ be the angle opposite to side c of ΔABC

$\therefore c^2 = a^2 + b^2 - 2ab\cos\theta = (a-b)^2 + 2ab(1-\cos\theta)$

Also, $\Delta = \dfrac{1}{2}ab\sin\theta \Rightarrow 2ab = \dfrac{4\Delta}{\sin\theta}$

$\Rightarrow c^2 = (a-b)^2 + 4\Delta\dfrac{1-\cos\theta}{\sin\theta} = (a-b)^2 + 4\Delta\tan\dfrac{\theta}{2}$

For c to be minimum, a = b

$\therefore$ 2ab = $2a^2$ = $\dfrac{4\Delta}{\sin\theta}$

$\therefore\ a = b = \sqrt{\dfrac{2\Delta}{\sin\theta}}$

7. Here, $\lim\limits_{x\to0^+} f(x) = \lim\limits_{x\to0^+}\dfrac{\tan^2 x}{x} = 1$

and $\lim\limits_{x\to0^-} f(x) = \sqrt{\cot 1}\ \left(\because \lim\limits_{x\to0^-}\{x\} = -1\right)$

8. Take log on both sides and $\log_3 x = t$

$(t-1)\left(t-\dfrac{1}{2}\right)(t-3) = 0$, $x = \sqrt{3}$, 3, 27

9. $\sin^2 x - \cos^2 x = -\cos 2x \le 1$

$\sqrt{\dfrac{6}{5}}\left(\dfrac{1}{\sqrt{2}}\sin x + \dfrac{1}{\sqrt{3}}\cos x\right) = \dfrac{\sqrt{3}}{\sqrt{5}}\sin x + \dfrac{\sqrt{2}}{\sqrt{5}}\cos x$ = sin x · sin ϕ + cos x cos ϕ

Where $\sin\phi = \sqrt{\dfrac{3}{5}},\ \cos\phi = \sqrt{\dfrac{2}{5}}$ = $\cos(x-\phi) \le 1$

$\cos^6 x + \sin^6 x = (\cos^2 x)^3 + (\sin^2 x)^3$ = 1 – 3 $\sin^2 x \cos^2 x$ = $1 - \dfrac{3}{4}(\sin 2x)^2 \le 1$

$\cos^2 x + \sin^4 x = 1 - \dfrac{(\sin 2x)^2}{4} \le 1$

10. f(x) $\le$ 0 and F′(x) = f(x)

$\Rightarrow$ f(x) $\ge$ cF(x) $\Rightarrow \dfrac{d}{dx}\left(e^{-cx}.F(x)\right) \ge 0$

$\Rightarrow e^{-cs}$ F(x) is an increasing function

$\Rightarrow e^{-cs}$ F(x) $\ge e^{-c(0)}$ F(0)

$\Rightarrow$ F(x) $\ge$ 0 $\Rightarrow$ f(x) $\ge$ 0

$\Rightarrow$ f(x) = 0

Also, $\dfrac{d}{dx}\left(e^{-x}\ g(x)\right) < 0$

$\Rightarrow e^{-x}$ g(x) is a decreasing function

$\Rightarrow e^{-x}$ g(x) < $e^{-(0)}$ g(0)

$\Rightarrow$ g(x) < 0 (as g(0) = 0)

Hence, f(x) = g(x) has one solution x = 0

11. $|x^2 + x - 6|$ = f(x) + g(x) = g(x)

$\Rightarrow$ No solution

12.-14. Total number of words
(1) 3 like, 1 different = 20
(2) 2 like, 2 like = 6
(3) 2 like, 2 different = 240
(4) all different = 360

SECTION – B

1. (A) $|\cot x| = \cot x + \frac{1}{\sin x}$

If $0 < x < \frac{\pi}{2} \Rightarrow \cot x > 0$

So, $\cot x = \cot x + \frac{1}{\sin x} \Rightarrow \frac{1}{\sin x} = 0$ (no solution)

If $\frac{\pi}{2} < \cot x < \pi$, $-\cot x = \cot x + \frac{1}{\sin x}$

$$\frac{2\cos x}{\sin x} + \frac{1}{\sin x} = 0$$

$1 + 2\cos x = 0$ and $\sin x \neq 0 \Rightarrow x = \frac{2\pi}{3}$

(C) $\sin^2\alpha + \sin\left(\frac{\pi}{3} - \alpha\right)\cdot\sin\left(\frac{\pi}{3} + \alpha\right) = \sin^2\alpha + \sin^2\frac{\pi}{3} - \sin^2\alpha = \frac{3}{4}$

(D) $\tan\theta = 3\tan\phi$

$$\tan(\theta - \phi) = \frac{\tan\theta - \tan\phi}{1 + \tan\theta\tan\phi} = \frac{2\tan\phi}{1 + 3\tan^2\phi} = \frac{2}{\cot\phi + 3\tan\phi}$$

Max if $\tan\phi > 0$, $\frac{\cot\phi + 3\tan\phi}{2} \geq \sqrt{3}$ (using AM $\geq$ GM)

$\Rightarrow (\cot\phi + 3\tan\phi)^2 \geq 12 \Rightarrow \tan^2(\theta - \phi) \leq \frac{1}{3}$

2. (A) $\int \frac{x^4 - 1}{x^3\sqrt{x^4 + x^2 + 1}/x}dx$, Let $\frac{\sqrt{x^4 + x^2 + 1}}{x} = t$

$\int \frac{x^2\cdot\sqrt{x^4 + x^2 + 1}}{x^3\cdot t}dt$, $\left(\frac{x^4 - 1}{x^2\cdot\sqrt{x^4 + x^2 + 1}}\right)dx = dt$

$\int \frac{\sqrt{x^4 + x^2 + 1}}{x\cdot t}dt$, $(x^4 - 1)dx = x^2\cdot\sqrt{x^4 + x^2 + 1}\,dt$

$\int \frac{t}{t}dt$, $\int dt = t + C = \frac{\sqrt{x^4 + x^2 + 1}}{x} + C$

(B) $\int \frac{(x^2 - 1)}{x\sqrt{1 + x^4}}dx$, $\int \frac{(x^2 - 1)}{x^2\sqrt{x^2 + \frac{1}{x^2}}}dx$, Let $x + \frac{1}{x} = t$, $\left(1 - \frac{1}{x^2}\right)dx = dt$

$\int \frac{dt}{\sqrt{t^2 - 2}} = \ln\left(t + \sqrt{t^2 - 2}\right) + C = \ln\left(x + \frac{1}{x} + \sqrt{\left(x + \frac{1}{x}\right)^2 - 2}\right) + C$

$\ln\left(\frac{(x^2 + 1) + \sqrt{1 + x^4}}{x}\right) + C$

(C) $\int \frac{(1+x^2)}{(1-x^2)\sqrt{1+x^4}}dx = \int \frac{\left(1+\frac{1}{x^2}\right)dx}{x\left(1-\frac{1}{x^2}\right)\sqrt{\frac{1}{x^2}+x^2}} = \int \frac{\left(1+\frac{1}{x^2}\right)dx}{\left(x-\frac{1}{x}\right)\sqrt{\left(x-\frac{1}{x}\right)^2+2}}$

Let $\left(x-\frac{1}{x}\right)=t$, $\left(1+\frac{1}{x^2}\right)dx=dt$, $\int \frac{dt}{t\sqrt{t^2+2}}$

Let $t^2 + 2 = y^2$, $2t\,dt = 2y\,dy$

$\int \frac{dy}{t^2} = \int \frac{dy}{(y^2-2)} = \frac{1}{2\cdot\sqrt{2}}\ln\left(\frac{y-\sqrt{2}}{y+\sqrt{2}}\right)+C = \frac{1}{2\sqrt{2}}\ln\left(\frac{\sqrt{t^2+2}-\sqrt{2}}{\sqrt{t^2+2}+\sqrt{2}}\right)+C$

$= \frac{1}{2\sqrt{2}}\ln\left(\frac{\left(\sqrt{t^2+2}-\sqrt{2}\right)^2}{t^2}\right)+C = \frac{1}{\sqrt{2}}\ln\left(\frac{\sqrt{t^2+2}-\sqrt{2}}{t}\right)+C$

$= \frac{1}{\sqrt{2}}\ln\left(\frac{\sqrt{\left(x-\frac{1}{x}\right)^2+2}-\sqrt{2}}{\left(x-\frac{1}{x}\right)}\right)+C = \frac{1}{\sqrt{2}}\ln\left(\frac{\sqrt{x^4+1}-\sqrt{2}x}{(x^2-1)}\right)+C$

(D) $\int \frac{dx}{(1+x^4)\sqrt{\sqrt{1+x^4}-x^2}} \Rightarrow \int \frac{dx}{x^5\left(1+\frac{1}{x^4}\right)\sqrt{\sqrt{1+\frac{1}{x^4}}-1}}$

Let $\sqrt{1+\frac{1}{x^4}}-1=t^2 \Rightarrow \frac{1}{2\sqrt{1+\frac{1}{x^4}}}\left(\frac{-4}{x^5}\right)dx = 2tdt \Rightarrow \frac{dx}{x^5} = -t\sqrt{1+\frac{1}{x^4}}\,dt$

$\Rightarrow \int \frac{-t\sqrt{1+\frac{1}{x^4}}dt}{\left(1+\frac{1}{x^4}\right)t} \Rightarrow -\int \frac{dt}{\sqrt{1+\frac{1}{x^4}}} \Rightarrow -\int \frac{dt}{(t^2+1)} \Rightarrow -\tan^{-1}t+C \Rightarrow C-\tan^{-1}\left(\sqrt{\sqrt{1+\frac{1}{x^4}}-1}\right)$

SECTION – C

1. On substituting $x = \frac{4}{9}$, we get 0 < a < 1

$\Rightarrow \log_a(x^2 - x + 2) > \log_a(-x^2 + 2x + 3) \equiv 0 < x^2 - x + 2 < -x^2 + 2x + 3$

$\Rightarrow \frac{3-\sqrt{17}}{4} < x < \frac{3+\sqrt{17}}{4}$

2. $\left[\vec{u}\ \vec{v}\ \vec{w}\right] = \vec{u}\cdot(\vec{v}\times\vec{w}) = |\vec{u}||\vec{v}\times\vec{w}|\cos\theta$

For maximum value, $\theta = 0°$

$\therefore\ p = |\vec{v}\times\vec{w}| = \sqrt{59}$

3. $I = \int e^x \left(\frac{1}{(1-x)\sqrt{1-x^2}} + \sqrt{\frac{1+x}{1-x}} \right) dx$

Now, $\frac{d}{dx}\left(\sqrt{\frac{1+x}{1-x}}\right) = \frac{1}{(1-x)\sqrt{1-x^2}}$

$\Rightarrow I = e^x \left(\frac{1+x}{1-x}\right)^{1/2} + c$

$\Rightarrow \mu = 1,\ \lambda = \frac{1}{2}$

4. LHS = $\begin{vmatrix} 2ka\cos A & kc & kb \\ kc & 2kb\cos B & ka \\ kb & ka & 2kc\cos C \end{vmatrix}$ (From sine rule)

$= k^3 \begin{vmatrix} 2a\cos A & c & b \\ c & 2b\cos B & a \\ b & a & 2c\cos C \end{vmatrix}$

$= k^3 \begin{vmatrix} \cos A & a & 0 \\ \cos B & b & 0 \\ \cos C & c & 0 \end{vmatrix} \begin{vmatrix} a & \cos A & 0 \\ b & \cos B & 0 \\ c & \cos C & 0 \end{vmatrix} = 0$

$\Rightarrow \lambda = 0$

5. Here, $\log_{|x-1|}\left|x^2 - 1\right| = 1$

$\Rightarrow \left|x^2 - 1\right| = |x-1|$

$\Rightarrow x = 1, 0, -2$ but $x \neq 0, 1$

$\Rightarrow$ Number of solutions is one

FIITJEE JEE (Main), 2015

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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ALL INDIA TEST SERIES

FULL TEST – V

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 30)** contains 30 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10$ m/s^2
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N-m^2
Density of water	$\rho_{water} = 10^3$ kg/m^3
Atmospheric pressure	$P_a = 10^5$ N/m^2
Gas constant	$R = 8.314$ J K^{-1} mol^{-1}

CHEMISTRY

Gas Constant	R	=	8.314 J K^{-1} mol^{-1}
		=	0.0821 Lit atm K^{-1} mol^{-1}
		=	1.987 ≈ 2 Cal K^{-1} mol^{-1}
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

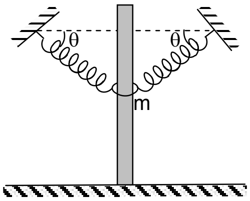
Physics

PART – I

SECTION – A

Single Correct Choice Type

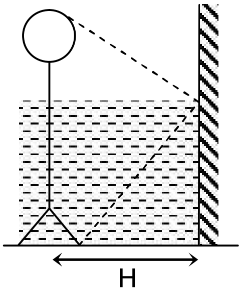
This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.



1. A ring of mass m can freely slide on a smooth vertical rod. The ring is symmetrically attached with two springs (as shown in the figure). Each of spring constant k. Each spring makes an angle θ with the horizontal. If the ring is slightly displaced vertically, its time period is:

(A) $2\pi\sqrt{\frac{m}{2k}}$ (B) $2\pi\sqrt{\frac{m}{k}}$

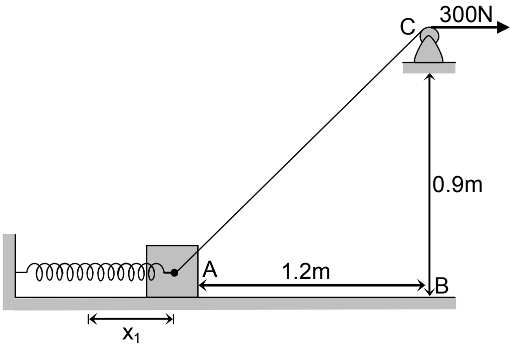
(C) $2\pi\sqrt{\frac{2m}{k\sin^2\theta}}$ (D) $2\pi\sqrt{\frac{m}{2k\sin^2\theta}}$.



2. A man of height H stands in front of a plane mirror. Water has been filled upto a height 3H/4. The man can just see his foot in the mirror placed parallel in front of him. What is the refractive index of water?

(A) $\frac{20}{3\sqrt{17}}$ (B) $\frac{5}{3\sqrt{17}}$

(C) $\frac{4}{3\sqrt{17}}$ (D) $\frac{5}{\sqrt{17}}$

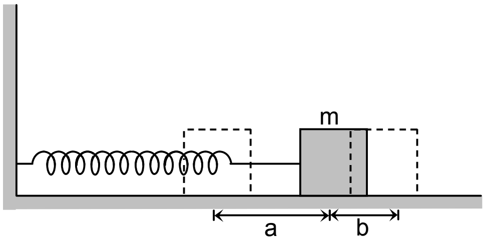


3. A 590 kg block at A moves along the horizontal surface with negligible friction under the action of the constant 300 N force in the cable. The block is released from rest at A, with the spring to which it is attached extended an initial amount x_1 = 0.3 m. The spring has a stiffness constant, K = 80 N/m. The kinetic energy of the block as it reaches position B is:

(A) 86.4 J
(B) 180 J
(C) 93.6 J
(D) None of these

Space for Rough work

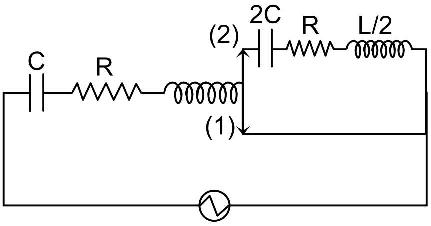
4. A mass-spring system as shown in the figure oscillates such that the mass moves on a rough surface having coefficient of friction μ. It is compressed by a distance a from its normal length and, on being released. It moves to a distance b from its equilibrium position. The decrease in amplitude for one half-cycle (–a to b) is:



(A) $\frac{\mu mg}{K}$
(B) $\frac{2\mu mg}{K}$
(C) $\frac{\mu g}{K}$
(D) None of these

5. In a series LR circuit, the frequency of the AC source increases. Which of the following options is correct?
(A) The phase difference between the current and the voltage increases.
(B) The power factor increases.
(C) The amplitude of the current increases.
(D) The amplitude of potential drop across the inductor decreases.

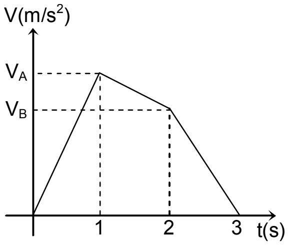
6. In the diagram shown, when the switch is at position 1 then the frequency of maximum current from the battery is ω. What will be the frequency of maximum current from the battery when the switch is at 2?



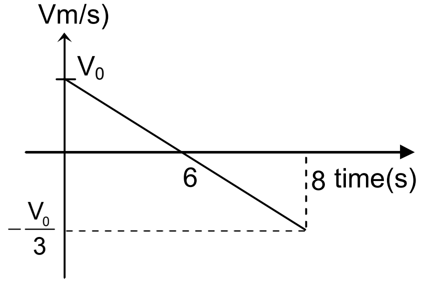
(A) ω
(B) 2ω
(C) $\omega/\sqrt{3}$
(D) None of these

Space for Rough work

7. Consider the velocity versus time graph of particle moving on a straight line. The average velocity on the 1st one second is V_1m/s and the average velocity on the 2nd one second is V_2 m/s.
What is the average velocity on the last one second?
(A) $V_2 - V_1$
(B) $(V_2 + V_1)/2$
(C) $2V_2$
(D) None of these



8. The velocity versus time graph of a particle is given.
If the total displacement of the particle is 4m then what is the initial velocity of the particle?
(A) 1.0 m/s
(B) 1.1 m/s
(C) 1.5 m/s
(D) None of these



9. The potential energy of harmonic oscillator of mass 2 kg in its mean position is 5J. If its total energy is 9J and its amplitude is 0.01m, its time period will be:

(A) $\frac{\pi}{100}$s
(B) $\frac{\pi}{50}$s
(C) $\frac{\pi}{20}$s
(D) $\frac{\pi}{10}$s

Space for Rough work

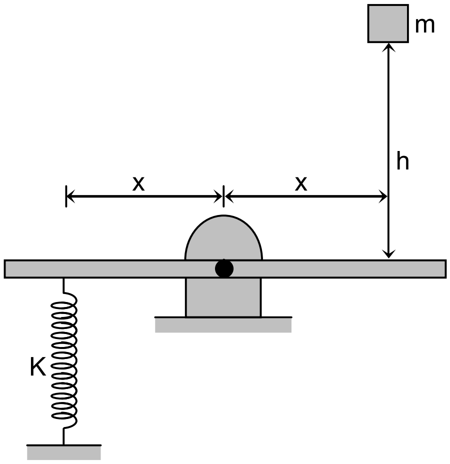
10. A crate of mass m falls from a height h onto the end of a platform, as shown in the figure. The spring is initially unstretched and the mass of the platform can be neglected. Assuming that there is no loss of energy, the maximum elongation of the spring is:

(A) $\dfrac{mg + \sqrt{m^2g^2 + 2mghK}}{K}$

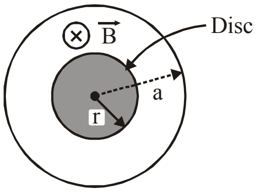
(B) $\dfrac{mg - \sqrt{m^2g^2 + 2mghK}}{K}$

(C) $\dfrac{K}{\sqrt{m^2g^2 + 2mghK}}$

(D) None of these

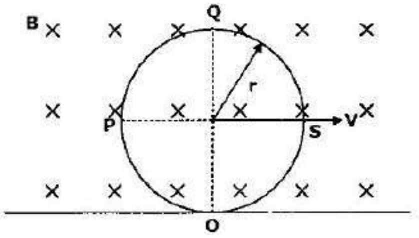


11. A uniform disc of radius r and mass m is charged uniformly with the charge q. This disc is placed flat on a rough horizontal surface having coefficient of friction μ. A uniform magnetic field is present in a circular region of radius a (> r) but varying as kt^3 as shown in figure. Find the time in second after which the disc begins to rotate. (Given r=1 m, m=18 kg, q=1C, μ=0.1, K=4, g=10 m/s^2)



(A) 2
(B) 4
(C) 8
(D) None of these

12. A conducting ring of radius r and resistance R rolls on a horizontal surface with constant velocity v. The magnetic field B is uniform normal to the plane of the loop.



(A) The induced emf, between O and Q is 2Bvr.

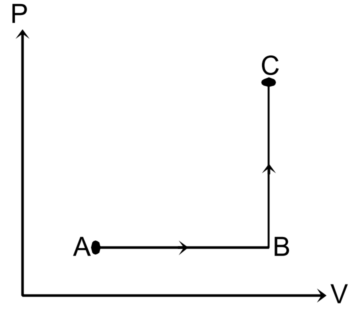
(B) An induced current $I = \dfrac{2Bvr}{R}$ flows in the clockwise direction.

(C) An induced current $I = \dfrac{2Bvr}{R}$ flows in the anticlockwise direction.

(D) None of these

Space for Rough work

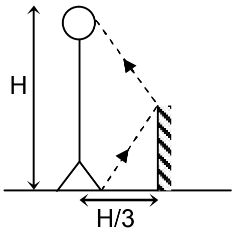
13. The P-V diagram of a system undergoing thermodynamic transformation as shown in the figure. The work done by the system in going from A $\rightarrow$ B $\rightarrow$ C is 30J and 4J heat is given to the system. The change in internal energy between A and C is
(A) 26 J
(B) – 26 J
(C) 34 J
(D) – 34 J



14. A sample of gas expands from volume V_1 to V_2. The amount of work done by the gas is greatest when the expansion is:
(A) Isothermal
(B) Isobaric
(C) Adiabatic
(D) Equal in all cases.

15. In a given process for an ideal gas, dW = 0 and dQ < 0. Then for the gas:
(A) The temperature will decrease
(B) The volume will increase
(C) The pressure will remain constant
(D) The temperature will increase.

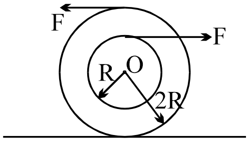
16. In the diagram shown, the length of the mirror is half of the height of the man. What length of his image can the man see in the mirror?
(A) H/3
(B) H/2
(C) H
(D) zero



17. Starting from rest at the same time, a coin and a ring roll down an incline without slipping. Which reaches the bottom of the incline first?
(A) The ring reaches the bottom first
(B) The coin reaches the bottom first
(C) They arrive at the bottom simultaneously
(D) The winner depends on the relative masses of the two

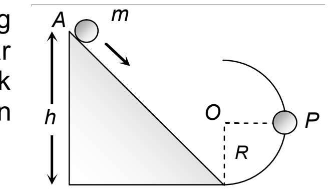
Space for Rough work

18. In the given figure F = 10 N, R = 1 m, mass of the body is 2 kg and moment of inertia of the body about an axis passing through O and perpendicular to plane of body 4kg-m^2. O is the centre of mass of the body. If the ground is smooth what is total kinetic energy of the body after 2 seconds



(A) 100 J (B) 75 J
(C) 50 J (D) 25 J

19. A solid ball of mass *m* and radius *r* rolls without slipping along the track shown in the fig. The radius of the circular part of the track is *R*. The ball starts rolling down the track from rest from a height of 8*R* from the ground level. When the ball reaches the point P then its velocity will be



(A) $\sqrt{gR}$ (B) $\sqrt{5gR}$
(C) $\sqrt{10gR}$ (D) $\sqrt{3gR}$

20. Three measurements are made as 18.425 cm, 7.21 cm and 5.00 cm. The addition should be written as:
(A) 30.635 cm (B) 30.64 cm
(C) 30.63 cm (D) 30.6 cm

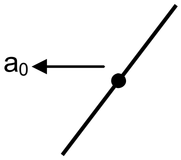
21. Two identical charged particles enter in a uniform magnetic field with same speed but at angles 30° and 60° with field. Let a, b and c be the ratio of their time periods, radii and pitches of the helical paths then:
(A) abc = 1 (B) abc > 1
(C) abc < 1 (D) ab = c

22. The acceleration due to gravity on the surface of the moon is $\frac{1}{6}$ that on the surface of earth and the diameter of the moon is one-fourth that of earth. The ratio of escape velocities on earth and moon will be:
(A) $\frac{\sqrt{6}}{2}$ (B) $\sqrt{24}$
(C) 3 (D) $\frac{\sqrt{3}}{2}$

Space for Rough work

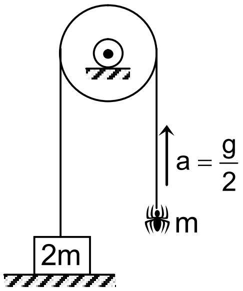
23. The greatest angle through which a man can oscillate on a swing the ropes of which can support twice his weight when at rest is:
(A) 90° (B) 60°
(C) 120° (D) 30°

24. A bead of mass m is fitted on a rod and can move on it without friction. Initially the bead is at the middle of the rod and the rod moves translationally in a horizontal plane with an acceleration a_0 in horizontal direction forming angle α with the rod. The acceleration of bead with respect to rod is:



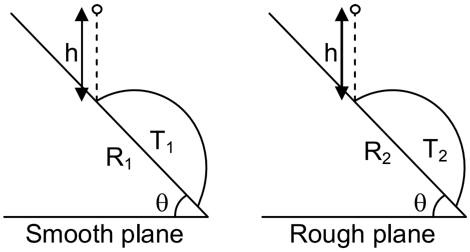
(A) $g \sin \alpha$ (B) $(g + a_0) \sin \alpha$
(C) $g \sin \alpha + a_0 \cos \alpha$ (D) $g \sin \alpha - a_0 \cos \alpha$

25. An insect of mass m crawls along the hanging thread with an acceleration $a = \frac{g}{2}$. The reaction offered by ground on the block of mass 2m is:



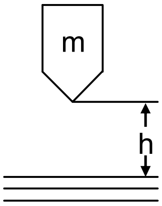
(A) $\frac{3mg}{2}$ (B) mg
(C) 2mg (D) $\frac{mg}{2}$

26. Two balls are dropped from same height h on a smooth plane and the other on a rough plane having same inclination θ with horizontal. Both the planes have same coefficient of restitution. If range and time of flight of first and second balls are R_1, T_1 and R_2, T_2 respectively, then:



(A) $T_1 = T_2, R_1 = R_2$
(B) $T_1 < T_2, R_1 < R_2$
(C) $T_1 = T_2, R_1 > R_2$
(D) $T_1 > T_2, R_1 > R_2$

27. An iron nail is falling from a height h. If it penetrates through a distance x into the sand, the average resistance of the sand is:



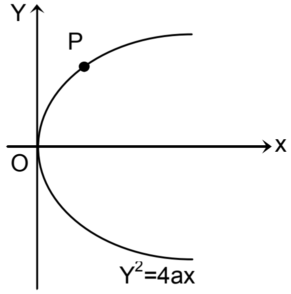
(A) $mg\frac{h}{x}$ (B) $mg\left(\frac{h}{x}+1\right)$
(C) $mg\frac{x}{h}$ (D) mg

Space for Rough work

28. A ray of light traveling in a medium of refractive index n_1 is incident on a medium of refractive index $n_2 (< n_1)$ at an angle of incidence 'θ'. The reflected and refracted rays make an angle of 120° with each other. Then the critical angle for the boundary separating the two media is:

(A) $\sin^{-1}\left(\frac{1}{2}\tan\theta\right)$
(B) $\sin^{-1}\left(\frac{1}{\sqrt{3}+\tan\theta}\right)$
(C) $\sin^{-1}\left(\frac{2\tan\theta}{\sqrt{3}-\tan\theta}\right)$
(D) $\sin^{-1}(2\cot\theta)$

29. A thin wire is bent into the shape of a parabola in the vertical plane as shown. A small bead 'P' can freely slide along the wire.
The coefficient of friction between the bead and the wire is 'μ'. The condition that bead does not slip on the wire is



(A) $y \geq 2a\mu$ (B) $y \geq \frac{2a}{\mu}$
(C) $y \leq 2a\mu$ (D) $y \leq \frac{2a}{\mu}$.

30. In a nuclear reactor, energy is produced by the following process :

$${}_1H^2 + {}_1H^2 \longrightarrow {}_1H^3 + P$$
$${}_1H^3 + {}_1H^2 \longrightarrow {}_2He^4 + n$$

The reactor produces a power of 10^{10} MW with 50% efficiency. Then the number of deutrons required to run the reactor for one year will be approximately :

$m({}_1H^2) = 2.014\,u$, $m(p) = 1.007\,u$, $m(n) = 1.008\,u$, $m({}_2He^4) = 4.001u$

(A) 5×10^{35}
(B) 5×10^{32}
(C) 5×10^{38}
(D) 5×10^{40}

Space for Rough work

Chemistry PART – II

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

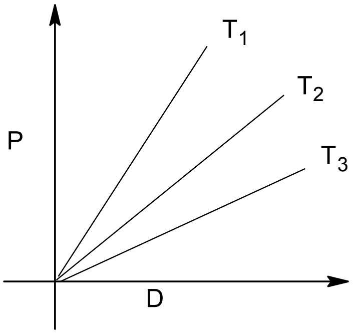
1. Lattice energies of BeF_2, MgF_2, CaF_2 and BaF_2 are –2906, –2610, –2459 and –2367 KJ/mol respectively. Hydration energies of Be^{2+}, Mg^{2+}, Ca^{2+}, Ba^{2+} and F^- are –2494, –1921, –1577, –1305 and –457 KJ mol^{-1} respectively. Which of the fluorides is not soluble in water?

(A) BeF_2	(B) MgF_2
(C) CaF_2	(D) BaF_2

2. The stability of dihalides of Si, Ge, Sn and Pb increases steadily in the sequence:

(A) $GeX_2 < SiX_2 < SnX_2 < PbX_2$	(B) $SiX_2 < GeX_2 < PbX_2 < SnX_2$
(C) $SiX_2 < GeX_2 < SnX_2 < PbX_2$	(D) $PbX_2 < SnX_2 < GeX_2 < SiX_2$

3. Pressure Vs. density curve for an ideal gas at three different temperatures T_1, T_2 and T_3 is shown below, which is correct relation here?



Which of these is correct?

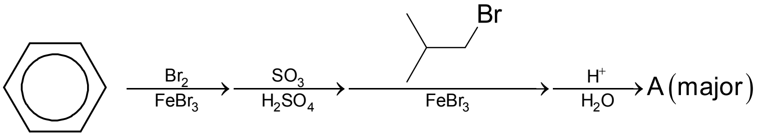
(A) $T_1 > T_2 > T_3$	(B) $T_1 > T_3 > T_2$
(C) $T_3 > T_2 > T_1$	(D) Can't be said

4. A metal oxide has the formula Z_2O_3. It can be reduced by hydrogen to give free metal and water. 0.16 g of the metal oxide requires 6 mg of hydrogen for complete reduction. The atomic weight of metal is

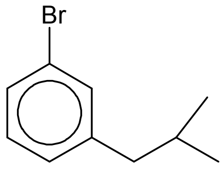
(A) 27.9	(B) 159.6
(C) 79.8	(D) 55.8

Space for Rough work

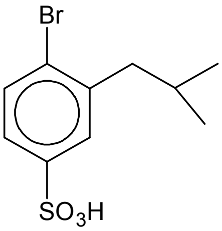
5. Give the major product from the following reaction sequence:


Br
Br2
FeBr3
SO3
H2SO4
FeBr3
H+
H2O
A (major)

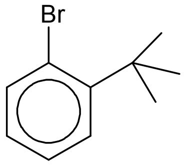
(A)



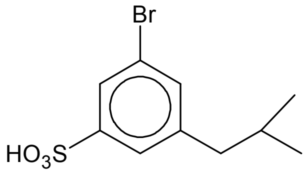
(B)



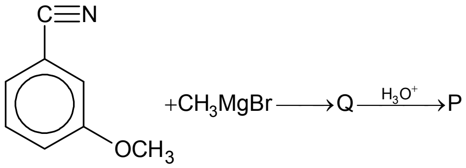
(C)



(D)

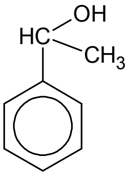


6.

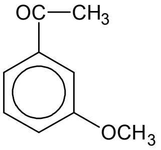

C≡N
OCH3
+CH3MgBr
Q
H3O+
P

The product ‘P’ in the above reaction is

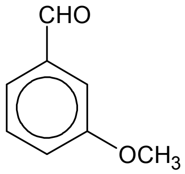
(A)



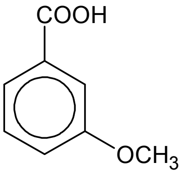
(B)



(C)



(D)



7. In an open-end manometer, one end filled with mercury is attached to a gas-filled container and the other end is open to the atmosphere. If the gas pressure in the container is less than atmospheric pressure.

(A) The Hg level will be higher in the arm open to the atmosphere
(B) Hg will be forced out of the open and of the U-tube.
(C) The difference between the Hg levels in the two arms will be greater than 76 cm.
(D) The Hg level will be higher in the arm connected to the container.

Space for Rough work

8. 100 ml of $NaHC_2O_4$ required 50 ml of 0.1 M $KMnO_4$ solution in acidic medium. Volume of 0.1 M NaOH required by 100 ml of $NaHC_2O_4$ is:

(A) 50 ml (B) 100 ml
(C) 125 ml (D) 150 ml

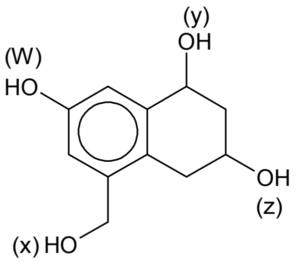
9. Ratio of σ and π bonds is maximum in

(A) Naphthalene (B) Tetra Cyanomethane
(C) Enolic form of urea (D) Equal in all

10. Which of the following statement is true for $CsBr_3$?

(A) It is a covalent compound (B) It contains Cs^{3+} and Br^{-1}
(C) It contains Cs^{+} and Br_3^{-} (D) It contains Cs^{+}, Br^{-} and lattice Br^{2} molecule

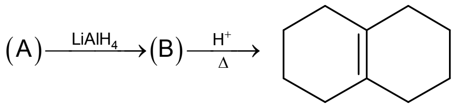
11.



Decreasing order of acidic strength of different (- OH) group is:

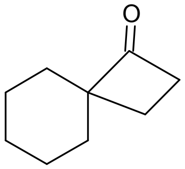
(A) w > x > y > z (B) w > z > x > y
(C) z > w > x > y (D) z > x > w > y

12.

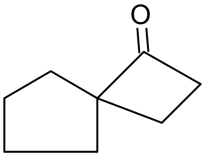


What is (A)?

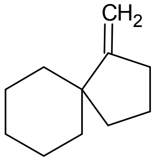
(A)



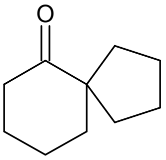
(B)



(C)

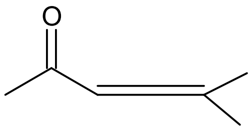


(D)



Space for Rough work

13. (P) $\xrightarrow[\Delta]{KOH}$



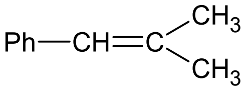
(Q) $\xrightarrow[\Delta]{KOH}$ $Ph-CH_2-OH + Ph-COO^{\ominus}K$

(R) $\xrightarrow{O_3}$ $P + Q$

What is the structure of (R):

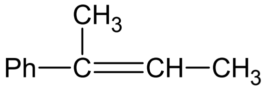
(A) $Ph-CH=CH-CH_3$

(B)



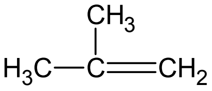
$Ph-CH=C(CH_3)_2$

(C)



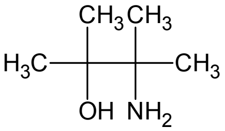
$Ph-C(CH_3)=CH-CH_3$

(D)



$H_3C-C(CH_3)=CH_2$

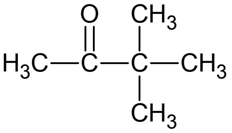
14.



$H_3C-C(CH_3)(OH)-C(CH_3)(NH_2)-CH_3$ $\xrightarrow[HCl]{NaNO_2}$ (A)

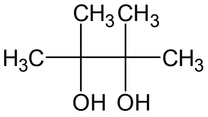
Product (A) is:

(A)



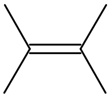
$H_3C-CO-C(CH_3)_2-CH_3$

(B)

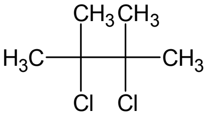


$H_3C-C(CH_3)(OH)-C(CH_3)(OH)-CH_3$

(C)



(D)



$H_3C-C(CH_3)(Cl)-C(CH_3)(Cl)-CH_3$

15. HNO_3 in pure state is colorless but it is often of yellow color. It is due to

(A) Unstable structure of HNO_3 which immediately changes to NO_2^-

(B) Photochemical decomposition in presence of sunlight

(C) Interaction of atmospheric gases with HNO_3

(D) Conversion of HNO_3 into NO_2^+

16. When K_2CrO_4 is added to $CuSO_4$ solution, there is formation of $CuCrO_4$ as well as $CuCr_2O_7$. Formation of $CuCr_2O_7$ is due to

(A) Basic nature of $CuSO_4$ solution which converts CrO_4^{2-} to $Cr_2O_7^{2-}$

(B) Acidic nature of $CuSO_4$ solution which converts CrO_4^{2-} to $Cr_2O_7^{2-}$

(C) $CuSO_4$ has the typical property of converting $CuCrO_4$ formed to $CuCr_2O_7$

(D) 10 $CuCr_2O_7$ is formed

Space for Rough work

17. A large excess of MgF_2(s) is maintained in contact with 1 lit of pure water to produce a saturated solution. When an additional 1 lit. of pure water is added to the solid-liquid mixture and equilibrium re-established, compared to its value in the original saturated solution $\left[Mg^{2+}\right]$ will be:

(A) The same (B) twice as large
(C) three times as large (D) half as large

18. A mixture of 2 colourless substances was dissolved in water. When gaseous Cl_2 was passed through the solution, a deep brown color developed. Addition of $BaCl_2$ or NaOH to the original solution give a white precipitate. The mixture contained.

(A) $NaNO_3$ and $AlCl_3$ (B) NaBr and KCl
(C) MgI_2 and $MgSoO_4$ (D) $BaSO_4$ and $PbCl_2$

19. $(Ag+Pb)\text{alloy} \xrightarrow[\text{add zinc}]{\text{melt and}} (Ag+Pb+Zn)\text{melt} \xrightarrow{\text{Cool}} \frac{\text{layer X}}{\text{layer Y}}$

Select correct statement based on above scheme.
(A) Layer X contain zinc and silver
(B) Layer Y contains lead and silver but amount of silver in this layer is smaller than in the layer X
(C) 'X' and 'Y' are immisible liquids
(D) All are correct

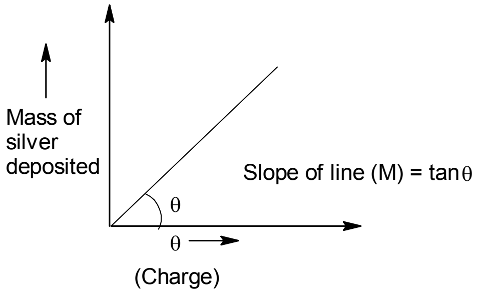
20. What is the molarity of HCl in a solution prepared by dissolving 5.5 g HCl in 200 g ethanol if the density of the solution is 0.79 g/ml?

(A) 2.1 M (B) 0.93 M
(C) 1.7 M (D) 0.58 M

21. Select the incorrect statement among the folloing:
(A) Nearest neighbour distance in NaCl = a/2
(B) Nearest neighbour distance in $CaF_2 = \frac{a\sqrt{3}}{4}$
(C) Nearest neighbour distance in CsCl = $\frac{a}{2}$
(D) Nearest neighbour distance in Na_2O = $\frac{a\sqrt{3}}{4}$

Space for Rough work

22. In the electrolysis of $AgNO_3$, the mass of silver deposited is plotted against the charge:

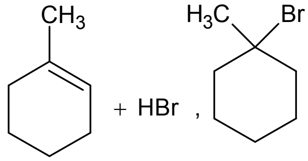


Slope of the line gives:

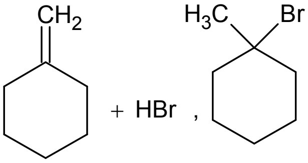
(A) The equivalent mass of silver
(B) Electrochemical equivalent of silver
(C) the value of Faraday
(D) the current passed through the cell

23. Which of the following is not correctly matched?

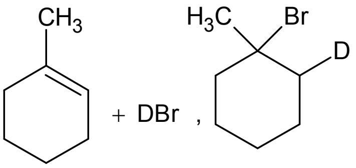
(A)


CH3
H3C
Br
+ HBr ,

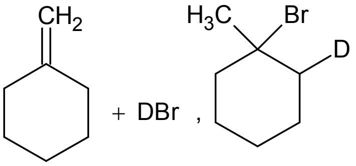
(B)


CH2
H3C
Br
+ HBr ,

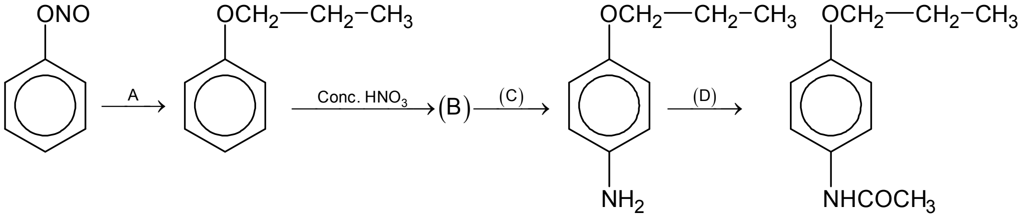
(C)


CH3
H3C
Br
D
+ DBr ,

(D)


CH2
H3C
Br
D
+ DBr ,

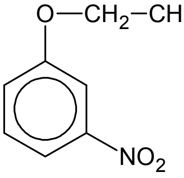
24.


ONO
A
OCH2—CH2–CH3
Conc. HNO3
(B)
(C)
OCH2—CH2–CH3
NH2
(D)
OCH2—CH2–CH3
NHCOCH3

In the given reaction

(I) A is $CH_3-CH_2-CH_2-Br$

(II) B is


O—CH2–CH2—CH3
NO2

(III) C is Sn/HCl

(IV) D is $(CH_3CO)_2O$

Out of these which are correct?

(A) (I) and (II)
(B) (I) and (III)
(C) (I), (III) and (IV)
(D) (I), (II), (III) and (IV)

Space for Rough work

25. Match List-I and List – II and select the correct answer using the codes given below the lists:

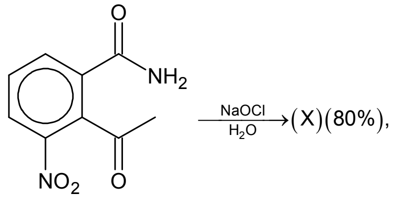
(a)	α-D and β-D glucose	(1)	Enantiomers
(b)	D-glucose and D-galactose	(2)	Anomers
(c)	Erythose and threose	(3)	Epimers
(d)	D-glyceraldehyde and L-glyceraldehyde	(4)	Diasteromers

(A) (a $\rightarrow$ 3), (b $\rightarrow$ 2), (c $\rightarrow$ 1), (d $\rightarrow$ 4)
(B) (a $\rightarrow$ 2), (b $\rightarrow$ 3), (c $\rightarrow$ 4), (d $\rightarrow$ 1)
(C) (a $\rightarrow$ 3), (b $\rightarrow$ 2), (c $\rightarrow$ 4), (d $\rightarrow$ 1)
(D) (a $\rightarrow$ 2), (b $\rightarrow$ 3), (c $\rightarrow$ 1), (d $\rightarrow$ 4)

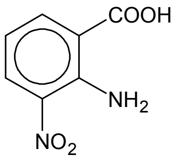
26. Which of the following statements is wrong for inter halogen?
(A) The value of n is AX_n (inter halogen) can be 1, 3, 5 or 7
(B) The value of n is AX_n (inter halogen) can be 2, 4 or 6
(C) A can never be fluorine as it is most electronegative halogen
(D) X can never be iodine as it is least electronegative halogen

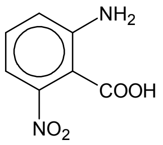
27. What are the products formed in the reaction of Xenon hexafluoride with silica?
(A) $XeSiO_4$ + HF
(B) $XeF_2 + SiF_4$
(C) $XeOF_4 + SiF_4$
(D) $XeO_3 + SiF_4$

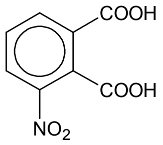
28. The straight chain polymer is formed
(A) hydrolysis is CH_3SiCl_3 followed by condensation polymerisation
(B) hydrolysis of $(CH_3)_4Si$ followed by addition polymerisation
(C) hydrolysis of $(CH_3)_2SiCl_2$ followed by condensation polymerisation
(D) hydrolysis of $(CH_3)_3SiCl$ followed by condensation polymerisation

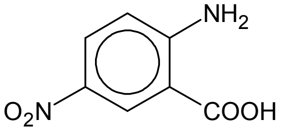
29.


Product X will be

(A)


(B)


(C)


(D)


30. Which of the following is a covalent carbide?
(A) CaC_2
(B) Al_4C_3
(C) WC
(D) SiC

Space for Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. The range of function f(x) where $f(x) + 2f(1 - x) = 1 - x^2$, $\forall x \in R$ is
(A) $(-\infty, 1]$ (B) $[1, \infty)$
(C) $(-1, 1)$ (D) $[-1, 1]$

2. Six digit numbers are formed using 1, 2, 3, 4, 5, 6, (repetition is not allowed). The number of ways such that even digits are in increasing order and odd digits are in decreasing order, is
(A) 20 (B) 40
(C) 60 (D) 120

3. The average of 2 sin 2º, 6 sin 6º, 10 sin 10º, ….. 178 sin 178º is
(A) cot 1º (B) 2 cosec 2º
(C) 2(1 + tan 2º) (D) 2(1 + 2 tan 2º sin 44º)

4. The number of points with integral co-ordinates that lie in the interior of the region common to the circle $x^2 + y^2 = 16$ and the parabola $y^2 = 4x$ is
(A) 10 (B) 16
(C) 17 (D) 13

5. The projection of the line segment joining the points (1, –2, 3) and (3, 1, 0) on the line whose direction ratios are (2, 1, 3) is
(A) $\frac{1}{\sqrt{14}}$ (B) $\frac{2}{\sqrt{14}}$
(C) $\frac{3}{\sqrt{14}}$ (D) $\frac{5}{\sqrt{14}}$

Space for rough work

6. Set A has 6 elements and its power set has n elements. Let m be the sum of distinct cardinal numbers of elements of power set of A, then the value of n – m is

(A) 43 (B) 40

(C) 35 (D) 50

7. Number of solutions of the equation cos 9x cos 3x = cos 18x cos 12x, $x \in [0, \pi]$ is

(A) 12 (B) 30

(C) 28 (D) 32

8. If the roots of the equation $x^2 + mx + n = 0$ are cubes of the roots of the equation $x^2 + px + q = 0$, then

(A) $m = p^3 + 3pq$ (B) $m = p^3 - 3pq$

(C) $m + n = p^3$ (D) $\frac{m}{n} = \left(\frac{p}{q}\right)^3$

9. The equation of the hyperbola whose foci are symmetrically situated on the x-axis with respect to the origin, the equation of the asymptotes as $y = \pm\frac{4}{3}x$ and distance between foci being 20, is

(A) $\frac{x^2}{64} - \frac{y^2}{36} = 1$ (B) $\frac{x^2}{16} - \frac{y^2}{9} = 1$

(C) $\frac{x^2}{9} - \frac{y^2}{16} = 1$ (D) $\frac{x^2}{36} - \frac{y^2}{64} = 1$

10. The value of $\int_0^\infty \frac{\ln\left(x + \frac{1}{x}\right)}{\left(1 + x^2\right)} dx$ is

(A) $\frac{\pi}{2}$ (B) $\frac{\pi}{2}\ln 2$

(C) $\frac{\pi}{2}\ln 4$ (D) none of these

11. Let $\vec{a} = \hat{i} + \hat{j} + \hat{k}$, $\vec{b} = \hat{i} + 4\hat{j} - \hat{k}$, $\vec{c} = \hat{i} + \hat{j} + 2\hat{k}$ and $\hat{s}$ be unit vector the magnitude of vector $(\vec{a}\cdot\hat{s})(\vec{b}\times\vec{c}) + (\vec{b}\cdot\hat{s})(\vec{c}\times\vec{a}) + (\vec{c}\cdot\hat{s})(\vec{a}\times\vec{b})$ is equal to

(A) 1 (B) 2

(C) 3 (D) 4

Space for rough work

12. The number of solutions of the equation $|x - 1| + |x - 10| + x = 9 + [x]$ is, (where [.] denote the greatest integer function)
(A) 10 (B) 2
(C) 4 (D) 20

13. Two dice are thrown at a time, the probability that the difference of the numbers is 2, is
(A) $\frac{1}{9}$ (B) $\frac{2}{9}$
(C) $\frac{4}{9}$ (D) $\frac{5}{9}$

14. The four sides of a quadrilateral are given by equation $(xy + 12 - 4x - 4y)^2 = (2x - 2y)^2$. The equation of a line with slope $\sqrt{3}$ which divides the area of quadrilateral in two equal parts is
(A) $y = \sqrt{3}(x+4)$ (B) $y = \sqrt{3}x + 4$
(C) $y = \sqrt{3}(x-4)+4$ (D) $y = \sqrt{3}(x-4)$

15. Let $I = \int_0^1 \frac{1}{\sqrt{1+x^5}}dx$ then which of following is correct
(A) $I < \frac{\pi}{4}$ (B) $I > 1$
(C) $I > 3$ (D) none of these

16. The arithmetic mean of a set of observation is $\bar{X}$. If each observation is divided by α and then is increased by 10, then the mean of the new series is
(A) $\frac{\bar{X}}{\alpha}$ (B) $\frac{\bar{X}+10}{\alpha}$
(C) $\frac{\bar{X}+10\alpha}{\alpha}$ (D) $\alpha\bar{X} + 10$

17. Let $w \neq 1$ and $w^{13} = 1$. If $a = w + w^3 + w^4 + w^{-4} + w^{-3} + w^{-1}$ and $b = w^2 + w^5 + w^6 + w^{-6} + w^{-5} + w^{-2}$, then the quadratic equation whose roots are a and b is
(A) $x^2 + x + 3 = 0$ (B) $x^2 + x + 4 = 0$
(C) $x^2 + x - 3 = 0$ (D) $x^2 + x - 4 = 0$

Space for rough work

18. On the ellipse $\frac{x^2}{18}+\frac{y^2}{8}=1$, the point M nearest to the line 2x – 3y + 25 = 0 is

(A) (–3, 2) (B) $\left(-\sqrt{2}, \frac{8}{3}\right)$

(C) (3, 2) (D) $\left(-3\sqrt{2}, 0\right)$

19. The value of $\lim_{x\to\infty}\left(\sqrt[4]{x^4+3x^3}-\sqrt[3]{x^3+2x^2}\right)$ is

(A) $\frac{1}{6}$ (B) $\frac{1}{18}$

(C) $\frac{1}{12}$ (D) $\frac{1}{24}$

20. In any triangle ABC, a, b, c be the sides opposite to angles A, B and C respectively and b + c = 3a. Then the value of $\left[\cot\frac{B}{2}\cot\frac{C}{2}+\tan\frac{B}{2}\tan\frac{C}{2}\right]$ is, (where [.] denotes the greatest integer function)

(A) 1 (B) 2
(C) 3 (D) 4

21. Number of solutions of the equation $\sin^{-1}(\sin x) + \cos^{-1}(\cos x) = x$, $\forall\ x \in (0, \pi]$ are

(A) 0 (B) 1
(C) 2 (D) 3

22. Let $f(x) = x^3 + x^2 + 2x - 1$. The minimum value of [x] that satisfy the f(f(x)) > f (2x + 1) is _________. (Where [.] denotes the greatest integer function).

(A) 0 (B) 1
(C) 2 (D) 3

23. If the two feet of normals drawn from a point to the parabola $x^2 - 6x - 4y + 5 = 0$ be (7, 3) and (–1, 3), then the third foot is

(A) (1, 0) (B) (–3, 8)
(C) (3, –1) (D) (5, 0)

Space for rough work

24. If α, β, γ are number of elements in sets A, B and C respectively and sum of number of all subsets of A, B and C is 28, then maximum number of ordered triplets (α, β, γ) is

(A) 1 (B) 2

(C) 4 (D) 6

25. A flag staff of 5 m height stands on a building 25 m high. At an observer at a height of 30 m, the flag staff and the building subtend equal angles. The distance of the observer from the top of flag staff is

(A) $\frac{5\sqrt{3}}{2}$ (B) $5\sqrt{\frac{3}{2}}$

(C) $\frac{2}{3}$ (D) None of these

26. Sum of series $\frac{1}{1.3}+\frac{1}{3.5}+\frac{1}{5.7}+.....$ upto 10 terms is

(A) $\frac{10}{21}$ (B) $\frac{1}{2}$

(C) $\frac{11}{21}$ (D) $\frac{9}{20}$

27. Solution of the differential equation $\left(x^2+6y\right)\frac{dy}{dx}+2\left(xy+1\right)=0$ is

(A) $yx^2 + 2x + 3y^2 = c$ (B) $xy^2 + 2x + 3y = c$

(C) $yx^2 - 2x - 3y^2 = c$ (D) none of these

28. The value of (1 – cot 3°)(1 – cot 7°)(1 – cot 11°)(1 – cot 34°)(1 – cot 38°)(1 – cot 42°) is equal to

(A) 3 (B) 2

(C) 27 (D) 8

29. An incident ray (L_1) is reflected by the mirror (L_2) $3x + 4y = 5$ and the equation of reflected ray (L_3) is $x + y = 1$, the equation of L_1 is

(A) $x - y = -3$ (B) $17x + 31y = 45$

(C) $17x - 31y = -77$ (D) none of these

30. If m is a natural number, then $m(m + 1)(m + 2) + (7^m - 1)$ is always divisible by

(A) 5 (B) 9

(C) 6 (D) 12

Space for rough work

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3.	C	A	B
4.	B	D	D
5.	A	C	B
6.	A	B	A
7.	A	D	C
8.	C	C	B
9.	A	C	D
10.	A	C	C
11.	A	A	C
12.	A	D	A
13.	B	B	B
14.	B	A	C
15.	A	B	D
16.	D	B	C
17.	B	A	C
18.	C	C	A
19.	C	D	C
20.	D	D	B
21.	A	C	B
22.	B	B	B
23.	B	D	C
24.	D	C	D
25.	D	B	B
26.	C	B	A
27.	B	C	A
28.	C	C	D
29.	B	B	B
30.	A	D	C

Physics

PART – I

SECTION – A

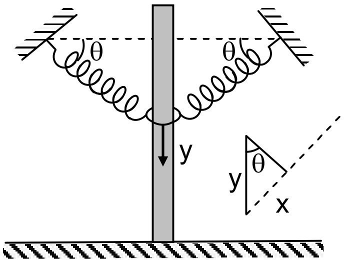
1. For small displacement $y = \frac{x}{\sin\theta}$

$2kx_0 \sin\theta = mg$ .... (1)

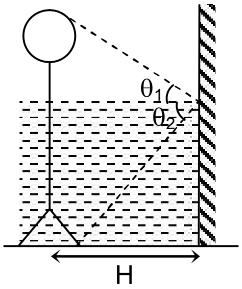
If ring is displaced y

$mg - 2k\left(x_0 + y\sin\theta\right)\sin\theta = ma$

$a = -\frac{2k\sin^2\theta}{m}y$



2. $\mu_1 \cos\theta_1 = \mu_2 \cos\theta_2$



3. $W_F = \Delta U + \Delta K$ Length AC

$300\{1.5 - 0.9\} = \frac{1}{2}K\left(x_2^2 - x_1^2\right) + \frac{1}{2}mV^2 \quad \ell = \sqrt{(1.2)^2 + (0.9)^2}$

4. $\frac{1}{2}Ka^2 = \mu mg(a+b) + \frac{1}{2}Kb^2$

$(a-b) = 2\mu mg/K.$

5. $\tan\phi = \frac{\omega L}{R}$

$\cos\phi = \frac{R}{\sqrt{R^2 + X_L^2}}$

$i_0 = \frac{\varepsilon_0}{\sqrt{R^2 + X_L^2}}, V_L = IX_L = \frac{\varepsilon X_L}{\sqrt{R^2 + X_L^2}}$

6. $\nu = \frac{1}{2\pi\sqrt{LC}}$

7. $\frac{0 + V_A}{2} = V_1$

$\frac{V_A + V_B}{2} = V_2$

$\frac{V_B + 0}{2} = V_3$

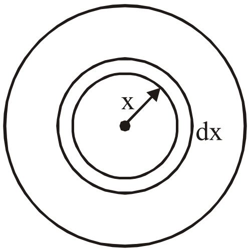
8. $$\frac{V_0 \times 6}{2} - \frac{\frac{V_0}{3} \times 2}{2} = 4$$

$$V_0 = \frac{3}{2}\text{m/s}$$

9. Kinetic energy at mean position $= 4\text{J} = \frac{1}{2}mA^2\omega^2 \Rightarrow \omega = 200\ \text{Rad / s.}$

10. $$mgh = \frac{1}{2}kx^2 - mgx$$

11. $$E = \frac{x}{2}\frac{dB}{dt}$$



$$E = \frac{3Kxt^2}{2}$$

$$d\tau = \frac{3Kxt^2}{2} \times \frac{2\pi x dx}{\pi r^2} q.x$$

$$\tau = \frac{3Kt^2q}{r^2}\int_0^r x^3 dx$$

$$\tau = \frac{3Kq.t^2}{4}.r^2 \qquad \ldots(i)$$

torque due to friction force

$$d\tau = \mu dmgx$$

$$\tau = 2\mu g\frac{qm}{r^2}\int_0^r x^2 dx = \frac{2}{3}\mu mgr \qquad \ldots(ii)$$

$$\frac{3Kq.t^2r^2}{4} = \frac{2}{3}\mu mgr$$

$$t = \sqrt{\frac{8\mu mg}{9Kqr}} = 2 \text{ seconds.}$$

12. About point O Ring is in pure rotation.

13. $\Delta\theta = W + \Delta U$

$\Delta U - \Delta Q - W$

14. Can be understood by graph.

15. $dQ = mS\Delta T < 0 \Rightarrow \Delta T < 0$

16. Light from any part of body can not reach the eye of man.

17. $$a = \frac{g\sin\theta}{\left(1 + \frac{I}{mr^2}\right)},\ a_{ring} = \frac{g\sin\theta}{2}$$

$$a_{coin} = \frac{2}{3}g\sin\theta$$

18. $F_{rat} = 0$

$F.2R - F.R = I\alpha \Rightarrow \alpha = 2.5\ \text{Rad/s}^2$

$\omega = \alpha t$

$K = \frac{1}{2}I\omega^2$

19. $mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

$7mgR = \frac{1}{2}mv^2 + \frac{1}{2}\times\frac{2}{5}mv^2$

$mv^2 = 10mgR \Rightarrow v = \sqrt{10gR}$

20. Number of significant figures in the answer must be three.

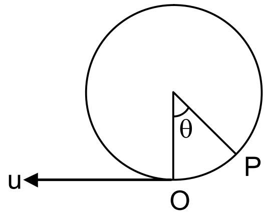
21. $\frac{T_1}{T_2} = a = 1$

$\frac{r_1}{r_2} = \frac{\sin\theta_1}{\sin\theta_2} = b = \frac{1}{\sqrt{3}}\ \frac{P_1}{P_2} = \frac{\cos\theta_1}{\cos\theta_2} = c = \sqrt{3}$

22. Escape velocity, $v = \sqrt{2gR}$

$\therefore\ \frac{v_E}{v_M} = \sqrt{\frac{2g_ER_E}{2g_MR_M}} = \sqrt{6\times4} = \sqrt{24}$

23. Tension in the string at the lowest point in vertical circle is given by



$T_L = mg + \frac{mu^2}{\ell}$

$2mg = mg + \frac{mu^2}{\ell}$

$u = \sqrt{g\ell}$

Using the law of conservation of energy, K.E. at O = P.E. at P

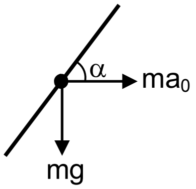
$\frac{1}{2}mu^2 = mg\ell(1-\cos\theta)$

$\frac{1}{2}mg\ell = mg\ell(1-\cos\theta)$

$\cos\theta = \frac{1}{2} \Rightarrow \theta = 60°$

24. Along the rod

$mg\sin\alpha - ma_0\cos\alpha = ma$



25. If the tension in the string is T then for insect

$T - mg = ma$

$T = \frac{3mg}{2}$

For block $T + N = 2mg$

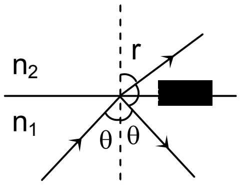
26. For the velocity perpendicular to incline after collision will be same for both so time for both will remains.

For the velocity along the incline after collision, velocity of the ball on smooth surface will be greater than that of rough surface.

27. mg(h+x) – F.x = 0

28. $n_1 \sin\theta = n_2 \sin r = n_2 \sin(60 - \theta)$

$\sin c = \frac{n_2}{n_1} = \frac{\sin\theta}{\sin(60-\theta)} = \frac{2\sin\theta}{\sqrt{3}\cos\theta - \sin\theta}$



29. For bead to be stationary

slope of tangent on the curve $\frac{dy}{dx} = \tan\theta \le \mu$

$\frac{2a}{y} \le \mu.$

30. For each reaction involving both the processes, mass defect

= 3 × 2.014 – 4.001 – 1.007 = 0.026 u

Energy released per deutron $= \frac{931.5 \times 0.026}{3}$MeV

Let n be the number of deutrons required

Total energy $= \frac{931.5 \times 0.026}{3} \times n\ \text{MeV} = \frac{P \times t}{\eta} = \frac{10^{16} \times 365 \times 24 \times 60 \times 60}{0.5}$

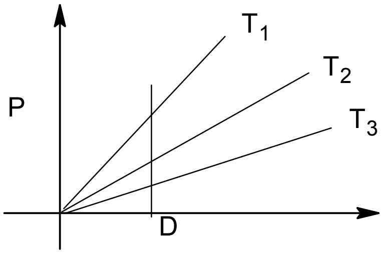
$n \simeq 5 \times 10^{35}.$

Chemistry PART – II

SECTION – A

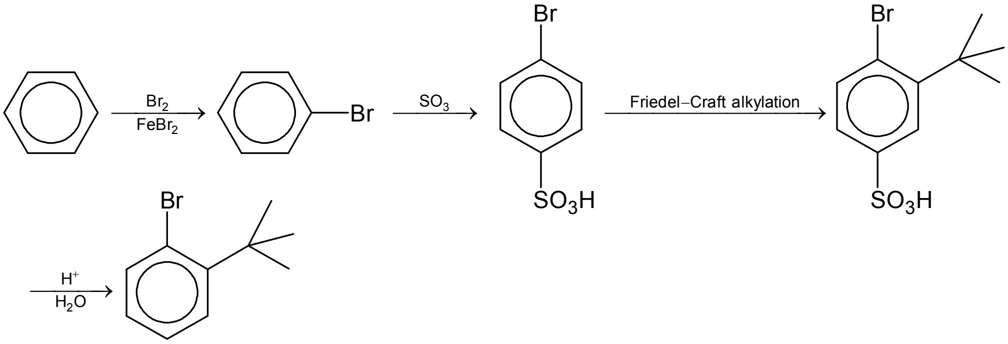
1. BaF_2 $\Delta H_{solution}$ = LE + $\Delta H_{hydratio}$
= 2367 – (457 ×2 + 1305)
= 148
BeF_2 $\Delta H_{solution}$ = 2906 – (457 × 2 + 2494)
= –502
For solubility : $\Delta H_{solution}$ should be negative.

3. At constant density, $P \propto T$

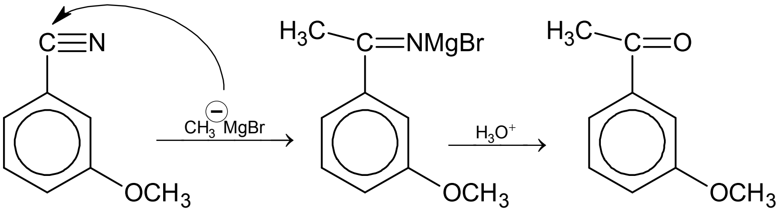


so, $T_1 > T_2 > T_3$

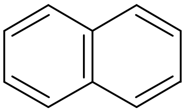
5.


Br_2
$FeBr_2$
Br
SO_3
Br
SO_3H
Friedel–Craft alkylation
Br
SO_3H
H^+
H_2O
Br

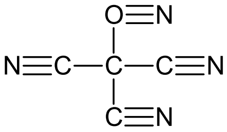
6.


C≡N
$\overset{\ominus}{CH_3}$ MgBr
OCH_3
H_3C–C=NMgBr
OCH_3
H_3O^+
H_3C–C=O
OCH_3

9.

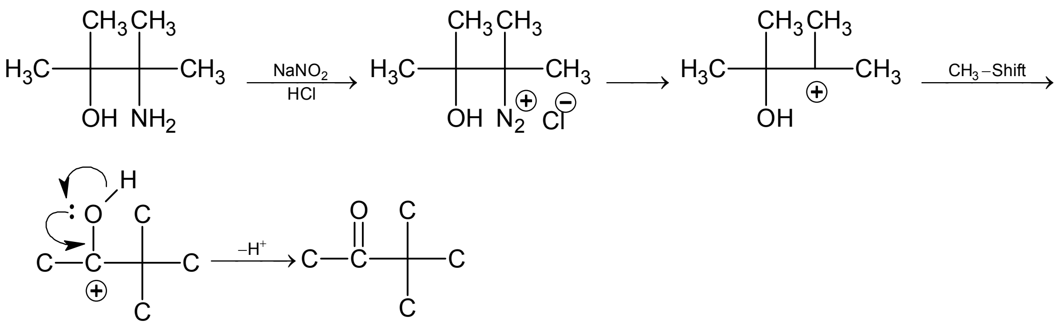


$19\sigma, 5\pi$



$8\sigma, 8\pi$

14.



15. $4HNO_3 \xrightarrow{h\nu} \underset{\text{Yellow}}{4NO_2} + O_2 + 2H_2O$

20. $V = \frac{W(\text{mass})}{d} = \frac{205.5}{0.79} = 260.13 \text{ ml}$

$M = \frac{W_B \times 1000}{m_B \times V} = \frac{5.5 \times 1000}{36.5 \times 260.13} = 0.58 \text{ M}$

22. According to Faraday's 1st law:

$W = \frac{QE}{F}$

$\text{Slope} = \frac{E}{F}$

27. $2XeF_6 + SiO_2 \longrightarrow 2XeOF_4 + SiF_4$

29. Hoffmann-degradation and Haloform reaction.

Mathematics PART – III

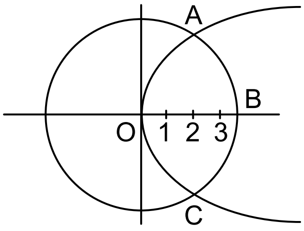
SECTION – A

1. $f(x) + 2f(1 - x) = 1 - x^2$ ….. (1)
$\Rightarrow 2f(x) + f(1 - x) = 1 - (1 - x)^2$ ….. (2)
$\Rightarrow f(x) = 1 - \frac{(x-2)^2}{3}$ {on solving (1) and (2)}
$\Rightarrow$ Range of f(x) is $(-\infty, 1]$

2. Required number of ways = $\frac{6!}{3!\cdot 3!} = 20$

3. Average = $\frac{2\sin 2^\circ + 6\sin 6^\circ + 10\sin 10^\circ + ... + 178\sin 178^\circ}{45}$
$= \frac{180\sin 2^\circ + 180\sin 6^\circ + ... + 90\sin 90^\circ}{45}$
$= \frac{180\left(\frac{\sin 44^\circ \sin 44^\circ}{\sin 2^\circ}\right) + 90}{45}$
$= 2\left(\frac{1 - \cos 88^\circ}{\sin 2^\circ} + 1\right)$
= 2(cosec 2° – 1 + 1)
$\Rightarrow$ Average = 2 cosec 2°

4. Interior region is closed figure OABC
Integral co-ordinates will be corresponding to
x = 1, x = 2 and x = 3 only
Integral co-ordinates are (1, –1), (1, 0), (1, 1)
(2, –2), (2, –1), (2, 0), (2, 1), (2, 2), (3, –2), (3, –1)
(3, 0), (3, 1), (3, 2)
$\Rightarrow$ Total such points are 13



5. Projection = $\left|\frac{(3-1)\times 2 + (1-(-2))\times 1 + (0-3)\times 3}{\sqrt{2^2 + 1^2 + 3^2}}\right| = \left|\frac{4+3-9}{\sqrt{14}}\right|$
$\Rightarrow$ Projection = $\frac{2}{\sqrt{14}}$

6. $n = 2^6 = 64$
m = 0 + 1 + 2 + 3 + 4 + 5 + 6 = 21
$\Rightarrow$ n – m = 64 – 21 = 43

7. cos 9x cos 3x = cos 18x cos 12x
$\Rightarrow$ cos 12x + cos 6x = cos 30x + cos 6x
$\Rightarrow$ cos 30x = cos 12x
$\Rightarrow 30x = 2n\pi \pm 12x$
$\Rightarrow 18x = 2n\pi,\ 42x = 2n\pi$
$\Rightarrow x = \frac{\pi n}{9},\ x = \frac{\pi n}{21}$
Number of solutions = 10 + 22 – 4 = 28

($\because$ 0, $\frac{\pi}{3}$, $\frac{2\pi}{3}$, π will be common in both)

8. Let α and β be the roots of the equation $x^2 + px + q = 0$
$\Rightarrow \alpha + \beta = -p, \alpha\beta = q$
$\Rightarrow \alpha^3 + \beta^3 = -m, (\alpha\beta)^3 = n$
$\Rightarrow -m = \alpha^3 + \beta^3 = (\alpha + \beta)^3 - 3\alpha\beta(\alpha + \beta)$
$\Rightarrow -m = -p^3 + 3pq$
$\Rightarrow m = p^3 - 3pq$

9. Hyperbola will be of the form $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$
$2ae = 20$
$\Rightarrow ae = 10, \frac{b}{a} = \frac{4}{3}$
$\Rightarrow b = 4k, a = 3k$
$\Rightarrow b^2 = a^2(e^2 - 1)$
$\Rightarrow b^2 + a^2 = a^2e^2$
$\Rightarrow k = 2$
$\Rightarrow b = 8, a = 6$
$\Rightarrow \frac{x^2}{36} - \frac{y^2}{64} = 1$

10. Put $x = \tan\theta$

11. $\begin{vmatrix} 1 & 1 & 1 \\ 1 & 4 & -1 \\ 1 & 1 & 2 \end{vmatrix} = 1(8+1) - 1(3) + 1(1-4)$ = 9 – 3 – 3 = 3

12. $|x - 1| + |x - 10| = 9 - \{x\}$
As LHS $\geq$ 9 and RHS $\leq$ 9
$\Rightarrow$ LHS = RHS = 9
$\Rightarrow \{x\} = 0 \ \forall \ x \in [1, 10]$
$\Rightarrow$ 10 solutions

13. Let x_1 and x_2 appears on the dice
$(x_1, x_2) \in \{(1, 3), (2, 4), (3, 5), (4, 6), (3, 1), (4, 2), (5, 3), (6, 4)\}$
$\Rightarrow$ Probability = $\frac{8}{6^2} = \frac{2}{9}$

14. The four sides of quadrilateral are given as x = 2, x = 6, y = 2, y = 6, which intersect at the points (2, 6), (2, 2), (6, 2), (6, 6)
The line which divides the area of this square in two equal parts will pass through its centre i.e. (4, 4)
$\Rightarrow \ y - 4 = \sqrt{3}(x - 4)$
$\Rightarrow \ y = \sqrt{3}(x - 4) + 4$

16. Let x_1, x_2, ……, x_n be n observations, then

$$\overline{X} = \frac{1}{2}\Sigma x_i$$

Let $y_i = \frac{x_i}{\alpha} + 10$, then

$$\overline{Y} = \frac{1}{n}\sum_{i=1}^{n} y_i = \frac{1}{\alpha}\left(\frac{1}{n}\Sigma x_i\right) + \frac{1}{n}(10n) \Rightarrow \overline{Y} = \frac{1}{\alpha}\overline{X} + 10 = \frac{\overline{X} + 10\alpha}{\alpha}.$$

17. $w^{13} = 1$

Now, $a + b = w + w^2 + w^3 + w^4 + w^5 + w^6 + w^{-6} + w^{-5} + w^{-4} + w^{-3} + w^{-2} + w^{-1}$

$= (w + w^2 + ... + w^6) + (w^7 + w^8 ..... w^{12}) = -1$

$ab = (w + w^3 + w^4 + w^{-4} + w^{-3} + w^{-1})(w^2 + w^5 + w^6 + w^{-6} + w^{-5} + w^{-2})$

$= 3(w + w^2 + w^3 + ….. + w^{12}) = -3$

$\Rightarrow$ Quadratic equation with a and b as roots

$= x^2 - (a + b)x + ab = 0$

$\Rightarrow x^2 + x - 3 = 0$

18. Let M be $\left(\sqrt{18}\cos\theta, \sqrt{8}\sin\theta\right)$. As shortest distance lies along common normal

$\Rightarrow$ Given line will be parallel to the tangent at M

$\Rightarrow \frac{x\cos\theta}{\sqrt{18}} + \frac{y\sin\theta}{\sqrt{8}} = 1$ is parallel to $2x - 3y + 25 = 0$

$\Rightarrow -\frac{\sqrt{8}\cos\theta}{\sqrt{18}\sin\theta} = \frac{2}{3} \Rightarrow \tan\theta = -1$

$\Rightarrow \theta = \frac{3\pi}{4} \Rightarrow$ point M is $(-3, 2)$

20. As $b + c = 3a$

$$\Rightarrow \frac{\sin B + \sin C}{\sin A} = 3$$

$$\Rightarrow \frac{2\sin\left(\frac{B+C}{2}\right)\cos\left(\frac{B-C}{2}\right)}{2\sin\frac{A}{2}\cos\frac{A}{2}} = 3$$

$$\Rightarrow \frac{\cos\frac{B}{2}\cos\frac{C}{2} + \sin\frac{B}{2}\sin\frac{C}{2}}{\cos\frac{B}{2}\cos\frac{C}{2} - \sin\frac{B}{2}\sin\frac{C}{2}} = 3$$

$$\Rightarrow \frac{\cot\frac{B}{2}\cot\frac{C}{2} + 1}{\cot\frac{B}{2}\cot\frac{C}{2} - 1} = 3$$

$$\Rightarrow \cot\frac{B}{2}\cot\frac{C}{2} = 2$$

$$\Rightarrow \tan\frac{B}{2}\tan\frac{C}{2} = \frac{1}{2}$$

$$\Rightarrow \left[\cot\frac{B}{2}\cot\frac{C}{2} + \tan\frac{B}{2}\tan\frac{C}{2}\right] = \left[2 + \frac{1}{2}\right] = 2$$

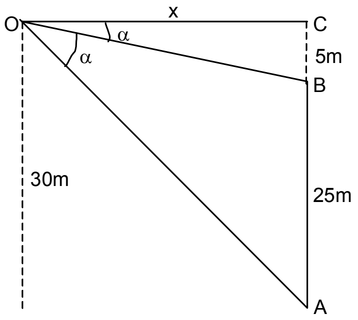
21. $\cos^{-1}(\cos x) = x, \forall x \in (0, \pi]$
$\Rightarrow \sin^{-1}(\sin x) = 0 \Rightarrow x = \pi$ is the solution

22. f (x) is increasing function
So, $x^3 + x^2 + 2x - 1 > 2x + 1$
$x^3 + x^2 - 2 > 0$
$(x - 1)(x^2 + 2x + 2) > 0.$

23. Equation of normal to $(x - 3)^2 = 4(y + 1)$ at $(2t + 3, t^2 - 1)$ is $(x - 3) = -t(y + 1) + 2t + t^3$
As these normals pass through (h, k)
$\Rightarrow t^3 + (1 - k)t + (3 - h) = 0$
$\Rightarrow t_1 + t_2 + t_3 = 0, 2t_1 + 3 = 7, 2t_2 + 3 = -1$
$\Rightarrow t_1 = 2, t_2 = -2$
$\Rightarrow t_3 = 0$
$\therefore$ Point is (3, –1)

24. $2^\alpha + 2^\beta + 2^\gamma = 28$
$\Rightarrow \alpha, \beta\ \gamma$ can (2, 3, 4), (2, 4, 3), (3, 2, 4), (3, 4, 2), (4, 2, 3) and (4, 3, 2)

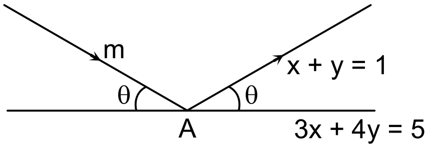
25. We have $\tan\alpha = \frac{5}{x}$ and $\tan 2\alpha = \frac{30}{x}$
$\Rightarrow \tan 2\alpha = \frac{30}{5\cot\alpha}$
$\Rightarrow \tan 2\alpha = 6\tan\alpha \Rightarrow 3 - 3\tan^2\alpha = 1$
$\Rightarrow \tan\alpha = \sqrt{\frac{2}{3}} \Rightarrow x = 5\cot\alpha = 5\sqrt{\frac{3}{2}}$ m



26. $$\sum_{r=0}^{9}\frac{1}{(2r+1)(2r+3)} = \sum_{r=0}^{9}\frac{1}{2}\left(\frac{(2r+3)-(2r+1)}{(2r+1)(2r+3)}\right)$$
$$\Rightarrow \sum_{r=0}^{9}\frac{1}{2}\left[\frac{1}{2r+1} - \frac{1}{2r+3}\right] = \frac{1}{2}\left[1 - \frac{1}{21}\right] = \frac{10}{21}$$

27. $$x^2\frac{dy}{dx} + 2xy + 2 + 6y\frac{dy}{dx} = 0$$
$$\Rightarrow \frac{d}{dx}\left(x^2 y\right) + 2 + 6y\frac{dy}{dx} = 0$$
$\Rightarrow yx^2 + 2x + 3y^2 = c$

28. $A + B = \frac{\pi}{4}$
$\Rightarrow \cot(A + B) = 1$
$$\Rightarrow \frac{\cot A \cot B - 1}{\cot A + \cot B} = 1$$
$\Rightarrow (1 - \cot A)(1 - \cot B) = 2$



29. $\tan\theta = \dfrac{-\frac{3}{4} - m}{1 + \left(-\frac{3}{4}\right)m} = \dfrac{-1 - \left(-\frac{3}{4}\right)}{1 + (-1)\left(-\frac{3}{4}\right)}$

$\Rightarrow \dfrac{4m+3}{3m-4} = \dfrac{-\frac{1}{4}}{\frac{7}{4}}$

$\Rightarrow 7(4m + 3) = (4 - 3m)$

$\Rightarrow 31m = -17,\ m = -\dfrac{17}{31}$

A = (–1, 2)

$\Rightarrow$ Equation of line (L_1) is 17x + 31y = 45

30. m(m + 1)(m + 2) is product of three consecutive numbers, hence divisible by 6 and (7^m – 1) is divisible by 6. Hence, given number is always divisible by 6

FIITJEE JEE (Advanced), 2015

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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ALL INDIA TEST SERIES

FULL TEST – V

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 234**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 – 12) contains 4 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

Section-A (13 to 18) contains 3 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-C (01 – 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	$6.625 \times 10^{-34}\ J{\cdot}s$
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

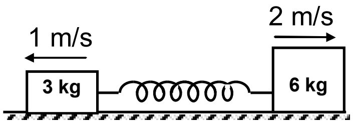
Physics PART – I

SECTION – A

Straight Objective Type

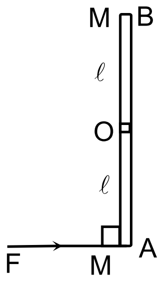
This section contains **8 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

1. Two blocks of mass 3 kg and 6 kg respectively are placed on a smooth horizontal surface. They are connected by a light spring of force constant k=200 N/m. Initially the spring is unstretched. The indicated velocities are imparted to the blocks. The maximum extension of the spring will be



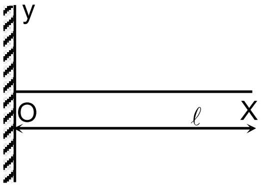
(A) 30 cm (B) 25 cm
(C) 20 cm (D) 15 cm

2. Two identical rods of mass M and length ℓ are hinged together as shown in the figure and lies at rest on smooth horizontal plane. A force F acts on end A of rod OA. The magnitude of instantaneous acceleration of hinge O is



(A) $\frac{F}{M}$ (B) $\frac{2F}{M}$
(C) $\frac{F}{2M}$ (D) None of these

3. Transverse wave are set in a thin rod clamped at one end O. The wave velocity is v. The rod vibrates in the 4th overtone mode with amplitude y_0. The equation of motion of the point at $x = 2\ell/3$ is



(A) $y = y_o \sin\frac{5\pi}{3}\cos\frac{5\pi vt}{2\ell}$
(B) $y = y_o \sin\frac{7\pi}{3}\cos\frac{7\pi vt}{2\ell}$
(C) $y = y_0 \sin\frac{10\pi}{3}\cos\frac{9\pi vt}{2\ell}$
(D) y = 0

Space for Rough work

4. A rigid box contain one mole of monatomic ideal gas. The walls of the box have total surface area A, thickness b and thermal conductivity K. Initially the gas is at temperature T_0 and pressure P_0. The temperature of surroundings is ½ T_0

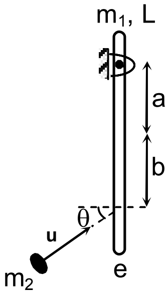
(A) The temperature as a function of time is $T = \frac{T_0}{4}\left[1 + e^{-\frac{2KAt}{bR}}\right]$

(B) The temperature as a function of time is $T = \frac{T_0}{4}\left[1 + e^{-\frac{2KAt}{3bR}}\right]$

(C) The pressure of gas as a function of time is $P = \frac{P_0}{4}\left[1 + e^{-\frac{2KAt}{3bR}}\right]$

(D) None of these

5. A smooth uniform straight rod of mass m_1 and length L is placed on a smooth horizontal table and hinged at a distance 'a' from centre. A particle of mass m_2 moving horizontally with speed u hits the rod at angle θ from normal. Coefficient of restitution between rod and particle is e. The angular velocity of rod just after collision.



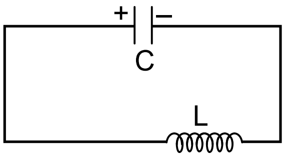
(A) $\frac{m_2(a+b)(e+1)u\cos\theta}{\left[m_1\left(\frac{L^2}{12}+a^2\right)+m_2(a+b)^2\right]}$

(B) $\frac{m_1(a+b)(e+1)u\cos\theta}{\left[m_2\left(\frac{L^2}{12}+a^2\right)+m_2(a+b)^2\right]}$

(C) $\omega = 0$

(D) None of these

6. In an LC circuit shown in the figure, C = 1F and L = 4H, at t = 0 charge on capacitor is 4C and it is decreasing at a rate of √5 C/sec. If maximum charge and current in the circuit are q_{max} and i_{max} then the value of i_{max}/q_{max} is



(A) $2s^{-1}$

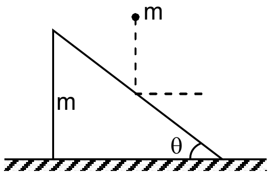
(B) $0.5\ s^{-1}$

(C) $\sqrt{\frac{2}{3}}\ s^{-1}$

(D) none of these

Space for Rough work

7. A particle of mass 'm' is dropped on a triangular wedge of same mass. Immediately after collision velocity of particle is in horizontal direction. If the surfaces are smooth. The maximum possible value of θ so that the above mentioned phenomenon takes place is



(A) $\theta < \tan^{-1}\left(\frac{1}{\sqrt{2}}\right)$ (B) $\theta > \tan^{-1}\left(\frac{1}{\sqrt{2}}\right)$

(C) $\theta > 45°$ (D) $\theta < 30°$

8. In an R-L-C circuit v = 20 sin (314 t + 5π/6) and i = 10 sin (314 t + 2π/3). The power factor of the circuit is

(A) 0.5 (B) 0.966

(C) 0.866 (D) 1

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

9. Bichromatic light of wavelength $\lambda_1 = 5000\,\overset{\circ}{A}$ and $\lambda_2 = 7000\,\overset{\circ}{A}$ are used in YDSE. Then

(A) 14th order maxima of λ_1 will coincide with 10th order maxima of λ_2

(B) 21st order maxima of λ_2 will coincide with 15th order maxima of λ_1

(C) 11th order minima of λ_1 will coincide with 8th order minima of λ_2

(D) 3rd order minima of λ_1 will coincide with 4th order minima of λ_2

10. P, Q and R are three particles of a medium which lie on the x-axis. A sine wave of wave length λ is traveling through the medium in the x-direction. P and Q always have the same speed, while P and R always have the same velocity. The minimum distance between

(A) P and Q is $\lambda/2$ (B) P and Q is λ

(C) P and R is $\lambda/2$ (D) P and R is λ

Space for Rough work

11. Which of the following statements is/are true?
(A) In vacuum the speed of red color is more than that of violet color
(B) An object in front of a mirror is moved towards the pole of a spherical mirror from infinity, it is found that image also moves towards the pole. The mirror must be convex.
(C) There exist two angles of incidence in a prism for which angles of deviation are same except minima deviation.
(D) A ray travels from a rarer medium to denser medium. There exist three angles of incidence for which the deviation is same.

12. Ten gm of oxygen at STP is expanded to a volume of 14×10^{-3} m^3. Then
(A) The final pressure is 0.5 atm in case of isothermal process
(B) The final pressure is $1/2^{7/5}$ atm in case of adiabatic process
(C) The final temperature is greater than 273K in case of adiabatic process
(D) The final temperature is 273K in case of isothermal process

Comprehension Type

This section contains **3 paragraphs**, each describing theory, experiments, data etc. Six questions relate to the three paragraphs with **two questions on each paragraph**. Each question has **only one** correct answer among the four given options (A), (B), (C) and (D).

Paragraph for Questions 13 & 14

When a surface is irradiated with light of wavelength $4950\,\overset{\circ}{A}$, a photocurrent appears which vanishes if a retarding potential greater than 0.6 volts is applied across the phototube. When a second source of light is used, it is found that the retarding potential is changed to 1.1 volt.

13. The work function of the emitting surface is:

(A) 2.2 eV	(B) 1.5 eV
(C) 1.9 eV	(D) 1.1 eV

14. The wavelength of the second source is:

(A) $6150\,\overset{\circ}{A}$	(B) $5150\,\overset{\circ}{A}$
(C) $4125\,\overset{\circ}{A}$	(D) $4500\,\overset{\circ}{A}$

Space for Rough work

Paragraph for Questions 15 & 16

The atomic masses of the hydrogen isotopes are:

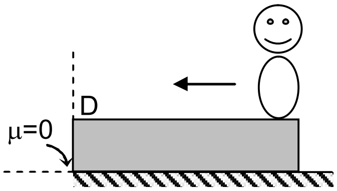
Hydrogen $_1H^1$ = 1.007825 amu
Deuterium $_1H^2$ = 2.014102 amu
Tritium $_1H^3$ = 3.016049 amu

15. The number of fusion reactions required to generate 1 kWh is nearly
(A) 10^8 (B) 10^{18}
(C) 10^{28} (D) 10^{38}

16. The mass of deuterium, $_1H^2$ that would be needed to generate 1 kWh
(A) 3.7 kg (B) 3.7 g
(C) 3.7×10^{-5} kg (D) 3.7×10^{-8} kg

Paragraph for Questions 17 & 18

A man of mass 50 kg is running on a plank of mass 150 kg with speed of 8 m/s relative to plank as shown in the figure. (both were initially at rest and the velocity of man with respect to ground any how remains constant). Plank is placed on smooth horizontal surface. The man, while running whistles with frequency f_0. A detector (D) is placed on plank detects frequency. The man jumps off with same velocity (with respect to ground) from point d and slides on the smooth horizontal surface [Assume coefficient of friction between man and horizontal is zero]. The speed of sound in still medium is 330 m/s. Answer following questions on the basis of above situations.



17. The frequency of sound detected by detector D, before man jumps off the plank is:
(A) $\frac{332}{324}f_0$ (B) $\frac{330}{322}f_0$
(C) $\frac{328}{336}f_0$ (D) $\frac{330}{338}f_0$

18. The frequency of sound detected by detector D, after man jumps off the plank is:
(A) $\frac{332}{324}f_0$ (B) $\frac{330}{322}f_0$
(C) $\frac{328}{336}f_0$ (D) $\frac{330}{338}f_0$

Space for Rough work

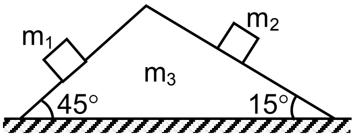
SECTION – C

Integer Answer Type

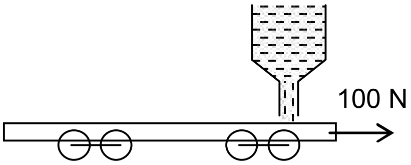
This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. To a man walking at the rate of 3 km/h the rain appears to fall vertically. When he increases his speed to 6 km/h it appears to meet him at an angle of 45° with vertical. The speed of rain is $n\sqrt{2}\,\text{km/hr}$. $\vec{V}_{RM} = \vec{V}_R - \vec{V}_M$ Find the value of n.

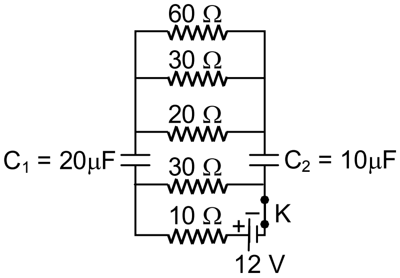
2. A wedge of mass m_3 is placed on a smooth horizontal surface. Blocks of mass m_1 and m_2 are placed on the smooth inclined faces of m_3. Angles of inclination are as shown. It is found that m_3 does not move. Find ratio of m_2/m_1.



3. A flat car of mass 50 kg starts moving to the right due to a constant force 100 N as shown in figure. S and spills on the flat car from a stationary hopper. The velocity of loading is constant and equal to 1 kg/s. The velocity of the car after 10 seconds. Is 100/n. Find n.



4. For the circuit arrangement shown in the figure, find the potential difference (in V) across C_2 in the steady state condition.



5. A charged particle is projected in a magnetic field $\vec{B}$ **=** (3i + 4j) × 10^{-2} T. The acceleration of the particle is found to be $\vec{a} = (-\frac{8}{3}\hat{i} + y\hat{j})$ m/s^2. Find the value of y.

Space for Rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

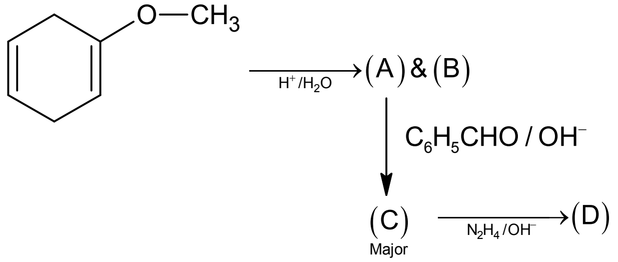
This section contains **8 multiple choice** questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONLY ONE** option is correct.

1. Which of the following is true for hydroxyl amine?
   (A) More basic than ammonia.
   (B) Disproportionates slowly in acidic solution producing N_2O and NH_4^+.
   (C) Disproportionates rapidly in acidic solution producing N_2 and NH_3.
   (D) Reacts with 2-methyl cyclohexanone to give cyclic amide of caproic acid.

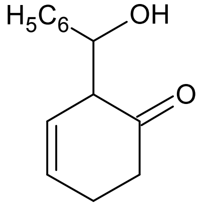
2. The molecule of P_4S_9 contains:
   (A) 4 $p\pi$ - $d\pi$ phosphorus – sulphur bonds.
   (B) P – S – P linkages.
   (C) Three phosphorus are tetrahedral unit and one phosphorus as pyramidal unit.
   (D) Has 4 P = S bonds.

3. How many moles of HSCN will react with iodine, so that the produced I^- will react with neutral 10 ml of 0.2 M $KMnO_4$?
   (A) 0.16×10^{-4} (B) 1.6×10^{-4}
   (C) 1.2×10^{-4} (D) 0.12×10^{-5}

Space for Rough work

4. 
O—CH3
H+/H2O
(A) & (B)
C6H5CHO / OH−
(C)
Major
N2H4 / OH−
(D)

The structure of compound (C) and has many enantiomeric pairs are possible for (D)?

(A) 

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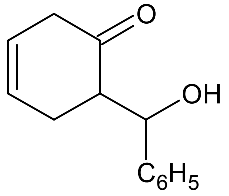
(B) 

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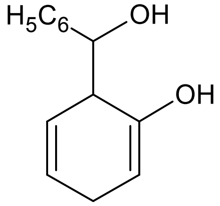
(C) 

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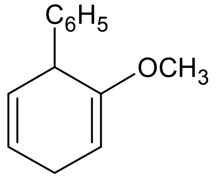
(D) 

, 0

5. $CoCl_2$ gives a buff coloured precipitate with KCN, but with excess of KCN, the precipitate dissolves due to the formation of:

(A) $Co(CN)_2$
(B) $K_4[Co(CN)_6]$
(C) $K_3[Co(CN)_6]$
(D) $K_4[Co(CN)_4Cl_2$

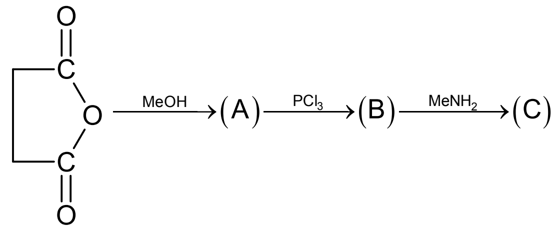
6. The emf of the following cell is – 0.46 V.

$Pt(H_2),\ HSO_3^-(0.4\text{ M}), SO_3^{2-}\left(6.4\times10^{-3}\text{ M}\right) || Zn^{2+}(0.3\text{M}) | Zn$. If $E^o_{Zn^{2+}/Zn} = 0.76$ V, calculate pK_a of HSO_3^-, i.e. for equilibrium

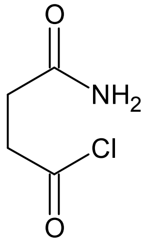
$$HSO_3^- \rightleftharpoons H^+ + SO_3^{2-}$$

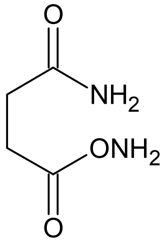
(A) 7.13
(B) 6.13
(C) 8
(D) 5.13

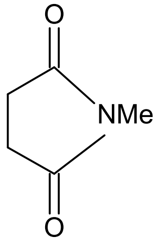
Space for Rough work

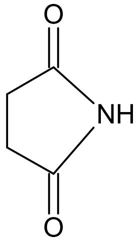
7. 

The product C is:

(A) 

(B) 

(C) 

(D) 

8. The ratio of masses of photons corresponding to transition with shortest wavelength of Lymann series of H-atom and lowest frequency of Paschen series of He^+ ion are:

(A) 7 : 36
(B) 5 : 9
(C) 9 : 5
(D) 36 : 7

Space for Rough work

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

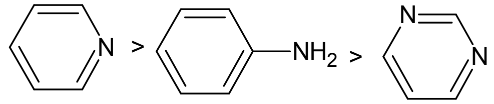
9. Which of the following statements are not correct?
(1) From a mixed precipitate of AgCl and AgI, ammonia solution only dissolves AgCl.
(2) $B(OH)_3 + NaOH \rightleftharpoons NaBO_2 + Na[B(OH)_4] + H_2O$ can be made to proceed forward by addition of trans-diol.
(3) On passing H_2S gas in II group sometimes the solution turns milky indicating the presence of reducing agent.
(4) $CuSO_4$ decolourises on addition of excess KCN, due to the formation of $[Cu(CN)_4]^{3-}$.

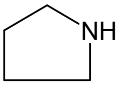
(A) 1 is correct (B) 2 is incorrect
(C) 3 is incorrect (D) 4 is correct

10. The reaction given below shows the enthalpy change for the chemical reactants between N_2, O_2, NO and NO_2 (taking the given data into account).

$$N_2(g) + O_2(g) \longrightarrow 2NO(g) \qquad \Delta H = 110 \text{ kJ/mol}$$
$$2NO(g) + O_2(g) \longrightarrow 2NO_2(g) \qquad \Delta H = -200 \text{ kJ/mol}$$

Select the correct statements:
(A) The standard heat of formation of NO_2 is 90 kJ mol^{-1}.
(B) The oxidation reaction from N_2 to NO_2 is exothermic.
(C) The standard heat of formation of NO is – 55 kJ mol^{-1}.
(D) The oxidation reaction of NO to NO_2 is endothermic.

11. Which of the following is correct order of basic strength:
(A) $BuNH_2 < Bu_2NH < Bu_3N$, order of basic strength having chlorobenzene as solvent.
(B) $m-MeOC_6H_4NH_2 < o-MeOC_6H_4NH_3 < p-MeOC_6H_5NH_2$ order of basic strength in gaseous phase.
(C)


Pyrimidine
(D)


> $(CH_3CH_2)_2NH$
Pyrrolidine

12. Which of the following are correct statements:
(A) Entropy of system increases when an ideal gas is expanded isothermally.
(B) Gas with higher γ has high magnitude of slope in a P(y-axis) v/s V(x – axis) curve.
(C) Final temperature in reversible adiabatic expansion is lesser than in irreversible adiabatic expansion.
(D) Vapourisation at boiling point, $\Delta G < 0$.

Space for Rough work

Comprehension Type

This section contains **3 paragraphs** each describing theory, experiment, data etc. **Six questions** relate to three paragraphs with two questions on each paragraph. Each question of a paragraph has **only one correct** answers among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 13 to 14

Chlorine on reaction with compound (X) in basic medium, according to the given equation:

$IO_3^- + xOH^- + Cl_2 \longrightarrow (A) + yH_2O + zCl^-$

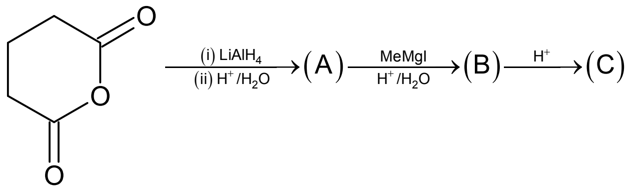
Compound (A) on heating in acidic medium $(A) \xrightarrow[-4H_2O]{100^\circ C} (B) \xrightarrow{200^\circ C} (C)$

13. Identify the compound (C)?
(A) I_2O_3 (B) I_2
(C) I_2O_7 (D) I_2O_5

14. The stoichiometric coefficient in the above (x), (y), (z) respectively are:
(A) 6, 3, 2 (B) 5, 4, 1
(C) 3, 4, 2 (D) 6, 2, 3

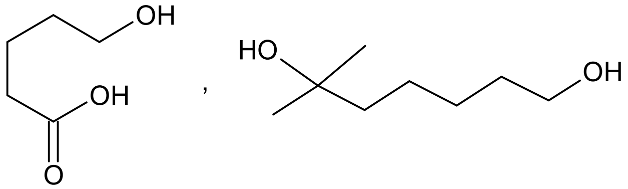
Space for Rough work

Paragraph for Question Nos. 15 to 16

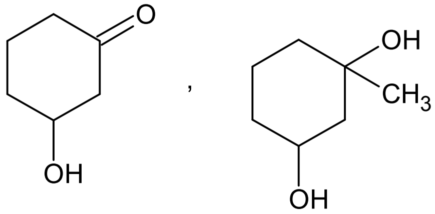

O
O
O
(i) LiAlH$_4$
(ii) H$^+$/H$_2$O
(A)
MeMgI
H$^+$/H$_2$O
(B)
H$^+$
(C)

15. The structure of compound (A) and (B) respectively are:

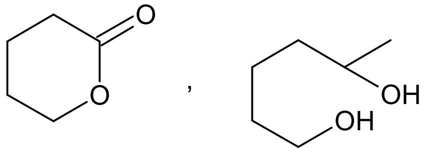
(A)



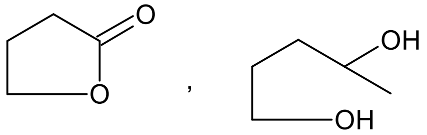
(B)


O
OH
OH
CH$_3$
OH

(C)

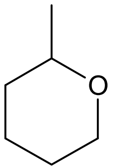


(D)

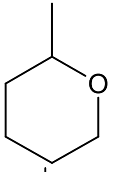


16. Which of the following statement is correct for compound (C)?

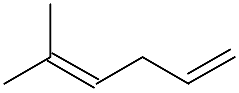
(A)

(C) is  and is optically active.

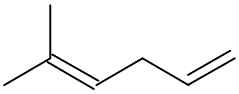
(B)

(C) is  and is optically inactive.

(C)

(C) is  shows geometrical isomerism.

(D)

(C) is  shows no geometrical isomerism.

Space for Rough work

Paragraph for Question Nos. 17 to 18

The vapour density of equilibrium mixture for
$N_2O_4(g) \rightleftharpoons 2NO_2(g)$ is 28.75 at 1 atm.
This mixture is allowed to diffuse out pressure for 10 seconds.

17. Calculate the respective mole fraction of the two gases in N_2O_4 and NO_2 in the effusing out mixture?

(A) $X_{N_2O_4} = 0.188$, $X_{NO_2} = 0.812$
(B) $X_{N_2O_4} = 0.812$, $X_{N_2O_4} = 0.188$
(C) $X_{N_2O_4} = 0.212$, $X_{NO_2} = 0.788$
(D) $X_{NO_2} = 0.788$, $X_{NO_2} = 0.212$

18. Calculate new K_P of reaction?

(A) 1.875
(B) 2.2
(C) 1.42
(D) 2.8

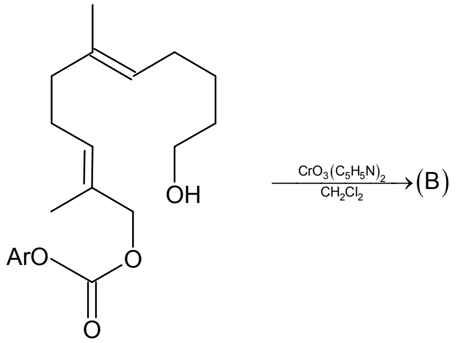
Space for Rough work

SECTION – C

Integer Answer Type

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. How many halogen atoms are bridging in $As_2Cl_8^{2-}$?

2. 

The number of stereoisomer possible for the compound (B) are:

3. The total number of tetrahedral units in the monomers of Buna-N?

4. While studying the decomposition of gaseous compound it is observed that a plot of logarithm of its partial pressure versus time is linear. What is the order of decomposition?

5. In the sodium chloride structure each Na^+ is surrounded by $\frac{6x}{2}$ next nearest Na^+ ions. What is the value of x?

Space for Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **8 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

1. If $[x^3 + x^2 + x + 1] = [x^3 + x^2 + 1] + x$, (where [.] denote the greatest integer function), then number of solutions of the equation $\log |[x]| = 2 - |[x]|$ is
(A) 1 (B) 0
(C) 3 (D) 2

2. A is a set containing 7 elements and a subset A_1 of A is chosen. Then set A is reconstructed by replacing the elements of A_1. Now another subset A_2 of A is chosen. In this way 4 subsets A_1, A_2, A_3, A_4 are formed. The number of ways of choosing A_1, A_2, A_3, A_4 so that these subsets are pair wise disjoint, is
(A) 5^7 (B) 7^5
(C) 4^7 (D) 840

3. Let $C_0, C_1, C_2 \ldots\ldots, C_n$ be the binomial co-efficient in the expansion of $(1 + x)^n$, $n \in N$.
If $S_n = \frac{2C_0}{2} + \frac{2^2C_1}{6} + \frac{2^3C_2}{12} \ldots\ldots \frac{2^{n+1}C_n}{(n+1)(n+2)} + \frac{1}{n+1} + \frac{1}{2(n+1)(n+2)}$, then the value of $\frac{S_7}{S_6}$ is
(A) 7 (B) $\frac{7}{6}$
(C) $\frac{7}{3}$ (D) $\frac{7}{2}$

Space for rough work

4. The number of complex numbers satisfying the conditions $\left|\frac{z}{\bar{z}}+\frac{\bar{z}}{z}\right|=1$, |z| = 1 and arg (z) $\in$ (0, 2π) is
(A) 1
(B) 2
(C) 4
(D) 8

5. $\frac{1}{2}\tan\frac{\theta}{2}+\frac{1}{4}\tan\frac{\theta}{4}$ is equal to
(A) $4\cot\frac{\theta}{4}-\cot\theta$
(B) $\cot\frac{\theta}{4}-\cot\theta$
(C) $\frac{1}{4}\cot\frac{\theta}{4}-\cot\theta$
(D) $\cot\frac{\theta}{4}-4\cot\theta$

6. Equation of the parabola with latus rectum $2\sqrt{2}$ units and axis as the line x – y = 0 and tangent at the vertex as x + y = 1, is (origin lies outside parabola)
(A) $x^2 + y^2 - 2xy + 4x + 4y + 4 = 0$
(B) $x^2 + y^2 - 2xy + 8x + 8y - 8 = 0$
(C) $x^2 + y^2 - 2xy - 4x - 4y + 4 = 0$
(D) $x^2 + y^2 - 2xy - 2x - 2y + 2 = 0$

7. If the circles $x^2 + y^2 + (3 + \sin\beta)x + (2\cos\alpha)y = 0$ and $x^2 + y^2 + (2\cos\alpha)x + 2cy = 0$ touch each other then the maximum value of ‘c’ is
(A) $\frac{1}{2}$
(B) 1
(C) $\frac{3}{2}$
(D) 2

8. If f be a continuous function on [0, 1], differentiable in (0, 1) such that f(1) = 0, then exists some c $\in$ (0, 1] such that
(A) $cf'(c) - f(c) = 0$
(B) $f'(c) + cf(c) = 0$
(C) $f'(c) - cf(c) = 0$
(D) $cf'(c) + f(c) = 0$

Space for rough work

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct

9. Let f(x) = $\begin{cases} 5x+1 & \text{if} \quad x \le 2 \\ \int\limits_0^x (5+|1-t|)dt & \text{if} \quad x > 2 \end{cases}$

then

(A) f(x) is continuous but not differentiable at x = 2
(B) f(x) is not continuous at x = 2
(C) f(x) is differentiable everywhere, $\forall\ x \in (2, \infty)$
(D) the right hand derivative of f(x) at x = 3 does not exist

10. Let $\vec{a} = \hat{i} + \hat{j} + \hat{k}$, $\vec{b} = \hat{i} - \hat{j} + \hat{k}$, $\vec{a} \times \vec{c} = \vec{b} + \lambda\vec{a}$ and $\vec{a} \cdot \vec{c} = 1$ then which of following is true

(A) $[\vec{a}\ \vec{b}\ \vec{c}] = -\frac{8}{3}$
(B) $\lambda = -\frac{2}{3}$
(C) $[\vec{a}\ \vec{b}\ \vec{c}] = -\frac{7}{3}$
(D) $\lambda = -\frac{1}{3}$

11. A right angle triangle ABC, right angle at A is inscribed in hyperbola xy = c^2 (c > 0) such that slope of BC is 2. If distance of point A from centre of xy = c^2 is $\sqrt{10}$, then which of the following is/are correct for xy = c^2

(A) the value of c is 2
(B) the value of c is 4
(C) the equation of normal at point A can be $y = 2x - 3\sqrt{2}$
(D) the equation of normal at point A can be $y = 3x + 8\sqrt{2}$

12. For the equation $|x^2 - a| = \cos^{-1} \cos x$ to be inconsistent, the value of 'a' can be

(A) $\frac{1}{2}$
(B) $\frac{1}{6}$
(C) $-\frac{1}{2}$
(D) $-\frac{2}{3}$

Space for rough work

Comprehension Type

This section contains **3 paragraphs** each describing theory, experiment, data etc. **Six questions** relate to three paragraphs with two questions on each paragraph. Each question of a paragraph has **only one correct** answers among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 13 to 14

Read the following write up carefully and answer the following questions:

Consider three points A, B and C lying on $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ (a > b) such that origin is a point interior to the ΔABC. Lines through A, B, C are drawn perpendicular to major axis to cut circle $x^2 + y^2 = a^2$ at P, Q, R respectively such that P, Q, R are on same side w.r.t major axis as that of A, B, C respectively

13. If ΔPQR is equilateral then area of ΔABC is

(A) $\frac{\sqrt{3}}{4}ab$

(B) $\frac{3\sqrt{3}}{4}ab$

(C) $\frac{3\sqrt{3}}{2}ab$

(D) none of these

14. Let ΔPQR is not necessarily equilateral, A and B lies in first quadrant such that slopes of OA and OB are m_1 and m_2 respectively, where O is the origin. If the area of sector OAB of ellipse is given by $\frac{1}{2}ab\theta$ then θ is equal to

(A) $\tan^{-1}\left|\frac{ab(m_1-m_2)}{b^2+a^2m_1m_2}\right|$

(B) $\tan^{-1}\left|\frac{m_1-m_2}{1+m_1m_2}\right|$

(C) $\tan^{-1}\left|\frac{ab(m_1-m_2)}{a^2+b^2m_1m_2}\right|$

(D) $\tan^{-1}\left|\frac{ab(m_1+m_2)}{a^2-b^2m_1m_2}\right|$

Space for rough work

Paragraph for Question Nos. 15 to 16

Read the following write up carefully and answer the following questions:
Consider a ΔABC with AB = c, BC = a and CA = b. Internal and external bisectors of $\angle C$ intersect AB and AB produced respectively at L and M, such that CL = CM. AD is a diameter of circum-circle of ΔABC. The radius of circum-circle is R

15. The value of $a^2 + b^2$ is
(A) R^2 (B) $2R^2$
(C) $3R^2$ (D) $4R^2$

16. Which of the following is incorrect?
(A) DC = a (B) $\angle BAC = \angle CAD$
(C) $\angle ADC = \angle CBM$ (D) $\angle BAC = \frac{\pi}{4} + \frac{\theta}{2}$, where $\theta = \angle ACB$

Paragraph for Question Nos. 17 to 18

Read the following write up carefully and answer the following questions:
If the expression for the nth term of the infinite sequence 1, 2, 2, 3, 3, 3, 4, 4, 4, 4, 5, ….. is $\left[\sqrt{\alpha n} + \frac{1}{\beta}\right]$, (where [.] denotes the greatest integer function) then

17. Let $a = \alpha$, $b = \alpha + 1$ and $c = \alpha + \beta + 1$ then number of numbers out of first 1000 natural numbers which are divisible by a, b or c is
(A) 764 (B) 867
(C) 734 (D) none of these

18. Let $a = \alpha$, $b = \alpha + 1$, $c = \alpha + \beta + 1$ and $d = 3\beta + 1$. The number of divisors of the number $a^c \cdot b^c \cdot c^b \cdot d^b$ which are of the form 4n + 1, $n \in N$ is equal to
(A) 24 (B) 48
(C) 96 (D) none of these

Space for rough work

SECTION – C

Integer Answer Type

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. Let f : R → R defined as $f(x) = x^3 + x + 1,\ 1 \le x \le 2$. The graph of $y = g(x)$ is the reflection of graph of $y = f(x)$ through the line $y = x$. If the domain of g(x) is [a, b], then $|a - b|$ is _____

2. In a paper of mathematics there are 5 questions, such that the sum of the marks is 30 and the marks for any question is not less than 2 and not more than 8 (only integer marks are awarded). If the number of ways in which the marks can be awarded is ABC, where A, B, C $\in$ N and A, B, C $\le$ 9. Then value of A + B – C is _____

3. If f: [0, 2] → R, $f(x) = \sqrt{x^3 + 2 - 2\sqrt{x^3 + 1}} + \sqrt{x^3 + 10 - 6\sqrt{x^3 + 1}}$ then $\int_0^2 f(x)\,dx$ is equal to _____

4. The plane $\frac{x}{1} + \frac{y}{2} + \frac{z}{3} = 1$ intersect x–axis, y–axis, z–axis at A, B, C respectively. If the distance between origin and orthocentre of ΔABC is equal to k then the value of 7k is equal to _____

5. The value of $\left| \lim_{x \to \frac{3\pi}{4}} \left(\frac{4\sin^2 x \cos x - \cos x + \sin x}{\sin x + \cos x} \right) \right|$ is equal to _____

Space for rough work

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FULL TEST– V
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	B	B
2.	A	C	A
3.	D	B	C
4.	B	A	D
5.	A	B	C
6.	B	A	C
7.	A	C	B
8.	C	A	D
9.	A, C	B, C	A, C
10.	A, D	B, C	A, D
11.	B, C	A, B, C, D	A, C
12.	A, B, D	A, B, C	C, D
13.	C	D	B
14.	C	A	A
15.	B	C	D
16.	D	A	D
17.	A	A	C
18.	C	B	B
1.	3	2	8
2.	2	4	4
3.	6	0	4
4.	6	1	6
5.	2	4	1

Physics

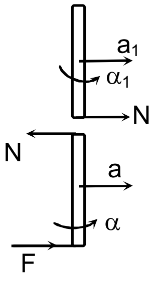
PART – I

SECTION – A

1. $V_{CM} = \dfrac{m_1v_1 + m_2v_2}{m_1 + m_2} = 1\,m/s$

At maximum extension both blocks will move in same direction with V_{CM} now use energy y conservation.

2. $(F + N)\dfrac{\ell}{2} = \dfrac{M\ell^2}{12}\alpha$



F – N = Ma

N = Ma$_1$

$\Rightarrow N\dfrac{\ell}{2} = \dfrac{M\ell^2}{12}\alpha_1$

Acceleration of hinge O

= $a - \dfrac{\ell}{2}\alpha = a_1 + \dfrac{\ell}{2}\alpha_1$

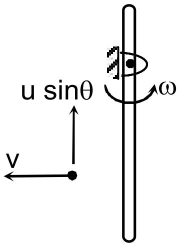
$\Rightarrow N_x = -F/4 \Rightarrow a = 5F/4M$ and $\alpha = 9F/2M\ell$

$\Rightarrow \vec{a}_o = \left(a - \dfrac{\ell}{2}\alpha\right)\hat{i} = -\dfrac{F}{M}\hat{i}$

3. $y = y_0 \sin kx \cos\omega t$ and $\dfrac{9\lambda}{4} = L$

4. $\dfrac{d\theta}{dt} = \dfrac{KA}{L}(T_1 - T_2) \rightarrow$ equation of heat flow through the box.

5. Just after collision.

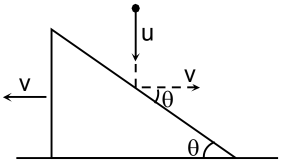


$\dfrac{\omega(a+b)+v}{u\cos\theta} = e$

$m_2(v + u\cos\theta)(a+b) = m_1\left(\dfrac{L^2}{12} + a^2\right)\omega$

6. $\dfrac{1}{2}LI^2 + \dfrac{\theta^2}{2C} = \text{constant}$

7. Using COM;



$v\cos\theta = u\sin\theta$

and $e = \dfrac{(2v\sin\theta)}{u\cos\theta} = 2\tan^2\theta$

$\Rightarrow 2\tan^2\theta < 1$

$\Rightarrow \tan\theta < 1/\sqrt{2} \Rightarrow \theta < \tan^{-1}\left(\dfrac{1}{\sqrt{2}}\right)$

8. Power factor = $V_{RMS}\, I_{RMS} \cos\phi$

9. For maxima $y = \frac{n\lambda p}{d}$ for minima $y = (2n-1)\frac{\lambda p}{2d}$

10. $y = A\sin(\omega t - kx)\frac{\delta y}{\delta t} = A\omega\cos(\omega t - kx)$

11. $V_{\text{medium}} = \frac{C}{\mu}$

12. Isothermal $PV = \text{constant}$ adiabatic $PV^r = \text{constant}$

13-14. $h\nu = \phi + eV_0$

15-16. $E = \Delta mc^2$

17-18. $f = \frac{C \pm V_0}{C \mp V_S} \times f_0$

SECTION – C

1. $3\sqrt{2}$ km/hr

2. The centre of mass of system will not move horizontally.

3. $F = U_{\text{Rel}}\frac{dM}{dt}$

4. In steady state the current in branch containing capacitor will become zero.

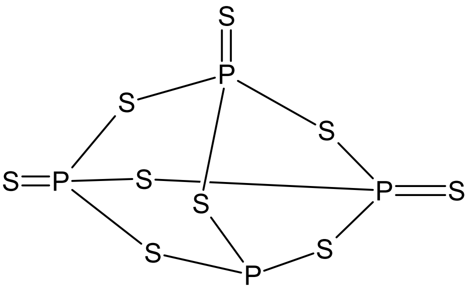
5. $F = q\left[\vec{E} + \vec{V} \times \vec{B}\right]$

Chemistry PART – II

SECTION – A

1. $\left[\overset{-1}{N}H_2OH-H\right]^+ \longrightarrow \overset{+1}{N}_2O + 2\overset{-3}{N}H_4 + 2H^+ + 3H_3O^+$

2.


S
P
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P

Has 3 pπ - dπ P – S bond
Has 3 P = S bonds
Has 3 tetrahedral units of P
Has 6 P – S – P linkages.

3. $KI + 2KMnO_4 + H_2O \longrightarrow KIO_3 + 2KOH + MnO_2$

$(n_f = 6)$ $(n_f = 3)$

Moles of KI × 6 = 3 × 0.2 × 10 × 10^{-3}

Moles of KI = 10^{-3} = 1 milli mole = x

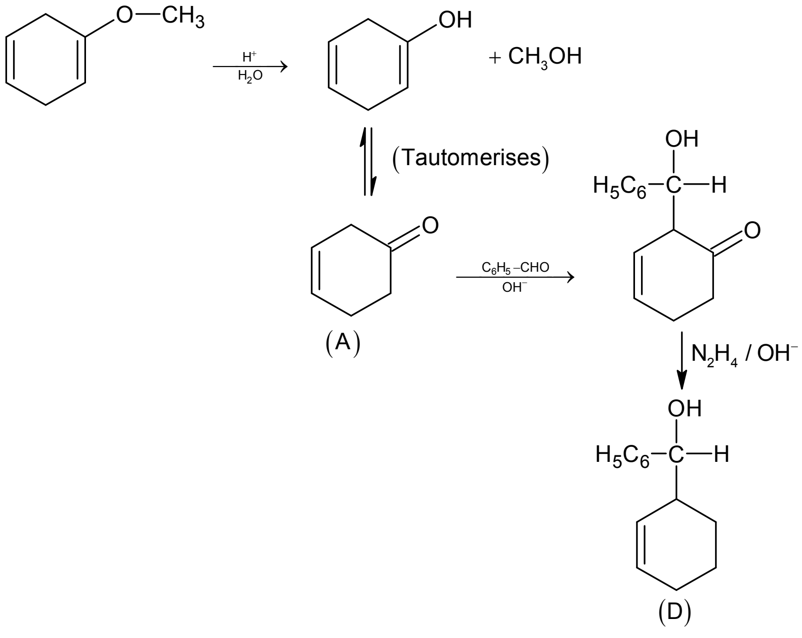
$\overset{-}{S}-C\equiv N + I_2 + H^+ \longrightarrow SO_4^{2-} + HCN + I^- + H_2O$

To produce 10^{-3} moles I^-,

Moles of $\overset{-}{S}CN \times 6 = 10^{-3} \times 1$

Moles $\overset{-}{S}CN = \dfrac{10^{-3}}{6} = 1.6 \times 10^{-4}$ moles

4.


O—CH3
H+
H2O
OH
+ CH3OH
(Tautomerises)
O
C6H5–CHO
OH−
(A)
OH
H5C6–C—H
O
N2H4 / OH−
OH
H5C6–C—H
(D)

2 enantiomeric pairs possible for (D).

5. $$\underset{\text{Buff coloured}}{CoCl_2 + 2KCN \longrightarrow Co(CN)_2 \downarrow + 2KCl}$$

$$Co(CN)_2 + 4KCN \longrightarrow K_4\left[Co(CN)_6\right]$$

6.

	Half cell	Reaction E°
L.H.S.	$H_2 \longrightarrow 2H^+ + 2e^-$	$E_{ox^o} = 0.00\text{ V}$
R.H.S.	$Zn^{2+} + 2e^- \longrightarrow Zn$	$E^o_{red} = 0.76\text{ V}$

$$\text{Net} \Rightarrow zn^{2+} + H_2 \longrightarrow Zn + 2H^+, E^o_{cell} = 0.76\text{ V}$$

$$K = \frac{\left[H^+\right]^2}{\left[Zn^{2+}\right]} = \frac{0.0591}{n}\log K$$

$$E_{cell} = E^o_{cell} - \frac{0.0591}{n}\log K$$

$$-0.46 = -0.76 - \frac{0.0591}{2}\frac{\log_{10}\left[H^+\right]^2}{0.3}$$

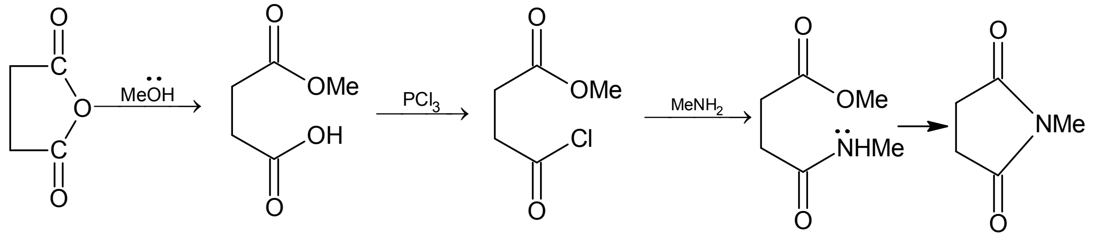
$$\left[H^+\right] = 4.60 \times 10^{-6}\text{ M}$$

$$\Rightarrow \quad \underset{0.4\text{ M}}{HSO_3^-} \rightleftharpoons \underset{4.6\times10^{-6}}{H^+} + \underset{6.4\times10^{-3}}{SO_3^{2-}}$$

$$K_a = \frac{\left[H^+\right]\left[SO_3^{2-}\right]}{HSO_3^-} = \frac{4.6\times10^{-6}\times6.4\times10^{-3}}{0.4} = 7.3\times10^{-8}$$

$pK_a = 7.13$

7.



8. Shortest λ of Lyman series $(\infty \to 1)$ for H-atom $\frac{1}{\lambda_1} = R_H\left(\frac{1}{1} - \frac{1}{\infty^2}\right) \Rightarrow \lambda_1 = R_H$

9. (2) $B(OH)_3 + NaOH \rightleftharpoons NaBO_2 + Na\left[B(OH)_4\right] + H_2O$ can be made to proceed forward by adding *cis-diol* to stabilization by chelation.

(3) The solution turning milky on passing H_2S through group II solution indicates the presence of oxidizing agent where H_2S is oxidised to $8O_2$.

10. (A) The heat of formation for NO_2 is calculated as – 45 kJ mol^{-1}.

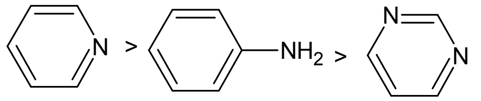
(B) For reaction $N_2 + 2O_2 \longrightarrow 2NO_2, \Delta H = -310\text{ kJ/mole}$. i.e. it is exothermic.

(C) $\frac{1}{2}N_2 + \frac{1}{2}O_2 \longrightarrow NO, \ \Delta H^o = -55\ \text{kJ/mol}$

(D) $NO + \frac{1}{2}O_2 \longrightarrow NO_2, \ \Delta H^o = -100\text{ kJ/mol}$, it is exothermic.

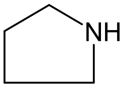
11. (A) No H-bonding can occur in chlorobenzene, so +I effect increases acidic strength.
(B) Due to both steric and polar effect has no ortho effect is observed in case of o-$MeOC_6H_4NH_2$. $MeOC_6H_5NH_2$.
p-$MeOC_6H_4NH_2$ > o-$MeOC_6H_4NH_2$ > m-$MeOC_6H_4NH_2$
$pK_a = 5.24$ $(pK_a = 4.45)$ $(pK_a = 4.2)$

(C)



$pK_a = 5.25$ $pK_a = 4.63$ $pK_a = 1.3$

(D)



> $(CH_3CH_2)_2NH$

Pyrrolidine
(pKa = 11.27) (pKa = 10.98)

12. (A) is correct, $\Delta S_{sys} = nR\ell n\frac{V_2}{V_1}$, $V_2 > V_1$.

$\therefore \Delta S_{sys} = +ve$

(B) PV^{γ} = constant, as γ is high, slope is higher.
(D) At boiling point, the process is at equilibrium $\therefore \Delta G = 0$.

14. x = 6, y = 3, z = 2
Solution for the Q. No. 13 & 14.

$$IO_3^- + 6OH^- + Cl_2 \longrightarrow IO_6^{5-} + 3H_2O + 2Cl^-$$

$$\Rightarrow IO_6^{5-} \xrightarrow{H^+} H_5IO_6$$

$$\Rightarrow 2H_5IO_6 \xrightarrow[-4H_2O]{100^\circ C} 2HIO_4 \xrightarrow{200^\circ C} I_2O_5.$$

17. V. D. = 28.75

$$\alpha = \frac{D-d}{(n-1)d} = 0.6$$

$$\begin{array}{lcc} & N_2O_4 & \rightleftharpoons & 2NO_2 \\ \text{At equilibrium}: & (1-0.6) & & 1.2 \\ & = 0.4 & & \end{array}$$

$$\frac{P_{N_2O_4}}{P_{NO_2}} = \frac{0.4}{1.2}$$

If moles of N_2O_4 escaping out is x, then for NO_2 it is (1 – x)

$$\left(\frac{x}{1-x}\right) = \frac{0.4}{1.2}\sqrt{\frac{46}{92}} \Rightarrow x = 0.188$$

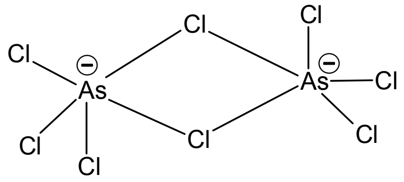
$$X_{N_2O_4(\text{escaping out})} = 0.188, \quad X_{NO_2(\text{escaping out})} = 0.812$$

18. $$K_P = \frac{P_{NO_2}}{P_{N_2O_4}} = \frac{\left(\frac{1.2}{1.6}\right)^2}{\left(\frac{0.4}{1.6}\right)} = 2.2$$

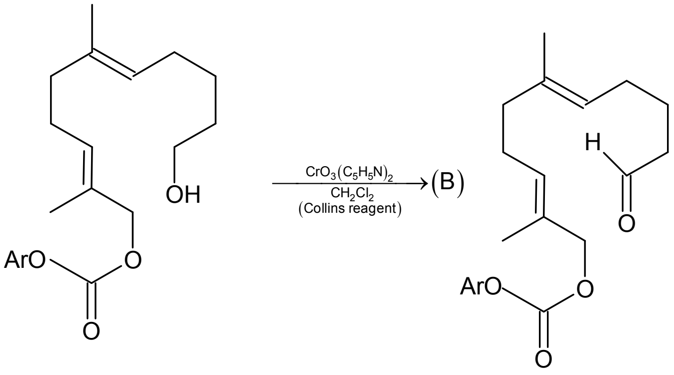
$\therefore$ K_P does not change.

SECTION – C

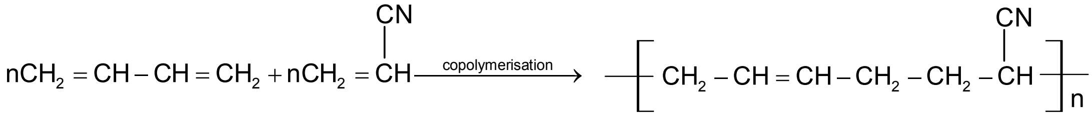
1.


Cl
Cl
Cl
As
As
Cl
Cl
Cl
Cl
Cl
Cl
Cl

2.


OH
ArO
O
O
CrO3(C5H5N)2
CH2Cl2
(Collins reagent)
(B)
H
O
ArO
O
O

3.



$$nCH_2=CH-CH=CH_2+nCH_2=\overset{CN}{\overset{|}{CH}}\xrightarrow{\text{copolymerisation}}\left[CH_2-CH=CH-CH_2-CH_2-\overset{CN}{\overset{|}{CH}}\right]_n$$

Mathematics PART – III

SECTION – A

1. If $[x^3 + x^2 + x + 1] = [x^3 + x^2 + 1] + x$, then x is integer
$\Rightarrow \log |[x]| = 2 - |[x]|$ has same solutions as $\log |x| = 2 - |x|$, x is integer
$\Rightarrow$ No integral solution $\Rightarrow 0$

2. Each element has 5 choices, as it may be in any one of A_1, A_2, A_3, A_4 or may not be in any one
$\Rightarrow$ The required number of ways = 5^7

3. $(1 + x)^n = C_0 + C_1x + C_2x^2 \,.....\, C_nx^n$

$$\Rightarrow \frac{(1+x)^{n+1}-1}{n+1} = C_0x + \frac{C_1x^2}{2} + \frac{C_2x^3}{3} ..... \frac{C_nx^{n+1}}{n+1}$$

$$\Rightarrow \frac{(1+x)^{n+2}}{(n+1)(n+2)} - \frac{x}{(n+1)} - \frac{1}{(n+1)(n+2)} = \frac{C_0x^2}{2\cdot1} + \frac{C_1x^3}{3\cdot2} ..... \frac{C_nx^{n+2}}{(n+1)(n+2)}$$

Put x = 2, we get $\dfrac{3^{n+2}-1}{(n+1)(n+2)} - \dfrac{2}{(n+1)} = \dfrac{C_0\cdot2^2}{2\cdot1} + \dfrac{C_1\cdot2^3}{2\cdot3} ..... \dfrac{C_n\cdot2^{n+2}}{(n+1)(n+2)}$

$$\Rightarrow \frac{C_0\cdot2}{2} + \frac{C_1\cdot2^2}{2\cdot3} + ... + \frac{C_n\cdot2^{n+1}}{(n+1)(n+2)} + \frac{1}{n+1} + \frac{1}{2(n+1)(n+2)} = \frac{3^{n+2}}{2(n+1)(n+2)}$$

$$\Rightarrow S_n = \frac{3^{n+2}}{2(n+1)(n+2)}$$

$$\Rightarrow \frac{S_7}{S_6} = \frac{3^9\times2\times7\times8}{2\times8\times9\times3^8} = \frac{7}{3}$$

4. It is given that $|z| = 1$
$z = \cos\theta + i\sin\theta$ (let), $\theta \in (0, 2\pi)$
Now, $\left|\dfrac{z}{\bar{z}} + \dfrac{\bar{z}}{z}\right| = 1$ gives $2\,|\cos 2\theta| = 1$

$$\Rightarrow \cos2\theta = \frac{1}{2}, -\frac{1}{2}$$

$$\Rightarrow \theta = \frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{11\pi}{6}, \frac{\pi}{3}, \frac{2\pi}{3}, \frac{4\pi}{3}, \frac{5\pi}{3} \text{ i.e. 8 values}$$

5. As $\cot\theta - \tan\theta = 2\cot2\theta$
$\Rightarrow \tan\theta = \cot\theta - 2\cot2\theta$

$$\Rightarrow \frac{1}{2}\tan\frac{\theta}{2} + \frac{1}{4}\tan\frac{\theta}{4} = \frac{1}{4}\cot\frac{\theta}{4} - \cot\theta$$

6. Latus rectum, $4a = 2\sqrt{2}$

$$\Rightarrow a = \frac{1}{\sqrt{2}}$$

Vertex = $\left(\dfrac{1}{2}, \dfrac{1}{2}\right)$
Axis = x – y = 0
As origin lies outside the parabola
$\Rightarrow$ Focus = (1, 1), Directrix = x + y = 0

$\Rightarrow$ Equation of parabola is $\left|\frac{x+y}{\sqrt{2}}\right|^2 = (x-1)^2 + (y-1)^2$

$\Rightarrow x^2 + y^2 - 2xy - 4x - 4y + 4 = 0$

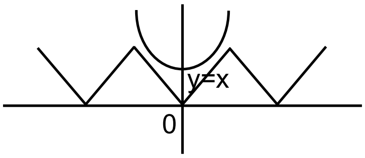
7. Tangent at (0, 0) will be same
(3 + sin B)x + (2 cos α)y = 0 and 2 cos α x + 2cy = 0 are same
$\Rightarrow c = \frac{2\cos^2\alpha}{3+\sin\beta} \Rightarrow c_{max} = 1$ where sin β = –1 and α = 0

8. Consider g(x) = xf(x)
g is continuous on [0, 1] and differentiable on (0, 1)
$\because$ f(1) = 0 $\Rightarrow$ g(0) = 0 = g(1)
By Rolles' Theorem g′(c) = 0 some for c $\in$ (0, 1)
$\Rightarrow$ cf′(c) + f(c) = 0

9. At x = 2, RHD = 5 + |1 – x| = 5 + 1 = 6 whereas LHD = 5

11. Let the coordinates of point A are (ct, c/t)
So, the slope of normal at A will be t^2.
And normal will be parallel to BC.
So, t will be $\pm\sqrt{2} \Rightarrow c = \pm 2$.

12. 'a' must be negative and $x^2 - a = x$ should have no solution
Now, D < 0 $\Rightarrow$ 1 + 4a < 0 $\Rightarrow a < -\frac{1}{4}$



13. $\because \frac{\Delta ABC}{\Delta PQR} = \frac{b}{a}$

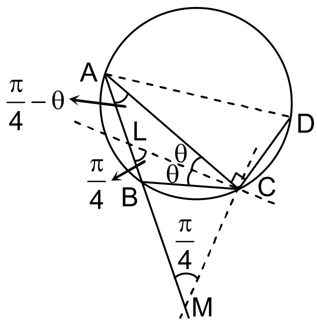
$\Rightarrow \Delta ABC = \frac{b}{a}\cdot\frac{3\sqrt{3}}{4}a^2 = \frac{3\sqrt{3}}{4}ab$

14. Slope of OP and OQ will be $\frac{am_1}{b}$ and $\frac{am_2}{b}$ respectively

If $\angle$POQ = θ than tan θ = $\left|\frac{\frac{a}{b}(m_1-m_2)}{1+\frac{a^2}{b^2}m_1m_2}\right| = \left|\frac{ab(m_1-m_2)}{b^2+a^2m_1m_2}\right|$

Now, area of sector OPQ of circle $x^2 + y^2 = a^2 = \frac{\pi a^2}{2\pi}\theta = \frac{1}{2}a^2\theta$

Area of sector OAB = $\frac{b}{a}\left(\frac{1}{2}a^2\cdot\theta\right) = \frac{1}{2}ab\theta$ where $\theta = \tan^{-1}\left|\frac{ab(m_1-m_2)}{b^2+a^2m_1m_2}\right|$



15.-16. $\because\ \angle LCM = 90^\circ$ and $CL = CM$

$\angle CLM = \angle CML = \frac{\pi}{4}$

Let $\angle ACB = 2\theta$

$\Rightarrow \angle LAC = \frac{\pi}{4} - \theta$ and $\angle LCB = \frac{3\pi}{4} - \theta$

By sine Rule in ΔABC

$$a^2 + b^2 = 4R^2\left(\sin^2\left(\frac{\pi}{4}-\theta\right) + \sin^2\left(\frac{3\pi}{4}-\theta\right)\right)$$

$$a^2 + b^2 = 4R^2\left(\sin^2\left(\frac{\pi}{4}-\theta\right) + \cos^2\left(\frac{\pi}{4}-\theta\right)\right) = 4R^2$$

Let $\angle ADC = \alpha \Rightarrow \angle ABC = \pi - \alpha \Rightarrow \angle CBM = \alpha$

$\Rightarrow \alpha = \frac{\pi}{4} + \theta$

$\because\ \angle CAD = \frac{\pi}{2} - \alpha = \frac{\pi}{4} - \theta$

$\therefore\ \angle BAC = \angle CAD \Rightarrow BC = CD$

17.-18. We want to have $a_n = k$ if $\frac{k(k-1)}{2} < n \le \frac{k(k+1)}{2}$

$\because$ n is an integer, this is equivalent to $\frac{k(k-1)}{2} + \frac{1}{8} < n < \frac{k(k+1)}{2} + \frac{1}{8}$

$\Rightarrow k^2 - k + \frac{1}{4} < 2n < k^2 + k + \frac{1}{4}$

$\Rightarrow k - \frac{1}{2} < \sqrt{2n} < k + \frac{1}{2} \Rightarrow k < \sqrt{2n} + \frac{1}{2} < k + 1$

Hence, $a_n = \left[\sqrt{2n} + \frac{1}{2}\right] \Rightarrow \alpha = 2 = \beta$

17. Now, a = 2, b = 3, c = 5

Let A = number of numbers which are divisible by 2
B = number of numbers which are divisible by 3
C = number of numbers which are divisible by 5

Required number = $A + B + C - A \cap B - B \cap C - C \cap A + A \cap B \cap C$

$$= \left[\frac{1000}{2}\right] + \left[\frac{1000}{3}\right] + \left[\frac{1000}{5}\right] - \left[\frac{1000}{6}\right] - \left[\frac{1000}{15}\right] + \left[\frac{1000}{10}\right] + \left[\frac{1000}{30}\right] = 734$$

18. a = 2, b = 3, c = 5, d = 7

Hence, the given number is $2^5 \cdot 3^5 \cdot 5^3 \cdot 7^3$

$\because$ 4n + 1 is odd number therefore the factor 2 will not occur in divisor. 3 and 7 are of 4n + 3 form, odd powers of 3 and 7 will be of 4n + 3 form and even powers will be 4n + 1 form

5 is 4n + 1 form and any power of 5 will be of 4n + 1 form

$\therefore$ Number of divisors of 4n + 1 type

= number of terms in the product $(1 + 3^2 + 3^4)(1 + 5 + 5^2 + 5^3)(1 + 7^2)$

+ number of terms in the product $(3 + 3^2 + 3^5)(1 + 5 + 5^2 + 5^3)(7 + 7^3) = 48$

SECTION – C

1. As g(x) is inverse of f(x)
$\Rightarrow$ Domain of g(x) is range of f(x)
$\Rightarrow$ a = 3, b = 11

2. Required number of ways = co-efficient of x^{30} in $(x^2 + x^3 + x^4 + x^5 + x^6 + x^7 + x^8)^5$
= co-efficient of x^{30} in $\left(\frac{x^2\left(1-x^7\right)}{1-x}\right)^5$
= co-efficient of x^{20} in $(1 - x^7)^5(1 - x)^{-5}$
= ${}^{24}C_{20} - 5\,{}^{17}C_{13} + 10\,{}^{10}C_6 = 826$
$\Rightarrow$ A = 8, B = 2, C = 6
A + B – C = 4

3. $\sqrt{\left(\sqrt{x^3+1}-1\right)^2}+\sqrt{\left(\sqrt{x^3+1}-3\right)^2} = \left|\sqrt{x^3+1}-1\right|+\left|\sqrt{x^3+1}-3\right|$
For $x \in [0, 2]$ $1 \le \sqrt{x^3+1} \le 3$
$\Rightarrow$ f(x) = 2
$\therefore \int_0^2 f(x)dx = 4$

4. Orthocentre is foot of perpendicular drawn from origin on the plane

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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FIITJEE **JEE (Advanced), 2015**

ALL INDIA TEST SERIES

FULL TEST – V

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 234**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 – 12) contains 4 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

Section-A (13 to 18) contains 3 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-C (01 – 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	$6.625 \times 10^{-34}\ J{\cdot}s$
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

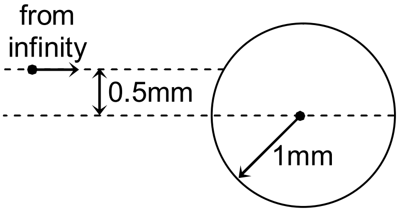
Physics PART – I

SECTION – A

Straight Objective Type

This section contains **8 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

1. A particle of mass 1 kg and charge $\frac{1}{3}\mu C$ is projected towards a non-conducting fixed spherical shell having same charge uniformly distributed on its surface. Find minimum initial velocity of projection required by the particle, if it just grazes the shell :



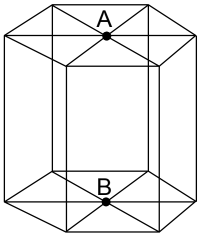
(A) $\sqrt{\frac{2}{3}}\,m/s$ (B) $2\sqrt{\frac{2}{3}}\,m/s$

(C) $\frac{2}{3}\,m/s$ (D) None of these

2. High-Quality camera lenses are coated to prevent reflection. A lens has an optical index of refraction 1.72 and a coating with an optical index of refraction of 1.31. For near-normal incidence, the minimum thickness of the coating to prevent reflection for wavelength of 5.3×10^{-7}m is:

(A) 0.75 μm (B) 0.2 μm
(C) 0.1 μm (D) 1.75 μm

3. In the diagram shown, all the straight segments have resistance 'R'. The equivalent resistance between the upper dot (A) and lower dot (B) is

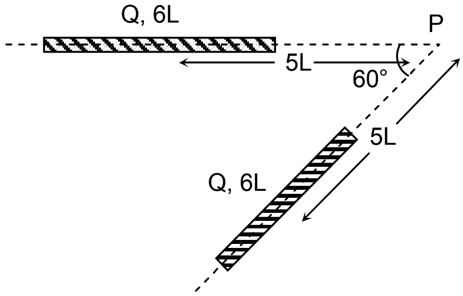


(A) $\frac{3R}{8}$ (B) R

(C) $\frac{R}{2}$ (D) $\frac{2R}{5}$

Space for Rough work

4. Two rods each of length 6L carry charge Q are placed as shown in figure. Find magnitude of electric field at point P, which is at a distance of 5L from centre of each rod.



(A) $\frac{1}{64\pi\epsilon_0}\cdot\frac{\sqrt{3}Q}{L^2}$

(B) $\frac{\sqrt{5}Q}{4\pi\epsilon_0 L^2}$

(C) $\frac{1}{2\pi\epsilon_0}\cdot\frac{Q}{L^2}$

(D) $\frac{3Q}{5\pi\epsilon_0 L^2}$

5. A particle moves along x-axis following the relation $px^2 + qv^2 = r$, where p, q, r are positive constants. x is co-ordinate of the particle and v is the instantaneous speed. Find the time interval between two consecutive instants, when particle is at rest.

(A) $2\pi\sqrt{\frac{q}{p}}$

(B) $\pi\sqrt{\frac{q}{p}}$

(C) $\pi\sqrt{\frac{p}{q}}$

(D) $2\pi\sqrt{\frac{p}{q}}$

6. A charged particle of specific charge $\left(\frac{\text{charge}}{\text{mass}}\right)$ 'α' is released from origin at t = 0 with velocity $\vec{v} = v_0(\hat{i} + \hat{j})$ in uniform magnetic field $\vec{B} = B_0\hat{i}$. Then co-ordinates of the particle at $t = \frac{\pi}{B_0\alpha}$ will be :

(A) $\left(\frac{v_0}{2B_0\alpha}, \frac{\sqrt{2}v_0}{\alpha B_0}, -\frac{v_0}{B_0\alpha}\right)$

(B) $\left(-\frac{v_0}{2B\alpha}, 0, 0\right)$

(C) $\left(0, \frac{2v_0}{B_0\alpha}, \frac{v_0\pi}{2B_0\alpha}\right)$

(D) $\left(\frac{v_0\pi}{B_0\alpha}, 0, -\frac{2v_0}{B_0\alpha}\right)$

Space for Rough work

7. A resistor ‘R’ is connected across a source of emf ‘E’ and unknown internal resistance. Power of resistor is maximum when internal resistance is
(A) R (B) < R
(C) > R (D) zero

8. A child loves to watch as you fill a transparent plastic bottle with shampoo. Horizontal cross-sections of the bottle are circles with varying diameters. You pour in shampoo with constant volume flow rate 16.5 cm^3/s. At what rate is its level in the bottle rising at a point where diameter of the bottle is 6.30 cm. Calculate keeping significant figures in view.
(A) 0.063 cm/s (B) 0.63/cm/s
(C) 0.529 cm/s (D) 0.5291 cm/s

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

9. A boy in the elevator with open roof shoots a bullet in vertical upward direction from a height of 1.5 above the floor of the elevator. The initial speed of the bullet with respect to elevator is 15 m/s. The bullet strikes the floor after 2 seconds. Then (Assuming g = 10 m/s^2)
(A) Lift is moving with constant speed
(B) Lift is moving with upward acceleration of 5.75 m/s^2
(C) Lift is moving with downward acceleration of 5.75 m/s^2
(D) Distance travelled by bullet during its flight can not be calculated from the given data.

Space for Rough work

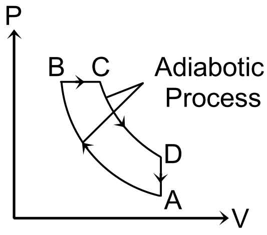
10. An idealized diesel engine operates in a cycle known as air standard diesel cycle as shown. Fuel is sprayed into the cylinder at the point of maximum compression, B. Combustion occurs during expansion BC.

(A) Heat is absorbed during process BC.

(B) Heat is released during process DA.

(C) Heat is absorbed during process CD.

(D) Efficiency of the cycle is $\left[1-\frac{1}{\gamma}\left(\frac{T_D-T_A}{T_C-T_B}\right)\right]$



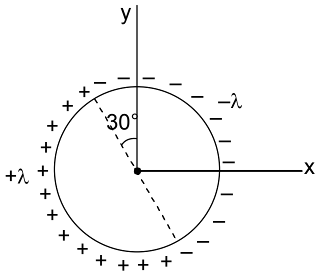
11. Consider a non-conducting ring of radius 'a' in x-y plane. The two semi-circular portions have linear charge densities + λ and – λ as shown. Then :

(A) Dipole moment of the ring is $-\left(2\sqrt{3}\,\hat{i}+2\hat{j}\right)\lambda a^2$

(B) Dipole moment of the ring is $-\left(2\hat{i}+2\sqrt{3}\,\hat{j}\right)\lambda a^2$

(C) Electric field at the center of the ring is $\frac{\lambda}{2\pi\epsilon_0 a}\left(\sqrt{3}\,\hat{i}+\hat{j}\right)$

(D) Electric field at the center of the ring is $\frac{\lambda}{2\pi\epsilon_0 a}\left(\hat{i}+\sqrt{3}\,\hat{j}\right)$



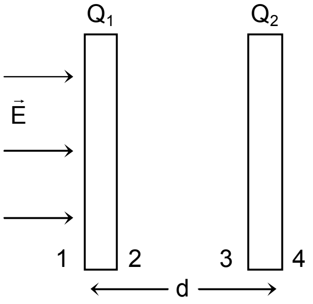
12. Two plates, each of one side area 'A' are kept at a separation 'd'. They have charge Q_1 and Q_2 and uniform electric field $\vec{E}$ exist in the region as shown. Then

(A) Charge on surface (1) is $\frac{Q_1+Q_2}{2}-A\epsilon_0 E$

(B) Field inside the gap is $E+\frac{Q_1-Q_2}{2A\epsilon_0}$

(C) Field outside the gap is E

(D) Field on either side of the plates is identical



Space for Rough work

Comprehension Type

This section contains **3 paragraphs**, each describing theory, experiments, data etc. Six questions relate to the three paragraphs with **two questions on each paragraph**. Each question has **only one** correct answer among the four given options (A), (B), (C) and (D).

Paragraph for Questions 13 & 14

Two astronauts, each having a mass 'M' are connected by a rope of length 'd' having negligible mass. They are isolated in space, orbiting their center of mass at speed 'v'. Treat astronauts as particles. By pulling the rope, one astronaut shortens the distance between them to '$\frac{d}{2}$'.

13. Calculate work done by the astronaut in shortening the rope :
    (A) $2Mv^2$ (B) $3Mv^2$
    (C) Mv^2 (D) zero

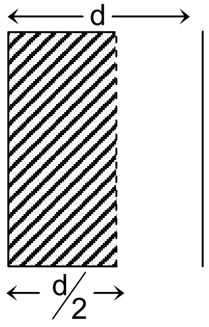
14. Physical quantity that will remain conserved during the process of pulling in rope.
    (A) Speed of astronauts
    (B) Energy of the system
    (C) Angular speed of astronauts about COM
    (D) Angular Momentum

Space for Rough work

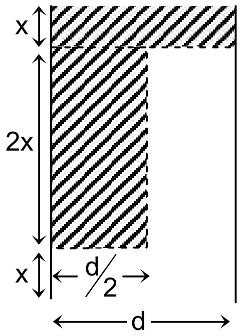
Paragraph for Questions 15 & 16

A parallel plate capacitor has plate area ‘A’ and plate separation ‘d’. A dielectric medium of volume $\frac{Ad}{2}$ and dielectric constant ‘K’ is available. To use it in the capacitor, two alternative methods are available as shown :

(1)



(2)



15. Capacitance in case (1) is $X_1 \frac{\epsilon_0 A}{d}$. Then x_1 is

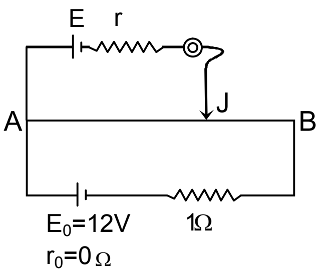
(A) $\frac{K}{3}$
(B) $\frac{2K}{k-1}$
(C) $\frac{3K+1}{2K}$
(D) $\frac{2K}{K+1}$

16. Capacitance is case (2) is $x_2 \frac{\epsilon_0 A}{d}$. Then x_2 is

(A) $\frac{K+1}{4}+\frac{K}{K+1}$
(B) $\frac{K+1}{4}+\frac{1}{K}$
(C) $\frac{2K}{4}+\frac{K}{3}$
(D) $\frac{K}{3}+\frac{K+1}{2}$

Space for Rough work

Paragraph for Questions 17 & 18



In the set-up shown 'E' is unknown emf with internal resistance 'r'. AB is a uniform potentiometer wire, 11m long and resistance $1\Omega m^{-1}$. When AJ = 1m, current through galvanometer is 2.4 A when AJ = 10m, current through galvanometer is $\frac{6}{11}$A, in the opposite direction as in previous case. Galvanometer has negligible resistance.

17. The value of E is

(A) 4 V (B) 6 V
(C) 8 V (D) 10 V

18. The vale of r is

(A) 1Ω (B) 2Ω
(C) 2.5Ω (D) 4Ω

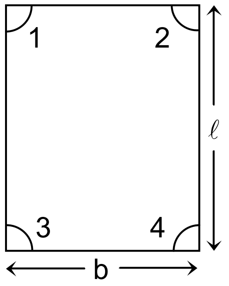
Space for Rough work

SECTION – C

Integer Answer Type

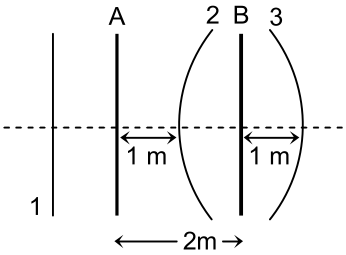
This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. Ball A is at rest somewhere on a smooth billiards table $\left(\frac{\ell}{b} = 3\right)$. An identical ball B moving with velocity 2 ms^{-1}, collides with a elastically. After $\frac{1}{2}$ sec both the balls simultaneously fall into pockets marked 1 and 2. Find area of the table in m^2.



2. A hydrogen atom in excited state n reaches the ground state by emitting three photons of frequency in ratio 5 : 72 : 243. Wavelength corresponding to one of the transitions belongs to visible region. Find the value of 'n'.

3. A and B are thin lenses. 1, 2 and 3 are representative wave fronts of incident and refracted monochromatic light with distances from the lenses as shown. The radii of curvature of wave fronts 2 and 3 are 4m and 7m respectively. Find the focal length (modulus value) of lens B in meter.



4. A particle is taken to a height K times radius of Earth, above the surface of earth and projected at an angle of 30° to the vertical. During its subsequent motion, it just grazes the surface of earth with a velocity $\frac{\sqrt{15}}{4}$ times the escape velocity from the surface of earth. Find the value of K. (K < 9).

5. ABCD is a semi-circular wire carrying current in a region of uniform magnetic field. Arc AB = Arc BC = Arc CD. The magnitude of the force on the wire is 8 N, while magnitude of the force on arc AB alone is 9 N. The lines of action of these two forces include an angle of $\cos^{-1}\left(\frac{2}{3}\right)$. Find the magnitude of the force (is N) on arc CD alone.

Space for Rough work

Chemistry PART – II

SECTION – A

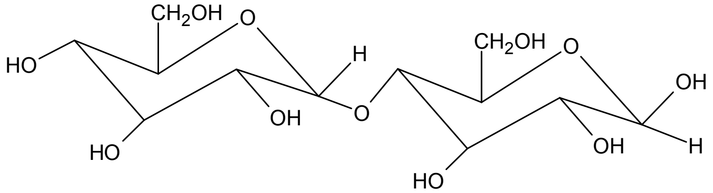
Straight Objective Type

This section contains **08 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** is/are correct.

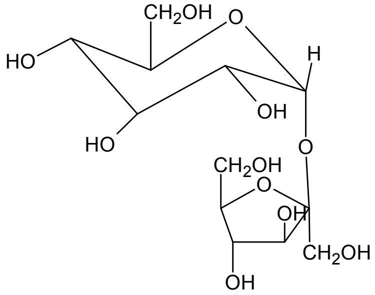
1. In a rock salt crystal and fluorite structure, if atoms along the plane cutting the two opposite edges are removed, then the new ratio of the cations in two respective unit cells and ratio of anions in respective unit cells are:
(A) 5 : 6 / 10 : 1
(B) 6 : 5 / 5 : 8
(C) 12 : 5 / 5 : 8
(D) 3 : 4 / 5 : 4

2. Which of the following is reducing sugar?

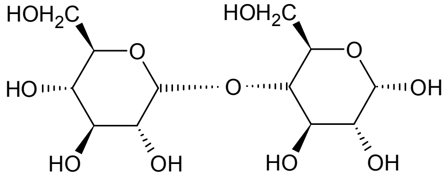
(A)


CH2OH
O
HO
H
HO
OH
O
CH2OH
O
OH
HO
OH
H

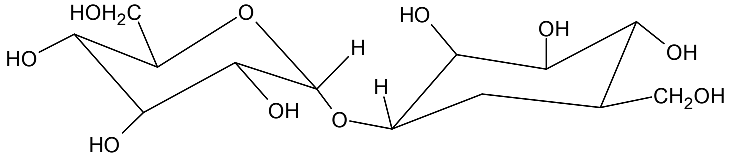
(B)


CH2OH
O
HO
H
OH
HO
O
CH2OH
O
OH
CH2OH
OH

(C)


HOH2C
O
HO
HO
OH
O
HOH2C
O
OH
HO
OH

(D)


HOH2C
O
HO
H
HO
OH
O
H
HO
OH
OH
CH2OH

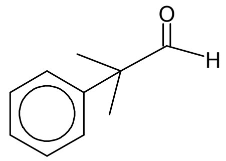
Space for Rough work

3. In compound (A) with molecular formula C_8H_8O, which responds to iodoform test?

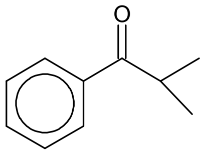
$$(A)\xrightarrow[\text{HOEt}]{\text{NaCN}}(B)\xrightarrow[\text{(ii) }H^+,H_2O]{\text{(i) MeMgBr}}(C)\xrightarrow{H^+}\underset{\text{(Major product)}}{(D)}$$

The structure of (D) is:

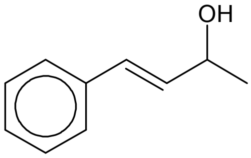
(A)



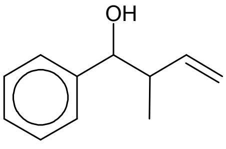
(B)



(C)



(D)



4. When copper is reacted with dil. HNO_3 a colourless gas is liberated. Which of the following is true for the gas?
(A) Has 11 valence e's, where extra electron occupies an antibonding π^*2p orbital.
(B) An acid anhydride.
(C) Paramagnetic in solid state.
(D) Has no resonance.

5. What is the number of five membered ring in the molecule of S_4N_4?

(A) 4	(B) 2
(C) 1	(D) 5

6. Consider the following complexes:
(I) $[Cr(CO)_x)]$ (II) $[Cr(CO)_{x-1}PF_3]$
If PF_3 is better π accepter than CO, what will be the order of bond length of CO in complexes (I) and (II):

(A) I > II	(B) II > I
(C) I = II	(D) cannot be compared

7. A compound (A) form a unstable pale blue colour solution in water. The solution decolourised Br_2 water and an acidified solution of $KMnO_4$. The possible compound (A) is:

(A) HNO_2	(B) HNO_3
(C) N_2O_3	(D) Both (A) and (C)

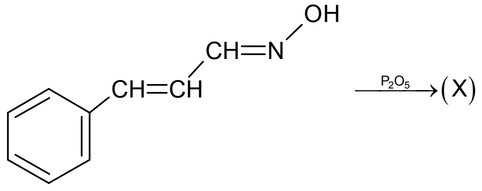
8. The 100 ml of 0.1 M CH_3COOH ($K_a = 10^{-5}$) is titrated with 0.1 M NaOH and pH is observed at three stages, at 298 K.
1st step ⇒ 50 ml of 0.1 M NaOH added.
2nd step ⇒ 100 ml of 0.1 M NaOH added.
3rd step ⇒ 120 ml of 0.1 M NaOH added.
Calculate the difference in pH between stages (I & II) and (II & III) stages.

(A) $(pH_{II} - pH_{I}) = 3.84$ & $(pH_{III} - pH_{II)} = 4.11$	(B) $(pH_{I} - pH_{II}) = 2$ & $(pH_{III} - pH_{II)} = 5.2$
(C) $(pH_{I} - pH_{II}) = 3.84$ & $(pH_{III} - pH_{II)} = 3.11$	(D) $(pH_{I} - pH_{II}) = 4.2$ & $(pH_{III} - pH_{II)} = 3.11$

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

9.



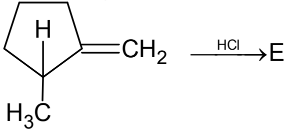
(A)

Which of the following are correct for compound (X)?
(A) (X) is aromatic and a heterocyclic compound.
(B) Compound (X) is more basic than aniline.
(C) The reaction that occur is stereospecific.
(D) The reaction do not follow a concerted mechanism and (X) is non-aromatic.

10. Which of the following the first pair has less parameter in the property mentioned:

(A)	CH_3NH_2 or $(CH_3)_2NH_2^+$	(Angle H – N – H)
(B)	PCl_2F_3 or PCl_3F_2	(Angle F – P – F)
(C)	NO^+ or NO	(Bond length)
(D)	CrO_3 or Cr_2O_3	(In acidic nature)

11. Which of the following statements are incorrect?
(A) 1, 1, 1-trideutero – 2-propanol reacts with conc. H_2SO_4 at high temperature to give only one alkene 3,3,3- trideuteropropene.
(B) Attack of chlorine radical on alkene is endothermic and attack of radical formed on HCl is exothermic.
(C) Rearrangement will occur in forming the major product in reaction.



(D) *Cis* form of 1,3-Dimethyl cyclohexane is more stable than its *trans* form with respect to atleast one group at equatorial position.

12. During discharging of lead storage battery, which of the following is/are true?
(A) H_2SO_4 is produced.
(B) H_2O is consumed.
(C) $PbSO_4$ is formed at both electrodes.
(D) Density of electrolytic solution increased.

Space for Rough work

Comprehension Type

This section contains **3 paragraphs**, each describing theory, experiments, data etc. Six questions relate to the three paragraphs with **two questions on each paragraph**. Each question has **only one** correct answer among the four given options (A), (B), (C) and (D).

Paragraph for Question Nos. 13 to 14

A substance 'X' dissociates by two parallel reactions with different Arrhenius constant (A_1 & A_2) and different activation energies $\left(E_{a_1} \,\&\, E_{a_2}\right)$ as shown:

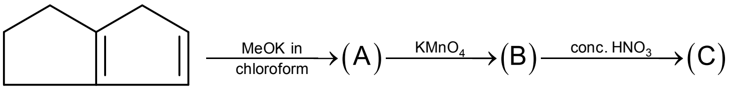
$$X(g)\xrightarrow[E_{a_1}=12\text{ kcal/mol}]{A_1=2\times10^{-14}\,s^{-1}}Y(g);\; X(g)\xrightarrow[E_{a_2}=9\text{ kcal/mol.}]{A_2=2\times10^{-14}\times e^{-2}s^{-1}}Z(g)$$

13. Temperature at which net activation energy for dissociation of X will be 10.5 kcal/mol?
(A) 200
(B) 750
(C) 800
(D) 1000

14. Which of the following statements are correct with respect to major product obtained in the above parallel decay?
(A) 'Y' will be the major product at temperature 300 K.
(B) 'Z' will be the major product at temperature 800 K.
(C) Both statements are correct.
(D) None of the statement are correct.

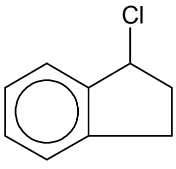
Space for Rough work

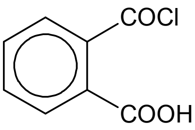
Paragraph for Question Nos. 15 to 16


MeOK in
chloroform
(A)
KMnO4
(B)
conc. HNO3
(C)

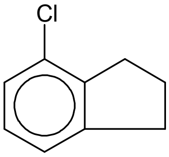
15. Identify the structure of (A) & (B):

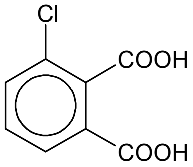
(A)

A ⇒


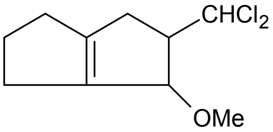
B ⇒


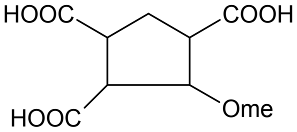
(B)

A ⇒


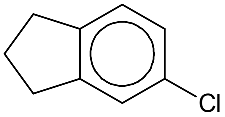
B ⇒

Cl
COOH
COOH

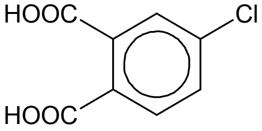
(C)

A ⇒


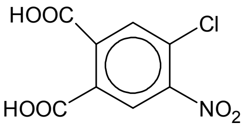
B ⇒

HOOC
COOH
HOOC
Ome

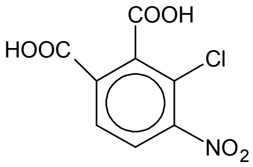
(D)

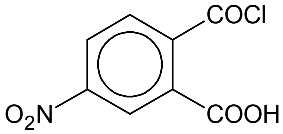
A ⇒


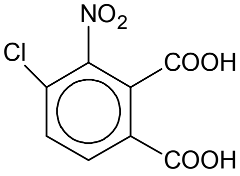
B ⇒

HOOC
Cl
HOOC

16. How many isomers of (C) are possible and the major product is:

(A) 3,

HOOC
Cl
HOOC
NO2

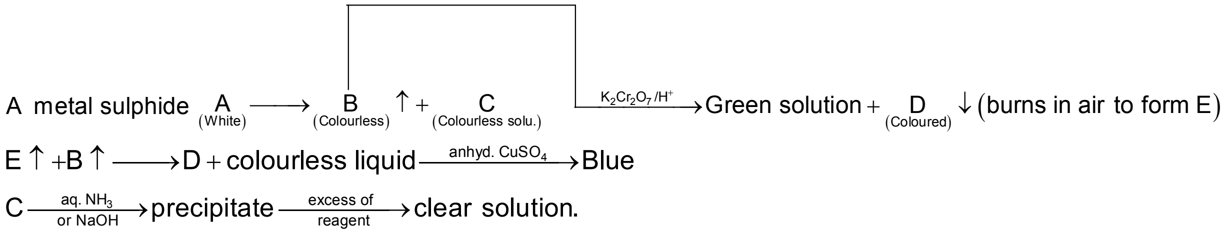
(B) 3,

COOH
HOOC
Cl
NO2

(C) 4,

COCl
O2N
COOH

(D) 2,

NO2
Cl
COOH
COOH

Space for Rough work

Paragraph for Question Nos. 17 to 18



A metal sulphide $\underset{(\text{White})}{A} \longrightarrow \underset{(\text{Colourless})}{B}\uparrow + \underset{(\text{Colourless solu.})}{C}$ $\xrightarrow{K_2Cr_2O_7/H^+}$ Green solution $+ \underset{(\text{Coloured})}{D}\downarrow$ (burns in air to form E)

$E\uparrow + B\uparrow \longrightarrow D +$ colourless liquid $\xrightarrow{\text{anhyd. } CuSO_4}$ Blue

$C \xrightarrow[\text{or NaOH}]{\text{aq. } NH_3}$ precipitate $\xrightarrow[\text{reagent}]{\text{excess of}}$ clear solution.

17. Calculate the weight of compound (A) required to produce (B), so that (B) will completely react with 10 ml of 0.2 M $K_2Cr_2O_7$?
(A) 650 mg (B) 288 mg
(C) 583 mg (D) 458 mg

18. Compound (C) on reaction with NH_3 or NaOH forms a precipitate and with excess of reagent forms a clear solution of compound (Z), (Z) is?
(A) $NaAlO_2$ (B) Na_2ZnO_2
(C) $Cu(OH)_2$ (D) $[Ag(NH_3)_2]^+$

Space for Rough work

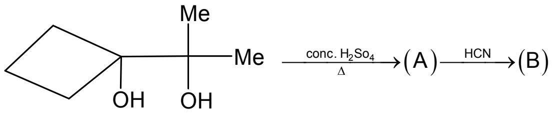
SECTION – C

Integer Answer Type

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. How many are the intensive properties?
Density, pressure, emf, free energy, specific heat, heat capacity, specific conductance, resistance, pH?

2. The sum of chiral centre and number of lone pair in compound (B) are:



3. One mole of an ideal monoatomic gas is expanded irreversibly in two stage isothermal expansion:
Stage 1. (8 bar, 4.0 litre, 300 K)
Stage 2. (2 bar, V_1 litre, 300 K)
Stage 3. (1 bar, V_2 litre, 300 K)
Calculate heat absorbed by the gas in the process (in kJ)

4. The sum of all sp^3, sp^2 & sp units present in solid PCl_5, solid Pbr_5 and solid N_2O_5 are:

5. How many diastereomeric pair are possible for compound $[Co(en)_2Cl_2]^+$?

Space for Rough work

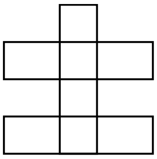
Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **8 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

1. Six different letters are placed in boxes of the given figure such that no row is empty. (In each box only one letter can be placed). The number of such arrangements is



(A) 2920 (B) 6480
(C) 8640 (D) 10800

2. Suppose b and c are real numbers randomly chosen in the interval [0, 1]. What is the probability that the distance in complex plane between the two roots of the equation $z^2 + bz + c = 0$ is not greater than 1?

(A) $\frac{1}{3}$ (B) $\frac{2}{3}$
(C) $\frac{1}{4}$ (D) $\frac{3}{4}$

3. The equation of line which intersect each of two lines $2x + y - 1 = 0 = x - 2y + 3z$ and $3x - y + z + 2 = 0$, $4x + 5y - 2z - 3 = 0$ and is parallel to $\frac{x}{1} = \frac{y}{2} = \frac{z}{3}$ is

(A) $4x + 7y - 6z - 3 = 0$, $2x - 7y + 4z + 7 = 0$ (B) $4x + 7y - 6z - 4 = 0$, $2x - 7y + 4z + 2 = 0$
(C) $4x + 7y - 6z - 2 = 0$, $2x - 7y + 4z + 5 = 0$ (D) none of these

4. If three positive distinct real number p, q, r satisfy the condition $\frac{1}{p} + \frac{1}{r} + \frac{1}{p-q} + \frac{1}{r-q} = 0$. If q = 2, then minimum value of pr is

(A) 1 (B) 2
(C) 3 (D) 4

Space for rough work

5. The value of $\int_0^\infty \frac{1}{\left(1+x^{17}\right)\left(1+x^2\right)}dx$ is equal to

(A) $\frac{\pi}{2}$
(B) $\frac{\pi}{3}$
(C) $\frac{\pi}{4}$
(D) $\frac{\pi}{6}$

6. If a curve is such that line joining origin to any point P(x, y) on the curve and line parallel to y-axis through P are equally inclined to tangent to curve at P, then the differential equation of the curve is

(A) $x\left(\frac{dy}{dx}\right)^2 - 2y\frac{dy}{dx} = x$
(B) $\left(\frac{dy}{dx}\right)^2 + 2y\frac{dy}{dx} = x$
(C) $y\left(\frac{dy}{dx}\right)^2 + 2y\frac{dy}{dx} = x$
(D) $y\left(\frac{dy}{dx}\right)^2 - 2y\frac{dy}{dx} = y$

7. Let f (x) = $x^3 + 2x^2 - x + 1$, then which of the following statement(s) is/are correct

(A) $\sin^{-1}\left(\sin\left([\alpha]\right)\right) + \cos^{-1}\left(\cos\left([\alpha]\right)\right) = 6 - \pi$ (where α is real root of f(x) = 0 and [.] denotes the G.I.F.)
(B) f (x) = 0 has three distinct real roots
(C) y = f (x) is increasing function
(D) $\sin^{-1}\left(\sin\left([\alpha]\right)\right) + \cos^{-1}\left(\cos\left([\alpha]\right)\right) = 5 - 2\pi$
(where α is real root of f(x) = 0 and [.] denotes the G.I.F.)

8. Which of the following functions is an injective (one–one) function in their respective domain?

(A) f(x) = 2x + sin 3x
(B) f(x) = x · [x], (where [.] denotes the G.I.F)
(C) f(x) = $\frac{2^x - 1}{4^x + 1}$
(D) f(x) = $\frac{2^x + 1}{4^x - 1}$

Space for rough work

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct

9. Let point A be (1, 1) and equation of BC is $(x + y - 1) + \lambda(2x - y + 4) = 0$ and area of ΔABC is maximum, then slope of the line AB and AC, may be equal to
(Given AB = AC and BC = 2 units)

(A) $\frac{-2-\sqrt{5}}{2\sqrt{5}-1}$
(B) $\frac{2-\sqrt{5}}{2\sqrt{5}-1}$
(C) $\frac{2-\sqrt{5}}{2\sqrt{5}+1}$
(D) $\frac{2+\sqrt{5}}{2\sqrt{5}+1}$

10. The value of x which satisfy the equation $\begin{vmatrix} \tan x & \tan 2x & \tan 3x \\ \tan 2x & \tan 3x & \tan x \\ \tan 3x & \tan x & \tan 2x \end{vmatrix} = 0$ is

(A) $\frac{13\pi}{12}$
(B) $\frac{13\pi}{3}$
(C) $\frac{\pi}{3}$
(D) none of these

11. The co-ordinate of foci of ellipse $\frac{(x-y)^2}{4} + \frac{(y+x)^2}{1} = 1$ are

(A) $\left(\sqrt{\frac{3}{2}}, -\sqrt{\frac{3}{2}}\right)$
(B) $\left(-\sqrt{\frac{3}{2}}, -\sqrt{\frac{3}{2}}\right)$
(C) $\left(\sqrt{\frac{3}{2}}, \sqrt{\frac{3}{2}}\right)$
(D) $\left(-\sqrt{\frac{3}{2}}, \sqrt{\frac{3}{2}}\right)$

12. For different values of k, the circle $x^2 + y^2 + (8 + k)x + (8 + k)y + (16 + 12k) = 0$, always passes through two fixed points P and Q. For $k = k_1$, then tangents at P and Q intersect at the origin. Which of the following is/are correct?

(A) the mid-point of P and Q is (–6, –6)
(B) the sum of ordinates of P and Q is –12
(C) k_1 may be equal to $-\frac{32}{9}$
(D) k_1 may be equal to $\frac{8}{3}$

Space for rough work

Comprehension Type

This section contains **3 paragraphs**, each describing theory, experiments, data etc. Six questions relate to the three paragraphs with **two questions on each paragraph**. Each question has **only one** correct answer among the four given options (A), (B), (C) and (D).

Paragraph for Question Nos. 13 to 14

Let continuous function f (x) = $\begin{cases} x^2 + 10x + 8, & x \le -2 \\ px^2 + qx + r, & -2 < x < 0 \\ x^2 + 2x, & x \ge 0 \end{cases}$, where $p \neq 0$. If a line 'L' touches the graph of y = f (x) at 3 points, then

13. The line 'L' touches which of the following curve

(A) $x^2 + y^2 = 1$
(B) $x^2 + y^2 - 2x - 4y - 9 = 0$
(C) $(y + 2)^2 = -48 (x + 1)$
(D) $(y + 2)^2 = 13 (x + 1)$

14. The value of p + q + r is equal to

(A) $5\sqrt{2}$
(B) 5
(C) 6
(D) 7

Paragraph for Question Nos. 15 to 16

Read the following write up carefully and answer the following questions:
Consider some special type of matrices. A square matrix is called idempotent matrix if $A^2 = A$
A matrix A is called nilpotent matrix if $A^k = 0$, for some $k \in N$
A square matrix is called involutary matrix if $A^2 = \mathbf{I}$

Now consider the following matrices $A = \begin{vmatrix} 2 & -3 & -5 \\ -1 & 4 & 5 \\ 1 & -3 & -4 \end{vmatrix}$, $B = \begin{vmatrix} 1 & -3 & -4 \\ -1 & 3 & 4 \\ 1 & -3 & -4 \end{vmatrix}$, $C = \begin{vmatrix} 0 & 1 & -1 \\ 4 & -3 & 4 \\ 3 & -3 & 4 \end{vmatrix}$

15. Which one of the following is a nilpotent matrix?

(A) A
(B) B
(C) C
(D) AC^2

16. Which one of the following is not an idempotent matrix?

(A) A^3C^2
(B) A^2C^2
(C) BC^2
(D) C^2A

Space for rough work

Paragraph for Question Nos. 17 to 18

Read the following write up carefully and answer the following questions:
$x^2 + y^2 - 2ax - 2y - 8 = 0$, where a is variable.

17. The equation represents a family of circle passing through two fixed point whose coordinates are
(A) (0, –2), (0, 2)
(B) (0, –2), (0, 4)
(C) (4, 0), (2, 0)
(D) none of these

18. Equation of a circle C of this family, tangent to which at these fixed points intersects on the line $2x + y + 5 = 0$ is
(A) $x^2 + y^2 - 2x - 8y - 8 = 0$
(B) $x^2 + y^2 - 2x + 6y - 8 = 0$
(C) $x^2 + y^2 - 2x + 8y - 8 = 0$
(D) $x^2 + y^2 - 6x - 2y - 8 = 0$

SECTION – C

Integer Answer Type

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. n balls are arranged to form an equilateral triangle such that first row consists of one ball, second row consists of two balls, third row consists of three balls and so on. 49 more balls are added to form a square. If each side of the square contains 3 balls more than that of the equilateral triangle, then sum of digits of n is _____

2. Let O, A(z_1), B(z_2), C(z_3) are vertices of rhombus such that $|z_1| = |z_2| = 4$ and $|z_3| = 6$ if $\arg(z_2 - z_1) = \frac{\pi}{3}$ then $\arg(z_3)$ is $\frac{3\pi}{k}$ then k is equal to _____

3. If $\int_0^{\pi} \frac{\cos x}{(x+4)^2} dx = P$ and $I = \int_0^{\pi/2} \frac{\sin 2x}{\pi + 4 - 2x} dx$, then the value of $P + 2I - \frac{1}{\pi + 4}$ is equal to $\frac{\lambda}{12}$ then λ is _____

4. The value of tan 1° tan 2° + tan 2° tan 3° + ... + tan 88° tan 89° is equal to $\cot^2 1° - n$, where n is a two digit number ab, then the value of b – a is _________

5. Let $\frac{1}{a_1 - 2i}, \frac{1}{a_2 - 2i}, \frac{1}{a_3 - 2i}, \frac{1}{a_4 - 2i}, \frac{1}{a_5 - 2i}, \frac{1}{a_6 - 2i}, \frac{1}{a_7 - 2i}, \frac{1}{a_8 - 2i}$ are vertices of regular octagon. If the area of octagon is A, then the value of $8\sqrt{2}A$ is
(where $a_i \in R$ for i = 1, 2, 3, 4, 5, 6, 7, 8) _______

Space for rough work

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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ANSWERS, HINTS & SOLUTIONS
FULL TEST– V
(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	B	D
2.	C	A	A
3.	C	A	A
4.	A	A	D
5.	B	A	C
6.	D	A	A
7.	D	D	A
8.	C	C	D
9.	B, D	A, B, C	A, C
10.	A, B, D	A, B, C	B, C
11.	A, C	A, B, C	A, D
12.	A, B	C, D	A, B
13.	B	A	C
14.	D	D	D
15.	D	D	B
16.	A	A	C
17.	C	C	B
18.	B	B	D
1.	3	7	6
2.	9	4	9
3.	2	4	3
4.	5	4	1
5.	7	2	2

Physics PART – I

SECTION – A

1. Apply conservation of energy and conservation of angular momentum between points at infinite separation and on the surface of the sphere.

2. To prevent reflection $\frac{\lambda}{2} = 2\mu t$

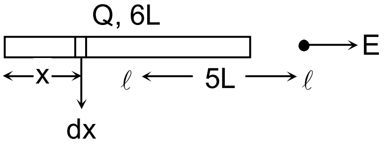
$t = \frac{\lambda}{4\mu} = \frac{5.3\times10^{-7}}{4\times1.31} \simeq 0.1\mu m.$

3. All the corners of the hexagonal faces will be at same potential. So wires joining the corners can be removed. Then in the remaining circuit we will have six '3R' resistors connected in parallel between A and B.

4. E due to rod.

$= \int_0^{6L} \frac{1}{4\pi\epsilon_0}.\left(\frac{Q}{6L}\right)\frac{dx}{(8L-x)^2} = \frac{1}{64\pi\epsilon_0}\frac{Q}{L^2}$

$E_{net} = 2\ E\cos 30°.$



5. $px^2 + qv^2 = r$

$\Rightarrow\ 2px\frac{dx}{dt} + 2qv\frac{dv}{dt} = 0 \qquad \Rightarrow a = -\frac{p}{q}x$

$\Rightarrow$ Particle is executing S.H.M. with angular frequency $= \sqrt{\frac{p}{q}}.$

6. Particle will move in helical path having circular projection in y-z plane. In the given time it will complete half revolution.
So, $x = v_0t$, $y = 0$, $z = -2R$

7. $P = \left(\frac{E}{R+r}\right)^2.R$

P will be maximum when r = 0

8. $\frac{dV}{dt} = \frac{\pi D^2}{4}.\frac{dh}{dt}$

$\frac{dh}{dt} = \frac{4\times16.5}{3.14\times(6.30)^2} = 0.529\ cm/s$

9. $-1.5 = 15T - \frac{1}{2}(10+a)T^2.$ Where T = 2 sec $\Rightarrow$ $a = 5.75\ m/s^2$

As we can not find velocity of bullet with respect to ground, we can not calculate distance from the given data.

10. $Q_{BC} = nC_P\Delta T > 0$

$Q_{DA} = nC_V\Delta T < 0$

$\eta = \frac{W}{Q_{absorbed}} = 1 - \frac{Q_{released}}{Q_{absorbed}} = 1 - \frac{nC_V(T_D - T_A)}{nC_P(T_C - T_B)} = 1 - \frac{1}{\gamma}\left(\frac{T_D - T_A}{T_C - T_B}\right)$

11. Dipole moment will be angle of 30° to '–x' – axis of magnitude $=(\lambda.\pi a).\left(2\times\frac{2a}{\pi}\right)=4\lambda a^2$.

E will be $2.\frac{2\lambda}{4\pi\varepsilon_0 a}$ at angle of 30° with '+x' – axis.

12. For $E_P = 0$

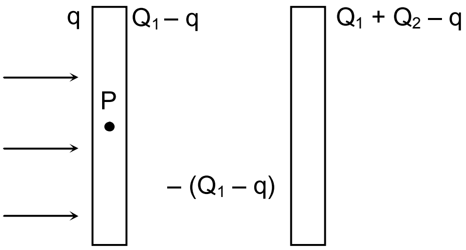
$$E+\frac{q}{2A\in_0}=\frac{Q_1-q}{2A\in_0}+\frac{Q_2}{2A\in_0}$$

$$\Rightarrow \qquad q=\frac{Q_1+Q_2}{2}-\in_0 AE$$

E inside the gap = $E+\frac{Q_1-Q_2}{2A\in_0}$

E on the left side of plates = $E-\frac{Q_1+Q_2}{2A\in_0}$

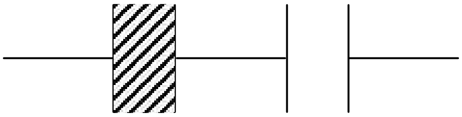
E on the right side of plates = $E+\frac{Q_1+Q_2}{2A\in_0}$



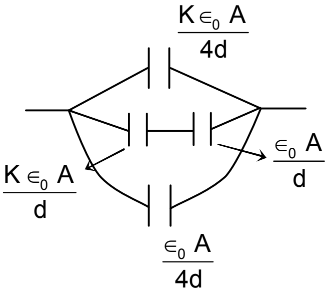
13. Apply conservation of Angular momentum about COM, to calculate final speed of the astronauts.
Work = Δ K.E. = 3 Mv²

14. Torque about COM is zero hence angular momentum remains conserved

15.
$$D=\frac{\left(\frac{K\in_0 A}{d/2}\right)\times\frac{\in_0 A}{d/2}}{\frac{k\in_0 A}{d/2}+\frac{\in_0 A}{d/2}}$$

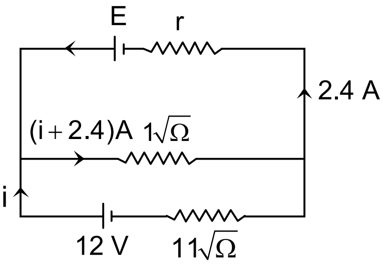


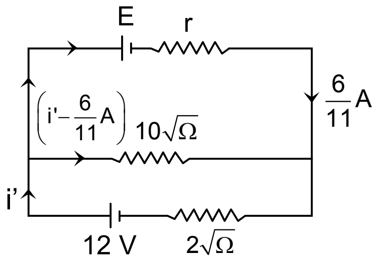
16.



17-18.

First case :
12 = 12i + 2.4
⇒ i = 0.8 A
E = i + 2.4 (r + 1)
⇒ E = 3.2 + 2.4 r





Second case :

$12 = 12i^1 - \frac{60}{11}$

$\Rightarrow \quad i^1 = \frac{16}{11}A$

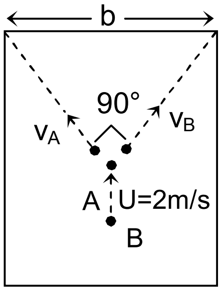
$E = 10i' - \frac{6}{11}(10 + r)$

$\Rightarrow \quad E = \frac{100}{11} - \frac{6r}{11}$ ……..(2)

Solving (1) and (2) E = 8V, r = 2Ω

SECTION – C

1. $v_A^2 t^2 + v_B^2 t^2 = b^2$



when identical balls collide obliquely and collision is elastic and one of them at rest, they move mutually perpendicular to each other after collision.

From energy conservation

$$\frac{1}{2}mu^2 = \frac{1}{2}mv_A^2 + \frac{1}{2}mv_B^2$$

so $b^2 = u^2 t^2 = 1$

$b = 1$ m

$\ell = 3$m

Area $= b\ell = 3m^2$.

2. $E_{n\to m} : E_{m\to 2} : E_{2\to 1} = 5 : 72 : 243$

$E_{m\to 2} \Rightarrow$ Transition corresponding to visible region.

$E_{n\to 2} : E_{2\to 1} = 77 : 243 \Rightarrow \left(\frac{1}{2^2} - \frac{1}{n^2}\right) : \left(\frac{1}{1^2} - \frac{1}{2^2}\right) = 77 : 243 \Rightarrow$ n = 9.

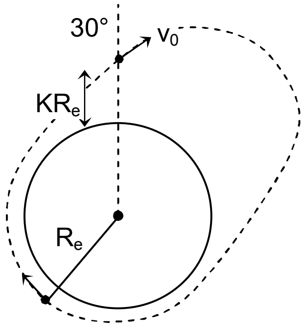
3. For lens B according to the figure

u = + 3

v = – 6

$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow f = -2$ m.

4. Conservation of angular momentum



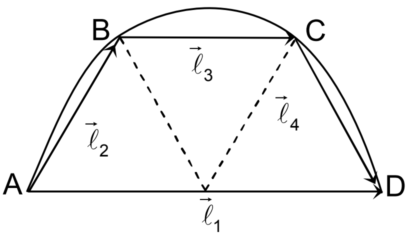
$$mv_0 \sin 30°(k+1)R_e = m\frac{\sqrt{15}}{4}v_e R_e$$

conservation of M.E.

$$-\frac{GM_e m}{(k+1)R_e} + \frac{1}{2}mv_0^2 = -\frac{GM_e m}{R_e} + \frac{1}{2}m\left(\frac{15}{16}v_e^2\right)$$

solving we get k = 5 or 9.

5. Given :



$$F_{loop} = \left|i\overrightarrow{\ell_1} \times \vec{B}\right| = 8N$$

$$F_{AB} = \left|i\overrightarrow{\ell_2} \times \vec{B}\right| = 9N$$

$$\vec{F}_{BC} = \frac{1}{2}\vec{F}_{loop}$$

Force on CD

$$\vec{F}_{CD} = i\vec{\ell}_4 \times \vec{B} = i\left(\vec{\ell}_1 - \vec{\ell}_2 - \vec{\ell}_3\right) \times \vec{B}$$

$$= i\vec{\ell}_1 \times \vec{B} - i\vec{\ell}_2 \times \vec{B} - i\vec{\ell}_3 \times \vec{B}$$

$$= \vec{F}_{loop} - \vec{F}_{AB} - \vec{F}_{\frac{loop}{2}} = \vec{F}_{\frac{loop}{2}} - \vec{F}_{AB}$$

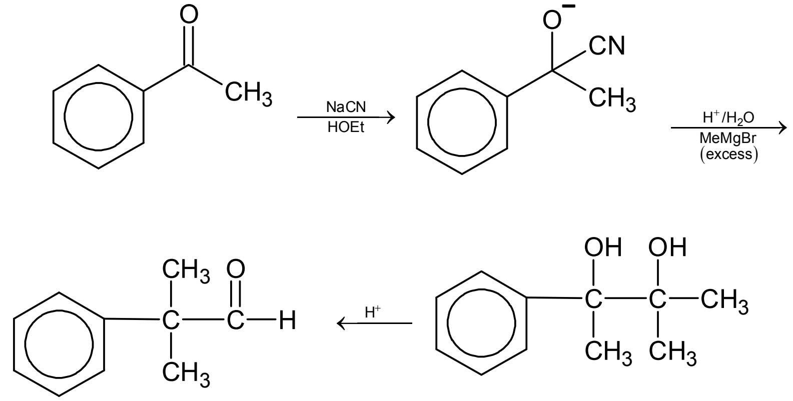
$$F_{CD} = \sqrt{4^2 + 9^2 - 2 \times 4 \times 9 \times \frac{2}{3}} = 7\text{ N.}$$

Chemistry PART – II

SECTION – A

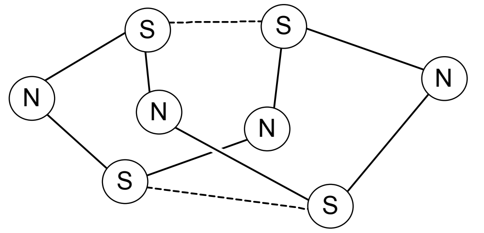
1. On removing atoms along the plane cutting two opposite edges.
In new NaCl lattice;
No. of Na^+ ion : No. of Cl^- atoms
$3Na^+$ atom : $\frac{5}{2}Cl^-$ atom.
In new fluorite structure:
No. of Ca^{2+} ion : No. of F^- ion
$\frac{5}{2}Ca^{2+} : 4F^-$
New cationic ratio $\frac{3}{\frac{5}{2}} = 6:5$
New anionic ratio = 5 : 8

3.



4. $3Cu + 8HNO_3 \longrightarrow 2NO + 3Cu(NO_3)_2 + 4H_2O$
NO ⇒ has 11 valence e^- with an unpaired.
e^- in π^*2p orbital.
⇒ is diamagnetic in solid state due to dimerisation.
⇒ shows resonance.

5. S_4N_4



⇒4 five membered ring

6. If PF_3 is better π accepter than CO, than C – O bond order in II complex is more than I complex.

7. HNO_2 pale blue in colour due to dissolution of N_2O_3.
Reaction with:
(A) Br_2 water : $HNO_2 + H_2O + Br_2 \longrightarrow HNO_3 + 2HBr$
(B) $KMnO_4$: $2KMnO_4 + 3H_2SO_4 + 5HNO_2 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5HNO_3$

8. At stage I:

$$\text{Left}\quad \underset{5\text{ meq}}{CH_3COOH} + \underset{0}{NaOH} \longrightarrow \underset{5\text{ meq}}{CH_3COONa}$$

So, its is a buffer solution, [Salt] = [Acid]

$pH = pK_a \Rightarrow pH_I = 5$

At statge II:

$$\text{Left}\quad \underset{0}{CH_3COOH} + \underset{0}{NaOH} \longrightarrow \underset{10\text{ meq in 200 ml.}}{CH_3COONa}$$

So, c = 0.05

So, anionic hydrolysis takes place and pH is:

$$\& \ pH = 7 + \frac{1}{2}\left(pK_a + \log C\right)$$

$$pH_{II} = 7 + \frac{1}{2}\left(5 + \log 0.05\right) = 8.84$$

Stage III:

$$\text{Left}\quad \underset{0}{CH_3COOH} + \underset{2\text{ meq/220ml}}{NaOH} \longrightarrow \underset{10\text{ meq/220 ml}}{CH_3COONa}$$

So, pH will be according to NaOH.

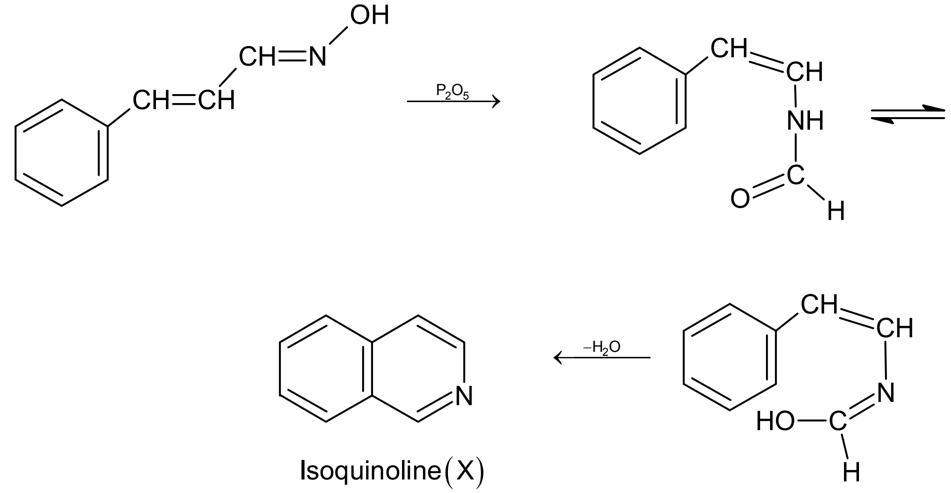
$[NaOH] = [a \times 10^{-3}]$

So, $[OH^-] = a \times 10^{-3}$

pOH = 2.040

$pH_{III} = 11.95$.

9. Beckmann rearrangement:



Isoquinoline(X)

(B) is aromatic, more basic than aniline.

10. $CH_3NH_2 < \left(CH_3\right)_2 NH_2^+$

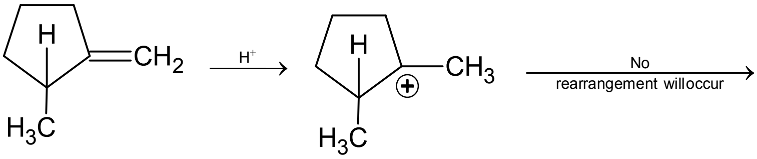
$PCl_2F_3 < \underset{(\theta=180^\circ)}{PCl_3F_2}$

$\underset{(B.O=3)}{NO^+} > \underset{(B.O.=2.5)}{NO} \Rightarrow NO^+ < NO$

$\overset{+6}{Cr}O_3 > \overset{+3}{Cr_2}O_3$ (Acidic nature)

11. (A) $CD_3-CH(OH)-CH_3 \xrightarrow{conc.H_2SO_4} \underset{(Major)}{CD_3-CH=CH_2} + \underset{(Minor)}{CD_2=CH-CH_3}$

(C)

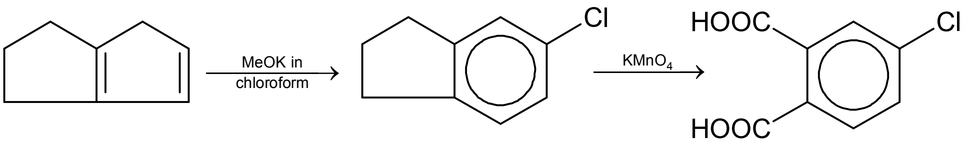

H
CH2
H3C
H+
H
CH3
+
H3C
No
rearrangement willoccur

(D) 1, 3 ⇒ diequitorial ⇒ *cis*
1,3 ⇒ axial and equatorial = 1 *trans*
So, groups are more stable at equatorial position.

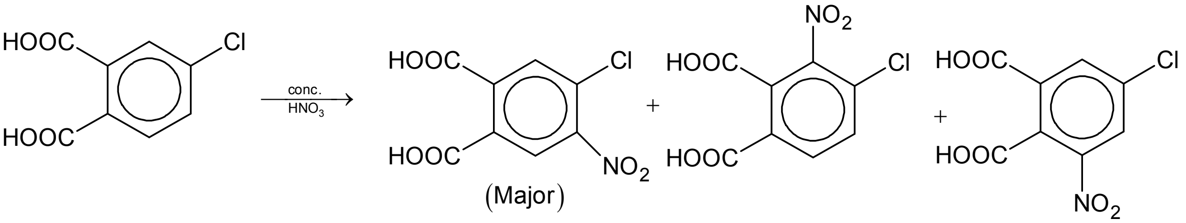
12. Electrode reactions are:
Anodic reaction⇒
$Pb(s)+HSO_4^-(aq.)\longrightarrow PbSO_4(s)+H^+(aq.)+2e^-$
Cathodic reaction⇒
$PbO_2(s)+HSO_4^-(aq.)+3H^+(aq.)+2e^-\longrightarrow PbSO_4(s)+2H_2O(\ell)$

Net reaction: $Pb(s)+PbO_2(s)+2H_2SO_4(aq.)\longrightarrow PbSO_4(s)+2H_2O(\ell)$

15.


MeOK in
chloroform
Cl
KMnO4
HOOC
Cl
HOOC

16.


HOOC
Cl
HOOC
conc.
HNO3
HOOC
Cl
HOOC
NO2
(Major)
+
NO2
HOOC
Cl
HOOC
+
HOOC
Cl
HOOC
NO2

Solution for the Q. No. 17 to 18.

$\underset{(A)}{ZnS} + H_2SO_4(dil.)\longrightarrow \underset{(C)}{ZnSO_4} + \underset{(B)}{H_2S}\uparrow$

Eq. (2) $3H_2S + K_2Cr_2O_7 + 4H_2SO_4 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O + \underset{(D)}{3S}$

$\Rightarrow (D) + O_2 \longrightarrow \underset{(E)}{SO_2}\uparrow \xrightarrow{2H_2S(B)} \underset{(colourless\ liq.)}{2H_2O} + \underset{(D)}{3S}\downarrow$

$\downarrow$

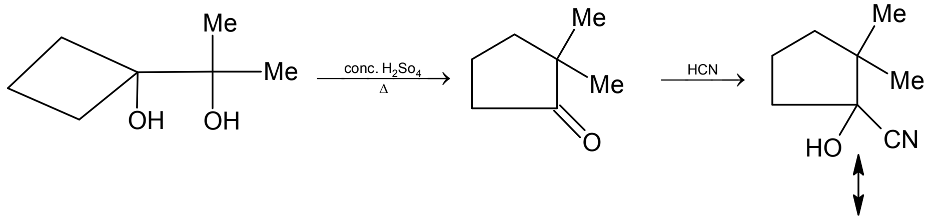
$\underset{(Blue)}{CuSO_4.5H_2O}$

$\underset{(C)}{ZnSO_4} + 2NaOH \longrightarrow Zn(OH)_2\downarrow \xrightarrow{2NaOH} \underset{(Soluble)}{Na_2ZnO_2} + 2H_2O$

In Eq. (2) $n_{eq}(H_2S) = n_{eq}(K_2Cr_2O_7)$
Moles(H_2S) × 2 = 0.2 × 10 × 6 = 6 milli moles
⇒ wt. of ZnS required is ⇒ Co = (6 × 97.3) mg
= 583.8 mg.

SECTION – C

2.



1 chiral centre
3 lone pairs

Sum = 1 + 3 = 4

3. $q = \Delta U = w = 0 - w = -w$

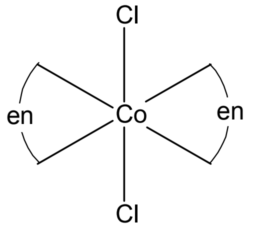
[-2(16 – 4) + (-1 × (32 – 16)] = 4 kJ.

4. $\text{Solid PCl}_5 \rightarrow \underset{\underset{sp^3}{\Downarrow}}{\left[PCl_4\right]^+}\underset{\underset{sp^3d^2}{\Downarrow}}{\left[PCl_6\right]^-}$

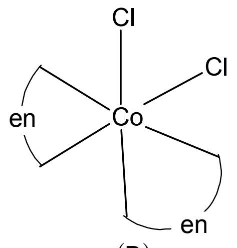
$\text{Solid PBr}_5 \rightarrow \underset{\underset{sp^3}{\Downarrow}}{\left[PBr_4\right]^+}\left[Br\right]^-$

$\text{Solid N}_2\text{O}_5 \rightarrow \underset{\underset{sp}{\Downarrow}}{\left[NO_2^+\right]^+}\underset{\underset{sp^2}{\Downarrow}}{\left[NO_3^-\right]^-}$

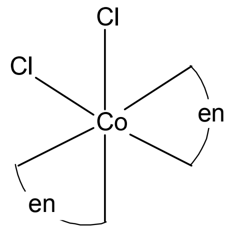
5.



(A)



(B)



(A)

$\left.\begin{matrix}\text{A \& B}\\ \text{A \& C}\end{matrix}\right\} \Rightarrow$ diastereomers

B & C ⇒ enantiomers

Mathematics PART – III

SECTION – A

1. Six letters can be arranged in following ways: 1, 1, 1, 3 or 1, 1, 2, 2
(1, 1, 1, 3) selection of boxes can be done as $^3C_1 \times 2$
(1, 1, 2, 2) selection of boxes can be done as $^3C_1 \times {}^3C_2$
$\therefore$ Total such selections = 6 + 9 = 15
$\therefore$ The number of required arrangements = 15 × 6! = 10,800

2. Distance between two roots = $\sqrt{b^2 - 4ac}$
Required $-1 \le b^2 - 4ac \le 1$
That means that the point P(b, c) lies on the intersection of the region in between two parabola $x^2 = 4y - 1$ and $x^2 = 4y + 1$ and the square formed by x = 0, x = 1, y = 0 and y = 1

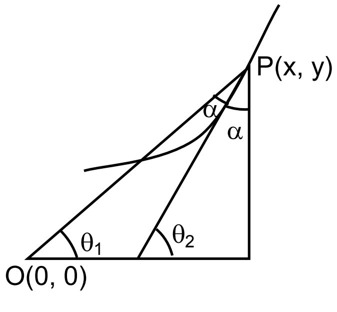
Required probability = $\dfrac{\int_0^1 \frac{x^2+1}{4}dx}{1} = \dfrac{1}{3}$

3. $$\begin{cases}(2x+y-1)+\lambda(x-2y+3z)=0\\(3x-y+z+2)+\mu(4x+5y-2z-3)=0\end{cases}$$
Line is parallel to $\frac{x}{1} = \frac{y}{2} = \frac{z}{3}$
So, $(2 + \lambda) \times 1 + (1 - 2\lambda) \times 2 + 3\lambda \times 3 = 0$
$\lambda = -\frac{2}{3}$
$(3 + 4\mu) \times 1 + (-1 + 5\mu) \times 2 + (1 - 2\mu) \times 3 = 0$
$\mu = -\frac{1}{2}$

4. p, q, r will be in H.P.
$\Rightarrow p + r = pr$
$\Rightarrow \frac{pr}{2} \ge \sqrt{pr}$
$\Rightarrow pr \ge 4$

5. Put $x = \frac{1}{t}$

6. $\theta_1 + \alpha = \theta_2$
$\theta_1 + 2\alpha = \frac{\pi}{2}$
$\theta_1 + 2(\theta_2 - \theta_1) = \frac{\pi}{2}$
$2\theta_2 - \theta_1 = \frac{\pi}{2}$
$\frac{2\tan(\theta_2)}{1-(\tan(\theta_2))^2} = -\frac{1}{\tan\theta_1}$



$$\frac{2\frac{dy}{dx}}{1-\left(\frac{dy}{dx}\right)^2} = -\frac{x}{y}$$

$$2y\frac{dy}{dx} = +x\left(\frac{dy}{dx}\right)^2 - x \Rightarrow x\left(\frac{dy}{dx}\right)^2 - 2y\frac{dy}{dx} = x$$

7. $f(-2) = 3$ and $f(-3)$ is negative
So, equation has one real root in between $(-3, -2)$

8. $f(x) = \frac{2^x+1}{4^x-1} = \frac{1}{2^x-1}$ is a one-one function.

10. Either $\tan x + \tan 2x + \tan 3x = 0$ or $\tan x = \tan 2x = \tan 3x$

11. Major axis will be $x + y = 0$ and centre at $(0, 0)$. Foci will be at distance $\sqrt{3}$ from centre on major axis

12. Circle is $x^2 + y^2 + 8x + 8y + 16 + k(x + y + 12) = 0$
From origin chord of contact is $T = 0$
$\Rightarrow (8 + k_1)x + (8 + k_1)y + 8(4 + 3k_1) = 0$
Which is same as $x + y + 12 = 0$
$\Rightarrow \frac{8+k_1}{1} = \frac{8(4+3k_1)}{12} \Rightarrow k_1 = \frac{16}{3}$
As PQ is chord to $x^2 + y^2 + 8x + 8y + 16 + \frac{16}{3}(x+y+12) = 0$
From mid-point of PQ(h, k) chord is $T = S_1 \Rightarrow (h, k) = (-6, -6)$

13.-14. The equation of line L is $y = 4x - 1$ and the value of $p = 1$, $q = 6$ and $r = 0$

15.-16. $|A| = 0 \Rightarrow$ A is singular
$|B| = 0 \Rightarrow$ B is singular
$|C| = -1 \Rightarrow$ C is non-singular

$$A^2 = \begin{vmatrix} 2 & -3 & -5 \\ -1 & 4 & 5 \\ 1 & -3 & -4 \end{vmatrix} = A \Rightarrow \text{A is idempotent}$$

$$B^2 = \begin{vmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{vmatrix} \Rightarrow \text{B is nilpotent}$$

$$C^2 = \begin{vmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{vmatrix} = I \Rightarrow \text{C is involutary}$$

Now, check the options

17. Equation of the given circle can be written as

$$(x^2 + y^2 - 2y - 8) - 2ax = 0$$

which represent the family of circle passing through points of intersection of $x^2 + y^2 - 2y - 8 = 0$ and $2ax = 0$.

Now, $2ax = 0$; $x = 0$ put in circle we get

$$y^2 - 2y - 8 = 0 \Rightarrow (y - 1)^2 = 9$$
$$y = 1 \pm 3$$
$$y = -2, 4$$

points can $(0, -2), (0, 4)$

18. Let the tangent at P and Q to a member of this family intersect at (h, k), then PQ is the chord of contact of (h, k) and its equation is

$hx + ky - a(x + h) - (y + k) - 8 = 0$

$x(h - a) + y(k - 1) - (ah + k + 8) = 0$

Comparing this with equation $x = 0$ of PQ. We get

$k = 1$ and $ah + k + 8 = 0$

Since (h, k) lies on the given line $2x + y + 5 = 0$

$2h + 1 + 5 = 0$

$h = 3$

$-3a + 1 + 8 = 0$

$a = 3$

Hence the equation of the required member c of this family is $x^2 + y^2 - 6x - 2y - 8 = 0$

SECTION – C

1. Let the number of rows in triangle is k

$\Rightarrow 1 + 2 + 3 \ldots\ldots k = n$

$\Rightarrow n = \dfrac{k(k+1)}{2}$

Also, $\dfrac{k(k+1)}{2} + 49 = (k+3)^2$

$\Rightarrow k^2 + k + 98 = 2k^2 + 12k + 18$

$\Rightarrow k^2 + 11k - 80 = 0$

$k^2 + 16k - 5k - 80 = 0$

$\Rightarrow k = 5$

$\Rightarrow$ Number of balls, $n = \dfrac{5(5+1)}{2} = 15$

3. $P = \left|-\left(\dfrac{\cos x}{x+4}\right)\right|_0^{\pi} - \displaystyle\int_0^{\pi} \dfrac{\sin x}{x+4}dx$, put $x = 2t$

$P = \dfrac{1}{\pi+4} + \dfrac{1}{4} - \displaystyle\int_0^{\pi/2} \dfrac{\sin 2t}{t+2}dt$

4. $T_r = \dfrac{\sin r^\circ \sin(r+1)^\circ}{\cos r^\circ \cos(1+r)^\circ} + 1 - 1 = \dfrac{\cos 1^\circ}{\cos r^\circ \cos(r+1)^\circ} - 1 = \dfrac{\cos 1^\circ}{\sin 1^\circ}\left\{\dfrac{\sin\{(r+1)^\circ - r^\circ\}}{\cos r^\circ \cos(r+1)^\circ}\right\} - 1$

$= \cot 1^\circ\{\tan(r+1)^\circ - \tan r^\circ\} - 1 \Rightarrow T_1 + T_2 + \ldots\ldots T_{88} = \cot 1^\circ(\tan 89^\circ - \tan 1^\circ) - 88 = \cot^2(1^\circ) - 89$

5. $X + iy = \dfrac{a_r + 2i}{(a_r)^2 + 4}$

$X = \dfrac{a_r}{a_r^2 + 4}$, $Y = \dfrac{2}{a_r^2 + 4}$

$X^2 + Y^2 = \dfrac{1}{2}Y$

$X^2 + Y^2 - \dfrac{1}{2}Y = 0$

So all points lies on circle $x^2 + y^2 - \dfrac{y}{2} = 0$

$r = \dfrac{1}{4}$

Area of regular octagon = $8\left(\dfrac{1}{2} \times r^2 \times \sin\left(\dfrac{2\pi}{8}\right)\right)$ = $8 \times \dfrac{1}{2} \times \dfrac{1}{16} \times \dfrac{1}{\sqrt{2}} = \dfrac{1}{4\sqrt{2}}$

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Main), 2015**

HALF COURSE TEST – V

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 02 and 09 to 30)** contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (03 to 08) contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10 \text{ m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3 \text{ kg/m}^3$
Atmospheric pressure	$P_a = 10^5 \text{ N/m}^2$
Gas constant	$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
		=	$0.0821 \text{ Lit atm K}^{-1} \text{ mol}^{-1}$
		=	$1.987 \approx 2 \text{ Cal K}^{-1} \text{ mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

(Single Correct Choice Type)

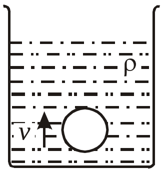
This section contains ***30 multiple choice questions***. Each question has four choice (A), (B), (C) and (D) out of which ***ONLY ONE*** is correct.

1. Kepler's third law of planetary motion when stated for circular orbits, has the form (v = orbital velocity of a planet and R = distance from the sun)

(A) $v \propto R$ (B) $v \propto 1/R$

(C) $v^2 \propto 1/R$ (D) none of the above

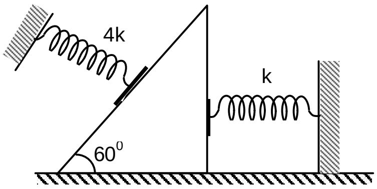
2. An air bubble of radius r rises steadily through a liquid of density ρ at the rate of *v*. Neglecting density of air, the coefficient of viscosity of liquid is



(A) $\frac{2}{9}\frac{r^2\rho g}{v}$ (B) $\frac{1}{3}\frac{r^2\rho g}{v}$

(C) $\frac{1}{9}\frac{r^2\rho g}{v}$ (D) None of these

3. A smooth wedge of mass m and angle of inclination 60^0 rests unattached between two springs of spring constant k and 4k, on a smooth horizontal plane, both springs in the unextended position. The time period of small oscillations of the wedge (assuming that the springs are constrained to get compressed along their length) equals



(A) $\pi\left(1+\frac{1}{2}\right)\sqrt{\frac{m}{k}}$ (B) $\pi\left(1+\frac{1}{\sqrt{3}}\right)\sqrt{\frac{m}{k}}$

(C) $2\pi\sqrt{\frac{m}{k}}$ (D) none of the above

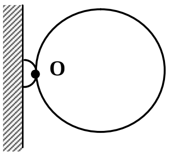
4. Two waveforms, $\psi_1(x, t) = A \sin(kx - \omega t)$ and $\psi_2(x, t) = A \sin(kx + \omega t + \pi/3)$, travelling along the x-axis, are superposed. The position of the nodes is given by ($k = \frac{2\pi}{\lambda}$, $\omega = 2\pi f$)

(A) $x_n = (n + 1/6)\frac{\lambda}{2}$ (B) $x_n = \left(n-\frac{1}{6}\right)\frac{\lambda}{2}$

(C) $x_n = n\frac{\lambda}{2}$ (D) none of these

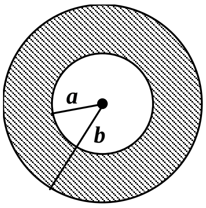
Space for rough work

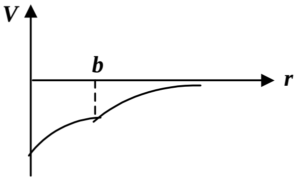
5. A uniform ring of mass m and radius r is hinged at point O so that it can rotate about horizontal axis passing through O in vertical plane. If the system is released from rest, then the initial acceleration of the ring is [Ring is in the vertical plane.]



(A) g (B) g/2
(C) g/4 (D) g/8

6. A sphere of mass *M* and radius *b* has a concentric cavity of radius *a* as shown in figure. The graph showing variation of gravitational potential *V* with distance *r* from the center of sphere is



(A)


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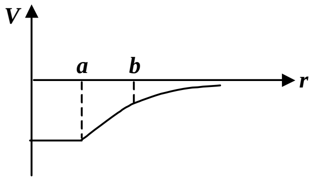
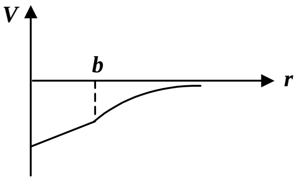
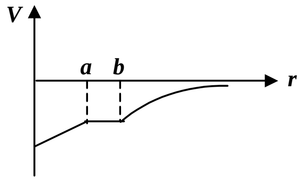
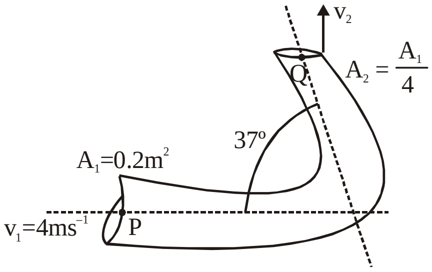


(C)


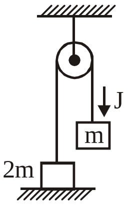
(D)


7. Oil enters the bend of a pipe in the horizontal plane with velocity 4 ms^{-1} and pressure 280×10^3 Nm^{-2} as shown in the figure. The pressure of oil at the point Q is 86λ. Find the value of λ. (KNm^{-2}).
(Take specific gravity of oil as 0.9 and sin 37° = 0.6)

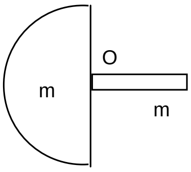


(A) 1 (B) 2
(C) 3 (D) 4

Space for rough work



8. In the given figure an impulse J is given to the block of mass m in the downward direction. As a result of the impulse
   (A) both the blocks start moving with speed $\frac{J}{3m}$ in opposite directions
   (B) both the blocks start moving with speed $\frac{J}{m}$ in opposite directions
   (C) the centre of mass of the system is moving downwards
   (D) the centre of mass of the system is not moving



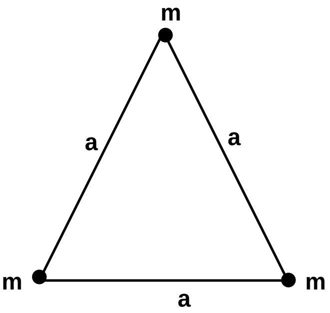
9. A rod of mass m and length 2r is attached to the centre of a semi-circular lamina of equal mass m and radius r, such that it remains in the plane of the lamina. The moment of inertia of the system, about an axis passing through the centre O, perpendicular to the plane of the lamina equals
   (A) $\frac{19}{6}mr^2$ (B) $\frac{5}{6}\,mr^2$
   (C) $\frac{11}{6}\,mr^2$ (D) none of the above

10. A small ball of density ρ plunges into a liquid of density 2ρ, after falling freely from a height h above its surface. The motion of the particle will be (assuming no loss of energy and no splashing of liquid)
   (A) simple harmonic with a period of $4\sqrt{\frac{2h}{g}}$ (B) simple harmonic with a period $2\sqrt{\frac{2h}{g}}$
   (C) periodic with a time period $2\sqrt{\frac{2h}{g}}$ (D) periodic with a time period $4\sqrt{\frac{2h}{g}}$

11. An ideal gas is taken through a process where dQ = dU - dW. The specific heat of the ideal gas in this process is (dQ = heat supplied to the gas, dU = change in internal energy, dW = work done by gas)
   (A) C_v (B) $C_v + \frac{3}{2}R$
   (C) $C_v - R$ (D) the process is impossible

Space for rough work

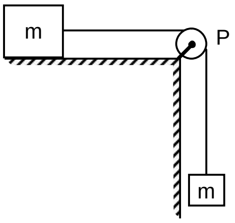
12. If the three point masses are released simultaneously to move under influence of mutual gravitational attraction, speed of each particle when each one of them has moved a distance $\left(\frac{a}{2\sqrt{3}}\right)$



(A) $\sqrt{\frac{6\sqrt{3}Gm}{\left(2-\sqrt{3}\right)a}}$ (B) $\sqrt{\frac{2Gm}{a}}$

(C) $\sqrt{\frac{Gm}{a}}$ (D) None of these

13. If the pulley 'P' as shown in the given arrangement is massless and there is no friction, force exerted by the pulley 'P' on the clamp would be



(A) √2 mg (B) $\frac{mg}{\sqrt{2}}$

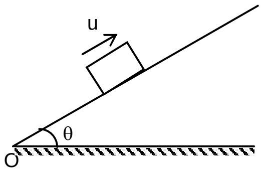
(C) 2mg (D) $\frac{mg}{2}$

14. A block of mass M is performing SHM with amplitude A on a smooth horizontal surface. At the extreme position a small block of mass m falls vertically and sticks to M. New amplitude of oscillation will be

(A) A (B) $A\sqrt{\frac{M}{M+m}}$

(C) $A\frac{M}{M+m}$ (D) $A\frac{M+m}{m}$

15. A block can slide down the incline plane with constant velocity. If it is projected with a velocity 'u' up the inclined plane at t = 0. The displacement of particle after a time $t = \frac{u}{g\sin\theta}$ from O will be

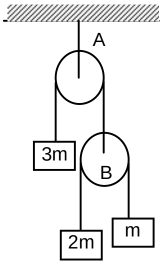


(A) $\frac{u^2}{4g\cos\theta}$ (B) $\frac{u^2}{2g\sin\theta}$

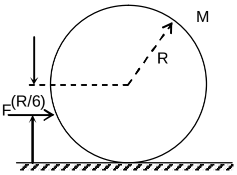
(C) zero (D) $\frac{u^2}{4g\sin\theta}$

Space for rough work

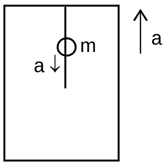
16. Consider the system shown when pulleys and strings are massless. If the system is released from rest, then centre of mass of the system (3m, 2m and m)
(A) is always at rest
(B) accelerates upwards
(C) accelerates downwards.
(D) has acceleration depending on the value of m.



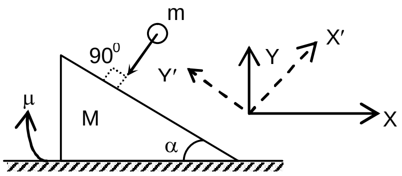
17. A solid sphere of mass M and radius R is placed vertically on a rough horizontal surface. If a horizontal force F is applied at a distance R/6 below the centre line parallel to the diameter of the sphere, the direction of frictional force will be
(A) forward
(B) backward
(C) depends upon value of F
(D) insufficient information.



18. A cabin is moving vertically upwards with an acceleration a. A massless string is attached to the ceiling of the cabin on which a bead of mass m is sliding downwards w.r.t. string with an acceleration a. The tension in the string is
(A) m(g + 2a)
(B) m (g + a)
(C) mg
(D) m (g – a)

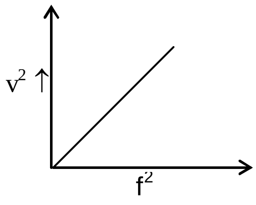


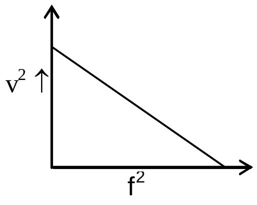
19. A ball of mass m strikes the inclined face of the wedge perpendicularly with speed v_0. The wedge is at rest on a rough horizontal surface before collision. The conservation of momentum is applicable for
(i) m as system, along y'
(ii) M as system, along y'
(iii) (M + m) as system, along x
(iv) (M + m) as system, along y
which of the following is correct ?
(A) (i) only
(B) (i) + (ii) only
(C) (iii) only
(D) (iii) + (iv) only.

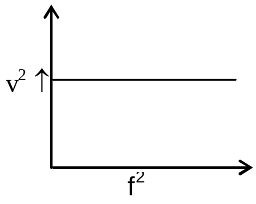


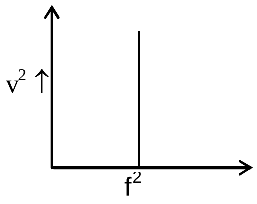
Space for rough work

20. A mass m is performing linear simple harmonic motion, then graph for square of acceleration f^2 and corresponding square of linear velocity v^2 is

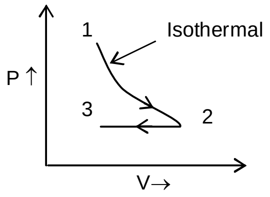
(A) 

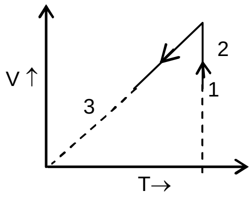
(B) 

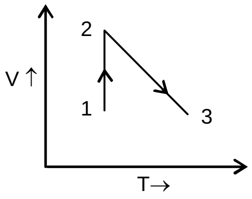
(C) 

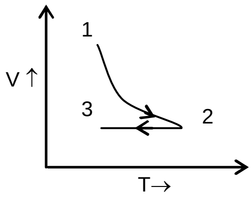
(D) 

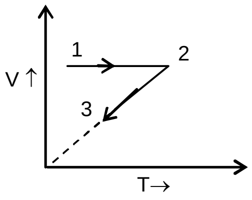
21. One mole of a monoatomic gas undergoes the processes 1 – 2 and 2 – 3 as shown. The corresponding graph for the above process for 2 moles of the gas is



(A) 

(B) 

(C) 

(D) 

Space for rough work

22. If ℓ_1 and ℓ_2 (> ℓ_1) are the lengths of an air column for the first and second resonance when a tunning fork of frequency n is sounded on a resonance tube, then the minimum distance of the anti-node from the top end of the resonance tube is
(A) $2(\ell_2 - \ell_1)$ (B) $\frac{1}{2}(2\ell_1 - \ell_2)$
(C) $\frac{\ell_2 - 3\ell_1}{2}$ (D) $\frac{\ell_2 + \ell_1}{2}$

23. Two different masses m and 2m of same ideal gas are heated separately in vessels of equal volume. The T-P curve for mass 2m makes angle α with T-axis and that for mass m makes angle β with T-axis then
(A) $\tan\alpha = \tan\beta$ (B) $\tan\alpha = 2\tan\beta$
(C) $\tan\beta = 2\tan\alpha$ (D) None of these

24. A viscous liquid flows through a uniform tube. As we move from the axis of the tube towards its wall, the speed of the liquid relative to the tube
(A) increases from zero to maximum value.
(B) decreases from maximum value to zero
(C) remains same throughout the cross section.
(D) increases from zero to a maximum value on one side and decreases from a maximum value to zero on the other side.

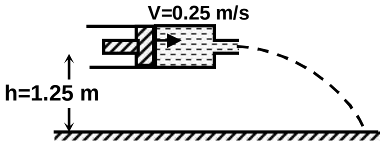
25. The displacement y of a particle executing a certain periodic motion is given by $y = 4\cos^2\left(\frac{1}{2}t\right)$ sin (1000t). This expression may be considered to be the superposition of n independent harmonic motions. Then, n is equal to
(A) 2 (B) 3
(C) 4 (D) 5

26. The escape velocity for a planet is v_e. A tunnel is dug along a diameter of the planet and a small body is dropped into it from the surface. When the body reaches the centre of the planet, its speed will be
(A) v_e (B) $V_e\sqrt{2}$
(C) $\frac{v_e}{2}$ (D) zero

27. In a resonance tube, closed at one end by a smooth moving piston and the other end open, exhibits the first three resonance lengths, L_1, L_2 and L_3 for the same tuning fork. Then they are related by
(A) $L_3 = 2L_2 = 4L_1$ (B) $L_3 = \frac{5}{3}L_2 = 5L_1$
(C) $(L_3 - L_2) = (L_2 - L_1)$ (D) $(L_3 - L_2) = 2(L_2 - L_1)$

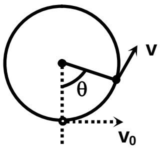
Space for rough work

28. A syringe of diameter D = 8 mm and having a nozzle of diameter d = 2 mm is placed horizontally at a height of 1.25 m as shown in the figure. An incompressible and non-viscous liquid is filled in syringe and the piston is moved at speed of 0.25 m/s. Find the range of liquid jet on the ground.



(A) 1 m
(B) 4 m
(C) 3 m
(D) 2 m

29. A pendulum of length ℓ = 1 m having a bob of mass m = 1 kg is hanging from a rigid support. If the bob is projected horizontally with a velocity $v_0 = \sqrt{35}$ m/s. The tension in the string is 6k Newton when angle made by string is 60° from vertical as shown. Find the value of k.



(A) 6
(B) 3
(C) 5
(D) 1

30. A particle of mass m moves towards a smooth vertical wall with a speed u (relative to the ground) and collides elastically with the wall; the wall moving towards the particle with a speed 2u (also relative to the ground). Assuming that the wall is extremely massive, the impulse delivered to the particle equals

(A) 5 mu
(B) 6 mu
(C) 4 mu
(D) none of these.

Space for rough work

Chemistry

PART – II

SECTION – A

(Single Correct Choice Type)

This section contains ***30 multiple choice questions***. Each question has four choice (A), (B), (C) and (D) out of which ***ONLY ONE*** is correct.

1. If $pK_a = 4$ and $K_a = Cx^2$ then van't Hoff factor for weak monobasic acid when C = 0.01 M is:

(A) 1.01 (B) 1.02

(C) 1.10 (D) 1.20

2. 10 g $CaCO_3$ is completely decomposed to X and CaO. X is passed into an aqueous solution containing one mole of sodium carbonate. What is the number of moles of sodium bicarbonate formed?

(A) 0.2 (B) 0.1

(C) 0.01 (D) 10

3. The average molar mass of air is 28.8. An open vessel at 27°C is heated upto t°C until 1/3rd of the air measured at final temperature escapes out. The rms velocity of air molecules at t°C is

(A) 340 m sec^{-1} (B) 420 m sec^{-1}

(C) 515 m sec^{-1} (D) 588 m sec^{-1}

4. Two solid compounds 'X' and 'Y' dissociates at certain temperature as follows :

$X(s) \rightleftharpoons A(g) + 2B(g) \quad Kp_1 = 9 \times 10^{-3}\ atm^3$

$Y(s) \rightleftharpoons 2B(g) + C(g) \quad Kp_2 = 4.5 \times 10^{-3}\ atm^3.$

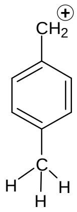
The total pressure(in atm) of gases over a mixture of 'X' and 'Y' is

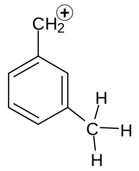
(A) 1.5 (B) 0.45

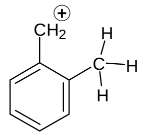
(C) 0.6 (D) 0.9

Space for rough work

5. Consider the below given intermediates


(i)


(ii)


(iii)

The stability order of above intermediate are

(A) i > ii > ii
(B) ii > i > iii
(C) iii > i > ii
(D) iii = i > ii

6. At 550 K, the K_c for the following reaction is 10^4 mol^{-1} L.

$$X(g) + Y(g) \rightleftharpoons Z(g)$$

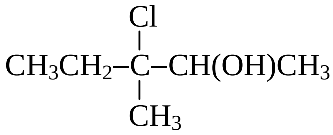
At equilibrium, it was observed that

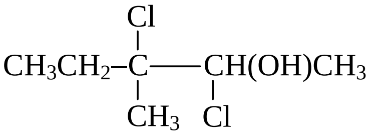
$[X] = \frac{1}{2}[Y] = \frac{1}{2}[Z]$

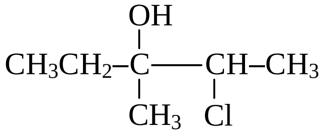
What is the value of [Z] at equilibrium?

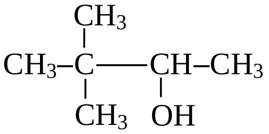
(A) 2×10^{-4} mol L^{-1}.
(B) 10^{-4} mol L^{-1}.
(C) 2×10^{4} mol L^{-1}.
(D) 10^{4} mol L^{-1}.

7. The predominant product formed when 3–methyl–2–pentene reacts with chlorine water is

(A) 
$$CH_3CH_2\text{–}\overset{\displaystyle Cl}{\underset{\displaystyle CH_3}{C}}\text{–}CH(OH)CH_3$$

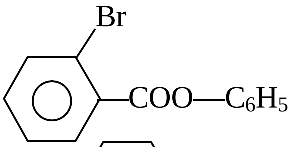
(B) 
$$CH_3CH_2\text{–}\overset{\displaystyle Cl}{\underset{\displaystyle CH_3}{C}}\text{——}\underset{\displaystyle Cl}{CH}(OH)CH_3$$

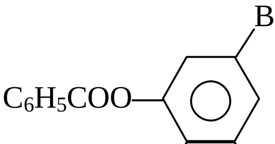
(C) 
$$CH_3CH_2\text{–}\overset{\displaystyle OH}{\underset{\displaystyle CH_3}{C}}\text{——}\underset{\displaystyle Cl}{CH}\text{–}CH_3$$

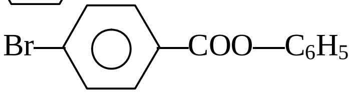
(D) 
$$CH_3\text{–}\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{C}}\text{——}\underset{\displaystyle OH}{CH}\text{–}CH_3$$

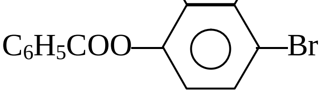
Space for rough work

8. The major product expected from the monobromination of phenyl benzoate is

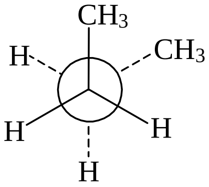
(A) 

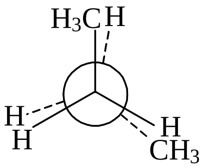
(B) 

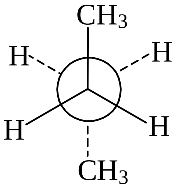
(C) 

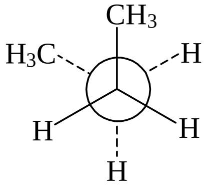
(D) 

9. Which of the following conformer of n–butane is achiral?

(A) 
CH3
H
CH3
H
H
H

(B) 
H3C
H
H
H
H
CH3

(C) 
CH3
H
H
H
H
CH3

(D) 
CH3
H3C
H
H
H
H

10. The correct order of basic strength the among the following is

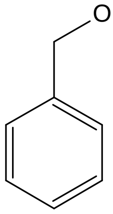
(A) $Li_2O < Na_2O < K_2O < Rb_2O$
(B) $Rb_2O > Na_2O = K_2O > Li_2O$
(C) $Li_2O > Na_2O > K_2O > Rb_2O$
(D) $Na_2O > Li_2O > K_2O > Rb_2O$

11. A hydrogen like ion in excited state can emit 3 spectral lines and the minimum energy emitted in one of the transition is 7.5 eV. The species and the excited state ion belongs to, is

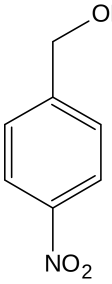
(A) H and 2nd
(B) He^+ and 2nd
(C) Li^{2+} and 2nd
(D) Can't be predicted

Space for rough work

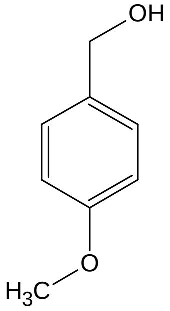
12. Which of the following is the correct order of basic nature of the compounds?



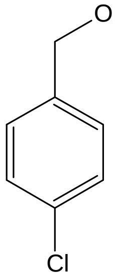
(I)



(II)



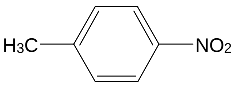
(III)



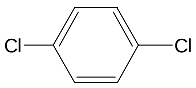
(IV)

(A) I > II > III > IV
(B) III > I > IV > II
(C) IV > III > I > II
(D) III > IV > I > II

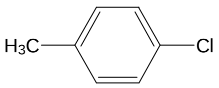
13. Arrange the following in order of decreasing dipole moment:



(I) ,



(II) ,



(III)

(A) I > II > III
(B) III > I > II
(C) I > III > II
(D) III > II > I

14. In the case of a first order reaction, the time required for 93.75% of reaction to take place is x times that required for half of the reaction. The value of 'x' is
(A) 1
(B) 2
(C) 3
(D) 4

15. In the following groups

$-OAc$	$-OMe$	$-OSO_2Me$	$-OSO_2CF_3$
(1)	(2)	(3)	(4)

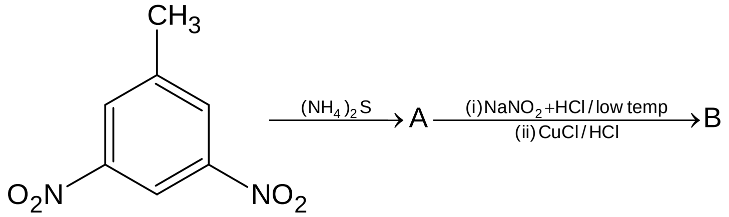
the order of leaving group ability is
(A) 1 > 2 > 3 > 4
(B) 4 > 3 > 1 > 2
(C) 3 > 2 > 1 > 4
(D) 2 > 3 > 4 > 1

Space for rough work

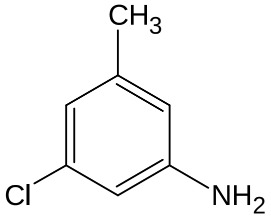
16. If 10^{-5}% reactant molecules are crossing over the barrier in transition state at 298 K, then the activation energy is

(A) 39.94 kJ	(B) 49.94 kJ
(C) 79.94 kJ	(D) 97.97 kJ

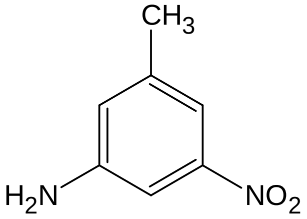
17.


CH3
O2N
NO2
(NH4)2S
A
(i) NaNO2+HCl / low temp
(ii) CuCl / HCl
B

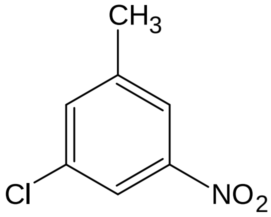
(A)



(B)



(C)

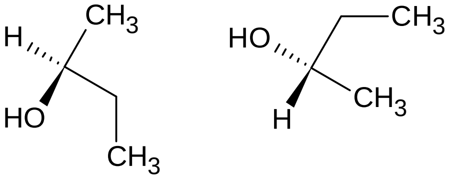


(D) None of the above

18. Which among the following compounds will give nucleophilic addition reaction?

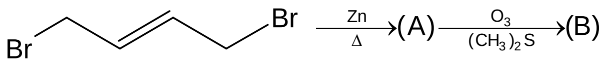
(A) carbonyl compounds	(B) nitriles
(C) isocyanides	(D) all of these

19. The pair of molecule given below represents


CH3
H
HO
CH3
HO
CH3
H
CH3

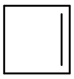
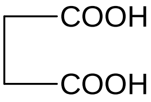
(A) Enentiomers	(B) Diastereomers
(C) Regiomers	(D) None of these

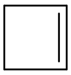
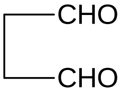
Space for rough work

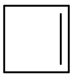
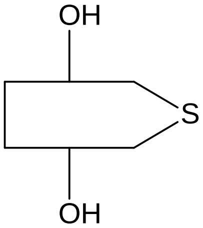
20. 

The product (A) and (B) in above sequence of reactions are

(A) (A) = $H_2C{=}C{=}C{=}CH_2$ (B) = HCHO

(B) (A) =  (B) = 

(C) (A) =  (B) = 

(D) (A) =  (B) = 

21. The hybridization of central atom in N_3^- and ICl_4^- are, respectively,

(A) sp^3d^2, sp (B) sp, sp^3d^2
(C) sp^2, sp^3d^2 (D) sp^3, sp^3d^2

22. The correct order of increasing N – O bond length in $\overset{+}{N}O_2, NO_2^-$ and NO_3^- is

(A) $NO_3^- < NO_2^- < \overset{+}{N}O_2$ (B) $NO_2^- < NO_2^+ < NO_3^-$
(C) $\overset{+}{N}O_2 < NO_3^- < NO_2^-$ (D) $\overset{+}{N}O_2 < NO_2^- < NO_3^-$

23. Atoms $_7A$, $_8B$ and $_9C^{17}$ are such that $_8B$ is an isobar of $_7A$ and atom $_9C^{17}$ is isotone to B from above information. Mass number of A and B are ………………….. respectively.

(A) 16 and 17 (B) 16 and 16
(C) 17 and 16 (D) 15 and 16

24. Six moles of Cl_2 undergo a loss and gain of 10 mole of electrons to form two oxidation states of Cl. The difference between the maximum and minimum oxidation states of Cl in this reaction is

(A) 4 (B) 8
(C) 6 (D) 3

Space for rough work

25. 50 ml of 0.1 M solution of protonated form of alanine (H_2A^+, $pKa_1 = 2.34$, $pKa_2 = 9.70$) is treated with 50 ml of 0.01 NaOH. The pH of the solution will be

(A) 5.2	(B) 7.02
(C) 6.02	(D) 4.6

26. A mixture of NH_3(g) and N_2H_4(g) is placed in a sealed container at 27°C, 0.5 atm. After complete decomposition of NH_3 and N_2H_4 at 927°C, the total pressure reached to 4.5 atm. The percentage of NH_3 (by mole) is

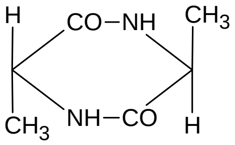
(A) 75%	(B) 25%
(C) 40%	(D) 60%

27. When one mol of an ideal gas is compressed to half of the initial volume and simultaneously heated to twice of its initial temperature. The change in enthalpy (ΔS) is

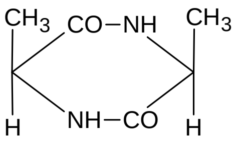
(A) Cv In2	(B) Cp In2
(C) R In2	(D) (Cv-R) In2

28. Which of the following compounds is resolvable?

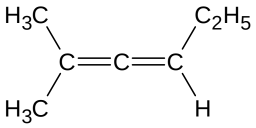
(A)



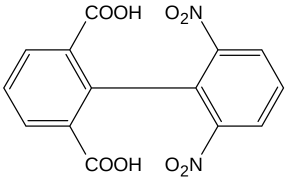
(B)



(C)



(D)



29. Borazene, $B_3N_3H_6$, is isoelectronic and isostructural with benzene. Which of the following statement(s) is/are true about borazene?
(i) Borazene is aromatic.
(ii) There are four isotopic disubstituted borazene molecules, $B_3N_3H_4X_2$.
(iii) Borazene is more reactive towards addition reactions than benzene.

(A) Only (i)	(B) (i) and (ii)
(C) (i) and (iii)	(D) (i), (ii) and (iii)

30. Structure of $Na_2B_4O_7.10H_2O$ contains:

(A) Two triangular and two tetrahedral units	(B) Three triangular and one tetrahedral units
(C) All tetrahedral units	(D) All triangular units.

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. If e is the eccentricity of the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ and θ is angle between the asymptotes, then $\cos\frac{\theta}{2}$ is equal to

(A) $\frac{1-e}{2}$
(B) $\frac{1}{e} - 1$
(C) $\frac{1}{e}$
(D) none of these

2. The sum of the abscissas of all the points on the line x + y = 4 that lie at a distance from the line 4x + 3y – 10 = 0 is

(A) 4
(B) –4
(C) 2
(D) –3

3. If $(x^2 + x + 2)^2 - (a - 3)(x^2 + x + 1)(x^2 + x + 2) + (a - 4)(x^2 + x + 1)^2 = 0$ has atleast one root then complete set of value of a is

(A) $\left(1, \frac{7}{3}\right]$
(B) $\left[\frac{7}{3}, 5\right)$
(C) $\left[\frac{3}{7}, 1\right)$
(D) $\left(5, \frac{19}{3}\right]$

4. Slope of the line $z\bar{a} + \bar{z}a + b = 0$, $b \in R$ is

(A) $-\frac{\text{Re}(a)}{\text{Im}(a)}$
(B) $-\frac{\text{Im}(a)}{\text{Re}(a)}$
(C) $\frac{\text{Re}(a)}{\text{Im}(a)}$
(D) $\frac{\text{Im}(a)}{\text{Re}(a)}$

Space for rough work

5. If $f : \{1, 2, 3, 4, 5\} \rightarrow \{x, y, z, t\}$, total number of onto functions 'f' is equal to

(A) 242	(B) 245
(C) 1024	(D) 240

6. Locus of mid–point of chords of circle $x^2 + y^2 + 2gx + 2fy + c = 0$ that subtends angle $\frac{2\pi}{3}$ at the centre of the circle is

(A) $4x^2 + 4y^2 + 8gx + 8fy + 3g^2 + 3f^2 + c = 0$

(B) $4x^2 + 4y^2 - 8gx - 8fy + 3g^2 + 3f^2 + c = 0$

(C) $4x^2 + 4y^2 + 8gx - 8fy + 3g^2 + 3f^2 + c = 0$

(D) $4x^2 + 4y^2 - 8gx + 8fy + 3g^2 + 3f^2 + c = 0$

7. If the normals to the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ at the extremities of the chords and $px + qy = 1$ are concurrent, then

(A) $a^2\ell p = bm^2q = -1$	(B) $a^2\ell p = b^2mq = -1$
(C) $a\ell p = bmq = 1$	(D) $a\ell p^2 = mbq^2 = 1$

8. Let $f(x) = ax^2 + bx + c$ where $a \in R^+$ and $b^2 - 4ac < 0$. Area bounded by f(x), x–axis and the line x = 0, x = 1 is equal to

(A) $\frac{1}{6}\{3f(1) + f(-1) + 2f(0)\}$	(B) $\frac{1}{12}\{5f(1) + f(-1) + 8f(0)\}$
(C) $\frac{1}{6}\{3f(1) - f(-1) + 2f(0)\}$	(D) $\frac{1}{12}\{5f(1) - f(-1) + 8f(0)\}$

9. If $\sin^3 x \sin 3x = \sum_{r=0}^{n} a_r \cos(rx)$, $\forall\, x \in R$ where, $a_0\ a_1\ a_2$ ….. a_n are constants and $a_n \neq 0$, then

(A) n = 5	(B) n = 6
(C) n = 7	(D) none of these

10. The numerical value of $\sum_{r=1}^{18} \sin^2 (5r)^{o}$ is equal to

(A) 9	(B) $\frac{19}{2}$
(C) $\frac{21}{2}$	(D) $\frac{17}{2}$

Space for rough work

11. If $x \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$, then the value of $\tan^{-1}\left(\frac{\tan x}{4}\right) + \tan^{-1}\left(\frac{3\sin 2x}{5+3\cos 2x}\right)$ is

(A) $\frac{x}{2}$ (B) 2x

(C) 3x (D) x

12. If a, b, c, d are positive numbers such that a + b + c + d = 2, then M = (a + b)(c + d) then M satisfies the relation

(A) $0 < M \leq 1$ (B) $1 \leq M \leq 2$

(C) $2 \leq M \leq 2$ (D) $3 \leq M \leq 4$

13. If $1^2 + 2^2 + 3^2 + \ldots.. + 2003^2 = (2003)(4007)(334)$ and (1)(2003) + (2)(2002) + (3)(2001) + ….. + (2003)(1) = (2003)(334)(x), then the value of x is

(A) 2005 (B) 2004

(C) 2003 (D) 2001

14. In ΔABC, the value of the expression $\sum_{r=0}^{n} {}^nC_r a^r b^{n-r} \cos\{rB - (n-r)\}$ is equal to

(A) c^n (B) 0

(C) a^n (D) b^n

15. Total number of ways, in which 22 different books can be given to 5 students, so that two students get 5 books each and all the remaining students get 4 books each, is equal to

(A) $\frac{22!}{2!3!5!(4!)^3}$ (B) $\frac{22!}{(3!)^2\,2!\,5!}$

(C) $\frac{22!}{3!2!5!4!}$ (D) none of these

16. In a complex number z = x + iy such that $\left(\frac{z-1}{z+1}\right)$, $z \neq -1$ whose argument is equal to $\frac{\pi}{4}$, then relation of variables is

(A) $x^2 - y^2 = 1$ (B) $x^2 + y^2 - 2y = 1$

(C) $x^2 - y^2 + 2y + 1 = 0$ (D) none of these

Space for rough work

17. If 1, ω, ω^2 are cubes roots of unity of complex number, then $(1 + \omega)(1 + \omega^2)(1 + \omega^4)(1 + \omega^8)$ ….. 2n term is

(A) 0
(B) –1
(C) 1
(D) 2

18. If $i^i = e^{-(4n+1)\pi/2}$ and the value of i^i are in G.P. then the common ratio is

(A) $e^{-2\pi}$
(B) $e^{2n\pi}$
(C) e^{π}
(D) e^{-1}

19. The value of $\cos\left[\tan^{-1}\left\{\sin\left(\cot^{-1}x\right)\right\}\right]$ is

(A) $\sqrt{\dfrac{x^2+1}{x^2+2}}$
(B) $\sqrt{\dfrac{x^2+2}{x^2+1}}$
(C) $\sqrt{\dfrac{x-2}{x^2+2}}$
(D) $\dfrac{x+1}{\sqrt{x^2+2}}$

20. If $f(x) = \log\left(\dfrac{1+x}{1-x}\right)$, and $g(x) = \left(\dfrac{3x+x^3}{1+3x^2}\right)$ then f[g(x)] is equal to

(A) –f(x)
(B) 3f(x)
(C) $[f(x)]^3$
(D) $[f(x)]^2$

21. If log $(1 + x + x^2 + x^3 + …..)$ = A log (1 – x), and A = cos θ, then the value of θ is

(A) 1
(B) $\dfrac{\pi}{2}$
(C) π
(D) 0

22. The complex number sin x + i cos 2x and cos x – i sin 2x are conjugate to each other for

(A) x = nπ
(B) $x = \left(n + \dfrac{1}{2}\right)\pi$
(C) x = 0
(D) no value of x

23. If $z^7 + 1 = 0$ then $\cos\dfrac{\pi}{7}\cos\dfrac{3\pi}{7}\cos\dfrac{5\pi}{7}$ is

(A) $\dfrac{1}{8}$
(B) $-\dfrac{1}{8}$
(C) $\dfrac{1}{2\sqrt{2}}$
(D) $\dfrac{1}{2}$

Space for rough work

24. An ordinary cube has 4 blank faces, one face mark 2 and another marked 3, and then probability of obtaining 12 in 5 throws is

(A) $\frac{5}{2592}$ (B) $\frac{5}{1944}$

(C) $\frac{5}{1296}$ (D) $\frac{5}{648}$

25. Negation of “2 + 3 = 5” and “8 < 10” is

(A) $2 + 5 \neq$ and < 10 (B) $2 + 3 = 5$ and $8 \neq< 10$

(C) $2 + 3 \neq 5$ or $8 \neq< 10$ (D) none of these

26. If (a, 0), (0, b) and (a, b) are the vertices of Δ circumscribed by a circle then radius of circle is

(A) $a^2 + b^2$ (B) $a^2 - b^2$

(C) $\frac{1}{2}\sqrt{a^2+b^2}$ (D) $\sqrt{a^2+b^2}$

27. The locus of mid–point of the chord of circle $x^2 + y^2 = y$ such that segment intersected by the chord on curve $x^2 - 2x - 2y = 0$ subtends right angles at the origin is

(A) $x^2 + y^2 - 2x - 2y = 0$ (B) $x^2 + y^2 + 2x + 2y = 0$

(C) $x^2 + y^2 = 0$ (D) none of these

28. If $C_0, C_1, C_2 \ldots.. C_n$ are the combinational coefficients in the expansion of $(1 + x)^n$, $n \in N$, then $C_0 + 3C_1 + 5C_2 + \ldots.. + (2n + 1)C_n$ is equal to

(A) $(n + 1)\, 2^n$ (B) $(n + 2)\, 2^{n-1}$

(C) $n\, 2^{n-1}$ (D) none of these

29. Let a, b, c are the sides of a triangle. No two of them are equal and $\lambda \in R$. If the roots of the equation $x^2 + 2(a + b + c)x + 3\lambda(ab + bc + ca) = 0$ are real then

(A) $\lambda < \frac{4}{3}$ (B) $\lambda > \frac{5}{3}$

(C) $\lambda \in \left(\frac{1}{3}, \frac{5}{3}\right)$ (D) $\lambda \in \left(\frac{4}{3}, \frac{5}{3}\right)$

30. The sum of 1st nth terms of an A.P. is given by $S_n = (1 + 2T_n)(1 - T_n)$ where T_n is nth term of series, then $T_n^2 = \frac{\sqrt{a}-\sqrt{b}}{4}$, $a, b \in N$, then (a + b) is

(A) 4 (B) 5

(C) 6 (D) 7

Space for rough work

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3.	B	D	D
4.	B	B	A
5.	B	C	D
6.	B	A	A
7.	B	C	B
8.	A	D	D
9.	C	C	B
10.	D	A	B
11.	A	B	D
12.	B	B	A
13.	B	C	A
14.	A	D	A
15.	D	D	A
16.	C	A	B
17.	B	C	C
18.	C	D	A
19.	A	D	A
20.	B	C	B
21.	D	B	C
22.	C	D	D
23.	B	B	B
24.	B	C	C
25.	B	C	D
26.	B	A	C
27.	C	D	A
28.	D	B	A
29.	C	D	A
30.	B	A	C

Physics

PART – I

SECTION – A

1. Kepler's IIIrd law may be written as $T^2 = \frac{4\pi^2}{GM}R^3$

$$v = \frac{2\pi R}{T}, \quad v^2 \propto \frac{1}{R}$$

2. Buoyant force = Weight of liquid displaced = $\frac{4}{3}\pi r^3 \rho g$

Viscous force = Stoke's drag force = $6\pi\eta rv$

$\therefore \quad 6\pi\eta rv = \frac{4}{3}\pi r^3 \rho g$

3. The oscillations in one direction are governed by the equation,
$m\ddot{x} = -kx$
in the other by,
$m\ddot{x} = -4kx\sin^2 60^0$

4. Superposing them gives 2A sin (kx + $\pi/6$) cos ($\omega t + \pi/6$)
Nodes are given by kx + $\pi/6 = n\pi$

5. $\alpha = \frac{\tau}{I} = \frac{mgr}{2mr^2} = \frac{g}{2r}$

$a = \alpha r = \frac{g}{2}$.

6. Gravitational potential inside a shell = constant

7. Let A_1 and A_2 be the cross–sectional area of the pipe at points P and Q respectively.
Let v_1 and v_2 be the velocities of oil at the points P and Q respectively.
By conservation of mass,

$$Q = A_1v_1 = A_2v_2$$

$$\Rightarrow \quad v_2 = \left(\frac{A_1}{A_2}\right)(v_1) = 4v_1$$

Applying Bernoullis's equation between points P and Q, we have

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$$

$$P_2 = P_1 + \frac{1}{2}\rho(v_1^2 - v_2^2)$$

$$= P_1 + \frac{1}{2}\times 0.9[16 - 256]\times 10^3$$

$$= 280\times 10^3 + (-108)\times 10^3$$

$P_2 = 172 \times 10^3$ Nm^{-2}
$P_2 = 172$ (KN m^{-2}).

8. By conservation of momentum
J = mV + 2 mV
V= J/3m.

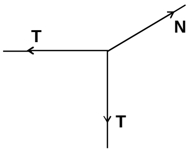
9. $I = \frac{1}{2}mr^2 + \frac{1}{3}m(2r)^2$

10. Within the liquid, the acceleration is g upward, outside it is g downward.

11. dQ = dU - dW, again dQ = dU + dW
dW = pdV = 0

12. Conservation of total mechanical energy

13. mg – T = ma
$T = ma \Rightarrow T = \frac{mg}{2}$ or $N = \frac{mg\sqrt{2}}{2}$



14. At extreme position velocity of M will be zero.

15. At the highest point velocity v = 0 after $t = \frac{u}{2g\sin\theta}$ and it will not return to point O.
So distance covered before coming to rest = $\frac{u^2}{4g\sin\theta}$

16. Tension in AB, 2T < 6 mg
⇒ Net downward force
⇒ C.O.M. has a downward acceleration.

17. The contact point has a tendency to slide in forward direction, so direction of friction will be in backward direction.

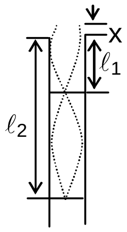
18. ma + mg – T = ma ⇒ T = mg

19. Normal force by the surface and frictional force an impulsive in nature.
Hence COM is applicable for m only along common tangent.

20. For y = a sin ωt, v = aω cos ωt
∴ Acceleration $f = -a\omega^2 \sin \omega t$
$$\frac{f^2}{\omega^2} + v^2 = a^2\omega^2$$

21. 1 – 2 is isothermal with volume increasing
2 – 3 is isobaric
⇒ v/T = k
⇒ v = kT
Change in number of moles of the gas does not affect the nature of graph.

22. $\ell_1 + x = \lambda/4$
$\ell_2 + x = \frac{3\lambda}{4}$
$\Rightarrow x = \frac{\ell_2 - 3\ell_1}{2}$



23. PV = nRT
$PV = \frac{m}{M}RT$ ⇒ slope is directly proportional to the mass of the gas.

30. Use the definition of an elastic collision.

Chemistry

PART – II

SECTION – A

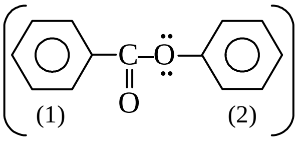
1. $K_a = Cx^2$
$10^{-4} = 10^{-2} \times x^2$
$x = 0.1$
$i = 1 + x =$ **1.1**

2. $CaCO_3 \xrightarrow{\Delta} CaO + CO_2 (X)$
So, X is CO_2
$Na_2CO_3 + H_2O + CO_2 \rightarrow 2NaHCO_3$
Moles of $CaCO_3 = \frac{10}{100} =$ moles of CO_2
Mole of $Na_2CO_3 = 1 mole$
So, moles of $NaHCO_3$ formed according to the moles of CO_2, which is limiting reagent so moles of $NaHCO_3$ formed will be (0.2) mole.

3. Initial temperature = 300 K at
Let new temperature corresponding to t°C is T K.
Let number of moles present at T K = n
Moles of air escaped at T K = n/3
So, number of moles at 300 K = n + $\frac{n}{3} = \frac{4n}{3}$
Volume and pressure are kept constant
$\therefore \quad \frac{n_1}{n_2} = \frac{T_2}{T_1}$
$\frac{4n}{3} \times 300 = nT$
$\therefore$ T = 400 K
Now r.m.s velocity = $\sqrt{\frac{3RT}{M}} = \sqrt{\frac{3 \times 8.314 \times 400}{28.8 \times 10^{-3}}}$ = **588.6 m sec^{-1}**.

6. $K_c = \frac{[Z]}{[X][Y]}$
$[X] = \frac{1}{2}[Y] = \frac{1}{2}[Z] = a$ (let)
$\therefore$ [Z] = 2a, [Y] = 2a, [X] = a
$\therefore \quad 10^4 = \frac{2a}{a \times 2a}$
a = 10^{-4}
$\therefore$ [Z] = 2a = **2×10^{-4} mol L^{-1}**.

8. In phenyl benzoate



the 1st ring gets deactivated, while 2nd ring gets activated due to lone pairs on oxygen atom. So it can give ortho or para bromo product. But the ortho position is sterically hindered, so it will give para compound as a major product.

9. Staggered conformer of n–butane is achiral because it has a plane of symmetry as well as a centre of symmetry.

10. Basic strength of the oxides of alkali metals increases down the group.

14. $t_{1/2} = \dfrac{0.0693}{k_1}$ ... (1)

Also, $t_{93.75} = \dfrac{2.303}{k_1}\log\dfrac{100}{100-93.75}$

$$= \frac{2.303}{k_1}\log\frac{100}{6.25} = \frac{2.303}{k_1}\log 2^4 = \frac{4\times 2.303\times \log 2}{k_1} = \frac{4\times 0.693}{k_1} = 4t_{1/2}$$

Hence, (D).

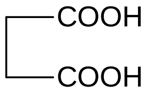
15. Weak base groups are the best leaving groups also stronger is an acid weaker its conjugate base. The CH_3OH is the weakest base among the given group.

16. $e^{-E_a/RT} = \dfrac{10^{-5}}{100}$

$\therefore \dfrac{-E_a}{RT} = \ell n\,\dfrac{10^{-5}}{100}$

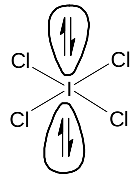
$\therefore E_a = 39.94\text{ kJ}$

20. In the presence of Zn, only Br_2 can be removed, not as HBr
In the presence of $(CH_3)_2S$



can not be formed (reductive ozonolysis)

21. $\overset{-}{N}=\overset{+}{N}=\overset{-}{N}$ sp ;



sp^3d^2

23. Given $_8B$ and $_7A$ are isobars and thus should have same mass number.
$_8B^m$ and $_7A^m$:
Now, also given $_9C^{17}$ is isotone to $_8B^m$.
$\therefore$ Number of neutrons in both should be same.
or, 17 – 9 = m – 8
m = 16
Mass number of A and B are 16.

24. $6Cl_2 + 10e^- \longrightarrow 2Cl^{5+} + 10Cl^-$

Hence, (C).

26. Let, NH_3 = x mole

N_2H_4 = y mole

$$\begin{array}{ccc} 2NH_3 \rightarrow & N_2 + & 3H_2 \\ x & 0 & 0 \\ 0 & \frac{x}{2} & \frac{3x}{2} \end{array}$$

$$\begin{array}{ccc} N_2H_4 \rightarrow & N_2 + & 2H_2 \\ y & 0 & 0 \\ 0 & y & 2y \end{array}$$

Initial total mole = x + y

Final total mole = 2x + 3y

$$\frac{2x+3y}{x+y} = \frac{4.5}{(0.5)\times(4)}$$

$\Rightarrow$ x = 3y $\Rightarrow$ %x = 75

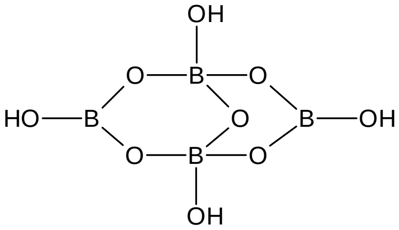
27. $\Delta S = C_V \ln\left(\frac{T_2}{T_1}\right) + R\ln\frac{V_2}{V_1}$

$= C_V\ln 2 + R \times \ln 1/2$

$= (C_V - R)\ln 2$

28. (B) don't have any symmetry.

30.



Mathematics PART – III

SECTION – A

1. Angle between the asymptotes of $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ is $2\tan^{-1}\left(\frac{b}{a}\right)$ (formula)

Given θ is angle between asymptotes of hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$, and e be its eccentricity

According to question $\theta = 2\tan^{-1}\left(\frac{b}{a}\right) \Rightarrow \frac{\theta}{2}=\tan^{-1}\frac{b}{a} \Rightarrow \tan\frac{\theta}{2}=\frac{b}{a}$

$$\cos\theta=\frac{1-\tan^2\frac{\theta}{2}}{1+\tan^2\frac{\theta}{2}} = \frac{1-\frac{b^2}{a^2}}{1+\frac{b^2}{a^2}}=\frac{a^2-b^2}{a^2+b^2} \Rightarrow 2\cos^2\frac{\theta}{2}-1=\frac{a^2-b^2}{a^2+b^2}$$

$$2\cos^2\frac{\theta}{2}=\frac{a^2-b^2}{a^2+b^2}+1=\frac{a^2-b^2+a^2+b^2}{a^2+b^2}=\frac{2a^2}{a^2+b^2}$$

$$\cos\frac{\theta}{2}=\frac{1}{\sqrt{1+\frac{b^2}{a^2}}}=\frac{1}{\sqrt{e^2}}=\frac{1}{e}$$

2. Any point on the line x + y = 4 can be taken as $(x_1, 4 – x_1)$ as it is a limit distance from the line 4x + 3y – 10 = 0 we get $\frac{\left|4x_1+3(4-x_1)-10\right|}{\sqrt{25}}=1 \Rightarrow |x_1 + 2| = 5$

$\Rightarrow x_1 + 2 = \pm 5,\ x_1 = 3$ or – 7

$\therefore$ The required sum = 3 + (–7) = –4

3. Let $A = x^2 + x + 1$

$\Rightarrow A \in \left[\frac{3}{4}, \infty\right)$

$\Rightarrow (A + 1)^2 – (a – 3)A(A + 1) + (a – 4)A^2 = 0$

$\Rightarrow A^2 + 2A + 1 – (a – 3)(A^2 + A) + (a – 4)A^2 = 0$

$\Rightarrow A(2 – a + 3) + 1 = 0$

$\Rightarrow A(5 – a) = –1$

$\Rightarrow A=\frac{1}{a-5}$

$\Rightarrow \frac{1}{a-5}\ge\frac{3}{4}$

$\Rightarrow \frac{19-3a}{a-5}\ge 0$

$\Rightarrow a\in\left(5, \frac{19}{3}\right]$

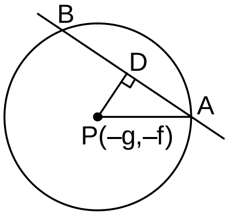
4. z = x + iy then line becomes $(x + iy)\bar{a} + (x – iy)a + b = 0$

$\Rightarrow x(a + \bar{a}) + y(\bar{a} – a)i + b = 0$

$\therefore$ Slope = $\frac{(a+\bar{a})}{i(a-\bar{a})}=-\frac{2\text{Re}(a)}{i-2i\{\text{Im}(a)\}}=-\frac{\text{Re}(a)}{\text{Im}(a)}$

5. Total function = 4^5
Total functions when any one element is the left out = ${}^4C_1\, 3^5$
Total functions when any two elements are left out = ${}^4C_2\, 2^5$
Total functions when any three of elements are left out = ${}^4C_3\, 1^5$
Thus the total number of onto functions = $4^5 - ({}^4C_1\, 3^5 + {}^4C_2\, 2^5 - {}^4C_3) = 240$

6. Let D(x, y) be the mid–point of chord AB, we have



$\angle BPA = \frac{2\pi}{3}$, $\angle DPA = \frac{\pi}{3}$

$\Rightarrow PD = PA\cos\frac{\pi}{3}$

$\Rightarrow 4PD^2 = PA^2$

$\Rightarrow 4[(x + g)^2 + (y + f)^2] = g^2 + f^2 - c$

$\Rightarrow 4x^2 + 4y^2 + 8gx + 8fy + 3g^2 + 3f^2 + c = 0$

7. Equation of normals at any point $P(x_1, y_1)$ on the $\frac{a^2(x - x_1)}{x_1} = \frac{b^2(y - y_1)}{y_1}$
If it passes through Q(h, k) then $a^2y_1(h - x_1) = b^2x_1(k - y_1)$ thus foot of normals drawn from Q(h, k) to the ellipse will lie on the hyperbola, whose equation will be
$b^2xk - a^2hy + (a^2 - b^2)xy = 0$ ….. (1)
In the given question if the normals are concurrent at Q(h, k) then
$\frac{x^2}{a^2} + \frac{y^2}{b^2} - 1 + \lambda(\ell x + my - 1)(px + qy - 1) = 0$ ….. (2)
Equation (2) will represent hyperbola given by (1) by comparing the coefficients $a^2\ell p = b^2mq = 1$

8. $f(x) > 0,\ \forall\ x \in R$

$\therefore$ Required area $A = \int_0^1 (ax^2 + bx + c)dx$

$A = \frac{a}{3} + \frac{b}{2} + c = \frac{1}{6}[2a + 3b + 6c]$

Now, f(0) = c, f(1) = a + b + c
f(–1) = a – b + c

$a = \frac{1}{2}\{f(1) + f(-1)\} - f(0)$ and $b = \frac{1}{2}\{f(1) - f(-1)\}$

$\therefore \Delta = \frac{1}{12}\{5f(1) - f(-1) + 8f(0)\}$

9. $\sin^3 x \sin 3x = \frac{1}{2}\sin^2 x(\cos 2x - \cos 4x)$

$= \frac{1}{2} \times \frac{1}{2}(1 - \cos 2x)(\cos 2x - \cos 4x)$

$= \frac{1}{4}(\cos 2x - \cos 4x - \cos^2 2x + \cos 2x\cos 4x)$

$= \frac{1}{4}\left[\cos 2x - \cos 4x - \frac{1 + \cos 4x}{2} + \frac{1}{2}(\cos 6x + \cos 2x)\right]$

$= \frac{1}{4}\left[\frac{3}{2}\cos 2x - \frac{3}{2}\cos 4x + \frac{1}{2}\cos 6x - \frac{1}{2}\right]$

$\Rightarrow n = 6$

10. $$I = \sum_{r=1}^{18} \sin^2(5r)^{\circ} = \sum_{r=0}^{18} \sin^2(5r)^{\circ} = \sum_{r=0}^{18} \sin^2\{5(18-r)\}^{\circ}$$

$$I = \sum_{r=0}^{18} \sin^2(90-5r)^{\circ} = \sum_{r=0}^{18} \cos^2(5r)^{\circ}$$

$$2I = \sum_{r=0}^{18} \left(\sin^2 5r + \cos^2 5r\right) = 19$$

$$\Rightarrow I = \frac{19}{2}$$

11. $$\tan^{-1}\left(\frac{\tan x}{4}\right) + \tan^{-1}\left(\frac{3\sin 2x}{5+3\cos 2x}\right)$$

$$= \tan^{-1}\left(\frac{\tan x}{4}\right) + \tan^{-1}\left[\frac{6\tan x}{8+2\tan^2 x}\right] = \tan^{-1}\left(\frac{\tan x}{4}\right) + \tan^{-1}\left[\frac{3\tan x}{4+\tan^2 x}\right]$$

$$= \tan^{-1}\left[\frac{16\tan x + \tan^3 x}{16+\tan^2 x}\right] = \tan^{-1}(\tan x) = x$$

12. $a + b + c + d = 2$

AM $\geq$ GM

$$\frac{(a+b)+(c+d)}{2} \geq [(a + b)(c + d)]^{1/2}$$

$1 \geq [(a + b)(c + d)]^{1/2} \Rightarrow (a + b)(c + d) \leq M$

$\therefore (a + b)(c + d) > 0$

So $0 < M \leq 1$

13. If $1^2 + 2^2 + 3^2 + \ldots\ldots + 2003^2 = (2003)(4007)(334)$

$(1)(2003) + (2)(2002) + 3(2001) + \ldots\ldots + (2003)(1) = (2003)(334)(x)$

$$\Rightarrow \sum_{r=1}^{2003} r(2003 - r + 1) = (2003)(334)(x)$$

$\Rightarrow 2004(\sum r) - (\sum r^2) = (2003)(334)(x)$

$$\Rightarrow 2004\frac{(2003\times 2004)}{2} - (2003)(4007)(334)$$

$\Rightarrow (2003)(334)x \Rightarrow x = 2005$

14. $$\sum_{r=0}^{n} {}^nC_r a^r b^{n-r} \cos\{rB - (n-r)A\} = \text{Re}\left[\sum_{r=0}^{n}\left\{{}^nC_r a^r b^{n-r} e^{i\{rB-(n-r)A\}}\right\}\right]$$

$$= \text{Re}\left[\sum_{r=0}^{n} {}^nC_r \left(ae^{iB}\right)^r \left(be^{-iA}\right)^{n-r}\right] = \text{Re}\left[ae^{iB} + be^{-iA}\right]^n$$

$= \text{Re}(a \cos B + ia \sin B + b \cos A - ib \sin A)^n$

$= \text{Re}(a \cos B + b \cos A)^n = c^n$

15. It is same as dividing 22 books in 5 packets such that two packets have 5 books, each and remaining three have four books each and then the distributing these packets thus total ways fo distributing these books = $\dfrac{22!}{(5!)^2(4!)^3\,2!3!}(5!) = \dfrac{22!}{2!3!5!(4!)^3}$

16. $\left(\frac{z-1}{z+1}\right)=\left(\frac{x+iy-1}{x+iy+1}\right)=\left\{\frac{(x-1)+iy}{(x+1)+iy}\right\}\times\left\{\frac{(x+1)-iy}{(x+1)-iy}\right\}=\frac{x^2+y^2-1}{(x+1)^2+y^2}+\frac{2iy}{(x+1)^2+y^2}$

Now, $\operatorname{agr}\left(\frac{z-1}{z+1}\right)=\frac{\pi}{4}$

$\therefore\ \tan^{-1}\left[\frac{2y}{(x+1)^2+y^2}\times\frac{(x+1)^2+y^2}{\left(x^2+y^2-1\right)}\right]=\frac{\pi}{4}$

$\Rightarrow x^2 + y^2 - 2y = 1$

17. $(1 + \omega)(1 + \omega^2)(1 + \omega^4)(1 + \omega^8)$ ….. 2n term $\quad(\because\ \omega^3 = \omega^6 = 1)$
$= (1 + \omega)(1 + \omega^2)(1 + \omega^3\omega)(1 + \omega^6\omega^2)$ ….. $= [(1 + \omega)(1 + \omega)$ ….. n term$][1 + \omega^2)(1 + \omega^2)$ ….. n term]
$= (1 + \omega)^n(1 + \omega^2)^n = [(1 + \omega)(1 + \omega^2)]^n = 1^n = 1$

18. $i^i = e^{i\log i} = e^{i[2n\pi i+\log i]} = e^{i\left[2n\pi i+\frac{1}{2}\log i+i\tan^{-1}\left(\frac{1}{0}\right)\right]}$
$= e^{i\left[2n\pi i+i\frac{\pi}{2}\right]} = e^{-(4n+1)\frac{\pi}{2}}$ (where n = 0, 1, 2, 3 …..)
Put n = 0, 1, 2, 3, ….. then $i^i = e^{-\frac{\pi}{2}},\ e^{-\frac{5\pi}{2}},\ e^{-\frac{9\pi}{2}}$ ….. are in G.P.
$\therefore$ Common ratio $= e^{-2\pi}$

19. $\cos\left[\tan^{-1}\left\{\sin\left(\cot^{-1}x\right)\right\}\right]$

$=\cos\left[\tan^{-1}\left\{\sin\left(\sin^{-1}\frac{1}{\sqrt{1+x^2}}\right)\right\}\right]=\cos\left[\tan^{-1}\frac{1}{\sqrt{1+x^2}}\right]$

$=\cos\cos^{-1}\left(\frac{\sqrt{1+x^2}}{\sqrt{2+x^2}}\right)=\sqrt{\frac{x^2+1}{x^2+2}}$

20. $f[g(x)] = f\left[\frac{3x+x^3}{1+3x^2}\right] = \log\left(\frac{1+x}{1-x}\right)^3 = 3\log\left(\frac{1+x}{1-x}\right) = 3f(x)$

21. $\log(1 + x + x^2 + \ldots) = \log(1 - x)^{-1} = -\log(1 - x)$
$\Rightarrow A = -1$
$\Rightarrow \cos\theta = -1$
$\Rightarrow \theta = \pi$

22. No value of x

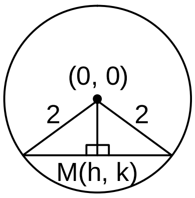
23. $z^7 + 1 = 0$
$\Rightarrow z^7 = -e^{i(\pi + 2k\pi)}$ (where k = 0, 1, 2, ….. 6)
$z = -1,\ e^{\pm i\frac{\pi}{7}},\ e^{\pm i\frac{3\pi}{7}},\ e^{\pm i\frac{5\pi}{7}}$
$z^7+1=[z-(-1)]\left[z-e^{i\frac{\pi}{7}}\right]\left[z-e^{-i\frac{\pi}{7}}\right]\left[z-e^{i\frac{3\pi}{7}}\right]\left[z-e^{-i\frac{3\pi}{7}}\right]\left[z-e^{i\frac{5\pi}{7}}\right]\left[z-e^{-i\frac{5\pi}{7}}\right]$
Put $z^2 + 1 = 0 \Rightarrow z = \pm i$

$-8\cos\frac{\pi}{7}\cos\frac{3\pi}{7}\cos\frac{5\pi}{7}=1$

$\Rightarrow\ \cos\frac{\pi}{7}\cos\frac{3\pi}{7}\cos\frac{5\pi}{7}=-\frac{1}{8}$

26. $x^2 + y^2 + 2gn + 2fg + c = 0$ is the equation of circle
$\because$ (a, 0), (0, b) and (a, b) passes through the circle
$\therefore a^2 + 2ag + c = 0$
$b^2 + 2bf + c = 0$
$a^2 + b^2 + 2ag + 2bf + c = 0$
$g = -\frac{a}{2},\ f = -\frac{b}{2},\ c = 0$
Radius = $\frac{1}{2}\sqrt{a^2 + b^2}$

27. Equation of chord T = S_1
$\Rightarrow xh + ky = h^2 + k^2$ ….. (1)
$\Rightarrow xh + hk - (h^2 + k^2) = 0$
$x^2 - 2x - 2y = 0$
$\Rightarrow x^2 - 2x - 1 - 2y - 1 = 0$
$\Rightarrow x^2 - 2x\left[\frac{hx+ky}{h^2+k^2}\right] - 2y\left[\frac{hx+ky}{h^2+k^2}\right] = 0$
$\Rightarrow h^2 + k^2 - 2h - 2k = 0$
$\Rightarrow x^2 + y^2 - 2x - 2y = 0$



28. $(1 + x)^n = C_0 + C_1x + C_2x^2 + C_3x^3$ …..
$C_0 + 3C_1 + 5C_2 +$ ….. $(2n + 1)C_n = (C_0 + C_1 + C_2 +$ ….. $+ C_n) + 2(C_1 + 2C_2 + 3C_3 +$ ….. $+ {}^nC_n)$
$= 2^n + n\,2^n \Rightarrow (n + 1)\,2^n$

29. D > 0
$\Rightarrow (a + b + c)^2 - 3(ab + bc + ca)\lambda > 0$
$\Rightarrow 3\lambda - 4 < 0,\ \left[\frac{a^2+b^2+c^2}{ab+bc+ca} < 2\right]$
$\Rightarrow \lambda < \frac{4}{3}$

30. $S_n = (1 + 2T_n)(1 - T_n)$
Put n = 1 then $T_1 = (1 + 2T_1)(1 - T_1)$
$\Rightarrow T_1 = \frac{1}{\sqrt{2}}$
Put n = 2 we get $T_2^2 = \frac{1}{2} - \frac{1}{2\sqrt{2}} = \frac{\sqrt{4}-\sqrt{2}}{4} = \frac{\sqrt{a}-\sqrt{b}}{4}$
$\Rightarrow (a + b) = 6$

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Main), 2015**

HALF COURSE TEST –VI

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 03 and 10 to 12)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (04 to 09 and 13 to 30) contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10 \text{ m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3 \text{ kg/m}^3$
Atmospheric pressure	$P_a = 10^5 \text{ N/m}^2$
Gas constant	$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
		=	$0.0821 \text{ Lit atm K}^{-1} \text{ mol}^{-1}$
		=	$1.987 \approx 2 \text{ Cal K}^{-1} \text{ mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Single Correct Choice Type

*This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.*

---

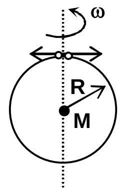
1. A cylinder released from the top of an inwclined plane of inclination θ and having coefficient of friction μ rolls without sliding and reaches the bottom with speed v_r. Another cylinder, released from the top of the same plane rolls with sliding till it reaches bottom with speed v_s. Then (given that $\mu > \frac{\tan\theta}{3}$)

(A) $V_s > V_r$ (B) $V_r > V_s$
(C) $V_r = V_s$ (D) none of these

2. A uniform rod of length ℓ is suspended from one end such that it is free to rotate about an axis passing through that end and perpendicular to the rod. A small sphere of same mass as that of rod strikes the other end of the rod and sticks to it. The minimum velocity of the sphere for which the rod can make full rotations is

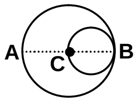
(A) $\sqrt{8g\ell}$ (B) $\sqrt{4g\ell}$
(C) $\sqrt{5g\ell}$ (D) none of these

3. From A ring of mass M and radius R rotating with angular velocity ω about it's diameter (being vertical) two beads of mass m are released from rest from the upper end of the diameter. The angular velocity of the ring when the two bead's meet at the lower end is



(A) ω (B) 2ω
(C) $M\omega/M+2m$ (D) none of these

4. The moment of inertia of a uniform disc with centre C and radius R, having circular cavity of diameter CB = R about an axis passing through A, B and C and perpendicular to the plane of disc is I_A, I_B and I_C respectively. Then



(A) $I_C > I_B > I_A$ (B) $I_B > I_C > I_A$
(C) $I_A > I_C > I_B$ (D) $I_B > I_A > I_C$

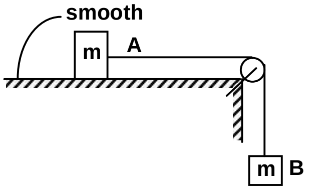
Space for rough work

5. If moment of inertia of a rod of mass m and length ℓ about an axis through it's end and perpendicular to the rod is I, then the moment of inertia about the same axis if the rod is bent at 90° at it's mid point is

(A) $\frac{5}{4}I$ (B) $\frac{5}{8}I$

(C) $\frac{13}{8}I$ (D) none of these

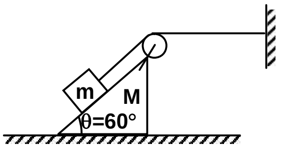
6. The system shown in figure is released from rest, if block B is stopped for a moment after 1 sec from the start, the time after which the string will again become taut is



(A) 1 sec (B) 2 sec

(C) 3 sec (D) none of these

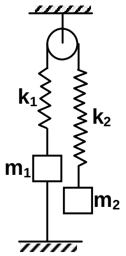
7. The system shown in figure is released from rest. The ratio of velocities of block and wedge after 2 sec from the start of motion is (Assuming all the surface to be frictionless)



(A) 1/2 (B) 1

(C) 2 (D) none of these

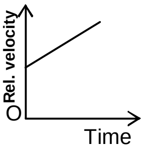
8. In the figure shown pulley string and spring are massless and the system is in equilibrium. If the string connected to the ground is cut, the instantaneous acceleration of m_1 mass is



(A) g/2 (B) g/3

(C) $\frac{m_1 g}{m_2}$ (D) $\frac{(m_2 - m_1)g}{m_1}$

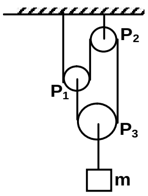
9. A particle is observed from two frames S_1 and S_2. The graph of relative velocity of S_1 with respect to S_2 is shown in figure. Let F_1 and F_2 be the pseudo forces on the particle when seen from S_1 and S_2 respectively. Which of the following is impossible?



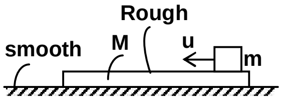
(A) $F_1 = 0, F_2 \neq 0$ (B) $F_1 \neq 0, F_2 = 0$

(C) $F_1 \neq 0, F_2 \neq 0$ (D) $F_1 = 0, F_2 = 0$

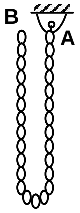
Space for rough work



10. In the figure shown neglect the masses of the pulley and also neglect friction. Then
(A) tension in the string connected to block is mg/2
(B) Acceleration of pulley P_1 is g upwards
(C) Acceleration of pulley P_3 is g/2 downwards
(D) Acceleration of block is g downwards.



11. A block of mass m is given velocity u over a long plank of mass M as shown in figure. The velocity of the block after a long time is
(A) $\frac{mu}{M}$
(B) $\frac{mu}{M+m}$
(C) $\frac{u}{2}$
(D) $\frac{Mu}{M+m}$



12. The end B of the chain of mass per unit length λ and length ℓ is released from rest as shown in figure. The force at the hinge when the end B is at $\ell/4$ from the ceiling is
(A) $\frac{3}{4}\lambda gL$
(B) $\frac{\lambda gL}{4}$
(C) $\frac{4}{3}\lambda gL$
(D) none of these

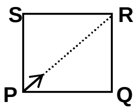
13. Choose the correct statement.
(A) Work done by friction force is always negative.
(B) Static friction is always greater than kinetic friction
(C) When the body slides on a surface the value of friction is equal to limiting friction.
(D) The coefficient of friction between two bodies does not depend upon the area of contact.

Space for rough work

14. For a body moving on a circular path, the angular velocity, linear velocity, angular acceleration, centripetal acceleration and tangential acceleration of the particle at any instant are $\vec{\omega}, \vec{v}, \vec{\alpha}, \vec{a}_c$ and $\vec{a}_t$ respectively. Which of the following relation is incorrect.

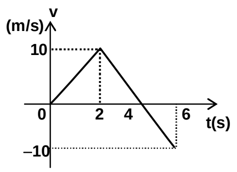
(A) $\vec{\omega} \perp \vec{v}$
(B) $\vec{a}_t \perp \vec{a}_c$
(C) $\vec{\omega} \perp \vec{a}_t$
(D) $\vec{\alpha} \perp \vec{\omega}$

15. A particle is projected from corner P of an elevator moving downwards with acceleration a towards diagonally opposite corner R. Then

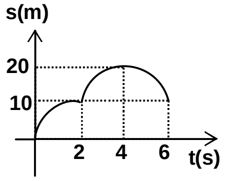


(A) particle will hit R only when a = g.
(B) particle will hit the wall QR if a > g
(C) particle will hit the roof RS if a < g.
(D) data insufficient

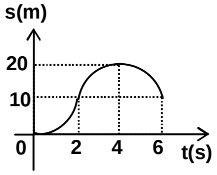
16. For the given velocity time curve, displacement is zero at t = 0 the corresponding displacement time curve is



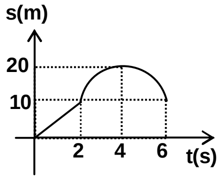
(A)



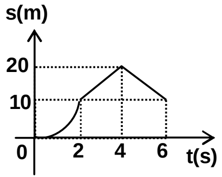
(B)



(C)

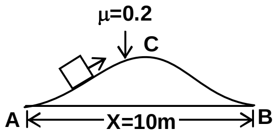


(D)



Space for rough work

17. A block of mass 1 kg is pulled along the curve path ACB by a tangential force as shown in figure. The work done by the friction force when the block moves from A to B is



(A) 5 J
(B) 10 J
(C) 20 J
(D) none of these

18. An inclined plane of height 10 m and angle of inclination 30° with the horizontal is having a groove at an angle of 45° with the line of greatest slope. A particle is released from rest from the top of incline plane in the groove, the time taken by the particle to reach the bottom of the groove is ($g = 10\ m/s^2$)
(A) 1 sec
(B) 2 sec
(C) 4 sec
(D) none of these

19. A light rod of length L, is hanging from on the vertical wall of a vehicle moving with acceleration $\sqrt{3}$ g having a small mass attached at it's one end is free to rotate about an axis passing through the other end. The minimum velocity given to the mass at it's equilibrium position so that it can complete vertical circular motion is
(A) $\sqrt{5gL}$
(B) $\sqrt{4gL}$
(C) $\sqrt{8gL}$
(D) none of these

20. A particle moves with a speed $v = |t - 3|$ m/s along a straight line, where t is time in seconds. Distance travelled by the particle during first 5 seconds is equal to:
(A) 1.5 m
(B) 2m
(C) 6.5 m
(D) none of these

21. Two particles A and B starts from rest and move for equal time on a straight line. Particle A has an acceleration of z m/s^2 for the first half of the total time and 2zm/s^2 for the second half. The particle B has an acceleration of 2z m/s^2 for the first half of the total time and z m/s^2 for the second half. Which particle has covered larger distance?
(A) A has covered the larger distance
(B) B has covered the larger distance
(C) both have covered the same distance
(D) none of these

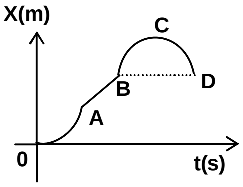
Space for rough work

22. A uniform circular ring of mass m and radius R is rotating in a gravity free space with angular velocity ω about its own axis. Tension in the ring is

(A) $\frac{mR\omega^2}{2\pi}$ (B) $\frac{mR\omega^2}{4\pi}$

(C) zero (D) $mR\omega^2$

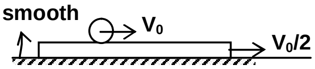
23. The displacement time graph for a particle in motion is shown in figure. For which portion of the graph the force acting on the particle is opposite to the direction of velocity



(A) AB (B) OA

(C) BC (D) CD

24. A cylinder of mass m and radius R is given velocity V_0 over a plank of same mass having velocity $V_0/2$. The velocity of the cylinder when it starts rolling without slipping is



(A) $\frac{V_0}{8}$ (B) $\frac{7V_0}{8}$

(C) $\frac{V_0}{4}$ (D) $\frac{3V_0}{4}$

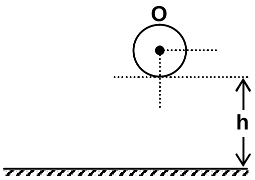
25. In the previous question if coefficient of friction between the plank and cylinder is μ, the work done by friction in the motion is

(A) $-\frac{1}{16}mv_0^2$ (B) $-\frac{1}{32}\mu mg$

(C) $-\frac{1}{32}mv_0^2$ (D) zero

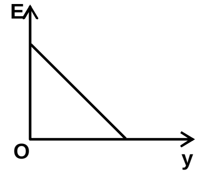
Space for rough work

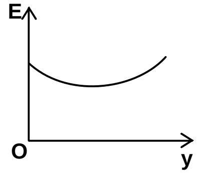
26. A small sphere and a big sphere are released from rest with a very small gap from height h as shown in figure. The mass of bigger sphere is very large as compared to mass of smaller sphere the height from the point of collision of smaller sphere with the bigger sphere to which the smaller sphere will rise if all the collision is elastic

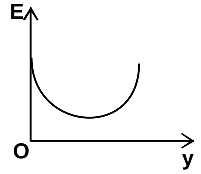


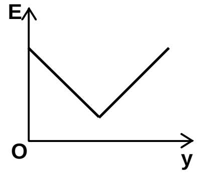
(A) 2h
(B) 4h
(C) 6h
(D) 9h

27. A particle is projected from a point at an angle with the horizontal at, $t = 0$. At an instant t, if p is magnitude of linear momentum, x is horizontal displacement, y is vertical displacement E is kinetic energy of the particle, then which of the following graph is correct.

(A)


(B)


(C)


(D)


28. A particle on the top of a fixed sphere of radius R is given horizontal velocity $\sqrt{2gR}$, the angle measured from vertical at which it will leave contact with the sphere is

(A) zero
(B) $\cos^{-1}(2/3)$
(C) $30°$
(D) $45°$

29. Work will be done by a force on an object, if

(A) the object is stationary but the point of application of the force moves.
(B) the force is always perpendicular to its velocity
(C) the object moves in such a way that the force is perpendicular to its displacement.
(D) none of these

30. A block is suspended by an ideal spring constant K. If the block is pulled down by constant force F and if maximum displacement of block from it's initial position of rest is z, then

(A) $z = F/K$
(B) $z = 2F/K$
(C) work done by force F is equal to 2Fz.
(D) increase in potential energy of the spring is $\frac{1}{2}Kz^2$

Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

*This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.*

1. How many substituted products are possible on monochlorination of isohexane (including isomers)?
(A) 5 (B) 6
(C) 7 (D) 8

2. For the reaction: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ equilibrium constant is
(A) $\dfrac{(\eta_{NH_3})^2}{(\eta_{N_2})(\eta_{H_2})^3}V$ (B) $\dfrac{(\eta_{NH_3})^2}{(\eta_{N_2})(\eta_{H_2})^3}V^2$
(C) $\dfrac{(\eta_{NH_3})^2}{(\eta_{N_2})(\eta_{H_2})^3}V^3$ (D) $\dfrac{(\eta_{NH_3})^2}{(\eta_{N_2})(\eta_{H_2})^3}$

3. The rate constant for the reaction: $2N_2O_5 \longrightarrow 4NO_2 + O_2$ is 6×10^{-5} s^{-1}. If the rate is 2.40×10^{-5} mol $L^{-1}s^{-1}$, then the concentration of N_2O_5 (in mol L^{-1}) is
(A) 0.8 (B) 0.4
(C) 0.2 (D) 0.1

4. Dolomite is mineral whose formula is
(A) $CaCO_3$ (B) $CaCO_3.MgCO_3$
(C) $MgCO_3$ (D) $CaSO_4.2H_2O$

5. Which of the following thermodynamic relation is correct for ideal gas?
(A) $\left(\dfrac{\partial V}{\partial T}\right)_P = 0$ (B) $\left(\dfrac{\partial P}{\partial T}\right)_V = 0$
(C) $\left(\dfrac{\partial E}{\partial V}\right)_T = 0$ (D) $\left(\dfrac{\partial V}{\partial T}\right)_P = 0$

Space for rough work

6. How many bonds are there in naphthalene?
(A) $18\sigma, 4\pi$ (B) $18\ \sigma, 5\pi$
(C) $19\ \sigma, 5\pi$ (D) $19\ \sigma, 4\pi$

7. Which of the following is correct relation between mole fraction of solute into molarity of solution?
(A) $M = \frac{x_2}{M_2\left(X_1M_1 + x_2M_2\right)}$ (B) $M = \frac{\left(x_1M_1 + x_2M_2\right)}{x_2M_2}$
(C) $M = \frac{x_2\rho}{\left(x_1M_1 + x_2M_2\right)}$ (D) $M = \frac{\left(1 - m\rho\right)}{mM_2}$

8. Which of the following expression is correct for rate of diffusion of 2 gases?
(A) $r_{H_2} = r_{D_2}$ (B) $r_{CO_2} = r_{NO_2}$
(C) $r_{N_2} = r_{CO_2}$ (D) $r_{CO_2} = r_{N_2O}$

9. K_{sp} of a substance MX_2 is 4×10^{-6} mol^3L^{-3}. Molecular mass of the substance is 200 its solubility would be
(A) 0.2 g/L^{-1} (B) 2 g/L
(C) 20 g/L (D) 200 g/L

10. Which of the following represents the given mole of hybridization $sp - sp - sp^2 - sp^2 - sp^3$ from left to right?
(A) $CH_3 - CH_3 - CH_2 = CH - NH_2$ (B) $CH \equiv CH - CH_2 - CH_2 - NH_2$
(C) $CH \equiv CH - CH_2 - NH - CH_3$ (D) $CH \equiv CH - N = N - CH_3$

11. The hybridization of diborane is
(A) sp (B) sp^2
(C) sp^3 (D) sp^3d

12. Which of the following ion has the maximum value of magnetic moment?
(A) Mn^{2+} (B) Fe^{2+}
(C) Co^{2+} (D) Ni^{2+}

Space for rough work

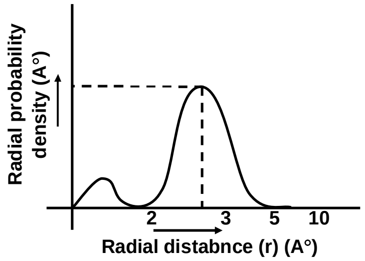
13. 2 moles of SO_2 and 1 mole of O_2 are allowed to react in a container of capacity 2 litre and following equilibrium is allowed to establish: $2SO_2(g)+O_2(g) \rightleftharpoons 2SO_3(g)$

The equilibrium mixture requires 200 ml of 0.1 M acidified $K_2Cr_2O_7$ solution. Hence K_c for the above equilibrium is approximately

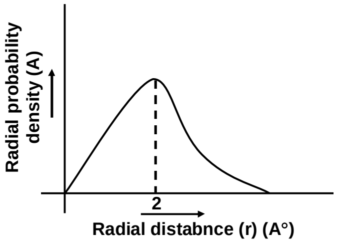
(A) 6.96×10^{2}
(B) 6.96×10^{3}
(C) 6.96×10^{4}
(D) 6.96×10^{5}

14. Which of the following radial probability curve is correct for a 3p – orbital? (Assume that all graphs have been plotted for the same parameters. In all these curves principal quantum number < 4)

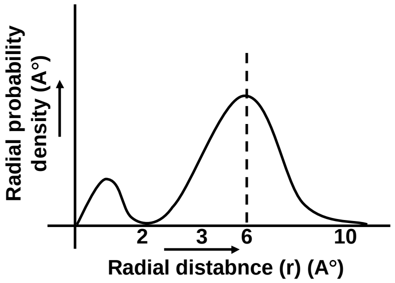
(A)



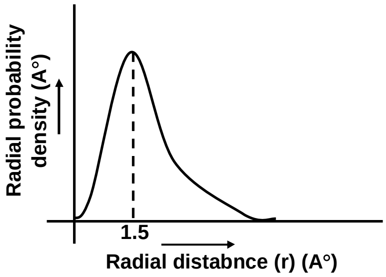
(B)



(C)



(D)



15. Which of the following species is incorrect method with its shape?

(A) $ClF_3 \longrightarrow$ T – shaped
(B) $SO_3^{2-} \longrightarrow$ tetrahedral
(C) $C_2O_4^{2-} \longrightarrow$ planar
(D) $I_3^{-} \longrightarrow$ linear

Space for rough work

16. Identify the incorrect statement (s) among the following:
(A) if spin quantum number curve having 3 possible values then 4th period of periodic table would have maximum of 27 elements.
(B) platinum (Pt) is one of the typical transition metal.
(C) total number of f – electrons in Gd (at. No. 64) is 8.
(D) atomic radius of Ga is nearly equal to that of Al.

17. To prepare a buffer of pH 8.26 amount of $(NH_4)_2SO_4$ to be added into 500 ml of 0.01 M NH_4OH solution $[pk_a(NH_4^+) = 9.26]$ is
(A) 0.05 mole (B) 0.025 mole
(C) 0.10 mole (D) 0.005 mole

18. Consider the following equilibria:

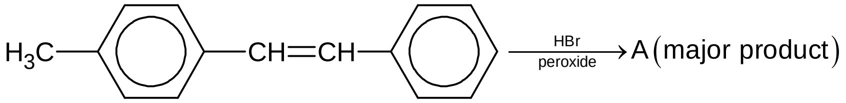
$$CH_3COOH + H_2O \rightleftharpoons H_3O^+ + CH_3COO^-$$

$$H_2SO_4 + CH_3COOH \rightleftharpoons CH_3COOH_2^+ + HSO_4^-$$

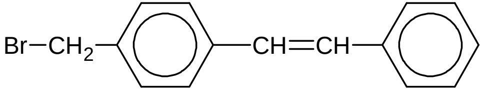
$$H_2SO_4 + HNO_3 \rightleftharpoons [H_2NO_3]^+ + HSO_4^-$$

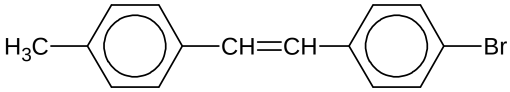
$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

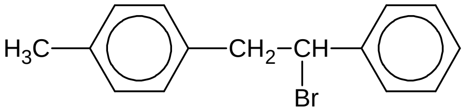
and, now select the incorrect statement among the following
(A) H_2SO_4 is a stronger acid than HNO_3
(B) NH_4^+ is a weaker acid than H_3O^+
(C) acetic acid is stronger acid than H_2O
(D) H_2O is a weaker acid than H_2SO_4 and HNO_3 both

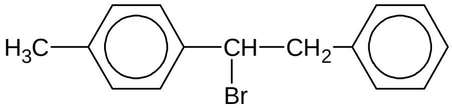
19.


Hence the major product (A) in the reaction is

(A)


(B)


(C)


(D)


Space for rough work

20. An inorganic compound (X) on hydrolysis produces a gas which on treatment with sodium followed by its reaction with ethyl chloride gives another compound (Y). Compound (Y) on heating with P – 2 catalyst gives (2Z) – pent – 2 – ene as major product. Hence the inorganic compound (X) is

(A) Tl_4C	(B) BaC_2
(C) SiC	(D) Mg_2C_3

21. Which of the following metal reacts most vigorously with water?

(A) Li	(B) Na
(C) K	(D) Be

22. Boron trichloride on heating with ammonium chloride at 140°C gives a compound (A) which on reduction with sodium borohydride followed by hydrolysis gives another compound (B). Hence compound (A) and (B) are respectively.

(A) inorganic graphite & ammonia	(B) inorganic benzene & orthoboric acid
(C) trichloroborazine & orthoboric acid	(D) diborane & orthoboric acid

23. (S) – 2 – chloropentane on reaction with Cl_2 (g) in the presence of U.V. light, gives 'N' number of optically active dichloro derivatives. Hence the value of N is

(A) 5	(B) 6
(C) 7	(D) 4

24. Which of the following statement regarding keto - enol forms of acetone and ethyl actoacetate is correct?
(A) both are more stable in enol form than in keto form
(B) both are more stable in keto form than in enol form
(C) acetone is more stable in keto form whereas enol form is more stable in ethyl acetoacetate
(D) acetone is more stable in enol form whereas keto form is more stable in ethyl actacetate

25. 3 mole of KIO_3, 4 mole of KI and 5 mole of HCl are allowed to react according to the equation given below:

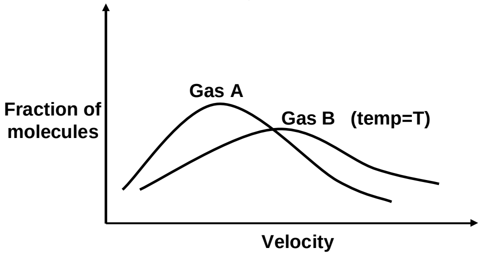
$$KIO_3 + 2KI + 6HCl \longrightarrow 3ICl + 3KCl + 3H_2O$$

The number of moles of products are

(A) 27	(B) 18
(C) 7.5	(D) 9.5

Space for rough work

26. Which of the following statement is incorrect for the given graph?



(A) The molecular weight of gas A will be greater than gas B
(B) The average kinetic energy of both the gases will be similar at a particular temperature
(C) The average velocity of particles of gas A will always be less than of particles of gas B at temperature T.
(D) The velocity of any particle of gas A can not be greater than velocity of any particle of gas B at same temperature.

27. A water sample is found to have 384 ppm of SO_4^{2-}. What will be the degree of hardness of water sample?

(A) 200 ppm
(B) 300 ppm
(C) 400 ppm
(D) 100 ppm

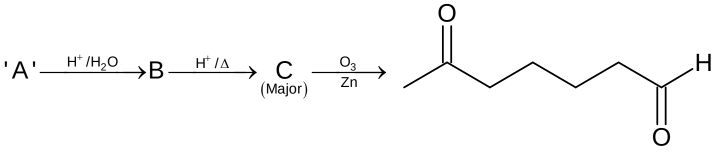
28. How many structural isomers are possible with molecular formula C_7H_{16}?

(A) 6
(B) 8
(C) 10
(D) 12

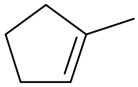
29. Which of the following is mismatched?

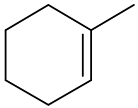
(A) $LiCO_3 \Rightarrow$ least stable carbonate among alkali metal carbonates.
(B) LiF $\Rightarrow$ almost insoluble in water due to its high covalent character.
(C) $Ba(OH)_2 \Rightarrow$ most soluble hydroxide among alkaline earth metal hydroxide.
(D) $BeSO_4 \Rightarrow$ more soluble than $BaSO_4$ in water.

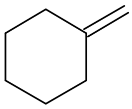
30.

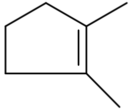


(A) and (C) are isomers.
Which of the following can be structure of (A)?

(A)


(B)


(C)


(D)


Mathematics PART – III

SECTION – A

Straight Objective Type

*This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.*

---

1. If the circle $x^2 + y^2 + 2gx + 2fy + c = 0$ is touched by $y = x$ at P such that OP = $6\sqrt{2}$, where O is the origin, then the value of c is
(A) 36 (B) 144
(C) 72 (D) none of these

2. If α is the nth root of unity, then $1 + 2\alpha + 3\alpha^2 + ...$ to n terms is equal to
(A) $-\frac{n}{(1-\alpha)^2}$ (B) $-\frac{n}{1-\alpha}$
(C) $-\frac{2n}{1-\alpha}$ (D) $-\frac{2n}{(1-\alpha)^2}$

3. If $(3 + x^{2008} + x^{2009})^{2010} = a_0 + a_1x + a_2x^2 + ... + a_nx^n$, then the value of
$a_0 - \frac{1}{2}a_1 - \frac{1}{2}a_2 + a_3 - \frac{1}{2}a_4 - \frac{1}{2}a_5 + a_6 - .....$ is
(A) 3^{2010} (B) 1
(C) 2^{2010} (D) none of these

4. Total number of words that can be formed using all letters of the word 'BRIJESH' that neither begins with 'I' nor ends with 'B' is equal to
(A) 3720 (B) 4920
(C) 3600 (D) 4800

5. If $\cos^2 A + \cos^2 B + \cos^2 C = 1$, then ΔABC is
(A) equilateral (B) isosceles
(C) right angled (D) none of these

Space for rough work

6. In triangle ABC, $\angle A = \frac{\pi}{2}$, then $\tan\left(\frac{C}{2}\right)$ is equal to

(A) $\frac{a-c}{2b}$ (B) $\frac{a-b}{2c}$

(C) $\frac{a-c}{b}$ (D) $\frac{a-b}{c}$

7. For the equation $\cos^{-1} x + \cos^{-1} 2x + \pi = 0$, the number of real solution is

(A) 1 (B) 2

(C) 0 (D) ∞

8. Let A ≡ (3, –4), B ≡ (1, 2), let P ≡ (2k – 1, 2k + 1) be a variable point such that PA + PB is minimum. Then k is

(A) $\frac{7}{9}$ (B) 0

(C) $\frac{7}{8}$ (D) none of these

9. If x, 2y, 3z are in A.P., where the distinct numbers x, y, z are in G.P., then the common ratio of the G.P. is

(A) 3 (B) $\frac{1}{3}$

(C) 2 (D) $\frac{1}{2}$

10. If $|z^2 - 3| = 3|z|$ then the maximum value of |z| is

(A) 1 (B) $\frac{3+\sqrt{21}}{2}$

(C) $\frac{\sqrt{21}-3}{2}$ (D) none of these

Space for rough work

11. Total number of values of a so that $x^2 - x - a = 0$ has integral roots, where $a \in N$ and $6 \le a \le 100$, is equal to
(A) 2
(B) 4
(C) 6
(D) 8

12. If normals are drawn from a point P(h, k) to the parabola $y^2 = 4ax$, then the sum of the intercepts which the normals cut off from the axis of the parabola is
(A) h + a
(B) 3(h + a)
(C) 2(h + a)
(D) none of these

13. The eccentric angle of a point on the ellipse $\frac{x^2}{4}+\frac{y^2}{3}=1$ at a distance of $\frac{5}{4}$ units from the focus on the positive x–axis, is
(A) $\cos^{-1}\left(\frac{3}{4}\right)$
(B) $\pi-\cos^{-1}\left(\frac{3}{4}\right)$
(C) $\pi+\cos^{-1}\left(\frac{3}{4}\right)$
(D) none of these

14. The eccentricity of the conic represented by $x^2 - y^2 - 4x + 4y + 16 = 0$ is
(A) 1
(B) $\sqrt{2}$
(C) 2
(D) $\frac{1}{2}$

15. If centre of a regular hexagon is at origin and one of the vertices on Argand diagram is 1 + 2i, then its perimeter is
(A) $2\sqrt{5}$
(B) $6\sqrt{2}$
(C) $4\sqrt{5}$
(D) $6\sqrt{5}$

16. The number of even divisors of the number N = 12600 is
(A) 72
(B) 54
(C) 18
(D) none of these

17. If x, y, z are in G.P. and $a^x = b^y = c^z$, then
(A) $\log_b a = \log_a c$
(B) $\log_c b = \log_a c$
(C) $\log_b a = \log_c b$
(D) none of these

Space for rough work

18. Consider the ten numbers ar, ar^2, ar^3, ..., ar^{10}. If their sum is 18 and the sum of their reciprocals is 6 then the product of these ten numbers, is
(A) 81 (B) 243
(C) 343 (D) 324

19. The value of m for which one of the roots of $x^2 - 3x + 2m = 0$ is double of one of the roots of $x^2 - x + m = 0$ is
(A) –2 (B) 1
(C) 2 (D) none of these

20. $x^2 - xy + y^2 - 4x - 4y + 16 = 0$ represents
(A) a point (B) a circle
(C) a pair of straight lines (D) none of these

21. The value of $\frac{1+2\log_3 2}{(1+\log_3 2)^2} + (\log_6 2)^2$ is
(A) 2 (B) 3
(C) 4 (D) 1

22. $\frac{\sin 3\theta + \sin 5\theta + \sin 7\theta + \sin 9\theta}{\cos 3\theta + \cos 5\theta + \cos 7\theta + \cos 9\theta}$ is equal to
(A) tan 3θ (B) cot 3θ
(C) tan 6θ (D) cot 6θ

23. If in a triangle, $\left(1-\frac{r_1}{r_2}\right)\left(1-\frac{r_1}{r_3}\right) = 2$, then the triangle is
(A) right angled (B) isosceles
(C) equilateral (D) none of these

24. $\tan^{-1}\left(\frac{x}{y}\right) - \tan^{-1}\left(\frac{x-y}{x+y}\right)$ is
(A) $\frac{\pi}{2}$ (B) $\frac{\pi}{3}$
(C) $\frac{\pi}{4}$ (D) $\frac{\pi}{4}$ or $-\frac{3\pi}{4}$

Space for rough work

25. The circle $x^2 + y^2 + 2\lambda x = 0$, $\lambda \in R$, touches the parabola $y^2 = 4x$ externally. Then

(A) $\lambda > 0$ (B) $\lambda < 0$

(C) $\lambda > 1$ (D) none of these

26. In a triangle ABC, $A \equiv (\alpha, \beta)$, $B \equiv (2, 3)$ and $C \equiv (1, 3)$ and point A lies on line $y = 2x + 3$ where $\alpha \in I$. Area of ΔABC, Δ, is such that $[\Delta] = 5$. Possible coordinates of A are (where [.] denotes the greatest integer function)

(A) (2, 3) (B) (5, 13)

(C) (–5, –7) (D) (–3, –5)

27. Sum of common roots of the equations $z^3 + 2z^2 + 2z + 1 = 0$ and $z^{1985} + z^{100} + 1 = 0$ is

(A) –1 (B) 1

(C) 0 (D) none of these

28. The last two digits of the number 3^{400} are

(A) 81 (B) 43

(C) 29 (D) 01

29. If t_n denotes the nth term of the series 2 + 3 + 6 + 11 + 18 + ….. then t_{50} is

(A) $49^2 - 1$ (B) 49^2

(C) $50^2 + 1$ (D) $49^2 + 2$

30. Number of ways in which Rs. 18 can be distributed amongst four persons such that no body receives less than Rs. 3 is

(A) 126 (B) 84

(C) 4! (D) none of these

Space for rough work

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014: 2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

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(Main)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	D	C
2.	A	B	B
3.	A	B	C
4.	D	B	A
5.	B	C	C
6.	A	C	D
7.	B	C	C
8.	D	D	C
9.	D	B	B
10.	D	D	B
11.	B	C	D
12.	C	A	C
13.	D	C	A
14.	D	C	B
15.	A	B	D
16.	B	C	B
17.	C	B	C
18.	C	B	B
19.	C	C	A
20.	C	D	A
21.	B	C	D
22.	A	C	C
23.	C	A	A
24.	B	C	C
25.	C	C	A
26.	D	D	B
27.	D	C	A
28.	A	B	D
29.	D	B	D
30.	B	C	B

Physics

PART – I

SECTION – A

1. In sliding maximum friction will act where as in rolling static friction will act.

2. Conservation of angular momentum

$$mv\ell = \left(\frac{m\ell^2}{3} + m\ell^2\right)\omega \qquad (1)$$

conservation of energy

$$-mg\frac{\ell}{2} - mg\ell + \frac{1}{2}\left(\frac{m\ell^2}{3} + m\ell^2\right)\omega^2 = mg\frac{\ell}{2} + mg\ell \qquad (2)$$

$$\Rightarrow \quad v = \sqrt{8g\ell}$$

3. Apply conservation of angular momentum.

4. Cheek the distribution of mass about the three axis.

5. $I = \frac{m\ell^2}{3}$, $I' = \left[\frac{1}{12}\left(\frac{m}{2}\right)\left(\frac{\ell}{2}\right)^2 + \frac{m}{2}\left(\frac{5\ell^2}{16}\right)\right] + \frac{1}{3}\left(\frac{m}{2}\right)\left(\frac{\ell}{2}\right)^2 = \frac{5}{8}I$

6. acceleration a = g/2

velocity after 1 sec $v = \frac{g}{2} \times 1 = \frac{g}{2}$ m/s

the string will given become taut when $\frac{g}{2}t = \frac{1}{2}gt^2$

$\Rightarrow$ t = 1 sec.

7. $V_{m/M} = V_M \qquad (1)$

$V_m^2 = V_{m/M}^2 + V_M^2 + 2V_{m/M}V_M\cos120°$

$\Rightarrow \quad V_m / V_M = 1$

8. $a = \frac{\text{spring force} - mg}{m_1} = \frac{m_2 g - m_1 g}{m_1}$

9. From the graph it can be concluded that both S_1 & S_2 are accelerated frame or either S_1 or S_2 is accelerated.

10. The tension in the string is zero and block is falling freely.

11. Conservation of linear momentum

mu = (M + m)V $\Rightarrow$ $V = \frac{mu}{M+m}$

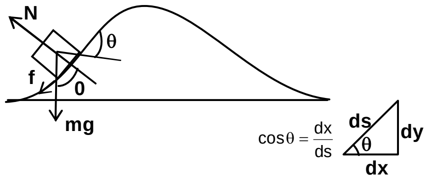
12. Using conservation of energy and $F = \frac{mu}{M+m}$

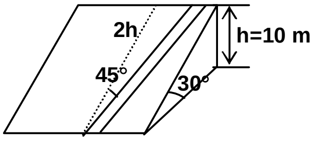
14. Angular velocity and angular acceleration are parallel or antiparallel in a circular motion.

16. Displacement time curve will be a parabola.

17. Work done by friction $= \int \vec{F}\cdot\overrightarrow{ds} = \int_0^x \mu mg\cos\theta\frac{dx}{\cos\theta}$

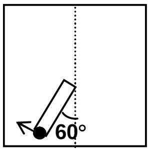
$= \mu mg\,x = 20$ J





18. $\ell = 2\sqrt{2}\,h = \frac{1}{2}\left(g\sin 30^\circ \cos 45^\circ\right)t^2$

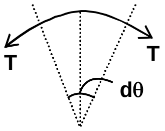
t = 4 sec.



19. Conservation of energy $\frac{1}{2}mv^2 - mg\frac{\ell}{2} = mg\frac{\ell}{2} + m\sqrt{3}\left(2\ell\frac{\sqrt{3}}{2}\right)$

$v = \sqrt{8g\ell}$

20. $s = \left[\int_0^3 (3-t)\,dt + \int_3^5 (t-3)\,dt\right] = 6.5\,m$



22. $2T\sin\frac{d\theta}{2} = dmR\omega^2$

$T = \frac{m}{2\pi}R\omega^2$

23. OA → acceleration is positive
AB → acceleration zero
BCD → velocity is decreasing i.e. acceleration is negative

24. for cylinder $V_c = V_0 - \mu gt$ (1)

$\omega = 0 + \frac{2\mu g}{R}t$ (2)

for plank $V_P = \frac{V_0}{2} + \mu gt$ (3)

$V_P = V_C - R\omega$ (4)

$\Rightarrow \quad V_C = \frac{7}{8}V_0$

25. Apply work energy theorem to calculate work done by friction

26. conservation of momentum

$M\sqrt{2gh} - m\sqrt{2gh} = MV_1 + mV_2$ ...(1)

$-1 = \frac{V_1 - V_2}{2\sqrt{2gh}}$ ...(2)

$V_2 = 3\sqrt{2gh}$

$h' = \frac{V_2^2}{2g} = 9h$

28. The particle will leave contact at the same point if $mg - N \le \frac{mv^2}{R}$

i.e N = 0; for $v \ge \sqrt{gR}$

30. apply work-energy theorem

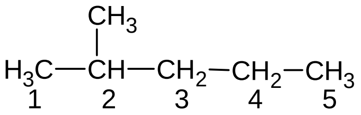
$$mgz - \left[\frac{1}{2}K\left(\frac{mg}{K} + z\right)^2 - \frac{1}{2}K\left(\frac{mg}{K}\right)^2\right] + Fz = 0$$

$\Rightarrow$ z = 2F/K.

Chemistry PART – II

SECTION – A

1.



$$H_3C-\overset{\overset{\large CH_3}{|}}{CH}-CH_2-CH_2-CH_3$$

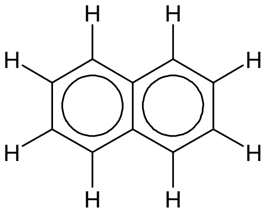
Iso hexane has 5 type of H for substitution in which C–1, C–3 & C–4 will form optically active compound on mono chlorination.

2. $N_2 + 3H_2 \rightleftharpoons 2NH_3$

$$K_c = \frac{\left(\eta_{NH_3}/V\right)^2}{\left(\eta_{N_2}/V\right)\left(\eta_{H_2}/V\right)^3} = \frac{\left(\eta_{NH_3}\right)^2}{\left(\eta_{N_2}\right)\left(\eta_{H_2}\right)^3}V^2$$

3. $[N_2O_5] = \frac{\text{Rate}}{K} = \frac{2.4\times10^{-5}}{6\times10^{-5}} = 0.4 \text{ mol L}^{-1}$

6.



7. $x_2 = \frac{n_2}{n_1 + n_2}$

Mass of solution = $n_1M_1 + n_2M_2$

Volume of solution = $\frac{\left(n_1M_1 + n_2M_2\right)}{\rho}$

$$M = \frac{n_2}{V} = \frac{n_2}{\left(n_1M_1 + n_2M_2\right)\rho} = \frac{x_2}{x_1M_1 + x_2M_2}$$

8. $r \propto \frac{1}{\sqrt{M}}$

$M_{CO_2} = M_{N_2O}$

9. $MX_2 \rightleftharpoons \underset{s}{M^{2+}} + \underset{2s}{2X^-}$

$K_{sp} = 4 \times 10^{-6} = 4s^3$
$s = 10^{-2}$ mol/lit
$s = 200 \times 10^{-2}$ g/L = 2g/lit

12. $Mn^{2+} = 3d^54s^0$
$Fe^{2+} = 3d^64s^0$
$Co^{2+} = 3d^74s^0$
$Ni^{2+} = 3d^84s^0$

$$2SO_2(g)+O_2(g) \rightleftharpoons 2SO_3(g)$$

13. Initial mol. 2 1 0

Eq. conc. $\frac{(2-2x)}{2}$ $\frac{(1-x)}{2}$ $\frac{2x}{2}$

$K_2Cr_2O_7$ oxides, SO_2 remaining of equilibrium, Hence
Equivalent of SO_2 left = equivalents of $K_2Cr_2O_7$ used
(2 – 2x) × 2 = (0.2 × 0.1 ×6)
This gives, $x \approx 0.97$

$$\text{Now, } K=\frac{\left(\frac{2x}{2}\right)^2}{\left(\frac{2-2x}{2}\right)^2\times\left(\frac{1-x}{2}\right)}\approx 6.96\times10^4$$

Hence (C) is correct.

14. Number of radial node in 3p orbital = 3 – 1 – 1 = 1 is its radial probability curve will meet the x – axis only at one point and this is the case in curve (A) and (C) is either for 3p or 2s orbital. Also, as the shell number increases, the distance of maximum probability increases from the nucleus. Hence (C) is correct.

15. In, SO_3^{2-}, S has 3 bond pairs and one lone pair and hence, it is pyramidal in shape not tetrahedral. Hence (B) is correct.

16. (A). Three possible spin quantum number means an orbital can have at the most three electrons.
So 4th period involves,
3s,3d and 4p subshells.
So, maximum of electrons (and hence elements) = $4s^3 3d^{15} 4p^9$ = 3 + 15 + 9 = 27
(B). All elements of VIIIth group (i.e. 8, 9, 10 groups) are called typical transition metals. Pt also belongs to 10th group. So it is a typical transition metal.
(C). E.C. of Gd (64) = $[Xe]4f^7 5d^1 6s^2$
So number of f – electrons = 7
(D). Due to ineffective shielding by 3d – electrons in Ga, size of Ga is smaller (almost equal) to that of Al.
Hence (C) is correct.

17. A mixture of NH_4OH and $(NH_4)_2SO_4$ is a basic buffer.

$$pOH = pk_b + \log\frac{(NH_4^+)}{(NH_4OH)}$$

$p^K{}_b$ (NH_4OH) = 14 – 9.26 = 4.74
pOH = 14 – 8.26 = 5.74
Let, moles of $(NH_4)_2SO_4$ to be added = x

$$5.74 = 4.74 + \log\frac{2x}{5\times10^{-3}}$$

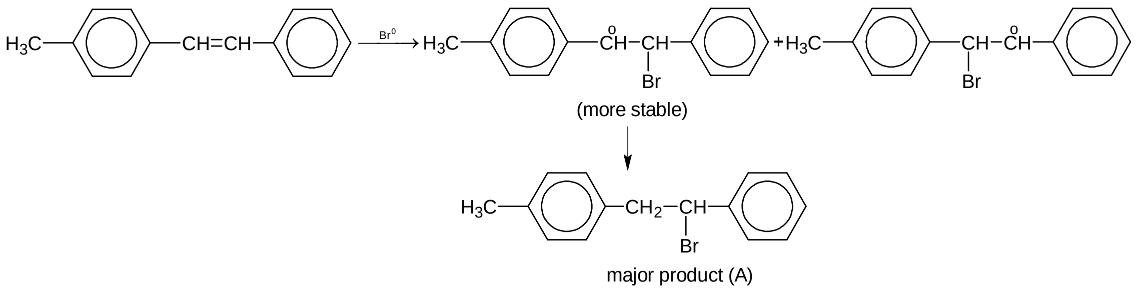
$\therefore$ x = 0.025 mole
Hence (B) is correct.

18. The following equilibrium shows that

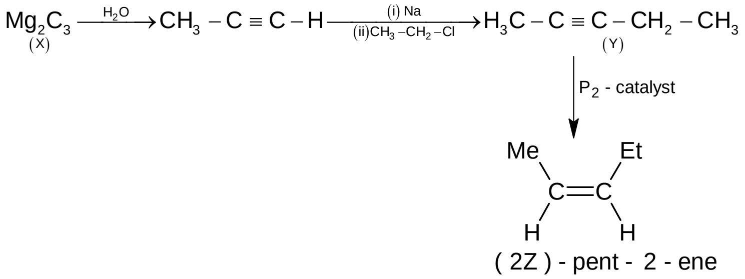
$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

So, NH_4^+ is a stronger acid than H_3O^+.
Hence (B) is correct.

19. It is a case of free radical addition to C = C bond.


H3C
CH=CH
Br0
H3C
CH–CH
Br
+H3C
CH–CH
Br
(more stable)
H3C
CH2–CH
Br
major product (A)

20.

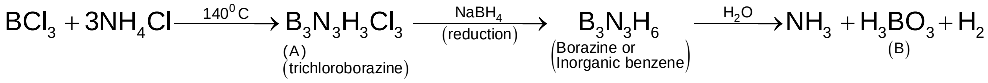

P2 - catalyst
Me
Et
C=C
H
H
(2Z) - pent - 2 - ene

$$\underset{(X)}{Mg_2C_3} \xrightarrow{H_2O} CH_3-C\equiv C-H \xrightarrow[(ii)CH_3-CH_2-Cl]{(i)\ Na} \underset{(Y)}{H_3C-C\equiv C-CH_2-CH_3}$$

Hence (D) is correct.

21. Since melting point of K is least among all, so heat released in the reaction immediately melts its surface and catches fire.
Hence (C) is correct.

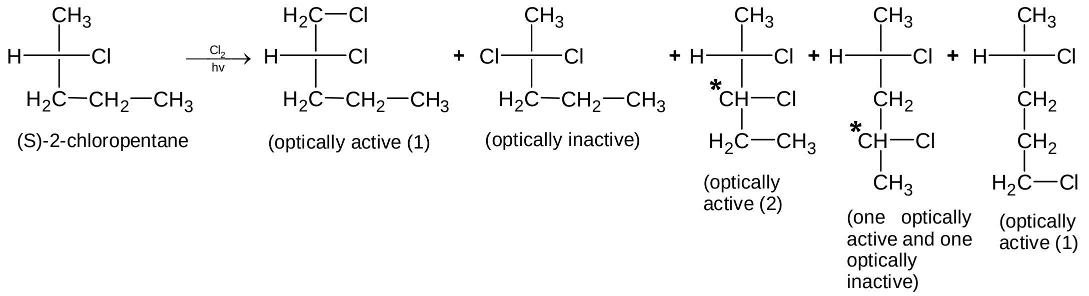
22.



$$BCl_3 + 3NH_4Cl \xrightarrow{140^0 C} \underset{\substack{(A)\\(\text{trichloroborazine})}}{B_3N_3H_3Cl_3} \xrightarrow[(\text{reduction})]{NaBH_4} \underset{\substack{(\text{Borazine or}\\ \text{Inorganic benzene})}}{B_3N_3H_6} \xrightarrow{H_2O} NH_3 + \underset{(B)}{H_3BO_3} + H_2$$

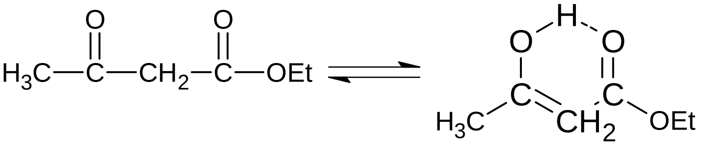
Hence (C) is correct.

23.


CH3
H
Cl
H2C—CH2—CH3
(S)-2-chloropentane
Cl2
hv
H2C—Cl
H
Cl
H2C—CH2—CH3
(optically active (1)
+
CH3
Cl
Cl
H2C—CH2—CH3
(optically inactive)
+ H
CH3
Cl
*CH—Cl
H2C—CH3
(optically active (2)
+ H
CH3
Cl
CH2
*CH—Cl
CH3
(one optically active and one optically inactive)
+ H
CH3
Cl
CH2
CH2
H2C—Cl
(optically active (1)

Hence (A) is correct.

24. Stability due to H – boding is present in ethyl acetoacetate.

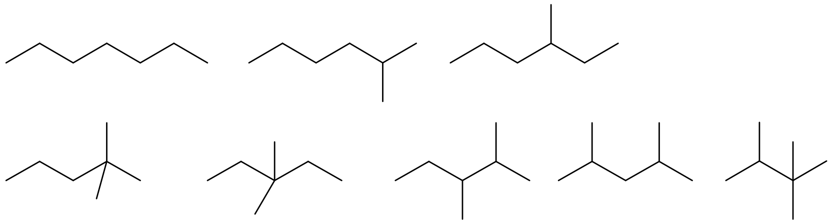

O
O
H3C—C—CH2—C—OEt
H
O
O
C
C
H3C
CH2
OEt

25. The limiting reagent here is HCl. So calculating with the limiting reagent, the total number of produces is 7.5.

26. It may be possible that few particles of gas A have higher velocities than that of few particles of gas B.

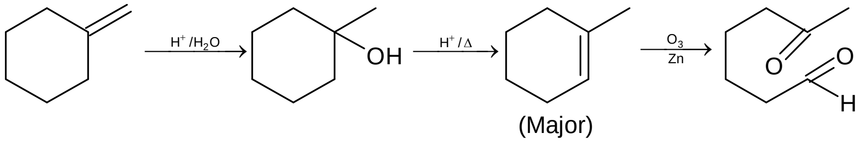
27. 96 ppm of SO_4^{2-} = 100 ppm of $CaCO_3$ so 384 ppm of SO_4^{2-} = 400 ppm of $CaCO_3$.

28.



29. LiF is insoluble in water but not because of its covalent character rather its high lattice energy which is not easily compensated by its hydration energy.

30.



Mathematics PART – III

SECTION – A

1. Here, $P \equiv (6, 6)$
It lies on the circle, thus $72 + 12(g + f) + c = 0$ ..... (1)
Since $y = x$ touches the circle, hence $(g + f)^2 = 2c$ ..... (2)
Solving (1) and (2), $c = 72$

2. Let, $S = 1 + 2\alpha + 3\alpha^2 + ... + n\alpha^{n-1}$
$\Rightarrow \alpha S = \alpha + 2\alpha^2 + 3\alpha^3 + ... + (n-1)\alpha^{n-1} + n\alpha^n$
On subtracting, $S(1 - \alpha) = 1 + [\alpha + \alpha^2 + ... + \alpha^{n-1}] - n\alpha^n$
$\Rightarrow S = -\frac{n}{1-\alpha}$

3. Put $x = \omega, \omega^2$ ..... (1)
$2^{2010} = a_0 + a_1\omega + a_2\omega^2 + ...$ ..... (2)
$2^{2010} = a_0 + a_1\omega^2 + a_2\omega + ...$
Adding (1) and (2) we get, $2 \times 2^{2010} = 2a_0 - a_1 - a_2 + 2a_3 - a_4 - a_5 + 2a_6 - .....$
$\Rightarrow 2^{2010} = a_0 - \frac{1}{2}a_1 - \frac{1}{2}a_2 + a_3 - \frac{1}{2}a_4 - \frac{1}{2}a_5 + a_6 - .....$

4. Total number of required words = 7! – 6! – 6! + 5!

5. $\cos^2 A + \cos^2 B - (1 - \cos^2 C) = 0$
$\cos^2 A + \cos^2 B - \sin^2 C = 0$
$\cos^2 A + \cos(B + C)\cos(B - C) = 0$
$\Rightarrow 2\cos A \cos B \cos C = 0$
Hence, either A or B or C is 90º

6. Here, $a^2 = b^2 + c^2$
$\sin C = \frac{c}{a} = \frac{2\tan\frac{C}{2}}{1+\tan^2\frac{C}{2}}$
$\Rightarrow c\tan^2\frac{C}{2} - 2a\tan\frac{C}{2} + c = 0$
$\Rightarrow \tan\frac{C}{2} = \frac{a \pm b}{c}$
$\therefore \tan\frac{C}{2} = \frac{a-b}{c}$ ($\because$ for $\frac{a+b}{c}$, $C > \frac{\pi}{2}$)

7. $\cos^{-1} x + \cos^{-1} 2x = -\pi$, which is not possible

8. PA + PB is minimum if PA + PB = AB
$$\therefore \begin{vmatrix} 3 & -4 & 1 \\ 1 & 2 & 1 \\ 2k-1 & 2k+1 & 1 \end{vmatrix} = 0$$
$\Rightarrow k = \frac{7}{8}$

9. Here, $y = xr$, $z = xr^2$
Also, x, 2y and 3z are in A.P.
Hence, $4y = x + 3z$
$\Rightarrow 4xr = x + 3xr^2$
$\Rightarrow 3r^2 - 4r + 1 = 0$
$\Rightarrow r = \frac{1}{3}$

10. $|z^2 - 3| \geq |z|^2 - 3$
$3|z| \geq |z|^2 - 3$
$|z|^2 - 3|z| - 3 \leq 0$
$0 < |z| \leq \frac{3+\sqrt{21}}{2}$

11. $x^2 - x - a = 0$, $D = 1 + 4a = \text{odd}$
D must be perfect square of some odd integer
Let $D = (2\lambda + 1)^2$
$\Rightarrow 1 + 4a = 1 + 4\lambda^2 + 4\lambda$
$\Rightarrow a = \lambda(\lambda + 1)$
Now, $a \in [6, 100]$
$\Rightarrow a = 6, 12, 20, 30, 42, 56, 72, 90$

12. Equation of normal $y = mx - 2am - am^3$
Put y = 0, we get $x_1 = 2a + am_1^2$
$x_2 = 2a + am_2^2$
$x_3 = 2a + am_3^2$
The normal passes through (h, k)
$\Rightarrow am^3 + (2a - h)m + k = 0$
$\Rightarrow m_1 + m_2 + m_3 = 0$
$m_1m_2 + m_2m_3 + m_3m_1 = \frac{2a-h}{a}$
$\Rightarrow m_1^2 + m_2^2 + m_3^2 = -\frac{2(2a-h)}{a}$
$\Rightarrow x_1 + x_2 + x_3 = 6a - 2(2a - h) = 2(h + a)$

13. Any point on the ellipse is $(2\cos\theta, \sqrt{3}\sin\theta)$
The focus on the positive x-axis is (1, 0)
Given that $(2\cos\theta - 1)^2 + 3\sin^2\theta = \frac{25}{16}$
$\Rightarrow \cos\theta = \frac{3}{4}$

14. Given curve is $\frac{(x-2)^2}{4^2} - \frac{(y-2)^2}{4^2} = -1$
So, a = b = 4
$\Rightarrow e = \sqrt{2}$

15. Let the vertices be $z_0, z_1, z_2, z_3, z_4, z_5$ w.r.t. centre O at origin and $|z_0| = \sqrt{5}$
Now, ΔOA_2A_3 is equilateral

$\Rightarrow A_2A_3 = \sqrt{5}$

$\Rightarrow$ Perimeter = $6\sqrt{5}$

16. N = 12600 = $2^3 3^2 5^2 7^1$
Number of even divisors = (3)(2 + 1)(2 + 1)(1 + 1) = 54

17. Here, $y^2 = xz$ ..... (1)
Also, $a^x = b^y = c^z = \lambda$ (Say)
$\Rightarrow x = \frac{\log\lambda}{\log a}, \ y = \frac{\log\lambda}{\log b}, \ z = \frac{\log\lambda}{\log c}$
Putting these values in (1), we get $\log_b a = \log_c b$

18. Given $\frac{ar(r^{10}-1)}{r-1} = 18$ ..... (1)
Also, $\frac{\frac{1}{ar}\left(1-\frac{1}{r^{10}}\right)}{1-\frac{1}{r}} = 6$
$\Rightarrow \frac{1}{a^2r^{11}}\frac{ar(r^{10}-1)}{r-1} = 6$ ..... (2)
From equation (1) and (2), we get $\frac{1}{a^2r^{11}}\cdot 18 = 6$
$\Rightarrow a^2r^{11} = 3$
Now, $P = a^{10}r^{53} = 3^5 = 243$

19. Let α be the root of $x^2 - x + m = 0$ and 2α be the root of $x^2 - 3x + 2m = 0$
Then, $\alpha^2 - \alpha + m = 0$ and $4\alpha^2 - 6\alpha + 2m = 0$
Eliminating α, $m^2 = -2m \Rightarrow m = 0, m = -2$

20. Given equation is, $x^2 - (y + 4)x + y^2 - 4y + 16 = 0$
Since x is real, so, $D \geq 0$
$\Rightarrow (y + 4)^2 - 4(y^2 - 4y + 16) \geq 0$
$\Rightarrow (y - 4)^2 \leq 0$
$\Rightarrow y = 4$
Since equation is symmetric in x and y
Hence, x = 4 only

21. $\frac{1+2\log_3 2}{(1+\log_3 2)^2} + \frac{(\log_3 2)^2}{(1+\log_3 2)^2} = 1$

22. $\frac{(\sin 3\theta + \sin 9\theta) + (\sin 5\theta + \sin 7\theta)}{(\cos 3\theta + \cos 9\theta) + (\cos 5\theta + \cos 7\theta)}$
= $\frac{2\sin 6\theta(\cos 3\theta + \cos\theta)}{2\cos 6\theta(\cos 3\theta + \cos\theta)} = \tan 6\theta$

23. $\left(1-\frac{(s-b)}{s-a}\right)\left(1-\frac{(s-c)}{s-a}\right) = 2$
$\Rightarrow a^2 = b^2 + c^2$
Hence, triangle is right angled

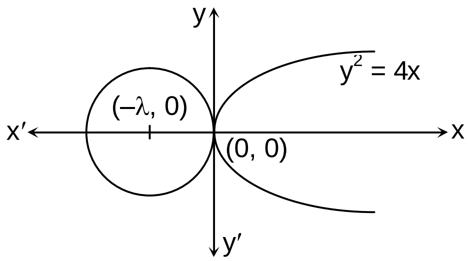
24. $\tan^{-1}\left(\frac{x}{y}\right)-\tan^{-1}\left(\frac{x-y}{x+y}\right)$

$= \tan^{-1}\left(\frac{x}{y}\right)-\tan^{-1}\left(\frac{1-\left(\frac{y}{x}\right)}{1+\left(\frac{y}{x}\right)}\right)$

$= \tan^{-1}\left(\frac{x}{y}\right)-\left(\tan^{-1}1-\tan^{-1}\frac{y}{x}\right)$

$= \tan^{-1}\frac{x}{y}+\tan^{-1}\frac{y}{x}-\frac{\pi}{4}=\frac{\pi}{2}-\frac{\pi}{4}=\frac{\pi}{4}$

25. The graph shows $\lambda > 0$



26. $A \equiv (\alpha, 2\alpha + 3)$, BC = 1 unit. Equation of BC is $y - 3 = 0$
Distance of A from BC is $p = |2\alpha + 3 - 3|$
Area of $\Delta ABC = \Delta = |\alpha|$; $5 \le \Delta < 6$
$\Rightarrow 5 \le |\alpha| < 6$

27. We have, $z^3 + 2z^2 + 2z + 1 = 0$
$\Rightarrow z = -1, \omega, \omega^2$
Since $z = -1$ does not satisfy $z^{1985} + z^{100} + 1 = 0$
While $z = \omega, \omega^2$ satisfy it
Hence, sum $= \omega + \omega^2 = -1$

28. $3^{400} = (81)^{100} = (1 + 80)^{100}$
$= {}^{100}C_0 + {}^{100}C_1 80 + \ldots.. + {}^{100}C_{100} 80^{100}$
$\Rightarrow$ Last two digits are 01

29. $2 + 3 + 6 + 11 + 18 + \ldots.. = (0^2 + 2) + (1^2 + 2) + (2^2 + 2) + (3^2 + 2) + \ldots..$
Hence, $t_{50} = 49^2 + 2$

30. Distribute Rs. 3 to each person
Then, we have to find non–negative integral solution of $y_1 + y_2 + y_3 + y_4 = 6$
Which is given by ${}^{6+4-1}C_{4-1} = {}^9C_3 = 84$

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014: 2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Advanced), 2015**

HALF COURSE TEST –VI

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 243**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-B**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 09)** contains 09 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (10 – 13) contains 4 Assertion-Reasoning (multiple choice questions) which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (14 – 19) contains 2 paragraphs. Based upon paragraph, 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-B (1 – 03)** contains 3 Matrix Match Type (4 × 4 Matrix) questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+6 marks** for all correct answer. There is no negative marking.

Name of the Candidate

Enrolment No.

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10 \text{ m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3 \text{ kg/m}^3$
Atmospheric pressure	$P_a = 10^5 \text{ N/m}^2$
Gas constant	$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
		=	$0.0821 \text{ Lit atm K}^{-1} \text{ mol}^{-1}$
		=	$1.987 \approx 2 \text{ Cal K}^{-1} \text{ mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

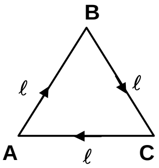
PART – I

SECTION – A

Single Correct Choice Type

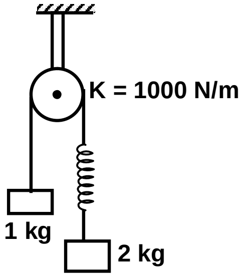
*This section contains **9 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.*

1. A particle moves over the sides of an equilateral triangle of side ℓ with constant speed v as shown in figure. The magnitude of average acceleration as it moves from A to C is



(A) $\frac{v^2}{\ell}$
(B) $\frac{\sqrt{3}}{2}\frac{v^2}{\ell}$
(C) $\frac{\sqrt{3}v^2}{\ell}$
(D) $\frac{v^2}{2\ell}$

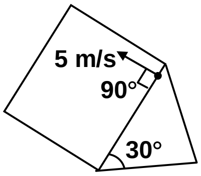
2. In the arrangement shown in the figure pulley is light and smooth. The extension in the spring is (g = 10 m/s^2)



(A) 1.33 cm
(B) 1 cm
(C) 1.67cm
(D) 2 cm

3. A block of mass m is gently placed over a massive plank moving horizontally over a smooth surface with velocity 6 m/s. The coefficient of friction between the block and plank is 0.2. The distance travelled by the block till it stop with respect to the plank is (g = 10 m/s^2)
(A) 4 m
(B) 6 m
(C) 9 m
(D) 12 m

4. A particle is given velocity 5 m/s on a fixed large inclined surface as shown in the figure. The radius of curvature of the path of the particle after 1 sec from the start is about(g = 10 m/s^2)



(A) 7 m
(B) 14 m
(C) 21 m
(D) 28 m

Space for rough work

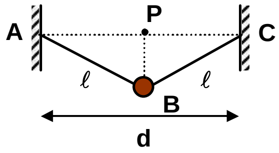
5. A liquid drop at temperature t, isolated from its surrounding breaks into a number of droplets the temperature of the droplets will be
(A) equal to t (B) greater than t
(C) less than t (D) none of these

6. In a mixture of gases, the average number of degree of freedom per molecule is 6. The rms speed of the molecules of the gas is C. The velocity of sound in the gas is
(A) $\frac{C}{\sqrt{2}}$ (B) $\frac{3C}{4}$
(C) $\frac{2C}{3}$ (D) $\frac{C}{\sqrt{3}}$

7. A wall of width ℓ and cross sectional area A is having variable coefficient of thermal conductivity given by $k = k_0 + \alpha x$ (where k_0 and α are positive constant) and x is measured from outer surface of wall. If the temperature of surroundings is T_0°C and the temperature of the room is maintained at T_r °C($T_0 > T_r$). The temperature of the wall at $x = \ell/2$ is (given $\alpha\ell/K_0 = 1$ S.I. unit, $T_0 = 45$°C, and $T_r = 20$°C)
(A) 20°C (B) 25°C
(C) 28°C (D) 30.37°C

8. A particle of mass 2 kg is moving with a uniform speed of $3\sqrt{2}$ m/s in XY plane along the line y = (x + 4)m. The magnitude of the angular momentum about origin is
(A) zero (B) 24 kgm^2/sec
(C) 30 kgm^2/sec (D) 35 kgm^2/sec

9. A bob of mass m is in equilibrium with the help of two inextensible string connected to fixed support. The bob is slightly displaced perpendicular to the plane of figure and released. The time period of oscillation of bob is



(A) $2\pi\sqrt{\frac{\ell}{g}}$ (B) $2\pi\sqrt{\frac{d}{g}}$
(C) $2\pi\sqrt{\frac{\ell + d}{g}}$ (D) $2\pi\sqrt{\frac{(\sqrt{4\ell^2 - d^2})}{2g}}$

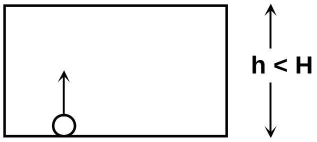
Space for rough work

Assertion - Reason Type

*This section contains 4 questions numbered 10 to 13. Each question contains STATEMENT – 1 (Assertion) and STATEMENT -2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.*

---

10. STATEMENT-1: A ball is projected upwards with such a velocity so as to reach to a height H. Collision of ball with ground is elastic. There is a roof at height h < H. Whatever may be the value of h and e (the coefficient of restitution between the roof and ball), the ball will definitely collide with the roof for second time provided $e \neq 0$.



because

STATEMENT-2: Magnitude of velocity will not change by the collision with ground.

(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

11. STATEMENT-1: Radius of circular orbit of a satellite is made two times, then its areal velocity will also becomes two times.

because

STATEMENT-2: Areal velocity is given as $\frac{dA}{dt} = \frac{L}{2m} = \frac{mvr}{2m}$.

(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

Space for rough work

12. STATEMENT-1: If a particle is projected from the ground with some velocity (not very large) at an angle with horizontal, path of the particle is assumed parabolic, although it is not exactly parabolic.

because
STATEMENT-2: Magnitude of acceleration due to gravity at all places is assumed to be the constant, although it is not so.

(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

13. STATEMENT-1: The two bodies of masses M and m (M > m) are allowed to fall from the same height. If the air resistance for each be the same then both the bodies will reach the earth simultaneously.

because
STATEMENT-2: For same air resistance, acceleration of both the bodies will be different.
(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

Space for rough work

Linked Comprehension Type

This section contains 2 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which ***ONLY ONE*** *is correct.*

Paragraph for Question Nos. 14 to 16

The air column in a pipe closed at one end is made to vibrate in its third over tone by tuning fork of frequency 220 Hz. The speed of sound in air is 330 m/sec. End correction may be neglected. Let P_0 denote the mean pressure at any point in the pipe and ΔP_0 the maximum amplitude of pressure vibration.

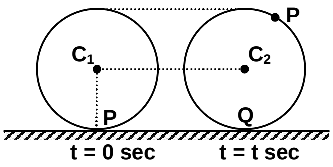
14. Find the length of the air column
(A) 3.2 m (B) 2.625 m
(C) 4.23 m (D) 1.16 m

15. What is the amplitude of pressure variation at the middle of the column
(A) $\frac{\Delta P_0}{\sqrt{2}}$ (B) $\frac{\sqrt{3}\Delta P_0}{2}$
(C) ΔP_0 (D) $\frac{\Delta P_0}{2}$

16. What is the maximum pressure at the open end of the pipe?
(A) P_0 (B) $P_0 + \Delta P_0$
(C) $P_0 + \frac{P_0}{2}$ (D) none of these

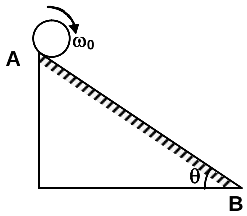
Space for rough work

Paragraph for Question Nos. 17 to 19



Rolling motion can be considered as superposition of pure translation and pure rotation about centre of mass of a body of uniform density. Rolling without slipping is a special case of rolling, in which the distance travelled by centre of mass of body of uniform density is equal to the distance travelled by point of contact on body of uniform density [say P] in a given time interval.

If $C_1C_2 = \overset{\frown}{PQ}$ $\Rightarrow$ Rolling without slipping, and if $C_1C_2 \neq \overset{\frown}{PQ}$ $\Rightarrow$ Rolling with slipping



Hence if velocity and tangential acceleration of point P with respect to surface must be zero but point P has a total acceleration in case of rolling without slipping. The rolling without slipping can also be viewed as a pure rotation about an axis passing through the point of contact and perpendicular to plane of motion, called "Instantaneous axis of rotation

A disc having radius R and mass M is placed gently on rough inclined surface as shown in the figure. Disc rolls down and comes to B in time t after placing at A. If AB is ℓ and ω_0 is the angular velocity of disc in clockwise direction just before placing it at A (Assume that the friction is sufficient to provide pure rolling to the disc for the given length of inclined plane).

17. A body performing rolling with slipping then
    (A) the radial velocity of point of contact of body relative surface is zero
    (B) the tangential velocity of point of contact of body relative to surface is zero
    (C) the net velocity of point of contact of body relative to surface is zero
    (D) none of the above

18. The nature of rolling of disc during motion from A to B is
    (A) Rolling with slipping
    (B) rolling without slipping
    (C) some time (A) sometime (B)
    (D) can't say

19. Work done by frictional force during time interval t is
    (A) zero
    (B) positive
    (C) Negative
    (D) none of the above

Space for rough work

SECTION – B

(Matching List Type)

This section contains **3 multiple choice questions.** Each question has matching Column(s). The codes for the Column(s) have choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. Match the processes in column I with the possibilities in column II, where ΔQ and W are heat change and work done respectively.

Column A	**Column B**
(A) Isobaric	(p) $\Delta Q > O$
(B) Isothermal	(q) $\Delta Q < O$
(C) Isochoric	(r) $W > O$
(D) Adiabatic	(s) $W < O$

Space for rough work

2. If the position vector of a particle at point P moving in space and distance traveled from a fixed point on the path are given by $\vec{r}$ and s respectively. Three vectors are defined as follows

$$\vec{N} = \frac{d\vec{r}}{ds}, \quad \vec{T} = R\frac{d\vec{N}}{ds} \text{ and } \vec{B} = \vec{N} \times \vec{T}$$

where R is the radius of curvature at point P and $\vec{r}$ is a non-zero vector. Now match the following on the basis of above concept

Column A	Column B
(A) $\vec{T}$	(p) Unit vector
(B) $\vec{N}$	(q) Zero
(C) $\vec{N}\cdot\vec{T}$	(r) $\hat{v}$ (unit vector along the direction of velocity)
(D) $\vec{B}$	(s) $\frac{v\vec{a} - \vec{v}\,a_T}{\lvert\vec{v}\times\vec{a}\rvert}$, where $\vec{a}$ and a_T are acceleration and magnitude of tangential acceleration of particle P.

3. Match the following.

Column – A	Column – B
(A) Equation of continuity (Av = constant)	(p) non-viscous flow
(B) Bernoulli’s equation	(q) steady flow
(C) Velocity at a given point is constant with time.	(r) incompressible flow
(D) Ideal flow	(s) irrotational flow

Space for rough work

Chemistry

PART - II

SECTION – A

Single Correct Choice Type

*This section contains **9 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.*

1. Lattice energy of chloride of alkali metals is in order:
(A) LiCl > NaCl > KCl > RbCl > CsCl
(B) LiCl < NaCl < KCl < RbCl < CsCl
(C) NaCl < KCl < LiCl < RbCl > CsCl
(D) NaCl < KCl < RbCl < CsCl > LiCl

2. A ball of mass 200 g is moving with a velocity of 10 m/sec. if the error is the measurement of velocity is 0.1%, then the uncertainty in its position is
(A) 3.3×10^{-31} m
(B) 3.3×10^{-27} m
(C) 5.3×10^{-25} m
(D) 2.6×10^{-32} m

3. Fluorine reacts with uranium to form UF_6:
$U(s) + 3F_2(g) \longrightarrow UF_6(g)$
How many fluorine molecules are required to produce 2 mg of UF_6 from an excess of uranium? (The molar mass of UF_6 is 352 g/mol)
(A) 3.4×10^{18}
(B) 1×10^{19}
(C) 2×10^{19}
(D) 3.4×10^{21}

4. In the disproportion reaction:
$H_3PO_2 \longrightarrow PH_3 + H_3PO_3$
The equivalent mass of H_3PO_2 is (m = molecular mass of H_3PO_2)
(A) $\frac{3m}{4}$
(B) $\frac{3m}{5}$
(C) $\frac{5m}{6}$
(D) $\frac{m}{4}$

Space for rough work

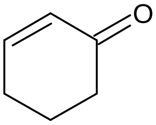
5. For the reaction: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$; $K_p = 6.1\times10^{-5}$ at 25°C. ΔG° for the reaction will be ($\log_{10}61 = 1.78$)

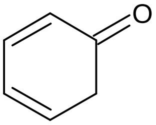
(A) 24 kJ	(B) –24 kJ
(C) –7.3 kJ	(D) 2 kJ

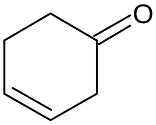
6. A diatomic molecule has a dipole moment of 1.2 D. If the bond length is 1.0×10^{-8} cm, what fraction of charge does exist on each atom?

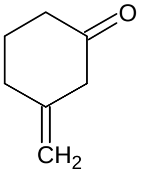
(A) 0.1	(B) 0.2
(C) 0.25	(D) 0.3

7. Which of the following has longest C – O bond?

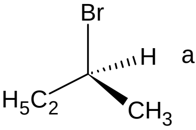
(A)


(B)


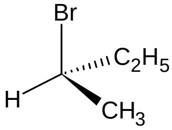
(C)


(D)


8. The given pair is

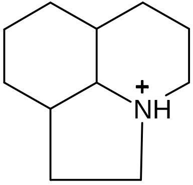


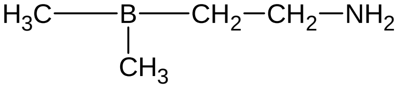
and



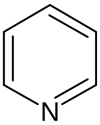
(A) enantiomers	(B) homomers
(C) constitutional isomers	(D) diastereomers

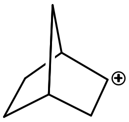
9. Which of the following species will act only as electrophile and not as nucleophile?

(A)


(B)


$H_3C{-}\underset{\displaystyle CH_3}{\underset{|}{B}}{-}CH_2{-}CH_2{-}NH_2$

(C)


(D)


Space for rough work

Assertion - Reason Type

*This section contains 4 questions numbered 10 to 13. Each question contains STATEMENT − 1 (Assertion) and STATEMENT -2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.*

10. STATEMENT-1: In Lother Meyer Curve the alkali elements occupy maxima of the curve.
and
STATEMENT-2: Alkali elements have largest volume in a period.
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

11. STATEMENT-1: Cyclopropane has greater ring strain than cyclobutane ,yet this is readily formed.
and
STATEMENT-2: Formation of four membered ring involves larger decrease in entropy than that of three membered ring.
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

Space for rough work

12. STATEMENT-1: pH of a neutral solution is always equal to $p^{k_w}/2$ at any temperature.

and

STATEMENT-2: A neutral solution at any temperature will have same concentration of $\left[H^+\right]$ and $\left[OH^-\right]$ ion in the expression for K_w.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

13. STATEMENT-1: 0.74g of $Ca(OH)_2$ is required for 10 litre of water to remove temporary hardness of 100 ppm due to $Mg(HCO_3)_2$ (atomic mass: Ca = 40, O = 16, H = 1,Mg = 24, C = 12).

and

STATEMENT-2: Hardness of water is caused due to calcium and magnesium salts of Cl^-, SO_4^{2-} and HCO_3^-.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

Space for rough work

Linked Comprehension Type

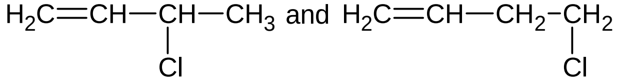
This section contains 2 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which ***ONLY ONE*** *is correct.*

Paragraph for Question Nos. 14 to 16

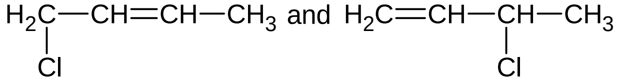
Alkene undergo free radical substitution reaction as it is carried out in the presence of sunlight. Experimentally it is found that relative rate of abstraction of hydrogen atoms from 1°, 2° and 3° carbon atoms are in the ratio 1: 3.8 : 5 during the monobromination while this ratio is 1 ; 82 : 1600 during the monobromination. Alkyl halide undergoes nucleophilic substituton reaction which may be unimolecular or bimolecular depending upon the nature of substrate alkyl halide. Former reaction proceeds via the carbocation intermediate while latter one proceeds via transition state.

14. $CH_2 = CH - CH_2 - CH_3 \xrightarrow{Cl_2/\Delta} (A) + (B)$

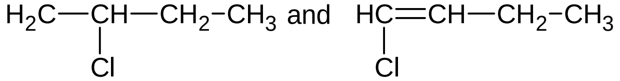
In the given equation (A) and (B) are

(A) 

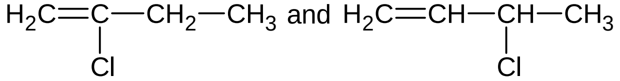
$H_2C{=}CH{-}\underset{\underset{Cl}{|}}{CH}{-}CH_3$ and $H_2C{=}CH{-}CH_2{-}\underset{\underset{Cl}{|}}{CH_2}$

(B 

$H_2\underset{\underset{Cl}{|}}{C}{-}CH{=}CH{-}CH_3$ and $H_2C{=}CH{-}\underset{\underset{Cl}{|}}{CH}{-}CH_3$

(C) 

$H_2C{-}\underset{\underset{Cl}{|}}{CH}{-}CH_2{-}CH_3$ and $H\underset{\underset{Cl}{|}}{C}{=}CH{-}CH_2{-}CH_3$

(D) 

$H_2C{=}\underset{\underset{Cl}{|}}{C}{-}CH_2{-}CH_3$ and $H_2C{=}CH{-}\underset{\underset{Cl}{|}}{CH}{-}CH_3$

15. Predict the product ratio during the monochlorination of 2 – methylbutane?

(A) 9 : 5 : 3	(B) 9 : 5 : 3.8 : 3
(C) 9 : 7.6 : 5	(D) 6 : 3 : 7.6 : 5

16. % isomer of products corresponding to 1° and 3° C – atoms obtained during the monobromination of 2 – methylpropane are

(A) 0.5% and 99.5%	(B) 80% and 20%
(C) 75% and 25%	(D) 15% and 85%

Space for rough work

Paragraph for Question Nos. 17 to 19

Werner Heisenberg stated the uncertainty principle which is the consequence of dual behaviour of matter and radiation. It states that if is impossible to determine simultaneously, the exact position and exact momentum (or velocity) of an electron.
Mathematically, it can be given as the equation:

$$\Delta x \times \Delta p \geq \frac{h}{4\pi}$$

Where Δx is the uncertainty in position and Δp_x (or ΔV_x) is the uncertainty in momentum (or velocity) of the particle.
If the position of the electron known with high degree of accuracy (Δx is small), then the velocity of the electron will be uncertain [$\Delta(V_x)$ is large]. On the other hand, if the velocity of the electron is known precisely [$\Delta(V_x)$ is small], then the position of the electron will be uncertain (Δx will be large). Thus if we carry out some physical measurements on the electron's position or velocity, the outcome will always depict a fuzzy or blue picture.

17. An electron moves around the nucleus in a circle of radius r. Assuming that the uncertainty of the momentum of electron is of the same order as momentum itself, the momentum of the electron would be

(A) $\frac{h}{4\pi r}$ (B) $2\pi hr$
(C) $\frac{h}{2\pi r}$ (D) $4\pi hr$

18. The uncertainty in the velocity of a cricket ball of mass 100 g, when uncertainty in its position is of the order of 1A°, would be

(A) $\geq 5.27 \times 10^{-24} ms^{-1}$ (B) $\geq 2.35 \times 10^{-23} ms^{-1}$
(C) $\geq 3.16 \times 10^{-22} ms^{-1}$ (D) $\geq 8.51 \times 10^{-24} ms^{-1}$

19. If one tries to find the exact location of an electron to an uncertainty of only 10^{-8} m, then uncertainty in velocity, i.e. ΔV would be

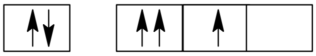
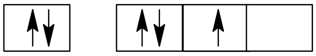
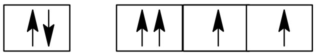
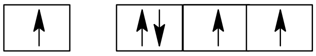
(A) 10^{-4} ms^{-1} (B) 10^{4} ms^{-1}
(C) 10^{-8} ms^{-1} (D) 10^{8} ms^{-1}

Space for rough work

SECTION – B
(Matching List Type)

This section contains **3 multiple choice questions.** Each question has matching Column(s). The codes for the Column(s) have choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

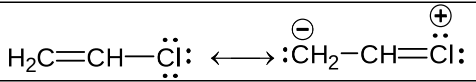
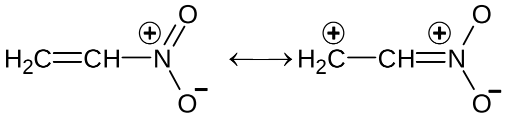
1. Match the electronic configuration listed in Column – II with the descriptions listed in Column – I:

Column – I		Column – II	
(A)	Violation of Aufbau's rule	(p)	
(B)	Violation of Pauli's exclusion principle	(q)	
(C)	Violation of Hund's rule	(r)	
(D)	Violation of both Pauli's and Hund's rules	(s)	

2. Match the following Column – I with Column – II:

Column – I		Column – II	
(A)	C_2	(p)	$\sigma 2p_Z (\pi 2p_x = \pi 2p_y)$
(B)	O_2	(q)	Paramagnetic
(C)	NO^+	(r)	Triple bond
(D)	N_2	(s)	Diamagnetic

3. Match the following Column – I with Column – II:

Column – I		Column – II	
(A)	$H_3C{-}CH{=}CH_2 \longleftrightarrow H\overset{+}{C}H_2{=}CH{-}\overset{-}{CH_2}$	(p)	–I effect
(B)	 $H_2C{=}CH{-}\ddot{\underset{..}{Cl}}: \longleftrightarrow :\overset{\ominus}{C}H_2{-}CH{=}\overset{\oplus}{\ddot{Cl}}:$	(q)	–R effect
(C)		(r)	+R effect
(D)	$\overset{\delta+}{CH_3} \longrightarrow \overset{\delta-}{CN}$	(s)	Hyper conjugation effect

Space for rough work

Mathematics PART – III

SECTION – A

Single Correct Choice Type

This section contains ***9 multiple choice questions****. Each question has four choices (A), (B), (C) and (D) out of which* ***ONLY ONE is correct****.*

1. Consider the sequence 1, 2, 2, 4, 4, 4, 4, 8, 8, 8, 8, 8, 8, 8, 8, ….. then 1025th term will be
(A) 2^9 (B) 2^{11}
(C) 2^{10} (D) 2^{12}

2. A student is allowed to select at most n books from a collection of (2n + 1) books. If the total number of ways in which he can select at least one book is 63, then the value of n is
(A) 2 (B) 3
(C) 4 (D) 5

3. If $|z - 1| \le 2$ and $|\omega z - 1 - \omega^2| = a$ (where ω is cube root of unity) then complete set of values of a is
(A) $0 \le a \le 2$ (B) $\frac{1}{2} \le a \le \frac{\sqrt{3}}{2}$
(C) $\frac{\sqrt{3}}{2} - \frac{1}{2} \le a \le \frac{1}{2} + \frac{\sqrt{3}}{2}$ (D) $0 \le a \le 4$

4. In triangle ABC, a = 5, b = 4 and c = 3. G is the centroid of the triangle. Circumradius of triangle GAB is equal to
(A) $2\sqrt{13}$ (B) $\frac{5}{12}\sqrt{13}$
(C) $\frac{5}{3}\sqrt{13}$ (D) $\frac{3}{2}\sqrt{13}$

Space for rough work

5. If $x \in [-1, 0)$, then $\cos^{-1}(2x^2 - 1) - 2\sin^{-1} x$ is equal to
(A) $-\frac{\pi}{2}$ (B) π
(C) $\frac{3\pi}{2}$ (D) -2π

6. The range of values of α for which the line $2y = gx + \alpha$ is a normal to the circle $x^2 + y^2 + 2gx + 2gy - 2 = 0$ for all values of g is
(A) $[1, \infty)$ (B) $[-1, \infty)$
(C) $(0, 1)$ (D) $(-\infty, 1]$

7. If $y = m_1x + c$ and $y = m_2x + c$ are two tangents to the parabola $y^2 + 4a(x + a) = 0$, then
(A) $m_1 + m_2 = 0$ (B) $1 + m_1 + m_2 = 0$
(C) $m_1m_2 - 1 = 0$ (D) $1 + m_1m_2 = 0$

8. $(x - 1)(y - 2) = 5$ and $(x - 1)^2 + (y + 2)^2 = r^2$ intersect at four points A, B, C, D and if centroid of ΔABC lies on line $y = 3x - 4$, then locus of D is
(A) $y = 3x$ (B) $x^2 + y^2 + 3x + 1 = 0$
(C) $3y = x + 1$ (D) $y = 3x + 1$

9. If roots of an equation $x^n - 1 = 0$ are 1, a_1, a_2, ….., a_{n-1}, then the value of $(1 - a_1)(1 - a_2)(1 - a_3)$ ….. $(1 - a_{n-1})$ will be
(A) n (B) n^2
(C) n^n (D) 0

Assertion - Reason Type

*This section contains 4 questions numbered 10 to 13. Each question contains STATEMENT – 1 (Assertion) and STATEMENT -2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.*

10. STATEMENT 1: 1111 …... 91 times is composite number
STATEMENT 2: 91 is composite number
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1
(C) Statement 1 is true and Statement 2 is false
(D) Statement 1 is false and Statement 2 is true

Space for rough work

11. STATEMENT 1: If n is an odd integer greater than 3 but not a multiple of 3, then $(x + 1)^n - x^n - 1$ is divisible by $x^3 + x^2 + x$
STATEMENT 2: If n is an odd integer greater than 3 but not a multiple of 3, we have $1 + \omega^n + \omega^{2n} = 3$
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1
(C) Statement 1 is true and Statement 2 is false
(D) Statement 1 is false and Statement 2 is true

12. STATEMENT 1: The minimum value of $27^{\cos 2x}81^{\sin 2x}$ is $\frac{1}{243}$
STATEMENT 2: The minimum value of a cos θ + b sin θ is $-\sqrt{a^2+b^2}$
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1
(C) Statement 1 is true and Statement 2 is false
(D) Statement 1 is false and Statement 2 is true

13. STATEMENT 1: The locus of a moving point satisfying $\sqrt{(x+2)^2+y^2}+\sqrt{(x-2)^2+y^2}=4$ is ellipse
STATEMENT 2: Distance between (–2, 0) and (2, 0) is 4
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1
(C) Statement 1 is true and Statement 2 is false
(D) Statement 1 is false and Statement 2 is true

Space for rough work

Linked Comprehension Type

*This section contains 2 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.*

Paragraph for Question Nos. 14 to 16

Read the following write up carefully and answer the following questions:

A(1, 3) and $C\left(-\frac{2}{5}, -\frac{2}{5}\right)$ are the vertices of a triangle ABC and the equation of the internal angle bisector of $\angle ABC$ is $x + y = 2$

14. Equation of side BC is
(A) $7x + 3y - 4 = 0$
(B) $7x + 3y + 4 = 0$
(C) $7x - 3y + 4 = 0$
(D) $7x - 3y - 4 = 0$

15. Co-ordinates of vertex B are
(A) $\left(\frac{3}{10}, \frac{17}{10}\right)$
(B) $\left(\frac{17}{10}, \frac{3}{10}\right)$
(C) $\left(-\frac{5}{2}, \frac{9}{2}\right)$
(D) (1, 1)

16. Equation of side AB is
(A) $3x + 7y = 24$
(B) $3x + 7y + 24 = 0$
(C) $13x + 7y + 8 = 0$
(D) $13x - 7y + 8 = 0$

Space for rough work

Paragraph for Question Nos. 17 to 19

Read the following write up carefully and answer the following questions:
Five balls are to be placed in three boxes. Each box should hold all the five balls so that no box remains empty

17. Number of ways if balls are different but boxes are identical is
(A) 30 (B) 25
(C) 21 (D) 35

18. Number of ways if balls and boxes are identical is
(A) 3 (B) 1
(C) 2 (D) none of these

19. Number of ways if balls as well as boxes are identical but boxes are kept in a row is
(A) 10 (B) 15
(C) 20 (D) 6

SECTION – B

(Matching List Type)

This section contains **3 multiple choice questions.** Each question has matching Column(s). The codes for the Column(s) have choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. Match the following Column–I with Column–II

	Column – I		Column – II
(A)	If a, b, c are in G.P., then $\log_a 10$, $\log_b 10$, $\log_c 10$ are in	(p)	A.P.
(B)	If $\frac{a+be^x}{a-be^x}=\frac{b+ce^x}{b-ce^x}=\frac{c+de^x}{c-de^x}$, then a, b, c, d are in	(q)	H.P.
(C)	If a, b, c are in A.P., a, x, b are in G.P. and b, y, c are in G.P., then x^2, b^2, y^2 are in	(r)	G.P.
(D)	If x, y, z are in G.P., $a^x = b^y = c^z$, then log a, log b, log c are in	(s)	None of these

Space for rough work

2. Match the following Column–I with Column–II

Column – I		**Column – II**	
(A)	$\cot\frac{A}{2} = \frac{b+c}{a}$	(p)	always right angled
(B)	a tan A + b tan B = (a + b) $\tan\left(\frac{A+B}{2}\right)$	(q)	always isosceles
(C)	a cos A = b cos B	(r)	may be right angled
(D)	cos A = $\frac{\sin B}{2\sin C}$	(s)	may be right angled isosceles

3. Match the following Column–I with Column–II

Column – I		**Column – II**	
(A)	If two circles $x^2 + y^2 + 2a_1x + b = 0$ and $x^2 + y^2 + 2a_2x + b = 0$ touch each other then triplet (a_1, a_2, b) can be	(p)	(2, 2, 2)
(B)	If two circles $x^2 + y^2 + 2a_1x + b = 0$ and $x^2 + y^2 + 2a_2y + b = 0$ touch each other then triplet (a_1, a_2, b) can be	(q)	$\left(1, 1, \frac{1}{2}\right)$
(C)	If the straight line $a_1x - by + b^2 = 0$ touches the circle $x^2 + y^2 = a_2x + by$, then triplet (a_1, a_2, b) can be	(r)	(2, 1, 0)
(D)	If the line 3x + 4y – 4 = 0 touches the circle $(x - a_1)^2 + (y - a_2)^2 = b^2$, then triplet (a_1, a_2, b) can be	(s)	$\left(1, 1, \frac{3}{5}\right)$

Space for rough work

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014: 2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

FIITJEE **JEE(Advanced), 2015**

ALL INDIA INTEGRATED TEST SERIES

ANSWERS, HINTS & SOLUTIONS
HALF COURSE TEST –VI
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	A	C
2.	A	D	B
3.	C	B	D
4.	B	A	B
5.	C	A	B
6.	C	C	B
7.	D	B	D
8.	B	A	A
9.	D	D	A
10.	A	A	B
11.	D	A	C
12.	A	A	A
13.	D	B	D
14.	B	B	B
15.	A	D	C
16.	A	A	A
17.	A	A	B
18.	C	A	C
19.	C	B	D
1.	(A) → (p), (q), (r), (s) (B) → (p), (q), (r), (s) (C) → (p), (q) (D) → (r), (s)	(A) → (s) (B) → (p, r) (C) → (p, q) (D) → (p)	(A) → (q) (B) → (r) (C) → (p) (D) → (r)
2.	(A) → (p), (s) (B) → (p), (r) (C) → (q) (D) → (p)	(A) → (s) (B) → (p, q) (C) → (p, r, s) (D) → (r, s)	(A) → (p, r) (B) → (q, r) (C) → (r, s) (D) → (q, r, s)
3.	(A) → (q) (B) → (p), (q), (r), (s) (C) → (q) (D) → (p), (q), (r), (s)	(A) → (s) (B) → (r) (C) → (q) (D) → (p)	(A) → (r) (B) → (p, q) (C) → (q, r) (D) → (p, s)

Physics

PART – I

SECTION – A

1. $< a > = \frac{|\vec{v}_2 - \vec{v}_1|}{\Delta t} = \frac{\sqrt{3}v}{(2\ell/v)} = \frac{\sqrt{3}v^2}{2\ell}$

2. $2g - T = 2a$ …(i)
$T - g = a$ …(ii)
$T = kx$ …(iii)
$x = 1.33$ cm

3. $v^2 = u^2 + 2as$
$36 = 0 + 2 \times 2 \times S$
$S = 9$ m

4. Velocity after 1 sec = $5\sqrt{2}$
Radius of curvature = $\frac{(5\sqrt{2})^2}{5/\sqrt{2}} = 10\sqrt{2} = 14$ m

Chemistry

PART – II

SECTION – A

9. The compounds given in options (A) & (C) has no electron deficiency. The compound (B) has both electrophilic and nucleophilic site. While the compound (D) has got only electrophilic site.

10. Lother Meyer Curve is plotted between atomic volume and atomic mass. More is the atomic volume, higher is the position occupied.

11. Decrease in entropy during formation of four membered ring is higher than that of three membered ring. That's why formation of four membered ring is thermodynamically less feasible.

12. $K_w = \left[H^+\right]\left[OH^-\right]$

For neutral solution $\left[H^+\right]^2 = K_w \left(\text{since}\left[H^+\right] = \left[OH^-\right]\right)$

$-2\log\left[H^+\right] = -\log K_w = pK_w$

$pH = \frac{pKw}{2}$

13. $Mg\left(HCO_3\right)_2 + Ca\left(OH\right)_2 \rightarrow CaCO_3 + 2H_2O + MgCO_3$

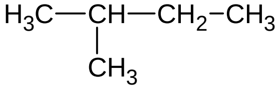
100ppm ⇒ 10^6 g of water has 100g of $CaCO_3$

10 l of H_2O ≡ 10^4 g of water has $\frac{100}{10^6}\times 10^4 g$ of $CaCO_3$ = 1g of $CaCO_3$

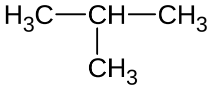
Moles of $CaCO_3$ = $\frac{1}{100}$ = moles of $Ca(OH)_2$

⇒ Mass of $Ca(OH)_2$ = $\frac{1}{100}\times 74 = 0.74g$

14. At high temperature, there is allyl substitution.

15. 
$H_3C-\underset{\underset{CH_3}{|}}{CH}-CH_2-CH_3$

It has four types of replaceable H – atoms hence monochloro derivatives will be four. The product ratio will be 6 : 3 : 7.6 : 5. It is total number of hydrogen atoms multiplied by relative reactivity.

16. 
$H_3C-\underset{\underset{CH_3}{|}}{CH}-CH_3$

1° = 9 × 1 = 9
3° = 1 × 1600 = 1600
Thus the product ratio is 9 : 1600 and hence

% of $1^\circ = \frac{9}{1609}\times 100 \approx 0.5\%$

% of $3^\circ = \frac{1600}{1609}\times 100 \approx 99.5\%$

17. $\Delta x = r$

$\Delta x.\Delta p = \frac{h}{4\pi} \Rightarrow \Delta p = \frac{h}{4\pi.\Delta x} = \frac{h}{4\pi r}$

$\Delta p = p \Rightarrow p = \frac{h}{4\pi r}$

18. $\Delta x \times m\Delta V \geq \frac{h}{4\pi}$ or $\Delta V \geq \frac{6.626\times10^{-34}}{4\times3.14\times0.1\times10^{-10}}$ m sec^{-1}

$\geq 5.27\times10^{-24}$ m sec^{-1}

19. $\Delta V.\Delta x = \frac{h}{4\pi m} = \frac{6.626\times10^{-34}}{4\times3.14\times9.11\times10^{-31}} = 10^{-4}\ m^2s^{-1}$

$\therefore \Delta V = \frac{10^{-4}}{10^{-8}} = 10^{4}$ ms^{-1}

Mathematics

PART – III

SECTION – A

1. Let the 1025th term falls in the n^{th} group.
Then, $1 + 2 + 4 + \ldots.. + 2^{n-1} < 1025 \le 1 + 2 + 4 + \ldots.. + 2^n$
$\Rightarrow 2^{n-1} < 1026 \le 2^{n+1}$
$\Rightarrow n = 10$
$\Rightarrow$ 1025th terms is 2^{10}

2. Here, ${}^{2n+1}C_1 + {}^{2n+1}C_2 + \ldots.. + {}^{2n+1}C_n = 63$
$\Rightarrow n = 3$

3. $|\omega z - 1 - \omega^2| = a$
$\Rightarrow |z + 1| = a \Rightarrow |z - 1 + 2| = a$
$\Rightarrow |z - 1| + 2 \ge a \Rightarrow 0 \le a \le 4$

4. $AG = \frac{1}{3}\sqrt{2b^2 + 2c^2 - a^2}$; $BG = \frac{1}{3}\sqrt{2a^2 + 2c^2 - b^2}$

$\Rightarrow AG = \frac{a}{3}$; $BG = \frac{1}{3}\sqrt{b^2 + 4c^2}$ as $a^2 = b^2 + c^2$

$\Rightarrow AG = \frac{5}{3}$; $BG = \frac{1}{3}\sqrt{16 + 36} = \frac{2}{3}\sqrt{13}$

Also, AB = c = 3 and $\Delta_{GAB} = \frac{1}{3}\Delta_{ABC} = 2$

If R_1 is the circumradius of triangle GAB, then

$R_1 = \frac{(AG)(BG)(AB)}{4\Delta_{GAB}} = \frac{5}{3}\times\frac{2}{3}\sqrt{13}\times 3\times\frac{1}{4\times 2} = \frac{5\sqrt{13}}{12}$ units

5. $\cos^{-1}(2x^2 - 1) = 2\pi - 2\cos^{-1}x$ (as $x < 0$)
$\Rightarrow \cos^{-1}(2x^2 - 1) - 2\sin^{-1}x = 2\pi - 2\cos^{-1}x - 2\sin^{-1}x$
$= 2\pi - 2(\cos^{-1}x + \sin^{-1}x) = 2\pi - 2\left(\frac{\pi}{2}\right) = \pi$

6. The line $2y = gx + \alpha$ should pass through $(-g, -g)$
So $-2g = -g^2 + \alpha \Rightarrow \alpha = g^2 - 2g = (g - 1)^2 - 1 \ge -1$

7. Tangents $y = m_1x + c$ and $y = m_2x + c$ intersect at $(0, c)$ which lies on the directrix of the given parabola
Hence, tangents are perpendicular for which $m_1m_2 = -1$

8. If (x_i, y_i) is the point of intersection of given curves

Then $\frac{\sum_{i=1}^{4} x_i}{4} = \frac{1+1}{2}$ and $\frac{\sum_{i=1}^{4} y_i}{4} = 0$

Now, $\frac{\sum_{i=1}^{3} x_i}{3} = \frac{4 - x_4}{3}$ and $\frac{\sum_{i=1}^{3} y_i}{3} = -\frac{y_4}{4}$

Centroid $\left(\frac{\sum_{i=1}^{3} x_i}{3}, \frac{\sum_{i=1}^{3} y_i}{3}\right)$ lies on the line $y = 3x - 4$

Hence, $-\frac{y_4}{3} = \frac{3(4 - x_4)}{3} - 4$

$\Rightarrow y_4 = 3x_4$
Hence, the locus of D is $y = 3x$

9. Clearly, $x^n - 1 = (x-1)(x-a_1)(x-a_2)\ .....\ (x-a_{n-1})$

$\Rightarrow \dfrac{x^n - 1}{x-1} = (x-a_1)(x-a_2).....(x-a_{n-1})$

$\Rightarrow 1 + x + x^2 + \ .....\ + x^{n-1} = (x-a_1)(x-a_2)\ .....\ (x-a_{n-1})$

$\Rightarrow n = (1-a_1)(1-a_2)\ .....\ (1-a_{n-1})$ (Putting $x = 1$)

10. $x = 1111\ .....\ 91$ times

$= 1 + 10 + 10^2 + \ .....\ + 10^{90} = \dfrac{10^{91}-1}{10-1}$

$= \dfrac{10^{91}-1}{10^{13}-1} \times \dfrac{10^{13}-1}{10-1}$

$= (1 + 10^{13} + 10^{26} + \ .....\ + 10^{78}) \times (1 + 10 + 10^2 + \ .....\ + 10^{12})$

= Composite number

11. $x^3 + x^2 + x = x(x^2 + x + 1) = x(x-\omega)(x-\omega^2)$

Now $f(x) = (x+1)^n - x^n - 1$ is divisible by $x^3 + x^2 + x$, if $f(0) = 0$, $f(\omega) = 0$ and $f(\omega^2) = 0$

Now, $f(0) = (0+1)^n - 0^n - 1 = 0$

$f(\omega) = (\omega + 1)^n - \omega^n - 1 = (-\omega^2)^n - \omega^n - 1 = 0$

Similarly, $f(\omega^2) = 0$

12. Let $y = 27^{\cos 2x} \times 81^{\sin 2x} = 3^{3\cos 2x + 4\sin 2x}$

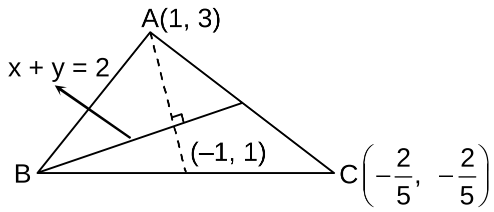
Now, $-\sqrt{3^2 + 4^2} \le 3\cos 2x + 4\sin 2x \le \sqrt{3^2 + 4^2}$

$\Rightarrow 3^{-5} \le 3^{3\cos 2x + 4\sin 2x} \le 3^5$

13. Locus of P is line segment between (–2, 0) and (2, 0)

14.-16. Image of A(1, 3) in line x + y = 2 is

$\left(1 - \dfrac{2(2)}{2},\ 3 - \dfrac{2(2)}{2}\right) \equiv (-1, 1)$



So line BC passes through (–1, 1) and $\left(-\dfrac{2}{5},\ -\dfrac{2}{5}\right)$

The equation of line BC is $y - 1 = \dfrac{\left(-\dfrac{2}{5} - 1\right)}{\left(-\dfrac{2}{5} + 1\right)}(x+1)$

$\Rightarrow 7x + 3y + 4 = 0$

Vertex B is point of intersection of $7x + 3y + 4 = 0$ and $x + y = 2$, i.e., $B \equiv \left(-\dfrac{5}{2},\ \dfrac{9}{2}\right)$

Line AB is $y - 3 = \dfrac{\left(3 - \dfrac{9}{2}\right)}{\left(1 + \dfrac{5}{2}\right)}(x-1) \Rightarrow 3x + 7y = 24$

17.-19. If no box remains empty, we can have (1, 1, 3) or (1, 2, 2) distribution pattern

17. Here, number of ways = $\dfrac{5!}{1!\ 2!\ 3!} + \dfrac{5!}{(2!)^2\ 1!\ 2!} = 25$

18. Here, we have only two ways (1, 1, 3) and (1, 2, 2)
Hence, number of ways is 2

19. When boxes are kept in a row, they will be treated as different. In this case, the number of ways will be ${}^{5-1}C_{3-1} = {}^{4}C_{2} = 6$

SECTION – B

1. (A) a, b, c are in G.P. Hence, $b^2 = ac$

$\Rightarrow 2\log_{10} b = \log_{10} a + \log_{10} c$

$$\Rightarrow \frac{2}{\log_b 10} = \frac{1}{\log_a 10} + \frac{1}{\log_c 10}$$

$$\Rightarrow \frac{2}{y} = \frac{1}{x} + \frac{1}{z}$$

Hence, x, y, z are in H.P.

(B) $$\frac{a+be^x}{a-be^x} = \frac{b+ce^x}{b-ce^x} = \frac{c+de^x}{c-de^x}$$

$$\Rightarrow \frac{2a}{a-be^x} - 1 = \frac{2b}{b-ce^x} - 1 = \frac{2c}{c-de^x} - 1$$

$$\Rightarrow \frac{a-be^x}{a} = \frac{b-ce^x}{b} = \frac{c-de^x}{c}$$

$\Rightarrow$ a, b, c, d are in G.P.

(C) Given, $2b = a + c$, $x^2 = ab$, $y^2 = bc$

Now, $x^2 + y^2 = b(a + c) = 2b^2$

$\Rightarrow x^2 + y^2 = 2b^2$

Hence, x^2, b^2, y^2 are in A.P.

(D) $x \log a = y \log b = z \log c = k$ (say)

Also, $y^2 = xz$

$$\Rightarrow \frac{k^2}{(\log b)^2} = \frac{k^2}{\log a \log c}$$

$\Rightarrow$ log a, log b, log c are in G.P.

2. (A) $\cot\frac{A}{2} = \frac{b+c}{2}$

$$\Rightarrow \frac{\cos\left(\frac{A}{2}\right)}{\sin\left(\frac{A}{2}\right)} = \frac{\sin B + \sin C}{\sin A} = \frac{2\sin\frac{B+C}{2}\cdot\cos\frac{B-C}{2}}{2\sin\frac{A}{2}\cos\frac{A}{2}}$$

$$\Rightarrow \cos\frac{A}{2} = \cos\frac{B-C}{2}$$

$A = B - C \Rightarrow A + B + C = 2B = \pi \Rightarrow B = \frac{\pi}{2}$

(B) In ΔABC, $a\tan A + b\tan B = (a+b)\tan\left(\frac{A+B}{2}\right)$

$$\Rightarrow a\left[\tan A - \tan\left(\frac{A+B}{2}\right)\right] = b\left[\tan\left(\frac{A+B}{2}\right) - \tan B\right]$$

$$\frac{a\sin\left(A - \frac{A+B}{2}\right)}{\cos A\cos\left(\frac{A+B}{2}\right)} = \frac{b\sin\left(\frac{A+B}{2} - B\right)}{\cos\left(\frac{A+B}{2}\right)\cos B}$$

$\Rightarrow \dfrac{2R\sin A\sin\left(\dfrac{A-B}{2}\right)}{\cos A} = \dfrac{2R\sin B\sin\left(\dfrac{A-B}{2}\right)}{\cos B}$

$\Rightarrow \sin\left(\dfrac{A-B}{2}\right)(\tan A - \tan B) = 0$

$\Rightarrow A = B$

(C) $a\cos A = b\cos B$

$2R\sin A\cos A = 2R\sin B\cos B$

$\Rightarrow \sin 2A = \sin 2B$

$\Rightarrow 2A = 2B$ or $2A = \pi - 2B$

$\Rightarrow A = B$ or $A + B = \dfrac{\pi}{2}$

(D) $\cos A = \dfrac{\sin B}{2\sin C}$

$\Rightarrow \dfrac{b^2 + c^2 - a^2}{2bc} = \dfrac{b}{2c}$

$\Rightarrow b^2 + c^2 - a^2 = b^2$

$\Rightarrow c^2 = a^2 \Rightarrow c = a \Rightarrow \Delta$ is isosceles

3. (A) Radical axis of $x^2 + y^2 + 2a_1x + b = 0$ and $x^2 + y^2 + 2a_2x + b = 0$ is $(a_1 - a_2)x = 0$ or $x = 0$

It must touch both the circles

Solving it with one of the circles we get $y^2 + b = 0$

$\Rightarrow b \le 0$

(B) Radical axis of given circle is $a_1x - a_2y = 0$

Solving it with one of the circles, we have $x^2 + \left(\dfrac{a_1}{a_2}\right)x^2 + 2a_1x + b = 0$

This must have equal roots

Hence, $4a_1^2 - 4b\left[1 + \dfrac{a_1^2}{a_2^2}\right] = 0$

$\Rightarrow a_1^2 - b\left(1 + \dfrac{a_1^2}{a_2^2}\right) = 0$

Options (p) and (q) satisfy this

(C) If the straight line $a_1x - by + b^2 = 0$ touches the circle $x^2 + y^2 = a_2x + by$

$\Rightarrow \dfrac{\left|a_1 \cdot \dfrac{a_2}{2} - b \cdot \dfrac{b}{2} + b^2\right|}{\sqrt{a_1^2 + b^2}} = \sqrt{\dfrac{a_2^2}{4} + \dfrac{b^2}{4}}$

$\Rightarrow a_1^2a_2^2 + 2b^2a_1a_2 + b^4 = a_1^2a_2^2 + a_1^2b^2 + a_2^2b^2 + b^4$

$\Rightarrow b^2 = 0$ or $2a_1a_2 = a_1^2 + a_2^2$

$\Rightarrow$ Options (q) and (r) satisfy this

(D) Line $3x + 4y - 4 = 0$ touches the circle $(x - a_1)^2 + (y - a_2)^2 = b^2$

$\Rightarrow \dfrac{|3a_1 + 4a_2 - 4|}{5} = b$

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ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Advanced), 2015**

HALF COURSE TEST –VI

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 243**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-B**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 09)** contains 09 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (10 – 13) contains 4 Assertion-Reasoning (multiple choice questions) which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (14 – 19) contains 2 paragraphs. Based upon paragraph, 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-B (1 – 03)** contains 3 Matrix Match Type (4 × 4 Matrix) questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+6 marks** for all correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	$6.625 \times 10^{-34}\ J{\cdot}s$
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Single Correct Choice Type

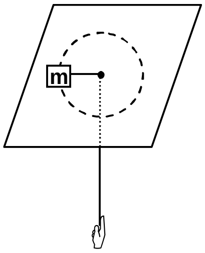
*This section contains **9 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.*

1. A particle moves along the positive branch of the curve $y = \frac{x^2}{2}$ with x governed by $x = \frac{t^2}{2}$ where x and y are in meter and t in second. At t = 2 the acceleration of the particle is

(A) $\hat{i} - 6\hat{j}$ (B) $\hat{i} + 6\hat{j}$

(C) $2\hat{i} + 4\hat{j}$ (D) $3\hat{i} - 6\hat{j}$

2. A block of mass ‘m’ is placed on a frictionless horizontal table and attached to a string passing through a small hole in the surface. Initially the mass moves in a circle of radius r_0 with a speed v_0 and the string is held by a person. The person pulls the string slowly to decrease the radius of the circle to r. The tension in the string depends on r as :



(A) r^{-3} (B) r^3

(C) r (D) r^{-1}

3. Two identical rods are joined to form a ‘X’. The smaller angle between the rod is θ. The moment of inertia of the system about an axis passing through the point of intersection of the rods and perpendicular to their plane is proportional to

(A) θ (B) $\sin^2 \theta$

(C) $\cos^2 \theta$ (D) independent of θ

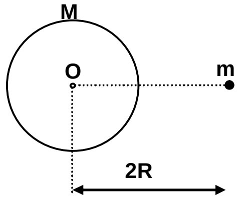
4. Three identical solid spheres move down on three fixed inclined planes A, B, and C all of the same dimensions A is without friction, the friction between B and sphere is sufficient to cause rolling without slipping, the friction between C and sphere cause rolling with slipping. The kinetic energies of sphere at the bottom of the inclines A, B and C are E_A, E_B and E_C respectively, then

(A) $E_A = E_B = E_C$ (B) $E_A = E_B > E_C$

(C) $E_A > E_B > E_C$ (D) $E_A > E_B = E_C$

Space for rough work

5. A particle of mass m is at a distance 2R from the centre of a thin shell of mass M and having radius R as shown in figure. The gravitational field at the centre of shell is



(A) zero (B) $\frac{GM}{R^2}$
(C) $\frac{G(M+m)}{4R^2}$ (D) $\frac{Gm}{4R^2}$

6. An organ pipe of cross sectional area 100 cm^2 resonates with a tuning fork of frequency 1000 Hz in fundamental tone. The minimum volume of water to be drain out so that the pipe again resonate with the same tuning fork is (take velocity of wave = 320 m/s)
(A) 800 cm^3 (B) 1200 cm^3
(C) 1600 cm^3 (D) 2000 cm^3

7. An elevator car starts descending with constant acceleration 2 m/s^2, 2 second after the start a ball is thrown horizontally with 3 m/s with respect to elevator from point P, then the magnitude of displacement of the ball w.r.t. the point P after 1 sec is
(A) 5 m (B) 10 m
(C) 3 m (D) 6 m

8. The standing wave on a 5 m long string clamped at both ends is represented by the equation y = 4 sin 6.28 x cos 6.28 t, where y is in cm. The phase difference between two points at x = 1.51 m and x = 2.75 m is
(A) π (B) zero
(C) $\pi/2$ (D) $3\pi/2$

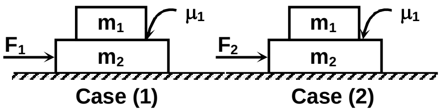
9. An ideal diatomic gas undergoes a process in which the heat absorbed by the gas is twice the increment of its internal energy. Then the polytropic exponent of the process is
(A) 2 (B) 3/5
(C) 2/5 (D) 5/2

Space for rough work

Assertion - Reason Type

*This section contains 4 questions numbered 10 to 13. Each question contains STATEMENT − 1 (Assertion) and STATEMENT -2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.*

10. STATEMENT-1: A force F_1 is applied on the lower block in case (1) due to which only lower block moves with constant velocity.



A force F_2 is applied on the lower block in case (2) due to which both the block moves with constant velocity. F_1 and F_2 will be equal. (Given that nature of surfaces is same for both the cases)

because

STATEMENT-2: Frictional force between ground and m_2 will be same for both the case.

(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

11. STATEMENT-1: When one object collides with another object, the impulse during deformation and restitution will be in same direction.

because

STATEMENT-2: Due to this impulse the objects first deform and due to the same impulse they again try to regain its original shape.

(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

Space for rough work

12. STATEMENT-1: Rolling without slipping can not be possible in absence of friction.

because

STATEMENT-2: During rolling without slipping, energy can remain conserved in absence of external applied force.

(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

13. STATEMENT-1: In absence of air friction, it is claimed that all objects fall with the same acceleration although, a heavier object is pulled towards the earth with more force than a lighter object.

because

STATEMENT-2: Net external force is always equal to rate of change of linear momentum.

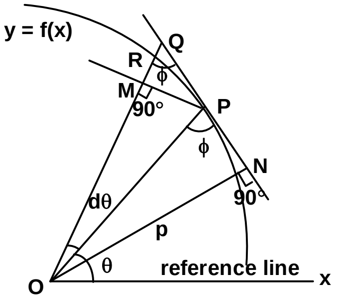
(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

Space for rough work

Linked Comprehension Type

*This section contains 2 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.*

Paragraph for Question Nos. 14 to 16



If a point P moves in plane along a given curve y = f(x), the angular velocity of point P about a fixed point O in the plane is the rate of change of the angle that OP line makes with a fixed direction $[\text{OX} - \text{line}]$ in the plane

Let OP = r at t = t sec

PM = rdθ = PQ sinϕ, But if dθ is very small then. $PQ \cong \overset{\frown}{PR} = ds$ (arc length)

$\Rightarrow$ rdθ = ds sin ϕ

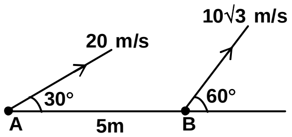
$$\Rightarrow \frac{d\theta}{dt} = \frac{1}{r}\frac{ds}{dt}\sin\phi = \frac{v\sin\phi}{r} = \frac{\text{Magnitude of component of velocity of point perpendicular to radius vector}}{\text{Magnitude of radius vector}}$$

$$\Rightarrow \frac{d\theta}{dt} = \frac{vp}{r^2}$$

Read the above passage carefully and answer the following questions

14. $r^2 \frac{d\theta}{dt}$ represents
(A) rate at which radius vector sweeps out area
(B) angular momentum
(C) moment of velocity about origin
(D) rate of increase of sectional area as P moves along curve

15. If two particles A and B are having speed 10√3 m/s and 20 m/s at a particular instant as shown in the figure, then the angular velocity of A with respect to B at the same instant is



(A) 1 rad/s clockwise
(B) 1 rad/s anticlockwise
(C) 2 rad/s clockwise
(D) 2 rad/s anticlockwise

16. If point P moves on parabolic path $y^2 = 4(x + 1)$, where x and y are in meter with constant speed 2 m/s. Its angular velocity about focus at an instant when it makes angle 60° at focus with x-axis is [all angles are measured in anticlockwise direction with positive x-axis]
(A) 0.25 rad/s
(B) 0.50 rad/s
(C) 0.12 rad/s
(D) none of the above

Space for rough work

Paragraph for Question Nos. 17 to 19

A cubical box of side 2 metre contains oxygen gas (atomic weight 32) at a pressure of 100N/m^2. During an observation time of one second, an atom travelling with the root-mean square speed parallel to one of the edges of the cube was found to make 500 hits with a particular wall, without any collision with the other atoms. ($R = \frac{25}{3}$ J/mol–K and $K = 1.38 \times 10^{-23}$ J/K)

17. What is the temperature of the gas

(A) 500 K	(B) 4520 K
(C) 5120 K	(D) 3600 K

18. What is the average translational kinetic energy per atom

(A) 106×10^{-21} J	(B) 96×10^{-21} J
(C) 116×10^{-21} J	(D) 112×10^{-21} J

19. Find the total mass of oxygen gas in the box.

(A) 30×10^{-4} kg	(B) 2.4×10^{-4} kg
(C) 6×10^{-4} kg	(D) 15×10^{-4} kg

Space for rough work

SECTION – B
(Matching List Type)

This section contains **3 multiple choice questions.** Each question has matching Column(s). The codes for the Column(s) have choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. A particle is moving according to the displacement time relation $x = 3t^2 - \frac{t^3}{2}$ (where x is in meters and t is in seconds). Match the condition of column I with time interval and instant of column II

	Column A		**Column B**
(A)	Velocity and acceleration will be in same direction	(p)	At t = 0 and t = 6 sec
(B)	particle will be at origin	(q)	0 < t < 2 sec
(C)	particle will retard	(r)	at t = 0 and t = 4 sec
(D)	velocity is zero	(s)	2 < t < 4

Space for rough work

2. A bob is attached to a string of length ℓ whose other end is fixed and is given horizontal velocity at the lowest point of the circle so that the bob moves in a vertical plane. Match the velocity given at the lowest point of circle in column I with tension and velocity at the highest point of the circle corresponding to velocity of column I of column II

Column A		**Column B**	
(A)	$\sqrt{2g\ell}$	(p)	$T = mg$, $v > \sqrt{g\ell}$
(B)	$\sqrt{6g\ell}$	(q)	$T > 2mg$ and $v > \sqrt{3g\ell}$
(C)	$\sqrt{8g\ell}$	(r)	$T = 0$ and $v = \sqrt{g\ell}$
(D)	$\sqrt{5g\ell}$	(s)	$T = 0$

3. Match the following.

Column – A		**Column – B**	
(A)	Ideal gas	(p)	Maximum emissivity
(B)	Black body	(q)	Maximum absorptive power
(C)	Wien's displacement law	(r)	An ideal concept
(D)	A red object having 0 K temperature.	(s)	Dominant wave in composite radiations.

Space for rough work

Chemistry

PART - II

SECTION – A

Single Correct Choice Type

*This section contains **9 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.*

1. $Ag(CN)_2^-$ is stable while $AgCl_2^-$ is unstable because
(A) CN^- is stronger than Cl^-
(B) Ag^+ is soft acid, CN^- is soft base while Cl^- is hard base
(C) both are equally stable
(D) None of the above

2. Glycerol on oxidation with Fenton's reagent produces
(A) glyceraldehyde
(B) dihydroxyacetone
(C) tartaric acid
(D) glyceraldehyde and dihydroxyacetone

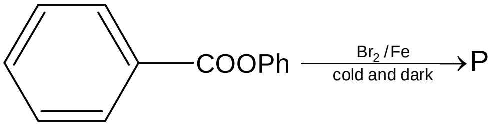
3. Consider following reaction,

$$Zn + 2H^+ \longrightarrow Zn^{2+} + H_2$$

half-life period is independent of concentration of Zn at constant pH. At constant Zn concentration, half-life is 10 minutes at pH = 2 and half-life is 100 minutes at pH = 3. Hence, rate law is
(A) $k\,[Zn]\,[H^+]$
(B) $k\,[Zn]\,[H^+]^2$
(C) $k\,[Zn]^0\,[H^+]$
(D) $k\,[Zn]^0\,[H^+]^2$

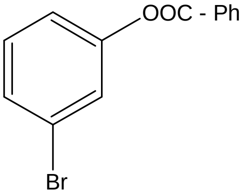
Space for rough work

4.

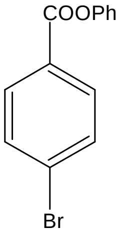


(a monobromo derivative), where P is

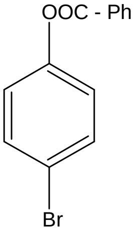
(A)



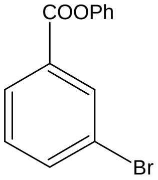
(B)



(C)



(D)



5. Which of the following acid contains one S – S bond?

(A) $H_2S_2O_7$
(B) $H_2S_2O_8$
(C) $H_2S_2O_6$
(D) none of these

6. Which of the following plots represent the behaviour of an ideal binary liquid solution?

(A) Plot of P_{Total} vs Y_A is linear
(B) Plot of $\frac{1}{P_{Total}}$ vs Y_B is linear
(C) Plot of P_{Total} vs Y_B is linear
(D) None of the above

7. The value of $\frac{RT}{PV}$ for a gas at critical condition is how many times of $\frac{RT}{PV}$ at normal condition?

(A) $\frac{8}{3}$
(B) $\frac{3}{8}$
(C) 3
(D) $\frac{1}{3}$

Space for rough work

8. In a closed vessel, ozone transforms into oxygen through two steps as mentioned below:

$O_3 \rightleftharpoons O_2 + O$ (fast)

$O + O_3 \longrightarrow 2O_2$ (slow)

If half of the oxygen produced is removed from the vessel without disturbing the temperature, then the rate of transformation of ozone into oxygen will be

(A) unaffected	(B) half the initial value
(C) double the initial rate	(D) None of the above

9. The stoichiometric equation for the oxidation of bromide ions by hydrogen peroxide in acidic solution is

$2Br^- + H_2O_2 + 2H^+ \longrightarrow Br_2 + 2H_2O$

$r = k\,[H_2O_2]\,[H^+]\,[Br^-]$

If, by the addition of water, the total volume were doubled, what would be the effect on the rate of disappearance of Br^- and rate of reaction?

(A) Rate of disappearance of Br^- becomes $\frac{1}{8}$ times and rate of reaction $\frac{1}{4}$ times

(B) Rate of disappearance of Br^- becomes $\frac{1}{4}$ times and rate of reaction $\frac{1}{8}$ times

(C) Both rate of disappearance of Br^- and rate of reaction becomes $\frac{1}{8}$ times

(D) Rate of disappearance of Br^- becomes 4 times and rate of reaction 8 times

Space for rough work

Assertion - Reason Type

This section contains 4 questions numbered 10 to 13. Each question contains STATEMENT − 1 (Assertion) and STATEMENT -2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which ***ONLY ONE*** *is correct.*

10. STATEMENT-1: The pH of pure water is less than 7 at 60^oC
and
STATEMENT-2: As the temperature increases, pure water becomes slightly acidic
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

11. STATEMENT-1: CO_2 is a gas and SiO_2 is a solid at room temperature.
and
STATEMENT-2: van der Waals' forces are far weaker than ordinary covalent bond.
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

Space for rough work

12. STATEMENT-1: Acidic strength boron halide is as $BF_3 < BCl_3 < BBr_3 < BI_3$

and

STATEMENT-2: Fluorine is more electronegative & creates greater electron deficiency on boron.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

13. STATEMENT-1: R.M.S velocity of a gas sample can be expressed as $C_{rms} = \sqrt{\frac{3PV}{M}}$

and

STATEMENT-2: The R.M.S velocity of a gas sample decreases if its volume is decreased.

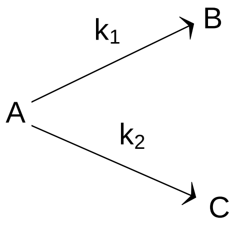
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

Space for rough work

Linked Comprehension Type

This section contains 2 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which ***ONLY ONE*** *is correct.*

Paragraph for Question Nos. 14 to 16



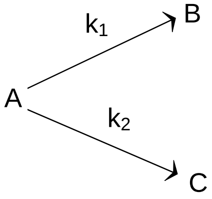
Parallel or competing reactions–
The reactions in which a substance reacts or decomposes in more than one manner are called parallel or side reactions. This type of kinetics can be observed in radioactive conversions where an element loses α, β particles simultaneously to form new products at the same time through different paths.

Then, $-\dfrac{d[A]}{dt} = (K_1 + K_2)\ [A] = K_{av.}\ [A]$

K_1 = Fractional yield of B × $K_{av.}$
K_2 = Fractional yield of C × $K_{av.}$
If $K_1 >> K_2$, then
$A \rightarrow B$ will become main reaction
$A \rightarrow C$ will become side reaction

Read the above paragraph carefully and answer the questions given below it:

14. A substance undergoes first order decomposition. The decomposition follows two parallel first order reactions as–

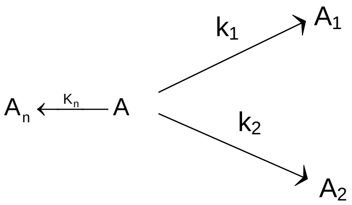


$K_1 = 1.26 \times 10^{-4}\ sec^{-1}$
$K_2 = 3.8 \times 10^{-5}\ sec^{-1}$

The percentage distribution of B and C are–
(A) 75% B and 25% C
(B) 80% B and 20% C
(C) 76.83% B and 23.17% C
(D) 90% B and 10% C

Space for rough work

15. For a first order decomposition–



Overall K will be given by–

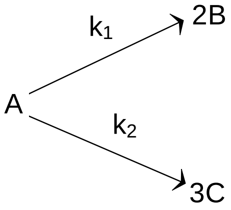
(A) $K = K_1 + K_2 + \ldots\ldots\ldots\ldots + K_n$

(B) $K = \dfrac{(K_1 + K_2 + \ldots\ldots\ldots + K_n)}{n}$

(C) $K = K_1 \times K_2 \times K_3 \;\ldots\ldots\ldots\ldots \times K_n$

(D) None

16. For a reaction,



Follow parallel kinetics, the ratio of [B] and [C] at any instant can be given by,

(A) $\dfrac{K_1}{K_2}$

(B) $\dfrac{K_2}{K_1}$

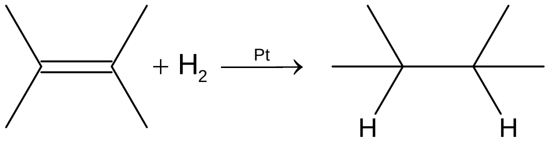
(C) $\dfrac{2K_1}{3K_2}$

(D) $\dfrac{3K_1}{2K_2}$

Space for rough work

Paragraph for Question Nos. 17 to 19

The *cis* and *trans* isomers of alkene do not have the same stability. The stability can be measured by hydrogenation and combustion. The reaction of alkene with hydrogen is endothermic and the enthalpy change in the reaction is called heat of hydrogenation.

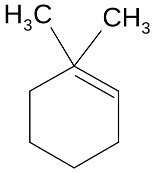


$\Delta H = -120\,kJ/mol$

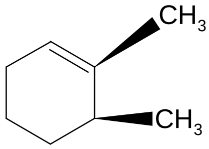
In all the isomers of 2–butene, the product is same but different amount of heat is evolved. In each reaction, it must be related with different relative stability. 1–butene evolves greatest amount of energy and *trans* 2–butene evolves least amount of energy. So, 1–butene must have greatest energy and it is least stable whereas trans 2–butene must have lowest energy and it is more stable. *cis* 2–butene has intermediate energy in relation to above.

Read the above paragraph carefully and answer the questions given below:

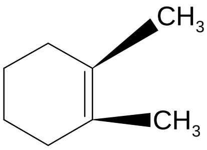
17. Which alkene has higher heat of hydrogenation?



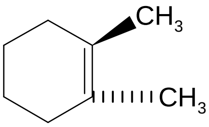
I



II



III

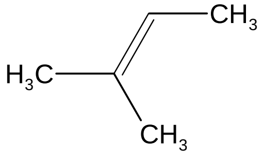


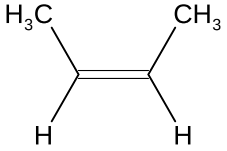
IV

(A) I (B) II
(C) III (D) IV

Space for rough work

18. Which alkene is most stable?

(A)


(B)


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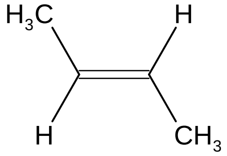

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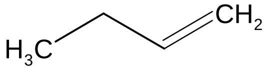
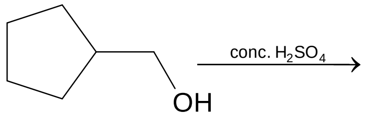
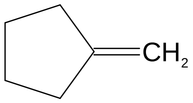
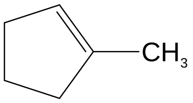


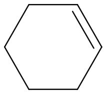
19. For the reaction,

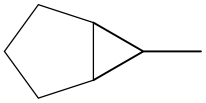

OH
conc. H2SO4

the major product is

(A)


(B)


(C)


(D)


Space for rough work

SECTION – B

(Matching List Type)

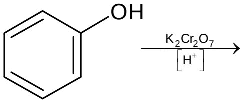
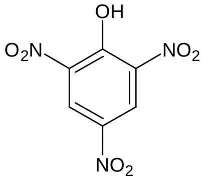
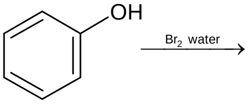
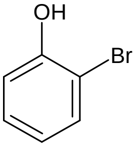
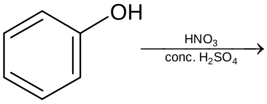
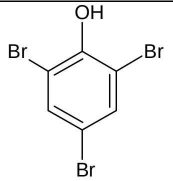
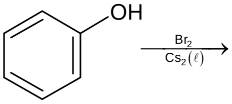
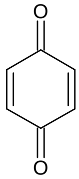
This section contains **3 multiple choice questions.** Each question has matching Column(s). The codes for the Column(s) have choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. Match Column–I and Column –II.

Column–I		**Column–II**	
(A)	The volume of mixture has no effect on the equilibrium constant.	(p)	Common ion effect
(B)	Increasing the pressure moves the equilibrium to the left.	(q)	pH = 4
(C)	The solution has hydronium ion concentration of 0.0001 mol/litre.	(r)	There is an increase in the number of moles from products to reactants.
(D)	The addition of NaOH to $Ca(OH)_2$ solution precipitates $Ca(OH)_2$.	(s)	There is no change in number of moles.

Space for rough work

2. Match the following:

	Column – I		Column – II
(A)	 OH $K_2Cr_2O_7$ $[H^+]$	(p)	 OH O_2N NO_2 NO_2 (picric acid)
(B)	 OH Br_2 water	(q)	 (ortho-bromophenol)
(C)	 OH HNO_3 conc. H_2SO_4	(r)	 (tribromophenol)
(D)	 OH Br_2 $Cs_2(\ell)$	(s)	 (para-benzoquinone)

3. Match the following:

	Column – I (Thermo chemical equations)		Column – II (Characteristics)
(A)	$CuSO_4.5H_2O + \text{Excess } H_2O + 2.9\text{ kcal} \longrightarrow CuSO_4.5H_2O(aq)$	(p)	Enthalpy change $\Delta H < 0$
(B)	$2H_2(g) + O_2(g) \longrightarrow 2H_2O(\ell) + 115.0\text{ kcal}$	(q)	Enthalpy of combustion
(C)	$H_2SO_4(aq) + NaOH(aq) \longrightarrow Na_2SO_4(aq) + H_2O + 57.1\text{ kJ}$	(r)	Enthalpy of solvation
(D)	$CH_4(g) + 2O_2(g) \longrightarrow 2H_2O(g) + CO_2(g) + 803.3\text{ kJ}$	(s)	Enthalpy of neutralization

Space for rough work

Mathematics PART – III

SECTION – A

Single Correct Choice Type

*This section contains **9 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.*

1. Maximum sum of coefficient in the expansion of $(1 - x \sin \theta + x^2)^n$ is
(A) 1 (B) 2^n
(C) 3^n (D) 0

2. The number of integral solutions of $x + y + z = 0$ with $x \geq -5$, $y \geq -5$, $z \geq -5$ is
(A) 134 (B) 136
(C) 138 (D) 140

3. Double ordinate AB of the parabola $y^2 = 4ax$ subtends an angle $\frac{\pi}{2}$ at the focus of the parabola, then tangents drawn to parabola at A and B will intersect at
(A) $(-4a, 0)$ (B) $(-2a, 0)$
(C) $(-3a, 0)$ (D) none of these

4. The tangent at a point P on the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ meets one of the directrix in F. If PF subtends an angle θ at the corresponding focus, then θ equals
(A) $\frac{\pi}{4}$ (B) $\frac{\pi}{2}$
(C) $\frac{3\pi}{4}$ (D) π

Space for rough work

5. If in triangle ABC, A ≡ (1, 10), circumcentre ≡ $\left(-\frac{1}{3}, \frac{2}{3}\right)$ and orthocentre ≡ $\left(\frac{11}{4}, \frac{4}{3}\right)$, then the coordinates of mid–point of side opposite to A is

(A) $\left(1, -\frac{11}{3}\right)$
(B) (1, 5)
(C) (1, –3)
(D) (1, 6)

6. $\cos^3 x \sin 2x = \sum_{x=0}^{n} a_r \sin(rx)\ \forall x \in R$, then

(A) $n = 5,\ a_1 = \frac{1}{2}$
(B) $n = 5,\ a_1 = \frac{1}{4}$
(C) $n = 5,\ a_2 = \frac{1}{8}$
(D) $n = 5,\ a_2 = \frac{1}{4}$

7. If the roots of the quadratic equation $(4p - p^2 - 5)x^2 - (2p - 1)x + 3p = 0$ lie on either side of unity, then the number of integral values of p is

(A) 1
(B) 2
(C) 3
(D) 4

8. If $z = (\lambda + 3) - i\sqrt{5 - \lambda^2}$, then the locus of z is

(A) ellipse
(B) semicircle
(C) parabola
(D) straight line

9. If $1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \frac{1}{11} + ... = \frac{\pi}{4}$, then value of $\frac{1}{1\times 3} + \frac{1}{5\times 7} + \frac{1}{9\times 11} + ...$ is

(A) $\frac{\pi}{8}$
(B) $\frac{\pi}{6}$
(C) $\frac{\pi}{4}$
(D) $\frac{\pi}{36}$

Space for rough work

Assertion - Reason Type

*This section contains 4 questions numbered 10 to 13. Each question contains STATEMENT − 1 (Assertion) and STATEMENT -2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.*

10. STATEMENT 1: Principal value of $\cos^{-1}(\cos 30)$ is $30 - 9\pi$
STATEMENT 2: $30 - 9\pi \in [0, \pi]$
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

11. STATEMENT 1: If there is exactly one point on the line $3x + 4y + 5\sqrt{5} = 0$, from which perpendicular tangents can be drawn to the ellipse $\frac{x^2}{a^2} + y^2 = 1$ $(a > 1)$, then the eccentricity of the ellipse is $\frac{1}{3}$
STATEMENT 2: For the condition given in statement 1, given line must touch the circle $x^2 + y^2 = a^2 + 1$
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

12. STATEMENT 1: If the point $(2a - 5, a^2)$ is on the same side of the line $x + y - 3 = 0$ as that of the origin, then $a \in (2, 4)$
STATEMENT 2: The points (x_1, y_1) and (x_2, y_2) lie on the same or opposite sides of the line $ax + by + c = 0$, as $ax_1 + by_1 + c$ and $ax_2 + by_2 + c$ have the same or opposite signs.
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

13. STATEMENT 1: If $px^2 + qx + r = 0$ is a quadratic equation $(p, q, r \in R)$ such that its roots are α, β and $p + q + r < 0$, $p - q + r < 0$ and $r > 0$, then $[\alpha] + [\beta] = -1$, (where [.] denotes the greatest integer function)
STATEMENT 2: If for any two real numbers a and b, function f(x) is such that $f(a)\,f(b) < 0$,
$\Rightarrow$ f(x) has at least one real root lying in (a, b)
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1.
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1.
(C) Statement 1 is true and Statement 2 is false.
(D) Statement 1 is false and Statement 2 is true.

Space for rough work

Linked Comprehension Type

*This section contains 2 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.*

Paragraph for Question Nos. 14 to 16

Read the following write up carefully and answer the following questions:
Two consecutive numbers from 1, 2, 3, ….., n are removed. The arithmetic mean of the remaining numbers is $\frac{105}{4}$

14. The value of n lies in
(A) [45, 55] (B) [52, 60]
(C) [41, 49] (D) none of these

15. The removed numbers
(A) lie between 10 and 20 (B) are greater than 10
(C) are less than 15 (D) none of these

16. Sum of all numbers
(A) exceeds 1600 (B) is less than 1500
(C) lies between 1300 and 1500 (D) none of these

Paragraph for Question Nos. 17 to 19

Read the following write up carefully and answer the following questions:
P is a set containing n elements. A subset A of P is chosen and the set P is reconstructed by replacing the elements of A. A subset B of P is chosen again

17. The number of ways of choosing A and B such that A and B have no common elements is
(A) 3^n (B) 2^n
(C) 4^n (D) none of these

18. The number of ways of choosing A and B such that B contains just one element more than A is
(A) 2^n (B) ${}^{2n}C_{n-1}$
(C) ${}^{2n}C_n$ (D) $(3^n)^2$

19. The number of ways of choosing A and B such that B is a subset of A is
(A) ${}^{2n}C_n$ (B) 4^n
(C) 3^n (D) none of these

Space for rough work

SECTION – B
(Matching List Type)

This section contains **3 multiple choice questions.** Each question has matching Column(s). The codes for the Column(s) have choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. If e_1 and e_2 are the roots of the equation $x^2 - ax + 2 = 0$, then match the following Column–I with Column–II

Column – I		**Column – II**	
(A)	If e_1 and e_2 are the eccentricities of the ellipse, and hyperbola, respectively then the values of ‘a’ are	(p)	6
(B)	If both e_1 and e_2 are the eccentricities of the hyperbolas, then values of a are	(q)	$\frac{5}{2}$
(C)	If e_1 and e_2 are eccentricities of hyperbola and conjugate hyperbola, then values of a are	(r)	$2\sqrt{2}$
(D)	If e_1 is the eccentricity of the hyperbola for which there exist infinite points from which perpendicular tangents can be drawn and e_2 is the eccentricity of the hyperbola in which no such points exist then the values of a are	(s)	5

2. Match the following Column–I with Column–II

Column – I		**Column – II**	
(A)	$\left(\sin^{-1}x\right)^2 + \left(\sin^{-1}y\right)^2 = \frac{\pi^2}{2} \Rightarrow x^3 + y^3$ is equal to	(p)	1
(B)	$\left(\cos^{-1}x\right)^2 + \left(\cos^{-1}y\right)^2 = 2\pi^2 \Rightarrow x^5 + y^5$ is equal to	(q)	–2
(C)	$\left(\sin^{-1}x\right)^2\left(\cos^{-1}y\right)^2 = \frac{\pi^4}{4} \Rightarrow \lvert x - y\rvert$ is equal to	(r)	0
(D)	$\left\lvert\sin^{-1}x - \sin^{-1}y\right\rvert = \pi \Rightarrow x^y$ is equal to	(s)	2

3. Match the following Column–I with Column–II

Column – I		**Column – II**	
(A)	$z^4 - 1 = 0$	(p)	$z = \cos\frac{\pi}{8} + i\sin\frac{\pi}{8}$
(B)	$z^4 + 1 = 0$	(q)	$z = \cos\frac{\pi}{8} - i\sin\frac{\pi}{8}$
(C)	$iz^4 + 1 = 0$	(r)	$z = \cos\frac{\pi}{4} + i\sin\frac{\pi}{4}$
(D)	$iz^4 - 1 = 0$	(s)	$z = \cos 0 + i\sin 0$

Space for rough work

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ANSWERS, HINTS & SOLUTIONS

HALF COURSE TEST –VI
(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	B	C
2.	A	D	B
3.	D	B	A
4.	B	C	B
5.	D	C	A
6.	C	B	B
7.	A	A	B
8.	B	C	B
9.	B	C	A
10.	D	C	D
11.	A	B	D
12.	D	C	D
13.	B	C	A
14.	C	C	A
15.	B	A	C
16.	A	C	B
17.	C	B	A
18.	A	A	B
19.	C	C	C
1.	(A) → (q) (B) → (p) (C) → (s) (D) → (r)	(A) → (s) (B) → (r) (C)→ (q) (D) → (p)	(A) → (p, s) (B) → (q, r) (C) → (r) (D) → (p, s)
2.	(A) → (s) (B) → (p) (C) → (q) (D) → (q), (r)	(A) → (s) (B) → (r) (C)→ (p) (D) → (q)	(A) → (q, r, s) (B) → (q) (C) → (r, s) (D) → (p)
3.	(A) → (r) (B) → (p), (q), (r) (C) → (s) (D) → (r)	(A) → (r) (B) → (p) (C) → (p, s) (D) → (p, q)	(A) → (s) (B) → (r) (C) → (p) (D) → (q)

Physics

PART – I

SECTION – A

5. Use superposition principle

6. $1000 = \dfrac{v}{4\ell_1} = \dfrac{3v}{4\ell_2}$

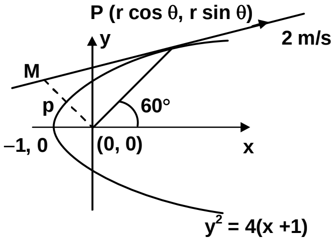
$\Rightarrow \ \ell_2 = 3\ell_1$

$\Rightarrow \ \ell_1$ = 8 cm and ℓ_2 = 24 cm

$\Rightarrow$ minimum volume = 16 × 100 = 1600 cm^3

14. $r^2 \dfrac{d\theta}{dt} = vp$

15. $\omega = \dfrac{\vec{v}_A - \vec{v}_B}{r} = \dfrac{10-15}{5} = -1$ rad/sec.



16. r cos θ + 2 = r

$\dfrac{2}{r} = 1 - \cos\theta = 2\sin^2\dfrac{\theta}{2}$

$\dfrac{1}{r} = \sin^2\dfrac{\theta}{2}$

p = $\sqrt{ar}$ [property of parabola, here a = 1]

$\omega = \dfrac{d\theta}{dt} = \dfrac{vp}{r^2} = \dfrac{v\sqrt{r}}{r^2} = \dfrac{v}{r^{3/2}} = 2 \times \left(\dfrac{1}{2}\right)^3$

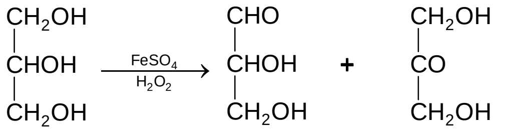
Chemistry

PART – II

SECTION – A

1. Salts of soft acid with soft base are more stable than soft acid and hard base.

2.



$$\begin{array}{c} CH_2OH \\ | \\ CHOH \\ | \\ CH_2OH \end{array} \xrightarrow[H_2O_2]{FeSO_4} \begin{array}{c} CHO \\ | \\ CHOH \\ | \\ CH_2OH \end{array} + \begin{array}{c} CH_2OH \\ | \\ CO \\ | \\ CH_2OH \end{array}$$

Glyceraldehyde Dihydroxyacetone

3. Half-life is independent of concentration of Zn, thus order w.r.t. [Zn] = 1

At pH = 2, $[H^+] = 10^{-2}$, $t_{1/2} = 10$ minutes

pH = 3, $[H^+] = 10^{-3}$, $t_{1/2} = 100$ minutes

$$\frac{[t_{1/2}]_1}{[t_{1/2}]_2} = \left(\frac{a_2}{a_1}\right)^{n-1}$$

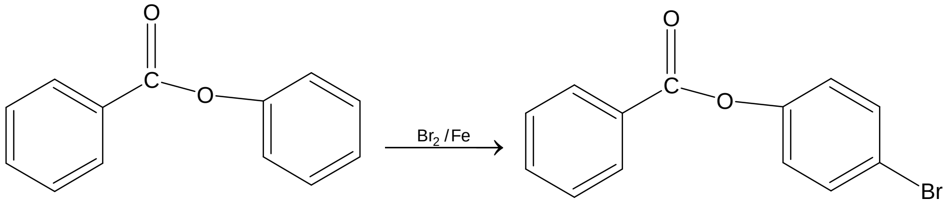
$$\frac{10}{100} = \left(\frac{10^{-3}}{10^{-2}}\right)^{n-1}$$

$\therefore$ n = 2, thus w.r.t. $[H^+]$ order = 2

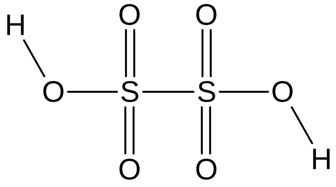
Rate law = $k\,[H^+]^2\,[Zn]$

Hence, (B).

4.



5.



6. $$Y_B = \frac{P_B^o X_B}{P_{Total}}$$

Graph Y_B vs $\frac{1}{P_{Total}}$ is linear.

7. $$P_c V_c = \frac{3}{8} RT_c$$

i.e. $\frac{8}{3}$ times of $\frac{RT}{PV}$ at normal condition

8. $O_3 \rightleftharpoons O_2 + O$ (fast)

$$K_{eq.} = \frac{[O_2][O]}{[O_3]} \quad \ldots(1)$$

From Eq. (1), $[O] = \frac{K_{eq.}[O_3]}{[O_2]}$

$$O + O_3 \xrightarrow{\text{slow}} 2O_2$$

$$\therefore \text{Rate}_1 = k[O][O_3]$$

$$\text{Rate}_1 = k.K_{eq.}\frac{[O_3]}{[O_2]} \times [O_3]$$

$$\text{Rate}_1 = \frac{k'[O_3]^2}{[O_2]}$$

$$\text{Rate}_2 = \frac{k'[O_3]^2}{\frac{[O_2]}{2}} = 2k'$$

Mathematics

PART – III

SECTION – A

1. Sum of coefficients in $(1 - x\sin\theta + x^2)^n$ is $(1 - \sin\theta + 1)^n$ (putting x = 1)
This sum is greatest when $\sin\theta = -1$, then maximum sum is 3^n

2. Let $x = p - 5$, $y -= q - 5$ and $z = r - 5$, where $p, q, r \geq 0$
Then the given equation reduces to $p + q + r = 15$
The total number of solutions to this is ${}^{17}C_2 = 136$

3. Let $A \equiv (at^2, 2at)$, $B \equiv (at^2, -2at)$

$m_{OA} = \frac{2}{t}$, $m_{OB} = -\frac{2}{t}$

Thus, $\left(\frac{2}{t}\right)\left(-\frac{2}{t}\right) = -1 \Rightarrow t^2 = 4$

Thus, tangents will intersect at (–4a, 0)

4. Let directrix be $x = \frac{a}{e}$ and focus be S(ae, 0). Let P(a sec θ, b tan θ) be any point on the curve

Equation of tangent at P is $\frac{x\sec\theta}{a} - \frac{y\tan\theta}{b} = 1$

Let F be the intersection point of tangent at directrix

Then, $F \equiv \left(\frac{a}{e}, \frac{b(\sec\theta - e)}{e\tan\theta}\right)$

$\Rightarrow m_{SF} = \frac{b(\sec\theta - e)}{-e\tan\theta(a^2 - 1)}$, $m_{PS} = \frac{b\tan\theta}{a(\sec\theta - e)}$

$\Rightarrow m_{SF} \cdot m_{PS} = -1$

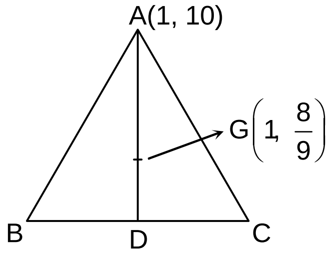
5. Circumcentre $O \equiv \left(-\frac{1}{3}, \frac{2}{3}\right)$ and

Orthocentre $H \equiv \left(\frac{11}{3}, \frac{4}{3}\right)$

Hence, co-ordinates of G are $\left(1, \frac{8}{9}\right)$

Now, AD : DG = 3 : 1

Hence, the co-ordinates of $D \equiv \left(1, -\frac{11}{3}\right)$



6. $\cos^3 x \sin 2x = \cos^2 x \cdot \cos x \cdot \sin 2x$

$= \left(\frac{1 - \cos 2x}{2}\right)\left(\frac{2\sin 2x \cos x}{2}\right)$

$= \frac{1}{4}(1 - \cos 2x)(\sin 3x + \sin x)$

$= \frac{1}{4}\left[\sin 3x + \sin x - \frac{1}{2}(2\sin 3x \cdot \cos 2x) - \frac{1}{2}(2\cos 2x \sin x)\right]$

$= \frac{1}{4}\left[\sin x + \frac{1}{2}\sin 3x - \frac{1}{2}\sin 5x\right]$

$\Rightarrow a_1 = \frac{1}{4}$, $a_3 = \frac{1}{8}$, n = 5

7. According to the question, 1 must lie between the roots
Since, $4p - p^2 - 5 < 0$, thus, $f(1) > 0$
$\Rightarrow p^2 - 5p + 4 < 0$
$\Rightarrow 1 < p < 4$
$\Rightarrow p \in \{2, 3\}$

8. Let $z = x + iy$. Then, $x = \lambda + 3$ and $y = -\sqrt{5-\lambda^2}$
$\Rightarrow (x - 3)^2 = \lambda^2$ and $y^2 = 5 - \lambda^2$
Thus, $(x - 3)^2 = 5 - y^2 \Rightarrow (x - 3)^2 + y^2 = 5$
It is a semicircle as $y < 0$

9. We have $\frac{\pi}{4} = \left(1-\frac{1}{3}\right)+\left(\frac{1}{5}-\frac{1}{7}\right)+\left(\frac{1}{9}-\frac{1}{11}\right)+.....$
$= \frac{2}{1\times 3}+\frac{2}{5\times 7}+\frac{2}{9\times 11}+.....$
$\Rightarrow \frac{1}{1\times 3}+\frac{1}{5\times 7}+\frac{1}{9\times 11}+..... = \frac{\pi}{8}$

10. $30 - 9\pi \in [0, \pi]$ is true but it is not principal value of $\cos^{-1}(\cos 30)$
as $\cos^{-1}(\cos 30) = \cos^{-1}(\cos(9\pi + (30 - 9\pi)))$
$= \cos^{-1}(-\cos(30 - 9\pi)) = \pi - (30 - 9\pi) = 10\pi - 30$

11. Locus of point of intersection of perpendicular tangents is director circle
If there exists exactly one such point on the line $3x + 4y + 5\sqrt{5} = 0$, then it must touch the director circle $x^2 + y^2 = a^2 + 1$
$\Rightarrow 5 = a^2 + 1$
$\Rightarrow a^2 = 4$
$\Rightarrow a = 2$
Hence, eccentricity = $\sqrt{1-\frac{1}{4}} = \frac{\sqrt{3}}{2}$

12. According to given data, $2a - 5 + a^2 - 3 < 0$
$\Rightarrow a^2 + 2a - 8 < 0$
$\Rightarrow a \in (-4, 2)$

13. Given equation is $px^2 + qx + r = 0$
Let, $f(x) = px^2 + qx + r$
$f(0) = r > 0$
$f(1) = p + q + r < 0$
$f(-1) = p - q + r < 0$
Hence, one root lies in $(-1, 0)$ and the other in $(0, 1)$
$\therefore [\alpha] = -1$ and $[\beta] = 0$
$\Rightarrow [\alpha] + [\beta] = -1$

14.-16. Let m and (m + 1) be the removed numbers from 1, 2, ….., n
Then, sum of the remaining numbers is $\frac{n(n+1)}{2} - (2m+1)$
From given conditions, $\frac{105}{4} = \frac{\frac{n(n+1)}{2} - (2m+1)}{n-2}$
$\Rightarrow 2n^2 - 103n - 8m + 206 = 0$
Since n and m are integers, so n must be even
Let n = 2k. Then, $m = \frac{4k^2 + 103(1-k)}{4}$
Since m is an integer, then $1 - k$ must be divisible by 4. Let $k = 1 + 4t$. Then we get $n = 8t + 2$ and $m = 16t^2 - 95t + 1$

Now, $1 < m < n$
$\Rightarrow 1 \le 16t^2 - 95t + 1 < 8t + 2$
Solving, we get t = 6. Hence, n = 50 and m = 7
Hence, the removed numbers are 7 and 8
Also, sum of all numbers is $\frac{50(50+1)}{2} = 1275$

17.-19. Suppose A contains r ($0 \le r \le n$) elements
Then, B is constructed by selecting some elements from the remaining n – r elements
Here, A can be chosen in ${}^nC_r$ ways and B in ${}^{n-r}C_0 + {}^{n-r}C_1 + \ldots + {}^{n-r}C_{n-r} = 2^{n-r}$ ways
So, the total number of ways of choosing A and B is ${}^nC_r \times 2^{n-r}$. But r can vary from 0 to n
So, total number of ways is $\sum_{r=0}^{n} {}^nC_r \times 2^{n-r} = (1+2)^n = 3^n$
If A contains r elements, then B contains (r + 1) elements
Then, the number of ways of choosing A and B is ${}^nC_r \times {}^nC_{r+1}$
But r can vary from 0 to (n – 1)
So, the number of ways is $\sum_{r=0}^{n-1} {}^nC_r {}^nC_{r+1} = {}^nC_0{}^nC_1 + {}^nC_1{}^nC_2 + \ldots + {}^nC_{n-1}{}^nC_n = {}^{2n}C_{n-1}$
Let A contains r($0 \le r \le n$) elements
Then, A can be chosen in ${}^nC_r$ ways. The subset B of A can have at most r elements, and the number of ways of choosing B is 2^r. Therefore, the number of ways of choosing A and B is ${}^nC_r \times 2^r$. But r can vary from 0 to n
So, the total number of ways is $\sum_{r=0}^{n} {}^nC_r \times 2^r = (1+2)^n = 3^n$

SECTION – B

1. (A) We must have, $e_1 < 1 < e_2$
$\Rightarrow f(1) < 0$
$\Rightarrow 1 - a + 2 < 0$
$\Rightarrow a > 3$

(B) We must have both roots greater than 1
(i) $D > 0$ or $a^2 - 4 > 0$ or $a \in (-\infty, -2) \cup (2, \infty)$
(ii) $1 \cdot f(1) > 0$ or $1 - a + 2 > 0$ or $a < 3$
(iii) $\frac{a}{2} > 1 \Rightarrow a > 2$
Thus, we have $a \in (2, 3)$

(C) We must have $\frac{1}{e_1^2} + \frac{1}{e_2^2} = 1$
$$\Rightarrow \frac{(e_1+e_2)^2 - 2e_1e_2}{e_1^2e_2^2} = 1$$
$$\Rightarrow \frac{a^2-4}{4} = 1$$
$\Rightarrow a = \pm 2\sqrt{2}$

(D) We must have $e_2 < \sqrt{2} < e_1$
$\Rightarrow f(\sqrt{2}) < 0$
$\Rightarrow 2 - a\sqrt{2} + 2 < 0$
$\Rightarrow a > 2\sqrt{2}$

2. (A) $\left(\sin^{-1}x\right)^2+\left(\sin^{-1}y\right)^2=\frac{\pi^2}{2}$

$\Rightarrow \left(\sin^{-1}x\right)^2=\left(\sin^{-1}y\right)^2=\frac{\pi^2}{4}$

$\Rightarrow \sin^{-1}x=\pm\frac{\pi}{2}$, $\sin^{-1}y=\pm\frac{\pi}{2}$

$\Rightarrow x = \pm1$ and $y = \pm 1$

$\Rightarrow x^3 + y^3 = -2, 0, 2$

(B) $\left(\cos^{-1}x\right)^2+\left(\cos^{-1}y\right)^2=2\pi^2$

$\Rightarrow \left(\cos^{-1}x\right)^2=\left(\cos^{-1}y\right)^2=\pi$

$\Rightarrow x = y = -1$

$\Rightarrow x^5 + y^5 = -2$

(C) $\left(\sin^{-1}x\right)^2\left(\cos^{-1}y\right)^2=\frac{\pi^4}{4}$

$\Rightarrow \left(\sin^{-1}x\right)^2=\frac{\pi^2}{4}$ and $\left(\cos^{-1}y\right)^2=\pi^2$

$\Rightarrow \left(\sin^{-1}x\right)=\pm\frac{\pi}{2}$ and $\left(\cos^{-1}y\right)=\pi$

$\Rightarrow x = \pm1$ and $y = -1$

$\Rightarrow |x - y| = 0, 2$

(D) $|\sin^{-1}x - \sin^{-1}y| = \pi$

$\Rightarrow \sin^{-1}x=-\frac{\pi}{2}$ and $\sin^{-1}y=\frac{\pi}{2}$

or $\sin^{-1}x=\frac{\pi}{2}$ and $\sin^{-1}y=-\frac{\pi}{2}$

$\Rightarrow x^y = 1^{(-1)}$ or $(-1) = 1$ or -1

3. (A) $z^4 - 1 = 0$

$\Rightarrow z^4 = 1 = \cos 0 + i \sin 0$

$\Rightarrow z = (\cos 0 + i \sin 0)^{1/4} = \cos 0 + i \sin 0$

(B) $z^4 + 1 = 0$

$\Rightarrow z^4 = -1 = \cos \pi + i \sin \pi$

$\Rightarrow z=(\cos\pi+i\sin\pi)^{1/4}=\cos\frac{\pi}{4}+i\sin\frac{\pi}{4}$

(C) $iz^4 + 1 = 0$

$\Rightarrow z^4 = i = \cos\frac{\pi}{2}+i\sin\frac{\pi}{2}$

$\Rightarrow z=\left(\cos\frac{\pi}{2}+i\sin\frac{\pi}{2}\right)^{1/4}=\cos\frac{\pi}{8}+i\sin\frac{\pi}{8}$

(D) $iz^4 - 1 = 0$

$z^4 = -i = \cos\frac{\pi}{2}-i\sin\frac{\pi}{2}$

$\Rightarrow z=\left(\cos\frac{\pi}{2}-i\sin\frac{\pi}{2}\right)^{1/4}=\cos\frac{\pi}{8}-i\sin\frac{\pi}{8}$

FIITJEE **JEE (Main), 2015**

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

ALL INDIA INTEGRATED TEST SERIES

HALF COURSE TEST – VII

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 30)** contains 30 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

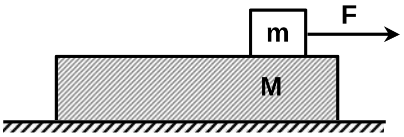
Physics

PART – I

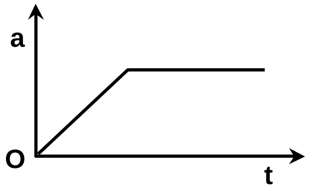
SECTION – A

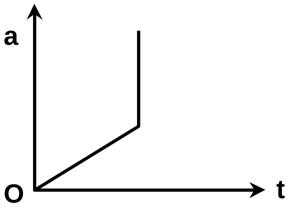
Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct



1. A block of mass m is placed on the plank of mass M as shown in the figure. Coefficient of friction between the surfaces of m and M is μ and there is no friction between ground and M. A horizontal force F = kt is applied on the block, where k is a constant and t is the time. Which of the following graphs shows the acceleration of the plank?

(A)


(B)


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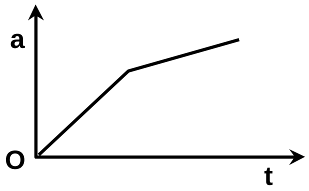
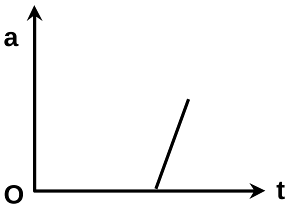
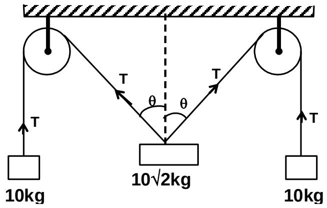


(D)




2. The pulleys and strings shown in the figure are smooth and of negligible mass. For the system to remain in equilibrium, the angle θ should be

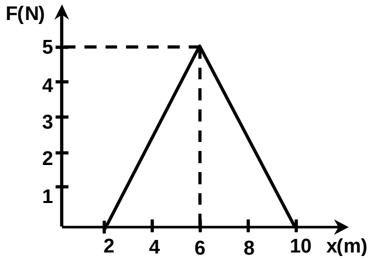
(A) 0°
(B) 30°
(C) 45°
(D) 60°

3. A body of mass m slides down on an incline plane. It reaches at the bottom with a velocity v. If the same mass were in the form of the ring which rolls down this inclined, the velocity of the ring at the bottom's

(A) $\sqrt{2}v$
(B) $\frac{1}{\sqrt{2}}v$
(C) v
(D) 2v

Space for rough work

4. A force shown in the F-x graph is applied to a 2 kg block horizontal as shown in the figure. The change in kinetic energy is
(A) 15 J
(B) 20 J
(C) 25 J
(D) 30 J



5. Two masses of 4 kg and 1 kg are moving in opposite direction with equal kinetic energies of 8 J. If the collision between the masses are perfectly inelastic the percentage loss of kinetic energy of the masses is
(A) 60% (B) 70%
(C) 80% (D) 90%

6. A particle of mass m and radius is moving in a horizontal circle of radius r with a centripetal force $F=-\frac{k}{r^2}\hat{r}$, where k = 1 unit. The total energy of the particle is
(A) $-\frac{k}{r}$ (B) $\frac{1.5k}{r}$
(C) $-\frac{k}{2r}$ (D) $-\frac{3k}{2r}$

7. A particle moves in the x-y plane under the action of a force $\vec{F}$ at any time t its linear momentum is given by $P_x = 2\cos(kt)$ and $P_y = 2\cos(kt)$

The angle between $\vec{F}$ and $\vec{P}$ at time t is
(A) 0° (B) 30°
(C) 90° (D) 180°

8. An ideal spring having force constant k is suspended from the rigid support and a block of mass M is attached to its lower end. The mass is released from the natural length of the spring. Then the maximum extension in the spring is
(A) $\frac{4Mg}{k}$ (B) $\frac{2Mg}{k}$
(C) $\frac{Mg}{k}$ (D) $\frac{Mg}{2k}$

Space for rough work

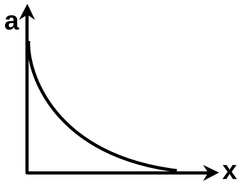
9. A particle of mass m is moving with a uniform speed v in x-y plane along a straight line, y = x+k, the angular momentum of the particle about the origin is

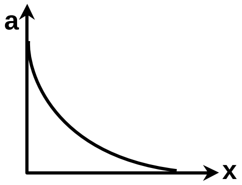
(A) $\frac{mvk}{\sqrt{2}}$ (B) $\frac{mvy}{\sqrt{2}}$
(C) $\frac{mvx}{\sqrt{2}}$ (D) mvk

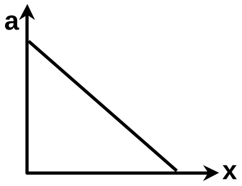
10. A disc and a ring having same mass M and radius R rotating about its axis which is normal to their plane. If both have the same angular momentum, then the ratio of acceleration of the particles at the circumference of the disc to the ring is

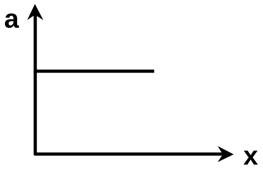
(A) 1 : 2 (B) 2 : 1
(C) 1 : 4 (D) 4 : 1

11. A spring-block system can oscillates on a smooth horizontal surface. If the spring is compressed and is released from rest. The graph between the acceleration of the block and the distance x travelled by it is given by

(A)


(B)


(C)


(D)


12. A hollow sphere is placed on a rough horizontal surface. A sharp impulse is given to the sphere horizontally towards its centre

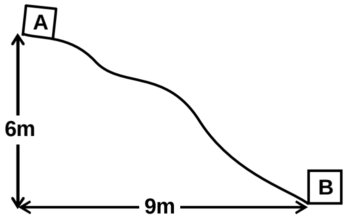
(A) A frictional force acts on the sphere throughout the motion.
(B) kinetic energy remains constant throughout the motion.
(C) kinetic energy of translation changes into rotation but total kinetic energy decreases initially and finally becomes constant.
(D) Work is done by the frictional force throughout the motion.

Space for rough work

13. The initial velocity of a particle is $\vec{u} = \left(2\hat{i} + 3\hat{j}\right)$m/s. A constant force $\vec{F} = \left(4\hat{i} + 3\hat{j}\right)$N acts on the particle. Hence
(A) Its velocity is constant.
(B) Its path is parabolic.
(C) its path is straight line.
(D) it moves on a circular path.

14. A particle moves along a curve y = $\frac{x^2}{2}$ and x = $\frac{t^2}{2}$, where x and y are measured in metre and t in seconds. At t = 2 sec. The velocity of the particle is
(A) $\left(2\hat{i} - 4\hat{j}\right)$m/s
(B) $\left(2\hat{i} + 4\hat{j}\right)$m/s
(C) $\left(4\hat{i} + 2\hat{j}\right)$m/s
(D) $\left(4\hat{i} - 2\hat{j}\right)$m/s

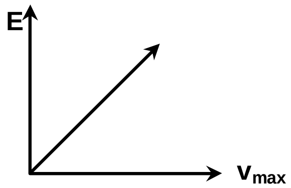
15. The 300 N crate slides down the curved path from A to B in the vertical plane as shown in the figure. If the crate has a velocity of 1.2 m/s down the inclined at point A and 8 m/s at B. Find the work done against friction during the motion

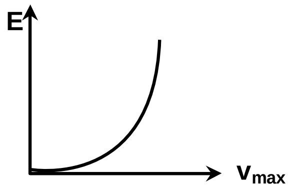


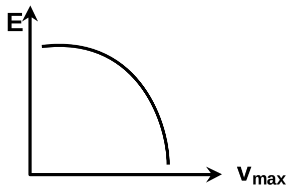
(A) 860 N m
(B) 987 N m
(C) 1200 N m
(D) 500 N m

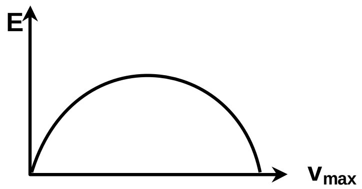
16. A block B of specific gravity 2 and another block C of specific gravity 0.5. Both are joined together and they are floating inside water such that they are completely dipped inside water, the ratio of the masses of the blocks B and C is
(A) 2 : 1
(B) 3 : 2
(C) 5 : 3
(D) 2 : 3

17. A source of sound emits sound waves in a uniform medium. If energy density is E and maximum speed of particles of the medium is v_{max} then the graph between E and v_{max} is best represented by

(A)


(B)


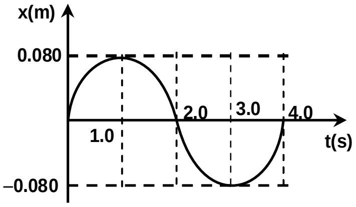
(C)


(D)


Space for rough work

18. The potential energy of a harmonic oscillation of mass 2 kg in its resting position is 5 joules. Its total energy is 9 joules and its amplitude is 1 cm. It is time period will be
(A) 3.14×10^{2} sec
(B) 3.14×10^{-2} sec
(C) 10^{3} sec
(D) data are not sufficient.

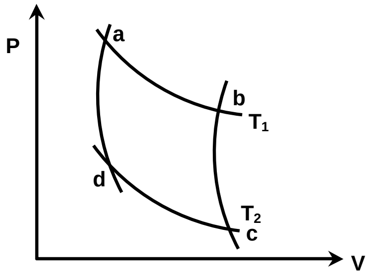
19. An object of mass 0.8 kg is attached to one end of a spring and the system is set into simple harmonic motion. The displacement x of the object as a function of time is shown in the figure with the aid of the data the magnitude of the objects acceleration at t = 1.0 is



(A) zero.
(B) 1.57 m/s^2
(C) 0.197 m/s^2
(D) 0.157 m/s^2

20. An air bubble 0.8 mm in diameter having density 1.293 kg/m^3 rise in a liquid of viscosity 0.15N-s/m^2 and specific gravity 0.9 with terminal velocity.
(A) 0.21 cm/s
(B) 0.42 cm/s
(C) 0.11 cm/s
(D) 0.183 cm/s

21. Two different adiabatic paths for the same gas intersects two isothermal T_1 and T_2 as shown in the P-V diagram. Then V_a/V_d is equal to



(A) $\frac{V_C}{V_b}$
(B) $V_C V_b$
(C) $\frac{V_b}{V_c}$
(D) $\frac{V_C V_b}{V_C + V_b}$

22. The potential energy of a particle oscillating along x-axis is given as U = 20+ $(x-2)^2$ where U is in joules and x in meters. Total mechanical energy of the particle is 36 J. Maximum kinetic energy of the particle is
(A) 24 J
(B) 36 J
(C) 16 J
(D) 20 J

23. Two spheres of the same material and same radius r are touching each other gravitational force between them is directly proportional to
(A) r^2
(B) r^3
(C) r^4
(D) r

Space for rough work

24. Force of attraction on a particle of mass m placed at the centre of a semicircular wire of length L and mass M is

(A) $\frac{GMm}{r^2}$ (B) $\frac{GMm}{2r^2}$

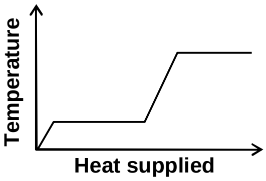
(C) zero (D) $\frac{2GMm\pi}{L^2}$

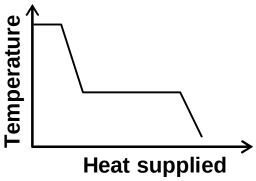
25. Starting with the same initial conditions if an ideal gas expands from volume V_1 to V_2 in three different ways. The work done by the gas is W_1 in the process is purely isothermal, W_2 is purely isobaric and W_3 is purely adiabatic, then

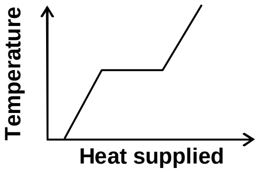
(A) $W_2 > W_1 > W_3$ (B) $W_2 > W_3 > W_1$

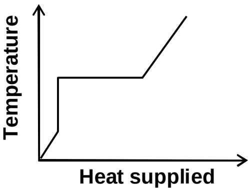
(C) $W_1 > W_2 > W_3$ (D) $W_1 > W_3 > W_2$

26. A block of ice at –10°C is slowly heated and converted to steam at 100°C. Which of the following curve represents the phenomenon qualitatively?

(A)


(B)


(C)


(D)


Space for rough work

27. A hollow sphere of radius R is made of metal whose specific gravity is ρ. The sphere will float in water if thickness of wall of the sphere is (thickness of the wall << R)

(A) $> \frac{R}{3\rho}$
(B) $= \frac{2R}{3\rho}$
(C) $< \frac{R}{3\rho}$
(D) $< \frac{4R}{3\rho}$

28. A tank containing a liquid, has two similar holes of area a on the opposite sides. The difference in height of two holes is y. If the tank has an open top and liquid jets out of the two holes, the net horizontal force experienced by the tank is given by

(A) $a\rho gy$
(B) $2a\rho gy$
(C) $\frac{1}{2}a\rho gy$
(D) $\frac{2}{3}a\rho gy$

29. When the temperature of a body increases from T to T + ΔT, its moment of inertia increases from I to I + ΔI. The coefficient of linear expansion of the body is α. The ratio $\Delta I/I$ is equal to

(A) $\frac{\Delta T}{T}$
(B) $\frac{2\Delta T}{T}$
(C) αT
(D) $2\alpha\Delta T$

30. Water rises in a capillary tube to a height of 2.0 cm. In another capillary tube whose radius is one third of it, water will rise to

(A) 2 cm
(B) 6 cm
(C) $\frac{2}{3}$ cm
(D) none of the above

Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. Find the orbital angular momentum of an electron having quantum numbers:
$n = 3,\ \ell = 2,\ m = 0,\ m_s = -\frac{1}{2}$

(A) $\frac{3h}{2\pi}$ (B) $3\hbar$

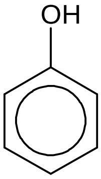
(C) $\sqrt{6}\,\hbar$ (D) $\sqrt{15}$ B.M.

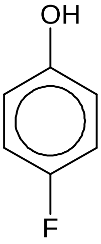
2. Oxidation number of carbon in carbon suboxide is

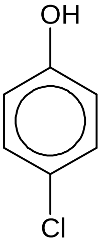
(A) $+\frac{2}{3}$ (B) $+\frac{4}{3}$

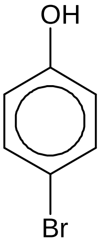
(C) +4 (D) $-\frac{4}{3}$

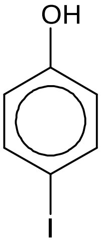
3. Arrange the following according to their increasing order of acidic strength:

(I) 

(II) 

(III) 

(IV) 

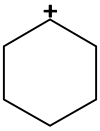
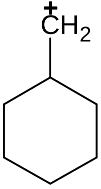
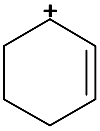
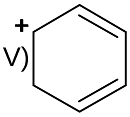
(V) 

(A) I < II < III < IV < V (B) III < I < II < IV < V
(C) I < II < V < IV < III (D) V < IV < III < II < I

Space for rough work

4. 10 moles of O_2 gas are contained in a cylinder of 5 litre capacity. If the cylinder leakage into atmosphere (pressure is 1 atm), then the work done by the gas will be
(A) –1.59 kJ
(B) –2.55 kJ
(C) –3.27 kJ
(D) –4.89 kJ

5. Arrange the following in an increasing order of stability:

(I) 
(II) 
(III) 
(IV) 

(A) I < II < III < IV
(B) IV < III < II < I
(C) II < I < III < IV
(D) III < I < IV < II

6. 90 gram of vicinal tetra bromopropane was reacted with $NaNH_2$ to form alkyne which then passes through ammonical $AgNO_3$ solution. The weight of precipitate formed will be
(A) 10.25 gm
(B) 36.75 gm
(C) 46.50 gm
(D) 54.28 gm

7. The volume of 0.1 M HCl required to react completely with 1 gm mixture of Na_2CO_3 and $NaHCO_3$ containing equimolar amount of two is
(A) 106 ml
(B) 128 ml
(C) 156 ml
(D) 212 ml

8. The volume of Cl_2 at STP react with 1 gm Fe to produce $FeCl_3$ will be
(A) 0.6 litre
(B) 1.2 litre
(C) 1.8 litre
(D) 2.2 litre

9. An electron whose total energy is -2.42×10^{-19} J given up a photon as its energy fall to -21.76×10^{-19} J. What is the wavelength of the emitted light?
(A) 806 $\overset{\circ}{A}$
(B) 1027 $\overset{\circ}{A}$
(C) 2812 $\overset{\circ}{A}$
(D) 5408 $\overset{\circ}{A}$

Space for rough work

10. What volume of N_2 at 300°C and 2.5 atm contains as many molecules as 2.5 L O_2 at STP?
(A) 1.6 L (B) 2.1 L
(C) 2.5 litre (D) 3.2 litre

11. The solubility of $Al(OH)_3$ at pH = 4, K_{sp} of $Al(OH)_3 = 5 \times 10^{-33}$
(A) 5×10^{-3} (B) 10×10^{-4}
(C) 1.53×10^{-8} (D) 2.6×10^{-3}

12. The dipole moment of NaCl molecule is 8.5 D and its bond length is 2.36 $\overset{\circ}{A}$. The percentage ionic character in this molecule will be
(A) 50.25 % (B) 60.30 %
(C) 75.03% (D) 100%

13. The solubility of $Cd(CN)_2$ in 0.050 M NaCN solution will be what? If the K_{sp} of $Cd(CN)_2$ is 1.0×10^{-8} m
(A) 1×10^{-6} (B) 1×10^{-8}
(C) 2×10^{-8} (D) 4×10^{-6}

14. Calculate free energy change for the following reaction at 298 K:
$$2NO(g) + Br_2(\ell) \longrightarrow 2NOBr(g)$$
Given the partial pressure of NO is 0.1 atm and the partial pressure of NOBr is 2.0 atm and $\Delta G_f{}^0{}_{NOBr} = 82.4$ kJmol^{-1}, $\Delta G^0{}_{NO} = 86.55$ kJmol^{-1}
(A) 6.7 kJ (B) –8.3 kJ
(C) –1.4 kJ (D) +8.3 kJ

15. What will be the activation energy of the reaction for which the rate of reaction triples with the temperature change by 15°C, from 298 K to 313 K?
(A) 36 kJ mol^{-1} (B) 40 kJ mole
(C) 48 kJmole (D) 57 kJ/mole^{-1}

16. A 200 ml solution of NaOH requires 100 ml of 0.44 M aqueous HCl for complete neutralization. The temperature of the mixture increased by 1.96 K. Calculate the enthalpy change for the neutralization of one mole of hydrogen ions. Given specific heat of water = 4.184 J/g K.
(A) –56 kJ (B) 40 kJ
(C) –90 kJ (D) –110 kJ

Space for rough work

17. For the equilibrium:
$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
If the equilibrium concentration of PCl_5(g) is doubled, the concentration of Cl_2(g) will be
(A) 1/2 of original value
(B) 1/4 of original value
(C) twice of original value
(D) none of these

18. Which of the following is correct for ClNO?
(A) shape is V – shaped and Cl – N – O bond angle is slightly less than 120°.
(B) shape is T – shaped and Cl – N – O bond angle is greater than 120°.
(C) shaped is linear and Cl – N – O bond angle is less than 120°
(D) none of these

19. Which of the following statements is correct for compound $HgCl_2$, $SnCl_2$ and F_2O have?
(A) all have linear shape
(B) $HgCl_2$ and $SnCl_2$ are linear and $HgCl_2$ is V – shaped
(C) $HgCl_2$ is linear while $SnCl_2$ and F_2O are V – shaped
(D) none of these

20. What is the molar mass of a gas if equal volume of oxygen gas and unknown gas take 3.25 and 8.41 minutes to effuse through a membrane respectively?
(A) 112 g/mole
(B) 160 g/mole
(C) 214 g/mole
(D) 306 g/mole

21. A 3.11 L container has 4.33 atm pressure at 27°C. If 2.11 L of gas at 2.55 atm is added to this container at same temperature. What will be the new pressure in the container?
(A) 4 atm
(B) 4.6 atm
(C) 5.2 atm
(D) 6.06 atm

22. What is the wavelength of light emitted by electron in C^{5+} ion during transition from n = 3 to n = 1?
(A) 2.92 nm
(B) 3.6 nm
(C) 8.7 nm
(D) 9.8 nm

23. Many gases when allowed to expand suddenly, there is a drop in temperature, but there is a pair of gas which do not obey this law are
(A) H_2, CO_2
(B) H_2, He
(C) Cl_2, O_2
(D) O_2, He

Space for rough work

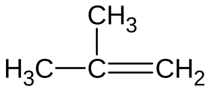
24. Calculate the weight of methane required to produce 356.4 kJ of heat on combustion. Given the heat of combustion of methane is –890.3 kJ
(A) 16 g
(B) 6.4 g
(C) 12.8 g
(D) 30.6 g

25. Molecular nitrogen can be converted into NO by the following reaction sequence,

$$N_2 + 3H_2 \longrightarrow 2NH_3$$

$$4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$$

Calculate the mass of NO formed from 100 g of N_2 with excess of H_2 and O_2?
(A) 100 gm
(B) 150.60 gm
(C) 214.28 gm
(D) 256.32 gm

26. A compound X having molecular formula C_4H_8 gives Y ($C_4H_{10}O$) when reacted with H_2O/H_2SO_4, Y can not be resolved in optical isomer. Compound X will be
(A) $H_3C—CH=CH—CH_3$
(B) $H_3C—CH_2—CH=CH_2$
(C)

$H_3C—\overset{\overset{\large CH_3}{|}}{C}=CH_2$
(D) None of these

27. Potassium salt of monocarboxylic acid containing n carbon atom undergo Kolbe's electrolysis then the alkane formed will contain number of carbon atom equal to
(A) 2n
(B) 2n+2
(C) 2n –1
(D) 2n – 2

28. Neopentyl bromide with alcoholic KOH gives the major product
(A) But – 2 – ene
(B) 2 - methyl but – 2 – ene
(C) 2 – methyl but – 1 – ene
(D) 2, 2 – dimethyl but – 1 – ene

29. Which of the following equilibrium will not be affected by adding inert gas at constant volume?
(A) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$
(B) $3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$
(C) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
(D) all the above

30. Which of the following statement is true about boron compounds?
(A) $BF_3 \Rightarrow$ least acidic among the boron halides
(B) $BF_3 \Rightarrow$ does not hydrolyses
(C) $B_2H_6 \Rightarrow$ does not have banana bond
(D) all are incorrect

Space for rough work

Mathematics

PART – III

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. A relation $R : A \to A$ be defined on set A which is union of disjoint sets $A_1A_2A_3....A_n$ having equal number of elements such that $\forall\ a \in A_i$ and $b \in A_j$ $(a, b) \in R$ if $i = j$ and $(a, b) \notin R$, if $i \neq j$
(A) if n(A) = 15 max value of n(R) is 45 (B) R is an equivalence relation
(C) $n(R) = [n(A)]^2$ (D) none of these

2. The value of a for which $2x^2 - 2(2a + 1)x + a(a + 1) = 0$ may have one root less that a and other root greater then 'a' are given by
(A) $1 > a > 0$ (B) $-1 < a < 0$
(C) $a \geq 0$ (D) $a > 0$ or $a < -1$

3. If $\sin^6 \theta + \cos^6 \theta + k \cos^2 2\theta = 1$, then k is equal to
(A) $\frac{1}{2}\tan^2 2\theta$ (B) $\frac{1}{4}\tan^2 2\theta$
(C) $4 \cot^2 2\theta$ (D) $\frac{3}{4}\tan^2 2\theta$

4. If $\frac{\tan x}{1} = \frac{\tan y}{2} = \frac{\tan x}{3}$ $(\neq 0)$ and $x + y + z = \pi$ then
(A) maximum value of tan x + tan y + tan z is –6 (B) minimum value of tan x + tan y + tan z is –6
(C) tan x tan y tan z = 1 (D) $\tan x + \tan y + \tan z = 0\ \forall\ x, y, z \in R$

5. If the equation $ax^2 + 25x - 3c = 0$ has non real roots and $\frac{3c}{4} < (a + b)$, then c is always
(A) negative (B) 0
(C) non-negative (D) zero

Space for rough work

6. Which of the following function is surjective but not injective

(A) $f : R \to R \; f(x) = x^4 + 2x^3 - x^2 + 1$ (B) $f : R \to R \; f(x) = x^3 + x + 1$

(C) $f : R \to R^+ \; f(x) = \sqrt{1+x^2}$ (D) $f : R \to R \; f(x) = x^3 + 2x^2 - x + 1$

7. If 5a + 4b + 20c = t, then the value of t for which the line ax + by + c – 1 = 0 always passes through a fixed point is

(A) 0 (B) 20
(C) 30 (D) none of these

8. The area bounded by the circles $x^2 + y^2 = r^2$, r = 1, 2 and the rays given by $2x^2 - 3xy - 2y^2 = 0$, y > 0 is

(A) $\frac{\pi}{4}$ sq. units (B) $\frac{\pi}{2}$ sq. units
(C) $\frac{3\pi}{4}$ sq. units (D) π sq. unit

9. The equation of the circle touching the lines |y| = x at a distance $\sqrt{2}$ units from the origin is

(A) $x^2 + y^2 - 4x + 2 = 0$ (B) $x^2 + y^2 + 4x - 2 = 0$
(C) $x^2 + y^2 + 4x + 2 = 0$ (D) none of these

10. If α, β, γ are the parameter of points A, B, C on the circle $x^2 + (y-2)^2 = a^2$ and if the ΔABC be equilateral, then

(A) $\sum \cos\alpha = 0$ (B) $\sum \sin\alpha = 0$
(C) $\sum \tan\alpha = 0$ (D) $\sum \cot\alpha = 0$

11. The orthocentre of the triangle formed by the pair of lines $2x^2 - xy - y^2 + x + 2y - 1 = 0$ and the line x + y + 1 = 0 is

(A) (–1, 0) (B) (0, 1)
(C) (–1, 1) (D) none of these

12. The equation $\sqrt{(x-2)^2 + y^2} + \sqrt{(x+2)^2 + y^2} = 4$ represents

(A) pair of lines (B) a parabola
(C) a hyperbola (D) none of these

Space for rough work

13. The pole of the line $\ell x + my + n = 0$ with respect to the parabola $y^2 = 4ax$

(A) $\left(-\frac{h}{\ell}, \frac{2am}{\ell}\right)$ (B) $\left(\frac{h}{\ell}, -\frac{2am}{\ell}\right)$

(C) $\left(-\frac{h}{\ell}, \frac{2am}{\ell}\right)$ (D) $\left(-\frac{h}{\ell}, -\frac{2am}{\ell}\right)$

14. If $\frac{x}{a}+\frac{y}{b}=\sqrt{2}$ touches the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ then the eccentric angle θ of the point of contact is equal to

(A) 0 (B) 90º
(C) 45º (D) 60º

15. If e, e′ be the eccentricities of two conics S and S′ and if $e^2 + e'^2 = 3$ then both S ands S′ can be

(A) hyperbolas (B) ellipse
(C) parabolas (D) none of these

16. Base angle of a triangle are $22\frac{1}{2}^{o}$ and $112\frac{1}{2}^{o}$ then find the height of triangle

(A) equal to base (B) one third of base
(C) half of base (D) one forth of base

17. If in a triangle ΔABC a, b, c are roots of the equation $x^3 - 11x^2 + 38x - 40 = 0$ then $\sum\frac{\cot A}{a}$ is equal to

(A) $\frac{3}{4}$ (B) 1

(C) $\frac{9}{16}$ (D) none of these

18. Two circles with radii a and b touch each other externally such that θ is the angle between their direct common tangents ($a > b \geq 2$), then

(A) $\theta = 2\cos^{-1}\left(\frac{a-b}{a+b}\right)$ (B) $\theta = 2\sin^{-1}\left(\frac{a+b}{a-b}\right)$

(C) $\theta = 2\cos^{-1}\left(\frac{a+b}{a-b}\right)$ (D) $\theta = 2\sin^{-1}\left(\frac{a-b}{a+b}\right)$

Space for rough work

19. If 'd' is the distance between parallel tangents with positive slope to $y^2 = 4x$ and $x^2 + y^2 - 2x + 4y - 11 = 0$

(A) $10 < d < 2$ (B) $4 < d < 6$
(C) $d < 4$ (D) none of these

20. Let P be any point on a directrix of an ellipse of eccentricity e, S be the corresponding focus and C is the centre of the ellipse. The line PC meets the ellipse at A and the angle between PS and tangent at A is α, then α is equal to

(A) $\tan^{-1} e$ (B) $\frac{\pi}{2}$
(C) $\tan(1 - e^2)$ (D) none of these

21. The equation $4x^2 + mxy - 3y^2 = 0$ represents a pair of real and distinct lines if

(A) $m \in R$ (B) $m \in (3, 4)$
(C) $m \in (-3, 4)$ (D) $m > 4$

22. In any triangle ABC, $\sum\left(\frac{\sin^2 A + \sin A + 1}{\sin A}\right)$ is always greater then or equal to

(A) 9 (B) 3
(C) 27 (D) none of these

23. ABCD is a square of side length a, $a \in N$, $a > 1$. Let L_1, L_2, L_3 ..... be points on BC such that $BL_1 = L_1L_2 = L_2L_3 = ... = 1$ and M_1, M_2, M_3 ..... be points on CD such that $CM_1 = M_1M_2 = M_2M_3 = ... = 1$, then $\sum_{n=1}^{a-1}\left(AL_n^2 + L_nM_n^2\right)$ is equal to

(A) $\frac{1}{2}a(a-1)^2$ (B) $\frac{1}{2}a(a-1)(4a-1)$
(C) $\frac{1}{2}(a-1)(2a-1)(4a-1)$ (D) none of these

24. The value of $\sum_{r=1}^{n}\frac{1}{\sqrt{a+rx}+\sqrt{a+(r-1)x}}$ is

(A) $\frac{n}{\sqrt{a}+\sqrt{a+nx}}$ (B) $\frac{\sqrt{a+nx}-\sqrt{a}}{x}$
(C) $\frac{n\left(\sqrt{a+nx}-a\right)}{x}$ (D) none of these

Space for rough work

25. If α and β are the distinct real roots of $x^2 + ax + b = 0$ and α^4 and β^4 are the roots of $x^2 - px + q = 0$ then the roots of $x^2 - 4bx + 2b^2 - p = 0$ are always
(A) both non-real
(B) both positive
(C) both negative
(D) one positive and other negative

26. The solution set of the equation $\log_x 2 \cdot \log_{2x} 2 = \log_{4x} 2$ is
(A) $\left\{2^{-\sqrt{2}},\ 2^{\sqrt{2}}\right\}$
(B) $\left\{\frac{1}{2},\ 2\right\}$
(C) $\left\{\frac{1}{4},\ 2^2\right\}$
(D) none of these

27. The equation of ellipse whose foci are ($\pm$5, 0) and one of its directrix is 5x = 36 is
(A) $\frac{x^2}{36} + \frac{y^2}{11} = 1$
(B) $\frac{x^2}{6} + \frac{y^2}{\sqrt{11}} = 1$
(C) $\frac{x^2}{6} + \frac{y^2}{11} = 1$
(D) none of these

28. The value of x and y satisfying the equation
$\sin^7 y = |x^3 - x^2 - 9x + 9| + |x^3 - 4x - x^2 + 4| + \sec^2 2y + \cos^4 y$ are
(A) $x = 6,\ y = n\pi$
(B) $x = 1,\ y = 2n\pi + \frac{\pi}{2}$
(C) $x = 1,\ y = 2n\pi$
(D) none of these

29. The equation of the tangents to the conic $3x^2 - y^2 = 3$ perpendicular to the line $x + 3y = 2$ is
(A) $y = 2x \pm \sqrt{6}$
(B) $y = 6x \pm \sqrt{3}$
(C) $y = x \pm \sqrt{6}$
(D) $y = 3x \pm \sqrt{6}$

30. The domain of the function $f(x) = \log_{3+x}\left(x^2 - 1\right)$ is
(A) $(-3, -1) \cup (1, \infty)$
(B) $[-3, -1) \cup [1, \infty)$
(C) $(-3, -2) \cup (-2, -1) \cup (1, \infty)$
(D) $[-3, -2) \cup (-2, -1)$

Space for rough work

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Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**A**	**C**	**B**
2.	**C**	**B**	**D**
3.	**B**	**C**	**D**
4.	**B**	**B**	**B**
5.	**D**	**C**	**A**
6.	**C**	**B**	**D**
7.	**D**	**C**	**B**
8.	**B**	**A**	**C**
9.	**A**	**B**	**A**
10.	**D**	**B**	**A**
11.	**C**	**A**	**A**
12.	**C**	**C**	**A**
13.	**B**	**D**	**B**
14.	**B**	**A**	**C**
15.	**A**	**D**	**A**
16.	**A**	**A**	**C**
17.	**B**	**D**	**C**
18.	**B**	**A**	**D**
19.	**C**	**C**	**C**
20.	**A**	**C**	**B**
21.	**C**	**D**	**A**
22.	**C**	**A**	**A**
23.	**C**	**B**	**B**
24.	**D**	**B**	**A**
25.	**A**	**C**	**D**
26.	**A**	**C**	**A**
27.	**C**	**D**	**A**
28.	**B**	**B**	**B**
29.	**D**	**D**	**D**
30.	**B**	**A**	**C**

Physics

PART – I

1. Initial acceleration a = $\frac{kt}{M+m}$

After some instant upper block slide over the plank and hence acceleration of the plank remains constant.

3. mgh = $\frac{1}{2}mv^2$ . . . (1)

$$\frac{1}{2}\lambda mR^2 \times \omega^2 + \frac{1}{2}mv^2 = mgh$$

$$\Rightarrow\ v' = \frac{v}{\sqrt{2}}$$

4. Change in kinetic energy Δk = $\frac{1}{2} \times 8 \times 5 = 20J$

5. Kinetic energy, k = $\frac{1}{2}mv^2$

$v_1 = 2\,m/s$ and $v_2 = 4\,m/s$

Now $4 \times 2 - 1 \times 4 = (4+1)v$

$$\Rightarrow\ v = \frac{4}{5}$$

$$\therefore\ \frac{\Delta k}{k} \times 100 = \left(\frac{8 \times 9}{16 \times 5}\right) \times 100 = 90\%$$

6. F = $-\frac{k}{r^2} = \frac{mv^2}{r}$

$$\Rightarrow\ KE = \frac{1}{2}mv^2 = \frac{-k}{2r}$$

and potential energy = $-\int Fdr = \int \frac{k}{r^2}dr = \left[-\frac{k}{r}\right]$

7. $\vec{P} = 2\cos kt\left(\hat{i} + \hat{j}\right)$

$\vec{F} = -2k\sin kt\left(\hat{i} + \hat{j}\right)$

Angle between $\vec{F}$ and $\vec{P}$ is 180°

8. Potential energy = $\frac{1}{2}kx^2 = Mgx$

$$\Rightarrow x = \frac{2Mg}{k}$$

9. y = mx + c and y = x+k

$\Rightarrow$ $\theta = 45°$ and c = k

$\therefore$ Angular momentum, L = mv $mv \times k \times \frac{1}{\sqrt{2}} = \frac{mvk}{\sqrt{2}}$

10. Angular momentum, L = Iω

$$\frac{MR^2}{2}\omega_1 = mR^2\omega_2 \Rightarrow \omega_1 = 2\omega_2$$

$$\frac{a_1}{a_2} = \frac{\omega_1^2 R}{\omega_2^2 R} = 4:1$$

11. F = kx = ma

$\Rightarrow$ $a \propto -x$

14. y = $\frac{x^2}{2}$ = $\frac{t^4}{8}$

$v_y = 4$ (At t = 2 sec)

and x=$\frac{t^2}{2}$

$v_x = 2$ (At t = 2 sec)

$\left(2\hat{i} + 4\hat{j}\right)$m/s

16. From the principle of flotation

$$g\left(m_B + m_C\right) = \left(\frac{m_B}{\rho_B} + \frac{m_C}{\rho_C}\right) \times 1 \times g$$

$$\left(m_B + m_C\right) = \frac{m_B}{2} + \frac{m_C}{0.5}$$

$$\frac{m_B}{m_C} = \frac{2}{1}$$

17. $v_{max} = A\omega = 2\pi fA$

Energy density E = $\frac{1}{2}\rho v_{max}^2$

So the curve between E and v_{max} is a parabola of increasing slope and symmetric about y-axis.

18. $\frac{1}{2}kA^2 = 9.5 = 4J$

$$k = \frac{8}{A^2} = \frac{8}{\left(10^{-2}\right)^2} = 8 \times 10^4 \text{ N/m}$$

$$T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{2.0}{8 \times 10^4}} = 3.14 \times 10^{-2} \text{ sec}$$

19. From the figure

T = 4 sec

$$\omega = \frac{2\pi}{T} = \frac{\pi}{2} = 1.57\,\text{rad/sec}$$

$$\omega = \sqrt{\frac{k\omega}{m}} \Rightarrow k = (0.8)\left(\frac{\pi}{2}\right)^2 = 1.97\,\text{N/m}$$

$$|a| = \omega^2 x = 0.197\,\text{m/s}^2$$

20. $$6\pi\eta r v_T + \frac{4}{3}\pi r^3 \rho_{air} g = \frac{4}{3}\pi r^3 \rho_\ell g$$

$$v_T = \frac{2r^2(\rho_\ell - \rho_{air})g}{9\eta}$$

Substituting values we get,

$$v_T = 0.21\ \text{cm/s}$$

21. $$T_1(V_a)^{\gamma-1} = T_2(V_d)^{\gamma-1}$$

$$\frac{T_1}{T_2} = \left(\frac{V_d}{V_a}\right)^{\gamma-1}$$

Also

$$T_1(V_b)^{\gamma-1} = T_2(V_c)^{\gamma-1}$$

$$\frac{T_1}{T_2} = \left(\frac{V_c}{V_b}\right)^{\gamma-1}$$

$$\frac{V_a}{V_d} = \frac{V_b}{V_c}$$

22. $$k_{max} = E - U_{min}$$

=36 – 20 = 16 J

23. $$m_1 = m_2 = \text{volume} \times \text{density}$$

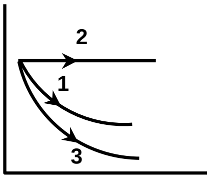
$$F = \frac{Gm_1m_2}{r^2} = \frac{G\left(\frac{4}{3}\pi r^3\right)\left(\frac{4}{3}\pi r^3\right)\rho^2}{r^2}$$

$$F \propto r^4$$

24. $$F = -\int_0^\pi \frac{Gm\left(\frac{M}{L}\right)rd\theta.\sin\theta}{r^2} = \frac{GMm}{Lr}\cos\theta\Big|_0^\pi$$

$$= \frac{GMm}{Lr}(-1) - \frac{GMm}{Lr} = \frac{2GMm}{Lr} = \frac{2GMm\pi}{L^2}$$

25. Area under PV graph = work done
Here area $A_2 >$ Area $A_1 >$ Area A_3



27. Let the thickness of the wall is t
Weight of the sphere = $\frac{4}{3}\pi\left[R^3 - (R-t)^3\right]$
Weight of the sphere = $\frac{4}{3}\pi R^3$
For flotation $\frac{4}{3}\pi R^3 > \frac{4\pi\rho}{3}\left[R^3 - (R-t)^3\right]$
$t \le \frac{R}{3\rho}$

28. Velocity of liquid from bottom hole $v_1 = \sqrt{2g(h+y)}$
Velocity of liquid from top hole $v_2 = \sqrt{2gh}$
Force on upper hole = $a\rho v_2^2$
Force on lower hole = $a\rho v_1^2$
Net force on the tank = $a\rho\left(v_1^2 - v_2^2\right) = 2a\rho gy$

Chemistry

PART – II

4. $V_1 = 5$ litre

$P_{ext} = 1$ atm, $T = 40° + 273 = 313$ K

$$V_2 = \frac{nRT}{P} = \frac{10 \times 0.0821 \times 313}{1} = 256.97 \text{ litre}$$

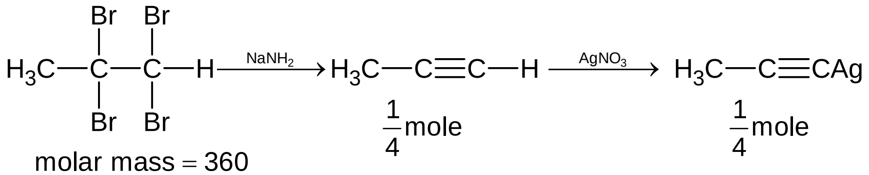
$W = -P_{ext}(V_2 - V_1)$

$= -1(256.97 - 5) = 251.97$ L atm

$= -251.97 \times 101.3$ J

$= -25524.8$ J $= -2.55$ kJ

6.



$$H_3C-\underset{Br}{\overset{Br}{C}}-\underset{Br}{\overset{Br}{C}}-H \xrightarrow{NaNH_2} \underset{\frac{1}{4}\text{mole}}{H_3C-C\equiv C-H} \xrightarrow{AgNO_3} \underset{\frac{1}{4}\text{mole}}{H_3C-C\equiv CAg}$$

molar mass $= 360$

$$\text{mole} = \frac{90}{360} = \frac{1}{4}$$

Mole of ppt = $\frac{1}{4}$mole

Weight = $\frac{1}{4} \times 147 = 36.75$

7. $\underset{n=2}{Na_2CO_3} + 2HCl \longrightarrow 2NaCl + Na_2CO_3$

$\underset{n=1}{NaHCO_3} + HCl \longrightarrow NaCl + CO_2 + H_2O$

	Na_2CO_3	$+NaHCO_3$
Wt.	x gm	$1-x$

$$\text{Mole} = \frac{x}{106} = \frac{1-x}{86} \quad ...(1) \text{ equimolar amount}$$

Meq of Na_2CO_3 + Meq of $NaHCO_3$ = Meq of HCl

$$\frac{x}{106} \times 2 + \frac{1-x}{86} = 0.1 \times V \quad ...(2)$$

From (1)

$$\frac{x}{106} = \frac{1-x}{86}$$

$86x = 106 - 106x$

$192x = 106 \Rightarrow x = 0.552$

$1 - x = 0.448$

From (2)

$$\frac{0.552}{106} \times 2 + \frac{0.448}{86} = 0.1 \times V$$

$0.0104 + 0.00520 = 0.1 \times V$

$0.01562 = 0.1$ V

V = 0.1562 litre

V = 156 ml

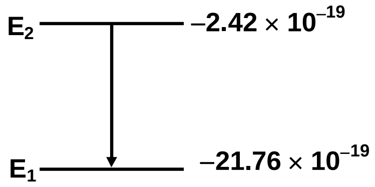
8. $3Cl_2 + 2Fe \longrightarrow 2FeCl_3(s)$

$\text{moles of Fe} = \frac{1}{56} = 0.01786$

mole of Cl_2 = $\frac{3}{2} \times 0.01786 = 0.02678$

Requirement volume of Cl_2 at STP will = 0.02678 × 22.4
= 0.6 litre

9.



$\Delta E = E_2 - E_1$

$= -2.42 \times 10^{-19} + 21.76 \times 10^{-19} = \frac{hc}{\lambda}$

$\text{or } 19.34 \times 10^{-19} = \frac{6.625 \times 10^{-34}}{\lambda} \times 3 \times 10^{8}$

$\lambda = \frac{19.875 \times 10^{-26}}{19.34 \times 10^{-19}} = 1.0276 \times 10^{-7} \text{m}$

$= 1027 \overset{\circ}{A}$

10. 2.5 litre O_2 at STP

Moles of O_2 = $\frac{2.5}{22.4} = 0.1116$

For N_2:
PV = nRT
2.5 × V = 0.1116 × 0.0821 × 573
V = 2.1 litre

12. $\mu_{exp} = e \times d = (4.8 \times 10^{-10}) \times (2.36 \times 10^{-8})$ e.s.u cm

$= 11.328 \times 10^{-18}$ e.s.u × cm
= 11.328 D

% ionic character = $\frac{\mu_{obs}}{\mu_{exp}} \times 100 = \frac{8.5}{11.328} \times 100$

= 75.03%

13. $Cd(CN)_2 \rightleftharpoons Cd^{2+} + 2CN^-$

$\qquad\qquad S \quad (2S + 0.50)$

$NaCN \longrightarrow Na^+ + CN^-$

$\qquad\qquad 0.50\text{ M}$

$K_{sp} = S \times (0.05)^2$

$S = \frac{1 \times 10^{-8} \times 100 \times 100}{0.05 \times 0.05}$

$= 4 \times 10^{-6}$

14. $\Delta G^0 = 2\left[\Delta G_f^0 NOBr\right] - 2\left[\Delta G_f^0 NO\right] + \Delta G_f^0\left[Br_2\right]$

$= 2 \times 82.4 - 2 \times 86.55 + 1 \times 0$

$= -8.3$ kJ $= -8.3 \times 10^3$ J

Now, $2NO(g) + Br_2(\ell) \longrightarrow 2NOBr$

$$Q_p = \frac{(pNOBr(g))^2}{(pNO(g))^2} = \frac{2^2}{(0.1)^2} = 4 \times 10^2$$

$\Delta G = \Delta G^0 + RT \ln Q_p$

$= -8.3 \times 10^3 + (8.314 \times 298) \ln 4 \times 10^2$

$= -8.3 \times 10^3 + 1.5 \times 10^4$ J

$= +6.7 \times 10^3 = 6.7$ kJ

15. $$\ln\frac{K_1}{K_2} = -\frac{E_a}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

$$\ln\left(\frac{1}{3}\right) = -\frac{E_a}{8.314}\left[\frac{1}{298} - \frac{1}{313}\right]$$

$\Rightarrow E_a = 5.7 \times 10^4\ \text{Jmol}^{-1}$

= 57 kJ/mole

16. Since specific heat of solution is not given assuming dilute have the same specific heat capacity as does water.

$q = mc_s\Delta T$

$= 300 \times 4.18 \times (1.96)$

= 2.46 kJ

Volume of solution = 100 + 200 ml

= 300

Weight of solution = 300 g

This heat flow is used to calculate ΔH for 1 mole of the reaction.

$HCl(aq) + NaOH(aq) \longrightarrow NaCl(aq) + H_2O(\ell)$

Moles of HCl reacted = 0.1 × 0.44

= 0.044 mole

1 mole HCl yield 1 mole of H^+

0.044 mole HCl yield 0.044 mole of H^+

$H^+ + OH^- \longrightarrow H_2O(\ell)$

Neutralization of 0.044 mole of H^+ generates 2.46 kJ of heat.

The reaction is exothermic:

ΔH = –ve

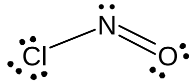
4.4×10^{-2} mole H^+ (aq) = –2.46 kJ

1 mole H^+ (aq) $= -\dfrac{2.46}{4.4 \times 10^{-2}}$

= –56 kJ

$\Delta H_{reaction} = -56$ kJ

18.



19.

	σ bond pair	Lone pair	Hybridization	Shape
$HgCl_2$	2	0	sp	Linear
$SnCl_2$	2	1	sp^2	V – shape
F_2O	2	2	sp^3	V – shape

20. $$\frac{t_x}{t_{O_2}} = \sqrt{\frac{M_x}{M_{O_2}}} \Rightarrow \frac{8.41}{3.25} = \sqrt{\frac{M_x}{M_{O_2}}}$$

$\Rightarrow M_x = 214.27$

21. Initially moles of gas at 4.33 atm

$$n_1 = \frac{PV}{RT} = \frac{4.33\times 3.11}{RT} \qquad ...(1)$$

Moles of gas in 2.11 L container at 2.55 atm

$$n_2 = \frac{2.55\times 2.11}{RT} \qquad ...(2)$$

On adding total moles = $n_1 + n_2$

$$\frac{4.33\times 3.11}{RT} + \frac{2.55\times 2.11}{RT}$$

New pressure in the container of volume 3.11 L

$$P = \frac{nRT}{V} = \left[\frac{4.33\times 3.11 + 2.55\times 2.11}{RT\times 3.11}\right]RT = 6.06 \text{ atm}$$

22. $$\frac{1}{\lambda} = Z^2 R_H\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$R_H = 1.097 \times 10^7 \text{ m}^{-1}$

Z = 6 for carbon

$n_1 = 1, n_2 = 3$

$$\frac{1}{\lambda} = 1.097\times 10^7 \times (6)^2\left[\frac{1}{1^2} - \frac{1}{3^2}\right]$$

$$= 1.097\times 10^7 \times 36\left[\frac{9-1}{9}\right]$$

$$= 1.097\times 10^7 \times 36 \times \frac{8}{9} = 35.1\times 10^7 = 2.85 \times 10^{-9} = 2.85 \text{ nm}$$

24. $$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(\ell)$$

$\Delta H = -890.3$ kJ

1 mole CH_4 produce = –890.3 kJ

$\Rightarrow$ –890.3 kJ heat is produced by 1 mole CH_4

1 kJ heat is produced by $\frac{1}{890.3}$ mole CH_4

356.4 kJ heat is produced by $\frac{356.4}{890.3} = 0.4$ mole

Weight of CH_4 required = 0.4 × 16 = 6.4 gm

25.

$$\begin{array}{lccccc} & N_2 & + & 3H_2 & \longrightarrow & 2NH_3 \\ \text{mole} = & \frac{100}{28} & & & & \frac{100}{28}\times 2 \end{array}$$

$$4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$$

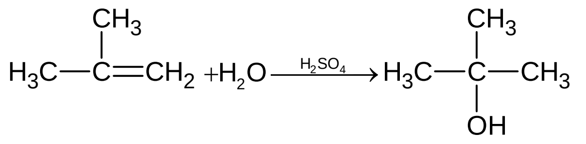
4 mole NH_3 gives 4 mole of NO

$\frac{200}{28}$ mole NH_3 gives 4 moles of $\frac{200}{28}$ mole of NO

Moles of NO formed from 100 g N_2 = $\frac{200}{28}$

Weight of NO formed = $\frac{200}{28} \times 30\text{gm} = 214.28$ gm

26.

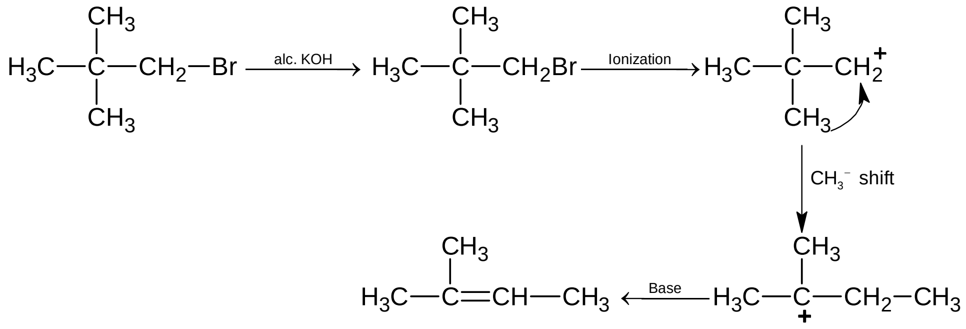


$$H_3C-\overset{\overset{CH_3}{|}}{C}=CH_2 + H_2O \xrightarrow{H_2SO_4} H_3C-\underset{\underset{OH}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_3$$

Optically inactive

27. During electrolysis, two molecule of potassium salt of mono carboxylic acid combine to form alkane along with the lost of two COO^- group. Hence alkane formed will contain = 2n – 2 (no of C–atom).

28.



$$H_3C-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_2-Br \xrightarrow{\text{alc. KOH}} H_3C-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_2Br \xrightarrow{\text{Ionization}} H_3C-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-\overset{+}{C}H_2 \xrightarrow{CH_3^-\ \text{shift}} H_3C-\underset{+}{\overset{\overset{CH_3}{|}}{C}}-CH_2-CH_3 \xrightarrow{\text{Base}} H_3C-\overset{\overset{CH_3}{|}}{C}=CH-CH_3$$

29. Adding inert gas at constant volume does not affect any equilibrium whether $\Delta n \geq 0$ or $\Delta n \leq 0$.

30. BF_3 is least acidic among boron halide.

Mathematics PART – III

1. (a, b) $\in$ R if a and b $\in A_j$
$\Rightarrow$ (b, a) $\in$ R which gives symmetry
(a, a) $\in$ R gives reflexivity
Similar argument gives transitivity also max value of n(R) = 15^2

2. The given condition suggest that a lies between the roots. Let $f(x) = 2x^2 - 2(2a + 1)x + a(a + 1)$ for a to lie between the roots, f(a) < 0
$2a^2 - 2a(2a + 1) + a(a + 1) < 0$
$-a^2 - a < 0$
$a^2 + a > 0$
a > 0 or a < –1

3. $\sin^6\theta + \cos^6\theta + k\cos^2 2\theta = 1$
$(\sin^2\theta + \cos^2\theta)(\sin^4\theta - \sin^2\theta\cos^2\theta + \cos^4\theta) + k\cos^2 2\theta = 1$
$\sin^4\theta + \cos^4\theta - \sin^2\theta\cos^2\theta + k\cos^2 2\theta = 1$
$(\sin^2\theta + \cos^2\theta)^2 - 3\sin^2\theta\cos^2\theta + k\cos^2 2\theta = 1$
$3\sin^2\theta\cos^2\theta = k\cos^2 2\theta$
$$\frac{3}{4}\sin^2 2\theta = k\cos^2 2\theta$$
$$k = \frac{3}{4}\tan^2 2\theta$$

4. $\tan x = \lambda$, $\tan y = 2\lambda$, $\tan z = 3\lambda$
$x + y + z = \pi$
tan x + tan y + tan z = tan x tan y tan z
$6\lambda = 6\lambda^2 \Rightarrow 6\lambda(\lambda^2 - 1) = 0$
$\lambda = \pm1$, $(\lambda \neq 0)$
tan x = ±1, tan y = ±2, tan z = ±3
tan x + tan y + tan z = ±6
Maximum value 6 minimum values is –6

5. Let $f(x) = ax^2 + 25x - 3c$
Since f(x) = 0 has non real roots, f(x) will have the same sign for all values of x
Given $\frac{3c}{4} < (a + b)$
$\Rightarrow 4a + 4b - 3c > 0$
f(2) > 0
$f(x) > 0\ \forall\ x \in R$
f(0) > 0
$\Rightarrow c < 0$

6. (A) $f(x) = x^4 + 2x^3 - x^2 + 1 \rightarrow$ A polynomial of degree even will always be into say
$$f(x) = a_0x^{2n} + a_1x^{2n-1} + a_2x^{2n-2} + ... + a_{2n}$$
$$\underset{x\to\pm\infty}{\text{Limit}}\ f(x) = \underset{x\to\pm\infty}{\text{Limit}}\ [x^{2n}\left(a_0 + \frac{a_1}{x} + \frac{a_2}{x^2} + ... + \frac{a_{2n}}{x^{2n}}\right) = \left[\begin{array}{ll} \infty & \text{if } a_0 > 0 \\ -\infty & \text{if } a_0 < 0 \end{array}\right.$$
Hence it will never approach $\infty / -\infty$
(B) $f(x) = x^3 + x + 1 \Rightarrow f'(x) = 3x^2 + 1$ - injective as well as surjective

(C) $f(x) = \sqrt{1+x^2}$ – neither injective nor surjective (minimum value = 1)

$f(x) = x^3 + 2x^2 - x + 1 \Rightarrow f'(x) = 3x^2 + 4x - 1 \Rightarrow D > 0$

Hence f(x) is surjective but not injective

7. Given equation of line is $\frac{ax}{c-1} + \frac{by}{c-1} + 1 = 0$

Line contains two independent parameters $\frac{a}{c-1}$ and $\frac{b}{c-1}$. A line will pass through a fixed point if it contains only one independent parameter

$\Rightarrow 5a + 4b + 20c = t$

$\frac{5a}{c-1} + \frac{4b}{c-1} = \frac{t-20c}{c-1}$

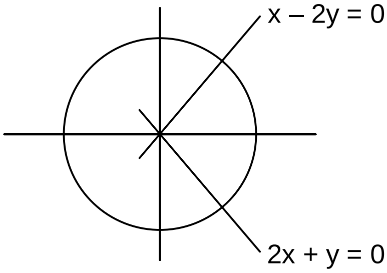
In this equation R.H.S will the independent of c if t = 20. Then we can express $\frac{b}{c-1}$ in terms of $\frac{a}{c-1}$ and vice-versa. Hence, if t = 20 then line will pass through a fixed point

8. $2x^2 - 3xy - 2y^2 = 0$

$(x - 2y)(2x + y) = 0$

Which represents a pair of perpendicular lines passing through the origin

Required area = $\frac{\pi(2)^2}{4} - \frac{\pi(1)^2}{4} = \frac{3\pi}{4}$ sq. units



9. As x = |y| > 0

Circle lies in I and IV quadrant

Centre of circle lies on x-axis

$OC = \sqrt{(OA)^2 + (AC)^2} = \sqrt{2+2} = 2$

Equation of circle is $(x - 2)^2 + (y - 0)^2 = 2$

$x^2 + y^2 - 4x + 2 = 0$

10. The point A is $(a \cos \alpha, 2 + a \sin \alpha)$

Since the triangle ABC is equilateral its circum centre (0, 2) coincides with its centroid

$\left(\frac{1}{3}\sum \cos\alpha, \frac{1}{3}\sum \sin\alpha\right) = (0, 2)$

$\sum \cos\alpha = 0$ and $\sum \sin\alpha = 6$

11. $2x^2 - xy - y^2 + x + 2y - 1 = 0$

$(2x + y - 1)(x - y + 1) = 0$

So the sides x – y + 1 = 0 and x + y + 1 = 0 are ⊥ to each other the orthocentre is intersection of ⊥ sides

12. $\sqrt{(x-2)^2 + y^2} = 4 - \sqrt{(x+2)^2 + y^2}$ ..... (1)

But $(x + 2)^2 + y^2 - [(x - 2)^2 + y^2] = 8$ ..... (2)

Dividing (2) by (1) we get

$\sqrt{(x+2)^2 + y^2} - \sqrt{(x-2)^2 + y^2} = 2x$ ..... (3)

Adding (1) and (2) we get

$$2\sqrt{(x+2)^2+y^2} = 4+2x$$

$$(x+2)^2+y^2 = (x+2)^2$$

$y^2 > 0$

Pair of coincident lines

13. Polar of (x_1, y_1) w.r.t. parabola $y^2 = 4a$ is $yy_1 = 2a(x + x_1)$

$2ax - yy_1 + 2ax_1 = 0$

Compare this with $\ell x + my + n = 0$

$$\frac{2a}{\ell} = -\frac{y_1}{m} = \frac{2ax_1}{n} \Rightarrow x_1 = \frac{n}{\ell}$$

$$y_1 = -\frac{2am}{\ell} \text{ pole } \left(\frac{h}{\ell}, -\frac{2am}{\ell}\right)$$

14. $\frac{x}{a}+\frac{y}{b} = \sqrt{2}$ is tangent to $\frac{x^2}{a^2}+\frac{y^2}{b^2} = 1$ ..... (1)

at P(a cos θ, b sin θ)

$$\frac{xx_1}{a^2}+\frac{yy_1}{b^2} = 1$$

$$\frac{xa\cos\theta}{a^2}+\frac{by\sin\theta}{b^2} = 1$$

$$\frac{x\cos\theta}{a}+\frac{y\sin\theta}{b} = 1 \qquad \text{..... (2)}$$

$$\frac{x}{a\sqrt{2}}+\frac{y}{b\sqrt{2}} = 1$$

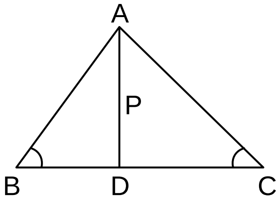
$$\cos\theta = \sin\theta = \frac{1}{\sqrt{2}} \Rightarrow \theta = \frac{\pi}{4}$$

15. When both are ellipse, then e, $e' < 1$ and so $e^2 + e'^2 = 3$ is not true and so it false

When both are parabolas $e = 1 = e' \Rightarrow e^2 + e'^2 = 3$ not true

When both are hyperbolas $e^2 + e'^2 = 3$ possible e, $e' > 1$

16. $BD = P\cot 22\frac{1}{2}^{o}$



$DC = P\cot 112\frac{1}{2}^{o}$

$$\text{Base} = P\left[\frac{\cos 22\frac{1}{2}^{o}}{\sin 22\frac{1}{2}^{o}}+\frac{\cos 112\frac{1}{2}^{o}}{\sin 112\frac{1}{2}^{o}}\right]$$

$$= P\frac{2\sin 135^{o}}{2\sin 22\frac{1}{2}^{o}\sin 112\frac{1}{2}^{o}} = \frac{2P\frac{1}{\sqrt{2}}}{\cos 90^{o}-\cos 135^{o}} = 2P$$

$$P = \frac{\text{Base}}{2}$$

17. $$\sum \frac{\cot A}{a} = \sum \frac{b^2+c^2-a^2}{2abc} = \frac{a^2+b^2+c^2}{2abc} = \frac{(a+b+c)^2-2\Sigma ab}{2abc} = \frac{121-76}{80} = \frac{9}{16}$$

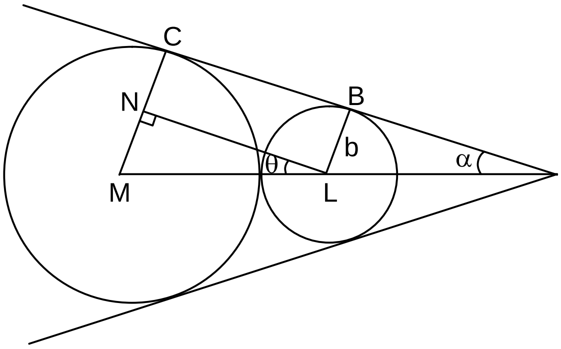
18. From ΔMLN

$$\sin\alpha = \frac{a-b}{a+b}$$

$$\alpha = \sin^{-1}\frac{a-b}{a+b}$$

Angle between AB and AD

$$2\alpha = \sin^{-1}\left(\frac{a-b}{a+b}\right)$$



19. Tangents to parabola $y^2 = 4x$ having slope m is $y = mx + \frac{1}{m}$ tangents to circle having slope m is $y + 2 = m(x - 1) + 4\sqrt{1+m^2}$

Distance between tangents = $\left|\frac{4\sqrt{1+m^2} - m - 2 - \frac{1}{m}}{\sqrt{1+m^2}}\right|$

$= \left|4 - \frac{2}{\sqrt{1+m^2}} - \frac{\sqrt{m^2+1}}{m}\right| \Rightarrow m > 0$

Hence d < 4

20. Let the ellipse be $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

$A = (a\cos\theta, b\sin\theta)$

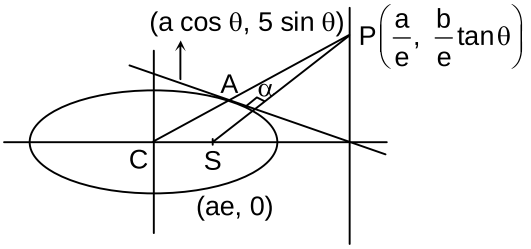
Equation of AC will be $y = \frac{b}{a}\tan\theta\, x$

Solving with $x = \frac{a}{e}$, we get $P\left(\frac{a}{e}, \frac{b}{e}\tan\theta\right)$

Slope of tangents at A is $-\frac{b}{a\tan\theta}$

Slope of $PS = \frac{\frac{b}{e}\tan\theta}{\frac{a}{e} - ae} = \frac{b\tan\theta}{a(1-e^2)} = \frac{a}{b}\tan\theta$

$\Rightarrow \alpha = \frac{\pi}{2}$



21. D should be $b^2 - 4ac > 0$

22. Using A.M. ≥ G.M.

$$\frac{\sin A + \frac{1}{\sin A} + 1}{3} \geq 1$$

$$\sin A + \frac{1}{\sin A} + 1 \geq 3$$

Similarly $\sin B + \frac{1}{\sin B} + 1 \geq 3$

$$\sin C + \frac{1}{\sin C} + 1 \geq 3$$

$$\sum\left(\sin A + \frac{1}{\sin A} + 1\right) \geq 9$$

23. $AL_1^2 + L_1M_1^2 = (a^2 + 1^2) + \left[(a-1)^2 + 1^2\right]$

$AL_2^2 + L_2M_2^2 = (a^2 + 2^2) + \left[(a-2)^2 + 2^2\right]$

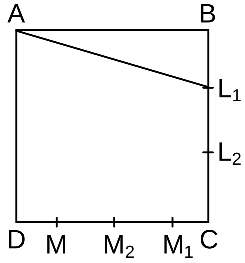
$AL_{a-1}^2 + L_{a-1}M_{a-1}^2 = a^2 + (a-1)^2 + \left[1^2 (a-1)^2\right]$

The required sum

$= (a-1)a^2 + \left[1^2 + 2^2 + \ldots..(a-1)^2\right] + 2\left[1^2 + 2^2 + \ldots..(a-1)^2\right]$

$(a-1)a^2 + \frac{3(a-1)a(2a-1)}{6}$

$\Rightarrow a(a-1)\left[a + \frac{2a-1}{2}\right]$



24. $\frac{1}{\sqrt{a+rx} + \sqrt{a+(r-1)x}} = \frac{1}{x}\left[\sqrt{a+rx} - \sqrt{a+(r-1)x}\right]$

$t_1 + t_2 + \ldots.. + t_n = \frac{1}{x}\left[\sqrt{a+nx} - \sqrt{a}\right] = \frac{n}{\sqrt{a} + \sqrt{a+nx}}$

25. $\alpha + \beta = -a$

$\alpha\beta = b$ ..... (1)

$\alpha^4 + \beta^4 = p$

$\alpha^4\beta^4 = q$ ..... (2)

Using (1) and (2), we get $(a^2 - 2b)^2 = p + 2b^2$

$a^2 - 4ba^2 + 2b^2 - p = 0$

a^2 is one of roots of $x^2 - 4bx + 2b^2 - p = 0$

Product of roots of equation = $2b^2 - p$

$2\alpha^2\beta^2 - (\alpha^4 + \beta^4) = -(\alpha^2 - \beta^2) < 0$

Hence one root is positive and other is negative

26. $\log_x 2 \cdot \log_{2x} 2 = \log_{4x} 2$

Here x > 0 and $x \neq 1, \frac{1}{2}, \frac{1}{4}$

$$\frac{1}{\log_2 x} \cdot \frac{1}{\log_2 2x} = \frac{1}{\log_2 4x}$$

$$\log_2 x(1 + \log_2 x) = (2 + \log_2 x)$$

Put $\log_2 x = t$

$t(1 + t) = 2 + t$

Hence $x = \left\{2^{-\sqrt{2}}, 2^{\sqrt{2}}\right\}$

27. Foci (±5, 0) where ae = 5

$x = \frac{a}{e} \Rightarrow \frac{a}{e} = \frac{36}{5}$

$ae \cdot \frac{a}{e} = 5 \cdot \frac{36}{5}$

$a = 6$

$e = \frac{5}{6}$

$b^2 = a^2(1 - e^2) = 11$

28. For $x = 1$

$\sin^7 y = \sec^2 2y + \cos^4 y$

$\sin^7 y \cos^2 2y = 1 + \cos^4 y \cos^2 2y$

RHS ≥ 1 and LHS ≤ 1

LHS = 1

$\sin^7 y \cos^2 2y = 1$

$\sin^7 y = 1$ and $\cos^2 2y = 1 \Rightarrow y = \frac{\pi}{2}$

General value of y is $2n\pi + \frac{\pi}{2}$

29. $x + 3y - 2 = 0$

Any perpendicular line $3x - y + c = 0$

$y = 3x + c$

Tangents to the hyperbola $\frac{x^2}{1} - \frac{y^2}{3} = 1$

$c^2 = a^2m^2 - b^2 \Rightarrow c = \pm\sqrt{6}$

$y = 3x \pm \sqrt{6}$

30. f(x) is defined when $x^2 - 1 > 0$ and $3 + x > 0$ and $3 + x \neq 1$

$x^2 > 1$ and $x > -3$ and $x \neq -2$

$x < -1$ or $x > 1$ and $x > -3$ and $x \neq -2$

$D_f = (-3, -2) \cup (-2, -1) \cup (1, \infty)$

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Advanced), 2015**

HALF COURSE TEST –VII

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 246**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 06)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-A (07 – 10)** contains 4 multiple choice questions having one or more than one correct answer and each question carries **+4 marks** for correct answer and there is no negative marking.

(iii) **Section-A (11 – 14)** contains 4 Assertion-Reasoning (multiple choice questions) which have only one correct answer. Each question carries **+3 marks** each for correct answer and **– 1 mark** for wrong answer.

(iv) **Section-A (15 – 23)** contains 3 paragraphs. Based upon paragraph, 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate

Enrolment No.

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

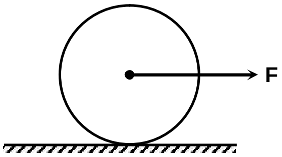
SECTION – A

Straight Objective Type

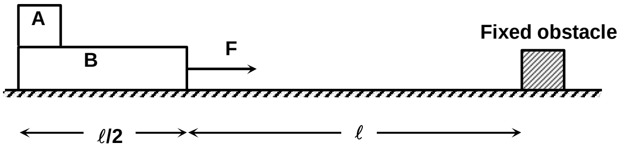
This section contains **6 multiple choice questions** numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Velocity of a body of mass 2kg moving in x-y plane is given by $\vec{v} = \left(2\hat{i} + 4t\hat{j}\right)$ m/s, where t is the time in seconds. The power delivered to the body by the resultant force acting on it at t = 5 sec is
(A) 80 Watts (B) 160 Watts
(C) 40 Watts (D) 100 Watts

2. A solid sphere of mass m is lying at rest on a rough horizontal surface. The coefficient of friction between ground and sphere is μ. The maximum value of F, so that sphere will not slip, is equal to
(A) 7μmg/5 (B) 4μmg/7
(C) 5μmg/7 (D) 7μmg/2



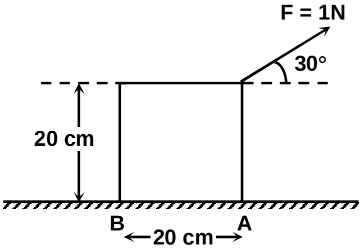
3. In the figure shown, mass of A and B is equal to M each. Friction between B and lowermost surface is negligible. Initially, both the blocks are at rest. The dimensions of the block A are very small.



A constant horizontal force F is applied on the block B and both the blocks start moving together without any relative motion.
Suddenly, the block B encounters a fixed obstacle and comes to rest. The block A continues to slide on the block B. The block A just manages to reach the opposite end of the block B. What is the coefficient of friction between the two blocks? (Required length are shown in the figure)
(A) F/Mg (B) 2F/Mg
(C) F/2Mg (D) none

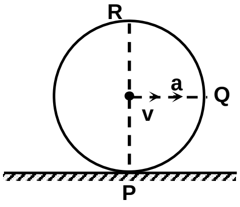
Space for rough work

4. A block of mass $\sqrt{3}/10\,\text{kg}$ is placed on a rough horizontal surface as shown in the figure. A force of 1 N is applied at one end of the block and the block remains stationary. The normal force exerted by the surface on the block acts (g = 10 m/s^2)
(A) through the centre of mass of the block.
(B) through point *A*.
(C) through point *B.*
(D) through the point at a distance 5 cm. from *A*.



5. An insect of mass m is initially at rest at the one end of a stick of length L and mass M, which rests on a smooth horizontal floor. The coefficient of friction between the insect and stick is k. The insect starts moving to reach the other end in shortest possible time. Choose the incorrect statement.
(A) The centre of mass of the stick has speed v = $\left[\frac{\text{kmg}}{\text{M}}\right]\text{t}$ w.r.t. horizontal floor at time t.
(B) Time taken by the insect to reach the other end is $t = \sqrt{\frac{2LM}{k(M+m)g}}$
(C) The magnitude of the linear momentum of the insect at time ‘t’ is equal to kmgt
(D) The maximum speed acquired by the stick is $v_{max} = \sqrt{\frac{2kLMm^2g}{(M+m)m}}$

6. A uniform wheel is rolling without slipping on a horizontal surface. At a certain instant, its centre of mass has velocity ‘v’ and acceleration ‘a’. P, Q and R are three points on the rim of the disc as shown in the figure. Choose the incorrect statement.
(A) Acceleration of P is vertically upwards
(B) Acceleration of Q may be vertically downwards
(C) Acceleration of R can be horizontal
(D) Acceleration of some point on the rim may be horizontal leftwards.



Space for rough work

Multiple Correct Choice Type

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

7. A particle moves with an initial velocity v_0 and retardation αv, where v is its velocity at any time t.
(A) The particle will cover a total distance v_0/α.
(B) The particle will come to rest after a time $1/\alpha$.
(C) The particle will continue to move for a very long time.
(D) The velocity of the particle will become $v_0/2$ after a time $1/\alpha$.

8. A wave is represented by the equation $y = A \sin (10\pi x + 15\pi t + \pi/3)$ where x is in meters and t is in seconds. The expression represents
(A) a wave travelling in the positive x-direction with a velocity 1.5m/s.
(B) a wave travelling in the negative x-direction with a velocity 1.5m/s.
(C) a wave travelling in the negative x-direction having a wavelength 0.2m.
(D) a wave travelling in the positive x-direction having a wavelength 0.2m.

9. A perfectly elastic uniform string is suspended vertically with its upper end fixed to the ceiling and the lower end is loaded with a weight. If a transverse wave is imparted to the lower end of the string, the pulse will
(A) not travel along the length of the string
(B) travel upwards with increasing speed
(C) travel upwards with decreasing speed
(D) travel upwards with constant acceleration

10. A bimetallic strip is formed out of two identical strips one of copper and the other of brass. The coefficients of linear expansion of the two metals are α_c and α_B. On heating, the temperature of the strip goes up by ΔT and the strip bends to form an arc of radius of curvature R. Then R is
(A) proportional to ΔT
(B) inversely proportional to ΔT
(C) proportional to $|\alpha_B - \alpha_C|$
(D) inversely proportional to $|\alpha_B - \alpha_C|$

Space for rough work

Reasoning Type

This section contains **4 questions** numbered 11 to 14. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

11. STATEMENT-1
Each molecule of a gas moves with rms speed if the temperature of gas is constant.
and

STATEMENT-2
The rms speed of molecules of a gas is equal to $\sqrt{\frac{3RT}{M}}$, where T and M are the temperature and molecular mass of the gas. R is the ideal gas constant.
(A) Statement-1 is True, Statement-2 is True; Statement -2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 is NOT a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

12. STATEMENT-1
Water is filled up in a hollow cylindrical container of conducting bases and adiabatic curved surface and kept vertical in an isolated system. If temperature of cylinder is decreased slowly from the bottom, the ice formation will start from the bottom.
and
STATEMENT-2
The temperature of liquid which is at the top will be lowest first.
(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

Space for rough work

13. From the base of an incline plane inclined at an angle of 30° with the horizontal a particle is projected with a speed u. The angle of projection of the particle is 60° with the horizontal.

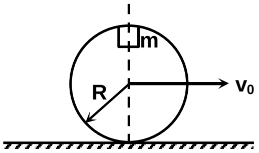
STATEMENT-1: The particle will strike the inclined plane normally for a particular u.

and

STATEMENT-2: The angle at which the particle hits the incline plane is independent of u.

(A) Statement-1 is True, Statement-2 is True; Statement -2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 is NOT a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

14. STATEMENT-1: A ring of mass m and radius R has a mass m attached to it. The ring rolls without slipping on the horizontal surface as shown in the figure. At the instant shown the normal contact force exerted by the floor on the ring is less than (2mg).



and

STATEMENT-2: $\vec{F}_{ext} = m\vec{a}_{cm}$ (i.e. net external force acting on a rigid body = mass times acceleration of centre of mass)

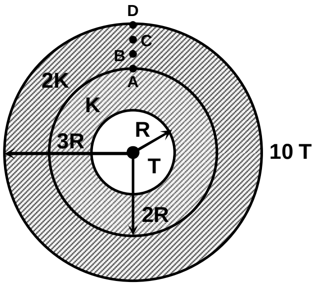
(A) Statement-1 is True, Statement-2 is True; Statement -2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 is NOT a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

Paragraph for Question Nos. 15 to 17



A composite spherical shell is made up of two materials having thermal conductivities K and 2K respectively as shown in the figure. The temperature at the innermost surface is maintained at T whereas the temperature at the outermost surface is maintained at 10T.

A, B, C and D are four points in the outer material such that AB = BC = CD. Now answer the following questions.

15. The effective thermal resistance between the inner surface of the shell and the outer surface of the shell for the radial heat flow is

(A) $\frac{1}{8\pi KR}$ (B) $\frac{1}{7\pi KR}$

(C) $\frac{7}{48\pi KR}$ (D) $\frac{6}{49\pi KR}$

16. The net rate of heat flow from the outermost surface to the innermost surface of the shell will be

(A) $63\pi RKT$ (B) $72\pi RKT$

(C) $\frac{432}{7}\pi RKT$ (D) $\frac{147}{2}\pi RKT$

17. Out of the segments AB, BC and CD the magnitude of the temperature difference will be maximum across

(A) AB (B) BC

(C) CD (D) equal across all the three.

Space for rough work

Paragraph for Question Nos. 18 to 20

Two coherent point light sources are placed at $x = -d/2$ and $x = d/2$. These sources are surrounded by a spherical screen having equation $x^2 + y^2 + z^2 = R^2$ (where R >> d). The sources emit monochromatic light of wavelength λ (= d/3).

Waves from both the sources reach screen and superimpose. When waves reaching any point on the screen have a constant path difference of $n\lambda$ (where λ is wavelength of light and n is some integer), the superposition of these waves is constructive in nature (i.e. maximum intensity) n may be called as order of maximum.

18. The number of maximas on the screen
(A) 7 (B) 12
(C) 6 (D) none of these

19. As screen is a bounded one, therefore the length of maxima is finite. Which of the following data is correct about shape and length of second order maxima?
(A) hyperbola, $\frac{2\pi R\sqrt{5}}{3}$ (B) circle, $\frac{2\pi R\sqrt{5}}{3}$
(C) hyperbola, $\frac{2\pi R}{3}$ (D) circle, $\frac{2\pi R}{3}$

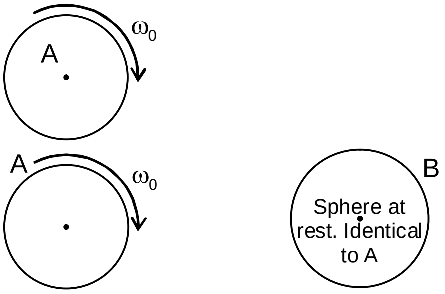
20. Which of the statements is incorrect about the interference experiment explained above
(A) if radius of spherical screen is doubled the intensity of maxima will become one fourth.
(B) All maximas are equally spaced along x-axis.
(C) The equation of first order maximum is $y^2 + z^2 = (8/9)\,R^2$ and $x = R/3$.
(D) none of these

Space for rough work

Paragraph for Questions Nos. 21 to 23

A uniform sphere of mass m and moment of inertia $\frac{2}{5}mR^2$ about its diameter is rotating with angular velocity ω_0 about a horizontal diametrical axis.

It is now placed on rough horizontal ground with friction coefficient μ.



21. The time taken by sphere A to achieve pure rolling is (assuming no collision)

(A) $\frac{R\omega_0}{\mu g}$ (B) $\frac{R\omega_0}{7\mu g}$

(C) $\frac{2R\omega_0}{7\mu g}$ (D) $\frac{R\omega_0}{4\mu g}$

22. Eventually, when sphere A collides elastically with sphere B, then immediately after collision the kinetic energy of sphere B is: (Assume no friction b/w spheres)

(A) $\frac{2}{49}\frac{mR^2\omega_0^2}{}$ (B) Zero

(C) $\frac{1}{49}mR^2\omega_0^2$ (D) $\frac{4}{49}mR^2\omega_0^2$

23. After collision, sphere B is allowed to move while sphere A is held back. The final kinetic energy of sphere B when pure rolling starts:

(A) $\frac{1}{2}mR^2\omega_0^2$ (B) $\frac{5}{343}mR^2\omega_0^2$

(C) $\frac{3}{343}mR^2\omega_0^2$ (D) $\frac{10}{343}mR^2\omega_0^2$

Space for rough work

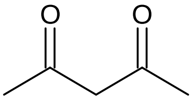
Chemistry PART – II

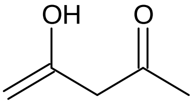
SECTION – A

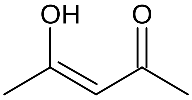
Straight Objective Type

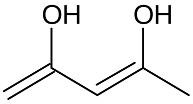
This section contains **6 multiple choice questions** numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. The catalyst decrease the E_a from 100 K mol^{-1} to 80 kJ mol^{-1}. At what temperature the rate of reaction in the absence of catalyst at 500 K will be equal to rate reaction in presence of catalyst.
(A) 400 K
(B) 200 K
(C) 625 K
(D) None of the above

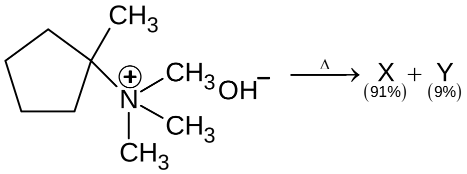
2. Which structure is most stable?
(A)


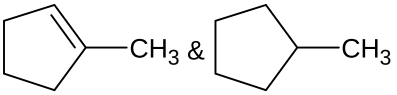
(B)


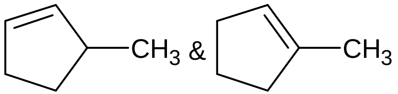
(C)


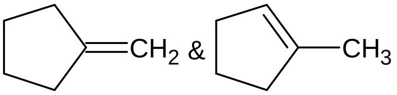
(D)


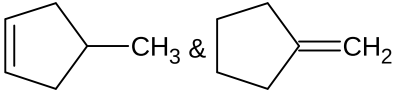
3. Total number of stereoisomer of the compound 1 – bromo – 3 – chloro cyclobutane
(A) 0
(B) 1
(C) 2
(D) 3

4. Two alkenes, X (91% yield) & Y (9% yield) are formed when the following compound is heated


X and Y are
(A)


(B)


(C)


(D)


Space for rough work

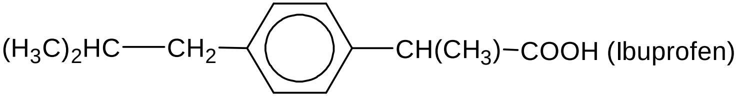
5. Potential energy of the electron at infinity is equal to
(A) 0 (B) ∞
(C) $-\frac{Ze^2}{R}$ (D) $-\frac{Z^2e}{R}$

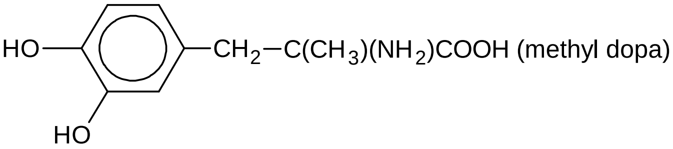
6. The rate law has the form
$\text{rate} = K[A][B]^{3/2}$
can the reaction be elementary process
(A) yes (B) no
(C) may be yes or no (D) cannot b predicted

Multiple Correct Choice Type

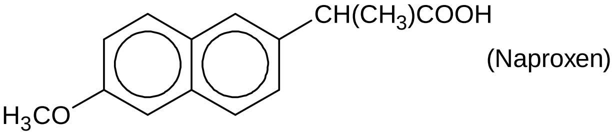
This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

7. Identify the correct statement (s) regarding hydrogen gas:
(A) unlike to H_2, D_2 do not show spin isomerism
(B) ortho hydrogen differs from para hydrogen w.r.t. their boiling point, specific heats & thermal conductivity
(C) as the temperature is increased from absolute zero some of the para form gradually changes to ortho form
(D) para hydrogen has lower energy than ortho hydrogen

8. Which of the following drugs are chiral?
(A)


(B)


(C) $(CH_3)_2C(SH)-CH(NH_2)COOH(\text{pencillamine})$

(D)


9. Which of the following are intensive properties?
(A) temperature (B) density
(C) specific heat (D) molar volume

Space for rough work

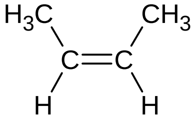
10. Which of the following mixture represent a buffer?
(A) 100 ml of 2 M HCN & 100 ml of 1M NaOH
(B) 100 ml of 2 M CH_3COONa & 100 ml of 1 M HCl
(C) 100 ml of 0.2 M NH_4OH & 100 ml of 0.1 M H_2SO_4
(D) 100 ml of 0.5 M $C_6H_5NH_2$ & 100 ml of 0.2 M H_2SO_4

Reasoning Type

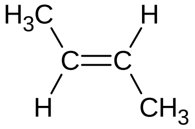
This section contains **4 questions** numbered 11 to 14. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

11. STATEMENT -1: CHF_3 is less acidic than $CHCl_3$
because
STATEMENT -2: Electron withdrawing groups increase the acidic nature.
(A) Statement -1 is True, Statement -2 is true; Statement-2 **is** a correct explanation for Statement-1
(B) Statement -1 is True, Statement -2 is true; Statement-2 **is NOT** a correct explanation for Statement-1
(C) Statement -1 is True, Statement -2 is False
(D) Statement -1 is False, Statement -2 is True

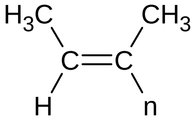
12. STATEMENT -1:



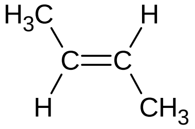
has higher boiling point than



but for melting point, it is the reverse.
because
STATEMENT -2:



has greater heat of hydrogenation than



(A) Statement -1 is True, Statement -2 is true; Statement-2 **is** a correct explanation for Statement-1
(B) Statement -1 is True, Statement -2 is true; Statement-2 **is NOT** a correct explanation for Statement-1
(C) Statement -1 is True, Statement -2 is False
(D) Statement -1 is False, Statement -2 is True

Space for rough work

13. STATEMENT -1: A mixture of ideal gases is cooled up to liquid He temperature (4.22K) to form an ideal solution.
because
STATEMENT -2: An ideal gas cannot be liquefied as there exists no force of attraction among the gas molecules.
(A) Statement -1 is True, Statement -2 is true; Statement-2 **is** a correct explanation for Statement-1
(B) Statement -1 is True, Statement -2 is true; Statement-2 **is NOT** a correct explanation for Statement-1
(C) Statement -1 is True, Statement -2 is False
(D) Statement -1 is False, Statement -2 is True

14. STATEMENT -1: At equilibrium at unit activity, $\Delta G^0 = -RT \ln K_c$.
because
STATEMENT -2: Since $\Delta G = \Delta G^\circ + RT\ln Q$ and at equilibrium, $\Delta G = 0$ & Q becomes K_c at unit activity.
(A) Statement -1 is True, Statement -2 is true; Statement-2 **is** a correct explanation for Statement-1
(B) Statement -1 is True, Statement -2 is true; Statement-2 **is NOT** a correct explanation for Statement-1
(C) Statement -1 is True, Statement -2 is False
(D) Statement -1 is False, Statement -2 is True

Comprehension Type

This section contains **3 groups of questions.** Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

Paragraph for Question Nos. 15 to 17

An organic Lewis acid (A) which gives fumes in moist air and intensity of fumes is increased when a rod dipped in NH_4OH is brought near to it. An acidic solution of (A) on addition of NH_4Cl and NH_4OH gives a precipitate (B) which dissolves in NaOH solution. An acidic solution of A does not gives precipitate with H_2S.

Read the above paragraph carefully and give the answer of following questions:

15. What will be structure of (A)?
(A) Planar
(B) Trigonal planar
(C) Pyramidal
(D) Octahedral

16. What will be (A) in above sequence?
(A) BF_3
(B) $AlCl_3$
(C) $GaCl_2$
(D) $ZnCl_2$

17. The intensity of fumes increase due to the formation of–
(A) NH_4OH
(B) HCl
(C) NH_4Cl
(D) $NaAlO_2$

Space for rough work

Paragraph for Question Nos. 18 to 20

Lithium only forms monoxide when heated in oxygen. Sodium forms monoxide & peroxide in excess of oxygen. Other alkali metals form superoxide with oxygen i.e. MO_2. The abnormal behaviour of Li is due to small size. The larger size of nearer alkali metals also decides the role in formation of superoxides. The three ions are related to each other as follows:

$$\underset{(\text{Oxide ion})}{O^{2-}} \xrightarrow{\frac{1}{2}O_2} \underset{(\text{Peroxide ion})}{O_2^{2-}} \xrightarrow{O_2} \underset{(\text{Superoxide ion})}{2O_2^{-}}$$

All the three ions abstract proton from water.

18. Consider the following reaction:

$$M + O_2 \longrightarrow \underset{(\text{superoxide})}{MO_2} \quad (M = \text{alkali metal})$$

Select the correct statement:

(A) M cannot be Li and Na	(B) M cannot be Cs & Rb
(C) M cannot be Li & Rb	(D) none of these

19. Lithium does not form stable peroxide because
(A) of its small size
(B) d – orbitals
(C) it is highly reactive & form superoxide in place of peroxide
(D) covalent nature of peroxide

20. Which anion is stable towards water?

(A) O^{2-}	(B) O_2^{2-}
(C) O_2^{-}	(D) none of these

Space for rough work

Paragraph for Question Nos. 21 to 23

A reversible reaction proceeds in the direction that decrease the free energy of the system. There is an important relationship between the equilibrium constant 'K' for a reaction and the standard free energy (ΔG^0): $\log K = \frac{-\Delta G^0}{2.30\text{ RT}}$

This equation is application to all reversible processes, allows us to estimate K form standard free energy of the reaction.
The value of equilibrium constant of an endothermic reaction rises with temperature, whereas a temperature increase lowers the equilibrium constant of an exothermic reaction.

$$\log\left[\frac{k_2}{k_1}\right] = \frac{\Delta H^0}{19.1}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

If ΔH^0 is positive (endothermic reaction) and $T_2 > T_1$ then $\log\frac{k_2}{k_1}$ is positive. The opposite situation occurs if ΔH^0 is negative.

21. The equilibrium constant for the dissociation of N_2O_4 into NO_2 is 0.155 at 25°C. What is the standard free energy change for this reaction given (log 0.155 = –0.810)
(A) –4.61 kJ/mole (B) +4.61 kJ/mole
(C) +8.12 (D) –8.12

22. The standard Gibbs free energy change for the reaction:
$$2NOBr(g) \rightleftharpoons 2NO(g) + Br_2(g)$$
is +11.70 kJ/mole at 25°C. What is the equilibrium constant for the reaction at 25°C?
(A) 8.8×10^{-3} (B) 1.6×10^{-4}
(C) 2.6×10^{-3} (D) 4.2×10^{-5}

23. The heat of formation of ammonia is –46.2 KJ/mole. What is the equilibrium constant for the reaction:
$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$$
at 500°C? The equilibrium constant at 25°C is 6.8×10^5 (given antilog (–9.98) is equal to 1.1×10^{-10})
(A) 2.5×10^{-4} (B) 5.0×10^{-5}
(C) 7.5×10^{-5} (D) 1.0×10^{-6}

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **6 multiple choice questions** numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Let $f(x) = e^{\{e^{|x|}\,\text{sgn}\,x\}}$ and $g(x) = e^{[e^{|x|}\,\text{sgn}\,x]}, x \in R$ where {x} and [.] denotes the fractional part and integral part functions respectively. Also $h(x) = \ln(f(x)) + \ln(g(x))$ then for all real x, h(x) is

(A) an odd function
(B) an even function
(C) neither an odd nor an even function
(D) both odd as well as even function

2. If a, b, c are three complex numbers selected randomly (without repetition) from the set {1, 2, 3 ….. 2013) then the probability that $\arg\left(\frac{a-b}{a-c}\right) = 0$ is

(A) $\frac{1}{3}$
(B) $\frac{2}{3}$
(C) $\frac{3}{2013}$
(D) none of these

3. Let a, b, c $\in$ R be such that a + b + c < 0, a – b + c < 0 and c > 0, if ‘α’ and ‘β’ are roots of the equation $ax^2 + bx + c = 0$, then value of $[\alpha] + [\beta]$ is

(A) 2
(B) 1
(C) –1
(D) 0

4. If a – b, b – c, c – a are in A.P., then the straight line (a – b)x + (b – c)y + (c – a) = 0 will pass through

(A) (1, 2)
(B) (2, 1)
(C) (2, 3)
(D) (3, 1)

Space for rough work

5. If $x = \log_e(\cos\theta), y = \cos(\log_e \theta)$ where $e^{-\pi/2} < \theta < e^{\frac{\pi}{2}}$, then

(A) x = y
(B) x > y
(C) x < y
(D) none of these

6. Evaluate $3^{2-\log_3 4}$

(A) $\frac{4}{9}$
(B) $\frac{9}{4}$
(C) 36
(D) none of these

Multiple Correct Choice Type

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

7. The function $f(x) = x^{\frac{1}{\ln x}}$

(A) is a constant function
(B) has a domain $(0,1) \cup (e, \infty)$
(C) is such that $\lim_{x\to 1} f(x)$ exist
(D) is periodic

8. If $\log_2(3^{2x-2} + 7) = 2 + \log_2(3^{x-1} + 1)$ then x equals

(A) 0
(B) 1
(C) 2
(D) none of these

9. If $\frac{2}{1!13!} + \frac{2}{3!11!} + \frac{2}{5!9!} + \frac{1}{7!7!} = \frac{2^m}{n!}$ then

(A) m + n = 27
(B) $m^2 = 1 + 2n$
(C) $n^2 - m^2 = 27$
(D) n = 1 + m

10. If $\left(8 + 3\sqrt{7}\right)^n = P + F$, where P is an integer and F is a proper fraction, then

(A) P is an odd integer
(B) P is an even integer
(C) F.(P + F) = 1
(D) (1 – F)(P + F) = 1

Space for rough work

Reasoning Type

This section contains **4 questions** numbered 11 to 14. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

11. STATEMENT 1: $P(A \cap B \cap C) = P\left(\frac{A}{B}\right).P\left(\frac{B}{C}\right).P(C)$

STATEMENT 2: $P\left(\frac{A}{B}\right)$ is probability of A when B has already happened

(A) Both the statements are true and Statement 2 is correct explanation of Statement 1
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1
(C) Statement 1 is true and Statement 2 is false
(D) Statement 1 is false and Statement 2 is true

12. STATEMENT 1: If x + y + z = xyz, then at most one of the number can be negative
STATEMENT 2: In a triangle ABC, tan A + tan B + tan C = tan A tan B tan C and there can be at most one obtuse angle in a triangle
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1
(C) Statement 1 is true and Statement 2 is false
(D) Statement 1 is false and Statement 2 is true

13. STATEMENT 1: Diagonals of any parallelogram inscribed in an ellipse always intersect at the centre of the ellipse
STATEMENT 2: Centre of the ellipse is the only point at which two chords can bisect each other and every chord passing through the centre of the ellipse gets bisected at the centre
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1
(C) Statement 1 is true and Statement 2 is false
(D) Statement 1 is false and Statement 2 is true

14. STATEMENT 1: The number of non-negative integer solutions to the inequality $x + y + z \leq 2013$ is ${}^{2016}C_3$

STATEMENT 2: $\sum\left({}^{n+1}C_r - {}^{n}C_r\right) = \sum\left({}^{n}C_{r-1}\right)$

(A) Both the statements are true and Statement 2 is correct explanation of Statement 1
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1
(C) Statement 1 is true and Statement 2 is false
(D) Statement 1 is false and Statement 2 is true

Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

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Paragraph for Question Nos. 15 to 17

Read the following write up carefully and answer the following questions:

An equation $a_0 + a_1x + a_2x^2 + ... + a_{99}x^{99} + x^{100} = 0$ has roots ${}^{99}C_0$, ${}^{99}C_1$, ${}^{99}C_2$, ... ${}^{99}C_{99}$

15. The value of a_{99} is equal to
(A) 2^{98}
(B) 2^{99}
(C) -2^{99}
(D) none of these

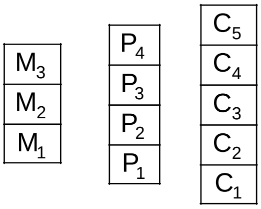
16. The value of a_{98} is
(A) $\frac{2^{198} - {}^{198}C_{99}}{2}$
(B) $\frac{2^{198} + {}^{198}C_{99}}{2}$
(C) $2^{99} - {}^{99}C_{49}$
(D) none of these

17. The value of a_{97} is
(A) $\frac{2^{198} - {}^{198}C_{99}}{2}$
(B) $\frac{2^{198} + {}^{198}C_{99}}{2}$
(C) $2^{99} - {}^{99}C_{49}$
(D) none of these

Space for rough work

Paragraph for Question Nos. 18 to 20

Read the following write up carefully and answer the following questions:
There are three different lots of Mathematics, Physics and Chemistry books arranged in three different lots as shown in the following diagram



18. In how many distinct ways we can pile up these books in a single lot without any restriction

(A) $\frac{12!}{3!}$ (B) 12!

(C) $\frac{12!}{4!}$ (D) $\frac{12!}{5!}$

19. In how many distinct ways we can pile up these 12 books such that at time of piling up all these books in a single lot we always pickup the book from the top of respective lots

(A) $\frac{12!}{3!\times 5!}$ (B) $\frac{12!}{4!\times 5!}$

(C) $\frac{12!}{3!\times 4!\times 5!}$ (D) $\frac{12!}{3!\times 4!}$

20. In how many different ways we can pile up such that no two physics book are together

(A) ${}^9P_4 \times 8!$ (B) ${}^8P_4 \times 8!$

(C) ${}^8P_4 \times 9!$ (D) ${}^9P_4 \times 9!$

Space for rough work

Paragraph for Question Nos. 21 to 23

Read the following write up carefully and answer the following questions:
Given the equation of a hyperbola in general 2nd degree form i.e. $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$, we can obtain the equation of its pair of asymptotes by adding a constant λ to the above equation. Now since after adding the constant λ, the new equation represents a pair of straight lines, therefore the determinant $\begin{vmatrix} a & h & g \\ h & b & f \\ g & f & c+\lambda \end{vmatrix}$ vanishes to zero. Hence λ and the equation of pair of asymptotes can be found. If C represents the equation of a conjugate hyperbola, then C + H = 2A, where H represents the equation of hyperbola and A the equation of pair of asymptotes

21. The equation of a hyperbola conjugate to the hyperbola $x^2 + 3xy + 2y^2 + 2x + 3y = 0$ is
(A) $x^2 + 3xy + 2y^2 + 2x + 3y + 1 = 0$
(B) $x^2 + 3xy + 2y^2 + 2x + 3y + 2 = 0$
(C) $x^2 + 3xy + 2y^2 + 2x + 3y + 3 = 0$
(D) $x^2 + 3xy + 2y^2 + 2x + 3y + 4 = 0$

22. A hyperbola passing through origin has $3x - 4y - 1 = 0$ and $4x - 3y - 6 = 0$ as its asymptotes, then the equation of its transverse and conjugate axes are
(A) $x - y - 5 = 0$ and $x + y + 1 = 0$
(B) $x - y = 0$ and $x + y + 5 = 0$
(C) $x - y - 5 = 0$ and $x - y - 1 = 0$
(D) $x + y - 1 = 0$ and $x - y - 5 = 0$

23. The tangent at any point of a hyperbola $16x^2 - 25y^2 = 400$ cuts off a triangle from the asymptotes and that the portion of it intercepted between the asymptotes, then the area of this triangle is
(A) 10 sq. units
(B) 20 sq. units
(C) 30 sq. units
(D) 40 sq. units

Space for rough work

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HALF COURSE TEST –VII
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	A	A
2.	D	C	B
3.	A	C	C
4.	B	C	A
5.	D	A	C
6.	C	B	B
7.	A, C	B, C, D	A, B, C
8.	B, C	A, B, C, D	A, C
9.	B, D	A, B, C, D	A, C, D
10.	B, D	A, B, D	A, D
11.	D	B	D
12.	D	C	D
13.	D	D	A
14.	A	A	B
15.	C	B	C
16.	C	B	A
17.	A	C	B
18.	A	A	B
19.	B	A	C
20.	D	D	A
21.	C	B	B
22.	A	A	C
23.	D	C	B

Physics

PART – I

1. Power = $\dfrac{d(\text{K.E.})}{dt}$

2. The force of friction, when it is not slipping, is less than its limiting value : |f| ≤ μN. This leads to the condition on F.

3. Velocity of upper block when lower block hits a obstacle,

$$v = \sqrt{2a.\ell} = \sqrt{2.\frac{F}{2M}\ell} = \sqrt{\frac{F\ell}{M}}$$

now after collision retardation of upper block w.r.t. earth,

$$a = \frac{\mu Mg}{M} = \mu g$$

$$\therefore \quad v^2 = u^2 + 2as$$

$$\therefore \quad 0 = \frac{F\ell}{M} - 2\mu g.\frac{\ell}{2}$$

$$\Rightarrow \quad \mu = \frac{F}{Mg}.$$

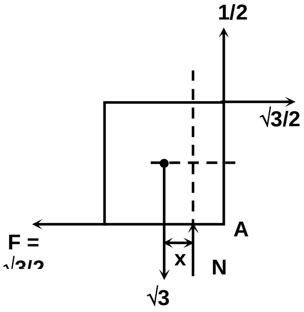
4. For equilibrium

$\Sigma\vec{F} = 0 \;\; \Sigma\vec{\tau} = 0$

N = $\dfrac{\sqrt{3}}{2} - \dfrac{1}{2}$

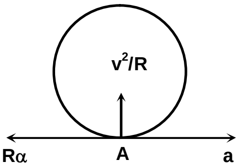
….(i)

Torque about A due to all forces excluding normal force is found to be zero.

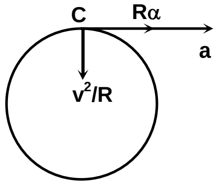


5. Impulse = Force × time; net momentum of the system is conserved as the net force on it is zero.

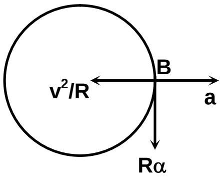
6. At A :
for a rolling wheel, a = Rα
∴ (A) is correct.



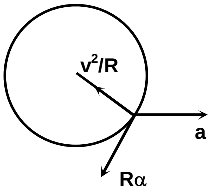
At C :
∴ (C) is correct.



At B :
If $\dfrac{V^2}{R} = a$ then a_B may be vertically downwards
∴ (B) is correct.



Consider this
∴ (D) is correct.



15. $R_{eff} = \int_{R}^{2R} \frac{dx}{K(4\pi x^2)} + \int_{2R}^{3R} \frac{dx}{2K(4\pi x^2)} = \frac{1}{4\pi K}\left[-\frac{1}{x}\right]_{R}^{2R} + \frac{1}{8\pi K}\left[-\frac{1}{x}\right]_{2R}^{3R}$

$\Rightarrow R_{eff} = \frac{7}{48\pi KR}$

17. Consider shell with cross sectional thickness equal to AB, BC and CA respectively. Since heat flow is same through all of them, therefore temperature difference will be maximum across the shell with maximum resistance which will be AB.

18. As explained in figure the no of maximums are 7.

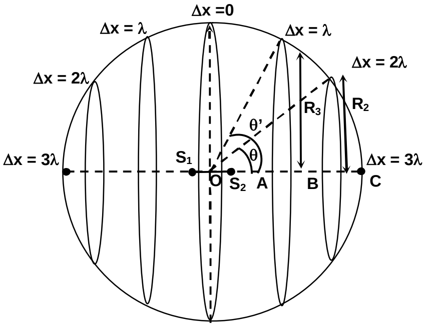
19. $R_2 = R\sin\theta$ and $(3\lambda\cos\theta = 2\lambda) = R\sqrt{5}/3$

Length = $\frac{2\pi R\sqrt{5}}{3}$

20. OC – OB = R – R cosθ = R/3

OB – OA = 2R./3 – Rcosθ’ = R/3 (3λ cosθ’ = λ cosθ’ = 1/3)

Hence $R_1 = R\sin\theta' = R\sqrt{8}/3$



21. N = mg   f = μmg

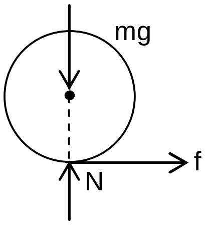
$V = \frac{f}{m}t = \mu g t$

$fR = \mu mgR = \frac{2}{5}mR^2\alpha$

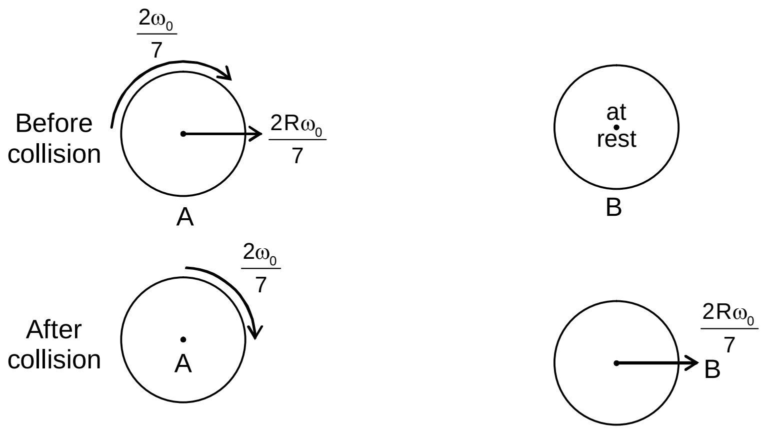
$\Rightarrow \alpha = \frac{5}{2}\mu\frac{g}{R} \quad \omega = \omega_0 - \frac{5\mu g}{2R}t$

$\mu g t = R\omega_0 - \frac{5}{2}\mu g t$

$\Rightarrow t = \frac{2R\omega_0}{7\mu g}$



22.

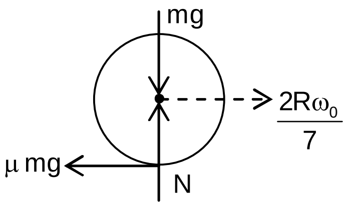

$\frac{2\omega_0}{7}$
Before collision
$\frac{2R\omega_0}{7}$
A
at rest
B
$\frac{2\omega_0}{7}$
After collision
A
$\frac{2R\omega_0}{7}$
B

$$\text{K.E.} = \frac{1}{2}m\left[\frac{2R\omega_0}{7}\right]^2 = 2\frac{mR^2\omega_0^2}{49}$$

23. $\mu mgR = \frac{2}{5}mR^2\alpha \quad \Rightarrow \quad \alpha = \frac{5}{2}\frac{\mu g}{R}$

$R\omega = \frac{5}{2}\mu gt \quad V = \frac{2R\omega_0}{7} - \mu gt = \frac{5}{2}\mu gt$

$\Rightarrow \frac{2R\omega_0}{7} = \frac{7}{2}\mu gt \quad \Rightarrow \quad t = \frac{4}{49}.\frac{R\omega_0}{\mu g}$


mg
$\frac{2R\omega_0}{7}$
μ mg
N

$\omega = \frac{5}{2}.\frac{\mu g}{R}.\frac{4}{49}\frac{R\omega_0}{\mu g} = \frac{10}{49}.\omega_0$

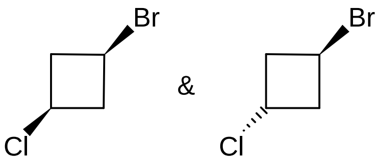
$V = \frac{10}{49}R\omega_0 \quad \text{K.E.} = \frac{1}{2}I\omega^2 + \frac{1}{2}mV^2$

Chemistry PART – II

1. $\frac{-Ea}{RT} = -\frac{E'_a}{RT'}, \frac{100}{500} = \frac{80}{T'}$, $\therefore$ T′ = 400 K
$\therefore$ Option (A) is the correct choice.

2. Due to conjugation & H – bonding.

3.



cis trans

4. Less substituted β - H is removed first.

5. PE of a free electron is zero at infinity i.e. out of the field of nucleus.

9. All are true except (A). D_2 also show spin isomerism like H_2.
Hence B, C, D is correct.

10. All compounds A, B, C, D contains chiral centres and hence optically active i.e. chiral.
Hence A, B, C, D is correct.

11. Intensive properties are independent of quantity of substance.
Hence A, B, C, D is correct.

12. A & B are acid buffers while (D) is a basic buffer. (C) is not a buffer because no base (NH_4OH) will be left after the reaction.
Hence A, B, D is correct.

Mathematics PART – III

1. $h(x) = \ln(f(x)\cdot g(x)) = \ln e^{[y]+\{y\}} = \{y\}+[y] = y = e^{|x|}\operatorname{sgn} x$

$$\therefore\ h(x) = e^{|x|}\operatorname{sgn} x = \begin{bmatrix} e^{x} & \text{if } x>0 \\ 0 & \text{if } x=0 \\ -e^{-x} & \text{if } x<0 \end{bmatrix}$$

$$h(-x) = \begin{bmatrix} e^{-x} & \text{if } x<0 \\ 0 & \text{if } x=0 \\ -e^{x} & \text{if } x>0 \end{bmatrix}$$

$h(x)+h(-x)=0$ for all x

2. For $\arg\left(\frac{a-b}{a-c}\right)=0 \Rightarrow \frac{a-b}{a-c}>0$

Select 3 numbers from the set and call the greatest as 'a' and remaining two as b and c. This can be done in ${}^{2013}C_3\times 2$ ways. Therefore the probability shall be $\frac{{}^{2013}C_3\times 4}{{}^{2013}C_3\times 3!}=\frac{2}{3}$

3. f(x) = ax^2 + bx + c = 0
Now as a + b + c < 0 ⇒ f(1) < 0
a – b + c < 0 ⇒ f(–1) < 0
c > 0 ⇒ f(0) > 0
Combining (i), (ii) and (iii) to get f(–1) f(0) < 0 and f(0) f(1) < 0
Hence one of the root lies between (–1, 0) and other root lies between (0, 1)
$[\alpha]+[\beta] = -1+0 = -1$

4. Line is satisfied by infinite points having x coordinate 1 and y coordinate ∈ R
(a – b)x + (b – c)y + (c – a) = 0 ….(1)
∵ (1) is satisfied by (1, 1)
Also as (a – b), (b – c), (c – a) are in AP

$$\therefore\ b-c = \frac{(a-b)+(c-a)}{2}$$

Putting in (1)

$$(a-b)x+\left[\frac{(a-b)+(c-a)}{2}\right]y+(c-a)=0$$

⇒ (a – b)(2x + y) + (c – a)(y + 2) = 0
Which represents family of line passing through (1, –2)
∴ Line (1) will pass through (1, 2) where y ∈ R

5. x ≤ 0 and y > 0. Hence x < y

6. $3^{2-\log_3 4} = 3^2.(3^{-\log_3 4}) = 9\times 4^{-1} = \frac{9}{4}$

7. $y = x^{\log_x e} = e$ (constant) ⇒ A and C
as $\lim\limits_{x\to 1} f(x) = e$

9. $\frac{2}{1!13!}+\frac{2}{3!11!}+\frac{2}{5!9!}+\frac{1}{7!7!}=\frac{1}{14!}(2^{14}C_1+2^{14}C_3+2^{14}C_5+{}^{14}C_7)=\frac{1}{14!}2^{14-1}=\frac{2^{13}}{14!}$
$\Rightarrow$ m = 13, n = 14

11. By a general Venn-diagram we can conclude that statement is not always true

12. Statement-1 is wrong as z can be written as $\frac{-(x+y)}{1-xy}$
$\Rightarrow$ For any values of x and y; ($xy \neq 1$) we get a value of z
And Statement-2 is correct
Hence, code (D) is the correct answer

13. Statement-2 is correct as ellipse is a central conic
And it also explains Statement-1
Hence, code (A) is the correct answer

18. We can pile up these 12 books in a single lot in 12! Ways

19. If we pickup the book always from the top of respective lot then these books will behave as alike books in a single lot of those 12 books. It means we have to arrange 12 distinct books in which 3 are alike, 4 are alike and 5 are alike
Hence required way is $\frac{12!}{3!\times 4!\times 5!}$

20. If we arrange Chemistry and Maths book, we can arrange in 8! Ways, and in remaining 9 slots we can place 4 Physics books $8!\times {}^9P_4$

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HALF COURSE TEST –VII

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 243**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-B**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 09)** contains 09 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (10 – 13) contains 4 Assertion-Reasoning (multiple choice questions) which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (14 – 19) contains 2 paragraphs. Based upon paragraph, 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-B (1 – 03)** contains 3 Matrix Match Type (4 × 4 Matrix) questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+6 marks** for all correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

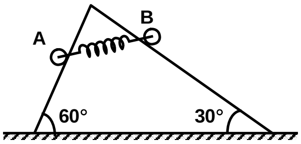
PART – I

SECTION – A

Straight Objective Type

This section contains **9 multiple choice questions** numbered 1 to 9. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. Two uniform solid cylinders A and B each of mass 1 kg are connected by a light spring of force constant 200 N/m at their axles and are placed on a fixed wedge as shown in the figure. The coefficient of friction between the wedge and the cylinders is 0.2. The angle made by the line AB with the horizontal, in equilibrium, is

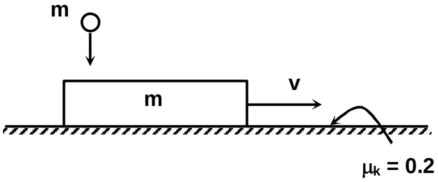


(A) 0º
(B) 15º
(C) 30º
(D) None of these.

2. A person wants to drive on the vertical surface of a large cylindrical wooden 'well' commonly known as 'deathwell' in a circus. The radius of the 'well' is 2 meter, and the coefficient of friction between the tyres of the motorcycle and the wall of the well is 0.2. Minimum speed the motorcyclist must have in order to prevent slipping should be (take g = 10 m/s^2)

(A) 10 m/s
(B) 15 m/s
(C) 20 m/s
(D) 25 m/s

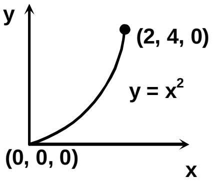
3. A ball of mass m falls vertically from a height h and collides with a block of equal mass m moving horizontally with a velocity v on a surface. The coefficient of kinetic friction between the block and the surface is $\mu_k = 0.2$, while the coefficient of restitution (e) between the ball and the block is 0.5. There is no friction acting between the ball and the block. The velocity of the block just after the collision decreases by



(A) $0.5\sqrt{2gh}$
(B) 0
(C) $0.1\sqrt{2gh}$
(D) $0.3\sqrt{2gh}$

Space for rough work

4. By applying a force $\vec{F} = (3xy - 5z)\hat{j} + 4z\hat{k}$ a particle is moved along the path $y = x^2$ from point (0, 0, 0) to the point (2, 4, 0). The work done by the F on the particle is



(A) $\frac{280}{5}$ (B) $\frac{140}{5}$

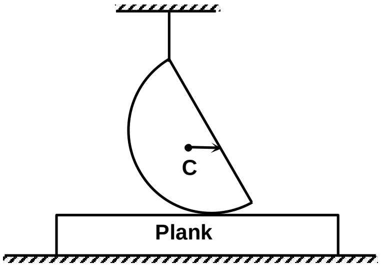
(C) $\frac{232}{5}$ (D) $\frac{192}{5}$

5. A bowler throws a ball horizontally along east direction with speed of 144 km/hr. The batsman hits the ball such that it deviates from its initial direction of motion by 74º north of east direction, without changing its speed. If mass of the ball is $\frac{1}{3}$ kg and time of contact between bat and ball is 0.02 s. Average force applied by batsman on ball is

(A) 800 N, 53º East of North (B) 800 N, 53º North of East

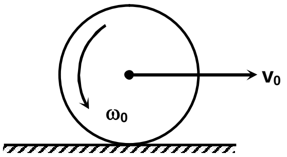
(C) 800 N, 53º North of West (D) 800 N, 53º West of North.

6. Lower surface of a plank is rough and lying at rest on a rough horizontal surface. Upper surface of the plank is smooth and has a smooth hemisphere placed over it through a light string as shown in the figure. After the string is burnt, trajectory of C.M. of the sphere is



(A) a circle
(B) a ellipse
(C) a straight line
(D) a parabola

7. A disc of radius R is spun to an angular speed ω_0 about its axis and then imparted a horizontal velocity of magnitude $\omega_0R/4$ (at t = 0) with its plane remaining vertical. The coefficient of friction between the disc and the plane is μ. The sense of rotation and direction of its linear speed are shown in the figure. Choose the correct statement. The disc will return to its initial position



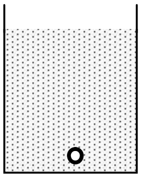
(A) if the value of $\mu < 0.5$. (B) irrespective of the value of μ ($\mu > 0$).

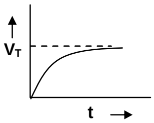
(C) if the value of $0.5 < \mu < 1$. (D) if $\mu > 1$.

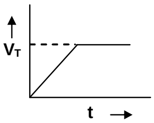
Space for rough work

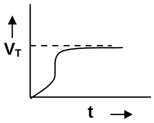
8. A particle is projected from the horizontal surface in earth's gravitational field at an angle θ with the horizontal then
(A) center of curvature of projectile's trajectory at the highest point is below the horizontal surface level if $\theta < \tan^{-1}\sqrt{2}$
(B) center of curvature of projectile's trajectory at the highest point is above horizontal surface if $\theta < \tan^{-1} 2$
(C) center of curvature of projectile's trajectory at the highest point is below the ground level is $\theta > \tan^{-1} 2$
(D) irrespective of the value of θ centre of curvature always lies below the horizontal surface of the earth.

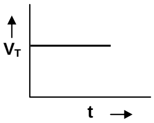
9. A small particle is released inside the depth of a liquid in the vessel. The volume of the particle is V. Density and viscosity of the liquid are ρ and η respectively. Buoyant force on the particle is greater than the weight of the particle. The variation of velocity of the particle with time is



(A)


(B)


(C)


(D)


Space for rough work

Reasoning Type

This section contains **4 questions** numbered 10 to 13. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

---

10. STATEMENT-1: In a standing wave formed in a stretched wire, the energy of each element of the wire remains constant.

and

STATEMENT-2: The net energy transfer in a standing wave is zero.

(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

11. STATEMENT-1: The molecules on the surface of liquid filled in a container always experience a force normal to the surface if viscosity is absent.

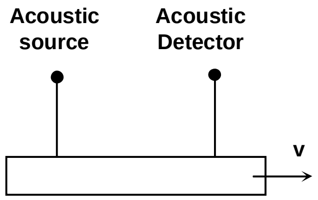
and

STATEMENT-2: The liquid cannot sustain tangential strain.

(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

Space for rough work

12. STATEMENT-1: If a plank is moving with speed v (v is greater than speed of sound). Acoustic source and detector are fixed as shown. Acoustic detector will never detect the sound emitted by acoustic source.



and

STATEMENT-2: The speed of sound is reference frame dependent.

(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

13. STATEMENT-1: When a displacement wave in a string is reflected back from a rigid end, its phase is changed by π.

and

STATEMENT-2: At rigid end, impulsive elastic force changes its phase.

(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

Space for rough work

Comprehension Type

This section contains **2 groups of questions.** Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

---

P_{14-16}: Paragraph for Question Nos. 14 to 16

When a particle is projected at some angle with the horizontal, the path of the particle is parabolic. In the process the horizontal velocity remains constant but the magnitude of vertical velocity changes. At any instant during flight the acceleration of the particle remains g in vertically downward direction. During flight at any point the path of particle can be considered as a part of circle and radius of that circle is called the radius of curvature of the path.

Consider that a particle is projected with velocity u = 10 m/s at an angle θ = 60º with the horizontal and take value of g = 10 m/s^2: Now answer the following questions.

14. The radius of curvature of path of particle at the instant when the velocity vector of the particle becomes perpendicular to initial velocity vector is

(A) $\frac{20}{3\sqrt{3}}$m	(B) $\frac{10}{3\sqrt{3}}$m
(C) $\frac{40}{3\sqrt{3}}$m	(D) $\frac{80}{3\sqrt{3}}$m

15. The magnitude of acceleration of particle at that instant is

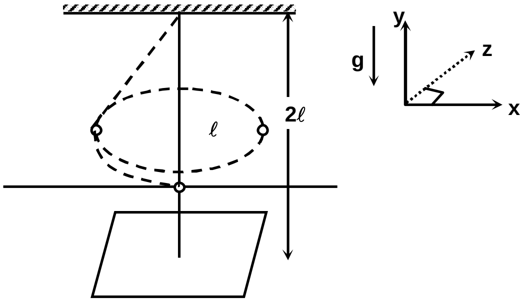
(A) 10 m/s^2	(B) $5\sqrt{3}\,m/s^2$
(C) 5 m/s^2	(D) $10\sqrt{3}\,m/s^2$

16. Tangential acceleration of particle at that instant is

(A) 10 m/s^2	(B) 20 m/s^2
(C) 5 m/s^2	(D) $5\sqrt{3}\,m/s^2$

Space for rough work

P_{17-19}: Paragraph for Question Nos. 17 to 19



A pendulum bob has mass m. The length of pendulum is ℓ. It is initially at rest. A particle P of mass m/2 moving horizontally along –ve x-direction with velocity $\sqrt{2g\ell}$ collides with the bob and comes to rest. When the bob comes to rest momentarily, another particle Q of mass m moving horizontally along z-direction collides with the bob and sticks to it. It is observed that the bob now moves along a horizontal circle. The floor is a horizontal surface at a distance 2ℓ below the point of suspension of the pendulum.

17. Tension in string immediately after the first collision is
(A) 2mg (B) mg
(C) $\frac{3}{2}$mg (D) $\frac{5}{2}$mg

18. The height of circular path above the floor is
(A) $\frac{3\ell}{2}$ (B) $\frac{4\ell}{3}$
(C) $\frac{5\ell}{4}$ (D) data not sufficient

19. Time period of the circular motion
(A) $2\pi\sqrt{\frac{\ell}{g}}$ (B) $2\pi\sqrt{\frac{\sqrt{7}\ell}{4g}}$
(C) $2\pi\sqrt{\frac{\sqrt{7}\ell}{3g}}$ (D) $2\pi\sqrt{\frac{3\ell}{4g}}$

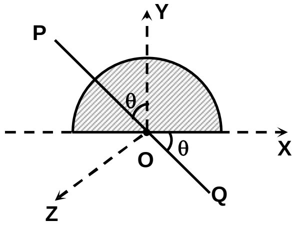
Space for rough work

SECTION – B

(Matching List Type)

This section contains **3 multiple choice questions.** Each question has matching Column(s). The codes for the Column(s) have choices (A), (B), (C) and (D) out of which **ONLY ONE or MORE** is/are correct

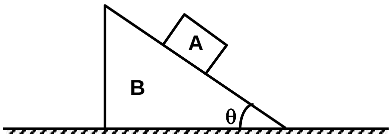
1. A uniform semi–circular disc of mass M and radius R lies in the X–Y plane with its centre at the origin as shown in figure. Also, axis PQ is in the X–Y plane. Then, match for the moment of inertia of semi–circular disc about different axis.



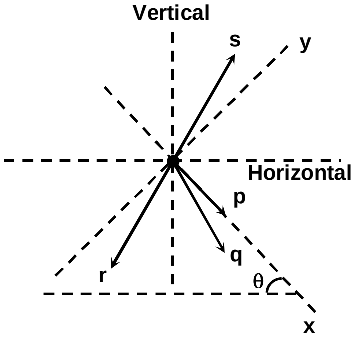
	Column I		Column II
(A)	I_X	(p)	$\frac{MR^2}{2}$
(B)	I_Y	(q)	$\frac{MR^2}{4}$
(C)	I_Z	(r)	$\frac{MR^2}{4}\cos^2\theta$
(D)	I_{PQ}	(s)	$\frac{MR^2}{2}\cos^2\theta$

Space for rough work

2. A block A is placed on wedge B, which is placed on horizontal surface. All the contact surfaces are rough but not sufficiently rough to prevent sliding at any surface. Match Column I and II. Column II indicates possible direction(s) X and Y axis are along incline and perpendicular to incline.

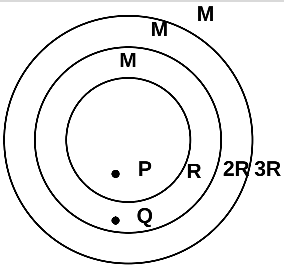
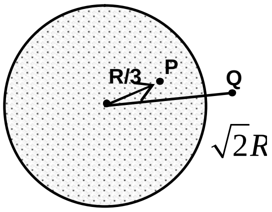
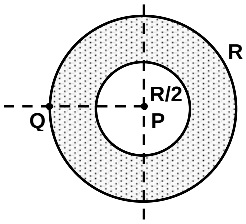
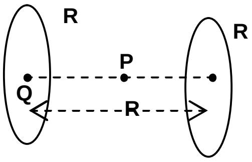


	Column I		**Column II**
(A)	Acceleration of A	(p)	
(B)	Net force applied by A on B	(q)	
(C)	Acceleration of A relative to B	(r)	
(D)	Net force applied by ground on B	(s)	



Space for rough work

3. E and V are the gravitational field and potential respectively.

	Column-I		**Column-II**
(A)	 Concentric charged spherical shells	(p)	$\frac{V_p}{V_q} < 1$
(B)	 solid uniformly charged sphere	(q)	$\frac{E_p}{E_q} < 1$
(C)	A charged spherical having inner radii R/2 and outer radii R. 	(r)	$\frac{V_p}{V_q} > 1$
(D)	 two identical co-axial charged rings	(s)	$\frac{E_p}{E_q} > 1$

Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **9 multiple choice questions** numbered 1 to 9. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

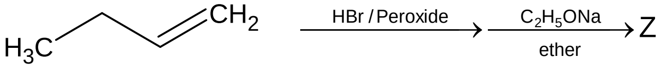
1. Cl_2 can displace I^- from KI but I displaces Cl^- from $KClO_3$. The statement is
(A) True (B) Partly true
(C) False (D) Can not be

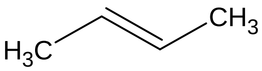
2. For a 4d electron the orbital angular momentum is
(A) $\sqrt{6}\hbar$ (B) $\sqrt{12}\hbar$
(C) $\sqrt{2}\hbar$ (D) zero

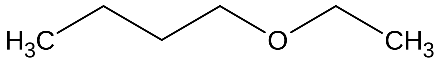
3. K_c for the reaction
$A_{(g)} + B_{(g)} \rightleftharpoons C_{(g)} + D_{(g)}$, is 20 at 25°C. If a container contains 1, 2, 4, 5 moles per litre of $A_{(g)}$, $B_{(g)}$, $C_{(g)}$ and $D_{(g)}$ respectively at 25°C, then the reaction shall
(A) proceed from left to right (B) proceed from right to left
(C) be at equilibrium (D) None

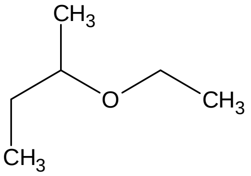
4. 10 ml of 0.2 M acid is added to 250 ml of a buffer solution with pH = 6.34 and the pH of the solution becomes 6.32. The buffer capacity of the solution is:
(A) 0.1 (B) 0.2
(C) 0.3 (D) 0.4

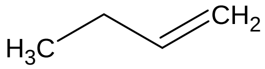
5. Identify Z in the following reaction sequence:



(A)


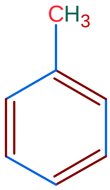
(B)


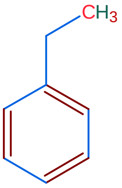
(C)


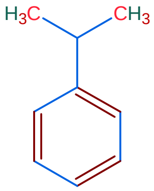
(D)


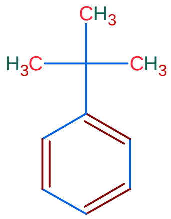
Space for rough work

6. Rate of electrophilic bromination in the aromatic nucleus will be maximum in

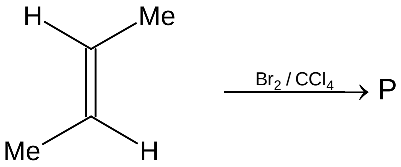
(A) 

(B) 

(C) 

(D) 

7. The incorrect statement about the product (P) of the reaction:



is which one of the following?

(A) P is optically inactive due to internal compensation

(B) P is optically inactive due to the presence of plane of symmetry in the molecule.

(C) The structure which P possesses can have four optical isomers possible.

(D) The structure of P can have three optical isomers possible.

8. For the gaseous reaction $A_{(g)} \longrightarrow 4B_{(g)} + 3C_{(g)}$ is found to be first order with respect to A. If at the starting the total pressure was 100 mm Hg and after 20 minutes it is found to be 400 mm Hg. The rate constant of the reaction is:

(A) 20 min^{-1}

(B) $1.2 \times 10^{3}\ \text{sec}^{-1}$

(C) $5.7 \times 10^{-4}\ \text{sec}^{-1}$

(D) 40 min^{-1}

9. The root mean square speed of an ideal gas at constant pressure varies with density (d) as

(A) d^2

(B) d

(C) $\frac{1}{\sqrt{d}}$

(D) $\sqrt{d}$

Space for rough work

Reasoning Type

This section contains **4 questions** numbered 10 to 13. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

10. STATEMENT-1: The alkali metals can form ionic hydrides which contain the H^- ion

and

STATEMENT-2: The alkali metals have low electronegativity.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

11. STATEMENT-1: Between $SiCl_4$ and CCl_4 only $SiCl_4$ reacts with water.

and

STATEMENT-2: Carbon does not contain empty d-orbitals.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

12. STATEMENT-1: Spectral line would not be seen for a $2p_x – 2p_z$ transition

and

STATEMENT-2: p–orbitals are degenerate orbitals

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

13. STATEMENT-1: The heat absorbed during the isothermal expansion of an ideal gas against vacuum is zero.

and

STATEMENT-2: The volume occupied by the molecules of a real gas is negligible.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement -2 is False.
(D) Statement-1 is False, Statement-2 is True.

Space for rough work

Comprehension Type

This section contains **2 groups of questions.** Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

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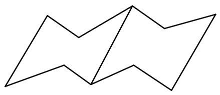
Paragraph for Question Nos. 14 to 16

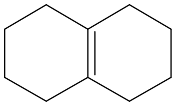
Read the following paragraph and answer the questions given below:

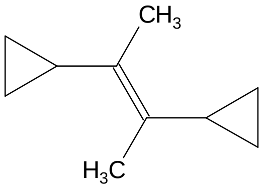
A hydrocarbon with molecular formula $C_{10}H_{16}$ undergoes reductive ozonolysis to give two moles of same compound having molecular formula C_5H_8O. Even the oxidative ozonolysis of the above hydrocarbon gives the same product. The hydrocarbon can react with three equivalents of H_2/Pd at 120^{o}C. Both the hydrocarbons and the ozonolysis products are not resolvable.

Choose the correct option:

14. The hydrocarbon is

(A)


(B)


(C)


(D) Both (A) and (B)

15. Hydrocarbon shows

(A) geometrical isomerism
(B) position isomerism
(C) functional isomerism
(D) Tautomerism

16. Which of the following is correct?

(A) The ozonolysis product is optically active.
(B) The ozonolysis product is optically inactive racemic mixture.
(C) The ozonolysis product is optically inactive due to plane of symmetry.
(D) The ozonolysis product is optically inactive due to absence of chirality.

Space for rough work

Paragraph for Question Nos. 17 to 19

Read the following paragraph and answer the questions given below:

Stable equilibrium is of various types. Mechanical equilibrium is achieved when all particles are at rest and total potential energy of the system is minimum. At any stage where particles are at rest but the system is not at stable equilibrium as it can reduce its potential energy by reverting to another position, is called metastable equilibrium. Thermal equilibrium results from the absence of temperature gradients in the system. Chemical equilibrium is obtained when no further reaction occurs between reacting substances, i.e. forward and reverse rates of reaction are equal. When steam reacts with solid iron at high temperature, Fe_3O_4(s) and hydrogen gas are produced. But the reaction never goes to completion. This is because as the products are formed, the reaction proceeds in reverse direction and when rate of reverse reaction is equal to rate of forward reaction, the concentration of reactants and products become constant and equilibrium is reached.

Choose the correct option:

17. The primary objective of the passage is
(A) to discuss different types of equilibrium
(B) to distinguish between different types of equilibrium
(C) to discuss concept of mechanical and chemical equilibrium
(D) to explain how changing state of equilibrium would influence internal energy

18. Which of the following is correct?
(A) Chemical equilibrium can be stable, unstable or metastable.
(B) The example given in the passage refers to thermodynamic equilibrium.
(C) Addition of catalyst to a reaction in chemical equilibrium increases the amount of heat evolved in the reaction.
(D) Addition of catalyst to a reaction in chemical equilibrium gives a new reaction path to the system.

19. The correct expression for equilibrium constant of the reaction, taken as an example of chemical equilibrium in the above passage is
(A) $\frac{(pH_2)^2}{(pH_2O)^2}$
(B) $\frac{(pH_2)^4}{(pH_2O)^4}$
(C) $\frac{(pH_2)^4[Fe_3O_4]}{(pH_2O)^4[Fe]}$
(D) $\frac{[Fe_3O_4]}{[Fe]}$

Space for rough work

SECTION – B

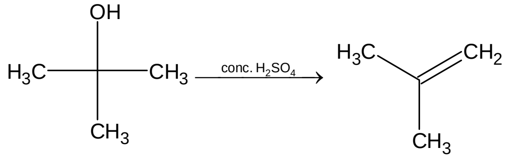
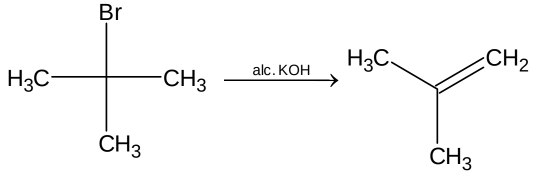
(Matching List Type)

This section contains **3 multiple choice questions.** Each question has matching Column(s). The codes for the Column(s) have choices (A), (B), (C) and (D) out of which **ONLY ONE or MORE** is/are correct

1. Match Column–I with Column–II and select the correct answer.

Column–I Ionic species		**Column–II Shape**	
(A)	SiF_5^-	(p)	Tetrahedral
(B)	ICl_4^-	(q)	Square planar
(C)	AsF_4^+	(r)	Linear
(D)	I_3^-	(s)	Trigonal bipyramidal

2. Match Column–I (reaction) with Column–II (reaction intermediate) and select the correct answer using the codes given below the lists:

Column–I		**Column–II**	
(A)	$CF_3-CHCl_2 \xrightarrow{\text{alc. KOH}} CF_2=CCl_2$	(p)	TS
(B)		(q)	Carbocation
(C)	$CH_3-CH_2-Br \xrightarrow{\text{alc. KOH}/\Delta} CH_2=CH_2$	(r)	Carbanion
(D)		(s)	Free radical

3. Match the following:

Column - I (Number of Moles)		**Column - II (Amount)**	
(A)	0.1 mole	(p)	4480 mL of CO_2 at STP
(B)	0.2 mole	(q)	0.1 g atom of iron
(C)	0.25 mole	(r)	1.5×10^{23} molecules of O_2 gas
(D)	0.5 mole	(s)	9 mL water

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **9 multiple choice questions** numbered 1 to 9. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. Vertices of a variable triangle are (3, 4), ($5\cos\theta$, $5\sin\theta$) and ($5\sin\theta$, $5\cos\theta$) then locus of its orthocentre is
(A) $(x + y - 1)^2 + (x - y - 7)^2 = 100$ (B) $(x + y - 7)^2 + (x - y - 1)^2 = 100$
(C) $(x + y - 7)^2 + (x + y - 1)^2 = 100$ (D) $(x + y - 7)^2 + (x - y + 1)^2 = 100$

2. The probability that at least one of the events A and B occur simultaneously with probability 3/5. If A and B occur simultaneously with probability 1/5 then $P(\overline{A}) + P(\overline{B})$ is
(A) $\frac{2}{5}$ (B) $\frac{4}{5}$
(C) $\frac{6}{5}$ (D) $\frac{7}{5}$

3. If a, b, c are three complex numbers selected randomly (without repetition) from the set {1, 2, 3…..2013) then the probability that $\arg\left(\frac{a-b}{a-c}\right) = 0$ is
(A) $\frac{1}{3}$ (B) $\frac{2}{3}$
(C) $\frac{3}{2013}$ (D) none of these

4. If one of the lines given by $6x^2 - xy + 4cy^2 = 0$ is $3x + 4y = 0$ then c is equal to
(A) –3 (B) –1
(C) 1 (D) 3

5. If the quadrate equation $4x^2 - 2(a + c - 1)x + ac - b = 0$ ($a > b > c$)
(A) both roots are greater than a
(B) both roots are less than c
(C) both roots be between $\left(\frac{c}{2}\right)$ and $\left(\frac{a}{2}\right)$
(D) exactly one of the roots has between $\left(\frac{c}{2}\right)$ and $\left(\frac{a}{2}\right)$

Space for rough work

6. If the focus of a parabola is at (0, –3) and its directrix is y = 3, then its equation is

(A) $x^2 = -12y$	(B) $x^2 = 12y$
(C) $y^2 = -12x$	(D) $y^2 = 12x$

7. Let z_k; k = 1, 2, 3, 4 be four complex numbers such that $|z_k| = \sqrt{k+1}$ and $|30z_1 + 20z_2 + 15z_3 + 12z_4| = \lambda|z_2z_3z_4 + z_3z_4z_1 + z_1z_2z_4 + z_1z_2z_3|$, then λ is equal to

(A) $|z_1\, z_2\, z_4|$	(B) $|z_2\, z_3\, z_4|$
(C) $|z_1\, z_3\, z_4|$	(D) $|z_1\, z_2\, z_3|$

8. A circle has the same centre as an ellipse and passes through the foci F_1 and F_2 of the ellipse the two curves intersect in four points. Let P be any point of intersection. If the major axis of the ellipse is 15 and the area of ΔPF_1F_2 is 26, then the distance between foci is

(A) 11	(B) 9
(C) 10	(D) 15

9. If normal chords at points P and Q on the parabola $y^2 = 4ax$ meets again on the parabola at R then the locus of the circum-centre of ΔPQR is

(A) $y^2 = 4a(x-a)$	(B) $2y^2 = a(x-a)$
(C) $2y^2 = a(x-2a)$	(D) none of these

Reasoning Type

This section contains **4 questions** numbered 10 to 13. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason). Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

10. STATEMENT 1: If P(2a, 0) be any point on the axis of parabola, then the chord QPR, satisfy $\frac{1}{PQ^2} + \frac{1}{PR^2} = \frac{1}{4a^2}$

STATEMENT 2: There exists a point on the axis of the parabola $y^2 = 4ax$, such that $\frac{1}{PQ^2} + \frac{1}{PR^2}$ is equal to constant for all chord QPR of the parabola

(A) Both the statements are true and Statement 2 is correct explanation of Statement 1
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1
(C) Statement 1 is true and Statement 2 is false
(D) Statement 1 is false and Statement 2 is true

Space for rough work

11. STATEMENT 1: 3 is a multiple root of order 2 of the equation $x^3 - 5x^2 + 3x + 9 = 0$
STATEMENT 2: If $f(x) = x^3 - 5x^2 + 3x + 9$, then $f''(3) = 0$
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1
(C) Statement 1 is true and Statement 2 is false
(D) Statement 1 is false and Statement 2 is true

12. STATEMENT 1: The function $f(x) = (3x - 1)|4x^2 - 12x + 5| \cos \pi x$ is differentiable at $x = \frac{1}{2}, \frac{5}{2}$
STATEMENT 2: $\cos(2n+1)\frac{\pi}{2} = 0, \forall n \in I$
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1
(C) Statement 1 is true and Statement 2 is false
(D) Statement 1 is false and Statement 2 is true

13. If positive numbers x, y, z satisfy $x + y + z = 1$, $(x, y, z < 1/2)$ then
STATEMENT 1: $\left[\frac{(1-2x)+(1-2y)+(1-2z)}{3}\right] \ge (1-2x)(1-2y)(1-2z)^{1/3}$
STATEMENT 2: For any three positive numbers a, b, c their AM ≥ GM
(A) Both the statements are true and Statement 2 is correct explanation of Statement 1
(B) Both the Statements are true and Statement 2 is not the correct explanation of Statement 1
(C) Statement 1 is true and Statement 2 is false
(D) Statement 1 is false and Statement 2 is true

Space for rough work

Comprehension Type

This section contains **2 groups of questions.** Each group has 3 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

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Paragraph for Question Nos. 14 to 16

Read the following write up carefully and answer the following questions:
Inequalities are very important to understand in mathematics.

$a > b$, $a < b$, $a \geq b$, $a \leq b$ and $a \neq b$ are called inequality terms. Many times calculus help us to prove inequalities e.g. To check which is greater of the two from e^{π} or π^{e} we take $f(x) = x^{1/x}$ and check, where the function increases and so on. Now answer the following questions

14. If $a = \pi^{3e}$, $b = 3^{\pi e}$, $c = e^{3\pi}$, then
    (A) $a < b < c$
    (B) $b < a < c$
    (C) $c < a < b$
    (D) $a < c < b$

15. The largest interval for which $x^{12} - x^{9} + x^{4} - x + 3 - \sin \pi x + \cos \pi x > 0$ is
    (A) $(-1, 1)$
    (B) $(-\infty, 2)$
    (C) $(-\log 12, \log 12)$
    (D) $(-\infty, \infty)$

16. If f(x) is a decreasing function and $f(0) = 0$ then
    (A) $f(3) > 0$
    (B) $f(2) < 0$
    (C) $f(-3) < 0$
    (D) none of these

Space for rough work

Paragraph for Question Nos. 17 to 19

Read the following write up carefully and answer the following questions:

$(1+x)^n = c_0 + c_1x + c_2x^2....c_nx^n$

17. Total number of term, that are dependent of the value of x, in the expansion of $\left(x^2 - 2 + \frac{1}{x^2}\right)^n$ is equal to

(A) 2n + 1 (B) 2n
(C) n (D) n + 1

18. In the expansion of $\left(a^3 + \frac{1}{a^3} + 1\right)^{100}$ number of distinct terms is

(A) 200 (B) 201
(C) 202 (D) none of these

19. An equation $a_0 + a_1x + a_2x^2 + ...a_{99}x^{99} + x^{100} = 0$ has roots ${}^{99}C_0, {}^{99}C_1, ...{}^{99}C_{99}$. Find the value of a_{98} is

(A) $2^{198} - {}^{198}C_{99}$ (B) $\frac{2^{198} + {}^{198}C_{99}}{2}$
(C) $2^{99} - {}^{99}C_{49}$ (D) none of these

SECTION – B

(Matching List Type)

This section contains **3 multiple choice questions.** Each question has matching Column(s). The codes for the Column(s) have choices (A), (B), (C) and (D) out of which **ONLY ONE or MORE** is/are correct

1. Match the following Column–I with Column–II

	Column – I		Column – II
(A)	If the normal at one end of a latus rectum of an ellipse of eccentricity e passes through one end of minor axis, then $e^2 + e^4$ is equal to	(p)	$\frac{\sqrt{5}}{2}$
(B)	The chords of contact of the pair of tangents to the circle $x^2 + y^2 = 1$ drawn from any point on the line 2x + y = 4 pass through the point $\left(\frac{1}{\lambda}, \frac{1}{2\lambda}\right)$, then λ is equal to	(q)	123
(C)	The eccentricity of the hyperbola $x^2 - 4y^2 = 1$ is	(r)	1
(D)	The number of lines passing through (3, 4) at a distance 5 units from (6, 8) are	(s)	2

Space for rough work

2. Let A and B are two independent events such that $P(A) = \frac{1}{3}$ and $P(B) = \frac{1}{4}$. Now match the following Column–I with Column–II

	Column – I		Column – II
(A)	$P(A \cup B)$ is equal to	(p)	$\frac{1}{12}$
(B)	$P(A \cup B')$ is equal to	(q)	$\frac{1}{2}$
(C)	$P(B \cup A')$ is equal to	(r)	$\frac{5}{6}$
(D)	$P(A \cap B)$ is equal to	(s)	$\frac{3}{4}$

3. Match the following Column–I with Column–II

	Column – I		Column – II
(A)	$x\,dy = y(dx + y\,dy)$, $y > 0$ $y(1) = 1$ and $y(x_0) = -3$, then $x_0 = \lambda$, then λ is less than	(p)	$\frac{1}{4}$
(B)	If $y(t)$ is solution of $(t+1)\frac{dy}{dt} - ty = 1$, $y(0) = -1$, and $y(1) = \lambda$, then λ is greater than	(q)	-15
(C)	$(x^2 + y^2)dx = xy\,dx$ and $y(1) = 1$ and $y(x_0) = \sqrt{e}$, then $x_0 = \lambda$, then λ is greater than	(r)	$-\frac{1}{2}$
(D)	$\frac{dy}{dx} + \frac{2y}{x} = 0$, $y(1) = 1$, then $y(2)$ is equal to	(s)	$\sqrt{3}e$

Space for rough work

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014: 2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE(Advanced), 2015**

ANSWERS, HINTS & SOLUTIONS

HALF COURSE TEST –VII
(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	A	D
2.	A	A	C
3.	D	A	B
4.	D	D	A
5.	C	B	D
6.	C	A	A
7.	B	C	A
8.	A	C	A
9.	A	C	B
10.	D	A	A
11.	A	A	C
12.	B	A	A
13.	A	C	B
14.	A	C	A
15.	A	A	D
16.	C	D	B
17.	C	C	C
18.	C	D	B
19.	D	B	A
1.	(A) → (q) (B) → (q) (C) → (p) (D) → (q)	(A) → (s) (B) → (q) (C) → (p) (D) → (r)	(A) → (r) (B) → (s) (C) → (p) (D) → (r)
2.	(A) → (q) (B) → (r) (C) → (p) (D) → (s)	(A) → (r) (B) → (q) (C) → (p) (D) → (q)	(A) → (q) (B) → (r) (C) → (s) (D) → (p)
3.	(A) → (q, r) (B) → (q, r) (C) → (q, r) (D) → (p, q)	(A) → (q) (B) → (p) (C) → (r) (D) → (s)	(A) → (p, r, s, t) (B) → (q) (C) → (p, q, r, t) (D) → (p)

Physics

PART – I

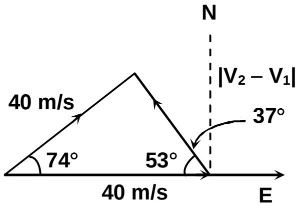
1. In equilibrium, there will not be any friction between the cylinder and the wedge. If θ be the required angle
Cylinder A: $mg \sin 60^\circ = kx \cos (60^\circ - \theta)$ ($= mg \cos 30^\circ$)
Cylinder B: $mg \sin 30^\circ = kx \cos (30^\circ + \theta) = kx \sin (60^\circ - \theta)$
$\therefore \quad \cot 30^\circ = \cot (60^\circ - \theta) \Rightarrow \theta = 30^\circ$.

2. $N = \dfrac{mv^2}{R}$
$f_{max} = mg$
$\mu N = mg$
$\mu \dfrac{mv^2}{R} = mg$
$v = \sqrt{\dfrac{Rg}{\mu}} = \sqrt{\dfrac{2 \times 10}{0.2}} = 10$ m/s

3. The impulse due to friction = $\mu_k \times$ impulse delivered by collision

4. The z-component of the force and the x-component of displacement are ineffective here.
$dW = F_y dy = 3xy.dy \qquad (\because z = 0)$
$= 6x^4 dx \ (\because y = x^2)$
Integrating between x = 0 and x = 2 gives the result.

5. 144 km/hr = $144 \times \dfrac{5}{18} = 40$ m/s



$$\frac{\left|\vec{V}_2 - \vec{V}_1\right|}{\sin 74^\circ} = \frac{40}{\sin(90 - 37^\circ)}$$

$$\Rightarrow \quad \left|V_2 - V_1\right| = \frac{40 \times 2\sin 37^\circ \cos 37^\circ}{\cos 37^\circ} = 48 \text{ m/s}$$

Change in momentum = $\dfrac{1}{3} \times 48 = 16$

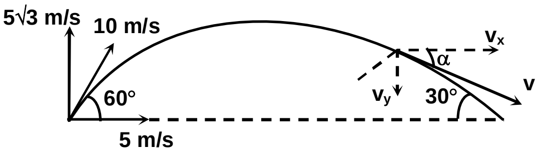
$f_{avg} = \dfrac{16}{0.02} = 800$ N.

7. Solve the problem using μ as the coefficient of kinetic friction.

8. If $\dfrac{u^2 \cos^2 \theta}{g} > \dfrac{u^2 \sin^2 \theta}{2g}$
$\theta < \tan^{-1}\sqrt{2}$
if $\dfrac{u^2 \cos^2 \theta}{g} < \dfrac{u^2 \sin^2 \theta}{2g}$
$\theta > \tan^{-1}\sqrt{2}$.

14. Time after which velocity vector becomes perpendicular to initial velocity vector is

$$t = \frac{u}{g\sin\theta} = \frac{10}{10\sin 60} = \frac{2}{\sqrt{3}}\text{ seconds}$$



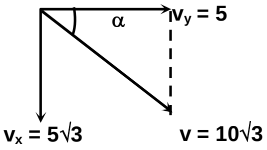
Let v_y be the vertical component of velocity at that instant then

$v_y = u + at$

$$v_y = 5\sqrt{3} - \frac{10\times 2}{\sqrt{3}}$$

$$v_y = -\frac{5}{\sqrt{3}}$$

$$\therefore \quad v = \sqrt{5^2 + \left(\frac{5}{\sqrt{3}}\right)^2} \Rightarrow v = \frac{10}{\sqrt{3}}\text{ m/s}$$



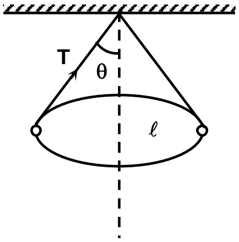
$$g\cos\alpha = \frac{v^2}{R}$$

$$R = \frac{v^2}{g\cos\alpha}$$

$$R = \frac{20}{3\sqrt{3}}\text{ m.}$$

16. $a_t = g\sin\alpha = 10\times\frac{5/\sqrt{3}}{10/\sqrt{3}} = 5\text{ m/s}^2.$

17.



19. $\omega = \sqrt{\frac{g}{\ell\cos\theta}}$ and $T = \frac{2\pi}{\omega}$

Chemistry PART – II

SECTION – A

3. $$Q = \frac{[C][D]}{[A][B]} = \frac{4\times5}{1\times2} = 10$$

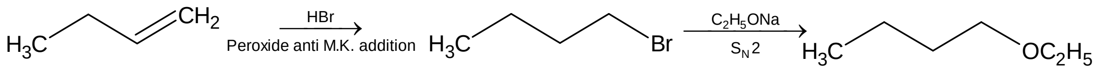
$K_c = 20$

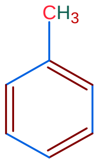
$\therefore Q < K_c$

Therefore equilibrium will shift from left to right.

4. $$\text{Buffer capacity} = \frac{\text{moles of acid or base added per litre}}{\text{change in pH}}$$

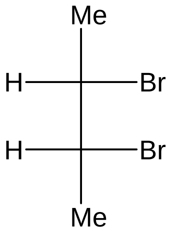
$$\text{Buffer capacity} = \frac{\frac{0.2\times10}{1000}\times\frac{1000}{250}}{6.34-6.32} = 0.4$$

5. 

6. 

will be most reactive in electrophilic substitution reaction due to hyperconjugation. It is having three α – hydrogen for hyperconjugation.

7. The product is



(Meso compound)

8. $$A_{(g)} \longrightarrow 4B_{(g)} + 3C_{(g)}$$

P_0 0 0 at initial

$P_0 - x$ 4x 3x at 20 minutes

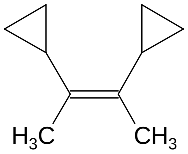
$P_0 - x + 4x + 3x = 400$

$P_0 = 100 \Rightarrow x = 50$

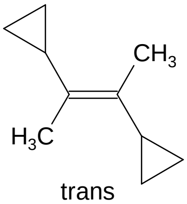
It shows 20 minutes is the half life time of the reaction.

9. $$u_{RMS} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3P}{M/V_m}} = \sqrt{\frac{3P}{\rho}}$$

15. Hydrocarbon ($C_{10}H_{16}$)



cis



trans

SECTION – B

2. Reaction (a) is E1CB, hence RI is a carbanion.
Reaction (b) is E1, hence RI is a carbocation.
Reaction (c) is E2, hence RI is a TS.
Reaction (d) is E1, hence RI is a carbocation.

Mathematics PART – III

SECTION – A

1. All the co–ordinates of vertices are at a distance of 5 units from origin. Hence circumcentre of the triangle is (0, 0)

   Centroid = $\left(\frac{3+5\cos\theta+5\sin\theta}{3}, \frac{4+5\sin\theta-5\cos\theta}{3}\right)$

   Centroid divides the line joining circumcentre and orthocentre in the ratio 1 : 2

   Suppose co-ordinate of orthocentre is (x_1, y_1)

   $x_1 = 3 + 5\cos\theta + 5\sin\theta$ ..... (1)

   $y_1 = 4 + 5\sin\theta - 5\cos\theta$ ..... (2)

   Solving (1) and (2) $\sin\theta = \left(\frac{x_1+y_1-7}{10}\right)\cos\theta = \frac{x_1-y_1+1}{10}$

   $(x_1 + y_1 - 7)^2 + (x_1 + y_1 + 1)^2 = 100$

   Replace x_1 by x and y_1 by y

   Locus of orthocentre in $(x + y - 7)^2 + (x - y + 1)^2 = 100$

2. $\frac{3}{5} = P(A) + P(B) - \frac{1}{5}$

   $\Rightarrow \frac{4}{5} = 1 - P(\bar{A}) + 1 - P(\bar{B})$

   $\Rightarrow P(\bar{A}) + P(\bar{B}) = \frac{6}{5}$

3. For $\arg\left(\frac{a-b}{a-c}\right) = 0 \Rightarrow \frac{a-b}{a-c} > 0$

   Select 3 numbers from the set and call the greatest as ‘a’ and remaining two as b and c. This can be done in ${}^{2013}C_3 \times 2$ ways. Therefore the probability shall be $\frac{{}^{2013}C_3 \times 4}{{}^{2013}C_3 \times 3!} = \frac{2}{3}$

4. Put $y = -\frac{3x}{4}$ and solve for C

5. f(x) = (2x – a)(2x – c) + (2x – b)

   So $f\left(\frac{a}{2}\right) = a - b$

   $f\left(\frac{c}{2}\right) = c - b$

   Now $f\left(\frac{a}{2}\right).f\left(\frac{c}{2}\right) = (a-b)(c-b) < 0$

   Hence exactly one root lies between $\left(\frac{c}{2}\right)$ and $\left(\frac{a}{2}\right)$

6. Let P(x, y) be any point on the parabola.

   Then by definition $\sqrt{(x-0)^2 + (y+3)^2} = y - 3 \Rightarrow x^2 = -12y$

7. $\left|\frac{z_1}{2}+\frac{z_2}{3}+\frac{z_3}{4}+\frac{z_4}{5}\right| = \frac{\lambda}{60}\left|z_1z_2z_3z_4\right|\left|\frac{1}{z_1}+\frac{1}{z_2}+\frac{1}{z_3}+\frac{1}{z_4}\right|$

Now, $z_1\bar{z}_1 = 2, z_2\bar{z}_2 = 3, z_3\bar{z}_3 = 4$ and $z_4\bar{z}_4 = 5$ $\left(\because |z_k| = \sqrt{k+1}\right)$

$\Rightarrow \lambda = \frac{60}{\left|z_1z_2z_3z_4\right|} = \frac{60}{\sqrt{2}\sqrt{3}\sqrt{4}\sqrt{5}} = \sqrt{30} = \left|z_1z_2z_4\right|$

8. $PF_1 + PF_2 = 15, PF_1.PF_2 = 52$

Let $PF_1 = x, PF_2 = y$

x + y = 15, xy = 52

$(F_1F_2)^2 = 225 - 104$

$(F_1F_2)^2 = 121 \Rightarrow F_1F_2 = 11$

9. Let us draw tangent at P and Q which meet in T. Let $P\left(at_1^2, 2at_1\right), Q\left(at_2^2, 2at_2\right)$ and $R\left(at_3^2, 2at_3\right)$

So $T\left(at_1t_2,\ a\left(t_1+t_2\right)\right)$

Any circle which passes through points P, Q and R must also pass through the points T as the four points are concyclic

$\Rightarrow$ Circumcentre is mid-point of TR that is M(h, k)

As normal chords at P and Q meet in R

$t_3 - t_1 - \frac{2}{t_1} = -t_2 - \frac{2}{t_1} \Rightarrow t_1t_2 = 2$

$\Rightarrow h = \frac{2a + at_3^2}{2bt_1 - 0} = \frac{2a + a(t_1+t_2)^2}{2}$

$\Rightarrow\ t_1 + t_2 = \frac{2k}{a}$

From equation (1) and (2) we get $2(h-a) = a\left(\frac{2k}{a}\right)^2 \Rightarrow 2y^2 = a(x-a)$

10. Let P(h, 0) be a point on axis of parabola the straight line passing through P cuts the parabola at a distance r

$\Rightarrow (r \sin\theta)^2 = 4a(h + r\cos\theta)$

$\Rightarrow r^2 \sin^2\theta - (4a\cos\theta)\, r - 4ah = 0$ ….(i)

Where, $r_1 + r_2 = \frac{4a\cos\theta}{\sin^2\theta}$

and $r_1r_2 = -\frac{4ah}{\sin^2\theta}$

$\therefore\ \frac{1}{PQ^2} + \frac{1}{PR^2} = \frac{1}{r_1^2 + r_2^2} = \frac{r_1^2 + r_2^2}{r_1^2r_2^2} = \frac{\cos^2\theta}{h^2} + \frac{\sin^2\theta}{2ah}$

Which is constant only, if $h^2 = 2ah$ i.e. h = 2a

$\Rightarrow\ \frac{\cos^2\theta}{4a^2} + \frac{\sin^2\theta}{4a^2} = \frac{1}{4a^2}$

Thus, $\frac{1}{PQ^2} + \frac{1}{PR^2} =$ constant for all chords QPR, if h = 2a

Hence, (2a, 0) is the required point on the axis of parabola

$\therefore$ Statement-1 and statement-2 are true and statement-2 is correct explanation of statement-1

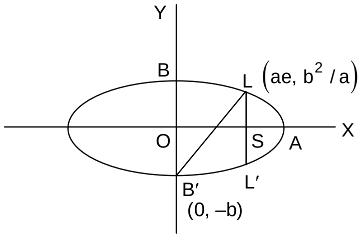
11. $f(x) = (x-3)^2 (x+1)$
$\Rightarrow$ 3 is a multiple root of order 2
$f'(x) = 3x^2 - 10x + 3$
$f''(x) = 6x - 10$
$f'(3) = 0,\ f''(3) \neq 0$
Statement-1 is true, statement-2 is false

12. Statement-1 is correct as through $|4x^2 - 12x + 5|$
is non-differentiable at $x = \frac{1}{2}, \frac{5}{2}$ but cos $\pi x = 0$ these points. So, $f'\left(\frac{1}{2}\right)$ and $f'\left(\frac{5}{2}\right)$ exists

13. If each of x, y, z is less than 1/2 then, statement-1 is obviously true
Also, $1 - 2x + 1 - 2y + 1 - 2z = 3 = 2(x + y + z) = 1$
$\Rightarrow$ The sum of the three given number is positive also at must one of x, y, z can be more than 1
$\Rightarrow$ If one of x, y, z is more than or equal to $\frac{1}{2}$, then their product is less than equal to zero hence still remains true
Statement-2 is always true but it does not explain statement-1

SECTION – B

1. (A) Write the equation of normal and use the given condition
Normal at $\left(ae, \frac{b^2}{a}\right)$ is



$$\frac{x-ae}{\frac{ae}{a^2}} = \frac{y-\frac{b^2}{a}}{\frac{\left(\frac{b^2}{a}\right)}{b^2}} \Rightarrow a(x-ae) = ea\left(y-\frac{b^2}{a}\right)$$

$$\Rightarrow x - ye = e\left(a - \frac{b^2}{a}\right)$$

It passes through (0, -b), $\therefore\ b = \frac{a^2-b^2}{a} = \frac{a^2e^2}{a} = ae^2$

$$\Rightarrow b^2 = a^2e^4 \Rightarrow a^2\left(1-e^2\right) = a^2\left(e^4\right) \therefore e^4 + e^2 = 1$$

(C) $x^2 - 4y^2 = 1$

$$\frac{1}{4} = \left(e^2 - 1\right) \quad e = \frac{\sqrt{5}}{2}$$

(D) 1
Find the line in terms of m and satisfy the condition to solve for m
Any line through (3, 4) is $y - 4 = m(x - 3)$
According to given condition

$$\frac{m(6-3)+4-8}{\sqrt{1+m^2}} = |s| \quad \Rightarrow \quad (4m+3)^2 = 0 \quad \Rightarrow \quad m = -\frac{3}{4} = 1$$

2. We have, $P(A \cap B) = P(A) \cdot P(B) = \frac{1}{12}$

(A) $P(A \cup B) = P(A) + P(B) - P(A \cap B) = \frac{1}{3} + \frac{1}{4} - \frac{1}{12} = \frac{1}{2}$

(B) $P(A \cup B') = 1 - \left(P(B) - P(A \cap B)\right)$ = 5/6

(C) $P(B \cup A')$ = 3/4

(D) $P(A \cap B) = P(A).P(B) = 1/12$

3. (A) x dy = y dx + y^2 dy $\Rightarrow \frac{xdy - ydx}{y^2} = dy \Rightarrow -d\left(\frac{x}{y}\right) = dy$

$-\frac{x}{y} = y + c$ put x = 1, y = 1 ⇒ c = –2

$-\frac{x}{y} = y - 2 \Rightarrow \frac{x}{3} = -5$

(B) $\frac{dy}{dt} - \frac{t}{t+1}y = \frac{1}{t+1}$

$I.f = e^{-\int \frac{t+1-1}{t+1}dt} = e^{-t+\ell n(t+1)} = (t+1)e^{-t}$

Solution is $(t + 1)e^{-t}$ $y = -e^{-t} + c$ put t = 0 and y = –1 ⇒ c = 0

$\therefore 2e^{-1} y = -e^{-1}$

$y = -\frac{1}{2}$

(C) $(x^2 + y^2)dy = xy\, dx$

$\frac{dy}{dx} = \frac{xy}{x^2 + y^2}$ put y = vx, $\frac{dy}{dx} = v + x\frac{dv}{dx}$

$\Rightarrow \ell nv - \frac{1}{2v^2} = -\ell nx + c$

$\therefore c = -\frac{1}{2} \therefore \ell n\frac{y}{x} - \frac{1}{2}\frac{x^2}{y^2} = -\ell nx - \frac{1}{2}$ put y = e

$\therefore x = \sqrt{3}e$

(D) $\frac{dy}{dx} + 2\frac{y}{x} = 0$

$x^2 y = C$ put x = 1, y = 1 and we get C = 1

put x = 2 $\Rightarrow y = \frac{1}{4}$

FIITJEE **JEE (Advanced), 2015**

HALF COURSE TEST –VIII

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 240**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-B**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (09 – 12) contains 4 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (13 – 18) contains 2 paragraphs. Based upon paragraph, 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+4 marks** for correct answer and **– 1 marks** for wrong answer.

2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 mark** will be awarded. There may be one or more than one correct choice. No marks will be given for any wrong match in any question. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

ALL INDIA INTEGRATED TEST SERIES

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION - A

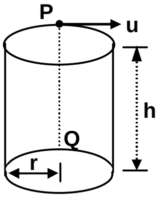
Straight Objective Type

*This section contains 8 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.*

1. The equation of a particle executing SHM is given by $x = 3\cos(\pi/2)t$ cm, here t is in second. The distance travelled by the particle in first 8.5 sec is

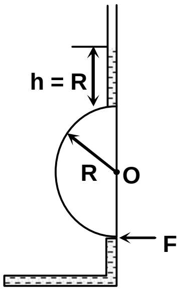
(A) $24 + \frac{3}{\sqrt{2}}$ cm
(B) $27 - \frac{3}{\sqrt{2}}$ cm
(C) $24 - \frac{3}{\sqrt{2}}$ cm
(D) $27 + \frac{3}{\sqrt{2}}$ cm

2. A hollow vertical cylinder of radius r and height h has smooth internal surface. A small particle is placed in contact with the inner side of the upper rim, at a point P. It is given a horizontal speed u, tangential to rim. It leaves the lower rim at point Q, vertically below P. the number of revolutions made by the particle will be



(A) $n = \frac{h}{2\pi r}$
(B) $n = \frac{u}{\sqrt{2gh}}$
(C) $n = \frac{2\pi r}{h}$
(D) $n = \frac{u}{2\pi r}\sqrt{\left(\frac{2h}{g}\right)}$

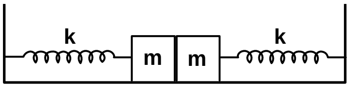
3. The figure shows a semi-cylindrical gate pivoted at the point O holding a stationary liquid of density ρ. A horizontal force F is applied at its lowest position to kept it stationary. The magnitude of the force is



(A) $\frac{9}{2}\rho gR^2$
(B) $\frac{3}{2}\rho gR^2$
(C) ρgR^2
(D) zero

Space for rough work

4. An assembly of identical spring mass system is placed on a smooth horizontal surface as shown. Initially the springs are relaxed. The left mass is displaced to the left while the right mass is displaced to right by two times more than the left spring and both are released. The resulting collision is elastic. The time period of the oscillation of the system is



(A) $2\pi\sqrt{\frac{2M}{k}}$
(B) $2\pi\sqrt{\frac{M}{2k}}$
(C) $2\pi\sqrt{\frac{M}{k}}$
(D) $\pi\sqrt{\frac{M}{k}}$

5. A body of mass m is free to move in a conservative field with potential energy $U = U_0(1 - \cos \alpha x)$ where U_0 and α are constants the time period of small oscillations is

(A) $2\pi\sqrt{\frac{U_0}{m\alpha^2}}$
(B) $2\pi\sqrt{\frac{m\alpha^2}{U_0}}$
(C) $2\pi\sqrt{\frac{m}{U_0\alpha^2}}$
(D) $2\pi\sqrt{\frac{U_0\alpha^2}{m}}$

6. A metallic sphere of mass 2 gm falls through a liquid with terminal velocity v. If we drop a sphere of mass 0.25 gm of the same metal through same liquid its terminal velocity would be

(A) v
(B) 2v
(C) v/2
(D) v/4

7. An artificial satellite of mass m is moving in circular orbit at a height equal to the radius R of the earth. Suddenly due to internal explosion the satellite breaks into two parts of equal masses. One part of the satellite stops just after the explosion and then falls to the surface of the earth. The increase in the mechanical energy of the system (satellite + earth) due to explosion will be (g is the acceleration due to gravity on the surface of earth)

(A) mgR
(B) $\frac{mgR}{2}$
(C) $\frac{mgR}{4}$
(D) $\frac{3mgR}{4}$

Space for rough work

8. A particle of mass equal to half of the earth's mass is released at a distance $h(h \ll R)$ from the surface of earth. The time after which the particle will hit earth's surface is
(A) $\sqrt{\frac{4h}{3g}}$
(B) $\sqrt{\frac{2h}{g}}$
(C) $\sqrt{\frac{h}{g}}$
(D) $\sqrt{\frac{2h}{3g}}$

(Multiple Correct Choice Type)

This section contains ***4 multiple choice questions***. Each question has four choices (A), (B), (C) and (D) out of which ***ONE or MORE*** are correct.

9. A satellite is revolving around the earth in a circular orbit. The universal gravitational constant suddenly becomes zero at time $t = 0$. Then
(A) The kinetic energy for $t < 0$ and $t > 0$ is same
(B) The angular momentum for $t < 0$ and $t > 0$ is same
(C) The angular momentum keeps changing for $t < 0$
(D) The angular momentum keeps changing for $t > 0$

10. Two waves of same frequency and wavelength but amplitude A_1 and A_2 meet a point at the same time. According to the superposition principle, the resultant amplitude
(A) may be $A_1 + A_2$
(B) may be $A_1 - A_2$
(C) $A_1 + A_2$ or $A_1 - A_2$
(D) $A_1 - A_2 \leq A \leq A_1 + A_2$

11. When tuning forks A and B are struck, a beat frequency f_{AB} is heard. When A and C are struck a beat frequency of f_{AC} is heard. It was found that $f_{AC} > f_{AB}$. If f_A, f_B and f_C are individual frequencies, then what are the possible relations?
(A) $f_A > f_B > f_C$
(B) $f_A < f_B < f_C$
(C) $f_B > f_A > f_C$
(D) $f_C > f_A > f_B$

12. A body of mass M is attached to the lower end of a metal wire, whose upper end is fixed. The mass M is brought slowly to the equilibrium position and the elongation in the wire is ℓ.
(A) the energy stored in the wire is $Mg\ell$
(B) the energy stored in the wire is $\frac{1}{2}Mg\ell$
(C) heat generated during the process is $\frac{1}{2}Mg\ell$
(D) heat generated during the process is $\frac{1}{4}Mg\ell$

Space for rough work

Linked Comprehension Type

*This section contains **2 paragraphs**. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.*

Paragraph for Question Nos. 13 to 15

If a body moves through a liquid or a gas then the fluid applies a force on the body which is called drag force. Direction of the drag force is always opposite to the motion of the body relative to the fluid. At low speeds of the body, drag force (F_P) is directly proportional to the speed.

$F_D = kv$

When k is a proportionally constant and it depends upon the dimension of the body moving in air at relatively high speeds, the drag force applied by air on the body is proportional to v^2 instead of v.

$F_D = k_1v^2$

Where this proportionally constant K can be given by

$k_1 = \rho CA$

Where ρ is the density of air
C is another constant giving the drag property of air
A is area of cross-section of the body

Consider a case an object of mass m is released from a height h and it falls under gravity. As it's speed increases the drag force starts increasing on the object. Due to this at some instant, the object attains equilibrium. The speed attained by the body at this instant is called "terminal speed" of the body.
Assume that the drag force applied by air on the body follows the relation F_D = kv, neglect the force of buoyancy applied by air on the body then answer the following questions.

Read the above passage carefully and answer the following questions

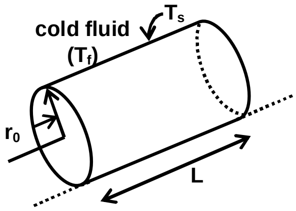
13. What is the pattern of acceleration change of the body?
(A) It first increases, then decreases to zero
(B) It decreases uniformly from starting to zero
(C) It decrease non-uniformly from starting to zero
(D) It first increases then becomes constant

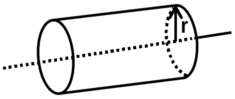
14. What is the terminal speed of the object?
(A) $\frac{mg}{k}$
(B) mgk
(C) $\frac{k}{mg}$
(D) $\sqrt{\frac{mg}{k}}$

15. What is the nature of change in speed of the body?
(A) It first decreases and then increases to a constant value
(B) It increases uniformly to a constant value
(C) It increases non-uniformly to a constant value
(D) It continuously decreases to zero.

Space for rough work

Paragraph for Question Nos. 16 to 18





Heat generation may occur in a variety of radial geometries. Consider a long, solid cylinder as shown in the figure, which could represent a current-carrying wire or a fuel element in a nuclear reactor. For steady state conditions, the rate at which heat is generated within the cylinder must equal the rate at which heat is convected from the surface of the cylinder to a moving fluid. This condition allows the surface temperature to be maintained at a fixed value of T_S.

To determine the temperature distribution in the cylinder, we begin with energy conservation principle. Consider a cylindrical section of radius r. The rate at which energy is generated within the given volume is conducted radially outward.

$$\therefore \quad \dot{q}\,\pi r^2\ell = -K2\pi r\ell \tfrac{dT}{dr}$$

where $\dot{q}$ is the energy generated per unit time per unit volume, K is the thermal conductivity and dT/dr is the temperature gradient at radius r.

If $\dot{q}$ is constant

$$T(r) = -\frac{\dot{q}}{4k}r^2 + C$$

At $\quad r = r_0, \quad T(r_0) = T_S$

Therefore, $T(r) = \frac{\dot{q}}{4k}r_0^2\left(1 - \frac{r^2}{r_0^2}\right) + T_S$

The rate of heat convected to the surrounding fluid (at temperature T_f) by the surface at temperature T_s is proportional to the temperature difference $(T_S - T_f)$ and the surface area in contact with the fluid.

Thus, rate of heat convection = $h\,(2\pi\, r_0 L)\,(T_S - T_f)$

where h is a constant called heat convection coefficient.

By overall energy balance,

$$\dot{q}\left(\pi r_0^2 L\right) = h\left(2\pi r_0 \ell\right)\left(T_S - T_f\right)$$

$$\Rightarrow T_S = T_f + \frac{\dot{q}r_0}{2h}$$

Read the above passage carefully and answer the following questions.

16. Consider a spherical nuclear fuel material of radius r_0 and rate of heat generation $\dot{q}$ (watt/m^3). Find the temperature difference between the surface and surrounding fluid in steady state (h is the heat convection coefficient).

(A) $\frac{\dot{q}r_0}{2h}$ (B) $\frac{2}{3}\frac{\dot{q}r_0}{h}$

(C) $\frac{\dot{q}r_0}{3h}$ (D) $\frac{\dot{q}r_0}{h}$

Space for rough work

17. In the above passage, the ratio of temperature gradient at r = $r_0/2$ and r = r_0 is

(A) 1 (B) 1/4

(C) 1/2 (D) 1/8

18. In the given passage, the difference in temperature at the axis and surface of the cylinder is

(A) $\frac{\dot{q}r_0^2}{4k}$ (B) $\frac{\dot{q}r_0^2}{k}$

(C) $\frac{\dot{q}r_0^2}{2k}$ (D) $\frac{2\dot{q}r_0}{k}$

Space for rough work

SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

---

1. Consider a situation (i) that two sound waves, $y_1 = (0.2\text{m}) \sin 504\pi\left(t - \frac{x}{300}\right)$ and $y_2 = (0.6\text{ m}) \sin 496\pi\left(t - \frac{x}{300}\right)$ are super imposed. Consider another situation (ii) that two sound waves $y_1 = (0.4\text{m}) \sin 504\pi\left(t - \frac{x}{300}\right)$ and $y_2 = (0.4\text{ m}) \sin 504\pi\left(t + \frac{x}{300}\right)$ are superimposed. Match the following.

Column – I	**Column – II**
(A) In situation (i)	(p) Stationary waves are formed.
(B) In situation (ii)	(q) There will be phenomenon of beats
(C) When two waves of same frequency and amplitude and travelling in opposite directions superimpose.	(r) Amplitude of the resultant wave will vary periodically with position
(D) If the intensity of sound alternately increases and decreases periodically a result of superposition of waves of highly different frequencies.	(s) Amplitude of the resultant wave will vary periodically with time
	(t) amplitude of the resultant wave will be constant

Space for rough work

2. Match the following:

Column I	Column II
(A) A cone resting with its slant surface touching against the smooth horizontal floor	(p) Stable Equilibrium
(B) A car moving on a banked smooth circular track of banking angle θ with constant speed without its tyres slipping	(q) Unstable equilibrium
(C) A rigid body suspended in a laboratory in such a manner that its centre of gravity lies vertically above point of suspension and its centre of mass lies vertically below point of suspension.	(r) Neutral equilibrium
(D) A uniform cube balanced on a horizontal floor on one of its edge (only a force parallel to horizontal plane can be applied).	(s) none of the above
	(t) potential energy of the system remains constant.

Space for rough work

Chemistry

PART – II

SECTION - A

Straight Objective Type

*This section contains 8 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.*

1. At 1400 K, $K_c = 2.5 \times 10^{-3}$ for the following reaction:

$$CH_4(g) + 2H_2S(g) \rightleftharpoons CS_2(g) + 4H_2(g)$$

If a 10 litre reaction vessel at 1400 K contains 2.0 moles of CH_4, 3.0 moles of CS_2, 3.0 moles of H_2 and 4.0 moles of H_2S, then equilibrium concentration of CS_2 will be

(A) = 0.3 M
(B) < 0.3 M
(C) > 0.3 M
(D) none of these

2. If the dipole moment of 1, 2, 3, 5 – tetrachloro benzene is xD, then the dipole moment of chlorobenzene will be

(A) 0.5 xD
(B) 0.25 xD
(C) xD
(D) 1.25 xD

3. A sample of four hydrogen atoms, all in the nth excited state, de – excite to the ground state, and shows a maximum of six different spectral lines. Hence the value of ‘n’ is

(A) 3
(B) 4
(C) 5
(D) 6

4. A mixture containing ferrous oxalate & ferrous sulphate required 100 ml of 0.1M acidified $KMnO_4$ solution. This mixture is now reduced by $SnCl_2$ so that all Fe^{3+} changes to Fe^{2+} ions & the resultant mixture now required 50 ml of the same permanganate solution, the percentage by mass of ferrous oxalate in the mixture is (Fe = 56, C = 12, O = 16, S = 32)

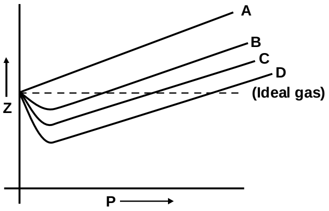
(A) 18.6%
(B) 28.6%
(C) 38.6%
(D) 48.6%

Space for rough work

5. Identify the incorrect statement among the following:
(A) If Auf- bau rule is not followed, then Sn(atomic number = 50) would be placed in d – block of the periodic table
(B) 5th ionization energy of As (Z = 33) is less than that of Ge (Z = 32)
(C) Increasing order of first I.E. of S, Se & Cl is Se < S < Cl
(D) Ionic radii of Mg^{2+} (Z = 12) is smaller than F^{-} (Z = 9)

6. 150 ml of 0.1 M NaOH solution is mixed with 100 ml of 0.1 M H_2CO_3 solution, if K_{a_1} and K_{a_2} of H_2CO_3 are 10^{-7} and 10^{-13} respectively, then pOH of the resulting solution will be
(A) 13 (B) 7
(C) 1 (D) 2

7. Compressibility factor (Z) is plotted against pressure (p) for four different gases A, B, C & D. The correct order of critical temperature of the gases shown in the above graph is



(A) A > B > C > D
(B) B < A < C < D
(C) A < B < C < D
(D) D < B < C < A

8. Which of the following compounds exhibits tautomerism?
(A) chloroethane (B) ethanol
(C) ethoxyethane (D) nitroethane

Space for rough work

(Multiple Correct Choice Type)

This section contains ***4 multiple choice questions***. Each question has four choices (A), (B), (C) and (D) out of which ***ONE or MORE*** are correct.

---

9. Which of the following mixture is/are buffers?
   (A) 100 ml of 0.1 M $Ca(CH_3COO)_2$ & 100 ml of 0.1 M HCl
   (B) 100 ml of 0.1 M $(PhNH_3)_2SO_4$ & 50 ml 0.1 M $Ca(OH)_2$
   (C) 100 ml of 0.1 M $(NH_4)_2SO_4$ & 100 ml of 0.1 M NH_4OH
   (D) 100 ml of 0.1 M borax solution ($Na_2B_4O_7.10H_2O$) & 25 ml of 0.05 M H_2SO_4

10. Which of the following equilibria shifts in the forward direction on decreasing the pressure?
   (A) $\text{ice} \rightleftharpoons \text{water}$
   (B) $\text{water} \rightleftharpoons \text{water vapour}$
   (C) $S(\ell) \rightleftharpoons S(s)$
   (D) $\text{diamond} \rightleftharpoons \text{graphite}$
   (density of diamond is more than graphite)

11. The percentage by mass of chlorine in the chloride of a metal is 80%. 33.375 g of this chloride on vaporization occupies a volume of 5.6 litre at NTP. Now select the correct options given below:
   (A) valency of the metal is 2
   (B) molecular weight of the metal chloride is 133.5
   (C) atomic weight of the metal is 27 g
   (D) 9 g of the metal can completely react with 8 g of oxygen

12. Identify the correct statement (s) among the following:
   (A) The electronegativity of an element is the tendency of an isolated atom to attract an electron
   (B) The second ionization potential of boron is greater than carbon
   (C) Nitrogen has almost zero electron gain enthalpy
   (D) The first electron affinity of fluorine is greater than that of chlorine

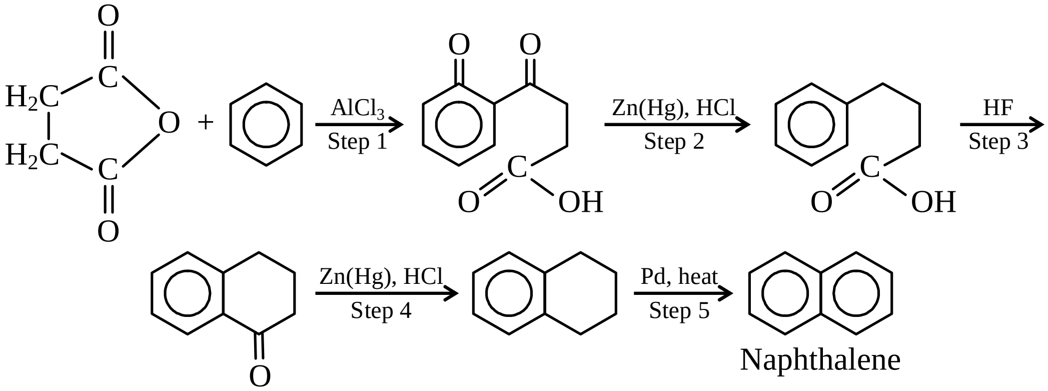
Space for rough work

Linked Comprehension Type

*This section contains **2 paragraphs**. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.*

Paragraph for Question Nos. 13 to 15

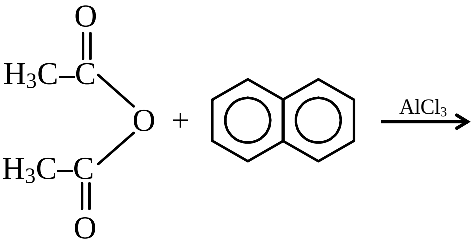
The Lewis acid usually reacts with the acyl halide to form an acylium ion. The acylium ion is stabilized by resonance. The acylium ion acts as an electrophile attacking the benzene ring to form an arenium ion. The arenium ion then loses a proton to generate the final product. Powerful electron withdrawing groups on the benzene ring such as another acyl group will retard this reaction. Naphthalene is the simplest and most important of the fused ring hydrocarbons. Five percent of all constituents of coal tar are naphthalene. Naphthalene can be manufactured using the Friedel-Crafts reaction via the reaction pathway shown below:

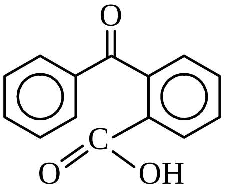


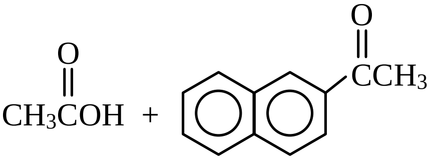
13. The Friedel-Crafts reaction occurs twice in the given sequence of reactions. Which two steps represent Friedel-Crafts reactions?
(A) Steps 1 and 3
(B) Steps 1 and 5
(C) Steps 2 and 4
(D) Steps 3 and 5

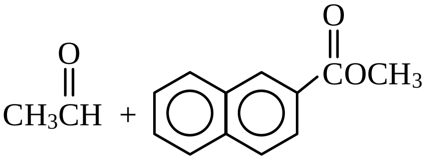
Space for rough work

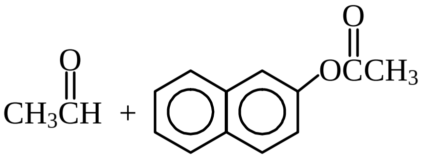
14. What are the most likely products of the following reaction?



(A) C_2H_6 +


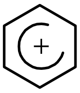
(B)

$CH_3\overset{O}{\overset{\|}{C}}OH$ +

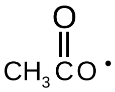
(C)

$CH_3\overset{O}{\overset{\|}{C}}H$ +

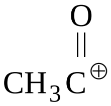
(D)

$CH_3\overset{O}{\overset{\|}{C}}H$ +

15. Which of the following is an acylium ion?

(A) $AlCl_4^-$

(B)


(C)

$CH_3\overset{O}{\overset{\|}{C}}O^{\bullet}$

(D)

$CH_3\overset{O}{\overset{\|}{C}}^{\oplus}$

Space for rough work

Paragraph for Question Nos. 16 to 18

The solubility of some sparingly soluble salts e.g. AgCl, AgBr, AgI, Ag_2CrO_4 etc can be appreciably increased through complexation reaction. Let's take the case of AgCl which is very feebly soluble in water (K_{sp} of AgCl = 1×10^{-10} at 25°C) but if liquid ammonia is added into this solution, its solubility increased so many folds due to the formation of complex $\left[Ag(NH_3)_2\right]^+$.

$$AgCl + 2NH_3(aq) \rightleftharpoons \left[Ag(NH_3)_2\right]^+ + Cl^-$$

A solution of Ag^+ ions at a concentration of 4.0×10^{-13} M just fails to yield a precipitate of AgCl with concentration of 1.0×10^{-3} M of Cl^- ions, when the concentration of ammonia in the solution is 2.0×10^{-2} M.

Now, answer the following questions.

16. The solubility of AgCl in water **(**without adding NH_3) at 25°C is

(A) 10^{-4} M
(B) 10^{-5} M
(C) 10^{-6} M
(D) 10^{-8} M

17. The dissociation constant of the complex $\left[Ag(NH_3)_2\right]^+$ at 25°C is

(A) 10^{-7}
(B) 10^{+7}
(C) 10^{-8}
(D) 10^{+8}

18. $Ag^+ + 2NH_3 \rightleftharpoons \left[Ag(NH_3)_2\right]^+$

On adding more NH_3, the above equilibrium shifts:

(A) In the forward direction
(B) In the backward direction
(C) The complex dissociation faster
(D) None of these

Space for rough work

SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

---

1. Match the statement in column – I with corresponding type (s) of silicates in column - II

Column – I		Column – II	
(A)	Only one corner of SiO_4^{4-} units is shared	(p)	Chain silicates
(B)	At least one corner of SiO_4^{4-} unit is shared	(q)	Sheet silicates
(C)	Only two corners of SiO_4^{4-} units are shared	(r)	Pyrosilicates
(D)	At least two corners of SiO_4^{4-} units are shared	(s)	Cyclic silicates

2. Match the compounds in column – I with their corresponding decreasing K_a value in column – II.

Column – I (compounds)		Column – II (Acidity)	
(A)	o, m, p – nitrophenols	(p)	o > m > p
(B)	o, m, p – cresols	(q)	p > o > m
(C)	o, m, p – chlorophenols	(r)	p > m > o
(D)	o, m, p – nitrobenzoic acid	(s)	m > p > o

Space for rough work

Mathematics PART – III

SECTION - A

Straight Objective Type

This section contains 8 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which ***ONLY ONE*** *is correct.*

1. If the roots of $ax^2 - bx - c = 0$ change by the same quantity then the expression in a, b, c that does not change is

(A) $\frac{b^2 - 4ac}{a^2}$ (B) $\frac{b - 4c}{a}$

(C) $\frac{b^2 + 4ac}{a^2}$ (D) $\frac{a^2 + b^2}{c^2}$

2. The point of intersection of the curves $\arg(z - 3i) = \frac{3\pi}{4}$ and $\arg(2z + 1 - 2i) = \frac{\pi}{4}$ is

(A) $\frac{1}{4}(3 + 9i)$ (B) $\frac{1}{4}(3 - 9i)$

(C) $\frac{1}{2}(3 + 2i)$ (D) none of these

3. Suppose a, b, c are in A.P. and a^2, b^2, c^2 are in G.P. If a < b < c and a + b + c = $\frac{3}{2}$, then the value of a is

(A) $\frac{1}{2\sqrt{2}}$ (B) $\frac{1}{2\sqrt{3}}$

(C) $\frac{1}{2} - \frac{1}{\sqrt{3}}$ (D) $\frac{1}{2} - \frac{1}{\sqrt{2}}$

Space for rough work

4. If {x} represents fractional part of x, then $\left\{\frac{5^{200}}{8}\right\}$ is

(A) $\frac{1}{4}$ (B) $\frac{1}{8}$
(C) $\frac{3}{8}$ (D) $\frac{5}{8}$

5. The maximum number of points of intersection of 8 circles is
(A) 16 (B) 24
(C) 28 (D) 56

6. If a sin x + b cos(x + θ) + b cos(x – θ) = d for some real x, then the minimum value of |cos θ| is
(A) $\frac{1}{2|b|}\sqrt{d^2 - a^2}$ (B) $\frac{1}{2|a|}\sqrt{d^2 - a^2}$
(C) $\frac{1}{2|d|}\sqrt{d^2 - a^2}$ (D) $\frac{1}{|a|}\sqrt{d^2 - a^2}$

7. The number of real solutions of the equation $\tan^{-1}\sqrt{x^2 - 3x + 2} + \sin^{-1}\sqrt{4x - x^2 - 3} = \pi$ is
(A) one (B) two
(C) zero (D) infinite

8. If in a triangle $a^2 + b^2 + c^2 = ac + \sqrt{3}ab$, then the triangle is
(A) equilateral (B) right angled isosceles
(C) right angled scalene (D) none of these

Space for rough work

(Multiple Correct Choice Type)

This section contains ***4 multiple choice questions***. Each question has four choices (A), (B), (C) and (D) out of which ***ONE or MORE*** are correct.

9. The roots of $ax^2 + bx + c = 0$, are non–real complex and $a + c < b$, then

(A) $4a + c > 2b$
(B) $4a + c < 2b$
(C) $a + 4c > 2b$
(D) $a + 4c < 2b$

10. A circle of radius r ($\neq 0$) touches the parabola $y^2 + 12x = 0$ at the vertex of the parabola. The centre of the circle lies to the left of the vertex and the circle lies entirely within the parabola, then the interval(s) in which r lies can be

(A) (1, 7)
(B) (0, 6)
(C) $\left(1, \frac{13}{2}\right)$
(D) (2, 8)

11. If $\left|\frac{2iz_1 - z_1 - z_2}{2iz_1 + z_1 + z_2}\right| = \left|\frac{\cos\theta + i\sin\theta}{\cos\theta - i\sin\theta}\right|$ and z_1, z_2 are non-zero complex numbers then

(A) $\frac{z_1 + z_2}{z_1}$ is purely real
(B) $\frac{z_1}{z_2}$ is purely real
(C) $\frac{z_1 + z_2}{z_1 - z_2}$ is purely real
(D) none of these

12. The equation $\left|\sqrt{x^2 + (y-1)^2} - \sqrt{x^2 + (y+1)^2}\right| = k$ will represent a hyperbola for

(A) $k \in (0, 2)$
(B) $k \in (0, 1)$
(C) $k \in (1, \infty)$
(D) $k \in (0, \infty)$

Space for rough work

Linked Comprehension Type

*This section contains **2 paragraphs**. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.*

Paragraph for Question Nos. 13 to 15

Read the following write up carefully and answer the following questions:
Let $\bar{r}$ be the position vector of a variable point such that $\bar{r} \cdot (10j - 8i - \bar{r}) = 40$ and $P_1 = \max\{|\bar{r} + 2i - 3j|\}$, $P_2 = \min\{|\bar{r} + 2i - 3j|^2\}$. A tangent is drawn to the curve $y = \frac{8}{x^2}$ at the point A with abscissa 2. The drawn line cuts the x-axis at B

13. The value of P_2 is equal to
    (A) 9 (B) $2\sqrt{2}-1$
    (C) $6\sqrt{2}+3$ (D) $9-4\sqrt{2}$

14. The value of $P_1 + P_2$ is equal to
    (A) 2 (B) 10
    (C) 18 (D) 5

15. $\overrightarrow{AB} \cdot \overrightarrow{OB}$ is equal to
    (A) 1 (B) 2
    (C) 3 (D) 4

Space for rough work

Paragraph for Question Nos. 16 to 18

Read the following write up carefully and answer the following questions:
Consider the complex numbers z_1 and z_2 satisfying the relation $|z_1 + z_2|^2 = |z_1|^2 + |z_2|^2$

16. Complex number $z_1\bar{z}_2$ is
(A) purely real
(B) purely imaginary
(C) zero
(D) none of these

17. $\frac{z_1}{z_2}$ is
(A) purely real
(B) purely imaginary
(C) zero
(D) none of these

18. One of the possible argument of $i\left(\frac{z_1}{z_2}\right)$ is
(A) $\frac{\pi}{2}$
(B) $-\frac{\pi}{2}$
(C) 0
(D) none of these

Space for rough work

SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the following Column–I with Column–II

Column – I		Column – II
(A)	The locus of mid-points of chords of an ellipse which are drawn through an end of minor axis, is	(p) pair of straight line
(B)	The locus of an end of latus rectum of all ellipse having a given major axis is	(q) circle
(C)	The locus of the foot of perpendicular from a focus of the ellipse on any tangent is	(r) parabola
(D)	A variable line drawn through a fixed point cuts axes at A and B. The locus of mid-point of AB is	(s) ellipse
		(t) hyperbola

2. Match the following Column–I with Column–II

Column – I		Column – II
(A)	If the equation $x^2 + 4 + 3\sin(ax + b) - 2x = 0$ has atleast one real solution, where $a, b \in [0, 2\pi]$, then $\sin(a + b)$ can be equal to	(p) -1
(B)	$\sin^{-1} x \le \cos^{-1} x$, then x can be equal to	(q) 0
(C)	The number of the ordered pairs (x, y) satisfying $\|y\| = \cos x$ and $y = \sin^{-1}(\sin x)$, where $-2\pi \le x \le 3\pi$, is equal to	(r) 1
(D)	If $n \in N$ and the set of equations $\cos^{-1} x + (\sin^{-1} y)^2 = \frac{n\pi^2}{4}$ and $\left(\sin^{-1} y\right)^2 - \cos^{-1} x = \frac{\pi^2}{16}$ is consistent, then n can be equal to	(s) 4
		(t) 5

Space for rough work

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ANSWERS, HINTS & SOLUTIONS

HALF COURSE TEST –VIII
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICCS
1.	B	B	C
2.	D	C	D
3.	D	A	D
4.	C	D	B
5.	C	A	D
6.	D	C	A
7.	C	C	C
8.	A	D	C
9.	A, B	A, B, C, D	B, D
10.	A, B, D	B, D	A, B, C, D
11.	A, B, C, D	B, C, D	A, B
12.	B, C	B, C, D	A, B
13.	C	A	D
14.	A	B	C
15.	C	D	C
16.	C	B	B
17.	C	C	B
18.	A	A	C
1.	(A) → (q, s) (B) → (p, r) (C) → (p, r) (D) → (q, s)	(A) → (r) (B) → (p, q, r, s,) (C) → (p, s) (D) → (p, q, s)	(A) → (s) (B) → (r) (C) → (q) (D) → (t)
2.	(A) → (r, t) (B) → (t) (C) → (q) (D) → (q)	(A) → (q) (B) → (s) (C) → (p) (D) → (p)	(A) → (p) (B) → (p, q) (C) → (t) (D) → (r)

Physics

PART – I

SECTION – A

1. In one oscillation distance covered = 4 × 3 = 12

Here $\omega = \frac{\pi}{2} = \frac{2\pi}{T} \Rightarrow T = 4$ sec

$\therefore$ 8.5 sec = 4 × 2 + 0.5 and distance covered = 2 × 12 +3 –3 cos[(π/2) × 0.5] = $27 - \frac{3}{\sqrt{2}}$

3. The line of force due to pressure every where passes through O.

$\therefore$ Net torque = 0

$\Rightarrow$ F = 0

4. Each block completes half the oscillation and time period is independent of amplitude

5. $F = -\frac{dU}{dx} = -U_0\alpha\sin\alpha x = -U_0\alpha\sin\alpha x$

for small angle

$$F = -U_0\alpha^2 x$$

$$T = 2\pi\sqrt{\frac{m}{U_0\alpha^2}}$$

6. Since $\frac{m_1}{m_2} = \frac{2}{0.25} = 8 = \frac{\frac{4}{3}\pi r_1^3\rho}{\frac{4}{3}\pi r_2^3\rho}$

$\Rightarrow \frac{r_1}{r_2} = 2$

$v_T \ \alpha\ r^2$

hence $v_T = \frac{v}{4}$

7. Conservation of linear momentum during the explosion

$mv = \frac{m}{2}\times 0 + \frac{m}{2}\times v' \Rightarrow v' = 2v$

Increase in the mechanical energy = ΔK + ΔU

$\Delta U = 0 \ \ \Delta K = \frac{1}{2}\frac{m}{2}(2v)^2 - \frac{1}{2}mv^2 = \frac{1}{2}mv^2$

$$v = \sqrt{\frac{GM}{2R}}$$

$$\Delta K = \frac{mgR}{4}$$

8. Acceleration for particle = g
Acceleration for earth = g/2

$$g_{rel} = g + \frac{g}{2} = \frac{3g}{2}$$

$$h = \frac{1}{2} g_{rel} t^2 \Rightarrow t = \sqrt{\frac{4h}{3g}}$$

9. The satellite will fly out tangentially with same speed.

10. Use vector sum for superposition principle

11. $f_{AC} > f_{AB}$
$\Rightarrow$ $|f_A - f_C| > |f_A - f_B|$
$\Rightarrow$ All of them are possible.

12. Energy stored per unit volume = $\frac{1}{2} \times$ stress $\times$ strain = $\frac{1}{2} \times \frac{F}{A} \times \frac{\Delta\ell}{\ell}$

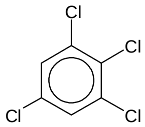
Total Energy = $\frac{1}{2} \times F \times \Delta\ell = \frac{1}{2} Mg\ell$

Chemistry PART – II

SECTION – A

1. The above reaction is not at equilibrium as,
$Q_c > K_c$, So the reaction will move in the backward direction.
Hence **(B)** is correct.

2. Let the dipole moment of chloro benzene =
$\mu_1 D_1$ then x = $2 \times \mu_1 \times \cos120°/2$
$\therefore \mu_1 = x$ D
Hence **(C)** is correct.



3 nth excited state means that electron is in the (n + 1)th level six, these 4 – H – atoms show a total of six different spectral lines, while returning to the ground level, that is possible only when (n + 1) = 4.
Hence **(A)** is correct.

4. Let moles of FeC_2O_4 be x & moles of $FeSO_4$ be y.
Then, $3x + y = 0.05$ ...(i)
also, $x + y = 0.025$ …(ii)
Hence **(D)** is correct.

5. $$Sn(50) = 1s^2 2s^2.2p^6 3s^2 3p^6.3d^{10}.4s^2.4p^6.4d^{10}.5s^2.5p^2 \text{ (by obeying Auf} - \text{bau rule)}$$
$$Sn(50) = 1s^2 2s^2.2p^6 3s^2 3p^6.3d^{10}.4s^2.4p^6.4d^{10}.4f^4 \text{ (if not following Auf} - \text{bau rule)}$$
So, if Auf – bau rule is not followed, then Sn would be placed of in f – block.
Hence **(A)** is correct.

6.
$$H_2CO_3 + NaOH \rightleftharpoons NaHCO_3 + H_2O$$

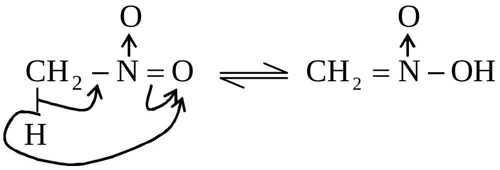
	H_2CO_3	NaOH	$NaHCO_3$	H_2O
m. mol	10	15	0	0
after the reaction	0	5	10	

Also,
$$NaHCO_3 + NaOH \rightleftharpoons Na_2CO_3 + H_2O$$

$NaHCO_3$	NaOH	Na_2CO_3	H_2O
10	5	0	
5	0	5	

So, it is a buffer,
$$pH = p^{k_{a_2}} + \log\frac{(Na_aCO_3)}{(NaHCO_3)}$$
$$\therefore pH = p^{k_{a_2}} = 13$$
$$\therefore pOH = 1$$
Hence **(C)** is correct.

7. The more is the derivation of a real gas from ideal behaviour the more is the critical temperature.
Hence **(C)** is correct.

8. 

$$\underset{\text{H}}{\text{CH}_2}-\overset{\overset{\text{O}}{\uparrow}}{\text{N}}=\text{O} \rightleftharpoons \text{CH}_2=\overset{\overset{\text{O}}{\uparrow}}{\text{N}}-\text{OH}$$

10. In case of physical equilibria, equilibria always shifts from low density to high density on increasing the pressure.

11. Since 5.6 littre are occupied by ¼ mole of NTP, so the molecular weight of metal chloride = 133.5 g.
Let the formula of the chloride be MCl_x
x × mole of metal = 1 × mole of Cl
Let the total mass of metal chloride = 100 g
Then mass of Cl = 80 g
& mass of metal = 20 g
& let mol weight of metal = M_A
Now,
$$x\times\frac{20}{M_A}=1\times\frac{80}{35.5} \qquad ...(i)$$
Also, $M_A + 35.5x = 133.5$ ….(ii)
On solving, x = 3 & M_A = 27 g
Hence (B, C, D)

16. $$AgCl(s) \rightleftharpoons Ag^{+}(aq)+Cl^{-}(aq)$$
$K_{sp} = x^2$
$$\therefore x=\sqrt{K_{sp}}=10^{-5}M$$
Hence (B) is correct.

17. $K_{sp} = [Ag^+]\,[Cl]$
$$10^{-10}=\left[Ag^{+}\right]\left[10^{-3}\right]\therefore\left[Ag^{+}\right]=10^{-7}M$$
Now,
$$\begin{array}{lccc} & \left[Ag(NH_3)_2\right]^{+} \rightleftharpoons & Ag^{+} \quad + & 2NH_3 \\ \text{Initial conc.} & 4\times10^{-3} & 10^{-7} & 2\times10^{-2} \\ \text{at equilibrium} & \left(4\times10^{-3}-x\right) & \left(10^{-7}+x\right) & \left(2\times10^{-2}+2x\right) \\ & \approx 4\times10^{-3} & \approx 10^{-7} & \approx 2\times10^{-2} \end{array}$$
So, $$K_d=\frac{\left[Ag^{+}\right]\left[NH_3\right]^2}{\left[Ag(NH_3)_2\right]^{+}}=\frac{10^{-7}\times\left(2\times10^{-2}\right)^2}{\left(4\times10^{-3}\right)}=10^{-8}$$
Hence (C) is correct.

Mathematics PART – III

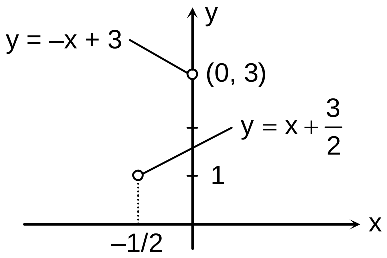
SECTION – A

1. Let α, β be the roots of $ax^2 - bx - c = 0$ and let α', β' be the roots of $a'x^2 - b'x - c' = 0$ such that $|\alpha - \beta| = |\alpha' - \beta'|$, i.e., $(\alpha + \beta)^2 - 4\alpha\beta = (\alpha' + \beta')^2 - 4\alpha'\beta'$

$\Rightarrow \frac{b^2 + 4ac}{a^2} = \frac{b'^2 + 4a'c'}{a'^2}$

Hence, the expression $\frac{b^2 + 4ac}{a^2}$ does not vary in value

2. Let z = x + iy, then $\arg(z - 3i) = \arg(x + iy - 3i) = \frac{3\pi}{4}$



$\Rightarrow x < 0, y - 3 > 0 \left(\because \frac{3\pi}{4} \text{ is in II quadrant}\right)$

and $\frac{y-3}{x} = \tan\frac{3\pi}{4} = -1$

$\Rightarrow y = -x + 3 \ \forall \ x < 0$ and $y > 3$ ..... (1)

and $\arg(2z + 1 - 2i) = \arg[(2x+1) + i(2y-2)] = \frac{\pi}{4}$

$\Rightarrow 2x + 1 > 0, 2y - 2 > 0 \left(\because \frac{\pi}{4} \text{ is in I quadrant}\right)$

and $\frac{2y-2}{2x+1} = \tan\frac{\pi}{4} = 1 \Rightarrow 2y - 2 = 2x + 1$

$\Rightarrow y = x + \frac{3}{2} \ \forall \ x > -\frac{1}{2}, y > 1$ ..... (2)

From equations (1) and (2), we get graph. It is clear from the graph that two lines do not intersect
$\therefore$ No point of intersection

3. Let a = b – d ad c = b + d, then a + b + c = $\frac{3}{2} \Rightarrow b = \frac{1}{2}$

$\therefore$ The numbers are $\frac{1}{2} - d$, $\frac{1}{2}$, $\frac{1}{2} + d$ [d > 0 as a < b < c]

Now a^2, b^2, c^2 are in G.P. $\Rightarrow (b^2)^2 - a^2c^2 \Rightarrow \left(\frac{1}{2}\right)^2 = \left(\frac{1}{2} - d\right)^2\left(\frac{1}{2} + d\right)^2$

$\Rightarrow \frac{1}{16} = \left(\frac{1}{4} - d^2\right)^2 \Rightarrow \frac{1}{4} - d^2 = \pm\frac{1}{4} \Rightarrow d = \pm\frac{1}{\sqrt{2}} \Rightarrow d = \frac{1}{\sqrt{2}}$ ($\because$ d > 0)

4. $\frac{(1+24)^{100}}{8} = \frac{1}{8} + \text{Integer}$

5. Maximum number of point of intersection = $2 \times {}^8C_2 = 56$

6. $a \sin x + b\{\cos(x + \theta) + \cos(x - \theta)\} = d$
$\Rightarrow a \sin x + 2b \cos x \cos \theta = d$

$$\cos^2\theta \ge \frac{d^2-a^2}{4b^2} \Rightarrow |\cos\theta| \ge \frac{\sqrt{d^2-a^2}}{2|b|}$$

7. $\tan^{-1}\sqrt{x^2-3x+2} < \frac{\pi}{2}$ and $\cos^{-1}\sqrt{4x-x^2-3} \le \frac{\pi}{2}$

$\therefore$ 0 < LHS < $\pi \Rightarrow$ no solution

8. $$\left[\left(\frac{a}{2}-c\right)^2+\left(b-\frac{\sqrt{3}a}{2}\right)^2\right]=0$$

$$\Rightarrow a = \frac{c}{\left(\frac{1}{2}\right)} = \frac{b}{\left(\frac{\sqrt{3}}{2}\right)}$$

9. $b^2 - 4ac < 0$

$\therefore$ $f(x) = ax^2 + bx + c$ must have same sign for all real x

$f(-1) = a - b + c < 0$

$\therefore$ $f(-2) < 0 \Rightarrow 4a - 2b + c \Rightarrow 4a + c < 2b$

$f\left(-\frac{1}{2}\right) < 0 \Rightarrow \frac{a}{4}-\frac{b}{2}+c<0 \Rightarrow a - 2b + 4c < 0 \Rightarrow a + 4c < 2b$

10. Circle $(\alpha + r)^2 + y^2 = r^2$

Solving with the parabola, x = 0 and $12 - 2r \neq 0$

$\therefore$ $r_{max} = 6$

11. $$\left|\frac{z_1+i\frac{z_1+z_2}{2}}{z_1-i\left(\frac{z_1+z_2}{2}\right)}\right|=1$$

$$\Rightarrow \left|\frac{\frac{2z_1}{z_1+z_2}+i}{\frac{2z_1}{z_1+z_2}-i}\right|=1$$

$\Rightarrow \frac{2z_1}{z_1+z_2}$ is purely real

$\Rightarrow \frac{z_1+z_2}{z_1}$ is purely real

$\Rightarrow \frac{z_2}{z_1}$ is purely real

12. Equation is equivalent to $|S_1P - S_2P|$ = constant

$\therefore$ 2a = k and $2ae = S_1S_2 = 2$

$\therefore$ $e = \frac{2}{k}$

Also, k > 0

$\therefore$ $k \in (0, 2)$

13.-15. $\vec{r} = xi + yj$

$x^2 + y^2 + 8x - 10y + 40 = 0$

$c = (-4, 5), r = 1$

$P_1 = \max\{(x + 2)^2 + (y - 3)^2\}$

$P_2 = \min\{(x + 2)^2 + (y - 3)^2\}$

$\therefore P = (-2, 3)$

$CP = 2\sqrt{2}$

$P_2 = \left(2\sqrt{2} - 1\right)^2$, $P_1 = \left(2\sqrt{2} + 1\right)^2$

$\overrightarrow{OA} = 2i + 2j$

$\overrightarrow{OB} = 3i$

$\therefore \overrightarrow{OA} \cdot \overrightarrow{OB} = 3$

16.-18. $(z_1 + z_2)\left(\overline{z_1 + z_2}\right) = |z_1|^2 + |z_2|^2$

$\Rightarrow z_1\bar{z}_2 + \bar{z}_1 z_2 = 0$

$\Rightarrow \frac{z_1}{z_2} + \left(\frac{\bar{z}_1}{\bar{z}_2}\right) = 0$

SECTION – B

1. (A) $\frac{hx}{a^2} + \frac{ky}{b^2} = \frac{h^2}{a^2} + \frac{k^2}{b^2}$ which passes through (0, b)

$\therefore \frac{k}{b} = \frac{h^2}{a^2} + \frac{k^2}{b^2}$

$\Rightarrow$ Ellipse

(B) $h = ae, k = a(1 - e^2)$

$\therefore h^2 = -a(k - a)$

$\therefore$ Parabola

(C) $y - mx = \sqrt{a^2m^2 + b^2}$

Perpendicular from (ae, 0) is $my + x = ae$

$\therefore x^2 + y^2 = a^2$

$\therefore$ Circle

(D) $\frac{x}{a} + \frac{y}{b} = 1$ passes through (α, β)

$\therefore \frac{\alpha}{a} + \frac{\beta}{b} = 1$

$h = \frac{a}{2}$, $k = \frac{b}{2}$

$\therefore \frac{\alpha}{h} + \frac{\beta}{k} = 2$

$\frac{\alpha}{x} + \frac{\beta}{y} = 2$

$\Rightarrow \left(x - \frac{\alpha}{2}\right)\left(y - \frac{\beta}{2}\right) = \frac{\alpha\beta}{4}$

$\therefore$ Rectangular hyperbola

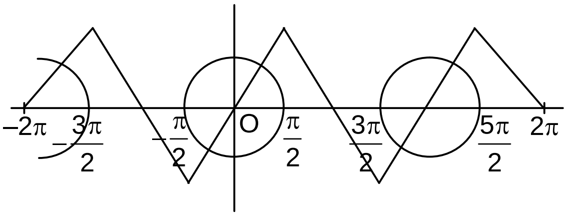
2. (A) $(x - 1)^2 + 3\{1 + \sin(ax + b)\} = 0$

$\Rightarrow \alpha = 1$ and $\sin(a + b) = -1$

(B) $\frac{\pi}{2} - \sin^{-1} x \geq \sin^{-1} x$

$\therefore -1 \leq x \leq \frac{1}{\sqrt{2}}$

(C) The graph of $|y| = \cos x$ and $y = \sin^{-1}(\sin x)$ intersect at 5 points in $[-2\pi, 3\pi]$


-2π
$-\frac{3\pi}{2}$
$-\frac{\pi}{2}$
O
$\frac{\pi}{2}$
$\frac{3\pi}{2}$
$\frac{5\pi}{2}$
2π

(D) Adding we get, $\left(\sin^{-1} y\right)^2 = \frac{4n+1}{32}\pi^2$

$\Rightarrow 0 \leq \frac{4n+1}{32}\pi^2 \leq \frac{\pi^2}{4}$

Also, $\cos^{-1} x = \frac{4n-1}{32}\pi^2$

$\therefore n = 1$

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Advanced), 2015**

HALF COURSE TEST –VIII

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 240**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 04)** contains 4 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.
   Section – A (05 – 09) contains 5 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 mark** will be awarded. There may be one or more than one correct choice. No marks will be given for any wrong match in any question. There is no negative marking.

3. **Section – C (01 – 08)** contains 8 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION - A

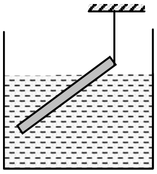
Straight Objective Type

*This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.*

1. A block of mass m attached to a spring executes SHM with angular frequency ω_0. The spring is cut into 4 equal parts and another block with mass $\frac{m}{2}$ is attached to the two pieces in parallel combination. The angular frequency of oscillations of the mass will be
(A) $2\omega_0$
(B) $4\omega_0$
(C) $2\sqrt{2}\omega_0$
(D) $\omega_0/4$

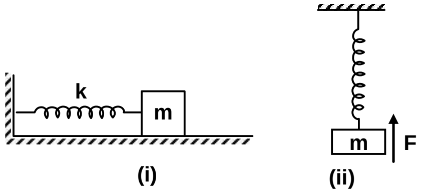
2. An artificial satellite is first taken to a height equal to half the radius of Earth. Let E_1 be the energy required. It is then given the appropriate orbital speed such that it goes in a circular orbit at that height. Let E_2 be the energy required. The ratio $\frac{E_1}{E_2}$ is
(A) 4 : 1
(B) 3 : 1
(C) 1 : 1
(D) 1 : 2.

3. A thin homogeneous rod of length 2L floats partly immersed in water, being supported by a string fastened to one of its end, as shown. The specific gravity of the rod is 0.75. the length of the rod that extends out of water in equilibrium is



(A) L
(B) L/2
(C) L/4
(D) 3L

4. A particle of mass m is executing SHM as shown in diagram (1) and (2). In diagram (2) a force F is applied on the particle in the upward direction F = mg. If their velocities are same at mean position and let A_1 and A_2 be their amplitudes and T_1 and T_2 be their time periods respectively then,



(A) $A_1 = A_2$, $T_1 = T_2$
(B) $A_1 = A_2$, $T_1 > T_2$
(C) $A_1 > A_2$, $T_1 = T_2$
(D) $A_1 > A_2$, $T_1 > T_2$

Space for rough work

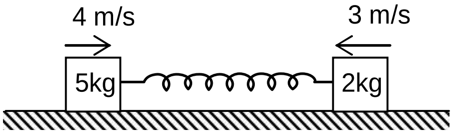
(Multiple Correct Choice Type)

This section contains ***5 multiple choice questions***. Each question has four choices (A), (B), (C) and (D) out of which ***ONE or MORE*** are correct.

5. A hollow sphere and a solid sphere of same radius and same material fall through a liquid from same height (neglect viscous force). Then, the correct option(s) from the following is/are:
(A) The solid sphere reaches the ground earlier than the hollow sphere.
(B) The hollow sphere reaches the ground earlier than the solid sphere.
(C) Buoyant forces on both solid as well as hollow sphere are same.
(D) Buoyant forces on the solid and hollow spheres are different.

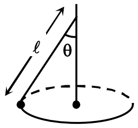
6. A spherical black body has radius r. If P is the power radiated by the black body and R is the rate of cooling of the black body, then
(A) $P \propto \frac{1}{r}$ (B) $P \propto r^2$
(C) $R \propto \frac{1}{r}$ (D) $R \propto r^2$

7. Two blocks connected with the spring of force constant 100 N/m are given velocities $4\hat{i}$ m/s and $-3\hat{i}$ m/s when the spring is in natural length as shown in figure



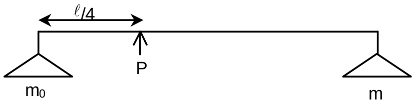
(A) The velocity of 2kg block is maximum when 5 kg block is at instantaneous rest.
(B) The maximum and minimum velocities of 2kg block is $7\hat{i}$ m/s and $-3\hat{i}$ m/s respectively.
(C) The maximum and minimum velocities of 5kg block is 4 m/s and zero respectively.
(D) None of these

8. A particle is rotating in a conical pendulum with help of a string of length ℓ as shown in the figure. The speed of the particle is constant and angle θ is also constant with time. It can be said that



(A) Angular momentum of the particle about the point of suspension is not constant.
(B) Only the direction of angular momentum of the particle about the point of suspension is constant.
(C) Only the magnitude of angular momentum about the point of suspension is constant.
(D) Net torque on the particle about the point of suspension is zero.

9. A light rod of length ℓ is pivoted at distance $\ell/4$ from the left end has two masses m_0 and m attached to its ends such that rod is in equilibrium. Find m in terms of m_0.



(A) $\frac{m_0}{2}$ (B) $\frac{m_0}{3}$
(C) Torque about P is zero (D) Torque about P is not zero

Space for rough work

SECTION - B

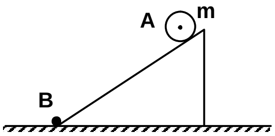
Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

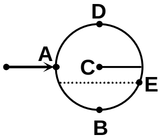
1. A sphere of mass m, radius R is left on a rough wedge (coefficient of friction μ) fixed with the ground. Now, match the following



Column A	Column B
(A) If $\mu = 0$	(p) ΔP.E. > ΔK.E.
(B) If $\mu \neq 0$; and before rolling starts	(q) Friction is acting upward
(C) If $\mu \neq 0$; and after rolling starts	(r) Friction is acting downward
(D) If $\mu \neq 0$; when the sphere is at bottom most point.	(s) ΔP.E $\leq$ ΔK.E.
	(t) Translational (ΔK.E.) > (Rotational) (ΔK.E.)

Space for rough work

2. A sphere of mass M, radius R kept on a horizontal frictionless surface. A small ball of mass m hits the sphere at a height h = R and rebounds elastically as shown in the figure. Consider the situation mentioned and match the following.



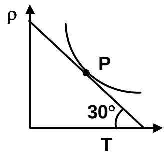
	Column A		Column B
(A)	Linear momentum for the sphere is conserved along tangent at	(p)	A
(B)	Angular momentum for the system is conserved about point.	(q)	B
(C)	Net torque on the sphere is zero about	(r)	C
(D)	Linear Impulse is acting about line joining points A and	(s)	D
		(t)	E

Space for rough work

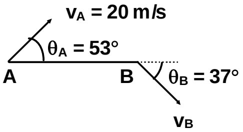
SECTION – C
(Integer value correct Type)

This section contains ***8 questions***. The answer to each question is ***a single digit integer***, ranging from 0 to 9 (*both inclusive*).

1. The variation of density (ρ) with temperature (T) of an ideal gas of molecular mass (M) at constant pressure is plotted as shown in figure. The pressure of the gas at state P is $\frac{RT^2}{\sqrt{KM}}$ Find the value of K.

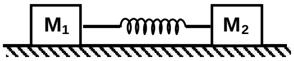


2. The two ends A and B of a uniform of length ℓ = 1m and mass m are moving with velocities V_A and V_B as shown. The length AP, where P is point on the rod with velocity 12 m/s, is 8K cm. Find the value of K.



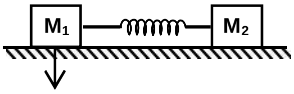
3. A particle moving on the sphere $X^2 + Y^2 + Z^2 = 1$ on the convex side. XY plane is vertical plane and 'g' acts along –ve Y axis. The speed of the particle is $2ms^{-1}$ always. The mass of the particle is 1kg. The normal reaction acting on the particle at point (0, 1m, 0) is _________.

4.



Frictionless surface

If M_1 & M_2 are free to oscillate together about their centre of Mass, then time period is T_1.



M_1 fixed

If M_1 is fixed, and only M_2 oscillates horizontally then time period is T_2

If $\frac{T_2}{T_1} = 3$ Then $\frac{M_2}{M_1}$ is ________

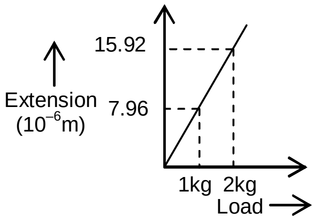
Space for rough work

5. The displacement of a string is given by $y(x_1, t) = .06\sin\left[\frac{2\pi X}{3}\right]\cos[120\pi t]$

Where X and Y are in m and t in sec. The length of the string is 1.5m and its mass is 3.0×10^{-2} Kg. This is a result of super position of two waves travelling in opposite directions.
The speed of any one of the component waves is 36X ms^{-1}. Then X = ?

6. A hollow sphere of volume V is floating on water surface half immersed. The minimum volume of water poured on surface so that the sphere now sinks into the water is V/K. Then K is:

7. In determination of Young's Modulus by Searle's Method, the extension Vs load curve is shown below. The radius of the wire is 1mm and length of the wire used is 2m. The Young's modulus is $X \times 10^{11} N/m^2$. Then X = _________.



8. A particle starts falling from the top of a tower at t = 0 where g = $10ms^{-2}$. Simultaneously, a car situated on ground some distance away starts moving towards the tower at a constant velocity of $5ms^{-1}$. The radius of curvature of the trajectory of particle as seen by an observer in the Jeep at some time 't' is $\frac{5}{2}(17)^{3/2}$ metre. Find the time 't' where 't' is in seconds.

Space for rough work

Chemistry

PART – II

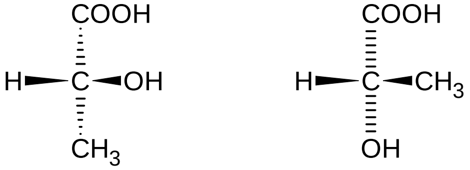
SECTION - A

Straight Objective Type

*This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.*

1. Which of the following is the correct nature of a solution obtained by mixing 100 ml of 0.10 M HA and 100 ml of 0.1 M NaOH?
(I) Neutral, if HA is a strong acid
(II) Basic if HA is a weak acid
(III) Neutral if HA is a weak acid.
(A) I only
(B) I and II only
(C) I and III only
(D) II and III only

2. The structures shown below,



are:
(A) Identical
(B) different conformations of the same compound
(C) Enatiomers
(D) Diastreomers

3. Consider the following statements:
(i) 4 g if O_2 gas occupies 11.2 litres at 0^0C and 0.25 atm pressure assuming ideal behaviour.
(ii) Vander Waal's constant 'a' for NH_3(g) is higher than CO_2(g).
(iii) Average distance travelled by a gas molecule between two successive collisions is directly proportional to the square of its collision diameter.
(iv) Average kinetic energy of two molecules of an ideal gas is $\frac{3}{2}kT$, where k is Boltzmann constant.
Identify the correct statements of the above
(A) I, ii and iii
(B) I, ii, iii and iv
(C) ii, iii and iv
(D) I, ii and iv

4. If we wish to prepare 250 ml of 0.1 M NaOH solution, it is advisable to use more than 1.0 g (as required) NaOH because,
(A) NaOH is hygroscopic in nature
(B) NaOH is easy to purify
(C) NaOH is less soluble in water
(D) NaOH is a strong base

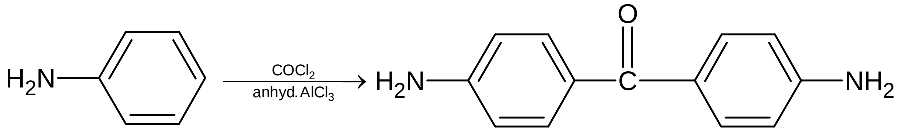
Space for rough work

(Multiple Correct Choice Type)

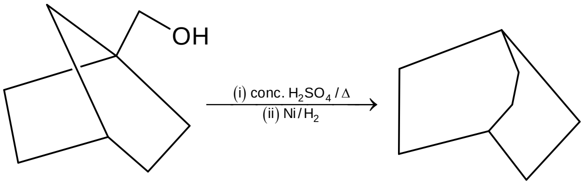
This section contains ***5 multiple choice questions***. Each question has four choices (A), (B), (C) and (D) out of which ***ONE or MORE*** are correct.

5. Which of the following reaction product is not correct?

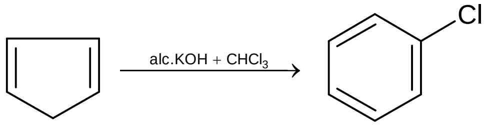
(A)


H2N
COCl2
anhyd. AlCl3
H2N
O
C
NH2

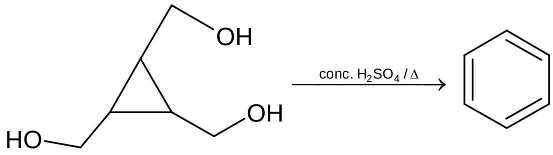
(B)


OH
(i) conc. H2SO4 / Δ
(ii) Ni / H2

(C)

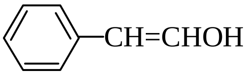

alc.KOH + CHCl3
Cl

(D)

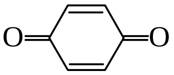

OH
OH
HO
conc. H2SO4 / Δ

6. Which of the following compounds exhibit tautomerism?

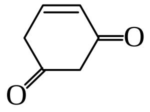
(A)



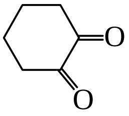
(B)



(C)



(D)



Space for rough work

7. In which of the following reaction(s), H_2O_2 can convert the underlined atom into the product with oxidation state = +6.

(A) $\underline{Cr}Cl_3 + H_2O_2 + OH^- \longrightarrow$
(B) $K_2\underline{Cr_2}O_7 + H_2O_2 + H_2SO_4 \longrightarrow$
(C) $\underline{S}O_2 + H_2O_2 + OH^- \longrightarrow$
(D) $H_2O_2 + Na_3\underline{As}O_3 + OH^- \longrightarrow$

8. From the following data for the reaction between A and B:

[A] [mol^{-1}]	[B] [mol^{-1}]	Initial rate at (mol^{-1}sec^{-1})	
		300 K	320 K
2.5×10^{-4}	3.0×10^{-5}	5.0×10^{-4}	2.0×10^{-3}
5.0×10^{-4}	6.0×10^{-5}	4.0×10^{-3}	-
1.0×10^{-3}	6.0×10^{-5}	1.6×10^{-2}	-

Now select the correct statement(s) of the following:
(A) Overall order of this reaction is 3.
(B) Units of rate constant of the above reaction is mol^{-2} l^{2} sec^{-1}
(C) Rate constant of this reaction at 300 K is 2.66×10^{8} mol^{-2} l^{2} sec^{-1}
(D) Rate constant of this reaction at 320 K is 12.66×10^{7} mol^{-2} l^{2} sec^{-1}

9. The correct statement regarding H_3BO_3 is/are
(A) Monobasic and weak Lewis acid
(B) when mannitol is added to aqueous solution of H_3BO_3 pH of the solution decreases
(C) titration of H_3BO_3 against NaOH is done in presence of mannitol
(D) Tribasic and weak Bronsted acid.

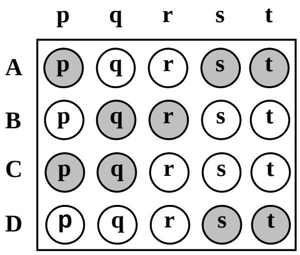
Space for rough work

SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

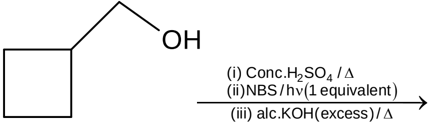
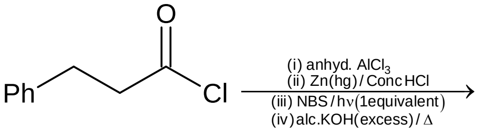
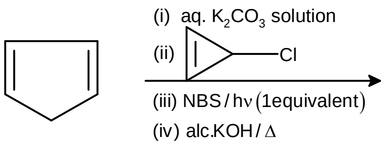
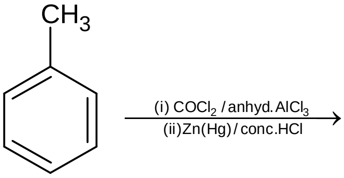


1. Match the species given in Column – I with their corresponding characteristics in Column – II:

Column – I (Species)		Column – II (Characteristics)	
(A)	ICl_2^-	(p)	possesses permanent dipole moment
(B)	$XeOF_4$	(q)	at least two lone pairs on the central atom
(C)	SeF_4	(r)	distorted structure
(D)	$Ba(BrO_3)_2$	(s)	sea-Saw shaped
		(t)	trigonal bipyramidal geometry

Space for rough work

2. Match the reaction in Column – I with the characteristics of corresponding organic product in Column – II:

Column – I (Reaction)		**Column – II (Characteristics of organic product)**	
(A)	 OH (i) Conc.H_2SO_4 / Δ (ii) NBS / hν (1 equivalent) (iii) alc.KOH(excess) / Δ	(p)	Aromatic
(B)	 O Ph Cl (i) anhyd. $AlCl_3$ (ii) Zn(hg) / Conc HCl (iii) NBS / hν (1equivalent) (iv) alc.KOH(excess) / Δ	(q)	All carbon atoms in the ring are sp^2 hybridised
(C)	 (i) aq. K_2CO_3 solution (ii) Cl (iii) NBS / hν (1equivalent) (iv) alc.KOH / Δ	(r)	Non-aromatic
(D)	 CH_3 (i) $COCl_2$ / anhyd. $AlCl_3$ (ii) Zn(Hg) / conc.HCl	(s)	Bicyclic
		(t)	At least one carbon atom is sp^3 hybridised

Space for rough work

SECTION – C
(Integer value correct Type)

This section contains ***8 questions***. The answer to each question is ***a single digit integer***, ranging from 0 to 9 (*both inclusive*).

1. Two moles of helium gas (γ = 5/3) are initially at a temperature of 27^0C and occupy a volume of 20 litre. The gas is first expanded at constant pressure until the volume is doubled. It then undergoes adiabatic change until the temperature returns to its initial value. If total work done by the gas is – xkcal, then what is x?

2. Magnesium carbide on hydrolysis gives a product which on heating with Na followed by treatment with ethyl chloride gives another product (A). (A) on catalytic reduction gives (B). Calculate the number of monochlorinated product (s) of compound (B).

3. 100 ml of tap water containing $Mg(HCO_3)_2$ was titrated with M/50 HCl with methyl orange as indicator. If 30 ml of HCl were required, calculate '**X**', if temporary hardness as parts of $CaCO_3$ per 10^6 parts of water is **X** $\times 10^2$.

4. Sodium borohydride on reaction with iodine in the presence of diglyme solution gives a gas (X) which is used as an important rocket fuel. The gas (X) on heating with ammonia forms an adduct which on further heating to high temperature forms another compound (Y).
Calculate the number of dichloro derivative of compound (Y).

5. How many isomeric dinitrobenzoic acids can exist? $C_6H_3(NO_2)_2CO_2H$

6. What is the number of monochloro substituted derivatives formed from diphenyl methane?

7. In an experiment, 50 ml of 0.1 M solution of a metallic salt reacted exactly with 25 ml of 0.1 M solution of Na_2SO_3. In the reaction SO_3^{2-} is oxidized to SO_4^{2-}. If the original oxidation number of the metal in the salt was 3, what would be the new oxidation number of metal?

8. For the reaction at 25^oC
$A(g) + 2B(g) \rightleftharpoons 2C(g) + D(g)$
The initial concentration of B is 1.5 times the initial concentration of A. If at equilibrium, the equilibrium concentration of A and D are equal. The equilibrium constant at 25^oC is

Space for rough work

Mathematics

PART – III

SECTION - A

Straight Objective Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which ***ONLY ONE*** *is correct.*

1. A straight line L with negative slope passes through (8, 2) and cuts the positive axes at P and Q. As L varies, the absolute minimum value of OP + OQ is (O is origin)
(A) 10 (B) 18
(C) 16 (D) 12

2. If (α, β) is a point on the circle whose centre lies on the x-axis and which touches the line x + y = 0 at (2, –2), then the greatest value of α is
(A) $4-\sqrt{2}$ (B) $4+\sqrt{2}$
(C) $4+2\sqrt{2}$ (D) 6

3. Maximum number of common normal of $y^2 = 4ax$ and $x^2 = 4by$ may be equal to
(A) 2 (B) 3
(C) 5 (D) infinite

4. The locus of foot of perpendicular from the centre on any tangent to the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ is
(A) a circle (B) ellipse
(C) hyperbola (D) none of these

Space for rough work

(Multiple Correct Choice Type)

This section contains ***5 multiple choice questions***. Each question has four choices (A), (B), (C) and (D) out of which ***ONE or MORE*** are correct.

5. The range of values of 'a' such that the angle θ between the pair of tangents drawn from (a, 0) to the circle $x^2 + y^2 = 1$ satisfies $\frac{\pi}{2} < \theta < \pi$, lies in

(A) (1, 2)
(B) $\left(1,\ \sqrt{2}\right)$
(C) $\left(-\sqrt{2},\ -1\right)$
(D) $\left(-\sqrt{2}, -1\right) \cup \left(1, \sqrt{2}\right)$

6. In a ΔABC, if $(a + b + c)(b + c - a) = xbc$ then x can be equal to

(A) 1
(B) 2
(C) 3
(D) 4

7. If the equation $\sin^{-1}(x^2 + x + 1) + \cot^{-1}(ax + 1) = \frac{\pi}{2}$ has exactly 2 solutions, then a can not have the integral values

(A) –1
(B) 0
(C) 1
(D) 2

8. If $\cos^4\theta + \alpha$, $\sin^4\theta + \alpha$ are the roots of $x^2 + b(2x + 1) = 0$ and $\cos^2\theta + \beta$, $\sin^2\theta + \beta$ are the roots of the equation $x^2 + 4x + 2 = 0$, then b is equal to

(A) 1
(B) –1
(C) 2
(D) –2

9. The sum of the coefficients in the expansion of $(2 + 3cx + c^2x^2)^{12}$ vanishes then c equals

(A) –2
(B) 2
(C) 1
(D) –1

Space for rough work

SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

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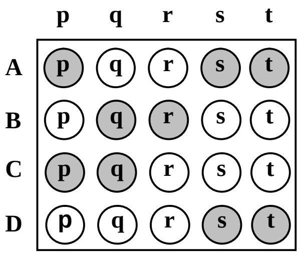

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1. Match the following Column–I with Column–II

Column – I	Column – II
(A) The function $\frac{\sin x \cos 3x}{\sin 3x \cos x}$ can take the values	(p) 4
(B) (sin 12º)(sin 48º)(sin 54º) is equal to	(q) $\frac{1}{8}$
(C) In an acute angled ΔABC, the least values of $\sum \sec A$	(r) 6
(D) $\left(\sqrt{3}\ \text{cosec}\ 20^o - \sec 20^o\right)$ is equal to	(s) 0
	(t) 2

2. ΔABC has side lengths 18, 24, 30 respectively. Match the following Column–I with Column–II

Column – I	Column – II
(A) The ratio of circum radius to in-radius is	(p) $\sqrt{2}$
(B) The distance between circum-centre and orthocentre is	(q) $\frac{4\sqrt{2}}{3}$
(C) The distance between circum-centre and in-centre	(r) $2\sqrt{2}$
(D) The area of triangle whose vertices are the in-centre, circum-centre and centroid respectively, is	(s) $4\sqrt{2}$
	(t) $\frac{\sqrt{3}}{2}$

Space for rough work

SECTION – C
(Integer value correct Type)

This section contains ***8 questions***. The answer to each question is ***a single digit integer***, ranging from 0 to 9 (*both inclusive*).

1. If z_0 lies on the curve $z\bar{z}-(6+i)\bar{z}-(6-i)z+28=0$ then minimum of $|z_0 + 5 - i|$ is equal to _____

2. $|z| = 2$ and the maximum value of $|z - 1| + |z - 2| + |z - 3|$ is M, then $\frac{M}{4}$ is equal to _____

3. Let k be the number of 8-digits number such that the product of any two consecutive digits is prime and $na+\frac{n(n-1)}{2}=k$, where a, n $\in$ N. If n is maximum, then $\frac{a}{64}$ is equal to _____

4. 6 boys, 5 girls and 3 teachers are arranged in a line such that boys are in ascending order, girls are in descending order, no two teachers are together. The number of such arrangement is $(220k)\cdot {}^{11}C_5$, then k is equal to _____

5. If 3 positive real numbers a, b, c are in A.P. and abc = 4 then the value of [b], (where [.] denotes greatest integer function) is _____

6. If $\cot(\theta - \alpha)$, $3\cot\theta$, $\cot(\theta + \alpha)$ are in A.P. and θ is not an integral multiple of $\frac{\pi}{2}$, then $\frac{2\sin^2\theta}{\sin^2\alpha}$ is equal to _____

7. If x, y, z $\in$ (0, 1] such that (log x)(log y) = log(xy) and 2(log x)(log z) = log(zx), then the value of 2x + 3y + 4z is equal to _____

8. $|z^2 - 9| + |z^2| = 41$, then the maximum value of $|z|$ is _____

Space for rough work

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ANSWERS, HINTS & SOLUTIONS

HALF COURSE TEST –VIII
(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICCS
1.	B	B	B
2.	C	C	C
3.	A	D	C
4.	A	A	D
5.	A, C	A, B, C	D
6.	B, C	A, C, D	A, B, C
7.	A, B, C	A, B, C	A, C, D
8.	A, C	A, B, C	B, C
9.	B, C	A, B, C	A, D
1.	(A) → (t) (B) → (q) (C) → (q) (D) → (p)	(A) → (q, r, t) (B) → (p, r) (C) → (p, r, s, t) (D) → (p, r)	(A) → (p, q, r, s) (B) → (q) (C) → (r) (D) → (p)
2	(A) → (p, q, r, s, t) (B) → (p, q, r, s, t) (C) → (p, q, r, s, t) (D) → (r)	(A) → (p, q) (B) → (p, q, s) (C) → (p, q, s) (D) → (q, r, s, t)	(A) → (r) (B) → (s) (C) → (q) (D) → (p)
1.	3	3	8
2.	8	4	3
3.	6	3	8
4.	8	4	6
5.	5	6	1
6.	2	4	3
7.	8	2	9
8.	2	4	5

Physics

PART – I

SECTION – A

1. $\omega_0 = \sqrt{\frac{K}{m}}$, $\omega' = \sqrt{\frac{8K}{m/2}}$ = 4 ω_0

2. $$E_1 = -\frac{GM_e m}{R_e + \frac{R_e}{2}} - \left(-\frac{GM_e m}{R_e}\right) = \frac{GM_e m}{3R_e}$$

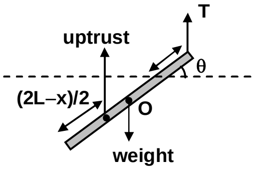
$$E_2 = \frac{1}{2}mv_0^2 = \frac{1}{2}m.\frac{GM_e}{R + \frac{R_e}{2}} = \frac{GM_e m}{3R_e}.$$

$\therefore$ (C)

3. For vertical equilibrium

T = weight – upthrust

$$T = 2LA\left(\frac{3}{4}\right)\rho g - (2L - x)A\rho g = Ag\rho\left[x - \frac{L}{2}\right]$$



where ρ is the density of water

for rotational equilibrium about O

$$(2L - x)Ag\rho\left[L - \left(\frac{2L - x}{2}\right)\right]\cos\theta = Ag\rho\left[x - \frac{L}{2}\right]L\cos\theta$$

$\Rightarrow$ x = L

4. If v be the velocity at mean position in two cases then

$\frac{1}{2}mv^2 = \frac{1}{2}kA_1^2$ and $T_1 = T_2 = 2\pi\sqrt{\frac{m}{k}}$

$A_1 = A_2$

5. Buoyant forces on both the spheres will be same because volume of both the spheres is same and weight of the hollow sphere is less. If ‘A’ and ‘a’ are the accelerations of solid and hollow spheres respectively, then A > a.

6. $P = \sigma(4\pi r^2)T^4$

$$R = \frac{dT}{dt} = \left(\frac{3\sigma T^4}{\rho s}\right)\frac{1}{r}$$

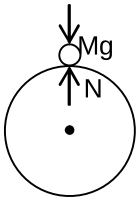
SECTION – C

1. At point P slope is tan 150°

$$\therefore \frac{d\rho}{dT} = \tan 150° = -\frac{1}{\sqrt{3}}$$

Since $\rho = \frac{PM}{RT} \Rightarrow \frac{d\rho}{dT} = -\frac{PM}{RT^2}$

3. $\frac{V^2}{R} = 4ms^{-2}$



$Mg - N = 10 - N = 1.\frac{V^2}{R} = 4$

$\Rightarrow$ N = 6 Newtons

4. $\omega = \sqrt{\frac{K}{M}} \quad T = 2\pi\sqrt{\frac{M}{K}}$

$T_1 = 2\pi\sqrt{\frac{M_1 M_2}{K(M_1 + M_2)}}$ $\qquad T_2 = 2\pi\sqrt{\frac{M_2}{K}}$

$T_2 = 2\pi\sqrt{\frac{M_2}{K}}$

$\frac{M_1 + M_2}{M_1} = \left(\frac{T_2}{T_1}\right)^2 = 9 = \frac{M_1 + M_2}{M_1} = \frac{1 + M_2}{M_1}$

$\therefore \quad \frac{M_2}{M_1} = 8$

5 $\omega = 120\,\pi$

K = $2\pi / 3$

$V = \frac{\omega}{K} = 180 = 36X$

X = 5

6. While floating net force = zero

Increase in buoyancy force = increase in weight

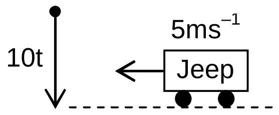
$\frac{V}{2}\rho g = x\rho g$

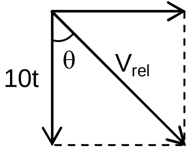
$\Rightarrow x = \frac{V}{2}$

7. $\tan\theta = \frac{\ell}{Mg} = \left[\frac{15.92 - 7.96}{1 \times 10}\right]10^{-6} = 7.96 \times 10^{-7}\frac{m}{Newton}$

$Y = \frac{2m}{3.14(10^{-3}m)^2}\frac{N}{7.96 \times 10^{-7}m} = 8 \times 10^{-11}\frac{N}{m^2}$

8.





$V_{rel} = 5\sqrt{1 + 4t^2}$

$\sin\theta = \frac{5}{5\sqrt{1+4t^2}} = \frac{1}{\sqrt{1+4t^2}}$ $\qquad g\sin\theta = a_N = \frac{10}{\sqrt{1+4t^2}}$

$R = \frac{V_{rel^2}}{a_N} = \frac{25}{10}(1 + 4t^2)^{3/2} = \frac{5}{2}(17)^{3/2}$ $\qquad \Rightarrow 1 + 4t^2 = 17$

t = 2 seconds.

Chemistry

PART – II

SECTION – A

3. (i) use PV = nRT

$$PV = \frac{w}{m}RT$$

(ii) due to hydrogen bonding $a_{NH_3} > a_{CO_2}$

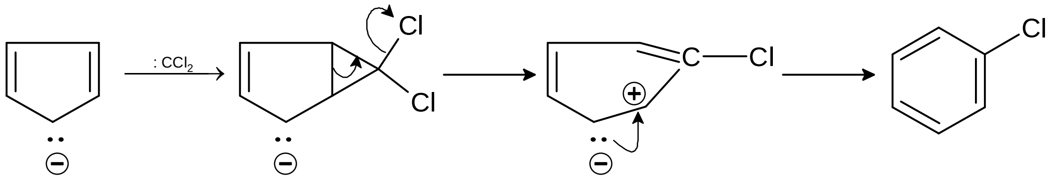
(iii) mean free path (λ) $\propto \frac{1}{\sigma^2}$

(iv) Average K.E per molecule = $\frac{3}{2}$ kT.

5. (A) Aniline does not undergo Fridel Craft reaction due to lone pair on N-atom which directly attacks on $AlCl_3$.

(B) formation of carbocation at bridge head position is not favoured.

(C) $CHCl_3 + \text{alc. KOH} \longrightarrow :CCl_2$ (dichlorocarbene)



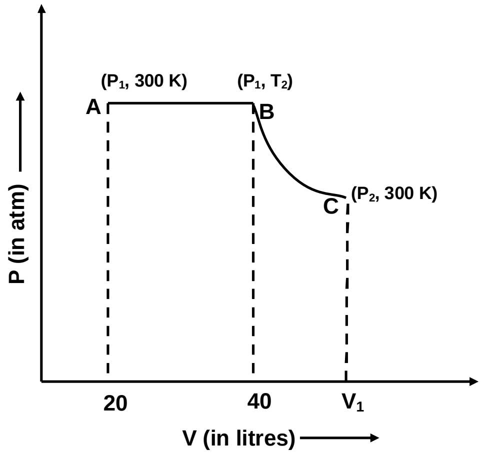
(D) Three times protonation followed by ring expansion gives benzene.

6. In the option (b), the H atom is linked to an sp^2 hybridised C atom.

8. $r = K [A]^m [B]^n$
on calculation, m = 2, n = 1 & K = 2.66×10^8 $mol^{-2} l^2 sec^{-1}$ at 300 K
so, K will be > 2.66×10^8 at 320 K.
Hence, (A, B, C)

SECTION – C

1. The PV diagram for the given changes is as:



for isobaric process AB,

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (from Charle's law)

$\frac{20}{300} = \frac{40}{T_2}$,

$\therefore$ $T_2 = 600$ K

$w_t = w_{AB} + w_{BC}$

Now, $w_{AB} = nRdT$ (Isobaric process)

$= -2 \times 2 \times (600 - 300) = -1200$ cal.

w_{BC} = for adiabatic process

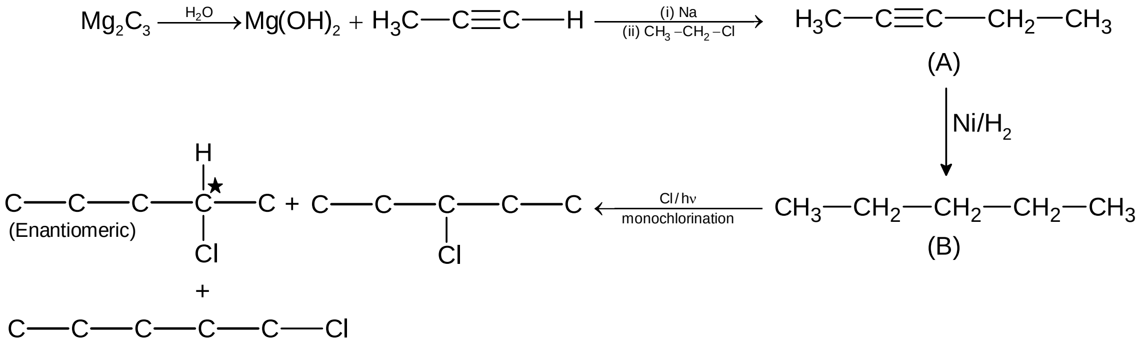
$w = -n\, C_V\, \Delta T$

$= -2 \times \frac{3}{2} \times R \times (600 - 300)$

$= -1800$ Cal

$\therefore$ $w_T = -1200 - 1800 = -3000$ Cal $= -3$ kcal.

2.



$$Mg_2C_3 \xrightarrow{H_2O} Mg(OH)_2 + H_3C-C\equiv C-H \xrightarrow[\text{(ii) } CH_3-CH_2-Cl]{\text{(i) Na}} \underset{(A)}{H_3C-C\equiv C-CH_2-CH_3}$$

$$\underset{(A)}{H_3C-C\equiv C-CH_2-CH_3} \xrightarrow{Ni/H_2} \underset{(B)}{CH_3-CH_2-CH_2-CH_2-CH_3}$$

$$\underset{(B)}{CH_3-CH_2-CH_2-CH_2-CH_3} \xrightarrow[\text{monochlorination}]{Cl/h\nu} \underset{\text{(Enantiomeric)}}{C-C-C-\overset{H}{\underset{Cl}{C^{\star}}}-C} + C-C-\underset{Cl}{C}-C-C + C-C-C-C-C-Cl$$

3. 30 ml of N/50 HCl = 30 ml of N/50 $Mg(HCO_3)_2$

= 30 ml of N/50 $CaCO_3$ = 100 ml of tap water

$\therefore$ mass of $CaCO_3$ in 100 ml tap water = $\frac{E \times N \times V}{1000}$

$= \frac{50 \times 30}{50 \times 1000} = 0.03$ g

$\therefore$ Hardness = 300 ppm

X = 3

4.

$$NaBH_4 + I_2 \xrightarrow[\text{solution}]{\text{diglyme}} \underset{(X)}{B_2H_6} + H_2 + 2NaI$$

$$B_2H_6 + 2NH_3 \longrightarrow \underset{\text{(adduct)}}{[B_2H_6.2NH_3]} \xrightarrow{\Delta} \underset{(Y)}{B_3N_3H_6} \xrightarrow{Cl_2} \underset{\text{(dichloro derivatives)}}{B_3N_3H_4Cl_2}$$

So, dichloro derivatives of (Y) = 4

Mathematics PART – III

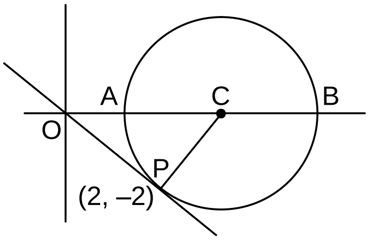
SECTION – A

1. Let the equation of the line L be $y - 2 = m(x - 8)$, $m < 0$

$\therefore\ P = \left(8 - \frac{2}{m},\ 0\right)$, $Q = (0,\ 2 - 8m)$

$\therefore\ OP + OQ = 8 - \frac{2}{m} + 2 - 8m \ge 18$

2. Let centre $C = (a, 0)$



$\angle COP = 45^{o}$

$OP = 2\sqrt{2} = CP$

$\therefore\ OC = 4$

The point on the circle with greatest abscissa is B

$\alpha = OB = 4 + 2\sqrt{2}$

3. $y = mx - 2am - am^3$, $y = mx + 2b + \frac{b}{m^2}$

For common normal, $2b + \frac{b}{m^2} + 2am + am^3 = 0$

$\Rightarrow am^5 + 2am^3 + 2bm^2 + b = 0$

$\therefore$ Maximum 5 normal

4. Equation of tangent $y = mx + \sqrt{a^2m^2 + b^2}$

Equation of a perpendicular from centre (0, 0) on the tangent is $y = -\frac{1}{m}x$

$\therefore$ Required locus $y = -\frac{x}{y}x + \sqrt{a^2\frac{x^2}{y^2} + b^2}$

5. Pair of tangents $SS' = T^2$

$\tan\theta = \frac{2\sqrt{h^2 - ab}}{a + b} = \frac{2\sqrt{(a^2 - 1)}}{a^2 - 2}$

$\tan\theta < 0$

$\therefore\ \frac{2\sqrt{a^2 - 1}}{a^2 - 2} < 0$

$\Rightarrow a \in (-\sqrt{2}, -1) \cup (1, \sqrt{2})$

6. $2s(2s - 2a) = xbc$

$\Rightarrow x = \frac{4s(s - a)}{bc} = 4\cos^2\frac{A}{2}$

$\therefore\ x \in (0, 4)$

7. $x^2 + x + 1 = ax + 1$ and $-1 \le x^2 + x + 1 \le 1$

$\Rightarrow \theta \le a < 1$

8. $\cos^4\theta - \sin^4\theta = \cos^2\theta - \sin^2\theta = \cos 2\theta$
$\Rightarrow (-2b)^2 - 4b = (-4)^2 - 4 \times 2$
$\therefore\ b = -1, 2$

9. Put x = 1
$\Rightarrow (2 + 3c + c^2)^{12} = 0$ (as the sum of coefficients vanishes)
$\Rightarrow c^2 + 3c + 2 = 0$
$\Rightarrow c = -1, -2$

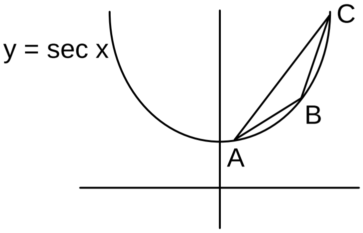
SECTION – B

1. (A) Can take any value except $\left(\frac{1}{3}, 3\right)$

(C) Centroid of ΔABC is $\left(\frac{A+B+C}{3}, \frac{\sec A + \sec B + \sec C}{3}\right)$

$$\therefore\ \frac{\sec A + \sec B + \sec C}{3} \geq \sec\left(\frac{A+B+C}{3}\right)$$

$$\frac{\sec A + \sec B + \sec C}{3} \geq 2 \Rightarrow \text{Least value of } \sum \sec A = 6$$



(D) $$\frac{2\sin 20^\circ \cos 20^\circ}{\frac{1}{2} \times \sin 20^\circ \cos 20^\circ} = 4$$

2. R = 15

$$r = \frac{\Delta}{s} = \frac{\frac{1}{2} \times 18 \times 24}{\frac{18+24+30}{2}} = 6$$

Circum-centre = (9, 12), orthocentre = (0, 0), in-centre = (6, 6), centroid = (6, 8)

SECTION – C

1. $x^2 + y^2 - 12x - 2y + 28 = 0$
C = (6, 1), r = 3
$\therefore\ |z_0 + 5 - i|_{\min} = 8$

2. $|z - 1| + |z - 2| + |z - 3| \leq |3z - 6| = 3|z - 2| = 3|2e^{i\theta} - 2| = 12$

3. $k = 2^9$

$$\Rightarrow\ na + \frac{n(n-1)}{2} = 2^9$$

$\Rightarrow n(2a + n - 1) = 2^{10}$
Which is only possible for n = 1
$\Rightarrow a = 512$

4. 6 boys and 5 girls in $\frac{11!}{6!\,5!}$

Teachers are at remaining places in ${}^{12}P_3$ ways

$\therefore\ {}^{12}P_3 \times \frac{11!}{5!\,6!}$

5. $b \ge \sqrt{ac}$

$\Rightarrow b^3 \ge abc$

$\Rightarrow b^3 \ge 4$

$\Rightarrow b \ge 4^{1/3}$

$\therefore$ [b] = 1

6. $6 \cot\theta = \cot(\theta - \alpha) + \cot(\theta + \alpha) = \frac{\sin 2\theta}{\sin(\theta+\alpha)\sin(\theta-\alpha)}$

$\Rightarrow \frac{3\cos\theta}{\sin\theta} = \frac{2\sin\theta\cos\theta}{\cot 2\alpha - \cos 2\theta}$

$\Rightarrow 4 \sin^2\theta = 6 \sin^2\alpha$

$\therefore\ \frac{2\sin^2\theta}{\sin^2\alpha} = 3$

7. x = y = z = 1

$\therefore$ 2x + 3y + 4z = 9

8. $2z\bar{z} + 2|z-3||z+3| = 82$

$\therefore |z + 3| + |z - 3| = 10$

$\therefore |z|_{max} = 5$

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014:
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ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Main), 2015**

PART TEST –III

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 03 and 10 to 12)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (04 to 09 and 13 to 30) contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

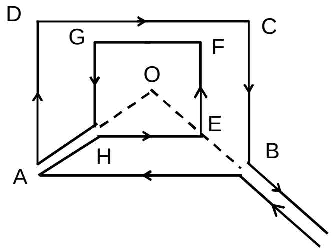
PART – I

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

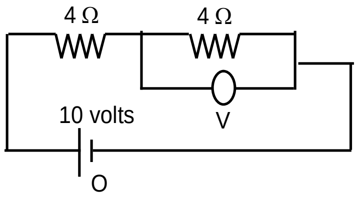
1. ABCD is a square of side 4R and EFGH is a square loop of side 2R. The loop carries a current I. The magnetic field at the centre O of the loop



(A) $\frac{\mu_0 I}{2\pi R}\odot$ (B) $\frac{\mu_0 I}{2\pi R}\otimes$

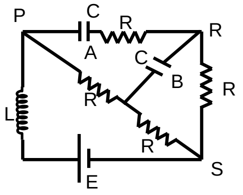
(C) $\frac{\mu_0 I}{\sqrt{2}\pi R}\otimes$ (D) $\frac{\mu_0 I}{\sqrt{2}\pi R}\odot$

2. In the given circuit, if the voltmeter is ideal its reading is V_1 volts. If the voltmeter has a resistance of 100Ω, the reading is V_2. Then $|V_1 - V_2|$ is equal to :-



(A) Zero (B) 0.3volts.
(C) 0.2volts (D) 0.1volts

3. The charge on the capacitors A and B in steady state is :-



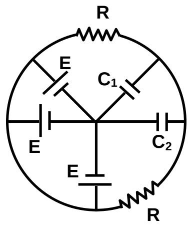
(A) $\frac{CE}{2}, CE$ (B) $\frac{CE}{2}, \frac{CE}{2}$

(C) $CE, \frac{CE}{2}$ (D) CE, CE

4. In a region, uniform electric field exists as $\vec{E} = \left[10\hat{i} + 10\hat{j}\right] N/C$. If the potential of origin is 0 volts, the potential of point (10m, 10m, 10m) is

(A) 20 volts (B) – 200 volts
(C) 10 volts (D) – 10 volts

5. Find the current in resistor R at steady state



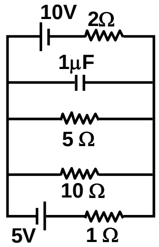
(A) $\frac{2E}{R}$ (B) zero

(C) $\frac{3E}{R}$ (D) $\frac{EC_1}{RC_2}$

Space for rough work

6. The charges on the plates of the capacitor in the steady state in the given circuit is

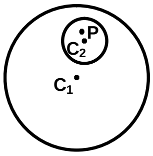
(A) zero. (B) 5 μC
(C) 10 μC (D) none of these



7. An infinite number of charges of magnitudes q, q/2, q/4, q/8 and so on are placed along the circumference of a circle of radius 1 unit with centre as origin. The potential at the origin will be

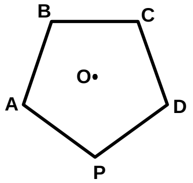
(A) $\frac{q}{2\pi\varepsilon_0}$ (B) $\frac{q}{4\pi\varepsilon_0}$
(C) $\frac{q}{3\pi\varepsilon_0}$ (D) infinite

8. From a uniform solid sphere an eccentric cavity has been cut out as shown in the figure. C_1 and C_2 represent their centres respectively. If the size of the cavity is increased keeping the centre at C_2, then the field strength at any internal point P will



(A) be zero
(B) remain constant in magnitude but direction of field will change with the change in position of P.
(C) remain constant in magnitude and direction for all positions of point P.
(D) gradually decrease in magnitude as the size of cavity increases.

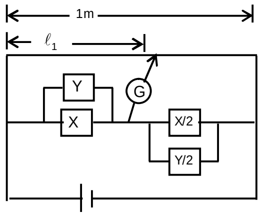
9. A regular pentagon having four identical charges of equal magnitude placed at the four corners A, B, C and D produce a field $\vec{E} = \left(-3\hat{i} + 4\hat{j} - 2\hat{k}\right)$ units at the centre O of the pentagon. If all the four charges are removed from the corners and reassembled at the fifth point P, find the field at O due to this rearrangement.



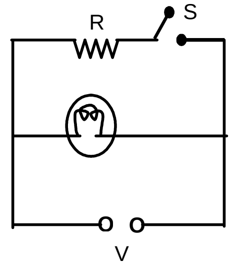
(A) $10\hat{i} - 5\hat{j} + 9\hat{k}$ (B) $3\hat{i} - 4\hat{j} + 2\hat{k}$
(C) $12\hat{i} - 16\hat{j} + 8\hat{k}$ (D) zero

10. Figure shows a meter bridge. If there is no current through galvanometer then ℓ_1 is equal to

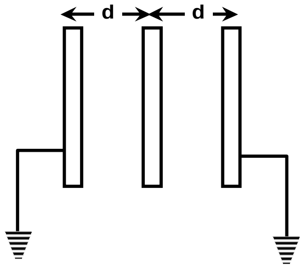
(A) 200/3 cm (B) 100/3 cm
(C) 50 cm (D) None of the above



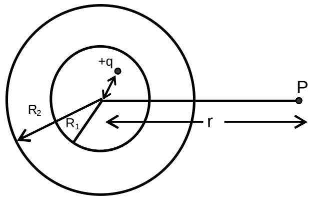
11. A bulb is connected across a voltage source. A resistor R is connected in parallel to the bulb through a switch S. If switch S is closed then
(A) Brightness of bulb decreases
(B) Brightness of bulb increases
(C) Brightness remains unchanged.
(D) None of the above



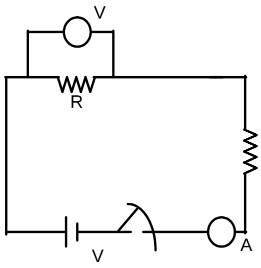
12. Three similar plates are arranged ‘d’ meters apart as shown in the figure. If area of each plate is A and a charge +Q is given to middle plate then potential of middle plate is
(A) $\frac{Qd}{A\in_0}$ (B) $\frac{Qd}{2A\in_0}$
(C) $\frac{Qd}{4A\in_0}$ (D) $\frac{2Qd}{A\in_0}$



13. A conducting shell having inner radius R_1 and outer radius R_2 contains a charge + q which is placed at a distance x from its centre. Field at an exterior point P which is situated at a distance r from centre of shell $\left(r > R_2\right)$
(A) depends on x
(B) depends on R_1 and R_2
(C) depends only or r
(D) None.



14. The potential deference across the resistor as measured by a voltmetre, is $60 \pm 1.5V$ and the current through the resistor as measured by an ammeter is $\left(2 \pm 0.01\right)$A. what is the maximum% error in the measured value of R?
(A) 3% (B) 1.5%
(C) 2.5% (D) None of these



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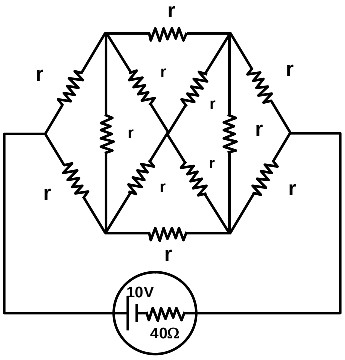
15. Find the value of r so that maximum power is generated in external circuit.

(A) r = 10 Ω (B) r = 20 Ω

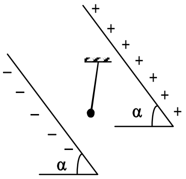
(C) r = 30 Ω (D) r = 40 Ω



16. Consider a parallel plate capacitor having an electric field E inside it as shown in the adjacent figure. A particle of mass m and charge q is hanging inside the capacitor through a light inextensible string of length ℓ. The time period of this pendulum is

(A) $T = 2\pi\sqrt{\dfrac{\ell}{g+(qE/m)}}$ (B) $T = 2\pi\sqrt{\dfrac{\ell}{\sqrt{g^2+\dfrac{q^2E^2}{m^2}-\dfrac{2qgE}{m}}}}$

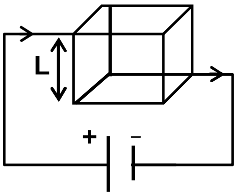
(C) $T = 2\pi\sqrt{\dfrac{\ell}{\sqrt{g^2+\dfrac{q^2E^2}{m^2}+\dfrac{2qgE}{m}}}}$ (D) none of the above



17. A cube made from wires of equal length is connected to a battery as shown in the figure. The magnetic field at the centre of the cube is

(A) $\dfrac{12\mu_0 I}{\sqrt{2}\,\pi L}$ (B) $\dfrac{6\mu_0 I}{\sqrt{2}\,\pi L}$

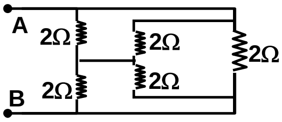
(C) $\dfrac{6\mu_0 I}{\pi L}$ (D) zero



18. Find the equivalent resistance across AB:

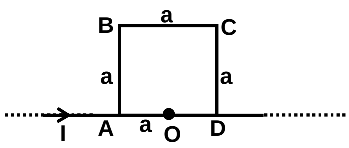
(A) 1 Ω (B) 2 Ω

(C) 3 Ω (D) 4 Ω



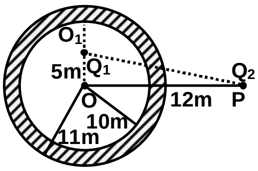
Space for rough work

19. The resistance per unit length of the wires in segments AB, BC, CD, and AD are the same. The magnetic field due to the current at point O is



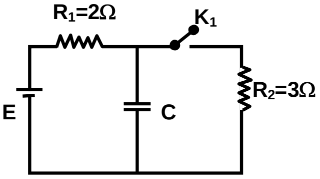
(A) $\frac{3\mu_0 I}{4\sqrt{5}\pi a}$
(B) $\frac{3\mu_0 I}{\sqrt{5}\pi a}$
(C) $\frac{\mu_0 I}{2\sqrt{5}\pi a}$
(D) none of the above

20. A charge Q_1 is placed at O, inside a hollow conducting sphere having inner and outer radii as 10 m and 11 m as shown. The force experienced by Q_2 at P is F_1 and force experienced by Q_2 when Q_1 is placed at O_1 is F_2. Then F_1/F_2 is equal to



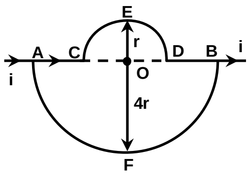
(A) 1
(B) $\left(\frac{12}{13}\right)^2$
(C) $\left(\frac{13}{12}\right)^2$
(D) none of the above

21. In the circuit shown in the figure k_1 is open. The charge on capacitor C in steady state is q_1. Now key is closed and at steady state charge on C is q_2. The ratio of charges q_1/q_2 is



(A) 5/3
(B) 3/5
(C) 1
(D) 2/3

22. In the shown in the figure AC and BD are straight lines and CED and AFB are semicircular with radii r and 4r respectively. The entire setup is lying in the same plane. If i is current entering at A what fraction of i will flow in the ACEDB such that resultant magnetic field at O is zero.

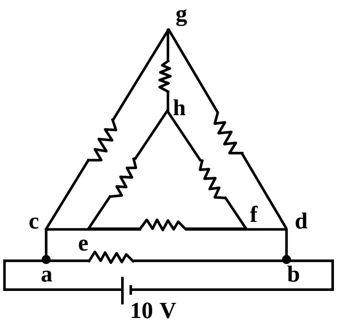


(A) i/5
(B) 4i/5
(C) 3i/5
(D) no current through bigger semicircular part.

Space for rough work

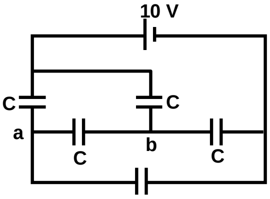
23. Consider the network shown in the figure. All resistances are equal to 2Ω. What is the potential difference between points e and h?

(A) zero (B) 5V
(C) 2.5 V (D) 10 V



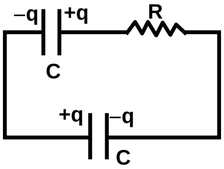
24. What is the energy stored in the capacitor between terminals a and b of the network shown in the figure? (Capacitance of each capacitor C = 5μF).

(A) 1 μJ (B) 0.25 μJ
(C) zero. (D) 15.6 μJ



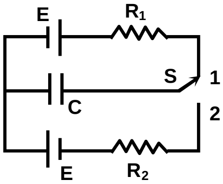
25. Two capacitors having equal capacitance C, are having same charges q each. They are connected across a resistor R as shown in the figure. What is the total heat generated in the resistor upto the instant when the steady state has reached?

(A) $q^2/2C$ (B) q^2/C
(C) zero (D) none of the above.



26. In the circuit shown, switch is placed in position1, till the capacitor is charged to half of the maximum possible charge in this situation. Now the switch S is placed in position 2. The maximum energy lost by the circuit after switch S is placed in position 2 is

(A) $\frac{1}{2}CE^2$ (B) $\frac{1}{8}CE^2$
(C) $\frac{7}{8}CE^2$ (D) $\frac{9}{8}CE^2$



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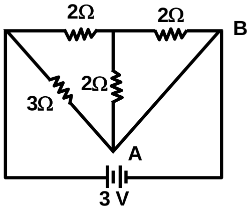
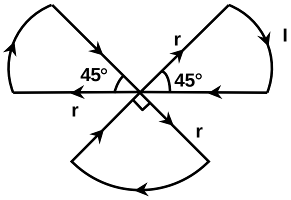
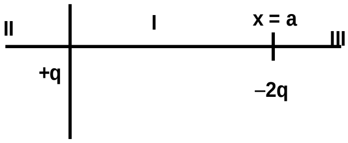
27. The current in branch AB is
(A) infinite (B) 1.33A
(C) 2 A (D) 1.5 A



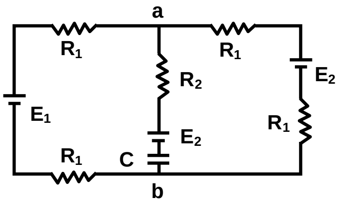
28. Calculate the magnetic field at point P due to three arcs as shown in the figure
(A) $\frac{\mu_0 I}{2r}$ (B) $\frac{\mu_0 I}{4r}$
(C) $\frac{\mu_0 I}{2\pi r}$ (D) zero



29. A point charge +q is located at the origin and a point charge − 2q is located at x = a (a > 0). In which of the following region or regions might there exists a point where the electric potential (V) is zero?
(A) $-\infty < x < a$ (B) $0 < x < a$
(C) $a < x < \infty$ (D) V does not vanish in the region $-\infty < x < \infty$



30. What is the potential difference between points a and b, in the steady state in the circuit given below? (E_1 = 2.1V, E_2 = 6.3 V, R_1 = 1.7 Ω, R_2 = 3.5 Ω, C = 2μF)
(A) 4.9 V (B) 2.8 V
(C) 5.9 V (D) 4.2 V



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Chemistry

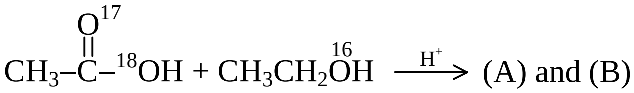
PART – II

SECTION – A

Straight Objective Type

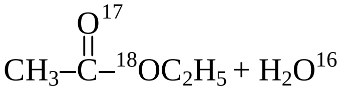
This section contains 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

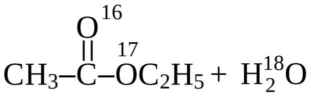
1. Consider the reaction,

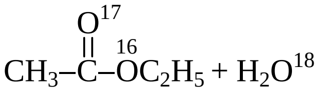


$$CH_3-\overset{\overset{O^{17}}{||}}{C}-{}^{18}OH + CH_3CH_2\overset{16}{O}H \xrightarrow{H^+} (A)\text{ and }(B)$$

(A) and (B) respectively are

(A)  $CH_3-\overset{\overset{O^{17}}{||}}{C}-{}^{18}OC_2H_5 + H_2O^{16}$

(B)  $CH_3-\overset{\overset{O^{16}}{||}}{C}-\overset{17}{O}C_2H_5 + H_2^{18}O$

(C)  $CH_3-\overset{\overset{O^{17}}{||}}{C}-\overset{16}{O}C_2H_5 + H_2O^{18}$

(D) Both (A) and (B)

2. The product of the given reaction $CH_3COOAg \xrightarrow{I_2/\Delta} [X]$

[X] is

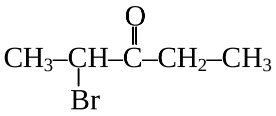
(A) CH_3-I

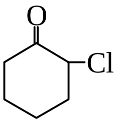
(B) CH_3COOCH_3

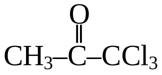
(C) CH_3-CH_3

(D) $CH_3-COOC_2H_5$

3. Which halo derivative(s) on treatment with $\overset{\ominus}{O}H$ will give carboxylic acid?

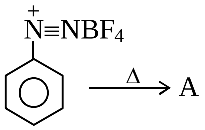
(A)  $CH_3-\underset{\underset{Br}{|}}{C}H-\overset{\overset{O}{||}}{C}-CH_2-CH_3$

(B) 

(C)  $CH_3-\overset{\overset{O}{||}}{C}-CCl_3$

(D) All of these

Space for rough work

4. 

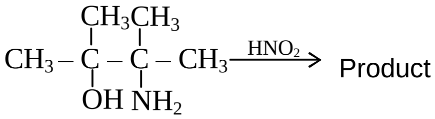
In the above process product A is

(A) Fluorobenzene	(B) Benzene
(C) 1,4-difluorobenzene	(D) 1,3-difluorobenzene

5. Treatment of NH_3 with excess of ethyl chloride gives:

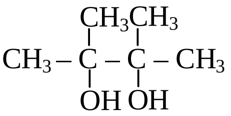
(A) diethylamine	(B) ethane
(C) tetraethylammonium chloride	(D) methylamine

6. The product of the given reaction,

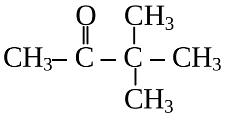


$CH_3-\underset{OH}{\overset{CH_3}{C}}-\underset{NH_2}{\overset{CH_3}{C}}-CH_3 \xrightarrow{HNO_2}$ Product

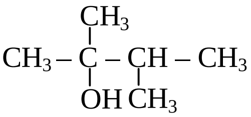
is

(A) 

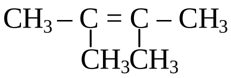
$CH_3-\underset{OH}{\overset{CH_3}{C}}-\underset{OH}{\overset{CH_3}{C}}-CH_3$

(B) 

$CH_3-\overset{O}{\overset{\|}{C}}-\underset{CH_3}{\overset{CH_3}{C}}-CH_3$

(C) 

$CH_3-\underset{OH}{\overset{CH_3}{C}}-\underset{CH_3}{CH}-CH_3$

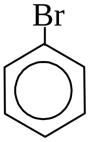
(D) 

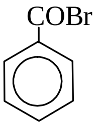
$CH_3-\underset{CH_3}{C}=\underset{CH_3}{C}-CH_3$

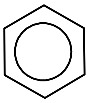
7. Which among the following amines will give carbylamine reaction?

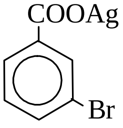
(A) $CH_3–CH_2–NH_2$	(B) $CH_3–NH–CH_3$
(C) $(C_6H_5)_3N$	(D) $CH_3–CH_2–NH–OH$

8. Silver benzoate reacts with bromine in acetone to form

(A) 

(B) 

(C) 

(D) 

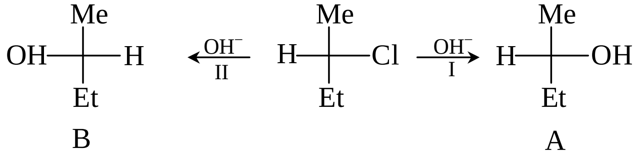
Space for rough work

9. Which of the following compound is most rapidly hydrolyzed by S_N 1 mechanism?

(A) C_6H_5Cl (B) $Cl-CH_2-CH=CH_2$

(C) $(C_6H_5)_3CCl$ (D) $C_6H_5CH_2Cl$

10.



(Racemic mixture)

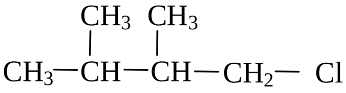
Steps I and II are:

(A) both S_N1 (B) both S_N2

(C) I S_N1, II S_N2 (D) I S_N2, II S_N1

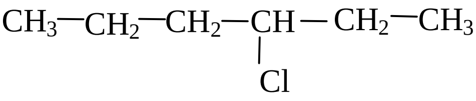
11. An alkyl halide (X) having molecular formula $C_6H_{13}Cl$ reacts with $(CH_3)_3C\overset{\ominus}{O}\overset{\oplus}{K}$ to form two isomeric alkenes (Y) and (Z) of molecular formula (C_6H_{12}). Both the alkenes give 2,3–Dimethyl butane on hydrogenation. The halide (X) is

(A)



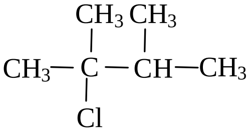
$CH_3-\overset{CH_3}{\overset{|}{CH}}-\overset{CH_3}{\overset{|}{CH}}-CH_2-Cl$

(B)



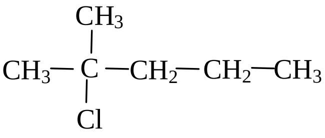
$CH_3-CH_2-CH_2-\underset{\underset{Cl}{|}}{CH}-CH_2-CH_3$

(C)



$CH_3-\overset{CH_3}{\overset{|}{\underset{\underset{Cl}{|}}{C}}}-\overset{CH_3}{\overset{|}{CH}}-CH_3$

(D)



$CH_3-\overset{CH_3}{\overset{|}{\underset{\underset{Cl}{|}}{C}}}-CH_2-CH_2-CH_3$

12. The formation of cyanohydrin from a ketone is an example of:

(A) nucleophilic substitution. (B) electrophilic substitution.

(C) electrophilic addition. (D) nucleophilic addition.

13. Acetone is mixed with bleaching powder to give:

(A) chloroform (B) acetaldehyde

(C) ethanol (D) phosgene

14. Which of the following compounds is stable?

(A) $CH_3CH(OH)_2$ (B) $(CH_3)_2CH(OH)_2$

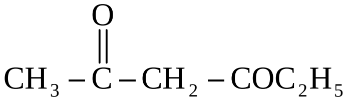
(C) $CCl_3CH(OH)_2$ (D) none of these

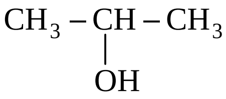
Space for rough work

15. Which of the following does not respond to haloform reaction?

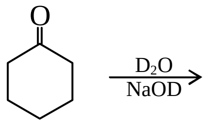
(A) CH_3-CH_2-OH

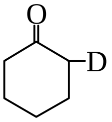
(B) CCl_3CHO

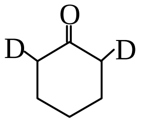
(C) 
$CH_3-\overset{\overset{O}{\|}}{C}-CH_2-COC_2H_5$

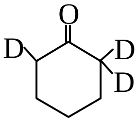
(D) 
$CH_3-\underset{\underset{OH}{|}}{CH}-CH_3$

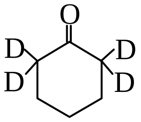
16. In the given reaction


(P) will be

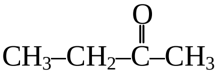
(A) 

(B) 

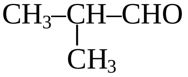
(C) 

(D) 

17. A compound (X) C_4H_8O which gives a 2, 4-DNP derivative and a positive iodoform test is:

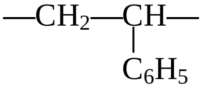
(A) 
$CH_3-CH_2-\overset{\overset{O}{\|}}{C}-CH_3$

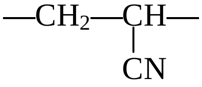
(B) $CH_3-CH_2-CH_2-CHO$

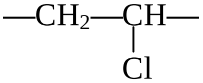
(C) 
$CH_3-\underset{\underset{CH_3}{|}}{CH}-CHO$

(D) All of these

18. The repeat unit of polystyrene is

(A) 
$-CH_2-\underset{\underset{C_6H_5}{|}}{CH}-$

(B) 
$-CH_2-\underset{\underset{CN}{|}}{CH}-$

(C) 
$-CH_2-\underset{\underset{Cl}{|}}{CH}-$

(D) $-CCl_2-CCl_2-$

Space for rough work

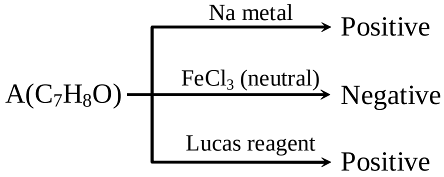
19. Which one of the following polymers may be classified as step growth polymer?

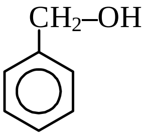
(A) Teflon
(B) Polythene
(C) PVC
(D) Nylon 66

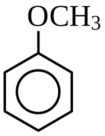
20. Propyne and propene can be distinguished by

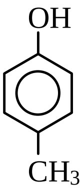
(A) conc. H_2SO_4
(B) Br_2 inCCl_4
(C) $AgNO_3$ [Ammonical]
(D) dil. $KMnO_4$

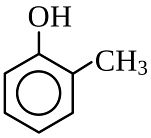
21. Identify an aromatic compound A(C_7H_8O) which gives following tests with the given reagents.


A(C7H8O)
Na metal
Positive
FeCl3 (neutral)
Negative
Lucas reagent
Positive

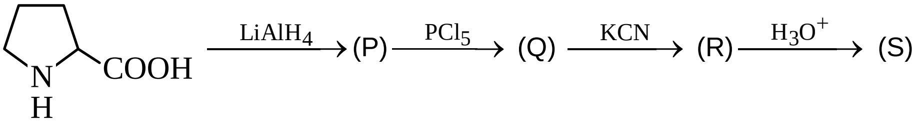
(A)


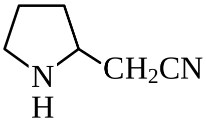
(B)


(C)


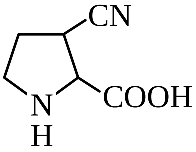
(D)


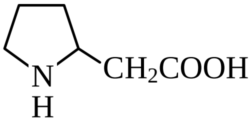
22. Predict the final product (S) formed in the following reaction sequence.


N
H
COOH
LiAlH4
(P)
PCl5
(Q)
KCN
(R)
H3O+
(S)

(A)


(B) $H_2N(CH_2)_3CH_2CH_2COOH$

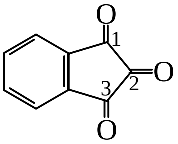
(C)


(D)


Space for rough work

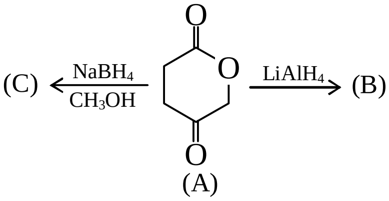
23. Carboxylic acids react with diazomethane to yield:
(A) Amines (B) Alcohols
(C) Esters (D) Amides

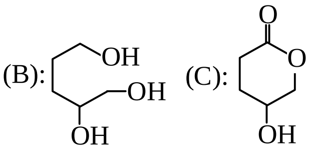
24. Which carbonyl group of the given compound is most reactive for nucleophilic addition reaction?

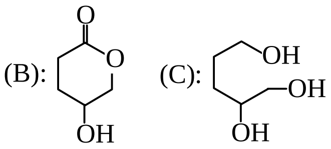


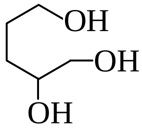
(A) 1 (B) 2
(C) 3 (D) All have equal reactivity

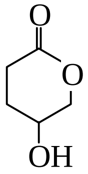
25. Identify the products (B) and (C) formed in the following set of reactions.



(A) 

(B) 

(C) Both (B) and (C): 

(D) Both (B) and (C): 

26. Identify the unknown products (A) and (B) in the given reaction:

Glucose + 3 $C_6H_5NH–NH_2 \xrightarrow{H^{\oplus}/\Delta}$ Osazone + (A) + (B)
(A) $C_6H_5NH_2$ and NH_3 (B) $C_6H_5NH_2$ and NH_2OH
(C) $C_6H_5NH—NHOH$ and NH_3 (D) NH_2OH and H_2O

Space for rough work

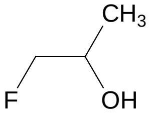
27. Buna–S rubber is a polymer of
(A) 1, 3-butadiene and styrene
(B) vinyl acetate
(C) Acrylonitrile
(D) none of these

28. Identify the final product (Z) in the following sequence of reactions:

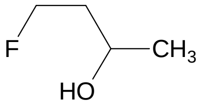
$$CH_3NH_2 \xrightarrow[\text{excess}]{CH_3I} X \xrightarrow{AgOH} Y \xrightarrow{\Delta} Z + CH_3OH$$

(A) $CH_3-CH_2-CH_2-NH_2$
(B) $(CH_3)_3N$
(C) $(CH_3)_2NH$
(D) $(CH_3)_4N^+OH^-$

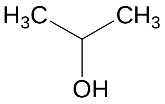
29. The order of reactivity of the following alcohols towards conc. HCl is



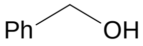
I



II



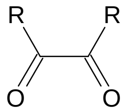
III

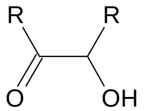


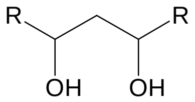
IV

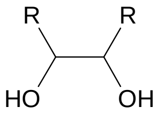
(A) I > II > III > IV
(B) I > III > II > IV
(C) IV > III > II > I
(D) IV > III > I > II

30. Which of the following will be oxidized by HIO_4?

(1)


(2)


(3)


(4)


Select the correct answer using the codes below:
(A) 1, 2 and 3
(B) 1, 3 and 4
(C) 1, 2 and 4
(D) 2, 3 and 4

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. $\int \frac{1-7\cos^2 x}{\sin^7 x \cos^2 x} dx = \frac{f(x)}{(\sin x)^7} + c$, then f(x) is equal to

(A) sin x (B) cos x
(C) tan x (D) cot x

2. $\int \tan^{-1}\alpha \tan x \, d\alpha$ is equal to

(A) $\tan^{-1}\alpha \sec x + c$
(B) $\tan^{-1}\alpha \, \ell n (\sec x) + c$
(C) $\tan x \left\{\alpha \tan^{-1}\alpha - \frac{1}{2}\ell n\left(1+\alpha^2\right)\right\} + c$
(D) $\tan\alpha \left\{x \tan^{-1} x - \frac{1}{2}\ell n\left(1+x^2\right)\right\} + c$

3. If $k = \int_0^1 \frac{e^t}{1+t} dt$, then $\int_0^1 e^t \ell n(1+t) dt$ is equal to

(A) k (B) 2k
(C) $e\ell n2 - k$ (D) none of these

4. If $I_n = \int e^x (\sin x)^n dx$, then $\frac{I_3}{I_1}$ is equal to

(A) $\frac{3}{5}$ (B) $\frac{1}{5}$
(C) 1 (D) $\frac{2}{5}$

Space for rough work

5. If k ∈ N and $I_k = \int_{-2k\pi}^{2k\pi} |\sin x|[\sin x]dx$, (where [.] denotes the greatest integer function) then $\sum_{k=1}^{100} I_k$ equal to
(A) –10100 (B) –40400
(C) –20200 (D) none of these

6. Consider a function 'f' defined on the set of all non-negative integers such that f(0) = 1, f(1) = 0 and f(n) + f(n – 1) = nf(n – 1) + (n – 1)f(n – 2) for n ≥ 2, then f(5) is equal to
(A) 40 (B) 44
(C) 45 (D) 60

7. Let R be the set of all real numbers the function f: R → R defined by $f(x) = x^3 - 3x^2 + 6x - 5$ is
(A) one-to-one but not onto (B) onto but not one-to-one
(C) neither one-to-one nor onto (D) one-to-one and onto

8. A function f: R → R is differentiable and satisfies the $f\left(\frac{1}{n}\right) = 0$ for all integers n ≥ 1, then
(A) f(x) = 0 for all n ∈ (0, 1] (B) f(0) = 0 = f ′(0)
(C) f(0) = 0 but f ′(0) need not be equal to (D) |f(x)| ≤ 1 for all x ∈ [0, 1]

9. The maximum value of the sum of the intercepts made by any tangent to the curve $(a \sin^2\theta, 2a \sin\theta)$ with the axes is
(A) 2a (B) $\frac{a}{4}$
(C) $\frac{a}{2}$ (D) a

10. $f(x) = \frac{x}{\sin x}$ and $g(x) = \frac{x}{\tan x}$ where 0 < x ≤ 1, then in this interval
(A) f(x) and g(x) both are increasing (B) f(x) is decreasing and g(x) is increasing
(C) f(x) is increasing and g(x) is decreasing (D) none of these

11. $\int_{-1}^{1} \frac{\log\left(x+\sqrt{1+x^2}\right)}{x+\log\left(x+\sqrt{1+x^2}\right)} f(x)dx - \int_{-1}^{1} \frac{\log\left(x+\sqrt{1+x^2}\right)}{x+\log\left(x+\sqrt{1+x^2}\right)} f(-x)dx$ is equal to
(A) 0 (B) $2\int_{0}^{1} \frac{\log\left(x+\sqrt{1+x^2}\right)}{x+\log\left(x+\sqrt{1+x^2}\right)} \{f(x) - f(-x)\}dx$
(C) 2f(x) (D) none of these

Space for rough work

12. $\int e^x\left(\tan^{-1}x+\frac{2x}{\left(1+x^2\right)^2}\right)dx$ is equal to

(A) $e^x\left(\tan^{-1}x-\frac{1}{1+x^2}\right)+c$
(B) $e^x\left(\tan^{-1}x+\frac{1}{1+x^2}\right)+c$
(C) $e^x\left(\cot^{-1}x-\frac{1}{1+x^2}\right)+c$
(D) $e^x\left(\tan^{-1}x+\frac{2}{1+x^2}\right)+c$

13. $\int\left(x^2+x\right)\left(x^{-8}+2x^{-9}\right)^{1/10}dx$ is

(A) $\frac{5}{11}\left(x^2+2x\right)^{11/10}+c$
(B) $\frac{5}{11}(x+1)^{11/10}+c$
(C) $\frac{6}{7}(x+1)^{11/10}+c$
(D) $\frac{11}{5}\left(x^2+2x\right)^{10/10}+c$

14. If $\int_0^1 \alpha e^{\beta x^2}\sin(x+k)\,dx=0$ (for some α, $\beta \in$ R), $\alpha \neq 0$, then the value of k can belong to

(A) $\left[\frac{\pi}{3},\frac{5\pi}{12}\right]$
(B) $\left[\frac{\pi}{3},\frac{\pi}{2}\right]$
(C) $\left[\frac{3\pi}{4},\frac{5\pi}{6}\right]$
(D) $\left[-\frac{\pi}{2},-\frac{\pi}{3}\right]$

15. $\int_0^{[x]/3}\frac{8^x}{2^{[3x]}}dx$ (where [.] denotes the greatest integer function) is equal to

(A) $\frac{[x]}{\ell n\,2}$
(B) $\frac{[x]}{\ell n\,4}$
(C) $\frac{2[x]}{\ell n\,2}$
(D) $\frac{[x]}{\ell n\,8}$

16. Domain of $\left(\sqrt{x^2-4x+3}+1\right)\log_5\left(\frac{x}{5}\right)+\frac{1}{x}\left(\sqrt{8x-2x^2-6}+1\right)\le 0$ are

(A) $(-\infty, 1] \cup [3, \infty)$
(B) [1, 3]
(C) {1, 3}
(D) {1}

Space for rough work

17. Let f: R → R and g: R → R be two one-one and onto function such that they are the mirror images of each other about the line y = a. If h(x) = f(x) + g(x), then h(x) is
(A) bijective function (B) injective but n of surjective
(C) surjective but not injective (D) neither injective nor surjective

18. The set of value of α so that $f(x) = \frac{x-1}{\alpha - x^2 + 1}$ does not take any value in the interval $\left[-1, -\frac{1}{3}\right]$ is
(A) $\left(-\infty, -\frac{1}{4}\right]$ (B) [2, ∞)
(C) $\left(-\frac{1}{4}, 2\right)$ (D) $\left(-\infty, -\frac{1}{4}\right] \cup [2, \infty)$

19. Period of the function f(x) = cos 2π{2x} + sin π{2x} is ((where {.} denotes the fractional part of function)
(A) 1 (B) $\frac{\pi}{2}$
(C) 1/2 (D) π

20. If $f(n+2) = \frac{1}{2}\left\{f(n+1) + \frac{9}{f(n)}\right\}$, n ∈ N and f(x) > 0 for all n ∈ N then $\lim_{n\to\infty} f(n)$ is equal to
(A) 3 (B) –3
(C) $\frac{1}{2}$ (D) none of these

21. The value of $\lim_{x\to 0}\left[\frac{x^2}{\sin x \tan x}\right]$ (where [.] denotes the greatest integer function) is
(A) 0 (B) 1
(C) limit does not exist (D) none of these

22. The left hand derivative of f(x) = [x] sin (πx), at x = k, where k is an integer is (where [.] denotes the greatest integer function)
(A) $(-1)^k (k - 1)\pi$ (B) $(-1)^{k-1} (k - 1)\pi$
(C) $(-1)^k k\pi$ (D) $(-1)^{k-1} k\pi$

Space for rough work

23. Let $f(x)=\begin{cases} x^2\sin\left(\frac{\pi}{x}\right), & -1<x<1\ (x\neq 0) \\ x|x|, & x>1 \text{ or } x<-1 \end{cases}$ then

(A) f(x) is an odd function
(B) f(x) is an even function
(C) f(x) is neither odd nor even
(D) none of these

24. Given the function f(x) such that 2f(x) + $xf\left(\frac{1}{x}\right)$ – $2f\left(\left|\sqrt{2}\sin\left\{\pi\left(x+\frac{1}{4}\right)\right\}\right|\right)=4\cos^2\frac{\pi x}{2}+x\cos\frac{\pi}{x}$

(A) $f(2)+f\left(\frac{1}{2}\right)=0$
(B) f(1) = –1, but f(2), $f\left(\frac{1}{2}\right)$ can't be determined
(C) $f(2)+f(1)=f\left(\frac{1}{2}\right)$
(D) f(2) + f(1) = 1

25. Let $f(x)=\frac{1}{x}$ and $g(x)=\frac{1}{\sqrt{x}}$ then

(A) f{g(x)} and g{f(x)} have different domain
(B) f{g(x)} and g{f(x)} have same domain
(C) g{f(x)} is a bijective mapping
(D) f{g(x)} is neither odd nor even

26. The period of the function f(x) = sin 3x cos [3x] – cos 3x sin [3x] (where [.] denotes the greatest integer function) is

(A) $\frac{1}{2}$
(B) $\frac{1}{3}$
(C) 1
(D) 3

27. The integer n for which $\lim_{x\to 0}\left(\frac{(\cos x-1)(\cos x-e^x)}{x^n}\right)$ is a finite non-zero number is

(A) 1
(B) 2
(C) 3
(D) 4

Space for rough work

28. If $f(x) = x^3 - x^2 + 100x + 2015$, then

(A) $f\left(\frac{1}{2015}\right) > f\left(\frac{1}{2016}\right)$
(B) $f(2015) > f(2016)$
(C) $f(2016) = f(2015)$
(D) $f\left(\frac{1}{2015}\right) = f\left(\frac{1}{2016}\right)$

29. The lines tangent to the curve $y^3 - x^2y + 5y - 2x = 0$ and $x^4 - x^3y^2 + 5x + 2y = 0$ at the origin intersect at an angle θ. Then θ is equal to

(A) $\frac{\pi}{6}$
(B) $\frac{\pi}{4}$
(C) $\frac{\pi}{3}$
(D) $\frac{\pi}{2}$

30. If the function $f(x) = ax^3 + bx^2 + 11x - 6$ satisfies conditions of Rolle's theorem in [1, 3] for $x = 2 + \frac{1}{\sqrt{3}}$, then value of a and b are respectively

(A) –3, 2
(B) 2, –4
(C) 1, –6
(D) none of these

Space for rough work

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FIITJEE **JEE(Main)-2015**

ANSWERS, HINTS & SOLUTIONS
PART TEST–III
(Main)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	D	C	C
2.	D	B	C
3.	C	D	C
4.	B	A	A
5.	B	C	C
6.	A	B	B
7.	A	A	D
8.	C	A	B
9.	C	C	A
10.	A	C	C
11.	C	C	A
12.	B	D	A
13.	C	A	A
14.	A	C	C
15.	C	C	D
16.	D	D	D
17.	D	A	D
18.	A	A	A
19.	A	D	C
20.	A	C	A
21.	A	A	A
22.	A	D	A
23.	B	C	A
24.	C	B	C
25.	B	A	B
26.	D	A	B
27.	D	A	C
28.	B	B	B
29.	A	C	D
30.	D	C	C

Physics

PART – I

SECTION – A

1. $4\times\frac{\mu_0 I}{4\pi}.\left[\sin 45^0+\sin 45^0\right]\left[\frac{1}{R}-\frac{1}{2R}\right]=\frac{\mu_0 I}{\pi}\left[\sqrt{2}\right]\left[\frac{1}{2R}\right]=\frac{\mu_0 I}{\sqrt{2}\pi R}$

2. $V_1=\frac{10}{4+4}\times 4$ volts = 5 volt

$$V_2=\frac{10\times\frac{100\times 4}{100+4}}{4+\frac{100\times 4}{100+4}}$$

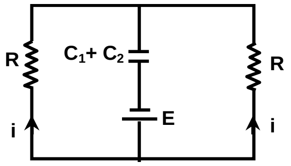
= 4.9 volts $\therefore\left|V_1-V_2\right|=0.1$ volt

3. In steady state :-

$$V_P-V_Q=\frac{E}{2R}\times R=\frac{E}{2}$$
$$V_Q-V_S=\frac{E}{2R}\times R=\frac{E}{2}$$
$$V_S=V_R$$
$$V_P-V_R=E$$
$$\therefore Q_A=CE$$
$$Q_B=\frac{CE}{2}$$

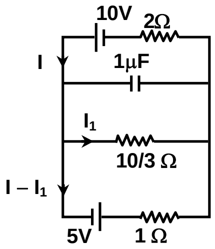
4. $V_P-V_0=-\left[10\times 10+10\times 10\right]$

= - 200 volts.

5. 

6. $\frac{10}{3}I_1+2I-10=0-5+I-I_1+2I-10=0$

After solving we get, $I_1=0$, Q = 0



7. $V=\frac{1}{4\pi\varepsilon_0\times 1}\left[q+\frac{q}{2}+\frac{q}{4}+\frac{q}{8}+...\right]=\frac{q}{4\pi\varepsilon_0}\left[\frac{1}{1-(1/2)}\right]=\frac{q}{2\pi\varepsilon_0}$

8. Field at any internal point of the cavity.

$$\vec{E} = G\frac{4}{3}\pi\rho\left(\overrightarrow{C_2C_1}\right)$$

Since C_1 and C_2 are fixed (cavity being concentric with C_2 all the time), field remains constant both in magnitude and direction.

9. If the fifth point P has identical charges the field at the centre of symmetry O would be zero. Hence the field due to one single such charge at P would produce a field $\vec{E}'$, such that ($\vec{E}'+\vec{E}$) = 0

$\therefore\ \vec{E}' = -\vec{E} = -(-3\hat{i} + 4\hat{j} - 2\hat{k})$

this field will be four times $\vec{E}'$ due to this rearrangement, hence the required field at O is

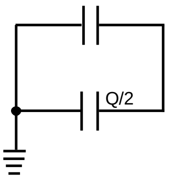
$4\vec{E}' = (12\hat{i} - 16\hat{j} + 8\hat{k})$ units

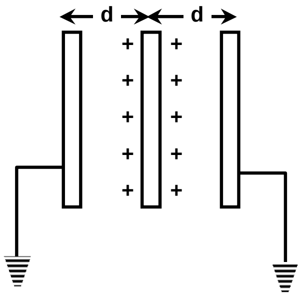
10. If $I_G = 0$ then it becomes a balanced whetstone bridge

$$\ell_1 = \frac{2}{3}\times 1m = \frac{2}{3}\times 100 = \frac{200}{3}\text{cm}$$

12. $E_1 = \frac{\sigma}{\epsilon_0} = \frac{Q}{2A\epsilon_0}$

$V = E_1 d = \frac{Qd}{2A\epsilon_0}$





13. Apply gaus theorem

$$E\left(4\pi r^2\right) = \frac{q_{in}}{\epsilon_0} \Rightarrow E = \frac{q}{4\pi\epsilon_0 r^2} \Rightarrow E \propto \frac{1}{r^2} \Rightarrow \text{ field depends only on r.}$$

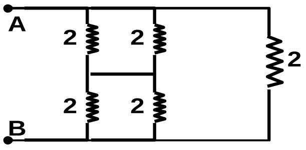
14. $\frac{\Delta R}{R} = \frac{\Delta V}{V} + \frac{\Delta I}{I}$

$\Rightarrow \frac{\Delta R}{R}\times 100 = \frac{\Delta V}{V}\times 100 + \frac{\Delta I}{I}\times 100$

$= 3\%$

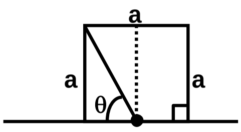
17. Magnetic field is zero at the centre due to symmetrical current distribution.

18.



19. B at O $= \frac{2\times\mu_0(I/4)}{4\pi(a/2)}\left(0+\frac{2}{\sqrt{5}}\right) + \frac{\mu_0(I/4)}{4\pi a}\left(\frac{2}{\sqrt{5}}+\frac{2}{\sqrt{5}}\right)$

$= \frac{2\mu_0 I}{4\sqrt{5}\pi a} + \frac{\mu_0 I}{4\pi a\sqrt{5}} = \frac{3\mu_0 I}{4\sqrt{5}\pi a}$



20. Due to electrostatic shielding, the ratio will be 1.

21. When key is open

$q_1 = CE$

when key is closed

$$q_2 = C\left[\frac{E}{R_1+R_2}R_2\right]$$

$$\therefore \frac{q_1}{q_2} = \left[\frac{CE}{CER_2}\left(R_1+R_2\right)\right] = \frac{\left(R_2+R_1\right)}{R_2} = \frac{5}{3}$$

22. If I_1 is current in ACDB then

$$\frac{\mu_0}{4}.\frac{i_1}{r} = \frac{\mu_0}{4}.\frac{i_2}{4r}$$

$$\frac{i_1}{i_2} = \frac{1}{4}$$

$$i_1 = \frac{1}{5}\times i = \frac{i}{5}$$

23. From symmetry the currents in segment gh is zero. Thus, the equivalent resistance R is given by

$$\frac{1}{R} = \frac{1}{4}+\frac{1}{4}+\frac{1}{2}+\frac{1}{2} = \frac{3}{2} \Rightarrow R = \frac{2}{3}\Omega$$

Current in eh = $\frac{10}{4} = 2.5A$

$\therefore$ Potential difference across eh = 5V

24. It is a balanced Wheatstone bridge for capacitor. Consequently the potentials of points a and b are equal. Thus energy stored in the capacitor is zero.

25. Let after steady state the charges on the capacitor be q_1 and q_2

$q_1 = CV$, $q_2 = CV$ where v is the potential difference between the plates.

Also from charge conservation

$q_1 + q_2 = 0$

$\Rightarrow$ V = 0

Thus, final energy stored in the capacitors = $\frac{1}{2}CV^2 + \frac{1}{2}CV^2 = 0$

Initial energy stored = $\frac{q^2}{2C}+\frac{q^2}{2C} = \frac{q^2}{C}$

Thus, heat developed in the resistor = q^2/C

26. Initial capacitor is charged to Q/2

Energy stored in capacitor = $\frac{1}{2}\left(\frac{Q}{2}\right)^2 \times \frac{1}{C} = \frac{1}{8}\frac{Q^2}{C} \Rightarrow \frac{1}{8}CE^2 = U_i$

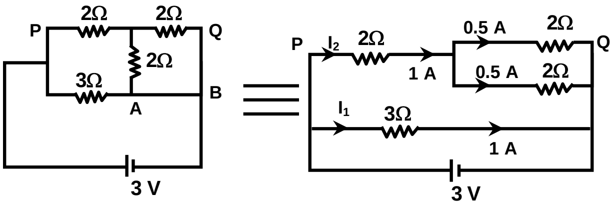
Finally energy stored in the capacitor, $U_f = \frac{1}{2}CE^2$

Work done by the battery = $\left(\frac{3}{2}CE\right) \times E = \frac{3}{2}CE^2$

$\therefore$ Heat energy lost = $\frac{3}{2}CE^2 - (U_f - U_i) = \frac{3}{2}CE^2 - \left(\frac{1}{2}CE^2 - \frac{1}{8}CE^2\right)$

= $CE^2\left(\frac{3}{2} - \frac{1}{2} + \frac{1}{8}\right) = \frac{9}{8}CE^2$

27. The equivalent circuit is
Current flowing through 3Ω resistance
= 3/3 = 1 Amp
Current flowing through P to Q is also
1 amp.
From the figure current flowing through
AB is 1 + 0.5 = 1.5 Amp



28. By using the relation

$$B = \frac{\mu_0 i\theta}{4\pi r} \text{ where } \theta \text{ is in radian}$$

Here θ = 180° i.e. π

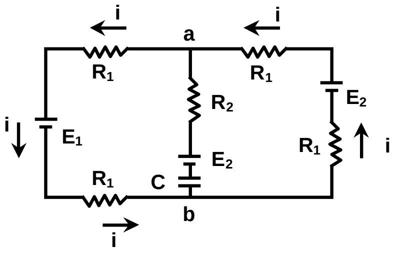
So, $B_p = \frac{\mu_0 I}{4r}$

29. Let x = a′ potential is zero (region II)

$$k\frac{q}{a'} = k\frac{2q}{a + a'}$$

$\Rightarrow$ a′ = a
So, in the region II,
Potential is zero and can be proved.
A solution can also found in region I (x = a/3).

30. In the steady state
$E_2 - iR_1 - iR_1 - E_1 - iR_1 - iR_1 = 0$
$E_2 - E_1 = 4iR_1$
$I = \frac{E_2 - E_2}{4R_1}$ = (6.3 – 2.1)/(4×1.7) = $\frac{2.1}{3.4}$
Solving, we get, $V_a - V_b = -iR_1 + E_2 - iR_1$
= 6.3 – 2×1.7×$\frac{2.1}{3.4}$ = 6.3 – 2.1 = 4.2 V

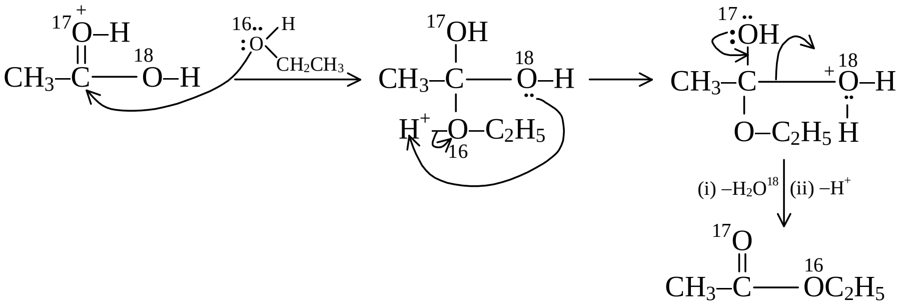


Chemistry

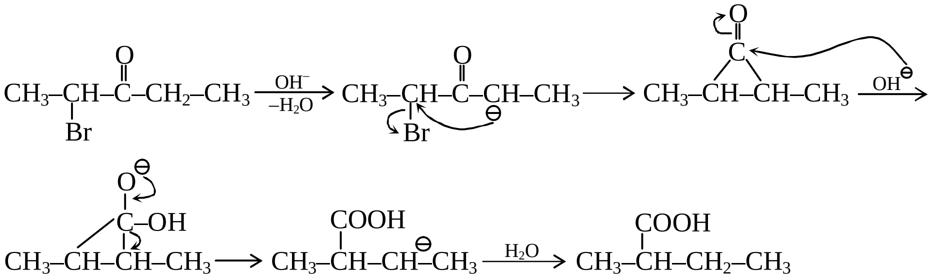
PART – II

SECTION – A

1.

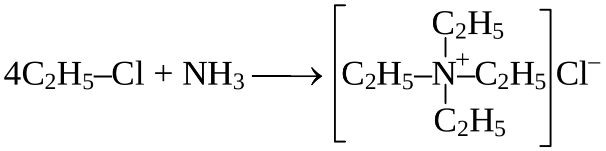


3.



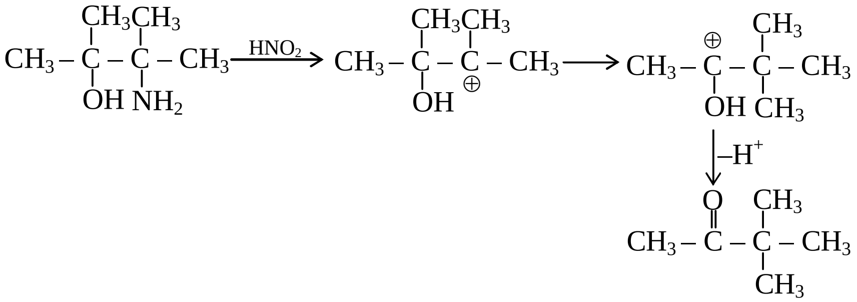
4. This is Baltz Schiemann reaction.

5



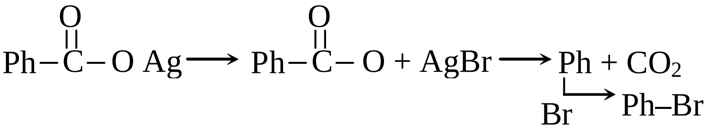
$$4C_2H_5\text{–}Cl + NH_3 \longrightarrow \left[C_2H_5\text{–}\overset{C_2H_5}{\underset{C_2H_5}{\overset{+}{N}}}\text{–}C_2H_5 \right]Cl^-$$

6.



7. Carbyl amine test is responded by only 1° aliphatic/aromatic amines.

8. This is Hundsdicker reaction.



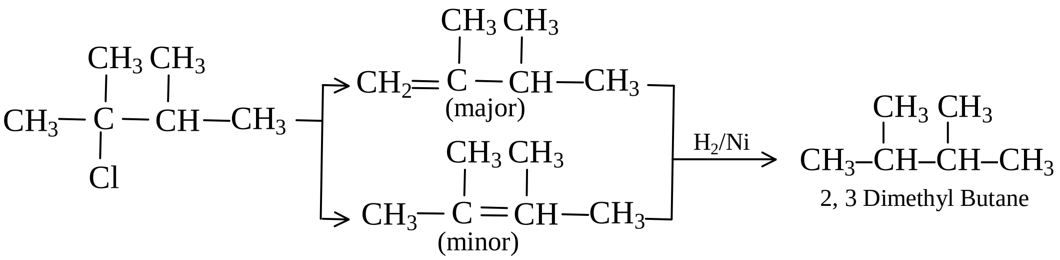
$$Ph-\overset{O}{\overset{\|}{C}}-O\,Ag \longrightarrow Ph-\overset{O}{\overset{\|}{C}}-O + AgBr \longrightarrow Ph + CO_2$$

$$Br \longrightarrow Ph\text{–}Br$$

9. $(C_6H_5)_3CCl$ is hydrolysed most rapidly by SN_1 because $(C_6H_5)_3C^+$ is most stable.

10. SN_1 reaction is accompanied by racemisation while SN_2 reaction is accompanied by inversion of configuration.

11.



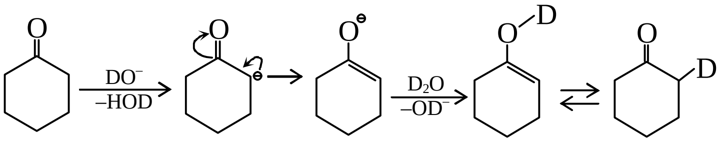
12. Nucleophilic addition.

13. Chloroform is formed when acetone is mixed with bleaching powder ($CaOCl_2$).

14. Due to intramolecular H–bonding.

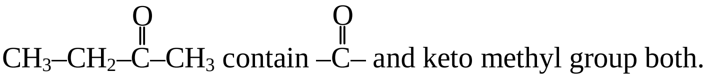
15. Because $–CH_2–$ hydrogen is more acidic than $–CH_3$ hydrogen.

16.



These steps are continued unless all the four α-H's are replaced by D.

17.



$CH_3–CH_2–\overset{\overset{O}{\|}}{C}–CH_3$ contain $–\overset{\overset{O}{\|}}{C}–$ and keto methyl group both.

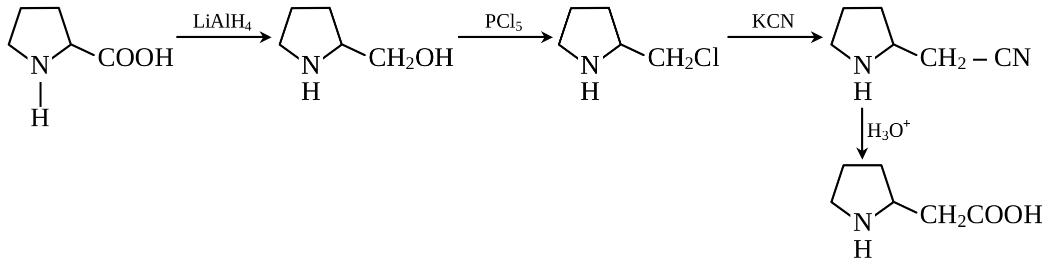
18. In polystyrene the monomeric unit is styrene which is having the formula of $H_2C{=}CH—C_6H_5$.

19. Step growth polymers (or condensation polymers) are prepared by reaction between two functional groups and thereby eliminating small molecules during polymerization. Nylon-66 is an example of step growth polymer.

20. Test of terminal alkynes.

21. Compound 'A' give positive test with Na metal. That means it contains polar Hydrogen i.e., alcoholic group. It gives negative test with neutral $FeCl_3$ implies it does not contain of a phenolic group. It gives positive Lucas test means it is an alcohol.

22



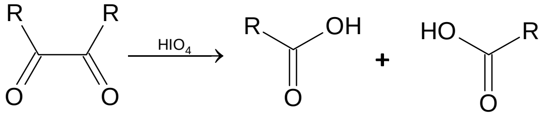
23. $RCOOH + CH_2N_2 \longrightarrow RCOOCH_3 + N_2$; methyl esters are formed.

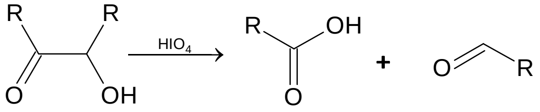
24. ‘2’ position is attached with two electron withdrawing groups.

25. $LiAlH_4$ can reduce both ketone and ester.

27. n $CH_2=CH–CH=CH_2$ + n $C_6H_5–CH=CH_2$ (styrene)
(1,3-butadiene)
$\longrightarrow$ $[CH_2–CH=CH–CH_2–CH(C_6H_5)–CH_2]_n$ —
(Buna–S)

28. $CH_3NH_2 \xrightarrow{CH_3I\text{ (excess)}} (CH_3)_3\overset{+}{N}I^- \xrightarrow{AgOH} (CH_3)_4\overset{+}{N}-OH^- \xrightarrow{\Delta} (CH_3)_3N + CH_3OH$

30.
(1)


(2)


(4) $R-CHOH-CHOH-R \xrightarrow{HIO_4} R-CH=O + R-CH=O$

Mathematics PART – III

SECTION – A

1. $\int \frac{1-7\cos^2 x}{\sin^7 x\cos^2 x}dx = \int \frac{\sec^2 x}{\sin^7 x}dx - \int \frac{7}{\sin^7 x} = \frac{\tan x}{\sin^7 x} + c$ S

2. $\tan x\int \tan^{-1}\alpha\ d\alpha = \tan x\left[\alpha\tan^{-1}\alpha - \int \frac{\alpha}{1+\alpha^2}d\alpha\right]$ = $\tan x\left\{\alpha\tan^{-1}\alpha - \frac{1}{2}\ell n\left(1+\alpha^2\right)\right\} + c$

3. $k = \int_0^1 \frac{e^t}{1+t}\ dt$ = $\int_0^1 e^t\ell n(1+t)dt$ = $\left[\ell n(1+t)e^t\right]_0^1 - \int_0^1 \frac{e^t}{1+t}dt$ = $e\ell n2 - k$

4. $I_n = \int_0^{\pi} e^x(\sin x)^n\ dx = e^x(\sin x)^n\Big|_0^{\pi} - n\int_0^{\pi}(\sin x)^{n-1}\cos x\ e^x dx$

$I_n = \frac{n(n-1)I_{n-2}}{1+n^2} \Rightarrow \frac{I_n}{I_{n-2}} = \frac{n(n-1)}{1+n^2}$

5. $\int_{-2k\pi}^{2k\pi} |\sin x|[\sin x]dx = \int_0^{2k\pi} |\sin x|\left([\sin x]+[-\sin x]\right)\ dx$

$= -2k\int_0^{\pi}\sin x\ dx = \left[-2k(-\cos x)\right]_0^{\pi} = -4k$

$I_k = -4k$

$\sum_{k=1}^{100} I_k = -20200$

6. f(n) – nf(n – 1) = (–1)[f(n – 1) – (n – 1) f(n – 2)] = $(-1)^{n-1}$ [f(1) – f(0)] = $(-1)^n$

$\therefore\ \frac{f(n)}{n!} = \frac{f(n-1)}{(n-1)!} + \frac{(-1)^n}{n!}$ and this gives

$f(n) = n!\left[1 - \frac{1}{1!} + \frac{1}{2!} - ..... + \frac{(-1)^n}{n!}\right]$

8. $x_n = \frac{1}{n}(n\in N)$ → 0 as n → ∞ by the definition of continuity $f(x_n) \to f(0)$ as n → ∞. But $f(x_n) = 0$ for all x ∈ N, so f(0) = 0

Also $\lim_{x\to 0}\frac{f(x)-f(0)}{x-0} = \lim_{x\to 0}\frac{f(x_n)-f(0)}{x_n - 0}$ ∵ f is derivable at x = 0

9. Equation of tangent $\frac{y-2a\sin\theta}{x-a\sin^2\theta} = \frac{1}{\sin\theta}$

$\Rightarrow \frac{x}{-a\sin^2\theta} + \frac{y}{a\sin\theta} = 1$

Sum of intercepts = $a\left(\sin^2\theta + \sin\theta\right)$ = 2a when $\sin\theta = 1$

10. $f'(x) = \frac{\sin x - x\cos x}{\sin^2 x}$

Let h(x) = sin x – x cos x
$h'(x) = x \sin x > 0 \; \forall \; 0 < x \leq 1$
h(x) is increasing
$h(0) < h(x) \Rightarrow \sin x - x \cos x > 0$ for $0 < x \leq 1$
$f'(x) > 0$
Similarly g(x) is decreasing

12. $\int e^x \left(\tan^{-1} x + \frac{1}{1+x^2} - \frac{1}{1+x^2} + \frac{2x}{\left(1+x^2\right)^2} \right) dx = e^x \left(\tan^{-1} x - \frac{1}{1+x^2} \right) + c$

13. $\int \left(x^2 + x\right)\left(x^{-8} + 2x^{-9}\right)^{1/10} dx = \int \left(x+1\right)\left(x^2 + 2x\right)^{1/10} dx = \frac{5}{11}\left(x^2 + 2x\right)^{11/10} + c$

14. Value of definite integral can be zero when either the lines coincide or f becomes identically zero for given interval or f(x) = 0 has some root in the given interval.
Here sin(x + k) = 0 in $n \in [0, 1]$

17. Let for particular x_0
$g(x_0) = a + k$ then $g(x) = a - k$
$\therefore \; h(x_0) = 2a$
$\therefore \; h(x) = 2a \; \forall \; x \in R$
$\therefore$ h(x) is many one and into

18. $y = \frac{x-1}{-x^2 + \alpha + 1}$; put y = –t $\therefore \; t \in \left[\frac{1}{3}, 1\right]$
Hence, we get $\alpha \in \left(-\infty, -\frac{1}{4}\right]$

20. As $n \to \infty$
$\lim_{n\to\infty} f(n) = \lim_{n\to\infty} f(n+2) = \lim_{n\to\infty} f(n+1) = k$ (say)
$\lim_{n\to\infty} f(n+2) = \lim_{n\to\infty} \frac{1}{2}\left\{ f(n+1) + \frac{9}{f(n)} \right\}$
$k = \frac{1}{2}\left\{ k + \frac{9}{k} \right\} \Rightarrow k = 3$

21. $f(x) = x^2 - \sin x \tan x$
$f'(x) = 2x - \sin x (\sec^2 x + 1)$
$\therefore \; f'(x) < 0 \Rightarrow f(x)$ is decreasing
$f(x) < f(0)$ as $x > 0$
$\therefore \; x^2 - \sin x \cos x < 0$

24. Put separately $x = \frac{1}{2}$, x = 1 and x = 2 we get
(A) $f(2) + f\left(\frac{1}{2}\right) = 1$ (C) $f(2) + f(1) = f\left(\frac{1}{2}\right)$ (D) f(2) + f(1) = 0

28. $f'(x) = 3x^2 - 2x + 100 > 0$

30. f(1) = f(3) ….. (1)
$f' = 3ax^2 + 3bx + 11 = 0$ ….. (2)
Solving we get a = 1 and b = –6

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ALL INDIA INTEGRATED TEST SERIES

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PART TEST – III

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 10)** contains 10 multiple choice questions which have only one correct answer. Each question carries **+2 marks** for correct answer. There is no negative marking.

Section-A (11 to 15) contains 5 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-C (01 to 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

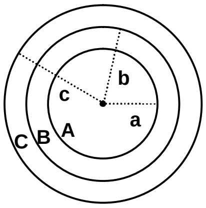
PART – I

SECTION – A

Single Correct Choice Type

*This section contains **10 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.*

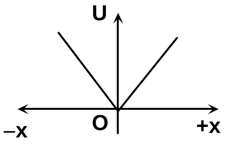
1. Three concentric charged metallic spherical shells A, B and C have radii a, b and c; charge densities σ, −σ and σ; and potentials V_A, V_B and V_C respectively. Then which of the following relations is correct?



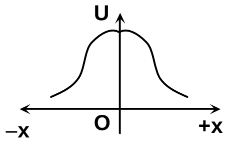
(A) $V_A = \frac{(a+b+c)\sigma}{\varepsilon_0}$
(B) $V_B = \frac{[(a^2/b)-b+c]\sigma}{\varepsilon_0}$
(C) $V_C = \frac{[(a^2+b^2)/c+c]\sigma}{\varepsilon_0}$
(D) $V_A = V_B = V_C = \frac{(a-b+c)\sigma}{\varepsilon_0}$

2. Four identical charges are placed at the four vertices of a square lying in YZ plane. A fifth charge is moved along X axis. The variation of potential energy (U) along X axis is correctly represented by

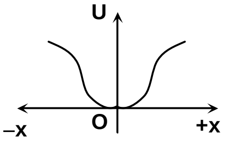
(A)



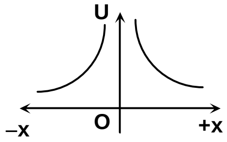
(B)



(C)



(D)

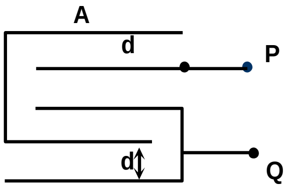


3. Two resistances 300 ohm and 400 ohm are connected in series with a 60 volt supply. A voltmeter connected across 400 ohm reads 30V. The same voltmeter when connected across the other resistance will read.

(A) 22.5 V
(B) 50 V
(C) 30 V
(D) 10 V

Space for rough work

4. The equivalent capacitance between P and Q in the figure is (area of each plate is A and separation between two consecutive plates is d)



(A) $\frac{A\varepsilon_0}{2d}$ (B) $\frac{3A\varepsilon_0}{2d}$

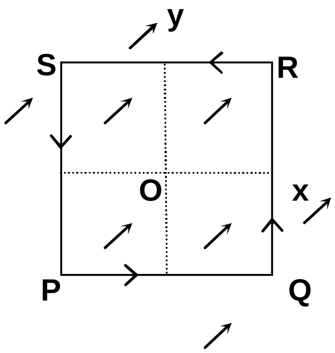
(C) $\frac{2A\varepsilon_0}{d}$ (D) $\frac{5}{3}\frac{A\varepsilon_0}{d}$

5. Two long parallel straight conductors carry currents i_1 and i_2 ($i_1 > i_2$). When the current are in the same direction, the magnetic field at a point midway between the wires is 20 μT. If the direction of i_2 is reversed, the field becomes 50 μT. the ratio of the currents i_1/i_2 is

(A) 5/2 (B) 7/3

(C) 4/3 (D) 5/3

6. A uniform constant magnetic field $\vec{B}$ is directed at an angle of 45° to the axis in the xy –plane. PQRS is a rigid, square wire frame carrying a steady current I_0, with its centre at the origin O. At time t = 0, the frame is at rest in the position as shown in figure, with its sides parallel to the x and y axes. Each side of the frame is of mass M and length L. The torque τ about O acting on the frame due to the magnetic field will be?



(A) $\frac{BI_0L^2}{\sqrt{2}}\left[+\hat{j}-\hat{i}\right]$ (B) $\frac{BI_0L^2}{\sqrt{2}}\left[-\hat{j}+\hat{i}\right]$

(C) $BI_0L^2\left[+\hat{j}-\hat{i}\right]$ (D) $BI_0L^2\left[-\hat{j}+\hat{i}\right]$

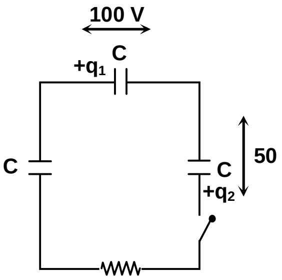
7. A coil is in the form of equilateral triangle of side 'a'. The current in the coil is I. The magnetic field at a distance 'a' equidistant' from all the vertices will be

(A) $\frac{\mu_0 I}{2\sqrt{3}\pi a}$ (B) $\frac{\sqrt{3}\mu_0 I}{2\pi a}$

(C) $\frac{\mu_0 I}{\sqrt{3}\pi a}$ (D) $\frac{\mu_0 I}{4\sqrt{3}\pi a}$

Space for rough work

8. Two capacitor each of capacitance C = 1 μF each charged to potential 100 V and 50 V respectively and connected across a uncharged capacitor 'C' = 1μF as shown in the figure if switch 'S' is closed then charge in the uncharged capacitor at equilibrium will be



(A) $\frac{50}{3}\mu C$ (B) 50 μC

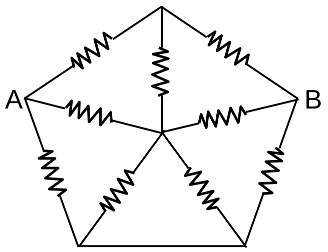
(C) 25 μC (D) $\frac{100}{3}\ \mu C$

9. Three point charges +q, −2q and +q are placed at points $\left(0, \frac{a}{\sqrt{2}}, \frac{a}{\sqrt{2}}\right)$; (0,0,0) and $\left(0, \frac{a}{\sqrt{2}}, -\frac{a}{\sqrt{2}}\right)$ respectively. Find the net electric dipole moment vector of this charge assembly.

(A) $\sqrt{2}qa(-\hat{j})$ (B) $\sqrt{2}qa(-\hat{k})$

(C) $\sqrt{2}qa(+\hat{j})$ (D) $2qa(+\hat{j})$

10. if resistance of each resistor is R, then effective resistance between points A and B of the shown network is



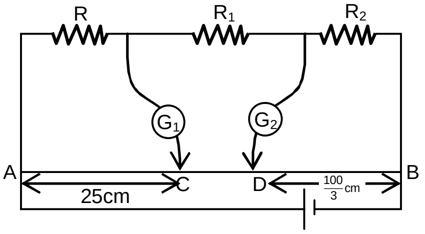
(A) $\frac{8R}{11}$ (B) $\frac{6R}{11}$

(C) $\frac{6R}{5}$ (D) $\frac{2R}{3}$

Multiple Correct Answer(s) Type

*This section contains **5 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.*

11 The diagram show is a modified meter bridge, which is used for measuring two unknown resistances R_1 and R_2 at the same time. When only the first galvanometer is used, balance point is found at point C. Now the first galvanometer is removed and the second galvanometer is used, which gives balance point D. Using the details given in the diagram, find out the value of R_1 and R_2



(A) $R_1 = 5R/3$ (B) $R_2 = 4R/3$

(C) $R_1 = 4R/3$ (D) $R_2 = 5R/3$

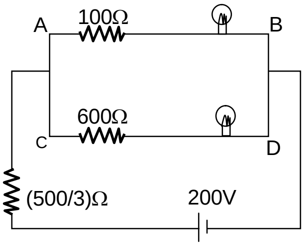
Space for rough work

12. 10C of charge is given to a conducting spherical shell and another– 3C point charge is placed inside the shell. For this arrangement mark out the correct statement(s).
(A) The charge on the inner surface of the shell will be +3C and it can be distributed uniformly or non uniformly
(B) The charge on the inner surface of the shell will be +3C and its distribution would be uniform
(C) The net charge on outer surface of the shell will be +7 C and its distribution can be uniform or non uniform
(D) The net charge on outer surface of the shell will be +7C and its distribution would be uniform

13. A parallel plate capacitor of plate area A and plate separation d is charged to a potential difference V and then the battery is disconnected. A slab of dielectric constant K is then inserted between the plates of the capacitor so as to fill the space between the plates. If Q, E and W denote the magnitude of charge, the electric field between the plates (after the slab is inserted) and magnitude of the work done on the system in question during the process of inserting the slab, then :
(A) $Q = \frac{\varepsilon_0 AV}{d}$
(B) $Q = \frac{\varepsilon_0 KAV}{d}$
(C) $E = \frac{V}{Kd}$
(D) $W = \frac{\varepsilon_0 AV^2}{2d}\left(1 - \frac{1}{K}\right)$

14. A proton is fired form origin with velocity $\vec{v} = v_0\hat{j} + v_0\hat{k}$ in a uniform magnetic field $\vec{B} = B_0\hat{j}$. In the subsequent motion of the proton
(A) its z coordinate can never be negative
(B) its x coordinate can never be positive
(C) its x and z coordinates cannot be zero at the same time
(D) its y coordinate will be proportional to its time of flight.

15. Two bulbs 25W, 100V (upper bulb in figure) and 100W, 200V (lower bulb in figure) are connected in the circuit as shown in figure. Choose the correct answer (s)
(A) Heat lost per second in the circuit will be 80J
(B) Ratio of heat produced per second in bulbs will be 1: 1
(C) Ratio of heat produced in branch AB to branch CD will be 1:2
(D) Current drawn from the cell is 0.4 A



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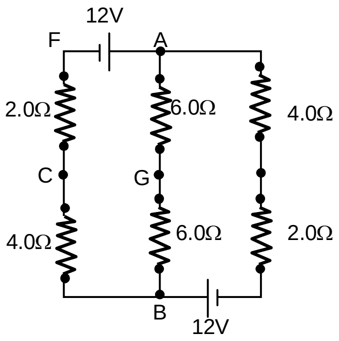
SECTION – C

(Integer Answer Type)

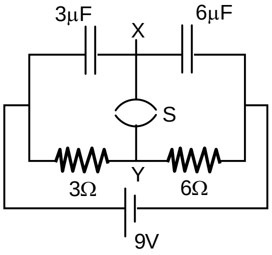
*This section contains **5** questions. The answer to each of the questions is a **single digit integer,** ranging from 0 to 9. The bubble corresponding to the correct is to be darkened in the ORS.*

1. In the network shown in the figure, the potential difference (in Volt) across points A and B is

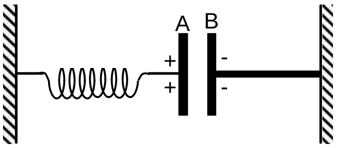


2. Two circular coils of radii 5cm and 10 cm carry equal current of 2A in opposite sense . The coils have 50 and 100 turns respectively and are placed in such a way that they lie in same plane and their centres coincide. Magnitude of magnetic field(in Tesla) at the common centre of coils is

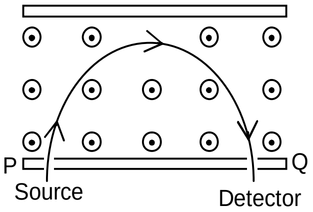
3. A circuit is connected as shown in the figure with the switch S open. When the switch is closed, if total amount of charge that flows from Y to X is Q(in μC), then $\frac{Q}{3} =$



4. Plate A of a parallel plate air filled capacitor is connected to a spring having force constant k and plate B is fixed. They rest on a frictionless table top as shown in the figure. if a charge +q is placed on plate A and a charge –q on plate B, by how much does the spring expand in equilibrium ($q^2 = 6kA\varepsilon_0$)



5. A uniform magnetic field with a slit system as shown in the figure is to be used as a momentum filter for high energy charged particles (enter and exit perpendicular to PQ) . With a field of B tesla it is found that the filter transmits α particle each of energy 2.2 MeV. The magnetic field is increased to 2.13B tesla and deuteron ions are passed into the filter. What is the approximate energy (In MeV) of each deuteron ionstransmitted by the filter?



Space for rough work

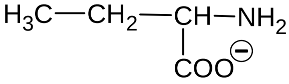
Chemistry PART - II

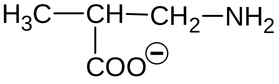
SECTION – A

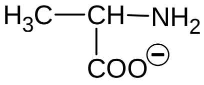
Single Correct Choice Type

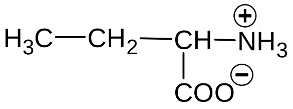
This section contains ***10 multiple choice questions****. Each question has four choices (A), (B), (C) and (D) out of which* ***ONLY ONE is correct****.*

1. In alkaline medium alanine exits predominantly as

(A) 
$H_3C-CH_2-\underset{COO^{\ominus}}{\underset{|}{CH}}-NH_2$

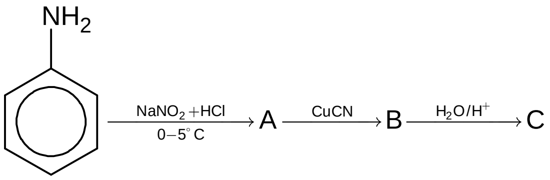
(B) 
$H_3C-\underset{COO^{\ominus}}{\underset{|}{CH}}-CH_2-NH_2$

(C) 
$H_3C-\underset{COO^{\ominus}}{\underset{|}{CH}}-NH_2$

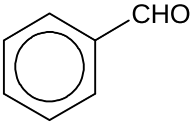
(D) 
$H_3C-CH_2-\underset{COO^{\ominus}}{\underset{|}{CH}}-\overset{\oplus}{N}H_3$

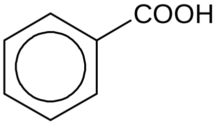
2. The Cannizzaro reaction is not given by:

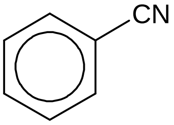
(A) trimethyl acetaldehyde
(B) benzaldehyde
(C) acetaldehyde
(D) formaldehyde

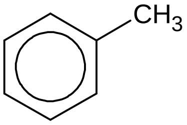
3. 

(C) is

(A) 

(B) 

(C) 

(D) 

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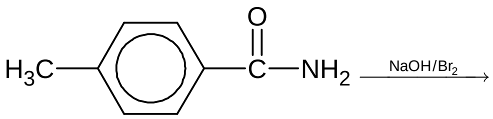
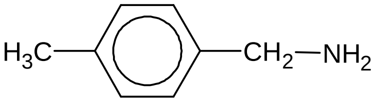
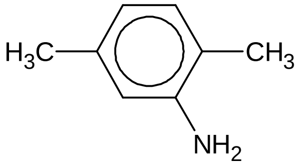
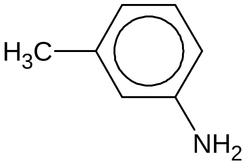
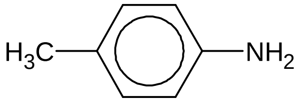
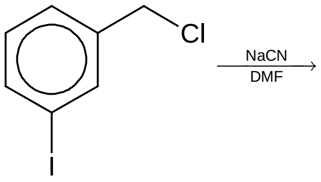
4. 
H3C
O
C
NH2
NaOH/Br2

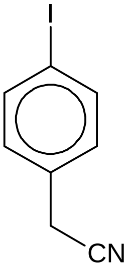
(A) 

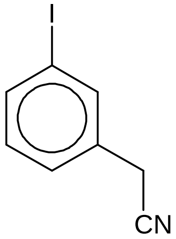
(B) 

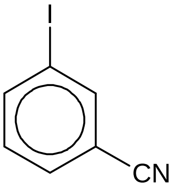
(C) 

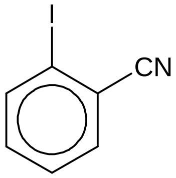
(D) 

5. 
Cl
I
NaCN
DMF

(A) 

(B) 

(C) 

(D) 

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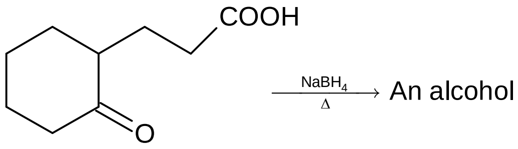
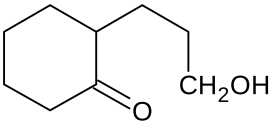
6.

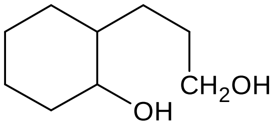

COOH
O
NaBH4
Δ
An alcohol

An alcohol is

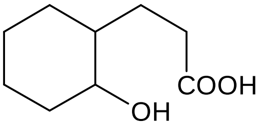
(A)



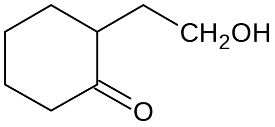
(B)



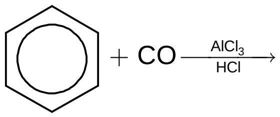
(C)



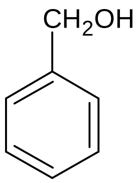
(D)



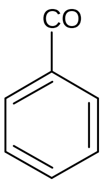
7.


+ CO
AlCl3
HCl

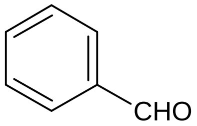
(A)



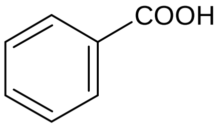
(B)



(C)



(D)



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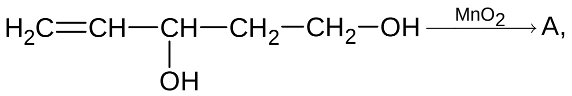
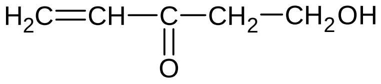
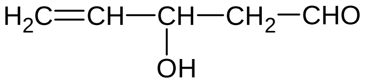
8. 

$H_2C{=}CH{-}\underset{\displaystyle OH}{\underset{|}{CH}}{-}CH_2{-}CH_2{-}OH \xrightarrow{MnO_2} A,$

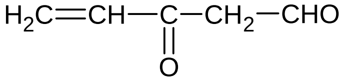
A is

(A) 

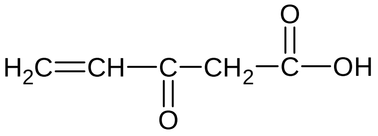
$H_2C{=}CH{-}\underset{\displaystyle O}{\underset{\|}{C}}{-}CH_2{-}CH_2OH$

(B) 

$H_2C{=}CH{-}\underset{\displaystyle OH}{\underset{|}{CH}}{-}CH_2{-}CHO$

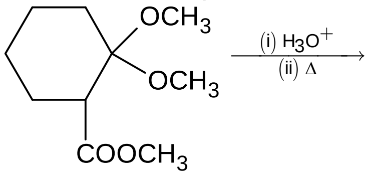
(C) 

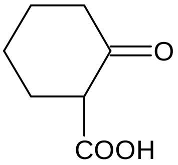
$H_2C{=}CH{-}\underset{\displaystyle O}{\underset{\|}{C}}{-}CH_2{-}CHO$

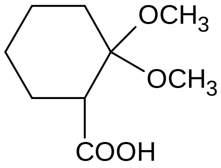
(D) 

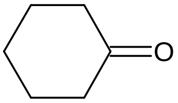
$H_2C{=}CH{-}\underset{\displaystyle O}{\underset{\|}{C}}{-}CH_2{-}\overset{\displaystyle O}{\overset{\|}{C}}{-}OH$

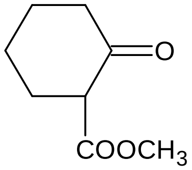
9. What is the final product of the following reaction?



(A) 

(B) 

(C) 

(D) 

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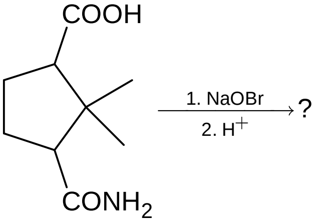
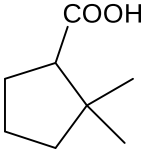
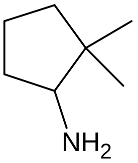
10. What is the final product of the following reaction?



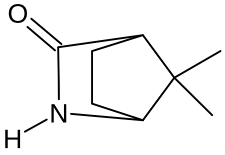
(A)



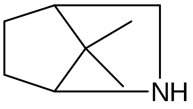
(B)



(C)



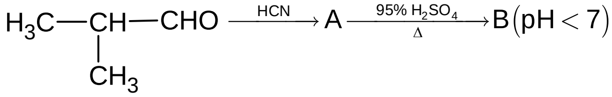
(D)



Multiple Correct Answer(s) Type

This section contains ***5 multiple choice questions****. Each question has four choices (A), (B), (C) and (D) out of which* ***ONE or MORE are correct****.*

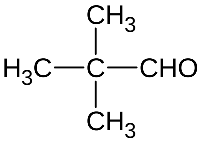
11.



$H_3C-\underset{CH_3}{\underset{|}{CH}}-CHO \xrightarrow{HCN} A \xrightarrow[\Delta]{95\%\ H_2SO_4} B(pH < 7)$

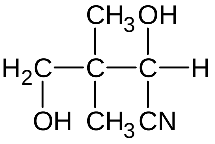
Which of these substances appear in reaction sequence?

(A)



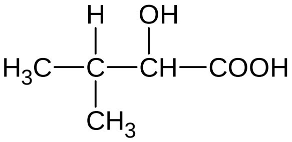
$H_3C-\underset{CH_3}{\underset{|}{\overset{CH_3}{\overset{|}{C}}}}-CHO$

(B)



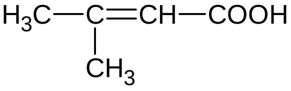
$\underset{OH}{\underset{|}{H_2C}}-\underset{CH_3}{\underset{|}{\overset{CH_3}{\overset{|}{C}}}}-\underset{CN}{\underset{|}{\overset{OH}{\overset{|}{C}}}}-H$

(C)



$H_3C-\underset{CH_3}{\underset{|}{\overset{H}{\overset{|}{C}}}}-\overset{OH}{\overset{|}{CH}}-COOH$

(D)

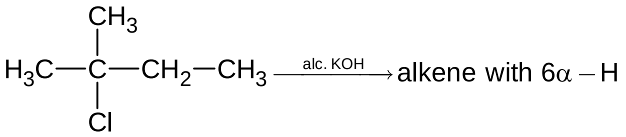


$H_3C-\underset{CH_3}{\underset{|}{C}}=CH-COOH$

Space for rough work

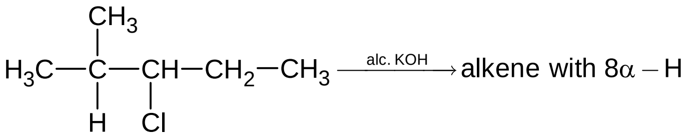
12. Which of the following statement(s) are correct?

(A)



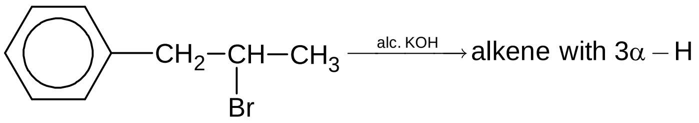
$$H_3C-\underset{Cl}{\overset{CH_3}{C}}-CH_2-CH_3 \xrightarrow{\text{alc. KOH}} \text{alkene with } 6\alpha-H$$

(B)

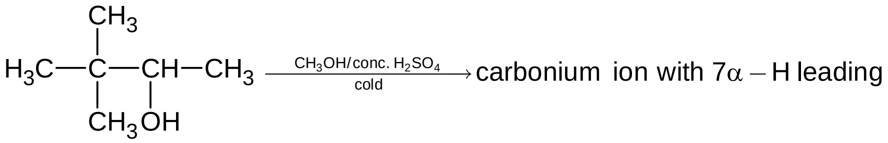


$$H_3C-\underset{H}{\overset{CH_3}{C}}-\underset{Cl}{CH}-CH_2-CH_3 \xrightarrow{\text{alc. KOH}} \text{alkene with } 8\alpha-H$$

(C)

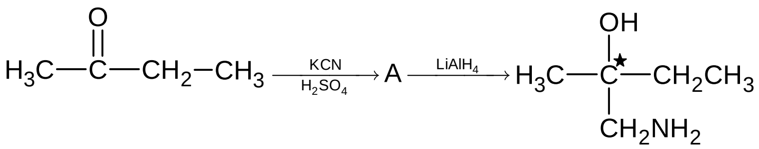


(D)



$$H_3C-\underset{CH_3}{\overset{CH_3}{C}}-\underset{OH}{CH}-CH_3 \xrightarrow[\text{cold}]{CH_3OH/\text{conc. } H_2SO_4} \text{carbonium ion with } 7\alpha-H \text{ leading}$$

13.

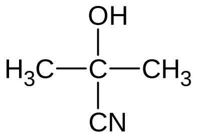


$$H_3C-\overset{O}{\overset{\|}{C}}-CH_2-CH_3 \xrightarrow[H_2SO_4]{KCN} A \xrightarrow{LiAlH_4} H_3C-\underset{CH_2NH_2}{\overset{OH}{C^{\star}}}-CH_2CH_3$$

Which of these statements are correct?

(A) One of these chemical substances gives iodoform test

(B)



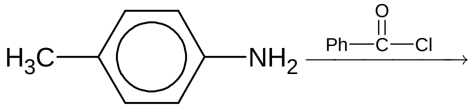
$$H_3C-\underset{CN}{\overset{OH}{C}}-CH_3$$

is formed

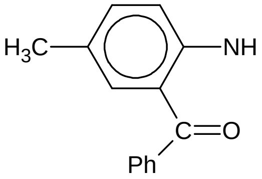
(C) The final mixture is optically active

(D) The final mixture is racemic

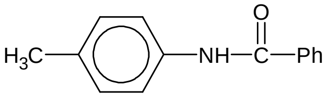
Space for rough work

14. 
organic compound with 2 benzene rings

Which of the following statements is/are correct?
(A) One of the benzene rings is ortho & para directing
(B) One of the benzene rings is meta directing
(C) Organic compound is



(D) Organic compound is



15. Select the correct statement(s), among the following given statements
(A) $CH_3CH_2CH_2I$ will react more readily than $(CH_3)_2CHI$ for SN^2 reactions
(B) $CH_3CH_2CH_2Cl$ will react more readily than $CH_3CH_2CH_2Br$ for SN^2 reactions
(C) $CH_3CH_2CH_2CH_2Br$ will react more readily than $(CH_3)_3C – CH_2Br$ for SN^2 reactions
(D) $CH_3 – O – C_6H_5 – Br$ will react more readily than $NO_2 – C_6H_5 – CH_2Br$ for SN^2 reaction

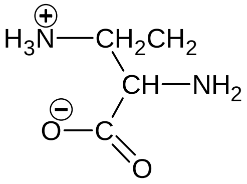
Space for rough work

SECTION – C

(Integer Answer Type)

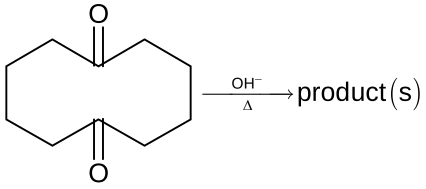
*This section contains **5** questions. The answer to each of the questions is a **single digit integer,** ranging from 0 to 9. The bubble corresponding to the correct is to be darkened in the ORS.*

1. What is the total number of basic groups in the following?



$H_3\overset{\oplus}{N}$—CH_2CH_2
CH—NH_2
$\overset{\ominus}{O}$—C
O

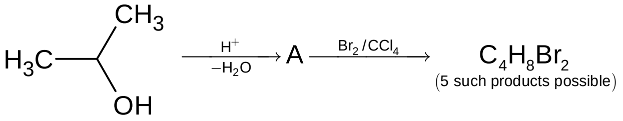
2.



O
O
OH^-
Δ
product(s)

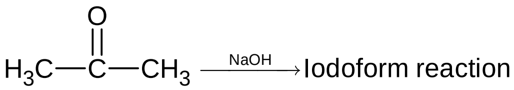
How many product(s) are possible?

3. How many structures of A are possible?



CH_3
H_3C
OH
H^+
$-H_2O$
A
Br_2/CCl_4
$C_4H_8Br_2$
(5 such products possible)

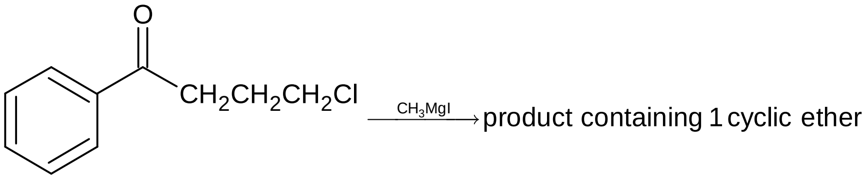
4.



$$H_3C-\overset{\overset{\displaystyle O}{||}}{C}-CH_3 \xrightarrow{NaOH} \text{Iodoform reaction}$$

How many molecules of I_2 are required for 3 molecules of CH_3COCH_3?

5.



O
$CH_2CH_2CH_2Cl$
CH_3MgI
product containing 1 cyclic ether

How many C atoms are part of cyclic ether?

Space for rough work

Mathematics PART – III

SECTION – A

Single Correct Choice Type

*This section contains **10 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.*

1. If (a, 0); a > 0 is the point where the curve $y = \sin 2x - \sqrt{3}\sin x$ cuts the x-axis first, A is the area bounded by this part of the curve the origin and the positive x-axis, then

(A) 4A + 8 cos a = 7 (B) 4A + 8 sin a = 7
(C) 4A – 8 sin a = 7 (D) 4A – 8 cos a = 7

2. Let $f(x) = \lim\limits_{h\to 0}\dfrac{(\sin(x+h))^{\ln(x+h)} - (\sin x)^{\ln x}}{h}$ then $f\left(\dfrac{\pi}{2}\right)$ is

(A) equal to 0 (B) equal to 1
(C) $\ln\dfrac{\pi}{2}$ (D) none existent

3. For any natural number m, $\int \left(x^{7m} + x^{2m} + x^{m}\right)\left(2x^{6m} + 7x^{m} + 14\right)^{1/m}dx$ (where x > 0) equals

(A) $\dfrac{\left(7x^{7m} + 2x^{2m} + 14x^{m}\right)^{\frac{m+1}{m}}}{14(m+1)} + c$ (B) $\dfrac{\left(2x^{7m} + 14x^{2m} + 7x^{m}\right)^{\frac{m+1}{m}}}{14(m+1)} + c$

(C) $\dfrac{\left(2x^{7m} + 7x^{2m} + 14x^{m}\right)^{\frac{m+1}{m}}}{14(m+1)} + c$ (D) $\dfrac{\left(7x^{7m} + 2x^{2m} + x^{m}\right)^{\frac{m+1}{m}}}{14(m+1)} + c$

4. Let u(x) and v(x) are differentiable function such that $\dfrac{u(x)}{v(x)} = 7$. If $\dfrac{u'(x)}{v'(x)} = p$ and $\left(\dfrac{u(x)}{v(x)}\right)' = q$ then $\dfrac{p+q}{p-q}$ has the value equal to

(A) 1 (B) 0
(C) 7 (D) –7

Space for rough work

5. A function is represented parametrically by the equation $x = \frac{1+t}{t^3}$; $y = \frac{3}{2t^2} + \frac{2}{t}$ then $\frac{dy}{dx} - x\left(\frac{dy}{dx}\right)^3$ has the value equal to

(A) 2	(B) 0
(C) –1	(D) –2

6. Let g is the inverse function of f and $f'(x) = \frac{x^{10}}{(1+x^2)}$. If g(2) = a then g′(2) is equal to

(A) $\frac{5}{2^{10}}$	(B) $\frac{1+a^2}{a^{10}}$
(C) $\frac{a^{10}}{1+a^2}$	(D) $\frac{1+a^{10}}{a^2}$

7. Let $f : \left[0, \frac{\pi}{2}\right] \to R$ be continuous and satisfy $f'(x) = \frac{1}{1+\cos x}$ for all $x \in \left(0, \frac{\pi}{2}\right)$. If f(0) = 3 then $f\left(\frac{\pi}{2}\right)$ has the value

(A) $\frac{13}{4}$	(B) 2
(C) 4	(D) none of these

8. For the curve represented implicitly as $3^x - 2^y = 1$, the value of $\lim\limits_{x \to \infty} \left(\frac{dy}{dx}\right)$ is

(A) equal to 1	(B) equal to 0
(C) equal to $\log_2 3$	(D) non existent

9. $\int \left(\sin(101x)\sin^{99} x\right)dx$ equals

(A) $\frac{\sin(100x)(\sin x)^{100}}{100} + c$	(B) $\frac{\cos(100x)(\sin x)^{100}}{100} + c$
(C) $\frac{\cos(100x)(\cos x)^{100}}{100} + c$	(D) $\frac{\sin(100x)(\sin x)^{101}}{101} + c$

Space for rough work

10. $\lim\limits_{x\to 0^+} \frac{1}{x\sqrt{x}}\left(a \text{ arc } \tan\frac{\sqrt{x}}{a} - b \text{ arc } \tan\frac{\sqrt{x}}{b}\right)$ the value equal to

(A) $\frac{a-b}{3}$
(B) 0
(C) $\frac{a^2-b^2}{6a^2b^2}$
(D) $\frac{a^2-b^2}{3a^2b^2}$

Multiple Correct Answer(s) Type

*This section contains **5 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE are correct**.*

11. If $2^x + 2^y = 2^{x+y}$ then $\frac{dy}{dx}$ has the value equal to

(A) $-\frac{2^y}{2^x}$
(B) $\frac{1}{1-2^x}$
(C) $1-2^y$
(D) $\frac{2^x\left(1-2^y\right)}{2^y\left(2^x-1\right)}$

12. Two functions f and g have first and second derivative at x = 0 and satisfy the relations $f(0)=\frac{2}{g(0)}$; $f'(0) = 2g'(0) = 4g(0)$; $g''(0) = 5f''(0) = 6f(0) = 3$ then

(A) if $h(x)=\frac{f(x)}{g(x)}$ then $h'(0)=\frac{15}{4}$
(B) if $k(x) = f(x)\, g(x) \sin x$ then $k'(0) = 2$
(C) $\lim\limits_{x\to 0}\frac{g'(x)}{f'(x)}=\frac{1}{2}$
(D) none of these

13. Let $f'(x)=3x^2\sin\frac{1}{x}-x\cos\frac{1}{x}$; if $x \neq 0$ $f(0) = 0$ and $f\left(\frac{1}{\pi}\right)=0$ then

(A) f(x) is continuous at x = 0
(B) f(x) is non derivable at x = 0
(C) f′(x) is continuous at x = 0
(D) f′(x) is non-derivable at x = 0

Space for rough work

14. Consider the function f(x) and g(x), both defined from $R \to R$ and are defined as $f(x) = 2x - x^2$ and $g(x) = x^n$ where $n \in N$. If the area between f(x) and g(x) is $\frac{1}{2}$ then n is a divisor of

(A) 12 (B) 15
(C) 20 (D) 30

15. Consider $f(x) = \begin{cases} \cos x & 0 \le x < \frac{\pi}{2} \\ \left(\frac{\pi}{2} - x\right)^2 & \frac{\pi}{2} \le x < \pi \end{cases}$ such that f is periodic with period x, then

(A) the range of f is $\left[0, \frac{\pi^2}{4}\right]$
(B) f is continuous for all real x, but not differentiable for some real x
(C) f is continuous for all real x
(D) the area bounded by y = f(x) and the x-axis from $x = -n\pi$ to $x = n\pi$ is $2n\left(1 + \frac{\pi^3}{24}\right)$ for $n \in N$

SECTION – C

(Integer Answer Type)

*This section contains **5** questions. The answer to each of the questions is a **single digit integer,** ranging from 0 to 9. The bubble corresponding to the correct is to be darkened in the ORS.*

1. Let $I_n = \int_0^{\pi/4} \tan^n x\,dx$ (n = 0, 1, 2, 3, …..) and $S_n = \sum_{n=0}^{n} \left(I_n I_{n+1} + I_n I_{n+3} + I_{n+1} I_{n+2}\right)$ then the value of $\lim_{x \to \infty} (S_n)$ is _____

Space for rough work

2. Let L denotes the value of $\lim\limits_{x\to 0^+} \frac{1}{x}\cos^{-1}\left(\frac{\sin x}{x}\right)$ and U denotes the value of f″(0) where $f(x) = \int_0^x \sin\left(t^2 - t + x\right)dt$, compute the value of $\frac{2U}{L^2}$ _____

3. Suppose $V = \int_0^{\pi/2} x\left|\sin^2 x - \frac{1}{2}\right|dx$, then the value of $\frac{32V}{\pi}$ _____

4. If the value of the integral $\int_0^{\pi} \frac{\cos 4x - \cos 4\alpha}{\cos x - \cos\alpha}dx$ is k(π cos 2α cos α) then the value of k _____

5. A function f(x) is defined as $f(x) = \begin{cases} x^m \sin\frac{1}{x} & x \neq 0, m \in N \\ 0 & \text{if } x = 0 \end{cases}$. The least value of m for which f′(x) is continuous at x = 0 _____

Space for rough work

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ANSWERS, HINTS & SOLUTIONS

PART TEST –III

(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	C	A
2.	B	C	A
3.	A	B	C
4.	D	D	A
5.	B	B	C
6.	A	C	B
7.	A	C	C
8.	A	A	C
9.	C	C	A
10.	D	C	D
11.	A, B	C, D	A, B, C, D
12.	A, D	B, C	A, B, C
13.	A, C, D	A, D	A, C, D
14.	B, D	A, B, D	B, C, D
15.	A, D	A, C	A, D
1.	0	2	1
2.	0	1	6
3.	9	3	4
4.	3	9	4
5.	5	4	3

Physics

PART – I

2. Potential energy will be finite and maximum at x = 0.

5. $B_1 - B_2 = 20\ \mu T$, $B_1 + B_2 = 50\ \mu T$ and $B \propto i$

6. Use $\tau = \vec{M} \times \vec{B}$

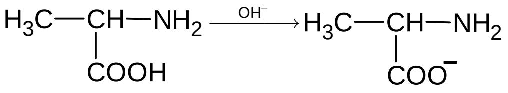
7. Use symmetry arguments. Net $\vec{B}$ will be perpendicular to the plane of the loop

9. Use $\vec{P} = \Sigma q_i \vec{r}_i$

Chemistry PART – II

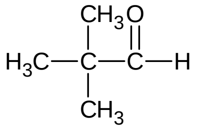
SECTION – A

1. In alkaline medium, alanine exists as anion:



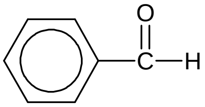
$$H_3C-\underset{\displaystyle COOH}{CH}-NH_2 \xrightarrow{OH^-} H_3C-\underset{\displaystyle COO^-}{CH}-NH_2$$

2.

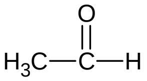


$$H_3C-\overset{CH_3}{\underset{CH_3}{C}}-\overset{O}{\overset{\|}{C}}-H$$

O α—H

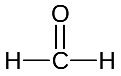


O α—H



$$H_3C-\overset{O}{\overset{\|}{C}}-H$$

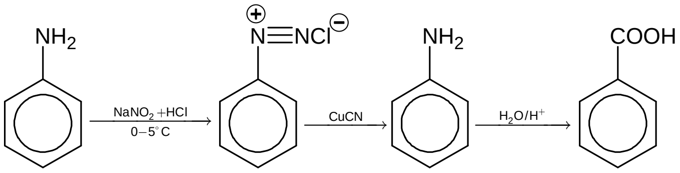
3 α—H(not appropriate for Cannizzaro reaciton



$$H-\overset{O}{\overset{\|}{C}}-H$$

O α—H

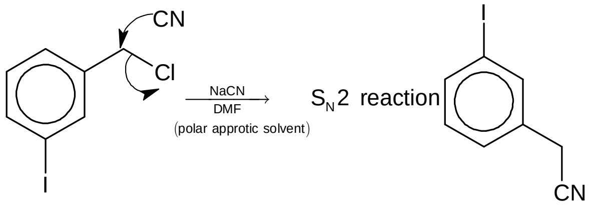
3.



NH2
NaNO2 +HCl
0–5°C
N≡NCl
CuCN
NH2
H2O/H+
COOH

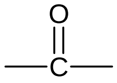
4. Hoffmann bronamide degradation.

5.



CN
Cl
I
NaCN
DMF
(polar approtic solvent)
SN2 reaction
I
CN

6. NaBH$_4$ selectively reduceds

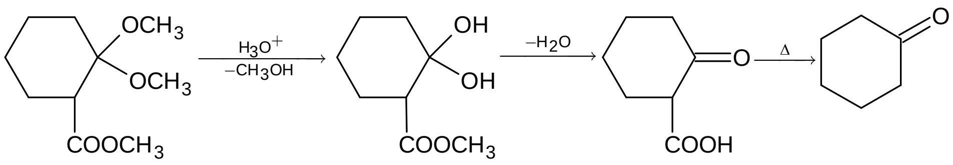


$$-\overset{O}{\overset{\|}{C}}-$$

7. Gattermann Koch reaction.

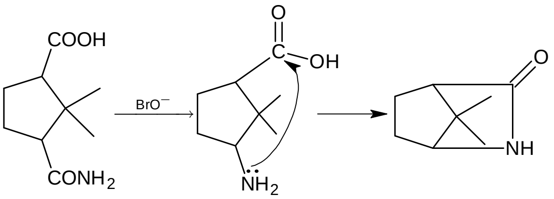
8. MnO$_2$ oxidized allylic alcohol.

9.

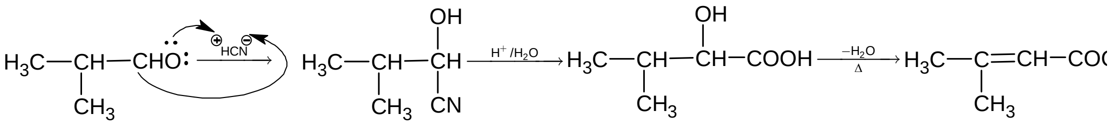


OCH3
OCH3
COOCH3
H3O+
–CH3OH
OH
OH
COOCH3
–H2O
O
COOH
Δ
O

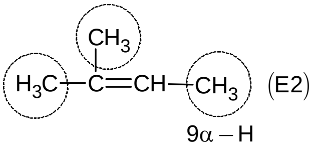
10.


COOH
CONH2
BrO⁻
O
C
OH
NH2
O
NH

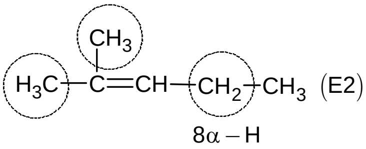
11.


H3C—CH—CHO:
CH3
HCN
OH
H3C—CH—CH
CH3 CN
H⁺/H2O
OH
H3C—CH—CH—COOH
CH3
−H2O
Δ
H3C—C=CH—CO(
CH3

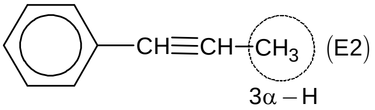
12. (A)


CH3
H3C—C=CH—CH3
(E2)
9α – H

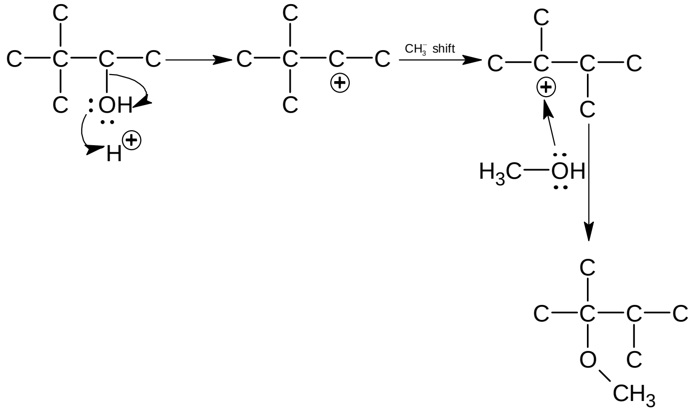
(B)


CH3
H3C—C=CH—CH2—CH3
(E2)
8α – H

(C)

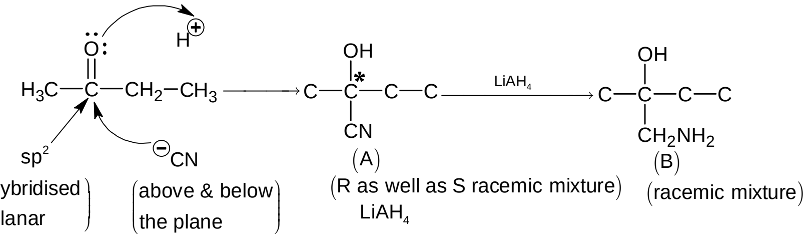

—CH≡CH—CH3
(E2)
3α – H

(D)

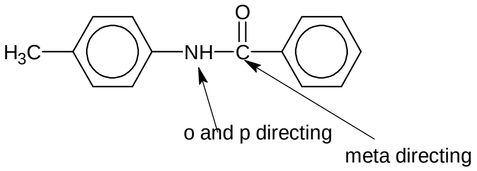

CH3⁻ shift
H3C—OH

(ether and NOT an alkalene)

13.


O:
H
H3C—C—CH2—CH3
sp2
(hybridised planar)
CN
(above & below the plane)
OH
C—C—C—C
CN
(A)
(R as well as S racemic mixture)
LiAH4
LiAH4
OH
C—C—C—C
CH2NH2
(B)
(racemic mixture)

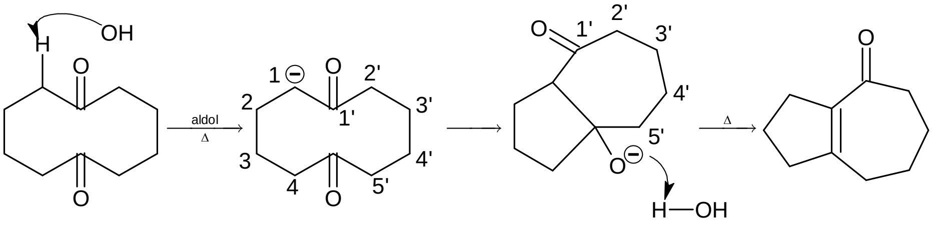
14. Organic compound is


H3C
NH
C
O
o and p directing
meta directing

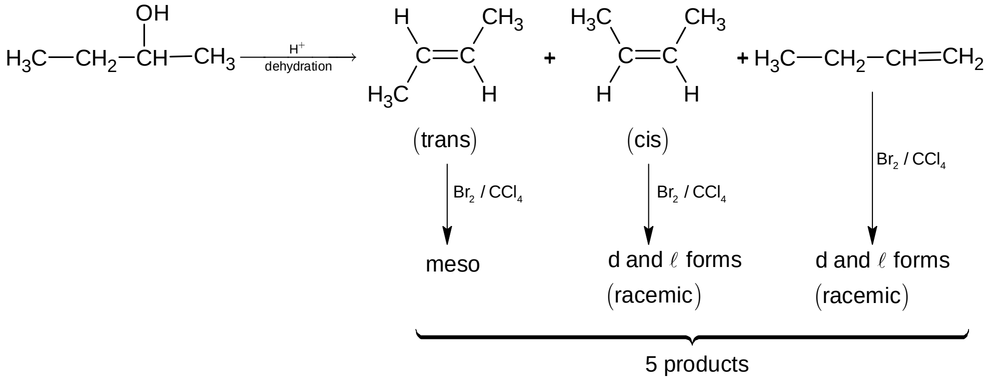
SECTION – C

1. —NH_2 si basic.
—COO^- is (conjugate) base.
—NH_3^+ is acidic.

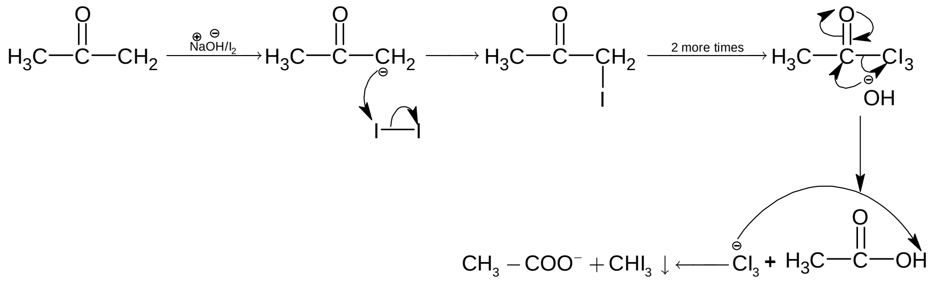
2.


H
OH
O
O
aldol
Δ
1
2
3
4
1'
2'
3'
4'
5'
O
O
H—OH
Δ

3. The compound A is represented by the 3 structures as follows:

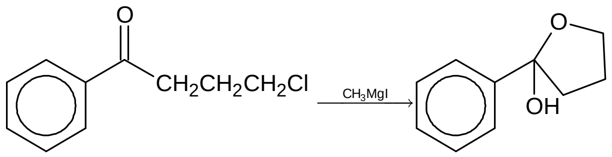

H3C—CH2—CH(OH)—CH3
H+
dehydration
(trans)
(cis)
H3C—CH2—CH=CH2
Br2 / CCl4
Br2 / CCl4
Br2 / CCl4
meso
d and ℓ forms
(racemic)
d and ℓ forms
(racemic)
5 products

4.


NaOH/I2
2 more times
I—I
OH
$CH_3-COO^- + CHI_3\downarrow$
Cl_3
H3C—C—OH

1 molecules of $H_3C-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$ requires 3 molecules of I_2.

5.


O
CH2CH2CH2Cl
CH3MgI
O
OH

Mathematics PART – III

SECTION – A

1. (a, 0) lies on the given curve

$\therefore\ o = \sin 2a - \sqrt{3}\sin a$

$\Rightarrow$ sin a = 0 or $\cos a = \frac{\sqrt{3}}{2}$

$\Rightarrow\ a = \frac{\pi}{6}$ (as a > 0 and 1st point of intersection with positive x-axis) and

$A = \int_0^{\pi/6}\left(\sin 2x - \sqrt{3}\sin x\right)dx\ = \frac{7}{4} - \sqrt{3} = \frac{7}{4} - 2\cos a\ \Rightarrow$ 4A + 8 cos a = 7

2. Let g(x) = $(\sin x)^{\ln x} = e^{\ln x \ln(\sin x)}$

$f(x) = g'(x) = (\sin x)^{\ln x}\left[\cot x(\ln x) + \frac{\ln(\sin x)}{x}\right]$

Hence, $f\left(\frac{\pi}{2}\right) = g'\left(\frac{\pi}{2}\right) = 0$

3. Put $2x^{7m} + 7x^{2m} + 14x^{m} = t^{m}$

$14\,m(x^{7m-1} + x^{2m-1} + x^{m-1})\,dx = mt^{m-1}\,dt$

4. u(x) = 7v(x) $\Rightarrow$ p = 7

$\Rightarrow\ \left(\frac{u(x)}{v(x)}\right)' = 0\ \Rightarrow$ q = 0

$\therefore\ \frac{p+q}{p-q} = 1$

5. $\frac{dx}{dt} = -\left(\frac{3+2t}{t^4}\right)$

$\frac{dy}{dt} = -\left(\frac{3+2t}{t^3}\right)$

6. f[g(x)] = x $\Rightarrow$ f′[g(2)] g′(2) = 12 $\Rightarrow$ f′(a) g′(2) [putting x = 2]

Given $f'(a) = \frac{a^{10}}{1+a^2}\ \Rightarrow\ g'(2) = \frac{1+a^2}{a^{10}}$

7. $f'(x) = \frac{1}{1+\cos x}$ integrating

$f(x) = \tan\frac{x}{2} + c$

f(0) = 3 $\therefore$ c = 3

$f(x) = \tan\frac{x}{2} + 3$

$\therefore\ f\left(\frac{\pi}{2}\right) = 4$

8. $2^y = 3^x - 1 \Rightarrow y \ln 2 = \ln(3^x - 1)$

$$\ln 2 \frac{dy}{dx} = \frac{3^x \ln 3}{3^x - 1} = \frac{\ln 3}{1 - 3^{-x}}$$

$$\lim_{x\to\infty} \frac{dy}{dx} = \frac{\ln 3}{\ln 2} \lim_{x\to\infty} \frac{1}{1 - 3^{-x}} = \log_2 3$$

9. $I = \int (\sin 100x + x)(\sin x)^{99}\,dx = \int \left[\left(\sin(100x)\cos x + \cos 100x \sin x\right)\right](\sin x)^{99}\,dx$

$$= \int \underbrace{\sin(100x)}_{I}\underbrace{\cos x(\sin x)^{99}}_{II}\,dx + \int \cos(100x)(\sin x)^{100}\,dx$$

$$= \frac{\sin(100x)(\sin x)^{100}}{100} - \frac{100}{100}\int \cos(100x)(\sin x)^{100}\,dx + \int \cos(100x)(\sin x)^{100}\,dx$$

$$= \frac{\sin(100x)(\sin x)^{100}}{100} + c$$

10. Using Lopital Rule

$$\lim_{x\to 0}\left(\frac{a\tan^{-1}\sqrt{x}/a - b\tan^{-1}\sqrt{x}/b}{x\sqrt{x}}\right)$$

$$= \lim_{x\to 0} \frac{\frac{a}{\left(1 + x/a^2\right)}\cdot\frac{1}{a}\cdot\frac{1}{2\sqrt{x}} - \frac{b}{\left(1 + x/b^2\right)}\cdot\frac{1}{b}\cdot\frac{1}{2\sqrt{x}}}{\frac{3}{2}\sqrt{x}}$$

$$= \lim_{x\to 0}\left[\frac{a^2}{\left(a^2 + x\right)x} - \frac{b^2}{\left(b^2 + x\right)x}\right]\cdot\frac{1}{3} = \frac{a^2 - b^2}{3a^2b^2}$$

13. $$f(x) = \begin{cases} x^3 \sin\frac{1}{x} & \text{if } x \neq 0 \\ 0 & \text{if } x = 0 \end{cases}$$

14. $2x - x^2 = x^n$

$\Rightarrow x = 0$ and 1

$$A = \int_0^1 \left(2x - x^2 - x^n\right)dx = \left. x^2 - \frac{x^3}{3} - \frac{x^{n+1}}{n+1}\right]_0^1 = \frac{2}{3} - \frac{1}{n+1}$$

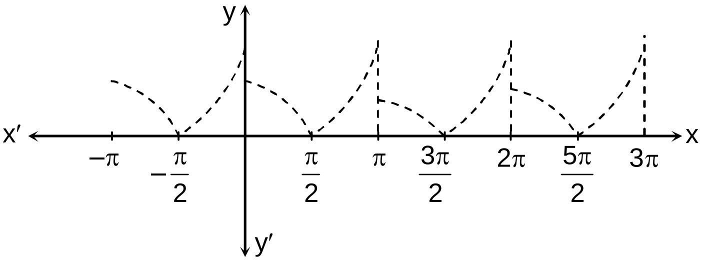
Hence, $\frac{2}{3} - \frac{1}{n+1} = \frac{1}{2}$

$\Rightarrow n = 5$

Hence, n is devisor of (20, 15, 30)

15. Given $f(x) = \begin{cases} \cos x & 0 \le x < \frac{\pi}{2} \\ \left(\frac{\pi}{2} - x\right)^2 & \frac{\pi}{2} \le x < \pi \end{cases}$ and f is periodic with period π

$\therefore$ We draw the graph of y = f(x)



From the graph the range of the function is $\left[0, \frac{\pi^2}{4}\right]$

It is discontinuous at x = nπ, n ∈ I at $x = \frac{n\pi}{2}$, n ∈ I

Area bounded by y = f(x) and the x-axis from –nπ to nπ for n ∈ N

$$= 2n\int_0^{\pi} f(x)dx = 2n\left[\int_0^{\pi/2}\cos x\,dx + \int_{\pi/2}^{\pi}\left(\frac{\pi}{2} - x\right)^2 dx\right] = 2n\left(1 + \frac{\pi^3}{24}\right)$$

SECTION – C

1. We have $I_n + I_{n+2} = \int_0^{\pi/4}\tan^n x dx + \int_0^{\pi/4}\tan^{n+2} x dx$

$$= \int_0^{\pi/4}\tan^n x\left(1 + \tan^2 x\right)dx = \int_0^1 u^n du = \frac{1}{n+1} \text{ (where u = tan x)}$$

So, $I_n + I_{n+2} = \frac{1}{1+n}$ which implies that $I_{n+1} + I_{n+3} = \frac{1}{n+2}$

Hence, $\sum_{n=0}^{\infty}\left(I_n\, I_{n+1} + I_n\, I_{n+3} + I_{n+1}\, I_{n+2} + I_{n+2}\, I_{n+3}\right)$

$$= \sum_{n=0}^{\infty}\left(I_n + I_{n+2}\right)\left(I_{n+1} + I_{n+3}\right) = \sum_{n=0}^{\infty}\left(\frac{1}{n+1}\right)\left(\frac{1}{n+2}\right) = \sum_{n=0}^{\infty}\left(\frac{1}{n+1} - \frac{1}{n+2}\right)$$

$$\therefore\ S_n = 1 - \frac{1}{n+2} \Rightarrow \lim_{x\to\infty}\left(1 - \frac{1}{n+2}\right) = 1$$

2. $$L : \lim_{x\to 0}\frac{\cos^{-1}\left(\frac{\sin x}{x}\right)}{x} = \lim_{x\to 0}\frac{\sin^{-1}\left(\sqrt{\frac{x^2 - \sin^2 x}{x^2}}\right)}{x}$$

$$= \lim_{x\to 0}\frac{\sin^{-1}(M)}{M}\cdot\lim_{x\to 0}\frac{M}{x} \text{ (Using } \cos^{-1}t = \sin^{-1}\sqrt{1-t^2}\text{)}$$

$$= 1\cdot\lim_{x\to 0}\sqrt{\frac{x^2 - \sin^2 x}{x^2\cdot x^2}} = 1\cdot\lim_{x\to 0}\sqrt{\frac{(x - \sin x)}{x^3}\frac{(x + \sin x)}{x}}$$

$$= \lim_{x\to 0}\sqrt{\frac{1}{6}\cdot 2} = \frac{1}{\sqrt{3}} \Rightarrow L = \frac{1}{\sqrt{3}}$$

$$U : f(x) = \int_0^x\left(\sin\left(t^2 - t\right)\cos x + \cos\left(t^2 - t\right)\sin x\right)dt$$

or $f(x) = \cos x\int_0^x \sin\left(t^2 - t\right)dt + \sin x\int_0^x \cos\left(t^2 - t\right)dt$

$$f'(x)=\cos x\cdot\sin\left(x^2-x\right)-\left(\int_0^x\sin\left(t^2-t\right)dt\right)\sin x+\left(\int_0^x\cos\left(t^2-t\right)dt\right)\cos x+\cos\left(x^2-x\right)\sin x$$

$$f''(x)=\left[-\sin\left(x^2-x\right)\sin x+\cos x\cdot\cos\left(x^2-x\right)(2x-1)\right]$$

$$-\left[\left(\int_0^x\sin\left(t^2-t\right)dt\right)\cos x+\sin x\sin x\left(x^2-x\right)\right]$$

$$+\left[\cos\left(x^2-x\right)\cos x-\sin x\sin\left(x^2-x\right)(2x-1)\right]$$

$$+\left[\cos x\cos\left(x^2-x\right)-\left(\int_0^x\cos\left(t^2-t\right)dt\right)\sin x\right]$$

$\therefore$ f″(0) = 1 $\therefore$ U = 1

3. $V=\dfrac{1}{2}\displaystyle\int_0^{\pi/2}x\left|2\sin^2x-1\right|dx\ =\ \dfrac{1}{2}\int_0^{\pi/2}x\left|\cos 2x\right|dx$

Put 2x = t, $dx=\dfrac{dt}{2}$

4. Consider the numerator cos 4x – cos 4α
= (2 $\cos^2$ 2x – 1) – (2 $\cos^2$ 2α – 1)
= 2($\cos^2$ 2x – $\cos^2$ 2α)
= 2(cos 2x + cos 2α)(cos 2x – cos 2α)
= 4(cos 2x + cos 2α)(cos x – cos α)(cos x + cos α)
$\therefore\ I=4\displaystyle\int_0^{\pi}\left(\cos 2x+\cos 2\alpha\right)\left(\cos x+\cos\alpha\right)dx\ =\ 4\int_0^{\pi}\left(\cos 2\alpha\cdot\cos\alpha\right)dx$ (all other integral vanish)
$\therefore$ 4π cos α·cos 2α

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ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Advanced), 2015**

PART TEST – III

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 08)** contains 8 multiple choice questions which have one or more correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 to 16) contains 4 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (17 – 20) contains 4 Matching Lists Type questions: Each question has four statements in LIST I & 4 statements in LIST II. The codes for lists have choices (A), (B), (C), (D) out of which only one is correct. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

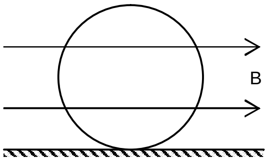
Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

SECTION – A

Single Correct Choice Type

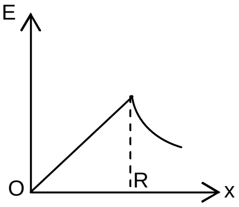
*This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.*



1. A conducting ring of mass 2 kg and radius 0.5 m is placed on a smooth horizontal plane. The ring carries a current of I = 4A. A horizontal magnetic field B = 10T, coplanar with ring exist in the region. if the ring is released from rest then

(A) angular acceleration of the ring is $40\pi \text{rad s}^{-2}$ (B) torque on the ring is 20 πNm

(C) angular acceleration of the ring is $20\pi \text{rad s}^{-2}$ (D) torque on the ring is 10 πNm



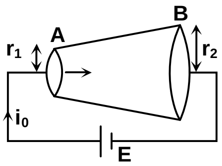
2. A sphere has a positive charge. Figure shows variation of electric field (E) with distance x from its centre. From this figure, we conclude that

(A) Sphere is made of a non conducting materials
(B) Diameter of sphere is equal to R/2
(C) Electric potential, due to sphere, is maximum at its centre
(D) Density of charge is uniform throughout the volume of sphere

3. Electric charge +q is uniformly distributed over the entire length of a ring of radius r rotating with constant angular velocity ω about its own axis. Assuming mass of ring to be m, its magnetic moment to be M and angular momentum to be L.

(A) $M = \frac{q\omega r^2}{2}$ (B) $M = \frac{2q\omega r^2}{5}$

(C) $\frac{M}{L} = \frac{q}{2m}$ (D) $\frac{M}{L} = \frac{2q}{m}$



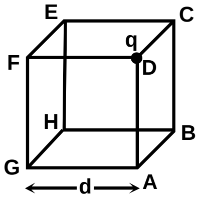
4. A battery of emf E is connected across a conductor as shown as one observe from A to B. then

(A) Current remains same
(B) Drift velocity of electron decreases
(C) Electric field decreases
(D) Potential drop across the length decreases

Space for rough work

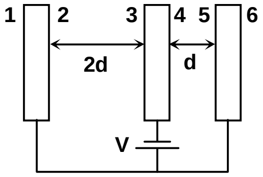
5. To convert galvanometer into a voltmeter, a large resistance is connected in series with the galvanometer. Due to the use of this large resistance is
(A) Accuracy increases (B) Least count increases
(C) Least count decreases (D) Range increase

6. A point charge q is placed at corner D of a cube of side d. Flux of electric field passing through face
(A) ABCD is zero (B) CDFE is zero
(C) DFGA is zero (D) ABHG is $\frac{q}{24\varepsilon_0}$



7. Select the correct statement(s) from the following.
The path of a charged particle moving with an initial velocity u
(A) parallel to the uniform electrostatic field is a straight line.
(B) perpendicular to the uniform electrostatic field is a parabola.
(C) parallel to the uniform magnetic field is a helix with its axis parallel to the direction of B.
(D) perpendicular to the uniform magnetic field is a circle in a plane normal to the field.

8. In the figure shown, area of each plate is A. Match the following
(A) Charge on plate 5 is $\frac{\varepsilon_0 A}{d}V$
(B) Potential difference between plates 2 and 3 is V
(C) Potential difference between plates 2 and 5 is zero
(D) Charge on the plate 3 is zero.

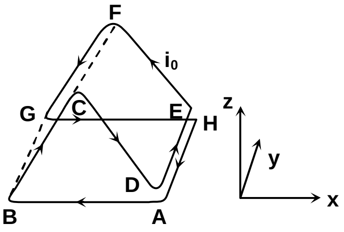


Linked Comprehension Type

This section contains 4 paragraphs. Based upon each paragraph, 2 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which ***ONLY ONE*** *is correct.*

Paragraph for Question Nos. 9 to 10

A coil (ABCDEFGH) is in the form of prism having each side equal to length ℓ carries a current i_0 (Assume gap between parallel wires AH and DE to be negligibly small)



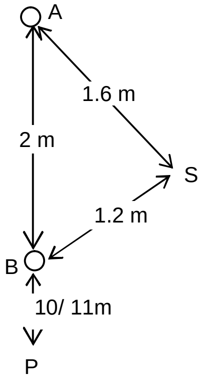
9. The direction of magnetic field at the geometric centre of three dimensional prism shaped coil will be
(A) along y-axis (B) along x-axis
(C) along z-axis (D) none of these

Space for rough work

10. If an external magnetic field B_0 is applied along +ve z-axis then the force on the coil ABCDEFGH due to B_0 only will be equal to
(A) zero (B) $L_0B\ell$
(C) $6L_0B\ell$ (D) $2L_0B\ell$

Paragraph for Question Nos. 11 to 12

Two long straight parallel wires are 2 metres part, perpendicular to the plane of the paper. The wire A carries a current of 9.6 amps, directed into the plane of the paper. The wire B carries a current such that the magnetic field of induction at the point P, at a distance of $\frac{10}{11}$ metre from the wire B, is zero. Answer the following questions.

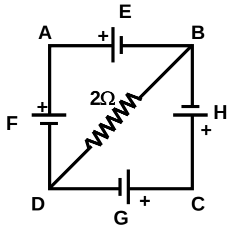


11. The magnitude of direction of the current in B.
(A) 4.0 A (B) 3.0 A
(C) 2.0 A (D) 1.0 A

12. The magnitude of the magnetic field of induction at the point S.
(A) 1.1 μT (B) 1.3 μT
(C) 1.4 μT (D) 2.8 μT

Paragraph for Question Nos. 13 to 14

In the circuit shown in fig. E, F, G and H are cells of emf 2, 1, 3 and 1 Volts respectively and their internal resistance are 2, 1, 3 and 1Ω respectively. Calculate



13. The potential difference between B and D and
(A) $\frac{2}{13}$V (B) $\frac{4}{13}$V
(C) $\frac{6}{13}$V (D) $\frac{8}{13}$V

Space for rough work

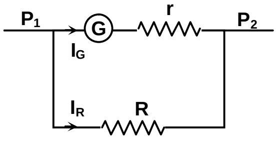
14. The potential difference across the terminals of the cell G.

(A) $\frac{19}{13}$V (B) $\frac{17}{13}$V

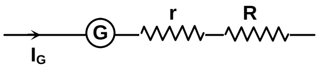
(C) $\frac{21}{13}$V (D) $\frac{23}{13}$V

Paragraph for Question Nos. 15 to 16

Measurements and interpretations of voltage and electric current signals are common in modern medicine. Occasionally, a situation arises in which a voltmeter or an ammeter is needed but it is not available. A galvanometer is an instrument that can be used to construct an ammeter. It can also be used to construct a voltmeter. In both cases, a resistor R must be connected to galvanometer to effect the change.



(i)



(ii)

To turn the galvanometer into an ammeter, the resister R is connected in parallel, as shown in the figure (i), The resistor R is connected in series with the galvanometer in order to turn it into a voltmeter, as shown in the figure (ii). The current required to produce a full scale deflection in a galvanometer is 10 mA. The internal resistance of galvanometer is 100 Ω. Let V_r be the voltage across r and V_r the voltage across R.

15. Which of the following formulas correctly applies to the ammeter concept?

(A) $V_r > V_R$ (B) $V_r < V_R$

(C) $V_r = V_R$ (D) more information needed

16. What resistance must be connected in parallel to the galvanometer to turn it into an ammeter capable of reading electric current upto 10.01 A?

(A) 0.1 Ω (B) 1 Ω

(C) 10 Ω (D) none of these

Space for rough work

SECTION – A

Matching List Type

This section contains **4 multiple choice questions**. Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

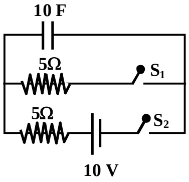
17. List–I specifies a point P at distance r from the center/axis of a symmetrical distribution of charge. List–II gives the variation of electric intensity at P as a function of r(>0). Match the entries of List–I with possible entries of List–II.

	List – I		List - II
(P)	P lies outside a long cylinder having uniform volume charge density	(1)	$E \propto \frac{1}{r^2}$
(Q)	P lies inside a spherical charged conductor	(2)	$E \propto \frac{1}{r}$
(R)	P lies inside a spherical body having uniform volume charge density	(3)	$E \propto r$
(S)	P lies outside of a nonconducting solid sphere of radius R and its volume charge density varies as $\rho = \frac{\rho_0 x^2}{R^2}$, where x is distance from centre of the sphere	(4)	$E \propto r^0$

Codes:

	P	Q	R	S
(A)	2	4	3	1
(B)	4	1	3	2
(C)	2	3	2	4
(D)	4	1	2	3

18. In the circuit shown the capacitor has an initial charge q = 100 C and a capacitor C = 10 F. The emfs of the batteries are shown in the figure and the batteries have negligible internal resistance. The switches are closed at t = 0. Match the following. The quantities on the right columns are given in SI units.



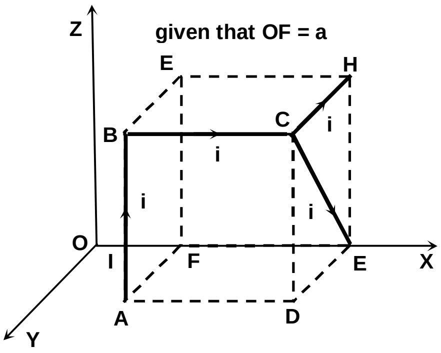
	List – I		List - II
(P)	Time constant of the circuit	(1)	0
(Q)	Current through S_1 at t = 0	(2)	25
(R)	Current through S_2 when $t \to 0$	(3)	2
(S)	Final charge on the capacitor	(4)	50

Codes:

	P	Q	R	S
(A)	3	1	4	2
(B)	2	1	3	4
(C)	4	3	2	1
(D)	2	1	4	3

Space for rough work

19. Side of the cube is ‘a’ and wire AB, BC, CH and CE are insulated with each other, and each having current I, then match the following.
External magnetic field applied along positive x-axis as $\vec{B} = B_0 x \hat{i}$



	List – I Magnitude of force due to external magnetic field only		List – II
(P)	On AB	(1)	zero
(Q)	On BC	(2)	$2\sqrt{2}iB_0a^2$
(R)	On CH	(3)	iB_0a^2
(S)	On CE	(4)	$2iB_0a^2$

Codes:

	P	Q	R	S
(A)	3	1	4	2
(B)	2	1	3	4
(C)	4	3	2	1
(D)	1	4	2	3

20. Match the following:

	List – I		List – II
(P)	Self–energy of a uniformly charged spherical shell	(1)	$\frac{1}{8\pi\varepsilon_0}\frac{Q^2}{R}$
(Q)	Energy stored per unit volume of a charged air filled capacitor.	(2)	$\frac{1}{4\pi\varepsilon_0}\frac{2Q^2}{R^2}$
(R)	Force between two circular plates of a charged parallel plate capacitor, radius of the plates being R and separation R/32.	(3)	$\frac{1}{4\pi\varepsilon_0}\frac{Q^2}{R}$
(S)	Work done by electric field in moving a point charge Q from the surface of a uniformly charged sphere of radius R, and moving it to infinity, total charge on the sphere $= Q$.	(4)	$\frac{1}{2}\varepsilon_0E^2$

Codes:

	P	Q	R	S
(A)	3	1	4	2
(B)	2	1	3	4
(C)	1	4	2	3
(D)	4	1	2	3

Space for rough work

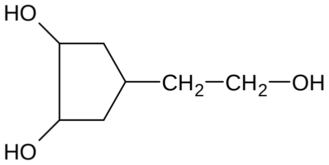
Chemistry PART - II

SECTION – A

Single Correct Choice Type

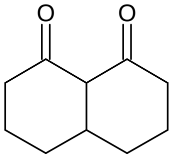
This section contains ***8 multiple choice questions****. Each question has four choices (A), (B), (C) and (D) out of which* ***ONLY ONE is correct****.*

1. Regarding the given compound:

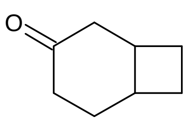


Choose the correct option (s)
(A) The above compound exhibit geometrical as well as optical isomerism
(B) Total number of stereoisomers possible for above compound is 4
(C) One of isomers of the above compounds shows plane of symmetry as well as axis of symmetry
(D) The above compound does not exhibit mesomerism

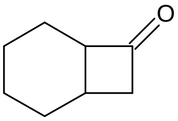
2. In the given compound choose the correct statement (s) regarding percentage enol content in H_2O



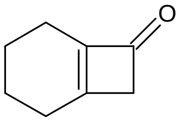
(I)



(II)



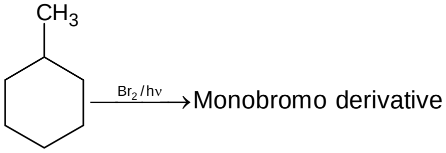
(III)



(IV)

(A) I > III
(B) I > III > IV
(C) II > III
(D) IV > I > II

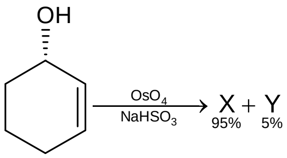
3. Which of the following option(s) is/are correct regarding given chemical reaction?



(A) Number of possible mono bromo product (including stereo) is 7
(B) Number of possible mono bromo product (excluding stereo) is 5
(C) Total number of optical active isomers per mono bromo products are 4
(D) Total number of optical inactive isomers for mono product are 2

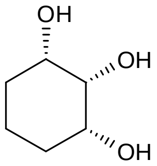
Space for rough work

4.

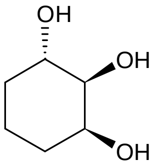


Which of the following statements are correct regarding product of above reaction?

(A) Compound Y is



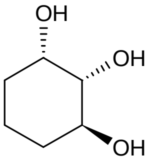
and compound X is



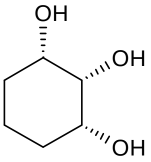
(B) Compound X and Y are enantiomers

(C) Compound X and Y both are optically active

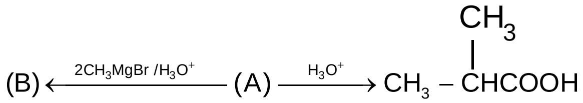
(D) Compound X is



and compound Y is



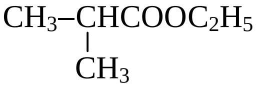
5. Consider the following reaction sequence



$$(B) \xleftarrow{2CH_3MgBr\,/H_3O^+} (A) \xrightarrow{H_3O^+} CH_3-\overset{\overset{CH_3}{|}}{C}HCOOH$$

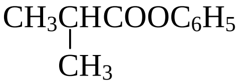
Which of the following statements are true?

(A) Compound (A) can be



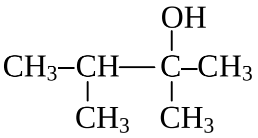
$CH_3-\underset{\underset{CH_3}{|}}{C}HCOOC_2H_5$

(B) Compound (A) can be



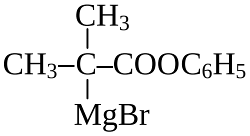
$CH_3\underset{\underset{CH_3}{|}}{C}HCOOC_6H_5$

(C) Compound (B) can be



$CH_3-\underset{\underset{CH_3}{|}}{C}H-\overset{\overset{OH}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_3$

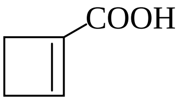
(D) Compound (B) can be

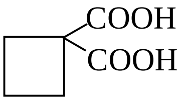


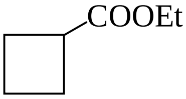
$CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{MgBr}{|}}{C}}-COOC_6H_5$

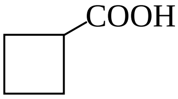
6. In the reaction sequence,

$CH_2(COOEt)_2 + BrCH_2–CH_2CH_2Br \xrightarrow[\text{excess}]{\text{NaOEt}} (A) \xrightarrow[\Delta]{H^+/H_2O}$? The possible final product(s) is/are

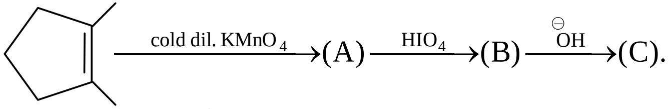
(A) 

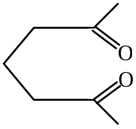
(B) 

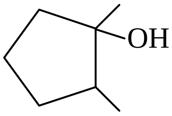
(C) 

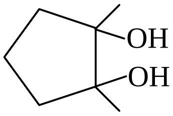
(D) 

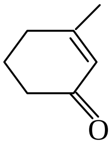
7. In a reaction sequence


cold dil. KMnO4
(A)
HIO4
(B)
⊖
OH
(C).

(A) (A) is 

(B) (B) is 

(C) (A) is 

(D) (C) is 

8. Which of the following isomer is an example of synthetic rubber?

(A) Buna–N
(B) ABS
(C) Neoprene
(D) cis–polyisoprene

Space for rough work

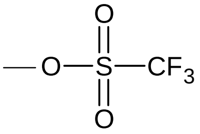
Linked Comprehension Type

*This section contains 4 paragraphs. Based upon each paragraph, 2 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.*

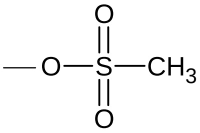
Paragraph for Question Nos. 09 to 10

Nucleophilic aliphatic substitution reaction is given by those compounds which have nucleophilic groups as leaving group. Less is the basicity of the leaving group, more is its leaving power. Leaving group leaves in the form of nucleophile (charged or neutral).

9. Leaving power of which group is maximum?

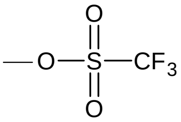
(A)

$-O-\overset{O}{\underset{O}{\overset{\|}{\underset{\|}{S}}}}-CF_3$

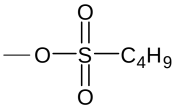
(B) $-\overset{\oplus}{N}\equiv N$

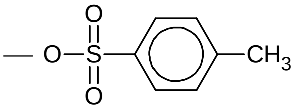
(C)

$-O-\overset{O}{\underset{O}{\overset{\|}{\underset{\|}{S}}}}-CH_3$

(D) $-\overset{\ominus}{Cl}$

10. Leaving power of which group is maximum?

(A)

$-O-\overset{O}{\underset{O}{\overset{\|}{\underset{\|}{S}}}}-CF_3$

(B)

$-O-\overset{O}{\underset{O}{\overset{\|}{\underset{\|}{S}}}}-C_4H_9$

(C)


(D) $-\overset{\ominus}{Br}$

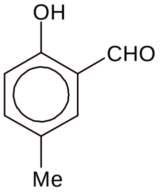
Space for rough work

Paragraph for Question Nos. 11 to 12

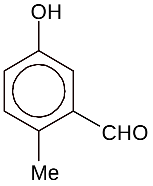
Reimer-Tiemann reaction involves an aryl carbanion/enolate anion and also $-CCl_3$ derived from the action of strong bases on $CHCl_3$, though the latter has only a transient existence decomposing to $:CCl_2$, a highly electron deficient electrophile that attacks the aromatic nucleus; the product from phenoxide ion is after acidification, very largely the *o*-aldehyde plus just a small amount of *p*-isomer.

11. If the above reaction is carried out on the anion of *p*-hydroxytoluene, what will be theproduct/products?

(A)



(B)



(C) Both (A) and (B)
(D) None of the above

12. Name the electrophile attacking carbanion in the above reaction.

(A) Chloroform
(B) Trichloromethyl anion
(C) dichlorocarbene
(D) hydrogen ion

Paragraph for Question Nos. 13 to 14

Aldehyde having no α-hydrogen when treated with strong base, undergoes redox reaction. This reaction is known as Cannizzaro reaction. Tischenko reaction is also a redox reaction which takes place in the presence of aluminium ethoxide.

13. Which of these compounds will give Cannizzaro reaction?

(A) $C_6H_5CH_2CHO$
(B) CHO–CHO
(C) $C_6H_5CH_2CHO$
(D) All of these

14. Internal crossed Cannizzaro reaction is given by:

(A) C_6H_5COCHO
(B) C_6H_5CHO
(C) CH_3–CHO
(D) C_6H_5–CH_2CO–CHO

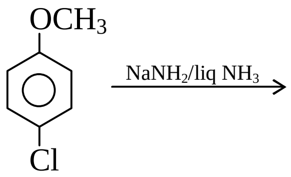
Paragraph for Question Nos. 15 to 16

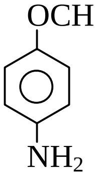
Aryl and vinyl halides are less reactive towards nucleophilic substitution reactions. Chlorobenzene itself and other aryl halides having electron–donating substituents undergo nucleophilic substitution reactions by benzyne mechanism while aryl halides having electron – withdrawing substituents at o- and p-positions undergo bimolecular nucleophilic substitution reactions.
Based on the given passage, reply the following questions:

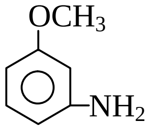
15. In the reaction of p-chlorotoluene with KNH_2 in liq NH_3, the major product is

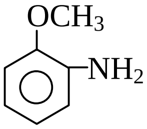
(A) o–toluidine
(B) m–toluidine
(C) p–toluidine
(D) p–chloroaniline

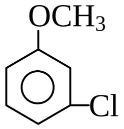
Space for rough work

16. In the reaction  A. The major product is

(A) 

(B) 

(C) 

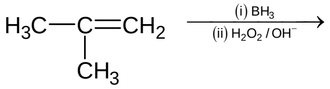
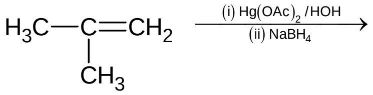
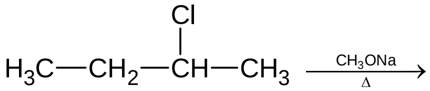
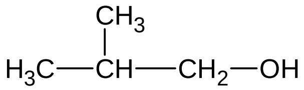
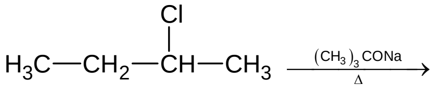
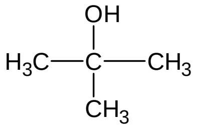
(D) 

SECTION – A

Matching List Type

This section contains **4 multiple choice questions**. Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

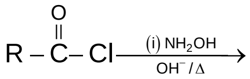
17. Match the List – I with List – II:

	List – I		List – II
(P)	 $H_3C-\underset{\underset{CH_3}{\vert}}{C}=CH_2 \xrightarrow[\text{(ii) } H_2O_2/OH^-]{\text{(i) } BH_3}$	(1)	$CH_3-CH_2-CH=CH_2$
(Q)	 $H_3C-\underset{\underset{CH_3}{\vert}}{C}=CH_2 \xrightarrow[\text{(ii) } NaBH_4]{\text{(i) } Hg(OAc)_2/HOH}$	(2)	$CH_3-CH=CH-CH_3$
(R)	 $H_3C-CH_2-\overset{\overset{Cl}{\vert}}{CH}-CH_3 \xrightarrow[\Delta]{CH_3ONa}$	(3)	 $H_3C-\overset{\overset{CH_3}{\vert}}{CH}-CH_2-OH$
(S)	 $H_3C-CH_2-\overset{\overset{Cl}{\vert}}{CH}-CH_3 \xrightarrow[\Delta]{(CH_3)_3CONa}$	(4)	 $H_3C-\overset{\overset{OH}{\vert}}{\underset{\underset{CH_3}{\vert}}{C}}-CH_3$

	P	Q	R	S
(A)	3	4	2	1
(B)	2	3	4	1
(C)	4	1	2	3
(D)	1	2	3	4

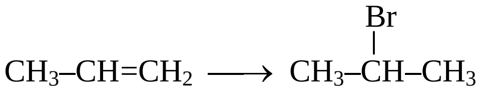
Space for rough work

18. Match the following:

List – I		List – II	
(P)	$RCONH_2 \xrightarrow{Br_2/KOH} RNH_2$	(1)	Curtius rearrangement
(Q)	$RCOOH \xrightarrow[H_2SO_4]{N_3H} R-NH_2$	(2)	Lossen rearrangement
(R)	$RCOCl \xrightarrow[\Delta]{NaN_3} R-NH_2$	(3)	Schmidt rearrangement
(S)	 $R-\overset{\overset{O}{\parallel}}{C}-Cl \xrightarrow[OH^-/\Delta]{(i)\ NH_2OH}$	(4)	Hoffmann bromamide degradation

	P	Q	R	S
(A)	3	2	1	4
(B)	2	3	4	1
(C)	4	3	1	2
(D)	1	2	3	4

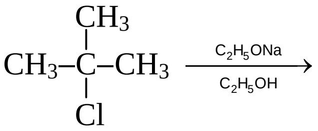
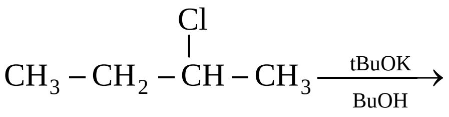
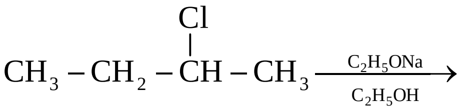
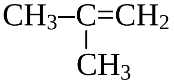
19. Match the following List – I with List – II:

List – I (Reaction)		List – II (Reagent)	
(P)	 $CH_3-CH=CH_2 \longrightarrow CH_3-\overset{\overset{Br}{\mid}}{C}H-CH_3$	(1)	HBr
(Q)	$CH_3-CH=CH_2 \longrightarrow CH_3-CH_2-CH_2Br$	(2)	NBS
(R)	$CH_3-CH=CH_2 \longrightarrow BrCH_2-CH=CH_2$	(3)	Br_2/CCl_4
(S)	$CH_3-CH=CH_2 \longrightarrow CH_3-CHBr-CH_2Br$	(4)	HBr (Peroxide)

	P	Q	R	S
(A)	3	2	1	4
(B)	2	3	4	1
(C)	4	1	2	3
(D)	1	4	2	3

Space for rough work

20. Match the following List – I with List – II:

List – I (Substrate + reagent)		List – II (Product)	
(P)	$CH_3-CH_2-CH_2-Cl \xrightarrow[C_2H_5OH]{C_2H_5ONa}$	(1)	$CH_3-CH_2-CH=CH_2$
(Q)	 $CH_3-\underset{Cl}{\overset{CH_3}{C}}-CH_3 \xrightarrow[C_2H_5OH]{C_2H_5ONa}$	(2)	$CH_3-CH=CH-CH_3$
(R)	 $CH_3-CH_2-\overset{Cl}{CH}-CH_3 \xrightarrow[BuOH]{tBuOK}$	(3)	$CH_3-CH=CH_2$
(S)	 $CH_3-CH_2-\overset{Cl}{CH}-CH_3 \xrightarrow[C_2H_5OH]{C_2H_5ONa}$	(4)	 $CH_3-\underset{CH_3}{C}=CH_2$

	P	Q	R	S
(A)	3	4	1	2
(B)	2	3	4	1
(C)	4	1	2	3
(D)	1	2	3	4

Space for rough work

Mathematics PART – III

SECTION – A

Single Correct Choice Type

*This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.*

1. The curve $y = ax^2 + bx + c$ passes through the point (1, 2) and its tangent at origin is the line y = x. The area bounded by the curve, the ordinate of the curve at minima and the tangent line is

(A) $\frac{1}{24}$ (B) $\frac{1}{12}$

(C) $\frac{1}{8}$ (D) $\frac{1}{6}$

2. Primitive of $I = \int \sqrt{1 + 2\,\text{cosec}\,x \cot x + 2\cot^2 x}\,dx$ w.r.t. x is

(A) $2\ln\cos\frac{x}{2} + c$ (B) $2\ln\sin\frac{x}{2} + c$

(C) $\frac{1}{2}\ln\cos\frac{x}{2} + c$ (D) ln sin x – ln (cosec x) + c

3. A non-zero polynomial with real coefficients has the property that $f(x) = f'(x)\cdot f''(x)$, then the leading coefficient of f(x) is

(A) $\frac{1}{6}$ (B) $\frac{1}{9}$

(C) $\frac{1}{12}$ (D) $\frac{1}{18}$

4. Let $f(x) = \frac{e^{\tan x} - e^{x} + \ln(\sec x + \tan x) - x}{\tan x - x}$ be a continuous function at x = 0. The value of f(0) equals

(A) $\frac{1}{2}$ (B) $\frac{2}{3}$

(C) $\frac{3}{2}$ (D) 2

Space for rough work

5. For the function y = f(x) = $(x^2 + bx + c)e^x$ which of the following holds?

(A) if f(x) > 0 for all real x ⇒ f′(x) > 0
(B) if f(x) > 0 for all real x ⇒ f′(x) > 0
(C) if f′(x) > 0 for all real x ⇒ f(x) > 0
(D) if f′(x) > 0 for all real x ⇒ f(x) > 0

6. Suppose f is defined from R → [–1, 1] as $f(x) = \frac{x^2 - 1}{x^2 + 1}$ where R is the set of real number. Then the statement which does not hold is

(A) f is many one onto
(B) f increases for x > 0 and decreases for x < 0
(C) minimum value is not attained even though f is bounded
(D) the area included by the curve y = f(x) and the line y = 1 is π sq. unit

7. People living at mars, instead of the usual definition of derivative D f(x) define a new kind of derivative, D* f(x) by the formula $D^*f(x) = \lim_{h\to 0} \frac{f^2(x+h) - f^2(x)}{h}$ where $f^2(x)$ means $[f(x)]^2$. If f(x) = x ln x then $D^*f(x)\big|_{x=e}$ has the value

(A) e
(B) 2e
(C) 4e
(D) 8e

8. Suppose $I_1 = \int_0^{\pi/2} \cos(\pi \sin^2 x)dx$, $I_2 = \int_0^{\pi/2} \cos(2\pi \sin^2 x)dx$, $I_3 = \int_0^{\pi/2} \cos(\pi \sin x)dx$ then

(A) $I_1 = 0$
(B) $I_2 + I_3 = 0$
(C) $I_1 + I_2 + I_3 = 0$
(D) $I_2 = I_3$

Linked Comprehension Type

This section contains 4 paragraphs. Based upon each paragraph, 2 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which ***ONLY ONE*** *is correct.*

Paragraph for Question Nos. 9 to 10

Read the following write up carefully and answer the following questions:
Let the function f satisfies f(x)·f′(–x) = f(–x)·f′(x) for all x and f(0) = 3

9. The value of f(x)·f(–x) for all x is

(A) 4
(B) 9
(C) 12
(D) 16

Space for rough work

10. $\int_{-51}^{51} \frac{dx}{3+f(x)}$ has the value equal to

(A) 17 (B) 34
(C) 102 (D) 0

Paragraph for Question Nos. 11 to 12

Read the following write up carefully and answer the following questions:
A curve is represented parametrically by the equations x = e^t cos t and y = e^t sin t where t is a parameter then

11. The relation between the parameter t and the angle α between the tangent to the given curve and the x-axis is given by 't' equals

(A) $\frac{\pi}{2}-\alpha$ (B) $\frac{\pi}{4}+\alpha$
(C) $\alpha-\frac{\pi}{4}$ (D) $\frac{\pi}{4}-\alpha$

12. If f(t) = $\int (x+y)dt$ then the value of $f\left(\frac{\pi}{2}\right)-f(0)$ is

(A) 1 (B) –1
(C) $e^{\pi/2}$ (D) 0

Paragraph for Question Nos. 13 to 14

Read the following write up carefully and answer the following questions:
A curve is represented parametrically by the equations x = f(t) = $a^{\ell n(b^t)}$ and y = g(t) = $b^{-\ell n(a^t)}$ a, b > 0 and a $\neq$ 1, b $\neq$ 1 where t $\in$ R

13. Which of the following is not a correct expression for $\frac{dy}{dx}$?

(A) $-\frac{1}{f(t)^2}$ (B) $-(g(t))^2$
(C) $-\frac{g(t)}{f(t)}$ (D) $-\frac{f(t)}{g(t)}$

Space for rough work

14. The value of $\frac{d^2y}{dx^2}$ at the point where f(t) = g(t) is

(A) 0 (B) $\frac{1}{2}$

(C) 1 (D) 2

Paragraph for Question Nos. 15 to 16

Read the following write up carefully and answer the following questions:

Consider a quadratic function $f(x) = ax^2 + bx + c$ ($a, b, c \in R$, $a \neq 0$) and satisfying the following conditions

(i) $f(x - 4) = f(2 - x)\ \forall\ x \in R$ and $f(x) \geq x\ \forall\ x \in R$

(ii) $f(x) \leq \left(\frac{x+1}{2}\right)^2\ \forall\ x \in (0, 2)$

(iii) The minimum value of f(x) is zero

15. The value of the leading coefficient to the quadratic polynomial is

(A) $\frac{1}{4}$ (B) $\frac{1}{3}$

(C) $\frac{1}{2}$ (D) 1

16. $f'(1)$ has the value equal to

(A) $\frac{1}{4}$ (B) $\frac{1}{3}$

(C) $\frac{1}{2}$ (D) 1

Space for rough work

SECTION – A

Matching List Type

This section contains **4 multiple choice questions**. Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

17. Match the following List–I with List–II

List – I		List – II	
(P)	$\int \frac{x^2\left(x^6+x^5-1\right)}{\left(2x^6+3x^5+2\right)^2}\,dx$	1.	$\frac{x}{\left(x^2+4x+1\right)^{1/2}}+c$
(Q)	$\int \frac{\left(x^5+x^4+x^2\right)}{\sqrt{4x^7+5x^6+10x^4}}\,dx$	2.	$\frac{1}{2}\left(1+x^{-2}+x^{-5}\right)^{-2}+c$
(R)	$\int \frac{\left(2x^{12}+5x^9\right)}{\left(x^5+x^3+1\right)^3}\,dx$	3.	$-\frac{1}{6}\left(2x^3+3x^2+2x^{-3}\right)^{-1}+c$
(S)	$\int \frac{\left(2x+1\right)}{\left(x^2+4x+1\right)^{3/2}}\,dx$	4.	$x\left(\frac{x^3}{25}+\frac{x^2}{20}+\frac{1}{10}\right)^{1/2}+c$

Codes:

	P	Q	R	S
(A)	4	1	2	3
(B)	3	4	2	1
(C)	1	3	4	2
(D)	3	2	1	4

Space for rough work

18. Let $I=\int \frac{e^{x}}{e^{4x}+1}dx$ and $J=\int \frac{e^{-x}}{e^{-4x}+1}dx$. Then for any arbitrary constant C match the following List–I with List–II

List – I		**List – II**	
(P)	I	1.	$\frac{1}{\sqrt{2}}\tan^{-1}\left(\frac{e^{2x}-1}{\sqrt{2}-e^{x}}\right)+c$
(Q)	J + I	2.	$\frac{1}{2\sqrt{2}}\ln\left(\frac{e^{2x}-\sqrt{2}e^{x}+1}{e^{2x}+\sqrt{2}e^{x}+1}\right)+c$
(R)	J – I	3.	$\frac{1}{2\sqrt{2}}\left(\tan^{-1}\left(\frac{e^{2x}-1}{\sqrt{2}e^{x}}\right)-\frac{1}{2}\ln\left(\frac{e^{2x}-\sqrt{2}e^{x}+1}{e^{2x}+\sqrt{2}e^{x}+1}\right)\right)+c$
(S)	J	4.	$\frac{1}{2\sqrt{2}}\left(\tan^{-1}\left(\frac{e^{2x}-1}{\sqrt{2}e^{x}}\right)+\frac{1}{2}\ln\left(\frac{e^{2x}-\sqrt{2}e^{x}+1}{e^{2x}+\sqrt{2}e^{x}+1}\right)\right)+c$

Codes:

	P	Q	R	S
(A)	4	1	2	3
(B)	3	4	1	2
(C)	1	3	4	2
(D)	3	1	2	4

19. Match the following List–I with List–II

List – I		**List – II**	
(P)	If $f(x)=\int_{0}^{g(x)}\frac{dt}{\sqrt{1+t^{3}}}$ where $g(x)=\int_{0}^{\cos x}\left(1+\sin t^{2}\right)dt$ then the value of $f'\left(\frac{\pi}{2}\right)$	1.	3
(Q)	If f(x) is non-zero differentiable function such that $\int_{0}^{x}f(t)dt=\left(f(x)\right)^{2}$ for all x then 2 + f(2) equals	2.	2
(R)	If $\int_{a}^{b}\left(2+x-x^{2}\right)dx$ is maximum then (a + b) has the value equal to	3.	1
(S)	If $\lim_{x\to0}\left(\frac{\sin 2x}{x^{3}}+a+\frac{b}{x^{2}}\right)=0$ then (3a + b) has the value equal to	4.	–1

Codes:

	P	Q	R	S
(A)	4	1	2	3
(B)	3	4	1	2
(C)	4	1	3	2
(D)	2	1	4	3

Space for rough work

20. Match the following List–I with List–II.

	List – I		List – II
(P)	If $I=\int_2^3\left((x-1)^3+(4-x)^3+x\right)\cos\pi x\,dx$ then $\lvert 50\pi^2 I\rvert$ is equal to	1.	0
(Q)	If $J=\int_0^{10}\text{sgn}(\sin\pi x)\,dx$ then 10J is equal to where sgn x denotes signam function of x	2.	100
(R)	If $K=\int_0^{102}\left[\cot^{-1}x\right]dx$ then 70 + [K] is equal to (where [y] denotes greatest integer equal to or less than y	3.	50
(S)	If $L=\dfrac{\int_0^{51}[x+25]\,dx}{\int_0^{51}\{x+25\}\,dx}$ then $\dfrac{L}{2}$ is equal to (where [y] and {y} denotes greatest integer function and fractional part of function	4.	70

Codes:

	P	Q	R	S
(A)	4	1	2	3
(B)	3	4	1	2
(C)	2	1	4	3
(D)	2	1	3	4

Space for rough work

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PART TEST –III

(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A, D	A, B, D	A
2.	A, C, D	A, B, C	B
3.	A, C	A, B, C	D
4.	A, B, C, D	A, B, C	C
5.	A, B, D	A, B, C	A, C
6.	A, B, C, D	D	A, C, D
7.	A, B, D	C, D	C
8.	A, B, C	A, B, C	A, B, C
9.	D	B	B
10.	A	A	A
11.	B	C	C
12.	B	C	C
13.	A	B	D
14.	C	A	D
15.	C	B	A
16.	A	B	D
17.	A	A	B
18.	B	C	D
19.	A	D	C
20.	C	A	C

Physics PART – I

9. Use symmetry arguments.

10. zero, due to symmetry

11. B due to infinite wire $\propto I/\ell$

12. $\vec{B} = \vec{B}_1 + \vec{B}_2$

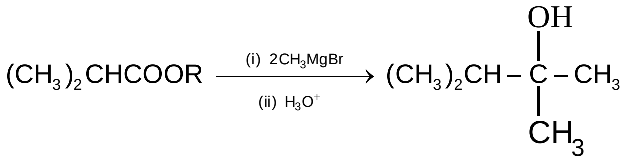
13-14. Use Kirchoff's Law

Chemistry

PART – II

SECTION – A

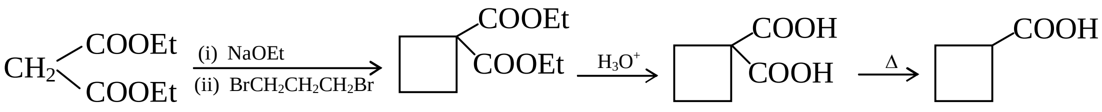
5.



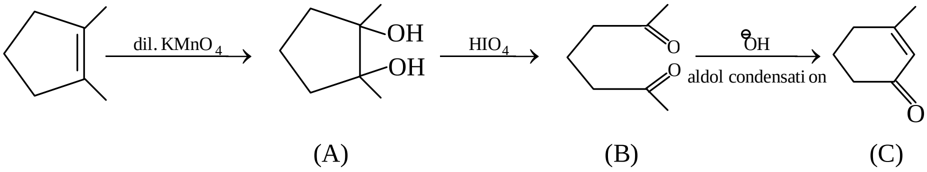
$$(CH_3)_2CHCOOR \xrightarrow[(ii)\ H_3O^+]{(i)\ 2CH_3MgBr} (CH_3)_2CH-\overset{OH}{\underset{CH_3}{C}}-CH_3$$

R = C_2H_5, C_6H_5

6.


CH2
COOEt
COOEt
(i) NaOEt
(ii) BrCH2CH2CH2Br
COOEt
COOEt
H3O+
COOH
COOH
Δ
COOH

7.

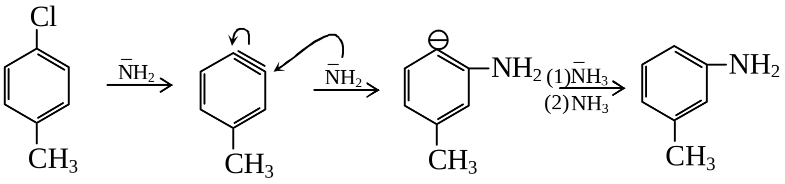

dil. KMnO4
OH
OH
HIO4
O
O
⊖OH
aldol condensation
O
(A)
(B)
(C)

8. ABS is a polymer of acrylonitrile, butadiene and styrene.
cis – polyisoprene is a natural rubber.

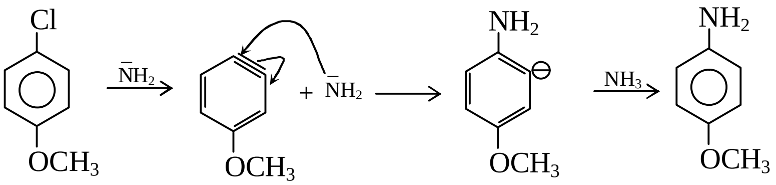
13. Aldehyde, without α hydrogen, can respond to Cannizzaro reaction.

14. Ph CO CHO contains one-CO-and another –CHO group adjacently without having α–hydrogen.

15.


Cl
CH3
NH2⁻
CH3
NH2⁻
NH2
CH3
(1) NH3⁻
(2) NH3
NH2
CH3

16.


Cl
OCH3
NH2⁻
OCH3
+ NH2⁻
NH2
OCH3
NH3
NH2
OCH3

Mathematics PART – III

1. $x = 1; y = 2$
$2 = a + b + c$ ….. (1)
$x = 0, y = 0 \Rightarrow c = 0 \Rightarrow a + b = 2$
Now, $\left.\frac{dy}{dx}\right|_{(0,\,0)} = 2ax + b = 1$
$\therefore$ b = 1, a = 1
Hence, the curve is $y = x^2 + x$
$$A = \int_{-1/2}^{0} \left(x^2 + x - x\right)dx = \int_{-1/2}^{0} \left(x^2\right)dx = \frac{1}{24} \text{ sq. units}$$

2. $I = \int \sqrt{1 + 2\,\text{cosec}\,x \cot x + 2\cot^2 x}\ dx$
$= \int \sqrt{\text{cosec}^2 x + 2\,\text{cosec}\,x \cot x + \cot^2 x}\ dx$
$= \int \text{cosec}\,x + \cot x\ dx$

3. Degree of f(x) = n
Degree of f′(x) = n – 1
Degree of f″(x) = n – 2
$\therefore$ n = (n – 1) + (n – 2) = 2n – 3
$\therefore$ n = 3
Hence, $f(x) = ax^3 + bx^2 + cx + d, (a \neq 0)$
$f'(x) = 3ax^2 + 2bx + c; f''(x) = 6ax + 2b$
$a = \frac{1}{18}$

4. For continuity of f at x = 0, we have
$k = f(0) = \lim_{x \to 0} f(x) = 1 + 3 \lim_{x \to 0} \frac{\sec x - 1}{3x^2}$ using L.H. Rule
$f(0) = 1 + \frac{1}{2} = \frac{3}{2}$

5. $f(x) = (x^2 + bx + c)e^x$
$\therefore f'(x) = (x^2 + (b + 2)x + (b + c))e^x$
$f(x) > 0$ iff $D = b^2 – 4ac < 0$
Now, $f'(x) > 0$ iff $D' = (b + 2)^2 – 4(b + c) = D + 4 < 0$
Thus for $f'(x) > 0$ $D + 4 < 0$ holds
$\Rightarrow D < 0 \Rightarrow f(x) > 0$

6. $y = f(x) = \frac{x^2 - 1}{x^2 + 1} = 1 - \frac{2}{x^2 + 1}$
$f'(x) = \frac{4x}{\left(x^2 + 1\right)^2}$
x > 0, f is increasing
x < 0, f is decreasing
range is [–1, 1] ⇒ into (A – false) minimum value occurs at x = 0
f(0) = –1 (C – false)
$$A = 2\int_0^{\infty} \left(1 - \frac{x^2 - 1}{x^2 + 1}\right)dx = 2\pi \text{ (D – false)}$$

7. $D^* f(x) = 2f(x) f'(x)$
$D^* (x \ln x) = 2x \ln x (1 + \ln x)$

9. Given $f(x)\cdot f'(-x) = f(-x)\cdot f'(x)$
$\frac{f'(x)}{f(x)} = \frac{f'(-x)}{f(-x)}$
Integrating $\ln f(x) = -\ln f(-x) + c$
$\ln (f(x)\cdot f(-x)) = c$
$f(x)\cdot f(-x) = c$
$f(0) = 3 \therefore f^2(0) = c \Rightarrow c = 9$
$\therefore f(x)\cdot f(-x) = 9$

10. Let $I = \int_{-51}^{51} \frac{dx}{3 + f(x)}$
$I = \int_{-51}^{51} \frac{dx}{3 + f(-x)}$ (Using king)
$\therefore I = 17$

11. $y = e^t \sin t \Rightarrow \frac{dy}{dt} = e^t (\cos t + \sin t)$
$x = e^t \cos t \Rightarrow \frac{dx}{dt} = e^t [\cos t - \sin t]$
$\therefore \frac{dy}{dx} = \frac{\cos t + \sin t}{\cos t - \sin t} = \tan\alpha$
$\therefore \tan\left(\frac{\pi}{4} + t\right) = \tan\alpha$
$\Rightarrow \frac{\pi}{4} + t = \alpha$
$t = \alpha - \frac{\pi}{4}$

12. $f(t) = \int e^t (\cos t + \sin t) dt = e^t \sin t + c$
$\therefore f\left(\frac{\pi}{2}\right) - f(0) = \left(e^{\pi/2} + c\right) - c = e^{\pi/2}$

13. $x = f(t) = a^{\ell n(b^t)} = a^{t\ell nb}$ ..... (1)
$y = g(t) = b^{-\ell n(a^t)} = \left(b^{\ell na}\right)^{-t} = \left(a^{\ell nb}\right)^{-t} = a^{-t\ell nb}$
$\therefore y = g(t) = a^{\ell n(b^{-t})} = f(-t)$ ..... (2)
From equation (1) and (2) we get, $xy = 1$

14. $f(t) = g(t) \Rightarrow f(t) = f(-t) \Rightarrow t = 0$
$\{\because$ f(t) is one-one function$\}$
At $t = 0$; $x = y = 1$
$\because xy = 1$
$\therefore \frac{dy}{dx} = -\frac{1}{x^2}$ and $\frac{d^2y}{dx^2} = \frac{2}{x^3}$
At $x = 1$, $\frac{d^2y}{dx^2} = 2$

15.-16. Since, minimum value is zero
Hence, y = f(x) touches the x-axis and mouth opening upward i.e. $a > 0$
Given $f(x-4) = f(2-x)$ $(x \to x+3)$
$f(x-1) = f(-1-x)$
$f(-1+x) = f(-1-x)$
Hence, f is symmetric about the line $x = -1$
$\therefore f(x) = a(x+1)^2$
Now, also given $f(x) \geq x \; \forall \; x \in R$
$\therefore f(1) \geq 1$ ….. (1)
and $f(x) \leq \left(\frac{x+1}{2}\right)^2$ in (0, 2)
$f(1) \leq 1$ ….. (2)
From (1) and (2), we get $f(1) = 1$
Now $f(x) = a(x+1)^2$
$f(1) = 4a = 1 \Rightarrow a = \frac{1}{4}$
$\therefore f(x) = \frac{(x+1)^2}{4}$ (Now proceed)

17. (P) Let $I_1 = \int \frac{x^2(x^6+x^5-1)}{(2x^6+3x^5+2)^2}dx = \int \frac{x^2(x^6+x^5-1)}{x^6\left(2x^3+3x^2+\frac{2}{x^3}\right)^2}dx = \int \frac{(x^2+x-x^{-4})}{(2x^3+3x^2+2x^{-3})^2}dx$

Putting $2x^3 + 3x^2 + 2x^{-x} = t$
$\therefore \frac{x^6+x^5-1}{x^4}dx = \frac{1}{6}dt$
Hence, $I_1 = \frac{1}{6}\int \frac{dt}{t^2} = \frac{-1}{6t} + c$

(Q) Putting $4x^5 + 5x^4 + 10x^2 = t$
$20(x^4 + x^3 + x)dx = dt$

(R) Putting $1 + x^{-2} + x^{-5} = t$
$(-2x^{-3} - 5x^{-6})dx = dt$

(S) $\int \frac{2x+1}{x^3\left(1+\frac{4}{x}+\frac{1}{x^2}\right)^{3/2}}dx = \int \frac{2x^{-2}+x^{-3}}{\left(1+\frac{4}{x}+\frac{1}{x^2}\right)^{3/2}}dx$

Now, put $\frac{1}{x^2} + \frac{4}{x} + 1 = t^2$

18. Given $I = \int \frac{e^x}{e^{4x}+1}dx$ and $J = \int \frac{e^{-x}}{e^{-4x}+1}dx$
$J = \int \frac{e^{4x} \cdot e^{-x}}{1+e^{4x}}dx = \int \frac{e^{3x}}{1+e^{4x}}dx$
$\therefore I + J = \int \frac{e^x(1+e^{2x})}{1+e^{4x}}dx$
Put $e^x = t \Rightarrow e^x\,dx = dt$
$\therefore I + J = \int \frac{1+t^2}{1+t^4}dx = \int \frac{1+\frac{1}{t^2}}{\left(t-\frac{1}{t}\right)^2+2}dt$

Put $t-\frac{1}{t}=y \Rightarrow dy=\left(t+\frac{1}{t^2}\right)dt$

$\therefore\ I+J=\int\frac{dy}{y^2+2}=\frac{1}{\sqrt{2}}\tan^{-1}\frac{y}{\sqrt{2}}\ =\ \frac{1}{\sqrt{2}}\tan^{-1}\frac{t^2-1}{\sqrt{2}t}$

I + J = $\frac{1}{\sqrt{2}}\tan^{-1}\left(\frac{e^{2x}-1}{\sqrt{2}e^x}\right)+c$ ….. (1)

Similarly, J – I = $\frac{1}{2\sqrt{2}}\frac{e^{2x}-\sqrt{2}e^x+1}{e^{2x}+\sqrt{2}e^x+1}$ ….. (2)

Equation (1) – (2) gives $I=\frac{1}{2\sqrt{2}}\left[\tan^{-1}\frac{e^{2x}-1}{\sqrt{2}e^x}-\frac{1}{2}\frac{e^{2x}-\sqrt{2}e^x+1}{e^{2x}+\sqrt{2}e^x+1}\right]$

Equation (1) + (2) gives $J=\frac{1}{2\sqrt{2}}\left[\tan^{-1}\frac{e^{2x}-1}{\sqrt{2}e^x}+\frac{1}{2}\frac{e^{2x}-\sqrt{2}e^x+1}{e^{2x}+\sqrt{2}e^x+1}\right]$

19. (P) $f'(x)=\frac{g'(x)}{\sqrt{1+g^3(x)}}$ and g′(x) = [1 + sin(cos^2 x)](–sin x)

Hence, $f'(x)=\frac{\left[1-\sin\left(\cos^2 x\right)(\sin x)\right]}{\sqrt{1+g^3(x)}}$

$f'\left(\frac{\pi}{2}\right)=\frac{1+0}{\sqrt{1+g^3\left(\frac{\pi}{2}\right)}}=\frac{-1}{1+0}=-1$

(R) Maximum when a = –1, b = 2

$\Rightarrow$ a + b = 1

(S) If $\lim\limits_{x\to0}\frac{\sin 2x}{x^3}+a+\frac{b}{x^2}=0$

$\Rightarrow\ \lim\limits_{x\to0}\frac{\sin 2x+ax^3+bx}{x^3}=0$ for limit to be exist 2 + b = 0

$\therefore$ b = –2

$\therefore\ \lim\limits_{x\to0}\frac{\sin 2x+ax^3-2x}{x^3}=0$

Applying L.H. rule

$\lim\limits_{x\to0}\frac{2\cos 2x+3ax^2-2}{3x^2}=0$

$\therefore\ a=\lim\limits_{x\to0}\frac{2(1-\cos 2x)}{3x^2}$

$\Rightarrow\ a=\frac{4\sin^2 x}{3x^2}=\frac{4}{3}$

20. (P) $I_1=\int\limits_2^3\left((x-1)^3+(4-x)^3+x\right)\cos\pi x dx$ ….. (1)

Applying king property we get $I_1=\int\limits_2^3\left((4-x)^3+(x-1)^3+5-x\right)\cos\left(\pi(5-x)\right)dx$

$$I_1 = -\int_2^3 \left((4-x)^3 + (x-1)^3 + 5 - x\right)\cos \pi x dx \qquad ..... (2)$$

Now, (1) + (2), gives $2I_1 = \int_2^3 (2x-5)\cos \pi x dx$

$$\Rightarrow\ 2I_1 = \int_2^3 2x\cos \pi x dx - \int_2^3 5\cos \pi x dx$$

$$2I_1 = 2\int_2^3 x\cos \pi x\ dx\ x - 5\int_2^3 \cos \pi x\ dx$$

$$2I_1 = 2\left(\frac{x\sin \pi x}{\pi} - \int \frac{\sin \pi x}{\pi} dx\right)_2^3 - 5\left(\frac{\sin \pi x}{\pi}\right)_2^3 = 0 + \frac{1}{\pi^2}(-1-1) = -\frac{2}{\pi^2}$$

$\Rightarrow 50\pi^2\ I_1 = -100$

Hence, $|50\ \pi^2\ I_1| = 100$

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014: 2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Main), 2015**

PART TEST –IV

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 03 and 10 to 12)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (04 to 09 and 13 to 30) contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

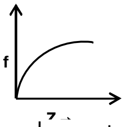
1. In a standard meter bridge experiment conducted to measure the specific resistance of a wire the following data was recorded:-
Length (L) $= (1 \pm \cdot 01)\,\text{m}$ measured by a meter scale
Radius of wire = 1mm ±.01mm. (measured by screw gauge).
Resistance of wire (R) = (5±.01) Ω
The maximum possible error in the measurement of specific resistance is
(You may use the formula:- $\rho = \frac{\pi r^2}{L} R$)
(A) .1μΩm (B) .2μΩm
(C) .5μΩm (D) .6μΩm

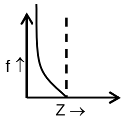
2. A physical quantity P is related to four measurable quantities as $P = \frac{a^3 b^2}{c^3 d^{4.}}$. If the errors in measurement of a, b, c, d are 0.1%, 0.2%, 0.3%, 0.1% respectively, what is the maximum percentage error in measurement of P.
(A) 1% (B) 2%
(C) 3% (D) 4%

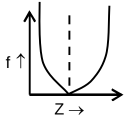
3. When N_0 molecules of a radioactive nuclide are taken at t = 0, the activity reduces to 'A' in time t_0. When $3N_o$ molecules of the same nuclide are taken, activity will become 3Ae in time t equal to
(A) t_0 (B) $t_0 + \frac{1}{\lambda}$
(C) $t_0 - \frac{1}{\lambda}$ (D) None of these
Where; λ is decay constant of the Nuclide

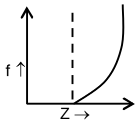
Space for rough work

4. The plot of characteristic frequency ‘f’ in case of K_y –X-rays, with the atomic number ‘Z’ of an element may be best represented by

(A)


(B)


(C)


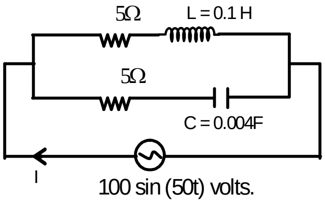
(D)


5. Two waves of Intensity I_1 and I_2 interfere. The maximum intensity produced to the minimum intensity is in the ratio α. Then, I_1 / I_2 is equal to

(A) $\frac{\alpha-1}{\alpha+1}$, if $I_1 > I_2$ (B) $\frac{1+\alpha}{\alpha-1}$, if $I_1 > I_2$

(C) $\left(\frac{1+\sqrt{\alpha}}{\sqrt{\alpha}-1}\right)^2$, if $I_1 < I_2$ (D) $\left(\frac{\sqrt{\alpha}-1}{1+\sqrt{\alpha}}\right)^2$ if $I_1 > I_2$

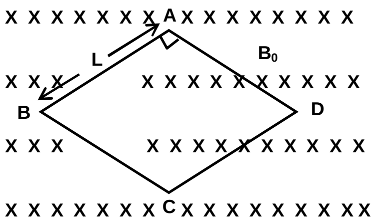
6. The current i in the circuit at any time t is



(A) 20 A (B) $20\sin\left[50t+\frac{\pi}{4}\right]$A

(C) $20\sin\left[50t\ \frac{-\pi}{4}\right]$A (D) $20\sin(50t)$ A

7. A conducting square loop of length ‘L’ is placed in a magnetic field of Induction B_0. End ‘A’ and End ‘C’ are moved away from each other. So that finally the square loop becomes a straight line. The total charge flowing through the loop, if its resistance is ‘R’ then

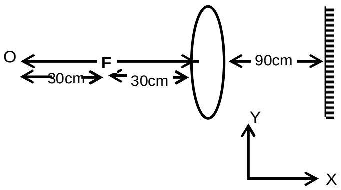


(A) $\frac{B_0L^2}{\pi R}$ (B) $< \frac{B_0L^2}{R}$

(C) $\frac{B_0L^2}{R}$ (D) $> \frac{B_0L^2}{R}$

Space for rough work

8. A thin biconvex lens of focal length 30cm is Kept 90 cm away from a plane mirror kept parallel to the plane of the lens. A point object is placed on the optical axis of the lens 60cm away from the lens as shown in the figure. Now, if the point object is slowly moved towards the lens with a small velocity, the image of the object in the mirror.

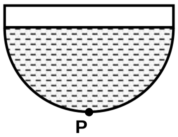


(A) Moves in the + ve x direction
(B) Moves in – ve x direction
(C) Does not move
(D) Data insufficient

9. The ratio of de-Broglie wavelength associated with an electron moving in nth orbit of a hydrogen atom and its first Bohr's radius is

(A) $2\pi n : 1$
(B) $\sqrt{n} : 2\pi$
(C) $n^3 : 1$
(D) $n : 1$

10. A hemispherical bowl of radius 10 cm is filled with liquid of refractive index μ = 4/3. A glass plate of refractive index 1.5 is placed on the top of bowl. If for the observer above the plate the shift in position of a point P on the bottom is 3 cm find the thickness of glass plate.



(A) 1.5 cm
(B) 1 cm
(C) 7 cm
(D) 10 cm

11. An electron is knocked out from K shell of tungsten atom. P_1, P_2, P_3 are probabilities that an electron jumps from L, M and N shell to K shell, then which is correct

(A) $P_1 = P_2 = P_3$
(B) $P_3 > P_2 > P_1$
(C) $P_1 = P_2 > P_3$
(D) $P_1 > P_2 > P_3$

12. A potential difference of 2 kV is applied across a X-ray tube and X-rays thus produced fall on a metallic plate at a potential of 100 V. What is the maximum K.E. of photoelectrons emitted from the plate if its work function is 5.8 eV ?

(A) 2094.2 eV
(B) 2105.8 eV
(C) 1906.8 eV
(D) 1894.2 eV

13. The velocity of a real object, moving along the principal axis of a lens, at an instant is 4 times the velocity of the virtual image for a lens. Then the ratio of focal length to image distance is

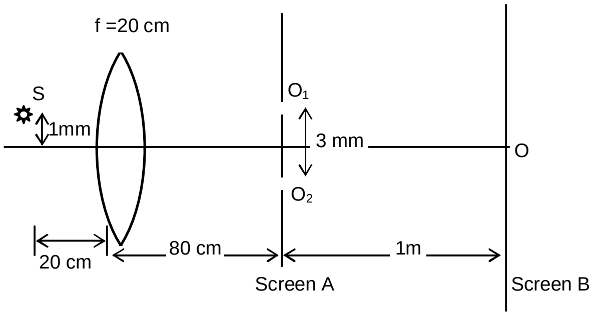
(A) 2 : 1
(B) 1 : 2
(C) 4 : 1
(D) 1 : 4

Space for rough work

14. There are 10 atoms of C^{14} in a sample of carbon atoms. After one half life period the number of radioactive atoms of C^{14} in sample will be

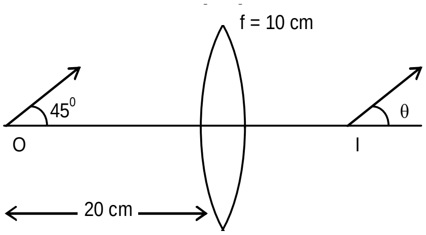
(A) exactly 5 (B) certainly more than 5
(C) certainly less than 5 (D) can not find exactly

15. An arrangement for YDSE is shown in figure. S is a light source then find the position of central maxima from point O on screen B.



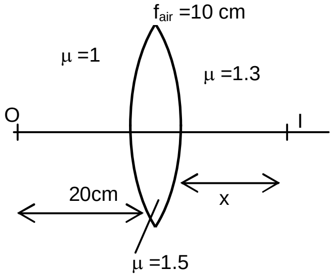
(A) 5 mm below O
(B) 5 mm above O
(C) 30 mm below O
(D) 12 mm above O

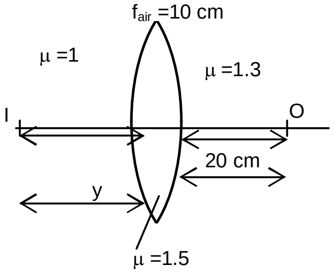
16. An object starts moving at an angle of 45^0 with the principal axis as shown in the figure in front of a biconvex lens of focal length + 10 cm. If θ denotes the angle at which image starts moving with principal axis then



(A) $\theta = \frac{3\pi}{4}$ (B) $\theta = \frac{\pi}{2}$
(C) $\theta = \frac{\pi}{4}$ (D) $\theta = -\frac{\pi}{4}$

17. A thin equiconvex lens, made of material of refractive index 1.5, has a focal length of 10 cm in air. One side of the lens is replaced by a medium (B) of refractive index 1.3. When a point object is placed in air at a distance of 20 cm from the lens on its principal axis, its image is formed at distance of x cm in the medium (B), from the lens. When the same object is placed in the medium B, at a distance of 20 cm from the lens on its principal axis, its image is formed at a distance of y cm in air, from the lens. Then

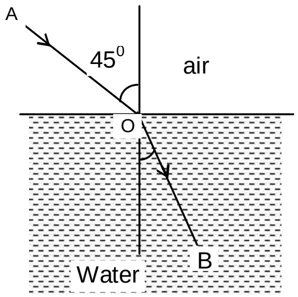




(A) x > 1.3 y (B) x < 1.3 y
(C) x = 1.3 y (D) none of the above is true.

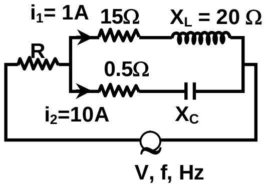
Space for rough work

18. Planar light waves and sound waves incident on the air – water interface along the direction of the line are AO as shown in the figure. Assume that AO represents the direction of the incident ray (for both light and sound). Given that the speed of sound wave in air and water is 330 m/s and 1500 m/s respectively and of the light wave it is 3×10^8 m/s and 2.26×10^8 m/s. respectively then, (assume Snell's law is valid for both waves):



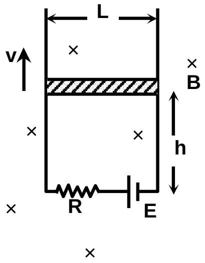
(A) light wave and sound wave will refract through same angle.
(B) angle of refraction for light wave will be 30^0.
(C) water is acoustically denser medium than air for sound wave.
(D) the angle between the two rays when they get separated by the air water surface is
$$\left\{\frac{3\pi}{4} - \sin^{-1}\left(\frac{0.75}{\sqrt{2}}\right)\right\}\text{rad..}$$

19. Find the value of reactance X_C as shown in the figure.



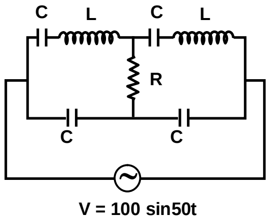
(A) 3Ω
(B) $\sqrt{6}\,\Omega$
(C) 2Ω
(D) none of these

20. A conducting cross bar of mass m and length L can slide, without friction, vertically up and down on two conducting rails. The rails are connected on the bottom via a variable resistance R and a battery E, so that rails and the bar form a rectangular conducting loop. A uniform magnetic field B points into the plane of the loop. Whole system is placed in constant gravitational field g. Find the value of E for which rod will move up with a constant velocity v.



(A) $\frac{mgR}{\ell B}$
(B) $\frac{mg}{R\ell B} - B\ell V$
(C) $\frac{mg}{R\ell B} + B\ell V$
(D) zero

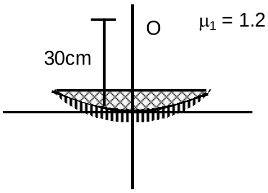
21. The value of the current in the resistor R in the following circuit will be (Given C = 1 μF, L = 1 H, R = 1 Ω)



(A) zero
(B) $\frac{100}{R}\sin(50t)$
(C) 100/R
(D) can't be calculated

Space for rough work

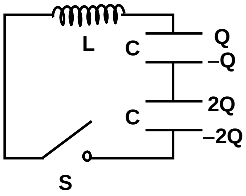
22. A concave mirror is placed in a medium of refractive index $\mu_1 = 1.2$. An object placed at 30 cm from pole of the mirror and its image coincides. Now a liquid of refractive index μ is placed in the concave mirror in the shaded region while the medium of refractive index 1.2 is retained in the remaining region. It is found that object needs to be shifted by 7.5 cm below O for the object and image to coincide. The refractive index of the liquid μ is



(A) $\frac{4}{3}$ (B) 1.2
(C) 1.6 (D) none of the above

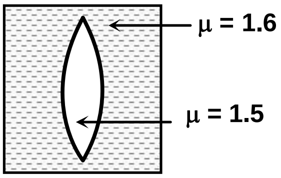
23. An object is placed at 30 cm from a convex lens of focal length 15cm. On the other side of the lens a convex mirror of focal length 12cm is placed so that the principal axis of both coincide. It is observed that the object and image coincide. What is the separation between the lens and mirror?
(A) 6 cm (B) 30 cm
(C) either (A) or (B) (D) none of the above

24. Initially two capacitors each of capacitors C have charges as shown and the inductor L has zero current. After the switch S is closed, the maximum current in the inductor is



(A) $\frac{3Q}{\sqrt{2LC}}$ (B) $\frac{3Q}{\sqrt{LC}}$
(C) $\frac{4Q}{\sqrt{LC}}$ (D) $\frac{5Q}{\sqrt{LC}}$

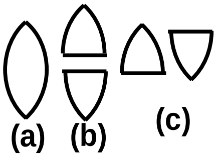
25. The given figure shows a convergent lens placed inside a cell filled with liquid. The lens has focal length +20 cm when in air, and its material has refractive index 1.50. If the liquid has refractive index 1.60, then focal length of the lens in the cell is



(A) 80 cm (B) –80 cm
(C) –24 cm (D) –160 cm

Space for rough work

26. An equiconvex glass lens (a) has focal length f and power P. It is cut into two symmetrical halves (b) by a plane containing the principal axis. The two pieces are recombined as shown in figure (c). The power of the new combination is

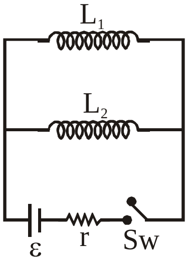


(A) zero
(B) $\frac{P}{2}$
(C) 2P
(D) none of the above

27. Choose incorrect statements:
An inductor of inductance L, capacitance C and resistance R are connected in series to a variable sinusoidal voltage supply, whose frequency is variable, but rms voltage is constant. At resonance
(I) Average power will be maximum
(II) Average power will be minimum
(III) Impedence will be maximum
(IV) current and voltage will be in same phase
(A) I and IV
(B) II and III
(C) I and III
(D) II, III, and IV

28. Which of the following is accompanied by the characteristic X-ray emission?
(A) α-particle emission
(B) Electron emission
(C) Positron emission
(D) K-electron capture

29. The switch Sw of the circuit shown in the figure is closed at t = 0. i_1 and i_2 are the electric current in the branch containing two ideal inductors L_1 and L_2 respectively, at a certain instant. Choose the most appropriate statement.



(A) At t = 0,(just after the switch is closed) $\frac{di_1}{dt} = \frac{\varepsilon}{L_1}$ and $\frac{di_2}{dt} = \frac{\varepsilon}{L_2}$
(B) At t = 0, ,(just after the switch is closed) $i_1 = 0, i_2 = 0$
(C) After long time $i_1 = \frac{\varepsilon L_2}{(L_1 + L_2)}$ and $i_2 = \frac{\varepsilon L_1}{(L_1 + L_2)r}$
(D) All the above are true

30. Monochromatic light is used in Young's double slit experiment. When one of the slits is covered by a transparent sheet of thickness 1.8×10^{-5} m, made of material of refractive index μ_1 number of fringes which shift is 18. when another sheet of thickness 3.6×10^{-5} m, made of material of refractive index μ_2 is used, number of fringes which shift is 9. Relation between μ_1 and μ_2 is given by
(A) $4\mu_2 - \mu_1 = 3$
(B) $4\mu_1 - \mu_2 = 3$
(C) $3\mu_2 - \mu_1 = 4$
(D) $2\mu_1 - \mu_2 = 4$

Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. If a metal crystal exists in fcc and bcc having the radius r. What is the edge length ratio (a_1/a_2) in two crystal structure, a_2, a_1 are the edge lengths of the cube in fcc and bcc respectively

(A) $\sqrt{3}:\sqrt{2}$ (B) $\sqrt{2}:\sqrt{3}$

(C) $\sqrt{6}:\sqrt{1}$ (D) $1:\sqrt{6}$

2. What is the oxidation number and coordination number of metal in $K_3\left[Fe\left(C_2O_4\right)_3\right]$

(A) O.N = +2, C.N = 3 (B) O.N = +3, C.N = 3

(C) O.N = +3, C.N = 6 (D) none of these

3. Orange red vapours of X is formed by heating the chloride salt with $K_2Cr_2O_7$ and concentrated H_2SO_4. When X on passing in NaOH gives yellow solution of Na_2CrO_4. Then X =

(A) CrO_3 (B) $CrCl_3$

(C) CrO_2Cl_2 (D) H_2CrO_4

4. The emf of the following three galvanic cells:

I. $Zn/Zn^{2+}(1\,m)||Cu^{2+}(1\,m)|Cu$

II. $Zn/Zn^{2+}(0.1\,m)||Cu^{2+}(1\,m)|Cu$

III. $Zn/Zn^{2+}(1\,m)||Cu^{2+}(0.1\,m)|Cu$

Are represented by E_1, E_2 and E_3. Which of the following statements is true?

(A) $E_1 > E_2 > E_3$ (B) $E_3 > E_2 > E_1$

(C) $E_3 > E_1 > E_2$ (D) $E_2 > E_1 > E_3$

5. In which of the following reactions, there is no change in valency?

(A) $4KClO_3 \longrightarrow 3KClO_4 + KCl$ (B) $SO_2 + 2H_2S \longrightarrow 2H_2O + 3S$

(C) $BaO_2 + H_2SO_4 \longrightarrow BaSO_4 + H_2O_2$ (D) $2BaO + O_2 \longrightarrow 2BaO_2$

6. The case of liquefaction of noble gases decreases in the order

(A) $He > Ne > Ar > Kr > Xe$ (B) $Xe > Kr > Ar > Ne > He$

(C) $Kr > Xe > He > Ar = Ne$ (D) $Ar > Kr > Xe > He > Ne$

Space for rough work

7. Which of the following is used as a foaming agent in froth floatation process is
(A) pine oil (B) amyl xanthenes
(C) $CuSO_4$ (D) KCN

8. The plot of $1/x_A$ versus $1/y_A$ (where x_A and y_A are the mole fractions of A in liquid and vapour phases respectively) is linear whose slope and intercept respectively are given as
(A) $P_A^0/P_B^0, \left(P_A^0 - P_B^0\right)/P_B^0$ (B) $P_A^0/P_B^0, \left(P_B^0 - P_A^0\right)/P_B^0$
(C) $P_B^0/P_A^0, \left(P_A^0 - P_B^0\right)/P_B^0$ (D) $P_B^0/P_A^0, \left(P_B^0 - P_A^0\right)/P_B^0$

9. K_{sp} of $AgBr = 8 \times 10^{-13}$
$Ag, AgNO_3\left(1.0M\right) // KBr\left(1.0M\right) AgBr, Ag$
The emf of the cell is
(A) –0.71 (B) +0.42
(C) –0.42 (D) +0.71

10. The voltage of a certain cell at 25°C and 20°C are 0.3525 and 0.3533 V respectively. If the number of electrons involved in the overall reaction are two, what is the value of ΔS^0 at 25°C
(A) 30.88 JK^{-1} (B) 60.11 JK^{-1}
(C) –30.88 JK^{-1} (D) –60.11 JK^{-1}

11. Which of the following is/are paramagnetic?
$NO_2, NO, N_2O_4, N_2O_2, N_2O_5$
(A) only NO_2 (B) NO_2, NO
(C) NO, NO_2, N_2O_5 (D) all are paramagnetic

12. $KClO_4$ is made in the following sequence of reactions:
$Cl_2 + KOH \longrightarrow KCl + KClO + H_2O$ ...(i)
$KClO \longrightarrow KCl + KClO_3$ ...(ii)
$KClO_3 \longrightarrow KClO_4 + KCl$ ...(iii)
What mass of Cl_2 is needed to produce 1.0 kg of $KClO_3$?
(A) 2.05 kg (B) 1 kg
(C) 4.02 kg (D) 5 kg

13. A solution containing 6 g urea per litre isotonic with a solution containing
(A) 5.85 g NaCl per litre (B) 34.2 g sucrose per lire
(C) 36.0 g glucose per litre (D) 6.0 g of sucrose per litre

Space for rough work

14. In the sequence of reaction

$A \xrightarrow{k_1} B \xrightarrow{k_2} C \xrightarrow{k_3} D$

$k_3 > k_2 > k_1$, then the rate determining step of the reaction is

(A) $A \to B$ (B) $B \to C$
(C) $C \to D$ (D) $A \to D$

15. Chemically rust of iron is
(A) hydrated ferrous oxide
(B) hydrated ferric oxide
(C) only ferric oxide
(D) a mixture of ferric oxide with a little of $Fe(OH)_3$

16. Which of the following will give four isomers?
(A) $\left[Co(en)(NH_3)_2Cl_2\right]Cl$ (B) $\left[Co(PPh_3)(NH_3)_2Cl_2\right]Cl$
(C) $\left[Co(en)_3\right]Cl_3$ (D) $\left[Co(en)_2Cl_2\right]Br$

17. The colourless species is
(A) VCl_3 (B) $VOSO_4$
(C) Na_3VO_4 (D) $\left[V(H_2O)_6SO_4\right]H_2O$

18. At 25°C, the standard emf of a cell having reaction involving two electron exchange is found to be 0.295 V. The equilibrium constant of the reaction is approximately
(A) 9.51×10^8 (B) 10
(C) 1×10^{10} (D) 9.51×10^9

19. A silver cup is plated with silver by passing 965 coulombs of electricity, the amount of silver deposited is: (Mass no. of Ag = 108)
(A) 1.08 g (B) 1.002 g
(C) 108 g (D) 9.89 g

20. E° values of Mg^{2+}/Mg is –2.37 volts of Zn^{+2}/Zn is –0.76 volt and Fe^{+2}/Fe is –0.44 volt. Which of the following statements is correct?
(A) Zn oxidize Fe (B) Zn will reduce Fe^{2+}
(C) Zn will reduce Mg^{2+} (D) Mg oxidizes Fe

21. Lowering of vapour pressure ΔP_1 of aqueous solution of acid HA_1 and ΔP_2 of aqueous solution of acid HA_2 are related as $\Delta P_1 > \Delta P_2$. Correct relation is (Assume same concentration for both acids)
(A) $pK_{a_1} > pK_{a_2}$ (B) $pK_{a_1} < pK_{a_2}$
(C) $pK_{a_1} = pK_{a_2}$ (D) none of these

Space for rough work

22. The correct relationship between the boiling points of very dilute solutions of $AlCl_3(T_1)$, and $CaCl_2(T_2)$ having the same molar concentrations is
(A) $T_1 = T_2$
(B) $T_1 > T_2$
(C) $T_2 > T_1$
(D) $T_2 \geq T_1$

23. The vapour pressure of pure benzene at 25°C is 639.7 mm Hg and the vapour pressure of a solution of solute in benzene at 25°C is 631.9 mm Hg. The molality of the solution is
(A) 0.156
(B) 0.108
(C) 0.518
(D) 0.815

24. The stabilization of the dispersed phase in a lyophobic sol is due to
(A) the viscosity of the medium.
(B) the surface tension of the medium.
(C) affinity for the medium.
(D) the formation of an electrical layer between the two phase.

25. The process which is catalysed by one of the products is called
(A) acid-based catalyst.
(B) auto catalyst.
(C) negative catalyst.
(D) positive catalyst.

26. Which of the following statements is correct regarding the slag obtained during the extraction of a metal like copper or iron?
(A) The slag is lighter and has higher melting point than the metal.
(B) The slag is lighter and has lower melting point than the metal.
(C) The slag is heavier and has higher melting point than the metal.
(D) The slag is heavier and has lower melting point than the metal.

27. In oxoacids of chlorine, Cl–O bond contains
(A) $p\pi$–$p\pi$ bond
(B) $d\pi$–$d\pi$ bond
(C) $p\pi$–$d\pi$ bond
(D) $d\pi$–$f\pi$ bond

28. The compound that is not a Lewis acid is
(A) $BaCl_2$
(B) $AlCl_3$
(C) BCl_3
(D) $SnCl_4$

29. The formula of sodium nitroprusside is
(A) $Na_4[Fe(CN)_5NO_2]$
(B) $Na_2[Fe(CN)_5NOS]$
(C) $NaFe[Fe(CN)_6]$
(D) $Na_2[Fe(CN)_6NO_2]$

30. Amongst $\left[TiF_6\right]^{2-}$, $\left[CoF_6\right]^{3-}$, Cu_2Cl_2 & $\left[NiCl_4\right]^{2-}$. The colourless species are
(A) $\left[TiF_6\right]^{2-}$ & Cu_2Cl_2
(B) $\left[CoF_6\right]^{3-}$ & $\left[NiCl_4\right]^{2-}$
(C) $\left[TiF_6\right]^{2-}$ & $\left[CoF_6\right]^{3-}$
(D) Cu_2Cl_2 & $\left[NiCl_4\right]^{2-}$

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. The number of values of a for which $\hat{\alpha} = a\hat{i} + 2a\hat{j} - 3a\hat{k}, \beta = (2a+1)\hat{i} + (2a+3)\hat{j} + (a+1)\hat{k}$, and $\hat{\gamma} = (3a+5)\hat{i} + (a+5)\hat{j} + (a+2)\hat{k}$ are coplanar

(A) 0	(B) 1
(C) 3	(D) 6

2. The differential equation $\left\{xy^3\left(1+\cos x\right) - y\right\}dx + xdy = 0$ represents the curve $\frac{x^2}{ay^2} = \frac{x^3}{b} + x^2 \sin x + cx\cos x - d\sin x + k$. Then a + b + c + d is equal to

(A) 8	(B) 9
(C) 10	(D) 11

3. Let $\overline{p}$ and $\overline{q}$ be unit vectors such that $\overline{p} \times \overline{q} + \overline{p} = \overline{r}$ and $\overline{r} \times \overline{p} = \overline{q}$. Then the value of $\left[\overline{p} \quad \overline{q} \quad \overline{r}\right]$ is

(A) 0	(B) 1
(C) 2	(D) 3

4. The matrix $A = \begin{bmatrix} a & b & c \\ c & a & b \\ b & c & a \end{bmatrix}$ is an orthogonal matrix. Then $a + b + c = \pm k$, where k is

(A) 0	(B) 1
(C) 2	(D) 3

5. Seven digit numbers are formed using digits 1, 2, 3, 4, 5, 6, 7, 8, 9 without repetition. The probability of selecting a number such that product of any 5 consecutive digits is divisible by either 5 or 7 is $\frac{k}{12}$, then k is

(A) 2	(B) 4
(C) 6	(D) 7

Space for rough work

6. If a singular matrix $A = \left[a_{ij}\right]_{2\times 2}$ always commute with $B = \begin{bmatrix} 1 & 1 \\ 2 & 1 \end{bmatrix}$ such that $\frac{a_{11}}{a_{12}} = \sqrt{k}$, then k is

(A) 0 (B) 1
(C) 2 (D) 3

7. Let $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ and $B = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$ be two matrices such that they are commutative and $c \neq 3b$ then the value of $\left|\frac{a-d}{3b-c}\right|$ is

(A) 0 (B) 1
(C) 2 (D) 3

8. Two natural numbers x and y are chosen at random. If P is the probability that $x^2 + y^2$ is divisible by 5 and 7 than the value of 25 P is
(A) 3 (B) 6
(C) 9 (D) none of these

9. $\left|\bar{p}\times\hat{i}\right|^2 + \left|\bar{p}\times\hat{j}\right|^2 + \left|\bar{p}\times\hat{k}\right|^2$ is $K\left|\bar{p}\right|^2$. Then K is

(A) 0 (B) 1
(C) 2 (D) 3

10. Given $\hat{a}, \hat{b}, \hat{c}$ are non – zero and coplanar then

(A) $\hat{a}-\hat{b}, \hat{b}-\hat{c}, \hat{c}-\hat{a}$ are always coplanar (B) $\hat{a}+\hat{b}, \hat{b}+\hat{c}, \hat{c}+\hat{a}$ are always coplanar
(C) $2\hat{a}+3\hat{b}, 2\hat{b}+3\hat{c}, 2\hat{c}+3\hat{a}$ are always coplanar (D) none of these

11. The lines $\frac{x-1}{2} = \frac{y}{-1} = \frac{z}{2}$ and $x - y + z - 2 = 0 = \lambda x + 3z + 5$ are coplanar for λ is equal to

(A) $-\frac{97}{11}$ (B) $-\frac{43}{5}$

(C) $-\frac{73}{9}$ (D) –5

12. If A is a square matrix of order n with |A| = 9 and |adj adj adj A| = 3^{16} then number of elements in A is
(A) 0 (B) 1
(C) 2 (D) 3

Space for rough work

13. For two unimodular complex numbers z_1 and z_2 $\begin{bmatrix} \bar{z}_1 & -z_2 \\ \bar{z}_2 & z_1 \end{bmatrix}^{-1} \begin{bmatrix} z_1 & z_2 \\ -\bar{z}_2 & \bar{z}_1 \end{bmatrix}^{-1} = k \begin{bmatrix} 1/4 & 0 \\ 0 & 1/4 \end{bmatrix}$ then k is

(A) 4 (B) 2

(C) 0 (D) 1

14. If a, b, c are the roots of $x^3 + 2x^2 + p = 0$, then the value of $\begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix}$ is

(A) 2 (B) 4

(C) 6 (D) 8

15. A line L is passing through (1, 1, 1) intersects line $x = \frac{y}{2} = \frac{z}{3}$ at A and line $L_2 \equiv 2(x + 1) = 6(y + 2) = 3(z + 3)$ at B. Then distance of B from (0, 0, 0) is

(A) $\sqrt{12}$ (B) $\sqrt{14}$

(C) $\sqrt{18}$ (D) none of these

16. The statements are not true

(A) $\det(A + B) = \det A + \det B$ for all square matrices A, B of order n

(B) $\det(AB) = \det A . \det B$ for all A, B of order n

(C) $\det(A.B) = \det A \times \det B$

(D) none of these

17. There are n urns u_1, u_2, ….., u_n. Each urn contains $2n + 1$ balls. The i^{th} urn contains 2i number of balls $P(u_i)$, i.e., probability of selecting i^{th} urn is proportional to $i^2 + 2$. If we randomly select one of the urns and draw one ball and probability of ball being white be $P(A)$, then $\lim_{n \to \infty} P(A)$ is

(A) $\frac{3}{4}$ (B) $\frac{1}{4}$

(C) $\frac{2}{3}$ (D) $\frac{3}{16}$

Space for rough work

18. Let $\bar{p}, \bar{q}, \bar{r}$ be three vectors such that $\left[\bar{p} \quad \bar{q} \quad \bar{r}\right] = 2$. If $\bar{a} = x\left(\bar{q}\times\bar{r}\right) + y\left(\bar{r}\times\bar{p}\right) + z\left(\bar{p}\times\bar{q}\right)$ is perpendicular to $\bar{p}+\bar{q}+\bar{r}$. Then the value of $x+y+z$ is
(A) 2 (B) 1
(C) 0 (D) none of these

19. PQRSP'Q'R'S' (where P′, Q′, R′, S′ are vertices corresponding to P, Q, R, S respectively) is a cube of edges 1 unit. A and B are midpoints of the edges Q'P' and Q'R' respectively. The distance of vertex S from the plane AQB is
(A) $\frac{3}{4}$ units (B) $\frac{3}{2}$ units
(C) $\frac{4}{3}$ units (D) 1 unit

20. If $\vec{a},\vec{b},\vec{c}$ are unit vectors perpendicular to each other such that $\vec{r}.\vec{a} = 1$, $\vec{r}.\vec{b} = 2$ and $\vec{r}.\vec{c} = 3$ then
(A) $\vec{r} = 3\vec{a} + 2\vec{b} + \vec{c}$ (B) $\vec{r} = \vec{a} + 2\vec{b} + 3\vec{c}$
(C) $\vec{r} = 3\vec{a}\times\vec{b} + 2\vec{b}\times\vec{c} + \vec{c}\times\vec{a}$ (D) none of these

21. Four of the eight vertices of a regular octagon are chosen at random. The probability that the figure with these four vertices is square, equals
(A) $\frac{1}{14}$ (B) $\frac{1}{7}$
(C) $\frac{1}{28}$ (D) $\frac{1}{35}$

22. The differential equation $\frac{dx}{dy} = \frac{\sqrt{1-x^2}}{x}$ determines a family of circles with
(A) variable radii and a fixed centre (1, 0)
(B) variable radii and a fixed centre (–1, 0)
(C) fixed radius 1 and variable centres along x-axis
(D) fixed radius 1 and variable centres along y-axis

23. If the lines $\frac{x-1}{2} = \frac{y-2}{3} = \frac{z-3}{4}$ and $\frac{x-4}{1} = \frac{y-6}{2} = \frac{z+k}{2}$ intersect then the value of k is
(A) – 7 (B) – 8
(C) – 9 (D) – 10

Space for rough work

24. The value of determinant $\Delta = \begin{vmatrix} 1 & \frac{4\sin B}{b} & \cos A \\ 2a & 8\sin A & 1 \\ 3a & 12\sin A & \cos B \end{vmatrix}$ is (where a, b and c are the sides of a triangle and A, B and C are angles opposite to a, b and c respectively)

(A) 0 (B) 1
(C) 2 (D) 3

25. The equations $ax + a^2y + z = 0$, $bx + b^2y + z = 0$, $cx + c^2y + z = 0$ have only zero solution if common ratio of G.P. is not equal to (here a, b, c are in G.P.)

(A) 0, ± 1 (B) 2, ± 3
(C) 4, ± 5 (D) none of these

26. The value of $\Delta = \begin{vmatrix} \lim\limits_{x\to0} \tan\left(\frac{\pi}{4}+x\right)^{1/x} & x^3 & e^2 \\ \lim\limits_{x\to\infty} (1)^x & x^4+1 & 1 \\ \lim\limits_{x\to0} \frac{x^2 \sin\frac{1}{x}}{\sin x} & x^5+9 & 0 \end{vmatrix}$ equals

(A) 1 (B) 2
(C) 3 (D) none of these

27. If $\hat{a}, \hat{b}, \hat{c}$ are three non-coplanar unit vectors, then

$\left[\hat{a}\ \vec{p}\ \vec{q}\right]\hat{a} + \left[\hat{b}\ \vec{p}\ \vec{q}\right]\hat{b} + \left[\hat{c}\ \vec{p}\ \vec{q}\right]\hat{c}$ is equal to

(A) $\left(\hat{a}+\hat{b}+\hat{c}\right)\times\left(\vec{p}\times\vec{q}\right)$ (B) $\hat{a}+\hat{b}+\hat{c}+\vec{p}+\vec{q}$
(C) $\vec{p}+\vec{q}$ (D) $\vec{p}\times\vec{q}$

Space for rough work

28. If $\vec{a}$ and $\vec{b}$ are two unit vectors and θ is the angle between them, then the unit vector along the angular bisector of $\vec{a}$ and $\vec{b}$ will be given by

(A) $\dfrac{\vec{a}-\vec{b}}{2\cos\frac{\theta}{2}}$

(B) $\dfrac{\vec{a}+\vec{b}}{2\cos\frac{\theta}{2}}$

(C) $\dfrac{\vec{a}+\vec{b}}{2\cos\frac{\theta}{2}}$

(D) none of these

29. The equation of the line passing through the point (1, –2, 3) and parallel to the line
$x - y + 2z = 5$ and $3x + y + z = 6$ is

(A) $\dfrac{x-1}{-3}=\dfrac{y+2}{5}=\dfrac{z-3}{4}$

(B) $\dfrac{x-1}{1}=\dfrac{y+2}{-1}=\dfrac{z-3}{2}$

(C) $\dfrac{x-1}{3}=\dfrac{y+2}{1}=\dfrac{z-3}{6}$

(D) $\dfrac{x-1}{3}=\dfrac{y+2}{-1}=\dfrac{z-3}{2}$

30. The area of the region bounded by $x = \dfrac{1}{2}$, $x = 2$, $y = \ln x$ and $y = 2^x$ is

(A) $\dfrac{3}{2}-\dfrac{5}{2}\ln 2 + \dfrac{4-\sqrt{2}}{\ln 2}$

(B) $\dfrac{3}{2}+\dfrac{5}{2}\ln 2 + \dfrac{4-\sqrt{2}}{\ln 2}$

(C) $\dfrac{3}{2}+\dfrac{5}{2}\ln 2+\dfrac{4+\sqrt{2}}{\ln 2}$

(D) $\dfrac{3}{2}-\dfrac{5}{2}\ln 2-\dfrac{4-\sqrt{2}}{\ln 2}$

Space for rough work

FIITJEE **JEE(Main)-2015**

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014: 2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

ALL INDIA INTEGRATED TEST SERIES

ANSWERS, HINTS & SOLUTIONS

PART TEST – IV
(Main)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	B	B
2.	B	C	B
3.	C	C	B
4.	D	D	B
5.	C	C	D
6.	D	B	C
7.	C	A	B
8.	B	B	C
9.	A	A	C
10.	A	C	B
11.	D	B	D
12.	D	A	D
13.	A	B	B
14.	D	A	D
15.	A	D	B
16.	D	D	A
17.	B	C	A
18.	D	C	C
19.	B	A	C
20.	C	B	B
21.	A	B	D
22.	C	B	D
23.	C	A	C
24.	A	D	A
25.	D	B	A
26.	C	B	D
27.	A	C	D
28.	D	A	B
29.	D	B	A
30.	A	A	A

Physics PART – I

1. $\rho = \dfrac{3\cdot 14\times 10^{-6}\times 5}{1} = 15.7\mu$ ohm metre.

$$\delta\rho = \rho\left[\frac{2\delta r}{r}+\frac{\delta L}{L}+\frac{\delta R}{R}\right]\text{ohm metre.}$$

$$= 15\cdot 7\mu\left[2\times\frac{\cdot 01}{1}+\frac{\cdot 01}{1}+\frac{\cdot 01}{5}\right]\text{ ohm metre}$$

$$= 15.7\mu\left[\cdot 02+\cdot 01+\cdot 002\right]\text{ohm – metre}$$

$$= 15.7\times\cdot 032\mu\,\Omega\text{ m}$$

$$= 0.50\ \mu\Omega\text{m}$$

2. $100\times\dfrac{\Delta P}{P} = 3\times 0\cdot 1+2\times 0\cdot 2+3\times 0\cdot 3+4\times 0\cdot 1$

$$= \cdot 3+\cdot 4+\cdot 9+\cdot 4 = 2\%$$

3. $A = \lambda N_0 e^{-\lambda t_0}$

$$3Ae = 3\lambda N_0 e^{-\lambda t}$$

$$\Rightarrow \frac{1}{e} = e^{\lambda(t-t_0)} = e^{-1}$$

$$t = t_0 - \frac{1}{\lambda}.$$

4. $f = a^2\left(Z-b\right)^2$.

$\therefore$ (D)

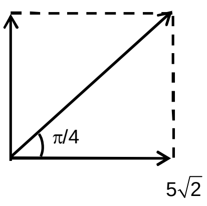
5. $\dfrac{I_{max}}{I_{min}} = \dfrac{\left(\sqrt{I_1}+\sqrt{I_2}\right)^2}{\left(\sqrt{I_1}-\sqrt{I_2}\right)^2} = \alpha$

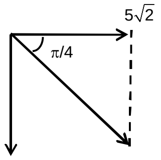
$$\frac{I_1}{I_2} = \left(\frac{\sqrt{\alpha}+1}{\sqrt{\alpha}-1}\right)^2 \text{ if } I_1 > I_2$$

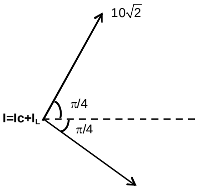
6. $I_c = \dfrac{100}{5\sqrt{2}}\sin\left(50t+\dfrac{\pi}{4}\right)$

$$I_L = \frac{100}{5\sqrt{2}}\sin\left[50t-\frac{\pi}{4}\right]$$

I = 20sin(50t)







8. When u decreases v increases. For plane mirror u decreases.
$\therefore$ the image in plane mirror moves towards the left.

9. $n\lambda = 2\pi r_n$ and $r_n = n^2 r_1$

$$\therefore \lambda : r_1 = 2\pi n : 1$$

10. Apparent depth = $\frac{t_1}{\mu_1} + \frac{t_2}{\mu_2}$

Shift = $\left(t_1 + t_2\right) - \left(\frac{t_1}{\mu_1} + \frac{t_2}{\mu_2}\right)$

$3.0 = \left(t_1 + 10\right) - \left(\frac{t_1}{1.5} + \frac{10 \times 3}{4}\right)$

3.0 = $\frac{t_1}{3} + 2.5$

t_1 = 1.5 cm

11. In case of X-rays characteristic intensity of K_α, K_β, K_γ . . . . goes on decreasing while photon energy increases. This indicates that probabilities of P_1, P_2 and P_3 should be in increasing order.

12. Maximum energy of X – ray photon = 2000 eV
KE_{max} = 2000 – (100 + 5.8) = 1894.2 eV

13. $\frac{v_0}{v_i} = \frac{x^2}{y^2}$

x = 2 y

$\therefore\ \frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

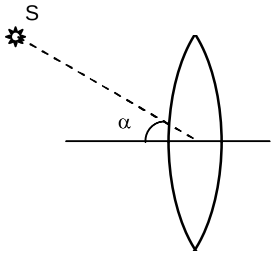
$\frac{1}{y} - \frac{1}{2y} = \frac{1}{f}$

$\frac{f}{y} = 2$

15. $\Delta x = d\sin\alpha - d\frac{y}{D} = 0$

$\Rightarrow$ y = D sin α

$= 1000 \times \frac{1}{200} = 5$ mm. below.



16. m = 1 and $V_{xo} = V_{oy}$
$V_{xI} = m^2 V_{xo}$
$V_{yI} = -m V_{yo}$

$\therefore\ \theta = -\frac{\pi}{4}$

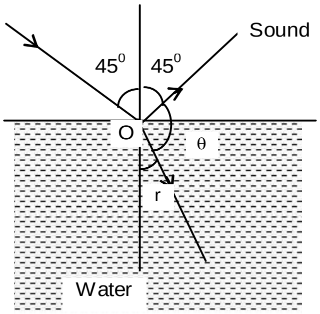
17. $\frac{\mu_2}{v'} - \frac{\mu_1}{4} = \frac{\mu_2 - \mu_1}{R}$

$\frac{\mu_3}{v} - \frac{\mu_2}{v'} = \frac{\mu_3 - \mu_2}{-R}$ $\Rightarrow \frac{\mu_3}{v} - \frac{\mu_1}{u} = \frac{\mu_3 + \mu_1 - 2\mu_2}{R}$

$\frac{1.3}{x} - \frac{1}{-20} = \frac{\mu_3 + \mu_1 - 2\mu_2}{R}$ $\Rightarrow \frac{1}{y} - \frac{1.3}{-20} = \frac{\mu_3 + \mu_1 - 2\mu_2}{R}$

Hence, $\frac{1.3}{x} + \frac{1}{20} = \frac{1}{y} + \frac{1.3}{20}$

$\therefore$ 1.3 y > x



18. The sound wave will be totally internally reflected on the surface.
For light wave

$$1 \sin 45^0 = \frac{3\times10^8}{2.2\times10^8}\sin r$$

$$\Rightarrow r = \sin^{-1}\left(\frac{0.75}{\sqrt{2}}\right)\text{rad}.$$

$$\therefore \quad \theta = \pi - \frac{\pi}{4} - \sin^{-1}\left(\frac{0.75}{\sqrt{2}}\right) = \left[\frac{3\pi}{4} - \sin^{-1}\left(\frac{0.75}{\sqrt{2}}\right)\right]\text{rad.}$$

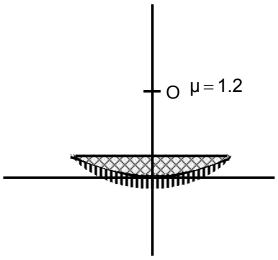
19. $15^2 + 20^2 = 5^2 + X_C^2 \times 100 \Rightarrow X_C^2\, 100 = 600 \Rightarrow X_C = \sqrt{6}\ \Omega$

20. $F_T = F_m + mg = ILB - mg$

$$\text{so, } I = \frac{E - B\ell V}{R} = \left(\frac{E - B\ell V}{R}\right)\ell B - mg = 0$$

$$E = \frac{mg}{R\ell B} + B\ell V$$

21. Using symmetry, current will not flow in the resistor.



22. $$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{2}{f_2} = \frac{1}{15} + \frac{2\left({}^m\mu_\ell - 1\right)}{R_1} = \frac{1}{15} + \frac{{}^m\mu_\ell - 1}{15} = \frac{{}^m\mu_\ell}{15} \Rightarrow f_{eq} = \frac{15}{{}^m\mu_\ell}$$

and $f_{eq} = \frac{(30 - 7.5)}{2} = \frac{22.5}{2}$

This $\frac{22.5}{2} = \frac{15}{{}^m\mu_1} \Rightarrow {}^m\mu_1 = \frac{4}{3}.$

Also ${}^m\mu_\ell = \frac{\mu_\ell}{\mu_m} = \Rightarrow \frac{4}{3} = \frac{\mu}{1.2} \Rightarrow \mu = \frac{4\times1.2}{3} = 1.6$

23. For image to be coincident, either the rays should retrace or the image due to the lens should formed just at the pole of the mirror in thin case. The image formed due to lens is at 30 cm (2f) be from the lens. Thus either this image should be at centre of curvature of the convex mirror or at the pole of the mirror. Hence 6cm or 30 cm should be the separation between the lens and the mirror.

24. The charges on each capacitor will be equal to Q/2 (how?) when the current in the circuit is maximum.

29. Initially the current in the circuit is zero, and there is no potential drop across the internal resistance.

$$L_1\frac{di_1}{dt} = L_2\frac{di_2}{dt} = \varepsilon, \text{at } t = 0.$$

At any time t,

$$L_1\frac{di_1}{dt} = L_2\frac{di_2}{dt} = \varepsilon - ir$$

30. $(\mu - 1)t = n\beta$

$$\frac{(\mu_1 - 1)\times1.8\times10^{-5}}{(\mu_2 - 1)\times3.6\times10^{-5}} = \frac{18\beta}{9\beta}$$

$$(\mu_1 - 1) = 4(\mu_2 - 1)$$

$$4\mu_2 - \mu_1 = 3$$

Chemistry PART – II

SECTION – A

1. In fcc $a_2 = 2\sqrt{2}r$

bcc $a_1 = \frac{4r}{\sqrt{3}}$

$\therefore \frac{a_1}{a_2} = \frac{4r}{\sqrt{3}} \times \frac{1}{2\sqrt{2}r} = \frac{\sqrt{2}}{\sqrt{3}}$

2. In $K_3\left[Fe\left(C_2O_4\right)_3\right]$; O.N. of Fe = 3 + x + 3(–2) = 0

x = +3

$C_2O_4^{2-}$ is a bidentate ligand.

C.N of Fe = 3(2) = 6

3. $4NaCl + K_2Cr_2O_7 + 3H_2SO_4 \longrightarrow 2CrO_2Cl_2 + 2Na_2SO_4 + K_2SO_4 + 3H_2O$

$Cr_2O_2Cl_2 + 4NaOH \longrightarrow Na_2CrO_4 + 2NaCl + 2H_2O$

4. Cell reaction is $Zn + Cu^{2+} \longrightarrow Zn^{2+} + Cu$

$$E_{cell} = E^0_{cell} - \frac{RT}{nF}\ln\frac{\left[Zn^{2+}\right]}{\left[Cu^{2+}\right]}$$

Greater the factor $\left[Zn^{2+}\right]/\left[Cu^{2+}\right]$, less is the EMF.

6. He has the weakest vander waal's forces of attraction due to its smallest size and hence lowest boiling point. In other words, its liquefaction is difficult. As the size of noble gas increases from He to Xe, vander waal's forces increase and consequently boiling point increases and liquefaction becomes easy.

8. $P^0_A = x_A P^0_A \qquad P^0_B = X_B P^0_B$

$$y_A = \frac{P_A}{P_A + P_B} = \frac{x_A P^0_A}{x_A P^0_A + x_B P^0_B} = \frac{x_A P^0_A}{x_A P^0_A + \left(1 - x_A\right)P^0_B}$$

$$\frac{1}{y_A} = \frac{x_A\left(P^0_A - P^0_B\right) + P^0_B}{x_A P^0_A}$$

$$\frac{1}{x_A} = \frac{P^0_A}{P^0_b}\frac{1}{y_A} + \frac{P^0_B - P^0_A}{P^0_B}$$

$$\therefore \text{slope} = \frac{P^0_A}{P^0_B} \quad \text{Iint ercept} = \frac{P^0_B - P^0_A}{P^0_B}$$

9. $\left[Ag^+\right]_R = 8 \times 10^{-13} \quad \left[Ag^+\right]_L = 1.0M$

$$E = 0 - 0.059\log\frac{\left[Ag^+\right]_L}{\left[Ag^+\right]_R} = -0.71\,V$$

10. $\Delta G^0 = -nFE^0$

$\Delta H^0 - T\Delta S^0 = -nFE^0$

$E^0 = \frac{\Delta S^0}{nF}T - \frac{\Delta H^0}{nF}$

Solving for E^0 at 25°C and 20°C gives

$\Delta S^0 = -30.88\ JK^{-1}$

12. $Cl_2 + 2KOH \longrightarrow KCl + KClO + H_2O$ ...(i)

$3KClO \longrightarrow 2KCl + KClO_3$ ...(ii)

$4KClO_3 \longrightarrow 3KClO_4 + KCl$ ...(iii)

Multiply equation (i) by 12 and equation (ii) by 4 and add equation (i), (ii) and (iii) to obtain

$12Cl_2 + 24KOH \longrightarrow 21KCl + 3KClO_4 + 12H_2O$

852 415.5

1000 g $KClO_4$ will be produced from = $\frac{852 \times 1000}{415.5}g$

= 2.05 kg

13. Isotonic solutions have same molar concentration.

6g urea/litre = 0.1 M

34.2 g sucrose/litre = 0.1 M

14. As k_1 is lowest, hence $A \xrightarrow{k_1} B$ is slowest.

16. $\left[Co(en)_2 Cl_2\right]Br$ shows ionization isomerism, cis and trans isomerism and optical isomerism.

17. Na_3VO_4 contains vanadium in +5 oxidation state which has vacant d – orbitals and is thus colourless.

18. $\Delta G° = -2FE° = -RT \ln K$

$K = 10^{10}$

19. m = ZQ ; m = $\frac{108}{1 \times 96500} \times 965$ = **1.08**

20. For $Zn + 2Fe^{+2} \rightarrow Zn^{+2} + 2Fe$ $E^o_{cell} = -0.44 + 0.76 = +ve$ and hence, the reaction is spontaneous.

21. Lowering, $\Delta P \propto$ 'a' number of solute particles.

Hence, HA_1 is stronger acid than HA_2 (Given $\Delta P_1 > \Delta P_2$) and $pK_{a_1} < pK_{a_2}$.

23. m = $\frac{(639.7 - 631.9)}{639.7} \times \frac{1000}{78}$ = **0.156**.

24. The stabilization of the dispersed phase is due to adsorption of the ions.

25. Auto catalyst

30. In case of Ti, it is in +4 oxidation state and has no d-electrons in case of Cu d-orbitals are filled so in both cases d-d-transition will not take place and compound will be colourless.

Mathematics PART – III

1. Because $|\alpha\beta\gamma| = 15a\left(\left(a+\frac{31}{30}\right)^2+\frac{1259}{900}\right)=0$

Only if a = 0

2. $$\frac{dy}{dx}+y^3\left(1+\cos x\right)-\frac{y}{x}=0$$

$$\frac{1}{y^3}\frac{dy}{dx}-\frac{1}{y^2x}=-\left(1+\cos x\right)$$

Let $\frac{-1}{y^2}=u$

$$\therefore \frac{1}{2}\frac{du}{dx}+\frac{u}{x}=-\left(1+\cos x\right)$$

$$\text{IF}=e^{\int\frac{2}{x}dx}=x^2$$

$$\therefore ux^2=-2\int x^2\left(1+\cos x\right)dx$$

$$\Rightarrow \frac{x^2}{2y^2}=\frac{x^3}{3}+x^2\sin x+2x\cos x-2\sin x+k$$

3. $$\left(\bar{p}\times\bar{q}+\bar{p}\right)\times\bar{p}=\bar{q}$$

$$\left(\bar{p}\times\bar{q}\right)\times\bar{p}=\bar{q}$$

$$\Rightarrow\left(\bar{p}.\bar{q}\right)=0$$

$$\therefore\left[\bar{p}\quad\bar{q}\quad\bar{r}\right]=\bar{p}.\left(\bar{q}\times\bar{r}\right)=\bar{p}.\left(\bar{q}\times\left(\bar{p}\times\bar{q}+\bar{p}\right)\right)=\left(\bar{q}^2\right).\left(\bar{p}^2\right)=1$$

4. $$AA^T=I$$

$$\Rightarrow\begin{bmatrix}a&b&c\\c&a&b\\b&c&a\end{bmatrix}\begin{bmatrix}a&c&b\\b&a&c\\c&b&a\end{bmatrix}=\begin{bmatrix}1&0&0\\0&1&0\\0&0&1\end{bmatrix}$$

$$\Rightarrow\begin{bmatrix}a^2+b^2+c^2&ac+ab+bc&ab+bc+ca\\ac+ab+bc&a^2+b^2+c^2&ab+bc+ca\\ab+bc+ac&bc+ac+ab&a^2+b^2+c^2\end{bmatrix}=\begin{bmatrix}1&0&0\\0&1&0\\0&0&1\end{bmatrix}$$

$$a^2+b^2+c^2=1\Rightarrow ab+bc+ca=0$$

$$\left(a+b+c\right)^2=1+2\left(0\right)=1\Rightarrow a+b+c=\pm1$$

6. $$\begin{bmatrix}a_{11}&a_{12}\\a_{21}&a_{22}\end{bmatrix}\begin{bmatrix}1&1\\2&1\end{bmatrix}=\begin{bmatrix}1&1\\2&1\end{bmatrix}\begin{bmatrix}a_{11}&a_{12}\\a_{21}&a_{22}\end{bmatrix}$$

$$\Rightarrow a_{11}+2a_{12}=a_{11}+a_{21}\qquad\text{..... (i)}$$

$$a_{11}+a_{12}=a_{12}+a_{22}\qquad\text{..... (ii)}$$

$$a_{21}+2a_{22}=2a_{11}+a_{21}$$

$$a_{21}+a_{22}=2a_{12}+a_{22}$$

$\therefore$ From (ii), $a_{11} = a_{22}$

$a_{21} = 2a_{12}$

$\because$ Given matrix is singular

$\Rightarrow a_{11}a_{22} = a_{21}a_{21}$

$\Rightarrow (a_{11})^2 = 2(a_{12})^2$

$\Rightarrow a_{11} = \sqrt{2}a_{12}$

7. AB = BA

8. P = $\dfrac{9}{25}$

9. Let $\bar{p} = p_1\hat{i} + p_2\hat{j} + p_3\hat{k}$

$\bar{p} \times \hat{i} = -p_2\hat{k} + p_3\hat{j}$

$\left|\bar{p} \times \hat{i}\right|^2 = p_2^2 + p_3^2$

$\left|\bar{p} \times \hat{j}\right|^2 = p_1^2 + p_3^2$

$\left|\bar{p} \times \hat{k}\right|^2 = p_1^2 + p_2^2$

Required solution = $2\left(p_1^2 + p_2^2 + p_3^2\right) = 2\left|\bar{p}\right|^2$

11. The lines should intersect or be parallel

Let $\left(2t+1, -t, 2t\right)$ be any point on the first line

Putting it in both the planes we get $\lambda = -5$

12. |adj adj adj A| = $|\,A\,|^{(n-1)^3} = 3^{16} \Rightarrow n = 3$

21. P = $\dfrac{2}{{}^8C_4} = \dfrac{2\times4\times3\times2\times1}{8\times7\times6\times5} = \dfrac{1}{35}$.

22. $\dfrac{-2xdx}{\sqrt{1-x^2}} == -2dy$

$\sqrt{1-x^2} = -(y+c)$

$x^2 + (y + c)^2 = 1$

$\therefore$ centre (0, – c).

23. $\dfrac{x-1}{2} = \dfrac{y-2}{3} = \dfrac{z-3}{4}$ = a

$\dfrac{x-4}{1} = \dfrac{y-6}{2} = \dfrac{z+k}{2}$ = b

x = 2a + 1, y = 3a + 2, z = 4a + 3

x = b + 4, y = 2b + 6, z = 2b – k

2a + 1 = b + 4

$\therefore$ 2a – b = 3 …(1)

3a – 2b = 4 …(2)

a = 2, b = 1

$4a + 3 = 2b - 12$
$\therefore$ $k = 2b - 4a - 3 = 2 - 8 - 3 = -9$.

24. $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c} = k$

$$\Delta = \begin{vmatrix} 1 & 4k & \cos A \\ 2a & 8ak & 1 \\ 3a & 12ak & \cos B \end{vmatrix} = 0.$$

25. a, b, c are in G.P. with common ratio r, such that $b = ar$, $c = ar^2$
Now system of equation have only zero (trivial) solution.

$$\text{If } \Delta = \begin{vmatrix} a & a^2 & 1 \\ b & b^2 & 1 \\ c & c^2 & 1 \end{vmatrix} \neq 0$$

$(a - b)(b - c)(c - a) \neq 0$
$(a - ar)(ar - ar^2)(ar^2 - a) \neq 0$
$a^3r(1 - r)^3(a + r) \neq 0$
$r \neq 0, \pm 1$.

26. $\lim\limits_{x\to 0} \tan\left(\frac{\pi}{4} + x\right)^{1/x} = e^2$

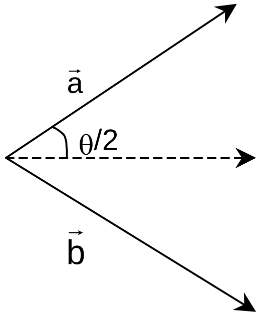
$\lim\limits_{x\to\infty} 1^x = 1$

$\lim\limits_{x\to 0} \frac{x^2 \sin\frac{1}{x}}{\sin x} = 0$

$\therefore$ $\Delta = 0$.

27. $\left[\hat{a} \quad \vec{p} \quad \vec{q}\right]$ = projection of $\vec{p}\times\vec{q}$ in the direction of $\hat{a}$. Hence the given vector is $\vec{p}\times\vec{q}$

28. Vector in the direction of angular bisector of $\vec{a}$ and $\vec{b}$ $= \frac{\vec{a}+\vec{b}}{2}$



$\frac{\vec{a}+\vec{b}}{2}$ have magnitude $\cos(\theta/2)$

So, the unit vector in this direction will have magnitude $\frac{\vec{a}+\vec{b}}{2\cos\frac{\theta}{2}}$

29. If l, m, n be the d.c.'s of the line, them as it lies in both the given planes it is perpendicular to their normals i.e. $l - m + 2n = 0$ and $3l + m + n = 0$ or $\frac{l}{-3} = \frac{m}{5} = \frac{n}{4}$

$\therefore$ Equation of the line is $\frac{x-1}{-3} = \frac{y+2}{5} = \frac{z-3}{4}$

30. Required area is $\int\limits_{1/2}^{2} (2^x - \ln x)dx = \frac{3}{2} - \frac{5}{2}\ln 2 + \frac{4-\sqrt{2}}{\ln 2}$

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ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Advanced), 2015**

PART TEST – IV

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 210**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 10)** contains 10 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (11 to 15) contains 5 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

(ii) **Section-C (01 to 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

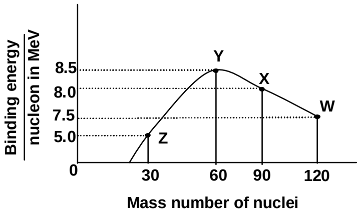
PART – I

SECTION – A

Straight Objective Type

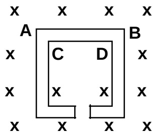
This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Binding energy per nucleon v_s mass number curve for nuclei is shown in the figure W, X, Y and Z are four nuclei indicated on the curve. The process that would release energy is



(A) Y → 2Z (B) W → X + Z
(C) W → 2Y (D) X → Y + Z

2. A wire is bent to form the double loop shown in the figure. There is a uniform magnetic field directed into the plane of the loop. If the magnitude of this field is decreasing, current will flow from



(A) A to B and C to D (B) B to A and D to C
(C) A to B and D to C (D) B to A and C to D

3. A cubical room is formed with 6 plane mirrors. An insect moves along the diagonal of the floor with uniform speed. The speed of its image in two adjacent walls is 20√2 cm/s. Then the speed of the image formed on the roof is

(A) 20 cm/s (B) 40 cm/s
(C) 20√2 cm/s (D) 10√2 cm/s

4. A prism of refractive index √2 refracting angle A produces minimum deviation D_m of a ray on one face at an angle of incidence 45° . The values of A and D_m are respectively.

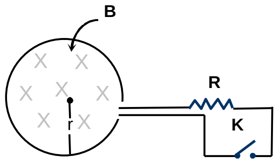
(A) 45°, 45° (B) 45°, 60°
(C) 60°, 30° (D) 60°, 45°

5. Which of the following statement is correct?

(A) The rest mass of a stable nucleus is less than the sum of the rest masses of its separated nucleons.
(B) The rest mass of a stable nucleus is greater than the sum of the rest masses of separated nucleons.
(C) In nuclear fission, energy is released by fusing two nuclei of medium mass (approximately 100 amu)
(D) In nuclear fission, energy is released by fragmentation of a very heavy nucleus.

Space for rough work

6. Shown in the figure is a circular loop of radius r and resistance R. A variable magnetic field of induction $B = e^{-t}$ is established inside the coil. If the key (K) is closed at t = 0, the electrical power developed in the external resistor at this instant is equal to



(A) $\frac{\pi r^2}{R}$ (B) $\frac{10r^3}{R}$

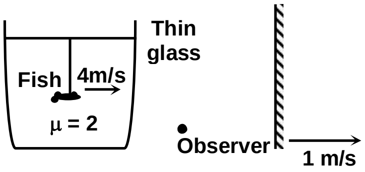
(C) $\frac{\pi^2 r^4 R}{5}$ (D) $\frac{\pi^2 r^4}{4R}$

7. In a YDSE apparatus, two films of thickness t_A and t_B, having refractive indices μ_A and μ_B are placed in front of slits A and B respectively. If $t_A\mu_A = t_B\mu_B$ the central maximum will

(A) not shift (B) shift towards A if $t_A < t_B$

(C) shift towards B if $t_A < t_B$ (D) shift towards A if $t_A > t_B$

8. Velocity of image of fish in the mirror with respect to ground is



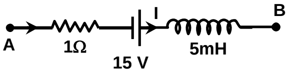
(A) zero

(B) 2 m/s towards mirror.

(C) 2 m/s away from mirror

(D) 4 m/s towards mirror.

9. The network shown in figure is a part of a complete circuit. If at a certain instant the current (I) is 5A, and is decreasing at a rate of 10^3 A/s. Then $V_B - V_A$ is equal to



(A) 15V (B) 25V

(C) 20V (D) 10 V

10. A planoconvex lens made of a material of refractive index 1.5 is silvered on the convex surface. Calculate the radius of curvature of the curved surface (Given : silvered lens which behaves as a mirror of focal length of -20 cm):

(A) 10 cm (B) 20 cm

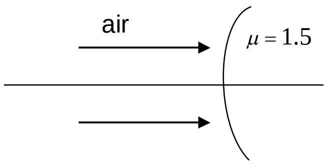
(C) 30 cm (D) 60 cm

Space for rough work

Multiple Correct Choice Type

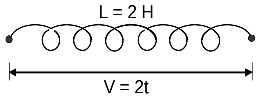
This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

11. Parallel rays of light are falling on convex spherical surface of radius of curvature R = 20 cm. Refractive index of the medium is $\mu = 1.5$. After refraction from the spherical surface parallel rays :



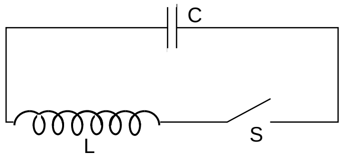
(A) actually meet at some point
(B) appears to meet after extending the refracted rays backwards
(C) meet (or appears to meet) at a distance of 30 cm from the spherical surface
(D) meet (or appears to meet) at a distance of 60 cm from the spherical surface

12. A variable voltage $V = 2t$ is applied across an inductor of inductance $L = 2H$ as shown in figure. Then,



(A) current versus time graph is a parabola
(B) energy stored in magnetic field at t = 2s is 4J
(C) potential energy at time t = 1 s in magnetic field is increasing at a rate of 1 J/s
(D) energy stored in magnetic field is zero all the time.

13. In the given circuit, initially the charge on capacitor is Q_o. At t = 0, the switch S is closed. Which of the following statement is/are correct?



(A) Maximum current through the inductor is $\frac{Q_o}{\sqrt{LC}}$

(B) Charge on the capacitor is zero at $t = \frac{\pi}{2}\sqrt{LC}$

(C) Current through the inductor is aero at$t = \frac{\pi}{2}\sqrt{LC}$

(D) Energy stored in magnetic field is zero all the time.

14. The potential difference applied to an X-ray tube is increased. Then which of the following is incorrect.
(A) The intensity increases.
(B) The minimum wavelength increases.
(C) The intensity decreases.
(D) The minimum wavelength remains constant.

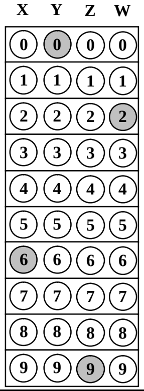
15. Which of the following is correct?
(A) Young's double slit experiment uses in coherent source
(B) Incoherent sources may having variable phase difference.
(C) Young's double slit experiment uses in incoherent source
(D) Incoherent sources must having same phase difference.

Space for rough work

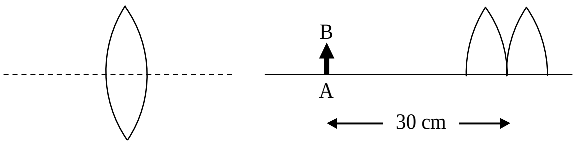
SECTION – C

Integer Answer Type

This section contains **5 questions.** The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. If a thin convex lens of focal length 20 cm is cut into two pieces from a plane passing through the pole, then both the pieces (touching each other) kept as shown in figure. If a object AB of length 2 cm is kept at distance of 30 cm. Find the height (in cm) of the image.

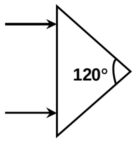


2. A solenoid of inductance 100 mH and resistance 20 Ω is connected to a cell of emf 10 V at t = 0. If the energy stored in the inductor when the time t = 5 ln2 milliseconds is $\frac{1}{64x}$ J, then find the value of "x"?

3. A wire of length ℓ = 6 ± 0.06 cm and radius r = 0.5 ± 0.005 cm and mass m = 0.3 ± 0.003 gm. Then find the maximum percentage error in density.

4. If the attractive potential between electron and proton were given by $V(r) = V_0 \ln\left(\frac{r}{r_0}\right)$ (where V_0, r_0 are constants), the radius r_n of the nth Bohr orbit in Hydrogen atom would be proportional to n^K. Then find the value of K.

5. An isosceles prism of angle 120^{o}C has a refractive index 1.44. Two parallel monochromatic rays enter the prism parallel to each other in air as shown. The rays emerge from the opposite faces make an angle **K** [$\sin^{-1}(0.72) - 30°$] with each other. Then find the value of K.



Space for rough work

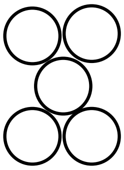
Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. The packing efficiency of the two dimensional square unit cell shown below is



(A) 39.27 % (B) 68.02%
(C) 74.05 % (D) 78.54 %

2. The freezing point of aqueous solution contains 5% by mass urea, 1% by mass KCl and 10% by mass of glucose is (K_f (H_2O) = 1.86 K molality)
(A) 290.2 K (B) 295.5 K
(C) 269.9 K (D) 250 K

3. Zn gives H_2 gas with H_2SO_4 and conc. HCl but not with conc. HNO_3 because
(A) NO_3^- ion is reduced in preference to hydronium ion
(B) conc. HNO_3 is a weaker acid than conc H_2SO_4 and conc. HCl
(C) conc. HNO_3 acts as a reducing agent
(D) Zn is more reactive than H_2

4. $\left[Fe(H_2O)_6\right]^{2+}$ and $\left[Fe(CN)_6\right]^{4-}$ differ in
(A) magnetic moment and colour
(B) geometry and magnetic moment
(C) oxidation state of central metal ion and number of unpaired electron
(D) geometry and hybridization

5. $HClO_4 + P_2O_5 \longrightarrow A + B$
(A) and (B) are
(A) $HClO_3$, H_3PO_4 (B) Cl_2O_6, HPO_3
(C) Cl_2O_7, HPO_3 (D) ClO_2, H_3PO_4

Space for rough work

6. Which of the following minerals does not contain aluminium?
(A) Cryolite (B) Mica
(C) Feldspar (D) Fluorspar

7. Copper metal on treatment with dil HNO_3 produces a gas X. X when passed through acidic solution of stannous chloride a nitrogen containing compound Y is obtained. Y on reaction with nitrous acid produces a gas Z. Gas Z is
(A) NO (B) N_2
(C) NO_2 (D) N_2O

8. Alum helps in purifying water by
(A) Coagulating the mud particles
(B) Making mud water soluble.
(C) Forming Si complex with clay particles.
(D) Sulphate part which coming with dirt and remove it.

9. Which of the following order is correct for bond angles in given compound?

OF_2	OCl_2	OH_2
(I)	(II)	(III)

(A) I > II > III (B) III > I >II
(C) II > III > I (D) II > I > III

10. Which of the following complex is sp^3 hybridized and paramagnetic?
(A) $Ni(CO)_4$ (B) $[Ni(CN)_4)]^{2-}$
(C) $[NiCl_4]^{2-}$ (D) $[Cu(NH_3)_4]^{2+}$

Space for rough work

Multiple Correct Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

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11. Which of the following compounds are coloured due to charge transfer spectrum?
(A) K_2CrO_7 (B) $KMnO_4$
(C) $[Co(NH_3)_6]Cl_3$ (D) $[Cu(NH_3)_4]SO_4$

12. Nitrogen dioxide can be obtained by heating
(A) KNO_3 (B) $Pb(NO_3)_2$
(C) $LiNO_3$ (D) $AgNO_3$

13. Which of the following statement is correct?
(A) Fe^{2+} gives brown colour with ammonium thiocyanate
(B) Fe^{2+} gives blue precipitate with potassium ferricyanide
(C) Fe^{3+} gives brown colour with potassium ferricyanide
(D) Fe^{3+} gives red colour with potassium ferrocyanide

14. Which of the following are ambidentate ligands?
(A) CN^- (B) SCN^-
(C) NO_2^- (D) CH_3COO^-

15. In which of the following pairs of solutions will be the values of the Van't Hoff factor be the same
(A) 0.05 M $K_4[Fe(CN)_6]$ and 0.10 M $FeSO_4$
(B) 0.10 M $K_4[Fe(CN)_6]$ and 0.05 M $FeSO_4$. $(NH_4)_2.SO_4.6H_2O$
(C) 0.20 M NaCl and 0.l M $BaCl_2$
(D) 0.05 M $FeSO_4(NH_4)_2SO_46H_2O$ and 0.02 M $KCl.MgCl_2.6H_2O$

Space for rough work

SECTION – C

Integer Answer Type

This section contains **5 questions.** The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.

X	Y	Z	W
⓪	⓿	⓪	⓪
①	①	①	①
②	②	②	❷
③	③	③	③
④	④	④	④
⑤	⑤	⑤	⑤
❻	⑥	⑥	⑥
⑦	⑦	⑦	⑦
⑧	⑧	⑧	⑧
⑨	⑨	❾	⑨

1. The total number of P – O – P and P – O – H bonds present in pyro phosphoric acid.

2. How many lone pairs are present in H_3O^+?

3. How many bond angles are 90°C in XeF_4?

4. Number of salts among the following that will give metal on heating is $Zn(NO_3)_2$, $AgNO_3$, $Cu(NO_3)_2$, $Hg(NO_3)_2$.

5. What is the value of spin only magnetic moment value of $Fe(CO)_5$?

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Solution of the differential $y' = \dfrac{3yx^2}{x^3 + 2y^4}$ is

(A) $x^3y^{-1} = \dfrac{2}{3}y^3 + c$ (B) $x^2y^{-1} = \dfrac{2}{3}y^3 + c$

(C) $xy^{-1} = \dfrac{2}{3}y^3 + c$ (D) none of these

2. Let $f(x) = \begin{vmatrix} [x] & \{x\} & 1 \\ \{x\} & 1 & [x] \\ 1 & [x] & \{x\} \end{vmatrix}$, where [x] = greatest integer function and {x} = fractional part of x.

Then which of the following is incorrect

(A) $f(x) \ge 0$ for $x \in (-\infty, -1]$

(B) f(x) has no real root for $x \in (0,1)$

(C) for $x \in [0,1)$, range of f(x) is $(-2, -1]$

(D) for $x \in [1, 2)$, f(x) has exactly one local minima

3. The solution of $\dfrac{xdy}{x^2 + y^2} = \left(\dfrac{y}{x^2 + y^2} - 1\right)dx$ is

(A) $y = x\cot(c - x)$ (B) $\cos^{-1}\left(\dfrac{y}{x}\right) = -x + C$

(C) $y = x\tan(C - x)$ (D) $\dfrac{y^2}{x^2} = x\tan(C - x)$

Space for rough work

4. Value of $\begin{vmatrix} \cos{}^{2\pi}\!/_{63} & \cos{}^{3\pi}\!/_{90} & \cos{}^{4\pi}\!/_{77} \\ \cos\left({}^{\pi}\!/_{72}\right) & \cos{}^{\pi}\!/_{40} & \cos{}^{3\pi}\!/_{88} \\ 1 & \cos\left({}^{\pi}\!/_{90}\right) & \cos\left({}^{2\pi}\!/_{99}\right) \end{vmatrix}$ is equal to

(A) 0
(B) –1
(C) –2
(D) none of these

5. If $\Delta = \begin{vmatrix} \sin A & \sin B & \sin C \\ \cos A & \cos B & \cos C \\ \cos^3 A & \cos^3 B & \cos^3 C \end{vmatrix} = 0$ and A, B, C are angles of a triangle

Then
(A) ΔABC is always isosceles
(B) ΔABC is always equilateral
(C) ΔABC is always scalable
(D) none of these

6. Solution of $ydx - xdy + (1 + x^2)dx + x^2 \sin y dy = 0$

(A) $\frac{y}{x} + \frac{1}{x} - x + \cos y + c = 0$
(B) $\frac{y}{x} + \frac{1}{x^2} - x + \cos y + c = 0$
(C) $\frac{2y}{x} - \frac{1}{x^2} - x + \cos y + c = 0$
(D) none of these

7. The simplification of $\begin{bmatrix} 1 & -\sqrt{3} \\ \sqrt{3} & 1 \end{bmatrix}^{15}$ is equal to

(A) $-2^{15}\mathbf{I}$
(B) $2^{15}\mathbf{I}$
(C) $(\sqrt{3})^{15}\mathbf{I}$
(D) none of these

8. If A and B are two 3 × 3 symmetric matrix such that X = AB – BA then det(X) is equal to

(A) 0
(B) 1
(C) 2
(D) 3

9. The curve whose equation satisfies $x\frac{dy}{dx} - 4y = x^2\sqrt{y}$ passes through $(1, (\ell n2)^2)$, then the value of y(2) is

(A) $6\,\ell n2$
(B) $(2\,\ell n2)^2$
(C) $(6\,\ell n2)^2$
(D) none of these

Space for rough work

10. The probability of scoring a century in a cricket match by Sachin and Saurabh are $\frac{1}{4}$ and $\frac{1}{5}$ respectively and probability of getting out of a player by bowled, LBW, Catch, Run and stumping are $\frac{1}{7}, \frac{2}{7}, \frac{2}{7}, \frac{1}{7}$ and $\frac{1}{7}$ respectively, if Sachin score a century while Saurabh does not, then the probability Sachin is catch out and Saurabh is bowled, is (given both players got out)

(A) $\frac{4}{49}$ (B) $\frac{1}{19}$

(C) $\frac{2}{49}$ (D) $\frac{2}{19}$

Multiple Correct Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

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11. For fixed integer n, $\Delta = \begin{vmatrix} n! & (n+1)! & (n+2)! \\ (n+1)! & (n+2)! & (n+3)! \\ (n+2)! & (n+3)! & (n+4)! \end{vmatrix}$, then $\left[\frac{\Delta}{(n!)^3} - 4\right]$ is divisible by

(A) n (B) $n^2 + 4n + 5$

(C) $n^2 + 4n - 5$ (D) $2n^2$

12. $A = \begin{bmatrix} 0 & 1 & 2 \\ 0 & -3 & 0 \\ 1 & 1 & 1 \end{bmatrix}$ and $6A^{-1} = aA^2 + bA + cI$, where a, b, c $\in$ integers and I is identity matrix. Then

(A) a + b + c = – 2

(B) $A^{-1} = \frac{1}{6}\begin{bmatrix} -3 & 1 & 6 \\ 0 & -2 & 0 \\ 3 & 1 & 0 \end{bmatrix}$

(C) $a + b + c = 18$

(D) $A^{-1} = \frac{1}{12}\begin{bmatrix} 3 & 3 & 2 \\ 2 & 4 & -1 \\ 5 & 1 & -4 \end{bmatrix}$

Space for rough work

13. If E and F are two independent events such that $P(E\cap F)=\frac{k}{3}$ and $P(\bar{E}\cap\bar{F})=\frac{k}{6}$ $(k\in I)$ and $(P(E)-P(F))(1-P(F))>0$. Then

(A) $P(E)=\frac{2}{3}$ (B) $P(F)=\frac{1}{2}$

(C) $P(E)=\frac{1}{2}$ (D) $P(E)+P(F)=\frac{7}{6}$

14. If $\vec{a},\ \vec{b},\ \vec{c}$ are non-coplanar unit vectors also $\vec{b},\ \vec{c}$ are non-collinear and $2\vec{a}\times\left(\vec{b}\times\vec{c}\right)=\vec{b}+\vec{c}$, then

(A) angle between $\vec{a}$ and $\vec{c}$ is 60° (B) angle between $\vec{b}$ and $\vec{c}$ is 30°

(C) angle between $\vec{a}$ and $\vec{b}$ is 120° (D) $\vec{b}$ is perpendicular to $\vec{c}$

15. If $\vec{a},\ \vec{b}$ and $\vec{c}$ are non-coplanar vectors such that $\bar{a}.\bar{a}=\bar{b}.\bar{b}=\bar{c}.\bar{c}=3$ and $\bar{a}.\bar{b}=\bar{b}.\bar{c}=\bar{c}.\bar{a}=1$, then

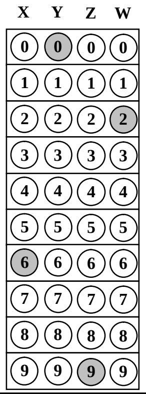
(A) $\left[\bar{a}+\bar{b}\quad \bar{b}+\bar{c}\quad \bar{c}+\bar{a}\right]=4\sqrt{5}$ (B) volume of tetrahedron is $\frac{\sqrt{5}}{3}$

(C) $\left[\bar{a}\times\bar{b}\quad \bar{b}\times\bar{c}\quad \bar{c}\times\bar{a}\right]=20$ (D) $\left[\bar{a}\ \bar{b}\ \bar{c}\right]=\frac{\sqrt{5}}{3}$

SECTION – C

Integer Answer Type

This section contains **5 questions.** The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown.



1. Three boxes are labelled as X, Y, Z and each box contains 5 balls numbered 1, 2, 3, 4, 5. The balls in each box are well mixed. One ball is chosen at random from each of the three boxes X, Y, Z respectively. If α, β, γ are the numbers on the balls chosen, then the probability that $\alpha=\beta+\gamma$ is equal to $\frac{K}{25}$ then K is equal to _____.

Space for rough work

2. There are 3 different pairs (i.e. 6 units say a, a, b, b, c, c) of shoes in a lot. Now three persons come and pick the shoes randomly (each gets 2 units). Let p be the probability that no one is able to wear shoes (i.e. no one gets a correct pair), then the value of $\frac{13p}{4-p}$, is _____.

3. Let $\vec{a} = \vec{b} + \vec{c}, \vec{b} \times \vec{d} = \vec{0}, \vec{c}.\vec{d} = 0, |\vec{d}| \neq 0$ and $|\vec{c}| = 2$ then the value of $\frac{\left|\vec{d} \times \left(\vec{a} \times \vec{d}\right)\right|}{\left|\vec{d}\right|^2 \left|\vec{c}\right|}$ is equal to _____.

4. Let $\vec{a} = \cos\theta\hat{i} + \hat{j} + \hat{k}, \vec{b} = \hat{i} + \cos\theta\hat{j} + \hat{k}, \vec{c} = \hat{i} + \hat{j} + \hat{k}$, $\left|\vec{a}.(\vec{b} \times \vec{c})\right|$ is maximum, then square of the shortest distance between $\vec{r} = \vec{a} + \lambda_1\vec{b}$ and $\vec{r} = \vec{b} + \lambda_2\vec{c}$ is _____.

5. The differential equation of $\left(y\sqrt{x^2 + y^2} - x\right)dx + \left(x\sqrt{x^2 + y^2} - y\right)dy = 0$ represents a curve given by $f(x, y) = 0$. The point (0, 2) satisfies the equation of the curve and the value of x when y = 1 is $\frac{-h}{4}$. Then h is equal to _____.

Space for rough work

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014: 2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

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ALL INDIA INTEGRATED TEST SERIES

ANSWERS, HINTS & SOLUTIONS

PART TEST –IV

(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	D	A
2.	C	C	D
3.	C	A	C
4.	C	A	A
5.	A	C	B
6.	D	D	B
7.	B	D	A
8.	A	A	A
9.	A	C	C
10.	D	C	C
11.	A, D	A, B	A, B
12.	A, B, C	B, C, D	A, B
13.	A, B	B, C	A, B, D
14.	A, B, C, D	A, B, C	A, C
15.	A, B	B, D	A, B, C
1.	1	5	2
2.	5	1	2
3.	4	4	1
4.	1	2	2
5.	2	0	3

Physics PART – I

2. Use Lenz's Rule

3. Speed of image = speed of object in all the mirrors

4. Use $\mu = \dfrac{\sin\left(\dfrac{A+\delta_m}{2}\right)}{\sin\left(\dfrac{A}{2}\right)}$

6. $\varepsilon = -\dfrac{d\phi}{dt}$ and $P = \dfrac{\varepsilon^2}{R}$

7. For CBF $\Delta P = 0 = t_A(\mu_A - 1) - t_B(\mu_B - 1) + \dfrac{dy}{D}$

9. $V_A - iR + 15 + (5 \times 10^{-3}) \times 10^3 = V_B$

Chemistry

PART – II

SECTION – A

1. $PF = \frac{2\pi r^2}{\left(2\sqrt{2}r\right)^2} = \frac{2\pi r^2}{8r^2} = \frac{\pi}{4}$

So packing efficiency = $\frac{\pi}{4} \times 100 = 78.54\%$

2. $\Delta T_f = \Delta T_f \text{ for glucose} + \Delta T_f \text{ for KCl} + \Delta T_f \text{ for urea}$

$\Delta T_f = \frac{1.86 \times 1000 \times 10}{100 \times 80} + 2 \times \frac{1.86 \times 1000 \times 1}{74.5 \times 100} + \frac{1.86 \times 1000 \times 5}{100 \times 60}$

$\Delta T_f = 3.069°$

$\therefore$ F. Pt = 273 – 3.069 = 269.93 K

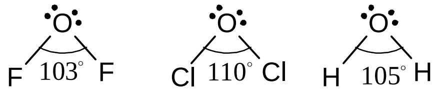
3. $Zn + 4HNO_3 \longrightarrow Zn(NO_3)_2 + 2NO_2 + 2H_2O$

NO_3^- ion is reduced to NO_2 in preference to H_3O^+ ion.

4. H_2O is a weak field ligand and CN^- is strong, field ligand.

5. $2HClO_4 + P_2O_5 \longrightarrow Cl_2O_7 + 2HPO_3$

7. $Cu + \text{dil } HNO_3 \longrightarrow \underset{(X)}{NO} \xrightarrow{SnCl_2/HCl} \underset{(Y)}{NH_2OH.HCl} \xrightarrow{HNO_2} \underset{(Z)}{N_2O}$

9. 

Because of larger size of Cl atm.

OCl_2 have largest bond angle.

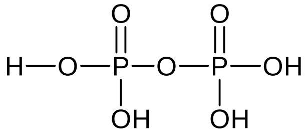
10. $[NiCl_4]^{2-}$ is sp^3 hybridized, because Cl^- is weak field ligand. Hence there is two unpaired electrons.

15. Number of particles from $K_4[Fe(CN)_6]$ = 5

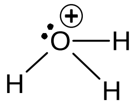
Number of particles from $FeSO_4.(NH_4)_2SO_4.6H_2O$ = 5

Number of particles from $KCl.MgCl_2.6H_2O$ = 5

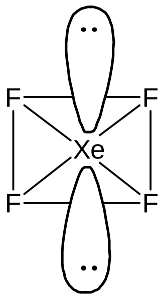
SECTION – C

1. 

$$H-O-\overset{\overset{O}{||}}{\underset{\underset{OH}{|}}{P}}-O-\overset{\overset{O}{||}}{\underset{\underset{OH}{|}}{P}}-OH$$

2. 

3.



4. $AgNO_3 \longrightarrow Ag + NO_2 + \frac{1}{2}O_2$

$Hg(NO_3)_2 \longrightarrow Hg + 2NO_2 + O_2$

5. In $[Fe(CO)_5]$, there is no unpaired electron.

Mathematics PART – III

1. $(3\,yx^2)\,dx + (-x^3 - 2y^4)\,dy = 0,\ x^3y^{-1} = \frac{2}{3}y^3 + c$

2. $f(x) = -\left(\frac{1+x}{2}\right)\left(([x]-1)^2 + (\{x\}-1)^2 + ([x]-\{x\})^2\right)$

3. $\frac{x\,dy - y\,dx}{x^2+y^2} = -\,dx \Rightarrow$ Solution is $y = x\tan(C - x)$

4. Given determinant $= \begin{vmatrix} \cos\left(\pi/7 - \pi/9\right) & \cos\left(\pi/7 - \pi/10\right) & \cos\left(\pi/7 - \pi/11\right) \\ \cos\left(\pi/8 - \pi/9\right) & \cos\left(\pi/8 - \pi/10\right) & \cos\left(\pi/8 - \pi/11\right) \\ \cos\left(\pi/9 - \pi/9\right) & \cos\left(\pi/9 - \pi/10\right) & \cos\left(\pi/9 - \pi/11\right) \end{vmatrix}$

$$= \begin{vmatrix} \cos\pi/7 & \sin\pi/8 & 0 \\ \cos\pi/8 & \sin\pi/8 & 0 \\ \cos\pi/9 & \sin\pi/9 & 0 \end{vmatrix} \begin{vmatrix} \cos\pi/9 & \sin\pi/9 & 0 \\ \cos\pi/10 & \sin\pi/10 & 0 \\ \cos\pi/11 & \sin\pi/11 & 0 \end{vmatrix} = 0$$

5. Let $\Delta = \begin{vmatrix} \sin A & \sin B & \sin C \\ \cos A & \cos B & \cos C \\ \cos^3 A & \cos^3 B & \cos^3 C \end{vmatrix} = \cos A\cos B\cos C \begin{vmatrix} \tan A & \tan B & \tan C \\ 1 & 1 & 1 \\ \cos^{-} A & \cos^{-} B & \cos^{-} C \end{vmatrix}$

$$= -\sin(B-C)\sin(C-A).\sin(A-B) = 0$$

6. $\frac{y\,dx - x\,dy}{x^2} + \left(\frac{1+x^2}{x^2}\right)dx + \sin y\,dy = 0$

$$-d\left(y/x\right) + d\left(\frac{-1}{x} + x\right) + d(-\cos y) = 0$$

$$\Rightarrow y/x + \frac{1}{x} - x + \cos y + c = 0$$

7. We know $\begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}^n = \begin{bmatrix} \cos n\theta & -\sin n\theta \\ \sin n\theta & \cos n\theta \end{bmatrix}$

Let $\theta = \pi/3 \therefore \begin{bmatrix} 1/2 & -\sqrt{3}/2 \\ \sqrt{3}/2 & 1/2 \end{bmatrix}^{15} = \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix} - I$

$$\therefore \begin{bmatrix} 1 & -\sqrt{3} \\ \sqrt{3} & 1 \end{bmatrix}^{15} = -2^{15}I$$

8. X is a skew symmetric matrix of odd order.
$\Rightarrow$ det(X) = 0

9. $x\frac{dy}{dx} - 4y = x^2\sqrt{y} \Rightarrow \frac{1}{2\sqrt{y}}\frac{dy}{dx} - \frac{2\sqrt{y}}{x} = \frac{x}{2}$ now let $\sqrt{y} = t \Rightarrow \frac{1}{2\sqrt{y}}\frac{dy}{dx} = \frac{dt}{dx}$

$\Rightarrow \frac{dt}{dx} - \frac{2}{x}t = \frac{x}{2}$ this is linear differential equation so

I.F. $= e^{\int \frac{-2}{x}dx} = e^{-2\ell nx} = \frac{1}{x^2}$ solution $t\frac{1}{x^2} = \int \frac{1}{x^2}.\frac{x}{2}dx \Rightarrow \frac{\sqrt{y}}{x^2} = \frac{1}{2}\ell nx + c \Rightarrow \sqrt{y} = \frac{x^2}{2}\ell nx + x^2c$

Given curve passes through $(1, (\ell n2)^2)$

$\sqrt{(\ell n2)^2} = c \Rightarrow c = \ell n2 \Rightarrow \sqrt{y} = \frac{x^2}{2}\ell nx + x^2.\ell n2$ now $\sqrt{y(2)} = 6\ell n2 \Rightarrow y(2) = (6\ell n2)^2$

10. Required probability $\dfrac{\left(\frac{1}{4}\times\frac{4}{5}\times\frac{1}{7}\times\frac{1}{7}\right)(1\times 2)}{\left(\frac{1}{4}\times\frac{4}{5}\times\frac{1}{7}\times\frac{1}{7}\right)[2(19)+11]} = \frac{2}{49}$

11.
$$\Delta = (n!)^3\begin{vmatrix} 1 & (n+1) & (n+1)(n+2) \\ n+1 & (n+1)(n+2) & (n+1)(n+2)(n+3) \\ (n+1)(n+2) & (n+1)(n+2)(n+3) & (n+4)(n+3)(n+2)(n+1) \end{vmatrix}$$

$$\frac{\Delta}{(n!)^3} = (n+1)^2(n+2)\begin{vmatrix} 1 & (n+1) & (n+2)(n+1) \\ 1 & (n+2) & (n+2)(n+3) \\ 1 & (n+3) & (n+3)(n+4) \end{vmatrix} = (n+1)^2(n+2)\begin{vmatrix} 1 & (n+1) & (n+2)(n+1) \\ 0 & 1 & 2(n+2) \\ 0 & 1 & 2(n+3) \end{vmatrix}$$

$= (n+1)^2(n+2).2(n+3-n-2)$

$= 2n(n^2+4n+5)+4$

12.
$$A^2 = \begin{bmatrix} 0 & 1 & 2 \\ 0 & -3 & 0 \\ 1 & 1 & 1 \end{bmatrix}\begin{bmatrix} 0 & 1 & 2 \\ 0 & -3 & 0 \\ 1 & 1 & 1 \end{bmatrix} = \begin{bmatrix} 2 & -1 & 2 \\ 0 & 9 & 0 \\ 1 & -1 & 3 \end{bmatrix}$$

$$\therefore A^{-1} = \frac{\text{adj}A}{|A|} = \frac{1}{6}\begin{bmatrix} -3 & 1 & 6 \\ 0 & -2 & 0 \\ 3 & 1 & 0 \end{bmatrix}$$

$\therefore$ Comparing L.H.S and R.H.S., we get a = 1, b = 4, c = –1, d = 12

Alternate method

By Cayley Hamilton theorem, A must satisfy $|A - \lambda I| = 0$

$\therefore \lambda^3 + 2\lambda^2 - 5\lambda + 6 = 0$

A must satisfy the above equation

$A^3 + 2A^2 - 5A - 6I = 0$

Multiplying by A^{-1}

$A^2 + 2A - 5I = 6A^{-1}$

13. $P(E\cap F) = P(E).P(F) = xy = \frac{k}{3}$ ….. (1)

Let P(E) = x and P(F) = y

And $P(\bar{E}\cap\bar{F}) = P(\bar{E}).P(\bar{F}) = (1-P(E))(1-P(F)) = \frac{k}{6}$

$= (1-x)(1-y) = \frac{k}{6}$ ….. (2)

Solving equation 1 and 2, we get $6x^2 - x(k+6) + 2k = 0$

As $x \in Q$; then D should be perfect square, which is possible for k = 1

Therefore we get $x = \frac{2}{3}$ or $\frac{1}{2}$ and y = $\frac{1}{2}$ or $\frac{2}{3}$

But given (P(E) – P(F)) (1–P(F)) > 0 $\Rightarrow$ P(E) > P(F)

Hence $x = \frac{2}{3}$ and $y = \frac{1}{2}$ $\Rightarrow$ P(E) = $\frac{2}{3}$ and P(F) = $\frac{1}{2}$

14. $(\vec{a}\cdot\vec{c})\vec{b} - (\vec{a}\cdot\vec{b})\vec{c} = \frac{\vec{b}+\vec{c}}{2}$

$\vec{b}\left(\vec{a}\cdot\vec{c} - \frac{1}{2}\right) - \vec{c}\left(\vec{a}\cdot\vec{b} + \frac{1}{2}\right) = 0$

$\Rightarrow$ $\vec{a}\cdot\vec{c} = \frac{1}{2}$ and $\vec{a}\cdot\vec{b} = -\frac{1}{2}$

$\Rightarrow$ θ_1 is $\frac{\pi}{3}$ and θ_2 = 120°

15. $$\begin{bmatrix}\bar{a} & \bar{b} & \bar{c}\end{bmatrix}^2 = \begin{vmatrix} \bar{a}.\bar{a} & \bar{a}.\bar{b} & \bar{a}.\bar{c} \\ \bar{b}.\bar{a} & \bar{b}.\bar{b} & \bar{b}.\bar{c} \\ \bar{c}.\bar{a} & \bar{c}.\bar{b} & \bar{c}.\bar{c} \end{vmatrix} = \begin{vmatrix} 3 & 1 & 1 \\ 1 & 3 & 1 \\ 1 & 1 & 3 \end{vmatrix} = 3(9-1) - 1(3-1) + 1(1-3) = 24 - 2 - 2 = 20$$

Volume of tetrahedron = $\frac{1}{6}\begin{bmatrix}\bar{a} & \bar{b} & \bar{c}\end{bmatrix} = \frac{\sqrt{5}}{3}$

$\begin{bmatrix}\bar{a}+\bar{b} & \bar{b}+\bar{c} & \bar{c}+\bar{a}\end{bmatrix} = \left[(\bar{a}+\bar{b})\times(\bar{b}+\bar{c})\right].(\bar{c}+\bar{a}) = \left[\bar{a}\times\bar{b} + \bar{a}\times\bar{c} + \bar{b}\times\bar{b} + \bar{b}\times\bar{c}\right](\bar{c}\times\bar{a})$

= $(\bar{a}\times\bar{b}).\bar{c} + (\bar{a}\times\bar{c}).\bar{c} + (\bar{b}\times\bar{c}).\bar{c} + (\bar{a}\times\bar{b}).\bar{a} + (\bar{a}\times\bar{c}).\bar{a} + (\bar{b}\times\bar{c}).\bar{a} = 2\begin{bmatrix}\bar{a} & \bar{b} & \bar{c}\end{bmatrix}$

$\begin{bmatrix}\bar{a}\times\bar{b} & \bar{b}\times\bar{c} & \bar{c}\times\bar{a}\end{bmatrix}$

Let $d = \bar{a}\times\bar{b}$

$= \left[(\bar{d}.\bar{c}).\bar{b} - (\bar{d}.\bar{b}).\bar{c}\right].(\bar{c}\times\bar{a}) = \left[\begin{bmatrix}\bar{a} & \bar{b} & \bar{c}\end{bmatrix}\bar{b} - 0\right](\bar{c}\times\bar{a})$

$= \begin{bmatrix}\bar{a} & \bar{b} & \bar{c}\end{bmatrix}\begin{bmatrix}\bar{b} & \bar{c} & \bar{a}\end{bmatrix} = \begin{bmatrix}\bar{a} & \bar{b} & \bar{c}\end{bmatrix}^2$

SECTION – C

1. n(S) = 5 × 5 × 5 = 125

n(A) = 514, 541, 523, 532, 413, 431, 422, 312, 321, 211

Required probability = $\frac{10}{125} = \frac{2}{25}$

2. $p = \dfrac{6c_2 4c_2 2c_2 - 3c_1 3c_1 4c_2 2c_2 + 3c_2 3c_2 \underline{|2} - \underline{|3}}{6c_2 4c_2 2c_2} = \dfrac{90 - 54 + 18 - 6}{90} = \dfrac{8}{15}$.

3. $\vec{d} \times \left(\vec{a} \times \vec{d}\right) = \left|\vec{d}\right|^2 \vec{c}$

4. $\left|\vec{a}.(\vec{b} \times \vec{c})\right|$ is maximum then cos $\theta = -1$.

$\therefore$ (S.D.)^2 = 2

5. $y\sqrt{x^2 + y^2}dx + x\sqrt{x^2 + y^2}dy = xdx + ydy$

$ydx + xdy = \dfrac{xdx + ydy}{\sqrt{x^2 + y^2}}$

Integrating both sides, $xy = \sqrt{x^2 + y^2} + c$, $c = -2$

$\Rightarrow \sqrt{x^2 + y^2} = xy + 2 \Rightarrow y = 1 \Rightarrow x = \dfrac{-3}{4}$

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ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Advanced), 2015**

PART TEST – IV

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 198**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 to 14) contains 3 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (15 to 20) contains 6 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

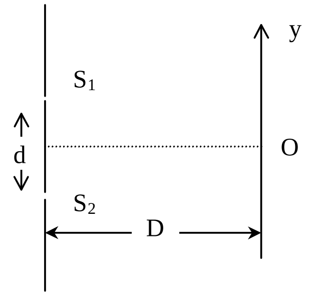
Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. Two mirrors, one concave and the other convex, are placed 60 cm apart with their reflecting surfaces facing each other. An object is placed 30 cm from the pole of either of them on their axis. If the focal lengths of both the mirrors are 15cm, the position of the image formed by reflection, first at the convex and then at the concave mirror, is
(A) 19.09 cm from the pole of the convex mirror
(B) 19.09 cm from the pole of the concave mirror
(C) 11.09 cm from the pole of the concave mirror
(D) 11.09 cm from the pole of the convex mirror

2. An alternating voltage $E = E_0 \sin \omega t$, is applied across a coil of inductor L. The current flowing through the circuit at any instant t is
(A) $\frac{E_0}{\omega L} \sin(\omega t + \pi/2)$
(B) $\frac{E_0}{\omega L} \sin(\omega t - \pi/2)$
(C) $E_0\, \omega L \sin(\omega t - \pi/2)$
(D) $E_0\, \omega L \sin(\omega t + \pi/2)$

3. Consider a usual set up of Young's double slit experiment with slits of equal intensity as shown in the figure. Take 'O' as origin and the Y axis as indicated. If average intensity between $y_1 = -\frac{\lambda D}{4d}$ and $y_2 = +\frac{\lambda D}{4d}$ equals 'n' times the intensity of maxima, then 'n' equals



(A) $\frac{1}{2}\left(1+\frac{2}{\pi}\right)$
(B) $2\left(1+\frac{2}{\pi}\right)$
(C) $\left(1+\frac{2}{\pi}\right)$
(D) $\frac{1}{2}\left(1-\frac{2}{\pi}\right)$

Space for rough work

4. One of the combination from the fundamental physical constants is hc/G. The unit of this expression is

(A) kg^2 (B) m^3

(C) s^{-1} (D) none of the above

5. Let $[\varepsilon_0]$ denote the dimensional formula of the permittivity of vacuum. If M = mass, L = length, T = time and I = electric current. Then

(A) $[\varepsilon_0] = [M^{-1}L^{-3}T^2I]$ (B) $[\varepsilon_0] = [M^{-1}L^{-3}T^4I^2]$

(C) $[\varepsilon_0] = [M^{-1}L^2T^{-1}I^{-2}]$ (D) $[\varepsilon_0] = [M^{-1}L^2T^{-1}I]$

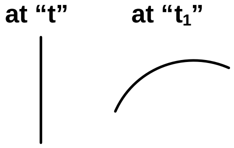
6. A coil of resistance R and inductance L is connected across an a.c. power supply of r.m.s. voltage V. The average power dissipated in the coil is,

(A) V^2/R (B) $\frac{V^2R}{(R^2+\omega^2L^2)}$

(C) $\frac{V^2}{\sqrt{(R^2+\omega^2L^2)}}$ (D) zero

7. The figure shows a plane wave front at a time 't' and at a time 't_1'

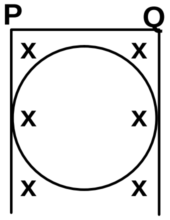
In the time interval $(t_1 - t)$ the wave front must have passed through



(A) a prism (B) a prism and a convex lens

(C) a convex lens (D) a plane mirror and a concave lens

8. A vertical ring of radius r and resistance R falls vertically. It is in contact with two vertical rails which are joined at the top. The rails are without friction and resistance. There is a horizontal uniform magnetic field of magnitude B perpendicular to the plane of the ring and the rails. When the speed of the ring is v, the current in the section PQ is



(A) zero (B) $\frac{2Brv}{R}$

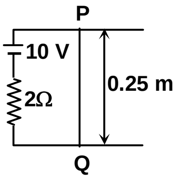
(C) $\frac{4Brv}{R}$ (D) $\frac{8Brv}{R}$

Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

Paragraph for Question Nos. 9 to 10



A metal wire PQ slides on parallel metallic rails having separation 0.25 m, each having negligible resistance. There is a 2 Ω resistor and 10 V battery as shown in figure.

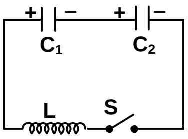
There is a uniform magnetic field directed into the plane of the paper of magnitude 0.5T. A force of 0.5 N to the left is required to move wire PQ with constant speed to the right.

Then find the answer of following questions based on above paragraph.

9. With what speed is the wire PQ moving?
   (A) 8 m/s (B) 4 m/s
   (C) 16 m/s (D) 32 m/s

10. Taking this as a simple motor, what is its efficiency?
   (A) 0.3 (B) 0.2
   (C) 0.1 (D) 0.4

Paragraph for Question Nos. 11 to 12



In the figure shown C_1 = 1F, C_2 = 2F and L = 5H. Initially C_1 is charged to 50 V and C_2 to 10 V. Switch S is closed at time t = 0. Suppose at some instant charge on C_1 is 20 C with the same polarities as shown in the figure.

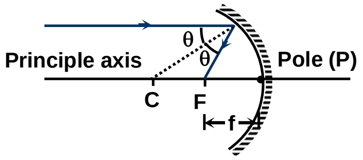
Then find the answer of following questions based on above paragraph.

11. Energy stored in capacitor C_2 at this instant will be:
   (A) 10 J (B) 15 J
   (C) 25 J (D) 40 J

12. Current in the circuit at this instant will be
   (A) $10\sqrt{2}$ A (B) $15\sqrt{2}$ A
   (C) 10 A (D) 20 A

Space for rough work

Paragraph for Question Nos. 13 to 14



Spherical aberration in spherical mirrors is a defect which is due to dependence of focal length 'f' on angle of incidence 'θ' as shown in figure is given by

$$f = R - \frac{R}{2}\sec\theta$$

Where R is radius of curvature of mirror and θ is the angle of incidence. The rays which are closed to principle axis are called paraxial rays and the rays far away from principal axis called marginal rays. As a result of above dependence different rays are brought to focus at different points and the image of a point object is not a point.

Then find the answer of following questions based on above paragraph.

13. If f_P and f_m represent the focal length of paraxial and marginal rays respectively, then correct relationship is:

(A) $f_p = f_m$
(B) $f_p > f_m$
(C) $f_p < f_m$
(D) none

14. If angle of incidence is 60°, then focal length of this ray is:

(A) R
(B) R/2
(C) 2R
(D) 0

Multiple Correct Choice Type

This section contains **6 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct

15. Suppose the potential energy between electron and proton at a distance r is given by $-\frac{Ke^2}{2r^3}$.

Using Bohrs theory choose the correct statements.

(A) Energy in the nth orbit is proportional to n^3
(B) Energy in the nth orbit is proportional to n^6
(C) Energy is proportional to m^2 (m : mass of electron)
(D) Energy is proportional to m^{-3} (m : mass of electron)

Space for rough work

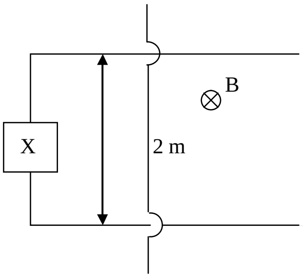
16. Let [ε_o] denote the dimensional formula of the permittivity of the vacuum, and [μ_o] that of the permeability of the vacuum. If M = mass, L = length, T = time and I = electric current,

(A) $[\mu_o] = M^{-1}L^{-3}T^{2}I$
(B) $[\varepsilon_o] = M^{-1}L^{-3}T^{4}I^{2}$
(C) $[\mu_o] = MLT^{-2}I^{-2}$
(D) $[\mu_o] = ML^{2}T^{-1}I$

17. Which of the following (referred to a spherical mirror) do (does) not depend on whether the rays are paraxial or not?

(A) Pole
(B) Focus
(C) Radius of curvature
(D) Principal axis

18. A resistance-less rod of length 'ℓ' and mass 'm' can slide without friction on long rails of zero resistance which are connected to circuit element named 'X' as shown. This arrangement is in the horizontal plane in a uniform vertical magnetic field 'B' as shown below. Then match what happens to the rod

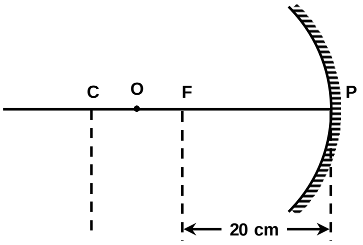


(A) X is resistor and rod is thrown with some velocity towards right and it comes to rest
(B) X is a resistor and the rod is pulled to right with constant force and it attains terminal velocity
(C) X is resistor and rod is thrown with some velocity towards right and it never comes in rest
(D) X is a resistor and the rod is pulled to right with constant force and it never attains terminal velocity

19. A long wire carrying a steady current I lies in the plane of a circular conducting loop placed at a certain distance from the wire. There will be an induced current in the loop if it is

(A) moved parallel to the wire
(B) rotated about an axis perpendicular to the plane of the loop, passing through the centre of the loop
(C) rotated about an axis parallel to the wire passing through the centre of the loop
(D) moved away from the wire

20. A point object 'O' is kept is front of a concave mirror of focal length 20 cm at a distance of 30 cm from the pole. The object is moving on the principal axis away from the pole with a velocity of 1 cm/second. The instantaneous velocity of the image is



(A) 2 cm/sec towards the pole
(B) 4 cm such that the image distance tends to increase
(C) 4 cm away from the pole parallel to the principal axis
(D) 4 cm/sec towards the pole and parallel to the principal axis

Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. Aqueous solutions of $Na_2S_2O_3$ on reaction with Cl_2 gives

(A) $Na_2S_4O_6$
(B) $NaHSO_4$
(C) NaCl
(D) NaOH

2. Both $[Ni(CO)_4]$ and $[Ni(CN)_4]^{2-}$ are diamagnetic. The hybridization of nickel in these complexes, respectively, are

(A) sp^3, sp^3
(B) sp^3, dsp^2
(C) dsp^2, sp^3
(D) dsp^2, dsp^2

3. At a certain temperature the dissociation constants of formic acid and acetic acid are 1.8×10^{-4} and 1.8×10^{-5} respectively. The concentration of acetic acid solution in which the hydrogen ion has the same concentration as in 0.001 M formic acid solution is equal to

(A) 0.001 M
(B) 0.01 M
(C) 0.1 M
(D) none of these

4. The increasing order of thermal stability for following salts will be

(A) $FeC_2O_4 < CaC_2O_4 < CaCO_3 < K_2C_2O_4$
(B) $K_2C_2O_4 < CaCO_3 < FeC_2O_4 < CaC_2O_4$
(C) $FeC_2O_4 < K_2C_2O_4 < CaC_2O_4 < CaCO_3$
(D) $CaCO_3 < K_2C_2O_4 < CaC_2O_4 < FeC_2O_4$

5. Which one of the following pairs of ions have the same electronic configuration?

(A) Cr^{3+}, Fe^{3+}
(B) Fe^{3+}, Mn^{2+}
(C) Mn^{2+}, Fe^{2+}
(D) Sc^{3+}, Cr^{3+}

6. A mono atomic gas is suddenly compressed to 1/8 of its volume adiabatically. The pressure of gas will change to

(A) 24/5 times
(B) 8 times
(C) 40/3 times
(F) 32 times

7. How do we differentiate between Fe^{3+} and Cr^{3+} in group III?

(A) By adding excess of NH_4OH solution
(B) By increasing NH_4^+ ion concentration
(C) By decreasing OH^- ion concentration
(D) Both (B) and (C)

Space for rough work

8. The compound which does not respond to ring test is
(A) $Pb(NO_3)_2$ (B) $LiNO_3$
(C) $NaNO_3$ (D) KNO_3

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

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Paragraph for question Nos. 9 to 10

$$(A) + NaCl \longrightarrow B(\text{white ppt.})$$
$$(B) + KI \longrightarrow C(\text{green ppt.})$$
$$(C) + KI(\text{excess}) \longrightarrow (D) + (E)(\text{colourless solution})$$
$$(E) + NH_3 + KOH \longrightarrow F$$

9. Compound (A) and (B) are respectively
(A) $AgNO_3$ and AgCl (B) $Pb(NO_3)_2$ ad $PbCl_2$
(C) $Hg_2(NO_3)_2$ and Hg_2Cl_2 (D) $Cu_2(NO_3)_2$ and Cu_2Cl_2

10. When compound (B) and reacts with NH_3 solution, the colour of the compound formed is
(A) black (B) red
(C) yellow (D) white

Paragraph for question Nos. 11 to 12

The binary compounds of oxygen with other elements are called oxides. They are classified either depending upon their acid – base characteristics or on the basis of oxygen content.

11. Which of the following pairs contains mixed oxides?
(A) Pb_3O_4, Fe_3O_4 (B) MnO_2, BaO_2
(C) KO_2, Na_2O_2 (D) Mn_3O_4, N_2O_5

12. Which of the following pairs contain amphoteric oxides?
(A) BeO, BaO (B) BeO, Al_2O_3
(C) Al_2O_3, P_2O_5 (D) FeO, CuO

Space for rough work

Paragraph for Question Nos. 13 to 14

A metal is regarded as an assembly of metal ions and free electrons. When the metal is in contact with water, some metal ions enter into the liquid due to a tendency in the metal, called by Nernst as "Electrolytic solution tension". An alloy of 1.45 gm Ag and Si was dissolved in desired amount of HNO_3 and volume made upto 500 ml. An Ag electrode was dipped in solution and E_{cell} of the cell is $\underset{(1\,atm)}{\text{Pt } H_2} \mid \underset{(1\,M)}{H^+} \parallel Ag^+/Ag$ was 0.503 V at 298 K. $\left[E^o_{Ag^+/Ag} = 0.80\text{ V}\right]$

Read the above paragraph carefully and answer the questions given below:

13. Observed concentration of Ag^+ in the cell
(A) 2.25×10^{-9} M (B) 9.25×10^{-6} M
(C) 9.25×10^{-7} M (D) 9.25×10^{-5} M

14. The emf of the cell involving the reaction, $2Ag^+(aq) + H_2(g) \longrightarrow 2Ag(s) + 2H^+(aq)$, is 0.80 V. The standard oxidation potential of Ag electrode is
(A) 0.80 V (B) –0.80 V
(C) 0.40 V (D) 0.20 V

Multiple Correct Choice Type

This section contains **6 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct

15. Which of the following exhibit Frenkel defects?
(A) AgI (B) AgCl
(C) KBr (D) ZnS

16. A d-block element forms octahedral complex but its magnetic moment remains same either in strong field or in a weak field ligand. Which of the following is/are correct?
(A) Element always form colourless compound
(B) Number of electrons in t_{2g} orbitals are higher than in e_g orbitals
(C) It can have either d^3 configuration
(D) It can have either d^7 configuration

17. The compound (s) which have peroxo linkage is (are)
(A) $H_2S_2O_3$ (B) H_2SO_5
(C) $H_2S_2O_7$ (D) $H_2S_2O_8$

Space for rough work

18. Identify the incorrect statement(s) among the following?
(A) CN^- is a pseudo halide
(B) Cl_2O(gas) on dissolving in KOH solution produces $KClO_3$
(C) Bleaching action of chlorine occurs in presence of moisture
(D) $H_3P_3O_9$ contains three P–P bonds

19. For a cell reaction represented by the equation

$$Cu(s) + 2Ag^+(aq) \longrightarrow Cu^{2+}(aq) + 2Ag(s)$$

The value of ΔG^o could be obtained by
(A) setting up $Cu(s)/Cu^{2+}(aq)$ and $Ag(s)/Ag^+(aq)$ half-cells (using molar solution and measuring the emf of the resulting cell)
(B) adding powdered copper to a solution of Ag^+ ions and determining the enthalpy change, repeating this experiment at different temperatures
(C) setting up $Cu(s)/Cu^{2+}(aq)$ and $Ag(s)/Ag^+(aq)$ half-cells and determining the molarities of the ions which gives an emf of zero for the cell
(D) setting up $Cu(s)/Cu^{2+}(aq)$ and $Ag(s)/Ag^+(aq)$ half-cells, using the resultant emf to drive a motor and measuring the work which it can do

20. In the depression of freezing point experiment, it is found that the
(A) vapour pressure of the solution is less than that of pure solvent
(B) vapour pressure of the solution is more than that of pure solvent
(C) only solute molecules solidify at the freezing point
(D) only solvent molecules solidify at the freezing point

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **8 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. Find the area enclosed between $x^2 + y^2 \le 9\pi^2$ and $\sin(x - y) \ge 0$

(A) $\frac{9\pi^3}{4}$ (B) $\frac{9\pi^3}{2}$

(C) $3\pi^3$ (D) π^3

2. Consider an invertible function f(x) with $f'(x) > 0$ and $f''(x) < 0\ \forall\ x \in R$. Also $f^{-1}(x)$ is the inverse function of f(x). Let f(x) and $f^{-1}(x)$ intersect each other at x = 0 and $x = \alpha(\alpha > 0)$ only and if $\int_0^{\alpha} f^{-1}(x)dx = A$; $\int_0^{\alpha} f(x)dx = B$ and $\frac{\alpha^2}{2} = C$ then

(A) A > B > C (B) A > C > B

(C) A < B < C (D) A < C < B

3. The area bounded by the curve $y^2 \le 4x$ and the circle $x^2 + y^2 - 2x - 3 \le 0$ is equal to

(A) $2\pi + \frac{8}{3}$ (B) $4\pi + \frac{8}{3}$

(C) $\pi + \frac{8}{3}$ (D) $\pi - \frac{8}{3}$

4. If P^{th}, q^{th}, r^{th} term of a GP are the positive numbers a, b, c then angle between the vectors $\log a^3\hat{i} + \log b^3\hat{j} + \log c^3\hat{k}$ and $(q-r)\hat{i} + (r-p)\hat{j} + (p-q)\hat{k}$ is

(A) $\frac{\pi}{6}$ (B) $\frac{\pi}{2}$

(C) $\frac{\pi}{3}$ (D) $\sin^{-1}\left(\frac{1}{\sqrt{a^2+b^2+c^2}}\right)$

5. If A is a square matrix of order n such that $|\text{adj}(\text{adj}A)| = |A|^9$, then the value of n can be

(A) 1 (B) 2

(C) 3 (D) 4

Space for rough work

6. Given that $A = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix}$ and $A^n = A^{n-2} + A^3 - A\ \forall n \geq 4$ and $A^3 - A^2 - A + I = 0$.

$A^{20} = \begin{bmatrix} 1 & 0 & 0 \\ k+1 & 1 & 0 \\ k+1 & 0 & 1 \end{bmatrix}$. Then k is equal to

(A) 3 (B) 6
(C) 9 (D) none of these

7. Let A be the event that P (A) = 0, then
(A) A is impossible event (always) (B) A could be possible
(C) A can be said (D) none of these

8. Forces $2\hat{i} + 7\hat{j}, 2\hat{i} - 5\hat{j} + 6\hat{k}, -\hat{i} + 2\hat{j} - \hat{k}$ act at a point P whose position vector is $4\hat{i} - 3\hat{j} - 2\hat{k}$. Then the vector moment of the resultant of three forces acting at P about the point Q, where position vector is $6\hat{i} + \hat{j} - 3\hat{k}$.

(A) $-24\hat{i} - 13\hat{j} - 4\hat{k}$ (B) $24\hat{i} - 13\hat{j} - 2\hat{k}$
(C) $-24\hat{i} + 13\hat{j} + 4\hat{k}$ (D) none of these

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

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Paragraph for Question Nos. 9 to 10

Read the following write up carefully and answer the following questions:

Let $M_1 = \begin{bmatrix} 3 & -4 \\ 1 & -1 \end{bmatrix}$ and $M_2 = \begin{bmatrix} x & 4 \\ 0 & 1 \end{bmatrix}$ (x ≠ 0, 1, x ∈ R) are two matrices and let $P = \begin{bmatrix} \frac{\sqrt{3}}{2} & \frac{1}{2} \\ -\frac{1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix}$ any matrix.

Also matrix $A = PM_1P^T$, $B = P^TA^{2012}P$, $C = PM_2P^T$ and $D = P^TC^{2012}P$.
Now answer the following questions

9. Trace (B + D) = 0 for
(A) x = 2 (B) x = –1
(C) more than 100 values of x (D) no value of x

Space for rough work

10. Let matrix $E = (M_1B^{-1}M_2D^{-1})^{-1}$, then sum of all elements of second row of E is equal to

(A) 0 (B) 2012

(C) −2010 (D) none of these

Paragraph for Question Nos. 11 to 12

Read the following write up carefully and answer the following questions:

If $P(A_1 \cap A_2) = P(A_1).P(A_2)$ then A_1, A_2 are called independent events for each pair is A_1, A_2, A_3 if $(A_i \cap A_j) = P(A_i).P(A_j)$ then A_1, A_2, A_3 are called mutually pair-wise independent events

11. An contains four tickets, each is marked as aab, aba, baa, bbb. And one ticket is drawn. Let A_i = event that i^{th} digit of the mark on ticket is a. Then

(A) A_1, A_2, A_3 are pair-wise independent

(B) A_1, A_2, A_3 are mutually independent

(C) A_1, A_2, A_3 are need not be pair-wise independent

(D) none of these

12. A and B are two independent events. The probability that both occur simultaneously is $\frac{1}{6}$ and the probability the neither occurs is $\frac{1}{3}$, then

(A) $P(A) = \frac{1}{2},\ P(B) = \frac{1}{3}$ (B) $P(A) = \frac{2}{3},\ P(B) = \frac{1}{3}$

(C) $P(A) = \frac{1}{3},\ P(B) = \frac{1}{3}$ (D) none of these

Paragraph for Question Nos. 13 to 14

Read the following write up carefully and answer the following questions:

If $P(x, yz)$ is varying such that $ax + by + cz + d = 0$ where $a^2 + b^2 + c^2 \neq 0$ then P traces a plane with normal $a\hat{i} + b\hat{j} + c\hat{k}$ and $a(x - x_1) + b(y - y_1) + c(z - z_1) = 0$ gives plane equation passing through $A(x_1, y_1, z_1)$ with normal vector $a\hat{i} + b\hat{j} + c\hat{k}$ $(a^2 + b^2 + c^2 \neq 0)$

13. A variable plane with a constant distance 'd' from origin cuts x, y, z axes at P, Q, R. Then locus of centroid of triangle PQR is

(A) $\frac{1}{x^2} + \frac{1}{y^2} + \frac{1}{z^2} = \frac{1}{d^2}$ (B) $\frac{1}{x^3} + \frac{1}{y^3} + \frac{1}{z^3} = \frac{9}{d^3}$

(C) $\frac{1}{\sqrt{|x|}} + \frac{1}{\sqrt{|y|}} + \frac{1}{\sqrt{|z|}} = \frac{1}{\sqrt{|d|}}$ (D) $\frac{1}{x^2} + \frac{1}{y^2} + \frac{1}{z^2} = \frac{9}{d^2}$

Space for rough work

14. A variable plane at a constant d from origin, intersects the axes at A, B, C. Planes are drawn to the coordinate planes and passing through A, B, C. Then locus of point of intersection of all planes is

(A) $\frac{1}{x^2}+\frac{1}{y^2}+\frac{1}{z^2}=\frac{1}{p^2}$ (B) $\frac{1}{x^2}+\frac{1}{y^2}+\frac{1}{z^2}=\frac{2}{p^2}$

(C) $\frac{1}{x^2}+\frac{1}{y^2}+\frac{1}{z^2}=\frac{3}{p^2}$ (D) none of these

Multiple Correct Choice Type

This section contains **6 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct

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15. Given three distinct planes $\begin{matrix} p_1 : ax+by+cz=1 \\ p_2 : bx+cy+az=1 \\ p_3 : cx+ay+bz=1 \end{matrix}$, then

(A) if the planes intersect at the single point (3,3,3) then a + b + c = $\frac{1}{3}$

(B) if a + b + c= 0, then the planes will not intersect at a common point

(C) if a + b + c $\neq$ 0 then the lines $\frac{x-1}{a}=\frac{y}{b}=\frac{z+1}{c}$ and $\frac{x+1}{c}=\frac{y}{b}=\frac{z-1}{a}$ will never intersect

(D) the lines $\frac{x-1}{a}=\frac{y-1}{b}=\frac{z-1}{c}$ and $\frac{x+1}{b}=\frac{y+1}{c}=\frac{z+1}{a}$ will never intersect

16. Which of the following is/are correct?

(A) P is orthogonal iff P^T is orthogonal

(B) if P is orthogonal, then P^{-1} is orthogonal

(C) if P and Q are orthogonal, then PQ is orthogonal

(D) none of these

17. Let A denotes the matrix $\begin{bmatrix} 0 & i \\ i & 0 \end{bmatrix}$, where $i^2 = -1$

(A) $I + A + A^2 + \dots\dots\dots + A^{2012} = I$ (B) $A^{4n+1} = A$, $n \in N$

(C) $A^{4n+2} = I$, $n \in N$ (D) $I + A + A^2 + \dots . + A^{2012} = A$

18. If A, B, C are the angles of a triangle and $\Delta = \begin{vmatrix} \sin^2 A & \sin A \cos A & \cos^2 A \\ \sin^2 B & \sin B \cos B & \cos^2 B \\ \sin^2 C & \sin C \cos C & \cos^2 C \end{vmatrix} = 0$, then

(A) triangle must be equilateral (B) triangle must be isosceles

(C) triangle can be equilateral (D) triangle must be right angled

Space for rough work

19. Let the vectors $\alpha\hat{i}+3\hat{j}-\hat{k},\ \hat{i}+(\alpha-1)\hat{j}+2\hat{k},\ 3\hat{i}+5\hat{j}+2\hat{k}.$ Then

(A) the number of planes determined above 3 vectors = 2

(B) angle between planes $=\cos^{-1}\left(\frac{17}{3\sqrt{23}}\right)$

(C) angle between planes $=\tan^{-1}\left(3/\sqrt{5}\right)$

(D) none of these

20. Let two curves y = f(x) with f(0) = 1 and $g(x)=\int\limits_{-\infty}^{x}f(t)dt$ with g(0) = 4 are such that, their tangents at the points with equal abscissa intersects on x-axis, then

(A) $\int\limits_{-1}^{1}\frac{x^2+4}{4+g(x)}dx=\frac{13}{3}$

(B) area bounded by y = f(x), y = g(x), x = 1 and y axis is $12(e^{1/4}-1)$ sq. unit

(C) f(x) – g(x) is decreasing in [–1, 1]

(D) period of $f\left(\left\{\frac{x}{2}\right\}\right)$ is 8 ({.} denotes fractional part of x)

Space for rough work

FIITJEE **JEE(Advanced)-2015**

ALL INDIA INTEGRATED TEST SERIES

FIITJEE Students From All Programs have bagged 34 in Top 100, 66 in Top 200 and 174 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2014: 2521 FIITJEE Students from Classroom / Integrated School Programs & 3579 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2014.

ANSWERS, HINTS & SOLUTIONS

PART TEST –IV
(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	B	B
2.	B	B	D
3.	A	B	A
4.	A	A	B
5.	B	B	D
6.	B	D	C
7.	B	C	B
8.	D	A	C
9.	C	C	D
10.	B	A	C
11.	C	A	A
12.	B	B	A
13.	B	B	D
14.	D	A	A
15.	B, D	A, B, D	A, B, D
16.	B, C	B, C	A, B, C
17.	A, C, D	B, D	A, B, C
18.	A, B	B, D	B, C
19.	C, D	A, C	A, B
20.	D	A, D	B, C

Physics

PART – I

1. Use $\frac{1}{v}+\frac{1}{u}=\frac{2}{R}$. Image after 1st reflection will act as object for 2nd reflection.

2. In inductor current lags voltage by $\pi/2$

3. $$n(4I_0)=\frac{\int\limits_{y=-\frac{\lambda D}{4d}}^{y=\frac{\lambda D}{4d}} 4I_0\cos^2\frac{\pi dy}{\lambda D}\,dy}{\int\limits_{-\frac{\lambda D}{4d}}^{\frac{\lambda d}{4d}} dy}$$

4. $E=\frac{hc}{\lambda}=\frac{GM^2}{L}$

   $\Rightarrow$ dimensions of $\frac{hc}{G}=\frac{LM^2}{L}=M^2$

5. $\langle P\rangle = V_{RMS}I_{RMS}\cos\phi$

14-16. $iB\ell = 0.5$

$\Rightarrow$ $i = \frac{0.5}{B\ell}=\frac{10-Bv\ell}{2}$

$\eta = \frac{(Bv\ell)i}{(0.5)v}$ = efficiency

17. $Q_2 - 20 = 20 - 50$

    $\Rightarrow$ $Q_2 = -10$

    $U_2 = \frac{Q_2^2}{2C_2}$

18. Energy conservation

    $\Rightarrow$ $\frac{Q_1^2}{2C}+\frac{Q_2^2}{2C}+\frac{1}{2}Li^2$ = constant

19. Use energy conservation

Chemistry

PART – II

SECTION – A

2. In $Ni(CO)_4$ = Ni → $3d^{10}4s^04p^0$ (sp^3 hybridization)
$[Ni(CN)_4]^{2-}$ = Ni^{2+} → $3d^84s^04p^0$ (dsp^2 hybridization)
CN^- is strong field ligand.

3. $$HCOOH \rightleftharpoons H^+ + HCOO^-$$

$$K_{HCOOH} = \frac{\left[H^+\right]^2}{[HCOOH]}$$

$$CH_3COOH \rightleftharpoons H^+ + CH_3OO^-$$

$$K_{CH_3COOH} = \frac{\left[H^+\right]^2}{[CH_3COOH]}$$

As $[H^+]$ in both cases are equal:

$$\frac{[CH_3COOH]}{[HCOOH]} = \frac{K_{HCOOH}}{K_{CH_3COOH}} \Rightarrow [CH_3COOH] = \frac{1.8\times10^{-4}}{1.8\times10^{-5}}\times10^{-3} = 10^{-2}M$$

5. $Fe^{3+} \rightarrow 3d^53s^0$
$Mn^{2+} \rightarrow 3d^54s^0$

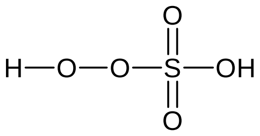
6. $$\because PV^{\gamma} = \text{constant}$$

$$P_0\left(V_0\right)^{\gamma} = P'\left(\frac{V_0}{8}\right)^{5/3}$$

$\Rightarrow P' = 32\ P_0$

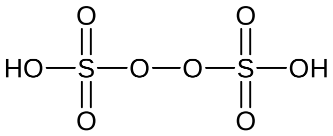
16. Irrespective of nature of ligand field, magnetic moment of octahedral complex having metal ions in d^1, d^2, d^8, d^9 configuration, remains same.
Elements may or may not form colourless complex.

17. (B)



$$H-O-O-\overset{\overset{\displaystyle O}{||}}{\underset{\underset{\displaystyle O}{||}}{S}}-OH$$

(D)



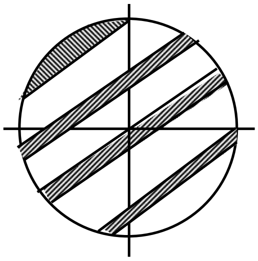
$$HO-\overset{\overset{\displaystyle O}{||}}{\underset{\underset{\displaystyle O}{||}}{S}}-O-O-\overset{\overset{\displaystyle O}{||}}{\underset{\underset{\displaystyle O}{||}}{S}}-OH$$

Mathematics PART – III

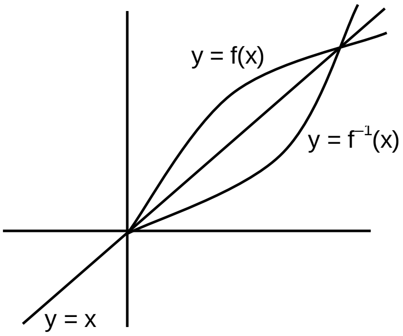
SECTION – A

1. It is clear by symmetry $2A = \pi(3\pi)^2$

$A = \dfrac{9\pi^3}{2}$



2. Clearly A < C < B



3. Circle intersect the $y^2 = 4x$ at $(1, \pm 2)$ end of latus rectum

Required curve = $2\int_0^1 2\sqrt{x} + 2\pi = \dfrac{8}{3} + 2\pi$

4. $\vec{a}.\vec{b} = 0$

5. $\left|\text{adj}A\right| = \left|A\right|^{n-1}$

$\left|\text{adj}\left(\text{adj}A\right)\right| = \left|\text{adj}A\right|^{n-1} = \left|A\right|^{(n-1)^2}$

6. $A^{20} - A^{18} = A\left(A^2 - I\right)$

$A^{18} - A^{16} = A\left(A^2 - I\right)$ ………..

$A^4 - A^2 = A\left(A^2 - I\right)$

$\therefore A^{20} - A^2 = 9A\left(A^2 - I\right)$

$= 9A^3 - 9A = 9A^2 - 9I \Rightarrow \left(\because A\left(A^2 - I\right) = A^2 - I\right)$

$\Rightarrow A^{20} = 10A^2 - 9I$

$\Rightarrow A^{20} = 10\begin{bmatrix} 1 & 0 & 0 \\ 1 & 1 & 0 \\ 1 & 0 & 1 \end{bmatrix} - 9I$

$\therefore k + 1 = 10$

$k = 9$

7. Consider S = {1, 2, 3, …..}

Consider event A = selecting the no. 1 from S

Probability of A = $\underset{n\to\infty}{\text{Let}}\frac{1}{n}=0.$

But still. Event A can occur

8. Required vector $=r^3\times f^3=\begin{vmatrix} i & j & k \\ -2 & -4 & 1 \\ 3 & 4 & 5 \end{vmatrix}$

10. $M_1^k=\begin{bmatrix} 1+2k & -4k \\ k & 1-2k \end{bmatrix},\ M_2^k=\begin{bmatrix} x^k & \frac{4(x^k-1)}{x-1} \\ 0 & 1 \end{bmatrix}$

Also, $PP^T=P^TP=I$ and $B=M_1^{2012}, D=M_2^{2012}, E=M_2^{2011}M_1^{2011}$

11. Clearly $P(A_1)=\frac{2}{4}=\frac{1}{2},\qquad P(A_2)=\frac{2}{4}=\frac{1}{2},\qquad P(A_3)=\frac{2}{4}=\frac{1}{2},$

$P(A_1\cap A_2)=\frac{1}{4},\ P(A_2\cap A_3)=\frac{1}{4},\ P(A_1\cap A_3)=\frac{1}{4}=P(A_1\cap A_2\cap A_3)=0$

12. P(A), P(B) are roots of $x^2-{}^5\!/_6\,x+{}^1\!/_6=0$

$\therefore x={}^1\!/_2,{}^1\!/_3$

$P(a,0,0)\qquad Q(0,b,0)\qquad R(0,0,c)$

13. $\therefore \alpha={}^a\!/_3,\beta={}^b\!/_3,\gamma={}^c\!/_3$

$$d=\frac{\left|\frac{0}{a}+\frac{6}{b}+\frac{b}{c}-1\right|}{\sqrt{\frac{1}{a^2}+\frac{1}{b^2}+\frac{1}{c^2}}}$$

Locus is $\frac{1}{d^2}=\frac{1}{9\alpha^2}+\frac{1}{9\beta^2}+\frac{1}{9\gamma^2}$

$\therefore$ Locus of α,β,γ is $\frac{1}{x^2}+\frac{1}{y^2}+\frac{1}{z^2}=\frac{9}{d^2}$

14. Equation of plane is $lx+my+nz=p$ (say)

$A\left({}^p\!/_l,0,0\right),B\left(0,{}^p\!/_m,0\right),C\left(0,0,{}^p\!/_n\right)$

Let (α,β,γ) is a point in locus

$\therefore \alpha={}^p\!/_\ell,\beta={}^p\!/_m,\gamma={}^p\!/_n$

$\therefore \ell^2+m^2+n^2=1$

15. D = 3abc – $(a^3 + b^3 + c^3)$

$D_1 = D_2 = D_3 = -(a^2 + b^2 + c^2 - ab - bc - ac)$

As plane are distinct then $a \neq b \neq c$

Point of intersection $\left(\frac{1}{a+b+c},\frac{1}{a+b+c},\frac{1}{a+b+c}\right)$

The lines $\frac{x-1}{a} = \frac{y}{b} = \frac{z+1}{c}$ and $\frac{x+1}{c} = \frac{y}{b} = \frac{z-1}{a}$ have shortest distance zero.

The lines $\frac{x-1}{a} = \frac{y-1}{b} = \frac{z-1}{c}$ and $\frac{x+1}{b} = \frac{y+1}{c} = \frac{z+1}{c}$ will intersect if a = b = c which is not possible

16. (A) $\left(P^T\right)^T = P$, P^T is orthogonal

$\Rightarrow \left(P^T\right)^T P^T = I$

$\Rightarrow PP^T = I$

$\Rightarrow$ P is orthogonal

(B) P is orthogonal

$\Rightarrow PP^T = I$

$\Rightarrow P^{-1}PP^T = P^{-1}I$

$\Rightarrow P^T = P^{-1}$

$\Rightarrow \quad \because P^T$ is orthogonal $\Rightarrow P^{-1}$ is orthogonal

(C) $P^T = P^{-1}$ and $Q^T = Q^{-1}$

$\therefore (PQ)(PQ)^T = PQQ^TP^T = PQQ^{-1}P^{-1} = PIP^{-1} = PP^{-1} = I$

$\therefore (PQ)^T = (PQ)^{-1}$

So, PQ is orthogonal

17. $A^2 = -I$, $A^3 = -A$, $A^4 = I$ also $I + A + A^2 + A^3 = 0$

18. $\Delta = \sin(A-B)\sin(B-C)\sin(C-A) = 0$

$\Rightarrow$ Either A = B or B = C or C = A or A = B = C

Hence, the result follows

20. y – f(x) = f′(x) (y – x) and y – g(x) = g′(x) (y – x)

$\Rightarrow \frac{f'(x)}{f(x)} = \frac{g'(x)}{g(x)} \Rightarrow f(x) = \frac{1}{4}g(x) \Rightarrow f(x) = e^{x/4}, g(x) = 4e^{x/4}$

$I = \int_{-1}^{1} \frac{x^2+4}{4+4e^{x/4}}dx = \frac{13}{12}$

Area $\int_{0}^{1} (4e^{x/4} - e^{x/4})dx = 12(e^{1/4} - 1)$

FIITJEE Students From Classroom / Integrated School Programs have secured to 2 Zonal, 6 State & 18 City Topper Ranks. 33 in Top 100, 78 in Top 200 and 205 in Top 500 All India Ranks bagged by FIITJEE Students from All Programs have qualified in JEE (Advanced), 2015.

ALL INDIA TEST SERIES

FIITJEE JEE (Advanced)-2016

FULL TEST – I

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 246**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 07)** contains 7 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (08 – 11) contains 4 multiple choice questions which have one or more than one correct answer. Each question carries **+3 marks** for correct answer. There is no negative marking.

   Section-A (12 – 16) contains 2 paragraphs. Based upon paragraph, 2 and 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct matching. No marks will be given for any wrong matching in any question. There is no negative marking.

3. **Section-C (01 – 06)** contains 6 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

SECTION – A

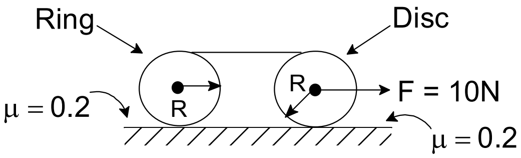
Straight Objective Type

This section contains **7 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

1. A particle strikes a horizontal frictionless floor with a speed u at an angle θ with the vertical and rebounds with a speed v at an angle ϕ with the vertical. The co-efficient of restitution between the particle and floor is e. The angle ϕ is equal to

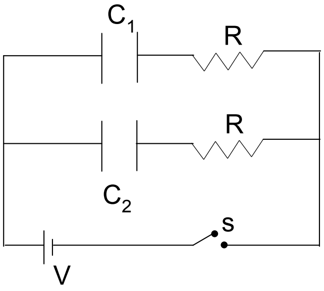
   (A) θ (B) $\tan^{-1}(e\tan\theta)$ (C) $\tan^{-1}\left(\frac{1}{e}\tan\theta\right)$ (D) $(1+e)\theta$

2. In the given situation disc and ring (2kg) are connected with a string. Both are placed on the rough surface. A force F = 10N is applied on the centre of disc horizontally. Assume initially both bodies were in rest. Then frictional force acting on the ring will be



   (A) $\frac{20}{3}$N
   (B) $\frac{10}{3}$N
   (C) Zero
   (D) None

3. In the circuit shown $C_1 = 2C_2$. Switch S is closed at time t = 0. Let i_1 & i_2 be the current flowing through C_1 and C_2 at any time t, then the ratio I_1/I_2

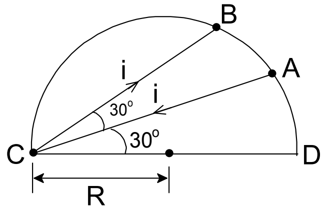


   (A) is constant
   (B) increases with increase in time t
   (C) decreases with increase in time t
   (D) first increases then decreases

Space for Rough work

4. The capacitor of an oscillatory circuit of frequency 10^4Hz is enclosed in a container. When the container is evacuated, the frequency changes by 50 Hz, the dielectric constant of the gas is
(A) 1.1 (B) 1.01 (C) 1.001 (D) 1.0001

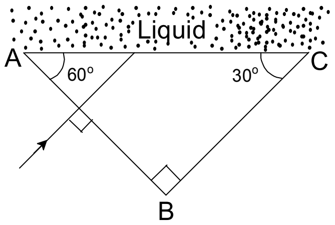
5. A current carrying wire is placed in the grooves of an insulating semicircular disc of radius 'R' as shown. The current enters at point A and leaves point B. Determine the magnetic field at point D.



(A) $\frac{\mu_0 i}{8\pi R\sqrt{3}}$ (B) $\frac{\mu_0 i}{4\pi R\sqrt{3}}$
(C) $\frac{\sqrt{3}\mu_0 i}{4\pi R}$ (D) None

6. The organ pipes, both closed at one end, have lengths ℓ and $(\ell+\Delta\ell)$ vibrates in fundamental mode. Neglect end correction. If the velocity of sound in air is v, then the number of beats/sec is $(\text{assume}\,\Delta\ell << \ell)$
(A) $\frac{v}{4\ell}$ (B) $\frac{v}{2\ell}$ (C) $\frac{v\Delta\ell}{4\ell^2}$ (D) $\frac{v\Delta\ell}{2\ell^2}$

7. Light is incident normally on face AB of a prism as shown. A liquid of refractive index μ is placed on face AC of the prism. The prism is made of glass of refractive index 3/2. The limit of μ for which total internal reflection takes place on face AC is



(A) $\mu > \frac{3}{4}$ (B) $\mu < \frac{3\sqrt{3}}{4}$
(C) $\mu > \sqrt{3}$ (D) $\mu < \frac{\sqrt{3}}{2}$

Space for Rough work

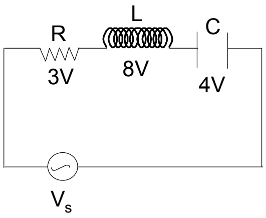
(Multiple Correct Choice Type)

This section contains **4 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** is/are correct.

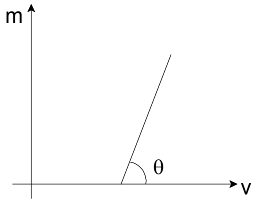
8. A photon collides with a stationary H – atom in ground state inelastically. Energy of the colliding photon is 10.2 eV. Almost instantaneously, another photon collides with same H – atom inelastically with an energy of 15 eV. What will be observed by the detector?
(A) two photons of energy 10.2 eV
(B) two photons of energy 1.4 eV
(C) One electron having kinetic energy nearly 11.6 eV
(D) One photon of energy 10.2 eV and an electron of energy 1.4 eV

9. An electron in H – atom is excited from ground state level to first excited level. Select the correct statements:
(A) Kinetic energy of electron is decreased
(B) Potential energy is increased while kinetic energy of electron is decreased
(C) Time period of rotation and angular momentum both are increased
(D) Total energy is increased while angular speed is decreased

10. In the given circuit, current in resistance R is 1A, then
(A) $V_s = 5\text{volt}$
(B) impedance of network is 5Ω
(C) Power factor of given circuit is 0.6 lagging
(D) Power factor of given circuit is 0.6 leading



11. Figure shows variation of magnification m(produced by a thin convex lens) and distance v of image from pole of the lens. Which of the following statements are correct?
(A) focal length of the lens is equal to intercept on v - axis
(B) focal length of the lens is equal to inverse of slope of the line
(C) Magnitude of intercept on m – axis is equal to unity
(D) None



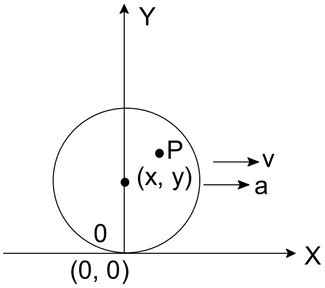
Space for Rough work

Comprehension Type

This section contains **2 paragraphs.** Based upon one of the paragraphs **2 multiple choice questions** and based on the other paragraph **3 multiple choice question** have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph for Questions 12 & 13

A disc having radius R is rolling without slipping on a horizontal plane as shown. Centre of the disc has a velocity v and acceleration a as shown.



12. Speed of point P having coordinates (x, y) is

(A) $\frac{V\sqrt{x^2+y^2}}{R}$ (B) $\frac{V\sqrt{x^2+(y+R)^2}}{R}$ (C) $\frac{V\sqrt{x^2+(y-R)^2}}{R}$ (D) None

13. If $V=\sqrt{2aR},$ the angle θ between acceleration of the topmost point and the horizontal is

(A) 0 (B) 45° (C) $\tan^{-1}(2)$ (D) $\tan^{-1}\left(\frac{1}{2}\right)$

Paragraph for Questions 14 & 16

A certain substance has a mass of 50g/mol. When 300J of heat is added to 25 gm of sample of this material, its temperature rises from 25 to 45°C.

14. The thermal heat capacity of the substance is

(A) $25J/^{\circ}C$ (B) $5J/^{\circ}C$ (C) $15J/^{\circ}C$ (D) $20J/^{\circ}C$

15. The specific heat capacity of the substance is

(A) $300J/kg^{\circ}C$ (B) $400J/Kg^{\circ}C$ (C) $500J/Kg^{\circ}C$ (D) $600J/kg^{\circ}C$

16. The molar heat capacity of the substance is

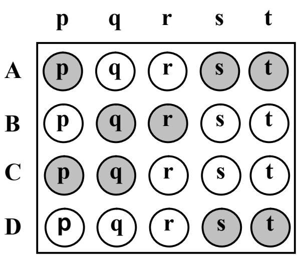
(A) $30J/mol^{\circ}C$ (B) $40J/mol^{\circ}C$ (C) $20J/mol^{\circ}C$ (D) $60J/mol^{\circ}C$

Space for Rough work

SECTION - B
Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in ***Column I*** *are labelled A, B, C and D, while the statements in* ***Column II*** *are labelled p, q, r, s and t. Any given statement in* ***Column I*** *can have correct matching with* ***ONE OR MORE*** *statement(s) in* ***Column II.*** *The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the following

	Column – I		Column – II
(A)	Zero gravity	(p)	SHM
(B)	$\sqrt{\frac{k}{m}}$of a spring	(q)	$Y = \pm\frac{A}{\sqrt{2}}$
(C)	KE = PE	(r)	$\frac{1}{3}$rd the time period of $y = \sin\omega t$
(D)	$y = \sin(3\omega t)$	(s)	writst watch can give correct time
		(t)	Per second

2. Match the following

	Column – I		Column – II
(A)	Nuclear fusion	(p)	Stratifies E = mc^2
(B)	Nuclear fission	(q)	Generally possible for nuclei with low atomic number
(C)	β – decay	(r)	Generally possible for nuclei with higher atomic number and instability
(D)	Exothermic nuclear reaction	(s)	Essentially proceeds by weak nuclear force
		(t)	Significant momentum conservation

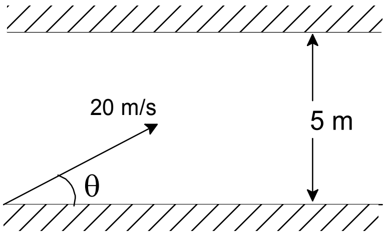
Space for Rough work

SECTION – C

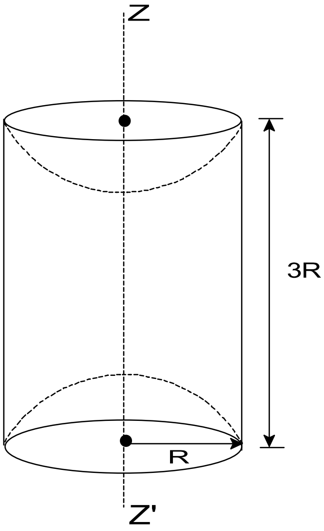
(Integer Answer Type)

This section contains **6 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. A projectile is projected with a speed 20 m/s from the floor of a 5 m high room as shown. The maximum horizontal range of the projectile is found to be $20\sqrt{n}$ m. Find n [Take $g = 10\ ms^{-2}$].

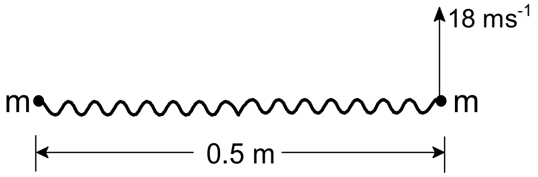


2. A solid cylinder is made of radius R and height 3R having mass density ρ. Now two half spheres of radius R are removed from both ends. The moment of intertia of remaining portion about axis ZZ' can be calculated as $\frac{29}{6K}\pi R^5 \rho$. Find K.



Space for Rough work

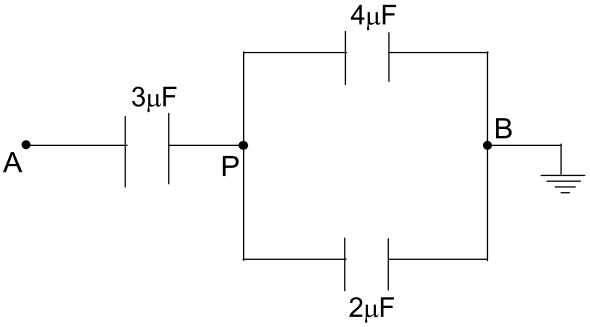
3. Two particles each of mass m are connected by a string of length 1m. The particles are kept on a smooth horizontal plane. The initial separation between the particles is 0.5 m. One of the particles is given a velocity 18 m/s as shown. Find the magnitude of angular velocity of one particle with respect to the other particle just after the string becomes taut (in m/s).



4. Two thin symmetrical lenses of different nature have equal radii of curvature of all faces R = 20 cm. The lenses are put close together and immersed in water. The focal length of the system is 24 cm. The difference between refractive indices of the lenses is $\left(\frac{5}{n}\right)$. Find n. The refractive index of water is $\frac{4}{3}$.

5. A 10 m long nichrome wire having 80Ω resistance has current carrying capacity of 5 A. This wire can be cut into equal parts and equal parts can be connected in series or parallel. What is the maximum power which can be obtained as heat by the wire from a 200 V mains supply (in KW).

6. In the given figure, a potential of +12 volt is given to point A, and point B is earthed. What is the potential at point P in volt?



Space for Rough work

Chemistry PART – II

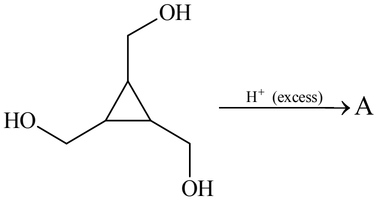
SECTION – A

Straight Objective Type

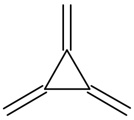
This section contains **7 multiple choice** questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONLY ONE** option is correct.

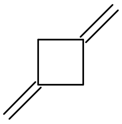
1. Which one of the following is not true about diborane?
(A) It has two bridging hydrogens and four terminal hydrogens.
(B) When methylated, the product is $Me_4B_2H_2$.
(C) The bridging hydrogen are in a plane perpendicular to the rest of the B – H bonds.
(D) All the six B – H bond distances are equal.

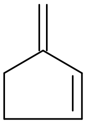
2. For the reaction,

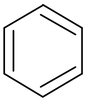


What is the product A?

(A)


(B)


(C)


(D)


Space for Rough work

3. The wave function of atomic orbital of H-like atoms is given as under:

$$\psi_{2s} = \frac{1}{4\sqrt{2\pi}} Z^{3/2}\left(2 - Zr\right)e^{-\frac{Zr}{2}}$$

Given that the radius is in Å, then which of the following is radius for nodal surface for He^+ ion

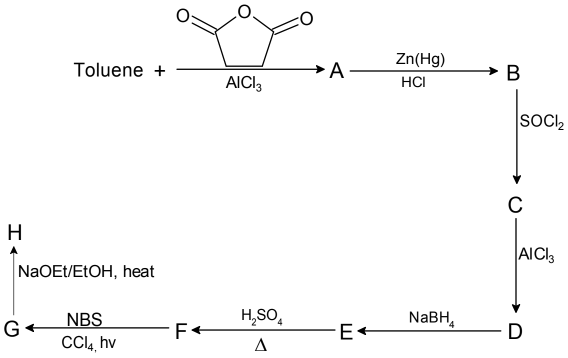
(A) 1Å (B) 2Å (C) 2.5Å (D) 4Å

4. Cyclopentadiene + Na $\longrightarrow$ C + H_2

$2C + FeCl_2 \longrightarrow D + 2NaCl$

Which one of the following in not true about D.
(A) D is an organometalic compound
(B) D is an optically inactive compound
(C) EAN of Fe^{+2} in D is 34
(D) All C – C bonds in D are of identical length

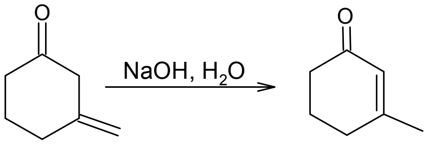
5. Which one of following statement is true
(A) G is an optically inactive compound
(B) H is an optically inactive compound and have all C – C bond of equal length
(C) F and D both have equal no of π-bond
(D) H is 3-methylnaphthalene



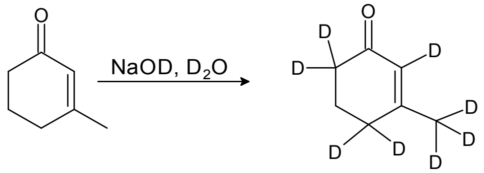
Space for Rough work

6. Which one of the following reaction is not possible:-

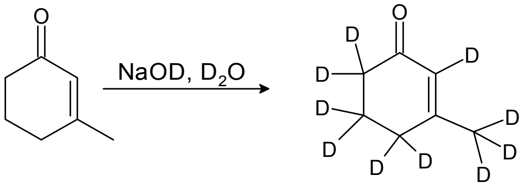
(A)



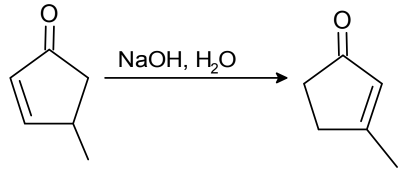
(B)



(C)



(D)



7. (I) $Co(CO)_6$
(II) $Co(CO)_5NH_3$
(III) $Co(CO)_4(NH_3)_2$
(IV) $Co(CO)_3(NH_3)_3$
(V) $Co(CO)_2(NH_3)_4$
(VI) $Co(CO)(NH_3)_5$

Which statement is correct for these compounds?

(A) order of Co – C bond length in complexes is I > II > III > IV > V > VI
(B) order of Co – C bond length in complexes is VI > V > IV > III > II > I
(C) order of Co – C bond strength in complexes is I = II = III = IV = V = VI
(D) order of C – O bond length in complexes is I = II = III = IV = V = VI

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

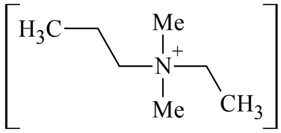
8. Which of the following is/are correct for the reaction with equilibrium constant K?

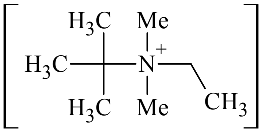
$$A(g)+B(g)\underset{K_b}{\overset{K_f}{\rightleftharpoons}}C(g)+D(g);\quad \Delta H^{\circ}=20J$$

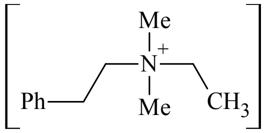
(A) K_{eq} will increase on increasing temperature
(B) K_f will increase on increasing temperature
(C) K_b will increase on increasing temperature
(D) K_b will decrease on increasing temperature

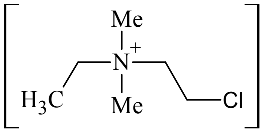
Space for Rough work

9. Which of the following reaction is incorrect regarding the formation of major product (alkene)?

(A)  $OH^- \xrightarrow{\Delta} CH_2 = CH_2$

(B)  $OH^- \xrightarrow{\Delta} CH_2 = CH_2$

(C)  $OH^- \xrightarrow{\Delta} Ph - CH_2 = CH_2$

(D)  $OH^- \xrightarrow{\Delta} CH_2 = CH_2 - Cl$

10. Which among the following statements is/are correct?
(A) pH of 10^{-8} M HCl is equal to 8
(B) Conjugate base of $H_2PO_4^-$ is HPO_4^{2-}
(C) pH of 0.1 M NaCl (aqueous solution) = $\frac{1}{2}pK_w$
(D) Ionization of water increases with decrease in temperature

11. 4.5 g of Al (atomic mass = 27) is deposited at cathode from Al^{+3} solution by certain quantity of charge. The correct statement/s is/are:
(A) The volume of H_2 produced at 0^oC and 1 atm pressure from H^+ ions in solution by the same quantity of charge will be 5.6 ℓ.
(B) The volume of H_2 produced at 0^oC and 1 atm pressure from H^+ ions in solution by the same quantity of charge will be 22.4 ℓ.
(C) The number of moles of Al deposited will be 0.166 moles
(D) The number of faraday used for reduction of 1 mole of Al^{+3} is $\frac{3}{18}$F.

Space for Rough work

Comprehension Type

This section contains **2 paragraphs.** Based upon the first paragraph 2 multiple choice questions and based upon the second paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices A), B), C) and D) out of **WHICH ONLY ONE IS CORRECT.**

Paragraph for Question Nos. 12 to 13

On the basis of aromaticity, there are three types of compounds i.e. aromatic, non-aromatic and anti-aromatic. The increasing order of stability of these compounds are is under:

Anti-aromatic compound < non-aromatic compound < aromatic compounds. Compounds to be aromatic follow the following conditions (according to valence bond theory)

(i) The compounds must be be cyclic in structure having $(4n + 2)\pi\ e^-$, where n = Hückel's number = 0, 1, 2, 3 et.c

(ii) The each atoms of the cyclic structure must have unhybridised p-orbital i.e. the atoms of the compounds have unhybridised p-orbital i.e. usually have sp^2 hybrid or planar.

(iii) There must be a ring current of π electrons in the ring or cyclic structure i.e. cyclic structure must undergo resonance .

Compounds to be anti-aromatic, it must have $4n\pi e^-$ where n = 1, 2… and it must be planar and undergo resonance. Non-aromatic compounds the name itself spells that compounds must be non-planar irrespective of number of π electrons. Either it has $4n\pi e^-$ or $(4n + 2)\ \pi$ electrons it does not matter.

The rate of reaction of any aromatic compounds depends upon the following factors:

(i) Electron density

(ii) stability of carbocation produced

Higher the amount of electron density of the ring, higher will be its rate towards aromatic electrophilic substitution and vice-versa. Similarly, higher will be the stability of the produced carbocation after the attack of electrophile, higher will be its rate towards aromatic electrophilic substitution. There is a great effect of kinetic labelling on the rate of aromatic electrophilic substitution. As we known that higher the atomic weight or, molecualr weight, higher will be the van der Waal's force of attraction or, bond energy. Since there will be effect of kienetic labelling if the 2nd step of the reaction will be the slow step, (r.d.s.) otherwise there will be no effect of kinetic labelling.

12. Which of the following is correct order of the rate of reaction of C_6H_6, C_6D_6 and C_6T_6 towards sulphonation?

(A) Same rate of reactions of C_6H_6, C_6D_6 and C_6T_6

(B) $C_6T_6 > C_6D_6 > C_6H_6$

(C) $C_6H_6 > C_6D_6 > C_6T_6$

(D) $C_6H_6 > C_6D_6 = C_6T_6$

Space for Rough work

13. Which of the following is the correct order of rate of reaction of C_6H_6, C_6D_6 and C_6T_6 towards nitrations?

(A) $C_6H_6 > C_6D_6 > C_6T_6$
(B) $C_6H_6 = C_6D_6 = C_6T_6$
(C) $C_6H_6 > C_6D_6 = C_6T_6$
(D) $C_6T_6 > C_6D_6 > C_6H_6$

Paragraph for Question Nos. 14 to 16

The Bertholet's equation of state for 1 mole real gas is given as under:

$$\left(P + \frac{a}{TV}\right)(V - b) = RT$$

Where a and b are van der Waal's constants. van der Waal's constant "a" signifies, the force of attraction among the gas molecules. van der Waal's constant "b" signifies incompressible volume i.e. volume having no effect of compression and expansion. It is also known as co-volume. Thereby the volume having effect of compression and expansion i.e. compressible volume = V – b (for 1 mole real gas).

One of the form of van der Waal's equation of state is virial equation. The virial equation for 1 mole real gas is as under:

$$PV = RT\left[1 + \frac{A}{V} + \frac{B}{V^2} + \frac{C}{V^3} + \ldots \text{to higher power of n}\right]$$

where A, B, C are known as 2nd, 3rd and 4th virial coefficients respectively. The temperature at which real gases obey ideal gas equation (PV = RT), is known as Boyles temperature i.e. T_B.

14. If $T_i = \frac{2a}{Rb}$, where T_i is the inversion temperature, then which of the following is the correct relation of the Boyle's temperature T_B obtained by the Bertholet's equation

(A) $T_i = 2T_B^2$
(B) $T_i = 2T_B$
(C) $2T_i = T_B$
(D) $T_i^2 = T_B$

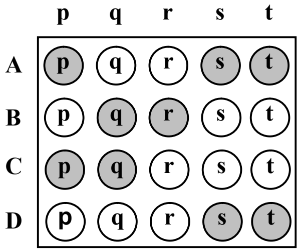
Space for Rough work

15. If the value of a and b increases by 8 times and 2 times respecively, then new Boyle’s temperature will increases by how many times and what will be effect on the ease of liquification ?
(A) 2 times, ease of liquification will increase
(B) 4 times, the ease of liquification will increase
(C) $\frac{1}{4}$ times, the ease of liquification will decrease
(D) $\frac{1}{2}$ times, the ease of liquification will decrease

16. If the third virial coefficient of 4 moles of mono-atomic as is 0.04 $(\text{lit/mol})^2$ at NTP, then what will be the real gas at NTP?
(A) 88.8 liters (B) 80 liters (C) 89 liters (D) 90.4 liters

SECTION-B
(Matrix-Match Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:
If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



1. Match the following.

Column – I (Carbides)		Column – II (Hydrolysis of compound in Column – I)	
(A)	SiC	(p)	Resulting gas does not produce red ppt with ammonical Cu_2Cl_2
(B)	Al_4C_3	(q)	Unsaturated hydrocarbon is produced
(C)	CaC_2	(r)	No hydrocarbon produced
(D)	Mg_2C_3	(s)	Resulting gas produce white ppt. with Tollen’s reagent
		(t)	Staturated hydrocarbon is produced

Space for Rough work

2. Match the solution given in column I with the properties given in column II.

Column – I		Column - II	
(A)	0.1 M $Al_2(SO_4)_3$	(p)	Solution with highest being point
(B)	0.1 M $AlPO_4$	(q)	Van't Hoff factor in greater than 1
(C)	0.1 M Urea	(r)	Solution with lowest osmotic pressure
(D)	0.1 M $MgCl_2$	(s)	Solution with lowest freezing point
		(t)	Solution with lowest boiling point

SECTION –C

Integer Answer Type

This section contains **6 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. The number of bicarbonates that do not exist in solid form among the following is...................

$LiHCO_3, NaHCO_3, Ca(HCO_3)_2, KHCO_3, NH_4HCO_3, Ba(HCO_3)_2, Mg(HCO_3)_2$.

2. In Borax

(i) Number of B – O – B bond is x

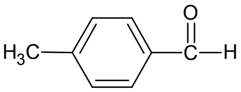
(ii) Number of B – B bond is y

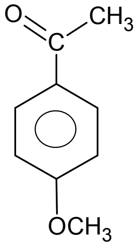
(iii) Number of sp^2 hybridized B atom is z

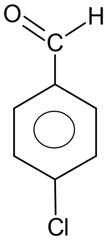
Calculate the value of x + y + z

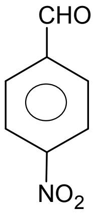
3. Examine the structural formulas of following compounds and find out number of compounds which show

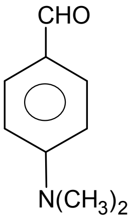
higher rate of nucleophilic addition than

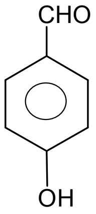


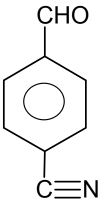






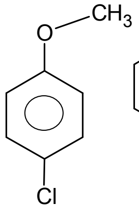


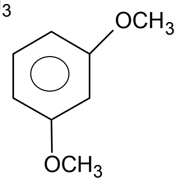


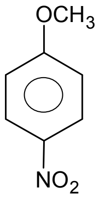


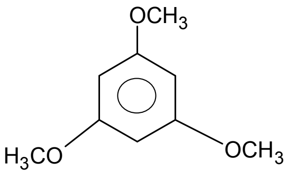
Space for Rough work

4. Examine the structural fromuals shown below and identify how many compounds will show coupling reaction with diazonium salt faster than anisole

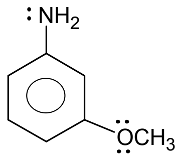


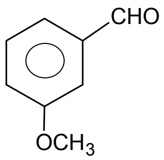






OCH3
H3CO
OCH3

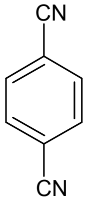




5. For the first order reaction $t_{99\%} = x \times t_{90\%}$

The value of x will be

6. Total no of molecules/ions which have non zero dipole moment is

$\left[Pt(CN)_4\right]^{-2}$,


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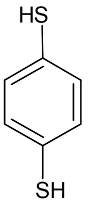

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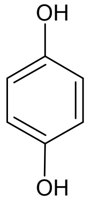

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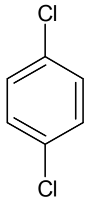

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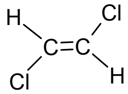

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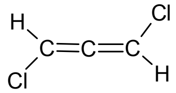

, I_3^- , XeF_4

Space for Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains 7 multiple choice questions numbered 1 to 7. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. If 'P' be a point on unit circle with centre at point 'O'. If Q is another point inclined at angle $\frac{\pi}{3}$ to 'OP' and $|\overrightarrow{OT}| = |\overrightarrow{OQ}| = r$, then the interval in which 'r' lies, so that $2|\overrightarrow{AT}| = |\overrightarrow{PQ}|$, and $\overrightarrow{OA} = \hat{a}$, is,

(A) $\left[\frac{7+\sqrt{13}}{6}, \infty\right)$ (B) $\left[\frac{7-\sqrt{13}}{6}, \frac{7+\sqrt{13}}{6}\right]$

(C) $\left(-\infty, \frac{7-\sqrt{13}}{6}\right]$ (D) None of these

2. If a bag contains five balls. Two balls are drawn and are found to be white. What is the probability that all the balls are white?

(A) $\frac{1}{4}$ (B) $\frac{1}{3}$ (C) $\frac{1}{2}$ (D) $\frac{2}{3}$

3. If f(x) and g(x) are defined and differentiable for $x \geq x_0$ and $f(x_0) = g(x_0)$, $f'(x) > g'(x)\ \forall x > x_0$, then

(A) $f(x) > g(x)$, for some $x > x_0$ (B) $f(x) > g(x)$, for no $x > x_0$

(C) $f(x) = g(x)$, for some $x > x_0$ (D) $f(x) > g(x)$, for all $x > x_0$

4. If z_1 and z_2 are two variable complex numbers such that, $|z_1|^2 \leq 169$ & $|z_2 + 3 - 4i|^2 \leq 25$. Then the maximum value of $|z_1 - z_2|$,is

(A) 23 (B) 13 (C) 5 (D) 18

Space for Rough work

5. If $S = \frac{4}{1.2.3} + \frac{5}{2.3.4} + \frac{6}{3.4.5} + \frac{7}{4.5.6}$........................ up to 'n' terms & $S = K - \frac{(2n+5)}{2(n+1)(n+2)}$, Then,

(A) $K = \frac{1}{4}$ (B) $K = \frac{1}{2}$ (C) $K = \frac{3}{4}$ (D) $K = \frac{5}{4}$

6. The perpendicular from origin to the tangent at any point on a curve is equal to the obscissa of the point of contact. If the curve passes through point (1, 2), then it also passes through point,

(A) $(1,-2)$ (B) $(1,3)$ (C) $(2,3)$ (D) $(-2,1)$

7. For an ellipse $\frac{x^2}{9} + \frac{y^2}{4} = 1$, with vertices A & A', tangent drawn at the point 'P' in the first quadrant meets the y – axis in Q and the chord A'P meets the y – axis in M. If 'O' is the centre of ellipse, then $OQ^2 - MQ^2$ is equal to,

(A) 9 (B) 13 (C) 4 (D) 5

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

8. If $f(x) = x^5 + x^4 + x^3 + x^2 + x + 3$. Then f(x) = 0 has,

(A) odd number of real roots
(B) Atleast one root lies between $(-\infty, -1)$
(C) Greatest integer value of at least one root = 2
(D) All roots are negative

9. Which of the following is/are not true,

(A) if $\{f(x) + g(x)\}$ is continuous at x = a, then f(x) and g(x) are both separately continuous at x = a.
(B) If f(x) .g(x) is continuous at x = a, then f(x) and g(x) are separately continuous at x = a
(C) If f(x). g(x) & f(x) are discontinuous at x = a then g(x) is continuous at x = a
(D) if both f(x) and g(x) are discontinuous at x = a then f(x) + g(x) may not be discontinuous at x = a

Space for Rough work

10. If $\int \tan^{-1}\left(\frac{\cos 2x}{1+\sin 2x}\right)dx = g(x)+c$, then

(A) g(x) represent an equation of parabola, whose concave side is upward

(B) g(x) have point of extrema at $x = \frac{\pi}{4}$

(C) g(x) represent an equation of parabola, whose concave side is downward

(D) Minimum value of g(x) = $\frac{\pi^2}{32}$

11. If α, β are the roots of equation, $x^2 - 2x - a^2 + 1 = 0$ and γ, δ are the roots of the equation, $x^2 - 2(a+1)x + a(a-1) = 0$ such that $\alpha, \beta \in (\gamma, \delta)$, then the interval in which 'a' lies,

(A) $a \in \left(-\frac{1}{4}, 1\right)$ (B) $a \in \left(-\frac{1}{8}, \frac{1}{2}\right)$ (C) $a \in (-\infty, 1)$ (D) $a \in (-\infty, -2)$

Comprehension Type

This section contains 2 paragraphs. Based upon one of paragraphs 2 multiple choice questions and based on the other paragraph 3 multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

---

Paragraph for Question Nos. 12 to 13

Consider the curves,

$C_1 \equiv y^2 = 4K_1x$, $\forall K_1 \in \left[\frac{1}{8}, \frac{1}{4}\right]$

$C_2 \equiv x^2 = 4K_2(y-2)$, $\forall K_2 \in \left[-1, -\frac{1}{4}\right]$

$C_3 \equiv x = 0$

12. Maximum area bounded by all of these three curve is,

(A) $\frac{7}{3} - \sqrt{2}$ (B) $\frac{7}{3} + \sqrt{2}$ (C) 2 (D) 1

13. Minimum area bounded by all of these three curve is,

(A) $\frac{7}{3} - \sqrt{2}$ (B) $\frac{7}{3} + \sqrt{2}$ (C) 2 (D) 1

Space for Rough work

Paragraph for Question Nos. 14 to 16

Triangle ABC has circumcentre 'O' and orthocentre 'H'. Points E and F are chosen on sides AC and AB respectively such that AE = AO and AF = AH. If 'R' be radius of circle circumscribing the triangle ABC. Then,

14. The area of quadrilateral BFEC is equal to,

(A) $\frac{R^2}{4}(\sin B+\sin C)$
(B) $\frac{R^2}{8}[\sin A]\cos(B-C)$
(C) $\frac{R^2}{2}\sin 2A$
(D) $\frac{R^2}{2}(\sin 2B+\sin 2C)$

15. The length of segment EF is equal to,

(A) $R\cos A$
(B) R
(C) $R\sin 2A$
(D) $2R\cos A$

16. Let $\angle AFE=\frac{\pi}{3}$, then sum of squares of three altitudes of triangle AFE is equal to,

(A) $\frac{9R^2}{4}$
(B) $2R^2$
(C) $\frac{3R^2}{2}$
(D) $\frac{8R^2}{3}$

Space for Rough work

SECTION-B
(Matrix-Match Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the following:

	Column – I		**Column – II**
(A)	Let $\theta_1, \theta_2, \theta_3, \theta_4$ be eccentric angles of four concylic points of ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$, and $\theta_1+\theta_2+\theta_3+\theta_4=K\pi$, then K can be,	(p)	2
(B)	Normals to parabola $y^2=4x$ at P and Q meets at $R(x_2,0)$, if $x_2=4$ and area of circle Circumscribing ΔPQR is $K\pi$ then K is equal to,	(q)	9
(C)	Let $S \equiv x^2+y^2-6x-8y+21 \le 0$. Then, max $\left[\left\{\frac{12x}{7}-\frac{5y}{7}\right\}; x, y \in s\right]$	(r)	4
(D)	In triangle ABC let $D(0,\sqrt{3}), E(1,0), F(-1,0)$ be the feet of $\perp^r$ dropped from A, B, C to opposite sides, Then square of the sum of ordinates of point A, B, and C is	(s)	3
		(t)	6

Space for Rough work

2. Match the following:

	Column – I		**Column – II**
(A)	The solution of 1 + secx = $\cot^2\frac{x}{2}$ Is given by $x = K\pi$, then K is/are	(p)	2
(B)	If α,β are roots of equation $A\left(x^2+m^2\right)+Amx+Cm^2x^2=0$ then $A\left(\alpha^2+\beta^2\right)+A\alpha\beta+C\alpha^2\beta^2+3$ is/are equal to	(q)	3
(C)	The sum of binomial co – efficient in expansion of $\left(x^{-\frac{3}{4}}+nx^{\frac{5}{4}}\right)^m$ where m is positive integer lies between 200 and 400 & the term independent of x equal to 448, then n^5 divisible by	(r)	4
(D)	If last digit of the number 2^{999} is α and last digit of $3^{5\alpha}$ is μ, then $\mu+\alpha=$	(s)	8
		(t)	9

SECTION – C

(Integer Answer Type)

This section contains **6 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. A line makes an angle of $\alpha,\beta,\gamma,\delta$ with the four diagonals of a cube then the value of $\left[\cos^2\alpha+\cos^2\beta+\cos^2\gamma+\cos^2\delta\right]$ is, (where[.]denotes the GIF)..............

2. Tangents drawn from any point ‘P’ on the curve $xy-2x-y-2=0$ intersect the asymptotes at A & B. Then the area of triangle QAB, is 4K (where Q is centre of the curve). Then value of K is………………

Space for Rough work

3. Consider a triangle ABC whose sides length are AB = 4, BC = 2 & CA = 3. If the bisector of the angle 'C' cuts AB in D and the circumcircle in E, then the value of $\left[\frac{CE}{DE}\right]$ is…………(where, [.] denotes the GIF)

4. If $\int_{0}^{10} f(x)dx = 5$ & $\sum_{K=1}^{10}\int_{0}^{1} f(K-1+x)dx = R$. Then value of R is…………..

5. If the number of ways in which four distinct balls can be put into two identical boxes so that no box remains empty is equal to K, then K =………….

6. The value of $|K|$ for which the following system of equations is consistent,

$$(K+1)^3 x + (K+3)^3 y = (K+3)^3$$
$$(K+1)x + (K+2)y = K+3$$
$$x + y = 1$$

Space for Rough work

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FIITJEE

JEE(Advanced)-2016

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – I
(PAPER-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**C**	**D**	**B**
2.	**C**	**D**	**C**
3.	**B**	**A**	**D**
4.	**B**	**C**	**A**
5.	**B**	**C**	**D**
6.	**C**	**C**	**A**
7.	**B**	**A**	**C**
8.	**C**	**A, B, C**	**A, B, D**
9.	**A, B, C, D**	**B**	**A, B, C**
10.	**A, B, C**	**B, C**	**B, C**
11.	**A, B, C**	**A, C**	**A, B**
12.	**A**	**C**	**C**
13.	**B**	**B**	**D**
14.	**C**	**A**	**D**
15.	**D**	**A**	**B**
16.	**A**	**D**	**A**
1.	**(A) → s, (B) → pt, (C) → q, (D) → pr**	**(A) → r, (B) → pt, (C) → qs, (D) → qs**	**(A) → prt, (B) → q, (C) → t, (D) → s**
2.	**(A) → pqt, (B) → prt, (C) → s, (D) → qr**	**(A) → pqs, (B) → q, (C) → rt, (D) → q**	**(A) → qt, (B) → q, (C) → prs, (D) → t**
1.	**3**	**4**	**1**
2.	**5**	**7**	**2**
3.	**9**	**3**	**1**
4.	**9**	**3**	**5**
5.	**2**	**2**	**7**
6.	**4**	**3**	**2**

Physics PART – I

SECTION – A

1. C

$\tan^{-1}\left(\frac{1}{e}\tan\theta\right)$

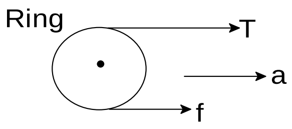
$\because$ vertical component after collision $= eu\cos\theta$

& Horizontal component $= u\sin\theta$

$\Rightarrow \tan\phi = \frac{u\sin\theta}{eu\cos\theta} \Rightarrow \phi = \tan^{-1}\left(\frac{1}{e}\tan\theta\right)$

2. C

Zero



$\because T + f = 2a$

$TR - fR = 2R^2\alpha$

$a = \alpha R$

$\Rightarrow f = 0.$

3. B

$\because I_1 = \frac{V}{R}e^{-t/RC_1}$ & $I_2 = \frac{V}{R}e^{-t/RC_2}$

$\Rightarrow \frac{I_1}{I_2} = e^{\frac{t}{R}\left(-\frac{1}{C_1}+\frac{1}{C_2}\right)}$

$\Rightarrow \frac{I_1}{I_2} = e^{\frac{t}{RC_1}}$

4. B

$\because f = \frac{1}{2\pi\sqrt{LC}}, \quad f + 50 = \frac{1}{2\pi\sqrt{LC/K}}$

$\Rightarrow K = \left(\frac{f+50}{f}\right)^2 \Rightarrow K = \left(1 + 2\times\frac{50}{f}\right) = \left(1 + \frac{100}{10^4}\right)$

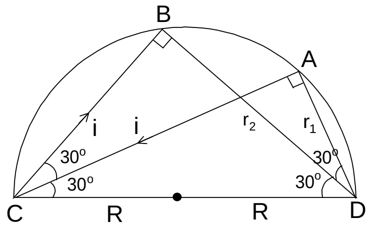
$\Rightarrow K = 1.01$

5. B

$\because r_1 = 2R\sin 30^o,\ r_2 = 2R\sin 60^o = R\sqrt{3} = R$

$B_D = B_{AC} + B_{CB} = \left(\frac{\mu_0 i}{4\pi r_1}\sin 60^o - \frac{\mu_0 i}{4\pi r_2}\sin 30^o\right)$

$\Rightarrow B_D = \frac{\mu_0 i}{4\pi R\sqrt{3}}$



6. C

$\text{Beats} = \frac{V}{4\ell} - \frac{V}{4(\ell+\Delta\ell)} = \frac{V\Delta\ell}{4\ell(\ell+\Delta\ell)}$

$= \frac{V\Delta\ell}{4\ell^2}$

7. B

$$\frac{3}{2}\sin 60^o \geq \mu \sin 90^o$$

$$\mu \leq \frac{3}{2}, \frac{\sqrt{3}}{2}$$

$$\mu \leq \frac{3\sqrt{3}}{4}$$

8. C

$$\because -13.6 + 10.2 = -3.4\text{eV} \longrightarrow 1\text{st collision}$$

$$\& \ -3.4 + 15 = 11.6\text{eV} \longrightarrow 2\text{nd collision.}$$

9. A, B, C, D

$$V \propto \frac{1}{n}$$

$$\text{P.E.} \propto (-)\frac{1}{r}$$

$$T \propto r^{3/2}$$

$$\text{T.E.} \propto (-)\frac{1}{r}$$

10. A, B, C

$$\because V_s^2 = (3)^2 + (8-4)^2 = 25 \Rightarrow V_s = 5 \text{ volt}$$

$$Z = \frac{Vs}{I} = 5\Omega$$

$$V_R = 3 = 1 \times R \Rightarrow R = 3\Omega$$

$$\text{P.F.} = \frac{R}{Z} = \frac{3}{5} = 0.6$$

$$\because V_L > V_C \Rightarrow \text{I lags V.}$$

11. A, B, C

$$\because \frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{v}{f} = \left(1 - \frac{v}{u}\right)$$

since m is positive in the graph,

$$\therefore m = \left|\frac{v}{u}\right| = (-)\frac{v}{u}$$

$$\Rightarrow m = \left(\frac{v}{f} - 1\right) = (-)\frac{v}{u}$$

$$\therefore \text{intercept on m} - \text{axis} = -1 \ \& \ \tan\theta = \frac{1}{f}$$

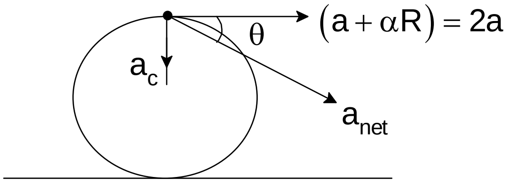
12. A

$$\because \omega = \frac{V}{R}, \text{OP} = \sqrt{x^2 + y^2}$$

origin is instantaneous centre of rotation

$$\therefore V_P = \omega r = \omega(\text{OP}) = \frac{V}{R}\sqrt{x^2 + y^2}$$

13. B



$\because a=\alpha R$

$a_c=\omega^2R=\left(\frac{V}{R}\right)^2R=\frac{V^2}{R}$

$=(2a)$

$\tan\theta=\frac{a_c}{2a}=1$

$\therefore\theta=45^o$

14. C

Thermal heat capacity, $C=\frac{Q}{\Delta T}=\frac{300}{20}=15J/{}^oC$

15. D

Specific heat capacity, $S=\frac{Q}{m\Delta T}=\frac{300}{0.025\times20}=600J/kg\ {}^oC$

16. A

Molar heat capacity

$$=\frac{Q}{n\Delta T}=\frac{300}{\left(\frac{25}{50}\right)(20)}$$

$=30J/mol\ {}^oC$

SECTION – B

1. $(A\rightarrow s)$ $(B\rightarrow p, t)$ $(C\rightarrow q)$ $(D\rightarrow p, r)$

In wrist watch spring force is not dependent on gravity.

$T=2\pi\sqrt{\frac{m}{K}}$

2. $(A\rightarrow p, q, t)$ $(B\rightarrow p, r, t)$ $(C\rightarrow s)$ $(D\rightarrow q, r)$

In nuclear reactions energy, charge, mass and momentum remain conserved.

SECTION – C

1. 3

for R^{max}, $\theta=45^o\Rightarrow H^{max}=\frac{(20)^2\sin^2(45^o)}{2\times10}=10m$

$\because H^{max}$allowed $=5m$,

$\Rightarrow5=\frac{(20)^2\sin^2\theta}{2\times10}\Rightarrow\theta=30^o$

$\Rightarrow R^{max}=\frac{(20)^2\sin60^o}{10}m=20\sqrt{3}m.$

2. 5

$\because M_{cylinder}=(\pi R^2\times3R)\rho.\ I_{cylinder}=\frac{1}{2}(3\pi R^3\rho)R^2$

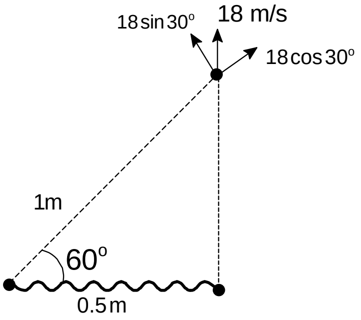
$M_{sphere}=\frac{2}{3}\pi R^3\rho,\ I_{sphere}=\frac{2}{5}\left(\frac{2}{3}\pi R^3\rho\right)R^2$

$\therefore I_{remaining\ portion}=I_{cylinder}-2\ I_{sphere}=\frac{29}{30}\pi R^5\rho.$

3. 9

$\because 18\sin 30^{o} = \omega r = \omega \times 1$

$= \omega = 9\ m/s.$



4. 9

$\because \frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$

$$\Rightarrow \frac{1}{24} = \left[\left(\frac{\mu_1}{\frac{4}{3}} - 1\right)\left(\frac{1}{20} + \frac{1}{20}\right) + \left(\frac{\mu_2}{\frac{4}{3}} - 1\right)\left(\frac{1}{-20} - \frac{1}{20}\right)\right]$$

$\Rightarrow (\mu_1 - \mu_2) = \left(\frac{5}{9}\right).$

5. 2

$\because I = \frac{V}{R} = \frac{200}{80} = 2.5A\ \&\ P = \frac{V^2}{R} = \frac{(200)^2}{80} = 500\,\text{watt}$

When the wire is divided into two equal parts and connected in parallel we get maximum power.

$\therefore$ Resistance of each part $= 40\Omega$

$\therefore I^{max} = 5A$

$\Rightarrow P_{max} = \frac{V^2}{R_{eq}} = \frac{(200)^2}{(20)} = 2000W = 2kw.$

6. 4

$\because \Delta V_{AP} = \frac{Q}{3}, \Delta V_{PB} = \frac{Q}{6}$

$\because 12 = \frac{Q}{3} + \frac{Q}{6} \Rightarrow Q = 24\mu C$

$\Rightarrow \Delta V_{AP} = \frac{24}{3} = 8$

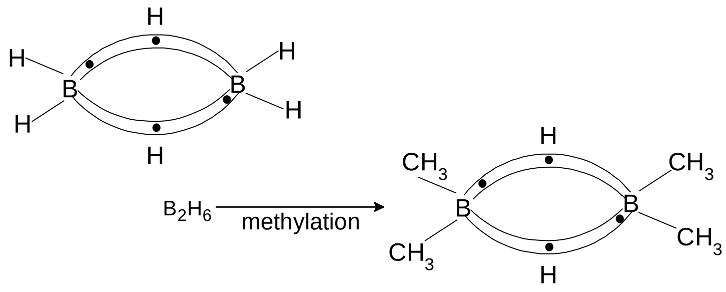
$\Rightarrow V_A - V_P = 8 \Rightarrow V_P = 4\text{volt}.$

Chemistry

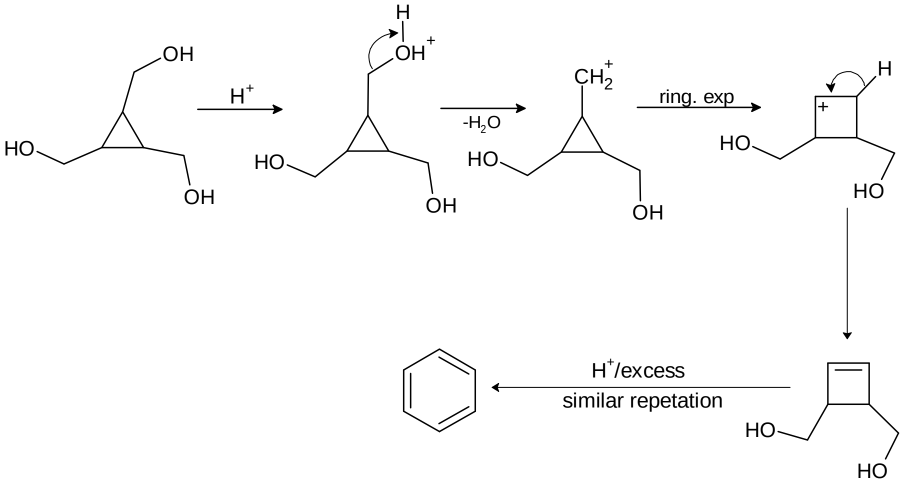
PART – II

SECTION – A

1. D


H
H
H
B
B
H
H
H
B_2H_6
methylation
H
CH_3
CH_3
B
B
CH_3
CH_3
H

2. D


OH
HO
OH
H^+
H
OH^+
HO
OH
$-H_2O$
CH_2^+
HO
OH
ring. exp
H
+
HO
HO
H^+/excess
similar repetation
HO
HO

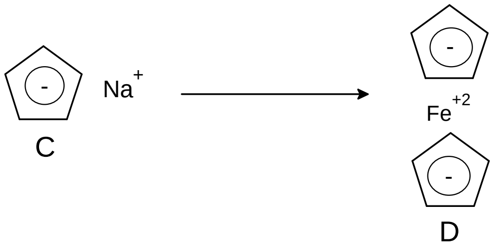
3. A

At nodal surface, $\psi = 0$

$$\Rightarrow r = \frac{2}{z} = \frac{2}{z}\ \text{Å} = 1\text{Å}$$

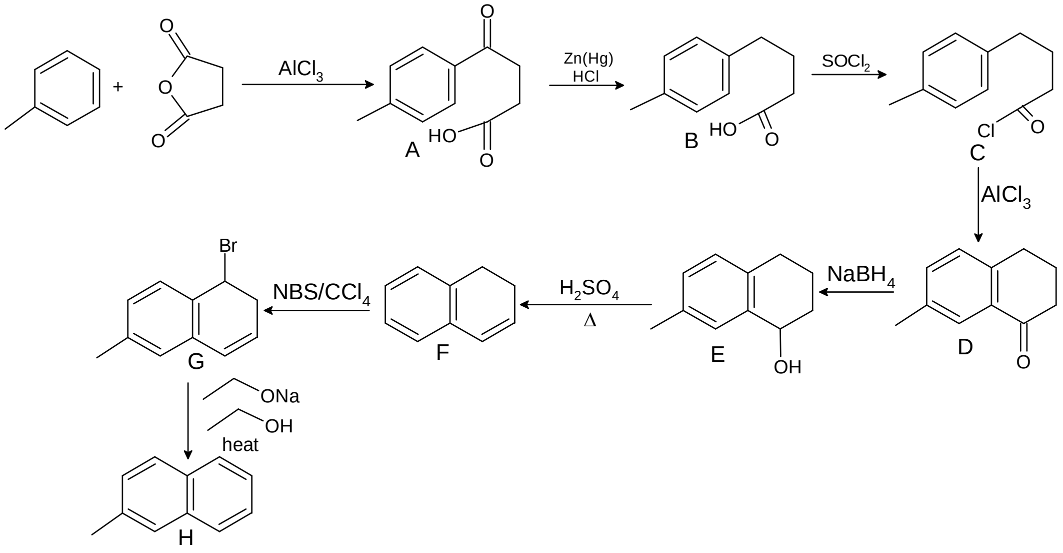
4. C

Co – ordination no of Fe^{+2} in D is 6

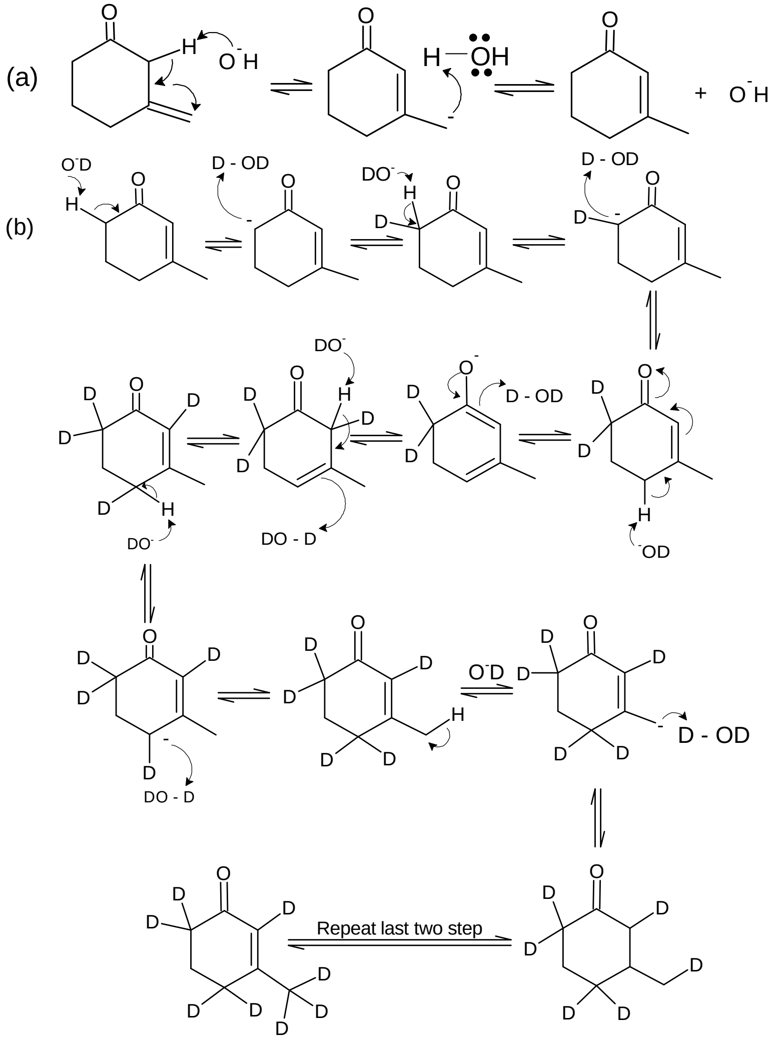


(a sandwhich compound)

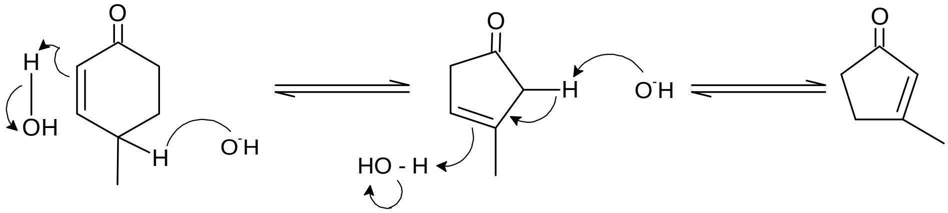
5. C


+
AlCl$_3$
A
Zn(Hg)
HCl
B
SOCl$_2$
C
AlCl$_3$
D
NaBH$_4$
E
H$_2$SO$_4$
Δ
F
NBS/CCl$_4$
G
ONa
OH
heat
H

6. C


(a)
(b)
Repeat last two step

(d)



7. A

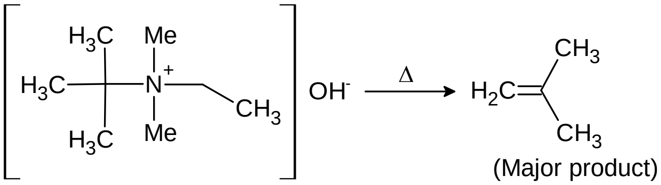
Synergic bonding.

8. A, B, C

$$\log\frac{K_2}{K_1}=\frac{\Delta H^o}{2.303R}\left[\frac{T_2-T_1}{T_1T_2}\right] \quad K_1 \& K_2 \text{ are eq. constant}$$

$$\log\frac{K_2}{K_1}=\frac{E_a}{2.303R}\left[\frac{T_2-T_1}{T_1T_2}\right] \quad K_1 \& K_2 \text{ are rate constant}$$

9. B



(Major product)

Due to greater probability of losing β-H (9 : 3 ratio).

10. B, C

(b) conjugate base of $H_2PO_4^-$ is HPO_4^{2-}

(c) pH of 0.1 M NaCl (aqueous solution) = $\frac{1}{2}pK_w$

11. A, C

$$A^{+3}+3e^- \longrightarrow Al$$

Number of moles of Al produced $=\frac{4.5}{27}=0.166$

Number of moles of electrons used $=3\times0.166$

$$H^+ + e^- \longrightarrow \frac{1}{2}H_2$$

Number of moles of H_2 produced $=\frac{1}{2}\times3\times0.166$

Volume of H_2 produced $=1.5\times0.166\times22.4\ell=5.57\ell=5.6\ell$

12. C

2nd step is r.d.s. in sulphonation reaction.

13. B

2nd step is fast step in nitration.

14. A

$$\left(P+\frac{a}{V}\right)(V-b)=RT$$

on converting into virial equation from, we get

$$PV=\left[RT\frac{\left(b-\frac{a}{RT^2}\right)}{V}+\frac{b^2}{V^2}+\frac{b^3}{V^4}+.......\right] \text{ to higher power of n} \qquad \ldots(i)$$

For Boyle's temperature, 2nd virial co-efficient becomes zero

$$\therefore b=\frac{a}{RT^2}$$

$$T_B=\sqrt{\frac{a}{Rb}}$$

$$\therefore T_B^2=\frac{a}{RB}$$

$$\therefore T_i=\frac{2a}{Rb}\Rightarrow T_i=2T_B^2$$

15. A

Let Boyle's temperature, $T_B^{'}$

$$\therefore T_B=\sqrt{\frac{a}{Rb}}$$

$$T_B^{'}=\sqrt{\frac{8a}{R\times 2b}}=2\sqrt{\frac{a}{Rb}}=2T_B$$

16. D

$b^2 = 0.04$

$b = 0.2$ lit/mol

$V_{real} = 4 \times 22.4 + 4 \times 0.2 = 90.4$ lit

SECTION – B

1. $(A\rightarrow r),(B\rightarrow p,t),(C\rightarrow q,s)(D\rightarrow q,s)$.

(A) Sic covalent carbide (Not hydrolysed)

(B) $Al_4C_3+12H_2O\longrightarrow 4Al(OH)_3+3CH_4$

(C) $CaI_2+2H_2O\longrightarrow Ca(OH)_2+H-C\equiv C-H$

(D) $Mg_2C_3+4H_2O\longrightarrow 2Mg(OH)_2+CH_3-C\equiv CH$

2. $(A \rightarrow p, q, s), (B \rightarrow q), (C \rightarrow r, t)(D \rightarrow q)$.

$$Al_2(SO_4)_3 \longrightarrow \underset{0.2M}{2Al^{+3}} + \underset{0.3M}{3SO_4^{--}}$$

$$AlPO_4 \longrightarrow \underset{0.1M}{Al^{+3}} + \underset{0.1M}{PO_4^{-3}}$$

$$Urea \longrightarrow \underset{0.1M}{Urea}$$

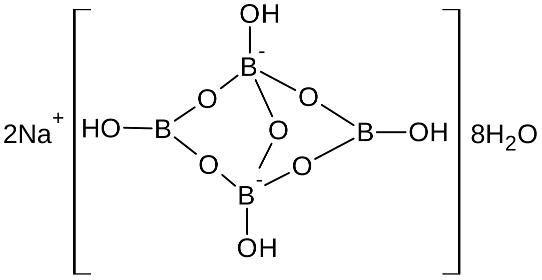
$$MgCl_2 \longrightarrow \underset{0.1M}{Mg^{+2}} + \underset{0.2M}{2Cl^{-}}$$

SECTION – C

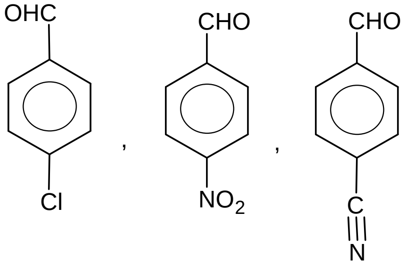
1. 4

Based on fact

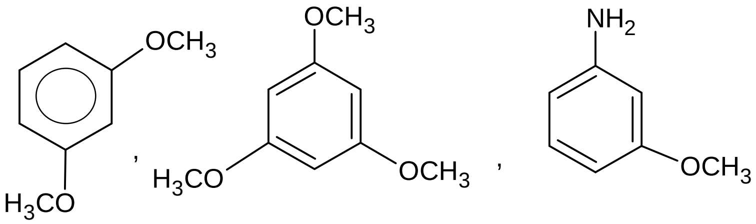
2. 7



3. 3



4. 3



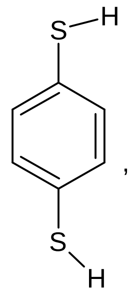
5. 2

$$t_{99} = \frac{1}{K}\ell n100;\ \ t_{90} = \frac{1}{K}\ell n\frac{100}{10}$$

$$\frac{t_{99}}{t_{90}} = \frac{\ell n100}{\ell n10} = \frac{2}{1} = 2$$

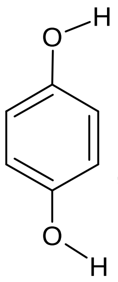
hence $x = 2$

6. 3



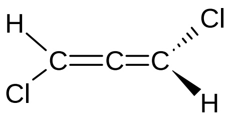
,

$\mu \neq 0$



,

$\mu \neq 0$



$\mu \neq 0$

Mathematics PART – III

SECTION – A

1. B

$$\left|\overrightarrow{PQ}\right| = \sqrt{r^2+1-2r\cos\frac{\pi}{3}} = \sqrt{r^2+1-r}$$

& $\left|\overrightarrow{AT}\right| = \sqrt{r^2+1-2r\cos\theta}$

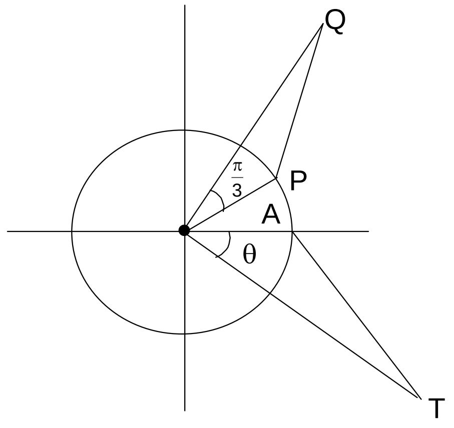
Where 'Q' is the angle between $\overrightarrow{OA}$ and $\overrightarrow{OT}$.

now, $\left|\overrightarrow{PQ}\right|^2 = 4\left|\overrightarrow{AT}\right|^2$

$\Rightarrow \left(1+r^2-r\right) = 4\left(r^2+1-2r\cos\theta\right)$

$\cos\theta = \frac{3r^2+r+3}{8r} \Rightarrow -1 \le \frac{3r^2+r+3}{8r} \le 1;\quad r > 0$

$\Rightarrow r \in \left[\frac{7-\sqrt{13}}{6}, \frac{7+\sqrt{13}}{6}\right].$



2. C

Here two balls are drawn and the result is known that the two balls are white, therefore Bayes's theorem should be used.

$$\text{Required probability} = \frac{\frac{1}{4}.1}{\frac{1}{4}.1+\frac{1}{4}.\frac{6}{10}+\frac{1}{4}.\frac{3}{10}+\frac{1}{4}.\frac{1}{10}} = \frac{1}{2}$$

3. D

Let $Q(x) = f(x) - g(x)$ in$[x_0 x]$

By LMVT,

$Q(x) - Q(x_0) = Q'(x) - Q'(x_0)$ for some $C \in (x_0, x)$

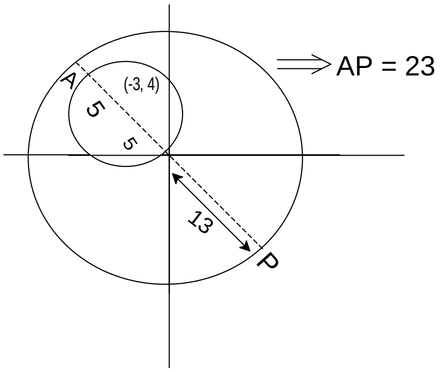
$\because Q(x_0) = 0,\ Q'(C) = f'(C) - g'(C) > 0$

$\Rightarrow Q(x) - Q(x_0) = Q(x)$

$= \left[F'(C) - g'(C)\right](x - x_0) > 0$

$\Rightarrow Q(x) > 0 \Rightarrow f(x) > g(x).$

4. A



5. D

$S_n = \frac{5}{4} - \frac{2n+5}{2(n+1)(n+2)}$

$\Rightarrow K = \frac{5}{4}$

6. A

Equation of tangent at 'P' is

$Y - y = m(X - x)$

Now, $\left|\frac{y - mx}{\sqrt{1+m^2}}\right| = x$

$\Rightarrow \frac{y^2 - x^2}{2xy} = \frac{dy}{dx}$ putting $y = vx$

Solving Differential equation

$x^2 + y^2 = Cx$

It passes through $(1,2) \Rightarrow C = 5$

Equation of curve $\equiv x^2 + y^2 - 5x = 0$

7. C

$T \equiv \frac{x\cos\theta}{3} + \frac{y\sin\theta}{2} = 1$

$x = 0,\ y = 2\operatorname{cosec}\theta,$

chord A'P;

$y = \frac{2\sin\theta}{3(\cos\theta+1)}(x+3)$

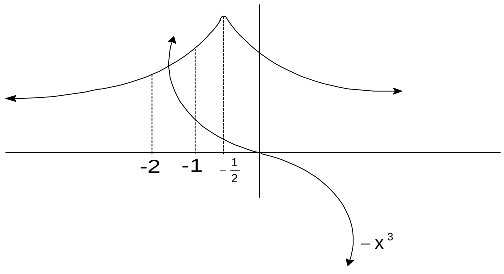
$x = 0,\ OM = \frac{2\sin\theta}{(\cos\theta+1)}$

$$\begin{aligned}
\text{Now, } OQ^2 - MQ^2 &= OQ^2 - (OQ - OM)^2 \\
&= 2(OM)(OQ) - OM^2 \\
&= OM[2OQ - OM] \\
&= \frac{2\sin\theta}{(\cos\theta+1)}\left[\frac{4}{\sin\theta} - \frac{2\sin\theta}{1+\cos\theta}\right] \\
&= \frac{2\sin\theta\left[4 + 4\cos\theta - 2\sin^2\theta\right]}{(1+\cos\theta)^2\sin\theta} \\
&= \frac{4\sin\theta\left[2 + 2\cos\theta - 1 + \cos^2\theta\right]}{(1+\cos\theta)^2\sin\theta} \\
&= 4
\end{aligned}$$

8. A, B, D

$f(x) = 0 \Rightarrow x^3\left(x^2 + x + 1\right) + \left(x^2 + x + 1\right) + 2 = 0$

$\Rightarrow -x^3 = 1 + \frac{2}{x^2 + x + 1}$



9. A, B, C

Take $f(x) = [x]$ and $g(x) = \{x\}$ and proceed.

10. B, C

$$I = \int \tan^{-1}\left(\frac{\cos 2x}{1+\sin 2x}\right)dx = \int \tan^{-1}\left[\tan\left(\frac{\pi}{4} - x\right)\right]dx$$

$$= \int\left(\frac{\pi}{4} - x\right)dx$$

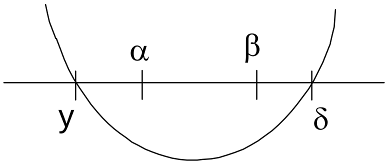
$$I = \frac{\pi}{4}x - \frac{x^2}{2} + C \Rightarrow g(x) = \frac{\pi}{4}x - \frac{x^2}{2}.$$

11. A, B

$$\alpha, \beta = \frac{2 \pm \sqrt{4 - 4(a^2 - 1)}}{2} = 1 + a, 1 - a$$

$$\Rightarrow f(1-a) < 0 \text{ \& } f(1+a) < 0$$

$$\Rightarrow a \in \left(-\frac{1}{4}, 1\right)$$



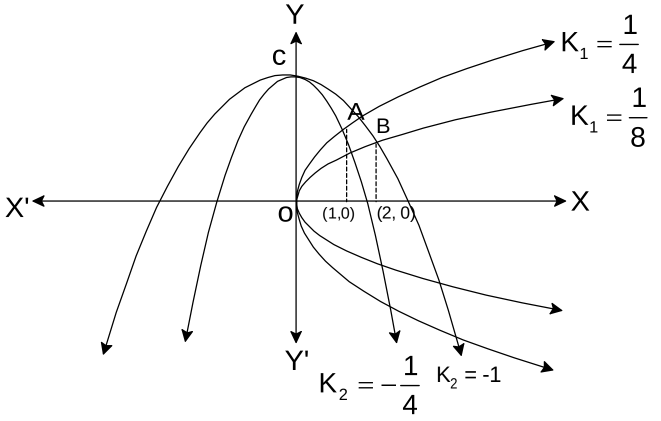
12. C

The value of K_1 & K_2 decide the opening of parabola

$\Rightarrow A_{max} = \text{Area}(OBCO)$

$\Rightarrow A_{min} = \text{Area}(OACO)$

13. D



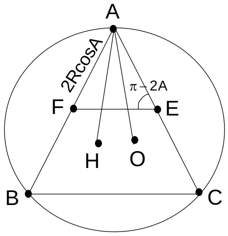
14. D

$\text{Area}(BFEC) = \text{Area}(\Delta ABC - \Delta AFE)$

$= \text{or } (\Delta AOB + \Delta BOC + \Delta COA - \Delta AFE)$

$= \frac{1}{2}R^2\left[\sin 2C + \sin 2A + \sin 2B - \sin(\pi - 2A)\right]$

$= \frac{1}{2}R^2(\sin 2B + \sin 2C)$



15. B

$AE = R, AF = 2R\cos A$

$\Rightarrow EF = R$

16. A

$\angle AFE = \frac{\pi}{3}$

$\Rightarrow \Delta AFE$ is equilateral

$\Rightarrow$ sum of square of altitudes $= 3\left(\frac{R\sqrt{3}}{2}\right)^2 = \frac{9}{4}R^2.$

SECTION – B

1. (A $\longrightarrow$ p, r, t) (B $\longrightarrow$ q) (C $\longrightarrow$ t) (D $\longrightarrow$ s)

$(A)\tan\left(\frac{\theta_1+\theta_2+\theta_3+\theta_4}{2}\right) = 0 \Rightarrow \theta_1+\theta_2+\theta_3+\theta_4 = 2n\pi$

$(B)x_2 = 4 \Rightarrow t^2 = 2$, TR is diameter = 6

Area of circle $= \frac{\pi}{4}(TR)^2 = 9\pi$

$(C)6$

$(D)(y_A + y_B + y_C)^2 = (\sqrt{3})^2 = 3$

2. (A $\longrightarrow$ q, t) (B $\longrightarrow$ q) (C $\longrightarrow$ p, r, s) (D $\longrightarrow$ t)

SECTION – C

1. 1

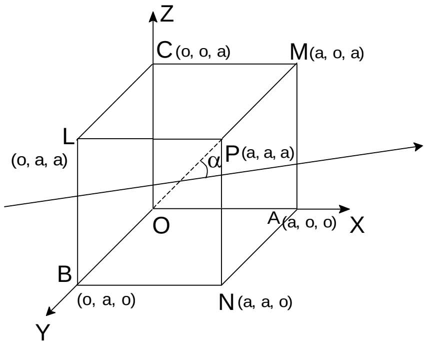
D.C's of OP are,

$$= \left(\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}\right)$$

$\Rightarrow$ D.C's of AL $\equiv \left(-\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}\right)$

D.C's of BM $\equiv \left(\frac{1}{\sqrt{3}}, -\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}\right)$

D.C's of CN $\equiv \left(\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, -\frac{1}{\sqrt{3}}\right)$



Let D.C's of required line be (ℓ, m, n)

$\therefore \cos\alpha = \frac{\ell+m+n}{\sqrt{3}}, \cos\beta = \frac{\ell+m-n}{\sqrt{3}}$

$\cos y = \frac{\ell+m+n}{\sqrt{3}}, \cos\delta = \frac{\ell+m-n}{\sqrt{3}}$

Hence, $\cos^2\alpha + \cos^2\beta + \cos^2 y + \cos^2\delta = \frac{4}{3}(\ell^2 + m^2 + n^2) = \frac{4}{3}$

$\Rightarrow \left[\cos^2\alpha + \cos^2\beta + \cos^2 y + \cos^2\delta\right] = \left[\frac{4}{3}\right] = 1.$

2. 2

The gives equation is $(x-1)(y-2)=4$

$$XY = 4$$

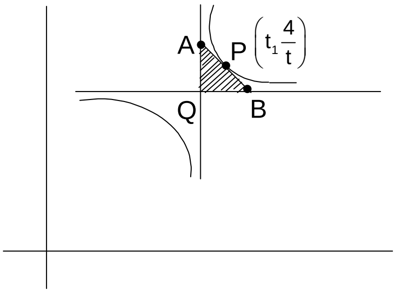
Equation of tangent is,

$$Y-\frac{4}{t}=-\frac{4}{t^2}(x-t)$$

$$\Rightarrow A \equiv \left(0,\frac{8}{t}\right) \text{ \& } B \equiv (2t_1 0)$$

$$\text{Area} = \frac{1}{2}\times\frac{8}{t}\times 2t = 8$$

$$4K = 8 \Rightarrow k = 2.$$



3. 1

$$\frac{CE}{DE}=\frac{(a+b)^2}{C^2}=\frac{(2+3)^2}{16}=\frac{25}{16}$$

$$\Rightarrow \left[\frac{CE}{DE}\right]=1$$

4. 5

$$\sum_{K=1}^{10}\int_0^1 f(K-1+x)dx=\int_0^1 f(x)dx+\int_0^1 f(x+1)dx..........\int_0^1 f(x+9)$$

$$=\text{putting } x+1=t,(x+2)=t............(x+9)=t$$

$$\Rightarrow \int_0^1 f(x)dx+\int_1^2 f(x)dx+\int_2^3 f(x)dx..........\int_9^{10} f(x)dx$$

$$=\int_0^{10} f(x)dx=5.$$

5. 7

Every ball have two options

$\Rightarrow$ 4 balls can be put in 2^4 ways.

Arrangement among themselves in 2!

$$=\frac{1}{2!}\times 2^4 = 2^3$$

But, above count also includes the one case in which all the balls are put in one box,

$\Rightarrow$ Required number of ways $= 2^3 - 1 = 7$.

6. 2

$$\begin{vmatrix}(K+1)^3 & (K+2)^3 & (K+3)^3\\ (K+1) & (K+2) & (K+3)\\ 1 & 1 & 1\end{vmatrix}=0$$

$$\Rightarrow K=-2 \qquad \Rightarrow |K|=2$$

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ALL INDIA TEST SERIES

FULL TEST – I

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 246**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 07)** contains 7 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (08 – 11) contains 4 multiple choice questions which have one or more than one correct answer. Each question carries **+3 marks** for correct answer. There is no negative marking.

   Section-A (12 – 16) contains 2 paragraphs. Based upon paragraph, 2 and 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct matching. No marks will be given for any wrong matching in any question. There is no negative marking.
3. **Section-C (01 – 06)** contains 6 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

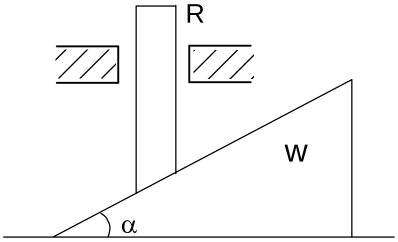
(Straight Objective Type)

This section contains **7 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** option **is correct**.

1. A flat coil of area A and n turns is placed at the centre of a ring of radius r (r^2 >> A) and resistance R. The two are co-planar when current in the coil increases from zero to i, the total charge circulating in the ring is

(A) $\frac{\mu_0 nAi}{2rR}$ (B) $\frac{\mu_0 nAi}{r^2R}$ (C) $\frac{\mu_0 nAi}{2\pi R}$ (D) $\frac{\mu_0 n^2 i}{4\pi rR}$

2. In the arrangement shown, all surfaces are frictionless. The rod R is constrained to move vertically. The vertical acceleration of R is a_1 and the horizontal acceleration of the wedge w is a_2. The ratio $\frac{a_1}{a_2}$ is equal to



(A) $\tan\alpha$ (B) $\cot\alpha$
(C) $\sin\alpha$ (D) $\cos\alpha$

3. An engine whistling at a constant frequency n_0 and moving with a constant velocity goes past a stationary observer. As the engine crosses him, the frequency of the sound heard by him changes by a factor f. The actual difference in the frequency of the sound heard by him before and after the engine across him is

(A) $\frac{1}{2}n_0\left(1-f^2\right)$ (B) $\frac{1}{2}n_0\left(\frac{1-f^2}{f}\right)$ (C) $n_0\left(\frac{1-f}{1+f}\right)$ (D) $\frac{1}{2}n_0\left(\frac{1-f}{1+f}\right)$

4. A ball of density ρ_0 falls from rest from point P onto the surface of a liquid of density ρ in time T. It enters the liquid stops moves up and returns to P in a total time 3T. Neglect viscosity, surface tension and splashing. The ratio $\frac{\rho}{\rho_0}$ is equal to

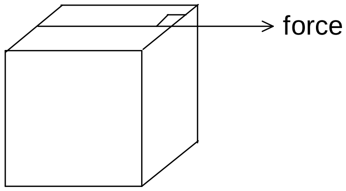
(A) 1.5 (B) 2 (C) 3 (D) 4

Space for Rough work

5. When an object is placed in front of a concave mirror of focal length f, a virtual image is produced with a magnification of 2. To obtain a real image with a magnification of 2. The object has to be moved by a distance equal to

(A) $\frac{f}{2}$ (B) $\frac{2}{5f}$ (C) f (D) $\frac{3}{2}f$

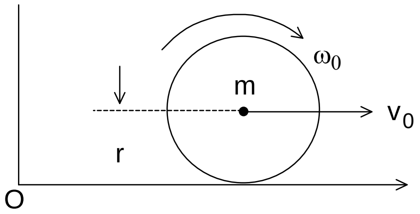
6. A solid cube is placed on a horizontal surface. The coefficient of friction between them is μ, where $\mu < \frac{1}{2}$. A variable horizontal force is applied on the cube's upper face, perpendicular to one edge and passing through the mid-point of that edge. The maximum acceleration with which it can move without toppling is



(A) μg (B) $2\mu g$

(C) $\frac{g}{2}(1-2\mu)$ (D) $\left(\mu+\frac{1}{2}\right)$

7. A spherical body of mass m, radius r and moment of inertia I about its centre moves along the x-axis. Its centre of mass moves with velocity = v_0 and it rotates about its centre of mass with angular velocity ω_0. Let $L_0 = I\omega_0 + mv_0r$. The angular momentum of the body about the origin O is



(A) L_0, only if $v_0 = r\omega_0$ (B) greater than L_0 if $v_0 > \omega_0 r$

(C) less than L_0, if $v_0 > \omega_0 r$ (D) L_0 for all values of ω_0 and v_0

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

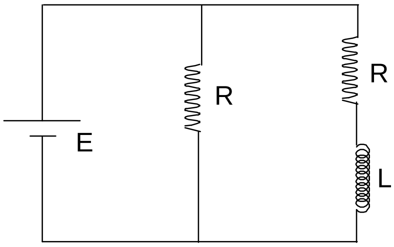
8. The temperature of a solid object is observed to be constant during a period. In this period
(A) heat may have been supplied to the body
(B) heat may have been extracted from the body
(C) no heat is supplied to the body
(D) no heat is exterted from the body

Space for Rough work

9. The electric potential decreases uniformly from 120 V to 80 V as one moves on the axis from x = –1 cm to x = 1 cm. The electric field at the origin
(A) must be equal to 20 V cm^{-1}
(B) may be equal to 20 V cm^{-1}
(C) may be greater than 20 V cm^{-1}
(D) may be less than 20 V cm^{-1}

10. A bag of mass M hangs by a long thread and a bullet (mass m) comes horizontally with velocity v and gets caught in the bag. Then for the combined system (bag + bullet)
(A) momentum is $\frac{mMv}{(M+m)}$
(B) KE = $\frac{1}{2}Mv^2$
(C) momentum is mv
(D) KE is $\frac{m^2v^2}{2(M+m)}$

11. In the circuit diagram shown



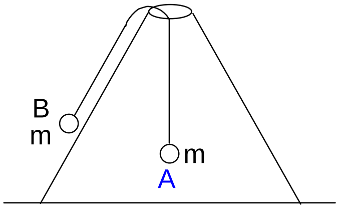
(A) time constant is $\frac{L}{R}$
(B) time constant is $\frac{2L}{R}$
(C) steady state current in inductor is $\frac{2E}{R}$
(D) steady state current in inductor is $\frac{E}{R}$

Comprehension Type

This section contains **2 paragraphs.** Based upon the first paragraph 2 multiple choice questions and based upon the second paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices A), B), C) and D) out of **WHICH ONLY ONE IS CORRECT.**

Paragraph For Question No.12 and 13

The base of a hollow right cone of semi vertical angle 30^o is fixed to a horizontal plane. Two particle each of mass m are connected by a light inextensible string which passes through a small hole in the vertex of the cone. One particle A hangs at rest inside the cone. The other particle B moves on the outer smooth surface of the cone at a distance ℓ from vertex in a horizontal circle with centre at A. Neglecting friction, now answer the following.



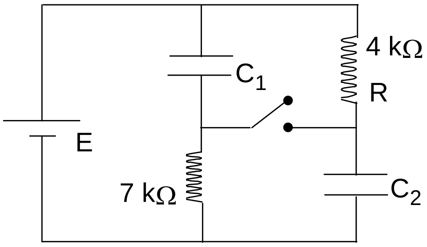
12. The tension in the string is
(A) $\frac{\sqrt{3}}{2}mg$
(B) $\frac{1}{2}mg$
(C) $\frac{2}{\sqrt{3}}mg$
(D) none of these

Space for Rough work

13. The angular velocity of B is
(A) $\sqrt{\frac{2g}{\ell}\left(2\sqrt{3}-1\right)}$ (B) $\sqrt{\frac{2g}{\ell}\left(\sqrt{3}-1\right)}$ (C) $\sqrt{\frac{2g}{\ell}\left(2-\sqrt{3}\right)}$ (D) $\sqrt{\frac{g}{\ell}\left(2-\sqrt{3}\right)}$

Paragraph For Question No.14 and 16

The switch S has been closed for long time and the electric circuit shown carries a steady current. Let $C_1 = 3\mu F$, $C_2 = 6\mu F$, $R_1 = 4\ k\Omega$ and $R_2 = 7.0\ k\Omega$. The power dissipated in R_2 is 2.8 W.



14. The power dissipated to the resistor R_1 is
(A) 2.8 W (B) 1.6 W (C) 4.9 W (D) 0

15. The charge on capacitance C_1 and C_2 are respectively
(A) 940 μC, 940 μC (B) 440 μC, 440 μC (C) 240 μC, 840 μC (D) 840 μC, 240 μC

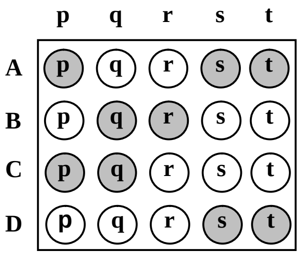
16. Long time after switch is opened the charge on C_1 is
(A) zero (B) 420 μC (C) 240 μC (D) 660 μC

Space for Rough work

SECTION-B
(Matrix-Match Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

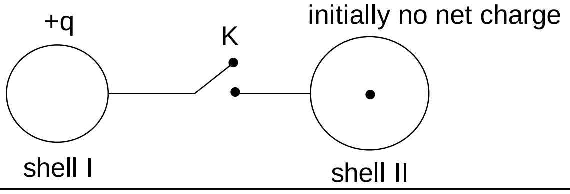
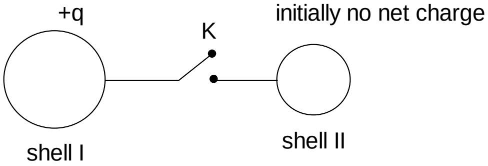
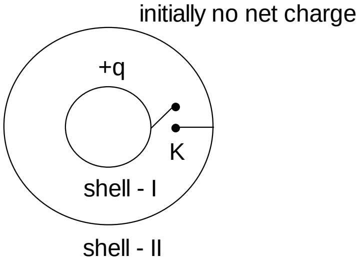
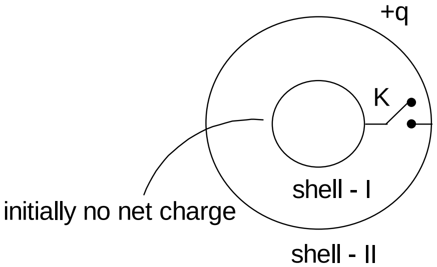
If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

---

1. Column – I gives certain situation involving two thin conducting shells connected by a conducting wire via a key K. In all situation one sphere has net charge +q and other sphere has no net charge. After the key K is pressed column – II gives some resulting effect. Match the figures in column with the statements in column – II.

Column – I		Column – II	
(A)	 +q K initially no net charge shell I shell II	(p)	Charge flow through the connecting wire
(B)	 +q K initially no net charge shell I shell II	(q)	Potential energy of system of spheres decreases
(C)	 initially no net charge +q K shell - I shell - II	(r)	No heat is produced
(D)	 +q K initially no net charge shell - I shell - II	(s)	The sphere I has no charge after equilibrium is reached
		(t)	Potential energy of system of sphere increase

Space for Rough work

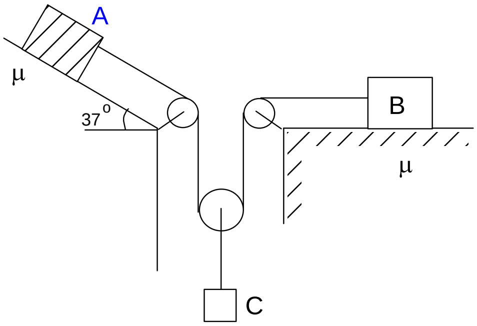
2. A particle of mass 2 kg is moving on straight line under the action of force F = (8 – 2x)N. The particle is released at rest from x = 6m. For the sub-sequent motion match the following (All the values in the right column are in there SI units).

Column – I		Column – II	
(A)	Equilibrium position is at x	(p)	$\frac{\pi}{4}$
(B)	Amplitude of SHM is	(q)	$\frac{\pi}{2}$
(C)	Time taken to go directly from x = 2 to x = 4	(r)	4
(D)	Energy of SHM is	(s)	6
		(t)	2

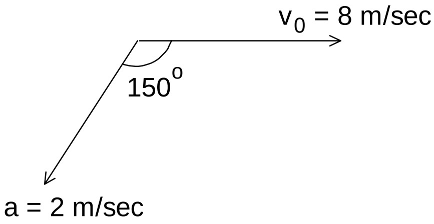
SECTION –C
Integer Answer Type

This section contains **6 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. In the arrangement shown in figure, pulley are light and frictionless, threads are inextensible and mass of blocks A, B and C are m_1 = 5 kg, m_2 = 4 kg and m_3 = 2.5 kg respectively and co-efficient of friction for both the planes is μ = 0.50. Calculate the acceleration of block A (in m/sec), when the system is released from rest. (g = 10 m/sec)

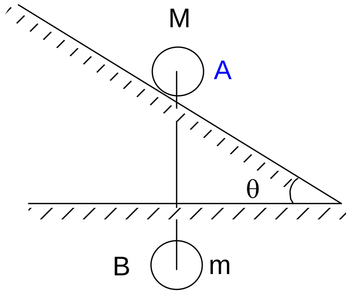


2. The figure shows the velocity and acceleration of a point like body at the initial moment of its motion. The acceleration vector of the body remains constant. The minimum radius of curvature of trajectory of the body is

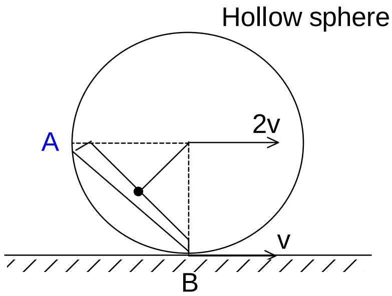


Space for Rough work

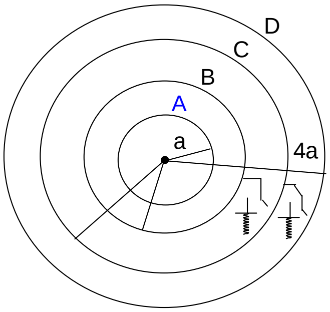
3. A disc 'A' of mass M is placed at rest on the smooth inclined surface of inclination θ. A ball B of mass m is suspended vertically from the centre of the disc A by a light inextensible string of light ℓ as shown in the figure. If the acceleration of the disc B immediately after the system is released from rest is $\frac{(M+km)g\sin^2\theta}{M+m\sin^2\theta}$. Find k



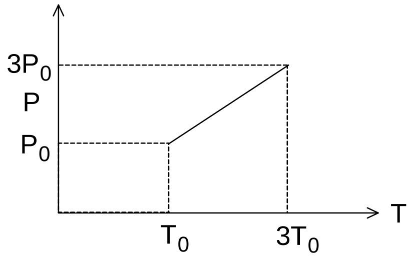
4. A uniform rod AB of mass M and length $R\sqrt{2}$ is moving in a vertical plane inside a hollow sphere of radius R. The sphere is rolling on a fixed horizontal surface without slipping with velocity of its centre of mass 2v, when the end B is at the lowest position, its speed is found to be v as shown in the figure. If the kinetic energy of rod at this instant is $\frac{4}{k}Mv^2$. Find k.



5. In the figure A, B, C and D are four concentric spheres of radius a, 2a, 3a and 4a and contain charges +3q, +6q, -6q and +12q respectively. In the beginning switches S_1 and S_2 are open. After earthing the sphere C Δq_1 amount of charge flows from the sphere C to the earth. If the sphere B is also earth, then Δq_2 amount of charge flows from the sphere B to the earth, find the value of $\frac{|\Delta q_1|}{|\Delta q_2|}$.



6. Two moles of a monoatomic ideal gas undergoes a process AB as shown in the figure. Then find the work done during the process in Joule.



Space for Rough work

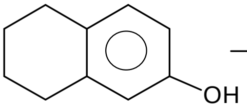
Chemistry

PART – II

SECTION – A

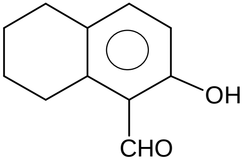
Straight Objective Type

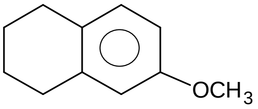
This section contains **7 multiple choice** questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONLY ONE** option is correct.

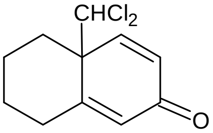
1. 

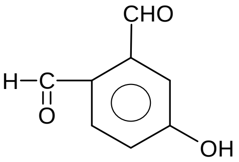
$\xrightarrow{CHCl_3 + KOH}$ A (Expected) + B (Unexpected)

The unexpected product B is

(A) 

(B) 

(C) 

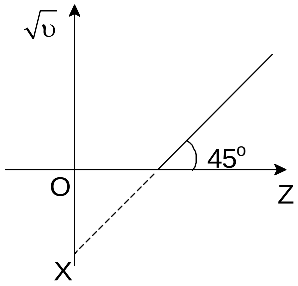
(D) 

2. $I_2(s) \mid I^-$ (0.1 M) half cell is connected to a H^+ (aq.) | H_2(1 bar) | Pt half cell and emf is found to be 0.7714 V. If $E^o_{I_2|I^-} = 0.535$ V, find the pH of $H^+ | H_2$ half cell.

(A) 1 (B) 3 (C) 5 (D) 7

3. In the graph between $\sqrt{\upsilon}$ and Z for the Mosley's equation, the intercept OX is -1 on $\sqrt{\upsilon}$ axis. What is the frequency when atomic number (Z) is 51?

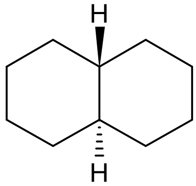
(A) 50 Hz (B) 100 Hz
(C) 2500 Hz (D) None

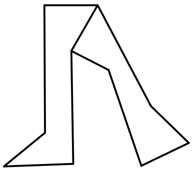


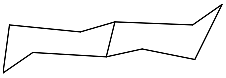
Space for Rough work

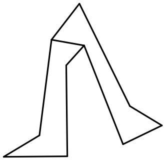
4. Sulphur reacts with chlorine in 1 : 2 ratio and forms X. Hydrolysis of X gives a sulphur compound Y. What is the hybridization state of central atom in the compound Y?
(A) sp^3 (B) sp^2 (C) sp (D) dsp^2

5. Find out correct representation of trans - decaline



(A)


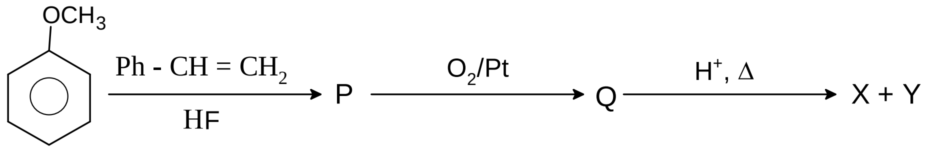
(B)


(C)


(D) None of these

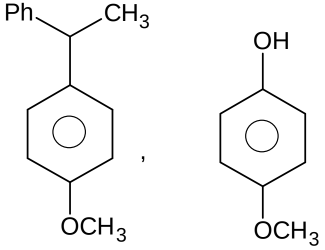
6. 50 ml of a solution containing 10^{-3} mol of Ag^+ is mixed with 50 ml of a 0.1 M HCl solution. How much $[Ag^+]$ remains in solution? Given: K_{sp} of AgCl = 10^{-10}
(A) 2.5×10^{-9} M (B) 2.5×10^{-7} M (C) 2.5×10^{-8} M (D) 2.5×10^{-10} M

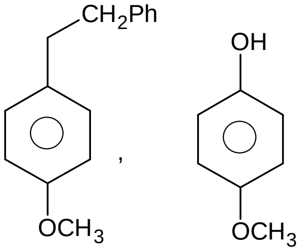
Space for Rough work

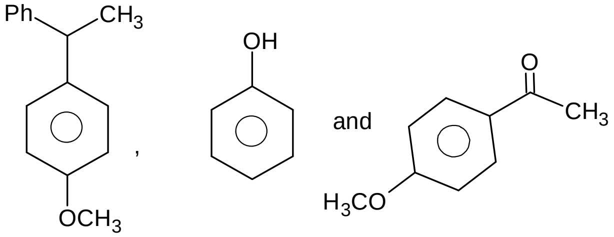
7. 
OCH3
Ph - CH = CH2
HF
P
O2/Pt
Q
H+, Δ
X + Y

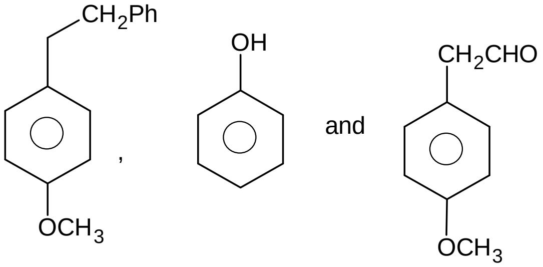
Where X is a compound that forms azodye with benzene diazonium chloride in faintly basic medium.

Hence the products P, X and Y are respectively.

(A) 
Ph
CH3
OCH3
OH
OCH3
and $PhCOCH_3$

(B) 
CH2Ph
OCH3
OH
OCH3
and $PhCH_2CHO$

(C) 
Ph
CH3
OCH3
OH
and
O
CH3
H3CO

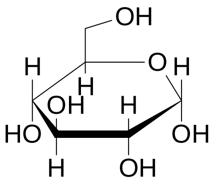
(D) 
CH2Ph
OCH3
OH
and
CH2CHO
OCH3

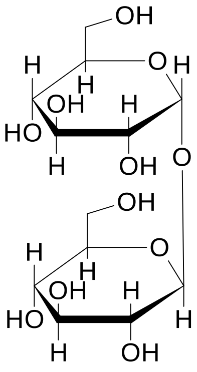
Space for Rough work

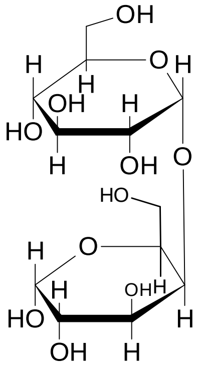
Multiple Correct Choice Type

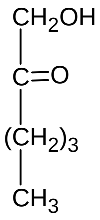
This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.

8. Some organic compounds are given below:


(I)


(II)


(III)



$CH_2OH-C(=O)-(CH_2)_3-CH_3$

(IV)

Select the correct statement(s) about the above compounds from the following:
(A) Compounds (I) and (III) will reduce Fehling's solution and will also mutarotate
(B) Compound (IV) will reduce Tollen's reagent but not mutarotate
(C) Compound (II) will not be reducing but mutarotating
(D) The product(s) of the acid catalysed hydrolysis of both (II) and (III) will be reducing but not mutarotating

9. Which of the following solutions show lowering of vopour pressure on mixing?
(A) Aniline and cyclohexane
(B) Chloroform and acetone
(C) Ethyl alcohol and pentane
(D) Dimethyl ether and chloroform

10. HI cannot be prepared by the action of conc. H_2SO_4 on KI because
(A) HI is stronger acid than H_2SO_4
(B) H_2SO_4 is an oxidizing agent
(C) HI is a strong reducing agent
(D) H_2SO_4 is stronger acid than HI

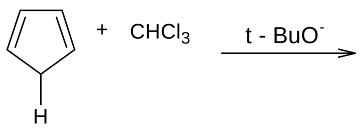
Space for Rough work

11. Which of the following will produce aromatic compound as a product?

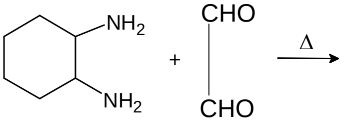
(A) $CH_3-C\equiv CH \xrightarrow[\Delta]{\text{Redhot Fe tube}}$

(B) $n-C_6H_{14} \xrightarrow[Cr_2O_3/600^\circ C]{Al_2O_3}$

(C)



(D)



Comprehension Type

This section contains **2 paragraphs.** Based upon the first paragraph 2 multiple choice questions and based upon the second paragraph **3 multiple choice questions** have to be answered. Each of these questions has four choices A), B), C) and D) out of **WHICH ONLY ONE IS CORRECT.**

Paragraph For Question No.12 and 13

A white compound (A) on strong heating decomposes to produce two products (B) and (C). (B) on reaction with white phosphorus produces (D), which is a strong dehydrating agent. (D) on reaction with perchloric acid converts it to its anhydride.

12. The compound (A) is

(A) NH_4NO_2 (B) NH_4ClO_4 (C) $(NH_4)_2Cr_2O_7$ (D) NH_4NO_3

13. The product/s obtained on hydrolysis of (D) is

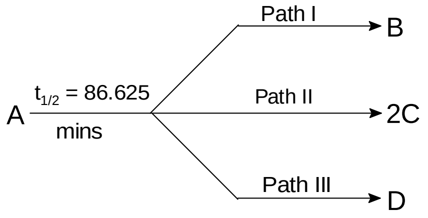
(A) Mixture of H_3PO_3 and H_3PO_4 (B) Only PH_3

(C) Only H_3PO_4 (D) Mixture of H_3PO_3 and H_3PO_2

Space for Rough work

Paragraph For Question No.14 and 16

'A' is a substance that converts into B, C and D by three first order parallel paths simultaneously according to the following stoichiometry



The partial $t_{1/2}$ of A along path I and path II are 173.25 min and 346.5 min respectively. The energies of activation of the reaction along path I, path II and path III are 40, 60 and 80 kJ/mol respectively.

14. The percent distribution of C in the product mixture B, C and D at any time is equal to
(A) 20 (B) 60 (C) 80 (D) 40

15. The initial rate of consumption of A and the sum of the initial rate of formation of B, C and D are respectively, taking [A] = 0.25 M, equal to
(A) $2\times10^{-3}\,\text{molL}^{-1}\,\text{min}^{-1}$ and $2.5\times10^{-3}\,\text{mol L}^{-1}\,\text{min}^{-1}$
(B) $2\times10^{-3}\,\text{mol L}^{-1}\,\text{min}^{-1}$ and $2\times10^{-3}\,\text{mol L}^{-1}\,\text{min}^{-1}$
(C) $2.5\times10^{-3}\,\text{molL}^{-1}\,\text{min}^{-1}$ and $3\times10^{-3}\,\text{mol L}^{-1}\,\text{min}^{-1}$
(D) $4\times10^{-3}\,\text{molL}^{-1}\,\text{min}^{-1}$ and $2\times10^{-3}\,\text{mol L}^{-1}\,\text{min}^{-1}$

16. The overall energy of activation of A along all the three parallel path is equal to
(A) 52 kJ/mol (B) 60 kJ/mol (C) 55 kJ/mol (D) 80 kJ/mol

Space for Rough work

SECTION-B
(Matrix-Match Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

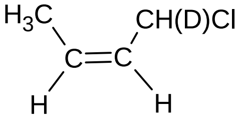
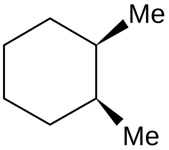
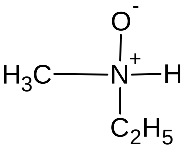
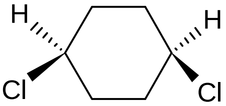
	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the following:

Column – I		Column - II	
(A)	$XeF_4 + H_2O(\ell) \longrightarrow$	(p)	Shows disproportionation reaction
(B)	$P_4(s) + OH^-(aq) + H_2O(\ell) \longrightarrow$	(q)	One of the product is a monobasic Lewis acid
(C)	$B_2H_6 + H_2O(\ell) \longrightarrow$	(r)	One/two of the products is/are gas(es)
(D)	$Br_2(g) + k_2CO_3(aq) \longrightarrow$	(s)	One of the product has trigonal pyramidal structure
		(t)	One of the gaseous product is used as Holme's signal in sea

Space for Rough work

2. Match the following:

Column – I		Column - II	
(A)		(p	Optically active
(B)		(q	Optically inactive
(C)	 $H_3C-\underset{C_2H_5}{\overset{O^-}{N^+}}-H$	(r)	Plane of symmetry
(D)		(s)	Number of chiral centre = 1
		(t)	Number of stereocentres = 2

SECTION –C
Integer Answer Type

This section contains **6 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. Number of nuclear particles (Projectiles + ejectiles) involved in the conversion of the nuclide ${}_{92}U^{238}$ into ${}_{94}Pu^{239}$ by neutron – capture method is ....

2. A crystal is made up of atoms X, Y and Z. Atoms X are in FCC packing. Y occupies all octahedral voids and Z occupies all tetrahedral voids. If all the atoms along two body diagonals are removed, the ratio of sum of effective number of atoms of Y and Z to the effective number of atoms of X is a : 1, what is the value of a?

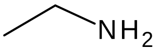
Space for Rough work

3. How many aldol products may be formed by the reaction of CH_3CH_2CHO with $CH_3COCH_2CH_3$?

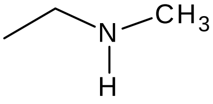
4. 5.6 L an unknown gas at NTP requires 12.5 calories to rise its temperature by 10^oC at constant volume. What is the atomicity of the gas?

5. After electrolysis of a NaCl solution with inert electrodes for a certain period of time, 60 ml of the solution was left which was found to be 1 N in NaOH. During the same time 31.75 g of Cu was deposited in a Cu voltameter in series with the electrolytic cell. Calculate the percentage of the theoretical yield of the sodium hydroxide obtained.

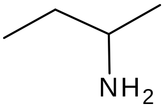
6. Of the following amines how many can be separated by Hoffmann's mustard oil reaction?



(i)



(ii)



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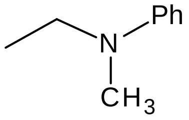
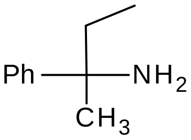
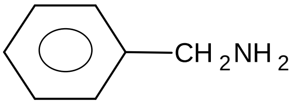


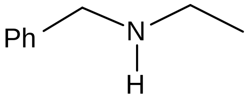
(iv)



(v)



(vi)



(vii)

Space for Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains 7 multiple choice questions numbered 1 to 7. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. If $f(x)=\dfrac{\int_0^n [x]dx}{\int_0^n \{x\}dx}$, then $\sum_{n=1}^{n} f(x)$ is equal to (where [•] and {•} denotes GIF and fraction parts of x), $n \in N$

   (A) $n^2 - 1$ (B) $\dfrac{n^2-n}{2}$ (C) $\dfrac{n(n+1)}{2}$ (D) $n^2 + 1$

2. The solution of the differential equation $y'y''' = 3(y'')^2$ is

   (A) $x = A_1y^2 + A_2y + A_3$ (B) $x = A_1y + A_2$
   (C) $x = A_1y^2 + A_2y$ (D) none of these

3. A point on the hypotenuse of a triangle is at distance a and b from the side of the triangle then minimum length of the hypotenuse is

   (A) $(a^2+b^2)^{\frac{1}{2}}$ (B) $(a^2+b^2)^{\frac{2}{3}}$ (C) $\left(a^{\frac{2}{3}}+b^{\frac{2}{3}}\right)^{\frac{3}{2}}$ (D) $\left(a^{\frac{1}{3}}+b^{\frac{1}{3}}\right)^{\frac{2}{3}}$

4. If the equation $x^4 - 4x^3 + ax^2 + bx + 1 = 0$ has four positive roots then

   (A) a = 6, b = –4 (B) a = 5, b = –4 (C) a = 6, b = –3 (D) a = 6, $b \in R$

5. Find the point P on the line 2x + 3y + 1 = 0 such that |PA – PB| is maximum where A is (2, 0) and B is (0, 2)

   (A) (1, –1) (B) (7, –5) (C) (–2, 1) (D) (4, –3)

Space for Rough work

6. Find the coefficient of x^5 in the expansion of $(2 - x + 3x^2)^6$

(A) –5049 (B) 5051 (C) –5052 (D) 5050

7. If $\tan 3\theta + \tan\theta = 2\tan 2\theta$ then θ is equal to $(n \in z)$

(A) $n\pi$ (B) $\frac{n\pi}{4}$ (C) $2n\pi$ (D) none of these

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

8. If x, y, z are respectively perpendiculars from the circumcenter to the sides of ΔABC, (a, b, c are usual meanings) then

(A) $\tan A = \frac{a}{2x}$ (B) $\frac{a}{x} + \frac{b}{y} + \frac{c}{z} = \frac{abc}{4xyz}$ (C) $\frac{a}{x} = \tan A$ (D) $\frac{a}{x} + \frac{b}{y} + \frac{c}{z} = \frac{abc}{2xyz}$

9. Which of the following is/are correct

(A) $(\tan x)^{\ln(\sin x)} > (\cot x)^{\ln(\sin x)}\ \forall\ x \in \left(0, \frac{\pi}{4}\right)$ (B) $4^{\ln(\operatorname{cosec} x)} > 5^{\ln(\operatorname{cosec} x)}\ \forall\ x \in \left(0, \frac{\pi}{2}\right)$

(C) $\left(\frac{1}{2}\right)^{\ln(\cos x)} < \left(\frac{1}{3}\right)^{\ln(\cos x)}\ \forall\ x \in \left(0, \frac{\pi}{2}\right)$ (D) none of these

10. The angle between the lines whose direction cosine are connected by the relations $\ell - 5m + 3n = 0$ and $7\ell^2 + 5m^2 - 3n^2 = 0$

(A) $\tan^{-1}\left(\frac{2}{\sqrt{3}}\right)$ (B) $\cos^{-1}\sqrt{\frac{7}{12}}$ (C) $\cos^{-1}\sqrt{\frac{3}{7}}$ (D) $\tan^{-1}\sqrt{\frac{5}{7}}$

11. If $\vec{a}, \vec{b}$ and $\vec{c}$ are three mutually perpendicular unit vectors and $\vec{d}$ is a unit vector which makes equal angles with $\vec{a}, \vec{b}$ and $\vec{c}$ then the value of $\left|\vec{a} + \vec{b} + \vec{c} + \vec{d}\right|^2$

(A) $4 + 2\sqrt{3}$ (B) $4 - 2\sqrt{3}$ (C) $2 + \sqrt{5}$ (D) $2 - \sqrt{5}$

Space for Rough work

Comprehension Type

This section contains 2 paragraphs. Based upon one of paragraphs 2 multiple choice questions and based on the other paragraph 3 multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

Paragraph for Question Nos. 12 to 13

PQ is the double ordinate of the parabola $y^2 = 4x$ which passes through the focus S. ΔPQA is an isosceles right angle triangle, where A is on the axis of the parabola. Line PA meets the parabola at C and QA meets the parabola at B.

12. The area of trapezium PBCQ is
(A) 96 sq units (B) 64 sq units (C) 72 sq units (D) 48 sq units

13. The circumradius of trapezium PBCQ is
(A) $6\sqrt{5}$ (B) $3\sqrt{6}$ (C) $2\sqrt{10}$ (D) $5\sqrt{3}$

Paragraph for Question Nos. 14 to 16

Let z be a complex number satisfying $z^2 + 2\alpha z + 1 = 0$ where α is a parameter which can take any real value.

14. The roots of this equation lie on a certain circle if
(A) $-1 < \alpha < 1$ (B) $\alpha > 1$ (C) $\alpha < 1$ (D) none of these

15. One root lies inside the unit circle and one outside if
(A) $-1 < \alpha < 1$ (B) $\alpha > 1$ (C) $\alpha < 1$ (D) none of these

16. For every large value of α the roots are approximately
(A) $-2\alpha, \frac{1}{\alpha}$ (B) $-\alpha, -\frac{1}{\alpha}$ (C) $-2\alpha, -\frac{1}{2\alpha}$ (D) none of these

Space for Rough work

SECTION-B
(Matrix-Match Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

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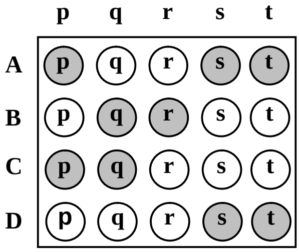

1. A function is defined as $f:\{a_1,a_2,a_3,a_4,a_5,a_6\}\to\{b_1,b_2,b_3\}$

Column – I		Column – II	
(A)	The number of onto functions	(p)	Is divisible by 9
(B)	Number of function in which $f(a_i) \neq b_i$	(q)	Is divisible by 5
(C)	Number of invertible functions	(r)	Is divisible by 4
(D)	Number of many one functions	(s)	Is divisible by 3
		(t)	Not possible

2. Match the following:

Column – I		Column – II	
(A)	$\sin^{-1}(\sin 10)$	(p)	$4\pi - 10$
(B)	$\cos^{-1}(\cos 10)$	(q)	$3\pi - 10$
(C)	$\tan^{-1} x + \tan^{-1}\frac{1}{x}$	(r)	$\frac{\pi}{2}$
(D)	$\sin^{-1}\frac{1}{\sqrt{2}} + \sin^{-1}\left(\frac{\sqrt{2}-1}{\sqrt{6}}\right) + ... + \sin^{-1}\left(\frac{\sqrt{n}-\sqrt{n-1}}{\sqrt{n(n+1)}}\right) +$ to ∞	(s)	$-\frac{\pi}{2}$
		(t)	10

Space for Rough work

SECTION – C

(Integer Answer Type)

This section contains **6 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

1. Two friends have equal number of sons. There are 3 tickets for a cricket match which are to be distributed among the sons. The probability that two tickets go to the sons of one and one tickets goes to the sons of other is $\frac{6}{7}$. Then total number of boys is equal to (sum of son of each friend).

2. A line through the origin meets the circle $x^2 + y^2 = a^2$ at P and the hyperbola $x^2 - y^2 = a^2$ at Q. Then locus of the point of intersections of tangent to the circle at P with the tangent at Q to the hyperbola is the curve $(a^4 + 4y^4)x^2 = a^K$ then K is equal to ..

3. In a ΔABC, $\Delta = \begin{vmatrix} e^{i2A} & e^{-iC} & e^{-iB} \\ e^{-iC} & e^{i2B} & e^{-iA} \\ e^{-iB} & e^{-iA} & e^{i2C} \end{vmatrix}$. Then the value of $|\Delta|$, where $|\bullet|$ denote absolute value.

4. If $\int \frac{1}{\left((x-1)^3(x+2)^5\right)^{\frac{1}{4}}} dx = \frac{P}{q}\left(\frac{x-1}{x+2}\right)^{\frac{1}{4}} + C$. Then P + q is

5. The area of region in first quadrant in which points are nearer to the origin then to the line x = 3.

6. Let $f(x) = \lim_{n\to\infty}\left(\frac{n!}{n^n}\right)^{\frac{1}{n}}$. Then the value of $[e^2f(x)]$, where $[\bullet]$ denotes GIF.

Space for Rough work

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FULL TEST – I
(PAPER-2)

No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**A**	**C**	**B**
2.	**A**	**B**	**A**
3.	**B**	**C**	**C**
4.	**C**	**A**	**A**
5.	**C**	**B**	**B**
6.	**C**	**A**	**C**
7.	**D**	**A**	**A**
8.	**A, B**	**A, B**	**A, B**
9.	**B, C**	**B, D**	**A, C**
10.	**C, D**	**B, C**	**B, D**
11.	**A, D**	**A, B, C**	**A, B**
12.	**D**	**D**	**B**
13.	**C**	**C**	**C**
14.	**B**	**D**	**A**
15.	**C**	**A**	**B**
16.	**D**	**C**	**C**
1.	**(A) → p,q, (B) → p,q, (C) → p,q,s, (D) → r,s**	**(A) → p,r,s, (B)→p,r,s,t, (C) → q, r, (D) → p, r, s**	**(A) → p, q, r, s (B) → p, r, s (C) → t (D) → p, s**
2.	**(A) → r, (B) → t, (C) → q, (D) → r**	**(A)→p,s, (B) → q,r,t, (C) → p,s, (D) →q,r,t**	**(A) → q, (B) → p, (C) → r, s, (D) → r**
1.	**4**	**3**	**8**
2.	**8**	**2**	**6**
3.	**1**	**6**	**4**
4.	**3**	**2**	**7**
5.	**1**	**6**	**3**
6.	**0**	**4**	**2**

Physics PART – I

SECTION – A

1. $Q = \frac{\Delta\phi}{R} = \frac{\text{charge in flux}}{\text{resistance}}$

$= \frac{(B \times A \times n)}{R} = \frac{\mu_0}{4\pi}\left(\frac{2\pi I}{r}\right) \times A \times n \times \frac{1}{R}$

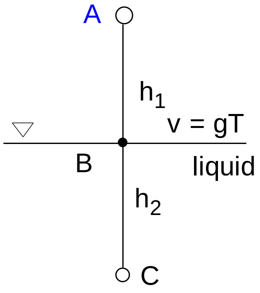
$= \left(\frac{\mu_0 IAn}{2rR}\right)$

2. Relative acceleration of rod with respect to wedge is parallel to the inclined plane.

3. $f_{app} = \left(\frac{v - v_D}{v - f_s}\right) f_0$

Simply use the above relation

4. for B to C part



$u = gT$

$a = -\frac{(v \times \rho - v \times \rho_0)g}{v\rho_0}$

$v = 0 \quad a = \frac{T}{2}$

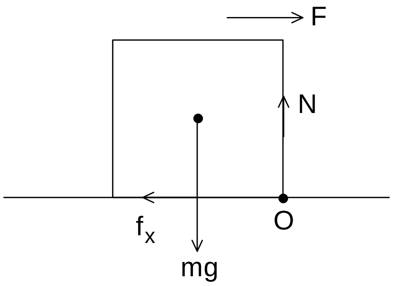
$O = gt - \left(\frac{\rho - \rho_0}{\rho_0}\right) g \times \frac{T}{2}$

$1 = \frac{\rho - \rho_0}{2\rho_0} \Rightarrow 2\rho_0 = \rho - \rho_0$

$\frac{\rho}{\rho_0} = 3$

5. Calculate the initial and final distance of object from the concave mirror.

6. To avoid t toppling



$$(\tau_{net})_0 = 0$$

$$F \times a - mg \times \frac{a}{2} = 0$$

$$F = \frac{mg}{2}$$

Now apply Newton's laws of motion.

7. As we know
$L_0 = L_1 + L_2$
L_1 = due to rotational motion
L_2 = due to linear motion.

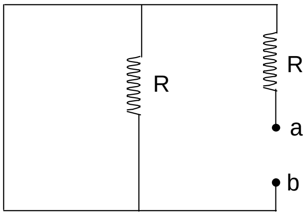
8. If temperature of a body is constant that means amount of hear energy received and amount of hear energy emitted are equal.

9. If direction of field is along the x-axis then its magnitude will be 20 V/cm other wise greatest then hat.

10. Apply conservation of linear momentum

$$KE = \frac{\rho^2}{2 \times \text{mass}}$$

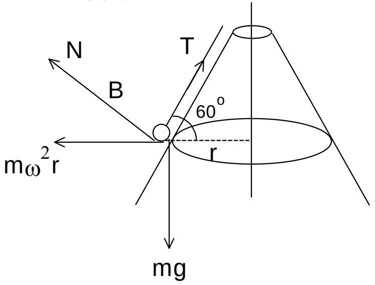
11. Calculate the time constant

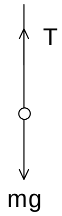


Battery is replaced by a wire

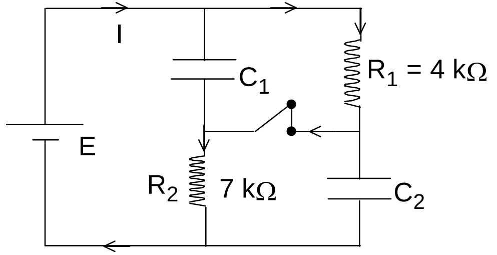
$$\tau = \frac{L}{R_{ab}} = \frac{L}{R}$$

12 – 13. Now apply newton's law of motion for the particle B.





14 – 16. Initially current will pass through the resistance only.



Power in $R_2 = 7 \times (I^2) = 2.8$ W

Power in $R_1 = 4 \times I^2 = 4 \times (4) = 1.6$

$$\text{Charge in } C_1 = 3 \times 10^{-6} \times 8 \times 10^3 \times \sqrt{\frac{2.8}{7 \times 10^3}}$$

$$= 240\ \mu\text{C}.$$

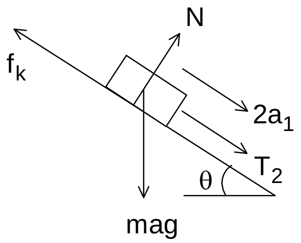
SECTION – B

1. In such type of situation, we have to use these basic facts.
   (a) charge will flow between the two body if there is potential difference between the two.
   (b) during this process energy will lose due to sparking.

2. At equilibrium F_{net} will be zero and at the extreme point, particle will be in state of rest.

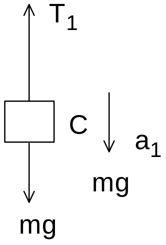
SECTION – C

1. in this situation block B will not move at all.

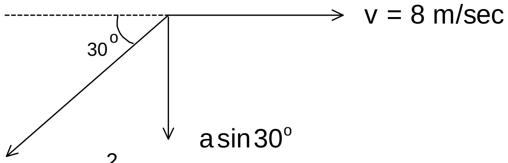


$T_2 = 2T_1$

Now apply newton's laws of motion.



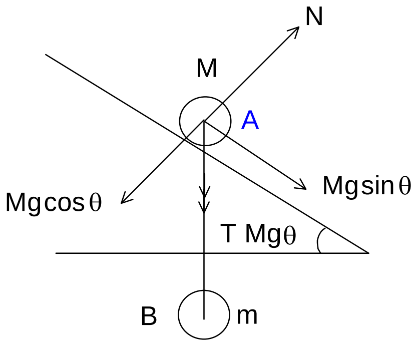
2. $a\sin 30^\circ = \frac{v_0^2}{R}$



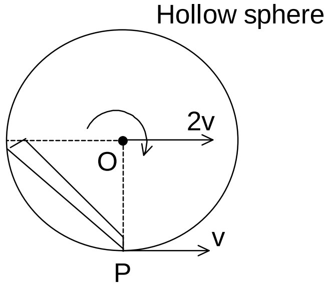
a = 2 m/sec^2

Where R is radius of curvature.

3. apply newton's laws of motion for the body A and body B



4. length of rod is $R\sqrt{2}$



Velocity of point P

$2v - \omega R = v$

KE of rod = rotational KE t translatory KE

5. simply use this concept
After earthing a conductor its potential will become zero.
If conductor are connected together both will be at the same potential.

6. from P – T diagram, write the P – T equation.
By using PV = nRT
Find P in terms of volume
$w = \int P dv$.

Chemistry

PART – II

SECTION – A

1. C

   Reimer – Tiemann's reaction

2. B

   The cell reaction is: $H_2(g) + I_2(s) \rightleftharpoons 2H^+(aq) + 2I^-(aq)$

   $$E_{cell} = E^o_{cell} - \frac{0.0591}{2}\log\frac{\left[H^+\right]^2\left[I^-\right]^2}{\left(P_{H_2}\right)}$$

   $$0.7714 = 0.535 - \frac{0.0591}{2}\log\frac{\left[H^+\right]^2(0.1)^2}{1}$$

   pH = 3

3. C

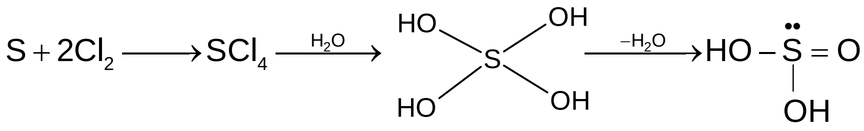
   Mosley's equation is : $\sqrt{\upsilon} = a(z-b)$

   $= az - ab$

   Given that, ab = 1, a = tan45° = 1

   $\therefore \sqrt{\upsilon} = 51 - 1 = 50 \Rightarrow \upsilon = 2500\text{ Hz}$

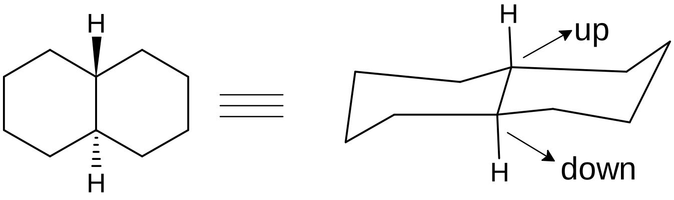
4. A



$$S + 2Cl_2 \longrightarrow SCl_4 \xrightarrow{H_2O} S(OH)_4 \xrightarrow{-H_2O} HO-\ddot{S}(OH)=O$$

   Hybridisation of S in H_2SO_3 = $\frac{1}{2}(6+2+0) = 4 = sp^3\ (3\sigma + 1\pi)$

5. B



6. A

   $[Ag^+]_{initial}$ just after mixing = $\frac{10^{-3}}{50+50}\times 1000 = 0.01\,M$

   $[Cl^-]_{initial}$ just after mixing $= \frac{0.1\times 50}{50+50} = 0.05\text{ M}$

   I.P = $[Ag^+]\,[Cl^-]$ = 5×10^{-4}

   $\because I.P > K_{sp}$

$$Ag^{+}(aq) \quad + \quad Cl^{-}(aq) \longrightarrow AgCl(s)$$

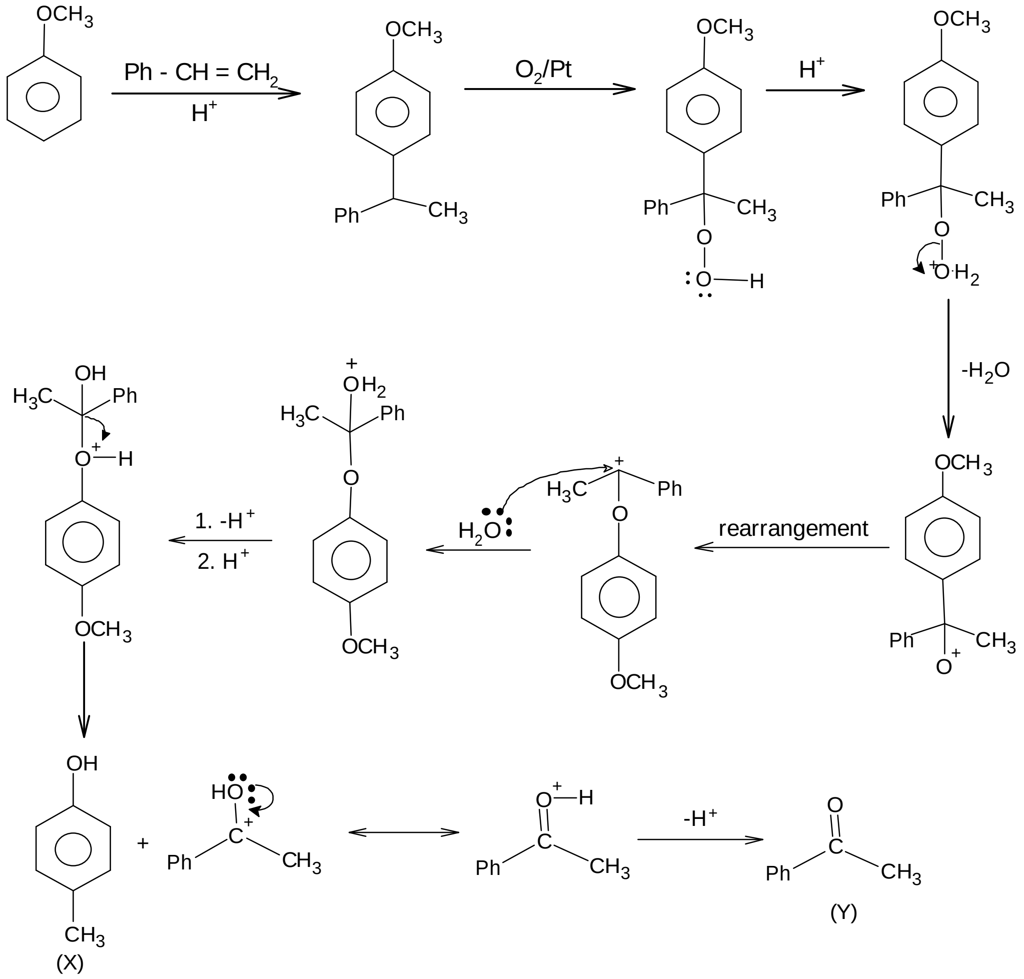
0.01 M 0.05 initial conc.
x 0.04 M conc. after precipitation

$$K_{sp} = [Ag^{+}][Cl^{-}]$$

$$10^{-10} = [Ag^{+}](0.04)$$

$$\therefore [Ag^{+}] = 2.5 \times 10^{-9} M$$

7. A

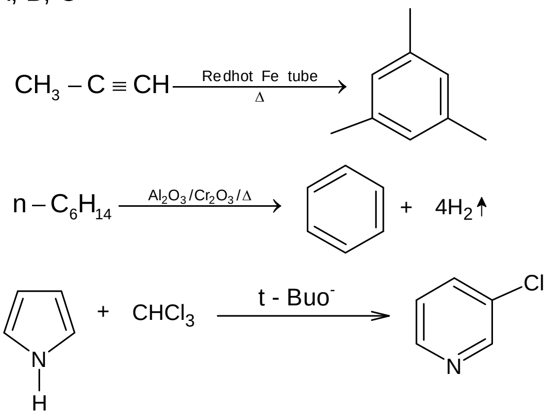


8. A, B
All reducing sugars are muatrotating. Although (IV) is an $\alpha -$ hydroxy ketone and hence reducing but it can't mutarotate as it not a carbohydrate, can't form ring. In (II) the glycosidic linkage is in between two anomeric carbons and hence ring opening can't occur, thus non – reducing as well as non – mutarotating.

9. B, D
In B and D compound after mixing undergoes H – bonding and hence boiling point will be raised and hence vapour pressure lowered.

10. B, C
Fact

11. A, B, C



12. D

$$\underset{(A)}{NH_4NO_3}\xrightarrow{\Delta}\underset{(B)}{N_2O}+\underset{(C)}{H_2O}$$

$$N_2O+P_4\longrightarrow\underset{(D)}{P_4O_{10}}+N_2$$

13. C

$$P_4O_{10}+HClO_4\longrightarrow Cl_2O_7+H_3PO_4$$

$$P_4O_{10}+6H_2O\longrightarrow 4H_3PO_4$$

14. D

If k_1, k_2 and k_3 be the rate constants of the reaction along path I, II and III respectively, then overall rate constant of consumption of A will be $k_1 + k_2 + k_3$. So,

$$86.625\text{ min}=\frac{0.693}{k_1+k_2+k_3}$$

$$\text{or } k_1+k_2+k_3=\frac{0.693}{86.625}=8\times10^{-3}\text{ min}^{-1}$$

$$k_1=\frac{0.693}{173.25}=4\times10^{-3}\text{ min}^{-1}$$

$$k_2=\frac{0.693}{346.5}=2\times10^{-3}\text{ min}^{-1}$$

$$\therefore k_3=8\times10^{-3}-(4+2)\times10^{-3}=2\times10^{-3}\text{ min}^{-1}$$

$$\%\text{distribution of C}=\frac{2k_2}{k_1+2k_2+k_3}\times100=\frac{2\times2\times10^{-3}}{10\times10^{-3}}=40$$

15. A

$$\frac{-d[A]}{dt}=(k_1+k_2+k_3)[A]$$

$$=8\times10^{-3}\times0.25=2\times10^{-3}\text{mol L}^{-1}\text{min}^{-1}$$

$$=\frac{d[B]}{dt}+\frac{d[C]}{dt}+\frac{d[D]}{dt}$$

$$=k_1[A]+2k_2[A]+k_3[A]$$

$$=(k_1+2k_2+k_3)[A]=10\times10^{-3}\times0.25=2.5\times10^{-3}\text{mol L}^{-1}\text{min}^{-1}.$$

16. C

$$E_{a(\text{overall})} = \frac{k_1E_{a_1}}{k_1+k_2+k_3} + \frac{k_2E_{a_2}}{k_1+k_2+k_3} + \frac{k_3E_{a_3}}{k_1+k_2+k_3}$$
$$= 0.5\times 40 + 0.25\times 60 + 0.25\times 80$$
$$= 55\ \text{kJ/mol}$$

SECTION – B

1. (A → p, r, s) (B → p, r, s, t) (C → q, r) (D → p, r, s)

$$3XeF_4 + 6H_2O \longrightarrow XeO_3 + 2Xe + \frac{3}{2}O_2 + 2HF$$
$$P_4 + 3OH^- + 3H_2O \longrightarrow PH_3 + 3H_2PO_2^-$$
$$B_2H_6 + 6H_2O \longrightarrow 2H_3BO_3 + 6H_2$$
$$B(OH)_3 + 2H_2O \longrightarrow [B(OH)_4]^- + H_3O^+$$
$$3Br_2 + 3Na_2CO_3 \longrightarrow 5NaBr + NaBrO_3 + 3CO_2$$

2. (A → p, s) (B → q, r, t) (C → p, s) (D → q, r, t)
Fact

SECTION – C

1. 3

$$_{92}U^{238} + {_o}n^1 \longrightarrow {_{92}}U^{239} \xrightarrow{-\beta} {_{93}}Np^{239} \xrightarrow{-\beta} {_{94}}Pu^{239}$$

2. 2

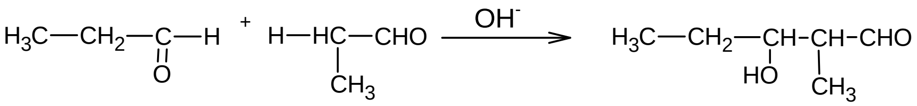
Effective no. of atoms of X = $4 - 4\times\frac{1}{8} = 3.5$

Effective no. of atoms of Y = 4 – 1 = 3

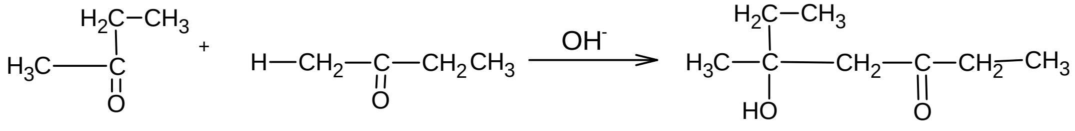
Effective no. of atoms Z = 8 – 4 = 4

Therefore, required answer = $\frac{3+4}{\frac{7}{2}} = 2$

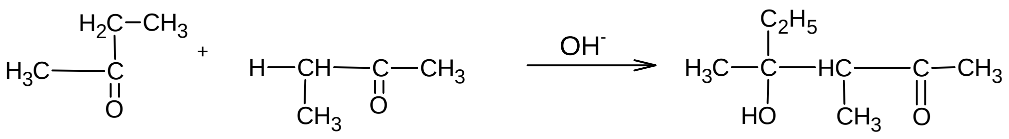
3. 6



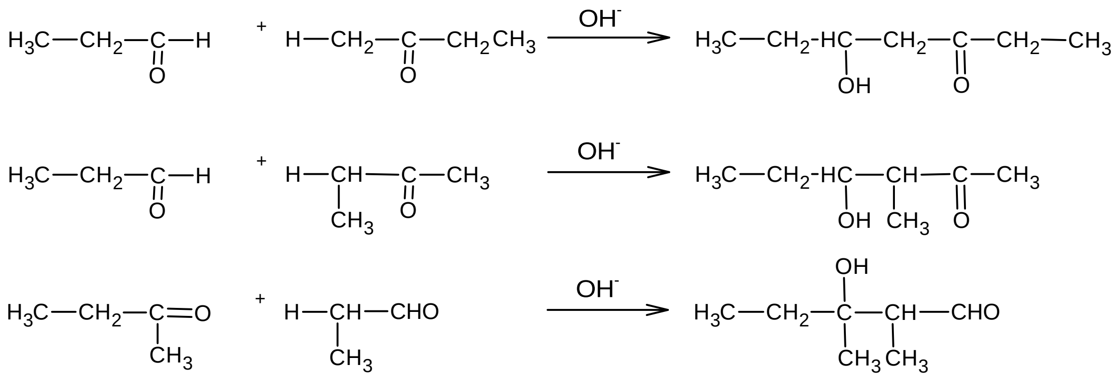
$H_3C-CH_2-\underset{\underset{O}{\|}}{C}-H + H-\underset{\underset{CH_3}{|}}{HC}-CHO \xrightarrow{OH^-} H_3C-CH_2-\underset{\underset{HO}{|}}{CH}-\underset{\underset{CH_3}{|}}{CH}-CHO$



$H_3C-\overset{\overset{H_2C-CH_3}{|}}{\underset{\underset{O}{\|}}{C}} + H-CH_2-\underset{\underset{O}{\|}}{C}-CH_2CH_3 \xrightarrow{OH^-} H_3C-\overset{\overset{H_2C-CH_3}{|}}{\underset{\underset{HO}{|}}{C}}-CH_2-\underset{\underset{O}{\|}}{C}-CH_2-CH_3$



$H_3C-\overset{\overset{H_2C-CH_3}{|}}{\underset{\underset{O}{\|}}{C}} + H-\underset{\underset{CH_3}{|}}{CH}-\underset{\underset{O}{\|}}{C}-CH_3 \xrightarrow{OH^-} H_3C-\overset{\overset{C_2H_5}{|}}{\underset{\underset{HO}{|}}{C}}-\underset{\underset{CH_3}{|}}{HC}-\underset{\underset{O}{\|}}{C}-CH_3$



$$H_3C-CH_2-\underset{\underset{O}{\|}}{C}-H + H-CH_2-\underset{\underset{O}{\|}}{C}-CH_2CH_3 \xrightarrow{OH^-} H_3C-CH_2\text{-}\underset{\underset{OH}{|}}{HC}-CH_2-\underset{\underset{O}{\|}}{C}-CH_2-CH_3$$

$$H_3C-CH_2-\underset{\underset{O}{\|}}{C}-H + H-\underset{\underset{CH_3}{|}}{CH}-\underset{\underset{O}{\|}}{C}-CH_3 \xrightarrow{OH^-} H_3C-CH_2\text{-}\underset{\underset{OH}{|}}{HC}-\underset{\underset{CH_3}{|}}{CH}-\underset{\underset{O}{\|}}{C}-CH_3$$

$$H_3C-CH_2-\underset{\underset{CH_3}{|}}{C}=O + H-\underset{\underset{CH_3}{|}}{CH}-CHO \xrightarrow{OH^-} H_3C-CH_2-\overset{\overset{OH}{|}}{\underset{\underset{CH_3}{|}}{C}}-\underset{\underset{CH_3}{|}}{CH}-CHO$$

4. 2

$\because \Delta U = nC_v\Delta T$

$$12.5 = \frac{5.6}{22.4}\times C_v \times 10$$

$$C_v = \frac{50}{10} = 5\text{ cal}$$

$\because C_p - C_v = R \Rightarrow C_p = 7\text{ cal}$

$$\therefore \gamma = \frac{C_P}{C_V} = \frac{7}{5} = 1.4$$

The gas is thus diatomic

5. 6

No. of eq. of NaOH that can be produced theoretically for 100% current efficiency = no of equivalents of NaCl decomposed = no of eq. of Cu deposited

$$= \frac{\text{wt. of Cu}}{\text{Eq. wt. of Cu}} = \frac{31.75}{63.5/2} = 1$$

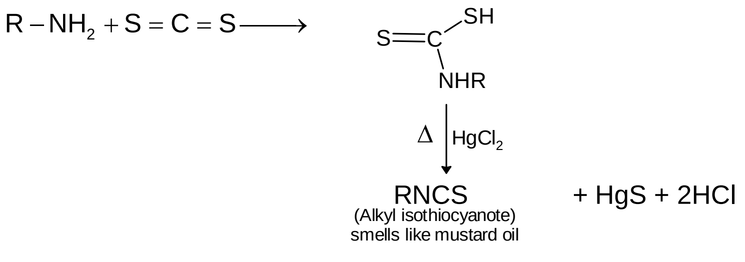
No. of eq. of NaOH produced experimentally = $\frac{\text{meq. of NaOH}}{1000}$

$$= \frac{N\times V}{1000} = \frac{1\times 60}{1000} = 0.06$$

$$\therefore \%\text{ yield} = \frac{0.06}{1}\times 100 = 6\%$$

6. 4

Hoffmann's mustard oil reaction is a test of 1^o amine.



$$R-NH_2 + S=C=S \longrightarrow S=C(SH)(NHR) \xrightarrow[\Delta]{HgCl_2} RNCS + HgS + 2HCl$$

RNCS
(Alkyl isothiocyanote)
smells like mustard oil

Mathematics PART – III

SECTION – A

1. $$f(x) = \frac{\int_0^n [x]dx}{\int_0^n \{x\}dx}$$

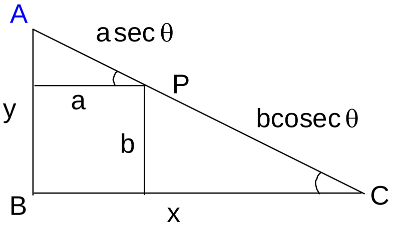
$$\therefore \sum f(x) = \sum n - 1 = \frac{n(n+1)}{2} - n = \frac{n^2 - n}{2}$$

2. $$\because y'y''' = 3(y'')^2$$

$$\Rightarrow \int \frac{y'''}{y''}dx = 3\int \frac{y''}{y'}dx$$

$$\therefore x = A_1y^2 + A_2y + A_3$$

3. $$\frac{d(AC)}{d\theta} = -b\operatorname{cosec}\theta.\cot\theta + a\sec\theta\tan\theta$$



$$AC = \frac{b\sqrt{a^{\frac{2}{3}} + b^{\frac{2}{3}}}}{b^{\frac{1}{3}}} + \frac{a\sqrt{a^{\frac{2}{3}} + b^{\frac{2}{3}}}}{a^{\frac{1}{3}}}$$

$$= \left(a^{\frac{2}{3}} + b^{\frac{2}{3}}\right)^{\frac{3}{2}}$$

4. Let $\alpha, \beta, \gamma, \delta$ be the four roots

Then $\alpha + \beta + \gamma + \delta = 4$ and $\alpha\beta\gamma\delta = 1$

AM = GM

$\therefore \alpha = \beta = \gamma = \delta$

$\Rightarrow \alpha = \beta = \gamma = \delta = 1$

$\therefore x^4 - 4x^3 + ax^2 + 5x + 1 = (x-1)^4$

$\therefore a = 6, b = -4$

5. Let APB = α

$$\cos\alpha = \frac{PA^2 + PB^2 - AB^2}{2PA.PB}$$

$\Rightarrow PA^2 + PB^2 - AB^2 = 2PA.PB\cos\alpha \le 2PA.PB\left(\text{as}\cos < 1\right)$

$\Rightarrow \left(PA - PB\right)^2 \le AB^2$

Thus the max value of |PA – PB| is AB

This is possible only when P lies on AB but P lies on AB

$\therefore$ P is the point of intersection of x + y = 2 and 2x + 3y + 1 = 0.

6. $\dfrac{6!}{P!q!r!}(2)^P(-x)^q\left(3x^2\right)^r$

$\because P + q + r = 6 \ \& \ q + 2r = 5$

$\therefore \text{coeff} = -5052$

7. $\tan 3\theta - \tan 2\theta = \tan 2\theta - \tan\theta$

$\Rightarrow \dfrac{\sin\left(3\theta - 2\theta\right)}{\cos 3\theta \cos 2\theta} = \dfrac{\sin\left(2\theta - \theta\right)}{\cos 2\theta \cos\theta}$

$\Rightarrow \sin\theta\left(2\sin\theta\sin 2\theta\right) = 0$

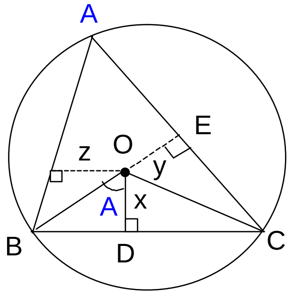
$\Rightarrow \sin\theta = 0 \text{ or } \sin 2\theta = 0$

$\therefore \theta = n\pi, n \in z$ or $2\theta = n\pi$ $\because \theta = \dfrac{n\pi}{2}$ is not for possible as n is odd $\tan\theta$ is not define.

Hence $\theta = n\pi, n \in z$ is the only solution.

8. $\because AB = c, BC = a, AC = b$

In ΔOBD



$\cos A = \dfrac{OD}{OB}$

$\cos A = \dfrac{x}{R}$

$x = R\cos A$

$x = \dfrac{a}{2\sin A}\cos A \left(\because \dfrac{a}{\sin A} = \dfrac{b}{\sin B} = \dfrac{c}{\sin C} = 2R\right)$

$x = \dfrac{a}{2}\cot A \ \therefore \tan A = \dfrac{a}{2x}$

Similarly

$\tan B = \dfrac{b}{2y}$

And $\tan C = \dfrac{c}{2z}$

Also $\tan A + \tan B + \tan C = \tan A.\tan B.\tan C$ (when A+ B + C = π)

$$\Rightarrow \frac{a}{2x}+\frac{b}{2y}+\frac{c}{2z}=\frac{abc}{8xyz}$$

$$\Rightarrow \frac{a}{x}+\frac{b}{y}+\frac{c}{z}=\frac{abc}{4xyz}$$

9. (A) $0 < x < \frac{\pi}{4}$

$\tan x < \cot x$

also $\ln(\sin x) < 0$

$(\tan x)^{\ln \sin x} > (\cot x)^{\ln(\sin x)}$

(B) in $\left(0, \frac{\pi}{2}\right)$

$\operatorname{cosec} x > 1$

$4^{\ln \operatorname{cosec} x} < 5^{\ln \operatorname{cosec} x}$

(C) in $\left(0, \frac{\pi}{2}\right)$, $\cos x \in (0,1)$

$\ln \cos x < 0$

also $\frac{1}{2} > \frac{1}{3}$

$\left(\frac{1}{2}\right)^{\ln(\cos x)} < \left(\frac{1}{3}\right)^{\ln(\cos x)}$

10 $\because\ \ell = 5m - 3n$

$\therefore\ 7(5m - 3n)^2 + 5m^2 - 3n^2 = 0$

$\Rightarrow 6m^2 - 7mn + 2n^2 = 0$

$m = \frac{2}{3}n$ or $m = \frac{n}{2}$

If m = 2/3n from (1) $\ell = 1/3\ n$

If m = n/2 ….. $\ell = -n/2$

$$\therefore \cos\theta = \frac{1\times -1+2\times 1+3\times 2}{\sqrt{1^2+2^2+3^3}\sqrt{(-1)^2+1^2+2^2}} = \frac{7}{\sqrt{14}\sqrt{6}} = \frac{\sqrt{7}}{\sqrt{12}}$$

11. $\left|\vec{a}+\vec{b}+\vec{c}+\vec{d}\right|^2 = \sum\left|\vec{a}\right|^2 + 2\sum \vec{a}.\vec{b} = 4 + 2\vec{d}.\left(\vec{a}+\vec{b}+\vec{c}\right)$ (a,b,c are mutually $\perp$ r)

Let $\vec{d} = \lambda\vec{a} + \mu\vec{b} + \nu\vec{c}$

Then $\vec{d}.\vec{a} = \vec{d}.\vec{b} = \vec{d}.\vec{c} = \cos\theta$

$\therefore \lambda = \mu = \nu = \cos\theta$

Also $\lambda^2 + \mu^2 + \nu^2 = 1 = 3\cos^2\theta$ or $\cos\theta = \frac{1}{\sqrt{3}}$

$\therefore \left|\vec{a}+\vec{b}+\vec{c}+\vec{d}\right|^2 = 4 \pm 2.\frac{3}{\sqrt{3}}$

$= 4 \pm 2\sqrt{3}$

12. end point of latus rectum P(1, 2) & Q(1, -2)

Δ PAQ is isosceles right angled

$\therefore$ slope of PA is – 1
In equation $y – 2 = - (x – 1)$
$x + y – 3 = 0$
similarly equation of line QB
$x – y – 3 = 0$
solving $x + y – 3 = 0$ with parabola $y^2 = 4x$
$(3-x)^2 = 4x$
$\therefore x = 1, 9$
$\therefore$ co-ordinate of B & C are (9, -6) & (9, 6) respectively
Area of trapezium
$= \frac{1}{2}\times(12+4)x8$
$= 64$ sq units

13. let the circumcenter of trapezium be T(n, 0)
Then PT = PB
$\sqrt{(n-1)^2+4} = \sqrt{(n-9)^2}+36$
or n = 7
radius $\sqrt{40} = 2\sqrt{10}$

14. – 16 $z = -\alpha \pm \sqrt{\alpha^2-1}$
Case I when $-1 < \alpha < 1$
We get $\alpha^2 < 1$
$z = -\alpha \pm i\sqrt{1-\alpha^2}$
or $x = - \alpha \Rightarrow y^2 = 1 – x^2$
or $x^2 + y^2 = 1$
case II $\alpha > 1$
$\alpha^2 - 1 > 0$
$z = -\alpha \pm \sqrt{\alpha^2-1}$
or $x = -\alpha \pm \sqrt{\alpha^2-1}, \ y = 0$
Roots are $\left(-\alpha+\sqrt{\alpha^2-1}, 0\right), \left(-\alpha-\sqrt{\alpha^2-1}, 0\right)$
One root lies inside the unit circle and other will lies outside the unit circle
Case III where α is very large then
$z = -\alpha - \sqrt{\alpha^2-1}$
$\cong -2\alpha$
$z = -\alpha + \sqrt{\alpha^2-1}$
$= \frac{1}{-\alpha-\sqrt{\alpha^2}-1} = -\frac{1}{2\alpha}$

SECTION – B

1. total number of function = $3^6 = 729$
(a) total number of onto function = ${}^3C_1 1^6 + {}^3C_2 2^6 + {}^3C_3 3^6$
$= 3 - 192 + 729$
$= 540$

(b) since $f(a_i) \neq b_i$
It means that a_1, a_2, a_3 cannot be assigned images b_1, b_2, b_3
Number of function = $2^3 3^3$ = 216
(c) number of invertible function = 0
as function is not one – one
(d) total many one function = 729 – 0
= 729

2. (a) $\sin^{-1}\sin(3\pi-10)$

$= 3\pi - 10$

(b) $\cos^{-1}\cos(4\pi-10)$

$= 4\pi - 10$

(c) $\tan^{-1}x + \tan^{-1}\frac{1}{x} = \frac{\pi}{2}$ if $x > 0$

$= -\frac{\pi}{2}$ if $x < 0$

(d) $\sin^{-1}\frac{\sqrt{n}-\sqrt{n-1}}{\sqrt{n(n+1)}} = \tan^{-}\left(\frac{\sqrt{n}-\sqrt{n-1}}{1+\sqrt{n(n-1)}}\right)$

$\therefore \sum_{n=1}^{\infty}\sin^{-1}\frac{\sqrt{n}-\sqrt{n-1}}{\sqrt{n(n-1)}} = \sum_{n=1}^{\infty}\tan\left(\frac{\sqrt{n}-\sqrt{n-1}}{1+\sqrt{n(n-1)}}\right)$

$= \tan^{-1}\sqrt{n}$

$= \frac{\pi}{2}$

SECTION – C

1. let each friend has n sons.
$\therefore$ 3 tickets can be distributed among 2n sons in ${}^{2n}C_3$ ways.
The number of ways distributing 3 tickets such that two tickets go to the sons of one and one tickets goes to sons of the other.

$= {}^nC_2 \times {}^nC_1 + {}^nC_1 \times {}^nC_2 = 2 \times {}^nC_1 \times {}^nC_2$

$\therefore$ probability that two tickets go to the sons of one and one tickets goes the sons of the other

$= \frac{2 \times {}^nC_1 \times {}^nC_2}{{}^{2n}C_3}$

$= \frac{6n^2(n-1)}{2n(2n-1)(2n-2)} = \frac{3n}{2(2n-1)}$

But from question

$\frac{6}{7} = \frac{3n}{2(2n-1)}$

$\therefore n = 4$

Hence total number of boys = 8.

2. the equation of the tangents to the circle $x^2 + y^2 = a^2$ at P and the hyperbola $x^2 - y^2 = a^2$ at Q are

$x + my = a\sqrt{1+m^2}$

or $x - my = a\sqrt{1-m^2}$ respectively

Where y = mx is intersecting line through (2, 0)
Let (h, k) be the point of intersection of these two lines

$\therefore h+mk=a\sqrt{1+m^2}$ are $h-mk=a\sqrt{1-m^2}$

$\Rightarrow (h+mK)^2=a^2(1+m^2)$ and $(h-mK)^2=a^2(1-m^2)$

$\Rightarrow m^2(K^2-a^2)+2mhK+h^2-a^2=0$

$\Rightarrow m^2(K^2+a^2)-2mhK+h^2-a^2=0$

Elimination m from these two equation and we get

$\Rightarrow (a^4+4y^4)x^2=a^6$

3. $\because A+B+C=\pi$

Since $e^{i\pi}=-1, e^{i(B+C)}=e^{i(\pi-A)}=-e^{iA}\theta$

$$\because \Delta=\begin{vmatrix} e^{i2A} & -e^{i(A+B)} & -e^{i(A+C)} \\ -e^{i(A+B)} & e^{i2B} & -e^{i(B+C)} \\ -e^{i(A+C)} & -e^{i(B+C)} & e^{i2C} \end{vmatrix}$$

$$\Delta=\begin{vmatrix} 1 & -1 & -1 \\ -1 & 1 & -1 \\ -1 & -1 & 1 \end{vmatrix}$$

$=-4$

$\therefore |\Delta|=|-4|=4$

4. put $\dfrac{x-1}{x+2}=t$

5. $OP<HP$

$\Rightarrow \sqrt{x^2+y^2}<3-x$

or $y^2<-6\left(x-\dfrac{3}{2}\right)$

Area of region = $\displaystyle\int_0^3 \frac{9-y^2}{6}dy$

= 3 sq unit

6. $f(x)=\displaystyle\lim_{n\to\infty}\left(\frac{1\times 2\times 3...\times n}{n\times n\times ....\times n}\right)^{\frac{1}{n}}$

$\log f(x)=\displaystyle\lim_{n\to\infty}\frac{1}{n}\left(\log\frac{1}{n}+\log\frac{2}{n}+...+\log\frac{n}{n}\right)$

$=\displaystyle\lim_{n\to\infty}\sum_{r=1}^{n}\frac{1}{n}\log\frac{r}{n}$

$=\displaystyle\int_0^1 \log x\,dx=-1$

$f(x)=e^{-1}=\dfrac{1}{e}$

Hence $e^2f(x)$ = $e^2\times\dfrac{1}{e}=e$

$[e^2f(x)]=[e]=2$

FIITJEE Students From Classroom / Integrated School Programs have secured to 2 Zonal, 6 State & 18 City Topper Ranks. 33 in Top 100, 78 in Top 200 and 205 in Top 500 All India Ranks bagged by FIITJEE Students from All Programs have qualified in JEE (Advanced), 2015.

ALL INDIA TEST SERIES

FULL TEST – I

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 03 and 10 to 12)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (04 to 09 and 13 to 30) contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

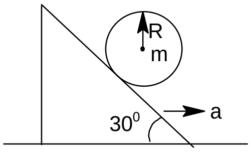
Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. In an adiabatic process where in pressure is increased by $\frac{2}{3}\%$ if $\frac{C_p}{C_v} = \frac{3}{2}$, then the volume decreases by about.

(A) $\frac{4}{9}\%$ (B) $\frac{2}{3}\%$ (C) 4% (D) $\frac{9}{4}\%$

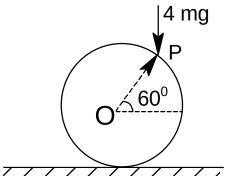
2. A sphere of mass m and radius R is kept on a rough wedge. The acceleration of wedge for the sphere to remain in equilibrium with respect to wedge should be.



(A) $g\sqrt{\frac{2}{3}}$ (B) $g\sqrt{\frac{3}{2}}$

(C) $\frac{g}{\sqrt{3}}$ (D) $g\frac{\sqrt{2}}{3}$

3. A solid sphere of mass m and radius R is lying on a rough horizontal plane. A constant force 4mg acts vertically at point P such that OP makes an angle 60^0 with horizontal. Find the minimum value of coefficient of friction so that sphere starts pure rolling.

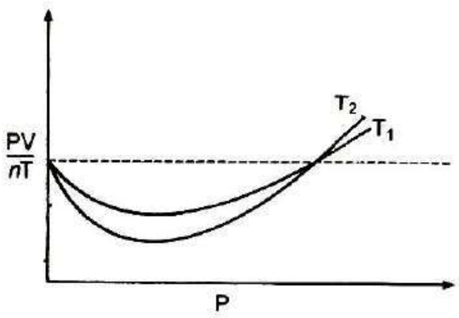


(A) $\frac{2}{7}$ (B) $\frac{3}{7}$

(C) $\frac{4}{7}$ (D) $\frac{5}{7}$

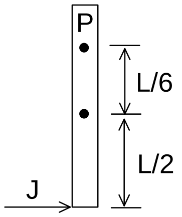
Space for Rough work

4. The fig below shows the plots of $\frac{PV}{nT}$ versus P for oxygen gas at two different temperature



Read the following statements concerning the above curve.
(i) the dotted line corresponds to the 'ideal' gas behavior
(ii) $T_1 > T_2$
(iii) the value of $\frac{PV}{nT}$ at the point where the curves meet on the y-axis is the same
(iv) which of the following statement is true.
(A) (i) only
(B) (i) and (ii)
(C) All of these
(D) None of these

5. A uniform rod of mass M and length L is kept on a horizontal surface. The rod receives an impulse J at its lowest point, normal to its length as shown, then choose the correct statement.

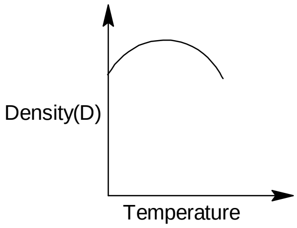


(A) The velocity of point P just after impact is $\frac{2J}{M}$
(B) The velocity of point P just after impact is $\frac{J}{M}$
(C) Kinetic energy after impact is $\frac{J^2}{M}$
(D) Kinetic energy after impact is $\left(\frac{2J^2}{M}\right)$

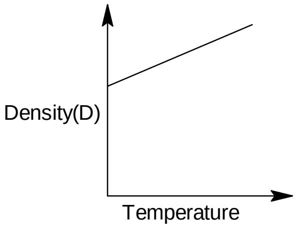
Space for Rough work

6. Which one of the figure gives the temperature dependence of density of water correctly

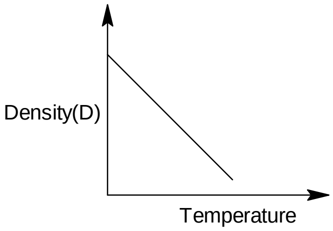
(A)



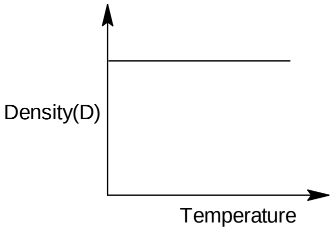
(B)



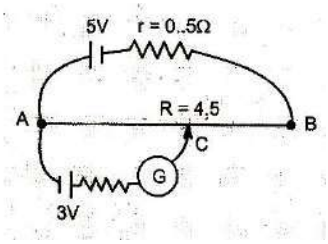
(C)



(D)



7. In the given potentiometer circuit length of the wire AB is 3 m and resistance is R = 4.5Ω. The length AC for no deflection in galvanometer is :



(A) 2 m
(B) 1.8 m
(C) dependent on r_1
(D) None of these

8. A plane sinusoidal undiminished sound wave is travelling in +x direction in a gaseous medium. Excess pressure amplitude for any location is p_0. Wave speed in the medium is 360 ms^{-1}. At some moment, instantaneous values of excess pressure at positions (0,0,0) & (+1, +1, 0) are $+p_o$ and $+p_0/2$. The frequency of wave is:

(A) 60HZ
(B) 120HZ
(C) $60\sqrt{2}$ HZ
(D) $120\sqrt{2}$ HZ.

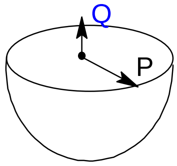
Space for Rough work

9. A point charge $q = 50\mu C$ is located in the x – y plane at the point of position vector $\vec{r_o} = 2\hat{i} + 3j$. What is the electric field at the point of position vector $\vec{r} = 8\hat{i} - 5j$

(A) $1200\frac{V}{m}$ (B) $4\times10^{-2}\frac{V}{m}$ (C) $900\frac{V}{m}$ (D) $4500\frac{V}{m}$

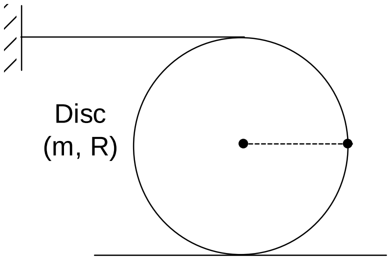
10. A listener is at rest with respect to the source of sound. A wind starts blowing along the lime joining the source and the observer. Which of the following quantities do not change?
(A) Wavelength
(B) Frequency
(C) Time period
(D) Velocity of sound

11. A point charge Q is located just above the centre of the flat face of hemisphere as shown in figure. The electric flux through the flat face and curved face of hemisphere are respectively



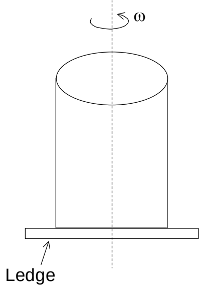
A) $\frac{Q}{2\in_o}, \frac{-Q}{2\in_o}$
(B) $\frac{-Q}{2\in_o}, \frac{Q}{2\in_o}$
(C) $\frac{Q}{\in_o}, \frac{-Q}{\in_o}$
(D) $\frac{-Q}{\in_o}, \frac{Q}{\in_o}$

12. Find μ_{min} between disc and floor for equilibrium



(A) $\frac{1}{4}$
(B) $\frac{1}{3}$
(C) $\frac{2}{3}$
(D) $\frac{3}{4}$

13. In a carnival ride called the rotor, people stand on a ledge inside a large cylinder that rotates about a vertical axis. When it reaches a high enough rotational speed, the ledge drops away. If radius be 2 m and the period of rotation be 2 sec, then the minimum coefficient of friction for the people not to slide down is
(A) 0.9
(B) 0.8
(C) 0.6
(D) 0.5



Space for Rough work

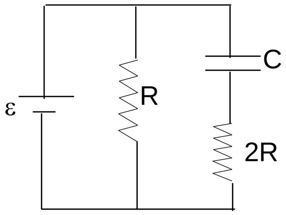
14. The binding energy of $_{17}Cl^{35}$ nucleus is 298 MeV. Find its atomic mass. The mass of hydrogen atom ($_1H^1$) is 1.008143 amu and that of a neutron is 1.008986 amu. Given 1 amu = 931 MeV.
(A) 148 (B) 298 (C) 340 (D) 348

15. A frame made of thin homogeneous wire, is shown in figure. Assume that the number of successively embedded equilateral triangle with sides decreasing by half tends to infinity. The side AB has a resistance R_o. The equivalent resistance between A and B is x.
(A) x is infinite (B) x is zero (C) x = $2R_0$ (D) $x = \left(\dfrac{\sqrt{7}-1}{3}\right)R_o$

16. Consider the following reaction;
$${}^1_1H + {}^{13}_6C \longrightarrow {}^{13}_7N + {}^1_0n$$
The atomic masses of the nuclei are
$M\left({}^1_1H\right) = 1.007825u$, $M\left({}_0n^1\right) = 1.008665$ u, $M\left({}^{13}_6C\right) = 13.00336$ u, $M\left({}^{13}_7N\right) = 13.00574$ u and 1 amu = 931 MeV. The kinetic energy of proton $\left({}^1_1H\right)$ required to initiate the reaction is
(A) 1.99 MeV (B) 2.99 MeV (C) 3.99 MeV (D) 4.99 MeV

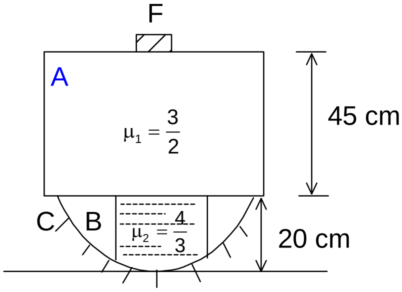
17. The YDSE is made in a liquid. The 10th bright fringe in the liquid lies where the 6th dark fringe lies in vacuum. The refractive index of the liquid is approximately.
(A) 1.81 (B) 1.54 (C) 1.67 (D) 1.20

18. The time constant of charging of the circuit shown in the figure
(A) $\dfrac{2RC}{3}$ (B) 2RC
(C) 3RC (D) 3RC/2



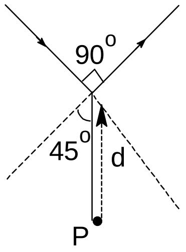
Space for Rough work

19. A fly F is sitting on a glass slab A, 45 cm thick and of refractive index 3/2. The slab covers the top of a container B containing water $\left(\mu_2 = \frac{4}{3}\right)$ upto a height of 20 cm. The bottom of container is closed by a concave mirror 'C' of radius of curvature 40 cm. The position of final image formed by all refractions and reflection, assuming paraxial rays is



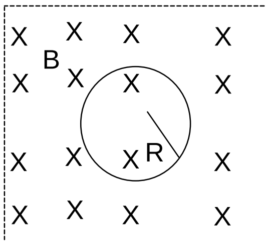
(A) at the bottom of glass slab
(B) in the middle of container B
(C) in the middle of glass slab
(D) none of these

20. Find the magnetic field at P due to the arrangement shown.



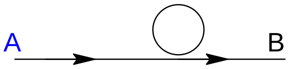
(A) $\frac{\mu_0 i}{\sqrt{2}\pi d}\left(1-\frac{1}{\sqrt{2}}\right)\otimes$
(B) $\frac{2\mu_0 i}{\sqrt{2}\pi d}\otimes$
(C) $\frac{\mu_0 i}{\sqrt{2}\pi d}$
(D) $\frac{\mu_0 i}{\sqrt{2}\pi d}\left(1+\frac{1}{\sqrt{2}}\right)\otimes$

21. A conducting loop of radius R is present in a uniform magnetic field B perpendicular to the plane of the ring. If radius R varies as a function of time 't' as R = R_0 + t. The e.m.f induced in the loop is



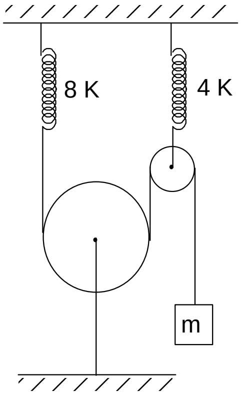
(A) $2\pi(R_o + t)B$
(B) $\pi(R_0 + t)B$ clockwise
(C) $2\pi(R_o + t)B$ anticlockwise
(D) Zero.

22. In the arrangement shown in given figure current from A to B is increasing in magnitude induced current in the loop will



(A) have clockwise direction
(B) have anticlockwise direction
(C) be zero
(D) oscillate between clockwise and anticlockwise

Space for Rough work



23. Find the time-period of SHM of mass 'm'.

(A) $2\pi\sqrt{\frac{3m}{2K}}$ (B) $2\pi\sqrt{\frac{9m}{8K}}$

(C) $2\pi\sqrt{\frac{3m}{K}}$ (D) $2\pi\sqrt{\frac{m}{K}}$

24. There is a uniform magnetic field B normal to the xy plane. A conductor ABC has length $AB = \ell_1$, parallel to the x-axis and length $BC = \ell_2$ parallel to y-axis. ABC moves in the xy plane with velocity $V_x\hat{i} + V_y\hat{j}$. The potential difference between A and C is proportional to.

(A) $V_x\ell_1 + V_y\ell_2$ (B) $V_x\ell_2 + V_y\ell_1$ (C) $V_x\ell_2 - v_y\ell_1$ (D) $V_x\ell_1 - V_y\ell_2$

25. A particle of mass 'm' was transferred from the centre of the base of a uniform hemisphere of mass M and radius R to infinity. The work performed by external agent in this process on the particle is

(A) $\left(\frac{GmM}{2R}\right)$ (B) $(-)\left(\frac{GmM}{2R}\right)$ (C) $\frac{3}{2}\left(\frac{GmM}{R}\right)$ (D) $(-)\frac{3}{2}\left(\frac{GmM}{R}\right)$

26. A small coil of radius r is placed at the centre of a large coil of radius R, where R>>r. The coil are coplanar. The co-efficient of mutual inductance between the coils is

(A) $\frac{\mu_o\pi r}{2R}$ (B) $\frac{\mu_o\pi r^2}{2R}$ (C) $\frac{\mu_o\pi r^2}{2R^2}$ (D) $\frac{\mu_o\pi r}{2R^2}$

Space for Rough work

27. A cube of wood supporting 200 gm mass just floats in water (ρ = 1g/cc). When the mass is removed, the cube rises by 2 cm. The volume of cube is

(A) 1000 cc (B) 800 cc (C) 500 cc (D) none of these

28. A charged particle goes undeflected in a region containing electric and magnetite fields. It is possible that:

(A) $\vec{E} \parallel \vec{B}, \vec{V} \parallel \vec{E}$ (B) $\vec{E}$ is parallel to $\vec{B}$

(C) $\vec{V} \parallel \vec{B}$ but $\vec{E}$ is not parallel to $\vec{B}$ (D) $\vec{E} \parallel \vec{B}$ but $\vec{V}$ is not parallel to $\vec{E}$

29. A particle of charge per unit mass α is released from origin with a velocity $\vec{v} = v_o i$ in a uniform magnetic field $\vec{B} = -B_o\hat{K}$. If the particle passes through (o, y, o) then y is equal to.

(A) $\frac{-2v_0}{B_0\alpha}$ (B) $\frac{v_o}{B_o\alpha}$ (C) $\frac{2v_o}{B_o\alpha}$ (D) $\frac{-v_o}{B_o\alpha}$

30. Spherical particles of pollen are shaken up in water and allowed to settle. The depth of water is 2 cm. What is the diameter of largest particles remaining in suspension one hour later? [The

density of pollen = 1.8 × 10^3 kg m^{-3}, viscosity of water = 10^{-2} poise, ρ = 10^3 kg/m^3 & g = 10 ms^{-2}.

Take appropriate assumptions]

(A) 1.77 × 10^{-6} m (B) 3.54 × 10^{-6} m

(C) 2.56 × 10^{-6} m (D) 1.28 × 10^{-6} m

Space for Rough work

Chemistry PART – II

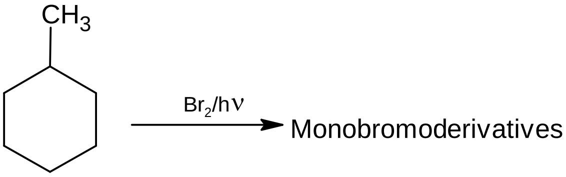
SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

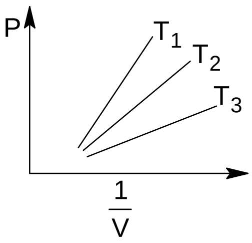
1. n-factor for HCl in reaction $K_2Cr_2O_7 + HCl \rightarrow KCl + CrCl_3 + Cl_2$

(A) $\frac{5}{7}$ (B) $\frac{3}{7}$ (C) $\frac{7}{3}$ (D) $\frac{7}{5}$

2. 

The number of possible monobromo products is excluding stereo isomers –
(A) 4 (B) 5 (C) 8 (D) 10

3. The curve drawn below shows the variations of P as a function of $\frac{1}{V}$ for a fixed mass and temp. of an ideal gas. It follows from the curve that



(A) $T_3 > T_2 > T_1$
(B) $T_1 > T_2 > T_3$
(C) $T_1 = T_2 = T_3$
(D) Nothing can be predicted about temp.

4. For adiabatic expansion of a perfect gas $\frac{dp}{P}$ is

(A) $\frac{dv}{V}$ (B) $\gamma \cdot \frac{dv}{V}$ (C) $-\gamma \frac{dv}{V}$ (D) $-\gamma^2 \frac{dv}{V}$

5. If E^0_{cell} for a given reaction is negative which gives the correct relationship for the value of ΔG^0 and k_{eq}?

(A) $\Delta G^0 > 0, k_{eq} < 1$ (B) $\Delta G^0 > 0, k_{eq} > 1$ (C) $\Delta G^0 < 0, k_{eq} > 1$ (D) $\Delta G^0 < 0, k_{eq} < 1$

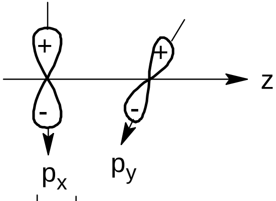
Space for Rough work

6. The solubility of AgBr in water and in 0.01M $CaBr_2$, 0.01M KBr, and 0.05M $AgNO_3$ be S_1, S_2, S_3 and S_4 respectively, give the relation of solubilities.
(A) $S_1 > S_2 > S_3 > S_4$ (B) $S_1 > S_3 > S_2 > S_4$ (C) $S_2 > S_1 > S_3 > S_4$ (D) $S_4 > S_3 > S_1 > S_2$

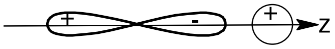
7. Which of the following traids have approximately equal size?
(A) $Na^{\oplus}, Mg^{2+}, Al^{3+}$ (isoelectronic)
(B) F^{-}, Ne, O^{2-} (isoelectronic)
(C) Fe, Co, Ni
(D) Mn^{2+}, Fe^{2+}, Cr (isoelectronic)

8. Which of the following is zero overlapping which leads to non-bonding?

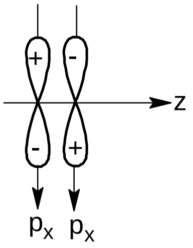
(A)



(B)



(C)



(D) All

9. The resultant dipole moment μ of two compound NOF and NO_2F is 1.81 D and 0.47D respectively. Which dipole moment do you predict?
(A) 1.81 D for NO_2F and 0.47D for NOF
(B) 0.47 D for NO_2F and 1.81 D for NOF
(C) For both $NO_2F$and NOF, dipole moment (μ) is 0.81D.
(D) For both NO_2F and NOF. Dipole moment (μ) is 0.47D.

10. $A_{(aq)} + Zn \rightarrow B_{(g)}$

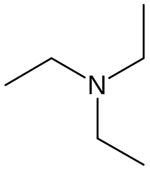
$A_{(aq)} + (C) \xrightarrow{\Delta} PH_3$

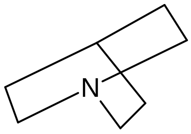
$A_{(aq)} + NH_4Cl \rightarrow D_{(g)}$

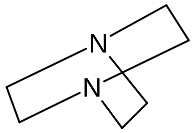
Find compound A which imparts golden yellow colour to the Bunsen flame.
(A) NaOH (B) LiOH (C) KOH (D) RbOH

Space for Rough work

11. Relative rate of reaction of following amine with methyl iodide is

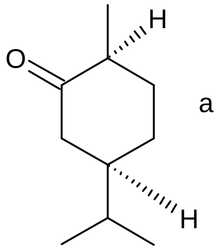

(A)


(B)

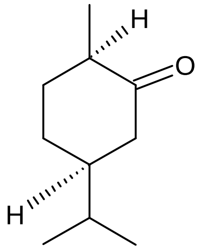

(C)

(A) A > B > C (B) A > C > B (C) B > C > A (D) B > A > C

12. The two compounds shown below are

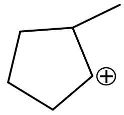

(i)

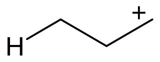
and

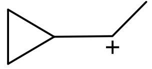

(ii)

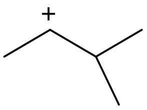
(A) Diastereomer (B) Enantiomer (C) Epimer (D) None

13. Which of the following would not rearrage to a more stable form?

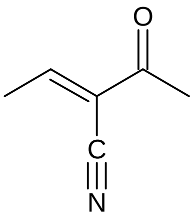
(A)


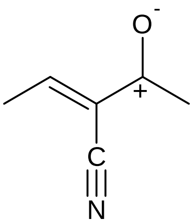
(B)


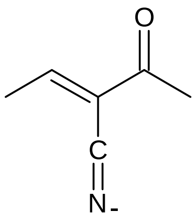
(C)


(D)


14. Compare relative stability of following resonating structure

(i)


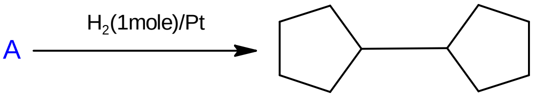
(ii)


(iii)


(A) I > II > III (B) II > I > III (C) I > III > II (D) II > III > I

Space for Rough work

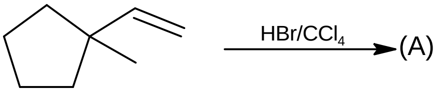
15.


A
H_2(1mole)/Pt

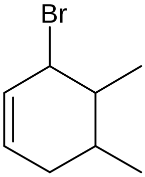
Double bond equivalent (degree of unsaturation) of (A) is

(A) 1 (B) 2 (C) 3 (D) 4

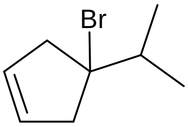
16.



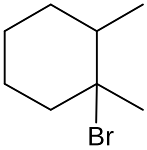
(A)



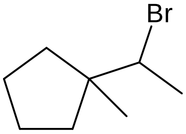
(B)



(C)



(D)

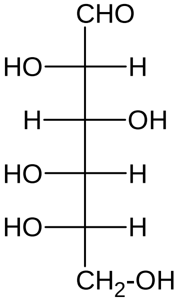


17. Iso-electric point of alanine is (pH = 6). At which pH, maximum concentration of zwitter ion of alanine will be present?

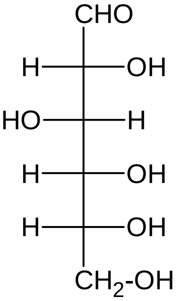
(A) pH > 6 (B) pH < 6 (C) pH = 6 (D) pH = 7

18. What is the structure of L⁻ glucose?

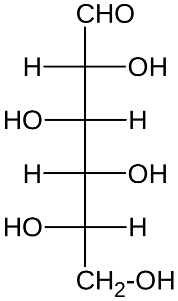
(A)


CHO
HO H
H OH
HO H
HO H
CH$_2$-OH

(B)


CHO
H OH
HO H
H OH
H OH
CH$_2$-OH

(C)


CHO
H OH
HO H
H OH
HO H
CH$_2$-OH

(D) None

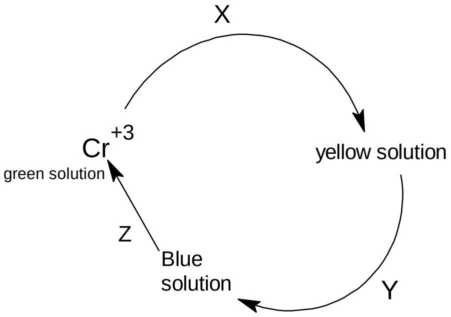
Space for Rough work

19. Which reactions are used for the preparation of the halogen acid?
(A) $KBr + H_2SO_4(conc.) \rightarrow K_2SO_4 + 2HBr$
(B) $CaF_2 + H_2SO_4(conc) \rightarrow Ca(HSO_4)_2 + HF$
(C) $NaCl + H_2SO_4(conc) \rightarrow NaHSO_4 + HCl$
(D) $2KI + H_2SO_4(conc) \rightarrow K_2SO_4 + 2HI$

20. Which of the following orders regarding thermal stability of hydrides MH_3 of group 15 is correct?
(A) $NH_3 > PH_3 > AsH_3$
(B) $NH_3 < PH_3 < AsH_3$
(C) $NH_3 > PH_3 < AsH_3$
(D) $NH_3 < PH_3 > AsH_3$

21. The formula of Azurite is
(A) $CuCO_3 \cdot Cu(OH)_2$
(B) $2CuCO_3 \cdot Cu(OH)_2$
(C) $CuCO_3 \cdot 2Cu(OH)_2$
(D) $CuSO_4 \cdot Cu(OH)_2$

22. In this sequence X, Y, Z are respectively



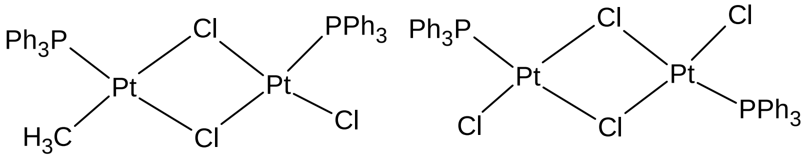
(A) Acidified H_2O_2, Alkaline H_2O_2, Acidified H_2O_2
(B) Alkaline H_2O_2, Acidified H_2O_2, Zn/HCl
(C) Acidified H_2O_2, Heat, alkaline H_2O_2
(D) Alkaline H_2O_2, Acidified H_2O_2, on standing

23. What will be the colour of the solution when $Mn(OH)_2$ is treated with conc. HNO_3 and sodium bismuthate (or red lead or lead dioxide)?
(A) yellow
(B) Purple
(C) Green
(D) Blue

24. In NaCl the centres of two nearest like charged ions are present at a distance of
(A) $\frac{a}{\sqrt{2}}$
(B) $\frac{a}{2}$
(C) $\frac{\sqrt{3}}{2}a$
(D) $\sqrt{2}a$

Space for Rough work

25. Complexes given below shows



(A) Optical isomer
(B) Co-ordinate isomerism
(C) Geometrical isomerism
(D) Bridge isomerism

26. The C.FS.E of $\left[Co\left(NH_3\right)_6\right]Cl_3$ is

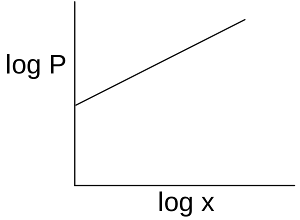
(A) $-7.2\Delta_0$
(B) $-0.4\Delta_0$
(C) $-2.4\Delta_0$
(D) $-3.6\Delta_0$

27. In the extraction of copper, metal is formed in the Bessemer converter due to reaction.

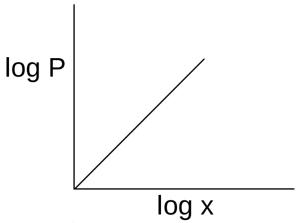
(A) $Cu_2s + 2Cu_2O \rightarrow 6Cu + SO_2$
(B) $Cu_2S \rightarrow 2Cu + S$
(C) $Fe + Cu_2O \rightarrow 2Cu + FeO$
(D) $2Cu_2O \rightarrow 4Cu + O_2$

28. Which of the following curve represents the Henry's law?

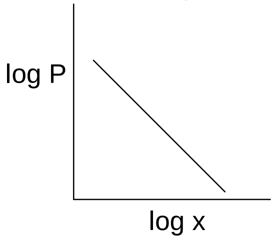
(A)



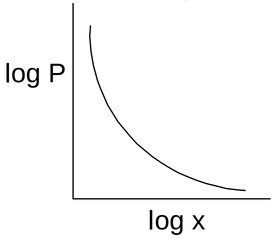
(B)



(C)



(D)



Space for Rough work

29. When two half-cells of electrode potential of E_1 and E_2 are combined to form a cell of electrode E_3, then (where n_1, n_2 and n_3 are number of electrons exchanged in first, second and combined half cells):

(A) $E_3 = E_2 - E_1$

(B) $E_3 = \frac{E_1n_1 + E_2n_2}{n_3}$

(C) $E_3 = \frac{E_1n_1 - E_2n_2}{n_3^2}$

(D) $E_3 = E_1 + E_2$

30. For a first order homogeneous gaseous reaction $A \rightarrow 2B + C$ then initial pressure was P_i while total pressure after time t was P_t. Then expression for rate constants K in terms P_i, P_t and t is.

(A) $K = \frac{2.303}{t}\log\left(\frac{2p_i}{3P_i - P_t}\right)$

(B) $K = \frac{2.303}{t}\log\left(\frac{2P_i}{2P_t - P_i}\right)$

(C) $K = \frac{2.303}{t}\log\left(\frac{P_i}{P_i - P_t}\right)$

(D) None of these

Space for Rough work

Mathematics

PART – III

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. If [x] denotes the integral part of x and $m = \left[\frac{|x|}{1+x^2}\right]$, n = least integral value of $\frac{1}{2-\sin 3x}$ then

(A) $m \neq n$ (B) $m > n$ (C) $m + n = 0$ (D) $n^m = 0$

2. If $1-\cos x = \frac{\sqrt{3}}{2}|x| + a$ has no solution, then complete set of values of a is

(A) $\left(\frac{1}{2},\infty\right)$ (B) $\left(\frac{3}{2}-\frac{\pi}{3},4\right)$ (C) $\left(\frac{3}{2}-\frac{\pi}{\sqrt{3}},\infty\right)$ (D) $(4,\infty)$

3. Let $fP(\alpha) = e^{\frac{i\alpha}{P^2}}.e^{\frac{2i\alpha}{P^2}}.e^{\frac{3i\alpha}{P^2}}.....e^{\frac{i\alpha}{P}}$ where $i=\sqrt{-1}$ and P ∈ N, then $\lim\limits_{n\to\infty} f\,n(\pi)$ is

(A) 1 (B) –1 (C) i (D) –i

4. $\sin^{-1}\left\{\frac{1}{i}(z-1)\right\}$ where z is non real and $i=\sqrt{-1}$ can be then angle of a triangle if

(A) $\text{Re}(z)=1\ \text{Im}(z)=2$ (B) $\text{Re}(z)1, -1\le \text{Im}(z)\le 1$

(C) $\text{Re}(z)+\text{Im}(z)=0$ (D) none of these

5. Let $S = \frac{8}{5}+\frac{16}{65}+\frac{24}{325}...+\frac{128}{2^{18}+1}$ then

(A) $S=\frac{1088}{545}$ (B) $S=\frac{545}{1088}$ (C) $S=\frac{1056}{545}$ (D) $S=\frac{545}{1056}$

6. If $a_1, a_2, a_3 \ldots a_{20}$ are A.Ms between 13 and 67 then the maximum value of $a_1a_2a_3\ldots.a_{20}$ is

(A) $(20)^{20}$ (B) $(40)^{20}$ (C) $(60)^{20}$ (D) $(80)^{20}$

Space for Rough work

7. If $A = \cos(\cos x) + \sin(\cos x)$, then least and greatest value of A are

(A) 0 and 2 (B) –1 and 1 (C) $-\sqrt{2}$ and $\sqrt{2}$ (D) 0 and $\sqrt{2}$

8. If $x = \sin\theta|\sin\theta|$ $y = \cos\theta|\cos\theta|$, where $\frac{99\pi}{2} \le \theta \le 50\pi$ then

(A) x – y = 1 (B) x + y = –1 (C) x + y = 1 (D) y – x = 1

9. Let n be a positive integer such that $\sin\left(\frac{\pi}{2n}\right) + \cos\left(\frac{\pi}{2n}\right) = \frac{\sqrt{n}}{2}$ then

(A) n = 6 (B) n = 2 (C) n = 1 (D) n = 3, 4, 5

10. Complete set of values of x in (0, π) satisfying $1 + \log_2 \sin x + \log_2 \sin 3x \ge 0$ is

(A) $\left(\frac{2\pi}{3}, \frac{3\pi}{4}\right]$ (B) $\left(\frac{\pi}{3}, \frac{2\pi}{3}\right)$ (C) $\left(0, \frac{\pi}{2}\right) \cup \left(\frac{2\pi}{3}, \pi\right)$ (D) $\left(\frac{\pi}{2}, \frac{2\pi}{3}\right)$

11. Let A = {x_1, x_2, x_3, x_4, x_5}; B = {y_1, y_2, y_3, y_4, y_5} then the number of one-one mapping from A to B such that $f(x_i) \ne y_i$, i = 1, 2, … 5 is

(A) 40 (B) 44 (C) 6 (D) 24

12. Coefficient of x^{15} in $(1 + x + x^3 + x^4)^n$ is

(A) $\sum_{r=0}^{5} {}^nC_{5-r}\,{}^nC_{3r}$ (B) $\sum_{r=0}^{5} {}^nC_{5r}$ (C) $\sum_{r=0}^{5} {}^nC_{3r}$ (D) $\sum_{r=0}^{3} {}^nC_{3-r}\,{}^nC_{5r}$

13. If two events A and B are such that $P(\overline{A}) = \frac{3}{10}, P(B) = \frac{2}{5}$ and $P(A \cap \overline{B}) = \frac{1}{2}$ then $P\left(\frac{B}{A \cup \overline{B}}\right)$ is equal to

(A) $\frac{1}{2}$ (B) $\frac{1}{3}$ (C) $\frac{1}{4}$ (D) $\frac{2}{3}$

Space for Rough work

14. If $\left(1+ax+bx^2\right)^4 = a_0 + a_1x + a_2x^2 + ... + a_8x^8$ when a, b, a_0, a_1 … $a_8 \in R$ such that $a_0 + a_1 + a_2 \neq 0$ and $\begin{vmatrix} a_0 & a_1 & a_2 \\ a_1 & a_2 & a_3 \\ a_2 & a_0 & a_1 \end{vmatrix} = 0$ then

(A) $a = \frac{3}{4}, b = \frac{5}{8}$ (B) $a = \frac{1}{4}, b = \frac{5}{32}$ (C) a = 1, $b = \frac{2}{3}$ (D) none of these

15. If $A = \left[aij\right]_{2\times 2}$ where $aij = \begin{cases} i+j & i \neq j \\ i-j & i = j \end{cases}$ then A^{-1} is

(A) $\begin{bmatrix} 0 & \frac{1}{3} \\ \frac{1}{3} & 0 \end{bmatrix}$ (B) $\begin{bmatrix} \frac{2}{9} & \frac{1}{3} \\ \frac{1}{3} & 0 \end{bmatrix}$ (C) $\begin{bmatrix} 0 & \frac{1}{3} \\ \frac{1}{3} & \frac{2}{9} \end{bmatrix}$ (D) $\begin{bmatrix} \frac{1}{9} & \frac{1}{3} \\ 0 & \frac{1}{3} \end{bmatrix}$

16. Equation of the circle having centre at (3, -1) and cutting the intercept of length 6 unit on the line 2x – 5y + 18 = 0 is

(A) $x^2 + y^2 - 6x + 2y - 18 = 0$ (B) $x^2 + y^2 - 6x + 2y - 38 = 0$
(C) $x^2 + y^2 - 6x + 2y - 28 = 0$ (D) none of these

17. Minimum distance between the curve $y^2 = 4x$ and $x^2 + y^2 - 12x + 31 = 0$ is equal to

(A) $\sqrt{21}$ (B) $\sqrt{26} - \sqrt{5}$ (C) $\sqrt{20} - \sqrt{5}$ (D) $\sqrt{28} - \sqrt{5}$

18. Locus of the mid point of the chords of the hyperbola $x^2 - y^2 = a^2$, that touch the parabola $y^2 = 4ax$ is

(A) $x^2\left(x-a\right) = y^3$ (B) $y^2\left(x-a\right) = x^3$ (C) $x^3\left(x-a\right) = y^2$ (D) $y^3\left(x-a\right) = x^2$

19. If the tangents from the point (λ, 3) to the ellipse $\frac{x^2}{9} + \frac{y^2}{4} = 1$ are at right angles then λ is

(A) ±1 (B) ±3 (C) ±2 (D) none of these

Space for Rough work

20. $\lim\limits_{x\to 0}\dfrac{x^a \sin^b x}{\sin\left(x^c\right)}$, a, b, c $\in$ R – {0} exists and has non-zero values then

(A) a, b, c are in AP (B) a, b, c are in GP (C) a, b, c are in HP (D) none of these

21. Suppose $f : R \to R$ is a differentiable function and f(1) = 4 then the value of $\lim\limits_{x\to 1}\displaystyle\int_4^{f(x)}\frac{2tdt}{x-1}$

(A) 8f′(1) (B) 4f′(1) (C) 2f′(1) (D) f′(1)

22. If $f\left(x\right)=x+\tan x$ and f is inverse of g then g′(x) is equal to

(A) $\dfrac{1}{1+\left(g\left(x\right)-x\right)^2}$ (B) $\dfrac{1}{1-\left(g\left(x\right)-x\right)^2}$ (C) $\dfrac{1}{2+\left(g\left(x\right)-x\right)^2}$ (D) $\dfrac{1}{2-\left(g\left(x\right)-x\right)^2}$

23. If the function $f\left(x\right)=\cos\left|x\right|-2ax+b$ increases along the centre number scale, the range of value of a is given by

(A) $a \le b$ (B) $a=\dfrac{b}{2}$ (C) $a \le \dfrac{-1}{2}$ (D) $a \ge \dfrac{-3}{2}$

24. The value of $\displaystyle\int\frac{1+\log x}{\sqrt{\left(x^x\right)^2-1}}dx$ is

(A) $\sec^{-1}\left(x^x\right)+c$ (B) $\tan^{-1}\left(x^x\right)+c$ (C) $\log\left(x+\sqrt{\left(x^x\right)^2-1}\right)$ (D) none of these

25. $\lim\limits_{n\to\infty}\dfrac{2^K+4^K+6^K+...\left(2n\right)^K}{n^{K+1}}$ $K \ne -1$ is equal to

(A) 2^K (B) $\dfrac{2K}{K+1}$ (C) $\dfrac{1}{K+1}$ (D) none of these

26. $I=\displaystyle\int_1^4 e^{\sqrt{x}}dx$ equals to

(A) e^2 (B) e (C) 2e (D) $2e^2$

Space for Rough work

27. Area bounded by the curve $y = \sin^{-1} x$, y-axis and $y = \cos^{-1} x$ is equal to

(A) $\left(2 + \sqrt{2}\right)$sq unit (B) $\left(2 - \sqrt{2}\right)$sq unit (C) $\left(1 + \sqrt{2}\right)$sq unit (D) $\left(\sqrt{2} - 1\right)$sq unit

28. The solution of the differential equation $\frac{dy}{dx} + \frac{\tan y}{x} = \left(e^x \sec y . x\right)$ is equal to

(A) $x \sin y = e^x \left(x^2 - 2x + 2\right) + c$ (B) $x^2 \sin y = e^x \left(x + 1\right)^2 + e^x + c$

(C) $x^2 \sin y = e^x \left(x - 1\right)^2 + e^x + c$ (D) $x \sin y = e^x \left(x^2 + 2x + 2\right) + c$

29. Value of $\left[\vec{a} \times \vec{b}\ \vec{a} \times \vec{c}\ \vec{d}\right]$ is always equal to

(A) $\left(\vec{a}.\vec{d}\right)\left[\vec{a}\vec{b}\vec{c}\right]$ (B) $\left(\vec{a}.\vec{c}\right)\left[\vec{a}.\vec{b}.\vec{c}\right]$ (C) $\left(\vec{a}.\vec{b}\right)\left[\vec{a}.\vec{b}.\vec{c}\right]$ (D) none of these

30. The equation of the plane passing through the points (2, -1, 0), (3, -4, 5) and parallel to the line 2x = 3y = 4z is

(A) $125x - 90y - 79z = 340$ (B) $32x - 21y - 36z = 85$

(C) $73x + 61y - 22z = 85$ (D) $29x - 27y - 22z = 85$

Space for Rough work

FIITJEE Students From Classroom / Integrated School Programs have secured to 2 Zonal, 6 State & 18 City Topper Ranks. 33 in Top 100, 78 in Top 200 and 205 in Top 500 All India Ranks bagged by FIITJEE Students from All Programs have qualified in JEE (Advanced), 2015.

FIITJEE **JEE(Main)-2016**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – I
(Main)

S. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	B	A
2.	C	B	C
3.	A	B	C
4.	C	C	B
5.	D	A	A
6.	A	B	B
7.	A	C	C
8.	A	A	D
9.	D	B	A
10.	B	A	A
11.	B	C	B
12.	B	B	A
13.	D	C	C
14.	B	A	B
15.	D	C	A
16.	B	C	C
17.	A	C	C
18.	B	A	B
19.	C	C	C
20.	A	A	D
21.	C	B	A
22.	A	D	C
23.	B	B	C
24.	C	A	A
25.	C	C	B
26.	B	C	D
27.	A	A	B
28.	A	A	A
29.	C	B	A
30.	B	A	D

Physics

PART – I

SECTION – A

1. For an adiabatic process $PV^{y} = k$
Here y = 3/2 and k = constant

$$PV^{\frac{3}{2}} = k$$

$$\log P + \frac{3}{2}\log v = \log k$$

$$\frac{\Delta P}{P} + \frac{3}{2}\frac{\Delta v}{v} = 0$$

$$\frac{\Delta V}{V} = \frac{-2}{3}\frac{\Delta P}{P}$$

$$\frac{\Delta V}{V}\times 100 = \left(\frac{-2}{3}\right)\left(\frac{\Delta P}{P}\times 100\right) = \frac{-2}{3}\times\frac{2}{3} = \frac{-4}{9}$$

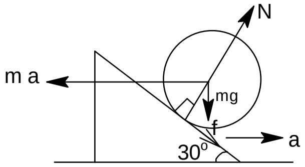
volume decreases by about $\frac{4}{9}\%$

2. $\tau_{\text{contact point}} = 0$

$$\Rightarrow \tau_{mg} = \tau_{ma}$$

$$\Rightarrow R\ mg\ \sin 30^{o} = R\ ma\ \cos 30^{o}$$

$$\Rightarrow a = \frac{g}{\sqrt{3}}$$



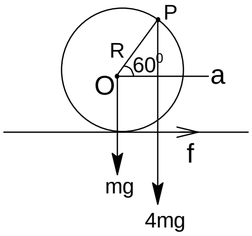
3. $\tau_0 = I_0\alpha$

$$\Rightarrow \frac{2}{5}mR\alpha + f = 2mg$$

& f = ma = mαR

$$\Rightarrow f = \frac{10}{7}mg \Rightarrow \frac{10}{7}mg \le \mu N$$

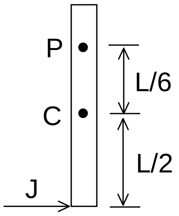
$$\Rightarrow \frac{10}{7}mg \le \mu(5mg), \mu \ge \left(\frac{2}{7}\right)$$



4. for ideal gas (i) and (iii) are correct
= for same pressure and no. of mole

$$\frac{PV_1}{nT_1} < \frac{PV_2}{nT_2} \Rightarrow \frac{V_1}{T_1} < \frac{V_2}{T_2} \Rightarrow T_1 > T_2$$

5. Conservation of linear momentum.



$$J = MV_f \Rightarrow V_f = \frac{J}{M}$$

Conservation of angular momentum
about C

$$J\frac{L}{2} = \frac{ML^2}{12}\omega \Rightarrow \omega = \frac{6J}{ML}$$

$$\Rightarrow KE = \frac{1}{2}I_{cm}\omega^2 + \frac{1}{2}MV_f^2 = \frac{2J^2}{M}$$

6. Initially increase in temperature increases the density and after T = 4^o C increase in temperature decreases the density

7. Let ℓ is the length on potentiometer $i = \frac{5V}{5R} = 1A$

$$(1.5\ell)A = 3 \Rightarrow \dagger = 2m$$

8. $\because p = p_0 \cos\left(\frac{2\pi}{\lambda}x\right) \Rightarrow \frac{p_0}{2} = p_0 \cos\left(\frac{2\pi}{\lambda}\times 1\right)$

$$\Rightarrow \lambda = 6m \Rightarrow \nu = 60HZ$$

9. $r = \sqrt{(8-2)^2 + (-5-3)^2} = 10$

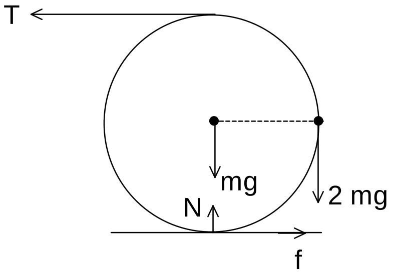
$$E = \frac{9\times 10^9 \times 50 \times 10^{-6}}{100} = \frac{9}{2}\times 10^3 = 4500\,V/m$$

10. $\because f' = \left(\frac{V_{sound} \pm V_0 + V_{wind}}{V_{sound} \mp V_{source} + V_{wind}}\right)f$

$$\therefore f' = f$$

11. Place another identical hemisphere on given one, so that flat faces of two coincide. The total flux linked with cross- section of bottom half (lower hemisphere) is $\frac{Q}{2\in_0}$ as charge enclosed by given hemisphere is zero. So flux linked with flat face of hemisphere is $\frac{-Q}{2\in_0}$

12. $\because f = T$ …. (i)



N = mg + 2mg …. (ii)
(T + f)R = 2mg R …. (iii)

$$\Rightarrow 2f = 2mg$$

$$\Rightarrow \mu N = mg$$

$$\Rightarrow \mu_{min} = \frac{1}{3}$$

13. $\because \mu N = \mu m\omega^2 r = mg$

$\Rightarrow \mu = \dfrac{g}{\omega^2 r} = \dfrac{5}{\pi^2} = 0.506$

14. $\left[17 \times m\left({}_1H^1\right) + 18 \times m\left({}_0n^1\right) - M\right] \times 931 = 298$

15. $x = \left(\dfrac{\sqrt{7}-1}{3}\right)R_0$

16. Required kinetic energy = $\left[m(N) + m(n) - m(H) - m(C)\right] \times 931\,\text{MeV}$
= 2.99 MeV

17. $\because 10\beta' = \dfrac{11}{2}\beta$

$\Rightarrow 10\lambda'\dfrac{D}{d} = \dfrac{11}{2}\dfrac{\lambda D}{d}$

$\Rightarrow \dfrac{\lambda}{\lambda'} = \dfrac{20}{11} = \mu$

$\therefore \mu = 1.81$

18. Time constant will be 2RC

19. For refraction at bottom of slab

$\dfrac{4}{3V_1} - \dfrac{3}{2(45)} = 0 \Rightarrow V_1 = (+)40\,\text{cm}$

For mirror

$\dfrac{1}{-20} = \dfrac{1}{V_2} + \dfrac{1}{-60} \Rightarrow V_2 = (-)30\,\text{cm}$

For refraction at bottom of glass slab

$\dfrac{3}{2V_3} - \dfrac{4}{3(10)} = 0 \Rightarrow V_3 = +\dfrac{45}{4}\,\text{cm}$

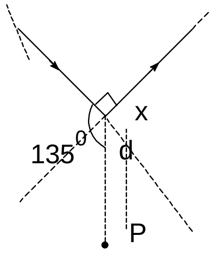
For refraction at upper surface of slab

$\dfrac{1}{V_4} - \dfrac{3/2}{-\left(45 - \dfrac{45}{4}\right)} = 0 \Rightarrow V_4 = (-)\dfrac{45}{2}\,\text{cm}$

20. $B = \dfrac{\mu_o I}{4\pi r}(\cos\alpha + \cos\beta) \times 2$

$\dfrac{\mu_o I}{2\pi\left(\dfrac{d}{\sqrt{2}}\right)}(\cos 0 + \cos 135)$

$= \dfrac{\mu_o I}{\sqrt{2}\pi d}\left(1 - \dfrac{1}{\sqrt{2}}\right)$



21. $\in = \dfrac{-d\phi}{dt}$

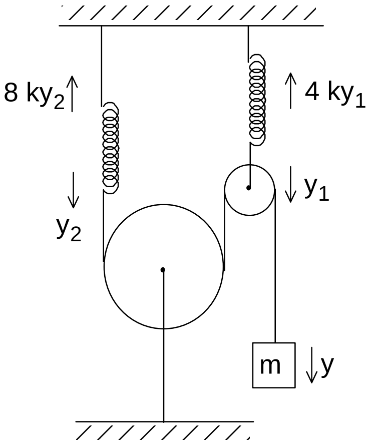
$= \dfrac{d\left(\left(\pi R^2\right)\cdot B\right)}{dt}$

$\pi B \cdot 2R\dfrac{dR}{dt}$

$2\pi B\left(R_o + t\right)\cdot 1$ anticlock wire

22. The current in wire AB, increase the flux through circular loop. Hence current in circular loop will be anticlockwise.

23. $\because 2F_0 = 4ky_1$



F_0 = Tension in the string

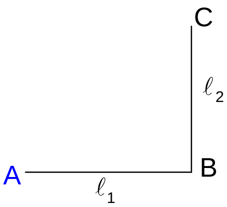
$F_0 = 8ky_2$

$y = 2y_1 + y_2 = \dfrac{9F_0}{8K}$

$\Rightarrow K_{eq} = \dfrac{F_0}{y} = \left(\dfrac{8K}{9}\right)$

$\therefore T = 2\pi\sqrt{\dfrac{9m}{8K}}$

24.



$V_x = V_x i + V_{yj}$

P.D = VBl

P.D = along y – axis = $VxBl_2$

P.D along x – axis = $V_yB.l_1$

P.D along AC = $V_xBl_2 + V_yBl_1$

25. Assume the hemisphere to be made of thin hemispherical layers.

26. Co-efficient of mutual inductance = $\mu_o n_1 n_2 \ell \pi r_1^2$

$= \mu_0 \pi r_1^2$

Hence $M = \frac{\mu_0 \pi r^2}{2R}$

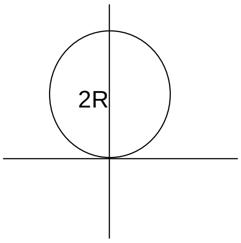
27. $\because 200 \times g = x^2 \times 2 \times 1 \times g$

$\Rightarrow x = 10\,cm$

$\therefore V = x^3 = 1000\,cm^3$

28. Electric field and magnetite field will be parallel and velocity will also parallel to electric filed
$\Rightarrow$ All three are parallel
Hence only electric force will act on it

29. $y = 2R = 2 \times \frac{mv_o}{qB} = \frac{2v_o}{\alpha \cdot B_0}$



30. $\because V_T = \frac{2r^2 g}{9\eta}(d - \rho)$

$\Rightarrow \frac{2 \times 10^{-2}}{3600} = \frac{2r^2 \times 10}{9 \times 10^{-2} \times 10^{-1}}\left(1.8 \times 10^3 - 10^3\right)$

$\Rightarrow r \approx 1.77 \times 10^{-6}\,m$

$\therefore D = 2r = 3.54 \times 10^{-6}\,m$

Chemistry

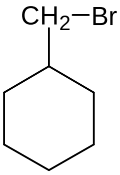
PART – II

SECTION – A

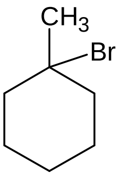
1. $K_2Cr_2O_7 + 14HCl \rightarrow 2KCl + 2CrCl_3 + 3Cl_2 + 7H_2O$

   n-factor of HCl = $\frac{6}{14} = \frac{3}{7}$

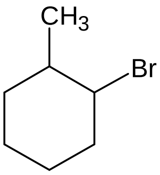
2. (i)



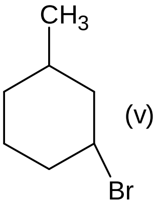
(ii)



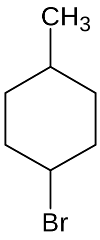
(iii)



(iv)



(v)



3. $PV = nRT \Rightarrow P = nRT / V$

4. $PV^{\gamma} = \text{const} \Rightarrow P\gamma V^{\gamma-1}dV + V^{\gamma}dP = 0$

   $$\frac{dP}{P} = -\gamma \cdot \frac{dV}{V}$$

5. $\Delta G^o = -0.059 \log k = -nFE^0_{cell} \therefore k < 1, \Delta G > 0$

6. $\left[Br^-\right]_{CaBr_2} = 0.01 \times 2, \quad \left[Br^-\right]_{KBr} = 0.01 \quad \left[Ag^+\right]_{AgNO_3} = 0.05$

   Both Br^- & Ag^+ ions act as common ions, so larger the conc. of Br^- or Ag^+ more is the suppression of ionization of gBr

7. Because shielding effect and increase in effective nuclear charge are cancelled

8. Not lies in same plane

9. NOF has lone pair while NO_2F has no lone pair

10. $Zn + NaOH(A) \rightarrow Na_2ZnO_2 + H_2(B)$

    $NaOH + P_4(C) \rightarrow NaH_2PO_2 + PH_3$

    $NaOH + NH_4Cl \rightarrow NaCl + NH_3(D) + H_2O$

11. Due to low electronegativity of N in compound C basic character decreases. Due to umbrella effect, A is least reactive.

12. Non super imposable mirror Image

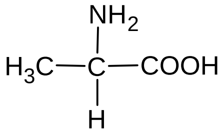
13. Due to cyclopropyl unique stability.

14. In (II) negative charge present on O atom while positive on C. (I) is most stable due to neutral.

15. Each ring contributes 1DBE.

16. Ring expansion will take place

17. Aniline is



$$H_3C-\overset{\overset{\large NH_2}{|}}{\underset{\underset{\large H}{|}}{C}}-COOH$$

18. Facts.

19.
$$\left.\begin{array}{l} NaCl + H_2SO_4 \xrightarrow{\Delta} NaHSO_4 + HCl \\ NaCl + NaHSO_4 \xrightarrow{\Delta} Na_2SO_4 + HCl \end{array}\right\} - \text{Craft process}$$

20. Bond strength α thermal stability

21. Fact.

22.
$$(X)\underset{\text{green}}{2Cr^{3+}} + 10OH^- + 3H_2O_2 \rightarrow \underset{\text{yellow}}{2CrO_4^{2-}}$$
$$(Y)CrO_4^{2-} + 2H_2O_2 + 2H^+ \rightarrow \underset{[\text{blue}]}{2CrO_5} + 3H_2O \rightarrow Cr_2O_3 + 7/2O_2 + H_2SO_4 \rightarrow Cr_2(SO_4)_3 + 3H_2O$$

23. Fact

24. Fact

25. (cis/trans) i.e. Geometrical

26. Due to strong ligand $t_{2g}^6\, e_g^o$

27. Self reduction
$Cu_2S + 2Cu_2O \rightarrow 6Cu + SO_2$

28. $P = K_H\, x$
$\log P = \log K_H + \log X$

29. Electraode potential is intensive property while gibb's free energy is extensive

30.
$$\begin{array}{lcccl} A & \longrightarrow & 2B & + & C \\ P_i & & 0 & & 0 \quad \text{Pressure at } t = 0 \\ P_i - P & & 2P & & P \quad \text{Pressure at any } t \end{array}$$
$$\therefore P_t = P_i + 2P$$
$$\text{or } P = \frac{P_t - P_i}{2}$$
$$\because K = \frac{2.303}{t}\log\left(\frac{P_i}{P_i - P}\right)$$
$$= \frac{2.303}{t}\log\left(\frac{P_i}{P_i - \frac{P_t - P_i}{2}}\right) = \frac{2.303}{t}\log\left(\frac{2P_i}{3P_i - P_t}\right)$$

Mathematics PART – III

SECTION – A

1. $0 \le \frac{|x|}{1+x^2} < 1 \therefore m = \left[\frac{|x|}{1+x^2}\right] = 0$

$1 \le 2 - \sin 3x \le 3$

$\frac{1}{3} \le \frac{1}{2-\sin 3x} \le 1$

$\therefore n = \text{integral value of } \frac{1}{2-\sin 3x} = 1$

$\therefore m \ne n$

2. at the point $\sin x = \frac{\sqrt{3}}{2}$

$P = \left(\frac{2\pi}{3}, \frac{3}{2}\right)$

$\frac{3}{2} = \frac{\sqrt{3}}{2} \cdot \frac{2\pi}{3} + a$

$a = \left(\frac{3}{2} - \frac{\pi}{\sqrt{3}}\right) \quad a \in \left(\frac{3}{2} - \frac{\pi}{\sqrt{3}}, \infty\right)$

3. $f_P(\alpha) = e^{\frac{i\alpha}{P^2}(1+2+\ldots P)} = e^{\frac{i\alpha}{P^2}\frac{P(P+1)}{2}} = e^{\frac{i\alpha}{2}\left(1+\frac{1}{P}\right)}$

$\therefore \lim_{n\to\infty} f_n(\pi) = \lim_{n\to\infty} e^{\frac{i\pi}{2}\left(1+\frac{1}{n}\right)} = i$

4. $\frac{z-1}{i} = \text{real}, \ \frac{x+iy-1}{i} = \text{real}$

$\frac{x-1}{i} + y = \text{real} \quad \therefore x-1 = 0, \ x = 1$

$\sin^{-1}\left(\frac{z-1}{i}\right) = \sin^{-1}(y) \Rightarrow -1 \le y \le 1$

$\text{Re}|z| = x = 1, \ -1 < \text{Im}(z) \le 1$

5. $S = \sum_{r=1}^{16} \frac{8r}{(4r^4+1)}$

$\sum_{r=1}^{16} \frac{8r}{(2r^2-2r+1)(2r^2+2r+1)} = 2\sum_{r=1}^{16}\left(\frac{1}{(2r^2-2r+1)} - \frac{1}{2r^2+2r+1}\right)$

$= 2\left(\frac{1}{1} - \frac{1}{5} + \frac{1}{5} - \frac{1}{13} + \frac{1}{13} + \ldots \frac{1}{481} - \frac{1}{545}\right)$

$= 2\left(1 - \frac{1}{545}\right) = \frac{1088}{545}$

6. 13, a_1, a_2 …. A_{20}, 67 are in AP

$$\therefore a_1 + a_2 .... + a_{20} = 20\left(\frac{13+67}{2}\right) = 800$$

AM ≥ GM

$$\therefore \frac{a_1 + a_2 + a_3 .... + a_{20}}{20} \le (40)^{20}$$

Maximum value is $(40)^{20}$.

7. $$\sqrt{2}\left(\cos\left(\cos x.\cos\frac{\pi}{4} + \sin(\cos x)\left(\sec\frac{\pi}{4}\right)\right)\right)$$

$$= \sqrt{2}\left\{\cos\left(\cos x - \frac{\pi}{4}\right)\right\}$$

$$= -1 \le \cos\left(\cos x - \frac{\pi}{4}\right) \le 1$$

$$-\sqrt{2} \le A \le \sqrt{2}$$

8. $$\frac{99\pi}{2} \le \theta \le 50\pi$$

$$\frac{3\pi}{2} \le \theta \le 2\pi$$

$$x = -\sin^2\theta, \cos y = \cos^2\theta$$

$$y - x = 1$$

9. $$\sqrt{2}\left(\frac{1}{\sqrt{2}}\cos\frac{\pi}{2n} + \frac{1}{\sqrt{2}}\sin\left(\frac{\pi}{2n}\right)\right) = \frac{\sqrt{n}}{2}$$

$$\Rightarrow \sqrt{2}\cos\left(\frac{\pi}{4} - \frac{\pi}{2n}\right) = \frac{\sqrt{n}}{2}$$

$$\cos\left(\frac{\pi}{4} - \frac{\pi}{2n}\right) = \frac{\sqrt{n}}{2\sqrt{2}}$$

$$n = 6,\ \cos\frac{\pi}{6} = \frac{\sqrt{3}}{2}$$

10. $\sin x > 0$ & $\sin 3x > 0$

$$\log_2(2\sin x \sin 3x) \ge 0$$

$$\Rightarrow 2\sin x.\sin 3x \ge 1$$

$$3x \in (0, \pi) \cup (2\pi, 3\pi)$$

$$x \in \left(0, \frac{\pi}{3}\right) \cup \left(\frac{2\pi}{3}, \pi\right)$$

for $2\sin x \sin 3x \ge 1$

$$2\sin^2 x\left(3 - 4\sin^2 x\right) \ge 1$$

$$8\sin^4 x - 6\sin^2 x + 1 \le 0$$

$$\Rightarrow \left(2\sin^2 x - 1\right)\left(4\sin^2 x - 1\right) \le 0$$

$$\Rightarrow \left(\sin x - \frac{1}{\sqrt{2}}\right)\left(\sin x + \frac{1}{\sqrt{2}}\right)\left(\sin x - \frac{1}{2}\right)\left(\sin x + \frac{1}{2}\right) \le 0$$

$$\frac{1}{2} \le \sin x \le \frac{1}{\sqrt{2}}$$

$$x \in \left[\frac{\pi}{3}, \frac{\pi}{4}\right] \cup \left[\frac{2\pi}{3}, \frac{3\pi}{4}\right]$$

finally $x \in \left(\frac{2\pi}{3}, \frac{3\pi}{4}\right]$

11. Required no = $5!\left(\frac{1}{2!} - \frac{1}{3!} - \frac{1}{4!} - \frac{1}{5!}\right)$

$$= 120\left(\frac{1}{2} - \frac{1}{6} + \frac{1}{24} - \frac{1}{120}\right)$$

$$= 60 - 20 + 5 - 1 = 44$$

12. $\left(1 + x + x^3 + x^4\right)^n = \left[(1+x)\left(1+x^3\right)\right]^n$

$$= (1+x)^n\left(1+x^3\right)^n$$

$$= \left(1 + {}^nC_1x + {}^nC_2x^2 ... + {}^nC_1x^n\right)\left(1 + {}^nC_1x^3 + {}^nC_2x^6 + ... {}^nC_nx^{3n}\right)$$

Coefficient of x^{15}

$$= \left({}^nC_5 \times {}^nC_0\right) + \left({}^nC_4 \times {}^nC_3\right) + \left({}^nC_3 \times {}^nC_6\right) + ... + \left({}^nC_2 \times {}^nC_9\right) + \left({}^nC_3 \times {}^nC_{12}\right) + \left({}^nC_6 \times {}^nC_{15}\right)$$

$$= \sum_{r=0}^{5} {}^nC_{5-r}\, {}^nC_{3r}$$

13. $P\left(\frac{B}{A \cup \overline{B}}\right) = \frac{P\left(B \cap \left(A \cup \overline{B}\right)\right)}{P\left(A \cup \overline{B}\right)} = \frac{P(A \cap B)}{P\left(A \cup \overline{B}\right)}$

Now $P\left(A \cap \overline{B}\right) = PA - P(A \cap B)$

$$\Rightarrow P(A \cap B) = P(A) - P\left(A \cap \overline{B}\right)$$

$$= \frac{7}{10} - \frac{1}{2} = \frac{1}{15}$$

Also $P\left(A \cup \overline{B}\right) = P(A) + P\left(\overline{B}\right) - P\left(A \cap \overline{B}\right)$

$$= \frac{7}{10} + \frac{3}{5} - \frac{1}{2} = \frac{4}{5},\ P\left(\frac{B}{A \cup \overline{B}}\right) = \frac{1}{4}$$

14. Putting x = 0, $a_0 = 1$

Differentiate both side and putting x = 0 we get $a_1 = 4a$

Differentiate again and putting x = 0

$$a_2 = 6a^2 + 4b$$

$$\Delta = -\left(a_0^3 + a_1^3 + a_2^3 - 3a_0a_1a_2\right) \quad \because\ a_0 + a_1 + a_2 \ne 0$$

$$1 = 4a = 6a^2 + 4b$$

$$a = \frac{1}{4},\ b = \frac{5}{32}$$

15. $a_{11} = 0$, $a_{12} = 3$, $a_{21} = 3$, $a_{22} = 0$

$$A = \begin{vmatrix} 0 & 3 \\ 3 & 0 \end{vmatrix} \quad |A| = 9$$

$$A^{-1} = \frac{-1}{9}\begin{bmatrix} 0 & -3 \\ -3 & 0 \end{bmatrix} \Rightarrow \begin{bmatrix} 0 & \frac{1}{3} \\ \frac{1}{3} & 0 \end{bmatrix}$$

16. $CD = \dfrac{16+5+181}{\sqrt{4+25}} = \sqrt{29}$

AD = 3

$\Rightarrow CA^2 = 9 + 29 = 38$

Equation of circle is $(x-3)^2 + (y+1)^2 = 38$

17 shortest distance will take place along the common normal

Equation of normal for $y^2 = 4ax$ at $(at^2, 2at)$

$y = -tx + t + t^3$

If it passes through (6, 0) then

$t^3 - 5t = 0$

$t = 0, t = \pm\sqrt{5}$

$\Rightarrow A\left(5, 2\sqrt{5}\right), C = \left(5, -2\sqrt{5}\right)$

$PA = PC = \sqrt{1+20} = \sqrt{21}; OP = 6$

Minimum distance = $\left(\sqrt{21} - \sqrt{5}\right)$ units

18. Let the mid point of chord be P(h, K); its equation will be

$xh - yK = h^2 - K^2$

$y = \dfrac{h}{K}x + \dfrac{K^2 - h^2}{K}$

It should be same as $y = mx + \dfrac{a}{m}$

$\Rightarrow m = \dfrac{h}{K}$ and $\dfrac{a}{m} = \dfrac{K^2 - h^2}{K}$

$\Rightarrow a = \dfrac{K^2 - h^2}{K}\dfrac{h}{K} \Rightarrow K^2a = K^2h.h^3$

$\Rightarrow h^3 = K^2(h - a)$

Locus is $x^3 = y^2(x - a)$

19. equation of tangents is $SS_1 = T^2$

$$\left(\frac{x^2}{9} + \frac{y^2}{4} - 1\right)\left(\frac{\lambda^2}{9} + \frac{9}{4} - 1\right) = \left(\frac{\lambda x}{9} + \frac{3y}{4} - 1\right)^2$$

Right angle a + b = 0

Solve it get $\lambda = \pm 2$

20. $$\lim_{x\to 0}\frac{x^a\left(\frac{\sin x}{x}\right)^b}{\sin\left(\frac{x^c}{x^c}\right).x^c}\Rightarrow \lim_{x\to 0}x^{a+b-c}\frac{\left(\frac{\sin x}{x}\right)^b}{\left(\frac{\sin x^c}{x^c}\right)}$$

The value of limit is non-zero only
a + b – c = 0

21. $$\lim_{x\to 1}\int_4^{f(x)}\frac{2tdt}{x-1}$$

$$\lim_{x\to 1}\frac{2f(x)\times f'(x)}{1}=2f(1).f'(1)$$

$$=8f'(1)$$

22 y = f(x)

$$x=f^{-1}(y)$$

$$f(x)=x+\tan x$$

$$y=f^{-1}(y)+\tan^{-1}f^{-1}(y)$$

$$y=g(y)+\tan(g(y))$$

$$x=g(x)+\tan(g(x))$$

Differentiate

$$1=g'(x)+\sec^2 g(x).g'(x)$$

$$g'(x)=\frac{1}{1+\sec^2(g(x))}=\frac{1}{2+(g(x)-x)^2}$$

23. $$f(x)=\cos|x|-2ax+b$$

$$=\cos x-2ax+b$$

$$f'(x)=-\sin x-2a$$

$$f'(x)\geq 0$$

$$-\sin x-2a\geq 0$$

$$a\leq -\frac{1}{2}$$

24. Let $x^x = t$

$$x\log x=\log t$$

$$(\log x+1)dx=\frac{1}{t}dt$$

$$t(1+\log x)dx=dt$$

$$I=\int\frac{1}{t\sqrt{t^2-1}}dt=\sec^{-1}(x^x)+c$$

25. $$\lim_{n\to\infty}2^K\left(\frac{1^K+2^K+3^K+...n^K}{n^{K+1}}\right)$$

$$= 2^K \lim_{n\to\infty} \sum \frac{1}{n}\left(\frac{r}{n}\right)^K$$

$$2^K \int_0^1 x^K dx = 2^K \left[\frac{x^{K+1}}{K+1}\right]_0^1 = \frac{2K}{K+1}$$

26. $I = 2\int_1^4 \frac{e^{\sqrt{x}}}{2\sqrt{x}}\sqrt{x}\,dx$

$$= 2\int_1^2 ze^z dz \qquad z = \sqrt{z}$$

$$= 2\left[ze^z - e^z\right]_1^2 = 2\left[2e^2 - e^2 - 0\right] = 2e^2$$

27. Area = $\int_0^{\frac{\pi}{4}} \sin y\,dy + \int_{\frac{\pi}{4}}^{\frac{\pi}{2}} \cos y\,dy$

$$= -\left[\cos y\right]_0^{\frac{\pi}{4}} + \left[\sin y\right]_{\frac{\pi}{4}}^{\frac{\pi}{2}}$$

$$= \frac{-1}{\sqrt{2}} + 1 + 1 - \frac{1}{\sqrt{2}} = \left(2 - \sqrt{2}\right)\text{sq unit}$$

28. $x\cos y\frac{dy}{dx} + \sin y = x^2.e^x$

$$\Rightarrow x\cos y dy + \sin y dx = x^2e^x dx$$

$$d\left(x.\sin y\right) = x^2e^x dx$$

$$x\sin y = x^2\,e^x - 2\int x.e^x dx$$

$$= x^2e^x - 2xe^x + 2e^x + c$$

$$x\sin y = e^x\left(x^2 - 2x + 2\right) + c$$

29. $\left(\vec{a}\times\vec{b}\right).\left(\left(\vec{a}\times\vec{c}\right)\times\vec{d}\right)$

$$= \left(\vec{a}\times\vec{b}\right).\left(\left(\vec{a}.\vec{d}\right)\vec{c} - \left(\vec{c}.\vec{d}\right)\vec{a}\right)$$

$$= \left(\vec{a}.\vec{d}\right)\left[\vec{a}\vec{b}\vec{c} - \left(\vec{c}.\vec{d}\right)\left[\vec{a}\vec{b}\vec{c}\right]\right]$$

$$= \left(\vec{a}.\vec{d}\right)\left[\vec{a}\vec{b}\vec{c}\right]$$

30. let the plane ax + by + cz = 1 & here $\frac{x}{6} = \frac{y}{4} = \frac{z}{3}$

When 6a + 4b + 3c = 0
2a – b = 1
3a – 4b + 5c = 1

$$a = \frac{29}{85}, b = \frac{-27}{85}, c = \frac{-22}{85}$$

$$29x - 27y - 22z = 85$$

FIITJEE

JEE (Advanced)-2016

FULL TEST – II

Paper 1

FIITJEE Students From Classroom / Integrated School Programs have secured to 2 Zonal, 6 State & 18 City Topper Ranks. 33 in Top 100, 78 in Top 200 and 205 in Top 500 All India Ranks bagged by FIITJEE Students from All Programs have qualified in JEE (Advanced), 2015.

ALL INDIA TEST SERIES

Time Allotted: 3 Hours **Maximum Marks: 243**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 06)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (07 – 09) contains 3 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

   Section-A (10 – 14) contains 2 paragraphs. Based upon paragraph, 2 and 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.
2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct matching. No marks will be given for any wrong matching in any question. There is no negative marking.
3. **Section-C (01 – 05)** contains 5 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

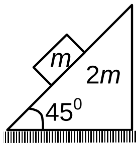
SECTION – A

Straight Objective Type

This section contains 6 multiple choice questions numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. Which of the following is the most accurate instrument for measuring length?
(A) vernier calipers having 20 divisions on the sliding scale which coincide with 19 divisions on the main millimeter scale
(B) a screw gauge having pitch 1 mm and 50 divisions on the circular scale
(C) a vernier scale of least count 0.01 mm
(D) a screw gauge of least count 0.001 mm

2. A block of mass *m* is placed on a wedge of mass 2m which rests on a rough horizontal surface. There is no friction between the block and the wedge. The minimum coefficient of friction between the wedge and the ground so that the wedge does not move is



(A) 0.167
(B) 0.20
(C) 0.23
(D) 0.33

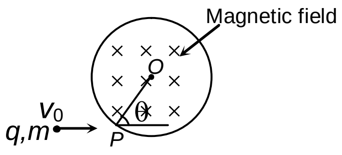
3. A small ball thrown with an initial velocity *u* directed at an angle θ = 37° above the horizontal collides inelastically (*e* = 1/4) with a vertical massive wall moving with a uniform horizontal velocity *u*/5 towards ball. After collision with the wall, the ball returns to the point from where it was thrown. Neglect friction between ball and wall. The time *t* from beginning of motion of the ball till the moment of its impact with the wall is (tan37° = 3/4)
(A) $\frac{3u}{5g}$
(B) $\frac{18u}{25g}$
(C) $\frac{54u}{125g}$
(D) $\frac{54u}{25g}$

Space for Rough work

4. A cube of side l and mass M is placed on rough horizontal surface and the friction is sufficient so that it will not move, if a constant force $F = Mg$ is applied horizontally $l/4$ above the surface. Then the torque due to normal force about center of the cube is equal to

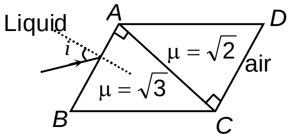
(A) $\frac{Mgl}{2}$
(B) $\frac{Mgl}{4}$
(C) $\frac{Mgl}{8}$
(D) zero

5. A particle of charge q and mass m is projected with a velocity v_0 towards a circular region having uniform magnetic field B perpendicular and into the plane of paper from point P as shown in the figure. R is the radius and O is the centre of the circular region. If the line OP makes an angle θ with the direction of v_0 then the value of v_0 so that particle passes through O is



(A) $\frac{qBR}{m\sin\theta}$
(B) $\frac{qBR}{2m\sin\theta}$
(C) $\frac{2qBR}{m\sin\theta}$
(D) $\frac{3qBR}{2m\sin\theta}$

6. A ray of light from a liquid $\left(\mu = \sqrt{3}\right)$ is incident on a system of two right angled prism of refractive indices $\sqrt{3}$ and $\sqrt{2}$ as shown. The ray suffers zero deviation when emerges into air from CD. The angle of incidence i is

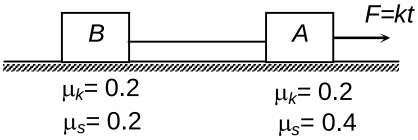


(A) 45^0
(B) 35^0
(C) 20^0
(D) 10^0

Multiple Correct Choice Type

This section contains 3 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

7. Two blocks *A* and *B* each of mass $\frac{1}{2}$ kg is connected by a massless inextensible string and kept on horizontal surface. Coefficient of friction between block and surface is shown in figure. A force $F = kt$ (where *k* = 1 N/s and *t* is time in second) applied on *A.* Then (g = 10 m/s^2)

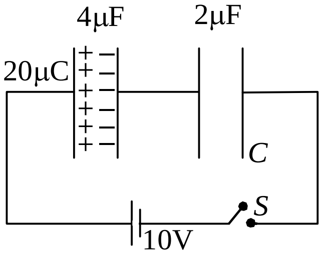


(A) work done by friction force on block *B* is zero in time interval *t* = 0 to *t* = 3s.
(B) work done by friction force on block *A* is zero in time interval *t* = 0 to *t* = 3s.
(C) work done by tension on *B* is also zero in time interval *t* = 0 to *t* = 3s.
(D) speed of blocks at *t* = 10s is 27.5 m/s.

8. A particle starts SHM at time $t = 0$. Its amplitude is *A* and angular frequency is ω. At time $t = 0$ its kinetic energy is $\frac{E}{4}$, where *E* is total energy. Assuming potential energy to be zero at mean position, the displacement-time equation of the particle can be written as

(A) $x = A\cos\left(\omega t + \frac{\pi}{6}\right)$
(B) $x = A\sin\left(\omega t + \frac{\pi}{3}\right)$
(C) $x = A\sin\left(\omega t - \frac{2\pi}{3}\right)$
(D) $x = A\cos\left(\omega t - \frac{\pi}{6}\right)$

9. A $4\,\mu\text{F}$ capacitor is given $20\,\mu\text{C}$ charge and is connected with an uncharged capacitor of capacitance $2\,\mu\text{F}$ as shown in figure. When switch *S* is closed.



(A) charged flown through the battery is $\frac{40}{3}\mu\text{C}$
(B) charge flown through the battery is $\frac{20}{3}\mu\text{C}$
(C) work done by the battery is $\frac{200}{3}\mu\text{J}$
(D) work done by the battery is $\frac{100}{3}\mu\text{J}$

Space for Rough work

Comprehension Type

This section contains 2 paragraphs. Based upon one of paragraph 2 multiple choice questions and based on the other paragraphs 3 multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

Paragraph for Question Nos. 10 and 11

A massive disc of radius *R* is mounted on a light axle with the axle held horizontal, the disc is made to spin with angular speed ω_0. It is then lowered gently on to a level table and released as soon as its rim makes contact with the table top. The disc begins to move along the table, skidding and picking up speed as it goes.

10. If μ_k is the coefficient of kinetic friction between the rim of the disc and table top, disc will continue to skid for a time

(A) $\frac{R\omega_0}{3\mu_k g}$ (B) $\frac{R\omega_0}{2\mu_k g}$

(C) $\frac{R\omega_0}{\mu_k g}$ (D) $\frac{3R\omega_0}{\mu_k g}$

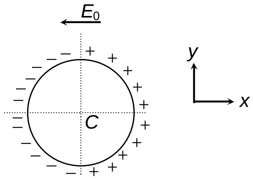
11. If initial kinetic energy of the disc is *K*, then the kinetic energy of the disc after it stars pure rolling will be

(A) $\frac{2}{3}K$ (B) $\frac{1}{2}K$

(C) $\frac{1}{3}K$ (D) $\frac{3}{4}K$

Space for Rough work

Paragraph for Question Nos. 12 and 14



A uniform ring of mass m and radius R can rotate freely about an axis passing through centre C and perpendicular to plane of paper. Half of ring is positively charge and other half is negatively charge. Uniform electric field E_0 is switched on along –ve x-axis (Axis are shown in figure)
[magnitude of charge density λ]

12. The dipole moment of ring is
(A) $2\lambda R^2$ (B) $4\lambda R^2$
(C) $2\pi\lambda R^2$ (D) $4\pi\lambda R^2$

13. The equilibrium of ring is
(A) stable (B) unstable
(C) neutral (D) can't say

14. If ring is slightly disturb from given position, find the angular speed of ring when it rotate by $\pi/2$.
(A) $2\sqrt{\frac{\lambda E_0}{m}}$ (B) $\sqrt{\frac{\lambda E_0}{m}}$
(C) $\sqrt{\frac{8\lambda E_0}{m}}$ (D) none

Space for Rough work

SECTION – B

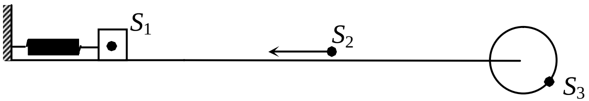
(Matrix-Match Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Three sound sources of same frequency f are arranged as shown in figure. S_2 moves towards left with speed $\frac{v}{n}$, S_3 moves on a circular path of radius R with constant speed $\frac{2v}{n}$, and S_1 performs S.H.M. with frequency $\frac{100v}{n\pi} s^{-1}$ and amplitude 1 cm. (n > 12 and v is speed of sound)



	Column I		Column II
(A)	Beat frequency heard by S_1 may be	(p)	$\frac{f}{n}$
(B)	Beat frequency heard by S_2 may be	(q)	$\frac{2f}{n+1}$
(C)	Beat frequency heard by S_3 may be	(r)	zero
(D)	Change in the wave length of wave emitted by S_3 and observed by S_2 may be	(s)	$\frac{2f}{n-1}$
		(t)	

Space for Rough work

2. Match the following:

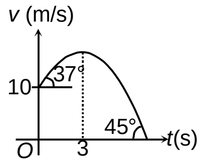
	Column I		Column II
(A)	The voltage applied to X-ray tube is increased.	(p)	Average K.E. of the electrons decreases
(B)	In photo electric effect work function of the target is increased.	(q)	Average K.E. of the electrons increases
(C)	Stopping potential decreased by	(r)	Cut off wavelength decreases
(D)	Wavelength of K_α , X-ray increased by	(s)	Atomic number of target material decreases
		(t)	

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. A particle starts moving with velocity 10 m/s in a straight line under an acceleration varying linearly with time. Its velocity time graph is as shown in figure. Its velocity is maximum at t = 3 sec. Find the time (in sec) when the particle stops ($\tan 37^0 = 3/4$)



2. A block of mass 1 kg start moving at t = 0 with speed 2 m/s on rough horizontal surface with coefficient of friction 0.2. A horizontal force F is applied in the direction of velocity which varies with time shown in figure (B). Find the speed (in m/s) of particle at t = 3 s (g = 10 m/s^2).

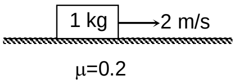
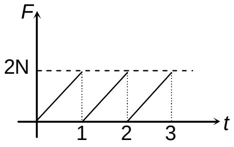


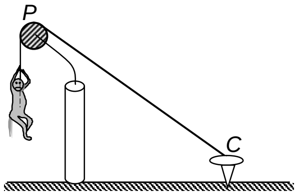
Figure (a)



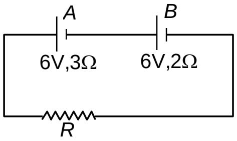
Figure

Space for Rough work

3. One end of a massless rope, which passes over a massless and frictionless pulley P is tied to a hook C while the other end is free. Maximum tension that the rope can bear is 360 N with what value of minimum safe acceleration (in ms^{-2}) can a monkey of 60 kg move down on the rope



4. Two sources of emf 6V and internal resistance 3Ω and 2Ω are connected to an external resistance R as shown. If potential difference across battery A is zero, then find the value of R (in ohm)



5. Two radioactive elements R and S disintegrate as

$R \longrightarrow P + \alpha$; $\lambda_R = 4.5\times10^{-3}$ years $^{-1}$

$S \longrightarrow Q + \beta$; $\lambda_S = 3\times10^{-3}$ years $^{-1}$

Starting with number of atoms of R and S in the ratio of 2 : 1, find the ratio after the lapse of three half lives of R……..

Space for Rough work

Chemistry

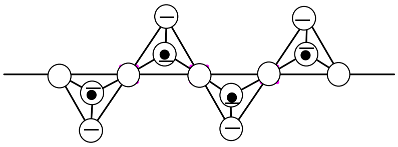
PART – II

SECTION – A

Straight Objective Type

This section contains 6 multiple choice questions numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. The formula of the following chain silicate (pyroxene) can be represented as



(A) $(Si_3O_9)^{6-}$ (B) $(SiO_4)_n^{3n-}$

(C) $(SiO_3)_n^{3n-}$ (D) $(SiO_3)_n^{2n-}$

2. Which of the following equations must be used for the exact calculation of [H$^+$] of an aqueous HCl solution at any concentration C_{HCl}. $[K_w = 10^{-14} M^2]$

(A) [H$^+$] $= C_{HCl}$ (B) $\left[H^+\right] = C_{HCl} + K_w$

(C) $\left[H^+\right] = C_{HCl} + \frac{K_W}{\left[H^+\right]}$ (D) $\left[H^+\right] = C_{HCl} - \frac{K_w}{\left[H^+\right]}$

3. Which of the following salts give different result by the action of heat?

(A) Li_2CO_3 and $CaCO_3$ (B) $NaHCO_3$ and $KHCO_3$

(C) Hydrated $MgCl_2$ and hydrated Na_2SO_4 (D) Li_2SO_4 and $MgSO_4$

4. $A \xrightarrow{High\ \ P\&T} 3B + C$ is a first order reaction. If A is strong mono protic acid and B is strong diprotic acid and reaction kinetic is studied by using a standard solution of NaOH required to neutralise reaction mixture at different instants of time. When initially we had taken same concentration of A in each case.

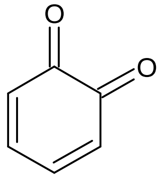
Now it was observer that volume required after 971 sec was double that required initially, then the half life of reaction is:

(A) 485 sec (B) 1942 sec

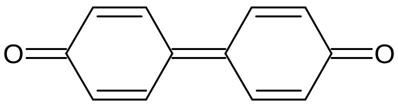
(C) 3010 sec (D) 971 sec

Space for Rough work

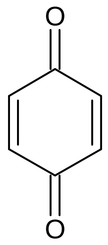
5. Consider the following conjugated diketo compounds:



I



II



III

Which of reduction potential the following is the correct decreasing order of E° values:

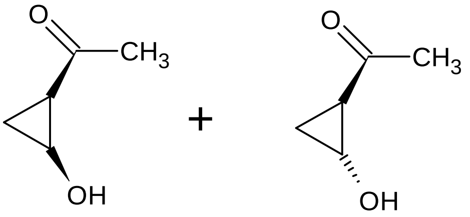
(A) $I > II > III$

(B) $III > II > I$

(C) $I > III > II$

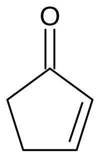
(D) $II > I > III$

6. Compound A and B, both were treated with $NaOH$, producing a single compound C:

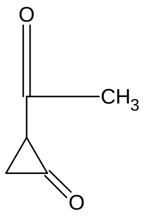


$\xrightarrow[heat]{HO^-} C$. Compound (C) is:

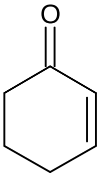
(A)



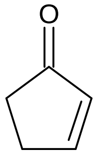
(B)



(C)



(D)



Space for Rough work

Multiple Correct Choice Type

This section contains 3 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

7. For the reaction $NH_3(g) \rightleftharpoons \frac{1}{2}N_2(g)+\frac{3}{2}H_2(g)$. If Kp of the above reaction is 78.1 at $400°C$ which is not correct:

(A) At pressure P degree of dissociation of NH_3 is $\left[1+\frac{3\sqrt{3}P}{4k_p}\right]^{-1/2}$

(B) $K_c = 1.413\, mol/\ell$

(C) If we increase pressure it will decrease K

(D) If we increase P by bringing piston down , then, degree of dissociation α will decrease

8. The correct statement(s) about solvent effect is/are

(A) Decreasing solvent polarity causes a large increase in the rate of the S_{N^2} attack by ammonia on an alkyl halide $R-X+\ddot{N}H_3 \longrightarrow R\overset{+}{N}H_3+X^-$

(B) Increasing solvent polarity causes a large decrease in the rate of the S_{N^2} attack by hydroxide ion on trimethyl sulphonium ion.

$$HO^- + \underset{\text{Trimethyl sulphonium ion}}{(CH_3)_3S^+} \longrightarrow CH_3OH + \underset{DMS}{(CH_3)_2S}$$

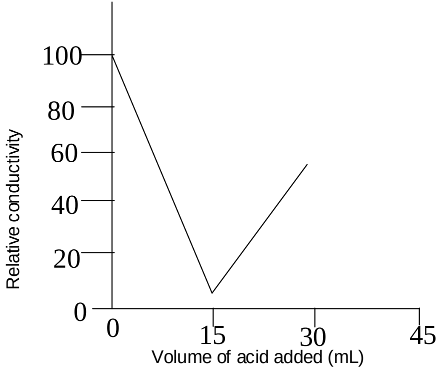
(C) Increasing solvent polarity causes a small decrease in the rate of the S_{N^2} attack by trimethyl amine on trimethyl sulphonium ion

$$(CH_3)_3\ddot{N}+(CH_3)_3\overset{+}{S} \longrightarrow CH_3\overset{+}{N}(CH_3)_3+(CH_3)_2S$$

(D) All are incorrect.

Space for Rough work

9. 20 mL of KOH solution was titrated with 0.20 mol L^{-1} H_2SO_4 solution in a conductively cell. The data obtained were plotted to give the graph shown below:



The concentration of the KOH solution was:

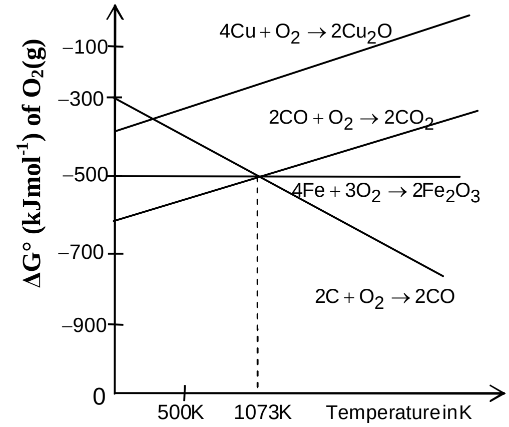
(A) 0.30 mol L^{-1}
(B) 0.15 mol L^{-1}
(C) 0.12 mol L^{-1}
(D) 0.075 mol L^{-1}

Comprehension Type

This section contains 2 paragraphs. Based upon one of paragraph 2 multiple choice questions and based on the other paragraphs 3 multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

Paragraph for Question Nos. 10 and 11

The Ellingham diagram for the reduction of haematite and that of cuprous oxide given below;



On the basis of the above plot, answer the following two questions:

Space for Rough work

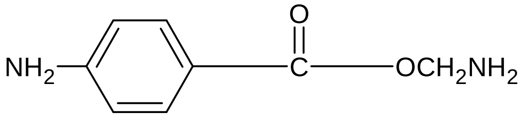
10. Choose the incorrect statement
(A) Above 1073 K carbon can reduce Fe_2O_3
(B) Below 1073 K ΔG° of the reaction given below is negative
$$Fe_2O_3(s)+3CO(s)\longrightarrow 2Fe(s)+3CO_2(g)$$
(C) Below 1073 K ΔG° of formation of CO_2 from CO is more negative than ΔG° of formation of Fe_2O_3.
(D) Above 1073 K ΔG° for the formation of CO is less negative than that of Fe_2O_3.

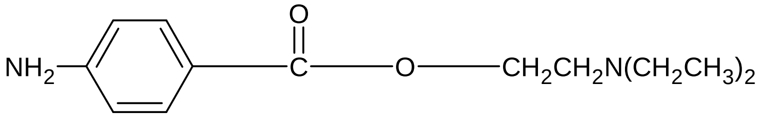
11. The incorrect statement amongst the following is
(A) The ΔG° of the formation of CO_2(g) will remains almost independent of temperature because of ΔS° of the reaction being almost equal to zero.
(B) The reaction: $2C(s) + O_2(g) \rightarrow 2CO(g)$ is most suitable at temperature above 1073 K.
(C) It is difficult to reduce Cu_2O to the metal by heating with coke as compared to Fe_2O_3.
(D) Reduction with carbon at high temperature is not preferred due to carbide formation.

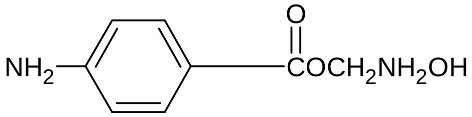
Paragraph for Question Nos. 12 and 14

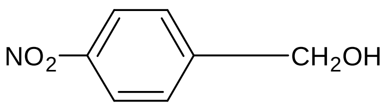
Dolacaine, a local anesthetic, is a compound with molecular formula, $C_{13}H_{20}O_2N_2$. It is insoluble in water and dilute NaOH, but soluble in dil. HCl. Upon treatment with $NaNO_2$ and HCl and then with β -naphthol, a highly coloured solid is formed. When Novocaine is boiled with aqueous $NaOH$, it slowly dissolves. The alkaline solution is shaken with ether and layers are separated.
Acidification of the aqueous layer causes the precipitation of white solid 'A'; continued addition of acid causes 'A' to redissolve. Upon isolation 'A' is found to have melting point of 185 -186° C and the formula $C_7H_7O_2N$:
Evaporation of ether layer leaves a liquid 'B' of formula $C_6H_{15}ON$. with acetic anhydride gives 'C', $C_8H_{17}O_2N$ which is insoluble in water and dilute bases, but soluble in dilute HCl.
'B' is found to be identical to the compound formed by the action of diethylamine on ethylene oxide.

12. When compound 'B' is treated with p – nitrobenzoyl chloride followed by moderate reduction with Ni/H_2; the compound formed is:

(A)


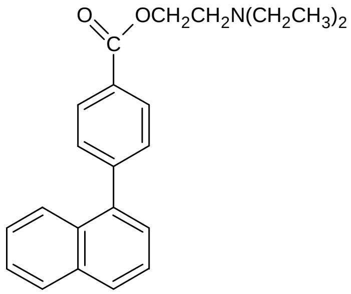
(B)


(C)


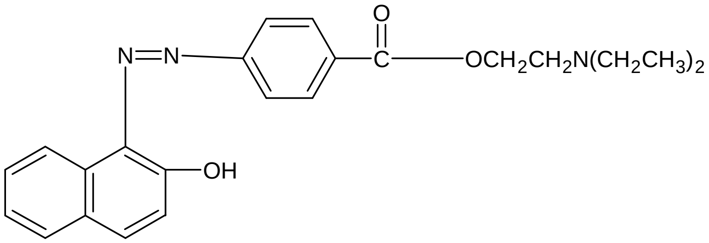
(D)


13. Dolacaine $\xrightarrow{NaNO_2, HCl}$ $\xrightarrow{\beta-naphthol}$ Product

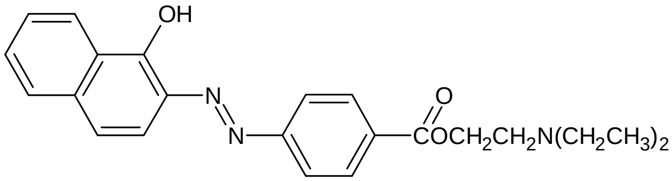
(A)



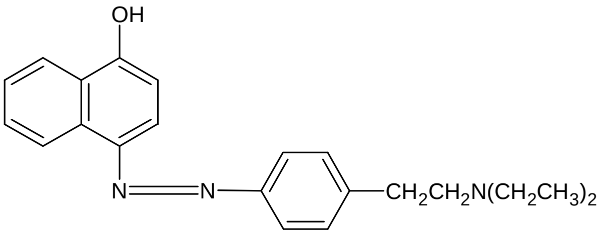
(B)



(C)



(D)



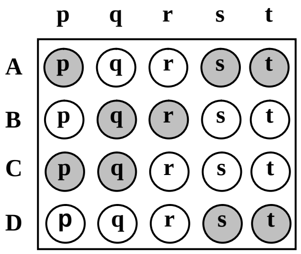
Space for Rough work

14. Compound B is having:
(A) 3° amine
(B) ether group
(C) acid group
(D) nitro group

SECTION – B

(Matrix-Match Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:
If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



1. [Use $\log 1.8 = 0.26$, ka of formic acid $= 1.8\times10^{-4}$ for acetic acid $= 1.8\times10^{-5}$, K_a of NH_3 $= 1.8\times10^{-5}$ Ka_1, of H_2S = 10^{-7} and Ka_2 of $H_2S = 10^{-14}$]
Match the entries of column – II for which the equality or inequality given in the column – I is valid:

	Column – I		Column – II
(A)	$10^{-5} M\ HCl$ solution> $0.1M\ H_2S$ solution	(p)	α_{water} (degree of dissociation of water)
(B)	CH_3COOH solution at pH equal to $4.74 = NH_4OH$ solution at pH equal to 9.26	(q)	$\left[O\bar{H}\right]$
(C)	$0.1M\ \ CH_3COOH$ solution $= 1.0M\ \ HCOOH$ solution	(r)	$\alpha_{electrolyte}$ (degree of dissociation of weak electrolytes)
(D)	$0.1M$ of a weak acid $HA\left[K_c = 10^{-5}\right]$ solution $< 0.01M$ of a weak acid $HA_2\left[K_a = 10^{-8}\right]$ solution	(s)	pH
		(t)	Essentially acidic solution

Space for Rough work

2. Matrix type the following questions:

Column – I (Cell)		Column – II (EMF or Electrode potential)	
(A)	Hydrogen electrode, reduction potential, set up in 1.0 M KCl, pH_2 = 1 atm	(p)	$1.24V$
(B)	$Pt\left(H_2\ at\ 1atm\right)\ \left\vert H^+\left(pH=2\right)\right.$	(q)	$-0.414V$
(C)	$Hg\ \left\vert Hg_2Cl_2\ \right\vert Cl^-\left(0.1M\right)\ \Vert Cl^-\left(0.01M\right)\ \left\vert Pt\left(Cl_2\right)\right.$ $\left(E^{\circ}=1.1\ V\right)$	(r)	$0.118\ V$
(D)	Reduction potential: $AgI\left(aq\right)$ saturated $\vert\ Ag$ $\left(E^{\circ}_{Ag^+/Ag}=0.8\ V, Ksp\ \text{of}\ AgI=10^{-16}\right)$	(s)	$0.327V$
		(t)	Metal-metal insoluble salt electrode

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. Sulphide ion react with $Na_2[Fe(NO)(CN)_5]$ to form a purple coloured compound $Na_4[Fe(CN)_5NOS]$. In this reaction the change in oxidation state of iron is?

2. Gold number of starch is 25. The amount of $0.3125\times a$ gm of starch is required to prevent coagulation of 100 ml of gold sol adding 10 ml of 10% NaCl solution? Value of a is………

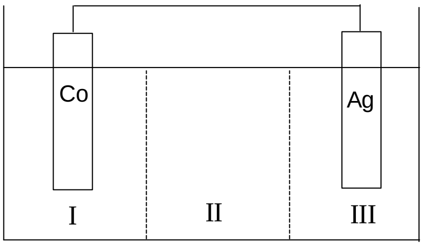
3. Dimethyl gloyoxime is added to aqueous solution of nickel chloride, made alkaline, by adding NH_4OH solution, a brilliant red ppt is obtained. The number of $Ni-N$ bonds in red ppt is…………..?

Space for Rough work

4. A coordination compound has empirical formula PdF_3. What is oxidation number of central atom?

Comprehension – (Question No. 5)

The cell given below consists of three compartments separated by porous barriers. The first contains a cobalt electrode in 5 L of 0.1 M $Co(NO_3)_2$; the second contains 5 L of 0.1 M KNO_3; the third contains a silver electrode in 5 L of 0.1 M $AgNO_3$. Assume that the current within in the cell is carried equally by the positive and negative ions(does not depend on the size) if there is a passage of 0.1 mole of electrons.



$E^\circ_{Co^{2+}/Co} = -0.28\ V$

$E^\circ_{Ag^+/Ag} = 0.8\ V$

5. The concentrations of Co^{2+} in the second compartment is $\frac{x}{1000}$ M, then the x will be:

Space for Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains 6 multiple choice questions numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. $\lim\limits_{x\to 0}\dfrac{\sin^{-1}x-\tan^{-1}x}{x^3}$ is equal to

(A) $\frac{1}{6}$ (B) $\frac{1}{2}$

(C) 2 (D) $-\frac{1}{2}$

2. Area of the region bounded by the curve $y=\frac{1}{x}+1,$ the tangent at $P(2,\frac{3}{2})$ and the line $x=1$ is

(A) $\frac{4}{5}+\ell n2$ (B) $-\frac{5}{4}+\ell n3$

(C) $-\frac{5}{8}+\ell n2$ (D) $\ell n2-\frac{5}{8}$

3. Solution of the differential equation $\frac{dy}{dx}=\frac{3x^2y^4+2xy}{x^2-2x^3y^3}$ is

(A) $x^2y^3+\frac{x}{y^2}=c$ (B) $x^3y^2+\frac{x^2}{y}=c$

(C) $\frac{x^2}{y^3}+xy^2=c$ (D) $x^3y^2-\frac{x^2}{y}=c$

Space for Rough work

4. Angle between $\bar{a}$ & $\bar{b}$ is $\frac{\pi}{4}$; $|\bar{a}| = 2\sqrt{2}$, $|\bar{b}| = 3$. Length of longer diagonal of the parallelogram having adjacent sides represented by $5\bar{a} + 2\bar{b}$ and $\bar{a} - 3\bar{b}$ is

(A) $\sqrt{593}$ (B) $\sqrt{26}$
(C) 15 (D) none of these

5. A number is selected at random from the set of natural numbers. The probability that the sum of the digits of its square is 39 is

(A) $\frac{1}{6}$ (B) 0
(C) $\frac{1}{10}$ (D) $\frac{1}{9}$

6. $A + B = \frac{\pi}{3}$; $\cos A + \cos B = 1$; value of $|\cos A - \cos B|$ is

(A) $\frac{1}{3}$ (B) $\sqrt{\frac{2}{3}}$
(C) $\sqrt{\frac{3}{2}}$ (D) $\frac{1}{2}$

Multiple Correct Choice Type

This section contains 3 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

7. If k denotes the remainder on dividing $\sum_{r=1}^{200} r!$ by n then (k, n) can be

(A) (5, 14) (B) (1, 3)
(C) (3, 10) (D) (3, 15)

Space for Rough work

8. The square roots of the matrix $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ are

(A) $\pm\begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}$ (B) $\pm\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$

(C) $\pm\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ (D) $\pm\begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix}$

9. Range of the function $f(x) = \sqrt{\dfrac{1-|x|}{2-|x|}}$ contains

(A) $[0,1)$ (B) $[1,2)$

(C) $(1,2)$ (D) $(2,\infty)$

Comprehension Type

This section contains 2 paragraphs. Based upon one of paragraph 2 multiple choice questions and based on the other paragraphs 3 multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

Paragraph for Question Nos. 10 and 11

a, b, c, d is an A.P. with integer terms and $d = a^2 + b^2 + c^2$.

10. The common difference is

(A) 1 (B) 2

(C) 3 (D) none

11. The value of $a + 2b + 3c + 4d$ is

(A) 0 (B) 10

(C) 100 (D) none of these

Paragraph for Question Nos. 12 and 14

$f(x) = \sin 2\pi x + \{x\} : x \in [0,10]$.

12. Number of points where *f* achieves local maximum is

(A) 10 (B) 11

(C) 20 (D) none of these

Space for Rough work

13. Number of roots of $f(x)=0$ in (0, 10) is

(A) 20 (B) 30
(C) 31 (D) none of these

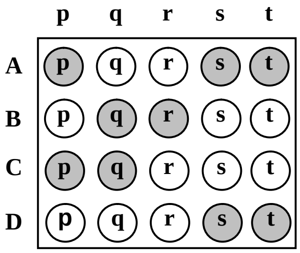
14. Number of points where f achieves local minima is

(A) 10 (B) 11
(C) 15 (D) none of these

SECTION – B

(Matrix-Match Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:
If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



1. Match the following column:

	Column I		Column II
(A)	Length of side of equilateral triangle with vertex at origin and inscribed in the parabola $y^2=12x$ is	(p)	$18\sqrt{3}$
(B)	Length of chord through origin of parabola $y^2=12x$ and having slope 1 unit is	(q)	$24\sqrt{3}$
(C)	Length of normal chord of the parabola $y^2=12x$ subtending a right angle at focus is	(r)	$7\sqrt{5}$
(D)	Length of normal chord of the parabola $y^2=12x$ subtending a right angle at the vertex is	(s)	$12\sqrt{2}$
		(t)	$15\sqrt{5}$

Space for Rough work

2. Consider the family of lines $ax+by+c=0$ where $4a^2+9b^2-c^2+12ab=0$. Let 'p' denote distance of R(6, 8) from the line $ax+by+c=0$

Match the following columns:

	Column I (value of p)		Column II (No. of lines)
(A)	$p=\sqrt{41}$	(p)	1
(B)	$p=2/\sqrt{13}$	(q)	2
(C)	$p=\sqrt{185}$	(r)	3
(D)	$p=\sqrt{80}$	(s)	4
		(t)	5

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

1. Number of points of discontinuity of the function $f(x)=\left[x^2+1\right]; x\in[1,3]$ is

2. A tangent to ellipse $x^2+4y^2=4$ meets the ellipse $x^2+2y^2=6$ at P and Q. Tangents at P and Q are inclined at an angle $\frac{\pi}{k}$. The value of *k* is

3. If $n^2+96 : n\in\mathbb{N}$, is square of an integer then number of possible values of n is

4. If $2\cos\theta+\sin\theta=1$, then maximum value of $7\cos\theta+6\sin\theta$ is

5. In ΔABC, $\angle A=\frac{\pi}{6}$, $\angle B=\frac{\pi}{4}$. If $c^2=ka^2+b^2$ then value of k^2 is

Space for Rough work

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ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST–II
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	D	D	B
2.	B	C	D
3.	C	C	B
4.	B	C	A
5.	B	D	B
6.	A	D	B
7.	A, B, C	C	A, C, D
8.	A, B, C, D	B, C	A, B, C
9.	B, C	A	C, D
10.	A	D	A
11.	C	C	B
12.	B	B	A
13.	B	B	D
14.	C	A	D
1.	(A) $\to$ p, q, r, s, (B) $\to$ p, q, r, s, (C) $\to$ p, q, r, s, (D) $\to$ r	(A) $\to$ p, q, r, s, t, (B) $\to$ p, r, (C) $\to$ r, t, (D) $\to$ p, q, s, t	(A) $\to$ q, (B) $\to$ s, (C) $\to$ t, (D) $\to$ p
2.	(A) $\to$ q, r, (B) $\to$ p, r, (C) $\to$ p, r, (D) $\to$ s	(A) $\to$ q, (B) $\to$ r, (C) $\to$ p, t, (D) $\to$ s, t	(A) $\to$ r, (B) $\to$ s, (C) $\to$ p, (D) $\to$ q
1.	7	0	9
2.	0	8	2
3.	4	4	4
4.	1	4	6
5.	1	5	3

Chemistry

PART – II

SECTION – A

1. D
It is a chain silicate.

2. C
Total $\left[H^{+}\right]=C_{H^{+} due\ to\ HCl}+\left[OH^{-}\right]$.

3. C
(A) Both carbonates give oxides and CO_2 gas.
(B) Both bicarbonates give carbonates, CO_2 and H_2O
(C) $MgCl_2.6H_2O \xrightarrow{\Delta} MgCl_2.H_2O + 5H_2O$

$$\longrightarrow Mg(OH)Cl + HCl$$

$$Na_2SO_4.10\,H_2O \xrightarrow{\Delta} Na_2SO_4 + 10\,H_2O$$

(D) Both the sulphates give oxides and SO_3

4. C

$$\begin{array}{ll} A \rightarrow & 3B \\ a & 0 \\ a-x & 3x \end{array}$$

$V_0 \alpha (a)$ and $V_t \alpha (a+5x)$

$\therefore$ equation is $K=\dfrac{2.303}{t}\log\dfrac{5V_0}{6V_0-V_t}$

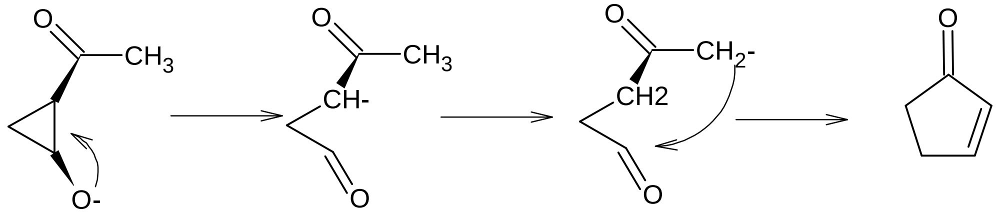
Substituting $V_t = 2V_0$ at $t = 971\sec$

$$K=\frac{2.303}{971}\times\log\frac{5}{4}=\frac{2.303}{971}\times.0971=2.303\times10^{-4}$$

$$\therefore t_{1/2}=\frac{.693}{2.303\times10^{-4}}=3010\sec$$

5. D
Ortho can be easily reduced than para isomer, more rings can also be reduced easily

6. D



7. C

$$NH_3\uparrow \rightleftharpoons \frac{1}{2}N_2\uparrow + \frac{3}{2}H_2\uparrow$$

$$\begin{array}{lll} n & 0 & 0 \\ n(1-\alpha) & \dfrac{n\alpha}{2} & \dfrac{3n\alpha}{2} \end{array}$$

Partial pressure at equation $\left(\frac{1-\alpha}{1+\alpha}\right)P; \frac{\alpha}{2(1+\alpha)}P; \frac{3}{2}\left(\frac{\alpha}{1+\alpha}\right)P$

$$K_p = \frac{\left(P_{N_2}\right)^{1/2}\left(P_{H_2}\right)^{3/2}}{P_{NH_3}} = \frac{3\sqrt{3}P}{4}\left[\frac{\alpha^2}{1-\alpha^2}\right]$$

$$\therefore \alpha = \left[1+\frac{3\sqrt{3}}{4}\frac{P}{K_p}\right]^{-1/2}$$

8. B, C

Polar forms are more stable in polar solvents.

9. A

Volume of H_2SO_4 used at equivalence point is 15mL.

$15 \times 0.2 \times 2 = 20 \times conc.$

Conc. = 0.3

SECTION – B

2. (A) → q, (B) → r, (C) → p, t, (D) → s, t

(p) $2H^+ + 2e^- \rightarrow H_2$

$$E = -\frac{0.0591}{2}\log\frac{1}{\left[10^{-7}\right]^2} = -0.414\ V$$

(q) $H_2 \longrightarrow 2H^+ + 2e^-$

[It will be oxidation potential]

(r) $2Hg + Cl_2 \longrightarrow Hg_2^{2+} + 2Cl^-$

(s) $Ag^+ + e^- \longrightarrow Ag$

$$\left(Ag^+\right) = \sqrt{10^{-16}} = 10^{-8}M$$

SECTION – C

4. The coordination compound is $Pd\left[PdF_6\right]$. The coordination number of $Pd\left(IV\right)$ is six:

Mathematics PART – III

SECTION – A

1. **Use expansion of** $\sin^{-1} x \,\&\, \tan^{-1} x$ to get the result

2. Plot the curve $y-1=\frac{1}{x}$ and translate the axis to get required area.

3. $$2x^3y\,dy+3x^2y^2dx=\frac{2yxdx-x^2dy}{y^2}$$

$$\int d\left(x^3y^2\right)=\int d\left(\frac{x^2}{\hat{j}}\right)$$

4. $$\frac{1-|x|}{2-|x|}\ge 0 \;\Rightarrow \frac{|x|-1}{|x|-2}\ge 0$$

$$\Rightarrow use\ wavy\ curve\ of\ \frac{(x-1)(x+1)}{(x-2)(x+2)}\ge 0$$

(10- 11)

$$\begin{aligned} Use\ a&=k-3e\\ b&=k-e\\ c&=k+e \qquad in\ \ d=a^2+b^2+c^2\\ d&=k+3e \end{aligned}$$

(12 – 14)

Plot the graphs using periodicity

SECTION – B

Matrix Match – 2

Use $(2a)^2+(3b)^2+12ab-c^2=0$

$\Rightarrow (2a+3b-c)(2a+3b+c)=0$

SECTION – C

[Integer Type]

2. Use director circle concept.

3. Use $-\sqrt{a^2+b^2}\le a\sin\theta+b\cos\theta\le\sqrt{a^2+b^2}$

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JEE (Advanced)-2016

FULL TEST – II

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 243**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 06)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (07 – 09) contains 3 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

   Section-A (10 – 14) contains 2 paragraphs. Based upon paragraph, 2 and 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.
2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct matching. No marks will be given for any wrong matching in any question. There is no negative marking.
3. **Section-C (01 – 05)** contains 5 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Straight Objective Type

This section contains 6 multiple choice questions numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

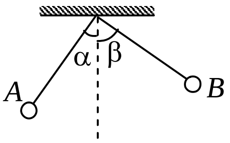
1. A particle is kept at rest at the top of a sphere of diameter 42 m. When disturbed slightly, it slides down. At what height *h* from the bottom, the particle will leave the sphere

(A) 14 m	(B) 16 m
(C) 35 m	(D) 70 m

2. A spherical object of mass 1 kg and radius 1 m is falling vertically downward inside a viscous liquid in a gravity free space. At a certain instant the velocity of the sphere is 2 m/s. If the coefficient of viscosity of the liquid is $\frac{1}{18\pi}$ N-s/m^2, then velocity of ball will become 0.5 m/s after a time

(A) ln 4 s	(B) 2 ln 4 s
(C) 3 ln 4 s	(D) 2 ln 2 s

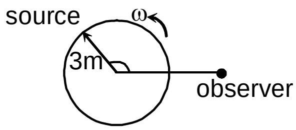
3. Two identical simple pendulums *A* and *B* are fixed at same point. They are displaced by an angle α and β (α and β are very small and $\beta > \alpha$) and released from rest. Find the time after which *B* reaches its initial position for the first time. Collisions are elastic and length of the strings is *l*.



(A) $\pi\sqrt{\frac{l}{g}}$	(B) $2\pi\sqrt{\frac{l}{g}}$
(C) $\frac{\pi\beta}{\alpha}\sqrt{\frac{l}{g}}$	(D) $\frac{2\pi\beta}{\alpha}\sqrt{\frac{l}{g}}$

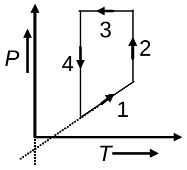
Space for Rough work

4. A source is moving on a circle of radius 3 m with constant angular velocity ω = 5 rad/s. If the observer is at a distance 5 m from the centre of circle, the time interval between maximum and minimum frequency received by the observer is



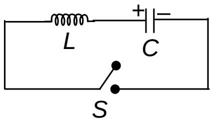
(A) $\frac{\pi}{5}$
(B) $\frac{2}{5}\cos^{-1}\left(\frac{3}{4}\right)$
(C) $\frac{2}{5}\cos^{-1}\left(\frac{3}{5}\right)$
(D) $\frac{2}{5}\sin^{-1}\left(\frac{3}{5}\right)$

5. In the cyclic process 1-2-3-4 shown in figure for a monoatomic gas, the volume of the gas in process 1.



(A) increases
(B) decreases
(C) constant
(D) first increases then decreases

6. A capacitor is charged to a potential of V_0. It is connected with an inductor through a switch *S*. The switch is closed at time *t* = 0. Which of the following statement is correct.

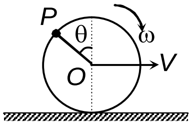


(A) maximum current in the circuit is $V_0\sqrt{LC}$
(B) potential across capacitor becomes zero for the first time at $t = \pi\sqrt{LC}$
(C) energy stored in the inductor at time $\frac{\pi}{2}\sqrt{LC}$ is $\frac{1}{4}CV_0^2$
(D) maximum energy stored in the inductor is $\frac{1}{2}CV_0^2$.

Space for Rough work

Multiple Correct Choice Type

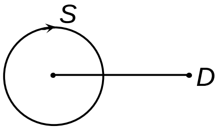
This section contains 3 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct



7. A disc of radius *R* rolls on a horizontal surface with linear velocity *V* and angular velocity ω. There is a point *P* on circumference of disc at angle θ with upward vertical diameter measured anticlockwise (see figure), which has a vertical velocity. Here θ is equal to

(A) $\pi + \sin^{-1}\frac{V}{R\omega}$ (B) $\frac{\pi}{2} - \sin^{-1}\frac{V}{R\omega}$

(C) $\pi - \cos^{-1}\frac{V}{R\omega}$ (D) $\pi + \cos^{-1}\frac{V}{R\omega}$



8. A source of sound moves along a circle of radius 2 m with constant angular velocity 40 rad/s. Frequency of the source is 300 Hz. A detector is kept at some distance from the circle in the same plane of the circle (as shown in figure). Which of the following is not the possible value of frequency registered by the detector? (Speed of sound = 320 m/s)

(A) 250 Hz (B) 360 Hz

(C) 410 Hz (D) 220 Hz

9. An electron in H-atom jumps from second excited state to first excited state and then from first excited to ground state. Let the ratio of wavelength, momentum and energy of photons emitted in these two cases be *a, b* and *c* respectively. Then

(A) $c = \frac{1}{a}$ (B) $a = \frac{9}{4}$

(C) $b = \frac{5}{27}$ (D) $c = \frac{5}{27}$

Space for Rough work

Comprehension Type

This section contains 2 paragraphs. Based upon one of paragraph 2 multiple choice questions and based on the other paragraphs 3 multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

Paragraph for Question Nos. 10 and 11

Four satellites *A*, *B*, *C* and *D* are orbiting around a spherical planet of uniform density. The orbits of all the satellites are coplanar. Orbits of satellites *A* and *B* are circular where radius of orbit *A* is greater than diameter of orbit *B*. Orbit *C* is touching orbits *A* and *B*. While orbit *D* is touching orbit *A* but its nearest distance from the planet is least among all four orbits. All the satellites have same mass and these satellite can be considered as particles. There is no gravitational force between the satellite and also there is no chance of collision between the satellites. Consider gravitational potential energy to be zero under infinite separation.

10. In which orbit can the gravitational potential energy have least possible value?

(A) A	(B) B
(C) C	(D) D

11. In which orbit does the angular momentum have largest magnitude?

(A) A	(B) B
(C) C	(D) D

Space for Rough work

Paragraph for Question Nos. 12 and 14

A thin non-conducting ring of mass *m*, radius *a* carrying a charge *q* can rotate freely about its own axis which is vertical. At the initial moment the ring was at rest in horizontal position and no magnetic field was present. At instant $t = 0$ A uniform magnetic field is switched on which is vertically downward and increases with time according to the law $B = B_0t$. Neglecting magnetism induced due to rotational motion of ring.

12. The magnitude of induced emf will be

(A) $\pi a^2 B_0$
(B) $2a^2 B_0$
(C) zero
(D) $\frac{1}{2}\pi a^2 B_0$

13. The magnitude of an electric field on the surface of the ring is

(A) aB_0
(B) $2aB_0$
(C) $\frac{1}{2}aB_0$
(D) zero

14. Find instantaneous power developed by electric force acting on the ring at $t = 1$ sec.

(A) $\frac{2q^2B_0^2a^2}{14m}$
(B) $\frac{q^2B_0^2a^2}{8m}$
(C) $\frac{3q^2B_0^2a^2}{m}$
(D) $\frac{q^2B_0^2a^2}{4m}$

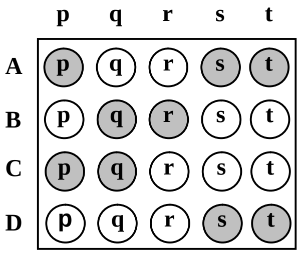
Space for Rough work

SECTION – B

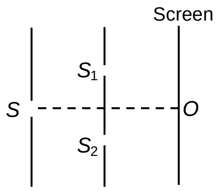
(Matrix-Match Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



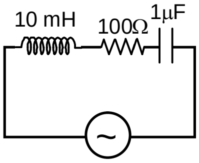
1. Figure shows a set-up to perform Young's double slit experiment. A monochromatic source of light is placed at S. S_1 and S_2 act as coherent sources and interference pattern is obtained on the screen. Match Column-I with Column-II in regard to interference in Young's double slit experiment:



	Column I		Column II
(A)	A thin transparent plate is placed in front of S_1. Assuming negligible absorption by the plate	(p)	Interference fringes disappear
(B)	S_1 is closed	(q)	There is uniform illumination on a large part of the screen
(C)	A thin transparent plate is placed in front of S_2.	(r)	The zero order fringe will not form at O
(D)	S is removed and two real sources emitting light of same wavelength are placed at S_1 and S_2.	(s)	Central maxima is formed below O
		(t)	

Space for Rough work

2. Referring to the given circuit, match Column-I with Column-II.



V = 10 sin ωt (Volt)

	Column I		Column II
(A)	For ω = 8000 rad/s	(p)	Peak current in the circuit is less than 0.1 A
(B)	For ω = 10000 rad/s	(q)	Voltage across the combination and the current are in same phase
(C)	For ω = 10500 rad/s	(r)	Voltage across the combination leads the current
(D)	For ω = 10000 rad/s, if R = 50 Ω instead of 100 Ω	(s)	Current through the circuit leads the voltage across it.
		(t)	

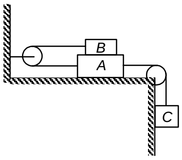
SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. The lengths of sides of a cuboid are a, $2a$ and $3a$. If the relative percentage error in the measurement of a is 1%, then find the relative percentage error in the measurement of volume of cube (in percentage)….

2. For the arrangement shown in figure, the masses of the blocks are $m_A = 2$ kg, $m_B = 1$ kg, $m_C = 1$ kg. Find the frictional force between the blocks A and B (in Newton) (coefficient of friction between any two surfaces is 0.5)



3. Suppose potential energy between particle A and B at separation r is given by $U = k \ln r$, where k is constant. For such hypothetical system, find the ratio of energy difference between energy levels (n = 1 and n = 2) and (n = 2 and n = 4) (The energy of a particle in n^{th} level is $-13.6/n^2$)

4. A uniform disc of radius R having charge Q distributed uniformly all over its surface is placed on a smooth horizontal surface. A magnetic field, $B = kxt^2$, where k is a constant, x is the distance (in metre) from the centre of the disc and t is the time (in second), is switched on perpendicular to the plane of the disc. Find the torque (in N-m) acting on the disc after 15 sec. (Take $4kQ$ = 1 S.I. unit and R = 1m) is

5. The hydrogen atom in its ground state are excited by means of monochromatic radiation of wavelength 1023 Å. Find the number of lines which can be seen in the resulting spectrum…

Space for Rough work

Chemistry

PART – II

SECTION – A

Straight Objective Type

This section contains 6 multiple choice questions numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. Which of these reaction is correct:
(A) $Br^{-} + Cl_2 \longrightarrow Cl^{-} + Br_2$
(B) $Mohr's\,salt \xrightarrow{Zn/NaOH} N_2\left(g\right)$
(C) $K_2Cr_2O_7\,solution \xrightarrow{SO_3}$ Green colour
(D) $FeCl_2 \xrightarrow{NaOH} \left(ppt.\right) \xrightarrow{Excess\ NaOH}$ Soluble complex

2. Potash alum contains the metals like potassium and aluminium. What are the metal ions present in chrome alum?
(A) Chromium and aluminium only
(B) Iron and aluminium
(C) Potassium and chromium only
(D) Potassium, chromium and aluminium

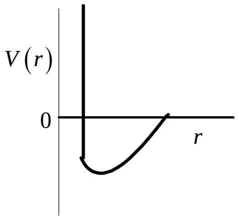
3. For a gaseous reaction, the rate of reaction is expressed in terms of $\frac{dP}{dt}$ instead of $\frac{dC}{dt}$ or $\frac{dn}{dt}$, where C is concentration and n is the number of moles. Hence, the relation between expression is:
(A) $\frac{dC}{dt} = \frac{dn}{dt} = \frac{V}{RT}\frac{dP}{dt}$
(B) $\frac{dC}{dt} = \frac{1}{V}\frac{dn}{dt} = \frac{1}{RT}\frac{dP}{dt}$
(C) $\frac{dP}{dt} = \frac{dn}{dt} = \frac{dC}{dt}$
(D) None of these

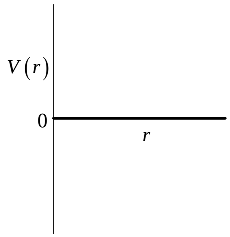
Space for Rough work

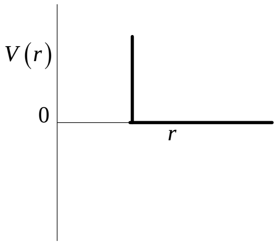
4. An excited electron of H-atoms emits of photon of wavelength λ and returns in the ground state, the principal quantum number of excited state is given by:

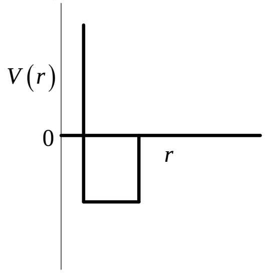
(A) $\sqrt{\lambda R(\lambda R-1)}$
(B) $\sqrt{\frac{\lambda R}{(\lambda R-1)}}$
(C) $\sqrt{\frac{1}{\lambda R(\lambda R-1)}}$
(D) $\sqrt{\frac{(\lambda R-1)}{\lambda R}}$

5. One mole of a monatomic real gas satisfies the equation $p(V-b)=RT$ where b is a constant. The relationship of interatomic potential $V(r)$ and interatomic distance r for the gas is given by

(A)


(B)


(C)


(D)


6. Which of the following will not undergo aldol condensation?

(A) trimethyl acetaldehyde
(B) formaldehyde
(C) benzaldehyde
(D) benzophenone

Space for Rough work

Multiple Correct Choice Type

This section contains 3 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

7. Identify the correct relationship:

(A) $\left[Cu\left(NH_3\right)_4\right]^{2+}$ with Hybridization of $Cu = dsp^2$

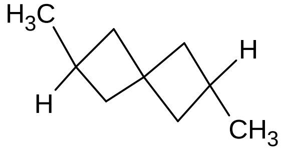
(B) $Fe\left(CO\right)_x$ with $x = 5$

(C) Ni^{2+} Complexes with dsp^2 hybridization and dimagnetic nature

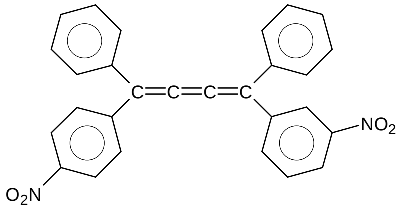
(D) Cr^{3+} Complexes with Paramagnetic nature

8. Identify the chiral molecule/molecules:

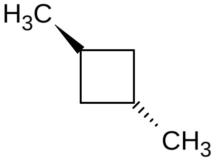
(A)



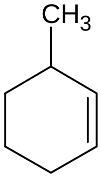
(B)



(C)



(D)



9. The correct statement/statements is/are:

(A) the distance between two octahedral voids of a cubic close packing of atoms with radius r is 2r

(B) the distance between two tetrahedral voids of a cubic close packing of atoms with radius r is $\sqrt{6} \times r$ at the body diagonal axes

(C) the distance between tetrahedral and octahedral void is $\sqrt{\frac{3}{2}} \times r$, where is the radius of atom forming the close packing

(D) the distance between the surface of atoms fcc arrangement along an edge is $2\left(\sqrt{2} - 1\right)r$

Space for Rough work

Comprehension Type

This section contains 2 paragraphs. Based upon one of paragraph 2 multiple choice questions and based on the other paragraphs 3 multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

Paragraph for Question Nos. 10 and 11

The cloud consist of charged particles of water dispersed in air. Some of them are +vely charged and other are -vely charged. When +vely charged clouds come closer they have lightening and thundering whereas - ve and +ve charged colloids come closer they cause heavy rain due to the aggregation of minute particles. It is possible to cause artificial rain by throwing electrified sand or AgI from aeroplane and thus coagulation the mist hanging in air.

10. When excess of $\mathrm{AgNO_3}$ is treated with KI solution, AgI forms.

(A) + vely charged solution
(B) - vely charged solution
(C) Neutral solution
(D) True solution

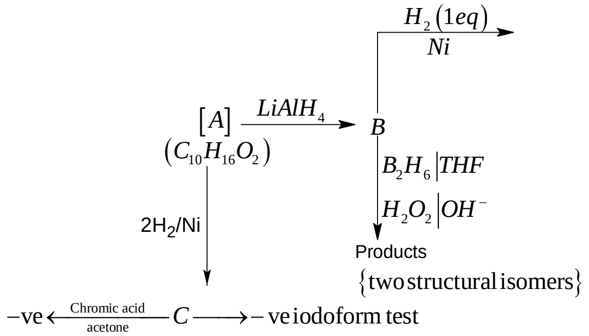
11. Electrical chimney are made on the principal of

(A) Electro-osmosis
(B) Electrophoresis
(C) Coagulation
(D) All of these

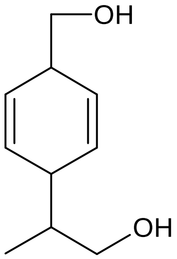
Space for Rough work

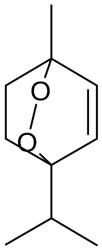
Paragraph for Question Nos. 12 and 14

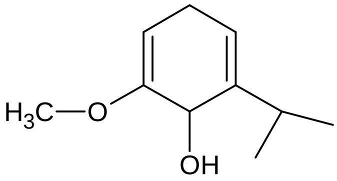
Compound (A), which can be distilled in high vacuum, gives positive test with Br_2 / H_2O, but does not react with Na metal in ethereal solution, but compound (B) and (C) gives $H_2(g)$ with sodium metal. Compound (A) undergoes following sequence of reactions-

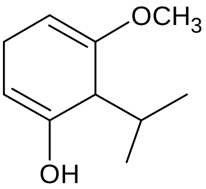

$H_2(1eq)$
Ni
$[A]$
$(C_{10}H_{16}O_2)$
$LiAlH_4$
B
$B_2H_6|THF$
$H_2O_2|OH^-$
Products
{two structural isomers}
2H$_2$/Ni
$-$ve
Chromic acid
acetone
C
$-$ ve iodoform test

12. Compound 'A' should be:

(A)


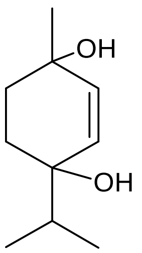
(B)


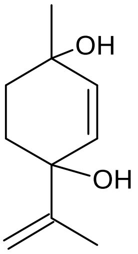
(C)


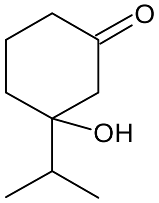
(D)


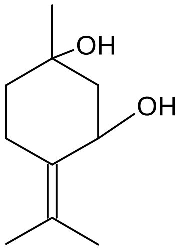
Space for Rough work

13. Compound $'B'$

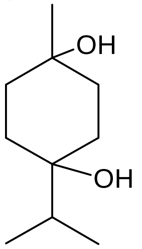
(A)


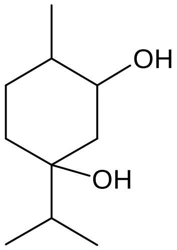
(B)


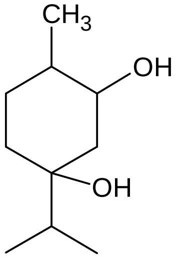
(C)


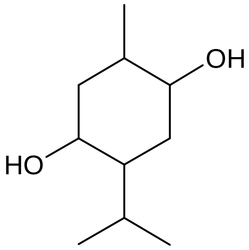
(D)


14. Compound $'C'$

(A)


(B)


(C)


(D)


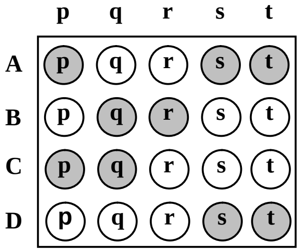
Space for Rough work

SECTION – B

(Matrix-Match Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



1. Match the following metal given in column-I with the appropriate metal exaction process listed with column- II

Column I		Column II	
(A)	*Fe*	(p)	Cyanide Process
(B)	*Ag*	(q)	Leaching
(C)	*Pb*	(r)	Carbon reduction
(D)	*Cu*	(s)	Self reduction
		(t)	Electrolysis

2.

Column I		Column II	
(A)	$\left[\mathrm{Fe}(\mathrm{NH_3})_6\right]^{3+}$ $\left[\mathrm{Fe}\left(\mathrm{H_2O}\right)_6\right]^{3+}$ $\left[\mathrm{Fe}\left(\mathrm{H_2O}\right)_6\right]^{2+}$ (I) (II) (III)	(p)	$I > II > III$ (decreasing order of stability for complexes
(B)	$[\mathrm{Ni\,Cl_4}]^{2-}$ $\left[\mathrm{PdCl_4}\right]^{2-}$ $\left[\mathrm{PtCl_4}\right]^{2-}$ (I) (II) (III)	(q)	At least one complex shows stereoisomerism
(C)	$\left[\mathrm{V}\left(\mathrm{CO}\right)_6\right]^{-}, \left[\mathrm{V}\left(\mathrm{NH_3}\right)_6\right]^{3+}, \left[\mathrm{V}\left(\mathrm{NH_3}\right)_4\mathrm{Cl_2}\right]^{+}$ (I) (II) (III)	(r)	All complexes has $\mathrm{EAN} \geq 36$
(D)	$\left[\mathrm{Ni}\left(\mathrm{EDTA}\right)\right]^{2-}, \left[\mathrm{Ni}\left(\mathrm{dien}\right)_2\right]^{2+}, \left[\mathrm{Ni}\left(\mathrm{en}\right)_3\right]^{2+}$ (I) (II) (III)	(s)	At least two complexes are d^2sp^3 or dsp^2 hybridised
		(t)	At least one complex is paramagnetic in nature

Space for Rough work

SECTION – C

(One Integer Value Correct Type)

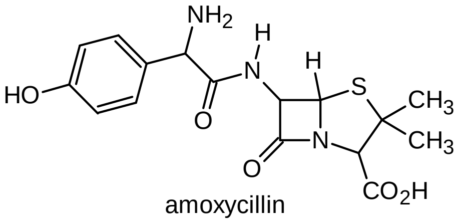
This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. A saturated solution of spraingly soluble salt $\mathrm{MCl_2}$ has a vapour pressure of 31.78 mm of Hg at $30°C$ while pure water exerts a pressure of 31.82 mm of Hg at the same temperature. The solubility product is $x \times 10^{-x}$. The value of x is

2. The number of unpaired e^- in first excited state of O_2 is

3. The number of geometrical isomers of the octahedral complex of the type [Mabcdef] is $n \times 3.$. The value of n is

4. How many double bond equivalents does amoxicillin (shown below) possesses?



amoxycillin

5.

$$\begin{tikzcd}
(i)\ FeSO_4 + KCN(excess) \arrow[r] & (X) \arrow[d, "conc. H_2SO_4"] \arrow[r, dash] & {} \arrow[d, "dil\, H_2SO_4"] \\
 & (A)\, gas & (B)\, gas
\end{tikzcd}$$

$(ii)\, CaC_2 + N_2 \xrightarrow{1100°C} (Y) + carbon$

Find the sum of the number of π bonds present in (A), (B) and (Y):

Space for Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains 6 multiple choice questions numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. $A(-2, 0), B(0, 4)$. The point M on line y = x for which perimeter of ΔAMB is least is

(A) (0, 0)
(B) $(-1, -1)$
(C) $\left(\frac{1}{2}, \frac{1}{2}\right)$
(D) none of these

2. Equation of common tangent to $y^2 = 8x$ and $xy = 1$ may be

(A) $3y = 9x + 2$
(B) $y = 2x + 1$
(C) $2y = x + 8$
(D) none of these

3. Let $S = \sum_{r=1}^{117} \frac{1}{2[\sqrt{r}] + 1}$ where [.] denotes the greatest integer function. The value of S is

(A) $\frac{69}{7}$
(B) $\frac{206}{21}$
(C) $\frac{76}{7}$
(D) $\frac{227}{21}$

4. Minimum value of function $f(x) = x^3(x^3 + 1)(x^3 + 2)(x^3 + 3) : x \in R,$ is

(A)–2
(B) –1
(C) 1
(D) none

Space for Rough work

5. The hands of a clock has lengths 3 & 4 units. The distance between their tips when the distance is increasing most rapidly is

(A) 2
(B) $\sqrt{7}$
(C) $\sqrt{3}$
(D) 5

6. $\overline{OA} = 2i + j + 2k$ is rotated about O (origin) by 90° such that it crosses the positive y axis during the rotation. If A goes to B then $\overline{OB}$ =

(A) $\frac{1}{\sqrt{2}}i - 2\sqrt{2}j + \frac{1}{\sqrt{2}}k$
(B) $-\frac{1}{\sqrt{2}}i + 2\sqrt{2}j - \frac{1}{\sqrt{2}}k$
(C) $2\sqrt{2}i - \frac{1}{\sqrt{2}}j - \frac{1}{\sqrt{2}}k$
(D) $-2\sqrt{2}i + \frac{1}{\sqrt{2}}j + \frac{1}{\sqrt{2}}k$

Multiple Correct Choice Type

This section contains 3 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

7. In $\Delta ABC,$ if $A = 45°, B = 75°$ then

(A) $a + \sqrt{2}c = 2b$
(B) $\sqrt{3}a = \sqrt{2}c$
(C) $a = \left(\sqrt{3} - 1\right)b$
(D) $3a = 5b$

8. Equation of plane through $A(1, 0, 0), B(0, 1, 0)$ and making an angle $\frac{\pi}{4}$ with the plane $x + y = 3$ can be

(A) $x - y + 2z = 1$
(B) $x + y + \sqrt{2}z = 1$
(C) $x + y - \sqrt{2}z = 1$
(D) $x - y - 2z = 1$

Space for Rough work

9. If the area bounded by the curve $y = x - x^2$ and the line y = mx equals $\frac{9}{2}$. Then the value of q m is

(A) – 4 (B) –2

(C) 2 (D) 4

Comprehension Type

This section contains 2 paragraphs. Based upon one of paragraph 2 multiple choice questions and based on the other paragraphs 3 multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

Paragraph for Question Nos. 10 and 11

A box has 10 coins. Five have heads on both sides. Three have tails on both sides; two are fair. A coin is chosen at random and tossed.

10. Probability that head appears is

(A) $\frac{4}{5}$ (B) $\frac{2}{5}$

(C) $\frac{3}{5}$ (D) $\frac{1}{5}$

11. Probability that the coin is fair given that head has appeared is

(A) $\frac{5}{6}$ (B) $\frac{1}{6}$

(C) $\frac{3}{8}$ (D) $\frac{5}{8}$

Space for Rough work

Paragraph for Question Nos. 12 and 14

ABC is a triangle. Complex numbers z_1, z_2, z_3 are represented by A, B, C respectively. Which are in anticlock wise order. Let $|z_1| = |z_2| = |z_3|$ and arg $\frac{z_3 - z_1}{z_2 - z_1} = \frac{\pi}{6}$

12. $|z_2 - z_3| =$

(A) $\frac{1}{2}|z_1 - z_3| \cos ec\left(\frac{1}{2}\arg\frac{z_1 - z_2}{z_3 - z_2}\right)$ (B) $\frac{1}{2}|z_1 - z_3| \operatorname{cosec}\left(\arg\frac{z_1 - z_2}{z_3 - z_2}\right)$

(C) $\frac{1}{2}|z_1 - z_3| \sin\left(\frac{1}{2}\arg\frac{z_1 - z_2}{z_3 - z_2}\right)$ (D) $\frac{1}{2}|z_1 - z_3| \sin\left(\arg\frac{z_1 - z_2}{z_3 - z_2}\right)$

13. Orthocentre H of ΔABC denotes the complex no.

(A) $i(z_1 + z_2 + z_3)$ (B) $\frac{z_1 + iz_2 + z_3}{2}$

(C) $z_1 + z_2 + z_3$ (D) $\frac{iz_1 + z_2 + z_3}{3}$

14. If $T(z)$ is any point such that HBTC is a parallelogram then $|z - z_1| =$

(A) $2|z_1 - z_3|$ (B) $2|z_2 - z_3|$

(C) $2|z_1 - z_2|$ (D) none

Space for Rough work

SECTION – B

(Matrix-Match Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

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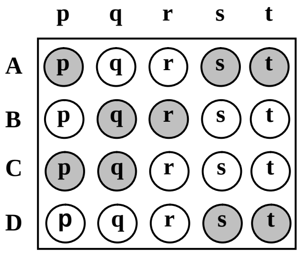


1.

	Column I		Column II
(A)	The coordinates of the point on the parabola $y = x^2 + 7x + 2$, which is nearest to the straight line y = 3x − 3 are	(p)	(2,1)
(B)	y = x + 2 is a tangent to the parabola $y^2 = 8x$. The point on this line, the other tangent from which is perpendicular to this tangent is	(q)	(–2, 0)
(C)	The point on the ellipse $x^2 + 2y^2 = 6$ whose distance from the line x + y = 7 is least is	(r)	$\left(2, \frac{2}{\sqrt{3}}\right)$
(D)	The foci of the ellipse $\frac{x^2}{25} + \frac{y^2}{9} = 1$ are S and S'. P is a point on the ellipse whose eccentric angle is $\pi/3$. The incentre of the triangle SPS' is	(s)	(–2,–8)
		(t)	(2, 2)

Space for Rough work

2.

	Column I		Column II
(A)	If sin $\theta = 3\sin(\theta + 2\alpha)$, then the value of $\tan(\theta + \alpha) + 2\tan\alpha$ is	(p)	0
(B)	If p sin θ + q cos θ = a and p cos θ – q sin θ = b then $\frac{p+a}{q+b} + \frac{q-b}{p-a} + 1$ is equal to	(q)	1
(C)	The value of the expression $\cos\frac{\pi}{7}\cos\frac{2\pi}{7}\cos\frac{10\pi}{7} - \sin\frac{\pi}{14}\sin\frac{3\pi}{14}\sin\frac{5\pi}{14}$ is	(r)	sec θ
(D)	If $\sec\theta + \tan\theta = 1$, then one root of the equation $(a-2b+c)x^2 + (b-2c+a)x + (c-2a+b) = 0$ is	(s)	$-\frac{1}{4}$
		(t)	-1/2

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

1. In equilateral triangle ABC of side p, a square is inscribed in its incircle. If area of the square is $\frac{p^2}{k}$ then value of *k* is

2. *f* is a function such that $f(x) + 2f(1-x) = x^2 + 1$. Value of $f(3)$ is

3. Degree of differential equation of family of ellipses of same size having minor axis along a given line is

4. In $\Delta ABC,\ \tan A :\ \tan B : \tan C \equiv 1:2:3.$ If $\sin A : \sin B : \sin C \equiv \sqrt{5} : 2\sqrt{2} : \lambda$, then $\lambda =$

5. Coefficient of x^6 in the expansion of $(1 + x + x^2 + x^3)^{-3}$ is

---

Space for Rough work

FIITJEE **JEE(Advanced)-2016**

ALL INDIA TEST SERIES

FIITJEE Students From Classroom / Integrated School Programs have secured to 2 Zonal, 6 State & 18 City Topper Ranks. 33 in Top 100, 78 in Top 200 and 205 in Top 500 All India Ranks bagged by FIITJEE Students from All Programs have qualified in JEE (Advanced), 2015.

ANSWERS, HINTS & SOLUTIONS

FULL TEST–II
(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	A	A
2.	C	C	D
3.	B	B	A
4.	C	B	B
5.	B	C	D
6.	D	A, B, C, D	B
7.	C, D	A, B, C, D	A, B, C
8.	C, D	A, D	B, C
9.	A, C, D	A, B, C, D	B
10.	D	B	C
11.	A	B	B
12.	A	B	B
13.	C	A	C
14.	D	A	B
1.	(A) → r, (B) → p, q, (C) → r, s, (D) → p, q	(A) → r, (B) → p, q, t, (C) → r, s, t, (D) → r, s, t	(A) → s, (B) → q, (C) → p, (D) → r
2.	(A) → p, s, (B) → q, (C) → p, r, (D) → q	(A) → p, t, (B) → s, t, (C) → p, q, s, t, (D) → p, q, t	(A) → p , (B) → p, (C) → s, (D) → q, r
1.	3	5	6
2.	0	0	0
3.	1	5	1
4.	1	9	3
5.	3	6	9

Chemistry PART – II

SECTION – A

1. $Fe(OH)_3$ is not soluble in excess NaOH.

2. C

$K_2SO_4.Cr_2(SO_4)_3.24H_2O$

3. B

$$C=\frac{P}{RT}=\frac{n}{V}$$

4. B

$$\frac{hC}{\lambda}=-RhC\left[\frac{1}{n^2}-1\right]$$

5. C

Here attraction is zero , so potential energy can't be less than 0.

7. A,B,C,D

Ni^{2+} complex becomes $3d^8$ with all e^- paired.

8. A, D

Chiral molecules do not have plane of symmetry

10. B

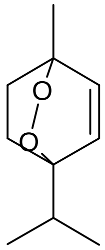
+vely charged colloid and –vely charged solution

11. B

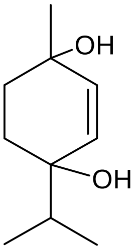
Neutralisation of charge of colloidal particle.

12.

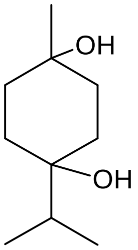
A=



B=



C=



Section –C

1.

$$\frac{31.82\text{-}31.78}{31.82};\frac{3\times\text{mole of solute}}{\text{moles of solvent}}$$

$$\frac{\text{mole of solute}}{\text{moles of solvent}}=\frac{0.00125}{3}$$

$$[MCl_2]=0.0233$$

$$K_{SP}=5\times10^{-5}$$

2. In excited state it is $\pi_{2P_X}{}^2$

3. Total 15 geometrical isomers.

4. 9

5. A=CO, B=HCN, Y=$CaCN_2$

Mathematics PART – III

SECTION – A

1. Use optimization technique

2. $y = mx + \dfrac{2}{m}$ to satisfy in $xy = 1$
   Put D = 0 to get tangents

3. $f(t) = t(t+1)(t+2)(t+3)$ where $t = x^3$
   $f(t) = (t^2+3t)(t^2+3t)+2$
   Use maxima minima concept

6. Use $\overline{OB} = \lambda(\overline{OA}) \times (\overline{OA} \times \hat{j})$

9. Use graph

10. Use binomial triad for probability

(12 – 14)
Use rotation of complex numbers.

Section –C

2. Replace x by (1-x) solve to get the result

3. See minimum number of unknowns

FIITJEE

JEE (Main)-2016

ALL INDIA TEST SERIES

FULL TEST – II

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 30)** contains 30 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
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FIITJEE Students From Classroom / Integrated School Programs have secured to 2 Zonal, 6 State & 18 City Topper Ranks. 33 in Top 100, 78 in Top 200 and 205 in Top 500 All India Ranks bagged by FIITJEE Students from All Programs have qualified in JEE (Advanced), 2015.

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

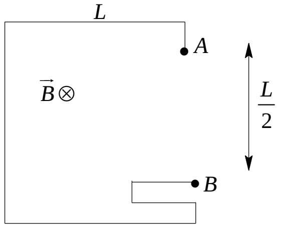
Physics

PART – I

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

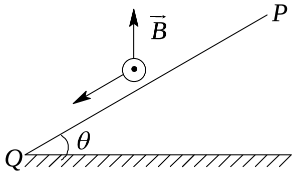


1. A bent wire AB carrying a current I is placed in a region of uniform magnetic field $\vec{B}$. The force on the wire AB is

(A) BIL
(B) $\frac{3}{2}BIL$
(C) Zero
(D) $\frac{BIL}{2}$

2. A conductor AB carries a current i in a magnetic field $\vec{B}$. If $\overrightarrow{AB}=\vec{r}$ and the force on the conductor is $\vec{F}$. Then:

(A) $\vec{F}=\left(\vec{r}\times\vec{B}\right)i$
(B) $\vec{F}=i\left(\vec{B}\times\vec{r}\right)$
(C) $\left|\vec{F}\right|=i\left(\vec{r}\cdot\vec{B}\right)$
(D) $\vec{F}$ is the resultant effect of the electric forces on the electrons in the conductor.

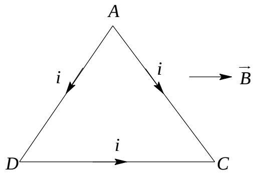


3. A copper rod of length L and mass m is sliding down a smooth inclined plane of inclination θ with a constant speed υ. A current I is flowing in perpendicular to the plane of diagram inwards. A vertically upward magnetic field $\vec{B}$ exists in this region. The magnitude of the required magnetic field $\vec{B}$ is

(A) $\frac{mg}{IL}\sin\theta$
(B) $\frac{mg}{IL}\cos\theta$
(C) $\frac{mg}{IL}\tan\theta$
(D) $\frac{mg}{IL\sin\theta}$

Space for Rough work

4. An equilateral triangular loop ADC of side l carries a current i in the direction shown in figure. The loop is kept in a uniform horizontal magnetic field $\vec{B}$ as shown in figure. Net force on the loop is



(A) Zero
(B) $\frac{2}{3}ilB$, parallel to the plane of the loop
(C) $\frac{\sqrt{2}}{3}ilB$, perpendicular to the plane of loop, inwards
(D) $\sqrt{3}\,ilB$, perpendicular to the plane of loop

5. An iron wire of length l is magnetized have a magnetic moment m. If it is bent into a semicircle of radius r, its magnetic moment is.

(A) m
(B) $\frac{2m}{\pi}$
(C) $\frac{m}{\pi}$
(D) $m\frac{1}{r}$

6. A magnet is suspended horizontally in the earth's magnetic field. When slightly displaced, it oscillates in the horizontal plane with a period T. If a piece of wood having the same moment of inertia as the magnet is attached to the magnet, the new period of oscillation is

(A) $\frac{T}{\sqrt{2}}$
(B) $\frac{T}{2}$
(C) $\sqrt{2}\,T$
(D) $2T$

7. An air core solenoid has 1000 turns and is one metre long. Its cross- sectional area is $10\,cm^2$. its self- inductance is

(A) $2.56\,mH$
(B) $1.92\,mH$
(C) $1.26\,mH$
(D) $2.78\,mH$

Space for Rough work

8. A capacitor of $10\,\mu F$ and an inductor of $1H$ are joined in series. An ac of $50\,Hz$ is applied to this combination. The impedance of the combination is

(A) $5.67\,\Omega$ (B) $4.16\,\Omega$

(C) $7.02\,\Omega$ (D) $3.21\,\Omega$

9. A light ray is incident an angle $45°$ with the normal to a $\sqrt{2}\,cm$ thick transparent plate $(n = 2)$. The lateral shift of the light as it emerges out from the plate is

[Given: Lateral shift, $S_L = \dfrac{t\sin(i-r)}{\cos r}$]

(A) $\dfrac{(\sqrt{7}-1)}{\sqrt{7}}cm$ (B) $(\sqrt{7}-1)cm$

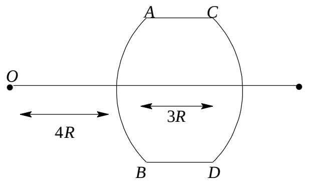
(C) $\dfrac{(\sqrt{7}-1)}{(\sqrt{7}+1)}cm$ (D) $\dfrac{\sqrt{2}-1}{\sqrt{2}}cm$

10. A fish is rising up vertically inside a pond with a velocity $4\,cm\,s^{-1}$, notices a bird, which is diving downwards. The velocity of the bird appears to be $16\,cm\,s^{-1}$ to the fish. The actual velocity of the diving bird is(refractive index of water is $\frac{4}{3}$)

(A) $12\,cm/s$ (B) $9\,cm/s$

(C) $8\,cm/s$ (D) $7.5\,cm/s$

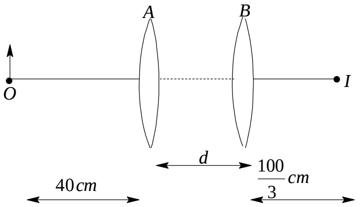
11. Two surfaces AB and CD of a thick lens have radii of curvature R and $2R$ respectively. Thickness at the centre is $3R$. Refractive index of the material of the lens is 1.5. The image of a point object placed on the axis of the lens at a distance $4R$ from the surface of smaller radius of curvature and to its left is formed at



(A) $\frac{4R}{3}$ from CD to its right (B) $\frac{4R}{3}$ from CD to its left

(C) $\frac{8R}{3}$ from CD to its right (D) $\frac{8R}{3}$ from CD to its left

Space for Rough work



12. Two convergent lenses $A\ and\ B$ (erect) of focal lengths $30\,cm\ and\ 50\,cm$ are separated by $d\ cm$ apart co- axially. An erect object of height $2\,cm$ is kept in front of I lens at $40\,cm$ from it. The real image is formed at $\frac{100}{3}cm$ to the right of II lens (see figure). The value of d is
(A) $20\,cm$
(B) $15\,cm$
(C) $10\,cm$
(D) $25\,cm$

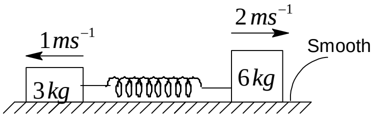
13. Radius of gyration of a body about an axis at a distance $6\,cm$ from its centre of mass is $10\,cm$. its radius of gyration about a parallel axis through its centre of mass is
(A) $6\,cm$
(B) $8\,cm$
(C) $10\,cm$
(D) $12\,cm$

14. Moment of inertia of uniform rod of mass m and length l is $\frac{17}{12}ml^2$ about a line perpendicular to the rod. The distance of this line from the middle point of the rod is
(A) l
(B) $\frac{l}{2\sqrt{3}}$
(C) $\frac{l}{\sqrt{2}}$
(D) $\frac{2}{3}l$

15. Two particles of masses $m\ and\ 2m$ moving in opposite directions collide elastically with velocities $\upsilon\ and\ 2\upsilon$ respectively. The velocity of $2\,m$ after collision is:
(A) υ
(B) 1.5υ
(C) Zero
(D) 1.1υ

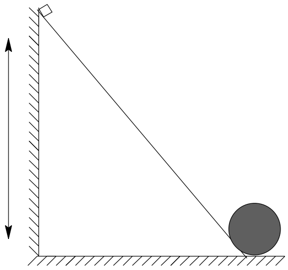
Space for Rough work

16. Two blocks of masses $3\,kg$ and $6\,kg$ are placed on a smooth horizontal surface. They are connected by a light spring of force constant, $k = 200\,Nm^{-1}$. Initially the spring is unstretched. The indicated velocities are imparted to the blocks. The maximum extension of the spring is



(A) $10\,cm$ (B) $15\,cm$
(C) $20\,cm$ (D) $30\,cm$

17. A block is released from rest at the top of an inclined plane which later curves into a circular track of radius r as shown in figure. Find the minimum height h form where it should be released so that it is able to complete the circle.



(A) $2.5\,r$ (B) $3\,r$
(C) $2\,r$ (D) $3.5\,r$

18. A body of mass m, having momentum p, is moving on a rough horizontal surface. If it is stopped in a distance x, the coefficient of friction between the body and the surface is given by:

(A) $\mu = \frac{p^2}{2\,gm^2x}$ (B) $\mu = \frac{p^2}{2\,gmx}$
(C) $\mu = \frac{p}{2\,gmx}$ (D) $\mu = \frac{p}{2\,gm^2x}$

19. Two equal masses are attached to the two ends of a spring of spring constant k. The masses are pulled apart symmetrically to stretch the spring by a length x over its natural length. The work done by the spring on each mass is:

(A) $\frac{1}{2}kx^2$ (B) $-\frac{1}{2}kx^2$
(C) $\frac{1}{4}kx^2$ (D) $-\frac{1}{4}kx^2$

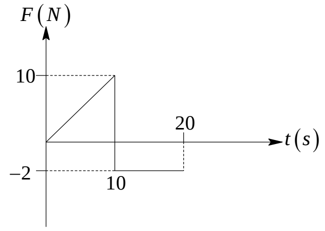
Space for Rough work

20. A net force of $200\,N$ gives a body of mass m_1 an acceleration of $80\,ms^{-2}$ and a body of mass m_2, an acceleration of $240\,ms^{-2}$. The acceleration that this force caused when the masses combine together is

(A) $50\,ms^{-2}$ (B) $60\,ms^{-2}$

(C) $120\,ms^{-2}$ (D) $100\,ms^{-2}$

21. The force- time graph for the motion of a body is shown in the following figure. The change in momentum of the body between $0\ and\ 20\,s$ is



(A) $20\,kg\ ms^{-1}$ (B) $25\,kg\ ms^{-1}$

(C) $30\,kg\ ms^{-1}$ (D) $35\,kg\ ms^{-1}$

22. A vessel contains oil (density= $0.8\,g\,cm^{-3}$) over mercury (density= $13.6\,g\,cm^{-3}$). A homogeneous sphere floats with half its volume immersed in mercury and the other half in oil. The density of the material of the sphere in $g\,cm^{-3}$ is:

(A) 3.3 (B) 6.4

(C) 7.2 (D) 12.8

23. A cubical block is floating in a liquid with half of its volume immersed in the liquid. When the whole system accelerates upwards with a net acceleration of $g/3$, the fraction of its volume immersed in the liquid is

(A) $1/2$ (B) $3/8$

(C) $2/3$ (D) $3/4$

Space for Rough work

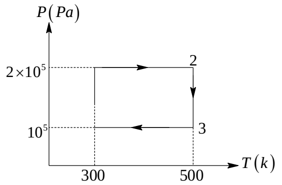
24. The time period of a simple pendulum is T. The pendulum is oscillated with its bob immersed in a liquid of density σ. If the density of the bob is p and viscous effect is neglected, the time period of the pendulum will be

(A) $\left(\frac{p}{p-\sigma}\right)^{1/2} T$
(B) $\left(\frac{\sigma}{p-\sigma}\right)^{1/2} T$
(C) $\left(\frac{p}{\sigma}\right)^{1/2} T$
(D) $\left(\frac{\sigma}{p}\right)^{1/2} T$

25. For hydrogen gas $C_p - C_v = x$ and for oxygen gas $C_p - C_v = y$ where C_p *and* C_v are molar specific heats. Then the relation between x *and* y is

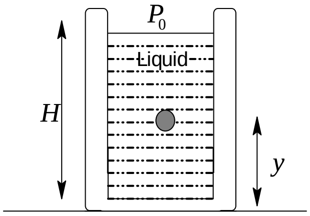
(A) $x = 16y$
(B) $y = 16x$
(C) $x = 4y$
(D) $x = y$

26. Two moles of helium gas are taken over the cycle 12341, as shown in the $p-T$ diagram. Assuming the gas to be ideal the work done on the gas in taking it from 1 *to* 2 is



(A) $200R$
(B) $300R$
(C) $400R$
(D) $500R$

27. A small spherical monoatomic ideal gas bubble $\left[\gamma = \frac{5}{3}\right]$ is trapped inside a liquid of density p_L Assume that the bubble does not exchange any heat with the liquid. The bubble contains n moles of gas. The temperature of the gas when the bubble is at bottom is T_0. The height of the liquid is H and the atmospheric pressure is P_0. Neglect surface tension. As the bubble moves upwards, besides the buoyancy force the forces acting on it are besides the buoyancy force the forces acting on it are



(A) Only the force of gravity
(B) The force due to gravity and force due to pressure of the liquid
(C) The force due to gravity, the force due to pressure of the liquid and force due to viscosity of the liquid
(D) The force due to gravity and the force due to viscosity of the liquid

Space for Rough work

28. A knife edge of mass M is dropped from a height h on a wooden floor with its tip pointing of downward. If the blade penetrates a distance S into the wood the average resistance offered by the wood to the blade is

(A) Mg

(B) $Mg\left(1+\frac{h}{s}\right)$

(C) $Mg\left(1-\frac{h}{s}\right)$

(D) $Mg\left(1+\frac{h}{s}\right)^2$

29. A uniform rope of mass M and length L is pulled along a frictionless inclined plane of angle(by appling a force $F\left(>Mg\right)$)parallel to incline. Tension in the chain at a distance x from the end at which force is applied is

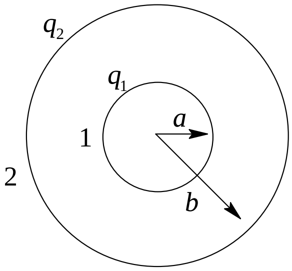
(A) $F\frac{x}{L}+\frac{x}{L}Mg\sin\theta$

(B) $F\left(1-\frac{x}{L}\right)$

(C) $F\left(1-\frac{x}{L}\right)+\frac{x}{L}Mg\sin\theta$

(D) None of these

30. Two Conducting spherical shells having radii $a\ and\ b$ charged to $q_1\ \&\ q_2$ respectively. Find the potential difference between $1\&2$



(A) $\frac{q_1}{4\pi\in_0}\left(\frac{1}{a}-\frac{1}{b}\right)$

(B) $\frac{q_2}{4\pi\in_0}\left(\frac{1}{a}-\frac{1}{b}\right)$

(C) $\frac{q_1+q_2}{4\pi\in_0}\left(\frac{1}{a}-\frac{1}{b}\right)$

(D) $\frac{q_1}{4\pi\in_0 a}$

Space for Rough work

Chemistry

PART – II

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. $112\ mL$ of NO_2 at NTP was liquefied, the density of the liquid being $1.15\,g\ mL^{-1}$. The volume of the liquid is:
(A) $0.1\ mL$ (B) $0.2\ mL$
(C) $128.8\ mL$ (D) $1.15\ mL$

2. A mixture of $HCOOH$ and $H_2C_2O_4$ is heated with conc. H_2SO_4. The gaseous mixture thus produced is collected and passed through $NaOH$ solution. The volume of the gaseous mixture decreases by $\left(\frac{1}{6}\right)^{th}$. The molar ratio of $HCOOH$ and $H_2C_2O_4$ in the mixture of acids is:
(A) $\frac{1}{4}$ (B) 6
(C) 4 (D) $\frac{1}{6}$

3. Equal volumes of ethanoic acid and KOH are mixed, the heat evolved is:
(A) equal to heat of formation of water from H^+ and OH^-
(B) less than the heat of formation of water from H^+ and OH^-
(C) equal to heat of formation of water from H_2 and O_2 in gaseous state
(D) equal to enthalpy of neutralization of KOH and HCl

4. Consider the following reaction,
$A(g) \longrightarrow 2B(g)$
The rate constant for this reaction is $2.303\times10^{-2}\ \text{min}^{-1}$. The time in which the molar ratio of A to B becomes $3:2$ is equal to:
(A) $12.5\ \text{min}$ (B) $2.303\ \text{min}$
(C) $5.12\ \text{min}$ (D) $80\ \text{min}$

Space for Rough work

5. Consider the following gaseous phase equilibrium, $A(g) \rightleftharpoons 2B(g)$. The degree of dissociation of A is $\frac{1}{3}$ and $\frac{2}{3}$ at P_1 and P_2 pressures respectively. The ratio of P_1 and P_2 is:

(A) $\frac{7}{4}$
(B) $\frac{7}{32}$
(C) $\frac{8}{32}$
(D) $\frac{32}{5}$

6. The pH of a H_2SO_4 solution is 2. The pH of this solution, if equal volume of $0.2\,M \quad NaCl$ solution is added to it, will be:

(A) 1.7
(B) 2.3
(C) 3.2
(D) 2

7. In a crystal structure of an element, atoms are present in ccp arrangement and tetrahedral voids, which of the following relation between the atomic radius and edge length is correct for the unit cell which is formed in this arrangement? (a is the edge length and R is the radius of atom):

(A) $\sqrt{2}a = 4R$
(B) $\sqrt{3}a = 8R$
(C) $\sqrt{3}a = 4R$
(D) $a = 2R$

8. $1000\,g$ of 1 molal aqueous solution of sucrose is cooled and maintained at $-3.534°C$. What is the amount of ice separated out $\left(K_f \; for\, H_2O\, is\, 1.86\right)$:

(A) $353\,g$
(B) $220\,g$
(C) $150\,g$
(D) $510\,g$

9. Acidified water is electrolysed using inert electrodes. The total volume of gases collected at cathode and anode is $V\,mL$ at STP. The amount of charge passed in the electrolytic cell is equal to:

(A) $\left(5.74\times10^3 \times V\right)C$
(B) $96500\,C$
(C) $\left(1.72\times10^3 \times V\right)C$
(D) $1.72\times10^3\,C$

Space for Rough work

10. The charge on As_2S_3 may be due to the adsorption of:

(A) H^+ (B) OH^-
(C) O_2^- (D) S^{2-}

11. The magnetic moment of Cr^{x+} is $\sqrt{15}\,BM$. The ratio of number of paired e^- and unpaired e^- in Cr^{x+} is equal to:

(A) seven (B) six
(C) five (D) four

12. Find ΔH in terms of KJ for the following reaction from the given data

$$M(g) + 2X(g) \longrightarrow M^{2+}(g) + 2X^-(g)$$

$$(IE)_1\ of\ M(g) = 705\,KJ\ mol^{-1}$$

$$(IE)_2\ of\ M(g) = 1151\,KJ\ mol^{-1}$$

$$(IA)_1\ of\ X(g) = -328\,KJ\ mol^{-1}$$

(A) $120\,KJ$ (B) $512\,KJ$
(C) $1200\,KJ$ (D) $110\,KJ$

13. Which of the following is not three dimensional network structures?

(A) SiO_2 (B) CO_2
(C) diamond (D) graphite

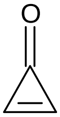
14. A 1g sample of H_2O_2 solution containing $x\%$ H_2O_2 by weight required $x\,mL$ of $KMnO_4$ for complete oxidation in acidic medium. The normality of $KMnO_4$ solution is approximately:

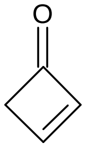
(A) 0.1 (B) 0.4
(C) 0.6 (D) 1.2

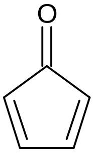
Space for Rough work

15. Consider the following statements about the structure of borax:
(i) number of $B-O-B$ bonds is x
(ii) number of $B-B$ bonds is y
(iii) number of sp^2 hybridized B atoms is z
The value of $\left(x+y+z\right)$ is equal to
(A) 3
(B) 4
(C) 6
(D) 7

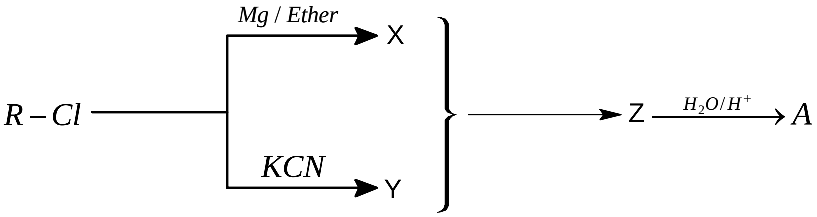
16. Which of the following has maximum dipole moment?

(A)


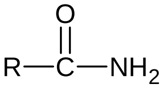
(B)


(C)


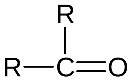
(D) All have equal value

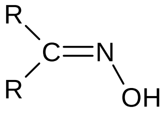
17.


What is $'A'$?

(A)

$R-\overset{\overset{\large O}{||}}{C}-NH_2$

(B) R—CHO

(C)

$R-\overset{\overset{\large R}{|}}{C}=O$

(D)


Space for Rough work

18. Which of the following will not convert $R-C\equiv N$ to $R-CHO$?

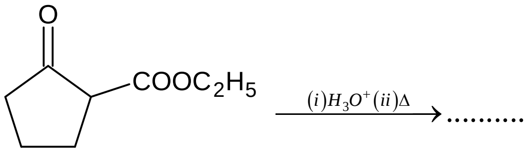
(A) $(i)\,SnCl_2/HCl$

(B) $(i)\,RMgX \quad (ii)\,H_2O/H^+$

(C) $(i)\,LiAlH_4 \quad (ii)\,H_2O/\Delta$

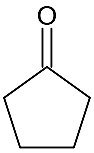
(D) $(i)\,AlH(i-Bu)_2 \quad (ii)\,H_2O/\Delta$

19.

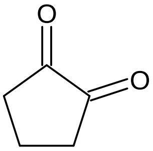

O
COOC2H5
(i)H3O+ (ii)Δ
....

The major product is:

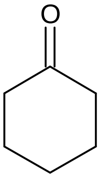
(A)



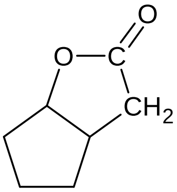
(B)



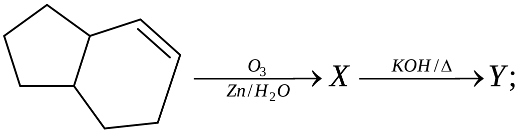
(C)



(D)

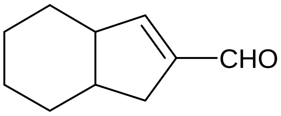


20.

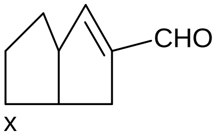

O3
Zn/H2O
X
KOH/Δ
Y;

the compound 'Y' is:

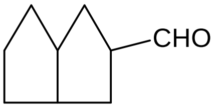
(A)



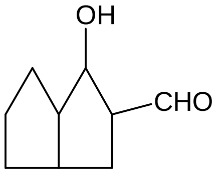
(B)



(C)

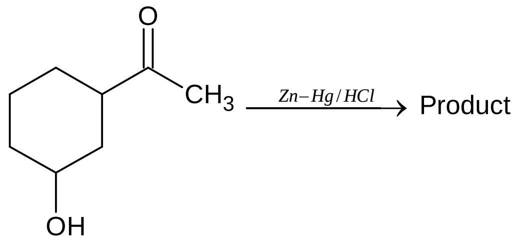


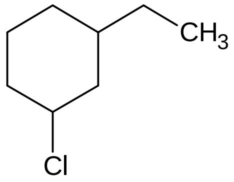
(D)

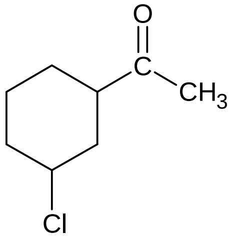


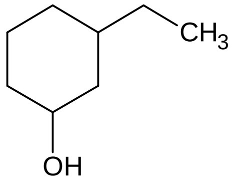
Space for Rough work

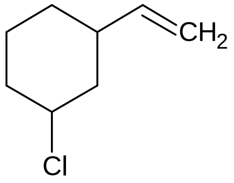
21.


O
CH3
Zn–Hg/HCl
Product
OH

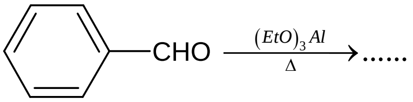
(A)


(B)


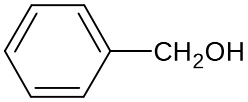
(C)


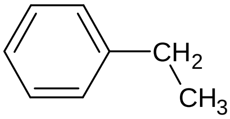
(D)


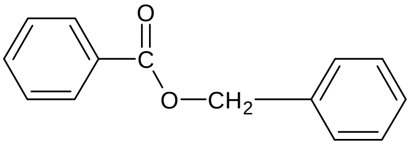
22.


CHO
(EtO)3Al
Δ
......

The major product is:

(A)


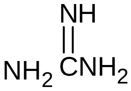
(B)


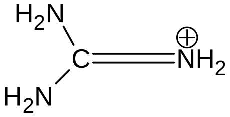
(C)


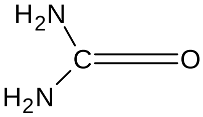
(D) No reaction

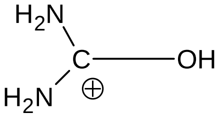
Space for Rough work

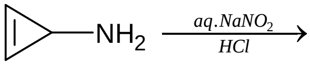
23. Strongest base is:

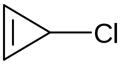
(A)

$NH_2\overset{\overset{NH}{||}}{C}NH_2$

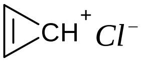
(B)


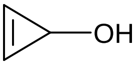
(C)


(D)


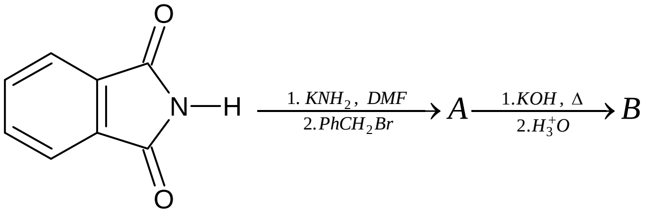
24.

P, P is:

(A)


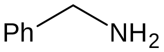
(B)


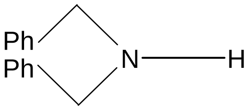
(C)


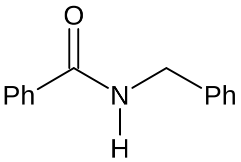
(D) None of these

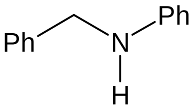
25.


The end product B of the above reaction is:

(A)


(B)


(C)


(D)


Space for Rough work

26. Marshall's acid is:
(A) $H_2S_2O_5$
(B) $H_2S_2O_8$
(C) H_2SO_4
(D) $H_2S_2O_7$

27. The correct order of $S-O$ bond in $(I)SO_2$, $(II)SO_3, (III)SO_4^{2-}$ is:
(A) $I > II > III$
(B) $III > I > II$
(C) $II > III > I$
(D) $I > III > II$

28. The following acids have been arranged in the order of increasing acid strength. Identify the correct order:
$(I)ClOH$
$(II)BrOH$
$(III)IOH$
(A) $I < II < III$
(B) $III < II < I$
(C) $II < I < III$
(D) $III < I < II$

29. The correct order of oxidizing power is:
(A) $HOCl > HOClO > HOClO_2 > HOClO_3$
(B) $HOClO_3 > HOClO_2 > HOClO > HOCl$
(C) $HOClO_2 > HOClO_3 > HOCl > HOClO$
(D) $HOCl > HOClO_2 > HOClO > HOClO_3$

30. Shape of $XeOF_4$ is:
(A) Trigonal bipyramid with lp at axial position
(B) Square pyramid with lp at axial position
(C) Distorted square pyramid with lp at axial position
(D) Square pyramid with lp at square plane.

Space for Rough work

Mathematics

PART – III

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. The number of ordered pairs (x, y) of real numbers satisfying $4x^2 - 4x + 2 = \sin^2 y$ and $x^2 + y^2 \le 3$ is equal to

(A) 0 (B) 2
(C) 4 (D) 8

2. $\sin 47° - \sin 25° + \sin 61° - \sin 11° =$

(A) $\cos 7°$ (B) $\sin 7°$
(C) $2\cos 7°$ (D) $2\sin 7°$

3. The tangent to the hyperbola $xy = c^2$ at the point P intersects the x-axis at T and the y-axis at T'. The normal to the hyperbola at P intersects the x-axis at N and the y-axis at N'. The areas of the triangles PNT and PN'T' are Δ and Δ' respectively , then $\frac{1}{\Delta} + \frac{1}{\Delta'}$ is

(A) equal to 1 (B) depends on t
(C) depends on c (D) equal to 2

4. The normal at P to a hyperbola of eccentricity e, intersects its transverse and conjugate axes at L and M respectively. If locus of the mid-point of LM is hyperbola, then eccentricity of the hyperbola is:

(A) $\left(\frac{e+1}{e-1}\right)$ (B) $\frac{e}{\sqrt{\left(e^2-1\right)}}$
(C) e (D) None of these

Space for Rough work

5. Area of the triangle formed by the lines $x-y=0, x+y=0$ and any tangent to the hyperbola $x^2-y^2=a^2$ is:

(A) $|a|$
(B) $\frac{1}{2}|a|$
(C) a^2
(D) $\frac{1}{2}a^2$

6. A rectangular hyperbola whose centre is C is cut by any circle of radius r in four points P, Q, R and S. Then $CP^2+CQ^2+CR^2+CS^2$ is equal to:

(A) r^2
(B) $2r^2$
(C) $3r^2$
(D) $4r^2$

7. The point, at shortest distance from the line $x+y=7$ and lying on an ellipse $x^2+2y^2=6$, has co-ordinates:

(A) $\left(\sqrt{2}, \sqrt{2}\right)$
(B) $\left(0, \sqrt{3}\right)$
(C) $(2,1)$
(D) $\left(\sqrt{5}, \frac{1}{\sqrt{2}}\right)$

8. Locus of the foot of perpendicular drawn from origin to any tangent to the ellipse $\frac{x^2}{2}+y^2=1$ is:

(A) $\left(x^2+y^2\right)^2=2x^2+y^2$
(B) $\left(x^2-y^2\right)^2=2x^2+y^2$
(C) $\left(x^2+y^2\right)^2=2x^2-y^2$
(D) None of these

9. The line $5x-3y=8\sqrt{2}$ is a normal to the ellipse $\frac{x^2}{25}+\frac{y^2}{9}=1$. If θ be the eccentric angle of the foot of this normal, then 'θ' is equal to:

(A) $\frac{\pi}{6}$
(B) $\frac{\pi}{3}$
(C) $\frac{\pi}{4}$
(D) None of these

Space for Rough work

10. For parabola $x^2+y^2+2xy-6x-2y+3=0$, then focus is:

(A) $(1,-1)$	(B) $(-1,1)$
(C) $(3,1)$	(D) None of these

11. The triangle formed by the tangent to the parabola $y=x^2$ at the point whose abscissa is x_0 $\left(x_0\in[1,2]\right)$, the y-axis and the straight line $y=x_0^2$ has the greatest area if x_0 is equal to:

(A) 0	(B) 1
(C) 2	(D) 3

12. The condition that the parabola $y^2=4c(x-d)$ *and* $y^2=4ax$ have a common normal other than x- axis $(a>0,c>0)$ is:

(A) $2a<2c+d$	(B) $2c<2a+d$
(C) $2d<2a+c$	(D) $2d<2c+a$

13. The point $([P+1],[P])$, (where $[.]$ denotes the greatest integer function) lying inside the region bounded by the circle $x^2+y^2-2x-15=0$ *and* $x^2+y^2-2x-7=0$ then:

(A) $p\in[-1,0)\cup[0,1)\cup[1,2)$	(B) $p\in[-1,2)-\{0,1\}$
(C) $p\in(-1,2)$	(D) None of the above

14. If the distance from the origin of the centres of three, circles $x^2+y^2+2\lambda_i x-c^2=0,(i=1,2,3)$ are in GP. then the lengths of the tangents drawn to them from any point on the circle $x^2+y^2=c^2$ are in:

(A) A. P	(B) G. P
(C) H.P	(D) None of these

Space for Rough work

15. The values of k for which the circle $x^2+y^2=1 \, and \, x^2+y^2-4\lambda x+8=0$ have two common tangents is:

(A) $\left(-\frac{9}{4},\frac{9}{4}\right)$
(B) $\left(-\infty,-\frac{9}{4}\right]\cup\left[\frac{9}{4},\infty\right)$
(C) $\left(-\infty,-\frac{9}{4}\right)\cup\left(\frac{9}{4},\infty\right)$
(D) None of these

16. The equation of image of pair of lines $y=|x-1|$ in y- axis is:

(A) $x^2+y^2+2x+1=0$
(B) $x^2-y^2+2x-1=0$
(C) $x^2-y^2+2x+1=0$
(D) None of these

17. If $\alpha,\beta>0 \, and \, \alpha<\beta \, and \, ax^2+4\gamma xy+\beta y^2+4p(x+y+1)=0$ represent a pair of straight lines, then:

(A) $\alpha\le p\le\beta$
(B) $p\le\alpha$
(C) $p\ge\alpha$
(D) $p\le\alpha \, or \, p\ge\beta$

18. If $\frac{2}{1!9!}+\frac{2}{3!7!}+\frac{4}{5!5!}=\frac{2^m}{n!}$, then orthocentre of the triangle having sides $x-y+1=0, x+y+3=0 \, and \, 2x+5y-2=0$ is:

(A) $(2m-2n,m-n)$
(B) $(2m-2n,n-m)$
(C) $(2m-n,m+n)$
(D) $(2m-n,m-n)$

19. In ΔABC, if $p=\tan\frac{B-C}{2}\cot\frac{B+C}{2}$ $q=\tan\frac{C-A}{2}\cot\frac{C+A}{2}$ and $r=\tan\frac{A-B}{2}\cot\frac{A+B}{2}$ then $\sum p=$:

(A) 1
(B) $\sum pq$
(C) $-pqr$
(D) None of these

Space for Rough work

20. In the triangle ABC the medians from B and C are perpendicular. The value of $\cot B + \cot C$ cannot be:

(A) $\frac{1}{3}$ (B) $\frac{2}{3}$

(C) $\frac{4}{3}$ (D) $\frac{5}{3}$

21. If $ABCD$ be a cyclic quadrilateral inscribed in a circle of radius 2 unit such that $BD = 2\sqrt{3}$; $AB = 1$ then $AD =$:

(A) $\frac{1+3\sqrt{5}}{2}$ (B) $\frac{3\sqrt{5}-1}{2}$

(C) $\frac{\sqrt{5}+1}{2}$ (D) None of these

22. If I be the incentre of ΔABC and P, Q are feet of perpendicular from A to BI, CI respectively. Then $AQ : CI + AP : BI =$:

(A) $\cot\left(\frac{A+B}{2}\right)$ (B) $\cot\left(\frac{B+C}{2}\right)$

(C) $\cot\left(\frac{C+A}{2}\right)$ (D) $\tan\left(\frac{B+C}{2}\right)$

23. Number of roots of the equation $\cos^2 x + \left(\frac{\sqrt{3}+1}{2}\right)\sin x - \frac{\sqrt{3}}{4} - 1 = 0$ which lie in the interval $[-\pi, \pi]$ is:

(A) 2 (B) 4

(C) 6 (D) 8

24. The number of solutions of $\tan(5\pi\cos\theta) = \cot(5\pi\sin\theta)$ for $\theta \in (0, 2\pi)$ is:

(A) 28 (B) 14

(C) 4 (D) 2

Space for Rough work

25. Number of solutions of the equation $4\sin^2 x+\tan^2 x+\cot^2 x+\cos ec^2 x=6$ in $\left[0,\pi\right]$ is:

(A) 0	(B) 2
(C) 8	(D) 4

26. The equation $2x=\left(2n+1\right)\pi\left(1-\cos x\right)$ has (where n is a positive integer):

(A) infinity many real roots	(B) exactly one real root
(C) exactly $2n+2$ real roots	(D) exactly $2n+3$ real roots

27. A vertical tower standing at O has marks P, Q, R, S at heights of 1m, 2m, 3m, and 4m from the foot O and A is a point on the horizontal plane through O. If PQ and RS subtend angles α and β respectively at A where OA = 2 m then $\cos\left(\alpha+\beta\right)=$:

(A) $5/\sqrt{26}$	(B) $24/\sqrt{650}$
(C) $23/\sqrt{650}$	(D) $1/\sqrt{26}$

28. A, B, C are three points on a horizontal line through the base O of a pillar OP, such that OA, OB, OC are in A. P. If α,β,γ the angles of elevation of the top of the pillar at A, B, C respectively are also in A. P. then $\sin\alpha,\sin\beta,\sin\gamma$ are in:

(A) A. P.	(B) G. P.
(C) H. P.	(D) None of these

29. If $n\in N,$ then $7^{2n}+2^{3n-3}.3^{n-1}$ is always divisible by:

(A) 25	(B) 35
(C) 45	(D) None of these

30. Let $P\left(n\right)$ denotes the statement that n^2+n is odd. It is seen that $P\left(n\right)\Rightarrow P\left(n+1\right).P_n$ is true for all:

(A) $n>1$	(B) $n\in N$
(C) $n>2$	(D) None of these

Space for Rough work

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4.	D	A	B
5.	B	D	A
6.	C	–	D
7.	C	B	C
8.	B	A	A
9.	A	A	C
10.	B	D	B
11.	A	B	C
12.	A	C	A
13.	B	B	D
14.	C	C	B
15.	C	D	C
16.	D	A	C
17.	A	C	D
18.	A	B	A
19.	D	A	B
20.	B	B	A
21.	C	A	A
22.	C	C	D
23.	A	A	B
24.	A	B	A
25.	D	A	B
26.	C	B	C
27.	D	B	C
28.	B	B	B
29.	B	A	A
30.	A	C	D

Physics

PART – I

SECTION - A

1. D

$\vec{F} = I\left(\vec{l} \times \vec{B}\right)$

Here $\vec{l}$ is directed from end A to end B of the wire.

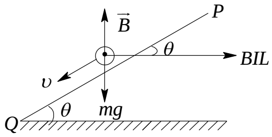
Here $\left|\vec{l}\right| = \frac{L}{2}$ $and\ \theta = 90°......F = I \times \frac{L}{2} \times B = \frac{BIL}{2}$

2. A

Force on a current carrying conductor is $\vec{F} = i\left(\vec{r} \times \vec{B}\right)$

3. C

$BIL\cos\theta = mg\sin\theta\ or B = \frac{mg}{IL}\frac{\sin\theta}{\cos\theta} = \frac{mg}{IL}\tan\theta$



4. D

The magnetic forces acing on the three sides of the triangle are as follows:

$F_{CD} = 0\, as\, CD$ is parallel to $\vec{B}$

$F_{AC} = ilB\sin 60° = \frac{\sqrt{3}}{2}ilB$ (Perpendicular to the plane of diagram and outwards) as the side AC makes an angle $60°$ with $\vec{B}$.

$F_{AD} = ilB\sin 120° = \frac{\sqrt{3}}{2}ilB$ (Perpendicular to the plane of diagram and outwards) as the side AD makes an angle $120°$ with $\vec{B}$.

Therefore, net force on the loop is

$F = 0 + \frac{\sqrt{3}}{2}ilB + \frac{\sqrt{3}}{2}ilB = \sqrt{3}\,ilB$ perpendicular to the plane of the loop, outwards.

5. B

The magnetic moment of straight wire, $m = \left(q_m\right)\left(l\right)$

The magnetic moment of the semicircular wire, $m' = \left(q_m\right)\left(2r\right)$

$\therefore \frac{m'}{m} = \frac{2r}{l} = \frac{2r}{\pi r} = \frac{2}{\pi} \therefore m' = \frac{2m}{\pi}$

6. C

$T = 2\pi\sqrt{\frac{I}{mB_H}}; T' = 2\pi\sqrt{\frac{2I}{mB_H}} = \sqrt{2}T$

7. C

For solenoid, $B = \mu_0 ni = \mu_0\frac{N}{l}i$

$\phi = NBA = N\left[\mu_0\frac{N}{l}i\right]A = \mu_0\frac{N^2A}{l}i$

Also $\phi = Li \therefore L = \frac{\mu_0 N^2 A}{l}$

So $L = 4\pi \times 10^{-7} \times \frac{(1000)^2}{1} \times 10 \times 10^{-4}$

$= 0.0012566H = 1.26mH$

8. B

$$X_L = \frac{1}{\omega C} = \frac{1}{2\pi\nu C} = \frac{1}{2\pi \times 50 \times 10 \times 10^{-6}} = 318.31\Omega$$

$$Z = \sqrt{R^2 + X^2} = \sqrt{R^2 + (X_L - X_C)^2}$$

$$= \sqrt{0^2 + (100\pi - 318.31)^2} = 4.16\Omega$$

9. A

$$i = 45^\circ \sin r = \frac{\sin i}{n} = \frac{\sin 45^\circ}{2} = \frac{1}{2\sqrt{2}}$$

Lateral shift $= \frac{t}{\cos r}\sin(i - r) = t\sin i - t\cos i \ \tan r$

$$= \sqrt{2}\,\frac{1}{\sqrt{2}} - \frac{1}{\sqrt{7}} = \frac{\sqrt{7}-1}{\sqrt{7}} \approx 0.62\,cm$$

10. B

The relative velocity of the diving bird relative to the fish $= 4 + \upsilon_a \times \frac{4}{3} = 16\,cm\ s^{-1}$

$\therefore \upsilon_a \times \frac{4}{3} = 12 \qquad \therefore \upsilon_B = \frac{36}{4} = 9\ cm\ s^{-1}$

11. A

Surface AB forms the image of O at v_1 from it. We have $\frac{1.5}{v_1} - \frac{1}{-4R} = \frac{1.5-1}{R}$

$\therefore$ For the surface $CD, \mu_2 =$ object distance= separation between the two surfaces $-v_1 = -3R + 6R = +3R$

Hence v_2 the image distance due to surface CD is got by

Giving $\frac{1}{v_2} = \frac{1}{4R} + \frac{1}{2R} = \frac{3}{4R}$

$or\ v_2 = \frac{4R}{3}$

A real image is formed at a distance $\frac{4R}{3}$ from the surface CD to its right

12. A

$\mu_1 = -40\,cm \quad f_1 = 30\,cm$

$\therefore \ v_1 = 120\,cm$ From $v = \frac{u\,f}{u+f}$

u_2 For the II lens= $(-d + 120)\,cm$ and $f_2 = 50\,cm$

$$\therefore\ v_2 = \frac{-50\left(d-120\right)}{-\left(d-170\right)} = \frac{100}{3}$$

By solving, we get $d = 20\,cm$

13. B

$$I = I_{COM} + mr^2 \Rightarrow 3\left(10\right)^2 = m\left(k\right)^2 + m\left(6\right)^2$$

$$\therefore\ k = 8\,cm$$

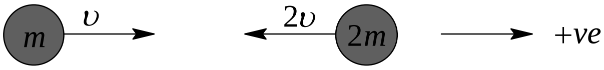
14. C

$$I = I_{COM} + mr^2 \Rightarrow \frac{7}{12}ml^2 = \frac{ml^2}{12} + mr^2$$

$$\therefore\ r^2 = \frac{l^2}{2} \Rightarrow r = \frac{l}{\sqrt{2}}$$

15. C

$u_1 = +\upsilon$ $\quad$ $u_2 = -2\upsilon$ $\quad$ $m_1 = m \quad m_2 = 2m$



$$\upsilon_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1 + \left(\frac{2m_2}{m_1 + m_2}\right)u_2$$

and $\upsilon_2 = \left(\frac{m_2 - m_1}{m_1 + m_2}\right)u_2 + \left(\frac{2m_1}{m_1 + m_2}\right)u_1$

$$\therefore \upsilon_2 = \left(\frac{2m - m}{2m + m}\right)\left(-2\upsilon\right) + \left(\frac{2m}{2m + m}\right)\left(\upsilon\right)$$

$$= -\frac{2}{3}\upsilon + \frac{2}{3}\upsilon = 0$$

16. D

When the extension is maximum, their velocities are equal. From the law of conservation of Momentum,

$$P_f = p_i \Rightarrow \left(6\right)\upsilon + \left(3\right)\upsilon = 6\left(2\right) + 3\left(-1\right)$$

$$\upsilon = 1\,m\,s^{-1}$$

This energy is also conserved

$$E_f = E_1 \Rightarrow \frac{1}{2}\left(6\right)\left(1\right)^2 + \frac{1}{2}\left(3\right)\left(1\right)^2 + \frac{1}{2}Kx_m^2$$

$$= \frac{1}{2}\left(6\right)\left(2\right)^2 + \frac{1}{2}\left(3\right)\left(1\right)^2$$

$$3 + 1.5 + \frac{1}{2}\left(200\right)x_m^2 = 12 + 1.5$$

$$100x_m^2 = 9 \Rightarrow x_m^2 = 0.09 \Rightarrow x_m = 0.3m = 30\,cm$$

17. A

$$mgh = \frac{1}{2}mu_{\min}^2$$

$$u_{\min} = \sqrt{5gr}$$

$$\therefore h = 2.5\,r$$

18. A

$$\left|W_f\right| = \frac{1}{2}m\upsilon^2 - 0 = \frac{1}{2}m\upsilon^2 = \frac{p^2}{2m}$$

$$\therefore \mu mgx = \frac{p^2}{2m} \Rightarrow \mu = \frac{p^2}{2gm^2x}$$

19. D

Work done on both the blocks is same and total work done by spring is $-\frac{1}{2}kx^2$

Hence work done on each blocks is $-\frac{1}{4}kx^2$

20. B

We know that $F = ma$

$$\therefore 200 = m_1 \times 80 \Rightarrow m_1 = \frac{200}{80} = 2.5\,kg$$

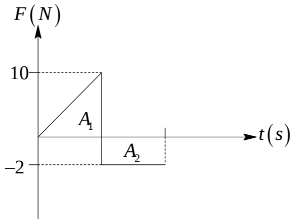
and $200 = m_2 \times 240 \Rightarrow m_2 = \frac{200}{240} = 0.833\,kg$

When joined together, $m = m_1 + m_2 = \frac{20}{6}kg$

Final acceleration is

$$a = \frac{F}{m} = \frac{200}{20/6} = 60\,ms^{-2}$$

21. C



Change in momentum= impulse
= Net area under $F - t$ graph

$$= \left(\frac{1}{2}\times 10 \times 10\right) - \left(10 \times 2\right) = 30\,kg\ \ ms^{-1}$$

22. C

Let density of material of sphere (in $g\,cm^{-3}$) be p Applying the condition of floatation,

Weight = Upthrust $\Rightarrow pVg = \frac{V}{2}p_{oil}g + \frac{V}{2}p_{Hg}g$

$$p = \frac{p_{oil}}{2} + \frac{p_{Hg}}{2} = \frac{0.8}{2} + \frac{13.6}{2} = 7.2g\ cm^{-3}$$

23. A

$$\frac{Volume\,submerged}{Volume} = \frac{p_s}{p_L} = \frac{1}{2}$$

The result is independent of the value of g_{eff}

24. A

This is the effective acceleration due to gravity

$$T' = 2\pi\sqrt{\frac{1}{g_{eff}}} = 2\pi\sqrt{\frac{pl}{\left(p-\sigma\right)g}} = \left(\frac{p}{p-\sigma}\right)^{1/2} T$$

$$\left(\because\ T = 2\pi\sqrt{\frac{l}{g}}\right)$$

25. D

$C_p - C_v = R$ for all gases

26. C

$W_{12} = p\left(V_2 - V_1\right)$ ($\because$ constant pressure process)

$$= nR\left(T_2 - T_1\right) = 2R\left(500-300\right) = 400R$$

27. D

The force of buoyancy arises due to pressure difference.

28. B

Velocity of knife edge is $\upsilon = \sqrt{2gh}$

Retardation, $a = \frac{\upsilon^2}{2^5} = \frac{gh}{5}$

Average resistance $R - mg = ma$

$$R = mg + m\left(\frac{gh}{s}\right)$$

$$= mg\left(1+\frac{h}{s}\right)$$

29. B

$F - mg\sin\theta = mA$ .... (1)

$F - \left(\frac{m}{L}x\,g\sin\theta\right) - T\,\frac{m}{L}x\left(\frac{F-mg\sin\theta}{m}\right)$ .... (2)

Buy solving equation $(1)\&(2)$

$$T = f\left(1-\frac{x}{L}\right)$$

30. A

Work done on bringing a test charge from (1) to (2) is

Is $V_1 - V_2 = \frac{q_1}{4\pi\in_0}\left(\frac{1}{a}-\frac{1}{b}\right)$

Chemistry

PART – II

SECTION - A

1. B

Moles of $NO_2 = \frac{112}{22400} moles = \frac{1}{200} moles$

$wt\ of\ NO_2 = \frac{1}{200} \times 46g$

Volume of liquid $NO_2 = \frac{46}{200}/1.15 = 0.2\,mL$

2. C

$HCOOH \longrightarrow CO(g) + H_2O(l)$

$a\ mole \qquad 0$

$0 \qquad a\ mole$

$H_2C_2O_4 \longrightarrow CO(g) + CO_2(g) + H_2O(l)$

$b\ mole \qquad 0 \qquad 0$

$0 \qquad b\ mole \qquad b\ mole$

$CO + CO + CO_2 = (a + 2b)$

$\frac{1}{6} \times (a + 2b) = b$

$a + 2b = 6b$

$a/b = 4$

4. A

$A(g) \longrightarrow 2B(g)$

$a\ molL^{-1} \qquad 0\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad t = 0$

$(a - x)\,mol\ H^{-1} \qquad 2x\ mol\ L^{-1}\ \ldots\ldots\ldots \quad t = t$

$\frac{a - x}{2x} = \frac{3}{1} \quad \Rightarrow 2a - 2x = 6x$

$8x = 2a \quad \Rightarrow x = a/4$

$t = \frac{2.303}{2.303 \times 10^{-2}} \log \frac{a}{a - \frac{a}{4}}$

$t = 10^2 \log \frac{4}{3}$

$12.5\,\text{min}$

5. D

$A(g) \rightleftharpoons 2B(g)$

$at\ P_1 \quad 1 - \frac{1}{3} \qquad \frac{2}{3} \ldots\ldots\ldots\ldots\ldots K_p = \frac{P_1}{2}$

$at\ P_2 \quad 1 - \frac{2}{3} \qquad \frac{4}{3} \ldots\ldots\ldots\ldots\ldots K_p = \frac{16 \times P_2}{5}$

$$\frac{P_1}{2} = \frac{16 \times P_2}{5} \Rightarrow \frac{P_1}{P_2} = \frac{32}{5}$$

6.

$$\left(H^+\right)_{initially} = 10^{-2}$$

$$\left(H^+\right)_{finally} = \frac{10^{-2}}{2}$$

$$pH = -\log\frac{10^{-2}}{2} = 2.3\left(\text{approximatly}\right)$$

7. B

fcc unit cell is formed.

$$\frac{\sqrt{3}a}{4} = 2R = \text{distance b/w corner and T.V}$$

$$\text{or } \sqrt{3}\,a = 8R$$

8. A

1 m sucrose solution means 1 mole sucrose $\left(C_{12}H_{22}O_{11}\right)/1000\,g\,H_2O$

$342\,g\ sucrose/1342\,g\ solution$

$254.8\ g$ sucrose $/1000\,g$ solution $/745.2\,g\ H_2O$

$$3.534 = \frac{1000 \times 1.86 \times 254.8}{342 \times W} \Rightarrow W = 392\,g$$

wt of ice separated out $= \left(745 - 392\right)g \Rightarrow 353g$

9. A

$$H_2O\left(l\right) \longrightarrow 2H_2\left(g\right) + O_2\left(g\right)$$

$$\frac{2V}{3}mL \quad \frac{V}{3}mL$$

5.6 mL O_2 at STP/ 96500 C charge

$\frac{V}{3}mL\,O_2\ at\ STP/\frac{96500}{5.6}\times\frac{V}{3}\ C$ charge $= 5.74 \times 10^3 \times V\ coulomb$

10. D

fact

11. B

$$\sqrt{n\left(n+2\right)} = \sqrt{15}$$

$$n^2 + 2n - 15 = 0$$

$$n = 3$$

$$24^{Cr^{3+}} = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^3$$

Paired $e^- = 18$

Unpaired $e^- = 3$

12. C

$$\Delta H = 705 + 1151 - 2 \times 328$$

$$= 1200\,KJ$$

13. B
Fact

14. C

$$1\,g\ x\%\ H_2O_2\ solution = \frac{x\times10^{-2}}{34}\ mole\ H_2O_2$$

$$H_2O_2 + KMnO_4 \xrightarrow{H^+} O_2 + M_n^{2+}$$

$$(n=2)\quad (n=5)$$

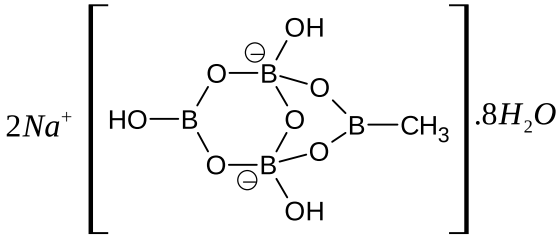
$$\frac{x\times10^{-2}}{34}\ mole\ H_2O_2 \equiv \frac{2}{5}\times\frac{x\times10^{-2}}{34}\ mole\ KMnO_4$$

$$\frac{2}{5}\times\frac{x\times10^{-2}}{34} = molarity\times x\times10^{-3}$$

Molarity = $\frac{2\times10}{5\times34}$

Normality $5\times\frac{2\times10}{5\times34} = \frac{20}{34}N = 0.58\,N \simeq 0.6N$

15. D

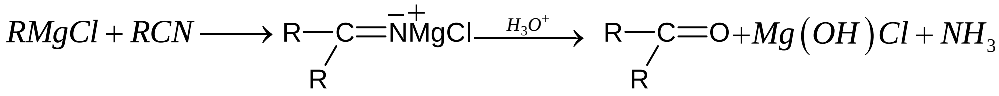


$2Na^+ \ldots .8H_2O$

Number of $B-O-B$ bonds $=5$
Number of $B-B$ bonds $=0$
Number of sp^2 B-atoms $=2$

16. A
A, due to aromaticity

17. C

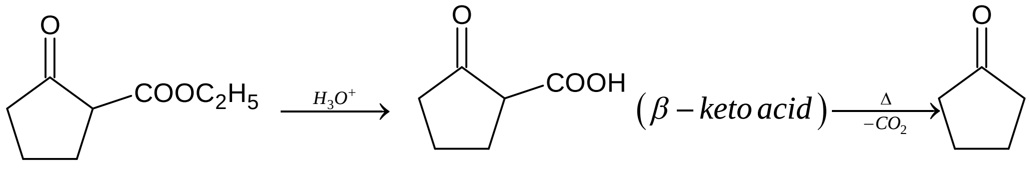


$$RMgCl + RCN \longrightarrow R-\underset{R}{C}=\overset{-+}{N}MgCl \xrightarrow{H_3O^+} R-\underset{R}{C}=O + Mg(OH)Cl + NH_3$$

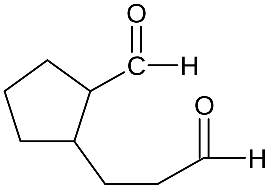
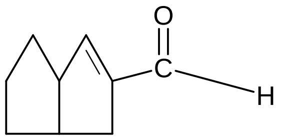
18. B

$$R-C\equiv N \xrightarrow[(ii)\,H_2O/H^+]{(i)\,RMgX} R_2CO$$

19. A



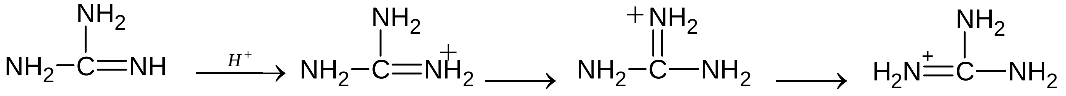
20. B

$X =$  ; $Y =$ 

21. A
Cl^- replaces OH^- due to acidic medium (elimination reduction)

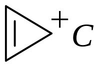
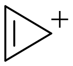
22. C
Tischenko's reaction

23. A
Protonation of base is stabilized by resonance.

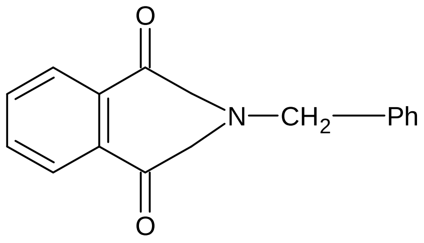


$$NH_2-\overset{\overset{NH_2}{|}}{C}=NH \xrightarrow{H^+} NH_2-\overset{\overset{NH_2}{|}}{C}=\overset{+}{N}H_2 \longrightarrow NH_2-\overset{\overset{+NH_2}{||}}{C}-NH_2 \longrightarrow H_2\overset{+}{N}=\overset{\overset{NH_2}{|}}{C}-NH_2$$

24. B

 Cl^- *because*  *is aromatic*

25. A

$A =$  ; $B = PhCH_2-NH_2$

26. B
Fact

27. B
On the basis of resonance.

28. B
Fact

29. A
Fact

30. C
VSEPR theory

Mathematics

PART – III

SECTION - A

1. B

$4x^2 - 4x + 2 = \sin^2 y$

since $0 \le \sin^2 y \le 1$

$\Rightarrow 0 < 4x^2 - 4x + 2 \le 1 \qquad (\because 4x^2 - 4x + 2 > 0)$

$\Rightarrow (2x-1)^2 \le 0$

$\Rightarrow x = \dfrac{1}{2}$

$\therefore \sin^2 y = 1$

$y = \pm\dfrac{\pi}{2}$

2. A

$\sin 47° - \sin 25° + \tan 61° - \sin 11°$

$= (\sin 61° + \sin 47°) - (\sin 25° + \sin 11°)$

$= 2\sin 54° \cos 7° - 2\sin 18° \cos 7°$

$= 2\cos 7°(\sin 54° - \sin 18°)$

$= 2\cos 7°(\cos 36° - \sin 18°)$

$= 2\cos 7°\left(\dfrac{\sqrt{5}+1}{4} - \dfrac{\sqrt{5}-1}{4}\right) = \cos 7°$

3. C

Let equation of tangent for $\left(ct,\ \dfrac{c}{t}\right)$ is $ty + \dfrac{x}{t} - 2c = 0$

Normal from P is $xt^3 - ty - ct^4 + c = 0$

Co – ordinate of T $(2ct,\ 0)$, $T'\left(0, \dfrac{2c}{t}\right)$, $N\left(\dfrac{ct^4 - c}{t^3},\ 0\right)$ and $N'\left(0,\ \dfrac{c - ct^4}{t}\right)$

$\Rightarrow \Delta = \dfrac{c^2\left(1+t^4\right)}{2t^4}$ and $\left|\dfrac{1}{OA^2} - \dfrac{1}{OB^2}\right| = \dfrac{1}{a^2} - \dfrac{1}{b^2}$

$\dfrac{1}{\Delta} + \dfrac{1}{\Delta'} = \dfrac{2}{c^2}$

13. D

The point $([P+1],[P])$ lies inside the circle $x^2 + y^2 - 2x - 15 = 0$

$\therefore [P+1]^2 + [P]^2 - 2[P+1] - 15 < 0$

$\Rightarrow \quad [P]^2 < 8$ ...... (1)

Point $([P+1].[P])$ lies outside the circle $x^2 + y^2 - 2x - 7 = 0$

$\Rightarrow [P+1]^2 + [P]^2 - 2[P+1] - 7 > 0$

$\Rightarrow [P]^2 > 4$ ...... (2)

$4 < [P]^2 < 8$

14. B

Centres of circles are

$C_1(-\lambda,0), C_2(-\lambda_2,0), C_3(-\lambda_3,0)$

$\because OC_1, OC_2, OC_3$ are in GP

$\therefore \quad \lambda_2^2 = \lambda_1, \lambda_3$

Let any point on $x^2 + y^2 = c^2$ be $P(c\cos\alpha, c\sin\alpha)$,

$\therefore$ Length of tangents are

$PT_1 = \sqrt{2\lambda_1(c\cos\alpha)}$

$PT_2 = \sqrt{2\lambda_2(c\cos\alpha)}$

$PT_3 = \sqrt{2\lambda_3(c\cos\alpha)}$

$\Rightarrow PT_2^2 = PT_1, PT_3$

15. C

Equation of the radical axis is

$4\lambda x = 9 \quad or \quad x = \frac{9}{4\lambda}$

Pitting x in $x^2 + y^2 = 1$

$y = \pm\sqrt{1 - \frac{81}{16\lambda^2}}$

For the circle to have two common tangents, they must intersect at two distinct points

$\therefore \quad 1 - \frac{81}{16\lambda^2} > 0$

$\Rightarrow \quad \lambda < \frac{-9}{4} \quad or \quad \lambda > \frac{9}{4}$

16. C

$y = |x-1|$

$\Rightarrow y^2 = (x-1)^2$

For image in y- axis, charge x by $-x$

$y^2 = (-x-1)^2$

$\Rightarrow x^2 - y^2 + 2x + 1 = 0$

17. D

Use $\Delta = 0$

$16\gamma^2 - 16p^2\gamma + 4p(\alpha p + \beta p - \alpha\beta) = 0$

Since γ is real

$\therefore D \ge 0$

$\Rightarrow (p-\alpha)(p-\beta) \ge 0$

18. A

$\because \frac{1}{10!}\left\{\frac{2\times10!}{1!9!} + \frac{2\times10!}{3!7!} + \frac{10!}{5!5!}\right\} = \frac{2^m}{n!}$

$\Rightarrow \frac{1}{10!}\left\{{}^{10}C_1 + {}^{10}C_3 + \ldots\ldots + {}^{10}C_9\right\} = \frac{2^m}{n!}$

$\Rightarrow \frac{1}{10!}2^9 = \frac{2^m}{n!}$

$\therefore m = 9 \;\; n = 10$

$\therefore$ Lines $x - y + 1 = 0$ & $x + y + 3 = 0$ are perpendicular to each other

$\therefore$ Orthocentre $(-2, -1)$

$\therefore (2m - 2n, m - n)$

19. B

Since $\tan\left(\frac{B-C}{2}\right) = \frac{b-c}{b+c}\cos\frac{A}{2} \quad [\tan gent\ rule]$

$\therefore \tan\left(\frac{B-C}{2}\right)\cot\left(\frac{B+C}{2}\right) = \frac{b-c}{b+c}$

$\Rightarrow p = \frac{b-c}{b+c} \quad \therefore \frac{1+p}{1-p} = \frac{b}{c} ------(1)$

Similarly $\frac{1+q}{1-q} = \frac{c}{a} ----(2)$

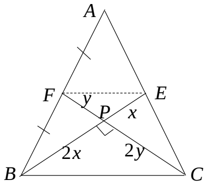
$\frac{1+p}{1-r} = \frac{a}{b} ---(3)$

$\therefore \left(\frac{1+p}{1-p}\right)\left(\frac{1+q}{1-q}\right)\left(\frac{1+r}{1-r}\right) = 1$

$\Rightarrow 2(p+q+r) = -2pqr$

$\sum p = -pqr$

20. A



$\tan\angle PBF = \frac{y}{2x}$

$\tan\angle PBC = \frac{y}{x}$

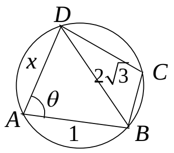
$$\tan B = \frac{\frac{y}{2x} + \frac{y}{x}}{1 - \frac{y^2}{2x^2}} = \frac{3xy}{2x^2 - y^2}$$

$$\cot B = \frac{2x^2 - y^2}{3xy}$$

Similarly $\cot C = \frac{2y^2 - x^2}{3xy}$

$$\cot B + \cot C = \frac{x^2 + y^2}{3xy} \ge \frac{2}{3}$$

21. A



Let $AD = x$ and $\angle BAD = \theta$

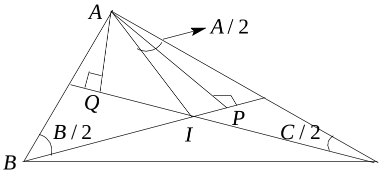
In ΔABD, $\frac{BD}{\sin\theta} = 2R$

$$\Rightarrow \sin\theta = \frac{2\sqrt{3}}{2\times 2} \quad \therefore \theta = 60^\circ$$

$$\cos 60^\circ = \frac{x^2+1^2-\left(2\sqrt{3}\right)^2}{2.x.1}$$

$$\Rightarrow x = \frac{1\pm 3\sqrt{5}}{2} \qquad \therefore x = \frac{1+3\sqrt{5}}{2} \ \left(\because x>0\right)$$

22. D



$$\frac{AQ}{AC} = \sin\frac{C}{2} \quad \Rightarrow AQ = AC\sin\frac{C}{2}.......(1)$$

In $\Delta AIC,\ \dfrac{CI}{\sin\dfrac{A}{2}} = \dfrac{AC}{\sin\left\{\pi-\left(\dfrac{A+C}{2}\right)\right\}}$

$$\Rightarrow CI = AC\frac{\sin A/2}{\cos B/2}----(2)$$

$(1)/(2) \quad \dfrac{AQ}{CI} = \dfrac{\cos\dfrac{B}{2}\sin\dfrac{C}{2}}{\sin\dfrac{A}{2}}$

Similarly $\dfrac{AP}{BI} = \dfrac{\cos\dfrac{C}{2}\sin\dfrac{B}{2}}{\sin\dfrac{A}{2}}$

$$\frac{AQ}{CI}+\frac{AP}{BI} = \frac{\sin\left(\dfrac{B}{2}+\dfrac{C}{2}\right)}{\sin\dfrac{A}{2}} \quad = \tan\left(\frac{B+C}{2}\right)$$

23. B

$$\cos^2 x+\left(\frac{\sqrt{3}+1}{2}\right)\sin x-\frac{\sqrt{3}}{4}-1=0$$

$$\Rightarrow 1-\sin^2 x+\left(\frac{\sqrt{3}+1}{2}\right)\sin x-\frac{\sqrt{3}}{4}-1=0$$

$$\Rightarrow \left(2\sin x-\sqrt{3}\right)\left(2\sin x-1\right)=0$$

$$\Rightarrow x = \frac{\pi}{3},\frac{2\pi}{3},\frac{\pi}{6},\frac{5\pi}{6} \quad \because x\in[-\pi,\pi]$$

24. A

$$\tan\left(5\pi\cos\theta\right) = \tan\left\{\frac{\pi}{2}-5\pi\sin\theta\right\}$$

$$\Rightarrow 5\pi\cos\theta = n\pi+\left(\frac{\pi}{2}-5\pi\sin\theta\right)$$

$$\Rightarrow \cos\theta+\sin\theta = \frac{2n+1}{10}$$

$\Rightarrow \sin\left(\theta + \frac{\pi}{4}\right) = \frac{2n+1}{10\sqrt{2}}$

$n = 14,$ for each n thane are two values of θ

$\therefore 28\, solutions$

25. B

Let $\tan x = t$

$\therefore$ equation reduces to

$\frac{4t^2}{1+t^2} + t^2 + \frac{2}{t^2} = 5$

$\Rightarrow \left(t^2 - 1\right)\left(t^4 + t^2 - 2\right) = 0$

$\Rightarrow t^2 = 1, -2$

$x = \frac{\pi}{4}, \frac{3\pi}{4}$

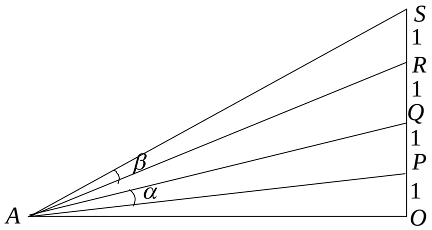
26. C

$\sin^2\left(\frac{x}{2}\right) = \frac{x}{(2n+1)\pi}$

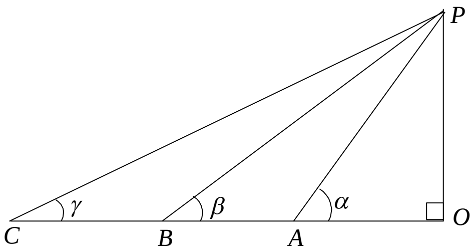
The last point after which graph of $y = \frac{x}{(2n+1)\pi}$ will stop cutting will be $(2n+1)\ \pi$

$\therefore$ Total intersection $= 2(n+1)$

27. C



28. B



29. A

Putting n = 1 $P(1) = 7^2 + 2°.3° = 50 = 2\times 25$

Also confirm by $P(n) \Rightarrow P(n+1)$ induction step

30. D

$n(n+1)$ is always even. So given $P(n)$ is wrong.

FIITJEE Students From All Programs have bagged 33 in Top 100, 77 in Top 200 and 205 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2015:
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ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Main), 2016**

HALF COURSE TEST – V

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 02 and 09 to 30)** contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (03 to 08) contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 marks** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

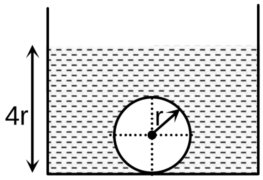
Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. When the temperature of a gas, filled in a closed vessel, is increased by 1^0C its pressure increases by 0.4 %. The initial temperature of the gas is,
(A) 250 K
(B) 2500 K
(C) 250^0C
(D) 25^0C

2. A string of linear mass density 0.8 kg/m is stretched to a tension 500 N. The mean power required to maintain a travelling wave of amplitude of 10 mm and wavelength 0.5 m is
(A) 70 W
(B) 85.3 W
(C) 98.7W
(D) 110 W

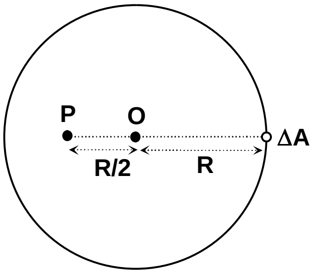
3. A spherical metal ball of radius 'r' is lying at the bottom of a stationary container containing liquid of density ρ as shown in the figure. Find the force exerted on the upper hemispherical portion of the sphere due to gauge pressure (P_0 = atmospheric pressure).



(A) $\frac{\pi r^2}{3}\left[3P_0 + 7r\rho g\right]$
(B) $\frac{\pi r^2}{2}\left[3P_0 + 7r\rho g\right]$
(C) $\pi r^2\left[3P_0 + 7r\rho g\right]$
(D) $2\pi r^2\left[3P_0 + 7r\rho g\right]$

4. A spring mass system executes damped harmonic oscillations given by the equation
$$y = Ae^{-\frac{bt}{2m}}\sin(\omega' t + \phi) \text{ where } \omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}},$$
where the symbols have their usual meanings.
If a 2 kg mass (m) is attached to a spring of force constant(K) 1250 N/m, the period of the oscillation is (π/12)s. The damping constant 'b' has the value.
(A) 9.8 kg/s
(B) 2.8 kg/s
(C) 98 kg/s
(D) 28 kg/s

Space for rough work

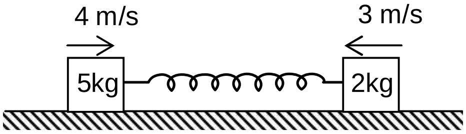


5. A small section of area 'ΔA' is removed from a uniform spherical shell with surface mass density σ and radius 'R' as shown in the figure. Find the magnitude of gravitational field intensity at point P due to the remaining mass.

(A) $\frac{4\sigma\Delta AG}{9R^2}$
(B) $\frac{4\sigma\Delta AG}{R^2}$
(C) $\frac{\sigma\Delta AG}{R^2}$
(D) zero

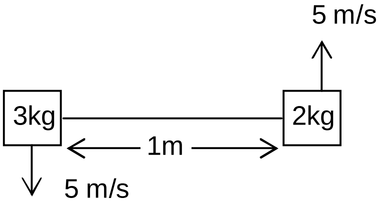
6. A horizontal spring mass system is executing SHM with time period of 4 sec. At time t = 0, it is at mean position. Find the minimum time after which its potential energy becomes three times of kinetic energy.

(A) 1 sec
(B) 1/2 sec
(C) 1/3 sec
(D) 2/3 sec



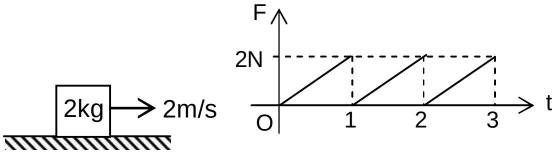
7. Two blocks connected with the spring of force constant 100 N/m are given velocities $4\hat{i}$ m/s and $-3\hat{i}$ m/s when the spring is in natural length as shown in figure

(A) The velocity of 2kg block is maximum when 5 kg block is at instantaneous rest.
(B) The maximum and minimum velocities of 2kg block is $7\hat{i}$ m/s and $-3\hat{i}$ m/s respectively.
(C) The maximum and minimum velocities of 5kg block is 4 m/s and zero respectively.
(D) All of the above



8. Two blocks of masses 2kg and 3kg are connected by string of length 1m. At any instant the velocities of block of mass 2kg and 3kg is 5 m/s in opposite direction and perpendicular to the length of string and is also parallel to horizontal table.

(A) Tension in the string is 110 N
(B) Tension in the string is 120 N
(C) Velocity of centre of mass is 2 m/s
(D) Velocity of centre of mass is 5 m/s



(a)

(b)

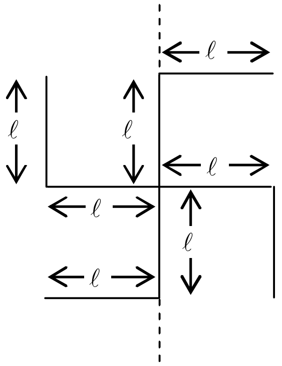
9. A block of mass 2kg starts moving at t = 0 with speed 2m/s on a smooth horizontal surface. A horizontal force F is applied in the direction of velocity which varies with time shown in figure (b) the speed of particle at t = 3 seconds (g = 10 m/s^2)

(A) 2.5 m/s
(B) 3.5 m/s
(C) 4.5 m/s
(D) none of these

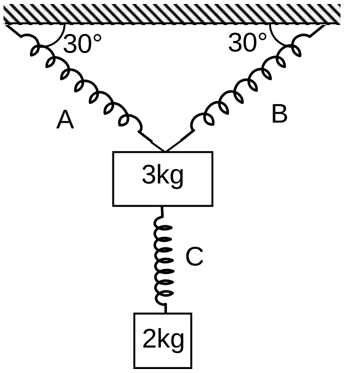
Space for rough work

10. Two objects of mass 3kg and 2kg move along x and y axis with speed 4 m/s and 3 m/s respectively on the horizontal smooth table. After collision the bodies stick together. Then
(A) Heat generated in the process is 15 J
(B) Heat generated in the process is 18 J
(C) Direction of motion with x-axis after collision is 60°.
(D) Direction of motion with x-axis after collision is $\tan^{-1}\left(\frac{1}{3}\right)$.

11. In the shown figure the linear mass density of the rod is λ and dimension are shown in figure. The moment of inertia about the dashed axis is
(A) $\frac{4}{3}\lambda\ell^3$
(B) $\frac{8}{3}\lambda\ell^3$
(C) $\frac{10}{3}\lambda\ell^3$
(D) $4\lambda\ell^3$



12. A block of mass 3kg is connected with two identical massless springs A and B and a block of mass 2kg is hanging with a third identical spring C as shown in figure then the magnitude of acceleration of 3kg and 2kg block just after cutting the spring A
(A) $\frac{25}{3}$ m/s^2 and zero
(B) $\frac{50}{3}$ m/s^{2}and zero
(C) $\frac{50}{3}$ m/s^2, 10 m/s^2
(D) 20 m/s^2, zero m/s^2



13. Two particles of masses 1kg and 2kg are moving with constant velocities 2m/s$(\hat{i})$ and 5m/s$(\hat{i})$ respectively and crosses the y-axis simultaneously at t = 0 sec and are moving on a smooth horizontal xy-plane. The separation between the two particles is 10 meter at t =0. The angular momentum of 2kg particle with respect to 1kg particle at t = 5 sec is
(A) 20 N-m-sec
(B) 40 N-m-sec
(C) 60 N-m-sec
(D) 80 N-m-sec

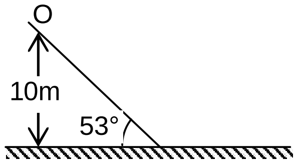
Space for rough work

14. A particle moves along an arbitrary path. If $\vec{v}$ and $\vec{a}$ are the instantaneous velocity and acceleration vectors of the particle, then the ratio of magnitude of tangential and centripetal acceleration is

(A) $\frac{|\vec{a}\cdot\vec{v}|}{|\vec{a}\times\vec{v}|}$ (B) $\frac{|\vec{a}\times\vec{v}|}{|\vec{a}\cdot\vec{v}|}$

(C) $\frac{d\vec{v}/dt}{d|\vec{v}/dt}$ (D) None of these

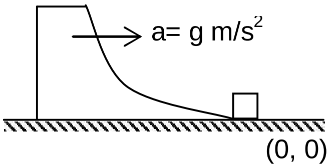
15. A ball is released from rest at a height of 10m on an inclined plane of inclination 53°. If collision is in elastic then find the horizontal velocity of the ball



(A) $10\sqrt{2}$ (B) $6\sqrt{2}$

(C) $12\sqrt{2}$ (D) $14\sqrt{2}$

16. A wedge whose curved surface is parabolic in shape and has equation $x^2 = 4y$ starts accelerating with acceleration g m/s^2 when a block is at the bottom of wedge and is located at (0, 0). The maximum height attained by the block (assume the curved surface is sufficiently long)



(A) 1m (B) 2m

(C) 4m (D) 8m

17. The ratio of magnitude of work done in moving slowly a block of mass m on a rough inclined surface of inclination $\theta = 45°(\tan\theta > \mu)$ from bottom to top and from top to bottom is 5. The coefficient of friction between the block and surface is

(A) $\frac{1}{2}$ (B) $\frac{2}{3}$

(C) $\frac{2}{5}$ (D) $\frac{4}{5}$

18. Four identical particles of mass m are projected along the plane towards the centre of a square from the corners of the square simultaneously with constant speed V_0. Then

(A) If the two spheres comes to rest after collision then the other two must also come to rest after collision.

(B) If the three spheres comes to rest after collision then the fourth one must also stop after collision.

(C) If all comes to rest after collision then loss of energy is $4mV_0^2$.

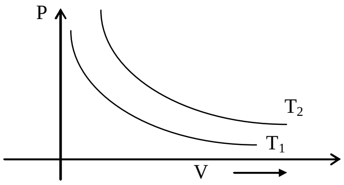
(D) If all comes to rest after collision then it will violate the law of conservation of momentum.

Space for rough work

19. Figure shows the pressure P versus volume V graphs for a certain mass of an ideal gas at two constant temperatures T_1 and T_2.

Which of the following option is correct?

(A) $T_1 = T_2$
(B) $T_1 > T_2$
(C) $T_1 < T_2$
(D) no inference can be drawn due to insufficient information.

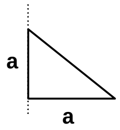


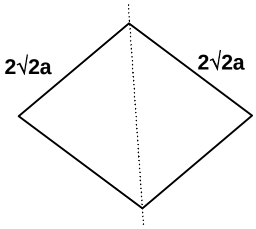
20. Two identical vessels A and B contain mass m and 2m of same gas respectively. The gases in the vessels are heated keeping their volumes constant and equal. The Temperature-Pressure curve for mass 2m makes angle α with T-axis and that for mass m makes an angle β with T-axis then

(A) $\tan \alpha = \tan \beta$ (B) $\tan \alpha = 2 \tan\beta$
(C) $\tan \beta = 2 \tan\alpha$ (D) None of these

21. If the moment of inertia of a isosceles right angle plate is I about an axis shown in figure. Then moment of inertia of a square plate of same material and thickness shown in figure about the given axis is

(A) 30I (B) 32I
(C) 64I (D) 90I

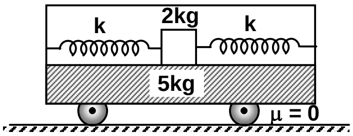




22. Two simple pendulum of length ℓ and 16 ℓ are released from the same phase together. They will be at the same phase after a minimum time.

(A) $\frac{8\pi}{3}\sqrt{\frac{\ell}{g}}$ (B) $\frac{\pi}{3}\sqrt{\frac{\ell}{g}}$
(C) 2s (D) none of these

Space for rough work



23. Two springs, each of spring constant k = 100 N/m are attached to a block of mass 2 kg as shown in figure. The block can slide smoothly along horizontal platform clamped to the opposite walls of trolley of mass 5 kg. The block is slightly displaced and then released. The period of oscillation is (in seconds). (all surfaces are smooth).

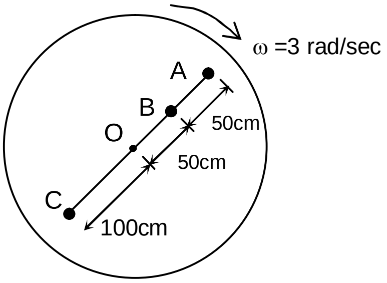
(A) $T = 2\pi\sqrt{\frac{7}{1000}}$
(B) $T = 2\pi\sqrt{\frac{1}{140}}$
(C) $T = 2\pi\sqrt{\frac{1}{20}}$
(D) $T = 2\pi\sqrt{\frac{49}{100}}$

24. Two particles are executing SHM of equal amplitude along parallel lines with same time period. Their velocity vectors are always oppositely directed to each other. The minimum phase difference between the two particles is

(A) 0°
(B) 90°
(C) 180°
(D) 270°

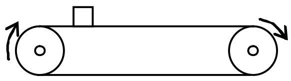
25. Which of the following statements is **incorrect?**

(A) Work done is zero if the point of application of force does not move.
(B) Total work done by static friction is zero in rolling without slipping for the complete system.
(C) Work done by friction must be zero in pure rolling for the rolling body.
(D) For an isolated system momentum of the system is conserved for any type of collision.



26. Three small spheres A, B and C of masses 1kg, 2kg and 3kg are rotating with a circular disc with angular velocity 3 radian/sec and are connected with strings to O as shown in figure. Coefficient of friction between spheres A, B, C and disc is 0.4, 0.3 and 0.2 respectively.

(A) Friction force acting on sphere B is 6 N.
(B) Tension in the string connecting sphere A and B is 9 N
(C) Tension in the string connecting sphere C and O is 8 N
(D) Data insufficient

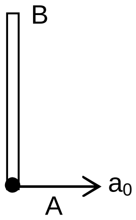


27. A block of mass 2kg is kept gently on a moving tape of a machine in which the rotating cylinders have angular speed of 20 rad/sec and there radius is 20cm. If coefficient of friction between the tape and block is 0.5 and there is no slipping between tape and cylinder. Then (take $g = 10\ m/s^2$)

(A) The distance travelled by the block before relative motion with tape ceases is 1.6 m
(B) Work done by friction on the block is 8 N
(C) Work done by friction on the block is – 16 N
(D) Linear velocity of tape is 40 m/s

Space for rough work

28. A rod of mass m kg and length ℓ meter is hinged about its end A and is vertical initially. Now the end A is accelerated horizontally with acceleration a_0 = g m/s^2. The hinge reaction when the rod becomes horizontal is



(A) $R_x = \frac{4mg}{3}N, R_y = \frac{mg}{3}N$ (B) $R_x = \frac{mg}{3}N, R_y = \frac{mg}{4}N$
(C) $R_x = \frac{mg}{4}N, R_y = \frac{mg}{3}N$ (D) $R_x = 4mgN, R_y = \frac{mg}{4}N$

29. The temperature at which the speed of sound wave in helium gas is same as that in hydrogen gas at 27°C, is
(A) 504°C (B) 45°C
(C) 327°C (D) 231°C

30. A triangular wave pulse on a taut string travels in positive x-direction with speed v. The tension in the string is F, and linear mass density of string is μ. At t = 0, the shape of pulse is given by

$$y(x,0) = \begin{cases} 0 & \text{if} \quad x < -L \\ \frac{h(L+x)}{L} & \text{for} \quad -L < x < 0 \\ \frac{h(L-x)}{L} & \text{for} \quad 0 < x < L \\ 0 & \text{for} \quad x > L \end{cases}$$

choose the correct statement.
(A) Magnitude of instantaneous power is zero for $-L < (x - vt) < 0$
(B) Magnitude of instantaneous power is $Fv\left(\frac{h}{L}\right)^2$ for $(x - vt) < -L$
(C) Magnitude of instantaneous power is $Fv\left(\frac{h}{L}\right)^2$ for $(x - vt) > L$
(D) Magnitude of instantaneous power is $Fv\left(\frac{h}{L}\right)^2$ for $0 < (x - vt) < L$

Space for rough work

Chemistry

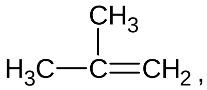
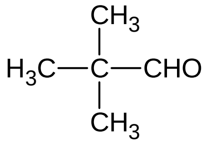
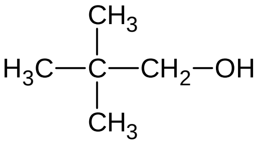
PART - 1

SECTION – A

Straight Objective Type

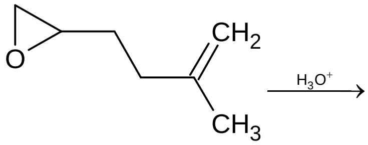
This section contains 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which only one is correct.

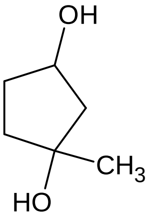
1. The velocity of electron in the second orbit of He^+ will be
(A) 2.18×10^6 m / s
(B) 1.09×10^6 m / s
(C) 3.8×10^6 m / s
(D) 6.8×10^{-6} m / s

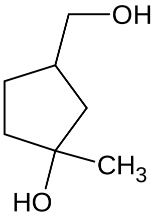
2. A mixture of $(CH_3)_3C-CHO$and HCHO on heating with aqueous KOH solution will give
(A) HCOONa + $(CH_3)_3C-CH_2-OH$
(B)

$H_3C-C(CH_3)=CH_2$, HCOONa
(C) HCOONa +

$H_3C-C(CH_3)_2-CHO$
(D) H_3C-CH_2-OH +

$H_3C-C(CH_3)_2-CH_2-OH$

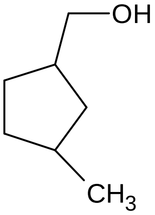
3. For the reaction:
$R-X+OH^- \longrightarrow ROH+X^-$
The rate of reaction is given as follows.
Rate = 4.74×10^{-5} [R – X] [OH^-] + 0.24×10^{-5} [RX].
What percentage of R – X will react by SN_2 path if [OH^-] = 10^{-3} molar
(A) 1.93
(B) 4.74
(C) 2.37
(D) 4.9

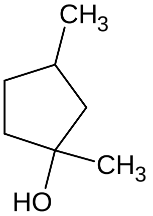
Space for rough work

4.  A, A is

(A) 

(B) 

(C) 

(D) 

5. If the radius of Bohr's is x, then de Broglie wavelength of electron in 3rd orbit is nearly

(A) $4\pi x$
(B) $6\pi x$
(C) $8\pi x$
(D) $\pi\frac{x}{3}$

6. Which of the following reagent solution can be used to distinguish between methanoic acid & ethanoic acid?

(A) Tollen's reagent
(B) $FeCl_3$ solution
(C) $FeSO_4/H_2O_2$
(D) Na_2CO_3 solution

7. Si-F bond is stronger than C-F bond due to

(A) Larger size of silicon atom
(B) Larger electronegativity difference between Si & F
(C) The presence of $p\pi$ - $d\pi$ bonding
(D) Overlapping of P – P atomic orbital

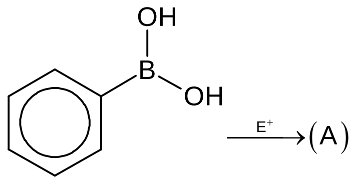
Space for rough work

8. Which of the following species have the bond order same an N_2?
(A) CN^- (B) OH^-
(C) NO^- (D) CO^+

9. In FCC lattice of NaCl structure, if the diameter of Na^+ is X & radius of Cl^- is Y, then bond length of NaCl in the crystal is
(A) 2x + 2y (B) x + y
(C) $\frac{x}{2}+\frac{y}{2}$ (D) $\frac{x}{3}+\frac{x}{2}$

10. CsCl has bcc structure with Cs^+ at the centre and Cl^- ion at each corner. If $rCs^+ = 1.69\ \overset{0}{A}$ & $rCs^- = 1.81\ \overset{0}{A}$. What is the edge lenght 'a' of each cube?
(A) $\frac{5}{\sqrt{2}}$ (B) $\frac{6}{\sqrt{3}}$
(C) $\frac{7}{\sqrt{3}}$ (D) $\frac{4}{\sqrt{3}}$

11. In the metallurgy of iron, when lime stone is added to the blast furnace, the calcium ion ends up in
(A) slag (B) gangue
(C) metallic calcium (D) calcium carbonate

12. 

In the product (A), the electrophile will be attached to the which position w.r.t $-B(OH)_2$ group
(A) ortho (B) para
(C) meta (D) ipso

13. Find total number of product as a result of given reaction:
$CH_3-CH=CH-CH_2-COOAg \xrightarrow{Br_2/CCl_4/\Delta}$
(A) 3 (B) 4
(C) 5 (D) 6

14. The aqueous solution of each of the following salt is coloured except
(A) $TiCl_4$ (B) $FeCl_3$
(C) $CuCl_2$ (D) $MnCl_2$

Space for rough work

15. Which of the following salt will not produce black ppt on passing $H_2S(g)$ through their aqueous salt solution in acidic medium?
(A) $CuSO_4$ (B) $PbCl_2$
(C) $CdSO_4$ (D) $NiCl_2$

16. A current of 2A passing for 1.93×10^4 sec through a molten Tin salt depositing 23.8 g Tin. The oxidation state of Tin in the salt is (given atomic number of Tin = 119)
(A) 2 (B) 4
(C) 1 (D) 3

17. What volume strength of 200 ml H_2O_2 required for complete reaction of 7.9 g of $KMnO_4$ in basic medium?
(A) 1.86 (B) 11.2
(C) 1.4 (D) 5.6

18. The molecular weight of an acid is 82. In a titration, 100 ml of solution of this acid containing 39 gm of acid per litre were completly neutralized by 95 cc of aqueous NaOH containing 40 gm NaOH per litre. What is the basicity of the acid?
(A) 1 (B) 2
(C) 3 (D) 4

19. Two sample of HI each of 5 gm were taken separately in two vessels of volume 5 & 10 litre respectively at 27°C. The extent of dissociation of HI will be
(A) more in 5 litre vessel (B) more in 10 litre vessel
(C) equal in both vessel (D) nota

20. The ratio of equivalent weight of oxidant & reductant in
$$C_2H_5OH + OH^- + I_2 \longrightarrow CHI_3 + HCO_2^- + H_2O + I^-$$
(A) 1:2 (B) 2:1
(C) 2:3 (D) 3:2

21. What is the pH of 10^{-3} M solution of NH_4OH ($K_b = 1.85 \times 10^{-5}$ M) at 25°C?
(A) 10.75 (B) 10.14
(C) 9.65 (D) 9.10

22. Which of the following compound would you expect to be molecular?
(A) N_2O (B) PCl_5
(C) $CaCl_2$ (D) both (A) & (B)

Space for rough work

23. Which one of the following shows maximum paramagnetic character?

(A) $\left[Cr(H_2O)_6\right]^{3+}$ (B) $\left[Fe(CN)_6\right]^{4-}$

(C) $\left[Fe(CN)_6\right]^{3-}$ (D) $\left[Cu(H_2O)_6\right]^{2+}$

24. Boron has two isotopes ${}^{10}_{5}B$ and ${}^{11}_{5}B$. If the atomic weight of boron is 10.81, the ratio of ${}^{10}_{5}B$ and ${}^{11}_{5}B$ in nature is

(A) 19/81 (B) 20/53

(C) 15/16 (D) 10/11

25. Which of the following is non stoichiometric and metal deficient?

(A) FeO (B) Fe_3O_4

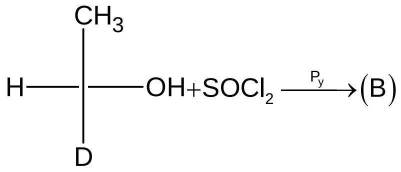
(C) Fe_2O_3 (D) all of these

26. Percentage of gold in 22 carat gold is

(A) 15 (B) 85

(C) 92.6 (D) 37.5

27. $CH_3-CH_2-OH+Na \longrightarrow (A)$

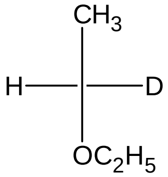


$\mathrm{H{-}\overset{CH_3}{\underset{D}{C}}{-}OH+SOCl_2 \xrightarrow{P_y} (B)}$

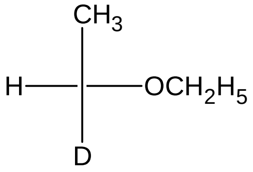
$A+B \longrightarrow (C)$

Find (C).

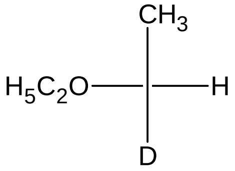
(A)



(B)



(C)



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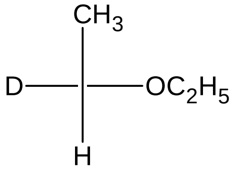
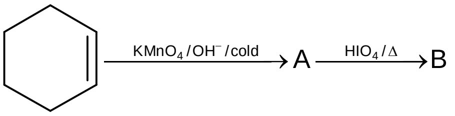


Space for rough work

28. Potassium 40 decay to Argon – 40 with a half life of 1.27×10^9 years. What is the age of rock in which the mass ratio of ^{40}Ar to ^{40}K is 3.6?

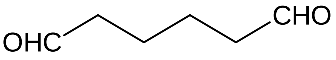
(A) 3.2×10^9 years
(B) 4.2×10^9 years
(C) 2.8×10^9 years
(D) 6.4×10^8 years

29.



Compound B is

(A)



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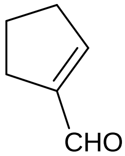
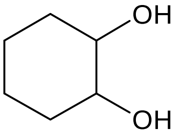


(C)



(D) None

30. The number of moles of $Cr_2O_7^{2-}$ needed to oxidise 0.136 equivalent of $N_2H_5^+$ by the reaction:

$$N_2H_5^+ + Cr_2O_7^{2-} \longrightarrow N_2 + Cr^{3+} + H_2O$$

is

(A) 0.136
(B) 0.272
(C) 0.816
(D) 0.0227

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains ***30 multiple choice questions*** *numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which* ***ONLY ONE*** *is correct*

1. If $N = \left(7 + 4\sqrt{3}\right)^n = P + B$ ($n \in N$) where P is the integral part of at N and B is the positive proper fraction then the value of (1 – B)(P + B)

(A) 1 (B) 2
(C) 3 (D) 4.

2. If {x} denotes the fractional part of 'x' then find the value of $\left\{\frac{3^{2n}}{8}\right\}$ where $n \in N$.

(A) $\frac{1}{2}$ (B) $\frac{1}{4}$
(C) $\frac{1}{8}$ (D) $\frac{1}{16}$.

3. The 8^m term in the expansion of $(1+2x)^{-1/2}$

(A) $(1)^7 \frac{(1.3.5...13)x^7}{7!}$ (B) $(-1)^7 \frac{(1.3.5...13)x^7}{7!}$
(C) $(-1)^6 \frac{(1.3.5...13)x^6}{6!}$ (D) None of these.

4. If A_0, A_1, A_2, A_3, A_4 and A_5 be the consecutive vertices of a regular hexagon inscribed in a unit circle. Then find the product of length of A_0A_1, A_0A_2, and A_0 A_4.

(A) 1 (B) 3
(C) 5 (D) 7

Space for rough work

5. Number of positive real value of x such that x, [x] and {x} are in H.P. (where [x] and {x} denotes the greatest integer and fraction part of x) is equal
(A) 1 (B) 2
(C) 0 (D) 3.

6. From the points on the circle $x^2 + y^2 = 4$ tangents are drawn to the ellipse $\frac{x^2}{4}+\frac{y^2}{3}=1$. If the locus of middle points of the chord of contact is the curve $a(bx^2 + cy^2) = (dx^2 + ey^2)^2$, then the value of $\left[\frac{a+b+c+d+e}{5}\right]$ where ([.] → G.I.P.)
(A) 4 (B) 5
(C) 6 (D) 9.

7. Let $a_1, a_2, a_3 \ldots a_{201}$ are in G.P. with $a_{101} = 25$ and $\sum_{i=1}^{201} a_i = 625$. Then one value of $\sum_{i=1}^{201} \frac{1}{a_i}$ is equal to
(A) 5 (B) 25
(C) 125 (D) 1.

8. If $x = \sec\theta - \cos\theta$ and $y = \sec^3\theta - \cos^3\theta$ then the value of $\left(\frac{dy}{dx}\right)^2$ at x = 0 is
(A) 0 (B) 2
(C) 4 (D) 9.

9. $\frac{x}{a}+\frac{y}{b}=1$ is a variable line, where $\frac{1}{a^2}+\frac{1}{b^2}=\frac{1}{c^2}$ (c is a constant). Locus of the foot of perpendicular drawn from origin to the variable line is
(A) $x^2 - y^2 = c^2$ (B) $x^2 + y^2 = c^2$
(C) $-x^2 + y^2 = c^2$ (D) $-x^2 - y^2 = c^2$

10. If the locus of the middle point of the chords of the parabola $y^2 = 4ax$ which subtends angle α at the vertex is $(32 + y^2 - 4x)^2 \tan^2\alpha = 64(8x - y^2)$ then the value of a is
(A) 1 (B) 2
(C) 3 (D) 4.

Space for rough work

11. The sum of real values of k for which the cubic $x^3 - kx + k - 1 = 0$ has exactly two distinct real solution

(A) $\frac{13}{4}$ (B) $\frac{15}{4}$

(C) $\frac{3}{4}$ (D) $\frac{11}{4}$

12. In triangle, if $\Delta = a^2 - (b - c)^2$ then tanA is equal to

(A) $\frac{7}{15}$ (B) $\frac{8}{15}$

(C) $\frac{11}{15}$ (D) $\frac{13}{15}$.

13. The value of the expression $\sum_{n=1}^{\infty} \frac{\tan\frac{(2n-1)\pi}{4}}{2^{n+1}}$ is

(A) $\frac{1}{2}$ (B) $\frac{1}{3}$

(C) $\frac{1}{6}$ (D) $\frac{2}{3}$.

14. Let $f(x) = (1 + b^2)x^2 + 2bx + 1$ and let m(b) be one minimum value of f(x). As b varies, the range of m(b) is

(A) [0, 1] (B) $\left(0, \frac{1}{2}\right]$

(C) $\left[\frac{1}{2}, 1\right]$ (D) $(0,1]$.

15. A line y = x + 2 is drawn on the co-ordinate plane. This line is rotated by 90º clockwise about the point (0, 2). A line y = – 2x + 10 is drawn and area of this triangle is Δ, then the value [Δ] is ([] → is G.I.F.)

(A) 128 (B) 64

(C) 21 (D) 20.

Space for rough work

16. Number of integers satisfying the inequalities

$$\sqrt{\log_3 x - 1} + \frac{\frac{1}{2}\log_3 x^3}{\log_3 \frac{1}{3}} + 2 > 0 \text{ , is}$$

(A) 5 (B) 6
(C) 7 (D) 8.

17. If the equation $||x+3|-2| = p$, where p is a constant integer has exactly three distinct solution then the number of integral values of p, is
(A) 0 (B) 1
(C) 2 (D) 4

18. Let $A = \{x : (x+2)(x-4) \le 0\}$, and $B = \{x : x^2 - ax + 4 \le 0\}$ if A ∪ B = A, then the largest integral value of a is
(A) 3 (B) 4
(C) 5 (D) 6.

19. If $\cos\theta_1 = \frac{2\cos\theta_2 - 1}{2 - \cos\theta_2}$ where $\theta_1, \theta_2 \in (0, \pi)$, then the value of $\frac{\tan^2 \frac{\theta_1}{2}}{\tan^2 \frac{\theta_2}{2}}$ is equal to
(A) 1 (B) 2
(C) 3 (D) 4.

20. Let $P(x) = x^5 + x^2 + 1$ have roots x_1, x_2, x_3, x_4 and x_5 $g(x) = x^2 - 2$, then the value of $g(x_1) \,.\, g(x_2) \,.\, g(x_3) \,.\, g(x_4) \,.\, g(x_5) - 30g(x_1x_2x_3x_4x_5)$ is
(A) 1 (B) 2
(C) 4 (D) 7.

21. If a + b + c = 0 and $a^2 + b^2 + c^2 = 1$ then the value of $2(a^4 + b^4 + c^4)$ is
(A) 1 (B) 2
(C) 3 (D) 3.

Space for rough work

22. If the value of $\alpha \in [0, 2\pi]$ such that the inequality $\sin\left(\frac{\pi}{3}+x\right)+\sin(\alpha+x) \geq 0$ is true for all that number x, is equal to $\frac{p\pi}{q}$ where p and q are relatively prime positive integers, then the value of (p + q) is

(A) 3 (B) 5
(C) 7 (D) 9

23. $f(x) = x^3 + px^2 + qx + 6$, where p, q $\in$ R if $f'(x)$ is negative in largest possible interval $\left(\frac{-5}{3}, -1\right)$, then the value of (p + q) is

(A) 3 (B) 5
(C) 7 (D) 9

24. In a ΔABC, the tangent of half the difference of two angles is one third the tangent of half the the sum of same angles. The ratio of the sides opposite to the angles.

(A) 2 : 1 (B) 1 : 2
(C) 2 : 4 (D) 4 : 2.

25. If $\cos^{-1}x + \cos^{-1}y + \cos^{-1}z = 3\pi$ then compute the value of

$$x^{2004} + y^{2004} + z^{2004} + \frac{6}{x^{2003} + y^{2003} + z^{2003}}$$

(A) 0 (B) 1
(C) 2 (D) none of these.

Space for rough work

26. Area of the parallelogram formed by the lines y = mx, y = mx + 1, y = nx and y = nx + 1 equals

(A) $|m + n|(m - n)^2$ (B) $\frac{2}{|m+n|}$

(C) $\frac{1}{|m-n|}$ (D) $\frac{1}{|m+n|}$.

27. Let PQ and RS be tangents at the extremities of the diameter PR of a circle of radius r, If PS and RQ intersect at a point x on the circumference of the circle, then 2r equals.

(A) $\sqrt{PQ\,.\,RS}$ (B) $\frac{(PQ+RS)}{2}$

(C) $\frac{2PQ\,.\,RS}{(PQ+RS)}$ (D) $\sqrt{\frac{(PQ^2+RS^2)}{2}}$.

28. If a > 2b > 0 then positive value of m for which $y = mx - b\sqrt{1+m^2}$ is a common tangent to $x^2 + y^2 = b^2$ and $(x - a)^2 + y^2 = b^2$ is

(A) $\frac{2b}{\sqrt{a^2-4b^2}}$ (B) $\frac{\sqrt{a^2-4b^2}}{2b}$

(C) $\frac{2b}{a-2b}$ (D) $\frac{b}{a-2}$.

29. The locus of the orthocentre of the triangle formed by the lines
$(1 + p)x - py + p(1 + p) = 0$
$(1 + q)x - qy + q(1 + q) = 0$ and $y = 0$, where $p \neq q$ is

(A) a hyperbola (B) a parabola

(C) an ellipse (D) a straight line.

30. Let $a_1\ a_2 \dots a_{10}$ be in A.P. $h_1\ h_2 \dots h_{10}$ be in H.P. if $a_1 = h_1 = 2$ and $a_{10} = h_{10} = 3$, then $a_4\ h_7$is

(A) 2 (B) 3

(C) 5 (D) 6

Space for rough work

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Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	A	A
2.	C	A	C
3.	A	A	B
4.	D	B	B
5.	A	B	A
6.	D	A	D
7.	D	C	D
8.	B	A	D
9.	B	C	B
10.	A	C	B
11.	C	A	B
12.	B	C	B
13.	C	B	C
14.	A	A	D
15.	B	C	C
16.	C	A	B
17.	B	C	C
18.	B	B	C
19.	C	B	C
20.	B	A	D
21.	C	B	A
22.	A	D	C
23.	B	A	D
24.	C	A	A
25.	C	D	B
26.	A	C	C
27.	A	B	A
28.	D	C	A
29.	D	A	D
30.	D	D	D

Physics

PART – I

SECTION – A

1. For isochoric process $P \propto T$

   $\therefore \quad \frac{\Delta P}{P} = \frac{\Delta T}{T}$

   $\therefore \quad T = \frac{\Delta T P}{\Delta P} = \frac{1 \times 100}{0.4} = 250$ K.

2. $P = \frac{1}{2}\mu\omega^2 a^2 v$

   $\omega = \frac{2\pi v}{\lambda}$ and $v = \sqrt{\frac{T}{\mu}}$

3. $P_0(\pi r^2)$ + weight of liquid above sphere.

4. $\omega' = \sqrt{\frac{K}{m} - \frac{b^2}{4m^2}}$

5. $I_{shell} + I_{element} = 0$

6. $\frac{1}{2}m\omega^2(A^2 - x^2) = \frac{1}{3}\left(\frac{1}{2}m\omega^2 x^2\right)$

   $\Rightarrow \quad x = \frac{\sqrt{3}}{2}A = A\sin\omega t$

   $\Rightarrow t = 2/3$ sec

7. $v_{CM} = \frac{20-6}{7} = 2$ m/s …(i)

   $\frac{1}{2}5(4)^2 + \frac{1}{2}(2)(3)^2 = \frac{1}{2}5v_1^2 + \frac{1}{2}2v_2^2$ …(ii)

   $v_{CM} = 2 = \frac{5v_1 + 2v_2}{7}$ …(iii)

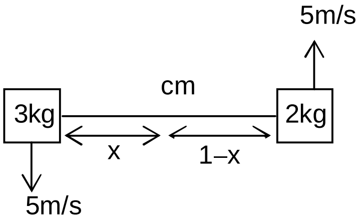
   Solving (ii) and (iii), we lead to desired result.

8. From centre of mass frame

   $T = \frac{mv^2}{r}$

   $T = \frac{3(4)^2}{(2/5)} = 120N$, where x = 2/5

   where, $v_{CM} = \frac{10-15}{5} = -1$ m/s



9. $v^2 - u^2 = kt^2/2m$

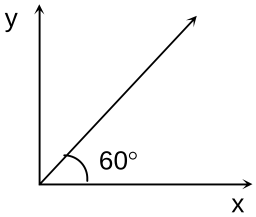
10. Momentum conservation

    $12\hat{i} + 6\hat{j} = 5\vec{v}$

    $\vec{v} = \frac{12\hat{i} + 6\hat{j}}{5}$ m/s

    So, $\tan\theta = 6/12$

    $\Rightarrow \theta = \tan^{-1}(1/2)$



$$=\left\{\frac{1}{2}\times\frac{5(144+36)}{25}\right\}-\left\{\frac{1}{2}\times3\times4^2+\frac{1}{2}\times2\times3^2\right\}=\left(\frac{1}{10}\times180\right)-(33)=-15J$$

11. $I=\frac{4m\ell^2}{3}+2m\ell^2$ when $(m=\lambda\ell)$

12. 2F cos 60° = 3g + 2g

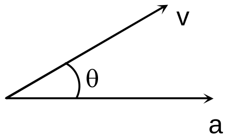
$2F_S\frac{1}{2}=3g+2g$

$\Rightarrow F_s = 50$

So, a = 50/3 m/s^2

13. $\vec{L}=\vec{r}\times\vec{p}$

14. $a\cos\theta=\frac{|\vec{a}\cdot\vec{v}|}{v}$



$a\sin\theta=\frac{|\vec{a}\times\vec{v}|}{v}$

29 $\sqrt{\frac{\gamma_1RT_1}{M_1}}=\sqrt{\frac{\gamma_2RT_2}{M_2}}$

30 $P(x,t)=-F\frac{\partial y}{\partial x}\cdot\frac{\partial y}{\partial t}$

Chemistry PART – II

SECTION – A

1. Velocity of electron in nth orbit of H – like atom is given by:

$= 2.18 \times 10^6 \times \frac{2}{n} m/s$

For second orbit of He^{2+} ion:

Z = 2, n = 2

$\therefore$ Velocity of electron = 2.18×10^6 m/s

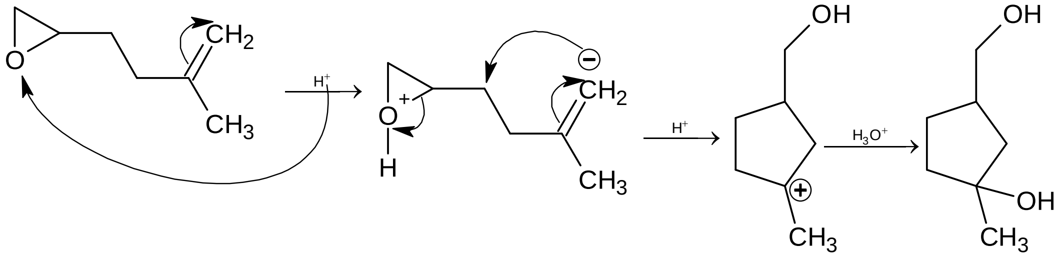
2. Cross Cannizzaro reaction will occur.

3. Percentage of SN_2 = $\frac{\text{Rate}\,SN_2}{\text{rate }SN_2 + \text{rate }SN_1} \times 100$

$= \frac{4.74 \times 10^{-5}[R-X][OH^-]}{4.74 \times 10^{-5}[R-X][OH^-] + 0.24 \times 10^{-5}[R-X]} \times 100$

= 1.93

4.



5. $r_n = \frac{n^2 a_0}{Z}$

$\therefore r_0 \propto n^2$

$\frac{r_3}{r_1} = \frac{9}{1}$

$r_3 = 9r_1 = 9x$

$mvr_n = \frac{nh}{2\pi}$

mv = $\frac{nh}{2\pi \times r_n}$

$= \frac{3 \times h}{2\pi \times 9x} = \frac{h}{6\pi x}$

$\lambda = \frac{h}{mv} = 6\pi x$

6. Because methanoic acid contain both aldehydic as well as carboxylic group.

7. Si-F bond is stronger than C-F bond due to the donation of electron from F to Si gives rise to pπ-dπ bonding.

8. N_2:

Bond order = $\dfrac{B.E - A.B.E}{2}$

$= \dfrac{10-4}{2} = 3$

CN^- is isoelectronic with N_2 & hence same B.O.

9. $\text{Bond length} = r_{Na^+} + r_{Cl^-}$

$= \dfrac{x}{2} + \dfrac{y}{2}$

10. The distance of closest approach between Cs^+ & Cl^-.
i.e. the half of the body digonal.

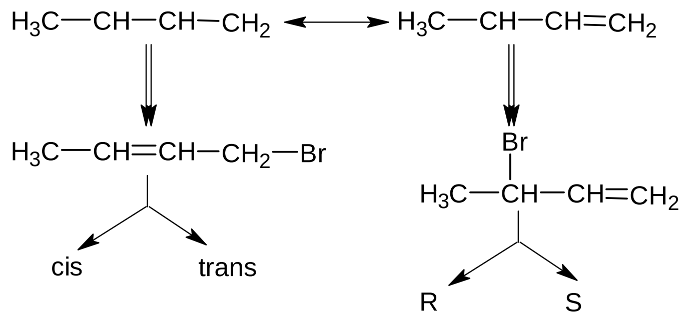
$= \dfrac{a\sqrt{3}}{2}$

$\dfrac{a\sqrt{3}}{2} = 1.69 + 1.81$

a = $\dfrac{3.50 \times 2}{\sqrt{3}} = \dfrac{7}{\sqrt{3}}$

11. $$\underset{\text{flux}}{CaCO_3} + \underset{\text{Impurity}}{SiO_2} \longrightarrow \underset{\text{slag}}{CaSiO_3} + CO_2$$

13.



14. Except $TiCl_4$ all other metal ion Fe^{3+}, Cu^{2+} & Mn^{2+} contains unpaired electron & are coloured.

15. CdS is yellow solid.

16. Q = i × t
= $2 \times 1.93 \times 10^4$

Number of Faraday $= \dfrac{2 \times 1.93 \times 10^4}{96500} = 0.4F$

Number of moles of till will deposite = $\dfrac{23.8}{119} = 0.2$ mole

Oxidation state $Sn = \dfrac{0.4}{0.2} = 2$

17. In basic medium:

$K\overset{+7}{Mn}O_4 \longrightarrow K_2\overset{+6}{Mn}O_4$; $n - \text{factor} = 1$

Let volume strength of H_2O_2 = x ml
Now meq of $KMnO_4$ = meq of H_2O_2

$$\frac{7.9}{158/1}\times 1000 = 200\times\frac{x}{5.6}$$

$$\frac{7.9\times 1000}{158} = \frac{200x}{5.6}$$

$$x = \frac{5.6}{4} = 1.4$$

18. $N \times V_{base} = N \times V_{acid}$

$$\frac{40\times 95}{40} = \frac{39\times 100}{82/n}$$

$$n = \frac{95\times 82}{39\times 100} = 2$$

19. α is inversely porportional to concentration.

20. 1 moles of C_2H_5OH = 1 mole of HCO_2^-
= 1 × 4 eq of HCO_2^-
$\therefore$ n factor for C_2H_5OH = 4

$$\therefore E_{C_2H_5OH} = \frac{M}{4}$$

Also,
4 moles of I_2 = 1 mole of CHI_3

1 mole of I_2 = $\frac{1}{4}$ mole of CHI_3

$$= \frac{1}{4}\times 8 \text{ eq } CHI_3 = 2 \text{ eq } I_2$$

21. By using:

$$\alpha = \sqrt{\frac{k_b}{c}} = \sqrt{\left(\frac{1.85\times 10^{-5}}{0.001}\right)} = 0.136$$

Hence,

$$\left[OH^-\right] = C\alpha = 10^{-3}\times 0.136 = 1.36\times 10^{-4}M$$

$$pOH = -\log\left[OH^-\right] = -\log\left(1.36\times 10^{-4}\right)$$

= –log 1.36 + 4 = 3.86
pH + pOH = 14
pH = 14 – pOH = 14 – 3.86 = 10.14

22. Ionic compound are generally combination of metals & non metals example $CaCl_2$, while molecule compound are generally composed of non metals only as in N_2O & PCl_5.

23. $\left[Cr\left(H_2O\right)_6\right]^{3+}$ contains three unpaired electron when as $\left[Fe\left(CN\right)_6\right]^{4-}$ contains zero unpaired electron. All other complexes have one unpaired electron each.

24. The percentage of ${}^{10}_{5}B$ = x
Then percentage of ${}^{11}_{5}B$ = 100 – x

$$= \frac{10x + (100 - x)11}{100} = 10.81$$

x = 19

The ratio of $\frac{{}^{10}_{5}B}{{}^{11}_{5}B} = \frac{19}{81}$

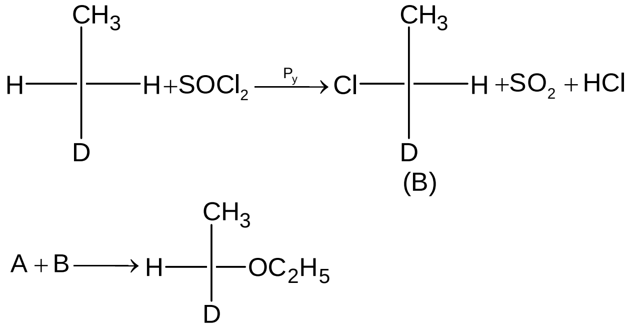
25. The fact that they are non stoichiometric is related to their structure, which are similar. The CCP structure differ only in the arrangement of Fe^{2+} and Fe^{3+} in the holes in the octahedral & tetrahedral crystal.

26. Percentage of gold $\frac{22}{24} \times 100$

27.

$$CH_3 - CH_2 - OH + Na \longrightarrow CH_3 - CH_2 - ONa + \frac{1}{2}H_2$$

(A)



$$H-\overset{CH_3}{\underset{D}{|}}-H + SOCl_2 \xrightarrow{P_y} Cl-\overset{CH_3}{\underset{D}{|}}-H + SO_2 + HCl$$

$$A + B \longrightarrow H-\overset{CH_3}{\underset{D}{|}}-OC_2H_5$$

28. $K = \frac{0.693}{1.27 \times 10^{9}} = 5.46 \times 10^{-10}\ \text{year}^{-1}$

If the mass of ${}^{40}Ar$ is 3.6 times that of ${}^{40}K$, then the original mass of ${}^{40}K$ must have been 3.6 + 1 = 4.6 times that now present.

$$t = \frac{2.303}{5.46 \times 10^{-10}\ \text{year}^{-1}} \times \log\frac{4.6}{1} = 2.8 \times 10^{9}\ \text{year}$$

30. n-factor of $Cr_2O_7^{2-}$ = 6

Equivalent of $Cr_2O_7^{2-}$ needed = equivalent of $N_2H_5^{+}$ = 0.136

$\therefore$ moles of $Cr_2O_7^{2-}$ = $\frac{0.136}{6} = 0.0227$

Mathematics

PART – III

SECTION – A

1. $\left(7-4\sqrt{3}\right)^n \to B'$ positive proper fraction

$B + B' = 1$

$\because \quad 1 - B = B'$

$B'(P + B)\ \left(7+4\sqrt{3}\right)^n\left(7-4\sqrt{3}\right)^n$

$= (49 - 48) = 1.$

2. $$\frac{3^{2n}}{8} = \frac{9^n}{8} = \frac{\left(1+8\right)^n}{8}$$

$$= \frac{{}^nC_0 + {}^nC_1 8 + {}^nC_2 8^2 \ldots {}^nC_n 8^n}{8} = \frac{1}{8} + \text{integer}$$

$$\because\ \left\{\frac{3^{2n}}{8}\right\} = \frac{1}{8}$$

3. $$\left(1+2x\right)^{-1/2} = 1 - x + \frac{\left(-\frac{1}{2}\right)\left(-\frac{1}{2}-1\right)\left(2x\right)^2}{2!} + \frac{\left(-\frac{1}{2}\right)\left(-\frac{1}{2}-1\right)\left(-\frac{1}{2}-2\right)\left(2x\right)^3}{3!} \ldots$$

$$T_{r+1} = \frac{\left(-\frac{1}{2}\right)\left(-\frac{1}{2}-1\right)\ldots\left(-\frac{1}{2}-\left(r-1\right)\right)\left(2x\right)^r}{r!}$$

$$= \frac{\left(-1\right)^r\left(\frac{1}{2}\right)\left(\frac{1}{2}+1\right)\left(\frac{1}{2}+2\right)\ldots\left(\frac{1}{2}+r-1\right)2^r x^r}{r!}$$

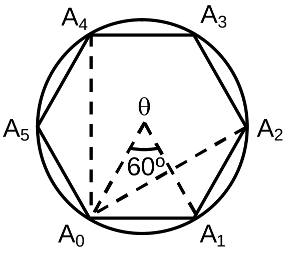
$$= \left(-1\right)^r \frac{\left(1.3.5\ldots\left(2r-1\right)\right)2^r \cdot x^r}{2^r \cdot r!}$$

$$= \left(-1\right)^r \frac{\left(1.3.5\ldots\left(2r-1\right)\right)x^r}{r!}$$

$$T_8 = \left(-1\right)^7 \frac{\left(1.3.5\ldots13\right)x^7}{7!}$$

4. We know, in hexagon centres angle is $\frac{360}{6} = 60^o$ and each angle.

$$= \frac{\left(2n-4\right)\pi}{2n} = \frac{\left(6-2\right)\times 180^o}{6} = 120^o$$



radius r = $A_0 A_1$

$\therefore$ In $\Delta A_0 A_1 A_2$

$$\cos 120^o = \frac{A_0A_1^2 + A_1A_2^2 - A_0A_2^2}{2A_0A_1.A_1A_2} = \frac{1+1-A_0A_2^2}{2.1.1}$$

$$A_0A_2 = \sqrt{3} \qquad \ldots \text{(i)}$$

similar in $\Delta A_0A_5A_4$ are have $A_0A_4 = \sqrt{3}$

$(A_0A_1) \,.\, (A_0A_2) \,.\, (A_0A_0)$

$= \sqrt{3}\sqrt{3} = 3$ unit.

5. We have

$\Rightarrow \quad [x] = \frac{2x\{x\}}{x+\{x\}} \Rightarrow [x] = \frac{2([x]+\{x\})\{x\}}{[x]+\{x\}+\{x\}}$

$\Rightarrow \quad [x] = \frac{2[x]\{x\}+2(\{x\})^2}{[x]+2\{x\}}$

$\Rightarrow \quad ([x])^2 + 2[x]\cdot\{x\} = 2[x]\{x\} + 2(\{x\})^2$

$\Rightarrow \quad [x] = \sqrt{2}\{x\}$

$\frac{[x]}{\sqrt{2}} = \{x\}$.

$\Rightarrow \quad 0 \le \{x\} < 1$

$\Rightarrow \quad 0 \le \frac{[x]}{\sqrt{2}} < 1 \Rightarrow 0 \le [x] < \sqrt{2}$

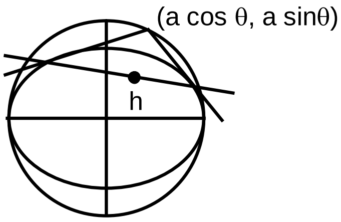
x = 0 (not possible) [x] = 0

[x] = 1, {x} = x – [x]

$\{x\} = \frac{1}{\sqrt{2}}$

$x = 1 + \frac{1}{\sqrt{2}} = \frac{\sqrt{2}+1}{\sqrt{2}}$.

6. Equation of C.O.C from (2 cosθ, 2 sin θ)



C.O.C = T

$\Rightarrow \quad \frac{2x\cos\theta}{4} + \frac{2\sin\theta y}{3} = 1 \qquad \ldots \text{(i)}$

Let mid point $(h_1. k_1)$

equation of chord $T = s_1$

$\frac{hx}{4} + \frac{ky}{3} - 1 = \frac{h^2}{4} + \frac{k^2}{3} - 1$

$\frac{hx}{4} + \frac{ky}{3} = \frac{h^2}{4} + \frac{k^2}{3} \qquad \ldots \text{(ii)}$

compare both (i) & (ii)

$\frac{2\frac{\cos\theta}{4}}{\frac{h}{4}} = \frac{\frac{2\sin\theta}{3}}{\frac{k}{3}} = \frac{1}{\frac{h^2}{4}+\frac{k^2}{3}}$

$\cos\theta = \frac{h \times 12}{2(3h^2+4k^2)} = \frac{6h}{(3h^2+4k^2)}$

$\sin\theta = \frac{12k}{(3h^2+4k^2)} = \frac{6k}{3h^2+4k^2}$

now for locus

$36(h^2 + k^2) = (3h^2 + 4k^2)^2$

$36(x^2 + y^2) = (3x^2 + 4y^2)^2$

7. $$\text{G.P.}\left\langle \begin{array}{l} 1^{\text{st}}\ \text{term} = a \\ \text{common ratio} = r \end{array}\right.$$

$$\sum_{i=1}^{201} ai = a + ar + ar^2 ... ar^{200}$$

$$625 = \frac{a\left(1-r^{201}\right)}{1-r} \qquad \ldots \text{(i)}$$

Now,

$$\sum_{i=1}^{201} \frac{1}{ai} = \left(\frac{1}{a_1} + \frac{1}{a_2} + ... \frac{1}{a_{200}} + \frac{1}{a_{201}}\right) = \left(\frac{1}{a} + \frac{1}{ar} ... \frac{1}{ar^{200}}\right)$$

$$= \frac{\frac{1}{a}\left(\left(\frac{1}{r}\right)^{201} - 1\right)}{\frac{1}{r} - 1} = \frac{1}{a}\left(\frac{1-r^{201}}{1-r}\right)\frac{1}{r^{200}} = \frac{1}{a} \times \frac{625}{a \cdot r^{200}}$$

$$= \frac{625}{\left(a_{101}\right)^2} = \frac{625}{625} = 1$$

8. $x = \sec\theta - \cos\theta$

$$\frac{dx}{d\theta} = \sec\theta\tan\theta + \sin\theta = \tan\theta\left(\sec\theta + \cos\theta\right)$$

also $y = \sec^3\theta - \cos^3\theta$

$$\frac{dy}{d\theta} = 3\sec^2\theta\sec\theta \cdot \tan\theta + 3\cos^2\theta \cdot \sin\theta$$

$= 3\tan\theta\ (\sec^3\theta + \cos^3\theta)$

$$\left(\frac{dy}{dx}\right)^2 = \left(\frac{\frac{dy}{d\theta}}{\frac{dx}{d\theta}}\right)^2 = \frac{9\tan^2\theta\left(\sec^3\theta + \cos^3\theta\right)^2}{\tan^2\theta\left(\sec\theta + \cos\theta\right)^2}$$

$$\left(\frac{dy}{dx}\right)^2_{x=0} \Rightarrow \left(\frac{dy}{dx}\right)^2_{\text{at } \theta = n\pi (n \in z)} = 9$$

9. $bx + ay = ab \qquad \ldots$ (i)

equation of line ⊥ r to (i) passing through origin is

$ax - by = 0 \qquad \ldots$ (ii)

from (i) &(ii)

$$a\frac{x^2}{y} + ay = ab$$

$$b = \frac{x^2 + y^2}{y} \qquad \therefore\ a = \frac{x^2 + y^2}{x}$$

Given $\frac{1}{a^2} + \frac{1}{b^2} = \frac{1}{c^2}$

$$\frac{x^2}{\left(x^2 + y^2\right)^2} + \frac{y^2}{\left(x^2 + y^2\right)^2} = \frac{1}{c^2}$$

$x^2 + y^2 = c^2$.

10. $T = s_1$ (mid point h_1 k_1)
$ky - 2a(x + h) = k^2 - 4ah$
$ky - 2ax = k^2 - 2ah$
$$\frac{ky-2ax}{k^2-2ah} = 1$$
parabola (homogenisation)
$y^2 = 4ax$
$$y^2 = 4ax(1) = 4a\left(\frac{ky-2ax}{k^2-2ah}\right)x$$
$$y^2 + \frac{8a^2x^2}{k^2-2ah} - \frac{4ak}{k^2-2ah}xy = 0$$
angle b/w two pair of straight line
$$\tan\alpha = \frac{2\sqrt{h^2-ab}}{a+b}$$
$$\tan^2\alpha = \frac{4\left(h^2-ab\right)}{\left(a+b\right)^2}$$
$$\tan^2\alpha = \frac{4\left[\left(\frac{2ak}{k^2-2ah}\right)^2 - (1)\left(\frac{8a^2}{k^2-2ah}\right)\right]}{\left(1+\frac{8a^2}{k^2-2ah}\right)^2}$$
$(8a^2 + y^2 - 2x)^2 \tan^2\alpha = 16a^2 (4ax - y^2)$
compare with
$(32 + y^2 - 4x)^2 \tan^2\alpha = 64(8x - y)^2$
$a = 2$.

11. $(x^3 - 1) - k(x - 1) = 0$
$(x - 1)\,[x^2 + x + 1 - k] = 0$
$x = 1$ or $x^2 + x + (1 - k) = 0$
for exactly two distinct real solution
either $D = 0 \Rightarrow 1 - 4(1 - k) = 0 \Rightarrow 1 - 4 + 4k = 0$
$$k = \frac{3}{4}$$
or $x^2 + x + \left(1-k\right) = \left\langle \begin{matrix} 1\,(\text{one root}) \\ -2\left(\text{other root}\right) \end{matrix} \right.$
$\Rightarrow 3 - k = 0 \Rightarrow k = 3$.

12. $\Delta = (a + b - c)(a + c - b)$
$\Delta = 2(s - c)2(s - b)$
$$\tan\frac{A}{2} = \sqrt{\frac{\left(s-b\right)\left(s-c\right)}{s\left(s-a\right)}} = \frac{\left(s-b\right)\left(s-c\right)}{\Delta} = \frac{1}{4}$$
$$\tan A = \frac{2\tan\frac{A}{2}}{1-\tan^2\frac{A}{2}}$$

$$= \frac{2\times\frac{1}{4}}{1-\left(\frac{1}{4}\right)^2} = \frac{8}{15}.$$

13. $S = \frac{\tan\frac{\pi}{4}}{4} + \frac{\tan\left(\frac{3\pi}{4}\right)}{8} + \frac{\tan\left(\frac{5\pi}{4}\right)}{16} + \frac{\tan\left(\frac{7\pi}{4}\right)}{32} + \ldots$

$= \frac{1}{4} - \frac{1}{8} + \frac{1}{16} - \frac{1}{32} + \ldots$

$\frac{\frac{1}{4}}{1+\frac{1}{2}} = \frac{1}{4}\times\frac{2}{3} = \frac{1}{6}.$

14. Minimum values of f(x) would occur at $x = \frac{-2b}{2\left(1+b^2\right)} = \frac{-b}{1+b^2}$

m(b) = $\left(1+b^2\right)\frac{b^2}{\left(1+b^2\right)^2} - \frac{2b^2}{1+b^2} + 1$

$m(b) = \frac{-b^2}{1+b^2} + 1 = \frac{1}{1+b^2}$ varies from (0, 1] as b varies from (– ∞, ∞).

15. y = x + 2

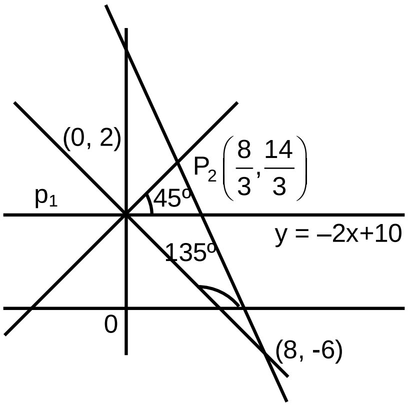
Area of triangle

$= \frac{1}{2}\begin{vmatrix} 0 & 2 & 1 \\ \frac{8}{3} & \frac{14}{3} & 1 \\ 8 & -6 & 1 \end{vmatrix}$

$= \frac{2}{2}\left|\frac{69}{3}\right| = \frac{64}{3}$

$\Delta = \frac{64}{3}$

$\left[\frac{64}{3}\right]$ = 21.



16. $\sqrt{\log_3 x - 1} + \frac{1}{2}\frac{3\log_3 x}{-\log_3^3} + 2 > 0$

$\sqrt{\log_3 x - 1} - \frac{3}{2}\log_3 x + 2 > 0$

put $\log_3 x - 1 = t^2$ $\log_3 x = t^2 + 1$

2|t| – 3(1 + t^2) + 4 > 0

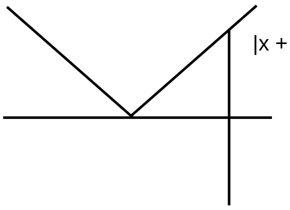
2|t| – 3 – 3t^2 + 4 > 0

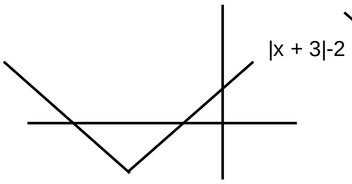
3t^2 – 3|t| + |t| – 1 < 0

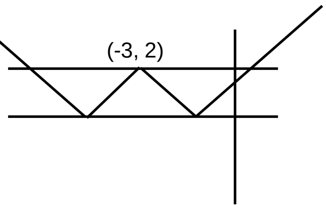
|t| ∈ $\left(\frac{-1}{3}, 1\right)$ ⇒ t^2 ∈ [0, 1)

x ∈ [3, 9) ⇒ 6 integers i.e. 3, 4, 5, 6, 7, 8.

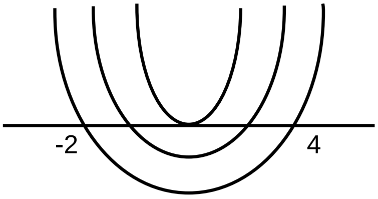
17.







18. $A \cup B = A$
$f(x) = x^2 - ax + 4$
$D \geq 0 \Rightarrow a^2 - 16 \geq 0 \Rightarrow a \leq -4$ or $a \geq 4$ … (i)
$f(-2) \geq 0 \Rightarrow 4 + 2a + 4 \geq 0 \Rightarrow a \geq -4$ … (ii)
$f(4) \geq 0 \Rightarrow 16 - 4a + 4 \geq 0 \Rightarrow a \leq 5$ … (iii)
and $-2 \leq \frac{a}{2} \leq 4\,;\ -4 \leq a \leq 8$
Also, if B = 0 then also $A \cup B = A$
$a^2 - 16 < 0,\ a \in (-4, 4)$.



19. $$\frac{\cos\theta_1}{1} = \frac{2\cos\theta_2 - 1}{2 - \cos\theta_2}$$
apply C & D
$$\frac{1-\cos\theta_1}{1+\cos\theta_1} = \frac{(2-\cos\theta_2)-(2\cos\theta_2-1)}{(2-\cos\theta_2)+(2\cos\theta_2-1)}$$
$$\tan^2\frac{\theta_1}{2} = \frac{3(1-\cos\theta_2)}{1+\cos\theta_2} = 3\tan^2\frac{\theta_2}{2}$$
$$\frac{\tan^2\frac{\theta_1}{2}}{\tan^2\frac{\theta_2}{2}} = 3\,.$$

20. $x = \sqrt{y+2}$
$$\left(\sqrt{y+2}\right)^5 + \left(\sqrt{y+2}\right)^2 + 1 = 0$$
$y^5 + 20y^4 + 40y^3 + 79y^2 + 74y + 23 = 0$
$\therefore\ g(x_1) . g(x_2) . g(x_3) . g(x_4) . g(x_5) =$ product of roots = – 23
$g(x_1) . g(x_2) . g(x_3) . g(x_4) . g(x_5) - 30g(x_1x_2x_3x_4x_5)$
= – 23 + 30 = 7.

21. $(a + b + c)^2 = a^2 + b^2 + c^2 + 2(ab + bc + ca)$
$ab + bc + ca = -\frac{1}{2}$
Now, $(ab + bc + ca)^2 = a^2b^2 + b^2c^2 + c^2a^2 + 2abc(a + b + c)$
$\Rightarrow\ a^2b^2 + b^2c^2 + c^2a^2 = \frac{1}{4}$
Hence $\Rightarrow a^4 + b^4 + c^4 = (a^2 + b^2 + c^2)^2 - 2(a^2b^2 + b^2c^2 + c^2a^2)$
$= \frac{1}{2}$.

22. $\sin\left(\frac{\pi}{3}+x\right)+\sin(\alpha+x)\ge 0$

$2\sin\left(\frac{\pi}{6}+\frac{\alpha}{2}+x\right)\cdot\cos\left(\frac{\pi}{6}-\frac{\alpha}{2}\right)\ge 0$ … (i)

Now $\sin\left(\frac{\pi}{6}+\frac{\alpha}{2}+x\right)\in[-1,1]$ for $x\in R$ hence (i) will be true.

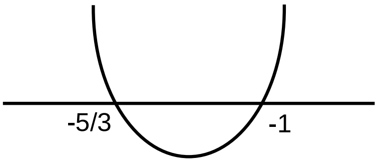
$\forall\ x\in R$ if $\frac{\pi}{6}-\frac{\alpha}{6}=(2k+1)\frac{\pi}{2}$

possible k = – 1

$\therefore\quad \frac{\alpha}{2}=\frac{\pi}{6}+\frac{\pi}{2}=\frac{2\pi}{3}$

$\alpha=\frac{4\pi}{3}=\frac{p\pi}{q}\ \Rightarrow p+q=7.$

23. $f'(x)=3x^2+2px+q<0\ \ x\in\left(\frac{-5}{3},-1\right)$



$3x^2+2px+q=(3x+5)(x+1)$

$2p=8;\ p=4\ \&\ q=5\Rightarrow p+q=9.$

24. $\tan\left(\frac{A-B}{2}\right)=\frac{1}{3}\tan\left(\frac{A+B}{2}\right)$ … (i)

using Napier’s analogy

$\tan\left(\frac{A-B}{2}\right)=\frac{a-b}{a+b}\cot\frac{c}{2}$

$\frac{1}{3}\tan\left(\frac{A+B}{2}\right)=\frac{a-b}{a+b}\cot\frac{c}{2}$

$\frac{1}{3}\cot\frac{c}{2}=\frac{a-b}{a+b}\cot\frac{c}{2}$

$a+b=3a-3b$

$a:b::2:1.$

25. If $\cos^{-1}x+\cos^{-1}y+\cos^{-1}z=3\pi$

$\cos^{-1}x=\pi,\ \cos^{-1}y=\pi,\ \cos^{-1}z=\pi$

$x=-1,\ y=-1,\ z=-1.$

Now $z^{2004}=1$

$x^{2003}=-1$

then

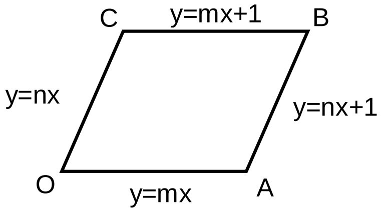
$$x^{2004}+y^{2004}+z^{2004}+\frac{6}{x^{2003}+y^{2003}+z^{2003}}$$

$$=1+1+1+\frac{6}{-(1+1+1)}=3-2=1.$$

26. The vertices 0(0, 0)

$A\left(\frac{1}{m-n},\frac{m}{m-n}\right)$, B(0,1)

are (parallel OABC = 2Ar(Δ OAB))



=

$$2\times\frac{1}{2}\left|0\left(\frac{m}{m-n}-1\right)+\frac{1}{m-n}(1-0)+0\left(0-\frac{m}{m-n}\right)\right|$$

$$=\frac{1}{|m-n|}.$$

27. $\angle RPS = \theta$

$\angle XPQ = 90 - \theta$

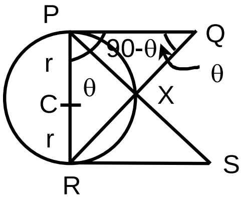
$\because$ $\angle PQX = \theta$ ($\therefore$ $\angle PXQ = 90^o$)

$\because$ ΔPRS or ΔQPR (AA similarity)

$\because$ $\frac{PR}{QP} = \frac{RS}{PR}$

$\Rightarrow$ $PR^2 = PQ \,.\, RS$

$PR = \sqrt{PQ\cdot RS} \Rightarrow 2r = \sqrt{PQ\,.\,RS}$.



28. $\therefore$ $a > 2b > 0$

Therefore, the two given circles do not intersect each other

$\therefore$ common tangents can be direct or indirect. As $y = \pm b$ are direct common tangents

$\therefore$ given line should be indirect common tangent. Clearly line $y = mx - b\sqrt{1+m^2}$ will pass from pt (a/2, 0) (mid-point of the centres of the circles)

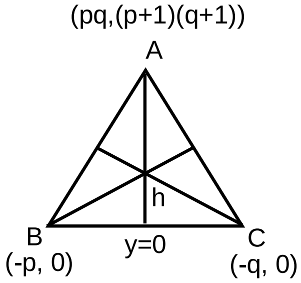
$\Rightarrow$ $m = \frac{2b}{\sqrt{a^2-4b^2}}$.

29. $AH \perp BC$ then $h = pq$

$BH \perp AC$ then $k = -pq$

$h + k = 0$

$x + y = 0$ is straight line



30. $a_1 = h_1 = 2$, $a_{10} = h_{10} = 3$

$3 = a_{10} = 2 + 9d \Rightarrow d = 1/9$

$a_4 = 2 + 3d = 7/3$

$3 = h_{10} \Rightarrow \frac{1}{3} = \frac{1}{h_{10}} = \frac{1}{2} + 9D \;\because D = -\frac{1}{54}$

$\frac{1}{h_7} = \frac{1}{2} + 6D = \frac{1}{2} - \frac{1}{9} = \frac{7}{18}$

$\therefore$ $a_4\, h_7 = \frac{7}{3}\times\frac{18}{7} = 6$.

HALF COURSE TEST – VI

Paper 1

ALL INDIA INTEGRATED TEST SERIES

FIITJEE Students From All Programs have bagged 33 in Top 100, 77 in Top 200 and 205 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2015:
4551 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2015.

Time Allotted: 3 Hours **Maximum Marks: 240**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 04)** contains 4 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (05 – 08) contains 4 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

   Section-A (09 to 11) contains 1 paragraph having 3 questions. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct matching. No marks will be given for any wrong matching in any question. There is no negative marking.

3. **Section-C (01 – 06)** contains 6 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Enrolment No. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant R = $8.314\ J\ K^{-1}\ mol^{-1}$
= 0.0821 Lit atm $K^{-1}\ mol^{-1}$
= $1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Single Correct Choice Type

*This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.*

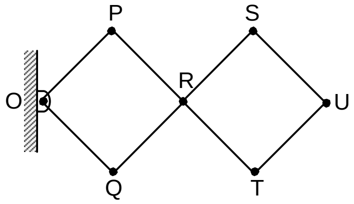
1. Block A and B have masses 40 kg. and 60 kg resp. They are placed on a smooth surface and the spring connected between them is stretched by 1.5m. If they are released from rest, determine the speeds of the blocks at the instant the spring became unstrentched

(A) $V_1 = 3$ m/s, $V_2 = 4.5$ m/s
(B) $V_1 = 4.5$ m/s, $V_2 = 3$ m/s
(C) $V_1 = 5$ m/s, $V_2 = 6$ m/s
(D) $V_1 = 4$ m/s, $V_2 = 3$ m/s

2. The end of a chain of length L and mass per unit length ρ, which is piled up on a horizontal platform is lifted vertically with a constant velocity u by a variable force F. Find F as a function of height x of the end above platform.

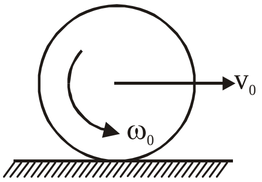
(A) $\rho\left(gx + 2u^2\right)$
(B) $\rho\left(2gx + \rho u^2\right)$
(C) $\rho\left(gx + u^2\right)$
(D) $\rho\left(u^2 - gx\right)$

3. In the arrangement of rigid links of equal length l, they can freely rotate about the joined ends as shown in the figure. If the end U is pulled horizontally with constant speed 20 m/s, find the approx. speed of end P when the angle SUT is 90^o.



(A) 5 m/s
(B) 10 m/s
(C) 7.1 m/s
(D) 14.12 m/s

4. A disc of radius R is spun to an angular speed ω_0 about its axis and then imparted a horizontal velocity of magnitude $\frac{\omega_0 R}{4}$ (at t = 0) with its plane remaining vertical. The coefficient of friction between the disc and the plane is μ. The sense of rotation and direction of its linear speed are shown in the figure. Choose the correct statement. The disc will return to its initial position



(A) if the value of $\mu < 0.5$.
(B) irrespective of the value of μ ($\mu > 0$).
(C) if the value of $0.5 < \mu < 1$.
(D) if $\mu > 1$.

Space for rough work

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

5. The figures represent two snaps of a travelling wave on a string of mass per unit length, μ= 0.25kg/m. The two snaps are taken at time t = 0 and at $t = \frac{1}{24}$ s. Then

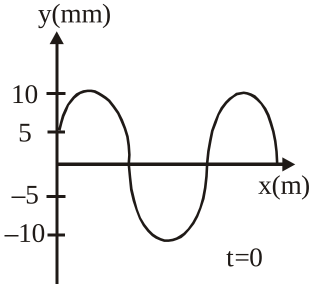


Figure -1

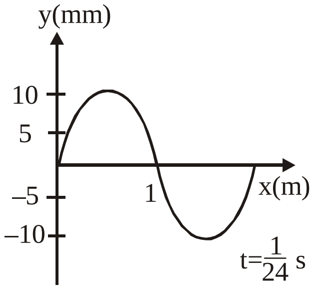


Figure -2

(A) speed of wave is 4 m/s
(B) the tension in the string is 4 N
(C) the equation of the wave is $y = 10 \sin (\pi x - 4\pi t + \frac{\pi}{6})$
(D) the maximum velocity of the particle $= \frac{\pi}{25} \text{m/s}$

6. An ideal gas undergoes a process such that $P \propto \frac{1}{T}$. The molar heat capacity of this process is 33.24 J/mol K.
(A) The work done by the gas is $2R\Delta T$.
(B) Degree of freedom of the gas is 4.
(C) Degree of freedom of the gas is 3.
(D) $Y\left(\frac{C_P}{C_V}\right)$ for the gas is 1.5.

Space for rough work

7. Velocity of a particle of mass 2 kg changes from $\vec{v}_1 = -2\hat{i} - 2\hat{j}\ \text{m/s}$ to $\vec{v}_2 = (\hat{i} - \hat{j})\text{m/s}$ after colliding with a plane surface

(A) the angle made by the plane surface with the positive x–axis is $90^\circ + \tan^{-1}\left(\frac{1}{3}\right)$

(B) the angle made by the plane surface with the positive x–axis is $\tan^{-1}\left(\frac{1}{3}\right)$

(C) the direction of change in momentum makes an angle $\tan^{-1}\left(\frac{1}{3}\right)$ with the +ve x–axis

(D) the direction of change in momentum makes an angle $90^\circ + \tan^{-1}\left(\frac{1}{3}\right)$ with the plane surface

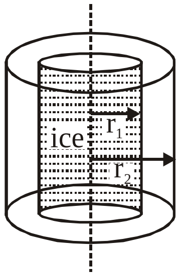
8. A 100 cm long cylindrical flask with inner and outer diameters 2 cm and 4 cm respectively is completely filled with ice as shown in the figure. The constant temperature outside the flask is 40ºC. (Thermal conductivity of the flask is 0.693 W/mºC, L_{ice} = 80 cal/gm).

(A) Rate of heat flow from outside to the flask is 80π J/s.

(B) The rate at which ice melts is $\frac{\pi}{4200}\text{Kg/s}$.

(C) The rate at which ice melts is 100π Kg/s.

(D) Rate of heat flow from outside to flask is $40\ \pi$ J/s.



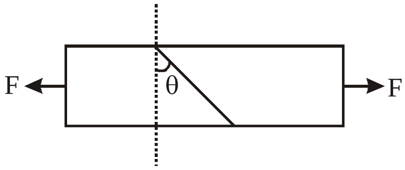
Space for rough work

Comprehension Type

*This section contains **one group** of questions. This group has **3 multiple** choice question based on a paragraph. This question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct*

Paragraph for Question Nos. 9 to 11

A bar of cross-section A is subjected to equal and opposite tensile forces F at its ends. Consider a plane through the bar making an angle θ with a plane at right angles to the bar as shown in figure



9. The tensile stress at this plane in terms of F, A and θ is

(A) $\frac{F\cos^2\theta}{A}$ (B) $\frac{F}{A\cos^2\theta}$

(C) $\frac{F\sin^2\theta}{A}$ (D) $\frac{F}{A\sin^2\theta}$

10. In the above problem, for what value of θ is the tensile stress a maximum?

(A) Zero (B) 90°

(C) 45° (D) 30°

11. The shearing stress at the plane, in terms of F, A and θ is

(A) $\frac{F\cos 2\theta}{2A}$ (B) $\frac{F\sin 2\theta}{2A}$

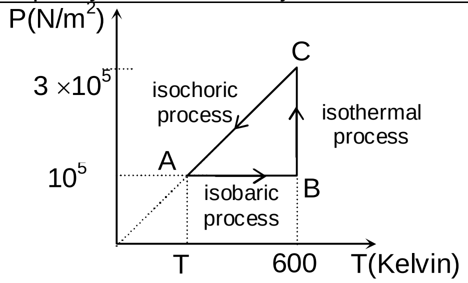
(C) $\frac{F\sin\theta}{A}$ (D) $\frac{F\cos\theta}{A}$

Space for rough work

SECTION – B
(Matching List Type)

This section contains ***2 questions.*** *Each question has four statements (A, B, C and D) given in* ***Column I*** *and* ***five statements*** *(p, q, r, s and t) in* ***Column II.*** *Any given statement in Column I can have correct matching with* ***ONE*** *or* ***MORE*** *statement(s) given in Column II. For example, if for a given question, statement B matches with the statements given q and r, then for the particular question, against statement B, darken the bubbles corresponding to q and r in the ORS.*

1. Column-I contains some thermodynamic system and column-II contains its properties. Match the following columns.

	Column – I		Column – II
(A)	A steel rod is clamped at its two ends and rests on a fixed horizontal base. The longitudinal strain developed in the rod when temperature rises to 50^0C is -3.6×10^{-4}, and the temperature coefficient of linear expansion of steel is $1.2 \times 10^{-5}\ /^0$C. Find the temperature at which rod is in relaxed state	(p)	400
(B)	Six hundred mole of a gas undergoes a process $P = \dfrac{7 \times 10^5 N/m^2}{2 + \dfrac{V}{4m^3}}$ where V is volume in m^3. When volume of the gas is 20 m^3, its temperature in Kelvin is approximately equal to	(q)	27
(C)	A block of mass 100 gm slides on a rough horizontal surface of zero heat capacity. When the speed of the block decreases from 10 m/s to 5 m/s, its temperature rises by 0.25^0C. The heat capacity of the block in joule/°C is	(r)	20
(D)	 P(N/m^2) C 3 ×10^5 isochoric process isothermal process A 10^5 isobaric process B T 600 T(Kelvin) If two moles of a gas consisting of 1 mole of He and 1 mole of H_2 undergo a cyclic process $A \rightarrow B \rightarrow C \rightarrow A$ as shown in the figure the total work done in the cycle is –600Rln[9/e] The temperature T in ^{0}C is	(s)	15
		(t)	None of these

Space for rough work

2. A standing wave, formed in an organ pipe aligned along the x-axis, is given by (displacement)$y = (5 \times 10^{-6}\text{ m})\sin(4\pi x)\cos(1320\pi t)$ where x is in metre and t is in seconds.

	Column – I		Column – II
(A)	Change in pressure is maximum	(p)	x = 1/4 m
(B)	Change in pressure is minimum	(q)	x = 1/2 m
(C)	Maximum amplitude of vibration	(r)	x = 1 m
(D)	Minimum amplitude of vibration	(s)	x = 1/8 m
		(t)	x = 3/8 m

SECTION – C

Integer Answer Type

*This section contains **6** questions. The answer to each of the questions is a **single digit integer,** ranging from 0 to 9. The bubble corresponding to the correct is to be darkened in the ORS.*

1. The equation of a transverse wave is given by

$$\psi = 10^{-2}\sin\pi[30t - x\sqrt{3} - y]$$

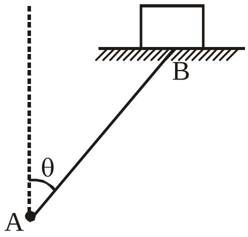
where x, y and ψ are in metre, and t in second.
If phase difference between two points
$A(2\sqrt{3}\text{m}, 2\text{m})$ and $B(3\sqrt{3}\text{m}, 3\text{m})$ be $n\pi$. Find value of n

2. The emissivity of tungsten is approximately 0.35. A tungsten sphere 1 cm in radius is suspended within a large evacuated enclosure whose walls are at 300 K. What power input is required to maintain the sphere at a temperature of 3000 K if heat conduction along the supports is neglected? Express your answer in kW after rounding off the nearest integer. Take $\sigma = \frac{17}{3}\times 10^{-8}$ S. I. units and $\pi = \frac{213}{68}$.

Space for rough work

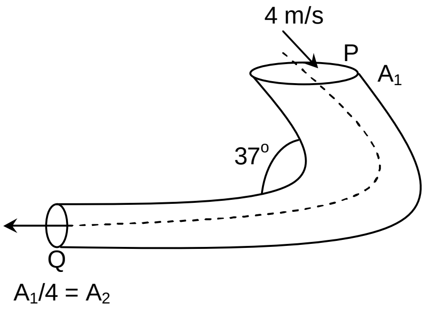
3. Maximum height reached by a rocket fired with a speed equal to 50% of the escape velocity from earth's surface is given by R/x. Calculate value of x ? Where R is radius of earth.

4. A rod AB of length 2 m is hinged at point A and it's other and B is attached to a platform on which a block of mass m is kept. Rod rotates about point A maintaining angle $\theta = 30^\circ$ with the vertical in such a way that platform remains horizontal and revolves on the horizontal circular path. If the coefficient of static friction between the block and platform is $\mu = 0.1$ then find the maximum angular velocity in rad/s of rod so that block does not slip on the platform. [$g = 10\ m/s^2$]



5. A cylinder of mass M radius R is resting on a horizontal platform (which is parallel to x–y plane) with its axis fixed along the y–axis and free to rotate about its axis. The platform is given a motion in X–direction given by $X = A\cos\omega t$. There is sufficient friction present in the surface of contact that can prevent the slipping between the cylinder and platform. The minimum torque in N-m acting on the cylinder during its motion is.
[Take M = 4 kg , R = 1m, A = 2m, ω = 1 rad/s]

6. Oil enters the bend of a pipe in the horizontal plane with velocity 4 m/s & pressure $280\times10^3 N/m^2$ A1/4=A_2 as shown. If pressure at Q in (KN/m^2) is $N\times43$. Find N (specific gravity of oil 0.9 & $\cos 37 = 0.8$)



Space for rough work

Chemistry PART - II

SECTION – A

Single Correct Choice Type

*This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.*

1. An inorganic compound (X) on hydrolysis produces a gas which on treatment with sodium followed by its reaction with ethyl chloride gives another compound (Y). Compound (Y) on heating with P – 2 catalyst gives (2Z) – pent – 2 – ene as major product. Hence the inorganic compound (X) is

(A) Tl_4C (B) BaC_2
(C) SiC (D) Mg_2C_3

2. Boron trichloride on heating with ammonium chloride at 140°C gives a compound (A) which on reduction with sodium borohydride followed by hydrolysis gives another compound (B). Hence compound (A) and (B) are respectively.

(A) inorganic graphite & ammonia (B) inorganic benzene & orthoboric acid
(C) trichloroborazine & orthoboric acid (D) diborane & orthoboric acid

3. (S) – 2 – chloropentane on reaction with Cl_2 (g) in the presence of U.V. light, gives 'N' number of optically active dichloro derivatives. Hence the value of N is

(A) 5 (B) 6
(C) 7 (D) 4

4. 3 mole of KIO_3, 4 mole of KI and 5 mole of HCl are allowed to react according to the equation given below:

$$KIO_3 + 2KI + 6HCl \longrightarrow 3ICl + 3KCl + 3H_2O$$

The number of moles of products are

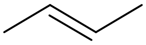
(A) 27 (B) 18
(C) 7.5 (D) 9.5

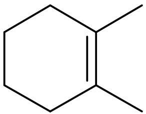
Space for rough work

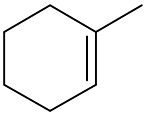
Multiple Correct Answers Type

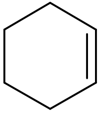
*This section contains 4 multiple correct answer(s) type questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE** is/are correct.*

5. Which of the following compounds will give same product in hydroboration oxidation and catalytic hydration?

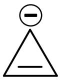
(A)


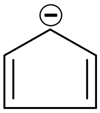
(B)


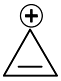
(C)


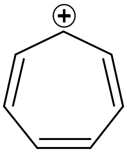
(D)


6. Which of the following are aromatic in character?

(A)


(B)


(C)


(D)


7. Which of the following compounds undergo hydrolysis?

(A) CCl_4
(B) $SiCl_4$
(C) BCl_3
(D) SiH_4

8. Which of the following statement (s) is/are correct regarding photoelectric effect?

(A) No electrons are ejected, regarding of the intensity of the radiation, unless the frequency exceeds a threshold value characteristic of the metal
(B) The kinetic energy of the ejected electrons increases linearly with the frequency of incident radiation but is independent of the intensity of the radiation.
(C) Even at low intensities, electrons are ejected immediately if the wavelength is above threshold value.
(D) It is a direct evidence for the dual nature of light.

Space for rough work

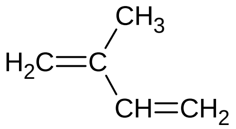
Linked Comprehension Type

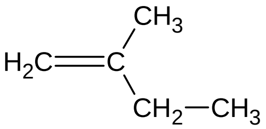
This section contains one group of questions. This group has 3 multiple choice question based on a paragraph. This question has 4 choices (A), (B), (C) and (D) for its answer, out of which ***ONLY ONE*** *is correct*

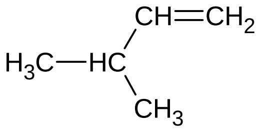
Paragraph for question Nos 9 to 11

A more widely used method for locating the double bond of alkene involves the use of ozone. Ozone reacts with alkene to form unstable compounds called ozonide. Ozonides on reduction with Zn and water produces carbonyl compound that can be isolated and identified. Ozonolysis can be either of reductive type or oxidative type.

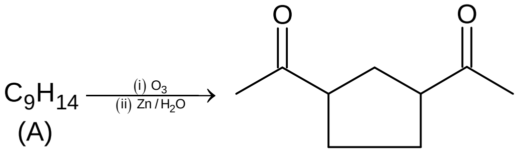
9. An organic compound A (C_5H_8) on hydrogenation gives compound B (C_5H_{12}). A on ozonolysis gives methanal and 2 – ketopropanal. The compound (A) is

(A) 

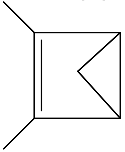
(B) 

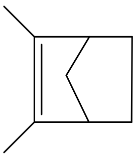
(C) 

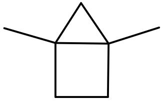
(D) $H_3C-CH=CH-CH_2-CH_3$

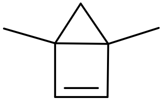
10. 

The reactant (A) is

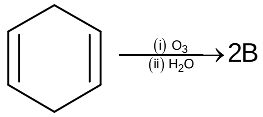
(A) 

(B) 

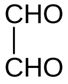
(C) 

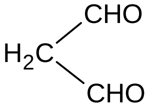
(D) 

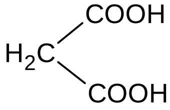
Space for rough work

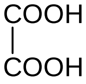
11. 

The product B is

(A) 
$CHO-CHO$

(B) 

(C) 

(D) 
$COOH-COOH$

SECTION – B

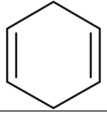
(Matrix-Match Type)

*This section contains **2 questions.** Each question has four statements (A, B, C and D) given in **Column I** and **five statements** (p, q, r, s and t) in **Column II.** Any given statement in Column I can have correct matching with **ONE** or **MORE** statement(s) given in Column II. For example, if for a given question, statement B matches with the statements given q and r, then for the particular question, against statement B, darken the bubbles corresponding to q and r in the ORS.*

1. Match the Column – I with Column – II:

Column – I		**Column – II**	
(A)	I_3^-	(p)	Linear
(B)	XeO_3	(q)	Square planar
(C)	$Ni(CN)_4$	(r)	Trigonal bipyramidal
(D)	OSF_4	(s)	sp^3
		(t)	dsp^2

2. Match the Column – I with Column – II:

Column – I (Compounds)		**Column – II (Ozonolysis products)**	
(A)		(p)	Formaldehyde
(B)	$CH_2 = CH – CH = CH – CH_3$	(q)	Glyoxal
(C)	$(CH_3)_2C = CH – CH = CH_2$	(r)	Propane – 1, 3 – dial
(D)	$CH_3 – CH = CH_2$	(s)	Acetone
		(t)	Acetaldehyde

Space for rough work

SECTION – C

(Integer Answer Type)

*This section contains **6** questions. The answer to each of the questions is a **single digit integer,** ranging from 0 to 9. The bubble corresponding to the correct is to be darkened in the ORS.*

1. One litre of saturated solution contains AgSCN and AgBr. Calculate the ratio of $\frac{[SCN^-]}{[Br^-]}$ in the solution. $\left[K_{sp} \text{ of AgSCN} = 1.0\times10^{-12}; K_{sp} \text{ of AgBr} = 5\times10^{-13}\right]$

2. In the following reaction we start with 2 mol of N_2 and 5 mol of H_2 exerting a total pressure of 7 atm at a given temperature in a closed vessel when 50% of N_2 is converted into NH_3, then
$N_2 + 3H_2 \longrightarrow 2NH_3$
What will be the partial pressure of NH_3 in atmosphere?

3. If uncertainities in measurement of position and momentum of an electron are equal, then the uncertainity in measurement of its velocity is 7.98 x 10^{6+x} m/s. then the value of x is.

4. An ion Mn^{x+} has the magnetic moment 4.9 B.M. The value of x is.

5. A cylinder having internal volume 20 litre contains helium gas at a pressure of 2 atm and 300 K temperature. The gas is to be used to fill balloons at one atomspheric pressure and 300 K temperatrue. Number of balloons of capacity 5 litre can be filled is.

6. The maximum number of electrons that can have principal quantum number n = 3 and spin quantum number s = –1/2 is.

Space for rough work

Mathematics PART – III

SECTION – A
Single Correct Choice Type

This section contains ***4 multiple choice questions****. Each question has four choices (A), (B), (C) and (D) out of which* ***ONLY ONE is correct****.*

1. If $(1 + x + x^2)^{25} = a_0 + a_1x + a_2 x^2 + \ldots + a_{50} x^{50}$ then $a_0 + a_2 + a_4 + \ldots + a_{50}$ is:
(A) even (B) odd and of the form 3n
(C) odd and of the form (3n – 1) (D) odd and of the form (3n + 1).

2. A circle is touching both the coordinate axes and its centre lies o the curve $y^2 = 4x$, then area of this circle is
(A) 16π (B) 4π
(C) 32π (D) none.

3. The number of ordered triplet of positive integers which satisfy the inequality $20 \le x + y + z \le 50$ is
(A) ${}^{50}C_3 - {}^{19}C_3$ (B) ${}^{50}C_2 - {}^{19}C_2$
(C) ${}^{51}C_3 - {}^{20}C_3$ (D) none.

4. If z_1, z_2, z_3 represent the vertices of an equilateral triangle ABC and

$$\sqrt{\frac{|z_2 - z_1|^2 + |z_3 - z_1|^2}{|z_2 + z_3 - 2z_1|^2 + |z_3 - z_2|^2}} = \sin\theta$$ the θ is $(0 < \theta < \pi)$

(A) $\frac{\pi}{4}$ (B) $\frac{2\pi}{3}$
(C) $\frac{\pi}{6}$ (D) $\frac{5\pi}{6}$.

Space for rough work

Multiple Correct Choice Type

This section contains 4 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

5. Let $\frac{x^2}{9}+\frac{y^2}{4}=1$ be a given ellipse and a bi-focal conic 'c' has its foci same as those of the given ellipse. If the conic 'c' passes through (3, 2), then its equation may be

(A) $x^2 - y^2 = 5$
(B) $\frac{x^2}{3}+\frac{y^2}{2}=1$
(C) $\frac{x^2}{15}+\frac{y^2}{10}=1$
(D) $\frac{x^2}{18}+\frac{y^2}{8}=1$

6. If the quadratic equation $x^2 + 2ax + b(a - 1) = 0$ has real roots for all real value of a and b is an integer, then which of the following is correct?

(A) greatest value of b is 4
(B) no such value of b is possible
(C) least value of b is 0
(D) b can be any integer.

7. In a ΔAEX, T is the mid point of XE, and P is the mid point of ET. If the ΔAPE is equilateral of side length equal to unity then which of the following alternative(s) is/are correct?

(A) $AX=\sqrt{13}$
(B) $\angle EAT = 90^\circ$
(C) $\cos(\angle XAE)=\frac{-1}{\sqrt{13}}$
(D) $AT=\frac{1}{\sqrt{3}}$.

8. The bisector of internal angles A and ΔABC meets BC in point D such that BD = 4 and CD = 2. If altitude AE > $\sqrt{10}$ and AB and AC are integers, then AC may be

(A) 4
(B) 5
(C) 6
(D) none.

Space for rough work

Comprehension Type

This section contains one group of questions. This group has 3 multiple choice question based on a paragraph. This question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

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Paragraph for Question Nos. 9 to 11

Read the following write up carefully and answer the following questions:
A line 4 cuts coordinate axes at A(7, 0) and B(0, –5) respectively. A variable line PQ is drawn perpendicular to AB meeting the coordinate axis at P & Q. The line AQ & BP intersect at R. T is the point on locus of R, farthest from the origin. A parabola C_1 with vertex at T and axis parallel to x-axis is drawn with lotus rectum 2 units opening towards the right of y-axis. Answer the following questions:

9. Coordinates of T are
(A) (7,5) (B) (7, –5)
(C) (–7, 5) (D) (–7, –5)

10. Equation of parabola C_1 is
(A) $y^2 + 10y - 2x + 39 = 0$ (B) $y^2 + 10y + 2x + 9 = 0$
(C) $y^2 + 10y - 2x + 9 = 0$ (D) none.

11. A light ray travelling along the line y = –3, gets reflected from the interior of the parabola, the equation of the reflected ray is
(A) $4x + 3y = 35$ (B) $4x - 3y = -45$
(C) $4x - 3y = 45$ (D) none.

Space for rough work

SECTION – B

(Matching List Type)

This section contains ***2 questions.*** *Each question has four statements (A, B, C and D) given in* ***Column I*** *and* ***five statements*** *(p, q, r, s and t) in* ***Column II.*** *Any given statement in Column I can have correct matching with* ***ONE*** *or* ***MORE*** *statement(s) given in Column II. For example, if for a given question, statement B matches with the statements given q and r, then for the particular question, against statement B, darken the bubbles corresponding to q and r in the ORS.*

1. There are two Indian couples, 2 American couples and one unmarried person

	Column – I		**Column – II**
(A)	The total numbers of ways in which they can sit in a row such that an Indian wife and an American wife are always on either side of the unmarried person	(p)	5760
(B)	The total numbers of ways in which they can sit in a row such that the unmarried man always occupy the middle position.	(q)	24230
(C)	The total number of ways in which they can sit around a circular table such that Indian wife & American wife are on either side of unmarried person.	(r)	40320
(D)	If all the nine persons are to be interviewed one by one then the total number of ways of arranging their interviews such that no wife gives interview before her husband	(s)	22680
		(t)	28410

2. Match the following Column-I with Column-II

	Column – I		**Column – II**
(A)	If 2sinx, sin 2x and 2 cosx are in A.P., then value of |sinx + cosx| is	(p)	$\frac{\sqrt{5}-1}{2}$
(B)	If angles of triangle are in A.P. with common difference equal to $\frac{1}{3}$ of the greatest angle then, ratio of the greater two sides is	(q)	$\frac{\sqrt{3}}{2}$
(C)	Let the sides AB, BC, CD & DA of a cyclic quadrilateral ABCD are in G.P. with common ratio 2, then $\frac{BD}{AB}$ is	(r)	$2\sqrt{5}$
(D)	Let a, b, c be in A.P. and a^2, b^2, c^2 be in H.P. If $a \neq c$, then a : c is	(s)	$\sqrt{3}-2$
		(t)	1

Space for rough work

SECTION – C

Integer Answer Type

*This section contains **6** questions. The answer to each of the questions is a **single digit integer,** ranging from 0 to 9. The bubble corresponding to the correct is to be darkened in the ORS.*

1. In ΔABCD, circumradius is 3 and inradius is 1.5 units. If the value of $a\cot^2 A + b^2 \cot^3 B + c^3 \cot^4 C$ is $m\sqrt{n}$ where m and n are prime members, them $\frac{m+n}{2}$ is

2. The value of the product
$\sin\left(\frac{5\pi}{2^{11}}\right)\cos\left(\frac{5\pi}{2^{11}}\right)\cos\left(\frac{5\pi}{2^{10}}\right)\cos\left(\frac{5\pi}{2^{9}}\right)...\cos\left(\frac{5\pi}{2^{3}}\right)\cos\left(\frac{5\pi}{2^{3}}\right)$
equals to 4^{-k}. Then value of k is

3. From a point P two tangents are drawn to $\frac{x^2}{2}-\frac{y^2}{3}=1$, such that their chord of contact subtends right angle at its centre. If locus of P is the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$, then $\frac{6}{13}\left(a^2+b^2\right)$ is equal to

4. A circle of radius 4 units is inscribed in an equilateral triangle ABC, then an equilateral triangle is inscribed in the circle, a circle again is inscribed in the later triangle and so on. In this way the process continues infinitely. If r, x_1, x_2, … x_n … be the radii of these circles respectively. Then the sum of radii of all these circles is

5. Consider the complex number z satisfying $|z - 3| + |z| + |z + 3| = 12$. If the greatest integer less than or equal to |z| is ‘a’ and the least integer greater than or equal to is ‘b’, then ‘a + b’ is

6. Let $p(x) = x^5 + x^2 + 1$ have roots x_1, x_2, x_3, x_4 and x_5
$g(x) = x^2 - 2$, then the value of
$g(x_1)\, g(x_2)\, g(x_3)\, g(x_4)\, g(x_5) - 30g\,(x_1x_2x_3x_4x_5)$ is

Space for rough work

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ALL INDIA INTEGRATED TEST SERIES

ANSWERS, HINTS & SOLUTIONS
HALF COURCE TEST –VI
(Paper - 1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	D	A
2.	C	C	A
3.	C	A	A
4.	B	C	A
5.	A, B, C, D	A, B, D	B, C
6.	A, B, D	B, C, D	A, C
7.	A, C	B, C, D	A, B, C
8.	A, B	A, B	A, B
9.	A	A	B
10.	A	B	A
11.	B	C	C
1.	(A) → (r) (B) → (p) (C) → (s) (D) → (q)	(A) → (p) (B) → (s) (C) → (q, t) (D) → (r)	(A) → (s) (B) → (p) (C) → (r) (D) → (q)
2.	(A) → (p, q, r) (B) → (s, t) (C) → (s, t) (D) → (p, q, r)	(A) → (r); (B) → (p, q, t) (C) → (p, q, s) (D) → (p, t)	(A) → (p) (B) → (q) (C) → (r) (D) → (s)
1.	4	2	8
2.	2	2	5
3.	3	6	1
4.	1	3	8
5.	4	4	7
6.	4	9	7

Physics PART – I

SECTION – A

1. $V_1 = 4.5$ m/s, $V_2 = 3$ m/s

2. $F + \rho g(L - x) - \rho g L = \frac{d}{dt}(\rho x u)$

3. $v_{p_x} = 5$, $v_{p_y} = 5$

   $5\sqrt{2}$ = 7.1 m/s approx.

4. Solve the problem using μ as the coefficient of kinetic friction. Linear velocity radius to zero before angular velocity becomes zero.

5. $y = A \sin(kx - \omega t + \phi)$
   at t = 0, x = 0, y = 5 mm
   at $t = \frac{1}{24}$, x = 0, y = 0
   also λ = 2m, A = 10 mm
   Solve to get answer.

6. Given PT = Constant and PV = nRT
   $\Rightarrow$ P^2V = constant
   $\Rightarrow$ $PV^{1/2} = K$.
   From first law of thermodynamics
   $\Delta Q = \Delta U + \Delta O$

   $$C\Delta T = C_V T + \left(\frac{P_f V_f - P_i V_i}{1 - \frac{1}{2}}\right)$$

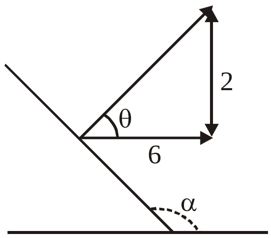
   $C = C_V + 2R$

   $$33.24 = \frac{R}{Y - 1} + 2R$$

   $\Rightarrow$ Y = 1.5 and $Y = 1 + \frac{2}{f}$

   $\therefore$ f = 4.

7. Impulse = change in momentum
   $= 2(\vec{v}_2 - \vec{v}_1)$
   $= 2(3\hat{i} + \hat{j})$
   As impulse is in the normal direction of colliding surface

   $\tan\theta = \frac{1}{3}$

   $\theta = \tan^{-1}\left(\frac{1}{3}\right)$

   $\alpha = 90° + \tan^{-1}\left(\frac{1}{3}\right)$.

8. $H = \frac{KAd\theta}{dr} = K(2\pi rL)\frac{d\theta}{dr}$

$\therefore \int_{r_1}^{r_2} \frac{dr}{r} = \frac{2\pi KL}{H}\int_{\theta_1}^{\theta_2} d\theta$

$\frac{dQ}{dt} = H = \frac{2\pi KL(\theta_2 - \theta_1)}{\ln\left(\frac{r_2}{r_1}\right)} = 80\pi$

$\Rightarrow \frac{dm}{dt}L = 80\pi$

$\Rightarrow \frac{dm}{dt} = \frac{80\pi}{L} = \frac{80\pi}{80 \times 4200} = \frac{\pi}{4200}$ kg/second.

9. Tensile stress $= \frac{F\cos\theta}{A/\cos\theta} = \frac{F\cos^2\theta}{A}$

10. Tensile stress is maximum when $\cos^2\theta$ is maximum i.e. at $\theta = 0^o$

11. Shearing stress $= \frac{F\sin\theta}{A/\cos\theta} = \frac{F\sin\theta\cos\theta}{A} = \frac{F\sin 2\theta}{2A}$

SECTION – C

1. $\psi = a\sin\left[\omega t - \frac{2\pi}{\lambda}(x\cos\alpha + y\cos\beta)\right]$

represents a wave travelling along a line in x-y plane through origin making an angle α with x-axis and β with the y-axis.

$\Delta\phi = \frac{2\pi}{\lambda}\left[(x_2 - x_1)\cos\alpha + (y_2 - y_1)\cos\beta\right]$

comparing with the given equation, we get

$\alpha = 30^o$, $\beta = 60^o$, $\lambda = 1m$, $\omega = 30/s$

Also, $\Delta\phi = 4\pi$.

2. $P = \sigma A e (3000^4 - 300^4) = 2$ kW.

3. $v = \frac{50}{100} V_e = \frac{1}{2}\sqrt{\frac{2GM}{R}}$

Applying energy conservation

$\Rightarrow -\frac{GMm}{R} + \frac{1}{2}mv^2 = -\frac{GMm}{(R+h)}$

$v^2 = \frac{2GM}{R} - \frac{2GM}{R+h}$

$\Rightarrow \frac{1}{4}.\frac{2GM}{R} = 2GM\left(\frac{1}{R} - \frac{1}{R+h}\right)$

$\Rightarrow \frac{1}{4R} = \frac{h}{R(R+h)}$

$\Rightarrow R + h = 4h$

$\Rightarrow h = R/3$

4 $N = mg$

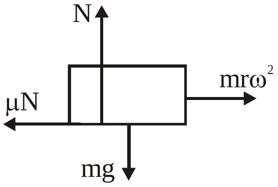
$\mu N = m r \omega^2$

$\mu mg = m.\ 2 \sin\theta\ \omega^2$

$\omega = \sqrt{\dfrac{\mu g}{2\sin\theta}}$

$\omega = \sqrt{\dfrac{0.1\times 10}{2\times \sin 30}}$

$\omega = 1$ rad / s.



5. $x = A\cos\omega t$

$v = \dfrac{dx}{dt} = -A\omega\sin\omega t$

$a = \dfrac{d^2x}{dt^2} = -A\omega^2\cos\omega t$

$a_{max} = A\omega^2$

$\tau_{max} = I\ \alpha_{max} = I\dfrac{a_{max}}{R} = \dfrac{1}{2}MR^2\dfrac{A\omega^2}{R} = \dfrac{1}{2}MR\,A\omega^2$

$\tau_{max} = 4 N.m$

6. $A_1v_1 = A_2v_2$

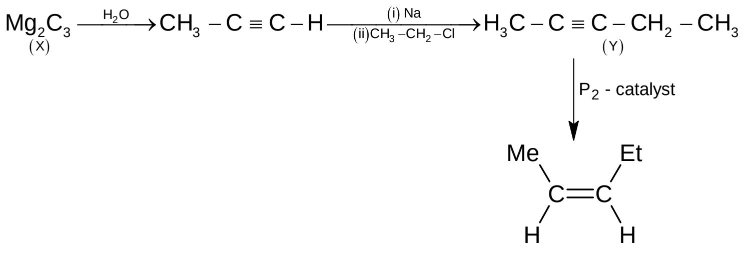
$v_2 = 16$ m/s

Applying Bernoulli's equation

$P_1 + \dfrac{1}{2}\rho v_1^2 = P_2 + \dfrac{1}{2}\rho v_2^2$ ($\rho = 0.9 \times 10^3$ kg/m^3)

Chemistry PART – II

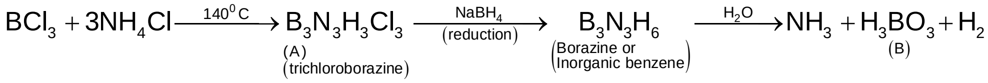
SECTION – A

1. 
P2 - catalyst
Me
Et
H
H

$\underset{(X)}{Mg_2C_3} \xrightarrow{H_2O} CH_3-C\equiv C-H \xrightarrow[(ii)CH_3-CH_2-Cl]{(i)\,Na} \underset{(Y)}{H_3C-C\equiv C-CH_2-CH_3}$

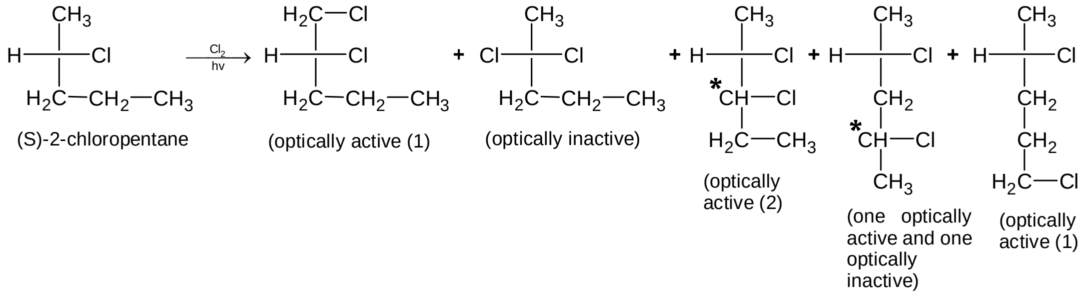
(2Z) - pent - 2 - ene

Hence (D) is correct.

2. 

$BCl_3 + 3NH_4Cl \xrightarrow{140^0 C} \underset{\substack{(A)\\(\text{trichloroborazine})}}{B_3N_3H_3Cl_3} \xrightarrow[(\text{reduction})]{NaBH_4} \underset{\substack{(\text{Borazine or}\\ \text{Inorganic benzene})}}{B_3N_3H_6} \xrightarrow{H_2O} NH_3 + \underset{(B)}{H_3BO_3} + H_2$

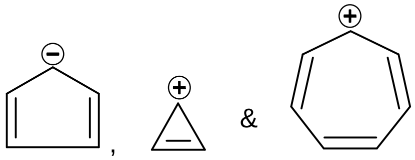
Hence (C) is correct.

3. 
Cl2
hv
(S)-2-chloropentane
(optically active (1)
(optically inactive)
(optically active (2)
(one optically active and one optically inactive)
(optically active (1)

Hence (A) is correct.

4. The limiting reagent here is HCl. So calculating with the limiting reagent, the total number of products is 7.5.

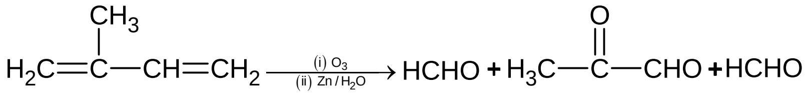
5. Symmetrical alkenes give same products.

6. 

have (4n + 2)π electrons.

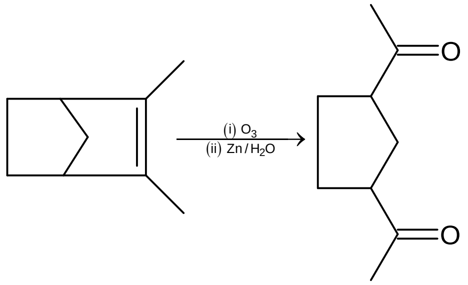
7. CCl_4 does not undergo hydrolysis.

8. KE_{max} of photoelectrons ejected depends only on frequency and not on its intensity.
Also, photoelectric effect is a direct evidence for the particle nature of light not of dual nature.
Hence (A), (B) is correct.

9. 

$H_2C=\overset{\overset{CH_3}{|}}{C}-CH=CH_2 \xrightarrow[(ii)\,Zn/H_2O]{(i)\,O_3} HCHO + H_3C-\overset{\overset{O}{||}}{C}-CHO + HCHO$

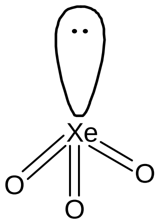
10.



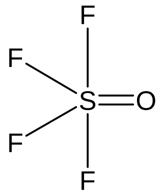
11. Oxidative ozonolysis

SECTION – B

1.



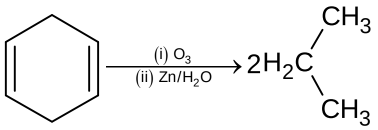
(B)



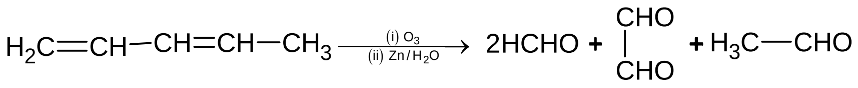
(D)

Trigonal bipyramidal

2. (A)

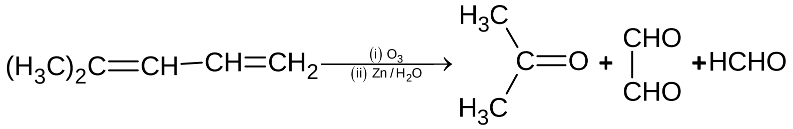


(B)



$H_2C{=}CH-CH{=}CH-CH_3 \xrightarrow[\text{(ii) Zn/H}_2\text{O}]{\text{(i) O}_3} 2HCHO + \begin{matrix}CHO\\|\\CHO\end{matrix} + H_3C-CHO$

(C)



$(H_3C)_2C{=}CH-CH{=}CH_2 \xrightarrow[\text{(ii) Zn/H}_2\text{O}]{\text{(i) O}_3} \begin{matrix}H_3C\\ & C{=}O\\H_3C\end{matrix} + \begin{matrix}CHO\\|\\CHO\end{matrix} + HCHO$

(D) $H_3C-CH{=}CH_2 \xrightarrow[\text{(ii) Zn/H}_2\text{O}]{\text{(i) O}_3} H_3C-CHO + HCHO$

SECTION – C

1.

$$AgSCN \rightleftharpoons \underset{a}{Ag^+} + \underset{a}{SCN^-}$$

$$AgBr \rightleftharpoons \underset{b}{Ag^+} + \underset{b}{Br^-}$$

$$\frac{(K_{sp})_{AgSCN}}{(K_{sp})_{AgBr}} = \frac{(a+b)a}{(a+b)b} = \frac{1.0\times10^{-12}}{5.0\times10^{-13}} = 2$$

2.

	N_2	$+\ 3H_2$	$\longrightarrow 2NH_3$
Initial	2	5	0
(after N_2 reacted 50%)	1	2	2

Total moles of N_2, H_2 and NH_3 = 5 mol (after reaction)
Initial mol = 7

Pressure at start = 7 atm.
Hence pressure at equilibrium = 5 atm.
Partial pressure of NH_3 = $\frac{2}{5}\times 5$ = 2 atm.

4. $\mu = 4.9$ B.M, $4.9 = \sqrt{n(n+2)}$
Number of unpaired electorn in Mn^{x+} = 4, x = 3

5. Volume withdrawn = (20 × 2) – 20 = 20 L
Numer of balloons = $\frac{20}{5} = 4$

6. Maximum number of electron in 3rd orbit = 18
$\therefore$ electrons with spin quantum number $m_s = -1/2 = 9$

Mathematics

PART – III

SECTION – A

1. Put x = 1 and x = – 1 and adding

$$a_0 + a_2 + \ldots + a_{50} = \frac{3^{25}+1}{2} = \frac{(1+2)^{25}+1}{2}$$

$$= \frac{{}^{25}C_0 + {}^{25}C_1\cdot 2 + {}^{25}C_2\cdot 2^2 + \ldots + {}^{25}C_{25}\cdot 2^{25} + 1}{2}$$

$$= \frac{2\left[1 + {}^{25}C_1 + {}^{25}C_2\,2 + \ldots + {}^{25}C_{25}2^{24}\right]}{2}$$

$$= 2\left[13 + {}^{25}C_2 + \ldots + {}^{25}C_{25}\,2^{25}\right] \Rightarrow \text{even.}$$

2. Circle touching y = x at (0, 0) can be taken as $x^2 + y^2 + \lambda(x - y) = 0$ … (i)
This bisects the circumference of the circle $x^2 + y^2 + 2y - 3 = 0$ … (ii)
Hence radical axis between (i) and (ii) must pass through the centre of (ii) which is (0, – 1)
Radical axis is $\lambda(x - y) - 2y + 3 = 0$, hence x = – 5 put x = – 5 in (i) to get the result.

3. Number of positive integral solution of x + y + z + w = 50 is ${}^{50}C_3$
Number of positive integral solution of x + y + z + w = 19 is ${}^{19}C_3$

4. For equilateral triangle

$$|z_2 - z_1| = |z_3 - z_2| = |z_1 - z_3| = a$$

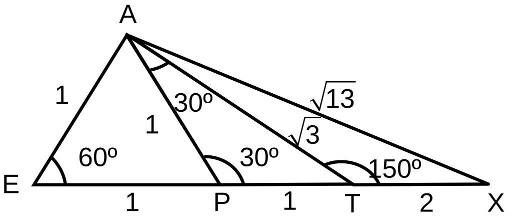
Also $\left|\frac{z_2+z_3}{2} - z_1\right|$ will be the length of median as well as altitude i.e. $\left|\frac{z_2+z_3}{2} - z_1\right| = \frac{a\sqrt{3}}{2}$

Hence, $\sin\theta = \sqrt{\frac{|z_2 - z_1|^2 + |z_3 - z_1|^2}{|z_2 + z_3 - 2z_1|^2 + |z_3 - z_2|^2}} = \frac{1}{\sqrt{2}} \Rightarrow \theta = \frac{\pi}{4}$.

5. Any conic having its foci same as the given ellipse will have equation $\frac{x^2}{9+\lambda} + \frac{y^2}{4+\lambda} = 1$, x is variable now if the curve passes through (3, 2), we get
$\lambda = \pm 6$
Putting value of λ, we get the required answer.

6. For real roots $4a^2 - 4b(a - 1) \ge 0$
$\Rightarrow a^2 - ba + b \ge 0$
Now for above inequality to hold for all values of a,
$b^2 - 4b \le 0$ or $0 \le b \le 4$.

7. We have AE = EP = AP = 1 ⇒ AP = PT = 1
⇒ ΔAPT is isosceles
This makes ΔAET a 30º – 60º – 90º triangle,
So AT = $\sqrt{3}$ and ∠ATX = 150º
since TX = 2
∴ By applying cosine rule in ΔATX, we get
$(AX)^2 = 3 + 4 - 4\sqrt{3}\cos 150^\circ$
$= 7 + 6 = 13$
$\Rightarrow AX = \sqrt{13}$



$$\therefore \cos\angle XAE = \frac{13+1-16}{(2)\left(\sqrt{13}\right)(1)} = \frac{-2}{2\sqrt{13}} = \frac{-1}{\sqrt{13}}.$$

8. Let A be (h, k), then altitude = k
Also AB : AC = 2 : 1, hence $AB^2 = 4AC^2$
Now, $AB^2 = h^2 + k^2$ and $AC^2 = (6 – h)^2 + k^2$

$\Rightarrow \quad 4AC^2 - \left(\frac{AC^2 + 12}{4}\right)^2 > 10$

$\Rightarrow \quad 20 - \sqrt{96} < AC < 20 + \sqrt{96}$

9-11. Slope of $AB = \frac{5}{7}$, hence slope of $PQ = \frac{-7}{5}$

Let equation of PQ be 7x + 5y = C, then coordinates of P & Q will be $\left(\frac{C}{7}, 0\right) \& \left(0, \frac{C}{5}\right)$. Now equation of AQ and BP will be $\frac{x}{7} + \frac{5y}{c} = 0$ & $\frac{7x}{C} - \frac{y}{5} = 1$

Eliminating C from these two equations gives the locus of R as the circle $x^2 + y^2 – 7x + 5y = 0$.
Now, T will be the point on the diameter through origin of this circle at a distance $\sqrt{74}$ i.e. distance of centre from origin + radius. Hence coordinate of T is (7, –5). Equation of the requires parabola $(y + 5)^2 = 2(x – 7)$. The line y = - 3 meets the parabola at (9, - 3). As the line is parallel to the axis so any ray incident along it will pass through focus $\left(\frac{15}{2}, -5\right)$ of the parabola after getting reflected. Hence the reflected ray will be travelling along the line joining (9, –3) & $\left(\frac{15}{2}, -5\right)$.

Hence equation of reflected ray will be 4x – 3y = 45.

SECTION – B

1. (A) Required numbers of ways = ${}^2C_1 \times {}^2C_1 \times 7! \times 2!$
(B) Required numbers of ways = 8!
(C) Required numbers of ways = $6! \times 2! \times {}^2C_1 \times {}^2C_1$
(D) Required numbers of ways = $9! \times {}^8C_2 \times {}^6C_2 \times {}^4C_2 \times {}^2C_2$

2. (A) 2 sinx, sin 2x & 2cosx are in A.P., hence sin 2x = sin x + cos x
Now, let sin x + cos x = t, then sin 2x = t^2 – 1, then the above equation gives $t^2 – t – 1 = 0$ or

$t = \sin x + \cos x = \frac{1-\sqrt{5}}{2}$

(B) Let C be the sides angles, then angles will be

$\frac{\pi}{3} - \frac{c}{3}, \frac{\pi}{3}, \frac{\pi}{3} + \frac{c}{3}$

$\Rightarrow \frac{\pi}{3} + \frac{c}{3} = c \Rightarrow c = \frac{\pi}{2}$, hence angles are $\frac{\pi}{6}, \frac{\pi}{3}, \frac{\pi}{2}$.

Now $\frac{a}{\sin\frac{\pi}{6}} = \frac{b}{\sin\frac{\pi}{2}} = \frac{c}{\sin\frac{\pi}{2}} \Rightarrow \frac{a}{1} = \frac{b}{\sqrt{3}} = \frac{c}{2}$

Hence angles are $\frac{\pi}{6}, \frac{\pi}{3}, \frac{\pi}{2}$.

Now $\frac{a}{\sin\frac{\pi}{6}} = \frac{b}{\sin\frac{\pi}{3}} = \frac{c}{\sin\frac{\pi}{2}}$

$\Rightarrow \frac{a}{1} = \frac{b}{\sqrt{3}} = \frac{c}{2}$.

(C) Let AB = a, BC = $\sqrt{3}$ a, CA = 3a & AD = $3\sqrt{3}$ a

Now cos A + cos C = 0 $\Rightarrow \frac{a^2 + 27a^2 - BD^2}{3\sqrt{3}a^2} + \frac{3a^2 + 9a^2 - BD^2}{3\sqrt{3}a^2} = 0$

$BD^2 = 20a^2 \Rightarrow \frac{BD}{AB} = \sqrt{20} = 2\sqrt{5}$

(D) a + c = 2b & $b^2 = \frac{2a^2c^2}{a^2 + c^2} \Rightarrow (a + c)^2 = \frac{8a^2c^2}{a^2 + c^2}$

$\Rightarrow (a + c)^4 - 2ac(a + c)^2 - 8a^2 c^2 = 0$

$\frac{(a+c)^2}{ac} = -2, 4$

But 4 gives a = c, hence taking – 2

$a^2 + 4ac + c^2 = 0 \Rightarrow \frac{a}{c} = \sqrt{3} - 2$.

SECTION – C

1. $\frac{R}{r} = \frac{3}{1.5} = 2 \Rightarrow \Delta ABC$ must be equilateral

so a = b = c = 2R sin $\frac{\pi}{3}$ = $R\sqrt{3}$

Now $a \cot^2 A + b^2 \cot^3 B + c^3 \cot^4 C = R\sqrt{3}\left(\frac{1}{\sqrt{3}}\right)^2 + \left(R\sqrt{3}\right)^2\left(\frac{1}{\sqrt{3}}\right)^3 + \left(R\sqrt{3}\right)^3\left(\frac{1}{\sqrt{3}}\right)^4$

$= \frac{R}{\sqrt{3}} + \frac{R^2}{\sqrt{3}} + \frac{R^3}{\sqrt{3}} = \frac{3 + 3^2 + 3^3}{\sqrt{3}} = \frac{39}{\sqrt{3}} = 13\sqrt{3}$

m = 13, n = 3 $\Rightarrow \frac{m+n}{2} = \frac{16}{2} = 8$.

2. $$\frac{2^{10}\sin\left(\frac{5\pi}{2^{11}}\right)\cos\left(\frac{5\pi}{2^{11}}\right)\cos\left(\frac{5\pi}{2^{10}}\right)\cos\left(\frac{5\pi}{2^{9}}\right)...\cos\left(\frac{5\pi}{2^{3}}\right)\cos\left(\frac{5\pi}{2^{2}}\right)}{2^{10}}$$

$= \frac{\sin\frac{5\pi}{2}}{2^{10}} = \frac{1}{1024} = 4^{-5}$

3. Let P be (h, k), then chord of contact will be $\frac{hx}{2} - \frac{ky}{3} = 1$

Homogenising equation of hyperbola by equation of chord of contact gives

$\frac{x^2}{2} - \frac{y^2}{3} = \left(\frac{hx}{2} - \frac{ky}{3} - 1\right)^2$. If these are perpendicular lines, then $\frac{1}{2} - \frac{h^2}{4} - \frac{1}{3} - \frac{k^2}{a} = 0$

hence required locus is $\frac{x^2}{4} + \frac{y^2}{9} = \frac{1}{6}$

4. For equilateral triangle $r = \frac{R}{2}$, hence R = 8

Now in radius r of ABC is the circum radius for second triangle. Hence $x_1 = \frac{r}{2} = \frac{R}{4}$

Similarly $x_2 = \frac{x_1}{2} = \frac{R}{8}$, $x_3 = \frac{R}{16}$ …

$x_1 + x_2 + x_3 + \ldots \infty = \frac{R}{4} + \frac{R}{8} + \frac{R}{16} + \ldots\infty$

Hence sum of all these radii is $\frac{\frac{R}{4}}{1-\frac{R}{2}} + \frac{R}{2} = R = 8$.

5. R.M.S. ≥ A.M. $\Rightarrow \sqrt{\frac{|z-3|^2 + |z|^2 + |z+3|^2}{3}} \ge \frac{|z-3| + |z| + |z+3|}{3}$

Also $|z-3|^2 + |z|^2 + |z+3|^2 = 2(|z|^2 + 9)$, hence $|z| \ge \sqrt{10} \Rightarrow a = 3$

where as $|z-3| + |z| + |z+3| \ge |z-3+2+2+3| \Rightarrow |z| \le 4$

$\Rightarrow b = 4$.
a + b = 7.

6. Let us form that equation having roots $y = g(x_i)$
i.e. $y = x^2 - 2 \Rightarrow x = \sqrt{y+2}$

$$\left(\sqrt{y+2}\right)^2 + \left(\sqrt{y+2}\right)^2 + 1 = 0$$

$\Rightarrow$ $y^5 + 20y^4 + 40y^3 + 79y^2 + 74y + 23 = 0$

$\therefore$ $g(x_1)\, g(x_2) \ldots g(x_5)$ = product of roots
= – 23

$x_1x_2x_3x_4x_5 = -1 \Rightarrow g(x_1x_2x_3x_4x_5) = -1$

$\Rightarrow$ $g(x_1)g(x_2) \ldots g(x_5) - 30g(x_1x_2 \ldots x_5) = 7$.

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ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Advanced), 2016**

HALF COURSE TEST – VI

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 240**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 04)** contains 4 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (05 – 08) contains 4 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

   Section-A (09 to 11) contains 1 paragraph having 3 questions. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct matching. No marks will be given for any wrong matching in any question. There is no negative marking.
3. **Section-C (01 – 06)** contains 6 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Single Correct Choice Type

*This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.*

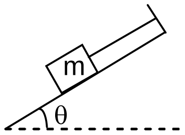
1. A railway track is banked for a speed v, by making the height of the outer rail 'h' higher than that of the inner rail. The horizontal separation between the rails is d. The radius of curvature of the track is 'r' : then which of the following relation is true?

(A) $\frac{h}{d} = \frac{v^2}{rg}$
(B) $\tan\left(\sin^{-1}\frac{h}{d}\right) = \frac{v^2}{rg}$
(C) $\tan^{-1}\left(\frac{h}{d}\right) = \frac{v^2}{rg}$
(D) $\frac{h}{r} = \frac{v^2}{dg}$

2. A horizontal spring mass system of mass M performs simple harmonic motion of amplitude a_0 and time period T_0. When the mass M passes through mean position, another stationary mass M sticks to it and both move together. If a and T be new amplitude and time period, then

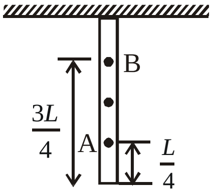
(A) $a = \frac{a_0}{\sqrt{2}}$
(B) $a = a_0\sqrt{2}$
(C) $T = \frac{T_0}{\sqrt{2}}$
(D) None

3. A metal block of mass m is placed on a smooth metallic plane in support with string as shown in diagram. If, after long time due to corrosion, the contact surface becomes rough with coefficient of friction μ, then friction force acting on the block will be



(A) $\mu mg\cos\theta$
(B) $mg\sin\theta$
(C) mg
(D) None

4. A string of mass *m* and length *l* is hanging from ceiling as shown in the figure. Wave in string moves upward. v_A and v_B are the speed of wave at *A* and *B* respectively. Then v_B is

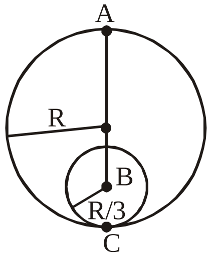


(A) $\sqrt{3}v_A$
(B) v_A
(C) $< v_A$
(D) $\sqrt{2}v_A$

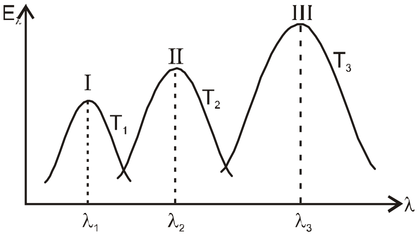
Space for rough work

Straight Objective Type

*This section contains **4 multiple** choice questions numbered 5 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE or MORE** are correct.*



5. Inside a uniform sphere of mass M and radius R, a cavity of radius R/3 is made in the sphere as shown.
(A) Gravitational field inside the cavity is uniform.
(B) Gravitational field inside the cavity is non–uniform.
(C) The escape velocity of a particle projected from point A is $\sqrt{\frac{88GM}{45R}}$.
(D) Escape velocity is defined for earth and particle system only.



6. Three identical bodies are at temperature T_1, T_2 and T_3 having e_1, e_2 and e_3 as their respective emissivities. The thermal spectrum obtained for them is as shown in the diagram. Choose the correct order of temperatures and emissivities:
(A) $T_1 > T_2 > T_3$
(B) $T_1 < T_2 < T_3$
(C) $e_1 < e_2 < e_3$
(D) $e_1 > e_2 > e_3$

7. An ideal monoatomic gas undergoes a process in which $P = 3V^3$. Choose the correct statements.
(A) If volume increases then temperature will also increase
(B) If temperature of the gas decreases, then pressure must also decrease.
(C) For expansion, heat will have to be supplied to the gas.
(D) If temperature increases then work done by gas is positive.

8. Which of the following will have a different time period (compared to that on the earth), if taken to the moon?
(A) A simple pendulum.
(B) A spring mass system oscillating vertically in the gravitational field.
(C) A torsion pendulum.
(D) An hourglass clock, which is essentially a vessel filled with a liquid, emptying through a hole in the bottom.

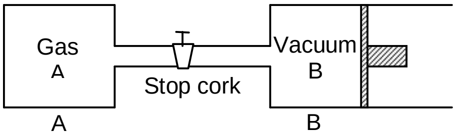
Space for rough work

Comprehension Type

*This section contains one group of questions. This group has 3 multiple choice question based on a paragraph. This question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct*

Paragraph for Question Nos. 9 to 11

An ideal diatomic gas is confined in a cylinder A of volume V_0. Then, cylinder is connected to another cylinder B with the help of tube of a negligible volume. The cylinder B is fitted with a movable piston, which can be adjusted from outside. Initially, piston is adjusted so that the volume of B is same as volume of A, i.e., V_0. B is evacuated and stop cork is opened so that gas expands and occupies the volume $2V_0$.



Answer the following questions based on above information.

9 During this free expansion, the internal energy of this system
(A) Increases (B) Decreases
(C) Remains constant (D) Nothing can be said

10 With open stop cork, the piston is slowly moved to compress the gas back to cylinder A at temperature T. Then, for n moles of gas, work done on the gas is
(A) $nRT\ln 2$ (B) $-nRT\ln 2$
(C) nRT (D) $-nRT$

11 The heat absorbed by the gas in the above process is
(A) $nRT\ln 2$ (B) $-nRT\ln 2$
(C) nRT (D) $-nRT$

Space for rough work

SECTION – B

(Matching List Type)

*This section contains **2 questions.** Each question has four statements (A, B, C and D) given in **Column I** and **five statements** (p, q, r, s and t) in **Column II.** Any given statement in Column I can have correct matching with **ONE** or **MORE** statement(s) given in Column II. For example, if for a given question, statement B matches with the statements given q and r, then for the particular question, against statement B, darken the bubbles corresponding to q and r in the ORS.*

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1. In Column I, some statements or expressions related to first law of thermodynamics are given and corresponding processes are given in Column-II. Match the entries of Column I with that of Column-II:

Column I		Column II	
(A)	Work done by the system on surroundings can be non-zero in	(p)	Adiabatic process
(B)	$dU = nC_v dT$ is valid for	(q)	Isothermal process
(C)	dU is zero for	(r)	Isothermal expansion process
(D)	$dQ = nCdT$ is non-zero for	(s)	Polytropic process
		(t)	Isochoric process

2. Match the following:

Column A		Column B	
(A)	Phase difference between any two particles can have any value between O to 2π.	(p)	Stationary waves.
(B)	Energy is transferred from one place to an other place.	(q)	Plane simple harmonic transverse waves.
(C)	Phase difference between any two particles is either zero or π.	(r)	Sound waves.
(D)	Amplitude of vibration of all particles are equal.	(s)	Standing waves in an open organ pipe.
		(t)	Plane simple harmonic longitudinal waves.

Space for rough work

SECTION – C

Integer Answer Type

*This section contains **6** questions. The answer to each of the questions is a **single digit integer,** ranging from 0 to 9. The bubble corresponding to the correct is to be darkened in the ORS.*

1. A string of length 2L, obeying Hooke's Law, is stretched so that its extension is L. The speed of the transverse wave travelling on the string is v. If the string is further stretched so that the extension in the string becomes 4L. The speed of transverse wave travelling on the string will be $x\sqrt{2}\,v$. Calculate the value of x.

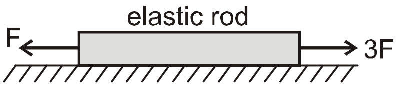
2. A train moves towards a stationary observer with a speed of 34 ms^{-1}. The train sounds a whistle and its frequency registered by the observer is f_1. If the train's speed is reduced to 17 ms^{-1}, the frequency registered is f_2. If the speed of sound is 340 ms^{-1}, then the ratio $\frac{f_1}{f_2}$ is $\frac{10+x}{18}$. Calculate the value of x.

3. A tuning fork A whose frequency is given by the manufacturer as 512 Hz. It is being tested using an accurate oscillator. It is found that they produce 2 beats per second when the oscillator reads 514 Hz and 6 beats per second when it reads 510 Hz. The actual frequency of the fork in Hz is (510 + x). Calculate the value of x.

Space for rough work

4. A small block of mass 1 kg is moving with constant speed of 10 m/s on a typical path in a x – y vertical plane whose equation is $y = \frac{x^3}{30} - \frac{x^2}{10}$. The coefficient of friction between the block and path is 0.01. Find the magnitude of power dissipated by frictional force in watt at x = 2 m?

5. A uniform elastic rod of cross- sectional area A, natural length L and Young's modulus Y is placed on a smooth horizontal surface. Now two horizontal forces (of magnitude F and 3F) directed along the length of rod and in opposite directions act at its ends as shown. After the rod has acquired steady state, the extension of the rod is given by $\frac{xF}{YA}L$. Calculate x.



6. A uniform square plate of mass m = 100 gm and side a = 24 cm can freely rotate about a vertical axis passing through one edge. It is initially at rest. A particle of mass m = 100 gm is moving horizontally and perpendicular to the plane of the plate with velocity u = 70 cm/s. The particle collides with the plate elastically at the centre of the plate. Find the angular velocity (in rad/s) of the plate just after collision.

Space for rough work

Chemistry

PART - II

SECTION – A

Single Correct Choice Type

*This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.*

1. Which of the following is paramagnetic?
(A) O_2^- (B) CN^-
(C) CO (D) NO^+

2. Which of the following species is incorrect matched with its shape?
(A) $ClF_3 \longrightarrow T-\text{shaped}$ (B) $SO_3^{2-} \longrightarrow \text{tetrahedral}$
(C) $C_2O_4^{2-} \longrightarrow \text{planar}$ (D) $I_3^- \longrightarrow \text{linear}$

3. Identify the incorrect statement (s) among the following:
(A) if spin quantum number curve having 3 possible values then 4th period of periodic table would have maximum of 27 elements.
(B) platinum (Pt) is one of the typical transition metal.
(C) total number of f – electrons in Gd (at. No. 64) is 8.
(D) atomic radius of Ga is nearly equal to that of Al.

4. SO_3(g) is heated in a closed vessel. A equilibrium $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$ is established. The vapour density of the mixture, in which SO_3 is 50% dissociated is?
(A) 32 (B) 35
(C) 42 (D) 55

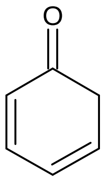
Space for rough work

Multiple Correct Answers Type

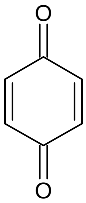
*This section contains 4 multiple correct answer(s) type questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE** is/are correct.*

5. Which of the following compounds exhibit keto – enol tautomerism?

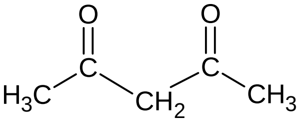
(A)



(B)

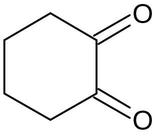


(C)



$H_3C-CO-CH_2-CO-CH_3$

(D)



6. Which of the following carbide on reaction with water give methane?

(A) CaC_2
(B) Be_2C
(C) Mg_2C_3
(D) Al_4C_3

7. Which of the following statement is/are true regarding a real gas?

(A) Boyle temperature is the temperature at which the slop $\left(\frac{dz}{dp}\right)$ of the curve between compressibility factor vs P is same as that for an ideal gas over a wide range of pressure.
(B) At larger molar volumes, a real gas always obeys ideal gas laws.
(C) At low pressure, attractive forces in the real gases dominates and the gas is more compressible.
(D) At critical state, the compressibility factor is 3/8.

8. Which of the following reaction is/are correct?

(A) $3CS_2 + 6NaOH \longrightarrow Na_2CO_3 + 2Na_2CS_3 + 3H_2O$
(B) $SiCl_4 + LiAlH_4 \longrightarrow SiH_4 + AlCl_3 + LiCl$
(C) $SiO_2 + 4HF(\text{excess}) \longrightarrow SiF_4 + 2H_2O$
(D) $Na_2B_4O_7 + H_2SO_4 \longrightarrow Na_2SO_4 + H_3BO_3$

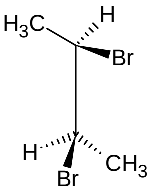
Space for rough work

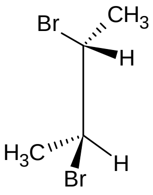
Linked Comprehension Type

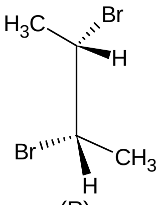
*This section contains **one group** of questions. This group has 3 multiple choice question based on a paragraph. This question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct*

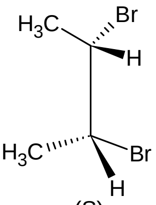
Paragraph for question Nos 9 to 11

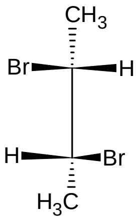
A structure with two stereogenic carbon does not always have four possible stereoisomers. Sometimes are only three. This happens because some molecules are achiral even though they contain stereogenic carbon atoms. Let us write stereo chemical formula for 2, 3 – dibromo butane.

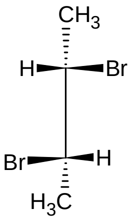

(P)


(Q)


(R)


(S)


(T)


(U)

Observe the above configurations carefully and answer the following questions:

9. Which of the following pair represents the identical compounds?
   (A) P & T (B) Q & T
   (C) R & S (D) S & T

10. Consider the following pairs:
    I. Q & S
    II. P & R
    III. T & R
    IV. P & U
    Which of the above pairs represents enantiomers?
    (A) I, II, III (B) II, III, IV
    (C) II & III (D) I, II, III & IV

11. Which of the following configuration is chiral?
    (A) Q (B) S
    (C) R (D) all of these

Space for rough work

SECTION – B

(Matrix-Match Type)

*This section contains **2 questions.** Each question has four statements (A, B, C and D) given in **Column I** and **five statements** (p, q, r, s and t) in **Column II.** Any given statement in Column I can have correct matching with **ONE** or **MORE** statement(s) given in Column II. For example, if for a given question, statement B matches with the statements given q and r, then for the particular question, against statement B, darken the bubbles corresponding to q and r in the ORS.*

1. Match the statement in column – I with corresponding type (s) of silicates in column - II

Column – I		**Column – II**	
(A)	Only one corner of SiO_4^{4-} units is shared	(p)	Chain silicates
(B)	At lest one corner of SiO_4^{4-} unit is shared	(q)	Sheet silicates
(C)	Only two corners of SiO_4^{4-} units are shared	(r)	Pyrosilicates
(D)	At least two corners of SiO_4^{4-} units are shared	(s)	Cyclic silicates
		(t)	sp^3 hybridised Si – centre

2. Match the compounds in column – I with their corresponding decreasing K_a value in column – II.

Column – I (compounds)		**Column – II (Acidity)**	
(A)	o, m, p – nitrophenols	(p)	o > m > p
(B)	o, m, p – cresols	(q)	p > o > m
(C)	o, m, p – chlorophenols	(r)	p > m > o
(D)	o, m, p – nitrobenzoic acid	(s)	m > p > o
		(t)	All three are more acidic than water

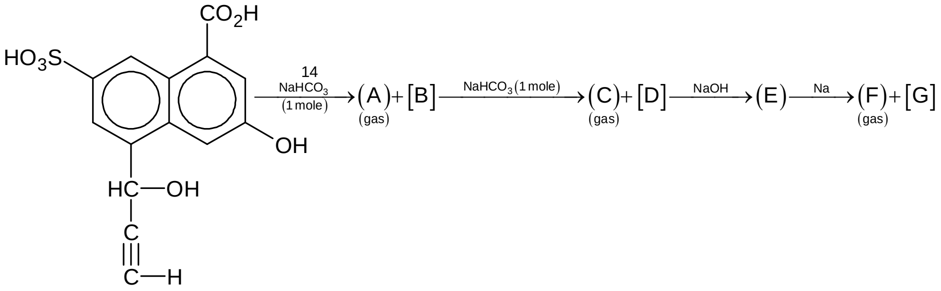
Space for rough work

SECTION – C

(Integer Answer Type)

*This section contains **6** questions. The answer to each of the questions is a **single digit integer,** ranging from 0 to 9. The bubble corresponding to the correct is to be darkened in the ORS.*

1. Consider the following reaction sequence of compound (A).



(A)

Find the total sum of different types of atoms present in gases A, C and F?

2. Haemoglobin contains 0.25% iron by weight. The molecular weight of haemoglobin is 89600. What is the number of iron atom per molecule of haemoglobin? (atomic weight Fe = 56)

3. At 400 K, the rms speed of a gas x (MW = 40) is equal to most probable speed of gas Y at 60 K. The molecular weight of Y is.

4. K_{sp} of $Cu(OH)_2$ is 5×10^{-16} at 25°C, then pH of a saturated solution of $Cu(OH)_2$ is.

5. In a closed flask at 400 K solid $(NH_4)_2S$ was taken. After some time a constant pressure of 3 bar was found in the flask. K_p of the reaction:
$\left(NH_4\right)_2 S(s) \rightleftharpoons 2NH_3(g) + H_2S(g)$ at 400 K is.

6. In a hydrogen atom an electron is in the 5th excited state. Total number of electronic transtions possible which will give vissible radiations.

Space for rough work

Mathematics PART – III

SECTION – A
Single Correct Choice Type

*This section contains **4 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.*

1. If a_1, a_2, a_3 … are positive numbers in G.P. and x_1, x_2, x_3 … are positive numbers such that $a_1^{\frac{1}{x_1}} = a_2^{\frac{1}{x_2}} = a_3^{\frac{1}{x_3}} = ...$ then x_1, x_2, x_3 … are in

(A) A.P. (B) G.P.
(C) H.P. (D) none.

2. A tangent drawn to hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ at a point with eccentric angle $\frac{\pi}{6}$ forms a triangle of area $3a^2$ square units with coordinate axes, then the square of its eccentricity is equal to

(A) 17 (B) 36
(C) 28 (D) 4.

3. If each of the quadratic equation $x^2 + 2ax + b = 0$, $x^2 + 2bx + c = 0$ and $x^2 + 2cx + a = 0$ gas real and equal roots and $a \neq b \neq c$ and $a > 0, b > 0, c > 0$, then

(A) a, b, c can't be rational numbers (B) a, b, c can't be integers
(C) a, b, c can't be irrational numbers (D) none of these.

4. In ΔABC, if $\sin 2A + \sin 2B + \sin 2C = 4 - 4 \cos A \cos B$, then triangle is

(A) equilateral (B) right angled but not isosceles
(C) isosceles but not right angled (D) isosceles and right angled.

Multiple Correct Choice Type

*This section contains **4 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct*

5. Let PQ be a chord of the parabola $y^2 = 4x$. A circle drawn with PQ as a diameter passes through the vertex V of the parabola. If ar(ΔPVQ) = 20 unit^2 then the coordinates of P are

(A) (16, 8) (B) (16, –8)
(C) (–16, 8) (D) (–16, –8).

Space for rough work

6. Let z be a complex number satisfying equation $z^n = \overline{z}^m$, where n, m $\in$ N, then
   (A) if n = m, then number of solution of equation will be finite
   (B) if n = m, then number of solution of equation will in finite
   (C) if n $\neq$ m, then number of solution of equation will be n + m
   (D) if n $\neq$ m, then number of solution of equation will be n + m + 1.

7. If $\left(3\sqrt{3}+5\right)^9 = R$ and [R] denotes the greatest integer less then or equal to R, then
   (A) [R] is divisible by 10 (B) [R] is divisible by 3
   (C) [R] is divisible by 15 (D) [R] is an even number.

8. Maximum number of regions into which 10 lines can divide a plane, is
   (A) 42 (B) 56
   (C) ${}^8P_2$ (D) ${}^7P_2$.

Comprehension Type

*This section contains **one group** of questions. This group has 3 multiple choice question based on a paragraph. This question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct*

Paragraph for Question Nos. 9 to 11

Read the following write up carefully and answer the following questions:

Consider the quadratic equation $ax^2 - (2a - 1)x + a - 3 = 0$ and answer the following questions:

9. If both the roots are real and are of opposite sign, then complete set of values of a is
   (A) (0, 3) (B) $(-\infty, 0) \cup (3, \infty)$
   (C) $\left\{\frac{1}{2}\right\}$ (D) none.

10. If a is given as $\frac{n^2+n}{2}$, where 'n' is national number, then both the roots are necessarily
   (A) Integers (B) Rational numbers
   (C) Even integers (D) None.

11. As per the data of pervious question both the roots will lie in the interval
   (A) [–1, 2] (B) $[1, \infty)$
   (C) [1, 2] (D) None.

Space for rough work

SECTION – B

(Matching List Type)

*This section contains **2 questions.** Each question has four statements (A, B, C and D) given in **Column I** and **five statements** (p, q, r, s and t) in **Column II.** Any given statement in Column I can have correct matching with **ONE** or **MORE** statement(s) given in Column II. For example, if for a given question, statement B matches with the statements given q and r, then for the particular question, against statement B, darken the bubbles corresponding to q and r in the ORS.*

1. Match the following Column-I with Column-II

	Column – I		Column – II
(A)	If the straight lines y = $a_1x + b$ and y = $a_2x + b$, ($a_1 \neq a_2$) and b $\in$ R meet the coordinate axes in concyclic points, then	(p)	$a_1^2 + a_2^2 = 4$
(B)	If the chord of contact of the tangents drawn to $x^2 + y^2 = 4$ and b $\in$ R from any point on $x^2 + y^2 = a_1^2$, touches the circle $x^2 + y^2 = a_2^2, (a_1 \neq a_2)$, then	(q)	$a_1 + a_2 = 20$
(C)	If the circles $x^2 + y^2 + 2a_1x - 2a_2y - 1 = 0$, ($a_1 \neq a_2$) cut orthogonally, then	(r)	$a_1a_2 = 4$
(D)	If the shortest and largest distance from the point (8, 5) to the circle $x^2 + y^2 - 4x + 6y - 12 = 0$ are a_1 and a_2 respectively, then	(s)	a_1a_2
		(t)	$a_2 + a_1 = 10$

2. Match the following Column-I with Column-II

	Column – I		Column – II
(A)	The number of real roots of the equation $\cos^7 x + \sin^4 x = 1$ in $(-\pi, \pi)$ is	(p)	1
(B)	The value of $\sqrt{3}$ cosec 20º – sec 20º is	(q)	4
(C)	4 cos 36º – 4 cos 72º + 4 cos 36º sin 18º equals	(r)	3
(D)	The number of values of x where x $\in[-2\pi, 2\pi]$, which satisfy cosec x = 1 + cot x	(s)	2
		(t)	5

Space for rough work

SECTION – C

Integer Answer Type

This section contains ***6*** *questions. The answer to each of the questions is a* ***single digit integer,*** *ranging from 0 to 9. The bubble corresponding to the correct is to be darkened in the ORS.*

1. If the equation $x^3 - bx^2y - cxy^2 + y^3 = 0$ represents three straight lines of which two are mutually perpendicular, then the value of (b + c) is

2. If $S_n = {}^nC_0\,{}^nC_1 + {}^nC_1\,{}^nC_2 + \ldots + {}^nC_{n-1}\,{}^nC_n$ and if $\frac{S_{n+1}}{S_n} = \frac{15}{4}$, then the sum of two possible values of n is

3. Normal chord to the parabola $y^2 = 8x$ at the point P(2, 4) and Q meets the curve again in R. If circumcenter of ΔPQR is (h, k) then h + k is

4. Number of all five digit numbers of the form 34x5y (x and y are digits) divisible by 36, is

5. An ellipse of major axis 4 and minor axis 3 is drawn tangential to the lines $x - 3y + 2 = 0$ and $3x + y - 4 = 0$. Centre of this ellipse will always lies on the circle, then the radius of the circle is

6. Let the lengths of the altitudes drawn from the vertices of a ΔABC to the opposite sides are 2, 2 and 3. If the area of ΔABC is Δ, then find the value of $2\sqrt{2}\Delta$.

Space for rough work

FIITJEE Students From All Programs have bagged 33 in Top 100, 77 in Top 200 and 205 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2015:
4551 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2015.

FIITJEE **JEE(Advanced)-2016**

ALL INDIA INTEGRATED TEST SERIES

ANSWERS, HINTS & SOLUTIONS
HALF COURCE TEST –VI
(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**A**	**A**	**C**
2.	**A**	**B**	**A**
3.	**D**	**C**	**B**
4.	**A**	**A**	**D**
5.	**A, C**	**A, C, D**	**A, B**
6.	**A, C**	**B, D**	**B, D**
7.	**A, B, C, D**	**A, C, D**	**A, D**
8.	**A, D**	**A, B, D**	**B, C**
9.	**C**	**A**	**A**
10.	**A**	**B**	**B**
11.	**B**	**C**	**A**
1.	**(A) → (p, q, r, s)** **(B) → (p, q, r, s, t)** **(C) → (q, r)** **(D) → (q, r, s, t)**	**(A) → (r, t)** **(B) → (p, q, r, s, t)** **(C) → (p, s, t)** **(D) → (p, q, s, t)**	**(A) → (s)** **(B) → (r)** **(C) → (p)** **(D) → (q)**
2.	**(A) → (q, r, t)** **(B) → (q, r, t)** **(C) → (p, s)** **(D) → (q, t)**	**(A) → (q, t)** **(B) → (s, t)** **(C) → (p, t)** **(D) → (p, t)**	**(A) → (r)** **(B) → (q)** **(C) → (r)** **(D) → (s)**
1.	**2**	**4**	**2**
2.	**9**	**4**	**6**
3.	**6**	**4**	**8**
4.	**3**	**9**	**3**
5.	**2**	**4**	**5**
6.	**5**	**4**	**9**

Physics PART – I

SECTION – A

1. $\tan\theta = \frac{v^2}{Rg}$ and $\frac{h}{d} = \tan\theta$

3. Static friction depends on tendency.

4. $v_A = \sqrt{\frac{\frac{\lambda L}{4}g}{\lambda}}$

$v_B = \sqrt{\frac{\frac{3L}{4}g}{\lambda}}$

$v_B = \sqrt{3}v_A$

5. Gravitational field inside the cavity is $\vec{E} = \frac{4}{3}\pi\rho G\vec{r}$

where ρ is mass density and $\vec{r}$ is separation between centre of sphere and centre of cavity.
Applying law of Conservation of energy :

$$\frac{1}{2}mV_{esc}^2 - \frac{GMm}{R} + \frac{GMm}{45R} = 0$$

Solving $V_{esc} = \sqrt{\frac{88GM}{45R}}$.

6. $\lambda \propto \frac{1}{T} \Rightarrow T_1 > T_2 > T_3$ as $\lambda_1 < \lambda_2 < \lambda_3$ (Wien's law)

Now as the area under the curve E_λ and λ gives the intensity; so

$\sigma Ae_3T_3^4 > \sigma Ae_2T_2^4$ {Areas of the bodies are same, given}

Now as $T_3 < T_2 \Rightarrow e_3 > e_2$.

7. $P = V^3$, for ideal gas
$PV = nRT$
(A) relation between V and T
$V \times (3V^3) = nRT$
$\Rightarrow V^4 = \left(\frac{nR}{3}\right)T \Rightarrow V^4 \propto T$
(B) Relation between P and T
$PV = nRT \Rightarrow P\left(\frac{P}{3}\right)^{1/3} = nRT$
$\Rightarrow P^{4/3} \propto T$
(C) For expansion
V → increases
work-done : positive
internal energy : increases
Hence, heat will have to supplied to the gas.
(D) As $T \propto V^4$
with increase in temperature, volume increases
Hence work done is positive.

8. Both (A) and (D) depend on g.

SECTION – B

1. Adiabatic dQ = 0
Isochoric dW = 0
Isothermal dT = 0 $\Rightarrow$ dU = 0

2. **(A) → (q, r, t), (B) → (q, r, t), (C) → (p, s), (D) → (q, t)**

SECTION – C

1. $v = \sqrt{\frac{T}{\mu}}$

T can be calculated by using Hooke's Law and on stretching μ also changes.

2. $f_1 = \left(\frac{340}{340-34}\right)f = \frac{10}{9}f$

and $f_2 = \left(\frac{340}{340-17}\right)f = \frac{20}{19}f$

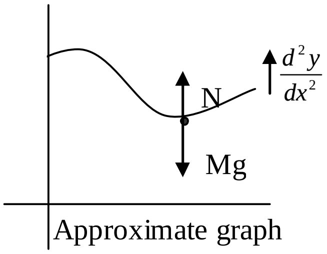
and $\frac{f_1}{f_2} = \frac{\frac{10}{9}}{\frac{20}{19}} = \frac{19}{18}$

3. For 1st reading of oscillator
$f_A = (514 \pm 2)\text{Hz}$
$\Rightarrow$ f_A = 516 Hz or 512 Hz
For 2nd reading of oscillator
$f_A = (510 \pm 6)$ Hz
$\Rightarrow$ f_A = 516 Hz or 504 Hz
$\Rightarrow$ A has a frequency of 516 Hz

4. $y = \frac{x^3}{30} - \frac{x^2}{10}$

$\frac{dy}{dx} = \frac{x^2}{10} - \frac{x}{5}$ and at $x = 2; \frac{dy}{dx} = 0$

$\frac{d^2y}{dx^2} = \frac{x}{5} - \frac{1}{5}$ and at $x = 2; \frac{d^2y}{dx^2} = +ve$



Hence the particle is at it's lowest (minimum) position, in it's path at x = 2 m

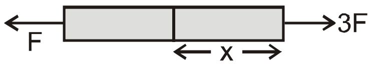
$$\frac{d^2y}{dt^2} = 2x\frac{dx}{dt} - 2\frac{dx}{dt}$$

$$\left(\frac{d^2y}{dt^2}\right)_{\text{at } x=2} = 20\text{m/s}^2$$

$$\Rightarrow N - mg = m\frac{d^2y}{dt^2} \Rightarrow N = 1(10+20) = 30\text{N}$$

$$P = f.v = (\mu N)V = \frac{1}{100} \times 30 \times 10 = 3\,\text{watt}$$

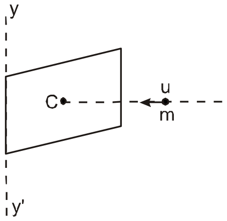
5. Tension in rod at a distance x from right edge is



$T = F(3 - 2\frac{x}{L})$

$\therefore$ net extension in rod = $\int_0^L \frac{T}{YA}dx = \frac{2F}{YA}L$

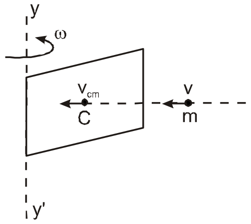
6. The plate is free to rotate about vertical axis yy'.



Let v, v_{cm} and ω be the velocity of particle, velocity of centre of mass of plate and angular velocity of plate just after collision.

$\therefore$ From conservation of angular momentum about vertical axis passing though O is

$\therefore \quad mu\frac{a}{2} = mv\frac{a}{2} + \frac{ma^2}{3}\omega$ ....(1)



since the collision is elastic, the equation of coefficient of restitution is

$e = \frac{v_{cm} - v}{u} = 1$ ....(2)

But $v_{cm} = \frac{a\omega}{2}$ ....(3)

solving equation (1), (2) and (3) we get $\omega = \frac{12}{7}\frac{u}{a}$

Chemistry PART – II

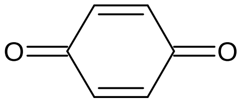
SECTION – A

1. O_2^- has one unpaired electron. It is paramagnetic.

2. In, SO_3^{2-}, S has 3 bond pairs and one lone pair and hence, it is pyramidal in shape not tetrahedral. Hence (B) is correct.

3. (A). Three possible spin quantum number means an orbital can have at the most three electrons.
   So 4th period involves,
   3s,3d and 4p subshells.
   So, maximum of electrons (and hence elements) = $4s^3 3d^{15} 4p^9$ = 3 + 15 + 9 = 27
   (B). All elements of VIII group (i.e. 8, 9, 10 groups) are called typical transition metals. Pt also belongs to 10th group. So it is a typical transition metal.
   (C). E.C. of Gd (64) = $[Xe]4f^7 5d^1 6s^2$
   So number of f – electrons = 7
   (D). Due to ineffective shielding by 3d – electrons in Ga, size of Ga is smaller (almost equal) to that of Al.
   Hence **(C)** is correct.

4. $\alpha = \dfrac{D-d}{(n-1)d} \Rightarrow 0.5 = \dfrac{40-d}{(1.5-1)d} \Rightarrow 0.5 \times 0.5 \times d = 40 - d$
   $\therefore$ 1.25d = 40 $\Rightarrow$ d = 32

5. 
   can not exhibit keto enol tautomerism.

6. $Be_2C + 4H_2O \longrightarrow 2Be(OH)_2 + CH_4$
   $Al_4C_3 + H_2O \longrightarrow 4Al(OH)_3 + 3CH_4$

7. At larger molar volume, a real gas may behave ideally only to a limit but not always. Hence (B) is incorrect and others (A, C and D) are correct statements.

8. SiO_2 reacts with HF to form H_2SiF_6 is
   $SiO_2 + 6HF \longrightarrow H_2SiF_6 + 2H_2O$
   Hence A, B, D is correct.

9. Both P & T represents (2R, 3R) – 2, 3 – dibromobutane.
   Hence (A) is correct.

10. (I) $\Rightarrow$ Identical & rest of II, III & IV are enantiomers.
    Hence (B) is correct.

11. Both Q & S are meso – 2, 3 - dibromobutane.
    While (R) is (2S, 3S) - 2, 3 – dibromobutane & hence optically active i.e. lacks in the plane of symmetry.
    Hence (C) is correct.

SECTION – C

1. $A = {}^{14}CO_2$
$C = CO_2$
$F = H_2$

2. Weight of Fe in 1 mole of haemoglobin = $98600 \times \frac{0.25}{100} = 224$

$\text{number of Fe} = \frac{224}{56} = 4$

3. $$\sqrt{\frac{3RT_x}{M_x}} = \sqrt{\frac{2RT_y}{M_y}}$$
$$\frac{3 \times 400}{40} = \frac{2 \times 60}{M_y}, M_y = 4$$

4. $K_{sp} = 4s^3$
$$S = 3\sqrt{\frac{5 \times 10^{-16}}{4}} = 5 \times 10^{-6}$$
$\left[OH^-\right] = 2s = 2 \times 5 \times 10^{-6} = 10^{-5}, pH = 9$

5. $P_{NH_3} = 2 \times P_{H_2S}$
$P = 1\,\text{bar}, P_{NH_3} = 2\,\text{bar}, P_{H_2S} = 1\,\text{bar}$
$K_p = (2)^2 \times 1 = 4$

6. 5th exited state $\Rightarrow n_2 = 6$
Visible radiation means $\Rightarrow n_2 = 2$
$6 \to 2, 5 \to 2, 4 \to 2, 3 \to 2$

Mathematics PART – III

SECTION – A

1. $a_1, a_2, a_3 \ldots$ are in G.P.

$$a_1^{\frac{1}{x_1}} = (a_1 r)^{\frac{1}{x_2}} = \left(a_1 r^2\right)^{\frac{1}{x_3}} = \ldots = k$$

$$\frac{1}{x_1} = \log_{a_1} k\,,\ \frac{1}{x_2} = \log_{a_2} k \text{ and } \frac{1}{x_3} = \log_{a_3} k$$

Clearly $x_1, x_2, x_3 \ldots$ are in H.P.

2. Equation of tangent will be $\frac{2x}{\sqrt{3}a} - \frac{y}{\sqrt{3}b} = 1$ hence x-intercept is $\frac{a\sqrt{3}}{2}$ and y intercept is $b\sqrt{3}$

$\Rightarrow \quad \frac{1}{2} \times \frac{a\sqrt{3}}{2} \times b\sqrt{3} = 3a^2 \Rightarrow \frac{b}{a} = 4 \Rightarrow e^2 = 17.$

3. For each of the three equations to have equal roots

$4a^2 = 4b,\ 4b^2 = 4c$ and $4c^2 = 4a$

$\Rightarrow \quad a^2b^2c^2 = abc \Rightarrow abc = 1$

hence a, b, c can't be integers.

4. We know that in ΔABC, $\sin 2A + \sin 2B + \sin 2C = 4 \sin A \sin B \sin C$

$\therefore \quad \sin A \sin B \sin C = 1 - \cos A \cos B$

$$\sin C = \frac{1 - \cos A \cos B}{\sin A \sin B} \le 1$$

$\cos(A - B) \ge 1$ i.e., A = B

Hence $\angle C = \frac{\pi}{2}$, $\angle A = \angle B = \frac{\pi}{4}$.

5. Slope of PV = $\frac{2t - 0}{t^2 - 0} = \frac{2}{t}$

$\therefore \quad$ equation of QV is $y = -\frac{t}{2}x$

solving it with $y^2 = 4x$, $Q = \left(\frac{16}{t^2}, \frac{-8}{t}\right)$

Now, as (ΔPVQ) $\frac{1}{2} \times PV \times VQ = 20$ (given)

$PV^2 \times VQ^2 = 40^2$

6. If n = m then equation becomes $z^n = \bar{z}^m$ and it has infinite solution because any $z \in$ real will satisfy it.

If $n \ne m$, let n > m, then $z^n = \bar{z}^m \Rightarrow |z|^n = |z|^m$

$\Rightarrow \quad |z|^m (|z|^{n-m} - 1) = 0$

$\Rightarrow \quad |z| = 0$ or $|z| = 1$, $|z| = 0 \Rightarrow z = 0 + 0i$

$|z| = 1 \Rightarrow z = e^{i\theta} \Rightarrow e^{(m+n)\theta I} = 1$

$\Rightarrow \quad z = 1^{\frac{1}{m+n}}$

$\Rightarrow \quad$ number of solution is m + n + 1.

7. Let $R = \left(3\sqrt{3}+5\right)^9 = [R]+f$ and $\left(3\sqrt{3}-5\right)^9 = f'$, then [R] + f – f′ = an even integer, which implies f – f′ = 0, Hence [R] is an even number

$$[R] = \left(3\sqrt{3}-5\right)^9 - \left(3\sqrt{3}+5\right)^9 \text{ = a multiple of 5}$$

Hence [R] is divisible by 10.

8. If n lines divide a plane is L(n) planes, then
L(n) = L(n – 1) + n
Hence L(10) = 2 + 2 + 3 + … + 10 = 56.

9. For roots of opposite sign a(a – 3) < 0, hence 0 <a < 3

10. Discriminate = $(2a – 1)^2 – 4a(a – 3) = 8a + 1$
for $a = \frac{n^2+n}{2}$ $D = (2n + 1)^2$
Hence roots must be rational numbers.

11. As per data of previous questions the roots will be
$\frac{n^2+3n}{n^2+n}, \frac{n^2-n-2}{n^2+n}$
Hence both the roots lie in [–1, 2].

SECTION – B

1. (A) Equation of any curve through the points in which given lines meet coordinate axes will be $(a_1x – y + b)(a_2x – y + b) + \lambda xy = 0$. If these points are concyclic then $a_1a_2 = 1$.

(B) Any point on $x^2+y^2 = a_1^2$ will be $(a_1 \cos\theta, b_1 \sin\theta)$.
The chord of contact of the tangents drawn to $x^2 + y^2 = 4$ from this point will be $a_1x \cos\theta + a_1y \sin\theta = 4$. If this touches the circle $x^2 + y^2 = a_2^2$, then $a_1a_2 = 4$.

(C) If the two circles cut orthogonally, then
$–a_1 \times a_1 – a_2 \times a_2 = 2(–1 –1) \Rightarrow a_1^2 + a_2^2 = 4$.

(D) Centre of the given circle is (2, –3) and radius is 5. Now distance between (8, 5) and the centre is 10.
Hence $a_1 = 5$ and $a_2 = 15$.

2. (A) $\cos^7 x + \sin^4 x = 1$
$\cos^7x = (1 + \sin^2 x)\cos^2x$
$\cos x = 0$ or $\cos^5x = 1 + \sin^2 x$
$\cos x = 0 \Rightarrow x = \frac{-\pi}{2}, \frac{\pi}{2}$, $\cos^5x = 1 + \sin^2 x$
$\Rightarrow x = 0$.
$\therefore\ x = \frac{-\pi}{2}, 0, \frac{\pi}{2}$.

(B) $\sqrt{3}\,\text{cosec}\,20^\circ - \sec 20^\circ$

$$= \frac{\sqrt{3}}{\sin 20^\circ} - \frac{1}{\cos 20^\circ} = \frac{\sqrt{3}\cos 20^\circ - \sin 20^\circ}{\sin 20^\circ \cos 20^\circ}$$

$$= \frac{2\left[\frac{\sqrt{3}}{2}\cos 20^\circ - \frac{1}{2}\sin 20^\circ\right]}{\sin 20^\circ \cos 20^\circ} = \frac{4\cos 50^\circ}{\sin 40^\circ} = 4$$

(C) $4\cos 36^\circ - 4\cos 72^\circ + 4\cos 18^\circ \cos 36^\circ$

$$= 4\left(\frac{55+1}{4}\right) - 4\left(\frac{55-1}{4}\right) + 4\left(\frac{55-1}{4}\right)\left(\frac{55+1}{4}\right)$$

$= 3$

(D) cosec x = 1 + cot x

$$\frac{1}{\sin x} = \frac{\sin x + \cos x}{\sin x} \Rightarrow \cos x + \sin x = 1 \text{ and } \sin x \neq 0$$

$$\cos\left(x - \frac{\pi}{4}\right) = \frac{1}{\sqrt{2}}$$

$$x - \frac{\pi}{4} = -2\pi + \frac{\pi}{4} \text{ or } x - \frac{\pi}{4} = \frac{\pi}{4}, \qquad x = \frac{-3\pi}{2}, \frac{\pi}{2}.$$

SECTION – C

1. Let these lines be given by $y = mx$ for $m = m_1, m_2$ & m_3
Then substituting $y = mx$ in the given equation gives
$m^3 - cm^2 - bm + 1 = 0$
Now $m_1 + m_2 + m_3 = b$, $m_1m_2 + m_2m_3 + m_3m_1 = -c$
$m_1m_2m_3 = -1$ & $m_1m_2 = -1$
Hence $b + c = 2$

2. $C_0C_1 + C_1C_2 + \dots + C_{n-1}C_n = {}^{2n}C_{n-1} = \dfrac{2n!}{(n-1)!(n+1)!}$

$$\Rightarrow \quad S_{n+1} = \frac{(2n+2)!}{n!(n+2)!} \Rightarrow \frac{S_{n+1}}{S_n} = \frac{4n^2+6n+2}{n^2+2n} = \frac{15}{4}$$

$\Rightarrow$ n = 2 or 4.

3. $P(2, 4) = (2t^2, 4t) \Rightarrow t = 1$

$t' = -t - \dfrac{2}{t} \Rightarrow t' = -3 \Rightarrow$ R is (18, – 12)

Also $tt' = 2$ gives $t' = 2$ hence Q(8, 8)
Perpendicular bisector of PR : $x - y = 14$ and of PQ : $3x + 2y = 27$
solving together gives $h = 11$, $k = -3$
$h + k = 8$

4. N = 34x5y
number is divisible by 4 if 5y is divisible by 4 i.e. y = 2, 6
if y = 2 then 3 + 4 + x + 5 + 2 must be divisible by 9 $\Rightarrow$ x = 4
if y = 6 then 3 + 4 + x + 5 + 6 must be divisible by 9 $\Rightarrow$ x = 0, 9.

5. Note that the two given lines are mutually perpendicular, hence their point of intersection i.e. (1, 1) will lie on director circle of the ellipse.
If centre of the ellipse is (h, k) the equation of direction circle will be $(x - h)^2 + (y - k)^2 = 25$
as (1, 1) lies on this circle hence locus of center will be
$(h - 1)^2 + (k - 1)^2 = 25$
$\therefore$ radius of circle is 25.

6. We have $a = \dfrac{2\Delta}{h_A}, b = \dfrac{2\Delta}{h_B}, c = \dfrac{2\Delta}{h_C}$

$\Rightarrow$ $a = \Delta$, $b = \Delta$, $c = \dfrac{2\Delta}{3}$

$\Rightarrow \quad a + b + c = 2\Delta\left(\frac{1}{h_A}+\frac{1}{h_B}+\frac{1}{h_C}\right)$

$2s = 2\Delta\left(\frac{1}{2}+\frac{1}{2}+\frac{1}{3}\right) = 2\Delta\left(\frac{8}{6}\right)$

$\Rightarrow \quad s = \frac{4}{3}\Delta$

Now $\Delta^2 = s(s-a)(s-b)(s-c)$

$\therefore \quad \Delta^2 = \frac{4}{3}\Delta\left(\frac{\Delta}{3}\right)\left(\frac{\Delta}{3}\right)\left(\frac{2\Delta}{3}\right)$

$\Rightarrow \quad 1 = \frac{8}{81}\Delta^2 \Rightarrow 8\Delta^2 = 81$

$\Rightarrow \quad 2\sqrt{2}\Delta = 9.$

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ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Main), 2016**

HALF COURSE TEST – VI

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 03 and 10 to 12)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (04 to 09 and 13 to 30) contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

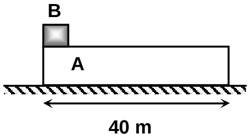
Physics

PART – I

SECTION – A

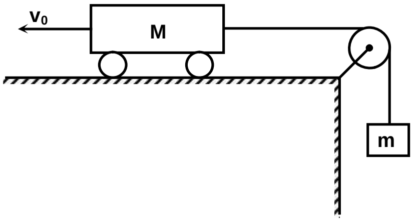
Single Correct Choice Type

*This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.*



1. In the figure shown, a block B of mass 1 kg is placed at the left end of a plank 'A' of mass 4 Kg, which in turn, is placed on a rough horizontal surface. The coefficient of friction between the plank 'A' and the surface is 0.2, whereas friction between the block B and the plank A is absent. Initially both A and B are at rest and at time t = 0, simultaneously they are imparted same velocity v = 10 m/s along the length of the plank. Calculate the time taken by the block to reach the other end of the plank is. (Length of the plank is 40 m).

(A) 6 sec (B) 12 sec
(C) 18 sec (D) 24 sec

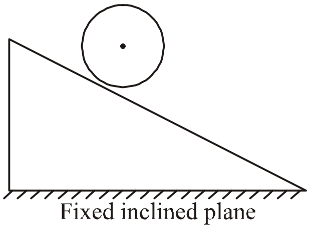


2. A cart with a mass $M = \frac{1}{2}$ kg is connected by a string to a mass of m = 200 g. At the initial moment the cart moves to the left along a horizontal plane at a speed $v_0 = 7$ m/s. ($g = 9.8$ m/s^2) Distance covered by cart after 5 sec is

(A) 3.75 (B) 17.5
(C) 20 (D) zero

3. Two identical glass spheres filled with air are connected by a horizontal glass tube. The glass tube contains a pellet of mercury at its mid point. Air in one sphere is at 0°C and the other is at 20°C. If both the vessels are heated through 10°C then neglecting the expansions of the bulbs and the tube. Ignore the conduction of heat by the mercury pellet.

(A) The mercury pellet gets displaced towards the sphere at lower temperature.
(B) The mercury pellet gets displaced towards the sphere at higher temperature.
(C) The mercury pellet does not get displaced at all.
(D) The temperature rise causes the pellet to expand without any displacement.

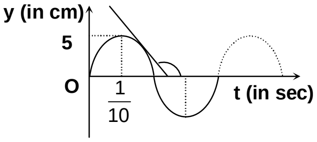


4. An experiment is carried out in which a conducting sphere is kept on the top of smooth inclined plane. Time taken by sphere to reach the bottom is t_1. Now a magnetic field B is switched on parallel to the inclined plane in downward direction and sphere is again left at top of inclined plane. Time taken by sphere in reaching to bottom is t_2 in this case. Now same experiment is repeated with magnetic field B switched on in vertically upward direction. Time taken by sphere in reaching to bottom of inclined plane is t_3 in this case. Then :

(A) $t_1 < t_2 = t_3$ (B) $t_1 = t_2 < t_3$
(C) $t_2 < t_1 < t_3$ (D) $t_1 < t_2 < t_3$

Space for rough work

5. The position of a particle describing simple harmonic motion along y-axis about the origin has been described in the adjacent figure by sinusoidal graph. The maximum speed of the particle is equal to

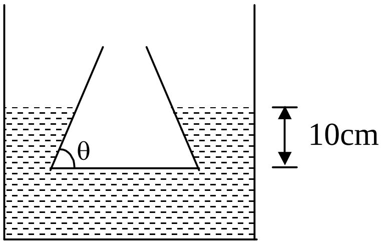


(A) 25π m/s
(B) 0.25π m/s
(C) $2.5\ \pi$ m/s
(D) none

6. A string of length ℓ is fixed at both ends. It is vibrating in its third overtone. Maximum amplitude of the particle on the string is A. The amplitude of the particle at a distance $\ell/3$ from one end is

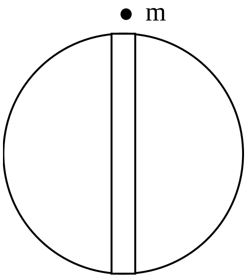
(A) A
(B) 0
(C) $\frac{\sqrt{3}A}{2}$
(D) A/2

7. A conical flask of mass 10 kg and base area as 10^3 cm^2 is floating in liquid of relative density 1.2, as shown in the figure. The force that liquid exerts on curved surface of conical flask will be
(Given g = 10 m/s^2)



(A) 20 N downward direction
(B) 40 N in downward direction
(C) can be determined only if θ is given
(D) 20 N in upward direction

8. A tunnel is made inside earth passing through center of earth. A particle is dropped from the surface of earth. Select the correct statement

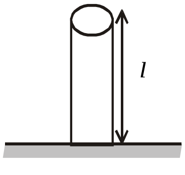


(A) Kinetic energy of particle is maximum at center and its potential energy is zero at center
(B) velocity of particle is proportional to x [where x is distance of particle from center of earth
(C) Kinetic energy of particle is maximum when it reaches on the other side of tunnel.
(D) kinetic energy of particle is maximum at center

9. The time period of a pendulum at temperature t_1 ºC is T_1 sec. Its time period at t_2ºC is T_2 sec. If coefficient of linear expansion of material of pendulum is α, then increase in time period is

(A) $\alpha(t_2 - t_1)$
(B) $\alpha(t_2 - t_1)/3$
(C) $T_1\alpha(t_2 - t_1)/2$
(D) none of these

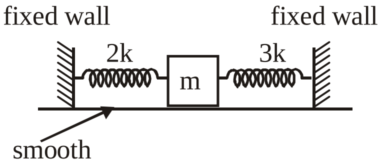
10. A solid cylinder of mass *m* length *l* and area of cross section *A* is placed as shown in the figure. If Young's modulus is *Y* then strain energy stored in the cylinder is



(A) $\frac{m^2g^2l}{3AY}$
(B) $\frac{m^2g^2l}{6AY}$
(C) $\frac{m^2g^2l}{2AY}$
(D) $\frac{m^2g^2l}{AY}$.

Space for rough work

11. A block of mass *m* is connected to two springs of spring constant 2k and 3k respectively, such that the spring of spring constant 2k is compressed by 3*l* when the block is in its mean position. If the block is displaced slightly and allowed to oscillate, the frequency will be



(A) $\frac{1}{2\pi}\sqrt{\frac{k}{m}}$
(B) $\frac{1}{2\pi}\sqrt{\frac{6k}{5m}}$
(C) $\frac{1}{2\pi}\sqrt{\frac{5k}{6m}}$
(D) none of these

12. A wave $y_1 = A\sin\left(2x - 4t + \frac{\pi}{3}\right)$ is superposed with a second waveform producing a standing wave with a node at x = 0. In the equation of the waveform, x is in metre and t is in second. The equation of the second waveform is
(A) $y_2 = A\sin\left(4t - 2x - \pi/3\right)$
(B) $y_2 = A\sin(2x + 4t + 5\pi/3)$
(C) $y_2 = A\sin(2x + 4t - 5\pi/3)$
(D) $y_2 = A\sin(-2x + 4t - \pi/3)$.

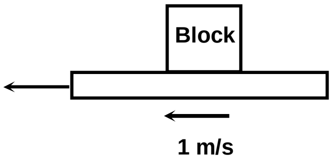
13. A force $\vec{F} = b\frac{-y\hat{i} + x\hat{j}}{x^2 + y^2}$N (b is a constant) acts on a particle as it undergoes counterclockwise circular motion in a circle: $x^2 + y^2 = 16$. The work done by the force when the particle undergoes one complete revolution is (x, y are in m)
(A) Zero
(B) 2π bJ
(C) 2 bJ
(D) None of these.

14. The rate of flow of glycerin of density ρ through conical section of a pipe, if the area of cross-sectional of its ends are A_1 and A_2 and pressure drop across its length be ΔP, is given by
(A) $A_1A_2\sqrt{\frac{\Delta P}{\rho\left(A_1^2 - A_2^2\right)}}$
(B) $A_1A_2\sqrt{\frac{2\Delta P}{\rho\left(A_1^2 - A_2^2\right)}}$
(C) $\sqrt{\frac{2\Delta P}{\rho\left(A_1^2 - A_2^2\right)}}$
(D) $A_1A_2\sqrt{\frac{2\Delta P}{3\rho\left(A_1^2 - A_2^2\right)}}$

Space for rough work

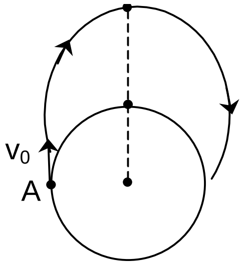
15. For an adiabatic compression (for an ideal gas) the quantity *PV*
(A) increases (B) decreases
(C) remains constant (D) depends on γ

16. A 10 kg block is gently placed on a plank moving at 1 m/s on a frictionless horizontal plane. Due to friction between the plank and the blocks the block accelerates. The velocity of the plank is maintained at a constant 1 m/s by an external force F acting on it. The block finally reaches a velocity of 1 m /s. The work done by the external force, which maintains the constant speed of plank, is [The coefficient of friction between plank and the block is 0.4]. (take g = 10 m/s^2)



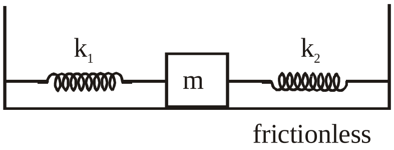
(A) 100 J (B) 50 J
(C) 10 J (D) 5 J.

17. A projectile projected tangentially from the surface of a planet of radius R from a point A, follows the indicated trajectory during its motion. If it is at a height of 3R at the farthest point of its trajectory, then the velocity of projection at A, v_0 is given by (acceleration due to gravity on surface = g)



(A) $v_0 = \sqrt{1.5gR}$ (B) $v_0 = \sqrt{0.5gR}$
(C) $v_0 = \sqrt{1.6gR}$ (D) $v_0 = \sqrt{2gR/3}$

18. Two springs with negligible masses and force constant of $k_1 = 200\ Nm^{-1}$ and $k_2 = 160\ Nm^{-1}$ are attached to the block of mass m = 10 kg as shown in the figure. Initially the block is at rest, at the equilibrium position in which both springs are neither stretched nor compressed. At time t = 0, sharp impulse of 50 N-s is given to the block with a hammer.



(A) period of oscillations for the mass m is $\frac{\pi}{6}$ s
(B) maximum velocity of the mass m during its oscillation is 10 ms^{-1}
(C) data are insufficient to determine maximum velocity
(D) amplitude of oscillation is 5/6 m

19. 1 mole of H_2 and 1 mole of He at a pressure of P_0 & $2P_0$ respectively and a temperature T_0 are kept in two different containers. The ratio of their rms velocities is $C_{H_2} : C_{He}$ =
(A) $\sqrt{10} : \sqrt{3}$ (B) 1 : 1
(C) 5 : 3 (D) 2 : $\sqrt{2}$

Space for rough work

20. An equimolar mixture of a monoatomic and a diatomic ideal gas is suddenly compressed to $\frac{1}{8}$ th of its original volume. The ratio of final temperature to the initial temperature.

(A) $8^{0.53}$ (B) $8^{0.5}$
(C) $8^{1.53}$ (D) $8^{2/3}$

21. An insect of mass m is initially at one end of the stick of length L and mass M, which rests on a smooth horizontal floor. The coefficient of friction between the insect and stick is k. The minimum time in which the insect can reach the other end of the stick is t. Mark all the correct statements.

(A) the centre of mass of the plank has velocity magnitudes $\left[\frac{kmg}{M}\right]t$ w.r.t. horizontal floor at time t.
(B) $t = 2\sqrt{\frac{LM}{k(M+m)g}}$
(C) the magnitude of the linear momentum of the insect at time 't' is (kmgt) w.r.t. horizontal floor
(D) all the above

22. A trolley is moving horizontally with a velocity of v m/s w.r.t. earth. A man starts running from one end of the trolley with a velocity 1.5 v m/s w.r.t. the trolley. After reaching the opposite end, the man turns back and continues running with a velocity of 1.5 v m/s w.r.t. trolley in the backward direction. If the length of the trolley is L then the displacement of the man with respect to earth measured as a function of time, will attain a maximum value of

(A) $\frac{4}{3}L$ (B) $\frac{2}{3}L$
(C) $\frac{5L}{3}$ (D) 1.5 L

23. The molar heat capacity of a diatomic ideal gas undergoing the process :
$PV^{1/4}$ = constant is

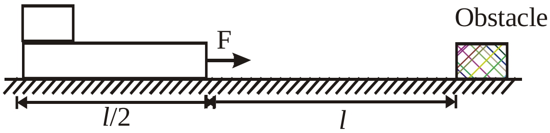
(A) $\frac{17}{6}R$ (B) $\frac{2}{5}R$
(C) $\frac{23}{6}R$ (D) 0

24. An organ pipe P_1 closed at one end vibrating in its first harmonic and another pipe P_2 open at both ends vibrating in its third harmonic are in resonance with a given tuning fork. The ratio of the length of P_1 to that of P_2 is

(A) $\frac{8}{3}$ (B) $\frac{3}{8}$
(C) $\frac{1}{6}$ (D) $\frac{1}{3}$

Space for rough work

25. As shown in the diagram, there are two blocks of the same mass M, one on top of the other, lying on a friction less horizontal surface. Both the blocks are at rest. The upper block is much smaller than the lower block. A force F is applied on the lower block and both the blocks start moving together without any relative motion. Suddenly, the lower block hits a fixed obstacle and comes to rest. The upper block continues to slide on the lower block. The upper block just manages to reach the opposite end of the lower block. What is the coefficient of friction between the two blocks ?

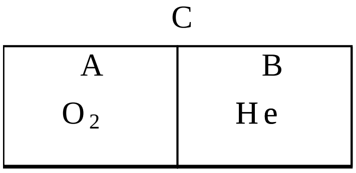


(A) F/Mg
(B) 2F/Mg
(C) F/2Mg
(D) none

26. Two point masses A of mass M and B of mass 4M are fixed at the ends of a rod of length ℓ and of negligible mass. The rod is set rotating about an axis perpendicular to its length with a uniform angular speed. For the rod to have the minimum possible kinetic energy of rotation, the axis of rotation should be at a distance of

(A) $\frac{2}{5}\ell$ from A
(B) $\frac{8}{5}\ell$ from A
(C) $\frac{4}{5}\ell$ from A
(D) $\frac{\ell}{5}$ from A

27. A fixed chamber isolated from surrounding is divided into two equal half A and B as shown in the figure. Part A contains one mole of oxygen and Part B contains one mole of helium, the separator C is thermally conducting and kept fixed. Initial temperature of oxygen chamber is 600 K and that of helium 300 K. Specific heat capacity of separator and chamber is negligible. Choose the correct statement.



(A) change of temperature of helium is equal to change in temperature of oxygen
(B) change in internal energy of helium is equal to 200 R joule (R represents the value of the gas constant in SI)
(C) temperature of oxygen in steady state condition is 487 K (approx)
(D) temperature in steady state can't be calculated

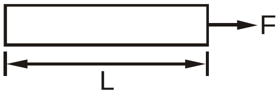
Space for rough work

28. A shot whose mass is m penetrates a thickness S of a fixed plate of mass M. If M were free to move the thickness penetrated will be

(A) $\frac{SM}{m}$ (B) $\frac{Sm}{(M+m)}$

(C) $\frac{SM}{(M+m)}$ (D) $\frac{Sm}{M}$.

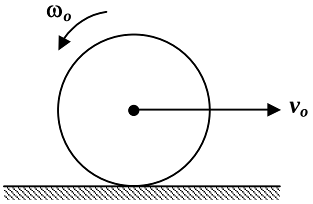
29. A rod of length *L* is pulled with a force *F* as shown on a smooth horizontal surface. If *A* is the area of cross-section and *Y* the Young's modulus of the material of the rod, the elastic potential energy stored in the rod is



(A) $\frac{F^2L}{3YA}$ (B) $\frac{F^2L}{2YA}$

(C) $\frac{F^2L}{6YA}$ (D) $\frac{F^2L}{YA}$

30. A uniform circular disc of radius *r* placed on a rough horizontal surface has initially a velocity v_o and angular velocity ω_o as shown in the figure. The disc comes to rest completely after moving some distance. Then $\frac{v_o}{r\omega_o}$ is



(A) 1 (B) 1/2

(C) 3/2 (D) 2

Space for rough work

Chemistry PART – II

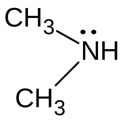
SECTION – A

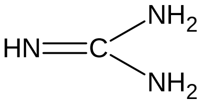
Straight Objective Type

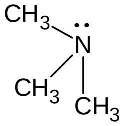
*This section contains 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.*

1. The order of basic character of

(I) $(CCl_3)_3\ddot{N}$

(II) 

(III) 

(IV)  is :

(A) I > III > II > IV
(B) III > II > IV > I
(C) I > II > IV > III
(D) IV > III > II > I

2. Arrange the following oxides in decreasing acidic order:

SiO_2	CO_2	SO_3	N_2O_5
(I)	(II)	(III)	(IV)

(A) III > IV > II > I
(B) IV > III > II > I
(C) IV > II > III > I
(D) III > II > IV > I

3.

List – 1 (ionic species)	**List – 2 (shapes)**
(P) XeF_5^+	(1) Tetrahedral
(Q) SiF_5^-	(2) Square planar
(R) AsF_4^+	(3) Trigonal bipyramidal
(S) ICl_4^-	(4) Square pyramidal
	(5) Octahedral

	P	**Q**	**R**	**S**
(A)	1	2	5	3
(B)	1	3	5	2
(C)	4	2	1	3
(D)	4	3	1	2

Space for rough work

4. The radial probability curve obtained for an orbital wave function (ψ) has 3 peaks and 2 radial nodes. The valence electron of which one of the following metals does this wave function (ψ) correspond to?

(A) Ca
(B) Li
(C) K
(D) Na

5. What is the minimum pH required to prevent the precipitation of ZnS in a solution i.e. 0.01 M $ZnCl_2$ and saturated with 0.1 M H_2S?

$K_{sp(ZnS)} = 10^{-21};\ K_{a_1(H_2S)} \times K_{a_2(H_2S)} = 10^{-20}$

(A) 4
(B) 1
(C) 3
(D) 2

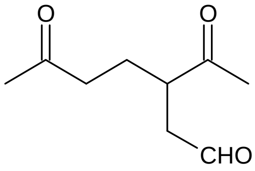
6. The relative rates of effusion of O_2 to CH_4 through a container containing O_2 and CH_4 in 3:2 mass ratio will be

(A) $\frac{3\sqrt{2}}{4}$
(B) $\frac{3}{4\sqrt{2}}$
(C) $\frac{3}{2\sqrt{2}}$
(D) none of these

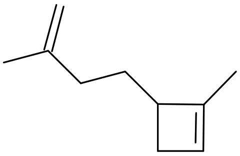
7. After 280 days the activity of a radioactive sample is 6000 dps, the activity reduces to 3000 dps after another 140 days. The initial activity of the sample in dps is

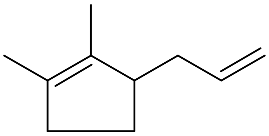
(A) 6000
(B) 9000
(C) 3000
(D) 2400

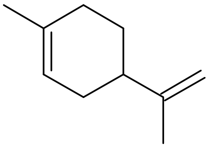
8. Compound (A) on hydrogenation consumed 2 mole equivalents of hydrogen and produces a saturated hydrocarbon. When A is treated with ozone, followed by reductive work up two products are isolated, formaldehyde and the diketone, structure of which is given below



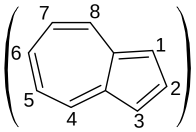
Compound (A) can be represented as

(A)


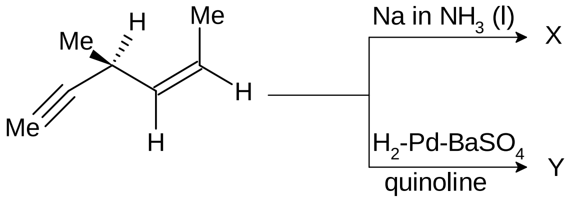
(B)


(C)


(D) All of these

9. When azulene 

is treated with electrophile, it attacks which position?
(A) position –1
(B) position 1 & 3
(C) position – 4
(D) position 1 & 4

10.


The correct statements regarding X and Y is/are
(A) both X and Y are optically inactive
(B) both X and Y are optically active
(C) X is optically inactive where as Y is inactive
(D) X is optically active where are Y is inactive

11. Cl_2 gas has been introduced in an 8 litres cubical container at pressure of 5 atm and at 300 K temperature. The following equilibrium has been achieved

$$Al_{(s)} + \frac{3}{2}Cl_{2(g)} \rightleftharpoons AlCl_{3(s)}$$

If the thickness of inner side of walls has been decreased by 0.04 mm at equilibrium, then find out K_p for the reaction $(\rho_{Al} = 1.13\ g/cc)$
(A) $(2.7)^{\frac{3}{2}}$
(B) $(2.7)^{-\frac{3}{2}}$
(C) $(5.4)^{\frac{3}{2}}$
(D) $(5.4)^{-\frac{3}{2}}$

12. For the reaction at 27°C, in 5 litre container $PCl_5 \rightleftharpoons PCl_3 + Cl_2$, $\Delta H = 5$ KJ/mole. Kp of the reaction can be calculated from the following equation Kp = $\frac{bcRT}{aV}$ where b, c and a are equilibrium moles of PCl_3, Cl_2 and PCl_5 respectively. On increasing temperature
(A) dissociation of PCl_5 will increase
(B) dissociation of PCl_5 will decrease
(C) pressure of container will increase
(D) both (A) and (C)

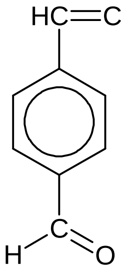
Space for rough work

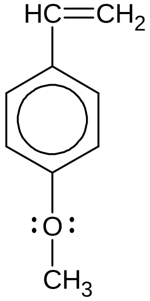
13. $B(OH)_3 + NaOH \rightleftharpoons Na[B(OH)_4]$

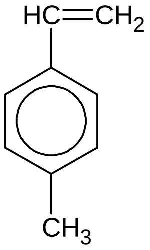
How can this reaction be made to proceed in forward direction by?
(A) Addition of borax
(B) Addition of cis-1,2-diol
(C) Addition of trans-1,2-diol
(D) Addition Na_2HPO_4

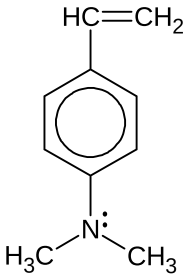
14. The aqueous solution of unknown salt of sodium give the following reactions
(i) It gives white turbidity with dilute HCl
(ii) It decolorizes a solution of iodine in potassium iodide
(iii) It gives white ppt. with $AgNO_3$ solution which changes colours and finally becomes black on standing
(A) sodium sulphite
(B) sodium sulphide
(C) sodium bisulphate
(D) sodium thiosulphide

15. Arrange the following compounds in decreasing order of rate of electrophilic addition reaction:


(I)


(II)

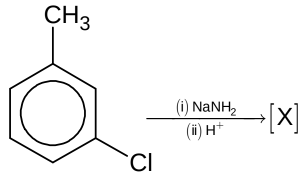

(III)


(IV)

(A) II > IV > I > III
(B) IV > II > III > I
(C) I > II > III > IV
(D) III > II> IV > I

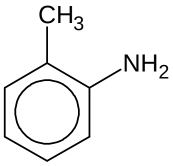
Space for rough work

16. Consider the following reaction:

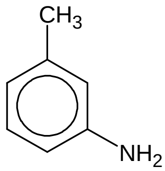

CH3
Cl
(i) NaNH2
(ii) H+
[X]

[X] will be

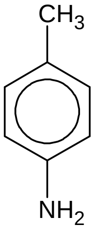
(A)



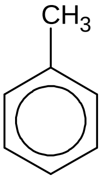
(B)



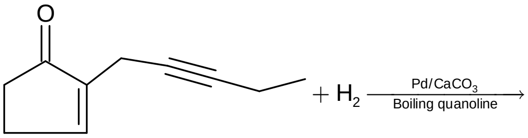
(C)



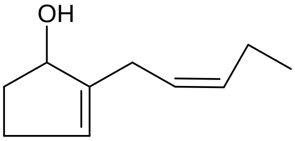
(D)



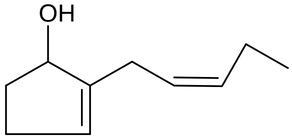
17. The product of the following reaction is


O
+ H2
Pd/CaCO3
Boiling quanoline

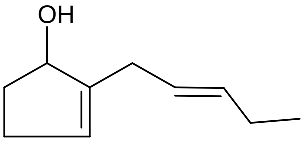
(A)



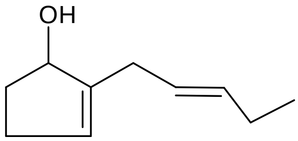
(B)



(C)

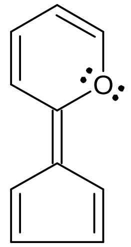


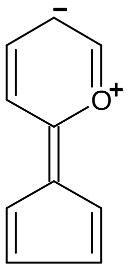
(D)

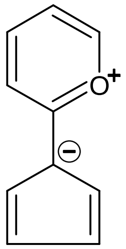


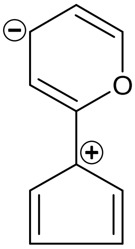
Space for rough work

18. The most stable canonical structures of this molecule is



(A)


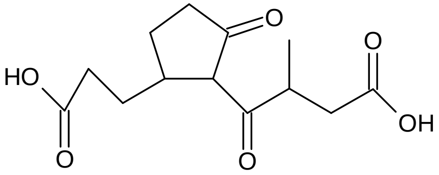
(B)


(C)


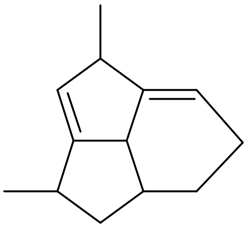
(D) None of these

Space for rough work

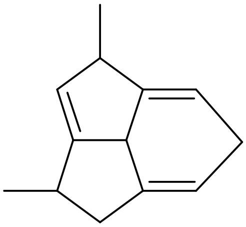
19. Which molecule will give following dicarboxylic acid upon treatment with acidic solution of $KMnO_4$?



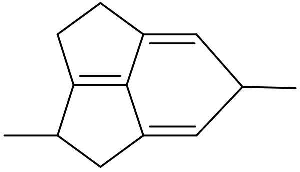
(A)



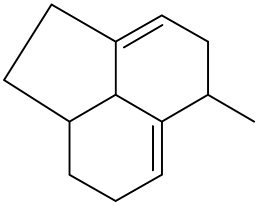
(B)



(C)



(D)



20. Among LiCl, RbCl, $BeCl_2$, $MgCl_2$ the compounds with greatest and least ionic character respectively are

(A) LiCl, RbCl
(B) RbCl, $BeCl_2$
(C) RbCl, $MgCl_2$
(D) $MgCl_2$, $BeCl_2$

21. Which of the following carbides give allylene on hydrolysis?

(A) CaC_2
(B) Be_2C
(C) Mg_2C_3
(D) MgC_2

Space for rough work

22. Mortar is a mixture of
(A) $Ca(OH)_2$, silica and water
(B) $CaCO_3$ and SiO_2
(C) CaO and silica
(D) $CaCO_3$, SiO_2 and water

23. Beryllium show diagonal relationship with aluminium. Which one of the following properties is not shown by both?
(A) BeO and Al_2O_3 amphoteric
(B) Be_2C and Al_4C_3 are methanides
(C) Both have same maximum covalency
(D) Both occur together in nature in beryl

24. At 25°C, the value of pk_b for NH_3 in aqueous solution is 4.7. What is the pH of 0.1 M aqueous solution of NH_4Cl with 0.01 N NH_3?
(A) 8.3
(B) 9
(C) 9.5
(D) 10

25. Equal volume of following solutions are mixed. In which case the pH of resulting solution will be average pH value of two solutions?
Given $K_{a\ (HCN)} = 10^{-10}$, $K_{a\ (CH_3COOH)} = K_{b\ (NH_3)_{aq.}} = 1.8 \times 10^{-5}$
(A) HCl (pH = 2) and NaOH (pH = 12)
(B) HCl (pH = 2) and HCl (pH = 4)
(C) HCN (pH = 2) and NaOH (pH = 12)
(D) CH_3COOH (pH = 6) and NH_3(aq)(pH = 9)

26. In a titration of a weak acid HX with NaOH. The pH is 5.8 after the addition of 10 mL of NaOH and is 6.8 after the addition of 20 mL of NaOH solution. Then ionization constant of acid is
[log 2 = 0.3 and log 5 = 0. 7]
(A) 5.9
(B) 6.8
(C) 7.2
(D) 4.8

Space for rough work

27. Standard free energy changes at 2000 K are as shown below:

Reaction	**ΔG^o (kJ mol^{-1})**
$2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$	–1140
$2Ni(s) + O_2(g) \longrightarrow 2NiO(s)$	–432
$2Zn(s) + O_2(g) \longrightarrow 2ZnO(s)$	–696

At 200 K, which of the following is/are feasible?

(A) Reduction of MgO by Zn
(B) Reduction of zinc oxide by nickel
(C) Oxidation of magnesium by nickel oxide
(D) Oxidation of nickel by zinc oxide

28. An ideal gas with pressure P, volume V and temperature T is expanded isothermally to a volume 2V and a final pressure P_i. If the same gas is expanded adiabatically to a volume 2V, the final pressure is P_a. The ratio of the specific heat for the gas is 1.67. The ratio of P_a/P_i is:

(A) $\frac{1}{(2)^{0.67}}$
(B) $(2)^{0.67}$
(C) $\left(-\frac{1}{2}\right)^{-0.67}$
(D) $\frac{1}{2^{-0.67}}$

29. Hydrogen [H], deuterium (D) and singly ionized helium (He^+) all have one electron around the nucleus. The wavelengths of radiations emitted for their transitions from n = 2 to 1 are λ_1, λ_2 and λ_3 respectively. Then approximately:

(A) $4\lambda_1 = 2\lambda_2 = 2\lambda_3$
(B) $\lambda_1 = 2\lambda_2 = 2\sqrt{2}\lambda_3$
(C) $\lambda_1 = \lambda_2 = 2\lambda_3$
(D) $\lambda_1 = \lambda_2 = 4\lambda_3$

30. If w_1, w_2, w_3 and w_4 for an ideal gas are work done in isothermal, adiabatic, isobaric and isochoric reversible expansion processes, the incorrect order is / are:

(A) $w_1 > w_2$
(B) $w_3 > w_2$
(C) $w_1 > w_2 > w_3$
(D) $w_3 > w_4$

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which ***ONLY ONE*** *is correct.*

1. The circle $x^2 + y^2 = 4$ cuts the line joining the points $A(1, 0)$ and $B(3, 4)$ in two points P and Q. Let $\frac{BP}{PA} = \alpha$ and $\frac{BQ}{QA} = \beta$. Then α and β are roots of the quadratic equation

(A) $3x^2 + 2x - 21 = 0$
(B) $3x^2 + 2x + 21 = 0$
(C) $2x^2 + 3x - 21 = 0$
(D) None of these

2. The eccentricity of the ellipse $ax^2 + by^2 + 2fx + 2gy + c = 0$ if axis of ellipse parallel to x-axis is

(A) $\sqrt{\left(\frac{b-a}{b}\right)}$
(B) $\sqrt{\left(\frac{a+b}{b}\right)}$
(C) $\sqrt{\left(\frac{a+b}{a}\right)}$
(D) none of these

3. If $\frac{(1-3x)^{1/2} + (1-x)^{5/3}}{\sqrt{4-x}}$ is approximately equal to $a + bx$ for small values of x, then $(a,b) =$

(A) $\left(1, \frac{35}{24}\right)$
(B) $\left(1, -\frac{35}{24}\right)$
(C) $\left(2, \frac{35}{12}\right)$
(D) $\left(2, -\frac{35}{12}\right)$

Space for rough work

4. A pair of straight lines drawn through the origin form with the line $2x+3y=6$ an isosceles right angled triangle, then the lines and the area of the triangle thus formed is

(A) $x-5y=0$, $5x+y=0$, $\Delta=\frac{36}{13}$

(B) $3x-y=0$, $x+3y=0$, $\Delta=\frac{12}{17}$

(C) $5x-y=0$, $x+5y=0$, $\Delta=\frac{13}{5}$

(D) None of these

5. The vertices of a triangle are (2, 1), (5, 2) and (4, 4). The lengths of the perpendicular from these vertices on the opposite sides are

(A) $\frac{7}{\sqrt{5}},\frac{7}{\sqrt{13}},\frac{7}{\sqrt{6}}$

(B) $\frac{7}{\sqrt{6}},\frac{7}{\sqrt{8}},\frac{7}{\sqrt{10}}$

(C) $\frac{7}{\sqrt{5}},\frac{7}{\sqrt{8}},\frac{7}{\sqrt{15}}$

(D) $\frac{7}{\sqrt{5}},\frac{7}{\sqrt{13}},\frac{7}{\sqrt{10}}$

6. If the straight line through the point $P(3,4)$ makes an angle $\frac{\pi}{6}$ with the x-axis and meets the line $12x+5y+10=0$ at Q, then the length PQ is

(A) $\frac{132}{12\sqrt{3}+5}$

(B) $\frac{132}{12\sqrt{3}-5}$

(C) $\frac{132}{5\sqrt{3}+12}$

(D) $\frac{132}{5\sqrt{3}-12}$

7. The locus of a point which divides the join of $A(-1,1)$ and a variable point P on the circle $x^2+y^2=4$ in the ratio 3 : 2, is

(A) $25(x^2+y^2)+20(x-y)+28=0$

(B) $25(x^2+y^2)+20(x-y)-28=0$

(C) $20(x^2+y^2)+25(x-y)+28=0$

(D) None of these

Space for rough work

8. The equation of the latusrectum of the parabola $y^2 - 6y + 4x - 3 = 0$ is
(A) $x = -2$
(B) $x = 2$
(C) $x = -3/2$
(D) $x = 3/2$

9. The curve described parametrically by $x = t^2 + t + 1,\ y = t^2 - t + 1$ represents
(A) a circle
(B) a parabola
(C) an ellipse
(D) a hyperbola

10. In a certain test there are n questions. In the test 2^{n-i} students gave wrong answers to at least i questions, where $i = 1, 2, ...n$. If the total number of wrong answers given is 2047, then n is equal to
(A) 10
(B) 11
(C) 12
(D) 13

11. If $\tan x = \frac{2b}{a-c}(a \neq c)$,
$y = a\cos^2 x + 2b\sin x\cos x + c\sin^2 x$
and $z = a\sin^2 x - 2b\sin x\cos x + c\cos^2 x$, then
(A) $y = z$
(B) $y + z = a + c$
(C) $y - z = a + c$
(D) $y - z = (a-c)^2 + 4b^2$

12. Given that the equation $z^2 + (p + iq)z + r + is = 0$, where p, q, r, s are real and non-zero has a real root, then
(A) $pqr = r^2 + p^2 s$
(B) $prs = q^2 + r^2 p$
(C) $qrs = p^2 + s^2 q$
(D) $pqs = s^2 + q^2 r$

13. The eccentricity of the conic $x = 3\left(\frac{1-t^2}{1+t^2}\right)$ and $y = \frac{2t}{1+t^2}$ is
(A) $\frac{2}{3}$
(B) $\frac{2\sqrt{2}}{3}$
(C) $\frac{3}{2}$
(D) $\frac{3}{2\sqrt{2}}$

Space for rough work

14. If P = (x, y), F_1 = (3, 0), F_2 = (–3, 0) and $16x^2 + 25y^2 = 400$, then $PF_1 + PF_2$ equals

(A) 8 (B) 6

(C) 10 (D) 12

15. A hyperbola, having the transverse axis of length $2\sin\theta$, is confocal with the ellipse $3x^2 + 4y^2 = 12$. Then its equation is:

(A) $x^2\operatorname{cosec}^2\theta - y^2\sec^2\theta = 1$ (B) $x^2\sec^2\theta - y^2\operatorname{cosec}^2\theta = 1$

(C) $x^2\sin^2\theta - y^2\cos^2\theta = 1$ (D) $x^2\cos^2\theta - y^2\sin^2\theta = 1$

16. If the coefficient of the middle term in the expansion of $(1+x)^{2n+2}$ is p and the coefficients of middle terms in the expansion of $(1+x)^{2n+1}$ are q and r, then

(A) $p + q = r$ (B) $p + r = q$

(C) $p = q + r$ (D) $p + q + r = 0$

17. The number of ways of dividing 52 cards amongst four players so that three players have 17 cards each and the fourth player just one card, is

(A) $\frac{52!}{(17!)^3}$ (B) $52!$

(C) $\frac{52!}{17!}$ (D) None of these

18. If $\tan(\cot x) = \cot(\tan x)$, then $\sin 2x$ =

(A) $(2n+1)\frac{\pi}{4}$ (B) $\frac{4}{(2n+1)\pi}$

(C) $4\pi(2n+1)$ (D) None of these

19. If $1 + \sin x + \sin^2 x + \ldots\ldots \text{ to } \infty = 4 + 2\sqrt{3}, 0 < x < \pi$, then

(A) $x = \frac{\pi}{6}$ (B) $x = \frac{\pi}{3}$

(C) $x = \frac{\pi}{3}$ or $\frac{\pi}{6}$ (D) $x = \frac{\pi}{3}$ or $\frac{2\pi}{3}$

Space for rough work

20. If $a\cos^3\alpha + 3a\cos\alpha\sin^2\alpha = m$ and $a\sin^3\alpha + 3a\cos^2\alpha\sin\alpha = n$, then $(m+n)^{2/3} + (m-n)^{2/3}$ is equal to
(A) $2a^2$
(B) $2a^{1/3}$
(C) $2a^{2/3}$
(D) $2a^3$

21 If $\sin A = n\sin B$, then $\frac{n-1}{n+1}\tan\frac{A+B}{2} =$
(A) $\sin\frac{A-B}{2}$
(B) $\tan\frac{A-B}{2}$
(C) $\cot\frac{A-B}{2}$
(D) None of these

22. If the equation $x^2 + \lambda x + \mu = 0$ has equal roots and one root of the equation $x^2 + \lambda x - 12 = 0$ is 2, then $(\lambda, \mu) =$
(A) (4, 4)
(B) (–4,4)
(C) (4,–4)
(D) (–4,–4)

23. If one root of the equation $ax^2 + bx + c = 0$ be n times the other root, then
(A) $na^2 = bc(n+1)^2$
(B) $nb^2 = ac(n+1)^2$
(C) $nc^2 = ab(n+1)^2$
(D) None of these

24. If $\sqrt{3} + i = (a+ib)(c+id)$, then $\tan^{-1}\left(\frac{b}{a}\right) + \tan^{-1}\left(\frac{d}{c}\right)$ has the value
(A) $\frac{\pi}{3} + 2n\pi, n \in I$
(B) $n\pi + \frac{\pi}{6}, n \in I$
(C) $n\pi - \frac{\pi}{3}, n \in I$
(D) $2n\pi - \frac{\pi}{3}, n \in I$

25. The locus of z satisfying the inequality $\log_{1/3}|z+1| > \log_{1/3}|z-1|$ is
(A) $R(z) < 0$
(B) $R(z) > 0$
(C) $I(z) < 0$
(D) None of these

Space for rough work

26. If $n \in N$, then $x^{2n-1} + y^{2n-1}$ is divisible by
(A) $x + y$
(B) $x - y$
(C) $x^2 + y^2$
(D) $x^2 + xy$

27. If n is a natural number then $\left(\frac{n+1}{2}\right)^n \geq n!$ is true when
(A) $n > 1$
(B) $n \geq 1$
(C) $n > 2$
(D) $n \geq 2$

28. From a 60 meter high tower angles of depression of the top and bottom of a house are α and β respectively. If the height of the house is $\frac{60\sin(\beta - \alpha)}{x}$, then x =
(A) $\sin\alpha \sin\beta$
(B) $\cos\alpha \cos\beta$
(C) $\sin\alpha \cos\beta$
(D) $\cos\alpha \sin\beta$

29. Two vertical poles of equal heights are 120 m apart. On the line joining their bottoms, A and B are two points. Angle of elevation of the top of one pole from A is 45^o and that of the other pole from B is also 45^o. If AB = 30 m, then the height of each pole is
(A) 40 m
(B) 45 m
(C) 50 m
(D) 42 m

30. If $x = \sqrt{1+\sqrt{1+\sqrt{1+\text{.......to infinity}}}}$, then x =
(A) $\frac{1+\sqrt{5}}{2}$
(B) $\frac{1-\sqrt{5}}{2}$
(C) $\frac{1\pm\sqrt{5}}{2}$
(D) None of these

Space for rough work

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FIITJEE Students From All Programs have bagged 33 in Top 100, 77 in Top 200 and 205 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2015:
4551 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2015.

ANSWERS, HINTS & SOLUTIONS

HALF COURSE TEST-VI
(Main)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	B	A
2.	B	A	A
3.	B	D	B
4.	B	D	A
5.	B	B	D
6.	C	B	A
7.	A	D	B
8.	D	D	B
9.	C	B	B
10.	B	B	B
11.	D	B	B
12.	B	D	D
13.	B	B	B
14.	B	D	C
15.	A	B	A
16.	C	B	C
17.	C	B	A
18.	D	B	B
19.	D	D	D
20.	B	B	C
21.	D	C	B
22.	C	C	A
23.	C	C	B
24.	C	A	B
25.	A	A	A
26.	C	A	A
27.	C	C	B
28.	C	A	D
29.	C	D	B
30.	B	C	A

Physics

PART – I

SECTION – A

1. Friction force on block A, $f_K = \mu N = 10$ N (opposite to v)

$\Rightarrow$ acceleration of A = $\frac{10N}{4kg} = 2.5$ m/s^2 (opposite to v)

Time taken by the plank to come at rest,

$t = \frac{10\text{ m/s}}{2.5\text{ m/s}^2} = 4$ sec (using, v = u + at)

In 4s distance moved by the plank $S_A = 20$ m (using $v^2 = u^2 + 2as$).

To reach the other end block will have to move by 20 m + 40 m = 60 m. As B is moving with constant speed

$\Rightarrow \quad T = \frac{60\text{ m/s}}{10\text{ m/s}} = 6\,\text{sec}$

2. Reference frame is at the edge of the plane with the leftward direction as the x-axis. Let x_0 be the distance of the cart at t = 0

mg – T = ma

T = Ma

$\therefore \quad a = \frac{mg}{M+m} = 2.8$ m/s^2

Since, M has an initial velocity to the left, a is in fact retardation for M.

$\therefore \quad V = 7 + (-2.8) \times 5 = -7$ m/s

i.e. after 5 sec the cart will have the same speed but in opposite direction.

$x = x_0 + 7 \times 5 + \frac{1}{2}(-2.8) \times 5$

$x = x_0 + 35 - 35 = x_0$

Let the cart go by S to the left from its initial position

$0^2 - 7^2 = 2(-2.8) \times S$

$\Rightarrow \quad S = 8.75$ m

$\therefore \quad$ Distance covered in up and down journey = 8.75 + 8.75 = 17.5 m

3. Let the pressures be P_1 and P_2 of the spheres having initial temperatures 0°C and 20°C respectively then.

Initially $P_1 = P_2 \Rightarrow \frac{n_1}{n_2} = \frac{293}{273}$

If P_1', P_2' be the pressures after rasing temperature then $\frac{P_1'}{P_2'} = \frac{283}{303} \times \frac{293}{273} > 1 \Rightarrow P_1' > P_2'$

thus the mercury pellet will be displaced towards the sphere at higher temp.

4. No eddy current form in case (i) & (ii) and hence motion is not opposed.

7. $(1.2 \times 10^3 \times 10 \times 10 \times 10^{-2}) \times (10^3 \times 10^{-4}) - F$

= Buoyant force – weight

$\Rightarrow$ F = 20 N in down ward direction

8. Kinetic energy is maximum at centre.

10. $$dU = \frac{1}{2}\left(\frac{mgx}{LA}\right)^2 \times \frac{1}{y} \times A.dx$$

$$U = \frac{1}{2}\frac{m^2g^2A}{L^2A^2Y}\int_0^l x^2 dx$$

$$\Rightarrow\ U = \frac{m^2g^2l}{6AY}.$$

12. A node is a point where there is no vibration. There is vibration at other points where nodes are not formed.

13. $$W = \oint \vec{F}.d\vec{r} = \oint \frac{b\,d\vec{r}}{|d\vec{r}|R}.d\vec{r} = \frac{b}{R}\oint |d\vec{r}| = \frac{2\pi Rb}{R} = 2\,\pi\,bJ.$$

14. Using $A_1v_1 = A_2v_2$ ……(i)
and Bernoulli’s principle we get

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2 \qquad \text{.....(ii)}$$

From (i) and (ii)

$$v_1 = A_2\sqrt{\frac{2(P_1 - P_2)}{\rho(A_1^2 - A_2^2)}}$$

Rate of flow = $A_1v_1 = A_1A_2\sqrt{\frac{2(P_1 - P_2)}{\rho(A_1^2 - A_2^2)}}$

But $P_1 – P_2 = \Delta P$

$\therefore$ rate of flow of glycerine $= A_1A_2\sqrt{\frac{2\Delta P}{\rho(A_1^2 - A_2^2)}}$

15. In adiabatic compression, the temperature always increases and since PV = nRT, the quantity PV also increases.

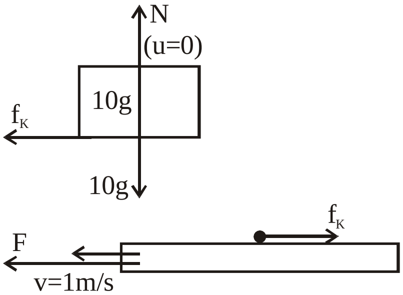
16. V = 0 + (0.4 × 10) t = 1 m/s.

$t = \frac{1}{4} = .25$ second.

$W_{f_K} + W_F = \Delta K = 0$

$W_F = -W_{f_k} = -(f_K \times S \times \cos 180°) = f_K \times S$

= (0.4 × 10 × 10) × .25 × 1= 40 × .25 = 10 J.



17. At the farthest point X,
$mv_0R = mv_x\,4R$

$$\frac{1}{2}m\,v_x^2 - \frac{GMm}{4R} = \frac{1}{2}mv_0^2 - \frac{GMm}{R}$$

$\Rightarrow$ $v_0 = \sqrt{1.6gR}$.

18. T = period $= 2\pi\sqrt{\dfrac{m}{K_1+K_2}} = 2\pi\sqrt{\dfrac{10}{360}} = \dfrac{\pi}{3}s$.

The maximum velocity is always at equilibrium position since at any other point there will be a restoring force attempting to slow the mass.

$\therefore \quad V_{max} = \dfrac{\text{impulse}}{\text{mass}} = \dfrac{50}{10} = 5ms^{-1}$

$A = \text{amplittude}=\dfrac{V_{max}}{\omega} = \dfrac{5}{\dfrac{(2\pi)}{\left(\dfrac{\pi}{3}\right)}} = \dfrac{5}{6}m.$

19. Their average translational K.E. is $\frac{3}{2}k_B$ T, $k_B \rightarrow$ Boltzmann's constant

$\frac{1}{2}m_{H_2}C_{H_2}^2 = \frac{1}{2}m_{He}C_{He}^2 = \frac{3}{2}k_BT$

$C_{H_2} : C_{He} = \sqrt{m_{He}} : \sqrt{m_{H_2}} = \sqrt{4} : \sqrt{2} = 2 : \sqrt{2}$

20. For the mixture, $\gamma = \dfrac{C_P^{(1)} + C_P^{(2)}}{C_V^{(1)} + C_V^{(2)}} = \dfrac{\frac{7}{2}R + \frac{5}{2}R}{\frac{5}{2}R + \frac{3}{2}R} = \dfrac{3}{2}$

Applying $TV^{\gamma - 1}$ = constant, the temperature increases by a factor of $\sqrt{8}$.

21. Impulse = Force × time; net momentum of the system is conserved as the net force on it is zero.

22. Since velocity of man w.r.t trolley is greater than velocity of trolley w.r.t. earth, after the man turns back displacement of the man will decrease, so maximum displacement will be at the moment when man turns back.

$\therefore \quad t = \dfrac{L}{1.5V}$

$\therefore \quad \text{Displacement} = (v+1.5v)t = 2.5v\dfrac{L}{1.5v} = \dfrac{5}{3}L$

23. $pV^{1/4}$ = constant

$\Rightarrow \dfrac{RT}{V}v^{1/4}$ = constant or $TV^{-3/4}$ = constant

$dT\,V^{-3/4} - \dfrac{3}{4}dV.V^{-7/4}.T = 0$ or $\dfrac{dV}{dt} = \dfrac{4}{3}\dfrac{V}{T}$

$C = \dfrac{dQ}{dT} = \dfrac{dU}{dT} + P\dfrac{dV}{dT} = C_v + p.\dfrac{4}{3}\dfrac{V}{T} = \dfrac{5}{2}R + \dfrac{4}{3}R = \dfrac{23}{6}R$.

24. $v = \dfrac{\upsilon}{4l_1}$ (for first harmonic)

$v = \dfrac{3\upsilon}{2l_3}$ (for third harmonic)

$\therefore \quad \dfrac{l_1}{l_3} = \dfrac{1}{6}$

25. velocity of upper block when lower block hits a obstacle,

$$v = \sqrt{2a.\ell} = \sqrt{2.\frac{F}{2M}\ell} = \sqrt{\frac{F\ell}{M}}$$

now after collision retardation of upper block w.r.t. earth,

$$a = \frac{\mu Mg}{M} = \mu g$$

$$\therefore \quad v^2 = u^2 + 2as$$

$$\therefore \quad 0 = \frac{F\ell}{M} - 2\mu g.\frac{\ell}{2} \quad \Rightarrow \quad \mu = \frac{F}{Mg}.$$

26. $w = \frac{1}{2}I\omega^2$

Let x is the distance of CM from A

$I = M.x^2 + 4M(\ell - x)^2$ and if I is minimum, W will be minimum

$$\therefore \quad \frac{dI}{dx} = 2Mx + 4M \times 2(\ell - x) \times (-1) = 2\ Mx - 8M\ \ (\ell - x)$$

$$\frac{dI}{dx} = 10Mx - 8M\ell$$

$$\therefore \quad 10Mx - 8M\ell = 0$$

$$x = \frac{4}{5}\ell.$$

27. Total internal energy of system will remain conserve

$$nC_{V_1}T_1 + nC_{V_2}T_2 = \left[nC_{V_1} + nC_{V_2}\right]T$$

$$\left(\frac{3}{2}R\right)300 + \left(\frac{5R}{2}\right)600 = \left[\frac{3R}{2} + \frac{5R}{2}\right]T$$

$$T = \left(\frac{9+30}{8}\right)100 = \frac{3900}{8} = 487\text{K (approx)}$$

$$\Delta E = \left(\frac{3}{2}R\right)\left[487 - 300\right] = 187 \times \frac{3}{2} \times R = 280.5\ R$$

28. Let initial velocity of the shot be u and P denote the force of resistance of penetration.
In the 1st case plate is fixed

$$\therefore \quad 0 - \frac{1}{2}mu^2 = -PS(\text{COE}) \qquad \ldots(i)$$

In the 2nd case plate is free to move. The shot will penetrate up to both acquire a common velocity V (say), there will be no further penetration thus P seases to act

$$\frac{1}{2}(M+m)V^2 - \frac{1}{2}mu^2 = -PS'(\text{COE}) \qquad \ldots(ii)$$

and $(M+m)V = mu(\text{COLM})$ …(iii)

From equation (iii) and (ii)

$$\frac{1}{2}\frac{m^2u^2}{(M+m)} - \frac{1}{2}mu^2 = -PS'$$

$$\Rightarrow \quad \frac{1}{2}mu^2 \times \frac{M}{(M+m)} = PS' \qquad \ldots(iv)$$

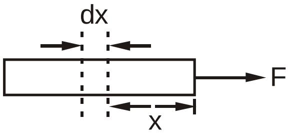
equation (i) and (ii)

$$\frac{S'}{S} = \frac{M}{(M+m)}$$

$$\therefore \quad S' = \frac{SM}{(M+m)}.$$

(COE = conservation of energy)
(COLM = conservation of linear momentum).

29. Stress = $\frac{T}{A}$ E = $\frac{1}{2}$ Stress × Strain × Volume



$\frac{\text{Stress}}{\text{Strain}}$ = Y, E = $\frac{1}{2}\frac{(\text{Stress})^2}{Y}$ × Volume

F = ma, E = $\int_o^L \frac{1}{2}\left(\frac{L-x}{L}\frac{F}{A}\right)^2 \frac{1}{Y}$ A dx

T = $(L - x)\lambda$ $\frac{F}{M}$ = $\frac{F^2 L}{6YA}$ = $\frac{L-x}{L}$F

30. $\upsilon_0 - at = 0 \quad \Rightarrow \quad \upsilon = at$

$\omega_0 - \alpha t = 0 \quad \Rightarrow \quad \omega_0 = \alpha t$

$\Rightarrow \quad \frac{v}{\omega_0} = \frac{a}{\alpha} = \frac{r}{2}$

$\Rightarrow \quad \frac{v}{\omega_0 r} = \frac{1}{2}$

Chemistry

PART – II

SECTION – A

4. $Na \longrightarrow 1s^2 2s^2 2p^6 3s^1$

$3s^1$ orbitals has n = 3, $\ell = 0$

Number of radial nodes = n $-\ell$ – 1 = 3 – 0 – 1 = 2

6. $$\frac{r_{O_2}}{r_{CH_4}} = \frac{P_{O_2}}{P_{CH_4}}\sqrt{\frac{M_{CH_4}}{M_{O_2}}} = \frac{n_{O_2}}{n_{CH_4}}\sqrt{\frac{16}{32}} = \frac{3}{32}\times\frac{16}{2}\sqrt{\frac{16}{32}} = \frac{3}{4\sqrt{2}}$$

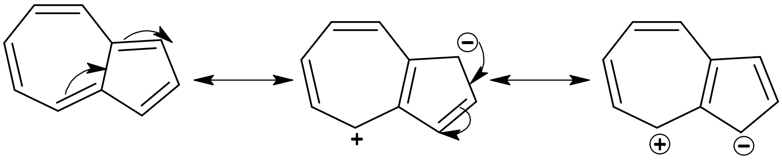
7. Half life $t_{1/2}$ = 140 days

Number of half lives in total time = $\frac{280+140}{140} = 3$

$R = R_0(1/2)^n$

$\Rightarrow 3000 = R_0(1/2)^3$, R_0 = 24000 dps

9.



11. $$n_{Cl_2} = \frac{5\times 8}{0.082\times 300} = 1.63$$

Mass of $Al_{(s)} = 0.05\times 10^{-1}\times(20\times 20\times 6)\times 1.13 = 13.56$ gm

So mass of $Al_{(s)}$ dissociated = 0.5 moles

So eq is established

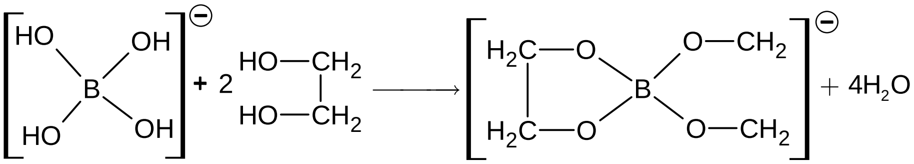
$$Al_{(s)} + \frac{3}{2}Cl_{2(g)} \rightleftharpoons AlCl_{3(s)}$$

$$1.63 - \frac{3}{2}\times 0.5 \qquad 0.5$$

$$K_p = \left(P_{Cl_2}\right)^{-\frac{3}{2}} = \left(\frac{0.88\times 0.082\times 300}{8}\right)^{-\frac{3}{2}} = (2.7)^{-\frac{3}{2}}$$

(Volume of the vessel is taken 8 lit approx even after eq is established).

13.



14. (i) $Na_2S_2O_3 + 2HCl \longrightarrow 2NaH + SO_2 + H_2O + S$

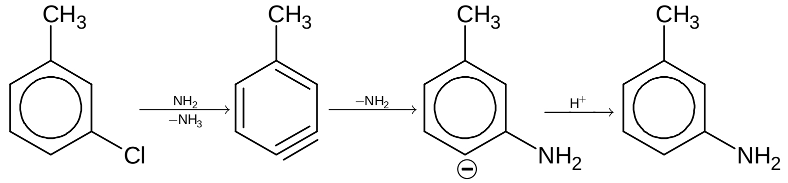
(ii) $KI_3 + 2Na_2S_2O_3 \longrightarrow KI + 2NaI + Na_2S_4O_6$

(iii) $2AgNO_3 + Na_2S_2O_3 \longrightarrow \underset{\text{(white)}}{Ag_2S_2O_3} + 2NaNO_3$

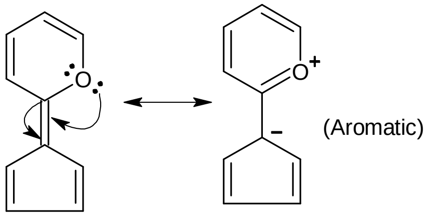
$$\xrightarrow{H_2O} \underset{\text{Black}}{Ag_2S} + H_2SO_4$$

15. Stability of intermediate carbocation increases rate of reaction.

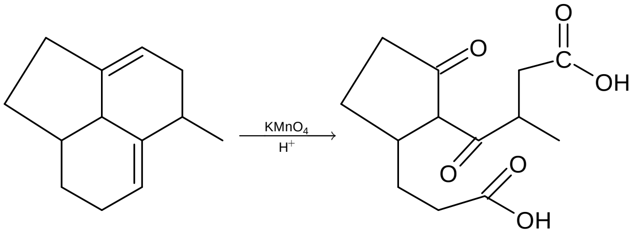
16.


CH3
Cl
NH2
–NH3
–NH2
H+
NH2
NH2

18.


O
O+
(Aromatic)

19.


KMnO4
H+
O
C
OH
O
O
OH

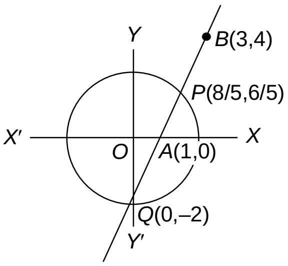
21. $Mg_2C_3 + 2H_2O \longrightarrow Mg(OH)_2 + CH_3 - C \equiv CH$

24. $pOH = pK_b + \log_{10}\frac{[NH_4Cl]}{[NH_4OH]} = 4.7 + \log\frac{0.1}{0.01} = 5.7$

pH = 14 – 5.7 = 8.3

Mathematics PART – III

SECTION – A



1. The equation of the line joining A(1, 0) and B(3, 4) is $y = 2x - 2$. This cuts the circle $x^2 + y^2 = 4$ at $Q(0, -2)$ and $P\left(\frac{8}{5}, \frac{6}{5}\right)$.

We have $BQ = 3\sqrt{5}, QA = \sqrt{5}, BP = \frac{7}{\sqrt{5}}$ and $PA = \frac{3}{\sqrt{5}}$

$$\therefore \alpha = \frac{BP}{PA} = \frac{7/\sqrt{5}}{3/\sqrt{5}} = \frac{7}{3} \text{ and } \beta = \frac{BQ}{QA} = \frac{3\sqrt{5}}{-\sqrt{5}} = -3$$

$\therefore \alpha, \beta$ are roots of the equation $x^2 - x(\alpha + \beta) + \alpha\beta = 0$

i.e., $x^2 - x\left(\frac{7}{3} - 3\right) + \frac{7}{3}(-3) = 0$ or $3x^2 + 2x - 21 = 0$.

2. $ax^2 + by^2 + 2fx + 2gy + c = 0$

$$a\left\{x^2 + \frac{2fx}{a}\right\} + b\left\{y^2 + \frac{2gy}{b}\right\} + c = 0$$

$$\Rightarrow a\left(x + \frac{f}{a}\right)^2 + b\left(y + \frac{g}{b}\right)^2 = \left(\frac{f^2}{a} + \frac{g^2}{b} - c\right)$$

$$\Rightarrow \frac{(x + f/a)^2}{\left(\frac{f^2}{a} + \frac{g^2}{b} - c\right)/a} + \frac{(y + g/b)^2}{\left(\frac{f^2}{a} + \frac{g^2}{b} - c\right)/b} = 1$$

i.e. e is eccentricity, then $\frac{\left(\frac{f^2}{a} + \frac{g^2}{b} - c\right)}{b} = \frac{\left(\frac{f^2}{a} + \frac{g^2}{b} - c\right)}{a}(1 - e^2)$

$$\Rightarrow 1 - e^2 = \frac{a}{b} \Rightarrow e^2 = \frac{b-a}{b} \quad \therefore e = \sqrt{\left(\frac{b-a}{b}\right)}$$

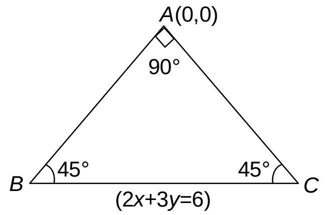
3. $$\frac{(1-3x)^{1/2} + (1-x)^{5/3}}{2\left[1 - \frac{x}{4}\right]^{1/2}}$$

$$= \frac{\left[1 + \frac{1}{2}(-3x) + \frac{1}{2}\left(-\frac{1}{2}\right)\frac{1}{2}(-3x)^2 + ...\right] + \left[1 + \frac{5}{3}(-x) + \frac{5}{3}\frac{2}{3}\frac{1}{2}(-x)^2 + ...\right]}{2\left[1 + \frac{1}{2}\left(-\frac{x}{4}\right) + \frac{1}{2}\left(-\frac{1}{2}\right)\frac{1}{2}\left(-\frac{x}{4}\right)^2 + ...\right]}$$

$$= \frac{\left[1 - \frac{19}{12}x + \frac{53}{144}x^2 - ....\right]}{\left[1 - \frac{x}{2} - \frac{1}{8}x^2 - ....\right]} = 1 - \frac{35}{24}x + ...$$

Neglecting higher powers of x, then

$$a + bx = 1 - \frac{35}{24}x \Rightarrow a = 1, b = -\frac{35}{24}.$$



4. $y = mx$. It makes an angle of $\pm 45^o$ with $2x + 3y = 6$.

$\therefore \quad \tan(\pm 45^o) = \dfrac{m - (-2/3)}{1 + m(-2/3)} = \pm 1$

or $\quad 3m + 2 = \pm(3 - 2m) \Rightarrow m = \dfrac{1}{5}, -5$

Hence sides are

$x - 5y = 0,$

$5x + y = 0$

and $2x + 3y = 6$.

Solving in pairs, vertices are $(0,0)$,

$\left(\dfrac{6}{13}, \dfrac{30}{13}\right), \left(\dfrac{30}{13}, -\dfrac{6}{13}\right)$.

5. $L_{12} \equiv x - 3y + 1 = 0$

$L_{23} \equiv 2x + y - 12 = 0$

$L_{13} \equiv 3x - 2y - 4 = 0$

Therefore, the required distances are

$$D_3 = \left|\frac{4 - 3 \times 4 + 1}{\sqrt{10}}\right| = \frac{7}{\sqrt{10}}$$

$$D_1 = \left|\frac{4 + 1 - 12}{\sqrt{5}}\right| = \frac{7}{\sqrt{5}}$$

$$D_2 = \left|\frac{3 \times 5 - 2 \times 2 - 4}{\sqrt{9 + 4}}\right| = \frac{7}{\sqrt{13}}.$$

6. The equation of any line passing through the given point P(3, 4) and making an angle $\dfrac{\pi}{6}$ with x-axis is $\dfrac{x - 3}{\cos 30^o} = \dfrac{y - 4}{\sin 30^o} = r$ (say) ......(i)

Where 'r' represents the distance of any point Q on this line from the given point P (3, 4).
The coordinates (x, y) of any point Q on line (i) are

$(3 + r\cos 30^o, 4 + r\sin 30^o)$ i.e., $\left(3 + \dfrac{r\sqrt{3}}{2}, 4 + \dfrac{r}{2}\right)$

If the point lies on the line $12x + 5y + 10 = 0$, then

$$12\left(3 + \frac{r\sqrt{3}}{2}\right) + 5\left(4 + \frac{r}{2}\right) + 10 = 0 \Rightarrow r = \frac{132}{12\sqrt{3} + 5}.$$

7. Suppose a point on circle is $B(x_1, y_1)$ and that which divides A and B in 3 : 2 is P given by

$h = \dfrac{-2 + 3x_1}{5}, k = \dfrac{2 + 3y_1}{5}$ or $\dfrac{5h + 2}{3} = x_1, \dfrac{5k - 2}{3} = y_1$

As (x_1, y_1) lies on circle $x^2 + y^2 = 4$, we get on substituting, $25(x^2 + y^2) + 20(x - y) - 28 = 0$.

8. $(y - 3)^2 = -4(x - 3)$ (given equation of parabola)

$\therefore$ equation of latus rectum is $x = 2$.

9. $x = t^2 + t + 1 \text{ and } y = t^2 - t + 1$

$\Rightarrow x + y - 2 = 2t^2 \text{ and } x - y = 2t$

$\Rightarrow 2(x + y - 2) = (x - y)^2 \;\; \Rightarrow x^2 + y^2 - 2xy - 2x - 2y + 4 = 0$

Comparing with the equation

$ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0,$

$\therefore abc + 2fgh - af^2 - bg^2 - ch^2 \neq 0$ and $h^2 = ab$

10. Since the number of students giving wrong answers to at least i question $(i = 1, 2, ..., n) = 2^{n-i}$.

The number of students answering exactly $i\,(1 \le i \le -1)$ questions wrongly = {the number of students answering at least i questions wrongly, $i = 1, 2, ..., n)\}$ – {the number of students answering at least $(i+1)$ questions wrongly $(2 \le i + 1 \le n)\}$ $= 2^{n-i} - 2^{n-(i+1)}(1 \le i \le n-1)$.

Now, the number of students answering all the n questions wrongly $= 2^{n-n} = 2^0$.

Thus the total number of wrong answers

$= 1(2^{n-1} - 2^{n-2} + 2(2^{n-2} - 2^{n-3}) + 3(2^{n-3} - 2^{n-4})$

11. We have,

$y + z = a(\cos^2 x + \sin^2 x) + c(\sin^2 x + \cos^2 x) = a + c$

$(\therefore$ solution is (b)}

$y - z = a(\cos^2 x - \sin^2 x) + 4b\sin x\cos x - c(\cos^2 x - \sin^2 x)$

$= (a - c)\cos 2x + 2b\sin 2x$

$= (a-c).\left(\dfrac{1-\tan^2 x}{1+\tan^2 x}\right) + 2b.\left(\dfrac{2\tan x}{1+\tan^2 x}\right)$

$= (a-c).\left\{\dfrac{1-4b^2/(a-c)^2}{1+4b^2/(a-c)^2}\right\} + 2b.\left\{\dfrac{2.2b/(a-c)}{1+4b^2/(a-c)^2}\right\}$

Since $\tan x = \dfrac{2b}{(a-c)}$,

$\therefore y - z = \dfrac{(a-c).\{(a-c)^2 - 4b^2\} + 8b^2(a-c)}{(a-c)^2 + 4b^2}$

$= \dfrac{(a-c)(a-c)^2 + 4b^2}{\{(a-c)^2 + 4b^2\}} = (a-c)$

$\Rightarrow y \neq z, (\because a \neq c)$.

12. Given that $z^2 + (p + iq)z + r + is = 0$ ......(i)

Let $z = \alpha$ (where α is real) be a root of (i), then

$\alpha^2 + (p + iq)\alpha + r + is = 0$

or $\alpha^2 + p\alpha + r + i(q\alpha + s) = 0$

Equating real and imaginary parts, we have $\alpha^2 + p\alpha + r = 0$ and $q\alpha + s = 0$

Eliminating α, we get $\left(\dfrac{-s}{q}\right)^2 + p\left(\dfrac{-s}{q}\right) + r = 0$

or $s^2 - pqs + q^2r = 0$ or $pqs = s^2 + q^2r$

13. $x = 3\left(\frac{1-t^2}{1+t^2}\right), y = \frac{2t}{1+t^2}$

$\frac{x^2}{9} + y^2 = \frac{\left(1-t^2\right)^2 + 4t^2}{\left(1+t^2\right)^2} = 1$ Which is an ellipse

$\therefore 1 = 9\left(1-e^2\right) \Rightarrow e^2 = 1 - \frac{1}{9} = \frac{8}{9}$

14. Here a = 5, b = 4 and e = $\frac{3}{5}$

Hence foci of the ellipse are (± 3, 0)
Hence $PF_1 + PF_2 = 10$.

15. The given ellipse is $\frac{x^2}{4} + \frac{y^2}{3} = 1 \Rightarrow a = 2, b = \sqrt{3}$

$\therefore\ 3 = 4\left(1-e^2\right) \Rightarrow e = \frac{1}{2}$

$\therefore\ ae = 2 \times \frac{1}{2} = 1$

Hence, the eccentricity e_1, of the hyperbola is given by

$1 = e_1 \sin\theta \Rightarrow e_1 = \operatorname{cosec}\theta\ \Rightarrow\ b^2 = \sin^2\theta\left(\operatorname{cosec}^2\theta - 1\right) = \cos^2\theta$

Hence, equation of hyperbola is $\frac{x^2}{\sin^2\theta} - \frac{y^2}{\cos^2\theta} = 1$ or $x^2 \operatorname{cosec}^2\theta - y^2 \sec^2\theta = 1$

16. Since $(n+2)^{th}$ term is the middle term in the expansion of $(1+x)^{2n+2}$, therefore $p = {}^{2n+2}C_{n+1}$.
Since $(n+1)^{th}$ and $(n+2)^{th}$ terms are middle terms in the expansion of $(1+x)^{2n+1}$, therefore $q = {}^{2n+1}C_n$ and $r = {}^{2n+1}C_{n+1}$ But ${}^{2n+1}C_n + {}^{2n+1}C_{n+1} = {}^{2n+2}C_{n+1}$
$\therefore\ q + r = p$

17. For the first set number of ways ${}^{52}C_{17}$. Now out of 35 cards left 17 cards can be put for second in ${}^{35}C_{17}$ ways similarly for 3rd in ${}^{18}C_{17}$. One card for the last set can be put in only one way. Therefore the required number of ways for the proper distribution

$$= \frac{52!}{35!17!} \times \frac{35!}{18!17!} \times \frac{18!}{17!1!} \times 1! = \frac{52!}{(17!)^3}.$$

18. $\tan(\cot x) = \cot(\tan x)\ \Rightarrow\ \tan(\cot x) = \tan\left(\frac{\pi}{2} - \tan x\right)$

$(70)^2 + 20h + h^2 = (6)(70)(20)\ \ \cot x = n\pi + \frac{\pi}{2} - \tan x \Rightarrow \cot x + \tan x = n\pi + \frac{\pi}{2}$

$(70)^2 + 20h + h^2 = (6)(70)(20)\ \ \frac{2}{\sin 2x} = n\pi + \frac{\pi}{2} \Rightarrow \sin 2x = \frac{2}{n\pi + \frac{\pi}{2}} = \frac{4}{(2n+1)\pi}$.

19. $1 + \sin x + \sin^2 x + ...\infty = 4 + 2\sqrt{3}$

$$\Rightarrow \frac{1}{1-\sin x} = 4+2\sqrt{3} \Rightarrow \sin x = 1-\frac{1}{4+2\sqrt{3}}$$

$$\Rightarrow \sin x = 1-\frac{(4-2\sqrt{3})}{4} = \frac{2\sqrt{3}}{4} = \frac{\sqrt{3}}{2}$$

$$\Rightarrow x = \frac{\pi}{3} \text{ or } \frac{2\pi}{3}.$$

20. Adding and subtracting the given relation,

we get $(m+n) = a\cos^3\alpha + 3a\cos\alpha\sin^2\alpha + 3a\cos^2\alpha.\sin\alpha + a\sin^3\alpha$

$= a(\cos\alpha+\sin\alpha)^3$

and similarly $(m-n) = a\ (\cos\alpha-\sin\alpha)^3$

Thus, $(m+n)^{2/3}+(m-n)^{2/3}$

$= a^{2/3}\{\cos\alpha+\sin\alpha)^2+(\cos\alpha-\sin\alpha)^2\}$

$= a^{2/3}\{2(\cos^2\alpha+\sin^2\alpha)\} = 2a^{2/3}$.

21. We have $\sin A = n\sin B \Rightarrow \frac{n}{1} = \frac{\sin A}{\sin B}$

$$\Rightarrow \frac{n-1}{n+1} = \frac{\sin A-\sin B}{\sin A+\sin B} = \frac{2\cos\frac{A+B}{2}\sin\frac{A-B}{2}}{2\sin\frac{A+B}{2}\cos\frac{A-B}{2}}$$

$$= \tan\frac{A-B}{2}\cot\frac{A+B}{2}$$

$$\Rightarrow \frac{n-1}{n+1}\tan\left(\frac{A+B}{2}\right) = \tan\frac{A-B}{2}\ .$$

22. We have equal roots, therefore $\lambda^2 = 4\mu$.

Now second equation $x^2+\lambda x-12=0$ has a root 2, so put $x=2 \Rightarrow 4+2\lambda-12=0 \Rightarrow \lambda = 4$

Hence from $\lambda^2 = 4\mu$, we have $\mu = \frac{16}{4} = 4$

$\Rightarrow (\lambda,\mu) = (4,4)$.

23. Let the roots are α and $n\alpha$

Sum of roots, $\alpha+n\alpha = -\frac{b}{a} \Rightarrow \alpha = -\frac{b}{a(n+1)}$ .....(i)

and product, $\alpha.n\alpha = \frac{c}{a} \Rightarrow \alpha^2 = \frac{c}{na}$ ....(ii)

From (i) and (ii), we get

$$\Rightarrow \left[-\frac{b}{a(n+1)}\right]^2 = \frac{c}{na} \Rightarrow \frac{b^2}{a^2(n+1)^2} = \frac{c}{na}$$

$\Rightarrow nb^2 = ac(n+1)^2$.

Note: Students should remember this question as a fact.

24. We have $\sqrt{3}+i = (a+ib)(c+id)$

$\therefore ac - bd = \sqrt{3}$ and $ad + bc = 1$

Now $\tan^{-1}\left(\frac{b}{a}\right) + \tan^{-1}\left(\frac{d}{c}\right)$

$$= \tan^{-1}\left(\frac{\frac{b}{a}+\frac{d}{c}}{1-\frac{b}{a}.\frac{d}{c}}\right) = \tan^{-1}\left(\frac{bc+ad}{ac-bd}\right) = \tan^{-1}\left(\frac{1}{\sqrt{3}}\right) \quad = n\pi + \frac{\pi}{6}, n \in I$$

25. We know that $\log_a m > \log_a n \Rightarrow \; m > n$ or $m < n$, according as $a > 1$ or $0 < a < 1$. Hence for $z = x + iy$

$\log_{(1/3)} |z+1| > \log_{(1/3)} |z-1| \Rightarrow |z+1| < |z-1| \qquad \left\{\because 0 < \frac{1}{3} < 1\right\}$

$\Rightarrow |x + iy + 1| < |x + iy - 1|$

$\Rightarrow \; (x+1)^2 + y^2 < (x-1)^2 + y^2$

$\Rightarrow \; 4x < 0 \Rightarrow x < 0 \Rightarrow \text{Re}(z) < 0$

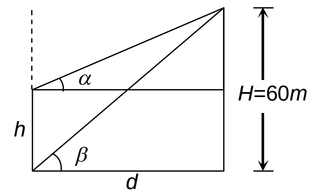
26. $x^{2n-1} + y^{2n-1}$ is always contain equal odd power. So it is always divisible by $x + y$.

27. Check through option, the condition $\left(\frac{n+1}{2}\right)^n \geq n!$ is true for $n \geq 1$.

28. $H = d\tan\beta$ and $H - h = d\tan\alpha$

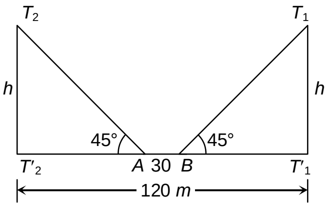
$\Rightarrow \; \frac{60}{60-h} = \frac{\tan\beta}{\tan\alpha} \; \Rightarrow \; -h = \frac{60\tan\alpha - 60\tan\beta}{\tan\beta}$

$\Rightarrow \; h = \frac{60\sin(\beta-\alpha)}{\cos\alpha\cos\beta\frac{\sin\beta}{\cos\beta}} \; \Rightarrow \; x = \cos\alpha\sin\beta$.



29. $\tan 45^o = 1 = \frac{h}{T_2'A} \Rightarrow T_2'A = h$

Hence $120 = h + 30 + h \Rightarrow h = 45$ m.



30. $x = \sqrt{1+\sqrt{1+\sqrt{1+.....}}}$ to ∞ ∞

We have $x = \sqrt{1+x}$

$\Rightarrow \; x^2 = 1 + x \; \Rightarrow x^2 - x - 1 = 0$

$\Rightarrow \; x = \frac{1 \pm \sqrt{1+4}}{2} = \frac{1 \pm \sqrt{5}}{2}$

As $x > 0$, we get $x = \frac{1+\sqrt{5}}{2}$

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ALL INDIA INTEGRATED TEST SERIES

ANSWERS, HINTS & SOLUTIONS
HALF COURSE TEST–VII
(Paper - 1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	A	C
2.	B	A	C
3.	A	A	A
4.	C	A	B
5.	B	A	A
6.	A	D	C
7.	A	D	A
8.	A, C	A, B, D	A, B, C
9.	A, C	A, B, C, D	A, C
10.	B, C, D	A, B, C, D	A, B, C, D
11.	A, B, C, D	A, B, C, D	A, B
12.	B	C	C
13.	A	A	A
14.	C	A	C
15.	D	B	B
16.	A	A	D
1.	(A → p); (B → q); (C → s); (D → p)	(A → t); (B → s); (C → p); (D → q, r)	(A → q); (B → r); (C → p) (D → s)
2.	(A → s); (B → p); (C → q); (D → r)	(A → q, r); (B → p); (C → s); (D → t)	(A → s) (B → p); (C → q); (D → r)
1.	7	7	4
2.	1	2	6
3.	3	1	1
4.	4	4	3
5.	2	4	0
6.	6	2	1

Physics

PART – I

Hints & Solution

SECTION – A

1. Pressure in the air inside the column of mercury is equal to the weight of mercury over the air divided by the internal cross sectional area of the tube. When the temperature increases, the weight of the upper part of the mercury column does not change. That is why the pressure in the air is also constant. For the isobaric process, the change in volume is proportional to the change in temperature. The same is true for the lengths of the air column.

$$\frac{l}{l_0} = \frac{T}{T_0} \Rightarrow l = \frac{l_0 T}{T_0} = 11 \text{ cm}.$$

2. Frequency received by car B is $f_1 = \left(\frac{v+w+u}{v+w-u}\right)f$

Now the car B will be treated as a source of frequency f_1

$\therefore$ wavelength of reflected sound received by the driver of car A is

$$\lambda' = \frac{(v-w-u)}{f_1} = \frac{(v-w-u)(v+w-u)}{(v+w+u)f}$$

$$\frac{(330-5-25)(330+5-25)}{(330+5+25)300} = \frac{31}{36}\text{m}$$

Hence (B) is correct

3. $$a = \frac{F_0}{m}e^{-Kx} \Rightarrow \int_0^{v_{max}} v\,dv = \frac{F_0}{m}\int_0^{\infty} e^{-Kx}dx$$

$$\Rightarrow \frac{v_{max^2}}{2} = \frac{F_0}{mK} \Rightarrow K_{max} = \frac{F_0}{K}$$

4. Let initial location of center of mass is 0 then find location of cm

$$X_{cm} = \frac{\lambda(90\text{cm})(5\text{cm}) + \lambda(10\text{cm})(45)}{\lambda(90)+\lambda(10)} = 9 \text{ cm}$$

5. As escape velocity is $\sqrt{2}$ times of orbital velocity.

6. The power developed by the man = power required in the reference frame of the man

= Force × velocity = m(g + a).(h/t)

Hence, (A) is correct.

7. $x + y = 100$ …(1)

Heat lost = Heat gained

$y \times 3.36 \times 10^5 = x \times 21 \times 10^5$

$$\frac{y}{x} = \frac{21}{3.36}$$

$336y = 21x \times 100$ …(2)

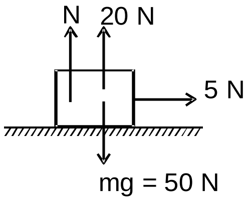
Using (1) & (2)

$$y = \frac{210000}{2436} = 86.21$$

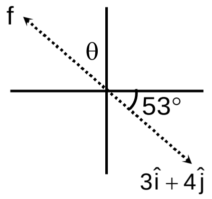
8. For a plane wave intensity (energy crossing per unit area per unit time) is constant at all point
For spherical wave
$I = \frac{p}{4\pi r^2} \Rightarrow \left(I \propto \frac{1}{r^2}\right)$

9. Acceleration of block is = 10 m/s^2
$\Rightarrow$ Displacement $s = \frac{1}{2}at^2 = \frac{1}{2} \times 10 \times \frac{4}{10} = 2\text{m}$
Tension in the string is 40 N

10. N = 50 – 20 = 30 N
Limiting friction force = μN = 12 N and applied force in horizontal direction is less than the limiting friction force, therefore the block will not slide.
For equilibrium in horizontal direction, friction force must be equal to 5 N.

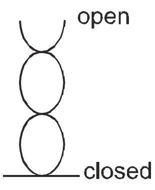


From the top view, it is clear that θ = 37° i.e. 127° from the x-axis that is the direction of the friction force. It is opposite to the applied force.
Contact force $= \sqrt{N^2 + f^2} = \sqrt{925}\,\text{N}$



11. $P = 3V^3$, for ideal gas
PV = nRT
(A) relation between V and T
$V \times (3V^3) = nRT \Rightarrow V^4 = \left(\frac{nR}{3}\right)T \qquad V^4 \propto T$
(B) Relation between P and T
PV = nRT
$\Rightarrow\ P\left(\frac{P}{3}\right)^{1/3} = nRT \Rightarrow P^{4/3} \propto T$
(C) For expansion
V → increases
work-done : positive
internal energy : increases
Hence, heat will have to supplied to the gas.
(D) As $T \propto V^4$
with increase in temperature, volume increases
Hence work done is positive.

12. $\frac{2\pi}{0.8} = \frac{2\pi}{\lambda}$ So λ = 0.8 and effective length of air column = 0.99 + 0.01 = 1m.
$\frac{\ell}{\lambda} = \frac{5}{4}$
$l = 5\frac{\lambda}{4}$, so five half loops will be formed
$\ell = 5\left(\frac{\lambda}{4}\right)$ so second overtone



13. $P_{ex} = -B\,\dfrac{d\xi}{dx}$

$= (5 \times 10^5) \times (0.1 \times 10^{-3})\,\dfrac{2\pi}{0.8}\,\sin\dfrac{2\pi}{0.8}\,(y + 1\text{cm})\cos 2\pi(400)\,t$

$= (125\,\pi\ \text{N/m}^2)\sin\dfrac{2\pi}{0.8}\,(y + 1\text{cm})\cos 2\pi(400t)$

14- 16. $\dfrac{m}{4}.\dfrac{2\ell}{3}.v_0 = \dfrac{m\ell^2}{3}\omega + \dfrac{m}{4}v_1\dfrac{2\ell}{3}$

$2v_0 = \dfrac{8\omega\ell}{3} \Rightarrow \omega = \dfrac{3v_0}{4\ell}$

$v_1 = \dfrac{2\omega\ell}{3} - v_0$

$v_1 = \dfrac{-v_0}{2}$

$\dfrac{mg\ell}{2}(1-\cos\theta) = \dfrac{1}{2}I\omega^2$

SECTION – C

1. $P = \left(\dfrac{0.16\times10^{-6}}{60}\right)\times1000\times4.2\times80\times10^3 + \left(\dfrac{0.16\times10^{-6}}{60}\right)\times1000\times2.3\times10^{+6} = 7$ watt.

2. $T\left(\dfrac{h}{2}\right) - N\left(\dfrac{h}{4}\right) > 0$

$T - \dfrac{N}{2} \quad > 0$

$T_{min} = \dfrac{Mg}{2}$

$a \quad = g/2 = 5\ \text{m/s}^2$.

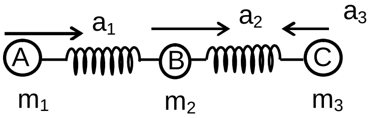
$mg - T \ = m(g/2)$

$mg - \dfrac{Mg}{2} = m\left(\dfrac{g}{2}\right)$

$\dfrac{Mg}{2} = \left(\dfrac{mg}{2}\right)$

$\dfrac{m}{M} = 1$

3. The acceleration of center of mass of the system



$a_{cm} = \dfrac{|m_1\vec{a}_1 + m_2\vec{a}_2 + m_3\vec{a}_3|}{m_1 + m_2 + m_3}$

$\Rightarrow$ The net force acting on the system

$= |m_1\vec{a}_1 + \vec{m}_2a_2 + m_3\vec{a}_3|$

$\Rightarrow F_{net} = (m_1\,a_1 + m_2\,a_2 - m_3\,a_3)$

$= \left[(1)(1) + (2)(2) - \dfrac{1}{2}(4)\right]\text{N} = 3\ \text{N}.$

4. $R_{max} = \frac{u^2}{g}$

So, maximum area covered = $\pi R_{max}^2 = \pi . \frac{u^4}{g^2} = 4m^2$

5. Velocity of block w.r.t. ground

$\vec{V}_{1G} = 20\hat{i} + 15\hat{j}$

$\Rightarrow \vec{V}_{1P} = 15\hat{j}$

Velocity of block w.r.t. ground after 10 sec. is zero (since block will stop w.r.t. board after 5 sec.)

$\vec{V}'_{1P} = \vec{V}_{1P} - \mu g t \hat{j} = 0$ (t = 5 sec)

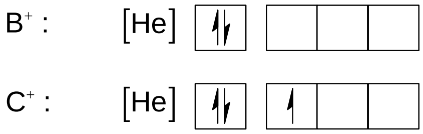
$\therefore \vec{V}'_{1G} = 20\hat{i}$

6. Area under graph = $\int \frac{1}{v} dx = \Delta t$

Chemistry

PART – II

1. $E = \frac{\text{Molecular weight}}{\text{Replaced } H^+}$ = 98/1 = 98

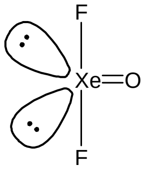
2. 

Sr^+, Ba^{2+} are relatively easily formed in order to achieve completely filled valence shell orbitals.

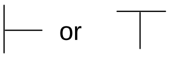
3. $$K_c^{-1} = \frac{[Ag^+][NH_3]^2}{[Ag(NH_3)_2^+]}$$

$$K_{sp} = [Ag^+][Cl^-] \Rightarrow \frac{1}{K_c} = \frac{K_{sp}[NH_3]^2}{[Ag(NH_3)_2^+][Cl^-]}$$

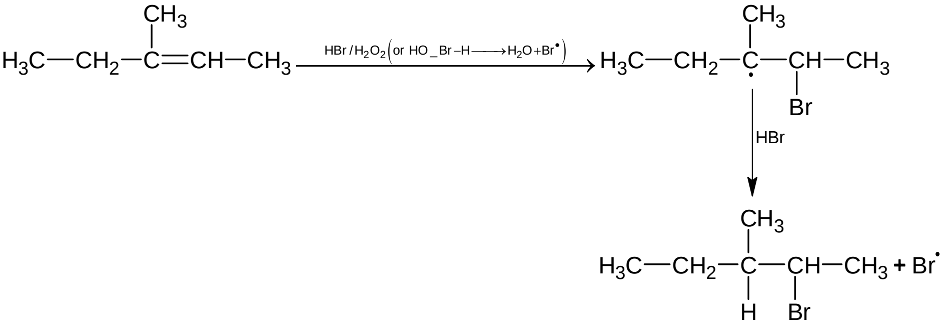
4. $XeOF_2$:



Hence,



5. $$\lambda = \frac{h}{mv} = \frac{6.626\times10^{-34}}{(9.1\times10^{-31})(2.19\times10^{6})} = 3.321 \times 10^{-10}\text{ m}$$

6. 

$$H_3C-CH_2-\overset{CH_3}{\overset{|}{C}}=CH-CH_3 \xrightarrow{HBr/H_2O_2\left(\text{or } HO\_Br-H \longrightarrow H_2O+Br^\bullet\right)} H_3C-CH_2-\overset{CH_3}{\overset{|}{\dot{C}}}-\underset{Br}{\underset{|}{CH}}-CH_3 \xrightarrow{HBr} H_3C-CH_2-\overset{CH_3}{\overset{|}{\underset{H}{\underset{|}{C}}}}-\underset{Br}{\underset{|}{CH}}-CH_3 + Br^\bullet$$

7. $$CO(g) + \frac{1}{2}O_2(g) \longrightarrow CO_2(g)$$

$$\Delta G^0 = \Delta G^0(CO_2) - \left[G^0(CO) + \frac{1}{2}G^0(O_2)\right] = -394.4 - (-137.2 + 0) = -257.2\text{ kJ}$$

$\Rightarrow$ Spontaneous (–ve sign)

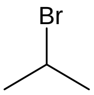
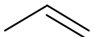
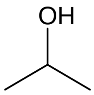
But $\Delta G^0 = \Delta H^0 - T\Delta S^0$

$\Rightarrow -257.2 = \Delta H^0 - 298\text{ K}(-0.094)$

$\Rightarrow \Delta H^0 = -285.2$ kJ $\Rightarrow$ exothermic (−ve sign)

8. Allyl carbocation is less stable than benzyl carbocation due to less number of resonating structures.

9. In (A) Cl and O
In (B) S and O
In (C) only O
In (D) P and O

10. (A)  (B)  (C)  (D) CHI_3 (E) CH_3COO^- (E) CH_3COOH

11. The balanced equation is

$$\underset{294\text{ g}}{K_2Cr_2O_7} + \underset{14\times36.5\text{ g}}{14HCl} \longrightarrow 2KCl + 2CrCl_3 + 7H_2O + \underset{3\times71\text{g}}{3Cl_2}$$

Mass of $K_2Cr_2O_7$ = $\frac{96}{100} \times 61.3 = 58.848$g

Mass of HCl = $\frac{30}{100} \times 320 \times 1.15 = 110.4$g

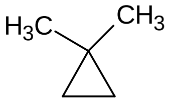
Hence, $K_2Cr_2O_7$ is limiting reagent.

$\therefore$ Mass of Cl_2 produced = 42.63 g

Also equivalent of $K_2Cr_2O_7$ = $\frac{M}{6}$

Equivalent of HCl = $\frac{7M}{3}$

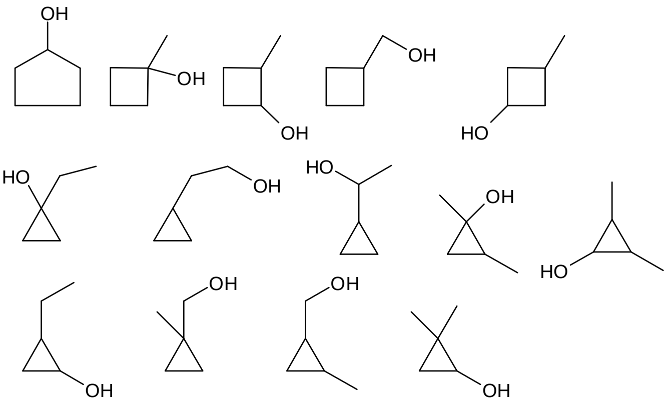
16. All the given molecules are cyclic isomers with molecular formula = C_5H_{10}
Number of pairs of diastereomers
= total number of pairs of stereomerms – number of pairs of enantiomers = ${}^3C_2 - 1 = 2$



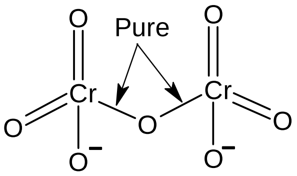
is th missing cyclic isomer.

SECTION – C

1.



x = 14 so x/2 = 7

2.


As these two does not participate in resonance.

3. It will produce most stable free radical.

4. meq of KOH = 20 meq = meq of acid

$$\frac{20}{1000} = \frac{0.45}{90} \times n - \text{factor}$$

n-factor for acid = 4 = number of replaceable proton.

5. $[H_2CO_3]$ in blood = 4M $[NaHCO_3]$ = 10 M
Volume of blood = 10 mL
Let the volume of $NaHCO_3$ used = x mL

$$\left[H_2CO_3\right] \text{ in mixture} = \frac{4 \times 10}{(x+10)}$$

$$\left[NaHCO_3\right] \text{ in mixture} = \frac{10 \times x}{(x+10)}$$

$$pH = pK_a + \log\frac{\text{salt}}{\text{acid}}$$

$$7.4 = 7 - \log 4 + \log\frac{(10 \times x)(x+10)}{(x+10)(4 \times 10)} \Rightarrow 7.4 = 6.4 + \log\frac{10x}{40}$$

$$\log\frac{10x}{40} = 1 \text{ so } \frac{10x}{40} = 10$$

x = 40 mL
Hence x/10 = 4

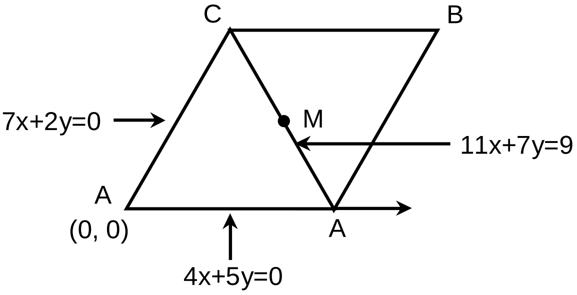
6.
$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

1	3	
0	0	2

$\therefore$ Ratio of initial and final volumes = 4/2 = 2

Mathematics PART – III

SECTION – A



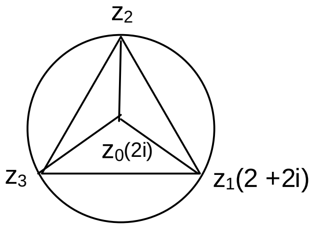
1. Since O(0, 0) does not lie on 11x + 7y = 9
hence it is the equation of AC,
solving OC with AC we get $C \equiv \left(-\frac{2}{3}, \frac{7}{3}\right)$
solving OA with AC we get $A \pm \left(\frac{5}{3}, -\frac{4}{3}\right)$
hence M = mid point of C & A $\equiv \left(\frac{1}{2}, \frac{1}{2}\right)$
hence equation of OB ≡ y = x.
2. The curve remains unchanged when y & x are interchanged.
3. Let the circle be $x^2 + y^2 + 2gx + 2fy + c = 0$, if $\left(m_i, \frac{1}{m_i}\right)$ lies on it then
$m^4 + 2gm^3 + 2fm + cm^2 + 1 = 0$ and m_1 m_2, m_3, m_4 are its roots.
4. Coefficient of x^r is $\frac{\left(-\frac{1}{2}\right)\left(-\frac{1}{2}-1\right)\ldots\left(-\frac{1}{2}-r+1\right)}{r!}(-2)^r$
$= \frac{1.3.5...(2r-1)}{2^r}.\frac{(-1)^r(-1)^r 2^r}{r!} = \frac{1.3.5...(2r-1)}{r!} = \frac{(2r)!}{r!r!}2^r$
5. $\frac{1}{2} + \frac{3}{8} + \frac{9}{32} + \frac{27}{128} + ...\infty = \frac{\frac{1}{2}}{1-\frac{3}{4}} = 2$.
6. $\frac{1-a^{x+1}}{1-a} = (1+a)(1+a^2)(1+a^4)$
i.e. $1-a^{x+1} = 1-x^8$
(multiply by (1 – a) on both the sides)
∴ x = 7.
7. ABC can speak in $^{10}C_3 \times 1$ ways
other 7 in 7! ways
so totally $^{10}C_3 . 7!$ ways $= \frac{10!}{6}$.
8. Putting x = ω in the equation,
$0 = a_0 + a_1\,\omega + a_2\omega^2 + a_3 + \;...$ .... (1)
Putting x = ω^2 in the equation,
$0 = a_0 + a_1\omega^2 + a_2\omega + a_3 + \;...$ .... (2)
Putting x = 1 in the equation,
$3^n = a_0 + a_1 + a_2 + a_3 + \;...$ .... (3)
adding (1), (2) and (3),
$3^n = 3(a_0 + a_3 + a_6 + \;....)$ .... (a)
$\Rightarrow a_0 + a_3 + a_6 + \;.... = 3^{n-1}$ (option C)
subtracting (2) from (1),
$0 = (\omega - \omega^2)(a_1 - a_2 + a_4 - a_5 + \;...\;)$
Since $\omega - \omega^2 \neq 0$, $a_1 + a_4 + a_7 + ... = a_2 + a_5 + a_8 + \;...$ ... (4)

Also from (3) – (a), $a_1 + a_2 + a_4 + a_5 + \ldots = 3^n - 3^{n-1} = 2.3^{n-1}$ ....(5)
From (4) and (5), $a_1 + a_4 + a_7 + \ldots = a_2 + a_5 + a_8 + \ldots = 3^{n-1} = a_0 + a_3 + a_6 + \ldots$

9. Clearly the inscried triangle is equilateral.

$\Rightarrow \frac{z_2 - z_0}{z_1 - z_0} = e^{i\frac{2\pi}{3}}, \ \frac{z_3 - z_0}{z_1 - z_0} = e^{-i\frac{2\pi}{3}}$

$\Rightarrow z_2 = -1 + i(2 + \sqrt{3})$ and $z_3 = -1 + i(2 - \sqrt{3})$



10. b is the H.M. of a and c and their G.M. = $\sqrt{ac}$

G.M > H.M $\Rightarrow \sqrt{ac} > b$

And A.M. of a^n and c^n > G.M. of a^n and c^n

$\frac{a^n + c^n}{2} > \sqrt{a^n c^n}$

$a^n + c^n > 2\left(\sqrt{ac}\right)^n > 2b^n$

Put n = 100, 3, 5, 2

11. $\sqrt{1 - \sin A} = \left|\sin\frac{A}{2} - \cos\frac{A}{2}\right| = \sin\frac{A}{2} - \cos\frac{A}{2}$ if $\sin\frac{A}{2} \ge \cos\frac{A}{2}$

ie $\frac{\pi}{4} \le \frac{A}{2} \le \frac{5\pi}{4} \Rightarrow 0 \le \frac{A}{2} - \frac{\pi}{2} \le \pi$.

12. 6 can be written in the following ways using 1's and 2's only.
Six 1's in 1 way
Four 1's and one 2's in $\frac{5!}{4!}$ = 5 ways
Two 1's and two 2's in $\frac{4!}{2!\,2!}$ = 6 ways
Three 2's in 1 way.
So f(6) = 1 + 5 + 6 + 1 = 13.

13. We have f(6) = 13, so f{f(6)} = f(13).
Now 13 can be expressed in the following ways:
Thirteen 1's in 1 way
Eleven 1's and one 2's in $\frac{12!}{11!}$ = 12 ways
Nine 1's and two 2's in $\frac{11!}{9!\,2!}$ = 55 ways
Seven 1's and three 2's in $\frac{10!}{7!\,3!}$ = 120 ways
Five 1's and four 2's in $\frac{9!}{5!\,4!}$ = 126 ways
Three 1's and five 2's in $\frac{8!}{3!\,5!}$ = 56 ways
One 1's and six 2's in $\frac{7!}{6!}$ = 7 ways.
$\therefore$ f(13) = 377.

14–16. $\lambda x - y + 2(1 + \lambda) = 0 \Rightarrow \lambda(x + 2) - (y - 2) = 0$ pass through (– 2, 2)
$\mu x - y + 2(1 - \mu) = 0 \Rightarrow \mu(x - 2) - (y - 2) = 0$ pass through (2, 2).

Clearly these represent the foci of ellipse, so 2ae = 4.

The circle $x^2 + y^2 - 4y - 5 = 0 \Rightarrow x^2 + (y - 2)^2 = 9$ represents auxiliary circle thus $a^2 = 9 \Rightarrow e = \frac{2}{3}$ and $b^2 = 5$.

SECTION – B

1 (A). $|a + ib|\,|z| = |z|\,|(a - 1) + ib|$

$\Rightarrow \frac{1}{\sqrt{2}} = \sqrt{(a-1)^2 + b^2}$ and $a^2 + b^2 = \frac{1}{2}$

$\Rightarrow 1 - 2a = 0 \Rightarrow a = \frac{1}{2}$

and $b^2 = \frac{1}{4} \Rightarrow b = \frac{1}{2}$

$\Rightarrow a - b = 0$.

(B) We must have either
$6a > 2^a \cdot 3^b$ or $6b > 2^a \cdot 3^b$.
If b = 0, then $6a > 2^a \Rightarrow a = 1, 2, 3, 4$.
If a = 0, then $6b > 3^b \Rightarrow b = 1, 2$
suppose a > 0 and b > 0 ⇒ if $6a > 2^a \cdot 3^b$
thus $6^a > 2^a \cdot 3$ so $2a > 2^a$ (not possible)
similarly if $6b > 2^a \cdot 3^b$ than $3b > 3^b$ not possible
⇒ only solutions are 2, 4, 8, 76, 3, 9.

(C). $\text{Re}\left(\frac{z}{4}\right) \in (0, 1)$, $\text{Im}\left(\frac{z}{4}\right) \in [0, 1)$

means that if z = a + ib than a, b ∈ (0, 4)

Now $\frac{4}{a - ib} = \frac{4a}{a^2 + b^2} + \frac{4bi}{a^2 + b^2}$

$\Rightarrow 0 < a, b < \frac{a^2 + b^2}{4}$

$\Rightarrow (a - 2)^2 + b^2 > 4$ and $a^2 + (b - 2)^2 > 4$

so we want area inside the square and outside the two circles

$\Rightarrow$ area $= 16 - 4\pi + (2\pi - 4)$

$12 - 2\pi$.

(D). $3x + 4y + z = 5$

let $\vec{a} = 3\hat{i} + 4\hat{j} + \hat{k}$

$\vec{b} = x\hat{i} + y\hat{j} + z\hat{k}$

$\Rightarrow (\vec{a} \cdot \vec{b}) \le |\vec{a}||\vec{b}|$

$\Rightarrow 5 \le \sqrt{9 + 16 + 1} \cdot \sqrt{x^2 + y^2 + z^2}$

$\Rightarrow 26(x^2 + y^2 + z^2) \ge \frac{25}{26}$

2 (A) $\sqrt{\sin(\cos x)} = \sin(\cos x) \ge 0$

$2n\pi \le \cos x \le (2n + 1)\pi$

$0 \le \cos x \le 1$

$x \in \left[2n\pi - \frac{\pi}{2},\ 2n\pi + \frac{\pi}{2}\right]$.

(B) $\left(\sqrt{\cos(\sin x)}\right)^{-1}$

$\cos(\sin x) > 0$

$-\frac{\pi}{2} < \sin x < \frac{\pi}{2} \Rightarrow x \in R.$

(C) $\tan(\pi \sin x)$

$\pi \sin x \neq \pm\frac{\pi}{2}$

$\sin x \neq \pm\frac{1}{2}$

$\therefore x \neq n\pi \pm \frac{\pi}{6}$

$x \in R - \left\{n\pi \pm \frac{\pi}{6}\right\}.$

(D) $\ln(\tan x)$

$\tan x > 0$

$0 < x < \frac{\pi}{2}$

$n\pi < x < n\pi - \frac{\pi}{2}.$

SECTION – C

1. $x = \frac{1/4}{1-\frac{1}{2}} = \frac{1}{2} \;\therefore\; \left(\frac{1}{5}\right)^{\log\sqrt{5}\left(\frac{1}{2}\right)} = 5^{-\log 5\left(4^{-1}\right)} = 4$

2. $\alpha+\beta = -\frac{7}{2},\ \alpha\beta = \frac{c}{2} \Rightarrow \alpha^2-\beta^2 = \pm\frac{7}{4}$

i.e. $(\alpha+\beta)(\alpha-\beta) = \pm\frac{7}{4}$ i.e. $-\frac{7}{2}\sqrt{\frac{49}{4}-2x} = \pm\frac{7}{4} \Rightarrow c = 6.$

4. The given expression can be written as

$= k^3\left(\sum \sin^3 A\cos(B-C)\right) = \frac{k^3}{2}\sum \sin^2 A(\sin 2B + \sin 2C)$

$= k^3\sum \sin A\sin B(\sin A\cos B + \cos A\sin B)$

$= k^3\sum \sin A\sin B\sin C = k^3 3\sin A\sin B\sin C = 3(abc).$

5. Line ‘L’ passes through the centre of second circle.

6. $\begin{vmatrix} a & 1 & 1 \\ 1 & b & 1 \\ 1 & 1 & c \end{vmatrix} = 0 \Rightarrow$ a(b – 1)(c – 1) – (b – 1)(1 – a) – (c – 1)(1 – a) = 0

$\Rightarrow \quad \frac{a}{1-a} + \frac{1}{1-b} + \frac{1}{1-c} = 0.$

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HALF COURSE TEST – VII

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 246**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 07)** contains 7 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (08 – 11) contains 4 multiple choice questions which have one or more than one correct answer. Each question carries **+3 marks** for correct answer. There is no negative marking.

   Section-A (12 – 16) contains 2 paragraphs. Based upon paragraph, 2 and 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct matching. No marks will be given for any wrong matching in any question. There is no negative marking.
3. **Section-C (01 – 06)** contains 6 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

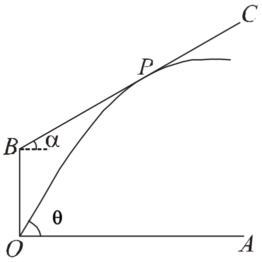
PART – I

SECTION – A

Straight Objective Type

This section contains ***7 multiple choice questions*** *numbered 1 to 7. Each question has 4 choices (A), (B), (C) and (D), out of which* ***ONLY ONE*** *is correct*

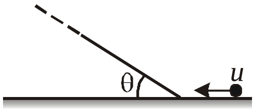
1. A particle is projected from a point O in a horizontal surface OA with speed v and angle of projection θ. It is just grazes the plane BC which make an angle α with the horizontal as shown in figure. The time taken by the projectile to reach P from the instant of projection is :



(A) $\frac{2u\sin\theta}{g\cos\alpha}$ (B) $\frac{u\sin\theta}{g\cos\alpha}$

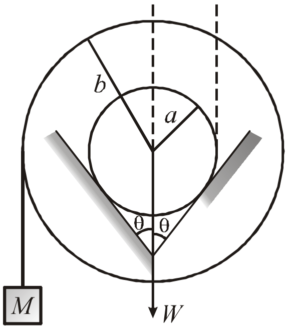
(C) $\frac{u\sin|\theta-\alpha|}{g\cos\alpha}$ (D) $\frac{u\cos|\theta-\alpha|}{g\cos\alpha}$

2. A particle of mass m is given initial speed u as shown in the figure. It moves to the fixed inclined plane without a jump, that is, its trajectory changes sharply from the horizontal line to the inclined line. All the surfaces are smooth and 90° ≥ θ > 0°. Then the height to which the particle shall rise on the inclined plane (assume the length of the inclined plane to be very large)



(A) Increases with increase in θ
(B) decreases with increase in θ
(C) is independent of θ
(D) data insufficient

3. The axle of a wheel rests in V grooves as shown in figure and string, fixed to the rim of the wheel, supported a mass M. If μ is the coefficient of friction, W weight of wheel and axle, a is the radius of the axle and b the radius of the wheel. The least value of M which will cause motion is :



(A) $\frac{\mu Wa}{g(b(1+\mu^2)\sin\theta-\mu a)}$

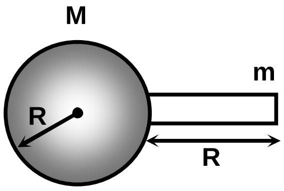
(B) $\frac{\mu Wb}{(a(1+\mu^2)\sin\theta-\mu b)g}$

(C) $\frac{\mu Wa}{(b(1+\mu^2)\sin\theta-\mu a)g}$

(D) $\frac{\mu Wb}{(a(1+\mu^2)\cos\theta-\mu b)g}$

Space for rough work

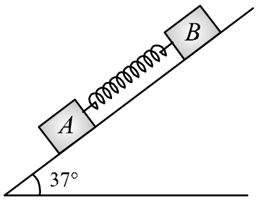
4. A uniform thin rod of mass m and length R is placed normally on surface of earth as shown. The mass of earth is M and its radius is R. Then the magnitude of gravitational force exerted by earth on the rod is:



(A) $\frac{GMm}{2R^2}$ (B) $\frac{GMm}{4R^2}$

(C) $\frac{4GMm}{9R^2}$ (D) $\frac{GMm}{8R^2}$

5. Two blocks A and B connected by spring (spring is in its natural length) are kept on smooth inclined plane and released. If acceleration of block B is 6 m/s^2 then that of block A at that instant (g = 10 m/s^2) :



(A) must be greater than 6 m/s^2

(B) may be less than 6 m/s^2

(C) must be 6 m/s^2

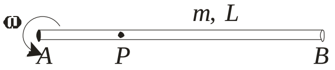
(D) any thing possible depending on masses of blocks A & B

6. Heat is being supplied at a constant rate to a sphere of ice which is melting at the rate of 0.1 gm/sec. It melts completely in 100 sec. The rate of rise of temperature thereafter will be Lf = 80 cal/gm, S = 1 cal/gm-°C :

(A) 0.8 °C/sec. (B) 5.4 °C/sec.

(C) 3.6 °C/sec. (D) will change with time

7. A uniform thin, rod AB of length L and mass m is undergoing fixed axis rotation about end A, such that end A remains stationary as shown. The kinetic energy of section AP of rod is equal to kinetic energy of section BP of rod at an instant. Then the ratio of length AP and length AB, that is, $\frac{AP}{AB}$



(A) $\frac{1}{2}$ (B) $\frac{1}{2^{1/3}}$

(C) $\frac{1}{\sqrt{2}}$ (D) $\frac{1}{2\sqrt{2}}$

Space for rough work

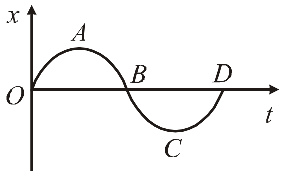
Multiple Correct Choice Type

*This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct*

8. Two particles A and B are performing SHM along x and y-axis respectively with equal amplitude and frequency of 2 cm and 1 Hz respectively. Equilibrium positions of the particles A and B are at the co-ordinates (3, 0) and (0, 4) respectively. At t = 0, B is at its equilibrium position and moving towards the origin, while A is nearest to the origin and moving away from the origin. Choose the correct option(s) :
(A) The distance between A and B is 3 cm at $t = t_0$ sec. It will again be 3 cm at $t = (t_0 + 1)$ sec.
(B) The distance between A and B can never be 5 cm.
(C) The maximum magnitude of force acting on each particle during the motion is same.
(D) Kinetic energy of the system (A and B) is conserved

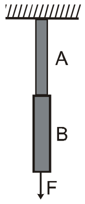
9. When the temperature of a copper coin is raised by 80°C, its diameter increases by 0.2%
(A) Percentage rise in the area of a face is 0.4%
(B) Percentage rise in the thickness is 0.4%
(C) Percentage rise in the volume is 0.6%
(D) Coefficient of linear expansion of copper is $0.25 \times 10^{-4}\ \text{C}^{\circ -1}$

10. A particle has a rectilinear motion and the figure gives its displacement as a function of time. Which of the following statements are true with respect to the motion



(A) in the motion between O and A the velocity is positive and acceleration is negative
(B) between A and B the velocity and acceleration are positive
(C) between B and C the velocity is negative and acceleration is positive
(D) between C and D the acceleration is positive

11. The wires A and B shown in the figure, are made of the same material and have radii of cross-section r_A and r_B. When a constant force F is applied as shown, one of the wires breaks. (Assume the m asses of the wire to be negligible)



(A) A will break before B if $r_A > r_B$
(B) B will break before A if $r_A < r_B$
(C) Either A or B will break if $r_A = r_B$
(D) The lengths of A and B must be known to decide which wire will break

Space for rough work

Comprehension Type

This section contains **2 paragraphs.** Based upon one of paragraphs **2 multiple** choice questions and based on the other paragraph **3 multiple** choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

Paragraph for Questions 12 and 13

A cutting tool under microprocessor control has several forces acting on it. One force is $\vec{F} = \alpha xy^2\hat{j}$, a force in the negative y-direction whose magnitude depend on the position of the tool. The constant is α = 2.50 N. Consider the displacement of the tool from the origin to the point x = 3.00 m, y = 3.00 m.

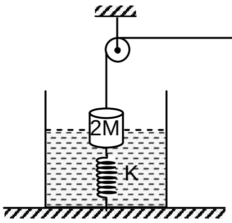
12. Calculate the work done on the tool by $\vec{F}$. If this displacement is along the straight line y = x that connects these two points ?
(A) 2.50 J (B) 500 J
(C) 50.6 J (D) 2 J

13. What can you predict about $\vec{F}$?
(A) Force is non-conservative
(B) Force is conservative
(C) Force is neither conservative nor non-conservative
(D) Data insufficient to conclude

Space for rough work

Paragraph for Question Nos. 14 to 16

A uniform cylindrical block of mass 2M and cross–sectional area A remains partially submerged in a non viscous liquid of density ρ, density of the material of the cylinder is 3ρ. The cylinder is connected to lower end of the tank by means of a light spring of spring constant K. The other end of the cylinder is connected to another block of mass M by means of a light inextensible string as shown in the figure. The pulleys shown are massless and frictionless and assume that the cross–section of the cylinder is very small in comparison to that of the tank. Under equilibrium conditions, half of the cylinder is submerged. [given $K > 8A\rho g$]



14. Under equilibrium conditions

(A) extension of the spring is $\frac{Mg}{3K}$
(B) compression of the spring is $\frac{2Mg}{3K}$
(C) compression of the spring is $\frac{Mg}{6K}$
(D) extension of the spring is $\frac{Mg}{6K}$

15. By what maximum distance cylinder will be pushed downward into the liquid from equilibrium position, so that when it is set free then tension in the string will not vanish. [Assume at equilibrium position system was at rest]

(A) $\frac{3Mg}{(K + A\rho g)}$
(B) $\frac{3Mg}{2(K + A\rho g)}$
(C) $\frac{8Mg}{3(K + A\rho g)}$
(D) $\frac{3Mg}{(2K + 3A\rho g)}$

16. If the cylinder is pushed down from equilibrium by a distance which is half the distance as calculated in the above question determine time period of subsequent motion

(A) $2\pi\sqrt{\frac{3M}{2(K + A\rho g)}}$
(B) $2\pi\sqrt{\frac{M}{2K + A\rho g}}$
(C) $2\pi\sqrt{\frac{3M}{K + A\rho g}}$
(D) $2\pi\sqrt{\frac{2M}{K + 3A\rho g}}$

Space for rough work

SECTION – B

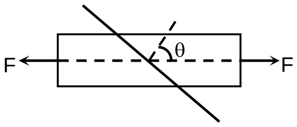
(Matrix-Match Type)

This section contains ***2 questions****. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in column I have to be matched with statements (p, q, r, s, t) in column II. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

If the correct match are A-p, A-s, B-q, B-r, C-p, C-q and D-s, then the correctly bubbled 4 × 4 matrix should be as follows:

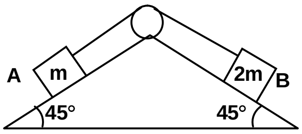
	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. A bar of cross-section A is subjected two equal and opposite tensile forces at its ends consider a plane section of the bar whose normal makes an angle θ with the axis of the bar.



	Column-I	Column-II
(A)	What is the tensile stress on this plane ?	(p) $\theta = 45°$
(B)	What is the shearing stress on this plane ?	(q) $\theta = 0°$
(C)	For what value of θ is the tensile stress is maximum?	(r) $(F/2A)\sin 2\theta$
(D)	For what value of θ is the shearing stress maximum?	(s) $(F/A)\cos^2\theta$
		(t) $\theta = 60°$

2. Two blocks A and B of mass m and 2m are placed on a fixed triangular wedge are placed on a fixed triangular wedge by massless inextensible string as shown. The pulley is massless and frictionless. The coefficient of friction between block A and the wedge is 2/3 and that between B and the wedge is 1/3. (Take m = 1 kg, g = 10 m/s^2)



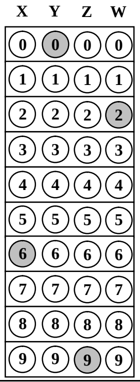
	Column – I		Column – II
(A)	Friction force between block A and wedge	(p)	$\frac{5}{\sqrt{2}}$ units
(B)	Friction fore between block B and wedge	(q)	$\frac{10}{3\sqrt{2}}$ units
(C)	Tension in the string	(r)	$\frac{10\sqrt{2}}{3}$ units
(D)	Maximum friction force between Block B and wedge.	(s)	$30\sqrt{2}$ units
		(t)	$\frac{20\sqrt{2}}{3}$ units

Space for rough work

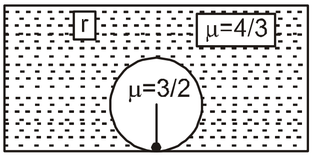
SECTION – C

Integer Answer Type

*This section contains **6 questions**. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown*



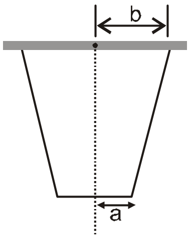
1. A glass sphere having refractive index (3/2) is having a small irregularity at its centre. It is placed in a liquid of refractive index 4/3 such that surface of liquid is r high above sphere where r is radius of sphere. If irregularity is viewed from above normally, calculate distance in cm from centre where eye will observe the irregularity is 10P in cm. Find the value of P.(r = 20 cm)



2. Two block of mass m and M are connected means of a metal of a metal wire passing over a frictionless fixed pulley. The area of cross-section of the wire is 6.67×10^{-9} m^2 and its breaking stress is 2×10^9 Nm^{-2}. If m = 1kg. Find the maximum value of M in kg for which the wire will not break. (g=10 m/s^2).

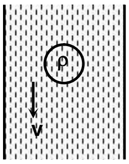
Space for rough work

3. A body of mass 3.14 kg is suspended from one end of a wire of length 10m. The radius of the wire is changing uniformly from 9.8×10^{-4} m at one end to 5×10^{-4} m at the other end. Find the change in length of the wire in mm. Young's modulus of the material of the wire is 2×10^{11} N/m^2. (mass of wire is negligible).

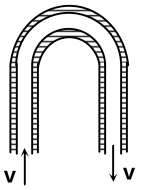


4. A conducting rod of length 1 m aligned along the unit vector $\left(\frac{3}{5}\hat{j}+\frac{4}{5}\hat{k}\right)$, is moving with a velocity $\vec{v}=\left(2\hat{i}\right)$ m/s. The motion take place in a uniform magnetic field $\vec{B}=\left(\hat{j}-2\hat{k}\right)$ tesla. Find the magnitude of induced emf in across the rod in volt.

5. A liquid of density ρ = 1000 kg/m^3 viscosity η = 0.1 Ns/m^2 is flowing down in vertical pipe of large cross section. A small ball of density ρ_0 = 100 kg/m^3 and r = 5 cm will be at rest in flowing liquid, if velocity of flowing liquid is 10k m/s. Then find the value of k.



6. A pipe of circular cross-section of inner radius r and outer radius 2r is bent into a semi circle as shown in the diagram. A fluid of density $\rho = 10^3$ kg/m^3 is flowing through it. The breaking stress of the material of the pipe is 3×10^7 N/m^2. The maximum velocity with which the fluid can flow in the pipe is k × 100 m/s. Find value of k.



Space for rough work

Chemistry

PART – II

SECTION – A

Straight Objective Type

This section contains ***7 multiple choice questions*** *numbered 1 to 7. Each question has 4 choices (A), (B), (C) and (D), out of which* ***ONLY ONE*** *is correct*

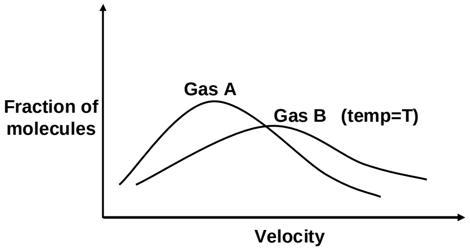
1. $Na_2SO_3 + S \xrightarrow[\Delta]{\text{alkaline}}$

(A) Na_2SO_3 (B) $Na_2S_2O_3$
(C) Na_2SO_4 (D) Na_2S

2. How much energy is required for breaking a hydrogen bond?

(A) 2 kcal (B) 100 kcal
(C) 2 kJ (D) 200 kJ

3. Which of the following statement is incorrect for the given graph?



(A) The molecular weight of gas A will be greater than gas B
(B) The average kinetic energy of both the gases will be similar at a particular temperature
(C) The average velocity of particles of gas A will always be less than of particles of gas B at temperature T.
(D) The velocity of any particle of gas A can not be greater than velocity of any particle of gas B at same temperature.

4. A water sample is found to have 384 ppm of SO_4^{2-}. What will be the degree of hardness of water sample?

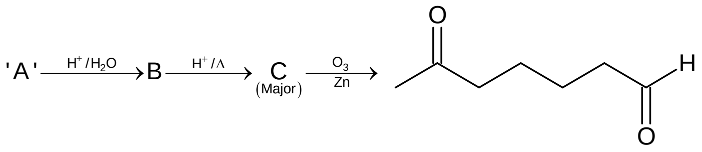
(A) 200 ppm (B) 300 ppm
(C) 400 ppm (D) 100 ppm

Space for rough work

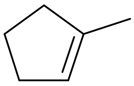
5. How many structural isomers are possible with molecular formula C_7H_{16}?
(A) 6 (B) 8
(C) 10 (D) 12

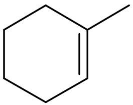
6. Which of the following is mismatched?
(A) $LiCO_3$ ⇒ least stable carbonate among alkali metal carbonates.
(B) LiF ⇒ almost insoluble in water due to its high covalent character.
(C) $Ba(OH)_2$ ⇒ most soluble hydroxide among alkaline earth metal hydroxide.
(D) $BeSO_4$ ⇒ more soluble than $BaSO_4$ in water.

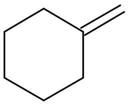
7.

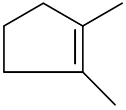


(A) and (C) are isomers.
Which of the following can be structure of (A)?

(A)


(B)


(C)


(D)


Multiple Correct Choice Type

This section contains **4 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

8. An electron in a hydrogen gas sample is excited to 5th excited level. Which of the following will be true for its spectrum?
(A) In spectrum total lines possible for Balmer series will be one
(B) In spectrum total lines possible for Lymann series will be five
(C) In spectrum total lines possible for IR region will be six
(D) In spectrum total lines possible for UV region will be five

Space for rough work

9. Which of the following relation is/are correct?

(A) $PV = \frac{RT}{d}$ (B) $d = \frac{PM}{RT}$

(C) $\frac{PV^2Md}{RT} = w^2$ (D) $n = \frac{w^2}{VMd}$

Where P = pressure (in atm)
V = volume (in litre)
T = temperature (in K)
R = Gas constant (0.0821 atm $LK^{-1}mol^{-1}$)
n = mole
d = density (g/L)
M = molecular weight (in g)

10. Which of the following oxides are basic only?

(A) MgO (B) BeO
(C) Al_2O_3 (D) BaO

11. Which bond properties are consistent with one another?

	Bond order	**Bond length**	**Vibrational frequency**
(A)	Higher	Longer	Lower
(B)	Higher	Shorter	Higher
(C)	Lower	Longer	Lower
(D)	Lower	Shorter	Higher

Comprehension Type

*This section contains **2 paragraphs.** Based upon one of paragraphs **2 multiple** choice questions and based on the other paragraph **3 multiple** choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct*

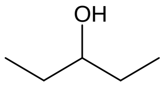
Paragraph for Question Nos. 12 to 13

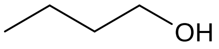
Among various reaction intermediates one of the important intermediate is carbocation in which carbon is bearing positive charge and is sp^2 hybridized so its structure is planar.

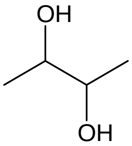
Many reactants like alkyl halides, alcohols and alkanes show reactions via carbonation. Higher the stability of respective intermediate higher the reactivity of the reactant towards that reaction.
Carbocations are stabilized mainly by aromaticity, resonance, hyperconjugation and positive inductive effect.

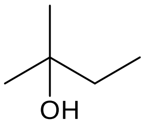
Space for rough work

12. Which of the following is the most reactive among given alcohols towards dehydration?

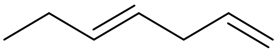
(A) 

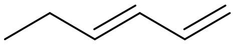
(B) 

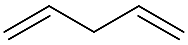
(C) 

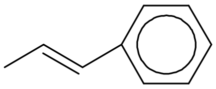
(D) 

13. Which of the following alkenes will be undergoing acid – catalysed hydration fastest?

(A) 

(B) 

(C) 

(D) 

Paragraph for Question Nos. 14 to 16

According to VSEPR theory the repulsion between various lone pairs & bond pairs are
lp – lp > lp – bp > bp – bp
Due to the repulsion the shape of the molecules also gets distorted from the normal geometries.

14. Which of the following molecule is having unsymmetrical shape?
(A) SF_4
(B) SF_6
(C) XeF_2
(D) XeF_4

15. Which of the following molecule has only bp – lp repulsion & bp – bp repulsion?
(A) CO_2
(B) CH_4
(C) $XeOF_4$
(D) XeF_2

16. Which of the following molecule is not unsymmetrical despite of being presence of lone pairs on central atom?
(A) CS_2
(B) SF_6
(C) ClF_3
(D) I_3^-

Space for rough work

SECTION – B

(Matrix-Match Type)

*This section contains **2 questions.** Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in column I have to be matched with statements (p, q, r, s, t) in column II. The answers to these questions have to be appropriately bubbled as illustrated in the following example.*

If the correct match are A-p, A-s, B-q, B-r, C-p, C-q and D-s, then the correctly bubbled 4 $\times$ 4 matrix should be as follows:

	p	**q**	**r**	**s**	**t**
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the Column – I with Column – II:

Column – I		**Column – II**	
(A)	$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$	(p)	Change in equilibrium constant on increasing temperature
(B)	$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$	(q)	Equilibrium is unaffected by adding inert gas at constant volume
(C)	$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$	(r)	Equilibrium is unaffected by adding inert gas at constant pressure
(D)	$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$	(s)	Equilibrium shift to forward on increasing pressure
		(t)	Increase in reactant concentration shifts equilibrium in forward direction

2. Match the Column – I with Column – II:

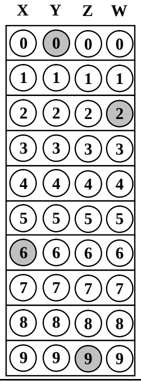
Column – I		**Column – II**	
(A)	C_3H_6O	(p)	Can exhibit functional isomerism (considering no cyclic structure)
(B)	C_4H_{10}	(q)	Can exhibit optical activity
(C)	C_7H_{16}	(r)	Can exhibit position isomerism
(D)	C_2H_7N	(s)	Can exhibit metamerism
		(t)	Can exhibit chain isomerism

Space for rough work

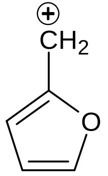
SECTION – C

Integer Answer Type

This section contains ***6 questions.*** *The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown*



1. How many significant resonating structures are possible for the given species including it?



2. The sum of oxidation states of sulphur in following compounds will be.
Cu_2S, FeS_2, $Na_2S_2O_3$, $Na_2S_2O_4$

3. The number of possible alcohols (saturated) with different boiling point with molecular formula C_4H_8O will be.

4. 2 mol of a solution containing A^{n+} requires 0.8 mol of $M_nO_4^-$ for the oxidation of A^{n+} to AO_3^- in acidic medium. The value of n is. (M is any metal)

5. 2 moles of A are mixed with 4 moles of B. When 2 moles of C and 1 mole of D is formed according to reaction. The value of equilibrium constant is $A + 2B \rightleftharpoons 2C + D$.

6. When an electron jumps from 6th excited level in a single H–atom. How many maximum lines can be obtained in Lyman series in the spectrum?

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

*This section contains **7 multiple choice questions** numbered 1 to 7. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct*

1. Which of there represent a triangle
(A) $|z - 1| = |z - 2|$ (B) $|z - 1| = |z - 2| = |z - i|$
(C) $|z - 1| - |z - 2| = 2a$ (D) $|z - 1|^2 + |z - 2|^2 = 4$.

2. If α, β, γ are the cube roots of $p(p < 0)$, then for any x, y, z, $\frac{x\alpha + y\beta + z\gamma}{x\beta + y\gamma + z\alpha} =$
(A) $\frac{1}{2}\left(-1-i\sqrt{3}\right)$ (B) $\frac{1}{2}\left(1+i\sqrt{3}\right)$
(C) $\frac{1}{2}\left(1-i\sqrt{3}\right)$ (D) none of these.

3. If A_1, A_2; G_1, G_2; and H_1, H_2 be two AMs, GMs and HMs between two numbers then $\frac{G_1G_2}{H_1H_2} \times \frac{H_1 + H_2}{A_1 + A_2} =$
(A) 1 (B) 0
(C) 2 (D) 3.

4. If a line intersect a hyperbola at (– 2, – 6) and (4, 2) and one of the asymptote at (1, – 2), then the centre of the hyperbola is
(A) (7, 6) (B) (1, – 2)
(C) (10, 10) (D) (– 5, – 10)

Space for rough work

5. If $0 \le A, B, C \le \pi$ and $A + B + C = \pi$ than the minimum value of sin3A + sin3B + sin3C is
(A) – 2
(B) $\frac{-3\sqrt{3}}{2}$
(C) 0
(D) none of these

6. A seven digit number without repetition and divisible by 9 is to be formed by using 7 digits out of 1, 2, 3, 4, 5, 6, 7, 8, 9. The number of ways in which this can be done is;
(A) 9!
(B) 2 (7!)
(C) 4 (7!)
(D) none of these

7. The largest two digit prime factor of ${}^{200}C_{100}$ is
(A) 61
(B) 59
(C) 17
(D) none of these

Multiple Correct Choice Type

*This section contains **4 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct*

8. If $ac > b^2$ then the sum of the coefficients in the expanssion of $(a\alpha^2x^2 + 2b\alpha x + c)^n$; ($a, b, c, \alpha \in R$, $n \in N$) is
(A) positive if a> 0
(B) positive if c > 0
(C) negative if a < 0 , n is odd
(D) positive if c < 0, n is even.

9. If f(x) and g(x) are two polynomials such that the polynomial $h(x) = x f(x^3) + x^2 g(x^6)$ is divisible by $x^2 + x + 1$, then
(A) f(1) = g(1)
(B) f(1) = - g(1)
(C) $f(1) = g(1) \neq 0$
(D) $f(1) = -g(1) \neq 0$

10. If three positive unequal numbers a, b, c are in H. P., then
(A) a + c > 2b
(B) $a^2 + c^2 > 2b^2$
(C) $a^2 + c^2 > 2ac$
(D) none of these.

11. If $\sin x + \cos x = \sqrt{y + \frac{1}{y}}$, $x \in [0, \pi]$, then
(A) $x = \pi/4$
(B) y =0
(C) y = 1
(D) $x = 3\pi/4$.

Space for rough work

Comprehension Type

This section contains 2 paragraphs. Based upon one of paragraphs 2 multiple choice questions and based on the other paragraph 3 multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

Paragraph for Question Nos. 12 to 13

Read the following writeup carefully:

$y = ax^2 + bx + c = 0$ is a quadratic equation which has real roots if and only if $b^2 - 4ac \geq 0$. If $f(x, y) = 0$ is a second degree equation, then using above fact we can get the range of x and y by treating it as quadratic equation in y or x. Similarly $ax^2 + bx + c \geq 0 \ \forall \ x \in R$ if $a > 0$ and $b^2 - 4ac \leq 0$.

Now answer the following questions:

12. If $0 < \alpha, \beta < 2\pi$, then the number of ordered pairs (α, β) satisfying $\sin^2(\alpha + \beta) - 2\sin\alpha \sin(\alpha + \beta) + \sin^2\alpha + \cos^2\beta = 0$ is

(A) 2 (B) 0
(C) 4 (D) none of these

13. If $A + B + C = \pi$, then the maximum value of $\cos A + \cos B + k \cos C$ (where $k > 1/2$) is

(A) $\frac{1}{k} + \frac{k}{2}$ (B) $\frac{2k^2 + 1}{3}$
(C) $\frac{k^2 + 2}{2}$ (D) $\frac{1}{2k} + k$

Space for rough work

Paragraph for Question Nos. 14 to 16

Read the following comprehension carefully:

a, b, c are complex numbers and all roots of $z^3 + az^2 + bz + c = 0$ satisfy $|z| = 1$.

Now answer the following questions.

14. The value of $|a| - |b|$ is
(A) 0 (B) 1
(C) – 1 (D) 2

15. The number of distinct real roots of the equation $z^3 + |a|z^2 + |b|z + |c| = 0$ is
(A) 1 (B) 2
(C) 3 (D) can’t say

16. All the roots of $z^3 + |a|z^2 + |b|z + |c| = 0$ satisfy
(A) $|z| < 1$ (B) $|z| = 1$
(C) $|z| > 1$ (D) can’t say

Space for rough work

SECTION – B

(Matching List Type)

This section contains ***2 multiple choice questions****. Each question has matching Column(s). The codes for the Column(s) have choices (A), (B), (C) and (D) out of which only* ***ONE OR MORE*** *is/are correct*

1. Match the following Column-I with Column-II

	Column – I		Column – II
(A)	Normal of parabola $y^2 = 4x$ at P and Q meets at R $(x_2, 0)$ and tangents at P and Q meets at T $(x_1, 0)$, then if $x_2 = 3$, then the area of quadrilateral PTQR is	(p)	3
(B)	The length of latus rectum plus tangent PT will be	(q)	6
(C)	The quadrilateral PTQR can be inscribed in a circle, then the value of circumference/ 4π will be	(r)	1
(D)	The number of normals that can be drawn to the parabola from $R(x_2, 0)$ is	(s)	8
		(t)	5

2. Match the following Column-I with Column-II

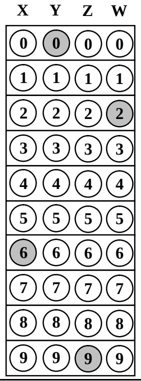
	Column – I		Column – II
(A)	In an A.P. $S_p = a$, $S_q = b$, $S_r = c$, then $\frac{a}{p}(q-r)+\frac{b}{q}(r-p)+\frac{c}{r}(p-q)$ is	(p)	3
(B)	In a G.P., $T_r = R$, $T_s = S$, $T_t = T$, then $R^{s-t} \cdot S^{t-r} \cdot T^{r-s}$ is	(q)	2
(C)	If x, y, z are both in A.P. and G.P., $T_m = x$, $T_n = y$, $T_p = z$, then $x^{y-z} \cdot y^{z-x} \cdot z^{x-y}$ is	(r)	1
(D)	If a, b, c, are both in G.P. and H.P., $T_p = 0$, $T_q = b$, $T_r = c$, then a (b – c) log a + b (c – a) log b + c (a – b) log c	(s)	0
		(t)	4

Space for rough work

SECTION – C

Integer Answer Type

This section contains ***6 questions****. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown*



1. If the roots of $x^3 - 12x^2 + 39x - 28 = 0$ are in A.P. then mod of their common difference will be …

2. If the roots of the equation $x^2 - bx + c = 0$ and $x^2 - cx + b = 0$ $[b \neq c]$ differ by the same quantity then $-(b + c)$ is …..

3. $\frac{c_1}{c_0}+2\frac{c_2}{c_1}+3\frac{c_3}{c_2}+\ldots+15\frac{c_{15}}{c_{14}}=5!k$ then k is ….

4. Value of '(–k)' such that the lines $2x - 3y + k = 0$, $3x - 4y - 13 = 0$ and $8x - 11y - 33 = 0$ are concurrent is …..

5. No. of common tangents to the circles $x^2 + y^2 = 4$ and $x^2 + y^2 - 6x - 8y = 24$ is …..

6. If the sum of the coefficients in the expansion of $(\alpha x^2 - 2x + 1)^{35}$ is equal to the sum of the coefficients in the expansion of $(x - \alpha y)^{35}$, then α = ……..

Space for rough work

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ALL INDIA INTEGRATED TEST SERIES

ANSWERS, HINTS & SOLUTIONS
HALF COURSE TEST–VII
(Paper - 2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**C**	**B**	**B**
2.	**B**	**A**	**A**
3.	**A, C**	**D**	**A**
4.	**A**	**C**	**B**
5.	**C**	**B**	**A**
6.	**A**	**B**	**C**
7.	**B**	**C**	**A**
8.	**A**	**B, C, D**	**A, B, C, D**
9.	**A, C, D**	**B, C, D**	**A, B**
10.	**A, C, D**	**A, D**	**A, B, C**
11.	**C**	**B, C**	**A, C**
12.	**C**	**D**	**C**
13.	**A**	**D**	**D**
14.	**B**	**A**	**A**
15.	**A**	**C**	**A**
16.	**C**	**D**	**B**
1.	**(A → s); (B → r); (C → q); (D → p)**	**(A → p, q, r, t); (B → p, q, t); (C → p, q, s, t); (D → p, q)**	**(A → s); (B → q); (C → r); (D → p)**
2.	**(A → q); (B → r); (C → t); (D → r)**	**(A → p); (B → t); (C → q, r, t); (D → p)**	**(A → s); (B → r); (C → r); (D → s)**
1.	**1**	**4**	**3**
2.	**2**	**2**	**4**
3.	**1**	**5**	**1**
4.	**4**	**3**	**7**
5.	**5**	**1**	**1**
6.	**3**	**1**	**1**

Physics

PART – I

Hints & Solution

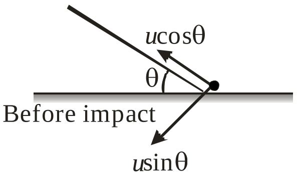
SECTION – A

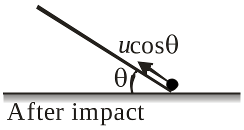
1. $V_P \cos\alpha = u\cos\theta$

$$t = \frac{u\sin\theta - V_P\sin\alpha}{g} = u\sin\theta - \frac{u\cos\theta\sin\alpha}{\cos\alpha}$$

$$= \frac{u\sin(\theta-\alpha)}{g\cos\alpha}$$

2. Just before the particle moves to inclined surface, we resolve its velocity along and normal to the plane.





For the trajectory of the particle to sharply change from the horizontal line to the inclined line, the impact of the particle with inclined plane should reduce the u sin θ component of velocity to zero. Hence the particle moves up the incline with speed u cos θ.
Hence as θ increases, the height to which the particle rises shall decrease.

3. By balancing force along horizontal and vertical direction

$\mu N_1 \sin\theta + \mu N_2 \sin\theta = (N_1 - N_2)\cos\theta$ … (1)

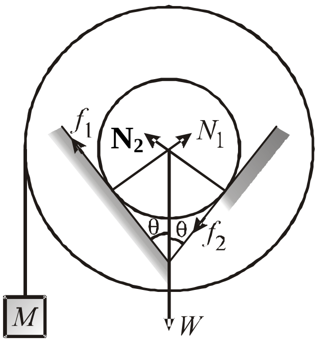
$(N_1 - N_2)\mu\cos\theta + (N_1 + N_2)\sin\theta = W + mg$ … (2)

Balancing torque about centre

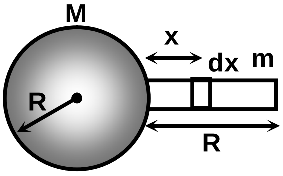
$(N_1 + N_2)\mu a = b\,mg$ … (3)

By solving (1), (2) and (3)

$$M = \frac{a\mu W}{(b(1+\mu^2)\sin\theta - \mu a)g}$$



4. $$F = \int_R^{2R} \frac{GM\left(\frac{m}{R}\right)dx}{x^2} = \frac{GMm}{2R^2}$$



5. $a_A = g\sin 37°$

Spring is at its natural length

Hence $a_B = g\sin 37° = 6\ \text{m/s}^2$

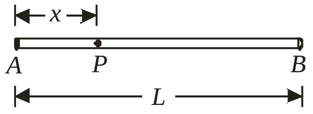
6. Total mass melted is 10 gm

Total heat in 100 sec 10 × 80

Heat given to ice/sec $= \frac{800}{100} = 8$ Cal/sec.

Rate of Rise of temp = $(10)(1)\frac{\Delta T}{\text{sec.}} = 8$, $\frac{\Delta T}{\text{sec.}} = .8$°C/sec.

7. The KE of given section AP and PB will be equal if MI of each section AP and section PB about A is same.

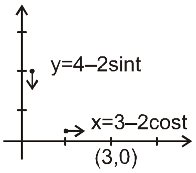


$I_{AP} = (\lambda x)\frac{x^2}{3}$ $I_{PB} = I_{AB} - I_{AP} = (\lambda x)\frac{L^2}{3} - (\lambda x)\frac{x^2}{3}$

$\lambda I_{AP} = I_{PB}$ $\lambda\frac{\lambda x^3}{3} = \frac{\lambda L^3}{3} - \frac{\lambda x^3}{3}$

or $x^3 = \frac{L^3}{2}$ or $x = \frac{L}{2^{1/3}}$

8. If S is the distance between them at any time :



$\Rightarrow$ $S^2 = (4 - 2\sin t)^2 + (3 - 2\cos t)^2$

$= 29 - (16\sin t + 12\cos t)$ .... (1)

S will be 3 cm only when

$\Rightarrow$ $16\sin t + 12\cos t = 20$

$\Rightarrow$ $4\sin t + 3\cos t = 5$

$\Rightarrow$ $\frac{4}{5}\sin t + \frac{3}{5}\cos t = 1 \Rightarrow \sin(t + 37°) = 1$

Now the only solution is t=53° so only once in a time period, it will be 3 cm.

(B) By equation (1), S varies between 3 cm and 7 cm.

(C) Maximum magnitude of force is $\omega^2 A$.

(D) Kinetic energy is not conserved.

9. % Rise in area will be 0.4%

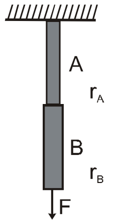
% Rise in vol will be 0.6%

$$\left[1 + \frac{0.2}{100}\right]D = [1 + \alpha \times 80]\,D$$

$$\alpha = \frac{0.002}{80} = \frac{1}{400} = 0.25 \times 10^{-4}\,°C^{-1}$$

10. Slope of displacement time graph is velocity and rate of change of velocity is acceleration.

11. That wire will break first whose stress reaches the breaking stress (for that material) first.



Stress = $\frac{F}{A} = \frac{F}{\pi r^2}$ where F is the tension in the wire. F is same in both the wires.

Thus stress $\propto \frac{1}{r^2}$ for the wire of smaller radius, the stress is more.

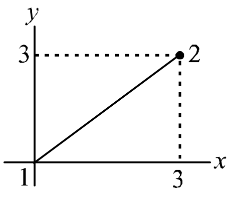
Thus the wire with smaller radius will break first.

If $r_A < r_B$, then wire A will break first.

If $r_A > r_B$, then wire B will break first.

If $r_A = r_B$, either of them could break.

12. $\vec{dl} = dx\,\hat{i} + dy\,\hat{j}$



$\vec{F}\cdot\vec{dl} = \alpha xy^2 dy$

on the path, $x = y$ so $\vec{F}\cdot\vec{dl} = \alpha y^3 dy$

$$W = \left(\frac{\alpha}{4}\right)\left|y^4\right|_{y_1}^{y_2} = \left(\frac{\alpha}{4}\right)\left(y_2^4 - y_1^4\right)$$

$y_1 = 0$; $y_2 = 3.00$ m

So $W = \frac{1}{4}(2.50)(3)^4 = 50.6\,\text{J}$

(14-16). $Kx_0 + A\frac{L}{2}\rho g + Mg - 2Mg = 0$

$$K(x_0 + x) + A\left(\frac{L}{2} + x\right)\rho g + Mg - 2Mg = 3Ma$$

$$\omega^2 = \frac{g}{\text{amplitude}}$$

SECTION – C

2. $Mg - T = Ma$

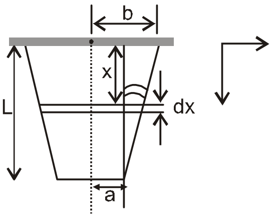
$T - mg = ma$

$$T = \frac{2Mmg}{(M+m)}$$

$$\Rightarrow \frac{T}{A} = \frac{2Mmg}{A(M+m)} = \frac{2mg}{A\left(1+\frac{m}{M}\right)} = 2\times10^9$$

$\Rightarrow$ M = 2

3. $Y = \frac{F/A}{dy/dx}, r = b - \left(\frac{b-a}{L}\right)x$



$r = b - \tan\theta x$, $A = \pi(b - x\tan\theta)^2$

$$\int_0^{\Delta L} dy = \frac{F}{\pi Y}\int_0^L \frac{dx}{(b - x\tan\theta)^2}$$

$\Delta L = 10^{-3}\text{m} = 1\text{mm}$

4. $|\varepsilon| = |\vec{v}\cdot(\vec{B}\times\vec{\ell})|$

$$= (2\hat{i})\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 0 & 1 & -2\\ 0 & 3/5 & 4/5\end{vmatrix} = 4$$

5. In fluid frame ball is moving with constant velocity (terminal) and resultant of all forces acting on it zero.

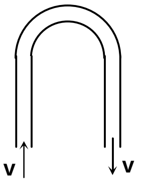
(A) Buoyant force

(B) viscous force

(C) mg

$$v_t = \frac{2}{9}\frac{(\rho-\rho_0)gr^2}{\eta} = \frac{2}{9}\times\frac{900\times10}{0.1}\times25\times10^{-4} = 50\text{ m/s}$$

6. $2\rho Av^2 = 2F$



$$\sigma = \frac{F}{3\pi r^2} = \frac{\rho A}{3\pi}$$

$$\sigma = \frac{\rho v^2}{3}$$

v = 30 m/s

Chemistry

PART – II

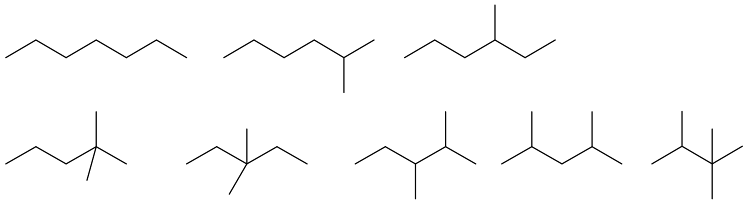
SECTION – A

2. Strength of H – bond: 2 – 10 kcal or (8 – 42 kJ)

3. It may be possible that few particles of gas A have higher velocities than that of few particles of gas B.

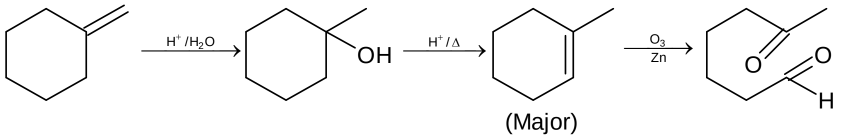
4. 96 ppm of SO_4^{2-} = 100 ppm of $CaCO_3$ so 384 ppm of SO_4^{2-} = 400 ppm of $CaCO_3$

5.



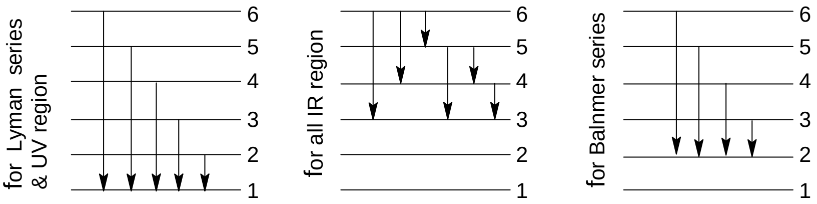
6. LiF is insoluble in water but not because of its covalent character rather its high lattice energy which is not easily compensated by its hydration energy.

7.



(Major)

8. **Total lines**



9. All are extension of PV = nRT, $n = \frac{w}{M}$ & $d = \frac{w}{V}$

10. (B) and (C) are amphoteric.

12. The carbocation formed will be 3°, hence will be more stable.

13. Compound (D) will form most stable carbocation on protonation.

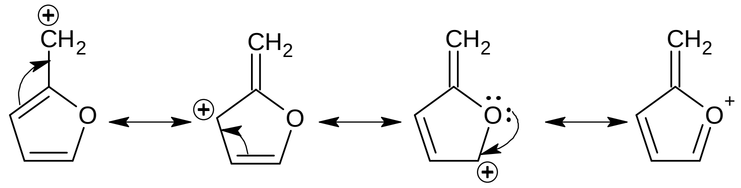
14. All other molecules are symmetrical.

15. It contains only one lone pair so no chances of lp – lp repulsion.
In CO_2 & CH_4 there are no lone pairs and in XeF_2 two lone pair are there so lp – lp repulsion is also present.

16. Shape of I_3^- is linear despite of the presence of 3 lone pairs.

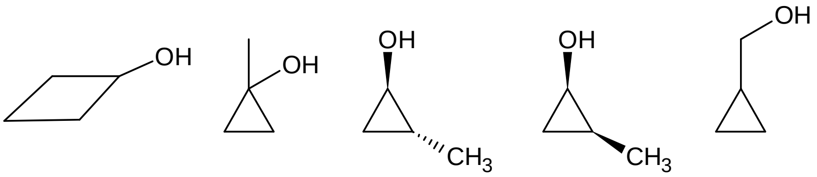
SECTION – C

1.



2. In $Cu_2S(-2)$, In $FeS_2(-1)$, In $Na_2S_2O_3(+2)$
In $Na_2S_2O_4(+3)$

3.



4.
$$A^{n+} \longrightarrow AO_3^-$$
$x = +n \qquad x - 6 = -1 \quad \therefore x = 5$

∴ number of electron releases in oxidation = (5 – n)
∴ equivalent of $A^{n+} = 2 \times (5 - n)$
∴ equivalent of $M_nO_4^- = 0.8 \times 5$
$2 \times (5 - n) = 0.8 \times 5$
n = 3

5.
$$\begin{array}{lccccc} & A & + & 2B & \rightleftharpoons & 2C & + & D \\ & 2 & & 4 & & 0 & & 0 \\ \text{at eq.} & 2-x & & 4-2x & & 2x & & x \end{array}$$
$2x = 2$ so $x = 1$
$$K_{eq} = \frac{(2x)^2 \times x}{(2-x)(4-2x)^2} = \frac{4}{4} = 1$$

6. Either 7 → 1 or 6 → 1 or 5 → 1 or 4 → 1 or 3 → 1 or 2 → 1
Only one transition can be obtained at a time as only single atom is given.

Mathematics PART – III

SECTION – A

1. It represent 3 different non concurrent lines hence can represent a triangle

2. $\because$ $p < 0$ let $p = -q$, $q > 0$, so $p^{1/3} = -q^{1/3}(1)^{1/3}$
$\therefore$ $\alpha = -q^{1/3}$
$\beta = -q^{1/3}w$
$\gamma = -q^{1/3}w$
so given expression is $\frac{x + yw + zw^2}{xw + yw^2 + z} = \frac{1}{w} = w^2$

3. Let a, 3 be two number the
$A_1 + A_2 = a + b$
$G_1G_2 = \left(\sqrt{ab}\right)^2$
$\frac{1}{H_1} + \frac{1}{H_2} = \frac{1}{a} + \frac{1}{b} \Rightarrow \frac{H_1H_2}{H_1 + H_2} = \frac{G_1G_2}{A_1 + A_2}$

4. Mid point of the chord intercepted by hyperbola is same as mid point of the chord intercepted between asymptotes.
$\Rightarrow \frac{h+1}{2} = \frac{-2+4}{2}, \frac{k-2}{2} = \frac{-6+2}{2}$
$\Rightarrow (h, k) \equiv (1, -2)$.
$\Rightarrow$ line intersect asymptote at one point only hence it is the centre of hyperbola.

5. Let y = sin3A + sin3B + sin3C for sin3A to be non positive
we have $2\pi < 3A < 3\pi \Rightarrow \frac{2\pi}{3} < A < \pi$
since A + B + C = $\pi \Rightarrow$ all of sin3A, sin3B, sin3C can't be negative.
Let us take sin3A = – 1 $\Rightarrow A = \frac{\pi}{2} \Rightarrow$ sin3A = – 1, sin3B = – 1 and sin3C = 0 is possible
$\Rightarrow$ the minimum value is – 2.

6. Sum of 7 digits = a multiple of 9
Sum of number 1, 2, 3, 4, 5, 6, 7, 8, 9 = 45 so two left should also have sum of 9.
The pair of left numbers is (1, 8), (2, 7), (3, 6), (4, 5).
with each pair left number of 7 digit number = 7!
So with all 4 pairs = 4 × 7! .

7. If p is a prime such that $100 > p > \frac{200}{3}$, then p and 2p but not 3p belong to [1, 2, …, 200].
While just p belongs to (1, 2, …, 100), so p does not divide ${}^{200}C_{100}$ but consider 61 the largest prime < $\frac{200}{3}$
61^3 divides 200! but only 61 divides 100!.
Hence 61 divides ${}^{200}C_{100}$.

8. In the expansion of $(a\alpha^2x^2 + 2b\alpha x + c)^n$
the sum of the coefficients = $(a\alpha^2 + 2b\alpha + c)^n$
Let $f(\alpha) = a\alpha^2 + 2b\alpha + c$
Its discriminant $= 4b^2 - 4ac = 4(b^2 - ac) < 0$
Hence, $f(\alpha) < 0$ or $f(\alpha) > 0$ for all $\alpha \in R$
If $a > 0$ then $f(\alpha) > 0 \Rightarrow (a\alpha^2 + 2b\alpha + c)^n > 0$
If $c > 0$ i.e. $f(0) > 0 \Rightarrow f(\alpha) > 0 \Rightarrow (a\alpha^2 + 2b\alpha + c)^n > 0$
If $a < 0$ then $f(\alpha) < 0 \Rightarrow (a\alpha^2 + 2b\alpha + c)^n < 0$ if n is odd
If $c < 0$ i.e. $f(0) < 0 \Rightarrow f(\alpha) < 0 \Rightarrow (a\alpha^2 + 2b\alpha + c)^n > 0$ if n is even.

9. Roots of $x^2 + x + 1 = 0$ are complex cube roots of unity,
so $h(w) = h(w^2) = 0$
$\Rightarrow w\,f(1) + w^2\,g(1) = 0$ and $w^2\,f(1) + wg(1) = 0$
$\Rightarrow f(1) = g(1) = 0$.

10. $\frac{a+b+c}{3} > b\ (\text{H.M})$
$\Rightarrow a + c > 2b$
Also $\frac{a^2+c^2}{2} > \sqrt{a^2c^2} \Rightarrow a^2 + c^2 > 2ac > 2b^2$ (G.M. > H.M)
$\Rightarrow a^2 + c^2 > 2b^2$.

11. $\sqrt{y+\frac{1}{y}} \geq \sqrt{2}$ and $|\sin x + \cos x| \leq \sqrt{2}$.

Hence $y + \frac{1}{y} = 2$ and $\sin x + \cos x = \sqrt{2}$, which is possible for $y = 1$, $x = \pi/4$.

12. Solving it, we get $\sin(\alpha + \beta) = \sin\alpha \pm \sqrt{-\cos^2\beta} \Rightarrow \cos\beta = 0 \Rightarrow \beta = \frac{\pi}{2}, \frac{3\pi}{2}$

(i) $\beta = \frac{\pi}{2} \Rightarrow \tan\alpha = 1, \alpha \in \left\{\frac{\pi}{4}, \frac{5\pi}{4}\right\}$.

(ii) $\beta = \frac{3\pi}{2} \Rightarrow \tan\alpha = -1, \alpha \in \left\{\frac{3\pi}{4}, \frac{7\pi}{4}\right\}$.

13. Let $\cos A + \cos B + k\cos C = y$
$\Rightarrow 2k\sin^2\frac{C}{2} - 2\cos\left(\frac{A-B}{2}\right)\sin\frac{C}{2} + y - k = 0$. As $D \geq 0$
$\Rightarrow k(y - k) \leq \frac{1}{2}\cos^2\left(\frac{A-B}{2}\right) \leq \frac{1}{2} \Rightarrow y \leq \frac{1}{2k} + k$.

14–16. Let the roots of $z^3 + az^2 + bz + c = 0$ be α, β, γ, then
$|c| = |\alpha\beta\gamma| = 1$ and $|\alpha\beta + \beta\gamma + \gamma\alpha| = \left|\frac{1}{\alpha} + \frac{1}{\beta} + \frac{1}{\gamma}\right|$
$= |\alpha + \beta + \gamma| = |a|$
$\Rightarrow |a| = |b|$ and $|c| = 1$
also, $|a| = |\alpha + \beta + \gamma| \leq 3$
put $|a| = 2k + 1$, where $-\frac{1}{2} \leq k \leq 1$
thus $z^3 + |a|z^2 + |b|z + |c| = z^3 + (2k + 1)z^2 + (2k + 1)z + 1$

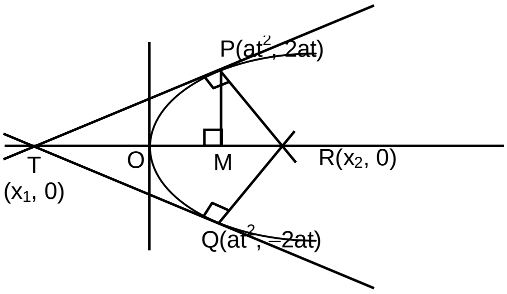
$= (z + 1)(z^2 + 2kz + 1)$.

It has roots – 1 and $-k \pm \sqrt{k^2 - 1}$ since $k^2 \le 1$, we have $\sqrt{k^2-1} = i\sqrt{1-k^2}$ so $\left|-k \pm \sqrt{k^2-1}\right|^2 = k^2 + 1 - k^2 = 1$.

so, all the roots have modulus 1.

SECTION – B

1 (A). $y^2 = 4x$



Clearly, if P $(at^2, 2at)$ then by symmetry,
Q $(at^2, -2at)$
Equation of tangent is
$ty = x + at^2$
for t, y = 0, $x_1 = -at^2$
and equation of normal is
$y = -tx + 2at + at^3$
for R, y = 0, $x_2 = (2a + at^2)$
Here, $a = 1 \Rightarrow x_1 = -t^2$ and $x_2\ (2 + t^2)$
$x_2 = 3 = 2 + t^2 \Rightarrow t^2 = 1 \Rightarrow t = \pm 1$
Take t = 1, then $x_1 = -1$, $\therefore$ PM = 2at = $2 \times 1 \times 1 = 2$
RT = $x_1 + x_2 = (1 + 3) = 4$
$\therefore$ Area of quadrilateral PTQR = $2 \times \left(\frac{1}{2} \times 4 \times 2\right)$ = 8 sq. units.

(B) Length of latus rectum + tangent PT = $4a + \sqrt{S_1}$
$= 4 \times 1 + \sqrt{0^2 - 4(-1)} = 4 + 2 = 6$ units.

(C) Clearly, RT will be the diameter of circle
$\therefore$ Circumference = $(\pi \times \text{diameter})$
$= \pi \times RT = \frac{\pi \times 4}{4\pi} = 1$.

(D) Since in the part (1), we have found $x_2\ (2a + at^2) > 2a$, (if $t \neq 0$)
$\therefore$ For three real normals, $x_2 > 2a = 2 \times 1 = 2$
i.e. $x_2 > 2$.

2. (A) $s_p = \frac{p}{2}\left[2A + (p-1)d\right] = a$

$$\frac{2a}{p} = 2A + (p-1)d \qquad \dots (1)$$

$$\frac{2b}{q} = 2A + (q-1)d \qquad \dots (2)$$

$$\frac{2c}{r} = 2A + (r-1)d \qquad \dots (3)$$

Multiply (1), (2) and (3) by (q – r), (r – p) and (p – q) and add

$\therefore \sum \frac{a}{p}(q - r) = 0$.

(B) Let common ratio be taken as k and a be the first term
$R = T_r = ak^{r-1}$
$R^{s-t} = a^{s-t}\, k^{(r-1)(s-t)}$
Similarly, $s^{t-r} = a^{t-r}\, k^{(s-1)(t-r)}$
$T^{r-x} = a^{r-s}\, k^{(t-1)(r-s)}$.
Multiplying the above three and knowing that
$A^mA^nA^p = A^{m+n+p}$
$R^{s-t}\, S^{t-r}\, T^{r-s} = a^0k^0 = 1$.

(C) $x = a + (m-1)d = AR^{m-1}$
$y = a + (n-1)d = AR^{n-1}$
$z = a + (p+1)d = AR^{p-1}$
$y - z = (n-p)d$, $z - x = (p-m)d$, $x - y = (m-n)d$
$x^{y-z} \cdot y^{z-x} \cdot z^{x-y} = \left(AR^{m-1}\right)^{(n-p)d} \cdot \left(AR^{n-1}\right)^{(p-m)d} \cdot \left(AR^{p-1}\right)^{(m-n)d}$
$= A^0R^0 = 1$.

(D) $a = AR^{p-1}$, $b = AR^{q-1}$, $c = AR^{r-1}$ for G.P.
$a = \dfrac{1}{A_1 + (p-1)D}$, $b = \dfrac{1}{A_1 + (q-1)D}$, $c = \dfrac{1}{A_1 + (r-1)D}$ for H.P.
$\dfrac{1}{b} - \dfrac{1}{c} = (q-r)D$ … (1)
$\log a = \log A + (p-1)\log R$
$= (\log A - \log R) + (\log R)$ … (2)
$\sum\left(\dfrac{1}{b} - \dfrac{1}{c}\right)\log a = D(\log A - \log R)\sum(q-r) + D\log R\sum p(q-r) = 0$
$\therefore \sum\dfrac{c-b}{bc}\log a = 0$
multiplying by – abc
$\sum a(b-c)\log a = 0$.

SECTION – C

1. Let a – d, d, a + d be roots then
$$\left.\begin{array}{r} a - d + d + a + d = 12 \\ (a-b)d(a+d) = 28 \end{array}\right\}\text{ solve } \begin{array}{l} a = 4 \\ d = \pm 3 \end{array}$$
$\therefore$ $|d| = 3$

2. Let root of $x^2 - 3x + c = 0$ be α, β and that of $x^2 - cx + b = 0$ is α', β'
$\alpha - \beta = \sqrt{(\alpha+\beta)^2 - 4\alpha\beta} = \sqrt{b^2 - 4c}$ r
$\alpha' - \beta' = \sqrt{c^2 - 4b}$ so $\alpha - \beta = \alpha' - \beta'$ gives $(b + c)(b - c) = 4(c - b)$
$\therefore -(b + c) = 4$.

3. We know that $\dfrac{c_1}{c_0} + 2\dfrac{c_2}{c_1} + \ldots + n\dfrac{c_n}{c_m} = \dfrac{n(n+1)}{2}$.

6. For sum of coefficients put x = 1 and so we get $(\alpha - 1)^{35} = (1 - \alpha)^{35} \Rightarrow \alpha = 1$.

FIITJEE Students From All Programs have bagged 33 in Top 100, 77 in Top 200 and 205 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2015:
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ALL INDIA INTEGRATED TEST SERIES

HALF COURSE TEST – VII

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 30)** contains 30 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10$ m/s^2
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N-m^2
Density of water	$\rho_{water} = 10^3$ kg/m^3
Atmospheric pressure	$P_a = 10^5$ N/m^2
Gas constant	$R = 8.314$ J K^{-1} mol^{-1}

CHEMISTRY

Gas Constant	R	=	8.314 J K^{-1} mol^{-1}
		=	0.0821 Lit atm K^{-1} mol^{-1}
		=	1.987 ≈ 2 Cal K^{-1} mol^{-1}
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

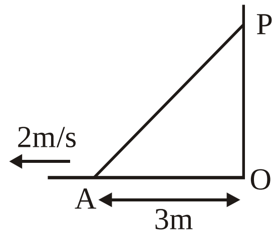
PART – I

SECTION – A

(Single Correct Choice Type)

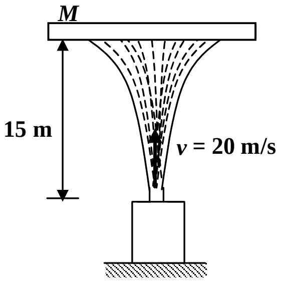
This section contains ***30 multiple choice questions***. Each question has four choice (A), (B), (C) and (D) out of which ***ONLY ONE*** is correct.

1. The end A of a ladder AP of length 5 m, kept inclined to a vertical wall is slipping over a horizontal surface with velocity of 2 m/s, when A is at a distance of 3m from the wall. Velocity of centre of mass at this moment is



(A) 1.25 m/s (B) 0 m/s
(C) 1 m/s (D) 2 m/s

2. A vertical jet of water coming out of a nozzle with velocity 20 m/s supports a plate of mass *M* stationary at a height *h* = 15m, as shown in the figure. If the rate of water flow is 1 litre per second, the mass of the plate is (Assume the collision to be *inelastic*).

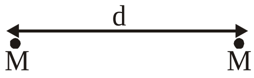


(A) 1 kg (B) 1.414 kg
(C) 2 kg (D) 10 kg

3. The binding energy of a particle of mass m with a planet, when it is on the planets surface, is $\frac{1}{2}mv_0^2$. A tunnel is dug along a diameter of the planet and the particle is dropped into it from the surface, when the body reaches the centre of the planet, its speed is

(A) v_0 (B) $\frac{v_0}{\sqrt{2}}$
(C) Zero (D) $\frac{v_0}{2}$

Space for rough work



4. Consider the two identical particles shown in the given figure. They are released from rest and can move towards each other under the influence of their mutual gravitation forces. Speed of each particle, when the separation reduces to half of initial value equals

(A) $\sqrt{\frac{GM}{d}}$ (B) $\sqrt{\frac{2GM}{d}}$

(C) $\sqrt{\frac{GM}{2d}}$ (D) none of these

5. A gas of adiabatic exponent γ is supplied heat at a constant pressure. What is the ratio between dQ, dW and dU in the process

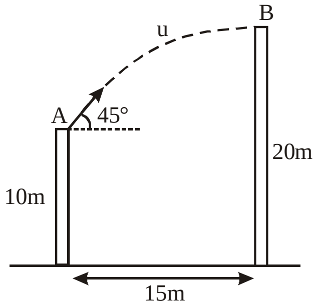
(A) $\gamma : \gamma - 1 : \frac{1}{\gamma}$ (B) $1 : 1 : \gamma - 1$

(C) $\gamma : \gamma - 1 : 1$ (D) $\gamma : 1 : \gamma - 1$

6. Find the value of 'u' so that the ball reaches at point B.
(Take $g = 10\ m/s^2$)

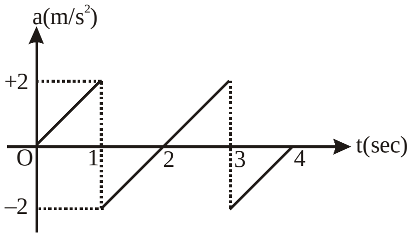
(A) 20 m/s (B) 40 m/s

(C) $15\sqrt{2}$ m/s (D) 50 m/s



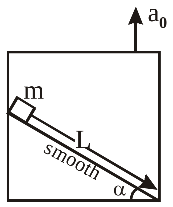
7. Acceleration vs time graph is shown in the figure for a particle moving along a straight line. The particle is initially at rest. Find the time instant(s) when the particle comes to rest ?

(A) t = 0, 1, 2, 3, 4
(B) t = 0, 2, 4
(C) t = 1, 3
(D) None of these



Space for rough work

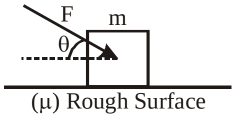
8. A body of mass 'm' is released from rest on an inclined plane in an elevator (moving up with acceleration a_0). Find the time taken by the body to reach the bottom of the inclined plane.



(A) $\sqrt{\dfrac{L}{(a_0+g)\sin\alpha}}$ (B) $\sqrt{\dfrac{2L}{(a_0+g)\sin\alpha}}$

(C) $\sqrt{\dfrac{3L}{(a_0+g)\sin\alpha}}$ (D) $2\sqrt{\dfrac{L}{(a_0+g)\sin\alpha}}$

9. Find minimum value of the angle θ so that block of mass m does not move on rough surface. The coefficient of static friction between the block and surface is μ whatever may be the value of applied force F.



(A) $\tan^{-1}(\mu)$ (B) $\frac{1}{2}\tan^{-1}(\mu)$

(C) $\cot^{-1}(\mu)$ (D) $\frac{1}{2}\cot^{-1}(\mu)$

10. A steel ring of radius r and cross-sectional area A is fitted on to a wooden disc of radius R(R > r). If Young's modulus be Y, then the force with which the steel ring is expanded is :

(A) $AY\dfrac{R}{r}$ (B) $AY\left(\dfrac{R-r}{r}\right)$

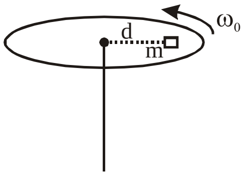
(C) $\dfrac{Y}{A}\left(\dfrac{R-r}{r}\right)$ (D) $\dfrac{Yr}{AR}$

11. A rod of length 40 cm has the coefficient of linear expansion $\alpha_1 = 6 \times 10^{-6}/^{o}C$. Another rod of length l has the coefficient of linear expansion $\alpha_2 = 4 \times 10^{-6}/^{o}C$. If the difference in the lengths of the two rods always remain same at all temperatures, then the value of l is

(A) 26 cm (B) 60 cm

(C) 80 cm (D) 32 cm

12. A small block of mass 'm' is placed on a rough rotating table. Find maximum angular velocity (ω_0) that can be given to the table so that the particle does not slip on the table. It is given that the coefficient of friction between the block and the table is (μ).

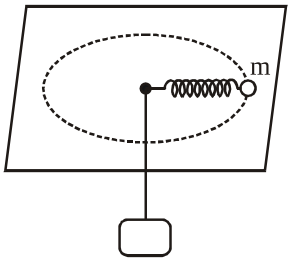


(A) $\sqrt{\dfrac{2\mu g}{d}}$ (B) $\sqrt{\dfrac{3\mu g}{d}}$

(C) $\sqrt{\dfrac{\mu g}{d}}$ (D) $2\sqrt{\dfrac{\mu g}{d}}$

13. A body executes simple harmonic motion. The potential energy (PE), kinetic energy (KE) and total energy (TE) are measured as a function of displacement x. Which of the following statements is true?
(A) TE is zero when $x = 0$
(B) PE is maximum when $x = 0$
(C) KE is maximum when $x = 0$
(D) KE is maximum when x is maximum

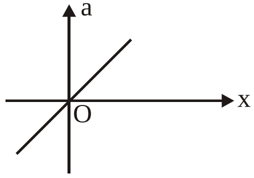
14. A mass m on a frictionless table is attached to a hanging mass by a spring (of spring constant K and natural length ℓ_0) and a cord through a hole in the table. If the hanging mass remains stationary and the mass m moves on a circular path with angular velocity ω the radius of its circular path is

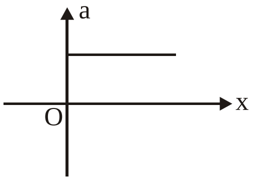


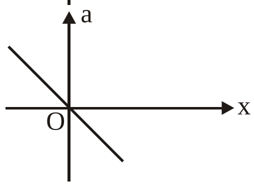
(A) ℓ_0
(B) $\frac{m\omega^2\ell_0}{K - m\omega^2}$
(C) $\frac{K\ell_0}{(K - m\omega^2)}$
(D) $\frac{K\ell_0}{K + m\omega^2}$

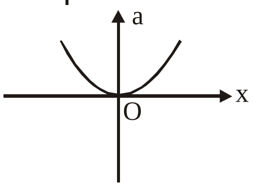
15. A progressive wave is travelling in a medium such that frequency of oscillation and displacement amplitude of the particles of the medium are f and A respectively. The ratio of their acceleration amplitude and velocity amplitude is
(A) $2\pi f$
(B) πf
(C) $\frac{2\pi f}{A}$
(D) $\frac{\pi f}{A}$.

16. For a particle executing simple harmonic motion, the correct variation of acceleration a with displacement x is given by

(A)


(B)


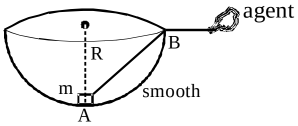
(C)


(D)


Space for rough work

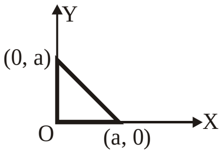
17. An open organ pipe of length 'L' vibrates in second harmonic mode. The pressure variation is maximum, (neglect end corrections)
(A) at the two ends
(B) at a distance $\frac{L}{4}$ from either end inside the tube
(C) at the mid–point of the tube
(D) none of these.

18. The minimum work done by the agent, in pulling a small particle of mass m from A to B as shown in figure, is



(A) 4 mgR
(B) mgR
(C) 3mgR
(D) 2mgR

19. Three rods of the same mass are placed as shown in the figure. What will be the co-ordinates of the center of mass of the system?



(A) (a/2, a/2)
(B) $\left(\frac{a}{\sqrt{2}}, \frac{a}{\sqrt{2}}\right)$
(C) $\left(\frac{\sqrt{2}a}{3}, \frac{\sqrt{2}a}{3}\right)$
(D) $\left(\frac{a}{3}, \frac{a}{3}\right)$

20. The density ρ of a liquid varies with depth h from the free surface as $\rho = kh$. A small body of density ρ_1 is released from the surface of liquid. The body will
(A) come to a momentary rest at a depth $\frac{2\rho_1}{k}$ from the free surface
(B) execute simple harmonic motion about a point at a depth $\frac{\rho_1}{k}$ from the surface
(C) execute simple harmonic motion of amplitude $\frac{\rho_1}{k}$
(D) all of the above

Space for rough work

21. At the center of a non-uniform ring of radius R, made up of two uniform halves of mass 2M and M (G : Newton's gravitational constant)
(A) field and potential both are zero
(B) field is zero but potential is $\frac{-3GM}{R}$
(C) field is zero but potential is $\frac{-GM}{R}$
(D) magnitude of field is $\frac{2GM}{\pi R^2}$ and potential is $-\frac{3GM}{R}$

22. For a satellite of mass m orbiting the earth very close to earth's surface (mass of earth = M, radius of earth = R) total energy is
(A) zero
(B) greater than zero
(C) $\frac{GMm}{R}$
(D) $-\frac{GMm}{2R}$

23. An ideal gas has initial volume V and pressure P. In doubling its volume the minimum work done will be in the following process (of given processes)
(A) Isobaric process
(B) Isothermal process
(C) Adiabatic process
(D) None of the above

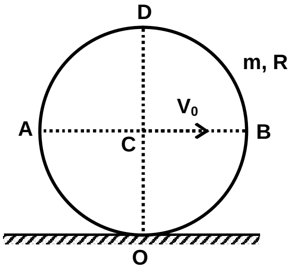
24. A particle moving in the positive x-direction has initial velocity v_0. The particle undergoes retardation kv^2, where v is its instantaneous velocity. The velocity of the particle as a function of time is given by
(A) $v = v_0/(1 + kv_0t)$
(B) $v = \frac{2v_0}{1+kt}$
(C) $v = \frac{v_0}{kt}$
(D) $v = \frac{v_0}{(1+k^2v_0^2t)}$

25. Velocity of a particle at any instant is given by the equation $\vec{v} = \left(2t\hat{i} + 3t^2\hat{j}\right)$ m/s and radius of the curvature of the path is 2m. Centripetal acceleration of the particle at t = 2 s is
(A) 80 m/s^2
(B) 160 m/s^2
(C) 40 m/s^2
(D) 100 m/s^2

Space for rough work

26. The elongation of a freely hanging uniform steel rope, if its length is doubled, will increase in the ratio of
(A) 2 : 1 (B) 4 : 1
(C) 8 : 1 (D) 16 : 1

27. A uniform ring of mass m and radius R is doing uniform pure rolling motion on a horizontal surface. The velocity of the centre of the ring is V_0. The kinetic energy of the segment AOB is



(A) $\frac{mV_0^2}{2} - \frac{mV_0^2}{\pi}$ (B) $\frac{mV_0^2}{2} + \frac{mV_0^2}{\pi}$
(C) $\frac{mV_0^2}{2}$ (D) mV_0^2.

28. A rope of mass 'm' is looped in a circle of radius R and rotated with a constant angular velocity ω_0 about its axis in gravity free space. Find the tension in the rope ?
(A) $T = mR\omega_0^2$ (B) $2\ m\ R\ \pi\omega^2$
(C) $T = \frac{mR\omega_0^2}{2\pi}$ (D) $4mR\pi\omega_0^2$

29. The displacement function of a oscillating body is given by x = 0.3 $\sin\left(10\pi t + \frac{\pi}{6}\right)$ where x and t are measured in meter and second respectively
(A) the period of oscillation is 5 s
(B) the body starts its motion from the equilibrium
(C) the minimum time the body takes to reach the equilibrium is 1/12 sec
(D) all of these

30. A simple pendulum is attached to the roof of a stationary elevator. If the time period of oscillation is T when it is stationary, what will be time period of oscillation when the elevator falls freely
(A) 0 (B) T/2
(C) 2T (D) none of these

Space for rough work

Chemistry PART – II

SECTION – A

(Single Correct Choice Type)

This section contains ***30 multiple choice questions***. Each question has four choice (A), (B), (C) and (D) out of which ***ONLY ONE*** is correct.

1. Which of the following is correct about the reaction?

$3NaClO \xrightarrow{\Delta} NaClO_3 + 2NaCl$

(A) It is disproportionation reaction
(B) Oxidation number of chlorine decreases as well as increases in this reaction
(C) This reaction is used for the manufacturing of halates
(D) All the above

2. $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$

For the above equilibrium, which is correct?
(A) Equilibrium will shift in forward direction by addition He at constant volume
(B) Equilibrium will shift in forward direction by addition of He at constant pressure
(C) Equilibrium with shift in backward direction by addition of He at constant volume
(D) Equilibrium will shift in backward by addition of He at constant pressure

3. In the reaction A_2 (g) + $4B_2$ (g) $\rightleftharpoons$ $2AB_4$ (g), $\Delta H < 0$. The decomposition of AB_4 (g) will be not favored at
(i) Low temperature and high pressure
(ii) High temperature and low pressure
(iii) Addition of inert gas at constant pressure
(iv) Addition of inert gas at constant volume
(v) Using catalyst
(vi) Compressing reaction mixture by mass less and friction less piston
(A) (ii), (iii) (B) (i), (iv), (v), (vi)
(C) (i), (ii), (iii), (iv) (D) (ii), (iii), (iv), (v), (vi)

4. Diborane reacts with ammonia under different condition to give a variety of products. Which one of among the following is not formed in these conditions?
(A) $B_2H_6.2NH_3$ (B) $B_{12}H_{12}$
(C) $B_3N_3H_6$ (D) $(BN)_3$

Space for rough work

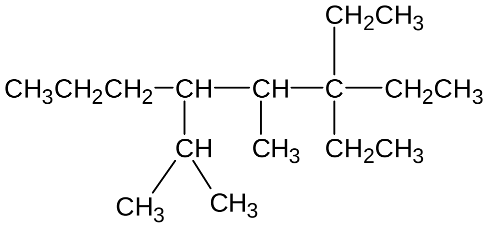
5.
$$\begin{tikzcd} B \arrow[r, "Z"] & X \arrow[r, "LiH"] & Y + LiBH_4 \arrow[ll, bend right, "Heat"'] \end{tikzcd}$$

Which of the statement is true for the above sequence of reactions?

(A) Z is hydrogen
(B) X is B_2H_6
(C) A and Y are F_2 and B_2H_6 respectively
(D) Z is potassium hydroxide

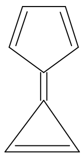
6. Find the value of wave number $\bar{\nu}$ in turns of Rydberg's constant, when transition of electron takes place between two level of He^+ ion whose sum is 4 and difference is 2.

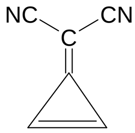
(A) 8R/9
(B) 32R/9
(C) 3R/4
(D) none

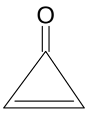
7. The IUPAC name of the compund 
$CH_3CH_2CH_2-CH(CH(CH_3)_2)-CH(CH_3)-C(CH_2CH_3)_2-CH_2CH_3$

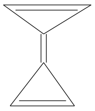
(A) 3, 3 –diethyl-4-methyl-5-isopropyloctane
(B) 3, 3 –diethyl-5-methyl-5-isopropyloctane
(C) 4-isopropyl-5-metheyl-6, 6-diethyloctane
(D) 6, 6-diethyl-4-isopropyl-5-metheyloctane

8. Which of the following is non - aromatic?

(A) 

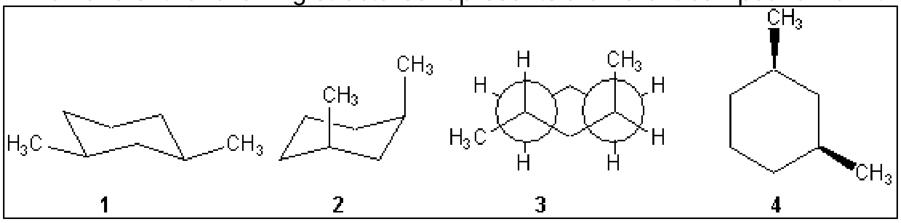
(B) 

(C) 

(D) 

Space for rough work

9. Which one of the following structures represents a different compound from the other three?



(A) 1 (B) 2
(C) 4 (D) 3

10. About the compound 3, 3–diethyl-4-methyl-5-isopropyloctane which of the following statement is/are not true
(A) It has three 3^0 carbon (B) It has one 4^0 carbon
(C It has six 1^0 carbon (D) It has ten 2^0 hydrogen

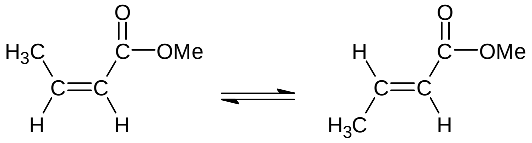
11. When a substance A reacts with water it produces a combustible gas B and a solution of a substance C in water. When another substance D reacts with this solution of C, it also produces the same gas B even on reaction with dilute sulphuric acid at room temperature. A imparts a deep golden yellow colour to a smokeless flame of Bunsen burner. A, B, C and D respectively are
(A) Na, H_2, NaOH and Zn (B) K, H_2, KOH and Al
(C) Ca, H_2, $Ca(OH)_2$ and Sn (D) CaC_2, C_2H_2, $Ca(OH)_2$ and Fe

12. Which of the following statements is incorrect?
(A) The hydrolysis of $(CH_3)_3SiCl$ gives a disiloxane.
(B) The hydrolysis of $(CH_3)_2SiCl_2$ gives a chain compound.
(C) The hydrolysis of CH_3SiCl_3 gives a cross-linked polymer.
(D) The hydrolysis of $(CH_3)_2SiCl_2$ gives $(CH_3)_2SiO_2$.

13. A compound X on heating gives a colourless gas. The residue is dissolved in water to obtain Y. Excess CO_2 is bubbled through aqueous solution of Y when Z is formed. Z on gentle heating gives back X. The X is
(A) $CaCO_3$ (B) $Ca(HCO_3)_2$
(C) Na_2CO_3 (D) $NaHCO_3$

Space for rough work

14. Consider the following processes. The correct prediction regarding the above isomerization is/are:



(A) $K_{eq} > 1$ for backward reaction
(B) Isomerization is due to existence of resonance properties in the molecule
(C) C = C double bond length is shorter than the in a normal alkene.
(D) Electron moves opposite to carbonyl group during resonance.

15. The enolic from of acetone contains

(A) 9 σ bonds, 1π bond and 2 lone pairs	(B) 8 σ bonds, 2π bond and 2 lone pairs
(C) 10σ bonds, 1π bond and 1 lone pairs	(D) 9σ bonds, 2π bond and 1 lone pairs

16. Consider the reaction: $2H_2(g) + 2NO(g) \longrightarrow N_2(g) + 2H_2O(g)$
The rate law for this reaction is
Rate = $K[H_2]\,[NO]^2$
Under what conditions could these steps represent the mechanism?

Step : 1 $2NO \rightleftharpoons N_2O_2$

Step : 2 $N_2O_2 + H_2 \longrightarrow N_2O + H_2O$

Step : 3 $N_2O + H_2 \longrightarrow N_2 + H_2O$

(A) These steps cannot be the mechanism under any circumstances
(B) These steps could be the mechanism if step 1 is the slow step
(C) These steps could be the mechanism if step 2 is the slow step
(D) These steps could be the mechanism if step 3 is the slow step

17. If $Ca_3(PO_4)_2$ and H_3PO_3 contain same number of 'P' atom, then the ratio of oxygen atoms in these compounds respectively is

(A) 8/3	(B) 2/3
(C) 3	(D) 4/3

Space for rough work

18. Give that for a reaction of n^{th} order, the integrated rate equation:

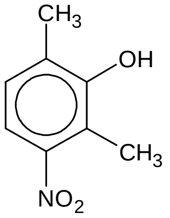
$K = \frac{1}{(n-1)t}\left[\frac{1}{C^{n-1}} - \frac{1}{C_0^{n-1}}\right]$, where C and C_0 are the concentration of reactant at time t and initially respectively. The $t_{3/4}$ and $t_{1/2}$ are related as

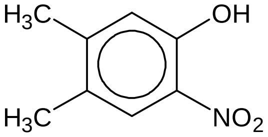
(A) $t_{3/4} = t_{1/2}\left[2^{n-1}+1\right]$
(B) $t_{3/4} = t_{1/2}\left[2^{n-1}-1\right]$
(C) $t_{3/4} = t_{1/2}\left[2^{n+1}+1\right]$
(D) $t_{3/4} = t_{1/2}\left[2^{n+1}-1\right]$

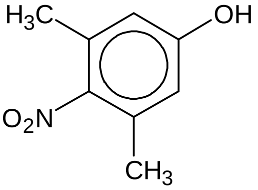
19. In which on of the following species the central atom has the type of hybridization which is not the same as that present in the other species?

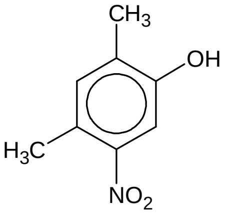
(A) SF_4
(B) I_3^-
(C) $SbCl_5^{2-}$
(D) PCl_5

20. Which one of the following phenols will show highest acidity?

(A)


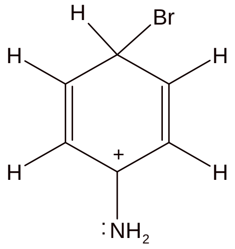
(B)


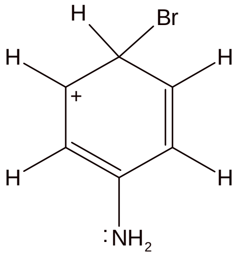
(C)


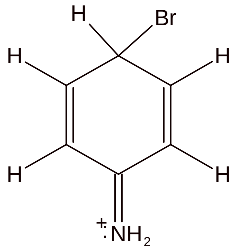
(D)


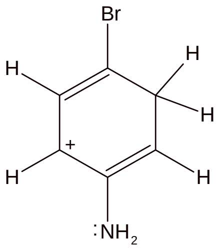
Space for rough work

21. Which one of the following is most stable?

(A)


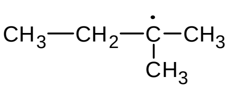
(B)


(C)


(D)


22. Rank the following free radical in order of decreasing stability:

(I) $C_6H_5\dot{C}HC_6H_5$ (II) $C_6H_5-\dot{C}H-CH=CH_2$ (III) $CH_3-\dot{C}H-CH_3$

(IV) $C_6H_5-\dot{C}H-CH_3$ (V) $CH_3CH=CHCH_2\dot{C}H_2$ (VI)

$CH_3-CH_2-\dot{C}(CH_3)-CH_3$

(A) I > II > III > IV > V > VI (B) VI > V > IV > III > II > I
(C) I > II > IV > VI > III > V (D) I > IV > VI > V > II > III

23. Consider the flowing reversible system $A(g) + 2B(g) \rightleftharpoons AB_2 \quad K_c = 1/2$. The above equilibrium is established in a 1L flask and at equilibrium 2 mol of each A and B are present. If 2 mol of B and 2x mol of AB_2 is added further so that mol of A does not change then the value of x is

(A) 6 (B) 8
(C) 3 (D) 4

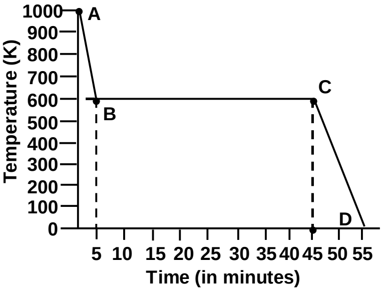
24. 0.02 M HCOOH has degree of dissociation 10%. The K_a of HCOOH is

(A) 2×10^{-3} (B) 2×10^{-4}
(C) 2×10^{-5} (D) 2×10^{-2}

Space for rough work

25. The degree of dissociation of two weak acids, α_1 and α_2 are in ratio 1 : 2. The value of $K_{a_1} = 2\times10^{-4}$, the value of K_{a_2} is (concentration of both acids are same)
(A) 8×10^{-4} (B) 2×10^{-4}
(C) 4×10^{-4} (D) 1×10^{-4}

26. Two moles of a substance is cooled at the rate of 0.4 kJ min^{-1} as shown in graph. Curve AB, B and C and curve CD represent respectively, the cooling of liquid, start of freezing, completion of freezing and cooling of the solid based on this data. The change in entropy of fusion in J mol^{-1}K^{-1} is
(A) 03.33 (B) 13.33
(C) 23.33 (D) 33.33



27. Two moles of CO and one mole of O_2 are taken in a container of volume one litre to form two moles of CO_2 according to equation:
$2CO(g) + O_2(g) \longrightarrow 2CO_2(g);\ \Delta H = -560$ kJ
The pressure in the vessel changes from 70 atm to 40 atm. If the gases deviate appreciably from ideal nature (1.0 L atm = 0.1 kJ), then
(A) $\Delta U = -555.895$ kJ (B) $\Delta U = -518.95$ kJ
(C) $\Delta U = -557$ kJ (D) $\Delta U = +518.95$ kJ

28. If the solubility of $SrSO_4$ in water, 0.01 M Na_2SO_4 and 0.02 M $Sr_3(PO_4)_2$ be S_1, S_2 and S_3, then select the correct order of solubility
(A) $S_1 < S_2 < S_3$ (B) $S_1 > S_2 > S_3$
(C) $S_1 < S_3 < S_2$ (D) $S_3 < S_1 < S_2$

29. The average speed of an ideal gas molecule at 27°C is 0.3 ms^{-1}. The average speed of the same at 927°C will be
(A) 0.6 ms^{-1} (B) 0.3 ms^{-1}
(C) 0.9 ms^{-1} (D) 3 ms^{-1}

30. Which of the following metal reacts most vigorously with water?
(A) Li (B) Na
(C) K (D) Be

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

*This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct*

1. If l,m,n are in A.P., then the straight line lx + my + n = 0 will pass through the point
(A) (–1, 2) (B) (1, – 2)
(C) (2, 1) (D) (1, 2)

2. Equation of lines which passes through the points of intersection of the lines $4x - 3y - 1 = 0$ and $2x - 5y + 3 = 0$ and are equally inclined to the axes are
(A) $y \pm x = 0$ (B) $y - 1 = \pm 1(x - 1)$
(C) $x - 1 = \pm 2(y - 1)$ (D) none of these.

3. The circle $x^2 + y^2 + 4x - 4y + 4 = 0$ touches
(A) x-axis (B) y-axis
(C) both axes (D) none of these.

4. If the line $x + 2by + 7 = 0$ is a diameter of the circle $x^2 + y^2 - 6x + 2y = 0$, then b =
(A) 3 (B) – 5
(C) 5 (D) – 1.

5. The centre of $14x^2 - 4xy + 11y^2 - 44x - 58y + 71 = 0$
(A) (2, 3) (B) (2, – 3)
(C) (–2, 3) (D) (–2, – 3)

6. Vertex of the parabola $x^2 + 4x + 2y - 7 = 0$ is
(A) $\left(-2, \frac{11}{2}\right)$ (B) (–2, 2)
(C) (–2, 11) (D) (2, 11).

Space for rough work

7. If latus rectum of an ellipse be equal to half of its minor axis then its eccentricity is
(A) rational number (B) irrational number
(C) ellipse not possible (D) Integer

8. If distance between the directices be thrice the distance between the focii then eccentricity of the ellipse is
(A) $\frac{1}{\sqrt{3}}$ (B) $\frac{2}{3}$
(C) $\frac{1}{2}$ (D) $\frac{7}{8}$.

9. By shifting the vertex of a parabola which of the following will definitely change
(A) latus rectum (B) axis of symmetry
(C) directrix (D) focus

10. The distance of the point 'θ' on the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ from a focus is
(A) a(e + cosθ) (B) a(e – cosθ)
(C) a(1 + ecosθ) (D) a(1 + 2cosθ).

11. The ellipse $\frac{x^2}{25}+\frac{y^2}{16}=1$ and the hyperbola $\frac{x^2}{25}-\frac{y^2}{16}=1$ have in common
(A) centre only (B) centre, foci and directrices
(C) centre, foci and vertices (D) centre and vertices only.

12. If $x=\sqrt{7+4\sqrt{3}}$ then $x+\frac{1}{x}=$
(A) 4 (B) 6
(C) 2 (D) 3.

Space for rough work

13. If l, m, n are real and $l \neq m$, then the roots of the equation $(l - m)x^2 - 5(l + m)x - 2(l - m) = 0$ are
(A) complex (B) real & distinct
(C) real and equal (D) none of these.

14. The equation $e^x - x - 1 = 0$ has
(A) only one real root (B) at least two real roots
(C) exactly two real roots (D) infinitely many roots.

15. The number of rectangles excluding squares from a rectangle of size 9×6 is
(A) 945 (B) 971
(C) 791 (D) 719

16. The sum of the digits in the unit place of all numbers formed with the help of 3, 4, 5 and 6 taken all at a time is
(A) 180 (B) 108
(C) 118 (D) 181

17. The middle term in the expansion of $(1 + 3x + 3x^2 + x^3)^6$ is
(A) 4th (B) 3rd
(C) 10th (D) none of these

18. If $\frac{1}{1-2x+x^2} = 1+\alpha_1 x + \alpha_2 x^2 + \cdots$, then the value of a_r is
(A) 2r (B) r + 1
(C) r (D) r – 1

19. The coefficient of x^{17} in the expansion of $(x - 1)(x - 2)(x - 3) \ldots (x - 18)$ is
(A) $\frac{171}{2}$ (B) 342
(C) -171 (D) 684

Space for rough work

20. If z_1, z_2 and z_3 are three distinct complex numbers and a, b, c are three positive real numbers such that $\frac{a}{|z_2 - z_3|} = \frac{b}{|z_3 - z_1|} = \frac{c}{|z_1 - z_2|}$, then $\frac{a^2}{(z_2 - z_3)} + \frac{b^2}{(z_3 - z_1)} + \frac{c^2}{(z_1 - z_2)} =$

(A) 0 (B) abc
(C) 3abc (D) (a + b + c)

21. Let f(z) is a complex polynomial in variable z. When f(z) is divided by z – i, the remainder is i and when divided by z + i, the remainder is 1 + i, then, the remainder, when f(z) is divided by $z^2 + 1$, is

(A) $\frac{1}{2} + i + z$ (B) $\frac{1}{2} + iz + i + \frac{1}{2}$
(C) iz + i + 1 (D) none of these

22. If z_1, z_2, z_3 are complex numbers representing the points A, B, C such that $\frac{2}{z_1} = \frac{1}{z_2} + \frac{1}{z_3}$. Then

(A) A, B, C are collinear
(B) circle through points A, B, C has centre at origin O
(C) circle through A, B, C passes through origin
(D) none of these

23. Let α and β be two distinct complex numbers such that $|\alpha| = |\beta|$. If real part of α is positive and imaginary part of β is negative, then the complex number $\frac{\alpha + \beta}{\alpha - \beta}$ may be

(A) real and positive (B) real and negative
(C) purely imaginary (D) zero

24. If x > 1, y > 1, z > 1 are in a G.P., then $\frac{1}{1 + \ln x}, \frac{1}{1 + \ln y}, \frac{1}{1 + \ln z}$ are in

(A) A.P (B) G.P.
(C) H.P. (D) None of these

Space for rough work

25. Sum of the series $S = 1^2 - 2^2 + 3^2 - 4^2 + \ldots - 2002^2 + 2003^2$ is

(A) 2007006 (B) 1005004

(C) 2000506 (D) None of these

26. Let x be the arithmetic mean and y, z be the two geometric means between any two positive numbers. Then the value of $\frac{y^3 + z^3}{xyz}$ is

(A) 2 (B) 3

(C) 1/2 (D) 3/2

27. If $f(x + y) = f(xy)\ \forall\ x, y \in R$, and $f(2003) = 2003$, then $f(-2003)$ equals

(A) 2003 (B) 0

(C) –2003 (D) None of these

28. If $a^2 + 4b^2 = 12ab$, then $\log(a + 2b)$ is

(A) $\frac{1}{2}(\log a + \log b)$ (B) $(\log 4 + \log a + \log b)$

(C) $2\log 2 + \frac{1}{2}(\log a + \log b)$ (D) none of these

29. The formula $\log(1 + x) = x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} + \cdots$ to ∞ is valid for

(A) all real x (B) $-1 < x < 1$

(C) $-1 < x \le 1$ (D) $-1 \le x \le 1$

30. If $\tan 3\theta = \cot \theta$, then $\theta =$

(A) $(2n+1)\frac{\pi}{8}$ (B) $(2n+1)\frac{\pi}{4}$

(C) $(n+1)\frac{\pi}{3}$ (D) $n\pi$

Space for rough work

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HALF COURSE TEST–VII
(MAIN)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	D	B
2.	A	B	B
3.	B	B	C
4.	A	B	C
5.	C	C	A
6.	C	B	A
7.	B	A	B
8.	B	D	A
9.	C	D	D
10.	B	C	C
11.	B	A	D
12.	C	D	A
13.	C	A	B
14.	C	B	A
15.	A	A	C
16.	C	C	B
17.	B	D	C
18.	B	A	B
19.	D	C	C
20.	D	C	A
21.	D	C	D
22.	D	C	C
23.	C	A	C
24.	A	B	C
25.	A	A	A
26.	A	B	A
27.	A	C	A
28.	C	B	C
29.	C	A	C
30.	D	C	A

Physics

PART – I

Hints & Solutions

1. The velocity of P along AP equals that of A along AP.

2. Force by liquid = Mg
$\Rightarrow \rho(Av)v = Mg$
But $Av = 1 \times 10^{-3}$ m^3/s and
$v = \sqrt{(20)^2 - 2 \times 10 \times 15} = 10$ m/s
$\therefore$ M = 1 kg

3. The motion of the particle within the tunnel is simple harmonic.

4. Total mechanical energy = gravitational P.E. + K.E., total mechanical energy is conserved.

5. $dQ = n\left(\frac{\gamma R}{\gamma - 1}\right)dT$, $dU = \frac{nR}{\gamma - 1}dT$
$dW = nRdT$
$dQ : dW : dU$
$\Rightarrow \gamma : \gamma - 1 : 1$

6. Using equation of Trajectory, we get
$u = 15\sqrt{2}$ m/s

8. From the free body diagram, we get,
$N = mg\cos\alpha + ma_0\cos\alpha$
$mg\sin\alpha + ma_0\sin\alpha = ma$
$a = (a_0 + g)\sin\alpha$
$L = \frac{1}{2}(a_0 + g)\sin\alpha t^2$
$t = \sqrt{\frac{2L}{(a_0 + g)\sin\alpha}}$

9. $F\cos\theta = \mu N$ …..(A)
$N = F\sin\theta + mg$ …..(B)
By (A) and (B)
$F\cos\theta = \mu(F\sin\theta + mg)$
$F\cos\theta - \mu F\sin\theta = \mu mg$
$F(\cos\theta - \mu\sin\theta) = \mu mg$
if F is ∞. Hence $\cos\theta - \mu\sin\theta = 0$
$\cos\theta - \mu\sin\theta = 0 \Rightarrow \cot\theta = \mu$
$\Rightarrow \theta = \cot^{-1}(\mu)$

10. Stress = Y × strain
force F = $Y\left(\frac{A\Delta\ell}{\ell}\right)$
$\Rightarrow F = \pi r^2 Y\left(\frac{A\Delta\ell}{\ell}\right)$

11. $\ell_2 - \ell_1 = (\ell'_0 - \ell_0) + t(\ell'_0\alpha_2 - \ell_0\alpha_1)$
By the condition given in the question,

$\ell_2 - \ell_1 = \ell'_0 - \ell_0$

$\therefore \quad t\left(\ell'_0\alpha_2 - \ell_0\alpha_1\right) = 0$

$\ell'_0 = 60$ cm

12. $f_{max} = md\omega^2_{0_{max}}$

$\omega_{0_{max}} = \sqrt{\frac{\mu mg}{md}} = \sqrt{\frac{\mu g}{d}}$

13. y = x

PE = $\frac{1}{2}m\omega^2y^2$

$KE = \frac{1}{2}m\omega^2(a^2 - y^2)$

TE = PE + KE = $\frac{1}{2}m\omega^2a^2$

14. T = Kx = $m\omega^2 r$

where r = $\ell_0 + x$

$\therefore \quad Kx = m\omega^2(\ell_0 + x) \Rightarrow \quad x = \frac{m\omega^2\ell_0}{K - m\omega^2}$

$\therefore \quad r = \ell_0 + x = \frac{K\ell_0}{K - m\omega^2}$.

15. V_{max} = (2πf) A

$a_{max} = (2\pi f)^2 A$

$\frac{a_{max}}{V_{max}} = (2\pi f)$.

16. Acceleration ∝ - displacement

17. In second harmonic of an organ pipe pressure antinode will be at $\frac{\lambda}{4}$ from the either side of the open organ pipe and $\lambda = L$ (length of the organ pipe).

18. $W_{agent} = \Delta K + \Delta U$

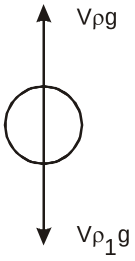
for minimum work done ΔK = 0

$W_{agent} = \Delta U = mgR$

19. Use the definition of C.M. :

$x_{cm} = \frac{\Sigma m_i x_i}{\Sigma m_i}$

20. From the F.B.D. of the body



a = $\frac{V\rho_1 g - V\rho g}{V\rho_1} = \left(1 - \frac{kh}{\rho_1}\right)g$ $\quad \because \rho = kh$

$\therefore \quad v\frac{dv}{dh} = \left(1 - \frac{kh}{\rho_1}\right)g$

$\Rightarrow \quad \frac{v^2}{2} = \left(h - \frac{k}{2\rho_1}h^2\right)g$

$\therefore \quad v = 0$ at $h = \frac{2\rho_1}{k}$

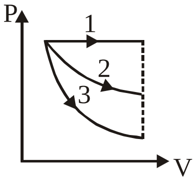
also $a = 0 \Rightarrow h = \frac{\rho_1}{k}$ is the mean position.

$\therefore \quad$ amplitude $= \frac{\rho_1}{k}$

21. Calculate the field due to a semi-circular ring and then use superposition principle.

22. Total mechanical energy = K.E. of satellite + P.E. of satellite.

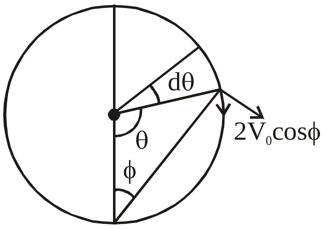
23. In the diagram since adiabatic process curve for P-V diagram is steeper than isothermal P-V curve. So curve 3 will denote adiabatic process, curve 2 isothermal and curve 1 isobaric. i.e. the minimum area enclosed with v-axis will be for adiabatic process



24. $a = -(dv/dt)$
$kv^2 = -(dv/dt)$,
$v = v_0/(1 + kv_0t)$

25. $a_R = \frac{|\vec{v}|^2}{R}$

27. $dm = \left(\frac{m}{2\pi R}\right)(Rd\theta) = \frac{md\theta}{2\pi}$



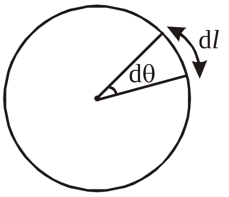
or, $V = 2V_0\cos\phi = 2V_0\sin\frac{\theta}{2}$

$dK = \frac{1}{2}(dm) \times 4V_0^2 \times \sin^2\frac{\theta}{2}$

or, $dK = \frac{mV_0^2}{2\pi}(1 - \cos\theta)d\theta$

$K_{AOB} = \frac{mV_0^2}{2\pi}\int_{-\pi/2}^{+\pi/2}(1 - \cos\theta)d\theta = \frac{mV_0^2}{2} - \frac{mV_0^2}{\pi}$.

28. $2T\sin\frac{d\theta}{2} = dma_R = dmR\omega_0^2$
…..(A)
Mass per unit length = mass/length



$dm = \frac{m}{2\pi}d\theta$

By equation (A) $2T\sin\frac{d\theta}{2} = dmR\omega_0^2$

$T = \frac{mR\omega_0^2}{2\pi}\left\{\sin\frac{d\theta}{2} = \frac{d\theta}{2}\right\}$

Chemistry

PART – II

SECTION – A

5. $B + \underset{(Z)}{F_2} \longrightarrow \underset{(X)}{BF_3}$

$8BF_3 + 6LiH \longrightarrow \underset{(Y)}{B_2H_6} + 6LiH_4$

6. $n_1 + n_2 = 4,\ n_2 - n_1 = 2$
$n_1 = 1,\ n_2 = 3$

$$\bar{\nu} = Rz^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right] = R \times 2^2\left[\frac{1}{(1)^2} - \frac{1}{3^2}\right] = \frac{32R}{9}$$

16. Step : 1 $2NO \rightleftharpoons N_2O_2$

Step : 2 $N_2O_2 + H_2 \longrightarrow N_2O + H_2O(\text{slow})$

Step : 3 $N_2O + H_2 \longrightarrow N_2 + H_2O$

Rate = $K'[N_2O_2]\,[H_2]$

From step 1 $K_c = \dfrac{N_2O_2}{[NO]^2} \Rightarrow [N_2O_2] = K_c[NO]^2$

$\text{Rate} = K'.K_c[NO]^2[H_2] = K[NO]^2[H_2]$

17. Let number of moles of $Ca_3(PO_4)_2$ and H_3PO_3 are x and y respectively

$\dfrac{x}{y} = \dfrac{1}{2}$

$$\frac{\text{Moles of O in } Ca_3(PO_4)_2}{\text{Moles of O in } H_3PO_3} = \frac{8x}{3y} = \frac{8}{3} \times \frac{1}{2} = \frac{4}{3}$$

18. $\dfrac{t_{3/4}}{t_{1/2}} = \dfrac{4^{(n-1)} - 1}{2^{n-1} - 1}$

$\Rightarrow \dfrac{t_{3/4}}{t_{1/2}} = \dfrac{(2^{n-1} - 1)(2^{n-1} + 1)}{(2^{n-1} - 1)} = (2^{n-1} + 1)$

$\therefore t_{3/4} = t_{1/2}(2^{n-1} + 1)$

19. SF_4, I_3^- and PCl_5 have sp^3d hybridization at central atom, however, however $SbCl_5^{2-}$ has sp^3d^2 hybridization.

20. Nitro group is present at para position. (–R effect, which increase acidic strength)

24. $K_a = C\alpha^2 = 0.02 \times \dfrac{10}{100} \times \dfrac{10}{100} = 2 \times 10^{-4}$

25. $\sqrt{\dfrac{\alpha_1}{\alpha_2}} = \sqrt{\dfrac{K_{a_1}}{K_{a_2}}}$

26. $C \rightarrow B$ part in the graph represents fusion at a constant temperature of 600 K and for 40 min.
Time of fusion = 45 – 5 = 40 min

So, total heated absorbed during the fusion = $\frac{0.4 \times 10^3 \times 40}{2} \text{J mol}^{-1}$

$\therefore \Delta S_{\text{fusion}} = \frac{0.4 \times 10^3 \times 40}{2 \times 600} = 13.33 \text{ J mol}^{-1}\text{K}^{-1}$

Hence (B) is correct.

27. $\Delta H = \Delta U + \Delta(PV) = \Delta U + P_2V_2 - P_1V_1$

We cannot use, $\Delta H = \Delta U + \Delta nRT$ as $PV \neq nRT$ since gases deviate from ideal behaviour.

$\therefore W = P_2V_2 - P_1V_1 = 40 \times 1 - 70 \times 1 = -30$ lit atm = –3 kJ

Also, $-560 = \Delta U - 3.0$

$\Delta U = -557$ kJ

28. Higher the concentration of common ion, the smaller is the solubility.

29. $\frac{C_2}{C_1} = \sqrt{\frac{T_2}{T_1}} = \sqrt{\frac{1200}{300}} = 2$

$C_2 = 2C_1 = 2 \times 0.3 \text{ ms}^{-1} = 0.6 \text{ ms}^{-1}$

30. Since melting point of K is least among all, so heat released in the reaction immediately melts its surface and catches fire.
Hence (C) is correct.

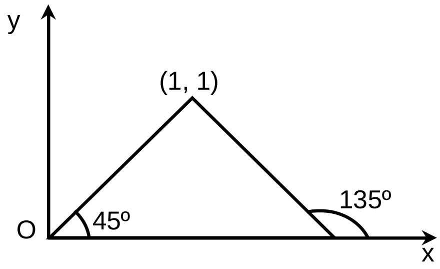
Mathematics

PART – III

SECTION – A

1. $l - 2m + n = 0$ ($\because l, m, n$ in A.P.)
compare with $lx + my + n = 0$
$x = 1, y = -2$.

2. Slope of the lines are 1 & – 1
Hence required equation are
$(y - 1) = \pm 1 (x - 1)$



3. Centre = (–2, 2), radius = 2

5. For centre of F(x, y) = 0 solve $\frac{df}{dx} = 0$ & $\frac{df}{dy} = 0$

6. Given parabola is $(x + 2)^2 = -2\left(y - \frac{11}{2}\right)$

7. $\frac{2b^2}{a} = b \Rightarrow e = \sqrt{1 - \frac{b^2}{a^2}} = \frac{\sqrt{3}}{2}$

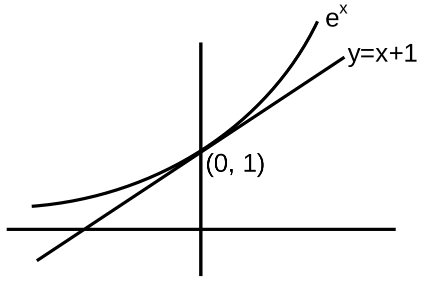
10. Focal distance of any point P(x, y) on the ellipse is equal to (a + ex) : so '$a + ae\cos\theta$' ($\because x = a\cos\theta$).

11. Centre of both = (0, 0)
vertices of both = (± 5, 0)

12. $\frac{1}{x} = \sqrt{7 - 4\sqrt{3}} \;\therefore\; x + \frac{1}{x} = \sqrt{7 + 4\sqrt{3}} + \sqrt{7 - 4\sqrt{3}} = \left(\sqrt{3} + 2\right) + \left(2 - \sqrt{3}\right) = 4$

13. $D = 25(l + m)^2 + 8(l - m)^2 > 0$

14. $e^x = x + 1 \Rightarrow 1 + \frac{x}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \ldots \infty = x + 1$
i.e., $\frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \ldots \frac{x^n}{n!} + \ldots = 0$
$\therefore \quad x^2 = x^3 = x^4 = \ldots = 0$
hence x = 0 only one real root
Alternate by graph, we see that
$y = x + 1$ touches $y = e^x$ at (0, 1) so only one real root.



15. Required number = $\frac{n \times p}{4}(n+1)(p+1) - \sum_{r=1}^{n}(n+1-r)(p+1-r)$,

where the given rectangle is of size n × p (n < p)

n = 6, p = 9.

$\therefore$ Number = $\frac{9 \times 6}{4}(9+1)(6+1) - \sum_{r=1}^{6}(7-r)(10-r)$

$= 945 - \sum_{r=1}^{6}\left(70 - 17r + r^2\right)$

= 945 – 154 = 791.

16. Let us fix 3 at unit place.

$\therefore$ Number of possible numbers is = 3! = 6.

$\therefore$ Each number can make to occur at unit place 6 times.

$\therefore$ Required sum = 6(3 + 4 + 5 + 6) = 6 × 18 = 108.

17. $(1 + 3x + 3x^2 + x^3)^6 = [(1 + x)^3]^6 = (1 + x)^{18}$

$\therefore$ Middle term = $\left(\frac{18}{2}+1\right)^{th}$ term i.e., 10th term.

18. $\frac{1}{1-2x+x^2} = (1-x)^{-2} = 1 + 2x + 3x^2 + \cdots$

$= 1 + a_1x + a_2x^2 + \ldots$

$\Rightarrow$ $a_r = r + 1$.

19. Coefficient of $x^{17} = -(1 + 2 + 3 + \cdots + 18)$

$= -\frac{18}{2}(1+18) = -9 \times 19 = -171.$

20. Let $\frac{a}{|z_2 - z_3|} = \frac{b}{|z_3 - z_1|} = \frac{c}{|z_1 - z_2|} = \lambda$ (say)

$\Rightarrow$ $a = \lambda|z_2 - z_3|, b = \lambda|z_3 - z_1|, c = \lambda|z_1 - z_2|$

$a^2 = \lambda^2|z_2 - z_3|^2 = \lambda^2(z_2 - z_3)(\bar{z}_2 - \bar{z}_3)$

$\therefore$ $\frac{a^2}{(z_2 - z_3)} = \lambda^2(\bar{z}_2 - \bar{z}_3)$

Similarly $\frac{b^2}{(z_3 - z_1)} = \lambda^2(\bar{z}_3 - \bar{z}_1)$ and $\frac{c^2}{(z_1 - z_2)} = \lambda^2(\bar{z}_1 - \bar{z}_2)$

$\therefore$ $\frac{a^2}{(z_2 - z_3)} + \frac{b^2}{(z_3 - z_1)} + \frac{c^2}{(z_1 - z_2)} = 0$

21. Remainder when f(x) is divided by $x - \alpha$ is $f(\alpha)$.

Let the remainder when f(z) is divided by $z^2 + 1$ is ax + b.

[remainder will be in general a linear expression as $z^2 + 1$ is quadratic]

Then $f(z) = (z^2 + 1)\,g(z) + (az + b)$ …(1)

Now $f(i) = i \Rightarrow ai + b = i$ …(2)

and $f(-i) = 1 + i \Rightarrow -ai + b = 1 + i$ …(3)

Solving (2) and (3), we get $b = \frac{1}{2} + i$ and $a = -\frac{1}{2i} = \frac{i}{2}$

Hence, the required remainder is $\frac{1}{2}iz + \frac{1}{2} + i$.

22. $\frac{2}{z_1} = \frac{1}{z_2} + \frac{1}{z_3}$

$\Rightarrow \quad \frac{1}{z_1} - \frac{1}{z_2} = \frac{1}{z_3} - \frac{1}{z_1} \qquad \Rightarrow \quad \frac{z_2 - z_1}{z_1 z_2} = \frac{z_1 - z_2}{z_1 z_3}$

$\Rightarrow \quad \frac{z_2 - z_1}{z_3 - z_1} = -\frac{z_2}{z_3} \qquad \Rightarrow \quad \arg\left(\frac{z_2 - z_1}{z_3 - z_1}\right) = \arg\left(-\frac{z_2}{z_3}\right) = \pi - \arg\left(\frac{z_2}{z_3}\right)$

$\Rightarrow \quad \arg\left(\frac{z_2 - z_1}{z_3 - z_1}\right) = \pi - \arg\left(\frac{z_2 - 0}{z_3 - 0}\right)$

$\Rightarrow \quad \angle CAB = \pi - \angle COB$

$\Rightarrow \quad \angle CAB + \angle COB = \pi \;\Rightarrow$ the points O, A, B and C are concyclic.

23. Let $\alpha = x + iy$ and $\beta = x - iy$ and a, b > 0

Since $|\alpha| = |\beta| \qquad \therefore \frac{\alpha+\beta}{\alpha-\beta} = \frac{2x}{2iy} = -\frac{ix}{y}$

Again, if $\alpha = x - iy$ and $\beta = -x - iy$

Then $\frac{\alpha+\beta}{\alpha-\beta} = \frac{-2iy}{2x} = -\frac{iy}{x}$

24. As x, y, z are in G.P. $\Rightarrow y^2 = xz$

$\Rightarrow \ln(y)^2 = \ln(xz)$

$\Rightarrow 2\ln(y) = \ln(x) + \ln(z)$

$\Rightarrow 2\{1 + \ln(y)\} = \{1 + \ln(x)\} + \{1 + \ln(z)\}$

$\Rightarrow 1 + \ln(x), 1 + \ln(y), 1 + \ln(z)$ are in A.P.

$\Rightarrow \frac{1}{1+\ln(x)}, \frac{1}{1+\ln(y)}, \frac{1}{1+\ln(z)}$ are in H.P.

25. We can write S as

$S = (1 - 2)(1 + 2) + (3 - 4)(3 + 4) + \ldots + (2001 - 2002)(2001 + 2002) + 2003^2$

$= -[1 + 2 + 3 + 4 + \ldots + 2002] + 2003^2$

$= -\frac{1}{2}(2002)(2003) + 2003^2 = 2007006.$

26. Let two positive numbers be a and b. Then x = (a + b)/ 2.

Also a, y, z, b are in G.P. If r is the common ratio of this G.P., then $b = ar^3 \Rightarrow r = (b/a)^{1/3}$

We have $\frac{y^3 + z^3}{xyz} = \frac{a^3r^3 + a^3r^6}{x(ar)(ar^2)} = \frac{a(1+r^3)}{x} = \frac{a+b}{(a+b)/2} = 2$.

27. f (2003) = f (2003 + 0) = f [2003(0)] = f (0) $\Rightarrow$ f (0) = 2003.

Also, f (–2003) = f (–2003 + 0) = f (0) = 2003

It can also be seen that f is a constant function.

28. $a^2 + 4b^2 = 12ab$

$\Rightarrow$ $a^2 + 4b^2 + 4ab = 16ab$

$\Rightarrow$ $2\log(a + 2b) = \log16 + \log a + \log b$

$\Rightarrow$ $\log(a+2b) = \frac{1}{2}[4\log 2 + \log a + \log b]$

$= 2\log 2 + \frac{1}{2}(\log a + \log b)$

29. The given expansion is valid only for $-1 < x \le 1$.

30. $\tan 3\theta = \tan\left(\frac{\pi}{2} - \theta\right)$

$\therefore\ 3\theta = n\pi + \left(\frac{\pi}{2} - \theta\right)$

$\Rightarrow\ 4\theta = (2n+1)\frac{\pi}{2} \Rightarrow\ \theta = (2n+1)\frac{\pi}{8}$

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HALF COURSE TEST – VIII

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 243**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 06)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (07 – 09) contains 3 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

   Section-A (10 – 14) contains 2 paragraphs. Based upon paragraph, 2 and 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.
2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct matching. No marks will be given for any wrong matching in any question. There is no negative marking.
3. **Section-C (01 – 05)** contains 5 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

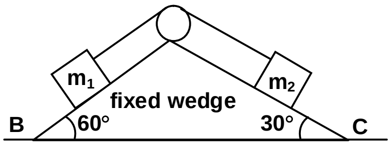
SECTION – A

Straight Objective Type

This section contains **6 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

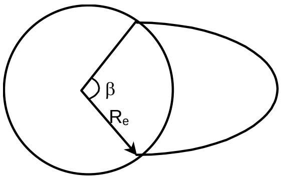
1. Ideal gas is in the container with a piston as one of the walls. There is a little hole in the wall opposite to piston, through which gas leaks out of the container at a rate R (number of molecules escaping the container per second). Now the gas is heated as well as compressed such that its temperature becomes 4 times its previous value, and pressure becomes 8 times its previous value. Now the rate of the gas out flow will be:

(A) 2R (B) 4R
(C) 8R (D) 16R



2. Two small masses m_1 and m_2 are at rest on a frictionless, fixed triangular wedge whose angles are 30° and 60° as shown. They are connected by a light inextensible string. The side BC of wedge is horizontal and both the masses are 1 metre vertically above the horizontal side BC of wedge. There is no friction between the wedge and both the masses. If the string is cut, which mass reaches the bottom of the wedge first? (Take $g = 10 m/s^2$)

(A) Mass m_1 reaches the bottom of the wedge first.
(B) Mass m_2 reaches the bottom of the wedge first.
(C) Both reach the bottom of the wedge at the same time.
(D) It's impossible to determine from the given information.



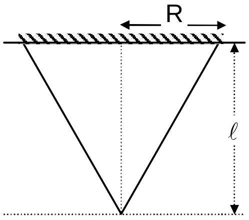
3. A particle is projected from the surface of the earth (of radius R_e and mass M_e) with speed equal to $\sqrt{\frac{GM_e}{R_e}}$, at certain angle from local horizontal as shown in the figure such that the angle subtended by arc between launching & landing site at earth's centre is $\beta = 90°$. Calculate the maximum separation of the particle from the centre of the earth. Consider earth to be uniformly dense and air resistance to be absent.

(A) $R_e\sqrt{2}$ (B) $R_e(\sqrt{2}+1)$
(C) $R_e\frac{(\sqrt{2}+1)}{\sqrt{2}}$ (D) $R_e\frac{(\sqrt{2}+1)}{(\sqrt{2}-1)}$

Space for rough work

4. A uniform circular disc of radius r undergoes small oscillations about a horizontal axis which lies in its own plane. Find distance of axis from centre for the period to be minimum.
(A) r/2 (B) r/4
(C) 3r/4 (D) 3r/8

5. A cone of circular cross–section having base radius R, height ℓ and mass m is suspended from its base as shown in the figure. The material of cone has Young's modulus Y. The acceleration due to gravity is g. Find elastic potential energy stored in the cone.



(A) $\frac{m^2g^2\ell}{10\pi R^2Y}$ (B) $\frac{m^2g^2}{5\pi R^2Y}$
(C) $\frac{m^2g^2\ell}{2\pi R^2Y}$ (D) $\frac{m^2g^2\ell^2}{10\pi R^2Y}$

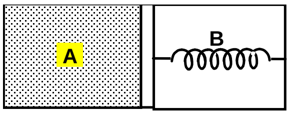
6. A particle of mass m is constrained to move along x-axis. The only force acting on the particle is given by $F(x)=F_0\cos\left(2\pi\frac{x}{\lambda}\right)$, where x is position of the particle on the x-axis. It is at rest on one of the equilibrium position but the equilibrium is unstable. Due to slight disturbance it moves, write the speed of the particle when it has covered a displacement of magnitude L.
(A) $\sqrt{\frac{F_0\lambda}{m\pi}\cos\left(\frac{2\pi L}{\lambda}\right)}$ (B) $\sqrt{\frac{F_0\lambda}{m\pi}\left(1-\cos\frac{2\pi L}{\lambda}\right)}$
(C) $\sqrt{\frac{F_0\lambda}{m\pi}\sin\left(\frac{2\pi L}{\lambda}\right)}$ (D) $\sqrt{\frac{F_0\lambda}{m\pi}\left(1-\sin\frac{2\pi L}{\lambda}\right)}$

Space for rough work

Multiple Correct Choice Type

This section contains **3 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

7. A thermally insulated chamber of volume $2V_0$ is divided by a frictionless piston of area S into two equal parts A and B. Part A has an ideal gas at pressure P_0 and temperature T_0 and in part B is vacuum. A massless spring of force constant K is connected with the piston and the wall of the container as shown. Initially the spring is unstretched. The ideal gas in chamber A is allowed to expand. Let in equilibrium the spring be compressed by a length x_o, then



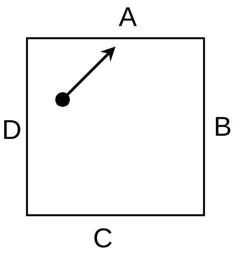
(A) Final pressure of the gas is Kx_0/S

(B) Work done by the gas is ½ kx_0^2

(C) Magnitude of change in internal energy of the gas is ½ kx_0^2

(D) none of these

8. A smooth uniform square wall frame of mass m of edge length 2a and small height lies in a smooth horizontal plane. At $t = 0$ a particle of mass m hits with speed $v\sqrt{2}$, one of the inner wall of the frame horizontally at an angle 45^0 from wall normal. Collision is perfectly elastic. The initial collision takes place at the mid point of wall A.



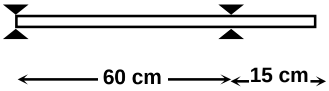
(A) Next collision takes place when $t = \frac{a}{v}$

(B) KE of frame when $t = \frac{3a}{2v}$, is mv^2

(C) after collision at B next collision takes place at wall D

(D) particle and frame comes to rest at regular intervals of time

9. A metal rod of length 75 cm is clamped at two points as shown in figure. One clamp is at an end and other is at 15 cm from other end. The Young's modulus of elasticity and density of the rod are $Y = 1.6\text{x}10^{11}$ N/m^2 and $\rho = 2.5$ gm/cc respectively.



(A) the rod will resonate if it is given longitudinal vibrations of frequency 13.33 kHz.

(B) the rod will resonate if it is given longitudinal vibrations of frequency 40 kHz.

(C) during resonance the number of complete loops between clamps may be 6.

(D) the maximum wavelength corresponding to vibrations of the rod is 60 cm.

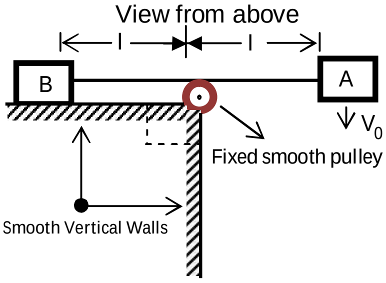
Space for rough work

Paragraph Type

This section contains **2 paragraphs.** Based upon one of paragraphs **2 multiple** choice questions and based on the other paragraph **3 multiple** choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

Paragraph for Questions Nos. 10 and 11

Two identical blocks are placed on a smooth horizontal surface, connected by a light string of length 2ℓ. String touches a fixed smooth pulley at its mid-point initially.
Shaded parts are two smooth vertical walls. Block A is given a speed V_0 perpendicular to string as shown in diagram. B strikes the pulley and stops.



10. Speed of block B when it hits the pulley is

(A) $\frac{V_0}{2}$ (B) $V_0\frac{\sqrt{3}}{2}$

(C) V_0 (D) $V_0\sqrt{\frac{3}{8}}$

11. Speed of A when it hits the wall is

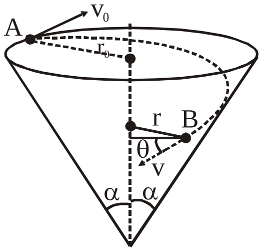
(A) $\frac{V_0}{2}$ (B) $V_0\frac{\sqrt{3}}{2}$

(C) V_0 (D) $V_0\sqrt{\frac{3}{8}}$

Space for rough work

Paragraph for Questions Nos. 12 and 14

A small particle of mass m is given an initial velocity v_0 tangent to the horizontal rim of a smooth cone at a radius r_0 from the vertical centerline as shown at point A. As the particle slides to point B, a vertical distance h below A and a distance r from the vertical centerline, its velocity v makes an angle θ with the horizontal tangent to the cone through B.



12. The value of θ is

(A) $\cos^{-1}\dfrac{v_0r_0}{\sqrt{v_0^2r_0^2+2gh(r_0-h\tan\alpha)}}$
(B) $\cos^{-1}\dfrac{v_0r_0}{\sqrt{v_0^2r_0^2+2gh(r_0+h\tan\alpha)}}$

(C) $\cos^{-1}\dfrac{v_0r_0}{\sqrt{v_0^2r_0^2-2gh(r_0-h\tan\alpha)}}$
(D) $\cos^{-1}\dfrac{v_0r_0}{r_0\sqrt{v_0^2+2gh}}$

13. The speed of particle at point B

(A) $\sqrt{v_0^2+2gh}$
(B) $\sqrt{v_0^2-2gh}$

(C) $\sqrt{v_0^2+gh}$
(D) $\sqrt{2v_0^2+2gh}$

14. The minimum value of v_0 for which particle will be moving in a horizontal circle of radius r_0.

(A) $\sqrt{\dfrac{2gr_0}{\tan\alpha}}$
(B) $\sqrt{\dfrac{gr_0}{2\tan\alpha}}$

(C) $\sqrt{\dfrac{gr_0}{\tan\alpha}}$
(D) $\sqrt{\dfrac{4gr_0}{\tan\alpha}}$

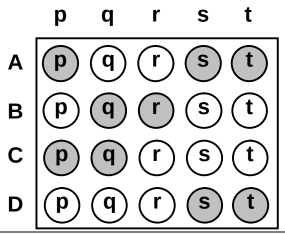
Space for rough work

SECTION – B

(Matrix-Match Type)

This section contains **2 questions**. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in column I have to be matched with statements (p, q, r, s, t) in column II. The answers to these questions have to be appropriately bubbled as illustrated in the following example.

If the correct match are A-p, A-s, B-q, B-r, C-p, C-q and D-s, then the correctly bubbled 4 × 4 matrix should be as follows:



1. For the following statements, except gravity and contact force between the contact surfaces, no other force is acting on the body.

Column A		Column B	
(A)	When a sphere is in pure–rolling on a fixed horizontal surface.	(p)	Upward direction
(B)	When a cylinder is in pure rolling on a fixed inclined plane in upward direction then friction force acts in	(q)	$v_{cm} > R\,\omega$
(C)	When a cylinder is in pure rolling down a fixed incline plane, friction force acts is	(r)	$v_{cm} < R\omega$
(D)	When a sphere of radius R is rolling with slipping on a fixed horizontal surface, the relation between v_{cm} and ω is	(s)	No frictional force acts.
		(t)	none of these

2. Match the column I with column II
In simple harmonic motion: $x = 1.0 \sin [12\pi t]$ and mass of particle executing SHM, m = 1/4 kg

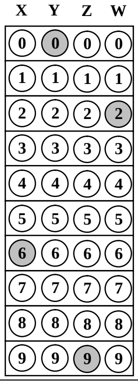
Column A		Column B	
(A)	Frequency with which kinetic energy oscillates = …	(p)	$\frac{1}{12}$
(B)	Speed of particle is maximum at time = ….	(q)	$18\pi^2$
(C)	Maximum potential energy = …	(r)	12
(D)	Force constant k = …	(s)	$36\pi^2$
		(t)	none of these

Space for rough work

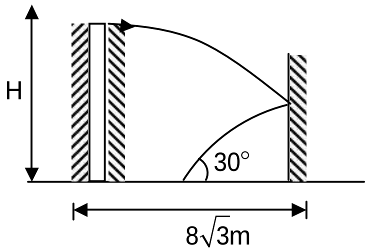
SECTION – C

Integer Answer Type

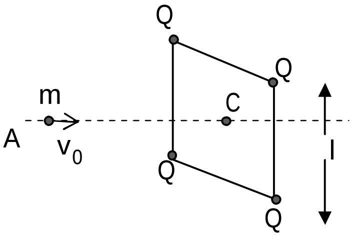
This section contains **5 questions**. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown



1. A ball is thrown horizontally from the top of a tower of unknown height. Ball strikes a vertical wall whose plane is normal to the plane of motion of ball. Collision is elastic and ball falls on ground exactly at the midpoint between the tower and the wall. Ball strikes the ground at an angle of the 30° with horizontal. Find the height of the tower (in meter).

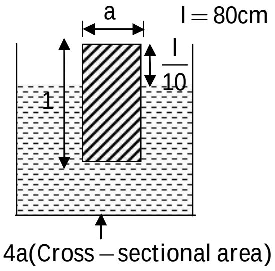


2. Four identical point charges are fixed at the four corners of a square of a side length l. Another charged particle of mass m and charge +q is projected towards centre of square from a large distance along the line perpendicular to plane of square. The minimum value of initial velocity v_0 required to cross the square is?
(m = 1 gm, l = $4\sqrt{2}$ m, Q = 1 μc, q = 0.5 μc)

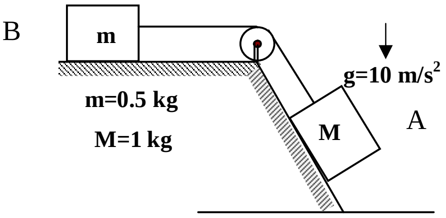


Space for rough work

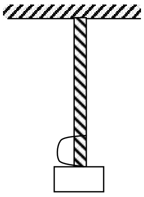
3. A uniform vertical cylinder of cross-sectional area 'a' floats, 90% submerged, in an unknown liquid inside a tank with cross-sectional area four times that of cylinder. When cylinder is pushed down gently and released it performs SHM. The maximum possible amplitude (in cm) for this SHM is



4. Horizontal surface below block B is rough but inclined surface below A is smooth as shown in diagram. When A is given a small impulse down the incline, blocks are found to slide with constant speed. T is tension in the string and μ is coefficient of friction between block B and horizontal surface. The value of $\frac{T}{\mu}$ is (in Newton)



5. A rope whose mass is not negligible supports a block of mass three times that of rope. A pulse is generated in string near lower end, the pulse moves up with acceleration in(m/s^2).



Space for rough work

Chemistry

PART – II

SECTION – A

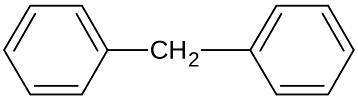
Straight Objective Type

This section contains **6 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. Ordinary hydrogen at room temperature is a mixture of
(A) 75% of O – hydrogen + 25 % of p – hydrogen
(B) 25% of O – hydrogen + 75 % of p – hydrogen
(C) 50% of O – hydrogen + 50 % of p – hydrogen
(D) 1% of O – hydrogen + 99 % of p – hydrogen

2. The enolic form of acetone contains
(A) 8 σ - bonds, 2π - bonds and 1 lone pairs
(B) 9 σ - bonds, 1π - bonds and 2 lone pairs
(C) 9 σ - bonds, 2π - bonds and 1 lone pairs
(D) 10 σ - bonds, 1π - bonds and 1 lone pairs

3. The molecular formula of diphenyl methane



is $C_{13}H_{12}$.
How many structural isomers are possible, when one of the hydrogen is replaced by a chlorine atom?
(A) 8
(B) 7
(C) 6
(D) 4

4. Nitrobenzene can be prepared from benzene by using a mixture of conc. HNO_3 and conc. H_2SO_4. In the nitrating mixture HNO_3 act as a
(A) Base
(B) Acid
(C) reducing agent
(D) catalyst

5. The degree of dissociation α of the reaction:
$N_2O_4(g) \rightleftharpoons 2NO_2(g)$ can be related to K_p as, where P is total pressure at equilibrium.
(A) $\alpha = \dfrac{K_p/P}{4+K_p/P}$
(B) $\alpha = \dfrac{K_p}{4+K_p}$
(C) $\alpha = \left[\dfrac{K_p/P}{4+K_p/P}\right]^{1/2}$
(D) $\alpha = \dfrac{K_p}{4+K_p}$

6. The solubility of A_2X_3 is Y mol dm^{-3}. if solubility product is
(A) $6Y^4$
(B) $64\ Y^4$
(C) $36\ Y^5$
(D) $108\ Y^5$

Space for rough work

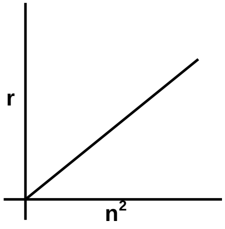
Multiple Correct Choice Type

This section contains **3 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

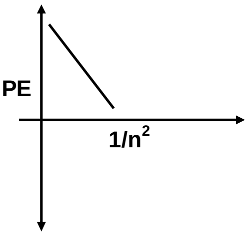
7. Which of the following is/are correct?
   (A) α - rays are more penetrating than β - rays
   (B) α - rays have greater ionizing power than β -rays
   (C) β - particles are not present in the nucleus yet they are emitted from the nucleus
   (D) γ - rays are not emitted simultaneously with α and β - rays

8. Select the correctly graph presented if
   v = velocity of electron in Bohr's orbit
   r = radius of Bohr's orbit
   U = potential energy
   T = kinetic energy of electron in Bohr's orbit

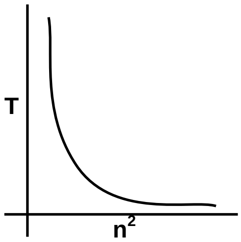
(A)



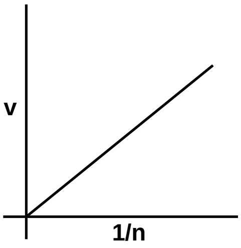
(B)



(C)



(D)



9. Which of the following name reactions may be used in the preparation of alkanes?
   (A) Corey – house synthesis
   (B) Wurtz reaction
   (C) Aldol reaction
   (D) Kolbe electrolysis method

Space for rough work

Paragraph Type

This section contains **2 paragraphs.** Based upon one of paragraphs **2 multiple** choice questions and based on the other paragraph **3 multiple** choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

Paragraph for Question Nos. 10 to 11

The concentration of hydrogen ion is a measure of acidity or alkalinity of a solution.
For mono basic acids

$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$

$$\alpha = \sqrt{\frac{K_a}{C}}$$

Where K_a = dissociation constant of acid
C = molarity of acid
$[H^+] = C\alpha$

$$\left[H^+\right] = \frac{K_a}{\alpha}$$

$$\left[H^+\right] = \sqrt{CK_a}$$

pH of a weak acid can be calculated using $[H^+]$ by any of above methods.

$$\left[H^+\right]_{total} = \sqrt{C_1K_{a_1} + C_2K_{a_2}}\left[\text{where two weak acids are mixed}\right]$$

$[H^+]$ of polyprotic acid [weak H_3A] has dissociation constant $K_{a_1} >> K_{a_2} >> K_{a_3}$ will be contributed by first dissociation at the most.

10. What will be value of $[H^+]$ of 10^{-6} M CH_3COOH? [$K_a = 1.8 \times 10^{-5}$]
(A) 4.2×10^{-6}M
(B) 10^{-4}M
(C) 9.5×10^{-7}M
(D) 10^{-10}M

11. The pH of 0.01 M HCOOH ($K_a = 1.4 \times 10^{-4}$) will be
(A) 2.926
(B) 3.296
(C) 4.926
(D) 5.926

Space for rough work

Paragraph for Question Nos. 12 to 14

Resonance concept is purely the critical and base on valence bond theory. According to this theory certain molecules showing at least one π bond can be represented by two or more than possible structures but none of them is real one. The real structure is hybrid of all these possible structure. This phenomenon is known as resonance.

12. In which resonance phenomenon is not possible?
(A) SO_4^{2-} (B) ClO_4^-
(C) CO_3^{2-} (D) CH_4

13. Bond order of Cl – O bond in ClO_4^- is
(A) 3 (B) 2
(C) 1.5 (D) 1.75

14. The carbon oxygen bond length order is as follows:
(A) $CO < CO_2 < CO_3^{2-}$ (B) $CO_2 > CO > CO_3^{2-}$
(C) $CO_3^{2-} > CO > CO_2$ (D) $CO_2 > CO_3^{2-} > CO$

Space for rough work

SECTION – B

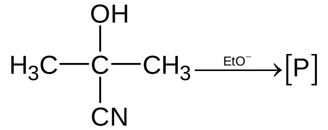
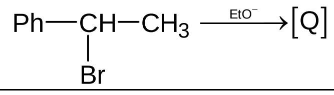
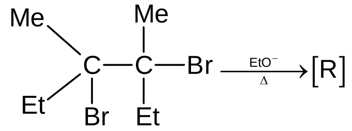
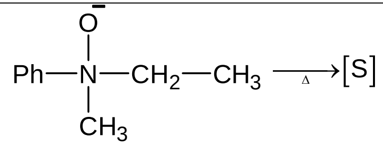
(Matrix-Match Type)

This section contains **2 questions**. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in column I have to be matched with statements (p, q, r, s, t) in column II. The answers to these questions have to be appropriately bubbled as illustrated in the following example.

If the correct match are A-p, A-s, B-q, B-r, C-p, C-q and D-s, then the correctly bubbled 4 × 4 matrix should be as follows:

	p	**q**	**r**	**s**	**t**
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the column – I with chemicals of that in valence in the process:

	Column – I		**Column – II**
(A)	 $H_3C-C(OH)(CN)-CH_3 \xrightarrow{EtO^-} [P]$	(p)	E_1
(B)	 $Ph-CH(Br)-CH_3 \xrightarrow{EtO^-} [Q]$	(q)	E_2
(C)		(r)	E_{1CB}
(D)	 $Ph-N(\bar{O})(CH_3)-CH_2-CH_3 \xrightarrow{\Delta} [S]$	(s)	E_i (Intramolecular elimination)
		(t)	Hoffmann elimination

2. All the compounds listed in Column-I react with water and in Column-II there product Column-II

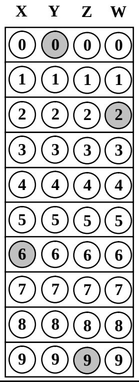
	Column – I		**Column – II**
(A)	$(CH_3)_2SiCl_2$	(p)	Hydrogen halide formation
(B)	XeF_4	(q)	Redox reaction
(C)	Cl_2	(r)	Reacts with glass
(D)	VCl_5	(s)	Polymerization
		(t)	O_2 formation

Space for rough work

SECTION – C

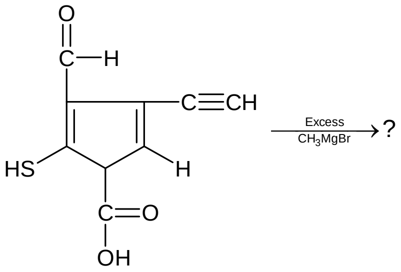
Integer Answer Type

This section contains **5 questions**. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown



1. What is the ratio of mole of $Mg(OH)_2$ and $Al(OH)_3$ in one litre in their saturated solution?
K_{sp} of $Mg(OH)_2 = 4 \times 10^{-12}$, $Al(OH)_3 = 1 \times 10^{-33}$
Gives answer by multiply it with 10^{-17}.

2. Find energy level of Li^{2+} having velocity 2.18×10^6 m/sec.

3. 

The number of CH_4 gas formed in the reaction are.

4. Most probable speed of a gas at 150 K is equal to the root mean square speed of O_2 gas at 400 K. Molecular mass of the gas is.

5. Total number of isomers (including stereoisomers) obtained by monochlorination of 2, 2, 4 – trimethylpentane is/are.

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **6 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. If a, b, c, d $\in$ R then the equation $(x^2 + ax - 3b)(x^2 - cx + b)(x^2 - dx + 2b) = 0$ has
(A) 6 real roots (B) 3 real roots
(C) 4 real roots (D) at least 2 real roots

2. The number of values of λ for which $[x^2 - (\lambda - 2)x + \lambda^2][x^2 + \lambda x + (2\lambda - 1)]$ is a perfect square is
(A) 1 (B) 2
(C) 0 (D) none of these.

3. If the equation of the family of ellipse is
$$\frac{x^2}{\cos^2\theta} + \frac{y^2}{\sin^2\theta} = 1\left(0 < \theta < \frac{\pi}{4}\right)$$
then the locus of the extremities of the latus rectum is
(A) $2y(1 - x^2) = 1 + x^2$ (B) $2y^2(1 + x^2) = (1 - x^2)^2$
(C) $y^2 = (1 - x^2)^2$ (D) $2y^2(1 - x^2) = (1 + x^2)^2$.

4. If PQ and QR are two focal chords of an ellipse and the eccentric angles of P, Q, R are 2α, 2β, 2γ respectively. Then $\tan\alpha \cdot \tan\gamma$ is equal to
(A) $\cot^2\beta$ (B) $\cot^2\alpha$
(C) $2\cot\alpha$ (D) none of these.

5. A focal chord of parabola $y^2 = 4x$ is inclined at an angle of $\frac{\pi}{4}$ with positive x-direction, then the slope of normal drawn at the ends of chord will satisfy the equation
(A) $m^2 - 2m + 1 = 0$ (B) $m^2 + 2m - 1 = 0$
(C) $m^2 - 1 = 0$ (D) $m^2 + 2m - 2 = 0$

6. The equation of a circle is $x^2 + y^2 - \lambda ax - ay - a^2(\lambda^2 + 1) = 0$. If two chords, each bisected by the x-axis can be drawn to the circle from the point $(a(\lambda - 1), a(\lambda + 1))$, which lies on the circle then λ satieties
(A) $\lambda^2 - 4\lambda - 12 > 0$ (B) $\lambda^2 - 4\lambda - 12 < 0$
(C) $\lambda^2 - 12\lambda - 4 > 0$ (D) $\lambda^2 - 12\lambda - 4 < 0$.

Space for rough work

Multiple Correct Choice Type

This section contains **3 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

7. The points A(0, 0), B(cosα, sinα) and C(cosβ, sinβ) are the vertices of a right angled triangle if

(A) $\sin\left(\frac{\alpha-\beta}{2}\right)=\frac{1}{\sqrt{2}}$ (B) $\cos\left(\frac{\alpha-\beta}{2}\right)=-\frac{1}{\sqrt{2}}$

(C) $\cos\left(\frac{\alpha-\beta}{2}\right)=\frac{1}{\sqrt{2}}$ (D) $\sin\left(\frac{\alpha-\beta}{2}\right)=-\frac{1}{\sqrt{2}}$.

8. Two straight lines u = 0 and v = 0 passes through the origin and angle between them is $\tan^{-1}\left(\frac{7}{9}\right)$. If the ratio of the slope of v = 0 and u = 0 is $\frac{9}{2}$, then their equations are

(A) y = 3x & 3y = 2x (B) 2y = 3x & 3y = x

(C) y + 3x = 0 & 3y + 2x = 0 (D) 2y + 3x = 0 & 3y + x = 0.

9. If P, Q and R are three co-normal points on the parabola $y^2 = 4ax$. Then the correct statement(s) is/are

(A) algebraic sum of the slopes of the normals at P, Q and R vanishes
(B) algebraic sum of the ordinates of points P, Q and R vanishes
(C) centroid of the triangle PQR lies on the axis of the parabola
(D) circle circumscribing the triangle PQR passes through the vertex of the parabola

Space for rough work

Paragraph Type

This section contains **2 paragraphs.** Based upon one of paragraphs **2 multiple** choice questions and based on the other paragraph **3 multiple** choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

Paragraph for Questions 10 and 11

Read the following write up carefully and answer the following questions:

Let $f(x) = x^2 + b_1x + c_1$, $g(x) = x^2 + b_2x + c_2$. Real roots of f(x) = 0 be α, β and real roots of g(x) = 0 be $\alpha + \delta$, $\beta + \delta$. Least value of f(x) be $-\frac{1}{4}$, least value of g(x) occurs at $x = \frac{7}{2}$

10. The least value of g(x) is

(A) -1 (B) $-\frac{1}{2}$

(C) $-\frac{1}{4}$ (D) $-\frac{1}{3}$

11. The value of b_2 is

(A) 6 (B) -7

(C) 8 (D) 0.

Paragraph for Questions 12 and 14

Read the following write up carefully and answer the following questions:

Tangents PA and PB are drawn to the circle $(x - 4)^2 + (y - 5)^2 = 4$, from the point P on the curve y = sinx, where A and B lie on the circle. Consider the function y = f(x) represented by the locus of the centre of the circumcircle of triangle PAB, then answer the following questions.

12. Range of y = f(x) is

(A) [– 2, 1] (B) [–1, 4]

(C) [0, 2] (D) [2, 3]

13. Period of y = f(x) is

(A) 2π (B) 3π

(C) π (D) not defined.

14. Which of the following is true

(A) f(x) = 4, has real roots (B) f(x) = 1, has real roots

(C) Range of $y = f^{-1}(x)$ is $\left[-\frac{\pi}{4}+2, \frac{\pi}{4}+2\right]$ (D) none of these.

Space for rough work

SECTION – B

(Matrix-Match Type)

This section contains **2 questions**. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in column I have to be matched with statements (p, q, r, s, t) in column II. The answers to these questions have to be appropriately bubbled as illustrated in the following example.

If the correct match are A-p, A-s, B-q, B-r, C-p, C-q and D-s, then the correctly bubbled 4 × 4 matrix should be as follows:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the following Column-I with Column-II

Column – I	Column – II
(A) Let N be the no. of solutions of the equation $\|x^2 - x - 6\| = x + 2$, then the value of N is	(p) –3
(B) If $x^2 + \lambda x + 1 = 0$ and $(b - c)x^2 + (c - a)x + (a - b) = 0$ have both the roots common, then $[\lambda - 1]$ is (where [.] denotes the greatest integer function)	(q) – 2
(C) If, $-3 < \dfrac{x^2 - \lambda x - 2}{x^2 + x + 1} < 2$, for $x \in R$, then $[\lambda]$ is can be where [.] denotes the greatest integer function	(r) –1
(D) the equation $x^3 - 6x^2 + 9x + \lambda = 0$ have exactly one root in (1, 3), then $[\lambda + 1]$ is (where [.] denotes the greatest integer function)	(s) 3
	(t) 0

2. Match the following Column-I with Column-II

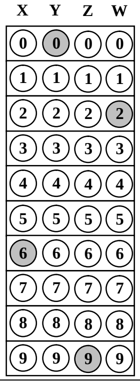
Column – I	Column – II
(A) Lines $x - 2y - 6 = 0$, $3x + y - 4 = 0$ and $\lambda x + 4y + \lambda^2 = 0$, are concurrent, then the value of λ is	(p) 2
(B) The points $(\lambda + 1, 1)$,$(2\lambda + 1, 3)$ and $(2\lambda + 2, 2\lambda)$ are collinear, then the value of λ is	(q) 4
(C) If line $x + y - 1 - \lambda = 0$, passing through the intersection of $x - y + 1 = 0$ and $3x + y - 5 = 0$, is perpendicular to one of them then the value of λ is	(r) – ½
(D) If line $y - x - 1 + \lambda = 0$ is equally inclined to axes and equidistant from the points (1, – 2) and (3, 4), then λ is	(s) – 4
	(t) 3

Space for rough work

SECTION – C

Integer Answer Type

This section contains **5 questions**. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown



1. The area of a triangle whose vertices are (b, c), (c, a) and (a, b) is Δ and the area of the triangle whose vertices are $(ac - b^2, ab - c^2)$, $(ab - c^2, bc - a^2)$ and $(bc, - a^2, ac - b^2)$ is Δ'. If a, b, c represent the sides of a triangle of perimeter 16. Then $\frac{\Delta'}{256\Delta}$ is equal to ______

2. If $ax + by - 5 = 0$ is the equation of the chord of the circle $(x - 3)^2 + (y - 4)^2 = 4$, which passes through (2, 3) and at the greatest distance from the centre of the circle, then $|a + b|$ is ____

3. The reflection of the point $(t - 1, 2t + 2)$ in a line is $(2t + 1, t)$ then the line has slope equals to ___

4. Radius of the largest circle which passes through the focus of the parabola $y^2 = 4x$ and contained in it, is _____

5. The shortest distance between parabolas $y^2 = 4x$ and $y^2 = 2x - 6$ is d then d^2 is _____

Space for rough work

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ALL INDIA INTEGRATED TEST SERIES

ANSWERS, HINTS & SOLUTIONS
HALF COURSE TEST–VIII
(Paper - 1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**B**	**A**	**D**
2.	**A**	**B**	**A**
3.	**C**	**D**	**B**
4.	**A**	**A**	**A**
5.	**A**	**C**	**B**
6.	**B**	**D**	**C**
7.	**A, B, C**	**B, C, D**	**A, C**
8.	**A, B, D**	**A, B, C, D**	**A, B, C, D**
9.	**A, B, C, D**	**A, B, D**	**A, B, C, D**
10.	**D**	**C**	**C**
11.	**A**	**A**	**B**
12.	**A**	**D**	**D**
13.	**A**	**D**	**C**
14.	**C**	**A**	**C**
1.	**(A) $\rightarrow$ (s),** **(B) $\rightarrow$ (p)** **(C) $\rightarrow$ (p),** **(D) $\rightarrow$ (q, r)**	**(A) $\rightarrow$ (r);** **(B) $\rightarrow$ (q);** **(C) $\rightarrow$ (p);** **(D) $\rightarrow$ (s, t)**	**(A) $\rightarrow$ (s)** **(B) $\rightarrow$ (p)** **(C) $\rightarrow$ (r,t)** **(D) $\rightarrow$ (p,q,r,t)**
2.	**(A) $\rightarrow$ (r),** **(B) $\rightarrow$ (q)** **(C) $\rightarrow$ (q),** **(D) $\rightarrow$ (s)**	**(A) $\rightarrow$ (p, s);** **(B) $\rightarrow$ (p, q, r, t);** **(C) $\rightarrow$ (p, q, t);** **(D) $\rightarrow$ (p)**	**(A) $\rightarrow$ (p, s)** **(B) $\rightarrow$ (p, r)** **(C) $\rightarrow$ (p)** **(D) $\rightarrow$ (p)**
1.	**6**	**8**	**1**
2.	**3**	**3**	**2**
3.	**6**	**4**	**1**
4.	**5**	**8**	**4**
5.	**5**	**5**	**5**

Physics

PART – I

SECTION – A

1. $R = \frac{N}{t} = a\frac{P}{T}\sqrt{T} = a\frac{P}{\sqrt{T}}$

Now we can see that when temperature increases 4 times and pressure increases 8 times, the rate of outflow of the gas increases 4 times.

2. The vertical component of acceleration of block 1 and block 2 are

$a_1 = g\sin^2 60°,\ a_2 = g\sin^2 30°$

Since vertical displacement for both blocks is 1 m, the block with larger acceleration will reach the base of wedge first. Hence block of mass m_1 shall reach base of wedge first.

3. Let length of semi major axis is a and eccentricity is e.

$$-\frac{GMm}{R_e} + \frac{1}{2}m\left(\sqrt{\frac{GM_e}{R_e}}\right)^2 = -\frac{GM_e m}{2a} \Rightarrow a = R_e$$

As the separation between ends of semi minor axis and focus is equal to length of semi major axis we can say that launching and landing sites are ends of semi minor axis.

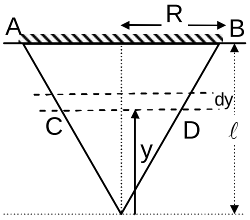
$\Rightarrow R_e\cos 45° = ae \Rightarrow e = 1/\sqrt{2}$

Then maximum separation will be $a + ae = R_e\frac{\left(\sqrt{2}+1\right)}{\sqrt{2}}$

4. $T = 2\pi\sqrt{\frac{\frac{mr^2}{4} + mx^2}{mgx}}$, put $\frac{dT}{dx} = 0$ we get $x = \frac{r}{2}$

5. Weight of OCD part = $m(y/L)^3 g$

Radius of CD = $(y/\ell)R$



Stress at CD = $\dfrac{m\left(\frac{y}{\ell}\right)^3 g}{\pi\left\{\left(\frac{y}{\ell}\right)R\right\}^2}$

Elastic potential energy per unit volume at CD = $\dfrac{1}{2}\dfrac{1}{Y}\left[\dfrac{m\left(\frac{y}{\ell}\right)^3 g}{\pi\left\{\left(\frac{y}{\ell}\right)R\right\}^2}\right]^2$

$$\text{Total elastic potential energy} = \int_0^{\ell}\frac{1}{2}\frac{1}{Y}\left[\frac{m\left(\frac{y}{\ell}\right)^3 g}{\pi\left\{\left(\frac{y}{\ell}\right)R\right\}^2}\right]^2 \pi\left\{\left(\frac{y}{\ell}\right)R\right\}^2 dy = \frac{m^2g^2\ell}{10\pi R^2 Y}$$

6. $$\frac{1}{2}mv^2 = \int_{\frac{3\lambda}{4}}^{L+\frac{3\lambda}{4}} F_0\cos\left(\frac{2\pi x}{\lambda}\right)dx = \frac{F_0\lambda}{2\pi}\int_{\frac{3\lambda}{4}}^{L+\frac{3\lambda}{4}} \cos y\,dy = \frac{F_0\lambda}{2\pi}\left[\sin\left(\frac{2\pi L}{\lambda}+\frac{3\pi}{2}\right)-\sin\frac{3\pi}{2}\right] = \frac{F_0\lambda}{2\pi}\left(1-\cos\frac{2\pi L}{\lambda}\right)$$

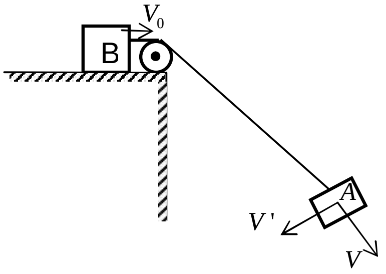
$$v = \sqrt{\frac{F_0\lambda}{m\pi}\left(1-\cos\frac{2\pi L}{\lambda}\right)}$$

7. Pressure force is balanced by spring force. Work done & change in internal energy can be calculated by energy conservation.

8. Apply conservation of momentum and equation of coefficient of restitution.

9. Node should be at clamped ends and antinode should be at free end.

11. Let velocity of block B at that moment be V. component of velocity of A along string at that instant is also V and component perpendicular to string ray V', then applying conservation of angular momentum about pulley $mV'2l = mV_0l$



$\Rightarrow V' = V_0/2$

Applying conservation of energy

Initial KE = Final KE

$$\frac{1}{2}mV^2 + \frac{1}{2}\left(V^2 + V'^2\right) = \frac{1}{2}mV_0^{\,2}$$

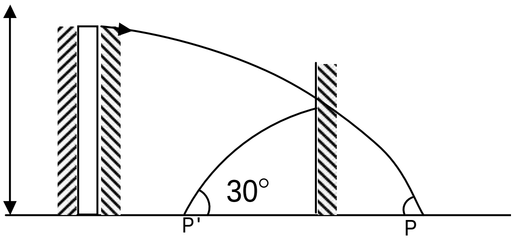
Solving, $V = V_0\sqrt{\frac{3}{8}}$.

After B strikes pulley component velocities along string becomes zero and component perpendicular to string remains unchanged

$$V' = \frac{V_0}{2}.$$

SECTION – C

1. AP is the motion of projectile in absence of wall, which is half of a normal projectile with range R = 2 OP and angle of projection θ = 30° and height H



$$BP' = OP' = \frac{1}{2}OB = BP$$

$$\Rightarrow OP = \frac{3}{2}OB$$

$$\Rightarrow R = 12\sqrt{3}m$$

$$H = \frac{u^2\sin^2\theta}{2g}$$

$$R = \frac{u^2\sin 2\theta}{g}$$

$$\Rightarrow H = \frac{1}{2}\left(\frac{\sin^2\theta}{\sin 2\theta}\right)R = 6$$

2. Particle will cross the square if it crosses the point of maximum potential between A and C–which is C itself.

$$\frac{1}{2}mv_0^2 = K + \frac{1}{4\pi\varepsilon_0}\frac{4Q^2q}{(l/\sqrt{2})}$$

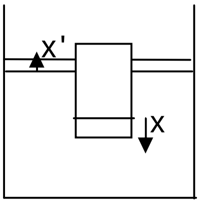
$$K > 0 \Rightarrow V_0^2 = 8\sqrt{2}\left(\frac{1}{4\pi\varepsilon_0}\right)\left(\frac{Qq}{ml}\right)$$

3. Cylinder can perform SHM only till it is partially submersed. When cylinder goes down x in ground from liquid level comes up by x' (say)

(4a – a)x' = xa ⇒ x' = x/3

So the centre of the cylinder goes down by (w.r.t. the liquid surface).

$$(x + x') = \frac{4}{3}x \le \frac{l}{10} \;\Rightarrow\; x \le \frac{3l}{40} = 6\text{cm}.$$



4. Constant velocity means zero acceleration, both block work under dynamic equilibrium.

For B,

T = f = μmg

$$\Rightarrow \frac{T}{\mu} = 5$$

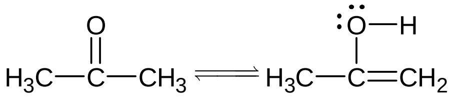
5. $$v^2 = \frac{T}{\mu} = \frac{3Mg}{\mu} + gx$$

$$a = v\frac{dv}{dx} = \frac{g}{2} = 5m/s^2.$$

Chemistry PART – II

SECTION – A

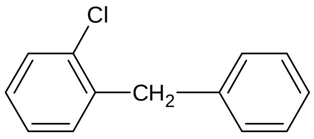
2.



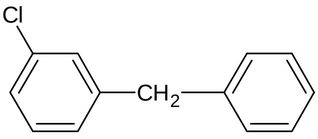
$$H_3C-\overset{\overset{O}{\|}}{C}-CH_3 \rightleftharpoons H_3C-\overset{\overset{:\ddot{O}-H}{|}}{C}=CH_2$$

keto form   enolic form

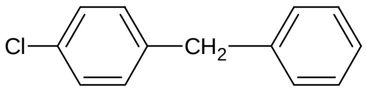
3.



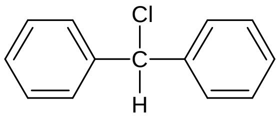
(I)



(I)



(III)



(IV)

4.

$$H_2SO_4 \rightleftharpoons H^+ + HSO_4^-$$

$$H^+ + OH-NO_2 \longrightarrow H_2O + \underset{\substack{(\text{nitronium ion})\\ \text{electrophile}}}{\overset{+}{N}O_2}$$

5.

$$\begin{array}{lcc} & N_2O_4(g) \rightleftharpoons & 2NO_2(g) \\ t_0 & 1 & 0 \\ t_{eq} & 1-\alpha & 2\alpha \end{array}$$

$\sum n = 1-\alpha+2\alpha = 1+\alpha$

$\Delta n_g = 2 - 1 = 1$

$$K_p = \frac{(2\alpha)^2}{(1-\alpha)} \times \left(\frac{P}{1+\alpha}\right)^1 \Rightarrow K_p = \frac{4\alpha^2}{1-\alpha^2}.P$$

$$\alpha = \left[\frac{K_p/P}{4+K_p/P}\right]^{1/2}$$

6.

$$A_2X_3 \rightleftharpoons 2A^{3+} + 3X^{2-}$$

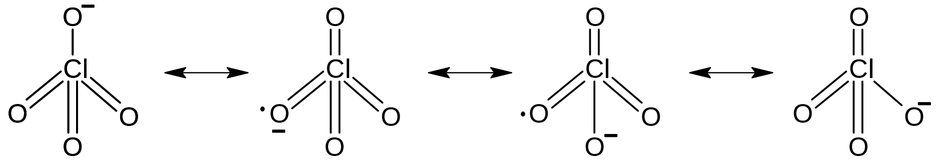
$$\quad 2s \quad 3s$$

$K_{sp} = [A^{3+}]^2[X^{2-}]^3 = [2s]^2[3s]^3 = 108\ s^5$

8. (a) $r \propto \frac{n^2}{Z}$, (b) P.E. $\propto \frac{-Z^2}{n^2}$, (c) K.E. $\propto \frac{Z^2}{n^2}$, (d) $v \propto \frac{Z}{n}$

12. CH_4 has no π - bond.

13.



$$\text{B.O.} = \frac{\text{total bond on Cl in any resonating structure}}{\text{total number of resonating structure}} = \frac{7}{4} = 1.75$$

SECTION – C

1.

$$Mg(OH)_2 \rightleftharpoons Mg^{2+} + 2OH^-$$

$$\qquad x \qquad 2x + 3y$$

$$Al(OH)_3 \rightleftharpoons Al^{3+} + 3OH^-$$

$$\qquad y \qquad 3y + 2x$$

$$K_{sp} = 4 \times 10^{-12} = x(3y + 2x)^2 \text{ and } 10^{-33} = y(3y + 2x)^3$$

$$\frac{x}{y} = 8 \times 10^{17} \times 10^{-17} = 8$$

Mathematics

PART – III

SECTION – A

1. $D_1 + D_2 + D_3 = a^2 + c^2 + d^2 \geq 0$

2. To be perfect square, both the given equations have equal roots

$\therefore \quad \frac{1}{1} = -\frac{(\lambda - 2)}{\lambda} = \frac{\lambda^2}{2\lambda - 1}$

$\therefore \quad \lambda = 1$

3. a = cos θ, b = sin θ

$\therefore \quad h = \sqrt{\cos^2\theta - \sin^2\theta},\ k = \frac{\sin^2\theta}{\cos\theta}$

$\therefore$ locus, is
$2y^2(x^2 + 1) = (x^2 - 1)^2$

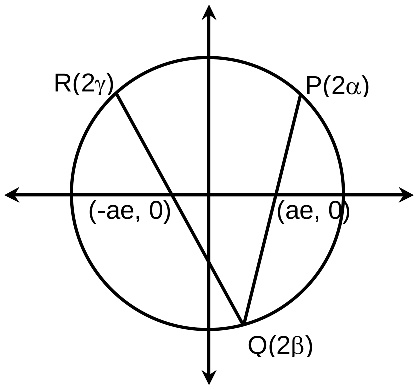
4. Equation of PQ : $\frac{x}{a}\cos(\alpha + \beta) + \frac{y}{b}\sin(\alpha + \beta) = \cos(\alpha - \beta)$

$e = \frac{\cos(\alpha - \beta)}{\cos(\alpha + \beta)}$

$e = -\frac{\cos(\beta - \gamma)}{\cos(\beta + \gamma)}$

$\therefore \quad \frac{\cos(\alpha - \beta)}{\cos(\alpha + \beta)} = -\frac{\cos(\beta - \gamma)}{\cos(\beta + \gamma)}$

Applying, component and dividend
$\tan\alpha \cdot \tan\gamma = \cot^2\beta$.



6. Let, P(h, 0) be point on x-axis apply
$T = S_1$, and passes through the point $(a(\lambda - 1), a(\lambda + 1))$
We get
$\lambda^2 - 12\lambda - 4 > 0$.

7. $\tan\alpha \cdot \tan\beta = -1$

$\Rightarrow \quad \alpha - \beta = \frac{\pi}{2}$.

8. Let the slope of u = 0 be m then the slope of v = 0 is $\frac{9m}{2}$

$\therefore \quad \frac{7}{9} = \left|\frac{m - \frac{9m}{2}}{1 + m \cdot \frac{9m}{2}}\right| \Rightarrow m = \pm\frac{1}{3}, \pm\frac{2}{3}$.

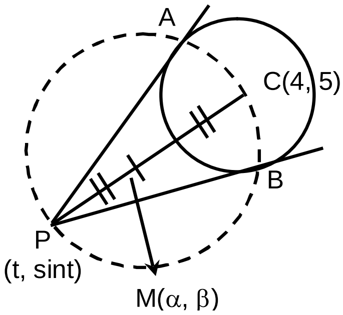
10. Clearly, $D_1 = D_2$

$\therefore \quad -\frac{D_1}{4} = -\frac{1}{4} \Rightarrow D_1 = D_2 = 1$

least value of g(x) = $-\dfrac{1}{4}$

11. $-\dfrac{b_2}{2} = \dfrac{7}{2} \Rightarrow b_2 = -7.$

12-14. $\alpha = \dfrac{t+4}{2}$



$\Rightarrow$ t = 2α – 4

$\beta = \dfrac{5+\sin t}{2}$

$\Rightarrow \quad = \dfrac{5\sin(2\alpha - 4)}{2}$

$\therefore \quad y = \dfrac{5+\sin(2x-4)}{2}$

$\therefore$ Range of f(x) = [2, 3]

Period of f(x) = π

Range of $f^{-1}(x)$ = $\left[-\dfrac{\pi}{4}+2, \dfrac{\pi}{4}+2\right]$

SECTION – B

1. (A) If, x < 2

$\therefore$ x = – 2, 4

no solution

If, –2 ≤ x < 3

$\therefore$ x = 2, – 2

two solution

If, x ≥ 3

$\therefore$ x = 4

one solution

$\therefore$ N = 3

(B) x = 1, satisfies

$\therefore$ λ = – 2

$\therefore$ [λ – 1] = – 3

(C) $-3x^2 - 3x - 3 < x^2 - \lambda x - 2 < 2x^2 + 2x + 2$

solving, we get

λ ∈ (–1, 2)

$\therefore$ [λ] = –1, 0, 1

(D) $f(x) = x^3 - 6x^2 + 9x + \lambda$

f(1) = λ + 4

f(3) = λ

f′(x) < 0 in (1, 3)

$\therefore$ f(1) f(3) < 0

$\therefore\ \lambda(\lambda + 4) < 0$

$\therefore\ [\lambda + 1] = -3, -2, -1, 0.$

2. (A) $\begin{vmatrix} 1 & -2 & -6 \\ 3 & 1 & -4 \\ \lambda & 4 & \lambda^2 \end{vmatrix} = 0 \Rightarrow \lambda = 2, -4$

(B) $\begin{vmatrix} \lambda+1 & 1 & 1 \\ 2\lambda+1 & 3 & 1 \\ 2\lambda+2 & 2\lambda & 1 \end{vmatrix} = 0 \Rightarrow \lambda = 2, -1/2.$

(C) Point of intersection of $x - y + 1 = 0$
and $3x + y - 5 = 0$, is (1, 2)
$\therefore\ 1 + 2 - 1 - \lambda = 0 \Rightarrow \lambda = 2.$

(D) Mid-point of (1, – 2) and (3, 4) will satisfy $y - x - 1 + \lambda = 0 \Rightarrow \lambda = 2.$

SECTION – C

1. $\Delta = \frac{1}{2}\begin{vmatrix} b & c & 1 \\ c & a & 1 \\ a & b & 1 \end{vmatrix} = \frac{1}{2}\ (ab + ca + ab - a^2 - b^2 - c^2)$

$\Delta' = (a + b + c)^2\,\Delta \Rightarrow \frac{\Delta'}{256\Delta} = 1$

2. $2a + 3b - 5 = 0$
$\therefore$ line is at greatest distance from centre
$\therefore\ \left(\frac{4-3}{3-2}\right)\left(-\frac{a}{b}\right) = -1 \Rightarrow a = b$
$\therefore\ |a + b| = 2$

3. Let m be the slope of line
$\therefore\ m \times \left(\frac{2t+2-t}{(t-1)-(2t+1)}\right) = -1$
$\therefore\ m = 1.$

4. Equation of the circle is
$(x - r - 1)^2 + y^2 = r^2$
putting $y^2 = 4x$ and D = 0
$\therefore\ r = 4$

5. Shortest distance along common normal, slope of common normal = 0, ±2
$\therefore$ feet of normals will be (4, 4) and (5, 2) or (4, – 4) and (5, – 2)
$\therefore\ d = \sqrt{1+4} = \sqrt{5} \Rightarrow d^2 = 5$

FIITJEE Students From All Programs have bagged 33 in Top 100, 77 in Top 200 and 205 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2015:
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ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Advanced), 2016**

HALF COURSE TEST – VIII

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 243**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 06)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (07 – 09) contains 3 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

   Section-A (10 – 14) contains 2 paragraphs. Based upon paragraph, 2 and 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.
2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct matching. No marks will be given for any wrong matching in any question. There is no negative marking.
3. **Section-C (01 – 05)** contains 5 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate

Enrolment No.

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Straight Objective Type

This section contains **6 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. A tank is filled with water to a height H. Two holes are made on its side wall, one at height of h from the bottom and the other at a depth h from the top. The horizontal jets starting from the two holes meets outside the tank at some point. The distance of this point from the side of the tank is

(A) $\sqrt{[4h(H-h)]}$ (B) $\sqrt{[4H(H-h)]}$

(C) $\sqrt{[2h(H-h)]}$ (D) $\sqrt{[3h(H-h)]}$

2. Shampoo is being poured into a vessel of frustum shaped with constant volume flow rate 16.5 cm^3/s. At what rate is its level in the bottle rising at a point where diameter of the bottle is 6.30 cm. (keeping significant figures in view)

(A) 0.063 cm/s (B) 0.63/cm/s
(C) 0.529 cm/s (D) 0.5291 cm/s

3. A particle moves along x-axis following the relation $px^2 + qv^2 = r,$ where p, q, r are positive constants. x is co-ordinate of the particle and v is the instantaneous speed. The time interval between two consecutive instants, when particle is at rest is

(A) $2\pi\sqrt{\frac{q}{p}}$ (B) $\pi\sqrt{\frac{q}{p}}$

(C) $\pi\sqrt{\frac{p}{q}}$ (D) $2\pi\sqrt{\frac{p}{q}}$

Space for rough work

4. A certain quaternary star system consist of three star, each of mass ‘m’ moving in same circular orbit of radius ‘r’ about a central star of mass ‘M’. The stars orbit in same sense and are positioned one-third of circumference apart from one another. The period of revolution of each star will be

(A) $2\pi\sqrt{\dfrac{r^3}{G\left(M+\dfrac{m}{\sqrt{3}}\right)}}$

(B) $2\pi\sqrt{\dfrac{r^3}{G(M+m)}}$

(C) $2\pi\sqrt{\dfrac{r^3}{G(M+3m)}}$

(D) $2\pi\sqrt{\dfrac{r^3}{GM}}$

5. If velocity of sound in Hydrogen at certain temperature is v_0. The velocity of sound in a mixture of two parts by volume of Hydrogen and one part of oxygen at same temperature is

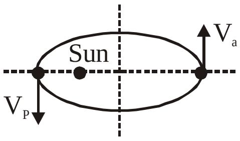
(A) $v_0\sqrt{6}$

(B) $v_0\sqrt{3}$

(C) $\dfrac{v_0}{\sqrt{6}}$

(D) $\dfrac{v_0}{\sqrt{3}}$

6. A planet moves around Sun in an elliptical orbit of eccentricity e. The ratio of the velocity at perigee V_p and at apogee V_a is given by



(A) $\dfrac{V_P}{V_a}=\dfrac{1+e}{1-e}$

(B) $\dfrac{V_P}{V_a}=\dfrac{1-e}{1+e}$

(C) $\dfrac{V_P}{V_a}=\sqrt{\dfrac{1+e}{1-e}}$

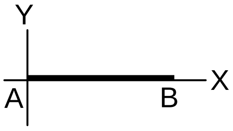
(D) $\dfrac{V_P}{V_a}=\sqrt{\dfrac{1-e}{1+e}}$

Space for rough work

Multiple Correct Choice Type

This section contains **3 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

7. A wire of mass M and length L is placed along x-axis with end A at origin. The linear mass density λ (of the rod) varies as $\lambda = \lambda_0 x$, where x is distance from end A, λ_0 is a constant.



(A) The value of λ_0 is $\frac{2M}{L^2}$

(B) Moment of Inertia of the rod about an axis passing through A and parallel to y-axis is $\frac{1}{2}ML^2$

(C) Moment of inertia of the rod about an axis passing through COM of the rod and parallel to y-axis is $\frac{ML^2}{18}$.

(D) Moment of inertia of the rod about an axis passing through B and parallel to y-axis is $\frac{1}{6}ML^2$.

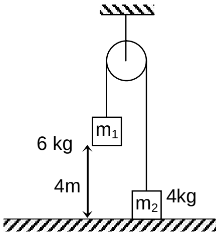
8. Two objects are connected by a light string passing over a light frictionless pulley as shown. The object of mass 6 kg is released from rest. (g = 10 m/s^2)

(A) Time taken by object of mass 6 kg to strike the surface is 2 sec.

(B) Maximum height attained by block of mass 4 kg is 4.8 m.

(C) Duration after which 6 kg block will leave the surface for the first time is 2.8 sec.

(D) None of the above.



9. A boy in an elevator with open roof shoots a bullet in vertically upward direction from a height of 1.5 m above the floor of the elevator. The initial speed of the bullet with respect to elevator is 15 m/s. The bullet strikes the floor after 2 seconds. Then (Assuming g = 10 m/s^2)

(A) Lift is moving with constant speed

(B) Lift is moving with upward acceleration of 5.75 m/s^2

(C) Lift is moving with downward acceleration of 5.75 m/s^2

(D) Distance travelled by bullet during its flight can not be calculated from the given data.

Space for rough work

Paragraph Type

This section contains **2 paragraphs.** Based upon one of paragraphs **2 multiple** choice questions and based on the other paragraph **3 multiple** choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

Paragraph for Questions Nos. 10 and 11

In a standing wave experiment a 1.2kg horizontal rope is fixed in place at its two ends ($x = 0$ and $x = 2.0m$) and made to oscillate up and down in the fundamental mode, at frequency 5.0Hz. At $t = 0$ the point at $x = 1.0m$ has zero displacement and is moving upward in the positive direction of y-axis with a transverse velocity $3.14ms^{-1}$.

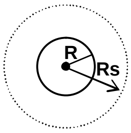
10. Amplitude of the motion of the particle at $x = 1.0m$ is
    (A) 0.16m (B) 0.1m
    (C) 0.08m (D) 0.05m

11. Displacement of the particle at $x = 0.5m$ and time $t = 0.15\sec$ is
    (A) $\frac{1}{5\sqrt{2}}m$ (B) $-\frac{1}{5\sqrt{2}}m$
    (C) $-\frac{1}{10\sqrt{2}}m$ (D) $-\frac{1}{20\sqrt{2}}m$

Space for rough work

Paragraph for Questions Nos. 12 and 14

Supernova refers to the explosion of a massive star. The material in the central case of such a star continues to collapse under its own gravitational pull. If mass of the core is less than 1.4 times the mass of sun, its collapse finally results in a white dwarf star. However, if the core has a mass greater than this, it could end up soon as a neutron star and if its mass is more than about three solar masses, the collapse may still continue till the star becomes a very small object with an extremely high value of density called a 'Black hole'. Escape speed for a black hole is very large. The figure shows a block hole of radius R and another concentric sphere of radius R_S, called the 'Schwarzschild Radius'. It is the critical radius at which escape speed equals the speed of light c. Nothing even the light, can escape from within the sphere of Radius R_S. So light from a black hole cannot escape and hence the terminology 'black hole'.



There has been astronomical evidence of a small and massive object at the centre of our galaxy the 'Milky way'. Suppose that there is a particle at a distance about 6 light years that orbits this massive object with an orbital speed of about 2×10^5 m/s. Use the given data wherever necessary and answer the questions that follow.
$G=6.67\times10^{-11}$ N–m^2/kg^2, Solar mass $M=2 \times 10^{30}$ kg, $C = 3 \times 10^8$ m/s, 1 light year = 9.5×10^{15} m.

12. Mass (in kg) of the massive object at the centre of the milky way galaxy is of the order.
(A) 10^{32} (B) 10^{37}
(C) 10^{43} (D) 10^{29}

13. Theories suggest that it is not possible for a single star to have a mass of more than 50 solar masses. The massive object at the centre of milky way galaxy is most likely to be a
(A) white dwarf (B) neutron star
(C) black hole (D) single ordinary star

14. If mass of earth $M_E \approx 6\times10^{24}$ kg and its radius R_E = 6400 km, to what fraction of its presents radius does the earth need to be compressed in order to become a black hole? (give only the order of your answer)
(A) 10^{-4} (B) 10^{-9}
(C) 10^{-7} (D) 10^{-14}

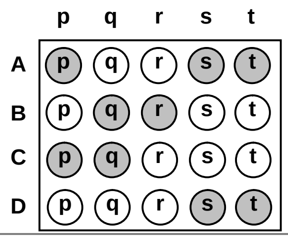
Space for rough work

SECTION – B

(Matrix-Match Type)

This section contains **2 questions**. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in column I have to be matched with statements (p, q, r, s, t) in column II. The answers to these questions have to be appropriately bubbled as illustrated in the following example.

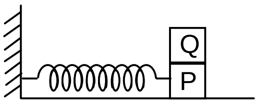
If the correct match are A-p, A-s, B-q, B-r, C-p, C-q and D-s, then the correctly bubbled 4 × 4 matrix should be as follows:



1. Relate the standard reversible process for an ideal gas in Column I to some facts in Column II corresponding to a process.

Column I		Column II	
(A)	Isochoric	(p)	Temperature remains constant.
(B)	Isobaric	(q)	Internal energy of the gas does not change.
(C)	Isothermal	(r)	Work done by the gas may be positive, negative or zero.
(D)	Adiabatic	(s)	Energy exchange between the system and surrounding takes place only through work.
		(t)	The density of the gas does not change.

2. Match the following :
A block P of mass m placed on smooth horizontal surface and connected with a spring. Another block Q of same mass is placed on the block P. The two blocks are pulled by a distance A and released. The blocks oscillates without slipping on each other. Then match the matrix.



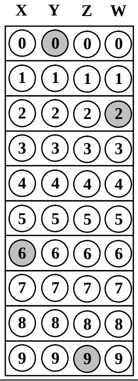
Column – I	Column – II
(A) Friction force on the block Q, When both block coming towards equilibrium position form left. (exclude the equilibrium position)	(p) towards right
(B) Friction force at the block Q when both block going right from equilibrium position. (exclude the equilibrium position)	(q) towards left
(C) Friction force will be maximum on Q.	(r) at equilibrium position
(D) Friction force on P when both block is coming towards the equilibrium position from right. (exclude the equilibrium position)	(s) At extreme position
	(t) none of these

Space for rough work

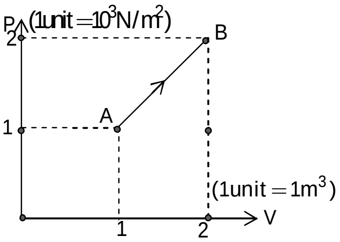
SECTION – C

Integer Answer Type

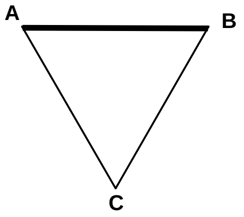
This section contains **5 questions**. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown



1. For P-V diagram shown for a diatomic ideal gas, heat given to the gas from A to B is(in kJ).



2. Three rods of equal length are joined to from an equilateral Δ ABC. The temperature coefficient of linear expansion is α_1 for AB, α_2 for AC and BC. For $\alpha_1 = k\alpha_2$, $\angle$ABC remains constant for small changes in temperature. Find K.



Space for rough work

3. A force $\vec{F} = \left(-y\hat{i} + x\hat{j}\right)$N acts on a particle which undergoes counterclockwise circular motion in x-y plane in a circle of radius 4 m and with the centre at the origin. The work done by the force when the particle undergoes one complete revolution is (assume x, y are in m) 4πK Joule. Find K.

4. A body of mass m = 4 kg starts moving with velocity v_0 in a straight line is such a way that on the body work is being done at the rate which is proportional to the square of velocity as given by P = βv^2 where $\beta = \frac{0.693}{2}$. Find the time elapsed in seconds before velocity of body is doubled.

5. A sound source of frequency f_0 = 130 Hz is dropped from a height slightly greater than 250 m above the ground. At the same time a detector is thrown upwards with velocity u = 50 ms^{-1} along the same line. If the speed of sound is v = 300 ms^{-1}, if the frequency (in Hz) detected by the detector after t = 5 s is 39 × n, find the value of n (Take g = 10 ms^{-2})

Space for rough work

Chemistry

PART – II

SECTION – A

Straight Objective Type

This section contains **6 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. SiCl$_4$ hydrolyses completely, its hydrolysis constant may be expressed in term of ionic product of water K$_w$ and K$_b$ of silicon hydroxide as

(A) $\frac{K_w}{K_b}$ (B) $\frac{K_w^2}{K_b}$
(C) $\frac{K_w^4}{K_b}$ (D) $\frac{K_w}{K_b^4}$

2. Which of the following are not acceptable sets of quantum numbers for an electron in an atom?

(1) $n = 3,\ \ell = 0,\ m = 1,\ s = -\frac{1}{2}$ (2) $n = 3,\ \ell = 1,\ m = -1,\ s = \frac{1}{2}$
(3) $n = 3,\ \ell = 2,\ m = 0,\ s = -\frac{1}{2}$ (4) $n = 3,\ \ell = 1,\ m = 2,\ s = \frac{1}{2}$

Select the correct answer from the code given below:
(A) 1 and 2 (B) 1 and 3
(C) 1 and 4 (D) 2 and 3

3. Equilibrium constant for the given reaction is K = 10^{20} at temperature 300 K:

$$\underset{(s)}{A} + \underset{(aq)}{2B} \rightleftharpoons \underset{(s)}{2C} + \underset{(aq)}{D}$$

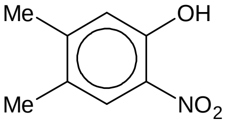
The equilibrium concentration of B starting with mixture of 1 mole of A and 1/3 mole/litre of B at 300 K is (volume of solution of A is 1 litre)
(A) 4×10^{-11} (B) 2×10^{-10}
(C) 2×10^{-11} (D) 10^{-10}

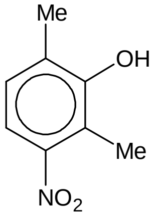
Space for rough work

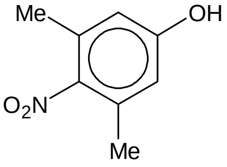
4. Three gases A, B and C are at the same pressure and temperature. If their root mean square velocities are in the ratio of $1 : \frac{1}{\sqrt{2}} : \frac{1}{\sqrt{3}}$ then their vapour densities will be in the ratio

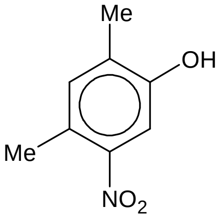
(A) 1 : 2 : 3
(B) 3 : 2 : 1
(C) $1 : \sqrt{2} : \sqrt{3}$
(D) $\sqrt{3} : \sqrt{2} : \sqrt{1}$

5. Which of the following phenols will show highest acidity?

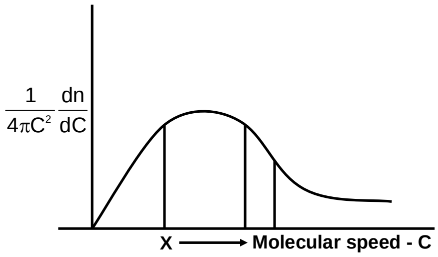
(A)


(B)


(C)


(D)


6. The Maxwell–Boltzmann distribution law of molecular speeds is graphically represented as:



The curve has which of the following characteristics:
(1) It has symmetrical distribution.
(2) The point X on axis represents the most probable speed.
(3) The area under the curve gives the total number of molecules.
(4) The maximum shift to the right as the temperature increases.
Choose the correct answer using the codes given below:
(A) 1, 2 and 3
(B) 2, 3 and 4
(C) 1 and 2
(D) 3 and 4

Space for rough work

Multiple Correct Choice Type

This section contains **3 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

7. Which of the following disproportionate (s) on heating with NaOH?
(A) P_4
(B) S_8
(C) Cl_2
(D) B

8. If 100 ml of 1 M H_2SO_4 is mixed with 100 ml of 98% (w/w) H_2SO_4 (d = 0.1 g/ml) then
(A) concentration of the solution remain same
(B) volume of the solution becomes 200 ml
(C) mass of H_2SO_4 becomes 98 g
(D) mass of H_2SO_4 in the solution is 19.6 g

9. In which of the following pair the first one is the stronger base than second?
(A) CH_3COO^-, $HCOO^-$
(B) OH^-, $\overset{-}{N}H_2$
(C) PhOH, PhO^-
(D) CH_3NH_2, CH_3OH

Paragraph Type

This section contains **2 paragraphs.** Based upon one of paragraphs **2 multiple** choice questions and based on the other paragraph **3 multiple** choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

Paragraph for Question Nos. 10 to 11

10 gm mixture of $FeSO_4$ and FeC_2O_4 on reaction with $KMnO_4$ is acidic medium utilises 100 ml of 5 M oxidising agent. When $FeSO_4$ is alone treated it used 25 ml of 0.05 M of same oxidising agent.

10. Total number of moles of ferrous ions oxidized by 1 mole of $KMnO_4$
(A) 5/3
(B) 4/5
(C) 2/5
(D) 5/2

11. Percentage of pure FeC_2O_4 in the mixture by weight is
(A) 95
(B) 9.5
(C) 90.5
(D) 25

Space for rough work

Paragraph for Question Nos. 12 to 14

Systematic arrangement of element on the basis of increasing atomic number give periodic table. This table is based on certain periodic properties which is helpful in study of the inorganic compound.

12. Select the correct arrangement:

(A) Melting point
AgCl $>$ KCl

(B) Ionic radii
$Li^+ > Na^+$

(C) Ionization energy
Be $>$ B

(D) Electronegativity
Cl $>$ F

13. Incorrect statement among the following is

(A) thermal stability increase in case of alkaline earth metal carbonate
(B) aqueous solution of $Ca_2B_6O_{11}$ can act as a buffer in aqueous solution
(C) solubility of alkaline earth metal sulphate increase down the group
(D) ionic character of alkaline earth metal chloride increase down the group

14. Which of the following is the strongest reducing agent in aqueous solution?

(A) Na
(B) K
(C) Cs
(D) Li

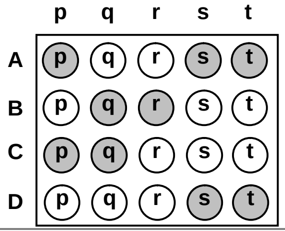
Space for rough work

SECTION – B

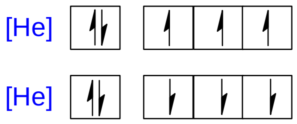
(Matrix-Match Type)

This section contains **2 questions**. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in column I have to be matched with statements (p, q, r, s, t) in column II. The answers to these questions have to be appropriately bubbled as illustrated in the following example.

If the correct match are A-p, A-s, B-q, B-r, C-p, C-q and D-s, then the correctly bubbled 4 × 4 matrix should be as follows:



1. Match the following:

	Column – I		Column – II
(A)	Pauli's exclusion principle	(p)	Energy: $\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s$
(B)	Hund's rule of maximum multiplicity	(q)	For B_2 $(\sigma 1s)^2 (\sigma^* 1s)^2 (\sigma 2s)^2 (\sigma^* 2s)^2 \mid (\pi 2p_y)^{m_s = -\frac{1}{2}} (\pi 2p_z)^{m = -\frac{1}{2}} \mid$
(C)	Aufbau energy rule	(r)	For Z = 29 [Ar] $4s^1 3d^{10}$
(D)	Stability of half filled orbitals	(s)	For Z = 7 
		(t)	For Z = 6 $[He] 2s^2 (2p_x)^{m_s = +\frac{1}{2}} (2p_y)^{m_8 = +\frac{1}{2}}$

Note: M_s = magnetic spin quantum number.

2. Match the column – I with chemicals of that in valence in the process:

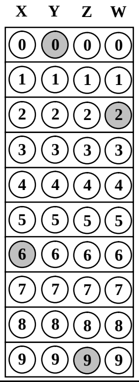
	Column – I		Column – II
(A)	Nelson cell	(p)	NaOH
(B)	Down's process	(q)	NaCl (aqueous)
(C)	Castner's process	(r)	Cl_2
(D)	Castner's kellner process	(s)	H_2
		(t)	NaCl (molten)

Space for rough work

SECTION – C

Integer Answer Type

This section contains **5 questions**. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown



1. The equivalent weight for underline molecule in the following reaction is M/n (M = molar mass of P_4). Find n.

   $\underline{P_4} \longrightarrow PH_3 + H_2PO_2^-$

2. Number of Si – O – Si bond in $[Si_3O_9]^{-6}$ is/are.

3. The number of compounds / species in which underlined atoms are sp^2 hybridized will be.

   $\underline{C}O_2, \underline{B}O_2^-, \underline{B}O_3^{3-}, H_3\underline{B}O_3, \underline{B}F_3, H\underline{C}HO, CH_3\underline{C}OOH, \underline{C}O_3^{2-}, \overset{-}{\underline{C}}H_3, \underline{C}(\text{graphite}), \underline{C}(\text{diamond})$

4. In an experiment one mole of $Na_2CO_3.10H_2O$ was heated to a temperature by which it got converted into $Na_2CO_3xH_2O$. Water vapour obtained in this process were used to convert $CuSO_4$ into $CuSO_4.5H_2O$. If 0.6 moles of $CuSO_4$ was hydrated, value of x is.

5. At 300 K and one atmospheric presure 2 L of N_2O_4 (g) was heated to 600 K at constant presure. 50 % of N_2O_4 (g) got dissociated according to the reaction:

   $N_2O_4(g) \rightleftharpoons N_2(g) + 2O_2(g)$

   Final volume of the mixture in litres is.

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **6 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. If, $\cos^6\alpha + \sin^6\alpha + k(\sin 2\alpha)^2 = 1$, $\forall\ \alpha \in \left(0, \frac{\pi}{2}\right)$, then k is

(A) $\frac{3}{4}$ (B) $\frac{1}{4}$

(C) $\frac{1}{3}$ (D) $\frac{1}{8}$.

2. In a ΔABC, if $\angle A = 30^\circ$ and $BC = 2 + \sqrt{5}$, then the distance of the vertex A from the orthocentre of the triangle is

(A) 1 (B) $\sqrt{3}(2+\sqrt{5})$

(C) $\frac{\sqrt{3}+1}{2\sqrt{2}}$ (D) $\frac{1}{2}$.

3. The remainder when $(27)^{40}$ is divided by 12 is

(A) 3 (B) 7

(C) 9 (D) 11.

4. If in a ΔABC, tanA + tanB + tanC > 0, then the triangle is

(A) Acute-angled (B) obtuse-angled

(C) right-angled (D) none of these.

Space for rough work

5. In a ΔABC, if cosA + cosB + cosC = $\frac{7}{4}$, then, $\frac{R}{r}$ is equal to

(A) $\frac{3}{4}$ (B) $\frac{4}{3}$

(C) $\frac{2}{3}$ (D) $\frac{3}{2}$.

6. In a ΔABC, if (a + b + c)(b + c – a) = λbc, then

(A) $\lambda < 0$ (B) $\lambda > 6$

(C) $0 < \lambda < 4$ (D) $\lambda > 4$.

Multiple Correct Choice Type

This section contains **3 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

---

7. Which of following functions have the maximum value unity?

(A) $\sin^2x - \cos^2x$ (B) $\sqrt{\frac{6}{5}}\left(\frac{1}{\sqrt{2}}\sin x + \frac{1}{\sqrt{3}}\cos x\right)$

(C) $\cos^6x + \sin^6x$ (D) $\cos^2x + \sin^4x$.

8. If, $\sin\theta + \cos\theta = -\frac{1}{5}$, then a value of $\tan\frac{\theta}{2}$ satisfies which of the following equations?

(A) $2x^2 - x - 1 = 0$ (B) $x^2 - 2x - 3 = 0$

(C) $2x^2 - 5x - 3 = 0$ (D) $2x^3 - 7x^2 + 2x + 3 = 0$.

9. The sides of a ΔABC satisfy the equation $2a^2 + 4b^2 + c^2 = 4ab + 2ac$, then.

(A) the triangle is isosceles (B) the triangle is obtuse

(C) $B = \cos^{-1}\left(\frac{7}{8}\right)$ (D) $A = \cos^{-1}\left(\frac{1}{4}\right)$

Space for rough work

Paragraph Type

This section contains **2 paragraphs.** Based upon one of paragraphs **2 multiple** choice questions and based on the other paragraph **3 multiple** choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

Paragraph for Question Nos. 10 to 11

Read the following write up carefully and answer the following questions:

Let a_n denote the number of all n-digit positive integers formed by the digits 0, 1 or both such that no consecutive digits in them are 0. Let b_n = the number of such n-digit integers ending with digit 1 and c_n = the number of such n-digit integers ending with digit 0.

10. The value of b_6 is
(A) 7 (B) 8
(C) 9 (D) 11.

11. Which of the following is correct?
(A) $a_{17} = a_{16} + a_{15}$ (B) $a_{17} \neq a_{16} + a_{15}$
(C) $a_{17} \neq b_{16} + c_{16}$ (D) $a_{17} = c_{17} + c_{16}$.

Paragraph for Question Nos. 12 to 14

Read the following write up carefully and answer the following questions:

Let a, b, c are the sides opposite to angles A, B, C respectively in a ΔABC and $\tan\left(\frac{A-B}{2}\right) = \frac{a-b}{a+b}\cot\frac{c}{2}$ and $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$, If a = 6, b = 3 and cos(A – B) = $\frac{4}{5}$

12. Angle C is equal to
(A) $\frac{\pi}{4}$ (B) $\frac{\pi}{2}$
(C) $\frac{3\pi}{4}$ (D) $\frac{2\pi}{3}$.

13. Area of the triangle is equal to
(A) 8 (B) 9
(C) 10 (D) 11.

14. Value of sinA is equal to
(A) $\frac{1}{\sqrt{5}}$ (B) $\frac{2}{\sqrt{5}}$
(C) $\frac{1}{2\sqrt{5}}$ (D) $\frac{1}{\sqrt{3}}$

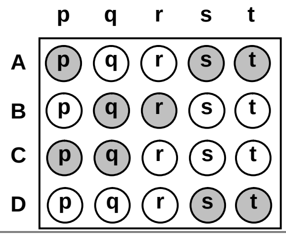
Space for rough work

SECTION – B

(Matrix-Match Type)

This section contains **2 questions**. Each question contains statements given in two columns which have to be matched. Statements (A, B, C, D) in column I have to be matched with statements (p, q, r, s, t) in column II. The answers to these questions have to be appropriately bubbled as illustrated in the following example.

If the correct match are A-p, A-s, B-q, B-r, C-p, C-q and D-s, then the correctly bubbled 4 × 4 matrix should be as follows:



	p	q	r	s	t
A	● p	○ q	○ r	● s	● t
B	○ p	● q	● r	○ s	○ t
C	● p	● q	○ r	○ s	○ t
D	○ p	○ q	○ r	● s	● t

1. Match the following Column-I with Column-II

Column – I		Column – II	
(A)	The total number of selections of atleast one of the fruits which can be made from 3 bananas, 4 apples, and 2 oranges is	(p)	Greater than 50
(B)	If 7 points out of 12 are in the same straight line, then the number of triangles formed is	(q)	Greater than 100
(C)	The number of ways of selecting 10 balls from unlimited number of red, black, white and green balls is	(r)	Greater than 150
(D)	The total number of proper divisors of 38808 is	(s)	Greater than 200
		(t)	Greater than 300

2. Match the following Column-I with Column-II

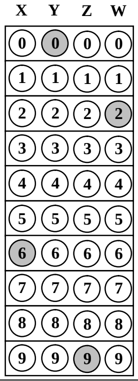
Column – I		Column – II	
(A)	If, $\cos A = \frac{\sin B}{2\sin C}$, then ΔABC is	(p)	isosceles
(B)	If, $\frac{\cos A + 2\cos C}{\cos A + 2\cos B} = \frac{\sin B}{\sin C}$, then ΔABC may be	(q)	obtuse angle
(C)	If, $\frac{2\cos A}{a} + \frac{\cos B}{b} + \frac{2\cos C}{c} = \frac{a}{bc} + \frac{b}{ca}$, then Δ is	(r)	right angle
(D)	If, $\frac{a^2 - b^2}{a^2 + b^2} = \frac{\sin(A-B)}{\sin(A+B)}$, then ΔABC may be	(s)	acute angle
		(t)	equilateral

Space for rough work

SECTION – C

Integer Answer Type

This section contains **5 questions**. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown



1. Let a_1, a_2, a_3, … a_{100} be on arithmetic progression with $a_1 = 3$ and $s_p = \sum_{i=1}^{p} a_i, 1 \le p \le 100$. For any integer n with $1 \le n \le 20$, let $m = 5n$. If $\frac{s_m}{s_n}$ does not depend on n, then a_2 is ______

2. A pack contains n cards numbered from 1 to n. Two consecutive cards are removed from the pack and the sum of the numbers on the remaining cards is 1224. If the smaller of the numbers on the removed cards is k. Then k – 20 = _______

3. If z is any complex number satisfying $|z - 3 - 2i| \le 2$, then the minimum value of $|2z - 6 + 5i|$ is ______.

4. If a, b, c are integers, not all simultaneously equal and ω is cube root of unity ($\omega \ne 1$), then minimum value of $|a + b\omega + c\omega^2|$ is _____

5. Consider a triangle ABC and let a, b, and c denote the lengths of the sides opposite the vertices A, B and C respectively. Suppose a = 6, b = 10 and the area of the triangle is $15\sqrt{3}$, if $\angle ACB$ is obtuse and if r denotes the radius of the incircle of the triangle, then r^2 is equal to _______

Space for rough work

FIITJEE **JEE (Advanced), 2016**

FIITJEE Students From All Programs have bagged 33 in Top 100, 77 in Top 200 and 205 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2015:
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ALL INDIA INTEGRATED TEST SERIES

PART TEST – III

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 10)** contains 10 multiple choice questions which have one or more than one correct answer. Each question carries **+3 marks** for correct answer. There is no negative marking.

(ii) **Section-C (01 – 10)** contains 10 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

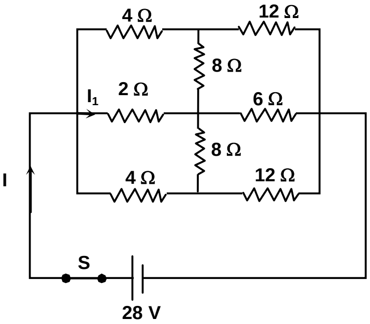
PART – I

SECTION – A

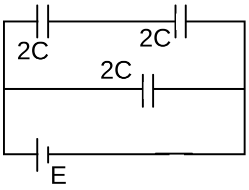
Straight Objective Type

This section contains 10 multiple choice questions numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which ***ONE or MORE*** are correct.

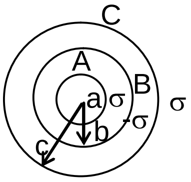
1. In the circuit shown, the current
(A) I = 8 A
(B) I = 7 A
(C) $I_1 = 3.5$ A
(D) $I_1 = 4$ A



2. Three capacitors are connected with the source of electromotive force E as shown in the figure. Heat Loss is
(A) $\frac{1}{2}CE^2$ (B) $\frac{3}{2}CE^2$
(C) $3CE^2$ (D) $2CE^2$

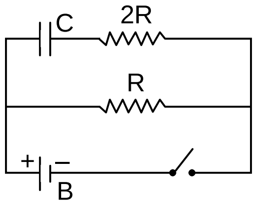


3. The adjacent figure shows charged spherical shells A, B and C having charge densities σ,-σ, σ and radii a, b, c respectively. If $V_A=V_c$ then c equal to (assuming a = 10 cm, b=20 cm,)
(A) 30 cm (B) 50 cm
(C) 25 cm (D) 35 cm



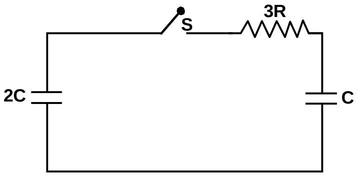
Space for rough work

4. In the circuit shown, when the switch is closed, the capacitor charges with a time constant



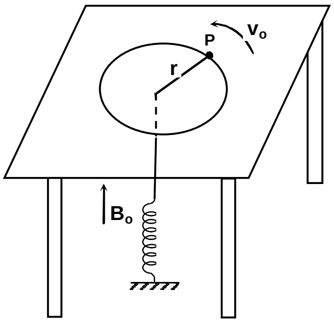
(A) RC
(B) 2RC
(C) $\frac{2RC}{3}$
(D) $\frac{8RC}{3}$

5. The capacitor 2C is charged to potential E_0 while the capacitor C is uncharged at t = 0. At this instant, the switch S is closed.



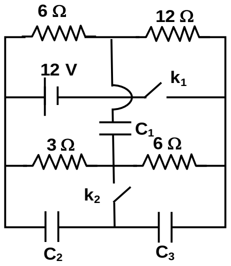
(A) Charge on the capacitor C is $\frac{2}{3}CE_0$ in steady state
(B) Charge on the capacitor 2C is $\frac{4}{3}CE_0$ in steady state
(C) Charge on the capacitor C is $\frac{1}{3}CE_0$ in steady state
(D) Charge on the capacitor 2C is $\frac{5}{3}CE_0$ in steady state

6. A particle mass m charge q is moving on a circular path on the surface of a frictionless table with speed v_o where a magnetic field B_o exists uniformly over the whole region. It is attached by a string which passes through a hole in the table to a spring as shown. The spring is stretched by x_o. If now the magnetic field is increased slowly to $2B_o$,



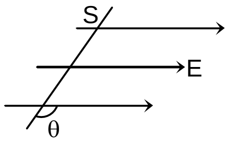
(A) The extension in the spring will increase
(B) The speed of the particle will increase
(C) The speed of the particle will decrease
(D) The kinetic energy of the particle will decrease

Space for rough work



7. Given C_1 = 2μF; C_2 = 4μF, C_3=8μF. C_1, C_2, C_3 are initially uncharged. Initially all the keys are open. Then
(A) In steady state, after closing k_1 alone the charge in capacitor C_1 is zero.
(B) In steady state, after closing k_1 alone the charge in capacitor C_2 and C_3 are 8μC and 4μC.
(C) In steady state, after closing k_1 alone the current drawn from the cell is 2A.
(D) In steady state, after closing k_1 and k_2 the current drawn from the cell is 1A.

8. A proton is fired form origin with velocity $\vec{v} = v_0\hat{j} + v_0\hat{k}$ in a uniform magnetic field $\vec{B} = B_0\hat{j}$. In the subsequent motion of the proton
(A) its z coordinate can never be negative
(B) its x coordinate can never be positive
(C) its x and z coordinates cannot be zero at the same time
(D) its y coordinate will be proportional to its time of flight.



9. A plane surface of area S is inclined at an angle θ with a uniform field $\vec{E}$ as shown in the figure. Find the magnitude of flux of $\vec{E}$ over S.
(A) ES cos θ (B) ES sin θ
(C) – ES cos θ (D) – ES sin θ

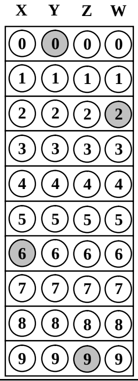
10. The magnetic field intensity inside a long solenoid is 1 T. If the current per turn of the winding is 1 A, Find the number of turns in one meter.
(A) $\frac{1}{4\pi}.10^7$ (B) $\frac{1}{4\pi}.10^6$
(C) $\frac{1}{2\pi}.10^6$ (D) $\frac{1}{8\pi}.10^7$

Space for rough work

SECTION – C

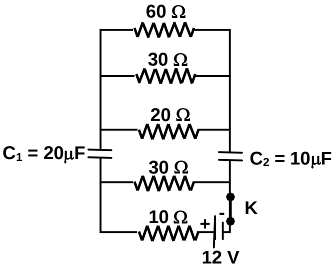
Integer Answer Type

This section contains 10 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown



1. A charged particle is projected in a magnetic field $\vec{B} = \left(x\hat{i} + 4\hat{j}\right)10^{-2}$ T . The acceleration of the particle is found to be a $\vec{a} = \left(\frac{8}{3}\hat{i} - 2\hat{j}\right)m/s^2$. Find the value of x.

2. For the circuit arrangement shown in the figure, find the potential difference (in V) across C_2 in the steady state condition.

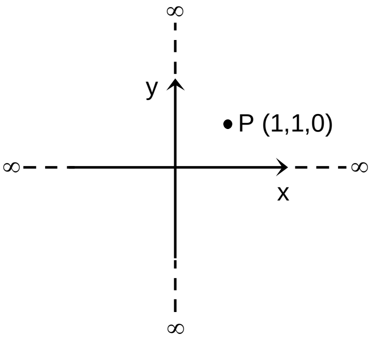


3. A steady current I goes through a wire loop PQR having shape of a right angle triangle with PQ= 3x, PR= 4x and QR= 5x. If the magnitude of the magnetic moment is $k(Ix^2)$. Find the value of k.

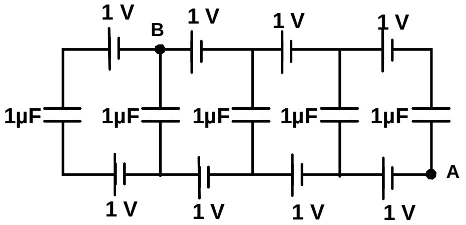
4. In a moving coil galvanometer, torque on the coil can be expressed as $\tau \propto i$, where i is current through the wire. The rectangular coil of the galvanometer having number of turns N, area A and moment of inertia I is placed in magnetic field B. The torsion constant of spring in the galvanometer is C and charge Q is passed through the coil almost instantaneously. If the maximum angle through which coil deflected is $\frac{KNABQ}{\sqrt{4CI}}$. (Ignore the damping in mechanical oscillations).

Space for rough work

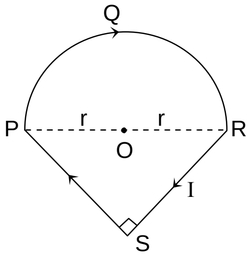
5. There are two infinitely long & broad sheets, one is lying on xz plane and another one is lying on yz plane. In both the sheets, current is moving in positive z direction having linear density (current per unit perpendicular length) equal to $\frac{\sqrt{2}}{\pi} \times 10^7$ Ampere/meter. Find the magnitude of magnetic field (in Tesla) at point P shown in the figure.



6. The potential difference $V_B - V_A$ for the circuit shown in the figure is $\frac{24}{k}$ V. Then find the value of k.

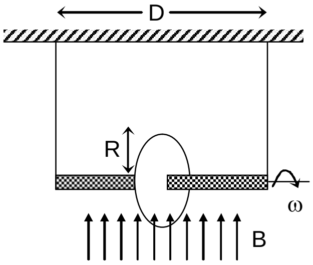


7. A steady current I = 10 A goes through a wire loop PQRS. Part PQR is semi-circle of radius r = 1 m. RS = SP and ∠RSP = 90°. Find the magnetic field at O in 10^{-6}T to the nearest integer.

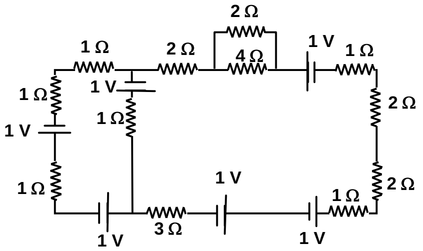


Space for rough work

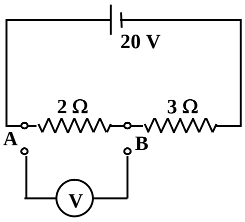
8 The axle of a circular wheel of radius R is held horizontally by two identical strings of equal lengths magnetic by a distance D. The tension in each string is T_0. The rim of the wheel carries a total charge + Q distributed uniformly on it. The wheel is vertical and is kept in a uniform vertical magnetic field $\vec{B}$. It is now rotated at an angular speed ω. If the string break at a tension of $3T_0 / 2$, If the maximum possible value of ω at which the wheel can be rotated without breaking a string is $\frac{KT_0D}{QR^2B}$. Then find the value of K.



9. Calculate the ratio of magnitude of current in 3Ω resistance is to magnitude of current in 4Ω resistance



10. When a voltmeter, as shown in n the figure is connected across a 2Ω resistance, it reads 5 volts. Find the internal resistance of the voltmeter (in ohm).



Space for rough work

Chemistry

PART – II

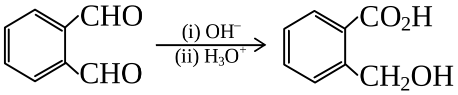
SECTION – A

Straight Objective Type

This section contains 10 multiple choice questions numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which ***ONE or MORE*** are correct.

1. Select the correct statement(s), among the following given statements
(A) $CH_3CH_2CH_2I$ will react more readily than $(CH_3)_2CHI$ for SN^2 reactions
(B) $CH_3CH_2CH_2Cl$ will react more readily than $CH_3CH_2CH_2Br$ for SN^2 reactions
(C) $CH_3CH_2CH_2CH_2Br$ will react more readily than $(CH_3)_3C – CH_2Br$ for SN^2 reactions
(D) $CH_3 – O – C_6H_5 – Br$ will react more readily than $NO_2 – C_6H_5 – CH_2Br$ for SN^2 reaction

2. Consider following reaction



This:
(A) is a crossed Cannizzaro reaction.
(B) is intramolecular Cannizzaro reaction.
(C) causes substitution of H^- by OH^- in one–CHO group and is thus oxidised while second –CHO undergoes an addition of H^- and is thus reduced to alcohol.
(D) resembles aldol type condensation reaction.

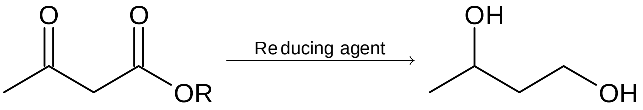
3. Lucas test is used to make distinction between 1°, 2° and 3° alcohols:

$$ROH + HCl(conc.) \xrightarrow{\text{anhy. } ZnCl_2} \underset{(\text{White turbidity})}{RCl\downarrow} + H_2O$$

This show that
(A) ROH behaves as a base
(B) Greater the value of pK_a(alcohol), greater the reactivity with conc. HCl & thus sooner the formation of white turbidity
(C) Alcohol which reacts fastest with Na metal, will give turbidity at fastest rate
(D) Alcohol which gives red colour during victor mayor test will give turbidity at slower rate in Lucas test than those giving blue or white colour during victor mayor test

Space for rough work

4. Reducing agent(s) which can be used to carry out following conversion is/are

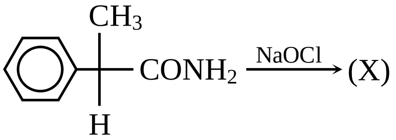


(A) $NaBH_4$ (B) $LiAlH_4$
(C) H_2/Ni (D) B_2H_6/THF

5. Which of the following statement(s) about D(+) glucose is/are true?
(A) Naturally occurring glucose is dextrorotatory (B) It reduces ammoniacal $AgNO_3$ solution
(C) On polymerisation it forms galactose (D) It forms cyanohydrin on reaction with HCN

6. Which of the following statements is/are correct?
(A) In S_N2 mechanism, the rate determining step involves two species
(B) The S_N2 mechanism involves the formation of intermediate carbocation
(C) The S_N2 mechanism is accompanied with Walden inversion
(D) The S_N2 mechanisms may involve intramolecular rearrangement

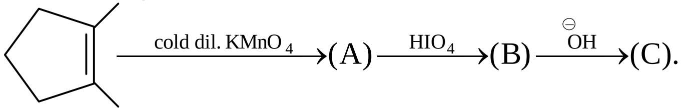
7. Which of the following statements are true about the major product (X) in the reaction?

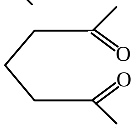


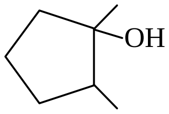
(A) (X) is a cyclic amide
(B) (X) has an asymmetric centre
(C) (X) is a primary amine
(D) (X) can also be obtained by treatment of NH_3 with $C_6H_5CH(CH_3)Br$

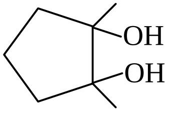
Space for rough work

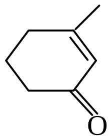
8. In a reaction sequence



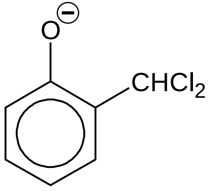
(A) A is 

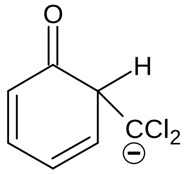
(B) B is 

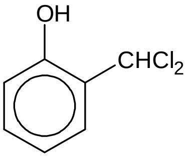
(C) A is 

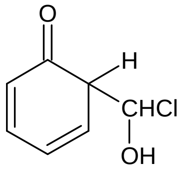
(D) C is 

9. When phenol is reacted with $CHCl_3$ and NaOH followed by acidification, salicylaldehyde is obtained. Which of the following species is/are involved in the above mentioned reaction as intermediates?

(A) 

(B) 

(C) 

(D) 

10. Which of the following statement (s) is/are correct?

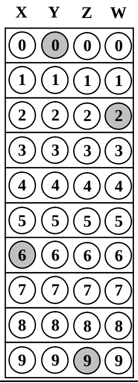
(A) The solubility of n – alcohol in water decreases with an increase in molecular weight
(B) The solubility of n – alcohol in water increases with an increase in molecule weight
(C) The reactive proportion of the hydrocarbon part in alcohols increases with increasing molecular weight which permits enhanced hydrogen bonding with water
(D) The reactive proportion of the hydrocarbon part in alcohols decreases with increasing molecular weight which reduces hydrogen bonding with water

Space for rough work

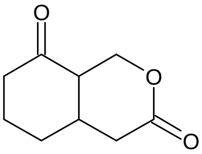
SECTION – C

Integer Answer Type

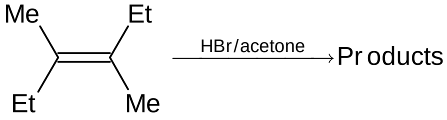
This section contains 10 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown


X Y Z W
0 0 0 0
1 1 1 1
2 2 2 2
3 3 3 3
4 4 4 4
5 5 5 5
6 6 6 6
7 7 7 7
8 8 8 8
9 9 9 9

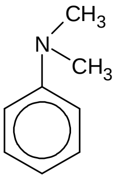
1. How many molecules of CH_3MgX are consumed in the reaction with one molecule of the following, in dry ether?

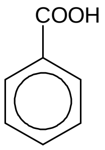


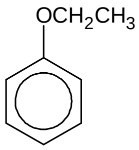
2. How many products will be formed in the following reaction?

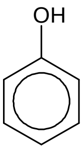

Me
Et
Et
Me
HBr/acetone
Products

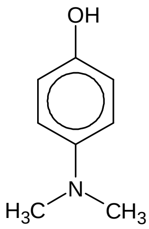
3. Amongst the following the total number of compounds soluble in aqueous NaOH is

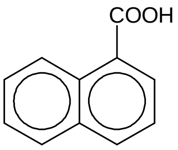












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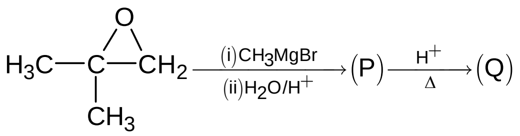
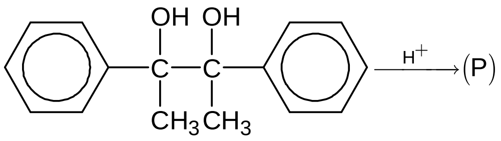
4.


O
H3C
C
CH2
CH3
(i)CH3MgBr
(ii)H2O/H+
(P)
H+
Δ
(Q)

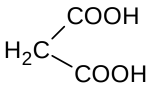
How many hyperconjugating structures of “Q” are possible?

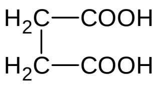
5.

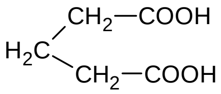

OH
OH
C
C
CH3
CH3
H+
(P)

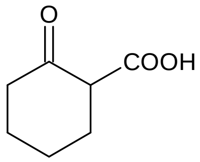
How many α - H to carbonyl groups are there in the product “P”?

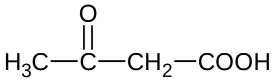
6. How many of the following acids easily undergo decarboxylation on heating?





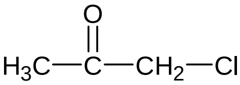






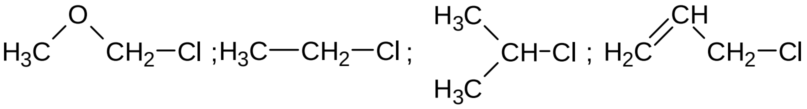
$H_3C-\overset{O}{\overset{\|}{C}}-CH_2-COOH$

7. How many of the following compounds are less reactive than

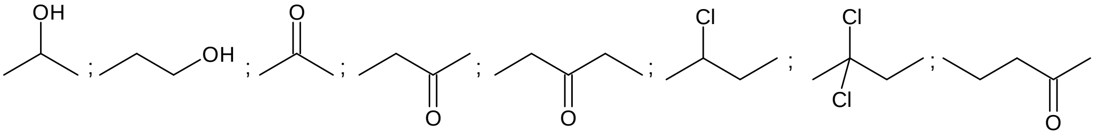


$H_3C-\overset{\overset{O}{\|}}{C}-CH_2-Cl$

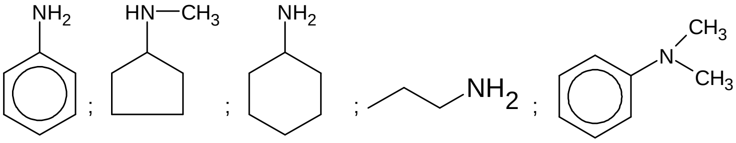
towards SN^2 reaction:



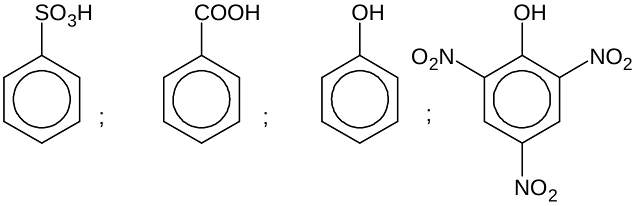
8. How many of the following compounds give positive haloform test?



9. How many of the following give positive carbyl amine test?



10. How many of the following acid liberate CO_2 from $NaHCO_3$ solution?



Space for rough work

Mathematics

PART – III

SECTION – A

Straight Objective Type

This section contains 10 multiple choice questions numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which ***ONE or MORE*** are correct.

1. Which of the following pair of function is identical?

(A) $f(x) = \cos(2\tan^{-1}x)$; $g(x) = \frac{1-x^2}{1+x^2}$

(B) $f(x) = \frac{2x}{1+x^2}$; $g(x) = \sin(2\cot^{-1}x)$

(C) $f(x) = \tan x + \cot x$; $g(x) = 2\,\text{cosec}\,2x$

(D) $f(x) = e^{\ln(\text{sgn}\cot^{-1}x)}$; $g(x) = e^{\ln[1+\{x\}]}$

(where {.}, [.] denotes fractional part function and greatest integer function)

2. Let $f(x) = (x-1)^4(x-2)^n$; $n \in N$ f(x) is

(A) local minima at x = 2; if n is even
(B) local minima at x = 1; if n is odd
(C) local maxima at x = 1 if n is odd
(D) local minima at x = 1 if n is even.

3. $f(x) = 2x^3 - 3(a+1)x^2 + 6ax - 12$ has local maximum at x_1 and local minimum at x_2 and if $2x_1 = x_2$ then value of a is

(A) 1
(B) $\frac{1}{2}$
(C) – 1
(D) 2.

4. Which of the following functions has/have removable discontinuity at x = 1

(A) $f(x) = \frac{1}{\ln|x|}$
(B) $f(x) = \frac{x^2-1}{x^3-1}$
(C) $f(x) = 2^{-2^{\frac{1}{1-x}}}$
(D) $f(x) = \frac{\sqrt{x+1}-\sqrt{2x}}{x^2-x}$

Space for rough work

5. $f(x) = \dfrac{[x]+1}{\{x\}+1}$ for $f : \left(0, \dfrac{5}{2}\right] \to \left(\dfrac{1}{2}, 3\right]$; where [.] represents G.I.F. and {.} → fractional part of x

(A) f(x) is injective discontinuous function
(B) f(x) is surjective non differentiable function
(C) $\min\left(\lim\limits_{x\to 1^-} f(x), \lim\limits_{x\to 1^+} f(x)\right) = f(1)$
(D) max (x values of point of discontinuity) = f(1)

6. $f(x) = \left(\dfrac{x}{2+x}\right)^{2x}$, then

(A) $\lim\limits_{x\to 0} f(x) = -4$ (B) $\lim\limits_{x\to \infty} f(x) = 2$
(C) $\lim\limits_{x\to \infty} f(x) = e^{-4}$ (D) $\lim\limits_{x\to 1} f(x) = \dfrac{1}{9}$.

7. If y = 10^{10^x} and $\dfrac{1}{y}\dfrac{dy}{dx} = 10^x \cdot \lambda$, then λ is

(A) ln 10 (B) $(\ln\ 10)^2$
(C) $e^{\ln(\ln 10)^2}$ (D) $(\log_{10} e)^2$.

8. For function $f(x) = \dfrac{\ln x}{x}$ which of the following statement are correct

(A) f(x) has horizontal tangent at x = e (B) f(x) cuts the x axis only one point
(C) f(x) is many one function (D) f(x) has one vertical tangent.

9. If $F(x) = \dfrac{1}{x^2}\int_4^{x^2}\left(4t^2 - 2F'(t)\right)dt$ then F′(4) equals to

(A) $\dfrac{32}{9}$ (B) $\dfrac{64}{9}$
(C) $\dfrac{F(8)}{28}$ (D) $\dfrac{11}{28}f(8)$

Space for rough work

10. $f(x)=\begin{cases} x+\frac{1}{2}; & x<0 \\ 2x+\frac{1}{3}; & x>0 \end{cases}$

[.] denotes greatest integer function

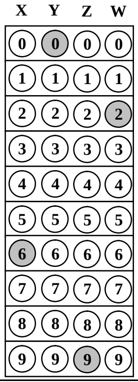
(A) $\lim\limits_{x\to 0}\left[f(x)\right]=0$ (B) $\lim\limits_{x\to 0} f(x)$ does not exist

(C) $\left|\lim\limits_{x\to 0} f(x)\right|$ exist (D) $\lim\limits_{x\to 0}\frac{\left[f(x)\right]}{x}$ does not exist.

SECTION – C

Integer Answer Type

This section contains 10 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown



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1. If $x^2 + y^2 = 1$ and maximum value of $x + y$ is $\frac{\sqrt{2}}{3}\lambda$ then value of λ is _____

2. $f\left(x+\frac{1}{2}\right)+f\left(x-\frac{1}{2}\right)=f(x)\,\forall\, x\in R$ then the period of f(x) is _______

3. Number of points where the function f(x) = max (| tanx |, cos |x|) is non differentiable in the interval $(-\pi, \pi)$ is _______

4. Tangent of acute angle between the curves $y = |x^2 - 1|$ and $y = |x^2 - 3|$ at their point of intersection is $\frac{4\sqrt{2}}{k}$ then value of k is ____

Space for rough work

5. $\int \dfrac{\cos^4 x\, dx}{\sin^3 x\left(\sin^5 x + \cos^5 x\right)^{\frac{3}{5}}} = -\dfrac{1}{2}\left(1+\cot^A x\right)^B + c$ then AB is equal to _____

6. $\int_{-\pi}^{\pi}\left(\cos px - \sin qx\right)^2 dx$ is equal to $m\pi$ then value of m ______

7. If $S_n = \dfrac{1}{2n} + \dfrac{1}{\sqrt{4n^2-1}} + \dfrac{1}{\sqrt{4n^2-4}} + \ldots \dfrac{1}{\sqrt{3n^2+2n-1}}$ is $n \in N$ then $\lim\limits_{n\to\infty} S_n$ is $\dfrac{\pi}{n}$ then N is ______

8. $\int\limits_{-1}^{1} \sin^3 x \cos^2 x\, dx$ is equal _______

9. The lateral edge of a regular hexagonal pyramid is 1 cm if the volume is maximum then the height must be $\dfrac{M}{\sqrt{3}}$; find the value of M ______

10. If $F''(x) = -f(x)$ and $g(x) = f'(x)$ and $F(x) = \left(f\left(\dfrac{x}{2}\right)\right)^2 + \left(g\left(\dfrac{x}{2}\right)\right)^2$ and given F(5) = 5 then F(10) is equal to

Space for rough work

FIITJEE **JEE(Advanced)-2016**

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ALL INDIA INTEGRATED TEST SERIES

ANSWERS, HINTS & SOLUTIONS
PART TEST-III
(Paper - 1)

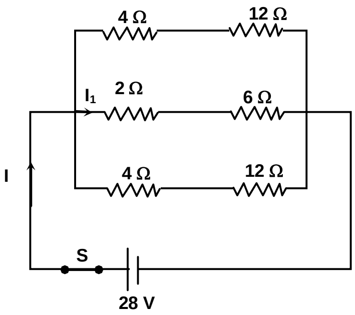
Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B, C	A, C	A, B, C, D
2.	B	B, C	A, C, D
3.	A	A, B, D	B, D
4.	B	B, C, D	B, D
5.	A, B	A, B, D	A, B, D
6.	A, C, D	A, C	C, D
7.	A, C	B, C, D	B, C
8.	B, D	C, D	A, B, C.
9.	B	A, B	A, D
10.	A	A, D	A, B
1.	3	3	3
2.	6	4	3
3.	6	4	4
4.	2	9	7
5.	4	3	2
6.	8	3	2
7.	7	4	6
8.	1	6	0
9.	3	3	1
10.	2	3	5

Physics

PART – I

SECTION – A

1. **B, C**
Equivalent circuit is



2. **B**
Loss of energy is $\frac{1}{2}C_eE^2$

3. **A**
$V_A=V_C$
$c=a+b$

4. **B**
Current through Battery, $I=\frac{V}{R}+\frac{V}{2R}e^{-\frac{t}{2RC}}$.

5. **A, B**
Final common potential across the capacitors is $\frac{2E_oC}{3C}=\frac{2}{3}E_o$ after a long time.

6. **A, C, D**
$\vec{F}_m=q\left(\vec{v}\times\vec{B}\right)$ and apply Newton's second law of motion.

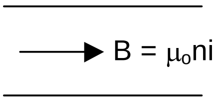
7. **A, C**
As four resistance forms a balanced Wheatstone bridge so potential difference across capacitor C_1 is zero.
Charge on $C_1 = 0$
Charge on $C_2 = 4\text{x}10^{-6}\text{ x }8 = 32\ \mu C$
Charge on $C_3 = 8\text{x}10^{-6}\text{ x }4 = 32\ \mu C$
$i = 12/6 = 2$ A
When k_2 is closed.
Potential difference across $C_2= 4V$
So change on it is $4\text{x}10^{-6}\text{ x }4 = 16\mu C$
Potential difference across $C_3 = 8V$
So change on it is $8\text{x}10^{-6}\text{x}8 = 64\ \mu C$
$i = 12/6 = 2A$

8. **B, D**
$\vec{F}_m=q(\vec{v}\times\vec{B})$.

9. **B**
$\phi=\vec{E}.\vec{A}$

10. **A**
$B = \mu_o ni$

$$n=\frac{B}{\mu_o i}=\frac{1}{4\pi\times10^{-7}\times1}=\frac{1}{4\pi}\cdot10^{7}\ \text{turns / m}$$



SECTION – C

1. **3**
Acceleration and magnetic field are perpendicular to each other thus $\vec{B}.\vec{a} = 0$

2. **6**
Current through 30Ω is $\frac{12}{40}$ and apply loop rule then charge on the capacitor C_2 is 60μC.

3. **6**
M = IA

4. **2**
$$\int \tau dt = NAB\int idt$$
$$I\omega_0 = NABQ \qquad \text{……(i)}$$
$$\frac{1}{2}I\omega_0^2 = \frac{1}{2}C\theta_{max}^2 \qquad \text{…….(ii)}$$
From equation (i) and (ii)
$$\theta_{max} = \frac{NABQ}{\sqrt{CI}}$$

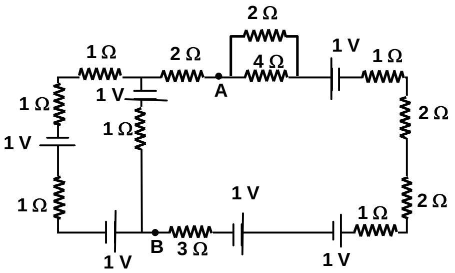
5. **4**
$$B_{net} = \frac{\mu_0 j\sqrt{2}}{2}$$

6. **8**
Apply KVL & symmetry charge on the capacitor 1μF is zero.

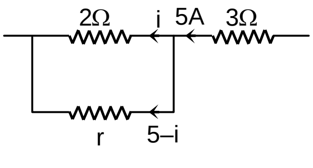
7. **7**
$$B_0 = \frac{\mu_0 I}{4r} + 2 : \left(\frac{\mu_0}{4\pi}.\frac{I}{\frac{r}{\sqrt{2}}}.2\sin 45^\circ\right) = 7.14 \times 10^{-6}\text{T}$$

8. **1**
$$B\int_0^R \frac{\omega}{2\pi}Q\frac{2\pi r}{\pi R^2}dr\,\pi r^2 = \frac{T_0 D}{2}$$
$$\Rightarrow \quad \omega = \frac{T_0 D}{QR^2 B}.$$

9. **3**
According to Kirchoff's current rule. Current passing through A towards left = current passing through B toward right.



10. **2**
Potential difference across 3Ω resistance is 20V – 5V = 15V
⇒ Current through 3Ω resistance = 5 Ampere.
5 Volt = (5 – i)r = 2i
⇒ r = 2Ω



Chemistry

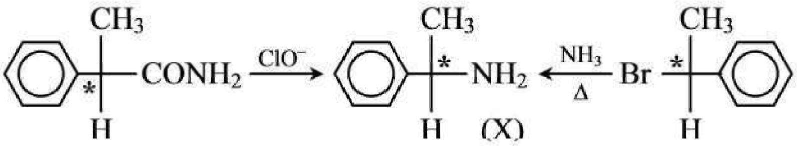
PART – II

SECTION – A

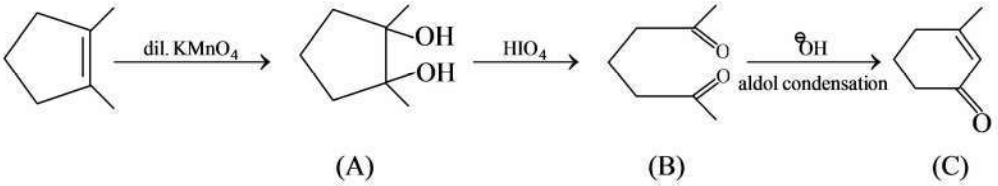
4. $NaBH_4$ does not reduce ester.

5. Galactose is empimer of D-(+)-glucose. It is monomer.

7.


CH3
CONH2
ClO⁻
CH3
NH2
NH3
Δ
Br
CH3
H
H
(X)
H

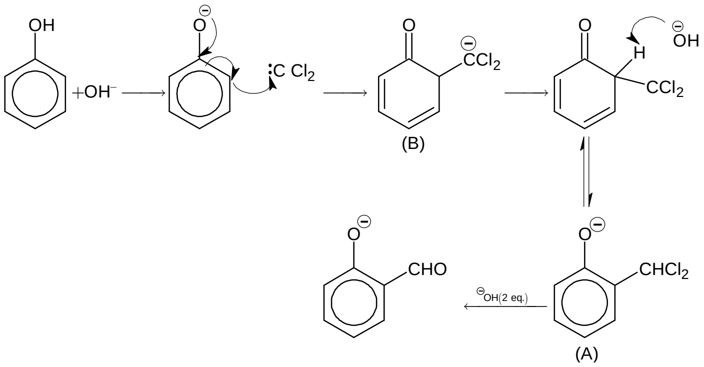
8.


dil. KMnO4
OH
OH
HIO4
O
O
⊖OH
aldol condensation
O
(A)
(B)
(C)

9.

$$CHCl_3 \xrightarrow{OH^-} CCl_3^- + H_2O$$

$$CCl_3^- \longrightarrow :CCl_2 + Cl^-$$


OH
+OH⁻
O⊖
:C Cl2
O
⊖CCl2
(B)
O
H
⊖OH
CCl2
O⊖
CHCl2
(A)
⊖OH(2 eq.)
O⊖
CHO

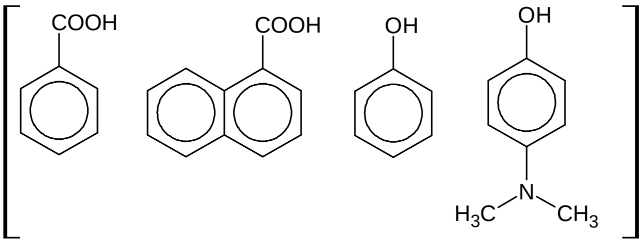
(C) cannot exist in presence of OH^-.

SECTION – C

1. One with keto and two with ester group (lactone).

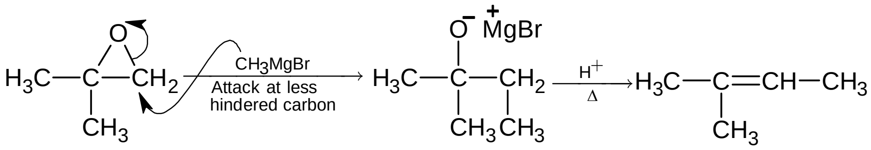
2. All are stereoisomers.

3.

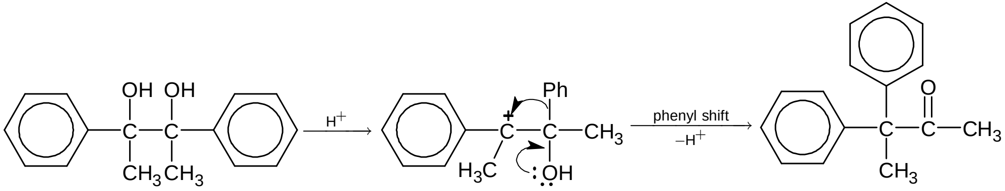

COOH
COOH
OH
OH
N
H3C
CH3

are soluble in alkalies.

4.


H3C—C—CH2 (O)
CH3
CH3MgBr
Attack at less hindered carbon
O⁻ M⁺gBr
H3C—C—CH2
CH3 CH3
H+
Δ
H3C—C=CH—CH3
CH3

5. Pinacol-Pinacolone rearrangement reaction.
The migratory aptitude is H > Ar > R.


OH OH
CH3 CH3
H+
Ph
CH3
H3C
OH
phenyl shift
−H+
O
CH3
CH3

Mathematics

PART – III

SECTION – A

2. $f(x) = (x-1)^4 (x-2)^n;\ n \in N$

$f'(x) = 4(x-1)^3 [x-2)^n + (x-1)^4 n(x-2)^{n-1}$

$= (x-1)^3 (x-2)^{n-1} [(n+4)x - (n+8)]$

If n is odd then $f'(x) > 0$ and if $x < 1$ and sufficiently close to 1

$f'(x) < 0$ if $x > 1$ and sufficiently close to 1

$\therefore$ x = 1 is point of local maxima

Similarly if n is even then x = 1 is a point of local minima further if n is even then $f'(x) < 0$ for $x < 2$ and sufficiently close to 2 and $f'(x) > 0$ for $x > 2$ and sufficiently close to 2 $\Rightarrow$ x = 2 local minima.

3. $f(x) = 2x^3 - 3(a+1)x^2 + 6ax - 12$

$f'(x) = 6\{x^2 - (a+1)x + a\} = 0$

$6\{(x-1)(x-a)\} = 0$

$f''(x) = 12x - 6(a+1)$

$f''(1) = 6 - 6a > 0$

$f''(a) = 12a - 6a - 6 = 6a - 6$

if a < 1 then x = a is a local max

$2a = 1 \therefore a = \frac{1}{2}$

if a > 1 then x = a is a local minima a = 2.

5. $$f(x) = \begin{cases} \frac{1}{x+1} & 0 \le x < 1 \\ \frac{2}{x} & 1 \le x < 2 \\ \frac{3}{x-1} & 2 \le x < \frac{5}{2} \end{cases}$$

8. $$f'(x) = \frac{x - \frac{1}{x} - \ln x}{x^2} = \frac{1 - \ln x}{x^2}$$

for horizontal tangent ln x = 1 $\Rightarrow$ x = 1

if cut the x axis

$\frac{\ln x}{x} = 0 \Rightarrow x = 1$

$f'(x)$ is +ve $x \in (0, e)$ and $f'(x)$ is –ve if $x \in (0, \infty)$

f(x) is not monotonic

for vertical tangent $f'(x) = \infty$

$\Rightarrow \quad \frac{1-\ln x}{x^2} = \infty \Rightarrow \frac{x^2}{1-\ln x} = 0$

$\Rightarrow$ x = 0 which is not in domain.

9. $$F'(x) = \frac{-2}{x^3}\int_0^x \{4t^2 - 2F(t)\}dt + \frac{1}{x^2}\left(4x^2 - 2F'(x)\right) \text{ put } x = 4$$

$$F'(4) = 0 + \frac{1}{16}\left[4(16) - 2F'(4)\right]$$

$$F'(4) = \frac{32}{9}$$

for option D

$$f(x) = \frac{1}{x^2}\int_0^k \left[4t^2 - F'(t)\right]dt = \frac{1}{x^2}\left[\frac{4t^3}{3} - 2F'(t)\right]_4^x$$

$$F(8) = \frac{1}{8^2}\left[\frac{4.8^3}{3} - 2F(8) - \frac{4.4^3}{3} + 2F(4)\right]$$

$$F(8) = \frac{32}{33}\left[\frac{28}{3}\right].$$

10. (A) $\lim\limits_{x\to 0^-}\left|x+\frac{1}{2}\right| = 0$ $\lim\limits_{x\to 0^+}\left|2x+\frac{1}{3}\right| = 0$ $\therefore$ $\lim\limits_{x\to 0}\left[f(x)\right] = 0$

(B) $\lim\limits_{x\to 0^-}\left(x+\frac{1}{2}\right) = \frac{1}{2}$; $\lim\limits_{x\to 0^+}\left(2x+\frac{1}{3}\right) = \frac{1}{3}$ $\therefore$ f(0) ≠ f(0^+)

(C) $\lim\limits_{x\to 0} f(x)$ does not exist so $\left|\lim\limits_{x\to 0} f(x)\right|$ no exist

(D) $\lim\limits_{x\to 0^-}\dfrac{\left|x+\frac{1}{2}\right|}{x} = 0$; $\lim\limits_{x\to 0^+}\dfrac{\left|2x+\frac{1}{3}\right|}{x} = 0$

$\therefore$ $\lim\limits_{x\to 0}\dfrac{\left[f(x)\right]}{x}$.

SECTION – C

1. x = cos θ y = sin θ
x + y = sinθ + cosθ

2. $$f\left(x+\frac{1}{2}\right) + f\left(x-\frac{1}{2}\right) = f(x)$$

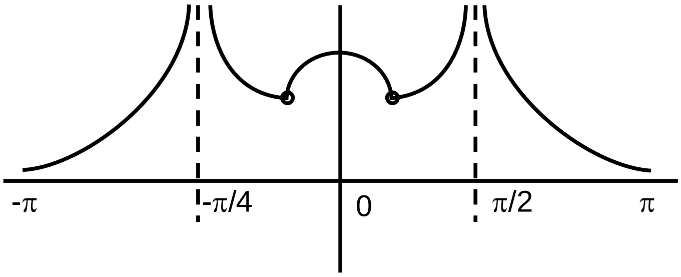
$$f(x+1) + f(x) = f\left(x+\frac{1}{x}\right)$$

$$\Rightarrow \quad f(x+1) + f\left(x-\frac{1}{2}\right) = 0$$

$$f\left(x+\frac{3}{2}\right) = -f(x)$$

$$\Rightarrow \quad f(x+3) = -f\left(x+\frac{3}{2}\right) = f(x)$$

3. Function is not differentiable in $(-\pi, \pi)$ at points $\left\{-\frac{\pi}{4}, \frac{\pi}{4}\right\}$ and $\left\{-\frac{\pi}{2}, \frac{\pi}{2}\right\}$.



4. Point of intersection are $\left(\pm\sqrt{2}, 1\right)$

$y = |x^2 - 1|$ and $y = |x^2 - 3|$

$\frac{dy}{dx} = 2x$ $\frac{dy}{dx} = -2x$

$m_1 = \left.\frac{dy}{dx}\right|_{\left(\sqrt{2},1\right)} = 2\sqrt{2}$ and $m_2 = \left.\frac{dy}{dx}\right|_{\left(\sqrt{2},1\right)} = -2\sqrt{2}$

$\tan\theta = \left|\frac{4\sqrt{2}}{7}\right|$.

5. $$I = \int \frac{\cos^4 x\, dx}{\sin^3 x\left(\sin^5 x + \cos^5 x\right)^{3/5}} = \int \frac{\cos^4 x\, dx}{\sin^6 x\left(1 + \cot^5 x\right)^{3/5}}$$

$$= -\frac{1}{5}\int \frac{dt}{t^{3/5}} = -\frac{1}{2}\left(1 + \cot^5 x\right)^{\frac{2}{5}} + c\,.$$

6. $$\int_{-\pi}^{\pi}\left(\cos px - \sin qx\right)^2\, dx = \int_0^{\pi}\left(\cos^2 px + \sin^2 qx - 2\sin qx \cos px\right)dx$$

$$= 2\int_0^{\pi}\left(\frac{1+\cos 2px}{2} + \frac{1-\cos 2qx}{2}\right)dx$$

7. $$\Rightarrow \lim_{n\to\infty}\sum_{r=0}^{n-1}\frac{1}{\sqrt{4n^2 - r^2}} = \lim_{n\to\infty}\sum_{r=0}^{n-1}\frac{1}{n}\cdot\frac{1}{\sqrt{4 - \left(\frac{r}{n}\right)^2}}$$

$$= \int_0^1 \frac{dx}{\sqrt{4 - x^2}} = \left[\sin^{-1}\left(\frac{x}{2}\right)\right]_0^1 = \frac{\pi}{6} - 0 = \frac{\pi}{6}\,.$$

9. Volume $= \frac{1}{3}$ (area of base x height)

$$= \frac{1}{3}\left(\frac{\sqrt{3}}{4}a^2\right) \times 6 \times h$$

$$a = \sqrt{1 - h^2}$$

$$v = \frac{\sqrt{3}}{2}h\left(1 - h^2\right)$$

$$v' = \frac{\sqrt{3}}{2}\,(1 - h^2 + h(-2h)] = 0$$

$h = \frac{1}{\sqrt{3}}$

$v'' < 0$ at $h = \frac{1}{\sqrt{3}}$

$h = \frac{1}{\sqrt{3}}$.

10. $F'(x) = \left[f\left(\frac{x}{2}\right)f'\left(\frac{x}{2}\right) + g\left(\frac{x}{2}\right)g'\left(\frac{x}{2}\right)\right]$

here $g(x) = f'(x)$

$F'(x) = f\left(\frac{x}{2}\right)g\left(\frac{x}{2}\right) - f\left(\frac{x}{2}\right)g\left(\frac{x}{2}\right) = 0$

$\Rightarrow$ F(x) is a constant function.

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ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Advanced), 2016**

PART TEST – III

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 10)** contains 10 multiple choice questions which have one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (11 to 16) contains 3 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (17 – 20) contains 4 Matching Lists Type questions: Each question has four statements in LIST I & 4 statements in LIST II. The codes for lists have choices (A), (B), (C), (D) out of which only one is correct. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

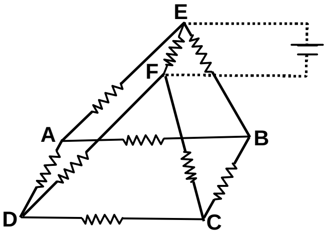
PART – I

SECTION - A

Straight Objective Type

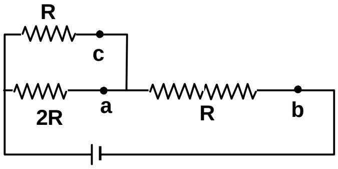
This section contains **10 multiple** choice questions numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. A prism is made of wire mesh with each side having equal resistance R. A battery of 6 V and zero resistance is connected across E and F as shown in the figure. The current in the branch AD, if R is equal to 5Ω is



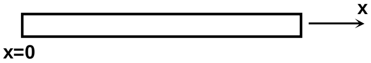
(A) 0.6A (B) 0.8 A
(C) 0.4 A (D) 2 A

2. Referring to the shown circuit, the current will be minimum in



(A) a
(B) b
(C) c
(D) same in all the branches

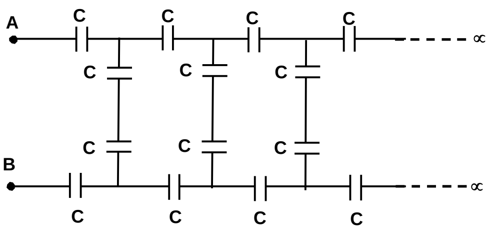
3. If along a uniform rod of length ℓ carrying current I, the voltage V changes with position x along the length of the rod such that dV/dx = – k, where k is a positive number, then the resistance of the rod is



(A) $k\ell/2I$ (B) $k\ell/I$
(C) $I/k\ell$ (D) $k\ell I$

Space for rough work

4. The equivalent capacitance of the shown infinite network across A and B, if each capacitor has a capacitance of C, is



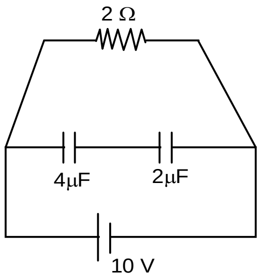
(A) $\left(\frac{\sqrt{3}-1}{4}\right)C$

(B) $\left(\frac{\sqrt{3}+1}{4}\right)C$

(C) $\left(\frac{\sqrt{5}-1}{4}\right)C$

(D) None of these

5. In the shown network, charge on 2μf capacitor in steady state would be

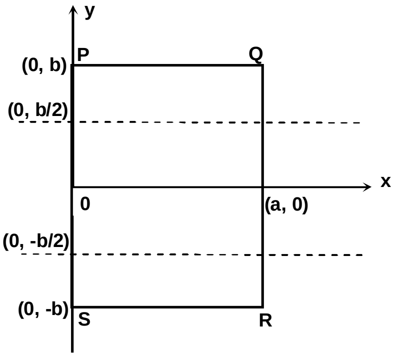


(A) 10 μC
(B) 20 μC
(C) 40/3 μC
(D) 40 μC

6 A uniform and constant magnetic field exists in a region as under

$$\begin{cases} B_o\hat{i} & \text{for } y > \frac{b}{2} \\ -B_o\hat{i} & \text{for } y < -\frac{b}{2} \\ \text{zero for } -\frac{b}{2} \le y \le \frac{b}{2} \end{cases}$$

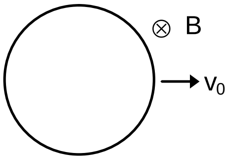
Then the current that must be passing thru the area enclosed by PQRS shown



(A) $\frac{2B_oa}{\mu_o}(-\hat{k})$
(B) $\frac{2B_oa}{\mu_o}(\hat{k})$
(C) $\frac{2B_ob}{\mu_o}(-\hat{k})$
(D) $\frac{2B_ob}{\mu_o}(\hat{k})$

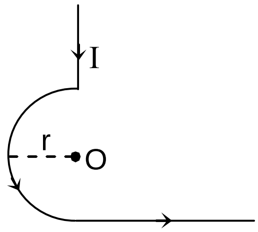
Space for rough work

7. A uniform ring of mass m with uniformly distributed charge q along its circumference of radius R is translating with speed v_0 perpendicular to a uniform magnetic field as shown. The acceleration of the ring is (Assuming gravity free space)



(A) $2 q v_0 B/m$
(B) 0
(C) $q v_0 B/m$
(D) $(q v_0 B)/2m$

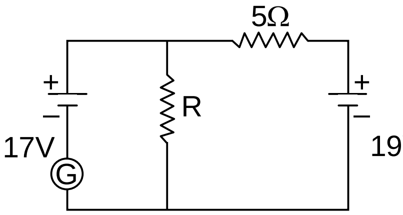
8. In the given figure, what is the magnitude of field induction at point O?



(A) $\frac{\mu_0 I}{4\pi r}$
(B) $\frac{\mu_0 I}{4r} + \frac{\mu_0 I}{2\pi r}$
(C) $\frac{\mu_0 I}{4r} + \frac{\mu_0 I}{4\pi r}$
(D) $\frac{\mu_0 I}{4r} - \frac{\mu_0 I}{4\pi r}$

9. A parallel plate capacitor is connected across a source of constant potential difference. When a dielectric plate is introduced between the two plates, then
(A) Potential difference between two plates increases
(B) Potential difference between two plates decreases
(C) Potential difference between two plates remains same
(D) Charge on the plates decreases

10. For what value of R will the current in galvanometer be zero ?
(A) 7 Ω
(B) 5 Ω
(C) 15 Ω
(D) 85/2 Ω



Space for rough work

Comprehension Type

This section contains **3 groups** of questions. Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

---

Paragraph for Question Nos. 11 to 12

In a region, charge density is

$$\begin{cases} \rho = \rho_o \sin\frac{\pi x}{L} \text{ for } 0 \le x \le L \\ = \text{zero} \quad \text{for all other values of } x \end{cases}$$

The charge density is independent of value of y and z and it extends from $-\infty < y < \infty$ and $-\infty < z < \infty$.

11. The electric field at (L/2, L/2, 0) is

(A) $\rho_o \frac{\pi}{2}\hat{i}$
(B) $\rho_o \frac{\pi}{22}\hat{i}$
(C) $\rho_o \frac{\pi}{\sqrt{2}L}\hat{i}$
(D) zero

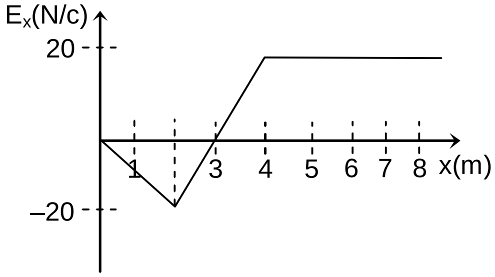
12. Equipotential surface will be

(A) Planes parallel to x-y plane
(B) Planes parallel to y-z plane
(C) Planes parallel to x-z plane
(D) None of these

Space for rough work

Paragraph for Question Nos. 13 to 14

A graph of the x-component of the electric field as a function of x in a region of space is shown in the figure. The y and z-components of the electric field are zero in this region. The electric potential at the origin is zero.

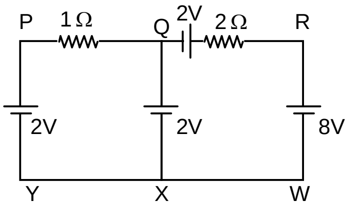


13. The electric potential at x = 2m is :
    (A) 10 V (B) 20 V
    (C) 30 V (D) 40 V

14. The greatest positive value of electric potential for points of the x-axis for which $0 \le x \le 6m$ is :
    (A) 10 V (B) 20 V
    (C) 30 V (D) 40 V

Paragraph for Question Nos. 15 to 16

For the electrical circuit shown in the figure:



Answers the following questions:

15. The current in branch PQ is
    (A) zero (B) 1 A
    (C) 2 A (D) 3 A

16. The current in branch QR is
    (A) zero (B) 1 A
    (C) 2 A (D) $\frac{2}{3}$ A

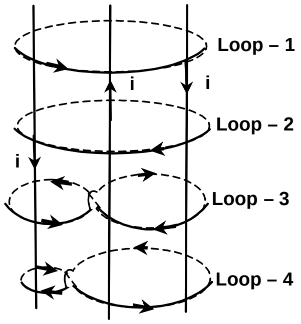
Space for rough work

(Matching list Type)

This section contains **4 multiple choice questions**. Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

17. **Read the following statements and match the following and write the correct pairs.**

Three wires are carrying same constant current in different directions. Four loops enclosing the wires in different manners are shown. The direction of $\mathbf{d}\vec{\ell}$ is shown in the figure.



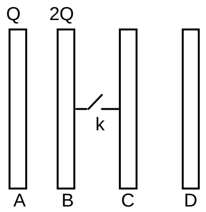
	List - I		List - II
(P)	Along closed loop – 1	(1)	$\oint \vec{B}.d\vec{\ell} = \mu_o i$
(Q)	Along closed loop – 2	(2)	$\oint \vec{B}.d\vec{\ell} = -\mu_o i$
(R)	Along closed loop – 3	(3)	$\oint \vec{B}.d\vec{\ell} = -3\mu_o i$
(S)	Along closed loop – 4	(4)	$\oint \vec{B}.d\vec{\ell} = 3\mu_o i$

Codes:

	P	Q	R	S
(A)	2	1	2	1
(B)	1	4	2	3
(C)	4	3	1	2
(D)	2	3	4	1

Space for rough work

18. *Read the following and write the correct pairs.*
Initially, the two plates (A and B) are given charges as shown. Find the final charges on the plates after the key k is closed. All plates are conducting, parallel and of infinite length and breadth.

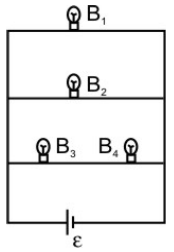


	List - I		List - II
(P)	Final charge on plate A	(1)	Q/2
(Q)	Final charge on plate B	(2)	Q
(R)	Final charge on plate C	(3)	0
(S)	Final charge on plate D	(4)	3Q/2

Codes:

	P	Q	R	S
(A)	2	3	1	4
(B)	1	4	2	3
(C)	4	3	1	2
(D)	2	1	4	3

19. Ratings of bulbs are as follows :
B_1 (100w, 200v) ; B_2 (50w, 200v) ; B_3 (100w, 200v) ; B_4 (200w, 200v)



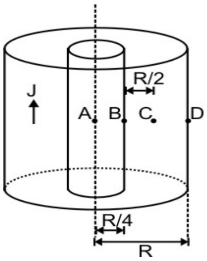
List – I		List - II	
(P)	Current drawn by B_1 are	(1)	Maximum
(Q)	Intensity of B_4 and are B_3	(2)	Minimum
(R)	Intensity of B_1	(3)	Same
(S)	Current drawn by B_2	(4)	Different

Codes:

	P	Q	R	S
(A)	2	1	2	1
(B)	1	4	1	2
(C)	4	3	1	2
(D)	2	3	4	1

Space for rough work

20. From an infinitely long cylinder of radius R, a cylinder of radius R/4 is removed and current density in the remaining portion is J as shown in the adjoining figure. BC = R/2. Match the entries of column I with the entries of column II.



List – I		List - II	
(P)	$\vec{B}$ at A is	(1)	Zero
(Q)	$\vec{B}$ at B is	(2)	$\frac{\mu_0 JR}{3}$
(R)	$\vec{B}$ at C is	(3)	$\frac{5\mu_0 JR}{3}$
(S)	$\vec{B}$ at D is	(4)	$\frac{15\mu_0 JR}{32}$

Codes:

	P	Q	R	S
(A)	2	1	2	1
(B)	1	4	2	3
(C)	1	1	2	4
(D)	2	3	4	1

Space for rough work

Chemistry

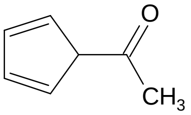
PART – II

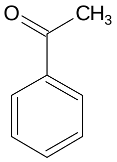
SECTION - A

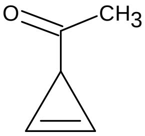
Straight Objective Type

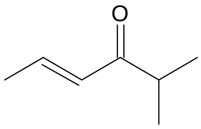
This section contains **10 multiple** choice questions numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Which of the following will be most acidic?

(A)


(B)


(C)


(D)


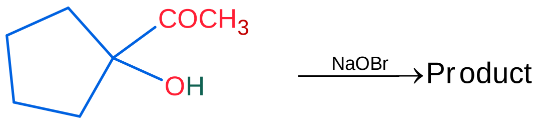
2. 1 - propoxy butane can be prepared by
(A) treating 1 – bromopropane with sodium 1 – propoxide
(B) heating with 3 – pentanol with conc. H_2SO_4 at 473 K.
(C) treating with 2 – bromopropane with sodium isopropoxide
(D) heating 1 – propanol with conc. H_2SO_4 at 443 K

3. Bromination of aniline gives 2, 4, 6 – tribromoaniline where as the nitration of aniline with mixed acids gives m – nitroaniline. In this case nitration, the m – derivative is formed because
(A) In the presence of strong acids the amino group is protonated to $-\overset{\oplus}{N}H_3$ which is m – orienting
(B) m – nitro aniline is thermodynamically more stable than the ortho and para-isomers
(C) nitro groups can not enter ortho and para-positions due to steric factor
(D) the mechanism of bromination and nitration are different

4. The major product formed by the reaction of a anisole with tert-butyl alcohol is
(A) 1- methoxycyclohexa – 1,4 diene
(B) 2 – methoxycyclohexa -1,3 diene
(C) 1- methoxycyclohexa – 1,3 diene
(D) 3- methoxycyclohexa – 1,4 diene

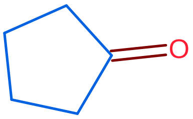
Space for rough work

5.

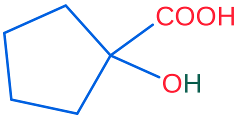

COCH3
OH
NaOBr
Product

The product is

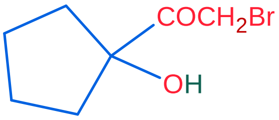
(A)



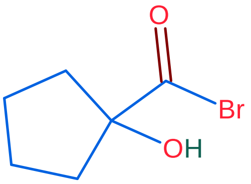
(B)



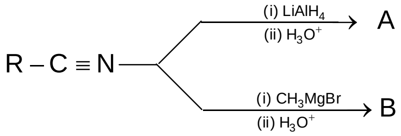
(C)



(D)

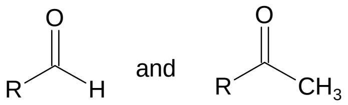


6.

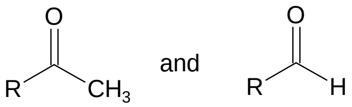

(i) LiAlH4
(ii) H3O+
A
R – C ≡ N
(i) CH3MgBr
(ii) H3O+
B

A and B are

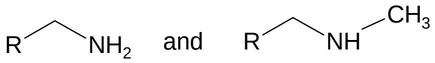
(A)


O
R
H
and
O
R
CH3

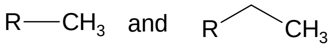
(B)


O
R
CH3
and
O
R
H

(C)

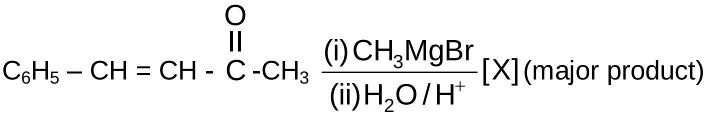

R
NH2
and
R
NH
CH3

(D)


R
CH3
and
R
CH3

Space for rough work

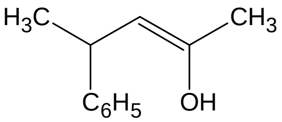
7. In the reaction sequence



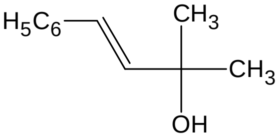
$$C_6H_5 - CH = CH - \overset{\overset{\large O}{\|}}{C} - CH_3 \xrightarrow[\text{(ii)}H_2O/H^+]{\text{(i)}CH_3MgBr} [X] \text{ (major product)}$$

X will be

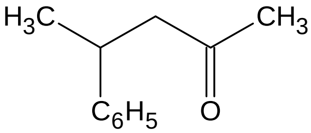
(A)



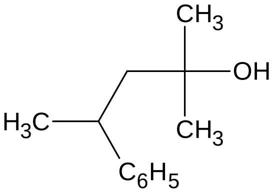
(B)



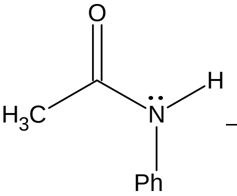
(C)



(D)



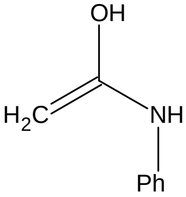
8.



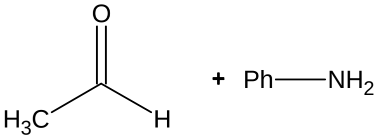
$\xrightarrow[\Delta]{H^+/DMSO}$ Major product;

Which of the following is major product?

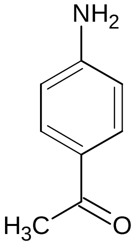
(A)



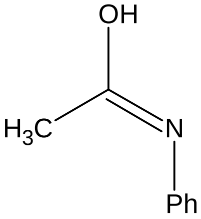
(B)



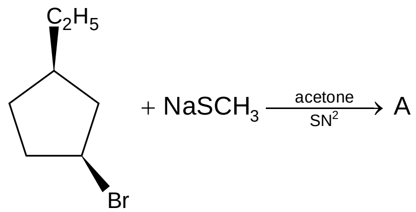
(C)



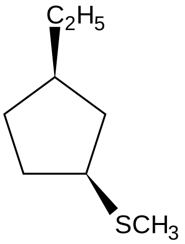
(D)

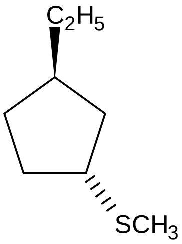


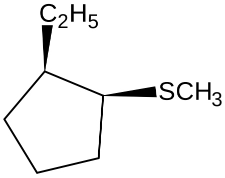
Space for rough work

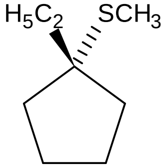
9. 
C_2H_5
Br
+ $NaSCH_3$
acetone
SN^2
A

The compound A is –

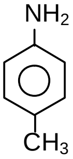
(A) 

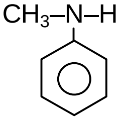
(B) 

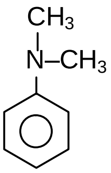
(C) 

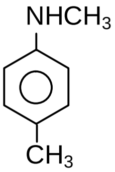
(D) 

10. Which of the following amine will show carbylamine reaction?

(A) 

(B) 

(C) 

(D) 

Space for rough work

Comprehension Type

This section contains **3 groups** of questions. Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 11 to 12

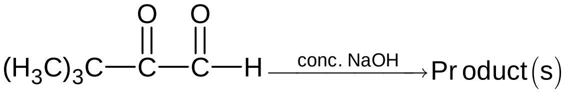
Aldehydes without α - hydrogen undergoes Cannizzaro reaction in the presence of conc. Alkali. Two molecule undergoes self oxidation and reduction to yield a mixture of alcohol and salt of carboxylic acid. Two different aldehydes without α hydrogen undergoes crossed Cannizzaro reaction. The rate of reaction is decided by the ease with which H^- is transferred.

11. $\mathrm{HCHO} + \mathrm{PhCHO} \xrightarrow{\text{50\% NaOH}} \mathrm{P} + \mathrm{Q}$

P and Q are

(A) HCOOH and PhCOONa
(B) HCOONa and PhCOOH
(C) CH_3OH and PhCOONa
(D) HCOONa and $PhCH_2OH$

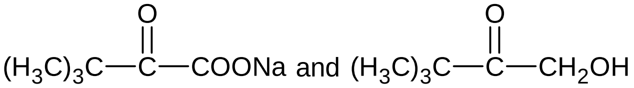
12.



$(H_3C)_3C-\overset{\overset{O}{\|}}{C}-\overset{\overset{O}{\|}}{C}-H \xrightarrow{\text{conc. NaOH}} \mathrm{Product(s)}$

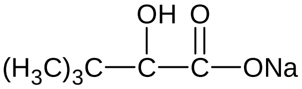
Choose the correct statements among the following statement:

(A) product are



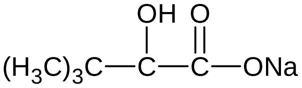
$(H_3C)_3C-\overset{\overset{O}{\|}}{C}-COONa$ and $(H_3C)_3C-\overset{\overset{O}{\|}}{C}-CH_2OH$

(B) Product is



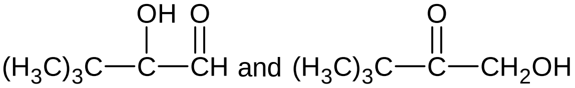
$(H_3C)_3C-\overset{\overset{OH}{|}}{C}-\overset{\overset{O}{\|}}{C}-ONa$ and reaction in disproportionation reaction

(C) Product is



$(H_3C)_3C-\overset{\overset{OH}{|}}{C}-\overset{\overset{O}{\|}}{C}-ONa$ but is not disproportionation reaction

(D) Product are



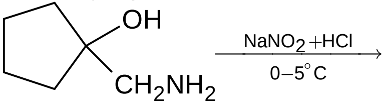
$(H_3C)_3C-\overset{\overset{OH}{|}}{C}-\overset{\overset{O}{\|}}{C}H$ and $(H_3C)_3C-\overset{\overset{O}{\|}}{C}-CH_2OH$

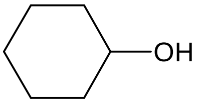
Space for rough work

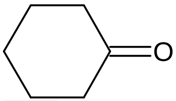
Paragraph for Question Nos. 13 to 14

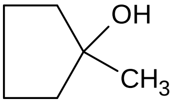
Aliphatic primary amines react with nitrous acid ($NaNO_2$ + HCl) form alcohol as the major product. In addition to alcohol, alkenes and alkyl halide are also formed as minor products. Nitrous acid also react with secondary and tertiary amine, nature of reaction depends whether amine is aliphatic or aromatic.

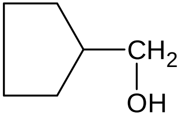
13. The major product obtained in the following reaction will be



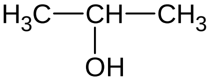
(A)


(B)


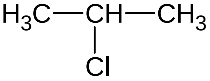
(C)


(D)


14. Which of the following product(s) will be obtained when n-propyl amine is treated with $NaNO_2$ and HCl?

(A)

$H_3C-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3$

(B) $H_3C-CH=CH_2$

(C)

$H_3C-\underset{\displaystyle Cl}{\underset{|}{CH}}-CH_3$

(D) All of these

Space for rough work

Paragraph for Question Nos. 15 to 16

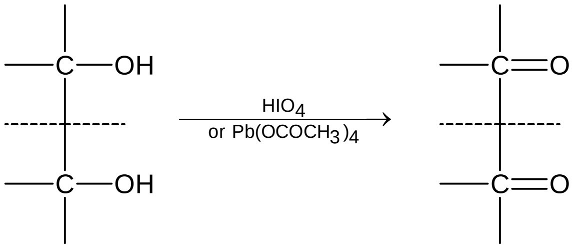
Read the paragraph carefully and answer the following questions:
In a polyhydric alcohol, the total numbers of hydroxyl groups are estimated by the following methods:

(i) A known mass of the acetyl derivative of polyhydric alcohol is taken. It is mixed with an excess volume of a standard alkali solution. Both are refluxed. Alkali is used in the hydrolysis of acetyl derivative. The unused alkali is measured by carrying out titration with a standard acid solution and total number of hydroxyl groups (n) can thus be calculated stoichiometrically.

$$A(OH)_n \xrightarrow{CH_3COCl} A(OCOCH_3)_n \xrightarrow{nKOH} A(OH)_n + nCH_3COOK$$

Polyhydric alcohol   Acetyl derivative

(ii) Total number of –OH groups in vicinal position can be calculated by oxidation with periodic acid or lead tetra acetate.



15. 0.436 g of acetyl derivative of a polyhydric alcohol (molecular mass = 92) require 0.336 g KOH for hydrolysis. The total numbers of hydroxyl group(s) in the alcohol are
(A) 1 (B) 2
(C) 3 (D) 4

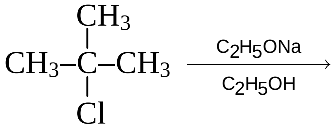
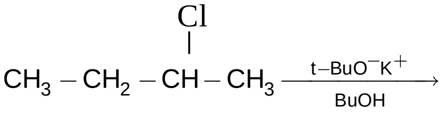
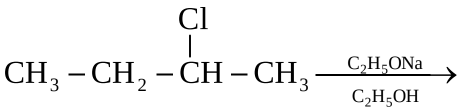
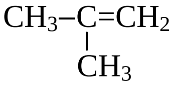
16. The product formed by the reaction of ethylene glycol and periodic acid (HIO_4) is
(A) acetic acid (B) formic acid
(C) formaldehyde (D) glyoxal

Space for rough work

(Matching list Type)

This section contains **4 multiple choice questions**. Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

1. Match the following:

Column – I (Substrate + reagent)		**Column - II (Major product)**	
(P)	$CH_3–CH_2–CH_2–Cl \xrightarrow[C_2H_5OH]{C_2H_5ONa}$	(1)	$CH_3–CH_2–CH=CH_2$
(Q)	 $CH_3–\underset{Cl}{\overset{CH_3}{C}}–CH_3 \xrightarrow[C_2H_5OH]{C_2H_5ONa}$	(2)	$CH_3–CH=CH–CH_3$
(R)	 $CH_3-CH_2-\overset{Cl}{CH}-CH_3 \xrightarrow[BuOH]{t-BuO^-K^+}$	(3)	$CH_3–CH=CH_2$
(S)	 $CH_3-CH_2-\overset{Cl}{CH}-CH_3 \xrightarrow[C_2H_5OH]{C_2H_5ONa}$	(4)	 $CH_3–\underset{CH_3}{C}=CH_2$

Codes:

	P	**Q**	**R**	**S**
(A)	3	4	1	2
(B)	1	4	3	2
(C)	3	2	1	4
(D)	4	3	2	1

Space for rough work

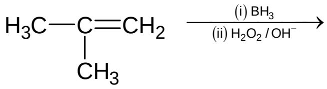
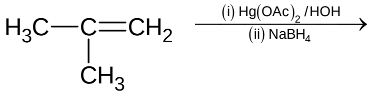
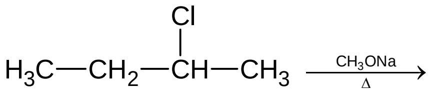
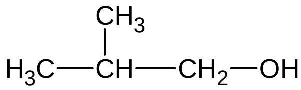
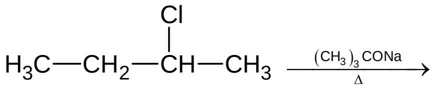
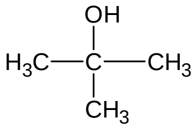
2. Match the following:

	Column I		Column II
(P)	Hell–Volhard-Zelinsky reaction	(1)	Preparation of amines
(Q)	Reformatsky reaction	(2)	Preparation of β–hydroxy ester
(R)	Claisen condensation reaction	(3)	α–halogenation of carboxylic acid
(S)	Schmidt reaction	(4)	Preparation of β–keto ester

Codes:

	P	**Q**	**R**	**S**
(A)	4	1	2	3
(B)	1	4	3	2
(C)	3	2	1	4
(D)	3	2	4	1

3. Match the Column – I with Column – II:

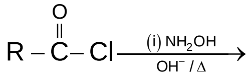
	Column – I		Column – II
(P)	 $H_3C-\underset{\underset{CH_3}{\vert}}{C}=CH_2 \xrightarrow[\text{(ii) } H_2O_2/OH^-]{\text{(i) } BH_3}$	(1)	$CH_3-CH_2-CH=CH_2$
(Q)	 $H_3C-\underset{\underset{CH_3}{\vert}}{C}=CH_2 \xrightarrow[\text{(ii) } NaBH_4]{\text{(i) } Hg(OAc)_2/HOH}$	(2)	$CH_3-CH=CH-CH_3$
(R)	 $H_3C-CH_2-\overset{\overset{Cl}{\vert}}{CH}-CH_3 \xrightarrow[\Delta]{CH_3ONa}$	(3)	 $H_3C-\overset{\overset{CH_3}{\vert}}{CH}-CH_2-OH$
(S)	 $H_3C-CH_2-\overset{\overset{Cl}{\vert}}{CH}-CH_3 \xrightarrow[\Delta]{(CH_3)_3CONa}$	(4)	 $H_3C-\underset{\underset{CH_3}{\vert}}{\overset{\overset{OH}{\vert}}{C}}-CH_3$

Codes:

	P	**Q**	**R**	**S**
(A)	4	1	2	3
(B)	3	4	2	1
(C)	3	2	1	4
(D)	3	2	4	1

Space for rough work

4. Match the following:

Column – I		**Column – II**	
(P)	$RCONH_2 \xrightarrow{Br_2/KOH} RNH_2$	(1)	Curtius rearrangement
(Q)	$RCOOH \xrightarrow[H_2SO_4]{N_3H} R-NH_2$	(2)	Lossen rearrangement
(R)	$RCOCl \xrightarrow[\Delta]{NaN_3} R-NH_2$	(3)	Schmidt rearrangement
(S)	 $R-\overset{\overset{O}{\parallel}}{C}-Cl \xrightarrow[OH^-/\Delta]{(i)\ NH_2OH}$	(4)	Hoffmann rearrangement

Codes:

	P	**Q**	**R**	**S**
(A)	4	1	2	3
(B)	1	4	3	2
(C)	3	2	1	4
(D)	4	3	1	2

Space for rough work

Mathematics

PART – III

SECTION - A

Straight Objective Type

This section contains **10 multiple** choice questions numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. If X = $\{8^n - 7n - 1 : n \in N\}$ and Y = $\{49(n-1) : n \in N\}$, then
   (A) $X \subseteq Y$ (B) $Y \subseteq X$
   (C) X = Y (D) none of these.

2. $\lim\limits_{x\to 1}\left(\sec\frac{\pi}{2^x}\right)(\ln x)$ is equal to
   (A) $-\frac{\pi}{2\ln 2}$ (B) $\frac{\pi}{2}$
   (C) $\frac{\pi}{2\ln 2}$ (D) $\frac{2}{\pi\ln 2}$.

3. If $f\left(x+\frac{y}{8}, x-\frac{y}{8}\right) = xy$ then $f(m,n) + f(n,m) = 0$
   (A) only when m = n (B) only when $m \neq n$
   (C) only when m = – n (D) for all m & n.

4. If $\int \frac{2\cos x - \sin x + \lambda}{\cos x + \sin x - 2}dx = A\ln\left|\cos x + \sin x - 2\right| + Bx + C$ then the ordered pair triplet A, B, C is
   (A) $\left(\frac{1}{2}, \frac{3}{2}, -1\right)$ (B) $\left(\frac{3}{2}, \frac{1}{2}, -1\right)$
   (C) $\left(\frac{1}{2}, -1, \frac{-3}{2}\right)$ (D) $\left(\frac{3}{2}, -1, \frac{1}{2}\right)$.

Space for rough work

5. $I_1 = \int_0^1 e^{-x}\cos^2 x dx \quad I_2 = \int_0^1 e^{-x^2}\cos^2 x\, dx \quad I_3 = \int_0^1 e^{-\frac{x^2}{2}}\cos^2 x\, dx \quad I_4 = \int_0^1 e^{-\frac{x^2}{2}} dx$ then

(A) $I_2 > I_4 > I_1 > I_3$	(B) $I_2 < I_4 < I_1 < I_3$
(C) $I_1 < I_2 < I_3 < I_4$	(D) $I_1 > I_2 > I_3 > I_4$.

6. $f(x)$ is a differentiable function satisfying the relation $f(x) = x^2 + \int_0^x e^{-t} f(x-t)\, dt$, then $\sum_{k=1}^{9} f(k)$ equals

(A) 1060	(B) 1260
(C) 960	(D) 1224

7. If $I = \int \frac{dx}{\sin\left(x - \frac{\pi}{3}\right)\cos x}$, then I equals

(A) 2 log $\left|\sin x + \sin\left(x - \frac{\pi}{3}\right)\right| + C$	(B) $2\log\left|\sin\left(x - \frac{\pi}{3}\right)\sec x\right| + C$
(C) $2\log\left|\sin x - \sin\left(x - \frac{\pi}{3}\right)\right| + C$	(D) None of these

8. Consider a function f defined on the set of all non-negative integers such that f(0)=1,f(1)=0and f(n)+f(n-1)=n f(n-1)+(n-1)f(n-2)for $n \geq 2$. Then f(5) =

(A) 40	(B) 44
(C) 45	(D) 60

9. Let $f : R \to R$ be a function such that $f\left(\frac{x+y}{3}\right) = \frac{f(x)+f(y)}{3}, f(0) = 0$ and $f'(0) = 3,$ then

(A) $\frac{f(x)}{x^2}$ is differentiable in R

(B) $f(x)$ is continuous but not differentiable in R

(C) f (x) is continuous in R

(D) f(x) is bounded in R

10. Let $f(x) = \frac{\tan x}{x}$, then $\log_e\left(\lim_{x\to 0}\left(\left[f(x)\right] + x^2\right)^{\frac{1}{\{f(x)\}}}\right)$ is equal, (where [·] denotes greatest integer function and {·} fractional part)

(A) 1	(B) 2
(C) 3	(D) 4

Space for rough work

Comprehension Type

This section contains **3 groups** of questions. Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 11 to 12

Read the following write up carefully and answer the following questions:

Definite integral of any discontinuous non differentiable function is normally solved by property $\int_a^b f(x)\,dx = \int_a^c f(x)dx + \int_c^b f(x)\,dx$; where c $\in$ (a, b) is a point of discontinuity or non differentiability

11. The value of $A = \int_1^{\infty} \left[\operatorname{cosec}^{-1} x\right] dx$ {where [.] denotes greatest integer function} is equal to

(A) cosec 1 – 1
(B) 1
(C) 1 – sin 1
(D) none of these.

12. The value of $B = \int_1^{100} \left[\sec^{-1} x\right] dx$ {where [.] denotes greatest integer function} is equal to

(A) sec 1
(B) 100 – sec 1
(C) 99 – sec 1
(D) none of these.

Paragraph for Question Nos. 13 to 14

Read the following write up carefully and answer the following questions:

If f : (0, ∞) → (0, ∞) satisfy $f(x(f(y))) = x^2 y^a$ ($a \in R$), then

13. Value of a is

(A) 4
(B) 2
(C) $\sqrt{2}$
(D) 1.

14. $\sum_{r=1}^{n} f(r) \cdot {}^nC_r$ is

(A) $n2^{n-1}$
(B) $n(n-1)2^{n-2}$
(C) $n2^{n-1} + n(n-1)2^{n-2}$
(D) 0.

Space for rough work

Paragraph for Question Nos. 15 to 16

Read the following write up carefully and answer the following questions:
Left hand derivative and right hand derivative of a function f(x) at a point x = a are defined as

$$f'\left(a^-\right) = \lim_{h\to 0^-} \frac{f(a)-f(a-h)}{h} = \lim_{h\to 0^-} \frac{f(a+h)-f(a)}{h} \text{ and}$$

$$f'\left(a^+\right) = \lim_{h\to 0^-} \frac{f(a+h)-f(a)}{h} = \lim_{h\to 0^-} \frac{f(a)-f(a-h)}{h} = \lim_{x\to a^+} \frac{f(a)-f(x)}{a-x} \text{ respectively.}$$

15. If f is odd, which of the following is left hand derivative of at x = – a

(A) $\lim\limits_{h\to 0^-} \dfrac{f(a-h)-f(a)}{-h}$ (B) $\lim\limits_{h\to 0^-} \dfrac{f(h-a)-f(a)}{h}$

(C) $\lim\limits_{h\to 0^+} \dfrac{f(a)+f(a-h)}{-h}$ (D) $\lim\limits_{h\to 0^-} \dfrac{f(-a)-f(-a-h)}{-h}$

16. If f is even which of following is right hand derivative of f′ at x = a

(A) $\lim\limits_{h\to 0} \dfrac{f'(a)+f'(-a+h)}{h}$ (B) $\lim\limits_{h\to 0^+} \dfrac{f'(a)+f'(-a-h)}{h}$

(C) $\lim\limits_{h\to 0^-} \dfrac{-f'(-a)+f'(-a-h)}{h}$ (D) $\lim\limits_{h\to 0} \dfrac{f'(a)+f'(-a+h)}{-h}$

(Matching list Type)

This section contains **4 multiple choice questions**. Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

17. Now match the following List–I with List–II.

	List – I		List – II
(P)	$f'(x)\sqrt{3x^2+6}$ and y = f(x^3) then at x = 1, $\dfrac{dy}{dx} =$	1.	– 2
(Q)	If f be a differentiable function such that f(xy) = f(x) + f(y) $\forall$ x $\in$ R, y $\in$ R then f(e) + f(1/e) =	2.	0
(R)	If f be a twice differentiable function such that f″(x) = – f(x) and f′(x) = g(x) if h(x) = $(f(x))^2$ + $(g(x))^2$ and h(5) = 9 then h(10) = A find value of 3A	3.	9
(S)	y = $\tan^{-1}$(cot x) + $\cot^{-1}$(tan x) $\dfrac{\pi}{2} < x < \pi$ then $\dfrac{dy}{dx}$	4.	27

Codes:

	P	Q	R	S
(A)	4	3	2	1
(B)	1	2	3	4
(C)	3	2	4	1
(D)	4	1	3	2

Space for rough work

18. Now match the following List–I with List–II.

	List – I		**List – II**
(P)	Number of points of discontinuity of $f(x) = \tan^2 x - \sec^2 x$ in $(0, 2\pi)$ is	1.	3
(Q)	Number of points at which $f(x) = \sin^{-1}x + \tan^{-1}x + \cot^{-1}x$ is non differentiable	2.	0
(R)	Number of points of discontinuity of $y = [\sin x]$, $x \in [0, 2\pi)$ is N then value of $\|2N\|$ where [.] represents greatest integer function	3.	2
(S)	Number of points where $y = \|(x-1)^3\| + \|(x-2)^5\| + \|x-3\|$ is non differentiable	4.	4

Codes:

	P	Q	R	S
(A)	4	3	2	1
(B)	1	2	3	4
(C)	4	1	3	2
(D)	3	2	4	1

19. Now match the following List–I with List–II.

	List – I		**List – II**
(P)	Let $f : R \to R$ be a differentiable function and $f(1) = 1$, $f'(1) = 3$; then the value of $\lim\limits_{x\to1}\int_1^{x^2}\frac{f(t)-t}{(x-1)^2}dt$	1.	0
(Q)	$\lim\limits_{n\to\infty}\left(\frac{1+\sqrt[n]{4}}{2}\right)^n$ is equal to	2.	– 1
(R)	If $\lim\limits_{n\to\infty}\frac{2x}{\pi}\tan^{-1}(nx)$; $x > 0$ then $\lim\limits_{x\to0^+}\left[f(x)-1\right]$ is {where [.] represents greatest integer function.	3.	2
(S)	$\lim\limits_{n\to\infty}\left[\sum_{r=1}^{n}\frac{1}{2^r}\right]$ where [.] denotes greatest integer function	4.	4

Codes:

	P	Q	R	S
(A)	4	3	2	1
(B)	1	2	3	4
(C)	2	3	4	1
(D)	4	1	2	3

Space for rough work

20. Now match the following List–I with List–II.

	List – I		List – II
(P)	$\int_{4}^{10} \frac{[x^2]dx}{[x^2-28x+196]+[x^2]} =$	1.	$\frac{1}{100}$
(Q)	$\int_{-1}^{2} \frac{\|x\|}{x} dx =$	2.	3
(R)	$\lim_{n\to\infty} \frac{1^{99}+2^{99}+3^{99}....n^{99}}{n^{100}} = 2A$ then value of A	3.	1
(S)	$5050\int_{-1}^{1} \sqrt{x^{200}}dx = \frac{1}{\alpha}$ then α =	4.	$\frac{1}{200}$

Codes:

	P	Q	R	S
(A)	4	3	2	1
(B)	1	2	3	4
(C)	2	3	4	1
(D)	4	1	2	3

Space for rough work

FIITJEE **JEE (Advanced), 2016**

FIITJEE Students From All Programs have bagged 33 in Top 100, 77 in Top 200 and 205 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2015: 4551 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2015.

ALL INDIA INTEGRATED TEST SERIES

PART TEST – III

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 10)** contains 10 multiple choice questions which have one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (11 to 16) contains 3 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (17 – 20) contains 4 Matching Lists Type questions: Each question has four statements in LIST I & 4 statements in LIST II. The codes for lists have choices (A), (B), (C), (D) out of which only one is correct. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

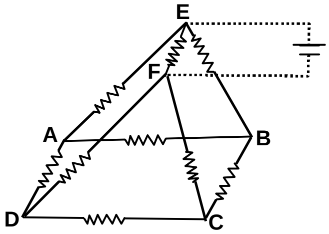
PART – I

SECTION - A

Straight Objective Type

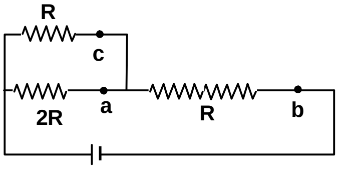
This section contains **10 multiple** choice questions numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. A prism is made of wire mesh with each side having equal resistance R. A battery of 6 V and zero resistance is connected across E and F as shown in the figure. The current in the branch AD, if R is equal to 5Ω is



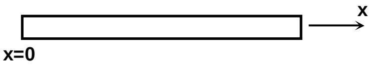
(A) 0.6A
(B) 0.8 A
(C) 0.4 A
(D) 2 A

2. Referring to the shown circuit, the current will be minimum in



(A) a
(B) b
(C) c
(D) same in all the branches

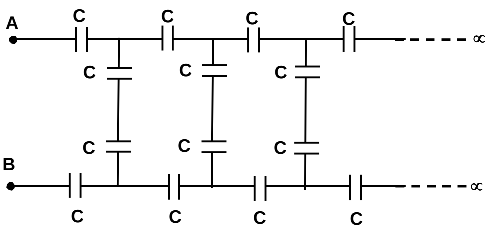
3. If along a uniform rod of length ℓ carrying current I, the voltage V changes with position x along the length of the rod such that dV/dx = – k, where k is a positive number, then the resistance of the rod is



(A) $k\ell/2I$
(B) $k\ell/I$
(C) $I/k\ell$
(D) $k\ell I$

Space for rough work

4. The equivalent capacitance of the shown infinite network across A and B, if each capacitor has a capacitance of C, is



(A) $\left(\frac{\sqrt{3}-1}{4}\right)C$

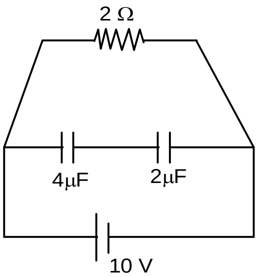
(B) $\left(\frac{\sqrt{3}+1}{4}\right)C$

(C) $\left(\frac{\sqrt{5}-1}{4}\right)C$

(D) None of these

5. In the shown network, charge on 2μf capacitor in steady state would be

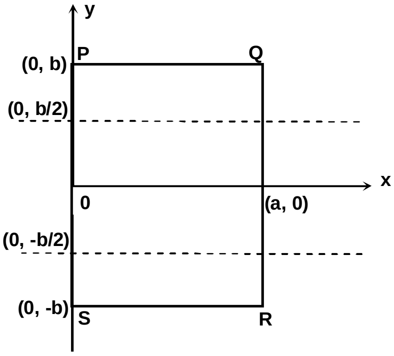
(A) 10 μC
(B) 20 μC
(C) 40/3 μC
(D) 40 μC



6 A uniform and constant magnetic field exists in a region as under

$$\begin{cases} B_o\hat{i} & \text{for } y > \frac{b}{2} \\ -B_o\hat{i} & \text{for } y < -\frac{b}{2} \\ \text{zero for } -\frac{b}{2} \le y \le \frac{b}{2} \end{cases}$$

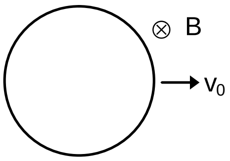
Then the current that must be passing thru the area enclosed by PQRS shown



(A) $\frac{2B_oa}{\mu_o}(-\hat{k})$
(B) $\frac{2B_oa}{\mu_o}(\hat{k})$
(C) $\frac{2B_ob}{\mu_o}(-\hat{k})$
(D) $\frac{2B_ob}{\mu_o}(\hat{k})$

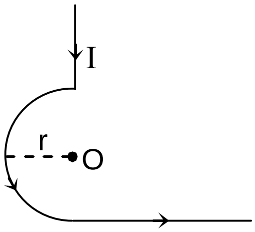
Space for rough work

7. A uniform ring of mass m with uniformly distributed charge q along its circumference of radius R is translating with speed v_0 perpendicular to a uniform magnetic field as shown. The acceleration of the ring is (Assuming gravity free space)



(A) 2 qv_0B/m
(B) 0
(C) qv_0B/m
(D) $(qv_0B)/2m$

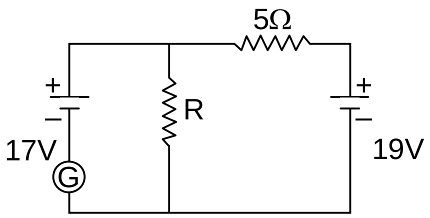
8. In the given figure, what is the magnitude of field induction at point O?



(A) $\frac{\mu_0 I}{4\pi r}$
(B) $\frac{\mu_0 I}{4r}+\frac{\mu_0 I}{2\pi r}$
(C) $\frac{\mu_0 I}{4r}+\frac{\mu_0 I}{4\pi r}$
(D) $\frac{\mu_0 I}{4r}-\frac{\mu_0 I}{4\pi r}$

9. A parallel plate capacitor is connected across a source of constant potential difference. When a dielectric plate is introduced between the two plates, then
(A) Potential difference between two plates increases
(B) Potential difference between two plates decreases
(C) Potential difference between two plates remains same
(D) Charge on the plates decreases

10. For what value of R will the current in galvanometer be zero ?



(A) 7 Ω
(B) 5 Ω
(C) 15 Ω
(D) 85/2 Ω

Space for rough work

Comprehension Type

This section contains **3 groups** of questions. Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

---

Paragraph for Question Nos. 11 to 12

In a region, charge density is

$$\begin{cases} \rho = \rho_o \sin\dfrac{\pi x}{L} \text{for } 0 \le x \le L \\ = \text{zero} \quad \text{for all other values of } x \end{cases}$$

The charge density is independent of value of y and z and it extends from $-\infty < y < \infty$ and $-\infty < z < \infty$.

11. The electric field at (L/2, L/2, 0) is

(A) $\rho_o \frac{\pi}{2}\hat{i}$ (B) $\rho_o \frac{\pi}{22}\hat{i}$

(C) $\rho_o \frac{\pi}{\sqrt{2}L}\hat{i}$ (D) zero

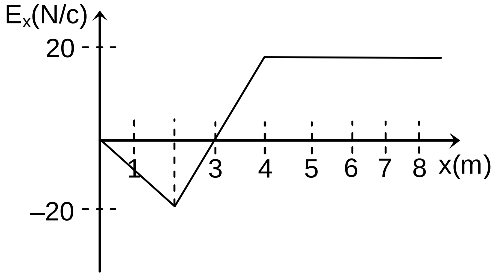
12. Equipotential surface will be

(A) Planes parallel to x-y plane (B) Planes parallel to y-z plane
(C) Planes parallel to x-z plane (D) None of these

Space for rough work

Paragraph for Question Nos. 13 to 14

A graph of the x-component of the electric field as a function of x in a region of space is shown in the figure. The y and z-components of the electric field are zero in this region. The electric potential at the origin is zero.

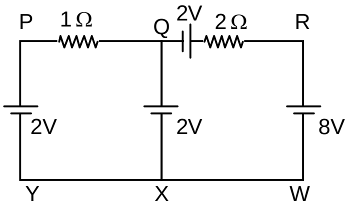


13. The electric potential at x = 2m is :
(A) 10 V
(B) 20 V
(C) 30 V
(D) 40 V

14. The greatest positive value of electric potential for points of the x-axis for which $0 \le x \le 6\text{m}$ is :
(A) 10 V
(B) 20 V
(C) 30 V
(D) 40 V

Paragraph for Question Nos. 15 to 16

For the electrical circuit shown in the figure:



Answers the following questions:

15. The current in branch PQ is
(A) zero
(B) 1 A
(C) 2 A
(D) 3 A

16. The current in branch QR is
(A) zero
(B) 1 A
(C) 2 A
(D) $\frac{2}{3}$ A

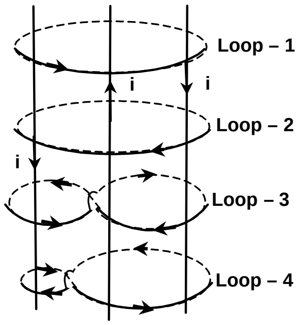
Space for rough work

(Matching list Type)

This section contains **4 multiple choice questions**. Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

17. **Read the following statements and match the following and write the correct pairs.**

Three wires are carrying same constant current in different directions. Four loops enclosing the wires in different manners are shown. The direction of $\mathbf{d}\vec{\ell}$ is shown in the figure.



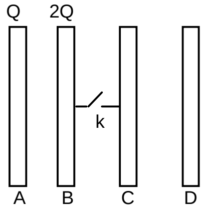
	List - I		List - II
(P)	Along closed loop – 1	(1)	$\oint \vec{B}.d\vec{\ell} = \mu_o i$
(Q)	Along closed loop – 2	(2)	$\oint \vec{B}.d\vec{\ell} = -\mu_o i$
(R)	Along closed loop – 3	(3)	$\oint \vec{B}.d\vec{\ell} = -3\mu_o i$
(S)	Along closed loop – 4	(4)	$\oint \vec{B}.d\vec{\ell} = 3\mu_o i$

Codes:

	P	Q	R	S
(A)	2	1	2	1
(B)	1	4	2	3
(C)	4	3	1	2
(D)	2	3	4	1

Space for rough work

18. *Read the following and write the correct pairs.*
Initially, the two plates (A and B) are given charges as shown. Find the final charges on the plates after the key k is closed. All plates are conducting, parallel and of infinite length and breadth.

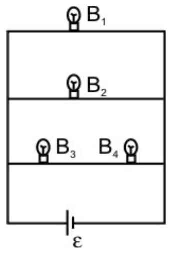


	List - I		List - II
(P)	Final charge on plate A	(1)	Q/2
(Q)	Final charge on plate B	(2)	Q
(R)	Final charge on plate C	(3)	0
(S)	Final charge on plate D	(4)	3Q/2

Codes:

	P	Q	R	S
(A)	2	3	1	4
(B)	1	4	2	3
(C)	4	3	1	2
(D)	2	1	4	3

19. Ratings of bulbs are as follows :
B_1 (100w, 200v) ; B_2 (50w, 200v) ; B_3 (100w, 200v) ; B_4 (200w, 200v)



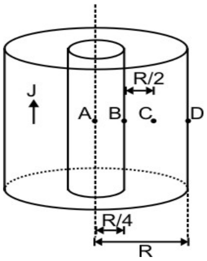
List – I		List - II	
(P)	Current drawn by B_1 are	(1)	Maximum
(Q)	Intensity of B_4 and are B_3	(2)	Minimum
(R)	Intensity of B_1	(3)	Same
(S)	Current drawn by B_2	(4)	Different

Codes:

	P	Q	R	S
(A)	2	1	2	1
(B)	1	4	1	2
(C)	4	3	1	2
(D)	2	3	4	1

Space for rough work

20. From an infinitely long cylinder of radius R, a cylinder of radius R/4 is removed and current density in the remaining portion is J as shown in the adjoining figure. BC = R/2. Match the entries of column I with the entries of column II.



List – I		List - II	
(P)	$\vec{B}$ at A is	(1)	Zero
(Q)	$\vec{B}$ at B is	(2)	$\frac{\mu_0 JR}{3}$
(R)	$\vec{B}$ at C is	(3)	$\frac{5\mu_0 JR}{3}$
(S)	$\vec{B}$ at D is	(4)	$\frac{15\mu_0 JR}{32}$

Codes:

	P	Q	R	S
(A)	2	1	2	1
(B)	1	4	2	3
(C)	1	1	2	4
(D)	2	3	4	1

Space for rough work

Chemistry

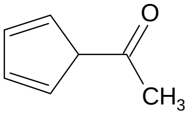
PART – II

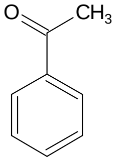
SECTION - A

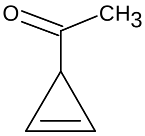
Straight Objective Type

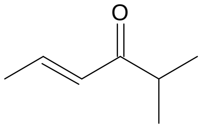
This section contains **10 multiple** choice questions numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. Which of the following will be most acidic?

(A)


(B)


(C)


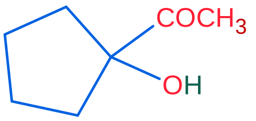
(D)


2. 1 - propoxy butane can be prepared by
(A) treating 1 – bromopropane with sodium 1 – propoxide
(B) heating with 3 – pentanol with conc. H_2SO_4 at 473 K.
(C) treating with 2 – bromopropane with sodium isopropoxide
(D) heating 1 – propanol with conc. H_2SO_4 at 443 K

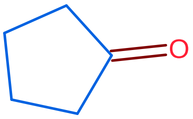
3. Bromination of aniline gives 2, 4, 6 – tribromoaniline where as the nitration of aniline with mixed acids gives m – nitroaniline. In this case nitration, the m – derivative is formed because
(A) In the presence of strong acids the amino group is protonated to $-\overset{\oplus}{N}H_3$ which is m – orienting
(B) m – nitro aniline is thermodynamically more stable than the ortho and para-isomers
(C) nitro groups can not enter ortho and para-positions due to steric factor
(D) the mechanism of bromination and nitration are different

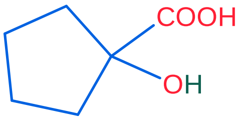
4. The major product formed by the reaction of a anisole with tert-butyl alcohol is
(A) 1- methoxycyclohexa – 1,4 diene
(B) 2 – methoxycyclohexa -1,3 diene
(C) 1- methoxycyclohexa – 1,3 diene
(D) 3- methoxycyclohexa – 1,4 diene

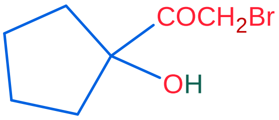
Space for rough work

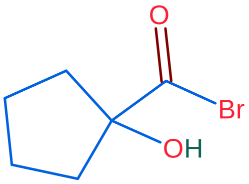
5.  $\xrightarrow{\text{NaOBr}}$ Product

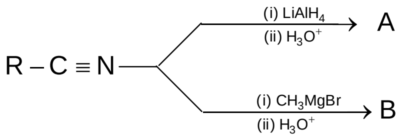
The product is

(A) 

(B) 

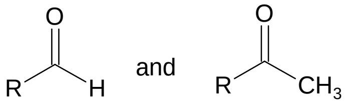
(C) 

(D) 

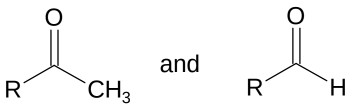
6. 

R – C ≡ N
(i) LiAlH4
(ii) H3O+
A
(i) CH3MgBr
(ii) H3O+
B

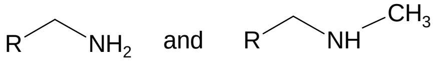
A and B are

(A) 

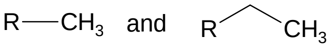
O
R
H
and
O
R
CH3

(B) 

O
R
CH3
and
O
R
H

(C) 

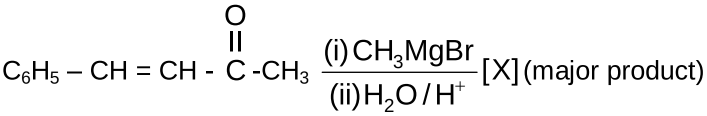
R
NH2
and
R
NH
CH3

(D) 

R
CH3
and
R
CH3

Space for rough work

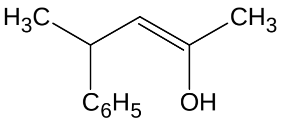
7. In the reaction sequence



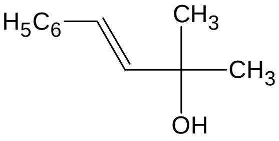
$$C_6H_5 - CH = CH - \overset{\overset{O}{\|}}{C} - CH_3 \xrightarrow[(ii)\,H_2O/H^+]{(i)\,CH_3MgBr} [X]\ \text{(major product)}$$

X will be

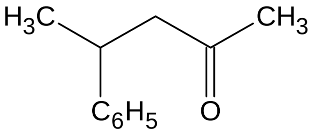
(A)


H$_3$C
CH$_3$
C$_6$H$_5$
OH

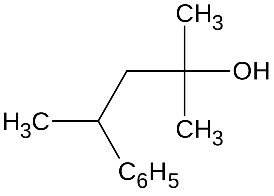
(B)


H$_5$C$_6$
CH$_3$
CH$_3$
OH

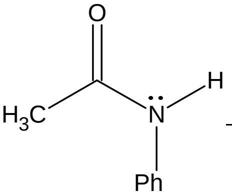
(C)


H$_3$C
CH$_3$
C$_6$H$_5$
O

(D)


CH$_3$
OH
H$_3$C
CH$_3$
C$_6$H$_5$

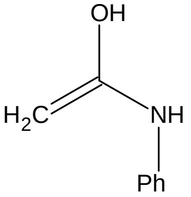
8.



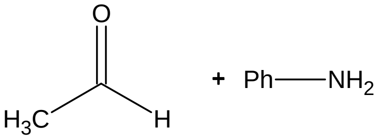
$\xrightarrow[\Delta]{H^+/DMSO}$ Major product;

Which of the following is major product?

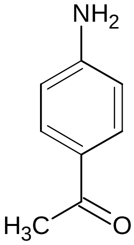
(A)



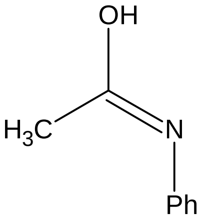
(B)


O
H$_3$C
H
+ Ph—NH$_2$

(C)



(D)



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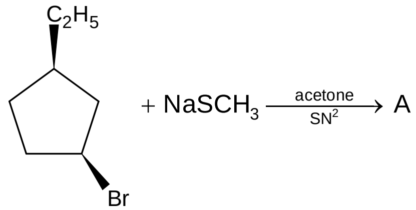
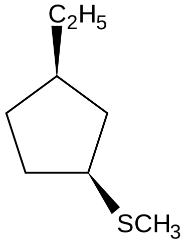
9.

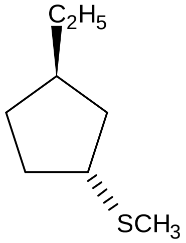

C₂H₅
Br
+ NaSCH₃
acetone
SN²
A

The compound A is –

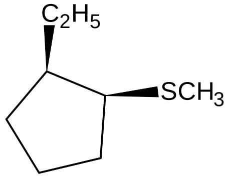
(A)



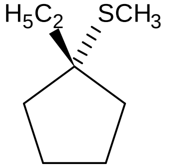
(B)



(C)

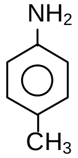


(D)

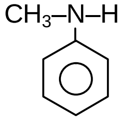


10. Which of the following amine will show carbylamine reaction?

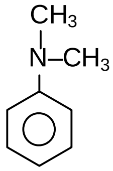
(A)



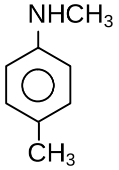
(B)



(C)



(D)



Space for rough work

Comprehension Type

This section contains **3 groups** of questions. Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

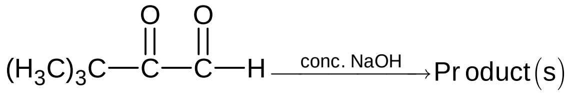
Paragraph for Question Nos. 11 to 12

Aldehydes without α - hydrogen undergoes Cannizzaro reaction in the presence of conc. Alkali. Two molecule undergoes self oxidation and reduction to yield a mixture of alcohol and salt of carboxylic acid. Two different aldehydes without α hydrogen undergoes crossed Cannizzaro reaction. The rate of reaction is decided by the ease with which H^- is transferred.

11. $HCHO + PhCHO \xrightarrow{\text{50\% NaOH}} P + Q$

P and Q are
(A) HCOOH and PhCOONa
(B) HCOONa and PhCOOH
(C) CH_3OH and PhCOONa
(D) HCOONa and $PhCH_2OH$

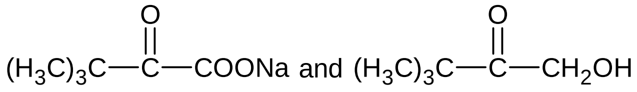
12.



$(H_3C)_3C-\overset{O}{\overset{\|}{C}}-\overset{O}{\overset{\|}{C}}-H \xrightarrow{\text{conc. NaOH}} \text{Product}(s)$

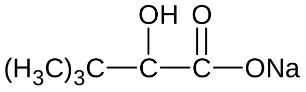
Choose the correct statements among the following statement:

(A) product are



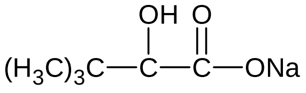
$(H_3C)_3C-\overset{O}{\overset{\|}{C}}-COONa$ and $(H_3C)_3C-\overset{O}{\overset{\|}{C}}-CH_2OH$

(B) Product is



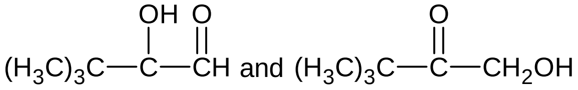
$(H_3C)_3C-\overset{OH}{\overset{|}{C}}-\overset{O}{\overset{\|}{C}}-ONa$ and reaction in disproportionation reaction

(C) Product is



$(H_3C)_3C-\overset{OH}{\overset{|}{C}}-\overset{O}{\overset{\|}{C}}-ONa$ but is not disproportionation reaction

(D) Product are



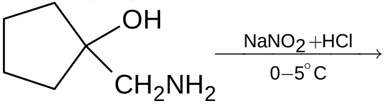
$(H_3C)_3C-\overset{OH}{\overset{|}{C}}-\overset{O}{\overset{\|}{C}}H$ and $(H_3C)_3C-\overset{O}{\overset{\|}{C}}-CH_2OH$

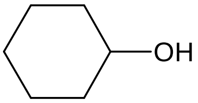
Space for rough work

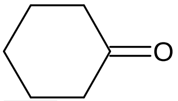
Paragraph for Question Nos. 13 to 14

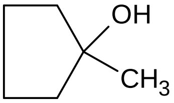
Aliphatic primary amines react with nitrous acid ($NaNO_2$ + HCl) form alcohol as the major product. In addition to alcohol, alkenes and alkyl halide are also formed as minor products. Nitrous acid also react with secondary and tertiary amine, nature of reaction depends whether amine is aliphatic or aromatic.

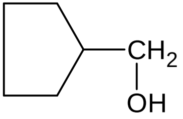
13. The major product obtained in the following reaction will be



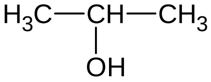
(A) 

(B) 

(C) 

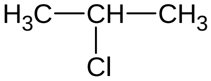
(D) 

14. Which of the following product(s) will be obtained when n-propyl amine is treated with $NaNO_2$ and HCl?

(A) 

$H_3C-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3$

(B) $H_3C-CH=CH_2$

(C) 

$H_3C-\underset{\displaystyle Cl}{\underset{|}{CH}}-CH_3$

(D) All of these

Space for rough work

Paragraph for Question Nos. 15 to 16

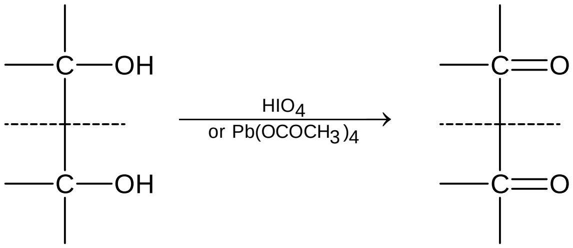
Read the paragraph carefully and answer the following questions:
In a polyhydric alcohol, the total numbers of hydroxyl groups are estimated by the following methods:

(i) A known mass of the acetyl derivative of polyhydric alcohol is taken. It is mixed with an excess volume of a standard alkali solution. Both are refluxed. Alkali is used in the hydrolysis of acetyl derivative. The unused alkali is measured by carrying out titration with a standard acid solution and total number of hydroxyl groups (n) can thus be calculated stoichiometrically.

$$A(OH)_n \xrightarrow{CH_3COCl} A(OCOCH_3)_n \xrightarrow{nKOH} A(OH)_n + nCH_3COOK$$

Polyhydric alcohol — Acetyl derivative

(ii) Total number of –OH groups in vicinal position can be calculated by oxidation with periodic acid or lead tetra acetate.



15. 0.436 g of acetyl derivative of a polyhydric alcohol (molecular mass = 92) require 0.336 g KOH for hydrolysis. The total numbers of hydroxyl group(s) in the alcohol are
(A) 1
(B) 2
(C) 3
(D) 4

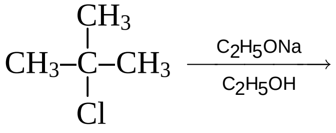
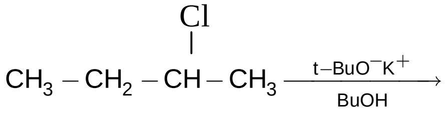
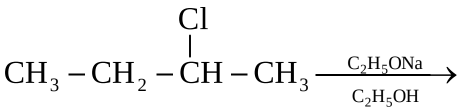
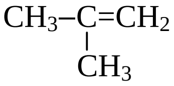
16. The product formed by the reaction of ethylene glycol and periodic acid (HIO_4) is
(A) acetic acid
(B) formic acid
(C) formaldehyde
(D) glyoxal

Space for rough work

(Matching list Type)

This section contains **4 multiple choice questions**. Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

1. Match the following:

	Column – I (Substrate + reagent)		**Column - II (Major product)**
(P)	$CH_3–CH_2–CH_2–Cl \xrightarrow[C_2H_5OH]{C_2H_5ONa}$	(1)	$CH_3–CH_2–CH=CH_2$
(Q)	 $CH_3-\underset{Cl}{\overset{CH_3}{C}}-CH_3 \xrightarrow[C_2H_5OH]{C_2H_5ONa}$	(2)	$CH_3–CH=CH–CH_3$
(R)	 $CH_3-CH_2-\overset{Cl}{CH}-CH_3 \xrightarrow[BuOH]{t-BuO^-K^+}$	(3)	$CH_3–CH=CH_2$
(S)	 $CH_3-CH_2-\overset{Cl}{CH}-CH_3 \xrightarrow[C_2H_5OH]{C_2H_5ONa}$	(4)	 $CH_3-\underset{CH_3}{C}=CH_2$

Codes:

	P	**Q**	**R**	**S**
(A)	3	4	1	2
(B)	1	4	3	2
(C)	3	2	1	4
(D)	4	3	2	1

Space for rough work

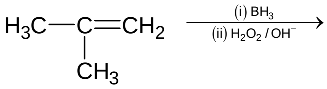
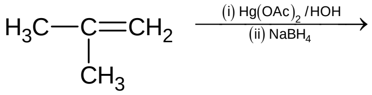
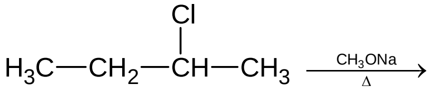
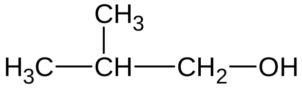
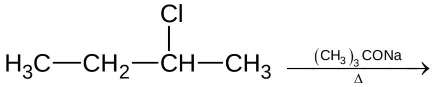
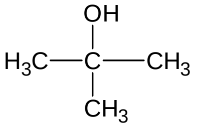
2. Match the following:

	Column I		Column II
(P)	Hell–Volhard-Zelinsky reaction	(1)	Preparation of amines
(Q)	Reformatsky reaction	(2)	Preparation of β–hydroxy ester
(R)	Claisen condensation reaction	(3)	α–halogenation of carboxylic acid
(S)	Schmidt reaction	(4)	Preparation of β–keto ester

Codes:

	P	**Q**	**R**	**S**
(A)	4	1	2	3
(B)	1	4	3	2
(C)	3	2	1	4
(D)	3	2	4	1

3. Match the Column – I with Column – II:

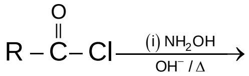
	Column – I		Column – II
(P)	 $H_3C-\underset{\underset{CH_3}{\vert}}{C}=CH_2 \xrightarrow[\text{(ii) } H_2O_2/OH^-]{\text{(i) } BH_3}$	(1)	$CH_3-CH_2-CH=CH_2$
(Q)	 $H_3C-\underset{\underset{CH_3}{\vert}}{C}=CH_2 \xrightarrow[\text{(ii) } NaBH_4]{\text{(i) } Hg(OAc)_2/HOH}$	(2)	$CH_3-CH=CH-CH_3$
(R)	 $H_3C-CH_2-\overset{\overset{Cl}{\vert}}{CH}-CH_3 \xrightarrow[\Delta]{CH_3ONa}$	(3)	 $H_3C-\overset{\overset{CH_3}{\vert}}{CH}-CH_2-OH$
(S)	 $H_3C-CH_2-\overset{\overset{Cl}{\vert}}{CH}-CH_3 \xrightarrow[\Delta]{(CH_3)_3CONa}$	(4)	 $H_3C-\overset{\overset{OH}{\vert}}{\underset{\underset{CH_3}{\vert}}{C}}-CH_3$

Codes:

	P	**Q**	**R**	**S**
(A)	4	1	2	3
(B)	3	4	2	1
(C)	3	2	1	4
(D)	3	2	4	1

Space for rough work

4. Match the following:

Column – I		Column – II	
(P)	$RCONH_2 \xrightarrow{Br_2/KOH} RNH_2$	(1)	Curtius rearrangement
(Q)	$RCOOH \xrightarrow[H_2SO_4]{N_3H} R-NH_2$	(2)	Lossen rearrangement
(R)	$RCOCl \xrightarrow[\Delta]{NaN_3} R-NH_2$	(3)	Schmidt rearrangement
(S)	 $R-\overset{\overset{\large O}{\parallel}}{C}-Cl \xrightarrow[OH^-/\Delta]{(i)\ NH_2OH}$	(4)	Hoffmann rearrangement

Codes:

	P	**Q**	**R**	**S**
(A)	4	1	2	3
(B)	1	4	3	2
(C)	3	2	1	4
(D)	4	3	1	2

Space for rough work

Mathematics PART – III

SECTION - A

Straight Objective Type

This section contains **10 multiple** choice questions numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. If $X = \{8^n - 7n - 1 : n \in N\}$ and $Y = \{49(n-1) : n \in N\}$, then
(A) $X \subseteq Y$ (B) $Y \subseteq X$
(C) $X = Y$ (D) none of these.

2. $\lim\limits_{x \to 1} \left(\sec \dfrac{\pi}{2^x} \right) (\ln x)$ is equal to
(A) $-\dfrac{\pi}{2 \ln 2}$ (B) $\dfrac{\pi}{2}$
(C) $\dfrac{\pi}{2 \ln 2}$ (D) $\dfrac{2}{\pi \ln 2}$.

3. If $f\left(x + \dfrac{y}{8}, x - \dfrac{y}{8} \right) = xy$ then $f(m, n) + f(n, m) = 0$
(A) only when m = n (B) only when $m \ne n$
(C) only when m = – n (D) for all m & n.

4. If $\int \dfrac{2\cos x - \sin x + \lambda}{\cos x + \sin x - 2} dx = A \ln |\cos x + \sin x - 2| + Bx + C$ then the ordered pair triplet A, B, C is
(A) $\left(\dfrac{1}{2}, \dfrac{3}{2}, -1 \right)$ (B) $\left(\dfrac{3}{2}, \dfrac{1}{2}, -1 \right)$
(C) $\left(\dfrac{1}{2}, -1, \dfrac{-3}{2} \right)$ (D) $\left(\dfrac{3}{2}, -1, \dfrac{1}{2} \right)$.

Space for rough work

5. $I_1 = \int_0^1 e^{-x}\cos^2 x dx$ $I_2 = \int_0^1 e^{-x^2}\cos^2 x\, dx$ $I_3 = \int_0^1 e^{-\frac{x^2}{2}}\cos^2 x\, dx$ $I_4 = \int_0^1 e^{-\frac{x^2}{2}} dx$ then
(A) $I_2 > I_4 > I_1 > I_3$
(B) $I_2 < I_4 < I_1 < I_3$
(C) $I_1 < I_2 < I_3 < I_4$
(D) $I_1 > I_2 > I_3 > I_4$.

6. $f(x)$ is a differentiable function satisfying the relation $f(x) = x^2 + \int_0^x e^{-t} f(x-t)\,dt$, then $\sum_{k=1}^{9} f(k)$ equals
(A) 1060
(B) 1260
(C) 960
(D) 1224

7. If $I = \int \frac{dx}{\sin\left(x - \frac{\pi}{3}\right)\cos x}$, then I equals
(A) 2 log $\left|\sin x + \sin\left(x - \frac{\pi}{3}\right)\right| + C$
(B) $2\log\left|\sin\left(x - \frac{\pi}{3}\right)\sec x\right| + C$
(C) $2\log\left|\sin x - \sin\left(x - \frac{\pi}{3}\right)\right| + C$
(D) None of these

8. Consider a function f defined on the set of all non-negative integers such that f(0)=1,f(1)=0and f(n)+f(n-1)=n f(n-1)+(n-1)f(n-2)for $n \geq 2$. Then f(5) =
(A) 40
(B) 44
(C) 45
(D) 60

9. Let $f: R \to R$ be a function such that $f\left(\frac{x+y}{3}\right) = \frac{f(x)+f(y)}{3}, f(0) = 0$ and $f'(0) = 3$, then
(A) $\frac{f(x)}{x^2}$ is differentiable in R
(B) $f(x)$ is continuous but not differentiable in R
(C) f (x) is continuous in R
(D) f(x) is bounded in R

10. Let $f(x) = \frac{\tan x}{x}$, then $\log_e\left(\lim_{x\to 0}\left([f(x)] + x^2\right)^{\frac{1}{\{f(x)\}}}\right)$ is equal, (where [·] denotes greatest integer function and {·} fractional part)
(A) 1
(B) 2
(C) 3
(D) 4

Space for rough work

Comprehension Type

This section contains **3 groups** of questions. Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 11 to 12

Read the following write up carefully and answer the following questions:

Definite integral of any discontinuous non differentiable function is normally solved by property $\int_a^b f(x)\,dx = \int_a^c f(x)dx + \int_c^b f(x)\,dx$; where c $\in$ (a, b) is a point of discontinuity or non differentiability

11. The value of $A = \int_1^{\infty}\left[\operatorname{cosec}^{-1}x\right]dx$ {where [.] denotes greatest integer function} is equal to

(A) cosec 1 – 1 (B) 1

(C) 1 – sin 1 (D) none of these.

12. The value of $B = \int_1^{100}\left[\sec^{-1}x\right]dx$ {where [.] denotes greatest integer function} is equal to

(A) sec 1 (B) 100 – sec 1

(C) 99 – sec 1 (D) none of these.

Paragraph for Question Nos. 13 to 14

Read the following write up carefully and answer the following questions:

If f : (0, ∞) $\to$ (0, ∞) satisfy f(x(f(y)) = $x^2 y^a$ (a $\in$ R), then

13. Value of a is

(A) 4 (B) 2

(C) $\sqrt{2}$ (D) 1.

14. $\sum_{r=1}^{n} f(r)\cdot {}^{n}C_r$ is

(A) $n2^{n-1}$ (B) $n(n-1)2^{n-2}$

(C) $n2^{n-1} + n(n-1)2^{n-2}$ (D) 0.

Space for rough work

Paragraph for Question Nos. 15 to 16

Read the following write up carefully and answer the following questions:
Left hand derivative and right hand derivative of a function f(x) at a point x = a are defined as

$$f'\left(a^{-}\right)=\lim_{h\to 0^{-}}\frac{f(a)-f(a-h)}{h}=\lim_{h\to 0^{-}}\frac{f(a+h)-f(a)}{h} \text{ and}$$

$$f'\left(a^{+}\right)=\lim_{h\to 0^{-}}\frac{f(a+h)-f(a)}{h}=\lim_{h\to 0^{-}}\frac{f(a)-f(a-h)}{h}=\lim_{x\to a^{+}}\frac{f(a)-f(x)}{a-x} \text{ respectively.}$$

15. If f is odd, which of the following is left hand derivative of at x = – a

(A) $\lim\limits_{h\to 0^{-}}\frac{f(a-h)-f(a)}{-h}$ (B) $\lim\limits_{h\to 0^{-}}\frac{f(h-a)-f(a)}{h}$

(C) $\lim\limits_{h\to 0^{+}}\frac{f(a)+f(a-h)}{-h}$ (D) $\lim\limits_{h\to 0^{-}}\frac{f(-a)-f(-a-h)}{-h}$

16. If f is even which of following is right hand derivative of f′ at x = a

(A) $\lim\limits_{h\to 0}\frac{f'(a)+f'(-a+h)}{h}$ (B) $\lim\limits_{h\to 0^{+}}\frac{f'(a)+f'(-a-h)}{h}$

(C) $\lim\limits_{h\to 0^{-}}\frac{-f'(-a)+f'(-a-h)}{h}$ (D) $\lim\limits_{h\to 0}\frac{f'(a)+f'(-a+h)}{-h}$

(Matching list Type)

This section contains **4 multiple choice questions**. Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

17. Now match the following List–I with List–II.

	List – I		List – II
(P)	$f'(x)\sqrt{3x^2+6}$ and y = f(x^3) then at x = 1, $\frac{dy}{dx}=$	1.	– 2
(Q)	If f be a differentiable function such that f(xy) = f(x) + f(y) $\forall$ x $\in$ R, y $\in$ R then f(e) + f(1/e) =	2.	0
(R)	If f be a twice differentiable function such that f″(x) = – f(x) and f′(x) = g(x) if h(x) = $(f(x))^2$ + $(g(x))^2$ and h(5) = 9 then h(10) = A find value of 3A	3.	9
(S)	y = $\tan^{-1}$(cot x) + $\cot^{-1}$(tan x) $\frac{\pi}{2}<x<\pi$ then $\frac{dy}{dx}$	4.	27

Codes:

	P	Q	R	S
(A)	4	3	2	1
(B)	1	2	3	4
(C)	3	2	4	1
(D)	4	1	3	2

Space for rough work

18. Now match the following List–I with List–II.

	List – I		**List – II**
(P)	Number of points of discontinuity of $f(x) = \tan^2 x - \sec^2 x$ in $(0, 2\pi)$ is	1.	3
(Q)	Number of points at which $f(x) = \sin^{-1}x + \tan^{-1}x + \cot^{-1}x$ is non differentiable	2.	0
(R)	Number of points of discontinuity of $y = [\sin x]$, $x \in [0, 2\pi)$ is N then value of $\|2N\|$ where [.] represents greatest integer function	3.	2
(S)	Number of points where $y = \|(x-1)^3\| + \|(x-2)^5\| + \|x-3\|$ is non differentiable	4.	4

Codes:

	P	Q	R	S
(A)	4	3	2	1
(B)	1	2	3	4
(C)	4	1	3	2
(D)	3	2	4	1

19. Now match the following List–I with List–II.

	List – I		**List – II**
(P)	Let $f : R \to R$ be a differentiable function and $f(1) = 1$, $f'(1) = 3$; then the value of $\lim_{x\to1}\int_1^{x^2}\frac{f(t)-t}{(x-1)^2}dt$	1.	0
(Q)	$\lim_{n\to\infty}\left(\frac{1+\sqrt[n]{4}}{2}\right)^n$ is equal to	2.	– 1
(R)	If $\lim_{n\to\infty}\frac{2x}{\pi}\tan^{-1}(nx)$; $x > 0$ then $\lim_{x\to0^+}\left[f(x)-1\right]$ is {where [.] represents greatest integer function.	3.	2
(S)	$\lim_{n\to\infty}\left[\sum_{r=1}^{n}\frac{1}{2^r}\right]$ where [.] denotes greatest integer function	4.	4

Codes:

	P	Q	R	S
(A)	4	3	2	1
(B)	1	2	3	4
(C)	2	3	4	1
(D)	4	1	2	3

Space for rough work

20. Now match the following List–I with List–II.

	List – I		List – II
(P)	$\int_{4}^{10} \frac{\left[x^2\right]dx}{\left[x^2-28x+196\right]+\left[x^2\right]} =$	1.	$\frac{1}{100}$
(Q)	$\int_{-1}^{2} \frac{\lvert x\rvert}{x}\,dx =$	2.	3
(R)	$\lim_{n\to\infty} \frac{1^{99}+2^{99}+3^{99}....n^{99}}{n^{100}} = 2A$ then value of A	3.	1
(S)	$5050\int_{-1}^{1} \sqrt{x^{200}}\,dx = \frac{1}{\alpha}$ then α =	4.	$\frac{1}{200}$

Codes:

	P	Q	R	S
(A)	4	3	2	1
(B)	1	2	3	4
(C)	2	3	4	1
(D)	4	1	2	3

Space for rough work

FIITJEE **JEE (Main), 2016**

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FIITJEE Students From All Programs have bagged 33 in Top 100, 77 in Top 200 and 205 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2015:
4551 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2015.

PART TEST – III

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 03 and 10 to 12)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (04 to 09 and 13 to 30) contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

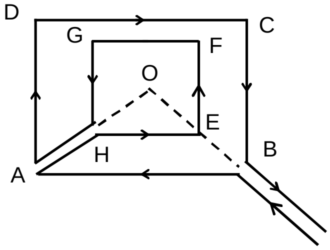
PART – I

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

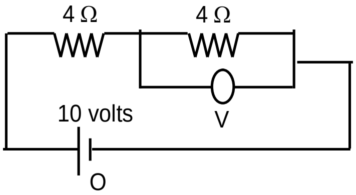
1. ABCD is a square of side 4R and EFGH is a square loop of side 2R. The loop carries a current I. The magnetic field at the centre O of the loop



(A) $\frac{\mu_0 I}{2\pi R}\odot$ (B) $\frac{\mu_0 I}{2\pi R}\otimes$

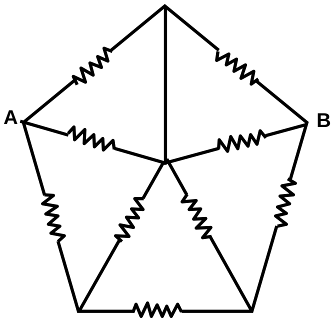
(C) $\frac{\mu_0 I}{\sqrt{2}\pi R}\otimes$ (D) $\frac{\mu_0 I}{\sqrt{2}\pi R}\odot$

2. In the given circuit, if the voltmeter is ideal its reading is V_1 volts. If the voltmeter has a resistance of 100Ω, the reading is V_2. Then $|V_1 - V_2|$ is equal to :-



(A) Zero (B) 0.3volts.
(C) 0.2volts (D) 0.1volts

3. The effective resistance between A & B of the shown network. Where resistance of each resistor is R, is



(A) $\frac{8R}{11}$ (B) $\frac{6R}{11}$

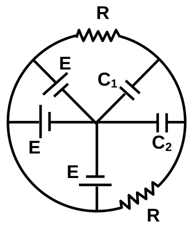
(C) $\frac{6R}{5}$ (D) none of these

4. In a region, uniform electric field exists as $\vec{E} = \left[10\hat{i} + 10\hat{j}\right]$ N / C. If the potential of origin is 0 volts, the potential of point (10m, 10m, 10m) is

(A) 20 volts (B) – 200 volts
(C) 10 volts (D) – 10 volts

Space for rough work

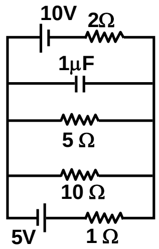
5. Find the current in resistor R at steady state



(A) $\frac{2E}{R}$ (B) zero

(C) $\frac{3E}{R}$ (D) $\frac{EC_1}{RC_2}$

6. The charges on the plates of the capacitor in the steady state in the given circuit is



(A) zero. (B) 5 μC

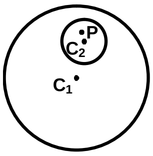
(C) 10 μC (D) none of these

7. An infinite number of charges of magnitudes q, q/2, q/4, q/8 and so on are placed along the circumference of a circle of radius 1 unit with centre as origin. The potential at the origin will be

(A) $\frac{q}{2\pi\varepsilon_0}$ (B) $\frac{q}{4\pi\varepsilon_0}$

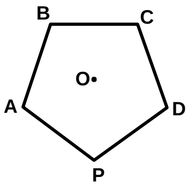
(C) $\frac{q}{3\pi\varepsilon_0}$ (D) infinite

8. From a uniform solid sphere an eccentric cavity has been cut out as shown in the figure. C_1 and C_2 represent their centres respectively. If the size of the cavity is increased keeping the centre at C_2, then the field strength at any internal point P will



(A) be zero
(B) remain constant in magnitude but direction of field will change with the change in position of P.
(C) remain constant in magnitude and direction for all positions of point P.
(D) gradually decrease in magnitude as the size of cavity increases.

9. A regular pentagon having four identical charges of equal magnitude placed at the four corners A, B, C and D produce a field $\vec{E} = \left(-3\hat{i} + 4\hat{j} - 2\hat{k}\right)$ units at the centre O of the pentagon. If all the four charges are removed from the corners and reassembled at the fifth point P, find the field at O due to this rearrangement.



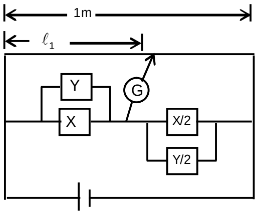
(A) $10\hat{i} - 5\hat{j} + 9\hat{k}$ (B) $3\hat{i} - 4\hat{j} + 2\hat{k}$

(C) $12\hat{i} - 16\hat{j} + 8\hat{k}$ (D) zero

Space for rough work

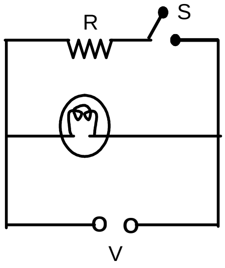
10. Figure shows a meter bridge. If there is no current through galvanometer then ℓ_1 is equal to

(A) 200/3 cm (B) 100/3 cm
(C) 50 cm (D) None of the above



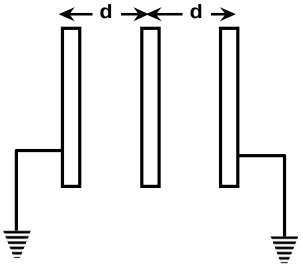
11. A bulb is connected across a voltage source. A resistor R is connected in parallel to the bulb through a switch S. If switch S is closed then

(A) Brightness of bulb decreases
(B) Brightness of bulb increases
(C) Brightness remains unchanged.
(D) None of the above



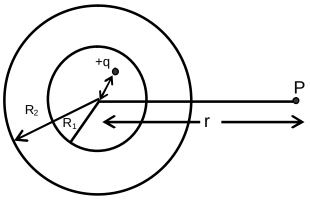
12. Three similar plates are arranged 'd' meters apart as shown in the figure. If area of each plate is A and a charge +Q is given to middle plate then potential of middle plate is

(A) $\frac{Qd}{A\in_0}$ (B) $\frac{Qd}{2A\in_0}$
(C) $\frac{Qd}{4A\in_0}$ (D) $\frac{2Qd}{A\in_0}$



13. A conducting shell having inner radius R_1 and outer radius R_2 contains a charge + q which is placed at a distance x from its centre. Field at an exterior point P which is situated at a distance r from centre of shell $(r > R_2)$

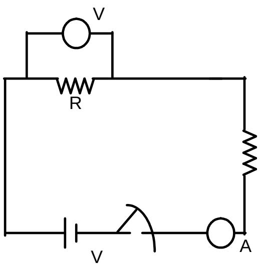
(A) depends on x
(B) depends on R_1 and R_2
(C) depends only or r
(D) None.



Space for rough work

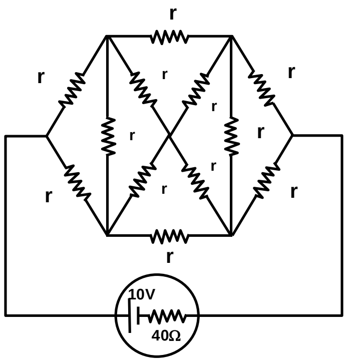
14. The potential deference across the resistor as measured by a voltmetre, is $60 \pm 1.5\text{V}$ and the current through the resistor as measured by an ammeter is (2 ± 0.01) A. what is the maximum% error in the measured value of R?

(A) 3% (B) 1.5%
(C) 2.5% (D) None of these



15. Find the value of r so that maximum power is generated in external circuit.

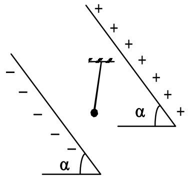
(A) r = 10 Ω (B) r = 20 Ω
(C) r = 30 Ω (D) r = 40 Ω



16. Consider a parallel plate capacitor having an electric field E inside it as shown in the adjacent figure. A particle of mass m and charge q is hanging inside the capacitor through a light inextensible string of length ℓ. The time period of this pendulum is

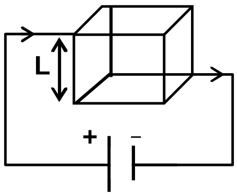
(A) $T = 2\pi\sqrt{\dfrac{\ell}{g + (qE/m)}}$ (B) $T = 2\pi\sqrt{\dfrac{\ell}{g^2 + \dfrac{q^2E^2}{m^2} - \dfrac{2qgE}{m}}}$

(C) $T = 2\pi\sqrt{\dfrac{\ell}{g^2 + \dfrac{q^2E^2}{m^2} + \dfrac{2qgE}{m}}}$ (D) none of the above



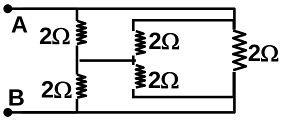
Space for rough work

17. A cube made from wires of equal length is connected to a battery as shown in the figure. The magnetic field at the centre of the cube is



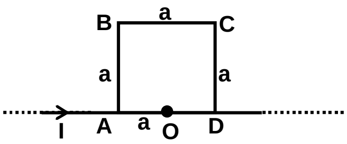
(A) $\frac{12\mu_0 I}{\sqrt{2}\pi L}$ (B) $\frac{6\mu_0 I}{\sqrt{2}\pi L}$
(C) $\frac{6\mu_0 I}{\pi L}$ (D) zero

18. Find the equivalent resistance across AB:



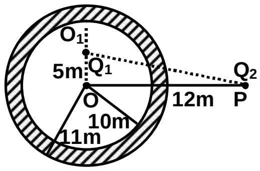
(A) 1 Ω (B) 2 Ω
(C) 3 Ω (D) 4 Ω

19. The resistance per unit length of the wires in segments AB, BC, CD, and AD are the same. The magnetic field due to the current at point O is



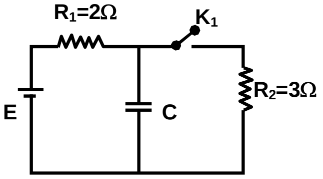
(A) $\frac{3\mu_0 I}{4\sqrt{5}\pi a}$ (B) $\frac{3\mu_0 I}{\sqrt{5}\pi a}$
(C) $\frac{\mu_0 I}{2\sqrt{5}\pi a}$ (D) none of the above

20. A charge Q_1 is placed at O, inside a hollow conducting sphere having inner and outer radii as 10 m and 11 m as shown. The force experienced by Q_2 at P is F_1 and force experienced by Q_2 when Q_1 is placed at O_1 is F_2. Then F_1/F_2 is equal to



(A) 1 (B) $\left(\frac{12}{13}\right)^2$
(C) $\left(\frac{13}{12}\right)^2$ (D) none of the above

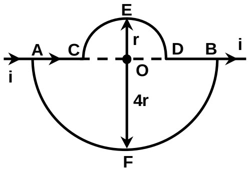
21. In the circuit shown in the figure k_1 is open. The charge on capacitor C in steady state is q_1. Now key is closed and at steady state charge on C is q_2. The ratio of charges q_1/q_2 is



(A) 5/3 (B) 3/5
(C) 1 (D) 2/3

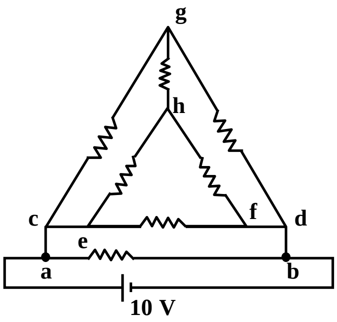
Space for rough work

22. In the shown in the figure AC and BD are straight lines and CED and AFB are semicircular with radii r and 4r respectively. The entire setup is lying in the same plane. If i is current entering at A what fraction of i will flow in the ACEDB such that resultant magnetic field at O is zero.



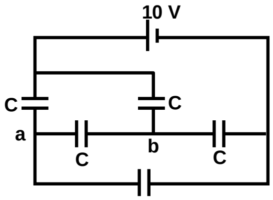
(A) i/5
(B) 4i/5
(C) 3i/5
(D) no current through bigger semicircular part.

23. Consider the network shown in the figure. All resistances are equal to 2Ω. What is the potential difference between points e and h?



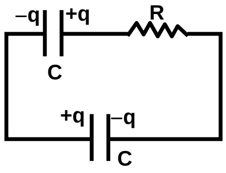
(A) zero
(B) 5V
(C) 2.5 V
(D) 10 V

24. What is the energy stored in the capacitor between terminals a and b of the network shown in the figure? (Capacitance of each capacitor C = 5μF).



(A) 1 μJ
(B) 0.25 μJ
(C) zero.
(D) 15.6 μJ

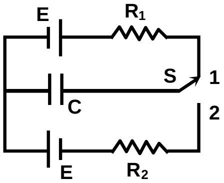
25. Two capacitors having equal capacitance C, are having same charges q each. They are connected across a resistor R as shown in the figure. What is the total heat generated in the resistor upto the instant when the steady state has reached?



(A) $q^2/2C$
(B) q^2/C
(C) zero
(D) none of the above.

Space for rough work

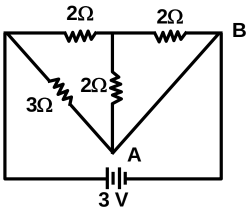
26. In the circuit shown, switch is placed in position1, till the capacitor is charged to half of the maximum possible charge in this situation. Now the switch S is placed in position 2. The maximum energy lost by the circuit after switch S is placed in position 2 is



(A) $\frac{1}{2}CE^2$ (B) $\frac{1}{8}CE^2$

(C) $\frac{7}{8}CE^2$ (D) $\frac{9}{8}CE^2$

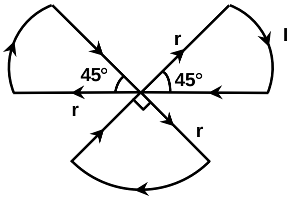
27. The current in branch AB is



(A) infinite (B) 1.33A

(C) 2 A (D) 1.5 A

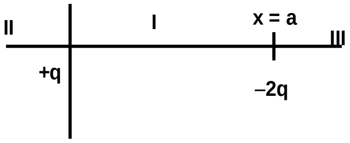
28. Calculate the magnetic field at point P due to three arcs as shown in the figure



(A) $\frac{\mu_0 I}{2r}$ (B) $\frac{\mu_0 I}{4r}$

(C) $\frac{\mu_0 I}{2\pi r}$ (D) zero

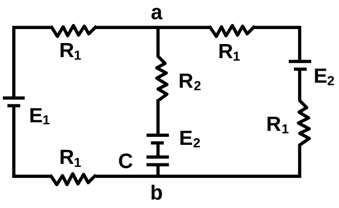
29. A point charge +q is located at the origin and a point charge – 2q is located at x = a (a > 0). In which of the following region or regions might there exists a point where the electric potential (V) is zero?



(A) $-\infty < x < a$ (B) $0 < x < a$

(C) $a < x < \infty$ (D) V does not vanish in the region $-\infty < x < \infty$

30. What is the potential difference between points a and b, in the steady state in the circuit given below? (E_1 = 2.1V, E_2 = 6.3 V, R_1 = 1.7 Ω, R_2 = 3.5 Ω, C = 2μF)



(A) 4.9 V (B) 2.8 V

(C) 5.9 V (D) 4.2 V

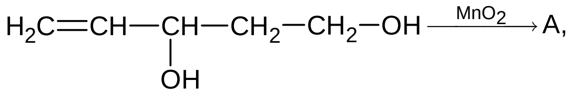
Space for rough work

Chemistry PART – II

SECTION – A

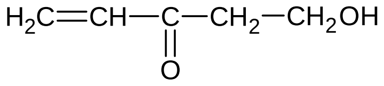
Straight Objective Type

This section contains 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

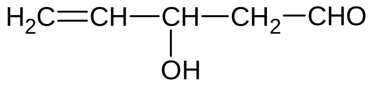
1. 

$H_2C{=}CH{-}\underset{\underset{OH}{|}}{CH}{-}CH_2{-}CH_2{-}OH \xrightarrow{MnO_2} A,$

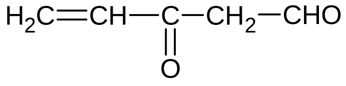
A is

(A) 

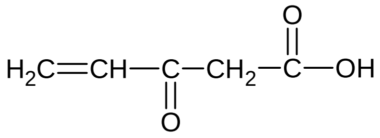
$H_2C{=}CH{-}\underset{\underset{O}{\|}}{C}{-}CH_2{-}CH_2OH$

(B) 

$H_2C{=}CH{-}\underset{\underset{OH}{|}}{CH}{-}CH_2{-}CHO$

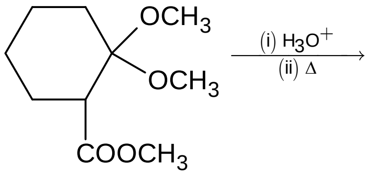
(C) 

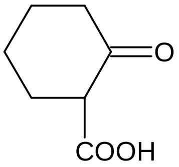
$H_2C{=}CH{-}\underset{\underset{O}{\|}}{C}{-}CH_2{-}CHO$

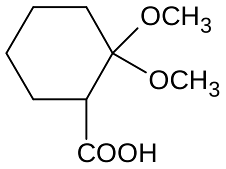
(D) 

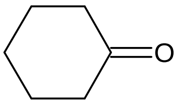
$H_2C{=}CH{-}\underset{\underset{O}{\|}}{C}{-}CH_2{-}\overset{\overset{O}{\|}}{C}{-}OH$

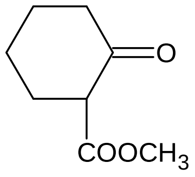
2. What is the final product of the following reaction?



(A) 

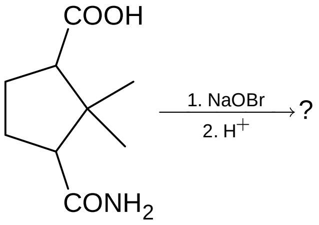
(B) 

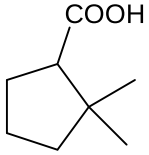
(C) 

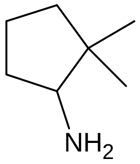
(D) 

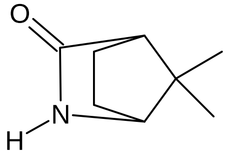
Space for rough work

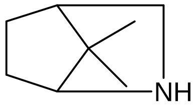
3. What is the final product of the following reaction?



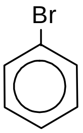
(A)


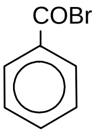
(B)


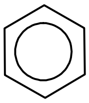
(C)


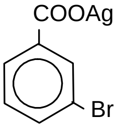
(D)


4. Silver benzoate reacts with bromine in acetone to form

(A)


(B)


(C)


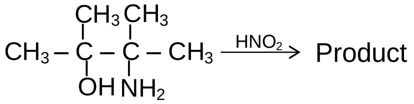
(D)


5. $RCOO^{-}Ag^{+} \xrightarrow{Br_2/CCl_4} R-Br+CO_2+AgBr$, This is Borodine – Hunsdiecker reaction, Reaction intermediate in this reaction is

(A) Free radical
(B) Carbocation
(C) Carbene
(D) Carbanion

Space for rough work

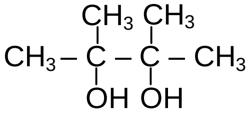
6. The product of the given reaction,



$$CH_3-\underset{OH}{\overset{CH_3}{C}}-\underset{NH_2}{\overset{CH_3}{C}}-CH_3 \xrightarrow{HNO_2} \text{Product}$$

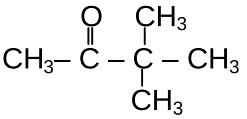
is

(A)



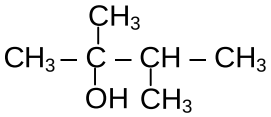
$$CH_3-\underset{OH}{\overset{CH_3}{C}}-\underset{OH}{\overset{CH_3}{C}}-CH_3$$

(B)



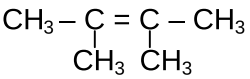
$$CH_3-\overset{O}{\overset{\|}{C}}-\underset{CH_3}{\overset{CH_3}{C}}-CH_3$$

(C)



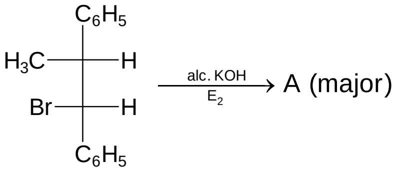
$$CH_3-\underset{OH}{\overset{CH_3}{C}}-\underset{CH_3}{CH}-CH_3$$

(D)



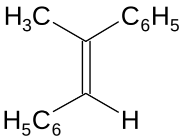
$$CH_3-\underset{CH_3}{C}=\underset{CH_3}{C}-CH_3$$

7.

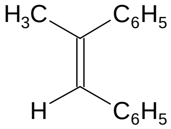


A is

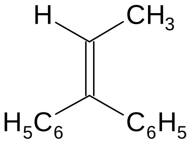
(A)



(B)

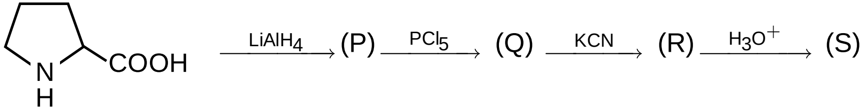


(C)

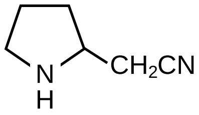


(D) All of the above

8. Predict the final product (S) formed in the following reaction sequence.

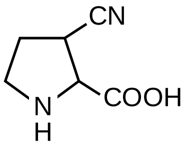


(A)

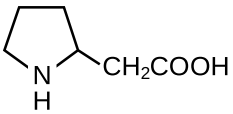


(B) $H_2N(CH_2)_3CH_2CH_2COOH$

(C)



(D)



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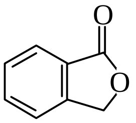
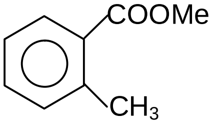
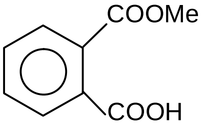
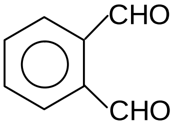
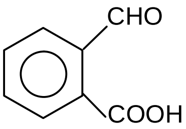
9. Which of the following compound on treatment with aqueous alkali followed by acidification gives the lactone  ?

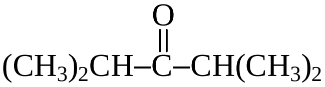
(A) 

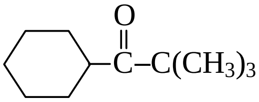
(B) 

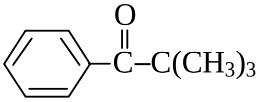
(C) 

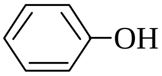
(D) 

10. Which of the following compounds would not form an enolate ion (anion of enol) when treated with a base?

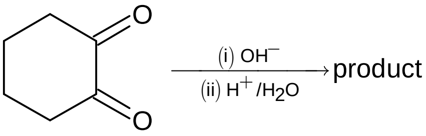
(A) 
$(CH_3)_2CH-\overset{\overset{O}{||}}{C}-CH(CH_3)_2$

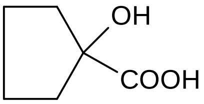
(B) 

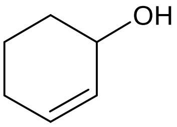
(C) 

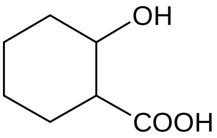
(D) 

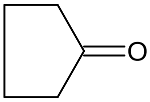
11. Predict the product in the following reaction:



(A) 

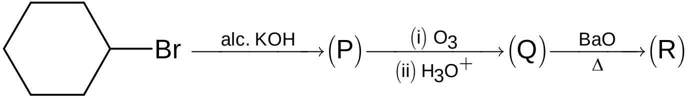
(B) 

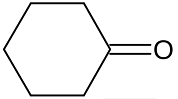
(C) 

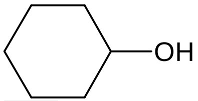
(D) 

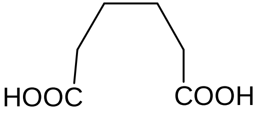
Space for rough work

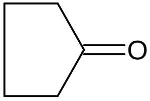
12. End product (R) of following sequence of reaction is


Br
alc. KOH
(P)
(i) O3
(ii) H3O+
(Q)
BaO
Δ
(R)

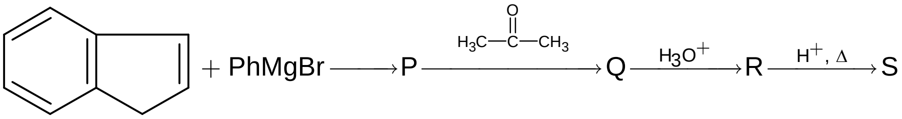
(A)


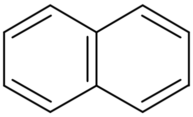
(B)


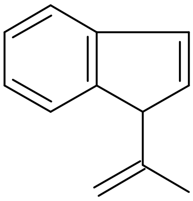
(C)


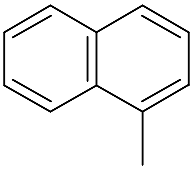
(D)


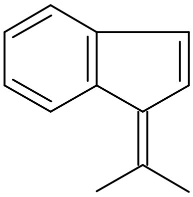
13. Identify S in the following reaction:


+ PhMgBr
P
O
H3C—C—CH3
Q
H3O+
R
H+, Δ
S

(A)


(B)


(C)


(D)


14. Propyne and propene can be distinguished by

(A) conc. H_2SO_4
(B) Br_2 inCCl_4
(C) $AgNO_3$ [Ammonical]
(D) dil. $KMnO_4$

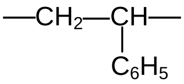
15. Identify the unknown products (A) and (B) in the given reaction:

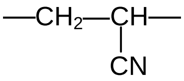
Glucose + $3C_6H_5NH\text{–}NH_2 \xrightarrow{H^{\oplus}/\Delta}$ Osazone + (A) + (B)

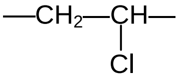
(A) $C_6H_5NH_2$ and NH_3
(B) $C_6H_5NH_2$ and NH_2OH
(C) $C_6H_5NH\text{—}NHOH$ and NH_3
(D) NH_2OH and H_2O

Space for rough work

16. The repeat unit of polystyrene is

(A) 
$-CH_2-\underset{C_6H_5}{\underset{|}{C}}H-$

(B) 
$-CH_2-\underset{CN}{\underset{|}{C}}H-$

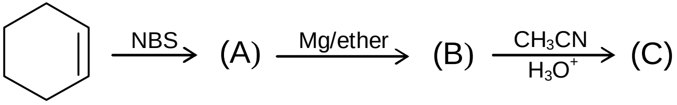
(C) 
$-CH_2-\underset{Cl}{\underset{|}{C}}H-$

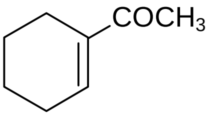
(D) $-CCl_2-CCl_2-$

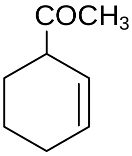
17. Buna–S rubber is a polymer of

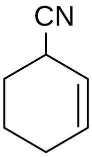
(A) 1, 3-butadiene and styrene
(B) vinyl acetate
(C) Acrylonitrile
(D) none of these

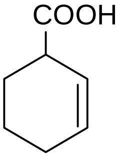
18. End product of the following sequence of reaction is:

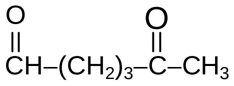


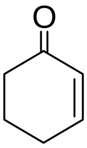
(A) 

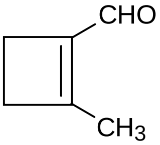
(B) 

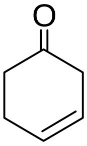
(C) 

(D) 

19. 
$\overset{O}{\overset{\|}{C}}H-(CH_2)_3-\overset{O}{\overset{\|}{C}}-CH_3 \xrightarrow[\text{(ii) }\Delta]{\text{(i) dil. OH}^-}$ (A), compound (A) is

(A) 

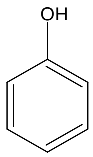
(B) 

(C) 

(D) None

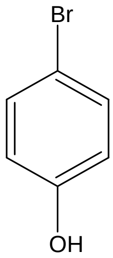
Space for rough work

20.

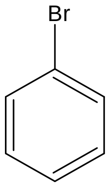


$+ Br_2 \xrightarrow[0^{o}C]{CS_2}$ A, A is

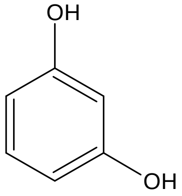
(A)



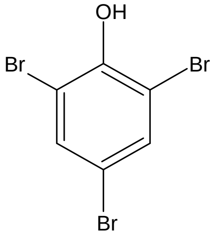
(B)



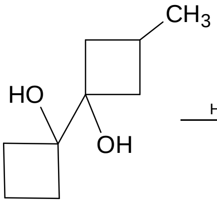
(C)



(D)

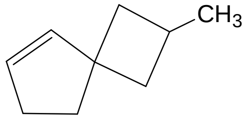


21. The product in the following reaction is

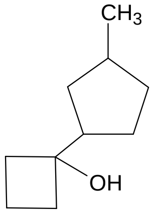


$\xrightarrow{H^+}$ Product

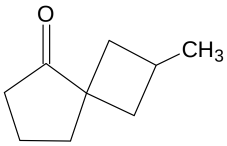
(A)



(B)



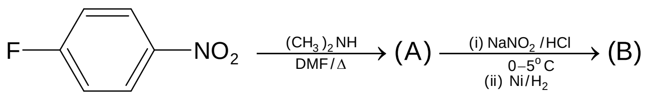
(C)



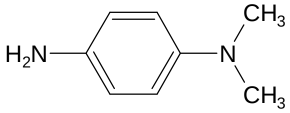
(D) None of the above

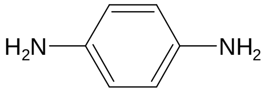
Space for rough work

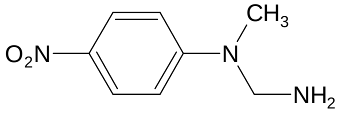
22.

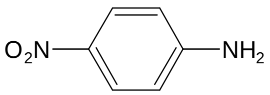

F
NO2
(CH3)2NH
DMF/Δ
(A)
(i) NaNO2/HCl
0–5° C
(ii) Ni/H2
(B)

The structure of (B) is

(A)

H2N
N
CH3
CH3

(B)


(C)

O2N
N
CH3
NH2

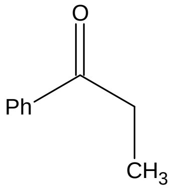
(D)


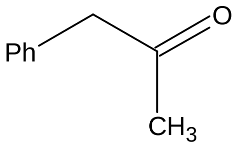
23.

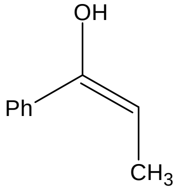
$$Ph-C\equiv C-CH_3 \xrightarrow[H_2O]{Hg^{2+}/H^{+}} (W)$$

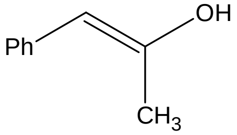
(Major)

(W) is

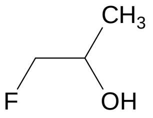
(A)


(B)


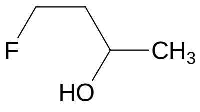
(C)


(D)


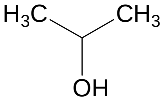
24. The order of reactivity of the following alcohols towards conc. HCl is



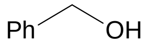
I



II



III

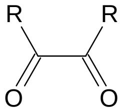


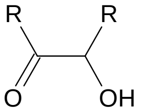
IV

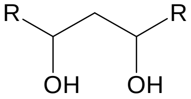
(A) I > II > III > IV
(B) I > III > II > IV
(C) IV > III > II > I
(D) IV > III > I > II

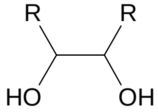
Space for rough work

25. Which of the following will be oxidized by HIO_4?

(1)


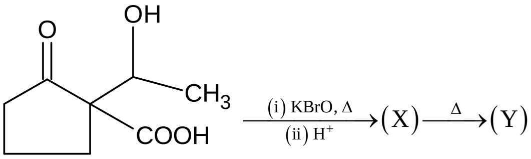
(2)


(3)


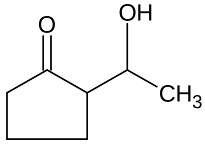
(4)


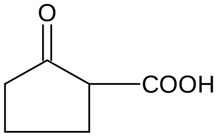
Select the correct answer using the codes below:

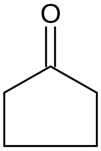
(A) 1, 2 and 3
(B) 1, 3 and 4
(C) 1, 2 and 4
(D) 2, 3 and 4

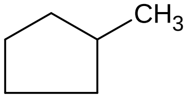
26.

O
OH
CH3
COOH
(i) KBrO, Δ
(ii) H+
(X)
Δ
(Y)

Hence the product (Y) in the above sequence of reaction is

(A)


(B)


(C)


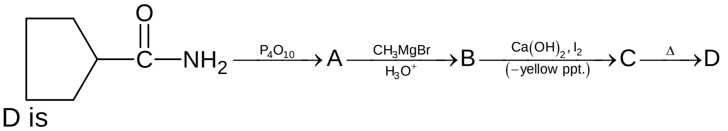
(D)


27. Osazone formation is used to characterize

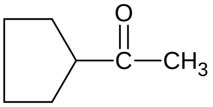
(A) polymers
(B) sugars
(C) carboxylic acid
(D) alcohols

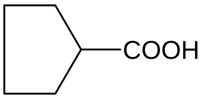
Space for rough work

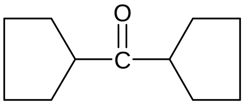
28.

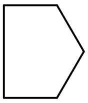

O
C—NH₂
P₄O₁₀
A
CH₃MgBr
H₃O⁺
B
Ca(OH)₂, I₂
(–yellow ppt.)
C
Δ
D

D is

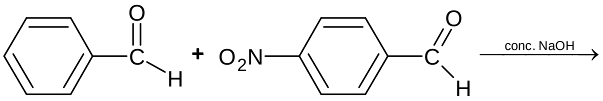
(A)


(B)


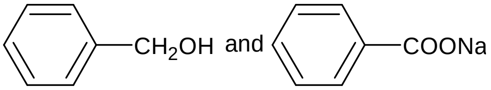
(C)


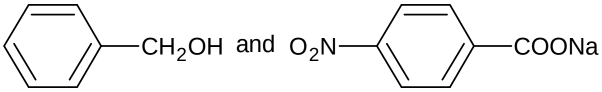
(D)


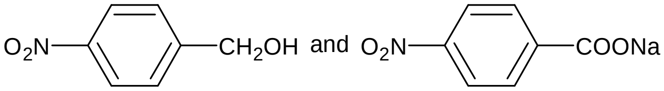
29.

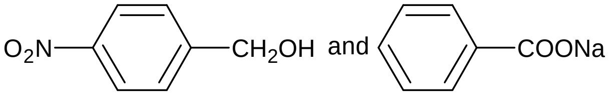

O
C
H
+
O₂N
O
C
H
conc. NaOH

The products likely to be obtained are

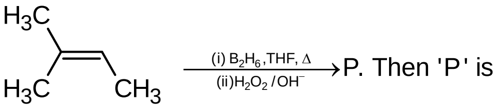
(A)

CH₂OH
and
COONa

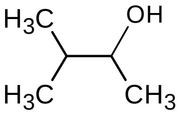
(B)

CH₂OH
and
O₂N
COONa

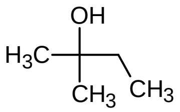
(C)

O₂N
CH₂OH
and
O₂N
COONa

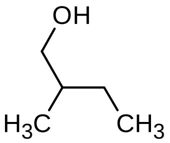
(D)

O₂N
CH₂OH
and
COONa

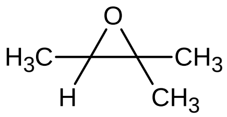
30.


H₃C
H₃C
CH₃
(i) B₂H₆, THF, Δ
(ii) H₂O₂ / OH⁻
P. Then 'P' is

(A)

H₃C
OH
H₃C
CH₃

(B)

OH
H₃C
CH₃
CH₃

(C)


(D)

O
H₃C
CH₃
H
CH₃

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. What is the limit $\lim_{x\to\infty}\frac{3-\sqrt{x}}{2\sqrt{x}+5}=?$

(A) $-\frac{1}{2}$ (B) $-\frac{1}{5}$

(C) $\frac{3}{5}$ (D) $\frac{3}{2}$.

2. Let A = {1, 2, 3, 4, 5}; B = {2, 3, 6, 7} then number of elements in (A × B) $\cap$ (B × A) is

(A) 18 (B) 6

(C) 4 (D) 0.

3. Find the slope of the line tangent to r = 2 – 2 cos θ at the point where $\theta = \frac{\pi}{4}$

(A) $\frac{\sqrt{2}}{2-\sqrt{2}}$ (B) $\frac{\sqrt{2}}{2+\sqrt{2}}$

(C) $\frac{2}{2+\sqrt{2}}$ (D) $\frac{2}{2-\sqrt{2}}$

4. Range of the function f(x) = $\log_{\sqrt{2}}\left(2-\log_2\left(16\sin^2 x+1\right)\right)$ is

(A) $(-\infty, -1)$ (B) $(-\infty, 2)$

(C) $(-\infty, 1]$ (D) $(-\infty, 2]$.

5. If f(x) = sgn(x) and g(x) = x(1 – x^2); then the number of points of discontinuity of function f(g(x)) is

(A) exact 2 (B) exact three

(C) finite and more than 3 (D) infinite many.

Space for rough work

6. Function $f(x)=\begin{cases} 2x+\tan x-\dfrac{\pi}{\cos x}; & x\neq\dfrac{\pi}{2} \\ k & x=\dfrac{\pi}{2}\end{cases}$ is continuous at $x=\dfrac{\pi}{2}$ if k=

(A) -2 (B) 2

(C) $\dfrac{1}{2}$ (D) no such value exit.

7. The function f(x) = $\dfrac{x}{e^x-1}+\dfrac{x}{2}+1$ is

(A) an odd function (B) an even function

(C) neither an odd nor an even function (D) a periodic function.

8. f : [0, 4] → R is a differentiable function, then for some a, b $\in$ (0, 4), $f^2(4) - f^2(0)$ =

(A) $8\,f'(a)\,.\,f'(b)$ (B) $4\,f'(a)\,f(a)$

(C) $2f'(b)\,f(a)$ (D) $f'(b)\,f(a)$.

9. $f(x) = x^3 + ax^2 + bx + 5\sin^2 x$ be a increasing function in the set of real number R; then a & b satisfy the condition

(A) $a^2 - 3b - 15 \geq 0$ (B) $a^2 - 3b + 15 \leq 0$

(C) $a^2 - 3b - 15 \leq 0$ (D) $a \geq 0$ & $b < 0$.

10. Slope of tangent to the curve $y = 2e^x \sin\left(\dfrac{\pi}{4}-\dfrac{x}{2}\right)\cdot\cos\left(\dfrac{\pi}{4}-\dfrac{x}{2}\right)$ where $0 \leq x \leq 2\pi$ is minimum a x =

(A) 0 (B) π

(C) 2π (D) none.

11. $\int 4\cos\left(x+\dfrac{\pi}{6}\right)\cos 2x\cdot\cos\left(\dfrac{5\pi}{6}+x\right)dx$

(A) $-\left(x+\dfrac{\sin 4x}{4}+\dfrac{\sin 2x}{2}\right)+c$ (B) $-\left(x+\dfrac{\sin 4x}{4}-\dfrac{\sin 2x}{2}\right)+c$

(C) $-\left(x-\dfrac{\sin 4x}{4}+\dfrac{\sin 2x}{2}\right)+c$ (D) $-\left(x-\dfrac{\sin 4x}{4}+\dfrac{\cos 2x}{2}\right)+c$.

Space for rough work

12. $\int \frac{dx}{(x+1)\sqrt{x^2-1}} =$

(A) $\sqrt{\frac{x+1}{x-1}}+c$ (B) $\sqrt{\frac{x^2-1}{x+1}}+c$

(C) $\sqrt{\frac{x-1}{x+c}}+c$ (D) $\sqrt{\frac{x-1}{x+1}}+c$

13. $\int_0^2 \sqrt{x+\sqrt{x+\sqrt{x+\sqrt{x+...\infty}}}}\,dx$ is equal to

(A) $\frac{19}{6}$ (B) $\frac{17}{6}$

(C) $\frac{13}{6}$ (D) can't determine.

14. $\int_0^{\pi} \frac{\sin x}{1+\cos^2 x}\,dx = \pi\frac{\cos\alpha}{1+\sin^2\alpha}$

(A) for no value of α (B) for exactly two values of α in $(0, \pi)$

(C) for at least one α in $\left(\frac{\pi}{2},\pi\right)$ (D) for exactly one α in $\left(0,\frac{\pi}{2}\right)$.

15. The function $f(x)=\int_1^x \frac{1}{t}\,dt$ satisfy

(A) $f(x + y) = f(x) + f(y)$ (B) $f\left(\frac{x}{y}\right)=f(x)+f(y)$

(C) $f(xy)=f(x)+f(y)$ (D) none.

16. If f is a function with period P, then $\int_a^{a+p} f(x)\,dx$ is

(A) equal to f(a) (B) equal to f(p)

(C) independent of a (D) none.

Space for rough work

17. Evaluate $\int_0^a \ln\left(\cot a + \tan x\right)dx;\ a \in \left(0, \frac{\pi}{2}\right)$

(A) a ln (sin a) (B) – a ln (sin a)
(C) ln (cos a) (D) – ln (cos a)

18. $\lim\limits_{n\to\infty} \frac{1.n + 2(n-1) + 3(n-2)...n1}{1^2 + 2^2 + 3^2 + 4^2...n^2}$ has value

(A) $\frac{1}{2}$ (B) $\frac{1}{3}$
(C) $\frac{1}{4}$ (D) 1.

19. If $f(x) = \frac{(1+x)^{\frac{1}{x}} - e}{x}$ then

(A) $\lim\limits_{x\to 0} f(x) = \frac{e}{2}$ (B) $\lim\limits_{x\to 0} f(x) = -\frac{e}{2}$
(C) $\lim\limits_{x\to 0} f(x) > 0$ (D) none.

20. If $y = e^{-x}\cos x$ and $y_4 + ky = 0$ where $y_4 = \frac{d^4y}{dx^4}$, then k is

(A) 4 (B) – 4
(C) 2 (D) – 2.

21. $\cos^{-1}(\sin x) = \frac{\pi}{2} - x$ is valid for

(A) $-\pi \le x \le 0$ (B) $0 \le x \le \pi$
(C) $-\frac{\pi}{2} \le x \le \frac{\pi}{2}$ (D) none of these.

22. $\lim\limits_{x\to 4} \frac{3 - \sqrt{5+x}}{1 - \sqrt{5-x}}$ is equal to

(A) 0 (B) $\frac{1}{3}$
(C) $-\frac{1}{3}$ (D) none of these.

Space for rough work

23. $\lim\limits_{x\to 0}\dfrac{\sin x^n}{(\sin x)^m}$ n > m > 0 is equal to

(A) 1 (B) 0

(C) $\dfrac{n}{m}$ (D) $\dfrac{m}{n}$

24. The interval of increase of the function $f(x)=\sin^{-1}\left(\dfrac{2x}{1+x^2}\right)$

(A) R (B) (–1, 1)

(C) [–1, 1] (D) none of these.

25. If f(a) = 2, f′(a) = 1, g(a) = – 1 and g′(a) = 2 then value of $\lim\limits_{x\to a}\dfrac{g(x)f(a)-g(a)f(x)}{x-a}$

(A) – 5 (B) $\dfrac{1}{5}$

(C) 5 (D) $-\dfrac{1}{5}$.

26. $\lim\limits_{n\to\infty}\left(6^n+5^n\right)^{\frac{1}{n}}$ is equal to

(A) 5 (B) 6

(C) 6e (D) 5e.

Space for rough work

27. The straight line $\frac{x}{a}+\frac{y}{b}=2$ touches the curve $\left(\frac{x}{a}\right)^n+\left(\frac{y}{b}\right)^n=2$ at the point (a, b) for

(A) n = 2
(B) n = 3
(C) any n
(D) for no n.

28. The number of values of k for which the equation $x^3 - 3x + k = 0$ has two distinct root lying in (0, 1) is

(A) 3
(B) 2
(C) 0
(D) none of these.

29. $y=\tan^{-1}\left(\frac{\log\frac{e}{x^2}}{\log ex^2}\right)+\tan^{-1}\left(\frac{3+2\log x}{1-6\log x}\right)$ then $\frac{d^ny}{dx^n}$ is equal to

(A) $\tan^{-1}(\log x)^n$
(B) 0
(C) $\frac{1}{2}$
(D) none of these.

30. $\lim\limits_{x\to 1}\frac{\sin\left(e^{x-1}-1\right)}{\log x}$ is equal to

(A) 0
(B) e
(C) $\frac{1}{e}$
(D) 1.

Space for rough work

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ANSWERS, HINTS & SOLUTIONS
PART TEST-III
(Main)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	D	A	A
2.	D	C	C
3.	A	C	A
4.	B	A	D
5.	B	A	B
6.	A	B	A
7.	A	B	B
8.	C	D	A
9.	C	C	B
10.	A	C	B
11.	C	A	A
12.	B	D	C
13.	C	D	A
14.	A	C	D
15.	C	A	C
16.	D	A	C
17.	D	A	B
18.	A	B	A
19.	A	A	B
20.	A	A	A
21.	A	C	C
22.	A	A	C
23.	B	A	B
24.	C	C	C
25.	B	C	C
26.	D	C	B
27.	D	B	C
28.	B	C	C
29.	A	B	B
30.	D	A	D

Physics

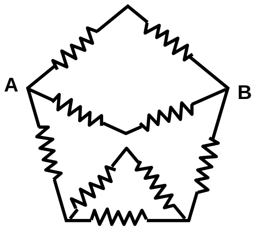
PART – I

SECTION – A

1. $$4\times\frac{\mu_0 I}{4\pi}.\left[\sin 45^0+\sin 45^0\right]\left[\frac{1}{R}-\frac{1}{2R}\right]$$
$$=\frac{\mu_0 I}{\pi}\left[\sqrt{2}\right]\left[\frac{1}{2R}\right]=\frac{\mu_0 I}{\sqrt{2}\pi R}\ \odot$$

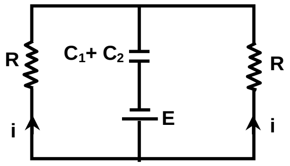
2. $$V_1=\frac{10}{4+4}\times 4\text{ volts} = 5\text{ volt}$$
$$V_2=\frac{10\times\frac{100\times 4}{100+4}}{4+\frac{100\times 4}{100+4}}$$
$$= 4.9\text{ volts}\ \therefore \left|V_1-V_2\right|=0.1\text{volt}$$

3. Equivalent circuit,
$R_{net} = \frac{8R}{11}$

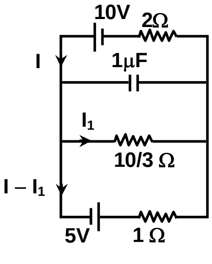


4. $$V_P-V_0=-\left[10\times 10+10\times 10\right]$$
= - 200 volts.

5.



6. $\frac{10}{3}I_1$+2I – 10 = 0 – 5 + I – I_1 + 2I – 10 = 0
After solving we get, I_1 = 0, Q = 0



7. $$V = \frac{1}{4\pi\varepsilon_0\times 1}\left[q+\frac{q}{2}+\frac{q}{4}+\frac{q}{8}+...\right]=\frac{q}{4\pi\varepsilon_0}\left[\frac{1}{1-\left(1/2\right)}\right]=\frac{q}{2\pi\varepsilon_0}$$

8. Field at any internal point of the cavity.

$$\vec{E} = G\frac{4}{3}\pi\rho\left(\overrightarrow{C_2C_1}\right)$$

Since C_1 and C_2 are fixed (cavity being concentric with C_2 all the time), field remains constant both in magnitude and direction.

9. If the fifth point P has identical charges the field at the centre of symmetry O would be zero. Hence the field due to one single such charge at P would produce a field $\vec{E}'$, such that $(\vec{E}' + \vec{E})$ = 0

$\therefore\ \vec{E}' = -\vec{E} = -(-3\hat{i} + 4\hat{j} - 2\hat{k})$

this field will be four times $\vec{E}'$ due to this rearrangement, hence the required field at O is

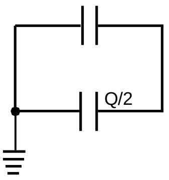
$4\vec{E}' = (12\hat{i} - 16\hat{j} + 8\hat{k})$ units

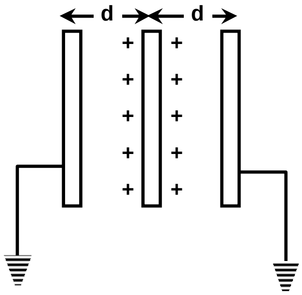
10. If $I_G = 0$ then it becomes a balanced whetstone bridge

$$\ell_1 = \frac{2}{3}\times 1\text{m} = \frac{2}{3}\times 100 = \frac{200}{3}\text{cm}$$

12. $$E_1 = \frac{\sigma}{\epsilon_0} = \frac{Q}{2A\epsilon_0}$$

$$V = E_1 d = \frac{Qd}{2A\epsilon_0}$$





13. Apply gaus theorem

$$E\left(4\pi r^2\right) = \frac{q_{in}}{\epsilon_0} \Rightarrow E = \frac{q}{4\pi\epsilon_0 r^2} \Rightarrow E \propto \frac{1}{r^2} \Rightarrow \text{ field depends only on r.}$$

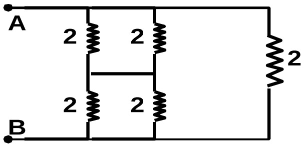
14. $$\frac{\Delta R}{R} = \frac{\Delta V}{V} + \frac{\Delta I}{I}$$

$$\Rightarrow \frac{\Delta R}{R}\times 100 = \frac{\Delta V}{V}\times 100 + \frac{\Delta I}{I}\times 100$$

$$= 3\%$$

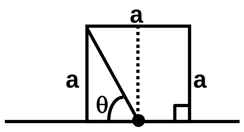
17. Magnetic field is zero at the centre due to symmetrical current distribution.

18.



19. $$\text{B at O} = \frac{2\times\mu_0(I/4)}{4\pi(a/2)}\left(0 + \frac{2}{\sqrt{5}}\right) + \frac{\mu_0(I/4)}{4\pi a}\left(\frac{2}{\sqrt{5}} + \frac{2}{\sqrt{5}}\right)$$

$$= \frac{2\mu_0 I}{4\sqrt{5}\pi a} + \frac{\mu_0 I}{4\pi a\sqrt{5}} = \frac{3\mu_0 I}{4\sqrt{5}\pi a}$$



20. Due to electrostatic shielding, the ratio will be 1.

21. When key is open

q_1 = CE

when key is closed

$$q_2 = C\left[\frac{E}{R_1+R_2}R_2\right]$$

$$\therefore \frac{q_1}{q_2} = \left[\frac{CE}{CER_2}(R_1+R_2)\right] = \frac{(R_2+R_1)}{R_2} = \frac{5}{3}$$

22. If I_1 is current in ACDB then

$$\frac{\mu_0}{4}.\frac{i_1}{r} = \frac{\mu_0}{4}.\frac{i_2}{4r}$$

$$\frac{i_1}{i_2} = \frac{1}{4}$$

$$i_1 = \frac{1}{5}\times i = \frac{i}{5}$$

23. From symmetry the currents in segment gh is zero. Thus, the equivalent resistance R is given by

$$\frac{1}{R} = \frac{1}{4}+\frac{1}{4}+\frac{1}{2}+\frac{1}{2} = \frac{3}{2} \Rightarrow R = \frac{2}{3}\Omega$$

Current in eh = $\frac{10}{4} = 2.5A$

$\therefore$ Potential difference across eh = 5V

24. It is a balanced Wheatstone bridge for capacitor. Consequently the potentials of points a and b are equal. Thus energy stored in the capacitor is zero.

25. Let after steady state the charges on the capacitor be q_1 and q_2

q_1 = CV, q_2 = CV where v is the potential difference between the plates.

Also from charge conservation

$q_1 + q_2 = 0$

$\Rightarrow$ V = 0

Thus, final energy stored in the capacitors = $\frac{1}{2}CV^2 + \frac{1}{2}CV^2 = 0$

Initial energy stored = $\frac{q^2}{2C}+\frac{q^2}{2C} = \frac{q^2}{C}$

Thus, heat developed in the resistor = q^2/C

26. Initial capacitor is charged to Q/2

Energy stored in capacitor = $\frac{1}{2}\left(\frac{Q}{2}\right)^2 \times \frac{1}{C} = \frac{1}{8}\frac{Q^2}{C} \Rightarrow \frac{1}{8}CE^2 = U_i$

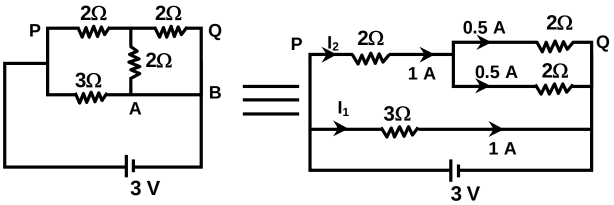
Finally energy stored in the capacitor, $U_f = \frac{1}{2}CE^2$

Work done by the battery = $\left(\frac{3}{2}CE\right)\times E = \frac{3}{2}CE^2$

$\therefore$ Heat energy lost = $\frac{3}{2}CE^2$ – $(U_f - U_i)$ = $\frac{3}{2}CE^2 - \left(\frac{1}{2}CE^2 - \frac{1}{8}CE^2\right)$

= $CE^2\left(\frac{3}{2} - \frac{1}{2} + \frac{1}{8}\right) = \frac{9}{8}CE^2$

27. The equivalent circuit is
Current flowing through 3Ω resistance
= 3/3 = 1 Amp
Current flowing through P to Q is also
1 amp.
From the figure current flowing through
AB is 1 + 0.5 = 1.5 Amp



28. By using the relation

$$B = \frac{\mu_0 i\theta}{4\pi r}$$ where θ is in radian

Here θ = 180° i.e. π

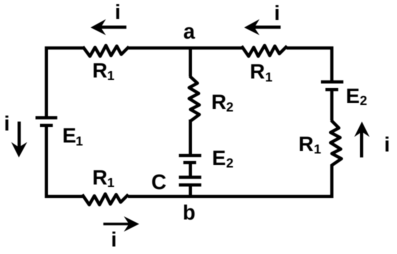
So, $B_p = \frac{\mu_0 I}{4r}$

29. Let x = a′ potential is zero (region II)

$$k\frac{q}{a'} = k\frac{2q}{a+a'}$$

$\Rightarrow$ a′ = a
So, in the region II,
Potential is zero and can be proved.
A solution can also found in region I (x = a/3).

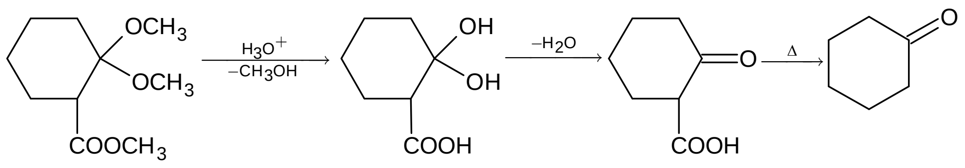
30. In the steady state
$E_2 - iR_1 - iR_1 - E_1 - iR_1 - iR_1 = 0$
$E_2 - E_1 = 4iR_1$
I = $\frac{E_2 - E_2}{4R_1}$ = (6.3 – 2.1)/(4×1.7) = $\frac{2.1}{3.4}$
Solving, we get, $V_a - V_b = -iR_1 + E_2 - iR_1$
= 6.3 – 2×1.7×$\frac{2.1}{3.4}$ = 6.3 – 2.1 = 4.2 V

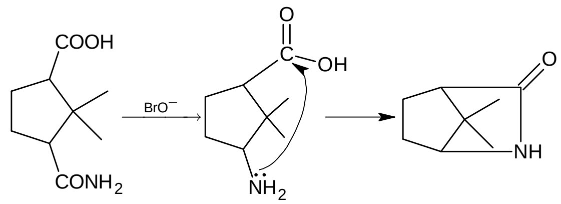


Chemistry PART – II

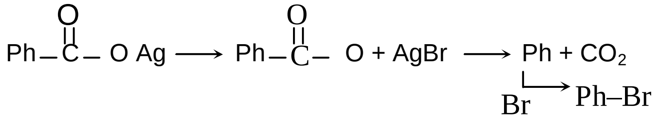
SECTION – A

1. MnO_2 oxidized allylic alcohol.

2. 
OCH3
OCH3
COOCH3
H3O+
–CH3OH
OH
OH
COOH
–H2O
O
COOH
Δ
O

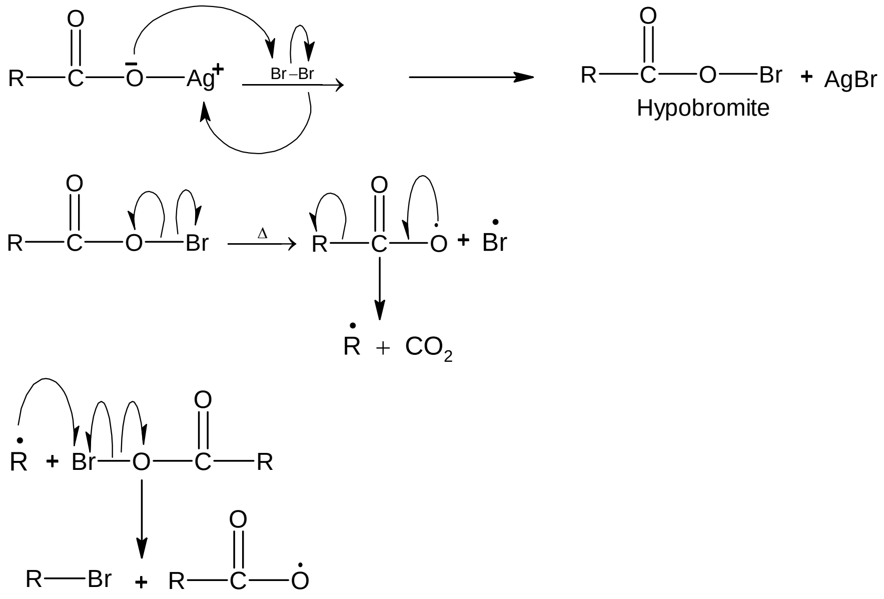
3. 
COOH
CONH2
BrO–
O
C
OH
NH2
O
NH

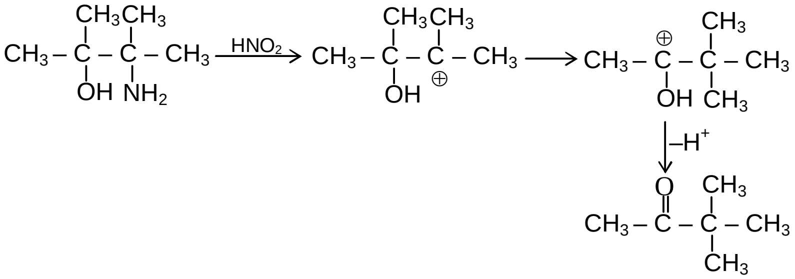
4. This is Hundsdicker reaction.



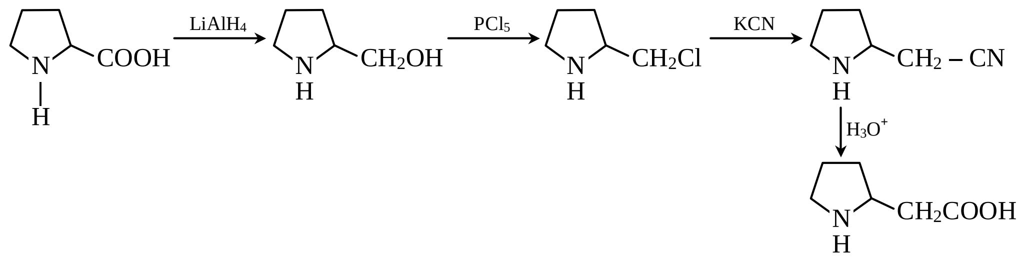
$$\mathrm{Ph-\overset{\overset{O}{\|}}{C}-O\,Ag \longrightarrow Ph-\overset{\overset{O}{\|}}{C}-O + AgBr \longrightarrow Ph + CO_2}$$

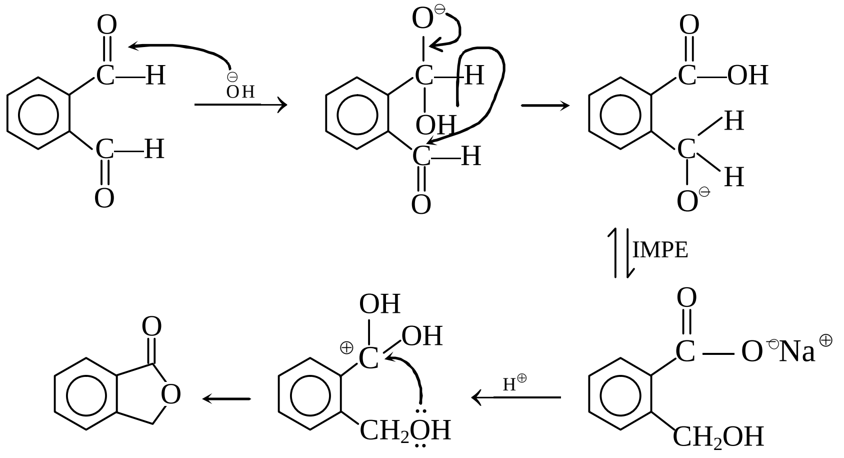
$$\mathrm{Br \longrightarrow Ph{-}Br}$$

5. 
O
R
C
O
Ag+
Br–Br
O
R
C
O
Br
+ AgBr
Hypobromite
Δ
R + CO2
+ Br
R + Br
R—Br + R—C—O

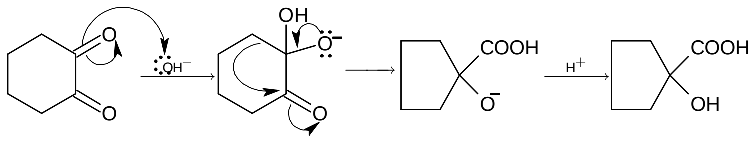
6. 

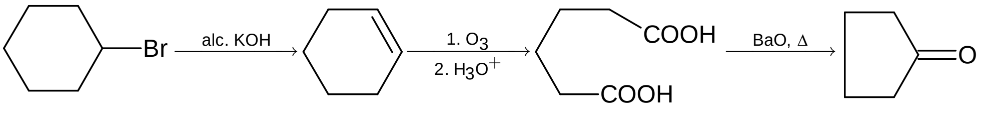
$$\mathrm{CH_3-\underset{OH}{\overset{CH_3}{C}}-\underset{NH_2}{\overset{CH_3}{C}}-CH_3 \xrightarrow{HNO_2} CH_3-\underset{OH}{\overset{CH_3}{C}}-\underset{\oplus}{\overset{CH_3}{C}}-CH_3 \longrightarrow CH_3-\underset{OH}{\overset{\oplus}{C}}-\underset{CH_3}{\overset{CH_3}{C}}-CH_3 \xrightarrow{-H^+} CH_3-\overset{\overset{O}{\|}}{C}-\underset{CH_3}{\overset{CH_3}{C}}-CH_3}$$

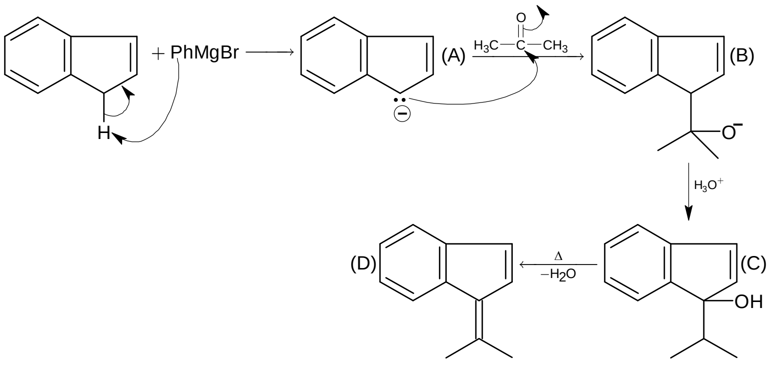
8.

COOH
LiAlH4
CH2OH
PCl5
CH2Cl
KCN
CH2 – CN
H3O+
CH2COOH
N
H

9.

OH
IMPE
H⊕
C — O⊖Na⊕
CH2OH
CH2ÖH

10. Compound (c) does not form enol and hence enolate ion with a base as it does not have α–hydrogen atom.

11.


12.

Br
alc. KOH
1. O3
2. H3O+
COOH
COOH
BaO, Δ
O

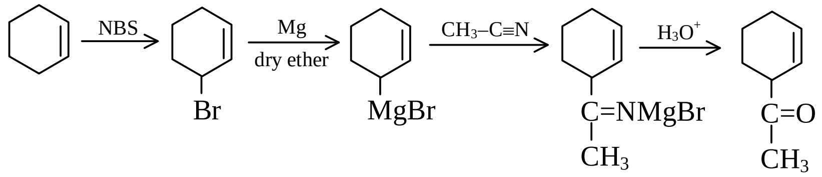
13.

+ PhMgBr
H
(A)
H3C—C—CH3
(B)
H3O+
(C)
OH
Δ
−H2O
(D)

14. Test of terminal alkynes.

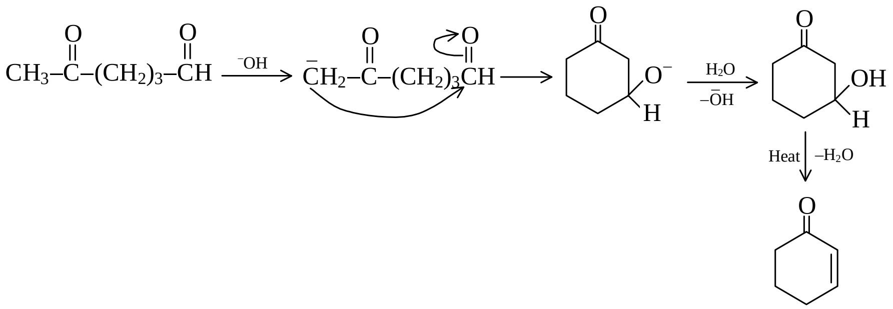
16. In polystyrene the monomeric unit is styrene which is having the formula of $H_2C{=}CH{-}C_6H_5$.

17. n $CH_2=CH-CH=CH_2$ + n $C_6H_5-CH=CH_2$ (styrene) → $[CH_2-CH=CH-CH_2-CH(C_6H_5)-CH_2]_n$
(1,3-butadiene) (Buna–S)

18.

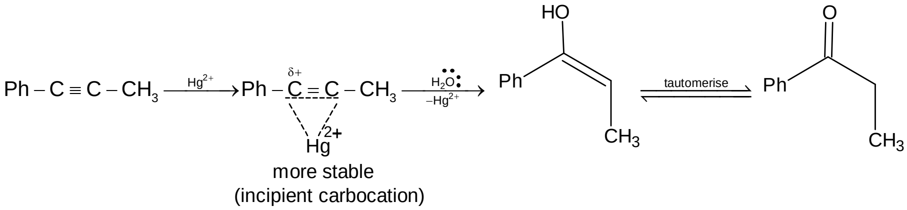

NBS
Br
Mg
dry ether
MgBr
CH3–C≡N
C=NMgBr
CH3
H3O+
C=O
CH3

19.


O
O
CH3–C–(CH2)3–CH
−OH
O
O
CH2–C–(CH2)3CH
O−
H
H2O
–OH
O
OH
H
Heat
–H2O
O

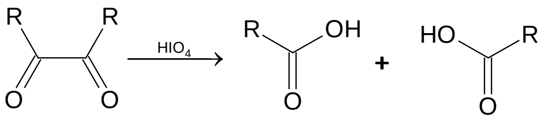
20. Due to the presence of CS_2, only monobromination takes place as CS_2 decrease the electrophilicity of Br_2 and also minimize phenol ionization.

23.

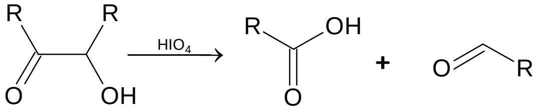

Ph – C ≡ C – CH3
Hg2+
δ+
Ph – C = C – CH3
Hg
2+
more stable
(incipient carbocation)
H2O:
–Hg2+
HO
Ph
CH3
tautomerise
O
Ph
CH3

25.

(1)

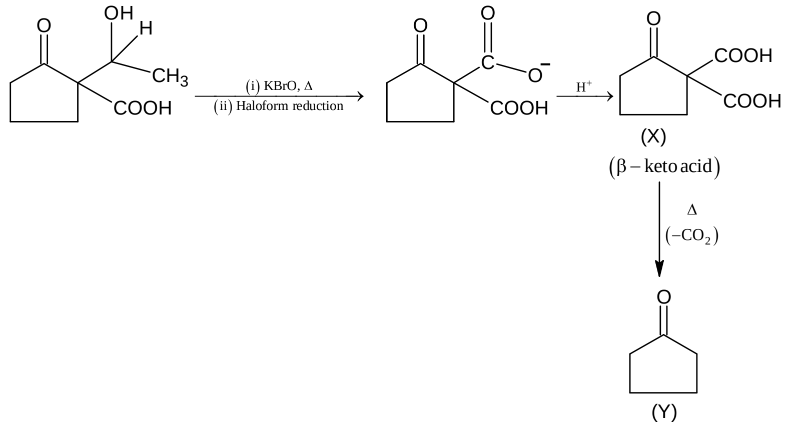

R
R
O
O
HIO4
R
OH
O
+
HO
R
O

(2)


R
R
O
OH
HIO4
R
OH
O
+
O
R

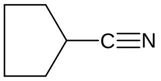
(4) $R-CHOH-CHOH-R \xrightarrow{HIO_4} R-CH=O + R-CH=O$

26.

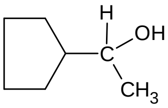

O
OH
H
CH3
COOH
(i) KBrO, Δ
(ii) Haloform reduction
O
O
C
O−
COOH
H+
O
COOH
COOH
(X)
(β – keto acid)
Δ
(–CO2)
O
(Y)

28.

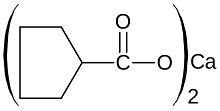
(A) -



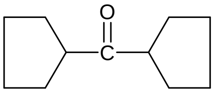
(B) -



(C) -



(D) -



29. This is an example of Cross – Cannizzaro reaction. The molecule first attacked is converted to sodium salt of benzoic acid in a Cannizzaro reaction. The presence of $-NO_2$ group activates the benzene ring towards nucleophilic attack. Therefore nitrobenzaldehyde is preferentially attacked.

Mathematics

PART – III

SECTION – A

1. $$\lim_{x\to\infty}\left(\frac{3-\sqrt{x}}{2\sqrt{x}+5}\right)\left(\frac{\frac{1}{\sqrt{x}}}{\frac{1}{\sqrt{x}}}\right)$$

$$=\frac{\lim}{x\to\infty}\frac{\frac{3}{\sqrt{x}}-1}{2+\frac{5}{\sqrt{x}}}=-\frac{1}{2}.$$

2. Here A & B set having 2 elements is common, so A × B & B × A have 2^2 i.e. four elements in common. Here $n\left[(A\times B)\cap(B\times A)\right]=4$.

3. $$\frac{dy}{dx}=\frac{r\cos\theta+\sin\theta\frac{dr}{d\theta}}{-r\sin\theta+\cos\theta\frac{dr}{d\theta}}$$

$$=\frac{(2-2\cos\theta)\cos\theta+\sin\theta(2\sin\theta)}{-2(2-2\cos\theta)\sin\theta+\cos\theta(2\sin\theta)}$$

$$\left.\frac{dy}{dx}\right|_{\theta=\frac{\pi}{4}}=\frac{\sqrt{2}}{2-\sqrt{2}}$$

4. f(x) = $\log_{\sqrt{2}}\left(2-\log_2\left(16\sin^2 x+1\right)\right)$

$1 \le 16\sin^2x + 1 \le 17$

$0 \le \log_2(16\sin^2x + 1) \le \log_2 17$

$2 - \log_2 17 \le 2 - \log_2(16\sin^2x + 1) \le 2$

now consider

$0 < 2 - \log_2(16\sin^2x + 1) \le 2$

$-\infty < \log_{\sqrt{2}}\left[2-\log_2\left(16\sin^2 x+1\right)\right]\le \log_{\sqrt{2}}^{2}=2$

5. $$\left|f\left(g(x)\right)\right|=\begin{cases}1 & x<-1\\ 0 & x=-1\\ -1 & -1<x<0\\ 0 & x=0\\ 1 & 0<x<1\\ 0 & x=1\\ 1 & x>1\end{cases}$$

points of discontinuity are x = –1, 0 1.

8. Here f is a differentiable function then f is continuous function so by L.M.V.T. theorem for any a ∈ (0,4)

$$f'(a) = \frac{f(4) - f(0)}{4 - 0} \qquad \ldots \text{(i)}$$

again from mean value for any b $\in$ (0, 4)

$$f(b) = \frac{f(4) + f(0)}{2} \qquad \ldots \text{(ii)}$$

multiply both (i) and (ii) we get

$$\frac{f^2(4) - f^2(0)}{8} = f'(a).f(b).$$

9. $f(x) = x^3 + ax^2 + bx + 5\sin^2 x$
$f'(x) = 3x^2 + 2ax + b + 10\sin x\cos x \ge 0\ \forall\ x \in R$
i.e. $3x^2 + 2ax + b + 5\sin 2x \ge 0\ \forall\ x \in R$
if $3x^2 + 2ax + b - 5 \ge 0$
$4a^2 - 12(b - 5) \le 0$
$\therefore$ $a^2 - 3b + 15 \le 0.$

10. Slope of the tangent to curve $y = 2e^x \sin\left(\frac{\pi}{4} - \frac{x}{2}\right)\cos\left(\frac{\pi}{4} - \frac{x}{2}\right)$

$y = e^x \cos x$

$$s = \frac{dy}{dx} = e^x(-\sin x + \cos x)$$

$$\frac{ds}{dx} = e^x(-\sin x + \cos x - \cos x - \sin x)$$

$= -2e^x \sin x$

$$\frac{ds}{dx} = 0 \quad x = 0, \pi, 2\pi\ (\because\ 0 \le x \le 2\pi)$$

value of s at x = 0 is 1, at x = π is – e^{π} at x = 2π is $e^{2\pi}$ minimum at x = π.

11. $$= \int 4\cos\left(x + \frac{\pi}{6}\right)\cos 2x \cdot \cos\left(\frac{5\pi}{6} + x\right)dx = 2\int \left(\cos(2x + \pi) + \cos\frac{2\pi}{3}\right)\cos 2x\ dx$$

$$= 2\int \left(-\cos 2x - \frac{1}{2}\right)\cos 2x\ dx = \int \left(-2\cos^2 2dx - \cos 2x\right)dx$$

$$= -\int (1 + \cos 4x + \cos 2x)dx = -x - \frac{\sin 4x}{4} - \frac{\sin 2x}{2} + c$$

13. Let $y = \sqrt{x + y}$
$y^2 - y - x = 0$

$$y = \frac{1 \pm \sqrt{1 + 4x}}{2} \quad y > 1$$

$$y = \frac{1 + \sqrt{1 + 4x}}{2}$$

14. $$I = 2\int_0^{\frac{\pi}{2}} \frac{\sin x}{1 + \cos^2 x}dx$$

$$I = -2\int_0^{\frac{\pi}{2}} \frac{-\sin x}{1 + \cos^2 x} = -2\left[\tan^{-1}(\cos x)\right]_0^{\frac{\pi}{2}}$$

$$= -2\left(\tan^{-1}(0) - \tan^{-1}1\right)$$

$$= \frac{\pi}{2}$$

$$\Rightarrow \quad \frac{\cos\alpha}{1+\sin^2\alpha} = \frac{1}{2}$$

17. $$I = \int \ln\left(\frac{\cos a}{\sin a} + \frac{\sin x}{\cos x}\right)dx$$

$$= \int_0^a \ln\left(\frac{\cos a\cos x + \sin a \sin x}{\sin a \cos x}\right)dx = \int_0^a \ln\left(\frac{\cos(a-x)}{\sin a\cos x}\right)dx$$

$$= \int \ln\cos\{a-(a-x)\}\,dx - \int_0^a \ln(\sin a)\,dx - \int_0^a \ln\cos x\,dx$$

18. $$\lim_{n\to\infty}\sum_{k=1}^{n}\frac{k\left[n-(k-1)\right]}{\sum k^2} = \frac{(n+1)\sum\limits_{k=1}^{n}k - \sum\limits_{k=1}^{n}k^2}{\sum k^2}$$

$$= \frac{\frac{n(n+1)^2}{2} - \frac{n(n+1)(2n+1)}{6}}{\frac{n(n+1)(2n+1)}{6}}.$$

19. $$\lim_{x\to 0}\frac{(1+x)^{\frac{1}{x}} - e}{x} = \lim_{x\to 0}\frac{e^{\ln(1+x)^{\frac{1}{x}}} - e}{x}$$

differentiate two times.

20. $y = e^{-x}\cos x$

$y_1 = -e^{-x}\sin x - e^{-x}\cos x = -e^{-x}\sin x - y$

$y_2 = -e^{-x}\cos x + e^{-x}\sin x - y_1$

$\Rightarrow \quad y_2 = -y - y_1 - e^{-x}\sin x$

$\Rightarrow \quad y_2 = -2(y + y_1)$

$\Rightarrow \quad y_3 = -2(y_1 + y_2)$

$\Rightarrow \quad y_3 = -2(e^{-x}\sin x - y)$

$\Rightarrow \quad y_4 = 2y_1 - 2y - 2y - 2y_1$

$\Rightarrow \quad y_4 + 4y = 0$

25. $$\Rightarrow \quad \lim_{h\to 0}\frac{g(a+h)f(a) - g(a)\cdot f(a+h)}{h}$$

$$\Rightarrow \quad \lim_{h\to 0}\frac{f(a)\cdot\{g(a+h)-g(a)\} - g(a)\cdot\{f(a+h)-f(a)\}}{h}$$

$\Rightarrow \quad f(a)\,.\,g'(a) - g(a)\,.\,f'(a)$

26. $$\lim_{n\to\infty}\left(6^n\right)^{\frac{1}{n}}\cdot\left(1+\left(\frac{5}{6}\right)^n\right)^{\frac{1}{n}}$$

$$\Rightarrow \quad 6\lim_{n\to\infty}\left\{\left[1+\left(\frac{5}{6}\right)^n\right]^{\left(\frac{6}{5}\right)^n}\right\}^{\frac{1}{n}\times\left(\frac{5}{6}\right)^n}$$

$= 6 \,.\, e^0 = 6.$

27. For all n it touches the curve.

28. $f(x) = x^3 - 3x + k \Rightarrow f'(x) = 3x^2 - 3$
$f'(x) = 3(x^2 - 1) < 0 \ \forall\ x \in (0, 1)$
Hence $f'(x)$ is strictly decreasing

29. $$y = \tan^{-1}\left(\frac{\log\left(\frac{e}{x^2}\right)}{\log\left(ex^2\right)}\right) + \tan^{-1}\left(\frac{3+2\log x}{1-6\log x}\right)$$

$$= \tan^{-1}\left(\frac{1-2\log x}{1+2\log x}\right) + \tan^{-1}\left(\frac{3+2\log x}{1-3.2\log x}\right)$$

$$= \tan^{-1}1 - \tan^{-1}\left(2\log x\right) + \tan^{-1}\left(3\right) + \tan^{-1}\left(2\log x\right)$$

$= \tan^{-1}(1) - \tan^{-1}(3)$
= constant function.

30. $$\lim_{x\to 1}\frac{\sin\left(e^{x-1}-1\right)}{\log x}$$

$$\lim_{x\to 1}\frac{\sin\left(e^{x-1}-1\right)}{\left(e^{x-1}-1\right)}\cdot\frac{e^{x-1}-1}{\log x}$$

$$\Rightarrow \quad 1\cdot\lim_{x\to 1}\left(\frac{e^{x-1}-1}{\log x}\right) \qquad \left\{\begin{matrix}\text{as } x\to 1 \\ e^{x-1}-1\to 0\end{matrix}\right\}$$

$$\Rightarrow \quad \lim_{h\to 0}\frac{e^h-1}{h}\times\frac{h}{\log(1+h)} = 1.$$

FIITJEE **JEE (Advanced), 2016**

ALL INDIA INTEGRATED TEST SERIES

PART TEST – IV

Paper 1

FIITJEE Students From All Programs have bagged 33 in Top 100, 77 in Top 200 and 205 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2015: 4551 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2015.

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 10)** contains 10 multiple choice questions which have only one correct answer. Each question carries **+2 marks** for correct answer. There is no negative marking.

Section-A (11 to 15) contains 5 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-C (01 to 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

SECTION – A

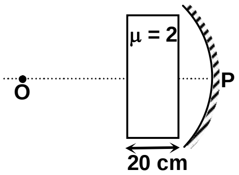
Straight Objective Type

This section contains **10 multiple** choice questions numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which only ***ONE*** is correct.

1. Two radioactive materials X_1 and X_2 have decay constants 10 λ and λ respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of X_1 to that of X_2 will be 1/e after a time

(A) $1/(10\lambda)$
(B) $1/(11\lambda)$
(C) $11/(10\lambda)$
(D) $1/(9\lambda)$

2. Radius of curvature of the concave mirror is 60 cm. In front of this a glass slab is situated very close to the mirror as shown in the figure. A point object O is lie at a distance of 100 cm from the pole then the position of the image from the pole is



(A) 45 cm
(B) 55 cm
(C) 40 cm
(D) 60 cm

3. The minimum distance between an object and its real image formed by a thin convex lens of focal length 30 cm is

(A) 45 cm
(B) 50 cm
(C) 75 cm
(D) 120 cm

4. A coil of resistance R and inductance L is connected across an a.c. power supply of r.m.s. voltage V. The power dissipated in the coil is,

(A) V^2/R
(B) $\frac{V^2}{\sqrt{(R^2+\omega^2L^2)}}$
(C) $\frac{V^2R}{(R^2+\omega L^2)}$
(D) zero

5. In young's double slit experiment, the intensity of light at a point on the screen where the path difference is λ is k units; λ being the wavelength of light used. The intensity at a point where the path difference is $\lambda/4$ will be

(A) k/4
(B) k/2
(C) k
(D) zero

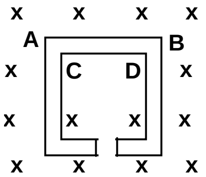
Space for rough work

6. In Young's double slit experiment the two slits act as coherent sources of equal amplitude A and of wavelength λ. In another experiment with same set up the two slits are sources of equal amplitude A and wavelength λ, but are incoherent. The ratio of intensity of light at the mid point of the screen in the first case to that in the second case is
(A) 1 : 1 (B) 1 : 2
(C) 2 : 1 (D) 4 : 1

7. The wavelength of K_α line for an element of atomic number 29 is λ. Then the wavelength of K_α line for an element of atomic no 15 is (Take Mosley's constant b = 1 for both elements)
(A) $\frac{29}{15}\lambda$ (B) $\frac{28}{15}\lambda$
(C) 4λ (D) 2λ

8. A certain radioactive material can undergo three different types of decay, each with a different decay constant λ_1, λ_2 and λ_3. Then the effective decay constant is
(A) $\lambda_{eff} = \frac{\lambda_1 + \lambda_2 + \lambda_3}{3}$ (B) $\frac{1}{\lambda_{eff}} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2} + \frac{1}{\lambda_3}$
(C) $\lambda_{eff} = \lambda_1 + \lambda_2 + \lambda_3$ (D) $\frac{1}{\lambda_{eff}} = \frac{1}{3}\left(\frac{1}{\lambda_1} + \frac{1}{\lambda_2} + \frac{1}{\lambda_3}\right)$

9. A wire is bent to form the double loop shown in the figure. There is a uniform magnetic field directed into the plane of the loop. If the magnitude of this field is decreasing, current will flow from
(A) A to B and C to D (B) B to A and D to C
(C) A to B and D to C (D) B to A and C to D



10. In the ideal double-slit experiment, when a glass-plate (refractive index 1.5) of thickness t is introduced in the path of one of the interfering beams (wave-length λ), the intensity at the position where the central maximum occurred previously remains unchanged. The minimum thickness of the glass-plate is
(A) 2λ (B) $2\lambda/3$
(C) $\lambda/3$ (D) λ

Space for rough work

Straight Objective Type

This section contains **5 multiple** choice questions numbered 11 to 15. Each question has 4 choices (A), (B), (C) and (D), out of which ***ONE or MORE*** are correct.

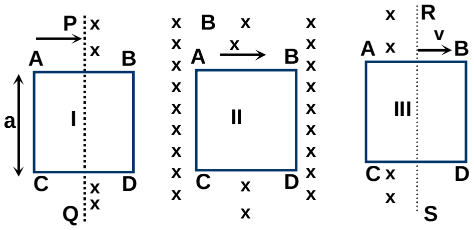
11. White light is used to illuminate the two slits in a Young's double slit experiment. The separation between the slits is b and the screen is at a distance D(>> b) from the slits. At a point on the screen directly in front of one of the slits, certain wavelengths are missing. Some of these missing wavelengths are

(A) $\lambda = \frac{b^2}{D}$ (B) $\lambda = \frac{2b^2}{D}$

(C) $\lambda = \frac{b^2}{3D}$ (D) $\lambda = \frac{b^2}{5D}$

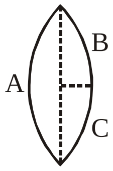
12. A square loop ABCD of edge 'a' moves to the right with a velocity v, parallel to AC. There is a uniform magnetic field of magnitude B, directed into the paper, in the region between PQ and RS only. I, II and III are three positions of the loop. Then,

(A) the current induced in the loop has magnitude Bav in all three positions
(B) the induced current is zero in position II
(C) the induced current is anticlockwise in position I
(D) the induced current is clockwise in position III



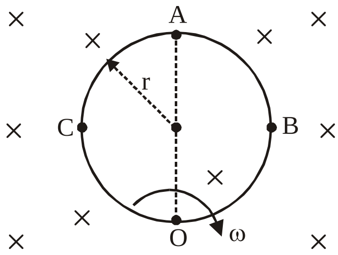
13. A thin equi-convex lens having power P is cut into three parts A, B and C as shown. The power of

(A) A is twice of B (B) B is equal to A
(C) C is equal to B (D) A is equal to C



Space for rough work

14. In figure, there is a conducting ring having resistance R placed in the plane of paper in a uniform magnetic field B_0. If the ring is rotating about in the plane of paper about an axis passing through point O and perpendicular to the plane of paper with constant angular speed ω in clockwise direction.



(A) Point A will be at higher potential than O.
(B) The potential of point B and C will be same.
(C) The current in ring will be zero.
(D) The current in the ring will be $\frac{2B_0\omega.r^2}{R}$.

15. X ray from a tube with a target A of atomic number Z shows strong K lines for target A and weak K lines for impurities. The wavelength of K_α lines is λ_z for target A and λ_1 and λ_2 for two impurities.

$\frac{\lambda_z}{\lambda_1} = 4$ and $\frac{\lambda_z}{\lambda_2} = \frac{1}{4}$.

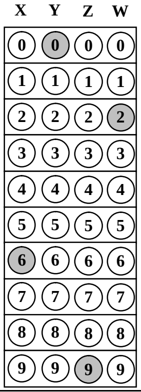
Screening constant of K_α lines to be unity. Select the correct statement(s)
(A) The atomic number of first impurity is 2z – 1.
(B) The atomic number of first impurity is 2z + 1.
(C) The atomic number of second impurity is $\frac{(z+1)}{2}$.
(D) The atomic number of second impurity is $\frac{z}{2}+1$.

Space for rough work

SECTION – C

Integer Answer Type

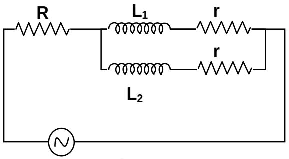
This section contains 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown



1. A plate of thickness t made of a material of refractive index $\mu = 2$ is placed in front of one of the slits in a double slit experiment. What should be the minimum thickness t in mm which will make the intensity at the centre of fringe pattern zero? ($\lambda = 4$ mm).

2. A bird in air looks at a fish vertically below inside water in a tank. The actual distance of bird and fish from the water level is equal but the distance of the fish as estimated by bird is S_1 and that of bird estimated by fish is S_2. [Given $(S_1/S_2) = 0.25$] then value of μ is _____ .

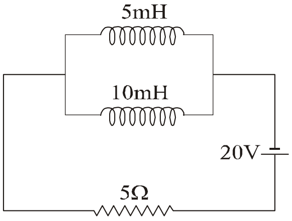
3. For the circuit shown in the figure, the rms value of voltage across R and coils are E_1 and E_2 respectively. The power developed across the coils in watts is K Watt. Find the value of K. (Given $E_0 = 5\sqrt{2}$ V, $\omega = 100\pi$, $L_1 = 5$ mH, $L_2=10$ mH, $r = 2\Omega$ and $R=2.5\ \Omega$)



e = E_0 sin ωt

4. Radiations of two photons of energies twice & five times the work function of a metal, are incident successively on the metal surface. The ratio of maximum velocities of photoelectrons emitted in the two case is given as 1/x. Then what is value of x?

5. In the given circuit, the current through 5mH indicator in steady state is x/3 amp. Calculate value of x. (Neglect the mutual inductance)



Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains 10 multiple choice questions numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which ***only one*** *is correct.*

1. Before adding the reagents of group (III) of basic radicals, the solution is heated with some concentrated HNO_3 in order to
(A) lower the pH
(B) oxidize Cr^{3+} to $Cr_2O_7^{2-}$
(C) oxidize Fe^{2+} to Fe^{3+}
(D) increase $[NO_3^-]$

2. When heated above 916°C, iron changes its crystal structure from bcc to ccp structure without any change in the radius of atom. The ratio of density of the crystal before heating and after heating is:
(A) 1.089
(B) 0.918
(C) 0.725
(D) 1.231

3. The aqueous solution of each of the following salt is coloured except
(A) $TiCl_4$
(B) $FeCl_3$
(C) $CuCl_2$
(D) $MnCl_2$

4. If all Fe^{2+} ions are replaced by Sr^{4+} ions in 0.1 mole of $Fe_{0.9}O$, then number of vacancies created are
(A) 0.035 N_A
(B) 0.01 N_A
(C) 0.07 N_A
(D) 0.1 N_A
(N_A is Avogadro number.)

5. In diamond, the lattice is fcc with C atoms occupying lattice points as well as some of the voids. Which of the following statement(s) is/are correct about the diamond structure?
(I) In the diamond lattice, half of the tetrahedral voids are occupied.
(II) Percentage space occupied (packing efficiency) is 74%.
(III) In the diamond lattice all octahedral voids are occupied.
(A) Only I
(B) Only III
(C) I, II and III
(D) Only II

Space for rough work

6. Na_2CO_3 cannot be used in place of $(NH_4)_2CO_3$ for the precipitation of group V cations, because
(A) Na^+ interferes in the detection of group V
(B) concentration of CO_3^{2-} is very low
(C) Na^+ will react with the acid radicals
(D) Mg^{2+} will precipitate as $MgCO_3$

7. When $K_4[Fe(CN)_6]$ is added to $FeCl_3$, the complex formed is
(A) $Fe_3[Fe(CN)_6]_4$
(B) $K_2Fe[Fe(CN)_6]$
(C) $Fe_4[Fe(CN)_6]_3$
(D) $K_2Fe[Fe(CN)_6]_2$

8. When excess of $SnCl_2$ is added to a solution of $HgCl_2$, a white precipitate that turn grey, is obtained. The grey colour is due to the formation of
(A) Hg_2Cl_2
(B) $SnCl_4$
(C) Sn
(D) Hg

9. For an ideal binary liquid solution with $P_A^0 > P_B^0$, which relation between χ_A (mole fraction of A in liquid phase) and Y_A (mole fraction of A in vapour phase) is correct? (χ_B & Y_B are the mole fractions of B in liquid and vapour phase respectively)
(A) $\frac{Y_A}{Y_B} < \frac{\chi_A}{\chi_B}$
(B) $\chi_A > \chi_B$
(C) $Y_A < Y_B$
(D) $\frac{Y_A}{Y_B} > \frac{\chi_A}{\chi_B}$

10. The ratio of van't Hoff factor, if PBr_5 and PCl_5 are assumed to be soluble in water and remains same as in solid state, is
(A) 2
(B) 1
(C) 1.5
(D) 2.5

Space for rough work

Multiple Correct Answers Type

*This section contains 5 multiple correct answer(s) type questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE** is/are correct.*

11. 1 mole benzene $(p^0_{benzene} = 42\text{ mm})$ and 2 mole toluene $(p^0_{toluene} = 36\text{ mm})$ will have:
(A) total vapour pressure 38 mm
(B) mole fraction of vapours of benzene above liquid mixture is $\frac{7}{19}$
(C) mole fraction of vapours of benzene above liquid mixture is $\frac{1}{3}$
(D) mole fraction of vapours of toluene above liquid mixture is $\frac{8}{19}$

12. In the equation, $X + CN^- + H_2O + O_2 \longrightarrow [X(CN)_2]^- + 4OH^-$; 'X' can be
(A) Au (B) Ag_2S
(C) Sb (D) As

13. 4.5g of Al (atomic mass = 27 amu) is deposited at cathode from Al^{+3} solution by a certain quantity of charge. The correct statement/s is are:
(A) The volume of H_2 produced at 0°C and 1atm pressure from H^+ ions in solution by the same quantity of charge will be 5.6 *l*.
(B) The volume of H_2 produced at 0°C and 1atm pressure from H^+ ions in solution by the same quantity of charge will be 22.4 *l*.
(C) The number of moles of Al deposited will be 0.166 moles.
(D) The number of faraday used for reduction of 1 mole of Al^{+3} is $\frac{3}{18}$F.

14. Which of the following statements are true regarding tetrahedral voids in fcc lattice?
(A) Tetrahedral voids formed by one corner spheres and three face spheres.
(B) Two tetrahedral voids can exist on one diagonal body line in fcc cubic.
(C) Tetrahedral voids are equal to number of spheres involved in body.
(D) Volume of tetrahedral voids are half of the octahedral voids.

15. Which of the following is/are the mixed salts?
(A) Rochelle's salt (sodium potassium tartrate) (B) Bleaching powder
(C) Calcium hypochlorite (D) Mohr's salt

Space for rough work

SECTION – C

(Integer Answer Type)

*This section contains **5** questions. The answer to each of the questions is a **single digit integer,** ranging from 0 to 9. The bubble corresponding to the correct is to be darkened in the ORS.*

1. Freezing point of 0.2 M KCN solution is –0.7°C. On adding 0.1 mole of $Hg(CN)_2$ to one litre of the 0.2 M KCN solution, the freezing point of the solution becomes –0.53°C due to the reaction $Hg(CN)_2 + mCN^- \rightarrow Hg\ (CN)_{m+2}^{m-}$. What is the value of m assuming molality = molarity?

2. In the electrolysis of KI, I_2 is formed at the anode by the reaction;

   $2I^- \longrightarrow I_2 + 2e^-$

   After the passage of current of 0.5 ampere for 9650 seconds, I_2 formed required 40 ml of 0.1 M $Na_2S_2O_3{\cdot}5H_2O$ solution in the reaction;

   $I_2 + 2S_2O_3^{2-} \longrightarrow S_4O_6^{2-} + 2I^-$

   What is the current efficiency?

3. What is the oxidation number of Fe in violet coloured complex $Na_4\left[Fe(CN)_5(NO)S\right]$?

4. An alloy of copper, silver and gold is found to have cubic lattice in which Cu atoms constitute CCP. If Ag atoms are located at the edge centres and Au atom is present at body centre, the alloy will have the formula $Cu_xAg_yAu_z$. What is the value of X?

5. If $E^0_{Fe^{2+}/Fe} = 5V$ and $E^0_{Fe^{3+}/Fe^{2+}} = 2V$ then $E^0_{Fe^{3+}/Fe}$ will be.

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

*This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct*

1. If $|\vec{a}| = a$ and $|\vec{b}| = b$, then $\left(\frac{\vec{a}}{a^2} - \frac{\vec{b}}{b^2}\right)^2 =$

(A) $\left(\frac{\vec{a}+\vec{b}}{ab}\right)^2$ (B) $\frac{(\vec{a}-\vec{b})^2}{ab}$

(C) $\left(\frac{\vec{a}-\vec{b}}{ab}\right)^2$ (D) $\frac{(\vec{a}+\vec{b})^2}{ab}$

2. Let $\vec{a}, \vec{b}$ and $\vec{c}$ be non-zero vectors such that no two are collinear $(\vec{a}\times\vec{b})\times\vec{c} = \frac{1}{3}|\vec{b}||\vec{c}|\vec{a}$. If θ is the acute angle between the vectors $\vec{b}$ and $\vec{c}$, then $\sin\theta$ equals

(A) $\frac{2\sqrt{2}}{3}$ (B) $\frac{\sqrt{2}}{3}$

(C) $\frac{2}{3}$ (D) $\frac{1}{3}$

3. The length and foot of the perpendicular from the point (2, –1, 5) to the line $\frac{x-11}{10} = \frac{y+2}{-4} = \frac{z+8}{-11}$ are

(A) $\sqrt{14}, (1, 2, -3)$ (B) $\sqrt{14}, (1, -2, 3)$

(C) $\sqrt{14}, (1, 2, 3)$ (D) None of these

Space for rough work

4. A box contains 15 tickets numbered 1, 2, ... 15. Seven tickets are drawn at random one after the other with replacement. The probability that the greatest number on a drawn ticket is 9, is

(A) $\left(\frac{9}{10}\right)^6$ (B) $\left(\frac{8}{15}\right)^7$

(C) $\left(\frac{3}{5}\right)^7$ (D) None of these

5. Image point of (5, 4, 6) in the plane $x+y+2z-15=0$ is

(A) (3, 2, 2) (B) (2, 3, 2)

(C) (2, 2, 3) (D) (– 5, –4, –6)

6. Out of 21 tickets marked with numbers from 1 to 21, three are drawn at random. The chance that the numbers on them are in A.P., is

(A) 10/133 (B) 9/133

(C) 9/1330 (D) None of these

7. If $A=\begin{vmatrix}\sin(\theta+\alpha) & \cos(\theta+\alpha) & 1\\ \sin(\theta+\beta) & \cos(\theta+\beta) & 1\\ \sin(\theta+\gamma) & \cos(\theta+\gamma) & 1\end{vmatrix}$,then

(A) $A=0$ for all θ (B) A is an odd Function of θ

(C) $A=0$ for $\theta=\alpha+\beta+\gamma$ (D) A is independent of θ

8. If $A=\begin{bmatrix}\cos^2\theta & \sin\theta\cos\theta\\ \sin\theta\cos\theta & \sin^2\theta\end{bmatrix}$, $B=\begin{bmatrix}\cos^2\varphi & \sin\varphi\cos\varphi\\ \sin\varphi\cos\varphi & \sin^2\varphi\end{bmatrix}$

and θ and φ differs by $\frac{\pi}{2}$, then $AB=$

(A) I (B) O

(C) – I (D) None of these

Space for rough work

9. The area bounded by the curves $y = 2 - |x-1|$, $y = \sin x$; $x = 0$ and $x = 2$ is

(A) $1 + 2\cos^2 1$ (B) $2 + \sin^2 1$

(C) $\frac{\pi}{2}$ (D) $1 + \log 2$

10. The solution of the equation $x\frac{dy}{dx} = y - x\tan\left(\frac{y}{x}\right)$ is

(A) $x\sin\left(\frac{x}{y}\right) + c = 0$ (B) $x\sin y + c = 0$

(C) $x\sin\left(\frac{y}{x}\right) = c$ (D) None of these

Multiple Correct Choice Type

*This section contains **5 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct*

11. If A and B are two events such that $P(A) = 1/2$ and $P(B) = 2/3$, then

(A) $P(A \cup B) \geq 2/3$ (B) $P(A \cap B') \leq 1/3$

(C) $1/6 \leq P(A \cap B) \leq 1/2$ (D) $1/6 \leq P(A' \cap B) \leq 1/2$

12. The possible values of 'K' for which $\begin{bmatrix} \cos\frac{2\pi}{7} & -\sin\frac{2\pi}{7} \\ \sin\frac{2\pi}{7} & \cos\frac{2\pi}{7} \end{bmatrix}^K = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ is/are

(A) 7 (B) 6

(C) 8 (D) 9

Space for rough work

13. If a, b, c are distinct and $\begin{vmatrix} a & b & a\alpha+b \\ b & c & b\alpha+c \\ a\alpha+b & b\alpha+c & 0 \end{vmatrix} = 0$

Then which of the following may be true

(A) a, b, c are in A.P.
(B) a, b, c are in G.P.
(C) α is a root of $ax^2 - bx - c = 0$
(D) α is a root of $ax^2 + 2bx + c = 0$

14. If $P = \begin{bmatrix} \frac{\sqrt{3}}{2} & \frac{1}{2} \\ -\frac{1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix}$, $A = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$ and Q = P AP' then P'(Q^{2005}) P' is equal to

(A) $\begin{bmatrix} 1 & 2005 \\ 0 & 1 \end{bmatrix}$
(B) $\begin{bmatrix} \frac{\sqrt{3}}{2} & 2005 \\ 0 & 1 \end{bmatrix}$
(C) $\begin{bmatrix} 1 & -\frac{1}{2} \\ \frac{\sqrt{3}}{2} & 2005 \end{bmatrix}$
(D) $\begin{bmatrix} \frac{\sqrt{3}}{2} & -1 \\ 1 & 2005 \end{bmatrix}$.

15. If a, b, c are positive and distinct then which of the following cannot be roots of

$$\begin{vmatrix} 0 & x-a & x-b \\ x+a & 0 & x-c \\ x+b & x+c & 0 \end{vmatrix} = 0$$

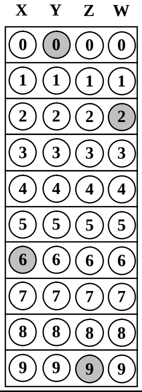
(A) a
(B) 0
(C) b
(D) c

Space for rough work

SECTION – C

Integer Answer Type

*This section contains **5 questions**. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. For example, if the correct answers to question numbers X, Y, Z and W (say) are 6, 0, 9 and 2, respectively, then the correct darkening of bubbles will look like the as shown*



1. Let a, b > 0 and $\vec{\alpha} = \frac{\hat{i}}{a}+\frac{4\hat{j}}{b}+bk$ and $\vec{\beta} = b\,\hat{i} + a\,\hat{j} + \frac{1}{b}\hat{k}$ then the maximum value of $\frac{10}{5+\vec{\alpha}.\vec{\beta}}$ is

2. The equation of the plane passing through the intersection of the planes $2x-5y+z=3$ and $x+y+4z=5$ and parallel to the plane $x+3y+6z=1$ is x + 3y + 6z = k, where k is

3. A and B are two independent events. The probability that both A and B occur is 1/6 and the probability that at least one of them occurs is 2/3. Find 8P(A) + 9P(B) if P(A) > P(B).

4. The minimum area bounded by the function y= f(x) and y = αx + 9 ($\alpha \in$R) where f satisfies the relation f(x + y) = f(x) + f(y) + y$\sqrt{f(x)}$ $\forall$x,y$\in$R and f′(0) = 0 is 9A, value of A is

5. If $x^3\frac{dy}{dx} = y^3 + y^2\sqrt{y^2-x^2}$ and $y=1$ when $x=1$, then $y=2$ when $5x = ...(x \neq 0)$

Space for rough work

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ALL INDIA INTEGRATED TEST SERIES

ANSWERS, HINTS & SOLUTIONS

PART TEST– IV
(Paper - 1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**D**	**C**	**C**
2.	**B**	**B**	**A**
3.	**D**	**A**	**C**
4.	**B**	**A**	**D**
5.	**B**	**A**	**A**
6.	**C**	**D**	**A**
7.	**C**	**C**	**D**
8.	**C**	**D**	**B**
9.	**C**	**D**	**A**
10.	**A**	**A**	**C**
11.	**A, C, D**	**A, B**	**A, B, C, D**
12.	**B, C, D**	**A, B**	**A**
13.	**B, C, D**	**A, C**	**B, D**
14.	**A, B, C**	**A, B**	**A**
15.	**A, C**	**A, B**	**A,C, D**
1.	**2**	**2**	**1**
2..	**4**	**8**	**7**
3.	**0**	**2**	**7**
4.	**2**	**4**	**8**
5.	**8**	**4**	**8**

HINTS AND SOLUTION

Physics PART – I

SECTION – A

1. $$\frac{1}{e} = \frac{e^{-10\lambda t}}{e^{-\lambda t}} = \frac{1}{e^{-\lambda t+10\lambda t}} = \frac{1}{e^{9\lambda t}}$$

$9\lambda t = 1$

$t = \frac{1}{9\lambda}$

2. Shift due to slab is = $t\left(1-\frac{1}{\mu}\right) = 20\left(1-\frac{1}{2}\right) = 10$ cm

$$\frac{1}{v} + \frac{1}{-(90)} = \frac{1}{-30}$$

$$\frac{1}{v} = \frac{1}{90} - \frac{1}{30}$$

$$\frac{1}{v} = \frac{1-3}{90} \Rightarrow v = -45 \text{ m}$$

so final image = 45 + 10(again shift) = 55 cm

3. Since object and image is real

then object distance = $-x_1$

Image distance = x_2

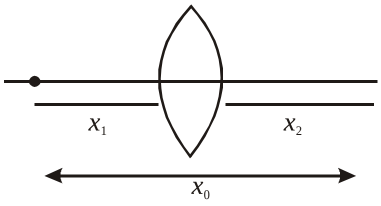
$$x_0 = x_1 + x_2; \frac{1}{x_2} - \frac{1}{-x_1} = \frac{1}{f}$$

$$\Rightarrow x_1 + x_2 = \frac{x_1 x_2}{f} \Rightarrow d = \frac{x_1(x_1 - d)}{f}$$

$$\Rightarrow x_0 = \frac{x_1^2}{x_1 - f}\,\frac{dx_0}{dx_1} = 0 \Rightarrow x_1 = 2f$$

which means $x_2 = 2f$

distance between object and image is 4f = 120 cm



5. $B.I_0 = K = I_1 + I_2 + \sqrt{2I_1I_2}\cos\phi \left(\phi = \frac{2\pi}{\lambda}\cdot\lambda\right)$

$k = 4I(I_1 = I_2 = I) \Rightarrow I = K/4$

when $\Delta x = \lambda/4$, $\phi = \frac{2\pi}{\lambda}\cdot\frac{\lambda}{4} = \frac{\pi}{2}$

$$I' = I_1 + I_2 = \frac{K}{4} + \frac{K}{4} = \frac{K}{2}$$

6. f_{max}(coherent) = I + I + $2\sqrt{II}$

f(in coherent) = I + I = 2I

$$\frac{f(\text{coherent})}{f(\text{incoherent})} = \frac{4I}{2I} = 2$$

7. $\sqrt{\nu} = a(z-b)$

$$\frac{k}{\sqrt{\lambda}} = a(z-b)$$

$$\frac{k}{\sqrt{\lambda_1}} = a(29-1) \qquad \text{....(i)}$$

$$\frac{k}{\sqrt{\lambda_2}} = a(15-1) \qquad \text{....(ii)}$$

from (i) and (ii) $\lambda_2 = 4\lambda_1 = 4\lambda$

11. $b \sin\theta = \left(n-\frac{1}{2}\right)\lambda$

$$\frac{b^2}{2D} = \left(n-\frac{1}{2}\right)\lambda$$

$\Rightarrow$ put n = 1, 2, 3, ………….

$\Rightarrow \ \lambda = \frac{b^2}{D}, \ \frac{b^2}{3D}, \ \frac{b^2}{5D}$

13. If power of the given lens is P

then $P_A = \frac{P}{2}; \ P_B = \frac{P}{2}; \ P_C = \frac{P}{2}$

15. Mosley's law :

$$\lambda\alpha\frac{1}{(z-1)}2$$

$$\frac{\lambda_z}{\lambda_1} = \frac{(z_1-1)^2}{(z-1)^2}$$

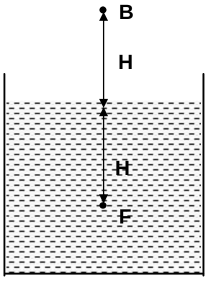
$z_1 - 1 = (z-1)\,2$

$z_1 = 2z - 1$

$$\frac{\lambda_z}{\lambda_2} = \frac{1}{4} = \left(\frac{z_2-1}{z-1}\right)^2.$$

SECTION – C

2. $s_1 = \left[H + \frac{H}{\mu}\right]$



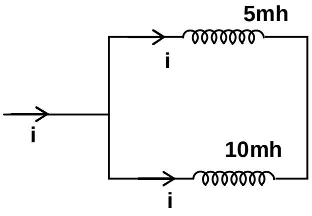
$s_2 = H + \mu H$

$$\frac{s_1}{s_2} = \frac{1}{\mu}$$

$$\frac{s_1}{s_2} = \frac{1}{\mu} = 0.25$$

$\mu = 4$

5. $i = \frac{10i}{15} = \frac{2i}{3} = \frac{x}{3}$



$$i = \frac{20}{5} = 4$$

So, x = 4 × 2 = 8

Chemistry PART – II

SECTION – A

2. $$\frac{d_{bcc}}{d_{ccp}} = \frac{\text{packing efficiency of bcc}}{\text{packing efficiency of ccp}} = \frac{67.92}{74.02} = 0.918$$

3. Except Ti(+IV) in $TiCl_4$ all other metal ions Fe^{3+} in $FeCl_3$, Cu^{2+} in $CuCl_2$ and Mn^{2+} in $MnCl_2$ contains unpaired electrons and are coloured.

4. Fe^{2+} = 0.07 mole in 0.1 mol of $Fe_{0.9}O$
So to balance charge, some of the place has been left vacant as Fe^{2+} is replaced by Sr^{4+}.
$0.07 \times 2 = x \times 4$
$$x = \frac{0.07 \times 2}{4} = 0.035$$
Vacant place = 0.07 – 0.035 = 0.035 N_A

5. In diamond, all the carbon atoms are tetrahedrally bonded to one another so octahedral voids cannot be occupied. Also, the lattice points and the holes are occupied by carbon atoms. As a result the packing efficiency is less than 74%.

7. $$4FeCl_3 + 3K_4[Fe(CN)_6] \longrightarrow \underset{\text{Prussian blue}}{Fe_4[Fe(CN)_6]_3} + 12KCl$$

8. $$SnCl_2 + HgCl_2 \longrightarrow SnCl_4 + \underset{(\text{white})}{Hg_2Cl_2} \downarrow$$
$$Hg_2Cl_2 + SnCl_2 \longrightarrow \underset{(\text{grey})}{Hg} \downarrow + SnCl_4$$

9. $$\frac{Y_A}{Y_B} = \frac{P_A / P_T}{P_B / P_T} = \frac{\chi_A . P_A^0}{\chi_B . P_B^0}$$
$$\Rightarrow \frac{Y_A}{\chi_A} = \frac{Y_B}{\chi_B}\left(\frac{P_A^0}{P_B^0}\right)$$
Because $\frac{P_A^0}{P_B^0} > 1$

Hence $\frac{Y_A}{Y_B} > \frac{\chi_A}{\chi_B}$

10. $$PBr_5(s) \longrightarrow [PBr_4]^+(s) + Br^-(s); \quad [i = 2]$$
$$2PCl_5(s) \longrightarrow [PCl_6]^- + [PCl_4]^+; \quad [i = 1]$$
$$\text{ratio} = \frac{2}{1} = 2$$

11. $$P_{total} = P_B^0 X_B + P_T^0 X_T$$

$= 42\times\frac{1}{3}+36\times\frac{2}{3}$ = 38 mm.

$P_M Y_B = P_B^0 \times X_B$; Where Y_B is the mole fraction of Benzene is vapour phase.

$38\times Y_B = 14$

$Y_B = \frac{14}{38} = \frac{7}{19}$.

12. In the given reaction 'X' can be Au and Ag_2S.

$4Au + 8CN^- + 2H_2O + O_2 \longrightarrow 4Au(CN)_2^- + 4OH^-$

$2Ag_2S + 8CN^- + 2H_2O + O_2 \longrightarrow 4Ag(CN)_2^- + 4OH^- + 2S$

13. $Al^{+3} + 3e^- \rightarrow Al$

Number of moles of Al produced = $\frac{4.5}{27} = 0.166$

Number of moles of electrons used = 3 × 0.166

$H^+ + e^- \rightarrow \frac{1}{2}H_2$

Number of moles of H_2 produced = $\frac{1}{2}\times 3\times 0.166$

Volume of H_2 produced = 1.5 × 0.166 × 22.4 *l* = 5.57 = 5.6 *l*

15. Rochelle salt (sodium potassium tartrate) and bleaching powder (calcium chloride hypochlorite) are mixed salts. Calcium hypochlorite is a simple salt. Mohr's salt [$FeSO_4.(NH_4)_2SO_4.6H_2O$] is a double salt.

SECTION – C

1. $0.7 = 2 \times K_f \times 0.2 \Rightarrow K_f = \frac{0.7}{0.4} = \frac{7}{4}$

$$\begin{array}{ccccc} Hg(CN)_2 & + & mCN^- & \longrightarrow & Hg\ (CN)_{m+2}^{m-} \\ 0.1 & & 0.2 & & 0 \\ 0 & & (0.2-0.1m) & & 0.1 \end{array}$$

Now, Molarity of K^+ = 0.2 M

Molarity of CN^- = (0.2 – 0.1m) M

Molarity of complex = 0.1 M

$0.53 = K_f (0.2 + 0.2 - 0.1m + 0.1) = K_f (0.5 - 0.1m)$

$\Rightarrow 0.53 = \frac{7}{4}(0.5 - 0.1m) \Rightarrow 2.1 = 3.5 - 0.7m$

$\Rightarrow 0.7m = 1.4 \Rightarrow m = \mathbf{2}$.

2. Number of moles of hypo = $\frac{MV}{1000}$

$= \frac{0.1 \times 40}{1000} = 4 \times 10^{-3}$

$\therefore$ Number of moles of $I_2 = 2 \times 10^{-3}$

Mass of $I_2 = 2 \times 10^{-3} \times 254$ g

$$w = \frac{i \times t \times E}{96500}$$

$$2 \times 10^{-3} \times 254 = \frac{i \times 9650 \times 127}{96500}$$

i = 0.04 ampere

Current efficiency = $\frac{0.04}{0.50} \times 100$ = **8%**.

5. $Fe^{2+} + 2e^- \longrightarrow Fe(s);\ E^0 = 5V$ ...(1)

$Fe^{3+} + e^- \longrightarrow Fe^{2+};\quad E^0 = 2V$ ...(2)

Equation (1) + (2):

$Fe^{3+} + 3e^- \longrightarrow Fe(s);\ E^0 = xV(\text{let})$

Hence, $3x = 2 \times 5 + 2$

$X = 4$.

Mathematics PART – III

SECTION – A

1. $\left(\frac{\vec{a}}{a^2}-\frac{\vec{b}}{b^2}\right)^2 = \frac{a^2}{a^4}+\frac{b^2}{b^4}-\frac{2\vec{a}.\vec{b}}{a^2b^2}$, $\left\{\because \vec{a}^2 = a^2 \text{ etc.}\right\}$

$$= \frac{a^2+b^2-2\vec{a}.\vec{b}}{a^2b^2} = \left(\frac{\vec{a}-\vec{b}}{ab}\right)^2.$$

2. $(\vec{a}\times\vec{b})\times\vec{c} = \frac{1}{3}|\vec{b}||\vec{c}|\vec{a}$

$\Rightarrow\ (\vec{a}.\vec{c})\vec{b}-(\vec{b}.\vec{c})\vec{a} = \frac{1}{3}|\vec{b}||\vec{c}|\vec{a}$

$\Rightarrow\ (\vec{a}.\vec{c})\vec{b} = \left\{(\vec{b}.\vec{c})+\frac{1}{3}|\vec{b}||\vec{c}|\right\}\vec{a}$

$\Rightarrow\ (\vec{a}.\vec{c})\vec{b} = |\vec{b}||\vec{c}|\left\{\cos\theta+\frac{1}{3}\right\}\vec{a}$

As $\vec{a}$ and $\vec{b}$ are not parallel, $\vec{a}.\vec{c} = 0$ and $\cos\theta+\frac{1}{3}=0$

$\Rightarrow\ \cos\theta = -\frac{1}{3}$. Hence $\sin\theta = \frac{2\sqrt{2}}{3}$.

3. Let co-ordinates of foot of perpendicular are (a, b, c).

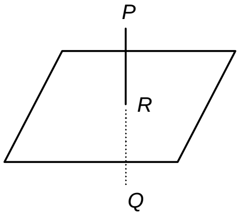
Since $\frac{a-11}{10} = \frac{b+2}{-4} = \frac{c+8}{-11} = k$

Then, $a = 10k+11, b = -4k-2, c = -11k-8$.

Here all alternates give a =1, then k = –1. So foot is (1, 2, 3) and perpendicular distance between (1, 2, 3) and (2, – 1, 5) is $\sqrt{14}$.

Trick : The foot must satisfy the line, so obviously (1,2,3) satisfies. Now length of perpendicular is distance between the foot and the point i.e. $\sqrt{14}$. But students should remember here that it is not necessary that the line segment joining (2, – 1, 5) and (1, 2, 3) is perpendicular to the given line, so they should check. Therefore, direction ratios of the line joining (2, – 1, 5) and (1, 2, 3) are (– 1, 3, – 2) and that of given line are (10, – 4, – 11). Hence the lines are perpendicular.

5. Let Q be image of the point $P(5,4,6)$ in the given plane, then PQ is normal to the plane. The direction ratios of PQ are 1,1,2. Since PQ passes through (5,4, 6) and has direction ratio 1,1,2;



Therefore, equation of PQ is

$\frac{x-5}{1} = \frac{y-4}{1} = \frac{z-6}{2} = r$, (say)

$\therefore\ x = r+5, y = r+4, z = 2r+6$

So, co-ordinates of Q be $(r+5, r+4, 2r+6)$

Let R be the mid point of PQ then co-ordinates of R are

$$\left(\frac{r+5+5}{2}, \frac{r+4+4}{2}, \frac{2r+6+6}{2}\right)$$

i.e., $\left(\frac{r+10}{2}, \frac{r+8}{2}, \frac{2r+12}{2}\right)$

Since R lies on the plane

$$\therefore\ \frac{r+10}{2} + \frac{r+8}{2} + 2\left(\frac{2r+12}{2}\right) - 15 = 0$$

$\Rightarrow\ r+10+r+8+4r+24-30 = 0$

$\Rightarrow\ 6r+12 = 0 \Rightarrow r = -2$

So, co-ordinates of Q are (3, 2, 2).

Trick : From option (a) , midpoint of (3, 2, 2) and (5, 4, 6) satisfies the equation of given plane.

7. Given $A = \begin{vmatrix} \sin(\theta+\alpha) & \cos(\theta+\alpha) & 1 \\ \sin(\theta+\beta) & \cos(\theta+\beta) & 1 \\ \sin(\theta+\gamma) & \cos(\theta+\gamma) & 1 \end{vmatrix}$

Operate $R_2 \to R_2 - R_1, R_3 \to R_3 - R_1$

$\therefore\ A = \{\cos(\theta+\gamma) - \cos(\theta+\alpha)\}$

$\{\sin(\theta+\beta) - \sin(\theta+\alpha)\} - \{\cos(\theta+\beta) - \cos(\theta+\alpha)\}\{\sin(\theta+\gamma) - \sin(\theta+\alpha)\}$

$= \sin(\beta-\gamma) - \sin(\beta-\alpha) - \sin(\alpha-\gamma)$,

which is independent of θ.

8. $AB = \begin{bmatrix} \cos^2\theta & \sin\theta\cos\theta \\ \sin\theta\cos\theta & \sin^2\theta \end{bmatrix} \begin{bmatrix} \cos^2\varphi & \sin\varphi\cos\varphi \\ \sin\varphi\cos\varphi & \sin^2\varphi \end{bmatrix}$

$= \begin{bmatrix} \cos\theta\cos\varphi\cos(\theta-\varphi) & \cos\theta\sin\varphi\cos(\theta-\varphi) \\ \cos\theta\sin\varphi\cos(\theta-\varphi) & \sin\theta\sin\varphi\cos(\theta-\varphi) \end{bmatrix}$

$= \cos(\theta-\varphi)\begin{bmatrix} \cos\theta\cos\varphi & \cos\theta\sin\varphi \\ \cos\theta\sin\varphi & \sin\theta\sin\varphi \end{bmatrix}$

$= O$, $\left(\because\ \theta-\varphi = \frac{\pi}{2}\right)$.

9. Area = $\int_0^1 (1+x-\sin x)dx + \int_1^2 (3-x-\sin x)dx$

$= \frac{3}{2} + (\cos 1 - 1) + 3 - \frac{3}{2} + (\cos 2 - \cos 1) = 2 + \cos 2$

10. $x\frac{dy}{dx} = y - x\tan\left(\frac{y}{x}\right)$ or $\frac{dy}{dx} = \frac{y}{x} - \tan\left(\frac{y}{x}\right)$

It is homogeneous equation, hence put $y = vx$

we get, $v + x\frac{dv}{dx} = v - \tan v$

$\Rightarrow \int \cot v\,dv = -\int \frac{dx}{x}$

$$\Rightarrow \log(x\sin v) = \log c$$

$$\Rightarrow x\sin\left(\frac{y}{x}\right) = c.$$

13. $R_3 : R_3 - \alpha R_1 - R_2$

$$\begin{vmatrix} a & b & a\alpha + b \\ b & c & b\alpha + c \\ 0 & 0 & -(a\alpha^2 + 2b\alpha + c) \end{vmatrix} = 0$$

$a\alpha^2 + 2b\alpha + c = 0$ or $b^2 = ac$

14. $P' = P^{-1}$ now Q = $PAP' = PAP^{-1}$

$Q^{2005} = \left(PAP^{-1}\right)^{2005} = PA^{2005}P^{-1}$

$\therefore\ P'\left(Q^{2005}\right)P = P^{-1}\left(PA^{2005}P^{-1}\right)P$

$= A^{2005} = (I+B)^{2005}$

where $B = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix}$ as $B^2 = 0$, we get $B^r = 0$, $\forall r \ge 2$ by Binomial theorem $A^{2005} = (I+B)^{2005}$

$= I + 2005\begin{bmatrix} 1 & 2005 \\ 0 & 1 \end{bmatrix}$.

15. $$\begin{vmatrix} 0 & x-a & x-b \\ x+a & 0 & x-c \\ x+b & x+c & 0 \end{vmatrix} = 0$$

$(x+a)(x-b)(x+c) + (x+b)(x-a)(x-c) = 0$

$((x^2+ac) + x(a+c))(x-b) + ((x^2+ac) - (a+c)x)(x+b) = 0$

$2(x^2+ac)x - 2bx(a+c) = 0$

$x = 0$ or $x^2 + ac - b(a+c) = 0$

SECTION – C

1. $\vec{\alpha}.\vec{\beta} = \left(\frac{\hat{i}}{a} + \frac{4\hat{j}}{b} + b\hat{k}\right).\left(b\hat{i} + a\hat{j} + \frac{1}{b}\hat{k}\right) = \frac{b}{a} + \frac{4a}{b} + 1$

Hence $\frac{10}{5+\vec{\alpha}.\vec{\beta}} = \frac{10}{5+\frac{b}{a}+\frac{4a}{b}+1} = \frac{10}{\frac{b}{a}+\frac{4a}{b}+6}$

Then the minimum value of $\frac{b}{a} + \frac{4a}{b}$ is 4

$\therefore$ maximum value of $\frac{10}{5+\vec{\alpha}.\vec{\beta}}$ is 1.

2. Equation of plane passing through the intersection of the planes $2x - 5y + z = 3$ and $x + y + 4z = 5$ is

$(2x - 5y + z - 3) + \lambda(x + y + 4z - 5) = 0$

$\Rightarrow (2+\lambda)x + (-5+\lambda)y + (1+4\lambda) - 3 - 5\lambda = 0$ ….(i) which is parallel to the plane x + 3y + 6z = 1.

Then $\frac{2+\lambda}{1} = \frac{-5+\lambda}{3} = \frac{1+4\lambda}{6}$

Then, $\frac{2+\lambda}{1} = \frac{-5+\lambda}{3} = \frac{1+4\lambda}{6}$

$\therefore \lambda = \frac{-11}{2}$

from eq. (i),

$-\frac{7}{2}x - \frac{21}{2}y - 21z + \frac{49}{2} = 0$

$\therefore\ x + 3y + 6z = 7$

Hence, k = 7

3. $P(A \cap B) = P(A)\,P(B) \Rightarrow 1/6 = P(A)\,P(B)$

$P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$\Rightarrow 2/3 = P(A) + \frac{1}{6P(A)} - \frac{1}{6}$

$\Rightarrow 6(P(A))^2 - 5P(A) + 1 = 0 \Rightarrow P(A) = 1/2,\ P(B) = 1/3$

So, 8P(A) + 9P(B) = 4 + 3 = 7

4. $f'(x) = \lim_{h\to 0} \frac{f(x+h) - f(x+0)}{h} \Rightarrow \lim_{h\to 0} \frac{f(x) + f(h) + h\sqrt{f(x)} - f(x) - f(0) - 0\sqrt{f(x)}}{h}$

$\Rightarrow \lim_{h\to 0}\left(\frac{f(h) - f(0)}{h - 0}\right) + \sqrt{f(x)}$

$f'(x) = \sqrt{f(x)}$

$\int \frac{f'(x)}{\sqrt{f(x)}}dx = \int dx$

$2\sqrt{f(x)} = x + c$

$f(x) = \frac{x^2}{4}$

when $\alpha = 0$ area is minimum

required minimum area = $2\int_0^9 2\sqrt{y}\,dy \Rightarrow 4\left(\frac{y^{3/2}}{3/2}\right)_0^9$ = 72 sq. unit.

5. Put $y = vx$

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PART TEST – IV

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 08)** contains 8 multiple choice questions which have one or more than one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 to 16) contains 4 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (17 – 20) contains 4 Matching Lists Type questions: Each question has four statements in LIST I & 4 statements in LIST II. The codes for lists have choices (A), (B), (C), (D) out of which only one is correct. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate

Enrolment No.

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Straight Objective Type

This section contains **8 multiple** choice questions numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which ***ONE or MORE*** are correct.

1. The mass number of a nucleus is
(A) May be equal to its atomic number.
(B) Always less than its atomic number.
(C) May be more than its atomic number
(D) May be more than or may be equal to its atomic number.

2. The potential difference applied to an X-ray tube is increased. As a result in the emitted radiation.
(A) The intensity increases.
(B) The minimum wavelength increases.
(C) The intensity remains unchanged.
(D) The minimum wavelength decreases.

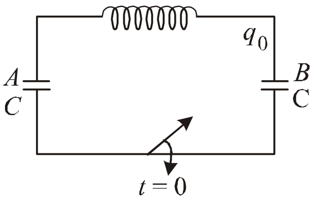
3. When photons of energy 4.0 eV strike the surface of a metal A, the ejected photoelectrons have maximum kinetic energy K_A eV and de-Broglie wavelength λ_A. The maximum kinetic energy of photoelectrons liberated from another metal B by photons of energy 4.50 eV is $K_B = (K_A - 1.50)$ eV. If the de-Broglie wavelength of these photoelectrons is $\lambda_B = \sqrt{2}\,\lambda_A$, then
(A) the work function of A is 1.0 eV
(B) the work function of B is 3.0 eV
(C) $K_A = 3.00$ eV
(D) $K_B = 3.0$ eV

4. A prism of refractive index $\sqrt{2}$, refracting angle A produces minimum deviation D_m of a ray on one face at an angle of incidence 45° . The values of A and D_m are respectively.
(A) 45°, 45°
(B) 45°, 60°
(C) 60°, 30°
(D) 60°, 45°

Space for rough work

5. At t = 0 capacitor B has charge q_0

(Take : $\frac{1}{\sqrt{LC}} = \frac{100\pi}{\sqrt{2}}$, $q_0 = 10^{-3}$C)



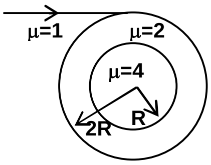
(A) If $i = i_{max}$ in the circuit then q will be same on each capacitor

(B) If $i = i_{max}$ in the circuit then $\frac{q_A}{q_B} = 2$

(C) $q_B = 50\,(1 - \cos 100\,\pi t) \times 10^{-3}$ C

(D) $q_A = 50\,(1 + \cos 100\,\pi t) \times 10^{-3}$ C

6. Figure shows two spherical surfaces of radii R and 2R separating three transparent media of refractive index μ = 4, μ = 2 and μ = 1. A ray of light travelling in medium μ = 1 is incident on outer sphere tangentially. The net deviation suffered by light ray will be.

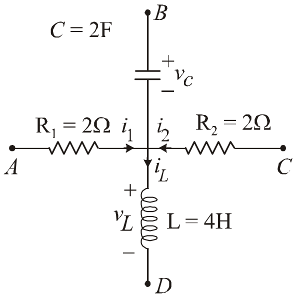


(A) 0°
(B) 90°
(C) 240°
(D) 280°

7. The magnetic field within a long straight solenoid with a circular cross section and radius R increases at a rate of $\frac{dB}{dt}$. The magnitude of the induced electric field outside the solenoid at a distance r_2 from the axis is :

(A) $\frac{R^2}{r_2}\frac{dB}{dt}$
(B) $\frac{R^2}{2r_2}\frac{dB}{dt}$
(C) $\frac{3R^2}{2r_2}\frac{dB}{dt}$
(D) $\frac{R^2}{\sqrt{2}r_2}\frac{dB}{dt}$

8. In figure, $i_1 = 10e^{-2t}$, $i_2 = 4$A and $v_c = 3e^{-2t}$V. The current i_L is :



(A) $\left[2 - 2(1 - e^{-2t})\right]$A
(B) $\left[2 + 2(1 - e^{-2t})\right]$A
(C) $\left[3 - 2(1 - e^{-2t})\right]$A
(D) $\left[2 + 3(1 - e^{-2t})\right]$A

Space for rough work

Comprehension Type

This section contains **4 groups** of questions. Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct

Paragraph for Question Nos. 9 to 10

An electron is orbiting in a circular orbit of radius r under the influence of a constant magnetic field B,. instead of coulombic attraction. Assuming that Bohr's postulate regarding the quantization of angular momentum holds good for this electron [h = planks constant, e = charge on electron and m = mass of electron]

Answer the following questions in view of the above passage:

9. Radius of n^{th} orbit of the electron will be

(A) $\sqrt{\frac{2nh}{\pi Be}}$ (B) $\sqrt{\frac{nh}{2\pi Be}}$

(C) $\sqrt{\frac{neh}{2\pi B}}$ (D) $\sqrt{\frac{2neh}{\pi B}}$

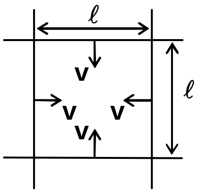
10. K.E of electron in n^{th} orbit will be:

(A) $\frac{nhBe}{4\pi m}$ (B) $\frac{nhBe}{2\pi m}$

(C) $\frac{nhB}{2\pi em}$ (D) $\frac{nhB}{4\pi em}$

Paragraph for Question Nos. 11 to 12

In the figure shown the figure rods have λ resistance per unit length. The arrangement is kept in a magnetic field of constant magnitude B and directed perpendicular to the plane of the figure and directed inwards. Initially the sides are given as shown and they form a square. Now each wire starts moving with constant velocity towards opposite wire.



11. Find as a function of time, induced emf in the circuit.

(A) $4vB(\ell - 2vt)$ (B) $8v^2Bt$

(C) $4v^2Bt$ (D) $4vB(\ell - 4vt)$

12. Induced current in the circuit with direction is

(A) $\frac{vB}{2\lambda}$, clockwise (B) $\frac{vB}{\lambda}$, clockwise

(C) $\frac{2vB}{\lambda}$, anticlockwise (D) none of these

Space for rough work

Paragraph for Question Nos. 13 to 14

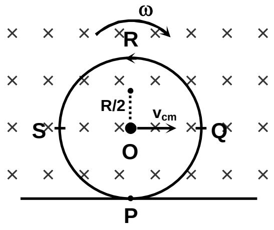
A thin equi-convex glass lens with radius of each of face R is placed between water and oil.
(Given: ${}_a\mu_g = \frac{3}{2}$, ${}_a\mu_{oil} = 2$ and ${}_a\mu_w = \frac{4}{3}$)
Answer the following questions in view of the above passage:

13. If incident ray is from oil then focal length will be :
(A) 4R
(B) 2R
(C) (3/2)R
(D) ∞

14. If incident ray is from water then focal length will be :
(A) 4R
(B) 2R
(C) (3/2)R
(D) 6R

Paragraph for Question Nos. 15 to 16

A conducting ring of radius R is rotating as well as translating on a smooth horizontal surface, where a uniform magnetic field B is present. Velocity of centre of mass is given as v = 2Rω, where ω is the angular velocity of the ring, then



15. Motional emf across PR is
(A) 2BRv
(B) BRv
(C) 3/4BRv
(D) 4BRv

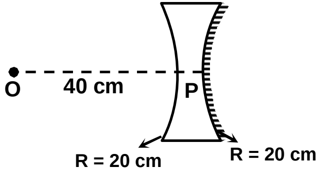
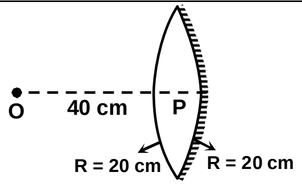
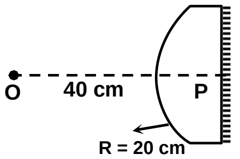
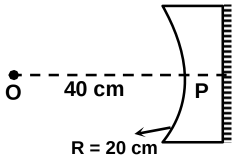
16 Motional emf across PS is
(A) 2BRv
(B) BRv
(C) 3/4BRv
(D) 4BRv

Space for rough work

Matching List Type

This section contains **4 multiple choice questions**. Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

17. Refractive index of lenses is 3/2. Then the final position of the image from the pole is

List – I		List - II	
(P)		(1)	40/7 cm, left to P
(Q)		(2)	40/9 cm, right to P
(R)		(3)	40/3 cm, right to P
(S)		(4)	40 cm, left to P

Codes:

	P	Q	R	S
(A)	4	1	2	1
(B)	2	4	1	3
(C)	4	3	1	2
(D)	2	1	4	3

18. Match the following list-I with List-II

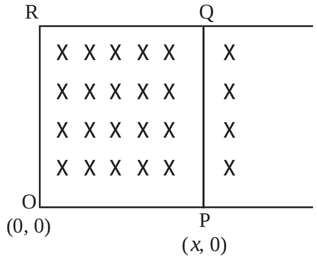
List - I		List - II	
(P)	Wave nature of light	(1)	Young's double slit experiment
(Q)	Particle nature of light	(2)	Photoelectric effect
(R)	Wave nature of electrons	(3)	Electron microscope
(S)	Particle nature of electrons	(4)	Cathode rays

Codes:

	P	Q	R	S
(A)	1	2	3	4
(B)	2	4	1	3
(C)	4	3	1	2
(D)	2	3	4	1

Space for rough work

19. Consider two parallel conducting frictionless, resistanceless tracks which are kept in gravity free space as shown in the figure. A moveable conductor PQ of resistance r initially kept at OR given a velocity v_0 m/s towards right. If there exists a magnetic field which depends on x-co-ordinate in space from O and perpendicular to plane of parallel tracks and given by



$\vec{B} = \alpha x(-\hat{k})$ (α is constant)

Take mass of conductor PQ m = 1 kg, length l = 1m α = 1 T/m, v_0 =10 m/s. ($2^{1/3} = 1.26$)

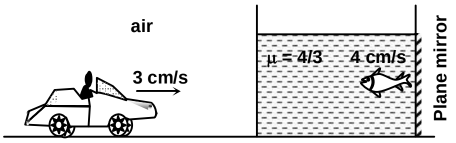
r = $\frac{9}{5}\Omega$. Then match List-I with List-II.

	List – I		List - II
(P)	x-coordinate of conductor when speed become half of initial value.	(1)	15 unit
(Q)	Current of conductor when speed become half of initial value	(2)	3 unit
(R)	E.M.F. induced in conductor when speed become half of initial value.	(3)	4 unit
(S)	x-coordinate when speed becomes zero (approximately)	(4)	$\frac{25}{3}$ unit

Codes:

	P	Q	R	S
(A)	1	4	2	1
(B)	4	2	1	3
(C)	2	4	1	3
(D)	2	3	4	1

20. A child in a toy car is moving towards a cubical container with a velocity of 3 cm/s, whereas fish is moving towards child with a velocity of 4 cm/s as shown in the figure. The wall behind the fish is silvered (Refractive index of water is μ = 4/3). Match the following



	List – I		List - II
(P)	Velocity of child as observed by fish by one refraction only	(1)	zero
(Q)	Velocity of fish as observed by child by one refraction only	(2)	6 cm/s
(R)	Velocity of image of fish by reflection from mirror as observed by child.	(3)	8 cm/s
(S)	Velocity of image of child by reflection from mirror as observed by fish	(4)	7 cm/s

Codes:

	P	Q	R	S
(A)	1	4	2	1
(B)	3	2	1	1
(C)	2	4	1	3
(D)	2	3	4	1

Space for rough work

Chemistry PART – II

SECTION – A

Multiple Correct Answers Type

This section contains 8 multiple correct answer(s) type questions. Each question has 4 choices (A), (B), (C) and (D), out of which ***ONE OR MORE*** *is/are correct.*

1. Cataphoresis is the process used for the coagulation of colloids. It can be used for
(A) colloids having positive charge (B) colloids having negative charge
(C) lyophilic colloids (D) All of the above

2. The solid compound SiO_2 exist in the forms of
(A) crystalline in quartz (B) amorphous in quartz
(C) amorphous in silica glass (D) crystalline in silica glass

3. Given $E^o_{Ag^+|Ag} = 0.80V, E^o_{Mg^{2+}|Mg} = -2.37V, E^o_{Cu^{2+}|Cu} = 0.34V, E^o_{Hg^{2+}|Hg} = 0.79V$. Which of the following statement(s) is/are incorrect?
(A) $AgNO_3$ can be stored in copper vessel.
(B) $Cu(NO_3)_2$ can be stored in magnesium vessel.
(C) $CuCl_2$ can be stored in silver vessel.
(D) $HgCl_2$ can be stored in copper vessel.

4. Identify the correct statement(s)
(A) 1 M NaCl has higher freezing point than 1 M glucose solution.
(B) 1 M NaCl solution has almost same boiling point as 1 M KCl solution, assuming 100% ionisation.
(C) Apparent molecular weight of NaCl will be less than 58.5 in water because it undergoes dissociation.
(D) *i* = 1 when acetic acid is dissolved in benzene.

5. Which of the following is/are true?
(A) All halogens exist as diatomic gaseous molecules at ordinary temperature
(B) Bromine dissolves in chloroform imparting blue colour
(C) Chlorine monoxide is evolved when $KClO_3$ is treated with conc. H_2SO_4
(D) Chloride ion is confirmed by chromyl chloride test

Space for rough work

6. Which of the following is/are correct for lyophillic aquasols?
   (A) Its surface tension is lower than that of H_2O
   (B) Its viscosity is higher than that of water
   (C) Colloidal silver
   (D) Colloidal antimony

7. Which of the following compounds are coloured due to charge transfer spectrum?
   (A) K_2CrO_7 (B) $KMnO_4$
   (C) $[Co(NH_3)_6]Cl_3$ (D) $[Cu(NH_3)_4]SO_4$

8. Nitrogen dioxide can be obtained by heating
   (A) KNO_3 (B) $Pb(NO_3)_2$
   (C) $LiNO_3$ (D) $AgNO_3$

Linked Comprehension Type

*This section contains 4 paragraphs. Based upon each paragraph, 2 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.*

Paragraph for Question Nos. 9 to 10

$$(A) + NaCl \longrightarrow B(\text{white ppt.})$$

$$(B) + KI \longrightarrow C(\text{green ppt.})$$

$$(C) + KI(\text{excess}) \longrightarrow (D) + (E)(\text{colourless solution})$$

$$(E) + NH_3 + KOH \longrightarrow F$$

9. Compound (A) and (B) are respectively
   (A) $AgNO_3$ and AgCl (B) $Pb(NO_3)_2$ ad $PbCl_2$
   (C) $Hg_2(NO_3)_2$ and Hg_2Cl_2 (D) $Cu_2(NO_3)_2$ and Cu_2Cl_2

10. When compound (B) reacts with NH_3 solution, the colour of the compound formed is
    (A) black (B) red
    (C) yellow (D) white

Space for rough work

Paragraph for Question Nos. 11 to 12

The binary compounds of oxygen with other elements are called oxides. They are classified either depending upon their acid – base characteristics or on the basis of oxygen content.

11. Which of the following pairs contain neutral oxides?
(A) SO_2, SO_3 (B) N_2O_3, N_2O_5
(C) CO, NO (D) Na_2O, CaO

12. Which of the following pairs contains mixed oxides?
(A) Pb_3O_4, Fe_3O_4 (B) MnO_2, BaO_2
(C) KO_2, Na_2O_2 (D) Mn_3O_4, N_2O_5

Paragraph for question Nos 13 to 14

The electrical energy produced by a galvanic cell is given by the product of its electromotive force and the quantity of electricity which passes. Till about the middle of the nineteenth century it was generally believed that electrical energy of a reversible cell originated from the decrease in the enthalpy ($-\Delta H$) of the cell reaction. This view received support from the fact that the enthalpy change of the reaction

$$Zn(s) + Cu^{2+}(aq) \longrightarrow Zn^{2+}(aq) + Cu(s)$$

taking place in the Daniell cell is about 210,000 joules which is very close to the electrical energy of the cell viz., 212,300 joules, as calculated above. However, towards the close of the century, it was pointed out by Gibbs, and independently by Helmholtz, that the electrical energy of a reversible cell originates from the free energy decrease ($-\Delta G$) of reaction occurring in the cell. Suppose in a particular cell reaction, n is the number of electrons liberated at one electrode (or taken up at the other electrode), then evidently, n faradays (nF coulombs) of electricity will be generated in the complete cell reaction. If, for the sake of simplicity, the EMF of the cell, viz., E_{cell} is denoted by E, then

Electrical energy produced by the cell = nFE

Hence, $-\Delta G = nFE$

Read the following paragraph and answer the questions given below:

13. In the Daniell cell, the EMF is 1.10 volts. The cell reaction involves liberation as well as taking up of 2 moles of electrons. What will be the electrical energy generated in the cell for the complete cell reaction
(A)106, 150 joule (B) 212, 300 joule
(C) 53, 075 joule (D) None of these

14. For the Daniel cell involving the cell reaction,
$Zn(s) + Cu^{2+}(aq) \longrightarrow Zn^{2+}(aq) + Cu(s)$
The standard free energies of formation of Zn(s), Cu(s), $Cu^{2+}(aq)$ and $Zn^{2+}(aq)$ are 0, 0, 64.4 kJ mol^{-1} and –154.0 kJ mol^{-1}, respectively. Calculate the standard EMF of the cell.
(A) 1.13 volt (B) 2.10 volt
(C) 0.5 volt (D) 1.95 volt

Space for rough work

Paragraph for question Nos 15 to 16

Addition of non-volatile solute always lowers the vapour pressure of solvent, therefore, it will be in equilibrium with solid phase at a lower pressure and hence at a lower temperature, the difference between the freezing points of the pure solvent and its solution is called depression of freezing point. The depression in freezing point when 1 mol of solute is dissolved in 1000 gm of solvent is called molal freezing point depression constant (K_f). The value of K_f for H_2O is 1.86 K mol^{-1}kg. To understand this, a solution of 25% (w/w) $MgCl_2$ containing impurity of the chloride of a trivalent metal M having atomic mass 43.5 gm (24% by weight of $MgCl_2$) has been prepared. In this solution $MgCl_2$ is completely dissociated. On the other hand only 50% dissociation of MCl_3 takes place and molality is approximately equal to molarity.

Read the following paragraph and answer the questions given below:

15. Depression in freezing point of the solution is
(A) 17.36 K (B) 13.02 K
(C) 14.88 K (D) 12.42 K

16. If the solution is cooled to –21.7°C, what weight of ice will be formed?
(A) 15 gm (B) 60 gm
(C) 40 gm (D) 51 gm

(Matrix-Match Type)

*This section contains **4 questions.** Each question has four statements (P, Q, R and S) given in **List-I** and **four statements** (1, 2, 3, 4) in **List-II.** Any given statement in **List**-I can have correct matching with **ONE** or **MORE** statement(s) given in **List-II**. For example, if for a given question, statement B matches with the statements given q and r, then for the particular question, against statement B, darken the bubbles corresponding to q and r in the ORS.*

17. Match the List – I with the List - II.

	List-I		List-II
(P)	$\wedge_m$	(1)	$\frac{1}{R} \times \frac{1}{\alpha}$
(Q)	κ (kappa)	(2)	$\frac{1000 \times \kappa}{M}$
(R)	α	(3)	$\overset{\circ}{\wedge}_{NaCl} = \overset{\circ}{\lambda}_{Na^+} + \overset{\circ}{\lambda}_{Cl^-}$
(S)	Kohlrausch's law	(4)	$\frac{\wedge}{\overset{\circ}{\wedge}}$

Codes:	**P**	**Q**	**R**	**S**
(A)	2	1	4	3
(B)	2	3	4	1
(C)	4	1	2	3
(D)	1	4	2	3

Space for rough work

18. Match the List-I with the List-II

List-I	List-II
(P) van Arkel method	(1) Purification of copper
(Q) Poling	(2) Refining of silver
(R) Cupellation	(3) Manufacture of Na_2CO_3
(S) Solvay process	(4) Purification of titanium

Codes:	**P**	**Q**	**R**	**S**
(A)	3	2	1	4
(B)	2	3	4	1
(C)	4	1	3	2
(D)	4	1	2	3

19. Match the List – I with List – II:

List-I		List-II	
(P)	Molality of water	(1)	1.13
(Q)	Mole fraction of sugar in 214.2 g sugar syrup containing 34.2 g of sugar.	(2)	0.555
(R)	Molality of sugar solution(II) prepared above	(3)	0.0099
(S)	Molality of CH_3OH is aqueous CH_3OH solution (Mole fraction of $CH_3OH = 0.02$ and density of solution = 0.994 g/cc)	(4)	55.5

Codes:	**P**	**Q**	**R**	**S**
(A)	3	2	1	4
(B)	4	3	2	1
(C)	4	1	2	3
(D)	1	4	2	3

20. Match the geometry (List – I) with the corresponding complex (List – II).

List – I (Geometry)		List – II (Complex)	
(P)	Octahedral	(1)	Tetracarbonyl nickel (0)
(Q)	Square planar	(2)	Pentafluoro antimonate (III) ion
(R)	Tetrahedral	(3)	Tetraammine copper (II) sulphate
(S)	Square pyramidal	(4)	Hexacyanoferrate (III) ion

Codes:	**P**	**Q**	**R**	**S**
(A)	3	2	1	4
(B)	2	3	4	1
(C)	4	3	1	2
(D)	1	4	2	3

Space for rough work

Mathematics PART – III

SECTION – A

Multiple Correct Choice Type

*This section contains **8 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct*

1. The line whose vector equations are $\vec{r}$ = 2i – 3j + 7k + λ (2i + pj + 5k) and $\vec{r}$ = i + 2j + 3k + μ (3i – pj + pk) are perpendicular for all values of λ and μ if p is equal to
(A) –1
(B) 2
(C) 5
(D) 6

2. The equation of projection forming plane of the line $\frac{x-1}{2}=\frac{y+1}{-1}=\frac{z-3}{4}$ in the plane x + 2y + z = 6 is/are
(A) x + 2y + z – 6 = 0
(B) 9x – 2y – 5z + 4 = 0
(C) x – 2y – z + 6 = 0
(D) 9x + y – 5z + 4 = 0

3. An urn contains four tickets with numbers 112, 121, 211, 222 and one ticket is drawn. Let Ai(i = 1, 2, 3) be the event that the ith digit of the number of ticket drawn is 1 then
(A) $P(A_1) = P(A_2) = P(A_3) = 1/2$
(B) $P(A_1 \cap A_2) = P(A_1) . P(A_2)$
(C) A_1, A_2, A_3 are pairwise independent events
(D) $P(A_1 \cap A_2 \cap A_3) \neq P(A_1) P(A_2) P(A_3)$

4. Let us define the events A and B as
A : An year chosen at random contains 29 days in the February month.
B : An year chosen at random has does not contain 53 Fridays.
If P(E) denotes the probability of happening of event E then
(A) $P(\bar{B}) = \frac{2}{7}$
(B) $P(B) = \frac{23}{28}$
(C) $P(A/\bar{B}) = 2/5$
(D) P(A/(B) = 5/23

Space for rough work

5. If A and B are any two different square matrices of order n with A – B is non-singular $A^3 = B^3$ and A(A(B)) = B(B(A)), then

(A) $A^2 + B^2 = O$ (B) $A^2 + B^2 = I$

(C) $A^2 + B^3 = I$ (D) $A^3 + B^3 = O$

6. Let $\Delta = \begin{vmatrix} a & a+d & a+2d \\ a+d & a+2d & a \\ a+2d & a & a+d \end{vmatrix}$, then

(A) Δ depends on a (B) Δ depends on d

(C) Δ is constant (D) all the above

7. Area bounded by curve $y^2 = x$ and x = 4 is divided into 4 equal parts by the lines x = a and y = b then.

(A) Area of each part = $\frac{8}{3}$ (B) b = 0

(C) $a = \sqrt{2}$ (D) $a = (16)^{1/3}$

8. The differential equation of the curve for which the initial ordinate of any tangent is equal to the corresponding subnormal.

(A) is linear in x (B) is homogenous of first degree

(C) has separable variables (D) is of second order.

Space for rough work

Comprehension Type

*This section contains **4 groups of questions**. Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct*

Paragraph for Question Nos. 9 to 10

$|\vec{a}| = |\vec{b}| = |\vec{c}| = |\vec{a}+\vec{b}| = 1$, $\vec{a}\cdot\vec{c} = 0$. If $\vec{a} = \frac{\hat{i}}{\sqrt{2}} + \frac{\hat{j}}{\sqrt{2}}$ and $\vec{a}$, $\hat{k}$ and $\vec{b}$ are linearly dependent.

9. If maximum and minimum value of $\vec{b}\cdot\vec{c}$ is M and m, then $4(M^2 + m^2)$ is

(A) 1	(B) 5
(C) 3	(D) 6

10. If for some $\vec{c}$, $|\vec{b}\times\vec{c}| = |\vec{a}\times\vec{c}|$ and $\vec{c} = p\hat{i} + q\hat{j} + r\hat{k}$, then $16(p^4 + q^4 + r^4)$ is

(A) 8	(B) 21
(C) $\frac{21}{3}$	(D) 4

Paragraph for Question Nos. 11 to 12

T is the region of the plane x + y + z = 1 with x, y, z > 0. S is the set of points (a, b, c) in T such that just two of the following three inequalities hold: $a \le \frac{1}{2}$, $b \le \frac{1}{3}$, $c \le \frac{1}{6}$.

11. Area of the region T is

(A) $\frac{\sqrt{3}}{4}$	(B) $\frac{\sqrt{3}}{2}$
(C) $\sqrt{3}$	(D) none of these

12. Area of the region S is

(A) $\frac{\sqrt{3}}{72}$	(B) $\frac{7\sqrt{3}}{36}$
(C) $\frac{\sqrt{3}}{4}$	(D) none of these

Space for rough work

Paragraph for Question Nos. 13 to 14

A matrix H = $[h_{jk}]$ is used to keep track of three football players (numbered 1, 2, and 3) in three matches (1st, 2nd and 3rd).
$\text{Re}(h_{jk})$ = number of matches in which both jth and kth players played or both did not play.
(If j = k it is 3)
$\text{Img}(h_{jk})$ = (number of matches played by kth player) – (number of matches played by jth player)

13. Let P = $[P_{jk}]$, $P_{jk} = 1$ if jth player played in kth match and P_{jk} = i otherwise $\left(i = \sqrt{-1}\right)$, then |det(H)| is equal to
(A) |det(P)|
(B) $|\det(P)|^2$
(C) $|\det(P)|^3$
(D) none of these

14. det(H) is
(A) complex with imaginary part a multiple of 4
(B) non–positive multiple of 3
(C) non negative multiple of 4
(D) none of these

Paragraph for Question Nos. 15 to 16

Given $f(x) = x^3 + x - 2$, f: R → R, area of bounded by f(x), $f^{-1}(x)$ and xy = 0 in 1st quadrant is A, where A = $3t - \frac{5}{2}$, where $t = a^{1/b}$ and 3(a + b) = n; a, b, n $\in$ N and a is prime.

15. Difference of last two digits of $a^{a^{11}-36}$ is
(A) 0
(B) 1
(C) 2
(D) 3

16. Number of ways of putting n alike apples and n alike oranges in six baskets if each basket can hold atmost five fruits is
(A) ${}^{20}C_5 - 6\ {}^{14}C_5 + 15\ {}^{8}C_5$
(B) $({}^{20}C_5 - 6\ {}^{14}C_5 + 15\ {}^{8}C_5)^2$
(C) $({}^{20}C_5 - 6\ {}^{14}C_5 + 15\ {}^{8}C_5)^2 - 5^6$
(D) none of these

Space for rough work

(Matching list Type)

*This section contains **4 multiple choice questions**. Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct*

17. Now match the following List–**I** with List–**II**.

	List – I		**List – II**
(P)	$\vec{a}, \vec{b}$ unit vectors and $\vec{a} + 2\vec{b} \perp 5\vec{a} - 4\vec{b}$, then $2(\vec{a} \cdot \vec{b})$ is equal to	(1)	0
(Q)	The points (1, 0, 3), (–1, 3, 4), (1, 2, 1), (k, 2, 5) are coplanar, then k =	(2)	– 1
(R)	The vectors (1, 1, m), (1, 1, m + 1), (1, –1, m) are coplanar, then number of values of m is	(3)	1
(S)	$\vec{a} \times (\vec{b} \times \vec{c}) + \vec{b} \times (\vec{c} \times \vec{a}) + \vec{c} \times (\vec{a} \times \vec{b})$ is equal to	(4)	2

Codes:

	P	Q	R	S
(A)	4	3	2	1
(B)	3	2	1	1
(C)	3	2	4	1
(D)	4	1	2	3

Space for rough work

18. India and Australia play a series of ‘n’ one day matches and probability that India wins a match against Australia is $\frac{1}{2}$.

	List – I		**List – II**
(P)	If ‘n’ is not fixed and series ends when any one of the team completes its 4th win then probability that India wins the series is	(1)	$\frac{4}{2^7}$
(Q)	If n = 7; then probability that India wins atleast three consecutive matches is	(2)	$\frac{47}{2^7}$
(R)	For n = 7, probability that India wins series through consecutive wins is	(3)	$\frac{1}{2}$
(S)	For n = 7, probability that India doesn’t win two consecutive matches is	(4)	$\frac{17}{2^6}$

Codes:

	P	Q	R	S
(A)	4	3	2	1
(B)	3	2	4	1
(C)	3	2	1	4
(D)	4	1	2	3

Space for rough work

19. Consider the system of equations:
$a^2x + (a^2 - (b - c)^2)y + bcz = 0$
$b^2x + (b^2 - (c - a)^2)y + caz = 0$
$c^2x + (c^2 - (a - b)^2)y + abz = 0$, then

List – I		**List – II**	
(P)	If $a + b + c = 0$ and no two out of a, b, c are equal then	(1)	system of equations have unique solution
(Q)	If $a = b = c = 0$, then	(2)	system of equations have infinite number of solutions
(R)	If $a = b = c$, $a + b + c \neq 0$, then	(3)	$\forall$ x, y, z $\in$ R, the system of equations will be true
(S)	If $a + b + c \neq 0$ and no two out of a, b, c are equal, then	(4)	solutions of system of equations are in the form $(\lambda_1, \lambda_2, -\lambda_1 - \lambda_2)$, where $\lambda_1, \lambda_2 \in R$

Codes:

	P	Q	R	S
(A)	2	2, 4	2, 3	3
(B)	4	3, 2	3	4
(C)	4	3, 4	4	1
(D)	2	2, 3	2, 4	1

Space for rough work

20. Now match the following List–I with List–II.

List – I		List – II	
(P)	Solution of the differential equation $y'' + e^{2y}(y')^3 = 0$ is	(1)	$x = \frac{1}{4}e^{2y} + c_1y + c_2$
(Q)	Solution of the differential equation $2x(x + y)y' = 3y^2 + 4xy$ at $y(1) = 1$ is	(2)	$y^2 + 2xy = 3x^3$
(R)	Equation of orthogonal trajectories of the curve $y = \tan x + k$ is	(3)	$2x + 4y + \sin 2x = c$
(S)	Solution of the differential equation $y' + 4xy + xy^3 = 0$ is	(4)	$y^2 = \left(ce^{4x^2} - \frac{1}{4}\right)^{-1}$

Codes:

	P	Q	R	S
(A)	4	3	2	1
(B)	1	2	3	4
(C)	1	2	4	3
(D)	4	1	2	3

Space for rough work

FIITJEE

JEE(Advanced)-2016

ALL INDIA INTEGRATED TEST SERIES

FIITJEE Students From All Programs have bagged 33 in Top 100, 77 in Top 200 and 205 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2015:
4551 FIITJEE Students from All Programs have qualified in JEE (Advanced), 2015.

ANSWERS, HINTS & SOLUTIONS

PART TEST– IV
(Paper - 2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A, C, D	A, B	A, D
2.	C, D	A, C	B
3.	A, B, C	A, B, D	A, B, C, D
4.	C	B, C	B,C, D
5.	A	D	A
6.	C	A, B	A, B
7.	B	A, B	A, B, D
8.	B	B, C, D	A, B
9.	B	C	D
10.	A	A	A
11.	A	C	B
12.	B	A	B
13.	A	B	B
14.	D	A	C
15.	A	A	D
16.	B	A	A
17.	D	A	B
18.	A	D	C
19.	C	B	D
20.	B	C	B

HINTS AND SOLUTION

Physics

PART – I

SECTION – A

9-10. $evB = \frac{mv^2}{r}$

$mvr = \frac{nh}{2\pi}$

$\frac{mr}{eB} = \frac{nhr}{2\pi mv^2}$

$m^2v^2 = \frac{eBnh}{2\pi}$

$K.E = \frac{1}{2}m\frac{eBnh}{2\pi m}$

$K.E. = \frac{eBnh}{4\pi m}$

$r = \frac{nh}{2\pi m}\sqrt{\frac{2\pi m^2}{eBnh}} = \sqrt{\frac{nh}{2\pi eB}}$

Chemistry

PART – II

SECTION – A

1. Cataphoresis is the process used for coagulation of colloids in which +ve particles move towards –ve pole and –ve particles move towards +ve pole in the presence of electric field.

2. SiO_2 has different molecular arrangements in different forms.

4. More the value of *i* lesser will be freezing point of solution and $i = \dfrac{\text{Molecular wt. theoretical}}{\text{Molecular wt. experimental}}$

5. The first statement is false because F_2 and Cl_2 are gases, Br_2 is liquid while I_2 is a solid. Bromine dissolves in chloroform imparting reddish-brown colour. Chlorine dioxide is evolved when $KClO_3$ is treated with conc. H_2SO_4

6. Surface tension of lyophilic aquasols is lower than that due to force of attraction between dispersed phase and dispersion medium.
Its viscosity is higher due to force of attraction between dispersed phase and dispersion medium.

13. $\Delta G = -nFE$
$= -2 \times 96500 \times 1.1$
$= -212300$ J

14. $(\Delta G^\circ)_R = (G^\circ)_P - (G^\circ)_R$
$= -154 - 64.4 = -218.4$ kJ.
$\Delta G^\circ = -nFE^\circ$
$-218.4 \times 10^3 = -2 \times 96500 \times E^\circ$
$E^\circ = 1.13$ V.

15. Let the solution is 100 gm
$\therefore$ 25 gm is impure $MgCl_2$ ($MgCl_2$ + MCl_3)
$\therefore$ 6 gm is MCl_3
$\Delta T_f = i \times k_f \times m$

$$= 1.86 \times \left[\left(i \times \frac{w_B}{M_B}\right)_{MgCl_2} + \left(i \times \frac{w_B}{M_B}\right)_{MCl_3}\right] \times \frac{1000}{w_A}$$

$$= 1.86 \times \left[\left(3 \times \frac{19}{95}\right) + \left(2.5 \times \frac{6}{150}\right)\right] \times \frac{1000}{75}$$

$$= 1.86 \times (0.6 + 0.1) \times \frac{1000}{75}$$

ΔT_f = **17.36 K**

16. At –21.7°C amount of solvent can be calculated as

$$21.7 = 1.86 \times \left[\left(3 \times \frac{19}{95}\right) + \left(2.5 \times \frac{6}{150}\right)\right] \times \frac{1000}{w_A}$$

$w_A = 60$ gm
$\therefore$ Amount of ice formed = 75 – 60 = **15 gm**.

Mathematics PART – III

SECTION – A

1. The given lines are perpendicular for all values of λ and μ if the vectors 2i + pj + 5k and 3i – pj + pk are perpendicular
$\Rightarrow 2 \times 3 + p(-p) + 5p = 0$
$\Rightarrow p^2 - 5p - 6 = 0 = 0 \Rightarrow p = -1$ or 6

2. Equation of any plane through the line is $a(x-1) + b(y+1) + c(z-3) = 0$
where $2a - b + 4c = 0$ ... (i)
The plane $x + 2y + z = 6$ perpendicular to $a(x-1) + b(y+1) + c(z-3) = 0$
$\therefore\ a + 2b + c = 0$ ... (ii)
Solving (i) & (ii) we get $\frac{a}{-9} = \frac{b}{2} = \frac{c}{5}$
equation of the plane is $9x - 2y - 5z + 4 = 0$
Hence the equation of projection is $9x - 2y - 5z + 4 = 0$

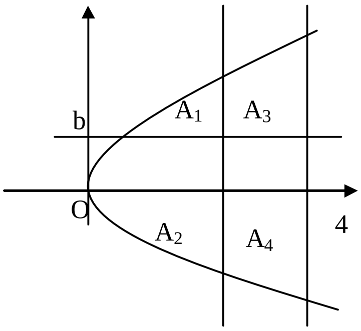
3. $P(A_1 \cap A_2) = 1/4$
$P(A_1) = 2/4$
$P(A_2) = \frac{1}{2}$. Thus $P(A_1 \cap A_2) = P(A_1)\,P(A_2)$. Similarly other are true.

4. $P(A) = 1/4$, $P(B/(A) = 5/7$, $P(B/\bar{A}) = 6/7$
$P(B) = P(A)\,P(B/(A) + P(\bar{A})\,P(B/\bar{A}) = 1/4 \times 5/7 + 3/4 \times 6/7 = 23/28$
$P(A/(B) = \frac{P(A \cap B)}{P(B)} = \frac{1/4 \times 5/7}{1/4 \times 5/7 + 3/4 \times 6/7} = \frac{5}{23}$
$P(A/\bar{B}) = \frac{P(A \cap \bar{B})}{P(\bar{B})} = \frac{\frac{1}{4} \times \frac{2}{7}}{1 - \frac{23}{28}} = \frac{2}{5}$

5. $A^3 = B^3$ …….(i)
$A^2B = B^2A$.................(ii)
subtracting (ii) by (i)
$\left(A^2 + B^2\right)(A - B) = 0$
$\because |A - B| \neq 0$, $A^2 + B^2 = 0$

6. Apply $C_1 \to C_1 - C_2$ and $C_2 \to C_2 - C_3$
$$\Delta = \begin{vmatrix} -d & -d & a+2d \\ -d & 2d & a \\ 2d & -d & a+d \end{vmatrix} = -9(a+d)d^2$$

7. Total area = $2\int_0^4 \sqrt{x}\,dx = \frac{32}{3}$



Area of each part = 8/3

$$A_3 = A_4 \Rightarrow \int_a^4 \left(\sqrt{x} - b\right)dx =$$

$$\int_a^4 \left(b + \sqrt{x}\right)dx = \frac{8}{3} \Rightarrow b = 0$$

$$\int_a^4 \sqrt{x}\,dx = \frac{8}{3} \Rightarrow a^3 = 16$$

8. If y = f(x) is the curve, then

Y – y = f ′(x) (X – x) is the equation of the tangent of (x, y). Take f′ (x) = $\frac{dy}{dx}$

Putting X = 0, the initial ordinate of the tangent is = y – x f′(x) = subnormal at this point $= y\frac{dy}{dx} \Rightarrow y - x\frac{dy}{dx} = y\frac{dy}{dx}$

Which is homogenous of first degree

Again

⇒ = 1 which is linear in x

⇒ (A), (B) are correct.

9-10. $\vec{b} = -\frac{1}{2}\vec{a} + \frac{\sqrt{3}}{2}\hat{k} = -\frac{1}{2\sqrt{2}}\hat{i} - \frac{1}{2\sqrt{2}}\hat{j} + \frac{\sqrt{3}}{2}\hat{k}$

$$8\left(\left(\frac{1}{2\sqrt{2}}\right)^4 + \left(\frac{1}{2\sqrt{2}}\right)^4 + \left(\frac{\sqrt{3}}{2}\right)^4\right) = \frac{19}{4}$$

also if $|\vec{b} \times \vec{c}| = |\vec{a} \times \vec{c}|$, then $\vec{c}$ is perpendicular to both $\vec{a}$ and $\vec{b}$

$$\Rightarrow \vec{c} = \hat{k} \times \left(\frac{\hat{i}}{\sqrt{2}} + \frac{\hat{j}}{\sqrt{2}}\right)$$

$(\vec{b}\cdot\vec{c})_{\max} = \cos 30^\circ$ and $(\vec{b}\cdot\vec{c})_{\min} = \cos 150^\circ$.

11. T is an equilateral triangle with the vertices at (1, 0, 0), (0, 1, 0) and (0, 0, 1)

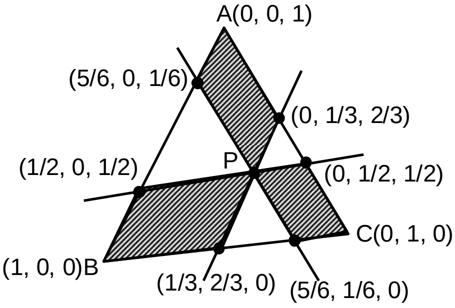
⇒ area of the region T is $\frac{\sqrt{3}}{2}$.

12. Take a point $P\left(\frac{1}{2}, \frac{1}{3}, \frac{1}{6}\right)$ on the plane x + y + z = 1

The region S is shown as shaded region.

Area of S = $\frac{\sqrt{3}}{2} - \frac{\sqrt{3}}{4}\left(a^2+b^2+c^2\right)$, where a, b, c are sides of three small equilateral triangles

= $\frac{7\sqrt{3}}{36}$.



13–14. Observe that H = PP* (P* = transposed conjugate of P)

So det(H) = det(P) · $\overline{\det(P)}$

Also |det(H)| = |det(P)|^2 ⇒ det(H) is non negative integer

Now in matrix P perform $R_2 \to R_2 - R_1$ and $R_3 \to R_3 - R_1$ and take common 1 – i (if possible) from R_2 and R_3

det(P) becomes $(1-i)^2z \Rightarrow \det(H) = 2^2|Z|^2$

15–16. f(x) and $f^{-1}(x)$ intersect at $f(x) = f^{-1}(x) = x$

so at $x = 2^{1/3}$

so area bounded is $(2^{1/3})^2 - 2\int_1^{2^{1/3}} f(x)dx = 3\cdot 2^{1/3} - \frac{5}{2}$ so $t = 2^{1/3}$

so a = 2, b = 3, n = 15.

Last two digits of 2^{2012} are 96 ⇒ difference = 3.

Number of ways of distribution of apples is coefficient of x^{15} in $(1 + x + x^2 + \ldots + x^5)^6$

Number of ways of distribution of oranges is 1.

17 (P) $\vec{a}, \vec{b}$ unit vectors

$$\left(\vec{a}+2\vec{b}\right)\cdot\left(5\vec{a}-4\vec{b}\right)=0$$

$$\Rightarrow 5\left|\vec{a}\right|^2+6\cdot\vec{a}\cdot\vec{b}-8\left|\vec{b}\right|^2=0$$

$$\Rightarrow 6\vec{a}\cdot\vec{b}=3$$

$$\Rightarrow \vec{a}\cdot\vec{b}=\frac{1}{2}$$

$$\Rightarrow 2\left(\vec{a}\cdot\vec{b}\right)=1$$

(Q) $\vec{a}=(1,0,3), \vec{b}=(-1,3,4), \vec{c}=(1,2,1)$ and $\vec{d}=(k,2,5)$ are coplanar if

$$\left[\vec{d}\ \ \vec{b}\ \ \vec{c}\right]+\left[\vec{d}\ \ \vec{c}\ \ \vec{a}\right]+\left[\vec{d}\ \ \vec{a}\ \ \vec{b}\right]=\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right]$$

$$\Rightarrow \begin{vmatrix} k & 2 & 5 \\ -1 & 3 & 4 \\ 1 & 2 & 1 \end{vmatrix}+\begin{vmatrix} k & 2 & 5 \\ 1 & 2 & 1 \\ 1 & 0 & 3 \end{vmatrix}+\begin{vmatrix} k & 2 & 5 \\ 1 & 0 & 3 \\ -1 & 3 & 4 \end{vmatrix}=\begin{vmatrix} 1 & 0 & 3 \\ -1 & 3 & 4 \\ 1 & 2 & 1 \end{vmatrix}$$

⇒ k = –1.

(R) (1, 1, m), (1, 1, m + 1), (1, –1, m) are coplanar if

$$\begin{vmatrix} 1 & 1 & m \\ 1 & 1 & m+1 \\ 1 & -1 & m \end{vmatrix}=0 \Rightarrow \begin{vmatrix} 1 & 0 & m \\ 1 & 0 & m+1 \\ 1 & -2 & m \end{vmatrix}=0$$

⇒ 2 = 0 which is absurd.

∴ there is no value of m for which the vectors are coplanar.

(S) $\vec{a}\times\left(\vec{b}\times\vec{c}\right)=(\vec{a}\cdot\vec{c})\vec{b}-\left(\vec{a}\cdot\vec{b}\right)\vec{c}$

$\vec{b}\times(\vec{c}\times\vec{a})=\left(\vec{b}\cdot\vec{a}\right)\vec{c}-\left(\vec{c}\cdot\vec{b}\right)\vec{a}$

$\vec{c}\times\left(\vec{a}\times\vec{b}\right)=\left(\vec{c}\cdot\vec{b}\right)\vec{a}-(\vec{c}\cdot\vec{a})\vec{b}$

since dot product is commutative, so we have, the sum = 0

18. (P) Required probability $=\frac{1}{2}$.

(Q) Required probability $=\left(\frac{1}{2}\right)^3+\left(\frac{1}{2}\right)^4+\left(\frac{1}{2}\right)^4+\left(\frac{1}{2}\right)^4+\left(\frac{1}{2}\right)^4-\left(\frac{1}{2}\right)^7=\frac{47}{2^7}$.

(R) Required probability $=\frac{4}{2^7}$.

(S) There are five cases 0, 1, 2, 3 or 4 wins

Required probability $=\frac{1+7+15+10+1}{2^7}=\frac{34}{2^7}$.

19. $$\Delta=\begin{vmatrix}a^2 & a^2-(b-c)^2 & bc\\ b^2 & b^2-(c-a)^2 & ca\\ c^2 & c^2-(a-b)^2 & ab\end{vmatrix}\qquad C_2\to C_2-C_1$$

$$=-\begin{vmatrix}a^2 & (b-c)^2 & bc\\ b^2 & (c-a)^2 & ca\\ c^2 & (a-b)^2 & ab\end{vmatrix}\qquad C_2\to C_2+2C_3$$

$$=-\begin{vmatrix}a^2 & b^2+c^2 & bc\\ b^2 & c^2+a^2 & ca\\ c^2 & a^2+b^2 & ab\end{vmatrix}=-\left(a^2+b^2+c^2\right)\begin{vmatrix}1 & b^2+c^2 & bc\\ 1 & c^2+a^2 & ca\\ 1 & a^2+b^2 & ab\end{vmatrix}\qquad C_1\to C_1+C_2.$$

$$=-\left(a^2+b^2+c^2\right)\begin{vmatrix}0 & (b-a)(b+a) & c(b-a)\\ 0 & (c-b)(c+b) & a(c-b)\\ 1 & a^2+b^2 & ab\end{vmatrix}\qquad R_1\to R_1-R_2,\ R_2\to R_2-R_3$$

$=-(a^2+b^2+c^2)(b-a)(c-b)(a-c)(a+b+c)$

$=(a-b)(b-c)(c-a)(a+b+c)(a^2+b^2+c^2)$

$\Delta=(a-b)(b-c)(c-a)(a+b+c)(a^2+b^2+c^2)$

(P) If $a+b+c=0\ \Rightarrow \Delta=0$

Given system is homogeneous system, therefore infinite number of solutions will exist.

(Q) If $a=b=c=0$, then all three equation will be $0\,.\,x+0\,.\,y+0\,.\,z=0$

therefore any (x, y, z) will satisfy the given set of equations where $x, y, z\in R$.

(R) $a=b=c,\ a+b+c\neq 0$

then all three equations will come in form $x+y+z=0$

Solution of equation are $(\lambda_1, \lambda_2, -\lambda_1-\lambda_2)$

(S) $\Delta\neq 0$

⇒ only (0, 0, 0) is the solution. ⇒ unique solution.

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ALL INDIA INTEGRATED TEST SERIES

FIITJEE **JEE (Main), 2016**

PART TEST – IV

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 03 and 10 to 12)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (04 to 09 and 13 to 30) contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

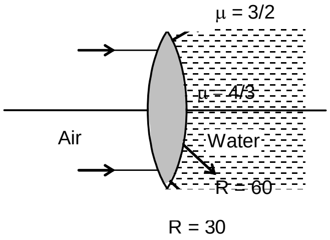
PART – I

SECTION – A

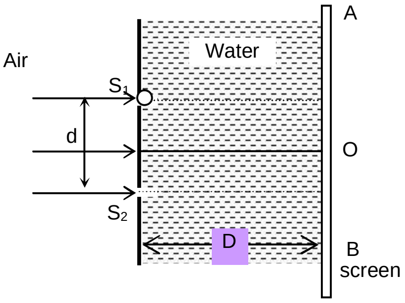
(Single Correct Choice Type)

This section contains ***30 multiple choice questions***. Each question has four choice (A), (B), (C) and (D) out of which ***ONLY ONE*** is correct.

1. A thin lens with radius of curvature 30 cm and 60 cm is placed with water on left side and air on right side, then the focal length of the lens for the parallel incident rays shown in the figure, is
(A) 72 cm (B) 144 cm
(C) 36 cm (D) none of these



2. Young's double slit experiment is submerged in water as shown in the figure. If an air bubble is formed on slit S_1, then the fringe pattern
(A) will shift towards A.
(B) will shift towards B.
(C) will not shift.
(D) can't say



3. A screw gauge used to determine the diameter of a wire has accuracy of the order of 0.001 cm. The same screw gauge is used to determine the radius of a wire as well as its length. If the length of the wire is found to be 2 cm and diameter is determined to be 0.5mm, the maximum percentage error accumulated in the resistance of the wire is
(A) 3.05 % (B) 3.1 %
(C) 4.05 % (D) 2.05 %

Space for rough work

4. A light of wavelength λ_1 is incident on a photoelectric plate. It is found that for certain potential difference the no. of photoelectrons reaching the collector plate is zero. When light of wavelength λ_2 is used, the no. of photoelectrons reaching the collector plate is zero at twice the above value of potential difference. The threshold wavelength for the photoelectric surface is

(A) $\frac{\lambda_1\lambda_2}{\lambda_2 - 2\lambda_1}$ (B) $\frac{2\lambda_1\lambda_2}{\lambda_2 - \lambda_1}$

(C) $\frac{\lambda_1\lambda_2}{\lambda_2 - \lambda_1}$ (D) $\frac{\lambda_1\lambda_2}{2\lambda_2 - \lambda_1}$

5. Consider two resistances R_1 (5 ± 0.2) Ω and R_2 = (10 ± 0.1) Ω. Find the ratio of their equivalent resistances when they are connected in series and in parallel, with proper error limits.

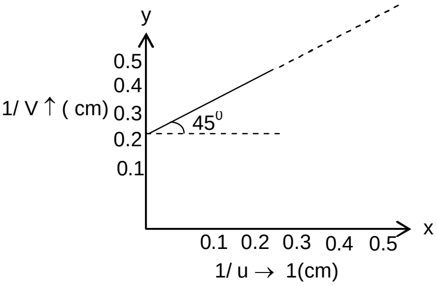
(A) (15 ± 0.5) (B) (4.5 ± 0.4)

(C) (15 ± 0.3) (D) (4.5 ± 0.5)

6. An experiment was conducted in the laboratory using a thin converging lens. The reciprocal of object distance (u) vs image distance (v) was plotted as shown. For the graph, the focal length of the lens used for the experiment, is

(A) 10 cm (B) 7.5 cm

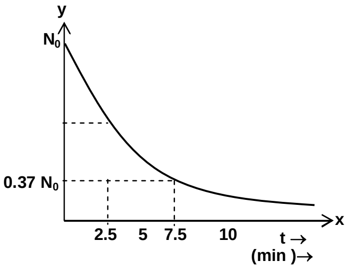
(C) 5 cm (D) 0.5 cm



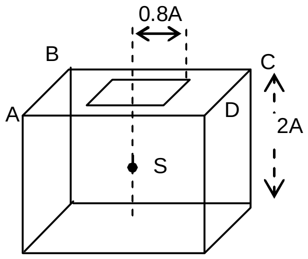
7. A radioactive sample undergoes decay as shown in the graph. Calculate the amount of sample left after 30 min. if initial amount of nuclei present is N_0, is

(A) N_0 / e^6 (B) N_0 / e^4

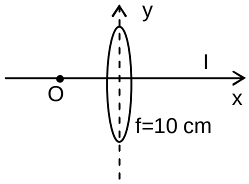
(C) N_0 / e^3 (D) N_0 / e^2



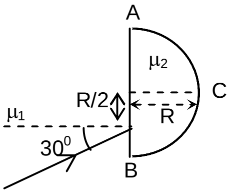
Space for rough work



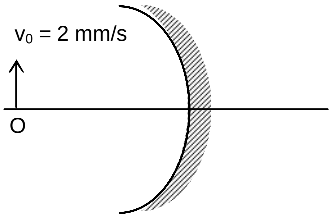
8. A cube of side 2A has a point source S at its centre. All the faces of the cube are blackened except the top surface which has got a square sheet of black paper of side 1.6 A. If the source starts oscillating inside a negligibly thin tunnel perpendicular to the direction of face ABCD, and having the mean position of oscillation at the centre of the ABC, then the maximum amplitude of oscillation so that the source may not be seen from the top surface is (Refractive index of material of cube $\mu = \sqrt{3.25}$. Assume black surface absorbs all light incident on it.)
(A) 0.1 A (B) 0.2 A
(C) 0.3 A (D) 0.4 A



9. An object is placed at a distance of 15 cm from converging lens of focal length 10 cm. Now if lens is displaced laterally (along y – axis) by 1 cm, the lateral shift of image will be
(A) 1 cm (B) 2 cm
(C) 3 cm (D) 4 cm.



10. A ray of light travelling in air (μ_1 = 1) strikes the surface AB of semicylindrical surface at an angle 30^0 from normal to the surface. If ray come out of slab parallel to itself from C, the refractive index (μ_2) of slab will be
(A) $\mu_2 = \frac{\sqrt{5}}{2}$ (B) $\mu_2 = \frac{\sqrt{5}}{\sqrt{2}}$
(C) $\frac{2\sqrt{5}}{3}$ (D) $\frac{4}{3}$



11. A point object placed at a distance of 15 cm in front of concave mirror of radius of curvature 20 cm. If object starts moving laterally at a speed of v_0 = 2 mm/s. as shown in the figure the lateral speed of image will be
(A) v = 1 mm/s (B) v = 2 mm/s
(C) v = 4 mm/s (D) none of these

Space for rough work

12. In Young's double slit experiment the maximum intensity obtained is I_0. The intensity at a point on screen where the phase difference between two interfering waves is $\pi/3$ is

(A) $I_0/4$ (B) $4I_0$

(C) I_0 (D) $\frac{3I_0}{4}$

13. An electron jumps from 7th orbit to 2nd orbit in an excited hydrogen like atom, the number of lines observed in the resulting spectrum is

(A) 10 (B) 15

(C) 12 (D) 8

14. A radionuclide Z is produced at constant rate k and decays with decay constant 'λ'. The maximum number of nuclei of radionuclide Z, (N_{max}) if number of nuclei of z are zero at t = 0,

(A) $N_{max} = \frac{\lambda}{k}$ (B) $N_{max} = \frac{k}{2\lambda}$

(C) $N_{max} = \frac{2k}{\lambda}$ (D) $N_{max} = \frac{k}{\lambda}$

15. A light of wavelength 280 nm is used in an experiment on photoelectric surface of lithium (ϕ = 2.5 eV) as cathode. The kinetic energy of electron coming out of cathodes cannot be equal to

(A) 1 eV (B) zero

(C) 2.4 eV (D) 1.9 eV

16. An element ${}_ZX^A$ undergoes n α - emissions followed by m β - emissions. If element formed is ${}_{z-2}X^{A-8}$, then

(A) n = 2, m = 4 (B) n = 4, m = 4

(C) n = 2, m = 2 (D) n = 4, m = 2

17. In Young's double slit experiment the angular fringe width for given light is $\Delta\theta$. Now if wavelength of light is doubled while distance between slit is halved, the angular fringe width will become

(A) $\frac{\Delta\theta}{2}$ (B) $\Delta\theta$

(C) $4\Delta\theta$ (D) $\frac{\Delta\theta}{4}$

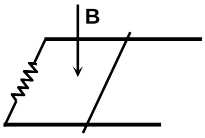
Space for rough work

18. The relation between the wavelength of radiation (λ) and the principal quantum no. n, when an electron jumps from $(n-1)^{th}$ orbit to n^{th} orbit [Assume n is large]

(A) $\lambda \propto n$ (B) $\lambda \propto n^2$

(C) $\lambda \propto n^3$ (D) $\lambda \propto n^4$

19. Two parallel rails of negligible resistances are fixed on a horizontal surface. One end of the rails are connected by a resistance R as shown in the figure. There is a uniform magnetic field B perpendicular to the plane of the rails. A sliding wire of negligible resistance, length ℓ and mass m can slide on the rails. The coefficient of friction between the rails and wire is μ. The minimum force required to move the wire with uniform velocity v is



(A) $\mu mg + \frac{B^2\ell^2}{R}v$ (B) $\frac{B^2\ell^2}{R}v$

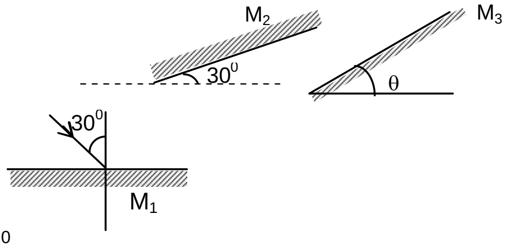
(C) $\frac{\mu mg}{\sqrt{\mu^2+1}} + \frac{B^2\ell^2}{R}\frac{v}{\sqrt{\mu^2+1}}$ (D) None of these

20. The length of a strip measured with metre rod is 10.0 cm. Its width measured with verniers callipers is 1.00 cm. The least count of metre rod is 0.1 cm and that of vernier callipers is 0.01 cm. the error in the measurement of its area is

(A) ± 0.01 cm^2 (B) ± 0.1 cm^2

(C) ± 0.11 cm^2 (D) ± 0.2 cm^2

21. M_1, M_2 and M_3 are plane mirror arranged as shown in the figure. A ray of light is incident on the mirror M_1 at an angle of 30^0 with the normal. It is observed that the ray of light after suffering reflection with M_1 followed by M_2 and M_3 emerges vertically upwards. The angle of inclination of mirror M_3 if M_2 is kept inclined at 30^0 to the horizontal is

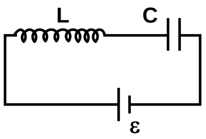


(A) 25^0 (B) 35^0

(C) 45^0 (D) 30^0

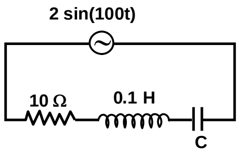
Space for rough work

22. An inductor L and uncharged capacitor C is connected to a cell of emf ε as shown in the figure. At t = 0, the switch is closed. Find charge on the capacitor q as a function of time t.



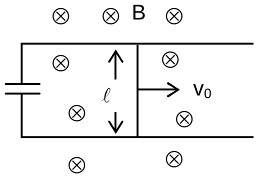
(A) $q = C\varepsilon \sin\left(\sqrt{\frac{1}{LC}}t\right)$
(B) $q = C\varepsilon \cos\left(\sqrt{\frac{1}{LC}}\, t\right)$
(C) $q = C\varepsilon\left[1-\cos\sqrt{\frac{1}{LC}}\, t\right]$
(D) $q = C\varepsilon\left[1-\sin\sqrt{\frac{1}{LC}}\, t\right]$

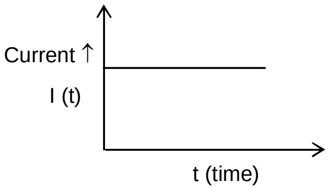
23. The power factor of the circuit is $1/\sqrt{2}$. The capacitance of the circuit is equal to

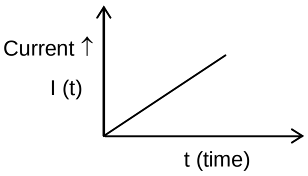


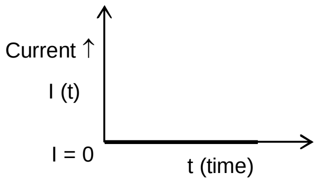
(A) 400 μF
(B) 300 μF
(C) 500 μF
(D) 200 μF

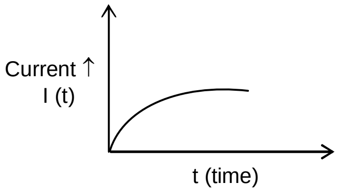
24. Two infinitely long conducting parallel rails are connected through a capacitor of capacitance C as shown in the figure. A perfect conductor of length ℓ is moved with constant speed v_0. Which of the following graph truly depicts the variation of current *through* the conductor with time ?



(A)


(B)


(C)


(D)


Space for rough work

25. Light from a monochromatic source is incident normally on a small photo sensitive surface having surface area S and work function ϕ. If power of source is k and a is the distance between source and the surface then

(i) number of photons striking the surface per unit time will be $\frac{k\lambda S}{4\pi hca^2}$

(ii) maximum energy of the emitted electrons will be $\frac{1}{\lambda}(hc - \lambda\phi)$

(iii) stopping potential needed to stop the most energetic photoelectrons will be $\frac{e}{\lambda}(hc - \lambda\phi)$

(iv) photo emission occurs only if $0 < \lambda \le \frac{hc}{\phi}$

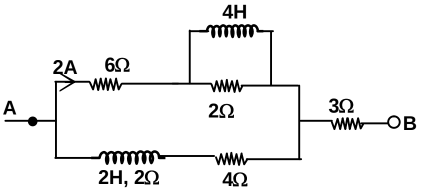
(A) (i) and (ii) are true.	(B) (ii) and (iii) are true.
(C) (i), (ii) and (iv) are true.	(D) (i), (ii) and (iii) are true.

26. If the potential energy of proton & electron of a hypothetical hydrogen like atom is given by $U = -\frac{he^2}{2r}$ where e = charge of electron and r is the radius of atom, then the radius of Bohr's first orbit is given by (Mass of electron is m_e)

(A) $\frac{h^2}{2\pi^2 me^2}$	(B) $\frac{h}{2\pi^2 me^2}$
(C) $\frac{e^2h^2}{2\pi^2 m}$	(D) $\frac{h}{4\pi^2 me^2}$

27. Find $V_A - V_B$ in steady state in figure shown below

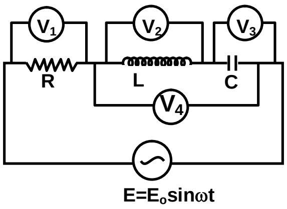
(A) 8 V	(B) 24 V
(C) 16 V	(D) none



Space for rough work

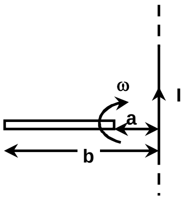
28. In the given figure, which voltmeter will read zero voltage at resonant frequency ω rad/sec?

(A) V_1
(B) V_2
(C) V_3
(D) V_4



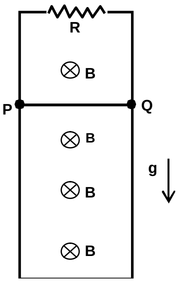
29. A copper rod moves with a constant angular velocity ω, about a long straight wire carrying a current I. If the ends of the rod from the wire are at distances a and b, then the e.m.f. induced in the rod is

(A) $\frac{\mu_0 i(\omega a)}{2\pi}\ln\left(\frac{b}{a}\right)$
(B) $\frac{\mu_0 i(\omega b)}{2\pi}\ln\left(\frac{b}{a}\right)$
(C) zero
(D) $\frac{\mu_0 i\omega(a+b)}{4\pi}\ln\left(\frac{b}{a}\right)$



30. A rod PQ mass 'm' and length ℓ can slide without friction on two vertical conducting semi infinite rails. It is given a velocity V_0 downwards, so that it continues to move downward with the same speed V_0 on its own at any later instant of time. Assuming g to be constant every where, the value of $\frac{V_0 B^2 L^2}{mgR}$ is

(A) 1
(B) 2
(C) 3
(D) 4



Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which only one is correct.

1. A mixture contains 1 mole of volatile liquid A (P_A° = 100 mm Hg) and 3 moles of volatile liquid B(P_B° = 80 mm Hg). If solution behaves ideally, the total vapour pressure of the distillate is
(A) 85 mm Hg
(B) 85.88 mm Hg
(C) 90 mm Hg
(D) 92 mm Hg

2. 0.04 M Na_2SO_4 solution is isotonic with 0.1 M glucose at the same temperature. What is the apparent degree of dissociation of Na_2SO_4?
(A) 0.25
(B) 0.50
(C) 0.75
(D) 0.85

3. When mercuric iodide is added to the aqueous solution of potassium iodide, the
(A) freezing point is raised.
(B) freezing point does not change.
(C) freezing point is lowered.
(D) boiling point does not change.

4. A 0.001 molal solution of $Pt(NH_3)_4Cl_4$ in water had a freezing point depression of 0.0054°C. If K_f for water is 1.80, the correct formula for the above compound assuming its complete dissociation is
(A) $[Pt(NH_3)_4Cl_3]Cl$
(B) $[Pt(NH_3)_4Cl_2]Cl_2$
(C) $[Pt(NH_3)_4Cl]Cl_3$
(D) $[Pt(NH_3)_4Cl_4]$

5. Yellow ammonium sulphide is a suitable reagent for the separation of
(A) Bi_2S_3 and CuS
(B) PbS and Bi_2S_3
(C) HgS and PbS
(D) CdS and As_2S_3

Space for rough work

6. An aqueous solution of a substance gives a white precipitate on treatment with dilute hydrochloric acid, which dissolved on heating. When hydrogen sulphide is passed through the hot acidic solution, a black precipitate is obtained. The substance is
(A) Hg_2^{2+} salt (B) Cu^{2+} salt
(C) Ag^+ salt (D) Pb^{2+} salt

7. Ammonium compound on heating produced a gas which gives white fumes when a rod dipped in HCl is brought in contact with the gas. Which one of the following will not produce the gas on heating?
(A) $(NH_4)_2SO_4$ (B) $(NH_4)_2SO_3$
(C) NH_4NO_2 (D) NH_4Cl

8. $H_2C_2O_4 \xrightarrow{H_2SO_4} A(gas) + B(gas) + C(liquid)$ oxalic acid
Gas (A) burns with blue flame and is oxidized to gas (B). Gas (B) turns lime water milky
(A), (B) & (C) are respectively
(A) CO_2, CO, H_2O (B) CO, CO_2, H_2O
(C) CO, SO_2, H_2O (D) SO_2, CO, H_2O

9. A solid compound AB has NaCl structure. If the radius of the cation is 100 pm, the radius of anion 'B' is
(A) 241.5 pm (B) 141.5 pm
(C) 41.5 pm (D) 21.5 pm

10. 0.1 M $Cr_2O_7^{2-}$ will be a better oxidizing agent in which of the following solution?
(A) 10 ml of 1 M CH_3COOH + 10 ml of 1 M NH_4OH
(B) 100 ml of 0.1 M NaOH + 100 ml of 0.1 M HCl
(C) 50 ml of 0.1 M HCl
(D) 100 ml of 10^{-7} M HCl

11. A cell made up of two hydrogen electrodes. The positive electrode is in contact with a solution of 10^{-4} M hydrogen ions. The emf of the cell is 0.118 V at 25°C. The concentration of hydrogen ions at negative electrode is
(A) 10^{-6} M (B) 10^{-4} M
(C) 10^{-2} M (D) None of the above

Space for rough work

12. One litre of 1 M $CuSO_4$ solution is electrolysed using copper and inert electrodes respectively. After passing 2F of electricity, molarity of $CuSO_4$ respectively, will be

(A) $\frac{M}{2}$, M (B) $\frac{M}{4}$, 0

(C) M, $\frac{M}{2}$ (D) M, 0

13. Equilibrium constant for the dissociation of $Ag(NH_3)_2^+$ into Ag^+ and NH_3 is 6 × 10^{-8}. Calculate E^o for the following half reaction, $Ag(NH_3)_2^+ + e^- \longrightarrow Ag(s) + 2NH_3$

$(E^o_{Ag^+/Ag} = 0.799\text{ V},\ \log 6 = 0.7781)$.

(A) 0.372 (B) 0.799

(C) 0.7781 (D) 0.6

14. The composition of a sample of Wustite is $Fe_{0.93}O$. What is the percentage of iron present as Fe^{3+}?

(A) 15% (B) 25%

(C) 35% (D) 45%

15. In a compound AB the ionic radii of A^+ and B^- are 88 pm and 200 pm respectively the coordination number of A^+ is

(A) 6 (B) 8

(C) 4 (D) 12

16. Radius ratio $\frac{r^+}{r^-} = \frac{88}{200} = 0.44$. This corresponds to co-ordiation number 6. 20. Bridging bonds in diborane are

(A) 3 centre – 4 electrons (B) 2 centre – 3 electrons

(C) 3 centre – 2 electrons (D) 3 centre – 3 electrons

17. The incorrect statement regarding ClO_2 molecule is that

(A) it contains odd number of electrons and hence paramagnetic.

(B) ClO_2 dimerises.

(C) the Cl – O bond length is shorter than the single Cl – O bond length.

(D) it is a highly reactive species.

Space for rough work

18. Aqueous sodium hydroxide reacts with white phosphorus to form phosphine and

(A) NaH_2PO_3	(B) P_2O_5
(C) Na_3PO_3	(D) P_2O_3

19. Pick out the incorrect statement with respect to SO_3
    (A) In solid state SO_3 exists as cyclic trimer in which four oxygen atoms are arranged approximately tetrahedrally around each S atom
    (B) In presence of moisture cyclic trimer changes into linear polymerized structure
    (C) It reacts explosively with H_2O to form H_2SO_4
    (D) It does not react with HBr

20. Van Arkel method of purification of metals involves converting the metal to a:

(A) volatile stable compound.	(B) non-volatile stable compound.
(C) volatile unstable compound.	(D) none of these.

21. The ore carnallite is represented by structure

(A) Na_3AlF_6	(B) $Na_2Al_2O_3$
(C) Fe_3O_4	(D) $KCl.MgCl_2.6H_2O$

22. Auto reduction process is used for the extraction of

(A) Hg	(B) Pb
(C) Cu	(D) All of these

23. Pb and Sn are extracted from their chief ore respectively by

(A) Carbon reduction and self reduction	(B) Self reduction and carbon reduction
(C) Electrolysis and self reduction	(D) Self reduction and electrolysis

24. Pink colour of $KMnO_4$ is due to

(A) d – d transition	(B) metal to ligand transition
(C) ligand to metal transition	(D) All the above

Space for rough work

25. In which compound does vanadium have on oxidation number of +4?
(A) NH_4VO_2 (B) $K_4[V(CN)_6]$
(C) VSO_4 (D) $VOSO_4$

26. The yellow colour solution of Na_2CrO_4 changes to orange red on passing CO_2 gas due to the formation of
(A) CrO_5 (B) CrO_3
(C) $Na_2Cr_2O_7$ (D) Cr_2O_3

27. Considering H_2O as a weak field ligand, the number of unpaired electrons in $[Mn(H_2O)_6]^{2+}$ will be
(A) Two (B) Four
(C) Three (D) Five

28. The smog is essentially caused by presence of
(A) O_2 and O_3 (B) O_3 and N_2
(C) oxides of sulphur and nitrogen (D) O_2 and N_2

29. Which molecule has tetrahedral geometry?
(A) $[Co(NH_3)_6]^{3+}$ (B) $[Ni(CN)_4]^{2+}$
(C) $Fe(CO)_5$ (D) $[NiCl_4]^{2-}$

30. Which of the following is wrong in the given statements?
(A) Coordination number of Cl^- in CsCl structure is 8.
(B) Ca^{+2} is present in tetrahedral voids of the cubic closed packed structure of F^-
(C) O^{-2} is present in the body centre of cube formed by Na^+ ions
(D) In NaCl schottky defect are observed.

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains 30 multiple choice questions numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. The vectors $\vec{a}, \vec{b}$ and $\vec{c}$ are of the same length and taken pairwise, they form equal angles. If $\vec{a} = \hat{i} + \hat{j}$ and $\vec{b} = \hat{j} + \hat{k}$, then the co-ordinates of $\vec{c}$ are
(A) (1, 0, 1)
(B) (1, 2, 3)
(C) (–1, 1, 2)
(D) None of these

2. The value of c so that for all real x, the vectors $cx\hat{i} - 6\hat{j} + 3\hat{k}$, $x\hat{i} + 2\hat{j} + 2cx\hat{k}$ make an obtuse angle are
(A) $c < 0$
(B) $0 < c < \frac{4}{3}$
(C) $-\frac{4}{3} < c < 0$
(D) $c > 0$

3. $\vec{a}, \vec{b}, \vec{c}$ are three non-zero, non-coplanar vectors and $\vec{p}, \vec{q}, \vec{r}$ are three other vectors such that $\vec{p} = \frac{\vec{b} \times \vec{c}}{\vec{a}.\vec{b} \times \vec{c}}, \vec{q} = \frac{\vec{c} \times \vec{a}}{\vec{a}.\vec{b} \times \vec{c}}, \vec{r} = \frac{\vec{a} \times \vec{b}}{\vec{a}.\vec{b} \times \vec{c}}$. Then $[\vec{p}\,\vec{q}\,\vec{r}]$ equals
(A) $\vec{a} . \vec{b} \times \vec{c}$
(B) $\frac{1}{\vec{a}.\vec{b} \times \vec{c}}$
(C) 0
(D) None of these

Space for rough work

4. If S is the circumcentre, G the centroid, O the orthocentre of a triangle ABC, then $\overrightarrow{SA}+\overrightarrow{SB}+\overrightarrow{SC}=$

(A) $\overrightarrow{SG}$ (B) $\overrightarrow{OS}$

(C) $\overrightarrow{SO}$ (D) $\overrightarrow{OG}$

5. If $\vec{a},\vec{b},\vec{c}$ are three non-coplanar vectors such that volume of parallelopiped formed with $\vec{a},\vec{b},\vec{c}$ as coterminous edges is equal to volume of parallelepiped formed with $\vec{a}\times\vec{b}$, $\vec{b}\times\vec{c}$, $\vec{c}\times\vec{a}$ as coterminous edges then $\left[\vec{a}\ \vec{b}\ \vec{c}\right]$ may be

(A) $[\vec{a}\vec{b}\vec{c}] = 0$ (B) $[\vec{a}\vec{b}\vec{c}] = 1$

(C) $[\vec{a}\vec{b}\vec{c}] = -2$ (D) $[\vec{a}\vec{b}\vec{c}] = 2$

6. If $\vec{a}$ and $\vec{b}$ are two unit vectors, then the vector $\left(\vec{a}+\vec{b}\right)\times\left(\vec{a}\times\vec{b}\right)$ is parallel to the vector

(A) $\vec{a}-\vec{b}$ (B) $\vec{a}+\vec{b}$

(C) $2\vec{a}-\vec{b}$ (D) $2\vec{a}+\vec{b}$

7. The point of intersection of the lines $\frac{x+1}{3}=\frac{y+3}{5}=\frac{z+5}{7}$ and $\frac{x-2}{1}=\frac{y-4}{3}=\frac{z-6}{5}$ is

(A) $\left(\frac{1}{2},\frac{1}{2},-\frac{3}{2}\right)$ (B) $\left(-\frac{1}{2},-\frac{1}{2},\frac{3}{2}\right)$

(C) $\left(\frac{1}{2},-\frac{1}{2},-\frac{3}{2}\right)$ (D) $\left(-\frac{1}{2},\frac{1}{2},\frac{3}{2}\right)$

8. The angle between the line $\frac{x+1}{3}=\frac{y-1}{2}=\frac{z-2}{4}$ and the plane $2x+y-3z+4=0$, is

(A) $\sin^{-1}\left(\frac{4}{\sqrt{406}}\right)$ (B) $\sin^{-1}\left(\frac{-4}{\sqrt{406}}\right)$

(C) $\sin^{-1}\left(\frac{4}{14\sqrt{229}}\right)$ (D) None of these

Space for rough work

9. The equation of the plane in which the lines $\frac{x-5}{4}=\frac{y-7}{4}=\frac{z+3}{-5}$ and $\frac{x-8}{7}=\frac{y-4}{1}=\frac{z-5}{3}$ lie, is

(A) $17x-47y-24z+172=0$ (B) $17x+47y-24z+172=0$

(C) $17x+47y+24z+172=0$ (D) $17x-47y+24z+172=0$

10. The direction ratios of the lines $\overline{OA}$ and $\overline{OB}$ are 1, –2, –1 and 3, –2, 3. Then the direction cosines of the normal of plane AOB where O is the origin, are

(A) $\left(\frac{4}{\sqrt{29}},\frac{3}{\sqrt{29}},\frac{-2}{\sqrt{29}}\right)$ (B) $\left(\frac{2}{\sqrt{29}},-\frac{3}{\sqrt{29}},\frac{4}{\sqrt{29}}\right)$

(C) $\left(-\frac{4}{\sqrt{29}},\frac{2}{\sqrt{29}},\frac{3}{\sqrt{29}}\right)$ (D) $\left(\frac{4}{\sqrt{29}},\frac{2}{\sqrt{29}},\frac{-3}{\sqrt{29}}\right)$

11. The length of projection, of the line segment joining the points (1, –1, 0) and (–1, 0, 1), to the plane 2x + y + 6z = 1, is equal to

(A) $\sqrt{\frac{255}{61}}$ (B) $\sqrt{\frac{237}{61}}$

(C) $\sqrt{\frac{137}{61}}$ (D) $\sqrt{\frac{155}{61}}$

12. Reflection of the line $\frac{x-1}{-1}=\frac{y-2}{3}=\frac{z-4}{1}$ in the plane x + y + z = 7 is

(A) $\frac{x-1}{3}=\frac{y-2}{1}=\frac{z-4}{1}$ (B) $\frac{x-1}{-3}=\frac{y-2}{-1}=\frac{z-4}{1}$

(C) $\frac{x-1}{-3}=\frac{y-2}{1}=\frac{z-4}{-1}$ (D) $\frac{x-1}{3}=\frac{y-2}{1}=\frac{z+4}{1}$

13. A man alternately tosses a coin and throws a dice beginning with the coin. The probability that he gets a head in the coin before he gets a 5 or 6 in the dice is

(A) 3/4 (B) 1/2

(C) 1/3 (D) None of these

Space for rough work

14. Let p denotes the probability that a man aged x years will die in a year. The probability that out of n men $A_1, A_2, A_3......A_n$ each aged x, A_1 will die in a year and will be the first to die,

(A) $\frac{1}{n}[1-(1-p)^n]$
(B) $[1-(1-p)^n]$
(C) $\frac{1}{n-1}[1-(1-p)^n]$
(D) None of these

15. One hundred identical coins each with probability p of showing up heads are tossed once. If $0 < p < 1$ and the probability of heads showing on 50 coins is equal to that of heads showing on 51 coins, then the value of p is

(A) $\frac{1}{2}$
(B) $\frac{49}{101}$
(C) $\frac{50}{101}$
(D) $\frac{51}{101}$

16. A man takes a step forward with probability 0.4 and backward with probability 0.6. The probability that at the end of eleven steps he is one step away from the starting point is

(A) ${}^{11}C_6\,(0.24)^5$
(B) ${}^{11}C_6(0.4)^6(0.6)^5$
(C) ${}^{11}C_6(0.6)^6\,(0.4)^5$
(D) None of these

17. A random variable X has Poisson's distribution with mean 2. Then $P(X > 1.5)$ equals

(A) $1-\frac{3}{e^2}$
(B) $\frac{3}{e^2}$
(C) $\frac{2}{e^2}$
(D) 0

Space for rough work

18. If $1, \omega, \omega^2$ are the cube roots of unity, then $\Delta = \begin{vmatrix} 1 & \omega^n & \omega^{2n} \\ \omega^n & \omega^{2n} & 1 \\ \omega^{2n} & 1 & \omega^n \end{vmatrix}$ is equal to

(A) 0 (B) 1

(C) ω (D) ω^2

19. Matrix A is such that $A^2 = 2A - I$, where I is the identity matrix. Then for $n \geq 2, A^n =$

(A) $nA - (n-1)I$ (B) $nA - I$

(C) $2^{n-1}A - (n-1)I$ (D) $2^{n-1}A - I$

20. If $a_1, a_2, a_3 .....a_n....$ are in G.P. then the value of the determinant $\begin{vmatrix} \log a_n & \log a_{n+1} & \log a_{n+2} \\ \log a_{n+3} & \log a_{n+4} & \log a_{n+5} \\ \log a_{n+6} & \log a_{n+7} & \log a_{n+8} \end{vmatrix}$ is

(A) – 2 (B) 1

(C) 2 (D) 0

21. If value of a third order determinant is 11, then the value of the square of the determinant formed by the cofactors will be

(A) 11 (B) 121

(C) 1331 (D) 14641

22. If $F(\alpha) = \begin{bmatrix} \cos\alpha & -\sin\alpha & 0 \\ \sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 1 \end{bmatrix}$ and $G(\beta) = \begin{bmatrix} \cos\beta & 0 & \sin\beta \\ 0 & 1 & 0 \\ -\sin\beta & 0 & \cos\beta \end{bmatrix}$, then $[F(\alpha)G(\beta)]^{-1} =$

(A) $F(\alpha) - G(\beta)$ (B) $-F(\alpha) - G(\beta)$

(C) $[F(\alpha)]^{-1}[G(\beta)]^{-1}$ (D) $[G(\beta)]^{-1}[F(\alpha)]^{-1}$

Space for rough work

23. For how many value (s) of x in the closed interval $[-4, -1]$ is the matrix $\begin{bmatrix} 3 & -1+x & 2 \\ 3 & -1 & x+2 \\ x+3 & -1 & 2 \end{bmatrix}$ singular

(A) 2
(B) 0
(C) 3
(D) 1

24. The area bounded by $x = x_1$, $y = y_1$ and $y = -(x + 1)^2$ where x_1, y_1 are the values of x, y satisfying the equation $\sin^{-1}x + \sin^{-1}y = -\pi$ will be, (nearer to origin).

(A) $\frac{1}{3}$
(B) $\frac{2}{3}$
(C) 1
(D) $\frac{3}{2}$

25. Let f(x) = x + sin x. The area bounded by $y = f^{-1}(x), y = x, x \in [0, \pi]$ is

(A) 1
(B) 2
(C) 3
(D) canot be found because $f^{-1}(x)$ cannot be determined

26. The area of the smaller region in which the curve $y = \left[\frac{x^3}{100} + \frac{x}{50}\right]$ where [.] denotes the greatest integer function, divides the circle $(x - 2)^2 + (y + 1)^2 = 4$, is equal to

(A) $\frac{2\pi - 3\sqrt{3}}{3}$ sq. units
(B) $\frac{3\sqrt{3} - \pi}{3}$ sq. units
(C) $\frac{4\pi - 3\sqrt{3}}{3}$ sq. units
(D) $\frac{5\pi - 3\sqrt{3}}{3}$ sq. units

Space for rough work

27. Let f(x) be a continuous function such that the area bounded by the curve y = f(x), the x-axis and the two ordinates x = 0 and x = a is $\frac{a^2}{2}+\frac{a}{2}\sin a+\frac{\pi}{2}\cos a$ then $f\left(\frac{\pi}{2}\right)$ is

(A) $\frac{1}{2}$ (B) $\frac{\pi^2}{8}+\frac{\pi}{4}$

(C) $\frac{\pi+1}{2}$ (D) $\frac{\pi^2}{8}-\frac{\pi}{4}$

28. The area bounded by the curve $y=\sqrt{\sin[x]+[\sin x]}$, lines $x=1,\ x=\frac{4}{3}$ and x-axis is

(A) $\sqrt{\sin 1}$ Sq.units (B) $\frac{1}{3}\sqrt{\sin 1}$ Sq.units

(C) $\frac{4}{3}\sqrt{\sin 1}$ Sq.units (D) None of these

29. Let $f:[0,\infty)\to R$ be a continuous and strictly increasing function such that $f^3(x)=\int_0^x t.f^2(t)dt, \forall x>0$. The area enclosed by $y=f(x)$, the x-axis and the ordinate at x=3, is

(A) 1 (B) $\frac{3}{2}$

(C) 2 (D) 3

30. The order of the differential equation whose general solution is given by $y=(c_1+c_2)\cos(x+c_3)-c_4e^{x+c_5}$, where c_1, c_2, c_3, c_4, c_5 are arbitrary constants, is

(A) 5 (B) 4

(C) 3 (D) 2

Space for rough work

FIITJEE

JEE(Main)-2016

ALL INDIA INTEGRATED TEST SERIES

FIITJEE Students From All Programs have bagged 33 in Top 100, 77 in Top 200 and 205 in Top 500 All India Ranks. FIITJEE Performance in JEE (Advanced), 2015:
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ANSWERS, HINTS & SOLUTIONS

PART TEST– IV
(MAIN)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	D	B	A
2.	B	C	C
3.	C	A	B
4.	D	B	C
5.	B	D	B
6.	C	D	A
7.	B	C	C
8.	B	B	B
9.	C	A	A
10.	A	C	A
11.	C	A	B
12.	D	D	C
13.	B	A	A
14.	D	A	A
15.	C	A	D
16.	C	C	A
17.	C	B	A
18.	C	A	A
19.	C	D	A
20.	D	A	D
21.	C	D	D
22.	C	D	D
23.	C	D	D
24.	C	C	B
25.	C	D	B
26.	B	C	C
27.	B	D	A
28.	D	C	B
29.	C	D	B
30.	A	C	C

HINTS AND SOLUTION

Physics

PART – I

1. $$\frac{3}{2v}-\frac{1}{\infty}=\frac{3/2-1}{30}$$

$\therefore$ v = + 90 cm

$$\frac{4}{3f}-\frac{3}{2\times 90}=\frac{(4/3)-(3/2)}{-60}$$

$\therefore$ f $\approx$ 69 cm.

2. Refractive index of bubble with respect to water is less than 1. So shifting of the fringe pattern would be towards B.

3. $R = \rho\frac{\ell}{A} = \rho\ \frac{\ell}{\pi d^2/4}$

$R = \frac{4\rho\ell}{\pi d^2}$

$$\frac{\Delta R}{R}\times 100=\left(\frac{\Delta\ell}{\ell}+2\frac{\Delta d}{d}\right)\times 100 = 4.05\ \%$$

4. use $ev = \frac{hc}{\lambda}+W$

6. $$\frac{1}{V}-\frac{1}{U}=\frac{1}{f}$$

$y=\frac{1}{V}$, $x=\frac{1}{U}$, $c = \frac{1}{f}$

$y - x = c$

$y = x + c$

Intercept

c = 0.2 /cm from graph

$f = \frac{1}{c} = 5\text{cm}$

7. Time at which no. of un-decayed nuclei become 0.37 N_0 is equal to the mean life of the sample.

$t_{av} = \frac{1}{\lambda}$

$7.5 = \frac{1}{\lambda}$

$\lambda = \frac{1}{7.5}$ / min.

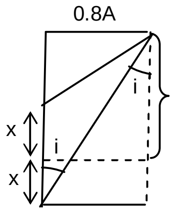
$N = N_0\, e^{-\lambda t} = N_0\ e^{-\left(\frac{1}{7.5}\right)\times 30} = N_0\, e^{-4}$

$N = \frac{N_0}{e^4}$

8. $$\frac{\sin i}{\sin 90}=\frac{1}{\sqrt{3.25}}$$

$$\sin i = \frac{1}{\sqrt{3.25}}$$

$$= \frac{0.8A}{\sqrt{(A+x)^2 + (0.8A)^2}} = \frac{1}{\sqrt{3.25}}$$



$$\therefore \quad \frac{0.64A^2}{(A+x)^2 + (0.8A)^2} = \frac{1}{3.25}$$

$x^2 + 2Ax - 0.44\,A^2 = 0$

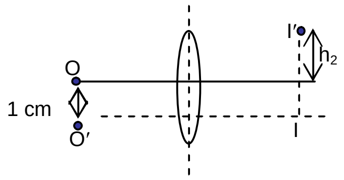
$x = 0.2\,A$

9. $\frac{1}{v} - \frac{1}{-15} = \frac{1}{10}$

$\Rightarrow$ v = 30 cm.

$m = \frac{v}{u} = -2 = \frac{h_2}{-1}$

Shift of image = II′ = (2 + 1) = 3 cm.

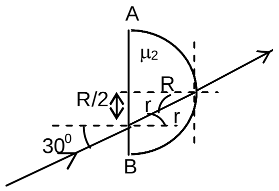


10. $\mu_1 \sin 30 = \mu_2 \sin r$

$\mu_1 = 1$ and $\tan r = \frac{1}{2}$

$\Rightarrow \sin r = \frac{1}{\sqrt{5}}$

$\Rightarrow \mu_2 = \frac{1/2}{1/\sqrt{5}} = \frac{\sqrt{5}}{2}$



11. $\frac{1}{u} + \frac{1}{v} = \frac{2}{R}$

$\Rightarrow \frac{1}{-15} + \frac{1}{v} = -\frac{1}{10}$

$\Rightarrow$ v = –30 cm.

$$v_I = \left|\frac{dh_2}{dt}\right| = \left|-\frac{v}{u}\frac{dh_1}{dt}\right| = \left|-\frac{v}{u}.v_0\right| = \left|\frac{30}{15} \times 2\right| = 4\,mm/s.$$

12. Resultant intensity is

$I_R = 4I \cos^2 \phi/2$

$I_{max} = I_0 = 4I$

$I_R = I_0 \cos^2 (\pi/6) = \frac{3I_0}{4}$

13. Number of lines obtained $= \frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2}$ $\quad n_2 = 7$

$= \frac{(7-2)(5+1)}{2} = 15$ $\quad n_1 = 2$

14. Number of nuclei of z will increase till the rates will become equal

i.e. $k = \lambda N_{max}$ or $k - \lambda N = \frac{dN}{dt}$,

$\Rightarrow$ $N_{max} = \frac{k}{\lambda}$

15. Maximum K.E. of the photoelectron is

$$KE_{max} = \frac{hc}{\lambda} - \phi$$

$$= \frac{1242eV - nm}{280nm} - 2.5eV = 1.9\ eV$$

since $0 \le$ k.E. ≤ 1.9 eV

$\therefore$ K.E. $\neq 2.4$ eV.

16. $_zX^A \rightarrow {}_{z-2}X^{A-8} + n\,{}_2He^4 + m\,{}_{-1}\beta^0$

4n = 8

2n – m = 2

n = 2, m = 2

17. Angular fringe width

$$= \Delta\theta = \frac{\lambda}{d}$$

If $\lambda \rightarrow 2\lambda$ & $d \rightarrow d/2$

then new fringe width $= \frac{4\lambda}{d} = 4\Delta\theta$

18. $$\frac{hc}{\lambda} = z^2Rhc\left(\frac{1}{(n-1)^2} - \frac{1}{n^2}\right)$$

$\Rightarrow$ $\lambda \propto n^3$

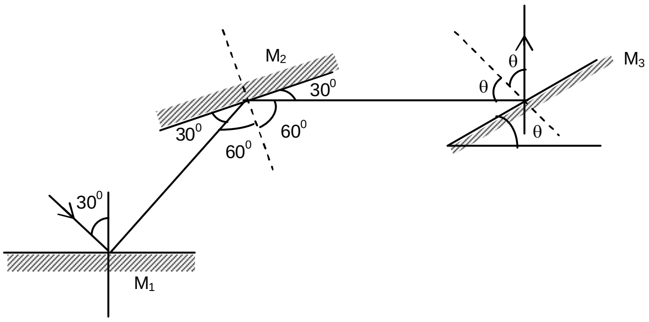
20. $$\frac{\Delta A}{A} = \frac{\Delta \ell}{\ell} + \frac{\Delta b}{b}$$

$$\Delta A = \left(\frac{0.1}{10.0} + \frac{0.01}{1.00}\right) \times (10.0 \times 1.00)cm^2 = 0.2\ cm^2$$

21. $\theta + \theta = 90^0$

$2\theta = 90^0$

$\theta = 45^0$



25. Energy received at photo sensitive surface per unit time $= \frac{ks}{4\pi a^2}$

Number of photons = $\dfrac{\frac{ks}{4\pi a^2}}{\frac{hc}{\lambda}} = \dfrac{k\lambda s}{4\pi hca^2}$

Maximum energy = $\left(\dfrac{hc - \lambda\phi}{\lambda}\right)$

26. $F = -\dfrac{dU}{dr} = \dfrac{he^2}{2r^2}$ . . . (i)

$F = \dfrac{mv^2}{r} = \dfrac{he^2}{2r^2}$ . . . (ii)

Also $mvr = \dfrac{h}{2\pi}$ . . . (iii)

$\therefore$ solving equation we get $r = \dfrac{h}{2\pi^2 me^2}$.

Chemistry PART – II

1. Total pressure of a mixture of 2 volatile liquids is given by

$P_{Total} = P_A^\circ X_A + P_B^\circ X_B = \left(100 \times \frac{1}{4}\right) + \left(80 \times \frac{3}{4}\right)$ = (25 + 60) = 85 mm Hg

Mole fraction of A in the vapour phase (X'_A) is given by

$$X'_A = \frac{P_A}{P_T} = \frac{\left(100 \times \frac{1}{4}\right)}{85} = \frac{25}{85} = 0.294$$

$\therefore \quad X'_B = 0.706$

These mole fractions will go into the distillate. The total vapour pressure of the distillate would be

$P'_{Total} = P_A^\circ X'_A + P_B^\circ X'_B$ = (100 × 0.294) + (80 × 0.706)

= (29.4 + 56.48) = **85.88 mm Hg**.

2. At the same temperature, isotonic solutions will have same concentrations.

$Na_2SO_4 \rightleftharpoons 2Na^+ + SO_4^{2-}$

$1 - \alpha \qquad 2\alpha \qquad \alpha$

$C_{Na_2SO_4} = C_{glucose}$

$0.04(1 + 2\alpha) = 0.1$

α = **0.75**

3. $2KI + HgI_2 \longrightarrow K_2[HgI_4] \rightleftharpoons 2K^+ + [HgI_4]^{2-}$

Thus, there is net decrease in number of ions present in solution and freezing point is raised

4. $\Delta T_f = i \times K_f \times m$

$0.0054 = i \times 1.80 \times 0.001$

$i = 3$

$i = 1 + (n - 1)\alpha$

$n = 3$

$\therefore$ The correct formula of the compound is $[Pt(NH_3)_4Cl_2]Cl_2$

5. $As_2S_3 + (NH_4)_2S_2 \longrightarrow \underset{\text{soluble}}{(NH_4)_3AsO_3}$

9. The number of units of AB in a unit cell (fcc) = 4

Now, $\frac{r_+}{r_-}$ for octahedral co-ordination = 0.414

$\therefore r_+ = 100 \times 10^{-10} = 10^{-10}$ cm

$\frac{r_+}{r_-} = 10^{-10}$

So, $r_- = 241.5$ pm

Hence, (A).

10. $E = E^o - \frac{0.0591}{n}\log\frac{(Cr^{3+})}{(Cr_2O_7^{2-})^{1/2}(H^+)^7}$

11. $Pt \mid H_2 \mid H^+ \parallel H^+ \mid H_2 \mid Pt$

$1\,atm \quad x \quad 10^{-4} \quad 1\,atm$

$E_{cell} = \frac{0.0591}{2}\log\frac{(10^{-4})^2}{x^2}$

$x = 10^{-6}$ M

13. $Ag^+ + e^- \longrightarrow Ag$; $E^o = 0.799$ V; $\Delta G^o = -7.71\times10^4$ J

$Ag(NH_3)_2^+ \longrightarrow Ag^+ + 2NH_3$; $K = 6\times10^{-8}$; $\Delta G^o = (-2.303\,RT)\log K = 4.12\times10^4$ J

$\Delta G^o_{net} = (-7.71\times10^4\text{ J}) + (4.12\times10^4\text{ J}) = -3.59\times10^4$ J

$E^o = \frac{-\Delta G^o}{nF} = 0.372\,V$

14. The total charge of Fe^{2+} and Fe^{3+} should be 2.
Let, the percentage of Fe^{3+} = x
Hence, 3 × x + 2(0.93 – x) = 2
$\therefore x = 0.14$

% of $Fe^{3+} = \frac{0.14}{0.93}\times100 = 15\%$

17. It does not dimerise due to delocalization of odd electrons.

19. $2HBr + SO_3 \longrightarrow H_2O + Br_2 + SO_2$;

20. $Ti + 2I_2 \xrightarrow{500K} \underset{\text{Volatile stable compound}}{TiI_4} \xrightarrow{1700K} \underset{\text{Pure metal}}{Ti} + 2I_2$

21. Carnallite is an important ore of magnesium. It's formula is $KCl.MgCl_2.6H_2O$.

23. $PbS + 2PbO \longrightarrow 2Pb + SO_2$, $SnO_2 + C \longrightarrow Sn + CO$, $SnO_2 + 2CO \longrightarrow Sn + 2CO_2$.

25. $VOSO_4 \Rightarrow VO^{2+} + SO_4^{2-}$
So oxidation state of V is +4.

26. $CO_2 + H_2O \rightleftharpoons H_2CO_3$

$CrO_4^{2-} + 2H^+ \rightleftharpoons \underset{\text{(orange red)}}{Cr_2O_7^{2-}} + H_2O$

27. Mn^{2+} : $3d^54s^0$
In presence of weak field ligand, three will be no pairing of electrons, so it will form a high spin complex i.e. the number of unpaired electrons = 5.

Mathematics PART – III

SECTION – A

1. Let $\vec{c} = (c_1, c_2, c_3)$, then

$|\vec{c}| = |\vec{a}| = |\vec{b}| = \sqrt{2} = \sqrt{c_1^2 + c_2^2 + c_3^2}$

It is given that the angles between the vectors are identical and equal to φ (say), then

$$\cos\varphi = \frac{\vec{a}.\vec{b}}{|\vec{a}||\vec{b}|} = \frac{0+1+0}{\sqrt{2}\sqrt{2}} = \frac{1}{2}$$

$$\frac{\vec{a}.\vec{c}}{|\vec{a}||\vec{c}|} = \frac{c_1 + c_2}{2} = \frac{1}{2} \text{ and } \frac{\vec{b}.\vec{c}}{|\vec{b}||\vec{c}|} = \frac{c_2 + c_3}{2} = \frac{1}{2}$$

Hence $c_1 + c_2 = 1, c_2 + c_3 = 1$ and $c_1^2 + c_2^2 + c_3^2 = 2$

On solving the equation, we get $c_1 = 1, -\frac{1}{3}; c_2 = 0, \frac{4}{3}; c_3 = 1, -\frac{1}{3}$

Hence co-ordinates of c are $(1, 0, 1)$ or $\left(-\frac{1}{3}, \frac{4}{3}, \frac{-1}{3}\right)$.

Trick : Obviously, length of the vector $(1, 0, 1)$ i.e., $\hat{i} + \hat{k}$ is equal to length of $\vec{a}$ and $\vec{b}$. Also it makes equal angle with $\vec{a}$ and $\vec{b}$ and equal to that of between $\vec{a}$ and $\vec{b}$ i.e. , $\frac{\pi}{3}$.

2. Since the vectors $\vec{a} = cx\hat{i} - 6\hat{j} + 3\hat{k}$ and $\vec{b} = x\hat{i} + 2\hat{j} + 2cx\hat{k}$ make an obtuse angle, therefore

$\vec{a}.\vec{b} < 0 \Rightarrow cx^2 - 12 + 6cx < 0$ for all x

$\Rightarrow c < 0$ and Discriminant < 0

$\Rightarrow c < 0$ and $36c^2 + 48c < 0$

$\Rightarrow c < 0$ and $3c + 4 > 0 \Rightarrow c < 0$ and $3c + 4 > 0$

$\Rightarrow -\frac{4}{3} < c < 0.$

3. $[\vec{p}\,\vec{q}\,\vec{r}] = \vec{p}.(\vec{q} \times \vec{r})$

$$= \frac{\vec{b} \times \vec{c}}{\vec{a}.\vec{b} \times \vec{c}} . \left[\frac{\vec{c} \times \vec{a}}{\vec{a}.\vec{b} \times \vec{c}} \times \frac{\vec{a} \times \vec{b}}{\vec{a}.\vec{b} \times \vec{c}}\right]$$

$$= \frac{(\vec{b} \times \vec{c}).\left[(\vec{c} \times \vec{a}) \times (\vec{a} \times \vec{b})\right]}{[\vec{a}\,.(\vec{b} \times \vec{c})]^3}$$

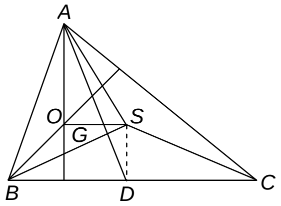
$$\frac{(\vec{b} \times \vec{c}).\left[\{(\vec{c} \times \vec{a}).\vec{b}\}\vec{a} - \{(\vec{c} \times \vec{a}).\vec{a}\}\vec{b}\right]}{[\vec{a}.(\vec{b} \times \vec{c})]^3}$$

$$= \frac{(\vec{b} \times \vec{c}) \cdot \left[\{(\vec{c} \times \vec{a}).\vec{b}\}\vec{a}\right]}{\left[\vec{a}.(\vec{b} \times \vec{c})\right]^3}, \qquad \{\because (\vec{c} \times \vec{a}).\vec{a} = 0\}$$

$$= \frac{(\vec{b} \times \vec{c})\left[\{(\vec{a}.(\vec{b} \times \vec{c})\}\vec{a}\right]}{[\vec{a}.(\vec{b} \times \vec{c})]^3} = \frac{[\vec{a}.(\vec{b} \times \vec{c})]\;[(\vec{b} \times \vec{c}).\vec{a}]}{[\vec{a}.(\vec{b} \times \vec{c})]^3}$$

$$=\frac{1}{\vec{a}.\vec{b}\times\vec{c}}.$$

4. Let P be any point in the plane of the triangle ABC. Then



$\overrightarrow{PA}+\overrightarrow{PB}+\overrightarrow{PC}=\overrightarrow{PA}+(\overrightarrow{PB}+\overrightarrow{PC})=\overrightarrow{PA}+2\overrightarrow{PD}$

$=(1+2)\overrightarrow{PG}=3\overrightarrow{PG}$

Since G divides AD in the ratio $2:1$.

$\therefore\ \overrightarrow{SA}+\overrightarrow{SB}+\overrightarrow{SC}=3\overrightarrow{SG}=2\overrightarrow{SG}+\overrightarrow{SG}$

$=\overrightarrow{GO}+\overrightarrow{SG}=\overrightarrow{SO}$, $(\because\ OG=2SG)$.

5. $[\vec{a}\vec{b}\vec{c}\,]\neq 0$

Also $|[\vec{a}\vec{b}\vec{c}\,]|=[\vec{b}\times\vec{c}\ \vec{c}\times\vec{a}\ \vec{a}\times\vec{b}]=[\vec{a}\vec{b}\vec{c}\,]^2$

or $t^2=|t|\Rightarrow t^2=\pm t,\ t=0,1,-1$

but $[\vec{a}\vec{b}\vec{c}\,]\neq 0$, $[\vec{a}\vec{b}\vec{c}]=1$

and $[\vec{a}\vec{b}\vec{c}\,]=-1$

6. $\left(\vec{a}+\vec{b}\right)\times\left(\vec{a}\times\vec{b}\right)=\vec{a}\times\left(\vec{a}\times\vec{b}\right)+\vec{b}\times\left(\vec{a}\times\vec{b}\right)=\left(\vec{a}.\vec{b}\right)\vec{a}-|\vec{a}|^2\vec{b}+|\vec{b}|^2\vec{a}-\left(\vec{a}.\vec{b}\right)\vec{b}$

$=\vec{a}.\vec{b}\left(\vec{a}-\vec{b}\right)-\vec{b}+\vec{a}\qquad(|\vec{a}|=|\vec{b}|=1)$

$=\left(\left(\vec{a}.\vec{b}\right)-1\right)\left(\vec{a}-\vec{b}\right)$

Hence $\left(\vec{a}+\vec{b}\right)\times\left(\vec{a}\times\vec{b}\right)$ is parallel to $\vec{a}-\vec{b}$

7. Let $\frac{x+1}{3}=\frac{y+3}{5}=\frac{z+5}{7}=\lambda$ .....(i)

Then $x=3\lambda-1,\ y=5\lambda-3, z=7\lambda-5$

General point on this line is $(3\lambda-1, 5\lambda-3, 7\lambda-5)$

Again let $\frac{x-2}{1}=\frac{y-4}{3}=\frac{z-6}{5}=\mu$ .....(ii)

Then $x=\mu+2, y=3\mu+4, z=5\mu+6$

A general point on this line is $(\mu+2, 3\mu+4, 5\mu+6)$

For intersection, they have a common point, for some values of λ and μ, we must have $bcx+cay-abz=0$,

$(5\lambda-3)=(3\mu+4),\quad(7\lambda-5)=(5\mu+6)$

From first two we have, $\mu=3\lambda-3$ ……(iii)

and $3\mu=5\lambda-7$ …..(iv)

From (iii), put the values of μ in (iv), we have $3(3\lambda-3)=5\lambda-7$

$\Rightarrow\ 9\lambda - 9 = 5\lambda - 7$ or $4\lambda = 2$ or $\lambda = \dfrac{1}{2}$

Put $\lambda = \dfrac{1}{2}$ in (iii), we get $\mu = -\dfrac{3}{2}$ (Putting $\lambda = \dfrac{1}{2}$)

The required point of intersection is

$\left[\dfrac{3}{2} - 1\right], \left[\dfrac{5}{2} - 3\right], \left[\dfrac{7}{2} - 5\right] = \left[\dfrac{1}{2}, -\dfrac{1}{2}, -\dfrac{3}{2}\right]$.

8. $\theta = \sin^{-1}\left(\dfrac{6+2-12}{\sqrt{14}.\sqrt{29}}\right) \Rightarrow \theta = \sin^{-1}\left(\dfrac{-4}{\sqrt{406}}\right)$.

9. The equation of plane, in which the line $\dfrac{x-5}{4} = \dfrac{y-7}{4} = \dfrac{z+3}{-5}$ lies, is

$A(x-5) + B(y-7) + C(z+3) = 0$ ……(i)

Where $4A + 4B - 5C = 0$ ……(ii)

Also, since line $\dfrac{x-8}{7} = \dfrac{y-4}{1} = \dfrac{z-5}{3}$ lies in this plane

$\therefore\ 7A + B + 3C = 0$ ……(iii)

By (ii) and (iii), we get $\dfrac{A}{17} = \dfrac{B}{-47} = \dfrac{C}{-24}$

$\therefore$ The required plane is

$17(x-5) - 47(y-7) + (-24)(z+3) = 0$

$\Rightarrow\ 17x - 47y - 24z + 172 = 0$.

10. Equation of a plane passing through origin is $ax + by + cz = 0$, but it also passes through (1, – 2, – 1) and (3,–2,3), therefore $a - 2b - c = 0$ and $3a - 2b + 3c = 0$.

$\Rightarrow a = -2c$ and $b = -\dfrac{3c}{2}$

$\therefore$ Plane is $-2cx - \dfrac{3c}{2}y + cz = 0 \Rightarrow 4x + 3y - 2z = 0$.

Hence direction cosines of plane are $\left(\dfrac{4}{\sqrt{29}}, \dfrac{3}{\sqrt{29}}, \dfrac{-2}{\sqrt{29}}\right)$

11. Let A ≡ (1, –1, 0), B ≡ (–1, 0, 1)

$\therefore$ direction ratios of segment AB are (2, –1, –1). If 'θ' be the acute angle between segment AB and normal to plane,

$\cos\theta = \dfrac{|2.2 - 1.1 - 1.6|}{\sqrt{4+1+36}.\sqrt{4+1+1}} = \dfrac{3}{\sqrt{246}}$

Length of projection = (AB) $\sin\theta$ = $\sqrt{6}\ .\ \sqrt{1 - \dfrac{9}{246}} = \sqrt{\dfrac{237}{61}}$ units.

12. Given line passes through (1, 2, 4) and this point also lies on the given plane.

Thus, required line will be in the form of $\dfrac{x-1}{l} = \dfrac{y-2}{m} = \dfrac{z-4}{n}$.

Any point on the given line is $(-r_1 + 1, 3r_1 + 2, r_1 + 4)$.

If $r_1 = 1$, this point becomes P = (0, 5, 5)

Let Q = (a, b, (C) be the reflection of P in the given plane, then

$\frac{a}{2}.1+\frac{b+5}{2}.1+\frac{5+c}{2}.1=7$

i.e., a + b + c = 4, and $\frac{a}{1}=\frac{b-5}{1}=\frac{c-5}{1}$ = λ (say)

⇒ a = λ, b = 5 + λ, c = 5 + λ

⇒ 10 + 3λ = 4 ⇒ λ = –2

Thus, Q ≡ (–2, 3, 3)

Hence, direction ratios of reflected line are (–3, 1, –1)

Thus, it's equation is $\frac{x-1}{-3}=\frac{y-2}{1}=\frac{z-4}{-1}$

13. In first trial he get's a head = ½

probability that say in first trial he get's a trial then in dice throwing we should get (1 to 4) and then head comes. Probability of that $=\frac{1}{2}\times\frac{4}{6}\times\frac{1}{2}=\frac{1}{6}$

So total probability will become $=\frac{1}{2}+\frac{1}{6}+\frac{1}{18}+...=\frac{1/2}{1-1/3}=\frac{3}{4}$

14. No one dies ⇒ probability = $(1-p)^n$

atleast one dies ⇒ 1 = $1-(1-p)^n$

now $A_1, A_2, \ldots A_n$ can make n! cases between them if the fix A_1 to die first then rest $A_2 \ldots A_n$ will make (n –1)! cases between them so probability of A_1 dies first $=\frac{(n-1)!}{n!}=\frac{1}{n}$

So, total probability of A_1 dies and dies first ⇒ $\frac{1}{n}\left(1-(1-p)^n\right)$.

15. We have ${}^{100}C_{50}\,p^{50}(1-p)^{50} = {}^{100}C_{51}(1-p)^{49}$

or $\frac{1-p}{p}=\frac{100!}{51!\,.\,49!}\times\frac{50!\,.\,50!}{100!}=\frac{50}{51}$

or $51-51p=50p$

$\Rightarrow p=\frac{51}{101}$.

16. The man will be one step away from the starting point if (i) either he is one step ahead or (ii) one step behind the starting point.

∴ The required probability $=P(i)+P(ii)$

The man will be one step ahead at the end of eleven steps if he moves six steps forward and five steps backward. The probability of this event $={}^{11}C_6(0.4)^6(0.6)^5$.

The man will be one step behind at the end of eleven steps if he moves six steps backward and five steps forward.

The probability of this event $={}^{11}C_6(0.6)^6(0.4)^5$.

Hence the required probability

$={}^{11}C_6(0.4)^6(0.6)^5+{}^{11}C_6(0.6)^6(0.4)^5$

$={}^{11}C_6(0.4)^5(0.6)^5(0.4+0.6)={}^{11}C_6(0.24)^5$.

17. $P(x>1.5)=1-P(x=0)-P(x=1)$ λ : expected minimum positive integer

$P(x = k) = e^{-\lambda}\dfrac{\lambda^k}{k!}$ e : Euler number.

$\therefore\ P(x > 1.5) = 1 - \dfrac{1}{e^2} - \dfrac{2}{e^2} = 1 - \dfrac{3}{e^2}$.

18. $\Delta = 1(\omega^{3n} - 1) + \omega^n(\omega^{2n} - \omega^{2n}) + \omega^{2n}(\omega^n - \omega^{4n})$

$\Delta = [(\omega^3)^n - 1] + 0 + \omega^{2n}[\omega^n - (\omega^3)^n.\omega^n]$

$\Delta = 1 - 1 + 0 + \omega^{2n}[\omega^n - \omega^n] = 0$.

19. As we have $A^2 = 2A - I \Rightarrow A^2.A = (2A - I)A$

$\Rightarrow\ A^3 = 2A^2 - IA = 2(2A - I) - A \Rightarrow A^3 = 3A - 2I\ \ \{\because IA = A \text{ and } A^2 = 2A - I\}$

Similarly, $A^4 = 4A - 3I, A^5 = 5A - 4I$..

Hence $y^b = e^m, x^c y^d = e^n$.

20. We have $a_1, a_2, a_3 \,.....\, a_n$ in G.P.

then $r = \dfrac{a_2}{a_1}$ i.e., $r = \dfrac{a_{n+1}}{a_n} = \dfrac{a_{n+2}}{a_{n+1}} = ...$

Hence $\log_r = \log(a_{n+1}) - \log(a_n) = \log(a_{n+2}) - \log(a_{n+1}) = ...$

Now $\begin{vmatrix} \log a_n & \log a_{n+1} & \log a_{n+2} \\ \log a_{n+3} & \log a_{n+4} & \log a_{n+5} \\ \log a_{n+6} & \log a_{n+7} & \log a_{n+8} \end{vmatrix}$

Operate $C_2 \to C_2 - C_1$ and $C_3 \to C_3 - C_2$

$$= \begin{vmatrix} \log a_n & (\log a_{n+1} - \log a_n) & (\log a_{n+2} - \log a_{n+1}) \\ \log a_{n+3} & (\log a_{n+4} - \log a_{n+3}) & (\log a_{n+5} - \log a_{n+4}) \\ \log a_{n+6} & (\log a_{n+7} - \log a_{n+6}) & (\log a_{n+8} - \log a_{n+7}) \end{vmatrix}$$

$$= \begin{vmatrix} \log a_n & \log r & \log r \\ \log a_{n+3} & \log r & \log r \\ \log a_{n+6} & \log r & \log r \end{vmatrix} = 0.$$

21. $\Delta^c = \Delta^{n-1} = \Delta^{3-1} = \Delta^2 = (11)^2 = 121$.

But we have to find the value of the square of the determinant, so required value is $(121)^2 = 14641$.

22. Since $(AB)^{-1} = B^{-1}A^{-1}$.

23. For the given matrix to be singular, we must have, $\begin{vmatrix} 3 & -1+x & 2 \\ 3 & -1 & x+2 \\ x+3 & -1 & 2 \end{vmatrix} = 0$

$$\Rightarrow \begin{vmatrix} 3 & -1+x & 2 \\ 0 & -x & x \\ x & -x & 0 \end{vmatrix} = 0,\ [R_2 \to R_2 - R_1, R_3 \to R_3 - R_1]$$

$$\Rightarrow \begin{vmatrix} x+4 & -1+x & 2 \\ 0 & -x & x \\ 0 & -x & 0 \end{vmatrix} = 0,\ [C_1 \to C_1 + C_2 + C_3]$$

$$\Rightarrow \quad (x+4)(0+x^2) = 0 \Rightarrow x = -4, 0$$

Note that only $-4 \in [-4, -1]$.

24. $-\frac{\pi}{2} \le \sin^{-1} x \le \frac{\pi}{2}$

$-\frac{\pi}{2} \le \sin^{-1} y \le \frac{\pi}{2}$

$-\pi \le \sin^{-1} x + \sin^{-1} y \le \pi$

so for $\sin^{-1} x + \sin^{-1} y = -\pi$

$\Rightarrow \sin^{-1} x = -\frac{\pi}{2}$ & $\sin^{-1} y = -\frac{\pi}{2}$

x = –1 and y = –1

area required $1 - \left| \int_{-1}^{0} -(x+1)^2 dx \right| = 1 - \frac{1}{3} = \frac{2}{3}$ sq. units.

25. The curves given by y = x + sin x and y = $f^{-1}(x)$ are images of each other in the line y = x.

Hence required area = $\int_0^{\pi} \left(\left(x + \sin x \right) - x \right) dx = -\left[\cos x \right]_0^{\pi} = 2$

26. Circle has (2, –1) as its centre and radius of this circle is 2.
Thus if P(x, y) be any point on it, then x $\in$ [0, 4].

Let $g(x) = \frac{x^3}{100} + \frac{x}{50}$

$g'(x) = \frac{3x^2}{100} + \frac{1}{50} > 0 \ \forall x \in (0, 4]$

The g(x) is increasing in [0, 4]

$g(0) = 0,\ g(4) = \frac{18}{25}$

$g(x) = \left[0, \frac{18}{25} \right] \forall x \in [0, 4] \Rightarrow [g(x)] = 0 \ \forall \ x \in [0, 4]$

$y = \left[\frac{x^3}{100} + \frac{x}{50} \right]$, represents the x-axis.

CA = CB = 2, CD = 1

$\cos\theta = \frac{CD}{CA} = \frac{1}{2} \ \ \theta = \frac{\pi}{3}$

$\angle ACB = \frac{2\pi}{3},\ \Delta ACB = \frac{1}{2} \times 2^2 \times \sin\frac{2\pi}{3} = \sqrt{3}$

Area of sector $ACB = \frac{1}{2} \times 2^2 \times \frac{2\pi}{3} = \frac{4\pi}{3}$ sq. units

27. Since $\int_0^a f(x)dx = \frac{a^2}{2} + \frac{a}{2}\sin a + \frac{\pi}{2}\cos a$

Differentiating both sides w.r.t. a, we get

$\Rightarrow \quad f(a) = a + \frac{a}{2}\cos a + \frac{1}{2}\sin a - \frac{\pi}{2}\sin a$

$\therefore \quad f\left(\frac{\pi}{2}\right) = \frac{\pi}{2} + 0 + \frac{1}{2}.1 - \frac{\pi}{2}.1 = \frac{1}{2}$

28. For $x \in [1, 4/3]$, $y = \sqrt{\sin 1 + 0} = \sqrt{\sin 1}$

So required area $= \int_{1}^{4/3} \sqrt{\sin 1}\, dx = \frac{1}{3}\sqrt{\sin 1}$ Sq. units.

29. $f(x) = \frac{x^2}{6}$ $A = \frac{1}{6}\int_{0}^{3} x^2 dx = 3/2$

30. $y = (c_1 + c_2)\cos(x + c_3) - c_4 e^{x + c_5}$

$y_1 = -(c_1 + c_2)\sin(x + c_3) - c_4 e^{x + c_5}$

$y_2 = -(c_1 + c_2)\cos(x + c_3) - c_4 e^{x + C_5} = -y - 2c_4 e^{x + c_5}$

$\Rightarrow y_3 = -y_1 - 2c_4 e^{x + c_5} = -y_1 + y_2 + y$

Hence the differential equation is $y_3 - y_2 + y_1 - y = 0$, which is of order 3.

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

FIITJEE **JEE (Advanced), 2017**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – I

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 186**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 05)** contains 5 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (06 to 13) contains 8 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer and **– 2 mark** for wrong answer.

(ii) **Section-C (01 to 05)** contains 5 Numerical based questions with single digit integer as answer, ranging from 0 to 9. Each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

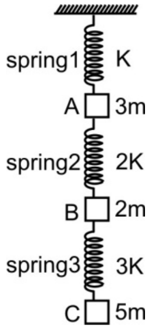
PART – I

SECTION – A

Straight Objective Type

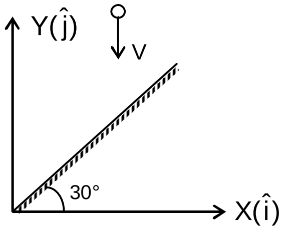
This section contains **5 multiple choice questions** numbered 1 to 5. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. The system of springs and masses are in equilibrium. If the spring 2 is cut then the initial acceleration of block B will be.



(A) $\frac{7}{2}g$ downward
(B) 2g downward
(C) 2g upward
(D) $\frac{7}{2}g$ upward

2. An object moves with velocity $V\,(-\hat{j})$ towards the inclined plane mirror as shown in figure. The velocity of the image is



(A) $V\,\hat{j}$
(B) $V\frac{\sqrt{3}}{2}(-\hat{i})+\frac{V}{2}\hat{j}$
(C) $V\frac{\sqrt{3}}{2}\hat{i}+\frac{V}{2}\hat{j}$
(D) $\frac{V}{2}(-\hat{i})+V\frac{\sqrt{3}}{2}(\hat{j})$

3. When a beam of accelerated electrons hits a target, a continuous X-ray spectrum is emitted from the target. Which of the following wavelength is absent in the X-ray spectrum, if the X-ray tube is operating at 40.000 volts?

(A) 0.25 Å
(B) 0.5 Å
(C) 1.5 Å
(D) 1.0 Å

Space for Rough work

4. The electric potential between a proton and an electron is given by $V = V_0 \ln\frac{r}{r_0}$, where r_0 is a constant. Assuming Bohr's model to be applicable, write variation of r_n with n, n being the principal quantum number.

(A) $r_n \propto n$
(B) $r_n \propto 1/n$
(C) $r_n \propto n^2$
(D) $r_n \propto 1/n^2$

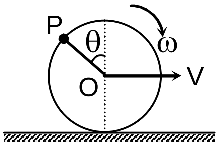
5. A string of mass m is fixed at both ends. The fundamental tone oscillation are excited in the string with angular frequency ω and maximum displacement amplitude A. Find the total energy contained in the string.

(A) $\frac{1}{2}m\omega^2A^2$
(B) $\frac{1}{4}m\omega^2A^2$
(C) $\frac{1}{6}m\omega^2A^2$
(D) $\frac{1}{8}m\omega^2A^2$

Multiple Correct Choice Type

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

6. A disc of radius *R* rolls on a horizontal surface with linear velocity *V* and angular velocity ω. There is a point *P* on circumference of disc at angle θ with upward vertical diameter measured anticlockwise see figure, which has a vertical velocity. Here θ is equal to



(A) $\pi + \sin^{-1}\frac{V}{R\omega}$
(B) $\frac{\pi}{2} - \sin^{-1}\frac{V}{R\omega}$
(C) $\pi - \cos^{-1}\frac{V}{R\omega}$
(D) $\pi + \cos^{-1}\frac{V}{R\omega}$

Space for Rough work

7. A point moves with deceleration along the circle of radius R so that at any time its tangential and normal acceleration are equal in magnitude. At the initial moment t =0, the velocity of the point is v_0. The velocity of the point will be

(A) $v = \dfrac{v_0}{1+\dfrac{v_0 t}{R}}$ at t second

(B) $v = v_0 e^{-S/R}$ after displacements

(C) $v = v_0 e^{-SR}$ after displacements

(D) $v = \dfrac{v_0}{1-\dfrac{v_0 t}{R}}$ at t second

8. A block of mass 1 kg moves under the influence of external forces on a rough horizontal surface. At some instant, it has a speed of 1 m/s due east and an acceleration of 1 m/s^2 due north. The force of friction acting on it is F
(A) F acts due west
(B) F acts due south
(C) F acts in the south west direction
(D) the magnitude of F cannot be found from the given data

9. A particle is taken from point A to point B under the influence of a force field. Now it is taken back from B to A and it is observed that the work done in taking the particle from A to B is not equal to the work done in taking it from B to A. If W_{nc} and W_c is the work done by non conservative forces and conservative forces present in the system respectively, ΔU is the change in potential energy, Δ k is the change is kinetic energy, then

(A) $W_{nc} - \Delta U = \Delta k$

(B) $W_c = -\Delta U$

(C) $W_{nc} + W_c = \Delta k$

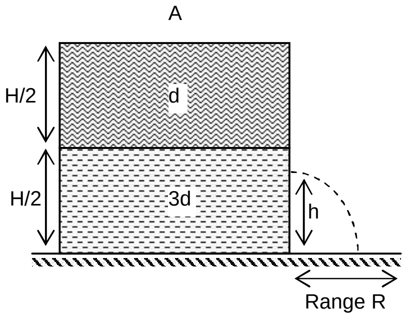
(D) $W_{nc} - \Delta U = -\Delta k$

10. A horizontal disc rotates freely about a vertical axis through its centre. A ring, having the same mass and radius as the disc, is now gently placed on the disc. After some time, they rotate with a common angular speed.
(A) some friction exists between the disc and the ring.
(B) the angular momentum of the disc plus ring is conserved.
(C) the final common angular speed is $\frac{2}{3}$rd of the initial angular velocity of the disc.
(D) $\frac{2}{3}$ rd of the initial kinetic energy changes to heat.

Space for Rough work

11. If electron of the hydrogen atom is replaced by another particle of same charge but of double the mass, then:
(A) Bohr radius will increase
(B) ionisation energy of the atom will be doubled
(C) speed of the new particle in a given state will be lesser than the electron's speed in same orbit
(D) gap between energy levels will now be doubled

12. A container of large uniform cross sectional area A resting on a horizontal surface holds two immiscible non viscous and incompressible liquids of density d and 3d, each of height H/2. The lower density liquid is open to the atmosphere having pressure P_0. A tiny hole of area a(a<<A) is punched to the vertical side of lower container at a height h (0<h<H/2) for which range is maximum.



(A) h = H /3
(B) Range R = $\frac{2H}{3}$
(C) Range R = $\frac{3H}{2}$
(D) Velocity of efflux $v = \sqrt{\frac{2}{3}gH}$

13. When a monochromatic point source of light is at a distance of 0.2 m from a photoelectric cell, the cut off voltage and the saturation current are respectively 0.6V and 18.0 mA. If the same source is placed 0.6 m away from the photoelectric cell, then:
(A) the stopping potential will be 0.2 volt
(B) the stopping potential will be 0.6 volt
(C) the saturation current will be 6.0 mA
(D) the saturation current will be 2.0 mA

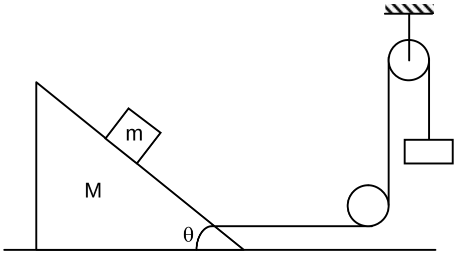
Space for Rough work

SECTION – C

(One Integer Value Correct Type)

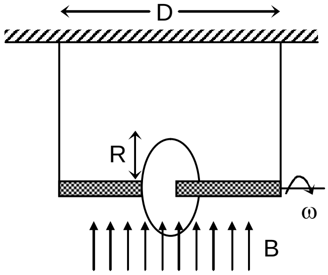
This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. Find the mass of the hanging block in kg, which will prevent the smaller block from slipping over the triangular block. All the surfaces are friction less and the strings and pulleys are light. (Given m = M = 1 kg, $\cot\theta = 2$)

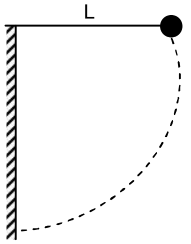


2. An ideal gas is expanding such that PT^2 = constant. The coefficient of volume expansion of the gas is A/T where T is temperature in kelvin. Find the value of A.

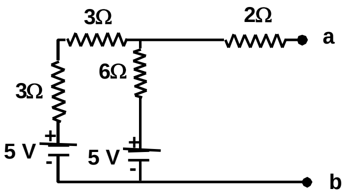
3. The axle of a circular wheel of radius R is held horizontally by two identical strings of equal lengths separated by a distance D. The tension in each string is T_0. The rim of the wheel carries a total charge + Q distributed uniformly on it. The wheel is vertical and is kept in a uniform vertical magnetic field $\vec{B}$. It is now rotated at an angular speed ω. The string break at a tension of $3T_0/2$. If the maximum possible value of ω at which the wheel can be rotated without breaking a string is $\frac{KT_0D}{QR^2B}$. Then find the value of K.



4. A simple pendulum is suspended from a peg on a vertical wall. The pendulum is pulled away from the wall to a horizontal position and released. The ball hits the wall, the coefficient of restitution is $\frac{2}{\sqrt{5}}$. What is the minimum number of collisions after which the amplitude of oscillations becomes less than 60 degrees ?



5. Determine the resistance in ohm is to be connected across a, b in given circuit to dissipate maximum power through it.



Space for Rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **5 multiple choice questions** numbered 1 to 5. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. 100 mL of a sample of hard water requires 25.1 mL of 0.02 N H_2SO_4 for complete reaction. The hardness of the sample is:
[Density of the sample = 1 g/mL]
(A) 200 ppm (B) 250 ppm
(C) 251 ppm (D) 258 ppm

2. Which of the following is not a property of NaOH?
(A) It is hygroscopic in nature (B) It decolourizes chlorine gas
(C) It behaves as a bleaching agent (D) Heat is liberated when it reacts with HCl

3. For the gaseous reaction, $A(g) \rightarrow 4B(g) + 3C(g)$ is found to be first order with respect to A. If at the starting the total pressure was 100 mm Hg and after 20 minutes it is found to be 400 mm Hg. The rate constant of the reaction is
(A) 20 min^{-1} (B) 1.2×10^{-3} sec^{-1}
(C) 5.7×10^{-4} sec^{-1} (D) 3.4×10^{-2} sec^{-1}

4. Four separate solutions (each of 0.1 M) of four sodium salts NaW, NaX, NaY and NaZ has pH 7.0, 9.0, 10.0 and 11.0 respectively. The acid with the lowest pKa value is
(A) HW (B) HX
(C) HY (D) HZ

5. What would be the formula of an ionic solid which crystals contains b.c.c unit cell in which X^{2+} ions are present at the body centre of Y^{2-} ions at the corners?
(A) X_2Y (B) XY
(C) XY_2 (D) X_2Y_3

Space for Rough work

Multiple Correct Choice Type

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

6. In which of the following option(s) the dipole moment of the left side molecule is greater than that of the right side molecule?

(A) NH_3, NF_3
(B) SCl_2, $BeCl_2$
(C) SF_4, CF_4
(D) PF_5, IF_5

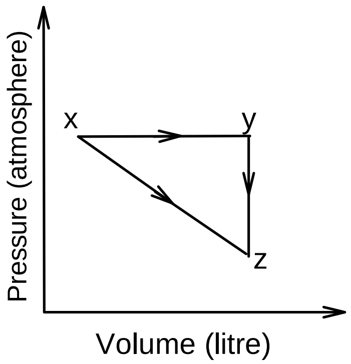
7. K_C for the reaction $2A\ (g) + B(g) \rightleftharpoons A_2B(g)$ is 2×10^{-2} at 25^oC and it is 2×10^{-1} at 50^oC. Choose the incorrect statement (s) from the following

(A) Decomposition of A_2B is favoured at low temperature
(B) Formation of A_2B is favoured at low pressure.
(C) Formation of A_2B is favoured by introducing an inert gas at constant pressure.
(D) Decomposition of A_2B is favoured by removing B(g) from the reaction mixture

8. Which carbides react with water to give methane?

(A) CaC_2
(B) Be_2C
(C) Mg_2C_3
(D) Al_4C_3

9. For an ideal gas, consider only P – V work in going from an initial state X to final state Z. The final state Z can be reached by either of the two paths shown in figure. Which of the following choice (s) is (are) correct? [Take ΔS as change is entropy ΔH change is enthalpy and W as work done]



(A) $\Delta S_{x\to z} = \Delta S_{x\to y} + \Delta S_{y\to z}$
(B) $W_{x\to z} = W_{x\to y} + W_{y\to z}$
(C) $W_{x\to y\to z} = W_{x\to y}$
(D) $\Delta H_{x\to y\to z} = \Delta H_{x\to z}$

Space for Rough work

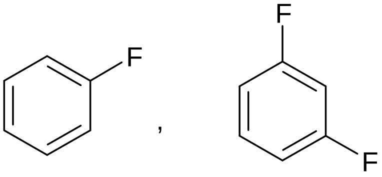
10. Which of the following ion(s) form(s) precipitate with aqueous ammonia solution in presence of ammonium chloride?

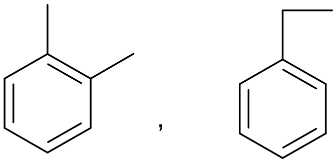
(A) Ca^{2+} (B) Fe^{3+}
(C) Cr^{3+} (D) Al^{3+}

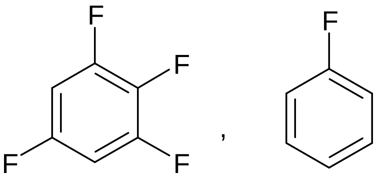
11. Which of the following ion(s) maintain an identical d-orbital configuration while forming octahedral complexes with strong field as well as weak field ligands according to crystal field theory?

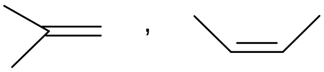
(A) Fe^{2+} (B) Co^{2+}
(C) Ni^{2+} (D) Zn^{2+}

12. Which of the following pair has same net dipole moment

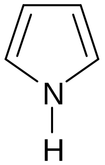
(A)


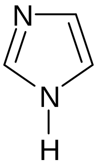
(B)


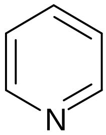
(C)


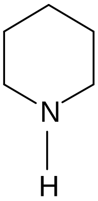
(D)


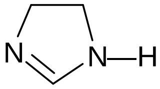
13. Arrange the following in decreasing order of basic strength?

(i)


(ii)


(iii)


(iv)


(v)


(A) iv > v > ii > iii > i (B) v > iv > ii > iii > i
(C) i > ii > iii > iv > v (D) v > iv > iii > ii > i

Space for Rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

1. What is the sum of azimuthal quantum number of all the valence electrons of aluminum? [At. No. of Al = 13]

2. How many S – O single bonds are present in Caro's acid (H_2SO_5)?

3. The formula of a spinel is $MgAl_2O_4$. How many effective no. of anionic vacancy for unit cell will be created if the oxide ions of the spinel are replaced by $X^{-8/3}$ ions?

4. The radiator of a car contains 50.5 g water. If 6.2 g of glycol ($HOCH_2CH_2OH$) is added to it, the solution freezes at $-4^{o}C$. How many gram of ice will be separated in the process? [$K_f = 1.86\ K\ kg\ mol^{-1}$]

5. How many maximum gram of aluminium will be deposited by passing 96500 ampere current for one second through molten aluminium nitrate?

Space for Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **5 multiple choice questions** numbered 1 to 5. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. If A and B are orthogonal square matrices of same order and $|A|+|B|=0$, then the matrix $A+B$ is always
(A) Invertible
(B) Singular
(C) Non – Null matrix
(D) None of these

2. 3 Tangents are drawn at random to a given circle in a plane. The probability that the circle is inscribed in the triangle formed by them is
(A) $\frac{1}{2}$
(B) $\frac{1}{3}$
(C) $\frac{1}{4}$
(D) $\frac{1}{8}$

3. The number of 6 digit numbers which are divisible by 3 and do not contain the digit 3 is
(A) $2^3 3^6$
(B) $2^3 3^9$
(C) $2^4 3^6$
(D) $2^4 3^9$

4. A monic quadratic trinomial P (x) is such that $P(x)=0$ and $P(P(P(x)))=0$ have a common root, then
(A) $P(0).P(1)>0$
(B) $P(0)P(1)<0$
(C) $P(0)P(1)=0$
(D) Data insufficient

5. The number of non – zero $z \in C$ satisfying $z^3 = 18+26i$, where $z = x+iy$ and x, y are integers, is $\left(i=\sqrt{-1}\right)$
(A) 0
(B) 1
(C) 2
(D) 3

Space for Rough work

Multiple Correct Choice Type

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

6. If $f(x+y) = f(x) + f(y) + |x|y + xy^2 \forall x, y \in R$ and $f'(0) = 0$, then
(A) f is differentiable for all $x \in R$
(B) f is non differentiable for at least one $x \in R$
(C) f is twice differentiable for all $x \in R$
(D) f is twice differentiable for all $x \in R - \{0\}$

7. Let $F:(1, \infty) \to R$ be a function defined as $F(x) = \int_x^{x^2} \frac{dt}{\ell n\, t}$. Which of the following statements are correct?
(A) $F(x)$ is strictly decreasing
(B) Range of $F(x)$ is $(0, \infty)$
(C) Range of $F(x)$ is $(\ell n 2, \infty)$
(D) $F(x)$ is one – one function

8. The sequence 1, 3, 4, 9, 10, 12, 13,……consists of all those positive integers which are powers of 3 or sums of distinct powers of 3. The hundredth term of this sequence is less than
(A) 982
(B) 983
(C) 981
(D) 980

9. A chord of negative slope from the point $P\left(\sqrt{264}, 0\right)$ is drawn to the ellipse $x^2 + 4y^2 = 16$. This chord intersects the ellipse at A and B (O is the origin).
(A) The maximum area of ΔAOB is 4
(B) The maximum area of ΔAOB is 8
(C) If the area of ΔAOB is maximum, then the slope of line AB is $\frac{-1}{2\sqrt{2}}$
(D) If the area of ΔAOB is maximum, then the slope of line AB is $\frac{-1}{8\sqrt{2}}$

Space for Rough work

10. A parallelogram is constructed with its sides parallel to the asymptotes of the hyperbola $x^2 - 2y^2 - 4x + 4y - 2 = 0$ and one of its diagonals is a chord of the same hyperbola. If the other diagonal passes through a fixed point (a, b) $a, b \in R$ then

(A) $a + b = 3$ (B) $a - b = 3$

(C) $\sum_{r=1}^{a+b} r = 6$ (D) $\sum_{r=1}^{a-b} r = 6$

11. If $m, n \in N$ such that m < n and the last three digits of 2978^m and 2978^n are same then

(A) the least value of m is 1 (B) the least value of m is 3

(C) the least value of n is 100 (D) the least value of n is 103

12. If the sum of squares of 3 real numbers a, b, c is equal to 1, then the value of expression $(4a - 3b)^2 + (5b - 4c)^2 + (3c - 5a)^2$ is always less than

(A) 50 (B) 51

(C) 52 (D) 53

13. Let $S_2 = 0$ be the mirror image of $S_1 : x^2 + y^2 - 4x - 6y + 12 = 0$ w.r.t. the line $L_1 : 10^4 x + (10^4 + 10)y + (10^4 + 20) = 0$. Let $L_2 : 2^{11}x + (2^{11} + 2^{12})y + (2^{11} + 2^{13}) = 0$ be a line. The equation of the line passing through the point of intersection of the line $L_2 = 0$ with the radical axis of $S_1 = 0, S_2 = 0$ and making equal intercepts with the coordinate axes, is

(A) $x - y - 3 = 0$ (B) $x + y + 1 = 0$

(C) $2x - 2y + 1 = 0$ (D) $2x + 2y + 3 = 0$

Space for Rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. If $g(x) = \lim\limits_{m\to\infty} \dfrac{x^m f(1) + h(x) + 1}{2x^m + 3x + 3}$ is continuous at x = 1 and $g(1) = \lim\limits_{x\to1}(\ell n\, ex)^{\frac{2}{\ell n x}}$ then evaluate $2g(1) + 2f(1) - h(1) + 2$. Assume that $f(x)$ and $h(x)$ are continuous at x = 1.

2. Let $f(x) = x^3 + 3x + 2$ and $g(x)$ be its inverse. If the area bounded by $g(x)$, x – axis and the ordinates x = – 2 and x = 6 is $\dfrac{p}{q}$ (where p& q are coprime), find value of $p + q - 1$

3. A coin of radius 1 cm is thrown at random onto an infinite chessboard with a side length of each square as 4 cm. If the probability that the coin intersects at most one side of a square is $\dfrac{p}{q}$ (where p and q are coprime) then find the value of $p + q - 2$

4. Consider a parabola touching x – axis at A (2, 0) and y – axis at B (0, 1). If (α, β) be the focus then $|\beta - 2\alpha|$ is equal to

5. If the maximum value of $\left|\sqrt{x^4 - 7x^2 - 4x + 20} - \sqrt{x^4 + 9x^2 + 16}\right|$ is P, find the value of $[P]$ (where [.] denotes GIF)

Space for Rough work

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CONCEPT RECAPITULATION TEST – I
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**A**	**C**	**B**
2.	**B**	**C**	**C**
3.	**A**	**C**	**B**
4.	**A**	**A**	**C**
5.	**B**	**B**	**B**
6.	**CD**	**ABC**	**AD**
7.	**AB**	**BC**	**CD**
8.	**AD**	**BD**	**AB**
9.	**ABC**	**ACD**	**AD**
10.	**ABD**	**BCD**	**AC**
11.	**BD**	**CD**	**BD**
12.	**ABD**	**AC**	**BCD**
13.	**BD**	**B**	**AB**
1.	**2**	**1**	**3**
2.	**3**	**2**	**8**
3.	**1**	**1**	**5**
4.	**4**	**4**	**0**
5.	**5**	**9**	**8**

Physics PART – I

SECTION – A

1. A

Sol. For C $5mg - 3kx_3 = 0 \quad \Rightarrow 3kx_3 = 5mg$

For B $3kx_3 + 2mg = 2k.x_2 \Rightarrow 2kx_2 = 7mg$

For A $2kx_2 + 3mg = kx_1$

If spring 2 is cut $kx_2 = 0$

$2mg + 3kx_3 = 2ma_B$

$7\ mg = 2ma_B$

$a_B = \frac{7}{2}g(\downarrow)$

2. B

Sol. $\vec{v} = 2V\cos 30° \sin 30° (-\hat{i}) + V(\cos^2 30° - \sin^2 30°)\hat{j}$

3. A

Sol. $\lambda_{min} = \frac{12375}{40,000} = 0.30$ Å. Hence wavelength less than 0.30 Å is not possible.

4. A

Sol. Potential energy $U = eV = eV_0 \ln\frac{r}{r_0}$

$\therefore$ Force $F = \left|\frac{dU}{dt}\right| = \frac{eV_0}{r}$.

$\therefore$ The force will provide the necessary centripetal force.

Hence, $\frac{mv^2}{r} = \frac{eV_0}{r} \Rightarrow v = \sqrt{\frac{eV_0}{m}} \qquad \ldots(i)$

and $mvr = \frac{nh}{2\pi} \qquad \ldots(ii)$

From equations (i) and (ii), $mr = \left(\frac{nh}{2\pi}\right)\sqrt{\frac{m}{eV_0}}$ or $r \propto n$.

5. B

Sol. $y = A\sin(kx)\cos(\omega t)$

$k = \frac{2\pi}{\lambda} = \frac{\pi}{\ell}$

$\ell \rightarrow$ length of sting

$U = \int dU$

$= \int_{x=0}^{x=\ell} \frac{1}{2}(dm)\,\omega^2 A^2 \sin^2\left(\frac{\pi x}{\ell}\right)$ and $dm = \frac{m}{\ell}dx$

6. CD

Sol. Particle *P* will have a velocity in vertical direction.

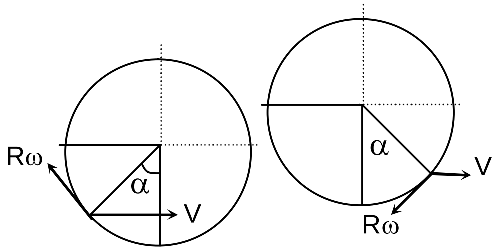
i.e. $R\,\omega \cos\alpha = V$

$$\alpha = \cos^{-1}\frac{V}{R\omega}$$

Required angle θ is $\theta = \pi - \alpha = \pi - \cos^{-1}\frac{V}{R\omega}$

And in second case $R\omega\cos\alpha = V$

$$\alpha = \cos^{-1}\frac{V}{R\omega},\ \theta = \pi + \cos^{-1}\frac{V}{R\omega}$$



7. AB

Sol. $-\frac{dv}{dt} = \frac{v^2}{R}$ & $-v\frac{dv}{ds} = \frac{v^2}{R}$

8. AD

Sol. Property of friction.

9. ABC

Sol. Work energy theorem.

10. ABD

Sol. By conservation of angular momentum,

$$I_1\omega_i = (I_1 + I_2)\omega_f$$

$$\omega_f = \omega_1/3$$

$$E_i = \frac{1}{2}I_1\omega_i^2$$

$$E_f = \frac{1}{2}(I_1 + I_2)\omega_f^2$$

Ratio of the heat produced to initial kinetic energy $= \frac{E_i - E_f}{E_i} = \frac{2}{3}$

11. BD

Sol. $E \propto m$ and $r \propto \frac{1}{m}$

12. ABD

Sol. Bernoulli’s theorem for an orifice at depth ‘x’ in liquid ‘3d’.

$$P_o + \left(dg\frac{H}{2} + 3dg.x\right) = P_o + \frac{1}{2}\times 3d\times v^z \quad \ldots(1)$$

$$\frac{H}{2} - x = \frac{1}{2}gt^2 \quad \ldots(2)$$

$$R = Vt \quad \ldots(3)$$

Solve for R and apply maxima/minima.

13. BD

Sol. Stopping potential does not depend on intensity and saturation current depends on intensity. Intensity I due to point source $\propto \frac{1}{r^2}$ where r is distance from the source.

SECTION – C

1. 2

Sol. For m not to slide over M, acceleration of the triangular block should be g tanθ if the required mass in m_0, then

$m_0g - T = m_0(g\tan\theta)$

& $T = (M+m)g\tan\theta$ &

T = 2g tanθ

& cotθ = 2

m_0 = 2 kg

2. 3

Sol. $PT^2 = k$

$$\gamma = \frac{1}{V}\left(\frac{dV}{dT}\right) \quad \ldots(i)$$

$$\left(\frac{nRT}{V}\right)T^2 = k$$

$$\Rightarrow \frac{T^3}{V} = k'$$

$$\Rightarrow V = \frac{T^3}{k'} \quad \ldots(ii)$$

$$\frac{dV}{dT} = \frac{3T^2}{K'} \quad \ldots(iii)$$

From (i), (ii) and (iii)

$$\gamma = \left(\frac{k'}{T^3}\right)\times\left(\frac{3T^2}{k'}\right) = \frac{3}{T}$$

3. 1

Sol. $$B\int_0^R \frac{\omega}{2\pi}Q\frac{2\pi r}{\pi R^2}dr\,\pi r^2 = \frac{T_0D}{2}$$

$$\Rightarrow \omega = \frac{T_0D}{QR^2B}.$$

4. 4

Sol. Consider energy losses in successive collisions, find θ, i.e. maximum deflection after each collision you will get $\cos\theta > \frac{1}{2}$ will satisfy $\theta < 60^0$ this condition will be met after nth collision.

After 1st collision, K.E. = $mghe^2$ = 0.8 mgh
After 2nd collision, K.E. = 0.64 mgh
After 3rd collision, K.E. = 0.512 mgh
After 4th collision, K.E. < $\frac{mgh}{2}$
i.e., θ < 60°.

5. 5

Sol. $5 = \frac{i}{2}(6) + i(2) + iR$

$\Rightarrow\ 5 = 3i + 2i + iR$

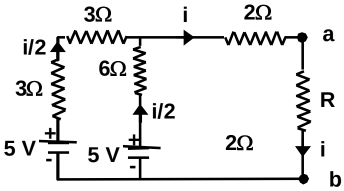
$\Rightarrow\ i = \frac{5}{5+R}$

$P = i^2R = \left(\frac{5}{5+R}\right)^2 R$

$P = i^2R$

$\frac{dP}{dR} = 0$

$R = 5\Omega.$



Chemistry PART – II

SECTION – A

1. C

Sol. $CaCO_3 + H_2SO_4 \longrightarrow CaSO_4 + CO_2 + H_2O$

Moles of $CaCO_3$ = Moles of H_2SO_4 = $\dfrac{25.1 \times \frac{0.02}{2}}{1000}$ = 2.51×10^{-4}

Moles of $CaCO_3$ = $2.51 \times 10^{-4} \times 100 = 2.51 \times 10^{-2}$

100 mL water contains = 2.51×10^{-2} g $CaCO_3$

$\therefore 10^6$ mL(10^6 g) water will contain = 251 g of $CaCO_3$

$\therefore$ Hardness of sample = 251 ppm

2. C

Sol. NaOH is not used as a bleaching agent.

3. C

Sol.
$$\begin{array}{lccc} & A(g) & \rightarrow 4B(g) & + \; 3C(g) \\ \text{At } t=0: & P_o & 0 & 0 \\ \text{At } t=20\,\text{min}: & P_o - x & 4x & 3x \end{array}$$

$P_o - x + 4x + 3x = 400 \Rightarrow P_o + 6x = 400 \Rightarrow 6x = 400 - 100 = 300$

x = 50

$K = \dfrac{0.693}{t_{1/2}} = \dfrac{0.693}{20 \times 60} = 5.7 \times 10^{-4}\ \text{sec}^{-1}$

4. A

Sol. The acidic strength of the acids is
HW > HX > HY > HZ

5. B

Sol. No. of X^{2+} ions per unit cell = 1

No. of Y^{2-} ions per unit cell = $8\,Y^{2-} \times \dfrac{1}{8} = Y^{2-}$

Hence the formula is XY.

6. ABC

Sol. Dipole moment of $NH_3 > NF_3$, $SCl_2 > BeCl_2$(zero value)
$SF_4 > CF_4$(zero value)

7. BC

Sol. It is an endothermic reaction as the equilibrium constant increases with increasing temperature.

8. BD

Sol. $Be_2C \xrightarrow{H_2O} Be(OH)_2 + CH_4$

$Al_4C_3 \xrightarrow{H_2O} Al(OH)_3 + CH_4$

9. ACD

Sol. $\Delta S_{x\to z} = \Delta S_{x\to y} + \Delta S_{y\to z}$ (Enthalpy is a state function and hence additive)

$\Delta H_{x\to y\to z} = \Delta H_{x\to z}$ (State function, depend in initial and final state)

$W_{x\to y\to z} = W_{x\to y}$ (work done in $y \to z$ is zero as it is an isochoric process)

10. BCD

Sol. Gr-III radicals are precipitated with ammonia solution.

11. CD

Sol. For Ni^{2+} the configuration is $t_{2g}^6 e_g^2$ and Zn^{2+} is $t_{2g}^6 e_g^4$.

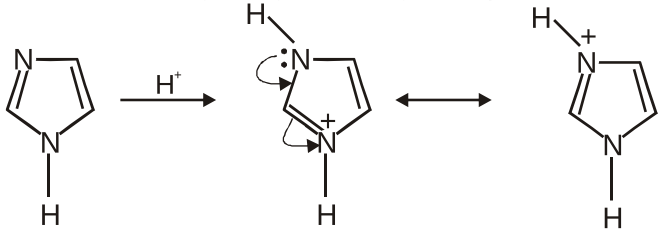
12. AC

Sol. $\mu = 2\mu \cos\frac{\theta}{2}$ [When two diploes are identical]

13. B

Sol. (i) Loses aromaticity if it gives away lone pair

(ii)



Conjugate acid is resonance stabilized but attached to sp^2 carbon atoms, which shows –I effect and destabilize the conjugate acid.

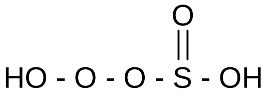
SECTION – C

1. 1

Sol. The valence electrons are $3s^2 3p^1$ for which ℓ = 0 and 1.

2. 2

Sol. The structure of H_2SO_5 is:



$$HO - O - O - \overset{\overset{\displaystyle O}{||}}{S} - OH$$

3. 1

Sol. Total charge on four oxide ions = -2 × 4 = -8

Let ‘n’ no. of $X^{-8/3}$ ions will replace O^{2-} ions

$\therefore\ n \times \frac{-8}{3} = -8 \Rightarrow n = 3$

$\therefore$ One vacancy will be created.

4. 4

Sol. $\Delta T_f = K_f \times n \times \frac{1000}{W}$

Or, $4 = 1.86 \times \frac{6.2}{62} \times \frac{1000}{W}$

$\therefore$ W = 46.5 g

$\therefore$ Mass of water converted to ice = 50.5 – 46.5 = 4 g

5. 9

Sol. Charge = 96500 × 1 = 96500 coulomb = 1 F

1F deposits 1 g eq = 9 g of aluminium

Mathematics PART – III

SECTION – A

1. B

Sol. $|A+B|=0$

2. C

Sol. 4 circles touch sides of any given triangle formed by 3 tangents.

3. B

Sol. Required number $=8\times9\times9\times9\times9\times3$

4. C

Sol. Let common root be α and $P(x)=x^2+bx+c$

Now $P(\alpha)=0$ and $P(P(P(\alpha)))=0$

$\therefore$ one of the roots must be 1.

5. B

Sol. $(x+iy)^3=18+26i$

$\Rightarrow x^3-3xy^2=18$

$3x^2y-y^3=26$

Use $y=tx$ and solve

6. AD

Sol. $f'(x)=\lim\limits_{n\to0}\dfrac{f(x+h)-f(x)}{h}=|x|$

Hence, f (x) is differentiable for all $x\in R$ but not twice differentiable at x = 0.

7. CD

Sol. $x\ell n2<F(x)<x^2\ell n2$ as $x\to1^+$

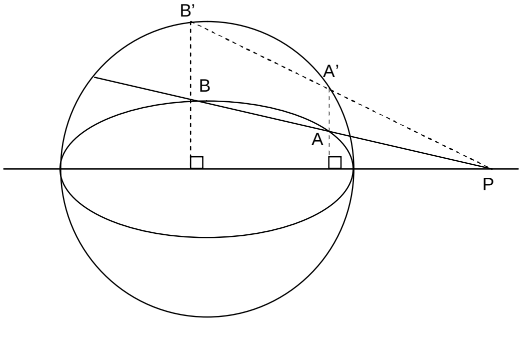
$\therefore$ Range of $F(x)$ is $(\ell n2,\infty)$

8. AB

Sol. Consider a number system with base 3 and using only the digits 0 or 1.

9. AD

Sol. Take $A(\theta_1)$ and $B(\theta_2)$



10. AC

Sol. Second diagonal will pass through the centre of the hyperbola.

11. BD

Sol. $2978^n - 2978^m = 1000k \;\; k \in N$

$\therefore m = 3\lambda$ and $n - m = 100\mu$

12. BCD

Sol. Let $\vec{r_1} = a\hat{i} + b\hat{j} + c\hat{k}$ and $\vec{r_2} = 3\hat{i} + 4\hat{j} + 5\hat{k}$ and $\left|\vec{r_1} \times \vec{r_2}\right| \le \left|\vec{r_1}\right|\left|\vec{r_2}\right|$

13. AB

Sol. Radical axis of $S_1 = 0$ and $S_2 = 0$ is the line $L_1 = 0$, the point of concurrency of family of lines $ax + by + c = 0$ if a,b,c are in A.P. is (1,-2)

SECTION – C

1. 3

Sol. $g(1) = e^2$

$$\lim_{x\to1^-} g(x) = \frac{h(1)+1}{6}$$

$$\lim_{x\to1^+} g(x) = \frac{f(1)}{2}$$

Since, $g(x)$ is continuous at $x = 1$

$$g(1) = \lim_{x\to1^-} g(x) = \lim_{x\to1^+} g(x)$$

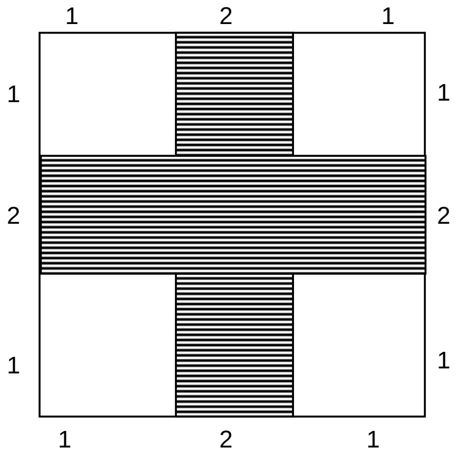
$$\Rightarrow 2g(1) + 2f(1) - h(1) + 2 = 3$$

2. 8

Sol. Area $= \int_0^1 \left(6 - f(x)\right)dx + \int_{-1}^0 \left(f(x) - (-2)\right)dx = \frac{5}{4}$

3. 5

Sol. Feasible region is



4. 0

Sol. Focus is $\left(\frac{2}{5}, -\frac{4}{5}\right)$

5. 8

Sol. $x^4 - 7x^2 - 4x + 20 = \left(x^2 - 4\right)^2 + \left(x - 2\right)^2$

$x^4 + 9x^2 + 16 = \left(x^2 + 4\right)^2 + x^2$

Take the curve $y = x^2$.

Both square roots can be interpreted as distances.

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

FIITJEE

JEE (Advanced), 2017

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – II

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 264**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i). **Section-A (01 – 10)** contains 10 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer and **– 2 marks** for wrong answer.

(ii). **Section – B (01 – 02)** contains 2 Match the following Type questions. Each question having 4 statements in Column I & 5 statements in Column II with any given statement in Column I having correct matching with 1 or more statement (s) given in Column II. Each statement carries **+2 marks** for correct answer and **– 1 mark** for wrong answer.

(iii). **Section-C (01 – 08)** contains 8 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

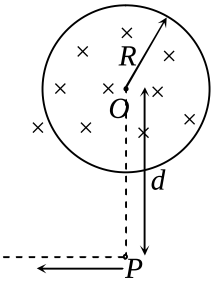
Physics PART – I

SECTION – A
(One or More Than One Options Correct Type)

This section contains **10 multiple choice type questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE** or **MORE THAN ONE** are correct.

1. A 10 m long horizontal stainless steel wire AB of mass 1 kg whose end A is fixed, is connected to a massless string BC passing over a smooth pulley. String BC is connected to a container of mass 2 kg at end C. Water (density = 1×10^3 kg/m^3) is poured in the container at a constant rate of 2.25 litre/sec at t = 0. Also at t = 0, a pulse is generated at end A. Choose from the following the correct option(s).
(A) Time taken by the pulse to reach point B is 0.612 sec
(B) Time taken by the pulse to reach point B is 0.212 sec
(C) Tension in the string at this moment is 33.77 N
(D) Tension in the string at this moment is 24.77 N

2. In a cylindrical region of radius R, there exists a time varying magnetic field B such that $\frac{dB}{dt} = k(>0)$. A charged particle having charge q is placed at the point P at a distance d (> R) from its centre O. Now, the particle is moved in the direction perpendicular to OP (see figure) by an external agent upto infinity so that there is no gain in kinetic energy of the charged particle. Choose the correct statement/s.



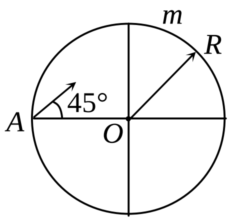
(A) Work done by external agent is $\frac{q\pi R^2}{4}k$ if d = 2R
(B) Work done by external agent is $\frac{q\pi R^2}{8}k$ if d = 4R
(C) Work done by external agent is $\frac{q\pi R^2}{4}k$ if d = 4R
(D) Work done by external agent is $\frac{q\pi R^2}{4}k$ if d = 6R

Space for Rough work

3. If the dimensions of length are expressed as $G^x c^y h^z$; where G, c and h are the universal gravitational constant, speed of light and Planck's constant respectively, then

(A) $x = \frac{1}{2}, y = \frac{1}{2}$
(B) $x = \frac{1}{2}, z = \frac{1}{2}$
(C) $y = \frac{1}{2}, z = \frac{3}{2}$
(D) $y = -\frac{3}{2}, z = \frac{1}{2}$

4. A ring of mass m and radius R is placed on a frictionless horizontal surface. A particle of mass m is projected from point A with velocity v at an angle of 45° with AO as shown. The correct statements are



(A) The particle reaches the same point A on the ring after time $\frac{4R\sqrt{2}}{v}$.

(B) Magnitude of impulse transformed during first collision is $\frac{mv}{\sqrt{2}}$.

(C) Magnitude of impulse transformed during second collision is $\frac{mv}{\sqrt{2}}$.

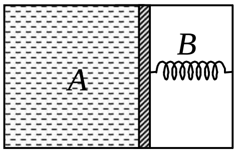
(D) Particle reaches diametrically opposite point on the ring in time $\frac{2R}{v}$.

5. Two projectile are thrown at the same time from two different points. The projectile thrown from the origin has initial velocity $3\hat{i} + 3\hat{j}$ with respect to earth. The projectile has initial velocity $a\hat{i} + b\hat{j}$ with respect to earth thrown from the point (10, 5). ($\hat{i}$ is a unit vector along horizontal, $\hat{j}$ along vertical). If the projectile collides after two second, then the

(A) value of a is -2
(B) value of a is $\frac{1}{2}$
(C) value of b is $\frac{1}{2}$
(D) value of b is –2

Space for Rough work

6. A thermally insulated chamber of volume $2V_0$ is divided by a frictionless piston of area S into two equal parts A and B. Part A has an ideal gas at pressure P_0 and temperature T_0 and in part B is vacuum. A massless spring of force constant k is connected with piston and the wall of the container as shown. Initially spring is unstretched. Gas in chamber A is allowed to expand. Let in equilibrium spring is compressed by x_0. Then



(A) final pressure of the gas is $\frac{kx_0}{S}$

(B) work done by the gas is $\frac{1}{2}kx_0^2$

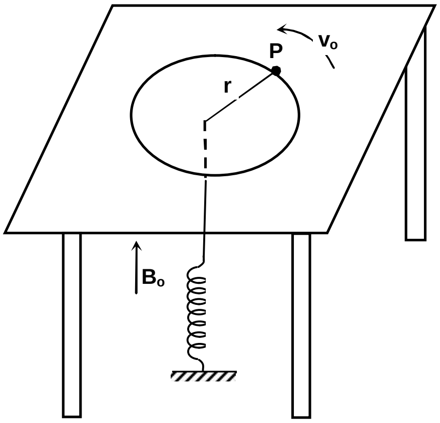
(C) change in internal energy of the gas is $\frac{1}{2}kx_0^2$

(D) temperature of the gas is decreased

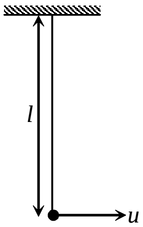
7. A particle mass m charge q is moving on a circular path on the surface of a frictionless table with speed v_o where a magnetic field B_o exists uniformly over the whole region. It is attached by a string which passes through a hole in the table to a spring as shown.

The spring is stretched by x_o. If now the magnetic field is increased slowly to $2B_o$, which of these are incorrect?

(A) The extension in the spring will increase
(B) The speed of the particle will increase
(C) The speed of the particle will decrease
(D) The kinetic energy of the particle will decrease



Space for Rough work



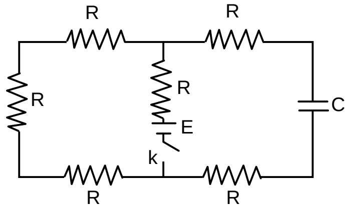
8. A particle of mass m is attached to one end of the light inextensible string and other end of the string is fixed in vertical plane as shown. Now particle is given horizontal velocity $u = \sqrt{\frac{5}{2}gl}$, then which of the following statement/s is/are correct.

(A) The string makes angle with the downward vertical is 60^0 when acceleration of the particle is horizontal.

(B) The tension in string is 2 mg when acceleration of the particle is horizontal.

(C) The speed of the particle is $\sqrt{\frac{3}{2}gl}$ when acceleration of the particle is horizontal

(D) The particle will not complete the circle.



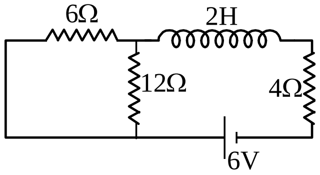
9. In the given circuit initially the capacitor is uncharged. At t = 0 the key k is closed. Choose the correct option(s)

(A) The time constant of the circuit is $\frac{11RC}{4}$.

(B) The time constant of the circuit is $\frac{11RC}{5}$.

(C) Current through the capacitor after one time constant is $\frac{3E}{11R}\left(\frac{1}{e}\right)$.

(D) Current through the capacitor after one time constant is $\frac{5E}{11R}\left(\frac{1}{e}\right)$.



10. For the circuit shown in the figure, which of the following statements is/are correct

(A) Its time constant is 0.25 second

(B) In steady sate, current through inductance will be equal to zero.

(C) in steady state, current through the battery will be equal to 0.75 amp.

(D) none of these

Space for Rough work

SECTION – B

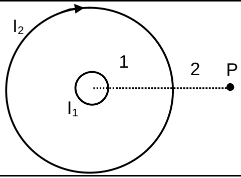
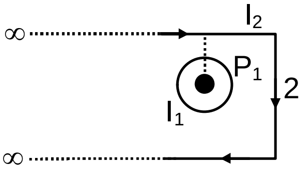
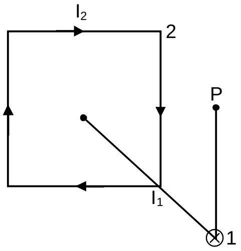
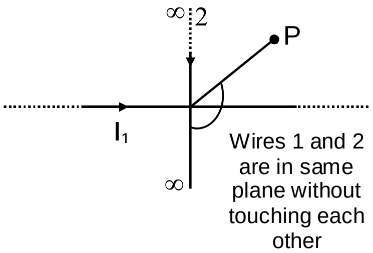
Matrix-Match Type

*This section contains 2 questions. Each question contains statements given in two columns which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A-p, s and t; B-q and r; C-p and q; and D-s and t; then the correct darkening of bubbles will look like the following.

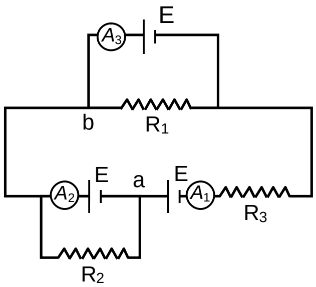
	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the Column:

	Column – I		**Column – II**
(A)		(p)	1 and 2 attract each other
(B)		(q)	1 and 2 repel each other
(C)		(r)	1 and 2 do not exert any force on each other
(D)	 ∞ 2 P I₁ ∞ Wires 1 and 2 are in same plane without touching each other	(s)	Magnetic field at point P due to wires 1 and 2 are perpendicular to each other.
		(t)	Magnetic field at point P due to wires 1 and 2 are in same direction.

Space for Rough work

2. In the circuit shown in figure, $R_1 = R_2 = R_3 = 3\Omega$ and e.m.f. of each cell is E = 4V and negligible internal resistance. All ammeters are ideal. Match the following:



Column - I		Column - II	
(A)	Reading of ammeter A_1 in ampere is	(p)	4/3
(B)	Reading of ammeter A_2 in ampere is	(q)	8/3
(C)	Reading of ammeter A_3 in ampere is	(r)	4
(D)	Potential difference between point a and point b in volt is	(s) (t)	zero 2

SECTION – C

(One Integer Value Correct Type)

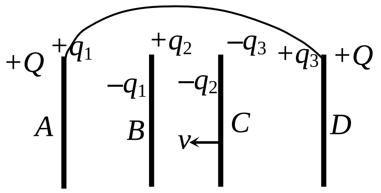
This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. A point source of power 4W is placed 1m below the free surface of liquid whose refractive index is '$\frac{2}{\sqrt{3}}$'. Find the rate of transfer of energy (in watt) from the liquid surface to air. Ignore any absorption or scattering of light energy.

2. A double convex lens forms a real image of an object on a screen which is fixed. Now the lens is given a constant velocity v_0 along its axis and away from the screen. For the purpose of forming the image always on the screen, the object is also required to be given an appropriate velocity. Find the velocity of the object at the instant its size is n times the size of image. (Take n = 1/2 and v_0 = 1 m/s)

Space for Rough work

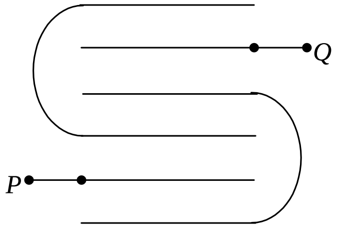
3. In the diagram there are four conducting plates A, B, C and D placed parallel to each other at equal separation L. If plate C starts moving towards plate B with velocity v. Find the current (in mA) flowing in the wire connecting A and D. (assume all other plates to be fixed) (Given: q_2 = 5μC, q_3 = 10μC, v = 10 m/s, L = 0.05 m)



4. A thin uniform rod of mass 'm', length 'ℓ' rotates uniformly about a vertical axis ω, form a conical pendulum, the upper end of the rod is hinged and θ is angle between rod and vertical.

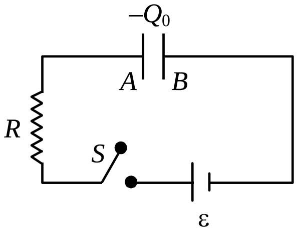
If the change of angular momentum of the rod about hinge is $\frac{m\ell^2}{x}\omega^2\sin 2\theta$ then the value of 'x' will be

5. Identical metal plates are located in air at equal distances *d* from one another. The area of each plate is equal to A. The capacity of system between points *P* and *Q* is $\frac{K\varepsilon_0 A}{d}$. Then the value of 'K' is



6. The figure shows a *RC* circuit with a parallel plate capacitor. Before switching on the circuit, plate *A* of the capacitor has a charge –Q_0 while plate *B* has no net charge. Now, at *t* = 0, the circuit is switched on. How much time (in second) will elapse before the net charge on plate *A* becomes zero.

(Given *C* = 1μF, Q_0 = 1mC, ε = 1000 V and $R = \frac{2\times10^6}{\ln 3}\Omega$)



7. A ring of mass 3 kg is rolling without slipping with linear velocity 1 m/sec on a smooth horizontal surface. A rod of same mass is fitted along its one diameter. Find total kinetic energy of the system (in J).

8. Potential energy of a particle moving along x-axis is given by U = $\frac{x^3}{3}-\frac{9x^2}{2}+20x$. Find out position of stable equilibrium state.

Space for Rough work

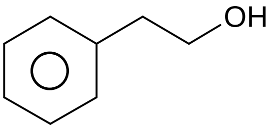
Chemistry PART – II

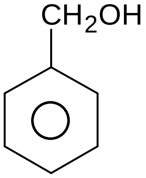
SECTION – A
Straight Objective Type

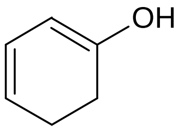
This section contains **10 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

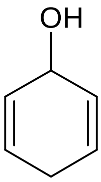
1. Which of the following compound produce any gas when reacts with water?
(A) KO_2 (B) CaC_2
(C) Mg_3N_2 (D) $Ba(NO_3)_2$

2. Which of the following compound does exhibit mesomeric effect?

(A) 

(B) 

(C) 

(D) 

3. Which of the following compound of carbon forms acidic solution when reacts with water at room temperature?
(A) CO (B) $COCl_2$
(C) CCl_4 (D) CH_4

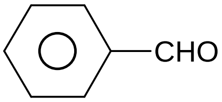
4. Which of the following element is present in silicones?
(A) Carbon (B) Hydrogen
(C) Oxygen (D) Sulphur

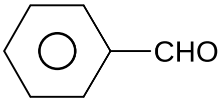
5. The boiling point of which of the following aqueous solution(s) is/are greater than 100°C?
(A) 0.2 M NaCl (B) 0.1 M $AlCl_3$
(C) 1 M KNO_3 (D) 2 M $BeSO_4$

Space for Rough work

6. Which of the following is/are the coordination isomer(s) of $[Co(NH_3)_6]\ [Cr(CN)_6]$?
(A) $[Cr(NH_3)_6]\ [Co(CN)_6]$
(B) $[Cr(NH_3)_4(CN)_2]\ [Co(CN)_4(NH_3)_2]$
(C) $[Cr(NH_3)_3(CN)_3]\ [Co(NH_3)_3(CN)_3]$
(D) $[Cr(NH_3)_4]\ [Co(CN)_4]$

7. Which of the following two compound(s) form different number of gases on heating?
(A) $LiNO_3$ and $NaNO_3$
(B) $MgCl_2.6H_2O$ and $Na_2SO_4.10\ H_2O$
(C) $FeSO_4$ and $Fe_2(SO_4)_3$
(D) $CaCO_3$ and $BeCO_3$

8. Which of the following compounds can be distinguished by Fehling's test?
(A) CH_3CHO and CH_3COCH_3
(B) CH_3CH_2CHO and 

(C) 

and CH_3COCH_3
(D) CH_3CHO and HCHO

9. The hcp and ccp structure for a given element would be expected to have
(A) the same coordination number
(B) the same density
(C) the same packing fraction
(D) the same edge length

10. In which of the following pair, the dipole moment of first compound is greater than that of the second compound?
(A) NH_3, NF_3
(B) $CHCl_3$, CCl_4
(C) CO_2, SO_2
(D) BF_3, NF_3

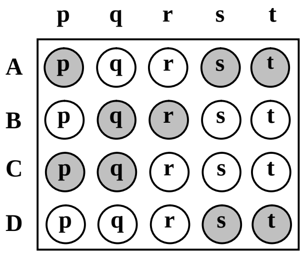
Space for Rough work

SECTION – B

Matrix-Match Type

*This section contains 2 questions. Each question contains statements given in two columns which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A-p, s and t; B-q and r; C-p and q; and D-s and t; then the correct darkening of bubbles will look like the following.



1. Match the radicals mentioned in Column-I with their reactions mentioned in Column-II.

Column – I		Column – II	
(A)	Fe^{2+}	(p)	Forms precipitate with KCN, which is soluble in excess of the reagent.
(B)	Hg^{2+}	(q)	Forms precipitate with NaOH and NH_4OH, which is insoluble in both excess of reagent.
(C)	Pb^{2+}	(r)	forms coloured precipitate with KI, which is soluble in excess of reagent.
(D)	Ag^{+}	(s)	forms black precipitate with H_2S which is soluble in hot and dilute HNO_3.

2. Match the aqueous solutions of acids, bases and salts mentioned in Column-I with their pH and nature mentioned in Column-II.

Column – I		Column – II	
(A)	HCOOH (p^{K_a} = 3.74, 0.1 M) + HCOONa (0.1 M)	(p)	Acidic buffer at its maximum capacity
(B)	CH_3COOH (0.1 M) + HCl (0.1 M)	(q)	behaves as a buffer
(C)	CH_3COOH (p^{K_a} = 4.74, 0.1 M) + NH_4OH (p^{K_a} = 9.26, 0.1 M)	(r)	pH < 7 at 298 K
(D)	HCOONa (300 mL of 0.1 M) + HCl (100 mL of 0.1 M)	(s)	pH = 7 at 298 K

Space for Rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. 4.48 litre of an ideal gas at STP requires 12 calorie to raise the temperature by 15^oC at constant volume. What is the value of C_P of the gas in calorie unit?

2. How many maximum number of nitro product(s) is/are formed when $CH_3CH_2CH_3$ reacts with fuming HNO_3?

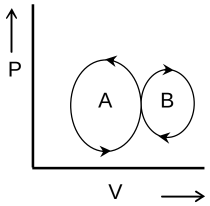
3. The half-life of a zero order reaction is 4 sec. How much seconds is needed for 75% completion of the reaction?

4. What is the sum of the number of equivalents of glucose and the number of equivalents of phenylhydrazine required to form one equivalent of glucosazone?

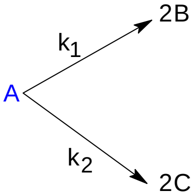
5. Compound X dissociates according to the reaction $2X(g) \rightleftharpoons 2Y(g) + Z(g)$, with degree of dissociation α which is small compared with unity, if expression for α in terms of equilibrium constant K_p and total pressure P is given as $\alpha = \left(\frac{2K_p}{P}\right)^{1/n}$. The value of n is

Space for Rough work

6. In the present graphs, the area of circle A and B are 25 unit and 20 unit respectively. Work done will be ____ unit.



7. For a hypothetical elementary reaction,



Where $\frac{k_1}{k_2} = \frac{1}{2}$ initially only 2 moles of A are present. Total number of moles of A,B and C at the end of 75% reaction are X. What will be the value of 2X

8. A vessel of 250 litres was filled with 0.01 mole of Sb_2S_3 and 0.01mole of H_2 to attain the equilibrium at 440^{0}C as $Sb_2S_3(s) + 3H_2(g) \rightleftharpoons 2Sb(s) + 2H_2S(g)$. After equilibrium, the H_2S formed was analysed by dissolved it in H_2O and treating with excess of Pb^{2+} to give 1.19g of PbS $(M_{Pb} = 207)$ as precipitate. The value of K_c at 440^{0}C is _____.

Space for Rough work

Mathematics PART – III

SECTION – A

Multiple Correct Choice Type

This section contains **10 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

1. Let $\vec{a}, \vec{b}$ and $\vec{c}$ be three vectors having magnitudes 1, 1 and 2 respectively. If $\vec{a} \times \left(\vec{a} \times \vec{c}\right) + \vec{b} = 0,$ then

(A) $\vec{b}$ is in the plane of $\vec{a}$ and $\vec{c}$ (B) $\vec{b}$ is parallel to $\vec{a} \times \vec{c}$

(C) angle between $\vec{a}$ and $\vec{c}$ is 30^o (D) angle between $\vec{a}$ and $\vec{c}$ is 150^o

2. The number of solutions of equation $8\sin x = \frac{\sqrt{3}}{\cos x} + \frac{1}{\sin x}$

(A) 6 if $x \in (0, 2\pi)$ (B) 4 if $x \in (0, \pi)$

(C) 5, if $x \in \left(0, \frac{3\pi}{2}\right)$ (D) There does not exist any solution

3. If A and B are two orthogonal matrices of order n and $\det(A) + \det(B) = 0,$ then which of the following must be correct

(A) $\det(A + B) = \det(A) + \det(B)$ (B) $\det(A + B) = 0$

(C) A + B = 0 (D) None of above are always correct

Space for Rough work

4. Consider the function g defined by $g(x) = \begin{bmatrix} x^2 \sin\frac{\pi}{x} + (x-1)^2 \sin\left(\frac{\pi}{x-1}\right), & x \neq 0,1 \\ 0, & \text{if } x = 0,1 \end{bmatrix}$ then which of the following statement (s) is/are correct?

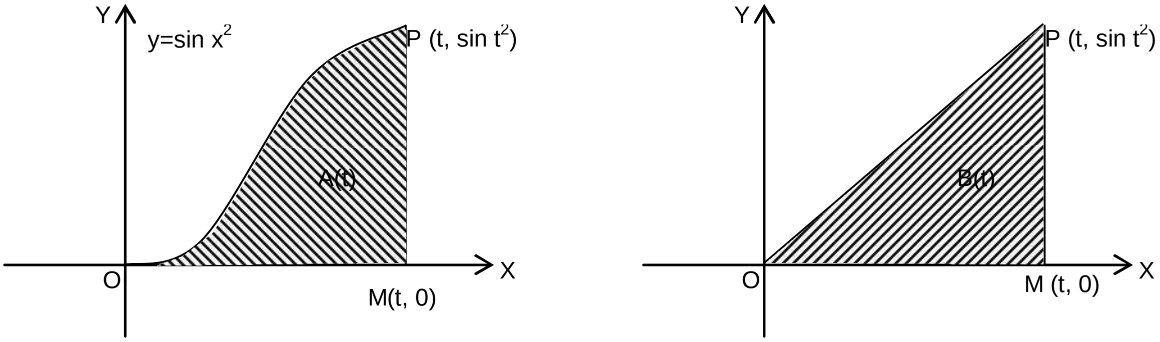
(A) $g(x)$ is differentiable $\forall x \in R$

(B) $g'(x)$ is discontinuous at $x = 0$ but continuous at x = 1

(C) $g'(x)$ is discontinuous at both $x = 0$ and $x = 1$

(D) Rolle's theorem is applicable for $g(x)$ in [0, 1]

5. The figure shows two regions in the first quadrant.



A(t) is the area under the curve , $y = \sin x^2$ from 0 to t and B (t) is the area of the triangle with vertices O, P and M (t, 0).Then $\lim\limits_{t \to 0} \frac{A(t)}{B(t)}$ equals

(A) $\frac{2}{3}$ (B) $\frac{3}{2}$

(C) $\frac{1}{2}$ (D) 1

6. Diagonals of a square are along pair of lines $2x^2 - 3xy - 2y^2 = 0$. If (2, 1) is a vertex of square then sides of square can be

(A) $3x - y + 5 = 0$ (B) $x + 3y + 5 = 0$

(C) $2x - y - 5 = 0$ (D) $x - 2y = 0$

Space for Rough work

7. If three planes $P_1 \equiv 2x + y + z - 1 = 0$, $P_2 \equiv x - y + z - 2 = 0$ and $P_3 = \alpha x - y + 3z - 5 = 0$ intersects each other at point P on XOY plane and at point Q on YOZ plane, where O is the origin then identify correct statement(s)
(A) The value of α is 4
(B) Straight line perpendicular to plane P_3 and passing through P is $\frac{x-1}{4} = \frac{y+1}{-1} = \frac{z}{3}$.
(C) The length of projection of $\overrightarrow{PQ}$ on x – axis is 1.
(D) Centroid of the triangle OPQ is $\left(\frac{1}{3}, \frac{-1}{2}, \frac{1}{2}\right)$

8. In the expansion of $(2x - 3y + z)^{10}$, then which of the following statement(s) is/are correct?
(A) The expansion will contain 66 terms
(B) Sum of all the coefficients is 0.
(C) The coefficient of $x^2y^3z^5$ equals $\left(\frac{-10! \times 9}{5!}\right)$
(D) None of these

9. The coefficient of x^{50} in the expansion of $\sum_{k=0}^{100} {}^{100}C_k (x-2)^{100-k} 3^k$ is also equal to
(A) number of ways in which 50 identical books can be distributed in 100 students, if each student can get atmost one book.
(B) number of ways in which 100 different white balls and 50 identical red balls can be arranged in a circle, if no two red balls are together.
(C) numbers of dissimilar terms in $(x_1 + x_2 + x_3 + ... + x_{50})^{51}$.
(D) $\frac{2.6.10.14......198}{50!}$

10. Let the complex number $z = x + iy$ (where $x, y \in R$) satisfy
$\cot^{-1}(\log_3 |2z+1|) > \cot^{-1}(\log_3 |2z-1|)$, then x can be
(A) –1 (B) –2
(C) 1 (D) 2

Space for Rough work

SECTION – B

Matrix-Match Type

This section contains 2 questions. Each question contains statements given in two columns which have to be matched. The statements in ***Column I*** *are labelled A, B, C and D, while the statements in* ***Column II*** *are labelled p, q, r, s and t. Any given statement in* ***Column I*** *can have correct matching with* ***ONE OR MORE*** *statement(s) in* ***Column II.*** *The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A-p, s and t; B-q and r; C-p and q; and D-s and t; then the correct darkening of bubbles will look like the following.

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

---

1. Match the columns:

	Column - I		**Column - II**
(A)	The maximum value of $\left(\cos\left(2A+\theta\right)+\cos\left(2B+\theta\right)\right)$, where A, B are constant, is	(p)	$2\sin\left(A+B\right)$
(B)	The maximum value of $\left(\cos 2A+\cos 2B\right)$, where (A + B) is constant and $A,B\in\left(0,\frac{\pi}{2}\right)$, is	(q)	$2\sec\left(A+B\right)$
(C)	The minimum value of $\left(\sec 2A+\sec 2B\right)$, where (A + B) is constant and $A,B\in\left(0,\frac{\pi}{4}\right)$, is	(r)	$2\cos\left(A+B\right)$
(D)	The minimum value of $\sqrt{\left(\tan\theta+\cot\theta-2\cos\left(A+B\right)\right)}$ where A, B are constants and $\theta\in\left(0,\frac{\pi}{2}\right)$, is	(s)	$\left\|2\cos\left(A-B\right)\right\|$
		(t)	$2\cos\left(A-B\right)$

Space for Rough work

2. A plane π passes through the point (1,1, 1) and is parallel to the vectors $\vec{a}$ = (–1, 1, 0) and $\vec{b} = (1, 0, -1)$ π meets the axis in A, B and C forming the tetrahedron OABC where O is origin.

	Column - I		Column - II
(A)	Volume of the tetrahedron OABC in cubic units	(p)	$\frac{9}{2}$
(B)	Area of the faces of the tetrahedron in square units	(q)	$\frac{9\sqrt{3}}{2}$
(C)	Distance of the points $\left(3\sqrt{3}/2, 3\sqrt{3}, 3\right)$ form the plane π in units	(r)	$\sqrt{3}$
(D)	Distance of the faces of the tetrahedron from the opposite vertex	(s)	3

SECTION – C

(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

1. The roots of the equation $z^4 + az^3 + (12 + 9i)z^2 + bz = 0$ are the vertices of a square then area of square is __________

2. Let $\beta = \int_0^1 \frac{2 + 3x + 4x^2}{2\sqrt{x^2 + x + 1}}\, dx$ then find the value of β^2.

3. The triangle ABC, right angled at C, has median AD, BE and CF. AD lies along the line $y = x + 3$, BE lies along the line $y = 2x + 4$. If the length of the hypotenuse is 60 and area of $\Delta ABC = 100(k)^2$ then k is ______________

Space for Rough work

4. Water is drained from a vertical cylindrical tank by opening a valve at the base of the tank. It is known that the rate at which the water level drops is proportional to the square root of water depth y, where the constant of proportionality k > 0 depends on the acceleration due to gravity and the geometry of the hole. If time to empty the tank be T minutes, then $\frac{T}{10} =$

5. If $\sum_{n=1}^{\infty} \tan^{-1}\left(\frac{\sqrt{2n+2}-\sqrt{2n-2}}{2+\sqrt{n^2-1}}\right) = \frac{\pi}{2} + \tan^{-1} k$ then find the value of k^2

6. If x, y, z are positive real numbers and $x + y + z = 1$, then find the minimum value of $\left(\frac{4}{x} + \frac{9}{y} + \frac{16}{z}\right).\frac{1}{27}$ is ___________

7 Let a, b, c be the sides of a triangle ABC and Δ be its area. If $a = 2, \Delta = \sqrt{3}$ and $a\cos C + \sqrt{3}\, a \sin C - b - c = 0$. Then the semi perimeter of the ΔABC is __________

8. Let slope of sides AB and BC of a ΔABC are roots of the equation $x^2 - 4x + 1 = 0$, (ΔABC lying in the first quadrant and B is origin) and inradius of the triangle is 1 unit. If co – ordinates of its incentre are (a, b) then $\left(a^2 + b^4\right)$ is _________

Space for Rough work

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

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ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

CONCEPT RECAPITULATION TEST – II
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**AC**	**ABC**	**ACD**
2.	**ACD**	**ABC**	**ABC**
3.	**BD**	**B**	**AB**
4.	**ABC**	**ABC**	**ACD**
5.	**AC**	**ABCD**	**A**
6.	**ABCD**	**AB**	**AB**
7.	**ACD**	**AC**	**ABCD**
8.	**ABCD**	**AB**	**ABC**
9.	**AC**	**AC**	**AD**
10.	**AC**	**AB**	**AB**
1.	**(A) → r,s** **(B) → r,s** **(C) → r,s** **(D) → r,t**	**(A) → p,q** **(B) → q,r** **(C) → r,s** **(D) → p,s**	**(A) → s** **(B) → r** **(C) → q** **(D) → p**
2.	**(A) → p** **(B) → q** **(C) → s** **(D) → r**	**(A) → p,q,r** **(B) → r** **(C) → q,s** **(D) → q,r**	**(A) → p** **(B) → p,q** **(C) → p** **(D) → r,s**
1.	**1**	**6**	**5**
2.	**3**	**4**	**3**
3.	**1**	**6**	**2**
4.	**6**	**4**	**6**
5.	**1**	**3**	**2**
6.	2	**5**	**3**
7.	**5**	**7**	**4**
8.	**5**	**1**	**6**

Physics PART – I

SECTION – A

1. AC

Sol. Mass per unit length of the wire = 0.1 kg/m.

At any instant, tension in the string is (2 + 2.25 t) g N

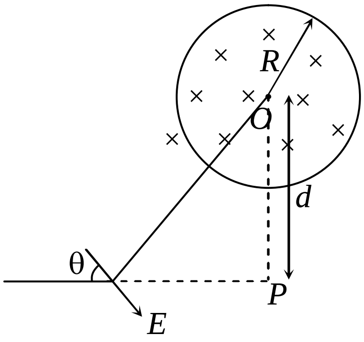
$$v = \sqrt{\frac{(2+2.25\,t)g}{0.1}} \quad ; \quad \int_0^{10} dx = 10\int_0^t \sqrt{2+2.25\,t}\,dt$$

t = 0.612 s

$$T = (2 + 2.25 \times 0.612) \times 10 = 33.77\text{ N}$$

2. ACD

Sol. $\oint \vec{E}\cdot d\vec{l} = A\dfrac{dB}{dt}$



$$E2\pi\sqrt{x^2+d^2} = \pi R^2 k$$

$$E = \frac{\pi R^2 k}{2\sqrt{x^2+d^2}}$$

$$W_{ext} = \int_0^{\infty} q\vec{E}\cdot dx = \frac{q\pi R^2}{4}k$$

3. BD

Sol. Length $\propto G^x c^y h^z$

$$L = \left[M^{-1}L^3T^{-2}\right]^x \left[LT^{-1}\right]^y \left[ML^2T^{-1}\right]^z$$

By comparing the power of M, L and T in both sides we get

$-x + z = 0, 3x + y + 2z = 1$ and $-2x - y - z = 0$

By solving above three equations we get

$$x = \frac{1}{2}, y = -\frac{3}{2}, z = \frac{1}{2}$$

4. ABC

Sol. Assume x-axis along OA and y-axis perpendicular to it in the plane of ring.

After 1st collision

Velocity of particle = $\dfrac{v}{\sqrt{2}}$ along x-axis

And velocity of ring = $\dfrac{v}{\sqrt{2}}$ along y-axis

After second collision velocity of ring = $\dfrac{v}{\sqrt{2}}\hat{i} + \dfrac{v}{\sqrt{2}}\hat{j}$

Velocity of particle = 0

Time to return at point A = $4 \times \dfrac{R\sqrt{2}}{v}$

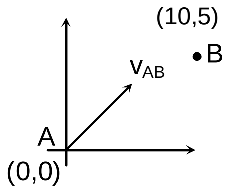
5. AC

Sol. $\vec{v}_{AB} = (3-a)\hat{i} + (3-b)\hat{j}$

$\vec{a}_{AB} = \vec{o}$

$(3-a)\times 2 = 10$ and $(3-b)\times 2 = 5$

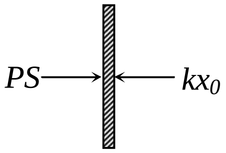
$a = -2$ and $b = \frac{1}{2}$



6. ABCD

Sol. Equilibrium of piston gives

$PS = kx_0$ or $P = \frac{kx_0}{S}$



Since, the chamber is thermally insulated $\Delta Q = 0$

$\therefore$ Elastic potential energy of spring = work done by gas

or, work done by gas = $\frac{1}{2}kx_0^2$

This work is done in the expense of internal energy of the gas.

Therefore, internal energy of the gas is decreased by $\frac{1}{2}kx_0^2$.

Internal energy of an ideal gas depends on its temperature only. Internal energy of the gas is decreasing. Therefore, temperature of the gas will decrease.

7. ACD

Sol. $\vec{F}_m = q(\vec{v}\times\vec{B})$ and apply Newton's second law of motion.

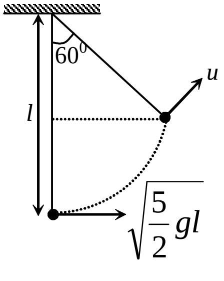
8. ABCD

Sol. $T - mg\cos 60^0 = \frac{mv^2}{l}$ … (i)

$\frac{1}{2}m\left(\sqrt{\frac{5}{2}gl}\right)^2 - mg\frac{l}{2} = \frac{1}{2}mv^2$ … (ii)

$v = \sqrt{\frac{3}{2}gl}$ and $T = 2mg$

Net force is in horizontal direction when $\theta = 60^0$



9. AC

Sol. Equivalent resistance across capacitor (after shorting the battery) = $\frac{11R}{4}$.

Voltage across capacitor in steady state = $\frac{3E}{4}$.

$$q = \frac{CE}{4}\left(1 - e^{\frac{-4t}{11RC}}\right)$$

10. AC

Sol. $\tau = \frac{L}{Req} = \frac{2}{8} = \frac{1}{4}$

at steady state inductor short circuited

Hence i = 0.75

SECTION – B

1. $A \to rs$ $B \to rs$ $C \to rs$ $D \to rt$

Sol. For cases (a), (b) and (c), magnetic field due to I_1 and I_2 are mutually perpendicular. Therefore, they do not exert any force on each other.
For case (d), magnetic fields at point P due to I_1 and I_2 are in the same direction.

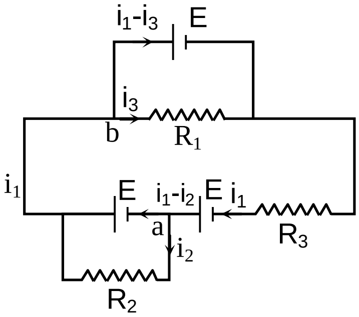
2. $A \to p$ $B \to q$ $C \to s$ $D \to r$

Sol. On solving by KVL we get, $i_1 = \frac{E}{R}$, $i_2 = -\frac{E}{R}$, $i_3 = \frac{E}{R}$

$\Rightarrow i_1 - i_2 = \frac{2E}{R}$ and $i_1 - i_3 = 0$

So reading of ammeter A_1 is E/R = 4/3

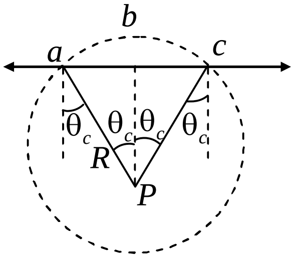
A_2 is 2E/R = 8/3, A_3 is zero and ΔV_{ab} = 4V



SECTION – C

1. 1

Sol. The light escape is confined within a cone of apex angle '$2\theta_c$' where θ_c is the critical angle. Imagine a sphere with source of light as its centre and the surface area abc is A.



here $A = \int_0^{\theta_c} 2\pi R^2 \sin\theta \, d\theta = 2\pi R^2 (1 - \cos\theta_c)$

$= \pi R^2 \quad \left[\therefore \theta_c = \sin^{-1}\left(\frac{\sqrt{3}}{2}\right) = 60^o \right]$

$\therefore$ Power transfer $= P \times \frac{A}{4\pi R^2} = 4 \times \frac{1}{4} = 1W$

2. 3

Sol. Applying lens formula, $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$-\frac{1}{v^2}\frac{dv}{dt} - \frac{1}{u^2}\frac{du}{dt} = 0$

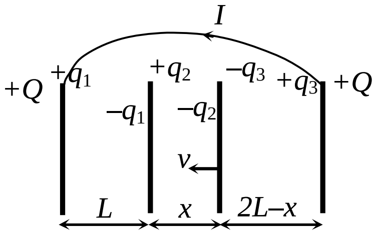
$\frac{dv}{dt} = v_0$

$$\frac{dv}{dt} = v_1 + v_0$$ (v_1 = velocity of object towards lens)

$\therefore \quad v_1 + v_0 = \frac{1}{n^2} v_0, \quad v_1 = \left(\frac{1-n^2}{n^2}\right) v_0, \quad v_1 = 3v_0$ = 3 m/s

3. 1

Sol. $$\frac{2q_1L}{2A\varepsilon_0} + \frac{2q_2x}{2A\varepsilon_0} - \frac{2q_3(2L-x)}{2A\varepsilon_0} = 0 \quad \ldots \text{(i)}$$



$$I = \frac{dq_1}{dt} = \frac{-dq_3}{dt} = \frac{dq_2}{dt} \quad \ldots \text{(ii)}$$

From (i),

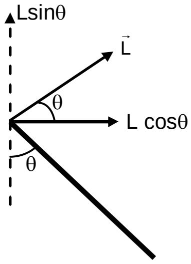
$$q_1L + q_2x - 2q_3L + q_3x = 0$$

$$\Rightarrow \quad L\frac{dq_1}{dt} + x\frac{dq_2}{dt} + q_2\frac{dx}{dt} - 2\frac{dq_3}{dt}L + x\frac{dq_3}{dt} + q_3\frac{dx}{dt} = 0$$

$$\Rightarrow \quad I = \frac{v}{3L}(q_2 + q_3) = 1 \text{ mA}$$

4. 6

Sol. $$\left|\frac{d\vec{L}}{dt}\right| = L\cos\theta\omega$$

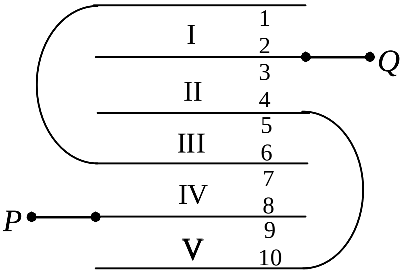


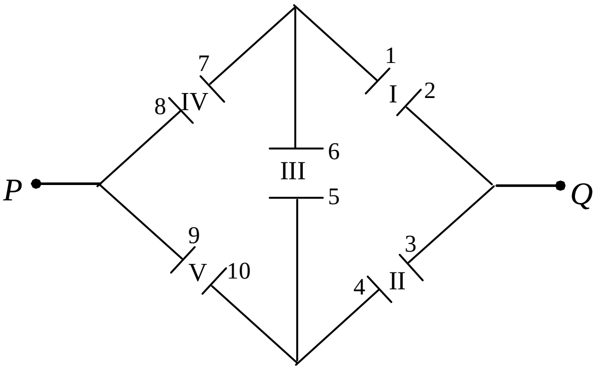
$$= \frac{m\ell^2}{3}\omega\sin\theta\cos\theta\omega$$

$$= \frac{m\ell^2}{3}\omega^2\sin\theta\cos\theta$$

5. 1

Sol.

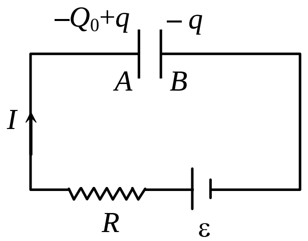




Equivalent capacity, $C_{PQ} = C = \frac{\varepsilon_0 A}{d}$

6. 2

Sol. Let at any time *t* charge flown through the plate *B* to plate *A* is *q* and instantaneous current is *I*.



From loop theorem $\left(\dfrac{2q - Q_0}{2C}\right) + IR - \varepsilon = 0$

$\Rightarrow$ $R\dfrac{dq}{dt} = \dfrac{-2q + 2\varepsilon C + Q_0}{2C}$

$\Rightarrow$ $\dfrac{dq}{2\varepsilon C + Q_0 - 2q} = \dfrac{dt}{2RC}$

Now for charge on plate *A* to be zero $q = Q_0$.

Integrating $\displaystyle\int_0^{Q_0} \frac{dq}{2\varepsilon C + Q_0 - 2q} = \int_0^t \frac{dt}{2RC}$

= $t = RC\ln\left[\dfrac{2\varepsilon C + Q_0}{2\varepsilon C - Q_0}\right]$

Putting the value of C, Q_0, ε and R
We get $t = 2$ seconds.

7. 5

Sol. K.E. = $\frac{1}{2}mv^2 + \frac{1}{2}mv^2 + \frac{1}{2}\frac{m(2r)^2}{12}w^2 + \frac{1}{2}mr^2w^2$ = 5.

8. 5

Sol. At stable equilibrium, U is minimum.

$\dfrac{dU}{dx} = 0$ and $\dfrac{d^2U}{dx^2} > 0$

$= \dfrac{1}{dx}\left(\dfrac{x^3}{3} - \dfrac{ax^2}{2} + 20x\right) = 0.$

$\Rightarrow$ $x^2 - 9x + 20 = 0$. $\Rightarrow$ $(x - 5)(x - 4) = 0$.

x = 5 and x = 4 are points of equilibrium.

And U minimum when $\dfrac{d^2U}{dx^2} > 0$. i.e. at x = 5.

Chemistry PART – II

SECTION – A

1. ABC

Sol. $KO \xrightarrow{H_2O} O_2$ gas

$CaC_2 \xrightarrow{H_2O} C_2H_2$ gas

$Mg_3N_2 \xrightarrow{H_2O} NH_3$ gas

$Ba(NO_3)_2 \xrightarrow{H_2O} Ba^{2+} + 2NO_3^-$

2. ABC

Sol. Neither the lone pair of oxygen nor the pi – bonds are in conjugation in (D).

3. B

Sol. $COCl_2 + H_2O \longrightarrow CO_2 + 2HCl$

4. ABC

Sol. Silicones are the polymers of the hydrolysis products of alkyl silicon chlorides.

5. ABCD

Sol. The boiling point of water is 100^oC.

$\therefore$ Dissolution of any non-volatile solute of any quantity in water will cause elevation in boiling point. So, the boiling point of aqueous solution of any non-volatile solute is greater than 100^oC.

6. AB

Sol. In C the net charge on cationic as well as anionic parts of the complex is zero. Such complexes are not formed. D is not an isomer of the complex due to different molecular formula and molecular mass.

7. AC

Sol. (A) $4LiNO_3 \xrightarrow{\Delta} 2Li_2O + 4NO_2 + O_2$

$2NaNO_3 \xrightarrow{\Delta} 2NaNO_2 + O_2$

(B) $MgCl_2.6H_2O \xrightarrow{\Delta} MgCl_2.H_2O + 5H_2O$

$Na_2SO_4.10H_2O \xrightarrow{\Delta} Na_2SO_4 + 10H_2O$

(C) $2FeSO_4 \xrightarrow{\Delta} Fe_2O_3 + SO_2 + SO_3$

$Fe_2(SO_4)_3 \xrightarrow{\Delta} Fe_2O_3 + 3SO_3$

8. AB

Sol. All aliphatic aldehydes respond to Fehling test. Benzaldehyde does not give Fehling's test.

9. AC

Sol. The coordination number in both the structure is 12 and the packing fraction is 74%

10. AB

Sol. • The dipole moment of NH_3 is greater than NF_3 because the bond pair dipole moment is enhanced by the lone pair dipole moment in NH_3. In NF_3 the resultant of bond pair dipole moment is opposed by the lone pair dipole moment.

• $CHCl_3$ is unsymmetrical, hence it contains certain dipole moment whereas CCl_4 is symmetrical with zero dipole moment.

SECTION – B

1. A → pq, B → qr, C → rs, D → ps

Sol. (A) $Fe^{2+} + 2KCN \longrightarrow Fe(CN)_2 \downarrow \xrightarrow[\text{excess}]{4KCN} K_4[Fe(CN)_6]$

$Fe(OH)_2$ is not soluble in excess NaOH and excess NH_4OH

(B) HgO is not soluble in excess NaOH and excess NH_4OH

$$Hg^{2+} + 2KI \longrightarrow HgI_2 \downarrow \xrightarrow{2KI} K_2[HgI_4]$$

(C) $Pb^{2+} + 2KI \longrightarrow PbI_2 \downarrow \xrightarrow{2KI} K_2[PbI_4]$

$$Pb^{2+} + H_2S \longrightarrow PbS \downarrow + 2H^+$$

$$3PbS + 8HNO_3 \longrightarrow 3Pb(NO_3)_2 + 2NO + 3S + 4H_2O$$

(D) $Ag^+ + KCN \longrightarrow AgCN \downarrow \xrightarrow{KCN} K[Ag(CN)_2]$

$$Ag^+ + H_2S \longrightarrow Ag_2S \downarrow + 2H^+$$

$$3Ag_2S + 8HNO_3 \longrightarrow 6AgNO_3 + 2NO + 3S + 4H_2O$$

2. A → pqr, B → r, C → qs, D → qr

Sol. (A) $pH = p^{K_a} + \log\frac{[HCOONa]}{[HCOOH]} = 3.74 + \log\frac{0.1}{0.2} = 3.74$

$\therefore$ pH < 7

(B) pH = -log [H^+] = -log10^{-1} = 1, $\therefore$ pH < 7

CH_3COOH cannot dissociated in presence of HCl due to common ion effect.

(C) $CH_3COOH + NH_4OH \longrightarrow CH_3COONH_4 + H_2O$

Hydrolysis of CH_3COONH_4 will take place

$$pH = \frac{1}{2}\left(p^{K_w} + p^{K_a} - p^{K_b}\right) = \frac{1}{2}\left[14 + 4.74 - (14 - 9.26)\right]$$

= ½ [14 + 4.74 – 4.74] = 7. $\therefore$ pH = 7 and the solution is a buffer

(D)	$HCOONa +$	$HCl \longrightarrow$	$HCOOH +$	$NaCl$
Initial meq	30	10	0	0
Meq. After reac^n	20	0	10	10

It is a buffer, $pH = p^{K_a} + \log\frac{[HCOONa]}{[HCOOH]} = 3.74 + \log\frac{20}{10} = 4.04, < 7$

SECTION – C

1. 6

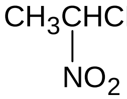
Sol. $\Delta H = nC_V\Delta T$

$$\text{or, } 12 = \frac{4.48}{22.4} \times C_V \times 15$$

or, $C_V = 4$

$C_P - C_V = R = 2 \Rightarrow C_P = C_V + 2 = 4 + 2 = 6$ cal

2. 4

Sol. The products are $CH_3CH_2CH_2NO_2$,  $\underset{\displaystyle NO_2}{CH_3\overset{}{C}HCH_3}$, $CH_3CH_2NO_2$ and CH_3NO_2 because C–C and C – H bond cleavage takes place in this reaction.

3. 6

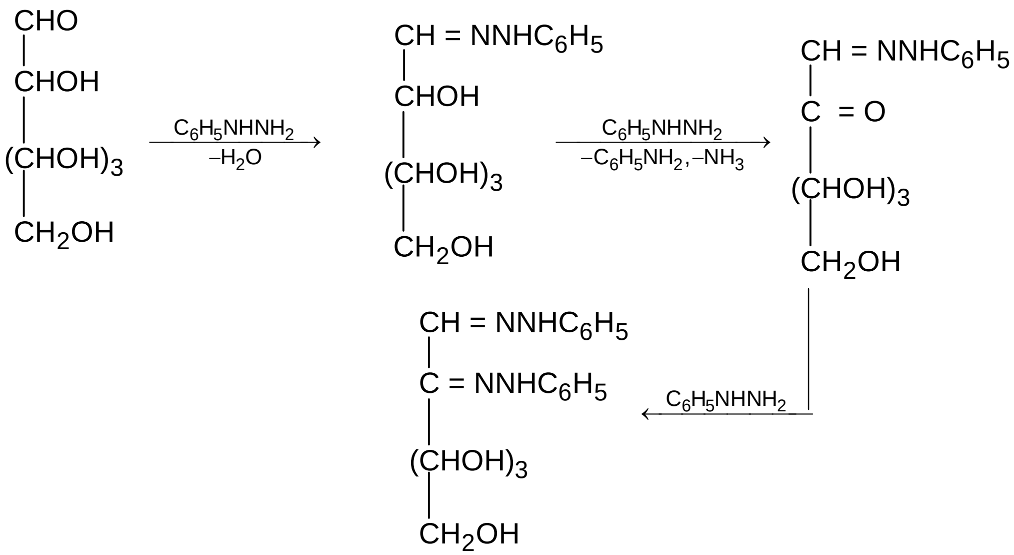
Sol. For zero order reaction the half-life is directly proportional to the concentration of reactant.

$$X \xrightarrow{t_{1/2}=4\text{sec}} \frac{X}{2} \xrightarrow{t_{1/2}=2\text{sec}} \frac{X}{4}$$

$\therefore$ Total time needed for 75% reaction = 4 + 2 = 6 sec

4. 4

Sol.


CHO
CHOH
(CHOH)3
CH2OH
C6H5NHNH2
–H2O
CH = NNHC6H5
CHOH
(CHOH)3
CH2OH
C6H5NHNH2
–C6H5NH2,–NH3
CH = NNHC6H5
C = O
(CHOH)3
CH2OH
C6H5NHNH2
CH = NNHC6H5
C = NNHC6H5
(CHOH)3
CH2OH

5. 3

Sol.

	$2X(g) \rightleftharpoons$	$2Y(g)$	$+\ Z(g)$
Initial	1	0	0
At equi	$1 - \propto$	$\propto$	$\propto/2$

$\therefore$ Partial pressure [If total pressure P]

$$p_x = \left[\frac{1-\propto}{1+\propto/2}\right]P \simeq P \quad p_y = \frac{\propto}{1+\propto/2}P \simeq \propto P$$

$$p_z = \left[\frac{\propto/2}{1+\propto/2}\right]P \simeq \frac{\propto P}{2}$$

$$\therefore K_p = \frac{[p_y]^2[p_z]}{[p_x]^2} = \frac{[\propto P]^2\left[\frac{\propto P}{2}\right]}{P^2}$$

$$K_p = \frac{\propto^3 P}{2}$$

$$\propto = \left(\frac{2K_p}{P}\right)^{\frac{1}{3}}$$

6. 5

Sol. Work done in anticlockwise cycle is positive and in clockwise cycle is negative.
moles of A are present. Total number of moles of A,B and C at the end of 75% reaction are X. What will be the value of 2X

7. 7

Sol. One mole of A will form 2 moles of B and C after completion of reaction when 75% of A converted into B and C then total No of moles X = 0.5 + (2 × 0.5 + 1×2) = 3.5
Hence 2X = 3.5×2 = 7

8. 1

Sol. $\underset{(0.01-x)}{Sb_2S_3(s)} + \underset{(0.01-3x)}{3H_2(g)} \rightarrow \underset{2x}{2Sb(s)} + \underset{3x}{3H_2S(g)}$

No.of moles of PbS formed = $\frac{1.19}{239} = 0.005$

At eqn. $\left[H^+\right] = \left(\frac{0.005}{250}\right)$

$$K_C = \left(\frac{0.005}{0.005}\right)^3 = 1$$

Mathematics PART – III

SECTION – A

1. ACD

Sol. On expanding we get $\left(\vec{a}.\,\vec{c}\right)\vec{a}-\left(\vec{a}.\,\vec{a}\right)\left(\vec{c}\right)=-\vec{b}$

$\Rightarrow \vec{c}-\left(\vec{a}.\,\vec{c}\right)\vec{a}=\vec{b}$

$\Rightarrow$ (a) is correct and (b) is ruled out.

$\Rightarrow \left|\vec{c}-\left(\vec{a}.\,\vec{c}\right)\vec{a}\right|^2=\left|\vec{b}\right|^2$

If θ is the angle between $\vec{a}$ and $\vec{c}$ then

$4+\left(2\cos\theta\right)^2-2\left(2\cos\theta\right)^2=1$

$\Rightarrow \cos\theta=\pm\frac{\sqrt{3}}{2}$ $\Rightarrow \theta=30^o;\,150^o$

$\Rightarrow$ (C) and (D) is correct.

2. ABC

Sol. $8\sin x=\frac{\sqrt{3}}{\cos x}+\frac{1}{\sin x}$

$\Rightarrow 8\sin^2 x\cos x=\sqrt{3}\sin x+\cos x$

$4\left(1-\cos 2x\right)\cos x=\sqrt{3}\sin x+\cos x$

$3\cos x-2\left(\cos 3x+\cos x\right)=\sqrt{3}\sin x$

$\cos x-2\cos 3x=\sqrt{3}\sin x$

$\frac{1}{2}\cos x-\frac{\sqrt{3}}{2}\sin x=\cos 3x$

$\cos\left(x+\frac{\pi}{3}\right)=\cos 3x$

$3x=2nx\pm\left(x+\frac{\pi}{3}\right)$

(+)	(–)
$3x=2x\pi+x+\frac{\pi}{3}$	$3x=2n\pi-x-\frac{\pi}{3}$
$2x=2n\pi+\frac{\pi}{3}$	$4x=2n\pi-\frac{\pi}{3}$
$x=nx+\frac{\pi}{6}$	$x=\frac{n\pi}{2}-\frac{\pi}{12}$
$\left[0,2\pi\right]$	
$\frac{\pi}{6}$	$\frac{\pi}{2}-\frac{\pi}{12}=\frac{6\pi-\pi}{12}=\frac{5\pi}{12}$

$\frac{5\pi}{6}$

$$\pi-\frac{\pi}{12}=\frac{11\pi}{12}$$

$$\frac{3\pi}{2}-\frac{\pi}{12}=\frac{18\pi-\pi}{12}=\frac{17\pi}{12}$$

$$2\pi-\frac{\pi}{12}=\frac{23\pi}{12}$$

3. AB

Sol. $\det(A+B)=-\det(A)\det(B)\det(A+B)$

$=-\det\left(A^T\right)\det\left(B^T\right)\det(A+B)$

$=-\det\left(A^T(A+B)B^T\right)$

$=-\det\left(A^T(A+B)B^T\right)$

$=-\det\left(A^TAB^T+A^TBB^T\right)$

$=-\det\left(B^T+A^T\right)$

$=-\det(A+B)^T$

$=-\det(A+B)\Rightarrow\det(A+B)=0$

4. ACD

Sol. $g'(0)=\lim\limits_{h\to\infty}\frac{g(0+h)-g(0)}{h}=0$

$\Rightarrow g(x)$ is differentiable $\forall x\in R$

$$g'(x)=\begin{cases}2x\sin\left(\frac{\pi}{x}\right)-\pi\sin\left(\frac{\pi}{x}\right)+2(x-1)\sin\left(\frac{\pi}{x-1}\right)-\pi\sin\left(\frac{\pi}{x-1}\right); & x\neq 1\\ 0\ ; & x=0,1\end{cases}$$

But $\lim\limits_{x\to 0}g'(x)=$ does not exist $\neq g'(0)\Rightarrow g'(x)$ is discontinuous at x = 0

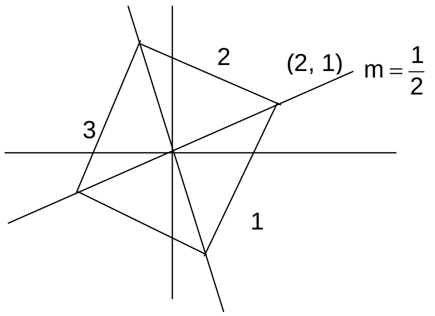
Similarly $\lim\limits_{x\to 1}g'(x)=$ does not exist.

5. A

Sol. $$\lim_{t\to 0}\frac{\int_0^t \sin t^2\,dt}{\frac{1}{2}t\sin t^2}=\lim_{t\to 0}\frac{2\sin t^2}{\sin t^2+2t^2\cos t^2}=\lim_{t\to 0}\frac{2}{1+2\frac{t^2}{\tan t^2}}=\frac{2}{1+2}=\frac{2}{3}$$

6. AB

Sol. The point of intersection of diagonal is (0, 0) and one vertex A (2, 1)



$\Rightarrow$ Vertex is (–2, –1) verties B and D are $\pm i(2+i)$

$=-1+2i,\ 1-2i$

$\Rightarrow B(-1,2)$ and $D(1,-2)$

$\Rightarrow$ Equation of the sides are

$x+3y=\pm 5,\ 3x-y=\pm 5$.

7. ABCD

Sol. The three planes intersect in a line.

8. ABC

Sol. $\left(2x-3y+z\right)^{10}$

General term $= \sum_{\alpha+\beta+\gamma=10} \frac{10!\left(2x\right)^{\alpha}\left(-3y\right)^{\beta}\left(z\right)^{\gamma}}{\alpha!\beta!\gamma!}$ ……….(1)

$\therefore$ Number of terms $= \frac{12!}{10!2!} = \frac{12\times 11}{2} = 66$

Put $x = y = z = 1$ in (1), we get

Sum of all the coefficients 0.

Put $\alpha = 2,\ \beta = 3,\ \gamma = 5$ in (1),

We get coefficient of $x^2y^3z^5 = \frac{10!}{2!.3!.5!}\left(2\right)^2\left(-3\right)^3 = \frac{-10!\times 9}{5!}$

9. AD

Sol. Clearly, $\sum_{k=0}^{100} {}^{100}C_k\left(x-2\right)^{100-k}3^k = \left(\left(x-2\right)+3\right)^{100} = \left(1+x\right)^{100}$

Hence, coefficient of x^{50} is ${}^{100}C_{50}$. Now verify

Option (A), (D) equal to ${}^{100}C_{50}$

(B) $99!\left({}^{100}C_{50}\right)$

(C) ${}^{100}C_{101}$

10. AB

Sol. $\log_3\left|2z+1\right| < \log_3\left|2z-1\right|$ (as $\cot^{-1}x$ is a decreasing function)

$\therefore\ \left|2z+1\right| < \left|2z-1\right|$

Or $\left(2z+1\right)\left(2\bar{z}+1\right) < \left(2z-1\right)\left(2\bar{z}-1\right)$

$2\left(z+\bar{z}\right) < -2\left(z+\bar{z}\right)$

$z+\bar{z} < 0$

$2\text{Re}\left(z\right) < 0$

$\therefore \text{Re}\left(z\right) < 0$

SECTION – B

1. A $\rightarrow$s B $\rightarrow$r C $\rightarrow$q D $\rightarrow$p

Sol. (A) $\left\{\cos\left(2A+\theta\right)+\cos\left(2B+\theta\right)\right\}$

$= 2\cos\left(A-B\right)\cos\left(A+B+\theta\right)$

Maximum value is $\left|2\cos\left(A-B\right)\right|$ when $\cos\left(A+B+\theta\right) = \pm 1$

(B) $\left\{\cos 2A+\cos 2B\right\} = 2\cos\left(A+B\right)\cos\left(A-B\right)$

Maximum value is $2\cos(A+B)$ when $\cos(A-B)=1$

(C) For $y=\sec x, x\in\left(0,\frac{\pi}{2}\right)$, tangent drawn to it any point lies completely below the graph of $y=\sec x$, thus $\frac{\sec 2A+\sec 2B}{2}\geq\sec(A+B)$

$\Rightarrow \quad \sec 2A+\sec 2B\geq 2\sec(A+B)$

Hence, minimum value is $A+B$

(D) $\sqrt{\{\tan\theta+\cot\theta-2\cos 2(A+B)\}}$

$=\sqrt{\left(\sqrt{\tan\theta}-\sqrt{\cot\theta}\right)^2+2-2\cos 2(A+B)}$

$=\sqrt{\left(\sqrt{\tan\theta}-\sqrt{\cot\theta}\right)^2+4\sin^2(A+B)}$

Minimum value occurs when $\sqrt{\tan\theta}=\sqrt{\cot\theta}$ and minimum value is

$\sqrt{4\sin^2(A+B)}=2\sin(A+B)$

2. A → p B → pq C → p D → rs

Sol. (A) Equation of the plane π is $A(x-1)+B(y-1)+C(z-1)=0$ where $A+0.\,B-1.C=0$ and $-A+B+0.C=0\Rightarrow A=B=C$ and the equation of π is $x+y+z=3$. which meets the co – ordinates axes at A (3, 0, 0), B (0, 3, 0) and C (0, 0, 3). So volume of the tetrhadron. $OABC=\frac{1}{6}\begin{vmatrix}0&0&0&1\\3&0&0&1\\0&3&0&1\\0&0&3&1\end{vmatrix}=\frac{1}{6}\times 27=\frac{9}{2}$

(B) $AB=BC=CA=3\sqrt{2}$, so the area of the face ABC which is an equilateral triangle $=\frac{\sqrt{3}}{4}\times\left(3\sqrt{2}\right)^2=\frac{9\sqrt{3}}{2}$. Each of the face OAB, OBC, OCA is an isosceles triangle with sides $3,3,3\sqrt{2}$

So, area of each of these faces is $\frac{1}{2}\times 3\sqrt{2}\sqrt{9-\frac{9}{2}}=\frac{9}{2}$

(C) Required distance is $\left|\frac{\frac{3\sqrt{3}}{2}+3\sqrt{3}+3-3}{\sqrt{1+1+1}}\right|=\frac{9}{2}$

(D) Distance of O from the face $ABC=\left|\frac{0+0+0-3}{\sqrt{1+1+1}}\right|=\sqrt{3}$ distance of A, B, C from opposite faces OBC, OAC, OAB are equal and is 3.

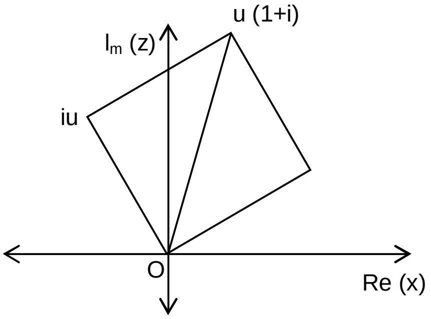
SECTION – C

1. 5

Sol. Note that $z = 0$ is one root of the given equation

$z^4 + az^3 + (12+9i)z^2 + bz = 0$

canceling z, we get $z^3 + az^2 + (12+9i)z + b = 0$ …………(1)



The 3 vertices of the square other than $(0+0i)$ are u, iu, u (1 + i)

Now $u(ui) + (iu) + (1+i)u + [(1+i)u]u = 12 + 9i$ (using theory of equation)

$u^2 = \dfrac{4+3i}{i} = 3 - 4i \Rightarrow u = \sqrt{3-4i} = \pm(2-i)$

$\therefore u = 2 - i$ or $-2 + i$

$\Rightarrow |u|^2 = 5$

2. 3

Sol. $\beta = \displaystyle\int_0^1 \frac{2x + 3x^2 + 4x^3}{2\sqrt{x^4 + x^3 + x^2}}dx$

Put $(x^2 + x^3 + x^4) = t \quad \Rightarrow \quad (2x + 3x^2 + 4x^3)dx = dt$

$\beta = \displaystyle\int_0^3 \frac{dt}{2\sqrt{t}}$

$\beta = \left[\sqrt{t}\right]_0^3 = \sqrt{3} \quad \Rightarrow \quad \beta^2 = 3$

3. 2

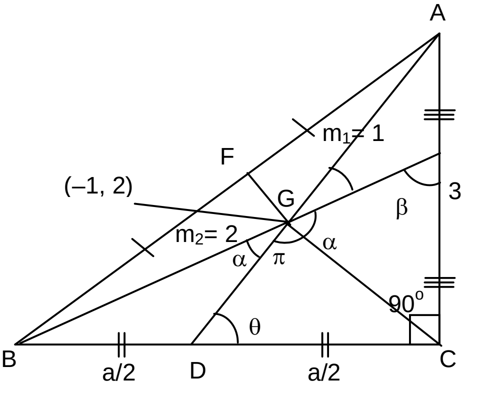
Sol. Area $= \dfrac{1}{2}ab$

$AD: y = x + 3$

$BE = y = 2x + 4$

solve $G(-1, 2)$

acute angle α between the medians is



$\tan\alpha = \dfrac{m_1 - m_2}{1 + m_1 m_2}$

$\tan\alpha = \dfrac{2-1}{1+2} \Rightarrow \tan\alpha = \dfrac{1}{3}$

now, $(180 - \alpha) + 90^o + \theta + \beta = 360^o$

$\Rightarrow \quad \alpha = \theta + \beta - 90^o$

$\cot\alpha = -\tan(\theta + \beta)$

$-3 = \dfrac{\tan\theta + \tan\beta}{1 - \tan\theta\tan\beta}$ or $-3 = \dfrac{\dfrac{2b}{a} + \dfrac{2a}{b}}{1 - \dfrac{2b}{a}\cdot\dfrac{2a}{b}}$

$\Rightarrow \qquad 9 = \dfrac{2\left(a^2 + b^2\right)}{ab}$

$9ab = 2 \times 3600$

$\Rightarrow \qquad \dfrac{1}{2}ab = 400$

$\therefore$ Area = 400 sq. units

4. 6

Sol. $\dfrac{dy}{dt} = -k\sqrt{y}$

$\dfrac{dy}{\sqrt{y}} - k\,dt$

$2\sqrt{y} = -kt + c$

$t = 0;\ y = 4$

$4 = c$

$2\sqrt{y} = -kt + 4$

$y = 0$

$kt = 4$

$t = \dfrac{4}{\frac{1}{15}} = 60 \text{ minutes}$

5. 2

Sol. $\text{Sum } = \sum_{n=1}^{n} \tan^{-1}\left[\dfrac{\sqrt{2n+2} - \sqrt{2n-2}}{2 + \sqrt{n^2 - 1}}\right] = \sum_{n=1}^{n} \tan^{-1}\left[\dfrac{\sqrt{\frac{n+1}{2}} - \sqrt{\frac{n-1}{2}}}{1 + \sqrt{\frac{n+1}{2}}, \sqrt{\frac{n-1}{2}}}\right]$ (divide by 2)

$= \sum_{n=1}^{n}\left(\tan^{-1}\sqrt{\dfrac{n+1}{2}} - \tan^{-1}\sqrt{\dfrac{n-1}{2}}\right) = \tan^{-1}\left(\sqrt{\dfrac{n+1}{2}}\right) + \tan^{-1}\sqrt{\dfrac{n-1}{2}} - \tan^{-1}\dfrac{1}{\sqrt{2}}$

$\lim\limits_{n\to\infty} \text{sum} = \pi - \tan^{-1}\left(\dfrac{1}{\sqrt{2}}\right) = \dfrac{\pi}{2} + \cot^{-1}\left(\dfrac{1}{\sqrt{2}}\right) = \dfrac{\pi}{2} + \tan^{-1}\left(\sqrt{2}\right)$

$\therefore k = \sqrt{2} \Rightarrow k^2 = 2$.

6. 3

Sol. $\dfrac{\frac{x}{2} + \frac{x}{2} + \frac{y}{3} + \frac{y}{3} + \frac{y}{3} + \frac{z}{4} + \frac{z}{4} + \frac{z}{4} + \frac{z}{4}}{9} \geq \dfrac{9}{\frac{2}{x} + \frac{2}{x} + \frac{3}{y} + \frac{3}{y} + \frac{3}{y} + \frac{4}{z} + \frac{4}{z} + \frac{4}{z} + \frac{4}{z}}$

7. 4

Sol. $\Delta = \dfrac{1}{2}ab\sin C \Rightarrow \sqrt{3} = \dfrac{1}{2}2b\sin C \Rightarrow \dfrac{\sqrt{3}}{b} = \sin C$

$$2\left[\cos C+\sqrt{3}\sin C\right]=b+c \qquad \ldots\ldots\ldots(1)$$

$$\cos C=\frac{a^2+b^2-c^2}{2ab}=\frac{4+b^2-c^2}{4b}$$

$$\Rightarrow 2\left(\frac{4+b^2-c^2}{4b}\right)+2\sqrt{3}\left(\frac{\sqrt{3}}{b}\right)=b+c$$

$$\Rightarrow \frac{4+b^2-c^2}{2b}+\frac{6}{b}=b+c\Rightarrow 4+b^2-c^2+12=2b^2+2bc$$

$$\Rightarrow b^2+c^2+2bc=16\Rightarrow (b+c)=4$$

8. 6

Sol. Given, $x^2-4x+1=0\Rightarrow x$

$$=\frac{4\pm\sqrt{16-4}}{2}=\frac{4\pm 2\sqrt{3}}{2}=2\pm\sqrt{3}$$

$\therefore$ From the figure, I (a, b) lies on line $y=x$,

So b = a

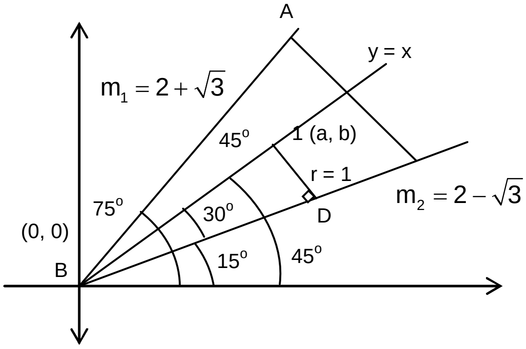
Also, from

ΔIBD, $\frac{r}{BI}=\sin 30^o\Rightarrow BI=2\ \left[\text{As, } r=1(\text{given})\right]$

$\therefore BI=2=\sqrt{a^2+a^2}\Rightarrow 4=2a^2\Rightarrow a=\sqrt{2}$

So, $I=\left(\sqrt{2},\sqrt{2}\right)=(a,b)$ (Given)

Hence, $\left(a^2+b^4\right)=\left(\sqrt{2}\right)^2+\left(\sqrt{2}\right)^4=2+4=6$



In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

ALL INDIA TEST SERIES

FIITJEE **JEE (Main), 2017**

CONCEPT RECAPITULATION TEST - I

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 02 and 09 to 30)** contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (03 to 08) contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 marks** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

(One Option Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE** option is correct.

1. The relation between time t and distance x moved by a particle is $t = \alpha x^2 + \beta x$ where α and β are constants. The retardation is (if v represents velocity)

(A) $2\alpha V^3$
(B) $2\beta V^3$
(C) $2\alpha\beta V^3$
(D) $2\beta^2 V^3$

2. An object is cooled from 75^0C to 65^0C in 2 minutes in a room at 30^0C. The time taken to cool another identical object from 55^0C to 45^0C in the same room in minutes is

(A) 4
(B) 5
(C) 6
(D) 7

3. A source of sound is moving towards a stationary observer with a speed of 50 m/s. The observer measures the frequency of the source as 1000 Hz. The speed of sound is 350 m/s. The apparent frequency measured by the observer when the source is moving away after crossing the observer is

(A) 750 Hz
(B) 850 Hz
(C) 1150 Hz
(D) 1250 Hz

4. A spherical solid ball of volume V is made of a material of density ρ_1. It is falling through a liquid of density $\rho_2(\rho_2 < \rho_1)$. Assume that the liquid applies a viscous force on the ball that is proportional to the square of its speed ν. i.e., $F_{viscous} = -k\nu^2$ (k > 0). The terminal speed of the ball is

(A) $\sqrt{\frac{Vg(\rho_1 - \rho_2)}{k}}$
(B) $\frac{Vg\rho_1}{k}$
(C) $\sqrt{\frac{Vg\rho_1}{k}}$
(D) $\frac{Vg(\rho_1 - \rho_2)}{k}$

Space for Rough work

5. A spring of force constant k is cut into two pieces such that one piece is double the length of the other. Then the long piece will have a force constant of

(A) $\frac{2}{3}k$ (B) $\frac{3}{2}k$

(C) 3k (D) 6k

6. A particle is projected horizontally from the top of a tower with a velocity v_0. If v be its velocity at any instant, then the radius of curvature of the path of the particle at the point (where the particle is at that instant) is directly proportional to

(A) v^3 (B) v^2

(C) v (D) $\frac{1}{v}$

7. One half mole of a monoatomic ideal gas absorbs 1200 J of heat energy while performing 2196 J of work. The temperature of the gas changes by

(A) 160^0C (B) 80^0C

(C) 40^0C (D) -160^0C

8. A train of mass m is moving on a circular track of radius R with constant speed v. The length of the train is half of the perimeter of the track. The linear momentum of the train will be

(A) Zero (B) mvR

(C) $2m\frac{v}{\pi}$ (D) mv

9. A piano string 1.5m long is made of steel of density 7.7×10^3 kg/m^3 and Young's modulus 2×10^{11}N/m^2. It is maintained at a tension which produces an elastic strain of 1% in the string. The fundamental frequency of transverse vibrations of string is

(A) 85Hz (B) 170Hz

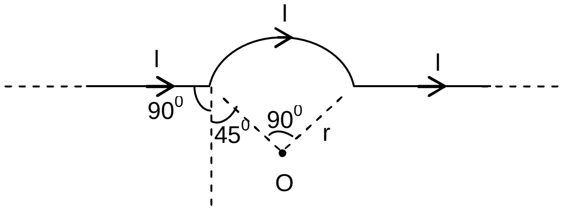
(C) 340Hz (D) 310Hz

Space for Rough work

10. Two organ pipes each closed at one end give 5 beats/sec when emitting their fundamental notes. If their length are in the ratio 50:51, their fundamental frequencies are
(A) 250,255 (B) 255,260
(C) 260,265 (D) 265,270

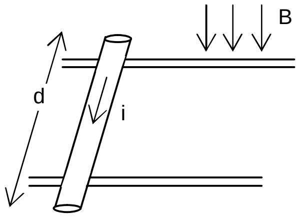
11. The escape velocity on earth is 11.2 km/s. What would be the escape velocity on a planet whose mass is 1000 times and radius is 10 times than that of earth
(A) 112 km/s (B) 11.2 km/s
(C) 1.12 km/s (D) 3.7 km/s

12. The magnetic field at the centre O of the arc in figure is (r is the radius of circular arc)



(A) $\frac{\mu_0 I}{4\pi \times r}\left[\sqrt{2}+\pi\right]$ (B) $\frac{\mu_0 I}{2\pi r}\left[\frac{\pi}{4}+1\left(\sqrt{2}-1\right)\right]$
(C) $\frac{\mu_0}{4\pi}\times\frac{I}{r}\left[\sqrt{2}+r\right]$ (D) $\frac{\mu_0}{4\pi}\times\frac{I}{r}\left[\sqrt{2}+\frac{\pi}{4}\right]$

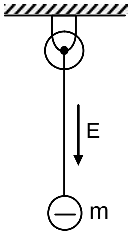
13. A solid cylindrical uniform rod of mass 0.72 kg, length 50 cm and radius 6 cm rests on two parallel rails, as shown. The rod caries a current I = 48A (In the direction shown) and rolls along the rails without slipping. If it starts from rest due to applications of uniform magnetic field of magnitudes 0.25 T (directed perpendicular to the rod and the rail), then the friction force (In N) between rod and rails is
(A) 2 (B) 3
(C) 4 (D) 5



14. The critical angle for a prism and its surrounding interface is 36°. The minimum angle of prism for which no emergent ray is possible is
(A) 18° (B) 36°
(C) 72° (D) 144°

Space for Rough work

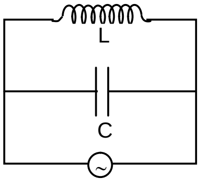
15. A simple pendulum charged negatively to q coulomb oscillates with a time period T in a downward electric field. If the electric field is with-drawn, the new time period is:
(A) = T (B) > T
(C) < T (D) none of these



16. Two electrons are moving with the same speed V. One electron enters a region of uniform electric field while the other enters a region of uniform magnetic field. After sometime if the de Broglie wavelength of the two are λ_1 and λ_2, then (select the best alternative)
(A) $\lambda_1 = \lambda_2$ (B) $\lambda_1 > \lambda_2$
(C) $\lambda_1 > \lambda_2$ or $\lambda_1 < \lambda_2$ (D) $\lambda_1 > \lambda_2$ or $\lambda_1 < \lambda_2$ or $\lambda_1 = \lambda_2$

17. The efficiency of carnot engine is 0.6. It rejects 20 J of heat to the sink. The work done by the engine is
(A) 20 J (B) 30 J
(C) 33.5 J (D) 50 J

18. For the circuit shown in the figure, the current through the inductor is 0.6 A, while the current through the capacitor is 0.4 A. The current drawn from the generator is
(A) 1.0 A (B) 0.4 A
(C) 0.6 A (D) 0.2 A



Generator

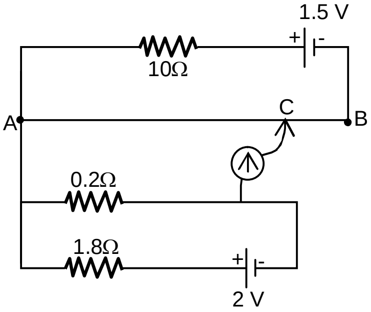
19. A uniform solid brass sphere is rotating with angular speed ω_0 about a diameter. If its temperature is now increased by 100^0C. What will be its new angular speed (Given: $\alpha_{brass} = 2.0 \times 10^{-5} per^0C$)
(A) 1.1 ω_0 (B) 1.01 ω_0
(C) 0.996 ω_0 (D) 0.824 ω_0

Space for Rough work

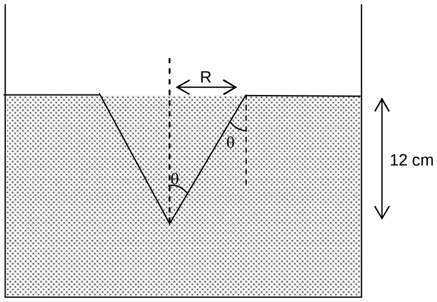
20. Which of the following phenomenon is not common to sound and light waves?
(A) interference (B) diffraction
(C) polarization (D) reflection

21. In a two slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance from the slits. If the screen is moved by 5×10^{-2} m towards the slits the change in fringe width is 3×10^{-5} m. If the distance between the slits is 10^{-3} m, the wavelength of light used is
(A) 4000 Å (B) 5550 Å
(C) 6000 Å (D) 6500 Å

22. In the figure, AB is a uniform wire of length 100 cm whose resistance is 5 Ω. If galvanometer reads zero, then AC =
(A) 10cm (B) 20cm
(C) 40cm (D) 80cm



23. A fish looking up through the water sees the outside world contained in a circular horizon. If the refractive index of water is 4/3 and the fish is 12 cm below the surface, the radius of this circle in cm is
(A) $36\sqrt{5}$
(B) $4\sqrt{5}$
(C) $36\sqrt{7}$
(D) $36 / \sqrt{7}$



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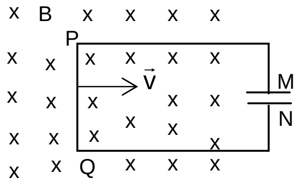


24. A rod PQ is connected to the capacitor plates. The rod is placed in a magnetic field (B) directed downward perpendicular to the plane of the paper. If the rod is pulled out of magnetic field with velocity v as shown in figure.
(A) plate M will be positively charged
(B) plate N will be positively charged
(C) both plates will be similarly charged
(D) no charge will be collected on plates

25. A tank has a hole made at its bottom. The time needed to empty the tank from level h_1 to h_2 will be proportional to
(A) $h_1 + h_2$ (B) $\sqrt{h_1} + \sqrt{h_2}$
(C) $h_1 - h_2$ (D) $\sqrt{h_1} - \sqrt{h_2}$

26. In hydrogen like atoms the ratio of difference of energies $E_{4n} - E_{2n}$ and $E_{2n} - E_n$ varies with atomic number z and principle quantum number n as
(A) $\frac{z^2}{n^2}$ (B) $\frac{z^4}{n^4}$
(C) $\frac{z}{n}$ (D) none of these

27. A star initially has 10^{40} deutrons. It produces energy via the processes

$${}_1H^2 + {}_1H^2 \rightarrow {}_1H^3 + p \text{ and } {}_1H^2 + {}_1H^3 \rightarrow {}_2He^4 + n.$$

If the average power radiated by the star is 10^{16} W, the deuteron supply of the star is exhausted in a time of the order of [The masses of nuclei are: m(H^2) = 2.014 u, m(p) = 1.007 u, m(n) = 1.008 u, m(He^4) = 4.001 u]
(A) 10^6 s (B) 10^8 s
(C) 10^{12} s (D) 10^{16} s

Space for Rough work

28. If the maximum kinetic energy of emitted photo electrons from a metal surface of work function 2.5 eV, is 1.7 eV. If wavelength of incident radiation is halved, then stopping potential will be

(A) 2.5 V	(B) 5.9 V
(C) 5 V	(D) 1.1 V

29. A light emitting diode (LED) has a voltage drop of 2V across it and passes a current of 10 mA. When it operates with a 6V battery through a limiting resistor R, the value of R is:

(A) 40 k Ω	(B) 4 k Ω
(C) 200 Ω	(D) 400 Ω

30. The number densities of electrons and holes in a pure germanium at room temperature are equal and its value is 3×10^{16} per m^3. On doping with aluminium, the hole density increases to 4.5×10^{22} per m^3. Then the electron density in doped germanium is

(A) 2.5×10^{10} m^{-3}	(B) 2×10^{10} m^{-3}
(C) 4.5×10^{9} m^{-3}	(D) 3×10^{9} m^{-3}

Space for Rough work

Chemistry PART – II

SECTION – A

(One Option Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE** option is correct.

1. 100 mL of $FeSO_4$ solution required 200 mL of 0.1 M acidified $KMnO_4$ solution for complete reaction. What is the molarity of the $FeSO_4$ solution?

$$MnO_4^- + Fe^{2+} + H^+ \longrightarrow Mn^{2+} + Fe^{3+} + H_2O$$

(A) 0.5 M (B) 1 M
(C) 2 M (D) 1.5 M

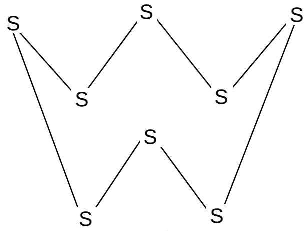
2. Which of the following molecule has the highest value of dipole moment?

(A) PCl_3F_2 (B) PCl_2Br_3
(C) PCl_2F_3 (D) PCl_5

3. Which gas shows real behaviour?

(A) 16 g of dioxygen at STP occupies 11.2 L
(B) One gram dihydrogen in 0.5 L flask exerts pressure of 24.63 atm at 300 K
(C) One mole of ammonia at 300 K and 1 atm pressure occupies 22.4 L
(D) 5.6 L of CO_2 at STP is equal to 11 g

4. The oxidation number and hybridization of sulphur in S_8 molecule are respectively:



(A) +2 and sp^2 (B) +2 and sp^3
(C) zero and sp^2 (D) zero and sp^3

Space for Rough work

5. Which of the following is most soluble in water?

(A) $BeSO_4$ (B) $MgSO_4$

(C) $CaSO_4$ (D) $BaSO_4$

6. $X(g) + 2Y(g) \longrightarrow \text{Products}$

The rate equation of above reaction is given as follows:

Rate = $k[X][Y]^{0.5}$

What is the unit of rate constant of above reaction?

(A) $mol^{1/2}L^{-1/2}s^{-1}$ (B) $mol^{-1/2}L^{1/2}s^{-1}$

(C) $mol^{3/2}L^{-3/2}s^{-1}$ (D) $mol^{-3/2}L^{3/2}s^{-1}$

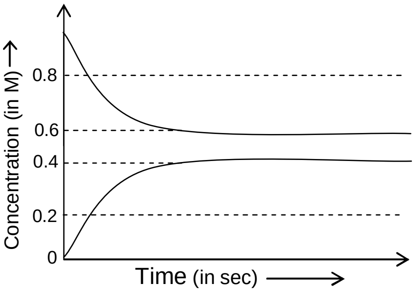
7. $HCN(aq) \rightleftharpoons H^+(aq) + CN^-(aq)$

The ionization constant (K_a) of above acid increases by

(A) adding more water (B) adding more HCN

(C) removing H^+ ions by adding bases (D) none of these

8.



Above graph is given for the following reversible reaction.

$X(g) \rightleftharpoons Y(g)$

The equilibrium constant K_C of above reaction is:

(A) $\frac{1}{4}$ (B) $\frac{3}{2}$

(C) $\frac{2}{3}$ (D) 4

Space for Rough work

9. Which of the following relation is correct for an equilibrium system?
(A) $\Delta S_{system} = 0$
(B) $\Delta S_{surrounding} = 0$
(C) $\Delta S_{Total} = 0$
(D) $\Delta S_{system} = \Delta S_{surrounding}$

10. Which of the following compound on hydrolysis forms products that are polymerized to silicones?
(A) $SiCl_4$
(B) $(CH_3)_2SiCl_2$
(C) SiH_2Cl_2
(D) H_2SiF_6

11. $X(g) \rightleftharpoons Y(g) + Z(g)$
The equilibrium constant K_p of above reaction is 3 atm at a certain temperature. If equal moles of X, Y and Z are present at equilibrium, the equilibrium pressure would be:
(A) 12 atm
(B) 3 atm
(C) 6 atm
(D) 9 atm

12. $NaOH + CO \longrightarrow Pr\,oduct$
Which of the following is/are the product(s) of above reaction?
(A) HCOONa
(B) $NaHCO_3$
(C) $Na_2CO_3 + H_2$
(D) $NaH + CO_2$

13. $SO_3^{2-} + H^+ \longrightarrow (X) + (Y)$
The unknown compounds of above reaction are:
(A) H_2S and O_2
(B) SO_2 and H_2O
(C) SO_3 and H_2
(D) SO_2 and H_2

14. For which of the following aqueous solution, there is maximum difference between the normal and abnormal colligative properties?
(A) 0.1 m $C_6H_{12}O_6$
(B) 0.1 m CH_3COOH
(C) 0.1 m HCOOH
(D) 0.1 m CH_3OH

15. Which of the following aqueous solution is colourless?
(A) $CuSO_4$
(B) $Zn(NO_3)_2$
(C) $FeCl_2$
(D) $KMnO_4$

Space for Rough work

16. The relation between the molar conductance ($\wedge_m$) and equivalent conductance ($\wedge_e$) of the solution of $MgCl_2.KCl.6H_2O$ is

(A) $\wedge_m = \wedge_e \times 8$
(B) $\wedge_m = \wedge_e \times 3$
(C) $\wedge_e = \wedge_m \times 3$
(D) $\wedge_e = \wedge_m \times 8$

17. The strongest reducing agent out of the following is:

(A) NH_3
(B) PH_3
(C) AsH_3
(D) BiH_3

18. Which of the following interhalogen compound does NOT exist?

(A) IF_3
(B) IF_4
(C) IF_5
(D) IF_7

19. The hybridization of xenon in XeO_3 is:

(A) sp^3d^2
(B) sp^3d
(C) sp^3d^3
(D) none of these

20. $Pb(NO_3)_2(\text{excess}) + CrO_2Cl_2 + NaOH \xrightarrow{25^oC} \text{Products}$

Which of the following precipitates are formed in the above reaction?

(A) $PbCrO_3$ and $PbCl_2$
(B) $PbCrO_4$ and $PbCl_2$
(C) $PbCr_2O_7$ and $PbCl_4$
(D) Na_2PbO_2 and $PbCl_4$

21. How many effective no. of Na^+ ions are present in the unit cell of NaCl if the ions along all the body diagonals of the unit cell are removed?

(A) 4
(B) 3
(C) 2
(D) 1

22. The fraction of chlorine precipitated by $AgNO_3$ solution from $[Cr(NH_3)_5Cl]Cl_2$ is

(A) $\frac{1}{2}$
(B) $\frac{1}{3}$
(C) $\frac{2}{3}$
(D) $\frac{1}{4}$

Space for Rough work

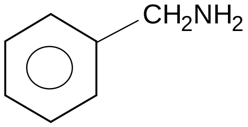
23. $Zn(s)|\,Zn^{2+}(1M)||\,Cu^{2+}(1M)|Cu(s)$
$E^{0}_{Zn^{2+}/Zn} = -0.76\,V$ and $E^{0}_{Cu^{2+}/Cu} = 0.34\,V$
Which of the following relation(s) is/are correct for the above electrochemical cell?
(A) $E^{0}_{cell} > 0$ (B) $E_{cell} > 0$
(C) $E_{cell} = E^{0}_{cell}$ (D) All are correct

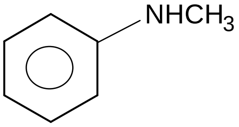
24. Which one of the following has aromatic character ?
(A) Cyclopentadienyl cation (B) Cyclopentadienyl radical
(C) Cyclopentadienyl anion (D) Cyclopentadiene

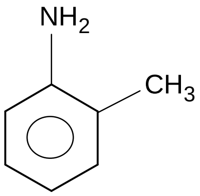
25. How many optical isomer(s) is/are possible for fructose?
(A) 10 (B) 8
(C) 16 (D) 12

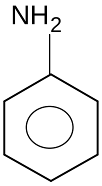
26. Number of C = C bonds present in anthracene is
(A) 5 (B) 3
(C) 9 (D) 7

27. Which of the following is the strongest base?

(A)


(B)


(C)


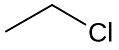
(D)


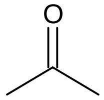
Space for Rough work

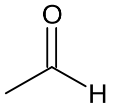
28. In order to response to xanthoproteic test. the amino acids should contain
(A) aliphatic vinyl group (B) phenyl group
(C) any cyclic group (D) allyclic group

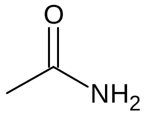
29. $[X]\xrightarrow[\text{(ii) }H^{+}(aq)]{\text{(i) }NH_4Cl;KCN(\text{equimolar})}CH_3CH(NH_2)COOH$

Compound[X] is

(A) 

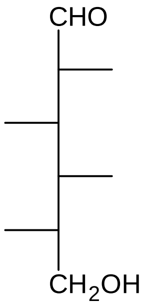
(B) 

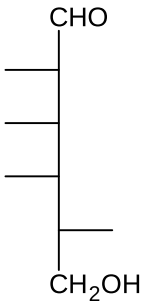
(C) 

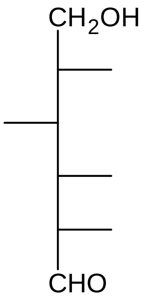
(D) 

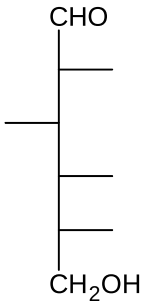
Space for Rough work

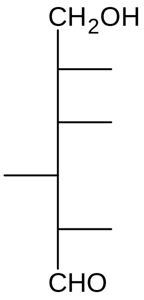
30. Compound which gives same osazone as given by



(A)


(B)


(C)


(D)


Space for Rough work

Mathematics PART – III

SECTION – A

(One Option Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE** option is correct.

1. Find the sum of the series $\cot^{-1}\frac{31}{12}+\cot^{-1}\frac{139}{12}+\cot^{-1}\frac{319}{12}+.....+\cot^{-1}\left(3n^2-\frac{5}{12}\right)$.

(A) $\cot^{-1}\frac{13n+18}{12n}$ (B) $\cot^{-1}\frac{18n+13}{12n}$

(C) $\cot^{-1}\frac{36n-5}{12n}$ (D) $\cot^{-1}\frac{28n+3}{12n}$

2. A curve satisfying the initial condition, $y(1)=0$, satisfies the differential equation, $x\frac{dy}{dx}=y-x^2$. The area bounded by the curve and the x – axis is:

(A) $\frac{1}{2}$ (B) $\frac{1}{3}$

(C) $\frac{1}{4}$ (D) $\frac{1}{6}$

3. The function f (x) = $\frac{\log(\pi+x)}{\log(e+x)}$ $(x \geq 0)$ is

(A) increasing in $[0, \infty)$

(B) decreasing in $[0, \infty)$

(C) increasing in $\left[0, \frac{\pi}{e}\right)$ and decreasing in $\left[\frac{\pi}{e}, \infty\right)$

(D) decreasing in $\left[0, \frac{\pi}{e}\right)$ and increasing in $\left[\frac{\pi}{e}, \infty\right)$

Space for Rough work

4. The total number of solutions of $\left|\cot x\right| = \cot x + \frac{1}{\sin x}$, $x \in \left[0, 3\pi\right]$ is

(A) 0 (B) 1
(C) 2 (D) 3

5. Let $a \in \left(0, 1\right]$ satisfies the equation $a^{2016} - 2a + 1 = 0$ and $S = 1 + a + a^2 + ... + a^{2015}$ Sum of all possible value(s) of S, is

(A) 2015 (B) 2016
(C) 2017 (D) 2018

6. Locus of all point P (x, y) satisfying $x^3 + y^3 + 3xy = 1$ consists of union of

(A) a line and an isolated point (B) a line pair and an isolated point
(C) a line and a circle (D) a circle and an isolated point

7. If $f\left(x\right) = x^2 + bx + c$ and $f\left(2+t\right) = f\left(2-t\right)$ for all real numbers t, then which of the following is true?

(A) $f\left(1\right) < f\left(2\right) < f\left(4\right)$ (B) $f\left(2\right) < f\left(1\right) < f\left(4\right)$
(C) $f\left(2\right) < f\left(4\right) < f\left(1\right)$ (D) $f\left(4\right) < f\left(2\right) < f\left(1\right)$

8. The average sales and standard deviation of sales for four months for a company are as follows :

	Month 1	Month 2	Month 3	Month 4
Average Sales :	30	57	82	28
Standard deviation of sales:	2	3	4	2

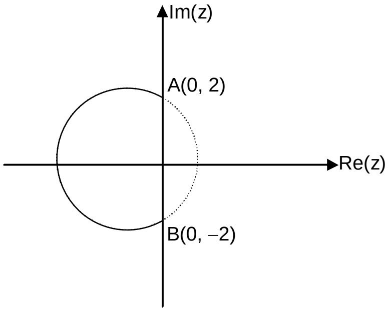
During which month are the sales most consistent?

(A) month 1 (B) month 2
(C) month 3 (D) month 4

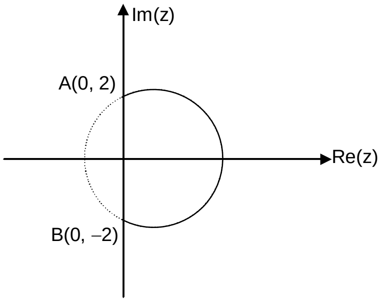
Space for Rough work

9. If $\arg\left(\frac{z-2i}{z+2i}\right)=\frac{\pi}{6}$, then which of the following options gives the correct locus of z ?

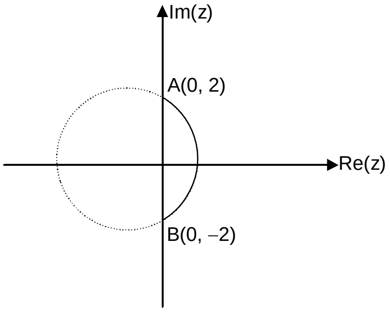
(A)


Im(z)
A(0, 2)
Re(z)
B(0, –2)

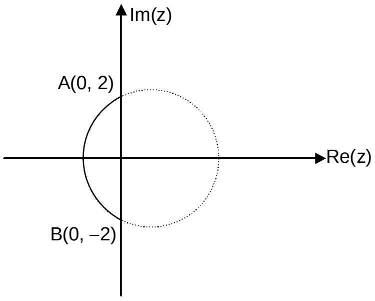
(B)


Im(z)
A(0, 2)
Re(z)
B(0, –2)

(C)


Im(z)
A(0, 2)
Re(z)
B(0, –2)

(D)


Im(z)
A(0, 2)
Re(z)
B(0, –2)

10. Let $S=\frac{1}{\sin 8^\circ}+\frac{1}{\sin 16^\circ}+\frac{1}{\sin 32^\circ}+.....+\frac{1}{\sin 4096^\circ}+\frac{1}{\sin 8192^\circ}$.

If $S=\frac{1}{\sin\alpha}$ where $\alpha \in (0, 90°)$, then the value of α (in degrees) is

(A) 4^{o}
(B) 2^{o}
(C) 6^{o}
(D) None of these

Space for Rough work

11. If $f(x)$ is a differentiable function such that $f'(2)=6$ and $f'(1)=4$, then $\lim\limits_{h\to 0}\dfrac{f(h^3+3h+2)-f(2)}{f(2h-2h^2+1)-f(1)}$ equals:

(A) $\frac{4}{3}$ (B) $\frac{4}{9}$

(C) $\frac{3}{4}$ (D) $\frac{9}{4}$

12. If $I=\int \sin x.\cos x.\cos 2x.\cos 4x.\cos 8x.\cos 16x\,dx$, then the value of I is

(A) $\frac{\sin 16x}{1024}+c$ (B) $-\frac{\cos 32x}{1024}+c$

(C) $\frac{\cos 32x}{1096}+c$ (D) $-\frac{\cos 32x}{1096}+c$

13. If the equation $x^4+8x^3+18x^2+8x+a=0$ has four distinct real roots, then the range of a is:

(A) (0, 9) (B) (–9, 0)

(C) (–8, 1) (D) (–1, 8)

14. $y=f(x)$ is a function which satisfies:

(i) $f(0)=0$

(ii) $f''(x)=f'(x)$ and

(iii) $f'(0)=1$

then the area bounded by the graph of $y=f(x)$, the lines $x=0$, $x-1=0$ and $y+1=0$, is:

(A) e (B) $e-2$

(C) $e-1$ (D) $e+1$

Space for Rough work

15. Three parallel chords of a circle have lengths 2,3,4 and subtend angles $\alpha, \beta, \alpha+\beta$ at the centre respectively (given $\alpha+\beta<\pi$), then $\cos\alpha$ is equal to

(A) $\frac{15}{31}$ (B) $\frac{17}{35}$

(C) $\frac{17}{32}$ (D) none of these

16. Let z_1, z_2, z_3 be three distinct points $|z|=1$. If θ_1, θ_2 and θ_3 be the arguments of z_1, z_2, z_3 respectively then $\cos(\theta_1-\theta_2)+\cos(\theta_2-\theta_3)+\cos(\theta_3-\theta_1)$

(A) $\geq -\frac{3}{2}$ (B) $\leq -\frac{3}{2}$

(C) $\geq \frac{3}{2}$ (D) ≤ 2

17. Number of solutions of the equation

$\log_{10}\left(\sqrt{5\cos^{-1}x-1}\right)+\frac{1}{2}\log_{10}\left(2\cos^{-1}x+3\right)+\log_{10}\sqrt{5}=1$ is:

(A) 0 (B) 1

(C) more than one but finite (D) infinite

18. If the function $f(x)=-4e^{\frac{1-x}{2}}+1+x+\frac{x^2}{2}+\frac{x^3}{3}$ and $g(x)=f^{-1}(x)$, then the value of $g'\left(-\frac{7}{6}\right)$ equals

(A) $\frac{1}{5}$ (B) $-\frac{1}{5}$

(C) $\frac{6}{7}$ (D) $-\frac{6}{7}$

Space for Rough work

19. If z is a complex number, then $\frac{z\left(|z|^2-1\right)+2\mathrm{Re}(z)}{|z|^2}$ is equal to

(A) $z+\frac{1}{z}$ (B) $z-\frac{1}{z}$

(C) $\mathrm{Re}(z)$ (D) none

20. Two teachers are interviewing top 6 students in FTRE 2016 exam in two different subjects, starting at the same time. Each teacher interviews a student for 15 minutes. The number of ways in which the interviews can be scheduled is

(A) 6! (B) 5!

(C) 44 x 6! (D) 265 x 6!

21. The length of the perpendicular from the origin to the plane passing through the point $\vec{a}$ and containing the line $\vec{r}=\vec{b}+\lambda\vec{c}$ is

(A) $\frac{\left[\vec{a}\ \vec{b}\ \vec{c}\right]}{\left|\vec{a}\times\vec{b}+\vec{b}\times\vec{c}+\vec{c}\times\vec{a}\right|}$ (B) $\frac{\left[\vec{a}\ \vec{b}\ \vec{c}\right]}{\left|\vec{a}\times\vec{b}+\vec{b}\times\vec{c}\right|}$

(C) $\frac{\left[\vec{a}\ \vec{b}\ \vec{c}\right]}{\left|\vec{b}\times\vec{c}+\vec{c}\times\vec{a}\right|}$ (D) $\frac{\left[\vec{a}\ \vec{b}\ \vec{c}\right]}{\left|\vec{c}\times\vec{a}+\vec{a}\times\vec{b}\right|}$

22. If $A=\begin{bmatrix}\cos\theta & \sin\theta\\ -\sin\theta & \cos\theta\end{bmatrix}$, then $\lim\limits_{n\to\infty}\frac{A^n}{n}$ is (where $\theta\in R$)

(A) a zero matrix (B) an identity matrix

(C) $\begin{bmatrix}0 & 1\\ 0 & -1\end{bmatrix}$ (D) $\begin{bmatrix}0 & 1\\ -1 & 0\end{bmatrix}$

Space for Rough work

23. Let $T=\int_0^{\ln 2}\frac{2e^{3x}+e^{2x}-1}{e^{3x}+e^{2x}-e^{x}+1}dx$, then e^{T} equals:

(A) $\frac{7}{4}$ (B) $\frac{7}{2}$

(C) $\frac{11}{2}$ (D) $\frac{11}{4}$

24. A line is drawn from the point P (1, 1, 1) and perpendicular to a line with direction ratios 1, 1, 1 to intersect the plane $x+2y+3z=4$ at Q. The locus of Q is

(A) $\frac{x}{1}=\frac{y-5}{-2}=\frac{z+2}{1}$ (B) $\frac{x}{-2}=\frac{y-5}{1}=\frac{z+2}{1}$

(C) $x=y=z$ (D) $\frac{x}{2}=\frac{y}{3}=\frac{2}{5}$

25. The lines $2x^2-3y^2+xy-3x-7y+2=0$ represent two normals of a circle which passes through the focus of the parabola $(5x+15)^2+\left(5y-\frac{5}{2}\right)^2=\left(3x+4y-\frac{1}{2}\right)^2$. The equation of the circle is

(A) $4x^2+4y^2-8x-8y-65=0$ (B) $4x^2+4y^2-8x+8y-65=0$

(C) $x^2+y^2-2x-2y-73=0$ (D) $x^2+y^2-2x+y+73=0$

26. The asymptotes of the hyperbola $y=x+\frac{1}{x}$ are

(A) $y=0,\ y=x$ (B) $y=0,\ y=-x$

(C) $x=0,\ y=-x$ (D) $x=0,\ y=x$

Space for Rough work

27. If $x\frac{dy}{dx} = y(\log_e y - \log_e x + 1)$, then the solution of the equation is

(A) $y\log_e\left(\frac{x}{y}\right) = cx$

(B) $x\log_e\left(\frac{y}{x}\right) = cy$

(C) $\log_e\left(\frac{y}{x}\right) = c\,x$

(D) $\log_e\left(\frac{x}{y}\right) = cy$

28. A man is dealt a poker hand (consisting of 5 cards) from an ordinary pack of 52 playing cards. The number of ways in which he can be dealt a "straight" (a straight is five consecutive values NOT of the same suit. e.g. {Ace 2, 3, 4, 5}, {2, 3, 4, 5, 6}……..and {10 . J. Q. K. Ace}) is

(A) $10(4^5 - 4)$

(B) $4!.2^{10}$

(C) 10.2^{10}

(D) none of these

29. The minimum value of $(\tan A - \cos B)^2 + (\cot A - \sin B)^2$ for all permissible independent variables A and B is

(A) 0

(B) $\sqrt{2} - 1$

(C) $3 - 2\sqrt{2}$

(D) cannot be determined

30. From a set of numbers $\{1, 2, 3, ..., 999\}$, six distinct numbers are chosen. Out of these six numbers three are chosen and labeled as a_1, a_2, a_3. The remaining are labeled as b_1, b_2, b_3. The probability that a brick of dimensions $a_1 \times a_2 \times a_3$ fits in a box of dimensions $b_1 \times b_2 \times b_3$ is equal to (assume that the brick can be rotated before putting into the box)

(A) $\frac{1}{2}$

(B) $\frac{1}{3}$

(C) $\frac{1}{4}$

(D) $\frac{1}{5}$

Space for Rough work

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

FIITJEE **JEE(Main)-2017**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

CONCEPT RECAPITULATION TEST – I
(Main)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	B	B
2.	A	C	D
3.	A	C	B
4.	A	D	C
5.	B	A	D
6.	A	B	A
7.	D	D	B
8.	C	C	C
9.	B	C	A
10.	A	B	A
11.	A	D	D
12.	B	A	B
13.	A	B	C
14.	C	C	C
15.	C	B	C
16.	D	B	A
17.	B	D	B
18.	D	B	A
19.	C	D	A
20.	C	B	D
21.	C	B	C
22.	C	C	A
23.	D	D	D
24.	A	C	A
25.	D	B	B
26.	D	D	D
27.	C	A	C
28.	B	B	A
29.	D	C	C
30.	B	B	C

Physics PART – I

SECTION – A

1. A

Sol. $\alpha x^2 + \beta x - t = 0 \;\Rightarrow\; x = \dfrac{-\beta \pm \sqrt{\beta^2 + 4\alpha t}}{2\alpha}$

$V = \dfrac{dx}{dt} = \dfrac{4\alpha}{2 \times 2\alpha\sqrt{\beta^2 + 4\alpha t}} = \pm\dfrac{1}{\sqrt{\beta^2 + 4\alpha t}}$

$a = \dfrac{dv}{dt} = \pm\dfrac{}{(\beta^2 + 4\alpha t)^{3/2}}\left(\dfrac{-1}{2}\right) \times 4\alpha = (-2\alpha)V^3$

2. A

Sol. Neutron law for cooling

Rate of decrease of temperature ∝ temperature difference between object and surrounding.

3. A

Sol. $1000 = \left(\dfrac{350}{350 - 50}\right)f$ …(i)

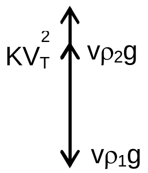
$f_1 = \left(\dfrac{350}{350 + 50}\right)f$ …(ii)

$f_1 = 750$ Hz

4. A

Sol. $v\rho_2 g + KV_T^2 = v\rho_1 g$

The ball is dynamic equilibrium.



5. B

Sol. $k'2\ell = k3\ell$

$k = \dfrac{3}{2}k$

6. A

Sol. $R = \dfrac{V^2}{gv_o} \cdot V = \dfrac{V^3}{gV_o}$; $R \,\alpha\, V^3$

7. D

Sol. $\Delta Q = \Delta U + \Delta W$ …(i)

and

$\Delta U = nC_v(\Delta T)$ …(ii)

8. C

Sol. The centre of mass = $\frac{2R}{\pi}$

Linear velocity = $\left(\frac{2R}{\pi}\right)\left(\frac{V}{R}\right)$

$\because$ V = rω.

9. B

Sol: Y = $\frac{F.\ell}{A.\Delta\ell}$ $\Rightarrow$ F = YA.$\frac{\Delta\ell}{\ell}$

$= 2\times10^{11}\times\frac{1}{100}\times A$

$n = \frac{1}{2\times1.5}\sqrt{\frac{F}{Ad}} = \frac{1}{3}\sqrt{\frac{2\times10^9 A}{A\times7.7\times10^3}}$

n = 170Hz

10. A

Sol. $\frac{\nu}{4L_i} - \frac{\nu}{4L_2} = 5$ …(i)

$\frac{L_1}{L_2} = \frac{50}{51}$ …(ii)

11. A

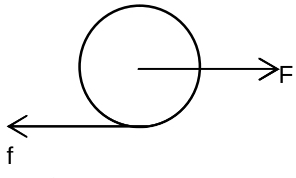
Sol. Escape velocity = $\sqrt{\frac{2GM}{R}}$

12. B

Sol. $B = 2\left[\frac{\mu_0 I}{4\pi r\cos45^0}\right]\left(\sin90^0 - \sin45^0\right) + \frac{\mu_0 I}{4\pi r}\left(\frac{\pi}{2}\right)$

13. A

Sol. $F = IBL$



$F - f = ma$

$fr = I\alpha$

$a = r\alpha$

14. C

Sol. A > 2θ_C

15. C

Sol. $T = 2\pi\sqrt{\frac{\ell}{g_{eff}}}$; $g_{eff} = g + \frac{qE}{m}$ (with electric field)

16. D

Sol. For electron in electric field, magnitude of its momentum may increase, decrease or remain constant w.r.t. initial value.

17. B

Sol. $0.6 = \frac{Q_1 - Q_2}{Q_1} = 1 - \frac{20}{Q_1}$

$\Rightarrow$ $Q_1 = 50$, $W = Q_1 - Q_2 = 30$ J

18. D

Sol. I_L and I_C will be in opposite phases.

$I_{net} = I_L - I_C$

$= 0.6 - 0.4 = 0.2$ A

19. C

Sol. Variation of moment of inertia with temperature

$I = I_o (1 + 2\alpha \Delta T)$

C.O.A.M:

$I_i\omega_i = I_f \omega_f$

20. C

Sol. Polarization occurs for transverse waves and not for longitudinal waves.

21. C

Sol. $W = \frac{\lambda D}{d}$;

$\Delta W = \frac{\lambda \Delta D}{d}$

22. C

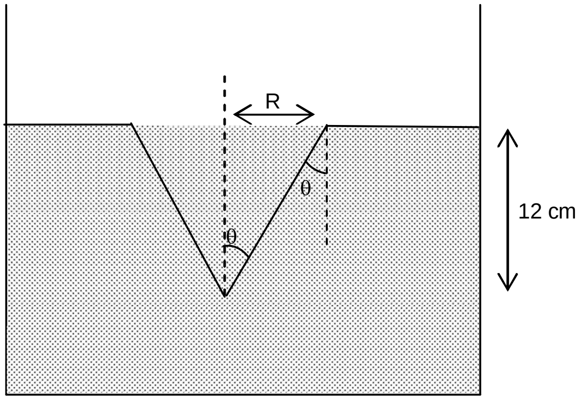
Sol. $V_{AC} = 2 \times \left(\frac{0.2}{1.8 + 0.2}\right)$ …(i)

Also, $V_{AC} = (1.5)\left(\frac{5}{15}\right)\left(\frac{\ell}{100}\right)$ …(ii)

23. D

Sol. $\theta = \theta_C$ (critical angle)

$\frac{R}{12} = \tan\theta_C$



24. A

Sol. $\varepsilon = B\ell v$ develops across rod PQ.

By Lenz's law, plate M get positively charged.

25. D

Sol. $A_1V_1 = A_2V_2$

$$\Rightarrow a\sqrt{2gh} = A\left(-\frac{dh}{dt}\right)$$

$$\Rightarrow \frac{a}{A}\int_0^t dt = -A\int_{h_1}^{h_2}\frac{dh}{\sqrt{2gh}}$$

26. D

Sol. $$\frac{E_{4n}-E_{2n}}{E_{2n}-E_n} = \frac{\frac{E_1}{16n^2}-\frac{E_1}{4n^2}}{\frac{E_1}{4n^2}-\frac{E_1}{n^2}} = \frac{1}{4} = \text{constant}$$

27. C

Sol. $\Delta m = 0.026$ amu

$Q_{value} = 2.42$ MeV

$t = 1.28\times10^{12}$ s

28. B

Sol. $$\frac{hc}{\lambda} = hv = 2.5+1.7 = 4.2eV$$

$$v\lambda = C$$

$$\& \ v'\frac{\lambda}{2} = C \Rightarrow v' = 2v$$

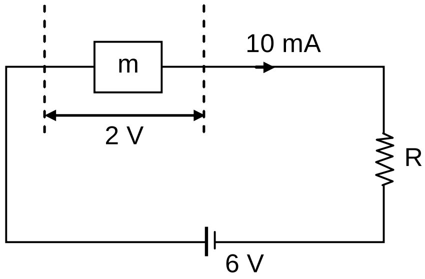
$$eV_0 = h(2v)-\varphi = 2\times4.2-2.5$$

$$V_0 = 5.9\,V$$

29. D

Sol. The potential drop across R is 4 V while current is 10 mA hence, $10 \times 10^{-3} \times R = 4$.

$R = 400\ \Omega$.



30. B

Sol. The electron density in doped semiconductor,

$$\eta_e = \frac{n_i^2}{n_h} = \frac{(3 \times 10^{16})^2}{4.5 \times 10^{22}} = 2 \times 10^{10}\ /\text{m}^3$$

Chemistry PART – II

SECTION – A

1. B

Sol. Meq. of $FeSO_4$ = Meq. of $KMnO_4$
or, $N_1V_1 = N_2V_2$
or, $100 \times N_1 = 200 \times 0.1 \times 5$
$\therefore$ $N_1 = 1$, also $M = 1$

2. C

Sol. It has unsymmetrical structures.

3. C

Sol. One mole of NH_3 occupy 22.4 L at NTP, not at 300 K and 1 atm.

4. D

Sol. Sulphur forms two sigma bonds with two lone pairs.

5. A

Sol. $BeSO_4$ forms complex with water i.e. $[Be(H_2O)_4]^{2+}$. Hence it is most soluble.

6. B

Sol. The unit of k will be $mol^{-1/2}L^{1/2}s^{-1}$.

7. D

Sol. K_a increases only by increasing temperature.

8. C

Sol. $K_C = \frac{[Y]}{[X]} = \frac{4}{6} = \frac{2}{3}$

9. C

Sol. For equilibrium system, $\Delta S(\text{system}) = -\Delta S(\text{surrounding})$

10. B

Sol. $(CH_3)_2SiCl_2 \xrightarrow{H_2O} (CH_3)_2Si(OH)_2 \xrightarrow{-H_2O} \text{Silicones}$

11. D

Sol. $K_P = \frac{p_y \times p_z}{p_x} = \frac{3 \times 3}{3} = 3$
$P_{equilibrium} = p_x + p_y + p_z = 3 + 3 + 3 = 9$ atm

12. A

Sol. $NaOH + CO \longrightarrow HCOONa$

13. B

Sol. $SO_3^{2-} + 2H^+ \longrightarrow SO_2 + H_2O$

14. C

Sol. HCOOH is stronger than CH_3COOH. Hence the solution of HCOOH will contain more no. of ions than that of CH_3COOH.

15. B

Sol. Zn^{2+} form colourless compounds in solution due to absence of d-d transition.

16. B

Sol. $\frac{\Lambda_m}{\Lambda_e} = 3 \Rightarrow \Lambda_m = 3\Lambda_e$

n-factor of $MgCl_2.KCl.6\ H_2O$ = 3.

17. D

Sol. Due to weak Bi – H bond.

18. B

Sol. Halogen atoms except fluorine form compounds with valency 1, 3, 5 and 7.

19. D

Sol. Xe undergoes sp^3 hybridization and forms three sigma and three pi-bonds with a lone pair on it.

20. B

Sol. $NaOH \xrightarrow{CrO_2Cl_2} Na_2CrO_4 + H_2O + Cl^-$

$Pb^{2+} + 2Cl^- \longrightarrow PbCl_2 \downarrow$

$Pb^{2+} + CrO_4^{2-} \longrightarrow PbCrO_4 \downarrow$

21. B

Sol. One Na^+ is removed and remaining three(effective no. per unit cell) are present.

22. C

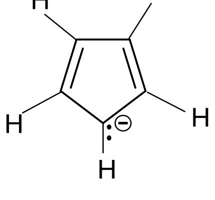
Sol. The fraction is $\frac{2}{3}$

23. D

Sol. E^0_{cell} = E^0_{cell} > 0 (due to 1 M concentration of ions)

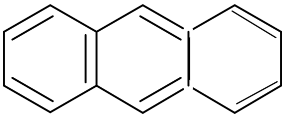
24. C

Sol. In cyclopentadienyl anion, each carbon is sp^2 hybridized



25. B
Sol. Fructose contains 3 chiral carbon atoms.

26. D
Sol.



27. A
Sol. Aliphatic amines are stronger base than aromatic amines

28. B
Sol. In xanthoproteic test, electrophylic nitration takes place.

29. C
Sol. $CH_3CHO \xrightarrow[KCN]{NH_4Cl} MeCH(NH_2)CN \xrightarrow[H_2O]{HCl} MeCH(NH_2)COOH$

30. B
Sol. The configuration of carbon atoms at 3, 4, 5 positions should be same.

Mathematics PART – III

SECTION – A

1. B

Sol. $T_r = \cot^{-1}\left(3r^2 - \frac{5}{12}\right)$

$$= \tan^{-1}\left(\frac{12}{36r^2-5}\right) = \tan^{-1}\left(\frac{12}{4+36r^2-9}\right)$$

$$= \tan^{-1}\left(\frac{3}{1+\frac{9}{4}\left(4r^2-1\right)}\right)$$

$$= \tan^{-1}\left(\frac{\frac{3}{2}(2r+1)-\frac{3}{2}(2r-1)}{1+\frac{3}{2}(2r+1).\frac{3}{2}(2r-1)}\right)$$

$$= \tan^{-1}\left(\frac{3}{2}(2r+1)\right) - \tan^{-1}\left(\frac{3}{2}(2r-1)\right)$$

$$\therefore S_n = \tan^{-1}\left(\frac{3}{2}(2n+1)\right) - \tan^{-1}\frac{3}{2}$$

$$= \tan^{-1}\left(\frac{12n}{18n+13}\right) = \cot^{-1}\left(\frac{18n+13}{12}\right)$$

2. D

Sol. Equation of the curve is $y = x(1-x)$

3. B

Sol. $f(x) = \frac{\ln(\pi+x)}{\ln(e+x)}$

$$f'(x) = \frac{\frac{\ln(e+x)}{(\pi+x)} - \frac{\ln(\pi+x)}{(e+x)}}{\left(\ln(e+x)\right)^2}$$

Now, consider the function $g(y) = y\ln y$

$g'(y) = \ln y + 1$

$g'(y) > 0$ when $y > \frac{1}{e}$

$g(y)$ is an increasing function when $x > \frac{1}{e}$

$\Rightarrow (e+x)\ln(e+x) < (\pi+x)\ln(\pi+x) \qquad (x \ge 0)$

$$\Rightarrow \frac{\ln(e+x)}{(\pi+x)} - \frac{\ln(\pi+x)}{(e+x)} < 0$$

$\Rightarrow f'(x) < 0 \ \forall x \geq 0$

$\Rightarrow f(x)$ is decreasing is $[0, \infty)$

4. C

Sol. When $\cot x \geq 0$

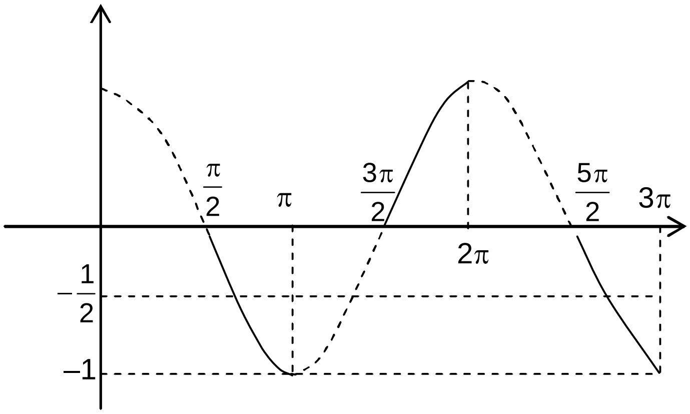
$$\Rightarrow \frac{1}{\sin x} = 0$$

$\Rightarrow$ No possible value of x.

When $\cot x < 0 \quad \Leftrightarrow \quad x \in \left(\frac{\pi}{2}, \pi\right) \cup \left(\frac{3\pi}{2}, 2\pi\right) \cup \left(\frac{5\pi}{2}, 3\pi\right)$

$$\Rightarrow -\cot x = \cot x + \frac{1}{\sin x}$$

$$\Rightarrow \cos x = \frac{-1}{2}$$



Number of solution = 2

5. D

Sol. $S = 2, S = 2016$

6. A

Sol. $x^3 + y^3 + (-1)^3 - 3(x)(y)(-1) = 0$

$\Rightarrow (x + y - 1) = 0$ OR $x^2 + y^2 - xy + x + y + 1 = 0$

7. B

Sol. $f(x)$ has minimum value at 2. $f(1)$ will be smaller than f (4) because 1 is closer to 2 as compared to 4.

8. C

Sol.

	M1	M2	M3	M4
$\frac{\sigma}{x}$	$\frac{2}{30}$	$\frac{3}{57}$	$\frac{4}{82}$	$\frac{2}{28}$

which ever is less is most consistent.

9. A

Sol. $\arg\left(\frac{z-2i}{z+2i}\right)=\frac{\pi}{6} \quad \Rightarrow \arg(z-2i)-\arg(z+2i)=\frac{\pi}{6}$

$\Rightarrow \tan^{-1}\left(\frac{y-2}{x}\right)-\tan^{-1}\left(\frac{y+2}{x}\right)=\frac{\pi}{6}$

$\Rightarrow \frac{xy-2x-xy-2x}{x^2+y^2-4}=\frac{1}{\sqrt{3}}$

$\Rightarrow x^2+y^2-4=-4\sqrt{3}\,x$

$\Rightarrow x^2+y^2+4\sqrt{3}\,x-4=0$

$\Rightarrow \left(x+2\sqrt{3}\right)^2+y^2=12+4=4^2$

$\therefore$ centre$\left(-2\sqrt{3},0\right)$, radius = 4

10. A

Sol. $S=\frac{\sin\left(8^o-4^o\right)}{\sin 8^o \sin 4^o}+\frac{\sin\left(16^o-8^o\right)}{\sin 16^o \sin 8^o}+..........+\frac{\sin\left(8192^o-4096^o\right)}{\sin 8192^o \sin 4096^o}$

$\Rightarrow S=\cot 4^o-\cot 8192^o$

11. D

Sol. $\lim\limits_{h\to 0}\frac{f\left(h^3+3h+2\right)-f(2)}{f\left(2h-2h^2+1\right)-f(1)}=\lim\limits_{h\to 0}\frac{f'\left(h^3+3h+2\right).\left(3h^2+3\right)}{f'\left(2h-2h^2+1\right).(2-4h)}=\frac{6.3}{4.2}=\frac{9}{4}$

(Using L' Hospital Rule)

12. B

Sol. $I=\int\frac{\sin 3x}{32}dx$

13. C

Sol. $\left(x^2+4x+1\right)^2+a-1=0$

$\therefore \quad \left(x^2+4x+1\right)^2=1-a$

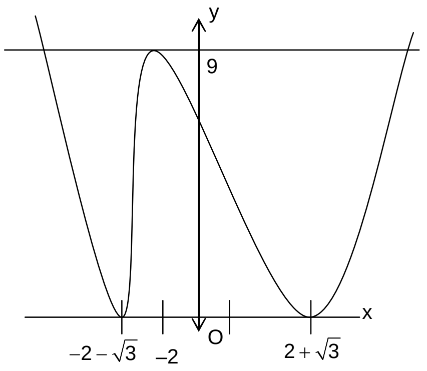
$f(x)=\left(x^2+4x+1\right)^2$

For four distinct solutions

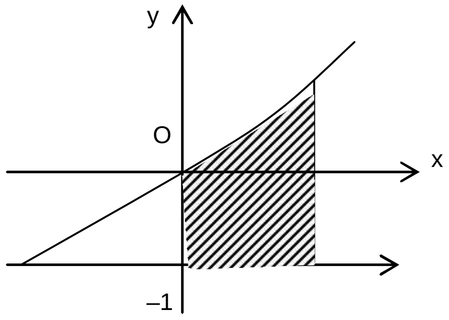
$1-a\in(0,\,9)$

$-a\in(-1,\,8)$

$a\in(-8,\,1)$



14. C



Sol. $\dfrac{f''(x)}{f'(x)} = 1$

Integrating $\ln f'(x) = x + c,\ f'(0) = 1 \Rightarrow c = 0$

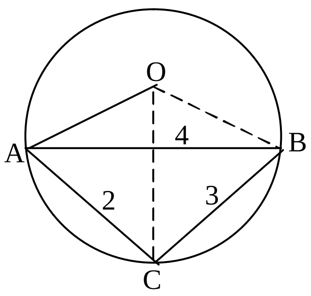
$f'(x) = e^x$

$f(x) = e^x + k,\ f(0) = 0 \Rightarrow k = -1$

$f(x) = e^x - 1$

Area $= \displaystyle\int_0^1 \left(e^x - 1 + 1\right)dx = e^x\Big]_0^1 = e - 1$

15. C



Sol. Using the property that equal chords subtends equal angles at centre of circle, then problem can be converted to the diagram in adjoining figure

$AB = 4, AC = 2, BC = 3$

$\angle ABC = \alpha/2$

$\cos(\alpha/2) = \dfrac{9 + 16 - 4}{2 \times 3 \times 4} = \dfrac{7}{8} \Rightarrow \cos\alpha = 2\cos^2(\alpha/2) - 1$

$= 2 \times \dfrac{49}{64} - 1 = \dfrac{98 - 64}{64} \Rightarrow \cos\alpha = \dfrac{34}{64} = \dfrac{17}{32}$

16. A

Sol. $\cos(\theta_1 - \theta_2) + \cos(\theta_2 - \theta_3) + \cos(\theta_3 - \theta_1) \ge -\dfrac{3}{2}$

17. B

Sol. $\cos^{-1} x = t \Rightarrow x \in [-1, 1]$ and $t \in [0, \pi]$

$\log_{10}\sqrt{5t - 1} + \dfrac{1}{2}\log_{10}(2t + 3) + \dfrac{1}{2}\log_{10} 5 = 1;\ \left(t > \dfrac{1}{5} \text{ and } t > -\dfrac{3}{2}\right)$

$\log_{10}\left((5t - 1)(2t + 3).5\right) = 2$

$(t - 1)(10t + 23) = 0 \Rightarrow t = 1$ or $t = -\dfrac{23}{10}$ (rejected)

$\cos^{-1} x = 1 \Rightarrow x = \cos 1$

18. A

Sol. $\dfrac{dy}{dx} = \dfrac{4}{2} e^{\frac{1-x}{2}} + 1 + x + x^2 = 2e^{\left(\frac{1-x}{2}\right)} + x^2 + x + 1$

$g'(y) = \dfrac{dx}{dy} = \dfrac{1}{2e^{-\left(\frac{x-1}{2}\right)} + x^2 + x + 1}$

When $y = -\dfrac{7}{6}$ then $x = 1$

$\left.\dfrac{dy}{dx}\right]_{x=-7/6} = \dfrac{1}{2 + 3} = \dfrac{1}{5}$

19. A

Sol. $= \dfrac{z\left(z\bar{z}-1\right)+z+\bar{z}}{z\bar{z}} = \left(z-\dfrac{1}{\bar{z}}\right)+\dfrac{1}{\bar{z}}+\dfrac{1}{z} = z+\dfrac{1}{z}$

20. D

Sol. Number of ways = (Number of one-one function from set A = {s_1, s_2 ….s_6} to A such that $f(s_i) \neq s_i \times 6! = D_6 \times 6!$

21. C

Sol. The given plane passes through $\vec{a}$ and is parallel to the vector $\vec{b}-\vec{a}$ and $\vec{c}$. So it is normal to $\left(\vec{b}-\vec{a}\right)\times\vec{c}$. Hence, its equation is $\left(\vec{r}-\vec{a}\right).\left(\left(\vec{b}-\vec{a}\right)\times\vec{c}\right)=0$ or

$\vec{r}.\left(\vec{b}\times\vec{c}+\vec{c}\times\vec{a}\right)=\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right]$

The length of the perpendicular from the origin to this plane is $\dfrac{\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right]}{\left|\vec{b}\times\vec{c}+\vec{c}\times\vec{a}\right|}$

22. A

Sol. $A^n = \begin{bmatrix} \cos n\theta & \sin n\theta \\ -\sin n\theta & \cos n\theta \end{bmatrix}$

$\therefore \lim\limits_{n\to\infty}\dfrac{A^n}{n} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$

23. D

Sol. We have $T = \displaystyle\int_0^{\ln 2}\dfrac{\left(3e^{3x}+2e^{2x}-e^{x}\right)-\left(e^{3x}+e^{2x}-e^{x}+1\right)}{e^{3x}+e^{2x}-e^{x}+1}dx$

$= \left[\ln\left(e^{3x}+e^{2x}-e^{x}+1\right)-x\right]_0^{\ln 2}$

$= \ln\dfrac{11}{2}-\ln 2 = \ln\dfrac{11}{4} \Rightarrow e^{T} = e^{\ln\frac{11}{4}} = \dfrac{11}{4}$

24. A

Sol. D.R's of PQ are $x_1-1,\ y_1-1,\ z_1-1$

$\Rightarrow 1\left(x_1-1\right)+1\left(y_1-1\right)+1\left(z_1-1\right)=0$

$\Rightarrow x_1+y_1+z_1=3$

Also $x_1+2y_1+3z_1=4$

$x_1+y_1+z_1=3$

$\Rightarrow \left(x_1, y_1, z_1\right)$ is a point on the two planes

$x+2y+3z=4$

$x+y+z=3$

$\therefore$ line of intersection of these two planes will be the required locus which is

$\dfrac{x}{1}=\dfrac{y-5}{-2}=\dfrac{z+2}{1}$

25. B

Sol. Parabola is of the form $\left(x+3\right)^2+\left(y-\frac{1}{2}\right)^2=\left(\frac{3x+4y-\frac{1}{2}}{5}\right)^2$ having focus $\left(-3,\frac{1}{2}\right)$ and point of intersection of lines given by the equation $2x^2-3y^2+xy-3x-7y+2=0$ can be obtained by solving equations $4x+y-3=0$ and $-6x+x-7=0$ (partial differentiation method), i.e $\left(1-1\right)\equiv$ centre (point of intersection of normals).

Hence required circle is $\left(x-1\right)^2+\left(y+1\right)^2=\left(1+3\right)^3+\left(-1-\frac{1}{2}\right)^2$

Or $x^2+y^2-2x+2y+2=16+\frac{9}{4}$ i.e. $4x^2+4y^2-8x+8y-65=0$

26. D

Sol. Asymptotes equations are $x^2-xy+k=0$

27. C

Sol. $\frac{dy}{dx}=\frac{y}{x}\left(\ell n\frac{y}{x}-1\right)$

Put $\frac{y}{x}=t$

28. A

Sol. Number of ways $=10\left(4^5-4\right)$

29. C

Sol. The expression can be interpreted as the square of distance between the points $\left(\tan A, \cot A\right)$ and $\left(\cos B, \sin B\right)$

The minimum value of this distance is the minimum distance between the curves $xy=1$ and $x^2+y^2=1$

30. C

Sol. For every selection of 6 numbers without loss of generality there will be 5 favorable cases out of every 20 cases.

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

FIITJEE **JEE (Advanced), 2017**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – II

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 264**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i). **Section-A (01 – 10)** contains 10 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer and **– 2 marks** for wrong answer.

(ii). **Section – B (01 – 02)** contains 2 Match the following Type questions. Each question having 4 statements in Column I & 5 statements in Column II with any given statement in Column I having correct matching with 1 or more statement (s) given in Column II. Each statement carries **+2 marks** for correct answer and **– 1 mark** for wrong answer.

(iii). **Section-C (01 – 08)** contains 8 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

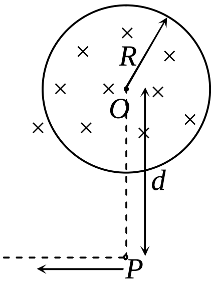
PART – I

SECTION – A
(One or More Than One Options Correct Type)

This section contains **10 multiple choice type questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE** or **MORE THAN ONE** are correct.

1. A 10 m long horizontal stainless steel wire AB of mass 1 kg whose end A is fixed, is connected to a massless string BC passing over a smooth pulley. String BC is connected to a container of mass 2 kg at end C. Water (density = 1×10^3 kg/m^3) is poured in the container at a constant rate of 2.25 litre/sec at t = 0. Also at t = 0, a pulse is generated at end A. Choose from the following the correct option(s).
(A) Time taken by the pulse to reach point B is 0.612 sec
(B) Time taken by the pulse to reach point B is 0.212 sec
(C) Tension in the string at this moment is 33.77 N
(D) Tension in the string at this moment is 24.77 N

2. In a cylindrical region of radius R, there exists a time varying magnetic field B such that $\frac{dB}{dt} = k(>0)$. A charged particle having charge q is placed at the point P at a distance d (> R) from its centre O. Now, the particle is moved in the direction perpendicular to OP (see figure) by an external agent upto infinity so that there is no gain in kinetic energy of the charged particle. Choose the correct statement/s.



(A) Work done by external agent is $\frac{q\pi R^2}{4}k$ if d = 2R
(B) Work done by external agent is $\frac{q\pi R^2}{8}k$ if d = 4R
(C) Work done by external agent is $\frac{q\pi R^2}{4}k$ if d = 4R
(D) Work done by external agent is $\frac{q\pi R^2}{4}k$ if d = 6R

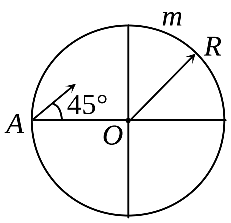
Space for Rough work

3. If the dimensions of length are expressed as $G^x c^y h^z$; where G, c and h are the universal gravitational constant, speed of light and Planck's constant respectively, then

(A) $x = \frac{1}{2}, y = \frac{1}{2}$ (B) $x = \frac{1}{2}, z = \frac{1}{2}$

(C) $y = \frac{1}{2}, z = \frac{3}{2}$ (D) $y = -\frac{3}{2}, z = \frac{1}{2}$

4. A ring of mass m and radius R is placed on a frictionless horizontal surface. A particle of mass m is projected from point A with velocity v at an angle of 45° with AO as shown. The correct statements are



(A) The particle reaches the same point A on the ring after time $\frac{4R\sqrt{2}}{v}$.

(B) Magnitude of impulse transformed during first collision is $\frac{mv}{\sqrt{2}}$.

(C) Magnitude of impulse transformed during second collision is $\frac{mv}{\sqrt{2}}$.

(D) Particle reaches diametrically opposite point on the ring in time $\frac{2R}{v}$.

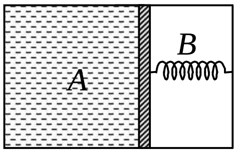
5. Two projectile are thrown at the same time from two different points. The projectile thrown from the origin has initial velocity $3\hat{i} + 3\hat{j}$ with respect to earth. The projectile has initial velocity $a\hat{i} + b\hat{j}$ with respect to earth thrown from the point (10, 5). ($\hat{i}$ is a unit vector along horizontal, $\hat{j}$ along vertical). If the projectile collides after two second, then the

(A) value of a is -2 (B) value of a is $\frac{1}{2}$

(C) value of b is $\frac{1}{2}$ (D) value of b is –2

Space for Rough work

6. A thermally insulated chamber of volume $2V_0$ is divided by a frictionless piston of area S into two equal parts A and B. Part A has an ideal gas at pressure P_0 and temperature T_0 and in part B is vacuum. A massless spring of force constant k is connected with piston and the wall of the container as shown. Initially spring is unstretched. Gas in chamber A is allowed to expand. Let in equilibrium spring is compressed by x_0. Then



(A) final pressure of the gas is $\frac{kx_0}{S}$

(B) work done by the gas is $\frac{1}{2}kx_0^2$

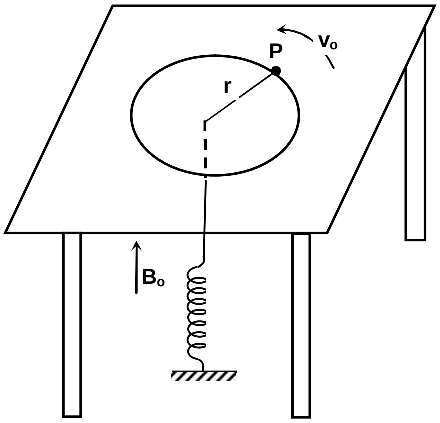
(C) change in internal energy of the gas is $\frac{1}{2}kx_0^2$

(D) temperature of the gas is decreased

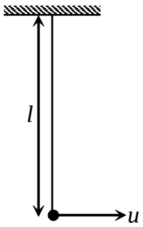
7. A particle mass m charge q is moving on a circular path on the surface of a frictionless table with speed v_o where a magnetic field B_o exists uniformly over the whole region. It is attached by a string which passes through a hole in the table to a spring as shown.

The spring is stretched by x_o. If now the magnetic field is increased slowly to $2B_o$, which of these are incorrect?

(A) The extension in the spring will increase
(B) The speed of the particle will increase
(C) The speed of the particle will decrease
(D) The kinetic energy of the particle will decrease



Space for Rough work



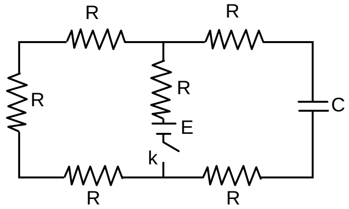
8. A particle of mass m is attached to one end of the light inextensible string and other end of the string is fixed in vertical plane as shown. Now particle is given horizontal velocity $u = \sqrt{\frac{5}{2}gl}$, then which of the following statement/s is/are correct.

(A) The string makes angle with the downward vertical is 60^0 when acceleration of the particle is horizontal.

(B) The tension in string is 2 mg when acceleration of the particle is horizontal.

(C) The speed of the particle is $\sqrt{\frac{3}{2}gl}$ when acceleration of the particle is horizontal

(D) The particle will not complete the circle.



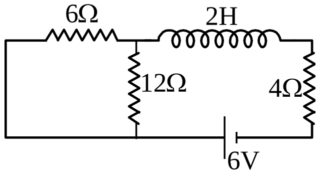
9. In the given circuit initially the capacitor is uncharged. At t = 0 the key k is closed. Choose the correct option(s)

(A) The time constant of the circuit is $\frac{11RC}{4}$.

(B) The time constant of the circuit is $\frac{11RC}{5}$.

(C) Current through the capacitor after one time constant is $\frac{3E}{11R}\left(\frac{1}{e}\right)$.

(D) Current through the capacitor after one time constant is $\frac{5E}{11R}\left(\frac{1}{e}\right)$.



10. For the circuit shown in the figure, which of the following statements is/are correct

(A) Its time constant is 0.25 second

(B) In steady sate, current through inductance will be equal to zero.

(C) in steady state, current through the battery will be equal to 0.75 amp.

(D) none of these

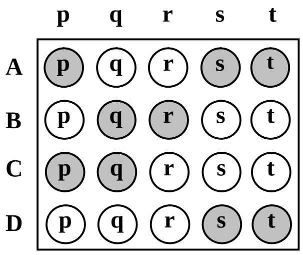
Space for Rough work

SECTION – B

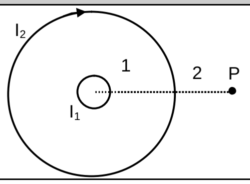
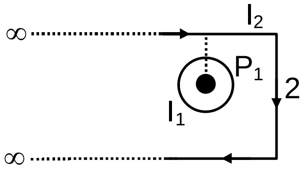
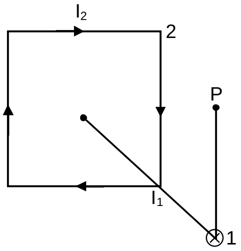
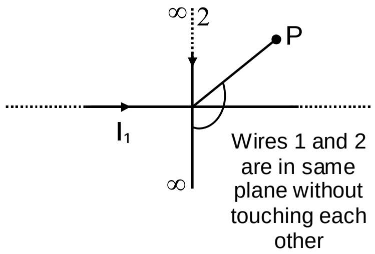
Matrix-Match Type

*This section contains 2 questions. Each question contains statements given in two columns which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A-p, s and t; B-q and r; C-p and q; and D-s and t; then the correct darkening of bubbles will look like the following.

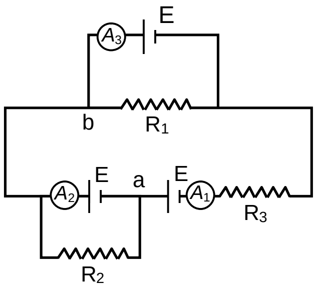


1. Match the Column:

Column – I		Column – II	
(A)		(p)	1 and 2 attract each other
(B)		(q)	1 and 2 repel each other
(C)		(r)	1 and 2 do not exert any force on each other
(D)	 Wires 1 and 2 are in same plane without touching each other	(s)	Magnetic field at point P due to wires 1 and 2 are perpendicular to each other.
		(t)	Magnetic field at point P due to wires 1 and 2 are in same direction.

Space for Rough work

2. In the circuit shown in figure, $R_1 = R_2 = R_3 = 3\Omega$ and e.m.f. of each cell is E = 4V and negligible internal resistance. All ammeters are ideal. Match the following:



Column - I		Column - II	
(A)	Reading of ammeter A_1 in ampere is	(p)	4/3
(B)	Reading of ammeter A_2 in ampere is	(q)	8/3
(C)	Reading of ammeter A_3 in ampere is	(r)	4
(D)	Potential difference between point a and point b in volt is	(s) (t)	zero 2

SECTION – C

(One Integer Value Correct Type)

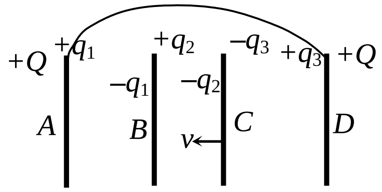
This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. A point source of power 4W is placed 1m below the free surface of liquid whose refractive index is '$\frac{2}{\sqrt{3}}$'. Find the rate of transfer of energy (in watt) from the liquid surface to air. Ignore any absorption or scattering of light energy.

2. A double convex lens forms a real image of an object on a screen which is fixed. Now the lens is given a constant velocity v_0 along its axis and away from the screen. For the purpose of forming the image always on the screen, the object is also required to be given an appropriate velocity. Find the velocity of the object at the instant its size is n times the size of image. (Take n = 1/2 and v_0 = 1 m/s)

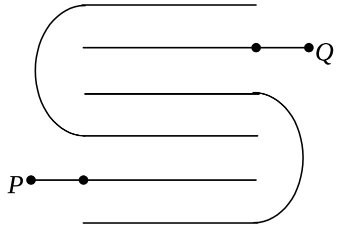
Space for Rough work

3. In the diagram there are four conducting plates A, B, C and D placed parallel to each other at equal separation L. If plate C starts moving towards plate B with velocity v. Find the current (in mA) flowing in the wire connecting A and D. (assume all other plates to be fixed) (Given: q_2 = 5μC, q_3 = 10μC, v = 10 m/s, L = 0.05 m)

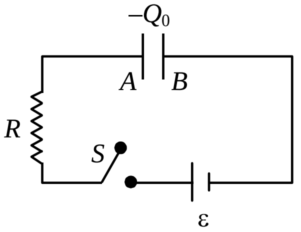


4. A thin uniform rod of mass 'm', length 'ℓ' rotates uniformly about a vertical axis ω, form a conical pendulum, the upper end of the rod is hinged and θ is angle between rod and vertical.
If the change of angular momentum of the rod about hinge is $\frac{m\ell^2}{x}\omega^2 \sin 2\theta$ then the value of 'x' will be

5. Identical metal plates are located in air at equal distances *d* from one another. The area of each plate is equal to A. The capacity of system between points *P* and *Q* is $\frac{K\varepsilon_o A}{d}$. Then the value of 'K' is



6. The figure shows a *RC* circuit with a parallel plate capacitor. Before switching on the circuit, plate *A* of the capacitor has a charge $-Q_0$ while plate *B* has no net charge. Now, at *t* = 0, the circuit is switched on. How much time (in second) will elapse before the net charge on plate *A* becomes zero.
(Given *C* = 1μF, Q_0 = 1mC, ε = 1000 V and $R = \frac{2\times 10^6}{\ln 3}\Omega$)



7. A ring of mass 3 kg is rolling without slipping with linear velocity 1 m/sec on a smooth horizontal surface. A rod of same mass is fitted along its one diameter. Find total kinetic energy of the system (in J).

8. Potential energy of a particle moving along x-axis is given by U = $\frac{x^3}{3} - \frac{9x^2}{2} + 20x$. Find out position of stable equilibrium state.

Space for Rough work

Chemistry

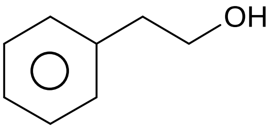
PART – II

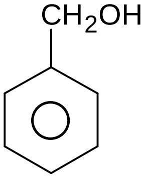
SECTION – A
Straight Objective Type

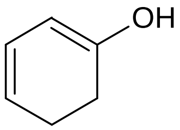
This section contains **10 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

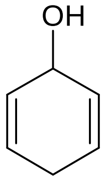
1. Which of the following compound produce any gas when reacts with water?
(A) KO_2 (B) CaC_2
(C) Mg_3N_2 (D) $Ba(NO_3)_2$

2. Which of the following compound does exhibit mesomeric effect?

(A)


(B)


(C)


(D)


3. Which of the following compound of carbon forms acidic solution when reacts with water at room temperature?
(A) CO (B) $COCl_2$
(C) CCl_4 (D) CH_4

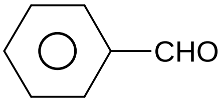
4. Which of the following element is present in silicones?
(A) Carbon (B) Hydrogen
(C) Oxygen (D) Sulphur

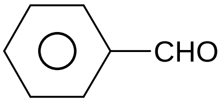
5. The boiling point of which of the following aqueous solution(s) is/are greater than 100°C?
(A) 0.2 M NaCl (B) 0.1 M $AlCl_3$
(C) 1 M KNO_3 (D) 2 M $BeSO_4$

Space for Rough work

6. Which of the following is/are the coordination isomer(s) of $[Co(NH_3)_6]\ [Cr(CN)_6]$?
(A) $[Cr(NH_3)_6]\ [Co(CN)_6]$
(B) $[Cr(NH_3)_4(CN)_2]\ [Co(CN)_4(NH_3)_2]$
(C) $[Cr(NH_3)_3(CN)_3]\ [Co(NH_3)_3(CN)_3]$
(D) $[Cr(NH_3)_4]\ [Co(CN)_4]$

7. Which of the following two compound(s) form different number of gases on heating?
(A) $LiNO_3$ and $NaNO_3$
(B) $MgCl_2.6H_2O$ and $Na_2SO_4.10\ H_2O$
(C) $FeSO_4$ and $Fe_2(SO_4)_3$
(D) $CaCO_3$ and $BeCO_3$

8. Which of the following compounds can be distinguished by Fehling's test?
(A) CH_3CHO and CH_3COCH_3
(B) CH_3CH_2CHO and 

(C) 

and CH_3COCH_3
(D) CH_3CHO and $HCHO$

9. The hcp and ccp structure for a given element would be expected to have
(A) the same coordination number
(B) the same density
(C) the same packing fraction
(D) the same edge length

10. In which of the following pair, the dipole moment of first compound is greater than that of the second compound?
(A) NH_3, NF_3
(B) $CHCl_3$, CCl_4
(C) CO_2, SO_2
(D) BF_3, NF_3

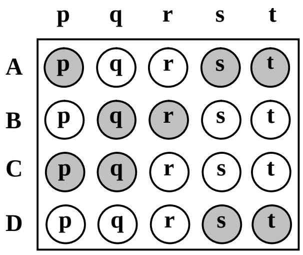
Space for Rough work

SECTION – B

Matrix-Match Type

*This section contains 2 questions. Each question contains statements given in two columns which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A-p, s and t; B-q and r; C-p and q; and D-s and t; then the correct darkening of bubbles will look like the following.



1. Match the radicals mentioned in Column-I with their reactions mentioned in Column-II.

Column – I		Column – II	
(A)	Fe^{2+}	(p)	Forms precipitate with KCN, which is soluble in excess of the reagent.
(B)	Hg^{2+}	(q)	Forms precipitate with NaOH and NH_4OH, which is insoluble in both excess of reagent.
(C)	Pb^{2+}	(r)	forms coloured precipitate with KI, which is soluble in excess of reagent.
(D)	Ag^{+}	(s)	forms black precipitate with H_2S which is soluble in hot and dilute HNO_3.

2. Match the aqueous solutions of acids, bases and salts mentioned in Column-I with their pH and nature mentioned in Column-II.

Column – I		Column – II	
(A)	HCOOH (p^{K_a} = 3.74, 0.1 M) + HCOONa (0.1 M)	(p)	Acidic buffer at its maximum capacity
(B)	CH_3COOH (0.1 M) + HCl (0.1 M)	(q)	behaves as a buffer
(C)	CH_3COOH (p^{K_a} = 4.74, 0.1 M) + NH_4OH (p^{K_a} = 9.26, 0.1 M)	(r)	pH < 7 at 298 K
(D)	HCOONa (300 mL of 0.1 M) + HCl (100 mL of 0.1 M)	(s)	pH = 7 at 298 K

Space for Rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. 4.48 litre of an ideal gas at STP requires 12 calorie to raise the temperature by 15°C at constant volume. What is the value of C_P of the gas in calorie unit?

2. How many maximum number of nitro product(s) is/are formed when $CH_3CH_2CH_3$ reacts with fuming HNO_3?

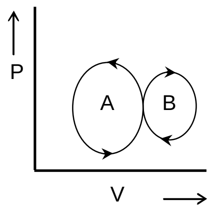
3. The half-life of a zero order reaction is 4 sec. How much seconds is needed for 75% completion of the reaction?

4. What is the sum of the number of equivalents of glucose and the number of equivalents of phenylhydrazine required to form one equivalent of glucosazone?

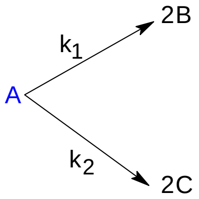
5. Compound X dissociates according to the reaction $2X(g) \rightleftharpoons 2Y(g) + Z(g)$, with degree of dissociation α which is small compared with unity, if expression for α in terms of equilibrium constant K_p and total pressure P is given as $\alpha = \left(\frac{2K_p}{P}\right)^{1/n}$. The value of n is

Space for Rough work

6. In the present graphs, the area of circle A and B are 25 unit and 20 unit respectively. Work done will be ____ unit.



7. For a hypothetical elementary reaction, Where $\frac{k_1}{k_2} = \frac{1}{2}$ initially only 2 moles of A are present. Total number of moles of A,B and C at the end of 75% reaction are X. What will be the value of 2X



8. A vessel of 250 litres was filled with 0.01 mole of Sb_2S_3 and 0.01mole of H_2 to attain the equilibrium at 440^{0}C as $Sb_2S_3(s) + 3H_2(g) \rightleftharpoons 2Sb(s) + 2H_2S(g)$. After equilibrium, the H_2S formed was analysed by dissolved it in H_2O and treating with excess of Pb^{2+} to give 1.19g of PbS $(M_{Pb} = 207)$ as precipitate. The value of K_c at 440^{0}C is _____.

Space for Rough work

Mathematics PART – III

SECTION – A

Multiple Correct Choice Type

This section contains **10 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

1. Let $\vec{a}, \vec{b}$ and $\vec{c}$ be three vectors having magnitudes 1, 1 and 2 respectively. If $\vec{a}\times\left(\vec{a}\times\vec{c}\right)+\vec{b}=0,$ then

(A) $\vec{b}$ is in the plane of $\vec{a}$ and $\vec{c}$ (B) $\vec{b}$ is parallel to $\vec{a}\times\vec{c}$

(C) angle between $\vec{a}$ and $\vec{c}$ is 30^o (D) angle between $\vec{a}$ and $\vec{c}$ is 150^o

2. The number of solutions of equation $8\sin x=\dfrac{\sqrt{3}}{\cos x}+\dfrac{1}{\sin x}$

(A) 6 if $x\in\left(0,\,2\pi\right)$ (B) 4 if $x\in\left(0,\pi\right)$

(C) 5, if $x\in\left(0,\dfrac{3\pi}{2}\right)$ (D) There does not exist any solution

3. If A and B are two orthogonal matrices of order n and $\det\left(A\right)+\det\left(B\right)=0,$ then which of the following must be correct

(A) $\det\left(A+B\right)=\det\left(A\right)+\det\left(B\right)$ (B) $\det\left(A+B\right)=0$

(C) A + B = 0 (D) None of above are always correct

Space for Rough work

4. Consider the function g defined by $g(x) = \begin{cases} x^2 \sin\dfrac{\pi}{x} + (x-1)^2 \sin\left(\dfrac{\pi}{x-1}\right), & x \neq 0,1 \\ 0, & \text{if } x = 0,1 \end{cases}$ then which of the following statement (s) is/are correct?

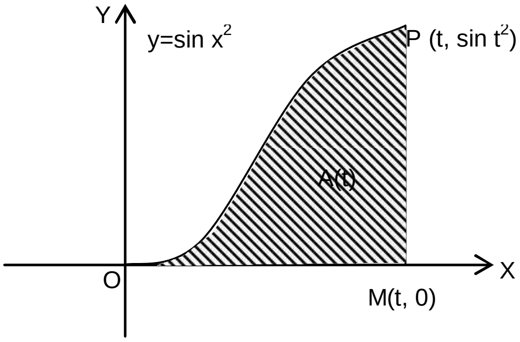
(A) $g(x)$ is differentiable $\forall x \in R$

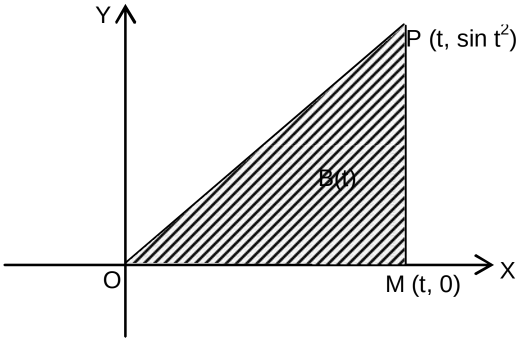
(B) $g'(x)$ is discontinuous at $x = 0$ but continuous at x = 1

(C) $g'(x)$ is discontinuous at both $x = 0$ and $x = 1$

(D) Rolle's theorem is applicable for $g(x)$ in [0, 1]

5. The figure shows two regions in the first quadrant.





A(t) is the area under the curve , $y = \sin x^2$ from 0 to t and B (t) is the area of the triangle with vertices O, P and M (t, 0).Then $\lim\limits_{t\to 0} \dfrac{A(t)}{B(t)}$ equals

(A) $\dfrac{2}{3}$ (B) $\dfrac{3}{2}$

(C) $\dfrac{1}{2}$ (D) 1

6. Diagonals of a square are along pair of lines $2x^2 - 3xy - 2y^2 = 0$. If (2, 1) is a vertex of square then sides of square can be

(A) $3x - y + 5 = 0$ (B) $x + 3y + 5 = 0$

(C) $2x - y - 5 = 0$ (D) $x - 2y = 0$

Space for Rough work

7. If three planes $P_1 \equiv 2x + y + z - 1 = 0$, $P_2 \equiv x - y + z - 2 = 0$ and $P_3 = \alpha x - y + 3z - 5 = 0$ intersects each other at point P on XOY plane and at point Q on YOZ plane, where O is the origin then identify correct statement(s)

(A) The value of α is 4

(B) Straight line perpendicular to plane P_3 and passing through P is $\frac{x-1}{4} = \frac{y+1}{-1} = \frac{z}{3}$.

(C) The length of projection of $\overrightarrow{PQ}$ on x – axis is 1.

(D) Centroid of the triangle OPQ is $\left(\frac{1}{3}, \frac{-1}{2}, \frac{1}{2}\right)$

8. In the expansion of $(2x - 3y + z)^{10}$, then which of the following statement(s) is/are correct?

(A) The expansion will contain 66 terms

(B) Sum of all the coefficients is 0.

(C) The coefficient of $x^2y^3z^5$ equals $\left(\frac{-10! \times 9}{5!}\right)$

(D) None of these

9. The coefficient of x^{50} in the expansion of $\sum_{k=0}^{100} {}^{100}C_k (x-2)^{100-k} 3^k$ is also equal to

(A) number of ways in which 50 identical books can be distributed in 100 students, if each student can get atmost one book.

(B) number of ways in which 100 different white balls and 50 identical red balls can be arranged in a circle, if no two red balls are together.

(C) numbers of dissimilar terms in $(x_1 + x_2 + x_3 + ... + x_{50})^{51}$.

(D) $\frac{2.6.10.14......198}{50!}$

10. Let the complex number $z = x + iy$ (where $x, y \in R$) satisfy $\cot^{-1}(\log_3 |2z+1|) > \cot^{-1}(\log_3 |2z-1|)$, then x can be

(A) –1 (B) –2

(C) 1 (D) 2

Space for Rough work

SECTION – B

Matrix-Match Type

This section contains 2 questions. Each question contains statements given in two columns which have to be matched. The statements in ***Column I*** *are labelled A, B, C and D, while the statements in* ***Column II*** *are labelled p, q, r, s and t. Any given statement in* ***Column I*** *can have correct matching with* ***ONE OR MORE*** *statement(s) in* ***Column II.*** *The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A-p, s and t; B-q and r; C-p and q; and D-s and t; then the correct darkening of bubbles will look like the following.

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the columns:

	Column - I		Column - II
(A)	The maximum value of $\left(\cos\left(2A+\theta\right)+\cos\left(2B+\theta\right)\right)$, where A, B are constant, is	(p)	$2\sin\left(A+B\right)$
(B)	The maximum value of $\left(\cos 2A+\cos 2B\right)$, where (A + B) is constant and $A, B \in \left(0, \frac{\pi}{2}\right)$, is	(q)	$2\sec\left(A+B\right)$
(C)	The minimum value of $\left(\sec 2A+\sec 2B\right)$, where (A + B) is constant and $A, B \in \left(0, \frac{\pi}{4}\right)$, is	(r)	$2\cos\left(A+B\right)$
(D)	The minimum value of $\sqrt{\left(\tan\theta+\cot\theta-2\cos\left(A+B\right)\right)}$ where A, B are constants and $\theta \in \left(0, \frac{\pi}{2}\right)$, is	(s)	$\left\|2\cos\left(A-B\right)\right\|$
		(t)	$2\cos\left(A-B\right)$

Space for Rough work

2. A plane π passes through the point (1,1, 1) and is parallel to the vectors $\vec{a} = (-1, 1, 0)$ and $\vec{b} = (1, 0, -1)$ π meets the axis in A, B and C forming the tetrahedron OABC where O is origin.

	Column - I		Column - II
(A)	Volume of the tetrahedron OABC in cubic units	(p)	$\frac{9}{2}$
(B)	Area of the faces of the tetrahedron in square units	(q)	$\frac{9\sqrt{3}}{2}$
(C)	Distance of the points $\left(3\sqrt{3}/2, 3\sqrt{3}, 3\right)$ form the plane π in units	(r)	$\sqrt{3}$
(D)	Distance of the faces of the tetrahedron from the opposite vertex	(s)	3

SECTION – C

(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

1. The roots of the equation $z^4 + az^3 + (12 + 9i)z^2 + bz = 0$ are the vertices of a square then area of square is __________

2. Let $\beta = \int_0^1 \frac{2 + 3x + 4x^2}{2\sqrt{x^2 + x + 1}} dx$ then find the value of β^2.

3. The triangle ABC, right angled at C, has median AD, BE and CF. AD lies along the line $y = x + 3$, BE lies along the line $y = 2x + 4$. If the length of the hypotenuse is 60 and area of $\Delta ABC = 100(k)^2$ then k is ______________

Space for Rough work

4. Water is drained from a vertical cylindrical tank by opening a valve at the base of the tank. It is known that the rate at which the water level drops is proportional to the square root of water depth y, where the constant of proportionality k > 0 depends on the acceleration due to gravity and the geometry of the hole. If time to empty the tank be T minutes, then $\frac{T}{10} =$

5. If $\sum_{n=1}^{\infty} \tan^{-1}\left(\frac{\sqrt{2n+2}-\sqrt{2n-2}}{2+\sqrt{n^2-1}}\right) = \frac{\pi}{2} + \tan^{-1}k$ then find the value of k^2

6. If x, y, z are positive real numbers and $x + y + z = 1$, then find the minimum value of $\left(\frac{4}{x}+\frac{9}{y}+\frac{16}{z}\right).\frac{1}{27}$ is ___________

7 Let a, b, c be the sides of a triangle ABC and Δ be its area. If $a = 2, \Delta = \sqrt{3}$ and $a\cos C + \sqrt{3}\,a\sin C - b - c = 0$. Then the semi perimeter of the ΔABC is __________

8. Let slope of sides AB and BC of a ΔABC are roots of the equation $x^2 - 4x + 1 = 0$, (ΔABC lying in the first quadrant and B is origin) and inradius of the triangle is 1 unit. If co – ordinates of its incentre are (a, b) then $\left(a^2 + b^4\right)$ is _________

Space for Rough work

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

FIITJEE **JEE(Advanced)-2017**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

CONCEPT RECAPITULATION TEST – II
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	AC	ABC	ACD
2.	ACD	ABC	ABC
3.	BD	B	AB
4.	ABC	ABC	ACD
5.	AC	ABCD	A
6.	ABCD	AB	AB
7.	ACD	AC	ABCD
8.	ABCD	AB	ABC
9.	AC	AC	AD
10.	AC	AB	AB
1.	(A) → r,s (B) → r,s (C) → r,s (D) → r,t	(A) → p,q (B) → q,r (C) → r,s (D) → p,s	(A) → s (B) → r (C) → q (D) → p
2.	(A) → p (B) → q (C) → s (D) → r	(A) → p,q,r (B) → r (C) → q,s (D) → q,r	(A) → p (B) → p,q (C) → p (D) → r,s
1.	1	6	5
2.	3	4	3
3.	1	6	2
4.	6	4	6
5.	1	3	2
6.	2	5	3
7.	5	7	4
8.	5	1	6

Physics PART – I

SECTION – A

1. AC

Sol. Mass per unit length of the wire = 0.1 kg/m.

At any instant, tension in the string is (2 + 2.25 t) g N

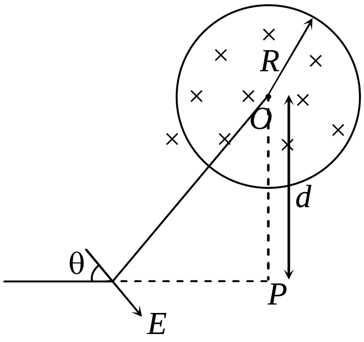
$$v = \sqrt{\frac{(2+2.25t)g}{0.1}} \quad ; \quad \int_0^{10} dx = 10\int_0^t \sqrt{2+2.25t}\,dt$$

t = 0.612 s

$$T = (2 + 2.25 \times 0.612) \times 10 = 33.77 \text{ N}$$

2. ACD

Sol. $$\int \vec{E}\cdot d\vec{l} = A\frac{dB}{dt}$$



$$E2\pi\sqrt{x^2+d^2} = \pi R^2 k$$

$$E = \frac{\pi R^2 k}{2\sqrt{x^2+d^2}}$$

$$W_{ext} = \int_0^{\infty} q\vec{E}\cdot dx = \frac{q\pi R^2}{4}k$$

3. BD

Sol. Length $\propto G^x c^y h^z$

$$L = \left[M^{-1}L^3T^{-2}\right]^x \left[LT^{-1}\right]^y \left[ML^2T^{-1}\right]^z$$

By comparing the power of M, L and T in both sides we get

$-x + z = 0, 3x + y + 2z = 1$ and $-2x - y - z = 0$

By solving above three equations we get

$$x = \frac{1}{2}, y = -\frac{3}{2}, z = \frac{1}{2}$$

4. ABC

Sol. Assume x-axis along OA and y-axis perpendicular to it in the plane of ring.

After 1st collision

Velocity of particle = $\frac{v}{\sqrt{2}}$ along x-axis

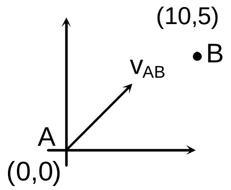
And velocity of ring = $\frac{v}{\sqrt{2}}$ along y-axis

After second collision velocity of ring = $\frac{v}{\sqrt{2}}\hat{i} + \frac{v}{\sqrt{2}}\hat{j}$

Velocity of particle = 0

Time to return at point A = $4 \times \frac{R\sqrt{2}}{v}$

5. AC



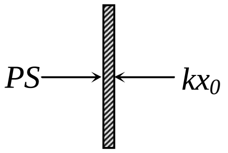
Sol. $\vec{v}_{AB} = (3-a)\hat{i} + (3-b)\hat{j}$

$\vec{a}_{AB} = \vec{o}$

$(3-a)\times 2 = 10$ and $(3-b)\times 2 = 5$

$a = -2$ and $b = \frac{1}{2}$

6. ABCD



Sol. Equilibrium of piston gives

$PS = kx_0$ or $P = \frac{kx_0}{S}$

Since, the chamber is thermally insulated $\Delta Q = 0$

$\therefore$ Elastic potential energy of spring = work done by gas

or, work done by gas = $\frac{1}{2}kx_0^2$

This work is done in the expense of internal energy of the gas.

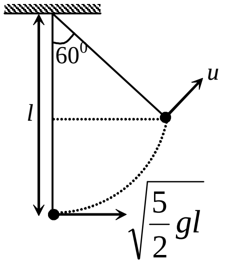
Therefore, internal energy of the gas is decreased by $\frac{1}{2}kx_0^2$.

Internal energy of an ideal gas depends on its temperature only. Internal energy of the gas is decreasing. Therefore, temperature of the gas will decrease.

7. ACD

Sol. $\vec{F}_m = q(\vec{v}\times\vec{B})$ and apply Newton's second law of motion.

8. ABCD



Sol. $T - mg\cos 60^0 = \frac{mv^2}{l}$ … (i)

$\frac{1}{2}m\left(\sqrt{\frac{5}{2}gl}\right)^2 - mg\frac{l}{2} = \frac{1}{2}mv^2$ … (ii)

$v = \sqrt{\frac{3}{2}gl}$ and $T = 2mg$

Net force is in horizontal direction when $\theta = 60^0$

9. AC

Sol. Equivalent resistance across capacitor (after shorting the battery) = $\frac{11R}{4}$.

Voltage across capacitor in steady state = $\frac{3E}{4}$.

$$q = \frac{CE}{4}\left(1 - e^{\frac{-4t}{11RC}}\right)$$

10. AC

Sol. $\tau = \frac{L}{Req} = \frac{2}{8} = \frac{1}{4}$

at steady state inductor short circuited

Hence i = 0.75

SECTION – B

1. A → rs B → rs C → rs D → rt

Sol. For cases (a), (b) and (c), magnetic field due to I_1 and I_2 are mutually perpendicular. Therefore, they do not exert any force on each other.
For case (d), magnetic fields at point P due to I_1 and I_2 are in the same direction.

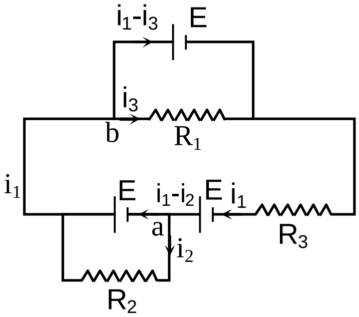
2. A → p B → q C → s D → r

Sol. On solving by KVL we get, $i_1 = \frac{E}{R}$, $i_2 = -\frac{E}{R}$, $i_3 = \frac{E}{R}$

$\Rightarrow i_1 - i_2 = \frac{2E}{R}$ and $i_1 - i_3 = 0$

So reading of ammeter A_1 is E/R = 4/3

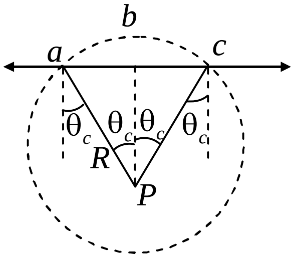
A_2 is 2E/R = 8/3, A_3 is zero and ΔV_{ab} = 4V



SECTION – C

1. 1

Sol. The light escape is confined within a cone of apex angle '$2\theta_c$' where θ_c is the critical angle. Imagine a sphere with source of light as its centre and the surface area abc is A.



here $A = \int_0^{\theta_c} 2\pi R^2 \sin\theta \, d\theta = 2\pi R^2(1 - \cos\theta_c)$

$= \pi R^2 \quad \left[\therefore \theta_c = \sin^{-1}\left(\frac{\sqrt{3}}{2}\right) = 60^o\right]$

$\therefore$ Power transfer $= P \times \frac{A}{4\pi R^2} = 4 \times \frac{1}{4} = 1W$

2. 3

Sol. Applying lens formula, $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$-\frac{1}{v^2}\frac{dv}{dt} - \frac{1}{u^2}\frac{du}{dt} = 0$

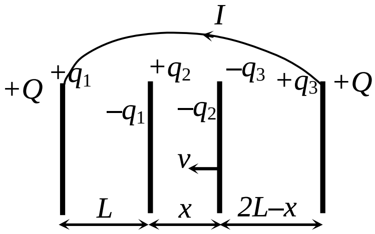
$\frac{dv}{dt} = v_0$

$\frac{dv}{dt} = v_1 + v_0$ (v_1 = velocity of object towards lens)

$\therefore \quad v_1 + v_0 = \frac{1}{n^2} v_0, \quad v_1 = \left(\frac{1-n^2}{n^2}\right) v_0, \quad v_1 = 3v_0$ = 3 m/s

3. 1

Sol. $\frac{2q_1L}{2A\varepsilon_0} + \frac{2q_2x}{2A\varepsilon_0} - \frac{2q_3(2L-x)}{2A\varepsilon_0} = 0$ … (i)



$I = \frac{dq_1}{dt} = \frac{-dq_3}{dt} = \frac{dq_2}{dt}$ … (ii)

From (i),

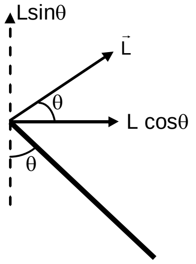
$q_1L + q_2x - 2q_3L + q_3x = 0$

$\Rightarrow \quad L\frac{dq_1}{dt} + x\frac{dq_2}{dt} + q_2\frac{dx}{dt} - 2\frac{dq_3}{dt}L + x\frac{dq_3}{dt} + q_3\frac{dx}{dt} = 0$

$\Rightarrow \quad I = \frac{v}{3L}(q_2 + q_3)$ = 1 mA

4. 6

Sol. $\left|\frac{d\vec{L}}{dt}\right| = L\cos\theta\omega$

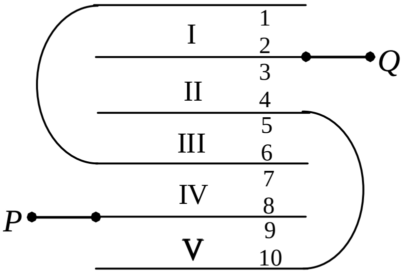


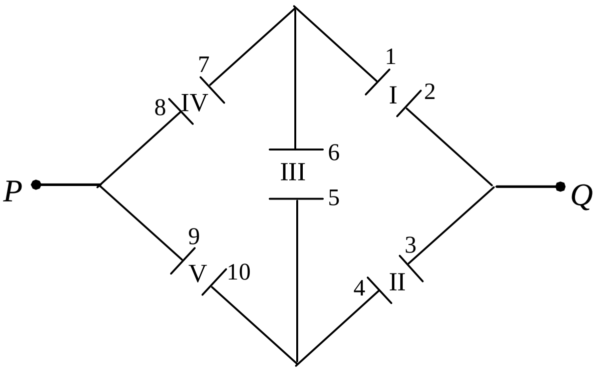
$= \frac{m\ell^2}{3}\omega\sin\theta\cos\theta\omega$

$= \frac{m\ell^2}{3}\omega^2\sin\theta\cos\theta$

5. 1

Sol.

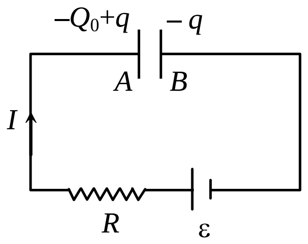




Equivalent capacity, $C_{PQ} = C = \frac{\varepsilon_0 A}{d}$

6. 2

Sol. Let at any time *t* charge flown through the plate *B* to plate *A* is *q* and instantaneous current is *I*.



From loop theorem $\left(\frac{2q-Q_0}{2C}\right)+IR-\varepsilon=0$

$\Rightarrow \qquad R\frac{dq}{dt}=\frac{-2q+2\varepsilon C+Q_0}{2C}$

$\Rightarrow \qquad \frac{dq}{2\varepsilon C+Q_0-2q}=\frac{dt}{2RC}$

Now for charge on plate *A* to be zero *q* = Q_0.

Integrating $\int_0^{Q_0}\frac{dq}{2\varepsilon C+Q_0-2q}=\int_0^t\frac{dt}{2RC}$

= $\qquad t=RC\ln\left[\frac{2\varepsilon C+Q_0}{2\varepsilon C-Q_0}\right]$

Putting the value of *C*, Q_0, ε and *R*
We get *t* = 2 seconds.

7. 5

Sol. K.E. = $\frac{1}{2}mv^2+\frac{1}{2}mv^2+\frac{1}{2}\frac{m(2r)^2}{12}w^2+\frac{1}{2}mr^2w^2$ = 5.

8. 5

Sol. At stable equilibrium, U is minimum.

$\frac{dU}{dx}$ = 0 and $\frac{d^2U}{dx^2}$ > 0

= $\frac{1}{dx}\left(\frac{x^3}{3}-\frac{ax^2}{2}+20x\right)$= 0.

$\Rightarrow$ $x^2 - 9x + 20 = 0$. $\Rightarrow$ (x – 5) (x – 4) = 0.

x = 5 and x = 4 are points of equilibrium.

And U minimum when $\frac{d^2U}{dx^2}$ > 0. i.e. at x = 5.

Chemistry PART – II

SECTION – A

1. ABC

Sol. $KO \xrightarrow{H_2O} O_2$ gas

$CaC_2 \xrightarrow{H_2O} C_2H_2$ gas

$Mg_3N_2 \xrightarrow{H_2O} NH_3$ gas

$Ba(NO_3)_2 \xrightarrow{H_2O} Ba^{2+} + 2NO_3^-$

2. ABC

Sol. Neither the lone pair of oxygen nor the pi – bonds are in conjugation in (D).

3. B

Sol. $COCl_2 + H_2O \longrightarrow CO_2 + 2HCl$

4. ABC

Sol. Silicones are the polymers of the hydrolysis products of alkyl silicon chlorides.

5. ABCD

Sol. The boiling point of water is 100^{o}C.
$\therefore$ Dissolution of any non-volatile solute of any quantity in water will cause elevation in boiling point. So, the boiling point of aqueous solution of any non-volatile solute is greater than 100^{o}C.

6. AB

Sol. In C the net charge on cationic as well as anionic parts of the complex is zero. Such complexes are not formed. D is not an isomer of the complex due to different molecular formula and molecular mass.

7. AC

Sol. (A) $4LiNO_3 \xrightarrow{\Delta} 2Li_2O + 4NO_2 + O_2$

$2NaNO_3 \xrightarrow{\Delta} 2NaNO_2 + O_2$

(B) $MgCl_2.6H_2O \xrightarrow{\Delta} MgCl_2.H_2O + 5H_2O$

$Na_2SO_4.10H_2O \xrightarrow{\Delta} Na_2SO_4 + 10H_2O$

(C) $2FeSO_4 \xrightarrow{\Delta} Fe_2O_3 + SO_2 + SO_3$

$Fe_2(SO_4)_3 \xrightarrow{\Delta} Fe_2O_3 + 3SO_3$

8. AB

Sol. All aliphatic aldehydes respond to Fehling test. Benzaldehyde does not give Fehling's test.

9. AC

Sol. The coordination number in both the structure is 12 and the packing fraction is 74%

10. AB

Sol. • The dipole moment of NH_3 is greater than NF_3 because the bond pair dipole moment is enhanced by the lone pair dipole moment in NH_3. In NF_3 the resultant of bond pair dipole moment is opposed by the lone pair dipole moment.

• $CHCl_3$ is unsymmetrical, hence it contains certain dipole moment whereas CCl_4 is symmetrical with zero dipole moment.

SECTION – B

1. A → pq, B → qr, C → rs, D → ps

Sol. (A) $Fe^{2+} + 2KCN \longrightarrow Fe(CN)_2 \downarrow \xrightarrow[\text{excess}]{4KCN} K_4[Fe(CN)_6]$

$Fe(OH)_2$ is not soluble in excess NaOH and excess NH_4OH

(B) HgO is not soluble in excess NaOH and excess NH_4OH

$Hg^{2+} + 2KI \longrightarrow HgI_2 \downarrow \xrightarrow{2KI} K_2[HgI_4]$

(C) $Pb^{2+} + 2KI \longrightarrow PbI_2 \downarrow \xrightarrow{2KI} K_2[PbI_4]$

$Pb^{2+} + H_2S \longrightarrow PbS \downarrow + 2H^+$

$3PbS + 8HNO_3 \longrightarrow 3Pb(NO_3)_2 + 2NO + 3S + 4H_2O$

(D) $Ag^+ + KCN \longrightarrow AgCN \downarrow \xrightarrow{KCN} K[Ag(CN)_2]$

$Ag^+ + H_2S \longrightarrow Ag_2S \downarrow + 2H^+$

$3Ag_2S + 8HNO_3 \longrightarrow 6AgNO_3 + 2NO + 3S + 4H_2O$

2. A → pqr, B → r, C → qs, D → qr

Sol. (A) $pH = p^{K_a} + \log\frac{[HCOONa]}{[HCOOH]} = 3.74 + \log\frac{0.1}{0.2} = 3.74$

$\therefore$ pH < 7

(B) pH = -log [H^+] = -log10^{-1} = 1, $\therefore$ pH < 7

CH_3COOH cannot dissociated in presence of HCl due to common ion effect.

(C) $CH_3COOH + NH_4OH \longrightarrow CH_3COONH_4 + H_2O$

Hydrolysis of CH_3COONH_4 will take place

$pH = \frac{1}{2}\left(p^{K_w} + p^{K_a} - p^{K_b}\right) = \frac{1}{2}\left[14 + 4.74 - (14 - 9.26)\right]$

= ½ [14 + 4.74 – 4.74] = 7. $\therefore$ pH = 7 and the solution is a buffer

(D) $HCOONa + HCl \longrightarrow HCOOH + NaCl$

Initial meq	30	10	0	0
Meq. After reac^n	20	0	10	10

It is a buffer, $pH = p^{K_a} + \log\frac{[HCOONa]}{[HCOOH]} = 3.74 + \log\frac{20}{10} = 4.04, < 7$

SECTION – C

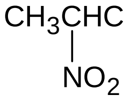
1. 6

Sol. $\Delta H = nC_V\Delta T$

or, $12 = \frac{4.48}{22.4} \times C_V \times 15$

or, $C_V = 4$
$C_P - C_V = R = 2 \Rightarrow C_P = C_V + 2 = 4 + 2 = 6$ cal

2. 4
Sol. The products are $CH_3CH_2CH_2NO_2$, $CH_3\underset{NO_2}{\underset{|}{C}}HCH_3$, $CH_3CH_2NO_2$ and CH_3NO_2 because C–C and C – H bond cleavage takes place in this reaction.

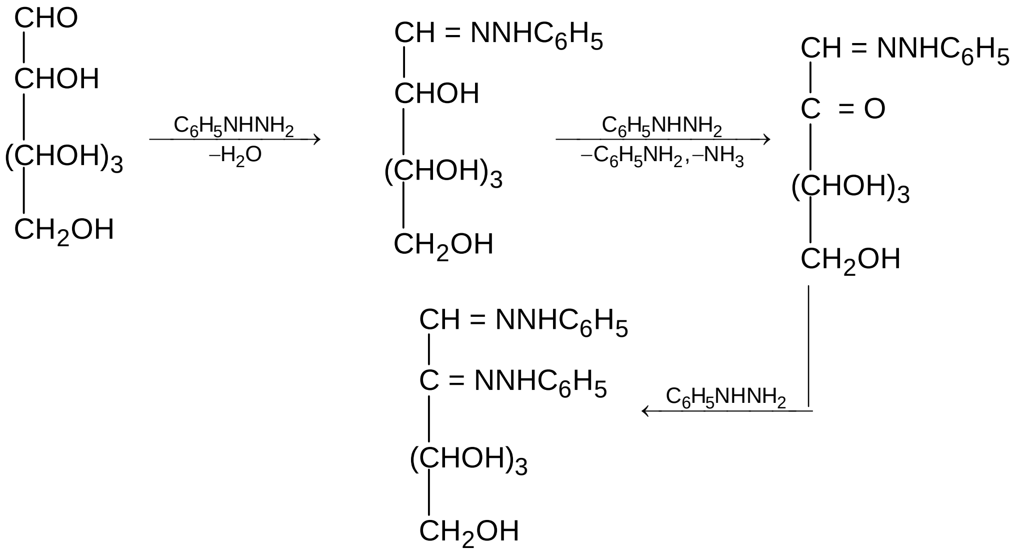

$CH_3\underset{NO_2}{\underset{|}{C}}HCH_3$

3. 6
Sol. For zero order reaction the half-life is directly proportional to the concentration of reactant.

$$X \xrightarrow{t_{1/2}=4\,sec} \frac{X}{2} \xrightarrow{t_{1/2}=2\,sec} \frac{X}{4}$$

$\therefore$ Total time needed for 75% reaction = 4 + 2 = 6 sec

4. 4
Sol.


CHO
CHOH
(CHOH)3
CH2OH
C6H5NHNH2
–H2O
CH = NNHC6H5
CHOH
(CHOH)3
CH2OH
C6H5NHNH2
–C6H5NH2, –NH3
CH = NNHC6H5
C = O
(CHOH)3
CH2OH
C6H5NHNH2
CH = NNHC6H5
C = NNHC6H5
(CHOH)3
CH2OH

5. 3
Sol.

$$2X(g) \rightleftharpoons 2Y(g) + Z(g)$$

Initial	1	0	0
At equi	1 - $\propto$	$\propto$	$\propto$/2

$\therefore$ Partial pressure [If total pressure P]

$$p_x = \left[\frac{1-\propto}{1+\propto/2}\right]P \simeq P \quad p_y = \frac{\propto}{1+\propto/2}P \simeq \propto P$$

$$p_z = \left[\frac{\propto/2}{1+\propto/2}\right]P \simeq \frac{\propto P}{2}$$

$$\therefore K_p = \frac{[p_y]^2[p_z]}{[p_x]^2} = \frac{[\propto P]^2\left[\frac{\propto P}{2}\right]}{P^2}$$

$$K_p = \frac{\propto^3 P}{2}$$

$$\propto = \left(\frac{2K_p}{P}\right)^{\frac{1}{3}}$$

6. 5

Sol. Work done in anticlockwise cycle is positive and in clockwise cycle is negative.
moles of A are present. Total number of moles of A,B and C at the end of 75% reaction are X. What will be the value of 2X

7. 7

Sol. One mole of A will form 2 moles of B and C after completion of reaction when 75% of A converted into B and C then total No of moles X = 0.5 + (2 × 0.5 + 1×2) = 3.5
Hence 2X = 3.5×2 = 7

8. 1

Sol. $$\underset{(0.01-x)}{Sb_2S_3(s)} + \underset{(0.01-3x)}{3H_2(g)} \rightarrow \underset{2x}{2Sb(s)} + \underset{3x}{3H_2S(g)}$$

No.of moles of PbS formed = $\frac{1.19}{239} = 0.005$

At eqn. $\left[H^+\right] = \left(\frac{0.005}{250}\right)$

$$K_C = \left(\frac{0.005}{0.005}\right)^3 = 1$$

Mathematics PART – III

SECTION – A

1. ACD

Sol. On expanding we get $\left(\vec{a}.\vec{c}\right)\vec{a}-\left(\vec{a}.\vec{a}\right)\left(\vec{c}\right)=-\vec{b}$

$$\Rightarrow \vec{c}-\left(\vec{a}.\vec{c}\right)\vec{a}=\vec{b}$$

$\Rightarrow$ (a) is correct and (b) is ruled out.

$$\Rightarrow \left|\vec{c}-\left(\vec{a}.\vec{c}\right)\vec{a}\right|^2=\left|\vec{b}\right|^2$$

If θ is the angle between $\vec{a}$ and $\vec{c}$ then

$$4+\left(2\cos\theta\right)^2-2\left(2\cos\theta\right)^2=1$$

$$\Rightarrow \cos\theta=\pm\frac{\sqrt{3}}{2} \qquad \Rightarrow \theta=30^o;\ 150^o$$

$\Rightarrow$ (C) and (D) is correct.

2. ABC

Sol. $8\sin x=\dfrac{\sqrt{3}}{\cos x}+\dfrac{1}{\sin x}$

$$\Rightarrow 8\sin^2 x\cos x=\sqrt{3}\sin x+\cos x$$

$$4\left(1-\cos 2x\right)\cos x=\sqrt{3}\sin x+\cos x$$

$$3\cos x-2\left(\cos 3x+\cos x\right)=\sqrt{3}\sin x$$

$$\cos x-2\cos 3x=\sqrt{3}\sin x$$

$$\frac{1}{2}\cos x-\frac{\sqrt{3}}{2}\sin x=\cos 3x$$

$$\cos\left(x+\frac{\pi}{3}\right)=\cos 3x$$

$$3x=2nx\pm\left(x+\frac{\pi}{3}\right)$$

(+)	(–)
$3x=2x\pi+x+\dfrac{\pi}{3}$	$3x=2n\pi-x-\dfrac{\pi}{3}$
$2x=2n\pi+\dfrac{\pi}{3}$	$4x=2n\pi-\dfrac{\pi}{3}$
$x=nx+\dfrac{\pi}{6}$	$x=\dfrac{n\pi}{2}-\dfrac{\pi}{12}$
$\left[0,2\pi\right]$	
$\dfrac{\pi}{6}$	$\dfrac{\pi}{2}-\dfrac{\pi}{12}=\dfrac{6\pi-\pi}{12}=\dfrac{5\pi}{12}$

$\frac{5\pi}{6}$

$$\pi-\frac{\pi}{12}=\frac{11\pi}{12}$$
$$\frac{3\pi}{2}-\frac{\pi}{12}=\frac{18\pi-\pi}{12}=\frac{17\pi}{12}$$
$$2\pi-\frac{\pi}{12}=\frac{23\pi}{12}$$

3. AB

Sol. $\det(A+B)=-\det(A)\det(B)\det(A+B)$

$=-\det\left(A^T\right)\det\left(B^T\right)\det(A+B)$

$=-\det\left(A^T(A+B)B^T\right)$

$=-\det\left(A^T(A+B)B^T\right)$

$=-\det\left(A^TAB^T+A^TBB^T\right)$

$=-\det\left(B^T+A^T\right)$

$=-\det(A+B)^T$

$=-\det(A+B)\Rightarrow\det(A+B)=0$

4. ACD

Sol. $g'(0)=\lim\limits_{h\to\infty}\frac{g(0+h)-g(0)}{h}=0$

$\Rightarrow g(x)$ is differentiable $\forall x\in R$

$$g'(x)=\begin{cases}2x\sin\left(\frac{\pi}{x}\right)-\pi\sin\left(\frac{\pi}{x}\right)+2(x-1)\sin\left(\frac{\pi}{x-1}\right)-\pi\sin\left(\frac{\pi}{x-1}\right); & x\neq 1\\ 0\ ; & x=0,1\end{cases}$$

But $\lim\limits_{x\to0}g'(x)=$ does not exist $\neq g'(0)\Rightarrow g'(x)$ is discontinuous at x = 0

Similarly $\lim\limits_{x\to1}g'(x)=$ does not exist.

5. A

Sol. $\lim\limits_{t\to0}\frac{\int_0^t\sin t^2\,dt}{\frac{1}{2}t\sin t^2}=\lim\limits_{t\to0}\frac{2\sin t^2}{\sin t^2+2t^2\cos t^2}=\lim\limits_{t\to0}\frac{2}{1+2\frac{t^2}{\tan t^2}}=\frac{2}{1+2}=\frac{2}{3}$

6. AB

Sol. The point of intersection of diagonal is (0, 0) and one vertex A (2, 1)

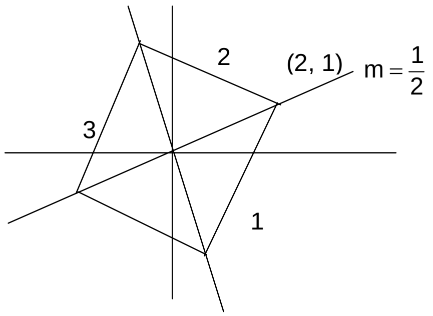
$\Rightarrow$ Vertex is (–2, –1) verties B and D are $\pm i(2+i)$

$=-1+2i,\ 1-2i$

$\Rightarrow B(-1,2)$ and $D(1,-2)$

$\Rightarrow$ Equation of the sides are

$x+3y=\pm5,\ 3x-y=\pm5$.



7. ABCD

Sol. The three planes intersect in a line.

8. ABC

Sol. $(2x-3y+z)^{10}$

General term $= \sum_{\alpha+\beta+\gamma=10} \dfrac{10!(2x)^{\alpha}(-3y)^{\beta}(z)^{\gamma}}{\alpha!\beta!\gamma!}$ ……….(1)

$\therefore$ Number of terms $= \dfrac{12!}{10!2!} = \dfrac{12\times 11}{2} = 66$

Put $x = y = z = 1$ in (1), we get

Sum of all the coefficients 0.

Put $\alpha = 2$, $\beta = 3$, $\gamma = 5$ in (1),

We get coefficient of $x^2y^3z^5 = \dfrac{10!}{2!.3!.5!}(2)^2(-3)^3 = \dfrac{-10!\times 9}{5!}$

9. AD

Sol. Clearly, $\sum_{k=0}^{100} {}^{100}C_k(x-2)^{100-k}3^k = ((x-2)+3)^{100} = (1+x)^{100}$

Hence, coefficient of x^{50} is ${}^{100}C_{50}$. Now verify

Option (A), (D) equal to ${}^{100}C_{50}$

(B) $99!\left({}^{100}C_{50}\right)$

(C) ${}^{100}C_{101}$

10. AB

Sol. $\log_3|2z+1| < \log_3|2z-1|$ (as $\cot^{-1}x$ is a decreasing function)

$\therefore$ $|2z+1| < |2z-1|$

Or $(2z+1)\left(2\bar{z}+1\right) < (2z-1)\left(2\bar{z}-1\right)$

$2\left(z+\bar{z}\right) < -2\left(z+\bar{z}\right)$

$z+\bar{z} < 0$

$2\text{Re}(z) < 0$

$\therefore \text{Re}(z) < 0$

SECTION – B

1. A →s B →r C →q D →p

Sol. (A) $\{\cos(2A+\theta)+\cos(2B+\theta)\}$

$= 2\cos(A-B)\cos(A+B+\theta)$

Maximum value is $|2\cos(A-B)|$ when $\cos(A+B+\theta) = \pm 1$

(B) $\{\cos 2A + \cos 2B\} = 2\cos(A+B)\cos(A-B)$

Maximum value is $2\cos(A+B)$ when $\cos(A-B)=1$

(C) For $y=\sec x, x\in\left(0,\frac{\pi}{2}\right)$, tangent drawn to it any point lies completely below the graph of $y=\sec x$, thus $\frac{\sec 2A+\sec 2B}{2}\geq \sec(A+B)$

$\Rightarrow \quad \sec 2A+\sec 2B\geq 2\sec(A+B)$

Hence, minimum value is $A+B$

(D) $\sqrt{\{\tan\theta+\cot\theta-2\cos 2(A+B)\}}$

$=\sqrt{\left(\sqrt{\tan\theta}-\sqrt{\cot\theta}\right)^2+2-2\cos 2(A+B)}$

$=\sqrt{\left(\sqrt{\tan\theta}-\sqrt{\cot\theta}\right)^2+4\sin^2(A+B)}$

Minimum value occurs when $\sqrt{\tan\theta}=\sqrt{\cot\theta}$ and minimum value is

$\sqrt{4\sin^2(A+B)}=2\sin(A+B)$

2. A → p B →pq C →p D →rs

Sol. (A) Equation of the plane π is $A(x-1)+B(y-1)+C(z-1)=0$ where $A+0.B-1.C=0$ and $-A+B+0.C=0\Rightarrow A=B=C$ and the equation of π is $x+y+z=3$. which meets the co – ordinates axes at A (3, 0, 0), B (0, 3, 0) and C (0, 0, 3). So volume of the tetrhadron. $OABC=\frac{1}{6}\begin{vmatrix}0&0&0&1\\3&0&0&1\\0&3&0&1\\0&0&3&1\end{vmatrix}=\frac{1}{6}\times 27=\frac{9}{2}$

(B) $AB=BC=CA=3\sqrt{2}$, so the area of the face ABC which is an equilateral triangle $=\frac{\sqrt{3}}{4}\times\left(3\sqrt{2}\right)^2=\frac{9\sqrt{3}}{2}$. Each of the face OAB, OBC, OCA is an isosceles triangle with sides $3,3,3\sqrt{2}$

So, area of each of these faces is $\frac{1}{2}\times 3\sqrt{2}\sqrt{9-\frac{9}{2}}=\frac{9}{2}$

(C) Required distance is $\left|\frac{\frac{3\sqrt{3}}{2}+3\sqrt{3}+3-3}{\sqrt{1+1+1}}\right|=\frac{9}{2}$

(D) Distance of O from the face $ABC=\left|\frac{0+0+0-3}{\sqrt{1+1+1}}\right|=\sqrt{3}$ distance of A, B, C from opposite faces OBC, OAC, OAB are equal and is 3.

SECTION – C

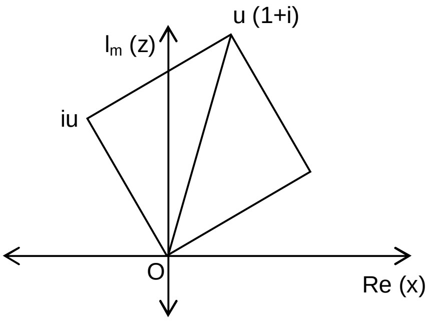
1. 5

Sol. Note that $z = 0$ is one root of the given equation

$z^4 + az^3 + (12+9i)z^2 + bz = 0$

canceling z, we get $z^3 + az^2 + (12+9i)z + b = 0$ …………(1)

The 3 vertices of the square other than $(0+0i)$ are u, iu, u (1 + i)



Now $u(ui) + (iu) + (1+i)u + [(1+i)u]u = 12+9i$ (using theory of equation)

$$u^2 = \frac{4+3i}{i} = 3-4i \Rightarrow u = \sqrt{3-4i} = \pm(2-i)$$

$\therefore u = 2-i$ or $-2+i$

$\Rightarrow |u|^2 = 5$

2. 3

Sol. $$\beta = \int_0^1 \frac{2x+3x^2+4x^3}{2\sqrt{x^4+x^3+x^2}}dx$$

Put $(x^2+x^3+x^4) = t \Rightarrow (2x+3x^2+4x^3)dx = dt$

$$\beta = \int_0^3 \frac{dt}{2\sqrt{t}}$$

$$\beta = \left[\sqrt{t}\right]_0^3 = \sqrt{3} \qquad \Rightarrow \qquad \beta^2 = 3$$

3. 2

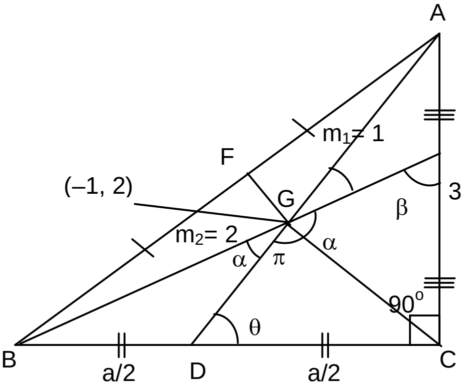
Sol. Area $= \frac{1}{2}ab$

$AD : y = x+3$

$BE = y = 2x+4$

solve $G(-1, 2)$

acute angle α between the medians is



$$\tan\alpha = \frac{m_1 - m_2}{1+m_1m_2}$$

$$\tan\alpha = \frac{2-1}{1+2} \Rightarrow \tan\alpha = \frac{1}{3}$$

now, $(180-\alpha) + 90^o + \theta + \beta = 360^o$

$\Rightarrow \qquad \alpha = \theta + \beta - 90^o$

$\cot\alpha = -\tan(\theta+\beta)$

$$-3 = \frac{\tan\theta + \tan\beta}{1-\tan\theta\tan\beta} \text{ or } -3 = \frac{\frac{2b}{a} + \frac{2a}{b}}{1 - \frac{2b}{a}\cdot\frac{2a}{b}}$$

$$\Rightarrow \qquad 9 = \frac{2\left(a^2 + b^2\right)}{ab}$$

$$9ab = 2 \times 3600$$

$$\Rightarrow \qquad \frac{1}{2}ab = 400$$

$\therefore$ Area = 400 sq. units

4. 6

Sol. $\frac{dy}{dt} = -k\sqrt{y}$

$$\frac{dy}{\sqrt{y}} - k\,dt$$

$$2\sqrt{y} = -kt + c$$

$$t = 0;\ y = 4$$

$$4 = c$$

$$2\sqrt{y} = -kt + 4$$

$$y = 0$$

$$kt = 4$$

$$t = \frac{4}{\frac{1}{15}} = 60 \text{ minutes}$$

5. 2

Sol. $\text{Sum } = \sum_{n=1}^{n} \tan^{-1}\left[\frac{\sqrt{2n+2} - \sqrt{2n-2}}{2 + \sqrt{n^2 - 1}}\right] = \sum_{n=1}^{n} \tan^{-1}\left[\frac{\sqrt{\frac{n+1}{2}} - \sqrt{\frac{n-1}{2}}}{1 + \sqrt{\frac{n+1}{2}}, \sqrt{\frac{n-1}{2}}}\right]$ (divide by 2)

$$= \sum_{n=1}^{n}\left(\tan^{-1}\sqrt{\frac{n+1}{2}} - \tan^{-1}\sqrt{\frac{n-1}{2}}\right) = \tan^{-1}\left(\sqrt{\frac{n+1}{2}}\right) + \tan^{-1}\sqrt{\frac{n-1}{2}} - \tan^{-1}\frac{1}{\sqrt{2}}$$

$$\lim_{n\to\infty} \text{sum} = \pi - \tan^{-1}\left(\frac{1}{\sqrt{2}}\right) = \frac{\pi}{2} + \cot^{-1}\left(\frac{1}{\sqrt{2}}\right) = \frac{\pi}{2} + \tan^{-1}\left(\sqrt{2}\right)$$

$$\therefore k = \sqrt{2} \Rightarrow k^2 = 2.$$

6. 3

Sol. $$\frac{\frac{x}{2} + \frac{x}{2} + \frac{y}{3} + \frac{y}{3} + \frac{y}{3} + \frac{z}{4} + \frac{z}{4} + \frac{z}{4} + \frac{z}{4}}{9} \geq \frac{9}{\frac{2}{x} + \frac{2}{x} + \frac{3}{y} + \frac{3}{y} + \frac{3}{y} + \frac{4}{z} + \frac{4}{z} + \frac{4}{z} + \frac{4}{z}}$$

7. 4

Sol. $\Delta = \frac{1}{2}ab\sin C \Rightarrow \sqrt{3} = \frac{1}{2}2b\sin C \Rightarrow \frac{\sqrt{3}}{b} = \sin C$

$$2\left[\cos C+\sqrt{3}\sin C\right]=b+c \qquad \ldots\ldots\ldots(1)$$

$$\cos C=\frac{a^2+b^2-c^2}{2ab}=\frac{4+b^2-c^2}{4b}$$

$$\Rightarrow 2\left(\frac{4+b^2-c^2}{4b}\right)+2\sqrt{3}\left(\frac{\sqrt{3}}{b}\right)=b+c$$

$$\Rightarrow \frac{4+b^2-c^2}{2b}+\frac{6}{b}=b+c\Rightarrow 4+b^2-c^2+12=2b^2+2bc$$

$$\Rightarrow b^2+c^2+2bc=16\Rightarrow (b+c)=4$$

8. 6

Sol. Given, $x^2-4x+1=0\Rightarrow x$

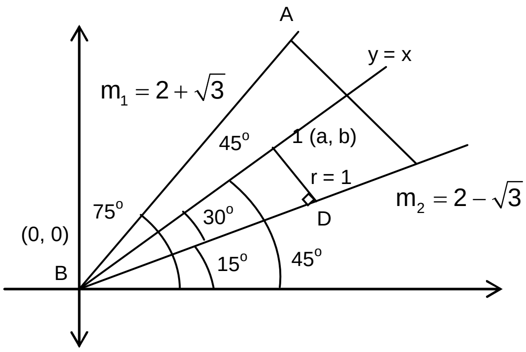
$$=\frac{4\pm\sqrt{16-4}}{2}=\frac{4\pm 2\sqrt{3}}{2}=2\pm\sqrt{3}$$

$\therefore$ From the figure, I (a, b) lies on line $y=x$,

So b = a

Also, from

ΔIBD, $\frac{r}{BI}=\sin 30^{o}\Rightarrow BI=2\ \left[\text{As, } r=1(\text{given})\right]$



$$\therefore BI=2=\sqrt{a^2+a^2}\Rightarrow 4=2a^2\Rightarrow a=\sqrt{2}$$

So, $I=\left(\sqrt{2},\sqrt{2}\right)=(a, b)$ (Given)

Hence, $\left(a^2+b^4\right)=\left(\sqrt{2}\right)^2+\left(\sqrt{2}\right)^4=2+4=6$

FIITJEE **JEE (Advanced), 2017**

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - III

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 10)** contains 10 multiple choice questions which have one or more than one correct answer. Each question carries **+3 marks** for correct answer. There is no negative marking.

(ii) **Section-C (01 – 10)** contains 10 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Enrolment No. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

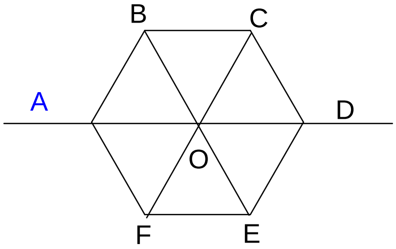
PART – I

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

1. 12 identical rods of length ℓ area cross section area A and thermal conductivity K are connected to form a regular hexagon ABCDEF with centre as O as shown in figure. If heat energy entering at point A at rate $\frac{dQ}{dt} = P$ and leaving from point D. Temperature at end A is T then



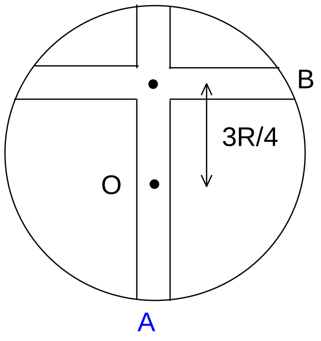
(A) temp at D is $\left(T - \frac{12\ell P}{KA}\right)$

(B) temp at O is $\left(T - \frac{2\ell P}{5KA}\right)$

(C) temp at B is $\left(T - \frac{3\ell P}{10KA}\right)$

(D) temp at D is $\left(T - \frac{4\ell P}{5KA}\right)$

2. Two tunnels are dug through the earth as shown in figure. O is the centre of earth. A particle B is released from rest from position shown and travels through the tunnel. At the same time particle from A is projected toward the centre O with velocity V such that both A and B collide before they could change their direction of motion. Then the velocity V given to A is



(A) $\frac{3}{4}\sqrt{\frac{GM}{R}}$

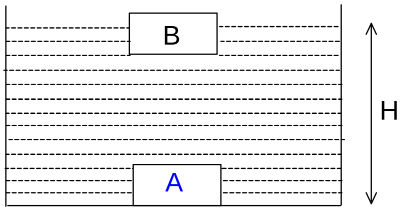
(B) $\frac{5}{12}\sqrt{\frac{GM}{R}}$

(C) $\frac{4}{9}\sqrt{\frac{GM}{R}}$

(D) $\frac{4}{5}\sqrt{\frac{GM}{R}}$

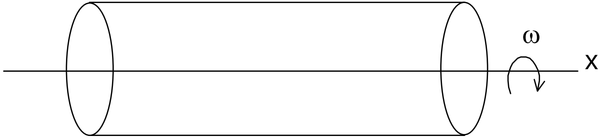
Space for rough work

3. Figure shows block B partially immersed in liquid and block A sunk completely and settled at bottom of the container. Area of the cross section of the container is always constant and equal to a. Assume that $d_A > d_L > d_B$ α and γ represent the coefficient of linear and volume expansion respectively. Choose correct statement.



(A) if $\alpha_\beta \neq 0$ and $\alpha_A = \gamma_L = 0$ then on increasing the temp of the system level of liquid H will increase
(B) if $\alpha_\beta \neq 0$ $\alpha_A = \gamma_L = 0$ then increasing the temp of system buoyant force on B increase
(C) if $3\alpha_\beta > \gamma_L$ then on decreasing the temp of the system the fraction of volume of B immersed will increase
(D) if $\alpha_A \neq 0$ $\alpha_\beta = \gamma_L = 0$ then on increasing the temp of the system buoyant force on A will increase

4. A long thin wooden cylindrical shell of radius R carries uniform surface charge density ρ. It is rotating about its axis with angular velocity ω. Which increases slowly with time t as $\omega = kt$ where k is constant. Which of the following statement is/are correct



(A) both the magnetic and the electric field are uniform and constant
(B) the magnetic field is uniform but not constant and the electric field is constant but not uniform
(C) the magnetic field is constant but not uniform electric field is uniform but not constant
(D) total energy U stored in both types of field varies with time as $U = a + bt^2$ where and b are positive constant

5. A metal plate when exposed to light of wavelength λ photoelectrons are ejected when a retarding electric field of intensity E is applied none of the photoelectrons can move away from the plate farther than a certain distance d. Which of the following correct expression for the threshold wavelength λ.

(A) $\lambda_{th} = \frac{hc}{eEd}$
(B) $\lambda_{th} = \lambda - \frac{hc}{eEd}$
(C) $\lambda_{th} = \left(\frac{1}{\lambda} - \frac{eEd}{hc}\right)^{-1}$
(D) none of these

Space for rough work

6. In the circuit are shown two parallel plate capacitor of capacitance C and 2C consisting of plates of identical dimensions having separation between two plates 2d & d respectively has shown in figure. They are connected with an ideal battery of terminal voltage as shown in figure – I. Now capacitor smaller in volume is completely inserted into the other capacitor larger in volume and kept in symmetric position and then connection polarities of the plates are reversed as shown in figure – II. Identify correct statements.

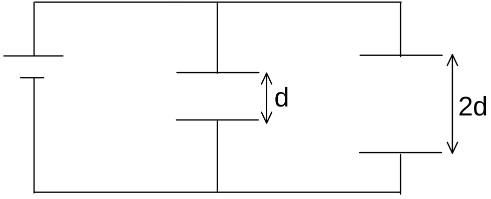


Figure - I

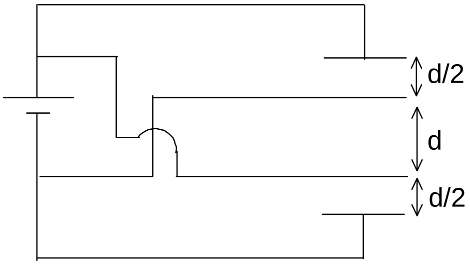


Figure - II

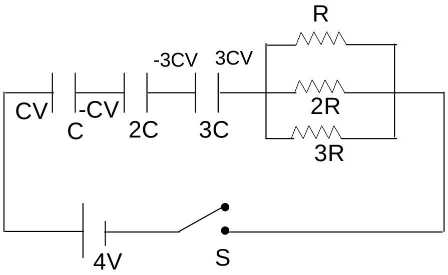
(A) charge flows through battery is 10 CV and battery absorbed energy
(B) charge flows through battery is 10 CV and battery delivers energy
(C) charge flows through battery is 7 CV and battery absorbs energy
(D) charge flows through battery is 7 CV and battery delivers energy

7. Two mirrors M_1 and M_2 make an angle ϕ with line AB. A point source S is kept at a distance r from the point of intersection of mirror along line AB. A small hemispherical annular mask is kept close to S so that no ray emanating from S directly reaches the screen kept at distance b from the source. Interference pattern of rays reflected from M_1 and M_2 is observed on screen. Find the fringe width of this interference pattern λ = wavelength of light being emitted by source.

(A) $\frac{\lambda\left(b+2r\sin^2\phi\right)}{2r\sin 2\phi}$
(B) $\frac{\lambda\left(b+2r\cos 2\phi\right)}{2r\sin 2\phi}$
(C) $\frac{\lambda\left(b+r\cos\phi\right)}{2r\sin 2\phi}$
(D) $\frac{\lambda\left(b+2r\cos 2\phi\right)}{r\sin 2\phi}$

Space for rough work

8. Three capacitors of capacitance C, 2C and 3C and three resistors R, 2R and 3R are connected with a battery and switch S as shown in figure. When the switch is open charge on capacitors are shown. Switch S is closed at t = 0. Time constant for the circuit is



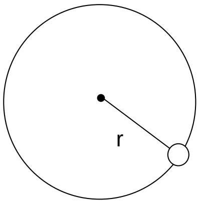
(A) RC

(B) $\frac{6RC}{11}$

(C) $\frac{36RC}{121}$

(D) none of these

9. A small collar of mass m is given an initial velocity of magnitude V_0 on the horizontal circular track fabricated from a slender rod. If co-efficient of friction is μ_k. Determine distance travelled by collar before comes to rest (Recognize that the friction force depends on the net normal force).



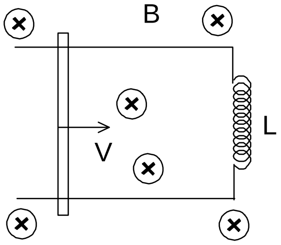
(A) $\frac{r}{\mu_k}\ln\left[\frac{V_0^2+\sqrt{V_0^4+r^2g^2}}{rg}\right]$

(B) $\frac{r}{4\mu_k}\ln\left[\frac{V_0^2+\sqrt{V_0^4+r^2g^2}}{rg}\right]$

(C) $\frac{2r}{\mu_k}\ln\left[\frac{V_0^2+\sqrt{V_0^4+r^2g^2}}{rg}\right]$

(D) $\frac{r}{2\mu_k}\ln\left[\frac{V_0^2+\sqrt{V_0^4+r^2g^2}}{rg}\right]$

10. Two parallel resistanceless rail are connected by an inductor of inductance L at one end as shown in figure. A magnetic field exist in space which is $\perp_r$ to plane of the rails. Now a conductor of length ℓ and m is placed transverse on rail and given an impulse J towards rightward direction. Select correct option



(A) velocity of conductor is half of initial velocity after displacement of conductor $d=\sqrt{\frac{3J^2L}{4B^2\ell^2m}}$

(B) velocity of conductor is half of initial velocity after displacement of the conductor $d=\sqrt{\frac{3J^2L}{B^2L^2m}}$

(C) current flowing through the inductor at the instant where velocity is half of initial is $I=\sqrt{\frac{3J^2}{4Lm}}$

(D) current flowing through the inductor at the instant when velocity of the conductor is half of the initial velocity is $I=\sqrt{\frac{3J^2}{mL}}$

Space for rough work

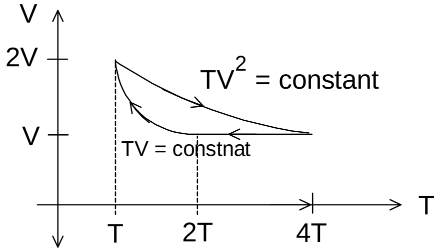
SECTION – C

(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

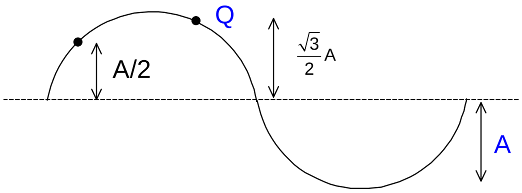
1. A uniform disk rotating about its vertical axis is placed on a horizontal floor divided in two halves. The co-efficient of friction are $\mu_1 = 0.78$ and $\mu_2 = 0.67$ between the disk and right and left halves respectively. Consider the line dividing two half as y-axis and point where centre of disk lies on origin of co-ordinate system. Acceleration of the centre of disk immediately after it is placed on floor is $\frac{K}{20}\text{ms}^{-2}$. g = 10 ms^{-2}, $\pi = \frac{22}{7}$.

2. Figure shows VT diagram for helium gas in a cyclic process. Then ratio of maximum and minimum pressure is



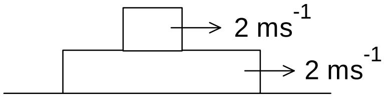
3. In a thin vertical U tube of very long arms is m_1 mass of mercury. Period of small amplitude oscillation of mercury is T_1 = 2S. If in one arm m_2 = 100 g of water is poured the period of small oscillation becomes T_2 = 3S then mass m_1 = 16 K gm. Find K …

4. Figure show the snapshot of the transverse sinusoidal wave on a string at time t = 0 sec. Frequency of wave is $\frac{125}{6}$Hz. T_1 is the time at which the line joining P and Q become horizontal for first time (after t = 0) if wave is travelling toward +ve x direction and T_2 is the time at which the line P and Q becomes horizontal for first time (after t = 0) if wave is travelling in – ve x direction then $\frac{T_1}{T_2} = \frac{22}{K}$. Find K …

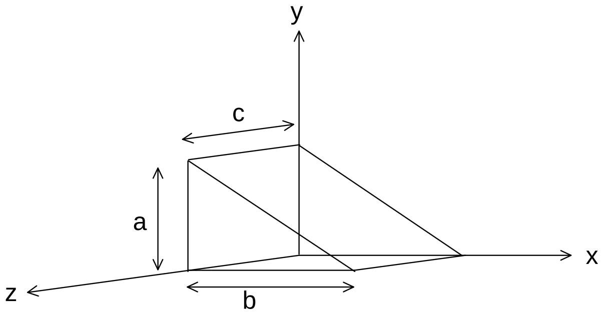


Space for rough work

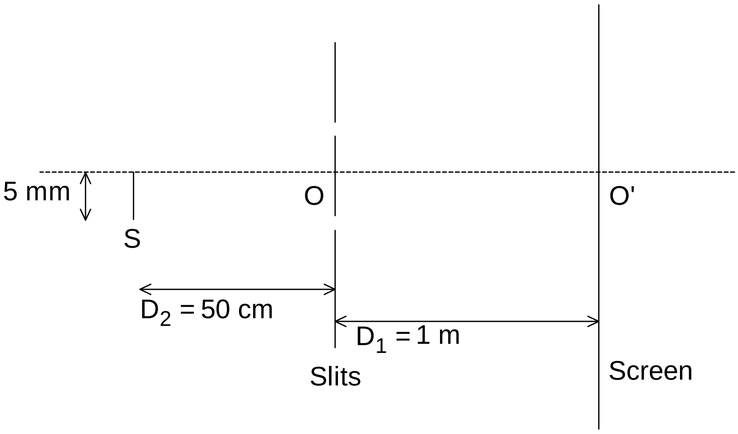
5. A block rest on a long plank moving at 2 ms^{-1}. The co-efficient of friction between the block and plank is 0.1. The plank starts decelerating uniformly and stops in 0.5 s. Acceleration due to gravity is 10 ms^{-2}. The distance slid by block on plank is $\frac{K}{4}$ m. Find K …



6. In the given electric field $\vec{E} = \left[(d+x)i + E_0\hat{j}\right]$ N/C a hypothetical closed surface is taken as shown in figure. The total charge enclosed within the closed surface is $k\in_0$. Then find the value of k(a = 2 m, b = 3 m and c = 2 m)



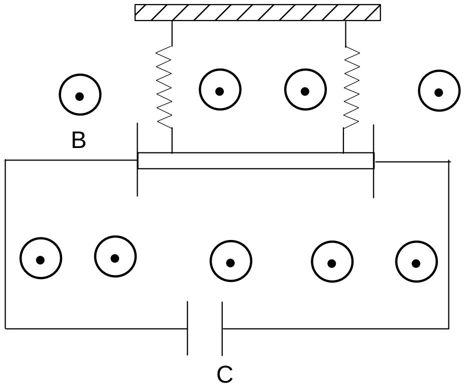
7. In the given Y.D.S.E the distance between the slits = 1 cm and the distance between slits and screen is D$_1$ = 1 m. If the source of the light S is placed at distance below 5 mm below the line OO′ at distance D$_2$ = 50 cm from slits. Find distance of central maxima from O′ (in cm)?



Space for rough work

8. A gas of hydrogen like atoms can absorb radiation of 68 eV in first excited state. Consequently the gas emit radiations of only three different wavelengths. All the wavelengths are equal or smaller than that of the absorbed photon. The atomic number of gas atom is …

9. A conducting rod of mass m and length ℓ is suspended horizontal with help of two identical non-conducting springs each of stiffness K in presence of uniform horizontal magnetic field of induction B. The rod can slid between two fixed frictionless vertical conducting guides as shown in figure. The rod is pulled slightly downward and then released. Neglect resistance and inductance in circuit. Acceleration due to gravity is g. The time period of oscillation is T = k′.π. If m = $7B^2\ell^2C$ and m = k. Find k′ ?



10. You have m = 1 kg of super cooled water at temperature – 10°C kept in a container and crushed at temp θ = - 20°C kept in another container. How much ice you should add to the water so that whole water freezes $S_\omega = 4.2\times10^3\ J\ kg^{-1}K^{-1}$, $S_I = 2.1\times10^3\ J\ Kg^{-1}K^{-1}$. Latent of heat of ice $L = 336\times10^3\ J\ Kg^{-1}$ and meeting point of ice is θ = 0°C. Heat capacity of the vessel and heat less to surrounding is negligible.

Space for rough work

Chemistry

PART – II

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

1. Select correct statement(s).
(A) all N – N bond lengths are same in N_3^- ion
(B) all N – N bond lengths are not identical in N_3H
(C) in HN_3 terminal N – N bond length is shorter than the central N – N bond length
(D) azide ion and hydrazoic acid have same number of electron.

2. For the Br^- catalyzed aqueous reaction
$$HNO_2 + C_6H_5NH_2 + H^+ \xrightarrow{Br^-} C_6H_5N_2^+ + 2H_2O$$
proposed mechanism is
(I) $H^+ + HNO_2 \underset{K_{-1}}{\overset{K_1}{\rightleftharpoons}} H_2NO_2^+ \ (fast)$
(II) $H_2NO_2^+ + Br^- \xrightarrow{K_2} ONBr + H_2O \ (slow)$
(III) $ONBr + C_6H_5NH_2 \xrightarrow{K_3} C_6H_5N_2^+ + H_2O + Br^- \ (fast)$
Which of the following statement(s) is/are correct?
(A) order with respect to H^+ is 1
(B) order with respect to Br^- is 1
(C) order with respect to $C_6H_5NH_2$ is 1
(D) order with respect to HNO_2 is 1

3. The order of first ionization energies are given below. Find the incorrect order(s).
(A) $F > N > O > C > B > Be$
(B) $C > Si > Ge > Pb > Sn$
(C) $B > Al > Ga > In > Tl$
(D) $O > Cl > Br > I > S$

4. In antifluorite structure
(A) oxide ions have face centred cubic arrangement
(B) cations are present in all the tetrahedral voids
(C) $r_{Na^+} + r_{O^{2-}} = \frac{\sqrt{3}a}{4}$
(D) cations are face centred and anions are present in all the tetrahedral voids

Space for rough work

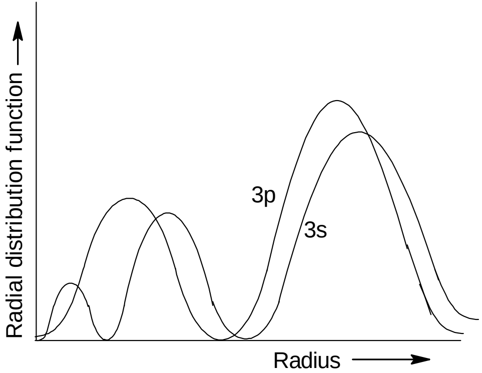
5. Identify the incorrect statement(s).
(A) $\left[NiCl_4\right]^{2-}$ as well as $[Ni(CO)_4]$ are paramagnetic
(B) CFSE for $[Ti(H_2O)_6]^{3+}$ is $-0.4\Delta_0$
(C) Δ_0 increasing order is $\left[CrCl_6\right]^{3-} < \left[Cr\left(NH_3\right)_6\right]^{3+} < \left[Cr\left(CN\right)_6\right]^{3-}$
(D) in spectro chemical series, halide ions are arranged as $I^- < Br^- < Cl^- < F^-$

6. On being treated with HCl, acetone gives

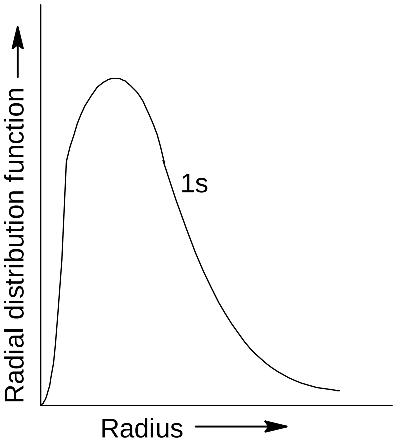
(A) mesityl oxide	(B) phorone
(C) mesitylene	(D) aldol

7. Which of the following plot(s) is/are correct

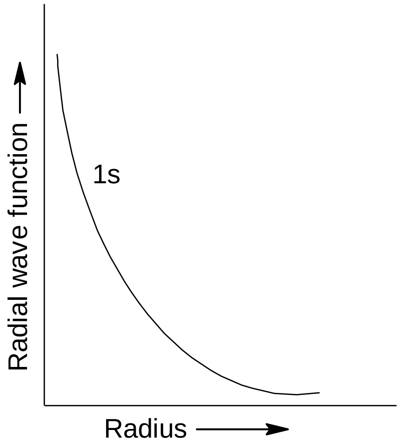
(A)



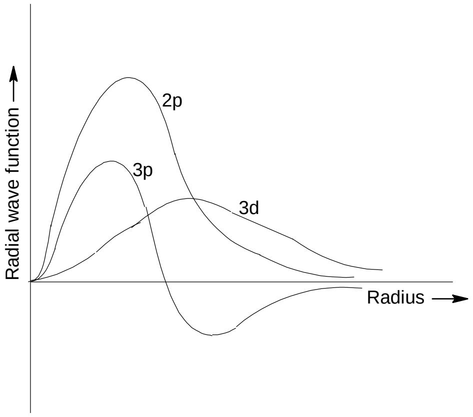
(B)



(C)



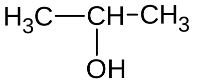
(D)



Space for rough work

8. $CH_3-CH_2-CH_2-NH_2 \xrightarrow{N_2O_3}$

The product(s) formed is/are

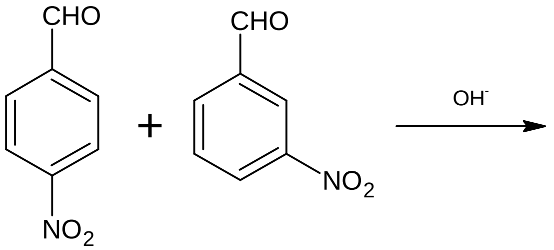
(A) 
$H_3C-\underset{OH}{\underset{|}{CH}}-CH_3$

(B) $CH_3-CH_2-CH_2-OH$

(C) $CH_3-CH=CH_2$

(D) $CH_3-CH_2-C\equiv N$

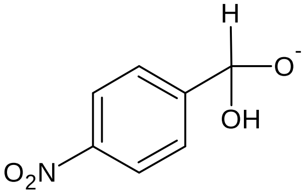
9. Which of the following statement(s) is/are correct for crossed cannizzaro reaction?

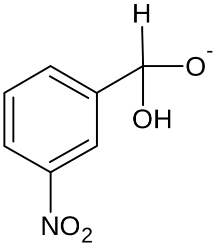


(A) (B)

(A) OH$^-$ attacks at the carbonyl C – atom of (A)

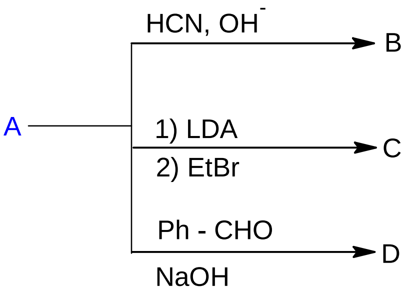
(B) OH$^-$ attacks at the carbonyl C – atom of (B)

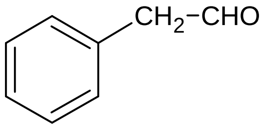
(C) the H$^-$ ion transfer takes place from 

(D) the H$^-$ ion transfer takes place from 

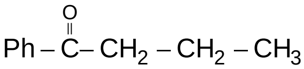
Space for rough work

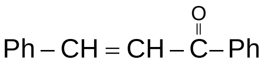
10. $C_8H_8O(A) \xrightarrow{I_2,\ NaOH}$ yellow ppt.



(A) A is 

(B) B is optically active

(C) C is 
$Ph-\overset{O}{\overset{\|}{C}}-CH_2-CH_2-CH_3$

(D) D is 
$Ph-CH=CH-\overset{O}{\overset{\|}{C}}-Ph$

SECTION – C

(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

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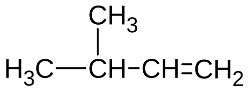
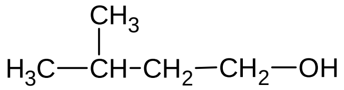
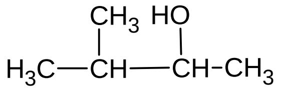
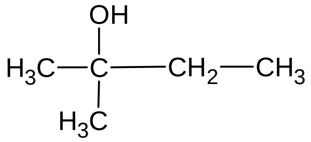
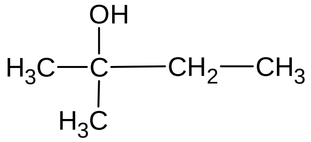
1. 
$H_3C-\underset{}{\overset{CH_3}{\overset{|}{C}}}H-CH=CH_2 \xrightarrow{\text{Reagent}}$ Alcohol

Following are the possibilities of products on applying specific reagents:

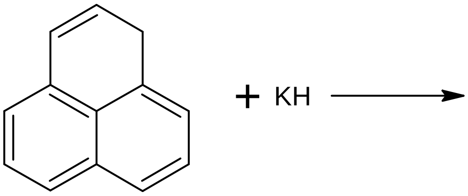
	Reagent	Possible product
1.	$B_2H_6\ /\ H_2O_2,\ NaOH$	 $H_3C-\overset{CH_3}{\overset{\mid}{C}}H-CH_2-CH_2-OH$
2.	$PdCl_2,\ H_2O,\ O_2\ /\ LAH$	 $H_3C-\overset{CH_3}{\overset{\mid}{C}}H-\overset{HO}{\overset{\mid}{C}}H-CH_3$
3.	$Hg(OAc)_2,\ H_2O\ /\ NaBH_4$	 $H_3C-\underset{\underset{H_3C}{\mid}}{\overset{OH}{\overset{\mid}{C}}}-CH_2-CH_3$
5.	dil. H_2SO_4	 $H_3C-\underset{\underset{H_3C}{\mid}}{\overset{OH}{\overset{\mid}{C}}}-CH_2-CH_3$

How many of the above mentioned pairs are correct?

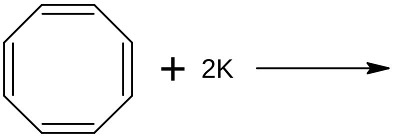
Space for rough work

2. How many of the following reactions give aromatic species?

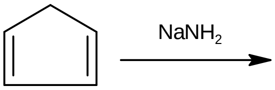
(I)



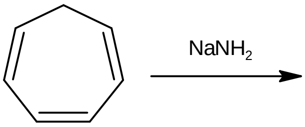
(II)



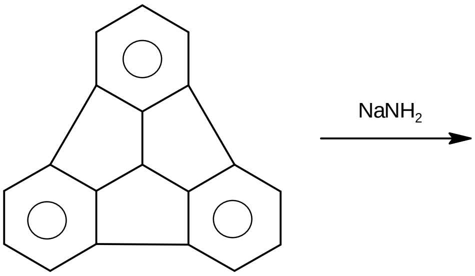
(III)



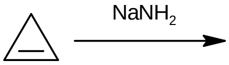
(IV)



(V)



(VI)



3. The formation constant is x × 10^5 for the reaction of a tripositive metal ion with thiocyanate ion to form the mono complex. If the total metal concentration in the solution is 2.0 × 10^{-3} M, the total SCN^- concentration is 1.50 × 10^{-3} M, and the free SCN^- concentration is 1.0 × 10^{-5} M. Find the value of x.

4. One of the most stable nuclei is ^{55}Mn. Its nuclidic mass is 54.9244 u. Determine its average binding energy per nucleon in MeV if mass of proton and neutron are 1.00783 u and 1.00867 u respectively.

Space for rough work

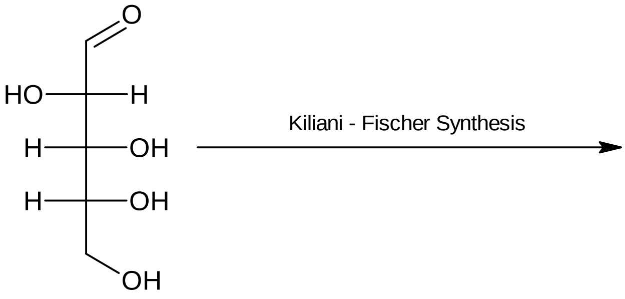
5. How many of the following chemical compound(s) appear black?
MnO_2, SnS, CO_3O_4, Ni_2O_3, $K_2Cr_2O_7$, CoS, anhydrous $CoSO_4$, Bi_2S_3, HgS, Sb_2S_3

6. K_a for the acid ionization of Fe^{3+} to $Fe(OH)^{2+}$ and H^+ is 5.26×10^{-7}. What is the maximum pOH value which could be used so that at least 95% of the total Iron(III) in a dilute solution exists as Fe^{3+}?

7. How many of the following chemical reagents impart brick red colouration to the flame during flame test? Dolomite, bleaching powder, rock salt, nitrolim, lime-stone, carnallite, alum, gypsum.

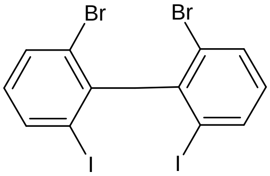
8. The number of P – O – P bonds in cyclic trimeric metaphosphoric acid are

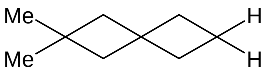
9. How many products are formed for the following synthesis?

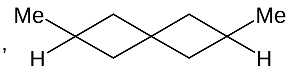


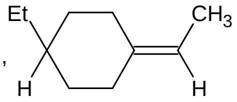
D-Arabinose

10. How many of these show optical activity?









$CH_3-CH=C=C=CH-C_2H_5, CH_3-CH=C=C=C=CH-C_2H_5$, cis-cyclooctene, trans-cyclooctene, (2R, 3S) 2, 3-dihydroxybutane-1, 4-dioic acid.

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

1. Let $f(n) = \sum_{K=n+1}^{2n} (K-n)^2 \left({}^nC_{K-n}\right)^2$ where $n \geq 2$ then

(A) $f(n) = n^2\,{}^{2n}C_n - 2n$

(B) $f(n) = \left(\frac{n^3+131n-150}{30}\right){}^{2n-2}C_{n-1}$

(C) $f(25) = \frac{625 \times 48!}{(24!)^2}$

(D) $f(25) = \frac{625 \times 50!}{(25!)^2} - 50$

2. The probability that a zoo has exactly n tiger is P^n, $n \geq 1$. All sex distribution of n tiger in that zoo have the same probability then the probability that the zoo contain exactly K male tiger (where K $\geq$ 1) is

(A) $\frac{1}{1-P}\left(\frac{P}{1-P}\right)^{K-1}$

(B) $\frac{2}{1-P}\left(\frac{P}{1-P}\right)^{K}$

(C) $\left(\frac{2}{2-P}\right)\left(\frac{P}{1-P}\right)^{K-1}$

(D) none of these

3. Which holds true if A is a square matrix of order n.

(A) $\text{adj adj }(\text{adj A}) = |A|^{n^2-3n+2} A^{-1}$

(B) $\text{adj adj }(\text{adj A}) = |A|^{n^2-3n+3} A^{-1}$

(C) $\left|A^{-1}\text{adj adj }(\text{adjA})\right| = |A|^{(n-1)^3+1}$

(D) $\left|A^{-1}\text{adj adj }(\text{adjA})\right| = |A|^{(n-1)^3-1}$

4. The equation of the straight line which meets the circle $x^2 + y^2 - 2x - 4y - p^2 = 0$ at points which are at a distance 'd' from a point $A(1 + \alpha, 2 + \beta)$ on the circle is

(A) $2\alpha x + 2\beta y - 2(\alpha + 2\beta) = 2(p^2+5) - d^2$

(B) $2\alpha x - 2\beta y - 2(\alpha - 2\beta) = 2(p^2+5) + d^2$

(C) $2\alpha x + 2\beta y - 2(\alpha + 2\beta) = 2(p^2+5) + d^2$

(D) $2\alpha x + 2\beta y - 2(\alpha + 2\beta) = d^2 - 2(p^2+5)$

Space for rough work

5. Let S & S′ be the foci of an ellipse $b^2(x-2)^2 + a^2(y-1)^2 = a^2b^2$ whose eccentricity is e and P is a variable point on the ellipse then
(A) locus of incentre of ΔPSS′ is hyperbola
(B) locus of incentre of ΔPSS′ is ellipse
(C) eccentricity of the locus of incentre of ΔPSS′ is $\sqrt{\frac{2e}{e+1}}$
(D) eccentricity of the locus of incentre of ΔPSS′ is $\sqrt{\frac{2e}{e-1}}$

6. Let f be a function satisfying $f_e(x) = \frac{e^x}{e^x + \sqrt{e}}$ and $g(x) = f_4(x)$
(A) $f_2(x) + f_2(1-x) = 1$
(B) $\sum_{r=1}^{1996} g\left(\frac{r}{1997}\right) = 1996$
(C) $\sum_{r=1}^{2n-1} 2f\left(\frac{r}{2n}\right) = (2n-1)$
(D) all of the above

7. Two tangents on a parabola are x – y – 1 = 0 & x + y + 11 = 0. If S(1, 3) is focus of the parabola where P & Q are end points of focal chord then
(A) equation of tangent at vertex 3y – 2x + 1 = 0
(B) equation of directrix 3y – 2x + 8 = 0
(C) latus rectum is $\frac{30}{\sqrt{13}}$
(D) $\frac{1}{SP} + \frac{1}{SQ} = \frac{2\sqrt{13}}{15}$

8. If a, b, c, d are in GP where a, b, c, d are positive number then
(A) a – b > d – c
(B) ab + cd > 2(ac + bd + bc)
(C) $2\left(c^{-1}d^{-1} + a^{-1}b^{-1}\right) > 2\left(b^{-1}d^{-1} + a^{-1}c^{-1} - a^{-1}d^{-1}\right)$
(D) $\frac{1}{d} + \frac{1}{b} > \frac{2}{c}$

Space for rough work

9. $\lim\limits_{x\to\infty} x_{c_n} \left(\frac{a}{x}\right)^n \left(1-\frac{a}{x}\right)^{x-n}$ is equal to

(A) $\frac{n!}{a^n e^{-a}}$
(B) $\frac{a^n e^{-a}}{n!}$
(C) $\frac{n!}{a^n e^{a}}$
(D) $\frac{a^n e^{a}}{n!}$

10. Suppose we uniformly and randomly select a permutation from the 20! Permutation of 1, 2, 3 …. 20. What is the probability that 2 appears at an earlier position than any other even number in the selected permutation.

(A) $\frac{1}{2}$
(B) $\frac{1}{10}$
(C) $\frac{9!}{20!}$
(D) none of these

SECTION – C

(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

1. A quadrilateral ABCD in which side AB, BC, CD, DA are in GP such that circle can be inscribed in it and another circle is circumscribed about it, then angle A is equal to $\frac{n\pi}{q}$ where n & q are coprime then (n + q) equal to

2. Set $S = \left\{|y| = |x|, |x| - r = 0 = |y| - r \,/\, r \in N, 1 \le r \le n\right\}$ then total number of triangles formed by the lines in the given sets is K(2n) then K is …

3. In ΔABC, ΔADB, ΔADC median AD, AE, AF respectively is drawn and BC is equal to 4, then the value of $AE^2 + AF^2 - 2AD^2$ is

4. The volume of the reel – shaped solid formed by the revolution about the y-axis of the part of the parabola $y^2 = 2x$ cut off by the latus rectum is P then value of $\frac{20}{\pi}P$ is

Space for rough work

5. If a + 1 > b and A, B, C are variable angles such that $\sqrt{\left(a^2-1\right)+b\left(2-b\right)}\tan A+a\tan B+\sqrt{\left(a^2+1\right)+b\left(b-2\right)}\tan C=3a$ then value of $\sum\tan^2 A$ is

6. Let PQRSTU is a hexagon such that PQ = QR = RS = 3 and ST = TU = UP = 6. If the vertices P, Q, R, S, T, U are concyclic, then the radius of the circle passing through them is $\sqrt{a}$, then $\frac{a}{3}$ is

7. If $\int_0^{\pi}\left[\frac{\cos\left(n+1\right)x-\cos nx}{\cos x-1}\right]dx=\frac{n\pi}{2}$ then value of n is

8. Assuming x – y + 2z = 0 to be the horizontal plane then equation of line of greatest slope through the point (2, 2, 1) in the plane 2x + y – 6z = 0 is L having cosine ratio a : b : c then value of $\left(\frac{2a+b}{c}\right)$ is ..

9. Number of real value of x satisfy this equation $e^{2x}+e^{x}\left(3-5\cos x\right)+1=0$

10. If $\sum_{i=1}^{45}\left[\sin^{-1}\left\{\text{Re}\left(\frac{ai+bi\omega+ci\omega^2}{bi+ai\omega^2+ci\omega}\right)\right\}+\cos^{-1}\left\{\text{Re}\left(\frac{ai+bi\omega+ci\omega^2}{bi\omega^2+ci+ai\omega}\right)\right\}\right]$ is equal $\frac{90\pi}{x}$ then x equal to

Space for rough work

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ANSWERS, HINTS & SOLUTIONS

CONCEPT RECAPITULATION TEST – III
(Paper–1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**BCD**	**ABCD**	**C**
2.	**A**	**ABD**	**D**
3.	**CD**	**AC**	**BD**
4.	**BD**	**ABC**	**AD**
5.	**C**	**A**	**BC**
6.	**D**	**AB**	**AC**
7.	**A**	**ABCD**	**BCD**
8.	**C**	**ABC**	**ACD**
9.	**D**	**AC**	**B**
10.	**AC**	**BCD**	**B**
1.	**7**	**3**	**3**
2.	**8**	**4**	**8**
3.	**5**	**3**	**2**
4.	**2**	**9**	**2**
5.	**6**	**6**	**3**
6.	**6**	**9**	**7**
7.	**2**	**5**	**2**
8.	**6**	**3**	**6**
9.	**4**	**2**	**1**
10.	**7**	**5**	**4**

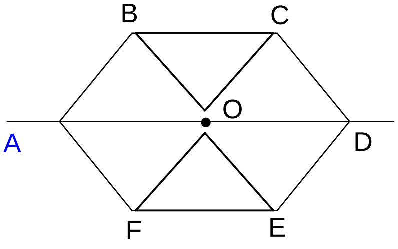
Physics

PART – I

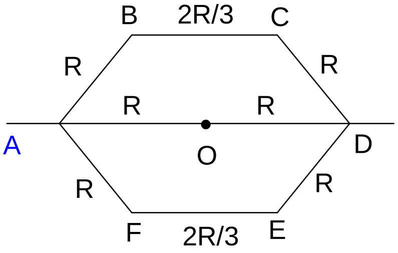
SECTION – A

1. BCD

Thermal resistance of each section $R = \dfrac{\ell}{KA}$



$R_{eq} = \dfrac{4R}{5}$

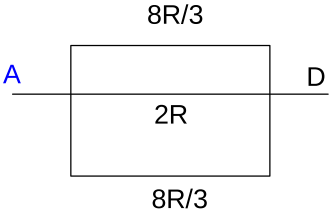


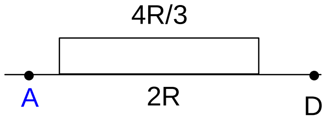
Hence $P = \dfrac{T_A - T_P}{4R} \times 5$

$T_D = T_A - \dfrac{4}{5}\dfrac{\ell P}{KA}$

Heat current through

ABCD & AFED = $\dfrac{P \times 2R}{\dfrac{4R}{2} + 2R} = \dfrac{P \times 3 \times 2}{10} = \dfrac{3P}{5}$





$AOD = \dfrac{2P}{5}$

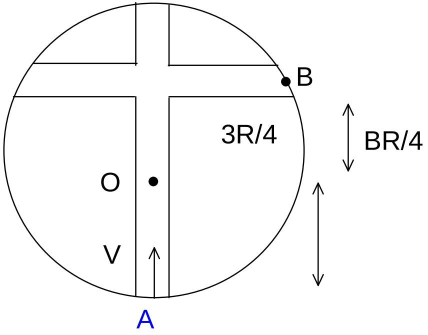
Temperature drop across AO = $\dfrac{2P}{5} \times R = T_A - T_0$

$T_o = T_A - \dfrac{2P\ell}{5KA}$

2. A

Time for B to move from B to centre of tunnel is $\frac{T}{4} = T = 2\pi\sqrt{\frac{R^3}{GM}} \quad \omega = \sqrt{\frac{GM}{R^3}}$

Time to move from A to given point is



$$\frac{1}{\omega}\left\{\sin^{-1}\left(\frac{R}{A}\right)+\sin^{-1}\left(\frac{3R}{4A}\right)\right\} = \frac{T}{4}$$

$$\sin^{-1}\left(\frac{R}{A}\right)+\sin^{-1}\left(\frac{3R}{4A}\right) = \frac{\pi}{2}$$

From above

$$\sin^{-1}\left(\frac{R}{A}\right) = \cos^{-1}\left(\frac{3R}{4A}\right) = \sin^{-1}\left(\sqrt{1-\frac{9R^2}{16A^2}}\right)$$

$$\frac{R}{A} = \sqrt{1-\frac{9R^2}{16}}$$

$$\frac{R^2}{A^2} = 1-\frac{9R^2}{16A^2} \quad \frac{25}{16}\frac{R^2}{A^2} = 1$$

$$A = \frac{5}{4}R$$

Hence

$$V = \omega\sqrt{A^2-R^2} = \frac{\omega\sqrt{25R^2-16R^2}}{4}$$

$$= \frac{3}{4}R\omega = \frac{3}{4}\sqrt{\frac{GM}{R}}$$

3. CD

Since fractional volume

$$\frac{V_{in}}{V_{body}} = \frac{\rho_{body}}{\rho_{liquid}}$$

$$\frac{V_{\text{inf}}}{V_{body}} = \frac{\rho_{Bf}}{\rho_{ef}} = \frac{\rho_{Bi}.(1+\gamma_L\Delta T)}{(1+\gamma_B\Delta T)\,\rho_{\ell i}}$$

$$x_f = x_i\left(\frac{1+\gamma_L\Delta T}{1+\gamma_B\Delta T}\right)$$

with fall in temperature

$x_f > x_i$ for $\gamma_B = 3\alpha_B > \gamma_L$

4. BD

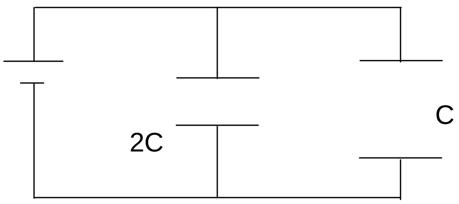
5. C

$$K.E_{\max} = \frac{hc}{\lambda} - \frac{hc}{\lambda_T}$$

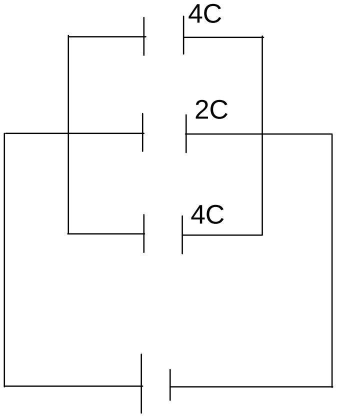
$$\ell Ed = \frac{hc}{\lambda} - \frac{hc}{\lambda_T}$$

$$\lambda_T = \left(\frac{1}{\lambda} - \frac{eEd}{hc}\right)^{-1}$$

6. D

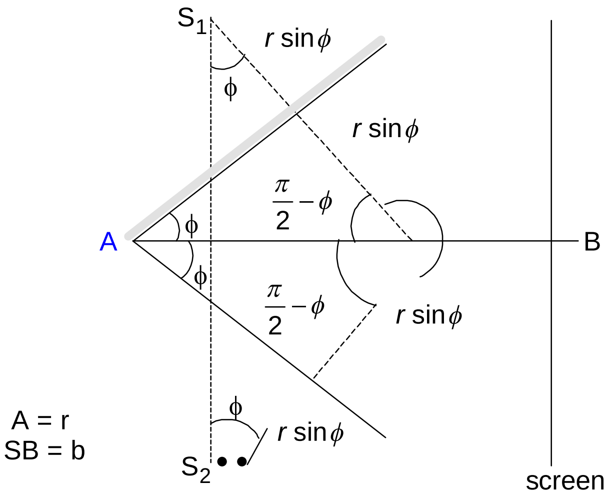


Initial
Q_{in} = 3 CV



Final
Q_f = 10 CV

7. A


S1
r sinϕ
ϕ
r sinϕ
π/2 − ϕ
A
ϕ
ϕ
B
π/2 − ϕ
r sinϕ
ϕ
r sinϕ
A = r
SB = b
S2
screen

$d = S_1S_2 = 2\{2r\sin\phi.\cos\phi\} = 2r\sin2\phi$

D = distance between source and screen

$= b + 2r\sin^2\phi$

Hence

Fringe width = $\dfrac{\left(b + 2r\sin^2\phi\right)\lambda}{2r\sin(2\phi)}$

8. C

$\tau = RC$

It do not depends on charge on capacitor

$$\tau = \frac{6R}{11}.\frac{6C}{11} = \frac{36RC}{121}$$

9. D

$$N = m\sqrt{\left(\frac{V^2}{R}\right)^2 + g^2}$$

$$ma_T = -\mu m\sqrt{\left(\frac{V^2}{R}\right)^2 + g^2}$$

$$V\frac{dv}{ds} = -\mu\sqrt{\left(\frac{V^2}{R}\right)^2 + g^2}$$

$$\frac{RVdv}{\sqrt{V^4 + R^2g^2}} = -\mu_K ds$$

Replacing $Z^2 = V^4 + R^2g^2$

$$\int \frac{R}{2}\frac{dz}{\sqrt{z^2 - (Rg)^2}} = -\mu_K ds$$

Replacing $z = Rg\sec\theta$

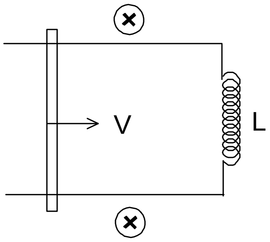
$$\ln(\sec\theta + \tan\theta) = \frac{-2\mu_K}{R}ds$$

$$\ln\left(\sec\theta\sqrt{\sec^2\theta - 1}\right) = \frac{-2\mu_K}{R}s$$

$$\ln\left(\frac{z + \sqrt{z^2 - R^2g^2}}{Rg}\right) = \frac{-2\mu_K}{R}s$$

$$\left[\ln\left(\frac{\sqrt{V^4 + R^2g^2} + V^2}{Rg}\right)\right]_{V_0}^{0} = \frac{-2\mu_K}{R}[S]_0^s$$

10. AC



$$B\ell V = L\frac{dI}{dt}$$

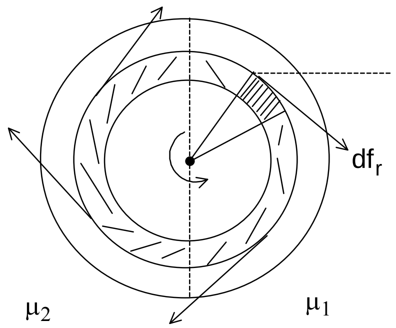
$$B\ell dx = LdI$$

$$B\ell x = LI$$

$$I = \frac{B\ell x}{L}$$

SECTION – C

1. 7



Let we consider a ring of radius r and thickness dr.
σ = mass per unit area.
Mass of shaded part $\sigma(rd\theta)dr$
Friction $\mu_1(\sigma rd\theta)dr$
Net horizontal force along x-axis is 0

$$\int df_y = \int(\mu_1\sigma rd\theta drg)\cos\theta$$

$$= \mu_1\sigma g\int rdr\int_{-\pi/2}^{\pi/2}\cos\theta d\theta$$

$$= 2\mu_1\sigma g\int rdr = 2\mu_1\sigma g.\frac{R}{2}\,(right\ half)\,(-ve\ y)$$

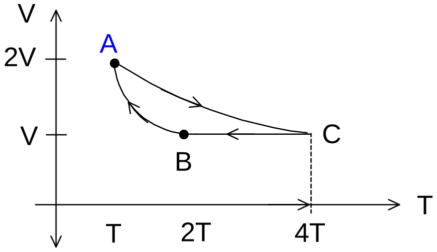
Left part

$$F_y = 2\mu_2\sigma g\frac{R}{2}\,(+ve\ y)$$

$$F_{net} = (\mu_1-\mu_2)\sigma gR^2 = \frac{(0.78-0.67).M}{\pi R}.g.R$$

$$a = \frac{0.11\times10}{22}\times7 = \frac{7}{20}ms^{-2}$$

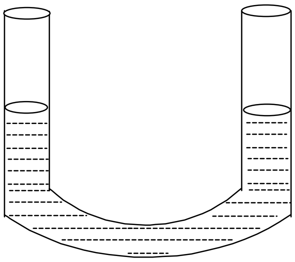
2. 8



AB $\rightarrow$ TV = constant = K$_1$
PV^2 = K$_1$ × nR
AC $\rightarrow$ TV^2 = constant = K$_2$
P$_{min}$ at A and maximum C
P$_B$ = 4P$_A$ and P$_C$ = 2P$_B$

Hence $\frac{P_C}{P_K} = 8$

3. 5



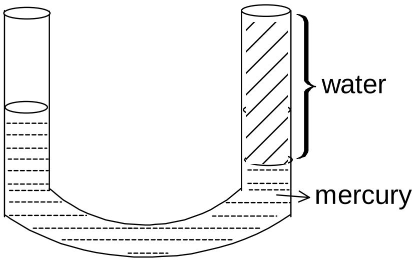
Initial

Let A = cross section area

Net force after x displacement

$$-2Ax\rho_{Hg}.g = m_1 a$$

$$\omega_1^2 = \frac{2A\rho_{Hg}.g}{m_1}$$



Final

Net force after displacement will be

$$= -2Ax\rho_{Hg}.g = (m_1 + m_2)a$$

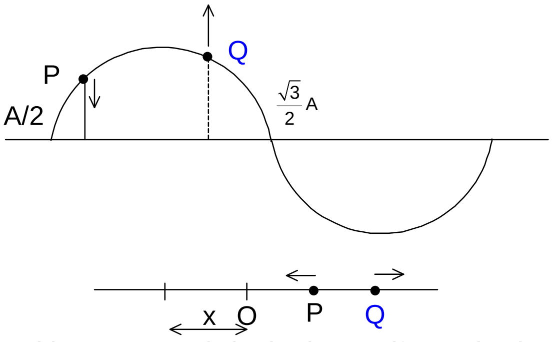
$$\omega_2^2 = \frac{2A\rho_{Hg}.g}{m_1 + m_2}$$

$$\frac{\omega_1}{\omega_2} = \sqrt{\frac{m_1 + m_2}{m_1}} = \frac{T_1}{T_2}$$

$$m_1 = 80\ m$$

4. 2

In case of +ve direction proceeding of wave.



In this case PQ will be horizontal if P and Q have same position propagating in opposite direction it will be in left half at position x.

For P $\frac{T}{12} + \frac{T}{4} + \frac{1}{\omega}\cos^{-1}\left(\frac{x}{A}\right)$

For Q $\frac{T}{12} + \frac{T}{4} + \frac{1}{\omega}\sin^{-1}\left(\frac{x}{A}\right)$

Equating these two

$$x = \frac{A}{\sqrt{2}}$$

Hence $t_1 = \frac{11T}{24}$

In case of propagating – ve x direction.

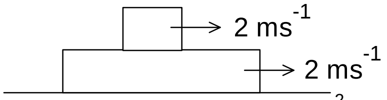
For PQ to be horizontal it will be positon i.e. right half.

$$\underbrace{\frac{1}{\omega}\sin^{-1}\left(\frac{x}{A}\right)-\frac{T}{12}}_{for\ P} = \underbrace{\frac{1}{\omega}\cos^{-1}\left(\frac{x}{A}\right)-\frac{T}{12}}_{for\ Q}$$

$x = \frac{A}{\sqrt{2}}$ hence $t_2 = \frac{T}{24}$

$$\frac{T_1}{T_2} = 11$$

5. 6



Retardation of plank = 4 ms^{-2} and retardation of block = 1.0 ms^{-2}

Hence relative acceleration of block w.r.t. plank = 3 ms

Skidding distance up to this time

$$\frac{1}{2}(3)\times\left(\frac{1}{4}\right) = \frac{3}{8}\,m$$

Plank is in rest now and block has velocity = $2 - 1\times\frac{1}{2} = \frac{3}{2}ms^{-1}$

Skidding distance = $\frac{u^2}{2.a} = \frac{9}{8}m$.

Total skidding distance = $\frac{12}{8}m = 1.5m$

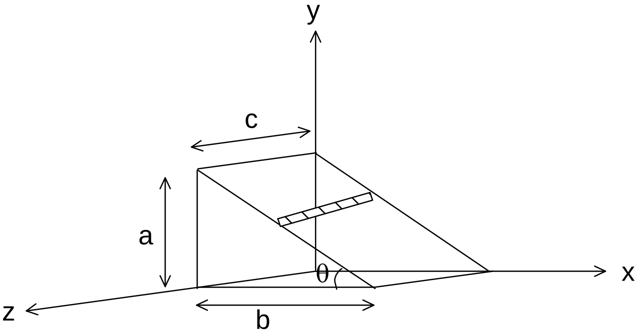
6. 6

$E = (d+x)i + E_0 i$

Net flux due to $E_y = 0$

Flux through left most surface is – ve and acceleration

Flux through inclined surface



$$\int\left(d+\ell\cos\theta\right)cd\ell.\sin\theta = dc\sin\theta.\ell + \frac{c.\ell^2\sin\theta.\cos\theta}{2}$$

$$= dc.a + \frac{c.a.b}{2}$$

Net = $\frac{a.b.c}{2} = 6$

7. 2
Path difference before slits = path difference after slits.

8. 6

9. 4
e.m.f of rod at any instant

$$\varepsilon_i = B\ell v$$

$$\theta = B\ell vc \qquad I = \frac{d\theta}{dt} = B\ell ca$$

Hence net force

$$2Kx - B^2\ell^2ca = ma$$

$$a = \frac{2Kx}{\left(B^2\ell^2c+m\right)} \qquad T = 2\pi\sqrt{\frac{m+B^2\ell^2c}{2K}}$$

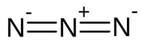
10. 7
Heat lost = heat gained

$$m_is_i\left(\theta_0-\theta_i\right) = m_\omega L - m_\omega s_\omega\left(\theta_0-\theta_\omega\right).$$

Chemistry PART – II

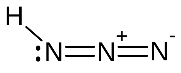
SECTION – A

1. ABCD



$\overset{-}{N}=\overset{+}{N}=\overset{-}{N}$

Azide ion



Hydrazoic acid

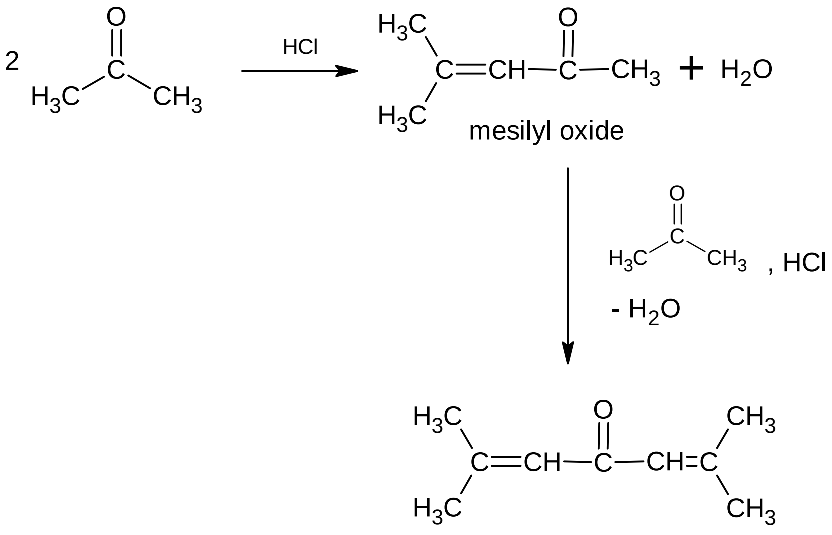
2. ABD
rate law equation is
rate = $K\left[H^{+}\right]\left[HNO_{2}\right]\left[Br^{-}\right]$

3. AC
Correct order is
F > N > O > C > Be > B
B > Tl > Ga > Al > In

4. ABC
Facts

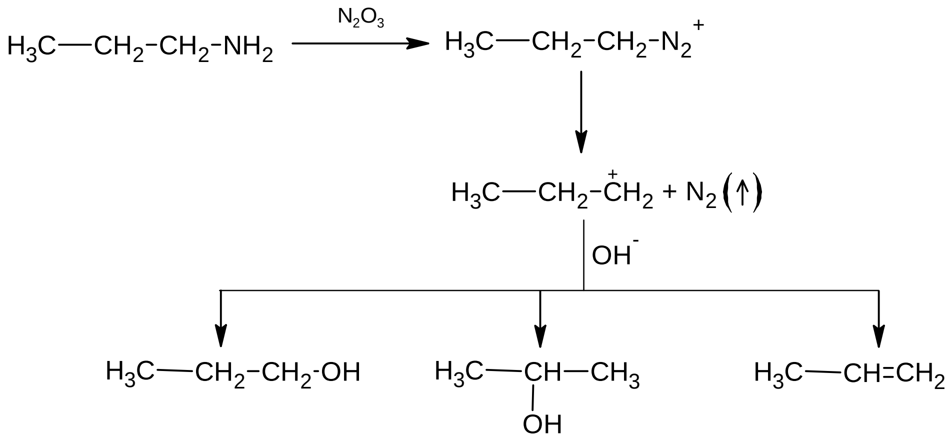
5. A
$[NiCl_4]^{2-}$ = tetrahedral, sp^3 hybridized so there are two odd e^-s in t_{2g} orbitals
$[Ni(CO)_4]$ = tetrahedral with sp^3 hybridization, no electrons unpaired

6. AB

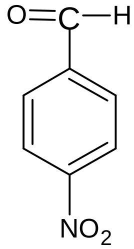


7. ABCD
Facts

8. ABC

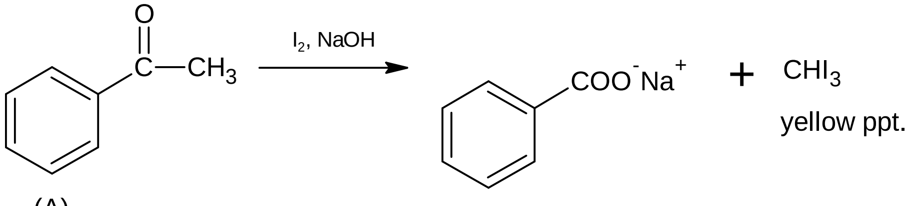

H3C—CH2-CH2-NH2
N2O3
H3C—CH2-CH2-N2+
H3C—CH2-CH2+ + N2(↑)
OH-
H3C—CH2-CH2-OH
H3C—CH—CH3
OH
H3C—CH=CH2

9. AC

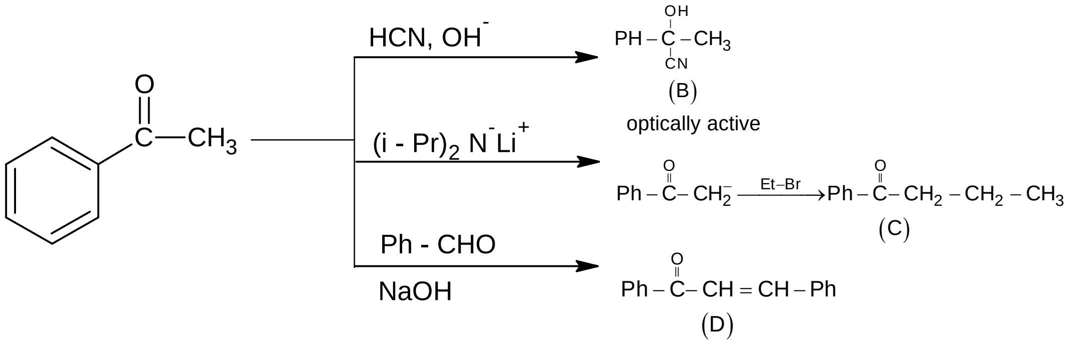


In the carbonyl carbon is more e^- deficient hence OH^- attacks over it.

10. BCD


O
C—CH3
I2, NaOH
COO-Na+
+
CHI3
yellow ppt.

(A)


O
C—CH3
HCN, OH-
PH–C–CH3
OH
CN
(B)
optically active
(i - Pr)2 N-Li+
Ph–C–CH2-
Et–Br
Ph–C–CH2–CH2–CH3
(C)
Ph - CHO
NaOH
Ph–C–CH=CH–Ph
(D)

SECTION – C

1. 3
Oxymercuration – demercuration doesn't allow rearrangement.

2. 4
(I), (II), (III) & (V) give aromatic species.

3. 3

$M^{3+} + SCN^{-} \rightleftharpoons MSCN^{2+}$

$[MSCN^{2+}] = \left(1.5\times10^{-3}\,M\right)-\left(1.0\times10^{-5}\,M\right)=1.49\times10^{-3}\,M$

So, free $[M^{3+}] = \left(2.0\times10^{-3}\,M\right)-\left(1.49\times10^{-3}\,M\right)$

$= 0.51 \times 10^{-3}$ M

$$\therefore K=\frac{\left[MSCN^{2+}\right]}{\left[M^{3+}\right]\left[SCN^{-}\right]}=\frac{1.49\times10^{-3}}{\left(0.51\times10^{-3}\right)\times\left(1.0\times10^{-5}\right)}=2.92\times10^{-5}\approx3.0\times10^{5}$$

4. 9

Mass of 25 protons = 25(1.00783 u) = 25.19575 u

And mass of 30 neutrons = 30(1.00867 u) = 30.2601

$\therefore$ Total mass = 55.45585 u

Given mass = 54.9244 u

Mass defect = 55.45585 u – 54.9244 u = 0.53145 u

$\therefore$ binding energy = $0.53145\text{ u}\times\left(931.5\text{ MeV / u}\right)=495.045675\text{ MeV}$

$$\therefore \frac{\text{BE}}{\text{Nucleon}}=\frac{495.045675}{55\text{ nucleons}}=9\text{ MeV}$$

5. 6

MnO_2, Co_3O_4, Ni_2O_3, CoS, HgS, Bi_2S_3 (blackish brown)

6. 9

$$Fe^{3+}+2H_2O \rightleftharpoons Fe\left(OH\right)^{2+}+H_3O^{+}$$

$$K_a=\frac{\left[Fe\left(OH\right)^{2+}\right]\left[H_3O^{+}\right]}{\left[Fe^{+3}\right]}=\frac{0.05\times\left[H_3O^{+}\right]}{0.95}$$

$$or\ 5.26\times10^{-7}=\frac{0.05\times\left[H_3O^{+}\right]}{0.95}$$

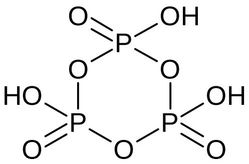
$$\therefore \left[H_3O^{+}\right]=10^{-5},\ pH=5,\ pOH=9$$

7. 5

All Ca containing compounds impart brick red colouration to the flame . Except carnallite, alum & rock salt all other are Ca containing compounds.

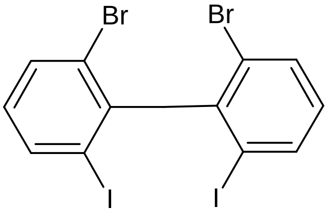
8. 3

$(HPO_3)_3$



9. 2
Two stereoisomers are formed.

10. 5



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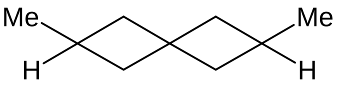

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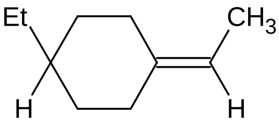


$CH_3CH = C = C = C = CHC_2H_5$, trans-cyclooctene are chiral.

Mathematics

PART – III

SECTION – A

1. C

$$\sum_{k=n+1}^{2n}(k-n)^2\left({}^{n}C_{k-n}\right)^2$$

Replace k – n → k

$$\sum_{k=1}^{n}k\left({}^{n}C_{k}\right)=\sum_{k=1}^{n}\frac{k\times n!}{k!(n-k)!}$$

$$=\sum_{k=1}^{n}\frac{n(n-1)!}{(k-1)!(n-k)!}$$

$$=n\left[\frac{(n-1)!}{(k-1)!(n-k)!}\right]$$

$$\sum_{k=1}^{n}k^2\left({}^{n}C_{k}\right)^2=n^2\sum_{k=0}^{n-1}\left({}^{n-1}C_{k}\right)^2$$

$$=n^2\left({}^{2n-2}C_{n-1}\right)$$

2. D

$${}^{n}C_{k}\left(\frac{1}{2}\right)^{k}\left(\frac{1}{2}\right)^{n-k}$$

Probability having exactly k male tigers

$$=P^{n}\,{}^{n}C_{k}\left(\frac{1}{2}\right)^{k}\left(\frac{1}{2}\right)^{n-k}\ (n\ge k)$$

So required probability $=\sum_{n=k}^{\infty}P^{n}\,{}^{n}C_{k}\left(\frac{1}{2}\right)^{k}\left(\frac{1}{2}\right)^{n-k}$

$$=\frac{2}{2-P}\left(\frac{P}{2-P}\right)^{k}$$

3. BD

$$\text{adj}\,(\text{adj}A)=|A|^{n-2}A$$

$$|\text{adj}\,(\text{adj}A)|=|A|^{(n-1)^2}$$

$$\text{so adj}(\text{adj}(\text{adj}A))=|A|^{(n-2)(n-1)}(\text{adj}A)$$

$$|\text{adj adj}\,(\text{adj}\,A)|=|A|^{(n-1)^3}$$

$$=|A|^{(n-1)^3}$$

4. AD

$$(x-1)^2+(y-2)^2=P^2+5$$

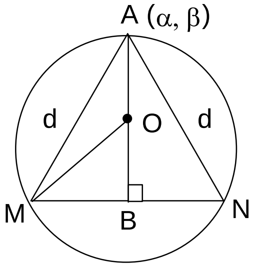
Shifted to (1, 2)

Let $a^2 = P^2 + 5$

Equation of line MN is $\beta y + \alpha x = k$

$= mOA = \frac{\beta}{\alpha}$

$AB = a \pm \frac{k}{a}$



$(BM)^2 = (OM)^2 - (OB)^2$

$= a^2 - \frac{k^2}{a^2}$

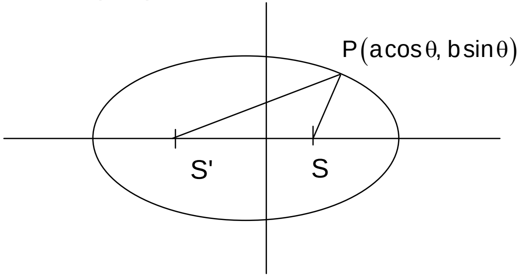
$(AM)^2 = (AB)^2 + (BM)^2$

$\Rightarrow d^2 = \left(a \pm \frac{k}{d}\right)^2 + a^2 - \frac{k^2}{d^2}$

$\Rightarrow d^2 = 2a^2 \pm 2k$

5. BC

Shift to (2, 1)



In $\Delta PSS'$

$SS' = 2ae,\ SP = a - ae\cos\theta,\ S'P = a + ae\cos\theta$

$h = ae\cos\theta$ & $k = \frac{eb\sin\theta}{e+1}$

So locus of incentres

$$\frac{x^2}{a^2e^2} + \frac{y^2}{\left(\frac{be}{e+1}\right)^2} = 1$$

And its eccentricity = $\sqrt{\frac{2e}{e+1}}$

6. AC

$$f(x) + f(1-x) = \frac{e^x}{e^x + \sqrt{e}} + \frac{\sqrt{e}}{e^x + \sqrt{e}} = 1$$

So $f_2(x) + f_2(1 - x) = 1$

$$\sum_{r=1}^{2n-1} 2f_e\left(\frac{r}{2n}\right) = 2\left[f_e\left(\frac{1}{2n}\right)+f_e\left(\frac{2}{2n}\right)+....f_e\left(\frac{2n-1}{2n}\right)\right]$$

$$=2\left[(n-1)+f_e\left(\frac{1}{2}\right)\right]$$

$$=2\left[n-1+\frac{1}{2}\right]$$

$$=2n-1$$

$$\sum_{r=1}^{1996} g\left(\frac{r}{1997}\right)=\left[g\left(\frac{1}{1997}\right)+g\left(\frac{1996}{1997}\right)\right]+\left[g\left(\frac{2}{1997}\right)+g\left(\frac{1995}{1997}\right)\right]+.....\left[g\left(\frac{998}{1997}\right)+g\left(\frac{999}{1997}\right)\right]$$

$$=998$$

7. BCD

Use the property, foot of perpendicular from focus to tangent lies on the tangent at vertex. Using this we get equation of tangent at vertex is 6y – 4x + 1 = 0

8. ACD

$$\frac{a+c}{2}\ge b \Rightarrow a+c>2b$$

Similary b + d > 2c
a + b + c + d > 2b + 2c
a + d > b + c
and GM ≥ HM

$$b>\frac{2ac}{a+c}$$

$$ab+bc>2ac$$

GM ≥ HM

$$\frac{1}{d}+\frac{1}{b}>\frac{2}{c}$$

Now $\frac{1}{a}+\frac{1}{d}>\frac{1}{b}+\frac{1}{c}$

Divide by abc, we get

$$ab+cd>2(ac+bd-bc)$$

Divide by abcd

$$2\left(c^{-1}d^{-1}+a^{-1}b^{-1}\right)>2\left(b^{-1}d^{-1}+a^{-1}c^{-1}-a^{-1}d^{-1}\right)$$

9. B

$$\lim_{x\to\infty}\frac{x!}{n!(x-n)!}\frac{a^n}{(x)^n}.\frac{\left(1-\frac{a}{x}\right)^x}{\left(1-\frac{a}{x}\right)^n}$$

$$\lim_{x\to\infty}\frac{a^n}{n!}\left(1-\frac{a}{x}\right)^x\left[\frac{(1)\left(1-\frac{1}{x}\right)\left(1-\frac{2}{x}\right)...\left(1+\frac{1-n}{x}\right)}{\left(1-\frac{a}{x}\right)^n}\right]$$

$$\lim_{x\to\infty}\frac{a^n}{n!}\times\frac{e^{-a}\times 1}{1^n}=\frac{a^n.e^{-a}}{n!}$$

10. B

Numbers of permutation with 2 in first position = 19!

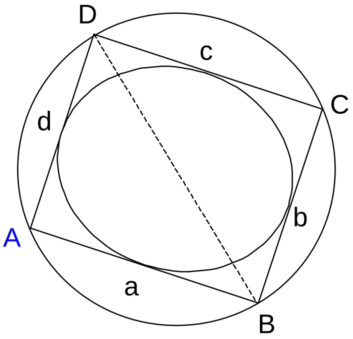
For second position = 10 × 18!

Similarly = $\dfrac{19!+10\times 18!+10\times 9\times 17!+...10!\times 9!}{20!}=0.1$

SECTION – C

1. 3

a + c = b + d



$\cos A=\dfrac{a^2+d^2-(BD)^2}{2ad}$

$BD^2=a^2+d^2-2ad\cos A$

and in ΔBCD

$\cos C=\dfrac{b^2+c^2-(BD)^2}{2bc}$

$(BD)^2=b^2+c^2-2bc\cos C$

$(BD)^2=b^2+c^2+2bc\cos A$

Compare we get $\cos A=\dfrac{ad-bc}{ad+bc}$

$=\dfrac{aar^3-arar^2}{a^2\left(r^3+r^2\right)}=0,\ A=\dfrac{\pi}{2}$

2. 8

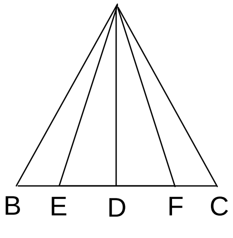
For n = 1 $\Rightarrow$ we get 16 triangle

For n = 2 $\Rightarrow$ we get 32 triangle

So for n total number of triangle is 16n

3. 2

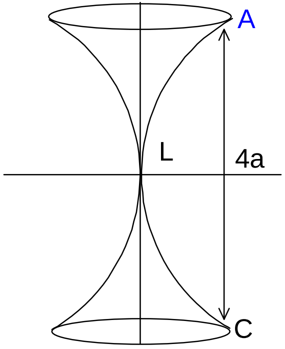
In ΔAEF



$AE^2 + AF^2 = 2(AD^2 + ED^2)$
$\Rightarrow AE^2 + AF^2 - 2AD^2 = 2$

4. 2

Required volume = 2(volume generate by the revolution about y-axis of the area ALC)



$$= 2\int_0^{2a} \pi x^2 dy$$

$$= 2\pi \int_0^{2a} \frac{y^4}{16a^2} dy$$

$$= \frac{4\pi a^3}{5} \text{ and } a = \frac{1}{2}$$

$$= \frac{\pi}{10}$$

$$\text{so } \frac{20}{\pi}.\frac{\pi}{10} = 2$$

5. 3

$$\bar{v}_1 = \sqrt{a^2 - (b-1)^2}\, i + aj + \sqrt{a^2 + (b-1)^2}\, \hat{k}$$

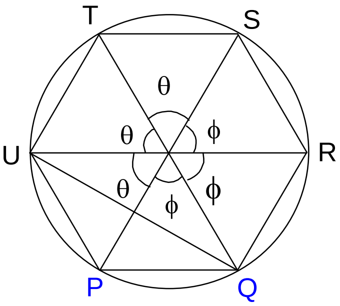
$$\bar{v}_2 = \tan A i + \tan B j + \tan C k$$

Let $\bar{v}_1.\bar{v}_2 = 3a$

$$\sum \tan^2 A = 3\sec^2\theta$$

so min $\sum \tan^2 A = 3$

6. 7



$$3(\theta + \phi) = 360^o$$

$$\theta + \phi = 120^o$$

$$\cos 120 = \frac{9+36-FB^2}{2(18)}$$

$$\cos(\theta+\phi) = \cos(120) = \frac{r^2+r^2-63}{2r^2}$$

$$\Rightarrow r^2 = 21$$

$$r = \sqrt{21}$$

7. 2

$$I_n = \int_0^{\pi} \left(\frac{2\sin\left(n+\frac{1}{2}\right)x.\sin\frac{x}{2}}{1-\cos x} \right) dx$$

$$I_n = I_{n-1} = I_{n-2} - I_0$$

$$I_n = I_0 \Rightarrow I_0 = \pi \Rightarrow I_n = \pi$$

$$\text{so } \frac{n\pi}{2} = \pi \Rightarrow n = 2$$

8. 6

$$L \equiv \frac{x-2}{a} = \frac{y-2}{b} = \frac{z-1}{c}$$

$$2a+b-6c = 0 \;\; \& \begin{vmatrix} a & b & c \\ 1 & -1 & 2 \\ 2 & 1 & -6 \end{vmatrix} = 0$$

We get a : b : c ≡ 33 : 30 : 16

$$\text{So } \frac{2a}{c} + \frac{b}{c} = \frac{33}{8} + \frac{15}{8} = 6$$

9. 1

$$e^x + e^{-x} + 3 - 5\cos x = 0$$

$$e^x + e^{-x} = 5\cos x - 3$$

So only one solution x = 0

10. 4

$$\sin^{-1}\left(-\frac{1}{2}\right) + \cos^{-1}\left(-\frac{1}{2}\right) = \frac{\pi}{2}$$

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

ALL INDIA TEST SERIES

FIITJEE

JEE (Main)-2017

CONCEPT RECAPITULATION TEST - II

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 03 and 10 to 12)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (04 to 09 and 13 to 30) contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

(One Option Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE** option is correct.

1. The biding energy per nucleon for deuteron $\left({}_1^2H\right)$ and helium $\left({}_2^4He\right)$ are 1.1 MeV and 7.0 MeV respectively. The energy released when two deuterons fuse to form a helium nucleus is

(A) 23.6 MeV	(B) 47.12 MeV
(C) 34.4 MeV	(D) 11.8 MeV

2. The K_α X-ray emission line of tungsten occurs at $\lambda = 0.021$ nm. The energy difference between K and L levels in this atom is about

(A) 0.51 MeV	(B) 1.2 MeV
(C) 59 keV	(D) 13.6 eV

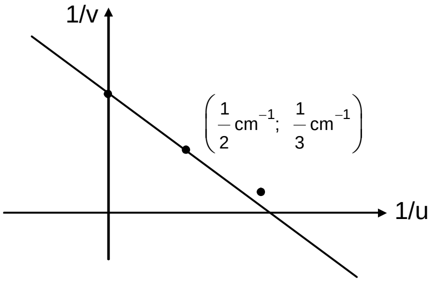
3. $\frac{1}{v}$ vs $\frac{1}{u}$ graph for a spherical mirror is shown in the figure. The focal length of the mirror will be

(A) 5 cm

(B) –5 cm

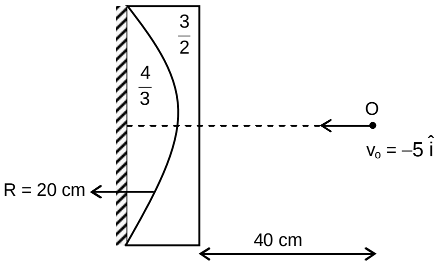
(C) $\frac{6}{5}$ cm

(D) $-\frac{6}{5}$ cm



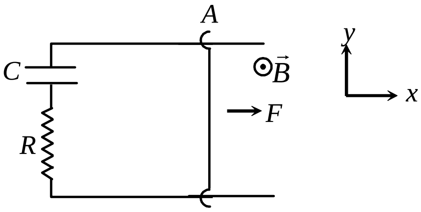
Space for Rough work

4. The lens combination having refractive indices $\frac{4}{3}$ & $\frac{3}{2}$ as shown in the figure, is silvered. The velocity of image will be?



(A) $1.8\,\hat{i}$ (B) $3\,\hat{i}$
(C) $3.6\,\hat{i}$ (D) $5\,\hat{i}$

5. A conducting rod *AB* moves parallel to *x*-axis in the *x*-*y* plane. A uniform magnetic field *B* pointing normally out of the plane exists throughout the region. A force *F* acts perpendicular to the rod, so that the rod moves with uniform velocity *v*. The force *F* is given by (neglect resistance of all the wires)

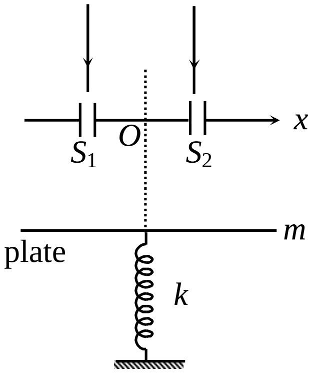


(A) $\frac{vB^2l^2}{R}e^{-t/RC}$ (B) $\frac{vB^2l^2}{R}$
(C) $\frac{vB^2l^2}{R}\left(1-e^{-t/RC}\right)$ (D) $\frac{vB^2l^2}{R}\left(1-e^{-2t/RC}\right)$

6. In a vernier calipers 9 divisions of it’s main scale match with 10 divisions on its vernier scale. Each division of the main scale is of 20 units. Least count of apparatus is:
(A) 1 unit (B) 2 units
(C) 3 units (D) 4 units

Space for Rough work

7. Two slits S_1 and S_2 lie on the x-axis and symmetric with respect to y-axis are illuminated by a parallel monochromatic light beam of wavelength λ as shown. The distance between slits is d (>> λ). Point O is the mid point of the line S_1S_2 and this point is considered as the origin. The slits are in horizontal plane. The interference pattern is observed on a horizontal plate (acting as screen) of mass m which is connected to one end of a vertical massless spring of spring constant k. The other end of the spring fixed to ground. At t = 0, the plate is at a distance D (>> d) below the plane of slits and spring is in its natural length. The plate is released from rest from its initial position. The rate by which fringe, width will increase when acceleration of plate is zero, is

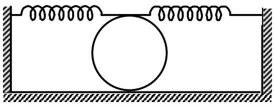


(A) $\frac{\lambda g}{d}\sqrt{\frac{m}{k}}$
(B) $\frac{\lambda g}{3d}\sqrt{\frac{m}{k}}$
(C) $\frac{\lambda g}{4d}\sqrt{\frac{m}{k}}$
(D) $\frac{\lambda g}{2d}\sqrt{\frac{m}{k}}$

8. A perfectly absorbing surface intercepts a parallel beam of monochromatic light of power 100W (λ = 500 nm) incident on it normally. If the force exerted by light beam on the surface is $\frac{10^{-6}}{n}$ N, then n =

(A) 1
(B) 2
(C) 3
(D) 4

9. A solid sphere of mass *M* is attached to two massless springs each of spring constant *k.* It can roll without slipping along a horizontal surface. If the system is released after a small stretch in spring, then the time period of oscillations will be :



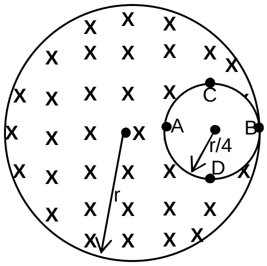
(A) $2\pi\sqrt{\frac{7M}{2k}}$
(B) $2\pi\sqrt{\frac{7M}{5k}}$
(C) $\pi\sqrt{\frac{7M}{10k}}$
(D) $2\pi\sqrt{\frac{M}{k}}$

Space for Rough work

10. A closed organ pipe of length L is vibrating in its first overtone. There is a point Q inside the pipe at a distance $7L/9$ from the open end. The ratio of pressure amplitude at Q to the maximum pressure amplitude in the pipe is

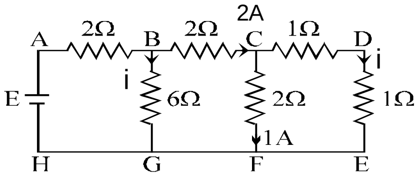
(A) 1 : 2	(B) 2 : 1
(C) 1 : 1	(D) 2 : 3

11. Consider a spherical charge distribution of volume charge density ρ c /m^3 Potential difference between A & B



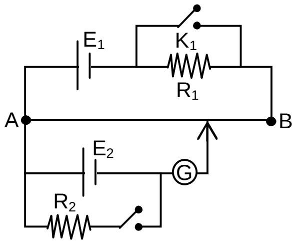
(A) $\dfrac{2\rho}{3\varepsilon_0} r^2$	(B) 0
(C) $\dfrac{\rho}{4\varepsilon_0} r^2$	(D) $\dfrac{\rho r^2}{8\varepsilon_0}$

12. The figure shows a network of resistors and a battery. If 1A current flows through the branch CF, then the emf E of the battery is



(A) 24 V	(B) 12 V
(C) 18V	(D) 6V

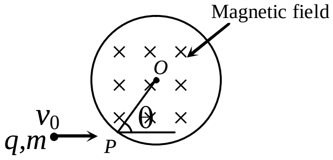
13. Figure shows the circuit of a potentiometer. The length of the potentiometer wire AB is 50 cm. The e.m.f. of the battery is 4 volt, having negligible internal resistance. Values of resistances R_1 and R_2 are 15 ohm and 5 ohm respectively. When both the keys are open, the null point is obtained at distance of 31.25 cm from end A but when both the keys are closed, the balance length reduces to 5 cm only. Given $R_{AB} = 10\ \Omega$. The e.m.f. of the cell E_2 is



(A) 1 volt	(B) 2 volt
(C) 3 volt	(D) 4 volt

Space for Rough work

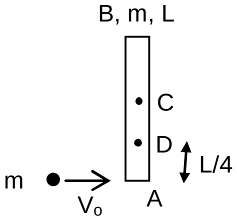
14. A particle charge q and mass m is projected with a velocity v_0 towards a circular region having uniform magnetic field B perpendicular and into the plane of paper from point P as shown in the figure. R is the radius and O is the centre of the circular region. If the line OP makes an angle θ with the direction of v_0 then the value of v_0 so that particle passes through O is



(A) $\frac{qBR}{m\sin\theta}$ (B) $\frac{qBR}{2m\sin\theta}$

(C) $\frac{2qBR}{m\sin\theta}$ (D) $\frac{3qBR}{2m\sin\theta}$

15. A thin, uniform rod of mass M and length L is at rest on a smooth horizontal surface. A particle of same mass M collides with the rod at one end perpendicular to its length with velocity V_o and sticks to it. C is the middle point of the rod and D is a point at a distance of L/4 from end A. The time taken by the rod to turn through 90^o after collision is



(A) $\frac{L}{V_o}$ (B) $\frac{\pi L}{V_o}$

(C) $\frac{3\pi L}{5V_o}$ (D) $\frac{5\pi L}{12V_o}$

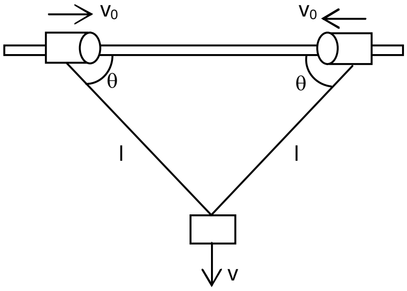
16. Velocity time equation of a particle moving in a straight line is $V = t^2 - 5t + 6$. The distance travelled by the particle in the time interval from t = 0 to t = 4 sec

(A) 0 (B) $\frac{17}{3}$

(C) 6 (D) $\frac{16}{3}$

Space for Rough work

17. In the shown figure two identical beads slide along a smooth horizontal rod as shown in figure. The relation between v and v_0 in the shown position will be



(A) $v = v_0 \cot\theta$
(B) $v = v_0 \sin\theta$
(C) $v = v_0 \tan\theta$
(D) $v = v_0 \cos\theta$

18. Water is flowing streamline motion through a horizontal tube. The pressure at a point in the tube is p where the velocity of flow is v. At another point, where the pressure is p/2, the velocity of flow is (density of water $= \rho$) :

(A) $\sqrt{v^2 + \frac{p}{\rho}}$
(B) $\sqrt{v^2 - \frac{p}{\rho}}$
(C) $\sqrt{v^2 + \frac{2p}{\rho}}$
(D) $\sqrt{v^2 - \frac{2p}{\rho}}$

19. A rod collides elastically with smooth horizontal surface after falling from a height. For maximum angular speed of the rod just after impact, the rod should be released in such a way that it makes an angle α with horizontal, the value of α will be

(A) 0°
(B) $\cos^{-1}\frac{1}{\sqrt{2}}$
(C) $\cos^{-1}\frac{1}{\sqrt{3}}$
(D) $\cos^{-1}\frac{1}{\sqrt{6}}$

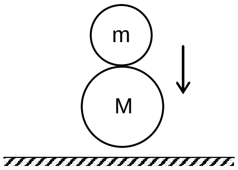
Space for Rough work

20. Three particles A, B and C are situated at the vertices of an equilateral triangle ABC of side d at t = 0, each of the particles moves with constant speed u. A always has its velocity along AB, B along BC and C along CA. Angular velocity of the line AB, at the time t, $\left(0 < t < \frac{2d}{3u}\right)$

(A) $\frac{u}{2d - 3ut}$ (B) $\frac{u\sqrt{3}}{2d - 3ut}$

(C) $\frac{2u}{d\sqrt{3} - 3\sqrt{3}\,ut}$ (D) none of these

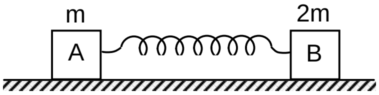
21. A small ball of mass m is placed on top of the "super ball" of mass M and the two ball are dropped to the floor from height h. Height rise of small ball after the collision is Nh, then 'N' is: (Assume that the collision with the superball are elastic, and the m << M)



(A) 8 (B) 9

(C) 10 (D) 11

22. In the figure shown, the spring is compressed by x_0 = 4 cm and released. Two locks A and B of masses m and 2 m respectively, are attached at the ends of the spring of force constant 4 N/m. Blocks are kept on a frictionless horizontal surface and released. The work done by the spring (in mJ) on A by the time compression of the spring is reduced to $\frac{x_0}{4}$ is:

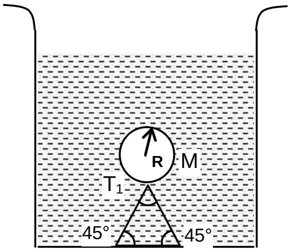


(A) 1 (B) 1.5

(C) 2 (D) 3

Space for Rough work

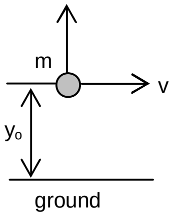
23. A hollow sphere of mass M and radius r is immersed in a tank of water (density ρ_w). The sphere would float if it were set free. The sphere is tied to the bottom of tank by two wires which makes angle 45° with the horizontal as shown in figure. The tension T_1 in the wire is



(A) $\dfrac{\frac{4}{3}\pi R^3\rho_w g - Mg}{\sqrt{2}}$ (B) $\frac{2}{3}\pi R^3\rho_w g - Mg$

(C) $\dfrac{\frac{4}{3}\pi R^3\rho_w g + Mg}{\sqrt{2}}$ (D) $\frac{4}{3}\pi R^3\rho_w g + Mg$

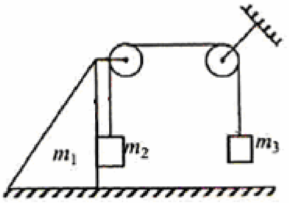
24. A particle of mass m is moving with a velocity of $v = \sqrt{\frac{k}{m}}$ in the horizontal direction at a height y_0 from the ground (y_0 = k/2mg). A variable force F = k/y acts on the particle at t = 0 in the vertical direction where y is the height of the particle from the ground. Find the speed of the particle when its acceleration become zero for the very first time. (k is a constant (N-m)



(A) $2\sqrt{\frac{k\,\ell n3}{m}}$ (B) $\sqrt{\frac{2k\,\ell n2}{m}}$

(C) $\sqrt{\frac{2k\,\ell n3}{m}}$ (D) $2\sqrt{\frac{k\,\ell n2}{m}}$

25. In the following figure both the pulleys and the string are massless and all the surfaces are frictionless.
Given: m_1 = 1 kg, m_2 = 2 kg, m_3 = 3 kg. The acceleration of m_1 is



(A) $\frac{40}{7}$ m / s^2 (B) $\frac{30}{7}$ m / s^2

(C) $\frac{20}{7}$ m / s^2 (D) None of these

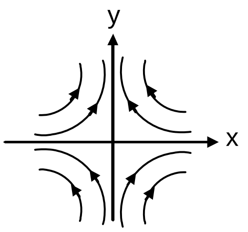
Space for Rough work

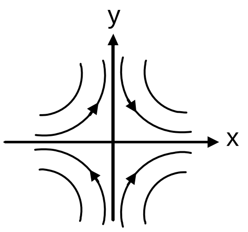
26. Potential energy of a particle moving along x-axis is given by U = $\frac{x^3}{3}-\frac{9x^2}{2}+20x$. Find out position of stable equilibrium state.
(A) 3 (B) 5
(C) 6 (D) 7

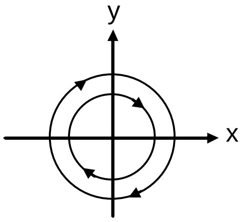
27. A conductor in the form of a right angle ABC with AB = 3 cm and BC = 4 cm carries a current of 10 A. There is a uniform magnetic field of 5 T perpendicular to the plane of the conductor. The force on the conductor will be
(A) 1.5 N (B) 2.0 N
(C) 2.5 N (D) 3.5 N

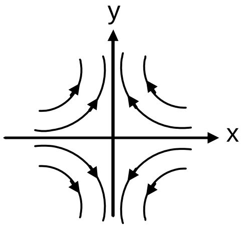
28. Curie temperature is the temperature above which:
(A) a ferromagnetic material becomes paramagnetic.
(B) a paramagnetic material becomes diamagnetic.
(C) a ferromagnetic material becomes diamagnetic.
(D) a paramagnetic material becomes ferromagnetic.

29. Potential is varying with x and y as V = $2\left(x^2-y^2\right)$. The corresponding field pattern is:

(A)


(B)


(C)


(D)


30. A tunnel is dug along diameter inside the surface of earth and a particle is projected from the centre of tunnel. The minimum velocity of particle such that it escape out from the earth's gravitation field is (Radius of earth = R_e)

(A) $\sqrt{2gR_e}$ (B) $\sqrt{\frac{3}{2}gR_e}$

(C) $\sqrt{3gR_e}$ (D) $\sqrt{\frac{5}{2}gR_e}$

Chemistry PART – II

SECTION – A

(One Option Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE** option is correct.

1.
$$\begin{tikzcd}
KO_2 + S \arrow[r, "\Delta"] & (P) \arrow[r, "BaCl_2"] & (Q)\downarrow(\text{White ppt.}) \arrow[dl, "\text{Carbon}", "\Delta"'] \\
\underset{\text{gas}}{(S)}\uparrow & (R) \arrow[l, "HCl"'] &
\end{tikzcd}$$

The unknown compounds P, Q, R and S in the above reaction sequence are respectively

(A) K_2SO_3, $BaSO_3$, BaS, H_2S (B) K_2S, BaS, CS_2, H_2S

(C) K_2SO_4, $BaSO_4$, BaS, H_2S (D) K_2SO_4, $BaSO_4$, $BaCO_3$, CO_2

2.
$$\begin{tikzcd}
 & \boxed{\text{Borax}} \arrow[r, "HCl"] & (A) + NaCl \arrow[dl, "H_2O"] & & \\
(C) \arrow[d, "Mg"] & (B) \arrow[l, "\Delta"'] & & & \\
\text{Boron} + (D) \arrow[r, "HNO_3"] & (E) \arrow[r, "\Delta"] & (D) + (F)\uparrow + O_2 & &
\end{tikzcd}$$

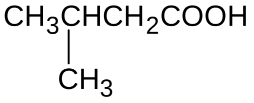
Which of the above unknown compound forms an alkaline solution when reacts with water?

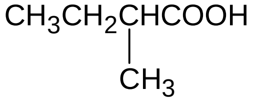
(A) C (B) D

(C) E (D) B

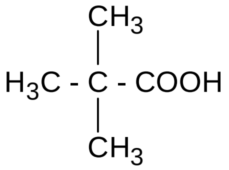
Space for Rough work

3. Which of the following compound is most acidic in nature?

(A) 
$CH_3CH(CH_3)CH_2COOH$

(B) 
$CH_3CH_2CH(CH_3)COOH$

(C) $CH_3CH_2CH_2CH_2COOH$

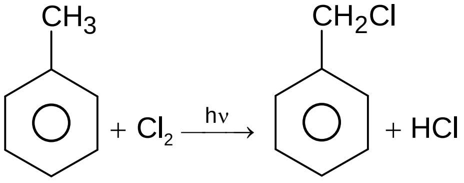
(D) 
$H_3C-C(CH_3)_2-COOH$

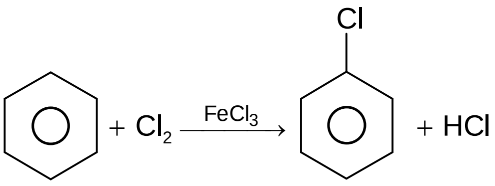
4. Which of the following reaction produces nascent hydrogen?
(A) Passing of steam on red hot coke
(B) Passing of steam on red hot iron
(C) Hydrolysis of ionic hydrides
(D) Reaction of sodium with ethanol

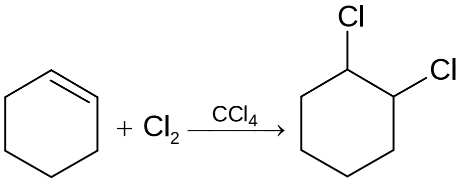
5. The smog is essentially caused by the presence of
(A) O_2 and O_3
(B) O_2 and N_2
(C) SO_2 and NO_2
(D) O_3 and N_2

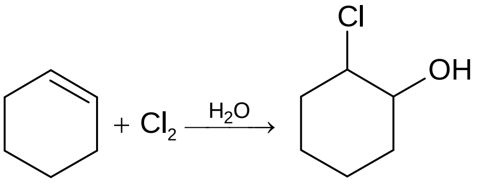
6. Which of the following carbonate needs maximum temperature for decomposition?
(A) Li_2CO_3
(B) Na_2CO_3
(C) $MgCO_3$
(D) $CaCO_3$

7. Which of the following is an electrophilic substitution reaction?

(A) 

(B) 

(C) 

(D) 

Space for Rough work

8. The process of 'eutrophication' is due to
(A) increase in concentration of insecticide in water
(B) increase in concentration of fluoride ion in water
(C) the reduction in concentration of the dissolved oxygen in water due to phosphate in water
(D) attack of younger leaves of a plant by peroxyacetyl nitrate

9. Which of the following is the most abundant hydrocarbon pollutant?
(A) CH_4 (B) C_2H_6
(C) C_3H_8 (D) C_4H_{10}

10. In aqueous solution beryllium sulphate exists as:
(A) $[Be(H_2O)_4]SO_4$ (B) $[Be(H_2O)_6]SO_4$
(C) $[Be(H_2O)_3]SO_4$ (D) $[Be(H_2O)_5]SO_4$

11. Which of the following liquid has the highest boiling point?
(A) H_2O (B) H_2O_2
(C) HCl (D) NH_3

12. Which of the following ion does not cause hardness of water?
(A) Ca^{2+} (B) Mg^{2+}
(C) NO_3^- (D) HCO_3^-

13. The normal boiling point of a liquid 'X' is 500 K. Which of the following statement(s) is/are incorrect for the following process?
$X(\text{liquid}) \longrightarrow X(\text{gas})$
(A) At 500 K and 1 atm pressure, $\Delta G = 0$
(B) At 500 K and 1.5 atm pressure, $\Delta G = +ve$
(C) At 500 K and 0.2 atm pressure, $\Delta G = -ve$
(D) At 520 K and 1 atm pressure, $\Delta G = +ve$

Space for Rough work

14. Which of the following complex(es) does not show(s) geometrical isomerism?
(A) $[Cr(H_2O)_5Cl]Cl_2.H_2O$ (B) $[Pt(NH_2CH_2COO)_2]$
(C) $[PtCl_2P(C_2H_5)_3]_2$ (D) $K_2[Fe(CN)_4(NH_3)_2]$

15. Find ΔH at 358 K for the reaction,
$Fe_2O_3(s) + 3H_2(g) \longrightarrow 2Fe(s) + 3H_2O(\ell)$
Given that, $\Delta H_{298} = -33.29\ kJ/mole$ and C_p for $Fe_2O_3(s)$, Fe(s), $H_2O(\ell)$ and $H_2(g)$ are 103.8, 25.1, 75.3 and 28.8 J/K mole.
(A) 85.9 kJ/mole (B) –28.136 kJ/mole
(C) +28.136 kJ/mole (D) 85.9 J/mole

16. Heat of neutralization of four monobasic acids A, B, C and D are -13.7, - 9.4, - 11.2 and – 12.4 Kcal / mole respectively, when they are neutralized by a common base. The acidic character obeys the order
(A) A > B > C > D (B) A > D > C > B
(C) D > C > B > A (D) D > B > C > A

17. The amount of NaOH required to be dissolved in one litre of solution to give a pH of 11 at 25°C
(A)0.04 g/l (B) 0.4 g/l
(C) 0.01 g/l (D) 0.53 g/l

18. The number of α and β particles emitted in nuclear reaction ${}_{90}Th^{228} \longrightarrow {}_{83}Bi^{212}$ are respectively
(A) 4,1 (B) 3,7
(C) 8,1 (D) 4,7

19. A weak acid HX has the dissociation constant 1×10^{-5} M. It forms a salt NaX on reaction with alkali. The percentage hydrolysis of 0.1 M solution of NaX is
(A) 0.0001% (B) 0.01%
(C) 0.1% (D) 0.15%

Space for Rough work

20. What is the molar solubility of $Mn(OH)_2$($K_{sp} = 4.5\times10^{-14}$) in a buffer solution containing equal amounts of NH_4^+ & NH_3($K_b=1.8\times10^{-5}$)

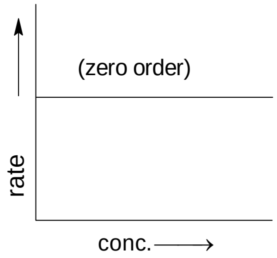
(A) 3.0×10^{-5}
(B) 1.38×10^{-4}
(C) 1.38×10^{-2}
(D) 7.3×10^{-6}

21. For the reaction,
$C_7H_8(l) + 9O_2(g) \rightarrow 7CO_2(g) + 4H_2O(l)$, calculated heat of reaction is 232.6 kJ/mol and observed heat of reaction is 50.4 kJ/mol, then the resonance energy is

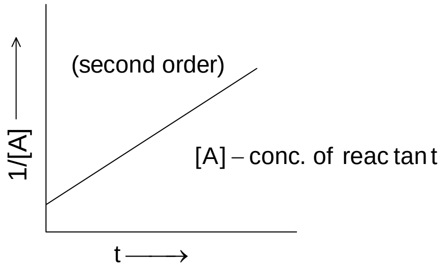
(A) – 182.2 kJ / mol
(B) + 182.2 kJ / mol
(C) 172 kJ/ mol
(D) None of these

22. Select the incorrect graph

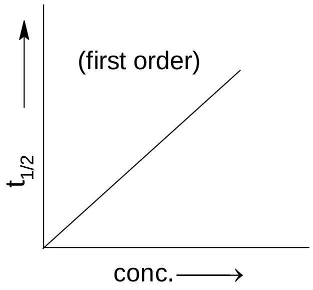
(A)



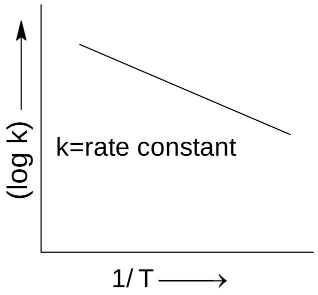
(B)



(C)



(D)



Space for Rough work

23. The following two equilibria exist simultaneously in a closed container of volume 2 L

$$A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$$
$$A_2(g) + C(g) \rightleftharpoons A_2C(g)$$

Which of the following change does not affect the concentration of AB(g)

(A) Increase in pressure
(B) Addition of C
(C) Addition of He gas at constant volume
(D) All of these

24. An acid-base indicator has $K_a = 3 \times 10^{-5}$. The acid form of the indicator is red and the basic form of the indicator is blue. By how much must the pH change in order to change the indicator from 75% red to 75% blue? [log 3 = 0.4770]

(A) 4.05
(B) 0.95
(C) 5
(D) 9

25. For an elementary reaction

$aA + bB \xrightarrow{\quad} P$; $\frac{dx}{dt} = k[A]^a . [B]^b$. If concentration of A is doubled, rate is doubled. If B is doubled, rate becomes four times. Which is correct?

(A) $\frac{-d[A]}{dt} = \frac{-d[B]}{dt}$
(B) $\frac{-d[A]}{dt} = \frac{-2d[B]}{dt}$
(C) $\frac{-2d[A]}{dt} = \frac{-d[B]}{dt}$
(D) none of these

26. In borax bead test, which compound is formed?

(A) Meta borate
(B) Ortho borate
(C) Tetra borate
(D) Double oxide

Space for Rough work

27. A + $C_2H_5OH \xrightarrow{H_2SO_4} (B)$, B on ignition gives green colour. A could be

(A) salt of sodium
(B) salt of iron
(C) salt of boric acid
(D) salt of meta phosphoric acid

28. AlF_3 is most soluble in

(A) HF
(B) KF
(C) KHF_2
(D) F_2

29. Solubility of $PbCl_2$ in 0.5 M NaCl is S_1 and that in 0.5 M $Pb(NO_3)_2$ is S_2 then which of the following is correct

(A) $\frac{S_1}{S_2^2} = 1$
(B) $S_1 - S_2^2 > 0$
(C) $S_1 - S_2^2 < 0$
(D) $\frac{S_1}{S_2} < 0$

30. Which silicate is formed from $[SiO_4]^{4-}$ tetrahedral units by sharing three oxygen atoms?

(A) Sheet silicate
(B) Pyro silicate
(C) Linear chain silicate
(D) 3-Dimensional silicate

Space for Rough work

Mathematics PART – III

SECTION – A

(One Option Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE** option is correct.

1. Circles of radii 5, 5 and 8 are mutually externally tangent. If a fourth circle of radius r touches all the three circles externally, then the value of r is

(A) 1 (B) $\frac{7}{8}$

(C) $\frac{8}{9}$ (D) $\frac{9}{11}$

2. If α, β are the roots the quadratic equation $x^2 - \left(3 + 2^{\sqrt{\log_2 3}} - 3^{\sqrt{\log_3 2}}\right)x - 2\left(3^{\log_3 2} - 2^{\log_2 3}\right) = 0,$ then the value of $\alpha^2 + \alpha\beta + \beta^2$ is equal to

(A) 11 (B) 7

(C) 3 (D) 5

3. If $f(x) = \int_0^x \left(e^t + 3\right)dt,$ then which of the following is always true $\forall x \in R$?

(A) $f(x-3) - f(x-1) \le 11$ (B) $f(x+1) - f(x-1) < 4$

(C) $f(x+3) - f(x-5) > 24$ (D) $f(x) + f(x+1) < -21$

4. If e_1 and e_2 are the roots of the equation $x^2 - ax + 2 = 0,$ where e_1 and e_2 are the eccentricities of an ellipse and hyperbola, respectively, then the value of a belongs to

(A) $(3, \infty)$ (B) $(2, \infty)$

(C) $(1, \infty)$ (D) $(-\infty, 1) \cup (1, 2)$

Space for Rough work

5. If $\theta_1 = \sin^{-1}\frac{4}{5} + \sin^{-1}\frac{1}{3}$ and $\theta_2 = \cos^{-1}\frac{4}{5} + \cos^{-1}\frac{1}{3}$, then

(A) $\theta_1 < \theta_2$ (B) $\theta_1 > \theta_2$

(C) $\theta_1 = \theta_2$ (D) None of these

6. $lx + my = 1$ is the equation of the chord PQ of $y^2 = 4x$ whose focus is S. If PS and QS meet the parabola again at R and T, respectively, then the slope of RT is

(A) $-\frac{1}{m}$ (B) $\frac{1}{m}$

(C) $\frac{2}{m}$ (D) None of these

7. Let ABC be an equilateral triangle, let KLMN be a rectangle with K, L on BC, M on AC and N on AB. Suppose AN/NB=2 and the area of triangle BKN is 6. The area of the triangle ABC is

(A) 54 (B) 108

(C) 48 (D) not determinable with the above data

8. The number of solutions in isosceles triangle ABC, $\tan A + \tan B + \tan C = \lambda, \lambda < 0$, is

(A) 0 (B) infinite

(C) 1 (D) 2

9. $\int_0^{\pi/2} \sin x \sin 2x \sin 3x \sin 4x \, dx =$

(A) $\frac{\pi}{4}$ (B) $\frac{\pi}{8}$

(C) $\frac{\pi}{16}$ (D) $\frac{\pi}{32}$

Space for Rough work

10. If $\sqrt{x+y}+\sqrt{y-x}=c$ then $\frac{d^2y}{dx^2}$ equals

(A) $\frac{2}{c^2}$ (B) $\frac{-2}{c^2}$

(C) $\frac{2}{c}$ (D) $\frac{-2}{c}$

11. If the curves $x^2-y^2=4$ and $xy=\sqrt{5}$ intersect at points A and B, then the possible number of point(s) C on the curve $x^2-y^2=4$ such that triangle ABC is equilateral is

(A) 0 (B) 1

(C) 2 (D) 4

12. If $A+B+C=\pi$ and $\sin\left(A+\frac{C}{2}\right)=k\sin\frac{C}{2}$, then $\tan\frac{A}{2}\tan\frac{B}{2}$ is equal to

(A) $\frac{k-1}{k+1}$ (B) $\frac{k+1}{k-1}$

(C) $\frac{k}{k+1}$ (D) 1

13. The number of rectangles that can be obtained by joining four of the twelve vertices of a 12 – sided regular polygon is

(A) 66 (B) 30

(C) 24 (D) 15

14. If $z^2+(p+iq)z+r+is=0$ where p, q, r, s are non – zero, has real roots, then

(A) $pqs=s^2+q^2r$ (B) $pqr=r^2+p^2s$

(C) $prs=q^2+r^2p$ (D) $prs=p^2+s^2q$

Space for Rough work

15. Let $a > 1$ be a real number and $f(x) = \log_a x^2$ for $x > 0$. If f^{-1} is the inverse function of f and b and c are real numbers then $f^{-1}(b+c)$ is equal to

(A) $f^{-1}(b).f^{-1}(c)$
(B) $f^{-1}(b)+f^{-1}(c)$
(C) $\frac{1}{f(b+c)}$
(D) $\frac{1}{f^{-1}(b)+f^{-1}(c)}$

16. The number of points at which $g(x) = \frac{1}{1+\frac{2}{f(x)}}$ is not differentiable, where $f(x) = \frac{1}{1+\frac{1}{x}}$ is

(A) 1
(B) 2
(C) 3
(D) 4

17. Cosine of the acute angle between the curves $y = 3^{x-1}\ln x$ and $y = x^x - 1$ is

(A) 0
(B) 1
(C) $\frac{\sqrt{3}}{2}$
(D) $\frac{1}{2}$

18. If $A_1, A_3, ...A_{2n-1}$ are n skew symmetric matrices of same order then

$B = \sum_{r=1}^{n}(2r-1)(A_{2r-1})^{2r-1}$ will be

(A) symmetric
(B) skew symmetric
(C) neither symmetric nor skew symmetric
(D) data is inadequate

19. A class has three teacher. Mr. X. Ms. Y and Mrs. Z and six students A, B, C, D, E, F. Number of ways in which they can be seated in a line of 9 chairs, if between any two teachers there are exactly two students, is

(A) 18.6!
(B) 12.6!
(C) 24.6!
(D) 6.6!

Space for Rough work

20. If $x=\frac{1}{1^2}+\frac{1}{3^2}+\frac{1}{5^2}+........y=\frac{1}{1^2}+\frac{3}{2^2}+\frac{1}{3^2}+\frac{3}{4^2}......$ and $z=\frac{1}{1^2}-\frac{1}{2^2}+\frac{1}{3^2}-\frac{1}{4^2}+......$, then

(A) x, y, z are in A.P.

(B) $\frac{y}{6},\frac{x}{3},\frac{z}{1}$ are in A.P.

(C) $\frac{y}{6},\frac{x}{3},\frac{z}{2}$ are in A.P.

(D) $6y, 3x, 2z$ are in H.P.

21. In the xy – plane, the length of the shortest path from (0, 0) to (12, 16) that does not go inside the circle $(x-6)^2+(y-8)^2=25$ is

(A) $10\sqrt{3}$

(B) $10\sqrt{5}$

(C) $10\sqrt{3}+\frac{5\pi}{3}$

(D) $10+5\pi$

22. Suppose $y=f(x)$ and $y=g(x)$ are two functions whose graphs intersect at the three points (0, 4), (2, 2) and (4, 0) with $f(x)>g(x)$ for $0<x<2$ and $f(x)<g(x)$ for $2<x<4$. If $\int_0^4\left[f(x)-g(x)\right]dx=10$ and $\int_2^4\left[g(x)-f(x)\right]dx=5$, the area between two curves for $0<x<2$, is

(A) 5

(B) 10

(C) 15

(D) 20

23. If A is square matrix of order 2×2 such that $A^2=I; B=\begin{bmatrix}1 & \sqrt{2}\\ 0 & 1\end{bmatrix}$ and $C=ABA$, then $(C)^{2009}=$

(A) $A\begin{bmatrix}1 & 2009\sqrt{2}\\ 0 & 1\end{bmatrix}$

(B) $A\begin{bmatrix}1 & 2009+\sqrt{2}\\ 0 & 1\end{bmatrix}A$

(C) $A\begin{bmatrix}1 & \sqrt{2}\\ 0 & 2009\end{bmatrix}A$

(D) $A\begin{bmatrix}1 & 2009\sqrt{2}\\ 0 & 1\end{bmatrix}A$

Space for Rough work

24. $\lim\limits_{x\to\infty} x^2 \sin\left(\log_e \sqrt{\cos\frac{\pi}{x}}\right) =$

(A) 0 (B) $-\frac{\pi^2}{2}$

(C) $-\frac{\pi^2}{4}$ (D) $\frac{\pi^2}{8}$

25. Let $I_1 = \int_0^\infty \frac{x^2\sqrt{x}}{(1+x)^6}dx, I_2 = \int_0^\infty \frac{x\sqrt{x}}{(1+x)^6}dx,$ then

(A) $I_1 = 2I_2$ (B) $I_2 = 2I_1$

(C) $I_1 = I_2^2$ (D) $I_1 = I_2$

26. Let AB be the chord of contact of the point (5, –5) w.r.t. the circle $x^2 + y^2 = 5$. Then the locus of the orthocenter of the $\Delta PAB,$ where P be any point moving on the circle, is

(A) $(x-1)^2 + (y+1)^2 = 5$ (B) $(x-1)^2 + (y+1)^2 = \frac{5}{2}$

(C) $(x+1)^2 + (y-1)^2 = 5$ (D) $(x+1)^2 + (y-1)^2 = \frac{5}{2}$

27. In the interval $\left[0, \frac{\pi}{2}\right]$, the equation $\cos^2 x - \cos x - x = 0$ has

(A) no solution (B) exactly one solution

(C) exactly two solutions (D) more than two solutions

Space for Rough work

28. If $\tan\left(\sum_{r=1}^{n}\tan^{-1}\left(\frac{2r-1}{\left(r^2+r+1\right)\left(r^2-r+1\right)-2r^3}\right)\right)=961$ then the value of n is equal to

(A) 31 (B) 30
(C) 60 (D) 61

29. Two tour guides are leading seven tourists. The guides decide to split up. Each tourist must choose one of the guides, but with the condition that each guide must take at least one tourist. Number of different groupings of guides and tourists are

(A) 120 (B) 124
(C) 126 (D) 127

30. If $P(F)=\frac{1}{2}$, $P(G)=\frac{4}{5}$, $P(E\cap F\cap G)=\frac{3}{10}$ and $P(E'\cap F\cap G)=\frac{1}{10}$, the value of $P\left(\frac{F}{G}\right)$ is

(A) $\frac{3}{125}$ (B) $\frac{1}{2}$
(C) $\frac{2}{5}$ (D) $\frac{1}{3}$

Space for Rough work

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

ALL INDIA TEST SERIES

FIITJEE **JEE(Main)-2017**

ANSWERS, HINTS & SOLUTIONS

CONCEPT RECAPITULATION TEST – II
(Main)

S. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	C	C
2.	C	B	B
3.	C	C	C
4.	A	D	A
5.	A	C	A
6.	B	B	A
7.	A	B	B
8.	C	C	B
9.	C	A	C
10.	A	A	A
11.	D	B	A
12.	B	C	D
13.	A	D	D
14.	B	A	A
15.	D	B	A
16.	B	B	C
17.	A	A	B
18.	A	A	B
19.	C	B	A
20.	B	B	B
21.	B	A	C
22.	C	C	C
23.	A	C	D
24.	B	B	C
25.	A	C	D
26.	B	A	A
27.	C	C	B
28.	A	B	A
29.	D	B	C
30.	C	A	B

Physics

PART – I

SECTION – A

1. A

Sol. Q – value = Binding energy of reactants – Binding energy of products.

2. C

Sol. $\Delta E = \frac{hc}{\lambda}$ = 59 keV

3. C

Sol. v = 2 cm, u = 3 cm

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \Rightarrow f = \frac{6}{5}\text{cm}$

4. A

Sol. $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

On solving,

$\frac{1}{f_1} = \frac{-1}{40}, \frac{1}{f_2} = \frac{1}{60}$

For combination & silvering,

$-\frac{1}{F} = \frac{2}{f_1} + \frac{2}{f_2} - \frac{1}{f_m}$

F = 60 cm

$\frac{1}{v} + \frac{1}{u} = \frac{1}{F}$

On solving with u = –40 cm, F = 60 cm we get V = 24 cm

$v_Z = -\frac{v^2}{u^2}V_o = 1.8\hat{i}$

5. A

Sol. Induced emf in the rod $\varepsilon = Blv$

Current in the circuit $I = \frac{\varepsilon}{R}e^{-t/RC} = \frac{Blv}{R}e^{-t/RC}$

Since the net force on the rod should be zero, the external force will be equal in magnitude but opposite to the magnetic force.

$\Rightarrow \quad F = I\,l\,B = \frac{B^2l^2v}{R}e^{-t/RC}$

6. B

Sol. Least count = Main scale / (number of division on the vernier scale) .

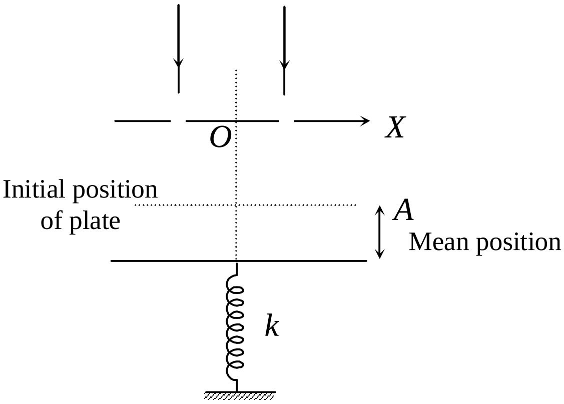
7. A

Sol. $\beta = \frac{(D+y)\lambda}{d}$

$\frac{d\beta}{dt} = \frac{\lambda}{d}\frac{dy}{dt} = \frac{\lambda}{d}v$

At mean position $v = A\omega = \frac{mg}{k}\sqrt{\frac{k}{m}} = g\sqrt{\frac{m}{k}}$

$\frac{d\beta}{dt} = \frac{\lambda g}{d}\sqrt{\frac{m}{k}}$



8. C

Sol. $F = \frac{dP}{dt}$ = rate of change of momentum of the photons. Thus, in case of complete absorption, F = Intensity of the wave / speed of light.

9. C

Sol. $\frac{1}{2}2k(2R\theta)^2 + \frac{1}{2}I\omega^2 = \text{constant}$

$4kR^2\theta^2 + \frac{7}{10}MR^2\omega^2 = \text{constant}$

$4kR^2 2\theta\frac{d\theta}{dt} + \frac{7}{10}MR^2 2\omega\frac{d\omega}{dt} = 0 \quad \Rightarrow \quad T = \pi\sqrt{\frac{7M}{10k}}$

10. A

Sol. $\Delta Pm = 2\Delta P_0 \cos kx$ (assuming closed end as origin)

At point Q, $x = L - \frac{7L}{9} = \frac{2L}{9}$

$\Delta Pm = 2\Delta P_0 \cos\left(\frac{2\pi}{\lambda} \times \frac{2L}{9}\right) = \Delta P_0$

$\therefore$ Required ratio = 1 : 2

11. D

Sol. $E = \frac{\rho}{4\varepsilon_o}r$

$V_{AB} = E \times \frac{r}{2}$

12. B

Sol. $\frac{E}{4} = 3$

$\Rightarrow$ E = 12

13. A

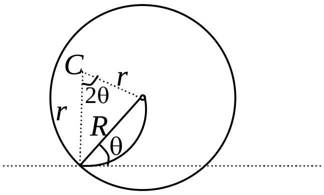
Sol. $E_2 = \frac{E_1}{R_1 + R_{AB}} \times \frac{31.25 \times 10}{50}$

14. B

Sol. $r = \frac{R}{2\sin\theta}$

$\frac{mv_0}{qB} = \frac{R}{2\sin\theta}$

$v_0 = \frac{qBR}{2m\sin\theta}$

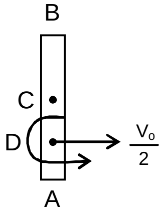


15. D

Sol. By COAM about point D (ie about new centre of mass)

$MV_o\frac{L}{4} = \left[\frac{ML^2}{12} + \frac{ML^2}{16} + \frac{ML^2}{16}\right]\omega$

or, w = $\frac{6v_o}{5L}$



Now, t = $\frac{\theta}{w} = \frac{(\pi/2)}{w} = \frac{5\pi L}{12v_o}$

16. B

Sol. distance = $\int_0^4 |t^2 - 5t + 6|\,dt$

17. A

Sol. $V_o\cos\theta = V\sin\theta$

18. A

Sol. By Bernoulli's theorem: $P + \frac{1}{2}\rho v^2 = \frac{P}{2} + \frac{1}{2}\rho v_1^2 \;\Rightarrow\; v_1 = \sqrt{v^2 + \frac{p}{\rho}}$

19. C

Sol. Apply conservation of angular momentum about the point of contact.

20. B

Sol. Rate of decrease of length AB = $\frac{3u}{2}$.

$\therefore \quad AB = d - \frac{3u}{2}t$

Angular velocity = $\frac{v_{tangential}}{AB}$

21. B

Sol. If initial velocities are: $u_1 = \sqrt{2gh}(\downarrow),\ u_2 = \sqrt{2gh}(\uparrow)$

Then final velocities: $v_1 = 3\sqrt{2gh},\ v_2 = \sqrt{2gh}$

By using conservation of momentum and equation of e & m << M.

22. C

Sol. Work done by spring = $U_i - U_f = 3J$

$mx_1 = 2mx_2$ ($\because$ position of COM does not change)

$x_1 = 2x_2$

$\therefore$ Work done by spring on m is $\frac{2}{3}$ of total work.

23. A

Sol. By equation of equilibrium,

$$2T \sin 45° + Mg = \frac{4}{3}\pi R^3 \rho_w g$$

24. B

Sol. Apply Newton's IInd law in y direction and use,

$a_y = \frac{v_y dv_y}{dy}$

25. A

Sol. Apply Newton's IInd law and constraint relations on the blocks.

26. B

Sol. For equilibrium positions:

$\frac{dU}{dx} = 0 \quad ; \quad x = 4, 5$

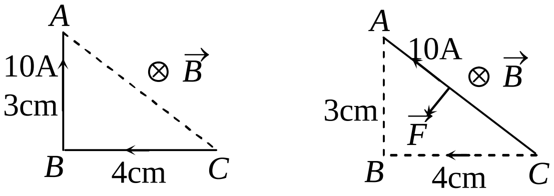
For, x = 5, $\frac{d^2U}{dx^2} = +ve$

27. C

Sol. Force on the conductor ABC

= Force on the conductor AC

= 5 × 10 × (5 × 10^{-2}) = 2.5 N


A
10A
3cm
$\otimes \vec{B}$
B
4cm
C
A
10A
$\otimes \vec{B}$
3cm
$\vec{F}$
B
4cm
C

28. A

Sol. Factual based

29. D

Sol. V = 2(x^2 – y^2)

Equipotential surfaces will be hyperbolic and $\vec{E}$ everywhere will be ⊥ to them.

30. C

Sol. Potential energy of particle at the centre of earth is $U = -\frac{3}{2}\frac{GMm}{R_e}$

$$\text{So}, V_e = \sqrt{\frac{3GM}{R_e}} = \sqrt{3gR_e}$$

Chemistry PART – II

SECTION – A

1. C

Sol. P = K_2SO_4, Q = $BaSO_4$, R = BaS, S = H_2S

2. B

Sol. A = $H_2B_4O_7$, B = H_3BO_3, C = B_2O_3, D = MgO
E = $Mg(NO_3)_2$, F = NO_2
$D(MgO) + H_2O \longrightarrow Mg(OH)_2$

3. C

Sol. The acid (C) is most acidic due to presence of least number of +I groups in it.

4. D

Sol. $C_2H_5OH + Na \longrightarrow C_2H_5ONa + H(\text{nascent hydrogen})$
$H + H \longrightarrow N_2$

5. C

Sol. London smog is caused by SO_2 and Los Angeles smog is caused by NO_2

6. B

Sol. Na_2CO_3 decomposes above 1100^oC

7. B

Sol. $Cl_2 + FeCl_3 \longrightarrow FeCl_4^- + Cl^+$
The electrophile Cl^+ substitutes a hydrogen atom from benzene.

8. C

Sol. Phosphates accelerate the growth of plants in water, which consume the dissolved oxygen

9. A

Sol. It is produced in marshy places unlike other hydrocarbons.

10. A

Sol. $Be \longrightarrow 1s^2 2s^2 2p^0$
$Be^{2+} \longrightarrow 2s^0 2p^0$ (Four vacant orbitals)
$\therefore$ Be^{2+} forms complex with four water molecules.

11. B

Sol. H_2O_2 forms more number of intermolecular hydrogen bond than water.

12. C

Sol. The ions that are responsible for hardness of water are Ca^{2+}, Mg^{2+}, HCO_3^-, Cl^- and SO_4^{2-}.

13. D

Sol. At normal boiling point (500 K), the following equilibrium exists between the two physical states at 1 atm.

$$X(\text{liquid}) \rightleftharpoons X(\text{gas})$$

For the equilibrium $\Delta G = 0$

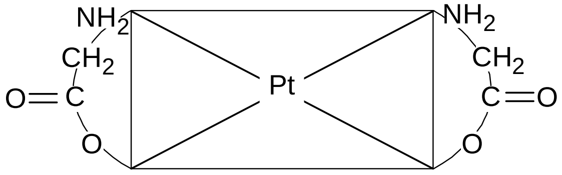
If the pressure increases the change shifts to backward direction for which ΔG = +ve.

If pressure decreases the change shifts towards forward direction, for which ΔG = -ve.

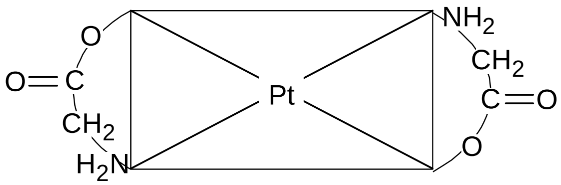
If temperature increase, the change will proceed towards forward direction, for which ΔG = -ve.

14. A

Sol. The geometrical isomers of (B) are

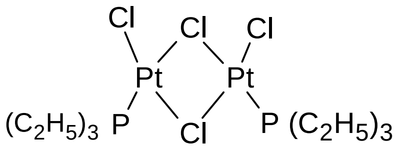

NH2
CH2
O=C
O
Pt
NH2
CH2
C=O
O

Cis

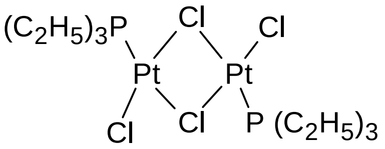

O
O=C
CH2
H2N
Pt
NH2
CH2
C=O
O

trans

The geometrical isomers of (C) are

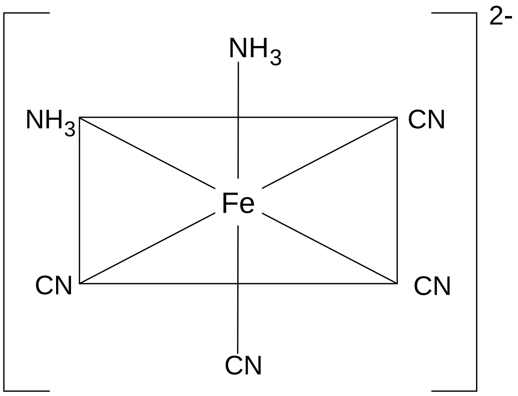

Cl
Cl
Cl
Pt
Pt
(C2H5)3 P
Cl
P (C2H5)3

Cis

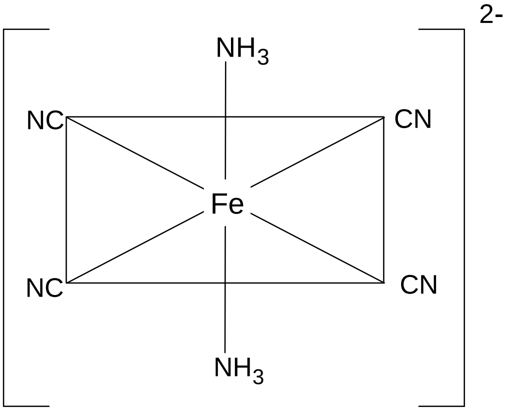

(C2H5)3P
Cl
Cl
Pt
Pt
Cl
Cl
P (C2H5)3

trans

The geometrical isomers of (D) are


2-
NH3
NH3
CN
Fe
CN
CN
CN

Cis


2-
NH3
NC
CN
Fe
NC
CN
NH3

trans

15. B

Sol. $\Delta C_p = 2 \times 25.1 + 3 \times 75.3 - (103.8 + 3 \times 28.8) = 85.9 \text{ J/mole}$

$$\frac{\Delta H_{358} - \Delta H_{298}}{T_2 - T_1} = \Delta C_p$$

$\Delta H_{358} = -28.136 \text{ kJ/mole}$

16. B

Sol. In case of weak acid heat of neutralization is greater than – 13.7 KCl / mole because extra energy is required to dissociate the acid

17. A

Sol. pH = 11 ⇔ pOH = 14–11 = 3, $[OH^-] = 10^{-3}$ M

$$10^{-3} = \frac{n_{NaOH}}{1} \Rightarrow \text{mass of NaOH} = 40\times10^{-3}\text{ gm} = 0.04\text{ gm}$$

18. A

Sol. ${}_{90}Th^{228} \longrightarrow {}_{83}Bi^{212}$ No. of α-particle = $\frac{228-212}{4} = 4$

No. of β-particle = 1

19. B

Sol. $NaX \longrightarrow Na^+ + X^-$

$$\begin{array}{lccccc} & X^- & + \; H_2O & \rightleftharpoons & HX & + \; OH^- \\ t=0 & 0.1.0 & \text{excess} & & 0 & 0 \\ t=\text{eq.} & 0.1(1-\alpha) & & & 0.1\alpha & 0.1\alpha \end{array}$$

$$K_h = \frac{[HX]\,[OH^-]}{[X^-]}$$

$$= \frac{[HX]}{[H^+]\,[X^-]} \times \frac{[H^+][OH^-]}{1}$$

$$= \frac{K_w}{K_a} = \frac{0.1\alpha\times0.1\alpha}{0.1(1-\alpha)} \simeq 0.1\,\alpha^2 \quad [1-\alpha \approx 1 \text{ as } 1 \gg \alpha \text{ for weak acid}]$$

$$\therefore \frac{10^{-14}}{10^{-5}} = 0.1\,\alpha^2$$

$\therefore \alpha = 1\times10^{-4}$

% hydrolysis = 0.01%

20. B

Sol. $$\text{pOH} = \text{pKb} + \log\frac{\left(NH_4^+\right)}{\left(NH_3\right)} = pK_b$$

$(OH^-) = 1.8\times10^{-5}$

$Ksp=[Mn^{2+}]\,[OH^-]^2$, $[Mn^{2+}] = 1.38\times10^{-4}$

21. A

Sol. (A) As we know that,

Resonance energy = ΔH° (observed) – ΔH° (calculated)

= (50.4 – 232.6) kJ / mol = – 182.2 kJ mol^{-1}

22. C

Sol. $t_{1/2}$ is independent of concentratin of reactant for 1st order reaction

23. C

Sol. Increases in pressure or addition of C affect the second equilibrium hence concentration of A_2 changes which further affect the first equilibrium. Addition of inert gas at constant volume does not affect the equilibrium

24. B

Sol. $\mathrm{HIn} \rightleftharpoons \mathrm{H}^+ + \mathrm{In}^-$

$$K_a = \frac{[H^+][In^-]}{[HIn]} = \frac{[H^+][\text{base}]}{[\text{Acid}]}$$

$$\text{or,}[H^+] = Ka\frac{[\text{Acid}]}{[\text{Base}]}$$

For 75% red, $[H^+] = \frac{Ka \times 75}{25} = \frac{3 \times 10^{-5} \times 75}{25} = 9 \times 10^{-5};\ pH = 4.05$

For 75% blue, $[H^+] = \frac{(3 \times 10^{-5}) \times 25}{75} = 1 \times 10^{-5};\ pH = 5$

The change in pH = 5-4.05 = 0.95

25. C

Sol. $\frac{r_1}{r_2} = \frac{K[A_1]^a[B_1]^b}{K[A_2]^a[B_2]^b}$ Apply

26. A

Sol. $Na_2B_4O_7.10H_2O \xrightarrow[-10H_2O]{\text{heat}} Na_2B_4O_7 \xrightarrow{740^o C} 2NaBO_2 + B_2O_3$

Sodium metaborate

$B_2O_3 + CuSO_4 \longrightarrow CuO.B_2O_3 + SO_3$

$\downarrow$

$Cu(BO_2)_2$ (blue)

Copper metaborate

27. C

Sol. $H_3BO_3 + 3C_2H_5OH \longrightarrow B(OC_2H_5) + 3H_2O$

(green colour)

28. B

Sol. $AlF_3 + 3KF \longrightarrow K_3[AlF_6]$

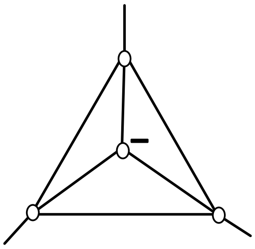
For this reaction, maximum concentration of F^- ions is obtained from KF.

29. B

Sol. $S_1 = \frac{K_{sp}}{0.25} S_2^2 = \frac{K_{sp}}{4 \times 0.5} = \frac{K_{sp}}{2}$

30. A

Sol.



Mathematics

PART – III

SECTION – A

1. C

Sol. From the figure, $12 = x + r + 8$

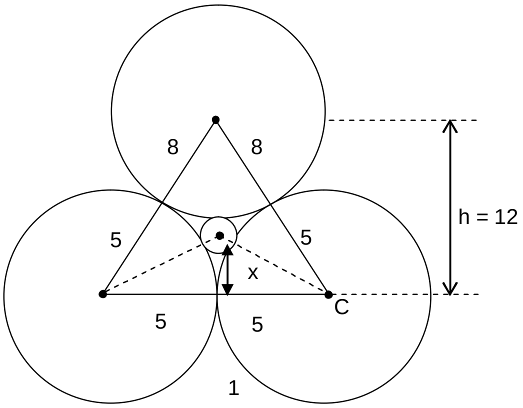
$\Rightarrow 12 = \sqrt{(r+5)^2 - 25} + r + 8$

$\Rightarrow 12 = \sqrt{r^2 + 10r} + r + 8$

$\Rightarrow (4-r)^2 = r^2 + 10r$

$\Rightarrow 18r = 16$

$\Rightarrow r = \dfrac{8}{9}$



2. B

Sol. $x^2\left(3 + 2^{\sqrt{\log_2 3}} - 3^{\sqrt{\log_3 2}}\right)x - 2\left(3^{\log_3 2} - 2^{\log_2 3}\right) = 0$

$\Rightarrow x^2 - 3(x) - 2(2-3) = 0$

$\Rightarrow x^2 - 3x + 2 = 0$

$\Rightarrow \alpha = 2, \beta = 1$

$\therefore \ \alpha^2 + \alpha\beta + \beta^2 = 4 + 2 + 1 = 7$

3. C

Sol. $f'(x) = e^x + 3$

$f'(x) > 3$

$\dfrac{f(x+3) - f(x-5)}{8} = f'(c) > 3$

$\Rightarrow f(x+3) - f(x-5) > 24$

4. A

Sol. We must have $e_1 < 1 < e_2$

$\Rightarrow f(1) < 0 \Rightarrow a > 3$

5. A

Sol. $\theta_1 + \theta_2 = \dfrac{\pi}{2} + \dfrac{\pi}{2} = \pi$

$\cos\theta_2 = \left(\dfrac{4}{5}\right)\left(\dfrac{1}{3}\right) - \left(\dfrac{3}{5}\right)\left(\dfrac{\sqrt{8}}{3}\right) = \dfrac{4 - 6\sqrt{2}}{15}$,

a negative number

Therefore, θ_2 is obtuse and hence θ_1 is acute.

$\therefore \ \theta_1 < \theta_2$

6. A

Sol. Taking P and Q as t_1 and t_2, respectively

The equation to PQ is $-2x+y\left(t_1+t_2\right)=2t_1t_2$

Comparing with $lx+my=1$, we get $t_1+t_2=-\frac{2m}{l}$ and $t_1t_2=-\frac{1}{l}$

R is $\left(\frac{1}{t_1^2}-\frac{2}{t_1}\right)$ and T is $\left(\frac{1}{t_2^2}-\frac{2}{t_1}\right)$

[$\because$ PSR and QST are focal chords]

$$\text{Slope of } RT=\frac{2\left(\frac{1}{t_2}-\frac{1}{t_1}\right)}{\frac{1}{t_1^2}-\frac{1}{t_2^2}}$$

$$=-\frac{2t_1t_2}{t_1+t_2}=\frac{-2\left(-\frac{1}{l}\right)}{-\frac{2m}{l}}=-\frac{1}{m}$$

7. B

Sol. $y=\frac{\sqrt{3}x}{2}$

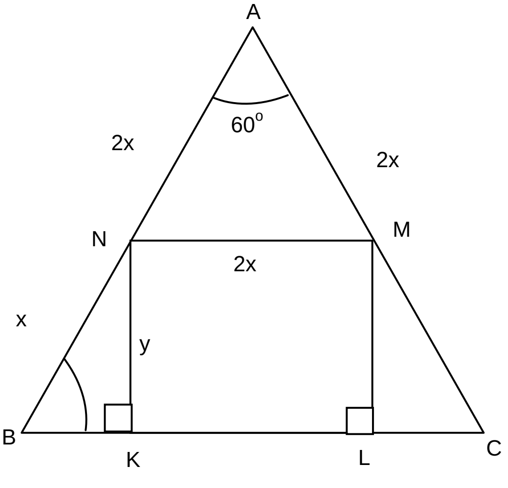
$z=\frac{x}{2}$

$\frac{1}{2}yz=6\ \Rightarrow x^2=\frac{48}{\sqrt{3}}$

Area of $\Delta ABC=6+6+2xy+\frac{1}{2}\left(2x\right)\left(2x\right)\sin 60^{o}$

$=12+2x\frac{\sqrt{3}x}{2}+2x^2\frac{\sqrt{3}}{2}$

$12+2\sqrt{3}\times\frac{48}{\sqrt{3}}=108$



8. B

Sol. $\tan A + \tan B + \tan C = \lambda$

$\Rightarrow \tan A\left(\tan^2 B\right) = \lambda\left(B = C\right)$

$\Rightarrow \tan^2 B = \left(\frac{\lambda}{\tan A}\right)$, $A > 90^o$, has infinitely many solutions.

9. C

Sol. $I = \int_0^{\pi/2} \sin x \sin 2x \sin 3x \sin 4x\, dx$ …..(i)

Replacing x by $\frac{\pi}{2} - x$, we get

$I = \int_0^{\pi/2} \cos x \sin 2x \cos 3x \sin 4x\, dx$ ……………(ii)

Adding (i) and (ii), we get

$2I = \int_0^{\pi/2} \cos 2x \sin 2x \sin 4x dx = \frac{\pi}{8}$

$\therefore I = \frac{\pi}{16}$

10. A

Sol. $\sqrt{x+y} + \sqrt{y-x} = c$ …………(i)

$\Rightarrow \quad \frac{(y+x)-(y-x)}{\sqrt{x+y}-\sqrt{y-x}} = c$

$\Rightarrow \quad \sqrt{y+x} - \sqrt{y-x} = \frac{2x}{c}$ ……….(ii)

By adding (i) and (ii), we get $2\sqrt{y+x} = c + \frac{2x}{c}$

$\Rightarrow \quad 4(y+x) = c^2 + \frac{4x^2}{c^2} + 4x$

$\therefore \quad 4\frac{dy}{dx} = \frac{8x}{c^2}$

$\therefore \quad \frac{d^2y}{dx^2} = \frac{2}{c^2}$

11. A

Sol. A and B are $\left(\sqrt{5}, 1\right)$ and $\left(-\sqrt{5}, -1\right)$.

Let C be $\left(2\sec\theta, 2\tan\theta\right)$.

$O(0,0)$ is the mid point of AB.

Slope of $OC = \sin\theta$ and slope of $AB = \frac{1}{\sqrt{5}}$

Since $OC \perp AB$,

$\sin\theta = -\sqrt{5}$ which is impossible

12. D

Sol. $\frac{k}{1}=\frac{\sin\left(A+\frac{C}{2}\right)}{\sin\frac{C}{2}}$

$$\Rightarrow \frac{k+1}{k-1}=\frac{\sin\left(A+\frac{C}{2}\right)+\sin\frac{C}{2}}{\sin\left(A+\frac{C}{2}\right)-\sin\frac{C}{2}}=\cot\frac{B}{2}\cot\frac{A}{2}$$

13. D

Sol. Number of diagonals passing through centre = 6

Number of rectangles $={}^{6}C_{2}=15$

14. A

Sol. Putting $z=x+iy,$ we get

$(x+iy)^2+(p+iq)(x+iy)+r+is=0$

$\Rightarrow (x^2-y^2+px-qy+r)+i(2xy+py+qx+s)=0$

$\Rightarrow x^2-y^2+px-qy+r=0$ ....(i)

and $2xy+py+qx+s=0$ ....(ii)

If the roots are real, then $y=0$

$\therefore$ (i) gives $x^2+px+r=0$ ....(iii)

and (ii) gives $qx+s=0$ ....(iv)

From (iv), $x=-\frac{s}{q}$

Putting in (iii), we get $\frac{s^2}{q^2}-\frac{ps}{q}+r=0$

$\Rightarrow \quad pqs=s^2+rq^2$

15. A

Sol. $y=2\log_a x$

$\Rightarrow \log_a x=\frac{y}{2}$

$\Rightarrow x=a^{y/2}$

$\Rightarrow f^{-1}(y)=a^{y/2}$

$\Rightarrow f^{-1}(b+c)=a^{\frac{b+c}{2}}=f^{-1}(b).f^{-1}(c)$

16. C

Sol. $f(x)=\frac{1}{1+\frac{1}{x}}=\frac{x}{x+1}$ is not differentiable at x = 0, –1.

Also, $g(x)=\dfrac{1}{1+\dfrac{2}{f(x)}}=\dfrac{1}{1+\dfrac{2(x+1)}{x}}=\dfrac{x}{3x+2}$

Thus, the point where $g(x)$ is not differentiable are $x=0,\ -1, -2/3$

17. B

Sol. Point of intersection of curves is (1, 0)

$y=3^{x-1}\ln x$

$\Rightarrow y'=\dfrac{3^{x-1}}{x}+\ln x.3^{x-1}.\ln 3$

$\therefore m_1=1$

Now, $y=x^x(1+\ln x)$

$\therefore\ m_2=1$

So, $\tan\theta=\tan\theta=\left|\dfrac{1-1}{1+1}\right|=0$

$\Rightarrow\theta=0\Rightarrow\cos 0^o=1$

18. B

Sol. $B=A_1+3A_3^3+....+(2n-1)(A_{2n-1})^{2n-1}$

$B^T=-\left[A_1+3A_3^3+.....+(2n-1)(A_{2r-1})^{2r-1}\right]$

$=-B$

Thus, B is skew symmetric.

19. A

Sol. The possible arrangements of teacher and students can be as follows:

(i) T S S T S S T S S

(ii) S T S S T S S T S

(iii) S S T S S T S S T

Hence, total number of ways $=3(3!)6!=(18)6!$

20. B

Sol. $y-x=3\left(\dfrac{1}{2^2}+\dfrac{1}{4^2}+\dfrac{1}{6^2}+.....\right)$

$x-z=\left(\dfrac{1}{2^2}+\dfrac{1}{4^2}+\dfrac{1}{6^2}+.......\right)$

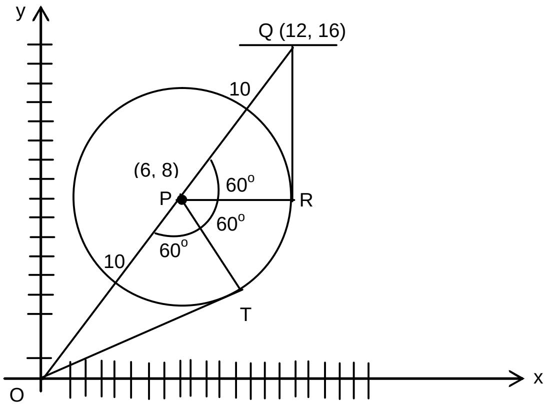
$\therefore(y-x)=3(x-z)$

$4x=y+3z$

$\Rightarrow$

$\Rightarrow 2\dfrac{x}{3}=\dfrac{y}{6}+\dfrac{z}{2}$

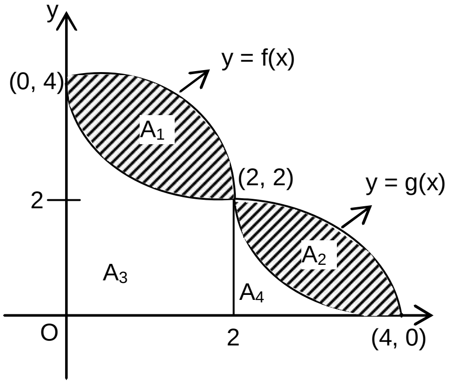
21. C



Sol. Let O = (0, 0), P = (6, 8) and Q = (12, 16).
As shown in the figure the shortest route consists of tangents OT, minor arc TR and tangent RQ.
Since $OP = 10$, $PT = 5$, and $\angle OTP = 90^o$
It follows that $\angle OPT = 60^o$ and $OT = 5\sqrt{3}$.
Similarly, $PQ = 10$, $PR = 5$
$\therefore\ \angle QPR = 60^o$ and $QR = 5\sqrt{3}$
Also points O, P and Q are collinear as $m_{OP} = m_{PQ}$
$\therefore \angle RPT = 60^o$, so arc TR is of length $\frac{5\pi}{3}$.

22. C

Sol. Given $\int_0^4 f(x)dx - \int_0^4 g(x)dx = 10$
$\Rightarrow (A_1 + A_3 + A_4) - (A_2 + A_3 + A_4) = 10$
$\Rightarrow\ A_1 - A_2 = 10$ (i)
Also $\int_2^4 g(x)dx - \int_2^4 f(x)dx = 5$
$\Rightarrow (A_2 + A_4) - A_4 = 5$
$\Rightarrow\ A_2 = 5$ (ii)
Adding (i) and (ii), $A_1 = 15$



23. D

Sol. $(ABA)^2 = (ABA)(ABA) = AB(AA)BA = AB^2A$
$(ABA)^3 = (AB^2A)(ABA)(ABA) = (AB^3A)$
$(ABA)^4 = (AB^3A)(ABA) = AB^4A$
Continuing in this manner, we get $C^{2009} = AB^{2009}A$

$$B^2 = \begin{bmatrix} 1 & \sqrt{2} \\ 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & \sqrt{2} \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 2\sqrt{2} \\ 0 & 1 \end{bmatrix}$$

$$B^3 = \begin{bmatrix} 1 & 2\sqrt{2} \\ 0 & 1 \end{bmatrix}\begin{bmatrix} 1 & \sqrt{2} \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 3\sqrt{2} \\ 0 & 1 \end{bmatrix}$$

Continuing in this manner, we get $B^{2009} = \begin{bmatrix} 1 & 2009\sqrt{2} \\ 0 & 1 \end{bmatrix}$

$$\therefore \quad C^{2009} = A\begin{bmatrix} 1 & 2009\sqrt{2} \\ 0 & 1 \end{bmatrix}A$$

24. C

Sol. $\lim\limits_{x\to\infty} x^2 \sin\left(\log_e \sqrt{\cos\frac{\pi}{x}}\right)$ (Form $0\times\infty$)

$$= \lim_{x\to\infty} \frac{x^2 \sin\left(\log_e \sqrt{\cos\frac{\pi}{x}}\right)}{\left(\log_e \sqrt{\cos\frac{\pi}{x}}\right)}\left(\log_e \sqrt{\cos\frac{\pi}{x}}\right)$$

$$= \lim_{x\to\infty} x^2 . \log_e \sqrt{\cos\frac{\pi}{x}} = \lim_{x\to\infty} \frac{x^2}{2}\log_e\left(\cos\frac{\pi}{x}\right)$$

$$= \lim_{x\to\infty} \frac{x^2 \log_e\left[1+\left(\cos\frac{\pi}{x}-1\right)\right]}{2\left(\cos\frac{\pi}{x}-1\right)}\left(-2\sin^2\frac{\pi}{2x}\right)$$

$$= \lim_{x\to\infty} \frac{x^2}{2}\frac{\left(-2\sin^2\frac{\pi}{2x}\right)}{\left(\frac{\pi}{2x}\right)^2}.\left(\frac{\pi}{2x}\right)^2 \quad = -\frac{\pi^2}{4}$$

25. D

Sol. $I_1 = \int\limits_0^\infty \frac{x^2\sqrt{x}}{(1+x)^6}dx$

Let $x = \frac{1}{t}$ $\quad \Rightarrow I_1 = \int\limits_\infty^0 \frac{\frac{1}{t^2\sqrt{t}}}{\left(1+\frac{1}{t}\right)^6}\left(-\frac{1}{t^2}dt\right)$

$$\Rightarrow \; I_1 = \int_0^\infty \frac{t\sqrt{t}}{(1+t)^6}dt = I_2$$

26. A

Sol. The equation of AB is x – y = 1.
Let the orthocenter be (h, k)

Its mage w.r.t. AB is $\left(k+1, h-1\right)$,

which will lie on the circle, so $\left(k+1\right)^2+\left(h-1\right)^2=5$

27. B

Sol. For $x \in \left(0, \frac{\pi}{2}\right)$

$\text{L.H.S.} = \cos x\left(\cos x-1\right)<0$

R.H.S $=$ x, positive as $x \in \left(0, \frac{\pi}{2}\right)$

$\therefore$ L.H.S. $\neq$ R.H.S

So, $x=0$ is only solution

28. A

Sol. $\sum\limits_{r=1}^{n}\tan^{-1}\left(\frac{2r-1}{\left(r^2+r+1\right)\left(r^2-r+1\right)-2r^3}\right)$

$$=\sum_{r=1}^{n}\tan^{-1}\left(\frac{2r-1}{r^4+r^2+1-2r^3}\right)=\sum_{r=1}^{n}\tan^{-1}\left(\frac{2r-1}{1+r^2\left(r^2-2r+1\right)}\right)$$

$$=\sum_{r=1}^{n}\tan^{-1}\left(\frac{r^2-\left(r-1\right)^2}{1+r^2\left(r-1\right)^2}\right)=\sum_{r=1}^{n}\left(\tan^{-1}\left(r\right)^2-\tan^{-1}\left(r-1\right)^2\right)$$

$$=\tan^{-1}\left(n^2\right)$$

$$\therefore\ \tan\left(\tan^{-1}\left(n^2\right)\right)=961$$

$$\Rightarrow n^2=961\Rightarrow n=31$$

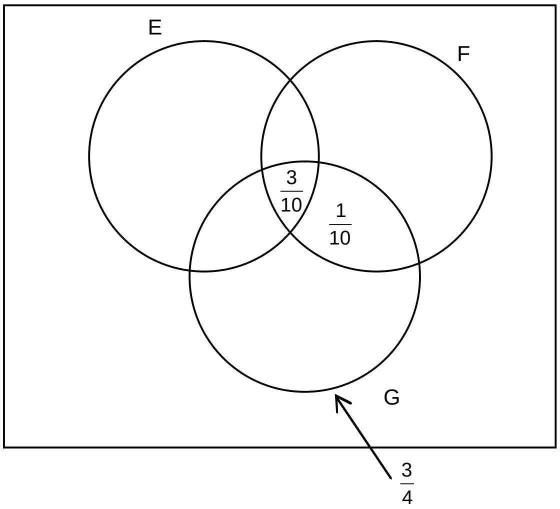
29. C

Sol. $2\left({}^7C_1+{}^7C_2+{}^7C_3\right)$

$=2\left(7+21+35\right)$ = 126

30. B

Sol. $P\left(\frac{F}{G}\right)=\frac{P\left(F\cap G\right)}{P\left(G\right)}=\frac{4}{10}.\frac{5}{4}=\frac{1}{2}$



FIITJEE **JEE (Advanced), 2017**

ALL INDIA TEST SERIES

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

CONCEPT RECAPITULATION TEST - III

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 10)** contains 10 multiple choice questions which have one or more than one correct answer. Each question carries **+3 marks** for correct answer. There is no negative marking.

(ii) **Section-C (01 – 10)** contains 10 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

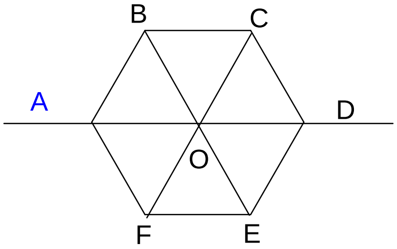
PART – I

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

1. 12 identical rods of length ℓ area cross section area A and thermal conductivity K are connected to form a regular hexagon ABCDEF with centre as O as shown in figure. If heat energy entering at point A at rate $\frac{dQ}{dt} = P$ and leaving from point D. Temperature at end A is T then



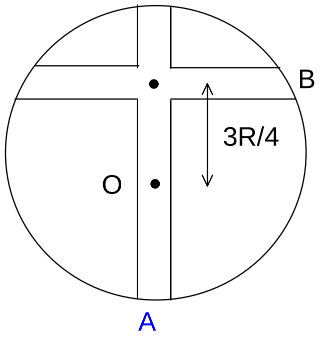
(A) temp at D is $\left(T - \frac{12\ell P}{KA}\right)$

(B) temp at O is $\left(T - \frac{2\ell P}{5KA}\right)$

(C) temp at B is $\left(T - \frac{3\ell P}{10KA}\right)$

(D) temp at D is $\left(T - \frac{4\ell P}{5KA}\right)$

2. Two tunnels are dug through the earth as shown in figure. O is the centre of earth. A particle B is released from rest from position shown and travels through the tunnel. At the same time particle from A is projected toward the centre O with velocity V such that both A and B collide before they could change their direction of motion. Then the velocity V given to A is

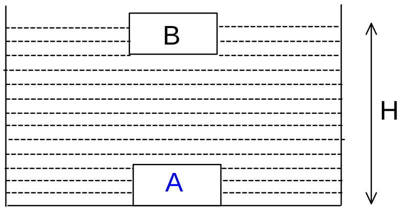


(A) $\frac{3}{4}\sqrt{\frac{GM}{R}}$ (B) $\frac{5}{12}\sqrt{\frac{GM}{R}}$

(C) $\frac{4}{9}\sqrt{\frac{GM}{R}}$ (D) $\frac{4}{5}\sqrt{\frac{GM}{R}}$

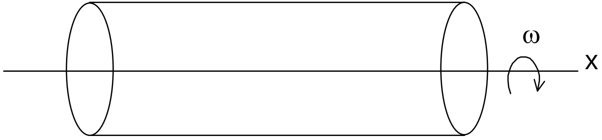
Space for rough work

3. Figure shows block B partially immersed in liquid and block A sunk completely and settled at bottom of the container. Area of the cross section of the container is always constant and equal to a. Assume that $d_A > d_L > d_B$ α and γ represent the coefficient of linear and volume expansion respectively. Choose correct statement.



(A) if $\alpha_\beta \neq 0$ and $\alpha_A = \gamma_L = 0$ then on increasing the temp of the system level of liquid H will increase
(B) if $\alpha_\beta \neq 0$ $\alpha_A = \gamma_L = 0$ then increasing the temp of system buoyant force on B increase
(C) if $3\alpha_\beta > \gamma_L$ then on decreasing the temp of the system the fraction of volume of B immersed will increase
(D) if $\alpha_A \neq 0$ $\alpha_\beta = \gamma_L = 0$ then on increasing the temp of the system buoyant force on A will increase

4. A long thin wooden cylindrical shell of radius R carries uniform surface charge density ρ. It is rotating about its axis with angular velocity ω. Which increases slowly with time t as $\omega = kt$ where k is constant. Which of the following statement is/are correct



(A) both the magnetic and the electric field are uniform and constant
(B) the magnetic field is uniform but not constant and the electric field is constant but not uniform
(C) the magnetic field is constant but not uniform electric field is uniform but not constant
(D) total energy U stored in both types of field varies with time as $U = a + bt^2$ where and b are positive constant

5. A metal plate when exposed to light of wavelength λ photoelectrons are ejected when a retarding electric field of intensity E is applied none of the photoelectrons can move away from the plate farther than a certain distance d. Which of the following correct expression for the threshold wavelength λ.

(A) $\lambda_{th} = \dfrac{hc}{eEd}$
(B) $\lambda_{th} = \lambda - \dfrac{hc}{eEd}$
(C) $\lambda_{th} = \left(\dfrac{1}{\lambda} - \dfrac{eEd}{hc}\right)^{-1}$
(D) none of these

Space for rough work

6. In the circuit are shown two parallel plate capacitor of capacitance C and 2C consisting of plates of identical dimensions having separation between two plates 2d & d respectively has shown in figure. They are connected with an ideal battery of terminal voltage as shown in figure – I. Now capacitor smaller in volume is completely inserted into the other capacitor larger in volume and kept in symmetric position and then connection polarities of the plates are reversed as shown in figure – II. Identify correct statements.

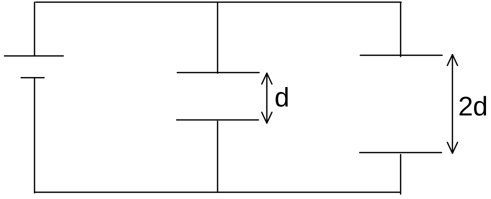


Figure - I

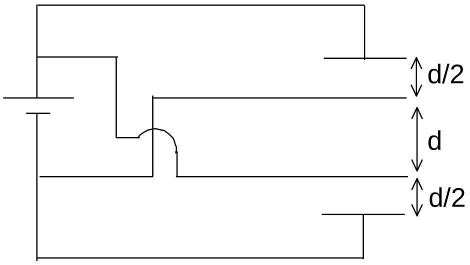


Figure - II

(A) charge flows through battery is 10 CV and battery absorbed energy
(B) charge flows through battery is 10 CV and battery delivers energy
(C) charge flows through battery is 7 CV and battery absorbs energy
(D) charge flows through battery is 7 CV and battery delivers energy

7. Two mirrors M_1 and M_2 make an angle ϕ with line AB. A point source S is kept at a distance r from the point of intersection of mirror along line AB. A small hemispherical annular mask is kept close to S so that no ray emanating from S directly reaches the screen kept at distance b from the source. Interference pattern of rays reflected from M_1 and M_2 is observed on screen. Find the fringe width of this interference pattern λ = wavelength of light being emitted by source.

(A) $\dfrac{\lambda\left(b+2r\sin^2\phi\right)}{2r\sin 2\phi}$

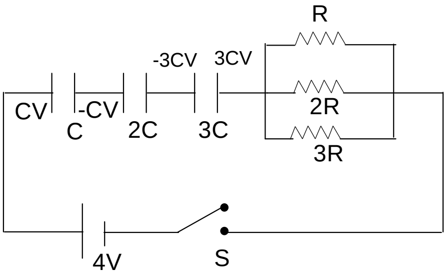
(B) $\dfrac{\lambda\left(b+2r\cos 2\phi\right)}{2r\sin 2\phi}$

(C) $\dfrac{\lambda\left(b+r\cos\phi\right)}{2r\sin 2\phi}$

(D) $\dfrac{\lambda\left(b+2r\cos 2\phi\right)}{r\sin 2\phi}$

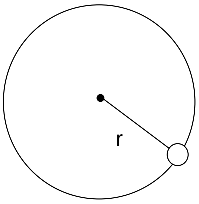
Space for rough work

8. Three capacitors of capacitance C, 2C and 3C and three resistors R, 2R and 3R are connected with a battery and switch S as shown in figure. When the switch is open charge on capacitors are shown. Switch S is closed at t = 0. Time constant for the circuit is



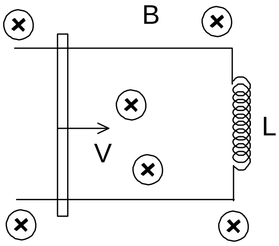
(A) RC
(B) $\frac{6RC}{11}$
(C) $\frac{36RC}{121}$
(D) none of these

9. A small collar of mass m is given an initial velocity of magnitude V_0 on the horizontal circular track fabricated from a slender rod. If co-efficient of friction is μ_k. Determine distance travelled by collar before comes to rest (Recognize that the friction force depends on the net normal force).



(A) $\frac{r}{\mu_k}\ln\left[\frac{V_0^2+\sqrt{V_0^4+r^2g^2}}{rg}\right]$
(B) $\frac{r}{4\mu_k}\ln\left[\frac{V_0^2+\sqrt{V_0^4+r^2g^2}}{rg}\right]$
(C) $\frac{2r}{\mu_k}\ln\left[\frac{V_0^2+\sqrt{V_0^4+r^2g^2}}{rg}\right]$
(D) $\frac{r}{2\mu_k}\ln\left[\frac{V_0^2+\sqrt{V_0^4+r^2g^2}}{rg}\right]$

10. Two parallel resistanceless rail are connected by an inductor of inductance L at one end as shown in figure. A magnetic field exist in space which is $\perp_r$ to plane of the rails. Now a conductor of length ℓ and m is placed transverse on rail and given an impulse J towards rightward direction. Select correct option



(A) velocity of conductor is half of initial velocity after displacement of conductor $d=\sqrt{\frac{3J^2L}{4B^2\ell^2m}}$
(B) velocity of conductor is half of initial velocity after displacement of the conductor $d=\sqrt{\frac{3J^2L}{B^2L^2m}}$
(C) current flowing through the inductor at the instant where velocity is half of initial is $I=\sqrt{\frac{3J^2}{4Lm}}$
(D) current flowing through the inductor at the instant when velocity of the conductor is half of the initial velocity is $I=\sqrt{\frac{3J^2}{mL}}$

Space for rough work

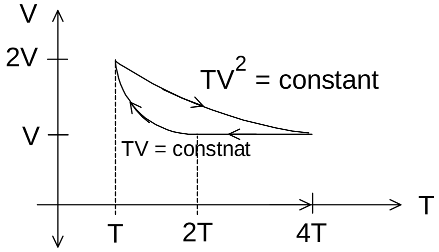
SECTION – C

(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

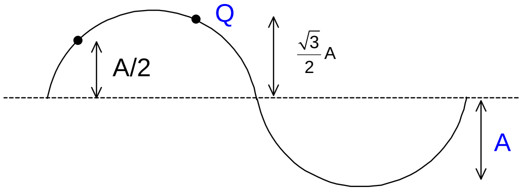
1. A uniform disk rotating about its vertical axis is placed on a horizontal floor divided in two halves. The co-efficient of friction are $\mu_1 = 0.78$ and $\mu_2 = 0.67$ between the disk and right and left halves respectively. Consider the line dividing two half as y-axis and point where centre of disk lies on origin of co-ordinate system. Acceleration of the centre of disk immediately after it is placed on floor is $\frac{K}{20}\text{ms}^{-2}$. $g = 10\ \text{ms}^{-2}$, $\pi = \frac{22}{7}$.

2. Figure shows VT diagram for helium gas in a cyclic process. Then ratio of maximum and minimum pressure is



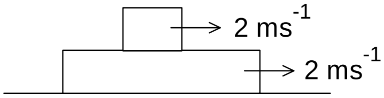
3. In a thin vertical U tube of very long arms is m_1 mass of mercury. Period of small amplitude oscillation of mercury is T_1 = 2S. If in one arm m_2 = 100 g of water is poured the period of small oscillation becomes T_2 = 3S then mass m_1 = 16 K gm. Find K …

4. Figure show the snapshot of the transverse sinusoidal wave on a string at time t = 0 sec. Frequency of wave is $\frac{125}{6}$Hz. T_1 is the time at which the line joining P and Q become horizontal for first time (after t = 0) if wave is travelling toward +ve x direction and T_2 is the time at which the line P and Q becomes horizontal for first time (after t = 0) if wave is travelling in – ve x direction then $\frac{T_1}{T_2} = \frac{22}{K}$. Find K …

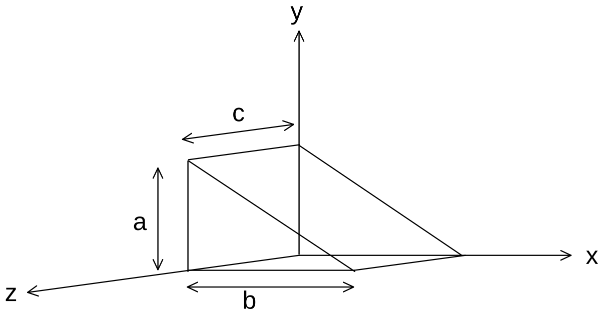


Space for rough work

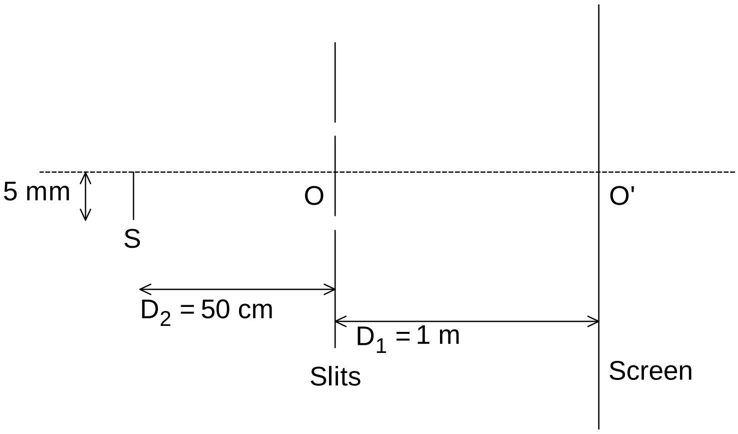
5. A block rest on a long plank moving at 2 ms^{-1}. The co-efficient of friction between the block and plank is 0.1. The plank starts decelerating uniformly and stops in 0.5 s. Acceleration due to gravity is 10 ms^{-2}. The distance slid by block on plank is $\frac{K}{4}$ m. Find K …



6. In the given electric field $\vec{E} = \left[(d+x)i + E_0\hat{j}\right]$ N/C a hypothetical closed surface is taken as shown in figure. The total charge enclosed within the closed surface is $k\in_0$. Then find the value of k(a = 2 m, b = 3 m and c = 2 m)



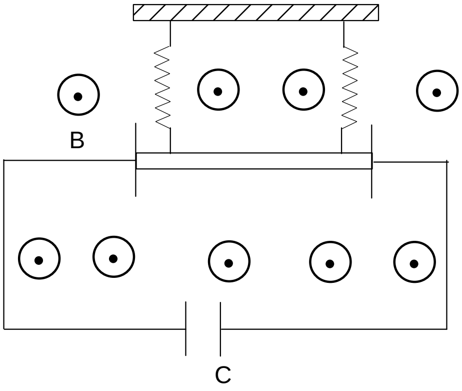
7. In the given Y.D.S.E the distance between the slits = 1 cm and the distance between slits and screen is D_1 = 1 m. If the source of the light S is placed at distance below 5 mm below the line OO′ at distance D_2 = 50 cm from slits. Find distance of central maxima from O′ (in cm)?



Space for rough work

8. A gas of hydrogen like atoms can absorb radiation of 68 eV in first excited state. Consequently the gas emit radiations of only three different wavelengths. All the wavelengths are equal or smaller than that of the absorbed photon. The atomic number of gas atom is …

9. A conducting rod of mass m and length ℓ is suspended horizontal with help of two identical non-conducting springs each of stiffness K in presence of uniform horizontal magnetic field of induction B. The rod can slid between two fixed frictionless vertical conducting guides as shown in figure. The rod is pulled slightly downward and then released. Neglect resistance and inductance in circuit. Acceleration due to gravity is g. The time period of oscillation is T = k′.π. If m = $7B^2\ell^2C$ and m = k. Find k′ ?



10. You have m = 1 kg of super cooled water at temperature – 10°C kept in a container and crushed at temp θ = - 20°C kept in another container. How much ice you should add to the water so that whole water freezes $S_\omega = 4.2\times10^3\ J\ kg^{-1}K^{-1}$, $S_I = 2.1\times10^3\ J\ Kg^{-1}K^{-1}$. Latent of heat of ice $L = 336\times10^3\ J\ Kg^{-1}$ and meeting point of ice is θ = 0°C. Heat capacity of the vessel and heat less to surrounding is negligible.

Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

1. Select correct statement(s).
(A) all N – N bond lengths are same in N_3^- ion
(B) all N – N bond lengths are not identical in N_3H
(C) in HN_3 terminal N – N bond length is shorter than the central N – N bond length
(D) azide ion and hydrazoic acid have same number of electron.

2. For the Br^- catalyzed aqueous reaction

$$HNO_2 + C_6H_5NH_2 + H^+ \xrightarrow{Br^-} C_6H_5N_2^+ + 2H_2O$$

proposed mechanism is

(I) $H^+ + HNO_2 \underset{K_{-1}}{\overset{K_1}{\rightleftharpoons}} H_2NO_2^+ \ (fast)$

(II) $H_2NO_2^+ + Br^- \xrightarrow{K_2} ONBr + H_2O \ (slow)$

(III) $ONBr + C_6H_5NH_2 \xrightarrow{K_3} C_6H_5N_2^+ + H_2O + Br^- \ (fast)$

Which of the following statement(s) is/are correct?
(A) order with respect to H^+ is 1
(B) order with respect to Br^- is 1
(C) order with respect to $C_6H_5NH_2$ is 1
(D) order with respect to HNO_2 is 1

3. The order of first ionization energies are given below. Find the incorrect order(s).
(A) $F > N > O > C > B > Be$
(B) $C > Si > Ge > Pb > Sn$
(C) $B > Al > Ga > In > Tl$
(D) $O > Cl > Br > I > S$

4. In antifluorite structure
(A) oxide ions have face centred cubic arrangement
(B) cations are present in all the tetrahedral voids
(C) $r_{Na^+} + r_{O^{2-}} = \frac{\sqrt{3}a}{4}$
(D) cations are face centred and anions are present in all the tetrahedral voids

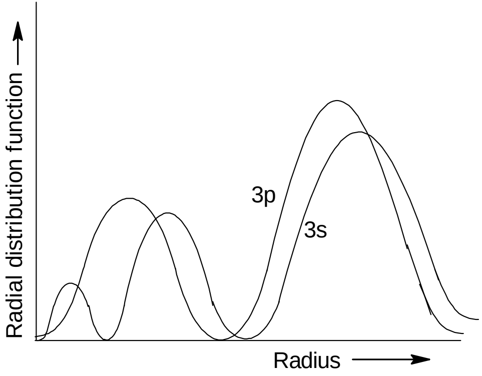
Space for rough work

5. Identify the incorrect statement(s).
   (A) $\left[NiCl_4\right]^{2-}$ as well as $[Ni(CO)_4]$ are paramagnetic
   (B) CFSE for $[Ti(H_2O)_6]^{3+}$ is $-0.4\Delta_0$
   (C) Δ_0 increasing order is $\left[CrCl_6\right]^{3-} < \left[Cr\left(NH_3\right)_6\right]^{3+} < \left[Cr\left(CN\right)_6\right]^{3-}$
   (D) in spectro chemical series, halide ions are arranged as $I^- < Br^- < Cl^- < F^-$

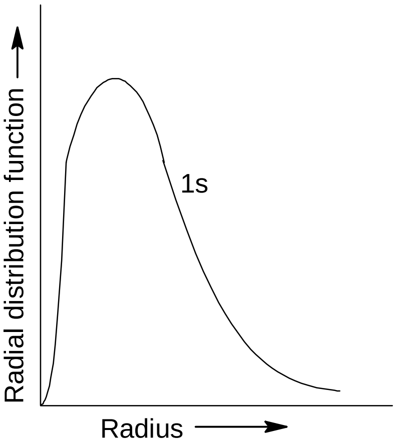
6. On being treated with HCl, acetone gives
   (A) mesityl oxide
   (B) phorone
   (C) mesitylene
   (D) aldol

7. Which of the following plot(s) is/are correct

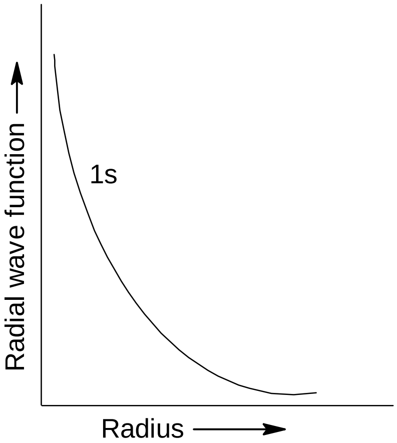
(A)



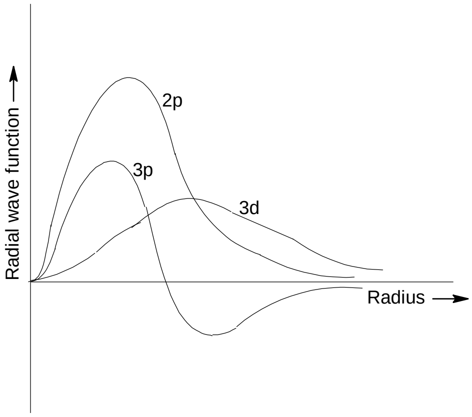
(B)



(C)



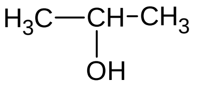
(D)



Space for rough work

8. $CH_3-CH_2-CH_2-NH_2 \xrightarrow{N_2O_3}$

The product(s) formed is/are

(A) 

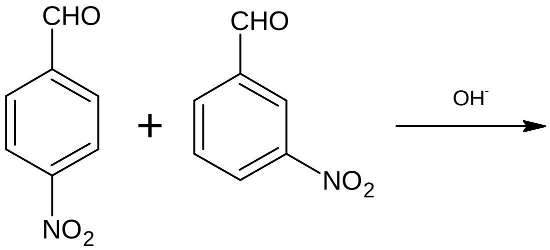
$H_3C-\underset{OH}{CH}-CH_3$

(B) $CH_3-CH_2-CH_2-OH$

(C) $CH_3-CH=CH_2$

(D) $CH_3-CH_2-C\equiv N$

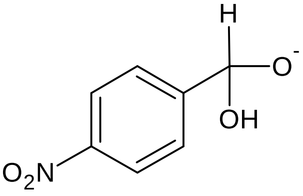
9. Which of the following statement(s) is/are correct for crossed cannizzaro reaction?

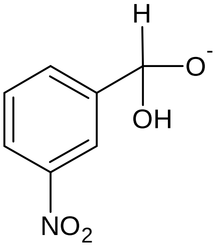


(A) (B)

(A) OH$^-$ attacks at the carbonyl C – atom of (A)

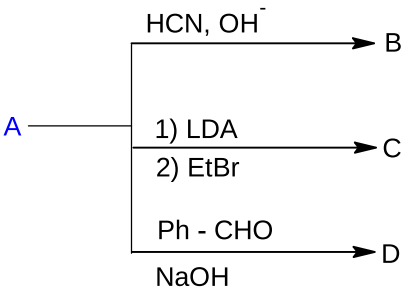
(B) OH$^-$ attacks at the carbonyl C – atom of (B)

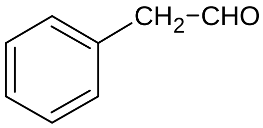
(C) the H$^-$ ion transfer takes place from 

(D) the H$^-$ ion transfer takes place from 

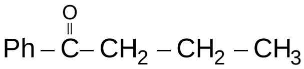
Space for rough work

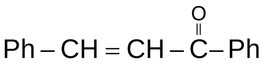
10. $C_8H_8O(A)\xrightarrow{I_2,\ NaOH}$ yellow ppt.



(A) A is 

(B) B is optically active

(C) C is  $Ph-\overset{O}{\overset{\parallel}{C}}-CH_2-CH_2-CH_3$

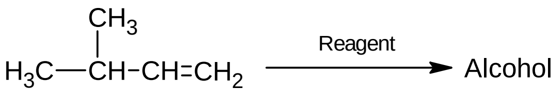
(D) D is  $Ph-CH=CH-\overset{O}{\overset{\parallel}{C}}-Ph$

SECTION – C

(One Integer Value Correct Type)

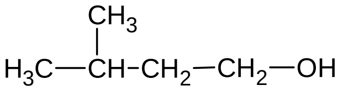
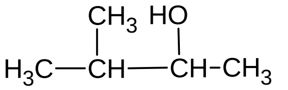
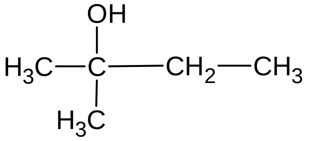
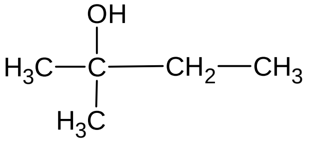
This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1.



$H_3C-\underset{}{\overset{CH_3}{\overset{|}{C}}}H-CH=CH_2 \xrightarrow{\text{Reagent}} \text{Alcohol}$

Following are the possibilities of products on applying specific reagents:

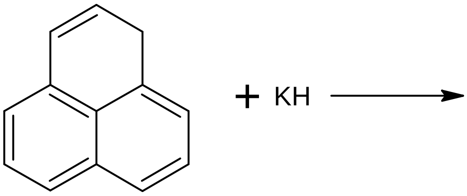
	Reagent	Possible product
1.	$B_2H_6\ /\ H_2O_2,\ NaOH$	 $H_3C-\overset{CH_3}{\overset{|}{C}}H-CH_2-CH_2-OH$
2.	$PdCl_2,\ H_2O,\ O_2\ /\ LAH$	 $H_3C-\overset{CH_3}{\overset{|}{C}}H-\overset{HO}{\overset{|}{C}}H-CH_3$
3.	$Hg(OAc)_2,\ H_2O\ /\ NaBH_4$	 $H_3C-\underset{H_3C}{\underset{|}{\overset{OH}{\overset{|}{C}}}}-CH_2-CH_3$
5.	dil. H_2SO_4	 $H_3C-\underset{H_3C}{\underset{|}{\overset{OH}{\overset{|}{C}}}}-CH_2-CH_3$

How many of the above mentioned pairs are correct?

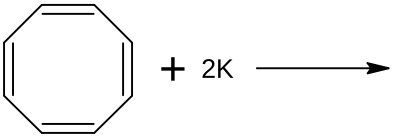
Space for rough work

2. How many of the following reactions give aromatic species?

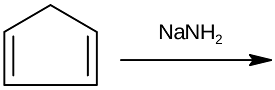
(I)



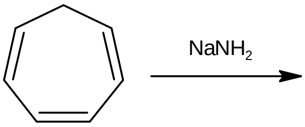
(II)



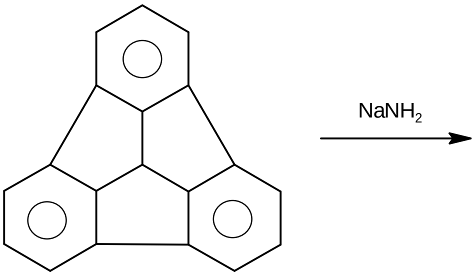
(III)



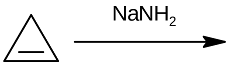
(IV)



(V)



(VI)



3. The formation constant is x × 10^5 for the reaction of a tripositive metal ion with thiocyanate ion to form the mono complex. If the total metal concentration in the solution is 2.0 × 10^{-3} M, the total SCN^- concentration is 1.50 × 10^{-3} M, and the free SCN^- concentration is 1.0 × 10^{-5} M. Find the value of x.

4. One of the most stable nuclei is ^{55}Mn. Its nuclidic mass is 54.9244 u. Determine its average binding energy per nucleon in MeV if mass of proton and neutron are 1.00783 u and 1.00867 u respectively.

Space for rough work

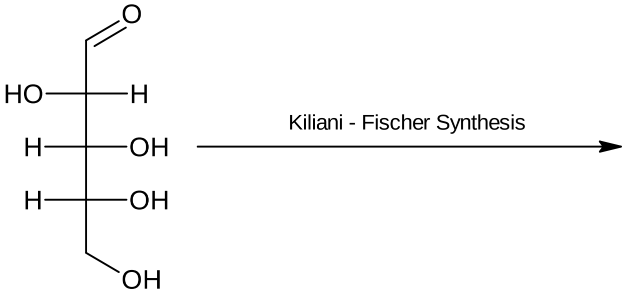
5. How many of the following chemical compound(s) appear black?
MnO_2, SnS, CO_3O_4, Ni_2O_3, $K_2Cr_2O_7$, CoS, anhydrous $CoSO_4$, Bi_2S_3, HgS, Sb_2S_3

6. K_a for the acid ionization of Fe^{3+} to $Fe(OH)^{2+}$ and H^+ is 5.26×10^{-7}. What is the maximum pOH value which could be used so that at least 95% of the total Iron(III) in a dilute solution exists as Fe^{3+}?

7. How many of the following chemical reagents impart brick red colouration to the flame during flame test? Dolomite, bleaching powder, rock salt, nitrolim, lime-stone, carnallite, alum, gypsum.

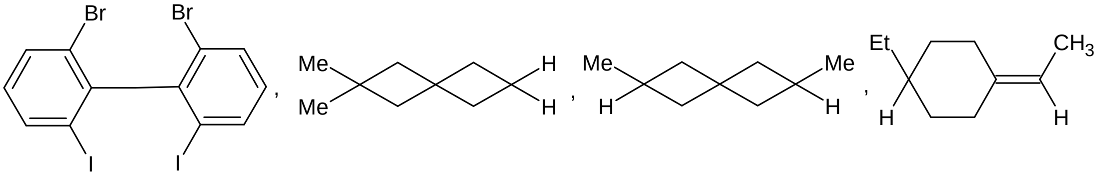
8. The number of P – O – P bonds in cyclic trimeric metaphosphoric acid are

9. How many products are formed for the following synthesis?



D-Arabinose

10. How many of these show optical activity?



$CH_3-CH=C=C=CH-C_2H_5, CH_3-CH=C=C=C=CH-C_2H_5$, cis-cyclooctene, trans-cyclooctene, (2R, 3S) 2, 3-dihydroxybutane-1, 4-dioic acid.

Space for rough work

Mathematics **PART – III**

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

1. Let $f(n) = \sum_{K=n+1}^{2n} (K-n)^2 \left({}^nC_{K-n}\right)^2$ where $n \geq 2$ then

(A) $f(n) = n^2\, {}^{2n}C_n - 2n$

(B) $f(n) = \left(\dfrac{n^3 + 131n - 150}{30}\right) {}^{2n-2}C_{n-1}$

(C) $f(25) = \dfrac{625 \times 48!}{(24!)^2}$

(D) $f(25) = \dfrac{625 \times 50!}{(25!)^2} - 50$

2. The probability that a zoo has exactly n tiger is P^n, $n \geq 1$. All sex distribution of n tiger in that zoo have the same probability then the probability that the zoo contain exactly K male tiger (where K ≥ 1) is

(A) $\dfrac{1}{1-P}\left(\dfrac{P}{1-P}\right)^{K-1}$

(B) $\dfrac{2}{1-P}\left(\dfrac{P}{1-P}\right)^{K}$

(C) $\left(\dfrac{2}{2-P}\right)\left(\dfrac{P}{1-P}\right)^{K-1}$

(D) none of these

3. Which holds true if A is a square matrix of order n.

(A) $\text{adj adj}\,(\text{adj } A) = |A|^{n^2-3n+2} A^{-1}$

(B) $\text{adj adj}\,(\text{adj } A) = |A|^{n^2-3n+3} A^{-1}$

(C) $\left|A^{-1}\text{adj adj}\,(\text{adj}A)\right| = |A|^{(n-1)^3+1}$

(D) $\left|A^{-1}\text{adj adj}\,(\text{adj}A)\right| = |A|^{(n-1)^3-1}$

4. The equation of the straight line which meets the circle $x^2 + y^2 - 2x - 4y - p^2 = 0$ at points which are at a distance 'd' from a point $A(1 + \alpha, 2 + \beta)$ on the circle is

(A) $2\alpha x + 2\beta y - 2(\alpha + 2\beta) = 2(p^2 + 5) - d^2$

(B) $2\alpha x - 2\beta y - 2(\alpha - 2\beta) = 2(p^2 + 5) + d^2$

(C) $2\alpha x + 2\beta y - 2(\alpha + 2\beta) = 2(p^2 + 5) + d^2$

(D) $2\alpha x + 2\beta y - 2(\alpha + 2\beta) = d^2 - 2(p^2 + 5)$

Space for rough work

5. Let S & S′ be the foci of an ellipse $b^2(x-2)^2 + a^2(y-1)^2 = a^2b^2$ whose eccentricity is e and P is a variable point on the ellipse then
(A) locus of incentre of $\Delta PSS'$ is hyperbola
(B) locus of incentre of $\Delta PSS'$ is ellipse
(C) eccentricity of the locus of incentre of $\Delta PSS'$ is $\sqrt{\frac{2e}{e+1}}$
(D) eccentricity of the locus of incentre of $\Delta PSS'$ is $\sqrt{\frac{2e}{e-1}}$

6. Let f be a function satisfying $f_e(x) = \frac{e^x}{e^x + \sqrt{e}}$ and $g(x) = f_4(x)$
(A) $f_2(x) + f_2(1-x) = 1$
(B) $\sum_{r=1}^{1996} g\left(\frac{r}{1997}\right) = 1996$
(C) $\sum_{r=1}^{2n-1} 2f\left(\frac{r}{2n}\right) = (2n-1)$
(D) all of the above

7. Two tangents on a parabola are x – y – 1 = 0 & x + y + 11 = 0. If S(1, 3) is focus of the parabola where P & Q are end points of focal chord then
(A) equation of tangent at vertex 3y – 2x + 1 = 0
(B) equation of directrix 3y – 2x + 8 = 0
(C) latus rectum is $\frac{30}{\sqrt{13}}$
(D) $\frac{1}{SP} + \frac{1}{SQ} = \frac{2\sqrt{13}}{15}$

8. If a, b, c, d are in GP where a, b, c, d are positive number then
(A) a – b > d – c
(B) ab + cd > 2(ac + bd + bc)
(C) $2\left(c^{-1}d^{-1} + a^{-1}b^{-1}\right) > 2\left(b^{-1}d^{-1} + a^{-1}c^{-1} - a^{-1}d^{-1}\right)$
(D) $\frac{1}{d} + \frac{1}{b} > \frac{2}{c}$

Space for rough work

9. $\lim\limits_{x\to\infty} x_{c_n}\left(\frac{a}{x}\right)^n\left(1-\frac{a}{x}\right)^{x-n}$ is equal to

(A) $\frac{n!}{a^n e^{-a}}$ (B) $\frac{a^n e^{-a}}{n!}$

(C) $\frac{n!}{a^n e^{a}}$ (D) $\frac{a^n e^{a}}{n!}$

10. Suppose we uniformly and randomly select a permutation from the 20! Permutation of 1, 2, 3 …. 20. What is the probability that 2 appears at an earlier position than any other even number in the selected permutation.

(A) $\frac{1}{2}$ (B) $\frac{1}{10}$

(C) $\frac{9!}{20!}$ (D) none of these

SECTION – C

(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

1. A quadrilateral ABCD in which side AB, BC, CD, DA are in GP such that circle can be inscribed in it and another circle is circumscribed about it, then angle A is equal to $\frac{n\pi}{q}$ where n & q are coprime then (n + q) equal to

2. Set $S = \{|y| = |x|, |x| - r = 0 = |y| - r / r \in N, 1 \le r \le n\}$ then total number of triangles formed by the lines in the given sets is K(2n) then K is …

3. In ∆ABC, ∆ADB, ∆ADC median AD, AE, AF respectively is drawn and BC is equal to 4, then the value of $AE^2 + AF^2 - 2AD^2$ is

4. The volume of the reel – shaped solid formed by the revolution about the y-axis of the part of the parabola $y^2 = 2x$ cut off by the latus rectum is P then value of $\frac{20}{\pi}P$ is

Space for rough work

5. If a + 1 > b and A, B, C are variable angles such that $\sqrt{\left(a^2-1\right)+b\left(2-b\right)}\tan A+a\tan B+\sqrt{\left(a^2+1\right)+b\left(b-2\right)}\tan C=3a$ then value of $\sum \tan^2 A$ is

6. Let PQRSTU is a hexagon such that PQ = QR = RS = 3 and ST = TU = UP = 6. If the vertices P, Q, R, S, T, U are concyclic, then the radius of the circle passing through them is $\sqrt{a}$, then $\frac{a}{3}$ is

7. If $\int_0^{\pi}\left[\frac{\cos\left(n+1\right)x-\cos nx}{\cos x-1}\right]dx=\frac{n\pi}{2}$ then value of n is

8. Assuming x – y + 2z = 0 to be the horizontal plane then equation of line of greatest slope through the point (2, 2, 1) in the plane 2x + y – 6z = 0 is L having cosine ratio a : b : c then value of $\left(\frac{2a+b}{c}\right)$ is ..

9. Number of real value of x satisfy this equation $e^{2x}+e^{x}\left(3-5\cos x\right)+1=0$

10. If $\sum_{i=1}^{45}\left[\sin^{-1}\left\{\text{Re}\left(\frac{ai+bi\omega+ci\omega^2}{bi+ai\omega^2+ci\omega}\right)\right\}+\cos^{-1}\left\{\text{Re}\left(\frac{ai+bi\omega+ci\omega^2}{bi\omega^2+ci+ai\omega}\right)\right\}\right]$ is equal $\frac{90\pi}{x}$ then x equal to

Space for rough work

FIITJEE **JEE(Advanced)-2017**

ALL INDIA TEST SERIES

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ANSWERS, HINTS & SOLUTIONS

CONCEPT RECAPITULATION TEST – III
(Paper–1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	BCD	ABCD	C
2.	A	ABD	D
3.	CD	AC	BD
4.	BD	ABC	AD
5.	C	A	BC
6.	D	AB	AC
7.	A	ABCD	BCD
8.	C	ABC	ACD
9.	D	AC	B
10.	AC	BCD	B
1.	7	3	3
2.	8	4	8
3.	5	3	2
4.	2	9	2
5.	6	6	3
6.	6	9	7
7.	2	5	2
8.	6	3	6
9.	4	2	1
10.	7	5	4

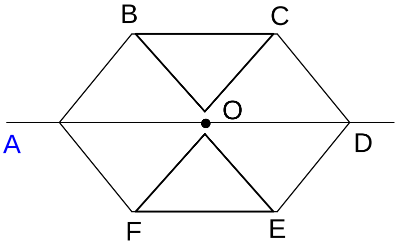
Physics

PART – I

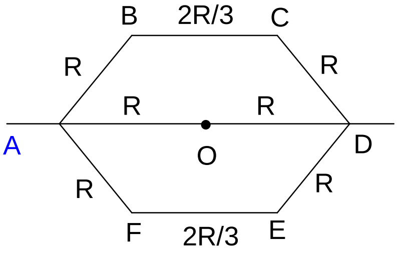
SECTION – A

1. BCD

Thermal resistance of each section $R = \frac{\ell}{KA}$



$R_{eq} = \frac{4R}{5}$

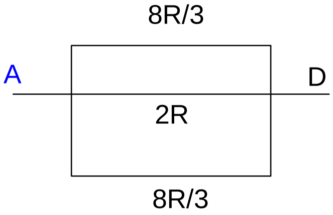


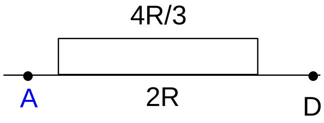
Hence $P = \frac{T_A - T_P}{4R} \times 5$

$T_D = T_A - \frac{4}{5}\frac{\ell P}{KA}$

Heat current through

ABCD & AFED = $\frac{P \times 2R}{\frac{4R}{2} + 2R} = \frac{P \times 3 \times 2}{10} = \frac{3P}{5}$





$AOD = \frac{2P}{5}$

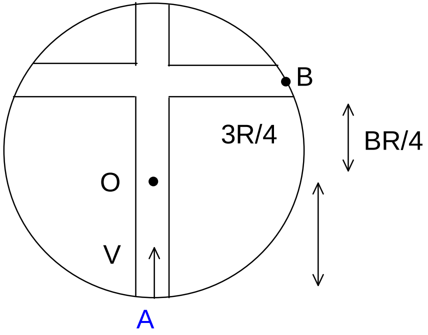
Temperature drop across AO = $\frac{2P}{5} \times R = T_A - T_0$

$T_o = T_A - \frac{2P\ell}{5KA}$

2. A

Time for B to move from B to centre of tunnel is $\frac{T}{4} = T = 2\pi\sqrt{\frac{R^3}{GM}} \quad \omega = \sqrt{\frac{GM}{R^3}}$

Time to move from A to given point is



$$\frac{1}{\omega}\left\{\sin^{-1}\left(\frac{R}{A}\right)+\sin^{-1}\left(\frac{3R}{4A}\right)\right\}=\frac{T}{4}$$

$$\sin^{-1}\left(\frac{R}{A}\right)+\sin^{-1}\left(\frac{3R}{4A}\right)=\frac{\pi}{2}$$

From above

$$\sin^{-1}\left(\frac{R}{A}\right)=\cos^{-1}\left(\frac{3R}{4A}\right)=\sin^{-1}\left(\sqrt{1-\frac{9R^2}{16A^2}}\right)$$

$$\frac{R}{A}=\sqrt{1-\frac{9R^2}{16}}$$

$$\frac{R^2}{A^2}=1-\frac{9R^2}{16A^2} \quad \frac{25}{16}\frac{R^2}{A^2}=1$$

$$A=\frac{5}{4}R$$

Hence

$$V=\omega\sqrt{A^2-R^2}=\frac{\omega\sqrt{25R^2-16R^2}}{4}$$

$$=\frac{3}{4}R\omega=\frac{3}{4}\sqrt{\frac{GM}{R}}$$

3. CD

Since fractional volume

$$\frac{V_{in}}{V_{body}}=\frac{\rho_{body}}{\rho_{liquid}}$$

$$\frac{V_{\inf}}{V_{body}}=\frac{\rho_{Bf}}{\rho_{ef}}=\frac{\rho_{Bi}.(1+\gamma_L\Delta T)}{(1+\gamma_B\Delta T)\,\rho_{\ell i}}$$

$$x_f=x_i\left(\frac{1+\gamma_L\Delta T}{1+\gamma_B\Delta T}\right)$$

with fall in temperature

$x_f > x_i$ for $\gamma_B = 3\alpha_B > \gamma_L$

4. BD

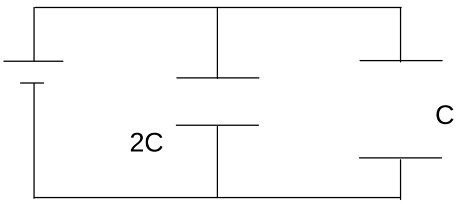
5. C

$$K.E_{\max} = \frac{hc}{\lambda} - \frac{hc}{\lambda_T}$$

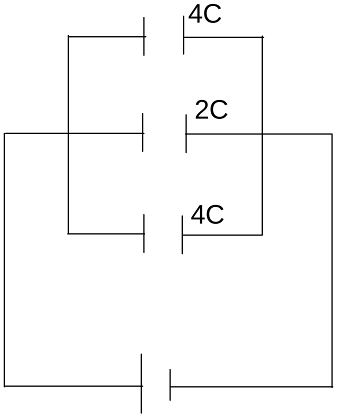
$$\ell Ed = \frac{hc}{\lambda} - \frac{hc}{\lambda_T}$$

$$\lambda_T = \left(\frac{1}{\lambda} - \frac{eEd}{hc}\right)^{-1}$$

6. D

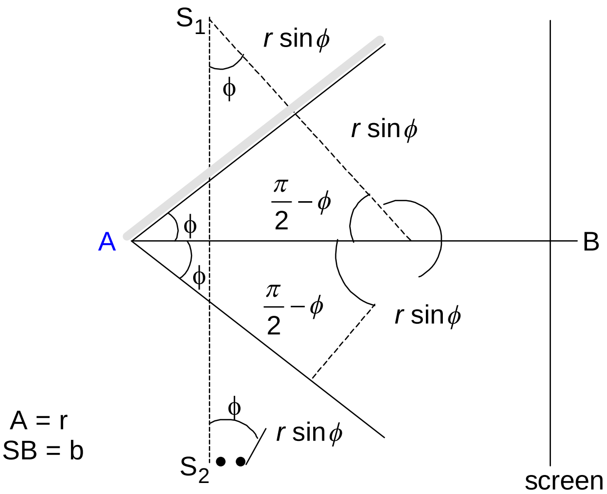


Initial
Q_{in} = 3 CV



Final
Q_f = 10 CV

7. A


S1
r sinϕ
ϕ
r sinϕ
π/2 − ϕ
A
ϕ
B
ϕ
π/2 − ϕ
r sinϕ
ϕ
r sinϕ
A = r
SB = b
S2
screen

$$d = S_1S_2 = 2\{2r\sin\phi.\cos\phi\} = 2r\sin 2\phi$$

D = distance between source and screen

$$= b + 2r\sin^2\phi$$

Hence

$$\text{Fringe width} = \frac{\left(b + 2r\sin^2\phi\right)\lambda}{2r\sin(2\phi)}$$

8. C

$\tau = RC$

It do not depends on charge on capacitor

$$\tau = \frac{6R}{11}.\frac{6C}{11} = \frac{36RC}{121}$$

9. D

$$N = m\sqrt{\left(\frac{V^2}{R}\right)^2 + g^2}$$

$$ma_T = -\mu m\sqrt{\left(\frac{V^2}{R}\right)^2 + g^2}$$

$$V\frac{dv}{ds} = -\mu\sqrt{\left(\frac{V^2}{R}\right)^2 + g^2}$$

$$\frac{RVdv}{\sqrt{V^4 + R^2g^2}} = -\mu_K ds$$

Replacing $Z^2 = V^4 + R^2g^2$

$$\int \frac{R}{2}\frac{dz}{\sqrt{z^2 - (Rg)^2}} = -\mu_K ds$$

Replacing $z = Rg\sec\theta$

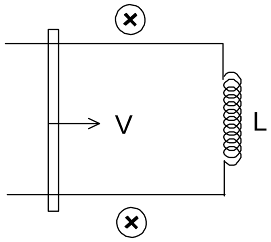
$$\ln(\sec\theta + \tan\theta) = \frac{-2\mu_K}{R}ds$$

$$\ln\left(\sec\theta\sqrt{\sec^2\theta - 1}\right) = \frac{-2\mu_K}{R}s$$

$$\ln\left(\frac{z + \sqrt{z^2 - R^2g^2}}{Rg}\right) = \frac{-2\mu_K}{R}s$$

$$\left[\ln\left(\frac{\sqrt{V^4 + R^2g^2} + V^2}{Rg}\right)\right]_{V_0}^{0} = \frac{-2\mu_K}{R}[S]_0^s$$

10. AC



$$B\ell V = L\frac{dI}{dt}$$

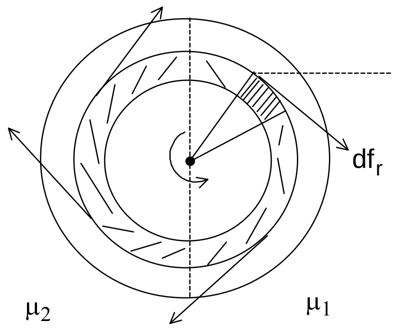
$$B\ell dx = LdI$$

$$B\ell x = LI$$

$$I = \frac{B\ell x}{L}$$

SECTION – C

1. 7



Let we consider a ring of radius r and thickness dr.
σ = mass per unit area.
Mass of shaded part $\sigma(rd\theta)dr$
Friction $\mu_1(\sigma rd\theta)dr$
Net horizontal force along x-axis is 0

$$\int df_y = \int(\mu_1\sigma rd\theta drg)\cos\theta$$

$$= \mu_1\sigma g\int rdr\int_{-\pi/2}^{\pi/2}\cos\theta d\theta$$

$$= 2\mu_1\sigma g\int rdr = 2\mu_1\sigma g.\frac{R}{2}\,(right\ half)\,(-ve\ y)$$

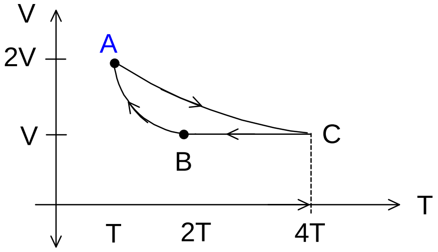
Left part

$$F_y = 2\mu_2\sigma g\frac{R}{2}\,(+ve\ y)$$

$$F_{net} = (\mu_1-\mu_2)\sigma gR^2 = \frac{(0.78-0.67).M}{\pi R}.g.R$$

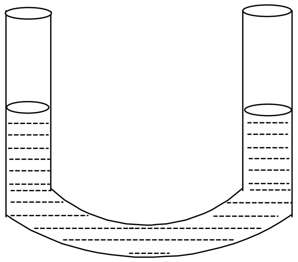
$$a = \frac{0.11\times10}{22}\times7 = \frac{7}{20}ms^{-2}$$

2. 8



AB → TV = constant = K_1
$PV^2 = K_1 \times nR$
AC → TV^2 = constant = K_2
P_{min} at A and maximum C
$P_B = 4P_A$ and $P_C = 2P_B$
Hence $\frac{P_C}{P_K} = 8$

3. 5



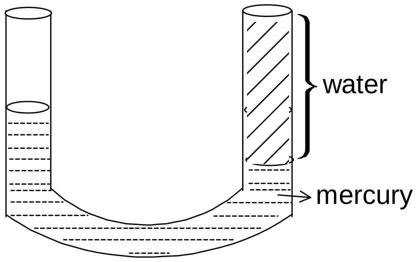
Initial

Let A = cross section area

Net force after x displacement

$-2Ax\rho_{Hg}.g = m_1 a$

$$\omega_1^2 = \frac{2A\rho_{Hg}.g}{m_1}$$



Final

Net force after displacement will be

$= -2Ax\rho_{Hg}.g = (m_1 + m_2)a$

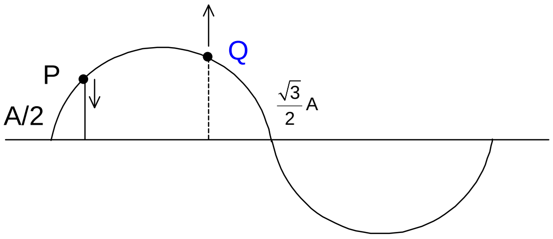
$$\omega_2^2 = \frac{2A\rho_{Hg}.g}{m_1 + m_2}$$

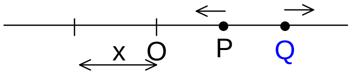
$$\frac{\omega_1}{\omega_2} = \sqrt{\frac{m_1 + m_2}{m_1}} = \frac{T_1}{T_2}$$

$m_1 = 80\ m$

4. 2

In case of +ve direction proceeding of wave.





In this case PQ will be horizontal if P and Q have same position propagating in opposite direction it will be in left half at position x.

For P $\frac{T}{12} + \frac{T}{4} + \frac{1}{\omega}\cos^{-1}\left(\frac{x}{A}\right)$

For Q $\frac{T}{12} + \frac{T}{4} + \frac{1}{\omega}\sin^{-1}\left(\frac{x}{A}\right)$

Equating these two

$$x = \frac{A}{\sqrt{2}}$$

Hence $t_1 = \frac{11T}{24}$

In case of propagating – ve x direction.

For PQ to be horizontal it will be positon i.e. right half.

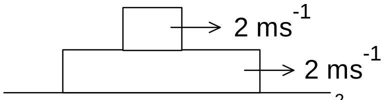
$$\frac{1}{\omega}\sin^{-1}\left(\frac{x}{A}\right) - \frac{T}{12} = \frac{1}{\omega}\cos^{-1}\left(\frac{x}{A}\right) - \frac{T}{12}$$

for P *for Q*

$x = \frac{A}{\sqrt{2}}$ hence $t_2 = \frac{T}{24}$

$$\frac{T_1}{T_2} = 11$$

5. 6



Retardation of plank = 4 ms^{-2} and retardation of block = 1.0 ms^{-2}

Hence relative acceleration of block w.r.t. plank = 3 ms

Skidding distance up to this time

$$\frac{1}{2}(3) \times \left(\frac{1}{4}\right) = \frac{3}{8}\, m$$

Plank is in rest now and block has velocity = $2 - 1 \times \frac{1}{2} = \frac{3}{2} ms^{-1}$

Skidding distance = $\frac{u^2}{2.a} = \frac{9}{8} m$.

Total skidding distance = $\frac{12}{8} m = 1.5 m$

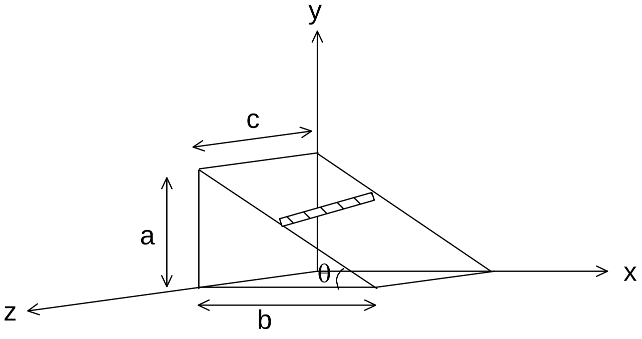
6. 6

$E = (d + x)i + E_0 i$

Net flux due to $E_y = 0$

Flux through left most surface is – ve and acceleration

Flux through inclined surface



$$\int (d + \ell\cos\theta) cd\ell.\sin\theta = dc\sin\theta.\ell + \frac{c.\ell^2\sin\theta.\cos\theta}{2}$$

$$= dc.a + \frac{c.a.b}{2}$$

Net = $\frac{a.b.c}{2} = 6$

7. 2
Path difference before slits = path difference after slits.

8. 6

9. 4
e.m.f of rod at any instant

$\varepsilon_i = B\ell v$

$\theta = B\ell vc \qquad I = \frac{d\theta}{dt} = B\ell ca$

Hence net force

$2Kx - B^2\ell^2ca = ma$

$a = \frac{2Kx}{(B^2\ell^2c + m)} \qquad T = 2\pi\sqrt{\frac{m + B^2\ell^2c}{2K}}$

10. 7
Heat lost = heat gained

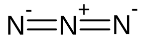
$m_i s_i(\theta_0 - \theta_i) = m_\omega L - m_\omega s_\omega(\theta_0 - \theta_\omega)$.

Chemistry

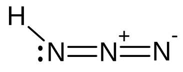
PART – II

SECTION – A

1. ABCD



Azide ion



Hydrazoic acid

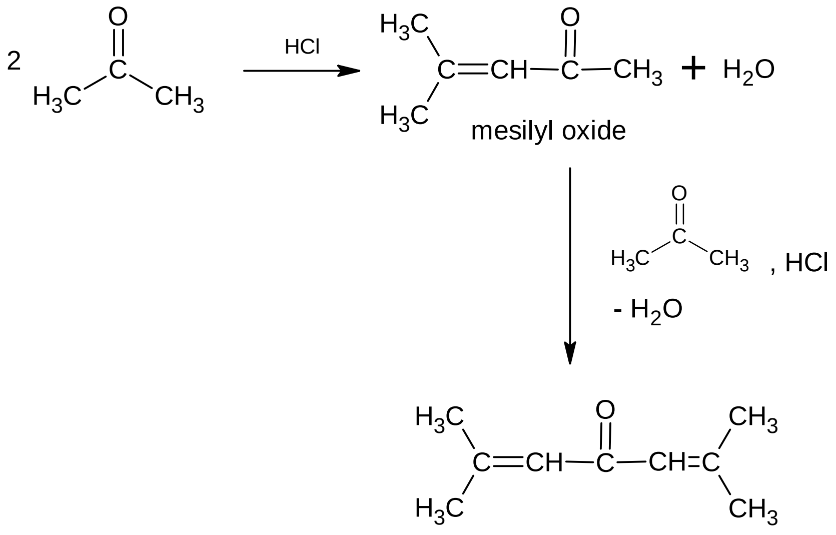
2. ABD
rate law equation is
rate = $K\left[H^{+}\right]\left[HNO_2\right]\left[Br^{-}\right]$

3. AC
Correct order is
F > N > O > C > Be > B
B > Tl > Ga > Al > In

4. ABC
Facts

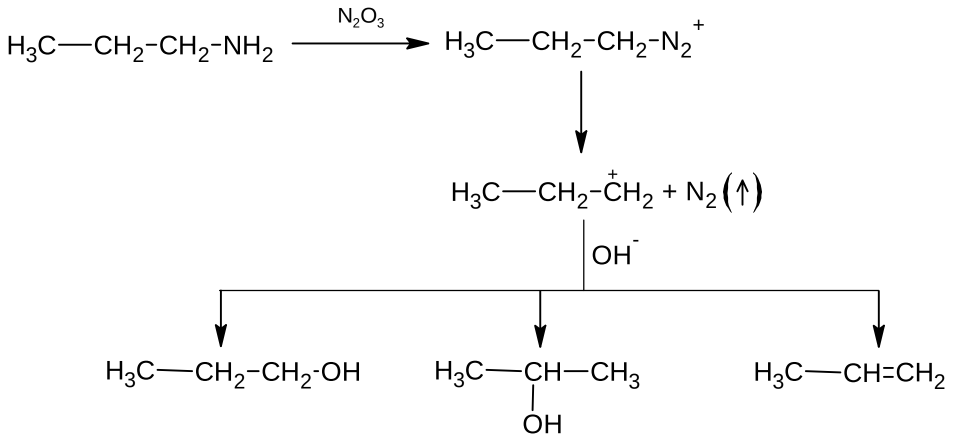
5. A
$[NiCl_4]^{2-}$ = tetrahedral, sp^3 hybridized so there are two odd e^-s in t_{2g} orbitals
$[Ni(CO)_4]$ = tetrahedral with sp^3 hybridization, no electrons unpaired

6. AB

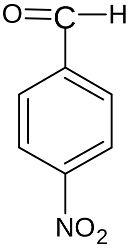


7. ABCD
Facts

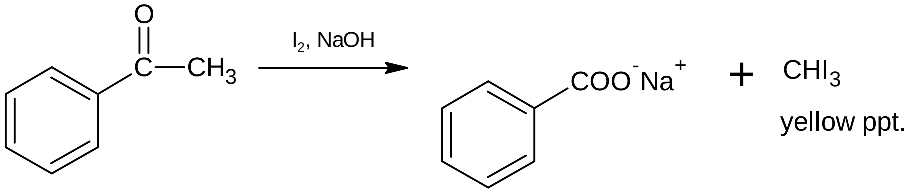
8. ABC


$H_3C-CH_2-CH_2-NH_2$
N_2O_3
$H_3C-CH_2-CH_2-N_2^+$
$H_3C-CH_2-\overset{+}{C}H_2 + N_2(\uparrow)$
OH^-
$H_3C-CH_2-CH_2-OH$
$H_3C-CH(OH)-CH_3$
$H_3C-CH=CH_2$

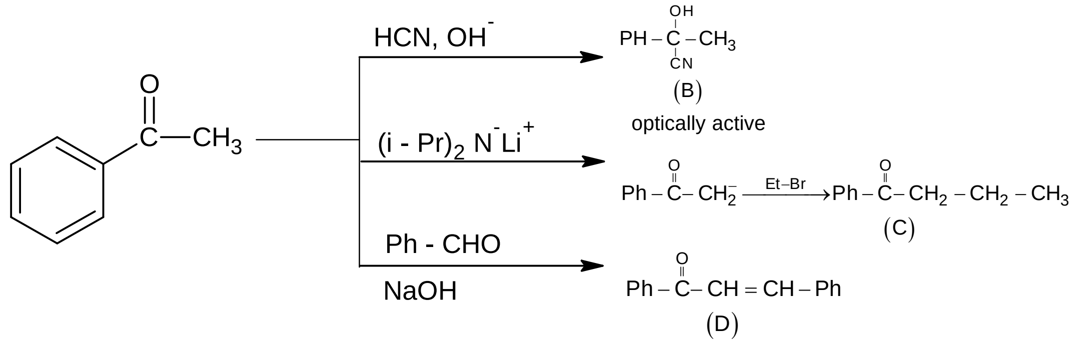
9. AC

In  the carbonyl carbon is more e^- deficient hence OH^- attacks over it.

10. BCD


I_2, NaOH
COO^-Na^+
+
CHI_3
yellow ppt.

(A)


HCN, OH^-
(i - Pr)$_2$ N^-Li^+
Ph - CHO
NaOH
$PH-C(OH)(CN)-CH_3$
(B)
optically active
$Ph-\overset{O}{C}-CH_2^-$
Et–Br
$Ph-\overset{O}{C}-CH_2-CH_2-CH_3$
(C)
$Ph-\overset{O}{C}-CH=CH-Ph$
(D)

SECTION – C

1. 3
Oxymercuration – demercuration doesn't allow rearrangement.

2. 4
(I), (II), (III) & (V) give aromatic species.

3. 3

$M^{3+} + SCN^- \rightleftharpoons MSCN^{2+}$

$[MSCN^{2+}] = (1.5\times10^{-3}\,M) - (1.0\times10^{-5}\,M) = 1.49\times10^{-3}\,M$

So, free $[M^{3+}] = (2.0\times10^{-3}\,M) - (1.49\times10^{-3}\,M)$

$= 0.51 \times 10^{-3}$ M

$$\therefore K = \frac{[MSCN^{2+}]}{[M^{3+}][SCN^-]} = \frac{1.49\times10^{-3}}{(0.51\times10^{-3})\times(1.0\times10^{-5})} = 2.92\times10^{-5} \approx 3.0\times10^{5}$$

4. 9

Mass of 25 protons = 25(1.00783 u) = 25.19575 u
And mass of 30 neutrons = 30(1.00867 u) = 30.2601
$\therefore$ Total mass = 55.45585 u
Given mass = 54.9244 u

Mass defect = 55.45585 u − 54.9244 u = 0.53145 u

$\therefore$ binding energy = $0.53145\text{ u}\times(931.5\text{ MeV / u}) = 495.045675\text{ MeV}$

$$\therefore \frac{\text{BE}}{\text{Nucleon}} = \frac{495.045675}{55\text{ nucleons}} = 9\text{ MeV}$$

5. 6

MnO_2, Co_3O_4, Ni_2O_3, CoS, HgS, Bi_2S_3 (blackish brown)

6. 9

$$Fe^{3+} + 2H_2O \rightleftharpoons Fe(OH)^{2+} + H_3O^+$$

$$K_a = \frac{[Fe(OH)^{2+}][H_3O^+]}{[Fe^{+3}]} = \frac{0.05\times[H_3O^+]}{0.95}$$

$$or\ 5.26\times10^{-7} = \frac{0.05\times[H_3O^+]}{0.95}$$

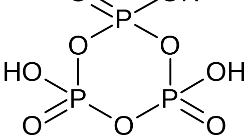
$$\therefore [H_3O^+] = 10^{-5},\ pH = 5,\ pOH = 9$$

7. 5

All Ca containing compounds impart brick red colouration to the flame . Except carnallite, alum & rock salt all other are Ca containing compounds.

8. 3

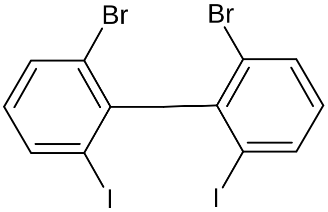
$(HPO_3)_3$



9. 2

Two stereoisomers are formed.

10. 5



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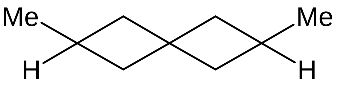

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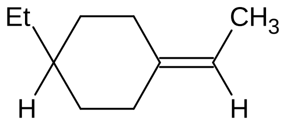


$CH_3CH = C = C = C = CHC_2H_5$, trans-cyclooctene are chiral.

Mathematics

PART – III

SECTION – A

1. C

$$\sum_{k=n+1}^{2n}(k-n)^2\left({}^nC_{k-n}\right)^2$$

Replace k – n → k

$$\sum_{k=1}^{n}k\left({}^nC_k\right)=\sum_{k=1}^{n}\frac{k\times n!}{k!(n-k)!}$$

$$=\sum_{k=1}^{n}\frac{n(n-1)!}{(k-1)!(n-k)!}$$

$$=n\left[\frac{(n-1)!}{(k-1)!(n-k)!}\right]$$

$$\sum_{k=1}^{n}k^2\left({}^nC_k\right)^2=n^2\sum_{k=0}^{n-1}\left({}^{n-1}C_k\right)^2$$

$$=n^2\left({}^{2n-2}C_{n-1}\right)$$

2. D

$${}^nC_k\left(\frac{1}{2}\right)^k\left(\frac{1}{2}\right)^{n-k}$$

Probability having exactly k male tigers

$$=P^n\,{}^nC_k\left(\frac{1}{2}\right)^k\left(\frac{1}{2}\right)^{n-k}\ (n\ge k)$$

So required probability $=\sum_{n=k}^{\infty}P^n\,{}^nC_k\left(\frac{1}{2}\right)^k\left(\frac{1}{2}\right)^{n-k}$

$$=\frac{2}{2-P}\left(\frac{P}{2-P}\right)^k$$

3. BD

$$\text{adj}\,(\text{adj}A)=|A|^{n-2}A$$

$$|\text{adj}\,(\text{adj}A)|=|A|^{(n-1)^2}$$

$$\text{so adj}(\text{adj}(\text{adj}A))=|A|^{(n-2)(n-1)}(\text{adj}A)$$

$$|\text{adj adj}\,(\text{adj }A)|=|A|^{(n-1)^3}$$

$$=|A|^{(n-1)^3}$$

4. AD

$$(x-1)^2+(y-2)^2=P^2+5$$

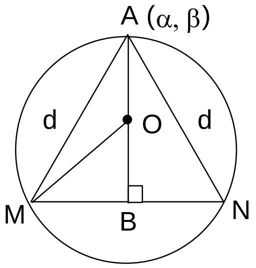
Shifted to (1, 2)

Let $a^2 = P^2 + 5$

Equation of line MN is $\beta y + \alpha x = k$

$= mOA = \frac{\beta}{\alpha}$

$AB = a \pm \frac{k}{a}$



$\left(BM\right)^2 = \left(OM\right)^2 - \left(OB\right)^2$

$= a^2 - \frac{k^2}{a^2}$

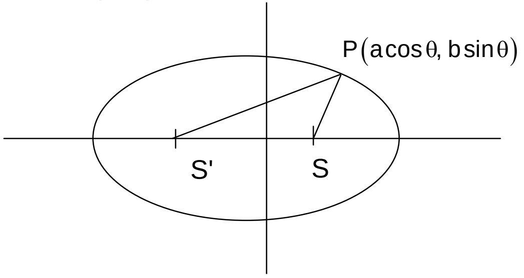
$\left(AM\right)^2 = \left(AB\right)^2 + \left(BM\right)^2$

$\Rightarrow d^2 = \left(a \pm \frac{k}{d}\right)^2 + a^2 - \frac{k^2}{d^2}$

$\Rightarrow d^2 = 2a^2 \pm 2k$

5. BC

Shift to (2, 1)



In $\Delta PSS'$

$SS' = 2ae,\ SP = a - ae\cos\theta,\ S'P = a + ae\cos\theta$

$h = ae\cos\theta \ \&\ k = \frac{eb\sin\theta}{e+1}$

So locus of incentres

$$\frac{x^2}{a^2e^2} + \frac{y^2}{\left(\frac{be}{e+1}\right)^2} = 1$$

And its eccentricity = $\sqrt{\frac{2e}{e+1}}$

6. AC

$f\left(x\right) + f\left(1-x\right) = \frac{e^x}{e^x + \sqrt{e}} + \frac{\sqrt{e}}{e^x + \sqrt{e}} = 1$

So $f_2(x) + f_2(1 - x) = 1$

$$\sum_{r=1}^{2n-1} 2f_e\left(\frac{r}{2n}\right) = 2\left[f_e\left(\frac{1}{2n}\right)+f_e\left(\frac{2}{2n}\right)+....f_e\left(\frac{2n-1}{2n}\right)\right]$$

$$=2\left[(n-1)+f_e\left(\frac{1}{2}\right)\right]$$

$$=2\left[n-1+\frac{1}{2}\right]$$

$$=2n-1$$

$$\sum_{r=1}^{1996} g\left(\frac{r}{1997}\right) = \left[g\left(\frac{1}{1997}\right)+g\left(\frac{1996}{1997}\right)\right]+\left[g\left(\frac{2}{1997}\right)+g\left(\frac{1995}{1997}\right)\right]+.....\left[g\left(\frac{998}{1997}\right)+g\left(\frac{999}{1997}\right)\right]$$

$$=998$$

7. BCD

Use the property, foot of perpendicular from focus to tangent lies on the tangent at vertex. Using this we get equation of tangent at vertex is 6y – 4x + 1 = 0

8. ACD

$$\frac{a+c}{2} \ge b \Rightarrow a+c > 2b$$

Similary b + d > 2c
a + b + c + d > 2b + 2c
a + d > b + c
and GM $\ge$ HM

$$b > \frac{2ac}{a+c}$$

$$ab+bc > 2ac$$

GM $\ge$ *HM*

$$\frac{1}{d}+\frac{1}{b} > \frac{2}{c}$$

Now $\frac{1}{a}+\frac{1}{d} > \frac{1}{b}+\frac{1}{c}$

Divide by abc, we get

$$ab+cd > 2(ac+bd-bc)$$

Divide by abcd

$$2\left(c^{-1}d^{-1}+a^{-1}b^{-1}\right) > 2\left(b^{-1}d^{-1}+a^{-1}c^{-1}-a^{-1}d^{-1}\right)$$

9. B

$$\lim_{x\to\infty} \frac{x!}{n!(x-n)!}\frac{a^n}{(x)^n}.\frac{\left(1-\frac{a}{x}\right)^x}{\left(1-\frac{a}{x}\right)^n}$$

$$\lim_{x\to\infty} \frac{a^n}{n!}\left(1-\frac{a}{x}\right)^x\left[\frac{(1)\left(1-\frac{1}{x}\right)\left(1-\frac{2}{x}\right)...\left(1+\frac{1-n}{x}\right)}{\left(1-\frac{a}{x}\right)^n}\right]$$

$$\lim_{x\to\infty} \frac{a^n}{n!}\times\frac{e^{-a}\times 1}{1^n} = \frac{a^n.e^{-a}}{n!}$$

10. B

Numbers of permutation with 2 in first position = 19!

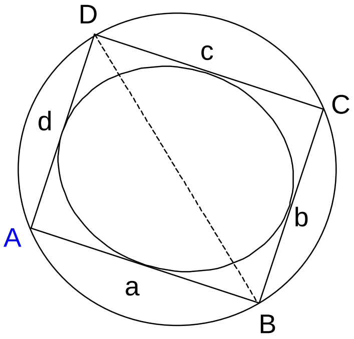
For second position = 10 × 18!

Similarly = $\frac{19!+10\times 18!+10\times 9\times 17!+...10!\times 9!}{20!}=0.1$

SECTION – C

1. 3

a + c = b + d



$\cos A=\frac{a^2+d^2-(BD)^2}{2ad}$

$BD^2=a^2+d^2-2ad\cos A$

and in ΔBCD

$\cos C=\frac{b^2+c^2-(BD)^2}{2bc}$

$(BD)^2=b^2+c^2-2bc\cos C$

$(BD)^2=b^2+c^2+2bc\cos A$

Compare we get $\cos A=\frac{ad-bc}{ad+bc}$

$=\frac{aar^3-arar^2}{a^2\left(r^3+r^2\right)}=0,\ A=\frac{\pi}{2}$

2. 8

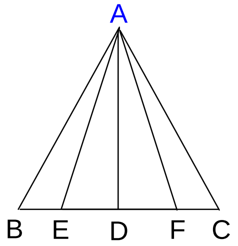
For n = 1 ⇒ we get 16 triangle

For n = 2 ⇒ we get 32 triangle

So for n total number of triangle is 16n

3. 2

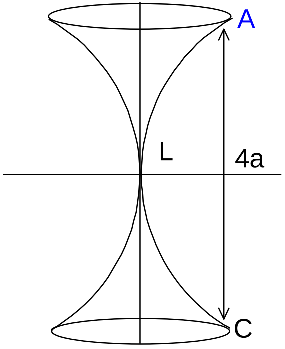
In ΔAEF



$AE^2 + AF^2 = 2(AD^2 + ED^2)$
$\Rightarrow AE^2 + AF^2 - 2AD^2 = 2$

4. 2

Required volume = 2(volume generate by the revolution about y-axis of the area ALC)



$= 2\int_0^{2a} \pi x^2 dy$

$= 2\pi \int_0^{2a} \frac{y^4}{16a^2} dy$

$= \frac{4\pi a^3}{5}$ and $a = \frac{1}{2}$

$= \frac{\pi}{10}$

so $\frac{20}{\pi} . \frac{\pi}{10} = 2$

5. 3

$\bar{v}_1 = \sqrt{a^2 - (b-1)^2}\, i + aj + \sqrt{a^2 + (b-1)^2}\, \hat{k}$

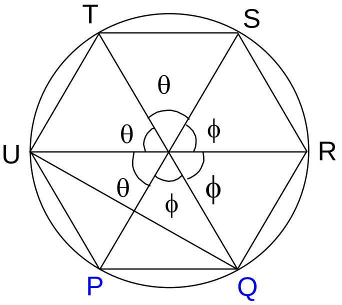
$\bar{v}_2 = \tan A i + \tan B j + \tan C k$

Let $\bar{v}_1 . \bar{v}_2 = 3a$

$\sum \tan^2 A = 3\sec^2 \theta$

so min $\sum \tan^2 A = 3$

6. 7



$3(\theta + \phi) = 360^o$

$\theta + \phi = 120^o$

$$\cos 120 = \frac{9+36-FB^2}{2(18)}$$

$$\cos(\theta+\phi) = \cos(120) = \frac{r^2+r^2-63}{2r^2}$$

$$\Rightarrow r^2 = 21$$

$$r = \sqrt{21}$$

7. 2

$$I_n = \int_0^{\pi}\left(\frac{2\sin\left(n+\frac{1}{2}\right)x.\sin\frac{x}{2}}{1-\cos x}\right)dx$$

$$I_n = I_{n-1} = I_{n-2} - I_0$$

$$I_n = I_0 \Rightarrow I_0 = \pi \Rightarrow I_n = \pi$$

so $\frac{n\pi}{2} = \pi \Rightarrow n = 2$

8. 6

$$L \equiv \frac{x-2}{a} = \frac{y-2}{b} = \frac{z-1}{c}$$

$$2a+b-6c = 0 \ \& \begin{vmatrix} a & b & c \\ 1 & -1 & 2 \\ 2 & 1 & -6 \end{vmatrix} = 0$$

We get a : b : c ≡ 33 : 30 : 16

So $\frac{2a}{c} + \frac{b}{c} = \frac{33}{8} + \frac{15}{8} = 6$

9. 1

$$e^x + e^{-x} + 3 - 5\cos x = 0$$

$$e^x + e^{-x} = 5\cos x - 3$$

So only one solution x = 0

10. 4

$$\sin^{-1}\left(-\frac{1}{2}\right) + \cos^{-1}\left(-\frac{1}{2}\right) = \frac{\pi}{2}$$

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

FIITJEE **JEE (Advanced), 2017**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - IV

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 186**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 05)** contains 5 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (06 to 13) contains 8 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer and **– 2 mark** for wrong answer.

(ii) **Section-C (01 to 05)** contains 5 Numerical based questions with single digit integer as answer, ranging from 0 to 9. Each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

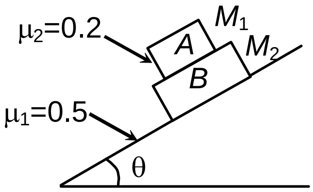
SECTION – A

Straight Objective Type

This section contains **5 multiple choice questions** numbered 1 to 5. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. Two trains *A* and *B* are moving on same track in opposite direction with velocity 25 m/s and 15m/s respectively. When separation between them becomes 225 m, drivers of both the trains apply brakes producing uniform retardation in train *A* while retardation of train *B* increases linearly with time at the rate of 0.3 m/s^3. The minimum retardation of train *A* to avoid collision will be
(A) 2 m/s^2 (B) 2.5 m/s^2
(C) 2.25 m/s^2 (D) 2.75 m/s^2

2. Two blocks M_1 and M_2 rest upon each other on an inclined plane. Coefficient of friction between surfaces are shown. If the angle θ is slowly increased, then ($M_1 < M_2$)



(A) block *A* slips first
(B) block *B* slips first
(C) both slip simultaneously
(D) both remain at rest

3. An artificial satellite of mass *m* is moving in a circular orbit at a height equal to the radius *R* of the earth. Suddenly due to internal explosion the satellite breaks into two parts of equal masses. One part of the satellite stops just after the explosion. The increase in the mechanical energy of the system (satellite + earth) due to explosion will be
(Given: acceleration due to gravity on the surface of earth is *g*)
(A) mgR (B) $\frac{mgR}{2}$
(C) $\frac{mgR}{4}$ (D) $\frac{3mgR}{4}$

Space for rough work

4. The equation of a particle executing SHM is given by $x = 3\cos\left(\frac{\pi}{2}\right)t$ cm, where t is in second. The distance travelled by the particle in the first 8.5 s is

(A) $\left(24 + \frac{3}{\sqrt{2}}\right)$ cm
(B) $\left(27 - \frac{3}{\sqrt{2}}\right)$ cm
(C) $\left(24 - \frac{3}{\sqrt{2}}\right)$ cm
(D) $\left(27 + \frac{3}{\sqrt{2}}\right)$ cm

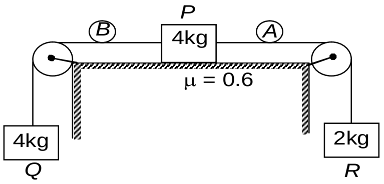
5. n identical charged particles are placed on the vertices of a regular polygon of n sides of side length a. One of the charge particle is released from polygon. When this particle reaches a far of distance, another particle adjacent to the first particle is released. The difference of kinetic energies of both the particles at infinity is k. Magnitude of charge is

(A) $\sqrt{4\pi\varepsilon_0 ak}$
(B) $\frac{k}{4\pi\varepsilon_0 a}$
(C) $\frac{k}{a}$
(D) $\sqrt{ka}$

Multiple Correct Choice Type

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

6. A blocks P of mass 4 kg is placed on horizontal rough surface with coefficient of friction μ = 0.6. And two blocks R and Q of masses 2 kg and 4 kg connected with the help of massless strings A and B respectively passing over frictionless pulleys as shown, then (g = 10m/s^2)



(A) acceleration of block P is zero.
(B) tension in string A is 20 N.
(C) tension in string B is 40 N.
(D) surface contact force on block P is $20\sqrt{5}$ N.

7. A body moving towards a finite body at rest collides with it. It is possible that
(A) both the bodies come to rest
(B) both the bodies move after collision
(C) the moving body comes to rest and the stationary body starts moving
(D) the stationary body remains stationary; the moving body changes its velocity

Space for rough work

8. An object is floating in a liquid, kept in a container. The container is placed in a lift. Choose the correct option(s)
(A) Buoyant force increases as lift accelerates up
(B) Buoyant force decreases as lift accelerates up
(C) Buoyant force remains constant as lift accelerates
(D) The fraction of solid submerged into liquid does not change

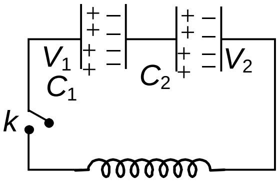
9. A standing wave of time period T is set up in a string clamped between two rigid supports. At $t = 0$ antinode is at its maximum displacement $2A$.
(A) The energy of a node is equal to energy of an antinode for the first time at $t = T/8$.
(B) The energy of node and antinode becomes equal after every $T/2$ second.
(C) The displacement of the particle of antinode at $t = \frac{T}{8}$ is $\sqrt{2}A$.
(D) The displacement of the particle of node is zero.

10. Charges Q_1 and Q_2 lie inside and outside respectively of a closed Gaussian surface S. Let E be the field at any point on S and ϕ be the flux of E over S:
(A) If Q_1 changes, both E and ϕ will change
(B) If Q_2 changes E will change
(C) If $Q_1 = 0$ and $Q_2 \neq 0$ then $E \neq 0$ but $\phi = 0$
(D) If $Q_1 \neq 0$ and $Q_2 = 0$ then $E = 0$ but $\phi \neq 0$

11. Two circular coils of radii 5 cm and 10 cm carry equal currents of 2A. The coils have 50 and 100 turns respectively and are placed in such a way that their planes as well as their centres coincide. Magnitude of magnetic field at the common centre of coils is
(A) $8\pi \times 10^{-4}$ T if current in the coil are in same sense
(B) $4\pi \times 10^{-4}$ T if current in the coil are in opposite sense
(C) zero if currents in the coils are in opposite sense
(D) $8\pi \times 10^{-4}$ T if current in the coil are in opposite sense

Space for rough work

12. Two capacitors of capacitance C_1 and C_2 are charged to a potential difference of V_1 and V_2 respectively and are connected to an inductor of inductance L as shown in the figure. Initially key k is open. Now key k is closed and current in the circuit starts increasing. When current in the circuit is maximum



(A) Charge on both the capacitors is same
(B) Induced emf in the inductor is zero
(C) Potential difference across both the capacitors is same
(D) Electrostatic potential energy stored in both the capacitors is same

13. When photons of energy 4.25 eV strike the surface of a metal A, the ejected photoelectrons have maximum kinetic energy T_A eV and de Broglie wavelength λ_A. The maximum kinetic energy of photoelectrons liberated from another metal B by photons of energy 4.70 eV is $T_B = (T_A - 1.50)$eV. If the de Broglie wavelength of these photoelectrons is $\lambda_B = 2\lambda_A$, then

(A) The work function of A is 1.25 eV
(B) the work function of B is 4.20 eV
(C) $T_A = 3.00$ eV
(D) $T_B = 1.5$ eV

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

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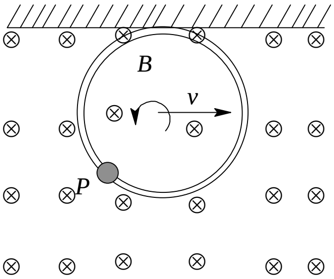
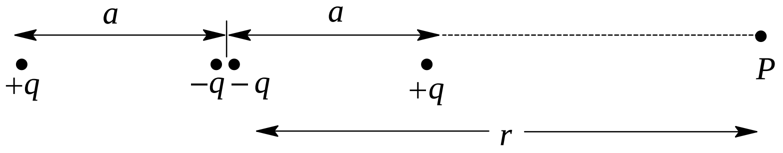
1. A rigid ring is made to roll along the ceiling of a room, where exists a uniform horizontal magnetic field of induction B perpendicular to the plane of the ring. The velocity of the centre of the ring is constant and its modulus is v. A charge particle P of mass m is fixed on the ring. The charge q on the particle is $\frac{kmg}{Bv}$ so that there is no force of interaction between the ring and the particle, then find the value of k ?

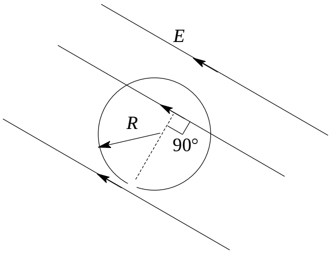


Space for rough work

2. Figure shows a charge array known as an "electric quadrupole". For a point on the axis of the quadruple, the dependence of potential on r $\left(\frac{r}{a} >> 1\right)$ is $\frac{1}{r^n}$. Find n?



3. A non conducting ring having uniform charge distribution q is having a small cut of length $b\left(b << R\right)$ is released from rest with its plane parallel to the field as shown in the figure. If the maximum angular velocity of the ring is $\sqrt{\frac{C\,qEb}{22mR^2}}$, then find the value of C?



4. Two wires are made of the same material and have the same volume. However, wire 1 has cross-sectional area A and wire-2 has cross-sectional area 3A. If the length of wire 1 increases by Δx on applying force 1 newton, how much force (in Newton) is needed to stretch wire 2 by the same amount?

5. Two pendulums of lengths 1.44 and 1 metre length start swinging together. After how many oscillation of first pendulum they will again start swing together?

Space for rough work

Chemistry   PART – II

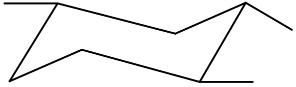
SECTION – A

Straight Objective Type

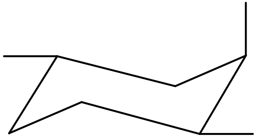
This section contains **5 multiple choice questions** numbered 1 to 5. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. Which of the following compound has lowest potential energy?

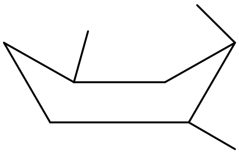
(A)



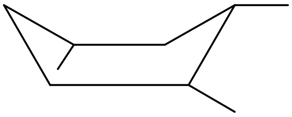
(B)



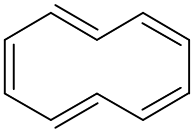
(C)



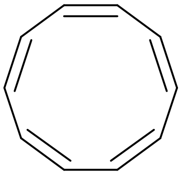
(D)



2. The following two compound are:



(I)



(II)

(A) Identical
(B) conformational isomers
(C) geometrical isomers
(D) structural isomers

3. If mercuric iodide is added to an aqueous solution of KI, the:
(A) freezing point is raised
(B) freezing point is lowered
(C) boiling point does not change
(D) freezing point does not change

Space for rough work

4. Which of the following is weaker base?

(A) $N\left(SiH_3\right)_3$ (B) $N\left(CH_3\right)_3$

(C) $NH\left(CH_3\right)_3$ (D) All are equally basic

5. Choose the correct method for each:

(A) $Ni:$ electrolysis, $Cu:$ van Arkel process, $Zn:$ zone refinining, $Ga:$ zone refining

(B) $Ni:$ mond's process, $Cu:$electrolysis, $Zr:$ van Arkel process, $Ga:$ zone refining

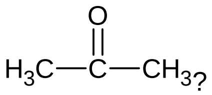
(C) $Ni:$ electrolysis, $Cu:$ zone refining, $Zr:$ van Arkel process, $Ga:$ electrolysis

(D) $Ni:$ electrolysis, $Cu:$ zone refining, $Zr:$ van Arkel process, $Ga:$ mond's process

Multiple Correct Choice Type

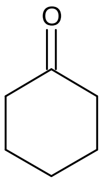
This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

6. Which of the following compound have larger $C-O$ bond length than $C-O$ bond length of

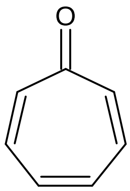


$$H_3C-\overset{\overset{\large O}{\|}}{C}-CH_3?$$

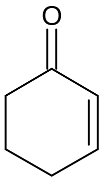
(A)



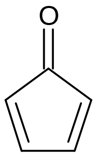
(B)



(C)



(D)

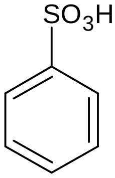


Space for rough work

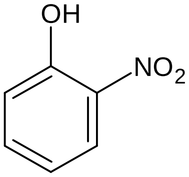
7. Which of the following compounds are soluble in $NaHCO_3$?

(A) Picric acid

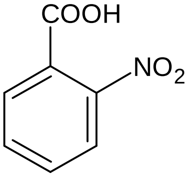
(B)



(C)



(D)



8. Which of the following statement/statements is/are correct?

(A) in the $NaCl$ structures, each Na^+ ion is surrounded by $6Cl^-$ ions as nearest neighbours and twelve Na^+ ions as next nearest neighbours.

(B) the co-ordination number of cation generally increases as the radius ratio increases

(C) packing efficiencies higher than 0.74 are possible only with cation and anion of different sizes

(D) during a crystal defect electrical neutrality should be maintained.

9. Which of the following has/have a dipole moment:

(A) $2,2,3,3-$tetramethylbutane

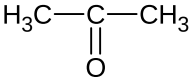
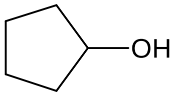
(B) Trans-2-pentene

(C) cis-1, 2-dichloroethene

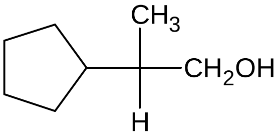
(D) trans-1, 2-dichloroethene

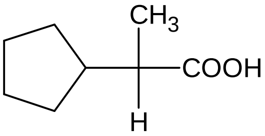
Space for rough work

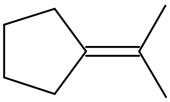
10. An optically active alcohol $A\left(C_8H_{16}O\right)$ on oxidation gives B. A on acidic heating gives $C\left(C_8H_{14}\right)$ as major product. C on ozonolysis produces $D\left(C_5H_8O\right)$ and

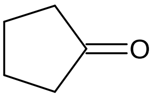

$H_3C-\underset{\underset{O}{\|}}{C}-CH_3$. D on reduction with $LiAlH_4$ gave  .

Identify correct answer:

(A) A is 

(B) B is 

(C) C is 

(D) D is 

11. A mixture of three proteins, (A) (pepsin), (B) (haemoglobin) and (C) (Lysozyme) was separated by electrophoresis method at pH=7. The pH at isoelectric point $\left(pI\right)$ of the proteins are pI of $\left(A\right)$, $\left(B\right)$ and $\left(C\right)$ which are following statement/statements is/are correct?

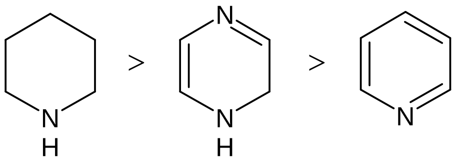
(A) pepsin $\left(A\right)$ will migrate to the cathode

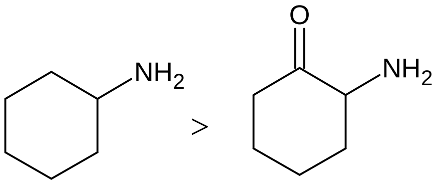
(B) Lysozyme $\left(C\right)$ will migrate to the anode

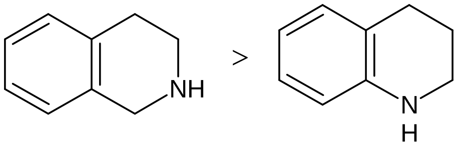
(C) Haemoglobin will not migrate

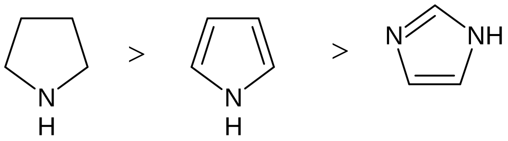
(D) at $pH = 7$, $\left(A\right)$ and $\left(C\right)$ would precipitate out while $\left(B\right)$ would remain in solution.

12. Which of the following order for basic strength is/are correct?

(A) 

(B) 

(C) 

(D) 

13. Which of the following has face centered Bravais lattice?

(A) Hexagonal

(B) Monoclinic

(C) cubic

(D) orthorhombic

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. If four atoms of same radius are placed at the alternate corner of a cube touching each other, than the length of body diagonal of the cube is equal to $\sqrt{x} \times R$, where R is the radius of atom. Find the value of x?

2. The cost of electricity required to deposit 1 g Mg is Rs. 5.00. The cost of 30 g of Al to be deposited is Rs. X. Find the value of $\frac{x}{40}$?

3. A certain buffer solution contains equal concentration of X^- and HX. The K_b for X^- is 10^{-10}. Find the pH of this buffer solution?

4. Co forms dinuclear complex with a sigma bond within two Co atoms. Consider that metal carbonyls follows EAN rule. The complex can be written as $\mathrm{CO}_2(CO)_x$. Find the value of x?

5. Diethyl$-\beta$, $\beta-$dimethylglutaric acid $(ester)$ is condensed with diethyl oxalate in presence of sodium ethoxide and ethanol to form a major product (P), which on acidic hydrolysis followed by heating gives another product (Q). Calculate total number of C=O bonds in (P) and (Q) compounds?

Space for rough work

Mathematics

PART – III

SECTION – A

Straight Objective Type

This section contains **5 multiple choice questions** numbered 1 to 5. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. Suppose f and g are functions having second derivatives f'' and g'' everywhere, if f(x) g(x) = 1 for all x and f ' (x) and g' are never zero, then $\frac{f''(x)}{f'(x)} - \frac{g''(x)}{g'(x)}$ equals

(A) $\frac{f'(x)}{f(x)}$
(B) $2\frac{f'(x)}{f(x)}$
(C) $-\frac{2g'(x)}{g(x)}$
(D) $-\frac{2f'(x)}{f(x)}$

2. Let a real valued differentiable function f(x) be strictly monotonic on [a, b], then

(A) $\int_a^b \left[(f(x))^2 - (f(b))^2\right]dx = \int_{f(a)}^{f(b)} 2x\left(b - f^{-1}(x)\right)dx$

(B) $\int_a^b \left[(f(x))^2 - (f(a))^2\right]dx = \int_{f(a)}^{f(b)} 2x\left(b - f^{-1}(x)\right)dx$

(C) $\int_a^b \left[f(x) - f(a)\right]^2 dx = \int_{f(a)}^{f(b)} x\left(b - f^{-1}(x)\right)^2 dx$

(D) None of these

Space for rough work

3. Let A be the point of intersection of the curve $y = \log_{\frac{1}{3}}\left(x - \frac{1}{3}\right) + \log_3 \sqrt{9x^2 - 6x + 1}$ and the circle $x^2 + y^2 = 17$. B is also a point on the curve but lies inside the given circle such that its abscissa is an integer, then max {AB} is
(A) 2 units (B) 3 units
(C) 4 units (D) none of these

4. If S_n denotes the sum of first n terms of an AP and $a_n = \frac{S_{3n}}{S_{2n} - S_n}$, then $\underset{n\to\infty}{\text{Lt}} \sum_{r=1}^{2n} \frac{a_r}{n}$ is equal to
(A) 2 (B) 4
(C) 6 (D) 8

5. The possible value of a for which $e^{2x} - (a - 2) e^x + a < 0$ holds for at least one positive x is
(A) 2 (B) 3
(C) 4 (D) 7

Multiple Correct Choice Type

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

6. The values of x for which $x^2 - 4x > \cot^{-1} x$ holds true belong to
(A) $(-\infty, -1)$ (B) $[5, \infty)$
(C) $(-1, 5]$ (D) none of these

7. For a given parabola $y^2 = 4ax$, two variable chords *PQ* and *RS* at right angles are drawn through the fixed point $A(x_1, y_1)$ inside the parabola, making variable angles θ and α with *x*–axis. If r_1, r_2, r_3, r_4 are distances of *P*, *Q*, *R* and *S* from *A*, then the value of $\frac{1}{r_1r_2} + \frac{1}{r_3r_4}$
(A) independent of θ (B) independent of α
(C) depends upon both θ and α (D) is a constant

Space for rough work

8. From (1, 2), tangents are drawn to the curve $y^2 - 2x^3 - 4y + 8 = 0$. Then
(A) sum of x–coordinates of points of contact is zero

(B) sum of x–coordinates of points of contact is 4

(C) sum of y–coordinates of points of contact is zero

(D) sum of y–coordinates of points of contact is 4

9. If $\left|\int_a^b f(x)dx\right| = \int_a^b |f(x)|dx \ (a \neq b)$ also $f(x) \neq 0$ for any $x \in (a, b)$ and $g(x) = \int_0^x f(x)dx$, then $\int_a^b f(x)g(x)dx$ when a and b are positive

(A) cannot be positive
(B) cannot be negative
(C) cannot be equal to zero
(D) nothing can be said

10. If $\alpha, \beta, \gamma \in R$, then the determinant

$$\Delta = \begin{vmatrix} (e^{i\alpha} + e^{-i\alpha})^2 & (e^{i\alpha} - e^{-i\alpha})^2 & 4 \\ (e^{i\beta} + e^{-i\beta})^2 & (e^{i\beta} - e^{-i\beta})^2 & 4 \\ (e^{i\gamma} + e^{-i\gamma})^2 & (e^{i\gamma} - e^{-i\gamma})^2 & 4 \end{vmatrix}$$ is

(A) equal to 0
(B) equal to $e^{i(\alpha+\beta+\gamma)}$
(C) independent of α, β and γ
(D) dependent of α, β and

Space for rough work

11. If AB = A and BA = B, where A and B are square matrices, then
(A) $A^2 = A$ (B) $A^2 = B$
(C) $B^2 = B$ (D) $B^2 = A$

12. If a complex number satisfies the equation $|z| - \log_2(z + 2) = 0$ (Re z > 0), then
(A) $z = -\bar{z}$ (B) $|z| = 2$
(C) $\arg(z) = \frac{\pi}{2}$ (D) $\arg(z) = 0$

13. If the equation $x^3 + 2x^2 + x + k = 0$ has three real roots in which two roots are equal, then value of k is/are
(A) 0 (B) $k = \frac{27}{4}$
(C) $k = \frac{4}{27}$ (D) none of these

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

1. Find number of positive integral solution of equation $\tan^{-1} x + \cos^{-1}\frac{y}{\sqrt{1-y^2}} = \sin^{-1}\frac{3}{\sqrt{10}}$

2. Tangent are drawn from any point on the hyperbola $x^2/9 - y^2/4 = 1$ to the circle $x^2 + y^2 = 9$ If the locus of the mid-point of the chord of contact is a $a\left(x^2 + y^2\right)^2 = bx^2 - cy^2,$ then the value of $a^2 + b^2 + c^2 - 7870$ is equal to……………

Space for rough work

3. If $A = \begin{pmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{pmatrix}$ and $A^2 - 4A - 5I = O$ where I and O are the unit matrix and the null matrix of order 3 respectively. If $15A^{-1} = \lambda \begin{vmatrix} -3 & 2 & 2 \\ 2 & -3 & 2 \\ 2 & 2 & -3 \end{vmatrix}$ then the find the value of λ.

4. The plane $2x - 2y + z = 3$ is rotated about the line where it cuts the xy plane by an acute angle α. If the new position of plane contains the point (3, 1, 1) then $9\cos\alpha$ equal to …….

5. If $0 < \alpha, \beta < 2\pi$, then the number of ordered pairs (α, β) satisfying $\sin^2(\alpha + \beta) - 2 \sin\alpha \sin(\alpha + \beta) + \sin^2\alpha + \cos^2\beta = 0$ is

Space for rough work

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

FIITJEE **JEE(Advanced)-2017**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

CONCEPT RECAPITULATION TEST - IV
(PAPER-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	A	B
2.	A	C	B
3.	C	A	B
4.	B	A	C
5.	A	B	D
6.	ABCD	BC	AB
7.	BC	ABD	ABD
8.	AD	ABCD	BD
9.	ACD	ABC	BC
10.	ABC	ABCD	AC
11.	AC	ABC	AC
12.	BC	ABC	BD
13.	ACD	CD	AC
1.	1	6	2
2.	3	5	3
3.	7	4	3
4.	9	8	7
5.	5	6	4

Physics

PART – I

SECTION – A

1. $$O=(25)^2-2ax............(1)$$

$$\frac{-3}{10}t=\frac{dv}{dt}$$

$$\int_{15}^{v}dv=\frac{3}{10}\int_{0}^{t}t\ dt$$

$$v=15-\frac{3}{20}t^2........(2)\,when\,v=0\Rightarrow t=10\sec$$

$$\int_{0}^{225-x}dx=15\int_{0}^{10}dt\frac{-3}{20}\int_{0}^{10}t^2\,dt$$

$$225-x=15(10)-\frac{3}{20}\frac{(1000)}{3}$$

$$225-x=150-50......(3)$$

Solving (1) and (3)

$$a=2.5\,m/s^2$$

2. $$M_1g\sin\theta>\frac{M_1g\cos\theta}{5}$$

M_1 will slip if $\tan\theta>\frac{1}{5}$

$$M_2g\sin\theta'+\frac{M_1g\sin\theta'}{5}>\frac{1}{2}M_2g\cos\theta'$$

M_2 will slip if $\tan\theta'>\dfrac{1}{2+\frac{2}{5}\frac{M_1}{M_2}}$

So M_1 will slip first

3. Using momentum conservation

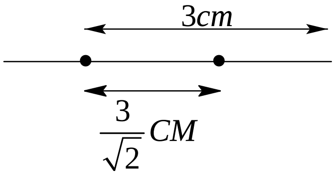
$$m\sqrt{\frac{GM}{2R}}=\frac{m}{2}V'$$

$$V'=\sqrt{\frac{2GM}{R}}$$

$$\Delta U=\left(\frac{1}{2}\frac{m}{2}\frac{2GM}{R}\right)-\left(\frac{1}{2}m\frac{GM}{2R}\right)$$

$$\Delta U=\frac{mgR}{4}$$

4.



Time period $= 4\sec$

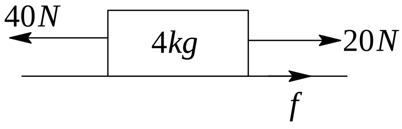
Distance travelled in $8\sec = 24cm$

Distance travelled in $8.5\sec = 24 + 3 - \frac{3}{\sqrt{2}} = \left(27 - \frac{3}{\sqrt{2}}\right)cm$

5. $k = \frac{1}{4\pi\varepsilon_0}\frac{q_2}{a}$

$q = \sqrt{4\pi\varepsilon_0 ak}$

6.



$f = 20N\left(< 24N\right)$

So block will not move

Contact force $= \sqrt{\left(20\right)^2 + \left(40\right)^2} = 20\sqrt{5}\ N$

7. Option (a) and (d) violate law of conservation of momentum.

8. Buoyancy force when lift accelerates upwards $= V_s\left(g + a\right)\rho$

$$V\sigma g = V_s\delta g.............(1)$$

$$V_s'\rho\left(g + a\right) - V\sigma g = V\sigma a$$

$$V_s'\rho g + V_s'\rho a - V\sigma g = V\sigma a$$

$$V_s'\rho g + V_s'\rho a - V_s\rho g = V_s\rho a\ \left(\text{Using equation}\left(1\right)\right)$$

$$V_s'\left(g + a\right) = V_s\left(a + g\right)$$

$$V_s' = V_s$$

10. Flux depends upon charges inside Gaussian surface and field on all charges.

11. For same sense field $B = \frac{N_1\mu_0 I}{2R_1} + \frac{N_2\mu_0 I}{2R_2} = 8\pi \times 10^{-4}T$

For opposite sense field $B' = \frac{N_1\mu_0 I}{2R_1} = \frac{N_2\mu_0 I}{2R_2} = 0$

12. $V_1' + V_2' = \frac{Ldi}{dt}$

When current is maximum $\frac{di}{dt} = 0 \Rightarrow V_1' = -V_2'$

And $\varepsilon = \frac{Ldi}{dt} = 0$

SECTION – C

3. $\frac{qb}{2\pi R} ER = \frac{1}{2} mR^2\omega^2$

$\omega = \sqrt{\frac{7qEb}{22mR^2}}$

So $C = 7$

4. $y = \frac{1/A}{x/\ell}$................(1)

$y = \frac{F/3A}{x/3\ell}$.............(2) $\Rightarrow F = 9N$

5. $T_1 = 2\pi\sqrt{\frac{1.44}{g}} = 1.2\ T_2\ \ where\,T_2 = \frac{2\pi}{\sqrt{g}}$

$\frac{T_1}{T_2} = \frac{6}{5}$

So after 5 oscillation of first they will swing in phase

Chemistry

PART – II

SECTION – A

1. In option (a) all methyl groups are equatorial

2. (I) is trans and (II) is cis form

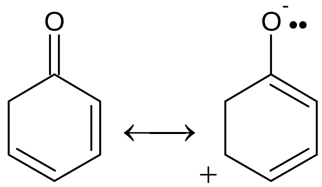
3.

$$\underbrace{2KI+HgI_2}_{\text{Four ions}} \longrightarrow \underbrace{K_2\left[HgI_4\right]}_{\text{three ions}}$$

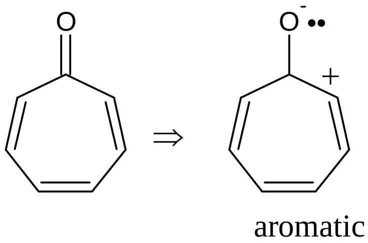
4. Due to back bonding (a) is a weaker base.

6.

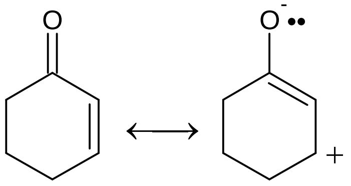
(a)



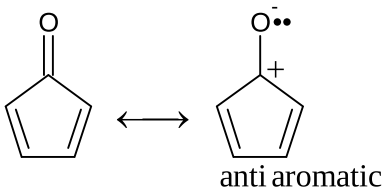
(b)



(c)

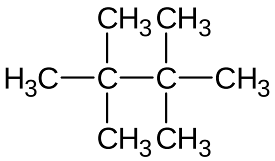


(d)



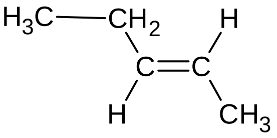
9.

(a)

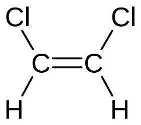


$H_3C-C(CH_3)_2-C(CH_3)_2-CH_3$

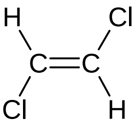
(b)



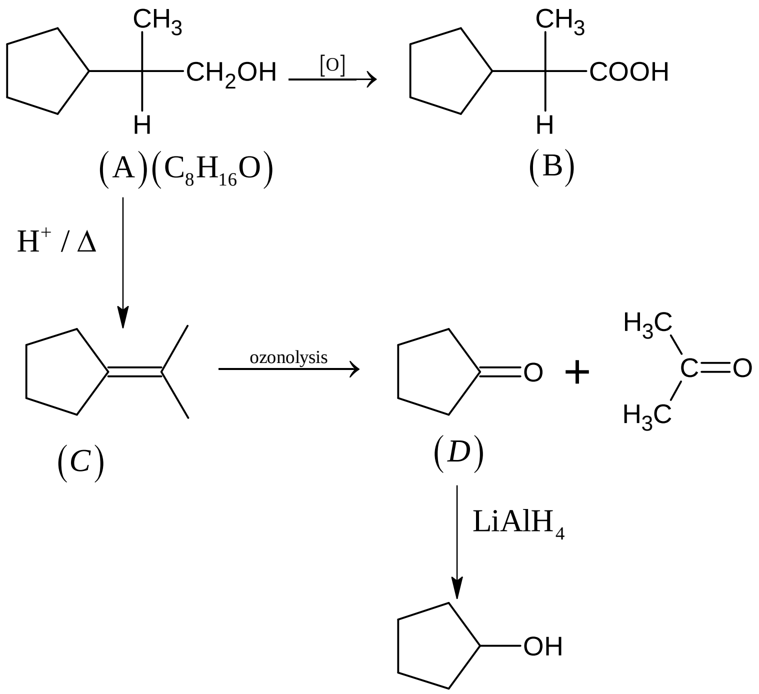
(c)



(d)



10.

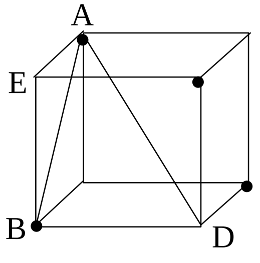

CH3
CH2OH
H
[O]
CH3
COOH
H
(A)(C8H16O)
(B)
H+ / Δ
ozonolysis
O
+
H3C
C=O
H3C
(C)
(D)
LiAlH4
OH

11. An amino acid at its isoelectric point, will not migrate.

12. A lone pair of N-atom participating in resonance will be less basic

SECTION – C

1.



Face diagonal of cube $(\mathrm{AB})=2\mathrm{R}$

Edge length of cube $(\mathrm{BE})=\dfrac{2\mathrm{R}}{\sqrt{2}}$

Body diagonal of cube $(\mathrm{AD})=\sqrt{3}\times\dfrac{2\mathrm{R}}{\sqrt{2}}$

$=\sqrt{6}\times R$

2. $$\mathrm{Mg}^{2+}+2e^{-}\longrightarrow Mg\left(E_{Mg}=\frac{24}{2}=12g\right)$$

Charge required for the deposition of $12g\ Mg=1F$

Charge required for the deposition of $1g\ Mg = \frac{1}{12}F$

$\therefore$ cost for $\frac{F}{12}$ charge=Rs.5

$Al^{3+} + 3e^{-} \longrightarrow Al\left(E_{Al} = \frac{27}{3} = 9g\right)$

Charge required for $9\,g = 1F$

Charge required for $30\,g = \frac{30}{9}F = \frac{10F}{3}$

Cost for $\frac{10F}{3}$ charge$=5\times12\times\frac{10F}{3}$

$= Rs.200$

3. $pKa\ of\ HX = 14-10 = 4$

$pH = pK_a + \log\frac{1}{1} = 4$

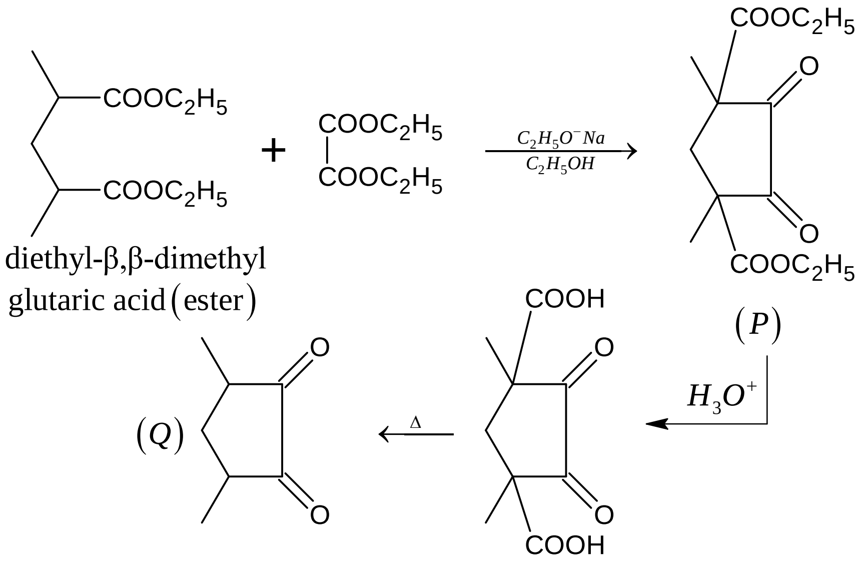
4. $(CO)_{x/2}\,Co-Co(CO)_{x/2}$

$EAN(=36) = 27+1+2\times\frac{x}{2}$

$\Rightarrow 28 + x = 36$

$x = 8$

5.


COOC2H5
COOC2H5
diethyl-β,β-dimethyl
glutaric acid (ester)
+
COOC2H5
COOC2H5
C2H5O⁻Na
C2H5OH
COOC2H5
O
O
COOC2H5
(P)
H3O+
COOH
O
O
COOH
Δ
O
O
(Q)

Mathematics PART – III

SECTION – A

1. $$\frac{f''(x)}{f'(x)} - \frac{g''(x)}{g'(x)} = \frac{\frac{d}{dx}\left(f'(x)/g'(x)\right)}{\frac{f'(x).g'(x)}{(g'(x))^2}} = \frac{g'}{f'}.\frac{d}{dx}\left(\frac{f'}{g'}\right) = \frac{2f'(x)}{f(x)}\left[\because f(x).g(x) = 1\right].$$

2. Let $f^{-1}(x) = t \Rightarrow f(t) = x$

$$\int_{f(a)}^{f(b)} 2x\left(b - f^{-1}(x)\right)dx = \int_a^b 2f(t).(b-t).f'(t)dt = b\,[(f(t))^2]_a^b - b\int_a^b t\,.2f(t)\,.f'(t)\,dt$$

$$= \int_a^b \left[(f(x))^2 - (f(a))^2\right]dx$$

3. $y = \log_{1/3}\left(x - \frac{1}{3}\right) + \log_3\sqrt{9x^2 - 6x + 1} = \log_{1/3}\left(x - \frac{1}{3}\right) + \log_3|3x - 1| = 1.$

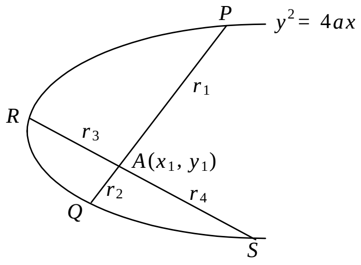
Since $x > \frac{1}{3}$, maximum {AB} = 3.

4. $$a_n = \frac{\frac{3n}{2}\left[a + (3n-1)d\right]}{\frac{2n}{2}\left[a + (2n-1)d\right] - \frac{n}{2}\left[a + (n-1)d\right]} = 3; \quad \therefore \lim_{n\to\infty}\sum_{r=1}^{2n}\frac{1}{n}.3 = 6.$$

5. $e^{2x} + 2e^x < a(e^x - 1) \Rightarrow (e^x - 1)^2 + 4(e^x - 1) + 3 < a(e^x - 1)$

$\Rightarrow (e^x - 1) + \frac{3}{e^x - 1} + 4 < a \Rightarrow a > 4 + 2\sqrt{3}$.

7. Let two perpendicular chords through $A(x_1, y_1)$ be *PQ* and *RS*.



Equation of *PQ* is $\frac{x - x_1}{\cos\theta} = \frac{y - y_1}{\sin\theta} = r$ where $\tan\theta$ = slope of *PQ*. Any point on this line may be taken as $(x_1 + r\cos\theta, y_1 + r\sin\theta)$. As the point lies on $y^2 = 4ax$,

$\therefore \quad (y_1 + r\sin\theta)^2 = 4a(x_1 + r\cos\theta)$.

$$\Rightarrow \quad r^2\sin^2\theta + 2y_1\sin\theta.r - 4a\cos\theta r + y_1^2 - 4ax_1 = 0$$

$$\therefore \quad r_1r_2 = \frac{-\left(y_1^2 - 4ax_1\right)}{\sin^2\theta}$$

Similarly $r_3r_4 = \frac{-\left(y_1^2 - 4ax_1\right)}{\sin^2\alpha}$ where $\tan\alpha$ = slope of *RS*

Since *PQ* is perpendicular to *RS*,

$\therefore \quad \alpha = 90 + \theta$ or $\theta - 90$

In either case; $\sin^2\alpha = \cos^2\theta$

Now $\frac{1}{r_1r_2}+\frac{1}{r_3r_4}=\frac{\sin^2\theta+\cos^2\theta}{-\left(y_1^2-4ax_1\right)}=\frac{1}{-\left(y_1^2-4ax_1\right)}$ which is constant

8. Curve is $(y-2)^2 = 2x^3 - 4$ (1)

$$\frac{dy}{dx}=\frac{3x^2}{y-2}$$

$\therefore$ Equation of tangent at (x_1, y_1)

$$y-y_1=\frac{3x_1^2}{y_1-2}\left(x-x_1\right)$$

As it passes through (1, 2)

$\Rightarrow$ $2-y_1=\frac{3x_1^2}{y_1-2}\left(1-x_1\right)$

or $\left(y_1-2\right)^2=3x_1^2\left(x_1-1\right)$

or $2x_1^3-4=3x_1^3-3x_1^2$ [As (x_1, y_1) lies on the curve]

or $x_1^3-3x_1^2+4=0$

or $(x_1 + 1)(x_1 - 2)^2 = 0$

$\therefore$ $x_1 = -1$ or 2

But $x_1 \neq = -1$ (it is clear from equation (1))

$\therefore$ $x_1 = 2$

$\therefore$ $y_1 = 2 \pm 2\sqrt{3}$

Points of contact are $(2, 2+2\sqrt{3})$ and $(2, 2-2\sqrt{3})$

$\therefore$ sum of x–coordinates of points of contact is 4

$\therefore$ sum of y–coordinates of points of contact is 4.

9. If $\left|\int_a^b f(x)dx\right|=\int_a^b\left|f(x)\right|dx$

$\Rightarrow$ $f(x)$ is either positive in (a, b)

or $f(x)$ is negative in (a, b) and also $b > a$

Also $g'(x)=f(x)$

When $f(x) > 0 \Rightarrow g'(x) > 0 \Rightarrow g(x)$ is increasing function

When $f(x) < 0 \Rightarrow g'(x) < 0 \Rightarrow g(x)$ is decreasing function

also $g(0) = 0$

$$\int_a^b f(x)g(x)dx=\int_a^b g(x)g'(x)dx$$

$=\frac{\left(g(b)\right)^2-\left(g(a)\right)^2}{2}$ which will be positive for $0 < a < b$.

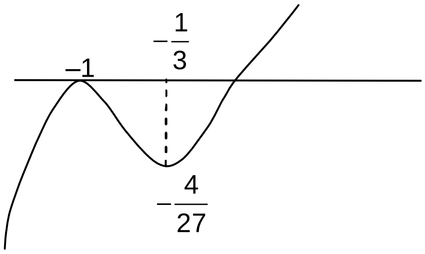
10. $C_1 \to C_1 - C_2$

$$\Rightarrow \Delta = \begin{vmatrix} 4 & (e^{i\alpha} - e^{-i\alpha})^2 & 4 \\ 4 & (e^{i\beta} - e^{-i\beta})^2 & 4 \\ 4 & (e^{i\gamma} - e^{-i\gamma})^2 & 4 \end{vmatrix} = 0 \qquad (\because C_1 \text{ \& } C_3 \text{ are identical}).$$

11. We have AB = A
$\Rightarrow$ A (BA) = A $[\because BA = B]$
$\Rightarrow$ (AB) A = A
$\Rightarrow$ AA = A $[\because AB = A]$
$\Rightarrow$ $A^2 = A$
Again BA = B
$\Rightarrow$ B (AB) = B $[\because AB = A]$
$\Rightarrow$ (BA) B = B
$\Rightarrow$ BB = B $\Rightarrow$ $B^2 = B$

12. $|z| - \log_2(z + 2) = 0$
$z + 2 = 2^{|z|}$
$x + 2 = 2^x$ and $y = 0$
hence x = 2, y = 0.

13.



SECTION – C

1. $\tan^{-1} x + \tan^{-1}\frac{1}{y} = \sin^{-1}\frac{3}{\sqrt{10}}$

$\tan^{-1}\frac{1}{y} = \tan^{-1} 3 - \tan^{-1} x$

$\tan^{-1}\frac{1}{y} = \tan^{-1}\frac{3-x}{1+3x}$

$y = \frac{3x+1}{3-x}$ x=1,2 and corresponding y=2,7, thus two solution

3. $A = \begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{bmatrix}$

$$A^2 = \begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{bmatrix}\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{bmatrix} = \begin{bmatrix} 9 & 8 & 8 \\ 8 & 9 & 8 \\ 8 & 8 & 9 \end{bmatrix}$$

$$4A = \begin{bmatrix} 4 & 8 & 8 \\ 8 & 4 & 8 \\ 8 & 8 & 4 \end{bmatrix}$$

$$A^2 - 4A - 5I = 0$$

$$\begin{bmatrix} 9 & 8 & 8 \\ 8 & 9 & 8 \\ 8 & 8 & 9 \end{bmatrix} - \begin{bmatrix} 4 & 8 & 8 \\ 8 & 4 & 8 \\ 8 & 8 & 4 \end{bmatrix} - \begin{bmatrix} 5 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & 5 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} = 0 \qquad A^2 - 4A - 5I = 0$$

Multiplying by A^{-1} both sides,

$$A^{-1}\left[A^2 - 4A - 5I\right] = A^{-1}0$$

$$A - 4I - 5A^{-1} = 0$$

$$A - 4I = 5A^{-1}$$

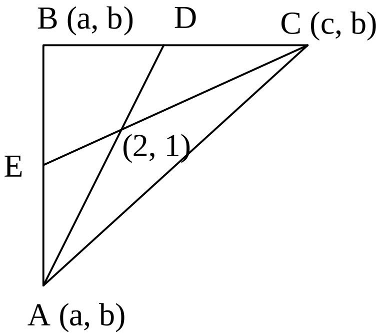
$$A^{-1} = \frac{1}{5}\left(A - 4I\right) = \frac{1}{5}\left(\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{bmatrix} - \begin{bmatrix} 4 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 4 \end{bmatrix}\right)$$

$$A^{-1} = \frac{1}{5}\begin{bmatrix} -3 & 2 & 2 \\ 2 & -3 & 2 \\ 2 & 2 & -3 \end{bmatrix}.$$

4. Let equation of new plane $2x - 2y + z - 3 + \lambda z = 0$

Point (3, 1, 1) lie on $it \Rightarrow \lambda = -2$

Hence equation of new plane 2x – 2y –z = 3



$$\cos\alpha = \frac{4+4-1}{3.3} = \frac{7}{9}$$

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

FIITJEE **JEE (Main), 2017**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - III

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 30)** contains 30 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

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Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

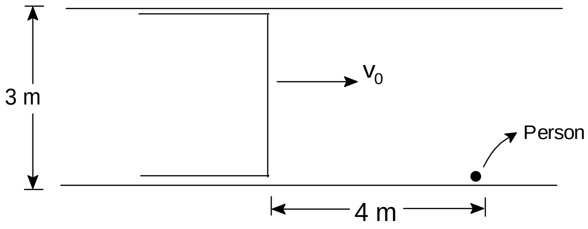
PART – I

SECTION – A

Straight Objective Type

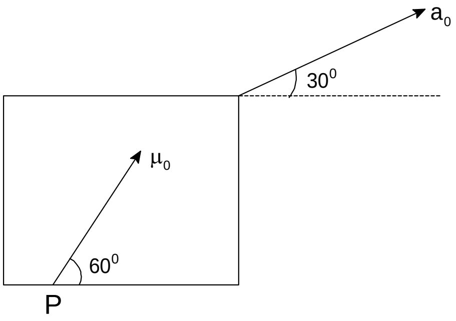
This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. A ‘3m’ wide truck is moving with a uniform velocity v_0 = 5m/s along a straight horizontal road. A person starts from rest to cross the road with an acceleration of constant magnitude ‘a’ m/s^2. When the truck is ‘4’ m away from him. For what minimum value of ‘a’ he can cross the road safely in 2 seconds.



(A) $\frac{75}{8} m/s^2$ (B) $\frac{5}{2} m/s^2$
(C) $\frac{125}{8} m/s^2$ (D) $\frac{3}{2} m/s^2$

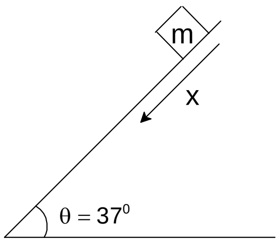
2. A cabin is moving in the vertical plane with constant acceleration ‘a_0’ as shown. A particle is projected with a velocity $u_0 = 10 m/s$ wrt. the cabin from point ‘p’ as shown. For what value of ‘a_0’ the particle will hit point ‘p’ during its downward motion. $\left(g = 10\ m/s^2\right)$



(A) $\frac{10}{\sqrt{3}} m/s^2$
(B) $10\ m/s^2$
(C) $10\sqrt{3}\ m/s^2$
(D) All of the above

Space for rough work

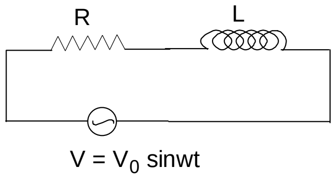
3. A block of mass 'm' starts sliding down the incline with initial zero velocity. The surface is rough and μ varies as $\mu = 0.5$ x, where 'x' is distance travelled down the incline. What is the distance travelled by the block till the speed achieved by it is half of its maximum possible speed achieved by it during its motion?



(A) $\frac{3}{2}$m (B) $\frac{3\sqrt{3}}{2}$m

(C) $\frac{3}{2}\left(2-\sqrt{3}\right)$m (D) $\left(2\sqrt{3}-3\right)$m

4. In the circuit shown in figure, the energy lost in one cycle is

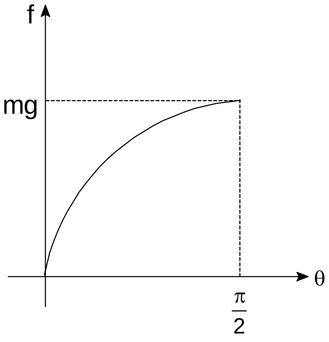


(A) zero (B) $\frac{V_0^2RT}{2R}$

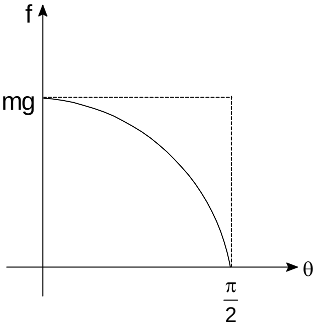
(C) $\frac{V_0^2RT}{2\left(R^2+\omega^2L^2\right)}$ (D) none of these

5. A block of mass 'm' is kept on rough inclined plane of inclination $'\theta'$, which is varied from $\theta = 0$ to $\theta = \frac{\pi}{2}$ very slowly. Graph of friction force vs θ is given by $\left(\mu_s = \mu_k = \sqrt{2}\sin\theta\right)$

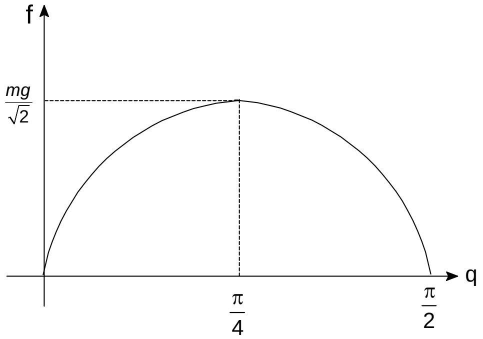
(A)



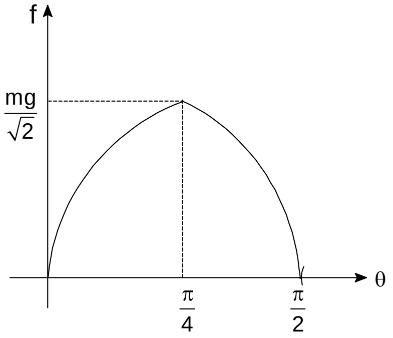
(B)



(C)



(D)

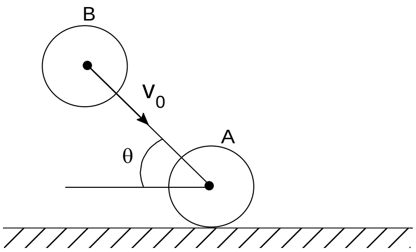


Space for rough work

6. A battery of emf E is connected in series with three resistances R, 2R and 3R. The voltage across 2R is measured with a voltmeter, whose resistance is 20 R. The percentage error (approximately) will be.

(A) –3.25% (B) –5.25%
(C) –6.25% (D) –4.25%

7. A small sphere 'A' of mass 'm' is kept on a rough horizontal surface. Another identical sphere 'B' strikes it with velocity 'v_0' at an angle 'θ' as shown. Value of 'e' for two spheres is '1' and for the sphere & surface is 'zero'. Which of the following statements is correct? $(\mu = 0.5)$



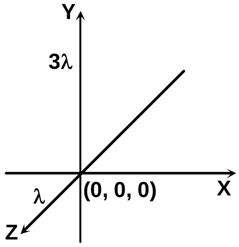
(A) Speed of sphere 'A' just after collision is $\frac{3v_0}{5}$ for $\theta = 37^0$

(B) Friction acting on the sphere during collision will be kinetic for $\theta = 30^0$

(C) Friction acting on the sphere during collision will be static for $\theta = 30^0$

(D) Nature of friction cannot be determined at $\theta = \tan^{-1}\left(\frac{4}{7}\right)$

8. The diagram shows three infinitely long uniform line charges 2λ, 3λ and λ placed on the X, Y and Z axis respectively. The work done in moving a unit positive charge from (1, 1, 1) to (0, 1,1) is equal to

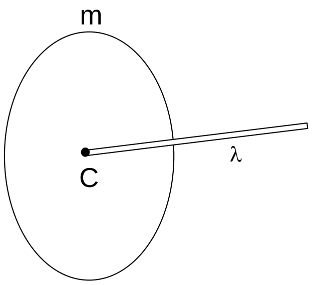


(A) $\frac{\lambda \ell n2}{2\pi \epsilon_0}$ (B) $\frac{\lambda \ell n2}{\pi \epsilon_0}$

(C) $\frac{3\lambda \ell n2}{2\pi \epsilon_0}$ (D) none

Space for rough work

9. A thin ring of radius R, mass m and an infinitely long uniform wire of linear mass density λ, is placed perpendicular to the plane of the ring along the axis of the ring with one of its ends coinciding with the centre of the ring, form a system. The gravitational force of interaction between ring and the wire is



(A) $\frac{2Gm\lambda}{R}$ (B) $\frac{Gm\lambda}{R}$

(C) $\frac{Gm\lambda}{2R}$ (D) $\frac{\sqrt{2}Gm\lambda}{2}$

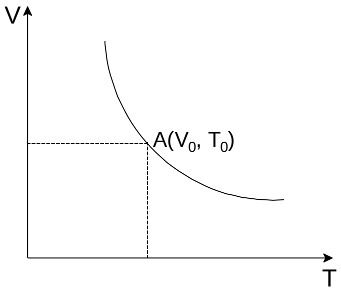
10. Consider an ideal gas with density $\rho\ mg/cm^3$ at standard pressure and temperature. If speed of sound propagation in this gas is v = 330 m/s, the degree of freedom of the gas is 5. Then the density ρ is

(A) $1.3\ mg/cm^3$ (B) $1.8\ mg/cm^3$

(C) $2.5\ mg/cm^3$ (D) $3\ mg/cm^3$

11. A gas is undergoing an adiabatic process. At a certain stage A, the value of volume and temperature is V_0 and T_0. $\left(C_v \text{ of the gas is } \frac{3R}{2}\right)$

Then $\frac{dV}{dt}$ at A, is

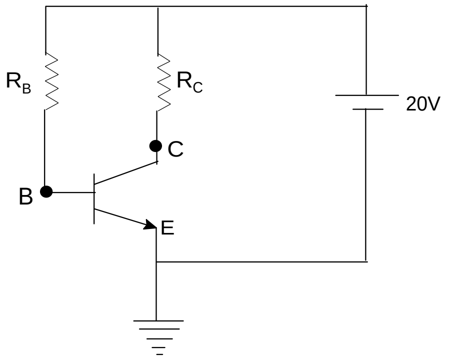


(A) $\frac{V_0}{3T_0}$ (B) $\frac{3V_0}{T_0}$

(C) $\frac{2V_0}{3T_0}$ (D) $\frac{3V_0}{2T_0}$

Space for rough work

12. For given CE biasing circuit, voltage across collector – emitter is 12 V, current gain is 100 and base current is 0.04 mA. Then the value of collector resistance 'R_c' is
(A) 1200 Ω
(B) 200 Ω
(C) 400 Ω
(D) 2000 Ω



13. Two identical metal plates with face area 'A' placed parallel to each other at separation 'd' are given charges +4Q and +6Q. If they are connected by a thin conducting wire, amount of heat produced will be given by
(A) $\frac{Q^2d}{\varepsilon_0 A}$ (B) $\frac{2Q^2d}{\varepsilon_0 A}$ (C) $\frac{5Q^2d}{2\varepsilon_0 A}$ (D) $\frac{Q^2d}{2\varepsilon_0 A}$

14. Rain drops fall from a certain height with a terminal velocity 'v' on the ground. The viscous force is $F = 6\pi\eta rv$. Here η is coefficient of viscocity, r is radius of rain drop and v is speed. Then work done by all the forces acting on the ball till it reaches the ground is proportional to
(A) r^7 (B) r^5 (C) r^3 (D) r^2

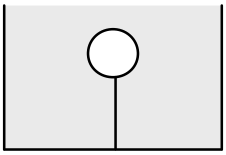
15. The threshold frequency for certain metal is f_0. When frequency of incident light is increased from $2f_0$ to $4f_0$, maximum velocity of photoelectrons is increased from v_0 to v. The value of v is
(A) $2v_0$ (B) $\sqrt{3}v_0$ (C) $4v_0$ (D) $3v_0$

16. A container has an ideal gas at pressure 'P' in thermal equilibrium. Let mass of a molecule is 'm' and all the molecules are moving with same speed 'v' in random directions. If 'n' molecules collide with unit area of container wall per second, the value of 'n' will be
(A) $\frac{P}{mv}$ (B) $\frac{P}{2mv}$ (C) $\frac{2P}{mv}$ (D) $\frac{\sqrt{3}P}{2mv}$

Space for rough work

17. A room at 20^oC is heated by a heater of resistance 20Ω connected to 200 V mains. The temperature is uniform throughout the room and the heat is transmitted through a glass window of area 1 m^2 and thickness 0.2 cm. Calculate the temperature outside thermal conductivity of the glass is 0.2 cal/ms^oC.
(A) 13.69^oC (B) 15.24^oC (C) 17.85^oC (D) 19.96^oC

18. A cork is attached to the bottom of a container filled with water with a string as shown in figure. If the container accelerate in a horizontal direction towards right. When the cork is in equilibrium w.r.t the container then which one is correct?

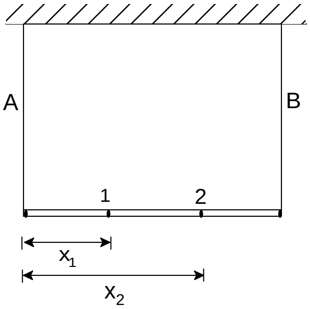


(A) Inclination of string with vertical is $\tan^{-1}(a/g)$ towards left.
(B) Inclination of the string with vertical is $\tan^{-1}(a/g)$ towards right.
(C) Inclination of the string with vertical is $\frac{\pi}{2}-\tan^{-1}(a/g)$ towards left.
(D) Inclination of the string with vertical is $\frac{\pi}{2}-\tan^{-1}(a/g)$ towards right.

19. The temperature at the bottom of a lake of depth 'L' is 4^0C. The temperature of the air just above the layer of ice frozen at the lake's surface is -2^0C for a long time. Thermal conductivity of ice is 3 times that of water. Thickness of the frozen layer of ice should be
(A) $\frac{L}{3}$ (B) $\frac{L}{2}$ (C) $\frac{3L}{5}$ (D) $\frac{2L}{3}$

20. The de – Broglie wavelength of a photon is n times the de – Broglie wavelength of an electron. If the speed of the electron is $v_e = \frac{2c}{100n}$, then the value of $\frac{E_e}{E_p}$ is $(E \to \text{kinetic energy})$
(A) 10^{-2} (B) 1 (C) 10^2 (D) 10^{-4}

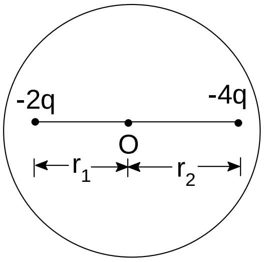
21. A light rigid rod of length 'ℓ' is suspended at its two ends by two wires 'A' and 'B' of equal lengths and area of cross section 'a' and '2a' respectively. $(Y_A = Y_0 \ \& \ Y_B = 3Y_0)$
A mass 'm' is suspended at points '1' and '2', one by one. When it is suspended at point '1', stress developed in both wires is same; and when it is suspended at point '2', strain developed in both wires is same. Ratio of x_1: x_2 is given by



(A) 7 : 18 (B) 7 : 9
(C) 7 : 3 (D) 14 : 3

Space for rough work

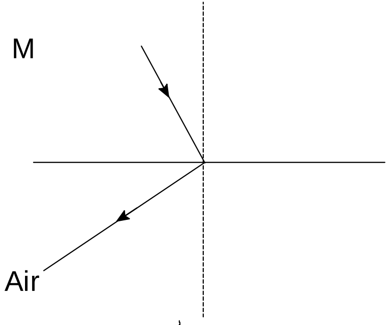
22. Charge density for a sphere of radius R is distributed as $\rho = \rho_0 r$ for $r \le R$. Total charge on the sphere is 10q and two point charges '-2q' and '-4q' are embedded in the sphere at distances 'r_1' and 'r_2' as shown such that net force on them is zero. The value of r_2 is



(A) $\dfrac{R}{\left\{\left(\sqrt{5}\right)\left(\sqrt{2}+1\right)\right\}^{\frac{1}{2}}}$
(B) $\dfrac{R}{\left\{\left(\sqrt{10}\right)\left(\sqrt{2}+1\right)\right\}^{\frac{1}{2}}}$
(C) $\dfrac{R}{\left\{\left(\sqrt{2}\right)\left(\sqrt{5}+1\right)\right\}^{\frac{1}{2}}}$
(D) $\dfrac{R}{\left\{\left(\sqrt{2}\right)\left(\sqrt{2}+1\right)\right\}^{\frac{1}{2}}}$

23. For a glass prism $\left(\mu = \sqrt{2}\right)$, the angle of minimum deviation is equal to the angle of the prism. The angle of the prism is equal to
(A) 30^0 (B) 90^0 (C) 60^0 (D) 75^0

24. A certain material has negative refractive index. A ray is incident from this medium into air. Path followed by the ray is given by

(A)


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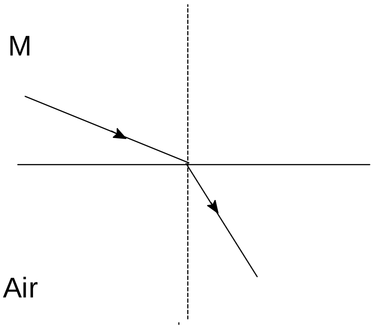

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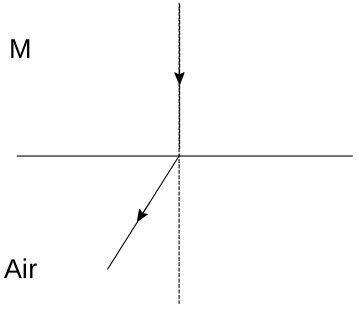

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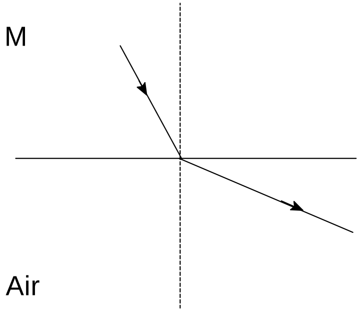
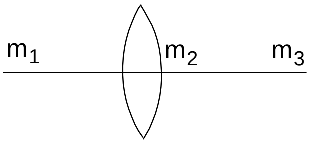


Space for rough work

25. The figure shows an equi-convex lens. What should be the condition of the refractive indices so that the lens become diverging



(A) $2\mu_3 > \mu_1 - \mu_2$ (B) $2\mu_2 < \mu_1 + \mu_3$

(C) $2\mu_2 > 2\mu_1 - \mu_3$ (D) none of these

26. A resistance coil of resistance 'r' connected to an external battery is placed inside an adiabatic cylinder fitted with a frictionless piston of same area. Cylinder contains 2 mol of ideal gas O_2. Current flows through the coil such that temperature of the gas varies as $T = T_0 + \alpha t + \beta t^2 + \gamma t^3$, keeping pressure constant with time 't'. Current flowing through the coil at t = 1s is given by $\left(\text{where } \alpha = 1\,s^{-1}, \beta = \frac{1}{2}s^{-2}, \gamma = \frac{1}{3}s^{-3}\right)$

(A) $\sqrt{\frac{7R}{r}\left(T_0 + \frac{7}{6}\right)}$ (B) $\sqrt{\frac{21R}{r}}$

(C) $\sqrt{\frac{7R}{r}\left(\frac{7}{6}\right)}$ (D) $7\sqrt{\frac{R}{r}}$

27. A certain radionuclide is known to become weaker in activity by 5% every day. Mean life of the radionuclide will be (Approximately)

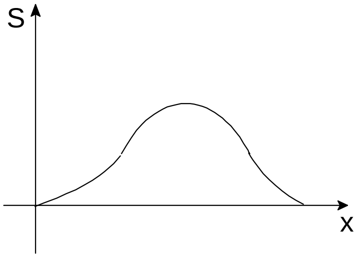
(A) 20 days (B) 20 hours (C) 20 min (D) 20 sec

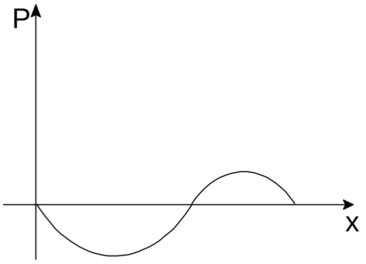
28. A $\beta-$ particle is moving along a circle of radius 'R' with a constant angular velocity $'\omega'$. Point 'A' lies in the same plane at a distance $'\frac{2}{\sqrt{3}}R'$ from the centre. Point 'A' records magnetic field produced by the $\beta-$particle. If the minimum time interval between two successive times at which 'A' records zero magnetic field is 't', $'\omega'$ in terms of t' is given by

(A) $\frac{2\pi}{3t}$ (B) $\frac{\pi}{3t}$ (C) $\frac{3\pi}{4t}$ (D) $\frac{\sqrt{3}\pi}{2t}$

Space for rough work

29. For the given displacement (s) vs 'x' graph for a sound wave, appropriate excess pressure (P) vs 'x' graph is



(A)


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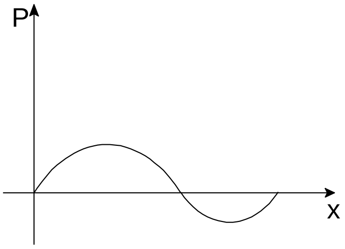

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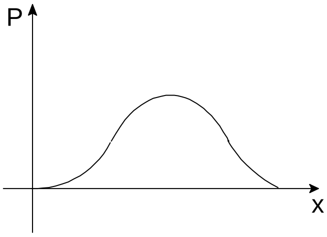

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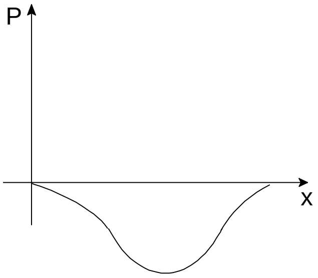


30. If between wavelength λ and λ + dλ e_λ and a_λ are the emissive power and absorptive powers of a body and E_λ is the emissive power of a perfectly black body, then according to Kirchhoff's law which is true?

(A) $e_\lambda = a_\lambda = E_\lambda$ (B) $e_\lambda E_\lambda = a_\lambda$

(C) $e_\lambda = a_\lambda E_\lambda$ (D) $e_\lambda a_\lambda E_\lambda = constant$

Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

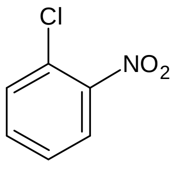
This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. Which of the following pair from the same osazone derivative?
(A) D – Glucose and L - glucose (B) D – Glucose and D - fructose
(C) D – Glucose and D galactose (D) None of these

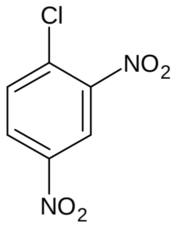
2. $CH_3 \equiv CCH_3 \xrightarrow[\text{Lindlar's Catalyst}]{H_2} A \xrightarrow{Br_2} B$. Then B is
(A) cis (B) trans (C) meso (D) racemic

3. Nineteen grams of molten $SnCl_2$ is electrolyzed for some time using inert electrodes until 0.119 g of Sn is deposited at the cathode. No substance is lost during the electrolysis. Find the ratio of the masses of $SnCl_2$ and $SnCl_4$ after electrolysis.
(A) 65.71 (B) 71.62 (C) 85.4 (D) None

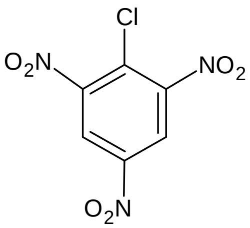
4. Arrange the following compounds in increasing order of reactivity towards nucleophilic substitution & choose correct option



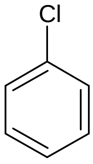
(A)



(B)



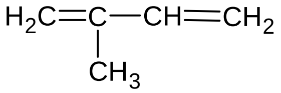
(C)

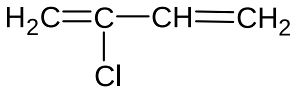


(D)

(A) $A > B > C > D$ (B) $C > B > A > D$ (C) $B > A > C > D$ (D) None

5. Buna – s rubber is a polymer of

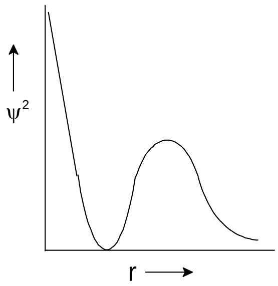
(A)

$H_2C{=}C(CH_3){-}CH{=}CH_2$

(B)

$H_2C{=}C(Cl){-}CH{=}CH_2$

(C) $CH_2 = CH - CH = CH_2$ & $CH_2 = CHCN$ (D) $CH_2 = CH - CH = CH_2$ & $C_6H_5CH = CH_2$

Space for rough work

6. The value of $(n+\ell)$ (where n = principle quantum no and $\ell =$ azimuthal quantum no) for the orbital shown by following curve
(A) 3 (B) 4
(C) 2 (D) None



7. A radioactive isotope ${}_{Z}A^{m}$ ($t_{1/2}$ = 10 days) decays to give ${}_{Z-6}B^{m-12}$ stable atom along with α – particle. If m gram of 'A' are taken & kept in a sealed tube. How much He will accumulate in 20 days. (calculate amt. in lit assuming process is occurring at STP).
(A) 22.4 lit (B) 2.25 lit (C) 50.4 lit (D) 100.8 lit

8. In 1 L saturated solution of AgCl $\left[K_{sp}(\text{AgCl}) = 1.6\times10^{-10}\right]$, 0.1 mole of CuCl $\left[K_{sp}(\text{CuCl}) = 1.0\times10^{-6}\right]$ is added. The resultant conc. of Ag^+ in the solution is 1.6×10^{-x} and y = 10 – x, then the value of y is
(A) 4 (B) 7 (C) 3 (D) None

9. In seven possible crystal system how many crystal systems have $\alpha = \beta$?
(A) 2 (B) 4 (C) 5 (D) 7

10. The distance between asoctahedral & tetrahedral void in fcc lattic would be
(A) $\sqrt{3}a$ (B) $\frac{\sqrt{3}a}{2}$ (C) $\frac{\sqrt{3}a}{3}$ (D) $\frac{\sqrt{3}a}{4}$

11. 0.1 M KI and 0.2 M AgNO3 are mixed in 3 :1 volume ratio. The depression of freezing point of the resulting solution will be $\left[K_f(H_2O) = 1.86 \text{ K Kg mol}^{-1}\right]$.
(A) 3.72 K (B) 1.86 K (C) 0.93 K (D) 0.279 K

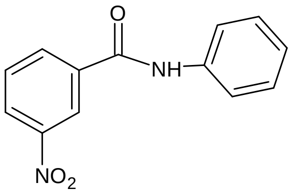
12. An e^- moves from the $n = 5$ to $n = 1$ energy level in H like atom and emits photons of energy 96J. Then the ionization energy of the given species is:
(A) -96 J (B) +96 J (C) 100 J (D) None

Space for rough work

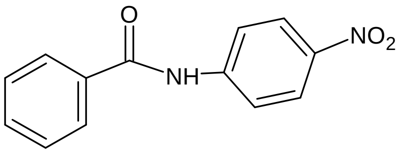
13. $(P)\xrightarrow[\text{(ii) H}^+]{\text{(i) NaOI}}(Q)\xrightarrow{\text{SOCl}_2}(R)\xrightarrow[\text{NaOH}]{C_6H_5NH_2}(S)\xrightarrow[\underset{(1eq)}{\text{Conc.}H_2SO_4}]{\text{Conc.}HNO_3}T(\text{major})$

T can be:

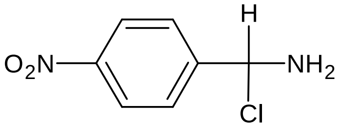
(A)



(B)

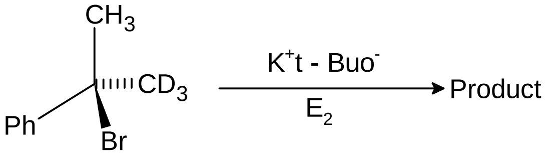


(C)



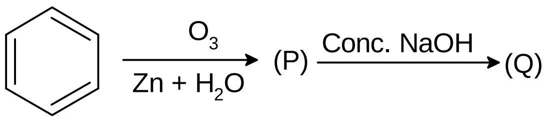
(D) None

14. Which best described the product of the following reaction?



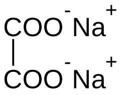
(A) Absolute configuration has been inverted (B) Absolute configuration has been retained
(C) Racemization has occured (D) Loss of chirality has occured

15.



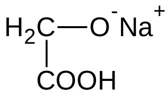
Product Q is

(A)



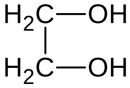
$\begin{array}{l}COO^-Na^+\\|\\COO^-Na^+\end{array}$

(B)



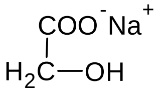
$\begin{array}{l}H_2C—O^-Na^+\\\quad|\\\quad COOH\end{array}$

(C)



$\begin{array}{l}H_2C—OH\\\quad|\\H_2C—OH\end{array}$

(D)



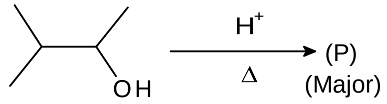
$\begin{array}{l}\quad COO^-Na^+\\\quad|\\H_2C—OH\end{array}$

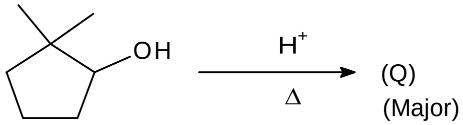
Space for rough work

16. What happens when chromium hydroxide is treated with hydrogen peroxide in the presence of NaOH?
(A) yellow coloured sodium chromate is obtained
(B) Blue coloured sodium chromate is obtained
(C) Cr^{+3} reduces to Cr^{+2}
(D) orange solution is obtained

17. Which of the following is microcosmic salt?
(A) $NaHCO_3$ (B) $Na_2S_2O_3$ (C) $Na(NH_4)HPO_4$ (D) $Na_2CO_3.10H_2O$

18. Which of the following equations is involved in Solvay process?
(A) $NaCl + NH_3 + H_2O + CO_2 \longrightarrow NH_4Cl + NaHCO_3$
(B) $CaO + 2NH_4Cl \longrightarrow 2NH_3 + H_2O + CaCl_2$
(C) $2NaHCO_3 \longrightarrow Na_2CO_3 + CO_2 + H_2O$
(D) All

19.
(1)


(2)


The total number of α - hydrogens in P + Q is
(A) 13 (B) 15 (C) 17 (D) 19

20. When NO and NO_2 are mixed the following equilibrium are readily obtained

$$2NO_2 \rightleftharpoons N_2O_4 \qquad K_p = 6.8\ atm^{-1}$$

and $NO + NO_2 \rightleftharpoons N_2O_3$

In an experiment when NO and NO_2 are mixed in the ratio of 1 : 2, the final total pressure was 5.05 atm and the partial pressure of N_2O_4 was 1.7 atm. Calculate the equilibrium partial pressure of NO.
(A) 2.5 atm (B) 1.8 atm (C) 1.05 atm (D) None

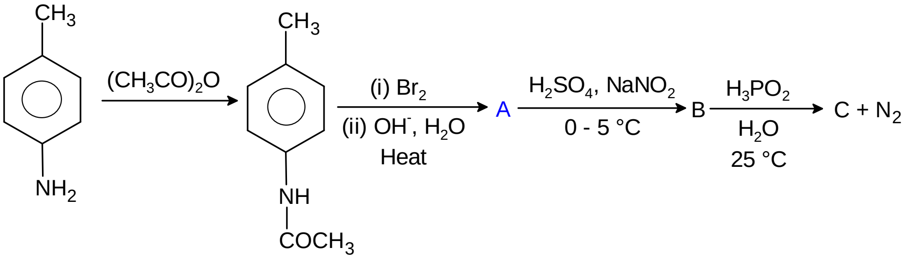
Space for rough work

21. Which of the following can be most readily, liquefied
$\left(\text{Give – value of 'a' for } NH_3 = 4.17, CO_2 = 3.59, SO_2 = 6.71, Cl_2 = 6.49\right)$
(A) NH_3 (B) Cl_2 (C) SO_2 (D) CO_2

22. 1 mole of an ideal gas $A\left(C_{v.m} = 3R\right)$ and mole of an ideal gas B are $\left(C_{v.m} = \frac{3}{2}R\right)$ taken in a container and expanded reversibly & adiabatically from 1 lit to 4 lit starting from initial temperature of 320 k. ΔE or ΔU for process is
(A) -240 R (B) -205 R (C) -405 R (D) None

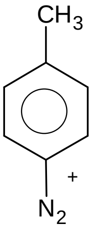
23. Magnetic behavior of complex $\left[Fe(en)_2Cl_2\right]Cl$ (en = ethane -1, 2-diamine) is
(A) Paramagnetic with 2 unpaired e^- (B) diamagnetic
(C) paramagnetic with one unpaired e^- (D) None

24. For reaction

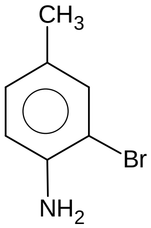

CH3
NH2
(CH3CO)2O
CH3
NH
COCH3
(i) Br2
(ii) OH-, H2O
Heat
A
H2SO4, NaNO2
0 - 5 °C
B
H3PO2
H2O
25 °C
C + N2

Then C is

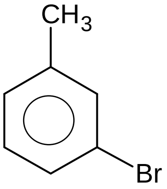
(A)



(B)



(C)



(D) None

Space for rough work

25. In sp^3d^3 hybridisation, which orbitals are involves?
(A) $dx^2 - y^2,\ dz^2, dxy$ (B) $dxy, dyz,\ d_2x$
(C) $dx^2 - y^2,\ dxy,\ dxz$ (D) $dz^2,\ dyz,\ dzx$

26. Which of following reaction does not occur in Bessemer converter?
(A) $2Cu_2S + 5O_2 \longrightarrow 2CuSO_4 + 2CuO$
(B) $2Cu_2S + 3O_2 \longrightarrow 2Cu_2O + 2SO_2 \uparrow$
(C) $2CuFeS_2 + O_2 \longrightarrow Cu_2S + 2FeS + SO_2$
(D) $FeO + SiO \longrightarrow FeSiO_3$

27. Consider the following reaction
$2XS + 3O_2 \xrightarrow{\Delta} 2XO + 2SO_2$
$2XO + XS \xrightarrow{\Delta} 3\,'X' + SO_2$
'X' can not be
(A) Hg (B) Pb (C) Zn (D) None

28. In the series reaction -
$A \xrightarrow{K_1} B \xrightarrow{K_2} C \xrightarrow{K_3} D.$
If $K_1 > K_2 > K_3$ then the rate determine step of the reaction is
(A) $A \rightarrow B$ (B) $C \rightarrow D$
(C) $B \rightarrow C$ (D) any step

29. $FeCr_2O_4 + NaOH + air \longrightarrow (A) + Fe_2O_3$
$(A) + (B) \longrightarrow Na_2Cr_2O_7$
Then compound (A) and (B) are
(A) $Na_2CrO_4,\ H_2SO_4$ (B) $Na_2Cr_2O_7$, HCl
(C) Na_2CrO_3, H_2SO_4 (D) None

30. For reaction:
$Na_2Cr_2O_7 + X \xrightarrow{\Delta} Cr_2O_3$
$Cr_2O_3 + Y \xrightarrow{\Delta} Cr$
(X) and (Y) are
(A) C and Al (B) Al and C (C) C in both (D) Al in both

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. The number of ways in which 10 persons can sit in a row having 40 chairs such that at least two chairs remain vacant between any two persons is
(A) ${}^{22}C_{10}10!$ (B) ${}^{22}C_{10}12!$ (C) ${}^{40}C_{10}10!$ (D) ${}^{49}C_{10}10!$

2. For any G.P, S_K denotes sum of first 'K' terms, the quantities $S_{2n}, 2(S_{2n} - S_n)$ and $S_{3n} - S_n$ always from
(A) G.P (B) A.P (C) H.P (D) none of these

3. If $\frac{\alpha^2 + 3\alpha - 4}{2} = \frac{2\beta^2 - 3\beta - 2}{1} = K$, then the value of $\left|\frac{2 - \alpha\beta}{2K}\right|$ is equal to
(A) $\frac{1}{2}$ (B) 2 (C) 4 (D) $\frac{1}{4}$

4. The number of solution for 'θ' in the equation $\sum\left[(-1)^{q+r}\frac{n!}{p!q!r!}\sin^{2q}\theta.\cos^{2r}\theta\right] = 1$, where p + q + r = n, p, q, r ∈ N is
(A) 0 (B) 2
(C) 4 (D) can't be solved manually

5. The inverse of the contrapositive of the conditional statement $p \to \sim q$ is equivalent to
(A) the contrapositive of the inverse of $p \to \sim q$ (B) negation of $p \to \sim q$
(C) negation of the converse of $p \to \sim q$ (D) none of these

6. If the domain of the function g(x) is (0, 1) then the domain of the function $y = g\left(\frac{1}{2^x - 1}\right) + g(\ln|x|)$
(A) $(0, \infty)$ (B) $(0,1)$ (C) $(1, \infty)$ (D) None of these

Space for rough work

7. If the inequality $\frac{mx^2+3x+4}{x^2+2x+2} < 5$ is satisfied for all $x \in R$, then

(A) $1 < m < 5$ (B) $-1 < m < 1$ (C) $-5 < m < \frac{11}{24}$ (D) $m < \frac{71}{24}$

8. The value of $\sum_{n=1}^{\infty}\left[\frac{1+2^n}{n!}(\ln 2)^n\right]$ is

(A) $e^2 - 2$ (B) e (C) 4 (D) 2^e

9. If the lines $x = a + m$, $y = -2$ and $y = mx$ are concurrent, then the least value of $|a|$ is

(A) 0 (B) $\sqrt{2}$ (C) $2\sqrt{2}$ (D) 2

10. Let f(x) be a continuous function on [0, 4] satisfying $f(x)f(4-x) = n^{-2}$. The value of the definite integral $\int_0^4 \frac{1}{1+nf(x)}dx$ is

(A) 0 (B) 1 (C) 2 (D) 4

11. Let AB be a line segment of length ‘d’ units with A on the line y = x and B on the line y = –x. The locus of the midpoint of all such line segments

(A) circle (B) parabola (C) hyperbola (D) ellipse

12. If $a_1 = 1$ and $a_n = n(1+a_{n-1}) \forall n \geq 2$, then the value of $\lim_{n\to\infty}\left(1+\frac{1}{a_1}\right)\left(1+\frac{1}{a_2}\right)\left(1+\frac{1}{a_3}\right)....\left(1+\frac{1}{a_n}\right) =$

(A) e (B) ln 2 (C) $e^{\frac{1}{2}}$ (D) $\frac{1}{\ln 2}$

13. The function f defined by $f(x) = \lim_{x\to\infty}\left\{\frac{(1+\sin\pi x)^t - 1}{(1+\sin\pi x)^t + 1}\right\}$ is

(A) continuous in (–∞, ∞) (B) discontinuous at all integral values of x

(C) continuous at x = 0 only (D) none of these

Space for rough work

14. If α, β, γ are the roots $px^3 + qx^2 + r = 0$, the value of the determinant $\begin{vmatrix} \alpha\beta & \beta\gamma & \gamma\alpha \\ \beta\gamma & \gamma\alpha & \alpha\beta \\ \gamma\alpha & \alpha\beta & \beta\gamma \end{vmatrix}$ is

(A) pq (B) qr (C) 0 (D) pr

15. If $A = \begin{bmatrix} 0 & 1 & 2 \\ 0 & 0 & 3 \\ 0 & 3 & 1 \end{bmatrix}$, then which of the following is true?

(A) $A^2 - A + 9I = 0$ (B) $A^2 - A - 9I = 0$
(C) $A^3 - A^2 - 9A = 0$ (D) $A^3 - A^2 + 9A = 0$

16. Vectors $\vec{a}, \vec{b}, \vec{c}$ are such that every pair is non-collinear and the vector $\vec{a} + \vec{b}$ is collinear with $\vec{c}$ and the vector $\vec{b} + \vec{c}$ is collinear with $\vec{a}$. The resultant of $\vec{a} + 2\vec{b} + 3\vec{c}$ is

(A) null vector (B) $2\vec{b}$ (C) $3\vec{c}$ (D) none of these

17. A plane meets the coordinate axes in A, B and C points such that the centroid of ΔABC is the point (p, q, r). The equation is the plane is

(A) $\frac{x}{p} + \frac{y}{q} + \frac{z}{r} = 1$ (B) $\frac{x}{2p} + \frac{y}{2q} + \frac{z}{2r} = 1$
(C) $\frac{x}{3p} + \frac{y}{3q} + \frac{z}{3r} = 1$ (D) $\frac{3x}{p} + \frac{3y}{q} + \frac{3z}{r} = 1$

18. A and B are two independent witnesses (i.e. there is no collusion between them) in a case. The probability that A will speak the truth is 'x' and the probability that B will speak the truth is 'y'. A and B agree in a certain statement. The probability that the statement is true is

(A) $\frac{x - y}{x + y}$ (B) $\frac{xy}{1 + x + y + xy}$
(C) $\frac{x - y}{1 - x + y + 2xy}$ (D) $\frac{xy}{1 - x - y + 2xy}$

Space for rough work

19. A random variable x takes the value of 0, 1, 2, 3, … with probability proportional to $(x+1)\left(\frac{1}{5}\right)^x$. Then

(A) $p(x=0)=\frac{9}{25}$ (B) $p(x\ge 1)=\frac{9}{25}$

(C) $p(x\le 1)=\frac{16}{25}$ (D) none

20. $\int \frac{1}{\sqrt{1+x^2}\left(\sqrt{x^2+1}-x\right)^{15}}dx = A\left\{x+\sqrt{1+x^2}\right\}^n + C$, then

(A) $A=\frac{1}{14}, n=14$ (B) $A=\frac{1}{15}, n=15$

(C) $A=-\frac{1}{16}, n=-16$ (D) $A=-\frac{1}{15}, n=-15$

21. If $I=\int_0^1 \frac{dx}{1+x^{\frac{\pi}{2}}}$, then

(A) I > ln 2 (B) I < ln 2 (C) $I>\frac{\pi}{4}$ (D) none of these

22. Let $f(x)=\begin{cases}1-|x|, & |x|\le 1\\ 0 & , |x|>1\end{cases}$, $g(x)=f(x-1)+f(x+1)\ \forall\ x\in R$ then g(x) is

(A) odd only (B) even only

(C) neither odd or even (D) None of these

23. Area bounded by the curves $y=\left[\frac{x^2}{64}+2\right]$, y = x – 1, x = 0 and $y=\sin^{-1}\left[\frac{|x|}{4}\right]$ is ([.] denotes the greatest integer function)

(A) 2 (B) 3 (C) 4 (D) $2\sqrt{3}$

Space for rough work

24. Solution of the differential equation $2y\sin x.\frac{dy}{dx}=\sin 2x-y^2\cos x$ satisfying $y\left(\frac{\pi}{2}\right)=1$

(A) $y^2=\sin x$ (B) $y=|\sin x|$

(C) $y^2=\cos x+1$ (D) $y^2\sin x=4\cos^2 x+1$

25. If $f'(1)=2$ and $g'\left(\sqrt{2}\right)=4$, then the derivative of $f(\tan x)$ with respect to $g(\text{sex})$ at $x=\frac{\pi}{4}$ is

(A) 1 (B) $\sqrt{2}$ (C) $\frac{1}{\sqrt{2}}$ (D) 2

26. If the imaginary part of the expression $\frac{z-1}{e^{i\theta}}+\frac{e^{i\theta}}{z-1}$ be zero, then the locus of 'z' can be

(A) a straight line parallel to the x-axis (B) a parabola
(C) a circle of unity radius (D) None of these

27. If $\alpha=\frac{2\pi}{7}$, then the value of $\tan\alpha.\tan 2\alpha+\tan 2\alpha.\tan 4\alpha+\tan 4\alpha.\tan\alpha$ is

(A) – 7 (B) – 4 (C) 0 (D) 4

28. If $\frac{x^2}{3}-4x+13=\sin\left(\frac{a}{x}\right)$ for some real value of 'x' then 'a' is equal to

(A) $(2n+1)\frac{\pi}{2}$ (B) $3(4n+1)\frac{\pi}{2}$ (C) $3(1+4n)\pi$ (D) None of these

29. If the parabola y = f(x), having axis parallel to y-axis, touches the line y = x at (1, 1) then

(A) $2f'(0)+f(0)=1$ (B) $2f(0)+f'(0)=1$ (C) $2f(0)-f'(0)=1$ (D) $2f'(0)+f(0)=1$

30. If x_1, x_2, x_3 ...., x_{10} are observations such that the sum of the algebraic deviations measured about '4' is 10 and the sum of their squares is 100. The triangle formed by the sides equal to 4, standard deviation and the mean of the sample is

(A) equilateral (B) scalene triangle (C) isosceles triangle (D) None of these

Space for rough work

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/
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CONCEPT RECAPITULATION TEST – III
(Main)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**D**	**B**	**A**
2.	**B**	**D**	**C**
3.	**B**	**B**	**A**
4.	**C**	**B**	**A**
5.	**D**	**D**	**A**
6.	**C**	**C**	**D**
7.	**C**	**C**	**D**
8.	**B**	**B**	**C**
9.	**B**	**C**	**C**
10.	**A**	**D**	**C**
11.	**D**	**D**	**A**
12.	**D**	**C**	**A**
13.	**D**	**B**	**B**
14.	**A**	**D**	**C**
15.	**B**	**D**	**C**
16.	**D**	**A**	**D**
17.	**B**	**C**	**C**
18.	**B**	**D**	**D**
19.	**C**	**D**	**A**
20.	**A**	**C**	**B**
21.	**B**	**C**	**A**
22.	**A**	**D**	**B**
23.	**B**	**C**	**C**
24.	**A**	**C**	**A**
25.	**B**	**A**	**C**
26.	**B**	**B**	**C**
27.	**A**	**C**	**A**
28.	**B**	**B**	**C**
29.	**C**	**A**	**B**
30.	**C**	**A**	**B**

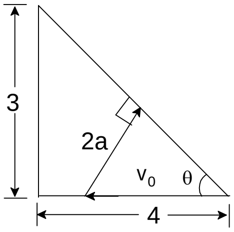
Physics PART – I

SECTION – A

1. $\tan\theta = \frac{3}{4}$

$\sin\theta = \frac{2a}{v_0}$

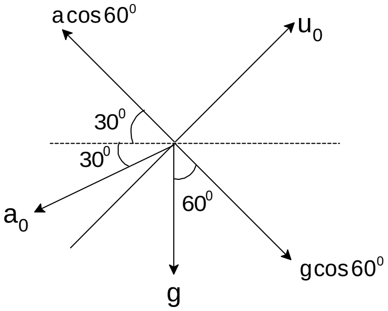
$\Rightarrow a = \frac{3}{2}$


3
2a
v_0
θ
4

2. From the frame of cabin

$\Rightarrow a_0 \cos 60^0 = g\cos 60^0$

$\Rightarrow a_0 = 10\ m/s^2$


$a\cos 60^0$
u_0
30^0
30^0
a_0
60^0
g
$g\cos 60^0$

3. When 'v' is maximum

$g\sin\theta = kxg\cos\theta$

$\Rightarrow x = \frac{\tan\theta}{k} = \frac{3}{2}$

Also, $\left(g\sin\theta - kxg\cos\theta\right) = \frac{vdv}{dx}$

$\Rightarrow \frac{v^2}{2} = gx\sin\theta - \frac{kx^2}{2}g\cos\theta$ ....(i)

putting $x = \frac{3}{2}$, we get $v_{max} = 3m/s$

putting $v = \frac{3}{2}$ in equation (i)

we get x_1 & x_2 $\left(x_2 > x_1\right)$

$= \frac{3\sqrt{3}}{2}m$

4. $i_{rms}^2 \times R \times T = H$

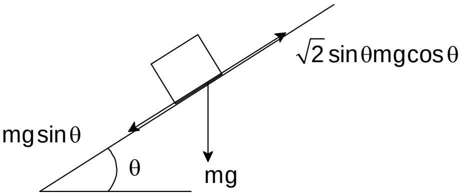
5. when sleeping starts for the first time

$\cos\theta = \frac{1}{\sqrt{2}}$

$\theta = \frac{\pi}{4}$

Just before sliding, f = $mg\sin\theta$

Just after sliding, f = $\frac{mg}{\sqrt{2}}\sin 2\theta$


$\sqrt{2}\sin\theta mg\cos\theta$
$mg\sin\theta$
θ
mg

6. % error = $\frac{\Delta V}{V} \times 100 = -6.25\%$

7. $ndt = m(v' + v_0)$

$(N\cos\theta - \mu N')dt = mv$

$N' = N\sin\theta$

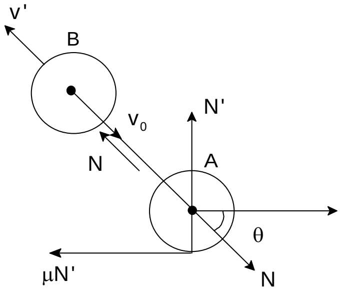
$\mu N'Rdt = \frac{2}{5}mR^2\omega$

for $\theta = 37^0$, we get $v = \frac{5v_0}{7}$

putting $v = R\omega$, we get $\tan\theta = \frac{4}{7}$

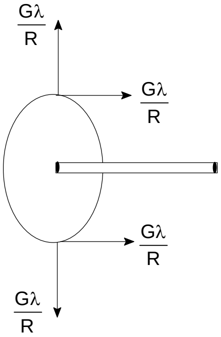
$\Rightarrow$ for $\theta > \tan^{-1}\left(\frac{4}{7}\right)$, friction will be static

& pure rolling will occur.



8. if $\Delta K = 0$, workdone by external force = ΔU

9. $\vec{F}_{net} = \frac{G\lambda}{R}m$



10. $\rho = \frac{\gamma P}{v^2}$

$\gamma = 1 + \frac{2}{F}$

$\rho = \frac{P}{v^2}.\left(1 + \frac{2}{f}\right)$

putting these value we get

$\rho = 1.3\ mg/cm^3$

11. $\frac{dv}{dT} = -\frac{v}{T(\gamma - 1)} \Rightarrow \gamma - 1 = \frac{v_0}{T_0\left(\frac{dv}{dT}\right)}$ at $v = v_0$, $T = T_0$ ....(i)

and $C_v = \frac{R}{\gamma - 1}$

$\frac{3R}{2} = \frac{R}{\gamma - 1}$ ......(ii)

putting the value of $\gamma - 1$

we get $\frac{dv}{dT} = \frac{3v_0}{2T_0}$

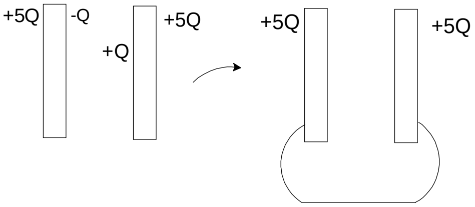
12. $I_C = 100 \times 0.04 \text{ mA} = 4 \text{ mA}$

$V_C = 20 - 12 = 8V$

$\Rightarrow R_C = \dfrac{8}{4 \times 10^{-3}} = 2000\Omega$

13. Heat $u_i - u_f$

$= \dfrac{1}{2}\dfrac{Q^2}{\left(\dfrac{\varepsilon_0 A}{d}\right)} - 0$



14. $W = \dfrac{1}{2}mv^2$

$= \dfrac{1}{2}\left(\dfrac{4}{3}\pi r^3 \rho\right)v^2 \qquad \left(V_{\text{terminal}} \propto r^2\right)$

$\Rightarrow W \propto r^7$

15. $\dfrac{1}{2}mv_0^2 = h(2f_0) - hf_0$

$\dfrac{1}{2}mv^2 = h(4f_0) - hf_0$

16. Let $v_x = v_y = v_z = v_0$

$\Rightarrow V_0 = \dfrac{V}{\sqrt{3}} \quad \Rightarrow P = nm\left(\dfrac{2v}{\sqrt{3}}\right)$

17. $\dfrac{V^2}{R} = \dfrac{KAd\theta}{\ell}$

18. $\theta = \tan^{-1}\left(\dfrac{a}{g}\right)$

19. $\dfrac{KA(4-0)}{L-x} = \dfrac{3KA(0-(-2))}{x}$

$\Rightarrow x = \dfrac{3L}{5}$

20. $\lambda_e = \dfrac{h}{m_e v_e}, E_e = \dfrac{1}{2}m_e v_e^2$

$\Rightarrow E_e = \dfrac{h^2}{2\lambda_e^2 me}$

$\Rightarrow E_p = \dfrac{hc}{\lambda_p} = \dfrac{hc}{n\lambda_e} = \dfrac{h\left(\dfrac{100nv_e}{2}\right)}{n\lambda_e}$

$\therefore \dfrac{E_e}{E_p} = \dfrac{1}{100}$

21. $(i)\ (\text{stress})_A = (\text{stress})_B$

$$\Rightarrow \frac{T_A}{a_A} = \frac{T_B}{a_B}\ \&\ T_A x_1 = T_B(\ell - x_1)$$

$$\Rightarrow x_1 = \frac{2\ell}{3}$$

$(ii)\ (\text{strain})_A = (\text{strain})_B$

$$\Rightarrow \frac{Y_A}{\left(\frac{T_A}{a_A}\right)} = \frac{Y_B}{\left(\frac{T_B}{a_B}\right)}\ \&\ T_A\,x_2 = T_B(\ell - x_2)$$

$$\Rightarrow x_2 = \frac{6\ell}{7}$$

Hence $x_1 : x_2 = 7 : 9$

$$\begin{pmatrix} a \to \text{Area of cross} - \text{sec tion} \\ T \to \text{Tension in the wire} \\ Y \to \text{Youngs Modulus} \end{pmatrix}$$

22. $10q = \int_0^R 4\pi r^2 dr \rho_0 r$ $\qquad$ $\int E.ds = \frac{q_{in}}{\in_0}$

$\Rightarrow \rho_0 = \frac{10q}{\pi R^4}$ $\qquad$ $\Rightarrow E(r) = \frac{1}{4\in_0}\rho_0 r^2$

For '$-2q$'

$$\frac{(10q)}{\pi R^4}\frac{r_1^2}{4\in_0}(2q) = \frac{1}{4\pi\in_0}\frac{(2q)(4q)}{(r_1+r_2)^2} \qquad ....(i)$$

For '$-4q$'

$$\frac{(10q)}{\pi R^4}\frac{r_2^2}{4\in_0}(4q) = \frac{1}{4\pi\in_0}\frac{(2q)(4q)}{(r_1+r_2)^2} \qquad ....(i)$$

from (i) & (ii)

$$r_2 = \frac{R}{\left(\sqrt{5}\left(\sqrt{2}+1\right)\right)^{\frac{1}{2}}}$$

23. $$\mu = \frac{\sin\left(\frac{A+D_m}{2}\right)}{\sin\left(\frac{A}{2}\right)},\ D_m = A$$

$$\Rightarrow \cos\frac{A}{2} = \frac{1}{\sqrt{2}}$$

$$\Rightarrow A = 90^0$$

24. For material with negative refractive index, ray bends or refracts differently as compared to materials with positive refractive index.

25. Use lens formula

26. $i^2 r dt = nC_p dT$

$$i^2 = \frac{nC_p}{r}\frac{dT}{dt} \qquad T = T_0 + \alpha t + \beta t^2 + \gamma t^3$$

$$i = \sqrt{\frac{2}{r}\frac{7R}{2}\left(\alpha + 2\beta t + 3\gamma t^2\right)} \qquad \frac{dT}{dt} = \alpha + 2\beta t + 3\gamma t^2$$

$$i = \sqrt{\frac{7R}{r} \times 3}$$

27. $A = \lambda N_0 e^{-\lambda t}$

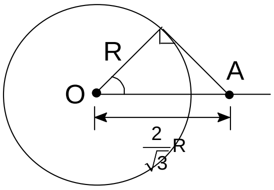
$$\%\text{decrease} = \frac{A_0 - A}{A_0} \times 100$$

$$\Rightarrow \frac{1}{\lambda} = 20 \text{ days}$$

28. $\theta = \frac{\pi}{6}$

$$t = \frac{T}{6} = \frac{1}{6} \times \frac{2\pi}{\omega}$$

$$\Rightarrow \omega = \frac{\pi}{3t}$$



29. $P = \frac{-B\partial s}{\partial x}$

30. $\left(\frac{e}{a}\right)_{body} = E_{black\ body}$ for a particular wavelength.

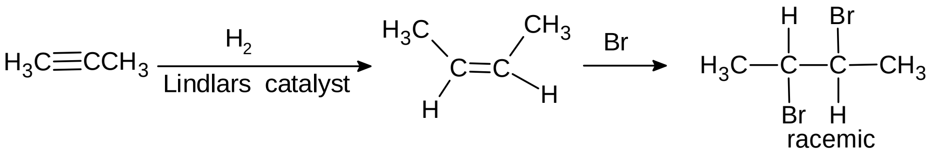
Chemistry

PART – II

SECTION – A

1. because they must have same constitution and configuration at all other carbon atoms from C – 3 to C – 6 but different constitution at C – 1 & C – 2.

2.



3. At cathode $= S\eta^{2+} + 2e^{-} \rightarrow S\eta$

$$\text{At anode} = Sn^{2+} \rightarrow Sn^{4+} + 2e^{-}$$

Total $S\eta$ lost from solution is 2×0.119 g of Sn^{2+}

At cathode = so mass of reaming $SnCl_2 = 18.621\,g$

$$\&\ \text{mass of } SnCl_4 = \frac{M_{SnCl_2}}{M_{Sn}} \times m_{Sn} = 0.26\ g$$

$$\text{now } \frac{m(SnCl_2)}{m(SnCl_4)} = \frac{18.621}{0.260} = 71.62$$

4. ^{-}I & ^{-}M effect increases the nucleophilic reactivity

5. $\text{Buta} - 1{,}3 - \text{diene} + \text{styrene} \rightarrow \text{Buna} - s$

6. It is curve of 2s so $(n + \ell) = 2 + 0 = 2$

7. $N = N_0\left(\frac{1}{2}\right)^n$ & no. of $t_{\frac{1}{2}} = \frac{20}{10} = 2$

So, $\frac{N}{N_0} = \frac{1}{4}$

Now, no. of decayed moles = $1 - \frac{1}{4} = \frac{3}{4}$

Total amt. of He = $3 \times \frac{3}{4} = \frac{9}{4}$ mole

Vol. at STP = $22.4 \times \frac{9}{4} = 50.4$ lit

8. $K_{sp}(AgCl) = 1.6 \times 10^{-10} = [Ag^{+}][Cl^{-}]$ ....(i)

$K_{sp}(CuCl) = 1 \times 10^{-6} = (1s')(1s')$

$$10^{-6} = \frac{1}{100} \times S^2 \qquad S^{12} = 10^{-4}$$

$$S' = 10^{-2} = [Cl^{-}]$$

$$= 1 \times 10^{-2}$$

$$= 10^{-3}$$

now put S' in eq(i)

$$1.6\times10^{-10}=\left[Ag^{+}\right]\left[10^{-3}\right]=1.6\times10^{-7}$$

so $x=7$ so $10-x=7$

9. Cubic, orthorhombic, Rhombohedral, Tetrahedral, hexagonal.

10. Octalhedral void present at the centre of cube and tetrahedral void is present at $\left(\frac{1}{4}\right)^{th}$ of the distance along each body diagonal.

11. $KI+AgNO_3\longrightarrow KNO_3+AgI\downarrow$

Total moles of solute ions after reaction,

$$(0.1+0.2)\times I=0.6 \text{ moles}$$

$$[\text{solute}]=\frac{0.6}{4}$$

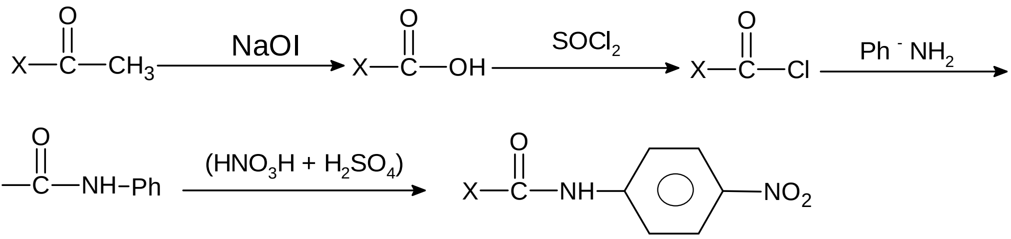
$$\Delta T_f=K_f\times\frac{0.6}{4}=0.279\text{ K}$$

12. $E_5-E_1=96$

$$E_1\times Z^2\left\{\frac{1}{n_2^2}-\frac{1}{n_1^2}\right\}=96$$

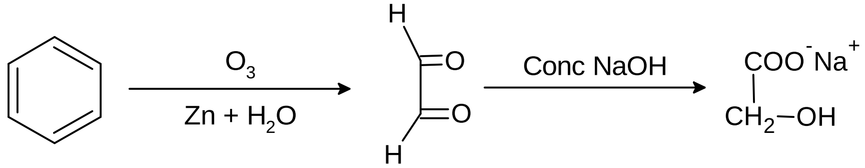
so $E_1=100J$

13. (B)



14. D

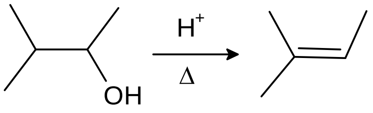
15.



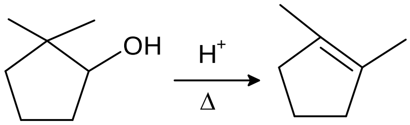
16. In basic solution Cr (III) converted Cr (VI) & it poses yellow chromate ion

17. Microcosmic salt is a white crystalline salt $Na(NH_4)HPO_4$ obtained by mixing solution of sodium phosphate & ammonium phosphate.

18. All rx^ns are involved in solvey process

19. 

$\alpha_H = 9 = P$

& 

$\alpha = 10 = Q$

so $P + Q = 19$

20. for equilibrium $\Rightarrow 2NO_2 \rightleftharpoons N_2O_4$

$6.8 = k_P = \frac{P'N_2O_4}{(P'NO_2)} = 6.8 \qquad \therefore P'N_2O_4 = 1.7$ atm

for IInd equilibriua

$$NO + NO_2 \rightleftharpoons N_2O_3$$

at $t = 0$ P $\quad 2P \quad 0$

at eq. $P - x \quad 2P - x - 3.4 \quad x$

since NO & NO_2 is in 1 : 2 ratio

at eq. $(P - x) \quad 0.5 \quad x$

$P'NO$ is same for both equilibria

now total $P = P - x + 0.5 + x + 1.7 = 5.05$

$x = 1.80$ atm

$P'NO = 1.05$ atm

21. due to max. force of attraction

22. $Av.Cv_1m = 2R$

For adiabatic process dv = dw

$$\frac{dr}{r} = -\frac{R}{C_{v'm}}\left(\frac{dv}{v}\right)$$

$$\eta_1 C_{vm_1} dT + \eta_2 C_{vm2} dT$$

$$= -(\eta_1 RT + \eta_2 RT)\frac{dv}{v}$$

$$\ell n\frac{T_2}{T_1} = -\frac{1}{2}\ell n\left(\frac{v_2}{v_1}\right)$$

$$T_2 = 320 \times \left(\frac{1}{4}\right)^{\frac{1}{2}}$$

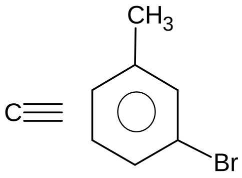
$$= 160k$$

$$\Delta U = \left(\eta_1 C_{v_1m_1} + \eta_2 C_{v_2m_2}\right)\Delta T = -960\ R$$

23. Fe has one unpaired e^-

.

24.



25. A (Fact based)

26. $2Cu_2S + 3O_2 \longrightarrow 2Cu_2O + 2SO_2 \uparrow$ does not occur in Bessemer's converter

27. X can't be Zn

28. Slowest step is R.d.s step

29. A is Na_2CrO_4 & B is H_2SO_4

30. Because Cr_2O_3 can't be reduced by C due to requirement of high energy.

Mathematics PART – III

SECTION – A

1. A

The number of gaps when 10 persons seat is 11.
Let $x_1, x_2, x_3, \ldots, x_{11}$ be the number of vacants in the gaps
$x_1 + x_2 + \ldots + x_{11} = 30$
x_1 & $x_{11} \ge 0$ other $x_i \ge 2 \quad (i \ne 2, 11)$
Number of integral solution is ${}^{22}C_{10}$

2. C

Let the GP be a, ar, ar^2, …

$$S_{2n} = \frac{a(1-r^{2n})}{1-r}; S_n = \frac{a(1-r^n)}{1-r}; S_{3n} = \frac{a(1-r^{3n})}{1-r}$$

Clearly, $S_n, S_{2n} - S_n, S_{3n} - S_{2n}$ in GP
Let $S_n = A, S_{2n} - S_n = AR, S_{3n} - S_{2n} = AR^2$
Then, AR + A, 2AR, AR^2 + AR in HP as

$$\frac{1}{A(R+1)} + \frac{1}{AR(R+1)} = \frac{1}{AR} = \frac{2}{2AR}$$

3. A

We have $\frac{\alpha^2 + 3\alpha - 4}{2} = \frac{2\beta^2 - 3\beta - 2}{1} = K$
Clearly, $\alpha^2 + 3\alpha - 4 - 2K = 0$ has roots α & - 2β
$\therefore -2\alpha\beta = -(4 + 2K)$
$\Rightarrow \alpha\beta = 2 + K$
$\therefore \left|\frac{2 - \alpha\beta}{2K}\right| = \frac{1}{2}$

4. A

$\sum\left[(-1)^{q+r}\frac{n!}{p!q!r!}\sin^{2q}\theta.\cos^{2r}\theta\right]$, $n = p + q + r$, $x, p, q, r \in N$ is the expansion of
$(1 - \sin^2\theta - \cos^2\theta)^n = 0$
Hence no solution.

5. A

Contrapositive of $p \to \sim q \equiv q \to \sim p$
Inverse of $p \to \sim q \equiv q \to \sim p$
Now, inverse of $p \to \sim q \equiv \sim p \to q$
Contrapositive of $\sim p \to q \equiv \sim q \to p$

6. D

$0 < \frac{1}{2^x - 1} < 1$ and $0 < \ln|x| < 1$

$\Rightarrow 2^x - 1 > 1 \ \Rightarrow 0 < |x| < e$

$\Rightarrow x > 1$

$\therefore x \in (1, e)$

7. D

$\because \left(x^2 + 2x + 2\right) > 0 \ \forall x \in$

$\therefore \dfrac{mx^2 + 3x + 4}{x^2 + 2x + 2} < 5$

$\Rightarrow (m-5)x^2 - 7x - 6 < 0 \ \forall x \in R$

$m - 5 < 0 \ \& \ D < 0 \Rightarrow m < \dfrac{71}{24}$

8. C

$$\sum_{n=1}^{\infty}\left[\frac{1+2^n}{n!}(\ln 2)^n\right] = \sum_{n=1}^{\infty}\frac{(\ln 2)^n}{n!} + \sum_{n=1}^{\infty}\frac{(2\ln 2)^n}{n!}$$

$= e^{\ln 2} - 1 + e^{2\ln 2} - 1 = 4$

9. C

Point of concurrency (a + m, - 2)

$-2 = m(a+m) \Rightarrow m^2 + am + 2 = 0$

$a^2 \geq 8 \Rightarrow |a| \geq 2\sqrt{2}$

10. C

$$I = \int_0^4 \frac{1}{1+nf(x)}dx \Rightarrow I = \int_0^4 \frac{1}{1+nf(4-x)}$$

$$I + I = \int_0^4 \left[\frac{1}{1+nf(x)} + \frac{1}{1+nf(4-x)}\right]dx$$

$$= \int_0^4 \frac{2 + n\left(f(x) + f(4-x)\right)}{1 + n^2 f(x) f(4-x) + n\left(f(x) + f(4-x)\right)}dx$$

$$= \int_0^4 dx = 4$$

$\therefore I = 2$

11. A

Let A be (α, α) & $B(\beta, -\beta)$

P(h, k) be midpoint

$2h = \alpha + \beta$, $2k = \alpha - \beta$

$\alpha = h + k$; $\beta = (h - k)$

$\sqrt{(\alpha-\beta)^2 + (\alpha+\beta)^2} = d^2$

$\Rightarrow 4k^2 + 4h^2 = d^2$

Which is a circle

12. A

Given $a_{n-1}+1=\frac{a_n}{n}$

$$\therefore \lim_{n\to\infty}\left(1+\frac{1}{a_1}\right)\left(1+\frac{1}{a_2}\right)...\left(1+\frac{1}{a_n}\right)$$

$$=\lim_{n\to\infty}\frac{a_{n+1}}{(n+1)!}=\lim_{n\to\infty}\left(\frac{1+a_n}{n!}\right)$$

$$=\lim_{n\to\infty}\left(\frac{1}{n!}+\frac{1}{(n-1)!}+\frac{a_{n-1}}{(n-1)!}\right)$$

as $a_1=1$

Unit value = $\lim\limits_{n\to\infty}\frac{1}{n!}+\frac{1}{(n-1)!}+...+\frac{1}{n}=e$

13. B

$$f(x)=\lim_{t\to\infty}\left\{\frac{(1+\sin\pi x)^t-1}{(1+\sin\pi x)^t+1}\right\}$$

$$=\begin{cases}1,\ 2n<x<2n+1\\-1,\ 2n+1<x<2n+2\\0,\ x=0,1,2,...............\end{cases}$$

14. C

$px^3+qx^2+r=0 \qquad \alpha,\beta,\gamma$

$\alpha\beta+\beta\gamma+\gamma\alpha=0$

$$\therefore\begin{vmatrix}\alpha\beta & \beta\gamma & \gamma\alpha\\ \beta\gamma & \gamma\alpha & \alpha\beta\\ \gamma\alpha & \alpha\beta & \beta\gamma\end{vmatrix}=\begin{vmatrix}\alpha\beta+\beta\gamma+\gamma\alpha & \beta\gamma & \gamma\alpha\\ \alpha\beta+\beta\gamma+\gamma\alpha & \gamma\alpha & \alpha\beta\\ \alpha\beta+\beta\gamma+\gamma\alpha & \alpha\beta & \beta\gamma\end{vmatrix}\left[C_1\to C_1+C_2+C_3\right]=0$$

15. C

$$A=\begin{vmatrix}0 & 1 & 2\\ 0 & 0 & 3\\ 0 & 3 & 1\end{vmatrix}$$

Find A^2, A^3 to verify

16. D

$\vec{a}+\vec{b}=k\vec{c}$ ...(I)

$\vec{b}+\vec{c}=\ell\vec{a}$ ....(II)

(I) − (II)

$\vec{a}-\vec{c}=k\vec{c}-\ell\vec{a}$

$\Rightarrow(1+\ell)\vec{a}+(1+k)\vec{c}=0$

$\Rightarrow\ell=k=-1$

i.e $\vec{a}+\vec{b}+\vec{c}=0$

17. C

The points A, B and C are (3p, 0, 0); (0, 3q, 0) and (0, 0, 3r) respectively.

18. D

Agreement happens when both speak either the truth or both tell a lie

E_1 = A and B both speak truth

E_2 = A and B both tell a lie

E = A and B agree in a certain statement

$$\therefore P\left(\frac{E_1}{E}\right) = \frac{xy}{1-x-y+2xy}$$

19. A

$$P(X=x) = K(x+1)\frac{1}{5^x}, K \text{ is proportionality constant}$$

$$k = \frac{16}{25}$$

Only (B) is true

20. B

$$\int \frac{1}{\sqrt{1+x^2}\left(\sqrt{1+x^2}-x\right)^{15}}dx = \int \frac{\left(\sqrt{1+x^2}+x\right)^{15}}{\sqrt{1+x^2}}dx$$

$$= \frac{1}{15}\left(\sqrt{1+x^2}+x\right)^{15} + c$$

21. A

$$I = \int_0^1 \frac{dx}{1+x^{\frac{\pi}{2}}}$$

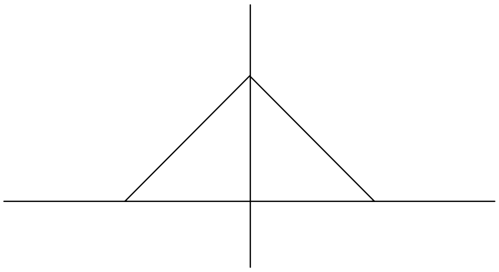
In (0, 1)

$$I > \int_0^1 \frac{dx}{1+x} \Rightarrow I > \ln 2$$

And $I < \int_0^1 \frac{1}{1+x^2}dx \Rightarrow I < \frac{\pi}{4}$

22. B

$$f(x) = \begin{cases} 1-|x|, & |x| \le 1 \\ 0, & |x| > 1 \end{cases}$$



$f(x)$ is even function

$g(x) = f(x-1) + f(x+1)$

$g(-x) = f(-x-1) + f(-x+1)$

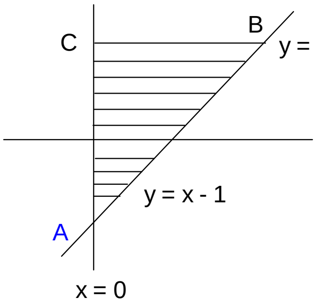
$= f(x+1) + f(x-1)$

$\therefore$ g(x) is also even only.

23. C

$y = \left[\frac{x^2}{64} + 2\right]$; $y = x - 1$ or $x = 0$

$y = \sin^{-1}\left[\frac{|x|}{4}\right] = 0$ for $|x| < 4$



$\therefore \text{area} = \frac{1}{2} \times 3 \times 3 = \frac{9}{2}$

Area above x-axis = $\frac{9}{2} - \frac{1}{2} \times 1 \times 1$

= 4

24. A

$2y \sin x \frac{dy}{dx} + y^2 \cos x = \sin 2x$

$\Rightarrow \frac{d(y^2 \sin x)}{dx} = \sin 2x$

$\Rightarrow y^2 \sin x = -\frac{\cos 2x}{2} + c$

At $x = \frac{\pi}{2}$

$1 = \frac{1}{2} + c \Rightarrow c = \frac{1}{2}$

$y^2 \sin x = \frac{1 - \cos 2x}{x}$

$\Rightarrow y^2 = \sin x$

25. C

$\frac{df(\tan x)}{dg(\sec x)} = \frac{f'(\tan x)\sec^2 x}{g'(\sec x)\sec x.\tan x}$

At $\tan x = 1$ & $\sec x = \sqrt{2}$

$$x = 2n\pi + \frac{\pi}{4}, n \in N$$

$$\therefore \frac{df(\tan x)}{dg(\tan x)} = \frac{2\times 2}{4\times\sqrt{2}} = \frac{1}{\sqrt{2}}$$

26. C

Let $\omega = \frac{z-1}{e^{i\theta}} + \frac{e^{i\theta}}{z-1}$

If z = x + iy

$$\omega = \frac{(x-1)+iy}{\cos\theta + i\sin\theta} + \frac{\cos\theta + i\sin\theta}{(x-1)+iy}$$

Im(ω) = 0

$$\Rightarrow -\sin\theta(x-1) + y\cos\theta + \frac{\sin\theta(x-1) - y\cos\theta}{(x-1)^2 + y^2} = 0$$

$$\Rightarrow \sin\theta\left[(x-1) + \frac{x-1}{(x-1)^2+y^2}\right] + \cos\theta\left[y - \frac{y}{(x-1)^2+y^2}\right] = 0$$

$$\Rightarrow (x-1)\left[(x-1)^2 + y^2 - 1\right] = 0 \text{ and } y\left[(x-1)^2 + y^2 - 1\right] = 0$$

$\therefore$ locus is circle with unity radius

27. A

$$\tan\alpha.\tan 2\alpha + \tan 2\alpha.\tan 4\alpha + \tan 4\alpha.\tan\alpha$$

$$= \frac{\sin\alpha.\sin 2\alpha\cos 4\alpha + \sin 2\alpha.\sin 4\alpha.\cos\alpha + \sin 4\alpha.\sin\alpha.\cos 2\alpha}{\cos\alpha.\cos 2\alpha.\cos 4\alpha}$$

$$= \frac{\cos\alpha.\cos 2\alpha.\cos 4\alpha - \cos(\alpha + 2\alpha + 4\alpha)}{\cos\alpha.\cos 2\alpha.\cos 4\alpha} = 1 - \frac{8\sin\alpha}{\sin 8\alpha} = -7$$

28. C

$$\frac{1}{3}\left(x^2 - 12x + 39\right) = \sin\left(\frac{a}{x}\right) \quad \Rightarrow \frac{(x-6)^2}{3} + 1 = \sin\left(\frac{a}{x}\right)$$

$$\Rightarrow \frac{a}{x} = 2n\pi + \frac{\pi}{2} \ \& \ \frac{x-6}{3} = 0 \quad \Rightarrow x = 6$$

$$\therefore a = 3\pi(1 + 4n), n \in z$$

29. B

Let the parabola be $y = Ax^2 + Bx + C$

(1, 1) satisfies $\Rightarrow$ A + B + C = 1 …. (1)

$$\left.\frac{dy}{dx}\right|_{x=1} = 1 \Rightarrow 2A + B = 1 \text{ ....(2)}$$

$$f(0) = C \ \& \ f'(0) = B$$

$$\therefore 2f(0) + f'(0) = 1$$

30. B

$$\sum_{i=1}^{10}(x_i - 4) = 10 \quad \Rightarrow \sum_{i=1}^{10}(x_i - 5) = 0$$

Also, $\sum_{i=1}^{10}\left(x_i-4\right)^2=100 \Rightarrow \sum_{i=1}^{10}\left(x_i-5\right)^2=90$

$\sigma=\sqrt{\frac{1}{10}\times 90}=3$

$\therefore$ right triangle but scalene.

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

FIITJEE **JEE (Advanced), 2017**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - IV

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 186**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 05)** contains 5 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (06 to 13) contains 8 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer and **– 2 mark** for wrong answer.

(ii) **Section-C (01 to 05)** contains 5 Numerical based questions with single digit integer as answer, ranging from 0 to 9. Each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10$ m/s^2
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N-m^2
Density of water	$\rho_{water} = 10^3$ kg/m^3
Atmospheric pressure	$P_a = 10^5$ N/m^2
Gas constant	$R = 8.314$ J K^{-1} mol^{-1}

CHEMISTRY

Gas Constant	R	=	8.314 J K^{-1} mol^{-1}
		=	0.0821 Lit atm K^{-1} mol^{-1}
		=	1.987 ≈ 2 Cal K^{-1} mol^{-1}
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

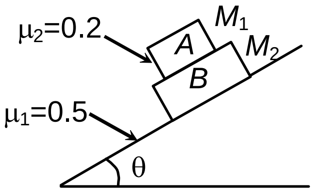
Straight Objective Type

This section contains **5 multiple choice questions** numbered 1 to 5. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. Two trains *A* and *B* are moving on same track in opposite direction with velocity 25 m/s and 15m/s respectively. When separation between them becomes 225 m, drivers of both the trains apply brakes producing uniform retardation in train *A* while retardation of train *B* increases linearly with time at the rate of 0.3 m/s^3. The minimum retardation of train *A* to avoid collision will be

(A) 2 m/s^2 (B) 2.5 m/s^2
(C) 2.25 m/s^2 (D) 2.75 m/s^2

2. Two blocks M_1 and M_2 rest upon each other on an inclined plane. Coefficient of friction between surfaces are shown. If the angle θ is slowly increased, then ($M_1 < M_2$)



(A) block *A* slips first
(B) block *B* slips first
(C) both slip simultaneously
(D) both remain at rest

3. An artificial satellite of mass *m* is moving in a circular orbit at a height equal to the radius *R* of the earth. Suddenly due to internal explosion the satellite breaks into two parts of equal masses. One part of the satellite stops just after the explosion. The increase in the mechanical energy of the system (satellite + earth) due to explosion will be
(Given: acceleration due to gravity on the surface of earth is *g*)

(A) mgR (B) $\frac{mgR}{2}$
(C) $\frac{mgR}{4}$ (D) $\frac{3mgR}{4}$

Space for rough work

4. The equation of a particle executing SHM is given by $x = 3\cos\left(\frac{\pi}{2}\right)t$ cm, where t is in second. The distance travelled by the particle in the first 8.5 s is

(A) $\left(24 + \frac{3}{\sqrt{2}}\right)$ cm
(B) $\left(27 - \frac{3}{\sqrt{2}}\right)$ cm
(C) $\left(24 - \frac{3}{\sqrt{2}}\right)$ cm
(D) $\left(27 + \frac{3}{\sqrt{2}}\right)$ cm

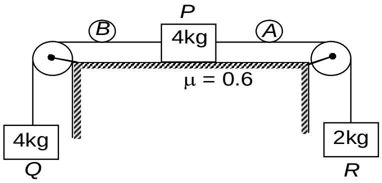
5. *n* identical charged particles are placed on the vertices of a regular polygon of *n* sides of side length *a*. One of the charge particle is released from polygon. When this particle reaches a far of distance, another particle adjacent to the first particle is released. The difference of kinetic energies of both the particles at infinity is *k*. Magnitude of charge is

(A) $\sqrt{4\pi\varepsilon_0 ak}$
(B) $\frac{k}{4\pi\varepsilon_0 a}$
(C) $\frac{k}{a}$
(D) $\sqrt{ka}$

Multiple Correct Choice Type

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

6. A blocks *P* of mass 4 kg is placed on horizontal rough surface with coefficient of friction μ = 0.6. And two blocks *R* and *Q* of masses 2 kg and 4 kg connected with the help of massless strings *A* and *B* respectively passing over frictionless pulleys as shown, then (g = 10m/s^2)



(A) acceleration of block *P* is zero.
(B) tension in string *A* is 20 N.
(C) tension in string *B* is 40 N.
(D) surface contact force on block *P* is $20\sqrt{5}$ N.

7. A body moving towards a finite body at rest collides with it. It is possible that
(A) both the bodies come to rest
(B) both the bodies move after collision
(C) the moving body comes to rest and the stationary body starts moving
(D) the stationary body remains stationary; the moving body changes its velocity

Space for rough work

8. An object is floating in a liquid, kept in a container. The container is placed in a lift. Choose the correct option(s)
   (A) Buoyant force increases as lift accelerates up
   (B) Buoyant force decreases as lift accelerates up
   (C) Buoyant force remains constant as lift accelerates
   (D) The fraction of solid submerged into liquid does not change

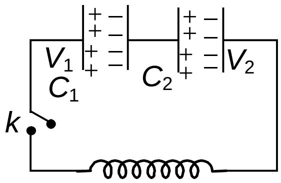
9. A standing wave of time period T is set up in a string clamped between two rigid supports. At t = 0 antinode is at its maximum displacement 2A.
   (A) The energy of a node is equal to energy of an antinode for the first time at t = T/8.
   (B) The energy of node and antinode becomes equal after every T/2 second.
   (C) The displacement of the particle of antinode at $t = \frac{T}{8}$ is $\sqrt{2}A$.
   (D) The displacement of the particle of node is zero.

10. Charges Q_1 and Q_2 lie inside and outside respectively of a closed Gaussian surface S. Let E be the field at any point on S and ϕ be the flux of E over S:
    (A) If Q_1 changes, both E and ϕ will change
    (B) If Q_2 changes E will change
    (C) If $Q_1 = 0$ and $Q_2 \neq 0$ then $E \neq 0$ but $\phi = 0$
    (D) If $Q_1 \neq 0$ and $Q_2 = 0$ then $E = 0$ but $\phi \neq 0$

11. Two circular coils of radii 5 cm and 10 cm carry equal currents of 2A. The coils have 50 and 100 turns respectively and are placed in such a way that their planes as well as their centres coincide. Magnitude of magnetic field at the common centre of coils is
    (A) $8\pi \times 10^{-4}$ T if current in the coil are in same sense
    (B) $4\pi \times 10^{-4}$ T if current in the coil are in opposite sense
    (C) zero if currents in the coils are in opposite sense
    (D) $8\pi \times 10^{-4}$ T if current in the coil are in opposite sense

Space for rough work

12. Two capacitors of capacitance C_1 and C_2 are charged to a potential difference of V_1 and V_2 respectively and are connected to an inductor of inductance L as shown in the figure. Initially key k is open. Now key k is closed and current in the circuit starts increasing. When current in the circuit is maximum



(A) Charge on both the capacitors is same
(B) Induced emf in the inductor is zero
(C) Potential difference across both the capacitors is same
(D) Electrostatic potential energy stored in both the capacitors is same

13. When photons of energy 4.25 eV strike the surface of a metal A, the ejected photoelectrons have maximum kinetic energy T_A eV and de Broglie wavelength λ_A. The maximum kinetic energy of photoelectrons liberated from another metal B by photons of energy 4.70 eV is $T_B = (T_A - 1.50)$eV. If the de Broglie wavelength of these photoelectrons is $\lambda_B = 2\lambda_A$, then

(A) The work function of A is 1.25 eV
(B) the work function of B is 4.20 eV
(C) $T_A = 3.00$ eV
(D) $T_B = 1.5$ eV

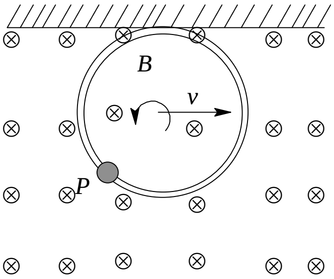
SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

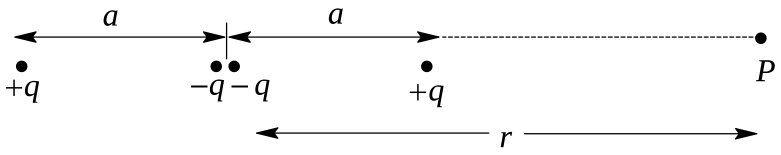
---

1. A rigid ring is made to roll along the ceiling of a room, where exists a uniform horizontal magnetic field of induction B perpendicular to the plane of the ring. The velocity of the centre of the ring is constant and its modulus is v. A charge particle P of mass m is fixed on the ring. The charge q on the particle is $\frac{kmg}{Bv}$ so that there is no force of interaction between the ring and the particle, then find the value of k ?

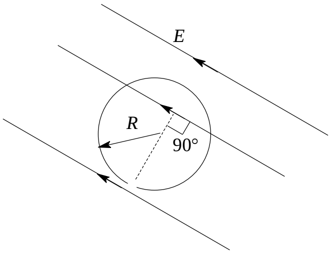


Space for rough work

2. Figure shows a charge array known as an "electric quadrupole". For a point on the axis of the quadruple, the dependence of potential on r $\left(\frac{r}{a} >> 1\right)$ is $\frac{1}{r^n}$. Find n ?



3. A non conducting ring having uniform charge distribution q is having a small cut of length $b\left(b << R\right)$ is released from rest with its plane parallel to the field as shown in the figure. If the maximum angular velocity of the ring is $\sqrt{\frac{C\,qEb}{22mR^2}}$, then find the value of C ?



4. Two wires are made of the same material and have the same volume. However, wire 1 has cross-sectional area A and wire-2 has cross-sectional area 3A. If the length of wire 1 increases by Δx on applying force 1 newton, how much force (in Newton) is needed to stretch wire 2 by the same amount?

5. Two pendulums of lengths 1.44 and 1 metre length start swinging together. After how many oscillation of first pendulum they will again start swing together?

Space for rough work

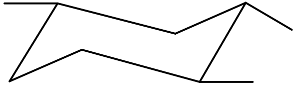
Chemistry PART – II

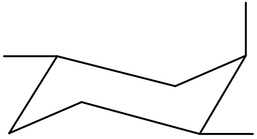
SECTION – A

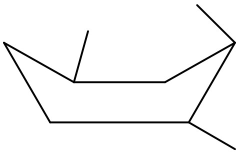
Straight Objective Type

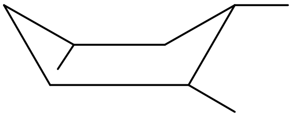
This section contains **5 multiple choice questions** numbered 1 to 5. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. Which of the following compound has lowest potential energy?

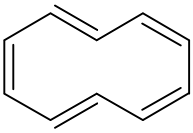
(A)


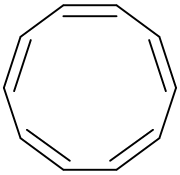
(B)


(C)


(D)


2. The following two compound are:


(I)


(II)

(A) Identical
(B) conformational isomers
(C) geometrical isomers
(D) structural isomers

3. If mercuric iodide is added to an aqueous solution of KI, the:
(A) freezing point is raised
(B) freezing point is lowered
(C) boiling point does not change
(D) freezing point does not change

Space for rough work

4. Which of the following is weaker base?

(A) $N\left(SiH_3\right)_3$
(B) $N\left(CH_3\right)_3$
(C) $NH\left(CH_3\right)_3$
(D) All are equally basic

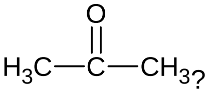
5. Choose the correct method for each:

(A) $Ni:$ electrolysis, $Cu:$ van Arkel process, $Zn:$ zone refinining, $Ga:$ zone refining
(B) $Ni:$ mond's process, $Cu:$electrolysis, $Zr:$ van Arkel process, $Ga:$ zone refining
(C) $Ni:$ electrolysis, $Cu:$ zone refining, $Zr:$ van Arkel process, $Ga:$ electrolysis
(D) $Ni:$ electrolysis, $Cu:$ zone refining, $Zr:$ van Arkel process, $Ga:$ mond's process

Multiple Correct Choice Type

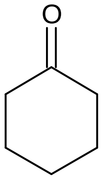
This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

6. Which of the following compound have larger $C-O$ bond length than $C-O$ bond length of

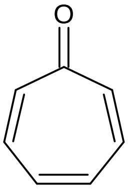


$H_3C-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$?

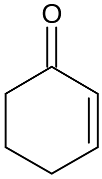
(A)



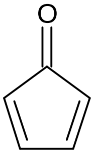
(B)



(C)



(D)

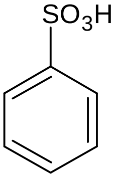


Space for rough work

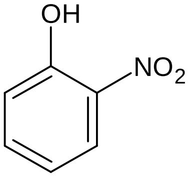
7. Which of the following compounds are soluble in $NaHCO_3$?

(A) Picric acid

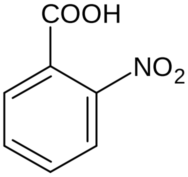
(B)



(C)



(D)



8. Which of the following statement/statements is/are correct?

(A) in the $NaCl$ structures, each Na^+ ion is surrounded by $6Cl^-$ ions as nearest neighbours and twelve Na^+ ions as next nearest neighbours.

(B) the co-ordination number of cation generally increases as the radius ratio increases

(C) packing efficiencies higher than 0.74 are possible only with cation and anion of different sizes

(D) during a crystal defect electrical neutrality should be maintained.

9. Which of the following has/have a dipole moment:

(A) $2,2,3,3-$tetramethylbutane

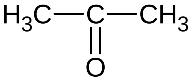
(B) Trans-2-pentene

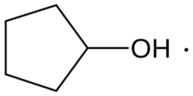
(C) cis-1, 2-dichloroethene

(D) trans-1, 2-dichloroethene

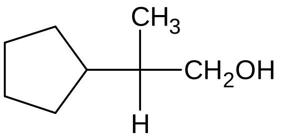
Space for rough work

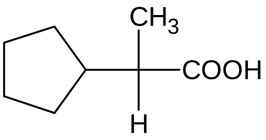
10. An optically active alcohol $A\left(C_8H_{16}O\right)$ on oxidation gives B. A on acidic heating gives $C\left(C_8H_{14}\right)$ as major product. C on ozonolysis produces $D\left(C_5H_8O\right)$ and

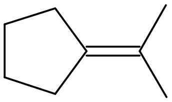


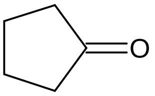
$H_3C-\underset{\underset{O}{\|}}{C}-CH_3$. D on reduction with $LiAlH_4$ gave  .

Identify correct answer:

(A) A is 

(B) B is 

(C) C is 

(D) D is 

11. A mixture of three proteins, (A) (pepsin), (B) (haemoglobin) and (C) (Lysozyme) was separated by electrophoresis method at $\mathrm{pH}=7$. The pH at isoelectric point $\left(pI\right)$ of the proteins are pI of $\left(A\right)$, $\left(B\right)$ and $\left(C\right)$ which are following statement/statements is/are correct?

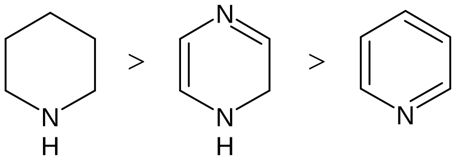
(A) pepsin $\left(A\right)$ will migrate to the cathode

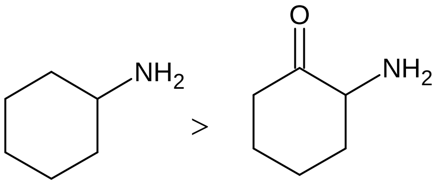
(B) Lysozyme $\left(C\right)$ will migrate to the anode

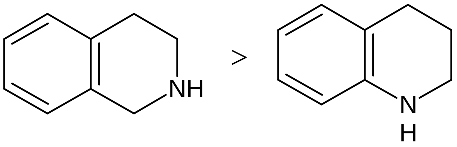
(C) Haemoglobin will not migrate

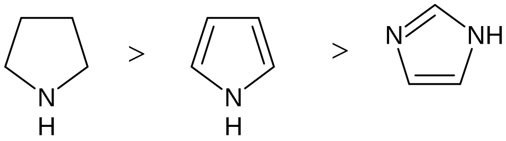
(D) at $pH=7,\ \left(A\right)$ and $\left(C\right)$ would precipitate out while $\left(B\right)$ would remain in solution.

12. Which of the following order for basic strength is/are correct?

(A) 

(B) 

(C) 

(D) 

13. Which of the following has face centered Bravais lattice?

(A) Hexagonal
(B) Monoclinic
(C) cubic
(D) orthorhombic

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. If four atoms of same radius are placed at the alternate corner of a cube touching each other, than the length of body diagonal of the cube is equal to $\sqrt{x} \times R$, where R is the radius of atom. Find the value of x?

2. The cost of electricity required to deposit 1 g Mg is Rs. 5.00. The cost of 30 g of Al to be deposited is Rs. X. Find the value of $\frac{x}{40}$?

3. A certain buffer solution contains equal concentration of X^- and HX. The K_b for X^- is 10^{-10}. Find the pH of this buffer solution?

4. Co forms dinuclear complex with a sigma bond within two Co atoms. Consider that metal carbonyls follows EAN rule. The complex can be written as $\mathrm{CO}_2(CO)_x$. Find the value of x?

5. Diethyl$-\beta$, $\beta-$dimethylglutaric acid $(ester)$ is condensed with diethyl oxalate in presence of sodium ethoxide and ethanol to form a major product (P), which on acidic hydrolysis followed by heating gives another product (Q). Calculate total number of C=O bonds in (P) and (Q) compounds?

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **5 multiple choice questions** numbered 1 to 5. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. Suppose f and g are functions having second derivatives f'' and g'' everywhere, if f(x) g(x) = 1 for all x and f ' (x) and g' are never zero, then $\frac{f''(x)}{f'(x)} - \frac{g''(x)}{g'(x)}$ equals

(A) $\frac{f'(x)}{f(x)}$ (B) $2\frac{f'(x)}{f(x)}$

(C) $-\frac{2g'(x)}{g(x)}$ (D) $-\frac{2f'(x)}{f(x)}$

2. Let a real valued differentiable function f(x) be strictly monotonic on [a, b], then

(A) $\int_a^b \left[(f(x))^2 - (f(b))^2\right]dx = \int_{f(a)}^{f(b)} 2x\left(b - f^{-1}(x)\right)dx$

(B) $\int_a^b \left[(f(x))^2 - (f(a))^2\right]dx = \int_{f(a)}^{f(b)} 2x\left(b - f^{-1}(x)\right)dx$

(C) $\int_a^b \left[f(x) - f(a)\right]^2 dx = \int_{f(a)}^{f(b)} x\left(b - f^{-1}(x)\right)^2 dx$

(D) None of these

Space for rough work

3. Let A be the point of intersection of the curve $y = \log_{\frac{1}{3}}\left(x - \frac{1}{3}\right) + \log_3 \sqrt{9x^2 - 6x + 1}$ and the circle $x^2 + y^2 = 17$. B is also a point on the curve but lies inside the given circle such that its abscissa is an integer, then max {AB} is

(A) 2 units (B) 3 units

(C) 4 units (D) none of these

4. If S_n denotes the sum of first n terms of an AP and $a_n = \frac{S_{3n}}{S_{2n} - S_n}$, then $\underset{n\to\infty}{\text{Lt}} \sum_{r=1}^{2n} \frac{a_r}{n}$ is equal to

(A) 2 (B) 4

(C) 6 (D) 8

5. The possible value of a for which $e^{2x} - (a - 2)e^x + a < 0$ holds for at least one positive x is

(A) 2 (B) 3

(C) 4 (D) 7

Multiple Correct Choice Type

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

6. The values of x for which $x^2 - 4x > \cot^{-1} x$ holds true belong to

(A) $(-\infty, -1)$ (B) $[5, \infty)$

(C) $(-1, 5]$ (D) none of these

7. For a given parabola $y^2 = 4ax$, two variable chords PQ and RS at right angles are drawn through the fixed point $A(x_1, y_1)$ inside the parabola, making variable angles θ and α with x–axis. If r_1, r_2, r_3, r_4 are distances of P, Q, R and S from A, then the value of $\frac{1}{r_1 r_2} + \frac{1}{r_3 r_4}$

(A) independent of θ (B) independent of α

(C) depends upon both θ and α (D) is a constant

Space for rough work

8. From (1, 2), tangents are drawn to the curve $y^2 - 2x^3 - 4y + 8 = 0$. Then
(A) sum of x–coordinates of points of contact is zero

(B) sum of x–coordinates of points of contact is 4

(C) sum of y–coordinates of points of contact is zero

(D) sum of y–coordinates of points of contact is 4

9. If $\left|\int_a^b f(x)dx\right| = \int_a^b |f(x)|dx \ (a \neq b)$ also $f(x) \neq 0$ for any $x \in (a, b)$ and $g(x) = \int_0^x f(x)dx$, then $\int_a^b f(x)g(x)dx$ when a and b are positive

(A) cannot be positive
(B) cannot be negative
(C) cannot be equal to zero
(D) nothing can be said

10. If $\alpha, \beta, \gamma \in R$, then the determinant

$$\Delta = \begin{vmatrix} (e^{i\alpha} + e^{-i\alpha})^2 & (e^{i\alpha} - e^{-i\alpha})^2 & 4 \\ (e^{i\beta} + e^{-i\beta})^2 & (e^{i\beta} - e^{-i\beta})^2 & 4 \\ (e^{i\gamma} + e^{-i\gamma})^2 & (e^{i\gamma} - e^{-i\gamma})^2 & 4 \end{vmatrix}$$ is

(A) equal to 0
(B) equal to $e^{i(\alpha+\beta+\gamma)}$
(C) independent of α, β and γ
(D) dependent of α, β and

Space for rough work

11. If AB = A and BA = B, where A and B are square matrices, then
(A) $A^2 = A$ (B) $A^2 = B$
(C) $B^2 = B$ (D) $B^2 = A$

12. If a complex number satisfies the equation $|z| - \log_2(z + 2) = 0$ (Re z > 0), then
(A) $z = -\bar{z}$ (B) $|z| = 2$
(C) $\arg(z) = \frac{\pi}{2}$ (D) $\arg(z) = 0$

13. If the equation $x^3 + 2x^2 + x + k = 0$ has three real roots in which two roots are equal, then value of k is/are
(A) 0 (B) $k = \frac{27}{4}$
(C) $k = \frac{4}{27}$ (D) none of these

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

1. Find number of positive integral solution of equation $\tan^{-1} x + \cos^{-1} \frac{y}{\sqrt{1-y^2}} = \sin^{-1} \frac{3}{\sqrt{10}}$

2. Tangent are drawn from any point on the hyperbola $x^2/9 - y^2/4 = 1$ to the circle $x^2 + y^2 = 9$ If the locus of the mid-point of the chord of contact is a $a\left(x^2 + y^2\right)^2 = bx^2 - cy^2,$ then the value of $a^2 + b^2 + c^2 - 7870$ is equal to……………

Space for rough work

3. If $A = \begin{pmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{pmatrix}$ and $A^2 - 4A - 5I = O$ where I and O are the unit matrix and the null matrix of order 3 respectively. If $15A^{-1} = \lambda \begin{vmatrix} -3 & 2 & 2 \\ 2 & -3 & 2 \\ 2 & 2 & -3 \end{vmatrix}$ then the find the value of λ.

4. The plane $2x - 2y + z = 3$ is rotated about the line where it cuts the xy plane by an acute angle α. If the new position of plane contains the point (3, 1, 1) then $9\cos\alpha$ equal to …….

5. If $0 < \alpha, \beta < 2\pi$, then the number of ordered pairs (α, β) satisfying $\sin^2(\alpha + \beta) - 2\sin\alpha\sin(\alpha + \beta) + \sin^2\alpha + \cos^2\beta = 0$ is

Space for rough work

FIITJEE **JEE(Advanced)-2017**

ALL INDIA TEST SERIES

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

ANSWERS, HINTS & SOLUTIONS

CONCEPT RECAPITULATION TEST - IV
(PAPER-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	A	B
2.	A	C	B
3.	C	A	B
4.	B	A	C
5.	A	B	D
6.	ABCD	BC	AB
7.	BC	ABD	ABD
8.	AD	ABCD	BD
9.	ACD	ABC	BC
10.	ABC	ABCD	AC
11.	AC	ABC	AC
12.	BC	ABC	BD
13.	ACD	CD	AC
1.	1	6	2
2.	3	5	3
3.	7	4	3
4.	9	8	7
5.	5	6	4

Physics

PART – I

SECTION – A

1. $O=(25)^2-2ax............(1)$

$$\frac{-3}{10}t=\frac{dv}{dt}$$

$$\int_{15}^{v}dv=\frac{3}{10}\int_{0}^{t}t\ dt$$

$$v=15-\frac{3}{20}t^2........(2)\,when\,v=0\Rightarrow t=10\sec$$

$$\int_{0}^{225-x}dx=15\int_{0}^{10}dt\frac{-3}{20}\int_{0}^{10}t^2\ dt$$

$$225-x=15(10)-\frac{3}{20}\frac{(1000)}{3}$$

$$225-x=150-50......(3)$$

Solving (1) and (3)

$$a=2.5\,m/s^2$$

2. $M_1g\sin\theta>\dfrac{M_1g\cos\theta}{5}$

M_1 will slip if $\tan\theta>\dfrac{1}{5}$

$$M_2g\sin\theta'+\frac{M_1g\sin\theta'}{5}>\frac{1}{2}M_2g\cos\theta'$$

M_2 will slip if $\tan\theta'>\dfrac{1}{2+\frac{2}{5}\frac{M_1}{M_2}}$

So M_1 will slip first

3. Using momentum conservation

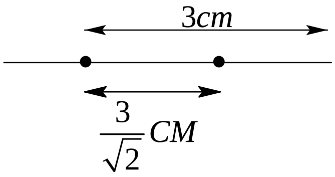
$$m\sqrt{\frac{GM}{2R}}=\frac{m}{2}V'$$

$$V'=\sqrt{\frac{2GM}{R}}$$

$$\Delta U=\left(\frac{1}{2}\frac{m}{2}\frac{2GM}{R}\right)-\left(\frac{1}{2}m\frac{GM}{2R}\right)$$

$$\Delta U=\frac{mgR}{4}$$

4.



Time period $= 4\sec$

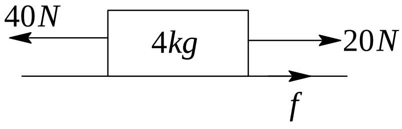
Distance travelled in $8\sec = 24cm$

Distance travelled in $8.5\sec = 24 + 3 - \frac{3}{\sqrt{2}} = \left(27 - \frac{3}{\sqrt{2}}\right)cm$

5. $k = \frac{1}{4\pi\varepsilon_0}\frac{q_2}{a}$

$q = \sqrt{4\pi\varepsilon_0 ak}$

6.



$f = 20N\left(< 24N\right)$

So block will not move

Contact force $= \sqrt{\left(20\right)^2 + \left(40\right)^2} = 20\sqrt{5}\,N$

7. Option (a) and (d) violate law of conservation of momentum.

8. Buoyancy force when lift accelerates upwards $= V_s\left(g + a\right)\rho$

$V\sigma g = V_s\delta g.............(1)$

$V_s'\rho\left(g + a\right) - V\sigma g = V\sigma a$

$V_s'\rho g + V_s'\rho a - V\sigma g = V\sigma a$

$V_s'\rho g + V_s'\rho a - V_s\rho g = V_s\rho a \left(\text{Using equation}\,(1)\right)$

$V_s'\left(g + a\right) = V_s\left(a + g\right)$

$V_s' = V_s$

10. Flux depends upon charges inside Gaussian surface and field on all charges.

11. For same sense field $B = \frac{N_1\mu_0 I}{2R_1} + \frac{N_2\mu_0 I}{2R_2} = 8\pi \times 10^{-4}T$

For opposite sense field $B' = \frac{N_1\mu_0 I}{2R_1} = \frac{N_2\mu_0 I}{2R_2} = 0$

12. $V_1^{'} + V_2^{'} = \frac{Ldi}{dt}$

When current is maximum $\frac{di}{dt} = 0 \Rightarrow V_1^{'} = -V_2^{'}$

And $\varepsilon = \frac{Ldi}{dt} = 0$

SECTION – C

3. $\frac{qb}{2\pi R} ER = \frac{1}{2} mR^2\omega^2$

$\omega = \sqrt{\frac{7qEb}{22mR^2}}$

So $C = 7$

4. $y = \frac{1/A}{x/\ell}$................(1)

$y = \frac{F/3A}{x/3\ell}$.............$(2) \Rightarrow F = 9N$

5. $T_1 = 2\pi\sqrt{\frac{1.44}{g}} = 1.2\ T_2\ \ where T_2 = \frac{2\pi}{\sqrt{g}}$

$\frac{T_1}{T_2} = \frac{6}{5}$

So after 5 oscillation of first they will swing in phase

Chemistry

PART – II

SECTION – A

1. In option (a) all methyl groups are equatorial

2. (I) is trans and (II) is cis form

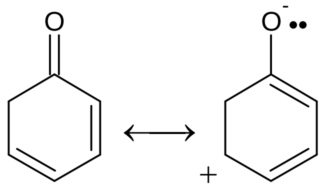
3.

$$\underbrace{2\mathrm{KI}}_{\text{Four ions}}+\mathrm{HgI_2} \longrightarrow \underbrace{\mathrm{K_2[HgI_4]}}_{\text{three ions}}$$

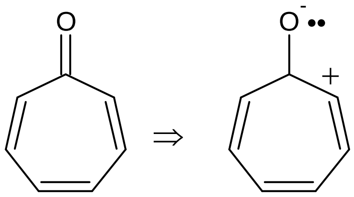
4. Due to back bonding (a) is a weaker base.

6.

(a)

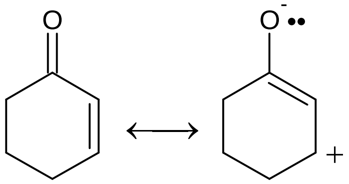


(b)

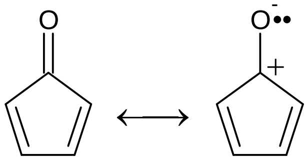


aromatic

(c)



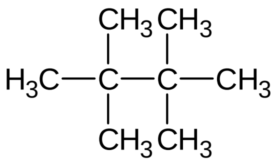
(d)



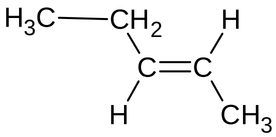
anti aromatic

9.

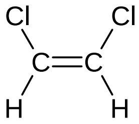
(a)



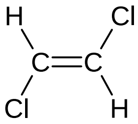
(b)



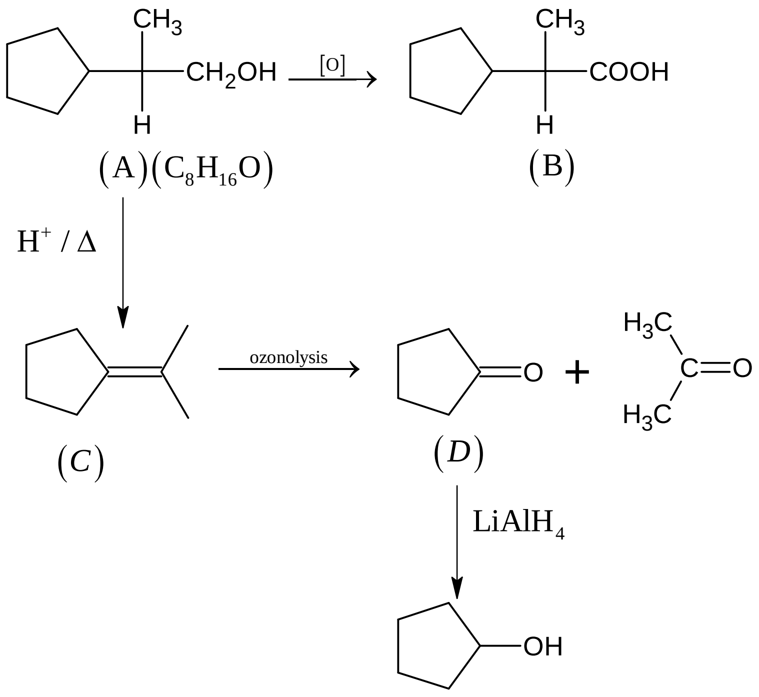
(c)



(d)



10.

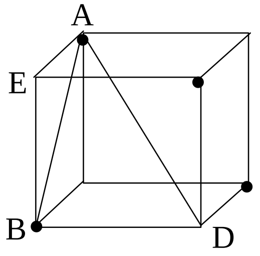

CH3
CH2OH
H
[O]
CH3
COOH
H
(A)(C8H16O)
(B)
H+ / Δ
ozonolysis
O
+
H3C
C=O
H3C
(C)
(D)
LiAlH4
OH

11. An amino acid at its isoelectric point, will not migrate.

12. A lone pair of N-atom participating in resonance will be less basic

SECTION – C

1.



Face diagonal of cube $(\mathrm{AB}) = 2\mathrm{R}$

Edge length of cube $(\mathrm{BE}) = \dfrac{2\mathrm{R}}{\sqrt{2}}$

Body diagonal of cube $(\mathrm{AD}) = \sqrt{3} \times \dfrac{2\mathrm{R}}{\sqrt{2}}$

$= \sqrt{6} \times R$

2. $\mathrm{Mg}^{2+} + 2e^- \longrightarrow Mg\left(E_{Mg} = \dfrac{24}{2} = 12g\right)$

Charge required for the deposition of $12g\ Mg = 1F$

Charge required for the deposition of $1g\ Mg = \frac{1}{12}F$

$\therefore$ cost for $\frac{F}{12}$ charge=Rs.5

$Al^{3+} + 3e^{-} \longrightarrow Al\left(E_{Al} = \frac{27}{3} = 9g\right)$

Charge required for $9\,g = 1F$

Charge required for $30\,g = \frac{30}{9}F = \frac{10F}{3}$

Cost for $\frac{10F}{3}$ charge$=5\times12\times\frac{10F}{3}$

$= Rs.200$

3. $pKa\,of\ HX = 14-10 = 4$

$pH = pK_a + \log\frac{1}{1} = 4$

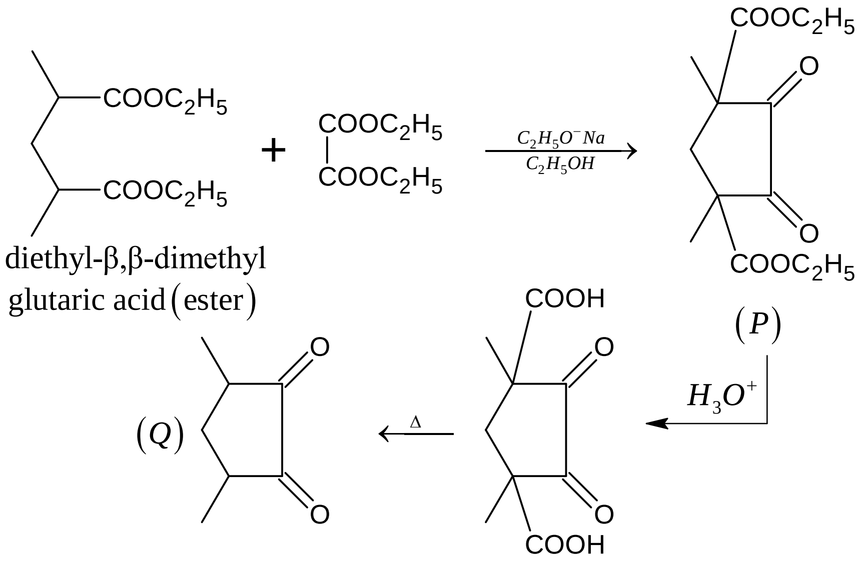
4. $(CO)_{x/2}\,Co-Co(CO)_{x/2}$

$EAN(=36) = 27+1+2\times\frac{x}{2}$

$\Rightarrow 28+x = 36$

$x = 8$

5.


COOC2H5
COOC2H5
diethyl-β,β-dimethyl glutaric acid(ester)
+
COOC2H5
COOC2H5
C2H5O⁻Na
C2H5OH
COOC2H5
O
O
COOC2H5
(P)
H3O+
COOH
O
O
COOH
Δ
(Q)
O
O

Mathematics PART – III

SECTION – A

1. $$\frac{f''(x)}{f'(x)} - \frac{g''(x)}{g'(x)} = \frac{\frac{d}{dx}\left(f'(x)/g'(x)\right)}{\frac{f'(x).g'(x)}{(g'(x))^2}} = \frac{g'}{f'}.\frac{d}{dx}\left(\frac{f'}{g'}\right) = \frac{2f'(x)}{f(x)}\left[\because f(x).g(x) = 1\right].$$

2. Let $f^{-1}(x) = t \Rightarrow f(t) = x$

$$\int_{f(a)}^{f(b)} 2x\left(b - f^{-1}(x)\right)dx = \int_a^b 2f(t).(b-t).f'(t)dt = b\,[(f(t))^2]_a^b - b\int_a^b t.2f(t).f'(t)\,dt$$

$$= \int_a^b \left[(f(x))^2 - (f(a))^2\right]dx$$

3. $y = \log_{1/3}\left(x - \frac{1}{3}\right) + \log_3\sqrt{9x^2 - 6x + 1} = \log_{1/3}\left(x - \frac{1}{3}\right) + \log_3|3x - 1| = 1.$

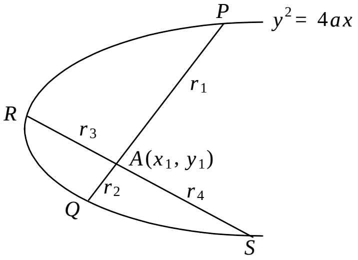
Since $x > \frac{1}{3}$, maximum {AB} = 3.

4. $$a_n = \frac{\frac{3n}{2}\left[a + (3n-1)d\right]}{\frac{2n}{2}\left[a + (2n-1)d\right] - \frac{n}{2}\left[a + (n-1)d\right]} = 3; \quad \therefore \lim_{n\to\infty}\sum_{r=1}^{2n}\frac{1}{n}.3 = 6.$$

5. $e^{2x} + 2e^x < a(e^x - 1) \Rightarrow (e^x - 1)^2 + 4(e^x - 1) + 3 < a(e^x - 1)$

$\Rightarrow (e^x - 1) + \frac{3}{e^x - 1} + 4 < a \Rightarrow a > 4 + 2\sqrt{3}$.

7. Let two perpendicular chords through $A(x_1, y_1)$ be PQ and RS.



Equation of PQ is $\frac{x - x_1}{\cos\theta} = \frac{y - y_1}{\sin\theta} = r$ where $\tan\theta$ = slope of PQ. Any point on this line may be taken as $(x_1 + r\cos\theta, y_1 + r\sin\theta)$. As the point lies on $y^2 = 4ax$,

$\therefore \quad (y_1 + r\sin\theta)^2 = 4a(x_1 + r\cos\theta)$.

$$\Rightarrow \quad r^2\sin^2\theta + 2y_1\sin\theta.r - 4a\cos\theta r + y_1^2 - 4ax_1 = 0$$

$$\therefore \quad r_1r_2 = \frac{-\left(y_1^2 - 4ax_1\right)}{\sin^2\theta}$$

Similarly $r_3r_4 = \frac{-\left(y_1^2 - 4ax_1\right)}{\sin^2\alpha}$ where $\tan\alpha$ = slope of RS

Since PQ is perpendicular to RS,

$\therefore \quad \alpha = 90 + \theta$ or $\theta - 90$

In either case; $\sin^2\alpha = \cos^2\theta$

Now $\frac{1}{r_1r_2}+\frac{1}{r_3r_4}=\frac{\sin^2\theta+\cos^2\theta}{-\left(y_1^2-4ax_1\right)}=\frac{1}{-\left(y_1^2-4ax_1\right)}$ which is constant

8. Curve is $(y-2)^2 = 2x^3 - 4$ (1)

$$\frac{dy}{dx}=\frac{3x^2}{y-2}$$

$\therefore$ Equation of tangent at (x_1, y_1)

$$y-y_1=\frac{3x_1^2}{y_1-2}\left(x-x_1\right)$$

As it passes through (1, 2)

$$\Rightarrow\ 2-y_1=\frac{3x_1^2}{y_1-2}\left(1-x_1\right)$$

or $\left(y_1-2\right)^2=3x_1^2\left(x_1-1\right)$

or $2x_1^3-4=3x_1^3-3x_1^2$ [As (x_1, y_1) lies on the curve]

or $x_1^3-3x_1^2+4=0$

or $(x_1 + 1)(x_1 - 2)^2 = 0$

$\therefore$ $x_1 = -1$ or 2

But $x_1 \neq = -1$ (it is clear from equation (1))

$\therefore$ $x_1 = 2$

$\therefore$ $y_1 = 2 \pm 2\sqrt{3}$

Points of contact are $(2, 2 + 2\sqrt{3})$ and $(2, 2 - 2\sqrt{3})$

$\therefore$ sum of x–coordinates of points of contact is 4

$\therefore$ sum of y–coordinates of points of contact is 4.

9. If $\left|\int_a^b f(x)dx\right|=\int_a^b\left|f(x)\right|dx$

$\Rightarrow$ $f(x)$ is either positive in (a, b)

or $f(x)$ is negative in (a, b) and also $b > a$

Also $g'(x)=f(x)$

When $f(x) > 0 \Rightarrow g'(x) > 0 \Rightarrow g(x)$ is increasing function

When $f(x) < 0 \Rightarrow g'(x) < 0 \Rightarrow g(x)$ is decreasing function

also $g(0) = 0$

$$\int_a^b f(x)g(x)dx=\int_a^b g(x)g'(x)dx$$

$$=\frac{\left(g(b)\right)^2-\left(g(a)\right)^2}{2}$$ which will be positive for $0 < a < b$.

10. $C_1 \to C_1 - C_2$

$$\Rightarrow \Delta = \begin{vmatrix} 4 & (e^{i\alpha} - e^{-i\alpha})^2 & 4 \\ 4 & (e^{i\beta} - e^{-i\beta})^2 & 4 \\ 4 & (e^{i\gamma} - e^{-i\gamma})^2 & 4 \end{vmatrix} = 0 \qquad (\because C_1 \text{ \& } C_3 \text{ are identical}).$$

11. We have AB = A

$\Rightarrow$ A (BA) = A $[\because BA = B]$

$\Rightarrow$ (AB) A = A

$\Rightarrow$ AA = A $[\because AB = A]$

$\Rightarrow$ $A^2 = A$

Again BA = B

$\Rightarrow$ B (AB) = B $[\because AB = A]$

$\Rightarrow$ (BA) B = B

$\Rightarrow$ BB = B $\Rightarrow$ $B^2 = B$

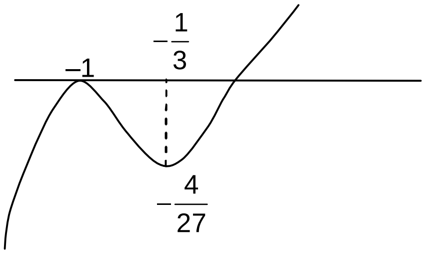
12. $|z| - \log_2(z + 2) = 0$

$z + 2 = 2^{|z|}$

$x + 2 = 2^x$ and $y = 0$

hence x = 2, y = 0.

13.



SECTION – C

1. $$\tan^{-1} x + \tan^{-1}\frac{1}{y} = \sin^{-1}\frac{3}{\sqrt{10}}$$

$$\tan^{-1}\frac{1}{y} = \tan^{-1} 3 - \tan^{-1} x$$

$$\tan^{-1}\frac{1}{y} = \tan^{-1}\frac{3-x}{1+3x}$$

$y = \dfrac{3x+1}{3-x}$ x=1,2 and corresponding y=2,7, thus two solution

3. $$A = \begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{bmatrix}$$

$$A^2 = \begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{bmatrix}\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{bmatrix} = \begin{bmatrix} 9 & 8 & 8 \\ 8 & 9 & 8 \\ 8 & 8 & 9 \end{bmatrix}$$

$$4A = \begin{bmatrix} 4 & 8 & 8 \\ 8 & 4 & 8 \\ 8 & 8 & 4 \end{bmatrix}$$

$$A^2 - 4A - 5I = 0$$

$$\begin{bmatrix} 9 & 8 & 8 \\ 8 & 9 & 8 \\ 8 & 8 & 9 \end{bmatrix} - \begin{bmatrix} 4 & 8 & 8 \\ 8 & 4 & 8 \\ 8 & 8 & 4 \end{bmatrix} - \begin{bmatrix} 5 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & 5 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} = 0 \qquad A^2 - 4A - 5I = 0$$

Multiplying by A^{-1} both sides,

$$A^{-1}\left[A^2 - 4A - 5I\right] = A^{-1}0$$

$$A - 4I - 5A^{-1} = 0$$

$$A - 4I = 5A^{-1}$$

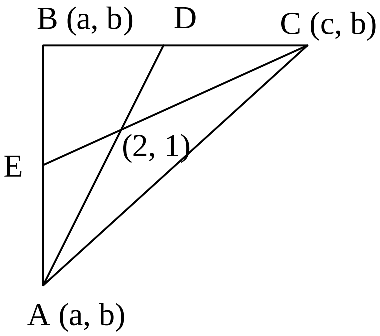
$$A^{-1} = \frac{1}{5}(A - 4I) = \frac{1}{5}\left(\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{bmatrix} - \begin{bmatrix} 4 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 4 \end{bmatrix}\right)$$

$$A^{-1} = \frac{1}{5}\begin{bmatrix} -3 & 2 & 2 \\ 2 & -3 & 2 \\ 2 & 2 & -3 \end{bmatrix}.$$

4. Let equation of new plane $2x - 2y + z - 3 + \lambda z = 0$

Point (3, 1, 1) lie on $it \Rightarrow \lambda = -2$

Hence equation of new plane 2x – 2y –z = 3



$$\cos\alpha = \frac{4+4-1}{3.3} = \frac{7}{9}$$

FIITJEE **JEE (Advanced), 2017**

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - IV

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 186**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 06)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (07 to 14) contains 8 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (15 – 18) contains 4 Paragraph Type questions: Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct. Each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate

Enrolment No.

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

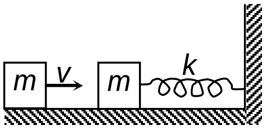
SECTION – A

Straight Objective Type

This section contains **6 multiple choice questions** numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. A particle is projected from a point *O* with velocity u in a direction making an angle α with the horizontal. At *P*, it is moving at right angles to its initial direction of projection. Its speed at *P* is
(A) $u \tan \alpha$ (B) $u \cot \alpha$
(C) $u \operatorname{cosec} \alpha$ (D) $u \sec \alpha$

2. A block of mass m moving with velocity v strikes elastically another identical mass connected to a spring as shown in figure. The maximum compression produced in the spring (Assume surfaces to be smooth) is



(A) $\sqrt{\dfrac{mv^2}{2k}}$ (B) $\sqrt{\dfrac{mv^2}{k}}$
(C) $\sqrt{\dfrac{mv^2}{3k}}$ (D) none of these

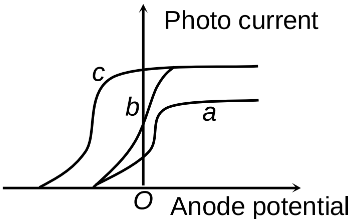
3. A block of mass 20 kg and volume 10^3 cm^3 is suspended vertically from a ceiling by a wire. The linear mass density of the wire is 5×10^{-3} kg/m and its length is 50 cm. The wire is vibrating in its fundamental mode and producing beats with a tuning fork of frequency 190 Hz. When the block is just completely immersed in a liquid and vibrated in its fundamental mode, it produces the same number of beats with tuning fork as earlier. Density of the liquid is (g = 10 m/s^2)
(A) 3.8 gm/cm^3 (B) 7.6 gm/ cm^3
(C) 1.9 gm/ cm^3 (D) 5.0 gm/ cm^3

4. A vertical cylinder with a massless piston filled with one mole of an ideal gas. The piston can move freely without friction. The piston is slowly raised so that the gas expands isothermally at temperature 300 K. The amount of work done in increasing the volume by two times is ($R = \dfrac{25}{3}$ J/mol/K , $\log_e 2$ =0.7)
(A) 1750 J (B) 2500 J
(C) 750 J (D) 4250 J

Space for rough work

5. In Young's double slit experiment, double slit of separation 0.1 cm is illuminated by white light. A coloured interference pattern is formed on a screen 100 cm away. If a pin hole is located on this screen at a distance of 2 mm from the central fringe, the wavelength in the visible spectrum which will be absent in the light transmitted through the pin-hole are
(A) 5714 Å and 4444 Å
(B) 6000 Å and 5000 Å
(C) 5500 Å and 4500 Å
(D) 5200 Å and 4200 Å

6. The figure shows the variation of photo current with anode potential for a photo-sensitive surface for three different radiations. Let I_a, I_b and I_c be the intensities and f_a, f_b and f_c be the frequencies for the curves *a*, *b* and *c* respectively;



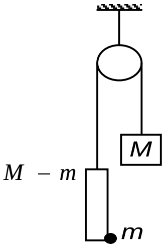
(A) $f_a = f_b$ and $I_a \neq I_b$
(B) $f_a = f_c$ and $I_a = I_C$
(C) $f_a = f_b$ and $I_a = I_b$
(D) $f_b = f_c$ and $I_b = I_c$

Multiple Correct Choice Type

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

7. A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle. The motion of the particle takes place in a plane. It follows that
(A) its velocity is constant
(B) its acceleration is constant
(C) its kinetic energy is constant
(D) it moves in a circular path

8. A rod of mass '$M - m$' carries an insect of mass '*m*' at its bottom end and its top end is connected with a string which passes over a smooth pulley and the other end of the string is connected to a counter mass *M*. Initially the insect is at rest. Choose the correct option(s).



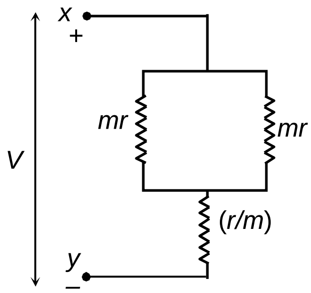
(A) As insect starts moving up relative to rod, the acceleration of centre of mass of the system (insect + rod + counter mass) becomes non-zero
(B) As insect starts moving up relative to rod, tension in the string remains constant and is equal to *Mg*.
(C) As insect starts moving up relative to rod, the tension in the string becomes more than *Mg*.
(D) Acceleration of centre of mass of the system (insect + rod +counter mass) is zero when insect moves with constant velocity.

Space for rough work

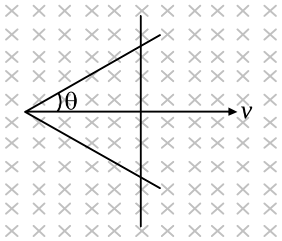
9. A particle of mass *m* moves in a straight line. If *v* is the velocity at a distance *x* from a fixed point on the line and $v^2 = a - bx^2,$ where *a* and *b* are constant, then
(A) The motion continues along the positive *x*-direction only
(B) The motion is simple harmonic
(C) The particle oscillates with a frequency equal to $\frac{\sqrt{b}}{2\pi}$
(D) The total energy of the particle is *ma*

10. 10 gms of ice at 0^0C is mixed with 5 gms of steam at 100^0C. If latent heat of fusion of ice is 80 cal/gm and latent heat of vaporization is 540 cal/gm. Then at thermal equilibrium
(A) temperature of mixture is 0^0C
(B) temperature of mixture is 100^0C
(C) mixture contains 13.33 gms of water and 1.67 gms of steam
(D) mixture contains 5.3 gms of ice and 9.7 gms of water

11. In the given circuit the value of *m* is varying. The correct statements about the circuit are
(A) The condition for maximum current flowing from *x* is $m = 2$.
(B) The maximum current is $\frac{V}{\sqrt{2}r}$.
(C) The condition for maximum current flowing from *x* is $m = \sqrt{2}$.
(D) The maximum current is $\frac{3V}{2r}$.



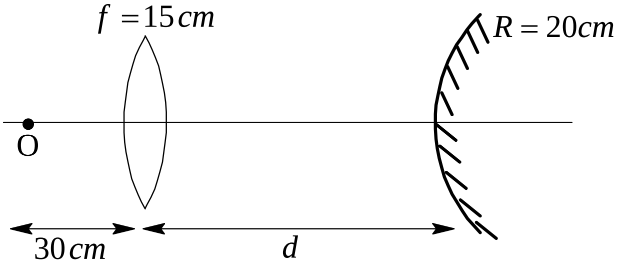
12. Two straight conducting rails form a right angle where their ends are joined. A conducting bar in contact with the rails start at the vertex at $t = 0$ and moves with a constant velocity *v* along them as shown. A magnetic field *B* is directed into the page. The induced emf in the circuit at any time *t* is proportional to



(A) t^0
(B) t
(C) v
(D) v^2

Space for rough work

13. The value of d for which the final image coinside with the object is/are:



(A) $10cm$ (B) $20cm$
(C) $30cm$ (D) $40cm$

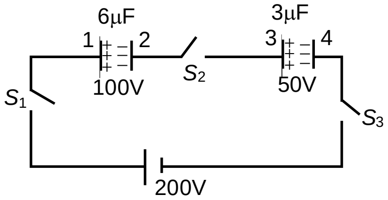
14. Hydrogen gas absorbs radiations of wavelength λ_0 and consequently emit radiations of 6 different wavelengths of which two wavelengths are shorter than λ_0. Choose the correct statement(s).
(A) The final excited state of the atom is $n = 4$
(B) The initial state of the atom may be n = 2
(C) The initial state of the atom may be n = 3
(D) There are three transitions belonging to Lyman series.

Comprehension Type

This section contains **2 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

Paragraph for Questions 15 & 16

Two capacitors of capacity 6 μF and 3μF are charged to 100V and 50V separately and connected as shown in figure. Now all the three switches S_1, S_2 and S_3 are closed.



15. Charges on the 6μF capacitor in steady state will be
(A) 400 μC (B) 700 μC
(C) 800 μC (D) 250 μC

Space for rough work

16. Suppose q_1, q_2 and q_3 be the magnitudes of charges flown from switches S_1, S_2 and S_3 after they are closed. Then

(A) $q_1 = q_3$ and $q_2 = 0$ (B) $q_1 = q_3 = \frac{q_2}{2}$

(C) $q_1 = q_3 = 2q_2$ (D) $q_1 = q_2 = q_3$

Paragraph for Questions 17 & 18

In physics laboratory, Peter is trying to calculate the focal lengths of a convex lens. He measures the distance between a screen and a light source lined up on the optical bench to be 120 cm. When Peter shifts the convex lens along the axis of optical bench, sharp images of the source is obtained at two lens positions. He also measures the ratio of these two magnifications to be 1 : 9.

17. The focal length of the convex lens measured by Peter is

(A) 22.5 cm (B) 30 cm

(C) 45 cm (D) none of these

18. Which image, as seen by Peter is brighter?

(A) smaller (B) bigger

(C) both are equally bright (D) cannot be judged

Space for rough work

Chemistry

PART – II

SECTION – A

Straight Objective Type

This section contains **6 multiple choice questions** numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. In a crystal structure of an element, atoms are present in fcc arrangement as well as in tetrahedral voids. Which of the following relation between the atomic radius and the edge length is correct?

(A) $\sqrt{2}a = 4r$
(B) $\sqrt{3}a = 8r$
(C) $\sqrt{3}a = 4r$
(D) $a = 2r$

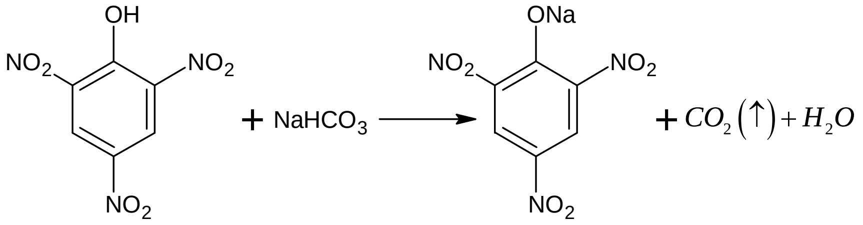
2. Which of the following does not contain transition metal?

(A) Haemoglobin
(B) Vitamin B_{12}
(C) Cis – platin
(D) Chlorophyll

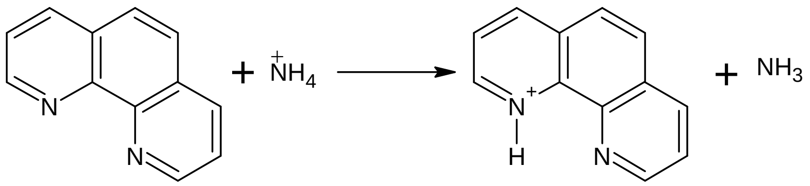
3. Which one of the following reactions is not correct?

(A) $CH_3COOK + CF_3COOH \longrightarrow CH_3COOH + CF_3COOK$

(B)



(C)

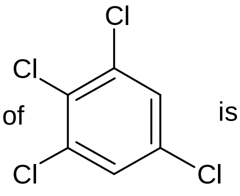
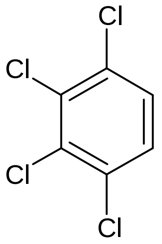


(D) $CH_3CH_2OH + NaHCO_3 \longrightarrow CH_3CH_3ONa + H_2O + CO_2(\uparrow)$

Space for rough work

4. The stopping potentials in an experiment of photoelectric effect are V_1 and V_2, with incident light of wavelength λ and $\frac{\lambda}{2}$ respectively. The correct relation between V_1 and V_2 may be:

(A) $V_2 > 2V_1 > V_1$
(B) $V_1 < V_2 < 2V_1$
(C) $V_2 = 2V_1$
(D) $V_2 < 2V_1$

5. The dipole moment of  is $1.5D\cdot$ The dipole moment of  is:

(A) zero
(B) $1.5D$
(C) $2.6D$
(D) $2.12D$

6. Which of the following is not the compound of aluminium?
(A) anhydrite
(B) bauxite
(C) corundum
(D) Diaspore

Multiple Correct Choice Type

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

7. Which of the following relation is/are correct about $NaCl$ structure (a is the edge length and r is the radius of atom)?

(A) $(a) > \left(2 \times r_{Cl^-}\right)$
(B) $\left(\sqrt{2} \times a\right) > \left(4 \times r_{Cl^-}\right)$
(C) $(a) = 2\left(r_{Cl^-} + r_{Na^+}\right)$
(D) Cl^- ions have expended fcc arrangement

Space for rough work

8. When 5 mL of a 1.0 M HCl solution is mixed with 5 mL of a $0.1M$ $NaOH$ solution, temperature of solution increases by $t°C$. Which of the following(s) can be predicted from this observation:

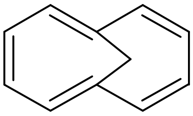
(A) If $5mL$ of $0.1M$ HCl is mixed with 5 mL 0.1 M NH_3 solution, the temperature rise will be less than $t°C$

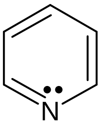
(B) If 5 mL 0.1 M CH_3COOH is mixed with 5 mL 0.1 M $NaOH$, the temperature rise will be less than $t°C$

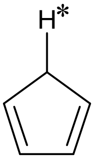
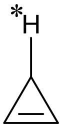
(C) If 10 mL of 1.0 M HCl is mixed with 10 mL of 0.1 M NaOH, the temperature rise will be $2t°C$.

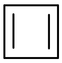
(D) If 10 mL of 0.1 M HCl is mixed with 10 mL of 0.1 M NaCl, the temperature rise will be $t°C$

9. Identify correct statement/statements from the following options:

(A)  has aromatic system

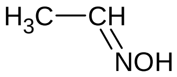
(B)  has cyclic $6\pi e^-$ system

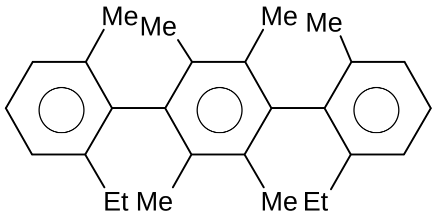
(C) Marked hydrogen in  is more acidic then marked hydrogen in 

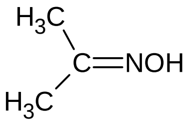
(D)  is unstable at room temperature

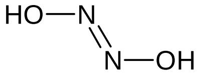
Space for rough work

10. Which will show geometrical isomerism?

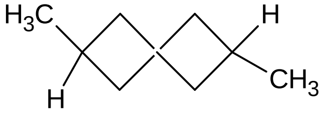
(A)

$H_3C-CH{=}NOH$

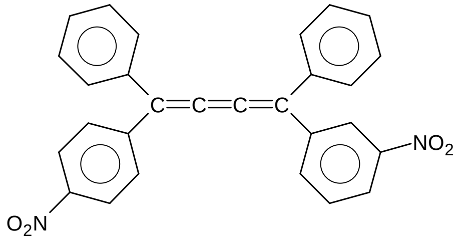
(B)

Me
Me
Me
Me
Et
Me
Me
Et

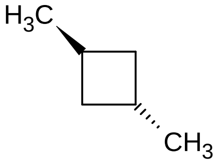
(C)

H3C
C=NOH
H3C

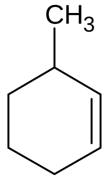
(D)

$HO-N{=}N-OH$

11. Identify the chiral molecule/molecules:

(A)


(B)

C=C=C=C
NO2
O2N

(C)


(D)


12. Which of the following is/are can produce H_2O_2 on hydrolysis?

(A) BaO_2

(B) PbO_2

(C) MnO_2

(D) Na_2O_2

Space for rough work

13. The correct statement/statements is/are:
(A) The distance between two octahedral voids of a cubic close packing of atoms with radius r is 2r
(B) The distance between two tetrahedral voids of a cubic close packing of atoms with radius r is $\sqrt{6}\times r$ at the body diagonal axes
(C) The distance between tetrahedral and octahedral void is $\sqrt{\frac{3}{2}}\times r$, where is the radius of atom forming the close packing
(D) The distance between the surface of atoms fcc arrangement along an edge is $2\left(\sqrt{2}-1\right)r$

14. Identify the correct relationship:
(A) $\left[Cu\left(NH_3\right)_4\right]^{2+}$ with Hybridization of $Cu = dsp^2$
(B) $Fe\left(CO\right)_x$ with $x = 5$
(C) Zn^{2+} Complexes with sp^3d^2 hybridization are diamagnetic in nature
(D) Cr^{3+} Complexes with Paramagnetic nature

Comprehension Type

This section contains **2 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

---

Paragraph for Question Nos. 15 to 16

Assume that water vapour behaves as an ideal gas and the volume occupied by the liquid water is negligible compared to the volume of the container. A sample of liquid water of mass 3 g is injected into an evacuated 76 L flask maintained at 320 K. At this temperature the vapour pressure of water is 32 mm of Hg:
Now give the answers to following questions:

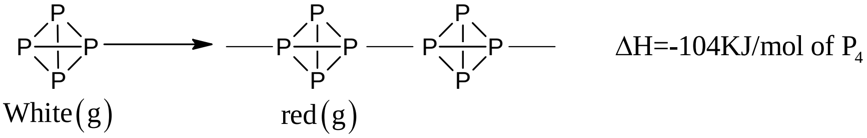
15. What % of the water will be vaporised, when the system comes to equilibrium:
(A) 18% (B) 73%
(C) 30% (D) 64%

16. What should be the minimum volume of the flask if no liquid water is to be present at equilibrium?
(A) $174L$ (B) $150L$
(C) $104L$ (D) $126L$

Space for rough work

Paragraph for Question Nos. 17 to 18

White phosphorus is a tetra atomic solid $\left[P_4(s)\right]$ at room temperature and on strong heating in absence of oxygen, it polymerizes into red phosphorus as:



The enthalpy of sublimation $\left[P_4(s)\longrightarrow P_4(g)\right]$ white is 59 KJ/mol and enthalpy of atomization is 316.25 KJ/mol of $P(g)$.

Now give the answers of following questions:

17. The average $P-P$ bond enthalpy in P_4 molecule is:

(A) $102KJ$	(B) $201KJ$
(C) $104KJ$	(D) $120KJ$

18. The $P-P$ bond enthalpy in red phosphorus joining the two tetrahedral is:

(A) $201KJ$	(B) $104KJ$
(C) $305KJ$	(D) $80KJ$

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **6 multiple choice questions** numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. If $z_0 = \frac{1+i}{2}$, then the value of the product $(1+z_0)(1+z_0^2)(1+z_0^{2^2})\ldots\ldots\ldots(1+z_0^{2^n})$ must be

(A) $2^{2^{n+1}}$

(B) $(1+i)\left(1-\frac{1}{2^{2^n}}\right)$, if $n > 1$

(C) $\frac{5}{4}(1+i)$, if $n = 1$

(D) 0

2. Let N be any four digit number say $x_1\,x_2\,x_3\,x_4$. Then maximum value of $\frac{N}{x_1 + x_2 + x_3 + x_4}$ is equal to

(A) 1000

(B) $\frac{1111}{4}$

(C) 800

(D) None of these

3. $\int \frac{e^{\cot x}}{\sin^2 x}$ [2 ln cosec x + sin 2x] dx is equal to

(A) – 2$e^{\cot x}$ ln (cosec x) + c

(B) $e^{\cot x}$ ln x + c

(C) $e^{\cot x}$ (ln (cosec x) + c

(D) none of these

4. Let P be any moving point on the circle $x^2 + y^2 - 2x = 1$. AB be the chord of contact of this point w.r.t the circle $x^2 + y^2 - 2x = 0$. The locus of the circumcentre of the triangle CAB, (C being centre of the circles) is

(A) $2x^2 + 2y^2 - 4x + 1 = 0$

(B) $x^2 + y^2 - 4x + 2 = 0$

(C) $x^2 + y^2 - 4x + 1 = 0$

(D) $2x^2 + 2y^2 - 4x + 3 = 0$

Space for rough work

5. ABCD is a quadrilateral with side lengths AB = 4, BC = 10, CD = 6 and AD = 6, and diagonal BD = 8 units. If the incircles of triangles ABD and BCD touch BD at P and Q respectively, then area of quadrilateral C_1PC_2Q (where C_1 and C_2 are incentres of triangle ABD and BCD respectively), is

(A) $3+\frac{5\sqrt{15}}{2}$ sq. units (B) 3 sq. Units

(C) $\frac{\sqrt{15}}{6}$ sq. units (D) none of these

6. $\lim\limits_{x\to 0}\frac{\sin^{-1}x-\tan^{-1}x}{x^3}$ is equal to

(A) $\frac{1}{6}$ (B) $\frac{1}{2}$

(C) 2 (D) $-\frac{1}{2}$

Multiple Correct Choice Type

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

---

7. Consider the equation tan $(5\pi\cos\theta) = \cot(5\pi\sin\theta)$ for $\theta \in (0, 2\pi)$, then

(A) number of real solution is 28 (B) number of real solution is 14

(C) $\sin\theta + \cos\theta = \frac{2n+1}{10}$ (D) $\sin\theta - \cos\theta = \frac{2n+1}{10}$

8. Three straight lines are drawn through a point 'P' lying in the interior of the ΔABC and parallel to its sides. The areas of the three resulting triangles with P as the vertex are s_1, s_2 and s_3 then area of ABC =

(A) $\left(\sqrt{s_1}+\sqrt{s_2}+\sqrt{s_3}\right)^2$ (B) $(s_1 + s_2 + s_3)$

(C) $\sqrt{s_1s_2+s_2s_3+s_3s_1}$ (D) $s_1 + s_2 + s_3 + 2\left(\sqrt{s_1s_2}+\sqrt{s_2s_3}+\sqrt{s_3s_1}\right)$

9. If k denotes the remainder on dividing $\sum_{r=1}^{200} r!$ by n then (k, n) can be

(A) (5, 14) (B) (1, 3)
(C) (3, 10) (D) (3, 15)

Space for rough work

10. The square roots of the matrix $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ are

(A) $\pm\begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}$
(B) $\pm\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$
(C) $\pm\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$
(D) $\pm\begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix}$

11. Range of the function $f(x)=\sqrt{\frac{1-|x|}{2-|x|}}$ contains

(A) $[0,1)$
(B) $[1,2)$
(C) $(1,2)$
(D) $(2,\infty)$

12. In $\Delta ABC,$ if $A=45°, B=75°$ then

(A) $a+\sqrt{2}c=2b$
(B) $\sqrt{3}a=\sqrt{2}c$
(C) $a=\left(\sqrt{3}-1\right)b$
(D) $3a=5b$

13. Equation of plane through $A(1,0,0), B(0,1,0)$ and making an angle $\frac{\pi}{4}$ with the plane $x+y=3$ can be

(A) $x-y+2z=1$
(B) $x+y+\sqrt{2}z=1$
(C) $x+y-\sqrt{2}z=1$
(D) $x-y-2z=1$

14. If the area bounded by the curve $\mathrm{y}=\mathrm{x}-\mathrm{x}^2$ and the line y = mx equals $\frac{9}{2}$. Then the value of m is:

(A) – 4
(B) –2
(C) 2
(D) 4

Space for rough work

Comprehension Type

This section contains **2 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

Paragraph for Question Nos. 15 to 16

Locus of the centre of a circle touching the circle $x^2 + y^2 - 4y - 2x = \frac{7}{4}$ internally and tangents on which from (1, 2) is making an angle 60^o with each other is director circle (C) of a variable ellipse E. On this basis given answers to the following questions

15. The equation of the director circle (C) is

(A) $(x-2)^2 + (y-1)^2 = \sqrt{3}$
(B) $(x-1)^2 + (y-2)^2 = 3$
(C) $(x+1)^2 + (y-2)^2 = \sqrt{3}$
(D) $(x-1)^2 + (y+2)^2 = 3$

16. Locus of focus of variable ellipse(E) when major axis is parallel to x–axis, is

(A) $\left\{(x,\ y)/\sqrt{\frac{3}{2}} <| x-1 |< \sqrt{3} \text{ and } y = 2\right\}$
(B) $\{(x,\ y)/ 0 <| x |< \sqrt{3} \text{ and } y = 2\}$
(C) $\{(x,\ y)/ 0 <| x+1 |< \sqrt{3} \text{ and } y = 2\}$
(D) $\{(x,\ y)/ 0 <| x-1 |< \sqrt{3} \text{ and } y = 2\}$

Space for rough work

Paragraph for Question Nos. 17 to 18

Let S = {1, 2, 3,…..n} be a set and two numbers x and y are drawn with replacement from S. Let P_k be the probability that $x^2 - y^2$ is divisible by k & [x] denotes greatest integer less than or equal to x.

17. The value of P_2 is equal to

(A) $\frac{1}{2}$

(B) $\left(\frac{\left[\frac{n}{2}\right]}{n}\right)^2$

(C) $1-2.\frac{\left[\frac{n}{2}\right]}{n}+2\left(\frac{\left[\frac{n}{2}\right]}{n}\right)^2$

(D) $1-\frac{2-\left[\frac{n}{2}\right]}{n}-2\left(\frac{\left[\frac{n}{2}\right]}{n}\right)^2$

18. The value of P_3 is equal to

(A) $\frac{\left[\frac{n}{3}\right]}{n}$

(B) $\left(\frac{\left[\frac{n}{3}\right]}{n}\right)^2$

(C) $1+\frac{\left[\frac{n}{3}\right]}{n}+\left(\frac{\left[\frac{n}{3}\right]}{n}\right)^2$

(D) $1-2.\frac{\left[\frac{n}{3}\right]}{n}+\left(\frac{\left[\frac{n}{3}\right]}{n}\right)^2$

Space for rough work

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/
Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

FIITJEE

JEE(Main) - 2017

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

CONCEPT RECAPITULATION TEST - IV
(Main)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	A	B
2.	C	C	C
3.	A	B	D
4.	C	A	A
5.	B	D	B
6.	C	D	B
7.	C	B	D
8.	D	C	A
9.	C	B	A
10.	A	B	C
11.	B	C	D
12.	C	D	C
13.	D	B	A
14.	C	A	A
15.	C	B	A
16.	A	C	D
17.	D	B	D
18.	C	B	A
19.	C	A	D
20.	B	D	C
21.	A	C	B
22.	A	C	B
23.	C	A	A
24.	D	B	A
25.	B	B	B
26.	A	D	C
27.	C	B	B
28.	B	B	C
29.	A	C	D
30.	B	D	A

Physics

PART – I

SECTION – A

3. $\vec{v}.\vec{r} \ge 0$

$$2u^2 - 3u\sin\theta gt + g^2 \ge 0$$

$$9u^2\sin^2\theta g^2 - 8u^2g^2 \ge 0 \Rightarrow \sin\theta \ge 2\sqrt{\frac{2}{3}}$$

6. From 0 to t_1 emf is constant and $-ive$

From $t_1\,to\,t_2$ emf is zero

From t_2 to $t_1 + t_2$ emf is constant and $+ive$

7. $V_{new} = \dfrac{\frac{\theta}{2} + cv}{c} = V + \dfrac{\theta}{2c}$

8. $V = \dfrac{1}{4\pi\in_0}.\dfrac{\theta}{1+\frac{1}{2}} = \dfrac{\theta}{6\pi\in_0}$

10. $rate \propto T^4$

11. $\dfrac{\text{dr}}{\text{dt}} = \text{constant}$

12. $\alpha = \dfrac{\omega dw}{dv} \Rightarrow at\,\theta = 1\alpha = 4\times 3 = 12\,rod/\sec^2$

16. $\dfrac{1}{2}.\dfrac{a_1 t}{2} = \dfrac{1}{2}a_2\left(t-2\right) \Rightarrow a_1 t = 2a_2 t = 4a_2$

20. Angle of incident u is greater than vertical angle

21. $91.3\times V = 0.31$

22. $L^2\sqrt{2gy} = 2\pi R^2\sqrt{2gy} \Rightarrow R = \dfrac{L}{\sqrt{2n}}$

25. $\dfrac{E_1 + E_2}{R + r_1 + r_2} > \dfrac{E_1}{R + r_1}$

27. $\dfrac{hc}{\lambda} - \phi = eV_{\max}$

28. $$\frac{t}{1/2} = \frac{3}{4}t$$

$$\Rightarrow \frac{11}{2}t - 4 \Rightarrow \frac{3}{2}t = \frac{2t}{1/2}$$

29. $$\left[\frac{\beta}{\alpha}\right] = \left[LT^{-1}\right]$$

30. $$2\pi\sqrt{\frac{L}{(mg-kv)/m}} = 2\pi\sqrt{\frac{L}{g}} \times 2$$

$$\Rightarrow \frac{1}{mg-kv} = \frac{4}{mg}$$

$$\Rightarrow mg - kv = mg/4$$

$$v = \frac{3mg}{4k}$$

Chemistry PART – II

SECTION – A

1. Down the group covalent character decrease

3. $Na\left[\overset{+I}{A}g\left(CN\right)_2\right]$

5. $EDTA^{4-}$ is Hexadentate and form optically active compounds.

9. Using MOT (paramagnetic entities are attracted towards externally applied magnetic field) find paramagnetic ions.

11. Rate of effusion $\propto \frac{1}{\sqrt{T}}$

13. Charge is not balanced in reaction except option (B)

15. Area under the curve $= -1\times 3\times 10^{-5} - \frac{1}{2}\times 3\times 3\times 10^{-5} = -7.5\times 10^{-5}\ J$

16. $P_4 + 20HNO_3 \longrightarrow 4H_3PO_4 + 20\,NO_2 \uparrow + 4H_2O$

$m.moles\,of\ NaOH = 2\times m.moles\,of\ H_3PO_4 \Rightarrow m.moles\,H_3PO_4 = \frac{100\times 0.1}{2} = 5$

$m.moles\,of\ HNO_3 = \frac{20}{4}\times 5 = 25$

Volume of $HNO_3 = 25\,ml$

20. $Zn + 2NaOH \rightarrow \underset{(A)}{Na_2ZnO_2} + \underset{(X)}{H_2}$

$Na_2ZnO_2 + H_2S \rightarrow Zns + 2NaOH$

22. Zn^{2+}, Li^+, K^+, Al^{3+} are colourless where as Co^{2+} is coloured.

27. [700]

$X_x = 0.30$

& $Y_x = 0.60$

$P_B^0 = 700\,mm$

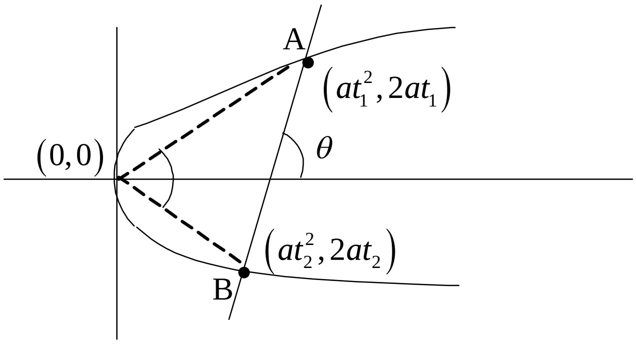
Mathematics PART – III

SECTION – A

1.
$$\int \frac{3x^2+4x-1}{\left(x^2+1\right)^2\sqrt{x+1}}dx$$
$$=\int \frac{4x^2+4x-x^2-1}{\left(x^2+1\right)^2\sqrt{x+1}}dx$$
$$=4\int \frac{x\left(x+1\right)dx}{\left(x^2+1\right)^2\sqrt{x+1}}-\int \frac{dx}{\left(x^2+1\right)\sqrt{x+1}}$$
$$4\int \frac{x\left(x+1\right)dx}{\left(x^2+1\right)^2\sqrt{x+1}}.\left[\frac{2\sqrt{x+1}}{x^2+1}\int \frac{-1\quad 2x.2\sqrt{x+1}}{\left(x^2+1\right)^2}.dx\right]$$
$$=4\int \frac{x\left(x+1\right)dx}{\left(x^2+1\right)^2\sqrt{x+1}}-\frac{2\sqrt{x+1}}{x^2+1}$$
$$=\frac{-2\sqrt{x+1}}{x^2+1}+c$$

2.
$$y\left(xy-\left(x^2-y^2\right)^2\right).dx=\left\{y^3-x\left(x^2-y^2\right)^2\right\}dy$$
$$\Rightarrow xy^2dx-y\left(x^2-y^2\right)^2dx=y^3dy-x\left(x^2-y^2\right)^2dy$$
$$\Rightarrow y^2\left(xdx-ydy\right)=\left(x^2-y^2\right)^2\left(ydx-xdy\right)$$
$$\Rightarrow xdx-ydy=\left(x^2-y^2\right)^2\frac{\left(ydx-xdy\right)}{y^2}$$
$$\frac{2\left(xdx-ydy\right)}{\left(x^2-y^2\right)^2}=\frac{2\left(ydx-xdy\right)}{y^2}$$
$$\int \frac{d\left(x^2-y^2\right)}{\left(x^2-y^2\right)^2}=2\int d\left(\frac{x}{y}\right)$$
$$\frac{-1}{x^2-y^2}=\frac{2x}{y}+C$$
$$\therefore \frac{2x}{y}+\frac{1}{x^2-y^2}=C$$

3.



$y^2 = 8x$

Now, $t_1t_2 = -4$

And $t_2 = -t_1 - \frac{2}{t_1}$

$\frac{-4}{t_1} = -t_1 - \frac{2}{t_1}$

$\Rightarrow -t_1^2 = -2$

$\Rightarrow t_1^2 = 2$

$y^2 = 4ax$

$\frac{dy}{dx} = \frac{4ax}{2y}$

$\frac{dy}{dx} = \frac{1}{t}$

Slope of normal $= -t$

And $\tan^2\theta = t_1^2 = 2$

4. $C: \left(x^2y^2 - 4x - 8y - 5\right) + \lambda\left(x^2 + y^2 - 12x + 2y + 29\right) = 0$

Centre : $\left(\frac{2+6\lambda}{1+\lambda}, \frac{4-\lambda}{1+\lambda}\right)$

Common chord $4x - 5y - 17 = 0$

Centre lies on common chord

$\therefore \lambda = \frac{29}{12}$

$\therefore$ centre $\left(\frac{1+6(29/12)}{1+29/12}, \frac{4-29/12}{1+29/12}\right)$

$\therefore$ centre $\left(\frac{198}{41}, \frac{19}{41}\right)$

5. $\int_0^{\frac{11\pi}{3}} \sqrt{1+\cos 2x}.dx$

$$= \int_0^{\frac{11\pi}{3}} \sqrt{2}\left|\cos x\right|.dx$$

$$= \int_0^{3\pi} \left|\sqrt{2}\cos x\right|.dx + \int_{3\pi}^{3\pi+2\pi/3} \sqrt{2}\left|\cos x\right| dx$$

$$3\sqrt{2}\int_0^{\pi} \left|\cos x\right|.dx + \sqrt{2}\int_0^{2\pi/3}\left|\cos x\right|.dx$$

$$= 6\sqrt{2}\int_0^{\pi/2}\left(\cos x\right)dx + \sqrt{2}\int_0^{\pi/2}\cos x.dx - \sqrt{2}\int_{\pi/2}^{2\pi/3}\cos x.dx$$

$$= 6\sqrt{2} + \sqrt{2}\frac{-\sqrt{3}}{\sqrt{2}} + \sqrt{2}$$

$$= \sqrt{2} - \sqrt{\frac{3}{2}}$$

6. $2\vec{a} - \vec{b} = \hat{i} + 3\hat{j} - 5\hat{k}$

$\vec{a} - 2\vec{b} = -4\hat{i} + 4\hat{j} - 4\hat{k}$

Area of $= \dfrac{1}{2}\left|\left(2\vec{a} - \vec{b}\right)\times\left(\vec{a} - 2\vec{b}\right)\right|$

$\left(2\vec{a} - \vec{b}\right)\times\left(\vec{a} - 2\vec{b}\right) = 3\hat{i} + 24\hat{j} + 15\hat{k}$

Area $= \dfrac{9\sqrt{10}}{2}$

7. Taking first two

$\dfrac{\tan\left(\pi/4+\alpha\right)}{\tan\left(\pi/4+\beta\right)} = \dfrac{5}{3}$

$\therefore \dfrac{\cos\left(\alpha+\beta\right)}{\sin\left(\alpha-\beta\right)} = \dfrac{8}{2} = 4$

$\therefore \cos\left(\alpha+\beta\right) = 4\sin\left(\alpha-\beta\right) --------(1)$

Similarly

$\cos\left(\beta+\alpha\right) = \sin\left(\beta-\alpha\right) ------(2)$

$3\cos\left(\gamma+\alpha\right) = -7\sin\left(\gamma-\alpha\right) -----(3)$

After marking $\sin^{-2}$ terms

$(1)+(2)-(3)$

Then,

$12\sin^2\left(\alpha-\beta\right) + 15\sin^2\left(\beta-\gamma\right) - 7\sin\left(\gamma-\alpha\right) = 0$

8. At $x = 0, y = 1$ for both curves intersect

Now $y = \left(1+x\right)^{\cos x} + \sin x$

$\therefore \dfrac{dy}{dx} = 2\,at\;\; x = 0$

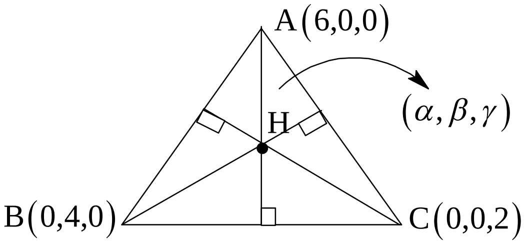
And $y=\frac{1}{2}\left(x^2+x+2\right)$

$\frac{dy}{dx}=\frac{1}{2}\ at\ x=0$

Now $m_1=2,\ m_2=\frac{1}{2}$

$\therefore \tan\theta=\left|\frac{2-1/2}{1+(2)(1/2)}\right|=\left|\frac{3/2}{2}\right|\Rightarrow\frac{3}{4}$

9.



Now $AH\perp BC$

Now D^r of $AH=(\alpha-6,\beta,\gamma)$

$D^r\ of\ BC=(0,4,-2)$

Now for 1 lines,

$a_1a_2+b_1b_2+c_1c_2=0$

$\therefore 0(\alpha-6)+\beta(4)-2\gamma=0$

$\therefore 4\beta-2\gamma=0$

$2\beta=\gamma---(1)$

Similarly

$-6\alpha+2\gamma=0-----(2)$

$-6\alpha+4\beta=0-----(3)$

$\therefore 2\beta=\gamma;\ \frac{2\beta}{3}=\alpha$

Now may lie on

$2x+3y+6z=12$

$\therefore 2\alpha+3\beta+6\gamma=12$

$2\left(\frac{2\beta}{3}\right)+3\beta+6(2\beta)=12$

$4\beta+9\beta+36\beta=36$

$49\beta=36$

$\beta=\frac{36}{49}$

Now, $\alpha=\frac{24}{49}$ and $\gamma=\frac{72}{49}$

$$(\alpha,\beta,\gamma)=\left(\frac{24}{49},\frac{36}{49},\frac{72}{49}\right)$$

10. $f(x)=\log_3\left(\log_{1/2}\left(\log_2\left(\log_{1/3}\right)\right)\right)$

$$\frac{x+1}{\sqrt{1-3x-4x^2}}$$

Now, $\sqrt{1-3x-4x^2}>0$

$4x^2+3x-1<0$

$\therefore(4x-1)(x+1)<0$

$\therefore x\in(-1,1/4)$

$\log_{1/2}\left(\log_2\left(\log_{1/3}(x)\right)\right)>0$

$\log_2\left(\log_{1/3}(x)\right)<1$

$\log_{1/3}(x)<2$

$x>1/9$

Now $F\left(f(x)\right)\in x>\frac{1}{9}\cap x\in(-1,1/4)$

$\therefore x\in\left(\frac{1}{9},\frac{1}{4}\right)$

11. $f(x)+f(1-x)=\frac{1}{27}$

$\frac{54}{27}=2$

12. $\cot\sum_{n=1}^{\infty}\cot^{-1}\frac{1}{n^2}\times n^2\frac{(n+1)^2}{2}$

$=\cot\sum_{n=1}^{\infty}\tan^{-1}\frac{2}{(n+1)^2}$

$=\cot\sum_{h=1}^{\infty}\left(\tan^{-1}(n+2)-\tan^{-1}n\right)$

$$s_n=\begin{bmatrix}\tan^{-1}3-\tan^{-1}1\\ \tan^{-1}4-\tan^{-1}2\\ \tan^{-1}(n+2)-\tan^{-1}n\end{bmatrix}$$

$s_n=\tan^{-1}\left(\frac{3n^2+7n}{n^2+9n+10}\right)$

$s_\infty=\tan^{-13}$

$$\cot\tan^{-13} = \cot\cot^{-1}\frac{1}{3} \Rightarrow \frac{1}{3}$$

13. $$\lim_{x\to\pi} a\,\frac{\left\{\frac{1}{1+9f(x)}\right\}9f'(x)-\cos\left(f(x)\right)f'(x)}{2f'(x)}$$

$$=\frac{9-1}{2}=4$$

$$\sum_{h=1}^{\infty}4^{-n}=\frac{1}{4}+\frac{1}{4^2}+......\infty$$

$$=\frac{1}{3}$$

14. Given $\dfrac{f(x)f'(x)}{\sqrt{1-\left(f(x)\right)^4}} \ge x$

$$\frac{2f(x)f'(x)}{\sqrt{1-\left(f(x)\right)^4}}-2\times \ge 0$$

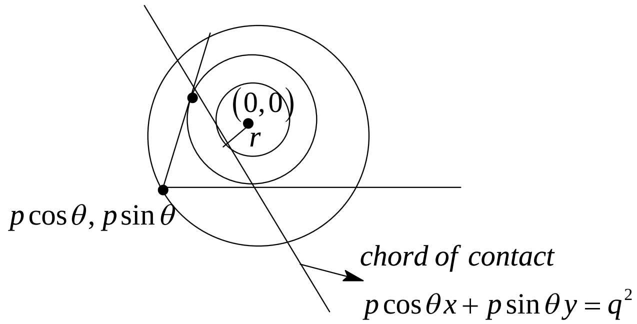
Let $g(x)=\sin^{-1}\left(f(x)\right)^2-x^2$ is non decreasing function

$$\lim_{x\to a^-} g(x) \le \lim_{x\to b^+} g(x)$$

$$\frac{\pi}{2}-a^2 \le \frac{\pi}{6}-b^2$$

$$a^2-b^2 \ge \frac{\pi}{3};\ \left[a^2-b^2\right]=1$$

15.



$\perp$ distance from (centre) to chord of contact

$$r=\left|\frac{p\cos\theta\times 0+p\sin\theta\times 0-q^2}{p}\right|$$

$$q^2=rp$$

$$p,q,r\ are\,in\,GP$$

$$\therefore 2a-\log_e^p,\ 4a-\log_e^q,\ 6a-\log_e^r\ are\,in\,AP$$

16. $G.E.of\ line$

$Ax+By+C=0$

$At_1+B\left(2at_1+at_1^3\right)+c=0$

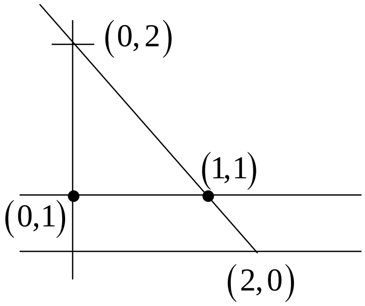
$Bat_1^3+\left(2aB+A\right)t_1+c=0$

Sum of roots

$t_1+t_2+t_3=0$

$2^{t_1}.2^{t_2}.2^{t_3}=2^{\circ}=1$

17.



$x^2-y^2+2y-1=0$

$x^2-\left(y-1\right)^2=0$

$\left(x+y-1\right)\left(x-y+1\right)=0$

Angle bisector

$\frac{x+y-1}{\sqrt{2}}=\pm\frac{x-y+1}{\sqrt{2}}$

$x+y-1=x-y+1$

$x+y-1=-x+y-1$

$\Rightarrow y=1 \quad \Rightarrow x=0$

Area $a=\frac{1}{2}\times1\times1=\frac{1}{2}$

Orthocentre $\left(0,1\right)\Rightarrow b=0,c=1$

$\therefore 4a+b+c=2+0+1=3$

18. $z^5=1$

$\frac{z^5}{z^5+z}+\frac{z}{z+1}+\frac{z^2}{z^2+1}+\frac{z^5}{z^2+z^5}$

$=\frac{1}{1+z}+\frac{z}{1+z}+\frac{z^2}{z^2+1}+\frac{1}{z^2+1}$

$=1+1=2$

19. Equation of tangent $y=3x\pm\sqrt{9a^2+b^2}$

This is normal to circle

$x^2+y^2+4x+1=0$

Panes – 1 brought $\left(-2,0\right)$

$\Rightarrow 0=-6\pm\sqrt{9a^2+b^2}$

$36=9a^2+b^2$

$AM\geq GM$

$\frac{9a^2+b^2}{2}\geq\sqrt{9a^2b^2}$

$18\geq 3ab$

$6\geq ab$

20. $F\left(x\right)=\int_0^x f\left(t\right)dt$

$F\left(x^2\right)=\int_0^{x^2} f\left(t\right)dt$

$=x^2\left(1+x\right)$

Diff. both side

$F'\left(x^2\right).2x=2x+3x^2$

$f\left(x^2\right)=1+\frac{3}{2}x$

$x=2,\ f\left(4\right)=1+\frac{3x}{2}$

$x=2,\ f\left(4\right)=1+\frac{3}{2}\times 2=4$

Unit place $\left(985697\right)^{16}=1$

26. $A=x^3-\frac{1}{x^3}=\left(x-\frac{1}{x}\right)^3+3\left(x-\frac{1}{x}\right)$

$A=B^3+3B$

$\frac{A}{B^2}=B+\frac{3}{B}$

Let $t=x-\frac{1}{x}$

$\frac{A}{B^2}=s=t+\frac{3}{t}$

$\frac{ds}{dt}=1-\frac{3}{t^2}$

$\frac{d^2s}{dt^2}=\frac{6}{t^3}$

$\frac{ds}{dt}=0\Rightarrow t=\pm\sqrt{3}$

For min $t = +2\sqrt{3}$

$$s = \sqrt{3} + \frac{3}{\sqrt{3}} = 2\sqrt{3}$$

27. $f\left(x\right) + f\left(x+2\right) = \sqrt{3} f\left(x+1\right)$

$x \to x+2 ------ \left(1\right)$

$f\left(x+2\right) + f\left(x-14\right) = \sqrt{3} f\left(x+3\right) ------ \left(2\right)$

$\left(1\right) + \left(2\right)$

$f\left(x\right) + 2 + \left(x+2\right) + f\left(x+14\right)$

$= \sqrt{3}\left\{ f\left(x+1\right) + f\left(x+3\right) \right\}$

$= 3 f\left(x+2\right)$

$f\left(x\right) + f\left(x+4\right) = f\left(x+2\right)$

$x \to x+2 ----- \left(3\right)$

$f\left(x+2\right) + f\left(x-16\right) = f\left(x+4\right) --- \left(4\right)$

$\left(3\right) + \left(4\right)$

$f\left(x\right) + f\left(x+6\right) = 0$

$f\left(x+6\right) = -f\left(x\right)$

$f\left(x+12\right) = -f\left(x+6\right)$

$= f\left(x\right)$

Period $T = 12$

$\frac{T}{2} = 6$

28. Centre $\left(0, -f\right)$

Equation of circle

$x^2 + y^2 + 2fy + c = 0$

$$\left(\log_e a_r\right)^2 + \frac{1}{\left(\log_e a_r\right)^2} + 2f\left(\frac{1}{\log_e a_r}\right) + c = 0$$

$\left(\log a_r\right)^4 + c\left(\log a_r\right)^2 + 2f\left(\log a_r\right) = 0$

$\log a_1, \log a_2, \log a_3, \log a_4$ are roots of equation

$\therefore \log\left(a_1.a_2.a_3.a_4\right) = 0$

$a_1 a_2 a_3 a_4 = 1$

$$\frac{a_1 + a_2 + a_3 + a_4}{4} \geq \left(1\right)^{1/4}$$

$\therefore a_1 + a_2 + a_3 + a_4 \geq 4$

29. $20c_0 \times 30c_{5m} + 20c_1 \times 30c_{5m-1}$

$+......+ 20c_{5m} \times 30c_0$

Coeff of $x^{5m} \rightarrow (1+x)^{20}(1+x)^{30}$

$50c_{5m}, 5m = \frac{50}{2} = 25$

$m = 5$

30. $1920 = 5\times3\times2^7 = 5\times3\times2\times2\times2\times2\times2\times2\times2 = \frac{9!}{7!} = 9\times8$

$1920 = 5\times3\times4\times2\times2\times2\times2\times2\times1 = \frac{9!}{5!} = 9\times8\times7\times6$

$1920 = 3,5,4,4,2,2,2,1,1$

$\frac{9!}{2!2!3!}$

$3,5,4,4,4,2,1,1,1$

$\frac{9!}{3!3!}$

Total = $\frac{9!}{7!} + \frac{9!}{5!} + \frac{9!}{2!2!3!} + \frac{9!}{3!3!}$

$= \frac{9!}{7!}(1+42+210+140)$

$=393\,{}^9P_2$

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

FIITJEE **JEE (Main), 2017**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - IV

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 30)** contains 30 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

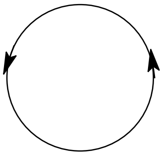
SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. A solid cylinder rolling down an inclined plane (with angle of inclination θ) without slipping which of the following statement is incorrect?
(A) the friction force is dissipative
(B) the friction force will aid rotation
(C) the friction force will hinder translation
(D) the friction force will change if θ is changed

2. The following field line does not represent any of the two fields given in which option?
(A) Induced electric field and electrostatic field
(B) Magneto static field and induced electric field
(C) Gravitational field of a mass at rest and electrostatic field
(D) Magneto static field and Gravitational field of a mass at rest

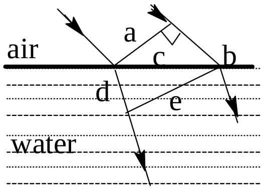


3. A particle is projected from ground at angle θ with horizontal, in such a way that a does not recede towards the point of projection. The maximum value of $\sin\theta$?

(A) $2\frac{\sqrt{2}}{3}$	(B) $\frac{\sqrt{2}}{3}$
(C) $\frac{\sqrt{3}}{2}$	(D) this is not possible

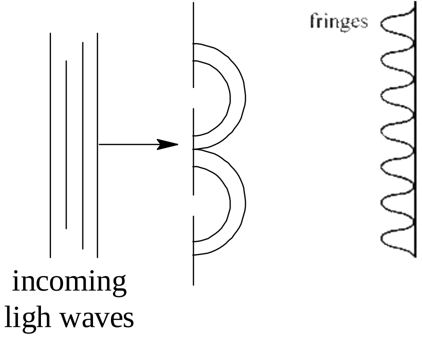
Space for rough work

4. Figure shown plane waves refracted for air to water using Huygen's principle a, b, c, d, e are lengths on the diagram. The refractive index of water w.r.t air is the ratio.



(A) a/e (B) b/e
(C) b/d (D) d/b

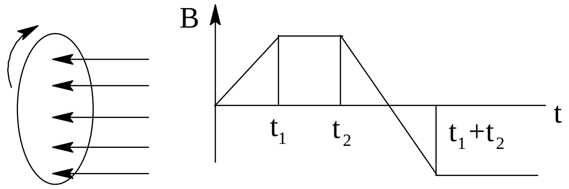
5. In a Young's double slit experiment, green light is incident on the two slits. The interference pattern is observed on a screen. Which of the following changes would cause the observed fringes to be more closely spaced?



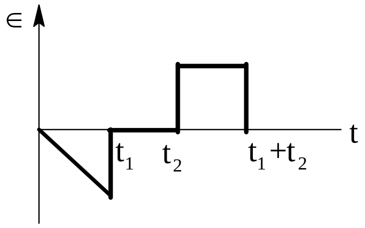
(A) Reducing the separation between the slits
(B) Using blue light instead of green light
(C) Used red light instead of green light
(D) Moving the light source further away from the slits.

Space for rough work

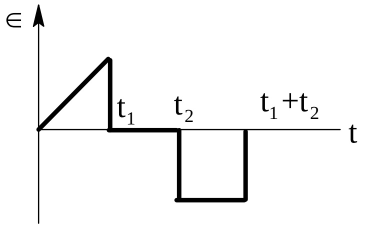
6. A wire loop is placed in a region of time varying magnetic field which is oriented orthogonally to the plane of the loop as shown in the figure. The graph shows the magnetic field variation as the function of time. Assume the positive emf is the one which drives a current in the clockwise direction and seen by the observer in the direction of B. Which of the following graphs best represents the induced emf as a function of time.



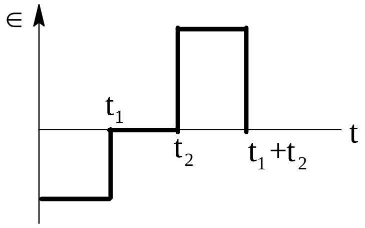
(A)



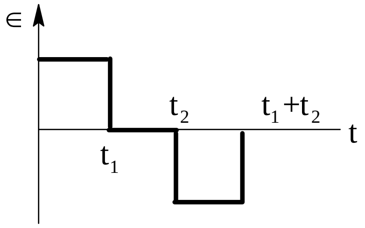
(B)



(C)



(D)



7. A capacitor of capacitance C is charged to a potential difference V from a cell and then disconnected from it. A charge +Q is now given to its positive plate. The potential difference across the capacitor is now:

(A) V

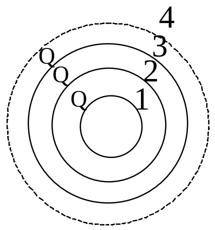
(B) $V+\frac{Q}{C}$

(C) $V+\frac{Q}{2C}$

(D) $V-\frac{Q}{C}, if\, V<CV$

Space for rough work

8. An infinite number of concentric rings carry a charge Q each alternately positive and negative. Their radii 1,2,4,8....meters in geometric progression as shown in the figure. The potential at the centre of the ring will be.



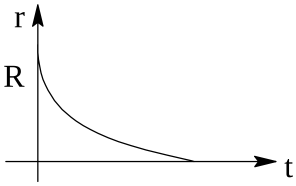
(A) Zero
(B) $\frac{Q}{12\pi\varepsilon_0}$
(C) $\frac{Q}{8\pi\varepsilon_0}$
(D) $\frac{Q}{6\pi\varepsilon_0}$

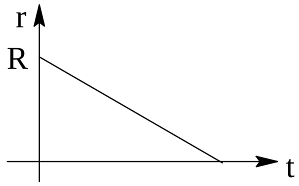
9. Select the correct choice:
(A) The gravitational field inside a spherical cavity, within a spherical planet must be non zero and uniform.
(B) When a body is projected horizontally at an appreciable large height above the earth, with a velocity less than for a circular orbit, it will fall to the earth along a parabolic path.
(C) A body of zero total mechanical energy placed in a gravitational field will escape the field
(D) Earth's satellite must be in equatorial plane.

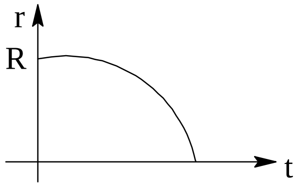
10. The rate of emission of radiation of a black body at 273°C is E, then the rate of emission of radiation of this body at 0°C will be:

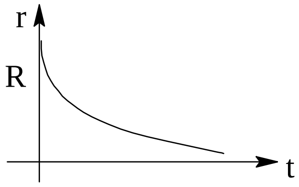
(A) $\frac{E}{16}$
(B) $\frac{E}{4}$
(C) $\frac{E}{8}$
(D) 0

11. A sphere of ice at 0°C having initial radius R is placed in an environment having ambient temperature > 0°C. The ice melts uniformly, such that shape remains spherical. After a time 't' the radius of the sphere has reduced to r. Assuming the rate of heat absorption is proportional to the surface area of the sphere at any moment, which graph best depicts r (t).

(A)


(B)


(C)


(D)


Space for rough work

12. If angular velocity of a disc depends an angle rotated θ as $\omega = \theta^2 + 2\theta$, then its angular acceleration α at $\theta = 1$ rad is :

(A) 8 rad/sec^2
(B) 10 rad/sec^2
(C) 12 rad/sec^2
(D) None

13. Two projectiles are thrown simultaneously in the same plane from the same point. If their velocities are v_1 and v_2 at angles θ_1 and θ_2 respectively from the horizontal. Then the trajectory of particle 1 with respect to particle 2 will be

(A) a parabola because both move in parabolic path.
(B) a straight line because both move in parabolic path
(C) a parabola because both move with same acceleration.
(D) a straight line because both move with same acceleration.

14. Which of the following statements is true for a particle moving in a circle with a constant angular speed?

(A) the velocity vector is normal to the circle.
(B) the acceleration vector is tangent to the circle.
(C) the acceleration vector points to the centre of the circle
(D) the velocity and acceleration vectors are parallel to each other

15 Three noncollinear vectors $\vec{a}, \vec{b}$ & $\vec{c}$ are coplanar then which of the following is incorrect:

(A) $\vec{a}.\left(\vec{b} \times \vec{c}\right) = 0$

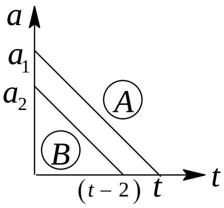
(B) $\left(\vec{b} \times \vec{a}\right).\vec{c} = 0$

(C) $\left(\vec{b} \times \vec{a}\right) \times \vec{c} = 0$

(D) $\vec{a} = k\vec{b} + m\vec{c}$ where k & m are two real numbers

Space for rough work

16. The acceleration-time (a-t) curves for two bodies A and B starting from rest are shown in the figure. Body A achieves maximum velocity V_m and body B achieves maximum velocity $V_m/2$. Find the value of time t in terms of a_1 and a_2:

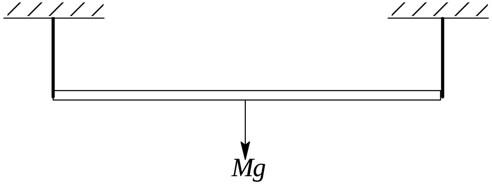


(A) $\frac{4a_2}{(2a_2-a_1)}$
(B) $\frac{4a_2}{(a_2-a_1)}$
(C) $\frac{a_2}{(2a_2-a_1)}$
(D) $\frac{2a_2}{(a_2-a_1)}$

17. The average total energy density of the electromagnetic wave is, if the rms value of the electric field of the light coming from the sun is $500\,NC^{-1}$. :

(A) $4\times10^{-6}\,Jm^{-3}$
(B) $3.7\times10^{-19}\,Jm^{-3}$
(C) $1.35\times10^{-12}\,Jm^{-3}$
(D) None of these

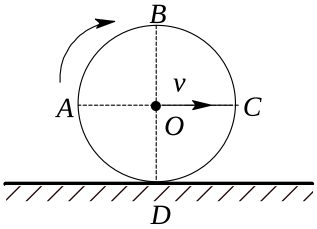
18. A rod is supported horizontally by means of two strings of equal length as shown in figure. If one of the string is cut. Then tension in other string at the same instant will:



(A) remain unaffected
(B) increase
(C) decreases
(D) become equal to weight of the rod

Space for rough work

19. A uniform circular ring rolls without slipping on a horizontal surface. At any instant, its position is as shown in the figure. Then mark the incorrect option:



(A) Section ABC has greater kinetic energy than section ADC
(B) Section BC has greater kinetic energy than section CD
(C) Section BC has the same kinetic energy as section DA
(D) None of these

20. A plane wave of sound travelling in air is incident upon a plane water surface. The angle of incidence is 60°. If velocity of sound in air and water are 330 m/s and 1400 m/s, then the wave undergoes:

(A) refraction only
(B) reflection only
(C) both reflection and refraction
(D) neither reflection nor refraction

21. A balloon filled with hydrogen has a volume 1 m^3 and its mass is 1 kg. Find the volume of a block of light material which it can just lift (in m^3): [density of block = 300 kg/m^3 and that of air = 2 kg/m^3]:

(A) $1/300$
(B) $1/250$
(C) $1/200$
(D) $1/100$

22. A large open tank has two holes in the wall. One is a square hole of side L at a depth y from the top and the other is a circular hole of radius R at a depth 4y from the top. When the tank is completely filled with water, the quantities of water flowing out per second from both holes are same. Then, R is equal to:

(A) $L/\sqrt{2\pi}$
(B) $2\pi L$
(C) L
(D) $L/2\pi$

Space for rough work

23. A piece of wire bent into an L shape with upright and horizontal portion of equal lengths 10 cm each is placed with the horizontal portion along the axis of the concave mirror towards pole of mirror whose radius of curvature is 1.0 cm. If the bend is 20 cm form the pole of the mirror, then the ratio of the lengths of the images of the upright and horizontal portion of the wire is:

(A) $1:2$ (B) $1:3$

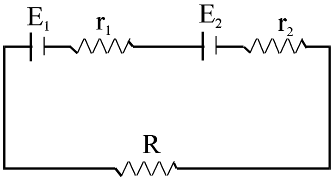
(C) $1:1$ (D) $2:1$

24. An object is kept at a distance of 16 cm from a thin lens and the image formed is real. If the object is kept at a distance of 6 cm from the same lens the image formed is virtual. If the size of the image formed are equal, the focal length of the lens will be:

(A) $19cm$ (B) $17cm$

(C) $21cm$ (D) $11cm$

25. Under what condition current passing through the resistance R can be increased by short circuiting the battery of emf E_2. The internal resistances of the two batteries are r_1 and r_2 respectively.



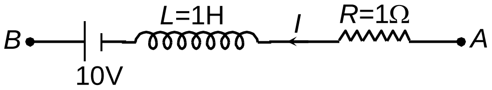
(A) $E_2r_1 > E_1 (R + r_2)$

(B) $E_1r_2 > E_2 (R + r_1)$

(C) $E_2r_2 > E_1 (R + r_2)$

(D) $E_1r_1 > E_2 (R + r_1)$

26. In the branch *AB* of a circuit, as shown in the figure, a current *I* = 5 A is flowing, where *t* is the time in second. At *t* =0, the value of (V_A - V_B) is



(A) 15 V (B) –5 V

(C) –15 V (D) 5 V

Space for rough work

27. A silver sphere (work function 4.6 eV) is suspended in a vacuum chamber by an insulating thread. Ultraviolet light of wavelength 0.2 μm strike on the sphere. The maximum electric potential of the sphere will be (hc = 12400 eVÅ)

(A) 4.6 V (B) 6.2 V
(C) 1.6 V (D) 3.2 V

28. The count rate observed from a radioactive source at t second was N_0 and at $4t$ second it was $\frac{N_0}{16}$. The count rate observed, at $\left(\frac{11}{2}\right)t$ second will be

(A) $\frac{N_0}{128}$ (B) $\frac{N_0}{64}$
(C) $\frac{N_0}{32}$ (D) $\frac{N_0}{256}$

29. Charge on the capacitor is given by $Q = I\alpha e^{-\frac{tI}{\Delta V \varepsilon_0 \beta}}$, where α and β are constant, t = time, I = current, ΔV = Potential difference then, dimension of $\frac{\beta}{\alpha}$ is same as dimension of

(A) $\frac{1}{\sqrt{\mu_0\varepsilon_0}}$ (B) $\mu_0\varepsilon_0$
(C) $\frac{\mu_0}{\varepsilon_0}$ (D) $\frac{1}{\mu_0\varepsilon_0}$

30. A simple pendulum is suspended from the ceiling of an empty box falling in air near earth surface. The total mass of system is M. The box experiences air resistance $\vec{R} = -k\vec{v}$ where v is the velocity of box and k is a positive constant. After some time it is found that period of oscillation of pendulum becomes double the value when it would have suspended from a point on earth. The velocity of box at that moment (take g in air same as on earth's surface)

(A) $\frac{Mg}{4k}$ (B) $\frac{3Mg}{4k}$
(C) $\frac{Mg}{2k}$ (D) $\frac{2Mg}{k}$

Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. Most soluble hydroxide in benzene is:
(A) $LiOH$ (B) $NaOH$
(C) KOH (D) $RbOH$

2. Referring to figure-1, identify the three spots obtained by electrophoresis at $p^H = 7$ of a mixture of the proteins pepsin $\left(p^I = 1.1\right)$ haemoglobin $\left(p^I = 6.8\right)$ and Lysozyme $\left(p^I = 11.0\right)$:

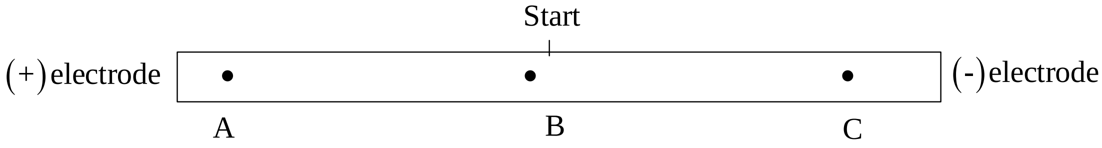


Fig-1

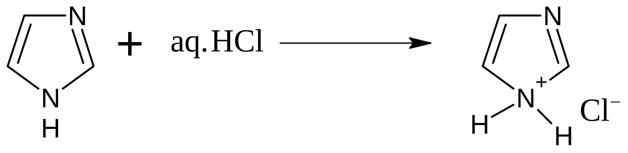
Which of the following options are correct about position of various proteins?
(A) Lysozyme will be present at spot A (B) pepsin will be present at spot B
(C) pepsin will be present at spot A (D) haemoglobin will be present at spot C

3. Silver sulphide dissolves in sodium cyanide solution to form the complex?
(A) $Na_2\left[Ag\left(CN\right)_4\right]$ (B) $Na\left[Ag\left(CN\right)_2\right]$
(C) $Na_3\left[Ag\left(CN\right)_4\right]$ (D) $Na_3\left[Ag\left(CN\right)\right]$

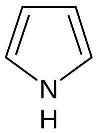
Space for rough work

4. Which of the following is incorrect statement/reaction?

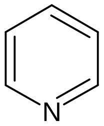
(A)



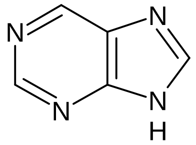
(B)



is less basic than

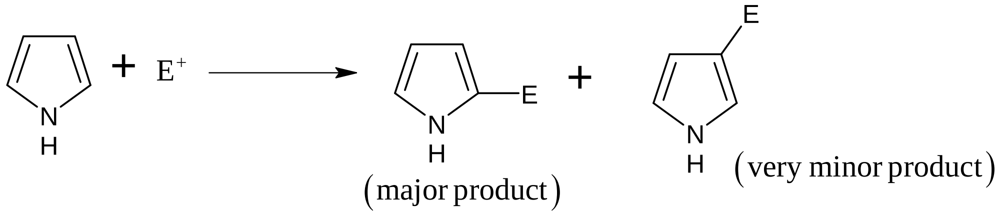


(C)



purine has 3 N's as basic sites

(D)

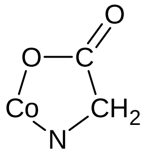


5. Which of the following statement is wrong about complex anion $\left[Co\left(EDTA\right)\right]^{-}$?

(A) oxidation state of Co is $+3$

(B) compound is optically active

(C) number of



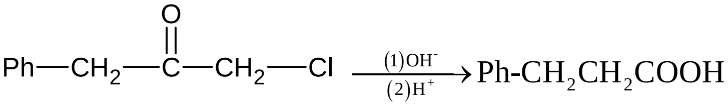
rings is 4

(D) total number of five member rings is 6

Space for rough work

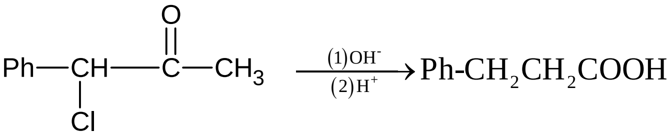
6. Which of the following reaction is incorrect?

(A)



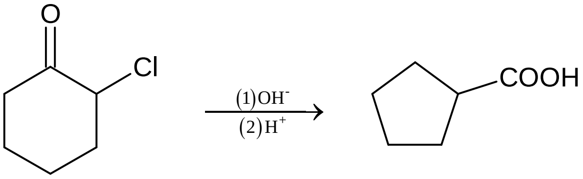
$$Ph-CH_2-\overset{O}{\overset{\|}{C}}-CH_2-Cl \xrightarrow[(2)H^+]{(1)OH^-} Ph\text{-}CH_2CH_2COOH$$

(B)

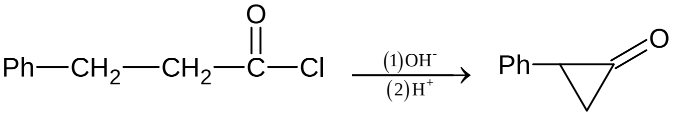


$$Ph-\underset{Cl}{\underset{|}{CH}}-\overset{O}{\overset{\|}{C}}-CH_3 \xrightarrow[(2)H^+]{(1)OH^-} Ph\text{-}CH_2CH_2COOH$$

(C)



(D)



7. What will be the ratio of volumes of $2M\ FeSO_4$ and $3M\ \ KMnO_4$ in acidic medium for oxidation of Fe^{2+} solution?

(A) $\frac{2}{9}$

(B) $\frac{15}{2}$

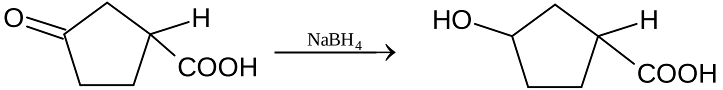
(C) $\frac{2}{15}$

(D) $\frac{9}{2}$

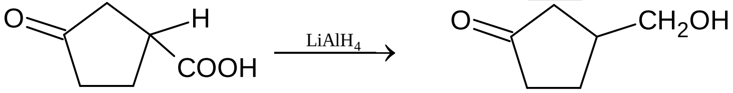
Space for rough work

8. Which of the following reaction can be used for preparation of alcohol from carbonyl compound

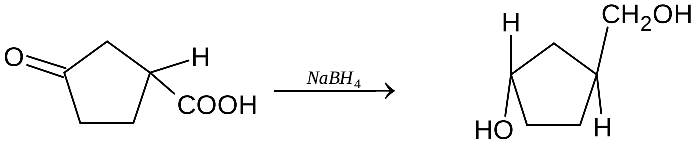
(A)


O
H
COOH
NaBH4
HO
H
COOH

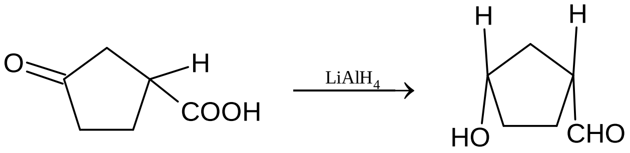
(B)


O
H
COOH
LiAlH4
O
CH2OH

(C)


O
H
COOH
NaBH4
H
CH2OH
HO
H

(D)


O
H
COOH
LiAlH4
H
H
HO
CHO

9. Which of the following molecules/ions are attracted by an externally applied magnetic field?

(A) $O_2, NO, N_2^{2+}, B_2, C_2^{2+}$

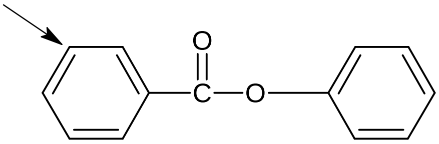
(B) $O_2^{+}, NO, N_2^{+}, C_2^{2+}, B_2$

(C) $N_2^{2-}, N_2^{2+}, C_2^{2-}, B_2^{2+}, O_2^{2+}$

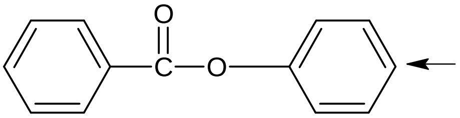
(D) $O_2^{+}, N_2^{-}, B_2^{2-}, NO, C_2^{2-}$

10. When phenyl benzoate ($PhOCOPh$) undergoes electrophilic substitution, which of the following indicates the site for attack of electrophile as major product?

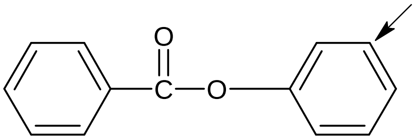
(A)



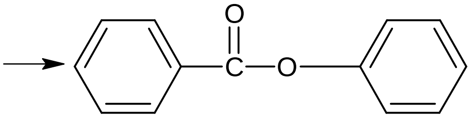
(B)



(C)



(D)



Space for rough work

11. Which of the following statement about diffusion of gas is true?

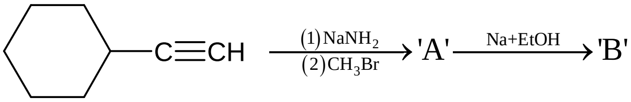
(A) Rate of diffusion of a gas will increase if an inert gas is added to gaseous mixture and allowed to diffuse through a pin hole

(B) Rate of effusion of O_2 is $\sqrt{2}$ times that of SO_2, for every composition of O_2 and SO_2 mixture

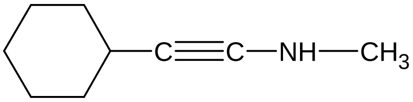
(C) Rate of effusion decrease on increasing the temperature

(D) All are true.

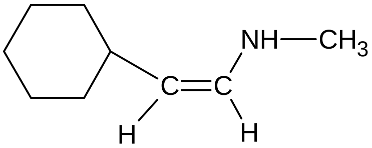
12.



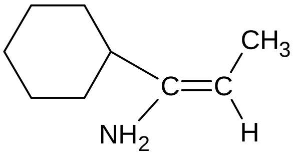
(A) 'A' is



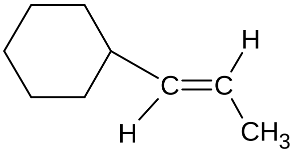
(B) 'B' is



(C) 'A' is



(D) 'B' is



13. Which of the following redox reaction is balanced redox reaction?

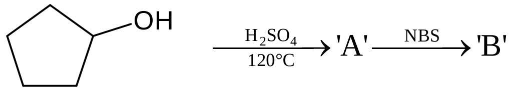
(A) $IO_3^- + SO_3^{2-} + 4H^+ \longrightarrow I^- + SO_4^{2-} + 2H_2O$

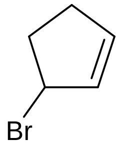
(B) $2BaO + O_2 \longrightarrow 2BaO_2$

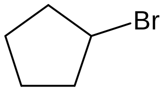
(C) $2I^- + 2IO_3^- \longrightarrow 2I_2 + 3O_2$

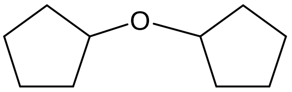
(D) $MnO_4^- + C_2O_4^{2-} + 8H^+ \longrightarrow M_n^{2+} + 2CO_2 + 4H_2O$

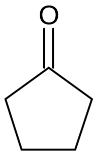
Space for rough work

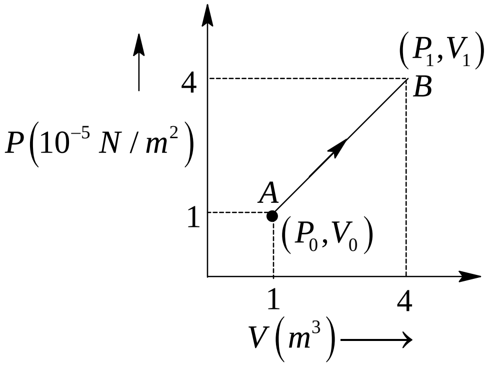
14. 

(A) 'B' is 

(B) 'B' is 

(C) 'A' is 

(D) 'A' is 

15. 

The work done in changing state from A to B in following system is………

(A) $-7.5\times10^{-5}\,J$
(B) $-7.5\times10^{5}\,J$
(C) $+7.5\times10^{-5}\,J$
(D) $+7.5\times10^{5}\,J$

Space for rough work

16. $P_4 + HNO_3 \longrightarrow H_3PO_4 + NO_2 \uparrow + H_2O$

Product mixture is titrated with $0.1M \ NaOH$, indicator shows colour change at second end point and $100ml$ of $NaOH$ is used for that. How much volume of $1M \ HNO_3$ is used is above reaction?

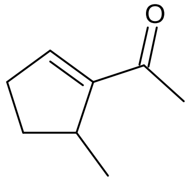
(A) $20ml$
(B) $10ml$
(C) $25ml$
(D) $\frac{50}{3}ml$

17. When Lithium di-(3-pentyl) cuprate reacts with ethyl bromide produces:

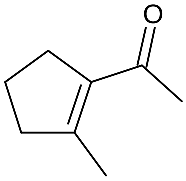
(A) heptane
(B) triethyl methane
(C) 2-ethylpentane
(D) 3-methyl hexane

18. 2, 7-Octanedione on treatment with aq. KOH and 100°C produces?

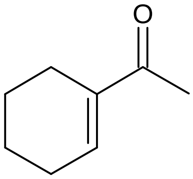
(A)



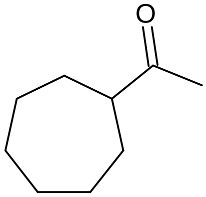
(B)



(C)



(D)



19. Which of the following salts are soluble in NH_4OH?

(A) $CuSO_4$
(B) $AlCl_3$
(C) $FeCl_3$
(D) all of the above

20. Zinc on reaction with NaOH gives a salt (A) along with a gas (X) and (A) on reaction with a gas H_2S gives white precipitate (W). Which of the following is correct?

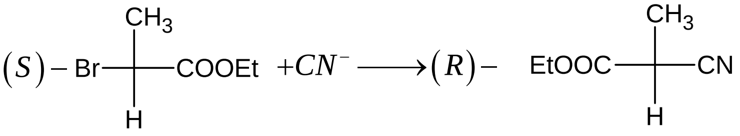
(A) (A) is Na_4ZnO_3, (Y) is H_2S
(B) (X) is H_2, (W) is $Zn(OH)_2$
(C) (A) is Na_2ZnO_2, (X) is O_2
(D) (W) is ZnS, (X) is H_2

Space for rough work

21. Which of the following substitution reaction $\left(SN^2\right)$ does not give product as shown is reactions?

(A) $\left(R\right)-CH_3CH\left(Br\right)CH_2CH_3+MeO^- \longrightarrow \left(S\right)-CH_3CH\left(OMe\right)CH_2CH_3$

(B) $\left(S\right)-CH_3CH\left(Br\right)CH_2CH_3+MeO^- \longrightarrow \left(R\right)-CH_3CH\left(OMe\right)CH_2CH_3$

(C) 

$(S)-\mathrm{Br}-\overset{\mathrm{CH_3}}{\underset{\mathrm{H}}{+}}-\mathrm{COOEt} + CN^- \longrightarrow (R)-\ \mathrm{EtOOC}-\overset{\mathrm{CH_3}}{\underset{\mathrm{H}}{+}}-\mathrm{CN}$

(D) cis-4-iodoethylcyclohexane+OH$^-$ $\longrightarrow$ trans-4-ethylcyelohexanol

22. The aqueous solution of which salt is coloured

(A) $Zn(NO_3)_2$
(B) $LiNO_3$
(C) $Co(NO_3)_2$
(D) Potash alum

23. Potassium crystallizes in BCC lattice with a unit cell length $a=5.0\mathring{A}$. What is the distance between next nearest neighbours?

(A) 5.0Å
(B) 4.33Å
(C) 3.5Å
(D) 7.07Å

24. For the second order reaction; $2\mathrm{A}\longrightarrow\mathrm{B}$, time taken for the $[A]$ to fall to one-fourth value is how many times the time it takes for $[A]$ to fall to half of its initial value?

(A) 2
(B) 3
(C) 4
(D) 7

25. What is the equilibrium constant of the reaction:

$2M^{3+}+N^{+}\longrightarrow 2M^{2+}+N^{3+}$?

Given $E^{\circ}_{N^+/N}=1.68V \quad E^{\circ}_{N^{3+}/N}=1.50V,\ E^{\circ}_{M^{3+}/M^{2+}}=0.75V$ and $\dfrac{2.303\ RT}{F}=.06$

(A) 1×10^{22}
(B) 1×10^{-22}
(C) 1×10^{-11}
(D) 1×10^{-72}

Space for rough work

26. If an electron has spin quantum number of $+\frac{1}{2}$ and magnetic quantum number of $-1,$ it cannot be present in:

(A) $p_x - orbital$ (B) $d_{xy} - orbital$

(C) $p_y - orbital$ (D) $s - orbital$

27. A solution of liquids 'A' and 'B' having vapour pressure in pure state P_A^0 & P_B^0. The solution contains 30% mole of A which is in equilibrium with 60% mole of 'A' in vapour phase. If P_B^0 is 200 mm of Hg, then P_A^0 (in mm of Hg) is:

(A) 500 (B) 700

(C) 800 (D) 600

28. Crystal field splitting energy (Δ_0) of complexes $\left[CrCl_6\right]^{3-}, \left[Cr(CN)_6\right]^{3-}$ and $\left[Cr(NH_3)_6\right]^{3+}$ are x, y and z cm^{-1} respectively. Then correct order Δ_0 values is:

(A) $x < y < z$ (B) $x < z < y$

(C) $x > y > z$ (D) $x > z > y$

29. Optical isomerism is not shown by the complex:

(A) $\left[Cr(ox)_3\right]^{3-}$ (B) $Cis\left[Co(en)_2 Cl_2\right]^{+}$

(C) $Trans\left[Co(en)_2 Cl_2\right]^{+}$ (D) $\left[Cr(en)_3\right]^{3+}$

30. What concentration of Ag^+ is solution will just fail to give a precipitate of Ag_2CrO_4 with a solution in which $\left[CrO_4^{2-}\right] = 3\times10^{-4}M$?

$\left(Given\ K_{sp}\left(Ag_2CrO_4\right) = 1.2\times10^{-11}\right)$

(A) $10^{-3}M$ (B) $2\times10^{-1}M$

(C) $2\times10^{-3}M$ (D) $2\times10^{-4}M$

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. $\int \frac{3x^2+4x-1}{\left(x^2+1\right)^2 \sqrt{x+1}} dx$ is equal to:

(A) $\frac{\sqrt{x+1}}{x^2+1}+c$
(B) $-\frac{2\sqrt{x+1}}{x^2+1}+c$
(C) $\frac{2}{\left(x^2+1\right)\sqrt{x+1}}$
(D) $\frac{-x}{\left(x^2+1\right)\sqrt{x+1}}+c$

2. The general solution of the differential $y\left(xy-\left(x^2-y^2\right)^2\right)dx=\left\{y^3-x\left(x^2-y^2\right)^2\right\}dy$ is:

(A) $\frac{y}{x}+\frac{1}{x^2-y^2}=c$
(B) $\frac{x}{y}-\frac{1}{2}\ln\left|\frac{x-y}{x+y}\right|=c$
(C) $\frac{2x}{y}+\frac{1}{x^2-y^2}=c$
(D) $\frac{2x}{y}-\frac{1}{x^2-y^2}=c$

3. A line is drawn at an angle θ with positive direction of x-axis. It intersects the parabola $y^2=8x$ at A and B. If AB is a normal chord which subtend a right angle at the vertex of the parabola, then $\tan^2\theta$ equals:

(A) $\frac{1}{2}$
(B) $\frac{3}{4}$
(C) 1
(D) 2

Space for rough work

4. The equation of a circle whose diameter is the common chord of the circle $x^2+y^2-4x-8y-5=0$ and $x^2+y^2-12x+2y+29=0$ is:

(A) $41x^2+41y^2-396x-38y+781=0$ (B) $2x^2+2y^2-16x-6y+25=0$

(C) $41x^2+41y^2+396x-38y-781=0$ (D) $17x^2+17y^2-300x+154y+901=0$

5. $\int_0^{\frac{11\pi}{3}}\sqrt{1+\cos 2x}\,dx$ is equal to:

(A) $\frac{11\sqrt{3}}{2}$ (B) $8\sqrt{2}-\sqrt{\frac{3}{2}}$

(C) $8\sqrt{2}-\frac{\sqrt{3}}{2}$ (D) $\frac{22}{3}$

6. Consider the vectors $\vec{a}=2\hat{i}+\hat{j}-2\hat{k}$ and $\vec{b}=3\hat{i}-\hat{j}+\hat{k}$. A parallelogram is constructed such that its diagonal are along $2\vec{a}-\vec{b}$ and $\vec{a}-2\vec{b}$. The area of the parallelogram is:

(A) $9\sqrt{5}\,sq.units$ (B) $\frac{9\sqrt{10}}{2}sq.units$

(C) $9\sqrt{10}\,sq.units$ (D) $18\sqrt{5}\,sq.units$

7. Let $\frac{\tan\left(\frac{\pi}{4}+\alpha\right)}{5}=\frac{\tan\left(\frac{\pi}{4}+\beta\right)}{3}=\frac{\tan\left(\frac{\pi}{4}+\gamma\right)}{2}$. Then $12\sin^2(\alpha-\beta)+15\sin^2(\beta-\gamma)-7\sin^2(\gamma-\alpha)$ is equal to:

(A) $-\frac{1}{2}$ (B) $\frac{1}{2}$

(C) 1 (D) 0

Space for rough work

8. The angle of intersection of the curves $y=(1+x)^{\cos x}+\sin x$ and $y=\frac{1}{2}\left(x^2+x+2\right)$ at (h,k) where h and k are integers, is θ, then $\tan\theta$ equals:

(A) $\frac{3}{4}$ (B) $\frac{4}{3}$

(C) 1 (D) 0

9. A plane $2x+3y+6z=12$ intersects the x-axis, y-axis and z-axis at A, B, C respectively. The orthocentre of the triangle ABC is:

(A) $\left(\frac{24}{49},\frac{36}{49},\frac{72}{49}\right)$ (B) $\left(\frac{36}{49},\frac{72}{49},\frac{27}{49}\right)$

(C) $\left(\frac{24}{49},\frac{16}{49},\frac{1}{49}\right)$ (D) $\left(\frac{36}{49},\frac{72}{49},\frac{24}{49}\right)$

10. The domain of the function given by $f(x)=\log_3\left(\log_{\frac{1}{2}}\left(\log_2\left(\log_{\frac{1}{3}}(x)\right)\right)\right)+\frac{x+1}{\sqrt{1-3x-4x^2}}$ is:

(A) $\left(-1,\frac{1}{3}\right)$ (B) $\left(\frac{1}{4},\frac{1}{3}\right)$

(C) $\left(\frac{1}{9},\frac{1}{4}\right)$ (D) $\left(\frac{1}{9},\frac{1}{3}\right)$

11. If $f(x)=\frac{3^{x-3}}{3^{1-x}+3^x}$ for all $x\in Q,$ then the value of

$f\left(\frac{1}{109}\right)+f\left(\frac{2}{109}\right)+f\left(\frac{3}{109}\right)+....+f\left(\frac{108}{109}\right)$ is:

(A) 54 (B) 55

(C) 108 (D) 2

Space for rough work

12. The value of $\cot \sum_{n=1}^{\infty} \cot^{-1}\left(\frac{2}{n^2}\sum_{k=1}^{n} k^3\right)$

(A) $\frac{1}{2}$ (B) $\frac{1}{4}$

(C) $\frac{1}{3}$ (D) $\frac{1}{6}$

13. The graph of the function $y = f(x)$ has a unique tangent at $(\pi^a, 0)$. If $A = \lim_{x \to \pi^a} \frac{\ln(1+9f(x)) - \sin f(x)}{2f(x)}$, then $\sum_{n=1}^{\infty} A^{-n}$ is equal to:

(A) $\frac{1}{3}$ (B) $\frac{1}{2}$

(C) 4 (D) $\frac{1}{4}$

14. Let f be a continuous and differentiable function in (a,b), if $f(x).f'(x) \ge x\sqrt{1-(f(x))^4}$ and $\lim_{x \to a^+}(f(x))^2 = 1$ and $\lim_{x \to b^-}(f(x))^2 = \frac{1}{2}$. Then the minimum value of $\left[a^2 - b^2\right]$ is $\left([.] \to \text{represent greatest integer function}\right)$:

(A) 1 (B) 9

(C) 3 (D) 81

15. The chord of contact of tangents drawn from any point on the circle $x^2 + y^2 = p^2$ to the circle $x^2 + y^2 = q^2$ touches the circle $x^2 + y^2 = r^2$, then $2a - \log_e p, 4a - \log_e q, 6a - \log_e r$ are in (a is real value):

(A) AP (B) GP

(C) HP (D) AGP

Space for rough work

16. If t_1, t_2 and t_3 are distinct, the points $\left(t_1, 2at_1 + at_1^3\right), \left(t_2, 2at_2 + at_2^3\right)$ and $\left(t_3, 2at_3 + at_3^3\right)$ are collinear, then $\frac{4^{t_1}.6^{t_2}.8^{t_3}}{2^{t_1}.3^{t_2}.4^{t_3}}$ is equal to:

(A) 0 (B) 4
(C) 2 (D) 1

17. The area of the triangle formed by the line $x + y = 2$ and angle bisectors of the pair of straight lines $x^2 - y^2 + 2y = 1$ is a and coordinate of orthocentre of triangle is (b, c), then $4a + b + c$ is equal to:

(A) 0 (B) 4
(C) 2 (D) 3

18. If z is the complex 5th root of unity, then $\frac{z^4}{z^4+1} + \frac{z}{1+z} + \frac{z^2}{z^2+1} + \frac{z^4}{z+z^4}$ is:

(A) 2 (B) 0
(C) 4 (D) 1

19. If a tangent of slope 3 of the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ is normal to the circle $x^2 + y^2 + 4x + 1 = 0$ then the maximum value of ab is:

(A) 2 (B) 3
(C) 4 (D) 6

20. If $F(x) = \int_0^x f(t).dt$ and $F\left(x^2\right) = x^2(1+x)$, then value of $f(4) = n$. Then unit place of $(985697)^{n^2}$ is:

(A) 3 (B) 7
(C) 1 (D) 9

Space for rough work

21. The number of points where $f(x) = \left|2 - \left|2 - |x|\right|\right|$ is not differentiable is:

(A) 3
(B) 5
(C) 7
(D) 0

22. If the sum of first n terms of the A. P. $85, 90, 95, ...$ is equal to the sum of first 3n terms of the A. P. $9, 11, 13, ...,$ then n equals:

(A) 8
(B) 9
(C) 10
(D) 11

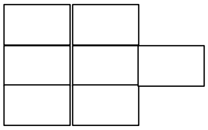
23. The value of $\frac{1}{2\pi^2}\int_{-\pi}^{11\pi} \sin^{-1}(\cos x)dx$ is:

(A) 0
(B) 1
(C) 2
(D) 3

24. The number of integral roots of the equations $(x-1)(x-3)(2x-1)(2x-3) = 3$ is:

(A) 1
(B) 2
(C) 3
(D) 0

25. The number of ways in which 7 different letters can be arranged in the figure given below such that no row is empty is $59k.\ 7!$



Then k is:

(A) 1
(B) 2
(C) 3
(D) 4

Space for rough work

26. If $A = x^3 - \frac{1}{x^3}$ and $B = x - \frac{1}{x}, x \in (0, \infty)$ and a is minimum value of $\frac{A}{B^2}$, then $[a]$ is equal to $\{[\ ]\text{is greatest integer function}\}$:

(A) 1
(B) 2
(C) 3
(D) 4

27. Let $\mathrm{f}(x)$ be a function such that $f(x) + f(x+2) = \sqrt{3} f(x+1)$ for all $x \in R,$ then f is periodic with period T. Then value of $\frac{T}{2}$ is:

(A) 12
(B) 6
(C) 3
(D) 4

28. Let $a_{r'}\ r = 1, 2, 3, 4$ represent four positive real numbers other than unity such that $\left(\log_e a_r, \frac{1}{\log_e, a_r}\right)$ is a point on a circle whose abscissa of end of diameter are α and $-\alpha$, then the minimum value of $a_1 + a_2 + a_3 + a_4$ is:

(A) 2
(B) 3
(C) 4
(D) 5

29. The sum $\sum_{i=0}^{5m} \binom{20}{i} \binom{30}{5m-i}, {}^p C_q = \binom{p}{q} = 0$ if $p < q$, is maximum, then m equals:

(A) 1
(B) 3
(C) 4
(D) 5

30. A nine digit number is formed from $1, 2, 3, 4, 5$ such that product of all digits is always 1920. The total number of ways is $393\left({}^9 P_r\right),$ where the value of r is:

(A) 2
(B) 3
(C) 4
(D) 6

Space for rough work

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

ALL INDIA TEST SERIES

FIITJEE

JEE (Advanced)-2017

FULL TEST – I

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 243**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-B & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section – A (01 – 06)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

   Section – A (07 – 09) contains 3 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

   Section-A (10 – 14) contains 2 paragraphs. Based upon paragraph, 2 and 3 multiple choice questions have to be answered. Each question has only one correct answer and carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.
2. **Section – B (01 – 02)** contains 2 Matrix Match Type questions containing statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. Each question carries **+8 marks** for all correct answer. For each correct row **+2 marks** will be awarded. There may be one or more than one correct matching. No marks will be given for any wrong matching in any question. There is no negative marking.
3. **Section-C (01 – 05)** contains 5 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	$6.625 \times 10^{-34}\ \text{J}\cdot\text{s}$
		=	$6.625 \times 10^{-27}\ \text{erg}\cdot\text{s}$
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

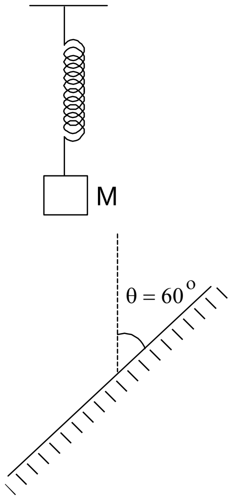
Straight Objective Type

This section contains 6 multiple choice questions numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. An insect of negligible mass is sitting on a block of mass M, tied with a spring of force constant K. The block performs simple harmonic motion with amplitude A infront of a plane mirror placed as shown. The maximum speed of insect relative to its image will be

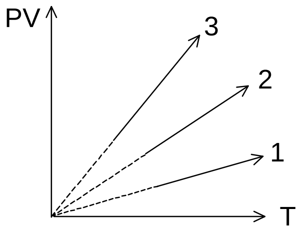
(A) $A\sqrt{\frac{K}{M}}$ (B) $\frac{A\sqrt{3}}{2}\sqrt{\frac{K}{M}}$

(C) $A\sqrt{3}\sqrt{\frac{K}{M}}$ (D) $A\sqrt{\frac{M}{K}}$



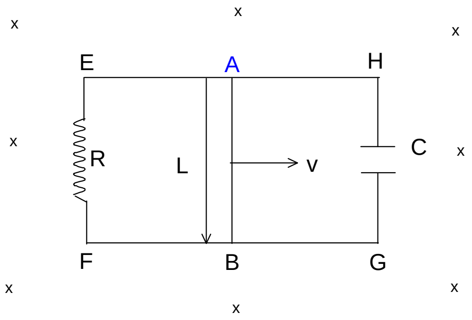
2. PV versus T graph of equal masses of H_2, He and CO_2 is shown in figure. Choose the correct alternative

(A) 3 corresponds to H_2, 2 to He and 1 to CO_2
(B) 1 corresponds to He, 2 to H_2 and 3 to CO_2
(C) 1 corresponds to He, 3 to H_2 and 2 to CO_2
(D) 1 corresponds to CO_2, 2 to H_2 and 3 to He



Space for Rough work

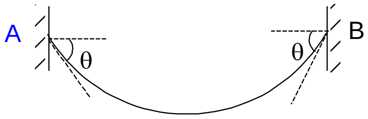
3. A conducting rod is moving with a constant velocity v over the parallel conducting rails which are connected at the ends through a resistor R and capacitor C as shown in the figure. Magnetic field B is into the plane. Consider the following statements.
(I) current in loop AEFBA is anticlockwise
(II) current in loop AHGBA is clockwise
(III) current through the capacitor is zero
(IV) energy stored in the capacitor is $\frac{1}{2}CB^2L^2V^2$
Which of the following option is correct
(A) statement (I) and (III) are only correct
(B) statement (II) and (IV) are only correct
(C) statement (I), (II) and (IV) are correct
(D) all the above



4. The activity of a radioactive sample goes down to about 6% in a time of 2 hours. The half life of sample in minutes is about
(A) 30 (B) 15 (C) 60 (D) 120

5. A particle of charge q and mass m starts moving from the origin under the action of an electric field $\vec{E} = E_0\hat{i}$ and magnetic field $\vec{B} = B_0\hat{k}$ its velocity at (x, 3, 0) is $\left(4\hat{i} + 3\hat{j}\right)$. The value of x is
(A) $\frac{36E_0B_0}{qm}$ (B) $\frac{25m}{2qE_0}$ (C) $\frac{10m}{qE_0}$ (D) $\frac{25E_0B_0}{m}$

6. A heavy string of mass m hangs between two fixed points A and B at the same level. The tangents to the string at A and B are at an angle θ with horizontal as shown in the figure. The tension of the string at its lowest point is
(A) $\frac{mg}{2\sin\theta}$ (B) $\frac{mg}{2\cos\theta}$
(C) $\frac{mg}{2\tan\theta}$ (D) $\frac{mg}{2\cot\theta}$



Space for Rough work

Multiple Correct Choice Type

This section contains 3 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

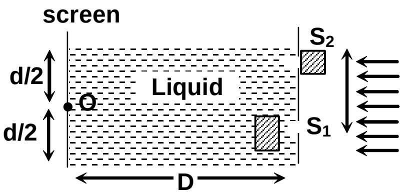
7. In a resonance tube experiment to determine speed of sound , air column in the pipe is made to resosnate with a given fork of frequency 480 Hz. At room temperature **T** using a resonance tube a student finds two resonance position 16.0 cm and 51.0 cm, length of the air column for the first and the second resonance respectively .It is known that speed of the sound at $273K$ is equal to 330 m/s.Then,

(A) percentage error in the measurement of speed of sound is $\frac{4}{7}\%$

(B) diameter of the tube is 5 cm
(C) temperature of the room **T** is nearly 283 K

(D) percentage error in the determination of **T** is $\frac{8}{7}\%$

8. A Young's double slit arrangement is immersed in a liquid of refractive index μ_1. The slit plane touches the liquid surface. A parallel beam of monochromatic light of wavelength 'λ' (with respect to air) is incident normally on slits. Choose the correct alternatives



(A) The fringe width is $D\lambda/\mu_1 d$.
(B) If the slit S_2 is covered by a transparent slab of refractive index μ_2 and thickness t, the new position of the central maxima will shift up by $\frac{(\mu_2 - 1).tD}{d}$
(C) The ratio of intensities at 'O' in the conditions of the option (A) and option the (B) is $1:\cos^2\left[\frac{\pi}{3\lambda}(\mu_2 - 1)t\right]$
(D) If a slab of thickness t and refractive index μ_3 is introduced in front of S_1 while S_2 is also covered by a slab of thickness t and refractive index μ_2 as shown in figure, then for relation of $\mu_3 = \mu_1\mu_2$ the central maxima will be at O.

9. A net non-zero external force acts on a system of particles. At an instant t, the velocity and the acceleration of CM are found to be u_0 and a_0, it is possible that

(A) $u_0 = 0, a_0 = 0$
(B) $u_0 \neq 0, a_0 \neq 0$
(C) $u_0 \neq 0, a_0 = 0$
(D) $u_0 = 0, a_0 \neq 0$

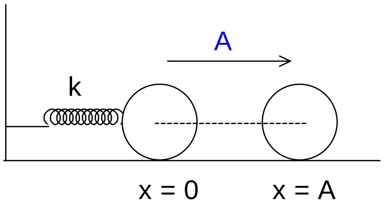
Space for Rough work

Comprehension Type

This section contains 2 paragraphs. Based upon one of paragraph 2 multiple choice questions and based on the other paragraphs 3 multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

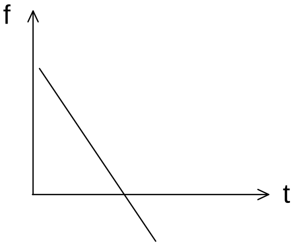
Paragraph for Question Nos. 10 and 11

A disc of mass m and radius R is attached with a spring of force constant K at its centre as shown in figure. At x = 0 spring is unstretched. The disc is moved to x = A and then released. There is no slipping between disc and ground. Let f be the force of friction on the disc from the ground.

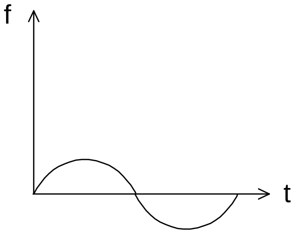


10. f versus t graph will be

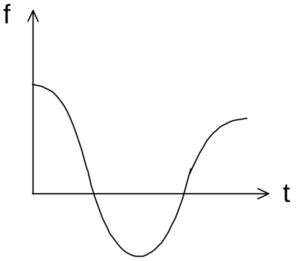
(A)



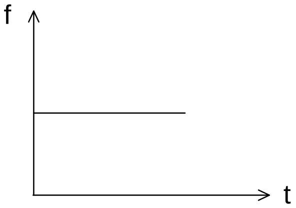
(B)



(C)



(D)

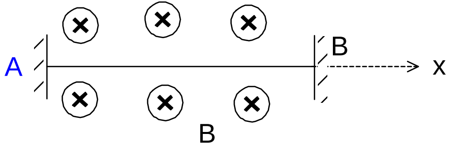


Space for Rough work

11. In the problem if k = 10 N/m, m = 2 kg, R = 1 m and A = 2 m. Find linear speed of the disc at mean position.
(A) $\sqrt{\frac{40}{3}}$ m/sec (B) $\sqrt{20}$ m/sec (C) $\sqrt{\frac{10}{3}}$ m/sec (D) $\sqrt{\frac{50}{3}}$ m/sec

Paragraph for Question Nos. 12 and 14

A standing wave $y = 2A\sin(kx)\cos(\omega t)$ set up in a wire AB fixed at both ends by two vertical wall contains a constant magnetic field B. Now answer the following questions.



12. The wire is found to vibrate in 3rd harmonic the maximum e.m.f induced is
(A) $\frac{4AB\omega}{k}$ (B) $\frac{3AB\omega}{k}$ (C) $\frac{2AB\omega}{k}$ (D) $\frac{AB\omega}{k}$

13. In above question the time when the e.m.f becomes maximum for first time is
(A) $\frac{2\pi}{\omega}$ (B) $\frac{\pi}{\omega}$ (C) $\frac{\pi}{2\omega}$ (D) $\frac{\pi}{4\omega}$

14. In which of following modes the e.m.f induced in AB is always zero.
(A) Fundamental mode (B) second harmonic (C) second overtone (D) fourth overtone

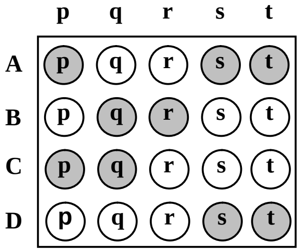
Space for Rough work

SECTION – B

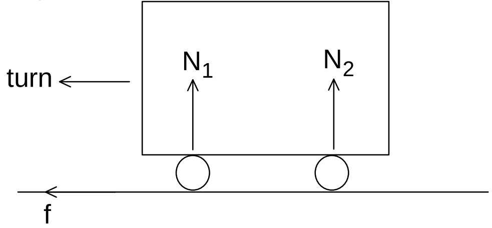
(Matrix-Match Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



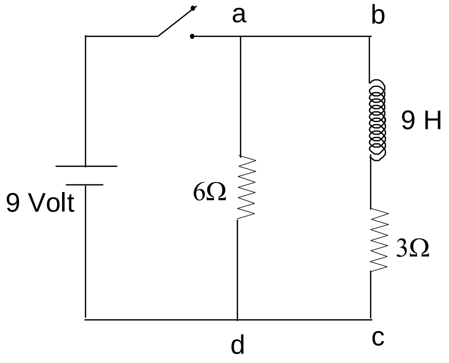
1. A car is taking a turn on a rough horizontal road without slipping as shown in figure. Let F is centripetal force, f the force of friction, N_1 and N_2 are two normal reactions. As the speed of car is increased match the following two columns



Column – I		Column – II	
(A)	N_1	(p)	Will increase
(B)	N_2	(q)	Will decrease
(C)	F/f	(r)	Will remains unchanged
(D)	F	(s)	Cannot say anything

Space for Rough work

2. In the circuit shown in figure, switch remains closed for long time. It is opened at time t = 0. Match the following columns at t = ln2 sec



Column – I		Column – II	
(A)	Potential difference across inductor	(p)	9 V
(B)	Potential difference across 3Ω resistor	(q)	4.5 V
(C)	Potential difference across 6Ω resistor	(r)	6 V
(D)	Potential difference between points b and c	(s)	None of these

Space for Rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. A frictionless tunnel is dug inside the uniform spheres as shown in the figure-1 and figure-2. A particle of mass m is to be projected from point P in both sphere so that it can escape from the influence of sphere. Let v_1 is the velocity given to the particle in figure-1 and v_2 is the velocity given to the particle in figure-2. Find the ratio of v_1/v_2. (Given: R is radius of sphere and M is mass of sphere.)

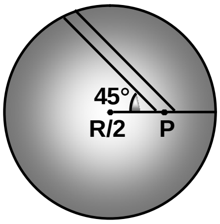


Figure-1

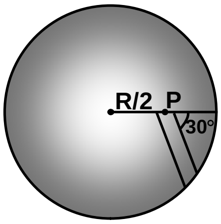
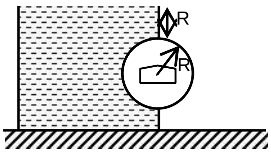


Figure-2

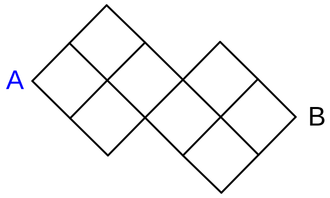
2. An α particle and proton are accelerated from rest by a potential difference of 100 V. After this their de-Broglie wavelengths are λ_α and λ_p respectively. The ratio $\frac{\lambda_p}{\lambda_\alpha}$ to the nearest integer is

3. A cylinder of radius R is kept embedded along the wall of a dam as shown. Take density of water as ρ and length of cylinder as L. The vertical force exerted by water on the cylinder is $\frac{\rho g L R^2 \pi}{X}$. Find the value of X.



4. A sphere of mass M and radius r rolls without slipping on a rough concave surface of large radius R. It makes small oscillation about lowest point. Find the value of k if time period is $\sqrt{\frac{k_1(R-r)}{5g}}$

5. Each branch in the following circuit has a resistance r = 1Ω. The equivalent resistance of the circuit between the points A and B is



Space for Rough work

Chemistry

PART – II

SECTION – A

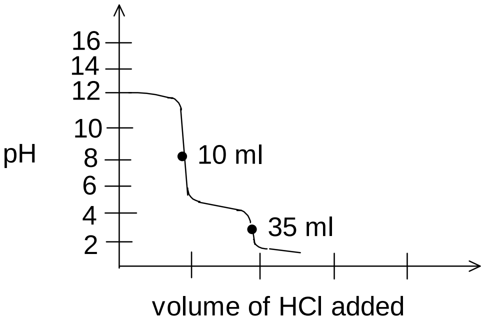
Straight Objective Type

This section contains 6 multiple choice questions numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. The equilibrium p-xyloquinone + methylene white $\rightleftharpoons$ p-xylohydroquinone + methylene blue may be conveniently by observing the difference in color methylene white and methylene blue. One mill mole of methylene blue was added to 1 L solution that was 0.24 M in p-xylohydroquinone and 0.012 M is p-xyloquinone. It was then found that 4% of the added methylene blue was reduced to methylene white. What is the equilibrium constant of the above reaction?
(A) 48 (B) 4.8 (C) 480 (D) 0.48

2. Sea water is found to contain 5.85% NaCl and 9.50% $MgCl_2$ by weight of solution. Calculate its normal boiling point assuming 80% ionization for NaCl and 50% ionization of $MgCl_2$. $\left[K_{b(H_2O)} = 0.51\,\text{kg mol}^{-1}\text{K}\right]$
(A) 102.29^{o}C (B) 102.92 ^{o}C
(C) 101.59 ^{o}C (D) 101 ^{o}C

3. 0.50 gm mixture containing $NaHCO_3$, Na_2CO_3 and KCl was dissolved in 50 ml water and titrated with 0.15 M HCl resulting in the following titration curve. Determine weight % of $NaHCO_3$, Na_2CO_3 and KCl in the mixture respectively.
(A) 37.8, 31.8, 30.4
(B) 31.8, 37.8, 30.4
(C) 30.4, 37.8, 31.8
(D) 31.8, 30.4, 37.8



Space for Rough work

4. Extraction of Mg from sea water

$$\begin{tikzcd}
\text{Sea water} \arrow[r, "p"] & Mg(OH)_2 \arrow[r, "q"] & MgCl_2 + H_2O \arrow[d, "\text{crystallisation}"] \\
Mg & \text{anhydrous } MgCl_2 \arrow[l, "t"'] & r \arrow[l, "s"']
\end{tikzcd}$$

Which of the following option describes the correct reactant, products and reaction conditions?

	p	q	r	s	t
(A)	Milk of magnesia	HCl (aq)	$MgCl_2.2H_2O$	Heating in limited supply of air	Reduction by coke
(B)	Lime water	HCl (aq)	$MgCl_2$	Heating in absence of air	Electrolytic reduction in molten state
(C)	Milk of lime	HCl (aq)	$MgCl_2.6H_2O$	Heating in presence of dry HCl	Electrolytic reduction in molten state
(D)	Milk of lime	HCl (aq)	$MgCl_2.6H_2O$	Heating in the presence of dry HCl	Electrolysis of aqueous solution

5. Which of the following statement is correct?
(A) geometrical isomerism is not observed in complexes of co-ordination number 4 having tetrahedral geometry
(B) square planar complexes generally do not show geometrical isomerism
(C) the square planar complex of general formula Ma_3b or Mab_3 exhibits cis-trans isomerism. (where M is central metal and a and b are monodentate ligands)
(D) the platinum glycinato complex $[Pt(Gly)_2]$ doesn't show geometrical isomerism.

6. Which of the following statement is correct?
(A) in an anti-fluorite structure anions form FCC lattice and cations occupy all tetrahedral voids.
(B) if the radius of cations and anions are 0.214 $\mathring{A}$ & 0.95 $\mathring{A}$ then co-ordinate number of cation in the crystal is 4
(C) an atom/ion is transferred from a lattice site to an interstitial position in Schottky defect
(D) density of crystal always increases due to substitutional impurity defect.

Space for Rough work

Multiple Correct Choice Type

This section contains 3 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

7. Pick out the correct statements among the following from inspection of standard reduction potentials

$$Cl_2(aq) + 2e \rightleftharpoons 2Cl^-(aq) \quad E^o_{Cl_2/Cl^-} = +1.36 \text{ Volt}$$

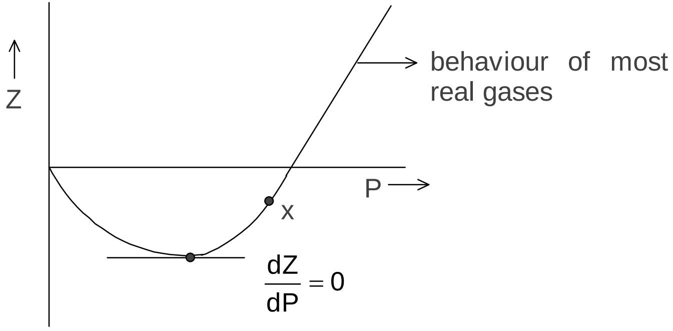
$$Br_2(aq) + 2e \rightleftharpoons 2Br^-(aq) \quad E^o_{Br_2/Br^-} = +1.09 \text{ Volt}$$

$$I_2(aq) + 2e \rightleftharpoons 2I^-(aq) \quad E^o_{I_2/I^-} = +0.54 \text{ Volt}$$

$$S_2O_8^{2-}(aq) + 2e^- \rightleftharpoons 2SO_4^{2-}(aq) \quad E^o_{S_2O_8^{2-}/SO_4^{2-}} = +2.00 \text{ Volt}$$

(A) Cl_2 can oxidise SO_4^{2-} from solution
(B) Cl_2 can oxidise Br^- and I^- from aqueous solution
(C) $S_2O_8^{2-}$ can oxidise Cl^-, Br^- and I^- from their aqueous solution
(D) $S_2O_8^{2-}$ is added slowly, Br^- can be reduced in the presence of Cl^-

8. Which of the following statement(s) are true about Z Vs P graph for a real gas at a particular temperature



(A) $Z \to 1$ as $P \to 0$ for most real gases
(B) $\frac{dz}{dp}$ is –ve as $P \to 0$ for most real gases
(C) $\frac{dz}{dp} \to 0$ at a pressure where replusive and attractive forces are comparable
(D) at point x, intermolecular attractive forces dominating over repulsive forces

Space for Rough work

9. Saturated solution of SO_2 is heated at 150°C in a closed container. The product obtained is treated with $BaCl_2$ solution. What is/are the observation(s)?
(A) no ppt. (B) white turbidity (C) evolution of SO_2 (D) white ppt.

Comprehension Type

This section contains 2 paragraphs. Based upon one of paragraph 2 multiple choice questions and based on the other paragraphs 3 multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

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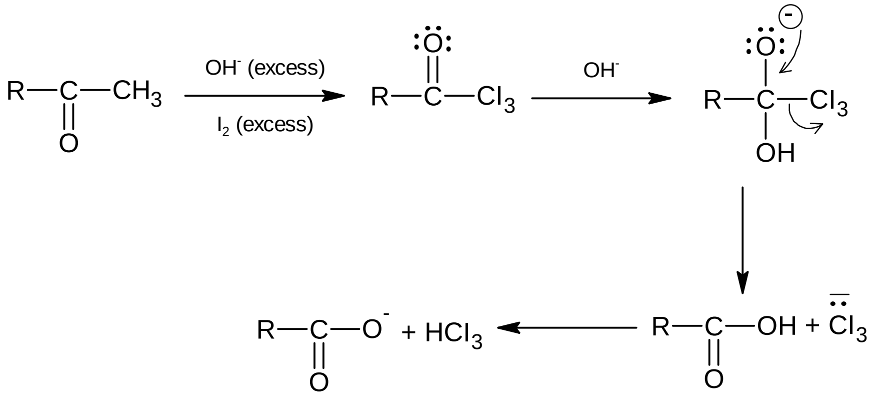
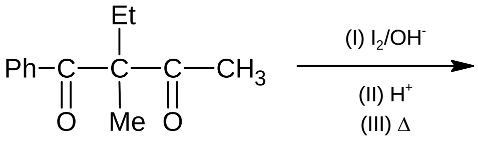
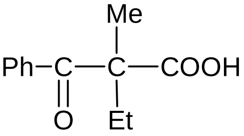
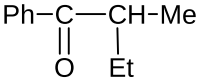
Paragraph for Question Nos. 10 and 11

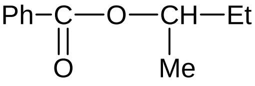
In the presence of excess base and excess halogen a methyl ketone is converted first into a trihalo substituted ketone and then into a carboxylic acid. After the trihalo substituted ketone is formed hydroxide ion attacks the carboxyl carbon because the trihalomethyl ion is the group more easily expelled from the tetrahedral intermediate. The conversion of a methyl ketone to a carboxylic acid is called a haloform reaction because one of the product is haloform $CHCl_3$ or CHI_3 or $CHBr_3$.

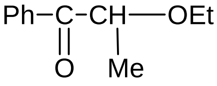


10.

$$Ph-\underset{\underset{O}{\|}}{C}-\overset{\overset{Et}{|}}{\underset{\underset{Me}{|}}{C}}-\underset{\underset{O}{\|}}{C}-CH_3 \xrightarrow[\text{(II) } H^+ \text{ (III) } \Delta]{\text{(I) } I_2/OH^-} \text{Product is}$$

(A)

$$Ph-\underset{\underset{O}{\|}}{C}-\overset{\overset{Me}{|}}{\underset{\underset{Et}{|}}{C}}-COOH$$

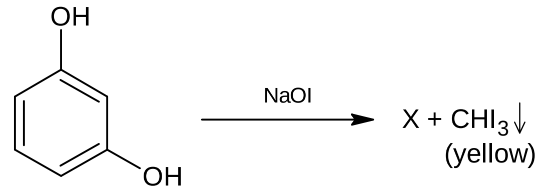
(B)

$$Ph-\underset{\underset{O}{\|}}{C}-\underset{\underset{Et}{|}}{CH}-Me$$

(C)

$$Ph-\underset{\underset{O}{\|}}{C}-O-\underset{\underset{Me}{|}}{CH}-Et$$

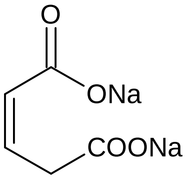
(D)

$$Ph-\underset{\underset{O}{\|}}{C}-\underset{\underset{Me}{|}}{CH}-OEt$$

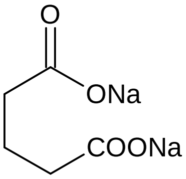
Space for Rough work

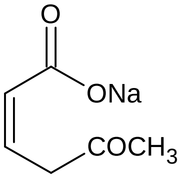
11.

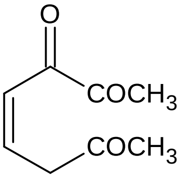


X is

(A)


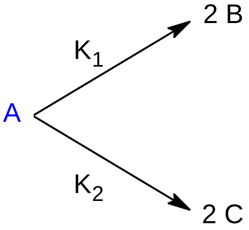
(B)


(C)


(D)


Paragraph for Question Nos. 12 to 14

For a hypothetical elementary reaction



Where $\frac{K_1}{K_2} = \frac{1}{2}$, initially only 2 moles of A are present

12. The total number of moles of A, B & C at the end of 50% reaction are

(A) 2 (B) 3 (C) 4 (D) 5

Space for Rough work

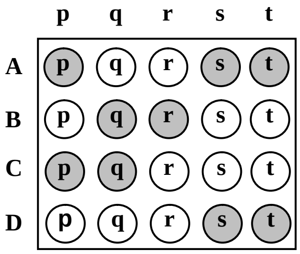
13. Number of moles of B at the end of 75% reaction is
(A) 2 (B) 1 (C) 0.50 (D) 1.5

14. The ratio of number of moles of B to C at the end of 100% reaction is
(A) 2 : 1 (B) 1 : 2 (C) 1 : 3 (D) 2 : 3

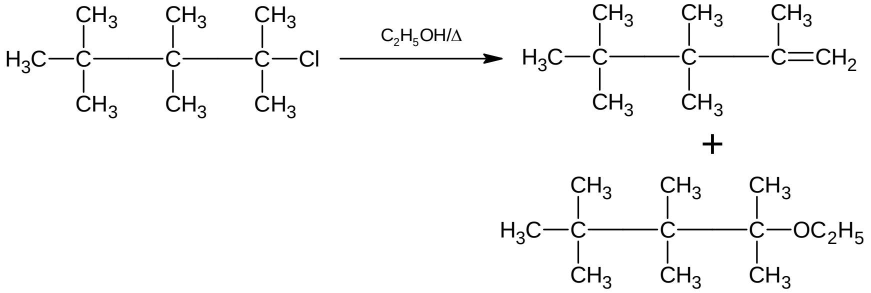
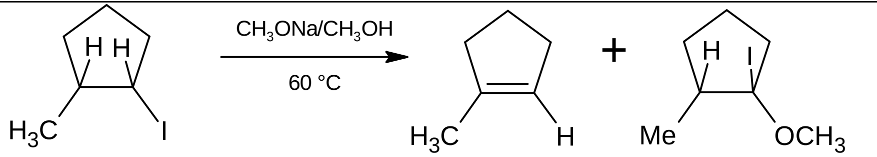
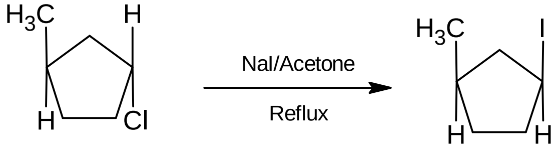
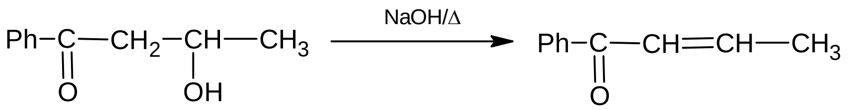
SECTION – B

(Matrix-Match Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:
If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:



1. Match the following.

	Column – I		Column–II
(A)		(p)	SN_1
(B)		(q)	E_1CB
(C)		(r)	E_1
(D)	 $\mathrm{Ph{-}\underset{\overset{\|}{O}}{C}{-}CH_2{-}\underset{\overset{\vert}{OH}}{CH}{-}CH_3} \xrightarrow{NaOH/\Delta} \mathrm{Ph{-}\underset{\overset{\|}{O}}{C}{-}CH{=}CH{-}CH_3}$	(s)	E_2
		(t)	SN_2

Space for Rough work

2. Match the Following

Column – I		Column - II	
(A)	Reversible adiabatic compression	(p)	$\Delta S_{system} > 0$
(B)	Reversible vaporization	(q)	$\Delta S_{system} < 0$
(C)	Adiabatic free expansion of ideal gas in vaccum	(r)	$\Delta S_{surrounding} < 0$
(D)	Dissociation of $CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$	(s)	$\Delta S_{surrounding} = 0$
		(t)	$\Delta S_{system} = 0$

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

1. For 1s orbital of hydrogen atom radial wave function is given as

$$R_{(r)} = \frac{1}{\sqrt{\pi}}\left(\frac{1}{a_0}\right)^{\frac{3}{2}} e^{-\frac{r}{a_0}} \text{ (where } a_0 = 0.529\,\overset{\circ}{A}\text{)}$$

The ratio of radial probability density of finding electron at r = a_0 to the radial probability density of finding electron at nucleus is given as $x.\,e^{-y}$. Calculate the value of (x + y).

2. 4 g isolated Ca atom in gaseous state is provided a total energy of 50 kJ. The molar ratio of Ca^+/Ca^{+2} ions produced is x/y then x + y = …….
IE_1 of Ca = 400 kJ/mole and IE_2 of Ca = 700 kJ/mole

3. The oxidation state of metal in Fehling solution, on the reaction with benzaldehyde changes by ……. units.

4. A decapeptide (Mol. wt. 796) on complete hydrolysis gives glycine (mol. wt. 75), alanine and phenylalanine. Glycine contributes 47% to the total weight of the hydrolysed products. The number of glycine units present in the decapeptide is

5. PDI (poly dispersity index) for natural polymers is generally close to …..

Space for Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains 6 multiple choice questions numbered 1 to 6. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct

1. P_1 is a parabola $y^2 = 4ax$, and P_2 is a parabola given by $y^2 = 4b(x + a)$. P_2 passes through A and B which are points of intersection of P_1 and line $x = a$. If T is the point of intersection of tangents to P_1 at A and B, and R is the point of intersection of normal at A and B to P_2 the area of quadrilateral TARB is

(A) $\sqrt{5}a^2$ (B) $2\sqrt{5}a^2$ (C) $3a^2$ (D) $6a^2$

2. The solution of the differential equation $\frac{dy}{dx} = -\frac{y\sin(x+y) + xy\cos(x+y) - x^2y^2}{x\sin(x+y) + xy\cos(x+y) - x^2y^2}$.

(A) $xy\sin(x+y) = c_1$ (B) $xy\sin(x+y+c_1) = c_2$; c_1, c_2 are related

(C) $x^2y^2\sin(x+y) = c_1$ (D) $x^2y^2\sin(x+y+c_1) = c_2$; c_1, c_2 are related

3. The number of proper divisors of $K = \sum_{i\le}\sum_{j\le}\sum_{n\le 10}\left({}^{10}C_n\,{}^{n}C_j\,{}^{j}C_i\right)$ is

(A) 19 (B) 20 (C) 21 (D) none of these

4. In a matrix $A_{4\times 4}$, an ant starts moving from a_{11} in such a way that it can move from a_{ij} to either $a_{(i+1)j}$ or $a_{i(j+1)}$ in one step. If it reaches a_{44}, the probability that it passes through a_{23} is

(A) $\frac{18}{35}$ (B) $\frac{1}{4}$ (C) $\frac{9}{20}$ (D) none of these

5. If $K \in R, 10^K.\left(x^{\log_{10}^2 x - K\log_{10} x - 1}\right) = 1$. The maximum number of solutions of the equation for ‘x’ is

(A) 0 (B) 1 (C) 3 (D) 4

Space for Rough work

6. The number of solution in x of the equation $\sqrt{\sqrt{3}f\left(x\right)-f'\left(x\right)-2}+\sqrt{\cot 3x+\text{cosec}^2 x-4}=\sin\left(\frac{3x}{2}\right)+\frac{\sqrt{2}}{2}$ if $a\in\left[0,6\pi\right]$ and f(x) satisfies the differential equation $f''\left(x\right)+f\left(x\right)=0$ and $\left(f'\left(x\right)\right)^2+\left(f\left(x\right)\right)^2=1$, and f(0) = 1 is

(A) 1 (B) 3 (C) 4 (D) 0

Multiple Correct Choice Type

This section contains 3 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct

---

7. A square is inscribed in a circle. If p_1 is the probability that a randomly chosen point of the circle lies within the square and p_2 is the probability that the point lies outside the square, then

(A) $p_1 < p_2$ (B) $p_1 = p_2$ (C) $p_1 > p_2$ (D) $p_1^2 - p_2^2 < \frac{1}{3}$

8. If $I_{m,n}=\int \sec^{2n} x\tan^m x\,dx$, n ≥ 1 and m ≥ 2, m, n ∈ N, then

(A) $I_{m,n}=\frac{\sec^{2n-2}x\tan^{m+1}x}{m+1}-\frac{\left(n-1\right)}{m+1}I_{m+2,\,n-1}$

(B) $I_{m,n}=\frac{\sec^{2n}x\tan^{m-1}x}{2n}-\frac{m-1}{2n}I_{m-2,\,n+1}$

(C) $\frac{m-1}{n}I_{m+2,n-1}+\frac{1}{m+1}=\frac{1}{n}+\frac{2\left(n-1\right)}{m+1}I_{m-2,n+1}$

(D) $\frac{m-1}{2n}I_{m+2,n-1}+\frac{1}{m+1}=\frac{1}{2n}+\frac{2\left(n-1\right)}{m+1}I_{m-2,n+1}$

9. If $\vec{a},\vec{b}$ and $\vec{c}$ are three unit vectors and $\vec{d},\vec{e}$ and $\vec{f}$ are three linearly independent unit vectors such that $\left(\vec{a}.\vec{b}\right)\vec{d}+\left(\vec{b}.\vec{c}\right)\vec{e}+\left(\vec{c}.\vec{a}\right)\vec{f}=0$, then

(A) $k\vec{a},\ \ell\vec{b}$ and $m\vec{c}$ are linearly independent

(B) $\left[\vec{d}\,\vec{e}\,\vec{f}\right]=\pm 1$

(C) $\left[\vec{a}\,\vec{b}\,\vec{c}\right]=\pm 1$

(D) $\left[\vec{a}+\left(\vec{b}\times\vec{c}\right)\right].\left(\vec{b}+\vec{c}\right)=0$

Space for Rough work

Comprehension Type

This section contains 2 paragraphs. Based upon one of paragraph 2 multiple choice questions and based on the other paragraphs 3 multiple choice questions have to be answered. Each of these questions has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct

Paragraph for Question Nos. 10 and 11

A circle C_1 touches the circle $x^2 + y^2 - a^2 = 0$ at A internally and the parabolas $y^4 - 16x^2 = 0$ at B and C externally.

10. If ΔABC formed is an equilateral then AB =

(A) $\frac{2}{\sqrt{3}}$ (B) $\frac{1}{3}$ (C) $\frac{2}{3}$ (D) $\frac{1}{\sqrt{3}}$

11. Which of the below is true?

(A) $|a| = \sqrt{3} - \frac{1}{\sqrt{3}}$ (B) radius of $C_1 = \frac{2}{\sqrt{3}}$ (C) $|a| = 2\sqrt{3}$ (D) radius of $C_1 = \frac{2}{3\sqrt{3}}$

Paragraph for Question Nos. 12 and 14

Let $\alpha_1, \alpha_2, ..., \alpha_n$ be the roots of the equation $f(x) = x^n + p_1x^{n-1} + ... + p_{n-1}x + p_n = 0$

$\frac{f(x)}{x - \alpha_i} = x^{n-1} + (\alpha_i + p_1)x^{n-2} + (\alpha_i^2 + \alpha_i p_1 + p_2)x^{n-3} + ...$ Then $\sum_{i=1}^{n} \frac{f(x)}{x - \alpha_i} = f'(x)$ is an identity where $f'(x) = \frac{df(x)}{dx}$

12. If f(x) = $x^5 + px^3 + qx + t = 0, \sum_{i=1}^{5} \alpha_i^3$

(A) $-p^3 + 3q$ (B) 1 (C) 0 (D) $-p^3 + 7q$

Space for Rough work

13. If f(x) = $x^3 - 2x^2 + x - 1$ and α_i, i = 1, 2, 3 are three roots of f(x) = 0 then $\sum \alpha_i^3$ is equal to
(A) 3 (B) 4 (C) 5 (D) 6

14. If f(x) = $x^3 - 2x^2 + x - 1 = 0$, $\sum \alpha_i^4 =$
(A) 10 (B) 15 (C) 20 (D) 25

SECTION – B

(Matrix-Match Type)

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.** The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:
If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. Match the following:

Column – I		Column – II	
(A)	The last three digits of $3^{50} - 7^{20}$ contains	(p)	1
(B)	Divisors of the number of solution of the equation $\lvert \tan x \rvert = \{x\}$, $x \in [0, 4]$ is/are ({x} is fractional part of x)	(q)	2
(C)	Divisors of the number of points of discontinuity of $f(x) = \lim\limits_{n \to \infty} \frac{\{(x-1)(x-3)(x-5)\}^{2n} - 3^{2n}}{\{(x-1)(x-3)(x-5)\}^{2n} + 3^{2n}}$	(r)	4
(D)	$f(x) = \begin{cases} Kx, & x < 0 \\ x + \{x\}, & x \in [0, 4] \\ \frac{K+8}{2} + (x-4)^2, & x > 4 \end{cases}$ has local minima at x = 0 and x = 4, then possible value of |K|, which are integer	(s)	6
		(t)	8

Space for Rough work

2. Match the following:

Column – I		Column – II	
(A)	$7\{x\}^4 + 9\{x\}^3\{-x\} - 5\{x\}^2 + 9\{x\}\{-x\} - 2 = 0$, {x} is factional part of x, then if m $\in$ z^+, 2mx may be equal to	(p)	0
(B)	If $2y^2 + 2xy - 5x = 0$ has non-negative integral solutions in x and y then y may be equal to	(q)	2
(C)	A = {1, 3, 5, 7} and B = {2, 4, 6, 8} number of one-one function f: A → B such that $f(i) - i \ge 2\ \forall\ i \in A$	(r)	3
(D)	If $f(x) = \begin{cases} x + \sin x, & x \in (0, \pi) \\ 0, & x = \pi \\ \pi + 1 - \dfrac{1}{1 + (x - \pi)^2}, & x \in (\pi, \infty) \end{cases}$ then the value of x for which f(x) = $f^{-1}(x)$	(s)	4
		(t)	5

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. If the number of ordered triplets (a, b, c) such that L.C.M (a, b) = 1000, L.C.M (b, c) = 2000 and L.C.M (c, a) = 2000 be N then sum of digits of N is/are _______________

2. If $\arg\left(z^{2n} + (n^2 + 1)z^n + 1\right) = kn\arg(z)$, |z| = 1, n $\in$ N then k equal …

3. If $f(x) = \begin{cases} e^x + e^{-x}, & x < 0 \\ \log_{10}(100 - x), & x \in [0, 100) \end{cases}$ then the number of solution of the equation $f(x) + \left(e - \frac{1}{e}\right)x = \frac{2}{e}$

4. The equation of a plane which passes through the line of intersection of the planes x + y + z – 1 = 0 and x – y + z – 3 = 0 and which is at maximum distance from the point (3, 4, 5) is ax + by + cz – d = 0, the value of $\left(\frac{a + b - c}{d}\right)$ is

5. The quadratic equation $2x^2 - 5\pi x + p = 0$ has roots equal to $2\sin^{-1}\alpha$ and $3\sin^{-1}\beta$, then $\left[\frac{p}{\pi}\right]$ equals, [.] denotes greatest integer function.

Space for Rough work

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

FIITJEE

JEE(Advanced)-2017

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – I
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	C	D
2.	A	A	B
3.	C	A	A
4.	A	C	C
5.	B	A	C
6.	C	B	A
7.	ABCD	BC	CD
8.	ABD	ABCD	B
9.	BD	BD	ACD
10.	C	B	C
11.	A	A	D
12.	A	B	C
13.	C	C	C
14.	B	B	A
1.	(A) $\rightarrow$ q, (B) $\rightarrow$ p, (C) $\rightarrow$ r, (D) $\rightarrow$ p	(A) $\rightarrow$ p, r, (B) $\rightarrow$ s, t, (C) $\rightarrow$ t, (D) $\rightarrow$ q	(A) $\rightarrow$ r, t, (B) $\rightarrow$ p, q, r (C) $\rightarrow$ p, q, s, (D) $\rightarrow$ p, q, r, s
2.	(A) $\rightarrow$ s, (B) $\rightarrow$ q, (C) $\rightarrow$ p, (D) $\rightarrow$ p	(A) $\rightarrow$ s, t (B) $\rightarrow$ p, r, (C) $\rightarrow$ p, s, (D) $\rightarrow$ p, r	(A) $\rightarrow$ r, t, (B) $\rightarrow$ p, q, (C) $\rightarrow$ p, (D) $\rightarrow$ p
1.	1	3	7
2.	3	7	1
3.	2	0	2
4.	7	6	5
5.	2	1	9

Physics PART – I

SECTION – A

1. C

The maximum velocity of the insect is $A\sqrt{\frac{k}{M}}$ its component perpendicular to the mirror is

$A\sqrt{\frac{k}{M}}\sin 60^o$.

Thus maximum relative speed = $\sqrt{3}\ A\sqrt{\frac{k}{M}}$

2. A

The slope $\tan\theta = \frac{PV}{T} = nR$

$= \frac{m}{M}R$

$M_{H_2} < M_{He} < M_{CO_2}$

$\Rightarrow (\tan\theta)_{H_2} > (\tan\theta)_{He} > (\tan\theta)_{CO_2}$

3. C

Since velocity is constant

$\text{emf} = \left|\frac{d\phi}{dt}\right| = BLV = \text{constnat}$

$\because$ potential difference across capacitor is constant and energy stored in the capacitor

$= \frac{1}{2}ce^2 = \frac{1}{2}C\left(B^2L^2V^2\right)$

Flux increases in the loop AEFBA, therefore current will flow in this loop in anticlockwise direction.

4. A

$A = A_0e^{-\lambda t} \Rightarrow \frac{6}{100} = e^{-\frac{\ln 2}{T_{\frac{1}{2}}}t}$

$\frac{1}{2^{\frac{t}{T_{\frac{1}{2}}}}} = \frac{6}{100} \Rightarrow \frac{1}{2^4}$

$T_{\frac{1}{2}} = 30\text{ mm}$

5. B

By the work – energy theorem

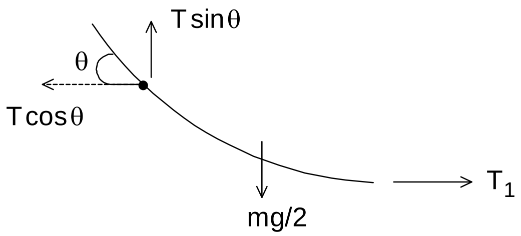
Charge in K.E. = work done by all the forces

$\frac{1}{2}(m)\left(5^2\right) = 0 = xqE_0$

$x = \frac{25m}{2qE_0}$

6. C

T be the tension at each points A & B



Apply Newtons law.

7. ABCD

Let l_1 and l_2 be the length of the air column for the first and the second resonance respectively with a tuning fork of frequency f.

Then $\lambda = 2(l_2 - l_1)$

From relation, $v = f\lambda$

$$v = 2f(l_2 - l_1)$$

$$= 2\times 480\times(51cm - 16cm) = 336 m/s$$

If T be the temperature of the air in air column of the resonance tube.

Then from formula,

$$\frac{\nu}{\nu_o} = \sqrt{\frac{T}{T_o}}$$

$$T = T_0\left(\frac{v}{v_0}\right)^2 = 273\left(\frac{336}{330}\right)^2 = 283K$$

Also $\frac{\lambda}{4} = l_1 + e = 16cm + 0.3d = \frac{v}{4f} = \frac{336}{4\times 480}m$

Therefore $d = 5cm$

Again

$$\frac{\Delta v}{v}\times 100\% = \frac{\Delta l_2 + \Delta l_1}{l_2 - l_1}\times 100\% = \frac{4}{7}\%$$

And $\frac{\Delta T}{T}\times 100\% = 2\times\frac{\Delta l_2 + \Delta l_1}{l_2 - l_1}\times 100\% = \frac{8}{7}\%$

8. ABD

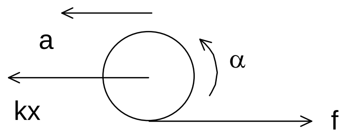
$\lambda \rightarrow \lambda/\mu_1$ shifting will be upward, for $\mu_3 = \mu_1 \times \mu_2$ the upward and downward shifts will cancel together

9. BD

Non zero external force must accelerate the centre of mass.

10-11. C – A

At displacement x



For disc rolling

$a = \alpha R$

$$\frac{kx - f}{m} = \frac{(fR)}{\frac{1}{2}mR^2} = \frac{2f}{m}$$

$$f = \left(\frac{k}{3}\right)A$$

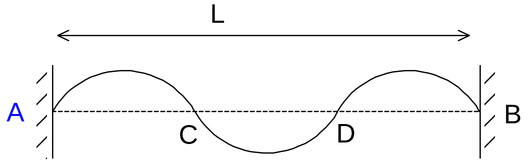
The cylinder is starting from x = A

$x = A\cos wt$

$$f = \frac{kA}{3}\cos wt$$

12. A

Maximum e.m.f induced will be when the string passes through mean position. e.m.f induced in segment AC and CD will counter each other and e.m.f induced in third segment will be maximum.



$$L = \frac{3\lambda}{2}$$

e.m.f induced in eliminated part

$$B\ell V = \int_{\frac{2L}{3}}^{L} B\left(2A\sin(kx)\omega\right)dx$$

$$= 2BA\omega\int_{\frac{2L}{3}}^{L} \sin(kx)\,dx$$

$$= -\frac{2BA\omega}{k}\left[\cos(kx)\right]_{\frac{2L}{3}}^{L}$$

$$= -\frac{2BA\omega}{k}\left[\cos\left(\frac{2\pi}{x}.L\right) - \cos\left(\frac{2\pi}{x}.\frac{2L}{3}\right)\right]$$

$$\left[\cos\left(\frac{2\pi}{2L}\times L\right) - \cos\left(\frac{2\pi}{2L}\times\frac{2L}{3}\right)\right]$$

$$= -\frac{2BA\omega}{k}\left[\cos(\omega\pi) - \cos(2\pi)\right] = \frac{4BA\omega}{k}$$

13. C

e.m.f will be maximum at one fourth of time period

i.e $t = \frac{\pi}{2\omega}$

14. B

In 2^{nd} harmonic two parts counter each other.

SECTION – B

1. $(A \rightarrow q)$ $(B \rightarrow p)$ $(C \rightarrow r)$ $(D \rightarrow p)$

Due to centrifugal force clockwise torque will increase to counter this N_2 will increase.

2. $(A \rightarrow s)$ $(B \rightarrow q)$ $(C \rightarrow p)$ $(D \rightarrow p)$

Current through the inductor at t = 0 is equal to 3A

$$I = I_0 e^{-\frac{t}{\tau}}$$

$$\tau = \frac{L}{R_a q} = \frac{9}{9} = 1$$

$$I_0 = 3A$$

SECTION – C

1. 1

Change in Potential energy of the system in both figure is same

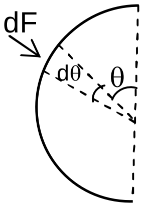
2. 3

$$\lambda = \frac{h}{P} = \frac{h}{\sqrt{2qVm}}$$

Or $\lambda \propto \frac{1}{\sqrt{qm}}$

3. 2

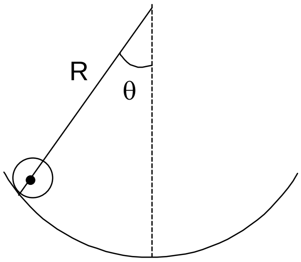
$$f_v = \int_0^R \rho g(2R - R\cos\theta)(LRd\theta)\cos\theta$$



$$= L\rho g R^2 \int_0^R (2\cos\theta - \cos^2\theta)d\theta$$

$$= \rho g L R^2 \frac{\pi}{2}$$

4. 7



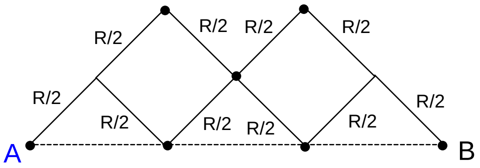
$$a = \frac{g\sin\theta}{1+\frac{k^2}{r^2}}$$

$$a = \frac{g}{\left(1+\frac{k^2}{r^2}\right)}\frac{x}{(R-r)}$$

$$a = -w^2x$$

$$w = \sqrt{\frac{g}{(R-r)\left(1+\frac{k^2}{r^2}\right)}}$$

5. 2



Chemistry

PART – II

SECTION – A

1. C

p-xyloquinone + methylene white $\rightleftharpoons$ p-xylohydroquinone + methylene blue

p-xyloquinone	+ methylene white		p-xylohydroquinone	+	methylene blue
0.012	0		0.24		10^{-3}
$0.012 + 4 \times 10^{-5}$	4×10^{-5}		$0.24 - 4 \times 10^{-5}$		0.96×10^{-3}
$\cong 0.012$			$\cong 0.24$		

$$K = \frac{0.24 \times 0.96 \times 10^{-3}}{0.012 \times 0.04 \times 10^{-3}} = 480$$

2. A

Mole of NaCl = 0.1 & $MgCl_2$ = 0.1 (assuming mass of solution = 100 gm)
Mass of solvent = 84.65 gm

$$i_{NaCl} = 1 + (n-1).\alpha \quad \text{and} \quad i_{MgCl_2} = 1 + (n-1).\alpha$$

$$= 1.8 \qquad\qquad = 2$$

$$\Delta T_b = K_b \times m \times i$$

$$\Delta T_b = 2.29$$

b.p of solution = (100 + 2.29) ^{o}C
= 102.29 ^{o}C

3. A

Let $NaHCO_3$ = X gm
Na_2CO_3 = Y gm
At HPh end point

$$Na_2CO_3 + HCl \longrightarrow NaHCO_3 + NaCl$$

$$\text{millimole of HCl} = 0.15 \times 10 = 1.5$$

$$\text{millimole of } Na_2CO_3 = 1.5$$

$$\frac{Y}{106} \times 1 \times 10^{3} = 1.5 \quad Y = 0.159 \text{ g}$$

At MeOH end point, $\left(\frac{X}{84}\right) + \left(\frac{Y}{106}\right) \times 2 = 0.15 \times 35 \times 10^{-3}$

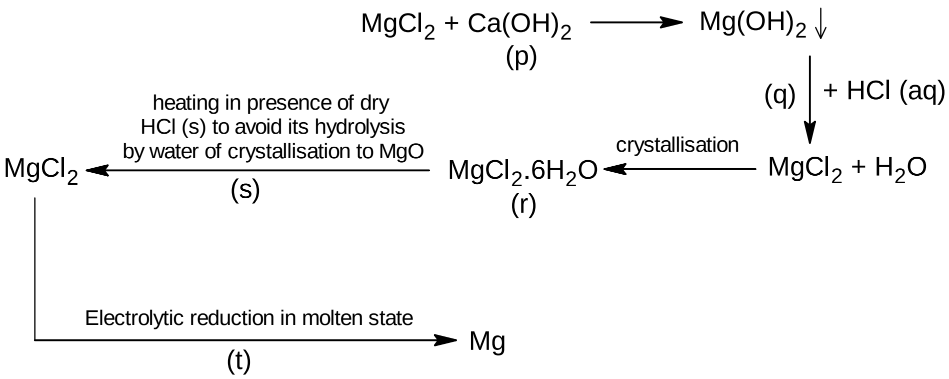
Putting value of Y/106, we get X
X = 0.189 g
$\therefore$ wt of KCl = 0.5 – 0.159 – 0.189 = 0.152 g

$$\% \text{ of } Na_2CO_3 = \frac{0.159 \times 100}{0.5} = 31.8\%$$

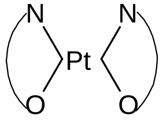
$$\% \text{ of } NaHCO_3 = \frac{0.189 \times 100}{0.5} = 37.8\%$$

$$\% \text{ KCl} = \frac{0.152 \times 100}{0.5} = 30.4\%$$

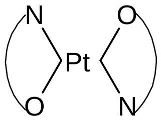
4. C


MgCl2 + Ca(OH)2
(p)
Mg(OH)2 ↓
(q)
+ HCl (aq)
MgCl2 + H2O
crystallisation
MgCl2.6H2O
(r)
heating in presence of dry
HCl (s) to avoid its hydrolysis
by water of crystallisation to MgO
(s)
MgCl2
Electrolytic reduction in molten state
(t)
Mg

5. A
(A) tetrahedral compounds can't show geometrical isomerism because positions are equivalent in tetrahedral geometry.
(B) gives cis & trans isomer
(C) Ma_3b & Mab_3 have only one form
(D)



cis



trans

6. B

$$\frac{r^+}{r^-} = \frac{0.221}{0.95} = 0.225$$

So, C.No. = 4

7. BC
the half cell which has higher value of SRP undergo reduction

$$Cl_2(aq) + 2e^- \longrightarrow 2Cl^-(aq) \quad E^o_{Cl_2/Cl^-} = 1.36\,V$$

$$Br_2(aq) + 2e^- \longrightarrow 2Br^-(aq) \quad E^o_{Br_2/Br^-} = 1.09\,V$$

Cl_2 will undergo reduction & Br^- will undergo oxidation.

$$Cl_2(aq) + 2Br^-(aq) \longrightarrow 2Cl^-(aq) + Br_2(aq) \quad E^o_{cell} = 0.27\,V$$

$\Delta G^o = -$ve spontaneous

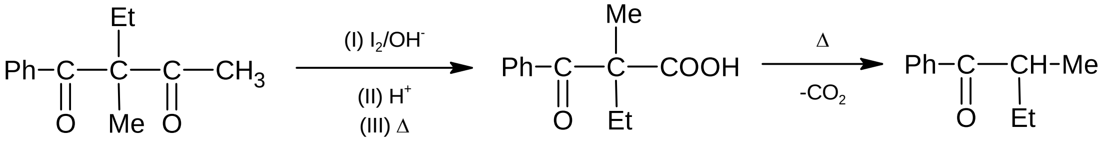
(C) $S_2O_8^{2-}$ have higher SRP.

8. ABCD
Z < 1. Intermolecular attractive force dominates.

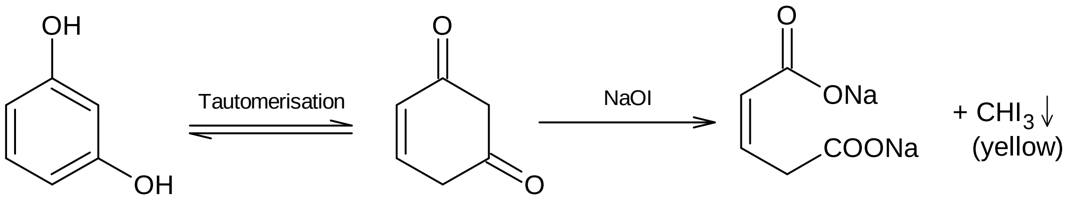
9. BD

$$\begin{tikzcd}
3SO_2 + 3H_2O \arrow[r] & 3H_2SO_3 \arrow[d, "150^{\circ}C"] \\
& \underset{\text{(White turbidity)}}{S} + 2H_2SO_4 + H_2O \arrow[d, "BaCl_2"] \\
& BaSO_4\downarrow \text{(white ppt.)}
\end{tikzcd}$$

10. B


Ph–C–C–C–CH3
O
Et
Me
O
(I) I2/OH-
(II) H+
(III) Δ
Ph–C–C–COOH
O
Me
Et
Δ
-CO2
Ph–C–CH–Me
O
Et

11. A


OH
OH
Tautomerisation
O
O
NaOI
O
ONa
COONa
+ CHI3↓
(yellow)

12. B

$$\frac{K_1}{K_2} = \frac{1}{2} = \frac{[B]}{[C]} = \frac{x}{y}$$

$t = 0 \; A_o$

$t = t_0 \; A_o - x - y$

$$x + y = \frac{A_o}{2} = \frac{2}{2} = 1 \quad ......(1)$$

$$\frac{x}{y} = \frac{1}{2} \Rightarrow 2x = y$$

Putting value of x in equation (1)

$$x = \frac{1}{3} \;\&\; y = \frac{2}{3}$$

$$n_T = n_A + n_B + n_C = 1 + \frac{2}{3} + \frac{4}{3} = \frac{9}{3} = 3$$

13. C

$$\frac{n_B}{n_C} = \frac{k_1}{k_2} = \frac{1}{2} = \frac{x}{y}$$

$2x + 2y = 75\%$ of 2 mole $= 1.5$

$\therefore$ solving the above equations, we get

$n_B = 2x = 0.5$ mole

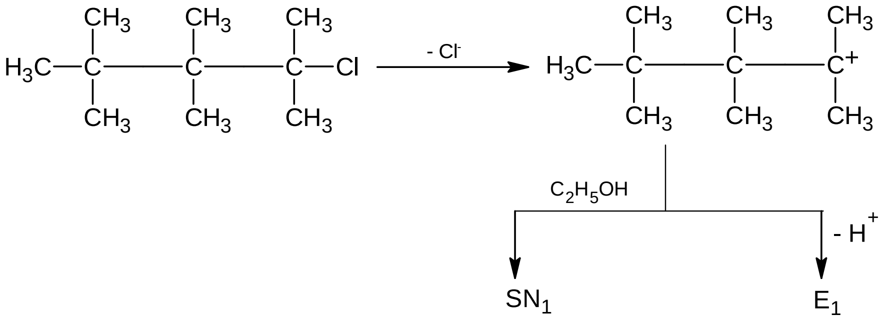
14. B

$\frac{n_B}{n_C} = \frac{K_1}{K_2}$ at any time

SECTION – B

1. A – pr; B – st; C – t; D – q

(A)



(B) SN^2 & E_2 reaction

(C) SN^2 reaction

(D) E_1 CB reaction due to presence of poor leaving group OH^- ion.

2. A – s; B – pr; C – ps; D – pr

For all reversible process

$\Delta S_{total} = 0$

For irreversible process $\Delta S_T > 0$

(A) $\Delta S_{system} = nC_V \ln\frac{T_2}{T_1} + nR\ln\frac{V_2}{V_1}$ $\left[T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}\right]$

$\Delta S = 0$

$\Delta S_{surrounding} = \frac{-q}{T} = 0$ $[q = 0]$

(B) Heat is supplied from surrounding to system

$\Delta S_{system} > 0$

$\Delta S_{surrounding} < 0$

(C) $\Delta T = 0$

w = q = 0, $\Delta S_{surrounding} = 0$

$\Delta S_{system} = nC_V \ln\frac{T_2}{T_1} + nR\ln\frac{V_2}{V_1}$

$\Delta S_{system} > 0$

(D) heart is supplied

$\Delta S_{surrounding}$ decreases

$\Delta S_{system} > 0$

SECTION – C

1. 3

ratio = $\frac{R^2(a_0)}{R^2(0)}$

$$= \frac{\left(\frac{1}{a_0^3}\right)e^{\frac{-2a_0}{a_0}}}{\left(\frac{1}{a_0^3}\right)e^{0}} = e^{-2}$$

= 3

2. 7

Mole of Ca = $\frac{4}{40} = 0.1$

$Ca \rightarrow Ca^{+} + e^{-}$

IE required = 0.1 × 400 = 40 kJ

$$\underset{0.1-x}{Ca^{+}} \rightarrow \underset{x}{Ca^{+2}} + e^{-}$$

$(0.1 - x) \times 700 = 10$

$x = \frac{3}{35}$

$Ca^{+} = 0.1 - \frac{3}{35} = \frac{0.5}{35}$

$$Molar\ ratio = \frac{\frac{0.5}{35}}{\frac{3}{35}} = \frac{1}{6} = \frac{x}{y}$$

$\therefore x + y = 7$

3. 0

Benzaldehyde does not reduce Fehling solution.

4. 6

Molecular weight of decapeptide = 796 g/mole

Total bonds to be hydrolysed = (10 – 1) = 9 per molecules

Total weight of H_2O added = 9 × 18 = 162 g/mol.

Total weight of hydrolysis product = 796 + 162 = 958

Total weight % of glycine = 47%

Total weight of glycine in product $= \frac{958 \times 47}{100} \approx 450\,gm$

Molecular wt of glycine in product = 75 g/mol.

$\therefore$ no. of glycine units = 450/75 = 6.

5. 1

For natural polymers PDI, $\overline{M}_w = \overline{M}_n$

PDI = $\frac{\overline{M}_w}{\overline{M}_n} = 1$

Mathematics PART – III

SECTION – A

1. D

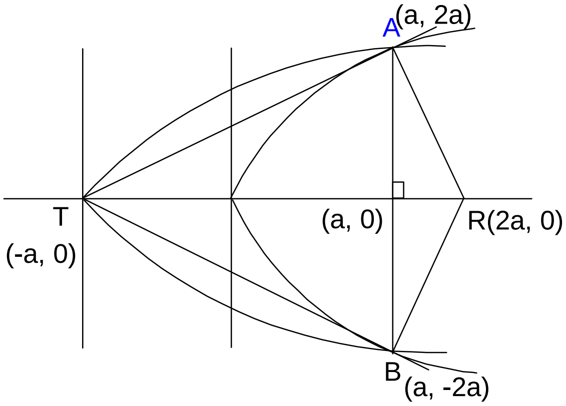
$A \equiv (a, 2a), B \equiv (a, -2a)$

$T \equiv (-a, 0)$

$y^2 = 4b(x + a)$

$\Rightarrow 4a^2 = 8ab \Rightarrow b = \frac{a}{2}$

Equation of normal at (a, 2a) to $y^2 = 2a(x + a)$ is $y + 2x = 4a$



$\therefore R \equiv (2a, 0)$

Area (TARB) = $6a^2$

2. B

Substitute x y = t , and x + y = u

$\frac{dt}{du} + t\cot u = t^2 \operatorname{cosec} u$

$xy\sin(x + y + c_1) = c_2$, c_1 and c_2 are related

3. A

$K = 4^{10} \Rightarrow K = 2^{20}$

No. of proper divisors = 19

4. C

P(passing through a_{23}) = $\frac{\frac{3!}{2!} \times \frac{3!}{2!}}{\frac{6!}{3!3!}} = \frac{9}{20}$

5. C

$\log_{10} x = t$, taking logarithm to base 10 both sides

$t^3 - kt^2 + k - t = 0$

$\Rightarrow t^2(t - k) - (t - k) = 0$

$\Rightarrow (t^2 - 1) = 0$ or $t = k$

$\therefore$ maximum number of three solutions if $k \neq -1, 1$

6. A

$f''(x) + f(x) = 0$ and $(f'(x))^2 + (f(x))^2 = 1$

$\Rightarrow x = \pm\sin^{-1}(f(x)) + c$

$f(0) = 1 \Rightarrow f(x) = \cos x$

Equation becomes

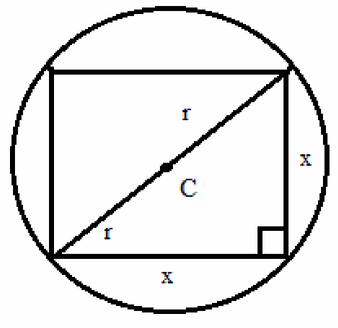
$\sqrt{\sqrt{3}\cos x + \sin x - 2} + \sqrt{\cot 3x + \operatorname{cosec}^2 x - 4} = \sin\left(\frac{3x}{2}\right) + \frac{\sqrt{2}}{2}$ is satisfied by only $x = \frac{13\pi}{6}$

7. CD

If r be the radius of the circle and if x be the side of the square, then

$x^2 + x^2 = (2r)^2$

or $x^2 = 2r^2$



Now, $P_1 = \frac{\text{Area of square}}{\text{Area of circle}} = \frac{x^2}{\pi r^2} = \frac{2r^2}{\pi r^2} = \frac{2}{\pi}$

$\therefore P_2 = 1 - P_1 = 1 - \frac{2}{\pi} = \frac{(\pi-2)}{\pi}$

$\therefore\ 2 > \pi - 2$

$\Rightarrow \frac{2}{\pi} > \frac{\pi-2}{\pi}$

$\Rightarrow P_1 > P_2$

Also, $P_1^2 + P_2^2 = (P_1 + P_2)(P_1 - P_2) = 1\ \frac{(4-\pi)}{\pi}$

$= \frac{4}{\pi} - 1 < \frac{1}{3}$

$\therefore \left(3 < \pi < 4 \Rightarrow \frac{3}{\pi} < 1 < \frac{4}{\pi}\right)$

8. B

$I_{m,n} = \int \sec^{2n} x \tan^m x\, dx = \frac{\sec^{2n-2} x \tan^{m+1} x}{m+1} - (2n-2)\int \frac{\sec^{2n-2} x \tan^{m+2}}{m+1} dx$

$= \frac{\sec^{2n-2} x \tan^{m+1} x}{m+1} - \frac{2(n-1)}{m+1} I_{m+2,\, n-1}$

Similarly

$I_{m,n} = \frac{\sec^{2n} x \tan^{m-1} x}{2n} - \frac{m-1}{2n} I_{m-2,n+1}$

9. ACD

$(\vec{a}.\vec{b})\vec{d} + (\vec{b}.\vec{c})\vec{e} + (\vec{c}.\vec{a})\vec{f} = 0$

$\vec{d}, \vec{e}, \vec{f}$ are linearly independent

$\therefore \vec{a}.\vec{b} = 0; \vec{b}.\vec{c} = 0$ and $\vec{c}.\vec{a} = 0$

$\Rightarrow \vec{a}, \vec{b}, \vec{c}$ from three mutually perpendicular vectors and are linearly independent vectors.

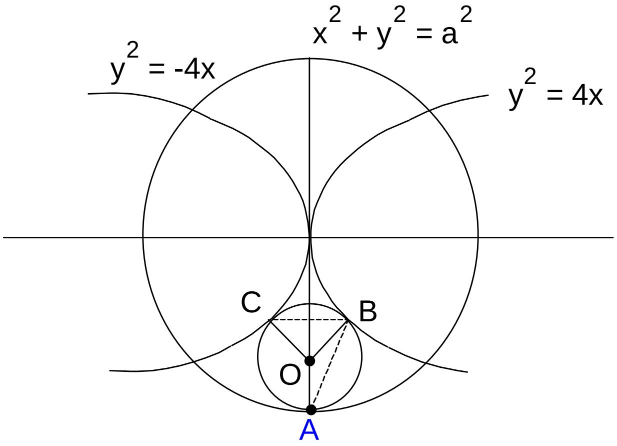
10-11. C – D

Let O be the centre of C_1 m(OB) × slope (tangent at B) = - 1

$$\Rightarrow \frac{1}{\sqrt{3}} \times \frac{2}{y} = -1 \Rightarrow \frac{1}{y} = \frac{-\sqrt{3}}{2} \Rightarrow y = \frac{-2}{\sqrt{3}}$$

$$x = \frac{1}{3} \Rightarrow B \equiv \left(\frac{1}{3}, \frac{-2}{\sqrt{3}}\right); C \equiv \left(\frac{-1}{3}, \frac{-2}{\sqrt{3}}\right)$$

$$AB = BC = \frac{2}{3}$$



Equation of OB

$$\left(y + \frac{2}{\sqrt{3}}\right) = \frac{1}{\sqrt{3}}\left(x - \frac{1}{3}\right)$$

$$\therefore O \equiv \left(0, \frac{-7}{3\sqrt{3}}\right)$$

Radius of C_1 = $\frac{2}{3\sqrt{3}}$

$$\therefore A \equiv \left(0, -\sqrt{3}\right)$$

12. C

$$f'(x) = 5x^4 + 3px^2 + q = 5x^4 + \sum\alpha_i x^3 + \left(5p + \sum\alpha_i^2\right)x^2 + \left(p\sum\alpha_i + \sum\alpha_i^3\right)x + \left(p\sum\alpha_i^2 + \sum\alpha_i^4 + q\right)$$

$$\therefore \sum\alpha_i = 0; \sum\alpha_i^2 = -2p$$

$$p\sum\alpha_i + \sum\alpha_i^3 = 0 \Rightarrow \sum\alpha_i^3 = -p\sum\alpha_i = 0$$

13. C

$$f'(x) = 3x^2 - 4x + 1 = 3x^2 + \left(\sum\alpha_i - 6\right)x + \left(\sum\alpha_i^2 - 2\sum\alpha_i + 3\right)$$

$$\Rightarrow \sum\alpha_i = 2; \sum\alpha_i^2 - 2\sum\alpha_i + 3 = 1 \Rightarrow \sum\alpha_i^2 = 2$$

As α_i is a root

$$\therefore \alpha_i^3 - 2\alpha_i^2 + \alpha_i - 1 = 0 \Rightarrow \sum\alpha_i^3 - 2\sum\alpha_i^2 + \sum\alpha_i - 3 = 0$$

As α_i is a root $\therefore \Rightarrow \sum\alpha_i^3 = 2\sum\alpha_i^2 - \sum\alpha_i + 3$

$= 5$

14. A

As in Q.13

$\sum\alpha_i^4 - 2\sum\alpha_i^3 + \sum\alpha_i^2 - \sum\alpha_i = 0$

$\Rightarrow \sum\alpha_i^4 = 2\times5 - 2 + 2 = 10$

SECTION – B

1. A – rt, B – pq, C – pqs, D – pqrs

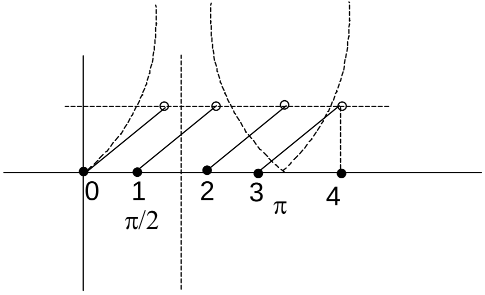
(A) $3^{50} - 7^{20}$

$= (10-1)^{25} - (50-1)^{10}$

$= 10^3K + 250 - 1 - 112500 + 500 - 1$

Last three digit = 748

(B) No. of solution = 4



(C) $f(x) = \lim\limits_{n\to\infty} \dfrac{\left\{\dfrac{(x-1)(x-3)(x-5)}{3}\right\}^{2n} - 1}{\left\{\dfrac{(x-1)(x-3)(x-5)}{3}\right\}^{2n} + 1}$

$g(x) = \dfrac{(x-1)(x-3)(x-5)}{3}$

$g'(x) = 3x^2 - 15x + 23 = 0$

$\Rightarrow x = \dfrac{18 \pm \sqrt{48}}{6}$

f(x) is discontinuous at six points.

A, B, C, D, E & F

(D) for local minima at x = 0

Kx > 0

$\Rightarrow$ K < 0 as x < 0

For local minima at x = 4

$\dfrac{K+8}{2} > 0 \Rightarrow K > -8$

Possible $K = \{-7, -6, -5, -4, -2, -1\}$

2. A – rt, B – pq, C – p, D – p

(A) $\{-x\} = 1 - \{x\}$

Let {x} = t

$\Rightarrow 7t^4 + 9t^3(1-t) - 5t^2 + 9t(1-t) - 2 = 0$

$\Rightarrow 2t^4 - 9t^3 + 14t^2 - 9t + 2 = 0$

$t + \frac{1}{t} = 2$ or $t + \frac{1}{t} = \frac{5}{2}$

$t = 1$ or $t = \frac{1}{2}$ or 2

$\therefore \{x\} = \frac{1}{2}$

$x = \frac{1}{2}, \frac{3}{2}, \frac{5}{2}$ etc

(B) $2y^2 + 2xy - 5x = 0$

$\Rightarrow x = \frac{2y^2}{5-2y}$

$x \ge 0 \Rightarrow \frac{2y^2}{5-2y} \ge 0$

$\Rightarrow 5 - 2y > 0$

$\Rightarrow y < \frac{5}{2}$

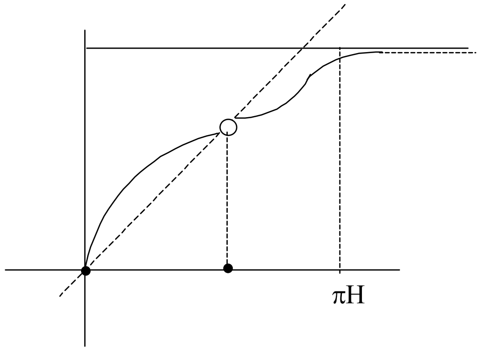
$\therefore y = 0, 1, 2$

For y = 0, 2, x is positive integer

(C) Not possible such function

(D) solving $f^{-1}(x) = f(x)$ is equivalent to solving y = f(x).

No solution



SECTION – C

1. 7

$1000 = 2^3 . 5^3$, $2000 = 2^4 . 5^3$

so, $a = 2^A . 5^R$, $b = 2^B . 5^S$, $c = 2^C . 5^T$,

max(A, B) = 3, max(A, C) = max(B, C) = 4

max(R, S) = max(R, T) = max(S, T) = 3.

There are 10 ways of choosing R, S, T

1 with all 3, 3 with one 2, 3 with one 1, 3 with one 0, C must be 4. There are 7 ways of choosing A, B;

1 with both 3, 3 with A = 3, B not, 3 with B = 3 and A not

thus 7 ways of choosing A, B, C hence

7 . 10 = 70 ways.

2. 1

Resultant of $z^{2n} + 1$ lies along z^n, if $|z| = 1$

$\therefore$ K = 1

3. 2

The graph of f(x) = y and $y = \left(\frac{1}{e} - e\right)x + \frac{2}{e}$

Two solutions exist.

4. 5

Any point on the line of intersection is (t, -1, 2 – t)

For maximum distance = $\sqrt{(3-t)^2 + 5^2 + (3+t)^2} = \sqrt{43 + 2t^2} \Rightarrow t = 0$

Normal $\vec{n} = (3-0)\hat{i} + (4+1)\hat{j} + (5-2)\hat{k}$

$\therefore$ equation of plane through the line at maximum distance 3x + 5y + 3z = 1

5. 9

$2\sin^{-1}\alpha + 3\sin^{-1}\beta = \frac{5\pi}{2}$

max. of $\sin^{-1}\alpha$ & $\sin^{-1}\beta$ is $\frac{\pi}{2}$

so $\sin^{-1}\alpha = \frac{\pi}{2}$ & $\sin^{-1}\beta = \frac{\pi}{2}$

so $\frac{P}{\pi} = \frac{\left(2\sin^{-1}\alpha \times 3\sin^{-1}\beta\right) \times 2}{\pi}$

$= \frac{12}{\pi} \times \frac{\pi^2}{4} = 3\pi$

so $[3\pi] = 9$

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

ALL INDIA TEST SERIES

FIITJEE

JEE (Advanced), 2017

FULL TEST – II

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 234**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 – 12) contains 4 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

Section-A (13 to 18) contains 3 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-C (01 – 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

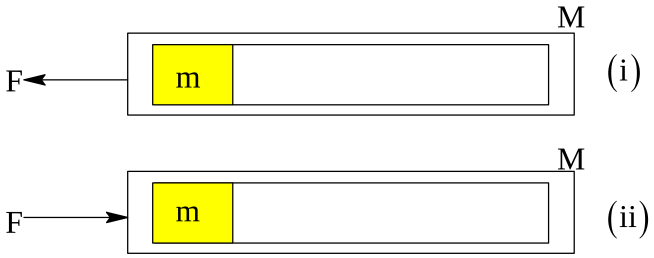
PART – I

SECTION – A

Straight Objective Type

This section contains **08 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. A block of mass m is placed in contact with one end of a smooth tube of mass M (see figure). A horizontal force F acts on the tube in each case (i) and (ii). Then mark **incorrect** option:



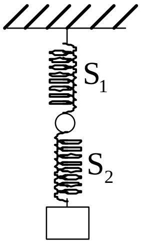
(A) $a_m = 0 \text{ and } a_M = \frac{F}{M} \text{ in } (i)$

(B) $a_m = a_M = \frac{F}{M+m} \text{ in } (i)$

(C) $a_m = a_M = \frac{F}{M+m} \text{ in } (ii)$

(D) Force on m is $\frac{mF}{M+m} \text{ in } (ii)$

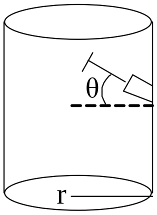
2. Two springs, S_1 and S_2, have negligible masses and the spring constant of S_1 is $1/3$ that of S_2. When a block is being hanged from the springs as shown above and the springs slowly come to equilibrium again, the ratio of the potential energy stored in S_1 to the S_2 is:



(A) 1/9
(B) 1/3
(C) 1
(D) 3

Space for rough work

3. A trick cyclist rides his bike around a well of death in the form of a vertical cylinder (see figure). The maximum frictional force parallel to the surface of the cylinder is equal to a fraction μ of the normal force exerted by the wall. At what minimum constant speed must the cyclist go to avoid slipping down? (Assume that size of motorcycle is very small as compared to cylinder.



(A) $\left[\frac{2gr\cos\theta}{\mu}\right]^{1/2}$ (B) $\left[\frac{gr\sin\theta}{2\mu}\right]^{1/2}$

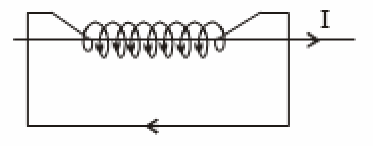
(C) $\left[\frac{gr}{\mu}\right]^{1/2}$ (D) $\left[\frac{2gr}{\mu}\right]^{1/2}$

4. A thermometer consists of a quantity of alcohol in a glass tube. When the thermometer is in thermal contact with soft ice cream in a box the length of the alcohol column is 5 cm and thermal equilibrium. When placed in a freezer the alcohol column remains 5 cm long in thermal equilibrium. When ice cream is put in the freezer.

(A) Ice cream melts (B) Ice cream freezes more

(C) Ice cream neither melts nor freezes more (D) Insufficient information.

5. In the diagram shown, a wire carries current I. What is the value of the $\oint \vec{B}.d\,\vec{s}$ (as in Ampere's law) on the helical loop shown in the figure? The integration in done in the sense shown. The loop has N turns and part of helical loop on which arrows are drawn is outside the plane of paper.



(A) $-\mu_0(NI)$ (B) $\mu_0(I)$

(C) $\mu_0(NI)$ (D) Zero

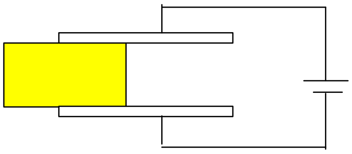
6. A projectile is thrown with velocity U = 20m/s ± 5% at an angle 60°. If the projectile falls back on the ground at the same level then which of following can not be a possible answer for range. Consider $g = 10\text{m/s}^2$.

(A) 39.0 m (B) 37.5 m

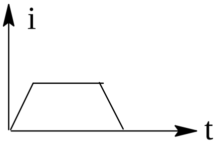
(C) 34.6 m (D) 32.0 m

Space for rough work

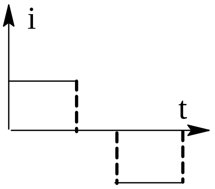
7. A dielectric slab of area A passes between the capacitor plates of area 2A with a constant speed v. The variation of current (i) through the circuit as function of time (t) can be qualitatively represented as



(A)



(B)



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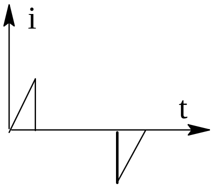
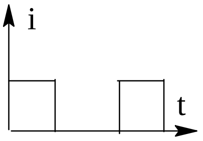
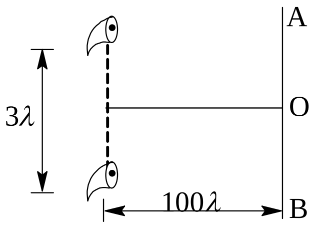


(D)



8. 2 loudspeakers are emitting sound waves of wavelength λ with an initial phase difference of $\frac{\pi}{2}$. At what minimum distance from O on line AB will one hear a maxima



(A) 25λ

(B) $\frac{100\lambda}{\sqrt{15}}$

(C) $\frac{25\lambda}{3}$

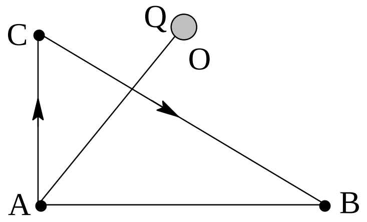
(D) 50λ

Space for rough work

Multiple Correct Choice Type

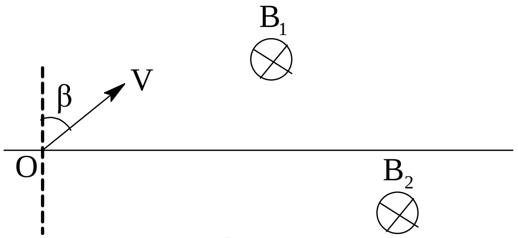
This section contains **04 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

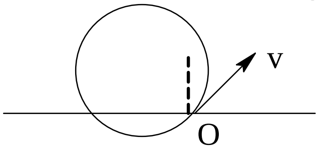
9. There is a fixed positive charge Q at O and A and B are points equidistant from O. A positive charge + q is taken slowly by an external agent from A to B along the line AC and then along the line CB.

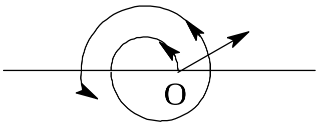


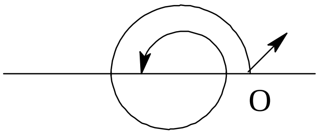
(A) The total work done on the charge is zero
(B) The work done by the electrostatic force from A to C is negative
(C) The work done by the electrostatic force from C to B is positive
(D) The work done by electrostatic force in taking the charge from A to B is dependent on the actual path followed.

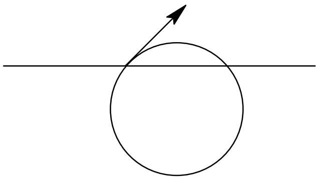
10. In the diagram shown, a particle of charge +Q and mass M is projected making an angle β with the vertical line. Which the possible path on which the charge will move. Above the dark line magnetic field is B_1 and below it is B_2. (Consider all possible cases for values of $B_1 \text{and } B_2$)



(A)


(B)


(C)


(D)


Space for rough work

11. Two particles of mass m1 and m2 are moving with velocity $\vec{v}_1$ and $\vec{v}_1$ respectively. Mark the correct statement about a perfectly inelastic collision between m_1 and m_2.

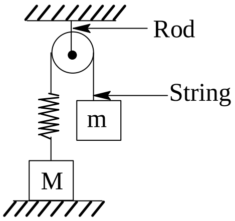
(A) Impulse by m_1 to m_2 is $\frac{m_1 m_2}{m_1 + m_2}(\vec{v}_1 - \vec{v}_2)$

(B) Momentum transferred by m_2 to m_1 is $\frac{m_1 m_2}{m_1 + m_2}(\vec{v}_2 - \vec{v}_1)$

(C) Impulse by m_1 on m_2 in CM frame is $\frac{m_1 m_2}{m_1 + m_2}(\vec{v}_2 - \vec{v}_1)$

(D) In CM frame both the particles come to rest after perfectly inelastic collision.

12. In figure, a block of mass m is released from rest when spring was in its natural length. The pulley also has mass m but it is frictionless. Suppose the value of m is such that finally it is just able to lift the block M up after releasing it.



(A) The weight of m required to just lift M is $\frac{M}{2}g$

(B) The tension in the rod, when m is in has zero acceleration $\frac{M}{2}g$

(C) The normal force acting on M when m has zero acceleration $\frac{M}{2}g$

(D) The tension in the string when displacement of m is maximum possible is Mg

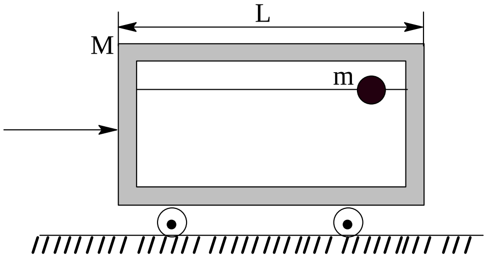
Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

Paragraph for Questions 13 & 14

A horizontal frictionless rod is threaded through a bead of mass m. The length of the cart is L and the radius of the bead, r, is very small in comparison with L (r << L). Initially at (t = 0) the bead is at the right edge of the cart. The cart is struck and as a result, it moves with velocity υ_0. When the bead collides with the cart's walls, the collisions are always completely elastic. (Given: m > M).



13. What is the velocity of the cart after the first collision, in the center of mass frame?

(A) $\frac{-m\,v_0}{m+M}$ (B) $\frac{M\,v_0}{m+M}$

(C) $\frac{M-m}{M+m}v^0$ (D) $\frac{2M}{m+M}v^0$

14. The first collision takes place at time t1 and the second collision takes place at $t=0 \text{ till } t=t_2 \text{ if } m>M_0$

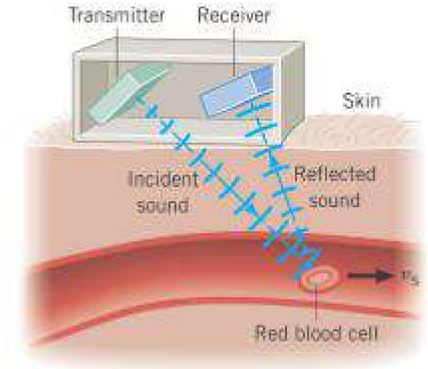
(A) $\frac{2ML}{m+M}$ (B) $\frac{ML}{2(m+M)}$

(C) $\frac{2M}{m+M}L$ (D) $\frac{ML}{2(m+M)}$

Space for rough work

Paragraph for Questions 15 & 16

The Doppler flow meter is a particularly interesting medical application of the Doppler effect. This device measures the speed of blood flow, using transmitting and receiving elements that are placed directly on the skin, as in Figure. The transmitter emits a continuous sound whose frequency is typically about 5 MHz. When the sound is reflected from the red blood cells, its frequency is changed in a kind of Doppler effect because the cells are moving with the same velocity as the blood. The receiving element detects the reflected sound, and an electronic counter measures its frequency, which is Doppler-shifted relative to the transmitter frequency. From the change in frequency the speed of the blood flow can be determined. Typically, the change in frequency is around 600 Hz for flow speeds of about 0.1 m/s.



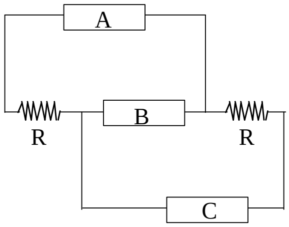
15. Assume that the red blood cell is directly moving away from the source and the receiver. What is the (approx) speed of the sound wave in the blood?
(A) 1700 m/s (B) 330 m/s
(C) 5000 m/s (D) 3000 m/s

16. An abnormal segment of the artery is narrowed down by an arteriosclerotic plaque to one-fourth the normal cross-sectional area. What will be the change in frequency due to reflection from the red blood cell in that region?
(A) 150 Hz (B) 300 Hz
(C) 600 Hz (D) 2400 Hz

Space for rough work

Paragraph for Questions 17 & 18

A circuit is shown below.



17. If A is an ideal ammeter, B an ideal Battery of voltage V, and C an ideal voltmeter, what will be the $\frac{\text{reading of C}}{\text{reading of A}}$?

(A) R
(B) 2R
(C) $\frac{R}{2}$
(D) 0

18. If A is a capacitor, B is an ideal ammeter and C is an ideal battery of voltage V, what is the voltage across the capacitor ?

(A) V
(B) $\frac{V}{2}$
(C) 2V
(D) 0

Space for rough work

SECTION – C

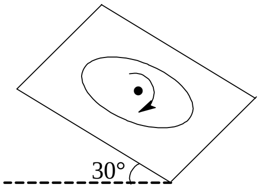
(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

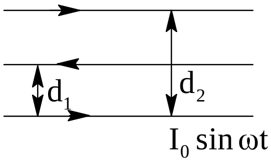
---

1. In a slow reaction, heat is being evolved at a rate about 10mW in a liquid. If the heat were being generated by the decay of $^{32}\mathrm{P}$, a radioactive isotope of phosphorus that has half-life of 14 days and emits only beta-particles with a mean energy of 700KeV. The number of $^{32}\mathrm{P}$ atoms in the liquid is $\mathrm{A}\times 77\times 10^{15}$ find a:
[Take: ln 2 = 0.7]

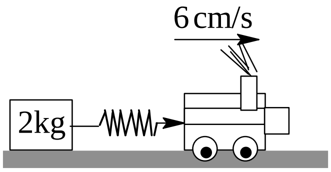
2. An old record player of 10 cm radius turns at 10 rad/s while mounted on a 30° incline as shown in the figure. A particle of mass m can be placed anywhere on the rotating record. If the least possible coefficient of friction μ that must exist for no slipping to occur is μ, find $2\sqrt{3}\mu$.



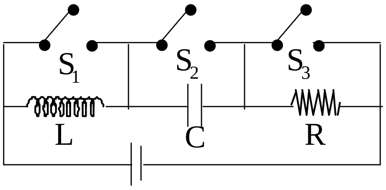
3. Two long straight wires of telephone circuit inside a house are coplanar with and run parallel to a third long straight conductor that carries a current $i = i_0 \sin \omega t$. The wires are at a distance of d_1 and d_2 from the conductor. The conductor induced a noise in the telephone circuit. The rms voltage per unit length of this induced emf is $x \times 5$, find x? Express your answer in µV. Take $d_2 = 2d_1, i_0 = \frac{2\sqrt{2}}{\ln 2} \mathrm{A}\ \omega = 50\,\mathrm{rad/s}$



4. Figure a shows a spring attached to a 2.0 kg block. The other end of the spring is pulled by a motorized toy train that moves forward at constant speed 6.0 cm/s. The spring constant is 50 N/m and the coefficient of static friction between the block and the surface is 0.60. The spring is at its natural length at t = 0s when the train starts to move. When does the block slip (express your answer in second)?



5. Consider the circuit shown in figure. With switch S_1 closed and the other two switches open, the circuit has a time constant 0.05 sec. With switch S_2 closed and the other two switches open, the circuit has a time constant 2 sec. With switch S_3 closed and the other two switches open, the circuit oscillates with a period T. Find T(in sec). (Take $\pi^2 = 10$)



Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **08 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. $$\underset{(\text{cis})}{CH_3HC = CHCH_3} + \underset{(\text{triplet state})}{CH_2} \rightarrow P$$

(A) P is a cis isomer
(B) P is a trans isomer
(C) P is a mixture of cis and trans isomers
(D) P is acyclic compound

2. $BaTiO_3$ crystallizes in perovskite structure. This structure may be described as a cubic lattice, with barium ions occupying the corners, oxide ions at the face centres and titanium ions in one of the octahedral holes. Which of the following is correct about $BaTiO_3$ crystal lattice?

(A) Ti^{4+} must the body centred octahedral hole
(B) Ti^{4+} must occupy the edge centred octahedral hole
(C) Ti^{4+} must occupy any of the octahedral holes
(D) $1/4$ th of the octahedral holes are occupied

3. Ammonium compound which on heating does not give NH_3 is

(A) $(NH_4)_2SO_4$
(B) $(NH_4)_2CO_3$
(C) NH_4NO_2
(D) NH_4Cl

Space for rough work

4. The standard electrode potentials of some of the alkali metals are

$\mathrm{Li^+/Li = -3.05\,V}$

$\mathrm{Na^+/Na = -2.71\,V}$

$\mathrm{K^+/K = -2.93\,V}$

Alkali metals react with water according to the following reaction. (M = alkali metal)

$\mathrm{2M + H_2O \rightarrow 2MOH + H_2}$

It is found Li reacts gently with water whereas potassium reacts violently with water. Which of the following statement (s) is/ are correct regarding the above two experimental facts?

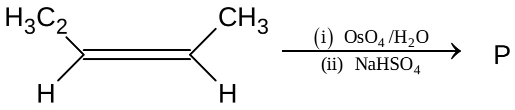
(A) ΔG values related with the kinetics of a reaction

(B) The metal having large standard oxidation potential will have lesser reactivity.

(C) K has a low melting point, and the heat of reaction is sufficient to make it melt or even vaporize. This leads to exponential increase in its surface area.

(D) The ionization potential of K is smaller than that of Li.

5.



Which of the following is true about P ?

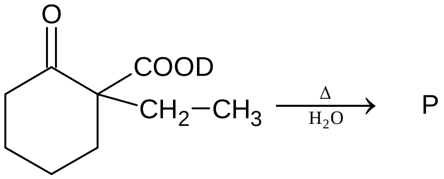
(A) P is optically inactive due to internal compensation

(B) P is optically inactive due to external compensation

(C) P is optically inactive

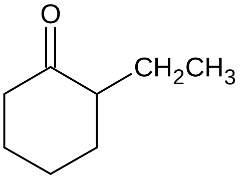
(D) P is optically inactive due the absence of chiral carbon.

6.

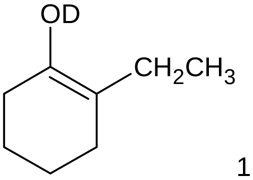


Which is not possible for P is

(A)



(B)



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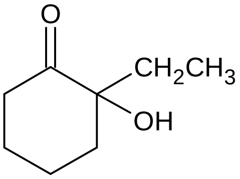
(C)



(D) None of these

Space for rough work

7. The salt having isoelectronic cation and anion among the following is
(A) $NaCl$ (B) KF
(C) $CaCl_2$ (D) KBr

8. Which of the following statement(s) is/ are incorrect?
(A) o – phenol sulphonic acid be converted into p – phenol sulphonic acid in the presence of H_2SO_4 if temperature is increased.
(B) Phenol is more acidic than benzyl alcohol
(C) Phenoxide ion activates the more in comparison to phenol
(D) Bromination of phenol in aqueous medium produces 2 – bromophenol and 4 - bromophenol

Multiple Correct Choice Type

This section contains **04 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

9. Which of the following special (s) is/ are isostructural with lF_4^- ?
(A) $\left[Cu\left(NH_3\right)_4\right]^{2+}$ (B) XeF_4
(C) BF_4^- (D) $\left[Ni\left(CN\right)_4\right]^{2-}$

10. Identify the incorrect statement (s)?
(A) The ration of the observed molar volume to ideal volume is called compressibility factor.
(B) The value of van der Waals constants ‘a’ and ‘b’ is independent of the nature of gas.
(C) At high temperature and low pressure, the behaviour of any gas can be explained by $\left(P+\frac{an^2}{V^2}\right)\left(V-nb\right)=nRT$
(D) H_2 and He gases are difficult to liquefy because their Critical temperature is very small.

Space for rough work

11. In which of the following reactions, the stiochiometric ratio of H_2SO_4 to H_2 gas is the same?
(A $Zn(s) \text{and} H_2SO_4$ (B) $Na(s) \text{and} H_2SO_4$
(C) $Al(s) \text{and} H_2SO_4$ (D) $Ni(s) \text{and} H_2SO_4$

12. Which of the following compound (s) will not dissolve in an alkali solution after it has undergone reaction with Hinsberg's reagent?
(A) Diethyl amine (B) Isopropyl amine
(C) N – methyl ethanamine (D) N, N – dimethyl aniline

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

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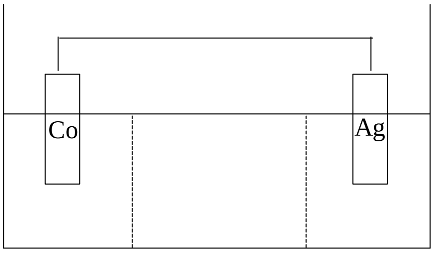
Paragraph for Questions 13 & 14

The cell given below consists of three compartments, separated by porous barriers. The first contains a cobalt electrode in $5\,L$ of $0.1\,M\,Co(NO_3)_2$; the second contains $5\,L$ of $0.1\,M$ KNO_3 the third contains a silver electrode in $5\,L$ of $0.1\,M\,AgNO_3$ Assume that the current within in the cell Is carried equally by the positive and negative ions. If 'there is a passage of 0.1 mol of electrons, answer the following (19, 20 and 21) questions.



$E^o_{Co^{2+}/Co} = -0.28V$
$E^o_{Ag^+/Ag} = 0.8V$

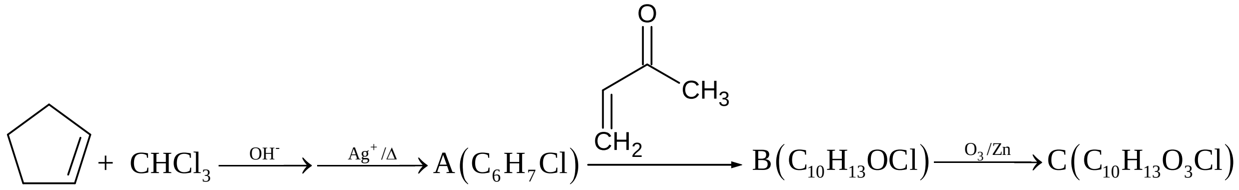
13. The concentrations of Co^{2+} and NO_3^- in the left hand side .compartment are
(A) $0.105\,M$ and $0.210\,M$ (B) $0.08\,M$ and $0.16\,M$
(C) $0.1\,M$ and $0.2\,M$ (D) $0.05\,M$ and $0.1\,M$

14. The concentrations of Ag^+ and NO_3^- In the right hand side compartment are.
(A) $0.08\,M$ and $0.09\,M$ (B) $0.75\,M$ and $0.08\,M$
(C) $0.01\,M$ and $0.09\,M$ (D) $0.75\,M$ and $0.09\,M$

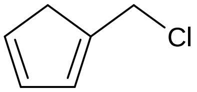
Space for rough work

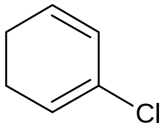
Paragraph for Questions 15 & 16

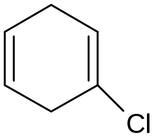
In the following sequence of reaction,


+ $CHCl_3$
OH^-
Ag^+/Δ
$A(C_6H_7Cl)$
O
CH_3
CH_2
$B(C_{10}H_{13}OCl)$
O_3/Zn
$C(C_{10}H_{13}O_3Cl)$

15. Compound A is

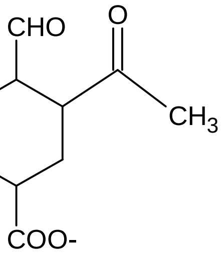
(A)


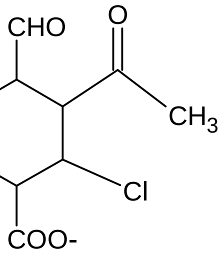
(B)


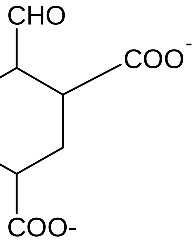
(C)


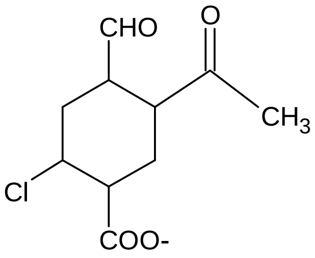
(D) None of these

16. Compound C when treated with NaOH/ X_2 gives

(A)

CHO
O
CH_3
COO-

(B)

CHO
O
CH_3
Cl
COO-

(C)


(D)

CHO
O
CH_3
Cl
COO-

Space for rough work

Paragraph for Questions 17 & 18

Potassium dichromate is used as lab reagent and dichromate ion can be used as a primary standard in volumetric analysis.

$$\frac{1}{2}Cr_2O_7^{2-} + 7H^+ + 3e \rightleftharpoons Cr^{3+} + 3\frac{1}{2}H_2O; E^\circ = 1.33V$$

When H_2O_2 is added to an acidified solution of dichromate, a complicated reaction occurs. The formation of product depends on the pH value and concentration of dichromate ions. A deep-blue violet peroxo compound X is formed which decomposes rapidly in aqueous solution. This compound can be extracted in ether, where it reacts with pyridine fanning the adduct $PyCro\left(O_2\right)_2$.

In alkaline solution $K_2Cr_2O_7$ with 30% H_2O_2, a read – brown compound $Y\left(K_3CrO_8\right)$ is formed. In alkaline solution the dark red – brown compound $Z\left[\left(NH_3\right)_3CrO_4\right]$ is formed. In alkaline solution dichromate ion changes to chromate ion which is also used as reagent in quantitative analysis of cations.

17. The shape of compound (Z) is

(A) Butterfly shape	(B) Pentagonal pyramidal
(C) Pentagonal bipyramidal	(D) Tetrahedral

18. What is the oxidation state of Cr In red-brown compound Y?

(A) + 6	(B) + 4
(C) + 5	(D) + 13

Space for rough work

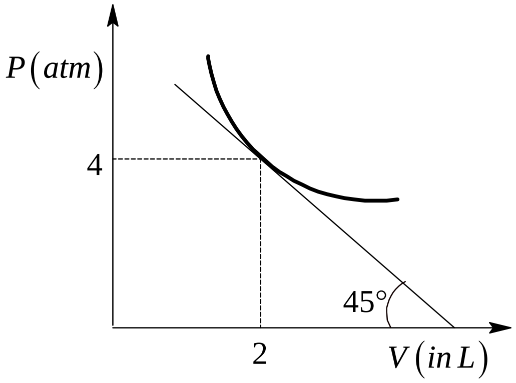
SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

1. The molar heat capacity of the ideal monoatomic gas undergoing the process shown in the figure is ‘x’. The value of ‘2x’ will be

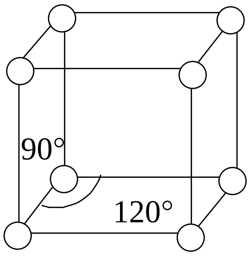


2. How many statement(s) are correct?

(a) if the critical micelle concentration (CMC) of a soap is $10^{-3}M$, then $10^{-4}M$ solution of this soap will have colloidal nature.
(b) charge on the colloidal particles may be determined with the help of dialysis
(c) peptization is the process of conversion of a colloidal sol into precipitate by adding some electrolyte
(d) when some oil-soluble dye is added in the water in oil emulsion, the back ground becomes coloured
(e) For the coagulation of a particular colloidal solution, the order of coagulation power of some electrolytes is in the order: $Na_3PO_4 > BaSO_4 > AlCl_3,$ in electro-osmosis, the dispersion medium move towards the anode
(f) diffused layer around colloidal particles in the electric double layer mostly contains negatively charged particles.(colloid is of ‘e’ part)
(g) it may be basic dye such as methylene blue (colloid is of ‘e’ part)
(h) it may be metal sol (colloid is of ‘e’ part)

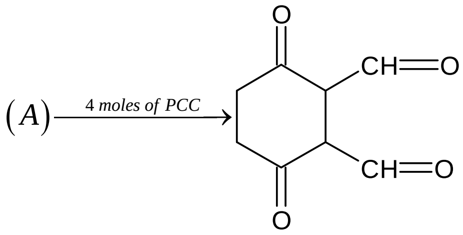
Space for rough work

3. Ice crystallizes is an hexagonal lattice. At the low temperatures at which the structure was determined, the lattice constants were $a = 4.53\AA$ and $b = 7.41\AA$ as shown in the figure. How many H molecules are contained in a unit cell? (Given that density of ice $= 0.92\, g/cm^3$)?



4. A weak acid type indicator was found to be 60% dissociated at pH = 9.18. If the degree of dissociation at pH = 9.0 is 'α'? Then the value of '10α' will be $(\log 2 = 0.3, \log 3 = 0.48)$

5.



Maximum number of moles of Ac_2O consumed by reactant (A) is?

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **08 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. Conditions so that equation $(a_1x^2+b_1x+c_1)(a_2x^2+b_2x+c_2)=0$, ($a_1a_2>0$) have fours real roots if
(i) $c_1c_2>0$ (ii) $a_1c_2<0$ (iii) $a_2c_1<0$
(A) only (i) is sufficient
(B) either of two statements are sufficient
(C) either of two statements are necessary and sufficient
(D) all the three statements are sufficient

2. In a ΔABC, the incircle touches the sides BC, CA and AB at D, E, F respectively. If radius of incircle is 4 units and BD, CE and AF are in A.P. with common difference 1, then area of ΔABC is
(A) 84 sq. units (B) 42 sq. units
(C) 168 sq. units (D) data insufficient

3. Let A be the area between co-ordinate axis, $y^2=x-1$, $x^2=y-1$ and the line which makes the shortest distance between two parabolas and A′ be the area between x=0, $x^2=y-1$, x=y and the shortest distance between $y^2=x-1$ and $x^2=y-1$, then
(A) A=A′ (B) $A=(A')^{1/2}$
(C) $A=2A'$ (D) can't say anything

4. a,b,c are in G.P. and the equation $(a+di)x^2+2(b+ei)x+(c+if)=0$ have one real root then $\frac{a}{d},\frac{b}{e},\frac{c}{f}$ are in, ($a,b,c,d,e,f\in R$)
(A) AP (B) GP
(C) HP (D) none of these

Space for rough work

5. $\int \sec^{p/3} x \operatorname{cosec}^{q/3} x dx = (p,q \in I^{+}$ and p+q=12)

(A) $\dfrac{\tan^{\frac{-p}{3}+1} x}{\frac{-p}{3}+1} + c$

(B) $\dfrac{\tan^{\frac{-p}{3}+1} x}{\frac{-p}{3}+1} + c + \dfrac{\tan^{\frac{-p}{3}+3} x}{\frac{-p}{3}+3} + c$

(C) $\dfrac{\tan^{\frac{-p}{3}+3} x}{\frac{-p}{3}+3} + c$

(D) none of these

6. A square ABCD of a diagonal 2a is folded along the diagonal AC, so that the planes DAC, BAC are at right angle. The shortest distance between DC and AB is

(A) $\sqrt{\frac{2}{3}}a$

(B) $\frac{2a}{\sqrt{3}}$

(C) $\sqrt{\frac{2a}{3}}$

(D) none of these

7. If $P = \int_0^{\infty} \frac{x^2 dx}{1+x^4}, Q = \int_0^{\infty} \frac{x dx}{1+x^4}$ and $R = \int_0^{\infty} \frac{dx}{1+x^4}$, then which of the following is false.

(A) $Q = \frac{\pi}{4}$

(B) P=R

(C) $P - \sqrt{2}Q + R = \frac{\pi}{2\sqrt{2}}$

(D) none of these

8. If $\int_{\pi/2}^{x} \sqrt{3\text{-}2\sin^2 t}\,dt + \int_0^{y} \cos t dt = 0,$ then $\left(\frac{dy}{dx}\right)$at $x = \pi$ and y=π is

(A) $\sqrt{3}$

(B) $-\sqrt{2}$

(C) $-\sqrt{3}$

(D) none of these

Space for rough work

Multiple Correct Choice Type

This section contains **04 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

9. Let z_1, z_2, z_3 be the coordinate of vertices *A*, *B*, *C* of the triangle if $W_1 = z_1 - z_2,\ W_2 = z_3 - z_2$ and $\angle A = 90°$, then

(A) $R_e\left(\frac{W_2}{W_1}\right) = 1$

(B) $R_e(W_1\overline{W_2}) = |W_1|^2$

(C) $R_e(W_1\overline{W_2}) = |W_2|^2$

(D) $R_e\left(\frac{W_1}{W_2}\right) = 1$

10. Let $(1 + x + x^2)^n = a_0 + a_1x + a_2x^2 ....a_{2n}x^{2n}$, where *n* is odd integer

$S_1 = a_0 + a_4 + a_8 + ...$

$S_2 = a_1 + a_5 + a_9 + ...$

$S_3 = a_2 + a_6 + a_{10} + ...$

$S_4 = a_3 + a_7 + a_{11} + ...$

(A) $S_1 = S_3$

(B) $S_2 = S_4$

(C) $S_2 + S_4 = 0$

(D) $S_1 = S_2 = S_3$ or $S_1 = S_3 = S_4$

11. If $f(x) = ax^2 + bx + c = 0$ have real roots and its coefficients are odd the integers then

(A) $f(x) = 0$ always have irrational roots

(B) $\left|f\left(\frac{p}{q}\right)\right| \geq \frac{1}{q^2}$ where $p,\ q \in I$

(C) If $a.c. = 1,$ then equation must have atleast are root α such that $[\alpha] = -1$, where [.] is GIF

(D) Equation have rational roots

Space for rough work

12. The curve $y = (|x|-1)\operatorname{sgn}(x-1)$ divides $\frac{9x^2}{64}+\frac{4}{25}y^2 = \frac{1}{\pi}$ in two parts having area A_1 and A_2 (where $A_1 < A_2$), then

(A) $\frac{A_1}{A_2} = \frac{7}{13}$
(B) $\frac{A_1}{A_2} = \frac{3}{7}$
(C) $A_1 = \frac{7}{3}$
(D) $A_2 = \frac{13}{7}$

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

---

Paragraph for Questions 13 & 14

If a circle *C*$_{0,}$ with radius 1 unit touches both the axes and as well as line (*L*$_1$) through *P*(0,4), cut the x-axis at $(x_1, 0)$. Again a circle C_1 is drawn touching x-axis, line L_1 and another line L_2 through point *P*. L_2 intersects x-axis at $(x_2, 0)$ and this process is repeated *n* times.

13. The centre of circle C_2 is

(A) $(3, 1)$
(B) $\left(\frac{15}{2}, 1\right)$
(C) $\left(\frac{31}{4}, 1\right)$
(D) none of these

14. The $\lim\limits_{n\to\infty} \frac{x_n}{2^n}$ is

(A) 4
(B) 0
(C) 1
(D) 2

Space for rough work

Paragraph for Questions 15 & 16

f(x), g(x), h(x) all are continuous and differentiable functions in [a, b] also a<c<b and f(a)=g(a)=h(a). Point of intersection of the tangent at x=c with chord joining x=a & x=b is on the left of c in y=f(x) and on the right in y=h(x). And tangent at x=c is parallel to the chord in case of y=g(x).

15. If f(b) = g(b) = h(b) then

(A) $f'(c) = g'(c) = h'(c)$ (B) $f'(c) > g'(c) > h'(c)$

(C) $f'(c) < g'(c) < h'(c)$ (D) none of these

16. If $c = \frac{a+b}{2}$ for each b, then

(A) $g(x)=Ax^2+Bx+C$ (B) g(x)=log x

(C) g(x)=sin x (D) $g(x)=e^x$

Paragraph for Questions 17 & 18

Let f: R → R be a function satisfying condition $f(x + y^3) = f(x) + (f(y))^3$ $\forall$ x, y $\in$ R and $f'(0) = k$.

17. If |k| > 0, then $\lim_{x\to0}\left[\frac{\tan x}{f(x)}\right]$ (where [.] denotes the greatest integer function) is

(A) 0 (B) 2

(C) – 2 (D) none of these

18. If |k| < 0 then value of $f\left(\frac{\sqrt{3}-1}{\sqrt{2}+\sqrt{5}}\right)$ is/are

(A) $-\left(\frac{\sqrt{3}-1}{\sqrt{2}+\sqrt{5}}\right)$ (B) 0

(C) $\left(\frac{\sqrt{3}-1}{\sqrt{2}+\sqrt{5}}\right)$ (D) ± 1

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. Let *M* be the midpoint of sides *QR* of a rectangle *PQRS* respectively. A line through *M*, intersect *RS* and *PS* extended at *T* and *L* respectively such that $PL = \frac{4}{3}PS$. Find the value of $20\left(\frac{\text{area of } \Delta\, MRT}{\text{area of } \bigcirc PQRS}\right)$.

2. If the equations $x^3 + 5x^2 + px + q = 0$ and $x^3 + 7x^2 + px + r = 0$ have two roots in common, then find the difference of two uncommon roots.

3. When 23^{23} is divided by 53, the remainder is *r*. Find $\frac{r}{10}$

4. The number of pairs (*x*, *y*) satisfying the equation $\sin x + \sin y = \sin(x + y)$ and $|x| + |y| = 1$ is

5. The value of $33\left\{\sum_{n=1}^{16}\left\{\frac{4n^4}{4n^2 - 1}\right\}\right\}$ is ……… (where {.} represents fractional part function)

Space for rough work

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ANSWERS, HINTS & SOLUTIONS

FULL TEST – II
(PAPER-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	A	B
2.	D	D	A
3.	C	C	C
4.	C	C	C
5.	C	B	B
6.	A	D	B
7.	B	C	D
8.	C	D	A
9.	ABC	ABD	AB
10.	A	BC	AD
11.	ABCD	ABD	ABC
12.	ACD	AC	AC
13.	A	A	C
14.	C	A	D
15.	A	B	C
16.	D	C	A
17.	A	C	C
18.	D	C	B
1.	2	7	3
2.	6	4	2
3.	4	4	3
4.	4	5	6
5.	2	4	4

Physics

PART – I

SECTION – A

1. In the first case, m will remain at rest.

$$a_M = \frac{F}{M}$$

In the second case, both will accelerate:

$$a_m = a_M = \frac{F}{M+m}$$

In the second case, force on $m = ma_m = \frac{mF}{M+m}$

2. $k_1x_1 = k_2x_2$

as $k_2 = 3k$

$$\frac{x_1}{x_2} = 3 \text{and} \frac{\frac{1}{2}k_1x_1^2}{\frac{1}{2}k_2x_2^2} = \frac{x_1}{x_2} = 3$$

3. $N = \frac{mv^2}{r}; f = \mu N = mg$

$$\text{or } \frac{\mu mv^2}{r} = mg$$

$$v = \left(\frac{gr}{\mu}\right)^{1/2}$$

4. Thermometer, ice cream box and freezer are in thermal equilibrium.

6. $R = \frac{20^2 \times \sin 120°}{g} = 20\sqrt{3} = \frac{\Delta R}{R} = \frac{24U}{U} \Rightarrow \Delta R = \frac{2\times 5}{100}\times 200\sqrt{3} = 2\sqrt{3}$

$$20\sqrt{3} - 2\sqrt{3} < R < 20\sqrt{3} + 2\sqrt{3} \Rightarrow 31.1\text{m} < R < 38.1\text{m}$$

7. $\left(\frac{\epsilon_0 klx}{d} + \frac{\epsilon_0 (2A - lx)}{d}\right)V = Q$

$$i = \left(\frac{\epsilon_0 klx}{d} + \frac{-\epsilon_0 l}{d}\right)\frac{dx}{dt} = \text{constant}$$

As the dielectric levels $c \downarrow \Rightarrow Q \downarrow \Rightarrow \text{i is} - \text{ve}$

8. $\Delta\phi = 2n\pi$

$$\Rightarrow \frac{\pi}{2}+\frac{2\pi}{\lambda}d\sin\theta = 2n\pi$$

$$\frac{2\pi}{\lambda}d\sin\theta = \left(2n-\frac{1}{2}\right)\pi$$

$$\sin\theta = \left(2n-\frac{1}{2}\right)\frac{\lambda}{2d} = \frac{1}{2}\times\frac{\lambda}{2\times3\lambda} = \frac{1}{12}$$

$$\Rightarrow \frac{y}{\sqrt{(100\lambda)^2}} = \frac{1}{2}$$

$$144y^2 = (100\lambda)^2$$

$$y \approx \frac{100\lambda}{12} = \frac{25\lambda}{3}$$

9. $V_A = V_B \Rightarrow \text{work} = 0$

10. Radius $R_1 = \dfrac{nv}{qB_1}$

In a given field radius should be same for every entry. So B & C are not possible.

15. $f = \dfrac{C-V_R}{C+V_R}f_0$

$$\frac{\Delta f}{f_0} = \frac{2V_R}{C+V_R} \approx \frac{2V_R}{C}$$

$$\Rightarrow C = \frac{2\times0.1}{600}\times5\times10^6 \approx 1700\text{m/s}$$

16. $f' = \dfrac{C-V_R}{C+V_R}f_0$

$$\frac{\Delta f}{f_0} = \frac{2V_R}{C+V_R}$$

Velocity is 4 times $\Rightarrow \Delta f = 4\Delta f_0 = 2400\text{Hz}$

17. Reading of C = V $\{\text{i in that branch} = 0\}$

Reading of $A = \dfrac{V}{R}$

$\Rightarrow R$

18. $V_B = iR_{\text{ammeter}} = 0$

$\Rightarrow \quad V_{\text{cap}} = 0$

$$\Rightarrow T = 2\pi\sqrt{LC} = 2\pi\sqrt{\frac{1}{10}} = 2\sec$$

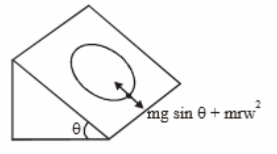
SECTION – C

1. $P = 700 \times 10^3 \times 1.6 \times 10^{-19} \times \frac{dn}{dt} = 10 \times 10^{-3}$

$$\frac{dN}{dt} = \frac{10^{-1}}{10^{-14}} \times \frac{1}{7 \times 16} = \frac{10^{12}}{11.2} = \lambda N_0$$

$$\lambda = \frac{\ln 2}{14 \times 86400} \Rightarrow N_0 = \frac{14 \times 86400 \times 10^{12}}{11.2 \ln 2} = 154 \times 10^{15}$$

2. $f \geq mg \sin\theta + mrw^2$



$$\mu\, mg \cos\theta \geq mg \sin\theta + mrw^2$$

$$\text{or } \mu \geq \tan\theta + \frac{w^2 r}{g \cos\theta}$$

3. $d\phi = \frac{\mu_0 i}{2\pi x} \times l\, dx$

$$\phi = \frac{\mu_0 i}{2\pi} l \ln\left(\frac{d_2}{d_1}\right)$$

$$\varepsilon = \frac{d\phi}{dt} = \frac{\mu_0}{2\pi} l \ln\left(\frac{d_2}{d_1}\right) \times i_0 \omega \cos wt$$

$$\varepsilon_{rms} = \frac{\mu_0}{2\pi} l \ln\left(\frac{d_2}{d_1}\right) \frac{i_0 \omega}{\sqrt{2}}$$

$$= \frac{4\pi \times 10^{-7}}{2\pi} \times 1 \times \ln 2 \times \frac{2\sqrt{2}}{\ln 2} \times \frac{50}{\sqrt{2}}$$

4. The block slips when the static friction force reaches its maximum value $f_{s\,max} = \mu_s n = \mu_s mg$. This occurs when the train has moved

$$\Delta x = \frac{f_{smax}}{k} = \frac{\mu_s mg}{k} = \frac{(0.60)(2.0\text{kg})(10\text{m/s}^2)}{50\text{N/m}} = 24\,\text{cm}$$

The time at which the block slips is

$$t = \frac{\Delta x}{v} = \frac{24\text{cm}}{6\,\text{cm/s}} = 4\text{s}$$

5. $\tau_1 = RC$

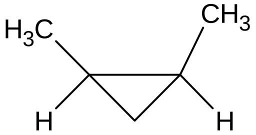
$$\tau_2 = \frac{L}{R}$$

$$\Rightarrow LC = t_1 t_2 = 0.1\text{sec}$$

Chemistry PART – II

SECTION – A

1.

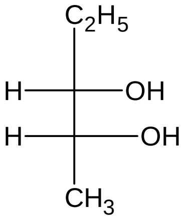


2. $BaTiO_3$

3. $(NH_4)_2SO_4$, $(NH_4)_2CO_3$, NH_4Cl all give NH_3 on heating

4. ΔG is the thermodynamical concept

5.



+ Mirror image

6. β-Keto acid on heating shows de-carboxylation on heating, through enol form

7. Ca^{2+} has 18 e^- and Cl^- has 18 e^-.

8. Phenol gives 2,4,6-tribromo phenol with aq. Br_2.

9. BF_4^- is tetrahedral and rest are is square planar

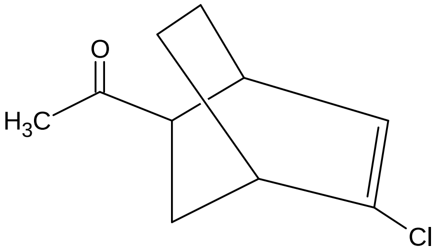
10. $$Z=\frac{V_{m,real}}{V_{m,ideal}}$$

at high temperature and low pressure the gas follows PV=nRT

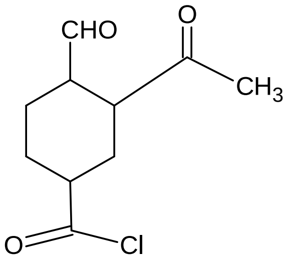
11. $$Zn+H_2SO_4 \longrightarrow ZnSO_4+H_2$$
$$2Na+H_2SO_4 \longrightarrow Na_2SO_4+H_2$$
$$2Al+6H_2SO_4 \longrightarrow Al_2(SO_4)_3+3SO_2+6H_2O$$

15. CCl_2 will form and show addition reaction then ring expansion takes place.

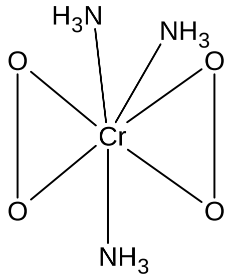
16.



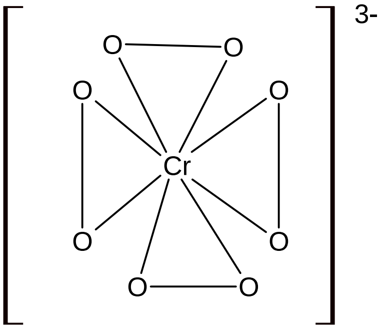
(B)



(C)

17. 

Pentagonal bipyramid

18. 

Pentagonal bipyramid

SECTION – C

1.

$$\frac{\mathrm{dq}}{\mathrm{dT}}=\frac{\Delta\mathrm{U}\text{-}\mathrm{w}}{\mathrm{ndT}}=\mathrm{C}_{\mathrm{m,V}}+\frac{\mathrm{PdV}}{\mathrm{dT}}=\frac{3}{2}\mathrm{R}+\frac{\mathrm{P}}{\mathrm{n}}\frac{\mathrm{dV}}{\mathrm{dT}}\text{-----}(1)$$

$$PV=nRT$$

$$PdV+VdP=nRdT$$

$$P+\frac{VdP}{dV}=nR\frac{dT}{dV}$$

$$P+V(-1)=nR\frac{dT}{dV}$$

$$4+2(-1)=nR\frac{dT}{dV}$$

$$\frac{dT}{dV}=\frac{2}{nR}$$

$$\frac{dV}{dT}=\frac{nR}{2}$$

Put in (1)

$$\frac{\mathrm{dq}}{\mathrm{dT}}=\frac{3}{2}\mathrm{R}+\frac{\mathrm{P}}{\mathrm{n}}\frac{nR}{2}$$

$$\frac{\mathrm{dq}}{\mathrm{dT}}=\frac{3}{2}\mathrm{R}+\frac{\mathrm{P}}{}\frac{R}{2}=\frac{3}{2}\mathrm{R}+\frac{4}{}\frac{R}{2}=3.5R$$

2. d,e,f,g are correct and Colloid is +ve.

3. Volume of unit cell$=\frac{\sqrt{3}}{4}\times(4.53)^2\times7.41\times10^{-24}\text{cm}^3$

so mass$=60.57\times10^{-24}$g

moles$= 3.365\times10^{-24}$

molecules of $H_2O=2.025$

number of H atom=4

4. $$K_{In}=\frac{\left[H^+\right]\left[I_n^-\right]}{\left[HI_n\right]}$$

$$=10^{-9.18}\times\frac{0.6}{0.4}$$

$$=\frac{3}{2}\times10^{-9.18}$$

$$K_{In}=10^{-9}\frac{\left[In^-\right]}{\left[HI_n\right]}$$

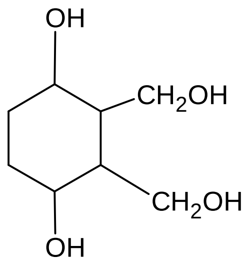
$$K_{In}=\frac{3}{2}\times10^{-9.18}=10^{-9}\times\frac{\alpha}{1-\alpha}$$

$$\frac{3}{2}\times0.66=\frac{\alpha}{1-\alpha}$$

$$\frac{\alpha}{1-\alpha}=1$$

$$2\alpha=1$$

$$\alpha=0.5$$

5. 

(A)

Mathematics PART – III

SECTION – A

2. As s–b, s–c, s–a are in AP with common difference =1

$\Rightarrow$ a,c, b are in AP with common difference equal to 1.

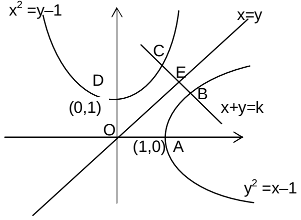
$\Rightarrow c = a+1,\ b = a+2 \qquad \Rightarrow s = \frac{a+a+1+a+2}{2} = \frac{3(a+1)}{2}$

$$\Rightarrow \Delta = \sqrt{\frac{3}{2}(a+1).\frac{a+3}{2}.\frac{a+1}{2}.\frac{a-1}{2}}$$

Also r = Δ/s $\Rightarrow a^2 + 2a - 195 = 0 \Rightarrow (a+15)(a-13)=0$

A = 13, c=14, b=15 $\qquad \Rightarrow \Delta = 84$ sq. units

3. Line of shortest distance will be perpendicular to line x=y. Also both parabolas are symmetric about x=y.



A=area OABCDO

A′=area OECDO

$\Rightarrow$ A′ =A/2

4. Let α be the real root then $(a\alpha^2 + 2b\alpha + c) + i(d\alpha^2 + 2e\alpha + f) = 0$

$$\Rightarrow a\alpha^2 + 2b\alpha + c = 0 \Rightarrow \alpha = \frac{-\sqrt{c}}{\sqrt{a}}$$

$$\Rightarrow d\alpha^2 + 2e\alpha + f = 0 \qquad \Rightarrow d.\frac{c}{a} - 2e\frac{\sqrt{c}}{\sqrt{a}} + f = 0 \qquad \Rightarrow \frac{d}{a} - 2.\frac{e}{b} + \frac{f}{c} = 0$$

5. $I = \int \tan^{-p/3} x.\sec^4 xdx$

$= \int \tan^{-p/3} x(1+\tan^2 x).\sec^2 xdx$

6. If equation of line AB is $\vec{r} = \vec{0} + \lambda(\sqrt{2}a\hat{j} - \vec{0}) = \lambda\hat{j}$

then equation of line DC is $\vec{r} = \sqrt{2}a\hat{i} + \mu\left(\frac{a}{\sqrt{2}}\hat{i} + \frac{a}{\sqrt{2}}\hat{j} + a\hat{k} - \sqrt{2}a\hat{i}\right)$

$$\vec{r} = \sqrt{2}a\hat{i} + \mu\left(\frac{-1}{\sqrt{2}}\hat{i} + \frac{1}{\sqrt{2}}\hat{j} + \hat{k}\right)$$

$$\Rightarrow \quad S.D = \left|\frac{(\vec{a}_2 - \vec{a}_1).(\vec{b}_1 \times \vec{b}_2)}{\left|\vec{b}_1 \times \vec{b}_2\right|}\right| = \frac{2a}{\sqrt{3}}$$

7. $Q = \int_0^\infty \frac{xdx}{1+x^4} = \frac{1}{2}\left|\tan^{-1} x^2\right|_0^\infty = \frac{1}{2}\left(\frac{\pi}{2} - 0\right) = \frac{\pi}{4}$

$P = \int_0^\infty \frac{x^2dx}{1+x^4}$, Put $x = \frac{1}{t} \Rightarrow$ $\quad P = \int_\infty^0 \frac{\frac{1}{t^2}(\frac{-1}{t^2}dt)}{1+\frac{1}{t^4}} = \int_0^\infty \frac{dt}{1+t^4} = R$

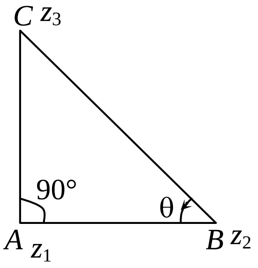
Also $P + R = \int_\infty^0 \frac{x^2+1}{1+x^4}dx = \int_0^\infty \frac{(1+\frac{1}{x^2})dx}{x^2+\frac{1}{x^2}} = \frac{\pi}{\sqrt{2}}$

8. $\int_{\pi/2}^{x} \sqrt{3-2\sin^2 t} + \int_0^y \cos t\,dt = 0$, then $\left(\frac{dy}{dx}\right)$ at x = π and y = π

$\left(\sqrt{3-2\sin^2 t}\right)\cdot 1 + \cos y\frac{dy}{dx} = 0$

$\Rightarrow \left(\frac{dy}{dx}\right)_{\pi,\pi} = \left.\frac{-\sqrt{3-2\sin^2 x}}{\cos y}\right|_{\pi,\,\pi} = \sqrt{3}$.

9. $\frac{W_2}{|W_2|} = \frac{W_1}{|W_1|}e^{-i\theta}$



$\Rightarrow \quad \frac{W_2}{W_1} = \frac{|W_2|}{|W_1|}e^{-i\theta} = 1 - i\tan\theta$

$W_1\overline{W}_2 = \frac{W_1}{W_2}|W_2|^2 = |W_1||W_2|e^{-i\theta} = \left(|W_1|^2 - i|W_1||W_2|\sin\theta\right)$

10. $(1+x+x^2)^n = a_0 + a_1x + a_2x^2 + \ldots + a_{2n}x^{2n}$ …(1)

$\Rightarrow a_0 + a_2 + a_4 \ldots = \frac{3^n+1}{2}$

$a_1 + a_3 + a_5 \ldots = \frac{3^n-1}{2}$

Put $x = i$ in equation (1) where $i = \sqrt{-1}$

If $n = 4m+1$

$\Rightarrow \quad a_1 - a_3 + a_5 \ldots = 1$

$a_0 - a_2 + a_4 \ldots = 0$

So, $a_1 + a_5 + a_9 \ldots = \frac{3^n+1}{4} = S_2$

$a_3 + a_7 + a_{11} \ldots = \frac{3^n-3}{4} = S_4$

Similarly if $n = 4m+3$

Then, $S_2 = \frac{3^n-3}{4}$ and $S_4 = \frac{3^n+1}{4}$

11. If a, b, c are odd integer then D can not be perfect square,

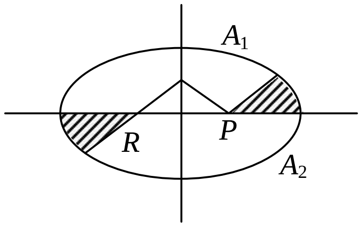
$\Rightarrow \quad |f(\lambda)| > 0$ where $\lambda \in Q$

$$\Rightarrow \quad |a\,p^2 + b\,pq + c\,q^2| \ge 1 \;\Rightarrow\; \left|f\left(\frac{p}{q}\right)\right| \ge \frac{1}{q^2}$$

If $a.c = 1 \quad \Rightarrow \quad a = c = 1$ and $b \ge 3$ as

$c.(a - b + c) < 0 \quad \Rightarrow \quad \alpha \in (-1, 0)$

12. Area of ellipse $= \pi \times \frac{8}{3\sqrt{A}} \times \frac{5}{2\sqrt{A}} = \frac{20}{3}$

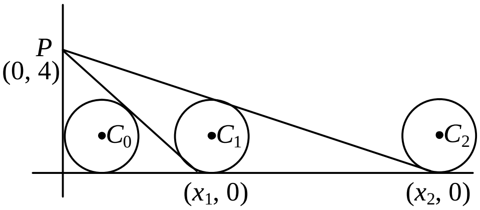


Both shaded areas are equal, then

$$A_1 = \frac{1}{2}Ae - \Delta PQR = \frac{10}{3} - 1$$

$$A_1 = \frac{1}{2}Ae + \Delta PQR = \frac{10}{3} + 1$$

(Q. No. 13 – 14)



For C_n circle let centre be $(\alpha_n, 1)$ and it touches line L_n and L_{n+1}.

i.e. $\frac{x}{x_n} + \frac{y}{4} = 1, \; \frac{x}{x_{n+1}} + \frac{y}{4} = 1$

$$\Rightarrow \quad \frac{4\alpha_n + x_n - 4x_n}{\sqrt{16 + x_n^{\;2}}} = 1 \qquad \ldots(i)$$

$$\Rightarrow \quad \frac{4\alpha_n + x_{n+1} - 4x_{n+1}}{\sqrt{16 + x_{n+1}^2}} = -1 \qquad \ldots(ii)$$

$$\Rightarrow \quad 3(x_{n+1} - x_n) = \sqrt{16 + x_n^2} + \sqrt{16 + x_{n+1}^2}$$

Let $x_n = 4\cot\theta_n \, 0 < \theta_n < \frac{\pi}{2}$

$$\Rightarrow \quad \tan\left(\frac{\theta_{n+1}}{2}\right) = \frac{1}{2}\tan\left(\frac{\theta_n}{2}\right)$$

As $x_1 = 3 \;\Rightarrow\; \tan\frac{\theta_1}{2} = \frac{1}{2} \;\Rightarrow\; \tan\left(\frac{\theta_n}{2}\right) = \frac{1}{2^n}$

$$\Rightarrow \quad x_n = \left(\frac{2^{2n} - 1}{2^{n-1}}\right) \qquad x_2 = \frac{15}{2}$$

Putting is (i), we get $\alpha_2 = \frac{31}{4}$.

$$\lim_{n\to\infty} \frac{x_n}{2^n} = \lim_{n\to\infty} \frac{2^{2n} - 1}{2^{n-1}2^n} = 2$$

15. According to paragraph $\frac{\mathrm{f(b) - f(a)}}{\mathrm{b - a}} > \mathrm{f'(c)}, \frac{\mathrm{g(b) - g(a)}}{\mathrm{b - a}} = \mathrm{g'(c)}$ and $\frac{\mathrm{h(b) - h(a)}}{\mathrm{b - a}} < \mathrm{h'(c)}$

16. If $g(x)=Ax^2+Bx+C$

$$\Rightarrow \frac{g(b)-g(a)}{b-a} = \frac{A(b^2-a^2)+B(b-a)}{b-a} \quad \Rightarrow 2A\frac{(b+a)}{2}+B = g'\left(\frac{b+a}{2}\right)$$

17. Put x = y = 0 in $f(x + y^3) = f(x) + (f(y))^3$
f(0) = 0

$$\Rightarrow k = \lim_{x\to 0}\frac{f(h)-f(0)}{h} = \lim_{x\to 0}\frac{f(h)}{h} = \lim_{x\to 0}\frac{f\left(0+\left(h^{1/3}\right)^3\right)-f(0)}{\left(h^{1/3}\right)^3}$$

$$= \lim_{x\to 0}\left(\frac{f\left(h^{1/3}\right)}{\left(h^{1/3}\right)}\right)^3 = k^3 \Rightarrow k = 0, 1, -1$$

since $|k| > 0 \Rightarrow k = 1, -1$

$$\Rightarrow f'(x) = \lim_{x\to 0}\frac{f(x+h)-f(x)}{h} = \lim_{x\to 0}\left(\frac{f\left(h^{1/3}\right)}{\left(h^{1/3}\right)}\right)^3 = k^3$$

$\Rightarrow f'(x) = -1$ or $1\ \forall\ x \in R$
$\Rightarrow f(x) = -x + c$ or $x + c\ \forall\ x \in R$
$\because\ f(0) = 0$
$\Rightarrow f(x) = -x\ \forall\ x \in R$
or $f(x) = x\ \forall\ x \in R$

$\frac{\tan x}{x} > 1\ \forall\ x \in (-h, h)$

and $\frac{\tan x}{-x} < -1\ \forall\ x \in (-h, h)$

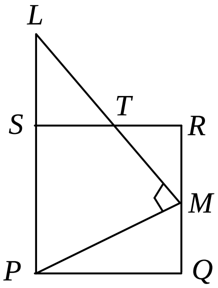
hence $\lim_{x\to 0}\left[\frac{\tan x}{f(x)}\right] = 1$ or -2.

18. If $k = 0 \Rightarrow f'(0) = 0$

$$\Rightarrow f(x) = \lim_{x\to 0}\left(\frac{f\left(h^{1/3}\right)}{\left(h^{1/3}\right)}\right)^3 = 0 \Rightarrow f(x) = c$$

since $f(0) = 0 \Rightarrow f(x) = 0\ \forall\ x \in R$.

SECTION – C



1. Let $Q(ai),\ S(bj),\ M\left(ai+\frac{b}{2}j\right), L\left(\frac{4}{3}bj\right),\ R(ai+aj)$

be required points:
T is intersection of LM and SR

i.e. $ai+\frac{b}{2}j+\lambda\left(ai+\frac{b}{2}j-\frac{4}{3}bj\right) = bj+\mu(ai)$

$\lambda = \frac{-3}{5}$ and $\mu = \frac{2}{5}$ one comparing the coefficient, we get $T \equiv \left(bj+\frac{2a}{5}i\right)$

Area of $\Delta MRT = \frac{1}{2}\times\frac{3.a}{5}\times\frac{b}{2} = \frac{3}{20}ab$.

2. Let first equation have roots α, β, γ_1 and second equation α, β, γ_2

then $\alpha+\beta+\gamma_1 = -5, \quad \alpha\beta+\gamma_1(\alpha+\beta) = p$

$\alpha+\beta+\gamma_2=-7, \qquad \alpha\beta+\gamma_2(\alpha+\beta)=p$

$\Rightarrow (\gamma_1-\gamma_2)(\alpha+\beta)=0$ as $(\gamma_1\neq\gamma_2)\Rightarrow\alpha+\beta=0$

$\gamma_1=-5,\ \gamma_2=-7$.

3. $(23)^{23}=(23)(530-1)^{11}=53\lambda-23$

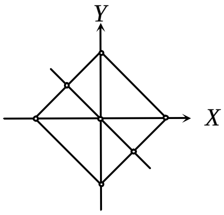
Hence remainder is 30.

4. $\sin x+\sin y=\sin(x+y)$

$\Rightarrow \sin\left(\frac{x+y}{2}\right)\sin\frac{x}{2}\sin\frac{y}{2}=0$

$\Rightarrow x+y=2h_1\pi$, $x=2h_2\pi$ or $y=2h_3\pi$, $h_1,\ h_2,\ h_3\in Z$

Only six solutions are possible



5. $\left\{\frac{4n^4}{4n^2-1}\right\}=\left\{\frac{1}{4}\left(4n^2+1+\frac{1}{4n^2-1}\right)\right\}$

$=\sum_{n=1}^{16}\left(\frac{1}{4}+\frac{1}{8}\left(\frac{1}{2n-1}-\frac{1}{2n+1}\right)\right)$

$=4+\frac{1}{8}\left(1-\frac{1}{33}\right)$

$=4+\frac{4}{33}$

Hence, $\left[33\left\{4+\frac{4}{33}\right\}\right]=4$.

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

FIITJEE **JEE (Main)-2017**

ALL INDIA TEST SERIES

FULL TEST – I

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 03 and 10 to 12)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (04 to 09 and 13 to 30) contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

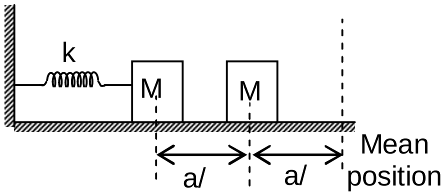
PART – I

SECTION – A

Single Correct Choice Type

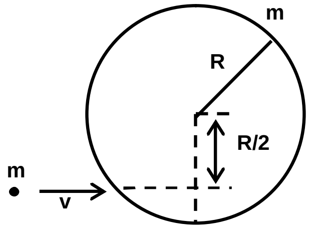
This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. A block of mass M is connected to a spring of force constant k and is placed on a smooth horizontal surface. The block is displaces and compresses the spring by a. The block is left free to move from this position, when the block is at a distance a/2 from the mean position it collides elastically with an identical block. Time the oscillating block takes to reach from extreme to the mean position is



(A) $2\pi\sqrt{\dfrac{M}{k}}$ (B) $\pi\sqrt{\dfrac{M}{k}}$ (C) $\dfrac{5\pi}{6}\sqrt{\dfrac{M}{k}}$ (D) None

2. A circular loop of mass m and radius R rests flat on a horizontal frictionless surface. A bullet of equal mass moving with a velocity V strikes the hoop and gets embedded in it. The angular velocity of the system after the impact is



(A) $\dfrac{v}{4R}$ (B) $\dfrac{v}{6R}$

(C) $\dfrac{2v}{3R}$ (D) $\dfrac{3v}{4R}$

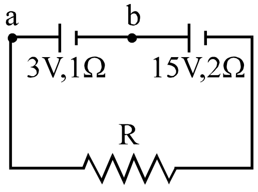
3. A sound source is located somewhere along the x–axis. Experiment shows that the same wave front simultaneously reaches listeners at x = -10 m and x = + 4.0 m. A third listener is positioned along the positive y–axis. What is his y–coordinate (in m) if the same wave front reaches at him at the same instant it does the first two listeners?

(A) $\sqrt{40}$ (B) 3 (C) 7 (D) $\sqrt{30}$

4. Assume that a star has uniform density. Then the gravitational pressure (P) on the surface of the star related to volume (V) of star is.

(A) $P \propto V^{-1/3}$ (B) $P \propto V^{-2/3}$ (C) $P \propto V^{-4/3}$ (D) $P \propto V^{-5/3}$

5. Two batteries one of the emf 3V, internal resistance 1 ohm and the other of emf 15 V, internal resistance 2 ohm are connected in series with a resistance R as shown. If the potential difference between a and b is zero the resistance of R in ohm is

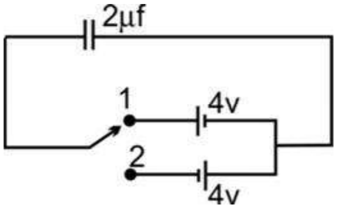


(A) 5 (B) 7

(C) 3 (D) 1

Space for Rough work

6. Heat generated in the circuit when switch is shifted from 1 to 2 is
(A) 32μJ (B) 16μJ
(C) 48μJ (D) 64μJ

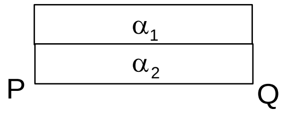


7. A light pointer fixed to one prong of a tuning fork touches a vertical plate. The fork is set vibrating and the plate is allowed to fall freely. Eight complete oscillations are counted when the plate falls through 40 cm. The frequency of tuning fork is (g = 980 cm)
(A) 56 Hz (B) 8 Hz (C) 49 Hz (D) 28 Hz

8. A large tank is filled with water at the rate of 70 cm^3/s. A hole of cross – section area 0.25 cm^2 is punched at the bottom of the tank. The maximum height to which the tank can be filled is
(A) 40 cm (B) 20 cm (C) 10 cm (D) 50 cm

9. Consider the following statements
(i) Young's modulus is numerically equal to the stress which will double the length of a wire
(ii) The surface tension of a liquid decreases due to the presence of insoluble contamination
(iii) Viscosity of gases is greater than that of liquids.
The number of above statements that are true is
(A) zero (B) Three (C) Two (D) One

10. Two composite bar having coefficient of linear expansion α_1 and α_2 respectively, are shown in fig. If the temperature of the bar is raised by t^oC then

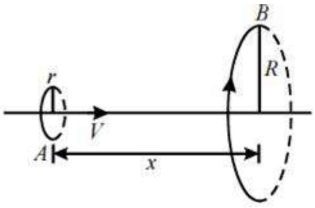


(A) Shape of the composite bar is concave toward PQ if $\alpha_1 < \alpha_2$
(B) Shape of the composite bar is convex toward PQ if $\alpha_1 < \alpha_2$
(C) Shape of the bar is concave towards PQ if $\alpha_1 = \alpha_2$
(D) Bar will not bend irrespective of the value of α_1 and α_2

11. The input resistance of a silicon transistor is 100 Ω. Base current is changed by 40 μA, which results in a change in collector current by 2 mA. This transistor is used as a common emitter amplifier with a load resistance of 4 KΩ. The voltage gain of the amplifier is
(A) 2000 (B) 3000 (C) 4000 (D) 1000

Space for Rough work

12. Loop A of radius (r << R) moves towards loop B with a constant velocity V in such a way that their planes are always parallel. What is the distance between the two loops (x) when the induced emf in loop A is maximum :



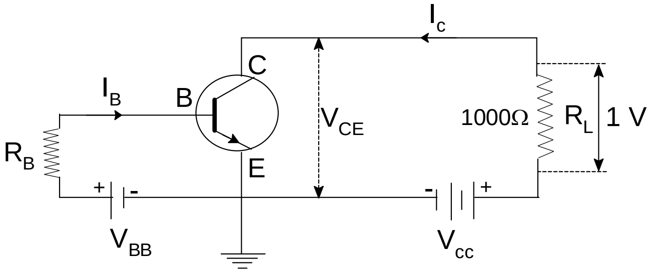
(A) R
(B) $\frac{R}{\sqrt{2}}$
(C) $\frac{R}{2}$
(D) $R\left(1-\frac{1}{\sqrt{2}}\right)$

13. Vernier constant of the Vernier caliper is
(A) least count of Vernier caliper
(B) value of 1 division of main scale
(C) value of 1 division of Vernier scale
(D) None of these

14. A block of mass *m* is placed on an another rough block of mass *M* and both are moving horizontally with same acceleration *a* due to a force which is applied on the lower block, then work done by lower block on the upper block in moving a distance *s* will be

(A) *Mas*
(B) $(m+M)as$
(C) $\frac{M^2}{m}as$
(D) *mas*

15. An N – P – N transistor is connected in common emitter configuration in which collector supply is 9V and the voltage drop across the load resistance of 1000 Ω connected in the collector circuit is 1V. If current amplification factor is (25/26) and the internal resistance of the resistor is 200 Ω.. Then which of the following statement is incorrect.



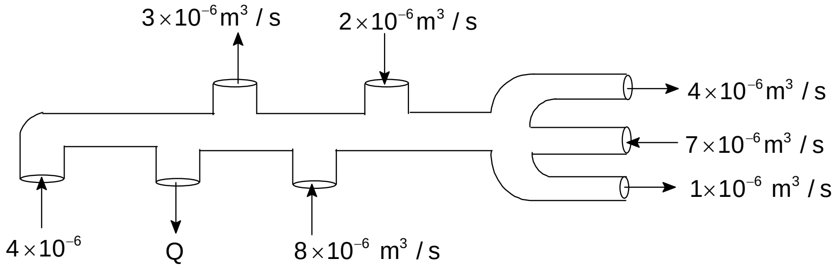
(A) $V_{CE} = 8V$
(B) collector current is 1.0 mA
(C) voltage gain $\frac{50}{23}$, power gain is 4.6
(D) emitter current is 2.04 mA

Space for Rough work

16. The magnifying power of the telescope is found to be 9 and the separation between the lenses is 20 cm for relaxed eye. Then the focal lengths of component lenses are
(A) 18 cm, 2 cm (B) 10 cm, 10 cm
(C) 9 cm, 11 cm (D) None of these

17. In compound microscope
(A) The objective has a shorter focal length
(B) The objective has a shorter aperture
(C) (a) and (b) both are correct
(D) The aperture of objective and eye piece are same

18. The pipe shows the volume flow rate of an ideal liquid at certain time and its direction. What is the value of Q in m^3/s (Assume steady state and equal area of cross section at each opening)



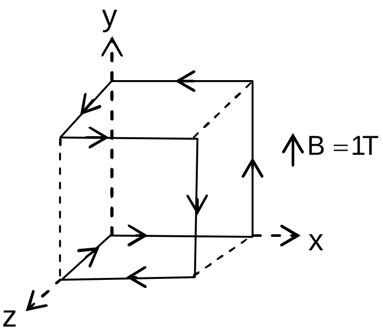
(A) $12\times10^{-6}m^3/s$ (B) $11\times10^{-6}m^3/s$
(C) $9\times10^{-6}m^3/s$ (D) $13\times10^{-6}m^3/s$

19. A parallel beam of monochromatic light is incident on a narrow rectangular slit of width 1 mm. When the diffraction pattern is seen on a screen placed at a distance of 2 m. The width of principal maxima is found to be 2.5 mm. The wave length of light is
(A) 6250 $\overset{o}{A}$ (B) 6200 $\overset{o}{A}$ (C) 5890 $\overset{o}{A}$ (D) 6000 $\overset{o}{A}$

20. In an electromagnetic wave, the amplitude of electric field is 1V/m. The frequency of wave is 5×10^{14}Hz. The wave is propagating along z – axis. The average energy density of electric field in Joule/m^3, will be
(A) 1.1×10^{11} (B) 2.2×10^{-12} (C) 3×10^{-13} (D) 4.4×10^{-14}

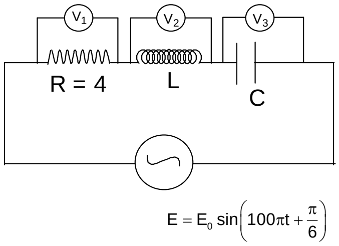
Space for Rough work

21. Figure shows a bent coil with all edges of length 1m and carrying a current 1A, then torque acting on the loop is
(A) zero (B) 3 N-m
(C) 2 N-m (D) 1 N-m



22. Find the minimum thickness of a film which will strongly reflect the light of wavelength 589 nm. The refractive index of the material of the film is 1.25
(A) 118 nm (B) 120 nm (C) 118 mm (D) 120 mm

23. In the figure shown the reading of voltmeters are V_1 = 40 V, V_2 = 40 V and V_3 = 10 V. Find the peak value of emf
(A) $50V$ (B) $50\sqrt{2}V$
(C) $50\sqrt{3}V$ (D) $100\sqrt{2}V$



24. If equation of transverse wave is y = $x_0 \cos 2\pi\left(nt - \frac{x}{\lambda}\right)$. Maximum velocity of particle is twice of wave velocity, if λ is.
(A) $2\pi x_0$ (B) πx (C) $\frac{\pi}{x_0}$ (D) πx_0

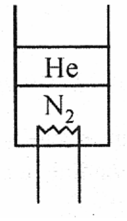
25. The focal length of the objective and the eyepiece of a microscope are 4 mm and 25 mm respectively. If the final image is formed at infinity and the length of the tube is 16 cm. The magnifying power of the microscope will be
(A) -327.5 (B) -32.75 (C) 3.275 (D) 32.75

26. An oscillator has a time period of 3 sec. Its amplitude decreases by 5% each cycle. Its energy decreases in each cycle is
(A) 5% (B) 10% (C) 1.0% (D) 2%

27. A mass 25×10^{-3}Kg is suspended from the lower end of a vertical spring having force constant 25 N/m. The mechanical resistance of the system is 1.5 N.s/m. The mass is displaced vertically and released. Its period of oscillation is
(A) 0.314 (B) 0.628 (C) 3.14 (D) 6.28

Space for Rough work

28. 5 moles of nitrogen gas are enclosed in an adiabatic cylindrical vessel. The piston itself is a rigid light cylindrical container containing 3 moles of Helium gas. There is heater which gives out a power 100 cal/sec to the nitrogen gas. A power of 30 cal/sec is transferred to Helium through the bottom surface of the piston. The rate of increment of temperature of the nitrogen gas assuming that the piston moves slowly:



(A) 2 K/sec (B) 4 K/sec
(C) 6 K/sec (D) 8 K/sec

29. A beam of natural light falls on a system of 6 polaroids, which are arranged in succession such that each polaroid is turned through 30^0 with respect to the preceding one. The percentage of incident intensity that passes through the system will be
(A) 100% (B) 50 %
(C) 30% (D) 12%

30. Which of the following electromagnetic waves have minimum frequency
(A) Micro waves (B) Audible waves
(C) ultrasonic waves (D) Radio waves

Space for Rough work

Chemistry

PART – II

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. The volume of an H_2O_2 solution (volume strength = 11.2) required to convert all the Fe^{+2} present in 4 mole of Fe_3O_4 to Fe^{+3} is:

(A) 2 mL (B) 1 mL (C) 4 L (D) 2 L

2. In an excited sample of Li^{+2} ions with all the electrons in the same energy state (n_1) produces 3 different spectral lines when all of them are now found to be in 1st excited state. What can't be the orbital angular momentum of the electron present in state n_1?

(A) $\sqrt{12}\hbar$ (B) $\sqrt{2}\hbar$ (C) 0 (D) $\sqrt{20}\hbar$

3. For a reaction $P \longrightarrow Q$, $\frac{-d[P]}{dt}$ increases by a factor of 2 upon increasing the concentration of P by 8 times. The order of the reaction with respect to P is

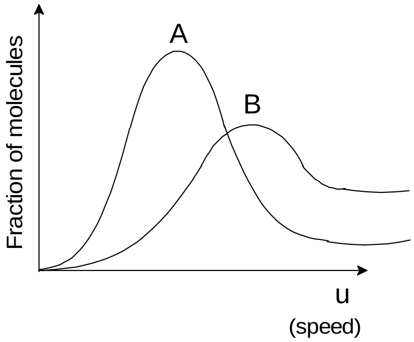
(A) 3 (B) 1/3 (C) 2 (D) 1/2

4. Assuming that, water vapour is an ideal gas, the internal energy change (ΔU), when 1 mol of water is vaporized at 1 bar pressure & 100^0C, (given: molar enthalpy of vaporization of water at 1 bar & 373 K = 41 $kJmol^{-1}$ & R = 8.314 $J\ mol^{-1}\ K^{-1}$) will be:

(A) 41.00 $kJmol^{-1}$ (B) 3.7904 $kJmol^{-1}$ (C) 4.100 $kJmol^{-1}$ (D) 37.904 $kJmol^{-1}$

Space for Rough work

5. Maxwell's Boltzmann's distribution of molecular speeds for two ideal gases A and B at the same temperature is given below:



Select the incorrect statement:
(A) Fraction of molecules moving with most probable speed of gas A is greater than that of gas B
(B) Most probable speed of molecules of gas B is greater than that of gas A
(C) Rate of diffusion of gas A < gas B under identical conditions
(D) Rate of diffusion of gas B < gas A under identical conditions

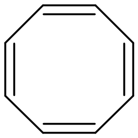
6. In an fcc arrangement of A and B in which A-atoms are at the corners of the unit cell and B – atom at the face centres, one of the A – atom is missing from one corner in unit cells. The simplest formula of the compound is:
(A) A_7B_3 (B) AB_3 (C) A_7B_{24} (D) A_8B_{21}

7. The pH of the following half – cell solution is:
$\text{Pt, } H_2\left(1\,\text{atm}\right)\middle|H^+\left(\text{HCl}\right);\ E = 0.25\text{ V}$
(A) 2.21 (B) 8.46 (C) 4.23 (D) 0

8. Which is not correct for physical adsorption?
(A) Adsorption is spontaneous
(B) Both enthalpy and entropy of adsorption are -ve
(C) Adsorption on solid is reversible
(D) Adsorption increases with increase in temperature

Space for Rough work

9. The osmotic pressure of urea solution is 500 mm at 10^0C. The solution is diluted and the temperature raised to 25^0C, when the osmotic pressure is found to be 105.3 mm.
$V_{final} : V_{initial} \simeq X : 1$
X is:
(A) 5 (B) 2 (C) 8 (D) 10

10. Select the correct statement:
(A) Al_2Cl_6 is a planar molecule
(B) I_2Cl_6 is a planar molecule
(C) B_2H_6 is a planar molecule
(D)  is a planar molecule

11. Which of the processes are endothermic?
(i) $Cl(g) + e^- \rightarrow Cl^-(g)$
(ii) $N(g) + e^- \rightarrow N^-(g)$
(iii) $Ne(g) + e^- \rightarrow Ne^-(g)$
(iv) $Ne(g) \rightarrow Ne^+(g) + e^-$
(v) $Li^+(g) \rightarrow Li^+(aq)(hydration)$
(vi) $Cl^-(g) \rightarrow Cl^-(aq)(hydration)$
(A) (ii), (iv) (B) (ii), (iii) (C) (ii), (iii), (iv) (D) (ii), (iii), (iv), (vi)

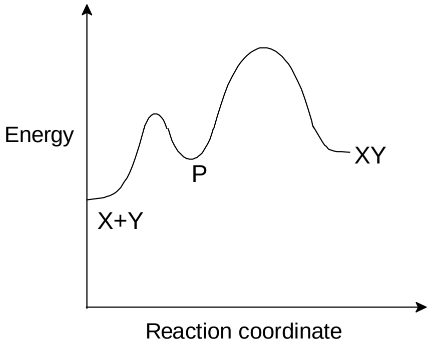
12. The blue colour of dilute solution of alkali metals in ammonia slowly fades because:
(A) electrons get paired
(B) metals form MNH_2 with release of H_2 gas
(C) electrons loose energy eventually because of solvation
(D) electrons get trapped in holes of tetrahedrally arranged NH_3 molecules

Space for Rough work

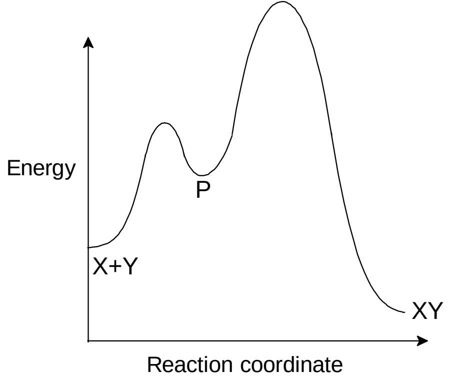
13. Select the correct statement:
(A) D_2O has higher dielectric constant, melting point, boiling point & ionic product than H_2O
(B) D_2O has higher melting point, boiling point & dielectric constant than H_2O but lower value of ionic product
(C) D_2O has higher melting point, boiling point & ionic product but lower dielectric constant than H_2O
(D) D_2O has higher melting point, boiling point but lower dielectric constant & ionic product than H_2O

14. For an exothermic chemical process occurring in two steps as follows:
$(i)\, X+Y \longrightarrow P(\text{slow})\ (ii)\, P \longrightarrow XY(\text{fast})$
The energy diagram for the above process is best described by:

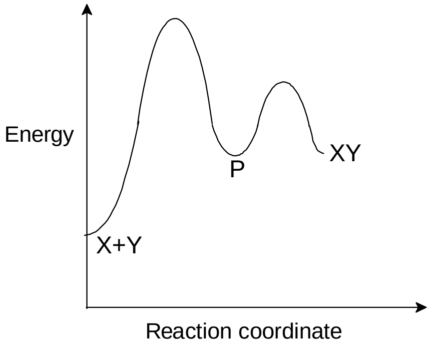
(A)


Energy
XY
P
X+Y
Reaction coordinate

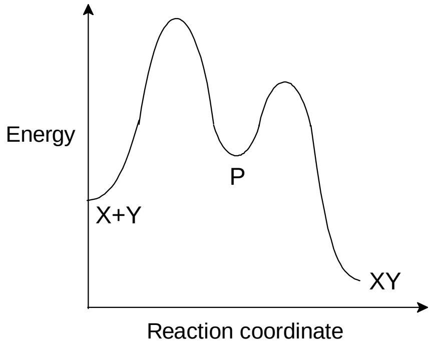
(B)


Energy
P
X+Y
XY
Reaction coordinate

(C)


Energy
XY
P
X+Y
Reaction coordinate

(D)


Energy
P
X+Y
XY
Reaction coordinate

Space for Rough work

15. Which of the following reactions depict the oxidizing behavior of H_2SO_4?

(A) $Ba(NO_3)_2 + H_2SO_4 \longrightarrow BaSO_4 + 2HNO_3$

(B) $2PCl_5 + H_2SO_4 \longrightarrow 2POCl_3 + 2HCl + SO_2Cl_2$

(C) $2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$

(D) $2HI + H_2SO_4 \longrightarrow I_2 + SO_2 + 2H_2O$

16. The process in which catalyst is not used:

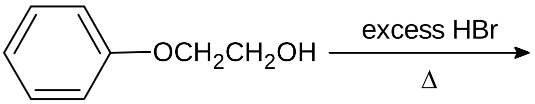
(A) Thermite process
(B) Contact process
(C) Haber's process
(D) Ostwald's process

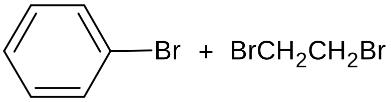
17. Complex compounds which are optically active and doesn't depend upon the orientation of the ligand around metal cation:

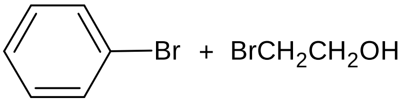
(i) $\left[CoCl_3(NH_3)_3\right]$
(ii) $\left[Co(en)_3\right]Cl_3$
(iii) $\left[Co(C_2O_4)_2(NH_3)_2\right]^-$

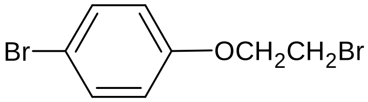
(A) (i), (ii) & (iii)
(B) (ii) & (iii)
(C) only (ii)
(D) all of the above

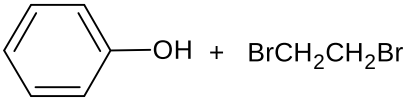
18. What is the product of the following reaction?



(A) 

(B) 

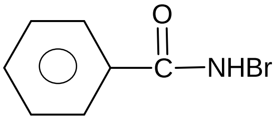
(C) 

(D) 

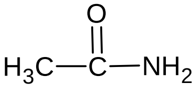
Space for Rough work

19. Which of the following does not give Hoffmann bromamide reaction?

(A)

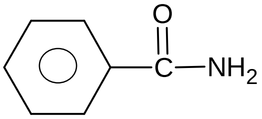


(B)

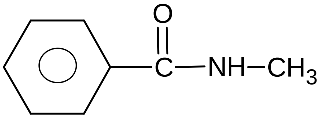


$H_3C-\overset{\overset{\displaystyle O}{||}}{C}-NH_2$

(C)



(D)

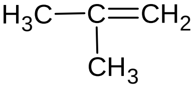


20. $CH_3-CH=CH-CH_2-CO_2H \xrightarrow[\Delta]{} \underset{(major)}{(X)}$

major product X is:

(A) $CH_3-CH=CH_2$

(B)



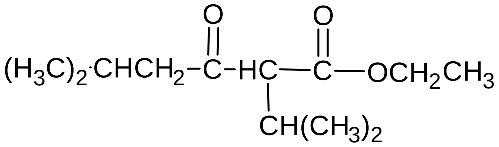
$H_3C-\underset{\underset{\displaystyle CH_3}{|}}{C}=CH_2$

(C) $CH_3-CH=CH-CH_3$

(D) $CH_3-CH_2-CH=CH_2$

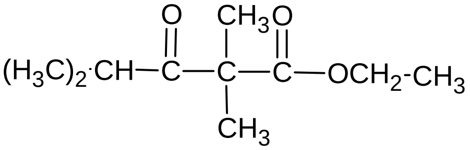
21. Which of the following keto esters is not likely to have been prepared by a claisen condensation?

(A)



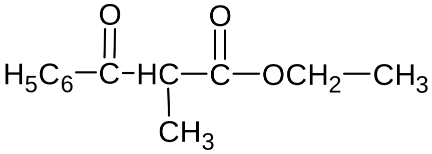
$(H_3C)_2\cdot CHCH_2-\overset{\overset{\displaystyle O}{||}}{C}-H\underset{\underset{\displaystyle CH(CH_3)_2}{|}}{C}-\overset{\overset{\displaystyle O}{||}}{C}-OCH_2CH_3$

(B)



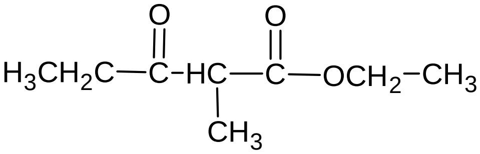
$(H_3C)_2\cdot CH-\overset{\overset{\displaystyle O}{||}}{C}-\overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle CH_3}{|}}{C}}-\overset{\overset{\displaystyle O}{||}}{C}-OCH_2\cdot CH_3$

(C)



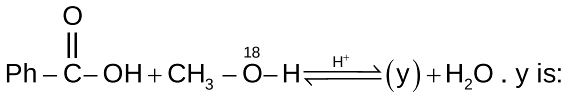
$H_5C_6-\overset{\overset{\displaystyle O}{||}}{C}-H\underset{\underset{\displaystyle CH_3}{|}}{C}-\overset{\overset{\displaystyle O}{||}}{C}-OCH_2-CH_3$

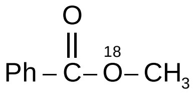
(D)

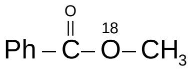


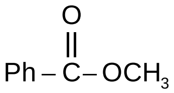
$H_3CH_2C-\overset{\overset{\displaystyle O}{||}}{C}-H\underset{\underset{\displaystyle CH_3}{|}}{C}-\overset{\overset{\displaystyle O}{||}}{C}-OCH_2-CH_3$

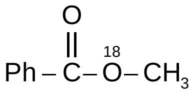
Space for Rough work

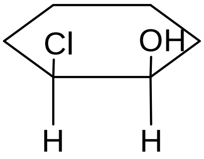
22. 
$Ph-\overset{\overset{O}{\parallel}}{C}-OH+CH_3-\overset{18}{O}-H \xrightleftharpoons{H^+} (y)+H_2O$. y is:

(A) 
$Ph-\overset{\overset{O}{\parallel}}{C}-\overset{18}{O}-CH_3$ (Trans esterification)

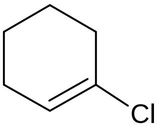
(B) 
$Ph-\overset{\overset{O}{\parallel}}{C}-\overset{18}{O}-CH_3$ (Esterification reaction)

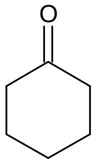
(C) 
$Ph-\overset{\overset{O}{\parallel}}{C}-OCH_3$ (hydrolysis)

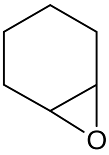
(D) 
$Ph-\overset{\overset{O}{\parallel}}{C}-\overset{18}{O}-CH_3$ (saponification)

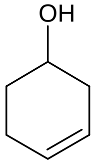
23. 

$\xrightarrow{\text{alc.KOH}}$ (X), product X is:

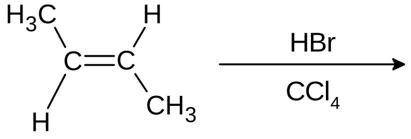
(A) 

(B) 

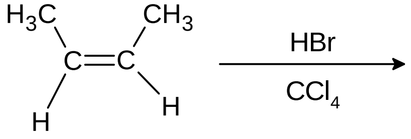
(C) 

(D) 

24. In which of the following reactions, product is racemic mixture?

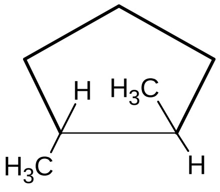
(A) 

(B) $CH_3-CH_2-CH=CH_2 \xrightarrow[CCl_4]{HBr}$

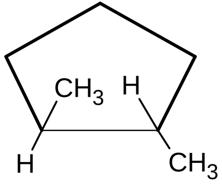
(C) 

(D) All of these

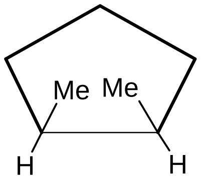
25. Select the enantiomers among the structures given below:



(I)



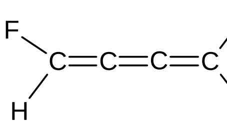
(II)

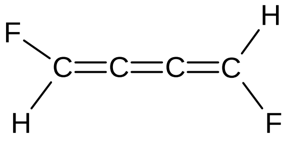


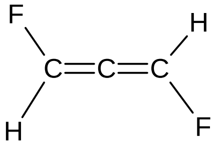
(III)

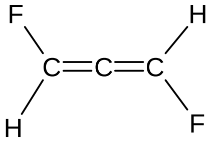
(A) I, II & III (B) I & III (C) I & II (D) II & III

26. Select the correct statement:

(A)  is optically active & non-polar

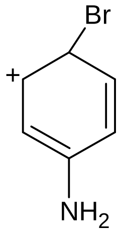
(B)  is optically inactive & polar

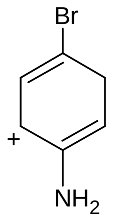
(C)  is optically inactive & non - polar

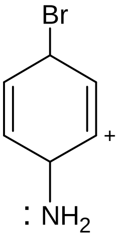
(D)  is optically active & polar

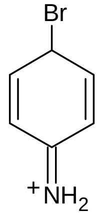
Space for Rough work

27. Which of the following structure is most stable?

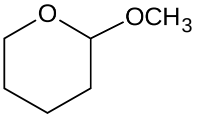
(A)


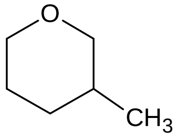
(B)


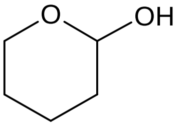
(C)


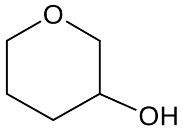
(D)


28. Which of the following compound give positive Tollen's test?

(A)


(B)


(C)


(D)


29. A sample of PCl_5 is allowed to decompose in a container against a constant external pressure till following equilibrium achieved:

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

Select the correct option:

(A) The relative vapour density of sample increases till equilibrium is achieved & after that it remains constant

(B) The degree of dissociation $('\alpha')$, is dependent on the total pressure under which the equilibrium is achieved

(C) The degree of dissociation $('\alpha')$ on attainment of the equilibrium is dependent on the total no. of moles of PCl_5 initially taken

(D) The molar mass of the sample increases and the density of the sample remains constant

30. A sparingly soluble salt A_2B_3 has concentration $\left[A^{+3}\right] = S\,M$ in its saturated aqueous solution. So its solubility (in M) is

$$A_2B_3(s) \rightleftharpoons 2A^{+3}_{(aq)} + 3B^{-2}_{(aq)}$$

(A) S (B) 2S (C) $\frac{S}{2}$ (D) 4S

Space for Rough work

Mathematics **PART – III**

SECTION – A

Single Correct Choice Type

This section contains **30 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. Solution of differential equation
$\dfrac{xdx - ydy}{xdy - ydx} = x,$ given that y = 0 at x = 1
(A) $y + 1 = \sqrt{x^2 - y^2}$ (B) $y + 1 = \sqrt{y^2 - x^2}$ (C) $y = \sqrt{y^2 - x^2}$ (D) None of these

2. The sum of the coefficient of all the integral power of x in the expansion of $\left(1 + \dfrac{\sqrt{x}}{2}\right)^{40}$ is
(A) $\dfrac{3^{40}+1}{2^{40}}$ (B) $\dfrac{3^{40}+1}{2^{41}}$ (C) $\dfrac{3^{20}+1}{2^{20}}$ (D) $\dfrac{3^{20}+1}{2^{21}}$

3. A family of lies is given by $(2 - 3\lambda)x + (1 + 2\lambda)y - 6 - 12\lambda = 0,$ λ being a parameters. The line belonging to this family at maximum distance from the point (4, 3) is L_1 and from the point (-2, -4) is L_2. Then angle between lines L_1 & L_2 is
(A) $\tan^{-1}\left(\dfrac{11}{23}\right)$ (B) $\tan^{-1}\left(\dfrac{23}{11}\right)$ (C) $\tan^{-1}\left(\dfrac{17}{19}\right)$ (D) $\tan^{-1}\left(\dfrac{19}{17}\right)$

4. If p, q, r are distinct complex number such that $\dfrac{p}{q} = \dfrac{q}{r} = \dfrac{r}{p} = \alpha$, then sum of all values of α will be
(A) 1 (B) -1 (C) 0 (D) None of these

5. If f(x) is differentiable & satisfying
$f(x+y) = f(x) + f(y) + (x^2 + y^2)xy \quad \forall\ x, y \in R$ and $\lim\limits_{x\to 0}\dfrac{f(x)}{x} = 2$ then f(x) will be
(A) $2 + x^3$ (B) $2x + \dfrac{x^4}{4}$ (C) $2 + \dfrac{x^4}{4}$ (D) $2x + x^4 + 2$

Space for Rough work

6. Two numbers x and y are randomly selected on the real number line, such that $0 \le x, y \le 60$. Find the probability that the difference between selected no is not greater than 10.

(A) $\frac{11}{36}$ (B) $\frac{11}{38}$ (C) $\frac{11}{40}$ (D) $\frac{11}{42}$

7. On 8×8 Chess board. If two squares of 1×1 are selected randomly, what is probability that, they have one side common.

(A) $\frac{1}{16}$ (B) $\frac{1}{18}$ (C) $\frac{1}{20}$ (D) $\frac{1}{22}$

8. Number of real value of x satisfy this equation, $2^{2x} + 2^{x}(3 - 5\cos x) + 1 = 0$

(A) 0 (B) 1 (C) 2 (D) 3

9. $f(x) = \prod_{n=1}^{50}(x-n)^{(51n-n^2)}$ then $\frac{f(51)}{f'(51)}$ equal to

(A) $\frac{1}{1275}$ (B) $\frac{1}{2500}$ (C) $\frac{1}{2550}$ (D) $\frac{1}{5050}$

10. A function defied as $R \to R$, $f(x) = e^{2x^3+3x^2+6x-5}$ will be

(A) One – One & onto (B) One – One & into (C) Many – One & onto (D) Many – One & into

11. $\int \frac{(\cot^2 x - n + 1)}{\cos^n x} = -f(x)[g(x)]^{n-1} + c$ where

$f\left(\frac{\pi}{2}\right) = 1$ then minimum value of $\left[[f(x)]^2 + [g(x)]^2\right]^n$

(A) 1 (B) 2^n (C) 2^{2n} (D) 2^{4n}

12. This equation $\sum_{r=-1}^{m}\left(x - \frac{1}{2^r}\right)^{2n+1} = 0$, has

(A) only one real root (B) has all real root

(C) has 2n real root (D) has (2n +1) real root

Space for Rough work

13. Consider number N = 75600 then sum of divisor of the form (4n + 2), $n \in N$ is
(A) 19840 (B) 29760 (C) 39680 (D) None of these

14. The inverse of the converse of $(p \wedge \sim q) \Rightarrow r$ will be equivalent to
(A) $\sim r \Rightarrow (q \Rightarrow p)$ (B) $\sim r \Rightarrow (\sim p \Rightarrow q)$ (C) $r \Rightarrow (p \Rightarrow q)$ (D) None of these

15. If a, b, c be the sides of a ΔABC and it roots of the equation $a(b-c)x^2 + b(c-a)x + c(a-b) = 0$ are equal then $\operatorname{cosec}^2 \frac{A}{2}, \operatorname{cosec}^2 \frac{B}{2}, \operatorname{cosec}^2 \frac{C}{2}$ are in
(A) AP (B) GP (C) HP (D) None of these

16. Area of the ellipse $3x^2 + 4xy + 3y^2 + 2x + 8y + 6 = 0$
(A) $\frac{\pi}{\sqrt{5}}$ (B) $\sqrt{5}\pi$ (C) $\frac{4\pi}{\sqrt{5}}$ (D) $4\sqrt{5}\pi$

17. $\int_{-\infty}^{0} e^{122x}\left(1-e^{x}\right)^{19} dx$ is equal to
(A) $\frac{19!121!}{71!}$ (B) $\frac{19!121!}{70!}$ (C) $\frac{19!121!}{141!}$ (D) $\frac{19!121!}{140!}$

18. How many 6 letter words can be formed using the letter from the word 'BORINGROAD' if each word has 3 vowels & 3 consonant
(A) 936 (B) 5616 (C) 17280 (D) 33676

19. A man can take a step forward, backward, left or right with equal probability. Then the probability that after nine steps he will be just one step away from his initial position.
(A) $P(E) = 4 \times \left(\frac{15874}{4^9}\right)$ (B) $P(E) = 4 \times \left(\frac{15875}{4^9}\right)$
(C) $P(E) = 4 \times \left(\frac{15876}{4^9}\right)$ (D) $P(E) = 4 \times \left(\frac{15877}{4^9}\right)$

Space for Rough work

20. If $\sum_{r=0}^{n-1}\left[x+\frac{r}{n}\right]=\sum_{r=0}^{n}x,$ where n is the positive integer and [x] represent greatest integer of x. Then total number of possible solution of x is

(A) 1 (B) n -1 (C) n (D) n + 1

21. $\int_0^{\frac{\pi}{8}}\frac{x\,dx}{1+\cos4x+\sin4x}=\frac{\pi}{b}\ell n2$ then value of b is

(A) 14 (B) 16 (C) 32 (D) 64

22. $\int_1^e(x+1)e^x\ell nx\,dx=ae^p+be^q+ce^r$ then value of (p + q + r) will be

(A) 2 (B) e + 2 (C) e + 1 (D) None of these

23. If a, b, c represent the sides of triangle ABC and quadratic equation $ax^2+cx+b=0$ does not have two distinct real root then which condition hold's true

(A) $b\geq4a+2c$ (B) $b\leq4a-2c$ (C) $b\leq2c-4a$ (D) $b\geq2c-4a$

24. $\cos^{-1}\left(x^2-3x+3\right)\geq\left[\pi+2\cos^{-1}\left(x^2\right)\right]$ then total number of possible value of x satisfying this equation is

(A) 0 (B) 1 (C) 2 (D) 3

25. If $A=\begin{bmatrix}1&2&3\\0&1&2\\0&0&1\end{bmatrix}$ & BA = A where B represent 3×3 order matrix. If total number of '1' in matrix A^{-1} & matrix B are p & q respectively then p + q is

(A) 3 (B) 4 (C) 5 (D) 7

26. $\frac{\sin A}{\sin C}=\frac{\sin(C+2B)}{\sin(A+2C)}$ then a sinA, b sinB, csinC are in,

(A) AP (B) GP (C) HP (D) None of these

Space for Rough work

27. The image of the parabola $x^2 = 4y$ in the line x + y = 2 is

(A) $(x-2)^2 = 4(2-y)$ (B) $(y-2)^2 = 4(2-x)$

(C) $(x-2)^2 = 4(2+y)$ (D) $(y-2)^2 = 4(2+x)$

28. If $(\sin 3A + \sin 3B + \sin 3C) + 12(\sin A.\sin B.\sin C) - 3(\sin A + \sin B + \sin C) = 0$ then

(A) $\cos C = \sin A + \sin B$ (B) $\sin C = \cos A + \cos B$

(C) $\sin A = \sin B + \sin C$ (D) None of these

29. $\lim\limits_{x \to 0} \dfrac{\left(e^{2002x}+1\right)-(1+1001x)\left(e^{1001x}+e^{-1001x}\right)}{x\left(e^{x}-1\right)}$

(A) (1001) (B) $(1001)^2$ (C) (2002) (D) $(2002)^2$

30. Equation $2.x^{\left[\left(\log_2^x\right)^2 - \log_2^x + 1\right]} = \sqrt[8]{2}$ has

(A) One real value of x (B) two real value of x

(C) three real value of x (D) None of these

Space for Rough work

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

FIITJEE

JEE(Main)-2017

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – I
(Main)

S. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**C**	D	A
2.	**B**	D	B
3.	A	B	B
4.	C	D	B
5.	**C**	D	B
6.	**D**	C	A
7.	D	C	**B**
8.	A	D	B
9.	C	A	A
10.	B	B	B
11.	A	C	C
12.	**C**	B	A
13.	A	D	A
14.	**D**	D	D
15.	C	D	A
16.	A	A	A
17.	C	C	C
18.	D	D	C
19.	A	D	**C**
20.	B	D	D
21.	**D**	B	D
22.	A	B	D
23.	**B**	B	D
24.	D	D	B
25.	A	C	D
26.	B	D	A
27.	B	D	B
28.	**A**	C	D
29.	D	B	B
30.	B	**C**	A

Physics

PART – I

SECTION – A

1. The time taken in first a/2 is T/6 and in next a/2 will be T/4. So

$$t = \frac{T}{6} + \frac{T}{4} = \frac{5}{12}T$$

$$= \frac{5}{12} \times 2\pi\sqrt{\frac{M}{k}} = \frac{5\pi}{6}\sqrt{\frac{m}{k}}$$

2. MI about CM = $mR^2 + 2\ mR^2/4$

$I = 3/2\ mR^2$

Conservation of AM about CM,

$Mv_o\ R/4 = 3/2\ mR^2\omega \qquad \Rightarrow \omega = v_o/6R$

3. $t = \frac{10+x}{C} = \frac{4-x}{C}$

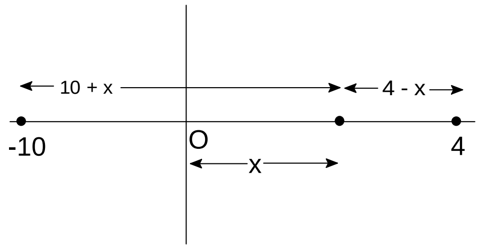
$\therefore -6 = 2x$

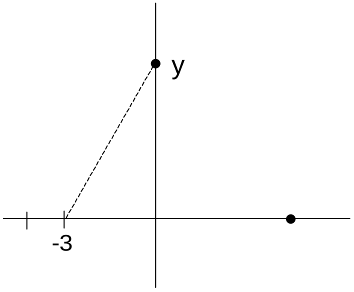
$t = \frac{10-3}{C} \qquad\qquad \therefore x = -3$

$\therefore t = \frac{7}{C}$

$\therefore 7 = \sqrt{3^2 + y^2}$

$\therefore y = \sqrt{40}$





4. We know gravitational potential energy is

$U = -\frac{3}{5}\frac{GM^2}{R}$

Volume of star V = $\frac{4\pi R^3}{3} \qquad \therefore R = \left(\frac{3V}{4\pi}\right)^{\frac{1}{3}}$

$\therefore U = -\frac{3}{5}\left(\frac{4\pi}{3V}\right)^{\frac{1}{3}} GM^2$

Pressure P = $-\frac{\partial u}{\partial V}$

$= -\frac{1}{5}\left(\frac{4\pi}{3}\right)\frac{GM^2}{V^{\frac{4}{3}}}$

$\therefore P \propto V^{-\frac{4}{3}}$

5. $V_a - 3 + \frac{18}{3+R} = V_b$

$V_a - V_b = 3 - \frac{18}{3+R} = 0$

$R = 3\Omega$

6. Δu in capacitor = 0
Work by battery = qE = 64 μJ
$\therefore$ Heat = 64 μJ

7. Time taken for the plate to fall is $t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2\times 40}{980}}$

$\therefore t = \frac{2}{7}\text{sec}$

time period $T = \frac{t}{8} = \frac{2}{8\times 7} = \frac{1}{28}\text{sec}$

$\therefore$ frequency $f = \frac{1}{T} = 28$ Hz

8. For the water level to remain stationary
Volume efflux = rate of filling (x)
$\therefore VA = x$

$\sqrt{2gh}\ A = x \qquad \therefore h = \frac{x^2}{2gA^2}$

$h = \frac{(70)^2}{2\times 980\times (0.25)^2}$

$h = 40$ cm

9. (i), (ii) are true but (iii) is false, as we know that viscosity in gaseous is about 100 times less than viscosity in liquids.

10. Shape of the composite bar is convex toward PQ if $\alpha_1 < \alpha_2$.

11. Voltage gain = $\frac{V_{out}}{V_{in}} = \frac{I_{out}}{I_{in}} + \frac{R_{out}}{R_{in}}$

$= \frac{2\times 10^{-3}}{40\times 10^{-6}} \times \frac{4\times 10^{3}}{100}$

$= 2000$

12. When $\frac{dE}{dt} = 0$
E is maximum

13. least count of Vernier caliper

14. Force on the upper block = *ma*
Work done = F.S = *ma*

15. Collector current I_c =

$$\frac{\text{voltage drop across} R_L}{R_L} = \frac{1}{1000} = 10^{-3} \text{amp}$$

Now $V_{CE} = 9 - 1 = 8$ volt

Current gain $\beta = \frac{I_C}{I_B}$

or $\frac{25}{26} = \frac{10^{-3}}{I_B}$ $\therefore I_B = 1.04 \times 10^{-3}$ amp.

Voltage gain $= \beta \frac{R_L}{R_C} = \frac{25}{26} \times \frac{1000}{200} = \frac{125}{26}$

Power gain $= \beta^2 \frac{R_L}{R_C} = \left(\frac{25}{26}\right)^2 \times \frac{1000}{200} = 4.6$

Again $I_E = I_B + I_C = 1.04 \times 10^{-3} + 10^{-3} = 2.04 \times 10^{-3}$ A

16. Magnification $M = \frac{F}{f} = 9$ $\therefore F = 9f$ ......(i)

Distance between lenses d = F + f $\therefore F + f = 20$ .....(ii)

From equation (i) & (ii) we get F = 18 cm

f = 2 cm

17. The objective has a shorter focal length. The objective has a shorter aperture.

18. Outgoing volume /sec = incoming volume per sec

$Q + 3 \times 10^{-6} + 4 \times 10^{-6} + 1 \times 10^{-6} = 4 \times 10^{-6} + 8 \times 10^{-6} + 2 \times 10^{-6} + 7 \times 10^{-6}$

$Q = 13 \times 10^{-6} m^3 / s$

19. Here the width of principal maxima is 2.5 mm

Then its half width is = $\frac{\beta}{2}$

$= \frac{2.5}{2} = 1.25 \times 10^{-3} m$

Diffraction angle $\theta = \frac{\left(\frac{\beta}{2}\right)}{D} = \frac{1.25 \times 10^{-3}}{2}$ ....(i)

$\therefore a\theta = \lambda$ $\therefore \theta = \frac{\lambda}{a}$ ....(ii)

from (i) & (ii)

$$\lambda = \theta a$$

$$= \frac{1.25 \times 10^{-3}}{2} \times 10^{-3}$$

$$= 6.25 \times 10^{-7} m$$

$$\therefore \lambda = 6250 \overset{0}{A}$$

20. Average energy density is given by,

$$U = \frac{1}{2}\in_0 E^2 = \frac{1}{2}\in_0\left(\frac{E_0}{\sqrt{2}}\right)^2 = \frac{1}{4}\in E^2$$

$$U = \frac{1}{4}\times 8.85\times 10^{-12}\times 1^2$$

$$U = 2.2\times 10^{-12}\,J/m^3$$

21. $\vec{\tau} = \hat{i}\times B\,\hat{j} = B\hat{k}$

22. For strong reflection, the least optical path difference introduced by the film should be $\frac{\lambda}{2}$. The optical path difference between the waves reflected from the surfaces of the film is $2\mu d$.

Thus for strong reflection $2\mu d = \frac{\lambda}{2}$

$$\therefore d = \frac{\lambda}{4\mu} = \frac{589}{4\times 1.25} = 118\text{ nm}$$

23. $$\frac{E_0}{\sqrt{2}} = \sqrt{V_1^2 + (V_2 - V_1)^2} = 50V$$

$$\therefore E_0 = 50\sqrt{2}\,V$$

24. $$y = x_0\cos 2\pi\left(nt - \frac{x}{\lambda}\right)$$

$$y = x_0\cos\frac{2\pi}{\lambda}(Vt - x) \qquad \because V = n\lambda$$

$$\left(\frac{dy}{dt}\right)_{max} = x_0\frac{2\pi}{\lambda}(v) = 2V \quad (\text{given})$$

$$\therefore \lambda = \pi x_0$$

25. $$M = -\frac{V_0}{U_0}\frac{D}{fe}$$

here $u_0 = -\left(\frac{54}{131}\right)$ cm

$$M = -\frac{13.5}{\left(\frac{54}{131}\right)}\times\frac{25}{2.5}$$

$$= -327.5$$

26. Energy $\propto (\text{Amplitude})^2$

$E = KA^2$, K (constant)

$$\frac{dE}{E} = 2\frac{dA}{A} = \frac{2\times 5}{100} = 10\%$$

27. we know $b = \frac{r}{2m} = \frac{1.5}{2\times 25\times 10^{-3}} = 30$

& $\omega = \sqrt{\frac{K}{m}} = \sqrt{\frac{25}{25 \times 10^{-3}}} = \sqrt{1000}$

$\therefore$ time period

$$T = \frac{2\pi}{\sqrt{\omega^2 - b^2}} = \frac{2\pi}{\sqrt{1000 - 900}} = 0.628 \text{ sec}$$

28. Net Power given to N2 gas = 100 – 30 = 70 cal/sec
The nitrogen gas expends isobarically.

$\therefore \quad Q = nC_p \frac{dT}{dt}$ or $70 = 5 \times \frac{7}{2} R \frac{dT}{dt}$ s

$\therefore \quad \frac{dT}{dt} = 2K / \text{sec}$

29. If I is the final intensity and I_0 is the initial intensity then

$I = \frac{I_0}{2}\left(\cos^2 30\right)^5$ or $\frac{I}{I_0} = \frac{1}{2} \times \left(\frac{\sqrt{3}}{2}\right)^{10} = 0.12$

$\therefore$ % change $= 12\%$

30. Audible waves.

Chemistry

PART – II

SECTION – A

1. Normality of H_2O_2 = 11.2/5.6

$\therefore \frac{11.2}{5.6} \times V = \underset{\text{moles of Fe}^{+2}}{4} \times 1$

Normality of H_2O_2

V = 2 L

2. $n_1 = 4 \quad \because 4 \rightarrow 2$ produces 3 different lines.

$n_1 = 4 \Rightarrow \ell = 0, 1, 2, 3$

$\therefore$ orbital angular momentum $= \sqrt{\ell(\ell+1)}\hbar$

$= 0$

or $\sqrt{2}\hbar$ or $\sqrt{6}\hbar$ or $\sqrt{12}\hbar$

3. $\frac{r_1}{r_2} = \frac{K[P]^n}{K(8[P])^n}$

$2 = 8^n$

$n = \frac{1}{3}$

4. $\Delta U = \Delta H - \Delta nRT$

$= 41000 - 1 \times 8.314 \times 373$

$= 37.9 \text{ kJ mol}^{-1}$

5. $U_{mps}(A) < U_{mps}(B)$

$U_{mps} \propto \frac{1}{\sqrt{M}}$

$\therefore M_A > M_B$

$\because r \propto \frac{1}{\sqrt{M}}$

$\therefore r_A > r_B$

6. No. of A atoms = $\left(\frac{1}{8}\right) \times 7 = \frac{7}{8}$

No. of B atoms = $6 \times \frac{1}{2} = 3$

$\therefore A : B = \frac{7}{8} : 3 = 7 : 24$

7. $H_2 \rightarrow 2H^+ + 2e^-$

$$E_{ox} = E^o_{ox} - \frac{0.0591}{2}\log\left[H^+\right]^2$$
$$pH = 4.23$$

8. T ↑ Adsorption ↓

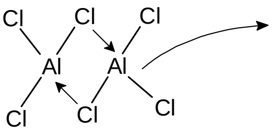
9. $\pi V = nST$

$500\ mm \times V_1 = nS \times 283$

$105.3\ mm \times V_2 = nS \times 298$

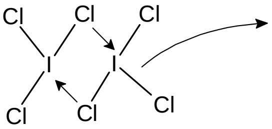
$$\frac{V_2}{V_1} = \left(\frac{298}{105.3} \times \frac{500}{283}\right)$$
$$= 5$$

10. (a)



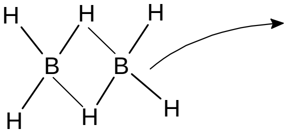
sp^3 non - planar

(b)



sp^3d^2 hybridization here square planar

(c)



sp^3 (non - planar)

(d) tub – like structure (non – planar)

11. (i) exothermic: (i), (v) & (vi)
(ii) endothermic: (ii), (iii) & (iv)

12. $M^+(NH_3) + e^-(NH_3) + NH_3(\ell) \longrightarrow MNH_2 + H_2(g)$

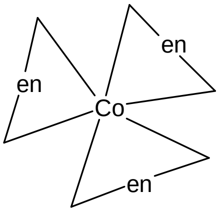
13. comparing D – O & H – O bond strength

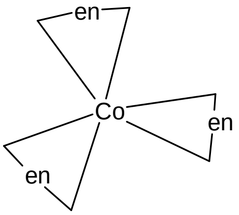
14. E_a of 1st step must be higher than 2nd step and XY has lower energy than X + Y.

15. $I^- \longrightarrow I_2$ (oxidized) & $S^{+6} \longrightarrow S^{+4}$ (Reduced)

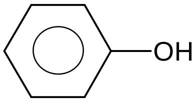
16. No catalyst is used in thermite process

17.



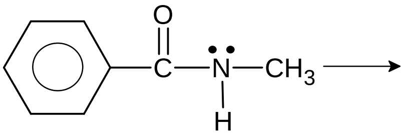


18.



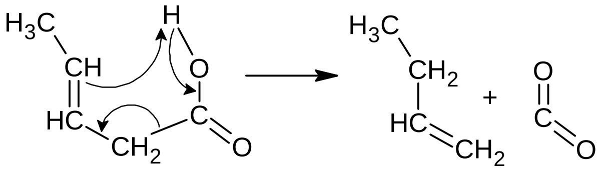
+ $BrCH_2CH_2Br$

19. In Hoffmann Bromamide reaction N-alkyl substituted amide.



will not be replaced so it dosent give hoffman bromamide reaction.

20.

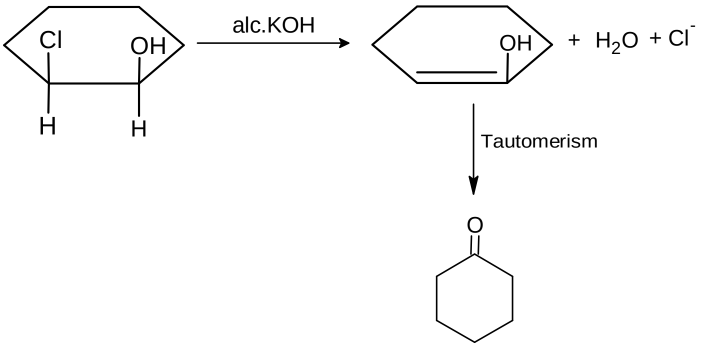


6-membered Transition state

21. $2\alpha-H$ are required for driving the equilibrium forward & getting enolate of an ester.

22. Esterification reaction

23.



24. all will produce racemic mixture, $\because$ all of them have planar intermediates.

25. IInd is non superimposable mirror image of (I).

26. A, B; planar molecule.
D-Allene, non planar with no plane/ point of symmetry.

27. octet complete.

28. It is converted into an aldehyde.

29. $K_p = \dfrac{\left(X_{Cl_2}\right)\left(X_{PCl_3}\right)}{\left(X_{PCl_5}\right)} P_T$

30. let solubility of A_2B_3 be x M $\therefore \left[A^{+3}\right] = 2x = S \therefore x = \dfrac{S}{2}M$

Mathematics PART – III

SECTION – A

1 $x = r\sec\theta$ $y = r\tan\theta$ $\left(r^2 = x^2 - y^2\right)$

$$\frac{rdr}{r^2\sec\theta d\theta} = r\sec\theta$$

$$\int\frac{dr}{r^2} = \int\sec^2\theta d\theta$$

$$-\frac{1}{r} = \tan\theta + c$$

$$-\frac{1}{\sqrt{x^2-y^2}} = \frac{y}{\sqrt{x^2-y^2}} + c$$

Put $y = 0$ at $x = 1$, $C = -1$

so $y + 1 = \sqrt{x^2-y^2}$

2. $$\frac{\left(1+\frac{\sqrt{x}}{2}\right)^{40} + \left(1-\frac{\sqrt{x}}{2}\right)^{40}}{2} = \left[nC_0 + nC_2\left(\frac{\sqrt{x}}{2}\right)^2 + nC_4\left(\frac{\sqrt{x}}{2}\right)^4 + ...\right]$$

Put x = 1,

$$\frac{\left(1+\frac{1}{2}\right)^{40} + \left(1-\frac{1}{2}\right)^{40}}{2} = \frac{\frac{3^{40}}{2^{40}} + \frac{1}{2^{40}}}{2}$$

$$= \frac{3^{40}+1}{2^{41}}$$

3. $(2x + y - 6) + \lambda(2y - 3x - 12) = 0$

so fixed point where ℓ_1 & ℓ_2 will pass is,

$2x + y - 6 = 0$

$2y - 3x - 12 = 0$

we get, $(0, 6)$

slope of line $\ell_1 = -\left(\dfrac{1}{\frac{3}{-4}}\right) = \dfrac{4}{3}$

slope of line $\ell_2 = -\left(\dfrac{r}{s}\right) = -\dfrac{1}{5}$

$\tan\theta = \left|\dfrac{m_1 - m_2}{1 + m_1m_2}\right| = \dfrac{23}{11} \Rightarrow \theta = \tan^{-1}\left(\dfrac{23}{11}\right)$

4. $\dfrac{p}{q}\times\dfrac{q}{r}\times\dfrac{r}{p} = 1$

$\Rightarrow \alpha^3 = 1 \Rightarrow$

$$\begin{tikzcd} & 1 & \text{(not possible b/c distinct p,q,r)} \\ \alpha \arrow[ur] \arrow[r] \arrow[dr] & \omega & \\ & \omega^2 & \end{tikzcd}$$

$\Rightarrow \alpha = \omega$ & $\alpha = \omega^2$

$\Rightarrow \omega + \omega^2 = -1$

5. $f'(x) = \dfrac{f(x+h) - f(x)}{h}$

$= \dfrac{f(h) + (x^2 + h^2)xh}{h}$

$f'(x) = \lim\limits_{h\to 0} \dfrac{f(h)}{h} + x(x^2 + h^2)$

$= 2 + x^3$

$f(x) = 2x + \dfrac{x^4}{4} + K$

for K, $\lim\limits_{n\to u} \dfrac{f(x)}{x} = 2$

$\dfrac{2x + \frac{x^4}{4} + K}{x} = 2 \Rightarrow k = 0$

so, $f(x) = 2x + \dfrac{x^4}{4}$

6. $S = \{x, y : 0 \le x, y \le 60\}$

$A \to$ Event that $x - y \le 10$

$B \to$ Event that $y - x \le 10$

$n(E) = 60^2 - 2 \times \dfrac{1}{2} \times 50 \times 50$

$P(E) = \dfrac{1100}{3600}$

7. $n(E) = \dfrac{1}{2}\left[{}^4C_1.{}^2C_1 + {}^{24}C_1.{}^3C_1 + {}^{36}C_1.{}^4C_1\right] = 112$

$\Rightarrow P(E) = \dfrac{112}{{}^{64}C_2} = \dfrac{1}{18}$

8. Divide by 2^x,

$2^x + 2^{-x} = 5\cos x - 3$

$\underset{(\ge 0)}{2^x + 2^{-x} - 2} = \underset{(\le 0)}{5(\cos x - 1)}$

$\cos x - 1 = 0$ & $2^x + 2^{-x} = 2$

$\Rightarrow x = 0, 2\pi, 4\pi \ \& \ x = 0$

Inter sec tion of both solution we get $x = 0$

Number of solution $= 1$

9. $\dfrac{f'(x)}{f(x)} = \sum\limits_{n=1}^{50}, n(51-n)\left(\dfrac{1}{x-n}\right)$

$\dfrac{f'(51)}{f(51)} = \sum\limits_{n=1}^{50} n(51-n) \times \dfrac{1}{(51-n)}$

$\dfrac{f(51)}{f'(51)} = \dfrac{1}{1275}$

10. $f'(n) = e^{2n^3} + 3n^2 + 6x - 5 \left(6x^2 + 6x + 6\right)$

$= 6\left(x^2 + x + 1\right)e^{2x^3+3x^2+6x-5} > 0$

and $e^{2x^3+3x^2+6x-5}$ will not be negative so one - one into

11. $\displaystyle\int \frac{\operatorname{cosec}^2 x - n}{\cos^n x}dx = \int\left(\operatorname{cosec}^2 x - n\right)\sec^n x \, dx$

$= \displaystyle\int\left(\operatorname{cosec}^2 x\right)\sec^n x \, dx - \int n \sec^n x \, dx$

using by part

we get $= -\sec^{(n-1)} x \operatorname{cosec} x$

so, $f(x) = \operatorname{cosec} x \ \& \ 9(x) = \sec x$

and min value of $\sqrt{\sec^2 x + \operatorname{cosec}^2 x} = 4$

so $(4)^n = (2)^{2n}$

12. Let $f(x) = \sum\limits_{r=-1}^{m}\left(x - \dfrac{1}{2^r}\right)^{2n+1}$

After differentiation f'(x) is positive so f(x) is increasing so only one real root & other are imaginary.

13. sum of division $= \underset{\downarrow}{(2)} \qquad \left(3^0 + 3^1 + 3^2 + 3^3\right)\left(5^0 + 5^1 + 5^2\right)\left(7^0 + 7^1\right)$

exact 2 will come

$= 2 \times 40 \times 31 \times 8$

$= 19840$

14. $(p \wedge \sim q) \Rightarrow r$

converse $r \Rightarrow (p \wedge \sim q)$

inverse $\sim r \Rightarrow \sim (p \wedge \sim q)$

$\sim r \Rightarrow (\sim p \vee q)$

$\sim r \Rightarrow (\sim p \vee q)$

$\sim r = (p \Rightarrow q)$

15. roots are x = 1, 1

Product of root = 1 $\Rightarrow$ b = $\frac{2ac}{a+c}$

$\Rightarrow$ a, b, c are in HP

$\frac{1}{a},\frac{1}{b},\frac{1}{C}$ are in AP

$\frac{S}{a},\frac{S}{b},\frac{S}{C}$ are in AP

$\frac{S-a}{a},\frac{S-b}{b},\frac{S-c}{c}$ are in AP

$\frac{bc}{(S-b)(S-c)},\frac{ca}{(S-c)(S-a)},\frac{ab}{(S-a)(s-b)}$ are in AP

16. This is shifted ellipse $3(x-1)^2+4(x-1)(y+2)+3(y+2)^2=0$

$$3X^2+4XY+3Y^2=1$$

so rotate 45^0 we get

$\frac{x^2}{5}-\frac{y^2}{1}=1\Rightarrow A=\frac{\pi}{\sqrt{5}}$

17. Put $e^x=t$

$$\int_0^1 t^{121}(1-t)^{19}\,dt$$

$$I_{121,18}=\frac{1}{(121+19+1)\left({}^{121+19}C_{19}\right)}$$

$$=\frac{1}{141\times\left({}^{140}C_{19}\right)}=\frac{19!121!}{141!}$$

18. 3 vowels can be selected by = 12 ways
Consonant can be selected by 72 ways
Total ways = $6C_3\times12\times72=17280$

19. $E_1\rightarrow n_F=n_B$ and $n_R=n_L+1$

$E_2\rightarrow n_F=n_B$ and $n_L=n_R+1$

$E_3\rightarrow n_R=n_L$ and $n_F=n_B+1$

$E_4\rightarrow n_R=n_L$ and $n_B=n_F+1$

$P(E_1)=P(E_2)=P(E_3)=P(E_4)$

$P(E)=4P(E_1)$

$n(s)=4^9$

Event E_1 can occurs in following ways,

F	B	R	L
0	0	5	4
1	1	4	3
2	2	3	2
3	3	2	1
4	4	1	0

$$n(E_1)={}^9C_5.{}^4C_4+{}^9C_1.{}^8C_1.{}^7C_4.{}^3C_3+{}^9C_2.{}^7C_2.{}^5C_3.{}^2C_2+{}^9C_3.{}^6C_3.{}^3C_2.{}^1C_1+{}^9C_4.{}^5C_4.{}^1C_1=15876$$

$$P(E)=4\times\left(\frac{15876}{4^9}\right)$$

20. $[nx] = (n+1)x$

$nx - \{nx\} = nx + x$

$-x = \{nx\}$

$\Rightarrow x = 0$ (one solution)

since n is the positive integer so Total solution of x is $n+1$

21. $$I = \int_0^{\frac{\pi}{8}} \frac{\left(\frac{\pi}{8} - x\right)}{1 + \cos 4\left(\frac{\pi}{8} - x\right) + \sin 4\left(\frac{\pi}{8} - x\right)} dx$$

$$2I = \frac{\pi}{8} \int_0^{\frac{\pi}{8}} \frac{1}{1 + \cos x + \sin 4x} dx$$

$$= \frac{\pi}{8} \int_0^{\frac{\pi}{8}} \frac{\sec^2 2x}{2 + 2\tan 2x} dx$$

$$I = \frac{\pi}{64} \int_0^{\frac{\pi}{4}} \frac{\sec^2 t}{1 + \tan t} dt$$

$$I = \frac{\pi}{64} \left|\ell n(1 + \tan t)\right|_0^{\frac{\pi}{4}} = \frac{\pi}{64} \ell n2$$

$$\Rightarrow b = 64$$

22. $$\int_1^e e^x (x\ell nx + \ell nx) dx$$

$$\int_1^e e^x (x\ell nx + \ell nx + 1 - 1)\, dx$$

$$\int_1^e e^x (x\ell nx + (\ell nx + 1)) - \int_1^e e^x dx$$

$$\left|e^x x\ell nx\right|_1^e - \left|e^x\right|_1^e$$

$$= e^{e+1} - e^e + e$$

$P = e + 1, q = e, r = 1$ & so, $p + q + r = e + 1 + e + 1$

$$= 2e + 2$$

$$= 2(e+1)$$

23. $a + b > c$ (sum of two side > third side)

$a - c + b > 0 \Rightarrow f(1) > 0$

$f(-2) \geq 0$ also

$4a - 2c + b \geq 0$

$\Rightarrow b \geq 2(-4a)$

24. $x^2 - 3x + 3 = 1 \quad \& \quad x^2 = 1$

$x = 1, 2 \quad ---(i) \quad \& \quad x = \pm 1 \; -------(ii)$

Taking intersection and we get x = 1.
So only one solution is possible.

25. $A^{-1} = \frac{1}{|A|}\text{adj}(A) \Rightarrow A^{-1} = \begin{bmatrix} 1 & -2 & 1 \\ 0 & 1 & -2 \\ 0 & 0 & 1 \end{bmatrix}$

$|A| = 1 \quad \& \; BA = A$

$BAA^{-1} = AA^{-1} \Rightarrow B = I$

Total no of 1 in matrix B = 3 & matrix $A^{-1} = 4$

26. $\frac{\sin A}{\sin c} = \frac{\sin(A-B)}{\sin(B-C)}$

$\sin(B+C)\sin(B-C) = \sin(A+B)\sin(A-B)$

$\sin^2 B - \sin^2 C = \sin^2 A - \sin^2 B$

$\Rightarrow \sin^2 A, \sin^2 B, \sin^2 C \Rightarrow AP$

$\sin A \sin A, \sin B \sin B, \sin C \sin C \Rightarrow AP$

$\frac{a}{2R}\sin A, \frac{b}{2R}\sin B, \frac{C}{2R}\sin C \Rightarrow AP$

$a\sin A, b\sin B, c\sin C \Rightarrow AP$

27. let any point on $x^2 = 4y$ as $(2t, t^2)$ mirror image of $(2t, t^2)$ along line x + y = 2 is (h, k). is

$\frac{h-2t}{1} = \frac{K-t^2}{1} = -2\left(\frac{2t+t^2-2}{2}\right)$

$h = 2t - 2t - t^2 + 2 = 2 - t^2$

$K = t^2 - 2t - t^2 + 2 = 2 - 2t$

$\frac{(2-K)}{2} = t \Rightarrow t^2 = 2 - h$

$(2-K)^2 = 4(2-h)$

$h \Rightarrow x \;\&\; y \Rightarrow y$

$(y-2)^2 = 4(2-x)$

28. $\therefore 4(\sin^3 A + \sin^3 B + \sin^3 C) + 12(\sin A \sin B \sin C) = 0$

$\therefore 4(\sin^3 A + \sin^3 B + \sin^3 C - 3\sin A \sin B \sin C) = 0$

$\Rightarrow \sin A + \sin B + \sin C = 0 \quad \sin A = \sin B = \sin C$

29. $$\lim_{n\to 0} \frac{(e^{2002x}+1) - (1+1001x)e^{-1001x} - (1+1001x)(e^{1001x}+1)}{x^2\left(\frac{e^x - 1}{x}\right)}$$

$$\underset{n\to 0}{\text{lt}}\left(e^{2002x}+1\right)e^{-1001x}\left[\frac{e^{1001x}-\left(1+1001x\right)}{n^2}\right]\left[\frac{x}{e^x-1}\right]$$

$$\underset{n\to 0}{\text{lt}}\,2\times 1\times\frac{\left(1001\right)^2}{2}\times 1=\left(1001\right)^2$$

30. let $\log_2^x = t$

$$\left(t^2-t+1\right)\log_2^x=\log_2^{2^{-1+\frac{1}{8}}}$$

$$\left(t^2-t+1\right)t=-\frac{7}{8}$$

$$\Rightarrow t^3-t^2+t+\frac{7}{8}=0$$

$$\Rightarrow\left(t+\frac{1}{2}\right)\left(t^2-\frac{3}{2}+t\frac{7}{4}\right)\qquad D<0\quad\text{so imaginary value of } t$$

so, $t=-\frac{1}{2}$

$$\log_2^x=-\frac{1}{2}$$

$$x=2^{-\frac{1}{2}}=\left(\text{real value}\right)$$

so we get one real value of x.

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

ALL INDIA TEST SERIES

FIITJEE **JEE (Advanced), 2017**

FULL TEST – II

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 234**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 – 12) contains 4 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

Section-A (13 to 18) contains 3 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-C (01 – 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

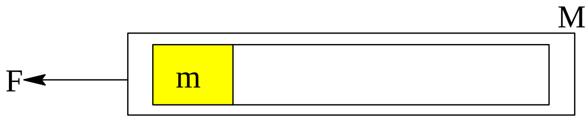
PART – I

SECTION – A

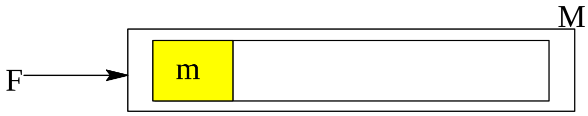
Straight Objective Type

This section contains **08 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. A block of mass m is placed in contact with one end of a smooth tube of mass M (see figure). A horizontal force F acts on the tube in each case (i) and (ii). Then mark **incorrect** option:



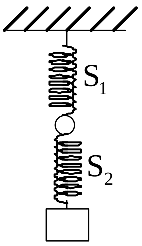
(i)



(ii)

(A) $a_m = 0 \text{ and } a_M = \frac{F}{M} \text{in} (i)$
(B) $a_m = a_M = \frac{F}{M+m} \text{in} (i)$
(C) $a_m = a_M = \frac{F}{M+m} \text{in} (ii)$
(D) Force on m is $\frac{mF}{M+m} \text{in} (ii)$

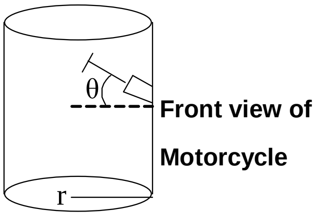
2. Two springs, S_1 and S_2, have negligible masses and the spring constant of S_1 is $1/3$ that of S_2. When a block is being hanged from the springs as shown above and the springs slowly come to equilibrium again, the ratio of the potential energy stored in S_1 to the S_2 is:



(A) 1/9
(B) 1/3
(C) 1
(D) 3

Space for rough work

3. A trick cyclist rides his bike around a well of death in the form of a vertical cylinder (see figure). The maximum frictional force parallel to the surface of the cylinder is equal to a fraction μ of the normal force exerted by the wall. At what minimum constant speed must the cyclist go to avoid slipping down? (Assume that size of motorcycle is very small as compared to cylinder.



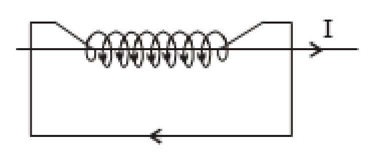
(A) $\left[\dfrac{2gr\cos\theta}{\mu}\right]^{1/2}$ (B) $\left[\dfrac{gr\sin\theta}{2\mu}\right]^{1/2}$

(C) $\left[\dfrac{gr}{\mu}\right]^{1/2}$ (D) $\left[\dfrac{2gr}{\mu}\right]^{1/2}$

4. A thermometer consists of a quantity of alcohol in a glass tube. When the thermometer is in thermal contact with soft ice cream in a box the length of the alcohol column is 5 cm and thermal equilibrium. When placed in a freezer the alcohol column remains 5 cm long in thermal equilibrium. When ice cream is put in the freezer.

(A) Ice cream melts (B) Ice cream freezes more
(C) Ice cream neither melts nor freezes more (D) Insufficient information.

5. In the diagram shown, a wire carries current I. What is the value of the $\oint \vec{B}.d\,\vec{s}$ (as in Ampere's law) on the helical loop shown in the figure? The integration in done in the sense shown. The loop has N turns and part of helical loop on which arrows are drawn is outside the plane of paper.



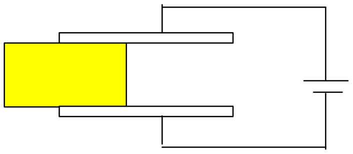
(A) $-\mu_0(NI)$ (B) $\mu_0(I)$
(C) $\mu_0(NI)$ (D) Zero

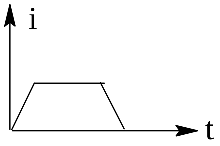
6. A projectile is thrown with velocity U = 20m/s ± 5% at an angle 60°. If the projectile falls back on the ground at the same level then which of following can not be a possible answer for range. Consider $g = 10 m/s^2$.

(A) 39.0 m (B) 37.5 m
(C) 34.6 m (D) 32.0 m

Space for rough work

7. A dielectric slab of area A passes between the capacitor plates of area 2A with a constant speed v. The variation of current (i) through the circuit as function of time (t) can be qualitatively represented as



(A)


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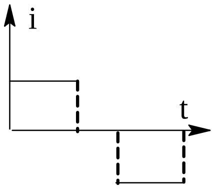

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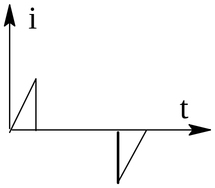

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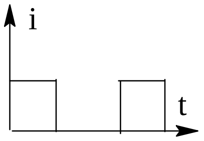
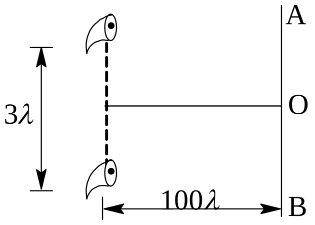


8. 2 loudspeakers are emitting sound waves of wavelength λ with an initial phase difference of $\frac{\pi}{2}$. At what minimum distance from O on line AB will one hear a maxima



(A) 25λ

(B) $\frac{100\lambda}{\sqrt{15}}$

(C) $\frac{25\lambda}{3}$

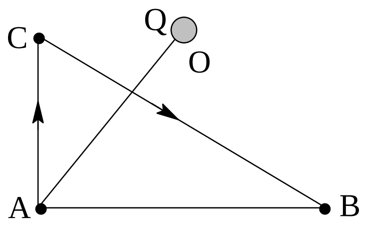
(D) 50λ

Space for rough work

Multiple Correct Choice Type

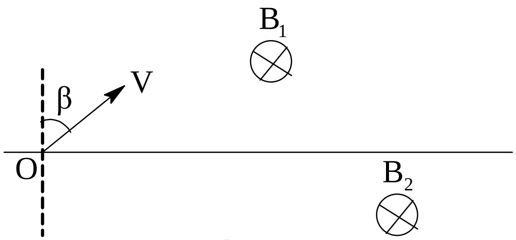
This section contains **04 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

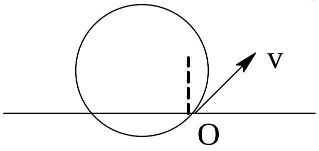
9. There is a fixed positive charge Q at O and A and B are points equidistant from O. A positive charge + q is taken slowly by an external agent from A to B along the line AC and then along the line CB.



(A) The total work done on the charge is zero
(B) The work done by the electrostatic force from A to C is negative
(C) The work done by the electrostatic force from C to B is positive
(D) The work done by electrostatic force in taking the charge from A to B is dependent on the actual path followed.

10. In the diagram shown, a particle of charge +Q and mass M is projected making an angle β with the vertical line. Which the possible path on which the charge will move. Above the dark line magnetic field is B_1 and below it is B_2. (Consider all possible cases for values of $B_1 \text{and } B_2$)



(A)


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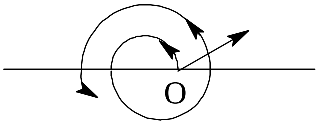

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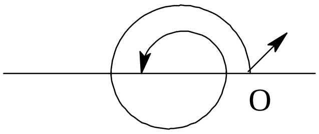
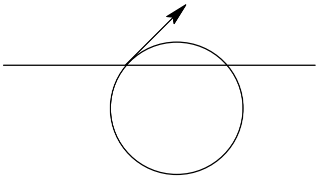


(D)


Space for rough work

11. Two particles of mass m1 and m2 are moving with velocity $\vec{v}_1$ and $\vec{v}_1$ respectively. Mark the correct statement about a perfectly inelastic collision between m_1 and m_2.

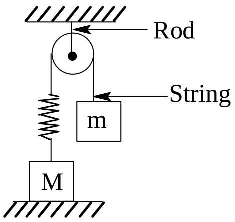
(A) Impulse by m_1 to m_2 is $\frac{m_1m_2}{m_1+m_2}\left(\vec{v}_1-\vec{v}_2\right)$

(B) Momentum transferred by m_2 to m_1 is $\frac{m_1m_2}{m_1+m_2}\left(\vec{v}_2-\vec{v}_1\right)$

(C) Impulse by m_1 on m_2 in CM frame is $\frac{m_1m_2}{m_1+m_2}\left(\vec{v}_2-\vec{v}_1\right)$

(D) In CM frame both the particles come to rest after perfectly inelastic collision.

12. In figure, a block of mass m is released from rest when spring was in its natural length. The pulley also has mass m but it is frictionless. Suppose the value of m is such that finally it is just able to lift the block M up after releasing it.



(A) The weight of m required to just lift M is $\frac{M}{2}g$

(B) The tension in the rod, when m is in has zero acceleration $\frac{M}{2}g$

(C) The normal force acting on M when m has zero acceleration $\frac{M}{2}g$

(D) The tension in the string when displacement of m is maximum possible is Mg

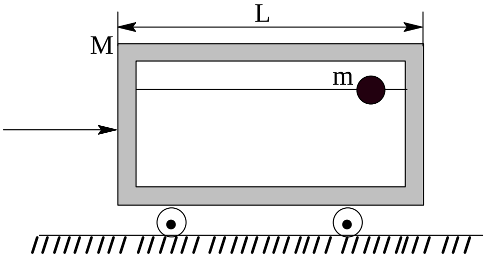
Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

Paragraph for Questions 13 & 14

A horizontal frictionless rod is threaded through a bead of mass m. The length of the cart is L and the radius of the bead, r, is very small in comparison with L (r << L). Initially at (t = 0) the bead is at the right edge of the cart. The cart is struck and as a result, it moves with velocity υ_0. When the bead collides with the cart's walls, the collisions are always completely elastic. (Given: m > M).



13. What is the velocity of the cart after the first collision, in the center of mass frame?

(A) $\frac{-m v_0}{m+M}$
(B) $\frac{M v_0}{m+M}$
(C) $\frac{M-m}{M+m}v^0$
(D) $\frac{2M}{m+M}v^0$

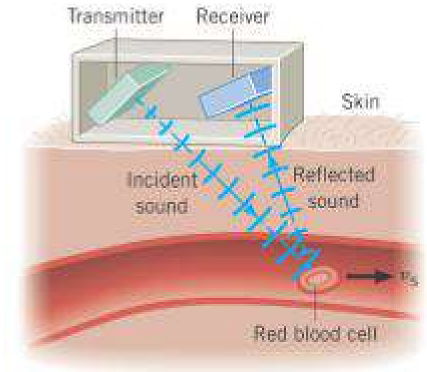
14. The first collision takes place at time t1 and the second collision takes place at $t=0 \text{ till } t=t_2 \text{ if } m>M_0$

(A) $\frac{2ML}{m+M}$
(B) $\frac{ML}{2(m+M)}$
(C) $\frac{2M}{m+M}L$
(D) $\frac{ML}{2(m+M)}$

Space for rough work

Paragraph for Questions 15 & 16

The Doppler flow meter is a particularly interesting medical application of the Doppler effect. This device measures the speed of blood flow, using transmitting and receiving elements that are placed directly on the skin, as in Figure. The transmitter emits a continuous sound whose frequency is typically about 5 MHz. When the sound is reflected from the red blood cells, its frequency is changed in a kind of Doppler effect because the cells are moving with the same velocity as the blood. The receiving element detects the reflected sound, and an electronic counter measures its frequency, which is Doppler-shifted relative to the transmitter frequency. From the change in frequency the speed of the blood flow can be determined. Typically, the change in frequency is around 600 Hz for flow speeds of about 0.1 m/s.



15. Assume that the red blood cell is directly moving away from the source and the receiver. What is the (approx) speed of the sound wave in the blood?

(A) 1700 m/s	(B) 330 m/s
(C) 5000 m/s	(D) 3000 m/s

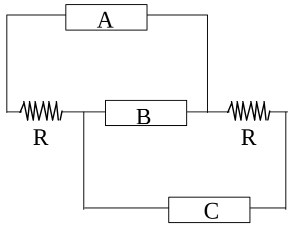
16. An abnormal segment of the artery is narrowed down by an arteriosclerotic plaque to one-fourth the normal cross-sectional area. What will be the change in frequency due to reflection from the red blood cell in that region?

(A) 150 Hz	(B) 300 Hz
(C) 600 Hz	(D) 2400 Hz

Space for rough work

Paragraph for Questions 17 & 18

A circuit is shown below.



17. If A is an ideal ammeter, B an ideal Battery of voltage V, and C an ideal voltmeter, what will be the $\frac{\text{reading of C}}{\text{reading of A}}$?

(A) R	(B) 2R
(C) $\frac{R}{2}$	(D) 0

18. If A is a capacitor, B is an ideal ammeter and C is an ideal battery of voltage V, what is the voltage across the capacitor ?

(A) V	(B) $\frac{V}{2}$
(C) 2V	(D) 0

Space for rough work

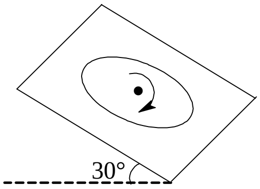
SECTION – C

(One Integer Value Correct Type)

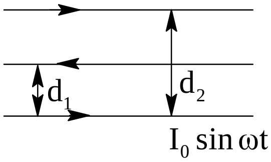
This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. In a slow reaction, heat is being evolved at a rate about 10mW in a liquid. If the heat were being generated by the decay of ^{32}P, a radioactive isotope of phosphorus that has half-life of 14 days and emits only beta-particles with a mean energy of 700KeV. The number of ^{32}P atoms in the liquid is $A \times 77 \times 10^{15}$ find a:
[Take: ln 2 = 0.7]

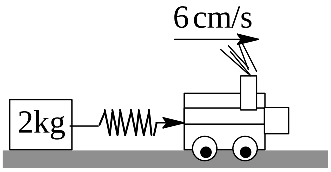
2. An old record player of 10 cm radius turns at 10 rad/s while mounted on a 30° incline as shown in the figure. A particle of mass m can be placed anywhere on the rotating record. If the least possible coefficient of friction μ that must exist for no slipping to occur is μ, find $2\sqrt{3}\mu$.



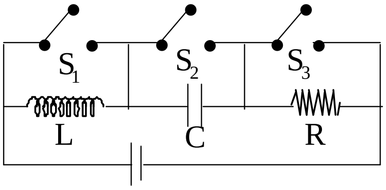
3. Two long straight wires of telephone circuit inside a house are coplanar with and run parallel to a third long straight conductor that carries a current $i = i_0 \sin \omega t$. The wires are at a distance of d_1 and d_2 from the conductor. The conductor induced a noise in the telephone circuit. The rms voltage per unit length of this induced emf is $x \times 5$, find x? Express your answer in µV. Take $d_2 = 2d_1, i_0 = \frac{2\sqrt{2}}{\ln 2} A\ \omega = 50\ \text{rad/s}$



4. Figure a shows a spring attached to a 2.0 kg block. The other end of the spring is pulled by a motorized toy train that moves forward at constant speed 6.0 cm/s. The spring constant is 50 N/m and the coefficient of static friction between the block and the surface is 0.60. The spring is at its natural length at t = 0s when the train starts to move. When does the block slip (express your answer in second)?



5. Consider the circuit shown in figure. With switch S_1 closed and the other two switches open, the circuit has a time constant 0.05 sec. With switch S_2 closed and the other two switches open, the circuit has a time constant 2 sec. With switch S_3 closed and the other two switches open, the circuit oscillates with a period T. Find T(in sec). (Take $\pi^2 = 10$)



Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **08 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. $$\underset{(\text{cis})}{CH_3HC=CHCH_3} + \underset{(\text{triplet state})}{CH_2} \rightarrow P$$

(A) P is a cis isomer
(B) P is a trans isomer
(C) P is a mixture of cis and trans isomers
(D) P is acyclic compound

2. $BaTiO_3$ crystallizes in perovskite structure. This structure may be described as a cubic lattice, with barium ions occupying the corners, oxide ions at the face centres and titanium ions in one of the octahedral holes. Which of the following is correct about $BaTiO_3$ crystal lattice?

(A) Ti^{4+} must the body centred octahedral hole
(B) Ti^{4+} must occupy the edge centred octahedral hole
(C) Ti^{4+} must occupy any of the octahedral holes
(D) $1/4$ th of the octahedral holes are occupied

3. Ammonium compound which on heating does not give NH_3 is

(A) $(NH_4)_2SO_4$
(B) $(NH_4)_2CO_3$
(C) NH_4NO_2
(D) NH_4Cl

Space for rough work

4. The standard electrode potentials of some of the alkali metals are

$$Li^+/Li = -3.05\,V$$

$$Na^+/Na = -2.71\,V$$

$$K^+/K = -2.93\,V$$

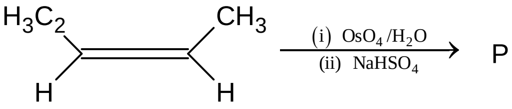
Alkali metals react with water according to the following reaction. (M = alkali metal)

$$2M + H_2O \rightarrow 2MOH + H_2$$

It is found Li reacts gently with water whereas potassium reacts violently with water. Which of the following statement (s) is/ are correct regarding the above two experimental facts?

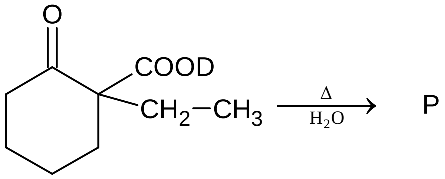
(A) ΔG values related with the kinetics of a reaction
(B) The metal having large standard oxidation potential will have lesser reactivity.
(C) K has a low melting point, and the heat of reaction is sufficient to make it melt or even vaporize. This leads to exponential increase in its surface area.
(D) The ionization potential of K is smaller than that of Li.

5.



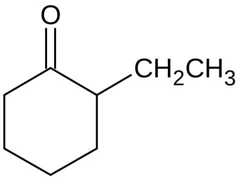
Which of the following is true about P ?
(A) P is optically inactive due to internal compensation
(B) P is optically inactive due to external compensation
(C) P is optically inactive
(D) P is optically inactive due the absence of chiral carbon.

6.

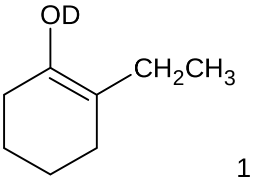


Which is not possible for P is

(A)



(B)



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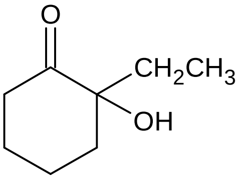
(C)



(D) None of these

Space for rough work

7. The salt having isoelectronic cation and anion among the following is

(A) $NaCl$	(B) KF
(C) $CaCl_2$	(D) KBr

8. Which of the following statement(s) is/ are incorrect?
(A) o – phenol sulphonic acid be converted into p – phenol sulphonic acid in the presence of H_2SO_4 if temperature is increased.
(B) Phenol is more acidic than benzyl alcohol
(C) Phenoxide ion activates the more in comparison to phenol
(D) Bromination of phenol in aqueous medium produces 2 – bromophenol and 4 - bromophenol

Multiple Correct Choice Type

This section contains **04 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

9. Which of the following special (s) is/ are isostructural with lF_4^- ?

(A) $\left[Cu\left(NH_3\right)_4\right]^{2+}$	(B) XeF_4
(C) BF_4^-	(D) $\left[Ni\left(CN\right)_4\right]^{2-}$

10. Identify the incorrect statement (s)?
(A) The ration of the observed molar volume to ideal volume is called compressibility factor.
(B) The value of van der Waals constants 'a' and 'b' is independent of the nature of gas.
(C) At high temperature and low pressure, the behaviour of any gas can be explained by $\left(P+\frac{an^2}{V^2}\right)\left(V-nb\right)=nRT$
(D) H_2 and He gases are difficult to liquefy because their Critical temperature is very small.

Space for rough work

11. In which of the following reactions, the stiochiometric ratio of H_2SO_4 to H_2 gas is the same?
(A $Zn(s) \text{and} H_2SO_4$ (B) $Na(s) \text{and} H_2SO_4$
(C) $Al(s) \text{and} H_2SO_4$ (D) $Ni(s) \text{and} H_2SO_4$

12. Which of the following compound (s) will not dissolve in an alkali solution after it has undergone reaction with Hinsberg's reagent?
(A) Diethyl amine (B) Isopropyl amine
(C) N – methyl ethanamine (D) N, N – dimethyl aniline

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

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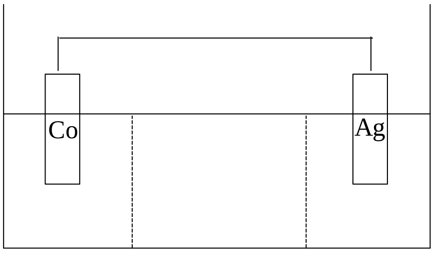
Paragraph for Questions 13 & 14

The cell given below consists of three compartments, separated by porous barriers. The first contains a cobalt electrode in $5\,L \text{ of } 0.1\,M\,Co(NO_3)_2$; the second contains $5\,L \text{ of } 0.1\,M$

KNO_3 the third contains a silver electrode in $5\,L \text{ of } 0.1\,M\,AgNO_3$ Assume that the current within in the cell Is carried equally by the positive and negative ions. If 'there is a passage of 0.1 mol of electrons, answer the following (19, 20 and 21) questions.



$E^o_{Co^{2+}/Co} = -0.28V$

$E^o_{Ag^+/Ag} = 0.8V$

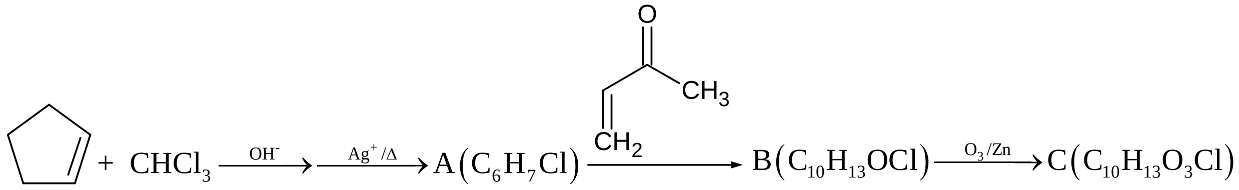
13. The concentrations of Co^{2+} and NO_3^- in the left hand side .compartment are
(A) $0.105\,M \text{ and } 0.210\,M$ (B) $0.08\,M \text{ and } 0.16\,M$
(C) $0.1\,M \text{ and } 0.2\,M$ (D) $0.05\,M \text{ and } 0.1\,M$

14. The concentrations of $Ag^+ \text{ and } NO_3^-$ In the right hand side compartment are.
(A) $0.08\,M \text{ and } 0.09\,M$ (B) $0.75\,M \text{ and } 0.08\,M$
(C) $0.01\,M \text{ and } 0.09\,M$ (D) $0.75\,M \text{ and } 0.09\,M$

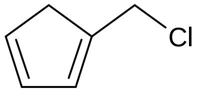
Space for rough work

Paragraph for Questions 15 & 16

In the following sequence of reaction,


+ $CHCl_3$
OH^-
Ag^+/Δ
$A(C_6H_7Cl)$
O
CH_3
CH_2
$B(C_{10}H_{13}OCl)$
O_3/Zn
$C(C_{10}H_{13}O_3Cl)$

15. Compound A is

(A)


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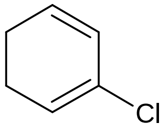

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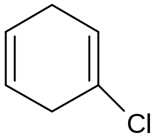
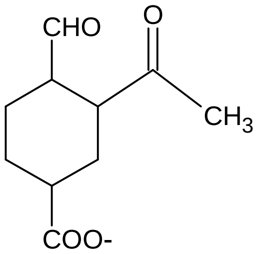
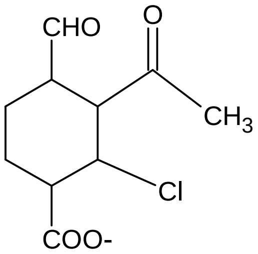
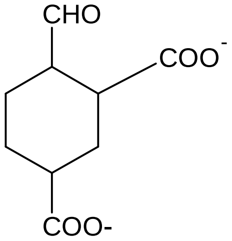


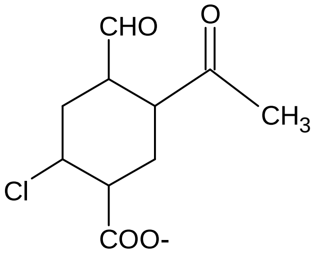
(D) None of these

16. Compound C when treated with NaOH/ X_2 gives

(A)

CHO
O
CH_3
COO-

(B)

CHO
O
CH_3
Cl
COO-

(C)


(D)

CHO
O
CH_3
Cl
COO-

Space for rough work

Paragraph for Questions 17 & 18

Potassium dichromate is used as lab reagent and dichromate ion can be used as a primary standard in volumetric analysis.

$$\frac{1}{2}Cr_2O_7^{2-}+7H^{+}+3e \rightleftharpoons Cr^{3+}+3\frac{1}{2}H_2O;E^{\circ}=1.33V$$

When H_2O_2 is added to an acidified solution of dichromate, a complicated reaction occurs. The formation of product depends on the pH value and concentration of dichromate ions. A deep-blue violet peroxo compound X is formed which decomposes rapidly in aqueous solution. This compound can be extracted in ether, where it reacts with pyridine fanning the adduct $PyCro(O_2)_2$.

In alkaline solution $K_2Cr_2O_7$ with 30% H_2O_2, a read – brown compound $Y(K_3CrO_8)$ is formed. In alkaline solution the dark red – brown compound $Z[(NH_3)_3CrO_4]$ is formed. In alkaline solution dichromate ion changes to chromate ion which is also used as reagent in quantitative analysis of cations.

17. The shape of compound (Z) is
    (A) Butterfly shape
    (B) Pentagonal pyramidal
    (C) Pentagonal bipyramidal
    (D) Tetrahedral

18. What is the oxidation state of Cr In red-brown compound Y?
    (A) + 6
    (B) + 4
    (C) + 5
    (D) + 13

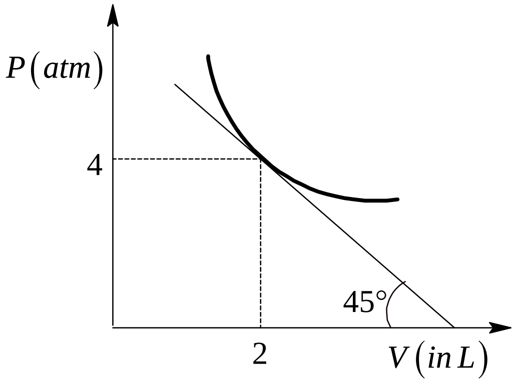
Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. The molar heat capacity of the ideal monoatomic gas undergoing the process shown in the figure is 'x'. The value of '2x' will be

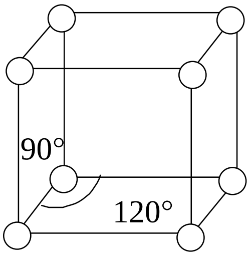


2. How many statement(s) are correct?

(a) if the critical micelle concentration (CMC) of a soap is $10^{-3}M$, then $10^{-4}M$ solution of this soap will have colloidal nature.
(b) charge on the colloidal particles may be determined with the help of dialysis
(c) peptization is the process of conversion of a colloidal sol into precipitate by adding some electrolyte
(d) when some oil-soluble dye is added in the water in oil emulsion, the back ground becomes coloured
(e) For the coagulation of a particular colloidal solution, the order of coagulation power of some electrolytes is in the order: $Na_3PO_4 > BaSO_4 > AlCl_3,$ in electro-osmosis, the dispersion medium move towards the anode
(f) diffused layer around colloidal particles in the electric double layer mostly contains negatively charged particles.(colloid is of 'e' part)
(g) it may be basic dye such as methylene blue (colloid is of 'e' part)
(h) it may be metal sol (colloid is of 'e' part)

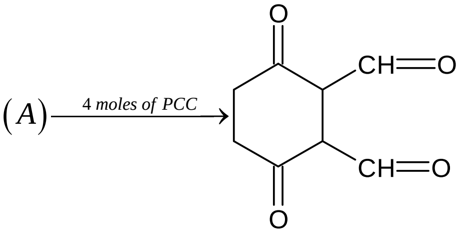
Space for rough work

3. Ice crystallizes is an hexagonal lattice. At the low temperatures at which the structure was determined, the lattice constants were $a = 4.53 \mathring{A}$ and $b = 7.41 \mathring{A}$ as shown in the figure. How many H molecules are contained in a unit cell? (Given that density of ice $= 0.92\, g/cm^3$)?



4. A weak acid type indicator was found to be 60% dissociated at pH = 9.18. If the degree of dissociation at pH = 9.0 is 'α'? Then the value of '10α' will be $\left(\log 2 = 0.3, \log 3 = 0.48\right)$

5.



Maximum number of moles of $\mathrm{Ac_2O}$ consumed by reactant (A) is?

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **08 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. Conditions so that equation $(a_1x^2+b_1x+c_1)(a_2x^2+b_2x+c_2)=0$, ($a_1a_2>0$) have fours real roots if
(i) $c_1c_2>0$ (ii) $a_1c_2<0$ (iii) $a_2c_1<0$
(A) only (i) is sufficient
(B) either of two statements are sufficient
(C) either of two statements are necessary and sufficient
(D) all the three statements are sufficient

2. In a ΔABC, the incircle touches the sides BC, CA and AB at D, E, F respectively. If radius of incircle is 4 units and BD, CE and AF are in A.P. with common difference 1, then area of ΔABC is
(A) 84 sq. units (B) 42 sq. units
(C) 168 sq. units (D) data insufficient

3. Let A be the area between co-ordinate axis, $y^2=x-1$, $x^2=y-1$ and the line which makes the shortest distance between two parabolas and A′ be the area between x=0, $x^2=y-1$, x=y and the shortest distance between $y^2=x-1$ and $x^2=y-1$, then
(A) A=A′ (B) $A=(A')^{1/2}$
(C) $A=2A'$ (D) can't say anything

4. a,b,c are in G.P. and the equation $(a+di)x^2+2(b+ei)x+(c+if)=0$ have one real root then $\frac{a}{d},\frac{b}{e},\frac{c}{f}$ are in, ($a,b,c,d,e,f\in R$)
(A) AP (B) GP
(C) HP (D) none of these

Space for rough work

5. $\int \sec^{p/3} x \operatorname{cosec}^{q/3} x dx =$ ($p, q \in I^+$ and p+q=12)

(A) $\dfrac{\tan^{\frac{-p}{3}+1} x}{\frac{-p}{3}+1} + c$

(B) $\dfrac{\tan^{\frac{-p}{3}+1} x}{\frac{-p}{3}+1} + c + \dfrac{\tan^{\frac{-p}{3}+3} x}{\frac{-p}{3}+3} + c$

(C) $\dfrac{\tan^{\frac{-p}{3}+3} x}{\frac{-p}{3}+3} + c$

(D) none of these

6. A square ABCD of a diagonal 2a is folded along the diagonal AC, so that the planes DAC, BAC are at right angle. The shortest distance between DC and AB is

(A) $\sqrt{\frac{2}{3}}a$

(B) $\frac{2a}{\sqrt{3}}$

(C) $\sqrt{\frac{2a}{3}}$

(D) none of these

7. If $P = \int_0^\infty \frac{x^2 dx}{1+x^4}, Q = \int_0^\infty \frac{x dx}{1+x^4}$ and $R = \int_0^\infty \frac{dx}{1+x^4}$, then which of the following is false.

(A) $Q = \frac{\pi}{4}$

(B) P=R

(C) $P - \sqrt{2}Q + R = \frac{\pi}{2\sqrt{2}}$

(D) none of these

8. If $\int_{\pi/2}^{x} \sqrt{3\text{-}2\sin^2 t}\, dt + \int_0^y \cos t\, dt = 0$, then $\left(\frac{dy}{dx}\right)$ at $x = \pi$ and $y = \pi$ is

(A) $\sqrt{3}$

(B) $-\sqrt{2}$

(C) $-\sqrt{3}$

(D) none of these

Space for rough work

Multiple Correct Choice Type

This section contains **04 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

9. Let z_1, z_2, z_3 be the coordinate of vertices *A*, *B*, *C* of the triangle if $W_1 = z_1 - z_2,\ W_2 = z_3 - z_2$ and $\angle A = 90°$, then

(A) $R_e\left(\frac{W_2}{W_1}\right) = 1$

(B) $R_e(W_1\overline{W_2}) = |W_1|^2$

(C) $R_e(W_1\overline{W_2}) = |W_2|^2$

(D) $R_e\left(\frac{W_1}{W_2}\right) = 1$

10. Let $(1+x+x^2)^n = a_0 + a_1x + a_2x^2 ....a_{2n}x^{2n}$, where *n* is odd integer

$S_1 = a_0 + a_4 + a_8 + ...$

$S_2 = a_1 + a_5 + a_9 + ...$

$S_3 = a_2 + a_6 + a_{10} + ...$

$S_4 = a_3 + a_7 + a_{11} + ...$

(A) $S_1 = S_3$

(B) $S_2 = S_4$

(C) $S_2 + S_4 = 0$

(D) $S_1 = S_2 = S_3$ or $S_1 = S_3 = S_4$

11. If $f(x) = ax^2 + bx + c = 0$ have real roots and its coefficients are odd the integers then

(A) $f(x) = 0$ always have irrational roots

(B) $\left|f\left(\frac{p}{q}\right)\right| \geq \frac{1}{q^2}$ where $p, q \in I$

(C) If $a.c. = 1,$ then equation must have atleast are root α such that $[\alpha] = -1$, where [.] is GIF

(D) Equation have rational roots

Space for rough work

12. The curve $y = (|x|-1)\,\mathrm{sgn}(x-1)$ divides $\frac{9x^2}{64} + \frac{4}{25}y^2 = \frac{1}{\pi}$ in two parts having area A_1 and A_2 (where $A_1 < A_2$), then

(A) $\frac{A_1}{A_2} = \frac{7}{13}$
(B) $\frac{A_1}{A_2} = \frac{3}{7}$
(C) $A_1 = \frac{7}{3}$
(D) $A_2 = \frac{13}{7}$

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

---

Paragraph for Questions 13 & 14

If a circle *C*$_{0,}$ with radius 1 unit touches both the axes and as well as line (*L*$_1$) through *P*(0,4), cut the x-axis at $(x_1, 0)$. Again a circle C_1 is drawn touching x-axis, line L_1 and another line L_2 through point *P*. L_2 intersects x-axis at $(x_2, 0)$ and this process is repeated *n* times.

13. The centre of circle C_2 is

(A) $(3, 1)$
(B) $\left(\frac{15}{2}, 1\right)$
(C) $\left(\frac{31}{4}, 1\right)$
(D) none of these

14. The $\lim_{n\to\infty} \frac{x_n}{2^n}$ is

(A) 4
(B) 0
(C) 1
(D) 2

Space for rough work

Paragraph for Questions 15 & 16

f(x), g(x), h(x) all are continuous and differentiable functions in [a, b] also a<c<b and f(a)=g(a)=h(a). Point of intersection of the tangent at x=c with chord joining x=a & x=b is on the left of c in y=f(x) and on the right in y=h(x). And tangent at x=c is parallel to the chord in case of y=g(x).

15. If f(b) = g(b) = h(b) then

(A) $f'(c) = g'(c) = h'(c)$ (B) $f'(c) > g'(c) > h'(c)$

(C) $f'(c) < g'(c) < h'(c)$ (D) none of these

16. If $c = \frac{a+b}{2}$ for each b, then

(A) $g(x)=Ax^2+Bx+C$ (B) g(x)=log x

(C) g(x)=sin x (D) $g(x)=e^x$

Paragraph for Questions 17 & 18

Let f: R → R be a function satisfying condition $f(x + y^3) = f(x) + (f(y))^3 \ \forall \ x, y \in R$ and $f'(0) = k$.

17. If |k| > 0, then $\lim_{x\to 0}\left[\frac{\tan x}{f(x)}\right]$ (where [.] denotes the greatest integer function) is

(A) 0 (B) 2

(C) – 2 (D) none of these

18. If |k| < 0 then value of $f\left(\frac{\sqrt{3}-1}{\sqrt{2}+\sqrt{5}}\right)$ is/are

(A) $-\left(\frac{\sqrt{3}-1}{\sqrt{2}+\sqrt{5}}\right)$ (B) 0

(C) $\left(\frac{\sqrt{3}-1}{\sqrt{2}+\sqrt{5}}\right)$ (D) ± 1

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

1. Let *M* be the midpoint of sides *QR* of a rectangle *PQRS* respectively. A line through *M*, intersect *RS* and *PS* extended at *T* and *L* respectively such that $PL = \frac{4}{3}PS$. Find the value of $20\left(\frac{\text{area of } \Delta MRT}{\text{area of } \square PQRS}\right)$.

2. If the equations $x^3 + 5x^2 + px + q = 0$ and $x^3 + 7x^2 + px + r = 0$ have two roots in common, then find the difference of two uncommon roots.

3. When 23^{23} is divided by 53, the remainder is *r*. Find $\frac{r}{10}$

4. The number of pairs (*x*, *y*) satisfying the equation $\sin x + \sin y = \sin(x + y)$ and $|x| + |y| = 1$ is

5. The value of $33\left\{\sum_{n=1}^{16}\left\{\frac{4n^4}{4n^2 - 1}\right\}\right\}$ is ……… (where {.} represents fractional part function)

Space for rough work

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FIITJEE

JEE(Advanced)-2017

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – II
(PAPER-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	A	B
2.	D	D	A
3.	C	C	C
4.	C	C	C
5.	C	B	B
6.	A	D	B
7.	B	C	D
8.	C	D	A
9.	ABC	ABD	AB
10.	A	BC	AD
11.	ABCD	ABD	ABC
12.	ACD	AC	AC
13.	A	A	C
14.	C	A	D
15.	A	B	C
16.	D	C	A
17.	A	C	C
18.	D	C	B
1.	2	7	3
2.	6	4	2
3.	4	4	3
4.	4	5	6
5.	2	4	4

Physics

PART – I

SECTION – A

1. In the first case, m will remain at rest.

$$a_M = \frac{F}{M}$$

In the second case, both will accelerate:

$$a_m = a_M = \frac{F}{M+m}$$

In the second case, force on $m = ma_m = \frac{mF}{M+m}$

2. $k_1x_1 = k_2x_2$

as $k_2 = 3k$

$$\frac{x_1}{x_2} = 3 \text{and} \frac{\frac{1}{2}k_1x_1^2}{\frac{1}{2}k_2x_2^2} = \frac{x_1}{x_2} = 3$$

3. $N = \frac{mv^2}{r}; f = \mu N = mg$

or $\frac{\mu mv^2}{r} = mg$

$$v = \left(\frac{gr}{\mu}\right)^{1/2}$$

4. Thermometer, ice cream box and freezer are in thermal equilibrium.

6. $R = \frac{20^2 \times \sin 120°}{g} = 20\sqrt{3} = \frac{\Delta R}{R} = \frac{24U}{U} \Rightarrow \Delta R = \frac{2\times 5}{100} \times 200\sqrt{3} = 2\sqrt{3}$

$$20\sqrt{3} - 2\sqrt{3} < R < 20\sqrt{3} + 2\sqrt{3} \Rightarrow 31.1\text{m} < R < 38.1\text{m}$$

7. $\left(\frac{\in_0 klx}{d} + \frac{\in_0 (2A - lx)}{d}\right)V = Q$

$$i = \left(\frac{\in_0 klx}{d} + \frac{-\in_0 l}{d}\right)\frac{dx}{dt} = \text{constant}$$

As the dielectric levels $c \downarrow \Rightarrow Q \downarrow \Rightarrow \text{i is} - \text{ve}$

8. $\Delta\phi = 2n\pi$

$$\Rightarrow \frac{\pi}{2}+\frac{2\pi}{\lambda}d\sin\theta = 2n\pi$$

$$\frac{2\pi}{\lambda}d\sin\theta = \left(2n-\frac{1}{2}\right)\pi$$

$$\sin\theta = \left(2n-\frac{1}{2}\right)\frac{\lambda}{2d} = \frac{1}{2}\times\frac{\lambda}{2\times 3\lambda} = \frac{1}{12}$$

$$\Rightarrow \frac{y}{\sqrt{(100\lambda)^2}} = \frac{1}{2}$$

$$144y^2 = (100\lambda)^2$$

$$y \approx \frac{100\lambda}{12} = \frac{25\lambda}{3}$$

9. $V_A = V_B \Rightarrow \text{work} = 0$

10. Radius $R_1 = \frac{nv}{qB_1}$

In a given field radius should be same for every entry. So B & C are not possible.

15. $f = \frac{C-V_R}{C+V_R}f_0$

$$\frac{\Delta f}{f_0} = \frac{2V_R}{C+V_R} \approx \frac{2V_R}{C}$$

$$\Rightarrow C = \frac{2\times 0.1}{600}\times 5\times 10^6 \approx 1700\text{m/s}$$

16. $f' = \frac{C-V_R}{C+V_R}f_0$

$$\frac{\Delta f}{f_0} = \frac{2V_R}{C+V_R}$$

Velocity is 4 times $\Rightarrow \Delta f = 4\Delta f_0 = 2400\text{Hz}$

17. Reading of C = V $\{\text{i in that branch} = 0\}$

Reading of $A = \frac{V}{R}$

$\Rightarrow R$

18. $V_B = iR_{\text{ammeter}} = 0$

$\Rightarrow \quad V_{\text{cap}} = 0$

$$\Rightarrow T = 2\pi\sqrt{LC} = 2\pi\sqrt{\frac{1}{10}} = 2\sec$$

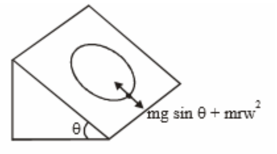
SECTION – C

1. $$P = 700\times10^{3}\times1.6\times10^{-19}\times\frac{dn}{dt} = 10\times10^{-3}$$

$$\frac{dN}{dt} = \frac{10^{-1}}{10^{-14}}\times\frac{1}{7\times16} = \frac{10^{12}}{11.2} = \lambda N_0$$

$$\lambda = \frac{\ln 2}{14\times86400} \Rightarrow N_0 = \frac{14\times86400\times10^{12}}{11.2\ln 2} = 154\times10^{15}$$

2. $$f \ge mg\sin\theta + mrw^2$$



$$\mu\, mg\cos\theta \ge mg\sin\theta + mrw^2$$

$$\text{or } \mu \ge \tan\theta + \frac{w^2 r}{g\cos\theta}$$

3. $$d\phi = \frac{\mu_0 i}{2\pi x}\times l\,dx$$

$$\phi = \frac{\mu_0 i}{2\pi} l \ln\left(\frac{d_2}{d_1}\right)$$

$$\varepsilon = \frac{d\phi}{dt} = \frac{\mu_0}{2\pi} l \ln\left(\frac{d_2}{d_1}\right)\times i_0\omega\cos wt$$

$$\varepsilon_{rms} = \frac{\mu_0}{2\pi} l \ln\left(\frac{d_2}{d_1}\right)\frac{i_0\omega}{\sqrt{2}}$$

$$= \frac{4\pi\times10^{-7}}{2\pi}\times1\times\ln 2\times\frac{2\sqrt{2}}{\ln 2}\times\frac{50}{\sqrt{2}}$$

4. The block slips when the static friction force reaches its maximum value $f_{s\,max} = \mu_s n = \mu_s mg$. This occurs when the train has moved

$$\Delta x = \frac{f_{smax}}{k} = \frac{\mu_s mg}{k} = \frac{(0.60)(2.0\text{kg})(10\text{m/s}^2)}{50\text{N/m}} = 24\,\text{cm}$$

The time at which the block slips is

$$t = \frac{\Delta x}{v} = \frac{24\text{cm}}{6\,\text{cm/s}} = 4\text{s}$$

5. $$\tau_1 = RC$$

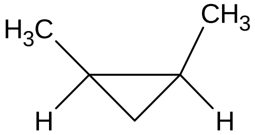
$$\tau_2 = \frac{L}{R}$$

$$\Rightarrow LC = t_1 t_2 = 0.1\text{sec}$$

Chemistry PART – II

SECTION – A

1.

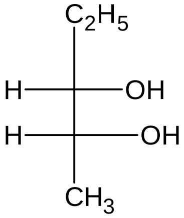


2. $BaTiO_3$

3. $(NH_4)_2SO_4$, $(NH_4)_2CO_3$, NH_4Cl all give NH_3 on heating

4. ΔG is the thermodynamical concept

5.



+ Mirror image

6. β-Keto acid on heating shows de-carboxylation on heating, through enol form

7. Ca^{2+} has 18 e^- and Cl^- has 18 e^-.

8. Phenol gives 2,4,6-tribromo phenol with aq. Br_2.

9. BF_4^- is tetrahedral and rest are is square planar

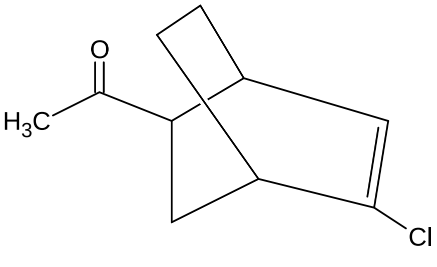
10.
$$Z = \frac{V_{m,real}}{V_{m,ideal}}$$

at high temperature and low pressure the gas follows PV=nRT

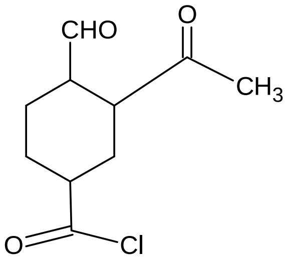
11.
$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$$
$$2Na + H_2SO_4 \longrightarrow Na_2SO_4 + H_2$$
$$2Al + 6H_2SO_4 \longrightarrow Al_2(SO_4)_3 + 3SO_2 + 6H_2O$$

15. CCl_2 will form and show addition reaction then ring expansion takes place.

16.

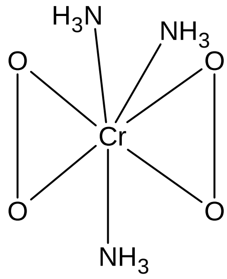


(B)



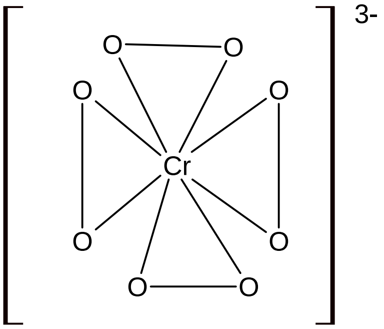
(C)

17.



Pentagonal bipyramid

18.



Pentagonal bipyramid

SECTION – C

1.

$$\frac{\mathrm{dq}}{\mathrm{dT}}=\frac{\Delta \mathrm{U\text{-}w}}{\mathrm{ndT}}=\mathrm{C_{m,V}}+\frac{\mathrm{PdV}}{\mathrm{dT}}=\frac{3}{2}\mathrm{R}+\frac{\mathrm{P}}{\mathrm{n}}\frac{\mathrm{dV}}{\mathrm{dT}}\text{-----}(1)$$

$$PV = nRT$$

$$PdV + VdP = nRdT$$

$$P+\frac{VdP}{dV}=nR\frac{dT}{dV}$$

$$P+V(-1)=nR\frac{dT}{dV}$$

$$4+2(-1)=nR\frac{dT}{dV}$$

$$\frac{dT}{dV}=\frac{2}{nR}$$

$$\frac{dV}{dT}=\frac{nR}{2}$$

Put in (1)

$$\frac{\mathrm{dq}}{\mathrm{dT}} = \frac{3}{2}\mathrm{R}+\frac{\mathrm{P}}{\mathrm{n}}\frac{nR}{2}$$

$$\frac{\mathrm{dq}}{\mathrm{dT}} = \frac{3}{2}\mathrm{R}+\frac{\mathrm{P}}{}\frac{R}{2} = \frac{3}{2}\mathrm{R}+\frac{4}{}\frac{R}{2}=3.5R$$

2. d,e,f,g are correct and Colloid is +ve.

3. Volume of unit cell$=\frac{\sqrt{3}}{4}\times(4.53)^2\times7.41\times10^{-24}\text{cm}^3$

so mass$=60.57\times10^{-24}$g

moles$=3.365\times10^{-24}$

molecules of $H_2O=2.025$

number of H atom=4

4. $$K_{In}=\frac{\left[H^+\right]\left[I_n^-\right]}{\left[HI_n\right]}$$

$$=10^{-9.18}\times\frac{0.6}{0.4}$$

$$=\frac{3}{2}\times10^{-9.18}$$

$$K_{In}=10^{-9}\frac{\left[In^-\right]}{\left[HI_n\right]}$$

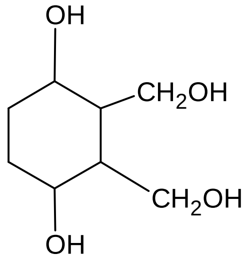
$$K_{In}=\frac{3}{2}\times10^{-9.18}=10^{-9}\times\frac{\alpha}{1-\alpha}$$

$$\frac{3}{2}\times0.66=\frac{\alpha}{1-\alpha}$$

$$\frac{\alpha}{1-\alpha}=1$$

$$2\alpha=1$$

$$\alpha=0.5$$

5. 

(A)

Mathematics PART – III

SECTION – A

2. As s–b, s–c, s–a are in AP with common difference =1

$\Rightarrow$ a,c, b are in AP with common difference equal to 1.

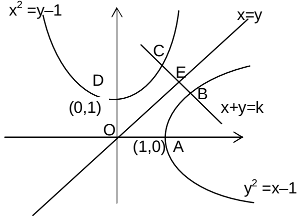
$\Rightarrow$ c = a+ 1, b = a+2 $\Rightarrow s = \frac{a+a+1+a+2}{2} = \frac{3(a+1)}{2}$

$$\Rightarrow \Delta = \sqrt{\frac{3}{2}(a+1).\frac{a+3}{2}.\frac{a+1}{2}.\frac{a-1}{2}}$$

Also r = Δ/s $\Rightarrow a^2+2a-195=0 \Rightarrow$ (a+15)(a–13)=0

A = 13, c=14, b=15 $\Rightarrow$ Δ = 84 sq. units

3. Line of shortest distance will be perpendicular to line x=y. Also both parabolas are symmetric about x=y.



A=area OABCDO

A′=area OECDO

$\Rightarrow$ A′ =A/2

4. Let α be the real root then $(a\alpha^2+2b\alpha+c)+i(d\alpha^2+2e\alpha+f)=0$

$$\Rightarrow a\alpha^2+2b\alpha+c=0 \Rightarrow \alpha = \frac{-\sqrt{c}}{\sqrt{a}}$$

$$\Rightarrow d\alpha^2+2e\alpha+f=0 \qquad \Rightarrow d.\frac{c}{a}-2e\frac{\sqrt{c}}{\sqrt{a}}+f=0 \qquad \Rightarrow \frac{d}{a}-2.\frac{e}{b}+\frac{f}{c}=0$$

5. $I = \int \tan^{-p/3} x.\sec^4 xdx$

$= \int \tan^{-p/3} x(1+\tan^2 x).\sec^2 xdx$

6. If equation of line AB is $\vec{r} = \vec{0}+\lambda(\sqrt{2}a\hat{j}-\vec{0}) = \lambda\hat{j}$

then equation of line DC is $\vec{r} = \sqrt{2}a\hat{i}+\mu\left(\frac{a}{\sqrt{2}}\hat{i}+\frac{a}{\sqrt{2}}\hat{j}+a\hat{k}-\sqrt{2}a\hat{i}\right)$

$$\vec{r} = \sqrt{2}a\hat{i}+\mu\left(\frac{-1}{\sqrt{2}}\hat{i}+\frac{1}{\sqrt{2}}\hat{j}+\hat{k}\right)$$

$$\Rightarrow \quad S.D = \left|\frac{(\vec{a}_2-\vec{a}_1).(\vec{b}_1\times\vec{b}_2)}{|\vec{b}_1\times\vec{b}_2|}\right| = \frac{2a}{\sqrt{3}}$$

7. $Q = \int_0^\infty \frac{xdx}{1+x^4} = \frac{1}{2}\left|\tan^{-1}x^2\right|_0^\infty = \frac{1}{2}\left(\frac{\pi}{2}-0\right) = \frac{\pi}{4}$

$$P = \int_0^\infty \frac{x^2dx}{1+x^4},\ \text{Put } x = \frac{1}{t} \Rightarrow \qquad P = \int_\infty^0 \frac{\frac{1}{t^2}(\frac{-1}{t^2}dt)}{1+\frac{1}{t^4}} = \int_0^\infty \frac{dt}{1+t^4} = R$$

$$\text{Also } P + R = \int_\infty^0 \frac{x^2+1}{1+x^4}dx = \int_0^\infty \frac{(1+\frac{1}{x^2})dx}{x^2+\frac{1}{x^2}} = \frac{\pi}{\sqrt{2}}$$

8. $\int_{\pi/2}^{x} \sqrt{3-2\sin^2 t} + \int_0^y \cos t\,dt = 0$, then $\left(\frac{dy}{dx}\right)$ at x = π and y = π

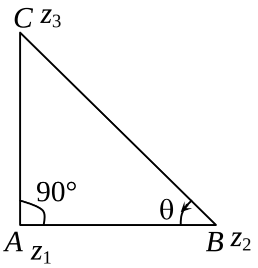
$$\left(\sqrt{3-2\sin^2 t}\right)\cdot 1 + \cos y\frac{dy}{dx} = 0$$

$$\Rightarrow \left(\frac{dy}{dx}\right)_{\pi,\pi} = \left.\frac{-\sqrt{3-2\sin^2 x}}{\cos y}\right|_{\pi,\,\pi} = \sqrt{3}\,.$$

9. $\frac{W_2}{|W_2|} = \frac{W_1}{|W_1|}e^{-i\theta}$

$$\Rightarrow \qquad \frac{W_2}{W_1} = \frac{|W_2|}{|W_1|}e^{-i\theta} = 1 - i\tan\theta$$

$$W_1\overline{W}_2 = \frac{W_1}{W_2}|W_2|^2 = |W_1||W_2|e^{-i\theta} = \left(|W_1|^2 - i|W_1||W_2|\sin\theta\right)$$



10. $(1+x+x^2)^n = a_0 + a_1x + a_2x^2 + \ldots + a_{2n}x^{2n}$ …(1)

$$\Rightarrow a_0 + a_2 + a_4 \ldots = \frac{3^n+1}{2}$$

$$a_1 + a_3 + a_5 \ldots = \frac{3^n-1}{2}$$

Put $x = i$ in equation (1) where $i = \sqrt{-1}$

If $n = 4m+1$

⇒ $a_1 - a_3 + a_5 \ldots = 1$

$a_0 - a_2 + a_4 \ldots = 0$

So, $a_1 + a_5 + a_9 \ldots = \frac{3^n+1}{4} = S_2$

$a_3 + a_7 + a_{11} \ldots = \frac{3^n-3}{4} = S_4$

Similarly if $n = 4m+3$

Then, $S_2 = \frac{3^n-3}{4}$ and $S_4 = \frac{3^n+1}{4}$

11. If a, b, c are odd integer then D can not be perfect square,

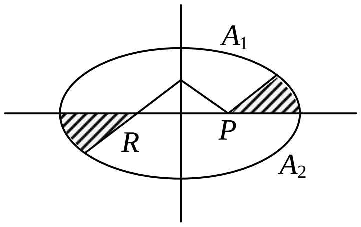
⇒ $|\ f(\lambda)\,| > 0$ where $\lambda \in Q$

$$\Rightarrow \quad |a\,p^2 + b\,pq + c\,q^2| \ge 1 \;\Rightarrow\quad \left|f\left(\frac{p}{q}\right)\right| \ge \frac{1}{q^2}$$

If $a.c = 1 \quad \Rightarrow \quad a = c = 1$ and $b \ge 3$ as

$c.(a - b + c) < 0 \quad \Rightarrow \quad \alpha \in (-1, 0)$

12. Area of ellipse $= \pi \times \frac{8}{3\sqrt{A}} \times \frac{5}{2\sqrt{A}} = \frac{20}{3}$

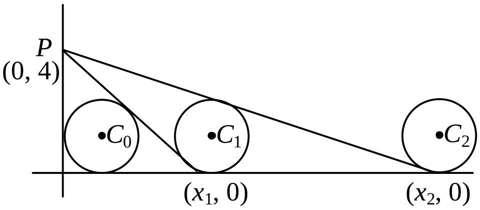


Both shaded areas are equal, then

$$A_1 = \frac{1}{2}Ae - \Delta PQR = \frac{10}{3} - 1$$

$$A_1 = \frac{1}{2}Ae + \Delta PQR = \frac{10}{3} + 1$$

(Q. No. 13 – 14)



For C_n circle let centre be $(\alpha_n, 1)$ and it touches line L_n and L_{n+1}.

i.e. $\frac{x}{x_n} + \frac{y}{4} = 1, \; \frac{x}{x_{n+1}} + \frac{y}{4} = 1$

$$\Rightarrow \quad \frac{4\alpha_n + x_n - 4x_n}{\sqrt{16 + x_n^{\,2}}} = 1 \qquad \text{...(i)}$$

$$\Rightarrow \quad \frac{4\alpha_n + x_{n+1} - 4x_{n+1}}{\sqrt{16 + x_{n+1}^2}} = -1 \qquad \text{...(ii)}$$

$$\Rightarrow \quad 3(x_{n+1} - x_n) = \sqrt{16 + x_n^2} + \sqrt{16 + x_{n+1}^2}$$

Let $x_n = 4\cot\theta_n \, 0 < \theta_n < \frac{\pi}{2}$

$$\Rightarrow \quad \tan\left(\frac{\theta_{n+1}}{2}\right) = \frac{1}{2}\tan\left(\frac{\theta_n}{2}\right)$$

As $x_1 = 3 \Rightarrow \tan\frac{\theta_1}{2} = \frac{1}{2} \;\Rightarrow\; \tan\left(\frac{\theta_n}{2}\right) = \frac{1}{2^n}$

$$\Rightarrow \quad x_n = \left(\frac{2^{2n} - 1}{2^{n-1}}\right) \qquad x_2 = \frac{15}{2}$$

Putting is (i), we get $\alpha_2 = \frac{31}{4}$.

$$\lim_{n\to\infty} \frac{x_n}{2^n} = \lim_{n\to\infty} \frac{2^{2n} - 1}{2^{n-1}2^n} = 2$$

15. According to paragraph $\frac{f(b) - f(a)}{b - a} > f'(c), \frac{g(b) - g(a)}{b - a} = g'(c)$ and $\frac{h(b) - h(a)}{b - a} < h'(c)$

16. If g(x)=Ax^2+Bx+C

$$\Rightarrow \frac{g(b)-g(a)}{b-a} = \frac{A(b^2-a^2)+B(b-a)}{b-a} \quad \Rightarrow 2A\frac{(b+a)}{2}+B = g'\left(\frac{b+a}{2}\right)$$

17. Put x = y = 0 in $f(x + y^3) = f(x) + (f(y))^3$

f(0) = 0

$$\Rightarrow k = \lim_{x\to 0}\frac{f(h)-f(0)}{h} = \lim_{x\to 0}\frac{f(h)}{h} = \lim_{x\to 0}\frac{f\left(0+\left(h^{1/3}\right)^3\right)-f(0)}{\left(h^{1/3}\right)^3}$$

$$= \lim_{x\to 0}\left(\frac{f\left(h^{1/3}\right)}{\left(h^{1/3}\right)}\right)^3 = k^3 \Rightarrow k = 0, 1, -1$$

since |k| > 0 ⇒ k = 1, – 1

$$\Rightarrow f'(x) = \lim_{x\to 0}\frac{f(x+h)-f(x)}{h} = \lim_{x\to 0}\left(\frac{f\left(h^{1/3}\right)}{\left(h^{1/3}\right)}\right)^3 = k^3$$

$\Rightarrow f'(x) = -1$ or $1\ \forall\ x \in R$

$\Rightarrow f(x) = -x + c$ or $x + c\ \forall\ x \in R$

$\because\ f(0) = 0$

$\Rightarrow f(x) = -x\ \forall\ x \in R$

or $f(x) = x\ \forall\ x \in R$

$\frac{\tan x}{x} > 1\ \forall\ x \in (-h, h)$

and $\frac{\tan x}{-x} < -1\ \forall\ x \in (-h, h)$

hence $\lim_{x\to 0}\left[\frac{\tan x}{f(x)}\right]$ = 1 or – 2.

18. If k = 0 ⇒ f′(0) = 0

$$\Rightarrow f(x) = \lim_{x\to 0}\left(\frac{f\left(h^{1/3}\right)}{\left(h^{1/3}\right)}\right)^3 = 0 \Rightarrow f(x) = c$$

since f(0) = 0 ⇒ f(x) = 0 ∀ x ∈ R.

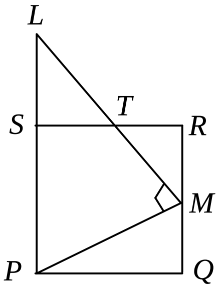
SECTION – C

1. Let $Q(ai),\ S(bj),\ M\left(ai+\frac{b}{2}j\right), L\left(\frac{4}{3}bj\right),\ R(ai+aj)$

be required points:

T is intersection of LM and SR

i.e. $ai+\frac{b}{2}j+\lambda\left(ai+\frac{b}{2}j-\frac{4}{3}bj\right) = bj+\mu(ai)$



$\lambda = \frac{-3}{5}$ and $\mu = \frac{2}{5}$ one comparing the coefficient, we get $T \equiv \left(bj+\frac{2a}{5}i\right)$

Area of $\Delta MRT = \frac{1}{2}\times\frac{3.a}{5}\times\frac{b}{2} = \frac{3}{20}ab$.

2. Let first equation have roots α, β, γ_1 and second equation α, β, γ_2

then $\alpha+\beta+\gamma_1 = -5, \qquad \alpha\beta+\gamma_1(\alpha+\beta) = p$

$\alpha + \beta + \gamma_2 = -7, \qquad \alpha\beta + \gamma_2(\alpha + \beta) = p$

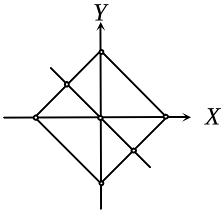
$\Rightarrow (\gamma_1 - \gamma_2)(\alpha + \beta) = 0$ as $(\gamma_1 \neq \gamma_2) \Rightarrow \alpha + \beta = 0$

$\gamma_1 = -5, \gamma_2 = -7$.

3. $(23)^{23} = (23)(530 - 1)^{11} = 53\lambda - 23$

Hence remainder is 30.

4. $\sin x + \sin y = \sin(x + y)$



$\Rightarrow \sin\left(\frac{x+y}{2}\right)\sin\frac{x}{2}\sin\frac{y}{2} = 0$

$\Rightarrow x + y = 2h_1\pi$, $x = 2h_2\pi$ or $y = 2h_3\pi$, $h_1, h_2, h_3 \in Z$

Only six solutions are possible

5. $\left\{\frac{4n^4}{4n^2-1}\right\} = \left\{\frac{1}{4}\left(4n^2 + 1 + \frac{1}{4n^2-1}\right)\right\}$

$= \sum_{n=1}^{16}\left(\frac{1}{4} + \frac{1}{8}\left(\frac{1}{2n-1} - \frac{1}{2n+1}\right)\right)$

$= 4 + \frac{1}{8}\left(1 - \frac{1}{33}\right)$

$= 4 + \frac{4}{33}$

Hence, $\left[33\left\{4 + \frac{4}{33}\right\}\right] = 4$.

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

FIITJEE **JEE (Advanced), 2017**

ALL INDIA TEST SERIES

FULL TEST – II

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 234**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (09 – 12) contains 4 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

Section-A (13 to 18) contains 3 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-C (01 – 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

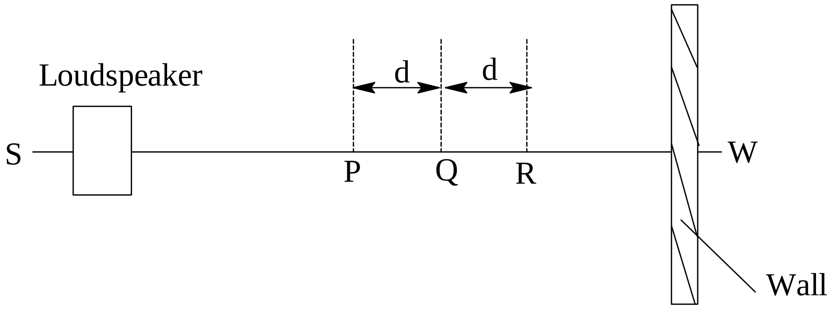
Straight Objective Type

This section contains **08 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. A glass tube of 1.0 meter length is filled with water. The water can be drained out slowly at the bottom of the tube. If a vibrating tuning fork of frequency 500Hz is brought at the upper end of the tube and the velocity of sound is 330m/s then the total number of resonances obtained will be

(A) 4 (B) 3
(C) 2 (D) 1

2. A loudspeaker emits sound of frequency f. The sound waves are reflected from a wall. The arrangement is shown below.

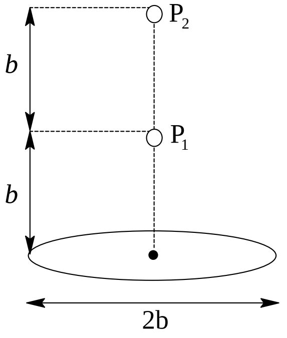


When a microphone is moved along the line SW, minimum loudness of sound is detected at points P, Q and R. There are no other minima between these points. The separation of the minima is d. The speed of the sound wave is :

(A) $\frac{1}{2}fd$ (B) $4fd$
(C) fd (D) $2fd$

Space for rough work

3. Consider a uniformly charged wire that has the form of a circular loop with radius b. Consider two points on the axis of the loop. P_1 is at a distance b from the loop's center, and P_2 is at a distance 2b from the loop's center. The potential V is zero, very far away from the loop. At P_1 and P_2 the potentials are V_1 and V_2, respectively. What is V_2 in terms of V_1?



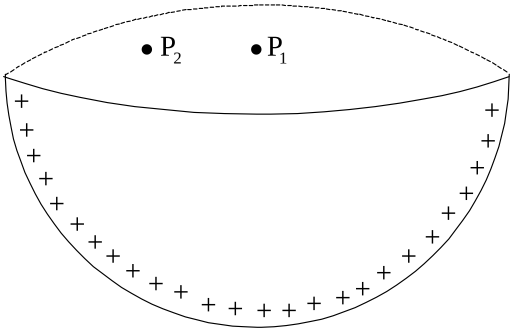
(A) $2V_1$

(B) $\frac{V_1}{2}$

(C) $\sqrt{\frac{5}{2}}V_1$

(D) $\sqrt{\frac{2}{5}}V_1$

4. Consider a uniformly charged hemispherical shell shown below. Indicate the directions (not magnitude) of the electric field at the central point P_1 and an off-centre point P_2 on the drumhead of the shell.



(A) ↑ ; ↖

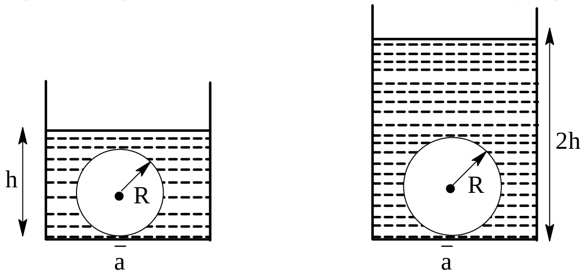
(B) ↑ ; ↗

(C) ↑ ; ↑

(D) ↑ ; ←

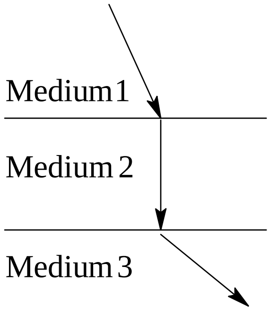
Space for rough work

5. Two identical cylinders have a hole of radius a (a<<R) at its bottom. A ball of radius R is kept on the hole and water is filled in the cylinder such that there is no water leakage from bottom. In case-1 water is filled upto height h and in second case it is filled upto height 2h. If F_1 is force by liquid on sphere in case-1 and F_2 is force by liquid on sphere in case-2 then.



(A) $F_1 = F_2 = 0$
(B) $F_1 > F_2$
(C) $F_2 > F_1$
(D) $F_1 = F_2 \neq 0$

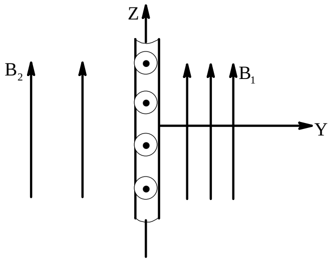
6. The diagram below shows the path taken by a monochromatic light ray travelling through three media. The symbols v_1, λ_1 and f_1 represent the speed, wavelength, and frequency of the light in Medium 1, respectively. Which of the following relationships for the light in the three media is true.



(A) $\lambda_1 < \lambda_2 < \lambda_3$
(B) $v_1 < v_3 < v_2$
(C) $f_1 < f_3 < f_2$
(D) $\lambda_2 < \lambda_1 < \lambda_3$

Space for rough work

7. Figure shows a thin metal sheet in the plane y = 0, for which the current of constant density flows in the positive x-direction. It is in a constant homogeneous magnetic field of value = (0, 0, B_0). As a result of superposition of magnetic fields in region y > 0, the induction field B_1 = (0, 0, B) and in y < 0 is B_2 = (0, 0, B_2) where $B_1 > B_2$. Specify the correct statement:



(A) $B_0 = \frac{(B_1 - B_2)}{2}$ (B) $B_0 = \frac{(B_1 + B_2)}{2}$

(C) $B_0 = B_1 + B_2$ (D) $B_0 = B_1 - B_2$

8. At ordinary temperature the molecules of an ideal gas have only translational and rotational energy. At high temperature, they may also have vibrational energy. As a result of this at high temperature.

(A) $C_V = \frac{3R}{2}$ for monoatomic gas (B) $C_V > \frac{3R}{2}$ for monoatomic gas

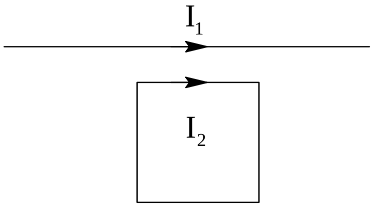
(C) $C_V < \frac{5R}{2}$ for Diatomic gas (D) $C_V > \frac{5R}{2}$ for Diatomic gas

Space for rough work

Multiple Correct Choice Type

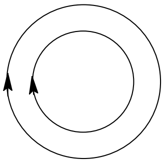
This section contains **04 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

9. A long straight wire carries a steady current I_1. Nearby is a rectangular loop that carries a steady current I_2. The directions of the two currents are shown in the figure.



Which statement is/are false?
(A) The loop is attracted to the wire
(B) There is no net force on the loop from the wire
(C) The loop is attracted to the wire if $I_1 > I_2$; otherwise it is repelled
(D) The loop is repelled from the wire if $I_1 > I_2$; otherwise it is attracted

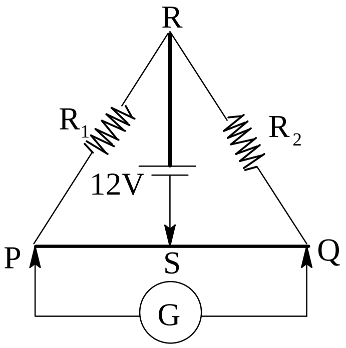
10. Two concentric, coplanar, circular loop of wire, with different diameter carry current in the same sense as shown in the figure. Which of the following statement(s) is (are) correct?



(A) The magnetic force exerted by the outer loop on a short portion of the inner loop is radially outward
(B) The magnetic force exerted by the outer loop on a short portion of the inner loop is radially inward
(C) The net magnetic force exerted by the outer loop on a whole inner loop is non zero and is radially outward
(D) The net magnetic force exerted by the outer loop on a whole inner loop is zero

Space for rough work

11. In the circuit shown $R_1 - R_2 = 10\Omega$ and resistance per unit length of wire $PQ = 1\Omega / cm$ and length $PQ = 10cm$. If R$_2$ is made 20Ω the to get zero deflection in galvanometer. S is midpoint of wire PQ?



(A) The jockey at P can be moved towards right 2 cm.
(B) The jockey at Q can be moved towards right 2 cm.
(C) The jockey at S can be moved towards left a distance 5/3 cm.
(D) The jockey at all positions fixed and R$_1$ should be made 20

12. A constant external torque acts for a very brief period t on a rotating system having moment of inertia I.
(A) The angular momentum of the system will change by $\tau\,\Delta t$
(B) The angular velocity of the system will change by $\frac{\tau\,\Delta t}{I}$
(C) If the system was initially at rest, it will acquire rotational kinetic energy $\frac{(\tau\,\Delta t)^2}{2I}$
(D) The kinetic energy of the system will change by $\frac{(\tau\,\Delta t)^2}{2I}$

Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

Paragraph for Questions 13 & 14

If the velocity of a charged particle moving through a uniform magnetic field has a component parallel to that field the particle will move in a helical path as shown in figure 1. The net force F on the particle can be described by the equation.

$$F = qvB\sin\theta$$

Where q is the charge on the particle, v is the velocity of the charge, B is the magnetic field strength, and θ is the angle between the velocity and the magnetic field. The pitch p of the helix is the distance between adjacent turns. The radius r of the helix is determined by the component of velocity of the charge perpendicular to the magnetic field and is independent of the component of the velocity parallel to the magnetic field.

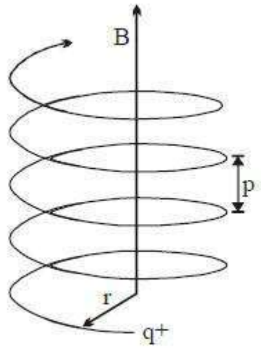


Figure 1

A nonuniform magnetic field that is stronger at its ends than at its middle can trap a charged particle by reflecting it back and forth between ends. Such a situation is shown in figure 2. In a similar phenomenon electrons and protons above the atmosphere are reflected back and forth between the north and south poles of the earth's magnetic field forming the two Van Allen belts high above the atmosphere. Occasionally a solar flare shoots additional electrons and protons into the Van Allen belts. This pushes the electrons to a lesser height. The repulsion due to additional electrons drives the charged particles along the earth's magnetic field lines into the atmosphere where they collide with the air molecules forcing them to a higher energy level emitting photons. Oxygen atoms emit green light and nitrogen atoms emit pink. This light forms the curtain of lights in the sky known in the northern hemisphere as the aurora borealis

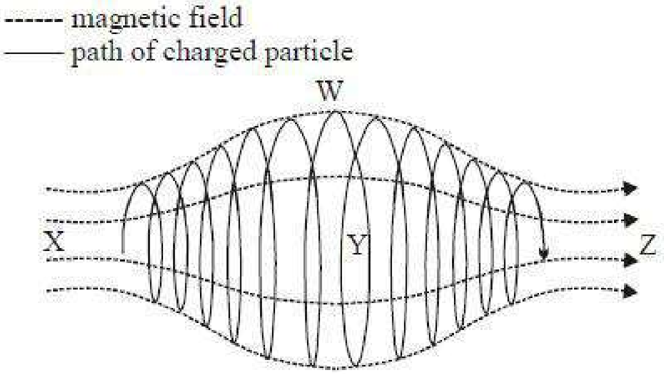


Figure 2 : Path of a charged particle trapped in a changing magnetic field

13. If the magnetic field in figure-2 represents a portion of the Earth's magnetic field, at which labelled point would you except to find the aurora borealis?
(A) W (B) X
(C) Y (D) Z

14. The electrons and protons caught in the Van Allen belt reflect from one pole to the other. Looking up from the North pole, electrons rotate counterclockwise. Protons rotate.
(A) Counterclockwise both when looking up from the North Pole or when looking up from the South Pole.
(B) Clockwise both when looking up from the North Pole of when looking up from the South Pole.
(C) Clockwise when looking up from the North Pole but counterclockwise when looking up from the South Pole.
(D) Counterclockwise when looking up from the North Pole but clockwise when looking up from the South Pole.

Paragraph for Questions 15 & 16

A piano creates sound by gently striking a taut wire with a soft hammer when a key on the piano is pressed. All piano wires in a given piano are approximately the same length. However, each wire is tied down at two points, the bridge and the agraffe. The length of the wire between the bridge and the agraffe is called the speaking length. The speaking length is the part of the wire that resonates. The point of the wire struck by the hammer is displaced perpendicularly to the wire's length. A standing wave is generated by the hammer strike, where □ is the velocity T is the tension in the wire, and μ is the mass per unit length of the wire.

$$v = \sqrt{\frac{T}{\mu}}$$

Tuning a piano involves adjustment of the tension in the wires until just the right pitch is achieved. Correct pitch is achieved by listening to the beat frequency between the piano and a precalibrated tuning fork.

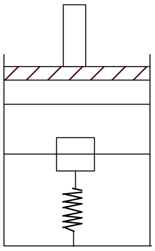
15. A piano note is compared to a tuning fork vibrating at 440 Hz. Three beats per second are discerned by the piano tuner. When the tension in the string is increased slightly, the beat frequency increases. What was the initial frequency of the piano wire?
(A) $434\,Hz$ (B) $437\,Hz$
(C) $443\,Hz$ (D) $446\,Hz$

16. Sound waves move through air at approximately 340 m/s. A piano wire with a 90 cm speaking length resonates at a frequency of 360 Hz. What is the wavelength of the resulting sound wave ?
(A) $0.94\,m$ (B) $1.06\,m$
(C) $4\,m$ (D) $1.8\,m$

Space for rough work

Paragraph for Questions 17 & 18

The figure shows a cylindrical container, fitted with a piston. It contains two immiscible incompressible liquids with densities ρ_1 and ρ_2. A block floats in equilibrium in the position shown.



17. Suppose the spring is initially in compressed state. Now, if the piston is moved downward slowly then
   (A) Spring will become more compressed.
   (B) Spring will become less compressed.
   (C) The compression in spring will remain same as before.
   (D) The compression will depend~~s~~ on ρ_1 and ρ_2.

18. Suppose the spring is initially in compressed state. Now, if the whole system is moved with some acceleration upward then
   (A) Spring will become more compressed.
   (B) Spring will become less compressed.
   (C) The compression in spring will remain same as before.
   (D) The compression will depend on ρ_1 and ρ_2.

Space for rough work

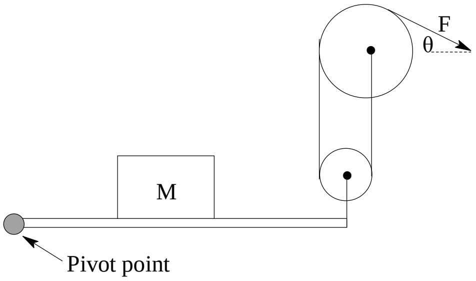
SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. A uniform rod of length l = 1m is free to move and rotate in gravity-free space. When an impulse is given to one end of the rod, perpendicular to its length, its centre of mass moves with velocity v = 1 m/s. What will be its angular velocity (in rad/s) about its centre of mass?

2. A pulley system is attached to a massless board as shown below. The board pivots only at the pivot point. A 10 kg mass M sits exactly in the middle of the board.



If the angle θ is 60°. The force F (in N) necessary to hold the board in the position shown is $5\times x$, find x?

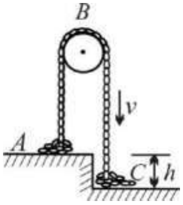
3. The peak emission from a black body at a certain temperature occurs at a wavelength of 6000 Å. On increasing its temperature, the total radiation emitted is increased 16 times. These radiations are allowed to fall on a metal surface. Photoelectrons emitted by the peak radiation at higher temperature can be bought to rest by applying a potential equivalent to the excitation potential corresponding to the transition for the level n = 4 to n = 2 in the Bohr's hydrogen atom. The work function of the metal is given by $\frac{\alpha}{100}eV$ where α is the numerical constant. The value of α is found $53\times x$, find x?

[Take: he = 12420 eV-Å]

Space for rough work

4. A positively charged particle starts at rest 25 cm from a second positively charged particle which is held stationary throughout the experiment. The first particle is released and accelerates directly always from the second particle. When the first particle has moved 25 cm, it has reached a velocity of $10\sqrt{2}$ m/s. The maximum velocity (in m/s) that the first particle will reach is $10\times x$, find x?

5. The ends of a chain lie in piles at *A* and *C*. When given an initial speed 10 m/s, the chain keeps moving freely at that speed over the fixed pulley *B*. Neglecting friction, the required value of *h is* $x\times 5$, then find the value of x (in m). (Take *g* = 10 m/s^2):



Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **08 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. The vapour pressure lowering of a 0.1 M aqueous solution of non – electrolyte at $75°C$ is $\left(\Delta H_v^0 \text{ of water} = 9720 \text{ cal/mol and antilog } 0.407 = 2.55\right)$

(A) 0.54 torr (B) 0.78 torr
(C) 0.02 torr (D) 0.22 torr

2. The C – C single bond distance is $1.54\overset{o}{A}$. The minimum distance between the terminal cartons in propane is $\left(\sin 54°45' = 0.8136\right)$

(A) Greater than $3.08\overset{o}{A}$ (B) Equal to $3.08\overset{o}{A}$
(C) $2.51\overset{o}{A}$ (D) Can't be calculated

3. A sample of aqueous solution of acetic acid $\left(0.5\,\text{mol}\,CH_3COOH\,\text{in}\,10\,\text{mol of}\,H_2O\right)$ is mixed with a sample of aqueous solution of $NaOH\left(0.5\,\text{mol}\,NaOH\,\text{in}\,10\,\text{mol of}\,H_2O\right)$. The freezing point of the solution is ($K_{f,\,H2O}$=1.86)

(A) -5°C (B) -5.16°C
(C) 0°C (D) 5.16°C

4. Hydrogen peroxide can be prepared by the successive reactions

$$2NH_4HSO_4 \rightarrow (NH_4)_2S_2O_8$$
$$(NH_4)_2S_2O_8 + 2H_2O \rightarrow 2NH_4HSO_4 + H_2O_2$$

The first is an electrolytic reaction, and the second a steam distillation.
What current would have to be used in the first reaction to produce enough intermediate to yied 100 g pure H_2O_2 per hour? Assume 50% current efficiency.

(A) 158 A (B) 315 A
(C) 102 A (D) 204 A

Space for rough work

5. Equilibrium constant for the dissociation of $Ag(NH_2)_2^+$ into Ag^+ and NH_3 is 6×10^{-8}. Calculate $E°$ for the following half reaction, $Ag(NH_3)_2^+ + e \rightarrow Ag(s) + 2NH_3$

$\left(E^{\circ}_{Ag^+/Ag} = 0.799V, \log 6 = 0.7781\right)$

(A) 0.37 (B) 0.799
(C) 0.7781 (D) 0.6

6. A student is analysing a salt in the laboratory. When he added dilute HCl to the salt solution, a gas is evolved, when the gas is exposed to a filter paper moistened with potassium iodate and starch solution, he observed blue colouration of the filter paper. Then he added $BaCl_2$ solution to the salt solution and observed white precipitate immediately. He found that the precipitate is soluble in dilute mineral acids. The anion of the salt is

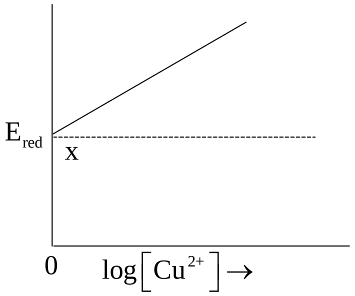
(A) $S_2O_3^{2-}$ (B) SO_3^{2-}
(C) CO_3^{2-} (D) HCO_3^-

7. Which of the following complexes is/are chiral?

(A) $cis-[Pt(NH_3)_2Cl_2]$ (B) $[Zn(H_2O)_2Cl_2](tetrahedral)$
(C) $\left[Pt(C_2O_4)_3\right]^{4-}$ (D) trans - $\left[Pt(NH_3)_4BrCl\right]^2$

8. For the reaction $Cu^{2+} + 2e \rightarrow Cu$

$\log\left[Cu^{2+}\right]$ vs. E_{red} graph can be plotted as following (At NTP)



Where OX = 0.34 V then electrode potential of the half cell of $Cu/Cu^{2+}(0.1M)$ will be:

(A) 0.3695 v (B) − 0.3105 V
(C) 0.3991 V (D) −0.2809 V

Space for rough work

Multiple Correct Choice Type

This section contains **04 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

9. An ideal gas expanding isothermally against the external pressure equal to zero, shows

(A) $\Delta E = 0$
(B) $W = 0$
(C) $q = 0$
(D) $\Delta H = +ve$

10. Electrolysis of molten $MgCl_2$ is the final production step in the isolation of magnesium from sea water by Dow's process. Assuming that 35.6 g of Mg metal forms. Which of the following statement (s) is/are correct?

(A) 2.96 moles of electrons are required
(B) $3.83 \times 10^5 C$ charge is required
(C) 31.8 A of current is required for 2.5 hours
(D) 41.5 A of current is required for approximately 115 mins

11. A 10 mL mixture containing 0.2 g NaOH and $0.25\,g\,Na_2CO_3$ was treated with $xN\,HCl$ required 15 mL of it with phenolphthalein indicator. After end point a $0.5\ g\ NaHCO_3$ was added and it was again titrated with $y\ N\ HCl$ required 25.5 mL of HCl with methyl orange. Which of the following is/are correct?

(A) x is almost 1.5 times of y
(B) If in above titration x N HCl is replaced with y N HCl then for first end point it will require 23mL of HCl.
(C) After first end point instead of 0.5 g if 2.5 g $NaHCO_3$ is added and fitrated with $x\ N\ HCl$ it will require 65.5 mL.
(D) Only (A) and (B) are correct.

12. In which of the following pair the later species is not having higher vapour pressure at a given temperature than former one?

(A) C_2H_6 and C_4H_{10}
(B) CH_3CH_2OH and CH_3CH_2F
(C) Xe and I_2
(D) NH_3 and PH_3

Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

Paragraph for Questions 13 & 14

A hydrated metallic salt A, light green in colour, on careful heating gives a white anhydrous residue B. B is soluble in water and its aqueous solution reacts with NO to give a dark brown residue D and on heating the mixture it gives two gases E and F.

13. The gaseous mixture (E + F) when passed through acidified permanganate solution, discharges the pink colour and when passed through acidified $BaCl_2$ solution gave a white precipitate Identify the gasses E and F.

(A) CO_2 and CO
(B) NO_2 and N_2O
(C) NO and NO_2 (D)
(D) SO_2 and SO_3

14. A hydrated metallic salt A and its anhydrous form B respectively are:

(A) $CuSO_4.5H_2O$ and $CuSO_4$
(B) $FeSO_4.7H_2O$ and $FeSO_4$
(C) $CaSO_4.2H_2O$ and $CaSO_4$
(D) $CaSO_4.1/2H_2O$ and $CaSO_4$

Space for rough work

Paragraph for Questions 15 & 16

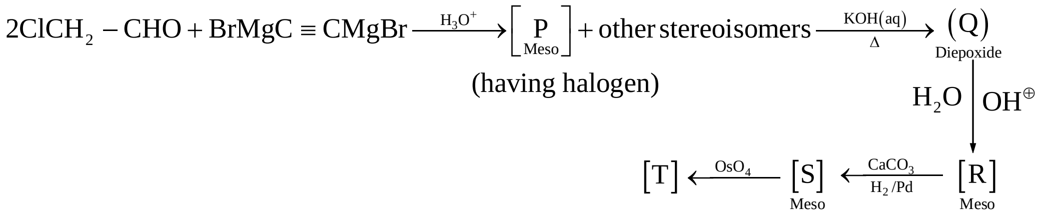
Strength of the sample of H_2O_2 is generally expressed in terms of the volume strength. It means the volume of oxygen liberated at N. T. P. by heating one volume of hydrogen peroxide. The concentration of H_2O_2 in a solution can also be expressed as percentage of H_2O_2 in solution. Normality of this solution can be calculated if the equivalent mass of H_2O_2 is known.

15. 25 ml of H_2O_2 solution was added to the excess of acidified KI solution. The iodine so liberated required 40 ml of 0.1 N sodium thiosulphate solutions. Calculate the normality of H_2O_2 solution.
(A) 0.08 (B) 0.16
(C) 0.02 (D) 0.20

16. The volume strength of the H_2O_2 solution is:
(A) 0.556 (B) 0.448
(C) 0.896 (D) 0.632

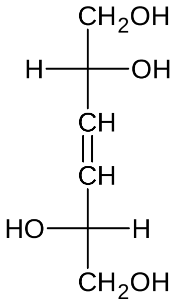
Space for rough work

Paragraph for Questions 17 & 18

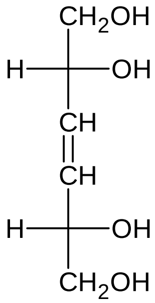

2ClCH$_2$ – CHO + BrMgC ≡ CMgBr
H$_3$O$^+$
P
Meso
(having halogen)
+ other stereoisomers
KOH(aq)
Δ
(Q)
Diepoxide
H$_2$O
OH$^\oplus$
[R]
Meso
CaCO$_3$
H$_2$/Pd
[S]
Meso
OsO$_4$
[T]

17. Compound S is?

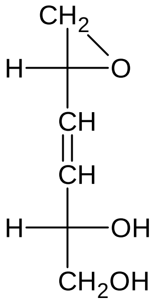
(A)


CH$_2$OH
H
OH
CH
CH
HO
H
CH$_2$OH

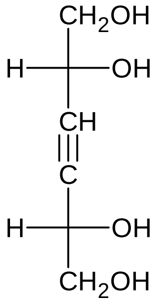
(B)


CH$_2$OH
H
OH
CH
CH
H
OH
CH$_2$OH

(C)


CH$_2$
H
O
CH
CH
H
OH
CH$_2$OH

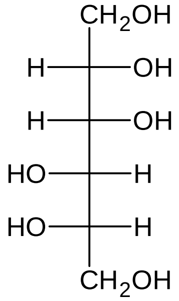
(D)


CH$_2$OH
H
OH
CH
C
H
OH
CH$_2$OH

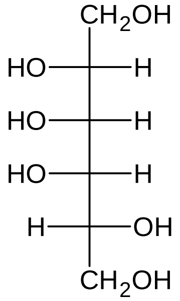
Space for rough work

18. Compound T is?

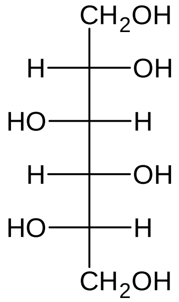
(A)


CH2OH
H OH
H OH
HO H
HO H
CH2OH

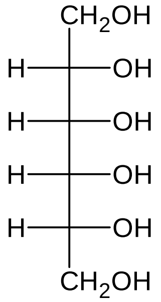
(B)


CH2OH
HO H
HO H
HO H
H OH
CH2OH

(C)


CH2OH
H OH
HO H
H OH
HO H
CH2OH

(D)


CH2OH
H OH
H OH
H OH
H OH
CH2OH

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

1. Find the number of native ores out of given ores?
Pyrolusite, Chromite, Siderite, Cassiterite, Calamine, Argentite, Lime stone, Chalcopyrite.

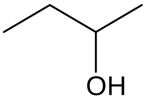
2. Out of given chemical, number of chemicals which is/are related to Solvay process:
$NH_3, KCl, CO_2, SO_2, Ca(OH)_2, NaCl, H_2SO_4, NaNO_3$:

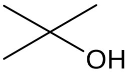
Space for rough work

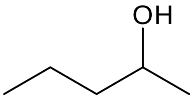
3. Find the number of properties which is/are correctly related to graphite?
(i) thermodynamically most stable allotropes of carbon
(ii) highest thermal conductivity among all allotropes of carbon
(iii) lowest electrical resistance among all allotropes of carbon
(iv) $\mathrm{C\text{-}C}$ covalent bond length is higher as compared to diamond
(v) hexagonal rings in structure
(vi) football like molecule

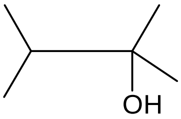
4. Consider the following $3\mathrm{d}$ series ions:
$\mathrm{Sc^{3+}, Ti^{3+}, V^{3+}, Cr^{3+}, Mn^{3+}, Fe^{3+}, Co^{3+}, Ni^{3+}}$
Find total number of ions for which all octahedral complexes are paramagnetic, irrespective of ligand

5.

(a)  $\xrightarrow[\Delta]{H^+} (x)$

(b)  $\xrightarrow[\Delta]{H^+} (y)$

(c)  $\xrightarrow[\Delta]{H^+} (z)$

(d)  $\xrightarrow[\Delta]{H^+} (p)$

Total number of products obtained in above reactions including minor products is (including stereoisomer including stereoisomer)

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **08 multiple choice questions** numbered 1 to 8. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. The ordered pair (a, *b*) such that $x^2 - x - 1$ divides the polynomial $ax^9 + bx^8 + 1$ is
(A) (–21, 34) (B) (21, –34)
(C) (47, –58) (D) (58, –47)

2. The number of possible integral pairs (*a*, *b*) for which $2ab - 5a + b = 55$ is
(A) 8 (B) 16
(C) 12 (D) 6

3. If $f_n = \sum_{k=0}^{n} (1+2^k)\binom{n}{k}$, then
(A) $f_{n+2} = 3f_{n+1} - 2f_n$ (B) $f_{n+2} = 3f_n + 2f_n$
(C) $f_{n+2} = 5f_{n+1} - 6f_n$ (D) $f_{n+2} = 6f_{n+1} - 5f_n$

4. A set contains 3*n* members. Let P_n be the probability that *S* is portioned into 3 disjoint subset with *n* members in each subset such that the three largest numbers in *S* are in different subsets. Then $\lim_{n\to\infty} P_n$ is
(A) $\frac{2}{7}$ (B) $\frac{1}{7}$
(C) $\frac{1}{9}$ (D) $\frac{2}{9}$

Space for rough work

5. If a, b, c are in H.P. and p is the length of the perpendicular drawn from the origin to any member of family of lines $(a + c - 2ac)\,bx - 2acy + 7abc = 0$ then $p \in$

(A) $\left[\frac{1}{4}, \frac{9}{\sqrt{2}}\right]$ (B) $\left(0, \frac{7}{\sqrt{2}}\right]$

(C) (7, 9) (D) $\left[\frac{7}{\sqrt{2}}, \frac{9}{\sqrt{2}}\right]$

6. The sides of a triangle are the roots of the cubic equation $x^3 - 13x^2 + 54x - 72 = 0$ then the area of the triangle in square units is

(A) $\frac{1}{2}\sqrt{455}$ (B) $\frac{1}{4}\sqrt{455}$

(C) $\frac{1}{2}\sqrt{394}$ (D) $\frac{1}{4}\sqrt{394}$

7. f(x) is a polynomial function and $(f(\alpha))^2 + (f'(\alpha))^2 = 0$ then find $\lim_{x\to\alpha} \frac{f(x)}{f'(x)}\left[\frac{f'(x)}{f(x)}\right]$ where [.] denotes greatest integer function.

(A) 0 (B) 1

(C) –1 (D) none of these

8. f(x) and g(x) are quadratic polynomials and $|f(x)| \geq |g(x)|, \forall x \in R$. Also f(x)=0 have real roots. Then number of distinct roots of equation $h(x)h''(x) + (h'(x))^2 = 0$ are (where h(x)=f(x)g(x)).

(A) 0 (B) 2

(C) 3 (D) 4

Space for rough work

Multiple Correct Choice Type

This section contains **04 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

9. If the equation $px^2 + y^2 + qz^2 + 2yz + zx + 3xy = 0$ represents a pair of perpendicular planes, then $p - q =$

(A) 5
(B) –5
(C) $\frac{5}{2}$
(D) $-\frac{5}{2}$

10. If $\frac{dy}{dx} + y\frac{dx}{dy} = x$ and $y(-2) = 1$, then

(A) $2x + y + 3 = 0$
(B) $x^3 + 8y = 0$
(C) $x + y + 1 = 0$
(D) $x^2 - 4y = 0$

11. If $(1, 2, p)$, $(2, 2p, -6)$ and $(\alpha^2 - 2\alpha, 1, 1)$ are the ordered triplets of form (*x, y,* z) which satisfies all the equations.

$\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 1$, $\frac{x}{b} + \frac{y}{c} + \frac{z}{a} = 1$ and $\frac{x}{c} + \frac{y}{a} + \frac{z}{b} = 1$ then α can be

(A) 2
(B) – 2
(C) – 4
(D) 4

12. If $f(x)$ is a continuous and differentiable function such that $f(t_k) = 1$ for $k = 1, 2, ...n,$ where $t_k = \sum_{r=1}^{k} \frac{1}{r(r+1)(r+2)}$ then

(A) $f\left(\frac{1}{4}\right) = 1$
(B) $f\left(\frac{1}{2}\right) = 1$
(C) $f'\left(\frac{1}{2}\right) = 0$
(D) $f'\left(\frac{1}{4}\right) = 0$

Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

---

Paragraph for Questions 13 & 14

Consider the function $h(n) = \int_{o}^{a} f(x)\, g(nx)\, dx$

13. Let $f(x) = 2,\ g(x) = |\sin \pi x|,$ and $n = \frac{1}{N},$ where *N* is natural number. If $h(n)/a$ is independent of *n* for $N = 1, 2, 3, 4$ then minimum value of *a* is

(A) 2
(B) 3
(C) 4
(D) 12

14. If $f(x) = \sin^2 x,\ g(x) = |\cos x|$ then $\lim\limits_{a \to \infty} \frac{h(1)}{a}$ is equal to

(A) $\frac{2}{3\pi}$
(B) $\frac{1}{3\pi}$
(C) $\frac{1}{2\pi}$
(D) $\frac{1}{\pi}$

Paragraph for Questions 15 & 16

In a $\Delta ABC,\ AB = 3,\ BC = 4,\ CA = 5.$ *P* is any point inside the $\Delta ABC,$ such that $\angle PAB = \angle PBC = \angle PCA = \alpha.$

15. $\cot \alpha =$

(A $\frac{1}{5}$
(B) $\frac{25}{4}$
(C) $\frac{25}{12}$
(D) 4

Space for rough work

16. Ratio of Areas of ΔPBC and ΔPAB is

(A) $\frac{16}{25}$ (B) $\frac{25}{16}$

(C) 2 (D) $\frac{4}{15}$

Paragraph for Questions 17 & 18

Using three basic colours (Red, Blue, Green) different colour are made by mixing these two or more colours in equal proportion. The *n* vertical stripes are painted by all colours available, such that no two consecutive stripes have same colour.

17. The number of ways of painting *n* stripes such that only alternate stripes are painted by a basic colour (*n* in odd) is

(A) $3^{\frac{n+1}{2}}.4^{\frac{n-1}{2}}$ (B) $7.12^{\frac{n+1}{2}}$

(C) $3^{\frac{n-1}{2}}.4^{\frac{n+1}{2}}$ (D) $7.12^{\frac{n-1}{2}}$

18. If *n* stripes are painted such that no two consecutive stripes have any basic colour common, then number ways of pointing *n* stripes is

(A) $\frac{1}{2}\left(\left(1+\sqrt{2}\right)^{n-1}+\left(1-\sqrt{2}\right)^{n-1}\right)$ (B) $\frac{1}{\sqrt{2}}\left(\left(1+\sqrt{2}\right)^{n-1}-\left(1-\sqrt{2}\right)^{n-1}\right)$

(C) $\frac{1}{2}\left(\left(1+\sqrt{2}\right)^{n}+\left(1-\sqrt{2}\right)^{n}\right)$ (D) $\frac{3}{\sqrt{2}}\left(\left(1+\sqrt{2}\right)^{n}-\left(1-\sqrt{2}\right)^{n}\right)$

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. Let L_1 be the projection and L_2 be the image of the z-axis in the plane $3x-4y+z+1=0.$ The distance of the point (1, 2, 3) from the plane containing the lines L_1 and L_2 is ……

2. The graphs of $x^2+y^2+6x-24y+72=0$ and $x^2-y^2+6x+16y-46=0$ intersect at four points. The sum of distances from these four points to the point $(-3,\ 2)$ is 10 *k*. Then value of *k* is equal to

3. Let $A=[a_{ij}]_{n\times n}$ be a matrix such that $a_{ij}=i.2^{-j}$ then find the value of $\lim\limits_{n\to\infty}\left(\text{trace } A^n\right)^{1/n}$ (where $n\in N$).

4. $f(x+1)=(-1)^{x+1}x-2f(x)$ for $x\in N$ and $f(1)=f(1986)$.
Compute the sum of digit of number $\left(f(1)+f(2)+\ldots f(1985)\right)$

5. Two rays begin at point *A* and form an angle of 43º with one another. Lines l_1, l_2, l_3 (no two being parallel) each form an isosceles triangle with the original rays. If θº is the largest angle of triangle formed by l_1, l_2 and l_3 then find value of $8\cos^2(\theta^\circ-9^\circ)$.

Space for rough work

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

FIITJEE

JEE(Advanced)-2017

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – II
(PAPER - 2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	B	A	B
2.	D	C	B
3.	D	A	C
4.	C	B	D
5.	B	A	B
6.	D	B	B
7.	B	C	B
8.	A	B	D
9.	BCD	ABC	AD
10.	AD	ACD	ACD
11.	AC	ABC	BD
12.	ABC	AC	AD
13.	D	D	D
14.	C	B	A
15.	C	B	C
16.	A	C	A
17.	C	B	D
18.	A	D	D
1.	6	0	2
2.	5	4	4
3.	3	3	2
4.	2	6	7
5.	2	9	2

Physics PART – I

SECTION – A

1. $\lambda=\frac{v}{f}=\frac{330}{500}=0.66m=\frac{4\lambda}{2n-1}\Rightarrow n=3$

2. $\Delta x=2d=\lambda,\ \text{Now}, U=fx=2fd$

3. $V_1=\frac{kQ}{\sqrt{2}b};V_2=\frac{kQ}{\sqrt{5}b}$

4. If another shell is kept upside down over it complete a sphere, net field should become zero

5. $F_1=F_B-\left(\pi a^2\right)\rho gh$

$F_2=F_B-\left(\pi a^2\right)\rho g\left(2h\right)$

6. $\mu_2>\mu_1>\mu_3$

$v_2<v_1<v_3$

$\lambda_2<\lambda_1<\lambda_3$

Frequency is independent of medium

7. B_w is magnetic field of wire

$B_1=B_0+B_w$

$B_2=B_0-B_w$

$\Rightarrow B_0=\frac{B_1+B_2}{2}$

8. $C_V>\frac{fR}{2}$

f is $=3$ for monoatomic but f is 5 for diatomic at normal temperature. But $f>5$ for diatomic gases. At high temperature energy of vibration also increases taken that into account C_V increases since molecules of monoatomic gas do not vibrate, its C_V remains same.

9. The loops is always attracted towards wire as the region part of loop getting attracted is experiencing stronger magnetic field

10. The magnetic field due to the outer loop is into the paper. The force on an element of the inner loop has the direction given by $\vec{ds}\times\vec{B}$ where $\vec{ds}$ is the element length in the direction of current. Thus the force is radially outward.

Since the force is symmetric, i.e. radially outwards everywhere and the loops are concentric, there is no net force on the inner loop.

11. Equivalent diagram is as shown in P is moved 2 cm right them R_1=12, R_3=3

$\frac{R_1}{R_2} = \frac{R_2}{R_4}$ (Hence wheat stone will be balanced)

If s is moved left $\frac{5}{3}cm$ then $R_4 = \frac{20}{3}$ hence $\frac{R_1}{R_3} = \frac{R_2}{R_4}$ (hence wheat stone will be balanced)

12. $I\omega = \tau\Delta t$

Hence $\frac{1}{2}I\omega^2 = \frac{(\tau\Delta t)^2}{2I}$

15. $f \propto \sqrt{T}$

So Δf increases by increasing T.

i.e. $f_2 = f_1 + 3 = 443\,Hz$

16. $v = f\lambda$

$\lambda = \frac{340}{360} = 0.94$

17. Pressure will increase, equally at all points

18. The compression will be proportional to g_{eff}

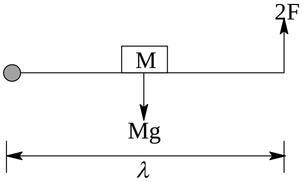
SECTION – C

1. By linear momentum conservation impulse (J) = mV.

By angular momentum conservation, angular impulse $= J\frac{\lambda}{2} = I\omega$

So $mv\frac{\lambda}{2} = I\omega \text{ or } \omega = \frac{mv\lambda}{2I} = \frac{mv\lambda}{2\left(\frac{m\lambda^2}{12}\right)} = \frac{6v}{\lambda} = 6\,rad/s$

2.



For equilibrium

$\left|Mg\frac{\lambda}{2}\right| = |2F|1$

$F = \frac{mg}{4} = \frac{100}{4} = 25\,N$

Chemistry

PART – II

SECTION – A

1. $$\log\frac{P_2}{P_1}=\frac{\Delta H}{2.303R}\left[\frac{1}{T_1}-\frac{1}{T_2}\right]$$

$$\log\frac{P_2}{760}=\frac{9720}{2.303\times 2}\left[\frac{1}{373}-\frac{1}{348}\right]$$

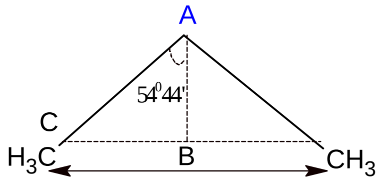
$$P_2=298\text{torr}$$

$$\frac{298-P_{sol.}}{298}=\frac{0.1}{0.1+\frac{1000}{18}}\approx\frac{0.1}{\frac{1000}{18}}$$

$$P_{sol}=297.46\text{torr}$$

Lowering in VP=(298-297.46)=0.54torr

2.



$$\text{Sin}(54^0\,44')=\frac{CB}{AC}$$

Terminal carbon carbon distance= $2\times CB$

$$=2\times\ 1.54\ \times\text{Sin}(54^0\,44')$$

$$=2.51\ A^0$$

3. 0.5.mol of CH_3COONa and 0.5mol H_2O is formed.

$$\Delta T_f=\frac{0.5\times 2}{20.5\times 18\times 10^{-3}}=5.04$$

4. 100g H_2O_2 per hr.
(100/34)mol H_2O_2 per hr.
(100/34)mol $(NH_4)_2S_2O_8$ per hr.

$$\frac{100\times 2}{34}\text{mole e}^-\ \text{per hr}$$

i =157.68amp

current required=315 amp

5. $$E_{cell}=E^0{}_{cell}-\frac{0.059}{1}\log Q$$

$$0=E^0{}_{cell}-\frac{0.059}{1}\log K$$

$$0=(x-0.799) - \frac{0.059}{1}\log(6\times10^{-8})$$

$$x = 0.37$$

6. $SO_3^{2-} + 2H^+ \longrightarrow SO_2 + 2H^+$

7. A, B, D is having plane of symmetry.

8. Intercept=$E^0_{Cu^{2+}/Cu}$=0.34

$$E_{Cu/Cu^{2+}} = E_{Cu/Cu^{2+}} - \frac{0.059}{2}\log[Cu^{2+}]$$

$$E_{Cu/Cu^{2+}} = -0.34 - \frac{0.059}{2}\log 0.1$$

$$E_{Cu/Cu^{2+}} = -0.3105V$$

9. In isothermal process $\Delta U=0$,

10. $\frac{35.6}{24}$ mole Mg

$(\frac{35.6}{24}\times 2)$ mole of e^-

$(\frac{35.6}{24}\times 2\times 96500)$ coloumb

12. C_4H_{10},CH_3CH_2OH, NH_3 and I_2 have high BP so low vapour pressure.

(13 – 14).

$$FeSO_4.7H_2O \xrightarrow{heat} FeSO_4(B)+H_2O$$

$$FeSO_4.7H_2O \xrightarrow{strong\ heat} Fe_2O_3(D)+SO_2(E) +SO_3(F)$$

(15 – 16)

$$H_2O_2 +2KI+ H_2SO_4 \longrightarrow K_2SO_4 +I_2 +2H_2O$$

$$I_2 + Na_2S_2O_3 \longrightarrow 2NaI + Na_2S_4O_6$$

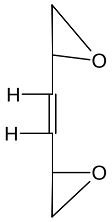
4mmol of hypo means 2mmole of I_2 and 2 mmole of H_2O_2.

so molarity=$\frac{2}{25}$, $normality = \frac{4}{25} = 0.16N$

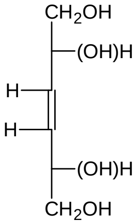
And volume strength=$\frac{2}{25}\times 11.2V = 0.896V$

17. C2 and C5 should having opposite configuration for S to be meso.

18. C2 and C5 should having opposite configuration for S to be meso it is possible with D only.



(Q)



S,Meso(C2 and C5 have opposite configuration)

SECTION – C

1. $\text{Pyrolusite} \longrightarrow \text{MnO}_2$

$\text{Iron Chromite} \longrightarrow \text{FeO.Cr}_2\text{O}_3$

$\text{Siderite} \longrightarrow \text{FeCO}_3$

$\text{Cassiterite} \longrightarrow \text{SnO}_2$

$\text{Calamine} \longrightarrow \text{ZnCO}_3$

$\text{Argentite} \longrightarrow \text{Ag}_2\text{S}$

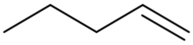
$\text{Lime stone} \longrightarrow \text{CaCO}_3$

$\text{Chalcopyrite} \longrightarrow CuFeS_2$

2. $\text{NH}_3, \text{SO}_2, \text{Ca}\left(\text{OH}\right)_2, \text{NaCl}$

3. I,ii,and V are correct

4. Sc^{3+} &Co^{3+} are diamagnetic Sol.



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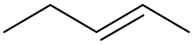

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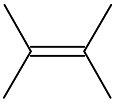

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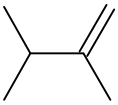

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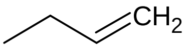

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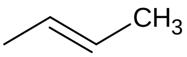

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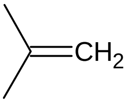


(1)

Mathematics PART – III

SECTION – A

1. $$a\left(\frac{1+\sqrt{5}}{2}\right)^9+b\left(\frac{1+\sqrt{5}}{2}\right)^8+1=0$$

$$2^9a+2^8b\left(\sqrt{5}-1\right)+\left(\sqrt{5}-1\right)^9=0$$
$$2a+b\left(\sqrt{5}-1\right)=76-34\sqrt{5}$$
$$\Rightarrow \quad 2a-b=76,\ b=-34\Rightarrow a=21$$

2. $$2ab-5a+b=55$$

$$\Rightarrow \quad (2a+1)\left(b-\frac{5}{2}\right)=55-\frac{5}{2}$$
$$\Rightarrow \quad (2a+1)(2b-5)=105=3.5.7$$

Total number of positive solutions $=2\times2\times2=8$

Total number of solutions $=16$.

3. $$f_n=2^n+3^n$$

$\Rightarrow \quad f_{n+1}-2f_n=3^n$ and $f_{n+2}-2f_{n+1}=3.3^n$

So option '*c*' is correct.

4. $$P_n=\frac{3!.(3n-3)!.(n!)^3}{((n-1)!)^3(3n)!}=\lim_{n\to\infty}\frac{6}{(3n)}\frac{n^3}{(3n-1)(3n-2)}$$

$$=\frac{2}{9}$$

5. $$\left(\frac{a+c}{ac}-2\right)bx-2y+7b=0$$

$$\Rightarrow \quad \left(\frac{2}{b}-2\right)bx-2y+7b=0$$
$$\Rightarrow \quad x-y-b\left(x-\frac{7}{2}\right)=0$$

Line passes through $\left(\frac{7}{2},\frac{7}{2}\right)$ maximum distance from origin $\sqrt{\left(\frac{7}{2}\right)^2+\left(\frac{7}{2}\right)^2}=\frac{7}{\sqrt{2}}$ and minimum is zero. $\left(0,\frac{7}{\sqrt{2}}\right]$

6. Let roots of the equation $x^3-13x^2+54x-72=0$ are, $a,\ b,\ c$

$$\sum a=13$$
$$\sum ab=54$$

$abc = 72 \qquad S = \dfrac{13}{2}$

or $\quad x^3 - 13x^2 + 54x - 72 = (x-a)(x-b)(x-c)$

$$\left(\frac{13}{2}\right)^3 - 13\left(\frac{13}{2}\right)^2 + 54\left(\frac{13}{2}\right) - 72 = (S-a)(S-b)(S-c)$$

$$\frac{35}{8} = (S-a)(S-b)(S-c)$$

$$\Delta = \sqrt{S(S-a)(S-b)(S-c)}$$

$$= \frac{\sqrt{455}}{4}$$

7. Clearly α is repeated root of f(x)=0

$$\lim_{x\to\alpha}\frac{f(x)}{f'(x)}\left(\frac{f'(x)}{f(x)} - \left\{\frac{f'(x)}{f(x)}\right\}\right) \quad \Rightarrow \quad \lim_{x\to\alpha}\left(1 - \frac{f(x)}{f'(x)}\left\{\frac{f'(x)}{f(x)}\right\}\right) = 1-0=1$$

$$\left(\lim_{x\to\alpha}\frac{f(x)}{f'(x)} = 0 \ \& \left\{\frac{f'(x)}{f(x)}\right\}\text{is bounded function}\right)$$

8. Clearly if f(x) = a(x–α)(x–β) then g(x) = b(x–α)(x–β)

$\Rightarrow h(x) = k(x-\alpha)^2(x-\beta)^2 \qquad \Rightarrow h(x)h'(x) = 2k(x-\alpha)^3(x-\beta)^3(2x-\alpha-\beta)$

So distinct roots of $\dfrac{d}{dx}(h(x)h'(x))$ =0 are 4.

9. $p\left(\dfrac{x}{z}\right)^2 + \left(\dfrac{y}{z}\right)^2 + 3\left(\dfrac{x}{z}\right)\left(\dfrac{y}{z}\right) + \left(\dfrac{x}{z}\right) + 2\left(\dfrac{y}{z}\right) + q = 0$

To factories make $\Delta = 0$

$$p\times 1\times q + 2\times\frac{1}{2}\times 1\times\frac{3}{2} - p\times 1^2 - 1\times\left(\frac{1}{2}\right)^2 - q\left(\frac{3}{2}\right)^2 = 0$$

and also for perpendicularity $p + q + 1 = 0$

$\Rightarrow \qquad 4p^2 - p - 14 = 0 \qquad (4p+7)\ (p-2) = 0$

$\qquad p = 2,\ q = -3, \qquad p = \dfrac{-7}{4},\ q = \dfrac{3}{4}$

10. Let $\dfrac{dy}{dx} = p,$ we have

$p^2 + y = xp$

$\Rightarrow \qquad 2pp' + p = p + xp'$

$\Rightarrow \qquad 2p = x$ or $p' = 0$

which givens $x^2 = 4y$ or $y = cx + (2c+1)$

or $y - 1 = c(x+2)$

11. Fro more than one triplet satisfying all three equations we have

$$\begin{vmatrix} \frac{1}{a} & \frac{1}{b} & \frac{1}{c} \\ \frac{1}{\text{b}} & \frac{1}{c} & \frac{1}{a} \\ \frac{1}{c} & \frac{1}{a} & \frac{1}{b} \end{vmatrix} = 0$$

$\Rightarrow$ $a = b = c$

$\Rightarrow$ $(x + y + z) = a$ satisfying the triplets

We get $a = 10, \;\; p = 7 \;\; \Rightarrow \; \alpha^2 - 2\alpha - 8 = 0$

$\alpha = -2$ and 4.

12. If $f(x)$ is continuous then $\lim\limits_{k\to\infty} f(t_k) = f\left(\lim\limits_{k\to\infty}(t_k)\right) = f\left(\frac{1}{4}\right) = 1$ (Where $\lim\limits_{k\to\infty} t_k = \frac{1}{4}$).

Also as graph is smooth $f'\left(\frac{1}{4}\right) = 0$

13. $h(n) = \int_o^a 2|\sin n\pi x|\,dx$

Let $a = \frac{k}{n} + \alpha$, $\quad 0 \le \alpha < \frac{1}{n}$, $\quad k \in I$

$$= k\int_0^{1/n} 2|\sin n\pi x|\,dx + \int_0^{\alpha} 2|\sin n\pi x|\,dx$$

$$= 4\frac{k}{n\pi} + \frac{2(1-\cos n\pi\alpha)}{n\pi}$$

$$\frac{h(n)}{a} = \frac{4(a-\alpha)}{a\pi} + \frac{2(1-\cos n\pi\alpha)}{n\pi}$$

$$= \frac{4}{\pi} + \frac{2(1-\cos n\pi\alpha)}{n\pi a} - \frac{4\alpha}{a\pi}$$

$\frac{h(n)}{a}$ is independent of *n* if $\alpha = 0$.

i.e. $an = k \Rightarrow a = kN$

a should be divisible by 2, 3, 4 i.e. minimum (*a*) = 12.

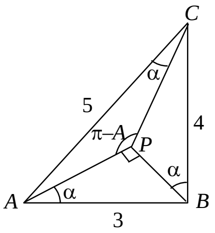
14. $h(1) = \int_0^a \sin^2 x.|\cos x|\,dx$

$$\Rightarrow \lim_{a\to\infty}\frac{h(1)}{a} = \lim_{a\to\infty}\frac{1}{a}\int_0^a \sin^2 x.|\cos x|\,dx$$

Let $a = n\pi + \alpha \qquad 0 \le \alpha < \pi$

$$\Rightarrow \lim_{n\to\infty}\int_0^{n\pi+\alpha} \sin^2 x.|\cos x|\,dx = \lim_{n\to\infty}.\frac{1}{n\pi+\alpha}\left(n\int_0^{\pi}\sin^2 x|\cos x|\,dx + \int_0^{\alpha}\sin^2 x.|\cos x|\,dx\right)$$

$$= \frac{1}{\pi}\int_0^{\pi}\sin^2 x|\cos x|\,dx = \frac{2}{3\pi}$$



15. $AP = 3\cos\alpha$

In ΔAPC

$$\frac{3\cos\alpha}{\sin\alpha} = \frac{5}{\sin(\pi - A)}$$

$$\Rightarrow \cot\alpha = \frac{25}{12}$$

16. $$\frac{\Delta PBC}{\Delta PAB} = \frac{\frac{1}{2}.PB.4.\sin\alpha}{\frac{1}{2}.PB.3.\sin(90^o - \alpha)} = \frac{4}{3}.\tan\alpha$$

$$= \frac{4}{3}.\frac{12}{25} = \frac{16}{25}$$

17. Either the stripes at odd number are painted with basic colour or at the even numbers.

Total ways $= 3^{\frac{n+1}{2}}\ 4^{\frac{n-1}{2}} + 3^{\frac{n-1}{2}}\ 4^{\frac{n+1}{2}} \quad = 7(12)^{\frac{n-1}{2}}$

18. t_n → No of ways of painting *n* stripes

a_n → No of way of painting *n* stripes when it ends with a particular basic colour (*R*, *B* or *G*)

b_n → No of way of painting *n* stripes when it ends with a particular non basic colour $(R/B,\ B/G \text{ or } R/G)$

$t_n = 3(a_n + b_n)$ (i)

$a_n = 2a_{n-1} + b_{n-1}$ (ii)

$b_n = a_{n-1}$ (iii)

Equation (ii) and (iii) givens

$$b_{n+1} = 2b_n + b_{n-1}$$

On solving characteristic equation $x^2 - 2x - 1 = 0$

we get $b_n = \alpha\left(1+\sqrt{2}\right)^{n-1} + \beta\left(1-\sqrt{2}\right)^{n-1}$

$b_2 = 1 \quad \Rightarrow 1 = \alpha + \beta + \sqrt{2}(\alpha - \beta)$

$\Rightarrow \alpha = \beta = \frac{1}{2} \quad \Rightarrow b_n = \frac{1}{2}\left(\left(1+\sqrt{2}\right)^{n-1} + \left(1-\sqrt{2}\right)^{n-1}\right)$

$$t_n = \frac{3}{\sqrt{2}}\left(\left(1+\sqrt{2}\right)^n - \left(1-\sqrt{2}\right)^n\right).$$

SECTION – C

1. Required plane contains z-axis and normal of $3x - 4y + z + 1 = 0$ hence its equation is $4x + 3y = 0$ distance from (1, 2, 3) is $\frac{4+6}{\sqrt{16+9}} = 2$ units.

2. On adding and subtracting the curves we get

$(x+3)^2 = 4(y-1),\ y^2 - 20y + 59 = 0$ respectively

Let point of intersection be $(x_1, y_1)(x_2, y_1)(x_3, y_2)(x_4, y_2)$

$\Rightarrow$ $y_1 + y_2 = 20$ and $y_1, y_2 > 0$

We required $\sum\sqrt{(x_1+3)^2+(y_1-2)^2} = \sum\sqrt{4(y_1-1)+(y_1-2)^2}$

$= \sum y_1 = 2(y_1+y_2) = 40$

3. $$A = \begin{bmatrix} 1 & 0 & 0 & \cdots & 0 \\ 2 & 0 & 0 & \cdots & 0 \\ 3 & 0 & 0 & \cdots & \\ \vdots & & & & \\ n & 0 & 0 & \cdots & 0 \end{bmatrix}\begin{bmatrix} 2^{-1} & 2^{-2} & 2^{-3} & \cdots & 2^{-n} \\ 0 & 0 & 0 & \cdots & 0 \\ 0 & 0 & 0 & \cdots & 0 \\ \vdots & & & & \\ 0 & 0 & 0 & \cdots & 0 \end{bmatrix}$$

$$A^2 = \begin{bmatrix} 1 & 0 & 0 & \cdots & 0 \\ 2 & 0 & 0 & \cdots & 0 \\ 3 & 0 & 0 & \cdots & \\ \vdots & & & & \\ n & 0 & 0 & \cdots & 0 \end{bmatrix}\begin{bmatrix} 2^{-1} & 2^{-2} & 2^{-3} & \cdots & 2^{-n} \\ 0 & 0 & 0 & \cdots & 0 \\ 0 & 0 & 0 & \cdots & 0 \\ \vdots & & & & \\ 0 & 0 & 0 & \cdots & 0 \end{bmatrix}\begin{bmatrix} 1 & 0 & 0 & \cdots & 0 \\ 2 & 0 & 0 & \cdots & 0 \\ 3 & 0 & 0 & \cdots & \\ \vdots & & & & \\ n & 0 & 0 & \cdots & 0 \end{bmatrix}\begin{bmatrix} 2^{-1} & 2^{-2} & 2^{-3} & \cdots & 2^{-n} \\ 0 & 0 & 0 & \cdots & 0 \\ 0 & 0 & 0 & \cdots & 0 \\ \vdots & & & & \\ 0 & 0 & 0 & \cdots & 0 \end{bmatrix}$$

$$A^2 = \begin{bmatrix} 1 & 0 & 0 & \cdots & 0 \\ 2 & 0 & 0 & \cdots & 0 \\ 3 & 0 & 0 & \cdots & \\ \vdots & & & & \\ n & 0 & 0 & \cdots & 0 \end{bmatrix}\begin{bmatrix} \sum i2^{-i} & 0\ 0\ 0 & \cdots & 0 \\ 0 & 0\ 0\ 0 & \cdots & 0 \\ 0 & & & \\ \vdots & & & \\ 0 & 0\ 0\ 0 & \cdots & 0 \end{bmatrix}\begin{bmatrix} 2^{-1} & 2^{-2} & 2^{-3} & \cdots & 2^{-n} \\ 0 & 0 & 0 & \cdots & 0 \\ 0 & 0 & 0 & \cdots & 0 \\ \vdots & & & & \\ 0 & 0 & 0 & \cdots & 0 \end{bmatrix}$$

$\Rightarrow$ $A^2 = \left(\sum i.2^{-i}\right)A$

$\Rightarrow$ $A^n = \left(\sum i.2^{-i}\right)^{n-1}$

$\Rightarrow$ $Trace\ A^n = \left(\sum i.2^{-i}\right)^{n-1}\left(\sum a_{ii}\right) = \left(\sum i.2^{-i}\right)^n$

$\Rightarrow$ $\lim\limits_{n\to\infty}\left(Trace\ A^n\right)^{1/n} = \lim\limits_{n\to\infty}\left(\sum i2^{-i}\right) = \frac{1}{2}+\frac{2}{4}+\frac{3}{8}+.....$ = 2

4. $$\sum_{x=1}^{1985} f(x+1) = \sum_{x=1}^{1985}(-1)^{x+1}x - 2\sum_{x=1}^{1985} f(x)$$

$\Rightarrow$ As $f(1) = f(1986)$

$$\Rightarrow 3\sum_{x=1}^{1985} f(x) = \sum_{x=1}^{1985}(-1)^{x+1}x$$

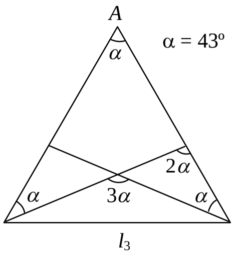
$$\Rightarrow \sum_{x=1}^{1985} f(x) = 331.$$

Sum of the digits = $3+3+1=7$.

5. From the figure

$\theta = 3\alpha = 129$

$8\cos^2\left(120^\circ\right) = 2$



In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

FIITJEE **JEE (Main), 2017**

ALL INDIA TEST SERIES

FULL TEST – II

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 30)** contains 30 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10 \text{ m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2\text{/N-m}^2$
Density of water	$\rho_{water} = 10^3 \text{ kg/m}^3$
Atmospheric pressure	$P_a = 10^5 \text{ N/m}^2$
Gas constant	$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

CHEMISTRY

Gas Constant R = $8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
= $0.0821 \text{ Lit atm K}^{-1} \text{ mol}^{-1}$
= $1.987 \approx 2 \text{ Cal K}^{-1} \text{ mol}^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. A box suspended by a rope is pulled to one side by a horizontal force. The tension in the rope
(A) Is less than before
(B) Remains unchanged
(C) Is greater than before
(D) May be any of the above, depending on the force applied

2. The co-efficient of kinetic friction between two steel surfaces is
(A) 0.57 N/kg (B) 0.7 N
(C) 0.63 N/m (D) 0.6 J/N-m

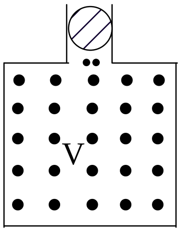
3. The head of an axe has a mass of 2.5 kg. It exerts a force of 80 kN as it penetrates 18 mm into the trunk of a tree. The speed with which the axe head struck the tree was
(A) 1.2 m/s (B) 34 m/s
(C) 3.4 m/s (D) 107 m/s

4. A ball strikes a horizontal surface at an angle α with it and rebounds at an angle β, then find the incorrect statement
(A) β may be equal to α (B) β may be less than α
(C) β may be greater than α (D) β can not be greater than α

5. The least count of a stop watch is 1/5 second. The time of 20 oscillations of a pendulum is measured to be 25 seconds. The percentage error in the measurement of time will be
(A) 0.1% (B) 0.8%
(C) 1.8% (D) 8%

Space for rough work

6. An air chamber of volume V has a neck area of cross – section 'a' into which a ball of mass m can move up and down without friction. If the ball is press down a little and released then find the time period of oscillation of ball. Here air is ideal & its temperature remains constant & the isothermal. Bulk modulus of air is B.



(A) T= $2\pi\sqrt{2Vm/Ba^2}$ (B) T= $2\pi\sqrt{Vm/Ba^2}$

(C) T= $2\pi\sqrt{Vm/2Ba^2}$ (D) None of these

7. A source when at rest in a medium produces waves with a velocity v and a wavelength of λ. If the source is set in motion with a velocity vs what would be the wavelengths produced directly in front of the source?

(A) $\lambda\left(1-\frac{v_s}{v}\right)$ (B) $\lambda\left(1+\frac{v_s}{v}\right)$

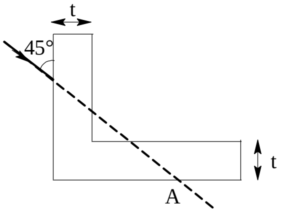
(C) $\lambda\left(1+\frac{v}{v_s}\right)$ (D) $\frac{\lambda v}{v+v_s}$

8. A car just leaves the road when it passes over a hump of radius 40 m. The car's velocity is

(A) 20 m/s (B) 392 m/s

(C) 62 m/s (D) It cannot be found with the mass of the car

9. Two glass slabs of same thickness are joined to form an L as shown. A ray is incident on the combination as shown (in the plane of paper). The final emergent ray will



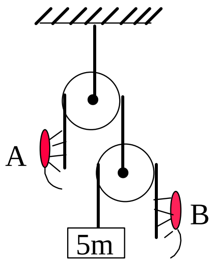
(A) Come out at point A in the same direction as that of the original ray.
(B) Come out at point A but not in the same direction as that of the original ray.
(C) Does not come out at point A but is in the same direction as that of the original ray.
(D) Does not come out at point A and is not in the same direction as that of the original ray.

Space for rough work

10. A solid steel cylinder A and an identical wooden cylinder B are released from two identical inclines from the same height. The incline of A has sufficient friction to ensure rolling and that of B is frictionless, then
(A) A reaches the bottom first
(B) B reaches the bottom with greater Kinetic Energy
(C) Both reach the bottom with same Kinetic Energy
(D) A reaches the bottom with greater Kinetic Energy

11. A 400g piston in a compressor oscillates up and down through a total distance of 80mm. The maximum force on the piston when it moves at 10 cycles/s is
(A) 64 N (B) 68 N
(C) 128 N (D) 132 N

12. Two monkeys A and B of equal mass 'm' can climb strings of a pulley arrangement as shown in figure. Find magnitude of acceleration (in $\mathrm{m/s^2}$) of A with respect to rope so that the block remains stationary. It is given that B is just holding the string. Assume pulley is frictionless and string is massless and inextensible.
(A) 90 $\mathrm{m/s^2}$ (B) 100 $\mathrm{m/s^2}$
(C) 110 $\mathrm{m/s^2}$ (D) 120 $\mathrm{m/s^2}$

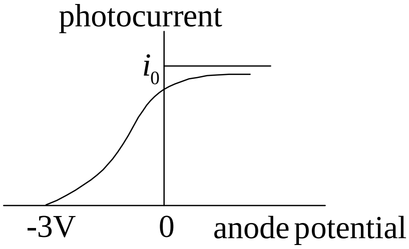


13. A boiler in which the gauge pressure is 4 bar develops a leak. The velocity at which the water comes out is
(A) 89 mm/s (B) 28 m/s
(C) 20 m/s (D) 0.8 km/s

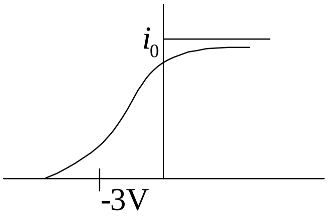
14. A proton (mass *m* and charge *e*) is fired from origin with velocity $\vec{v}=v_0\hat{i}+v_0\hat{j}$ in a uniform magnetic field $\vec{B}=B_0\hat{i}$. In the subsequent motion of the particle the axis of the helical path is
(A) $z=+\dfrac{mv_0}{eB_0} in\, xz-plane$ (B) $z=+\dfrac{mv_0}{eB_0} in\, yz-plane$
(C) $z=-\dfrac{mv_0}{eB_0} in\, xz-plane$ (D) $z=-\dfrac{mv_0}{eB_0} in\, yz-plane$

Space for rough work

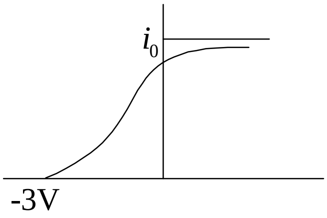
15. Figure shows the anode potential vs photo-current graph when photons of 6eV are incident on cathode in a photoelectric experiment set-up. In the same experimental set-up, if photons of 8eV and same intensity are incident on cathode, then anode-potential *vs* photo-current graph will be (assume 100% efficiency of photons to eject photo-electrons in both cases)



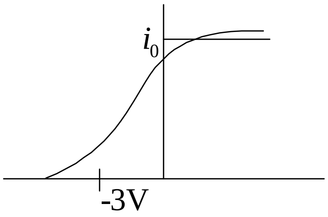
(A)



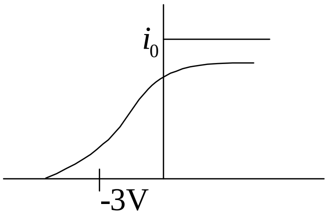
(B)



(C)

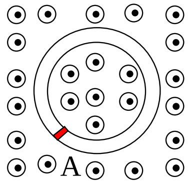


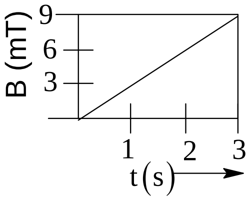
(D)

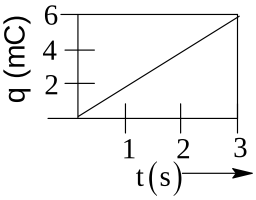


Space for rough work

16. A uniform magnetic field B increases in magnitude with time $'t'$ as given in fig. 1. A circular conducting loop of area 8 × 10–4 m^2 lies in the field, the field is $\perp$ to the plane of loop. The amount of charge $'q'$ that passed through the point A on the loop is given in fig. 2 as a function of time $'t'$. The resistance of loop is:



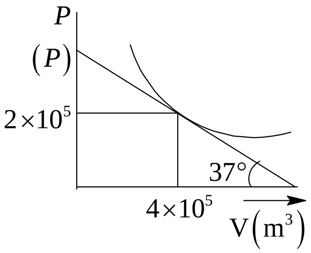




(A) $2.4\,m\Omega$ (B) $6\,m\Omega$

(C) $1.2\,m\Omega$ (D) $4\,m\Omega$

17. *P–V* graph for an ideal gas undergoing polytropic process $PV^N =$ constant is shown here. Then N is



(A) 1.5 (B) 2

(C) 1 (D) 3

18. Which of the following combination of units is equal to the watt?

(A) Js (B) $A^2\Omega$

(C) V^2 / A (D) $V^2\Omega$

Space for rough work

19. A light bulb rated at 240 V, 150 W is connected to a 120 V power line. The current that flows in it is

(A) 0.313 A (B) 1.25 A
(C) 0.625 A (D) 1.88 A

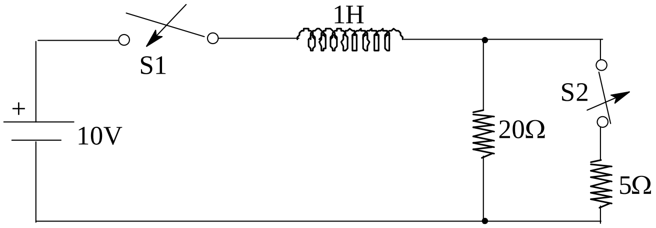
20. A network of three 5 Ω resistors cannot have an equivalent resistance of

(A) 1.67 Ω (B) 7.5 Ω
(C) 2.5 Ω (D) 15 Ω

21. Frequency of the k_α x-ray for the element calcium (*Ca, z=20) is 8.95*×10^{17}*Hz. Frequency of* k_α x-ray for element cadmium (*Cd*, z = 48) will be

(A) 5.46×10^{18}*Hz* (B) 6.31×10^{18}*Hz*
(C) 5.71×10^{17}*Hz* (D) 6.31×10^{17}*Hz*

22. In the circuit shown, switch S is initially open. At time *t* = 0, S is closed, at this instant the potential difference across the 5 Ω resistor is



(A) 10 V (B) 2.5 V
(C) 5 V (D) 0 V

Space for rough work

23. An organ pipe of length *L* is open at one end and closed at the other end. The air column in the pipe is vibrating in second overtone. The minimum distance from the open end where the pressure amplitude is half of the maximum value is

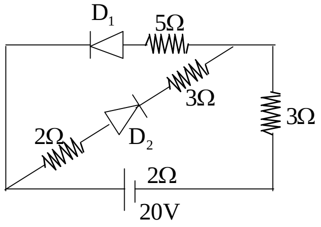
(A) $L/4$	(B) $L/8$
(C) $L/12$	(D) $L/15$

24. A long straight wire of circular cross-section is made of a non-magnetic material. The radius of cross-section of the wire is *a*. The wire carries a current *I* which is uniformly distributed over its cross-section. The energy stored per unit length in the magnetic field contained with the wire is

(A) $\mu I^2/2\pi$	(B) $\mu I^2/4\pi$
(C) $\mu I^2/8\pi$	(D) $\mu I^2/16\pi$

25. In the given circuit all diodes are ideal. The current through battery (shown in figure) is

(A) 2 A	(B) 1 A
(C) 4 A	(D) 4 A



26. At certain time the activity of three radioactive materials are in the ratio of 3: 5:7. What will be the ratio of their activities at any further date?

(A) 1 : 2 : 3	(B) 1 : 1 : 1
(C) 3 : 5 : 7	(D) 7 : 5 : 3

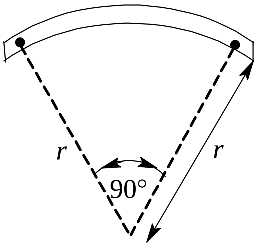
27. Two moles of a monatomic gas is mixed with three moles of a diatomic gas. The molar specific heat of the mixture at constant volume is

(A) 1.9 R	(B) 2.1 R
(C) 2 R	(D) 1.67 R

Space for rough work

28. A coil of self-inductance L is connected in series with a bulb B and an AC source. Brightness of the bulb increases when:
(A) Number of turns in the coil is increased.
(B) A capacitance of reactance $X_C = X_L$ is included in the same circuit.
(C) An iron rod is inserted in the coil.
(D) Frequency of the AC source is increased.

29. A bar magnet of length '*l*' and magnetic dipole moment 'M' is bent in the form of an arc as shown in figure. The new magnetic dipole moment will be



(A) $\frac{3}{\pi}M$
(B) $\frac{2\sqrt{2}}{\pi}M$
(C) $\frac{M}{2}$
(D) M

30. In a common emitter (CE) amplifier having a voltage gain 12, the transistor used has trans conductance 0.03 mho and current gain 25. If the above transistor is replaced with another one with trans conductance 0.02 mho and current gain 20, the voltage gain will be:
(A) 18
(B) 4
(C) 12
(D) 8

Space for rough work

Chemistry

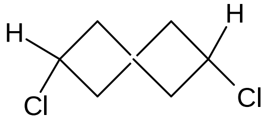
PART – II

SECTION – A

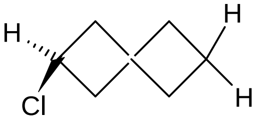
Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. 'A' is



'B' is



Which of the following statement is correct about organic compounds A and B ?

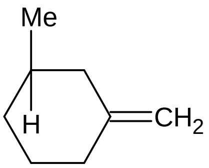
(A) Both are optically active
(B) 'A' is optically active and B is optically inactive
(C) 'B' is optically active and 'A' is optically inactive
(D) Both are optically inactive.

2. Dilute solution of KOH reacts with I_2 and forms:

(I) KI
(II) KI_3
(III) KIO

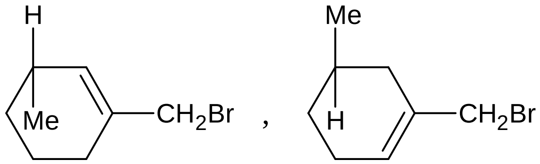
(A) II, II
(B) I, III
(C) I
(D) I, II, III

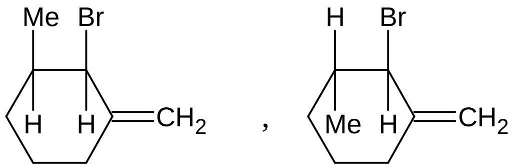
Space for rough work

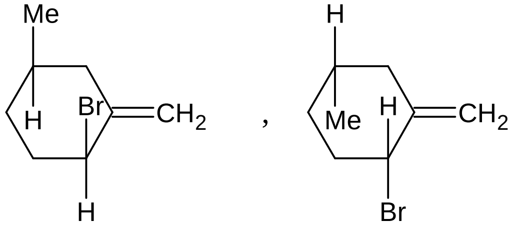
3. 

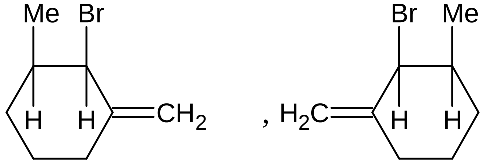
$+$ NBS $\longrightarrow$ six procucts:

Which of the following statements is incorrect about products?

(A) 
H
Me
CH₂Br
,
Me
H
CH₂Br
are two possible products.

(B) 
Me
Br
H
H
CH₂
,
H
Br
Me
H
CH₂
are other two possible products.

(C) 
Me
H
Br
CH₂
H
,
H
Me
H
CH₂
Br
are other two possible products.

(D) 
Me
Br
H
H
CH₂
,
H₂C
Br
Me
H
H
are other two possible products.

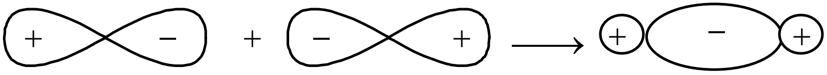
4. $0.42g$ of Mg_2C_3 reacts with water produces gas X. The gas X combination with O_2 produce CO_2. The volume of CO_2 at STP:

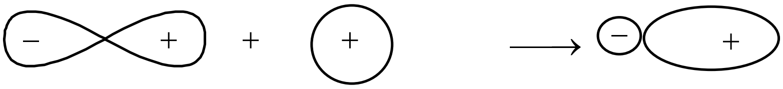
(A) $112mL$
(B) $448mL$
(C) $336mL$
(D) $448mL$

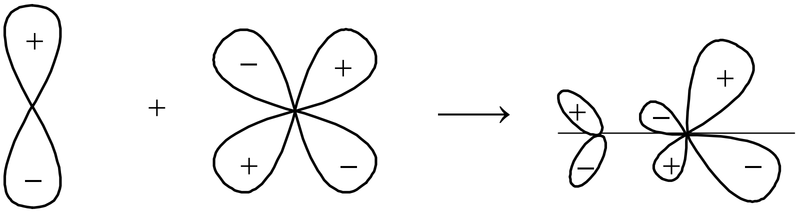
Space for rough work

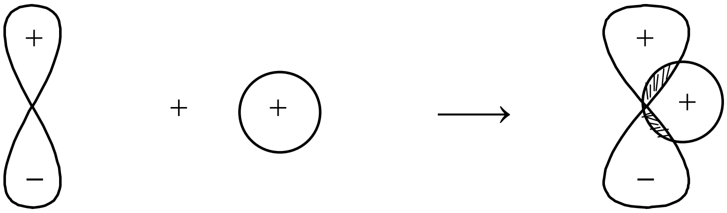
5. Down the group 13 and group 14, lower oxidation state compounds are more stable because:
(A) Down the group $I.E.$ decreases
(B) Poor shielding of electrons in s & p – orbitals as compare to d & f-orbitals
(C) Down the group electronegativity decreases
(D) Outer shell electron are less shielded from nucleus due to presence of electrons in d-orbitals of penultimate shell

6. Which of the following combination of atomic orbitals result into non-bonding?

(A)


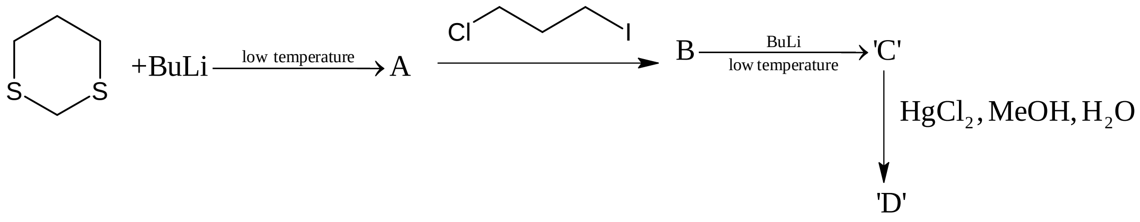
(B)


(C)


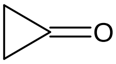
(D)


Space for rough work

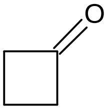
7.



Correct structure of compound 'D' is:

(A)


(B) CH_3CH_2CHO

(C)


(D) $CH_3CH_2CH_2CHO$

8. Consider the Vander Waal's equation of state $\left(p+\frac{a}{V^2}\right)(V-b)=RT$ correct statements is:

(A) Value of $'a'$ of N_2 is larger than that of NH_3 due to higher molecular weight of N_2

(B) Gas $'A'$ has Vander Wall's constants $'a'$ $\left(L^2\,atm/mol^2\right)$ and $'b'(L/mol)$ as 7 and 4.98×10^{-2}, this gas cannot be liquid at temperature $200°C$ however high pressure may be applied.

(C) At high pressure above equation reduces to $Z=1-\frac{b}{RTV}$

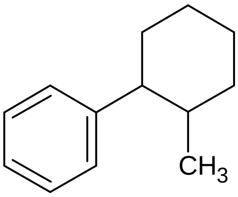
(D) If $Z<1$, attractive forces are dominating among the gaseous molecules

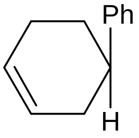
9. cis-2-phenylcyclohexanol $\xrightarrow{\text{Na}}$ 'A' $\xrightarrow{\text{CS}_2}$ 'B' $\xrightarrow{\text{CH}_3\text{I}}$ 'C'

'C' is S-methyl xanthate, which on pyrolysis gives:

(A) 3-phenylcyclohexene

(B) 1-phenylcyclohexene

(C)


(D)


Space for rough work

10. Bond dissociation enthalpy of gaseous H_2, Cl_2 and HCl are $104, 58$ and 103 $Kcal/mol$ respectively. Then enthalpy of formation of HCl gas is:

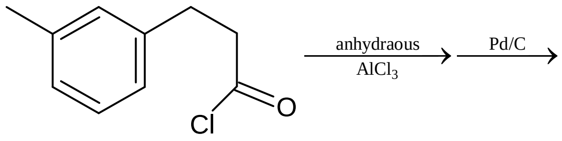
(A) $-22\,kcal$
(B) $+22\,kcal$
(C) $-44\,kcal$
(D) $+44\,kcal$

11. Which of the following process would result into formation of 7-methyl-1-naphthol?

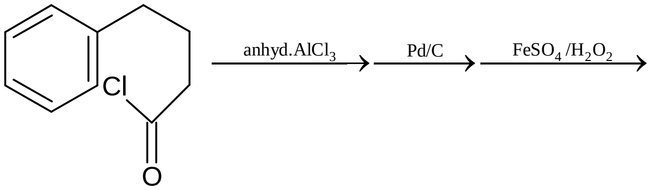
(A) cis-4-(p-Tolyl)-3-butenoic acid+HF

(B) trans-4-(p-Tolyl)-3-butenoic acid+HF

(C)



(D)



12. When a hydrocarbon C_xH_y is burnt, gives $100ml$ of gaseous mixture of CO_2 and H_2O (vapour). On passing product mixture through anhydrous $CuSO_4$ result into decrease of volume by $60\,ml$. Which of the following lowest molecular weight hydrocarbon can satisfy the above condition?

(A) CH_4
(B) C_2H_6
(C) C_2H_4
(D) C_4H_{10}

13. While testing BO_3^{3-}, there is green-edges flame on heating the salt with conc. H_2SO_4 and CH_3OH. Green colour is of

(A) $(CH_3)_3B$
(B) $(CH_3O)_3B$
(C) B_2O_3
(D) H_3Bo_3

Space for rough work

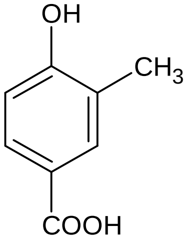
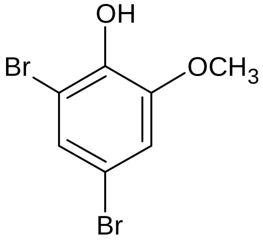
14. Vanillin $(L), C_8H_8O_3,$ is isolated from vanilla beans. It give an intense colour with $FeCl_3$ and positive Tollen's test. It is not steam-distilled and does not react with HCl. It goes through following steps:

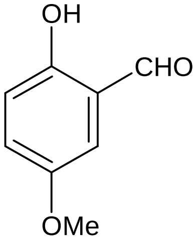
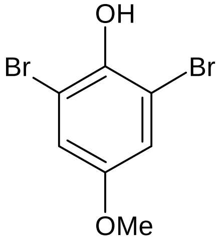
$$L \xrightarrow[1.\text{equivalent of } CH_3I]{OH^-} M, (C_9H_{10}O_3) \xrightarrow{KMnO_4} N, (C_9H_{10}O_4), (HCO_3^- \text{ soluble})$$

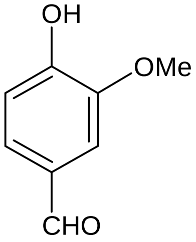
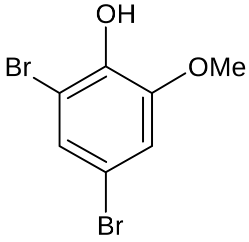
$$N \xrightarrow{conc. HI\ \Delta} \text{3,4-dihydroxy benzoic acid}$$

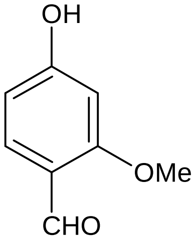
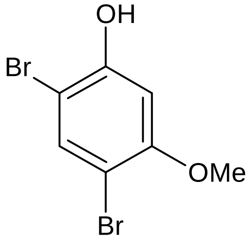
$$\text{L} \xrightarrow{[Ag(NH_3)_2]} O \xrightarrow{2\,Br_2} P, (C_7H_6Br_2O_2)$$

Which of the following is correct statement about various products?

(A) L is  and P is 

(B) L is  and P is 

(C) L is  and P is 

(D) L is  and P is 

Space for rough work

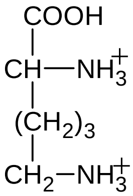
15. $[X] + H_2SO_4 \longrightarrow [Y]$, a colourless gas with irritating smell

$[Y] + K_2Cr_2O_7 + H_2SO_4 \longrightarrow$ Green solution

The species [X] and [Y] are

(A) SO_3^{2-}, SO_2
(B) Cl^-, HCl
(C) S^{2-}, H_2S
(D) CO_3^{2-}, CO_2

16.



$$\begin{array}{l} \text{COOH} \\ | \\ \text{CH}-\text{NH}_3^+ \\ | \\ (\text{CH}_2)_3 \\ | \\ \text{CH}_2-\text{NH}_3^+ \end{array}$$

Lysine has $p^{ka_1}, p^{ka_2}, p^{ka_3}$ values 2.18, 8.95 and 10.53 respectively. Then value of its isoelectric point $\left(p^I\right)$ is:

(A) 7.22
(B) 5.565
(C) 6.355
(D) 9.74

17. The colour of potassium dichromate is due to:

(A) d-d transition
(B) transition in K^+ ion
(C) ligand-to-metal charge transfer
(D) metal to ligand charge transfer

18. The crystal field stabilization energy of high spin d^7 octahedral complex is:

(Where P is pairing energy and Δ_0 is octahedral splitting energy)

(A) $\frac{-4}{5}\Delta_0 + 2P$
(B) $\frac{-4}{5}\Delta_0 + 3P$
(C) $\frac{-9}{5}\Delta_0 + 2P$
(D) $\frac{-9}{5}\Delta_0 + 3P$

Space for rough work

19. Incorrect statement for metal carbonyl [M(CO)$_6$] is:

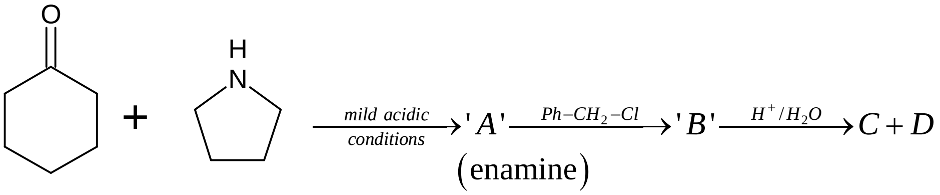
(A) σ bonding electrons are donated by CO group to the metal.

(B) $d\pi - p\pi$ back bonding occurs from the filled metal orbitals.

(C) $d\pi - p\pi$ back bonding makes M-CO bond stronger.

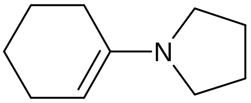
(D) C – O bond length is greater in CO molecules as compare to C – O bond length in given complex.

20.

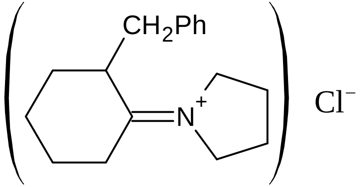


The incorrect statement about various organic products in above sequence is:

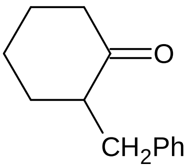
(A) A is



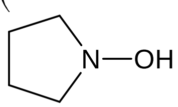
(B) B is



(C) C is



(D) D is



21. A 0.001 molal solution of a complex represented as $Pt(NH_3)_4Cl_4$ in water had freezing point depression of 0.0054^{0}C. Given K$_f$ for H$_2$O = 1.86 K molality^{-1}. Assuming 100% ionisation of the complex. Which of the following is incorrect statement about the complex?

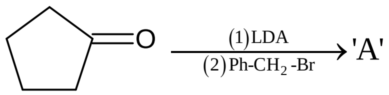
(A) Formula of Complex is $[Pt(NH_3)_4]Cl_4$

(B) 2 Cl atoms are attached as ligands in the complex

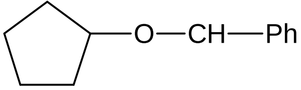
(C) The value of Van't Hoff factor is 3

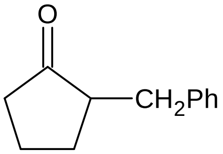
(D) The complex is octahedral in shape

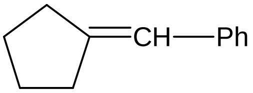
Space for rough work

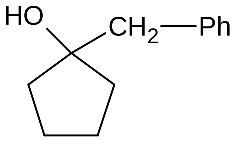
22. 
O
(1)LDA
(2)Ph-CH2-Br
'A'

Which of the following is correct statement about compound 'A':

(A) A is 

(B) A is 

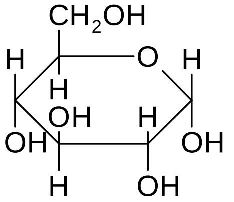
(C) A is 

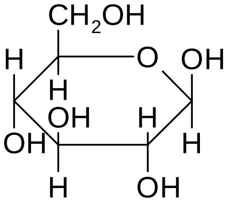
(D) A is 

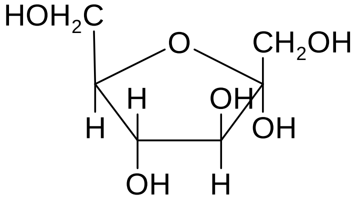
23. An orange coloured compound (A) when treated with $NaCl$ & conc. H_2SO_4 gives red brown vapour (B). This vapour when passed through $NaOH$ gives yellow coloured solution (C). On addition of CH_3COOH and $(CH_3COO)_2Pb$ to this yellow solution, yellow colured ppt (D) is obtained. Which of the following compound is not resemble with above information:

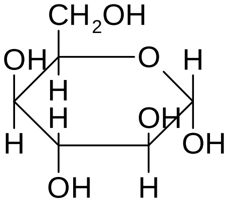
(A) 'A' is $K_2Cr_2O_7$
(B) 'B' is CrO_2Cl_2
(C) 'C' is Na_2CrO_4
(D) 'D' is $PbCl_2$

24. Which of the following is correct Haworth projection for α-D glucopyranose?

(A) 
CH2OH
H
O
H
H
OH
H
OH
OH
H
OH

(B) 
CH2OH
H
O
OH
H
OH
H
OH
H
H
OH

(C) 
HOH2C
O
CH2OH
H
OH
H
OH
OH
H

(D) 
CH2OH
OH
O
H
H
H
OH
H
OH
OH
H

Space for rough work

25. Adsorption of gases on solid surface is generally exothermic because:
(A) chemical bonds are always formed
(B) adsorbate decreases the surface energy of adsorbent
(C) entropy increases
(D) free energy increases

26. Which of the following statement is false, if $'a'$ is the unit cell edge length?
(A) $0.866a$ is the shortest distance between cation and anion in $CsCl$ crystal.
(B) $0.707\,a$ is the shortest distance between two cations in CaF_2 crystal
(C) $0.433a$ is the shortest distance between carbon atom in diamond
(D) $0.866a$ is the shortest distance between two cation in rock salt crystal

27. $2A+C \longrightarrow P$ follows the mechansm as shown below
$2A \rightleftharpoons B \quad K\,(\text{equilibrium constant})$
$B+C \longrightarrow P \quad K_f\,(\text{rate constant})$
The overall rate, $+\frac{d[P]}{dt}$ based on above mechanism is given by

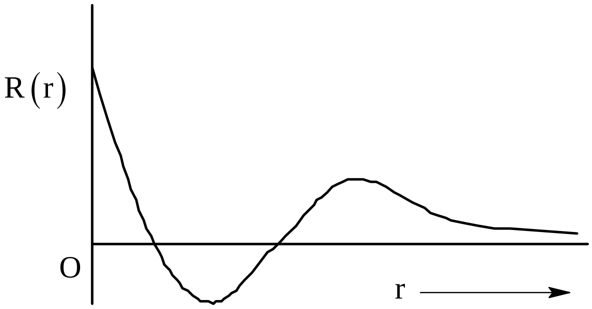
(A) $KK_f[A]^2[C][B]$	(B) $KK_f[A]^2[C]$
(C) $K[A][B]$	(D) $K_f[B][C]$

28. A current of $0.55\,\text{Amp}$ deposits $0.55\,\text{gm}$ of a metal in 100 minutes. Calculate atomic mass of the metal if equivalent weight $=\frac{M.W.}{3}$?

(A) 100	(B) 45
(C) 48.25	(D) 144.75

Space for rough work

29.



The radial part of wave function of an orbital is plotted against distance from nucleus. Which orbital represent above graph?

(A) $1s$ (B) $2s$

(C) $3s$ (D) $2p$

30. pH of $0.01M - (NH_4)_2SO_4$ and $0.02M - NH_4OH$ buffer $\left(p^{Ka}\ of\ NH_4^+ = 9.26\right)$ is:

(A) 9.26 (B) $9.26 + \log 2$

(C) $9.26 - \log 2$ (D) $4.74 + \log 2$

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. If $\mathrm{n}(\mathrm{s})$ represents the number of elements in the set S, such that $n(A)=10$ and $n(B)=20$, then the value of $n(A\Delta B)$ cannot be:

(A) 30 (B) 10
(C) 8 (D) 12

2. If $\sqrt{\left(x^2+2x+1\right)}+2^{f(x)}=4,$ then the maximum value of $f(x)$ is:

(A) 1 (B) 2
(C) 3 (D) 4

3. The number of solution(s) of $\max\left\{2^{-x},2^{x},\frac{1}{2}\right\}=\frac{3}{4}-|x|$ is:

(A) 1 (B) 0
(C) 2 (D) Infinitely many

4. Let $\frac{1}{3}+\frac{2}{2.3.4}+\frac{2}{3.4.5}+....+\frac{2}{n(n+1)(n+2)}=\frac{n(n+3)}{k(n+1)(n+2)}\forall nfN,$ then the value of k is:

(A) 1 (B) 2
(C) 3 (D) 4

Space for rough work

5. A student preparing for IIT-JEE at FIITJEE is given 6 targets numbered to 1 to 6 of each subject physics, chemistry and mathematics. He or she keeps all his books in different shelves (for each subject) in order, number of ways to select all 18 books one by one such that books of each subject must be selected in order (i.e. all books of one subject to the selected one after another, then of second subject and then of third subject) is:

(A) $\frac{18!}{6!6!6!}$ (B) $\frac{18!}{6!6!6!}\times 3!$

(C) $\frac{6!6!6!}{3!}$ (D) $\frac{18!}{6!6!6!3!}$

6. If x is such that $[2\sin x]+[\cos x]=-3$, for some $x\in[0,25]$ then range of the function $g(x)=\sin x+\cos x,$ where $[.]$ represents greatest integer function is:

(A) $\left[-\sqrt{2},-1\right]$ (B) $\left[-\sqrt{2},-1\right)$

(C) $\left(-\sqrt{2},\frac{-1-\sqrt{3}}{2}\right)$ (D) $\left[\frac{-1-\sqrt{3}}{2},-1\right]$

7. If $f(x)=\{x\}+\{-x\}$ and $g(x)=\sin^{-1}x$, then number of elements in the range of $gof(x)$ is (where $\{.\}$ represents fractional part function):

(A) 0 (B) 1

(C) 2 (D) 3

8. The number of real solution of (x,y) where $|y|=\cos x$ and $y=\cos^{-1}(\cos x),-2\pi\le x\le 2\pi$ is/are:

(A) 1 (B) 2

(C) 3 (D) 4

Space for rough work

9. Let $f(x)=[x+2]$ and $g(x)=\cos x,$ where $[.]$ denotes the greatest integer function. The value of $(fog)'\left(\frac{\pi}{2}\right),$ is:

(A) 0 (B) 1
(C) -1 (D) Does not exist

10. Number of points of non-differentiability of $f(x)=\min\{0,\cos x,\sin x\}$ in $(0,2n\pi)$ is:

(A) $3n-1$ (B) $3n$
(C) $3n+1$ (D) $3n+2$

11. If $y=\cos x$ then $\frac{d^2}{dy^2}\left(\sin^5 x\right)$ is:

(A) $15\sin x+20\sin^3 x$ (B) $15\sin x-20\sin^3 x$
(C) $20\sin x+15\sin^3 x$ (D) $20\sin x-15\sin^3 x$

12. Find the maximum possible area of rectangle such that it two vertices are on y-axis and other two vertices on the lines $y=x$ and $3x+2y=6$ respectively and the rectangle is inscribed in triangle, $y\ge 0,\ y\ge x,\ 3x+2y\le 6$ is:

(A) $\frac{3}{10}$ (B) $\frac{7}{10}$
(C) $\frac{9}{10}$ (D) $\frac{11}{10}$

13. If the line $\ell x+my+n=0$ is a normal to the curve $xy=1,$ then possible value of ℓ and m is:

(A) $\ell=2,m=1$ (B) $\ell=2,m=-1$
(C) $\ell=-2,m=-1$ (D) $\ell=-1,m=-2$

Space for rough work

14. In a ΔPQR (with usual solutions) if $\begin{vmatrix} 1 & p & q \\ 1 & q & r \\ 1 & r & p \end{vmatrix} = 0,$ then the value of $\cos 2P + \cos 2Q + \cos 2R$ is:

(A) $\frac{1}{2}$ (B) $-\frac{1}{2}$

(C) $\frac{3}{2}$ (D) $-\frac{3}{2}$

15. The number of values of $'t'$ for which the system of equations $(t+1)x + 8y = 4t,\ tx + (t+3)y = 3t - 1$ has no solution is:

(A) 0 (B) 1

(C) 2 (D) 3

16. If $4x - ay + 3z = 0,\ x + 2y + az = 0$ and $ax + 2z = 0$ have a non-trivial solution, then the value of a is:

(A) 0 (B) 1

(C) 2 (D) -0

17. $\int \frac{3x^2 + 2x}{x^6 + 2x^5 + x^4 + 2x^3 + 2x^2 + 5} dx$ is equal to:

(A) $\frac{1}{2}\tan^{-1}\left(\frac{x^3 + x^2 + 1}{2}\right) + C$ (B) $\frac{1}{2}\sin^{-1}\left(\frac{x^3 + x^2 + 1}{2}\right) + C$

(C) $\tan^{-1}\left(\frac{x^3 + x^2 + 1}{2}\right) + C$ (D) $\sin^{-1}\left(\frac{x^3 + x^2 + 1}{2}\right) + C$

Space for rough work

18. If $f(x)=\int_{\frac{1}{x}}^{\sqrt{x}}\sin\left(t^2\right)dt,$ then $f'(1)$ is equal to:

(A) $\frac{3}{2}\sin 1$ (B) $\frac{1}{2}\sin 1$

(C) $\sin 1$ (D) $2\sin 1$

19. Area bounded by the curves $y=\left[\frac{x^2}{36}+1\right], y=x-2$ and $x=0$ above x-axis is, where $[.]$ denotes greatest integer function:

(A) $\frac{1}{2}$ (B) $\frac{3}{2}$

(C) $\frac{5}{2}$ (D) $\frac{7}{2}$

20. If the equation represented by the solution of the differential equation $(xy-1)\frac{dy}{dx}+y^2=0$ passes through the points $(2,1)$ and (k,e), then the value of k is:

(A) e^2 (B) $\frac{1}{e}$

(C) $\frac{2}{e}$ (D) $\frac{3}{e}$

Space for rough work

21. Total number of unit vectors in $xy-$plane making on angle of $45°$ with the vector $\hat{i}+\hat{j}$ and an angle of $60°$ with the vector $3\hat{i}-\hat{j}$ is:

(A) 0 (B) 1
(C) 2 (D) 4

22. If a and b are selected from the set $\{1,2,3,.....10\}$, then probability that a^2-b^2 is divisible by 3 is:

(A) $\frac{1}{15}$ (B) $\frac{4}{15}$
(C) $\frac{8}{15}$ (D) $\frac{13}{15}$

23. The value of sum of the series ${}^{13}C_0.{}^{14}C_1+{}^{13}C_1.{}^{14}C_2+{}^{13}C_2.{}^{14}C_3+.....+{}^{13}C_{13}.{}^{14}C_{14}$ is:

(A) ${}^{27}C_{12}$ (B) ${}^{27}C_{14}$
(C) ${}^{27}C_{16}$ (D) ${}^{27}C_{10}$

24. The distance of the point $(2,3)$ from the line $2x-3y+9=0$ measured along a line parallel to $x-y+1=0$ is:

(A) $4\sqrt{2}$ (B) $3\sqrt{2}$
(C) $2\sqrt{2}$ (D) $\sqrt{2}$

25. If the two circles $x^2+y^2=1$ and $x^2+y^2-8x-6y+\lambda^2=0$ have exactly two common tangents then the number of integral value of λ is:

(A) 0 (B) 1
(C) 3 (D) 5

Space for rough work

26. If PQ and RS are two perpendicular chord of the rectangular hyperbola $xy = 1.$ If C is the centre of this hyperbola then product of the slopes of CP, CQ, CR and CS is:
(A) 0 (B) 1
(C) -1 (D) Not defined

27. If z_1, z_2 and z_3 are the vertices of $\Delta ABC,$ taken is anticlockwise order such that $\angle B = \frac{\pi}{4}$ and $BC = \sqrt{2}(AB),$ then $i(z_2 - z_3)$ is equal to:
(A) $z_1 + z_2 + z_3$ (B) $z_2 + z_3 - z_1$
(C) $z_1 + z_3 - 2z_2$ (D) $z_2 + z_3 - 2z_1$

28. 6 person A, B, C, D, E and F are to be seated at a circular table. In how many ways can this be done if A must always has either B or C on his right and B must always has either C or D on his right:
(A) 8 (B) 12
(C) 18 (D) 30

29. Standard deviation of two distributions are same and their arithmetic means are 30 and 25 respectively. If their coefficient of variation is v_1 and v_2, then $6v_1 - 5v_2$ is equal to:
(A) 0 (B) 1
(C) 2 (D) 3

30. If A, G and H are arithmetic, geometric and harmonic means between three given numbers a, b and c then the equation having a, b and c as its roots is:
(A) $x^3 + 3Ax^2 + \frac{3G^3}{H}x - G^3 = 0$ (B) $x^3 - 3Ax^2 + \frac{3G^3}{H}x - G^3 = 0$
(C) $x^3 - 3Ax^2 + \frac{3G^3}{H}x + G^3 = 0$ (D) $x^3 + 3Ax^2 - \frac{3G^3}{H}x + G^3 = 0$

Space for rough work

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FIITJEE

JEE(Main) - 2017

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – II
(Main)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	B	C
2.	D	B	B
3.	B	D	B
4.	D	C	B
5.	B	D	A
6.	B	D	D
7.	A	C	C
8.	A	D	D
9.	A	A	A
10.	D	A	A
11.	D	A	B
12.	C	B	C
13.	B	B	B
14.	C	C	D
15.	D	A	B
16.	C	D	C
17.	A	C	A
18.	B	A	A
19.	A	D	C
20.	C	D	B
21.	A	A	A
22.	D	B	C
23.	D	D	B
24.	D	A	A
25.	A	B	D
26.	C	D	B
27.	B	B	D
28.	B	C	C
29.	A	C	A
30.	D	A	B

Physics PART – I

SECTION – A

3. $m = 2.5kg, F = 80\times10^3 N$

$\therefore a \Rightarrow \frac{F}{m} = 32\times10^3 m/s^2, v = 0, s = 18\times10^{-3} m$

Applying, $v^2 - u^2 = 2as$

$$u^2 = 2\times32\times10^3\times18\times10^{-3}$$
$$u = 24\sqrt{2} \approx 34 m/s$$

6. When the ball is pressed by $'x'$

$\Delta V = -ax,$ for small $'x'$ final volume $\approx V$

$$\Delta P = -B\frac{\Delta V}{V} \Rightarrow \frac{Bax}{V}$$

$$F = -\Delta P \times a \Rightarrow \frac{d^2x}{dt^2} = -\frac{Ba^2}{Vm}x$$

$$\therefore \omega = \sqrt{\frac{Ba^2}{Vm}}, \ Hence\, T = 2\pi\sqrt{\frac{Vm}{Ba^2}}$$

8. $N = mg - \frac{mV^2}{R}, if\ car\ leaves\ the\ road\ \ N = 0$

$$\therefore \frac{V^2}{R} = g \quad or \quad v = \sqrt{gR} = 20 m/s$$

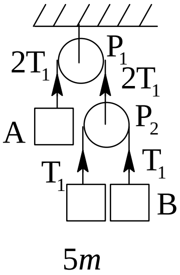
11. $F_{\max} - mg = m\omega^2 A \Rightarrow F_{\max} = m\left(g + \omega^2 A\right)$

$$\omega = 2\pi\times10 \Rightarrow 20\pi\ rod/s, A = \frac{80\times10^{-3}}{2} \Rightarrow 40\times10^{-3} m$$

$$m = 400\times10^{-3} kg$$

Substituting the values we get $F_{\max} \Rightarrow 68N$

12.



Since 5m is stationary, T_1=5mg

If the acceleration of the pulley $P_2 = a_1 \uparrow$

$a_b = 2a_1 \uparrow \left(w.r.t.\ ground \right)$

$\therefore 5mg - mg = 2ma_1 --------(1)$

If $a_{A/P_1} = a_2,\ a_A = \left(a_2 - a_1\right) w.r.t. ground$

$\therefore 10mg - mg = m\left(a_2 - a_1\right) -----(2)$

From equation (1) $a_1 \Rightarrow 2g$

Thus $a_2 = 11g \Rightarrow 110\, m/s^2$

13. Applying Bernoulli's theorem

$$4\times10^5 + P_{atm} = P_{atm} + \frac{1}{2}\rho v^2$$

$$v \Rightarrow \sqrt{\frac{8\times10^5}{10^3}} \Rightarrow 20\sqrt{2} \approx 28\, m/s$$

16. From graphs, $\left|\in\right| = \left|-A\times\frac{dB}{dt}\right| \Rightarrow 8\times10^{-4}\times3\times10^{-3}$

$\Rightarrow 24\times10^{-7} V$

Also, $I = 2mA,\ R = \frac{\in}{I} \Rightarrow \frac{24\times10^{-7}}{2\times10^{-3}} \approx 1.2\, m\Omega$

17. $PV^N = k$

$\therefore V^N dP + NPV^{N-1} dV = 0$

Or $VdP = -NP\ dV$

$\therefore \frac{dP}{dV} = \frac{-NP}{V}$, also at $P = 2\times10^5\ P_a\ \& V = 4\times10^5\ m^3$

$\frac{dP}{dV} = \frac{-3}{4} \Rightarrow \therefore N = \frac{4}{2}\times\frac{3}{4} \Rightarrow 1.5$

21. Applying Moseley's Law

$$\upsilon_2 = \upsilon_1 \left(\frac{z_2 - 1}{z_1 - 1}\right)^2$$

24. $dU = \frac{1}{2}\frac{B^2}{\mu} dV$

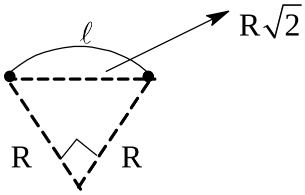
$\Rightarrow \frac{1}{2}\frac{B^2}{\mu}\times 2\pi dr$

$B = \frac{\mu r^2}{a^2}\frac{I}{2\pi r} \Rightarrow \frac{\mu I r}{2\pi a^2}$

$$dU = \frac{1}{2} \times \frac{1}{\mu} \times \frac{\mu^x I^2 r^2}{4\pi^2 a^4} \times 2\pi r dr$$

$$U \Rightarrow \frac{\mu I^2}{4\pi a^4} \int_0^a r^3 dr \Rightarrow \frac{\mu I^2}{16\pi}$$

29.



Let the pole strength be $'m'$

$\therefore M = m\ell$

$M^1 = mR\sqrt{2},\ R = \frac{2\ell}{\pi}$

$\therefore M^1 = \frac{2ml\sqrt{2}}{\pi} \Rightarrow \frac{2\sqrt{2}M}{\pi}$

Chemistry PART – II

SECTION – A

2. $I_2 + dil.OH^- \longrightarrow I^- + IO^- + H_2O$

4. $Mg_2C_3 + H_2O \longrightarrow Mg\left(OH\right)_2 + C_3H_4$

5. Inert pair effect

6. $a \equiv bonding \qquad C \equiv anti\,bording$
$b \equiv bonding \qquad D \equiv non - bonding$

8. $T_c = \dfrac{89}{27Rb}$ comes out to be more then $200°C$ option D is correct.

10. $\frac{1}{2}H_2\left(g\right) + \frac{1}{2}Cl_2\left(g\right) \longrightarrow HCl\left(g\right) \ \Delta H_f = B.E.of\ reactions - B.E.of\ products$
$= \frac{1}{2}\left(104 + 56\right) - 103 = -22\,Kcal/mol$

12. $C_xH_y + \left(\dfrac{2x + \frac{4}{2}}{2}\right)O_2 \longrightarrow xCO_2 + \frac{4}{2}H_2O$

Volume of $CO_2 = 100 - 60 = 40\,ml$

molar ratio of $CO_2 : H_2O = 40 : 60 = 2 : 3$

13. $BO_3^{3-} + CH_3OH \xrightarrow{H^+} B\left(OMe\right)_3$

15. $\underset{(X)}{SO_3^{2-}} + 2H^+ \longrightarrow H_2O + \underset{(Y)}{SO_2}$

SO_2 is a colourless gas with irritating smell.

$3SO_2 + K_2Cr_2O_7 + H_2SO_4 \longrightarrow \underset{(Green)}{Cr_2(SO_4)_3} + K_2SO_4 + H_2O$

17. Because Cr(+VI) has d° configuration hence d-d transition will not possible.

18. d^7 → 1 1 eg
→ ↑↓ ↑↓ ↑ t_2g $t2g^5eg^2$
Total paired electron = 2
Total pairing energy = 2P
CFSE $= -0.8\Delta_0$ (or − 8 Dq) + 2P

21. $\Delta T_f = i\,k_f m$

$i = \dfrac{\Delta T_f}{k_f m} = \dfrac{.0054}{1.86 \times .001} = 2.9 \cong 3$

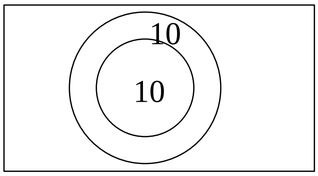
Hence, no. of ions =3

$\left[Pt\left(NH_3\right)_4Cl_2\right] \rightarrow \left[Pt\left(NH_3\right)_4Cl_2\right]^{2+} + 2Cl^-$

Mathematics PART – III

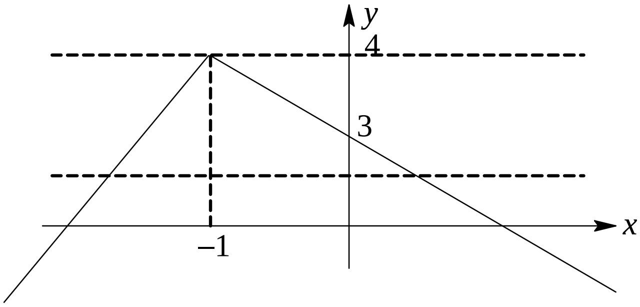
SECTION – A

1. $n(A)=10, n(B)=20$



$$\mathrm{n}(\mathrm{A}\Delta\mathrm{B})=10$$

2.



$$2^{f(x)}=2^2 \Rightarrow f(x)=2$$

4. $Tn=\dfrac{2}{n(n+1)(n+2)}$

$$Tn=\frac{1}{n(n+1)}-\frac{1}{(n+1)(n+2)}$$

On solving

$$=\frac{n(n+3)}{2(n+1)(n+2)} \Rightarrow K=2$$

5. $\dfrac{18!}{6!6!6!}$

7. $f(x)=\begin{cases}0 & x\in\mathbb{Z}\\ 1 & x\phi\mathbb{Z}\end{cases}$

$$gof=\sin^{-1}0=0$$

$$\sin^{-1}1=\frac{\pi}{2}$$

9. $f(x)=[x]+2 \Rightarrow f(g(x))=[\cos x]+2$

$$f\left(g\left(\frac{\pi}{2}\right)\right)=0$$

13. $$xy = 1$$
$$x\frac{dy}{dx} + y = 0$$
$$\frac{dy}{dx} = -\frac{y}{x}$$
$$y - y_1 = \frac{x_1}{y_1}(x - x_1)$$
$$yy_1 - y_1^2 = x_1x - x_1^2$$
$$x_1x - yy_1 + y_1^2 - x_1^2 = 0$$

14. $$= \begin{vmatrix} 1 & p & q \\ 0 & q-p & r-q \\ 0 & r-q & p-r \end{vmatrix}$$
$$= 1\left[(q-p)(p-r) - (r-q)(r-q)\right]$$
$$= \frac{-1}{2}\left[(p-q)^2 + (q-r)^2 + (r-p)^2\right] = 0$$
$$\Rightarrow p = q = r$$
$$\angle P = \angle Q = \angle R$$

15. $$(t+1)x + 8y - 4t = 0$$
$$tx + (t+3)y - (3t-1) = 0$$
$$\frac{t+1}{t} = \frac{8}{t+3} \pm \frac{-4t}{-(3t-1)}$$
$$t = 3$$

16. $$\begin{vmatrix} 4 & -a & -3 \\ 1 & 2 & a \\ a & 0 & 2 \end{vmatrix} = 0$$
$$4(4-0) + a(2-a^2) + 3(0-2a) = 0$$
$$a^3 + 4a - 16 = 0$$
$$a = 2$$

17. $$I\int \frac{3x^2 + 2x}{(x^3 + x^2 + 1)^2 + 2^2}dx$$
$$= \frac{1}{2}\tan^{-1}\left(\frac{x^3 + x^2 + 1}{2}\right) + C$$

18. $$f(x)=\int_{1/x}^{\sqrt{x}}\sin\left(t^2\right)dt$$

$$f'(x)=\sin x.\frac{1}{2\sqrt{x}}-\sin\left(\frac{1}{x^2}\right)\left(\frac{-1}{x^2}\right)$$

$$f'(1)=\frac{\sin 1}{2}+\sin 1$$

$$=\frac{3}{2}\sin 1$$

19. $$y=\left[\frac{x^2}{36}+1\right]$$

Area $=\frac{1}{2}(2+3)\times 1$

$$=\frac{5}{2}$$

20. $$(xy-1)\frac{dy}{dx}=-y^2$$

$$\frac{xy-1}{y^2}=\frac{-dx}{dy}$$

$$\frac{dx}{dy}=\frac{1}{y^2}-\frac{x}{y}$$

$$\frac{dx}{dy}+\frac{1}{y}x=\frac{1}{y^2}$$

$$I.F.=e^{\sqrt{\frac{1}{y}dy}}=y$$

$$x.y=\int\frac{1}{y^2}.ydy$$

$$xy=\ln y$$

$$ke=\ln e$$

$$k=\frac{1}{e}$$

22. $$n(E)={}^3\mathrm{C}_2+{}^3\mathrm{C}_2+{}^4\mathrm{C}_2+{}^3\mathrm{C}_1\times{}^4\mathrm{C}_1=24$$

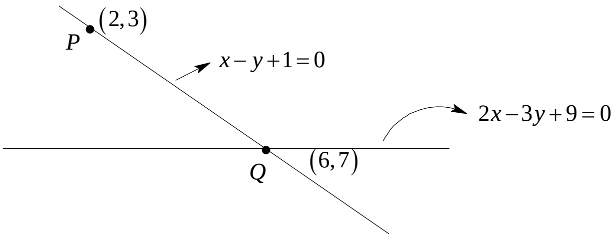
$$n(S)={}^{10}C_2=45$$

$$P(E)=\frac{24}{45}\Rightarrow\frac{8}{15}$$

23. $$(1+x)^{13}(x+1)^{14}=\left\{{}^{13}C_0+{}^{13}C_1x+{}^{13}C_2x^2+....+{}^{13}C_{13}x^{13}\right\}$$

Coeff of x^{13} in $(1+x)^{27}={}^{27}C_{13}={}^{27}C_{14}$

24.



$$PQ=\sqrt{16+16}$$
$$=4\sqrt{2}$$

25. For two common tangents.

$$|r_1-r_2|<C_1C_2<r_1+r_2$$
$$r_1=1$$
$$r_2=\sqrt{16+9-x^2}$$
$$C_1C_2=\sqrt{16+9}=5$$
$$\left|\sqrt{25-\lambda^2}-1\right|<5<6\sqrt{25-\lambda^2}+1$$
$$-3<\lambda<3$$

26. Slope of $PQ=\dfrac{\frac{C}{t_1}-\frac{C}{t_2}}{Ct_1-Ct_2}$

Slope of $PQ=\dfrac{-1}{t_1t_2}$

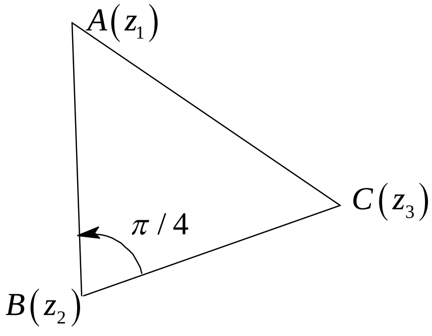
Slope of $RS=\dfrac{-1}{t_3t_4}$

$$t_1t_2t_3t_4=-1$$

Slope of $CP=\dfrac{\frac{C}{4}-0}{Ct_1-0}=\dfrac{1}{t_1^2}$

$$\frac{1}{t_1^2}\cdot\frac{1}{t_2^2}\cdot\frac{1}{t_3^2}\cdot\frac{1}{t_4^2}=1$$

27. $\dfrac{z_1-z_2}{z_3-z_2}=\left|\dfrac{z_1-z_2}{z_3-z_2}\right|e^{i\pi/4}$



$$\frac{z_1-z_2}{z_3-z_2}=\frac{1}{2}(1+i)$$
$$\Rightarrow 2z_1-2z_2=(1+i)(z_3-z_2)$$
$$\Rightarrow 2z_1-2z_2=z_3-z_2+i(z_3-z_2)$$
$$i(z_2-z_3)=z_3-z_2-2z_1+2z_2$$
$$=z_3+z_2-2z_1$$

29. $CV = \frac{\sigma}{x} \Rightarrow V_1 = \frac{\sigma}{30} \quad V_2 = \frac{\sigma}{25}$

$$6V_1 - 5V_2 = \frac{\sigma}{5} - \frac{\sigma}{5} = 0$$

30. $\frac{a+b+c}{3} = A \quad (abc)^{1/3} = G$

$$a+b+c = 3A \quad abc = G^3$$

$$H = \frac{3}{\frac{1}{b}+\frac{1}{b}+\frac{1}{c}} \Rightarrow H = \frac{3abc}{ab+bc+ca} \Rightarrow H = \frac{3G^3}{ab+bc+ca}$$

$$ab+bc+ca = \frac{3G^3}{H}$$

$$x^3 - 3Ax^2 + \frac{3G^3}{H}x - G^3 = 0$$

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ALL INDIA TEST SERIES

FIITJEE **JEE (Advanced), 2017**

FULL TEST – IV

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 10)** contains 10 multiple choice questions which have only one correct answer. Each question carries **+2 marks** for correct answer. There is no negative marking.

Section-A (11 to 15) contains 5 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

(ii) **Section-C (01 to 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct.

1. A cylindrical block of radius R, height h and density ρ is floating in liquid of density 2ρ contained in a cylindrical container of radius 2R. Time period of small vertical oscillations of the block is

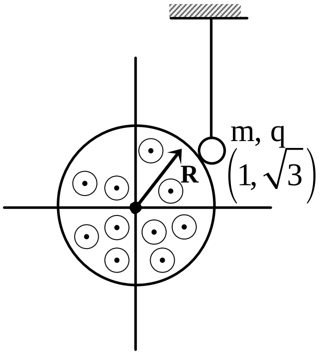
(A) $2\pi\sqrt{\frac{5h}{6g}}$ (B) $\pi\sqrt{\frac{3h}{2g}}$

(C) $2\pi\sqrt{\frac{h}{2g}}$ (D) $\pi\sqrt{\frac{h}{2g}}$

2. A charge particle of mass m and charge q is suspended with the help of a string having breaking strength of 2mg and mass having co-ordinates $\left(1, \sqrt{3}\right)$ while the space carries a uniform magnetic field in cylindrical region with centre at origin and radius R = 2 m. Maximum charge q if string does not break at the instant magnetic field start increasing with rate 0.5 Tesla per second is

(A) 4mg (B) 8mg

(C) 2mg (D) None



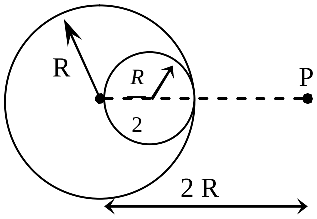
3. In a certain region of space gravitational field is given by $g = \left(-\frac{K}{r}\right)$. Taking potential at r = r_0 to be V_0 the potential at any general point is given by

(A) $V = K\ln\left(\frac{r}{r_0}\right) + V_0$ (B) $V = K\ln\left(\frac{r}{r_0}\right) - V_0$

(C) $V = K\ln\left(\frac{r_0}{r}\right) + V_0$ (D) $V = K\ln\left(\frac{r_0}{r}\right) - V_0$

Space for rough work

4. A solid sphere of uniform density and radius R exerts a gravitational force F_1 on a particle at P. A spherical cavity of radius $\frac{R}{2}$ is now removed from the sphere. Now the same sphere (with cavity) exerts a gravitational force F_2 on the same particle at P. Then, $\frac{F_1}{F_2}$ is



(A) $\frac{9}{7}$ (B) $\frac{7}{9}$

(C) $\frac{1}{2}$ (D) $\frac{4}{3}$

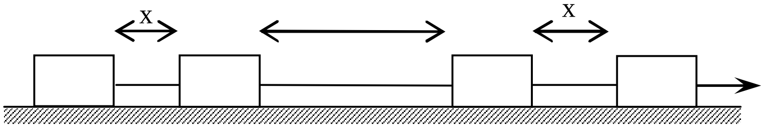
5. A cylinder of height h and radius R is made to move with constant velocity v at small angle θ with its flat bottom or flat top. In a polluted atmosphere having uniform and stagnant dust density ρ. If dust particles stick to cylinder on striking them neglecting any change in size of cylinder, power to be delivered to cylinder to maintain its velocity is

(A) $2\rho v^2 Rh$ (B) $2\rho v^3 Rh$

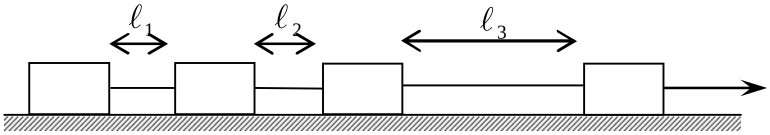
(C) $2\rho v^3 Rh\cos\theta + \rho v^3 \pi R^2 \sin\theta$ (D) None

6. Each of the pictures shows four objects tied together with rubber bands being pulled to right across a horizontal smooth surface by a horizontal force F. All the objects have same mass, all rubber bands are identical naturally and obey Hook's law. Then which of the following possibility of the arrangement is most correct?

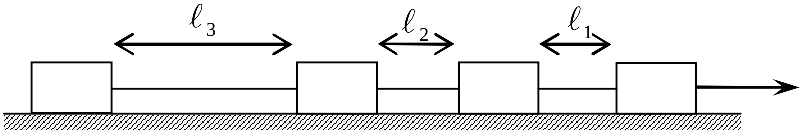
(A)



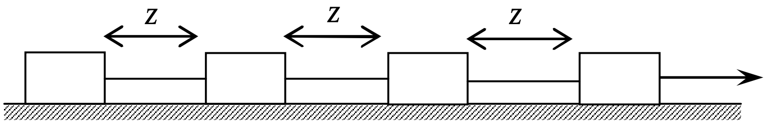
(B)



(C)

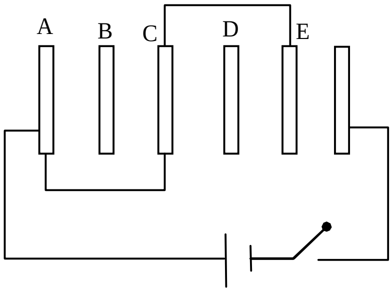


(D)



Space for rough work

7. A, B, C, D, E and F are conducting plates each of area A and any two consecutive plates with separation d. The net energy stored in system after the switch S is closed is



(A) $\frac{3\varepsilon_0 AV^2}{2d}$ (B) $\frac{5\varepsilon_0 AV^2}{12d}$

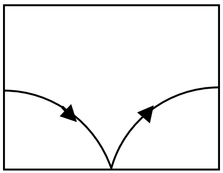
(C) $\frac{\varepsilon_0 AV^2}{2d}$ (D) $\frac{\varepsilon_0 AV^2}{d}$

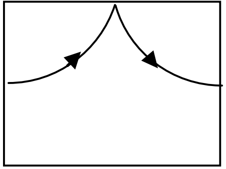
8. When the string of a sonometer wire of length L between the bridges vibrate in the first overtone, the amplitude of vibration is maximum at

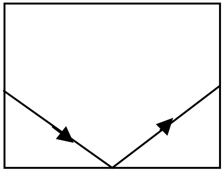
(A) $\frac{L}{2}$ (B) $\frac{L}{4}$ and $\frac{3L}{4}$

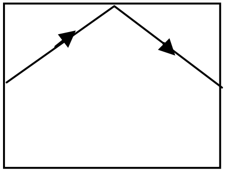
(C) $\frac{L}{6}$, $\frac{3L}{6}$ and $\frac{5L}{6}$ (D) $\frac{L}{8}$, $\frac{3L}{8}$, $\frac{5L}{8}$, $\frac{7L}{8}$

9. A cubical container is filled with a liquid whose refractive index increases linearly from top to bottom. Which of the following represents the path of a ray of light inside the liquid?

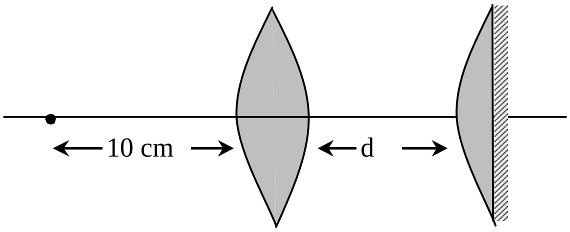
(A)


(B)


(C)


(D)


10. A convex lens of focal length 20 cm and another plano convex lens of focal length 40 cm are placed coaxially as shown in the diagram. The plano convex lens is silvered at plane surface. If final image of object O is formed on itself, then find the value of d.



(A) 10 cm
(B) 40 cm
(C) 20 cm
(D) 80 cm

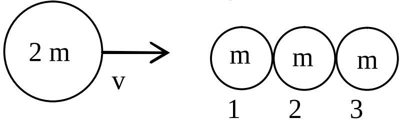
Space for rough work

Multiple Correct Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

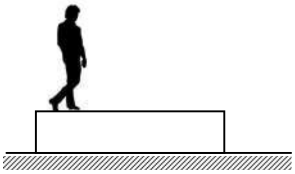
11. A uniformly charged non-conducting ring is rotating with angular velocity ω_1 about its axis in gravity free space and a nearly horizontal but uniform magnetic field B is switched on, then after some time
(A) Angular momentum of the ring must be parallel to its angular velocity
(B) Magnitude of angular momentum may be more than $mR^2\omega_1$
(C) Magnitude of angular momentum must be equal to $mR^2\omega_1$
(D) Angular momentum must be coplanar with angular velocity

12. A steel ball of mass 2m suffers one dimensional elastic collision with a row of three steel balls each of mass m. If ball of mass 2m has velocity v initially and the three balls with small separation were at rest. Then, after all possible collisions



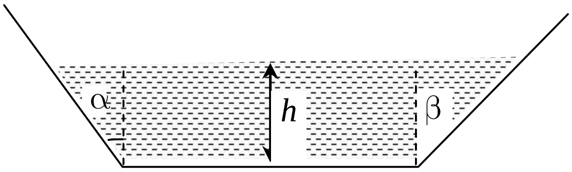
(A) Ball 1 and ball of mass 2m would remain at rest
(B) Ball 2 moves with velocity $\frac{4v_0}{9}$ towards right
(C) Ball 3 moves towards right with velocity $\frac{4v_0}{3}$
(D) Ball of mass 2m moves towards right with velocity one fourth that of ball 1

13. A man is standing over a plank which is placed over a smooth horizontal surface. There is sufficient friction between feet of man and plank. Now, man starts running over the plank. Then, work done by friction
(A) On man w.r.t. ground is negative
(B) On man w.r.t. ground is positive
(C) On plank w.r.t. ground is positive
(D) On man w.r.t. plank is zero



Space for rough work

14. A liquid is filled upto height h in a rectangular vessel as shown in figure. Then, find correct option(s):



(A) Only if $\alpha = \beta$ horizontal component of forces on left and right side of inclined faces will be equal and opposite
(B) If $\alpha \neq \beta$ horizontal component of forces on left and right side of inclined faces are not equal
(C) If $\alpha \neq \beta$ still horizontal component of forces on the left and right inclined faces are equal and opposite
(D) If base area is A, then force on bottom by liquid is more than ρghA

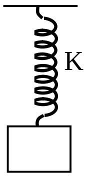
15. For an ideal gas at very high temperature,
(A) $C_V = \frac{3R}{2}$ for a monoatomic gas
(B) $C_V > \frac{3R}{2}$ for a monoatomic gas
(C) $C_V < \frac{5R}{2}$ for a diatomic or linear poly atomic gas
(D) $C_V > \frac{5R}{2}$ for a diatomic gas

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).



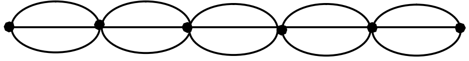
1. A non-conducting block of mass 1 kg and charge 1 C is connected to a non-conducting spring of force constant $K = \pi^2$ N/m and released. After one second from release a vertical uniform electric field 10 N/C is switched on. If time after switching on the electric field spring returns back to its natural length is T, then find $\frac{1}{T}$.

2. A particle of charge q and mass m is projected with velocity 200 m/s at an angle of 60^o with x-axis. At the instant speed of projectile becomes minimum a uniform magnetic field $-B_0\hat{k}$ is switched on. If time of flight of particle is T, then find $\frac{2}{T}$. (Given: m = 1 kg, q = 0.1 C, B = 1 T)

3. Figure shows two conducting thin concentric shells of radii r and 3r. The outer shell carries a charge q and the inner shell is neutral. The amount of charge that flows from inner shell to the earth after key K is closed is equal to n^{th} part of charge of outer shell. Then the value of n is ………

4. A vessel contains helium, which expands at constant pressure when 15 KJ of heat is supplied to it. What will be the variation in internal energy of gas in KJ?

5. Two identical sinusoidal waves travel in opposite direction in a 15 m long wire and produce a standing wave in the wire with nodes at ends. If speed of wave is 12 m/s and there are 6 nodes in standing wave, find the frequency (in Hz) of wave.



Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct.

1. Which of the following process is used to remove temporary as well as permanent hardness of water?

(A) only boiling	(B) adding lime & boiling
(C) adding $Ca(OH)_2$	(D) adding Na_2CO_3

2. When 10 gm mixture of KI and $Fe_2(SO_4)_3$ is treated with 200 cc HCl, gives a solution which consumes 40 ml $\frac{N}{10}$ $Na_2S_2O_3$ solution. Then the correct statement is/are

(A) Equivalent weight of iodine in the reaction is $\frac{M}{2}$
(B) Percentage of KI in the mixture is 66.4%
(C) Sodium thiosulphate is converted to $Na_4S_4O_6$
(D) Percentage of $Fe_2(SO_4)_3$ is 66.4%

3. Both AgCNS and AgBr are simultaneously dissolved in water. K_{sp}(AgBr) 5×10^{-13}; K_{sp}(AgCNS) = 8.5×10^{-12}. The concentration of Ag^+ in final solution will be

(A) 4×10^{-7} M	(B) 2×10^{-7} M
(C) 3×10^{-6} M	(D) 6.2×10^{-7} M

4. Compare basic strength of following compounds

Aniline	o-toluidine	m-toluidine	p-toluidine	o-anisidine
1	2	3	4	5

(A) 1 > 2 > 3 > 4 > 5	(B) 2 > 5 > 3 > 4 > 1
(C) 4 > 3 > 1 > 5 > 2	(D) None of these

Space for rough work

5. $$AgNO_3 \xrightarrow{Na_2S_2O_3} \underset{\text{White PPt}}{A} \xrightarrow{H_2O} \underset{\text{Black PPt}}{B}$$

Black PPt is

(A) $Na_3\left[Ag(S_2O_3)_2\right]$ (B) $Ag_2S_4O_6$

(C) Ag_2O (D) Ag_2S

6. When glucose is heated with conc. H_2SO_4, charring occurs, it is due to

(A) Reduction of glucose (B) Oxidation of glucose

(C) Dehydration of glucose (D) Mutarotation of glucose

7. IUPAC name of $\left[Fe(O_2)(CN)_4Cl\right]^{4-}$ is

(A) chloridortetracyanodioxoferrate (II) ion

(B) chloridortetracyanoperoxoferrate (II) ion

(C) chloridortetracyanosuperoxoferrate (II) ion

(D) tetracyanochloridosuperoxoferrate (II) ion

8. The $\pi -$ acid ligand which uses its d-orbital during synergic bonding in its complex compound is

(A) $\bar{C}N$ (B) PR_3

(C) NO (D) N_2

9. Efficiency of a cell with cell reaction under standard condition is 85%.

$A_{(s)} + B^{2+}_{(aq)} \rightleftharpoons A^{2+}{}_{(aq)} + B_{(s)};\ \Delta H^0 = -285kJ$

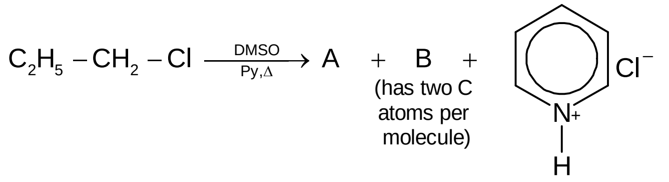
The E^0_{cell} is:

(A) 1.26 V (B) 1.34 V

(C) 2.96 V (D) 2.07 V

Space for rough work

10.


$C_2H_5-CH_2-Cl \xrightarrow[Py,\Delta]{DMSO} A + B +$
(has two C atoms per molecule)
N+
H
Cl^-

Which is true?

(A) A gives Lucas test

(B) A does not give Schiff's test

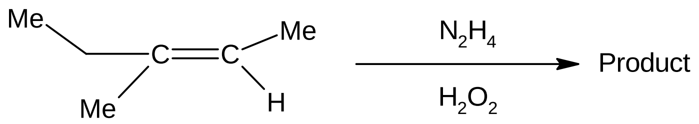
(C) B can be used in reductive ozonolysis of alkenes

(D) A gives smell of burning S on combustion

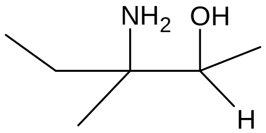
Multiple Correct Choice Type

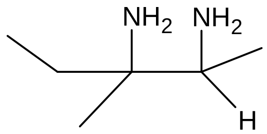
This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

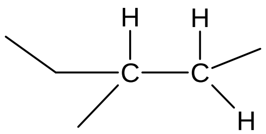
11.

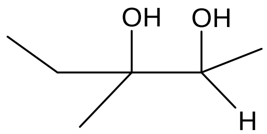

Me
Me
Me
H
C
C
N_2H_4
H_2O_2
Product

What is/are not the product of above reaction?

(A)


(B)


(C)


(D)


12. Which of the following crystal system does/do not have more than one Bravais lattice?

(A) Triclinic
(B) Monoclinic
(C) Rhombohedral
(D) hexagonal

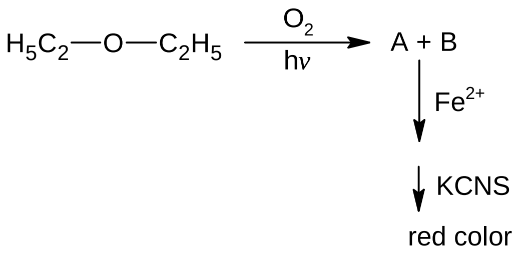
Space for rough work

13. Which is/are white or not coloured?

(A) $\left[Co(SCN)_4\right]^{2-}$ (B) $\left[Fe(H_2O)_5SCN\right]^{2+}$

(C) $CuSO_4.5H_2O$ (D) anhyd $CuSO_4$

14. Which is/are true for the following reaction?



$$\begin{tikzcd} H_5C_2-O-C_2H_5 \arrow[r, "O_2", "h\nu"'] & A + B \arrow[d, "Fe^{2+}"] \\ & {} \arrow[d, "KCNS"] \\ & \text{red color} \end{tikzcd}$$

(A) Compounds A & B are explosives

(B) If compounds A & B are present in ether, then prior to its use, A & B must be removed from ether

(C) Compounds A & B can not be removed by adding Fe^{3+}

(D) When compounds A & B are treated with Fe^{2+} followed by KCNS, no redox reaction is involved

15. $\left(NaNO_2 + HCl\right)$ converts an amino acid into hydroxyl acid with retention of configuration. Estimation of N_2 gas evolved in the reaction is the basis of van slyke estimation of amino acids, which of the following can be analysed by this method?

(A) Cysteine (B) Proline

(C) Histidine (D) Valine

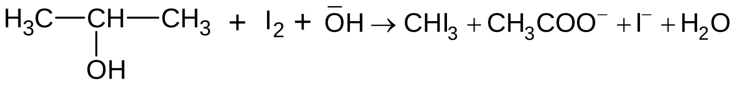
Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. How many moles I_2 is consumed per mole of isopropanol?



$$H_3C{-}\underset{\displaystyle OH}{\underset{|}{CH}}{-}CH_3 + I_2 + \bar{O}H \rightarrow CHI_3 + CH_3COO^- + I^- + H_2O$$

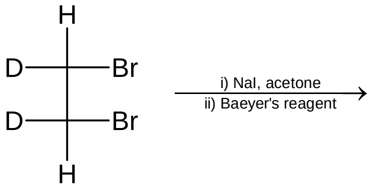
2. How many octahedral voids per unit cell of BCC are present?

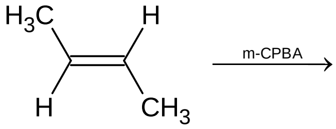
3. The coagulation of 20 ml standard gold sol is completely prevented by addition of 0.04 gm starch solution to it. The gold number of starch solution is 2×10^x. Find x.

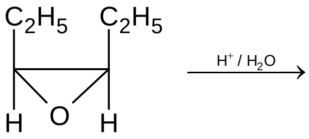
4. If H_2 (g) + $\frac{1}{2}O_2$ (g) $\longrightarrow$ H_2O (l) (Let ΔC_p = 32 J/K and ΔH at 27°C = –28.58 KJ/mol) reaction is carried out at 87°C in a fuel cell with 90% efficiency. The electrical energy produced is 3 x a KJ/mol. Find a (to nearest integer). (Let ΔC_p remains same in this temperature range)

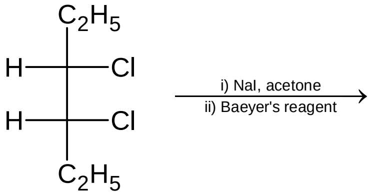
Space for rough work

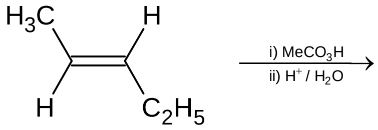
5. In how many of the following reactions end product is meso?

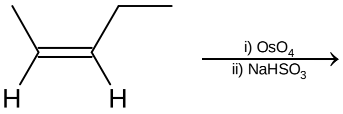
(a) 
H
D
Br
D
Br
H
i) NaI, acetone
ii) Baeyer's reagent

(b) 
H3C
H
H
CH3
m-CPBA

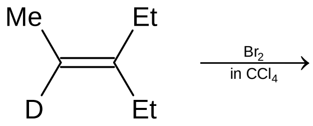
(c) 
C2H5
C2H5
H
O
H
H+ / H2O

(d) 
C2H5
H
Cl
H
Cl
C2H5
i) NaI, acetone
ii) Baeyer's reagent

(e) 
H3C
H
H
C2H5
i) MeCO3H
ii) H+ / H2O

(f) 
H
H
i) OsO4
ii) NaHSO3

(g) $H_3C-C\equiv C-CH_3 \xrightarrow[\text{ii) cold dil. alk. } KMnO_4]{\text{i) } H_2 \text{ / } Ni_2B}$

(h) 
Me
Et
D
Et
Br2
in CCl4

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct.

1. If $\mathrm{I}=\int_0^{\pi} f(\tan 2x)\cos x\,dx$ and $\mathrm{J}=\int_0^{\pi/4} f(\cot 2x)\sin x\,dx$, where $f(-x)=-f(x)$, then $\frac{\mathrm{I}}{\mathrm{J}}$ is equal to

(A) $\sqrt{2}$ (B) $\frac{1}{\sqrt{2}}$

(C) $2\sqrt{2}$ (D) $\frac{1}{2\sqrt{2}}$

2. If $A=\left[a_{ij}\right]_{2\times2}$, $B=\left[b_{ij}\right]_{2\times2}$ such that $a_{ij}=f\left(x^{2i-j-2}\right)$ and $b_{ij}=f\left(x^{2i-j-1}\right)$ and

$$A+B^T=\begin{pmatrix} -x^2 f\left(x+f(1)\right) & \left(1-\frac{1}{x^4}\right)f\left(\frac{1}{x^2}\right) \\ f\left(\frac{1}{x}\right)\left(1-\frac{1}{x^2}\right) & -\frac{1}{x^2}f\left(\frac{1+f(1)}{x}\right)\end{pmatrix}$$, then $\int_x^{1/x} f(t)\,dt$ is always equal to

(A) $f(1)$ (B) $f(1)-1$

(C) $f(1)+1$ (D) None of these

3. If $f(x)=(\cos x)\hat{i}+(\sin x)\hat{j}+(\cos 2x)\hat{k}$, $g(x)=(\tan x)\hat{i}+(\sin 3x)\hat{j}+(\cos 4x)\hat{k}$ and $h(x)=(\cos 3x)\hat{i}+(\sin 5x)\hat{j}+(\cos 6x)\hat{k}$ are three variable vectors given, then $\int_0^{\pi}\left[f(x),\ g(x),\ h(x)\right]dx$, where [.] denotes scalar triple product, is belonging to

(A) $(-1,\ 0)$ (B) $(0,\ 1)$

(C) $(-\infty,\ -1)\cup(1,\ \infty)$ (D) (–1, 1)

Space for rough work

4. If $\vec{a}_1 = a\hat{i} + b\hat{j}$, $\vec{a}_2 = \vec{a}_1 - \left(2\hat{i} + \sqrt{5}\hat{j}\right)$ and $\vec{a}_3 = \vec{a}_1 + \left(2\hat{i} - \sqrt{5}\hat{j}\right)$, then $\begin{vmatrix} 1+\vec{a}_1.\vec{a}_1 & 1+\vec{a}_1.\vec{a}_2 & 1+\vec{a}_1.\vec{a}_3 \\ 1+\vec{a}_2.\vec{a}_2 & 1+\vec{a}_2.\vec{a}_2 & 1+\vec{a}_2.\vec{a}_3 \\ 1+\vec{a}_3.\vec{a}_1 & 1+\vec{a}_3.\vec{a}_2 & 1+\vec{a}_3.\vec{a}_3 \end{vmatrix}$ is equal to

(A) 0 (B) 20
(C) 40 (D) 80

5. $\int_0^{\pi/2} \frac{\sin^3 x\, dx}{(1+\tan x)} =$

(A) $\frac{1}{2} - \frac{1}{2\sqrt{2}}\ln\left(\sqrt{2}+1\right)$ (B) $\frac{1}{2} + \frac{1}{2\sqrt{2}}\ln\left(\sqrt{2}+1\right)$
(C) $\frac{1}{2} - \frac{1}{\sqrt{2}}\ln\left(\sqrt{2}+1\right)$ (D) None of these

6. If $|f(x)| \le |\sin \pi x|$ and $g(x) = f'(x)$, then maximum value of $|g(n)|$ for $n \in I$ is

(A) 0 (B) 1
(C) π (D) 2π

7. If $f(x) = \tan x + \tan^2 x \tan 2x$ and $g(n) = \sum_{n=0}^{n=n} f\left(2^n\right)$, then $g(2013) - \tan\left(2^{2014}\right)$ is equal to

(A) 0 (B) tan1
(C) −tan1 (D) None of these

Space for rough work

8. The value of product

$$\frac{\sin\frac{\theta}{2}}{\tan^2\frac{\theta}{2}\tan\theta+\tan\frac{\theta}{2}}\times\frac{\sin\frac{\theta}{2^3}}{\tan^2\frac{\theta}{2^3}\tan\frac{\theta}{2^2}+\tan\frac{\theta}{2^3}}\times\ldots\ldots\ldots\frac{\sin\frac{\theta}{2^n}}{\tan^2\frac{\theta}{2^n}\tan\frac{\theta}{2^{n-1}}+\tan\frac{\theta}{2^n}}\times\ldots\ldots\ldots \text{ upto } \infty \text{ is}$$

(A) 1 for $\theta=\frac{\pi}{2}$
(B) 1 for $\theta=\frac{\pi}{4}$
(C) $\frac{1}{2\pi}$ for $\theta=\frac{\pi}{4}$
(D) $\frac{2}{\pi}$ for $\theta=\frac{\pi}{4}$

9. If $f(x)=\frac{\alpha x+1}{x-\beta}\forall x\in R-\{\beta\}$ & $\alpha\beta\neq 1$ & $\alpha\neq 1$ is a self – inverse function such that $\frac{f(4)}{4}=\frac{f(12)}{12}=f\left(\frac{1+\beta}{1-\alpha}\right)$, then "β" is equal to

(A) 2
(B) 4
(C) 8
(D) 16

10. If $f(x)=x+1$ & $g^{-1}(x)=x^3+x+1$, let gof(x) = h(x), then $\underset{x\to 1}{\text{lt}}\frac{h^{-1}(x)-h^{-1}(1)}{x-1}$

(A) 2
(B) 4
(C) 1
(D) 8

Multiple Correct Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

11. If $\int_1^2\frac{2x^2-x^{-1}+\sqrt{x}}{\left(1+x^3\right)}dx=\ln\left(\frac{p}{q}\right)+\frac{2}{3}\cos^{-1}\left(\frac{1}{m}\right)-\frac{\pi}{6}$, $p,q\in I^+$, HCF (*p*, *q*) = 1, then

(A) $p=m^2-1$
(B) $p=m^2$
(C) $q=m+1$
(D) $pq=4m^2$

Space for rough work

12. If a singular matrix $A=\left[a_{ij}\right]_{2\times2}$ always commute with $B=\begin{pmatrix}1 & 1\\ 2 & 1\end{pmatrix}$, then

(A) $a_{11}=a_{22}$
(B) $a_{11}=\sqrt{2}a_{12}$
(C) $a_{21}=2a_{12}$
(D) $a_{11}=\sqrt{2}a_{21}$

13. If $\log_k a=a$ and $\log_k b=b$ for exactly two distinct positive real numbers a and b, then k can't be equal to

(A) $e^{\frac{1}{2e}}$
(B) $e^{\frac{2}{e}}$
(C) $e^{\frac{1}{2}}$
(D) $e^{\frac{1}{3}}$

14. If $\Delta(x)=\begin{vmatrix}\cos x+1 & \cos^2 x & 1+\sin^2 x\\ -\sin x & -\sin 2x & \sin 2x\\ \sin x & 2^2\sin 2x & -2^2\cos 2x\end{vmatrix}$, then

(A) $\int_0^{\pi/2}\Delta(x)dx=4$
(B) $\int_0^{\pi/2}\Delta(x)dx=-4$
(C) $\int_{\pi/2}^{\pi}\Delta(x)dx=4$
(D) $\int_{\pi/2}^{\pi}\Delta(x)dx=-4$

15. If curve $A\equiv\{z:|z-3|+|z+3|=8\}$ & $B\equiv\{z:|z-3|=K\}$, $K\in R^+$ touches the curve 'A' internally, and given another curve $C\equiv\{z\,||z-3|-|z+3||=4\}$, then;

(A) A & C intersect orthogonally & k = 1
(B) K = 1
(C) K = 3/2
(D) B touches also C internally

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. If $I = \int_1^2 \frac{x^3 - 3x^2}{\ln(x-1)} dx$ and $J = \int_2^3 \frac{(3x-5)}{\ln(x-2)} dx$, then e^{I+J} equals ……….

2. Position vector of a point A is $\left(a\hat{i} + b\hat{j} + c\hat{k}\right)$ and $a^2 + b^2 + c^2 = 4$; and position vector of another point B is $\left(p\hat{i} + q\hat{j} + r\hat{k}\right)$ and $p^2 + q^2 + r^2 = 9$. Given $\angle AOB = 2\cos^{-1}\frac{1}{5}$, where O is origin. If AQ is perpendicular to angle bisector of $\angle AOB$ i.e. line OQD where D lies on AB, then value of $25\left|QD\right|$ = ?

3. If $\frac{3x^2+1}{\sqrt{x^4+x^2}} \ge f(x)$, where $f(x)$ is a constant function in $0 < x \le \sqrt{2}$, then minimum value of $\int_0^{\sqrt{2}} \frac{\left(3x^2+1\right)dx}{\sqrt{x^4+x^2}}$ is ………

4. If $\left|\text{adj}\left(\text{adj}\left(\text{adj } A\right)\right)\right| = \left|\text{adj } \left(A\right)\right|^4$, then number of entries in diagonal of *A* is ……..

5. If $AB = BA = I$ such that $A = \left[a_{ij}\right]_{2\times2}$, $B = \left[b_{ij}\right]_{2\times2}$, $a_{ii} = b_{ii}$, $a_{12} = -b_{12}$, $a_{21} = -b_{21}$ and a_{ij} are co prime natural numbers, then $\left|a_{21} - a_{12}\right| =$ ………

Space for rough work

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

FIITJEE

JEE(Advanced)-2017

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – IV
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**B**	**D**	**C**
2.	**A**	**A**	**A**
3.	**A**	**C**	**D**
4.	**A**	**C**	**D**
5.	**C**	**D**	**A**
6.	**B**	**C**	**C**
7.	**C**	**C**	**C**
8.	**B**	**B**	**D**
9.	**A**	**A**	**C**
10.	**C**	**C**	**B**
11.	**B**	**A, B, D**	**B, C, D**
12.	**B, C, D**	**A, C, D**	**A, B, C**
13.	**A, C, D**	**D**	**B, C**
14.	**C, D**	**A, B, C**	**B, D**
15.	**A, D**	**A, C, D**	**A, B, D**
1.	**2**	**4**	**4**
2.	**0**	**0**	**2**
3.	**3**	**1**	**4**
4.	**9**	**8**	**3**
5.	**2**	**2**	**2**

Physics

PART – I

SECTION – A

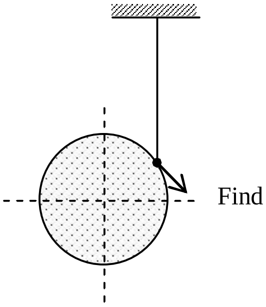
1. **B**

When block is further pushed by x in liquid buoyant force increases due to $\frac{4x}{3}$ height of liquid displaced as $\pi R^2 x = \left(4\pi R^2 - \pi R^2\right)y$

$$\Rightarrow y = \frac{x}{3}$$

Hence extra buoyant force $= \pi R^2\left(x + \frac{x}{3}\right).2\rho g$

2. **A**



$$E_{ind}.2\pi R = \pi R^2\frac{dB}{dt} \Rightarrow E_{ind} = \frac{dB}{dt}$$

Now, $T = mg + qE\cos 60^o$

$$2mg = mg + \frac{qE}{2}$$

$$qE_{ind}\cos 60 = mg$$

$$q.\frac{1}{2}.\frac{1}{2} = mg$$

$$\Rightarrow q = 4mg$$

3. **A**

$$g = -\frac{dV}{dr}$$

$$\frac{-K}{r} = -\frac{dV}{dr}$$

$$\int_{V_0}^{V} dV = K\int_{r_0}^{r}\frac{dr}{r}$$

$$V = K\ln\left(\frac{r}{r_0}\right) + V_0$$

4. **A**

$$F_1 = \frac{GMm}{4R^2},\ m_{cavity} = \frac{M}{8}$$

$$F_2 = F_1 - F_{cavity} = \frac{GMm}{4R^2} - \frac{G\frac{M}{8}.m}{\left(\frac{3R}{2}\right)^2} = \frac{7}{36}\frac{GMm}{R^2}$$

$$\Rightarrow \frac{F_1}{F_2} = \frac{9}{7}$$

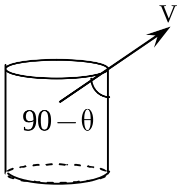
5. **C**

Effective area receiving the particles is

$$\frac{\pi R^2}{2}\sin\theta + 2Rh\cos\theta + \frac{\pi R^2}{2}\sin\theta$$

Hence, $F = \rho v^2 A_{eff.}$

$\rho = Fv = \rho v^3 A_{eff.}$



6. **B**

More the value of T more must be extension in rubber band. Tension in rubber band is in decreasing order from right to left.

7. **C**

$V_A = V_C = V_E$

Hence, only one capacitor between E and F remains effective.

So, $U = \frac{1}{2}CV^2 = \frac{1}{2}\frac{\varepsilon_0 A}{d}V^2$

8. **B**

9. **A**

Since refractive index is changing ray cannot travel in straight line. Hence (C) and (D) are wrong options. Initially it has to bend towards normal and later on away from normal.

10. **C**

For plano convex lens

$$\frac{1}{f} = \frac{1}{40} = \frac{(\mu - 1)}{R}$$

For biconvex lens

$$\frac{1}{v_1} - \frac{1}{-10} = \frac{1}{20} \Rightarrow v_1 = -20 \text{ cm}$$

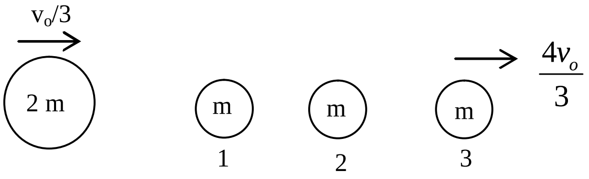
$$\frac{\mu}{\infty} - \frac{1}{-(d+20)} = \frac{(\mu - 1)}{R} \Rightarrow \frac{1}{d+20} = \frac{1}{40} \Rightarrow d = 20$$

11. **B**

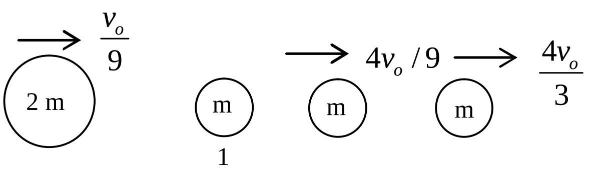
Ring will get some angular velocity about its diameter due to torque of magnetic field.

12. **B, C, D**

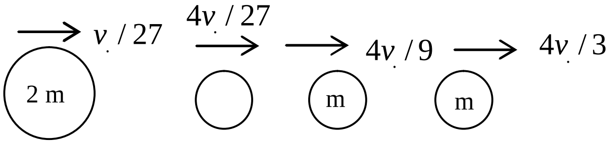
When 2m collides with ball 1 which in turn with 2 and then with 3, then



Now 2m again strikes with ball which in turn with ball 2, then

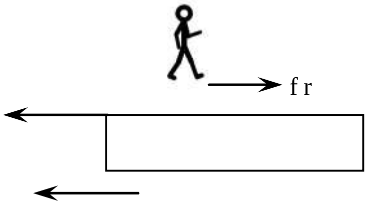


Now 2m again strikes with ball 1, then



Above is the final state.

13. **A, C, D**
In frame of plank work done by friction on man is zero as w.r.t. plank there is no slipping at contact. Work done by friction on plank is positive.
Foot of person moves leftward, plank moves leftward.



14. **C, D**
Force on left and right inclined faces must have same and opposite horizontal components and force on base is $\left(\rho gh + P_{atm}\right)A$.

15. **A, D**
At high temperature vibrational degrees of freedom get excited.

SECTION – C

1. **2**
In one second block comes to lower extreme and after switching on the electric field equilibrium of block is with natural length of spring.

2. **0**
At highest point, $q\bar{v} \times \bar{B} = mg \Rightarrow$ particle does not come back, hence $T = \infty$

$qvB = mg$

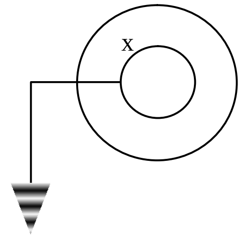
$q.100.B = mg$

3. **3**
Let charge on inner shell is x.
Then,

$$V_{\text{inner shell}} = \frac{Kq}{3r} + \frac{Kx}{r} = 0$$

$$\Rightarrow x = \frac{-q}{3}$$

So, charge flowing through switch is $\frac{q}{3}$.



4. **9**

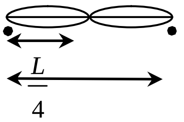
$\Delta Q = 15000\text{ J} = nC_P\Delta T$ & $\Delta U = nC_V\Delta T$

$$\frac{\Delta U}{\Delta Q} = \frac{C_V}{C_P} = \frac{1}{\gamma} \Rightarrow \Delta U = \frac{\Delta Q}{\gamma} \Rightarrow \Delta U = \frac{3}{5}\times 15 = 9\text{ KJ}$$

5. **2**

$$\frac{5\lambda}{2} = \ell \Rightarrow \lambda = 6$$

$$f = \frac{v}{\lambda} = \frac{12}{6} = 2\text{ Hz}$$



Chemistry

PART – II

SECTION – A

1. **D**

Lime removes temporary hardness & boiling also removes temporary hardness.

$CaCl_2 + Na_2CO_3 \longrightarrow CaCO_3\downarrow + Na_2CO_3$ & $Ca(HCO_3)_2 + Na_2CO_3 \longrightarrow CaCO_3\downarrow + NaHCO_3$

2. **A**

Use law of gram equivalence.

3. **C**

$AgCNS \xrightleftharpoons{H_2O} \underset{S+S'}{Ag^+} + \underset{S}{\overset{-}{S}}CN \Rightarrow K_{sp} = 8.5 \times 10^{-12} = (S+S')S$ ……… (1)

$AgBr \rightleftharpoons \underset{S+S'}{Ag^+} + \underset{S'}{Br^-} \Rightarrow 5 \times 10^{-13} = (S+S')S$ ………… (2)

Adding (i) and (ii),

$(S+S')^2 = 9\times10^{-12}$

$(S+S') = 3\times10^{-6}$

4. **C**

Methyl is electron releasing group. Also refer ortho effect.

5. **D**

$$AgNO_3 \xrightarrow{Na_2S_2O_3} Ag_2S_2O_3 \xrightarrow{H_2O} \underset{\text{Black}}{Ag_2S\downarrow}$$

6. **C**

$$C_6H_{12}O_6 \xrightarrow[\Delta]{conc H_2SO_4} C + H_2O$$

7. **C**

Refer rules of IUPAC.

8. **B**

PR_3 is π acid ligand which forms π bond with C.M using d orbital of P.

9. **A**

$$\text{Efficiency } = \frac{\Delta G^0}{\Delta H^0}\times 100 = 85$$

$$\Rightarrow \Delta G^0 = -\frac{85\times285\times10^3}{100}$$

$$= -85\times2850\,kJ$$

$$= -2\times96500\times E^0_{cell}$$

$$E^0_{cell} = 1.26 \text{ Volt}$$

10. **C**

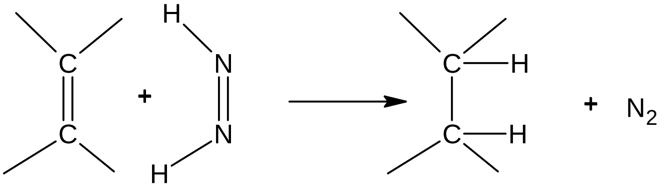
A is C_2H_5CHO and B is Me_2S.

Me_2S can be used in reductive ozonolysis.

$CH_2{=}CH_2 \xrightarrow[\text{ii) } Me_2S]{\text{i) } O_3} 2HCHO + Me_2SO$

11. **A, B, D**

$N_2H_4 + H_2O_2 \rightarrow N_2H_2 + 2H_2O$



12. **A, C, D**

Hexagonal, rhombohedral and triclinic have only one bravais lattice.

13. **D**

Anhyd. $CuSO_4$ is white, while $CuSO_4$. $5H_2O$ is blue, other complexes (A) and (B) are also coloured.

14. **A, B, C**

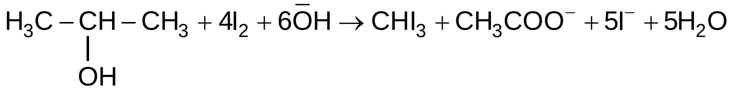
A & B are peroxide & hydroperoxide which oxidise $Fe^{2+}$to Fe^{3+} and these peroxides and hydroperoxides are explosives.

15. **A, C, D**

Proline has 2^o amino group, which can not be diazotised.

SECTION – C

1. **4**



$$H_3C-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3 + 4I_2 + 6\overline{O}H \rightarrow CHI_3 + CH_3COO^- + 5I^- + 5H_2O$$

2. **0**

Among cubic unit cells only FCC has O.V.

3. **1**

For 10 ml standard gold solution starch required is 0.02 gm, i.e., 20 mg
So, gold number is 20 = 2 x 10^1

4. **8**

$$\frac{\Delta H_2 - \Delta H_1}{T_2 - T_1} = \Delta C_p$$

$$\Rightarrow \Delta H_2 = -28.58 \times 10^3 + 32 \times 60$$

$$= -28580 + 1920 = -26660 \text{ J}$$

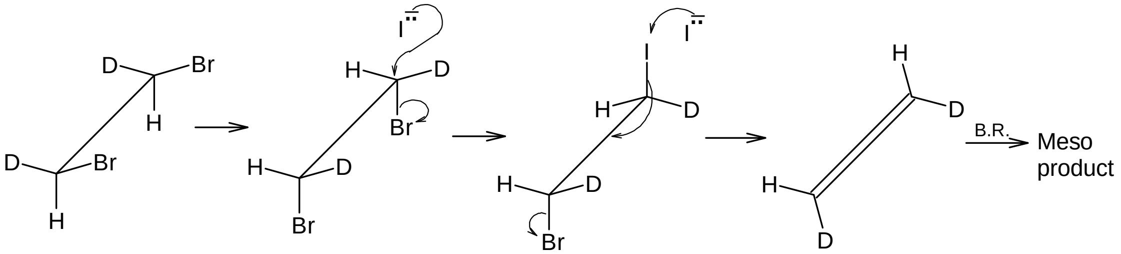
i.e., $\Delta H_{87^oC} = -26.66$ KJ

Efficiency of fuel cell $= \frac{\Delta G}{\Delta H} \times 100 = 90 \Rightarrow \Delta G = \frac{\Delta H \times 90}{100}$

$\Delta G = \frac{-26.66 \times 90}{100} = -23.994 \approx -24$ KJ/mol $\Rightarrow 3 \times a \Rightarrow a = 8$

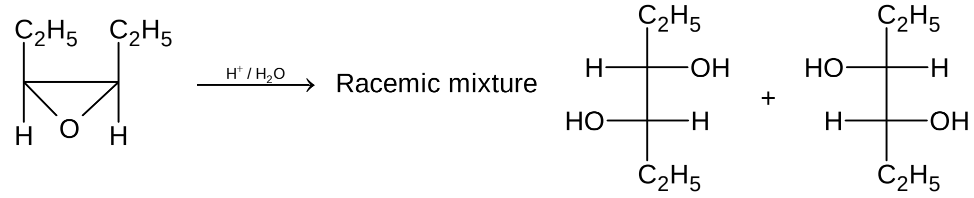
5. **2**

(a) Different mechanism operates with 1^{o} vicinaldihalides, and first cis alkene then meso product are obtained here.

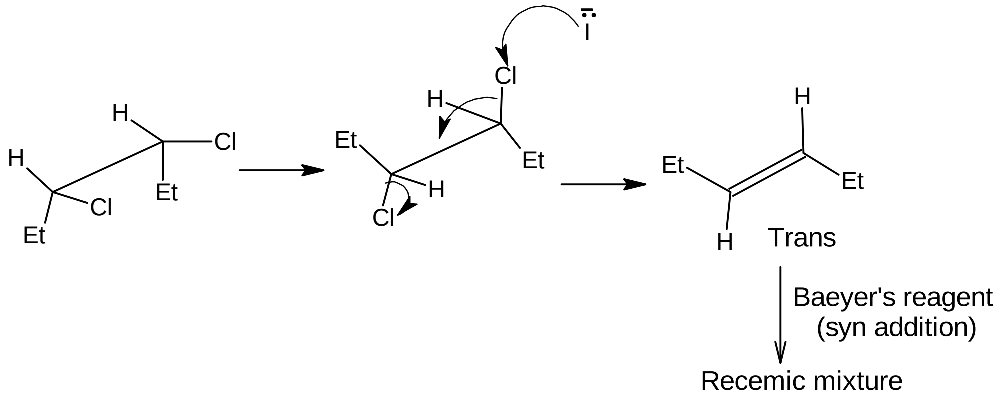

I
D
Br
H
D
Br
H
H
D
Br
H
D
Br
I
I
H
D
H
D
Br
H
D
H
D
B.R.
Meso product

(b) Trans alkene ⇒ syn addition ⇒ racemic mixture product, as epoxide is formed.

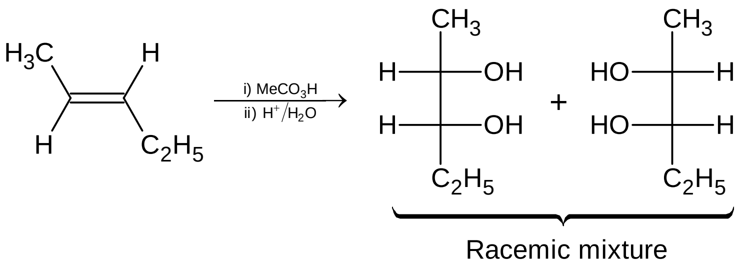
(c)


C_2H_5
C_2H_5
H
O
H
H^+ / H_2O
Racemic mixture
C_2H_5
H
OH
HO
H
C_2H_5
+
C_2H_5
HO
H
H
OH
C_2H_5

(d)


I
H
Cl
H
Cl
Et
Et
Cl
H
Et
Et
H
Cl
H
Et
H
Et
H
Trans
Baeyer's reagent (syn addition)
Recemic mixture

(e)


H_3C
H
H
C_2H_5
i) $MeCO_3H$
ii) H^+/H_2O
CH_3
H
OH
H
OH
C_2H_5
+
CH_3
HO
H
HO
H
C_2H_5
Racemic mixture

(f) Racemic mixture is obtained. Meso can not be obtained in this reaction as alkene is not symmetrical.

(g) First cis alkene, then sys addition of –OH group, so meso product.

(h) Anti addition, but alkene is not symmetrical, product is racemic mixture.

Mathematics

PART – III

SECTION – A

1. **C**

$$\because I = \int_0^{\pi} f(\tan 2x)\cos x\, dx \quad .... (1)$$

$$I = \int_0^{\pi} f(-\tan 2x)(-\cos x)dx = I$$

$$\Rightarrow I = 2\int_0^{\pi/2} f(\tan 2x)\cos x\, dx$$

$$\Rightarrow I = 2\int_0^{\pi/2} f(-\tan 2x)\sin x\, dx$$

$$2I = 2\int_0^{\pi/2} f(\tan 2x)(\cos x - \sin x)dx$$

$$= \sqrt{2}I\int_0^{\pi/2} f(\tan 2x)\cos\left(\frac{\pi}{4} + x\right)dx$$

$$= \sqrt{2}\int_{-\pi/4}^{\pi/4} f(-\cot 2x)(-\sin x)dx$$

$$I = 2\sqrt{2}\int_0^{\pi/4} f(\cot 2x)\sin x\, dx$$

$$= 2\sqrt{2}J$$

2. **A**

$a_{11} = f\left(x^{2-1-2}\right) = f\left(\frac{1}{x}\right)$, $a_{21} = f\left(x^{4-1-2}\right) = f(x)$, $a_{12} = f\left(x^{2-2-2}\right) = f\left(\frac{1}{x^2}\right)$ and

$a_{22} = f\left(x^{4-2-2}\right) = f(1)$.

$$\therefore A = \begin{pmatrix} f\left(\frac{1}{x}\right) & f\left(\frac{1}{x^2}\right) \\ f(x) & f(1) \end{pmatrix} \text{ and } B = \begin{pmatrix} f(1) & f\left(\frac{1}{x}\right) \\ f\left(x^2\right) & f(x) \end{pmatrix}$$

$$\therefore A + B^T = \begin{pmatrix} f\left(\frac{1}{x}\right) + f(1) & f\left(\frac{1}{x^2}\right) + f\left(x^2\right) \\ f(x) + f\left(\frac{1}{x}\right) & f(1) + f(x) \end{pmatrix}$$

From given matrix,

$$f\left(\frac{1}{x}\right) + f(1) = -x^2 f\left((x) + f(1)\right) \quad \text{……….. (i)}$$

$$f\left(\frac{1}{x^2}\right) + f\left(x^2\right) = \left(1 - \frac{1}{x^4}\right) f\left(\frac{1}{x^2}\right) \quad \text{……….. (ii)}$$

$f(x)+f\left(\frac{1}{x}\right)=f\left(\frac{1}{x}\right)\left(1-\frac{1}{x^2}\right)$ ………. (iii)

$f(1)+f(x)=-\frac{1}{x^2}f\left(\frac{1+f(1)}{x}\right)$ ………. (iv)

From (ii), $x=1$ $2f(1)=0\Rightarrow f(1)=0$

$\therefore$ Eqn. (i), $-x^2f(x)=f\left(\frac{1}{x}\right)$ ……… (*)

Now, $\int\limits_x^{1/x}f(t)dt=I$

Replace $t\to\frac{1}{t}$

$$\Rightarrow I=\int\limits_{1/x}^{x}f\left(\frac{1}{t}\right)\left(-\frac{1}{t^2}\right)dt=\int\limits_x^{1/x}f\left(\frac{1}{t}\right)\frac{1}{t^2}dt$$

$\Rightarrow 2I=\int\limits_x^{1/x}\left(f(t)+\frac{1}{t^2}f(t)\right)dt=0$ from (*)

i.e., $I=0=f(1)$

Option (a) is correct.

3. **D**

$$\left[f(x)\quad g(x)\quad h(x)\right]=\begin{vmatrix}\cos x & \sin x & \cos 2x\\ \tan x & \sin 3x & \cos 4x\\ \cos 3x & \sin 5x & \cos 6x\end{vmatrix}$$

$$\therefore\int\limits_0^{\pi}[f,\quad g,\quad h](x)dx=\int\limits_0^{\pi}[f,\quad g,\quad h](\pi-x)dx$$

$$\Rightarrow\int\limits_0^{\pi}[f,\quad g,\quad h]dx=-\int\limits_0^{\pi}[f,\quad g,\quad h]dx\qquad(\because C_1\to -C_1)$$

$$\Rightarrow\int\limits_0^{\pi}[f,\quad g,\quad h]dx=0$$

Option (d) is correct.

4. **D**

$\vec{a}_1=(a,\ b)$, $\vec{a}_2=\left(a-2,\ b-\sqrt{5}\right)$, $\vec{a}_3=\left(a+2,\ b-\sqrt{5}\right)$

Area of Δ, whose vertices are $\vec{a}_1,\ \vec{a}_2$ and $\vec{a}_3$, is

$$\Delta=\frac{1}{2}\begin{vmatrix}1 & a & b\\ 1 & a-2 & b-\sqrt{5}\\ 1 & a+2 & b-\sqrt{5}\end{vmatrix}$$

$$\Rightarrow \Delta^2 = \frac{1}{4}\begin{vmatrix}1 & a & b\\ 1 & a-2 & b-\sqrt{5}\\ 1 & a+2 & b-\sqrt{5}\end{vmatrix}\begin{vmatrix}1 & a & b\\ 1 & a-2 & b-\sqrt{5}\\ 1 & a+2 & b-\sqrt{5}\end{vmatrix} \text{ and}$$

$$\left|\vec{a}_1-\vec{a}_2\right| = 3,\ \left|\vec{a}_1-\vec{a}_3\right| = 3,\ \left|\vec{a}_1-\vec{a}_3\right| = 4$$

$$\Rightarrow \Delta = \sqrt{5\times 2\times 2\times 1} = 2\sqrt{5}$$

$$\left(2\sqrt{5}\right)^2 = \frac{1}{4}\begin{vmatrix}1+\vec{a}_1.\vec{a}_1 & 1+\vec{a}_1.\vec{a}_2 & 1+\vec{a}_1.\vec{a}_3\\ 1+\vec{a}_2.\vec{a}_1 & 1+\vec{a}_2.\vec{a}_2 & 1+\vec{a}_2.\vec{a}_3\\ 1+\vec{a}_3.\vec{a}_1 & 1+\vec{a}_3.\vec{a}_2 & 1+\vec{a}_3.\vec{a}_3\end{vmatrix}$$

$\therefore$ Required answer = 4 x 5 x 4 = 80

Option (d) is correct.

5. **A**

$$I = \int_0^{\pi/2} \frac{\sin^3 x\cos x}{\cos x+\sin x}dx$$

$$I = \int_0^{\pi/2} \frac{\cos^3 x\sin xdx}{\sin x+\cos x} \qquad \text{Prop. } \int_0^a f\left(x\right)dx = \int_0^a f\left(a-x\right)dx$$

$$\Rightarrow 2I = \int_0^{\pi/2} \frac{\sin x\cos x\ dx}{\sin x+\cos x}$$

$$2I = 2\int_0^{\pi/4} \frac{\sin x\cos xdx}{\sqrt{2}\cos\left(x-\frac{\pi}{4}\right)}$$

$$I = \frac{1}{2\sqrt{2}}\int_0^{\pi/4} \frac{\sin 2x}{\cos\left(x-\frac{\pi}{4}\right)}dx = \frac{1}{2\sqrt{2}}\int_0^{\pi/4}\frac{\cos 2x}{\cos x}dx$$

$$= \frac{1}{2\sqrt{2}}\int_0^{\pi/4}\left(2\cos x-\sec x\right)dx = \frac{1}{2\sqrt{2}}\left[2\sin x-\ln\left|\sec x+\tan x\right|\right]_0^{\pi/4}$$

$$= \frac{1}{2\sqrt{2}}\left[2\left(\frac{1}{\sqrt{2}}\right)-\ln\left|\sqrt{2}+1\right|\right] = \frac{1}{2}-\frac{1}{2\sqrt{2}}\ln\left|\sqrt{2}+1\right|$$

Option (a) is correct.

6. **C**

$$\because \left|f\left(n\right)\right| \le \left|0\right| \Rightarrow f\left(n\right) = 0$$

$$\& \ \left|f\left(x\right)-f\left(n\right)\right| \le \left|\sin\pi x\right|$$

$$\Rightarrow \left|f'\left(n\right)\right| \le \left|\lim_{x\to n}\cos\pi x\times\pi\right|$$

$$\Rightarrow \left|f'\left(n\right)\right| \le \pi$$

7. **C**

$$\because f\left(x\right) = \tan 2x-\tan x$$

$f(1) = \tan 2 - \tan 1$

$f(2) = \tan 4 - \tan 2$

....

....

$f(2^n) = \tan 2.2^n - \tan 2^n$

$g(x) = \tan 2^{x+1} - \tan 1$

8. **D**

Using $\tan\theta - \tan\frac{\theta}{2} = \tan\frac{\theta}{2} + \tan\theta\tan^2\frac{\theta}{2}$

9. **C**

$$\because \quad \beta = \frac{f(4)+f(12)}{2}$$

$$= \frac{4+12}{2} = 8$$

10. **B**

$f^{-1}(x) = x - 1$ then $h^{-1}(x) = (g\cdot f(x))^{-1}$

$\therefore \frac{d}{dx}\left(h^{-1}(x)\right) = 3x^2 + 1$ $\quad = f^{-1}\cdot g^{-1}(x)$ (reversal law)

$= f^{-1}\left(x^3 + x^3 + x + 1\right)$

$= x^3 + x$

$\left(h^{-1}(1)\right)' = 3 + 1 = 4$

11. **B, C, D**

$$\int \frac{2x^2 - \frac{1}{x} + \sqrt{x}}{\left(1+x^3\right)}dx = \int \frac{x\left(2x - \frac{1}{x^2}\right)dx}{x\left(x^2 + \frac{1}{x}\right)} + \int \frac{\sqrt{x}dx}{1+\left(x^{3/2}\right)^2}$$

$$= \ln\left(x^2 + \frac{1}{x}\right) + \frac{2}{3}\tan^{-1}\left(x^{3/2}\right)$$

$$\Rightarrow \int_1^2 \frac{2x^2 - \frac{1}{x} + \sqrt{x}}{\left(1+x^3\right)}dx = \ln\left(\frac{9}{2}\right) - \ln 2 + \frac{2}{3}\cos^{-1}\frac{1}{3} - \frac{\pi}{6} = \ln\left(\frac{9}{4}\right)$$

Options (b), (c), (d) are correct.

12. **A, B, C**

$$\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}\begin{pmatrix} 1 & 1 \\ 2 & 1 \end{pmatrix} = \begin{pmatrix} 1 & 1 \\ 2 & 1 \end{pmatrix}\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}$$

$\Rightarrow a_{11} + 2a_{12} = a_{11} + a_{21}$ ……… (i)

$a_{11} + a_{12} = a_{12} + a_{22}$ ………. (ii)

$a_{21} + 2a_{22} = 2a_{11} + a_{21}$ ………. (iii)

and $\Rightarrow a_{21} + a_{22} = 2a_{12} + a_{22}$ ………. (iv)

From (ii), $a_{11} = a_{22}$

From (iv), $a_{21} = 2a_{12}$

$\because a_{11}a_{22} = a_{21}a_{21} \Rightarrow \left(a_{11}\right)^2 = 2\left(a_{12}\right)^2 \Rightarrow a_{11} = \sqrt{2}a_{12}$

13. **B, C**

Using $f(x) = \frac{\ln x}{x}$ has two distinct roots.

14. **B, D**

$$\Delta(x) = \begin{vmatrix} f & g & h \\ f' & g' & h' \\ f'' & g'' & h'' \end{vmatrix}$$

$$\Rightarrow \Delta'(x) = \begin{vmatrix} f & g & h \\ f' & g' & h' \\ f''' & g''' & h''' \end{vmatrix}$$

15. **A, B, D**

Confocalconics always intersect orthogonally & circle touches at vertex of ellipse .

$\therefore k = 1$

SECTION – C

1. **4**

$$I = \int_1^2 \frac{x^3 - 3x^2}{\ln(x-1)} \text{ and } J = \int_2^3 \frac{3x-5}{\ln(x-2)}$$

$$\Rightarrow J = \int_1^2 \frac{3x-2}{\ln(x-1)}$$

$$J + I = \int_1^2 \frac{x^3 - 3x^2 + 3x - 2}{\ln(x-1)} = \int_1^2 \frac{(x-1)^3 - 1}{\ln(x-1)}dx$$

$$= \int_1^2 \frac{(x-1)^3 - 1}{\ln(x-1)}dx = \int_0^1 \frac{x^3 - 1}{\ln x}dx = \ln 4$$

$$\therefore e^{\ln 4} = 4$$

2. **2**

$\overrightarrow{OA} = a\hat{i} + b\hat{j} + c\hat{k}$ and $a^2 + b^2 + c^2 = 4$

$$\Rightarrow AB = \left(25 - 24\cos^2\frac{\theta}{2}\right)$$

$$\therefore \left|QD\right| = \frac{2}{5}\cos\frac{\theta}{2}$$

$$\Rightarrow 25\left|QD\right| = 2$$

3. **4**

$$\frac{3x^2+1}{\sqrt{x^4+x^2}}=\frac{3x^2+1}{x\sqrt{x^2+1}}=\frac{x^2+1+2x^2}{x\sqrt{x^2+1}}$$

$$=\frac{\sqrt{x^2+1}}{x}+\frac{2x}{\sqrt{x^2+1}}\geq 2\sqrt{2}$$

$$f(x)=2\sqrt{2}$$

$$\therefore x^2+1=2x^2$$

$$x^2=1$$

$$x=\pm 1 \qquad x=1$$

$$\int_0^{\sqrt{2}}\frac{\left(3x^2+1\right)dx}{\sqrt{x^4+x^2}}\geq 2\sqrt{2}\times\sqrt{2}=4$$

4. **3**

$$\because \left|\text{adj}(A)\right|=|A|^{n-1}$$

$$\Rightarrow \left|\text{adj}\left(\text{adj}(A)\right)\right|=\left|\text{adj}(A)\right|^{n-1}=|A|^{(n-1)^2}$$

$$\Rightarrow \left|\text{adj}\left(\text{adj}\left(\text{adj}(A)\right)\right)\right|=|A|^{(n-1)^3}\Rightarrow (n-1)^2=4$$

$$n-1=2$$

$$n=3$$

5. **2**

Given $a_{11}=b_{11},\ a_{22}=b_{22},\ a_{12}=-b_{12},\ a_{21}=-b_{21}$

and $AB=BA=I$

$$\Rightarrow A=\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{11}\end{pmatrix} \text{ and } |A|=1$$

$$\therefore a_{11}^2-a_{12}a_{21}=1$$

$$a_{12}a_{21}=a_{11}^2-1$$

$$\Rightarrow a_{12}\text{ or }a_{21}=\left(a_{11}-1\right)\text{ or }\left(a_{11}+1\right)$$

$$\Rightarrow \left|a_{12}-a_{21}\right|=2$$

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

ALL INDIA TEST SERIES

FIITJEE

JEE (Advanced), 2017

FULL TEST – V

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 10)** contains 10 multiple choice questions which have one or more than one correct answer. Each question carries **+3 marks** for correct answer. There is no negative marking.

(ii) **Section-C (01 – 10)** contains 10 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

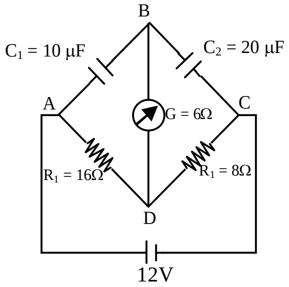
SECTION – A

Straight Objective Type

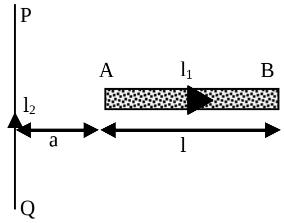
This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

1. Four point charges +q, +q, – q, and – q are placed respectively at corners A, B, C and D of a square. Then
(A) the potential at the centre O of the square is zero
(B) the electric field at the centre O of the square is zero
(C) If E is the mid-point of side BC, the work done in carrying an electron from O to E is zero
(D) If F is the mid-point of side CD, the work done is carrying an electron from O to F is zero

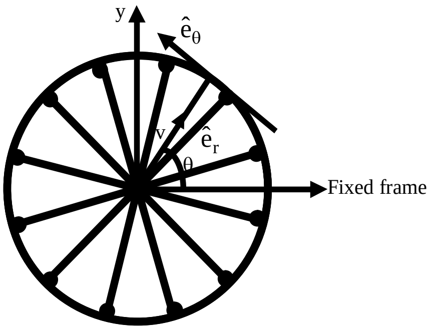
2. In the circuit show in figure, if the galvanometer resistance is 6 Ω, then in the steady state
(A) no current flows through the galvanometer
(B) the current through R_2 is 4A
(C) the charge on C_1 is 80 μC.
(D) the charge on C_2 is 80 μC



3. A thin rod AB of length l carries a current I_1. It is placed in the magnetic field of a long wire PQ carrying a current I_2 as shown in figure
(A) The force experienced by the rod is $F = \frac{\mu_0 I_1 I_2}{4\pi}\log_e\left(1+\frac{l}{2a}\right)$
(B) The force experienced by the rod is $F = \frac{\mu_0 I_1 I_2}{4\pi}\log_e\left(1+\frac{l}{a}\right)$
(C) The rod experiences no torque
(D) The rod experiences a force as well as a torque.

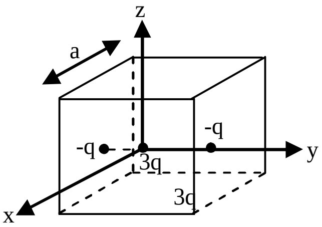


Space for rough work



4. A fly crawls with constant speed v along the radial spoke of a wheel which is rotating with constant angular speed ω. Initially the fly starts from centre of the wheel along x-axis. Then (where $r = v\theta$)
   (A) The actual velocity of the fly in fixed frame is $\vec{v} = v\hat{e}_r + r\omega\hat{e}_\theta$
   (B) The actual velocity of the fly in fixed frame is $\vec{v} = \sqrt{v\theta\omega}\hat{e}_r + r\omega\hat{e}_\theta$
   (C) The position of fly at any instant $\vec{r} = \frac{v.\theta}{\omega}\hat{e}_r$
   (D) The position of fly at any instant $\vec{r} = \frac{vt}{\omega}\hat{e}_r$

5. A cubical region of side a has its centre at the origin. It encloses three fixed point charges, -q at (0, -a/4, 0) + 3q at (0, 0, 0) and -q at (0 + a/4, 0) Choose the correct options(s)



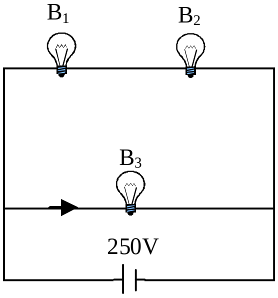
   (A) The net electric flux crossing the plane x = +a/2 is equal to the net electric flux crossing the plane x =-a/2
   (B) The net electric flux crossing the plane y = +a/2 is more than the net electric flux crossing the plane y =- a/2
   (C) The net electric flux crossing the entire region is q/ε_0
   (D) The net electric flux crossing the plane z = +a/2 is equal to the net electric flux crossing the plane x = +a/2

6. Let the energy, magnitude of linear momentum and angular frequency of an electron in hydrogen atom be E,P and ω respectively. If n be the corresponding quantum number, then
   (A) E/W varies as n
   (B) E P/W is independent of n
   (C) P W varies as $n^{1/2}$
   (D) E P W is independent of n.

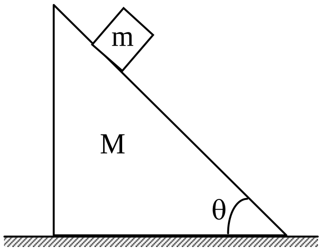
7. A nitrogen nucleus $^{14}N_7$ absorbs a neutron and can be transformed to lithium nucleus $^6Li_3$ under suitable condition, after emitting
(A) 4 proton and 3 neutrons
(B) 5 proton and 1 beta particle
(C) 2 alpha particles, 1 neutron and 2 gama photons
(D) 4 protons and 4 neutrons

8. At 0^oC a black body placed in 0^oC surrounding then it emits
(A) all wavelengths of radiation (B) only visible light
(C) only micro wave radiation (D) no radiation

9. A 100 W bulb B_1, and two 60 W bulbs B_2 and B_3, are connected to a 250 V source, as shown in figure. Now W_1, W_2 and W_3 are the output powers of the bulbs B_1, B_2 and B_3, respectively. Then
(A) $W_1 > W_2 = W_3$ (B) $W_1 > W_2 > W_3$
(C) $W_1 < W_2 = W_3$ (D) $W_1 < W_2 < W_3$



10. A block of mass m is placed on a prims of mass M. The inclined surface is smooth and inclination with horizontal is θ. The horizontal surface is sufficiently rough to prevent slipping of prism. The body of mass *m* is coming down the inclined face then
(A) Acceleration of body along the inclined surface is g sin θ
(B) Frictional force is $\frac{1}{2}mg\sin 2\theta$
(C) Maximum frictional force is $\frac{mg}{2}$
(D) Friction force will be maximum when $\theta = 45^0$



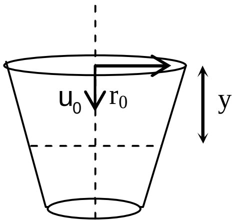
Space for rough work

SECTION – C

(One Integer Value Correct Type)

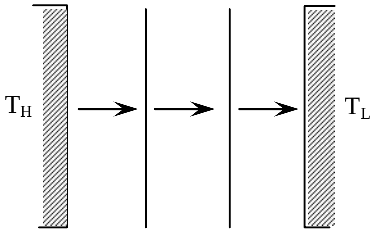
This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. Water flows vertically down ward out of a round nozzle of radius r_0 with a speed $u_{0.}$ Which is not quite large for some distance below nozzle the flow in water laminar stream over this distance the stream radius r_y as a function of the distance of belong the nozzle is $r_y = r_0\left[1+\eta y\right]^{-1/\alpha}$. Value of $(\eta+\alpha)$is$\left(\text{take value of } u_0^2 / g = 1\right)$.



2. A 60 cm metal rod M_1 is joined to another 100 cm metal rod M_2 to form an L shaped single piece This piece is hung on a ply at the joint. The two rods are observed to be equality inclined to the vertical. The two rods are equally thick. If the ratio of density M_1 to that of M_2 is η, then value of $\frac{18\eta}{25}$ is

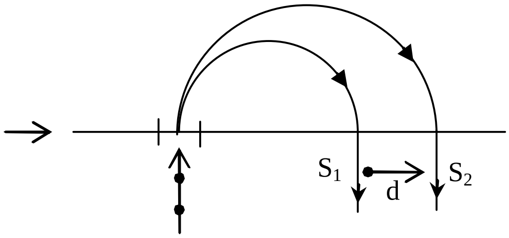
3. A black surface at constant high temperature T_H is parallel to another black plane surface at a constant lower temperature T_L (enclose vacuum in between). A heat shield consisting of two thin black plates is placed between the warm and the cold surfaces and parallel to these. After some time steady state is achieved. The value of $\eta = \frac{J_0}{J}$ is (J_o is initial heat current and J is final current)



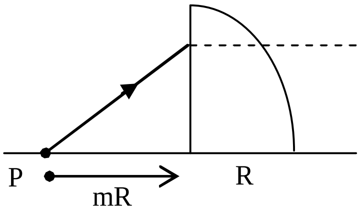
Space for rough work

4. The velocity filter of a mass spectrometer uses a uniform E = 100 v/m and a magnetic field $B_1 = 2\times10^{-2}$ T below filter at the uniform magnetic filed of induction 8×10^{-2} used to deflect the beam above filter. Both the beams are +e charged having mass numbers 20 and 22 pass through the filter and make a 180^o turn in the deflecting filed. If the distance between the points S_1 & S_2 is d, then find the approximate (integer) value of 2d?

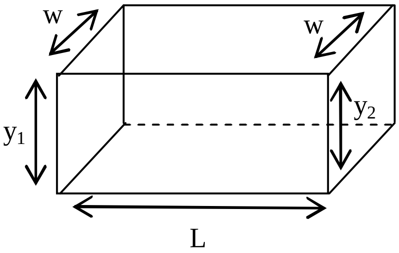
(Value of $\frac{1\text{amu}}{e} = 10^{-8}$ SI unit) (Note: spectrometer does not changes speed of ions)



5. A quarter cylinder of radius R and refractive index 1.5 is placed on a table as shown in figure. For what value of 3m, a ray from P will emerge parallel to table? Assume small aperture.

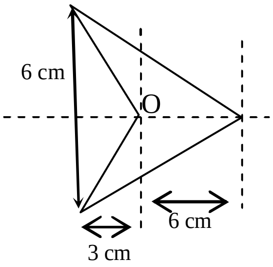


6. A material with uniform restively ρ is formed in the shape of a wedge as shown. The resistance of wedge across length L is $R = \frac{\rho\eta}{L}\ln\eta'$. Then find the value of $\frac{\eta}{6}+\eta'$. $\left(y = \frac{L}{3}, y_2 = \frac{L}{6}, W = \frac{L}{6}\right)$

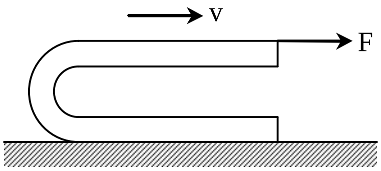


Space for rough work

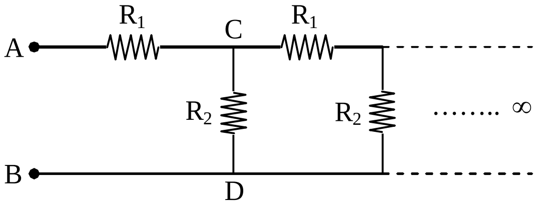
7. A uniformly thick plate in the shape of an arrowhead has dimension as shown. The centre of mass lies at a distance x cm from O. The value of x is



8. A long flexible inextensible rope of uniform mass density λ is being pulled on a rough floor with horizontal force F in such a way that the lower part is at rest and upper part moves with constant speed v as shown, the magnitude of F will be (in N) . $(\lambda = 1\,kg/m, v = 2m/s)$



9. Consider an infinite ladder net work as shown in figure A voltage is applied between points A and B. If the voltage is hawed after each section, find the ratio R_2/R_1.



10. Value of electric field at centre of charged hemisphere is ……… N/C if it has uniform charged density $\delta = 8\varepsilon_o c/m^2$ at surface.

Space for rough work

Chemistry

PART – II

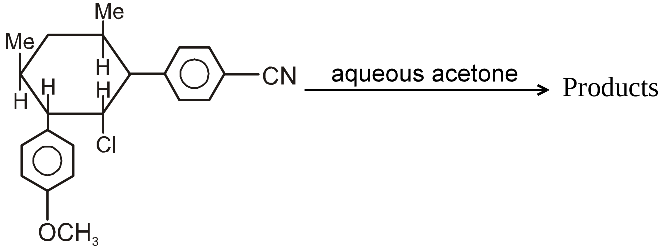
SECTION – A

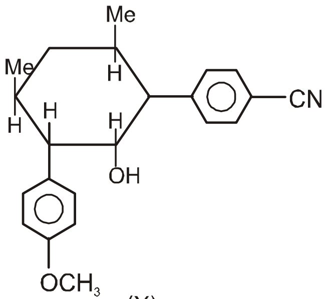
Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

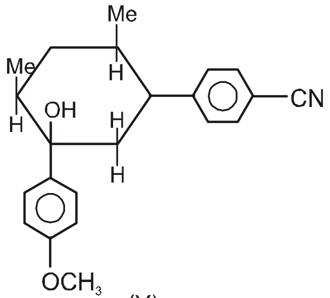
1. A system is changed from an initial state to a final state by a manner such that if the same change from the initial state to the final state were made by a different path, which of the following statements are correct for ΔH system?
(A) remain the same
(B) will depend upon the type of path
(C) Heat exchanged q will be same if the path is isobaric
(D) Heat exchanged q will be different if the path is not isobaric

2. Which of the following are correct regarding the products of the given reaction?

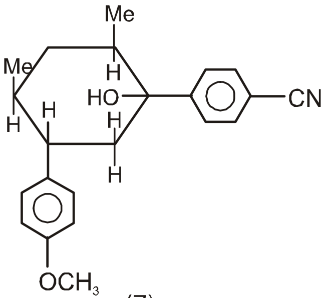




(X)



(Y)



(Z)

(A) only X and Z are formed
(B) Y > Z (amount)
(C) X > Y (amount)
(D) Y > X (amount)

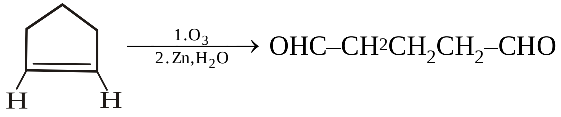
Space for rough work

3. Which of the following pairs of nitrates give the same gaseous products on thermal decomposition?
(A) KNO_3 and $Pb(NO_3)_2$ (B) KNO_3 and $NaNO_3$
(C) $Pb(NO_3)_2$ and $Cu(NO_3)_2$ (D) $NaNO_3$ and $Ca(NO_3)_2$

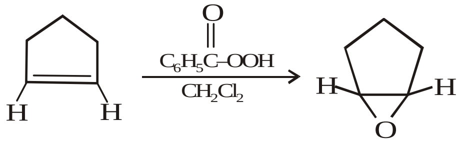
4. KO_2 finds use in oxygen cylinders used for space and submarines. The fact(s) related to such use of KO_2 is/are:
(A) it produces O_2 (B) It produces O_3
(C) It absorbs CO_2 (D) It absorbs both CO and CO_2

5. Which of the following are correct?

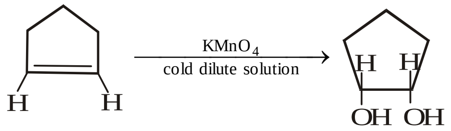
(A)


1.O3
2.Zn,H2O
OHC–CH2CH2CH2–CHO
H
H

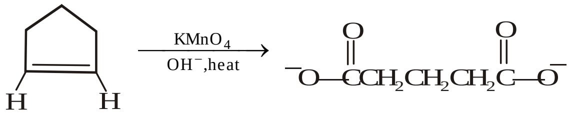
(B)


O
C6H5C–OOH
CH2Cl2
H
H
H
H
O

(C)


KMnO4
cold dilute solution
H
H
H
H
OH OH

(D)


KMnO4
OH⁻,heat
H
H
O
O
⁻O–CCH2CH2CH2C–O⁻

6. Which of the following statements are correct about stability of chelates–
(A) As the number of rings in complex increases, stability of chelate also increases
(B) A chelate having five membered ring is more stable if it contains double bonds.
(C) A chelate having six membered ring is more stable than if it does not contain double bonds.
(D) Chelating ligands are at least bidentate ligands.

7. Which of the following is/are extracted by electrolytic reduction?
(A) Cu (B) Al
(C) Mg (D) Ag

Space for rough work

8. Choose the incorrect statement:
   (A) Salicylic acid (o–Hydroxybenzoic acid) is much stronger acid than its m-,p-isomers and benzoic acid itself.
   (B) Acidity of salicylic acid is due to steric inhibition of resonance, as – OH group forces – COOH out of the plane of ring
   (C) The orbitals which are in the same plane take part in resonance
   (D) All the resonating structures have real existence

9. Rotation around the bond (between the underlined atoms) is restricted in:
   (A) $\underline{C}_2H_4$ (B) $H_2\underline{O}_2$
   (C) $\underline{C}_2H_2$ (D) $\underline{C}_2H_6$

10. Select the coloured compound(s):
   (A) $K_2Cr_2O_7$ (B) $CuSO_4.5H_2O$
   (C) $\left[V\left(H_2O\right)_6\right]Cl_3$ (D) $\left[Cu\left(NH_3\right)_4\right]SO_4$

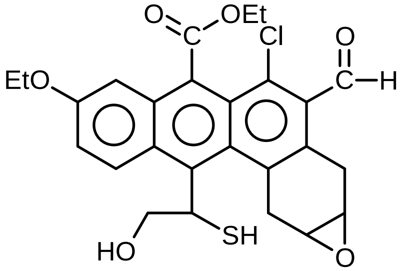
SECTION – C

(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. Find the total number of species having planar shape.
   $I_3^+, XeF_4, SF_4, C_2F_4, H_2O_2, BrF_5, SO_3, NOCl, ClF_3, F_2CO, XeF_5^-$

2. How many moles of Grignard reagent are consumed in given compound?



Space for rough work

3. How many monochloro compounds including stereoisomers will give propene on treatment with Mg/ether followed by H_2O ?

4. Find the sum of optically active isomers of both $\left[Pt\left(gly\right)_2 Cl_2\right]$ and $\left[Co\left(en\right)_2 Cl_2\right]$.

5. A polyhydric alcohol is acylated by using ethanoyl chloride in presence of alkali. It was observed that molecular mass of alcohol is increased to 237% on acylation. If the molecular mass of polyhydric alcohol is 92, then the number of –OH groups present in polyhydric alcohol are____

6. For the synthesis of ammonia at 300 K :

$$N_2(g) + 3H_{2(g)} \longrightarrow 2NH_3(g)$$

Calculate the value of Δ G° in Kcal and give your answer in magnitude by using the following data:

	N_2	H_2	NH_3
ΔH°_f (Kcal/mole)	0	0	-10
ΔS° (Cal/K-mole)	40	30	45

7. Calculate the change in pressure (in atm) when 2 mole of NO and 16 g O_2 in a 6.25 litre originally at 27°C react to produce the maximum quantity of NO_2 possible according to the equation.

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g) \qquad (\text{Take } R = \frac{1}{12} \text{ ltr. Atm/mol K})$$

8. Electrons in a sample of H$-$atoms make transitions from state n = x, to some lower excited state. The emission spectrum from the sample is found to contain only the lines belonging to a particular series. If one of the photons had an energy of 0.6375 eV. Then find the value of x.

[Take 0.6375 eV = $\frac{3}{4}$ × 0.85eV]

9. If the atomic number of the inert gas is XY in which the total number of d-electrons is equal to the difference in the number of total p- and s- electrons. Find |X-Y|.

10. For the reaction $3A(g) \rightarrow 2B(g) + 2C(g)$, starting with pure A, pressure after 9 min was 387.5 mm of Hg and after a long time was 400mm of Hg. Calculate half life of A in min.

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

1. If $2f(x)+xf\left(\frac{1}{x}\right)-2f\left(\left|\sqrt{2}\sin\pi\left(x+\frac{1}{4}\right)\right|\right)=4\cos^2\left(\frac{\pi x}{2}\right)+x\cos\frac{\pi}{x},\forall x\in R=\{0\}$, then which of the following statement(s) is/are true?

(A) $f(2)+f\left(\frac{1}{2}\right)=1$
(B) $f(2)+f(1)=0$
(C) $f(2)+f(1)=f\left(\frac{1}{2}\right)$
(D) $f(1)f\left(\frac{1}{2}\right)f(2)=1$

2. Let ABC be a non obtuse triangle such that AB > AC & $\angle B=45^o$. Let O and I denote the circumcenter and incentre of $\triangle ABC$ respectively. Suppose that $\sqrt{2}OI=AB-AC$, then the possible values of sin $\angle BAC$ is/are

(A) $1/\sqrt{2}$
(B) $\sqrt{\frac{4\sqrt{2}-2}{2}}$
(C) $\frac{\sqrt{4\sqrt{2}-2}}{2}$
(D) 1/2

3. $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=1$ intersects the coordinate axis at points A, B and C resp. If $\triangle PQR$ has midpoints A, B, & C then

(A) centroid of $\triangle ABC$ & $\triangle PQR$ coincide
(B) foot of normal to $\triangle ABC$ from O is circumcentre of $\triangle PQR$
(C) area$(\triangle PQR)=2\sqrt{a^2b^2+b^2c^2+c^2a^2}$
(D) incentres of $\triangle ABC$ and $\triangle PQR$ coincide

Space for rough work

4. $\bar{x}\times\bar{y}=\bar{a},\ \bar{y}\times\bar{z}=\bar{b},\ \bar{x}.\,\bar{b}=\gamma, \bar{x}\ .\ \bar{y}=1\ \&\ \bar{y}.\bar{z}=1$ then

(A) $\bar{y}=\dfrac{\bar{a}\times\bar{b}}{\gamma}$ (B) $\bar{x}=\dfrac{1}{y^2}\left[\bar{y}-\bar{a}\times\bar{y}\right]$

(C) $\bar{z}=\dfrac{1}{y^2}\left[\bar{y}+\bar{b}\times\bar{y}\right]$ (D) $\bar{x}=\dfrac{1}{\gamma^2}\left[\bar{y}+\bar{a}\times\bar{y}\right]$

5. If the value of the definite integral $\int_0^1 {}^{207}C_7 x^{200}(1-x)^7\,dx$ is equal to $\dfrac{1}{k}$ where $k\in N$, then k is divisible by

(A) 13 (B) 16

(C) 9 (D) 52

6. A function $f:R\to R$ satisfies the equation $f(x+y)=f(x)+f(y)\forall x,y\in R$ & is continuous through out the domain. If $I_1+I_2+I_3+I_4+I_5=450$ where $I_n=n\int_0^n f(x)\,dx$, then

(A) $f(x)=4x$ (B) $f(x)=2x$

(C) $f'(0)=4$ (D) $f'(0)=2$

7. $A(\bar{a}),B(\bar{b}),C(\bar{c})$ are position vector of vertices of $\triangle ABC$ such that $\bar{a}.\bar{b}+\bar{a}.\bar{c}=\bar{a}.\bar{a}+\bar{b}.\bar{c}$. Also $\left|\bar{b}-\bar{c}\right|+\left|\bar{a}-\bar{b}\right|=2\left|\bar{a}-\bar{c}\right|$. Inradius of triangle is 1 unit, then which of the following statement is/are correct?

(A) $\sin^2 B+\sin^2 C=1$ where B = $\underline{|AB}$C & C = $\underline{|ACB}$

(B) Diameter of circumcircle of $\triangle ABC$ is 5 units

(C) Area of $\triangle ABC$ is 6 sq. units

(D) $\dfrac{\text{Area of }\triangle ABC}{\text{semi perimeter of }\triangle ABC}=2$

Space for rough work

8. The curves $y = ax^3 + 4x\left(a \neq 0\right)$ & $xy = 1$ touch each other at points P and Q, where P is in first quadrant. A triangle is formed by drawing a tangent to $y = ax^3 + 4x$ at point Q and coordinate axes. Then which of the following is/are correct?
(A) The value of a is – 4
(B) The area of the triangle formed is 2
(C) The value of a is – 2
(D) The area of the triangle formed is 1

9. If the value of definite integral $\int_{-1}^{1} \cot^{-1}\left(\frac{1}{\sqrt{1-x^2}}\right)\left(\cot^{-1}\frac{x}{\sqrt{1-\left(x^2\right)^{|x|}}}\right)dx = \pi^2\left(\frac{\sqrt{a}-\sqrt{b}}{c}\right)$,
where a, b, c, $\in$ N in their lowest form then
(A) a = 1 (B) b = 2
(C) a = 2 (D) b = 1

10. Let $A = \begin{bmatrix} 0 & \alpha \\ 0 & 0 \end{bmatrix}$ & $\left(A + I\right)^{50} - 50A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$ then
(A) a + d =2 (B) a + b = 1
(C) b + c = 0 (D) a+ d = 1

SECTION – C

(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. $\frac{\tan 1}{\cos 2} + \frac{\tan 2}{\cos 4} + ... + \frac{\tan 1024}{\cos 2048} = \tan\lambda - \tan\mu$, then $\left[\frac{\lambda-\mu}{1000}\right] = ...,$ $[\ ]$ G.I.F .

2. A triangle ABC has positive integer sides, $\angle A = 2\angle B$ and $\angle C > 90^o$, then the minimum length of the perimeter of ABC is 70 + K then K is equal to

Space for rough work

3. The value of $\sum_{k=0}^{7}\left(\frac{{}^{7}C_k}{{}^{14}C_k}\sum_{r=k}^{14}\left({}^{r}C_k\right)\left({}^{14}C_r\right)\right)$ is $(k)^{k+1}$. Then k is

4. If the value of $\int_0^1 \frac{\sin^{-1}\sqrt{x}}{x^2-x+1}dx$ is $\frac{\pi^2}{\sqrt{n}}$ $(\text{where } n \in N)$, then the value of $\frac{n}{27}$ is

5. The sum of the following n term series for $\theta = 30^o$

$\cos^2\theta + \cos^2\theta\cos(2\theta) + \cos^3\theta(\cos 3\theta) + ... + \cos^n\theta\cos(n\theta)$ is $(n+1)\left(\sin\frac{n\pi}{6}\right)\left(\frac{1}{k}\right)^n$, then k is

6. A tourist takes a trip through a city in stages each stage consist of three segments of length 100 meters separated by right turns of 60^o. Between the last segment of one stage and first segment of the next stage, the tourist makes a left turn of 60^o. The distance the tourist will be from his initial position after 2017 stages is 100 k. Then k is

7. Let $A_n (n \in N)$ be a matrix of order $(2n-1)\times(2n-1)$ such that $a_{ij} = 0\ \forall i \neq j$ & $a_{ij} = n^2 + i + 1 - 2n\ \forall i = j$, where a_{ij} denotes the element of i^{th} row & j^{th} column of A_n. Let T_n = $(-1)^n \times$ (sum of all the element of A_n). Then the value of $\left[\frac{\sum_{n=1}^{102} T_n}{520200}\right]$, where $[.]$ represents the G.I.F, is

8. The minimum area bounded by the function $y = f(x)$ and $y = kx + 9$, $(k - R)$, where f satisfies the relation $f(x+y) = 2f(x) + xf(y) + y\sqrt{f(x)}\ \forall x, y \in R$ & $f'(0) = 0$ is 9 A, value of A is

9. Let $f(x)$ be a differentiable function such that $f'(x)$ is symmetrical about the line 2x = 5 and f(1) = 2, f(4) = 6 then $\int_2^3 f(x)dx$ is equal to

10. If the radius of circumcircle of the ΔTPQ where PQ is the chord of contact corresponding to point T with respect to circle $x^2 + y^2 - 2x + 4y - 11 = 0$ is b units. Then the minimum distance of T from director circle of the given circle is $12 - 4\sqrt{x}$, then k is equal to

Space for rough work

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ANSWERS, HINTS & SOLUTIONS

FULL TEST – V
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A, C	A, C, D	A, B, C
2.	A, C, D	B, D	A, C
3.	B, D	B, C	A, B, C
4.	A, C	A, C	A, B, C
5.	A, C, D	A, B, C, D	A, B, C, D
6.	A, B	A, D	A, C
7.	C	B, C	A, B, C
8.	A	B, D	A, B
9.	D	A, C	C, D
10.	A, B, D	A, B, C, D	A, B, C
1.	6	7	2
2.	2	6	7
3.	3	4	6
4.	5	8	4
5.	4	3	2
6.	8	8	2
7.	1	2	2
8.	4	8	8
9.	2	3	4
10.	2	3	2

Physics

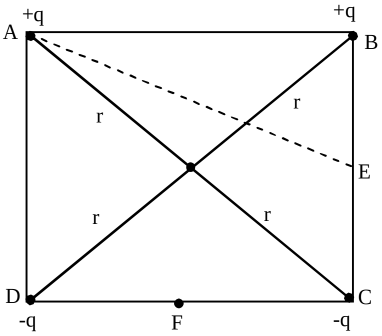
PART – I

SECTION – A

1. **A, C**

Refer to figure. potential at O is

$$V_0 = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r}+\frac{q}{r}-\frac{q}{r}-\frac{q}{r}\right)=0$$



Refer to fig. again $(AE)^2 = a^2 + \left(\frac{a}{2}\right)^2$

$= \frac{5a^2}{4}$, giving $AE - \frac{\sqrt{5}a}{2}$. Similarly $DE = \frac{\sqrt{5}a}{2}$ and $BE = \frac{a}{2}, CE = \frac{a}{2}$. Potential at E is

$$V_E = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{AE}+\frac{q}{BE}-\frac{q}{DE}-\frac{q}{CE}\right)=0$$

Work done in carrying a charge – e from O to E is

$$W = -e(V_E - V_0)$$
$$= -e(0-0) = 0$$

Potential at F is

$$V_F = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{AF}+\frac{q}{BF}-\frac{q}{DF}-\frac{q}{CF}\right)$$

Now, $AF = BF = \sqrt{5}\ a/2$ and CF = DF = a/2

Putting these values, we get

$$V_F = \frac{q}{\pi\varepsilon_0 a}\left(\frac{1}{\sqrt{5}}-1\right)$$

Work done is carrying a charge – e from O to F is

$$W = -e\left(V_F - V_0\right) = -eV_F$$
$$= \frac{qe}{\pi\varepsilon_0 a}\left(1-\frac{1}{\sqrt{5}}\right)$$

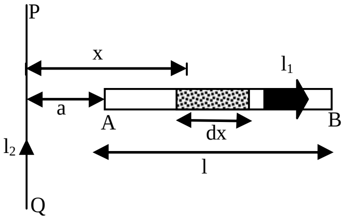
Hence the correct choice is (a) and (c).

2. **A, C, D**

In the steady state, no current flows through the branch ABC containing the capacitors. Thus all the current flows through ADC. So choice (a) is correct. Current through R_1 = current through R_2 = I = 12/24 = 0.5 A. Now p.d. across A and C = 12 V. Therefore $Q = V_1C_1 = V_2C_2$. Thus

$\frac{V_1}{V_2} = \frac{C_2}{C_1}$ =2. Also $V_1 + V_2 = 12$. Therefore, V_1 = 8 V and V_2 = 4V. Thus
$Q = C_1V_1 = 10\mu F \times 8V = 80\mu C =$ charge on C_2. Thus the correct choices are (a), (c) and (d)

3. **B, D**
Consider a small element of length dx of the rod at a distance x from wire PQ as shown in figure. The magnetic field use to wire PQ at the element is



$dF = Bl_1\,dx = \frac{\mu_0 l_1 l_2 dx}{2\pi x}$

$\therefore$ Total force experienced by the rod is

$$F = \int dF$$

$$= \frac{\mu_0 l_1 l_2}{2\pi_2} \int_{x=a}^{x=(a+l)} \frac{dx}{x}$$

$$= \frac{\mu_0 l_1 l_2}{2\pi} \log_e\left(\frac{a+l}{a}\right)$$

Now, the magnetic field B is not uniform; it decreases as we go from and A to end B of the rod. Hence the rod will also experience a torque. Thus the correct choices are (b) and (d).

4. **A, C**
$\vec{v} = v\hat{e}_r + r\omega\hat{e}_\theta,\ t = \frac{\theta}{\omega},\ \vec{r} = \frac{v\theta}{\omega}\hat{e}$

5. **A, C, D**
Using Gauss theorem.

6. **A, B**
(a,b) as E $\propto \frac{1}{n^2}$, P $\propto \frac{1}{n}$ & W $\propto \frac{1}{n^3}$

7. **C**
$^{17}N_7 \longrightarrow {}^{6}Li_3 + 2\ {}_{2}He^4 + {}_{0}n^1 + 2\gamma$

8. **A**
From black body radiation concept.

9. **D**
The resistances of bulbs B_1, B_2 and B_3 respectively are

$$R_1 = \frac{V^2}{W_1} = \frac{(250)^2}{100} = 625\Omega$$

$$R_2 = \frac{(250)^2}{60} = 1042\Omega = R_3$$

Voltage across B_3 is V_3 = 250 V

Voltage across B_1 is $V_1 = \frac{VR_1}{(R_1 + R_2)}$

$$= \frac{250 \times 625}{(625 + 1042)} = 93.7V$$

Voltage across B_2 is $V_2 = 250 - 93.7 = 156.3V$

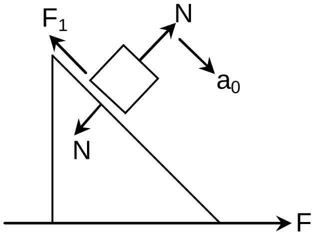
$$W_1 = \frac{V_1^2}{R_1} = \frac{(93.7)^2}{625} = 14W$$

Power output $W_2 = \frac{(156.3)^2}{1042} = 23W$

$$W_3 = \frac{(250)^2}{1042} = 60W$$

Hence $W_1 < W_2 < W_3$, which is choice (D)

10. **A, B, D**



$a_0 = g\sin\theta$

$F = N\sin\theta,\ N = mg\cos\theta$

$\Rightarrow F = \frac{1}{2}mg\sin 2\theta$

SECTION – C

1. **6**

$A_1V_1 = A_2V_2$

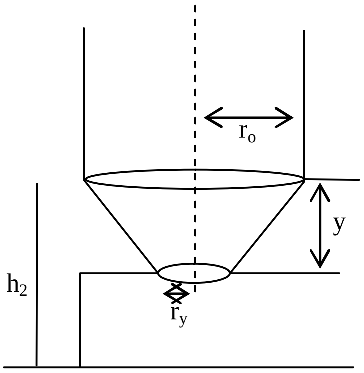
$V_y = \left(\frac{r_0}{r_y}\right)^2 u_0$

By Bernoulli's theorem

$$\frac{p}{\rho} + \frac{1}{2}V_y^2 + gh_1 = \frac{p}{\rho} + \frac{1}{2}u_0^2 + gh_2$$

$$\Rightarrow r_y = r_0\left(1 + \frac{2gy}{u_0^2}\right)^{-1/4} = r_0[1 + 2y]^{-1/4}$$

$\Rightarrow \eta + \alpha = 6$



2. **2**

$\overline{\tau}_A = 0$

$m_2 g \ell_2 \sin 45^o = m_1 g \ell_1 \sin 45^o$ .... (1)

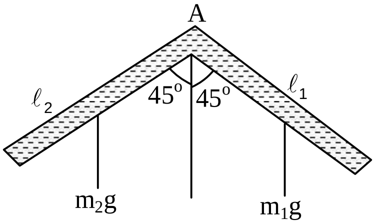
$m_1 = \rho_1 \ell_1,\ m_2 = \rho_2 \ell_2$

From (1),

$\rho_1 \ell_1^2 = \rho_2 \ell_2^2$

$\eta = \frac{-\rho_1}{\rho_2} = \left(\frac{5}{3}\right)^2 = \frac{25}{9}$

$x = \frac{18}{25}\eta = 2$



3. **3**

In steady state heat flow will be same across each sheet.

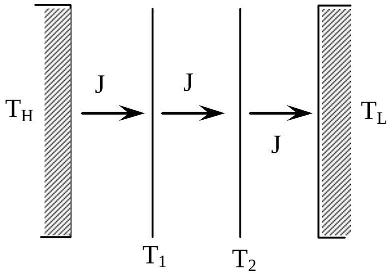
Now $J = \sigma\left(T_H^4 - T_1^4\right)A$

$J = \sigma\left(T_1^4 - T_2^4\right)A$

$J = \sigma\left(T_2^4 - T_L^4\right)A$

Now $3J = \sigma\left(T_H^4 - T_L^4\right) = J_o$

$\frac{J_o}{J} = 3$



4. **5**

Speed of ions

$V = \frac{E_1}{B_1} = 5000 \text{ m s}^{-1}$

$S_1S_2 = 2(r_2 - r_1) = 2\left[\frac{m_2 v}{qB} - \frac{m_1 v}{qB}\right]$

$= \frac{2 \times 5000}{B} \times (22 - 20)\frac{\text{amu}}{e}$

$= \frac{10^4}{8 \times 10^{-2}} \times 2 \times 10^{-8}$

$d = \frac{1}{4} \times 10^{-2}\text{m} = 2.5\text{mm}$

5. **4**

For plane surface.

$\frac{n_1}{-mR} + \frac{n_2}{v} = \frac{n_2 - n_1}{R_1}$

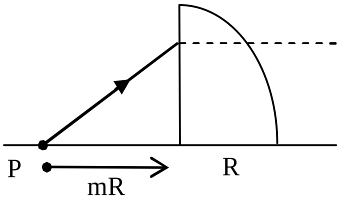
$n_1 = 1, n_2 = 1.5$ 1 $R_1 = \infty \Rightarrow v = -1.5mR$

For curve surface

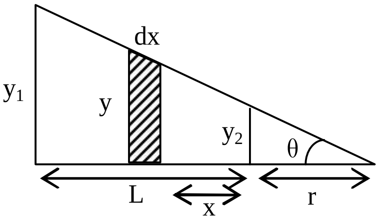
$\frac{n_1}{-(1.5mR + R)} + \frac{n_2}{\infty} = \frac{n_2 - n_1}{R}$

$n_2 = 1, n_1 = 1.5$

$\Rightarrow m = \frac{4}{3}, 3m = 4$



6. **8**



$$dR = \rho\frac{dx}{wy} \Rightarrow \frac{y}{x+r} = \frac{y_1}{L+r}$$

$$R = \int_0^L \rho\frac{dx}{wy} = \frac{\rho\left(L+r\right)}{wy_1}\ln\ \frac{L+r}{r}$$

$$\text{Now } r = \frac{y_2}{y_1-y_2}L \quad R = \frac{\rho L}{w\left(y_1-y_2\right)}\ln\frac{y_1}{y_2} = \frac{36\rho}{L}\ln 2$$

7. **1**

$$x_{cm} = \frac{A_1x_1 - A_2x_2}{A_1 - A_2}$$

$$A_1 = \frac{1}{2}\times 6\times 9 = 27cm^2$$

$$A_2 = \frac{1}{2}\times 6\times 3 = 9cm^2$$

$$X_1 = 0, X_2 = -2$$

$$X_{cm} = \frac{27\times 0 - 9\times -2}{27-9} = 1cm$$

8. **4**

$$F = v\frac{dm}{dt} = \lambda v^2$$

4N

9. **2**

$$V_{AB} = X$$

$$R_1 + \frac{R_2x}{R_2+x} = x$$

$$V_{AB} = 2V_{cd}$$

$$\therefore V_{AC} = V_{CD}$$

$$\therefore R_1 = \frac{R_2x}{R_2+x}$$

$$\text{Now } 2R_x = x$$

$$R_1 = \frac{R_1R_2}{R_2+2R_1} \Rightarrow \frac{R_2}{R_1} = 2$$

10. **2**

$$E_c = \frac{\delta}{4\varepsilon_o} = 2N/C$$

Chemistry PART – II

SECTION – A

1. **A, C, D**
ΔH is a state function so it is independent of path.

2. **B, D**
The yield of product will depend on stability of the carbocation. Carbocation corresponding to (y) is more stable than (z) as well as (x).

3. **B, C**
$KNO_3 \longrightarrow KNO_2 + O_2$
$NaNO_3 \longrightarrow NaNO_2 + O_2$
$Cu(NO_3)_2 \longrightarrow CuO + NO_2$
$Pb(NO_3)_2 \longrightarrow PbO + NO_2$

4. **A, C**
Fact.

5. **A, B, C, D**
(A) bond cleavage takes place as a result of reductive ozonolysis.
(B) epoxidation
(C) syn addition
(D) oxidative cleavages in basic medium

6. **A, D**
Fact.

7. **B, C**
Highly electropositive metal are extracted by electrolytic reduction.

8. **B, D**
Fact.

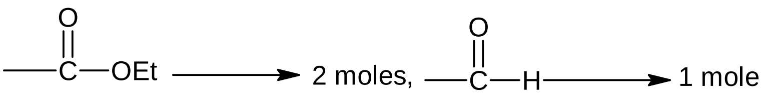
9. **A, C**
Rotation is restricted about $\pi - \text{bond}$.

10. **A, B, C, D**
Fact.

SECTION – C

1. **7**
I_3^+, XeF_4, C_2F_4
$SO_3, NOCl, ClF_3$
$F_2CO,$

2. **6**

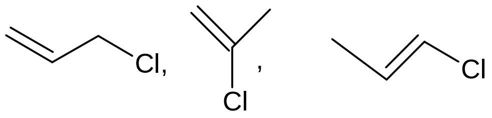


$$-\overset{\overset{\displaystyle O}{||}}{C}-OEt \longrightarrow 2\text{ moles}, \ -\overset{\overset{\displaystyle O}{||}}{C}-H \longrightarrow 1\text{ mole}$$

$-OH \longrightarrow 1$ mole, $-SH \longrightarrow 1$ mole,

Epoxide – 1 mole so total 6 moles.

3. **4**

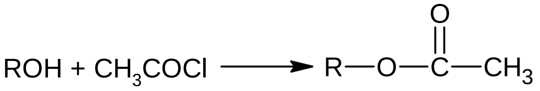


(E & Z)

4. **8**

$\left[Pt(gly)_2Cl_2\right]and\left[Co(en)_2Cl_2\right]$ have 6 & 2 optically active isomers respectively.

5. **3**



$$ROH + CH_3COCl \longrightarrow R-O-\overset{\overset{\displaystyle O}{||}}{C}-CH_3$$

In the above reaction molecule wt. of product is increased by 42 units.
So if n, - OH groups were present in the compound then increase in molecule wt. will be 42 n
increase in mass of compound $= 218 - 92 = 126$

$42n = 126 \Rightarrow n = 3$

6. **8**

$$\Delta H_R^0 = 2 \times \Delta H_f^0(NH_3) - 3 \times \Delta H_f^0(H_2) - \Delta H_f^0(H_2) = -20\text{Kcal}$$

$$\Delta S_R^0 = 2 \times \Delta S_f^0(NH_3) - 3 \times \Delta S_f^0(H_2) - \Delta S_f^0(N_2)$$

$$= 2 \times 45 - 3 \times 30 - 40 = -40\text{ cal} = -0.04\text{ Kcal}$$

$$\Delta G^0 = \Delta H^0 - T\Delta S^0 = -8\text{ K cal}$$

7. **2**

$$2NO + O_2 \longrightarrow 2NO_2$$

2	0.5	0
$2-1$	0	1

$n_i = 2.5,\ n_f = 2$

$\Delta n = 0.5$

$$\Delta P = \frac{\Delta nRT}{v} = \frac{0.5 \times 0.0821 \times 300}{6.25} = 2$$

8. **8**

$$\Delta E = \frac{3}{4} \times 0.85\text{eV}$$

$$0.85\left(1 - \frac{1}{4}\right) = 13.6\left(\frac{1}{4^2} - \frac{1}{n^2}\right)$$

$n = 8$

9. **3**

$S - e^{-} = 8$

$P - e = 18$

$Pe^{-} - Se^{-} = 10$

$de^{-} = 10$

$At.No = 36$

$6 - 3 = 3$

10. **3**

$$3A(g) \rightarrow 2B(g) + 2C(g)$$

t = 0	3P	0	0
t = 9	$3P - 3P_1$	$2P_1$	$2P_1$
t = ∞	0	2P	2P

Total pressure after long time = 4P = 400 $\Rightarrow$ P = 100

Pressure after 9 minutes = $3P + P_1 = 387.5 \Rightarrow P_1 = 87.5$

Pressure of A becomes one-eighth in 9 minutes. That means $3t_{1/2} = 9 \Rightarrow t_{1/2} = 3$

Mathematics

PART – III

SECTION – A

1. **A, B, C**

Replace x by 2, we get

$$2f(2)+2f\left(\frac{1}{2}\right)-2f(1)=4 \qquad ....(i)$$

$$\Rightarrow f(2)+f\left(\frac{1}{2}\right)=2+f(1)$$

Replace x by 1, $f(1)=-1 \qquad ....(ii)$

Replace x by $\frac{1}{2}, 2f\left(\frac{1}{2}\right)+\frac{1}{2}f(2)+2=\frac{5}{2} \qquad ......(iii)$

Solving (i) & (iii) $f\left(\frac{1}{2}\right)=0, f(2)=1$

2. **A, C**

$$\sin B=\frac{1}{\sqrt{2}},\ \tan\left(\frac{B}{2}\right)=\left(\sqrt{2}-1\right)$$

$$\&\sin C=\sin\left(135^{o}-A\right)=\frac{\sqrt{2}\left(\sin A+\cos A\right)}{2}$$

$$r=\frac{c+a-b}{2}\tan\left(\frac{\mathbf{B}}{2}\right)$$

$$=R\left(\sqrt{2}-1\right)\left(\sin A+\sin C-\sin B\right)$$

$$OI=R^{2}-2Rr$$

$$OI^{2}=R^{2}\left(1-2\sin A-2\sin C+2\sin B\left(\sqrt{2}-1\right)\right) \quad ....(ii)$$

$$\&\sqrt{2}OI=AB-AC$$

$$OI^{2}=\left(C-2\left(\sin A+\sin C-\sin B\right)\right)\left(\sqrt{2}-1\right)...........(iii)$$

From(i) & (ii), we obtain

$$2\left(\sin C-\sin B\right)^{2}=\left(1-2\left(\sin A+\sin C-\sin B\right)\left(\sqrt{2}-1\right)\right)$$

$$\Rightarrow 1-2\left(\sin C-\sin B\right)^{2}=\left(\sin A+\sin C-\sin B\right)\left(\sqrt{2}-1\right)$$

$$\Rightarrow 1-2\sin^{2}C+2\sqrt{2}\sin C-1=2\left(\sin A+\sin C\right)\left(\sqrt{2}-1\right)-\left(2-\sqrt{2}\right)$$

$$\Rightarrow -\left(\sin A+\cos A\right)+2\left(\sin A+\cos A\right)=\left(2\sqrt{2}-2\right)\sin A+\left(2-\sqrt{2}\right)\left(\sin A+\cos A\right)$$

$$<-\left(2-\sqrt{2}\right)$$

$$\Rightarrow -1-2\sin A\cos A=\left(\sqrt{2}-2\right)\sin A-\sqrt{2}\cos B-2\left(2-\sqrt{2}\right)$$

$$\Rightarrow \left(\sqrt{2}\sin A-1\right)\left(\sqrt{2}\cos A-\sqrt{2}+1\right)=0$$

$$\Rightarrow \sin A=\frac{1}{\sqrt{2}}\ \&\cos A=\frac{1-\sqrt{2}}{\sqrt{2}} \quad \Rightarrow \sin A=\frac{\sqrt{4\sqrt{2}-2}}{2}$$

3. **A, B, C**

$AC \parallel PR$ & $2AC = PR$

So, ABPC is a parallelogram comparing the coordinates of midpoints of diagonal, we get

$P(-a,b,c)\,Q(a,-b,c)\,\&\,R(a,b,-c)$.

Also AD & AP are medians of ΔABC and ΔPQR respectively.

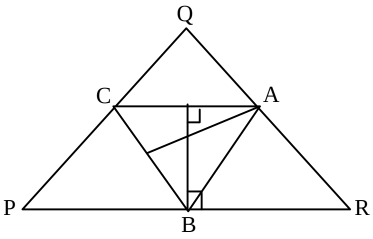
So, centroids are coinciding. The perpendicular bisector of PR is also perpendicular to AC.

$\therefore$ the circumcenter of ΔPQR is orthocentre of ΔABC

$\text{area}(\Delta PQR) = 4\text{area}(\Delta ABC)$

$= 4\sqrt{(OAB)^2 + (OBC)^2} + (OAC)^2$

Where OAB is the area of projection of ΔABC on the plane XOZ etc.



4. **A, B, C**

$(\bar{x}\times\bar{y})\times\bar{b} = \bar{a}\times\bar{b}$

$\Rightarrow (\bar{x}.\,\bar{b}).\bar{y} - (\bar{y}\,.\,\bar{b})\bar{x} = \bar{a}\times\bar{b}$

$\Rightarrow \gamma.\bar{y} - (\bar{y}\,.\,\bar{b}).\bar{x} = \bar{a}\times\bar{b} \qquad (\because \bar{x}.\bar{b} = \gamma)$

$\bar{y}.\bar{b} = \bar{y}.(\bar{y}\times\bar{z}) = 0$

$\Rightarrow \bar{y} = \dfrac{\bar{a}\times\bar{b}}{\gamma}$

$\Rightarrow (\bar{x}\times\bar{y})\times\bar{y} = \bar{a}\times\bar{y}$

$\Rightarrow (\bar{x}.\bar{y}).\bar{y} - (\bar{y}.\bar{y})\bar{x} = \bar{a}\times\bar{y}$

$\Rightarrow \bar{y} - |\bar{y}|^2\,\bar{x} = \bar{a}\times\bar{y} \qquad (\because \bar{x}.\bar{y} = 1)$

$\Rightarrow \bar{x} = \dfrac{1}{y^2}[\bar{y} - \bar{a}\times\bar{y}]$

$(\bar{y}\times\bar{z})\times\bar{y} = \bar{b}\times\bar{y}$

$\Rightarrow y^2\bar{z} - (\bar{z}.\,\bar{y}).\bar{y} = \bar{b}\times\bar{y} \quad \Rightarrow y^2\bar{z} - \bar{y} = \bar{b}\times\bar{y}$

$\Rightarrow \bar{z} = \dfrac{1}{y^2}[\bar{y} + \bar{b}\times\bar{y}]$

5. **A, B, C, D**

$$I = \int_0^1 {}^{207}C_7\, \underset{II}{x^{200}}\, \underset{I}{(1-x)^7\, dx}$$

$$= {}^{207}C_7\left[(1-x)^7, \frac{x^{201}}{201}\right]_0^1 + \frac{7}{207}\int_0^1 (1-x)^6 .x^{201}dx$$

$$= {}^{207}C_7\, \frac{7}{201}\int_0^1 (1-x)^6\, x^{201}dx$$

Similarly by applying integration by part 6 times we get

$$I = {}^{207}C_7 . \frac{7.6.5.4.3.2.1}{201.202.203......207}\int_0^1 x^{207}dx$$

$$= \frac{207!}{7!200!} . \frac{7!}{201!202.203} .... \frac{1}{207....208}$$

$$= \frac{1}{208} = \frac{1}{k}$$

6. **A, C**

$f(x) = kx$

$$1.\int_0^1 kxdx + 2\int_0^2 kxdx$$

$$+3\int_0^3 kxdx + 4\int_0^4 kxdx + 5.\int_0^5 kxdx$$

$$= \frac{k}{2}\left[1^3 + 2^3 + 3^3 + 4^3 + 5^3\right]$$

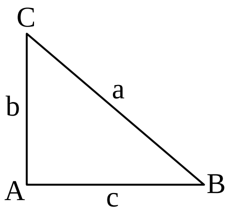
$$= \frac{k}{2}\left[\frac{5\times 6}{3}\right]^2$$

$$= \frac{225K}{2}$$

$$\text{given}\frac{225K}{2} = 450$$

$$\Rightarrow k = 4$$

7. **A, B, C**



$\bar{a}.\left(\bar{b} - \bar{a}\right) - \bar{c}\left(\bar{b} - \bar{a}\right) = 0$

$\overline{AC}.\ \overline{AB} = 0$

Also $a + c = 2b - (i)$ & $b^2 + c^2 = a^2$

$b^2 = (a - c)(a + c) = 2b(a - c)$

$\Rightarrow b = 2(a - c) - (ii)$

From(i) & (ii) we get

$$\frac{a}{5} = \frac{b}{4} = \frac{c}{3} = \lambda$$

$\because$ Inradius $= 1 \Rightarrow \frac{6\lambda^2}{6\lambda} = 1 \Rightarrow \lambda = 1$

$\therefore a = 5, b = 4, c = 3$

8. **A, B**

At the point of contact of two functions their value are equal and their derivatives are equal.

$$f(x)=g(x) \qquad \& \ f'(x)=g'(x)$$

$$ax^3+4x=\frac{1}{x} \qquad \& \ 3ax^2+4=-\frac{1}{x^2}$$

$$\Rightarrow x^2=\frac{1}{2}$$

$$\Rightarrow a=-4$$

$$\therefore P\left(\frac{1}{\sqrt{2}},\sqrt{2}\right) \& \quad Q\left(\frac{-1}{\sqrt{2}},-\sqrt{2}\right)$$

Area of triangle formed by any tangent to rectangular hyperbola $xy=c^2$ with coordinate axis equal to $2c^2$

$\therefore$ Area $=2$

9. **C, D**

$$\int_{-1}^{1}\cot^{-1}\left(\frac{1}{\sqrt{1-x^2}}\right)\cot^{-1}\frac{x}{\sqrt{1-\left(x^2\right)^{|x|}}}dx$$

$$=\int_{-1}^{1}\cot^{-1}\left(\frac{1}{\sqrt{1-x^2}}\right)\cot^{-1}\left(\frac{-x}{\sqrt{1-\left(x^2\right)^{|x|}}}\right)dx$$

$$2I=\int_{-1}^{1}\cot^{-1}\frac{1}{\sqrt{1-x^2}}\left(\cot^{-1}\frac{x}{\sqrt{1-\left(x^2\right)^{|x|}}}+\pi-\cot^{-1}\frac{x}{\sqrt{1-(x)^{2|x|}}}\right)dx$$

$$2I=\pi\int_{-1}^{1}\cot^{-1}\frac{1}{\sqrt{1-x^2}}dx$$

$$2I=\pi\int_{-1}^{1}\tan^{-1}\sqrt{1-x^2}\,dx$$

Integrating by parts

$$I=\frac{\pi}{2}\left[x\tan^{-1}\sqrt{1-x^2}\right]_0^1-\pi\int_0^1\frac{x}{1+1-x^2}\left(\frac{-x}{\sqrt{1-x^2}}\right)dx$$

$$I=\frac{\pi}{2}\int_0^1\frac{x^2dx}{\left(2-x^2\right)\sqrt{1-x^2}} \quad \text{put } x=\sin\theta,\ dx=\cos\theta\, d\theta$$

$$=\frac{\pi}{2}\int_0^{\pi/2}\frac{\sin^2\theta}{2-\sin^2\theta}d\theta$$

$$=\frac{\pi}{2}\int_0^{\pi/2}\frac{\sin^2\theta-2+2}{2-\sin^2\theta}d\theta$$

$$=\frac{-\pi}{2}\int_0^{\pi/2}d\theta+\pi\int_0^{\pi/2}\frac{d\theta}{2-\sin^2\theta}$$

$$=\frac{-\pi^2}{4}+\pi\int_0^{\pi/2}\frac{\sec^2\theta d\theta}{2\tan^2\theta+2-\tan^2\theta}$$

$$= \frac{-\pi^2}{4} + \pi\int_0^{\infty} \frac{dk}{k^2+2} \qquad (\tan\theta = k)$$

$$= \frac{-\pi^2}{4} + \pi.\frac{1}{\sqrt{2}}\left[\tan^{-1}\frac{k}{\sqrt{2}}\right]_0^{\infty}$$

$$= \frac{-\pi^2}{4} + \frac{\pi^2}{2\sqrt{2}}$$

$$= \pi^2\left(\frac{-1+\sqrt{2}}{4}\right)$$

10. **A, B, C**

$$A = \begin{bmatrix} 0 & \alpha \\ 0 & 0 \end{bmatrix}$$

$$A^2 = \begin{bmatrix} 0 & \alpha \\ 0 & 0 \end{bmatrix}\begin{bmatrix} 0 & \alpha \\ 0 & 0 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

$$\Rightarrow A^3 = 0$$

$$(A+I)^3 = A^3 + 3A^2 + 3A + I$$

$$(A+I)^{50} = 50A + I$$

$$(A+I)^{50} - 50A = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

SECTION – C

1. **2**

$$\frac{\tan\theta}{\cos 2\theta} = \frac{\tan\theta\left(1+\tan^2\theta\right)}{1-\tan^2\theta} = \tan 2\theta - \tan\theta$$

$$\therefore (\tan 2 - \tan 1) + (\tan 4 - \tan 2) + ... + \tan(2048 - \tan 1024)$$

$$= \tan 2048 - \tan 1$$

2. **7**

$\sin A = \sin 2B \Rightarrow \sin A = 2\sin B\cos B$

Also, sinC = sin3B = 3 sinB – 4 $\sin^3$B

$\therefore a = 2b\cos B, c = b\left(3 - 4\sin^2 B\right) = b\left(4\cos^2 B - 1\right)$

hence $a^2 = b(b+c)$

A triangle of smallest perimeter means $\gcd(a,b,c) = 1$.

In fact $\gcd(b,c) = 1$ since any common factor of b, c would be a factor of a as well.

$\because$ A perfect square a^2 is being expressed as the product of two relatively prime integers b and c, it must be the case that both b & b + c are perfect squares. Thus for some integer m & n with $\gcd(m,\ n) = 1$ we have

$b = m^2 \ \& \ b + c = n^2, a = mn$

$$2\cos B = \frac{n}{m} = \frac{a}{b}$$

$\because \angle C > 90^o \Rightarrow O < B < 30^o$

$$\& \sqrt{3} < 2\cos B = \frac{n}{m} < 2$$

The smallest value of (m, n) that satisfies the above mentioned conditions are 4 and 7.

3. **6**

$$\sum_{k=0}^{7}\left(\frac{{}^7C_k}{\underline{|14}}\underline{|k}\ \underline{|14-k}\sum_{r=K}^{14}\frac{\underline{|r}}{\underline{|k}\ \underline{|r-k}}\frac{\underline{|14}}{\underline{|r}\ \underline{|14-r}}\right)$$

$$= \sum_{k=0}^{7}\left({}^7C_k\sum_{r=k}^{14}{}^{14-K}C_{7-k}\right) = \sum_{k=0}^{7}{}^7C_k\,2^{14-k}$$

$$= 2^{14}\sum_{k=0}^{7}{}^7C_k\left(\frac{1}{2}\right)^k = 6^7 > 7^6$$

4. **4**

$$I = \int_0^1 \frac{\sin^{-1}\sqrt{x}}{x^2 - x + 1}dx \quad .....(i)$$

$$= \int_0^1 \frac{\sin^{-1}\sqrt{1-x}}{(1-x)^2 - (1-x) + 1}dx$$

$$= \int_0^1 \frac{\cos^{-1}\sqrt{x}}{x^2 - x + 1}dx \quad ....(ii)$$

$\text{Adding}(i) \ \& \ (ii)$

$$2I = \frac{\pi}{2}\int_0^1 \frac{1}{x^2 - x + 1}dx$$

$$2I = \frac{\pi}{2}.\frac{1}{\left(\frac{\sqrt{3}}{2}\right)}\left[\tan^{-1}\left(\frac{2x-1}{\sqrt{3}}\right)\right]_0^1$$

$$2I = \frac{\pi^2}{3\sqrt{3}}$$

$$I = \frac{\pi^2}{\sqrt{108}}$$

$n = 108$

5. **2**

$z = \cos\theta(\cos\theta + i\sin\theta)$

$$\sum_{k=1}^{n} z^k = \frac{z - z^{n+1}}{1 - z}$$

$$\sum_{k=1}^{n}\cos^k\theta(\cos k\theta + i\sin k\theta)$$

$$= \frac{\cos\theta(\cos\theta + i\sin\theta) - \cos^{n+1}\theta(\cos(n+1)\theta + i\sin(n+1)\theta)}{\sin^2\theta - i\cos\theta\sin\theta}$$

$$= \frac{i\cos\theta(\cos\theta + i\sin\theta) - \cos^{n+1}\theta(\cos(n+1)\theta + i\sin(n+1)\theta)}{\sin\theta(\cos\theta + i\sin\theta)}$$

$$= i\left(\cot\theta - \frac{\cos^{n+1}\theta(\cos n\theta + i\sin n\theta)}{\sin\theta}\right)$$

$$= \frac{\sin n\theta\cos^{n+1}\theta}{\sin\theta} + i\left(\cot\theta - \frac{\cos^{n+1}\theta\cos n\theta}{\sin\theta}\right)$$

$$\sum_{k=1}^{n}(\cos\theta)^k\cos k\theta = \frac{\sin n\theta\cos^{n+1}\theta}{\sin\theta}$$

For $\theta = 30^o$

$$= 2\sin\frac{n\pi}{6}\left(\frac{\sqrt{3}}{2}\right)^{n+1}$$

6. **2**

In one stage the tourist traverses the complex number

$$x = 100 + 100\bar{z} + 100\bar{z}^2 = 100 - 100\sqrt{3}i$$

$$\text{where } z = \cos\frac{\pi}{3} + i\sin\frac{\pi}{3}$$

In 2017 stages, the tourist traverses the complex number

$$W = x + xz + xz^2 + ... + xz^{2016}$$

$$= x\left(\frac{1-z^{2017}}{1-z}\right) =$$

$$= xz$$

$$|W| = |xz| = 200$$

7. **2**

$$a_{ij} = 0 \forall i \neq j$$

$$a_{ij} = (n-1)^2 + i \forall i = j$$

$\therefore$ sum of all the elements of A_n

$$= \sum_{i=1}^{2n-1}\left[(n-1)^2 + i\right]$$

$$= (2n-1)(n-1)^2 + (2n-1)n$$

$$= 2n^3 - 3n^2 + 3n + 1$$

$$= n^3 + (n-1)^3$$

$$T_n = (-1)^n\left[n^3 + (n-1)^3\right]$$

$$= (-1)^n n^3 - (-1)^{n-1}(n-1)^3$$

$$= V_n - V_{n-1}$$

$$\Rightarrow \sum_{n=1}^{102} T_n = \sum_{n=1}^{102}(V_n - V_{n-1}) = V_{102} - V_0 = (102)^3$$

$$\Rightarrow \left[\frac{\sum_{n=1}^{-102} T_n}{520200}\right] = 2$$

8. **8**

$$f'(x) = \lim_{x\to\infty} \frac{f(x+h) - f(x+0)}{h}$$

$$= \lim_{x\to\infty} \frac{2f(x) + xf(h) + h\sqrt{f(x)} - 2f(x) - xf(0) + 0\sqrt{f(x)}}{h}$$

As f (0) = 0

$$\Rightarrow \lim_{h\to 0} x\left(\frac{f(h) - f(0)}{h - 0}\right) + \sqrt{f(x)}$$

$$f'(x) = \sqrt{f(x)}$$

$$\int \frac{f'(x)}{\sqrt{f(x)}}dx = \int dx \quad \Rightarrow 2\sqrt{f(x)} = x + C$$

$$f(x) = \frac{x^2}{4}$$

when $\alpha = 0$, area is minimum

Required min area = $2\int_0^9 2\sqrt{y}dy$

$= 72$ sq. unit

9. **4**

$$f'\left(\frac{5}{2} - x\right) = f'\left(\frac{5}{2} + x\right)$$

Replacing x by $\frac{5}{2} - x$

$$f'(x) = f'(5 - x) \Rightarrow F(x) = -F(5 - x) + C$$

$$\Rightarrow C = f(x) + f(5 - x)$$

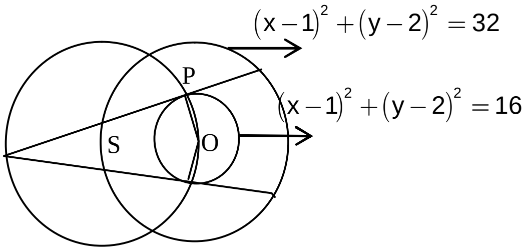
$$\Rightarrow C = 8$$

$$I = \int_2^3 f(x)dx = \int_2^3 f(5 - x)dx$$

$$\Rightarrow 2I = \int_2^3 f(x) + f(5 - x)dx$$

$$= \int_2^3 8dx \quad \Rightarrow I = 4$$

10. **2**



$$TS = OT - SO = 12 - 4\sqrt{2}$$

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

ALL INDIA TEST SERIES

FIITJEE **JEE (Main), 2017**

FULL TEST – IV

Time Allotted: 3 Hours **Maximum Marks: 432**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 03 and 10 to 12)** contains 6 multiple choice questions which have only one correct answer. Each question carries **+8 marks** for correct answer and **– 2 mark** for wrong answer.

Section-A (04 to 09 and 13 to 30) contains 24 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct.

1. The curvilinear motion of a particle is defined by $v_x = 50 - 16t$ and $y = 100 - 4t^2$, where v_x is in meters per second, y is in meters, and t is in seconds. It is also known that x=0 when t = 0. Determine its velocity and acceleration when the position y = 0 is reached.

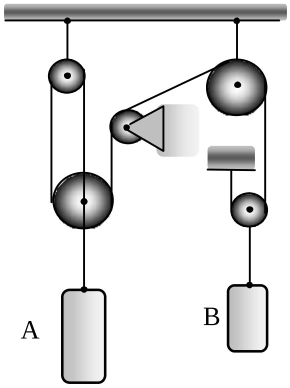
(A) $-30\hat{i} - 40\hat{j}$, $-16\hat{i} - 16\hat{j}$
(B) $-40\hat{i} - 30\hat{j}$, $-8\hat{i} - 16\hat{j}$
(C) $-30\hat{i} - 40\hat{j}$, $-16\hat{i} - 8\hat{j}$
(D) $-40\hat{i} - 30\hat{j}$, $-16\hat{i} - 8\hat{j}$

2. A projectile is ejected into an experimental fluid at time t = 0. The initial speed is v_0 and the angle to the horizontal is θ. The drag on the projectile results in an acceleration term a_D = -kv, where k is a constant and v is the velocity of the projectile. What is the terminal velocity? Include the effects of gravitational acceleration.

(A) $v_0 \cos\theta$
(B) $-\frac{g}{k}$
(C) $-\frac{v_0}{k}$
(D) Zero

3. At a certain instant, cylinder A has a downward velocity of 0.8 m/s and an upward acceleration of 2 m/s^2. Determine the corresponding velocity and acceleration of cylinder B.

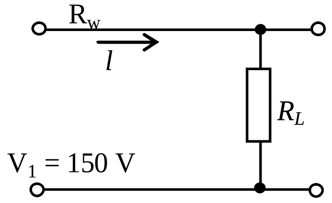
(A) v_B = 1.2 m/s down, a_B = 3 m/s^2 up
(B) v_B = 1.2 m/s up, a_B = 3 m/s^2 down
(C) v_B = 2.4 m/s up, a_B = 6 m/s^2 down
(D) v_B = 0.6 m/s down, a_B = 1.5 m/s^2 up



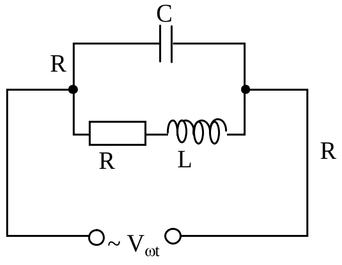
Space for rough work

4. The mean value of the kinetic energy and the root-mean-square velocity of helium molecules under normal conditions is close to
(Given: the pressure and temperature of helium under normal conditions are
$p_0 = 1.013 \times 10^5$ Pa and $T_0 = 273$ K respectively. From tables, we find the molar mass of helium,
$M = 4 \times 10^{-3}$ kg/mol, the Boltzmann constant $k = 1.38 \times 10^{-23}$ J/K, the Avogadro constant
$N_A = 6.02 \times 10^{23}$ mol^{-1}, and the density of helium under normal conditions, $\rho_0 = 0.18$ kg/m^3.)
(A) 5.65×10^{-21} J, 1300 m/s
(B) 9.34×10^{-21} J,1950 m/s
(C) 5.65×10^{-21} J, 1950 m/s
(D) 9.34×10^{-21} J, 1300 m/s

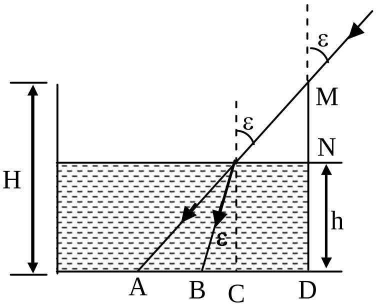
5. A telegram is sent from Delhi to Allahabad (The distance between the cities of 650 km) via a steel telegraph line carrying a current of 1.7 mA at a voltage of 150 V. The cross-sectional area of the wire is 5.0 mm^2. The voltage drop across the load resistances is (resistivity of steel is 1.2×10^{-7} Ω m)
(A) 53 V
(B) 97 V
(C) 150 V
(D) 0 V



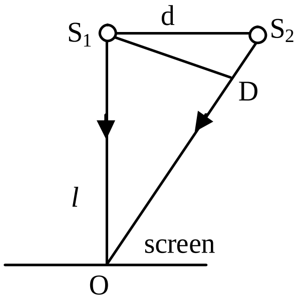
6. Impedance of given circuit is (Given: R = 1 Ω, C = $\frac{5\sqrt{2}}{2\pi} \times 10^{-2}$ Farad, L = $\frac{1}{40\pi}$ Henry, frequency of A.C. source = 100 Hz)
(A) 1 Ω
(B) 2 Ω
(C) $\sqrt{2}$ Ω
(D) $2\sqrt{2}$ Ω



7. The sun forms an angle of 60° with the horizon. Determine the length of the umbra at the bottom of an opaque vessel illuminated by sun light. The height of the vessel is 25 cm. What will the change in the length of the umbra be when water is poured into the vessel to a height of 20 cm shown in figure.
Given: H = 25 cm is the height of the vessel, $\varphi = 60^\circ$ is the altitude of the Sun above the horizon, h = 20 cm is the height of the water column. From tables, we take the refractive index for water, n = 1.33. The change Δl of the length of the umbra in the vessel with water is
(A) 11 cm
(B) 3.4 cm
(C) 14.4 cm
(D) 25.4 cm



Space for rough work



8. Two coherent light sources emit light of wavelength 550 nm which produces an interference pattern on a screen (figure).
The sources are 2.2 mm apart and 2.2 m from the screen.
(A) Path difference at point O on screen is 2.2 μm
(B) There is a bright fringe at O
(C) Path difference at point O on screen is 1.1 mm
(D) There is a dark fringe at O

9. A 1 kg object oscillates at the end of a vertical spring that has a spring constant of 100 N/m. The effect of air resistance is represented by the damping coefficient 10 N-s/m. The angular frequency of the damped oscillation is
(A) 10 s^{-1}
(B) 5 s^{-1}
(C) $5\sqrt{3}$ s^{-1}
(D) $5\sqrt{2}$ s^{-1}

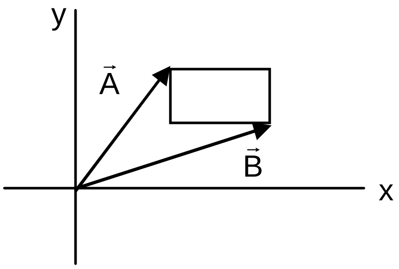
10. A steel wire of length 30.0 m and a copper wire of length 20.0 m, both with 1.00 mm diameters, are connected end to end and stretched to a tension of 150 N. During what time interval will a transverse wave travel the entire length of the two wires?
(A) 0.137 sec
(B) 0.192 sec
(C) 0.285 sec
(D) 0.329 sec

11. Light of wavelength 587.5 nm illuminates a slit of width 0.75 mm. At what distance from the slit should a screen be placed if the first minimum in the diffraction pattern is to be 0.85 mm from the central maximum?
(A) 2 m
(B) 10 m
(C) 1.1 m
(D) 2.2 m

12. What is the energy of a photon that, when absorbed by a hydrogen atom, could cause an electronic transition from the n = 2 state to the n = 5 state?
(A) 2.86 eV
(B) 0.472 eV
(C) 1.92 eV
(D) 10.2 eV

Space for rough work

13. The rectangle shown in figure has sides parallel to the x and y axes. The position vectors of two corners are $\vec{A} = 10.0$ m at 53^o and $\vec{B} = 12.0$ m at 30.0^o. Find the perimeter of the rectangle.



(A) 6.2 m (B) 24.8 m
(C) 12.4 m (D) 18.6 m

14. A solid piece of lead has a mass of 23.94 g and a volume of 2.10 cm^3. From these data, calculate the density of lead in SI units (kilograms per cubic meter).
(A) 1.14×10^4 kg/m^3 (B) 2.28×10^4 kg/m^3
(C) 2.14×10^3 kg/m^3 (D) 1.28×10^3 kg/m^3

15. A fixed mass of gas is trapped in a syringe. The volume of the syringe is slowly reduced, compressing the gas without changing the temperature. The pressure exerted on walls of syringe charges because
(A) The particles have more kinetic energy
(B) The particles collide with each other more often
(C) The particles hit the walls of the syringe with more force
(D) The particles hit the walls of the syringe more often

16. Light and sound can both be thought of as a wave. Which of the following statements is not true?
(A) They can both transfer energy (B) They can both be polarised
(C) They can both be refracted (D) They can both be diffracted

17. An aircraft of mass 4000 kg produces a thrust of 10 Kn. The aircraft needs to travel at 35 m/s to take off from a standing start, the time to become airborne is approximately.
(A) 2.5 s (B) 3.5 s
(C) 9 s (D) 14 s

Space for rough work

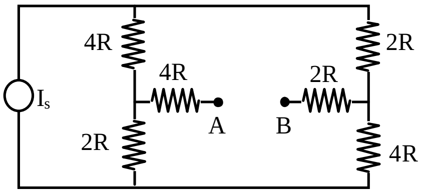
18. The initial activity of a radioactive isotope is 120 Bq and the half-life is 20 minutes. For a sample of the same isotope with twice the mass, the values would be:

	Initial Activity/Bq	Half life/minutes
(A)	120	20
(B)	240	20
(C)	60	20
(D)	120	40

19. The average wavelength of light emitted from an incandescent torch bulb with a metal filament is 120 nm. Calculate the number of photons emitted by a 20 W torch bulb in one hour.

(A) 2.1×10^{19}
(B) 2.1×10^{20}
(C) 12×10^{20}
(D) 1.2×10^{19}

20. Consider the circuit shown below. I_s is a constant current source, meaning that no matter what device is connected between points A and B, the current provided by the constant current source is the same.
Connect an ideal voltmeter between A and B. Determine the voltage reading in terms of any or all of R and I_s.

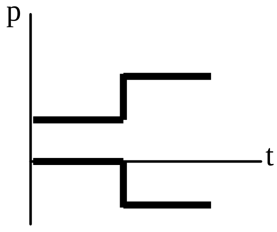


(A) 2iR
(B) 0
(C) iR
(D) $\frac{iR}{2}$

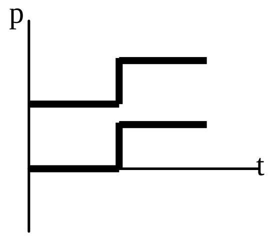
Space for rough work

21. A particle moves along the x-axis. It collides elastically head-on with an identical particle initially at rest. Which of the following graphs could illustrate the momentum of each particle as a function of time?

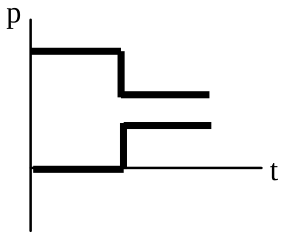
(A)



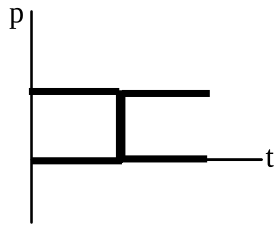
(B)



(C)



(D)



22. The voltage – current graph for a filament light bulb is shown below.

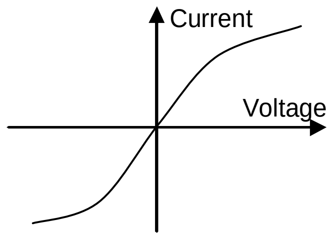
The graph has this shape because:

(A) Resistance of the filament increases as the current increases

(B) Resistance of the filament decreases as the current increase

(C) The filament has a higher resistance than the connecting wires

(D) The filament has a lower resistance than the connecting wires



23. A steel ball bearing is dropped onto a concrete floor and rebounds to 80% of its initial height. The percentage of the kinetic energy lost in the collision is

(A) 80%
(B) 64%
(C) 36%
(D) 20%

Space for rough work

24. An air molecule of mass 5.0×10^{-26} kg and moving with a speed of 500 ms^{-1} has kinetic energy of about $(e = 1.6 \times 10^{-19} C)$

(A) 1 eV
(B) 0.4 eV
(C) 40 meV
(D) 4 meV

25. The Moon takes 2 minutes to sink below the horizon at the equator when observed at night (about the same time as the Sun takes to set). If the radius of the Earth is 6400 km and the radius of the Moon is 1700 km, what is the angular size of the Earth when observed from the Moon?

(A) 3.8^0
(B) 3.5^0
(C) 1.9^0
(D) 0.3^0

26. A bubble is made from a soap film of uniform thickness enclosing a spherical volume of air. If the diameter of the bubble is trebled, the thickness of the soap film, t, will become

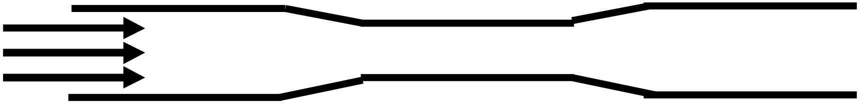
(A) t/27
(B) t/9
(C) t/4
(D) t/3

27. The radius of the Sun is 6.9×10^5 km and that of the Earth is 6400 km. Approximately how many rigid earth spheres could be fitted into the interior of the sun?

(A) 100
(B) 1200
(C) 10000
(D) 10^6

Space for rough work

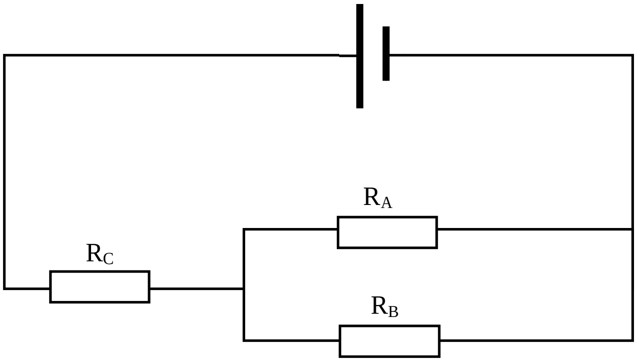
28. An incompressible liquid flows through a pipe which has a section with a narrower bore. What is the speed of the liquid and the volume rate of flow in the narrow section compared to the wider section of the pipe?



	Speed of flow/ms^{-1}	Volume rate of flow /m^3s^{-1}
(A)	Slower	Same
(B)	Faster	Less
(C)	Faster	Same
(D)	Slower	More

29. In the circuit shown below, the power converted in R_A is 1 W. The value of R_A is R, that of R_B is 2R and R_C. How much power is supplied by the cell?

(A) 3W
(B) 4W
(C) 6 W
(D) 8 W



30. The neutral point between the Earth and the Moon is the point where the gravitational pull of the Moon is equal to the gravitational pull of the Earth. If the energy a 1000 kg spacecraft needs in order to reach the neutral point from the Earth is 6.0×10^{10} J and to reach the neutral point from the Moon is 0.25×10^{10}J, what is the minimum energy needed to send a 1 kg rock from the Moon to the Earth?

(A) 0.25×10^7 J
(B) 5.75×10^7 J
(C) 6.0×10^7 J
(D) 6.25×10^7 J

Space for rough work

Chemistry

PART – II

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct.

1. A mixture contains NaCl and unknown chloride MCl. (a) 1g of this is dissolved in water, excess of acidified $AgNO_3$ solution is added to it, so that 2.567 g of white ppt. is obtained (b) 1 g of original mixture is heated to 300^oC. Some vapours come out which are absorbed in $AgNO_3$ (acidified) solution. 1.341 g of white precipitate is obtained. Find molecular weight of unknown chloride.

(A) 53.50	(B) 45.5
(C) 58.5	(D) none of these

2. At 20^oC, two balloons of equal volume and porosity are filled to a pressure of 2 atm, one with 14 kg N_2 and other with 1 kg of H_2. The N_2 balloon leaks to a pressure of ½ atm in 1 hr. How long will take for H_2 balloon to reach a pressure of ½ atm?

(A) 4 min	(B) 12 min
(C) 16 min	(D) 20 min

3. When photons of energy 4.25 eV strike the surface of a metal A, the ejected photoelectrons have maximum kinetic energy, T_A (expressed in eV) and de Broglie wavelength λ_A. The maximum kinetic energy of photoelectrons liberated from another metal B by photons of energy 4.70 eV is $T_B = T_A - 1.50$ eV. If the de Broglie wavelength of these photoelectrons is $\lambda_B = 2\lambda_A$, then which is not correct

(A) The work function of A is 2.25 eV	(B) the work function of B is 1.20 eV
(C) $T_A = 2.00$ eV	(D) $T_B = 0.5$ eV

Space for rough work

4. A radioactive isotope decays as ${}_{z}^{m}A \xrightarrow{} {}_{z-2}^{m-4}B \xrightarrow{} {}_{z-1}^{m-4}C$. The half-lives of A and B are 10 month and 6 month respectively. Assuming that initially only A was present, will it be possible to achieve radioactive equilibrium for B. If so what would be the ratio of A and B at equilibrium? What would happen if the half-lives A and B were 6 month and 10 month respectively?
(A) 1.66, no equilibrium
(B) 1.77, $t_{\frac{1}{2}A} > t_{\frac{1}{2}B}$
(C) 2.77, $\lambda_B > \lambda_A$
(D) 2.88 $\lambda_B = \lambda_A$

5. An electric current is passed through two electrolytic cells connected in series, one containing $AgNO_3$ (aq) and other H_2SO_4 (aq). What volume of O_2 measured at 25^{o}C and 750 mm Hg would be liberated from H_2SO_4, if
(a) 1 mole of Ag^+ are deposited from $AgNO_3$ solution
(b) 8×10^{22} ions of Ag^+ are deposited from $AgNO_3$ solution
(A) 6.2, 0.823
(B) 3.27, 0.78
(C) 3.1, 5.26
(D) 1.12, 3.17

6. 1 g of Mg atoms in the vapour phase absorbs 50.0 kJ of energy. Find the composition of Mg^+ and Mg^{2+} formed as a result of absorption of energy. IE_1 and IE_2 for Mg are 740 and 1450 kJ mol^{-1} respectively.
(A) 68.28%, & 31.72%
(B) 31.72% & 68.28%
(C) 70% & 30%
(D) 20% & 80%

7. The following compounds have been arranged in order of their increasing thermal stabilities. Identify the correct order:
K_2CO_3 (I) $MgCO_3$(II) $CaCO_3$(III) $BeCO_3$(IV)
(A) I < II < III < IV
(B) IV < II < III < I
(C) IV < II < I < III
(D) II < IV < III < I

Space for rough work

8. The freezing point of a solution containing 0.2 g of acetic acid in 20.0 g benzene is lowered by 0.45^{o}C. Calculate the degree of association of acetic acid in benzene. Assume acetic acid dimerizes in benzene. K_f for benzene 5.12 K mol^{-1} kg.

(A) 46.6% (B) 94.6%
(C) 86.6% (D) 37.6%

9. For the system $A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$, $\Delta H = -80$ KJ/mole

If the activation energy for the forward step is 100 kcal/mole. What is the ratio of temperature at which the forward and backward reaction shows the same % change of rate constant per degree rise of temperature ? (1 cal = 4.2 J)

(A) $\sqrt{0.72}$ (B) $\sqrt{0.84}$
(C) $\sqrt{0.42}$ (D) $\sqrt{1}$

10. At 273 K and one atm, 'a' litre of N_2O_4 decomposes to NO_2 as : $N_2O_4(g) \rightleftharpoons 2NO_2(g)$. To what extent has the decomposition proceeded when the original volume is 25% less than that of existing volume?

(A) 25% (B) 30%
(C) 60% (D) 33%

11. N_2O_4 dissociates as : $N_2O_4 \rightleftharpoons 2NO_2$. At 55^{o}C and one atmosphere, N_2O_4 was decomposed to 50.3%. At what P and temperature, the equilibrium mixture has the ratio of N_2O_4: NO_2 as 1 : 8?

(A) 2.18 (B) 0.19
(C) 3.7 (D) 1.18

12. An equilibrium mixture at 300 K contains N_2O_4 and NO_2 at 0.28 and 1.1 atmosphere respectively. If the volume of container is doubled, calculate the new equilibrium pressure of two gases.

(A) 4.32 (B) 4.68
(C) 2.4 (D) 1.98

Space for rough work

13. Calculate the amount of NH_3 and NH_4Cl required to prepare a buffer solution of pH 9.0 when total concentration of buffering reagents is 0.6 mol L^{-1}.

$pK_b\ \ for\ NH_3 = 4.7,\ \log 2 = 0.30$

(A) 0.2 M & 0.4 M
(B) 0.4 M & 0.4 M
(C) 0.2 & 0.2 M
(D) 2 M & 4 M

14. For a reaction,

$$M_2O(s) \longrightarrow 2M(s) + \frac{1}{2}O_2(g)$$

ΔH=30 kJ mol^{-1} and ΔS=0.07 kJ K^{-1} mol^{-1} at 1 atm. Calculate upto which temperature, the reaction would not be spontaneous.

(A) 528 K
(B) 428 K
(C) 480 K
(D) 820 K

15. Dipole moment will be zero in complexes

$I : \left[Ni(CN)_4\right]^{2-} \qquad II : cis - Pt\left[(NH_3)_2 Cl_2\right] \qquad III : trans - \left[Pt(NH_3)_2 Cl_2\right]$

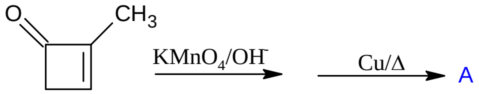
(A) I and II
(B) I and III
(C) II and III
(D) I, II and III

16. Primary alkyl halide C_4H_9Br (A) reacted with alcoholic KOH to give compound (B). Compound (B) is reacted with HBr to give (C) which is an isomer of (A). When (A) is reacted with sodium metal it gives compound (D), C_8H_{18} which is different from the compound formed when n-butyl bromide is reacted with sodium. Give the structural formula of (A).

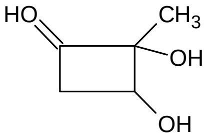
(A) n-butyl bromide
(B) isobutyl bromide
(C) 1-bromo 2-methyl propane
(D) butane

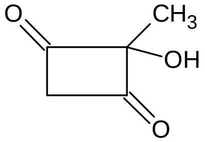
Space for rough work

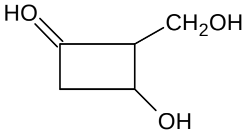
17. Consider the following reaction,

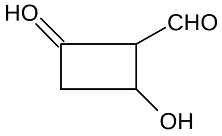

O
CH3
KMnO4/OH-
Cu/Δ
A

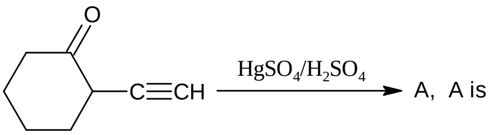
A formed is

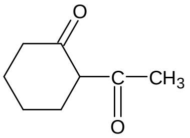
(A) 

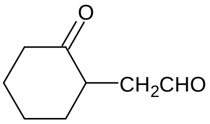
(B) 

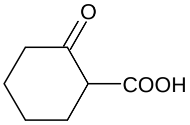
(C) 

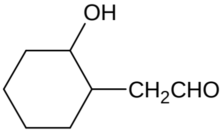
(D) 

18.  A, A is
O
C≡CH
HgSO4/H2SO4

(A) 

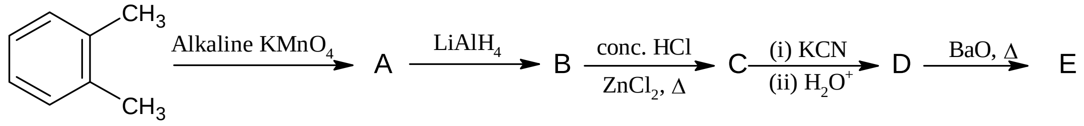
(B) 

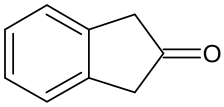
(C) 

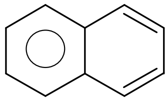
(D) 

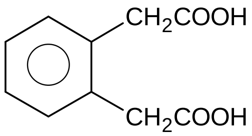
Space for rough work

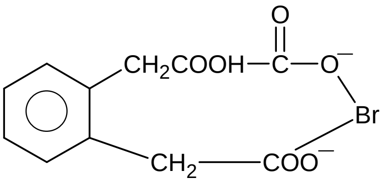
19. Identify E in the following:


CH3
CH3
Alkaline KMnO4
A
LiAlH4
B
conc. HCl
ZnCl2, Δ
C
(i) KCN
(ii) H2O+
D
BaO, Δ
E

(A) 

(B) 

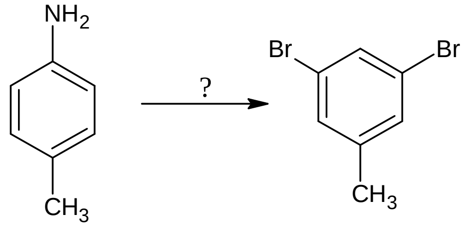
(C) 
CH2COOH
CH2COOH

(D) 
O
CH2COOH—C—O–
Br
CH2
COO–

20. Amongst the following, total number of essential amino acids are:
valine, glycine, phenylalanine, lysine, leucine, isoleucine, methionine, alanine, threonine.

(A) 3
(B) 7
(C) 5
(D) 9

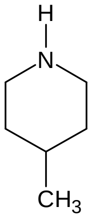
21. Which sequence of reactions will accompanish this transformation?

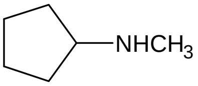

NH2
CH3
?
Br
Br
CH3

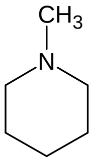
(A) NaNO$_2$/HCl/0^{o}C, H$_3$PO$_2$ and Br$_2$
(B) Br$_2$, LiAlH$_4$ and H$_3$O$^+$
(C) NaNO$_2$/HCl/0^{o}C, CuBr
(D) Br$_2$, NaNO$_2$/HCl/0^{o}C, H$_3$PO$_2$

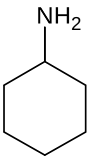
Space for rough work

22. The amines shown are isomers. Choose the one with the lowest boiling point.

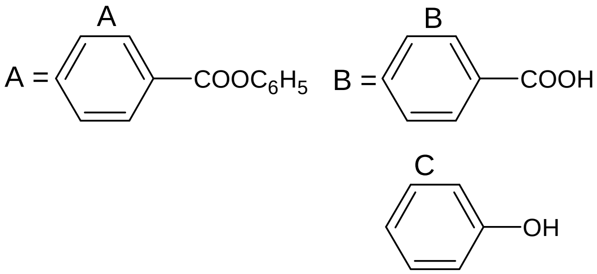
(A) 

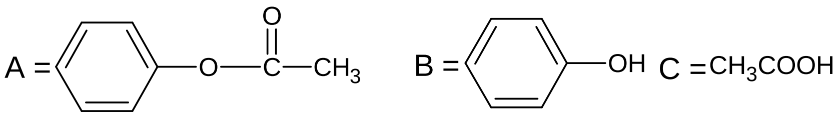
(B) 

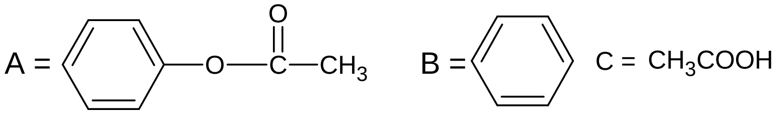
(C) 

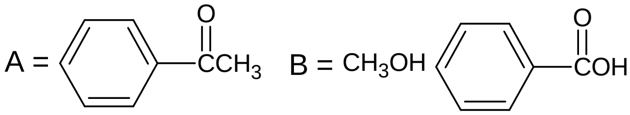
(D) 

23. An ester (A) on acidic hydrolysis gives (B) and (C). (B) gives violet colour and (C) gives blood red colour with neutral $FeCl_3$ solution. (A), (B) and (C) are

(A) 
A
A =
COOC6H5
B
B =
COOH
C
OH

(B) 
A =
O
O—C—CH3
B =
OH
C = CH3COOH

(C) 
A =
O
O—C—CH3
B =
C = CH3COOH

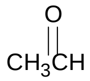
(D) 
A =
O
CCH3
B = CH3OH
O
COH

24. An organic compound with the molecular formula $C_9H_{10}O$ forms 2, 4-DNP derivative, reduces Tollen's reagent and undergoes Cannizzaro reaction. On vigorous oxidation, it give 1, 2-benzenedicarboxylic acid. Identify the compound.
(A) 2 ethyl benzaldehyde
(B) 3-ethyl benzoic acid
(C) 2 methyl benzaldehyde
(D) 3-ethyl benzaldehyde

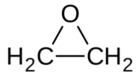
25. From the following compounds, how many compounds are soluble in water?
$C_6H_5OH\left(NO_2\right),\ C_6H_5COC_6H_5,\ C_6H_5Cl,\ C_6H_5CHO,\ C_6H_5OH.$
(A) 2
(B) 3
(C) 1
(D) 4

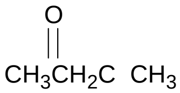
26. An organic compound (X) has molecular formula $C_7H_6O_2$ and it does not effervesces with $NaHCO_3$. A on treatment with excess of HBr (aq) gives $Y(C_6H_6O_2)$ and CH_2Br_2. Y forms a violet coloured solution with $FeCl_3$. If X is treated with Br_2/Fe, How many different monobromination product would result?
(A) 4
(B) 3
(C) 2
(D) 4

27. An organic compound B is formed by the reaction of ethyl magnesium iodide (CH_3CH_2MgI) with a substance A, followed by treatment with dilute aqueous acid. Compound B does not react with PCC or PDC in dichloromethane. Which of the following is a possible candidate for A?

(A)

CH_3CHO

(B) $H_2C{=}O$

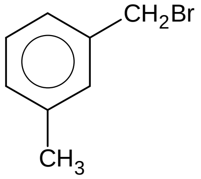
(C)


(D)

$CH_3CH_2COCH_3$

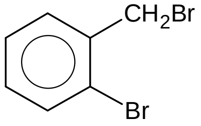
Space for rough work

28. Compound (A), C_8H_9Br gives a white precipitate when warmed with alcoholic $AgNO_3$. Oxidation of (A) gives and acid (B), $C_8H_6O_4$. (B) easily forms anhydride on heating. Identify the compound (A).

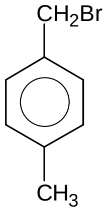
(A)



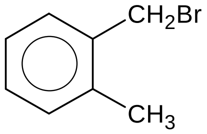
(B)



(C)



(D)



29. In XeF_4, no. of lone pair e^- are

(A) 2
(B) 3
(C) 5
(D) 4

30. 1 mole each of H_3PO_2, H_3PO_3 and H_3PO_4 will neutralise x moles of NaOH, y moles of $Ca(OH)_2$ and z moles $Al(OH)_3$ (assuming all as strong electrolytes). x, y, z are in the ratio of

(A) 3 : 15 : 1
(B) 1 : 2 : 3
(C) 3 : 2 : 1
(D) 1 : 1 : 1

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions** numbered 1 to 30. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct.

1. The total number of local maxima and local minima of $f(x) = x\,|x^2 - x| + |x - 2|$ is

(A) 2 (B) 3
(C) 4 (D) 0

2. If $f(x) = x^2 + \frac{1}{x}\int_1^x f(t)\,dt$ then total number of points where $|f(x)|$ is not differentiable.

(A) 0 (B) 1
(C) 2 (D) 3

3. If f(x) is a differentiable function for all $x \geq 1$, f(1) = 1 and $f'(x) > 2f(x)$, the total number of solution of the equation f(x) = e^{2x-2} in $x \in (1, \infty)$ is,

(A) 1 (B) 2
(C) 0 (D) 4

4. If $A = \begin{bmatrix} \cos\theta & \sin\theta \\ \text{-}\sin\theta & \cos\theta \end{bmatrix}$ and $A(adj(A)) = k\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ the K is

(A) 1 (B) 3
(C) 5 (D) 4

5. Number of real roots of the equation $f(x) = x^2e^x - 2e^x + 3$ in (-4, 0) is

(A) 0 (B) 1
(C) 2 (D) 3

Space for rough work

6. The number of solution of the equation $e^x = 3x^2$ is
(A) 0 (B) 1
(C) 2 (D) 3

7. Let tangent drawn form the point (3, 2) to the circle $x^2 + y^2 - 2x - 2y = 0$ meet at the points A and B. The ortho centre of triangle OAB is where 'O' is origin.
(A) $\left(\frac{67}{25}, \frac{56}{25}\right)$ (B) $\left(\frac{67}{25}, \frac{-1}{25}\right)$
(C) $\left(\frac{57}{25}, \frac{-4}{25}\right)$ (D) $\left(\frac{57}{25}, \frac{4}{25}\right)$

8. The value of $\frac{\int_0^1 \left(1-x^n\right)^m}{\int_0^1 \left(1-x^n\right)^{m+1}}$ is (where m,n $\in I^t$)
(A) $\frac{m+1}{mn+1}$ (B) $\frac{mn+n+1}{mn+n}$
(C) $\frac{mn+n-1}{mn+n}$ (D) $\frac{n+1}{mn+n}$

9. The point on the curve which is nearest to line y = 2x – 1
(A) (1, 2) (B) (1,3)
(C) (-1, 3) (D) (-1, 2)

10. The number of complex numbers which satisfy the equation $z^2 = iz + |z| - 2$
(A) 4 (B) 2
(C) 3 (D) 1

Space for rough work

11. The general solution of the differential equation ydx – xdy + $3x^2y^2$ e^{x^3} dx = 0, is

(A) $\frac{x}{y}-e^{x^3}$ = C (B) $\frac{x}{y}+e^{x^3}=C$

(C) $\frac{y}{x}-e^{x^3}=C$ (D) $\frac{y}{x}+e^{x^3}=C$

12. If $f\left(a\right)=0, f\left(b\right)=3, f\left(c\right)=-1, f\left(d\right)=2, f\left(e\right)=0$ and

h(x) = $x\left(f'\left(x\right)\right)^2+\left(x^2-1\right)f'\left(x\right)f''\left(x\right)$ then min number of zeros of h(x) is,

(A) 8 (B) 5
(C) 6 (D) 10

13. f(x) is polynomial of 8th degree satisfies f(x) = f(1- x) $\forall n\in R$ if f(x) = 0 has 6 distinct roots and two equal roots then sum of the roots are

(A) 4 (B) 8
(C) 12 (D) 2

14. If $f\left(x\right)=x^5+2x-4$

If $g\left(x\right)=f^{-1}\left(x\right)$

Then value of $f'\left(g'\left(x\right)\right)$. at x = - 4 is

(A) $\frac{35}{16}$ (B) $\frac{37}{16}$

(C) $\frac{1}{2}$ (D) $\frac{-4}{16}$

15. The equation of circle having least radius which touches the line y = 2x at the point (1, 2) and also touches the x axis is,

(A) $x^2+y^2-2\sqrt{5}x-y\left(5-\sqrt{5}\right)+5=0$ (B) $x^2+y^2+2\sqrt{5}x-y\left(5-\sqrt{5}\right)+5=0$

(C) $x^2+y^2+2\sqrt{5}x+y\left(5-\sqrt{5}\right)+5=0$ (D) $x^2+y^2+2\sqrt{5}x+y\left(5+\sqrt{5}\right)+5=0$

Space for rough work

16. Resolved part of vector $\vec{a}$ along the vector $\vec{b}$ is $\overrightarrow{a_1}$ and that perpendicular to $\vec{b}$ is $\vec{a}_2$ then $\overrightarrow{a_1} \times \overrightarrow{a_2}$ is equal to

(A) $\frac{\left(\vec{a}\times\vec{b}\right)\vec{b}}{\left|\vec{b}\right|^2}$
(B) $\frac{\left(\vec{a}\cdot\vec{b}\right)\vec{a}}{\left|\vec{a}\right|^2}$
(C) $\frac{\left(\vec{a}\cdot\vec{b}\right)\left(\vec{b}\times\vec{a}\right)}{\left|\vec{a}\right|^2}$
(D) $\frac{\left(\vec{a}\cdot\vec{b}\right)\left(\vec{b}\times\vec{a}\right)}{\left|\vec{b}\right|^2}$

17. Angle between vector $\vec{a}$ and $\vec{b}$ where $\vec{a},\vec{b},\vec{c}$ are unit vectors satisfying $\vec{a}+\vec{b}+\sqrt{3}\vec{c}=0$ is

(A) $\pi/3$
(B) $\pi/6$
(C) $2\pi/3$
(D) $\pi/12$

18. Volume of parallelepiped determined by vectors $\vec{a},\vec{b}$ and $\vec{c}$ is 4 unit, Then the volume of the parallelepiped determined by vectors. $\vec{a}\times\vec{b},\vec{c}\times\vec{a},\vec{b}\times\vec{c}$ is,

(A) 8
(B) 16
(C) 32
(D) 64

19. If f(x) = $\left(1+x\right)\left(1+\int_1^x \frac{f^2\left(t\right)}{1+t}dt\right)$, then f(7) is

(A) -1
(B) -5
(C) 1
(D) 4

Space for rough work

20. The value of $\sum_{r=1}^{n}(-1)^{r-1}\left(\frac{r}{r+1}\right)\cdot{}^{n}C_r$ is

(A) $\frac{1}{n+1}$ (B) $\frac{1}{n+2}$

(C) $\frac{1}{n-1}$ (D) $\frac{n+1}{n+2}$

21. If $a_1, a_2, a_3 \ldots\ldots a_{11}$ are in A.P if $a_6 = 10$ then value of $\sum_{i=1}^{11} a_i$ is

(A) 110 (B) 50
(C) 100 (D) 95

22. If $(1+x+x^2)^n = a_0 + a_1x + a_2x^2 + a_3x^3 + ... + a_{2n}x^{2n}$ Then $a_0 + a_3 + a_6 + ...is$

(A) 3^{n-1} (B) 3^n

(C) 2^n (D) 2

23. If z_1 and z_2 are two complex numbers such that $z_1, z_2 \neq 0,$ If $\left|\frac{z_1 - z_2}{z_1 + z_2}\right| = 1$, then $\left|Arg\left(\frac{z_1}{z_2}\right)\right|$ is

(A) $\frac{\pi}{3}$ (B) π

(C) $\frac{\pi}{2}$ (D) $\frac{\pi}{4}$

24. If |z| = 2 the locus of $w = z + \frac{1}{z}$ is,

(A) ellipse with eccentricity = 2/5 (B) ellipse with e = 4/5
(C)Hyperbola with e = 5/4 (D) Pe (z) = 0

Space for rough work

25. $\sum_{n=2}^{49} \frac{1}{2^{n-1}+2^{-n}-1.5}$ is

(A) $4-\frac{2^{50}}{2^{49}-1}$ (B) $6-\frac{2^{50}}{2^{49}-1}$

(C) $8-\frac{2^{50}}{2^{49}-1}$ (D) None of these

26. The value of integral $\int_0^{100+m} \{2x\} e^{\{2x\}} dx$ is
Where $O < m < 1/2$ is

(A) $\frac{e^{2m}(2m-1)+201}{2}$ (B) $\frac{e^{2m}(m-1)+201}{2}$

(C) $\frac{e^{2m}+201}{2}$ (D) $\frac{(m+1)e^{2m}+201}{2}$

27. The equation of tangents drawn from the point (0,4) to the hyperbola $x^2-4y^2=36$ are

(A) $5x-6y+24=0$ and $5x+6y-24=0$ (B) $x-4y+16=0$ and $x+4y-16=0$

(C) $2x-y+4=0$ and $2x+y-4=0$ (D) none of these

Space for rough work

28. There are exactly two points on the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ whose distance from the center of the ellipse are equal and equal to $\sqrt{\frac{a^2+2b^2}{2}}$. Eccentricity of this ellipse is equal to

(A) $\frac{\sqrt{3}}{2}$ (B) $\frac{1}{\sqrt{3}}$

(C) $\frac{1}{\sqrt{2}}$ (D) $\sqrt{\frac{2}{3}}$

29. The sum of two natural numbers m and n is equal to 100, The probability that their product being greater than 1600 is,

(A) $\frac{10}{94}$ (B) $\frac{13}{99}$

(C) $\frac{28}{99}$ (D) $\frac{59}{99}$

30. If x_1 is a solution $2^{x^2+2x+3} \le 4-\left(x^2-1\right)^2$ then . $\lim\limits_{x\to x_1}\left(1+\sin\pi x\right)^{\tan\frac{x\pi}{2}}$

(A) e^{-2} (B) e

(C) e^{-1} (D) e^2

Space for rough work

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

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(Main)

S. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	C	A	A
2.	B	C	C
3.	B	B	C
4.	A	A	A
5.	B	A	A
6.	A	A	D
7.	B	B	B
8.	B	B	C
9.	C	B	B
10.	D	D	B
11.	C	B	B
12.	A	A	B
13.	C	A	A
14.	A	B	B
15.	D	B	A
16.	B	C	D
17.	D	B	A
18.	B	B	B
19.	D	A	A
20.	C	B	A
21.	D	D	A
22.	A	C	A
23.	D	B	C
24.	C	A	B
25.	C	B	A
26.	B	C	A
27.	D	D	A
28.	C	D	C
29.	C	A	D
30.	A	D	D

Physics

PART – I

SECTION – A

1. **C**

The x-coordinate is obtained by integrating the expression for v_x, and the x-component of the acceleration is obtained by differentiating v_x. Thus,

$$\int dx = \int vx\ dt \qquad \int_0^x dx = \int_0^x (50-16t)dt \qquad x = 50t - 8t^2\ m$$

$$a_x = \frac{d}{dt}(50-16t) \qquad a_x = -16\,m/s^2$$

The y-components of velocity and acceleration are

$$\left[v_y - \vec{y}\right] \qquad v_y = \frac{d}{dt}\left(100-4t^2\right) \qquad v_y = -8t\ m/s$$

$$\left[a^y - v_y\right] \qquad a_y = \frac{d}{dt}(-8t) \qquad a_y = -8m/s^2$$

We now calculate corresponding values of x and y for various values of t and plot x against y to obtain the path as shown.

When $y = 0,\ 0 = 100 - 4t^2$, so $t = 5s$. For this value of the time, we have

$$v_x = 50 - 16(5) = -30\ m/s$$

$$v_y = -8(5) = -40\ m/s$$

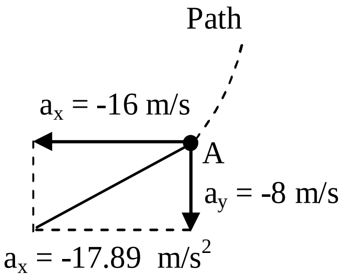
$$v = \sqrt{(-30)^2 + (40)^2} = 50m/s$$

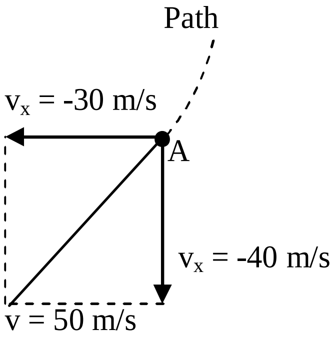
$$a = \sqrt{(-16)^2 + (-8)^2} = 17.89\ m/s^2$$

The velocity and acceleration components and their resultants are shown on the separate diagram for point A, where y = 0. Thus, for this condition we may write

$$v = -30\hat{i} - 40\hat{j}\ m/s$$

$$a = -16\hat{i} - 8\hat{j}\ m/s^2$$





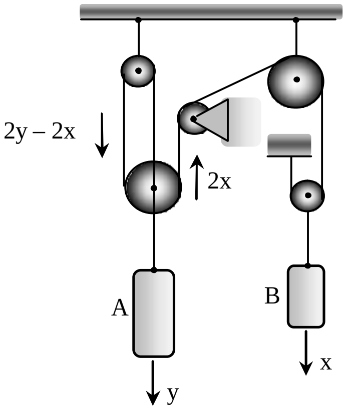
2. **B**

$$v_x = (v_0\cos\theta)e^{-kt}$$

$$v_y = \left(v_0\sin\theta + \frac{g}{k}\right)e^{-kt} - \frac{g}{k}$$

$$v_x \to 0,\ v_y \to -\frac{g}{k}$$

3. **B**



From figure,

$2x - 2y = y$

$x = \frac{3y}{2}$

$v_x = \frac{3}{2} v_y$

$a_x = \frac{3}{2} a_y$

$v_B = 1.2 \text{ m/s up}$

$a_B = 3 \text{ m/s}^2 \text{ down}$

4. **A**

We express the mean kinetic energy of a helium molecule in terms of the temperature: $\bar{E}_k = (3/2)kT_0$. For monatomic gases like helium, this will be the total kinetic energy of molecules:

$\bar{E} = \frac{3}{2} \times 1.38 \times 10^{-23} \text{ J/K} \times 273\text{K} \simeq 5.65 \times 10^{-21} \text{J}.$

Since $\bar{E} = m_0 \bar{v}_{rms} / 2$, we have $\bar{v}_{rms} = \sqrt{2\bar{E} / m_0}$, where m_0 is the mass of a helium molecule, which can be expressed as the ratio of the molar mass and the Avogadro constant: $m_0 = M / N_A$.

Finally, we obtain

$\bar{v}_{rms} = \sqrt{\frac{2\bar{E}N_A}{M}},$

$\bar{v}_{rms} = \sqrt{\frac{2 \times 5.65 \times 10^{-21} \text{J} \times 6.02 \times 10^{23} \text{mol}^{-1}}{4 \times 10^{-3} \text{kg/mol}}} \simeq 1300 \text{ m/s}$

5. **B**

Voltage across load resistances $V_2 = V_1 - 2iR$

$= 150 - 2 \times 1.7 \times 10^{-3} \times \frac{650 \times 10^3 \times 1.2 \times 10^{-7}}{5 \times 10^{-6}}$

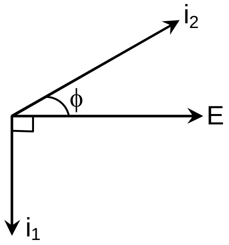
V_2 = 97 volt

6. **A**

$X_L = \omega L = 40\pi \times \frac{1}{40\pi} = 1\,\Omega$

$X_C = \frac{1}{\omega C} = \frac{1}{40\pi} \Omega$

$R = 1\,\Omega$



$\tan\phi = \frac{X_L}{R} = 1$

$\phi = 45^o$

$X_C = \sqrt{2}\ \Omega$

$X_L = 1\,\Omega,\ R = 1\,\Omega$

$z = 1\,\Omega$

7. **B**

We use ε to denote the angle formed by the direction of incident rays with the vertical wall of the vessel. It can be seen from the figure that the angle of incidence ε and the altitude of the Sun φ are related: $\varepsilon + \varphi = \pi/2$, $\varepsilon = 90^o - 60^o = 30^o$.

The rays propagate in the empty vessel along a straight line (along AM), and the length *l* of the umbra can be calculated from the right-angled triangle AMD:

$l_1 = AD = H\tan\ \varepsilon,\ \tan 30^o = 0.577,$

$l_1 = 25\text{ cm} \times 0.577 \simeq 14.4\text{ cm}.$

If the vessel contains water, he rays will be refracted at the air-water interface since a light ray bends away from the rarer medium into a denser medium. In this case, the refracted ray is closer to the vertical, and the angle of refraction ε' is smaller than the angle of incidence ε. The length of the umbra in the vessel filled with water is

$l_2 = BD = BC + CD.$ But CD = ON.

In the right-angled triangle OMN, we have ON = (H –h) × tan ε, ON = 5 cm × 0.577 $\simeq$ 2.9 cm. From the triangle BOC, we find BC = h tan ε'. In order to determine the angle of refraction, we use the second law of refraction: sin ε/sin ε' = n, sin ε' = sin ε/n, sin ε' = 0.5/1.33 = 0.3759, so tan ε' = 0.404. Consequently, BC = 20 cm × 0.404 = 8.1 cm.

The length of the umbra in the vessel with water is

$l_2 = BD = 8.1\text{ cm} + 2.9\text{ cm} = 11\text{cm}.$

When the vessel is filled with water, the length of the umbra decreases by Δl:

$\Delta l = 14.4\text{ cm} - 11\text{cm} = 3.4\text{ cm}.$

8. **B**

In order answer the question, we must know the path difference for the rays. The optical path difference is equal to their geometrical difference (since the rays propagate in the same medium, viz. air):

$$\Delta = S_2D = S_2D - S_1O,\ S_1O = l.$$

From the triangle SS_1, OS_2, we determine $S_2O : S_2O = \sqrt{l^2 + d^2} = l\sqrt{1 + (d/l)^2}$. since d/l is much smaller than l, we can use approximation $\left(\sqrt{1 \pm a^2} = 1 \pm \frac{1}{2}a^2\right)$, whence $S_2 = O = l\left[1 + \frac{1}{2}\left(\frac{d}{l}\right)^2\right]$.

Then

$$\Delta = l\left[1 + \frac{1}{2}\frac{d^2}{l^2} - 1\right] = \frac{d^2}{2l},$$

$$\Delta = \frac{\left(2.2\times10^{-3}\text{m}\right)^2}{2\times2.2\text{ m}} = 1.1\times10^{-6}\text{m}.$$

There will be constructive interference at O if the path difference contains integral number of waves, i.e. k =1, 2, 3, ………:

$$k = \frac{\Delta}{\lambda} = \frac{1.1\times10^{-5}\text{m}}{5.5\times10^{-7}\text{m}} = 2$$

Answer. Constructive interference (bright fringe) occurs at O.

9. **C**

$$\omega^2 = \omega_0^2 - \left(\frac{b}{2m}\right)^2$$

$$= \frac{k}{m} - \left(\frac{b}{2m}\right)^2$$

$$= \frac{100}{1} - \frac{100}{4}$$

$$\omega = 5\sqrt{3} = 8.5\text{ s}^{-1}$$

10. **D**

The total time interval is the sum of the two time intervals.
In each wire

$$\Delta t = \frac{L}{v} = L\sqrt{\frac{\mu}{T}}$$

Let A represent the cross-sectional area of one wire. The mass of one wire can be written both as m = ρV=ρAL and also as m = μL.

Then we have $\mu = \rho A = \frac{\pi\rho d^2}{4}$.

Thus, $\Delta t = L\left(\frac{\pi\rho d^2}{4T}\right)^{1/2}$

For copper,

$$\Delta t = \left(20.0\text{m}\right)\left[\frac{(\pi)\left(8920\text{ kg/m}^3\right)^2}{4T}\right]^{1/2} = 0.137\text{ s}$$

For steel,

$$\Delta t = \left(30.0\text{ m}\right)\left[\frac{(\pi)\left(7860\text{ kg/m}^3\right)\left(1.00\times10^{-3}\right)^2}{(4)(150\text{ N})}\right]^{1/2} = 0.192\text{ s}$$

The total time interval is 0.137+0.192 = 0.329 s

11. **C**

According to Equation 38.1, dark bands (minima) occur where

$$\sin\theta = m\frac{\lambda}{a}$$

For the first minimum, m = 1, and the distance from the center of the central maximum is

$$y_1 = L\tan\theta \approx L\sin\theta = L\left(\frac{\lambda}{a}\right)$$

Thus, the needed distance to the screen is

$$L = y_1\left(\frac{a}{\lambda}\right) = \left(0.85\times10^{-3}\right)\left(\frac{0.75\times10^{-3}\,m}{587.5\times10^{-9}\,m}\right) = 1.1\,m$$

12. **A**
The allowed energy levels of the hydrogen atom are given by

$$E_n = -\frac{13.6\,eV}{n^2} \text{ where } n = 1, 2, 3......$$

A transition in which a lower state n_i absorbs a photon of energy ΔE results in a higher state n_f, and energy is conserved:

$$E_1 + \Delta E = E_f$$

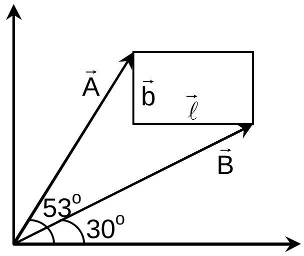
Or

$$\Delta E = E_f - E_i = -\frac{13.6\,eV}{n_1^2} = -\left(\frac{13.6\,eV}{n_1^2}\right) = 13.6\text{ eV}\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)$$

For the transition $n_i = 2$ to $n_f = 5$,

$$\Delta E = 13.6\,eV\left(\frac{1}{2^2} - \frac{1}{5^2}\right) = 2.86\text{ eV}$$

13. **C**



$$\vec{A} + \vec{b} + \vec{\ell} = \vec{B}$$

$$10\left(\cos53\hat{i} + \sin53\hat{j}\right) + \left(-b\hat{j}\right) + \ell\hat{i} = 12\left(\cos30\hat{i} + \sin30\hat{j}\right)$$

$$6\hat{i} + 8\hat{j} + \ell\hat{i} - b\hat{j} = 6\sqrt{3}\hat{i} + 6\hat{j}$$

$$\ell + 6 = 6\sqrt{3}$$

$$8 - b = 6$$

$$b = 2\text{ m}$$

$$\ell = 6\left(\sqrt{3} - 1\right) = 4.2\text{ m}$$

14. **A**
The density of lead is $1.13\times10^4\,kg/m^3$, so we should expect our calculated value to be close to this value. The density of water is $1.00\times10^3\,kg/m^3$, so we see that lead is about 11 times denser than water, which agrees with our experience that lead sinks.
Density is defined as $\rho = m/V$. We must convert to SI units in the calculation.

$$\rho = \left(\frac{23.94\,g}{2.10\,cm^3}\right)\left(\frac{1kg}{1000\text{ g}}\right)\left(\frac{100\text{ cm}}{1m}\right)^3$$

$$= \left(\frac{23.94\,g}{2.10\text{ cm}^3}\right)\left(\frac{1\,kg}{1000\,g}\right)\left(\frac{1000\,000\,cm^3}{1\,m^3}\right)$$

$$= 1.14\times10^4\text{ kg/m}^3$$

15. **D**
Conceptual.

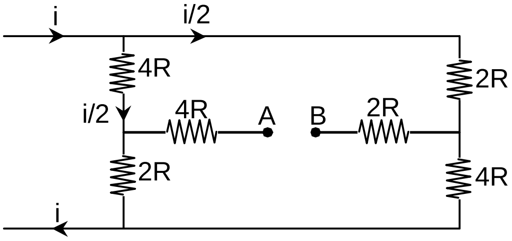
16. **B**
Conceptual.

17. **D**
Apply $v = u + at$.

18. **B**
Conceptual.

19. **D**
Number of photon $= \frac{20}{hc/\lambda}$

20. **C**



$$V_A + 4R.\frac{i}{2} - 2R.\frac{i}{2} = V_B$$
$$V_A - V_B = iR$$

21. **D**
In head on elastic collision between identical bodies velocities get interchanged.

22. **A**
Slope of graph $= \frac{1}{R}$

23. **D**
Ignore air resistance, the gpe reduces to 80% so 20% of the energy is lost.

24. **C**
$$\frac{1}{2}mv^2 = \frac{1}{2} \times 5 \times 10^{-26} \times (500)^2 = 39$$

25. **C**
2 minutes in 24 hours is 1/720 of a full rotation of the earth. So the angle subtended by the moon at the eyes is about ½ ^{0}. The distance earth – moon is a fixed value so the angle subtended by the earth at the moon is greater by 6400/1700. Hence 0.5 × 6400/1700 = 1.9^0.

26. **B**
Volume of the water of the film is fixed, so if the bubble has three times the radius, it has nine times the surface are, and as the film is very thin, this makes it thinner by a factor of nine in order to keep the volume of the film the same. This does expect that the thickness of the film t << R, the radius of the bubble.

27. **D**
A ratio question. The shapes are the same, and the ratio of the linear dimensions is 690/6.4 = 108, so the ratio of volumes is $\approx 10^6$.

28. **C**
The liquid has to flow faster through the narrower section because if unit volume passes a one point in the pipe every second, that same volume must flow through any other point each second otherwise there would be an accumulation of an incompressible fluid in the pipe.

29. **C**
The power dissipates in a resistor is given by I^2R. If R_A is unit current through unit resistance, R_B has twice the resistance and half the current, so that I^2R will be half the value (1/2W). R_C takes 3/2 units of current and is twice unit resistance sod resistance so dissipates 9/2 w. powers add up and so the total of these is 6W. The cell would supply the appropriate4 emf to supply these currents, otherwise the initial assumption of the 1W that we are given in R_A would not be right.

30. **A**
The rock only has to be lifted up to the neutral point and it will fall the rest of the way to earth.

Chemistry

PART – II

SECTION – A

1. **A**

By statement given in (a)

Wt. of NaCl = a g

Wt. of MCl = b g

$\therefore$ a + b = 1

Also, Meq. Of NaCl + Meq. Of MCl = Meq. of $AgNO_3$

= Meq. of AgCl

$= \frac{2.567}{143.5} \times 1000$

$\therefore$ Meq. of NaCl + Meq. of MCl = 17.889

Now, as reported in statement(b), mixture is heated to 300^oC, Since, NaCl is stable, the possibility seems for the decomposition of MCl and thus, after heating only MCl form vapours which react with $AgNO_3$

$\therefore$ Meq. of MCl = meq. of $AgNO_3$ = Meq. of AgCl

$= \frac{1.341}{143.5} \times 1000$

Meq. of MCl = 9.345

$\therefore$ Meq. of NaCl = 17.889 – 9.345 = 8.544

$$\frac{w}{58.5} \times 1000 = 8.544$$

$\therefore$ $w_{NaCl} = 0.50g$

$\therefore$ Meq. of MCl in mixture = 9.345

$\therefore$ $\frac{w}{M/1} \times 1000 = 9.345$

$\therefore$ $\frac{1-0.50}{M} \times 1000 = 9.345$ $(\because a+b=1)$

$\therefore$ M = 53.50

MCl may be NH_4Cl.

2. **C**

Given, for N_2 : Initially, P_1 = 2atm.

w_1 = 14 kg (diffusion time 1 hr)

After diffusion, $P_2 = \frac{1}{2}$atm, $w_2 = ?$

Since, at constant V and temperature, for a gas

$$P \propto w$$

$\therefore$ $\frac{P_1}{P_2} = \frac{w_1}{w_2}$ or $\frac{2}{1/2} = \frac{14}{w_2}$

$\therefore$ $w_2 = \frac{14}{4} kgN_2$

$\therefore$ Weight of N_2 diffused in 1 hr = 14 – (14/4) = 21/2) kg

Similarly for H_2 : initially P_1 = atm, w_1 = 1 kg.

(diffusion time t hr)

After diffusion, $P_2 = \frac{1}{2}\text{atm}, \ w_2 = ?$

Again, $\frac{P_1}{P_2} = \frac{w_1}{w_2}$ or $\frac{2}{1/2} = \frac{1}{w_2}$

∴ $w_2 = \frac{1}{4}\text{kg}$

∴ Weight of H_2 and H_2 diffused $= 1 - \left(\frac{1}{4}\right) = \frac{3}{4}\text{kg}$

For diffusion of N_2 and H_2: t_{H_2} = 1 hr = 60 minute

$$\frac{w_{H_2}}{t_{H_2}} \times \frac{t_{N_2}}{w_{N_2}} = \sqrt{\frac{M_{H_2}}{M_{N_2}}}$$

$$\frac{(3/4)}{(21/2)} \times \frac{60}{t} = \sqrt{\frac{2}{28}}$$

t = 16 minute

3. **B**

Let work function of A and B be W_A and W_B respectively the,

$4.25 = W_A + T_A$

$T_A = 4.25 - W_A$ ....(i)

$T_B = 4.70 - W_B$ ....(ii)

$T_B - T_A = 0.45 + W_A - W_B$

∵ $T_B - T_A = -1.5$

∴ $W_B - T_A = 1.95$ ...(iii)

Now, $\lambda = \frac{h}{mu} = \sqrt{\frac{h}{2k.m}}$ $(\because \text{K.E.} = \frac{1}{2}mu^2)$

$\lambda \propto \frac{1}{\sqrt{k}}$ (K is kinetic energy)

$\frac{\lambda_B}{\lambda_A} = \sqrt{\frac{K_A}{K_B}} = 2$

∴ $\frac{K_A}{K_B} = 4 = \frac{T_A}{T_B}$ $(\because \text{K.E.} = T)$

$\frac{T_A}{T_A - 1.5} = 4$

∴ $T_A = 2\text{eV}$

$T_B = 0.5\text{eV}$

$W_A = 2.25\text{eV}$

$W_B = 4.2\text{eV}$

4. **A**

$${}^{m}_{z}A \xrightarrow{-a} {}^{m-4}_{z-2}B \xrightarrow{-\beta} {}^{m-4}_{z-1}C$$

$(t_{1/2})_A = 10$ month $(t_{1/2})_B = 6$ month

The radioactive equilibrium is attached then, at equilibrium the ratio of atoms of A and B left is

$$\frac{N_A}{N_B} = \frac{t_{1/2}A}{t_{1/2}B} = \frac{10}{6} = \mathbf{1.66}$$

If half-life of A = 6 month and B is 10 month, then since $t_{1/2}A < t_{1/2}B$ or $\lambda_A > \lambda_B$ and thus no equilibrium will be set.

5. **A**

(a) $\because$ Eq. of O_2 = Eq. of Ag

or $w_{O_2}/8 = 1$ $(\because 1 \text{ mole of Ag} = 1 \text{eq. of Ag})$

$\therefore$ $w_{O_2} = 8g$

Using PV =(w/m) RT for volume of O_2, at T = 298 K, P = 750/760 atm

$$\frac{750}{760} \times V_{O_2} = \frac{8}{32} \times 0.0821 \times 298$$

$\therefore$ $V_{O_2} = 6.20$ litre

(b) Eq. of O_2 = Eq. of Ag.

or $$\frac{w_{O_2}}{8} = \frac{8 \times 10^{22} \times 108}{6.023 \times 10^{23} \times 108} \qquad \left(\therefore w_{Ag} = \frac{8 \times 10^{22} \times 108}{6.023 \times 10^{23}}\right)$$

$\therefore$ $w_{O_2} = 1.063g$

Again using PV=(w/m) RT: $V_{O_2} = 0.823$ litre

6. **A**

Mole of Mg = $\frac{1}{24}$

These moles of Mg will be converted to Mg^+ and Mg^{2+}. Let a mole of Mg^+ are formed, then

$$a \times 740 + \left(\frac{1}{24} - a\right) \times 2190 = 50$$

$\therefore$ $a = 0.02845$

$\therefore$ $$\% of\ Mg^+ = \frac{0.02845}{1/24} \times 100 = 68.28$$

$$\% of\ Mg^+ = 31.72$$

7. **B**

The stability of carbonates increases with increasing electropositive character of metal.

8. **B**

For $2CH_3COOH \rightleftharpoons (CH_3COOH)_2$

Before association	1	0
After association	$1 - \alpha$	$\alpha/2$

Where, α is degree of association.

$\therefore$ $$i = 1 - \alpha + \frac{\alpha}{2}$$

Given, w = 0.2 g, W=20 g, ΔT = 0.45

$$\because \quad \Delta T = \frac{1000 \times K_f \times w}{m \times W}\left(1-\alpha+\frac{\alpha}{2}\right)$$

$$or \quad 0.45 = \frac{1000 \times 5.12 \times 0.2}{20 \times 60}\left(1-\alpha+\frac{\alpha}{2}\right)$$

$$or \quad 1-\alpha+\frac{\alpha}{2} = 0.527$$

$$or \quad \alpha = 0.946 \quad or \quad 94.6\%$$

9. **B**

$$\frac{T_f}{T_b} = \sqrt{\frac{E_{ab}}{E_{af}}} = \sqrt{\frac{420}{500}} = \sqrt{0.84}$$

10. **D**

($\because$ Moles $\propto$ volume at constant P and T)

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

Initial moles a 0

Moles at equilibrium (a –x) 2x

Given original volume = (75/100) or existing volume at equilibrium

Or Initial moles = (75/100) × moles at equilibrium

$$\therefore \quad a = \frac{75}{100}(a+x)$$

$$or \quad x = \frac{25}{75}a = 0.33\ a$$

$\therefore$ degree of dissociation,

$$\alpha = \frac{x}{a}$$

$$= \frac{0.33a}{a} = 0.33\ or\ 33\%$$

11. **B**

$$N_2O_4 \rightleftharpoons 2NO_2$$

Initial moles 1 0

Moles at equilibrium 1— α 2α

Where, α is degree of dissociation = 0.503

$$\because \quad K_p = \frac{(n_{NO_2})^2}{(n_{N_2O_4})} \times \left(\frac{p}{\sum n}\right)^{\Delta n}$$

$$= \frac{(2\alpha)^2}{(1-\alpha)} \times \left(\frac{p}{1+\alpha}\right)1$$

$$Kp = \frac{4\alpha^2 p}{(1-\alpha^2)} = \frac{4 \times (0.503)^2 \times 1}{\left[1-(0.503)^2\right]}$$

Again at pressure P, $N_2O_4 \rightleftharpoons 2NO_2$

Initial moles 1 0
Moles at equilibrium 1-x 2x

Given
$$\frac{N_2O_4}{NO_2} = \frac{1-x}{2x} = \frac{1}{8}$$

$$\therefore \qquad x = \frac{8}{10} = 0.8$$

Using again,

$$Kp = \frac{4x^2.P}{1-x^2}$$

$$or \qquad 1.355 = \frac{4\times(0.8)^2.P}{\left[1-(0.8)^2\right]}$$

$$or \qquad P = 0.19\ atm$$

12. **A**

$$N_2O_4 \rightleftharpoons 2NO_2$$

Pressure at equilibrium 0.28 1.1

$$\therefore \qquad K_p = \frac{\left(P'_{NO_2}\right)^2}{\left(P'_{N_2O_4}\right)} = \frac{(1.1)^2}{0.28} = 4.32\ atm$$

If volume of container is doubled, i.e., pressure becomes half, the reaction will also proceed in the half, the reaction will also proceed in the direction where the reaction shows an increase in moles, i.e., decomposition of N_2O_4 is favoured;

$$N_2O_4 \rightleftharpoons 2NO_2$$

New pressure at equilibrium $\left[\frac{0.28}{2} - P\right]$ $\left[\frac{1.1}{2} + 2P\right]$

Where, N_2O_4 equivalent to pressure P is used up in doing so.

13. **A**

$$pOH = -\log K_b + \log\frac{[conjugate\ acid]}{[Base]}$$

$$5 = 4.7 + \log\frac{a}{b}$$

$$\frac{a}{b} = 2 \quad \therefore\ a = 2b \qquad ....(i)$$

$$Given, \qquad a + b = 0.6 \qquad ....(ii)$$

By Eqs. (i) and (ii), 2b+ b = 0.6

$$\therefore \qquad 3b = 0.6$$

$$or \qquad b = 0.2\ mole = 0.2\times17 = 3.4g/litre$$

$$\therefore \qquad a = 0.4mole = 0.4\times53.5 = 21.4g/litre$$

$$Thus, \quad [Salt] = 0.4\ M \quad and \quad [Base] = 0.2\ M$$

14. **B**

$\because \quad \Delta G = \Delta H - T\Delta S$

For a non-spontaneous reaction ΔG = +ve;

$\therefore \quad \Delta H = T\Delta S = +ve$

$or \quad \Delta H > T\Delta S \quad or \quad T < \left(\Delta H / \Delta S\right)$

$\because \quad \Delta S = 70\,JK^{-1}mol^{-1}$

$Thus, \quad T < \left[\left(30 \times 10^3\right)/70\right]$

$T < 428.57\ K$

15. **B**

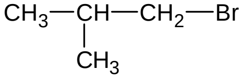
16. **C**

Two possible isomers of C_4H_9Br are:

$CH_3-CH_2-CH_2-CH_2-Br$

[I]

(1^o)



$CH_3-\underset{CH_3}{\underset{|}{CH}}-CH_2-Br$

[II]

(1^o)

According to the question, compound (A) on reaction with sodium does not give the same product produced by n-butylbromide. So, (A) cannot be [I]

$2CH_3-CH_2-CH_2-CH_2-Br + 2Na \xrightarrow{Ether}$

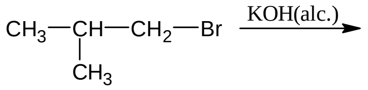
n-butylbromide

$CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$

n-octane (not formed in the reaction)

C_8H_{18}

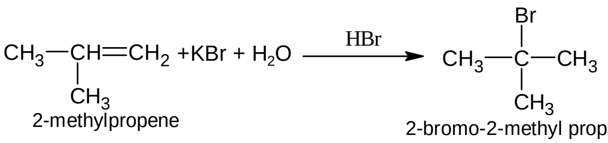
Now second must be the correct isomer.



$CH_3-\underset{CH_3}{\underset{|}{CH}}-CH_2-Br \xrightarrow{KOH(alc.)}$

Iso-butylbromide

(1-bromo-2-methylpropane) (A)



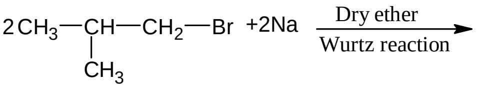
$CH_3-\underset{CH_3}{\underset{|}{CH}}=CH_2 + KBr + H_2O \xrightarrow{HBr} CH_3-\overset{Br}{\overset{|}{\underset{CH_3}{\underset{|}{C}}}}-CH_3$

2-methylpropene

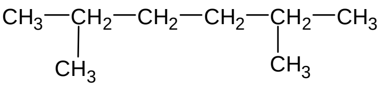
(B)

2-bromo-2-methyl propane

(C)



$2CH_3-\underset{CH_3}{\underset{|}{CH}}-CH_2-Br + 2Na \xrightarrow[\text{Wurtz reaction}]{\text{Dry ether}}$

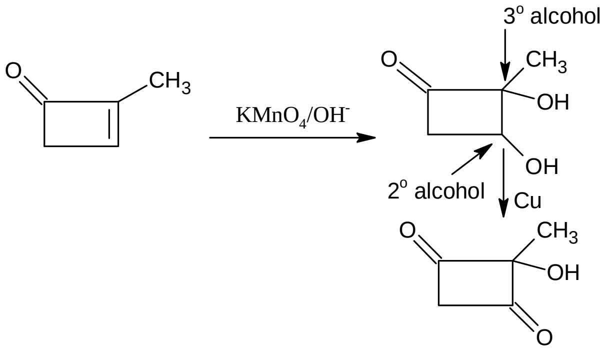


$CH_3-\underset{CH_3}{\underset{|}{CH_2}}-CH_2-CH_2-\underset{CH_3}{\underset{|}{CH_2}}-CH_3$

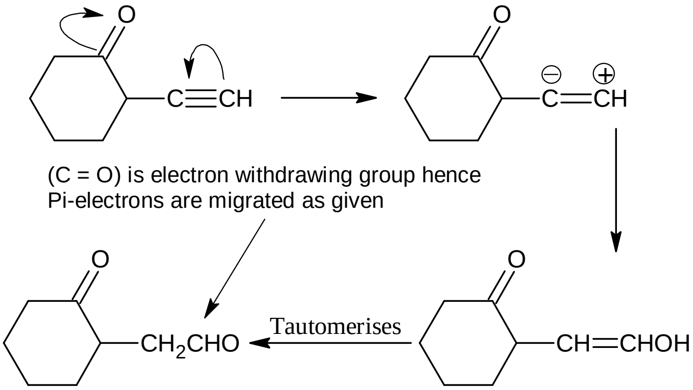
2,5-dimethylhexane

$(C_8H_{18})D$

17. **B**

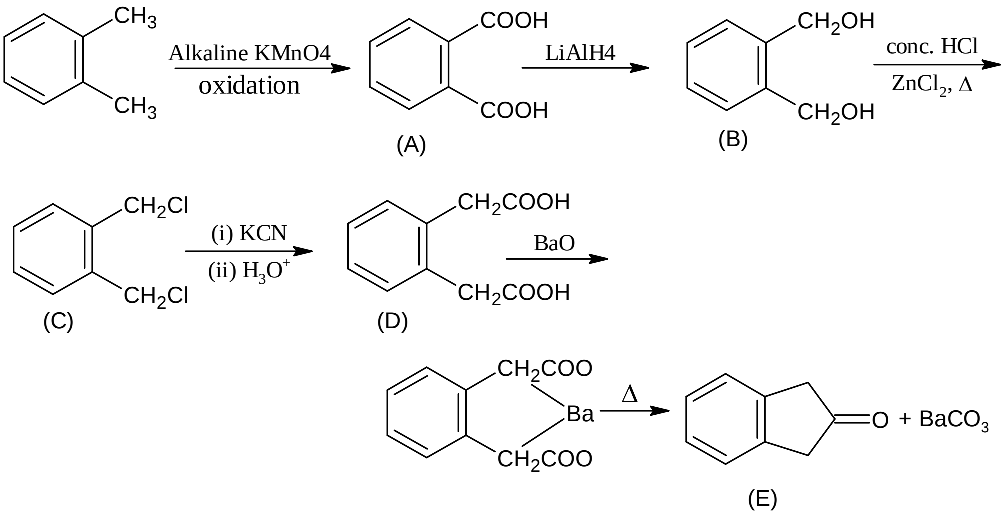

O
CH3
KMnO4/OH-
3° alcohol
O
CH3
OH
OH
2° alcohol
Cu
O
CH3
OH
O

18. **B**


O
C≡CH
O
⊖ ⊕
C=CH
O
CH2CHO
Tautomerises
O
CH=CHOH

(C = O) is electron withdrawing group hence
Pi-electrons are migrated as given

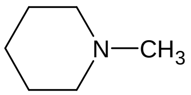
19. **A**


CH3
CH3
Alkaline KMnO4
oxidation
COOH
COOH
(A)
LiAlH4
CH2OH
CH2OH
(B)
conc. HCl
ZnCl2, Δ
CH2Cl
CH2Cl
(C)
(i) KCN
(ii) H3O+
CH2COOH
CH2COOH
(D)
BaO
CH2COO
Ba
CH2COO
Δ
O + BaCO3
(E)

20. **B**

21. **D**

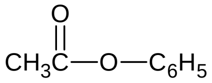
22. **C**



No H-atom at N-atm (3^o amine) hence, no H-bonding. Thus least boiling point

23. **B**

Compound (B) gives violet colour with neutral $FeCl_3$, thus, it is phenol. Compound (C) Gives blood red colour with neutral $FeCl_3$. Thus, it is CH_3COOH



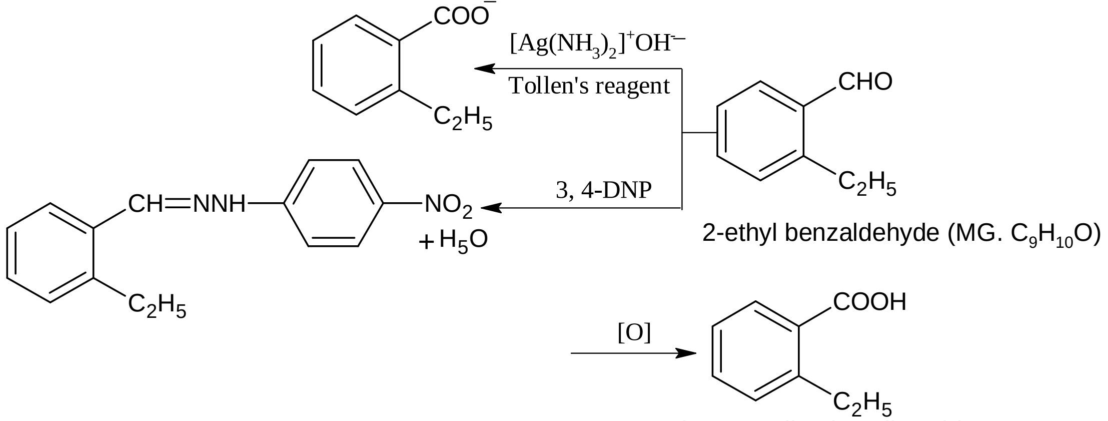
$$CH_3COOH + C_6H_5OH \rightleftharpoons CH_3\overset{\overset{O}{||}}{C}—O—C_6H_5$$

24. **A**

(i) Since, the given compound with MF $C_9H_{10}O$ forms a 2,4-DNP derivative and reduces Tollen's reagent, it must be an aldehyde.

(ii) Since, it undergoes cannizzaro reaction, therefore, CHO group is directly attached to the benzene ring.

(iii) Since, on vigorous oxidation, it gives 1, 2-benzene dicarboxylic acid, there fore, it must be an ortho substituted benzaldehyde.

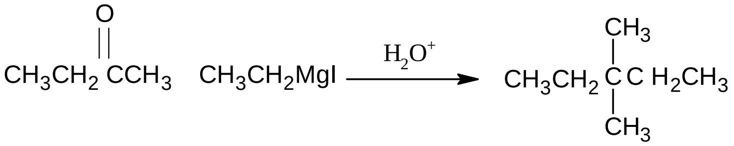

COO⁻
[Ag(NH3)2]+OH⁻
Tollen's reagent
C2H5
CHO
C2H5
CH=NNH
NO2
+H5O
3, 4-DNP
C2H5
2-ethyl benzaldehyde (MG. C9H10O)
[O]
COOH
C2H5

1, 2-benzenedicarboxylic acid

25. **B**

26. **C**

27. **D**



$$CH_3CH_2\overset{\overset{O}{||}}{C}CH_3 \quad CH_3CH_2MgI \xrightarrow{H_2O^+} CH_3CH_2\overset{CH_3}{\underset{CH_3}{C}}C\,H_2CH_3$$

3^o alcohol

28. **D**

29. **A**

30. **D**

Write the reaction of acid & base to get the answer.

Mathematics

PART – III

SECTION – A

1. **A**

$$f(x)=\begin{cases} x^3-x^2+x-2 & x>2 \\ x^3-x^2+2-x & 1<x\le 2 \\ x^2-x^3+2-x & 0<x\le 1 \\ x^3-x^2+2-x & x\le 0 \end{cases}$$

$$f'(x)=\begin{cases} 3x^2-2x+1 & x>2 \\ 3x^2-2x-1 & 1<x\le 2 \\ 2x-3x^2-1 & 0<x\le 1 \\ 3x^2-2x-1 & x\le 0 \end{cases}$$

$f'(x)=0 \qquad 3x^2-2x+1=0 \qquad \Rightarrow x=\phi, \quad X>2$

$f'(x)=0 \qquad 3x^2-2x-1=0 \Rightarrow x=\dfrac{2\pm 4}{6} \Rightarrow x=1, \dfrac{-1}{3}; 1<x<2 \Rightarrow x=\phi$

$f'(x)=0 \qquad 2x-3x^2-1=0 \qquad 0 < x \le 1$

$\Rightarrow 3x^2-2x+1=0 \qquad \Rightarrow x=\phi$

$f'(x)=0 \qquad 3x^2-2x-1=0 \qquad x \le 0$

$\Rightarrow x=1, \dfrac{-1}{3} \qquad \Rightarrow x=-1/3$

Also x < 1 $\quad \Rightarrow f'(x)<0 \qquad$ x > 1 $\quad \Rightarrow f'(x)>0$

$\therefore$ minimum at x = 1.

2. **C**

$f(x)=x^3+\int_1^x f(t)\,dt$

$xf'(x)+f(x)=3x^2+f(x)$

$f'(x)=3x$

$f(x)=\dfrac{3x^2}{2}+c$ .....(i) Also, $\quad f(1)=1^2+\dfrac{1}{1}\int_1^1 f(t)\,dt=1$

$\therefore \; f(x)=\dfrac{3x^2-1}{2}$

3. **C**

Since $\quad f'(x)-2f(x)>0, \quad x\ge 1$

$\Rightarrow \dfrac{d}{dx}\left(e^{-2x}\cdot f(x)\right)>0, \; x\ge 1$

$h(x) = e^{-2x} f(x)$ is increasing in x ≥ 1. Now x > 1

$\Rightarrow e^{-2x} f(x) > e^{-2} \cdot f(1)$

$\Rightarrow f(x) > e^{2x-2}, \quad x > 1$

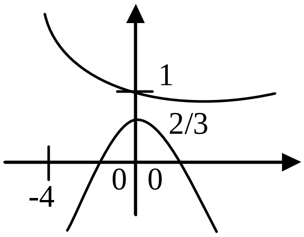
4. **A**

Since $A(adj(A)) = |A| \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ hence K = |A| = 1

5. **A**

$\therefore f'(x) = x^2 e^x + 2x \cdot e^x - 2e^x$

$= e^x (x^2 + 2x - 2)$



$f''(x) = x^2 e^x + x4e^x = xe^x (x+4)$

$= x^2 e^x + 4 \times e^x \; xe^x (x+4) < 0.$

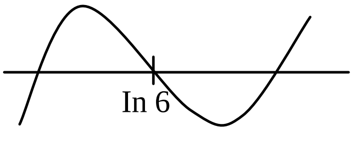
Also f(x) > 0 and f(0) > 0

Hence f(x) > 0 $\forall x \in (-4, 0)$

Hence no. real roots.

$(x^2 - 2)e^x = -3 \qquad \Rightarrow x^2 - 2 = -3e^{-x} \Rightarrow \frac{2 - x^2}{3} = e^{-x}$

6. **D**



$f(x) = e^x - 3x^2$

$f'(x) = e^x - 6x$

$f''(x) = e^x - 6$

$f''(x) > 0$

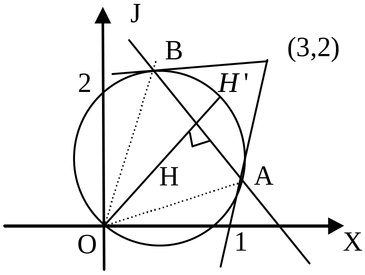
$\Rightarrow e^x > 6$

$\Rightarrow x > \ln 6.$

$f''(x) < 0 \Rightarrow e^n < 6 = x < \ln 6$

7. **B**

If altitude from O meet the circle at H' then ortho centre of triangle OAB is the mirror image of H' about the line AB.



$$3x+2y-(x+3)-(y+2)=0$$

$\Rightarrow 2x+y=5 \quad \Rightarrow$ AB

$y=-2$ 1/ 2 $y=\dfrac{1}{2}$ $\Rightarrow$ x = 2y (OMA')

8. **C**

Let $I_2=\int_0^1\left(1-x^n\right)^{m+1}$

$$I_2=\int_0^1\left(1-x^n\right)^m-\int_0^1 x^n\left(1-x^n\right)^m$$

$$I_2=I_1-\left\{\left(x\frac{\left(1-x^n\right)^{m+1}}{n(m+1)}\right)_0^1-\int_0^1\frac{\left(1-x^n\right)^{m+1}}{n(m+1)}\right\}$$

$I_2=I_1+\dfrac{I_2}{n(m+1)}$

9. **B**

Now $\dfrac{dy}{dx}=2x=2 \qquad \Rightarrow x=1 \qquad \Rightarrow y=3$

Hence point is (1, 3)

10. **B**

Let z = x + iy

$$x^2-y^2+2xiy=ix-y+\sqrt{x^2+y^2}-2$$

Now $x^2-y^2=-y+\sqrt{x^2+y^2}-2$ ….(i)

Also $2xy-x=0 \qquad \Rightarrow$

x = 0 and $y={}^1\!/_2$

Now x = 0, $-y^2=-y+|y|-2$

$-y^2=-2$ y >0

$y=\pm\sqrt{2} \qquad \Rightarrow y=\sqrt{2}$

$\left(0,\sqrt{2}\right)$

Also $y\le 0.$

$-y^2=-2y-2$

$$y^2-2y-2=0$$

$$(y-1)^2=3 \quad \Rightarrow y=\pm\sqrt{3}.\text{hence } \left(0,1-\sqrt{3}\right)$$

Now $y=1/2$

$$x^2-\tfrac{1}{4}=-\tfrac{1}{2}-2+\sqrt{x^2+\tfrac{1}{4}}$$

$$x^2+\frac{9}{4}=\sqrt{x^2+\tfrac{1}{4}}$$, Let x^2 = t

$$t^2+\frac{81}{16}+\frac{9t}{2}=t+\frac{1}{4} \qquad 16t^2+56t+77=0$$

Equation has no any real solution.

11. **B**

$$y\,dx-x\,dy+3x^2y^2\cdot e^{x^3}dx=0$$

$$\Rightarrow \frac{y\,dx-x\,dy}{y^2}+3x^2\cdot e^{x^3}dx=0$$

$$\Rightarrow d\left(\frac{x}{y}\right)+d\left(e^{x^3}\right)=0$$

$$\Rightarrow \frac{x}{y}+e^{x^3}=C$$

12. **B**

$$h(x)=\frac{1}{2}\frac{d}{dx}\left(x^2-1\right)\left(f'(x)\right)^2$$

Hence $f(x)$ have 4 zeros

hence 10.

13. **A**

Roots are $\alpha_1,1-\alpha_1,\alpha_2,1-\alpha_2,\alpha_3,1-\alpha_3,\frac{1}{2},\frac{1}{2}$

Sum = $3+\frac{1}{2}+\frac{1}{2}=4$

14. **B**

$$g\left(f(x)\right)=x\Rightarrow g'\left(f(x)\right)f'(x)=1$$

$$g'\left(f(0)\right)=\frac{1}{f'(0)}=\tfrac{1}{2}=g'(-4)$$

Now $f'\left(\tfrac{1}{2}\right)=5\times\frac{1}{16}+2=\frac{37}{16}$

$$f\left(g(x)\right)=x$$

$$\Rightarrow f'\left(g(x)\right)g'(x)=1$$

15. **A**

Equ^n of circle is $(x-1)^2+(y-2)^2+\lambda(y-2x)=0$

Put y = 0

$x^2+1-2x+4-2\lambda x=0$

$x^2-2x(1+\lambda)+5=0$

Now D= 0

$4(1+\lambda)^2-20=0$

$(1+\lambda)^2=5$

$\lambda=\pm\sqrt{5}-1$

$x^2+y^2-2x-4y+\left(\sqrt{5}-1\right)y-2\left(\sqrt{5}-1\right)x=0$

$x^2+y^2-2x\sqrt{5}-y\left(5-\sqrt{5}\right)+5=0$

16. **D**

$$\overrightarrow{a_1}=\left(\vec{a}\cdot\vec{b}\right)\vec{b}=\frac{\left(\vec{a}\cdot\vec{b}\right)\vec{b}}{\left|\vec{b}\right|^2}$$

$$\Rightarrow \overrightarrow{a_2}=\vec{a}-\overrightarrow{a_1}=\vec{a}-\frac{\left(\vec{a}\cdot\vec{b}\right)\vec{b}}{\left|\vec{b}\right|^2}$$

Now, $\overrightarrow{a_1}\times\overrightarrow{a_2}\frac{\left(\vec{a}\cdot\vec{b}\right)\vec{b}}{\left|\vec{b}\right|^2}\times\left(\vec{a}-\frac{\left(\vec{a}\cdot\vec{b}\right)\vec{b}}{\left|\vec{b}\right|^2}\right)$

$$=\frac{\left(\vec{a}\cdot\vec{b}\right)\left(\vec{b}\times\vec{a}\right)}{\left|\vec{b}\right|^2}$$

17. **A**

$|\vec{a}+\vec{b}|=|-\sqrt{3}\vec{c}|$

$\left(\vec{a}\right)^2+\left(\vec{b}\right)^2+2\vec{a}\cdot\vec{b}=3|\vec{c}|^2$

$2\vec{a}\cdot\vec{b}=3|\vec{c}|^2$

$2\vec{a}\cdot\vec{b}=1$

$\vec{a}\cdot\vec{b}=1/2\Rightarrow\cos\theta=1/2\Rightarrow\theta=\frac{\pi}{3}$

18. **B**

$\left(\left(\vec{a}\times\vec{b}\right)\times\left(\vec{b}\times\vec{c}\right)\right)\cdot\left(\vec{c}\times\vec{a}\right)$

$\left(\left[\vec{a}\vec{b}\vec{c}\right]\vec{b}\cdot\left(\vec{c}\times\vec{a}\right)\right)$

$= \left[\vec{a}\vec{b}\vec{c}\right]^2 = 16$

19. **A**

$$\frac{f(x)}{1+x} = 1 + \int_1^x \frac{f^2(x)}{1+t}dt$$

$$\frac{(1+x)f'(x) + f(x)}{(1+x)} = \frac{f^2(x)}{(1+x)}$$

$$(1+x)\frac{dy}{dx} + y = y^2$$

$$(1+x)\frac{dy}{dx} = y^2 - y$$

$$\frac{dy}{y^2 - y} = \frac{dx}{1+x}$$

$$\int\left(\frac{1}{y-1} - \frac{1}{y}\right)dy = \text{ln(1 + x) + c}$$

$$ln\left(\frac{y-1}{y}\right) = ln(1+x) + c$$

$$ln\left(\frac{1}{2}\right) = ln(2) + c$$

$$\Rightarrow c = -2ln2 = \ln(1/4)$$

$$\therefore \frac{y-1}{y} = \left(\frac{1+x}{4}\right)$$

$$4y - 4 = y(1+x) \;\Rightarrow y(3-x) = 4$$

$$y = \frac{4}{3-x}$$

$$\therefore f(7) = \frac{4}{3-7} = -1$$

20. **A**

$$\left(\frac{r}{r+1}\right){}^nC_r = \left(1 - \frac{1}{r+1}\right){}^nC_r$$

$$= {}^nC_r - \frac{1}{r+1}\;{}^nC_r$$

On solving we get $\frac{1}{n+1}$

21. **A**

Since $a_1 + a_{11} = a_2 + a_{10} = a_3 + a_9 = a_4 + a_8$

$a_5 + a_7 = 20$

22. **A**

23. **C**

Since $\left|\frac{z_1 - z_2}{z_1 + z_2}\right| = 1 \qquad \Rightarrow \left|\frac{z_1}{z_2} - 1\right| = \left|\frac{z_1}{z_2} + 1\right|$

$\therefore \frac{z_1}{z_2}$ lies on y – axis.

$\therefore \left|\arg\left(\frac{z_1}{z_2}\right)\right| = \pi / 2$

24. **B**

Left Z = 2(cosθ + i sin θ)

$z = 2(\cos\theta + i\sin\theta) + \frac{1}{2}(\cos\theta - i\sin\theta)$

w = $h + ik = \frac{5\cos\theta}{2} + \frac{3}{2}i\sin\theta$

$\cos\theta = \frac{2h}{5}, \sin\theta = \frac{2k}{3}$

Hence locus is $\frac{4x^2}{25} + \frac{4y^2}{9} = 1$

$b^2 = a^2(1 - e^2)$

$\Rightarrow \frac{9}{4} = \frac{25}{4}(1 - e^2)$

$e = 4/5$

25. **A**

$$T_n = \frac{1}{2^{n-1} + 2^{-n} - 1.5} = \frac{2^n}{2^{2n-1} - 1.5\ 2^n + 1}$$

$$T_n = \frac{2^{n+1}}{4^n - 3.2^n + 2} = \frac{2^{n+1}}{(2^n - 2)(2^n - 1)} = \frac{2^n}{(2^{n-1} - 1)(2^n - 1)} = \frac{2^n}{2^{n-1} - 1} - \frac{2^{n+1}}{2^n - 1}$$

$T_n = V_n - V_{n+1}$

$T_1 = V_1 - V_2$

$T_2 = V_2 - V_3$

$T_n = V_n - V_{n+1}$

$S_n = V_2 - V_{n+1}$

$$S_n = 4 - \frac{2^{n+1}}{2^n - 1} = 4 - \frac{2^{50}}{2^{49} - 1}$$

26. **A**

$$\int_0^m \{2x\} e^{\{2x\}} dx + 200 \int_0^{1/2} (2x) e^{2x} dx$$

$$2\int_0^m xe^{2x}dx + 400\int_0^{1/2} xe^{2x}dx$$

$$2\left\{\frac{xe^{2x}}{2} - \frac{1}{4}e^{2x}\right\}_0^m + 400\left\{\frac{x}{2}e^{2x} - \frac{1}{4}e^{2x}\right\}_0^{1/2}$$

$$= me^{2m} - \frac{1}{2}e^{2m} + \frac{1}{2} + 400\left\{\frac{1}{4}e - \frac{1}{4} + e\frac{1}{4}\right\}$$

$$e^{2m}\left(m - \frac{1}{2}\right) + \frac{1}{2} + 100$$

$$\frac{e^{2m}(2m-1) + 201}{2}$$

27. **A**

Any tangents will be in the form y = mx + c, where $c^2 = 36m^2 - 9$

If it passes through (0, 4), then 4 = c

$$\Rightarrow 16 = 36m^2 - 9$$

$$\Rightarrow m = \pm\frac{5}{6}.$$

Hence tangent are $6y = 5x + 24, 6y = -5x + 24$

28. **C**

The given distance is clearly the length of semi major axis

Thus , $\sqrt{\dfrac{a^2 + 2b^2}{2}} = a$

$$\Rightarrow 2b^2 = a^2 \quad \Rightarrow 2a^2(1 - e^2) = a^2$$

$$e^2 = \frac{1}{2} \Rightarrow e = \frac{1}{\sqrt{2}}$$

29. **D**

Given m + n = 100

Also m.n > 1600

Or m (100 – n) > 1600 on solving

20 , m < 80 $\Rightarrow$ 21 $\le$ m $\le$ 79

Hence total number of favorable ways is 79 – 21 + 1 = 59 hence required probability is 59/99.

30. **D**

$$2^{(x+1)^2+2} \le 4 - (x^2 - 1)^2$$

Since $4 - (x^2 - 3)^2 \le 4$ and $2^{(x+1)^2+2} \ge 4$

hence $2^{(x+1)^2+2} = 4$ and $4 - (x^2 - 1)^2 = 4$

$(x^2 - 1)^2 = 0 \quad \Rightarrow x = \pm 1$ and x = - 1 hence x = -1

$$\lim_{x\to -1}(1 + \sin\pi x)^{\tan\frac{x\pi}{2}} = \lim_{x\to -1} e^{\sin\pi x\left(\frac{\sin\frac{\pi x}{2}}{\cos\frac{\pi x}{2}}\right)} = e^{-2}$$

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

ALL INDIA TEST SERIES

FIITJEE **JEE (Advanced), 2017**

FULL TEST – V

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 – 10)** contains 10 multiple choice questions which have one or more than one correct answer. Each question carries **+3 marks** for correct answer. There is no negative marking.

(ii) **Section-C (01 – 10)** contains 10 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

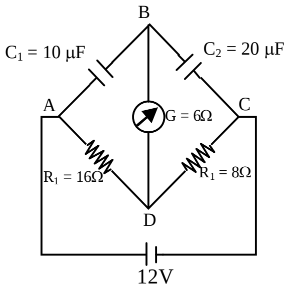
SECTION – A

Straight Objective Type

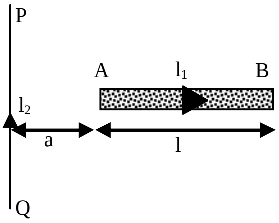
This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

1. Four point charges +q, +q, – q, and – q are placed respectively at corners A, B, C and D of a square. Then
(A) the potential at the centre O of the square is zero
(B) the electric field at the centre O of the square is zero
(C) If E is the mid-point of side BC, the work done in carrying an electron from O to E is zero
(D) If F is the mid-point of side CD, the work done is carrying an electron from O to F is zero

2. In the circuit show in figure, if the galvanometer resistance is 6 Ω, then in the steady state
(A) no current flows through the galvanometer
(B) the current through R_2 is 4A
(C) the charge on C_1 is 80 μC.
(D) the charge on C_2 is 80 μC

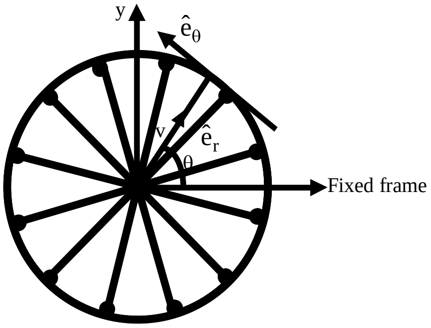


3. A thin rod AB of length l carries a current I_1. It is placed in the magnetic field of a long wire PQ carrying a current I_2 as shown in figure
(A) The force experienced by the rod is $F = \frac{\mu_0 I_1 I_2}{4\pi}\log_e\left(1+\frac{l}{2a}\right)$
(B) The force experienced by the rod is $F = \frac{\mu_0 I_1 I_2}{4\pi}\log_e\left(1+\frac{l}{a}\right)$
(C) The rod experiences no torque
(D) The rod experiences a force as well as a torque.



Space for rough work

4. A fly crawls with constant speed v along the radial spoke of a wheel which is rotating with constant angular speed ω. Initially the fly starts from centre of the wheel along x-axis. Then (where $r = v\theta$)



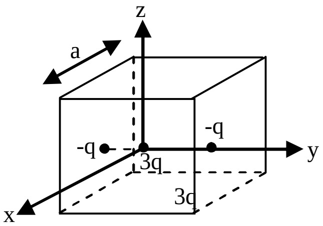
(A) The actual velocity of the fly in fixed frame is $\vec{v} = v\hat{e}_r + r\omega\hat{e}_\theta$

(B) The actual velocity of the fly in fixed frame is $\vec{v} = \sqrt{v\theta\omega}\hat{e}_r + r\omega\hat{e}_\theta$

(C) The position of fly at any instant $\vec{r} = \frac{v.\theta}{\omega}\hat{e}_r$

(D) The position of fly at any instant $\vec{r} = \frac{vt}{\omega}\hat{e}_r$

5. A cubical region of side a has its centre at the origin. It encloses three fixed point charges, -q at (0, -a/4, 0) + 3q at (0, 0, 0) and -q at (0 + a/4, 0) Choose the correct options(s)



(A) The net electric flux crossing the plane x = +a/2 is equal to the net electric flux crossing the plane x =-a/2

(B) The net electric flux crossing the plane y = +a/2 is more than the net electric flux crossing the plane y =- a/2

(C) The net electric flux crossing the entire region is q/ε_0

(D) The net electric flux crossing the plane z = +a/2 is equal to the net electric flux crossing the plane x = +a/2

6. Let the energy, magnitude of linear momentum and angular frequency of an electron in hydrogen atom be E,P and ω respectively. If n be the corresponding quantum number, then

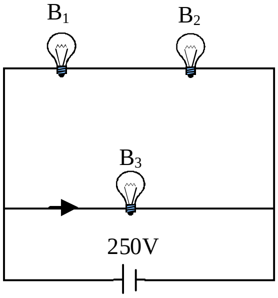
(A) E/W varies as n	(B) E P/W is independent of n
(C) P W varies as $n^{1/2}$	(D) E P W is independent of n.

Space for rough work

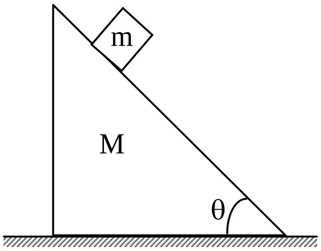
7. A nitrogen nucleus $^{14}N_7$ absorbs a neutron and can be transformed to lithium nucleus $^{6}Li_3$ under suitable condition, after emitting
(A) 4 proton and 3 neutrons
(B) 5 proton and 1 beta particle
(C) 2 alpha particles, 1 neutron and 2 gama photons
(D) 4 protons and 4 neutrons

8. At 0^oC a black body placed in 0^oC surrounding then it emits
(A) all wavelengths of radiation (B) only visible light
(C) only micro wave radiation (D) no radiation

9. A 100 W bulb B_1, and two 60 W bulbs B_2 and B_3, are connected to a 250 V source, as shown in figure. Now W_1, W_2 and W_3 are the output powers of the bulbs B_1, B_2 and B_3, respectively. Then
(A) $W_1 > W_2 = W_3$ (B) $W_1 > W_2 > W_3$
(C) $W_1 < W_2 = W_3$ (D) $W_1 < W_2 < W_3$



10. A block of mass m is placed on a prims of mass M. The inclined surface is smooth and inclination with horizontal is θ. The horizontal surface is sufficiently rough to prevent slipping of prism. The body of mass *m* is coming down the inclined face then
(A) Acceleration of body along the inclined surface is g sin θ
(B) Frictional force is $\frac{1}{2}mg\sin 2\theta$
(C) Maximum frictional force is $\frac{mg}{2}$
(D) Friction force will be maximum when $\theta = 45^0$



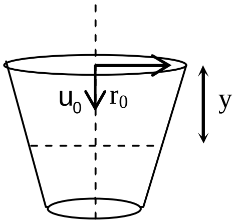
Space for rough work

SECTION – C

(One Integer Value Correct Type)

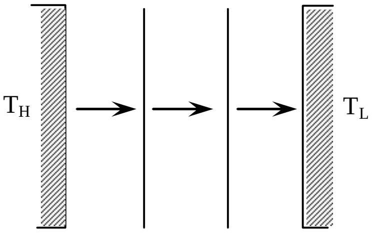
This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. Water flows vertically down ward out of a round nozzle of radius r_0 with a speed u_0. Which is not quite large for some distance below nozzle the flow in water laminar stream over this distance the stream radius r_y as a function of the distance of belong the nozzle is $r_y = r_0[1+\eta y]^{-1/\alpha}$. Value of $(\eta+\alpha)$is$\left(\text{take value of } u_0^2/g = 1\right)$.



2. A 60 cm metal rod M_1 is joined to another 100 cm metal rod M_2 to form an L shaped single piece This piece is hung on a ply at the joint. The two rods are observed to be equality inclined to the vertical. The two rods are equally thick. If the ratio of density M_1 to that of M_2 is η, then value of $\frac{18\eta}{25}$ is

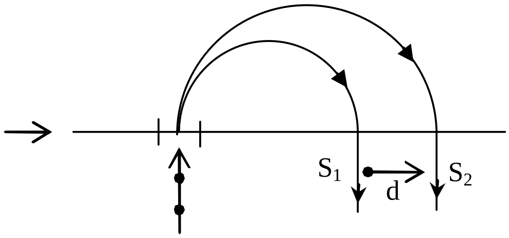
3. A black surface at constant high temperature T_H is parallel to another black plane surface at a constant lower temperature T_L (enclose vacuum in between). A heat shield consisting of two thin black plates is placed between the warm and the cold surfaces and parallel to these. After some time steady state is achieved. The value of $\eta = \frac{J_0}{J}$ is (J_o is initial heat current and J is final current)



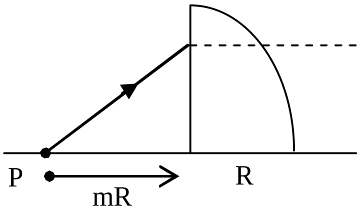
Space for rough work

4. The velocity filter of a mass spectrometer uses a uniform E = 100 v/m and a magnetic field $B_1 = 2\times10^{-2}$ T below filter at the uniform magnetic filed of induction 8×10^{-2} used to deflect the beam above filter. Both the beams are +e charged having mass numbers 20 and 22 pass through the filter and make a 180^{0} turn in the deflecting filed. If the distance between the points S_1 & S_2 is d, then find the approximate (integer) value of 2d?

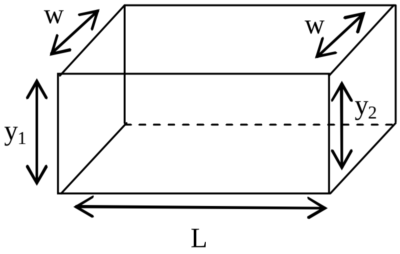
(Value of $\frac{1\text{amu}}{e} = 10^{-8}$ SI unit) (Note: spectrometer does not changes speed of ions)



5. A quarter cylinder of radius R and refractive index 1.5 is placed on a table as shown in figure. For what value of 3m, a ray from P will emerge parallel to table? Assume small aperture.

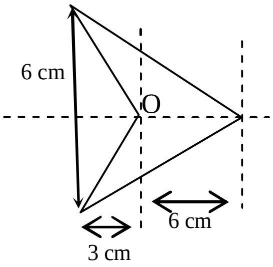


6. A material with uniform restively ρ is formed in the shape of a wedge as shown. The resistance of wedge across length L is $R = \frac{\rho\eta}{L}\ln\eta'$. Then find the value of $\frac{\eta}{6} + \eta'$. $\left(y = \frac{L}{3}, y_2 = \frac{L}{6}, W = \frac{L}{6}\right)$

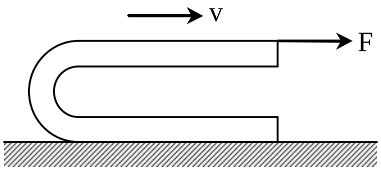


Space for rough work

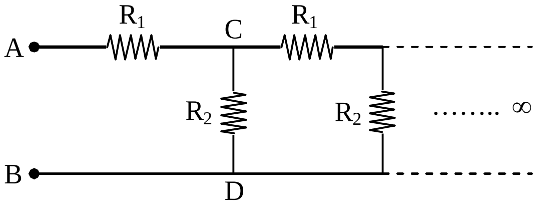
7. A uniformly thick plate in the shape of an arrowhead has dimension as shown. The centre of mass lies at a distance x cm from O. The value of x is



8. A long flexible inextensible rope of uniform mass density λ is being pulled on a rough floor with horizontal force F in such a way that the lower part is at rest and upper part moves with constant speed v as shown, the magnitude of F will be (in N) . $(\lambda = 1\,kg/m, v = 2m/s)$



9. Consider an infinite ladder net work as shown in figure A voltage is applied between points A and B. If the voltage is hawed after each section, find the ratio R_2/R_1.



10. Value of electric field at centre of charged hemisphere is ……… N/C if it has uniform charged density $\delta = 8\varepsilon_o c/m^2$ at surface.

Space for rough work

Chemistry PART – II

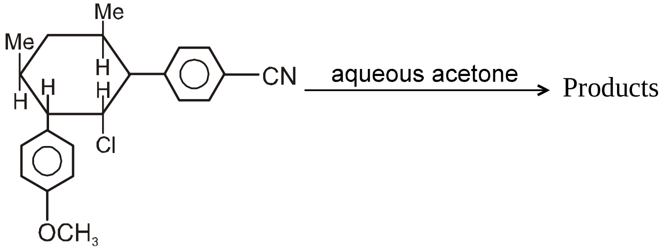
SECTION – A

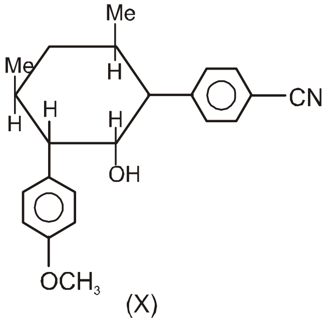
Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

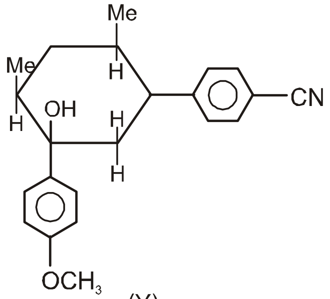
1. A system is changed from an initial state to a final state by a manner such that if the same change from the initial state to the final state were made by a different path, which of the following statements are correct for ΔH system?
(A) remain the same
(B) will depend upon the type of path
(C) Heat exchanged q will be same if the path is isobaric
(D) Heat exchanged q will be different if the path is not isobaric

2. Which of the following are correct regarding the products of the given reaction?

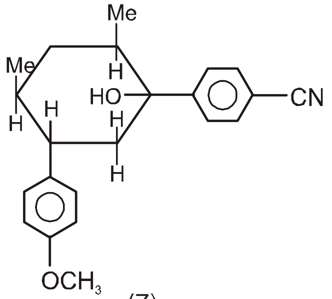

Me
Me
H
H
H
H
H
Cl
CN
aqueous acetone
Products
OCH_3


Me
Me
H
H
H
H
OH
CN
OCH_3

(X)


Me
Me
H
H
OH
H
H
CN
OCH_3

(Y)


Me
Me
H
HO
H
H
H
H
CN
OCH_3

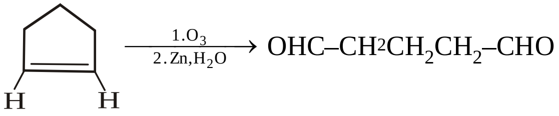
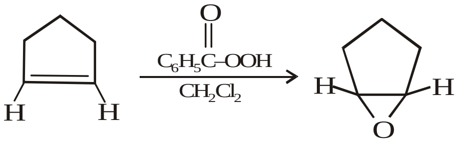
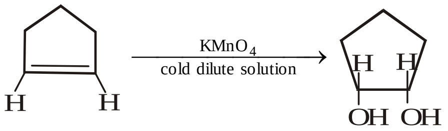
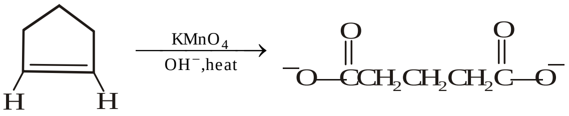
(Z)

(A) only X and Z are formed (B) Y > Z (amount)
(C) X > Y (amount) (D) Y > X (amount)

Space for rough work

3. Which of the following pairs of nitrates give the same gaseous products on thermal decomposition?
(A) KNO_3 and $Pb(NO_3)_2$ (B) KNO_3 and $NaNO_3$
(C) $Pb(NO_3)_2$ and $Cu(NO_3)_2$ (D) $NaNO_3$ and $Ca(NO_3)_2$

4. KO_2 finds use in oxygen cylinders used for space and submarines. The fact(s) related to such use of KO_2 is/are:
(A) it produces O_2 (B) It produces O_3
(C) It absorbs CO_2 (D) It absorbs both CO and CO_2

5. Which of the following are correct?
(A)

1.O3
2.Zn,H2O
OHC–CH2CH2CH2–CHO
H
H
(B)

O
C6H5C–OOH
CH2Cl2
H
H
H
H
O
(C)

KMnO4
cold dilute solution
H
H
H H
OH OH
(D)

KMnO4
OH⁻,heat
H
H
O
O
⁻O–CCH2CH2CH2C–O⁻

6. Which of the following statements are correct about stability of chelates–
(A) As the number of rings in complex increases, stability of chelate also increases
(B) A chelate having five membered ring is more stable if it contains double bonds.
(C) A chelate having six membered ring is more stable than if it does not contain double bonds.
(D) Chelating ligands are at least bidentate ligands.

7. Which of the following is/are extracted by electrolytic reduction?
(A) Cu (B) Al
(C) Mg (D) Ag

Space for rough work

8. Choose the incorrect statement:
(A) Salicylic acid (o–Hydroxybenzoic acid) is much stronger acid than its m-,p-isomers and benzoic acid itself.
(B) Acidity of salicylic acid is due to steric inhibition of resonance, as – OH group forces – COOH out of the plane of ring
(C) The orbitals which are in the same plane take part in resonance
(D) All the resonating structures have real existence

9. Rotation around the bond (between the underlined atoms) is restricted in:
(A) $\underline{C}_2H_4$
(B) $H_2\underline{O}_2$
(C) $\underline{C}_2H_2$
(D) $\underline{C}_2H_6$

10. Select the coloured compound(s):
(A) $K_2Cr_2O_7$
(B) $CuSO_4.5H_2O$
(C) $\left[V\left(H_2O\right)_6\right]Cl_3$
(D) $\left[Cu\left(NH_3\right)_4\right]SO_4$

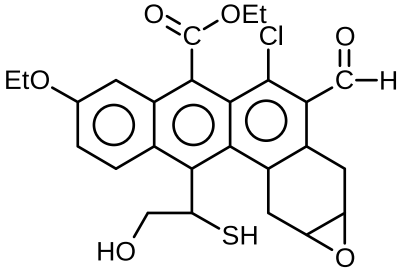
SECTION – C

(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

1. Find the total number of species having planar shape.
$I_3^+, XeF_4, SF_4, C_2F_4, H_2O_2, BrF_5, SO_3, NOCl, ClF_3, F_2CO, XeF_5^-$

2. How many moles of Grignard reagent are consumed in given compound?



Space for rough work

3. How many monochloro compounds including stereoisomers will give propene on treatment with Mg/ether followed by H_2O?

4. Find the sum of optically active isomers of both $\left[\mathrm{Pt(gly)_2Cl_2}\right]$ and $\left[\mathrm{Co(en)_2Cl_2}\right]$.

5. A polyhydric alcohol is acylated by using ethanoyl chloride in presence of alkali. It was observed that molecular mass of alcohol is increased to 237% on acylation. If the molecular mass of polyhydric alcohol is 92, then the number of –OH groups present in polyhydric alcohol are____

6. For the synthesis of ammonia at 300 K :

$$N_2(g) + 3H_{2(g)} \longrightarrow 2NH_3(g)$$

Calculate the value of Δ G° in Kcal and give your answer in magnitude by using the following data:

	N_2	H_2	NH_3
ΔH_f° (Kcal/mole)	0	0	-10
ΔS° (Cal/K-mole)	40	30	45

7. Calculate the change in pressure (in atm) when 2 mole of NO and 16 g O_2 in a 6.25 litre originally at 27°C react to produce the maximum quantity of NO_2 possible according to the equation.

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g) \qquad (\text{Take } R = \frac{1}{12} \text{ ltr. Atm/mol K})$$

8. Electrons in a sample of H−atoms make transitions from state n = x, to some lower excited state. The emission spectrum from the sample is found to contain only the lines belonging to a particular series. If one of the photons had an energy of 0.6375 eV. Then find the value of x.

[Take 0.6375 eV = $\frac{3}{4} \times 0.85$eV]

9. If the atomic number of the inert gas is XY in which the total number of d-electrons is equal to the difference in the number of total p- and s- electrons. Find |X-Y|.

10. For the reaction $3A(g) \rightarrow 2B(g) + 2C(g)$, starting with pure A, pressure after 9 min was 387.5 mm of Hg and after a long time was 400mm of Hg. Calculate half life of A in min.

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **10 multiple choice questions** numbered 1 to 10. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

1. If $2f(x)+xf\left(\frac{1}{x}\right)-2f\left(\left|\sqrt{2}\sin\pi\left(x+\frac{1}{4}\right)\right|\right)=4\cos^2\left(\frac{\pi x}{2}\right)+x\cos\frac{\pi}{x}, \forall x\in R=\{0\}$, then which of the following statement(s) is/are true?

(A) $f(2)+f\left(\frac{1}{2}\right)=1$

(B) $f(2)+f(1)=0$

(C) $f(2)+f(1)=f\left(\frac{1}{2}\right)$

(D) $f(1)f\left(\frac{1}{2}\right)f(2)=1$

2. Let ABC be a non obtuse triangle such that AB > AC & $\angle B=45^o$. Let O and I denote the circumcenter and incentre of $\triangle ABC$ respectively. Suppose that $\sqrt{2}OI=AB-AC$, then the possible values of sin $\angle BAC$ is/are

(A) $1/\sqrt{2}$

(B) $\sqrt{\frac{4\sqrt{2}-2}{2}}$

(C) $\frac{\sqrt{4\sqrt{2}-2}}{2}$

(D) 1/2

3. $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=1$ intersects the coordinate axis at points A, B and C resp. If $\triangle PQR$ has midpoints A, B, & C then

(A) centroid of $\triangle ABC$ & $\triangle PQR$ coincide

(B) foot of normal to $\triangle ABC$ from O is circumcentre of $\triangle PQR$

(C) area$(\triangle PQR)=2\sqrt{a^2b^2+b^2c^2+c^2a^2}$

(D) incentres of $\triangle ABC$ and $\triangle PQR$ coincide

Space for rough work

4. $\bar{x}\times\bar{y}=\bar{a},\ \bar{y}\times\bar{z}=\bar{b},\ \bar{x}.\,\bar{b}=\gamma, \bar{x}\,.\,\bar{y}=1\ \&\ \bar{y}.\bar{z}=1$ then

(A) $\bar{y}=\dfrac{\bar{a}\times\bar{b}}{\gamma}$
(B) $\bar{x}=\dfrac{1}{y^2}\left[\bar{y}-\bar{a}\times\bar{y}\right]$
(C) $\bar{z}=\dfrac{1}{y^2}\left[\bar{y}+\bar{b}\times\bar{y}\right]$
(D) $\bar{x}=\dfrac{1}{\gamma^2}\left[\bar{y}+\bar{a}\times\bar{y}\right]$

5. If the value of the definite integral $\int_0^1 {}^{207}C_7 x^{200}(1-x)^7\,dx$ is equal to $\dfrac{1}{k}$ where $k\in N$, then k is divisible by

(A) 13
(B) 16
(C) 9
(D) 52

6. A function $f:R\to R$ satisfies the equation $f(x+y)=f(x)+f(y)\forall x,y\in R$ & is continuous through out the domain. If $I_1+I_2+I_3+I_4+I_5=450$ where $I_n=n\int_0^n f(x)\,dx$, then

(A) $f(x)=4x$
(B) $f(x)=2x$
(C) $f'(0)=4$
(D) $f'(0)=2$

7. $A(\bar{a}),B(\bar{b}),C(\bar{c})$ are position vector of vertices of $\triangle ABC$ such that $\bar{a}.\bar{b}+\bar{a}.\bar{c}=\bar{a}.\bar{a}+\bar{b}.\bar{c}$. Also $\left|\bar{b}-\bar{c}\right|+\left|\bar{a}-\bar{b}\right|=2\left|\bar{a}-\bar{c}\right|$. Inradius of triangle is 1 unit, then which of the following statement is/are correct?

(A) $\sin^2 B+\sin^2 C=1$ where B = $\underline{|ABC}$ & C = $\underline{|ACB}$
(B) Diameter of circumcircle of $\triangle ABC$ is 5 units
(C) Area of $\triangle ABC$ is 6 sq. units
(D) $\dfrac{\text{Area of }\triangle ABC}{\text{semi perimeter of }\triangle ABC}=2$

Space for rough work

8. The curves $y = ax^3 + 4x\left(a \neq 0\right)$ & $xy = 1$ touch each other at points P and Q, where P is in first quadrant. A triangle is formed by drawing a tangent to $y = ax^3 + 4x$ at point Q and coordinate axes. Then which of the following is/are correct?
(A) The value of a is – 4
(B) The area of the triangle formed is 2
(C) The value of a is – 2
(D) The area of the triangle formed is 1

9. If the value of definite integral $\int_{-1}^{1} \cot^{-1}\left(\frac{1}{\sqrt{1-x^2}}\right)\left(\cot^{-1}\frac{x}{\sqrt{1-\left(x^2\right)^{|x|}}}\right)dx = \pi^2\left(\frac{\sqrt{a}-\sqrt{b}}{c}\right)$,
where a, b, c, $\in$ N in their lowest form then
(A) a = 1 (B) b = 2
(C) a = 2 (D) b = 1

10. Let $A = \begin{bmatrix} 0 & \alpha \\ 0 & 0 \end{bmatrix}$ & $\left(A + I\right)^{50} - 50A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$ then
(A) a + d =2 (B) a + b = 1
(C) b + c = 0 (D) a+ d = 1

SECTION – C

(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

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1. $\frac{\tan 1}{\cos 2} + \frac{\tan 2}{\cos 4} + ... + \frac{\tan 1024}{\cos 2048} = \tan\lambda - \tan\mu$, then $\left[\frac{\lambda-\mu}{1000}\right] = ...$, [ ] G.I.F .

2. A triangle ABC has positive integer sides, $\angle A = 2\angle B$ and $\angle C > 90^o$, then the minimum length of the perimeter of ABC is 70 + K then K is equal to

Space for rough work

3. The value of $\sum_{k=0}^{7}\left(\frac{{}^{7}C_k}{{}^{14}C_k}\sum_{r=k}^{14}\left({}^{r}C_k\right)\left({}^{14}C_r\right)\right)$ is $(k)^{k+1}$. Then k is

4. If the value of $\int_0^1 \frac{\sin^{-1}\sqrt{x}}{x^2-x+1}dx$ is $\frac{\pi^2}{\sqrt{n}}$ $(\text{where } n \in N)$, then the value of $\frac{n}{27}$ is

5. The sum of the following n term series for $\theta = 30^o$

$$\cos^2\theta + \cos^2\theta\cos(2\theta) + \cos^3\theta(\cos 3\theta) + ... + \cos^n\theta\cos(n\theta) \text{ is } (n+1)\left(\sin\frac{n\pi}{6}\right)\left(\frac{1}{k}\right)^n \text{, then k is}$$

6. A tourist takes a trip through a city in stages each stage consist of three segments of length 100 meters separated by right turns of 60^o. Between the last segment of one stage and first segment of the next stage, the tourist makes a left turn of 60^o. The distance the tourist will be from his initial position after 2017 stages is 100 k. Then k is

7. Let $A_n (n \in N)$ be a matrix of order $(2n-1)\times(2n-1)$ such that $a_{ij} = 0\ \forall i \neq j$ & $a_{ij} = n^2 + i + 1 - 2n\ \forall i = j$, where a_{ij} denotes the element of i^{th} row & j^{th} column of A_n. Let T_n = $(-1)^n \times$ (sum of all the element of A_n). Then the value of $\left[\frac{\sum_{n=1}^{102} T_n}{520200}\right]$, where $[.]$ represents the G.I.F, is

8. The minimum area bounded by the function $y = f(x)$ and $y = kx + 9$, $(k - R)$, where f satisfies the relation $f(x+y) = 2f(x) + xf(y) + y\sqrt{f(x)}\ \forall x, y \in R$ & $f'(0) = 0$ is 9 A, value of A is

9. Let $f(x)$ be a differentiable function such that $f'(x)$ is symmetrical about the line 2x = 5 and f(1) = 2, f(4) = 6 then $\int_2^3 f(x)dx$ is equal to

10. If the radius of circumcircle of the ΔTPQ where PQ is the chord of contact corresponding to point T with respect to circle $x^2 + y^2 - 2x + 4y - 11 = 0$ is b units. Then the minimum distance of T from director circle of the given circle is $12 - 4\sqrt{x}$, then k is equal to

Space for rough work

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ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – V
(Paper-1)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**A, C**	**A, C, D**	**A, B, C**
2.	**A, C, D**	**B, D**	**A, C**
3.	**B, D**	**B, C**	**A, B, C**
4.	**A, C**	**A, C**	**A, B, C**
5.	**A, C, D**	**A, B, C, D**	**A, B, C, D**
6.	**A, B**	**A, D**	**A, C**
7.	**C**	**B, C**	**A, B, C**
8.	**A**	**B, D**	**A, B**
9.	**D**	**A, C**	**C, D**
10.	**A, B, D**	**A, B, C, D**	**A, B, C**
1.	**6**	**7**	**2**
2.	**2**	**6**	**7**
3.	**3**	**4**	**6**
4.	**5**	**8**	**4**
5.	**4**	**3**	**2**
6.	**8**	**8**	**2**
7.	**1**	**2**	**2**
8.	**4**	**8**	**8**
9.	**2**	**3**	**4**
10.	**2**	**3**	**2**

Physics

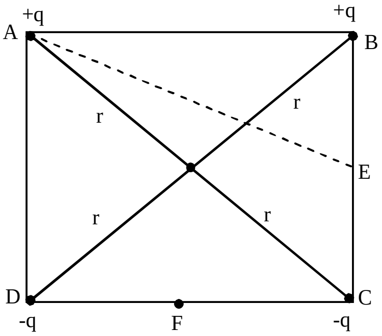
PART – I

SECTION – A

1. **A, C**

Refer to figure. potential at O is

$$V_0 = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{r}+\frac{q}{r}-\frac{q}{r}-\frac{q}{r}\right)=0$$



Refer to fig. again $(AE)^2 = a^2 + \left(\frac{a}{2}\right)^2$

$= \frac{5a^2}{4}$, giving $AE - \frac{\sqrt{5}a}{2}$. Similarly $DE = \frac{\sqrt{5}a}{2}$ and $BE = \frac{a}{2}, CE = \frac{a}{2}$. Potential at E is

$$V_E = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{AE}+\frac{q}{BE}-\frac{q}{DE}-\frac{q}{CE}\right)=0$$

Work done in carrying a charge – e from O to E is

$$W = -e(V_E - V_0)$$
$$= -e(0-0) = 0$$

Potential at F is

$$V_F = \frac{1}{4\pi\varepsilon_0}\left(\frac{q}{AF}+\frac{q}{BF}-\frac{q}{DF}-\frac{q}{CF}\right)$$

Now, $AF = BF = \sqrt{5}\ a/2$ and CF = DF = a/2

Putting these values, we get

$$V_F = \frac{q}{\pi\varepsilon_0 a}\left(\frac{1}{\sqrt{5}}-1\right)$$

Work done is carrying a charge – e from O to F is

$$W = -e\left(V_F - V_0\right) = -eV_F$$
$$= \frac{qe}{\pi\varepsilon_0 a}\left(1-\frac{1}{\sqrt{5}}\right)$$

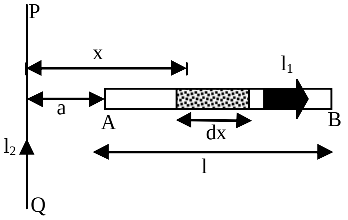
Hence the correct choice is (a) and (c).

2. **A, C, D**

In the steady state, no current flows through the branch ABC containing the capacitors. Thus all the current flows through ADC. So choice (a) is correct. Current through R_1 = current through R_2 = I = 12/24 = 0.5 A. Now p.d. across A and C = 12 V. Therefore $Q = V_1C_1 = V_2C_2$. Thus

$\frac{V_1}{V_2} = \frac{C_2}{C_1}$ =2. Also $V_1 + V_2 = 12$. Therefore, V_1 = 8 V and V_2 = 4V. Thus
$Q = C_1V_1 = 10\mu F \times 8V = 80\mu C =$ charge on C_2. Thus the correct choices are (a), (c) and (d)

3. **B, D**
Consider a small element of length dx of the rod at a distance x from wire PQ as shown in figure. The magnetic field use to wire PQ at the element is



$$dF = BI_1\, dx = \frac{\mu_0 I_1 I_2 dx}{2\pi x}$$

∴ Total force experienced by the rod is

$$F = \int dF$$

$$= \frac{\mu_0 I_1 I_2}{2\pi_2} \int_{x=a}^{x=(a+l)} \frac{dx}{x}$$

$$= \frac{\mu_0 I_1 I_2}{2\pi} \log_e\left(\frac{a+l}{a}\right)$$

Now, the magnetic field B is not uniform; it decreases as we go from and A to end B of the rod. Hence the rod will also experience a torque. Thus the correct choices are (b) and (d).

4. **A, C**
$\vec{v} = v\hat{e}_r + r\omega\hat{e}_\theta,\ t = \frac{\theta}{\omega},\ \vec{r} = \frac{v\theta}{\omega}\hat{e}$

5. **A, C, D**
Using Gauss theorem.

6. **A, B**
(a,b) as E $\propto \frac{1}{n^2}$, P $\propto \frac{1}{n}$ & W $\propto \frac{1}{n^3}$

7. **C**
$^{17}N_7 \longrightarrow {}^{6}Li_3 + 2\ {}_2He^4 + {}_0n^1 + 2\gamma$

8. **A**
From black body radiation concept.

9. **D**
The resistances of bulbs B_1, B_2 and B_3 respectively are

$$R_1 = \frac{V^2}{W_1} = \frac{(250)^2}{100} = 625\Omega$$

$$R_2 = \frac{(250)^2}{60} = 1042\Omega = R_3$$

Voltage across B_3 is V_3 = 250 V

Voltage across B_1 is $V_1 = \frac{VR_1}{(R_1 + R_2)}$

$$= \frac{250 \times 625}{(625 + 1042)} = 93.7V$$

Voltage across B_2 is $V_2 = 250 - 93.7 = 156.3V$

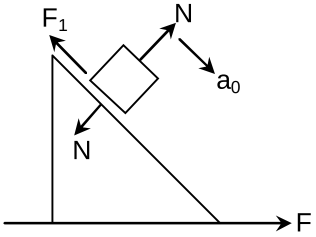
$$W_1 = \frac{V_1^2}{R_1} = \frac{(93.7)^2}{625} = 14W$$

Power output $W_2 = \frac{(156.3)^2}{1042} = 23W$

$$W_3 = \frac{(250)^2}{1042} = 60W$$

Hence $W_1 < W_2 < W_3$, which is choice (D)

10. **A, B, D**



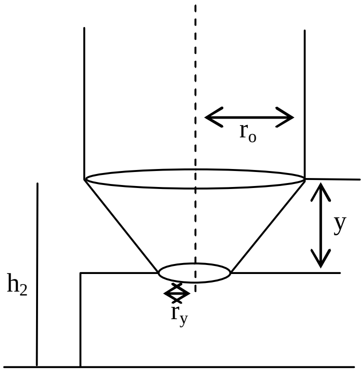
$$a_0 = g\sin\theta$$

$$F = N\sin\theta,\ N = mg\cos\theta$$

$$\Rightarrow F = \frac{1}{2}mg\sin 2\theta$$

SECTION – C

1. **6**



$$A_1V_1 = A_2V_2$$

$$V_y = \left(\frac{r_0}{r_y}\right)^2 u_0$$

By Bernoulli's theorem

$$\frac{p}{\rho} + \frac{1}{2}V_y^2 + gh_1 = \frac{p}{\rho} + \frac{1}{2}u_0^2 + gh_2$$

$$\Rightarrow r_y = r_0\left(1 + \frac{2gy}{u_0^2}\right)^{-1/4} = r_0[1 + 2y]^{-1/4}$$

$$\Rightarrow \eta + \alpha = 6$$

2. **2**

$\overline{\tau}_A = 0$

$m_2 g \ell_2 \sin 45^o = m_1 g \ell_1 \sin 45^o$ .... (1)

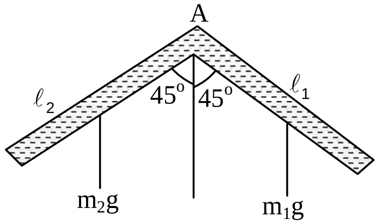
$m_1 = \rho_1 \ell_1,\ m_2 = \rho_2 \ell_2$

From (1),

$\rho_1 \ell_1^2 = \rho_2 \ell_2^2$

$$\eta = \frac{-\rho_1}{\rho_2} = \left(\frac{5}{3}\right)^2 = \frac{25}{9}$$

$$x = \frac{18}{25}\eta = 2$$



3. **3**

In steady state heat flow will be same across each sheet.

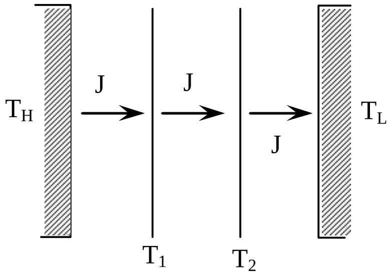
Now $J = \sigma\left(T_H^4 - T_1^4\right)A$

$J = \sigma\left(T_1^4 - T_2^4\right)A$

$J = \sigma\left(T_2^4 - T_L^4\right)A$

Now $3J = \sigma\left(T_H^4 - T_L^4\right) = J_o$

$$\frac{J_o}{J} = 3$$



4. **5**

Speed of ions

$$V = \frac{E_1}{B_1} = 5000 \text{ m s}^{-1}$$

$$S_1S_2 = 2(r_2 - r_1) = 2\left[\frac{m_2 v}{qB} - \frac{m_1 v}{qB}\right]$$

$$= \frac{2\times 5000}{B}\times(22-20)\frac{amu}{e}$$

$$= \frac{10^4}{8\times 10^{-2}}\times 2\times 10^{-8}$$

$$d = \frac{1}{4}\times 10^{-2}\text{m} = 2.5\text{mm}$$

5. **4**

For plane surface.

$$\frac{n_1}{-mR} + \frac{n_2}{v} = \frac{n_2 - n_1}{R_1}$$

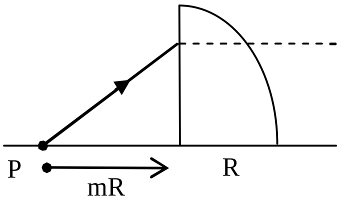
$n_1 = 1, n_2 = 1.5$ 1 $R_1 = \infty \Rightarrow v = -1.5mR$

For curve surface

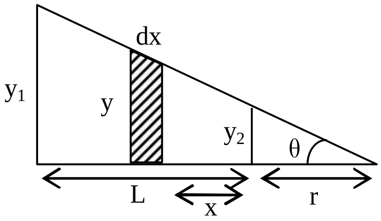
$$\frac{n_1}{-(1.5mR + R)} + \frac{n_2}{\infty} = \frac{n_2 - n_1}{R}$$

$n_2 = 1, n_1 = 1.5$

$$\Rightarrow m = \frac{4}{3}, 3m = 4$$



6. **8**



$$dR = \rho\frac{dx}{wy} \Rightarrow \frac{y}{x+r} = \frac{y_1}{L+r}$$

$$R = \int_0^L \rho\frac{dx}{wy} = \frac{\rho(L+r)}{wy_1}\ln\frac{L+r}{r}$$

$$\text{Now } r = \frac{y_2}{y_1-y_2}L \quad R = \frac{\rho L}{w(y_1-y_2)}\ln\frac{y_1}{y_2} = \frac{36\rho}{L}\ln 2$$

7. **1**

$$x_{cm} = \frac{A_1x_1 - A_2x_2}{A_1 - A_2}$$

$$A_1 = \frac{1}{2}\times 6\times 9 = 27cm^2$$

$$A_2 = \frac{1}{2}\times 6\times 3 = 9cm^2$$

$$X_1 = 0, X_2 = -2$$

$$X_{cm} = \frac{27\times 0 - 9\times -2}{27-9} = 1cm$$

8. **4**

$$F = v\frac{dm}{dt} = \lambda v^2$$

4N

9. **2**

$$V_{AB} = X$$

$$R_1 + \frac{R_2x}{R_2+x} = x$$

$$V_{AB} = 2V_{cd}$$

$$\therefore V_{AC} = V_{CD}$$

$$\therefore R_1 = \frac{R_2x}{R_2+x}$$

$$\text{Now } 2R_x = x$$

$$R_1 = \frac{R_1R_2}{R_2+2R_1} \Rightarrow \frac{R_2}{R_1} = 2$$

10. **2**

$$E_c = \frac{\delta}{4\varepsilon_o} = 2N/C$$

Chemistry PART – II

SECTION – A

1. **A, C, D**
ΔH is a state function so it is independent of path.

2. **B, D**
The yield of product will depend on stability of the carbocation. Carbocation corresponding to (y) is more stable than (z) as well as (x).

3. **B, C**
$KNO_3 \longrightarrow KNO_2 + O_2$
$NaNO_3 \longrightarrow NaNO_2 + O_2$
$Cu(NO_3)_2 \longrightarrow CuO + NO_2$
$Pb(NO_3)_2 \longrightarrow PbO + NO_2$

4. **A, C**
Fact.

5. **A, B, C, D**
(A) bond cleavage takes place as a result of reductive ozonolysis.
(B) epoxidation
(C) syn addition
(D) oxidative cleavages in basic medium

6. **A, D**
Fact.

7. **B, C**
Highly electropositive metal are extracted by electrolytic reduction.

8. **B, D**
Fact.

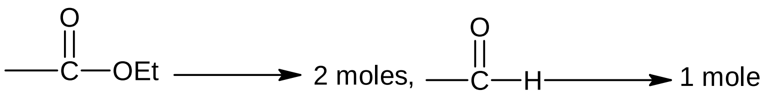
9. **A, C**
Rotation is restricted about $\pi - \text{bond}$.

10. **A, B, C, D**
Fact.

SECTION – C

1. **7**
I_3^+, XeF_4, C_2F_4
$SO_3, NOCl, ClF_3$
$F_2CO,$

2. **6**

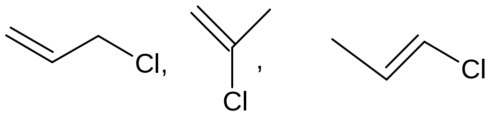


$$-\overset{\overset{\displaystyle O}{||}}{C}-OEt \longrightarrow 2\text{ moles},\ -\overset{\overset{\displaystyle O}{||}}{C}-H \longrightarrow 1\text{ mole}$$

$-OH \longrightarrow$ 1 mole, $-SH \longrightarrow$ 1 mole,

Epoxide – 1 mole so total 6 moles.

3. **4**

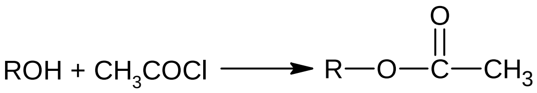


(E & Z)

4. **8**

$\left[Pt(gly)_2Cl_2\right]and\left[Co(en)_2Cl_2\right]$ have 6 & 2 optically active isomers respectively.

5. **3**



$$ROH + CH_3COCl \longrightarrow R-O-\overset{\overset{\displaystyle O}{||}}{C}-CH_3$$

In the above reaction molecule wt. of product is increased by 42 units.
So if n, - OH groups were present in the compound then increase in molecule wt. will be 42 n
increase in mass of compound $= 218 - 92 = 126$
$42n = 126 \Rightarrow n = 3$

6. **8**

$$\Delta H^0_R = 2\times\Delta H^0_f(NH_3) - 3\times\Delta H^0_f(H_2) - \Delta H^0_f(H_2) = -20Kcal$$
$$\Delta S^0_R = 2\times\Delta S^0_f(NH_3) - 3\times\Delta S^0_f(H_2) - \Delta S^0_f(N_2)$$
$$= 2\times45 - 3\times30 - 40 = -40\text{ cal} = -0.04\text{ Kcal}$$
$$\Delta G^0 = \Delta H^0 - T\Delta S^0 = -8\text{ K cal}$$

7. **2**

$$\begin{array}{lll} 2NO + O_2 & \longrightarrow & 2NO_2 \\ 2 \quad\ \ 0.5 & & 0 \\ 2-1 \quad 0 & & 1 \end{array}$$
$n_i = 2.5,\ n_f = 2$
$\Delta n = 0.5$
$$\Delta P = \frac{\Delta nRT}{v} = \frac{0.5\times0.0821\times300}{6.25} = 2$$

8. **8**

$$\Delta E = \frac{3}{4}\times0.85eV$$
$$0.85\left(1-\frac{1}{4}\right) = 13.6\left(\frac{1}{4^2}-\frac{1}{n^2}\right)$$
$n = 8$

9. **3**

$S - e^{-} = 8$

$P - e = 18$

$Pe^{-} - Se^{-} = 10$

$de^{-} = 10$

$At.No = 36$

$6 - 3 = 3$

10. **3**

$$3A(g) \rightarrow 2B(g) + 2C(g)$$

t = 0	3P	0	0
t = 9	$3P - 3P_1$	$2P_1$	$2P_1$
t = ∞	0	2P	2P

Total pressure after long time = 4P = 400 $\Rightarrow$ P = 100

Pressure after 9 minutes = 3P + P_1 = 387.5 $\Rightarrow$ P_1 = 87.5

Pressure of A becomes one-eighth in 9 minutes. That means $3t_{1/2} = 9 \Rightarrow t_{1/2} = 3$

Mathematics

PART – III

SECTION – A

1. **A, B, C**

Replace x by 2, we get

$$2f(2)+2f\left(\frac{1}{2}\right)-2f(1)=4 \qquad ....(i)$$

$$\Rightarrow f(2)+f\left(\frac{1}{2}\right)=2+f(1)$$

Replace x by 1, $f(1)=-1$ ....(ii)

Replace x by $\frac{1}{2}, 2f\left(\frac{1}{2}\right)+\frac{1}{2}f(2)+2=\frac{5}{2}$ ......(iii)

Solving (i) & (iii) $f\left(\frac{1}{2}\right)=0, f(2)=1$

2. **A, C**

$$\sin B=\frac{1}{\sqrt{2}},\ \tan\left(\frac{B}{2}\right)=\left(\sqrt{2}-1\right)$$

$$\&\sin C=\sin\left(135^{o}-A\right)=\frac{\sqrt{2}\left(\sin A+\cos A\right)}{2}$$

$$r=\frac{c+a-b}{2}\tan\left(\frac{\mathbf{B}}{2}\right)$$

$$=R\left(\sqrt{2}-1\right)\left(\sin A+\sin C-\sin B\right)$$

$$OI=R^{2}-2Rr$$

$$OI^{2}=R^{2}\left(1-2\sin A-2\sin C+2\sin B\left(\sqrt{2}-1\right)\right) \quad ....(ii)$$

$$\&\sqrt{2}OI=AB-AC$$

$$OI^{2}=\left(C-2\left(\sin A+\sin C-\sin B\right)\right)\left(\sqrt{2}-1\right)...........(iii)$$

From (i) & (ii), we obtain

$$2\left(\sin C-\sin B\right)^{2}=\left(1-2\left(\sin A+\sin C-\sin B\right)\left(\sqrt{2}-1\right)\right)$$

$$\Rightarrow 1-2\left(\sin C-\sin B\right)^{2}=\left(\sin A+\sin C-\sin B\right)\left(\sqrt{2}-1\right)$$

$$\Rightarrow 1-2\sin^{2}C+2\sqrt{2}\sin C-1=2\left(\sin A+\sin C\right)\left(\sqrt{2}-1\right)-\left(2-\sqrt{2}\right)$$

$$\Rightarrow -\left(\sin A+\cos A\right)+2\left(\sin A+\cos A\right)=\left(2\sqrt{2}-2\right)\sin A+\left(2-\sqrt{2}\right)\left(\sin A+\cos A\right)$$

$$<-\left(2-\sqrt{2}\right)$$

$$\Rightarrow -1-2\sin A\cos A=\left(\sqrt{2}-2\right)\sin A-\sqrt{2}\cos B-2\left(2-\sqrt{2}\right)$$

$$\Rightarrow \left(\sqrt{2}\sin A-1\right)\left(\sqrt{2}\cos A-\sqrt{2}+1\right)=0$$

$$\Rightarrow \sin A=\frac{1}{\sqrt{2}}\ \&\cos A=\frac{1-\sqrt{2}}{\sqrt{2}} \quad \Rightarrow \sin A=\frac{\sqrt{4\sqrt{2}-2}}{2}$$

3. **A, B, C**

$AC \parallel PR \ \& \ 2AC = PR$

So, ABPC is a parallelogram comparing the coordinates of midpoints of diagonal, we get

$P(-a,b,c)Q(a,-b,c)\,\&\,R(a,b,-c)$.

Also AD & AP are medians of ΔABC and ΔPQR respectively.

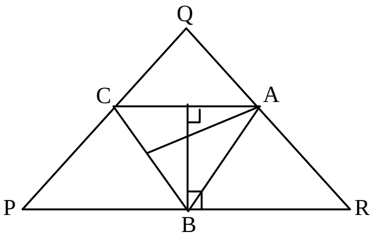
So, centroids are coinciding. The perpendicular bisector of PR is also perpendicular to AC.

$\therefore$ the circumcenter of ΔPQR is orthocentre of ΔABC

$\text{area}(\Delta PQR) = 4\text{area}(\Delta ABC)$

$= 4\sqrt{(OAB)^2 + (OBC)^2} + (OAC)^2$

Where OAB is the area of projection of ΔABC on the plane XOZ etc.



4. **A, B, C**

$(\bar{x} \times \bar{y}) \times \bar{b} = \bar{a} \times \bar{b}$

$\Rightarrow (\bar{x}.\ \bar{b}).\bar{y} - (\bar{y}\ .\ \bar{b})\bar{x} = \bar{a} \times \bar{b}$

$\Rightarrow \gamma.\bar{y} - (\bar{y}\ .\ \bar{b}).\bar{x} = \bar{a} \times \bar{b} \qquad (\because \bar{x}.\bar{b} = \gamma)$

$\bar{y}.\bar{b} = \bar{y}.(\bar{y} \times \bar{z}) = 0$

$\Rightarrow \bar{y} = \dfrac{\bar{a} \times \bar{b}}{\gamma}$

$\Rightarrow (\bar{x} \times \bar{y}) \times \bar{y} = \bar{a} \times \bar{y}$

$\Rightarrow (\bar{x}.\bar{y}).\bar{y} - (\bar{y}.\bar{y})\bar{x} = \bar{a} \times \bar{y}$

$\Rightarrow \bar{y} - |\bar{y}|^2\,\bar{x} = \bar{a} \times \bar{y} \qquad (\because \bar{x}.\bar{y} = 1)$

$\Rightarrow \bar{x} = \dfrac{1}{y^2}\left[\bar{y} - \bar{a} \times \bar{y}\right]$

$(\bar{y} \times \bar{z}) \times \bar{y} = \bar{b} \times \bar{y}$

$\Rightarrow y^2\bar{z} - (\bar{z}.\ \bar{y}).\bar{y} = \bar{b} \times \bar{y} \ \ \Rightarrow y^2\bar{z} - \bar{y} = \bar{b} \times \bar{y}$

$\Rightarrow \bar{z} = \dfrac{1}{y^2}\left[\bar{y} + \bar{b} \times \bar{y}\right]$

5. **A, B, C, D**

$$I = \int_0^1 {}^{207}C_7\, \underset{II}{x^{200}}\, \underset{I}{(1-x)^7\, dx}$$

$$= {}^{207}C_7 \left[(1-x)^7, \frac{x^{201}}{201}\right]_0^1 + \frac{7}{207}\int_0^1 (1-x)^6 .x^{201} dx$$

$$= {}^{207}C_7\, \frac{7}{201}\int_0^1 (1-x)^6\, x^{201} dx$$

Similarly by applying integration by part 6 times we get

$$I = {}^{207}C_7 . \frac{7.6.5.4.3.2.1}{201.202.203......207}\int_0^1 x^{207}dx$$

$$= \frac{207!}{7!200!}.\frac{7!}{201!202.203}.............\frac{1}{207....208}$$

$$= \frac{1}{208} = \frac{1}{k}$$

6. **A, C**

$f(x) = kx$

$$1.\int_0^1 kxdx + 2\int_0^2 kxdx$$

$$+3\int_0^3 kxdx + 4\int_0^4 kxdx + 5.\int_0^5 kxdx$$

$$= \frac{k}{2}\left[1^3 + 2^3 + 3^3 + 4^3 + 5^3\right]$$

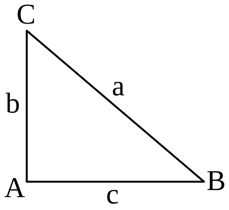
$$= \frac{k}{2}\left[\frac{5\times 6}{3}\right]^2$$

$$= \frac{225K}{2}$$

$$\text{given}\frac{225K}{2} = 450$$

$$\Rightarrow k = 4$$

7. **A, B, C**



$\bar{a}.(\bar{b} - \bar{a}) - \bar{c}(\bar{b} - \bar{a}) = 0$

$\overline{AC}.\ \overline{AB} = 0$

Also $a + c = 2b - (i)\ \&\ b^2 + c^2 = a^2$

$b^2 = (a-c)(a+c) = 2b(a-c)$

$\Rightarrow b = 2(a-c) - (ii)$

From $(i)\ \&\ (ii)$ we get

$$\frac{a}{5} = \frac{b}{4} = \frac{c}{3} = \lambda$$

$\because$ Inradius $= 1 \Rightarrow \dfrac{6\lambda^2}{6\lambda} = 1 \Rightarrow \lambda = 1$

$\therefore a = 5, b = 4, c = 3$

8. **A, B**

At the point of contact of two functions their value are equal and their derivatives are equal.

$$f(x) = g(x) \qquad \& \ f'(x) = g'(x)$$

$$ax^3 + 4x = \frac{1}{x} \qquad \& \ 3ax^2 + 4 = -\frac{1}{x^2}$$

$$\Rightarrow x^2 = \frac{1}{2}$$

$$\Rightarrow a = -4$$

$$\therefore P\left(\frac{1}{\sqrt{2}}, \sqrt{2}\right) \& \quad Q\left(\frac{-1}{\sqrt{2}}, -\sqrt{2}\right)$$

Area of triangle formed by any tangent to rectangular hyperbola $xy = c^2$ with coordinate axis equal to $2c^2$

$\therefore$ Area $= 2$

9. **C, D**

$$\int_{-1}^{1} \cot^{-1}\left(\frac{1}{\sqrt{1-x^2}}\right)\cot^{-1}\frac{x}{\sqrt{1-\left(x^2\right)^{|x|}}}dx$$

$$= \int_{-1}^{1} \cot^{-1}\left(\frac{1}{\sqrt{1-x^2}}\right)\cot^{-1}\left(\frac{-x}{\sqrt{1-\left(x^2\right)^{|x|}}}\right)dx$$

$$2I = \int_{-1}^{1} \cot^{-1}\frac{1}{\sqrt{1-x^2}}\left(\cot^{-1}\frac{x}{\sqrt{1-\left(x^2\right)^{|x|}}} + \pi - \cot^{-1}\frac{x}{\sqrt{1-\left(x\right)^{2|x|}}}\right)dx$$

$$2I = \pi\int_{-1}^{1} \cot^{-1}\frac{1}{\sqrt{1-x^2}}dx$$

$$2I = \pi\int_{-1}^{1} \tan^{-1}\sqrt{1-x^2}\,dx$$

Integrating by parts

$$I = \frac{\pi}{2}\left[x\tan^{-1}\sqrt{1-x^2}\right]_0^1 - \pi\int_0^1 \frac{x}{1+1-x^2}\left(\frac{-x}{\sqrt{1-x^2}}\right)dx$$

$$I = \frac{\pi}{2}\int_0^1 \frac{x^2dx}{\left(2-x^2\right)\sqrt{1-x^2}} \quad \text{put } x = \sin\theta,\ dx = \cos\theta\ d\theta$$

$$= \frac{\pi}{2}\int_0^{\pi/2} \frac{\sin^2\theta}{2-\sin^2\theta}d\theta$$

$$= \frac{\pi}{2}\int_0^{\pi/2} \frac{\sin^2\theta - 2 + 2}{2-\sin^2\theta}d\theta$$

$$= \frac{-\pi}{2}\int_0^{\pi/2} d\theta + \pi\int_0^{\pi/2} \frac{d\theta}{2-\sin^2\theta}$$

$$= \frac{-\pi^2}{4} + \pi\int_0^{\pi/2} \frac{\sec^2\theta d\theta}{2\tan^2\theta + 2 - \tan^2\theta}$$

$$= \frac{-\pi^2}{4} + \pi\int_0^\infty \frac{dk}{k^2+2} \qquad (\tan\theta = k)$$

$$= \frac{-\pi^2}{4} + \pi.\frac{1}{\sqrt{2}}\left[\tan^{-1}\frac{k}{\sqrt{2}}\right]_0^\infty$$

$$= \frac{-\pi^2}{4} + \frac{\pi^2}{2\sqrt{2}}$$

$$= \pi^2\left(\frac{-1+\sqrt{2}}{4}\right)$$

10. **A, B, C**

$$A = \begin{bmatrix} 0 & \alpha \\ 0 & 0 \end{bmatrix}$$

$$A^2 = \begin{bmatrix} 0 & \alpha \\ 0 & 0 \end{bmatrix}\begin{bmatrix} 0 & \alpha \\ 0 & 0 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

$$\Rightarrow A^3 = 0$$

$$(A+I)^3 = A^3 + 3A^2 + 3A + I$$

$$(A+I)^{50} = 50A + I$$

$$(A+I)^{50} - 50A = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

SECTION – C

1. **2**

$$\frac{\tan\theta}{\cos 2\theta} = \frac{\tan\theta(1+\tan^2\theta)}{1-\tan^2\theta} = \tan 2\theta - \tan\theta$$

$$\therefore (\tan 2 - \tan 1) + (\tan 4 - \tan 2) + \ldots\ldots\ldots\ldots\ldots + \tan(2048 - \tan 1024)$$

$$= \tan 2048 - \tan 1$$

2. **7**

$\sin A = \sin 2B \Rightarrow \sin A = 2\sin B\cos B$

Also, sinC = sin3B = 3 sinB – 4 $\sin^3$B

$\therefore a = 2b\cos B, c = b(3 - 4\sin^2 B) = b(4\cos^2 B - 1)$

hence $a^2 = b(b+c)$

A triangle of smallest perimeter means $\gcd(a,b,c) = 1$.

In fact $\gcd(b,c) = 1$ since any common factor of b, c would be a factor of a as well.

$\because$ A perfect square a^2 is being expressed as the product of two relatively prime integers b and c, it must be the case that both b & b + c are perfect squares. Thus for some integer m & n with $\gcd(m,\ n) = 1$ we have

$b = m^2 \ \& \ b + c = n^2, a = mn$

$2\cos B = \frac{n}{m} = \frac{a}{b}$

$\because \angle C > 90^o \Rightarrow O < B < 30^o$

$\& \sqrt{3} < 2\cos B = \frac{n}{m} < 2$

The smallest value of (m, n) that satisfies the above mentioned conditions are 4 and 7.

3. **6**

$$\sum_{k=0}^{7}\left(\frac{{}^7C_k}{\underline{|14}}\underline{|k}\ \underline{|14-k}\sum_{r=K}^{14}\frac{\underline{|r}}{\underline{|k}\ \underline{|r-k}}\frac{\underline{|14}}{\underline{|r}\ \underline{|14-r}}\right)$$

$$= \sum_{k=0}^{7}\left({}^7C_k\sum_{r=k}^{14}{}^{14-K}C_{7-k}\right) = \sum_{k=0}^{7}{}^7C_k 2^{14-k}$$

$$= 2^{14}\sum_{k=0}^{7}{}^7C_k\left(\frac{1}{2}\right)^k = 6^7 > 7^6$$

4. **4**

$$I = \int_0^1 \frac{\sin^{-1}\sqrt{x}}{x^2 - x + 1}dx \quad .....(i)$$

$$= \int_0^1 \frac{\sin^{-1}\sqrt{1-x}}{(1-x)^2 - (1-x) + 1}dx$$

$$= \int_0^1 \frac{\cos^{-1}\sqrt{x}}{x^2 - x + 1}dx \qquad ....(ii)$$

$\text{Adding}(i) \& (ii)$

$$2I = \frac{\pi}{2}\int_0^1 \frac{1}{x^2 - x + 1}dx$$

$$2I = \frac{\pi}{2}.\frac{1}{\left(\frac{\sqrt{3}}{2}\right)}\left[\tan^{-1}\left(\frac{2x-1}{\sqrt{3}}\right)\right]_0^1$$

$$2I = \frac{\pi^2}{3\sqrt{3}}$$

$$I = \frac{\pi^2}{\sqrt{108}}$$

$n = 108$

5. **2**

$z = \cos\theta(\cos\theta + i\sin\theta)$

$$\sum_{k=1}^{n} z^k = \frac{z - z^{n+1}}{1 - z}$$

$$\sum_{k=1}^{n}\cos^k\theta(\cos k\theta + i\sin k\theta)$$

$$= \frac{\cos\theta(\cos\theta + i\sin\theta) - \cos^{n+1}\theta(\cos(n+1)\theta + i\sin(n+1)\theta)}{\sin^2\theta - i\cos\theta\sin\theta}$$

$$=\frac{i\cos\theta(\cos\theta+i\sin\theta)-\cos^{n+1}\theta(\cos(n+1)\theta+i\sin(n+1)\theta)}{\sin\theta(\cos\theta+i\sin\theta)}$$

$$=i\left(\cot\theta-\frac{\cos^{n+1}\theta(\cos n\theta+i\sin n\theta)}{\sin\theta}\right)$$

$$=\frac{\sin n\theta\cos^{n+1}\theta}{\sin\theta}+i\left(\cot\theta-\frac{\cos^{n+1}\theta\cos n\theta}{\sin\theta}\right)$$

$$\sum_{k=1}^{n}(\cos\theta)^k\cos k\theta=\frac{\sin n\theta\cos^{n+1}\theta}{\sin\theta}$$

For θ= 30°

$$=2\sin\frac{n\pi}{6}\left(\frac{\sqrt{3}}{2}\right)^{n+1}$$

6. **2**

In one stage the tourist traverses the complex number

$$x=100+100\bar{z}+100\bar{z}^2=100-100\sqrt{3}i$$

where $z=\cos\frac{\pi}{3}+i\sin\frac{\pi}{3}$

In 2017 stages, the tourist traverses the complex number

$$W=x+xz+xz^2+.....+xz^{2016}$$

$$=x\left(\frac{1-z^{2017}}{1-z}\right)=$$

$$=xz$$

$$|W|=|xz|=200$$

7. **2**

$$a_{ij}=0\forall i\neq j$$

$$a_{ij}=(n-1)^2+i\forall i=j$$

$\therefore$ sum of all the elements of A_n

$$=\sum_{i=1}^{2n-1}\left[(n-1)^2+i\right]$$

$$=(2n-1)(n-1)^2+(2n-1)n$$

$$=2n^3-3n^2+3n+1$$

$$=n^3+(n-1)^3$$

$$T_n=(-1)^n\left[n^3+(n-1)^3\right]$$

$$=(-1)^n n^3-(-1)^{n-1}(n-1)^3$$

$$=V_n-V_{n-1}$$

$$\Rightarrow\sum_{n=1}^{102}T_n=\sum_{n=1}^{102}(V_n-V_{n-1})=V_{102}-V_0=(102)^3$$

$$\Rightarrow\left[\frac{\sum_{n=1}^{-102}T_n}{520200}\right]=2$$

8. **8**

$$f'(x) = \lim_{x\to\infty} \frac{f(x+h) - f(x+0)}{h}$$

$$= \lim_{x\to\infty} \frac{2f(x) + xf(h) + h\sqrt{f(x)} - 2f(x) - xf(0) + 0\sqrt{f(x)}}{h}$$

As f (0) = 0

$$\Rightarrow \lim_{h\to 0} x\left(\frac{f(h) - f(0)}{h - 0}\right) + \sqrt{f(x)}$$

$$f'(x) = \sqrt{f(x)}$$

$$\int \frac{f'(x)}{\sqrt{f(x)}} dx = \int dx \quad \Rightarrow 2\sqrt{f(x)} = x + C$$

$$f(x) = \frac{x^2}{4}$$

when $\alpha = 0$, area is minimum

Required min area = $2\int_0^9 2\sqrt{y}dy$

$= 72$ sq. unit

9. **4**

$$f'\left(\frac{5}{2} - x\right) = f'\left(\frac{5}{2} + x\right)$$

Replacing x by $\frac{5}{2} - x$

$$f'(x) = f'(5 - x) \Rightarrow F(x) = -F(5 - x) + C$$

$$\Rightarrow C = f(x) + f(5 - x)$$

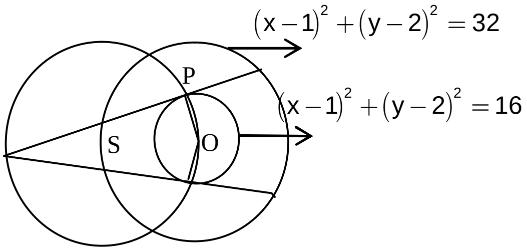
$$\Rightarrow C = 8$$

$$I = \int_2^3 f(x)dx = \int_2^3 f(5 - x)dx$$

$$\Rightarrow 2I = \int_2^3 f(x) + f(5 - x)dx$$

$$= \int_2^3 8dx \quad \Rightarrow I = 4$$

10. **2**



$$TS = OT - SO = 12 - 4\sqrt{2}$$

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

ALL INDIA TEST SERIES

FIITJEE **JEE (Advanced), 2017**

FULL TEST – V

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 10)** contains 10 multiple choice questions which have one correct answer. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (11 to 16) contains 3 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Section-A (17 – 20) contains 4 Matching Lists Type questions: Each question has four statements in LIST I & 4 or 5 statements in LIST II. The codes for lists have choices (A), (B), (C), (D) out of which only one is correct. Each question carries **+3 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

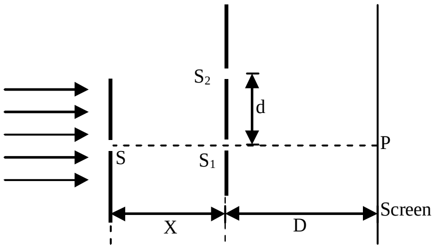
SECTION – A

Single Correct Choice Type

This section contains **10 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct.

1. A heavy nucleus at rest breaks into two fragments which fly off with velocities in the ratio of 8 : 1. The ratio of the radii of the fragments (assumed spherical) is
(A) 1 : 2 (B) 1 : 4
(C) 4 : 1 (D) 2 : 1

2. Monochromatic light of wavelength λ emerging from slit S illuminates slits S_1 and S_2 which are placed with respect to S as shown in Fig. 27.5. The distances x and D are large compared to the separation d between the slits. If x = D/2, the minimum value of d so that there is a dark fringe at the centre P of the screen is



(A) $\sqrt{\frac{\lambda D}{3}}$ (B) $\sqrt{\frac{2\lambda D}{3}}$
(C) $\sqrt{\lambda D}$ (D) $2\sqrt{\frac{\lambda D}{3}}$

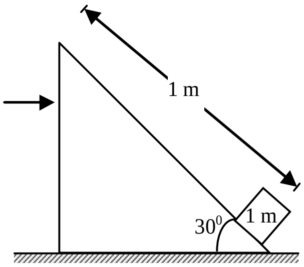
3. A particle free to move along the x-axis has potential energy given by
$U(x) = k[1-\exp(-x^2)]$ for $-\infty \le x \le +\infty$
where k is a constant of appropriate dimension.
Then
(A) at points away from the origin, the particle is in unstable equilibrium
(B) for any finite nonzero value of x, there is a force directed away from the origin
(C) if its total mechanical energy is k/2, it has its minimum kinetic energy at the origin
(D) for small displacements from x = 0, the motion is simple harmonic

Space for rough work

4. Three rods of the same length are arranged to form an equilateral triangle. Two rods are made of the same material of coefficient of linear expansion α_1 and the third rod which forms the base of the triangle has coefficient of expansion α_2. The altitude of the triangle will remain the same at all temperatures if the α_1 / α_2 is nearly

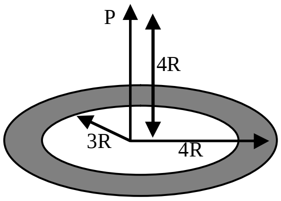
(A) 1	(B) 1/2
(C) 1/4	(D) 4

5. In the figure, the wedge is pushed with an acceleration of $10\sqrt{3}\ m/s^1$. It is seen that the block starts climbing upon the smooth inclined face of wedge. What will be the time taken by the block to reach the top?



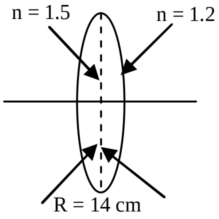
(A) $\frac{2}{\sqrt{5}}$s	(B) $\frac{1}{\sqrt{5}}$s
(C) $\sqrt{5}$ s	(D) $\sqrt{\frac{5}{2}}$ s

6. A thin uniform annular disc (see figure) of mass M has outer radius 4R and inner radius 3R. The work required to take a unit mass from point P on its axis to infinity is



(A) $\frac{2GM}{7R}\left(4\sqrt{2}-5\right)$	(B) $-\frac{2GM}{7R}\left(4\sqrt{2}-5\right)$
(C) $\frac{GM}{4R}$	(D) $\frac{2GM}{5R}\left(\sqrt{2}-1\right)$

7. A bi-convex lens is formed with two thin planoconvex lenses as shown in the figure. Refractive index n of the first lens is 1.5 and that of the second lens is 1.2. Both the curved surface are of the same radius of curvature R = 14 cm, For this Bi-convex lens, for an object distance of 40 cm, the image distance will be

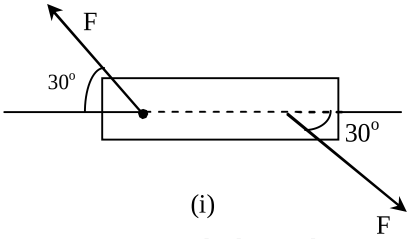


(A) -280.0 cm	(B) 40.0 cm
(C) 21.5 cm	(D) 13.3 cm

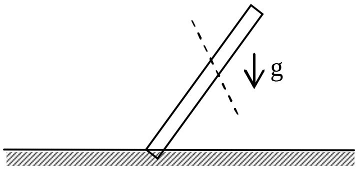
Space for rough work

8. The half-life of ^{131}I is 8 days. Given a sample of ^{131}I at time t = 0, we can conclude that
(A) no nucleus will decay before t = 4 days
(B) no nucleus will decay before t = 8 days
(C) all neclei will decay before t = 16 days
(D) a given nucleus may decay any time after t = 0

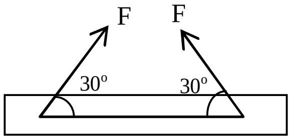
9. Which of cases have a non zero net torque activity on the rod about its centre?



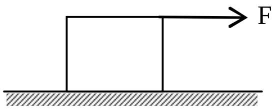
(i)
Force are applied on rod



(ii
Rod sliding on smooth ground



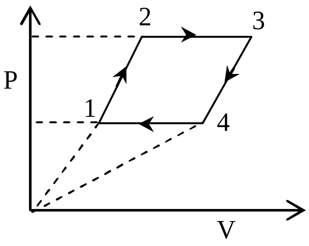
(iii)



(iv)
(Cube is pulled on smooth surface and moving with constant acceleration)

(A) In case (i), (ii)
(B) In case (ii), (iv), (i)
(C) In case (i) & (iii)
(D) In all case

10. Three moles of an ideal monatomic gas performs a cycle shown in figure then temperature of the gas is different states asked as 1, 2, 3 and 4 in figure are 400, 700, 2500 & 1100 K respectively
(A) value of $= P_2 / P_1 = V_4 / V_3$
(B) value of $P_2 / P_1 = V_3 / V_4$
(C) work done = 14 J
(D) work done $= 18.247$J

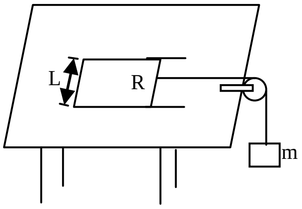


Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct.

Paragraph for Questions 11 & 12



A pair of parallel horizontal conducting rails of negligible resistance shorted at one end is fixed on a table. The distance between the rails is L. A conducting massless road of resistance R can slide on the rails without friction. The rod is tied to a massless string which passes over a pulley fixed to the edge of the table. A mass m, fixed to the other end of the string, hang vertically. A constant magnetic field B exists perpendicular to the table. The system is released from rest.

11. The acceleration the mass m moving in the downward direction is

(A) g
(B) $\frac{B^2L^2v}{MR}$
(C) $\left(g-\frac{B^2L^2v}{MR}\right)$
(D) $\left(g+\frac{B^2L^2v}{mR}\right)$

12. The acceleration of mass m when the velocity of the rod is half the terminal velocity is

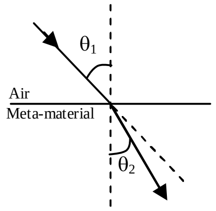
(A) g
(B) g/2
(C) g/3
(D) g/4

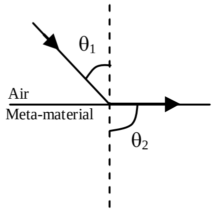
Space for rough work

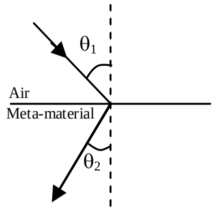
Paragraph for Questions 13 & 14

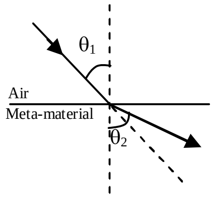
Most materials have the refractive index, n > 1. So, when a light ray from air enters naturally occurring material, then by snell's law, $\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1}$, it is under stood that the refracted ray bends towards the normal. But is never emerges on the same side of the normal as the incident ray. According to electromagnetism, the refractive index of the medium is given by the relation, $n = \left(\frac{C}{v}\right) = \pm\sqrt{\varepsilon_r\mu_r}$ where ε is the speed of electromagnetic waves in vacuum, v its speed in the medium, ε_r, and μ, are relative permittivity and permeability of medium respectively. In normal materials, ε_r and μ_r, are positive, implying positive n for the medium. When both ε_r and μ_r, are negative, one must choose the negative root of n. Such negative refractive index materials can now be artificially prepared and are called meta-materials. They exhibit significantly different optical behavior, without violating any physical laws. Since n is negative, it results in a change in the direction of propagation of the refracted light. However, similar to normal materials, the frequency of light remains unchanged upon refraction even in meta-materials.

13. For light incident from air on a meta-material, the appropriate ray diagram is

(A)


(B)


(C)


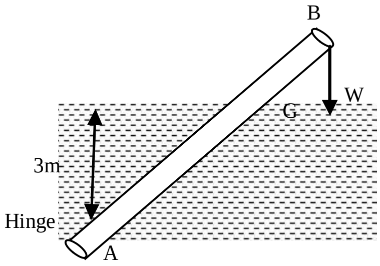
(D)


Space for rough work

14. Choose the correct statement:
(A) The speed of light in the meta-material is $v = c\,|n|$
(B) The speed of light in the meta-meterial is $v = \frac{C}{n}$
(C) The speed of light in the meta-material is v = c
(D) The wavelength of the light in the meta-material (λ_m) is given $\lambda_m = \lambda_{air}\,|n|$. Where λ_{air} is wavelength of the light in air.

Paragraph for Questions 15 & 16

A rod of length 6 m has a mass 12 kg. it is hinged at on end A at a distance of 3 m below water surface. The specific gravity of the material of rod is 0.5.



15. What weight must be attached to the other end B so that 5 m of the rod is immersed in water?
(A) 7 kgf
(B) $\frac{7}{3}$ kgf
(C) $\frac{7}{5}$ kgf
(D) $\frac{7}{2}$ kgf

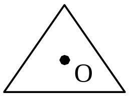
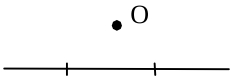
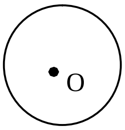
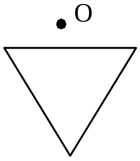
16. Find the magnitude and direction of the force exerted by the hinge on the rod:
(A) $\frac{17}{3}$ kgf in the downward direction
(B) 8 kgf in the downward direction
(C) 4 kgf in the downward direction
(D) 5 kgf in the downward direction

Space for rough work

(Match List Type)

This section contains **4 multiple choice questions.** Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which only **ONE** is correct.

17. Three wires of length l and linear charge density λ each is shaped into an equilateral triangle with point O as centroid of this triangle. Now the wires are arranged in different shapes with point O fixed as defined earlier. Math List – I having different shapes with List – II potential at point O:

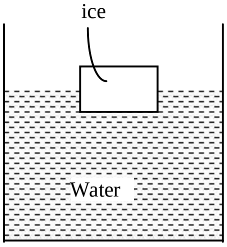
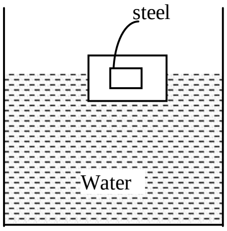
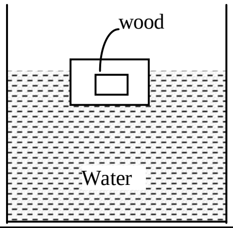
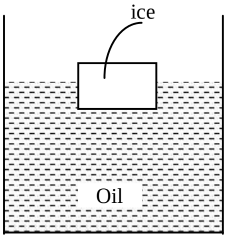
List - I		**List - II**	
(P)		(1)	$\frac{\lambda}{\pi\varepsilon_0}\ln\left(2+\sqrt{3}\right)$
(Q)		(2)	$\frac{\lambda}{2\pi\varepsilon_0}\ln\left(2\sqrt{7}+3\sqrt{3}\right)$
(R)		(3)	$\frac{3\lambda}{2\pi\varepsilon_0}\ln\left(2+\sqrt{3}\right)$
(S)		(4)	$\frac{\pi\lambda}{2\pi\varepsilon_0}$

Codes:

	P	Q	R	S
(A)	1	2	3	4
(B)	1	4	2	3
(C)	3	2	4	1
(D)	3	4	2	1

Space for rough work

18. When ice melts completely, level of liquid in which ice is submerged:

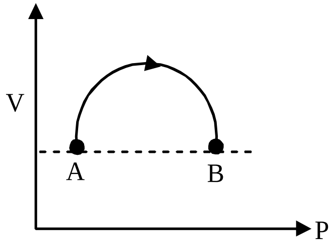
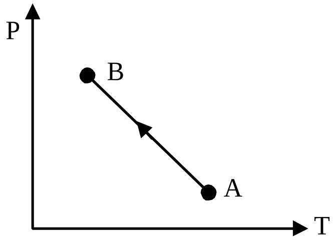
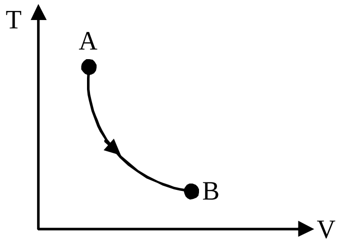
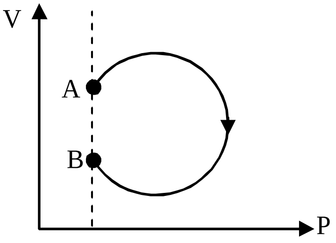
List – I		List – II	
(P)		(1)	Increases
(Q)		(2)	Decreases
(R)		(3)	Remains same
(S)	 Density of oil is greater than density of ice	(4)	May increases or decreases

Codes:

	P	Q	R	S
(A)	1	2	4	4
(B)	3	2	4	4
(C)	3	1	4	1
(D)	3	2	3	1

Space for rough work

19. A sample of gas goes from state A to state B in four different manners, as shown by the graphs. Let W be the work done by the gas and ΔU be change in internal energy along the path AB. Correctly match the graphs with the statements provided.

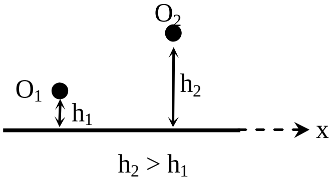
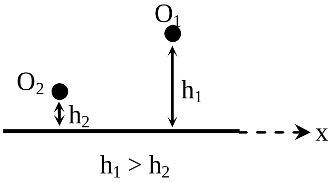
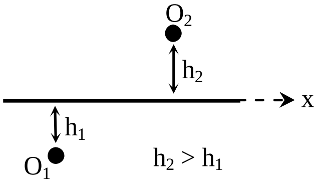
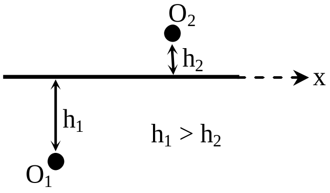
List – I		**List – II**	
(P)		(1)	Both W and ΔU are positive
(Q)		(2)	Both W and ΔU are negative
(R)		(3)	W is positive whereas ΔU is negative
(S)		(4)	W is negative whereas ΔU is positive
		(5)	Specific heat of gas must be positive

Codes:

	P	Q	R	S
(A)	4	2,5	3	2,5
(B)	4	2,5	1	2,5
(C)	4,5	2,5	3	4,5
(D)	5	3,5	3,5	3

Space for rough work

20. Column shows O_1 object and O_2 image. The optical system responsible can be a spherical mirror, plane mirror or a thin lens. In the case of the lens and spherical mirror, straight line shows the principal axis. Match List-I and List-II:

List – I		**List – II**	
(P)		(1)	Concave mirror between O_1 and O_2
(Q)		(2)	Diverging lens between O_1 and O_2
(R)		(3)	Convex mirror between O_1 and O_2
(S)		(4)	Converging lens between O_1 and O_2
		(5)	Inclined plane mirror somewhere between O_1 and O_2

Codes:

	P	Q	R	S
(A)	1,2,5	3,5	4,5	4,5
(B)	1,5	2,5	1,2,5	1,4,5
(C)	1,2,5	3,4,5	4,5	3,4,5
(D)	1,5	3,5	4,5	4,5

Space for rough work

Chemistry

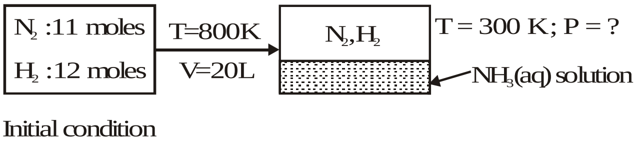
PART – II

SECTION – A

Single Correct Choice Type

This section contains **10 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct.

1. 11 moles N_2 and 12 moles of H_2 mixture reacted in 20 litre vessel at 800 K. After equilibrium was reached, 6 mole of H_2 was present. 3.58 litre of liquid water is injected in equilibrium mixture and resultant gaseous mixture suddenly cooled to 300 K. What is the final pressure of gaseous mixture? Neglect vapour pressure of liquid solution. Assume (i) all NH_3 dissolved in water (ii) no change in volume of liquid (iii) no reaction of N_2 and H_2 at 300 K :



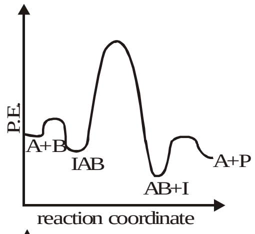
(A) 18.47 atm
(B) 60 atm
(C) 22.5 atm
(D) 45 atm

2. The following mechanism has been proposed for the exothermic catalyzed complex reaction:

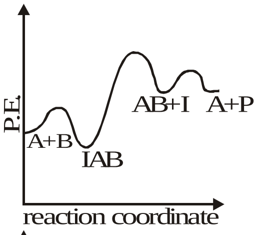
$$A + B \overset{fast}{\rightleftharpoons} IAB \overset{k_1}{\rightleftharpoons} AB + I \overset{k_2}{\rightleftharpoons} P + A$$

If k_1 is much smaller than k_2, the most suitable qualitative plot of potential energy (P.E.) versus reaction coordinate for the above reaction.

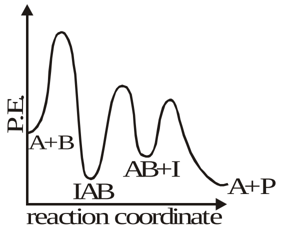
(A)



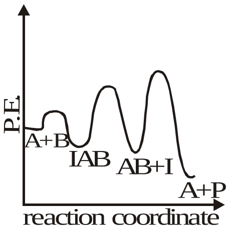
(B)



(C)



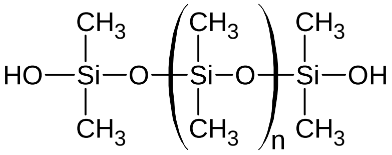
(D)



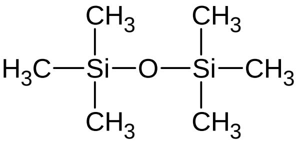
Space for rough work

3. The final product of complete hydrolysis of $(CH_3)_2SiCl_2$ followed by polymerization forms

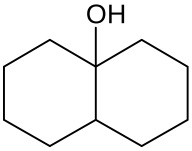
(A) $(CH_3)_2SiOSi(CH_3)_2$
(B) $(CH_3)_2Si(OH)_2$

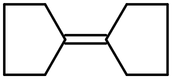
(C) 

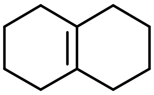
$HO-\underset{CH_3}{\overset{CH_3}{Si}}-O\left(\underset{CH_3}{\overset{CH_3}{Si}}-O\right)_n\underset{CH_3}{\overset{CH_3}{Si}}-OH$

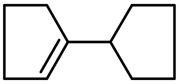
(D) 

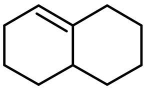
$H_3C-\underset{CH_3}{\overset{CH_3}{Si}}-O-\underset{CH_3}{\overset{CH_3}{Si}}-CH_3$

4. Which of the following alkene is obtained as major product when the alcohol  reacts with dil. H_2SO_4?

(A) 

(B) 

(C) 

(D) 

5. At what $\frac{[Br^-]}{\sqrt{[CO_3^{2-}]}}$ does the following cell have its reaction at equilibrium?

Ag(s) | Ag_2CO_3(s) | Na_2CO_3 (aq) || KBr(aq) | AgBr(s) | Ag(s)

$K_{SP} = 8 \times 10^{-12}$ for Ag_2CO_3 and $K_{SP} = 4 \times 10^{-13}$ for AgBr

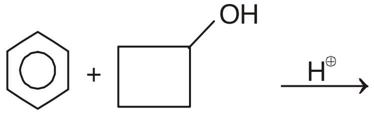
(A) $\sqrt{1} \times 10^{-7}$
(B) $\sqrt{2} \times 10^{-7}$
(C) $\sqrt{3} \times 10^{-7}$
(D) $\sqrt{4} \times 10^{-7}$

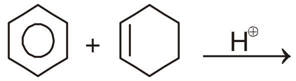
6. Which of the following species do not have $O-O$ bond length longer than that in O_2 molecule?

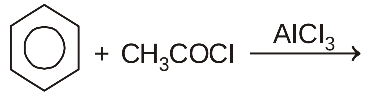
(A) $H_2S_2O_8$
(B) H_2SO_5
(C) H_2O_2
(D) $O_2[BF_4]$

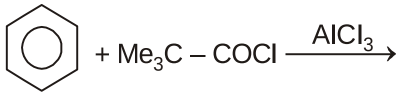
Space for rough work

7. Which of the following reactions will not give alkylation product?

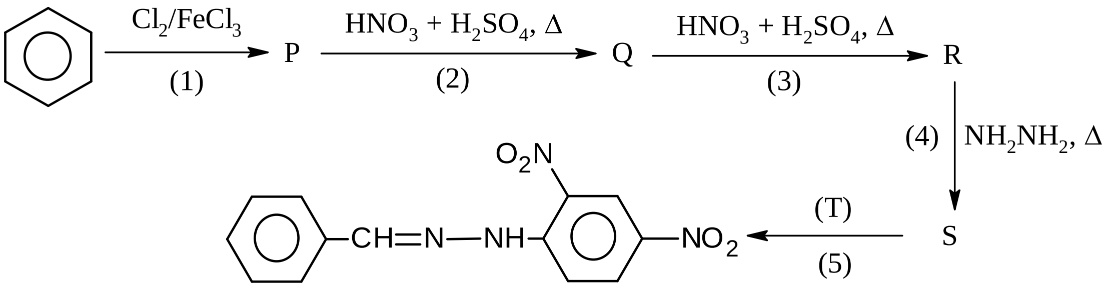
(A) 

(B) 

(C) 
+ CH₃COCl
AlCl₃

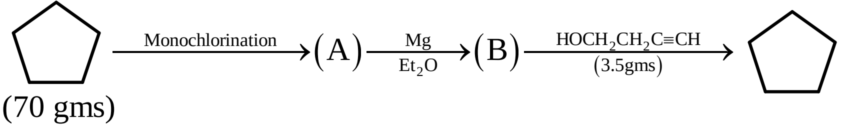
(D) 
+ Me₃C – COCl
AlCl₃

8. The incorrect statement about the following reaction sequence is


Cl₂/FeCl₃
(1)
P
HNO₃ + H₂SO₄, Δ
(2)
Q
HNO₃ + H₂SO₄, Δ
(3)
R
(4)
NH₂NH₂, Δ
S
(T)
(5)
O₂N
CH=N—NH
NO₂

(A) 'T' gives an aldol condensation reaction on heating with NaOH solution
(B) Compound R is more reactive towards N_2H_4 than compound Q.
(C) compound $Q \xrightarrow[\text{(ii)}NaNO_2-HCl\ \ 0-5^0C]{\text{(i)}Sn/HCl} X \xrightarrow{H_3PO_2} P$; P is PhCl
(D) In step 5 Acetaldehyde is more reactive than T

9. How many gms of cyclopentane will be formed in the reaction given below (Consider the yield be 100% in each step)?


Monochlorination
(A)
Mg
Et₂O
(B)
HOCH₂CH₂C≡CH
(3.5gms)
(70 gms)

(A) 5
(B) 6
(C) 7
(D) 8

10. The number of vacant hybrid orbitals which participate in the formation of 3-centre 2 electron bonds i.e., banana bonds in diborane structure are:
(A) 0
(B) 1
(C) 2
(D) 3

Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct.

Paragraph for Questions 11 & 12

In the manufacture of $Na_2CO_3(s)$ by Solvay process, $NaHCO_3(s)$ is decomposed by heating:

$2NaHCO_3(s) \rightleftharpoons Na_2CO_3(s) + CO_2(g) + H_2O(g)$

$K_p = 0.23$ at 100°C $\Delta H^o = 136$ kJ

11. If a sample of $NaHCO_3$ (s) is brought to a temperature of 100°C in a closed container total gas pressure at equilibrium is:

(A) 0.96 atm (B) 0.23 atm
(C) 0.48 atm (D) 0.46 atm

12. A mixture of 1.00 mol each of $NaHCO_3(s)$ and $Na_2CO_3(s)$ is introduced into a 2.5 L flask in which $P_{CO_2} = 2.10$ atm and $P_{H_2O} = 0.94$ atm.When equilibrium is established at 100°C, then partial pressure of

(A) $CO_2(g)$ and $H_2O(g)$ will be greater than their initial pressure
(B) $CO_2(g)$ and $H_2O(g)$ will be less than their initial pressure
(C) $CO_2(g)$ will be larger and that of $H_2O(g)$ will be less than their initial pressure
(D) $H_2O(g)$ will be larger and that of $CO_2(g)$ will be less than their initial pressure

Paragraph for Questions 13 & 14

The empirical formula of a cobalt (III) complex is $Co(NH_3)_x Cl_3$. The coordination no.of cobalt in the above complex is six. Say that all complexes ionize.

13. K_b of water 2K kg mole^{-1}, when one mole of the above complex is added to 1kg water the rise in B.Pt is 6K. Then the value of x is

(A) 4 (B) 3
(C) 5 (D) 6

14. One mole of the above complex gave 143.5g white ppt with excess $AgNO_3$ solution. Then x is

(A) 4 (B) 5
(C) 6 (D) 3

Space for rough work

Paragraph for Questions 15 & 16

A white crystalline solid (A) on dehydration gave a poisonous pseudo halogen gas (B). Compound (A) when filed with alkali gave a colourless gas (C), which forms white fumes with HCl. The fumes condenses to white solid with HCl. The fumes condenses to white solid (D) on cooling. (B) dissolves in KOH solution to gave two compounds (pseudo halides) (E) and (F). Compound (E) gave white ppt. (G) with $AgNO_3$ solution, but ppt (G) dissolves on addition of excess (E). When (F) is heated together with (D) a well known fertilizer (H) is obtained.

15. As per the above passage (A) is

(A) $(NH_4)_2C_2O_4$
(B) $(NH_4)_2CO_3$
(C) NH_4CN
(D) NH_4BrO_3

16. Which of the following dehydration agent can not be used for the conversion of (A) to (B)?

(A) P_2O_5
(B) $conc.H_2SO_4$
(C) CaO
(D) (B) and (C) both

(Match List Type)

This section contains **4 multiple choice questions.** Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which only **ONE** is correct.

17. Match the following:

List – I		**List – II**	
(P)	Isothermal process	(1)	$\Delta E = 0$
(Q)	Reversible adiabatic process	(2)	$\Delta H = 0$
(R)	Cyclic process	(3)	$\Delta S = 0$
(S)	Isochoric process	(4)	$w = 0$
		(5)	$\Delta G = 0$

Codes:

	P	Q	R	S
(A)	1, 2	3	1,2,3,5	4
(B)	2	4	4, 5	1
(C)	1	2	3	5
(D)	4	5	2	3, 4

Space for rough work

18. Match the following:

List – I		**List – II**	
(P)	O_2	(1)	Paramagnetic
(Q)	B_2	(2)	Día magnetic
(R)	C_2	(3)	Bond order : 2
(S)	N_2	(4)	Last e^- goes in anti-bonding molecular orbital
		(5)	Last e^- goes in bonding molecular orbital

Codes:

	P	Q	R	S
(A)	2,4	3,4	4	5
(B)	1,3,4	1,5	2,3,5	2,5
(C)	2,5	2,3,4	4	3,5
(D)	4	3,5	4,5	1,3,4

19. Match the following:

List – I		**List – II**	
(P)	Addition of HCl can make the buffer solution	(1)	CH_3COONa
(Q)	Addition of NaOH can make the buffer solution	(2)	NH_3
(R)	Increase solubility when added to a saturated solution of $CuCO_3$	(3)	NH_4Cl
(S)	Form buffer on mixing with solution of their conjugate acid base	(4)	$NaHCO_3$
		(5)	HCOONa

Codes:

	P	Q	R	S
(A)	1, 2, 4, 5	3, 4	2	1, 2, 3, 4, 5
(B)	2	3	4	5
(C)	5, 1	2, 4	3, 5	2, 4
(D)	5, 1	3, 5	4, 5	5, 6

20. Match the following:

List – I		**List – II**	
(P)	$NO_{(g)} + NO_{3(g)} \rightleftharpoons 2NO_{2(g)}$	(1)	$K_p > K_c$
(Q)	$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$	(2)	$K_p = K_c(RT)^2$
(R)	$2O_{3(g)} \rightleftharpoons 3O_{2(g)}$	(3)	$K_p = K_c$
(S)	$BrF_{5(g)} \rightleftharpoons \frac{1}{2}Br_{2(g)} + \frac{5}{2}F_{2(g)}$ note : T > 300°C	(4)	$K_p < K_c$
		(5)	$K_p = K_c(RT)^1$

Codes:

	P	Q	R	S
(A)	3	4	1, 5	1,2
(B)	4	5, 3	5, 1	1
(C)	5,1	2, 5	4, 2	3
(D)	1	2	3	4

Space for rough work

Mathematics

PART – III

SECTION – A

Single Correct Choice Type

This section contains **10 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct.

1. A triangle ABC has incentre I. Points X, Y are located on the line segment AB, AC respectively so that BX. AB = IB^2 and CY. AC = IC^2. Given that X, I, Y are collinear. The possible values of measure of angle A is

(A) 120^o (B) 60^o
(C) 30^o (D) cannot be determined

2. An equilateral triangle of side length 2 units is inscribed in a circle. The length of a chord of this circle which passes through the midpoints of two sides of this triangle is

(A) $\frac{\sqrt{5}}{2}$ (B) $\sqrt{5}$
(C) $\frac{2}{3}$ (D) $\frac{\sqrt{2}}{3}$

3. $N = 7^{\log_{49} 900}$, $A = 2^{\log_2 4} + 3^{\log_2 4} + 4^{\log_2 2} - 4^{\log_2 3}$, $D = (\log_5 49)(\log_7 125)$.

The value of $\log_{\left(A - \frac{N}{10}\right)} |N + A + D + 6| - \log_5 2$ is equal to

(A) 1 (B) 2
(C) 3 (D) 4

4. Let $a_1, a_2, \ldots\ldots\ldots\ldots$ be real constants and $y(x) = \cos(a_1 + x) + \frac{1}{2}\cos(a_2 + x) + \frac{1}{2^2}$ $\cos(a_3 + x) + \ldots\ldots\ldots\ldots + \frac{1}{2^{n-1}}\cos(a_n + x)$. If $x_1 x_2$ are real & $y(x_1) = y(x_2) = 0$, then $x_2 - x_1 =$

(A) $n\pi, n \in I$ (B) $\frac{n\pi}{2}, n \in I$
(C) $\frac{n\pi}{3}, n \in I$ (D) $\frac{n\pi}{4}, n \in I$

Space for rough work

5. Let a_n & b_n are positive integers and $a_n + \sqrt{2}b_n = \left(2+\sqrt{2}\right)^n$ then $\lim\limits_{n\to\infty}\left(\dfrac{a_n}{b_n}\right) =$

(A) $\sqrt{2}$ (B) 2

(C) $e^{\sqrt{2}}$ (D) e^2

6. For any positive integer n, $a_n = \sum\limits_{k=1}^{n}\tan^2\dfrac{k\pi}{2n+1}$ & $b_n = \prod\limits_{k=1}^{n}\tan^2\dfrac{k\pi}{2n+1}$, then the value of $\dfrac{a_n}{b_n}$ is equal to

(A) $\tan^2\dfrac{n\pi}{n^2+1}$ (B) $n\pi$

(C) n (D) $\dfrac{n\pi}{n^2+1}$

7. An equation $a_0 + a_1x + a_2x^2 + a_3x^3 + \text{.........} + a_{99}x^{99} + x^{100} = 0$ has roots ${}^{100}C_r\sin(r\theta)$, where r = 1, ...100 , then the value of a_{99} is

(A) $\left(\cos\dfrac{\theta}{2}\right)^{100}\sin 50\theta$ (B) $2^{100}\left(\cos\dfrac{\theta}{2}\right)^{100}$

(C) $2^{100}\sin 50\theta$ (D) $2^{100}\left(\cos\dfrac{\theta}{2}\right)^{100}\sin 50\theta$

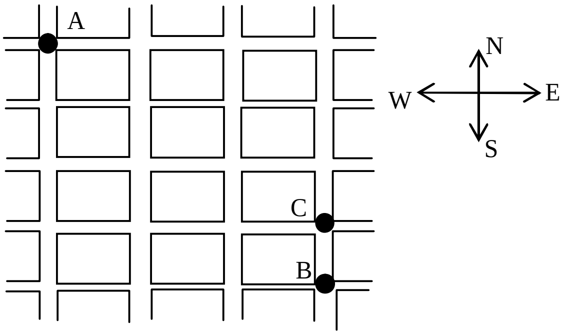
8. In ΔABC, there is a interior point P such that $\angle PAB = 10^o, \angle PBA = 20^o, \angle PCA = 30^o$ & $\angle PAC = 40^o$, then $\angle ACB$ =

(A) 50^o (B) 40^o

(C) 20^o (D) 10^o

Space for rough work

9. The adjoining figure is a map of a part of a city. The small rectangles are blocks & spaces in between are streets. Each morning a student walks from intersection A to intersection B, always walking along streets shown, always going east or south. For variety, at each intersection where he has a choice, he chooses with probability ½ (independent of all other choices) whether to go east or south. The probability that, on any given morning, he walks through intersection C is



(A) $\frac{11}{32}$ (B) $\frac{1}{2}$

(C) $\frac{4}{7}$ (D) $\frac{21}{32}$

10. If $f(0) = 0$ and f is differentiable at x = 0 and k is positive integer then

$\lim_{x\to\infty} \frac{1}{x}\left[f(x) + f\left(\frac{x}{2}\right) + f\left(\frac{x}{3}\right) + ... + f\left(\frac{x}{k}\right)\right]$ is equal to

(A) $k.\, f'(0)$ (B) $\left(\sum_{r=1}^{k} \frac{1}{r}\right) f'(0)$

(C) $\sum_{r=1}^{k} \frac{1}{r}$ (D) does not exist

Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct.

Paragraph for Questions 11 & 12

A function of satisfies the equation $f(x).f'(-x) = f(-x)f'(x)$ for all x and f(0) = 3.

11. The value of $f(x).f(-x)$ for all *x* is

(A) 1	(B) 4
(C) 9	(D) 16

12. $\int_{-51}^{51} \frac{dx}{3+f(x)}$ is equal to

(A) 17	(B) 34
(C) 102	(D) 0

Paragraph for Questions 13 & 14

In a $\triangle ABC$ $B(2,4)$, $C(6,4)$ & A lies on a curve S such that $\tan\frac{B}{2}\tan\frac{C}{2} = \frac{1}{2}$.

13. Let a line passing through C and perpendicular to BC intersects the curve S at P and Q. It R is the midpoint of BC then area of $\triangle PQR$ is

(A) $\frac{18}{3}$ sq. units	(B) $\frac{8}{3}$ sq. units
(C) $\frac{32}{3}$ sq. units	(D) $\frac{26}{3}$ sq. units

14. The eccentricity of the hyperbola, whose transverse axis lies along the line through B, C and the hyperbola passes through B, C & (0, 2)

(A) $\frac{\sqrt{19}}{4}$	(B) $\frac{\sqrt{17}}{2}$
(C) $\sqrt{\frac{7}{3}}$	(D) $\frac{2}{\sqrt{3}}$

Space for rough work

Paragraph for Questions 15 & 16

Let PQRS be a rectangle of size 9×3, if it is folded along QS such that plane PQS is perpendicular to plane QRS & point R moves to point T.

15. Distance between the points P and T will be

(A) $\sqrt{90}$
(B) $\frac{3}{5}\sqrt{205}$
(C) $\frac{4}{5}$
(D) None of these

16. Shortest distance between the edges PQ & TS is

(A) $3\sqrt{\frac{10}{19}}$
(B) $\sqrt{\frac{10}{19}}$
(C) $2\sqrt{\frac{10}{19}}$
(D) None of these

(Match List Type)

This section contains **4 multiple choice questions.** Each question has matching lists. The codes for the lists have choices (A), (B), (C) and (D) out of which only **ONE** is correct.

17. Let a, b, c are roots of the equation $x^3-3x^2+5x-1=0$. A and B are two matrices given as $A=\begin{bmatrix} a & b & c\\ b & c & a\\ c & a & b\end{bmatrix}$ $B=\begin{bmatrix} bc-a^2 & ca-b^2 & ab-c^2\\ ca-b^2 & ab-c^2 & bc-a^2\\ ab-c^2 & bc-a^2 & ca-b^2\end{bmatrix}$ If α,β,γ are the roots of equation $|B-xI|=0$ where I is identity matrix of order 3 then match List I with List II:

List I		**List II**	
(P)	The value of det (A) det (B) is	(1)	18
(Q)	The value of $\alpha+\beta+\gamma$ is	(2)	$(18)^2$
(R)	The value of $\lvert B\rvert$ is	(3)	$(18)^3$
(S)	The value of $\lvert A\rvert$ is	(4)	6
		(5)	$(18)^4$

Codes:

	P	Q	R	S
(A)	4	3	1	2
(B)	3	2	4	1
(C)	3	4	2	1
(D)	4	2	1	3

Space for rough work

18. A straight line passing through O (0, 0) cuts the lines $x=\alpha, y=\beta$ & $x+y=8$ at A, B, C resp such that OA. OB . OC = $48\sqrt{2}$ & $f(\alpha,\beta)\le 0$ where $f(x,y)=\left|\frac{y}{x}-\frac{3}{2}\right|+(3x-2y)^6+\sqrt{e^x+2y-e^2-6}$.

Match the List -I with List-II:

List-I		**List-II**	
(P)	The value of $2\sqrt{2}(OA+OB+OC)$ is	(1)	50
(Q)	The volume of $OA.OB+OB.OC+O.C.OA$ is	(2)	54
(R)	The value of 25α is	(3)	36
(S)	The value of 18 β is	(4)	52

Codes:

	P	Q	R	S
(A)	1	3	4	2
(B)	2	4	1	3
(C)	4	3	1	2
(D)	3	4	1	2

19. Match List I with List II:

List-I		**List-II**	
(P)	If $\alpha=\lim\limits_{y\to\infty}\frac{\int_1^y\left[\tan^{-1}x\right]dx}{\int_1^y\left[1+\frac{1}{x}\right]dx}$, α^2+3 is divisible by ([.] denotes greatest integer factor)	(1)	9
(Q)	If $a+b=3-\cos 4\theta$ and $a-b=4\sin 2\theta$, then the maximum value of ab is	(2)	4
(R)	A point D is taken on the side AC of an acute triangle ABC such that AD = 1, DC = 2 and BD is altitude of ΔABC. A circle of radius 2 which passes through points A and D touches the circumcircle of ΔBDC at point D. If area of ΔABC is N then the value of $\frac{N^2}{15}$ is equal to	(3)	1
(S)	$\lim\limits_{x\to\infty}\frac{\sqrt[3]{x^2}\sin(x!)}{(x+1)}$ is less than or equal to	(4)	5
		(5)	0

Codes:

	P	Q	R	S
(A)	3	4	1	1,2,3,4
(B)	1,2	4	1,2,3	1,2
(C)	3	1,4	1,2,3	2,3,4
(D)	1,3	2,4	1,2	2,3

Space for rough work

20. Match List I with List II:

List-I		**List-II**	
(P)	Consider the integral $I_1 = \int_1^e (1+x)(x+\ln x)^{100}dx$ $I_2 = \int_{\sin^{-1}1/e}^{\pi/2} (1+e\sin x+\ln\sin x)^{101}\cos x dx$ If $I_1 + \frac{e}{101}I_2 = \frac{e(1+e)^{101}-k}{101}$, then K	(1)	3/2
(Q)	$I(k) = \int_0^\infty \frac{\ln x}{x^2+kx+k^2}dx (k>0)$ & $kI(x) - I(1) = \frac{\pi}{\sqrt{3}}, k = e^{\alpha}$ α is equal to	(2)	1
(R)	Let f(x) be a continuous function satisfying $9f(3) \le \int_0^3 (x^2 f'(x) + (f(x))^2)dx + k$, then the least passible value of k is	(3)	5
(S)	The values of definite integral $\int_1^a x\, a^{-[\log_a x]}dx$ where a > 1 & [.] denotes the greatest integer is $\frac{e-1}{2}$, then the value of 5[a] is	(4)	2
		(5)	9

Codes:

	P	Q	R	S
(A)	1	2	4	3
(B)	2	1	5	3
(C)	2	1	4	3
(D)	2	4	3	1

Space for rough work

FIITJEE **JEE(Advanced)-2017**

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – V
(Paper-2)

Q. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	A	C	B
2.	A	A	B
3.	D	C	B
4.	C	B	A
5.	B	B	A
6.	A	D	C
7.	B	C	D
8.	D	A	A
9.	A	C	D
10.	B	C	B
11.	C	A	C
12.	B	B	A
13.	C	C	C
14.	D	A	D
15.	B	A	B
16.	A	C	A
17.	C	A	C
18.	D	B	D
19.	A	A	A
20.	D	A	B

Physics

PART – I

SECTION – A

1. **A**

Let m_1 and m_2 be the atomic masses of the fragments and v_1 and v_2 their velocities. From the principle of conservation of linear momentum, we have

$$m_1v_1 + m_2v_2 = 0 \qquad \text{or} \qquad \frac{m_1}{m_2} = \left|\frac{v_2}{v_1}\right| = \frac{1}{8}$$

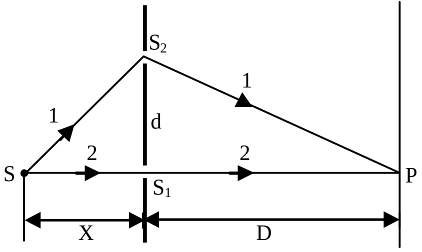
Now $m_1 = A_0(R_1)^{1/3}$ and $m_2 = A_0(R_2)^{1/3}$. Hence

$$\frac{m_1}{m_2} = \left(\frac{R_1}{R_2}\right)^{1/3}$$

or $\quad \frac{1}{8} = \left(\frac{R_1}{R_2}\right)^{1/3} \quad$ or $\quad \frac{R_1}{R_2} = \frac{1}{2}$

2. **A**

Refer to figure. to reach point P, wave 1 has to travel a path (SS_2 + S_2P) while wave 2 has to travel a path (SS_1 + S_1P). Therefore, when the waves arrive at P, the path difference is



$$\Delta = (SS_2 + S_2P) - (SS_1 + S_1P) \qquad \text{………(1)}$$

Now, in triangle SS_2S_1, we have

$$SS_2 = (x^2 + d^2)^{1/2} = x\left(1 + \frac{d^2}{x^2}\right)^{1/2}$$

$$= \left(1 + \frac{d^2}{2x^2}\right) \qquad (\because\ d << x)$$

Similarly, $S_2P = (D^2 + d^2)^{1/2} = D\left(1 + \frac{d^2}{2D^2}\right) \qquad (\because\ d << D)$

Also $(SS_1 + S_1P) = x + D.$ Using these in Eq. (1), we have

$$\Delta = x\left(1 + \frac{d^2}{2x^2}\right) + D\left(1 + \frac{d^2}{2D^2}\right) - (x + D)$$

$$= x + \frac{d^2}{2x} + D + \frac{d^2}{2D} - x - D$$

or $\quad \Delta = \frac{d^2}{2}\left(\frac{1}{x} + \frac{1}{D}\right)$

In order to have a dark fringe at $P, \Delta = \frac{\lambda}{2}$. Hence

$$\frac{\lambda}{2} = \frac{d^2}{2}\left(\frac{1}{x} + \frac{1}{D}\right) \qquad \ldots\ldots(1)$$

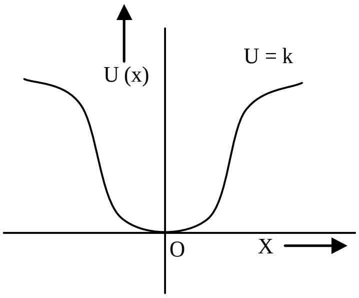
or $$d = \left[\frac{\lambda x D}{x + D}\right]^{1/2} \qquad \ldots\ldots.(2)$$

Putting $x = \frac{D}{2}$ in Eq. (2), we find that the correct option is (A).

3. **D**

Figure shows the plot of U(x) versus x. At x = 0, potential energy $U(0) = k[1 - \exp(0)] = k(1-1) = 0$ and it has a maximum value = k at $x = \pm\infty$ since

$$U(\pm\infty) = k[1 - \exp(-\pm\infty)^2]$$
$$= k(1-0) = k$$



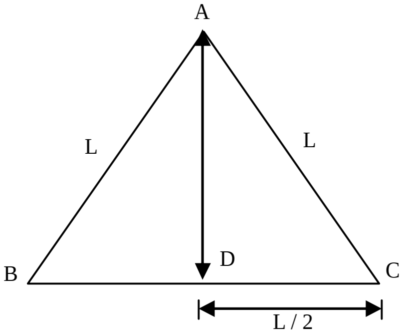
Since the total mechanical energy has a constant value = (k/2), the kinetic energy will be maximum at x = 0 and minimum at $x = \pm\infty$. At x = 0

$$\left(\frac{dU}{dx}\right)_{x=0} = [2\text{ kx } \exp(-x^2)]_{\text{at } x=0} = 0$$

Hence the particle is in stable equilibrium at x = 0 (origin) and would oscillate about x = 0 (for small displacements) simple harmonically. Hence (d) is the only correct choice.

4. **C**

Let L be the length of each rod at 0^oC and h_0 be the altitude AD at 0^oC. Then figure.



$$h_0 = \left(L^2 - \frac{L^2}{4}\right)^{1/2} \qquad \ldots\ldots..(1)$$

When the rods are heated to a temperature t, the altitude becomes

$$h = \left[L^2(1+\alpha_1 t)^2 - \frac{L^2}{4}(1+\alpha_2 t)^2\right]^{1/2}$$

Since α_1 and α_2 are much less than unity, we can write $(1+\alpha_1 t)^2 \simeq 1+2\alpha_1 t$ and $(1+\alpha_2 t)^2 \simeq 1+2\alpha_2 t$. Thus

$$h = \left[L^2(1+2\alpha_1 t) - \frac{L^2}{4}(1+2\alpha_2 t\right]^{1/2} \quad .....(2)$$

Equation (1) and (2), we get

$$\left(L^2 - \frac{L^2}{4}\right)^{1/2} = \left[L^2(1+2\alpha_1 t) - \frac{L^2}{4}(1+2\alpha_2 t\right]^{1/2}$$

Which simplifies to give $\frac{\alpha_1}{\alpha_2} = \frac{1}{4}$, which is choice (C)

5. **B**

$a_{rel} = a\cos 30^o - g\sin 30^o$

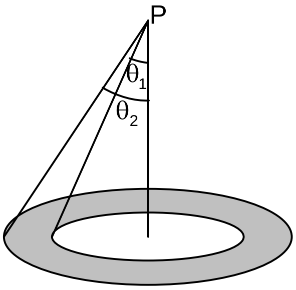
$= 10\sqrt{3} \times \frac{\sqrt{3}}{2} - 5 = 10$

$S = \frac{1}{2}at^2$

$5t^2 = 1$

$t = \frac{1}{\sqrt{5}}$

6. **A**



$v_P = -2\pi G\sigma\left(\cos\theta_1 - \cos\theta_2\right)$

$\theta_1 = 37^o,\ \theta_2 = 45^o$

$\sigma = \frac{M}{\pi R^2\left(16-9\right)} = \frac{M}{7\pi R^2}$

$W = -v_P$

7. **B**

$\frac{1}{f_1} = \frac{\left(\mu_1 - 1\right)}{R_1} = \frac{0.5}{+14}$

$\frac{1}{f_2} = -\frac{\left(\mu_2 - 1\right)}{R_2} = \frac{0.2}{+14}$

$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{0.7}{14} = \frac{1}{20}$

$$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$$

u = 40 cm, v = 40 cm

8. **D**

A radioactive nucleus may decay any time after t = 0. The number of neclei at any time t is given by $N = N_0 e^{-\lambda t}$, where $\lambda = \frac{0.693}{T}$

Where T is the half-life. Hence the correct choice is (d)

9. **A**

$\tau = \bar{r} \times \bar{F} = I_{cm}\alpha$

Hence, answer is (i), (ii), i.e. (A).

10. **B**

W = area of loop = $\frac{1}{2}\left[P_2V_3 - P_2V_2 - P_1V_4 + P_1V_1\right]$

$= \frac{1}{2}nR\left[T_3 - T_2 - T_4 + T_1\right]$

$W = 13.718 KJ$

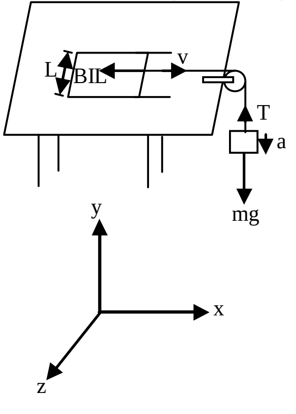
for $1-2, \frac{P_1}{P_2} = \frac{V_1}{V_2}$ & $3 \to 4 \frac{P_2}{P_1} = \frac{V_3}{V_4}$

11. **C**

Refer to figure let v be the velocity of the rod along the positive x-direction at an instant of time and let the magnetic field B act perpendicular to the table along the positive y-direction. The emf induced in the rod is $e = Blv$. Therefore, the induced current is

$$I = \frac{e}{R} = \frac{BLv}{R} \qquad \text{…….(1)}$$

The rod of length L carrying a current I in magnetic field will experience a force



Along the negative x-direction. Since the rod is massless, this force will also be equal to the tension T in the string acting along the positive x-direction i.e. T = f = BIL.

Let α be the acceleration of mass m moving in the downward direction, then

Ma = net force acting on m = mg – T = mg – F

or $\qquad a = g - \frac{F}{m}$

Using (1) and (2) in (3), we have

$$a = g - \frac{BIL}{m} = g - \frac{B \times BL^2 v}{mR}$$

$$= g - \frac{B^2L^2v}{mR}$$

So the correct choice is (c)

12. **B**

When the velocity of the rod is half the terminal velocity, then $a = \frac{g}{2}$.

13. **C**

From Snell's law and n is negative.

14. **D**

$|n_1|\lambda_1 = |n_2|\lambda_2$

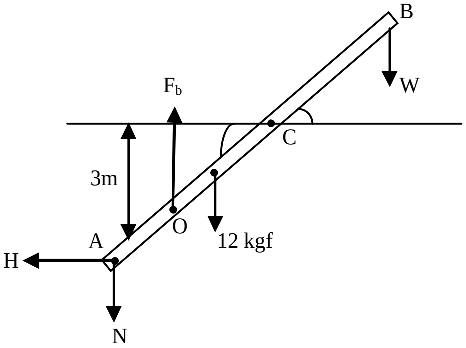
15. **B**

Mass per unit length of rod is 2 kg.

Mass of submerged portion of rod is 10 kg and its volume is $\frac{10}{500}\text{m}^2$.

Buoyant force $= F_B = \frac{10}{500} \times 1000 = 20\text{kgf}$

16. **A**



Let N and H be the vertical and horizontal reactions of the hinge on the rod. Considering horizontal and vertical translation equilibrium of rod.

N + 12 + W = 20, where W is the weight to be attached at end

H = 0

Considering the rotation equilibrium of rod about A

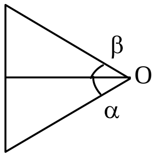
$$20 \times 2.5 \cos\theta + 12 \times g \times 3 \cos\theta + W \times 6 \cos\theta = 0$$

$$6w = 50g - 36g = 14g$$

$$W = \frac{7}{3}g = \frac{7}{3}\text{kgf}$$

$$N = 8 - \frac{7}{3} = \frac{17}{3}\text{kgf}$$

17. **C**



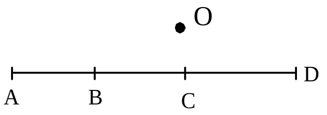
Potential at O,

$$V = K\lambda lm\left(\frac{\sec\alpha + \tan\alpha}{\sec\beta - \tan\beta}\right)$$

In case P, $\alpha = \beta = 60$

$$V = 3 \times V_1 = 3K\lambda \ln\left(\frac{2+\sqrt{3}}{2-\sqrt{3}}\right) = 6K\lambda Ln\left(2+\sqrt{3}\right)$$

In case Q,



$$V_{BC} = 2K\lambda \ln\left(2+\sqrt{3}\right)$$

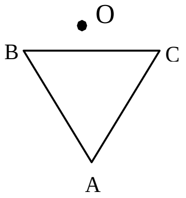
$$V_{AB} = V_{CD} = K\lambda \ln\left(\frac{\sqrt{28}+3\sqrt{3}}{2+\sqrt{3}}\right)$$

$$V = V_{BC} + V_{AB} + V_{CD} = 2K\lambda \ln\left(2\sqrt{7}+3\sqrt{3}\right)$$

Case – R,

$$V = \frac{Kq}{r} = \frac{K\lambda 2\pi r}{r} = K\lambda \cdot 2\pi$$

Case S,



$$V_{AB} = V_{AC} = K\lambda \ln\left(2+\sqrt{3}\right)$$

$$V = 4K\lambda \ln\left(2+\sqrt{3}\right)$$

18. **D**

From the concept of floating level will remain same if object floats and will down if it sinks.

19. **A**

Area = work, $\Delta U = nC_v\Delta T$ and $\Delta Q = \Delta U + W = \int nCdT$

(P) Work is negative and $\Delta U > 0$

(Q) For Q, $\Delta U < 0$, $\therefore \Delta T < 0,\ \Delta V < 0$ from $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

So, answer is (2, 5).

(R) $\Delta V > 0,\ W > 0$, but $\Delta T < 0$, $\therefore \Delta U < 0$

Answer is 3.

(S) $W < 0,\ \Delta U < 0$

Answer is (2, 5).

20. **D**

Use the property of images formed by mirror and lenses.

Chemistry

PART – II

SECTION – A

1. **C**

$$N_2 \quad + \quad 3H_2 \rightleftharpoons 2NH_3$$

$$11 \qquad 12$$

$$11 - x \quad 12 - 3x \qquad 2x$$

at equilibrium $12 - 3x = 6$

$x = 2$

$n_{H_2} = 6 \quad n_{N_2} = 9 \quad n_{NH_3} = 4$

$PV = \left(n_{N_2} + n_{H_2}\right)RT$

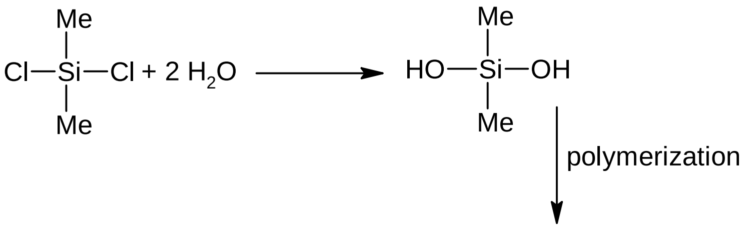
$P \times (20 - 3.58) = 15 \times 0.0821 \times 300$

$P = 22.5$ atm

2. **A**

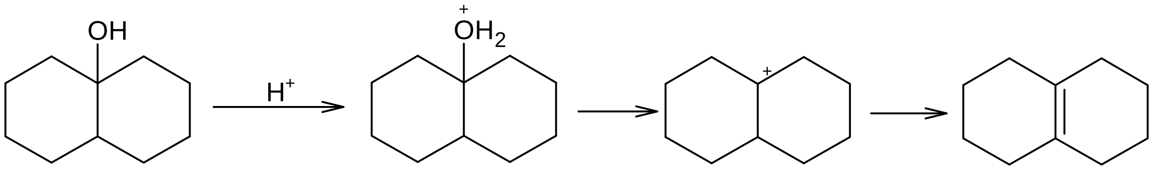
Exothermic reaction mean products are having lesser energy than reactants and $k_1 < k_2 \Rightarrow$ activation energy corresponding k_1 is more than k_2.

3. **C**



$Cl-Si(Me)_2-Cl + 2\,H_2O \longrightarrow HO-Si(Me)_2-OH$

4. **B**



5. **B**

Anode $Ag(s) \rightarrow Ag^{+}(aq) + e^{-}$

Cathode $Ag^{+}(aq) + e^{-} \rightarrow Ag(s)$

$$E_{cell} = E^{0}_{cell} - \frac{0.0591}{n}\log\frac{\left[Ag^{+}\right](anode)}{\left[Ag^{+}\right]cathode}$$

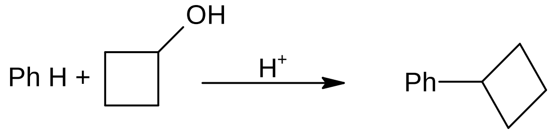
At equilibrium, $E_{cell} = 0$

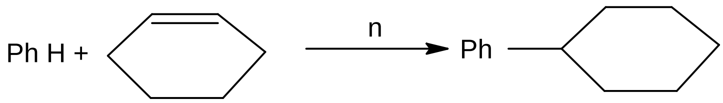
K_{sp} of AgBr = $\left[Ag^{+}\right]\left[Br^{-}\right]$

6. **D**

The bond order in O_2 is 2 while in $H_2S_2O_8$, H_2O_2 have one peroxide bond each while in $O_2[BF_4]$ the bond order is 2.5.

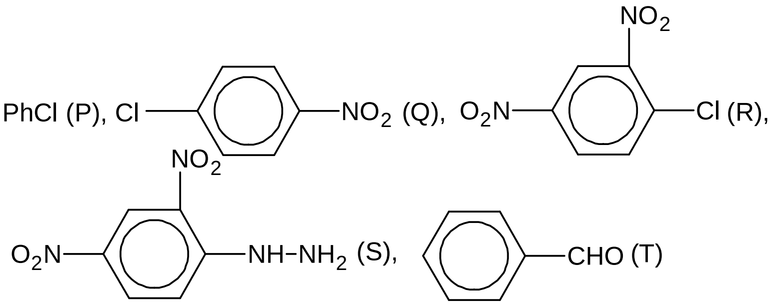
7. **C**



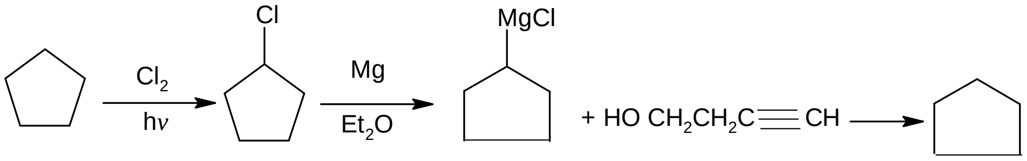


$$\text{Ph H} + \text{Me}_3\ \text{CCOCl} \xrightarrow{\text{AlCl}_3} \text{Ph - C (Me)}_3$$

8. **A**


PhCl (P), Cl
NO2 (Q),
NO2
O2N
Cl (R),
NO2
O2N
NH–NH2 (S),
CHO (T)

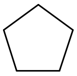
9. **C**

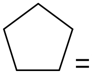

Cl2
hν
Cl
Mg
Et2O
MgCl
+ HO CH2CH2C≡CH

1 mole

2 mole

$$n = \frac{3.5}{70} = 0.05$$

0.5 moles of compound $HOCH_2CH_2–C\equiv CH$ give = 1 mole 

0.05 moles of compound give = 0.1 mole  =7 gm

10. **C**
Fact.

11. **A**

$$2\text{NaHCO}_{3(s)} \rightleftharpoons \text{Na}_2\text{CO}_{3(s)} + \text{CO}_{2(g)} + \text{H}_2\text{O}_{(s)}$$

P P

$$K_p = P^2 = 0.23 \Rightarrow P = 0.48 \Rightarrow P_{\text{total}} = 2P = 0.96\text{atm}$$

12. **B**

$$2\text{NaHCO}_3 \rightleftharpoons \text{Na}_2\text{CO}_{3(s)} + \text{CO}_{2(g)} + \text{H}_2\text{O}_{(g)}$$

$2.1 - P_1$ $0.94 - P_1$

$$(2.1 - P_1)(0.94 - P_1) = 0.23$$

$$P_1 = 0.77\text{ atm} \quad P_{CO_2} 1.33\text{ atm} \quad P_{H_2O} = 0.19\text{ atm}$$

13. **C**

$\Delta T_b = iK_b.m$

$6 = i \times 2 \times 1$

$i = 3$

Complex will dissociate in three fragments only so complex is $\left[CO\left(NH_3\right)_5 Cl\right]Cl_2$

14. **A**

Moles of AgCl = 1
Moles of AgCl / mole of complex
= ionizable Cl^- in complex = 1 $\left[CO\left(NH_3\right)_4 Cl_2\right]Cl$

15. **A**

$(NH_4)_2C_2O_4 \longrightarrow (CN)_2 + 4H_2O$
White crystalline solid Cyanogen gas (Pseudohalogen gas)

16. **C**

Fact.

17. **A**

(P) $\Delta E = nC_V\Delta T$
$\Delta H = nC_P\Delta T$ and $\Delta T = 0$

(Q) $Q_{rev} = 0$

(R) Δ State functions are zero.

(S) $\Delta V = 0$

18. **B**

(P) $\sigma 1s^2,\ \sigma^* 1s^2,\ \sigma 2s^2,\ \sigma^* 2s^2,\ \sigma 2p_x^2,\ \pi 2p_y^2,\ \pi 2p_z^2,\ \pi^* 2p_y^1,\ \pi^* 2p_z^1$

(Q) $\sigma 1s^2,\ \sigma^* 1s^2,\ \sigma 2s^2,\ \sigma^* 2s^2,\ \pi 2p_y^1,\ \pi 2p_z^1$

(R) $\sigma 1s^2,\ \sigma^* 1s^2,\ \sigma 2s^2,\ \sigma^* 2s^2,\ \pi 2p_y^2,\ \pi 2p_z^2$

(S) $\sigma 1s^2,\ \sigma^* 1s^2,\ \sigma 2s^2,\ \sigma^* 2s^2,\ \pi 2p_y^2,\ \pi 2p_z^2,\ \sigma 2p_x^2$

19. **A**

(P) CH_3COONa, NH_3, $NaHCO_3$, HCOONa will react with HCl and form a weak acid, so can make buffer.

(Q) NH_4Cl and $NaHCO_3$ will react with NaOH to form buffer.

(R) Will form an ammonia complex.

(S) All weak acids and weak base can form buffer solution.

20. **A**

(P) $\Delta n = 0$

(Q) $\Delta n = -2$

(R) $\Delta n = +1$

(S) $\Delta n = +2$

Mathematics

PART – III

SECTION – A

1. **B**

From the relation $(BI)^2 = BX.BA$, we see that BI is a tangent to the circle passing through A, X, I at I.

Hence $\angle BIX = \angle BAI = A/2$ .....(i)

Similarly $CI^2 = CY.CA$ we have

$\angle CIY = \angle CAI = A/2$ .....(ii)

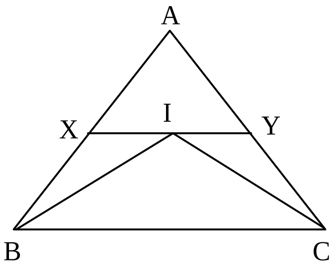
It is known that

$\angle BIC = 90^o + A/2$ ......(iii)

From (i),(ii) & (iii) we obtain

$$\frac{A}{2} + \frac{A}{2} + \left(90^o + \frac{A}{2}\right) = 180^o$$

$\Rightarrow A = 60^o$



2. **B**

Let the circumcircle of the equilateral $\triangle ABC$ have centre O(0, 0) & radius r. Join A to D, the midpoint of BC, then AD passes through O & is perpendicular to BC. Draw OB. Let LM cut the sides AB & AC of $\triangle ABC$ at X & Y. Then $\angle$ XYM is parallel to BC

$OD = \tan 30^o = 1/\sqrt{3}$, $D = \left(0, -1/\sqrt{3}\right)$, $A\left(0, \frac{2}{\sqrt{3}}\right)$ & $B\left(-1, -1/\sqrt{3}\right)$

Equation of circle is $x^2 + y^2 = \frac{4}{3}$

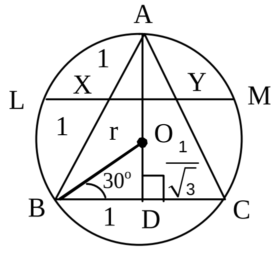
X is midpoint of AB $\left(\frac{-1}{2}, \frac{-10}{2\sqrt{3}}\right)$

on solving $x^2 + y^2 = \frac{4}{3}$ with line y = $-\frac{1}{2\sqrt{3}}$ we get

$$x^2 + \left(\frac{1}{2\sqrt{3}}\right)^2 = \frac{4}{3}$$

$\therefore$ x coordinate of L & M is $\frac{\sqrt{5}}{2}$ & $\frac{-\sqrt{5}}{2}$ respectively

$LM = \sqrt{5}$



3. **B**

$\log_5 50 - \log_5 2 = 2$

4. **A**

Using $\cos(\theta + \phi) = \cos\theta\cos\phi - \sin\theta\sin\phi$ in each term & simplifying we have

$y(x) = \lambda \sin(x + \alpha)$ for some constant λ & α. So zeroes of y(x) are of the form $x + \alpha = n\pi,\ n \in I$.

$y(x_1) = y(x_2) \Rightarrow x_1 - x_2 = n\pi$.

5. **A**

$$a_n + \sqrt{2}b_n = \left(2+\sqrt{2}\right)^n$$

$$a_n - \sqrt{2}b_n = \left(2-\sqrt{2}\right)^n$$

$$a_n = \frac{1}{2}\left[\left(2+\sqrt{2}\right)^n + \left(2-\sqrt{2}\right)^n\right]$$

$$b_n = \frac{\left(2+\sqrt{2}\right)^n - \left(2-\sqrt{2}\right)^n}{2\sqrt{2}}$$

$$\lim_{n\to\infty}\frac{a_n}{b_n} = \lim_{n\to\infty}\sqrt{2}\left(\frac{1+\left(\frac{2-\sqrt{2}}{2+\sqrt{2}}\right)^n}{1-\left(\frac{2-\sqrt{2}}{2+\sqrt{2}}\right)^n}\right)$$

$$= \sqrt{2}\left(\frac{2-\sqrt{2}}{2+\sqrt{2}} < 1\right)$$

6. **C**

Using De Moivre's theorem

$$\left(\cos\theta + i\sin\theta\right)^n = \cos n\theta + i\sin n\theta$$

$$\Rightarrow \sin n\theta = \sum_{k=0}^{\left[\frac{n-1}{2}\right]} \left(-1\right)^k\ {}^{n}C_{2k+1}\cos^{n-2k-1}\theta\sin^{(2k+1)}\theta$$

$$\sin\left(2n+1\right)\theta = \sum_{k=0}^{n}\left(-1\right)^k\ {}^{2n+1}C_{2k+1}\ \cos^{2n-2k}\theta\sin^{2k+1}\theta$$

$$= \tan\theta\cos^{2n+1}\theta\sum_{k=0}^{n}\left(-1\right)^k.{}^{2n+1}C_{2k+1}\left(\tan\theta\right)^{2k}$$

$$\sum_{k=0}^{n}\left(-1\right)^k\ {}^{2n+1}C_{2k+1}\ \tan^{2k}\theta = 0$$

for $\theta=\frac{j\pi}{2n+1},\ 1 \le j \le n$

so $\tan^2\frac{j\pi}{2n+1}, I\ \le j \le n$ are the roots of $\sum_{k=0}^{n}\left(-1\right)^k.{}^{2n+1}C_{2k+1}.x^k\ = 0$

$\because a_n$ & b_n are the sum and the product of the roots respectively, we have

$$a_n = {}^{2n+1}C_2 = n\left(2n+1\right)$$

$$b_n = {}^{2n+1}C_{2n} = 2n+1$$

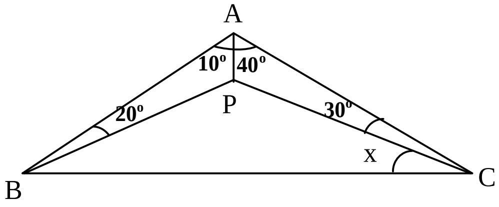
$$\therefore \frac{a_n}{b_n} = n$$

7. **D**

${}^{100}C_1\sin\theta + {}^{100}C_2\sin2\theta + ... + {}^{100}C_{100}\sin100\theta$ = Imaginary part of $\left(1+e^{i\theta}\right)^{100}$

= Imaginary part of $\left(1+\cos\theta+i\sin\theta\right)^{100} = 2^{100}\left(\cos\frac{\theta}{2}\right)^{100}\ \sin50\theta$

8. **A**



Let $x = \angle PCB$ then $\angle$ PBC = $80^o - x$

By sin law

$$1=\frac{PA}{PB}.\frac{PB}{PC}.\frac{PC}{PA}$$

$$=\frac{\sin\angle PBA}{\sin\angle PAB}.\frac{\sin\angle PCB}{\sin\angle PCB}.\frac{\sin\angle PAC}{\sin\angle PCA}$$

$$=\frac{\sin 20^o \sin x^o \sin 40^o}{\sin 10^o \sin\left(80^o - x\right)\sin 30^o}$$

$$=\frac{4\sin x \sin 40^o \cos 10^o}{\sin\left(80^o - x\right)}$$

$$1=\frac{2\sin x\left(\sin 30^o + \sin 50^o\right)}{\sin\left(80^o - x\right)}$$

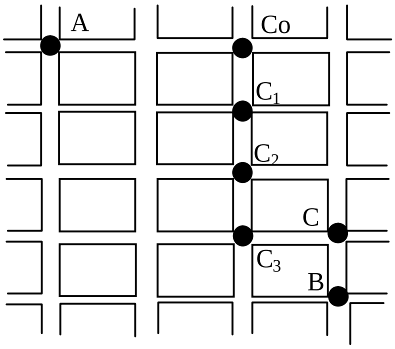
$$=\frac{\sin x\left(1+2\cos 40^o\right)}{\sin\left(80^o - x\right)}$$

& so 2 sinx cos40^o $= \sin\left(80^o - x\right) - \sin x = 2\sin\left(40^o - x\right)\cos 40^o$

$\Rightarrow x = 40^o - x$ or x = 20^o

$\therefore \angle ACB = 50^o$.

9. **D**



The probability that the student passes through C is the sum from $i = 0$ to 3 of the probabilities that he enters intersection C$_i$ in the adjoining figure & goes east. The number of paths from A to C$_i$ is $^{2+i}C_2$ because each such path has 2 eastward block segments & they can occur in any order. The probability of taking any one of these paths to C$_i$ and then going east is $\left(\frac{1}{2}\right)^{3+i}$ because there are $3+i$ intersection along the way (including A & C$_i$) where an independent choice with probability ½ is, made

$$\therefore \sum_{i=0}^{3} {}^{2+i}C_2\left(\frac{1}{2}\right)^{3+i} = \frac{21}{32}$$

10. **B**

$$\lim_{x\to 0}\left\{\frac{f(x)-f(0)}{x-0}+\frac{f\left(\frac{x}{2}\right)-f(0)}{x-0}+\frac{f\left(\frac{x}{3}\right)-f(0)}{x-0}+..........+\frac{f\left(\frac{x}{k}\right)-f(0)}{x-0}\right\}.$$

$$=\left(1+\frac{1}{2}+\frac{1}{3}+........+\frac{1}{k}\right)f'(0)$$

11. **C**

$$\frac{f'(x)}{f(x)} = \frac{f'(-x)}{f(-x)}$$

Integrating we get

$f(x).f(-x) = c$

$f(0) = 3 \Rightarrow c = 9$

$f(x)f(-x) = 9$

12. **A**

$$I = \int_{-51}^{51} \frac{dx}{3 + f(x)}$$

Let $x = -t$

$$I = \int_{-51}^{51} \frac{dt}{3 + f(-t)}$$

$$2I = \int_{-51}^{51} \frac{6 + f(x) + f(-x)}{18 + 3(f(x) + f(-x))}$$

$$\Rightarrow 2I = \int_{-51}^{51} \frac{dx}{3}$$

$I = 17$

13. **C**

14. **D**

(Soln: 13 – 14)

$\frac{s-a}{s} = \frac{1}{2} \Rightarrow b + c = 3a \Rightarrow CA + BA = 12$

A lies on ellipse whose foci are B & C centre of ellipse is (4, 4)

Length of major axis = 12

$12e = 4 \Rightarrow e = \frac{1}{3}$

Length of minor axis $= 8\sqrt{2}$.

(i) PQ is the latus rectum of ellipse

$\therefore$ Area $= 2\left(\frac{1}{2} \times K_1 e \times \frac{k_2^2}{k_1}\right) = ek_2^2 = \frac{32}{3}$ sq.units

(ii) ΔPBC is et $L^d at^c$

(iii) Equation of Hyperbola is

$$\frac{(x-4)^2}{4} - \frac{(y-4)^2}{4(e^2-1)} = 1$$

It passes through $(0,2) \Rightarrow e = \frac{2}{\sqrt{3}}$

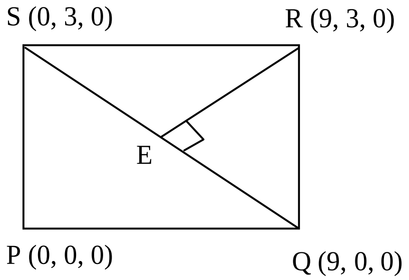
15. **B**

Equation of lines QS in 2D will be $x+3y-9=0$

$RE=\frac{9}{\sqrt{10}}$ & $E\left(\frac{81}{10},\frac{3}{10},0\right)$

So point T will be

$\therefore PT=\frac{3}{5}\sqrt{205}$



16. **A**

Shortest distance between the lines

$\bar{r}=\bar{a}+\lambda\bar{\alpha}$ & $\bar{r}=\bar{b}+\mu\bar{\beta}$

Is given by $\frac{\left|\left(\bar{a}-\bar{b}\right).\left(\bar{\alpha}\times\bar{\beta}\right)\right|}{\left|\bar{\alpha}\times\bar{\beta}\right|}=3\sqrt{\frac{10}{19}}$

17. **C**

B is cofactor of A

$\therefore |B|=|A|^2$

$\det(AB)=|A|^3$

$|A|=3abc-a^3-b^3-c^3$

$=18$

$|AB|=(18)^3$

$\alpha+\beta+\gamma=tr(|B|)=ab+bc+ca-a^2-b^2-c^2$

$=3(ab+bc+ca)-(a+b+c)^2$

$=3\times5-9=6$

18. **D**

Let the line be $\frac{x}{\cos\theta}=\frac{y}{\sin\theta}=r$

$r_1\cos\theta=\alpha$

$r_2\sin\theta=\beta$

$r_3(\sin\theta+\cos\theta)=8$

$r_1r_2r_3=48\sqrt{2}$

$f(\alpha,\beta)\le 0$

$\Rightarrow\left|\frac{\beta}{\alpha}-\frac{3}{2}\right|+(3\alpha-2\beta)+\sqrt{e^{\alpha}+2\beta-2e-6}\le 0$

$\Rightarrow\left|\frac{\beta}{\alpha}-\frac{3}{2}\right|+(3\alpha-2\beta)^6+\sqrt{e^{\alpha}+2\beta-e^2-6}=0$

$\frac{\beta}{\alpha}-\frac{3}{2}=0,\ 3\alpha-2\beta=0$ & $e^{\alpha}+2\beta=e^2+6$ ......(1)

$\beta = \frac{3\alpha}{2}, \beta = \frac{3\alpha}{2},$

Putting $\beta = \frac{3\alpha}{2}$ in (1)

$e^{\alpha} + 3\alpha = e^2 + 6$

$\Rightarrow \alpha = 2, \beta = 3$

$\Rightarrow \quad r_1 = \frac{2}{\cos\theta}$

$r_2 = \frac{3}{\sin\theta}$

$r_3 = \frac{8}{\sin\theta + \cos\theta}$

$\frac{48}{\cos\theta \sin\theta(\sin\theta + \cos\theta)} = 48\sqrt{2}$

$\cos\theta \sin\theta(\sin\theta + \cos\theta) = \frac{1}{\sqrt{2}}$

$\Rightarrow \quad \theta = \frac{\pi}{4}$

$r_1 = 2\sqrt{2},\ r_2 = 3\sqrt{2},\ r_3 = 4\sqrt{2}$

19. **A**

(P) $\lim_{y\to\infty} \frac{y - \tan 1}{y - 1} = 1$

(Q) $4ab = (a+b)^2 - (a-b)^2$

$4ab = (2 + 2\sin^2 2\theta)^2 - 4^2 \sin^2 2\theta$

$ab = (1 + \sin^2 2\theta)^2 - 4\sin^2 2\theta$

$\Rightarrow ab = (1 - \sin^2 2\theta)^2$

$(ab)_{\max} = 1$

(R) $\cos\alpha = \frac{\frac{1}{2}}{2} = \frac{1}{4}$ (from Δ OED)

$\theta = \pi - 2\alpha$

$BD = 2\cot\frac{\theta}{2} = 2\cot\left(\frac{\pi}{2} - \alpha\right)$

$= 2\tan\alpha$

$= 2\sqrt{15}$

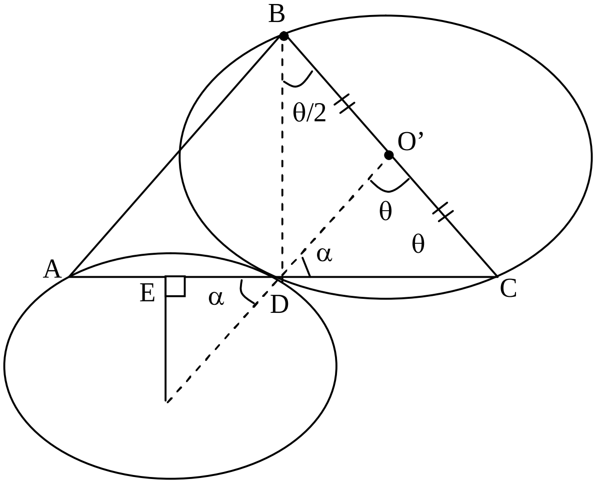
Area of $\Delta ABC = \frac{1}{2}(AC)(BD)$

$= \frac{1}{2} \times 3 \times 2\sqrt{15}$

$= 3\sqrt{15}$

$= \sqrt{135}$

$\frac{N^2}{15} = 9$



(S)

$$\lim_{n\to\infty}\frac{n^{2/3}\sin(n!)}{n\left(1+\frac{1}{n}\right)}=\lim_{n\to\infty}\frac{1}{n^{1/3}}.\frac{\sin(n!)}{1+\frac{1}{n}}$$

$$=\frac{1}{\infty}\left(\frac{\text{a number between }-1\&1}{1}\right)$$

$$=0$$

20. **B**

(P)

$$I_1=\int_1^e x\left(\frac{1+x}{x}\right)\left(x+\ln x\right)^{100}dx$$

$$=\frac{e(e+1)^{101}-1}{101}-\frac{1}{101}\int_1^e(x+\ln x)^{101}dx$$

$$I_2=\frac{1}{e}\int_1^e(t+\ln t)^{101}dt \qquad \text{let}\quad e\sin x=t$$

$$\Rightarrow I_1+\frac{eI_2}{101}=\frac{e(e+1)^{101}-1}{101}$$

$$\Rightarrow K=1$$

(Q)

$$KI(k)=\int_0^\infty\frac{k\ln x}{x^2+kx+k^2}dx$$

$$x=kt$$

$$kI(k)=\int_0^\infty\frac{\ln Kt}{t^2+t+1}dt$$

$$kI(k)-I(1)=\ln k\int_0^\infty\frac{dt}{1+t+t^2}$$

$$=\ln k\int_0^\infty\frac{dt}{\left(t+\frac{1}{2}\right)^2+\left(\frac{\sqrt{3}}{2}\right)^2}$$

$$\Rightarrow\frac{\pi}{\sqrt{3}}=\left(\ln k\right)\frac{2}{\sqrt{3}}.\frac{2\pi}{6}$$

$$k=e^{3/2}$$

(R)

$$9f(3)\quad\le\int_0^3x^2f'(x)+\int_0^3\left(f(x)\right)^2dx+k$$

$$\le\left[x^2b(x)\right]_0^3-\int_0^3 2xf(x)dx+\int_0^3\left(f(x)\right)^2dx+k$$

$$\Rightarrow\qquad\int_0^3\left(2xf(x)-(f(x))^2\right)dx\le k$$

$$2xf(x)-f^2(x)=x^2-\left(f(x)-x\right)^2\le x^2$$

$$\int_0^3 2xf(x)-f^2(x)dx\le\int_0^3x^2dx$$

$$\int_0^3\left(2xf(x)-\left(f(x)\right)^2\right)dx\le 9$$

$$K_{\min}=9$$

(S)

$$\log_a x = t$$

$$\Rightarrow \quad a^t = x$$

$$\Rightarrow \quad dx = a^t \ln a\, dt$$

$$\therefore \quad \int_1^a x\, a^{-[\log_a x]} dx = \ln a \int_0^1 a^t . a^{-[t]} . a^t dt$$

$$= \quad \ln a \int_0^1 a^{2t} dt = \frac{a^2 - 1}{2} = \frac{e-1}{2}$$

$$\Rightarrow \quad a = \sqrt{e}$$

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

ALL INDIA TEST SERIES

FIITJEE **JEE (Main), 2017**

FULL TEST – V

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **Section-A (01 to 30)** contains 30 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

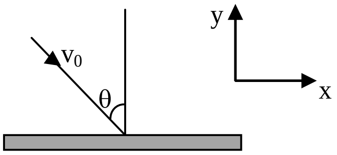
PART – I

SECTION – A

(Only One Option Correct Type)

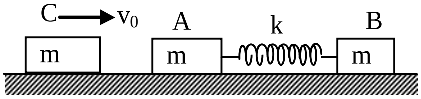
This section contains **30 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

1. A ball is thrown such that it strikes the ground with velocity v_0 making an angle θ with the vertical. The height to which it rises after the collision (if the coefficient of restitution is e) is



(A) $\frac{e^2v_0^2\cos^2\theta}{2g}$
(B) $\frac{e^2v_0^2\sin^2\theta}{2g}$
(C) $\frac{e^2v_0^2\tan^2\theta}{2g}$
(D) $\frac{e^2v_0^2\cos^2\theta}{g}$

2. The maximum potential energy that the spring connecting blocks A and B can have as a consequence of collision of block C with A is (ignore any friction.)



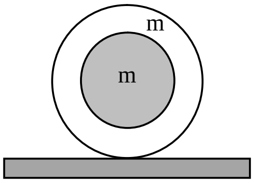
(A) mv_0^2
(B) $\frac{mv_0^2}{2}$
(C) $\frac{mv_0^2}{4}$
(D) $\frac{2mv_0^2}{3}$

3. A block m_1 strikes a stationary blocks m_3 inelastically. Another block m_2 is kept on m_3. Neglecting the friction between all contacting surfaces, the maximum fractional decreases of K. E. of the system in collision is:

(A) $\frac{m_1}{m_1+m_2+m_3}$
(B) $\frac{m_1}{m_2+m_3}$
(C) $\frac{m_3}{m_1+m_3}$
(D) $\frac{m_2+m_3}{m_1+m_2+m_3}$

Space for rough work

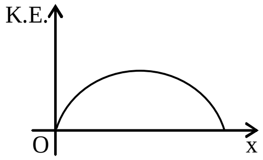
4. A thin hollow sphere of mass m is completely filled with an ideal liquid of mass m. when the sphere rolls with a velocity v kinetic energy of the system is equal to

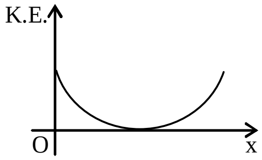


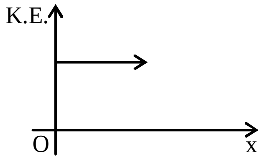
(A) $\frac{1}{2}mv^2$ (B) mv^2

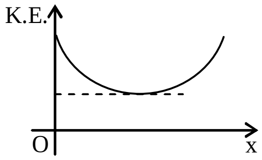
(C) $\frac{4}{3}mv^2$ (D) $\frac{4}{5}mv^2$

5. A projectile is fired with some velocity making certain angle with the horizontal. Which of the following graphs is the best representation for the kinetic energy of a projectile (K. E.) versus its horizontal displacement (x)?

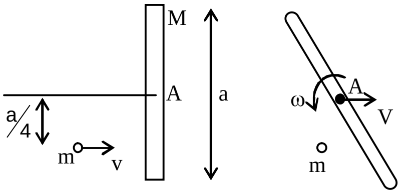
(A)


(B)


(C)


(D)


6. A uniform rod of mass M and length a lies on a smooth horizontal plane. A particle of mass m moving at a speed v perpendicular to the length of the rod strikes it at a distance of a/4 from the centre and stops after the collision. The angular velocity of the rod about its centre just after the collision is



Before Collision After Collision

(A) $\frac{3mv}{Ma}$ (B) $\frac{2mv}{Ma}$

(C) $\frac{3Mv}{ma}$ (D) $\frac{4mv}{Ma}$

Space for rough work

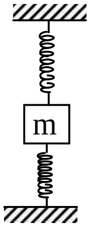
7. Two coherent waves represented by $y_1 = A\sin\left(\frac{2\pi x_1}{\lambda} - \omega t + \frac{\pi}{6}\right)$ and $y_2 = A\sin\left(\frac{2\pi x_2}{\lambda} - \omega t + \frac{\pi}{8}\right)$ are superposed. Find the path difference $(x_1 - x_2)$ to produce constructive interference ($n \in I$).

(A) $n\lambda$
(B) $\left(n - \frac{1}{48}\right)\lambda$
(C) $(n - 48)\lambda$
(D) $n\lambda / 2$

8. A small air bubble of radius r is found to form at a depth of H from the open surface of the liquid contained in a beaker. If S is the surface tension and ρ, the density of the liquid and p_0, the atmospheric pressure the pressure inside the bubble is

(A) $\frac{4S}{r} + \rho gH + p_0$
(B) $\frac{2S}{r} - \rho gH + p_0$
(C) $\frac{4S}{r} - \rho gH + p_0$
(D) $\frac{2S}{r} + \rho gH + p_0$

9. A block of mass m is suspended from a spring. Its frequency of oscillation is *f*. The spring is cut into two identical halves and the same block is suspended from one of the two pieces of the spring, such that it just touches the other spring below in its equilibrium position. The frequency of small oscillations of the mass will be



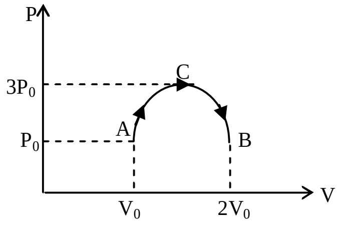
(A) f
(B) $\sqrt{2}$ f
(C) 2f
(D) $4f\left(\sqrt{2} - 1\right)$

10. Two tuning forks with natural frequencies of 340 Hz each move relative to a stationary observer. One fork moves away from the observer white the other moves towards him at the same speed. The observer hears beats of frequency 3 Hz. The speed of the tuning fork is (velocity of sound = 340 m/s.)

(A) 1.5 m/s
(B) 0.45 m/s
(C) 3 m/s
(D) 4.5 m/s

Space for rough work

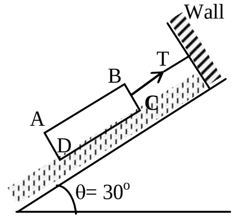
11. One mole of an ideal monatomic gas is taken through a semi-circular thermodynamic process ACB shown in the P–V diagram. The heat supplied to the system is



(A) $P_0^2\left(\frac{5+\pi}{2}\right)$ (B) $P_0V_0\left(\frac{2\pi-1}{2}\right)$

(C) $P_0V_0\left(1+\pi\right)$ (D) $P_0V_0\left(\frac{5+\pi}{2}\right)$

12. Water is flowing in a streamline down the incline having inclination 30^o with the horizontal. A box ABCD, attached with the wall, is floating on the surface of the water keeping face CD of the box downward as shown in the figure. The box has a weight of 200 N and base are $1m^2$. If the velocity of the streamline at a distance of 1 mm from the base CD is 0.1 m/s, then the tension in the string connecting the block to the wall as shown is (Given viscosity of water = 0.1 N-s/m^2.]



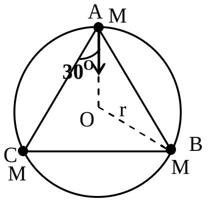
(A) 110 N (B) 90 N
(C) 95 N (D) 100 N

13. The amplitude of a wave disturbance propagating in the positive x-direction is given by $y = 1/\left(1+x^2\right)$ at time t = 0 and by $y = 1/\left[1+\left(x-1\right)^2\right]$ at $t = 2$ seconds, where x and y are in metres. The shape of the wave disturbance does not change during the propagation. The velocity of the wave is

(A) $1\,ms^{-1}$ (B) $0.5\,ms^{-1}$

(C) $1.5\,ms^{-1}$ (D) $2\,ms^{-1}$

14. The particles each of mass M, are located at the vertices of an equilateral triangle of side 'a'. At what speed must they move if they all revolve under the influence of their gravitational force of attraction in a circular orbit circumscribing the triangle while still preserving the equilateral triangle?

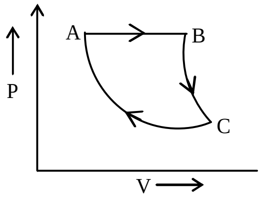


(A) $\sqrt{\frac{MG}{a}}$ (B) $\sqrt{\frac{2MG}{a}}$

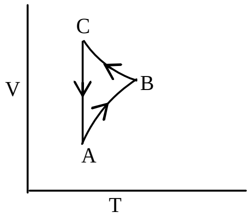
(C) $\sqrt{\frac{MG}{2a}}$ (D) None of the above

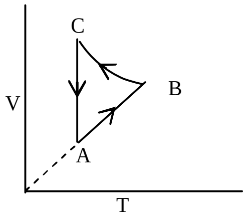
Space for rough work

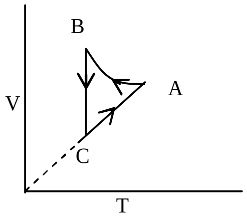
15. For a given thermodynamic process, the P –V diagram is as shown below: which of the following is the V – T diagram for the process?

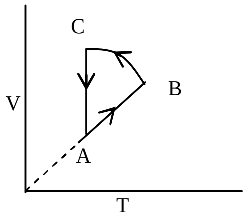


A → B : Isobaric
B → C : adiabatic
C → A : isothermal

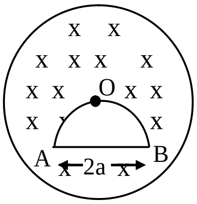
(A)


(B)


(C)


(D)


16. In cylindrical magnetic field B is changing as $B = B_0 + \alpha t$. Find the value of $\int \vec{E}.d\vec{l}$ for the path of BOA, as shown in the figure. Line AOB is semi circular. ($\vec{E}$ is the induced electric field in the region).



(A) $\frac{\pi a^2 \alpha}{2}$

(B) $a^2 \alpha \left(\frac{\pi}{2} - 1 \right)$

(C) $a^2 \alpha$

(D) $\pi a^2 \alpha$

Space for rough work

17. A capacitor of capacitance C is charged to a potential difference V from a cell and then disconnected from it. A charge +Q is now given to its positive plate. The potential difference across the capacitor is now

(A) V
(B) $V+\frac{Q}{C}$
(C) $V+\frac{Q}{2C}$
(D) $V-\frac{Q}{C}$, if $V < CV$

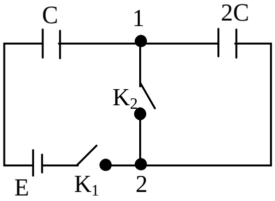
18. A potentiometer wire of length 100 cm has a resistance of 10Ω. It is connected in series with an external resistance and a cell of emf 2 volt and negligible internal resistance. A source of emf 10 mV is balanced against a length of 40 cm of the potentiometer wire. The value of external resistance is

(A) 800 Ω
(B) 790 Ω
(C) 825 Ω
(D) 745 Ω

19. An AC source of angular frequency ω is fed across a resistor R and a capacitor C in series. The current resistered is I. If now the frequency of source is changed to ω/3 (but maintaining the same voltage), the current in the circuit is found to be halved. The ratio of reactance to resistance at the original frequency ω will be.

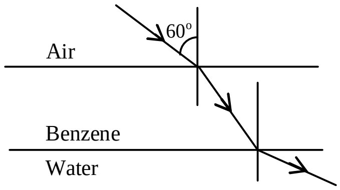
(A) $\sqrt{\frac{3}{5}}$
(B) $\sqrt{\frac{5}{3}}$
(C) 3/5
(D) 5/3

20. Consider the capacitor circuit shown in the figure initially only K_1 is closed and after sufficiently long time, K_2 is also closed. The charge flowing through section 1 → 2 after closing the K_2 is



(A) $-\frac{CE}{2}$ from 2 to 1
(B) $-\frac{CE}{6}$ from 2 to 1
(C) $-CE$ from 2 to 1
(D) $\frac{CE}{4}$ from 1 to 1

Space for rough work



21. A layer of benzene floats on water. If the angle of incidence of the light entering benzene form air is 60°, then the angle that light makes with normal in water is
(Refractive index of water = 4/3.)
(A) 30°
(B) $\sin^{-1}\left(\frac{3\sqrt{3}}{8}\right)$
(C) $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$
(D) data not sufficient

22. A ray of light is incident normally on one of the faces of a prism of apex angle 30° and refractive index $\sqrt{2}$. The angle of deviation of the ray is
(A) 15° (B) 75°
(C) 30° (D) none of these

23. Light of wavelength 4000 $\overset{o}{A}$ falls on a metal surface having work function of 2.0 eV. What is the stopping potential?
(A) 3.1 V (B) 2.0 V
(C) 5.1 V (D) 1.1 V

24. When the voltage applied to an X-ray tube is increased from V_1 = 10 kV to V_2 = 20 kV, the wavelength interval between the K_α line and the short-wave cut-off of the continuous X-ray spectrum increases by a factor η=3.0. Find the atomic number of the element of which the tube's anti-cathode is made.
(A) 29 (B) 30
(C) 28 (D) none of the above

25. Two radioactive materials X_1 and X_2 have decay constant 10λ and λ, respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of X_1 to that of X_2 will be 1/e after a time
(A) $1/(10\lambda)$ (B) $1/(11\lambda)$
(C) $11/(10\lambda)$ (D) $1/(9\lambda)$

Space for rough work

26. In the measurement of the acceleration due to gravity using a simple pendulum, the percentage error in the measured value of the length of the pendulum is 2% and that in the time period of oscillation is 1%. What is the percentage error in the measured value of the acceleration due to gravity?

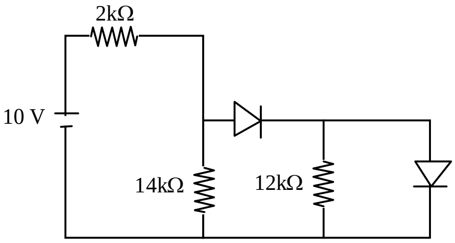
(A) 4%	(B) 5%
(C) 6%	(D) 3%

27. In a Coolidge tube, the potential difference used to accelerate the electrons is increased from 12.4 kV to 24.8 kV. As a result, the difference between the wavelengths of K_α line is $\left(\frac{hc}{e} = 12.4\,V\,\overset{o}{A}\right)$

(A) $1\overset{o}{A}$ (B)	(B) $0.5\ \overset{o}{A}$
(C) $1.5\overset{o}{A}$	(D) 0

28. In the following circuit i_1 and i_2 are respectively (diodes are ideal)

(A) 0, 0
(B) 0, 5mA
(C) 5mA, 0
(D) 5mA, 5mA



29. For a common base configuration of PNP transistor $\frac{I_C}{I_E} = 0.98$ then maximum current gain in common emitter configuration will be

(A) 12	(B) 24
(C) 6	(D) 48

30. Due to annihilation of electron-positron of same kinetic energy 0.95 MeV, a photon is produced which can also be produced by an electron of energy E, the possible value (S) of E is e(mass of electron $C = 9.1\times10^{-31}$kg, $e = 1.6\times10^{-19}$c)

(A) 1.02 MeV	(B) 2.42 MeV
(C) 1.03 MeV	(D) 2.93 MeV

Space for rough work

Chemistry

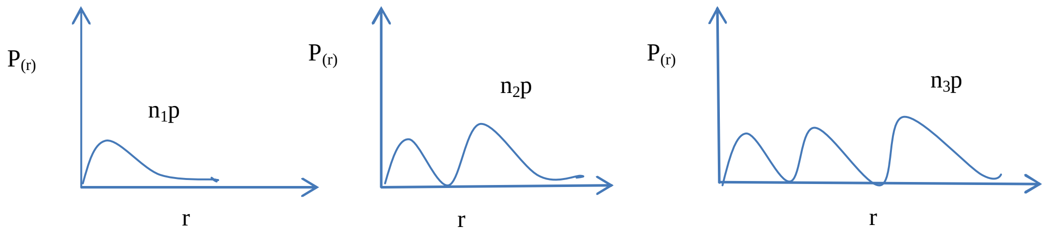
PART – II

SECTION – A

(Only One Option Correct Type)

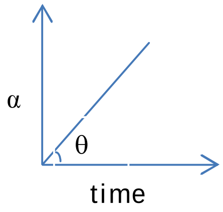
This section contains **30 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

1. When sum of radius ratio(using Bohr's modal) of hydrogen atom obtained from following given qualitative sketch of radial probability density $P_{(r)}$ vs r for p subshells is 'x'. Then value of $\frac{x-4\sigma}{2}$ (σ = value of bond order of c-c bond in benzene, and n_1, n_2, n_3 are corresponding shell number of p subshells whose sketches are given) is……



(A) 7
(B) 11.5
(C) 13.5
(D) 15.5

2. A zero order kinetic, 2A $\xrightarrow{\hspace{1em}}$ P. The initial concentration of reactant is 0.05M is given. The variation of degree of dissociation with time is …….

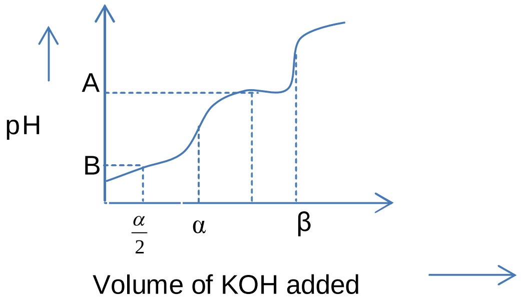


Using graph calculate value of rate constant . $\left(a = \text{degree of dissociation, } \tan\,\theta = 0.5\right)$.

(A) 0.125
(B) 0.0125
(C) 1.25
(D) 12.5

Space for rough work

3. The titration curve of diprotic acid with standard KOH solution is given as:



(A) The pH of amphiprotic anion represents at volume β.
(B) The pH (B) represent the 50% neutralization, pH that give idea about Pka_1
(C) pH of salt solution at 100% neutralization obtained at volume β.
(D) The pH (B) represents the end point at pH=7

4. $NaNO_3$ on heating to 500°C decomposes to produce $NaNO_2$ and oxygen, while salt on heating above 800°C, decomposes to Na_2O,N_2 and O_2 because of
(A) high heat of hydration of Na^+ ion than NO_3^-
(B) solvated electron of Na in $NaNO_3$ have high density than $NaNO_2$
(C) greater effective nuclear charge of Na^+ in $NaNO_3$ than in $NaNO_2$
(D) less polarizability of smaller nitrite ion than nitrate ion

5. The deposited mass of Metal M (molar mass = 50) on electrolysis of aq. MCl_x by passing 965 ampere current for 50 seconds is 5g.What will be the value of x+y+z of the following given ionic equation where M used as reducing agent.

$$xMnO_4^- + yM + zH^+ \dashrightarrow aM^{+x} + bMn^{+2} + cH_2O$$

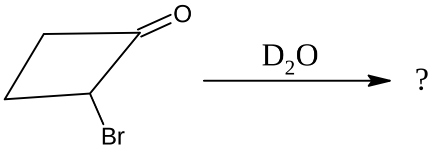
(A) 10 (B) 12
(C) 14 (D) 15

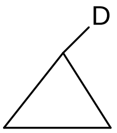
6. The P^H of 0.1 molar monobasic acid is 2.The osmotic pressure of solution at 25°C is
(A) 3 (B) 5
(C) 4 (D) 2.69

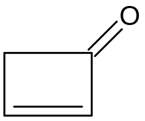
Space for rough work

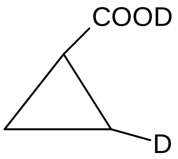
7. Which of the following will not give lassaigne test' for nitrogen?
(A) NH_2-NH_2 (B) C_6H_5-N=NC_6H_5
(C) CH_3CONH_2 (D)CH_3CN

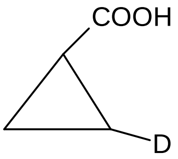
8. The Product of the given reaction:



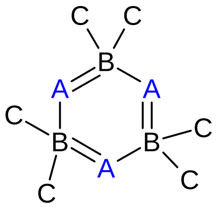
(A)


(B)


(C)


(D)


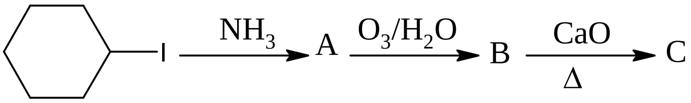
9. A stable molecule containing atoms of elements A,B and C has a following structure. Which of the following is possible combination of elements?

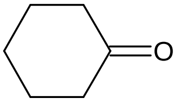
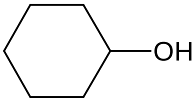
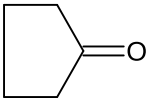
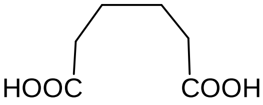


(A) N, P, Cl (B) O, S, Cl
(C) B, C, H (D) P, N, F

10. Which of the following statements are correct for S_N^2 reaction?
(A) In the gaseous phase, the order of reactivity of halide ions is $F^- > Cl^- > I^-$ while in methanol the order of reactivity is $I^- > Br > Cl^- > F^-$
(B) Among similar solvents, in general, the greater the polarity, slower the S_N^2 reaction.
(C) In an aprotic solvent such as dimethyl sulphoxide the order of reactivity of halide ions as nucleophiles is $F^{\ominus} > Cl^{\ominus} > Br^{\ominus} > I^{\ominus}$
(D) All are correct.

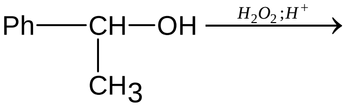
Space for rough work

11. 

(A)  (B)  (C)  (D) 

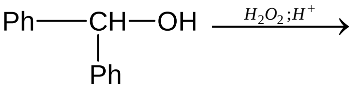
12. Which of the following reaction gives the alcohol, whose molecular weight is lowered by 14 unit than its starting reactant?

(A) $\left(CH_3\right)_2 CH - OH \xrightarrow{H_2O_2;H^+}$

(B) 

$\underset{CH_3}{Ph-CH-OH} \xrightarrow{H_2O_2;H^+}$

(C) $CH_3CH_2OH \xrightarrow{H_2O_2;H^{\oplus}}$

(D) 

$\underset{Ph}{Ph-CH-OH} \xrightarrow{H_2O_2;H^+}$

13. Select the most effective drying agent at O˚C out of the basis of following equilibria.

$$\underset{(s)}{ACl_2\bullet 6H_2O} \rightleftharpoons \underset{(s)}{ACl_2\bullet 2H_2O} + \underset{(g)}{4H_2O}$$

$$K_P = 6\bullet 89\times 10^{-12}$$

$$\underset{(s)}{A_2HPO_4\bullet 12H_2O} \rightleftharpoons \underset{(s)}{Na_2HPO_4\bullet 7H_2O} + 5H_2O$$

$$K_P = 5.25\times 10^{-13}$$

$$\underset{(s)}{ASO_4\bullet 10H_2O} \rightleftharpoons \underset{(s)}{ASO_4} + \underset{(g)}{10H_2O}$$

$$K_P = 4.08\times 10^{-25}$$

The vapour Pressure of water at 0^0C is $4\bullet 58$ torr in atmosphere?

(A) $ACl_2\bullet 2H_2O$

(B) $\underset{(s)}{AHPO_4\bullet 7H_2O}$

(C) ASO_4

(D) All are equal

Space for rough work

14. $Cr_2O_7^{-2} \xrightarrow{P^H = X} CrO_4^{-2} \xrightarrow{P^H = Y} Cr_2O_7^{-2}$

Select the correct option.

(A) X > Y
(B) X < Y
(C) X = Y
(D) X = Y = 7

15. Statements:

I. An especially favorable conformation for the peptide linkages in protein is the ‘$\propto$’ helix arrangement.

II. I_4 O_9 ionises as I^{3+} + $\left(IO_3^-\right)_3$

III. O_2 reacts with P_tF_6 to give the compound $\left[O_2^+\right]\ \left[P_tF_6\right]^-$,

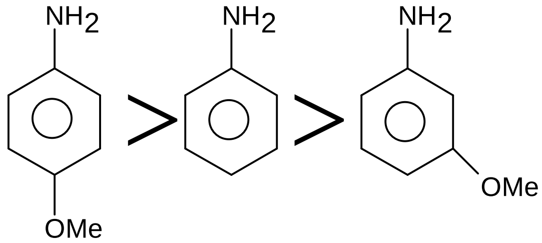
IV. Froth floatation process used for concentration of sulphide ore where sodium ethyl xanthate used as collector. Out of these statements,

(A) I, II and III are correct.
(B) II, III, and IV are correct
(C) Only III correct
(D) I, II, III and IV are correct.

16. Which of the following order(s) of properties given is/are correct?

I. Tendency of alkyl halides to undergoes dehydrohalogenation in williamson, synthesis Follows the order $3^0 > 2^0 > 1^0$

II. Propanol < 2 – methyl – 1 – Propanol < 2 – butanol < 2 – Methyl – 2 Propanol (rate of reaction with HBr)

III. 

(Basic order)

IV. Toluene < m-dichlorobenzene < O- dichloro benzene < P- dichloro benzene - (Order of dipole moment).

Select correct option:

(A) I, II, IV, are correct
(B) IV,I are correct
(C) II, II, IV, are correct
(D) I, II, and III, are correct

Space for rough work

17. The specific conductivity of $AB_{(aq)}$ at 298 k is 1.26 $\times 10^{-6}$ and ionic conductivity of $A^{\oplus}_{(aq)}$ and $B^{\ominus}_{(aq)}$ at infinite dilution are 62 s cm^2 mol^{-1} and 76 s cm^2 mol^{-1} respectively. The number of $B^{\ominus}$ ions in saturated solution per litre (aproximately)

(A) 1×10^{14}	(B) 5×10^{-14}
(C) 55×10^{14}	(D) 1×10^{24}

18. S_8 exist as a mixture of S_8 and S_2 according to dissociation $S_8 \rightleftharpoons 4S_2$
The rate of diffusion of mixture is 0.75 times more than that of pure sulpher(S_8). The mass percentage of S_2 in the sample

(A) 40 %	(B) 30 %
(C) 80 %	(D) 52 %

19. In silicon dioxide
(A) There are double bonds between silicon and oxygen atoms
(B) silicon atom is bonded to two oxygen atoms
(C) Each silicon atom is surrounded by two oxygen atoms and each oxygen atom is bonded two silicon atoms.
(D) Each silicon atom is surrounded by four oxygen atoms and each oxygen atom is bonded to two silicon atoms.

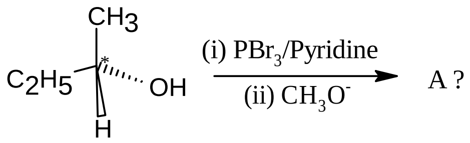
20. Statement not correct regarding ortho and para hydrogen
(A) Ortho is more stable than Para
(B) Ortho and Para hydrogen are called spin isomers.
(C) magnetic moment of Para is zero while ortho has twice that of proton.
(D) Conductivity of ortho and Para is equal.

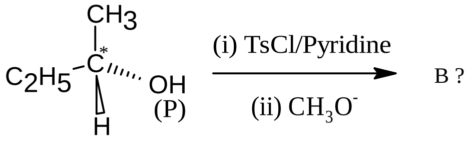
21. Which of the following mixtures can be separated by using an NH_3 solution?

(A) Fe^{+3} and Al^{+3}	(B) Al^{+3} and Zn^{+2}
(C) Sn^{+2} and Pb^{+3}	(D) Cu^{+2} Cd^{+2}

Space for rough work

22.

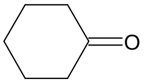




Select the correct statements:
(A) A and B have same configuration
(B) A and B are diastereomers with each other
(C) A have same configuration as the starting material
(D) A and B have same configuration as the starting material

23. Incorrect statement is:
(A) $HCHO \xrightarrow[K]{\bar{O}H} HCOO^{-} + CH_3OH$, The reaction can have rate law expression,

$r = K\left[HCHO\right]^2\left[\bar{O}H\right]$ or $r = K\left[HCHO\right]^2\left[\bar{O}H\right]^2$

(B) ortho chlorobenzaldehyde and meta chlorobenzaldehycle gives cannizarro reaction.
(C)  $+H_2N-OH \xrightarrow{P^H\, 3.4 to 4} A \xrightarrow{SOCl_2} B,$

where B is an amide.
(D) acid halide > acid anhydride > aldehydo > ketone > ester $\simeq$ carboxylic acid > amide > carboxylate ion. (relative reaclivities towards Nuclcophile)

24. The group of negative charged colloids
(A) starch, Haemoglobin and ferric hydroxide
(B) Au, Ag and Aluminium hydroxide
(C) Clay Haemoglobin and starch
(D) Arsenic sulphide, starch, and clay

Space for rough work

25. The incorrect statement among the following is
(A) $\left[Ni\left(CN\right)_4\right]^{2-}$ is square Planer complex
(B) $\left[ZnCl_4\right]^{2-}$ is tetrahedral complex
(C) In $\left[Cu\left(NO_2\right)_4\right]^{4-}$ tetragonal distortion takes place.
(D) The bond length of C – O' in CO (free state) is more than in complex Fe $(CO)_5$ (as a ligand)

26. Of the following mixture, the most likely, mixture nearer to ideal solution is

(A) NaCl – water	(B) ethanol – benzene
(C) heptane – water	(D) heptane - octane

27. A clourless salt changes to yellow on heating, salt is also soluble in NaOH as well in dil HCl. Salt can be

(A) FeO	(B) PbO
(C) ZnO	(D) CdO

28. The temperature voltage coefficient for a simple alkaline torch battery is - 6×10^{-4} VK^{-1}
What is the entropy change associated with battery discharge? The number of electrons transferred in the cell reaction n = 2.

(A) -1.16 JK^{-1} mol^{-1}	(B) 1.16 JK^{-1}
(C) 11. 6 JK^{-1} mol^{-1}	(D) -11.6 JK^{-1} mol^{-1}

29. Vander wall constant for hydrogen chloride gas a = 3.67 atm $litre^{-2}$ and b = .0408 mL mol^{-1}. The ratio of Tc (critical temperature) and Pc (critical pressure) of the gas is (approximately)

(A) 2	(B) 3
(C) 4	(D) 5

30. How many moles of HIO_4 (Periodic acid) are required for cleavage C- C bonds in the sucrose?

(A) 5	(B) 2
(C) 8	(D) 3

Space for rough work

Mathematics

PART – III

SECTION – A

(Only One Option Correct Type)

This section contains **30 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

1. The value of integral $\int_0^2 \cos^{-1}\left\{(x-1)|x-1|+(x-1)^3\right\}dx$ is

(A) 2π (B) 3π

(C) 4π (D) π

2. If $\ln\left(2x^2+a^2\right)>\ln\left(x^2+2x+3\right)$, then set of values of 'a' will be

(A) $(-\infty,-2)\cup(2,\infty)$ (B) $(-\infty,-1)\cup(0,\infty)$

(C) $(-2,\infty)$ (D) R

3. f(x) = $\sin\left(\pi\left\{\frac{x}{2}\right\}\right),\ x\in R.$

Then

(A) f(x) is discontinuous where x = 2K, $k\in I.$

(B) f(x) is discontinuous where x = 2K, $k\in I^+$

(C) f(x) is discontinuous every where except x = 2

(D) f(x) is continuous every where.

4. If $\sqrt{x^2+x+1}\ge 2-x$ exhaustive set of x is

(A) $(3/5,\ \infty)$ (B) $[3/5,\ \infty)$

(C) $[3/5,\ 2)$ (D) $[2,\ \infty)$

5. If $f(x)=\frac{x+1}{2x-1}$, then $f(f(x))$ is

(A) x (B) x + 1

(C) x – 1 (D) None of these

Space for rough work

6. If $f(x) = \max(3 - x^3, |x - 3|)$ then f(x) is non differentiable at exactly

(A) 4 point
(B) 2 point
(C) 3 point
(D) 1 point

7. If in a triangle ABC, $b\cos^2\frac{A}{2} + a\cos^2\frac{B}{2} = \frac{3c}{2}$, then a, b, c are in

(A) GP
(B) AP
(C) HP
(D) None of these

8. If $\tan B = \frac{5\sin A\cos A}{1 - 5\cos^2 A}$, then the value of $4\tan(A + B) + \tan A$ is

(A) -1
(B) 2
(C) 0
(D) 4

9. If $\sin 3\theta = 4\sin\theta\sin 2\theta\sin 4\theta,\ 0 \le \theta \le \pi$, then the number of real solution for $'\theta'$ is

(A) 2
(B) 6
(C) 0
(D) 8

10. In a triangle ABC, I is incentre and I_1, I_2, I_3 are excentres, then the value of $(II_1)\cdot(II_2)\cdot(II_3)$ is

(A) Rr^2
(B) $2R^2r$
(C) $2Rr^2$
(D) $16R^2r$

11. If $\cos\alpha = \frac{2\cos\beta - 1}{2\cos\beta}$, when $\theta < \alpha, \beta < \pi$ and $\tan\theta = \left|\frac{\tan\alpha/2}{\tan\beta/2}\right|$, then θ is

(A) 60^0
(B) 45^0
(C) $\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$
(D) 30^0

12. If $2x - 2y + 3z = 0,\ x + ay + 2z = 0$ and $2x + az = 0$ have a non-trivial solution, then

(A) $a = 1$
(B) $a = 2$
(C) $a = 0$
(D) None of these

Space for rough work

13. $\dfrac{a\cos A+b\cos B+c\cos C}{a+b+c}$ is

(A) $\dfrac{r}{R}$ (B) $\dfrac{R}{2r}$

(C) $\dfrac{R}{r}$ (D) $\dfrac{2r}{R}$

14. If $a\cos^3\alpha+3a\cos\alpha\cdot\sin^2\alpha=m$ and $a\sin^3\alpha+3a\cos^2\alpha\sin\alpha=n$ then value of $(m+n)^{2/3}+(m-n)^{2/3}$ is

(A) a^2 (B) $2a^{2/3}$

(C) $2a^{1/3}$ (D) $2a^3$

15. The coefficient of x^r where $o\le r\le n-1$ in the expression $(x+2)^{n-1}+(x+2)^{n-2}(x+1)+(x+2)^{n-3}(x+1)^2+.......+(x+1)^{n-1}$ is

(A) ${}^nC_r\left(2^r-1\right)$ (B) ${}^nC_r\left(2^{n-r}-1\right)$

(C) ${}^nC_r\left(2^r+1\right)$ (D) ${}^nC_r\left(2^{n-r}+1\right)$

16. If the term independent of 'x' in the expansion $\left(x\sin\theta+\dfrac{\cos\theta}{x}\right)^{10}$ is $f(\theta)$, then value of $f\left(\dfrac{\pi}{12}\right)$ is

(A) ${}^{10}C_5$ (B) $2^{-10}\,{}^{10}C_5$

(C) $2^{-5}\,{}^{10}C_5$ (D) $2^{5}\,{}^{10}C_5$

17. The sum of last three digit if the number N = 7^{100} - 3^{100} is

(A) 0 (B) 1

(C) 3 (D) 4

Space for rough work

18. If A + B = $\frac{\pi}{2}$, then

(A) $\left(1-\tan A/2\right)\left(1-\tan B/2\right)=2$
(B) $\left(1+\cot A/2\right)\left(1+\cot B/2\right)=2$
(C) $\left(1+\sec A/2\right)\left(1+\cos ec\, A/2\right)=2$
(D) $\left(1+\cot A/2\right)\left(1+\cot B/2\right)=2$

19. If $a_1, a_2, a_3 ....., a_{20}$ are in AP and $a_1 + a_4 + a_7 = 10$ and $a_2 + a_{10} = 8$ the sum of all terms is

(A) 110
(B) 120
(C) $\frac{110}{3}$
(D) 220

20. If the points $A\left(x_1, y_1\right), B\left(x_2, y_2\right),\ C\left(x_3, y_3\right)$ lie on the parabola $y^2 = 2x^2$ such that x_1, x_2, x_3 are in A.P. and y_1, y_2, y_3 are in G.P. If the common ratio has two values r_1 and r_2, then $r_1 + r_2$ is

(A) 6
(B) $4\sqrt{2}$
(C) 8
(D) – 6

21. If $a_1, a_2, a_3 .... a_n$ is an increasing GP and $a_1^2 + a_2^2 + a_3^2 = 91$ also $a_1 + a_2 + a_3 = 13$, then S_n is

(A) $\frac{3^n - 3}{2}$
(B) $\frac{3^{n+1} - 3}{2}$
(C) $3^n - 3$
(D) $\frac{3^{n+1} - 3}{4}$

22. If the sum of the roots of the quadratic equation $ax^2 + bx + c = 0$ is equal to sum of the square of their reciprocal, then, $a/c,\ b/a,\ c/b$ are in

(A) AP
(B) GP
(C) HP
(D) none of these

23. A variable rectangle PQRS has its sides parallel to fixed directions, Q and S lie respectively on the lines x = a, x = - a and P lies on the x-axis. Then locus of R is

(A) circle
(B) parabola
(C) straight locus
(D) Hyperbola

Space for rough work

24. From an external point P, pair of tangents are drawn to the parabola $y^2 = 4x,$ α and β are the inclination tangents with x axis such that $\alpha + \beta = \frac{\pi}{4}$. The locus of P is

(A) $x - y - 2 = 0$ (B) $x - y - 1 = 0$

(C) $2x + 3y - 1 = 0$ (D) $x - 3y + 1 = 0$

25. For an ellipse $\frac{x^2}{9} + \frac{y^2}{4} = 1$ with vertices A and A', tangents are drawn at the point P in the first quadrant meets the y-axis in Q and chord A'P meets y-axis in M. If O is the origin, then $OQ^2 - MQ^2$ is equals to

(A) 4 (B) 7

(C) 5 (D) 2

26. Let $y^2 = 4ax$ and circle $x^2 + y^2 + 2bx = 0$ touch each other externally then the equations $ax^2 + cx - b = 0$ will have

(A) Both roots are real and distinct all for all $c \in R$

(B) Both roots are complex for all $\in R$

(C) Both roots are real and distinct $\forall c > ab$

(D) Both roots are complex $\forall c < ab$

27. If the circle $x^2 + y^2 = a^2$ intersects the hyperbola xy = c^2 in four points $P(x_1, y_1),\ Q(x_2, y_2),\ R(x_3, y_3),\ S(x_4, y_4)$, then

(A) $x_1 + x_2 + x_3 + x_4 = c^2$ (B) $x_1 + x_2 + x_3 + x_4 = -c^2$

(C) $x_1 + x_2 + x_3 + x_4 = 0$ (D) $y_1 + y_2 + y_3 + y_4 = c^2$

Space for rough work

28. If A is a orthogonal matrix of order 4 and det (A) = 2, then value of det (A - I) is.
(A) 1 (B) -1
(C) 0 (D) 2

29. Genereal solution of $\frac{dy}{dy} = \frac{x^2 + y^2 + 1}{2xy}$ is
(A) $y^2 + 1 = x^2 + cy$ (B) $y^2 + 1 = x^2 + cx$
(C) $x^2 + 1 = y^2 + cy$ (D) $x^2 + 1 = y^2 + cx$

30. A fair coin is tossed 'n' number of times. The probability that head will turn up an even number of times, is equal to
(A) $\frac{n-1}{2n}$ (B) $\frac{1}{2}$
(C) $\frac{n+1}{2n}$ (D) $\frac{2^{n-1}-1}{2^n}$

Space for rough work

In JEE Advanced 2016, FIITJEE Students bag 36 in Top 100 AIR, 75 in Top 200 AIR, 183 in Top 500 AIR. 3541 Students from Long Term Classroom/ Integrated School Program & 4423 Students from All Programs have qualified in JEE Advanced, 2016

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FULL TEST – V
(Main)

S. No.	PHYSICS	CHEMISTRY	MATHEMATICS
1.	**A**	**B**	**D**
2.	**C**	**B**	**A**
3.	**C**	**B**	**D**
4.	**C**	**D**	**A**
5.	**D**	**A**	**A**
6.	**A**	**D**	**A**
7.	**B**	**A**	**D**
8.	**D**	**C**	**C**
9.	**D**	**A**	**D**
10.	**A**	**D**	**D**
11.	**D**	**C**	**A**
12.	**A**	**C**	**B**
13.	**B**	**A**	**A**
14.	**A**	**A**	**B**
15.	**B**	**D**	**B**
16.	**B**	**D**	**B**
17.	**C**	**C**	**A**
18.	**B**	**D**	**D**
19.	**A**	**D**	**A**
20.	**C**	**D**	**A**
21.	**B**	**B**	**B**
22.	**A**	**C**	**C**
23.	**D**	**B**	**C**
24.	**A**	**D**	**B**
25.	**D**	**D**	**A**
26.	**A**	**D**	**A**
27.	**D**	**C**	**C**
28.	**B**	**D**	**C**
29.	**D**	**C**	**B**
30.	**D**	**D**	**B**

Physics

PART – I

SECTION – A

1. **A**

$$e = -\left[\frac{v_y}{v_{0y}}\right]$$

Where v_y and v_{0y} are components of velocities after and before collision along y-axis.

Hence, $e = -\left[\frac{v_y}{-v_0\cos\theta}\right]$ $\Rightarrow$ $v_y = e\, v_0 \cos\theta$

Hence, the required height $= \frac{v_y^2}{2g} = \frac{e^2 v_0^2 \cos^2\theta}{2g}$

2. **C**

Taking the collision between A and C as elastic, it can be concluded that 'C' comes to rest immediately after collision and A starts moving with v_0 (the spring force, if any, during collision can be treated as non-impulsive one.)

At the instant of maximum compression or elongation, relative velocity of A with respect to B would be zero and hence A and B would be moving with a common velocity. From conservation of momentum,

$mv_0 = 2mv$ $\Rightarrow$ $v = v_0/2$

Hence, from conservation of energy

$$(\text{P.E.})_{\max} = \frac{1}{2}mv_0^2 - \frac{1}{2}(2m)\left(\frac{v_0}{2}\right)^2$$

$$= \frac{1}{2}mv_0^2 - \frac{1}{4}mv_0^2 = \frac{1}{4}mv_0^2$$

3. **C**

Impact takes place between m_1 and m_2 horizontally. Since m_2 is kept on m_3 and the all the surfaces in contact are smooth, friction does not act between m_2 and m_3 during the displacement of m_3 in the impact. Even though if there is a friction between m_2 and m_3. Which is very less than the impact force, is assumed as non-impulsive force here.

Since the impact between m_1 and m_3 is inelastic, m_1 and m_3 will move combiningly toward right and m_2 does not move due to the absence of friction.

The velocity of the combined mass = $v' = \frac{m_1 v}{m_1 + m_3}$

$$\Rightarrow \quad \frac{|\Delta KE|}{KE} = \frac{\frac{1}{2}m_1v^2 - \frac{1}{2}(m_1+m_3)v'^2}{\frac{1}{2}m_1v^2} = 1 - \left(\frac{m_1+m_3}{m_1}\right)\left(\frac{v'}{v}\right)^2$$

$$= 1 - \left(\frac{m_1+m_3}{m_1}\right)\left(\frac{m_1}{m_1+m_3}\right)^2 = 1 - \frac{m_1}{m_1+m_3} = \frac{m_3}{m_1+m_3}$$

4. **C**

$$KE = (KE_{\text{hollow sphere}}) + (KE_{\text{liquid}}) = (KE_{\text{h.s.}})_{\text{trans}} + (KE)_{\text{rot}} + (KE_{\text{liquid}})_{\text{trans}}$$

$$= \frac{1}{2}(mv^2) + \frac{1}{2}\left(\frac{2}{3}mr^2\right)\left(\frac{v}{r}\right)^2 + \frac{1}{2}mv^2 = \frac{4}{3}mv^2$$

Due to the absence of friction, the liquid does not rotate. It only translates that means it does not possesses rotational K. E.

5. **D**

Velocity of a projectile at any instant of time (t) is

$$v^2 = v_x^2 + v_y^2 = (u\cos\theta)^2 + \left(u\sin\theta - g\frac{x}{u\cos\theta}\right)^2$$

$$\therefore \qquad KE = \frac{1}{2}mu^2 - mg \times \tan\theta + \frac{gx^2}{u^2\cos^2\theta}$$

The given equation represents equation of a parabola

6. **A**

Conserving angular momentum of rod A about centre of mass.

$$mv\frac{a}{4} = I\omega = \frac{Ma^2}{12}\omega \qquad \Rightarrow \qquad \omega = \frac{3mv}{Ma}$$

7. **B**

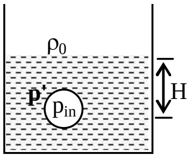
$$\left(\frac{2\pi x_1}{\lambda} - \omega t + \frac{\pi}{6}\right) - \left(\frac{2\pi x_2}{\lambda} - \omega t + \frac{\pi}{8}\right) = 2\pi n$$

$$\Rightarrow x_1 - x_2 = \left(n - \frac{1}{48}\right)\lambda$$

8. **D**

$$P_{in} - p' = \frac{2S}{r}$$

$$\Rightarrow \qquad p_{in} = \frac{2S}{r} + p' = \frac{2S}{r} + p_0 + \rho gH$$



9. **D**

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}},$$ k = spring constant of the uncut spring.

10. **A**

$$f' = \left(\frac{v}{v - v_s}\right)f, \quad f' = \left(\frac{v}{v + v_s}\right)f$$

Beat frequency of f' – f''

11. **D**

$$\Delta W = P_0V_0 + \frac{1}{2}\pi 2P_0V_0 \times \frac{1}{2} = P_0V_0\left(1 + \frac{\pi}{2}\right)$$

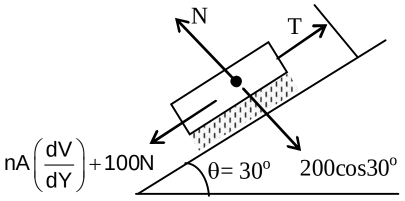
$$\Delta U = \frac{3}{2}(P_0 2V_0 - P_0V_0) = \frac{3}{2}P_0V_0$$

$$\Delta Q = P_0V_0\left(1 + \frac{\pi}{2} + \frac{3}{2}\right) = P_0V_0\left(\frac{5 + \pi}{2}\right)$$

12. **A**

$$\tau = 0.1 \times 1\text{m}^2 \times \frac{10^{-1}}{10^{-3}} = 10\text{N}$$

$$\therefore \qquad T = \tau + 100 = 110\text{N}$$



13. **B**

Writing the general expression for y ins terms of x as

$$y = \frac{1}{1+\left(x-vt^2\right)}.\ \text{at } t =,\ \ y = 1/\left(1+x^2\right).\ \ \text{at } t = 2s,\ y = \frac{1}{1+\left[x-v(2)\right]^2}$$

Comparing with the given equation we get 2v = 1 and v= 0.5 m/s.

14. **A**

$$\bar{F}_A = \bar{F}_{AB} + \bar{F}_{AC} = 2\left[\frac{GM^2}{a^2}\right]\cos 30^\circ = \left[\frac{GM^2}{a^2} \times \sqrt{3}\right]$$

$$r = \frac{a}{\sqrt{3}}.\ \ \text{Now, } \frac{Mv^2}{r} = F$$

$$v = \sqrt{\frac{MG}{a}}$$

15. **B**

Apply gas equation

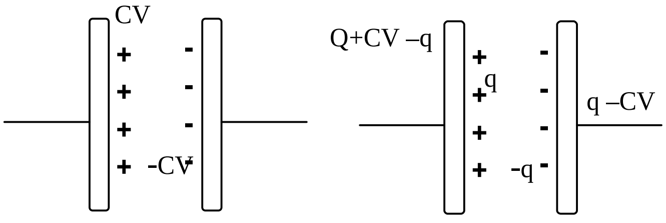
16. **B**

$$\frac{\pi a^2 \alpha}{2} = \int\limits_{BOA} \vec{E}.d\vec{l} + \int\limits_{AB} \vec{E}.d\vec{l}$$

$$\frac{\pi a^2 \alpha}{2} = \int\limits_{BOA} \vec{E}.d\vec{l} + a^2\alpha \quad \Rightarrow \quad \int\limits_{BOA} \vec{E}.d\vec{l} = a^2\alpha\left(\frac{\pi}{2} - 1\right)$$

17. **C**

In the adjacent figure, let X and Y be the positive and negative plates. After charging from the cell, the inner faces of X and Y have charges ± CV, as shown in (i). The outer surfaces have no charge.



(i) **(ii)**

When charge Q is given to X, let the inner faces of X and Y have charges ± q. Then, by the principle of charge conservation, the outer faces have charges $(Q + CV - q)$ for X and $(q - CV)$ for Y, as shown in (ii). Now, the outer faces must have equal charges.

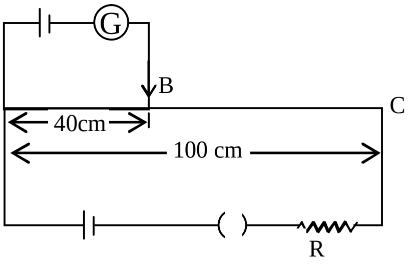
$\therefore \quad Q + CV - q = q - CV$

or $\quad 2q = 2CV + Q$

or $\quad q = CV + \frac{Q}{2}$

Potential difference $= \frac{q}{C} = V + \frac{Q}{2C}$

18. **B**



As shown in figure, if R is the unknown resistance, current in the circuit

$$I = \frac{V}{(r+R)} = \frac{2}{(10+R)}$$

Now, as 100 cm wire has resistance 10 Ω, the resistance of 40 cm wire will be

$$40 \times (10/100) = 4\,\text{ohm}.$$

Potential drop across 40 cm wire will be V = I × 4

But V = 10 mV (given)

and $I = \frac{2}{(10+R)} \times 4 \qquad \Rightarrow \qquad R = 790\,\Omega$

19. **A**

According to given problem,

$$I = \frac{V}{Z} = V/\left[R^2 + \left(1/C^2\omega^2\right)\right]^{\frac{1}{2}} \qquad \text{................(1)}$$

and $$\frac{I}{2} = \frac{V}{\left[R^2 + \left(9/C^2\omega^2\right)\right]^{\frac{1}{2}}} \qquad \text{.................(2)}$$

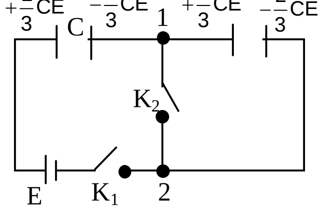
Substituting the value of I from equation (1) in (2),

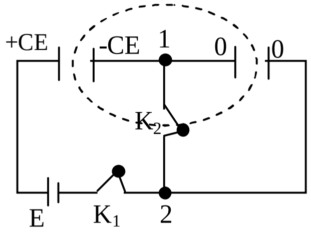
$$4\left(R^2 + \frac{1}{C^2\omega^2}\right) = R^2 + \frac{9}{C^2\omega^2}, \qquad \text{i.e.,} \qquad \frac{1}{C^2\omega^2} = \frac{3}{5}R^2$$

So than $\frac{X}{R} = \frac{(1/C\omega)}{R} = \frac{\left[(3/5)R^2\right]^{1/2}}{R} = \sqrt{\frac{3}{5}}$

20. **C**

Initially charge configuration (before K_2 is closed) is





Final charge configuration (after K_2 is closed) is

The net change of charge in the encircled region can happen only because of charge flowing in section 1 → 2.

Initial charge = 0

Final charge = -CE

⇒ Charge flown = -CE from 2 to 1.

21. **B**

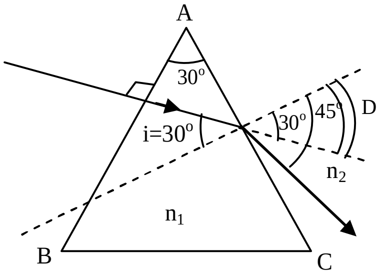
Here, one might be tempted to think that since the refractive index of benzene is not given. But actually we do not need this data.

$\mu_1 \sin i_1 = \mu_2 \sin i_2 = \mu_3 \sin i_3$

$$\therefore \quad \sin i_3 = \frac{\mu_1 \sin i_1}{\mu_3} = \frac{3\sqrt{3}}{8}$$

22. **A**

Besides the formulae given for prism, we can always use the basic laws of refraction. Using Snell's law for the reaction at AC, we obtain



$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1}$$

$$\Rightarrow \quad \frac{\sin 30^o}{\sin r} = \frac{1}{\sqrt{2}}$$

$$\Rightarrow \quad \sin r = 1/\sqrt{2}$$

$$\Rightarrow \quad r = 45^o$$

The angle of deviation, D = 45^o -30^o =15^o.

23. **D**

Energy of incident photon

$$= \frac{hc}{\lambda} = \frac{12400}{\lambda} eV = \frac{12400}{4000} eV = 3.1 eV$$

$k_{max} = h\nu - \phi$

$= 3.1 eV - 2.0 eV = 1.1 eV$

Hence, stopping potential 1.1 V

24. **A**

$$\lambda_\alpha = \frac{4}{3R(Z-1)^2}$$

Cut-off wavelengths: $\lambda_1 = \frac{hc}{eV_1}$; $\lambda_2 = \frac{hc}{eV_2}$

Using given condition: $(\lambda_2 - \lambda_\alpha) = 3(\lambda_1 - \lambda_\alpha)$

or $3\lambda_1 - \lambda_2 = 2\lambda_\alpha$ or $\frac{hc}{e}\left[\frac{3}{V_1} - \frac{1}{V_2}\right] = \frac{8}{3R(Z-1)^2}$

Taking $V_1 = 10 \times 10^3$ V and $V_2 = 20 \times 10^3$ V, we get

$Z = 29$

25. **D**

$N_1 / N_0 = e^{-\lambda_1 t}$ ....(1)

$N_2 / N_0 = e^{-\lambda_1 t}$ ....(2)

$\Rightarrow \quad N_1 / N_0 = e^{-(\lambda_1 - \lambda_2)t}$

Putting $N_1 / N_0 = 1/e$ we obtain $(\lambda_1 - \lambda_2)t = 1$

$\Rightarrow \quad t = 1/(\lambda_1 - \lambda_2) = 1/(10\lambda - \lambda) = 1/9\lambda$

26. **A**

$$T = 2\pi\sqrt{\frac{l}{g}} \Rightarrow g = \frac{4\pi^2 l}{T^2}$$

$\Rightarrow$ $$\frac{\Delta g}{g} = \frac{\Delta l}{T} + 2\frac{\Delta T}{T}$$

$\Rightarrow$ $$\left(\%\frac{\Delta g}{g}\right) = \left(\%\frac{\Delta l}{l}\right) + 2\left(\%\frac{\Delta T}{T}\right)$$

$\Rightarrow$ $$\frac{\Delta g}{g}(\text{in}\%) = 2\% + 2\times 1\% = 4\%$$

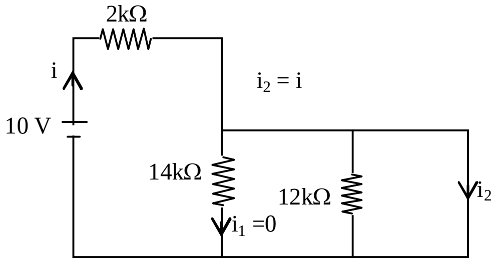
27. **D**

There is no change in λ_{K_α} as it is characteristic X-ray.

28. **B**

$$i = \frac{10}{2} = 5\text{mA} = i_2$$

$$i_1 = 0$$



29. **D**

$$\text{Current gain} = \frac{\Delta I_C}{\Delta I_b} = \beta = \frac{\alpha}{1-\alpha} = 48$$

30. **D**

$$E_{min} = 2\left[\frac{9.1\times10^{-31}\times\left(3\times10^{8}\right)^2}{1.6\times10^{-13}}\text{MeV} + 0.95\text{ MeV}\right]$$

= 2.924

Chemistry

PART – II

SECTION – A

1. From lines sketches → $n_1 = 2$
$n_2 = 3$
$n_3 = 4$

The radius ratio of given orbit will be

$$\Rightarrow r \propto n^2 \Rightarrow 4:9:16$$
$$\Rightarrow x = 4+9+16$$
= 29
$$\Rightarrow \text{ then } \frac{x-4\sigma}{2} \Rightarrow \frac{29-4\times1.5}{2} = \frac{23}{2} = 11.5$$

2. $$2A \longrightarrow P$$
$$a_0 - 2x \quad x$$
now $\propto = \frac{2x}{a_0}$ ⇒ from zero order kintics x = kt
$$\propto = \frac{2kt}{a_0}$$
Slope = 0.5 $\quad \Rightarrow \frac{2K}{a_0} = .5 \qquad a_0 = .05$
$$K = \frac{.5}{2}\times.05 \qquad K = 0.0125$$

3. $$\begin{array}{lllll} & \mathrm{H_2A} & +\mathrm{O^{\Theta}H} \xrightleftharpoons{\mathrm{Ka_1}} & \mathrm{HA^{\Theta}} & +\mathrm{H_2O} \\ \mathrm{t=0} & \mathrm{a_0} & & 0 & 0 \\ \mathrm{t=t} & \mathrm{a_0 - a_0x} & & \mathrm{a_0\,x} & \end{array}$$
$$\Rightarrow \mathrm{a_0\,x} = \frac{\mathrm{a_0}}{2} \text{ at 50\% neutralization.}$$
From Henderson Equation
$$\mathrm{P^H = PK_{a_1} + \log\frac{[HA^-]}{[H_2A]}} \quad \Rightarrow \mathrm{[HA^-] = [H_2A]}$$
$$\mathrm{P^H = PK_{a_1}}$$

5. From 1st law of faraday
$$W = \frac{Mm\times i\times t}{X\times F}$$
$$5_g = \frac{50\times965\times50}{X\times96500}$$
X = 5
$$\underbrace{\mathrm{Mn\bar{O}4} + \overbracket{\mathrm{M} \longrightarrow \mathrm{Mn}^{+2}}}_{x=5} + \mathrm{M}^{+5}$$
or $MnO_4^- + M + 8H^+ \longrightarrow Mn^{+2} + M^{+5} + 4H_2O$
$$\Rightarrow 1+1+8 = 10$$

6. $HA \rightleftharpoons H^+ + A^-$

$P^H = 2 \Rightarrow \left[H^+\right] = 10^{-2}$

$a_0\alpha = 10^{-2} \Rightarrow$ Initial conc. = a_0

$\alpha = 0.1$

$\Rightarrow$ Total particle = 1 + α

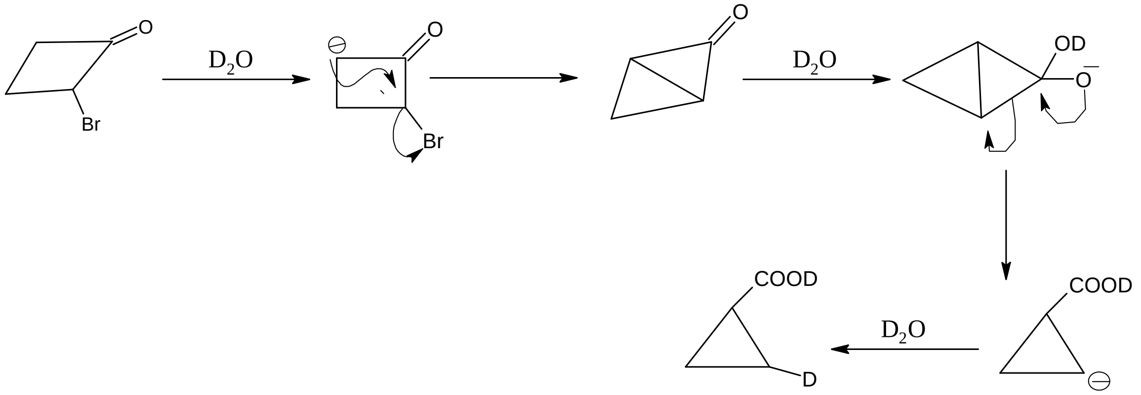
$\pi = (1+\alpha)CST$

$= 0.1 \times 0.0821 \times 298 \times 1.1$

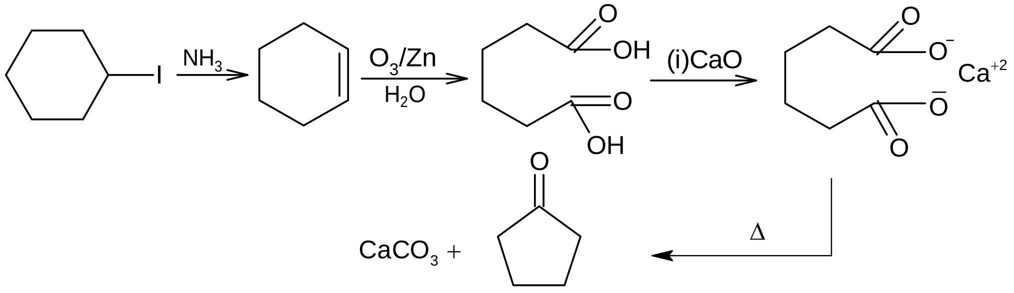
$\pi = 2.69$ atm

7. Lassainge test given by compounds which contains C and N.

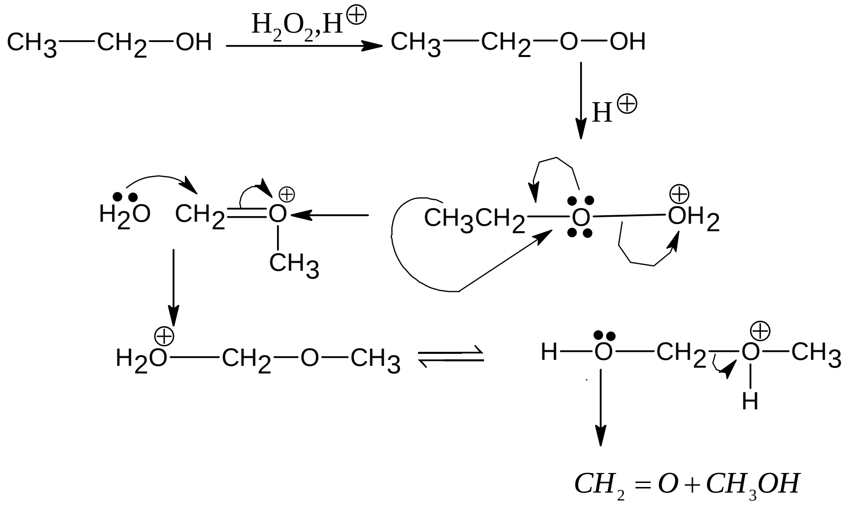
8.


O
Br
D2O
O
Br
O
D2O
OD
O
COOD
D2O
COOD
D

11.


I
NH3
O3/Zn
H2O
O
OH
O
OH
(i)CaO
O
O
O
O
Ca+2
Δ
CaCO3 +
O

12.


CH3—CH2—OH
H2O2,H⊕
CH3—CH2—O—OH
H⊕
H2O
CH2═O⊕
CH3
CH3CH2—O—OH2⊕
H2O⊕—CH2—O—CH3
H—O—CH2—O⊕—CH3
H
CH2 = O + CH3OH

13. Lower the relative humidity better will be drying agent.

$$R.H. = \frac{P_{H_2O}\ \text{in equilibrium}}{P_{H_2O}\ \text{in atmosphere}}$$

$ACl_2 \bullet 2H_2O$ has lowest relative humidity.

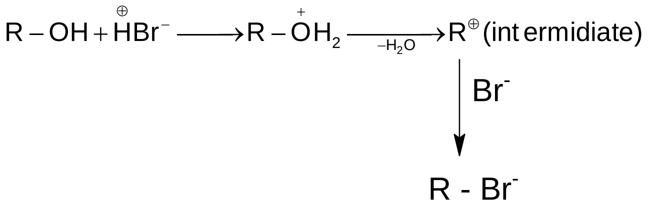
14. In aqueous solution, chromate and dichromate ion exist in equilibrium

$$2CrO_4^{-2} + 2H^{\oplus} \rightleftharpoons Cr_2O_7^{-2} + H_2O$$

Equilibrium depends depends on both P^H and analytical concentration. CrO_4^{-2} is the predominant in alkaline solutions, but dichromate can become the predominant ion in acidic solution

16. (i) bulky substrate with base gives akene in williamson synthesis

(ii)



$$\begin{tikzcd} R-OH+\overset{\oplus}{H}Br^{-} \arrow[r] & R-\overset{+}{O}H_2 \arrow[r, "-H_2O"'] & R^{\oplus}\text{(int ermidiate)} \arrow[d, "Br^-"] \\ & & R - Br^- \end{tikzcd}$$

Greater the stability of $R^{\oplus}$ (Intermediate) Greater will be reactivity of alcohol.

(iii) Basic nature $\propto +I+M$ group

$$\propto \frac{I}{-I,-M\ \text{group}}$$

(iv) Dipole moment of Para - chlorodibenzene is zero.

17. $\wedge^{\infty} = \dfrac{k\times 1000}{5}$ => $\wedge^{\infty} AB = 62+76 = 138\,\text{s}\,\text{cm}^2\,\text{mol}^{-1}$

$$138 = \frac{1.26\times10^{-6}\times1000}{5}$$

s = 9.13×10^{-6} mol/litre.

Number of B^{Θ} per litre = $9.13 \times 10^{-6} \times N_A = 54.96 \times 10^{14}$

18. $S_8 \rightleftharpoons 4S_2$

$1-\alpha \quad 4\alpha$

$\Rightarrow n_T = 1-\alpha+4\alpha = 1+3\alpha$

$$\Rightarrow now\ \frac{r_{mix}\left(S_2+S_8\right)}{r_{S_8}} = .75$$

$$\Rightarrow .75 = \sqrt{\frac{256}{M_{mix}}}\ \text{or}\ 0.75\times0.75 = \frac{256}{M_{mix}}\ \text{or}\ 0.5625 = \frac{256}{M_{mix}}$$

$$\therefore M_{mix} = \frac{256}{0.5625} = 455.11$$

$$\Rightarrow \text{now} \Rightarrow M_{mix} = \frac{256}{1+3\alpha}$$

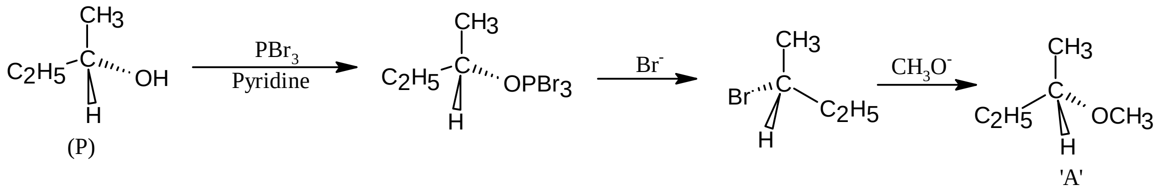
$\Rightarrow 1+3\alpha = .5625$

$3\alpha = 1.5625$

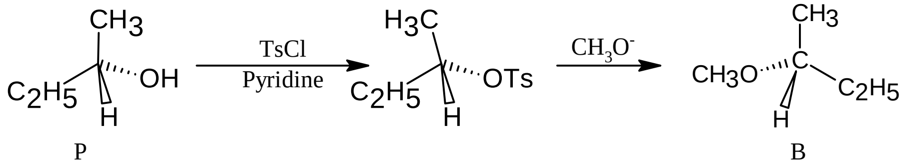
$$\alpha = \frac{1.5625}{3} = 52\%$$

21. $Al(OH)_3$ is not dissolved in excess of the NH_3 solution while Zn $(OH)_2$ dissolved in NH_3.

22.

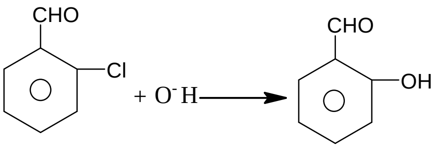

CH3
C2H5
C
OH
H
(P)
PBr3
Pyridine
CH3
C2H5
C
OPBr3
H
Br-
CH3
Br
C
C2H5
H
CH3O-
CH3
C2H5
C
OCH3
H
'A'

P and A have same configuration.

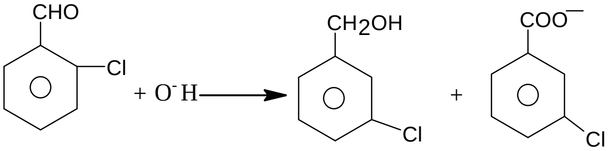

CH3
C2H5
OH
H
P
TsCl
Pyridine
H3C
C2H5
OTs
H
CH3O-
CH3
CH3O
C
C2H5
H
B

B have inverted configuration.

23.


CHO
Cl
+ O-H
CHO
OH

Give Aromatic SN reaction because Θve charge stabilizing group present at ortho position wrt leaving group


CHO
Cl
+ O-H
CH2OH
Cl
+
COO—
Cl

28. $$\Delta S = nF\left(\frac{dE^0}{dt}\right)_P$$

$$= 2 \times 96485\, C\, mol^{-1} \times -6 \times 10^{-4} V\, K^{-1}$$

$$= -116 JK^{-1} mol^{-1}$$

29. $$\frac{Tc}{Pc} = \frac{\dfrac{8a}{27Rb}}{a/27b^2} = \frac{8 \times b}{R}$$

$$= \frac{8 \times .0408}{.0521}$$

$\simeq 4$

Mathematics

PART – III

SECTION – A

1. **D**

Put $x-1=t$, then integral become, I = $\int_{-1}^{1}\cos^{-1}\left(t|t|+(t)^3\right)dt$

Applying property then I = $\int_{-1}^{1}\left(\pi-\cos^{-1}\left(t|t|+(t)^3\right)\right)dt$

2. **A**

$2x^2+a^2>x^2+2x+3$

$x^2-2x+a^2-3>0 \qquad \forall \in R.$

hence $4-4\left(a^2-3\right)<0$

$1-a^2+3<0 \Rightarrow a^2>4$

or $a>2$ or $a<-2$

hence $a\in(-\infty,-2)\cup(2,\infty)$.

3. **D**

f(x) is continuous everywhere.

4. **A**

$x>2,$ is a solution

Let $x\le 2$ then $x^2+x+1\ge 4+x^2-4x \Rightarrow x\ge 3/5$

5. **A**

$f(x)=\frac{x+1}{2x-1},$

$f(f(x))=\frac{f(x)+1}{2f(x)-1}=\frac{3x}{3}=x$

6. **A**

Since $3-x^3=|x-3|$ the solution are x = 0, ±1

Also function is not differentiable at x = 3

7. **D**

$\frac{1}{2}(1+\cos A)+\frac{a}{2}(1+\cos B)=\frac{3c}{2}$

Or $a+b+c=3c \qquad \Rightarrow a+b=2c$

8. **C**

$\tan(A+B)=\frac{-1}{4}\tan A$

9. **D**

$3\sin\theta-4\sin^3\theta=4\sin\theta\sin2\theta\sin4\theta$

$\sin\theta = 0 \Rightarrow \theta = n\pi$

Or $3-4\sin^2\theta = 4\sin 2\theta \sin 4\theta$

$\Rightarrow \cos 6\theta = -1/2$

10. **D**

Since $I\,I_1 = a\sec A/2 = 4R\sin A/2$

$I\,I_2 = a\sec B/2 = 4R\sin B/2$

$I\,I_3 = a\sec C/2 = 4R\sin C/2$

11. **A**

Since $\dfrac{\tan^2\alpha/2}{\tan^2\beta/2} = 3$

12. **B**

For no trivial solution, we must have

$$\begin{vmatrix} 2a & -2 & 3 \\ 1 & \text{a} & 2 \\ 2 & 0 & \text{a} \end{vmatrix} = 0 \qquad \Rightarrow a = 2$$

13. **A**

$$\frac{a\cos A + b\cos B + c\cos C}{a+b+c}$$

$$= \frac{R}{2R}\left(\frac{\sin 2A + \sin 2B + \sin 2C}{\sin A + \sin B + \sin C}\right) \qquad = 4\sin A/2\sin B/2\sin C/2 = \frac{r}{R}$$

14. **B**

$m+n = a(\cos\alpha + \sin\alpha)^3$

$m-n = a(\cos\alpha - \sin\alpha)^3$

hence $(m+n)^{2/3} + (m-n)^{2/3} = 2a^{2/3}$

15. **B**

$$(x+2)^{n-1}\left[1+\frac{x+1}{x+2}+\left(\frac{x+1}{x+2}\right)^2+......+\left(\frac{x+1}{x+2}\right)^{n-1}\right] = (x+2)^{n-1}\left[\frac{1.\left(\left(\frac{x+1}{x+2}\right)^n-1\right)}{\frac{x+1}{x+2}-1}\right]$$

$= (x+2)^n - (x+1)^n$

Now coefficient of x^r in $\left\{(x+2)^n - (x+1)^n\right\}$ is

$= {}^nC_r 2^{n-r} - {}^nC_r$

16. **B**

$$\left(x\sin\theta+\frac{\cos\theta}{x}\right)^{10}$$

$$T_{r+1}={}^{10}C_r\left(\sin\theta\right)^{10-r}\left(\cos\theta\right)^r x^{(10-2r)}$$

$$10-2r=0\Rightarrow r=5$$

Hence $f\left(\theta\right)=\frac{{}^{10}C_5}{2^5}\left(\sin 2\theta\right)^5$

17. **A**

$$N=\left(5+2\right)^{100}-\left(5-2\right)^{100}$$

$$=2\{\ {}^{100}C_1 5^{99}\cdot 2^1+{}^{100}C_3 5^{97},2^3+.....+\ {}^{100}C_{99}5.2^{99}]$$

hence last three digits are 000

18. **D**

$$\tan\left(\frac{A+B}{2}\right)=\frac{\tan A/2+\tan B/2}{1-\tan A/2\tan B/2}$$

19. **A**

Let $a_1=a$ and d is common difference $a+a+3d+a+6d=10$

$$\Rightarrow 3a+9d=10$$

also $a+d+a+9d=8\Rightarrow a+5d=4\Rightarrow 3a+15d=12$

$$\therefore d=\frac{1}{3}\text{ and }a=\frac{7}{3}$$

$$\therefore S=\frac{20}{2}\left[\frac{14}{3}+\frac{19}{3}\right]=110$$

20. **A**

Let $x_1=a-d$ $\qquad y_1=2\left(a-d\right)^2$

$x_2=a$ $\qquad y_2=2a^2$

$x_3=a+d$ $\qquad y_3=2\left(a+d\right)^2$

since y_1,y_2,y_3 are in G.P. then

$$4a^4=4\left(a-d\right)^2\left(a+d\right)^2$$

or $a^2=\pm\left(a^2-d^2\right)$ $\qquad \Rightarrow 2a^2=d^2$

$$a=\pm\frac{d}{\sqrt{2}}$$

Now common ratio is $r=\frac{2a^2}{2\left(a-d\right)^2}$ $\qquad r=\frac{1}{\left(3-2\sqrt{2}\right)}=3+2\sqrt{2}$

21. **B**

Let the terms are a,ar,ar^2

then $a\left(1+r+r^2\right)=13$

and $a^2\left(1+r^2+r^4\right)=91$

or $\dfrac{\left(1+r+r^2\right)^2}{\left(1+r^2+r^4\right)}=\dfrac{13}{7} \quad \Rightarrow \dfrac{1+r+r^2}{1+r+r^4}=\dfrac{13}{7}$

hence a = 3 , $\qquad r-\dfrac{1}{3},3$

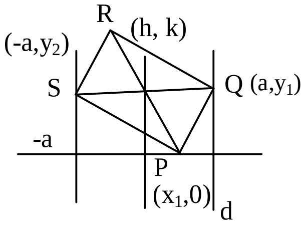
$$S_n=\frac{3\left(3^n-1\right)}{3-1}=\frac{3^{n+1}-3}{2}$$

22. **C**

Given $\alpha+\beta=\dfrac{1}{\alpha^2}+\dfrac{1}{\beta^2}$ where α,β are the roots, $ab^2+bc^2=2a^2c$

$\Rightarrow {}^{b}\!/\!_{c},\ {}^{a}\!/\!_{b},\ {}^{c}\!/\!_{a}$ are in A.P.

23. **C**



0 = h + x$_1$ …….. (i)
x$_1$ = - h
Let equation of PQ is y = mx + mh
since Q lies on line hence
y$_1$ = ma + mh

$\text{Slope of } QR=-\dfrac{1}{m}=\dfrac{y_1-k}{a-h}\Rightarrow my_1-km=h-a$

or $h+mk=a+\left(a+h\right)m^2$

$\therefore$ Locus is straight line.

24. **B**

$y=mx+\dfrac{1}{m}$

Let P = (h, k) then

$m^2h-mk+1=0 \qquad \Rightarrow m_1+m_2=\dfrac{k}{h},m_1m_2=\dfrac{1}{h}$

Now $\tan\left(\alpha+\beta\right)=\dfrac{\tan\alpha\tan\beta}{1-\tan\left(\alpha+\beta\right)}=1 \qquad \Rightarrow y=x-1$

25. **A**

Let P $\left(3\cos\theta,2\sin\theta\right)$

Equation tangent is $\dfrac{x\cos\theta}{3}+\dfrac{y\sin\theta}{2}=1$

Equation chard A ‘P is $y=\dfrac{2\sin\theta}{3\left(\cos\theta+1\right)}\left(x+3\right)$

Now $OM=\dfrac{2\sin\theta}{1+\cos\theta}$

$OQ^2 - MQ^2 = OQ^2 - (OQ - OM)^2$

Only solving we get, $OQ^2 - MQ^2 = 4$

26. **A**

a and b must have same sigh hence ab > 0

27. **C**

Since $x + \frac{c^4}{x^2} = a^2$ $\Rightarrow x^4 - x^2a^2 + c^4 = 0$

Now some of the roots = 0

28. **C**

Since $AA^T = I$

Now $(A-I)^T = A^T - I$

$$A(A-I)^T = I - A$$

$$\det(A)\det(A-I) = \det(I-A)$$

$$\Rightarrow 2\det(A-I) - \det(A-I) = 0$$

$$\Rightarrow \det(A-I) = 0$$

29. **B**

$$\frac{dy}{dx} = \frac{(x^2+y^2+1)}{2xy}$$

$$\Rightarrow 2xy\ \ dy = (x^2+1)dx + y^2dx$$

$$\Rightarrow \frac{2xy\,dy - y^2dx}{x^2} = \left(1 + \frac{1}{x^2}\right)dx$$

$$\Rightarrow d\left(\frac{y^2}{x}\right) = d\left(x - \frac{1}{x}\right)$$

$$\Rightarrow \frac{y^2}{x} = x - \frac{1}{x} + c$$

$$\Rightarrow y^2 + 1 = x^2 + cx$$

30. **B**

Total outcomes = 2^n.

Total number of favourable outcomes

$${}^nC_0 + {}^nC_2 + {}^nC_4 + \ldots .{}^nC_{\left[\frac{n}{2}\right]}$$

$$= 2^{n-1}$$

Thus, required probability = $\frac{2^{n-1}}{2^n} = \frac{1}{2}$.

FIITJEE

ALL INDIA INTERNAL TEST SERIES

CHEMISTRY, MATHEMATICS & PHYSICS

SET – A

APT - 3 **080163.1** **Ai^{2}TS-6**

CLASS XII

Time Allotted : 3 Hours **Maximum Marks: 300**

INSTRUCTIONS

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

✓ Attempt ALL the questions. Answers have to be marked on the OMR sheets.

✓ This question paper contains **Three Sections**.

✓ **Section – I** is *“Chemistry”*, **Section – II** is *“Mathematics”* and **Section – III** is *“Physics”*.

✓ Each Section is further divided into three Parts: **Part – A, Part – B** & **Part – C**.

✓ Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.

✓ Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with HB pencil for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **PART-A (01 – 04)** contains 4 Multiple Choice Questions which have Only One Correct answer. Each question carries **+5 marks** for correct answer and **–3 marks** for wrong answer.
PART-A (05 – 10) contains 6 Multiple Choice Questions which have One or More Than One Correct answer. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

(ii) **PART-B (01 – 04)** contains 4 Matrix Match Type Question which have statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. There may be One or More Than One Correct choices. Each question carries **+8 marks** for all correct answer however for each correct row **+2 marks** will be awarded. There is no negative marking.

(iii) **PART-C (01 – 06)** contains 6 Numerical Based questions with Single Digit Integer as answer, ranging from 0 to 9 and each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

Name of Candidate :

Batch ID : **Date of Examination :** / / 2 0 1

Enrolment Number :

SECTION- I (CHEMISTRY)

PART – A

Straight Objective Type

This section (**01 - 04)** contains 4 multiple choice questions which have only one correct answers. Each question carries **+5 marks** for correct answer and **– 3 mark** for wrong answer.

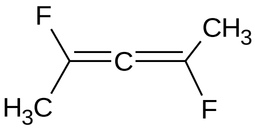
1.

CF_3

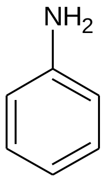
p

CH_3

q



r



s

Planar species of above is/are___

(a) p,q (b) p,q,r (c) p,q,r,s (d) q,s

2. 200 ml of 0.15 M H_3AsO_4 (given $K_{a_1} = 10^{-3}$ $K_{a_2} = 10^{-7}$ $K_{a_3} = 10^{-12}$); 50 ml of 0.6 M Na_2HAsO_4 solutions and 100 ml of 0.1M NaOH are mixed. pH of the final solution is

(a) 6.3 (b) 7.0 (c) 6.7 (d) can not be found.

3. $Mg_2C_3 \xrightarrow{H_2O} Mg(OH)_2 + A$

$A \xrightarrow{\text{red hot iron tube}} B$

$A \xrightarrow{H_3O^+/Hg^{2+}} C$

$C \xrightarrow{Conc.\ H_2SO_4} D$

$C(3\,moles) \xrightarrow{NaOH/\Delta} E$

Then the correct option is....

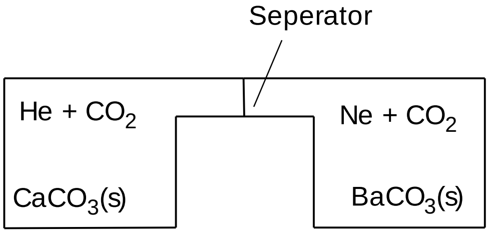
(a) B and E are same (b) C and D are same

(c) B and D are same (d) D and E are same

4. A container having two partition of equal volume with a separator contains excess of $CaCO_{3(s)}$ in one partition and $BaCO_{3(s)}$ in other partition. First partition contains He and CO_2 with total pressure 8 atm and mole fraction of He as 0.50 while second partition contains Ne and CO_2 with total pressure of 8 atm and mole fraction of Ne as 0.25. Temperature of the container is 600 K at which following equilibriums are established.

$CaCO_{3(s)} \xrightarrow{600K} CaO_{(s)} + CO_{2(g)}$

$BaCO_{3(s)} \xrightarrow{600K} BaO_{(s)} + CO_{2(g)}$



If the separator is removed then total pressure inside the container will be___(neglect volume change due to solid compounds)

(a) 8 atm (b) 13 atm (c) 9 atm (d) 7 atm

Straight Objective Type

This section (**05-10)** contains 6 multiple choice questions which have one or more than one correct answers. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

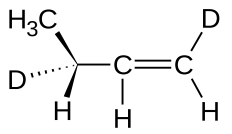
5. If 50 litre flask containing one mole of N_2 and one mole of PCl_5 is connected to a 50 litre flask containing 2 moles of PCl_5, both vessel heated to 227ºC. The equilibrium pressure is found to be 2.05 atm. Assuming ideal behaviour and for the reaction $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ correct option(s) is/are

(a) degree of dissociation of PCl_5 is $\frac{1}{3}$

(b) K_P for the reaction is 0.205 atm

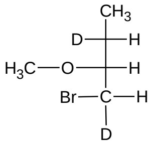
(c) One mole of PCl_5 is present in each flask

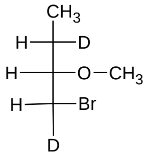
(d) 0.5 moles of all gases are present in each flask.

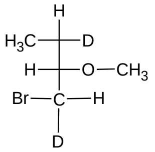
6. 

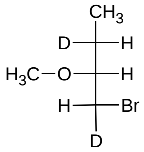
$\xrightarrow{Br_2/CH_3OH}$ P (Mixture of compounds)

P May be :

(a) 

(b) 

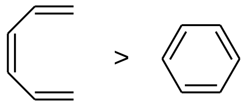
(c) 

(d) 

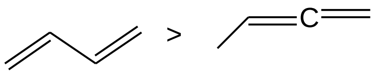
7. Ashutosh collected 1 ltr water in a jar. Kaustub mixed 0.2 mol of H_2S in it while Ananya mixed 0.1 mol of NaOH in it. Arav brought a big piece of NiS and put it in the solution. After long time, some FIITJEE students are observing the solution. Correct observation(s) made by them is/are
(Given K_{a1} (H_2S) = 10^{-5} K_{a2} (H_2S) = 10^{-8} K_{sp} (NiS) = 10^{-20})

(a) Manish found that Solubility of NiS was increased in that solution from normal solubility (ie s = 10^{-10} M) due to reaction of S^{2-} ion with H^+ present in the solution.
(b) Nischay found pH of the solution to be 5
(c) Shivang said, "Concentration of [S^{2-}] is 10^{-4} M"
(d) Utkarsh said, "Concentration of Ni^{2+} is 10^{-10} M"

8. Which is ordered correctly

(a) 

heat of hydrogenatio

(b) 

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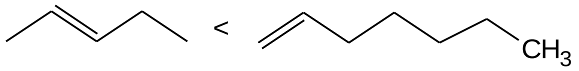
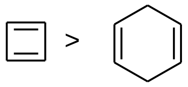
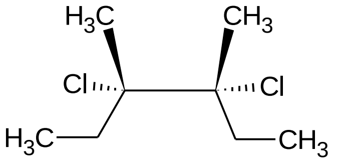
(c) 

heat of combustio

(d) 

heat of hydrogenatio

9. Consider following reaction and find correct option(s) regarding product(s)



$\xrightarrow{Cl_2/h\upsilon}$ $C_8H_{15}Cl_3$
All possible compound

(a) Number of optically active compound formed is 10
(b) Number of pair of enantiomers is 5
(c) Number of pair of diastereomers formed is 4
(d) Number of optically inactive compounds formed is 2

10. Consider following equilibriums :

$$A(s) \overset{K_{p_1}}{\rightleftharpoons} B(g) + C(g)$$

$$E(s) \overset{K_{p_2}}{\rightleftharpoons} B(g) + D(g)$$

$$P(s) \overset{K_{p_3}}{\rightleftharpoons} B(g) + Q(s)$$

Pressure above the solids $A_{(s)}$, $E_{(s)}$ and $P_{(s)}$ when kept alone are 4 atm, $8\sqrt{2}$ atm and 5 atm respectively at temperature T(K). When three solids A(s),s E(s), P(s) are kept together at the same temperature T(K) then.
(a) Partial pressure of $B_{(g)}$ is 5 atm
(b) Partial pressure of $C_{(g)}$ is 4/5 atm
(c) Partial pressure of $D_{(g)}$ is 32/5 atm
(d) Total pressure is 12 atm.

SECTION – B

Matrix Match Type

This section **(01 – 04)** contains 4 Matrix Match Type Question which have statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. There may be One or More Than One Correct choices. Each question carries **+8 marks** for all correct answer however for each correct row **+2 marks** will be awarded. There is no negative marking.

1. Match the Column-I with Column – II (where α = degree of dissociation, M_{mix} = average molecular weight of mixture ; P = equilibrium pressure)

COLUMN – I		**COLUMN – II**	
(a)	$A_{(g)} \rightleftharpoons B_{(g)} + C_{(g)}\ \Delta H = -ve$	(p)	$\alpha = \sqrt{\frac{K_p}{4P + K_p}}$
(b)	$D_{(g)} \rightleftharpoons 2E_{(g)} + \text{Energy}$	(q)	Yield of product(s) will be high at low temperature
(c)	$PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$	(r)	Yield of product(s) will be high at high temperature
(d)	$N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$	(s)	$M_{mix} = \frac{M_{reactant}}{1+\alpha}$
		(t)	Yield of product(s) will be high at low pressure

2.

Column – I (Reactions)		**Column – II (Product(s))**	
(a)	$\text{Borax} \xrightarrow{\Delta}$	P	$H_2B_4O_7$
(b)	$\text{Borax} + H_2O \longrightarrow$	Q	H_3BO_3
(c)	$\text{Borax} + NaOH \longrightarrow$	R	Used in glass formation
(d)	$\text{Borax} + HCl \longrightarrow$	S	$NaBO_2$
		T	B_2O_3

3. Match the Column-I with Column – II

Column – I (Mixing equal volume for H_2S $Ka_1 = 10^{-6}$ $Ka_2 = 10^{-9}$)		**Column – II**	
(a)	1 M H_2S + 1 M Na_2S	(P)	pH =7.5
(b)	2 M H_2S + 1 M Na_2S	(Q)	pH = 6
(c)	1 M H_2S + 2 M Na_2S	(R)	pH = 9
(d)	1 M Na_2S + 2 M HCl	(S)	Buffer
		(T)	pH = 3.15

4.

COLUMN – I		**COLUMN – II**	
(a)	cis–2-butene $\xrightarrow{Br_2/CCl_4}$	(p)	Cyclic intermediate
(b)	Trans-2-butene $\xrightarrow[\text{alk.KMnO}_4]{\text{cold}}$	(q)	Recemic mixture
(c)	Trans-2-butene $\xrightarrow{Br_2/CS_2}$	(r)	Meso-isomer
(d)	Cis-2-butene $\xrightarrow{HOCl}$	(s)	Enantiomeric pairs
		(t)	Product/s mixture is/are optically inactive

PART – C

(Integer Type)

This section contains **6 questions**. The answer to each question is a **single-digit integer**, ranging from 0 to 9. The correct digit below the question number in the ORS is to be bubbled. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

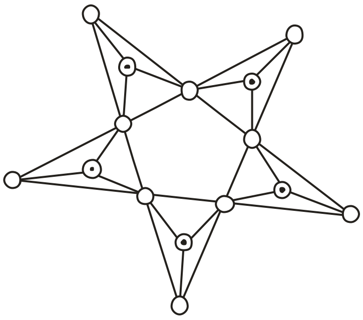
1. Maximum pH that must be maintained in a saturated H_2S (0.1 M) to precipitate CdS but not ZnS is x and concentration of Cd^{2+} ion at that pH is y × 10^{-7} then x + y =....
given $[Cd^{2+}] = [Zn^{2+}] = 0.1$ M initially ?

K_{sp} (CdS) = 8×10^{-27}

K_{sp} (ZnS) = 1×10^{-21}

K_{a1} (H_2S) = 1.0×10^{-8} ,K_{a2} (H_2S) = 1.0×10^{-13}

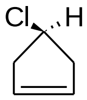
2.



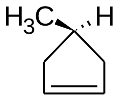
One molecule of silicate mineral containing above anion has x number of atoms of a metal M, y number of atoms of Potassium and z number of atoms of Calcium as cations.

If $x^2+y^2+2z^2 = 2yz + 2x + 4z – 5$ then oxidation state of metal M is___

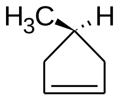
3.



$\xrightarrow{HCl}$ P (Number of Products)



$\xrightarrow{ICl/CCl_4}$ Q (Number of Products)



$\xrightarrow{\text{Cold Dil Alk } KMnO_4}$ R (Number of Products)

Value of P + Q + R is _______________

4. The equilibrium composition in 1 litre container for the reaction is -

$$PCl_3 + Cl_2 \rightleftharpoons PCl_5$$

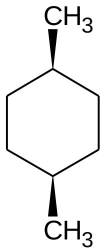
0.20 0.08 0.40 moles/litre

0.22 mole of Cl_2 is added at same temperature and new equilibrium is established and If sum of new equilibrium concentration of PCl_3, Cl_2 and PCl_5 is p then value of $p \times 10$ is_______

5. $B_2H_6 + NH_3 \xrightarrow[\text{low temperature}]{\text{excess of } NH_3} P \xrightarrow{\text{strong heating}} Q(\text{an aromatic compound})$

Number of bond between B and N in cation part of P is x, in anion part of P is y and in compound Q is z then the sum x+y+z =….(count only sigma or coordinate bond)

6. Number of diastereomer pairs that can be grouped from the products formed by mono chlorination of following compound is...



$\xrightarrow{Cl2/h\nu}$ products

SECTION- II (MATHMETICS)

PART – A

Straight Objective Type

This section (**01 - 04)** contains 4 multiple choice questions which have only one correct answers. Each question carries **+5 marks** for correct answer and **– 3 mark** for wrong answer.

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1. The normal chord to the parabola $y^2 = 8x$ at the point (8, 8) subtends an angle θ at the focus, where θ is :
(a) $\frac{\pi}{4}$ (b) $\frac{\pi}{3}$ (c) $\frac{\pi}{2}$ (d) $\frac{\pi}{6}$

2. The locus of the point of intersection of tangents to an ellipse at two points, sum of whose eccentric angle is constant is a part of a/an :
(a) ellipse (b) hyperbola (c) parabola (d) straight line

3. Equation of a line passing through the centre of a rectangular hyperbola is $x - y - 1 = 0$. If one if of its asymptotes is $3x - 4y - 6 = 0$ and the equation of other asymptote is $ax + by + c = 0$, (where a, b, c $\in N$), then the minimum value of a + b + c is
(a) 10 (b) 24 (c) 22 (d) 28

4. If the slope of one of the lines represented by the equation $ax^2 + 2hxy + by^2 = 0$ be k times that of the other, then :
(a) $4kh = ab(1 + k)$ (b) $kh = ab(1 + k)^2$ (c) $4kh^2 = ab(1 + k)^2$ (d) None of these

Straight Objective Type

This section (**05-10)** contains 6 multiple choice questions which have one or more than one correct answers. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

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5. If $y = 3x + 1$ is a tangent to the hyperbola $\frac{x^2}{p^2} - \frac{y^2}{8} = 1$, then which of the following cannot be the sides of a right angle triangle ?
(a) $p^4, \sqrt{10}, 3$ (b) $p^4, 10, \sqrt{3}$ (c) $\sqrt{p^4}, 10, 3$ (d) $\sqrt{p^4}, \sqrt{10}, 3$

6. If $y\sin(x)\left(\frac{dy}{dx}\right) = \cos(x)[\sin(x) - y^2]$ and $y = \sqrt{\frac{2}{3}}$ at $x = \frac{\pi}{2}$, then the value of y at $x = \frac{\pi}{3}$ is NOT equal to
(a) $3^{1/2}$ (b) $3^{1/4}$ (c) $3^{-1/4}$ (d) $3^{-1/2}$

7. If the length of intercepts made on the line passing through origin and $x + y = 1$ by the circle $x^2 + y^2 = x - 3y$ are equal, then the above mentioned line can be
(a) $x + y = 0$ (b) $x - y = 0$ (c) $x + 7y = 0$ (d) $x - 7y = 0$

8. If the line $y = 2x + a$ lies between the circles $x^2 + y^2 - 2x - 2y + 1 = 0$ and $x^2 + y^2 - 16x - 2y + 61 = 0$ without intersecting or touching either circle, then a can be
(a) – 2 (b) – 4 (c) – 6 (d) – 8

9. If the line x = P divides the area of the region $S = \{(x, y) \in R \times R;\ x^3 \le y \le x, 0 \le x \le 1\}$ into two equal parts, then
(a) $0 < P \le \frac{1}{2}$ (b) $\frac{1}{2} < P < 1$ (c) $2P^4 - 4P^2 + 1 = 0$ (d) $P^4 + 4P^2 - 1 = 0$

10. If the curve passing through (0, 1) and satisfying the differential equation $\frac{dy}{dx} = \frac{y}{(2y\ell n(y) + y - x)}$ is y = f(x), then f(e) is greater than
(a) e (b) 1 (c) π (d) 2

SECTION – B

Matrix Match Type

This section **(01 – 04)** contains 4 Matrix Match Type Question which have statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. There may be One or More Than One Correct choices. Each question carries **+8 marks** for all correct answer however for each correct row **+2 marks** will be awarded. There is no negative marking.

1. Match the following :

Column – I		**Column – II**	
(a)	4y = 5x is a secant to the curve(s)	(P)	$x^2 + y^2 = 1$
(b)	The curve passing through (1, 0) and satisfying $[1+y^2] = xy\left(\frac{dy}{dx}\right)$ is/are	(Q)	$x^2 - y^2 = 1$
(c)	The curve for which the lines $x^2 = 1$ are tangent is/are	(R)	$2x^2 - y^2 = 2$
(d)	$\left(0, \frac{5}{4}\right)$ is an exterior point for	(S)	$2x^2 + y^2 = 2$

2. For the parabola $(x-2)^2 + (y-3)^2 = \frac{(3x-y+7)^2}{10}$

Column – I		**Column – II**	
(a)	The equation of line about which parabola is symmetrical	(P)	$3x - y + 7 = 0$
(b)	The equation of line along which minimum length of focal chord occurs	(Q)	$3x - y - 3 = 0$
(c)	The locus of point of intersection of perpendicular tangents	(R)	$x + 3y - 11 = 0$
(d)	The locus of foot of perpendicular from focus upon any tangent	(S)	$3x - y + 2 = 0$

3. Match the following

Column – I		**Column – II**	
(a)	If the circles $x^2 + y^2 = b^2$ and $x^2 + y^2 + 2gx + 2fy + ac = 0$ cut each other orthogonally, then	(P)	$ac \geq 0$
(b)	If the circles $x^2 + y^2 + 2ax + b = 0$ and $x^2 + y^2 + 2cx + b = 0$ touch each other $(a \neq c)$	(Q)	$b^2 = ac$
(c)	If in (b), the first circle lies completely inside the second circle, then	(R)	$b > 0$
(d)	If the chord of contact of the tangents drawn to $x^2 + y^2 = b^2$ from any point on $x^2 + y^2 = a^2$, touches the circle $x^2 + y^2 = c^2$ then	(S)	$b = 0$
		(T)	$\|b\| \leq 0$

4. Match the following

Column – I		**Column – II**	
(a)	The area bounded by $x^2 \leq y$ and $y \leq x + 2$ is	(P)	-12
(b)	The sum of the distance of any point on the ellipse $3x^2 + 4y^2 = 12$ from its directrix is	(Q)	9/2
(c)	The value of c for which $3x^2 - 5xy - 2y^2 + 5x + 11y + c = 0$ are the asymptotes of the hyperbola $3x^2 - 5xy - 2y^2 + 5x + 11y - 8 = 0$ is	(R)	8
(d)	If e is the eccentricity of $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ and θ is the angle between the asymptotes then $8e\cos\left(\frac{\theta}{2}\right)$ equals	(S)	$\frac{\sqrt{386}}{88}$

PART – C
(Integer Type)

This section contains **6 questions**. The answer to each question is a **single-digit integer**, ranging from 0 to 9. The correct digit below the question number in the ORS is to be bubbled. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

---

1. A curve y = f(x) passes through origin and slope of tangent line at any point (x, y) of the curve is $\frac{x^4+2xy-1}{1+x^2}$, then the value of greatest integer which is less than or equal to f(-1) is

2. If the equation of the directrix of the parabola which touches x-axis and y-axis at (2, 0) and (0, 3) respectively, is ax + by + c = 0, (a, b, c are integers) then the minimum value of |a + b + c| is

3. If the differential equation corresponding to the family of curves $y = (A + Bx)e^{3x}$ is given by $\frac{d^2y}{dx^2} = a\frac{dy}{dx} + by$, then $\frac{(a-b)}{5}$ equals

4. Let A be a point on $\frac{(x-2)^2}{16} + \frac{y^2}{12} = 1$, B and C be its foci. If the locus of the incentre of ΔABC is an ellipse with eccentricity e, then $9e^2$ is equal to

5. If (x, y) satisfies the equation $x^2 + y^2 - 6x - 8y + 21 = 0$ then the minimum value of $\frac{1}{2}(x^2+y^2+1)+(x-y)$ is equal to

6. Chords of the hyperbola $x^2 - y^2 = a^2$ touch the parabola $y^2 = 4ax$. If the locus of their middle points is the curve $y^m(x - a) = x^n$, then m +n equals

SECTION- III (PHYSICS)

PART – A

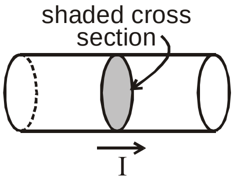
Straight Objective Type

This section (**01 - 04)** contains 4 multiple choice questions which have only one correct answer. Each question carries **+5 marks** for correct answer and **– 3 mark** for wrong answer.

1. A variable resistance is connected across a non ideal cell of constant emf and constant internal resistance. Initial value of variable resistance is R. Now the magnitude of variable resistance has been made n times, that is, its new value is nR. Surprisingly the new value of power dissipated in variable resistance is still same as its initial value. The value of internal resistance of cell is

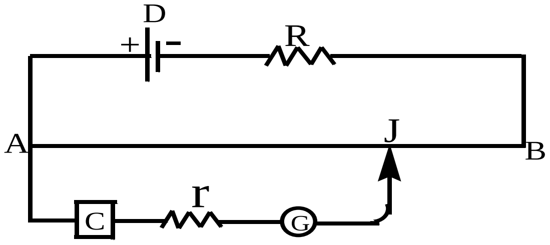
(A) $\frac{1+n}{2}R$ (B) $R\sqrt{n}$ (C) $\sqrt{\frac{1+n^2}{2}}R$ (D) $R+nR$

2. A current I flows through a cylindrical rod of uniform cross-section area A and resistivity ρ . The electric flux through the shaded cross-section of rod as shown in figure is :



(A) $\frac{I}{\rho}$ (B) ρI (C) $\frac{\rho I}{A}$ (D) $\frac{\rho A}{I}$

3. In the given potentiometer circuit, the resistance of the potentiometer wire AB is R_0 . ‘C’is a cell whose internal resistance r is separately shown. The zero centered galvanometer ‘*G*’ does not give zero deflection for any position of the jockey J. Which of the following cannot be a reason for this?



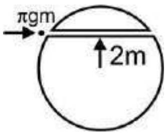
(A) r > R_0

(B) R >> R_0

(C) emf of cell C > emf of cell D

(D) The negative terminal of C is connected to A.

4. A unit positive point charge of mass π gm is to be projected inside the tunnel in sphere of radius 4m (as shown in figure), with a velocity of 5 m/sec. The tunnel has been made inside a uniformly charged $(\rho = 1\,c/m^3)$ non conducting sphere. The minimum velocity with which the point charge should be projected such that it can reach the opposite end of the tunnel, is equal to

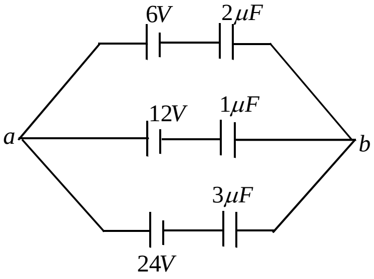


(a) 1.0 × 10^6 m/sec
(b) 12 × 10^6 m/sec
(c) zero, because the initial and the final points are at same potential
(d) 4.8 × 10^6 m/sec

Straight Objective Type

This section (**05-10)** contains 6 multiple choice questions which have one or more than one correct answers. Each question carries **+4 marks** for correct answer and **– 1 mark** for wrong answer.

5. In the given electric circuit which of the following statements are correct (Assume that the given capacitors are uncharged before they are connected in the circuit and the batteries of negligible internal resistance)

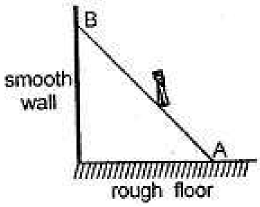


A) $V_a - V_b = -16V$ B) Charge on the $2\mu F$ capacitor is $20\mu C$

C) Charge on the $1\mu F$ capacitor is $4\mu C$ D) Charge on the $3\mu F$ capacitor is $24\mu C$

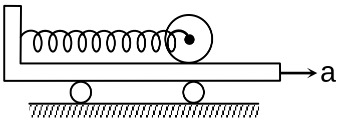
6. A ring rolls without slipping on the ground. Its centre C moves with a constant sped u. P is any point on the ring. The speed of P with respect to the ground is v, then
A) $0 \le v \le 2u$
B) v = u, if CP is horizontal
C) $v = \sqrt{6}u$, if CP makes an angle of 30^0 with the horizontal
D) $v = \sqrt{2}u$, if CP is horizontal

7. A ladder AB is supported by a smooth vertical wall and rough horizontal floor as shown. A boy starts moving from A to B slowly. The ladder remains at rest, then pick up the correct statements(s):



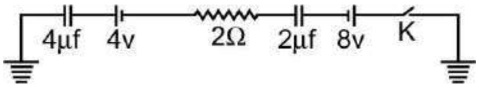
a) Magnitude of normal reaction by wall on ladder at point B will increase.
b) Magnitude of normal reaction by wall on ladder at point B will decrease.
c) Magnitude of normal reaction by floor on ladder at point A will remain unchanged
d) Magnitude of friction force by floor on ladder at point A will increase

8. A solid uniform sphere is connected with a moving trolley car by a light spring. The trolley car moves with an acceleration a. If the sphere remains at rest relative to the trolley car, then :



(A) Spring force = ma
(B) Friction between the sphere and trolley car is equal to zero
(C) Friction between the sphere and trolley car is equal to $\frac{ma}{2}$
(D) Spring force is equal to $\frac{ma}{2}$

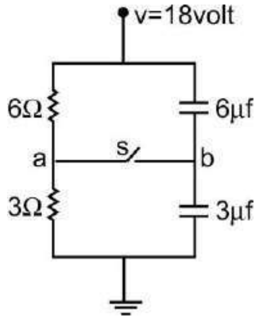
9. As shown in the figure find the correct statement/s :



(a) i at instant switch is closed is 2A
(b) i after long time is 2A
(c) charge on 4μf after long time is $\frac{16}{3}$μc (when switch is closed)

(d) charge on $2\mu f$ at instant switch is closed is $8\mu c$

10. Initially switch is open. After some time switch is closed. Choose the correct statements
(a) the charge flown through the switch is 54 μc
(b) Point b is at higher potential than point a before the switch is closed
(c) the potential of point b is 6v w.r.t. ground, after s is closed
(d) the potential of point b is 12v, after s is closed

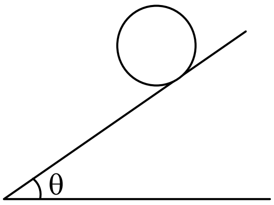


SECTION – B

Matrix Match Type

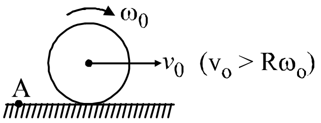
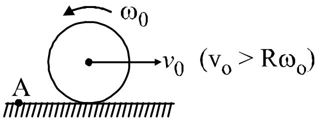
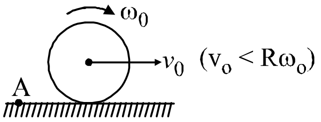
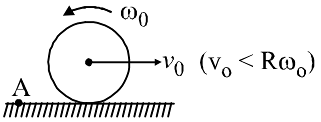
This section **(01 – 04)** contains 4 Matrix Match Type Question which have statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. There may be One or More Than One Correct choices. Each question carries **+8 marks** for all correct answer however for each correct row **+2 marks** will be awarded. There is no negative marking.

1. A ring of mass m and radius R is placed on a rough inclined plane so that it rolls without slipping. Match the following table.



	Column I		**Column II**
(A)	Linear acceleration of centre of mass	(p)	Is directly proportional to m
(B)	Angular acceleration	(q)	Is inversely proportional to m
(C)	Rotational kinetic energy at any instant	(r)	Is directly proportional to R^2
(D)	Translational kinetic energy at any instant	(s)	Is directly proportional to R^3
		(t)	None of these

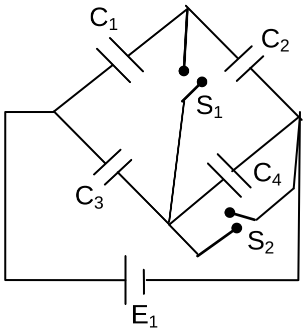
2. In each situation of column–I a uniform disc of mass m and radius R rolls on a rough fixed horizontal surface as shown. At t = 0 (initially) the angular velocity of disc is ω_o and velocity of centre of mass of disc is v_o (in horizontal direction). The relation between v_o and ω_o for each situation and also initial sense of rotation is given for each situation in column–I. Then match the statements in column–I with the corresponding results in column–II

	Column-I		**Column-II**
(A)		(P)	The angular momentum of disc about point A (as shown in figure) remains conserved.
(B)		(Q)	The kinetic energy of disc after it starts rolling without slipping is less than its initial kinetic energy
(C)		(R)	In the duration disc rolls with slipping, the friction force on disc acts backward.
(D)		(S)	Before rolling starts acceleration of the disc remain constant in magnitude and direction
		(T)	Final angular velocity is independent friction coefficient between disc and the surface

3. A galvanometer has a resistance of 100Ω and a full scale range of $100\mu A$. It can be used as a higher range ammeter or a voltmeter by providing a resistance. Match the statements of the two columns :

Column - I		Column - II	
(a)	25 V range with	(P)	$200K\Omega$ resistance in series
(b)	20 V range with	(Q)	$10K\Omega$ resistance in series
(c)	5 mA range with	(R)	1Ω resistance in parallel
(d)	10 mA range with	(S)	None of these
		(T)	$2\ \Omega$ resistance in parallel

4. Four capacitors with capacitances $C_1 = 2\mu F$, $C_2 = 4\mu F$, $C_3 = 4\mu F$, $C_4 = 2\mu F$ are connected as shown in figure and are connected to a 12 V source. Charge flow battery Δq_E and switch is Δq_S.



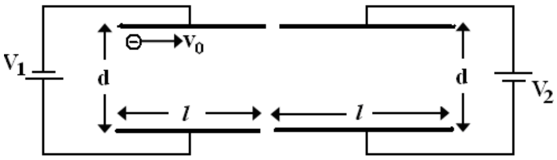
List I			List II	
(A)	Switch S_1 is closed value of Δq_E		(P)	32 μC
(B)	Switch S_1 is closed value of Δq_S		(Q)	4 μC
(C)	Switch S_2 is closed value of Δq_E		(R)	48 μC
(D)	Switch S_1 is closed value of Δq_S		(S)	12 μC

PART – C
(Integer Type)

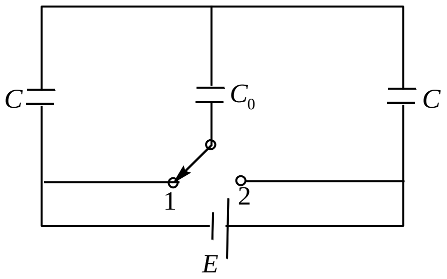
This section contains **6 questions**. The answer to each question is a **single-digit integer**, ranging from 0 to 9. The correct digit below the question number in the ORS is to be bubbled. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

---

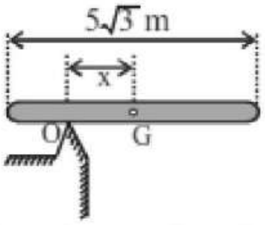
1. Two identical parallel plate capacitors are placed side by side with a small gap between them as shown in fig. V$_1$ and V$_2$ are potential difference across the two capacitors respectively. An electron is projected from the end of upper plate of the left capacitor with velocity v_0 towards right as shown. Charge and mass of electron 'e' and 'm' respectively. V$_2$ is applied such that the electron just grazes the lower plate of right capacitor horizontally while coming out of it. Assume that there is no gravity and no collision of electron with any plate. What is the ratio $\frac{V_2}{V_1}$? (neglect the time taken by electron from one capacitor to another capacitor.)



2. What amount of heat in micro joule will be generated in the circuit , after the switch is shifted from position 1 to position 2 ? $\left(C = C_0 = 2\mu F, E = \sqrt{6}\,V\right)$

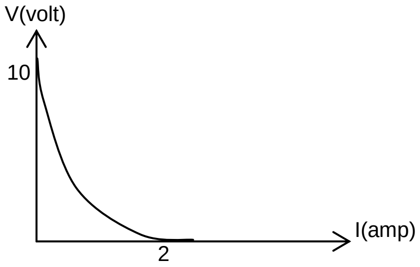


3.

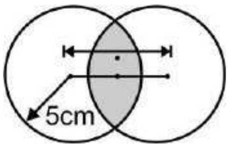


In the adjacent figure a uniform rod of length $5\sqrt{3}m$ and mass 2 kg is kept at rest in horizontal position on an elevated edge. Friction is sufficient to prevent slipping between rod and elevated edge. The value of x (consider the figure) is chosen such that the rod will have maximum angular acceleration α , as soon as it is set free. Find the maximum angular acceleration of the rod (in rad / s^2).

4. A battery of emf E and internal resistance r is connected with external resistance R. Resistance R can be adjusted to any value greater than or equal to zero. Graph is plotted between the current passing through the resistance (I) and potential difference (V) across it. Internal resistance of the battery (in Ω) is

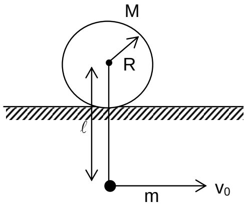


5. Two identical intersecting spheres having the same volume charge density of magnitude ε_0 (in S.I. unit) opposite in nature of charge, are shown in figure. Radius of spheres are 5cm. The distance between the centres is 6cm. Then the magnitude of electric field in the shaded portion is $\frac{E_0}{100}$, then E_0 will to (In S.I. unit)



6. A disc of radius R and mass M is placed on smooth horizontal surface as shown in figure. A light rod of length ℓ is hanged from the centre of disc and a small mass m is attached at the end as shown in figure. Now a velocity V_0 is given to mass m. The maximum height which mass m can attain. $[v_0 = \sqrt{8g}, M = 3m]$

(Assume rod can rotate < 90°)



ALL INDIA INTERNAL TEST SERIES

CHEMISTRY, MATHEMATICS & PHYSICS

CLASS XIIth

SET – A **080163.1** **Ai^{2}TS – 6**

ANSWER KEY

Chemistry (Section – I)			Mathematics (Section – II)			Physics (Section – III)		
1	D	C111303	1	C	M110904	1	B	P121517
2	A	C110504	2	D	M111029	2	B	P121411
3	C	C111711	3	B	M111123	3	A	P121515
4	C	C110403	4	C	M110730	4	B	P120104
5	ABC	C110402	5	BC	M111120	5	BCD	P121420
6	CD	C111707	6	ABD	M122407	6	AD	P111825
7	BC	C110501	7	BC	M110823	7	ACD	P111823
8	ACD	C111303	8	BCD	M110808	8	AB	P111820
9	ABC	C111405	9	BC	M121003	9	AC	P120118
10	D	C110403	10	BD	M122407	10	ABC	P120115
11	QST,PQST,RST,PRST	C110403	11	PRS,Q,PQRS,PQR	M111003	11	T,T,P,P	P111829
12	RST,QRS,RS,RQ	C111503	12	R,Q,P,S	M110909	12	PQRST,PQRST,PQST,PQRST	P111822
13	P,QS,RS,T	C110502	13	PQ,ST,R,PQ	M11082	13	S,P,T,R	P120212
14	PQST,PQST,PRT,PQST	C111707	14	Q,R,P,R	M111123	14	Q,S,P,R	P120216
15	9	C110501	15	1	M1122407	15	1	P120106
16	4	C111608	16	5	M1110909	16	4	P121422
17	9	C111707	17	3	M1122402	17	2	P111815
18	8	C110403	18	6	M111029	18	5	P120205
19	8	C111508	19	4	M111082	19	2	P121406
20	5	C111804	20	5	M110903	20	3	P111822

SOLUTIONS

CHEMISTRY :

1. (D)

CH_3 and aniline are planar

2. (A) [Concept Code : C110507/504]

$$H_3AsO_4 + OH^- \longrightarrow H_2AsO_4^- + H_2O$$

Initial milimols	30	10	0
After reaction	20	0	10

$$H_3AsO_4 + HAsO_4^{2-} \longrightarrow 2H_2AsO_4^-$$

Initial milimols	20	30	10
After reaction	0	10	50

So final pH = $pKa_2 + \log\frac{10}{50} = 6.3$

3. (C)

A=> propyne B=> mesitylele C => acetone D => mesitylene E=> phorone

4. (C)

Kp ($CaCO_3$) = 4 atm

Kp ($BaCO_3$) = 6 atm

Pressure above ($CaCO_3$+$BaCO_3$) = 6 atm

Total pressure = 6+1+2= 9 atm

5. (ABC)

$$N_2 + PCl_5 \rightleftharpoons PCl_3 + Cl_2$$

Moles at t = 0	1	3	0	0
Moles at equilibrium	1	(3 – x)	x	x

Total moles present at equilibrium = 4 + x
Given total pressure at equilibrium = 2.05
Total volume = 100 Litre
Θ PV = nRT
$\therefore$ 2.05 × 100 = (4 + x) × 0.082 × 500
$\therefore$ x = 1.0
Degree of dissociation 'α' for PCl_5

$= \frac{\text{Moles dissociated}}{\text{Total moles present}} = \frac{1}{3}$ = 0.3333 = 33.33%

Also $K_P = \frac{x^2}{(3-x)}\left[\frac{P}{\sum n}\right]^2 = \frac{x^2}{(3-x)} \times \frac{2.05}{(4+x)}$

$= \frac{(1)^2 \times 2.05}{(3-1)(4+1)}$

K_P= 0.205 atm.

6. (CD)

7. (BC)

At equilibrium

$$\underset{0.1}{H_2S} \xrightleftharpoons{K_{a_1}=10^{-5}} \underset{0.1}{HS^-} + \underset{10^{-5}}{H^+}$$

$$\underset{0.1}{HS^-} \xrightleftharpoons{K_{a_2}=10^{-8}} \underset{10^{-4}}{S^{2-}} + \underset{10^{-5}}{H^+}$$

$$NiS_{(S)} \xrightleftharpoons{K_{sp}=10^{-20}} \underset{10^{-4}}{S^{2-}} + \underset{10^{-16}}{Ni^{2+}}$$

8. (ACD)

9. (ABC)

Compounds formed

Total = 10

Optically active =10

Optically inactive=0

Diastereomer pairs = 4

Enantiomer pairsm= 5

10. (D) [Concept Code : C110402]

When solids $A_{(s)}$, $E_{(s)}$ and $P_{(s)}$ are kept together then

$$A_{(s)} \xrightleftharpoons{Kp_1=4atm^2} \underset{p_1}{C_{(g)}} + \underset{p_1+p_2+p_3}{B_{(g)}}$$

$$E_{(s)} \xrightleftharpoons{Kp_2=32atm^2} \underset{p_2}{D_{(g)}} + \underset{p_1+p_2+p_3}{B_{(g)}}$$

$$P_{(s)} \xrightleftharpoons{Kp_3=5atm} Q_{(s)} + \underset{p_1+p_2+p_3}{B_{(g)}}$$

$$p_1 = \frac{4}{5}, \; p_2 = \frac{32}{5}, \; p_3 = -1$$

But $p_3 = -1$ means to establish $P_{(s)} \rightleftharpoons B_{(g)} + Q_{(s)}$, it has to go backward which is not possible due to absence of $Q_{(s)}$ in the container so $p_3 = 0$

Hence $(p_1 + p_2)p_1 = 4$, $(p_1 + p_2)p_2 = 32$

$\Rightarrow p_1 + p_2$ = Partial pressure of $B_{(g)}$ = 6 atm

and the total pressure = 12 atm

(Integer Type)

1. (9)

In order to prevent precipitation of ZnS,

$[Zn^{2+}]\,[S^{2-}] < K_{sp}$ (ZnS) = 1×10^{-21}

(Ionic product)

or $(0.1).[S^{2-}] < 1 \times 10^{-21}$

or $[S^{2-}] < 1 \times 10^{-20}$

This is the maximum value of $[S^{2-}]$ before ZnS will precipitate. Let $[H^+]$ to maintain this $[S^{2-}]$ be x.

Thus for $H_2S \rightleftharpoons 2H^+ + S^{2-}$,

$$K_a = \frac{[H^+]^2[S^{2-}]}{[H_2S]} = \frac{x^2(1\times10^{-20})}{0.1}$$

$= 1.0 \times 10^{-21}$

or $x = [H^+] = 0.1$ M. => pH= 1

when $[S^{2-}] = 1 \times 10^{-20}$ M and $[Cd^{2+}][S^{2-}] = K_{sp}$ (CdS) $= 8 \times 10^{-27}$

Then $[Cd^{2+}] = 8 \times 10^{-7}$ M

So, x=1 and y=8 => x+y = 9

∴ No ZnS will precipitate at a concentration of H^+ greater than 0.1 M.

2. (4)

$x^2+y^2+2z^2 = 2yz + 2x + 4z - 5$

=> x = 1; z = y = 2

3. (9)

3 + 4 + 2 = 9

4. 8

$PCl_3 + Cl_2 \rightleftharpoons PCl_5$

0.20 0.08 0.40 moles/litre

Kc = 25

If 0.22 mole of Cl_2 is added then at equilibrium

0.20 – x 0.30 – x 0.40 + x

$$25 = \frac{0.40 + x}{(0.20 - x)(0.30 - x)}$$

or x = 0.1

$[PCl_3] = 0.2 - 0.1 = 0.1$ moles

$[Cl_2] = 0.3 - 0.1 = 0.2$ moles

$[PCl_5] = 0.4 + 0.1 = 0.5$ moles

Sum of conc. = 0.8

5. (8)

P is $[BH_2(NH_3)_2]^+[BH_4]^-$ Q is borazine

6. (5)

MATHS

1. $y^2 = 4ax$. The normal chord at (4a, 4a) subtends a right angle at focus.

2. Tangents at $(a\cos\alpha, b\sin\alpha)$ and $(a\cos\beta, b\sin\beta)$

meet at $\left(\dfrac{a\cos\left(\frac{\alpha+\beta}{2}\right)}{\cos\left(\frac{\alpha-\beta}{2}\right)}, \dfrac{b\sin\left(\frac{\alpha+\beta}{2}\right)}{\cos\left(\frac{\alpha-\beta}{2}\right)}\right) \equiv (h,k)$

$\dfrac{k}{h} = \dfrac{b}{a}\tan\left(\dfrac{\alpha+\beta}{2}\right) = \text{constant} \Rightarrow y = \left[\dfrac{b}{a}\tan\left(\dfrac{\alpha+\beta}{2}\right)\right]x$

3. Asymptotes of a rectangular hyperbola are perpendicular

$(x-y-1)+\lambda(3x-4y-6)=0 \Rightarrow \text{slope} = \dfrac{-4}{3}$

$4x + 3y = 17$

4. $y = mx$ in $ax^2 + 2hxy + by^2 = 0$

$\Rightarrow x^2[a+(2h)m+bm^2]=0$

$m_1 = km_2$ $\quad m_1 + m_2 = \dfrac{-2h}{b}$ $\quad m_1m_2 = \dfrac{a}{b}$

5. $y = mx + \sqrt{a^2m^2 - b^2}$

$\Rightarrow \sqrt{9p^2 - 8} = 1 \Rightarrow p^2 = 1$

6. $t = y^2$, First order linear differential equation in variable t.

7. The length of perpendicular from centre of the circle on both the lines will be equal.

8. Length of perpendicular from centre on the line will be greater than the radius of the circle

9. $\displaystyle\int_0^{\alpha}(x-x^3)\,dx = \frac{1}{2}\int_0^{1}(x-x^3)\,dx$

10. First order linear D.E. in $\dfrac{dx}{dy}$

Integer :

1. $\dfrac{dy}{dx} - \left(\dfrac{2x}{1+x^2}\right)y = (x^2-1)$

2. The line joining origin and (2,3) will be parallel to the axis of the parabola

4. Sum of focal distances for any point = 8

$A : (2+4\cos(\theta), \sqrt{12}\sin(\theta))$

5. $\dfrac{(x^2+y^2+1)}{2} + (x-y) = k$

$C_1C_2 = r_1 + r_2$

6. $hx - ky = h^2 - k^2$ becomes a tangent to $y^2 = 4ax$

$\Rightarrow y = \left(\dfrac{h}{k}\right)x + \left(\dfrac{k^2-h^2}{k}\right)$

$$\Rightarrow \frac{h(k^2-h^2)}{k^2}=a$$

SOLUTIONS (PHYSICS)

1) (B)

$$P=\frac{\varepsilon^2 R}{(r+R)^2}=\frac{\varepsilon^2 n}{(r+nR)^2}R$$

$$\Rightarrow \quad r=R\sqrt{n}$$

2) (B)

The current density J, electric field E at the cross-section are related by

$$J=\frac{E}{\rho}$$

multiplying both side by A.

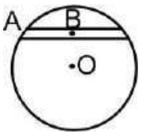
$$\mathrm{JA}=\frac{\mathrm{EA}}{\rho} \quad \text{or} \quad \mathrm{I}=\frac{\phi}{\rho} \quad \text{Where } \phi \text{ is electric flux.}$$

$$\mathrm{JA}=\frac{\mathrm{EA}}{\rho} \quad \text{or} \quad \mathrm{I}=\frac{\phi}{\rho} \qquad \text{or} \quad \phi=\rho I$$

3) (A)

In the position of balance no current exists through the galvanometer, and hence through the cell. Therefore the magnitude of r does not affect the condition for balance

4. (b)



If point B is being crossed then the particle will reach to other end

$$\Delta \mathrm{KE}=(\mathrm{V_B}-\mathrm{V_A})\mathrm{q}$$

$$\mathrm{V_B}=\mathrm{K}\rho\pi \mathrm{R}^2\times\frac{11}{6}$$

$$\mathrm{V_A}=\mathrm{K}\rho\pi \mathrm{R}^2\times\frac{4}{3}$$

5. BCD

With the help of loop law & junction law

$$V_a-V_b=+16V$$

Hence b, c, d are correct

6. AD

7. ACD

8. AB

w.r.t. trolley, $\dot{\mathrm{F}}=0$ & $\dot{\tau}_{cm}=0$

9. AC

$$-\frac{q}{4}-4-\frac{q}{2}+8=0$$

$$\Rightarrow q=\frac{16}{3}$$

at $t=\infty \qquad i=0$

at $t=0\Rightarrow -4-2i+8=0\Rightarrow i=2A$

10. ABC

MATRIX MATCHING :

1. A–t; B–t; C–p; D–p
   From theory

2. (A) P,Q,R, S, T; (B) P,Q,R,S,T; (C) P,Q, S,T; (D) P,Q,R,S,T

3. a-S, b-P, c-T, d-R

$V - ig(G + R)$
$= (100)(10^{-6})(100 + 2 \times 10^5)$
$= 20V$
$\frac{i - i_g}{i_g} = \frac{G}{S}$
$i = i_g + \left(\frac{G}{S}\right) i_g$
$= 100(10^{-6}) + \left(\frac{100}{1}\right)(100)(10^{-6})$
$= 0.1 \times 10^{-3} + 10(10^{-3})$
$\simeq 10mA$.

22. **A-Q, B-S, C-P, D-R**
$\Delta q_E = \varepsilon_1\left(C'_{eq} - C_q\right)$. $C^1_{eq} \rightarrow$ equation capacitance with S_1 closed
$= 12\left[3 - \frac{8}{3}\right] = 4\mu C$
$\Delta q_S = 12\mu C$
$\Delta q_E = \varepsilon_1\left(C^4_{eq} - C_{eq}\right)$, $12\left[4 - \frac{4}{3}\right] = 32\ \mu C$
$\Delta q_S = 12 \times 4 = 48\ \mu C$

NUMERICAL :

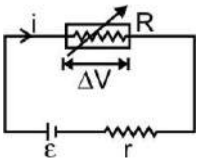
1. (1)

The electron covers a distance $\frac{d}{2}$ across the first capacitor when if comes out of it.

$\therefore$ in second capacitor it has to cover $\frac{d}{2}$ across it.

$\therefore V_1 = V_2$

2. 4
3. **2**
4. **5**



When i = 0 and $\Delta V = 10V$
$\varepsilon = 10V$ ...(i)
When $\Delta V = 0, R = 0$ and i = 2A
$\therefore$ $\varepsilon = ir$
$r = \frac{10}{2} = 5$

5. (2)

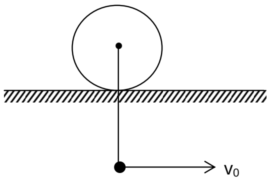
E inside shaded portion is

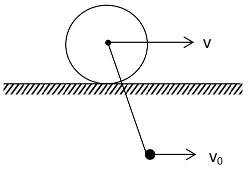
ℓ = distance between centres

$$E = \frac{\rho\ell}{3\varepsilon_0} = \frac{\varepsilon_0 \times 6 - 10 + 10^{-2}}{3 \times \varepsilon_0} = 2 \times 10^{-2} N/C$$

$$\Rightarrow \frac{E_0}{100} = \frac{2}{100} \Rightarrow E_0 = 2$$

6. 3





$mV_0 = (M + m)\ V$

$V = \dfrac{mV_0}{M+m}$

From energy conservation

$\frac{1}{2}mV_0^2 + Mg\ell = mgh + Mg\ell + \frac{1}{2}(M+m)V^2$

$\frac{1}{2}mV_0^2 - \frac{1}{2}\frac{m^2v_0^2}{(M+m)} = mgh$

$\frac{1}{2}\frac{mV_0^2[M+m-m]}{[M+m]} = mgh$

$h = \frac{1}{2}\frac{V_0^2}{g}\frac{M}{(M+m)}$

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - I

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 183**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into Two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01– 07, 19 – 25, 37 – 43)*** *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (08 – 13, 26 – 31, 44 – 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S).*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (14 – 18, 32 – 36, 50 – 54)*** *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10 \text{ m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

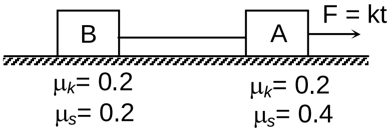
Physics

PART – I

SECTION – A
(One or More than one correct type)

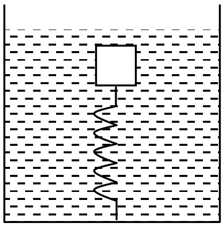
This section contains **7** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. Two block *A* and *B* each of mass $\frac{1}{2}$ kg is connected by a massless inextensible string and kept on horizontal surface. Coefficient of friction between block and surface shown in figure. A force $F = kt$ (where *k* = 1 N/s and *t* is time in second) applied on *A*. Then (g = 10 m/s^2)



(A) work done by friction force on block *B* is zero in time interval *t* = 0 to *t* = 3s.
(B) work done by friction force on block *A* is zero in time interval *t* = 0 to *t* = 3s.
(C) work done by tension on *B* is also zero in time interval *t* = 0 to *t* = 3s.
(D) speed of blocks at *t* = 10s is 27.5 m/s.

2. A block of mass '*m*' is attached by means of a spring to the bottom of a tank of water as shown in figure. At equilibrium, the spring is under compression. If the tank is now allowed to fall freely, then choose the correct alternative(s)



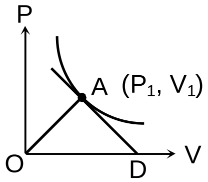
(A) the spring comes to its relaxed position
(B) the spring compresses more than its equilibrium compression
(C) the boyant force becomes zero
(D) there will be some elongation is the spring

Space for Rough work

3. A particle of mass *m* moves in a straight line. If *v* is the velocity at a distance *x* from a fixed point on the line and $v^2 = a - bx^2$, where *a* and *b* are constant, then
(A) the motion continues along the positive *x*-direction only
(B) the motion is simple harmonic\
(C) the particle oscillates with a frequency equal to $\frac{\sqrt{b}}{2\pi}$
(D) the total energy of the particle is *ma*

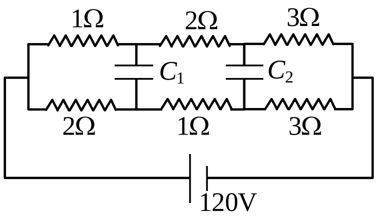
4. A traveling wave pulse is given by $y = \frac{6}{2+(x+3t)^2}$ where symbols have their usual meanings, *x, y* are in metre and t is in second. Then
(A) the pulse is traveling along +ve *x*-axis with velocity 3 m/s
(B) the pulse is traveling along –ve *x*-axis with velocity 3 m/s
(C) the amplitude of the wave pulse is 3 m
(D) the pulse is a symmetric pulse

5. *n* moles of an ideal gas undergo an isothermal process at temperature *T*. P-V graph of the process is as shown in the figure. A point *A* (V_1, P_1) is located on the P-V curve. Tangent at point *A*, cuts the *V*-axis at point *D*. *AO* is the line joining the point *A* to the origin *O* of PV diagram. Then,



(A) coordinates of points *D* is $\left(\frac{3V_1}{2}, 0\right)$
(B) coordinates of points *D* is $(2V_1, 0)$
(C) area of the triangle *AOD* is *nRT*
(D) area of the triangle *AOD* is $\frac{3}{4}$nRT

6. In the circuit shown in figure $C_1 = C_2 = 2\mu F$. Then charge stored in
(A) capacitor C_1 is zero
(B) capacitor C_2 is zero
(C) both capacitors is zero
(D) capacitor C_1 is 40 μC



Space for Rough work

7. A converging lens of focal length f_1 is placed in front of and coaxially with the convex mirror of focal length f_2. Their separation is d. A parallel beam of light incident on the lens returns as a parallel beam from the arrangement
(A) The beam diameters of the incident and reflected beams must be the same
(B) $d = |f_1| - 2|f_2|$
(C) $d = |f_2| - |f_1|$
(D) If the entire arrangement immersed in water, the conditions will remain unaltered

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

A container of cross section area A_1 and height L is filled with a liquid of density d_1 up to height 4L/5. A cylinder of length L, cross section area A_2 and density d_2 is submerged into the container gently so that it is floating. ℓ is height of liquid in container after cylinder is submerged.

Column 1	Column 2	Column 3
(I) $d_1 = 2d$ $d_1 = 2d$	(i) $\ell = 0.88L$	(P) $A_1 = 12A$ $A_2 = 2A$
(II) $d_1 = d$ $d_2 = d$	(ii) $\ell = L$	(Q) $A_1 = 10A$ $A_2 = A$
(III) $d_1 = d$ $d_2 = 5d$	(iii) $\ell = 0.85L$	(R) $A_1 = 5A$ $A_2 = A$
(IV) $d_1 = 3d$ $d_2 = 9d$	(iv) $\ell = 0.82L$	(S) $A_1 = 18A$ $A_2 = 3A$

8. In which case would the cylinder be floating completely submerged.
(A) (I) (ii) (S)
(B) (I) (iii) (R)
(C) (II) (ii) (R)
(D) (II) (iii) (Q)

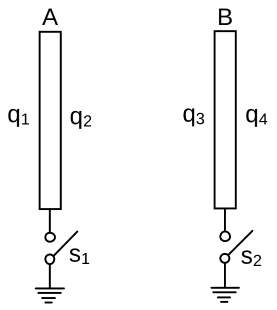
Space for Rough work

9. In which case the change in pressure at the bottom of the container is minimum?
(A) (III)(ii) (S) (B) (I) (iv) (Q)
(C) (III) (iv) (Q) (D) (II) (iii) (Q)

10. In which case the liquid will exert maximum force on the cylinder?
(A) (IV)(ii) (P) (B) (I) (iv) (S)
(C) (IV) (iii) (S) (D) (II) (iii) (Q)

Answer questions 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

In the figure given below, plate A has 100µC charge, while plate B has 60 µC charge. Switches S_1 and S_2 are connected to the ground. q_1, q_2, q_3 and q_4 are charges on faces of plates as shown in figure



Column 1	Column 2	Column 3
(I) q_1 =80 µC	(i) q_2= 100 µC	(P) q_3= -20 µC
(II) q_1 = 60 µC	(ii) q_2= 0 µC	(Q) q_3= -100 µC
(III) q_1 = 0 µC	(iii) q_2= 20 µC	(R) q_3= 60 µC
(IV) q_1 = -60 µC	(iv) q_2= 60 µC	(S) q_3= 0 µC

11. Which of the following options correctly represents the case when switch S_1 is closed and S_2 is open?
(A) (IV)(ii) (P) (B) (III) (i) (R)
(C) (III) (iv) (S) (D) (II) (iii) (Q)

Space for Rough work

12. Which of the following options correctly represents the case when switch S_2 is closed and S_1 is open?
(A) (IV)(ii) (P)
(B) (III) (i) (Q)
(C) (II) (i) (Q)
(D) (II) (iii) (Q)

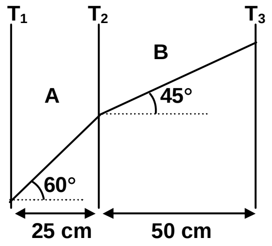
13. Which of the following options correctly represents the case when both the switches S_1 and S_2 is open?
(A) (I) (ii) (P)
(B) (IV) (iv) (P)
(C) (I) (ii) (S)
(D) (II) (iii) (Q)

SECTION – C

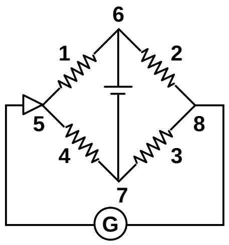
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

14. Two conductors A and B each of cross section area 5 cm^2 are connected in series. Variation of temperature (in °C) along the length (in cm) is as shown in the figure. If thermal conductivity of A is $2\sqrt{3}$ J/m-sec-°C and the heat current in the conductors is 0.173 J/s. Find thermal conductivity of B (in J/m-sec-°C upto one decimal place.)



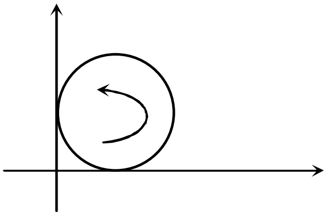
15. Four wires of equal length 8 m are arranged as shown in the figure. Wires, 2, 3 and 4 are of equal cross sectional area and wire 1 is of half the cross section of these wires. By how much distance pointer at point 5 must be moved to get null point?



Space for Rough work

16. Two particles of mass M = 3 kg each are kept on a horizontal circular platform on two mutually perpendicular radii at equal distance R = 1 m from the centre of the table. The particles are connected with a string, which is just taught when the platform is not rotating. Coefficient of friction between the platform and block is $\mu = 0.1$. Then the maximum angular speed (ω in rad/sec) of platform about its centre so that the blocks remain stationary relative to platform. (take $g = 10\ m/s^2$)

17. A uniform cylinder of radius R(= 3m) is spin about its axis at an angular velocity ω_0 (= $4\sqrt{10}\pi$ rad/sec) and placed between two perpendicular wall. The coefficient of friction between the walls and cylinder is μ(= 2). Then, how many turns will the cylinder make before it stops.



18. If voltage V = (100 ± 5) V and current I = (10 ± 0.2) A, the percentage error in resistance R is

Space for Rough work

Chemistry PART – II

SECTION – A
(One or More than one correct type)

This section contains **7** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Silicate having one monovalent corner oxygen atom in each tetrahedron unit is
(A) Sheet silicate (B) Cyclic silicate
(C) Single chain silicate (D) Double chain silicate

20. Choose incorrect statements:
(A) $AlCl_3$ undergoes hydrolysis to form $\left[Al(H_2O)_6\right]^{3+}$
(B) Amalgamated Al reacts with cold water to liberate H_2
(C) The ash formed on burning magnesium in air fumes on wetting and exposing to HCl
(D) B^{3+} ion can exist in aqueous solution in the hydrated form

21. Which of the following species exhibits the paramagnetic behaviour?
(A) NO (B) O_2^{2-}
(C) O_2^{2+} (D) O_2

22. Which of the following have identical bond order?
(A) CN^- (B) O_2
(C) NO^+ (D) CN^+

Space for Rough work

23. Given $\Delta H_f^0(C_2H_6, g) = -85\,kJ/mole$,

$\Delta H_f^0(C_3H_8, g) = -104\,kJ/mole$,

$\Delta H_{sub}^0(C, s) = 718\,kJ/mole\,\&\,B.E.of\,(H-H) = 436$ kJ/mole.

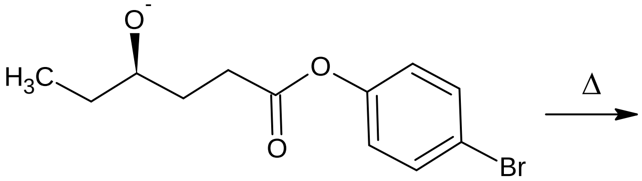
Then, in kJ/mole, the

(A) C – C bond enthalpy is 218
(B) C – H bond enthalpy is 414
(C) C – C bond enthalpy is 345
(D) C – H bond enthalpy is 448

24. Which of the following statement(s) is/are false?

(A) All adiabatic processes are isoentropic (or isentropic) process
(B) The heat of vaporization of water at 100^0C is 40.6 kJ/mole. When 9g of water vapour condenses to liquid at 100^0C of 1 atm, then $\Delta S_{system} = 54.42\,J/K$
(C) When $(\Delta G_{system})_{T,P} < 0$; the reaction must be exothermic
(D) dG = Vdp – S dT is applicable for closed system, both PV and non – PV work

25.



Which of the statements regarding the product formed in the above reaction is correct?

(A) If Br is replaced with NO_2 rate of reaction increases
(B) Inversion of configuration takes place.
(C) I Nucleophillic acyl substitution takes place.
(D) Configuration at chiral carbon does not change

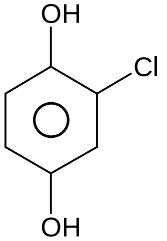
Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 26, 27 and 28 by appropriately matching the information given in the three columns of the following table.

Column-1 contains organic compounds treated with suitable reagent given in column-2 to give desired products listed in column-3. Now, answer the following questions

Column – 1		**Column – 2**		**Column – 3**	
(I)	Acetone	(i)	HCl	(P)	Pinacol
(II)	P-benzoquinone	(ii)	KOH(Fuse)	(Q)	Benzene+ $C_6H_5COO^-K^+$
(III)	Acetophenone	(iii)	(a) Mg/Benzene (b) H_2O	(R)	Benzoic acid
(IV)	Benzophenone	(iv)	(a) I_2 + NaOH (b) H^+/H_2O	(S)	

26. Which of the following is correct matching resulting into desired product as indicated?
(A) (IV), (i) & (S)
(B) (III), (ii) & (R)
(C) (I), (iii) & (R)
(D) (II), (i) & (S)

27. In which of the following sequence of reaction the diradical is formed as immediate.
(A) (II), (iv) & (R)
(B) (III), (iv) & (R)
(C) (I), (iii) & (P)
(D) (IV), (i) & (S)

28. Which of the following reaction sequence is correctly matched and does not involve redox reaction?
(A) (I), (iii) & (P)
(B) (II), (i) & (S)
(C) (III), (iv) & (R)
(D) (IV), (ii) & (Q)

Space for Rough work

Answer questions 29, 30 and 31 by appropriately matching the information given in the three columns of the following table.

Column-1 contains compounds & column-2 & column-3. Now, answer the following questions

Column – 1		**Column – 2**		**Column – 3**	
(I)	Methyl isocyanate	(i)	sd^3-hybridisation	(P)	Reducing agent
(II)	Silyl isocyanate	(ii)	C-C bond length longer than 1.54 $\overset{o}{A}$	(Q)	Coloured due to charge transfer
(III)	Oxalic acid	(iii)	N is sp-hybridized	(R)	Linear
(IV)	$KMnO_4$	(iv)	N is sp^2 hybridized	(S)	V-shaped

29. Which of the following is correctly matched?
(A) (I), (iii) & (R) (B) (II), (iv) & (S)
(C) (III), (ii) & (P) (D) (IV), (i) & (S)

30. Which of the following statement is NOT correct for methyl isocyanate?
(A) (I), (iv) & (S) (B) (III), (i) & (P)
(C) (I), (ii) & (R) (D) (II), (iii) & (Q)

31. Which of the following is correctly matched?
(A) (II), (iii) & (R) (B) (II), (iv) & (R)
(C) (I), (iii) & (R) (D) (I), (i) & (S)

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

32. In alkaline medium, how many moles of potassium permanganate are required for complete oxidation of 3.5 moles of KI to KIO_3?

33. When H_2S is passed through a solution of $CoCl_2$, a black precipitate is formed. It is soluble in aqua regia. On adding acetic acid in excess and potassium nitrate, yellow precipitate is formed. The oxidation number of cobalt in this compound is +n. Find the value of n.

34. How many geometrical isomers are possible for the following complex?
$\left[Pt\left(NH_3\right)\left(NH_2OH\right)\left(NO_2\right)\left(py\right)\right]NO_2$

35. Dissociation constant for a weak base BOH is 10^{-5}. What is the value of pH when it is half neutralized by HCl?

36. The number types of monochloroalkanes formed by chlorination of sobutene is

Space for Rough work

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **7** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. Let P_n be the point on the complex plane with origin O expressed by

$P_n = (1+i)\left(1+\frac{i}{\sqrt{2}}\right)\left(1+\frac{i}{\sqrt{3}}\right)......\left(1+\frac{i}{\sqrt{n}}\right)(n = 1, 2, 3, ...)$ then correct option(s) is (are)

(A) $\tan\left(\arg\left(\frac{P_{n+1}}{P_n}\right)\right) = \sqrt{\frac{n+2}{n+1}}$

(B) area of $\Delta OP_nP_{n+1} = \frac{\sqrt{n+1}}{2}$

(C) area of $\Delta OP_nP_{n+1} = \frac{\sqrt{n+3}}{2}$

(D) $\tan\left(\arg\left(\frac{P_{n+1}}{P_n}\right)\right) = \frac{1}{\sqrt{n+1}}$

38. Let $\vec{a}, \vec{b}, \vec{c}$ are vectors in xy plane such that $\vec{a}.\vec{c} = \vec{b}.\vec{c} = -\sqrt{3}\,\vec{a}.\vec{b}$ and $|\vec{a}| = |\vec{b}| = |\vec{c}| = 1$ then $\vec{a}.\vec{b}$ can be equal to

(A) $\frac{1}{2}$

(B) $\frac{-1}{2}$

(C) $\frac{1}{3}$

(D) $\frac{-1}{3}$

Space for Rough work

39. Let f:[0, 1] $\rightarrow [0,\infty)$ be a real valued continuous function such that $(f(t))^2$ $\le 1 + 2\int_0^t f(u)du \, \forall \, t \in [0,1]$ then which of the following is (are) correct?

(A) $f\left(\frac{1}{2}\right) \le \frac{3}{2}$ (B) $f\left(\frac{3}{4}\right) \ge \frac{7}{4}$

(C) $\int_0^{3/4} f(u)du > \frac{33}{32}$ (D) $\int_0^{1/2} f(u) \le \frac{5}{8}$

40. Let $f:[0,1] \rightarrow R$ be a continuous and differentiable function such that for any $x, y \in [0,1]$, $x f(y) + y f(x) \le 1$, then which of the following option(s) is (are) correct

(A) $\int_0^1 f(x)dx \le \frac{\pi}{4}$ (B) $\int_0^1 f'(x)x^2dx \ge f(1) - 1$

(C) $\int_0^1 x f'(x)dx \ge f(1) - \frac{\pi}{4}$ (D) $\int_0^1 f(x)dx \le \frac{\pi}{8}$

41. Let ABC be a triangle such that $\angle B = 2\angle C$. Side BC is extended by a segment CD equal to $\frac{BC}{3}$. Also $\angle BAD = \phi$. Then which of the following is (are) correct?

(A) $(AC)^2 - (AB)^2 = (AB)(BC)$ (B) $AD = \frac{1}{3}(3AB + 2BC)$

(C) $AD = \frac{1}{3}(3AB - 2BC)$ (D) Area of $\Delta ABC = \frac{1}{2}(BC)^2 \cot\left(\frac{\phi}{2}\right)$

Space for Rough work

42. Let N be the number of functions $f:\{1,2,3,.........,2018\} \rightarrow \{1,2,3,.......2018\}$ satisfying $f(j) < f(i) + j - i \ \forall$ integers I, j such that $1 \le i < j \le 2018$. Then correct option(s) is/are

(A) $N \in \left(2\sum_{i=0}^{2017}\left({}^{2017}C_i\right)^2, 3\sum_{i=0}^{2017}\left({}^{2017}C_i\right)^2\right)$

(B) $N \in \left(\sum_{i=0}^{2017}\left({}^{2017}C_i\right)^2, 2\sum_{i=0}^{2017}\left({}^{2017}C_i\right)^2\right)$

(C) $N = {}^{2018}C_{2018} + {}^{2019}C_{2018} + ... + {}^{4034}C_{2018}$

(D) $N = {}^{2017}C_{2017} + {}^{2018}C_{2017} + ... + {}^{4034}C_{2017}$

43. Let $f:R \rightarrow R$ be a continuous function such that $f(f(f(x))) = x \ \forall x \in R$, then correct option(s) is (are)

(A) $y = f(x)$ is a bijective function

(B) $y = f(x)$ is strictly increasing function

(C) $y = f(x)$ is strictly decreasing function

(D) $y = f(x)$ intersects $y = x^2$ at exactly two distinct points.

Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 44, 45 and 46 by appropriately matching the information given in the three columns of the following table.

$A(2,-1,4), B(1,0,-1), C(1,2,3), D(a,b,c)$ be the vertices of a parallelogram ABCD taken in order. Let π be the plane containing parallelogram ABCD. Let L be the line passing through P (2, 1, 0) and parallel to vector $\hat{i}+\hat{j}+\hat{k}$. Let F be the foot of perpendicular from P to Plane π and I is mirror image of P in plane π.

Column 1		Column 2		Column 3	
(I)	Coordinates of D : (2, 1, 8)	(i)	(i) Equation of line AB $\vec{r}=(1,0,-1)+\delta(1,-1,5)(\delta\in R)$	(P)	Distance between AB and CD is $2\sqrt{2}$
(II)	Coordinates of F : $\left(\frac{13}{27},\frac{19}{27},\frac{4}{27}\right)$	(ii)	(ii) Equation of line PF $\vec{r}=(-5,-1,1)+\delta(7,2,-1)(\delta\in R)$	(Q)	Acute angle between line L and plane π is $\cos^{-1}\left(\frac{8}{9\sqrt{2}}\right)$
(III)	Coordinates of I : $\left(\frac{-2}{27},\frac{11}{27},\frac{8}{27}\right)$	(iii)	(iii) Equation of projection of line L on plane π $\vec{r}=(1,0,-1)+\delta(1,-19,-31)(\delta\in R)$	(R)	Equation of plane, containing line L and perpendicular to plane π is $-3x+8y-5z-3=0$.
(IV)	Foot of Perpendicular from A to BC: $\left(2,\frac{9}{5},\frac{13}{5}\right)$	(iv)	(iv) Equation of mirror image of line L in plane π $\vec{r}=(1,0,-1)+\delta(29,-11,-35)$ $(\delta\in R)$	(S)	Equation of plane passing through P and parallel to plane π is $7x+2y-z-16=0$

44. Which of the following is correct combination?
   (A) (I) (i) (Q)
   (B) (II) (iii) (S)
   (C) (III) (i) (P)
   (D) (II) (ii) (P)

Space for Rough work

45. Which of the following is incorrect combination?
(A) (I) (i) (P)
(B) (III) (ii) (S)
(C) (III) (iv) (S)
(D) (II) (i) (Q)

46. Which of the following is correct combination?
(A) (I) (i) (R)
(B) (I) (iv) (R)
(C) (IV) (iv) (S)
(D) (III) (i) (S)

Answer questions 47, 48 and 49 by appropriately matching the information given in the three columns of the following table.

A tangent L is drawn at any point P in the first quadrant on the ellipse $\frac{x^2}{16}+\frac{y^2}{9}=1$. It intersect the x - axis at A and y – axis at B, such that area of ΔOAB is minimum. A variable point $Q(\alpha,\beta)$ is taken on L from which pair of tangents QC and QD are drawn to the circle $x^2+y^2=12$ (O is origin)

Column 1		**Column 2**		**Column 3**	
(I)	Coordinate of A : $\left(4\sqrt{2},0\right)$	(i)	Minimum area of $\Delta OAB=12$	(P)	Locus of circumcentre of ΔQCD is $3x+4y=6\sqrt{2}$
(II)	Coordinate of P: $\left(\frac{4}{\sqrt{2}},\frac{3}{\sqrt{2}}\right)$	(ii)	Number of points where L intersects circle $x^2+y^2=12$ is 2	(Q)	Equation of Line L: $3x+4y-12\sqrt{2}=0$
(III)	Coordinate of B: $\left(0,4\sqrt{2}\right)$	(iii)	Number of points where L intersects circle $x^2+y^2=12$ is 0	(R)	Equation of locus of curve from where perpendicular tangents can be drawn to given ellipse is $x^2+y^2=24$
(IV)	Point of concurrency of variable chord of contact CD of the circle $x^2+y^2=12$ is $\left(\frac{3}{\sqrt{2}},\frac{4}{\sqrt{2}}\right)$	(iv)	Number of points on the curve $x^2+y^2=25$, from where perpendicular tangents can be drawn to $x^2+y^2=12$ is infinite	(S)	Line $x-y-\sqrt{7}=0$ intersecting the ellipse after reflection will pass through $\left(-\sqrt{7},0\right)$

47. Which of the following is correct combination?
(A) (I) (i) (P)
(B) (II) (iv) (S)
(C) (IV) (iii) (P)
(D) (III) (iii) (S)

Space for Rough work

48. Which of the following is correct combination?

(A) (III) (i) (P) (B) (IV) (iv) (S)
(C) (I) (iii) (R) (D) (II) (ii) (Q)

49. Which of the following is incorrect combination?

(A) (IV) (i) (P) (B) (IV) (iv) (R)
(C) (II) (i) (P) (D) (I) (ii) (P)

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

50. Suppose that the circle $x^2 + y^2 - 4ax - 2ay + 4a^2 = 0\left(a > 0\right)$ touches the lines $y = mx$ at A and B such that AB = 3. Then the value of $\frac{4a}{\sqrt{5}}$ is

51. Let (x, y, z) be an ordered triplet of real numbers, such that $x < 1, y < 2, z < 3$ and $x + \frac{y}{2} + \frac{z}{3} > 0$. Let $\left(x_0, y_0, z_0\right)$ be the triplet (x, y, z) for which expression $\left(1 - x\right)\left(2 - y\right)\left(3 - z\right)\left(x + \frac{y}{2} + \frac{z}{3}\right)$ is maximum, then the value of $\frac{z_0}{x_0 y_0}$ is

52. Number of ordered pair (x, y) of real numbers such that $\sin x + \sin y = \sin\left(x + y\right)$ and $\left|x\right| + \left|y\right| = 1$ is

Space for Rough work

53. Let 'ℓ' be a tangent line at the point $T\left(t, \frac{t^2}{2}\right)(t > 0)$ on the curve $C : y = \frac{x^2}{2}$. A circle S touches the curve C and the x – axis. Denote by $\left(x(t), y(t)\right)$ the center of circle S. If $\lim\limits_{r \to 0^+} \int_r^1 x(t)\,y(t)\,dt = \frac{\tan\frac{3\pi}{8}}{6a}$, then the value of a is

54. Urn A contains four white balls and two red balls. Urn B contains three red balls and three black balls. An urn is randomly selected and then a ball inside of that urn is drawn. The process of selecting an urn and drawing out a ball is repeated, without replacing the first ball. Let ‘p’ be the probability that the first ball drawn was red, given that the second ball drawn was black, than 15p equals

Space for Rough work

FIITJEE **JEE(Advanced)-2018**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS
CONCEPT RECAPITULATION TEST – I
PAPER-1

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**ABC**	19.	**ABC**	37.	**BD**
2.	**BC**	20.	**AD**	38.	**AD**
3.	**BC**	21.	**ACD**	39.	**AD**
4.	**BCD**	22.	**AC**	40.	**ABC**
5.	**BC**	23.	**BC**	41.	**AB**
6.	**BD**	24.	**ABCD**	42.	**BD**
7.	**AB**	25.	**ACD**	43.	**ABD**
8.	**C**	26.	**D**	44.	**C**
9.	**C**	27.	**C**	45.	**D**
10.	**C**	28.	**B**	46.	**D**
11.	**B**	29.	**C**	47.	**A**
12.	**B**	30.	**C**	48.	**D**
13.	**A**	31.	**A**	49.	**B**
14.	**6**	32.	**7**	50.	**3**
15.	**2**	33.	**3**	51.	**6**
16.	**1**	34.	**3**	52.	**6**
17.	**5**	35.	**9**	53.	**5**
18.	**7**	36.	**2**	54.	**7**

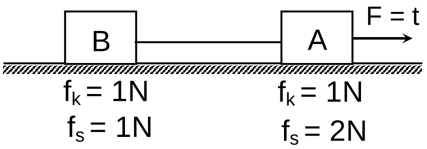
Physics

PART – I

SECTION – A

1. ABC

Sol. When *t* = 3s block just about to move and acceleration of block given by $a = \frac{t-2}{1}$ *t* > 3



$$\int_0^v dv = \int_3^{10} (t-2)\,dt$$

$$v = \left.\frac{t^2}{2} - 2t\right|_3^{10} = (50-20) - \left(\frac{9}{2} - 6\right)$$

$$= 30 + 1.5 = 31.5 \text{ m/s}$$

2. BC

Sol. As the tank allowed to fall vertically, so bouyant force becomes zero, so the spring compresses more than its equilibrium compression.

3. BC

Sol. $v^2 = a - bx^2$

differentiating both side w.r.t. time

$$2v\frac{dv}{dt} = -2bx\left(\frac{dx}{dt}\right) \qquad \frac{dv}{dt} = A \text{ (acceleration)}$$

$A = -bx$

Hence motion will be S.H.M. $\omega^2 = b$, $4\pi^2 f^2 = b$, $f = \frac{\sqrt{b}}{2\pi}$

$$\text{T.E.} = \frac{1}{2}m\omega^2 (\text{Amplitude})^2 = \frac{1}{2}m\,b\,\frac{a}{b} = \frac{1}{2}ma$$

4. BCD

Sol. Sign between *x* and *t* is ⊕ hence wave is propagating in negative *x* direction.

$$\text{wave velocity} = \frac{\text{coefficient of t}}{\text{coefficient of x}} = \frac{3}{1}$$

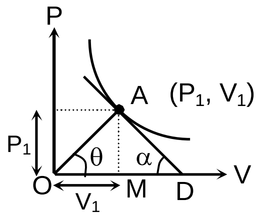
Max value of *y* is amplitude, *y* has maximum value when denominator is least i.e. when $(x+3t)^2$ is zero

$y = 3m$

shape of pulse is given by $y = \frac{6}{2+x^2}$ $(t=0)$

shape of pulse is symmetrical out y-axis

5. BC



Sol. $\tan\alpha = -$ [slope at (P_1, V_1)] $= \frac{P_1}{V_1}$

$\tan\theta = \frac{P_1}{V_1}$

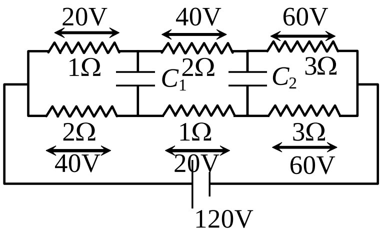
$\therefore\ \alpha = \theta$

$OM = MD = V_1$

$\therefore\ OD = 2V_1$

Area of triangle *AOD* $= \frac{1}{2}(AM \times OD) = \frac{1}{2}(P_1 \times 2V_1) = P_1V_1 = nRT$

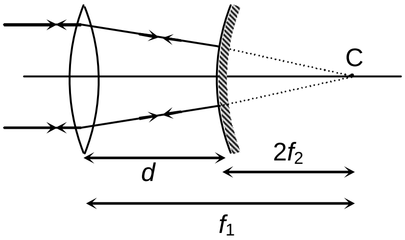
6. BD



Sol. Now, potential difference across C_1 is 20 V and across C_2 is zero.
$\therefore$ charge stored in C_1 is 40 μC and in C_2 is zero.

7. AB

Sol.



8. C

Sol. Fraction of volume submerged = $d_1/d_2 = 1$.

9. C

Sol. When ratio of extra weight to total base area is minimum.

10. C

Sol. When ratio of extra weight to total base area is maximum.

11. B

Sol. $Q_{outside}$ = earthed plate will have zero charge on outer surface for its zero potential condition.

12. B

Sol. Earthed plate will have zero charge on outer surface for its zero potential condition.

13. A

Sol. $Q_{outside} = (Q_1+Q_2)/2$, and conservation of charge.

SECTION – C

14. 6

Sol. $\frac{\Delta Q}{\Delta t} = K_A A \frac{dT}{dx}$

$\frac{dT}{dx}$ in conductor A = slope of graph = $\sqrt{3}$

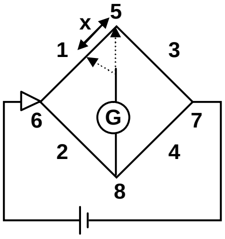
Since both conductors are connected in series, same heat current will flow in A and B.

$K_A (dT/dx)_A = K_B (dT/dx)_B$

$K_B = 6$

15. 2

Sol. For getting null point



$\frac{R_1}{R_3} = \frac{R_2}{R_4}$

as R2 = R4

R1 = R3

Let the pointer at point 5 is moved to left by distance x to get nul point as shown in the figure. If resistance per unit length of wire 3 is r then that of wire 1 will be 2r.

$(8 - x)2r = x \times 2r + 8 \times r$

$4x = 8$

$x = 2m$

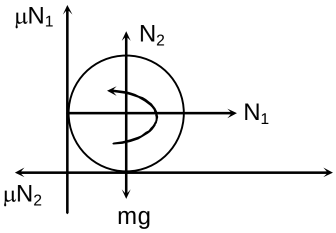
16. 1

Sol. $\omega = \sqrt{\frac{\mu g}{R}}$ = 1 rad/sec

17. 5

Sol. $\mu N_1 + N_2 = mg$ . . . (1)

$N_1 = \mu N_2$ . . . (2)



$N_2 = \frac{mg}{(1+\mu^2)}$

$N_1 = \frac{\mu mg}{(1+\mu^2)}$

Torque about centre of mass

$\mu(N_1 + N_2)R = \frac{1}{2}mR^2\alpha$

$\alpha = \frac{2\mu(N_1+N_2)}{mR} = \frac{2\mu(1+\mu)g}{(1+\mu^2)R}$

$\omega^2 = \omega_0^2 - 2\alpha\theta$

$\theta = \frac{\omega_0^2}{2\alpha}$

$$\theta = \frac{\omega_0^2\left(1+\mu^2\right)R}{2\times 2\mu\left(1+\mu\right)g}$$

Hence number of turns

$$N = \frac{\theta}{2\pi} = \frac{\omega_0^2 R\left(1+\mu^2\right)}{4\mu\left(1+\mu\right)g.2\pi} \quad ; \quad N = \frac{\omega_0^2 R\left(1+\mu^2\right)}{8\mu\pi g\left(1+\mu\right)}$$

18. 7

Sol. Given, voltage V = (100 ± 5)V

Current I = (10 ± 0.2)A

According to Ohm's law, V = IR or R = V/I

Taking log of both sides,

Log R = log V – log I

Differentiating, we get

$$\frac{\Delta R}{R} = \frac{\Delta V}{V} - \frac{\Delta I}{I}$$

For maximum error, $\frac{\Delta R}{R} = \frac{\Delta V}{V} + \frac{\Delta I}{I}$

Multiplying both sides by 100 for taking percentage, we get

$$\frac{\Delta R}{R}\times 100 = \frac{\Delta V}{V}\times 100 + \frac{\Delta I}{I}\times 100$$

Percentage error in resistance R

$$= \frac{\Delta V}{V}\times 100 + \frac{\Delta I}{I}\times 100$$

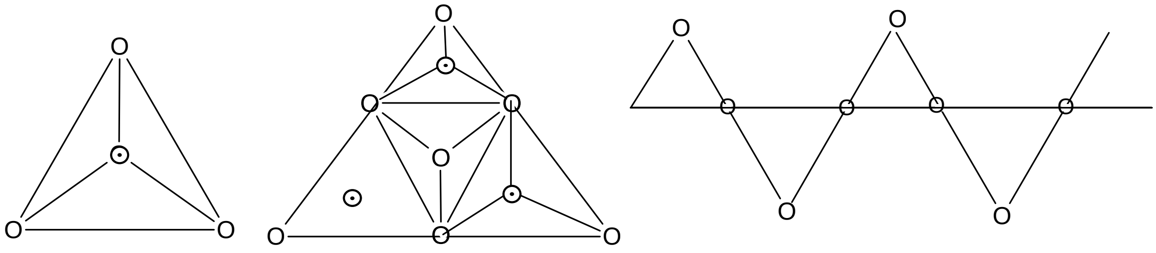
$$= \frac{5}{100}\times 100 + \frac{0.2}{10}\times 100 = 7\%.$$

Chemistry PART – II

SECTION – A

19. ABC

Sol.



20. AD

Sol. $AlCl_3 + 3H_2O \xrightarrow{\text{Hydrolysis}} Al(OH)_3 + 3HCl$

B^{3+} cannot exist in aqueous media

21. ACD

Sol. NO, O_2^{2+} and oxygen having unpaired electrons in molecular orbital.

22. AC

Sol. CN^- and NO^+ total no. of electrons is 14. Hence bond order is 3.

23. BC

Sol. $\underset{(s)}{2C} + \underset{(g)}{3H_2} \rightarrow \underset{(g)}{C_2H_6}$

$\Delta H_f^0 = \left[2 \times \Delta H_{sub}^0 + 3 \times B.E(H-H)\right] - \left[B.E.(C-C) + 6 \times B.E(C-H)\right]$

$\Rightarrow -85 = \left[(2 \times 718) + (3 \times 436)\right] - (x + 6y)$

$\therefore x + 6y = 2829$ 1

Similarly for $C_3H_8(g)$

$2x + 8y = 4002$ 2

Solving (1) & (2), x = 345

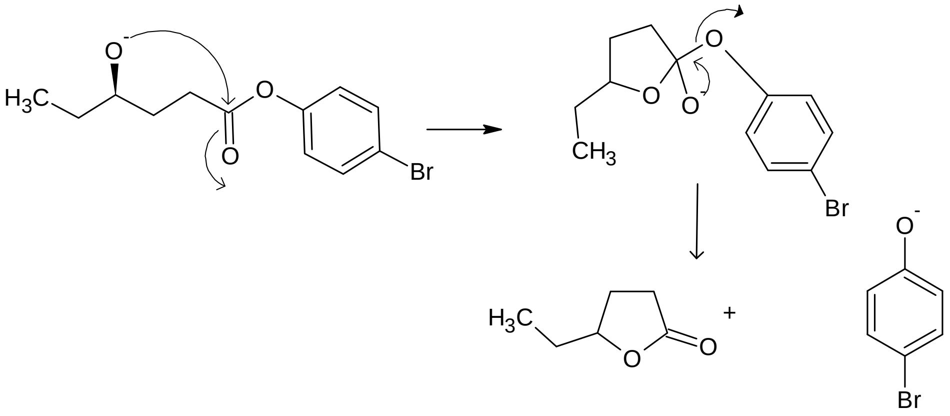
y = 414

24. ABCD

Sol. $\Delta S = \frac{\Delta H}{T} = \frac{-40,600}{373} = -54.42\,J/K$

25. ACD

Sol.



26. D

Sol. Attack of H^+ on oxygen and then nucleophilic attack of Cl^-

27. C

Sol. Pinawl formation-diracdical formation of Mg complex, then recombination and then hydrolysis.

28. B

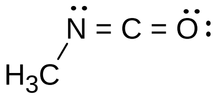
Sol. Attack of H^+ on oxygen and then nucleophilic attack of Cl^-

29. C

Sol. An oxalic acid is strong reducing agent having C – C bond length longer than C – C bond length in ethane.

30. C

Sol.



N is sp^2 hybridized having two bp and one lp and so bent.

31. A

Sol. Silyl isocyanate is linear due to pπ-dπ bonding in between nitrogen and silicon.

SECTION – C

32. 7

Sol. $2KMnO_4 + KI + H_2O \rightarrow 2KOH + 2MnO_2 + KIO_3$

3.5 moles of potassium iodide requires 7 mol of potassium permanganate.

33. 3

Sol. $CoCl_2 + H_2S \rightarrow CoS \downarrow + 2HCl$

$3CoS + 6HCl + 2HNO_3 \rightarrow 3CoCl_2 + 2NO + 3S + 4H_2O$

aqua regia

$KNO_2 + CH_3COOH \rightarrow CH_3COOK + HNO_2$

$CoCl_2 + 2KNO_2 \rightarrow Co(NO_2)_2 + 2KCl$

$Co(NO_2)_2 + 2HNO_2 \rightarrow Co(NO_2)_3 + NO + H_2O$

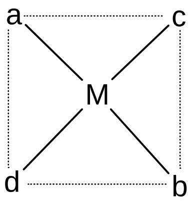
$Co(NO_2)_3 + 3KNO_2 \rightarrow K_3[Co(NO_2)_6]$

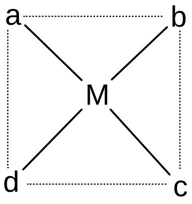
Oxidation number of cobalt in this compound is +3.

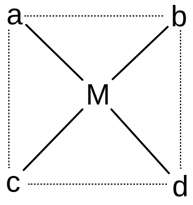
34. 3

Sol. $\left[Pt(NH_3)(NH_2OH)(NO_2)(py)\right]NO_2$

All four ligands are different, so it can be compared to M abcd. Three geometrical isomers are possible as follows







35. 9

Sol. $K_b = 10^{-5}$, $pK_b = 5$

$BOH + HCl \rightarrow BCl + H_2O$

At half neutralization, 50% of the base is converted to its salt, with strong acid HCl, it forms a basic buffer.

$$pOH = pK_b + \log\frac{[salt]}{[base]}$$

$$pOH = 5 + \log\frac{[salt]}{[base]}$$

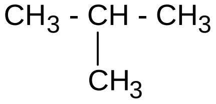
[salt] = [base]

pOH = 5

pH = 14 – pOH = 9

36. 2

Sol.

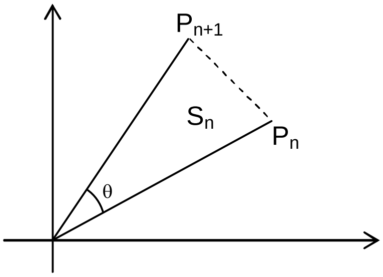


$$CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_3$$

Mathematics PART – III

SECTION – A

37. BD



Sol. $S_n = \frac{1}{2}|P_n||P_{n+1}|\sin\theta$

$|P_n| = \sqrt{n+1}$

$|P_{n+1}| = \sqrt{n+2}$

$\arg\left(\frac{P_{n+1}}{P_n}\right) = \arg\left(1+\frac{i}{\sqrt{n+1}}\right) = \tan^{-1}\left(\frac{1}{\sqrt{n+1}}\right)$

38. AD

Sol. Let $\vec{a} = \cos\alpha\hat{i} + \sin\alpha\hat{j},\ \vec{b} = \cos\beta\hat{i} + \sin\beta\hat{j}, \alpha, \beta, \delta \in [0, 2\pi)$

$\vec{c} = \cos\delta\hat{i} + \sin\delta\hat{j}$

$\Rightarrow \cos(\alpha-\delta) = \cos(\beta-\delta) = (\cos(\alpha-\beta))(-\sqrt{3})$

let $A = \alpha - \beta,\ B = \beta - \delta$

$\Rightarrow \cos A = \cos B = -\sqrt{3}\cos(A-B)$

$\cos A = \cos B \Rightarrow B = 2m\pi \pm A$

$\Rightarrow B = A, B = -A, B = -2\pi + A, B = 2\pi - A$

$\Rightarrow B = A, B = -2\pi + A$ rejected.

$\Rightarrow$ when $B = -A, B = 2\pi - A$

$\Rightarrow \cos A = -\sqrt{3}\cos(2A - 2\pi)$ or $\cos A = -\sqrt{3}\cos 2A$

$\Rightarrow \cos A = \frac{1}{\sqrt{3}}, -\frac{\sqrt{3}}{2}$

$\vec{a}.\vec{b} = \cos 2A = \frac{-1}{3}, \frac{1}{2}$

39. AD

Sol. Let $\int_0^t f(u)du = F(t) \Rightarrow F'(t) = f(t)$ and $F(0) = 0$

Also $f(t) \geq 0 \Rightarrow \int_0^t f(u)du \geq 0\ \forall t \in [0,1]$

$\Rightarrow |f(t)| \leq \sqrt{1+2\int_0^t f(u)du}$

$\Rightarrow F'(t) \leq \sqrt{1+2F(t)} \Rightarrow \frac{F'(t)}{\sqrt{1+2F(t)}} \leq 1$ as $f(t) \geq 0$

$\int_0^t \frac{F'(t)dt}{\sqrt{1+2F(t)}} \leq \int_0^t dt\ \forall t \in [0, 1]$

$$\Rightarrow \sqrt{1+2F(t)} \le t+1$$

$$\Rightarrow f(t) \le t+1 \text{Also } 1+2F(t) \le (t+1)^2$$

$$\Rightarrow 2F(t) \le t^2 + 2t$$

$$\Rightarrow F(t) \le \frac{t^2}{2} + t \ \Rightarrow \int_0^t f(u)du \le \frac{t^2}{2} + t$$

40. ABC

Sol. $\int_0^1 x f'(x) dx$, Put $x = \sin\theta \Rightarrow dx = \cos\theta\, d\theta$

$$J = \int_0^{\pi/2} f(\sin\theta)(\cos\theta) d\theta = \int_0^{\pi/2} f(\cos\theta) \sin\theta\, d\theta$$

$$2J = \int_0^{\pi/2} f(\sin\theta)\cos\theta + f(\cos\theta)(\sin\theta) d\theta$$

$2J \le \int_0^{\pi/2} 1.d\theta \Rightarrow I \le \frac{\pi}{4}$ and equality holds if $f(x) = \sqrt{1-x^2}$

Put $x = y \Rightarrow xf(x) \le \frac{1}{2}$

$$\Rightarrow \int_0^1 x f(x) dx \le \int_0^1 \frac{1}{2} dx$$

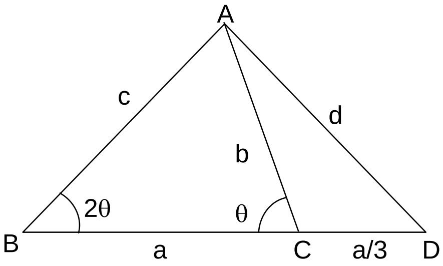
$$\Rightarrow f(x)\frac{x^2}{2}\bigg|_0^1 - \int_0^1 f'(x)\frac{x^2}{2} dx \le \frac{1}{2}$$

$$\Rightarrow f(1) - \int_0^1 x^2 f'(x) dx \le 1$$

Also $\int_0^1 f(x) dx \le \frac{\pi}{4}$ (Again use By parts)

41. AB

Sol. Using sine law



$$\frac{b}{\sin 2\theta} = \frac{c}{\sin\theta} = \frac{a}{\sin(\pi - 3\theta)}$$

$$\Rightarrow \frac{b}{2\cos\theta} = c = \frac{a}{3 - 4\sin^2\theta}$$

$\Rightarrow b = 2c\cos\theta$ and $a = \left(4\cos^2\theta - 1\right)c$

$\Rightarrow ca = b^2 - c^2$ (eliminate $\cos\theta$)

Also $\cos(\angle ACB) + \cos(\angle ACD) = 0$

$$\Rightarrow \frac{a^2+b^2-c^2}{2ab}+\frac{b^2+\frac{a^2}{9}-d^2}{2\frac{(a)}{3}(b)}=0 \Rightarrow d=\frac{1}{3}(3c+2a)$$

Also $\cos\phi=\dfrac{c^2+d^2-\left(\frac{4a}{3}\right)^2}{2cd}$

$\Rightarrow$ On manipulation $cd=\dfrac{a^2}{3\sin^2\frac{\phi}{2}}$

$$\Delta ABC=\frac{3}{4}(\Delta ABD)=\left(\frac{3}{8}\right)cd\sin\phi = \frac{1}{4}(BC)^2\frac{\cot\phi}{2}$$

42. BD

Sol. Given $f(j)-j<f(i)-i\ \forall i<j$

Let $g(k)=f(k)-k \Rightarrow g(k)$ is decreasing function. Also

$1\le f(k)\le 2018$

$.\Rightarrow 1-k\le g(k)\le 2018-k$.

Also $g(k+1)$ will always be in the desired range as long as g (k) is in the desired Range.

We are supposed to select $g(1),g(2),......g(2018)$ values in decreasing order from $[-2017, 2017]$

$\Rightarrow {}^{4035}C_{2018}$ ways.

$${}^{2n}C_n=\sum_{i=0}^{n}\left({}^{n}C_i\right)^2 \ \Rightarrow {}^{4035}C_{2018}=\frac{4035}{2018}\ {}^{4034}C_{2017}$$

43. ABD

Sol. Let $h(x)=f(f(f(x)))=x\ \forall\ x\in R$

$\Rightarrow h(x)$ is a strictly increasing and bijective

Also if f is strictly decreasing, $f(f)$ is increasing function,

$\Rightarrow f(f(f(x)))$ is decreasing, hence contradiction.

Also if for $x_2>x_1$, $f(x_2)=f(x_1)$

$\Rightarrow f(f(x_2))=f((f(x_1)))$

$\Rightarrow f(f(x_2))-f(f(f(x_2)))$

$\Rightarrow h(x_2)=h(x_2)$ not possible for $x_2\ne x_1$

If f is a strictly increasing function

$\Rightarrow$ $f(f)$ is a strictly increasing function

$\Rightarrow$ $f(f(f))$ is a strictly increasing function

Also Range of $h(x)=R\subseteq$ Range of $f(x)$

$\Rightarrow f(x)$ is on to $\Rightarrow$ hence bijective.

Also $h(0)=0 \Rightarrow f(f(f))=0$ and $f(x)$ and $f(f(x))$ are inverse of each other $\Rightarrow f(0)=0$ and increasing i.e. Non – zero slope. Hence will cut y = x^2 at two distinct points.

44. C
45. D
46. D

(Sol. 44 to 46)

$A+C=B+D \Rightarrow D:(2,1,8)$

$B\overline{A}=(1,-1,5), B\overline{C}=(0,2,4)$

Equation of plane π is $7x+2y-z-8=0$

Equation of line PF $\bar{r}=(2,1,0)+\delta(7,2,-1)$

$$\Rightarrow \delta=(2+7\delta,1+2\delta,-\delta), \text{for other point put } \delta=-1$$

For point F: $7(2+7\delta)+2(1+2\delta)+\delta-8=0$ i.e. satisfying in Plane π

$$\Rightarrow \delta=\frac{-4}{27}$$

F : $\left(\frac{26}{27},\frac{19}{27},\frac{4}{27}\right)$

$I:2F-P:\left(\frac{-2}{27},\frac{11}{27},\frac{8}{27}\right)$

Foot of perpendicular from A to BC:

Equation of BC : (1, 0, –1) + λ (0, 1, 2)

$$:(1,\lambda,-1+2\lambda)$$

For foot of perpendicular $(\hat{j}+2\hat{k}).(\hat{i}+(-1-\lambda)\hat{j}+(5-2\lambda)\hat{k})=0$

$$\lambda=\frac{9}{5}\Rightarrow\left(1,\frac{9}{5},\frac{13}{5}\right)$$

Line L intersects plane π at (1, 0, –1) (Solve plane and line L)

Equation of Projection of line L is passing through F and (1, 0, –1)

Equation of mirror image of line L in Plane is line passing through I and (1, 0, –1)

Let ϕ be the acute angle between line L and plane π

$\Rightarrow \cos\theta=\left|\frac{(\hat{i}+\hat{j}+\hat{k}).(7\hat{i}+2\hat{j}-\hat{k})}{\sqrt{3}.\sqrt{54}}\right|$ where, $\theta+\phi=\frac{\pi}{2}$

$=\left|\frac{8}{9\sqrt{2}}\right|$

$\Rightarrow \phi=\sin^{-1}\left(\frac{8}{9\sqrt{2}}\right)$

For distance between AB and CD say H

Area of parallelogram ABCD $=\left|A\vec{B}\times\vec{B}C\right|=2\sqrt{54}$

$(H)(BA)=2\sqrt{54}$ when $BA=\sqrt{27}$

47. A
48. D
49. B

(Sol. 47 to 49)

Equation of tangent is $\frac{x\cos\theta}{a}+\frac{y\sin\theta}{b}=1$

a = 4, b = 3

$\Rightarrow A:\left(4\sec\theta,0\right),B:\left(0,3\operatorname{cosec}\theta\right)$

$\Delta OAB=\frac{1}{2}\left(45\sec\theta\right)\left(3\operatorname{cosec}\theta\right)=\frac{12}{\sin 2\theta}$

$\left(\Delta OAB\right)_{\min}=12$ where $\theta=\frac{\pi}{4}$

$P:\left(\frac{4}{\sqrt{2}},\frac{3}{\sqrt{2}}\right),A:\left(4\sqrt{2},\,0\right),B:\left(0,3\sqrt{2}\right)$

Equation of tangents: $\frac{x\left(\frac{1}{\sqrt{2}}\right)}{4}+\frac{y\left(\frac{1}{\sqrt{2}}\right)}{3}=1$

$\Rightarrow 3x+4y=12\sqrt{2}$

Let $Q:\left(\alpha,\beta\right)\Rightarrow 3\alpha+4\beta=12\sqrt{2}$

Equation of CD : $x\alpha+y\beta=12\Rightarrow x\left(\frac{12\sqrt{2}-4\beta}{3}\right)+y\beta=12$

$\Rightarrow\left(12\sqrt{2}x-36\right)+\beta\left(3y-4x\right)=0$

$\Rightarrow$ Point of concurrency: $\left(\frac{3}{\sqrt{2}},\frac{4}{\sqrt{2}}\right)$

Also distance of (0, 0) from $3x+4y-12\sqrt{2}=0$ is $\frac{12\sqrt{2}}{5}$ as radius of circle is $\sqrt{12}$

$\Rightarrow\frac{\text{distance}}{\text{radius}}=\frac{\sqrt{24}}{\sqrt{25}}<1$

$\Rightarrow$ cuts at 2 points.

Let (h, k) be the circumcentre of ΔQCD

$\Rightarrow\left(h,k\right)$ is midpoint of (0, 0) and $\left(\alpha,\beta\right)$

$\Rightarrow 2h=\alpha,\ 2k=\beta$

Also $3\alpha+4\beta=12\sqrt{2}\Rightarrow 3h+4k=6\sqrt{2}$

For R equation of director circle of ellipse
For (iv) equation of director circle of circle
For (S) Any line passing through one focus of ellipse will pass through other focus after reflection.

SECTION – C

50. 3

Sol. $y = mx$ touches circle

$\Rightarrow D = 0$ for $\left(m^2+1\right)x^2 - 2a\left(m+2\right)x + 4a^2 = 0$

$\Rightarrow 4a^2\left(m+2\right)^2 = 4\left(m^2+1\right)\left(4a^2\right)$

$\Rightarrow m = 0, \frac{4}{3}$

Let $A:\left(x_1, m_1x_1\right), B:\left(x_2, m_2x_2\right)$

$AB^2 = 9 \Rightarrow \left(x_1 - x_2\right)^2 + \left(m_1x_1 - m_2x_2\right)^2 = 9$ where

$x_1 = \frac{\left(m_1+2\right)}{{m_1}^2+1}a,\ x_2 = \frac{\left(m_2+2\right)}{{m_2}^2+1}a,\ m_1 = 0,\ m_2 = \frac{4}{3}$

get $a = \frac{3\sqrt{5}}{4}$

51. 6

Sol. Let $1 - x = a,\ 2 - y = b,\ 3 - z = c \Rightarrow a, b, c > 0$

$E = \left(abc\right)\left(3 - a - \frac{b}{2} - \frac{c}{3}\right)$

$E = 6\left(a\right)\left(\frac{b}{2}\right)\left(\frac{c}{3}\right)\left(3 - a - \frac{b}{2} - \frac{c}{3}\right)$

Apply $AM \ge GM$

$$\Rightarrow \frac{a + \frac{b}{2} + \frac{c}{3} + \left(3 - a - \frac{b}{2} - \frac{c}{3}\right)}{4} \ge \left[a\left(\frac{b}{2}\right)\left(\frac{c}{3}\right)\left(3 - a - \frac{b}{2} - \frac{c}{3}\right)\right]^{1/4}$$

$\Rightarrow E \le \frac{243}{128}$ and equality holds for $a = \frac{3}{4},\ b = \frac{3}{2},\ c = \frac{9}{4}$

$\Rightarrow \left(x_0, y_0, z_0\right) \equiv \left(\frac{1}{4}, \frac{1}{2}, \frac{3}{4}\right)$

52. 6

Sol. $\sin x + \sin y = \sin\left(x + y\right)$

$\Rightarrow$ Either $\sin\left(\frac{x+y}{2}\right) = 0$ or $\cos\left(\frac{x+y}{2}\right) = \cos\left(\frac{x-y}{2}\right)$

$\Rightarrow x + y = 2m\pi$ or $\frac{x}{2} = p\pi$ or $\frac{y}{2} = k\pi$ $\left(m, p, k \in \text{Integer}\right)$

$\Rightarrow x + y = 2m\pi$ or $x = 2p\pi$ or $y = 2k\pi$

Plot and get (0, 1), (0, –1) , (–1, 0), (1, 0) $\left(\frac{1}{2}, \frac{-1}{2}\right), \left(\frac{-1}{2}, \frac{1}{2}\right)$

53. 5

Sol. Equation of normal at point $T\left(t, \frac{t^2}{2}\right)$ to C is $y - \frac{t^2}{2} = \frac{-1}{t}(x-t) \Rightarrow y = \frac{-x}{t} + \frac{t^2}{2} + 1$

If circle S touches curve C at T.

$\Rightarrow (x(t), y(t))$ must lie on normal

$\Rightarrow y(t) = \frac{-x(t)}{t} + \frac{t^2}{2} + 1$

Also distance of centre of circle from T equals radius = distance of centre of circle from x – axis.

$\Rightarrow (x(t)-t)^2 + \left(y(t) - \frac{t^2}{2}\right)^2 = (y(t))^2$

$x(t) = \frac{t\left(1+\sqrt{t^2+1}\right)}{2}$, $y(t) = \frac{t^2+1-\sqrt{t^2+1}}{2}$

$\Rightarrow x(t)y(t) = \frac{1}{4}t^3\sqrt{t^2+1}$

$\lim_{r\to 0^+} \int_r^1 \frac{1}{4}t^3\sqrt{t^2+1}\,dt$

Let $\sqrt{1+t^2} = z \Rightarrow 2tdt = 2z\,dz$

$\Rightarrow \lim_{r\to 0^+} \int_{\sqrt{1+r^2}}^{\sqrt{2}} \frac{1}{4}(z^2-1)z^2dz = \frac{\sqrt{2}+1}{30}$

54. 7

Sol. Let E_1 : first ball drawn red from Urn A and 2nd ball drawn black from B.

E_2 : first ball drawn while from A and 2nd ball drawn black from B

E_3 : first ball drawn red from B and 2nd ball drawn black from B

E_4 : first ball drawn black from B and 2nd ball drawn black from B.

$P = \frac{P(E_1)+P(E_3)}{P(E_1)+P(E_2)+P(E_3)+P(E_4)}$

$P(E_1) = \left(\frac{1}{2}\right)\left(\frac{2}{6}\right)\left(\frac{3}{6}\right)\left(\frac{1}{2}\right) = \frac{6}{144}$

$P(E_2) = \left(\frac{1}{2}\right)\left(\frac{4}{6}\right)\left(\frac{1}{2}\right)\left(\frac{3}{6}\right) = \frac{12}{144}$

$P(E_3) = \left(\frac{1}{2}\right)\left(\frac{3}{6}\right)\left(\frac{1}{2}\right)\left(\frac{3}{5}\right) = \frac{9}{120}$

$P(E_4) = \left(\frac{1}{2}\right)\left(\frac{3}{6}\right)\left(\frac{1}{2}\right)\left(\frac{2}{5}\right) = \frac{6}{120} \Rightarrow P = \frac{7}{15}$

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - I

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 231**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-C & Section-D**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01 – 03, 24 – 26, 47 – 49)*** *contains 9 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (04 – 08, 27 – 31, 50 – 54) *contains 15 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (09 – 10, 32 – 33, 55 – 56) *contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer. There is no negative marking.*

2. ***Section-C (11 – 20, 34 – 43, 57 – 66)*** *contains 30 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

3. ***Section-D (21 – 23, 44 – 46, 67 – 69)*** *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

PART – I (Physics), PART – II (Chemistry), PART – III (Mathematics):

(SECTION – D)

For questions **21 to 23, 44 to 46, 67 to 69.**
Numerical answer type questions with answer XXXXX. XX

If answer is 348.4 / 251.37 / 213

Correct Method :

0	0	3	4	8	.	4	0

0	0	2	5	1	.	3	7

0	0	2	1	3	.	0	0

Wrong Method :

	3	4	8		.	4	

3	4	8			.		4

		3	4	8	.		4

	3		4	8	.	4	

	2		5	1	.	3	7

		2	1	3	.		

		2	1	3	.	0	

		2	1	3	.		0

		3	4	8	.	4	0

		2	5	1	.	3	7

		2	1	3	.	0	0

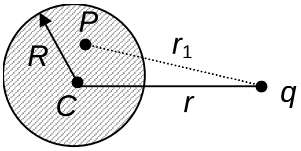
Physics

PART – I

SECTION – A
(One Options Correct Type)

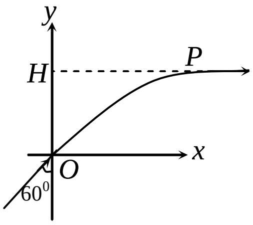
This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A point charge is placed at a distance r from center of a conducting neutral sphere of radius R ($r > R$). The potential at any point P inside the sphere at a distance r_1 from point charge due to induced charge of the sphere is given by [$k = \frac{1}{4\pi\varepsilon_0}$]



(A) kq/r_1 (B) kq/r
(C) $kq/r - kq/r_1$ (D) $-kq/R$

2. A system of coordinates is drawn in a medium whose refractive index varies as $\mu = \frac{2}{1+y^2}$, where $0 \le y \le 1$. A ray of light is incident at origin at an angle 60^0 with y –axis as shown in the figure. At point P ray becomes parallel to x-axis. The value of H is



(A) $\left\{\left(\frac{2}{\sqrt{3}}\right)-1\right\}^{1/2}$ (B) $\left\{\frac{2}{\sqrt{3}}\right\}^{1/2}$

(C) $\left\{\left(\sqrt{3}\right)-1\right\}^{1/2}$ (D) $\left\{\left(\sqrt{3}+1\right)\right\}^{1/2}$

3. An open organ pipe has fundamental frequency 100 Hz. What frequencies will be produced if its one end is closed?
(A) 100,200,300….. (B) 50,150,250,……
(C) 50,100,200,300,…… (D) 50,100,150,200…..

Space for Rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

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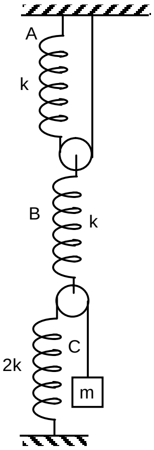
4. In the given figure, the block is attached with a system of three ideal springs A, B, C. The block is displaced by a small distance x from its equilibrium position vertically downwards and released. T represents the time period of small vertical oscillations of the block (pulleys are ideal). Choose the correct alternative(s).



(A) $T = 2\pi\sqrt{\frac{11m}{2k}}$

(B) the deformation of the spring A is (2/11) times the displacement of the block.

(C) the deformation of the spring C is (1/11) times the displacement of the block.

(D) the deformation of the spring B is (4/11) times the displacement of the block.

5. One mole of monoatomic gas expands with temperature according to the relation $V = KT^{2/3}$ where ‘k’ is constant. Then choose the correct alternative(s).

(A) Work done to change the temperature by 30°C is 20 R.

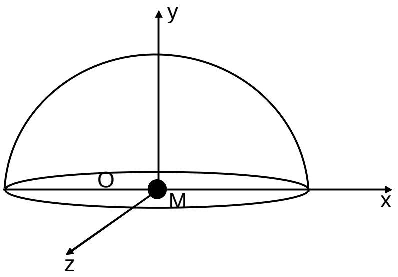
(B) Change in internal energy when temperature is changed by 20°C is 30 R.

(C) If volume of gas is changed by 2% the temperature will change by 3%.

(D) If temperature of gas is changed by 2% the pressure will change by 6%.

Space for Rough work

6. A hemispherical shell of mass 2M and radius 6R and a point mass M are performing circular motion due to their mutual gravitational interaction. Their positions are shown in figure at any moment of time during motion. If r_1 and r_2 are the radii of circular path of hemispherical shell and point mass respectively and ω_1 and ω_2 are the angular speeds of hemi-spherical shell and point mass respectively, then choose the correct statement(s).



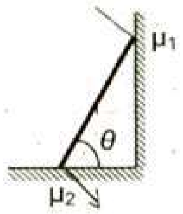
(A) $\frac{r_1}{r_2} = \frac{2}{1}$ (B) $\frac{r_1}{r_2} = \frac{1}{2}$

(C) $\omega_1 = \sqrt{\frac{GM}{72R^3}}$ (D) $\omega_2 = \sqrt{\frac{GM}{72R^3}}$

7. An ammeter has a resistance of 50 Ω and a full scale deflection current of 50 μA. It can be used as a voltmeter or as a higher range ammeter provided that a resistance is added to it. Choose the correct range and resistance combination from the following

(A) 20 V range with approximately 400 kΩ resistance in series
(B) 100 V range with approximately 2 × 10^6Ω resistance in series
(C) 1 mA range with 50 Ω resistance in parallel
(D) 0.1 mA range with 50 Ω resistance in parallel

8. In figure, a ladder of mass m is shown leaning against a wall. It is in static equilibrium making an angle θ with the horizontal floor. The coefficient of friction between the wall and the ladder is μ_1 and that between the floor and the ladder is μ_2. The normal reaction of the wall on the ladder is N_1 and that of the floor is N_2. If the ladder is about to slip, then



(A) $\mu_1 = 0\ \ \mu_2 \neq 0$ and $N_2 \tan\theta = \frac{mg}{2}$ (B) $\mu_1 \neq 0\ \ \mu_2 = 0$ and $N_1 \tan\theta = \frac{mg}{2}$

(C) $\mu_1 \neq 0\ \ \mu_2 \neq 0$ and $N_2 = \frac{mg}{1+\mu_1\mu_2}$ (D) $\mu_1 = 0\ \ \mu_2 \neq 0$ and $N_1 \tan\theta = \frac{mg}{2}$

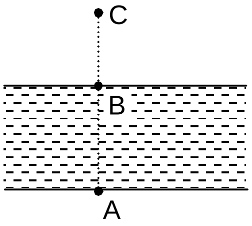
Space for Rough work

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 9 and 10

A river of width *d* is flowing with uniform velocity *u*. A boat starts moving from point *A* (one bank of river) with speed *u* relative to the river. The direction of resultant velocity is always perpendicular to line joining boat and fixed point *C* (see figure). Point *B* is on the opposite side of the river and *A*, *B*, *C* are in straight line. If *AB* = *BC* = *d*



9. The path of boat is

(A) straight line (B) parabolic
(C) elliptical (D) circular

10. The time taken by the boat to cross the river is

(A) $\frac{d}{u}$ (B) $\frac{d}{u}\ln\left[2+\sqrt{3}\right]$
(C) $\frac{d}{u}\ln\left[2-\sqrt{3}\right]$ (D) $\frac{2d}{u}$

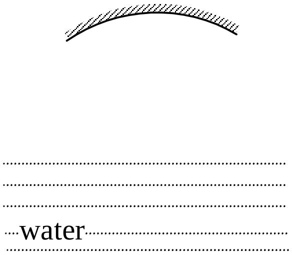
Space for Rough work

SECTION – C
(Single digit integer type)

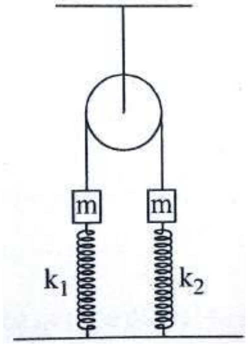
This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

11. In YDSE experiment if the screen is shifted by a distance of 0.5 m away from the slit, 3rd maxima is shifted by 3×10^{-4} m. The separation between slit is 2×10^{-3} m. If the wavelength (in 100 nm) used in the experiment is 'k', find the value of 'k'.

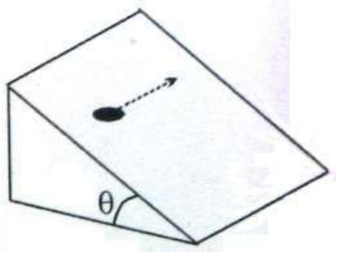
12. A concave mirror of focal length 15 cm is placed in air at a height of 45 cm above the water surface as shown. The axis of the mirror is vertical and the reflecting surface faces the water surface. A point object is placed on the axis of concave mirror at a distance 35 cm above the water surface. Find the position of image formed after two successive processes- first reflection from the concave mirror and then first refraction from the water (reflective Index of water 4/3). The distance of image from water surface (in m) is



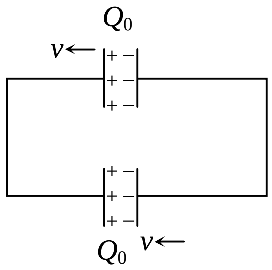
13. On the diagram, two blocks of equal mass are connected by an ideal string. The values of m = 1 kg and k_2 = 100 N/m are given. Initially, both springs are relaxed. Then the left block is slowly pulled down a distance 0.1 m and released. The maximum possible value of k_1 (in N/m) for which both blocks will have same magnitude of acceleration just after releasing, is k. Both spring have natural length of 2m. Then find the value of $\frac{k}{100}$.



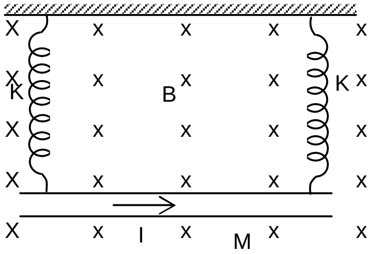
Space for Rough work



14. An object of mass $m = \sqrt{8}\,kg$ rests on an inclined plane that makes angle θ = 45° with the horizontal floor. The minimum horizontal force (in N), parallel to the base of the incline that must be applied to the object in order to begin its movement is F. The coefficient of static friction between the object and the plane is μ_s = 1.25. Then the value of $\frac{F}{3}$ is



15. Two identical capacitor connected as shown and having initial charge Q_0. Separation between plates of capacitor is d_0. Suddenly the left plate of upper capacitor and right plate of lower capacitor start moving with speed v towards left while other plate of capacitor remains fixed. (given $\frac{Q_0 v}{2d}$ =1 amp). Find the value of current (in amp) in the circuit.



16. A metal rod of mass 10gm and length 25 cm is suspended on two springs as shown in figure. The springs are extended by 4 cm. When a 20 ampere current passes through the rod it rises by 1 cm. The magnetic field is x × 10^{-2} T (g = 10 m/s^2). Find the value of 2x.

17. A uniform disc of radius R having charge Q distributed uniformly all over its surface is placed on a smooth horizontal surface. A magnetic field, $B = kxt^2$, where k is a constant, x is the distance (in metre) from the centre of the disc and t is the time (in second), is switched on perpendicular to the plane of the disc. Find the torque (in N-m) acting on the disc after 15 sec. (Take 4kQ = 1 S.I. unit and R = 1 m)

18. Suppose potential energy between electron and proton at separation r is given by U = k ln r, where k is constant. For such hypothetical hydrogen atom, find the ratio of energy difference between energy levels (n = 1 and n = 2) and (n = 2 and n = 4) is

Space for Rough work

19. K_α wavelength emitted by an atom of atomic number Z = 11 is λ. Find the atomic number for an atom that emits K_α radiation with wavelength 4λ.

20. In a certain hypothetical radioactive decay process, species A decays into species B and species B decays into species C according to the reactions

$A \longrightarrow 2B$ + particles + energy
$B \longrightarrow 3C$ + particles + energy

The decay constant for species A is $\lambda_1 = 1\sec^{-1}$ and that for species B is $\lambda_2 = 100\sec^{-1}$. Initially 10^4 moles of species of A were present while there was none of B and C. It was found that species B reaches its maximum number at a time t_0 = 2 ln(10)sec. Calculate the value of maximum number of moles of B.

SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

21. The main scale of vernier calipers reads in mm and its vernier is divided into 10 divisions which coincides with 9 divisions of the main scale. It was also observed when two jaws are brought in contact the zero of the vernier scale coincided with the zero of the main scale. The length of a cube is measured with this vernier calipers. The main scale reads 10 mm and the first division of the vernier scale coincides with the main scale. If the mass of the cube is 2.7369 g then, find the density of the cube in (gm/cm^3) upto appropriate significant figures.

22. A point mass of 1 kg collides elastically with a stationary point mass of 5 kg. After their collision, the 1 kg mass reverses its direction and moves with a speed of 2 ms^{-1}. Find the kinetic energy (in Joule) of a particle of mass 6 kg moving with same velocity as that of centre of mass of the above two particles of mass 1 kg and 5 kg.

23. In YDSE distance between the slits plane and screen is 1m and distance between two slits is 5 mm. If slabs of thickness 2 mm and 1.5 mm having refractive index 1.5 and 1.4 are placed in front of two slits, find the shift (in m) of central maxima

Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

24. Which of the following solutions of complex compounds have maximum vapour pressure?
(A) $[Co(NH_3)_6]Cl_3$ (B) $[Co(NH_3)_5Cl]Cl_2$
(C) $[Co(NH_3)_4Cl_2]Cl$ (D) $[Co(NH_3)_3Cl_3]$

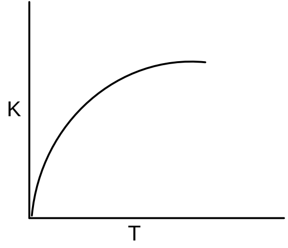
25. Hydrolysis of which of the following compounds is an example of disproportionation reaction.
(A) XeF_6 (B) XeF_4
(C) PCl_5 (D) PCl_3

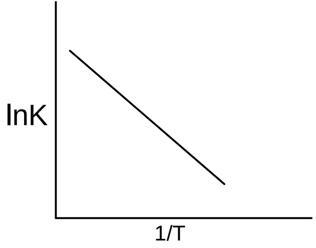
26. Which of the following compounds show π-back bonding?
(A) $AlCl_3$ (B) BF_3
(C) SF_4 (D) BH_3

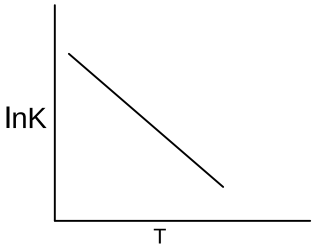
(One or More than one correct type)

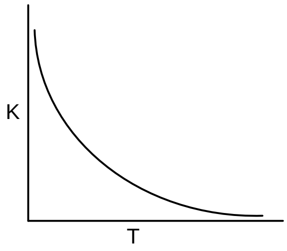
This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

27. Which of the following plots of rate constant vs temperature is correct?

(A)


(B)


(C)


(D)


Space for Rough work

28. The radial distribution function |P(r)| is used to determine the most probable radius, which is used to find the electron in a given orbital $\frac{dP(r)}{dt}$ for 1s orbital of hydrogen like atom having atomic number Z, is $\frac{dP}{dr} = \frac{4Z^3}{a_0^3}\left(2r - \frac{2Zr^2}{a^0}\right)e^{-2Zr/a_0}$. Then which of the following statements is/are correct?

(A) At the point of maximum value of radial distribution function $\frac{dP(r)}{dr} = 0$; one antinode is present.

(B) Most probable radius of Li^{2+} is $\frac{a_0}{3}$ pm

(C) Most probable radius of He^+ is $\frac{a_0}{2}$ pm

(D) Most probable radius of hydrogen atom is a_0 pm

29. The normal boiling point of a liquid X is 400 K. ΔH_{vap} at normal boiling point is 40 kJ/mol. Select the correct statements.

(A) $\Delta S_{vap} < 100$ J/mol K at 400 K and 2 atm

(B) $\Delta S_{vap} < 10$ J/mol K at 400 K and 1 atm

(C) $\Delta G_{vap} < 0$ at 410 K and 1 atm

(D) $\Delta U = 43.22$ kJ/mol K at 400 K and 1 atm

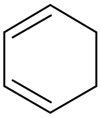
30. Which of the following are concentration cells?

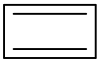
(A) $Pt\,|\,\underset{P_1}{H_2(g)}\,|\,HCl\,|\,\underset{P_2}{H_2(g)}\,|\,Pt$ (B) $\underset{a_1}{Cd(Hg)}\,|\,\underset{c}{Cd^{2+}}\,|\,\underset{a_2}{Hg(Cd)}$

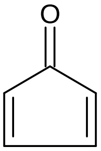
(C) $Zn(s)\,|\,\underset{(C_1)}{Zn^{2+}}\,||\,\underset{(C_2)}{Cu^{2+}}\,|\,Cu$ (D) $Ag\,|\,AgCl\,|\,\underset{C_1}{Cl^-(aq)}\,||\,\underset{C_2}{Br^-(aq)}\,|\,AgBr\,|\,Ag$

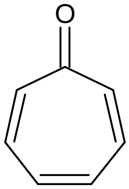
Space for Rough work

31. Which of the following molecule in pure forms is/are unstable at room temperature?

(A) 

(B) 

(C) 

(D) 

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 32 and 33

In complexes of weak field ligands, Δ_0 < P(Pairing energy), the energy difference between t_{2g} and e_g sets is relatively less. Under the influence of strong field ligands Δ_0 > P(Pairing energy), the energy difference between t_{2g} and e_g sets is relatively high.

32. Which of the following is correct statement?
(A) Complex $[Co(H_2O)_6]^{2+}$ is more stable than $[Co(H_2O)_6]^{3+}$
(B) All complexes of Ni(II) are bound to be outer d-orbital complexes
(C) Stability constant for $[Ni(en)_3]^{2+}$ is greater than stability constant for $[Ni(NH_3)_6]^{2+}$
(D) Δ_{oct} for $[Cr(H_2O)_6]^{3+}$ is greater than Δ_{oct} for $[Cr(NH_3)_6]^{3+}$

33. Select the correct increasing order of 10 Dq. value for chromium complexes:
(1) $[Cr(en)_3]^{3+}$ (2) $[Cr(ox)_3]^{3-}$
(3) $[CrF_6]^{3-}$ (4) $[Cr(H_2O)_6]^{3+}$
(A) 4 < 3 < 1 < 2 (B) 3 < 4 < 2 < 1
(C) 4 < 3 < 2 < 1 (D) 3 < 4 < 1 < 2

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

34. In the following reaction:
$P_4 + xNaOH + yH_2O \longrightarrow PH_3 + 3NaH_2PO_2$
Sum of x + y is

35. Compound x dissociates according to the reaction $2X(g) \rightleftharpoons 2Y(g) + Z(g)$, with degree of dissociation which is small compared to unity, if the expression for α in terms of equilibrium constant K_P and total pressure P is given as $\alpha = \left(\frac{2K_P}{P}\right)^{1/2}$. The value of x is

36. How many of the following polymer are co-polymer:
Nylon-6, Buna-N, Dacron, Buna-S, Teflon, PHBV

37. How many of the following metals can be refined by vapour phase refining?
Zr, Zn, Cd, Hg, Ni, Co, Pt, Fe, Ti

38. If ΔG^o for the half cell MnO_4^- / MnO_2 in an acid solution is -xF, then find the value of x
Given $\left(\text{Given}: E^o_{MnO_4^-/Mn^{2+}} = 1.5\,V; E^o_{MnO_2/Mn^{2+}} = 1.25\,V\right)$

39. A bulb is having an ideal gas at 27^{o}C on heating the bulb to 227^{o}C, 2 litre of gas measured at 227^{o}C is expelled out. The volume of the bulb in litre is

40. Sample of 28 mL of H_2O_2(aq) solution required 10 mL of 0.1 M $KMnO_4$(aq) solution for complete reaction in acidic medium. What is volume strength of H_2O_2?

Space for Rough work

41. The ionic radii of A^+ and B^- are $1.7\overset{o}{A}$ and $1.8\overset{o}{A}$ respectively. Find the coordination number of A^+.

42. For a reaction $A \rightarrow B$, ΔH = +ve, graph between log K_{eq} and $\frac{1}{T}$ is a straight line of slope $= -\frac{1}{4.606}$. Find ΔH in calories.

43. B_2H_6 has unusual 'x' centre-2 electron bonds. What is x?

SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

44. Calculate the boiling point of water at 700 mm pressure of Hg. The heat of vapourisation of water in 540 cal g.

45. Calculate the numerical value of resonance energy of N_2O from the following data: (ΔH_f^0 of N_2O = 82 kJ/mol)

$BE_{N \equiv N}$ = 946.2 kJ/mol
$BE_{N = N}$ = 418 kJ/mol
$BE_{O = O}$ = 497 kJ/mol
$BE_{N = O}$ = 605.3 kJ/mol

46. Two buffers(X) and (Y) of pH 4.0 and 6.0 respectively are prepared from acid HA and the salt NaA. Both the buffers are 0.5 M in HA. What would be the pH of the solution obtained by mixing equal volume of two buffers?

$K_{HA} = 1.0 \times 10^{-5}$
log 5.05 = 0.7

Space for Rough work

Mathematics

PART – III

SECTION – A
(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

47. If P be a point inside and equilateral triangle ABC such that PA=3, PB=4 and PC=5, then the side length of the equilateral triangle ABC is

(A) $\sqrt{25-12\sqrt{3}}$ (B) 13

(C) $\sqrt{25+12\sqrt{3}}$ (D) 17

48. If f(x) be an invertible function with $f'(x)f''(x) > 0 \forall x \in R$, then $\frac{d^2f^{-1}(x)}{dx^2}$, where $f^{-1}(x)$ is the inverse function of f(x) is

(A) positive $\forall x \in R$

(B) negative $\forall x \in R$

(C) data insufficient

(D) $\frac{d^2f^{-1}(x)}{dx^2}$ will have sign opp. to $\frac{d^2f^{-1}(x)}{dx^2}$

49. For $\alpha \in R$, the range of the function $f(\alpha) = \int_{\tan^{-1}\alpha}^{\cot^{-1}\alpha} \left(\frac{\tan x}{\tan x + \cot x}\right) dx$ is equal to

(A) $\left(\frac{-\pi}{2}, \frac{\pi}{2}\right)$ (B) $(0, \pi)$

(C) $\left(\frac{-\pi}{4}, \frac{3\pi}{4}\right)$ (D) $\left(0, \frac{\pi}{2}\right)$

Space for Rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

50. 3 married couples are to seated around a circular table. Let x denotes the number of ways where atmost two couples sit together and let y denotes the number of ways where only two particular couples sit together, then identify the correct option(s)

(A) $x - 8y = 60$
(B) $x + y = 113$
(C) $x = 13y$
(D) None of these

51. Let a, b, c be unequal real numbers. If a, b, c are in G.P. and $a + b + c = bx,$ then 'x' can not be equal to:

(A) –1
(B) 0
(C) 2
(D) 3

52. Let $f:\left[0, \frac{5}{2}\right) \to \left(\frac{1}{2}, 3\right]$ such that $f(x) = \frac{[x]+1}{\{x\}+1}$ where $[.]$ represents the greatest integer function and $\{.\}$ represents the fractional part of x, then which of the following is / are true.

(A) f(x) is injective discontinuous function.
(B) f(x) is surjective non – differentiable function.
(C) $\min\left(\lim\limits_{x\to 1^-} f(x), \lim\limits_{x\to 1^+} f(x)\right) = f(1)$
(D) $\max\left(\lim\limits_{x\to 2^-} f(x), \lim\limits_{x\to 2^+} f(x)\right) = f(2)$

53. If x, y and z lie on domain of the equation such that ln(x + z) + ln(x – 2y + z) = 2 ln (x – z), then which of the following is / are true

(A) $y = \frac{2xz}{x+z}$
(B) $y^2 = xz$
(C) $2y = x + z$
(D) $\frac{x}{z} = \frac{x-y}{y-z}$

Space for Rough work

54. The content of 3 bags w.r.t. green and red marbles is as given in the table shown.

Bag	Green	Red
A	3	1
B	2	2
C	1	3

A child randomly selects one of the bags, and draws a marble from it and retains it. If the marble is green, the child draws the second marbles randomly from one of the two remaining bags. If the first marble drawn is red the child draws one more marble from the same bag. The probability that the second drawn marble is green is expressed as $\frac{m}{n}$ (where m and n are coprime). Then

(A) $n - m = 71$
(B) $n - 2m + 2 = 0$
(C) $n - m = 73$
(D) none of the above

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 55 and 56

Let S=0 be the equation of the locus of point P in the plane of a square ABCD such that max(PA,PC)= $\frac{1}{\sqrt{2}}\left(PB + PD\right)$.

55. The ratio of radii of circumcircle of square ABCD and director circle of S = 0 is

(A) $\frac{\sqrt{3}}{2}$
(B) $\frac{1}{4}$
(C) $\frac{1}{2}$
(D) none of these

56. The ratio of perimeter of S=0 and the given square is

(A) $\frac{1}{2\sqrt{2}}$
(B) $\frac{1}{\sqrt{3}}$
(C) $\frac{1}{7}$
(D) $\frac{\pi}{2\sqrt{2}}$

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

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57. If $f: R \to R$ is a function such that $f(x) = x^3 + x^2 f'(1) + xf''(2) + f'''(3)$ for all $x \in R$, then $f(1) - f(2)$

58. $\left(\sum_{r=1}^{30} \frac{r^2}{\left(r^2 - 30r + 450\right)}\right) - 24$ is____

59. Let $f(x) = ax^4 + bx^2 + 3x + 7$ and $f(-4) = 2286$ and $f(4) = N$. If K be the number of ways in which the number N can be resolved as a product of two divisors which are relatively prime then $K - 7$

60. Let two non – collinear vectors $\vec{a}$ and $\vec{b}$ inclined at an angle $\frac{2\pi}{3}$ be such that $|\vec{a}| = 3$ and $|\vec{b}| = 4$. A point P moves so that any time t the position vector $\overrightarrow{OP}$ (where O is the origin) is given as $\overrightarrow{OP} = \left(e^t + t^{-t}\right)\vec{a} + \left(e^t - e^{-t}\right)\vec{b}$. If the least distance of P from origin is $\sqrt{2}\sqrt{\sqrt{a} - b}$ where $a, b \in N$ then find the value of $\frac{(a+b)}{8}$.

61. Let $A = \left[a_{ij}\right]_{3\times 3}$ be a matrix such that $AA^T = 4.I$ and $a_{ij} + 2c_{ij} = 0$ where c_{ij} is the cofactor of $a_{ij} \forall i$ and j and I is the unit matrix of order 3.
If $\begin{vmatrix} a_{11}+4 & a_{12} & a_{13} \\ a_{21} & a_{22}+4 & a_{23} \\ a_{31} & a_{32} & a_{33}+4 \end{vmatrix} + 5\lambda \begin{vmatrix} a_{11}+1 & a_{12} & a_{13} \\ a_{21} & a_{22}+1 & a_{23} \\ a_{31} & a_{32} & a_{33}+1 \end{vmatrix} = 0$, then find the value of 5λ is

Space for Rough work

62. Let $f(x)$ be a cubic polynomial which has local maximum at x = –1 and $f'(x)$ has a local minimum at $x = 1$. If $f(-1) = 10$ and $f(3) = -22$, If the distance between its two horizontal tangents is D then $\frac{D}{8}$ is

63. In ΔABC, circumradius is 3 and inradius is 1.5 units. If the value of $a\cot^2 A + b^2\cot^3 B + c^3\cot^4 C$ is $m\sqrt{n}$ where m and n are prime numbers, then find the value of $|(m - 2n)|$.

64. Let a, b, c, d be four distinct real numbers in A.P. Find the smallest positive value of k satisfying $2(a-b) + 4k(b-c)^2 + (c-a)^3 = 2(a-d) + (b-d)^2 + (c-d)^3$

65. Number of positive integer x such that product of its digits in the decimal representation is $x^2 - 10x - 22$ is

66. The side of a triangle are in the ratio 3:5 and the third side is 16, if the largest possible area of the triangle is k, then $\frac{k}{30}$ is _____

SECTION – D

(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

---

67. If the dependent variable y is changed to 'z' by the substitution $y = \tan z$ and the differential equation $\frac{d^2y}{dx^2} = 1 + \frac{2(1+y)}{1+y^2}\left(\frac{dy}{dx}\right)^2$ is changed to $\frac{d^2z}{dx^2} = \cos^2 z + k\left(\frac{dz}{dx}\right)^2$, then the value of $(305.33) \times k$ equals

68. ABC is a right angle triangle (right angled at B) inscribed in the parabola $y^2 = 4x$. The minimum length of the intercept cut off by the tangents at A and C to the parabola from y-axis is λ then 1002.2λ is

69. Rectangle ABCD has area 200. An ellipse with area 200π passes through A and C and has foci at B and D. Let perimeter of the rectangle ABCD is P, then 103.44P is

Space for Rough work

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CONCEPT RECAPITULATION TEST – I

PAPER-2

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**C**	24.	**D**	47.	**C**
2.	**A**	25.	**B**	48.	**B**
3.	**B**	26.	**B**	49.	**C**
4.	**ABCD**	27.	**AB**	50.	**BC**
5.	**ABC**	28.	**ABCD**	51.	**ABCD**
6.	**BCD**	29.	**AC**	52.	**ABD**
7.	**ABD**	30.	**AD**	53.	**AD**
8.	**CD**	31.	**B**	54.	**AB**
9.	**D**	32.	**C**	55.	**D**
10.	**B**	33.	**B**	56.	**D**
11.	**4**	34.	**6**	57.	**6**
12.	**1**	35.	**3**	58.	**6**
13.	**3**	36.	**4**	59.	**9**
14.	**5**	37.	**3**	60.	**9**
15.	**2**	38.	**5**	61.	**2**
16.	**3**	39.	**3**	62.	**4**
17.	**1**	40.	**1**	63.	**7**
18.	**1**	41.	**8**	64.	**4**
19.	**6**	42.	**1**	65.	**1**
20.	**2**	43.	**3**	66.	**4**
21.	**00002.66**	44.	**00370.65**	67.	**00610.66**
22.	**00000.75**	45.	**00089.40**	68.	**04008.80**
23.	**00000.08**	46.	**00005.70**	69.	**08275.20**

Physics

PART – I

SECTION – A

1. C

Sol. Potential of centre of sphere = $\frac{Kq}{r}+V_i=\frac{Kq}{r}$

where V_i = potential due to induced charge at centre = 0 [$\therefore$ Σq_i = 0 and all induced charges are equidistance from centre]

$\therefore$ potential at point *P* = $\frac{Kq}{r}=\frac{Kq}{r_1}+V_i$ (For conductor all points are equipotential)

$\therefore$ $V_i=K\left(\frac{q}{r}-\frac{q}{r_1}\right)$

2. A

Sol. Applying Snell's law between the points *O* and *P*, we have

$$2\times\sin60^0=\left(\sin90^0\right)\times\frac{2}{\left(1+H^2\right)},\quad 2\times\frac{\sqrt{3}}{2}=1\times\frac{2}{\left(1+H^2\right)}$$

$$\left(1+H^2\right)=\frac{2}{\sqrt{3}},\qquad H=\sqrt{\left(\frac{2}{\sqrt{3}}-1\right)}$$

3. B

Sol. $\lambda=v,\frac{v}{2},\frac{v}{3}$ ……

$\lambda'=4\ell,\frac{4\ell}{3},\frac{4\ell}{5}$

$\Rightarrow$ f′ = 50, 150, 250 …..

4. ABCD

Sol. Let elongation in spring A, B and C be x_1, x_2 and x_3 respectively.

Considering spring forces and constraint relations

$x_2 = 4x_3$ …(i)

$x_2 = 2x_1$ …(ii)

and $x_1 + 2x_2 + x_3 = x$ …(iii)

$\Rightarrow$ $x_1=\left(\frac{2}{11}\right)x$; $x_2=\left(\frac{4}{11}\right)x$; $x_3=\left(\frac{1}{11}\right)x$

Also, F = $2K\left(\frac{x}{11}\right)$ $\Rightarrow$ $T=2\pi\sqrt{\frac{11m}{2k}}$

5. ABC

Sol. $\Delta U=\frac{fR\Delta T}{2}$

$\Delta W=\frac{nR\Delta T}{1-x}$ where PV^x = constant. Here $x=-\frac{1}{2}$

6. BCD

Sol. The system is equivalent to a binary system as shown in the diagram.

$$r_1 = \frac{M \times 3R}{M + 2M} = R$$

$$r_2 = 2R$$

Considering the circular motion of point mass m

$$M\omega_2^2 r_2 = \frac{GM^2}{36R^2} \quad ; \quad \omega_2 = \sqrt{\frac{GM}{72R^3}} = \omega_1$$

7. ABD

Sol. For ammeter,

$$i = \frac{i_{max}\left(R_s + R_A\right)}{\left(R_s\right)}$$

$\Rightarrow$ $i = 0.1\text{mA}$ for $R_s = 50\,\Omega$ [as $R_A = 50\,\Omega$ and $i_{max} = 50\,\mu\text{A}$]

For voltmeter,

$$V = i_{max}(R_A + R_V)$$

$\Rightarrow$ $V \approx 10\text{V}$ for $R_v = 200\,\text{k}\Omega$

8. CD

Sol. If $\mu_1 = 0$, $\mu_2 \neq 0$

$t_1 = 0$, balancing torques about A

$$N_1\ell \sin\theta = mg\frac{\cos\theta}{2}$$

$$N_1 \tan\theta = \frac{mg}{2}$$

If $\mu_1 \neq 0$, $\mu_2 \neq 0$

$T_2 = 0$, equilibrium cannot be attained.

If $\mu_1 \neq 0$, $\mu_2 \neq 0$

$N_1 = t_2 = \mu_2 N_2$; $N_2 + t_1 = mg$

$$N_2 + \mu_1 N_1 = mg \quad ; \quad N_2 + \mu_1(\mu_2 N_2) = mg \quad ; \quad N_2 = \frac{mg}{1 + \mu_1\mu_2}$$

9. D

Sol. Because resultant velocity is always perpendicular to line joining C and boat, so path is circular with center at C.

10. B

Sol. Let any time the velocity of boat with respect to river makes an angle α with *CP*.

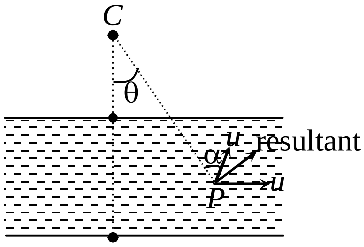
Since along *CP*, net velocity is zero

$$u\cos\alpha = u\sin\theta$$

$$\cos\alpha = \sin\theta \;\Rightarrow\; \alpha = \frac{\pi}{2} - \theta$$

$V_{resultant} = u\sin\alpha + u\cos\theta$

$= u\cos\theta + u\cos\theta = 2u\cos\theta$.



Angular velocity $\omega = \dfrac{2u\cos\theta}{2d} = \dfrac{u\cos\theta}{d}$, $\dfrac{d\theta}{dt} = \dfrac{u\cos\theta}{d}$

$$\int_0^{\pi/3} \frac{d\theta}{\cos\theta} = \int_0^t \frac{u}{d}dt \Rightarrow t = \frac{d}{u}\ln\left[2+\sqrt{3}\right]$$

SECTION – C

11. 4

Sol. Here 3rd maxima is shifted by 3×10^{-4} m. It indicates fringe width increases by 1×10^{-4} m.

Hence $\beta = \dfrac{\lambda(D+0.5)}{d} = \dfrac{\lambda D}{d} + 1\times10^{-4}$

or $\dfrac{0.5\lambda}{d} = 1\times10^{-4}$ m or $\lambda = \dfrac{2\times10^{-3}\times1\times10^{-4}}{0.5} = 4\times10^{-7}$ m = 400 nm

12. 1

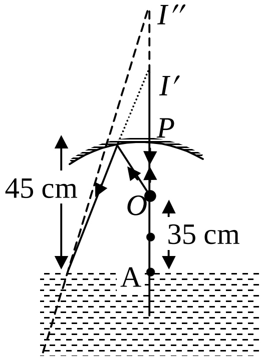
Sol. For the reflection at the concave mirror,

u = – 10 cm; v = ?; f = – 15 cm

From the mirror formula, we have

$$v = \frac{uf}{u-f} = \frac{(-10)\times(-15)}{-10+15} = \frac{150}{5} = +30 \text{ cm}$$

The positive sign indicates that the image is formed on the other side of the concave mirror,



Now, the image formed by the concave mirror serves as a virtual object for refraction at water surface which takes placed from air to water. So,

$$\mu = \frac{\text{Apparent height}}{\text{Real height}}$$

$\therefore$ AI" = Apparent height = μ × real height $= \dfrac{4}{3}\times75$ = 100 cm.

13. 3

Sol. Let T be the tension in the ideal string and ‘a’ be the acceleration of the blocks at the instant of release. For the block on the left, the upward acceleration may be found from

$T + k_1x - mg = ma$

For the block on the right, the downward acceleration may be found from

$k_2x + mg - T = ma$

Adding the equations gives the acceleration of the blocks as

$a = (k_1 + k_2)x/(2m)$

However, subtracting the equations gives

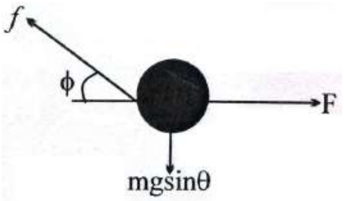
$T = mg - (k_1 - k_2)x/2$

for maximum value of k_1T will be zero.

$mg = \left(\frac{k_1 - k_2}{2}\right)x$; $k_1 = 300$.

14. 5

Sol. There are four forces acting on the object; a normal force N perpendicularly away from the incline, gravity mg vertically downward, the applied force F in the direction of motion and a static frictional force f before the object begins to move. Since the object is about to slide along the plane, the frictional force must be at its maximum value, $f = \mu_s N$. The sum of the force components perpendicular to the incline is zero, so,



$N = mg\cos\theta \Rightarrow f = \mu_s mg\cos\theta$ …(1)

On the other hand, the force components parallel to the surface of the incline are sketched in the following free-body diagram.

Note that the frictional force must make some angle ϕ as drawn because it initially balances the other two forces on this diagram,

$F = f\cos\theta$ …(2)

for the minimum applied force to get the object to start sliding, and

$f\sin\phi = mg\sin\phi \Rightarrow f = \frac{mg\sin\theta}{\sin\phi}$ ...(3)

Substitute eq. (3) into (2) along with

$\cos\phi = \sqrt{1 - \sin^2\phi}$

to obtain

$F = mg\sin\theta\sqrt{\frac{1}{\sin^2\phi} - 1}$ …(4)

Also substitute eq (3) into (1) and rearrange to find

$\frac{1}{\sin\phi} = \frac{\mu_s\cos\theta}{\sin\theta}$ …(5)

Now put eq. (5) into (4) to get

$F = mg\sqrt{\mu_s^2\cos^2\theta - \sin^2\theta}$ …(6)

where we required $\mu_s > \tan\theta$, as otherwise the object will slip even in the absence of an applied force. Note that if $\mu_k < \mu_s$, as is usually the case, then the object will begin to accelerate after it starts moving.

15. 2

Sol. $\frac{q_1}{C_1} = \frac{q_2}{C_2}$; $q_1 + q_2 = 2Q_0$

$C_1 = \frac{\varepsilon_0 A}{d_0 + vt}$; $C_2 = \frac{\varepsilon_0 A}{d_0 - vt}$

$\frac{q_1}{q_2} = \frac{d_0 - vt}{d_0 + vt}$

$$q_2\left(\frac{d_0 - vt}{d_0 + vt}\right) + q_2 = 2Q_0$$

$$q_2\left[\frac{2d_0}{d_0 + vt}\right] = 2Q_0$$

$$q_2 = \frac{2Q_0}{2d_0}\left(d_0 + vt\right)$$

$$I = \frac{dq_2}{dt} = \frac{Q_0 v}{d_0} = 2 \text{ amp}$$

16. 3

Sol. Initially the rod will be in equilibrium if

$2T_o = Mg$ with $T_o = kx_o$ …(i)

when the current I is passed through the rod, it will experience a force F = BIL vertically up,

In equilibriums

2T + BIL = Mg with T = kx …(ii)

from (i) & (ii)

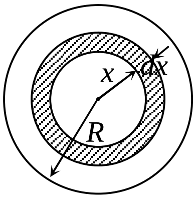
$$\frac{T}{T_o} = \frac{Mg - BIL}{Mg} \text{ i.c. } \frac{x}{x_o} = 1 - \frac{BIL}{Mg}$$

$$\text{or, } B = \frac{Mg\left(x_o - x\right)}{I \;\; L \;\; x_0}$$

Putting the values we get $B = 1.5 \times 10^{-2}$ T .

17. 1

Sol. $d\varphi = (2\pi x dx)kxt^2$



$$\varphi = \frac{2}{3}kt^2\pi x^3$$

$$\frac{d\varphi}{dt} = \frac{4k\pi tx^3}{3}$$

$$E2\pi x = \frac{4\pi ktx^3}{3} \;;\qquad E = \frac{2}{3}ktx^2 \;;\quad d\tau = \left(\frac{2}{3}ktx^2\right)\frac{Q}{\pi R^2}(2\pi x dx)x$$

$$\int d\tau = \frac{4}{3}\frac{ktQ}{R^2}\int_0^R x^4 dx \quad\Rightarrow\qquad \tau = \frac{4}{3}\frac{ktQ}{R^2}\frac{R^5}{5}$$

At t = 15sec, τ = 1 N-m

18. 1

Sol. $F = -\dfrac{dU}{dr} = -\dfrac{k}{r},\ \dfrac{k}{r} = \dfrac{mv^2}{r}$ ..... (i)

$E_n = \dfrac{1}{2}mv^2 + k\ln r$ ..... (ii)

$mvr = \dfrac{nh}{2\pi}$ ..... (iii)

Solving these $E_n = \frac{k}{2}\left(1 + \ln\left(\frac{n^2h^2}{4\pi^2 mk}\right)\right)$

required ratio = $\frac{E_2 - E_1}{E_4 - E_2} = 1.$

19. 6

Sol. $\sqrt{f_1} = \sqrt{\frac{v}{\lambda_1}} = a(11-1)$ and $\sqrt{f_2} = \sqrt{\frac{v}{\lambda_2}} = a(Z-1)$

By dividing, $\sqrt{\frac{\lambda_2}{\lambda_1}} = \frac{10}{Z-1} \Rightarrow \sqrt{\frac{4}{1}} = \frac{10}{Z-1}$

$\Rightarrow$ Z = 6.

20. 2

Sol. $\frac{dN_A}{dt} = -\lambda_1 N_A$, $\frac{dN_B}{dt} = 2\lambda_1 N_A - \lambda_2 N_B$,

N_B = maximum $\Rightarrow \frac{dN_B}{dt} = 0$

$\Rightarrow \quad 2\lambda_1 N_A = \lambda_2 N_{B_{max}}$

$\Rightarrow \quad N_{B_{max}} = \frac{2\lambda_1}{\lambda_2} N_A$

$\Rightarrow \quad N_{B_{max}} = \frac{2\lambda_1}{\lambda_2} N_0 e^{-\lambda_1 t}$ = 2.

SECTION – D

21. 00002.66

Sol. The observed reading will be = 10 mm + 1 × 01 mm = 1.01 cm

$\therefore$ density = $\frac{\text{Mass}}{\text{vol}} = \frac{2.7369}{(1.01)^3}$ = 2.65654 ≈ 2.66 gm/cm^3

22. 00000.75

Sol. $e = \frac{v_2 - v_1}{u_1 - u_2}$

$1 = \frac{v_2 - (-2)}{u_1}$

$u_1 = v_2 + 2$

$u_1 = 1(-2) + 5(u_1 - 2)$

$u_1 = -2 + 5u_1 - 10$

$u_1 = \frac{12}{4} = 3 m/s$

$v_2 = 1\,m/s$

Kinetic energy of the given particle of mass 6 kg = $\frac{1}{2}\times(1+5)\times\left(\frac{3}{1+5}\right)^2=\frac{3}{4}$J

23 00000.08

Sol. $D=1m, d=5\times10^{-3}m$

shift = $\frac{D}{d}\left[t_1(\mu_1-1)-t_2(\mu_2-1)\right]$

$=\frac{1}{5\times10^{-3}}\left[2(1.5-1)-1.5(1.4-1)\right]\times10^{-3}=\frac{0.4}{5}=0.08m$

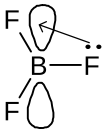
Chemistry PART – II

SECTION – A

24. D
Sol. Relatively lowering will be minimum for $[Co(NH_3)_3Cl_3]$ as i = 1 and hence it will have maximum vapour pressure.

25. B
Sol. $6\overset{+4}{Xe}F_4 + 12H_2O \longrightarrow 4\overset{0}{Xe} + 2\overset{+6}{Xe}O_3 + 24HF + 3O_2$

26. B
Sol. BF_3 has back bonding



27. AB
Sol. $k = Ae^{-E_a/RT}$ or $\ell nk = \ell nA \frac{-E_a}{RT}$

28. ABCD
Sol. At the point of maximum value of RDF $\frac{dP}{dR} = 0$

$\left(2r - \frac{2Zr^2}{a_0}\right) = 0;\ r = \frac{a_0}{Z}$

Where Z = 3 for Li^{2+}, Z = 2 for He^+; Z = 1 for hydrogen.

29. AC
Sol. At 400 K $\Delta S_{vap} = \frac{\Delta H_{vap}}{T_b}$ = 100 J/mol K.

30. AD
Sol. In (A) pressure of H_2 is different
(D) conc of electrolyte is different

31. B
Sol. Antiaromatic

32. C
33. B
(Sol. for Q. no. 32 & 33)
Stronger the ligand field, more is Δ.

SECTION – C

34. 6

Sol. $P_4 + 3NaOH + 3H_2O \longrightarrow PH_3 + 3NaH_2PO_2$

X + y = 6

35. 3

Sol. $2X(g) \rightleftharpoons 2Y(g) + Z(g)$

$1 - \alpha \qquad \alpha \qquad \frac{\alpha}{2}$ Total moles = $1 + \frac{\alpha}{2} = \frac{2+\alpha}{2}$

$$K_P = \frac{(P_Y)^2 (P_Z)}{(P_X)^2}$$

$$= \frac{\left(\frac{2\alpha}{(2+\alpha)}\right)^2 P^2 . \left(\frac{\alpha}{2+\alpha}\right) P}{\left(\frac{2(1-\alpha)}{(2+\alpha)}\right)^2 P^2}$$

neglecting α compared to 1 and solving

$$\alpha = \left(\frac{2K_P}{P}\right)^{1/3} \Rightarrow n = 3$$

36. 4

Sol. Nylon-6 & Teflon are homopolymer rest all are co-polymers

37. 3

Sol. Zr, Ni & Ti are refined by vapour phase refining.

38. 5

Sol. $4H^+ + MnO_4^- \rightleftharpoons MnO_2 + 2H_2O$

$$\Delta G^o = -3F\left(\frac{1.5 \times 5 - 2 \times 1.25}{3}\right) = -5F$$

x = 5

39. 3

Sol. At 300 K volume be V

At 500 K volume = V + 2

Using $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

V = 3L

40. 1

Sol. $KMnO_4 \qquad H_2O_2$

$N_1V_1 = N_2V_2$

$5 \times 0.1 \times 10 = 28 \times N_2$

$N_2 = \frac{5}{28}$ 1 N = 5.6 V

$$\frac{5}{28}N = \frac{5.6}{10} \times \frac{5}{28} = 1V$$

41. 8

Sol. $\frac{r_+}{r_-}$ = radius ratio = $\frac{1.7}{1.8}$ = 0.944

Hence C.No. 8

42. 1

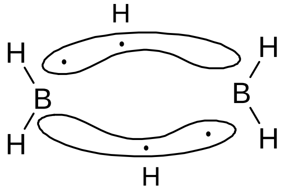
Sol. $\text{Slope} = \frac{-\Delta H}{2.303\,R}$

so, $\frac{-\Delta H}{2.303\,R} = \frac{-1}{4.606}$

ΔH = 1 cal

43. 3

Sol.



Bridge hydrogen are 3c – 2e bond

SECTION – D

44. 00370.65 K

Sol. $2.303\log\frac{P_2}{P_1} = \frac{\Delta H}{R}\left(\frac{T_2 - T_1}{T_1T_2}\right)$

$T_2 = 100^oC$ $\quad P_2$ = 760 mm (1 atm)

= 373 K

T_1 = ? $\quad P_1$ = 700 mm

Δ H = 540 × 18 cal/ mol

$$2.303\ \log\ \frac{760}{700} = \frac{540 \times 18}{2}\left(\frac{373 - T_1}{T_1 \times 373}\right)$$

T_1 = 370.65 K

45. 00089.40 kJ

Sol. $\underset{N\equiv N}{N_2} + \frac{1}{2}\underset{O=O}{O_2} \longrightarrow N = N = 0$

$\Delta H = \sum BE_R - \sum BE_P$

$= \left(946.2 + \frac{497}{2}\right) - (418 + 605.3) = 171.4\,kJ/mol$

RE = ΔH_{exp} - ΔH_{cal} = 82 – 171.4 = -89.4 kJ = 89.4 kJ

46. 00005.70

Sol. $pH = -\log K_a + \log\frac{[\text{Conj.base}]}{[\text{Acid}]}$

For - I : $4 = -\log 10^{-5} + \log\frac{[\text{Conj.base}]}{0.5}$

Conjugate base = 0.05 M = salt

For – II: 6 = $-\log 10^{-5}$ + $\log\frac{[\text{Conj.base}]}{0.5}$

[C.base] = [Salt] = 5 M

On mixing equal volumes

New conc. of salt NaA = $\frac{0.05\times V + 5\times V}{2V} = \frac{5.05}{2}M$

New conc. of HA in mixed buffer = $\frac{0.5V + 5V}{2V}$

$pH = -\log 10^{-5} + \log\frac{5.05}{2\times 0.5} = 0.5M = 5.70$

Mathematics PART – III

SECTION – A

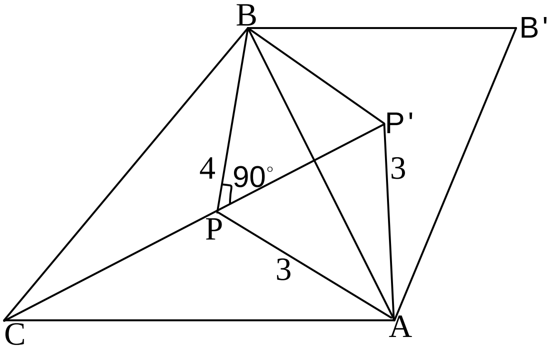
47. C

Sol. Rotate the triangle in clockwise direction through an angle 60°. Let the points A,B,C and P will be A,B', B and P' respectively after the rotation.

We have PA=P'A=3

And $\angle PAP' = 60^\circ \Rightarrow PP' = 3$

Also CP=BP'=5



So $\Delta BPP'$ is right angle triangle which $\angle BPP' = 90^\circ$.

Now apply cosine rule in triangle BPA because

$\angle BPA = 90^\circ + 60^\circ = 150^\circ$, PA=3 and BP=4, we can get AB

48. B

Sol. If $f'(x) > 0$ and $f''(x) > 0 \Rightarrow \frac{d^2f^{-1}(x)}{dx^2} < 0$

If $f'(x) < 0$ and $f''(x) < 0 \Rightarrow \frac{d^2f^{-1}(x)}{dx^2} < 0$

49. C

Sol. We have, $f(\alpha) = \int_{\tan^{-1}\alpha}^{\cot^{-1}\alpha} \left(\frac{\tan x}{\tan x + \cot x}\right) dx$ …(1)

$\Rightarrow$ $f(\alpha) = \int_{\tan^{-1}\alpha}^{\cot^{-1}\alpha} \frac{\cot x}{\cot x + \tan x} dx$ …(2)

$\therefore$ Adding (1) and (2), we get

$$f(\alpha) = \frac{1}{2}\left(\cot^{-1}\alpha - \tan^{-1}\alpha\right) = \frac{1}{2}\left(\frac{\pi}{2} - 2\tan^{-1}\alpha\right) = \frac{\pi}{4} - \tan^{-1}\alpha$$

Clearly, range of $f(\alpha)$ is $\left(-\frac{\pi}{4}, \frac{3\pi}{4}\right)$.

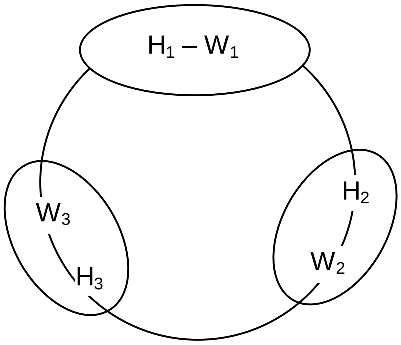
50. BC

Sol. n (All couples are together)

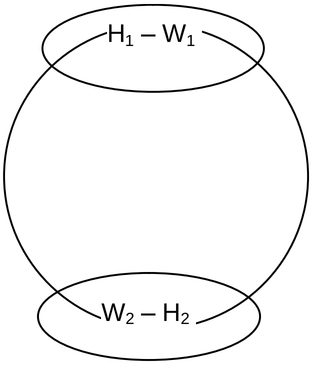
$= 2 \times 2 \times 2 \times 2 \times 2 = 16$ ways

$\therefore$ $x =$ Total – 16

$x = 5! - 16 = 105$



To find y, first Let H_1, W_1, H_2, W_2 sit in $2 \times 2 = 4$ ways



Now H_3, and W_3 can sit in 2 ways

$\therefore y = 4 \times 2 = 8$

51. ABCD

Sol. $a, b = ar,\ c = ar^2$ are in G.P. where $r \neq \pm 1$

$a + b + c = bx \Rightarrow 1 + r + r^2 = rx$ ....(i)

$\Rightarrow \quad r^2 + (1 - x)r + 1 = 0$

$\Delta \geq 0 \Rightarrow (1 - x)^2 - 4 \geq 0$

$(x - 1)^2 - 2^2 \geq 0, (x - 3)(x + 1) \geq 0$

$x \in (-\infty, -1] \cup [3, \infty)$

If $x = -1$, then $r = -1 \Rightarrow x = -1$ (rejected)

and $x = 3$, then $r = 1 \Rightarrow r = 3$ (rejected)

$\therefore \ x \in (-\infty, -1) \cup (3, \infty)$

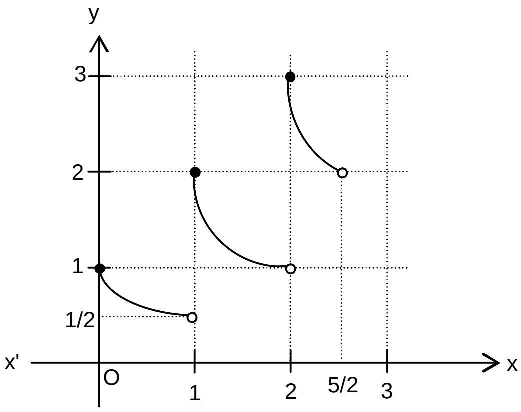
52. ABD

Sol. $$f(x) = \begin{cases} \dfrac{1}{1+x}, & 0 \leq x < 1 \\ \dfrac{2}{x}, & 1 \leq x < 2 \\ \dfrac{3}{x-1}, & 2 \leq x < \dfrac{5}{2} \end{cases}$$

Clearly, f(x) is discontinuous and bijective function

$\lim\limits_{x\to1^-} f(x)=\frac{1}{2},\ \lim\limits_{x\to1^+} f(x)=2$ ”

$\min\left(\lim\limits_{x\to1^-} f(x),\ \lim\limits_{x\to1^+} f(x)\right)=\frac{1}{2}\neq f(1)$



53. AD

Sol. $y=\frac{2xz}{x+z}\Rightarrow x, y$ and z are in H.P.

$\Rightarrow \frac{1}{z}-\frac{1}{y}=\frac{1}{y}-\frac{1}{x}$

$\Rightarrow \frac{x}{z}=\frac{x-y}{y-z}$

54. AB

Sol. Let E: second drawn marble is green.

$$P(E)=\frac{1}{3}\left[\left\{\frac{1}{4}.1+\frac{3}{4}.\frac{1}{2}\left(\frac{1}{2}+\frac{1}{4}\right)\right\}+\frac{1}{2}\left\{\frac{2}{3}+\frac{1}{2}\left(\frac{3}{4}+\frac{1}{4}\right)\right\}+\left\{\frac{3}{4}.\frac{1}{3}+\frac{1}{4}.\frac{1}{2}\left(\frac{3}{4}+\frac{1}{2}\right)\right\}\right]$$

$$=\frac{1}{3}\left[\frac{73}{48}\right]=\frac{73}{144}$$

n=144, m= 73 hence n-m= 71 and n-2m +2 =0

correct options are A & B

55. D

56. D

(Solution-(55 to 56)

Let $P(h,k)$ be a point with the given property and assume h, k > 0

Now, without loss of generality, we take PC > PA

So, $\sqrt{2}PC=PB+PD$

$$\Rightarrow 2h^2+2(k+a)^2=(h-a)^2+(h+a)^2+2k^2+2\sqrt{(h+a)^2+k^2}\times\sqrt{(h+a)^2+k^2}$$

$\Rightarrow$ locus comes out to be $x^2+y^2=a^2$

So, circumcircle of square ABCD will be locus of point P.

SECTION – C

57. 6

Sol. $\because f(x)=x^3+x^2f'(1)+xf''(2)+f'''(3)$

$\therefore\ f'(x)=3x^2+2xf'(1)+f''(2)$

Put $x=1$

$\therefore\ f'(1)+f''(2)=-3$ ………………..(i)

Again, $f''(x)=6x+2f'(1),\ f'''(x)=6$

Put $x=2$

$\therefore\quad f''(2)=12+2f'(1)$ ………………(ii)

Solving equation (i) and (ii), we get

$f'(1)=-5$ and $f''(2)=2$

$\therefore\quad f(x)=x^3-5x^2+2x+6$

$\therefore\quad f(2)-f(1)=-6=-f(0)$

58. 6

Sol. $t_r=\dfrac{2r^2}{2r^2-60r+900}$

$=\dfrac{2r^2}{(r-30)^2+r^2}$

$\Rightarrow t_1+t_{30}=2$

But $t_{15}=1$

$\Rightarrow$ Final sum = 31

So required answer is 7

59. 9

Sol. We have $f(x)-f(-x)=6x$

$\therefore\quad f(4)-f(-4)=24$

$\Rightarrow\quad N=f(4)=24+2286=2310=2.3.5.7.11$

Hence number of divisors $=2^{n-1}=2^{5-1}=16$

60. 9

Sol. We have $\left(\overrightarrow{OP}\right)^2=\left(e^t+e^{-t}\right)^2\left(\vec{a}\right)^2+\left(e^t-e^{-t}\right)^2+2\left(e^t+e^{-t}\right)\left(e^t-e^{-t}\right)\left(\vec{a}.\vec{b}\right)$

$\left(\left(\vec{a}\right)^2=\left|\vec{a}\right|^2=9,\ \left(\vec{b}\right)^2=\left|\vec{b}\right|^2=16\text{ and }\vec{a}.\vec{b}=\left|\vec{a}\right|\left|\vec{b}\right|\cos\dfrac{2\pi}{3}\right)$

$\Rightarrow\left|\overrightarrow{OP}\right|^2=9\left(e^t+e^{-t}\right)^2+16\left(e^t-e^{-t}\right)^2+2\left(e^{2t}-e^{-2t}\right).3.4.\left(-\dfrac{1}{2}\right)=13e^{2t}+5e^{-2t}-14$

Now $\dfrac{d}{dt}\left|\overrightarrow{OP}\right|^2=0\Rightarrow 26e^{2t}-10e^{-2t}=0\Rightarrow e^{4t}=\dfrac{5}{13}$,

So $e^{2t}=\dfrac{\sqrt{5}}{\sqrt{13}}$

$\therefore\ \left|\overrightarrow{OP}\right|^2_{\min}=13\left(\dfrac{\sqrt{5}}{\sqrt{13}}\right)+5\left(\dfrac{\sqrt{13}}{\sqrt{5}}\right)-14\Rightarrow\left|\overrightarrow{OP}\right|^2_{\min}=2\sqrt{65}-14$

$\Rightarrow\ \left|\overrightarrow{OP}\right|_{\min}=\sqrt{2}\sqrt{\sqrt{65}-7}=\sqrt{2}\sqrt{\sqrt{a}-b}$,

So $a=65,\ b=7$

Hence $(a+b) = 72$ or $\dfrac{(a+b)}{8} = 9$

61. 2

Sol. Given that $AA^T = 4.I \Rightarrow |A|^2 = 4 \Rightarrow |A| = \pm 2,$ so

$$A^T = 4A^{-1} = 4\frac{\text{adj}\,A}{|A|} \Rightarrow \begin{bmatrix} a_{11} & a_{21} & a_{31} \\ a_{12} & a_{22} & a_{32} \\ a_{13} & a_{23} & a_{33} \end{bmatrix} = \frac{4}{|A|}\begin{bmatrix} c_{11} & c_{21} & c_{31} \\ c_{12} & c_{22} & c_{32} \\ c_{13} & c_{23} & c_{33} \end{bmatrix}$$

Now $a_{ij} = \dfrac{4}{|A|}c_{ij} \Rightarrow -2c_{ij} = \dfrac{4}{|A|}c_{ij}\left(\text{As } a_{ij} + 2c_{ij} = 0\right) \Rightarrow |A| = -2$

Now $|A + 4I| = \left|A + AA^T\right| = |A|\left|I + A^T\right| = -2\left|(I + A)^T\right| = -2|I + A|$

$\Rightarrow |A + 4I| + 2|A + I| = 0,$ so on comparing we get $5\lambda = 2 \Rightarrow \lambda = \dfrac{2}{5}$

Hence $5\lambda = 2$

62. 4

Sol. Let $f''(x) = 6a(x-1)(a>0)$ then $f'(x) = 6a\left(\dfrac{x^2}{2} - x\right) + b = 3a\left(x^2 - 2x\right) + b$

Now $f'(-1) = 0 \Rightarrow 9a + b = 0 \Rightarrow b = -9a$

$\therefore$ $f'(x) = 3a\left(x^2 - 2x - 3\right) = 0 \Rightarrow x = -1$ and 3

So $y = f(-1)$ and $y = f(3)$ are two horizontal tangent s $= \left|f(3) - f(-1)\right| = |-22 - 10| = 32$

So $\dfrac{D}{8}$ is 4

63. 7

Sol. Given $R : r = 3 : 1.5 = 2 \Rightarrow \Delta ABC$ must be equilateral.

So $a = b = c = 2R\sin\dfrac{\pi}{3} = R\sqrt{3}$ (By sine rule)

Now $a\cot^2 A + b^2\cot^3 B + c^3\cot^4 C = R\sqrt{3}\left(\dfrac{1}{\sqrt{3}}\right)^2 + \left(R\sqrt{3}\right)^2\left(\dfrac{1}{\sqrt{3}}\right)^3 + \left(R\sqrt{3}\right)^3\left(\dfrac{1}{\sqrt{3}}\right)^4$

$$= \frac{R}{\sqrt{3}} + \frac{R^2}{\sqrt{3}} + \frac{R^3}{\sqrt{3}} = \frac{3 + 3^2 + 3^3}{\sqrt{3}} = \frac{39}{\sqrt{3}} = 13\sqrt{3} = m\sqrt{n}$$

Hence $\left|(m - 2n)\right| = 7$

64. 4

Sol. Since a, b, c, d are in A.P.

$\therefore$ $b - a = c - b = d - c = D$ (let common difference)

$\Rightarrow$ $d = a + 3d$ $\Rightarrow$ $a - d = -3D$ and $d = b + 2D$ $\Rightarrow$ $b - d = -2d$

Also $c = a + 2D$ $\Rightarrow$ $c - a = 2D$

$\therefore$ Given equation $2(a-b) + 4k(b-c)^2 + (c-a)^3 = 2(a-d) + (b-d)^2 + (c-d)^3$

becomes $-2D+4kD^2+(2D)^3=-6D+4D^2-D^3$

$\Rightarrow \quad 9D^2+(4k-4)D+4=0$

Since D is real $\Rightarrow (4k-4)^2-4(4)(9)\geq 0$

$\Rightarrow \quad 16k^2-32k-128\geq 0 \quad \Rightarrow (4k-16)(4k+8)\geq 0$

$\therefore \quad k\in(-\infty,-2]\cup[4,\infty)$

Hence smallest positive value of k = 4

65. 1

Sol. Let $x=10^k.a_k+10^{k-1}.a_{k-1}+......+10.a_1+a_0$ where $a_k,a_{k-1}.....a_0$ are its digits.

From $a_0.a_1.......a_k=x^2-10x-22\geq 0$

$\Rightarrow x>11$

For every positive integer x using digits $a_k,a_{k-1},.......a_1,a_0$

$a_0.a_1a_2........a_k\leq a_k.9^k<a_k.10^k+a_{k-1}10^{k-1}+......+10.a_1+a_0$

or, $x^2-10x-22<x$

Hence, $x<\dfrac{11+\sqrt{209}}{2}<13$

So, $x\in(11,13)\Rightarrow$ only possible value of x is 12.

Hence answer is 1.

66. 4

Sol. $S=\dfrac{16+3x+5x}{2}=8+4x$

Now $3x+5x>16\Rightarrow x>2$

$3x+16>5x\Rightarrow x<8\Rightarrow x\in(2,8)$

$5x+16>3x\Rightarrow x>-8$

Now $A^2(x)=(8+4x)(4x-18)(x+8)(8-x)=(16x^2-64)(64-x^2)$

Let $x^2=t\Rightarrow t\in(4,64), f(t)=16(t-4)(64-t)=16(64t-t^2-256+4t)$

$\therefore f(t)=-16(t^2-68t+256), f'(t)=2t-68=0\Rightarrow t=34$

$f''(t)=-32<0$

Maxima occurs at t=34

F(34)=16(30)(30)

$\therefore$ largest possible area = 120

SECTION – D

67. 00610.66

Sol. Given $y=\tan z$

$$\frac{dy}{dx}=\sec^2 z.\frac{dz}{dx} \qquad \text{- - - - (1)}$$

Now $\dfrac{d^2y}{dx^2}=\sec^2 z.\dfrac{d^2z}{dx^2}+\dfrac{dz}{dx}.\dfrac{d}{dx}(\sec^2 z)$ [Using product rule]

$$=\sec^2 z.\frac{d^2z}{dx^2}+\frac{dz}{dx}.\frac{d}{dz}\left(\sec^2 z\right)\frac{dz}{dx}$$

$$\frac{d^2y}{dx^2}=\sec^2 z.\frac{d^2z}{dx^2}+\left(\frac{dz}{dx}\right)^2.2\sec^2 z.\tan z \qquad ---- \ (2)$$

Now $1+\frac{2(1+y)}{1+y^2}\left(\frac{dy}{dx}\right)^2$

$$=1+\frac{2(1+\tan z)}{\sec^2 z}.\sec^4 z.\left(\frac{dz}{dx}\right)^2=1+2(1+\tan z).\sec^2 z.\left(\frac{dz}{dx}\right)^2$$

$$=1+2\sec^2 z\left(\frac{dz}{dx}\right)^2+2\tan z.\sec^2 z\left(\frac{dz}{dx}\right)^2 \qquad (3)$$

From (2) and (3), we have RHS of (2) = RHS of (3)

$$\sec^2 z.\frac{d^2z}{dx^2}=1+2\sec^2 z\left(\frac{dz}{dx}\right)^2$$

$$\Rightarrow \qquad \frac{d^2z}{dx^2}=\cos^2 z+2\left(\frac{dz}{dx}\right)^2$$

$\Rightarrow \qquad k=2$ so $(305.33)\times k$ = 610.66

68. 04008.80

Sol. Let $A(t_1), B(t_2)$ and $C(t_3)$ be the points on the parabola

Since $AB\perp BC \Rightarrow \frac{4}{(t_1+t_2)(t_2+t_3)}=-1$

$$t_2^2+t_2(t_1+t_3)+t_1t_3+4=0$$

$$\Rightarrow (t_1+t_3)^2\ge 4(t_1t_3+4)\Rightarrow (t_1-t_3)^2\ge 16$$

$$\Rightarrow (t_1+t_3)^2\ge 4(t_1t_3+4)\Rightarrow (t_1-t_3)^2\ge 16$$

also length of intercept cut off by tangents from y-axis is $|t_1-t_3|\ge 4$, hence 1002.2λ is greater than 4008.80

69. 08275.20

Sol. $(AB)(AD)=200$

$AB+AD=2a$

$BD^2=AB^2+AD^2=(2ae)^2$

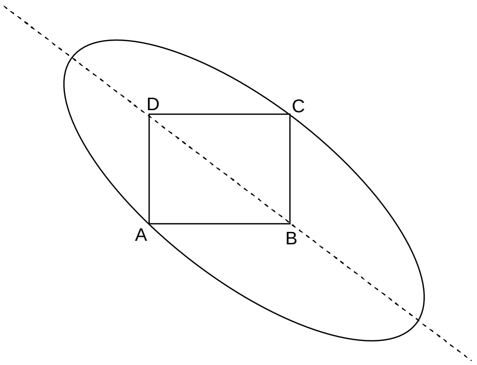
$(AB+AD)^2=AB^2+AD^2+2(AB)(AD)$

$\Rightarrow 4a^2=4a^2e^2+400 \Rightarrow b=10$

$\Rightarrow a^2(1-e^2)=b^2=100\Rightarrow a=20$

$P=2(AB+AD)=4a=80$

Or 103.44P = 8275.20



FIITJEE **JEE (Main)-2018**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - I

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 – 30, 31 – 60, 61 – 90)** *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

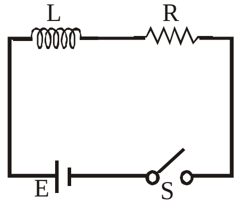
SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. Two capillary tubes of radii 0.2 cm and 0.4 cm are dipped in the same liquid. The ratio of heights through which liquid will rise in the tube is
(A) 1:2 (B) 2:1
(C) 1:4 (D) 4:1

2. A particle executes S.H.M. with a time period of 4 s. Find the time taken by the particle to go directly from its mean position to half of its amplitude.
(A) 1 s (B) $\frac{1}{2}$s
(C) $\frac{1}{3}$s (D) $\frac{1}{4}$s

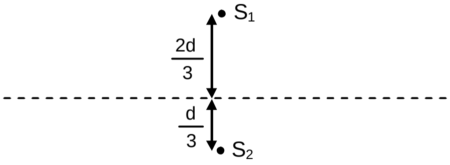
3. In the LR circuit as shown in figure, the switch is closed at t = 0. Mark the incorrect statement of the following:
(A)The current increases with time
(B)The current increases with a decreasing rate
(C)The voltage drop across the inductor increases
(D)The voltage drop across the resistor increases



4. In hydrogen like atoms the ratio of difference of energies $E_{4n} - E_{2n}$ and $E_{2n} - E_n$ varies with atomic number z and principle quantum number n as
(A) $\frac{z^2}{n^2}$ (B) $\frac{z^4}{n^4}$
(C) $\frac{z}{n}$ (D) none of these

Space for Rough work

5. Two coherent point sources of frequency $(f = \frac{10v}{d}$ where v is speed of light) are placed at a distance d apart as shown in figure. The receiver is free to move along the dotted line shown in the figure. Find total number of maxima observed by receiver.



(A) 6 (B) 7
(C) 5 (D) 8

6. The temperature of an ideal gas is increased for 100k to 400k. If at 100K the root mean square velocity of the gas molecules is v, at 400K it becomes
(A) 4v (B) 2v
(C) v/2 (D) v/4

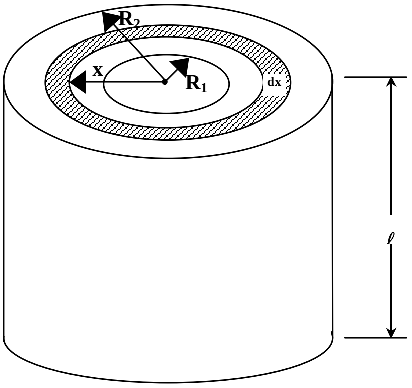
7. A boat which has a speed of 6 km/h in still water crosses a river of width 1 km along the shortest possible path in 20 min. The velocity of the river water in km/h is
(A) 1 (B) 3
(C) 4 (D) $3\sqrt{3}$

8. If photons of energy 12.75 eV are passing through hydrogen gas in ground state then no. of lines in emission spectrum will be
(A) 6 (B) 4
(C) 3 (D) 2

9. The momentum of α-particles moving in a circular path of radius 10 cm in a perpendicular magnetic field of 0.05 Tesla will be:
(A) 1.6×10^{-20} kg m/s (B) 1.6×10^{-21} kg m/s
(C) 1.6×10^{-19} kg m/s (D) 1.6×10^{-18} kg m/s

Space for Rough work

10. A cylindrical conductor of length ℓ and inner radius R_1 and outer radius R_2 has specific resistance ρ. A cell of emf ε is connected across the two lateral faces of the conductor. Find the current drown from the cell.



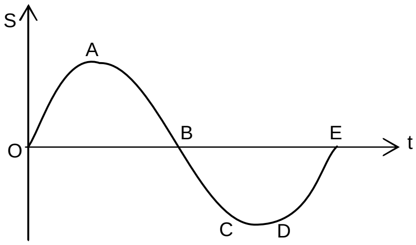
(A) $\dfrac{2\pi\ell\varepsilon}{\rho \ln \dfrac{R_2}{R_1}}$

(B) $\dfrac{2\pi\ell\varepsilon}{\rho (R_2^2 - R_1^2)}$

(C) $\dfrac{2\ell\varepsilon}{\rho\pi(R_2^2 - R_1^2)}$

(D) None of thee

11. A particle has a rectilinear motion and the figure gives its displacement as a function of time. Which of the following statements is incorrect with respect to the motion?



(A) in motion between 0 to A, the velocity is positive and acceleration is negative

(B) between A and B, the velocity and acceleration are positive

(C) between B and C, the velocity is negative and acceleration is positive

(D) between D and E, the acceleration is positive

12. Force acting on a particle of mass m moving in straight line varies with the velocity of the particle as F = K/V here K is constant then speed of the particle in time t.

(A) $\sqrt{\dfrac{kt}{m}}$ (B) $\sqrt{\dfrac{2kt}{m}}$

(C) $2\sqrt{\dfrac{kt}{m}}$ (D) None of these

Space for Rough work

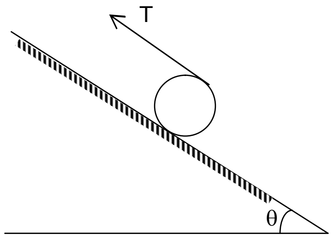
13. The current in a wire varies with time according to the equation I = 4 + 2t, where I is in ampere and t is in sec. The quantity of charge which has passed through a cross-section of the wire during the time t = 2 sec to t = 6 sec will be

(A) 60 coulomb	(B) 24 coulomb
(C) 48 coulomb	(D) 30 coulomb

14. If ρ is the density of the material of a wire and σ is the breaking stress. The greatest length of the wire that can hang freely without breaking is

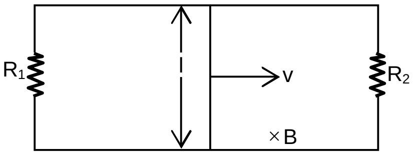
(A) $\frac{2\sigma}{\rho g}$	(B) $\frac{\rho}{\sigma g}$
(C) $\frac{\rho g}{2\sigma}$	(D) $\frac{\sigma}{\rho g}$

15. A sphere kept on a rough inclined plane is in equilibrium by a string wrapped over it. If angle of inclination is θ, the tension in string will be equal to



(A) mg $\sin\theta$	(B) 2 mg $\sin\theta$
(C) $\frac{mg\sin\theta}{2}$	(D) mg $\cos\theta$

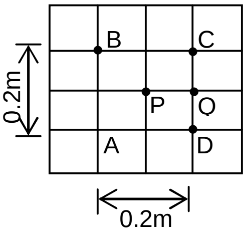
16. A rectangular loop with a slide wire of length l is kept in a uniform magnetic field as shown in figure. The resistance of slider is R. neglecting self inductance of the loop find the current in the connector during its motion with a velocity v.



(A) $\frac{Blv}{R_1+R_2+R}$	(B) $\frac{Blv(R_1+R_2)}{R+(R_1+R_2)}$
(C) $\frac{Blv(R_1+R_2)}{RR_1+RR_2+R_1R_2}$	(D) $Blv\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right)$

Space for Rough work

17. A, B, C, D, P and Q are points in a uniform electric field. The potentials at these points are V(A) = 2 volt. V(P) = V(B) = V(D) = 5 volt. V (C) = 8 volt. The electric field at P is



(A) 10Vm^{-1}along PQ (B) 5Vm^{-1} along PC
(C) $15\sqrt{2}$ Vm^{-1} along PA (D) 5 Vm^{-1} along PA

18. A concave mirror of focal length 15 cm is placed in water of refractive index μ = 4/3. Water is filled upto 30 cm. An object of height 1 cm is placed at a distance of 20 cm in front of the mirror. If the size of image is n times size of object, then n =
(A) 3 (B) 2
(C) 2.5 (D) 5

19. An ideal gas expands according to the law $PV^{3/2}$=constant. We conclude that
(A) the adiabatic exponent of the gas k = 1.5
(B) the molar heat capacity $C = C_V - 2R$
(C) temperature increases during the process
(D) such a gas is not feasible

20. A tank has a hole made at its bottom. The time needed to empty the tank from level h_1 to h_2 will be proportional to
(A) $h_1 + h_2$ (B) $\sqrt{h_1} + \sqrt{h_2}$
(C) $h_1 - h_2$ (D) $\sqrt{h_1} - \sqrt{h_2}$

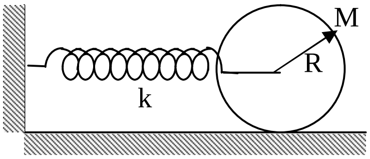
21. A source of sound emitting a note of frequency 200Hz moves towards an observer with a velocity v equal to the velocity of sound. If the observer also moves away from the source with the same velocity v, the apparent frequency heard by the observer is
(A) 50Hz (B) 100Hz
(C) 150Hz (D) 200Hz

Space for Rough work

22. A lake is covered with ice 2 cm thick. The temperature of ambient air is -15^{o}C. Find the rate of thickening of ice. For ice k = 4×10^{-4}k-cal-$m^{-1}s^{-1}(^{\circ}C)^{-1}$. Density $=0.9\times10^{3}$ kg/$m^3$and latent heat L = 80 Kilo Cal/Kg.
(A) 1.5 cm/h
(B) 0.75 cm/h
(C) 3 cm/h
(D) 2 cm/h

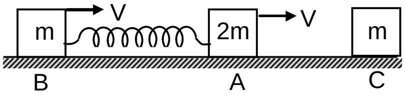
23. A cylindrical hall has a horizontal smooth floor. A ball is projected along the floor from A point on the wall in a direction making an angle θ with the radius through the point the ball returns back to the initial point after two impacts with the wall. If the coefficient of restitution is e then $\tan^2\theta$ will be
(A) $\frac{1+e+e^2}{e^3}$
(B) $\frac{1+e}{e^2}$
(C) $\frac{e^2}{1+e}$
(D) $\frac{e^3}{1+e+e^2}$

24. A solid cylinder of mass M is attached to the spring by means of a frictionless pivot. The cylinder is placed on floor. Find the time period of small oscillation of the system, if the floor is sufficiently rough to prevent any slipping of cylinder. Assume stiffness of spring to be K.



(A) $2\pi\sqrt{\frac{7M}{5K}}$
(B) $2\pi\sqrt{\frac{5M}{3K}}$
(C) $2\pi\sqrt{\frac{3M}{2K}}$
(D) $2\pi\sqrt{\frac{M}{K}}$

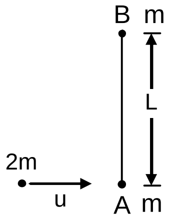
25. Two blocks A and B of mass 2m and m respectively are connected to a massless spring of spring constant K. If A and B moving on the horizontal frictionless surface with velocity v to right. If A collides with C of mass m elastically and head on, then the maximum compressions of the spring will be



(A) $\sqrt{\frac{3}{2}\frac{m}{k}}V$
(B) $\sqrt{\frac{27\,m}{8\,K}}V$
(C) $\sqrt{\frac{9\,m}{8\,K}}V$
(D) $\sqrt{\frac{8\,m}{27\,K}}V$

Space for Rough work

26. Two small balls A and B, each of mass m, are joined rigidly at the ends of a light rod of length L. They are placed on a frictionless horizontal surface. Another ball of mass 2 m moving with speed u towards one of the ball and perpendicular to the length of the rod on the horizontal frictionless surface as shown in the figure. If the coefficient of restitution is 1/2 then the angular speed of the rod after the collision will be



(A) $\frac{4}{3}\frac{u}{L}$ (B) $\frac{u}{L}$

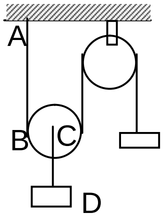
(C) $\frac{2}{3}\frac{u}{L}$ (D) None of these

27. A rod of negligible heat capacity has a length of 50 cm, area of cross-section 5 cm^2 and thermal conductivity 500 W/m^{o}C. The temperature of one end is maintained at 0°C and that of the other end is slowly and linearly varied from 0°C to 60°C in 20 min. Assuming no heat loss through the lateral side, the total heat transmitted through the rod in 20 minutes is

(A) 18 kJ (B) 9 kJ

(C) 27 kJ (D) 4.5 kJ

28. Both the strings shown in figure are made of same material and have same cross – section. The pulleys are light. The wave speed of a transverse wave in the string AB is v_1 and in CD it is v_2. Then v_1/v_2 is



(A) 1 (B) 2

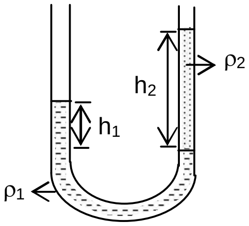
(C) $\sqrt{2}$ (D) $1/\sqrt{2}$

29. The excess pressure inside one soap bubble is four times that of other. Then the ratio of volume of the first bubble to other is

(A) 1 : 64 (B) 1 : 4

(C) 64 : 1 (D) 1 : 2

30. Two liquids which do not react chemically are placed in a bent tube as shown in figure. The heights of the liquids above their surface of separation are



(A) directly proportional to their densities

(B) inversely proportional to their densities

(C) directly proportional to square of their densities

(D) inversely proportional to square of their densities

Space for Rough work

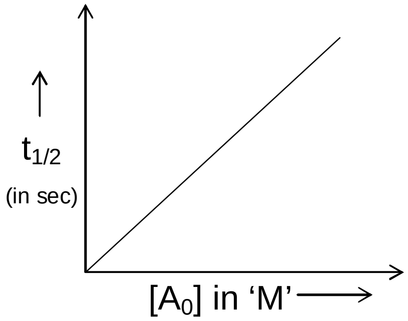
Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. The correct statement regarding the third orbit of hydrogen atom is
(A) it can accommodate a maximum of nine electrons
(B) it contains nine degenerate atomic orbitals
(C) it contains nine atomic orbitals having three sets of degeneracy
(D) it contains nine sub-shells

32.



What is the unit of rate constant of the reaction, for which the above graph is given?

(A) s^{-1} (B) mol $L^{-1}s^{-1}$
(C) mol $L^{-1}s$ (D) mol^{-1} $L^{2}s^{-1}$

33. $SO_3(g)+CO(g) \rightleftharpoons SO_2(g)+CO_2(g)$
Which of the following activity can reduce the equilibrium concentration of CO to half?
(A) Increasing pressure twice
(B) Increasing the volume of reaction container to two times of its initial value
(C) Adding two moles of CO_2 gas
(D) Adding two moles of helium gas at constant pressure

Space for Rough work

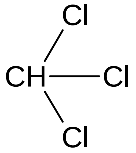
34. 200 mL of 0.4 M solution of CH_3COONa is mixed with 400 mL of 0.2 M solution of CH_3COOH. After complete mixing, 400 mL of 0.1 M NaCl is added to it. What is the pH of the resulting solution? [K_a of $CH_3COOH = 10^{-5}$]
(A) 5.4 (B) 6
(C) 5 (D) 6.2

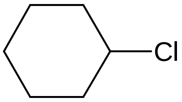
35. Which of the following bond angle is not observed in PCl_5 molecule in gaseous state?
(A) 120^o (B) 180^o
(C) 90^o (D) 60^o

36. Which of the following produces a coloured gas on heating?
(A) $NaNO_3$ (B) $LiNO_3$
(C) $MgCO_3$ (D) Li_3N

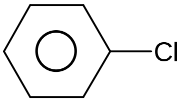
37. Which of the following type of compound is mixed with detergent powder to provide brightness to fabrics?
(A) Borates (B) Peroxoborates
(C) Boranes (D) Borides

38. In which of the following compound, chlorine exerts the maximum number of electronic effects?

(A) 

(B) 

(C) $CH_2 = CH – CH_2Cl$

(D) 

39. The soda extract of which of the following compound gives the test of nitrogen?
(A) NH_2NH_2 (B) HNO_2
(C) $HCONH_2$ (D) All are correct

Space for Rough work

40. Which of the following linkage is present in “Teflon”?

(A) H – C (B) F – F

(C) C – C (D) C = C

41. Which of the following reaction does not produce H_3PO_4?

(A) Reaction between P_4O_{10} and H_2O

(B) Heating of H_3PO_3

(C) Heating of H_3PO_2

(D) Reaction between Ca_3P_2 and H_2O

42. Which of the following reaction produce Cl_2 gas?

(A) $NaCl + H_2SO_4 \longrightarrow$ (B) $KClO_3 \xrightarrow{\text{Heat}}$

(C) $HCl + O_3 \longrightarrow$ (D) $KCl + AgNO_3 \longrightarrow$

43. Which of the following is a colourless complex ion?

(A) $[Cu(NH_3)_4]^{2+}$ (B) $[Cr(H_2O)_6]^{3+}$

(C) $[FeF_6]^{3-}$ (D) $[Mn(H_2O)_6]^{3+}$

44. Which of the following metallurgical process is not needed in order to extract Zn from $ZnCO_3$?

(A) Calcination (B) Roasting

(C) Carbon reduction (D) Distillation

45. Which of the following salt can increase the boiling point of water by maximum extent? (Assume equimolar quantities are added) (Assume complete dissociation of the salts)

(A) NaCl (B) $CaCl_2$

(C) $AlCl_3$ (D) KCl

46. Which of the following ion has the highest coagulation power for the sol. which is obtained by the following reaction?

$FeCl_3\left(\text{excess}\right) + NaOH \longrightarrow Sol$

(A) Al^{3+} (B) SO_4^{2-}

(C) I^- (D) Na^+

Space for Rough work

47. A hydrogen electrode is prepared by using a sample of HCl solution with pH = 4 and H_2 gas at 1 atm pressure. What is the electrode potential of the electrode?
(A) 0.814 V (B) 0.236 V
(C) -0.06 V (D) -0.618 V

48. The heat of atomization of a compound XY_3 in gaseous state is E kJ mol^{-1}. What is the X – Y bond energy of kJ mol^{-1} unit?
(A) E (B) 3E
(C) $\frac{E}{3}$ (D) $\frac{E}{6}$

49. $P(g) + 2Q(g) \longrightarrow PQ_2(g);\ \Delta H = 18\,kJ\ mol^{-1}$
The entropy change of the above reaction(ΔS_{system}) is 60 $JK^{-1}mol^{-1}$. At what temperature, the reaction becomes spontaneous?
(A) Below 200 K (B) Above 300 K
(C) Below 300 K (D) Above 200 K and below 300 K

50. 1.2 L of 0.4 M HCl solution can be completely neutralized by
(A) 600 mL of 1.2 M NaOH solution (B) 800 mL of 0.2 M NaOH solution
(C) 19.2 g of solid NaOH (D) 4.8 mole of NaOH

51. Which of the following should have the highest value for easily liquefiable gases?
(A) ab (B) $\frac{a}{b}$
(C) a + b (D) $\left(\frac{1}{a} + b\right)$

52. $(X) \xrightarrow{Ba^{2+}} \underset{\text{White ppt}}{Y\downarrow} \xrightarrow{Cl_2/H_2O} \underset{\text{White ppt}}{Z\downarrow}$
If the precipitate ($Z\downarrow$) is $BaSO_4$, which of the following can be (X)?
(A) Na_2SO_4 (B) Na_2SO_3
(C) $NaHSO_4$ (D) Na_2CO_3

Space for Rough work

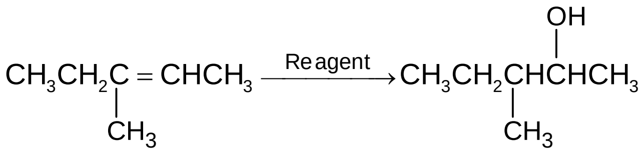
53. In the crystal lattice of CsCl, Cs^+ ions are present at the
(A) tetrahedral voids of the unit cell (B) octahedral voids of the unit cell
(C) body-centre of the unit cell (D) face-centre of the unit cell

54. Which of the following pollutant can form complex with haemoglobin of blood?
(A) CF_2Cl_2 (B) CO
(C) SO_3 (D) $CHCl_3$

55. Which of the following is an artificial sweetner?
(A) Sucrose (B) Sucrolose
(C) Frcutose (D) Maltose

56. Which of the following reagent can convert phenol(PhOH) to anisole($PhOCH_3$)?
(A) $CHCl_3$ (B) CH_2N_2
(C) CH_3Cl (D) HCHO

57.



$$CH_3CH_2\underset{\underset{CH_3}{|}}{C}=CHCH_3 \xrightarrow{\text{Reagent}} CH_3CH_2\underset{\underset{CH_3}{|}}{C}H\overset{\overset{OH}{|}}{C}HCH_3$$

Which reagent forms the above organic product as the single product in the above reaction?
(A) H_2O/H^+ (B) $\frac{Hg(OCOCH_3)_2, H_2O}{NaBH_4}$
(C) $\frac{B_2H_6, THF}{NaOH, H_2O_2}$ (D) $KMnO_4/OH^-$/Cold

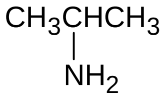
58. Which of the following compound forms two stereoisomers when treated with NH_2OH in weakly acidic medium?
(A) CH_3COCH_3 (B) HCHO
(C) $CH_3COC_2H_5$ (D) $C_2H_5COCH_2CH_3$

Space for Rough work

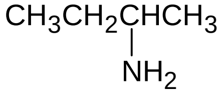
59. $CH_3CH_2CH_2CONH_2 \xrightarrow{Br_2/KOH} \text{Product}$

The organic product of above reaction is

(A) $CH_3CH_2CH_2NH_2$

(B) 
$CH_3\underset{\underset{NH_2}{|}}{C}HCH_3$

(C) $CH_3CH_2CH_2CH_2NH_2$

(D) 
$CH_3CH_2\underset{\underset{NH_2}{|}}{C}HCH_3$

60. Which of the following compound has the highest boiling point?

(A) $CH_3CH_2COOCH_3$

(B) $CH_3CH_2CH_2CONH_2$

(C) $CH_3COOCOCH_3$

(D) CH_3CH_2COCl

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. Let $S=\frac{8}{5}+\frac{16}{65}+\frac{24}{325}+........+\frac{128}{2^{18}+1}$, then

(A) $S=\frac{1088}{545}$ (B) $S=\frac{545}{1088}$

(C) $S=\frac{1056}{545}$ (D) $S=\frac{545}{1056}$

62. A function y = f(x) satisfies $(x+1).f'(x)-2\left(x^2+x\right)f(x)=\frac{e^{x^2}}{(x+1)}$, $\forall x>-1$. If f(0) = 5, then f(x) is

(A) $\left(\frac{3x+5}{x+1}\right).\,e^{x^2}$ (B) $\left(\frac{6x+5}{x+1}\right).e^{x^2}$

(C) $\left(\frac{6x+5}{(x+1)^2}\right).e^{x^2}$ (D) $\left(\frac{5-6x}{x+1}\right).e^{x^2}$

63. If $\vec{a}$ and $\vec{b}$ are not perpendicular to each other and $\vec{r}\times\vec{a}=\vec{b}\times\vec{a}.\vec{r}.\vec{c}=0$, then $\vec{r}$ is equal to

(A) $\vec{a}-\vec{c}$ (B) $\vec{b}+x\vec{a}$ for all scalars x

(C) $\vec{b}-\frac{\left(\vec{b}.\vec{c}\right)}{\left(\vec{a}.\vec{c}\right)}\vec{a}$ (D) None of these

Space for Rough work

64. If $f : R \to R$, $f(f(x)) = (f(x))^2$ then ffff(x) is equal to
(A) $(f(x^4))^2$ (B) $(f(x))^4$
(C) $(f(x^2))^2$ (D) $f(x^4)$

65. If α is a root of $x^2 + ax + 1 = 0$, then $\lim\limits_{x\to 1/\alpha} \dfrac{\sin\left(x^2+ax+1\right)}{\left(\alpha x-1\right)}$ is equal to
(A) $2a\alpha$ (B) $a\alpha^2$
(C) $\dfrac{1-\alpha^2}{\alpha^2}$ (D) does not exist

66. The differential coefficient of f(cosx) with respect to g (sinx) at $x = \pi/3$ if $f'(1/2)$, $g'(\sqrt{3}/2) = -2$ is equal to
(A) $2\sqrt{3}$ (B) $1/\sqrt{3}$
(C) $\sqrt{3}$ (D) $-\sqrt{3}$

67. If $f(x) = |1 - x|$, then the points where $\sin^{-1}(f|x|)$ is non–differentiable are
(A) {0, 1} (B) {0, – 1}
(C) {0, 1, – 1} (D) none of these

68. If the curve $y = x^2 + bx + c$ touches the straight line $y = x$ at the point (1, 1), then b and c are given by
(A) –1, 1 (B) –1, 2
(C) 2, 1 (D) 1, 1

69. $\int e^x\left(\dfrac{2\tan x}{1+\tan x}+\cot^2\left(x+\dfrac{\pi}{4}\right)\right)dx$ is equal to
(A) $e^x \tan\left(\dfrac{\pi}{4}-x\right)+c$ (B) $e^x \tan\left(x-\dfrac{\pi}{4}\right)+c$
(C) $e^x \tan\left(\dfrac{3\pi}{4}-x\right)+c$ (D) none of these

Space for Rough work

70. If $\int \frac{(\sqrt{x})^5}{(\sqrt{x})^7 + x^6} dx = a \ln \frac{x^k}{x^k + 1} + c$, the value of a and k respectively are

(A) $\frac{5}{2}$ and $\frac{2}{5}$ (B) $\frac{2}{5}$ and $\frac{5}{2}$

(C) $\frac{5}{2}$ and 2 (D) none of these

71. The value of $\int_0^{\pi/4} \ln \cos\left(\frac{\pi}{4} + x\right)^{\cot\left(\frac{\pi}{4} - x\right)} dx$ is

(A) 0 (B) 1

(C) 2 (D) not defined

72. The value of $\int_{-10}^{10} \frac{3^x}{3^{[x]}} dx$ is equal to

(A) 20 (B) $\frac{40}{\ln 3}$

(C) $\frac{20}{\ln 3}$ (D) none of these

73. If the intercept made on the line y = mx by the lines x = 2 and x =5 is less then 5, then the range of m is

(A) $\left(-\frac{4}{3}, \frac{4}{3}\right)$ (B) $\left(-\infty, -\frac{4}{3}\right) \cup \left(\frac{4}{3}, \infty\right)$

(C) $\left[-\frac{4}{3}, \frac{4}{3}\right)$ (D) none of these.

74. A pair of unbiased dice is rolled together till a sum of either 5 or 7 is obtained. The probability that 5 comes before 7 is

(A) 2/5 (B) 3/5

(C) 4/5 (D) none of these

Space for Rough work

75. The value of $\sum_{r=1}^{n+1}\left(\sum_{k=1}^{n} {}^{k}C_{r-1}\right)$ (where r, k, n $\in$ N) is equal to

(A) $2^{n+1}-2$ (B) $2^{n+1}-1$
(C) 2^{n+1} (D) none of these

76. If $b_{n+1}=\frac{1}{1-b_n}$ for $n\ge 1$ and $b_1=b_3$, then $\sum_{r=1}^{2001} {b_r}^{2001}$ is equal to

(A) 2001 (B) –2001
(C) 0 (D) none of these

77. The ratio in which the plane $\vec{r}.\left(\vec{i}-2\vec{j}+3\vec{k}\right)=17$ divides the line joining the points $-2\,\vec{i}+4\vec{j}+7\vec{k}$ and $3\vec{i}-5\vec{j}+8\vec{k}$

(A) 1 : 5 (B) 1 : 10
(C) 3 : 5 (D) 3 : 10

78. A tetrahedron has vertices O (0, 0, 0), A (1, 2, 1), B (2, 1, 3) and C (–1, 1, 2), then angle between faces OAB and ABC will be:

(A) $\cos^{-1}\left(\frac{17}{31}\right)$ (B) 30^{o}
(C) 90^{o} (D) $\cos^{-1}\left(\frac{19}{35}\right)$

79. Which of the following are equations of the plane passing through the points P (1, 1, –1), Q (3, 0, 2) and R (–2, 1, 0)?

(A) $\left(2\hat{i}-3\hat{j}+3\hat{k}\right),\left(\left(x+2\right)\hat{i}+\left(y-1\right)\hat{j}+z\hat{k}\right)=0$

(B) $x=3-t,\ y=-11t,\ z=2-3t$

(C) $\left(x+2\right)+11\left(y-1\right)=3z$

(D) $\left(2\hat{i}-\hat{j}+3\hat{k}\right)\times\left(-3\hat{i}+\hat{k}\right).\left(\left(x+2\right)\hat{i}+\left(y-1\right)\hat{j}+z\hat{k}\right)=0$

Space for Rough work

80. The number of pairs of integer (x, y) that satisfy the following two equations $\begin{cases}\cos(xy) = x \\ \tan(xy) = y\end{cases}$ is

(A) 1 (B) 2
(C) 4 (D) 6

81. The total number of solutions of $\ln|\sin x| = -x^2 + 2x$ in $\left[-\frac{\pi}{2}, \frac{3\pi}{2}\right]$ is equal to

(A) 1 (B) 2
(C) 4 (D) none of these

82. Let AD be a median of the ΔABC. If AE and AF are medians of the triangle ABD and ADC, respectively. And $AD = m_1,\ AE = m_2,\ AF = m_3,$ then $a^2/8$ is equal to

(A) $m_2^2 + m_3^2 - 2m_1^2$ (B) $m_1^2 + m_2^2 - 2m_3^2$
(C) $m_1^2 + m_3^2 - 2m_2^2$ (D) none of these

83. If A is order 3 square matrix such that $|A| = 2,$ then $|\text{adj}(\text{adj}(\text{adj}\,A))|$ is

(A) 512 (B) 256
(C) 64 (D) none of these

84. Let $\{D_1, D_2, D_3, ...D_n\}$ be the set of third order determinants that can be made with the distinct non – zero real numbers a_1, a_2 ……..a_9. Then

(A) $\sum_{i=1}^{n} D_i = 1$ (B) $\sum_{i=1}^{n} D_i = 0$
(C) $D_i = D_{j,}\ \forall i, j$ (D) None of these

85. If A and B are square matrices of the same order and A is non singular, then for a positive integer $n, \left(A^{-1}BA\right)^n$ is equal to

(A) $A^{-n}B^nA^n$ (B) $A^nB^nA^{-n}$
(C) $A^{-1}B^nA$ (D) $n\left(A^{-1}BA\right)$

Space for Rough work

86. If both roots of equation $ax^2 + x + c - a = 0$ are imaginary and $c > -1$, then
(A) $3a > 2 + 4c$ (B) $3a < 2 + 4c$
(C) $c < a$ (D) none of these

87. The value of a for which the equation $x^3 + 2ax + 2 = 0$ and $x^4 + 2ax^2 + 1 = 0$ have a common root is
(A) $\frac{17}{8}$ (B) $-\frac{17}{8}$
(C) $\frac{15}{8}$ (D) $-\frac{15}{8}$

88. Let S be the set of 6-digit numbers $a_1a_2a_3a_4a_5a_6$ (all digits distinct)
where $a_1 > a_2 > a_3 > a_4 < a_5 < a_6$. Then n(S) is equal to
(A) 210 (B) 2100
(C) 4200 (D) 420

89. 6 boys and 4 girls sit in a line so that p is the number of arrangements when no two girls sit together and q is the number of arrangements when all the girls sit together, then $\frac{p}{q}$ is
(A) 1 (B) $\frac{7}{2}$
(C) 5 (D) none of these

90. In a n sided regular polygon the probability that the two diagonal chosen at random will intersect inside the polygon is
(A) $\frac{2\,{}^nC_2}{{}^{({}^nC_2-n)}C_2}$ (B) $\frac{{}^{n(n-1)}C_2}{{}^{({}^nC_2-n)}C_2}$
(C) $\frac{{}^nC_4}{{}^{({}^nC_2-n)}C_2}$ (D) none of these

Space for Rough work

FIITJEE

JEE(Main)-2018

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

CONCEPT RECAPITULATION TEST – I

(Main)

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**B**	31.	**B**	61.	**A**
2.	**C**	32.	**B**	62.	**B**
3.	**C**	33.	**B**	63.	**C**
4.	**D**	34.	**C**	64.	**A**
5.	**A**	35.	**D**	65.	**C**
6.	**B**	36.	**B**	66.	**C**
7.	**D**	37.	**B**	67.	**C**
8.	**A**	38.	**D**	68.	**A**
9.	**B**	39.	**C**	69.	**B**
10.	**A**	40.	**C**	70.	**B**
11.	**B**	41.	**D**	71.	**D**
12.	**B**	42.	**C**	72.	**B**
13.	**C**	43.	**C**	73.	**A**
14.	**D**	44.	**B**	74.	**A**
15.	**C**	45.	**C**	75.	**A**
16.	**C**	46.	**B**	76.	**B**
17.	**C**	47.	**B**	77.	**D**
18.	**A**	48.	**C**	78.	**D**
19.	**B**	49.	**B**	79.	**D**
20.	**D**	50.	**C**	80.	**A**
21.	**D**	51.	**B**	81.	**B**
22.	**A**	52.	**B**	82.	**C**
23.	**D**	53.	**C**	83.	**B**
24.	**C**	54.	**B**	84.	**B**
25.	**D**	55.	**B**	85.	**C**
26.	**C**	56.	**B**	86.	**B**
27.	**A**	57.	**C**	87.	**B**
28.	**D**	58.	**C**	88.	**B**
29.	**A**	59.	**A**	89.	**C**
30.	**B**	60.	**B**	90.	**C**

Physics PART – I

SECTION – A

1. B

Sol. capillary rise

$$h = \frac{2T\cos(\theta)}{r\rho g}$$

$$\therefore \frac{h_1}{h_2} = \frac{r_2}{r_1} = \frac{0.4}{0.2} = 2:1$$

2. C

Sol. x = A $\sin(\omega t + \phi_o)$

At t = 0, x = 0 $\Rightarrow A\sin\phi_o = 0$ or $\phi_o = 0$

Hence, x = A $\sin(\omega t)$

or A/2 = A sin (ωt)

or 1/2 = sin (ωt)

$$\omega t = \sin^{-1}\left(\frac{1}{2}\right) = \frac{\pi}{6}$$

$$t = \frac{\pi}{6\omega} = \frac{\pi.T}{6(2\pi)}$$

as $\omega = 2\pi / T$ $\Rightarrow$ t T/12 = 1/3 s

3. C

Sol. $$i = \frac{E}{R}\left(1 - e^{-\frac{tR}{L}}\right)$$

4. D

Sol. $$\frac{E_{4n} - E_{2n}}{E_{2n} - E_n} = \frac{\frac{E_1}{16n^2} - \frac{E_1}{4n^2}}{\frac{E_1}{4n^2} - \frac{E_1}{n^2}} = \frac{1}{4} = \text{constant}$$

5. A

Sol. $f\lambda = v = \frac{10\lambda v}{d} \Rightarrow \lambda = \frac{d}{10}$.

Maximum path diff. can be $\frac{d}{3}$. Hence, number of maximum will be 6.

6. B

Sol. $C_{rms} = \sqrt{\frac{3RT}{M}}$ or $C_{rms} \alpha \sqrt{T}$

$$\frac{(C_{rms})_{T_2}}{(C_{rms})_{T_1}} = \sqrt{\frac{T_2}{T_1}} = \sqrt{\frac{400}{100}} = 2$$

$(C_{rms})_{T_2} = 2(C_{rms})_{T_1} = 2 \times v = 2v$

7. D

Sol. $t = 20 \text{ min} = \frac{1}{3}\text{hr}$

$1 \text{ km} = \sqrt{(6)^2 - V^2} \times \left(\frac{1}{3}\text{hr}\right)$

$V = 3\sqrt{3}$ km/hr.

8. A

Sol. $12.75 = \left|E_0 - \frac{E_0}{n^2}\right| = \left|-13.6 - \frac{(-13.6)}{n_1^2}\right|$

$\Rightarrow \quad n = 4$

no. of lines $= \frac{n(n-1)}{2} = 6$

9. B

Sol. $qvB = \frac{mv^2}{R}$

$mv = qRB = 1.6 \times 10^{-21}$ kg m/sec

10. A

Sol: Consider the differential element of the cylinder as shown in the figure.

$\therefore \quad R = \int_{R_1}^{R_2} \rho \frac{dx}{2\pi x l} \qquad (\because R = \rho\frac{l}{a})$

$\Rightarrow R = \frac{\rho}{2\pi l}\ln\left(R_2/R_1\right)$

$I = \frac{\varepsilon}{R} \quad ; \quad \Rightarrow I = \frac{2\pi l \varepsilon}{\rho \ln\left(\frac{R_2}{R_1}\right)}$

11. B

Sol. +ve slope = +ve velocity and convex graph = –ve acceleration
Concave graph = +ve acceleration

12. B

Sol. $\frac{1}{2}mv^2$ = Power t = Fv t = kt

$\therefore \quad V = \sqrt{\frac{2kt}{m}}$

13. C

Sol: Let dq be the charge which has passed in a small interval of time dt, then dq = idt = (4 + 2t)dt. Hence total charge passed between interval t = 2 sec and t = 6 sec $q = \int_2^6 (4+2t)dt$ = 48 coulomb.

14. D

Sol. Maximum stress on the wire will be at highest point (at the point of suspension)

$\therefore$ stress = $\frac{\text{weight}}{A} = \frac{Al\rho g}{A} = \sigma$

$\therefore$ $l = \frac{\sigma}{\rho g}$

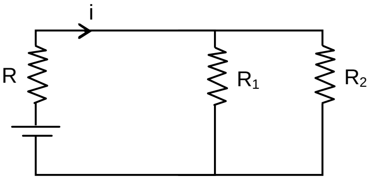
15. C

Sol. T + f = mg sin θ (Translational equilibrium)

T(R) = f(R) (Rotational equilibrium)

16. C

Sol. Inductor behaves like a cell of emf, ε' = Blv and equivalent ckt is



Blv = ε'

Hence, $i = \frac{Blv}{R + \frac{R_1R_2}{R_1+R_2}}$

$= \frac{Blv(R_1+R_2)}{RR_1+RR_2+R_1R_2}$

17. C

Sol. $E = -\frac{\Delta V}{\Delta r}$ directed $\perp^r$ to an equipotential surface.

18. A

Sol. Inside water

u = –20 cm

f = –15 cm

$\Rightarrow$ v = –60 cm

$m = \frac{-v}{u} = -3$

$\Rightarrow$ n = 3

19. B

Sol. $C = C_v + \frac{PdV}{ndT}$,

$PV^{3/2} = k$, $PV = nRT$

find relation in V and T

$\frac{dV}{dT} = -\frac{2V}{T}$

$\therefore C = C_v - 2R$

20. D

Sol. $A_1V_1 = A_2V_2 \Rightarrow a\sqrt{2gh} = A\left(-\frac{dh}{dt}\right)$

$$\Rightarrow \frac{a}{A}\int_0^t dt = -A\int_{h_1}^{h_2} \frac{dh}{\sqrt{2gh}}$$

21. D

Sol. No relative motion between source and observers.

22. A

Sol. Heat energy flowing per sec is given by

$$H = \frac{Q}{t} = KA\frac{\Delta\theta}{\Delta x} \qquad \text{. . . (i)}$$

if dm mass of ice is increased in time dt, then

$$\frac{dm}{dt} = \frac{A\,dx\,\rho}{dt} = A.\rho.\frac{dx}{dt}$$

Since, $H = \left(\frac{dm}{dt}\right)L$

$$\therefore \qquad H = A\rho\frac{dx}{dt}L \qquad \text{. . . (ii)}$$

From eq. (I) and (II)

$$A\rho L\frac{dx}{dt} = KA\frac{\Delta\theta}{\Delta x}$$

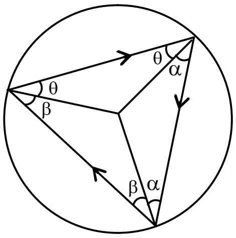
Rate of thickening of ice = dx/dt

$$\therefore \qquad \frac{dx}{dt} = \frac{KA}{\rho AL}\,\frac{\Delta\theta}{\Delta x} = \frac{K}{\rho L}\,\frac{\Delta\theta}{\Delta x} = \frac{4\times10^{-4}}{0.9\times10^3\times80}\times\left[\frac{0-(-15)}{2\times10^{-2}}\right]$$

$= 4.166 \times 10^{-6}$ m/s = 1.5 cm/ hour.

23. D

Sol. $\tan\alpha = \frac{u\sin\theta}{eu\cos\theta} = \frac{\tan\theta}{e}$



$\therefore\ \tan\alpha = \frac{1}{e}\tan\theta$

$\therefore\ \tan\beta = \frac{1}{e}\tan\theta$

$2\theta + 2\alpha + 2\beta = 180°$

$\alpha + \beta = (90 - \theta)$

$\tan(\alpha + \beta) = \cot\theta$

$$\Rightarrow \frac{\tan\alpha + \tan\beta}{1 - \tan\alpha\tan\beta} = \frac{1}{\tan\theta}$$

$$\Rightarrow \frac{\frac{1}{e}\tan\theta + \frac{1}{e^2}\tan\theta}{1 - \frac{1}{e^3}\tan^2\theta} = \frac{1}{\tan\theta}$$

$$\Rightarrow \quad \tan^2\theta\left(\frac{1}{e}+\frac{1}{e^2}\right)=1-\frac{1}{e^3}\tan^2\theta$$

$$\Rightarrow \quad \tan^2\theta\left(\frac{1}{e}+\frac{1}{e^2}+\frac{1}{e^3}\right)=1$$

$$\tan^2\theta\left(\frac{1}{\frac{1}{e}+\frac{1}{e^2}+\frac{1}{e^3}}\right)=\frac{e^3}{1+e+e^2}$$

24. C

Sol. Let the cylinder is slightly displaced from mean position.
The total energy of the system when elongation in spring is x.

$$E = \frac{1}{2}kx^2+\frac{1}{2}Mv^2+\frac{1}{2}\times\left(\frac{1}{2}MR^2\right)\omega^2$$

Differentiating the above expression, we get

$$2kx\frac{dx}{dt}+M2v\frac{dv}{dt}+\frac{1}{2}MR^2\frac{2v}{R^2}\frac{dv}{dt}=0$$

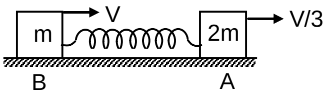
$$2kx + (2M + M)\ \frac{dv}{dt} = 0$$

$$\frac{dv}{dt}=-\left(\frac{2K}{3M}\right)x$$

$$T = 2\pi\sqrt{\frac{3M}{2k}}$$

25. D

Sol. Velocity of A after the collision with C, $V_1 = \frac{V}{3}$



$\therefore$ Velocity of each block A and B at maximum compression

$$V_2 = \frac{5}{9}V$$

$$\therefore \quad \frac{1}{2}k\,x^2+\frac{1}{2}3m\left(\frac{5}{9}V\right)^2$$

$$= \frac{1}{2}mv^2+\frac{1}{2}2m\left(\frac{V}{3}\right)^2$$

$$x = \sqrt{\frac{8m}{27K}}V$$

26. C

Sol. Velocity of ball 'A' just after the collision $V=\left(1+\frac{1}{2}\right)\cdot\frac{2}{3}u=u$

Velocity of ball 'B' just after the collision = 0.

$$\therefore \quad \omega=\frac{u-0}{L}=\frac{u}{L}$$

27. A

Sol. $T = \frac{t}{20}$ °C where t is time in seconds.

$$\frac{d\theta}{dt} = \frac{kA(T-0)}{\ell}$$

$$\Delta Q = \int dQ = \frac{kA}{\ell}\int \frac{t}{20}dt = 18000 \text{ J.}$$

28. D

Sol. $v = \sqrt{\frac{T}{\mu}}$; $V_{AB} = \sqrt{\frac{T}{\mu}}$; $V_{CD} = \sqrt{\frac{2T}{\mu}}$

29. A

Sol. $\frac{4S}{R_1} = 4\left(\frac{4S}{R_2}\right)$

$\Rightarrow$ $R_2 = 4R_1$

Required ratio = $\frac{\frac{4}{3}\pi R_1^3}{\frac{4}{3}\pi R_2^3}$

30. B

Sol. At the level of interface

$P_{left} = P_{right}$

$\rho_1 g h_1 = \rho_2 g h_2$

$\Rightarrow$ $\rho \propto \frac{1}{h}$.

Chemistry PART – II

SECTION – A

31. B

Sol. In H-atom, the orbitals(five 3d, three 3p and one 3s) have same energy. So, they are called degenerate orbitals.

32. B

Sol. It is a zero order reaction.

33. B

Sol. Increasing the volume of reaction container twice, the concentration of all the species will reduce to half.

34. C

Sol. $$pH = p_{Ka} + \log\frac{[CH_3COONa]}{[CH_3COOH]} = 5 + \log\frac{200\times0.4}{400\times0.2} = 5$$

35. D

Sol. The observed bond angles are 120°, 180° and 90°.

36. B

Sol. $4LiNO_3 \longrightarrow 2Li_2O + 4NO_2 + O_2$

37. B

Sol. Peroxoborates contain peroxide linkages, which behave as bleaching agent.

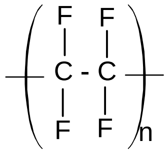
38. D

Sol. In chlorobenzene, Cl exerts –I and +R effect. In other compounds, it only exerts –I effect.

39. C

Sol. Carbon should be present in the compound for giving nitrogen test.

40. C

Sol. Teflon is 

$$\left(-\overset{F}{\underset{F}{C}}-\overset{F}{\underset{F}{C}}-\right)_n$$

41. D

Sol. $Ca_3P_2 + 6H_2O \longrightarrow 3Ca(OH)_2 + 2PH_3$

42. C

Sol. $NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$

$$2KClO_3 \xrightarrow{\Delta} 2KCl + 3O_2$$

$$2HCl + O_3 \longrightarrow Cl_2 + O_2 + H_2O$$

$$KCl + AgNO_3 \longrightarrow AgCl + KNO_3$$

43. C

Sol. Due to stable $t_{2g}^3 e_g^2$ configuration of Fe^{3+} ion.

44. B

Sol. Roasting is carried out for sulphide ores.

45. C

Sol. It produces maximum number of ions as compared to other salts.

46. B

Sol. The sol becomes positively charged due to excess of Fe^{3+} ions.

47. B

Sol. $E = E^o - \frac{0.0591}{n}\log\left[H^+\right] = 0 - \frac{0.0591}{1}\log 10^{-4} = 0.236\,V$

48. C

Sol. $XY_3(g) \longrightarrow X(g) + 3Y(g)$; $\Delta H = E$ kJ mol^{-1}

$\therefore$ B.E of XY = $\frac{E}{3}$ as XY_3 contains three X – Y bonds.

49. B

Sol. For spontaneous process, $\Delta G < 0$.

$\therefore$ $\Delta H - T\Delta S < 0$, $\Delta H < T\Delta S$

$\therefore$ $T > \frac{\Delta H}{\Delta S} = \frac{18000}{60} = 300\,K$

50. C

Sol. Moles of HCl = $\frac{1200 \times 0.4}{1000} = 0.48$

Moles of NaOH = $\frac{19.2}{40} = 0.48$

51. B

Sol. Easily liquefiable gases should have high critical temperature(T_C), which is given by

$T_C = \frac{8a}{27Rb} = \left(\frac{8}{27R}\right)\frac{a}{b}$

$\therefore T_C \, \alpha \, \frac{a}{b}$

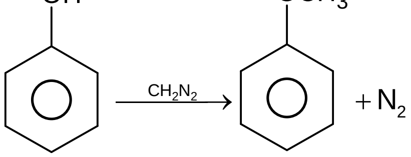
52. B
Sol. X = Na_2SO_3
Y = $BaSO_3$
Z = $BaSO_4$

53. C
Sol. CsCl has b.c.c. unit cell.

54. B
Sol. ‘CO’ can form carboxy haemoglobin.

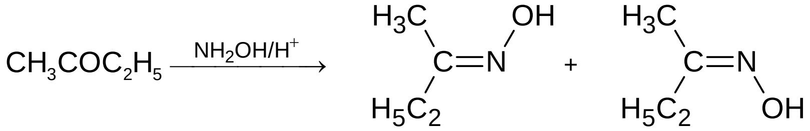
55. B
Sol. Sucrolose is an artificial sweetner.

56. B
Sol.


OH
CH_2N_2
OCH_3
$+N_2$

57. C
Sol. Anti Markownikoff reaction takes place in this case.

58. C
Sol.


$CH_3COC_2H_5$
NH_2OH/H^+
H_3C
OH
C=N
H_5C_2
+
H_3C
C=N
H_5C_2
OH

59. A
Sol. $CH_3CH_2CH_2CONH_2 \xrightarrow[KOH]{Br_2} CH_3CH_2CH_2NH_2$

60. B
Sol. Due to intermolecular hydrogen bonding.

Mathematics PART – III

SECTION – A

61. A

Sol. $\because$ $S=\sum_{r=1}^{16}\frac{8r}{\left(4r^4+1\right)}$

$$=\sum_{r=1}^{16}\frac{8r}{\left(2r^2-2r+1\right)\left(2r^2+2r+1\right)}$$

$$=2\sum_{r=1}^{16}\left(\frac{1}{2r^2-2r+1}-\frac{1}{2r^2+2r+1}\right)$$

$$=2\left\{\frac{1}{1}-\frac{1}{5}+\frac{1}{5}-\frac{1}{13}+\frac{1}{13}+......+\frac{1}{481}-\frac{1}{545}\right\}\quad=2\left(1-\frac{1}{545}\right)=\frac{1088}{545}$$

62. B

Sol. $f'(x)-\frac{2x(x+1)}{x+1}f(x)=\frac{e^{x^2}}{(x+1)^2}$

$$\text{IF }=e^{\int -2x\,dx}=e^{-x^2}$$

$\Rightarrow$ $f(x).\left(-e^{-x^2}\right)=\int\frac{dx}{(x+1)^2}$

$\Rightarrow$ $f(x).e^{-x^2}=\frac{1}{x+1}+C$

At x = 0, f(0) = 5

$\Rightarrow$ $C = 6$

$\therefore$ $f(x)=\left(\frac{6x+5}{x+1}\right).e^{x^2}$

Hence, (b) is the correct answer.

63. C

Sol. We have $\vec{r}\times\vec{a}=\vec{b}\times\vec{a}$

$\Rightarrow$ $\left(\vec{r}-\vec{b}\right)\times\vec{a}=0$

$\Rightarrow$ $\vec{r}-\vec{b}$ is parallel to $\vec{a}$

$\Rightarrow$ $\vec{r}=\vec{b}+\lambda\vec{a}$ ....(i)

Now, $\vec{r}.\vec{c}=0$

$\Rightarrow$ $\left(\vec{b}+\lambda\vec{a}\right).\vec{c}=0$

$\Rightarrow$ $\vec{b}\,.\,\vec{c}+\lambda\left(\vec{a}.\vec{c}\right)=0$

$\Rightarrow$ $\lambda=-\frac{\vec{b}.\vec{c}}{\vec{a}.\vec{c}}$

On putting the value of λ in Eq. (i), we get

$$\vec{r} = \vec{b} - \frac{\left(\vec{b}.\vec{c}\right)}{\left(\vec{a}.\vec{c}\right)}\vec{a}$$

Hence, (c) is the correct answer.

64. A

Sol. Replacing f (x) by x, we f (x) = x^2

$\Rightarrow$ ffff (x) = x^{16} also $(f(x^4))^2 = x^{16}$.

65. C

Sol. Since coefficient of $x^2 + ax + 1$ are symmetrical so roots will be α, $\frac{1}{\alpha}$

$$\lim_{x\to 1/\alpha} \frac{\sin\left(x^2+ax+1\right)}{(\alpha x-1)} = \lim_{x\to 1/\alpha} \frac{\sin\left[\left(x-\frac{1}{\alpha}\right)(x-\alpha)\right]}{\left(x-\frac{1}{\alpha}\right)(x-\alpha)} . \frac{\left(x-\frac{1}{\alpha}\right)(x-\alpha)}{(\alpha x-1)}$$

$$= \lim_{x\to 1/\alpha} \frac{(x-\alpha)}{\alpha} = \frac{\frac{1}{\alpha}-\alpha}{\alpha} = \frac{1-\alpha^2}{\alpha^2}$$

66. C

Sol. If u = f(cos x) and v = g (sinx)

$$\Rightarrow \quad \frac{du}{dv} = \frac{-f'(\cos x)\sin x}{g'(\sin x)\cos x}$$

At x = $\frac{\pi}{3}$, $= \dfrac{-f'\left(\frac{1}{2}\right)\tan\frac{\pi}{3}}{g'\left(\frac{\sqrt{3}}{2}\right)} = \dfrac{-2}{-2}\times\sqrt{3} = \sqrt{3}$

67. C

Sol. Given that f (x) = |1 − x|

$$\Rightarrow f(|x|) = \begin{cases} x-1, & x>1 \\ 1-x, & 0<x\le 1 \\ 1+x, & -1\le x\le 0 \\ -x-1, & x<-1 \end{cases}$$

Clearly the domain of $\sin^{-1}$ (f |x|) is [–2, 2].

$\Rightarrow$ It is non differentiable at the points {– 1, 0, 1}.

68. A

Sol. y = x touches y = $x^2 + bx + c$

1 = 1 + b + c $\Rightarrow$ b + c = 0 ……(1)

$$\frac{dy}{dx} = 2x+b\Big|_{(1,\ 1)} = 2+b = 1 \Rightarrow b = -1, \text{ c = 1.}$$

(b, c) = (–1, 1).

69. B

Sol. $\int e^x\left(\frac{2\tan x}{1+\tan x}+\tan^2\left(x-\frac{\pi}{4}\right)\right)dx$

$=\int e^x\left(\tan\left(x-\frac{\pi}{4}\right)+\sec^2\left(x-\frac{\pi}{4}\right)\right)dx$

$=e^x\tan\left(x-\frac{\pi}{4}\right)+c$.

70. B

Sol. $\int\frac{dx}{(\sqrt{x})^2+(\sqrt{x})^7}=\int\frac{dx}{(\sqrt{x})^7\left(1+\frac{1}{(\sqrt{x})^5}\right)}$

Put $\frac{1}{(\sqrt{x})^5}=y$

$\frac{dy}{dx}=-\frac{5}{2(\sqrt{x})^7}$

$\therefore$ I = $\int\frac{-2dy}{5(1+y)}=-\frac{2}{5}\ln|1+y|+c=+\frac{2}{5}\ln\left(\frac{1}{1+\frac{1}{(\sqrt{x})^5}}\right)$

$\therefore$ a = $\frac{2}{5}$, k = $\frac{5}{2}$.

71 D

Sol. $\int_0^{\pi/4}\ln\left(\cos\left(\frac{\pi}{4}+x\right)\right)^{\cot\left(\frac{\pi}{4}-x\right)}dx=\int_0^{\pi/4}\cot\left(\frac{\pi}{4}-x\right).\ln\cos\left(\frac{\pi}{4}+x\right)dx$

$\int_0^{\pi/4}\cot\left(\frac{\pi}{4}-\left(\frac{\pi}{4}+0-x\right)\right)\ln\cos\left(\frac{\pi}{4}+\left(\frac{\pi}{4}+0-x\right)\right)dx$

$=\int_0^{\pi/4}\cot x.\ln(\sin x)dx=\frac{1}{2}(\ln\sin x)^2\Big|_0^{\pi/4}$ = not defined.

72. B

Sol. $\int_{-10}^{10}\frac{3^x}{3^{[x]}}dx=20\int_0^1 3^{x-[x]}dx=20\int_0^1 3^{\{x\}}dx=20\int_0^1 3^x dx$

$=20\left[\frac{3^x}{\ln 3}\right]_0^1=\frac{40}{\ln 3}$.

73. A

Sol. The distance between (2, 2m) and (5, 5m) is less then 5.
$\Rightarrow(5-2)^2+(5m-2m)^2<25$

$\Rightarrow 9m^2 < 16$

$m^2 < \left(\frac{4}{3}\right)^2 \Rightarrow -\frac{4}{3} < m < \frac{4}{3}$.

74. A

Sol. Let A denote the event that a sum of 5 occurs, B the event that a sum of 7 occurs and C the event that neither a sum of 5 nor a sum of 7 occurs. We have

$P(A) = \frac{4}{36} = \frac{1}{9}, P(B) = \frac{6}{36} = \frac{1}{6}$

$P(C) = \frac{26}{36} = \frac{13}{18}$

Thus, probability that A occurs before B is

$P\left[A \text{ or} (C \cap A) \text{or} (C \cap C \cap A) \text{or} ....\right]$

$= P(A) + P(C \cap A) + P(C \cap C \cap A) + ...$

$= P(A) + P(C)P(A) + P(C)^2 P(A) + ...$

$= \frac{1}{9} + \left(\frac{13}{18}\right) \times \frac{1}{9} + \left(\frac{13}{18}\right)^2 \frac{1}{9} + ...$

$= \frac{1/9}{1 - 13/18} = \frac{2}{5}$

75. A

Sol $\sum_{r=1}^{n+1}\left(\sum_{k=1}^{n} {}^kC_{r-1}\right)$

$= \sum_{r=1}^{n+1}\left(\sum_{k=1}^{n}\left({}^{k+1}C_r - {}^kC_r\right)\right)$

$= \sum_{r=1}^{n+1}\left({}^{n+1}C_r - {}^1C_r\right) = 2^{n+1} - 2$

76. B

Sol. $b_2 = \frac{1}{1 - b_1}$

$b_3 = \frac{1}{1 - b_2} = \frac{1}{1 - \frac{1}{1 - b_1}} = \frac{1 - b_1}{-b_1} = \frac{b_1 - 1}{b_1}$

$b_1 = b_3 \Rightarrow b_1^2 - b_1 + 1 = 0$

$\Rightarrow b_1 = -\omega$ or $\omega^2 \Rightarrow b_2 = \frac{1}{1 + \omega} = -\omega$ or ω^2

$\sum_{r=1}^{2001} b_r^{2001} = \sum_{r=1}^{2001} (-\omega)^{2001}$

$= \sum_{r=1}^{2001} -1 = -2001$

77. D

Sol. Let the plane $\vec{r}.\left(\vec{i}-\vec{2}\,j+3\vec{k}\right)=17$ divide the line joining the points $-2\vec{i}+\vec{4}j+7\vec{k}$ and $\vec{3}i--5\vec{j}+8\vec{k}$ in the ratio t : 1 at point P.

Therefore, point P is

$$\frac{3t-2}{t+1}\vec{i}+\frac{-5t+4}{t+1}\vec{j}+\frac{8t+7}{t+1}\vec{k}$$

This lies on the given plane

$$\therefore\frac{3t-2}{t+1}(1)+\frac{-5t+4}{t+1}(-2)+\frac{8t+7}{t+1}(3)=17$$

Solving, we get

$$t=\frac{3}{10}$$

78. D

Sol. Vector perpendicular to the face OAB is

$$\overrightarrow{OA}\times\overrightarrow{OB}=\left(\hat{i}+2\hat{j}+\hat{k}\right)\times\left(2\hat{i}+\hat{j}+3\hat{k}\right)$$

$$=5\hat{i}-\hat{j}-3\hat{k}$$

Vector perpendicular to face ABC is

$$\overrightarrow{AB}\times\overrightarrow{AC}=\left(\hat{i}-\hat{j}+2\hat{k}\right)\times\left(-2\hat{i}-\hat{j}+\hat{k}\right)$$

$$=\hat{i}-5\hat{j}-3\hat{k}$$

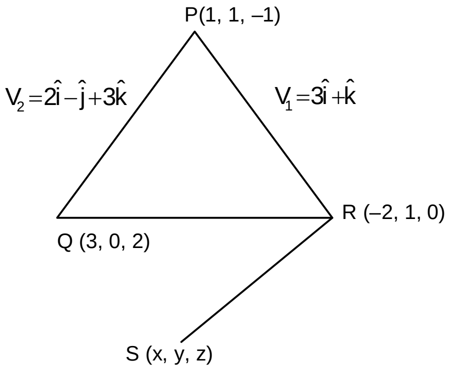
Since the angle between the face = angle between their normal, therefore

$$\cos\theta=\frac{5+5+9}{\sqrt{35}\sqrt{35}}=\frac{19}{35}\Rightarrow\theta=\cos^{-1}\left(\frac{19}{35}\right)$$

79. D

Sol. $\vec{V}_1$, $\vec{V}_2$, $\overrightarrow{PS}$ are in the same plane

$$\therefore\left(2\hat{i}-\hat{j}+3\hat{k}\right)\times\left(-3\hat{i}+\hat{k}\right).\left((x+2)\hat{i}+(y-1)\hat{j}+z\hat{k}\right)=0$$



80. A

Sol. $$\frac{\sin(xy)}{\cos(xy)}=y$$

$$\Rightarrow\sin(xy)=xy$$

$$\Rightarrow xy=0$$

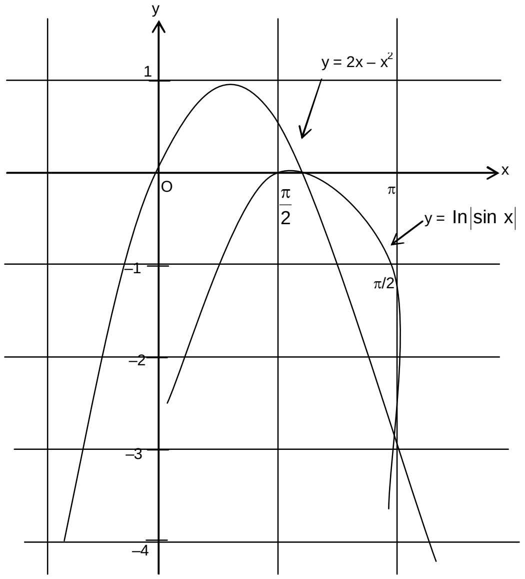
$\Rightarrow x=0$ or y = 0

But x = 0 is not possible

$\therefore$ y = 0 and x = 1, i.e. (1, 0)

81. B

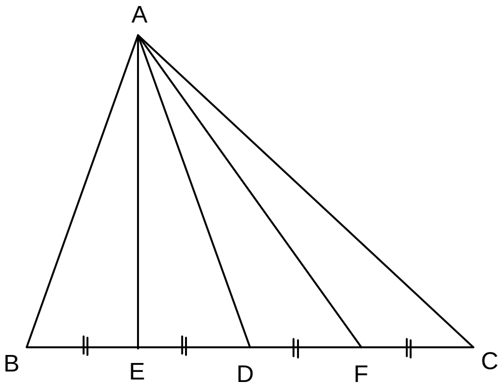
Sol.



$\ln|\sin x| = -x(x-2)$

Graphs of $y = \ln|\sin x|$ and $y = -x(x-2)$ meet exactly two times in $\left[-\frac{\pi}{2}, \frac{3\pi}{2}\right]$

82. C



Sol. In ΔABC, $AD^2 = m_1^2 = \frac{c^2+b^2}{2} - \frac{a^2}{4}$

In ΔABD, $AE^2 = m_2^2 = \frac{AD^2+c^2}{2} - \frac{\left(\frac{a}{2}\right)^2}{4}$

[Apollonius Theorem]

In ΔADC, $AF^2 = m_3^2 = \frac{AD^2+b^2}{2} - \frac{\left(\frac{a}{2}\right)^2}{4}$

$$\therefore \quad m_2^2 + m_3^2 = AD^2 + \frac{b^2+c^2}{2} - \frac{a^2}{8}$$

$$= m_1^2 + \frac{a^2}{4} - \frac{a^2}{8} = 2m_1^2 + \frac{a^2}{8}$$

$$\Rightarrow \quad m_2^2 + m_3^2 - 2m_1^2 = \frac{a^2}{8}$$

83. B

Sol. We know that $|\text{adj}(\text{adj } A)| = |A|^{(n-1)^2}$

$$\Rightarrow \quad |\text{adj}(\text{adj}(\text{adj } A))| = |\text{adj} A|^{(n-1)^2}$$

$$= |A|^{(n-1)^3} = 2^8 = 256$$

84. B

Sol. The total number of third order determinants is 9! Since the number of determinants is even and in which there are 9!/2 pairs of determinants which are obtained by changing two consecutive rows,

So $\sum_{i=1}^{n} D_i = 0$.

85. C

Sol. $\left(A^{-1}BA\right)^2 = \left(A^{-1}BA\right)\left(A^{-1}BA\right)$

$= A^{-1}B\left(AA^{-1}\right)BA$

$\Rightarrow A^{-1}BIBA = A^{-1}B^2A$

$\left(A^{-1}BA\right)^3 = \left(A^{-1}B^2A\right)\left(A^{-1}BA\right)$

$= A^{-1}B^2\left(AA^{-1}\right)BA$

$= A^{-1}B^3A$ and so on

$\therefore \left(A^{-1}BA\right)^n = A^{-1}B^nA$

86. B

Sol. Let f (x) = $ax^2 + x + c - a$

f (1) = c + 1 > 0 $(\because c > -1)$

$\therefore$ Given expression is positive for every $x \in R$

So, $f\left(\frac{1}{2}\right) > 0 \Rightarrow \frac{a}{4} + \frac{1}{2} + c - a > 0 \Rightarrow 4c - 3a + 2 > 0$

$\Rightarrow 4c + 2 > 3a$.

87. B

Sol. Let α be a common root then $\alpha^3 + 2a\alpha + 2 = 0$ and $\alpha^4 + 2a\alpha^2 + 1 = 0$

i.e. $\alpha^4 + 2a\alpha^2 + 2\alpha = 0$ ….(i)

$\alpha^4 + 2a\alpha^2 + 1 = 0$ …(ii)

From (i) and (ii) $2\alpha - 1 = 0 \Rightarrow \alpha = \frac{1}{2}$

So, $\left(\frac{1}{2}\right)^3 + 2a\frac{1}{2} + 2 = 0 \Rightarrow \frac{1}{8} + a + 2 = 0 \Rightarrow a = -2 - \frac{1}{8} = -\frac{17}{8}$.

88. B

Sol. First, 6 distinct digits can be selected in ${}^{10}C_6$ ways. Now the position of smallest digit in them is fixed i.e. position 4. Of the remaining 5 digits, two digits can be selected in ${}^{5}C_2$ ways. These two digits can be placed to the right of 4th position in one way only. The remaining three digits to the left of 4th position are in the required order automatically.

So n(S) = ${}^{10}C_6 \times {}^{5}C_2 = 210 \times 10 = 2100$.

89. C

Sol. Clearly $p = 6!\ {}^7P_4$

$q = 7!\ .\ 4!$

$\frac{p}{q} = 5$

90. C

Sol. When 4 points are selected we get one intersecting point. So probability is $\frac{{}^nC_4}{{}^{({}^nC_2 - n)}C_2}$.

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - II

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 183**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into Two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01– 07, 19 – 25, 37 – 43)*** *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (08 – 13, 26 – 31, 44 – 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S).*

   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (14 – 18, 32 – 36, 50 – 54)*** *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant R = $8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
= $0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
= $1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

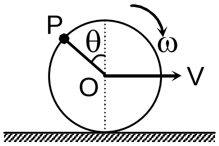
Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

SECTION – A
(One or More than one correct type)

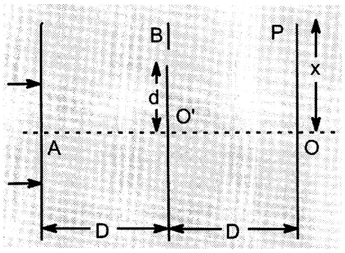
This section contains **7** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A disc of radius *R* rolls on a horizontal surface with linear velocity *V* and angular velocity ω. There is a point *P* on circumference of disc at angle θ with upward vertical diameter measured anticlockwise see figure, which has a vertical velocity. Here θ is equal to



(A) $\pi + \sin^{-1}\frac{V}{R\omega}$
(B) $\frac{\pi}{2} - \sin^{-1}\frac{V}{R\omega}$
(C) $\pi - \cos^{-1}\frac{V}{R\omega}$
(D) $\pi + \cos^{-1}\frac{V}{R\omega}$

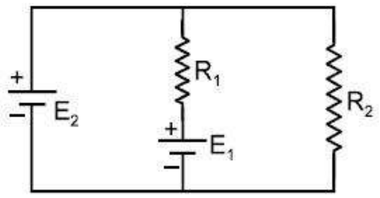
2. The minimum value of d so that there is a dark fringe at O is d_{min}. For the value of d_{min}, the distance at which the next bright fringe is formed is x. Then:

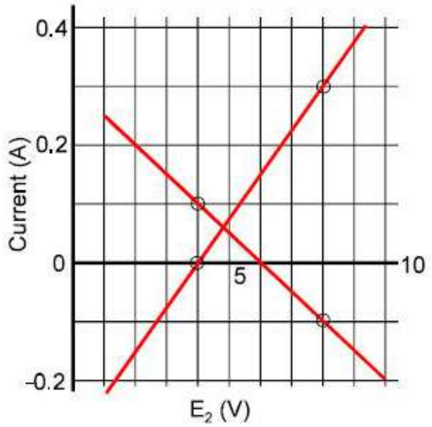


(A) $d_{min} = \sqrt{\lambda D}$
(B) $d_{min} = \sqrt{\frac{\lambda D}{2}}$
(C) $x = \frac{d_{min}}{2}$
(D) $x = d_{min}$

Space for Rough work

3. In the circuit given below, both batteries are ideal. EMF E_1 of battery 1 has a fixed value, but emf E_2 of battery 2 can be varied between 1.0 V and 10.0 V. The graph gives the currents through the two batteries as a function of E_2, but are not marked as which plot corresponds to which battery. But for both plots current is assumed to be negative when the direction of the current through the battery is opposite the direction of that battery's emf. (direction of emf is from negative to positive)





The value of emf E_1 is

(A) 8 V (B) 6 V

(C) 4 V (D) 2 V

4. In the series L – C – R circuit, the voltage across resistance, capacitance and inductance are 30V each at frequency $f = f_0$.

(A) It the inductor is short-circuited, the voltage across the capacitor will be $30\sqrt{2}$ V.

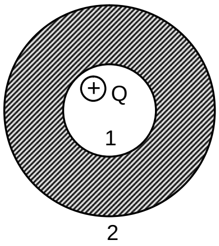
(B) If the capacitor is short-circuited, the voltage drop across the inductor will be $\frac{30}{\sqrt{2}}$ V.

(C) If the frequency is changed to $2f_0$, the ratio of reactance of the inductor to that of the capacitor is 4 : 1.

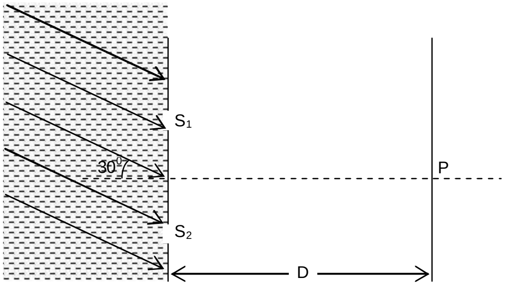
(D) If the frequency is changed to $2f_0$, the ratio of the reactance of the inductor to that of the capacitor is 1 : 4.

Space for Rough work

5. The positive charge Q is placed in the cavity of the spherical conductor.
(A) the induced charge at the surface 1 is –Q and on the surface 2 is +Q
(B) the surface charge density at inner surface is uniform
(C) the surface charge density at the outer surface is uniform
(D) the charge Q does not experience electric force if it is placed at the centre of the spherical cavity.



6. The given figure shows a YDSE apparatus. Parallel monochromatic coherent light rays are incident on slits S_1 and S_2 ($S_1S_2 = \frac{2}{3}\text{mm}$) at an angle 30^o with the horizontal. The medium on left side of the slits is water $(\mu_w = 4/3)$. To obtain the central maxima at point P, a glass slab $(\mu_g = 3/2)$ inside water is introduced in front of slit S_1. The thickness of the glass slab required for this purpose is



(A) 2mm (B) 4/3 mm
(C) 4 mm (D) 8/3 mm

7. The electron in the hydrogen atom make a transition from an excited state to the ground state. Which of the following statement is true?
(A) Its kinetic energy increases and its potential and total energies decrease
(B) Its kinetic energy decreases, potential energy increases and its total energy remains the same
(C) Its kinetic and total energies decrease and its potential energy increases
(D) Its kinetic potential and total energies decreases

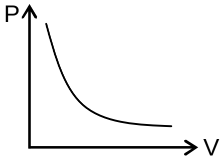
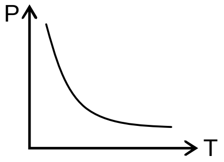
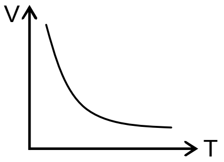
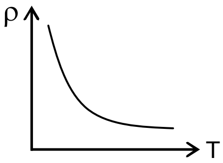
Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

Column–1 shows rectangular hyperbola graphs, Column–2 shows molar heat capacities for monoatomic gases and Column-3 shows work done when process goes from initial state 1 to final state 2.

Column –1	**Column –2**	**Column –3**
(I) 	(i) $C = \frac{7R}{2}$	(P) $\Delta W = nR(T_2 - T_1)$
(II) 	(ii) $C = \frac{R}{2}$	(Q) $\Delta W = -nR(T_2 - T_1)$
(III) 	(iii) $C = \frac{5R}{2}$	(R) $\Delta W = 2nR(T_2 - T_1)$
(IV) 	(iv) $C = \infty$	(S) $\Delta W = nRT\ \ln\frac{V_2}{V_1}$

8. Which option matches the data for an isobaric process?
(A) (IV) (iv) (P) (B) (III) (iii) (P)
(C) (IV) (iii) (P) (D) (III) (i) (Q)

Space for Rough work

9. Which of the following options is a correct combination?
(A) (II) (iii) (R) (B) (III) (ii) (Q)
(C) (III) (iii) (Q) (D) (II) (ii) (Q)

10. Which option matches the data for a process whose $\Delta U = 0$?
(A) (IV) (ii) (S) (B) (II) (iv) (S)
(C) (I) (ii) (Q) (D) (I) (iv) (S)

Answer questions 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

If m gm of ice at θ_1°C is mixed with 100 gm of water at 20°C, the mixture contains m_1 gm of ice and m_2 gm water at θ_2 °C in equilibrium. (Specific heat of water = 1 cal/gm/°C, Specific heat of ice = 0.5 cal/gm/°C, L_{ice} = 80 cal/ gm.

Column -1	Column -2	Column -3
(I) m = 25 gm & θ_1 = 0°C	(i) $m_1 = 0$	(P) θ_2 = 0°C
(II) m = 20 gm & θ_1 = –10°C	(ii) m_1 = 38.75 gm	(Q) θ_2 = 2.5°C
(III) m = 60 gm & θ_1 = –10°C	(iii) m_1 = 100 gm	(R) m_2 = 120 gm
(IV) m = 100 gm & θ_1 = –40°C	(iv) m_1 = 30 gm	(S) m_2 = 125 gm

11. Which of the following options is a correct combination?
(A) (II) (i) (S) (B) (I) (i) (R)
(C) (II) (i) (Q) (D) (I) (iv) (Q)

12. Which of the following options is a correct combination?
(A) (III) (iv) (P) (B) (III) (ii) (P)
(C) (II) (iii) (P) (D) (II) (ii) (P)

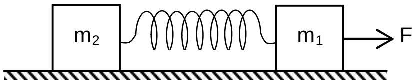
13. Which of the following options is a correct combination?
(A) (IV) (iii) (P) (B) (IV) (iv) (P)
(C) (III) (iv) (Q) (D) (I) (ii) (P)

Space for Rough work

SECTION – C
(Single digit integer type)

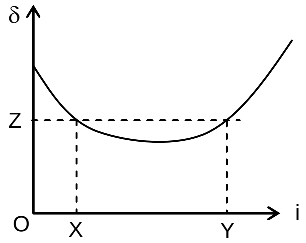
This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

14. Two blocks of masses m_1 = 1kg and m_2 = 2kg are connected by a non deformed light spring. They are lying on a rough horizontal surface. The coefficient of friction between the blocks and the surface is 0.4, what minimum constant force F (In N) has to be applied in horizontal direction to the block of mass m_1 in order to shift the other block? (g = 10 m/s^2)



15. Potential energy of a particle moving along x-axis is given by U = $\frac{x^3}{3} - \frac{9x^2}{2} + 20x$. Find out position of stable equilibrium state.

16. Graph shown is between deviation (δ) and angle of incidence I then angle of prism is (in degree) [x = 30°, y = 32° & z = 60°]



17. The period of oscillation of a simple pendulum is given by T = $2\pi\sqrt{\frac{\ell}{g}}$ where I is about 100 cm and is known to have 1mm accuracy. The period is about 2s. The time of 100 oscillations is measured by a stop watch of least count 0.1 s. The percentage error in g is x% then 10x is

18. In an experiment the angle are required to be measured using an instrument. 29 divisions of the main scale exactly coincide with the 30 divisions of the vernier scale. If the smallest division of the main scale is half – a – degree (= 0.5^o) then the least count of the instrument is (in minutes)

Space for Rough work

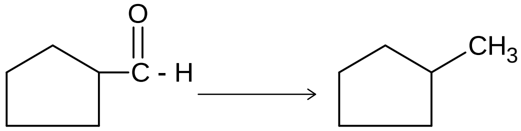
Chemistry PART – II

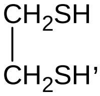
SECTION – A
(One or More than one correct type)

This section contains **7** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Which of the following concentrated terms are temperature independent?
(A) Molarity (B) Molality
(C) Mole fraction (D) PPM

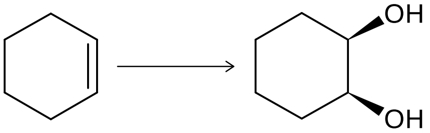
20.



The above transformation can be carried out by following methods?
(A) Zn(Hg)/Conc HCl (B) NH_2NH_2, OH^-
(C) 

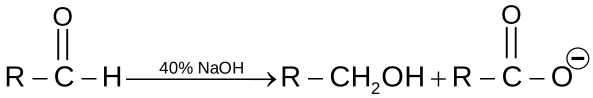
$\begin{matrix} CH_2SH \\ | \\ CH_2SH \end{matrix}$, Dry HCl and Raney Ni, Δ
(D) $LiAlH_4$

21.

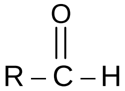


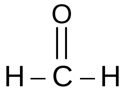
The above transformation can be carried out by the following methods.
(A) Bayer's reagent (B) $OsO_4/NaHSO_3$
(C) CH_3COOOH, H_3O^+ (D) m-CPBA, OH^-

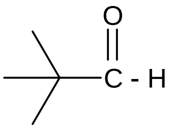
Space for Rough work

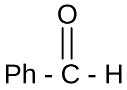
22. 

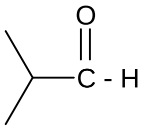
$$R-\overset{\overset{O}{||}}{C}-H \xrightarrow{\text{40\% NaOH}} R-CH_2OH + R-\overset{\overset{O}{||}}{C}-O^{\ominus}$$

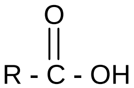
In the above case  $R-\overset{\overset{O}{||}}{C}-H$ can be

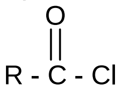
(A)  $H-\overset{\overset{O}{||}}{C}-H$

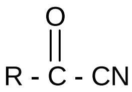
(B) 

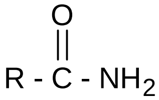
(C)  $Ph-\overset{\overset{O}{||}}{C}-H$

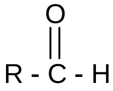
(D) 

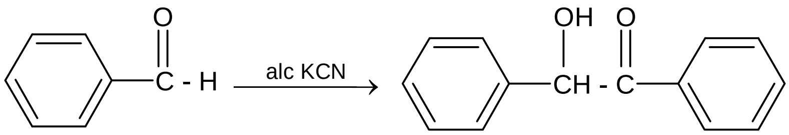
23. Which of the following compounds are more reactive than  $R-\overset{\overset{O}{||}}{C}-OH$ towards attack of nucleophile?

(A)  $R-\overset{\overset{O}{||}}{C}-Cl$

(B)  $R-\overset{\overset{O}{||}}{C}-CN$

(C)  $R-\overset{\overset{O}{||}}{C}-NH_2$

(D)  $R-\overset{\overset{O}{||}}{C}-H$

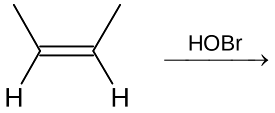
24. 

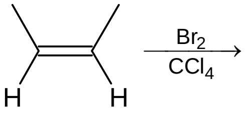
In the above reaction alcohol KCN performs the following function?

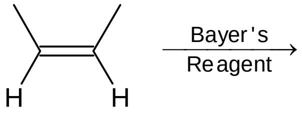
(A) Nucleophile
(B) Base
(C) Electron withdrawing
(D) Leaving group

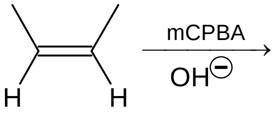
Space for Rough work

25. Which of the following reactions are stereospecific as well as stereoselective?

(A) 

(B) 

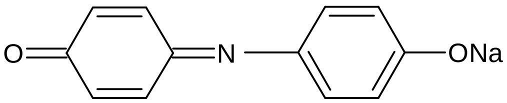
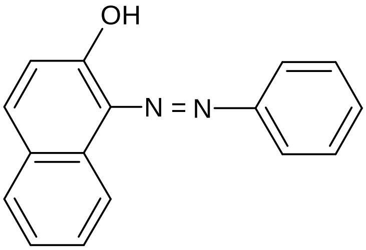
(C) 

(D) 

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 26, 27 and 28 by appropriately matching the information given in the three columns of the following table.

Column – 1 **Complexes**		**Column – 2** **Colour**		**Column – 3** **Test**	
(I)	$Na_4[Fe(CN)_5NOS]$	(i)	Red colour	(P)	Liberman's nitroso test
(II)	$[Fe(H_2O)_5NO]SO_4$	(ii)	Blue colour	(Q)	Dye test
(III)		(iii)	Brown colour	(R)	Lassaigne's test
(IV)		(iv)	Violet colour	(S)	Ring test

26. Which of the following pair is correct for detection of phenolic group?

(A) (I), (ii) & (R)
(B) (III), (i) & (P)
(C) (IV), (i) & (Q)
(D) (II), (iii) & (S)

Space for Rough work

27. Which of the following pair is correct for detection of aromatic amine?
(A) (IV), (i) & (Q)
(B) (III), (ii) & (P)
(C) (II), (iii) & (R)
(D) None of these

28. Which of the following is used for NO_3^- group detection?
(A) (II), (iii) & (S)
(B) (III), (ii) & (Q)
(C) (IV), (iv) & (P)
(D) None of these

Answer questions 29, 30 and 31 by appropriately matching the information given in the three columns of the following table.

Column – 1 **Order**		**Column – 2** **$t_{½}$**		**Column – 3** **Rate constant**	
(I)	Zero	(i)	$\alpha[\quad]$	(P)	$\frac{2.303}{t}\log\frac{r_0 - r_\infty}{r_t - r_\infty}$
(II)	1st	(ii)	$\alpha[\quad]^{-1}$	(Q)	$\frac{2.303}{t}\log\frac{V_\infty - V_0}{V_\infty - V_t}$
(III)	2nd	(iii)	$\alpha[\quad]^{-2}$	(R)	$\frac{2.303}{t}\log\frac{V_0}{V_t}$
(IV)	3rd	(iv)	$\alpha[\quad]^{0}$	(S)	None of the above

29. Which of the following pair is correct for saponification?
(A) (I), (i) & (S)
(B) (II), (iv) & (S)
(C) (III), (ii) & (S)
(D) (IV), (iii) & (S)

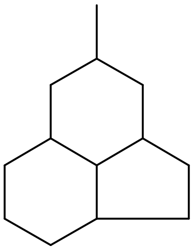
30. Which of the following is correct for ester hydrolysis in acidic medium?
(A) (I), (i) & (Q)
(B) (II), (iv) & (Q)
(C) (II), (iv) & (R)
(D) (III), (ii) & (S)

31. Thermal decomposition of H_2O_2 has correct combination as follows.
(A) (II), (iv) & (Q)
(B) (I), (iv) & (R)
(C) (III), (ii) & (S)
(D) None of these

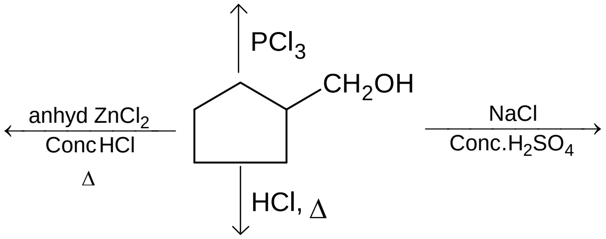
Space for Rough work

SECTION – C
(Single digit integer type)

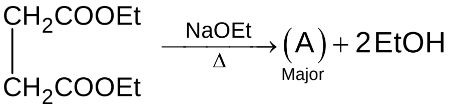
This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

32. 

Total how many chiral C atoms are present in this compound?

33. 

In how many above reaction ring expansion takes place.

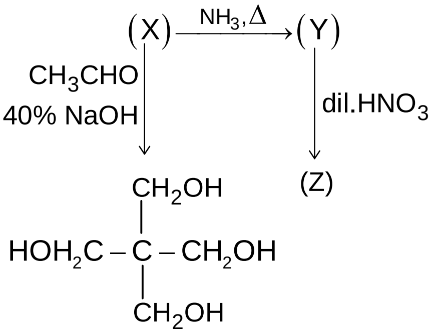
34. 

$$\begin{array}{l} CH_2COOEt \\ | \\ CH_2COOEt \end{array} \xrightarrow[\Delta]{NaOEt} \underset{\text{Major}}{(A)} + 2EtOH$$

Total how many mole of Grignard's reagent are required to completely react with (A).

Space for Rough work

35.


(X)
NH3, Δ
(Y)
CH3CHO
40% NaOH
dil.HNO3
(Z)
CH2OH
HOH2C – C – CH2OH
CH2OH

Total how many sp^2 hybridised N are present in (Z)

36. Determine 2x – y – z where x is the no. of mole of HIO_4 required to oxidize the 1 mole of Fructose, y is the no. of mole of HCOOH produced and z is the no. of mole of HCHO produced.

Space for Rough work

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **7** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. Consider the functions $f(x)$ and $g(x)$, both defined from $R \to R$ and are defined as $f(x) = 2x - x^2$ and $g(x) = x^n$ where $n \in N$. If the area between $f(x)$ and $g(x)$ in first quadrant is $\frac{1}{2}$ then n is a divisor of

(A) 12　　(B) 15
(C) 20　　(D) 30

38. A function $f : R \to R$ is given by $f(x) = \begin{cases} x^4\left(2 + \sin\frac{1}{x}\right) & x \neq 0 \\ 0 & x = 0 \end{cases}$, then

(A) f has a continuous derivative $\forall x \in R$　　(B) f is a bounded function
(C) f has an global minimum at x = 0　　(D) f” is continuous $\forall x \in R$

39. Identify correct statement(s) about conic $\sqrt{(x-5)^2 + (y-7)^2} + \sqrt{(x+1)^2 + (y+1)^2} = 12$.

(A) centre is (2, 3)　　(B) hyperbola with foci (5, 7) and (–1, –1)
(C) ellipse with major axis $4x - 3y + 1 = 0$　　(D) eccentricity is $\frac{5}{7}$

40. If $b^2 \geq 4ac$ for the equation $ax^4 + bx^2 + c = 0$, then all roots of the equation will be real, if:

(A) $b > 0, a > 0, c > 0$　　(B) $b < 0, a > 0, c > 0$
(C) $b > 0, a > 0, c < 0$　　(D) $b > 0, a < 0, c < 0$

41. If a, b, c, d are distinct positive numbers in A.P., then

(A) $ad < bc$　　(B) $a + c < b + d$
(C) $a + d = b + c$　　(D) $(a+1)(d+1) < (b+1)(c+1)$

Space for Rough work

42. The last digit of $3^{3^{4n}} + 1, n \in N$ is:

(A) ${}^4C_3$ (B) ${}^8C_7$

(C) 8 (D) 4

43. In a class tournament when the participants were to play one game with another, two class players fell ill, having played 3 games each. If the total number of games played is 84, the number of participants at the beginning was:

(A) 15 (B) 30

(C) ${}^6C_2$ (D) 48

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 44, 45 and 46 by appropriately matching the information given in the three columns of the following table.

Columns –1 contains different functions. Column –2 and Column –3 contains their domain and range respectively.

Column -1	**Column -2**	**Column -3**
(I) For the function $f(x) = \ell n(x^2 - 6x + 5)$	(i) $x \in [-2, -1] \cup [1, 2]$	(P) $\left(0, \frac{1}{\sqrt{2}}\right) \cup \left(\frac{1}{\sqrt{2}}, 1\right)$
(II) $f(x) = \frac{\{x\}}{1+\{x\}}$	(ii) $x \in (-\infty, 1) \cup (5, \infty)$	(Q) R
(III) $f(x) = \sin\left(2\pi\left(\frac{\sqrt{x+7}-4}{x-9}\right)\right)$	(iii) $x \in R$	(R) $\left[0, \frac{1}{2}\right)$
(IV) $f(x) = \sqrt{4-x^2} + \sqrt{x^2-1}$	(iv) $x \in [-7, \infty) - \{9\}$	(S) $\left[\sqrt{3}, \sqrt{6}\right]$

44. Which of the following is correct combination?

(A) (III) (ii) (P) (B) (IV) (i) (Q)

(C) (II) (iii) (R) (D) (I) (ii) (S)

Space for Rough work

45. Which of the following is incorrect combination?
(A) (I) (ii) (Q) (B) (II) (iii) (R)
(C) (III) (iv) (P) (D) (IV) (i) (P)

46. Which of the following is correct combination?
(A) (I) (iii) (R) (B) (IV) (i) (S)
(C) (II) (iii) (S) (D) (IV) (i) (P)

Answer questions 47, 48 and 49 by appropriately matching the information given in the three columns of the following table.

In all these cases $p, q \in N$ and also co – prime numbers.		
Column -1	**Column -2**	**Column -3**
(I) $P(x) = x^4 + ax^3 + bx^2 + cx + d$ where $a, b, c, d \in R$. Suppose $P(0) = 6$, $P(1) = 7$, $P(2) = 8$ and $P(3) = 9$ then $P(4) - 4 = \frac{p}{q}$.	(i) p = 19	(P) q = 1
(II) If the sum $\sum_{n=1}^{\infty} \tan^{-1}\left(\frac{2}{n^2 + n + 4}\right) = \tan^{-1}\left(\frac{q}{p}\right)$	(ii) p = 16	(Q) q = 8
(III) Let $P = 1^{-4} + 2^{-4} + 3^{-4} + 4^{-4} + ...\infty$ and $q = 1^{-4} + 3^{-4} + 5^{-4} + 7^{-4} + ...\infty$ then $\frac{p}{q}$	(iii) p = 1	(R) q = 2
(IV) Let $S_1, S_2, S_3, ...$ and $t_1, t_2, t_3........$ are two arithmetic sequence such that $S_1 = t_1 \neq 0$, $S_2 = 2t_2$ and $\sum_{i=1}^{10} S_i = \sum_{i=1}^{15} t_i$ then $\frac{S_2 - S_1}{t_2 - t_1} = \frac{p}{q}$	(iv) p = 30	(S) q = 15

47. Which of the following is correct combination?
(A) (IV) (i) (R) (B) (III) (ii) (S)
(C) (I) (iii) (P) (D) (II) (iii) (P)

Space for Rough work

48. Which of the following is incorrect combination?
(A) (III) (ii) (S) (B) (II) (iii) (R)
(C) (IV) (i) (Q) (D) (I) (ii) (P)

49. Which of the following is correct combination?
(A) (I) (iv) (P) (B) (II) (iii) (S)
(C) (IV) (i) (R) (D) (II) (i) (P)

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

50. If $\int_0^1 \frac{dx}{(1+x)(2+x)\sqrt{x(1-x)}} = \frac{\pi A}{\sqrt{6}\left(\sqrt{3}+1\right)}$ then A is equal to

51. Let $f(x) = \frac{e^x - e^{-x}}{2}$ and if $f(g(x)) = x$ then $\frac{1}{501} g\left(\frac{e^{1002}-1}{2e^{501}}\right)$ is equal to

52. If $y = \left(1+\frac{1}{x}\right)^x$ then $\frac{2\sqrt{y_2(2)+\frac{1}{8}}}{\left(\log\frac{3}{2}-\frac{1}{3}\right)}$ is equal to

53. A coin is tossed n times. The probability of getting at least one head is greater than that of getting at least two tails by $\frac{5}{32}$. Then n is:

54. If l_1 and l_2 be the length of the focal chord other than latus rectum of ellipse $\frac{x^2}{4}+\frac{y^2}{3}=1$ which are perpendicular to each other, then $12\left(\frac{l}{l_1}+\frac{l}{l_2}\right)=$

Space for Rough work

FIITJEE **JEE(Advanced)-2018**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS
CONCEPT RECAPITULATION TEST – II
PAPER-1

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**CD**	19.	**BCD**	37.	**BCD**
2.	**BD**	20.	**ABC**	38.	**AC**
3.	**B**	21.	**AB**	39.	**AC**
4.	**BC**	22.	**ABC**	40.	**BD**
5.	**ACD**	23.	**ABD**	41.	**ACD**
6.	**D**	24.	**ACD**	42.	**AD**
7.	**BD**	25.	**BCD**	43.	**AC**
8.	**C**	26.	**B**	44.	**C**
9.	**B**	27.	**A**	45.	**D**
10.	**D**	28.	**A**	46.	**B**
11.	**C**	29.	**C**	47.	**B**
12.	**B**	30.	**B**	48.	**D**
13.	**A**	31.	**D**	49.	**A**
14.	**8**	32.	**5**	50.	**2**
15.	**5**	33.	**1**	51.	**1**
16.	**2**	34.	**8**	52.	**3**
17.	**2**	35.	**6**	53.	**5**
18.	**1**	36.	**5**	54.	**7**

Physics PART – I

SECTION – A

1. CD

Sol. Particle *P* will have a velocity in vertical direction.

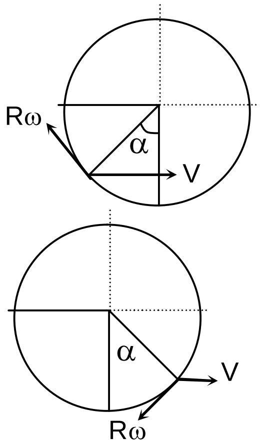
i.e. $R\,\omega\cos\alpha = V$

$$\alpha = \cos^{-1}\frac{V}{R\omega}$$

Required angle θ is $\theta = \pi - \alpha = \pi - \cos^{-1}\frac{V}{R\omega}$

And in second case $R\omega\cos\alpha = V$

$$\alpha = \cos^{-1}\frac{V}{R\omega},\ \theta = \pi + \cos^{-1}\frac{V}{R\omega}$$



2. BD

Sol. $\beta = \lambda\frac{D}{d}$

3. B

Sol. Apply KVL.

4. BC

Sol. $v_L = v_C = v_R$;

$\Rightarrow x_L = x_C = R$

when inductor is short circuited

$Z = \sqrt{R^2 + x_C^2} = \sqrt{2}\,R$

$\therefore\ I = \frac{30}{Z} = \frac{30}{\sqrt{2}R}$

$\therefore V_L = ix_L = \frac{30}{\sqrt{2}R} \times R = \frac{30}{\sqrt{2}}$

∴ (A) is incorrect and with similar calculations (B) will be correct.

Here f_0 is the resonance frequency as $v_L = v_C$

$\omega_0 = 2\pi f_0 = \frac{1}{\sqrt{LC}}$

$\frac{x_L}{x_C} = \frac{\omega L}{1/\omega C} = \omega^2 LC$

Given $f = 2f_0$

$\Rightarrow\ \omega = 2\omega_0$

$\therefore\ \frac{x_L}{x_C} = 4$

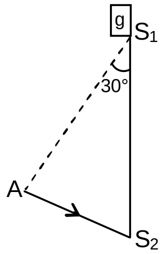
∴ (C) is also correct.

5. ACD

Sol. Apply Gauss law and property of conductor.

6. D

Sol. Extra phase change in glass = phae change in water of length AS_2.



$$\frac{2\pi t}{\lambda g}-\frac{2\pi}{\lambda \omega}t=\frac{2\pi}{\lambda \omega}\cdot\frac{2}{3}\sin 30^o$$

$$\Rightarrow \quad t\left[\frac{3}{2}-\frac{4}{3}\right]=\frac{4}{3}\times\frac{1}{3}\Rightarrow t=\frac{8}{3}mm.$$

7. BD

Sol. $E\propto\frac{1}{n^2}$ and total energy is –ve.

8. C
9. B
10. D

(Sol. for 8 – 10) Convert into polytropic process and use formulas of C and ΔW.

11. C
12. B
13. A

(Sol. for 11 – 13) Apply principle of caloriemetry.

SECTION – C

14. 8

Sol $F.x-\mu m_1 gx-\frac{1}{2}kx^2=0$

$kx=\mu m_2 g$ for just shifting m_2

$$F.x-\mu m_1 gx-\frac{1}{2}\mu m_2 gx=0$$

$$F=\mu\left(m_1+\frac{m_2}{2}\right)g=0.4\left(1+\frac{2}{2}\right)(10) = 8N$$

15. 5

Sol. At stable equilibrium, U is minimum.

$\frac{dU}{dx}$ = 0 and $\frac{d^2U}{dx^2}$ > 0

$$=\frac{1}{dx}\left(\frac{x^3}{3}-\frac{ax^2}{2}+20x\right)=0.$$

$\Rightarrow \quad x^2-9x+20=0. \quad \Rightarrow \quad (x-5)(x-4)=0.$

x = 5 and x = 4 are points of equilibrium.

And U minimum when $\frac{d^2U}{dx^2}$ > 0. i.e. at x = 5.

16. 2

Sol. $\delta = x + y - z$

17. 2

Sol. $T = 2\pi\sqrt{\frac{1}{g}} \Rightarrow T^2 = 4\pi^2 1/g \Rightarrow g = \frac{4\pi^2 l}{T^2}$

Here % error in l = $\frac{1mm}{100cm} \times 100 = \frac{0.1}{100} \times 100 = 0.1\%$

and % error in T = $\frac{0.1}{2 \times 100} \times 100 = 0.05\%$

$\therefore$ % error in g = % error in l + 2 (% error in T) = 0.1 + 2 × 0.05 = 0.2%.

18. 1

Sol. 30 VSD = 29 MSD

1 VSD = $\frac{29}{30}$MSD

L.C. = 1 MSD – 1 VSD

= $\left(1 - \frac{29}{30}\right)MSD = \frac{1}{30} \times 0.5^0 = 1$ minute

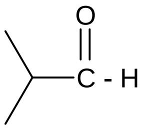
Chemistry PART – II

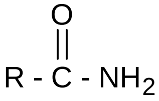
SECTION – A

19. BCD
Sol. These concentrated terms don’t depend upon volume.

20. ABC
Sol. $LiAlH_4$, converts carbonyl compound into alcohol.

21. AB
Sol. In peroxy acid anti-addition takes place.

22. ABC
Sol.  undergoes aldol condensation.

23. ABD
Sol. 
$R-\overset{\overset{O}{||}}{C}-NH_2$ has least +ve charge density among all of the given compound.

24. ACD
Sol. It is benzoin condensation.

25. BCD
Sol. HOBr is Br_2/H_2O.

26. B
Sol. Liberman’s test is used for phenolic group.

27. A
Sol. Dye test is used for aromatic amine.

28. A
Sol. Ring test is for NO_3^- ion.

29. C
Sol. Saponification is second order kinetics.

30. B
Sol. Ester hydrolysis in acidic medium is first order kinetics.

31. D
Sol. It is first order kinetics.

SECTION – C

32. 5

Sol. Chiral C is attached to 4 different groups.

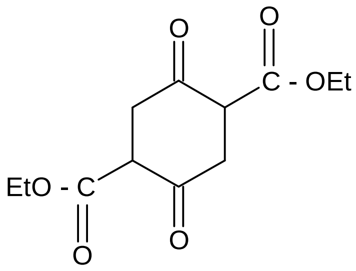
33. 1

Sol. Conc. H_2SO_4 is a dehydrating agent.

34. 8

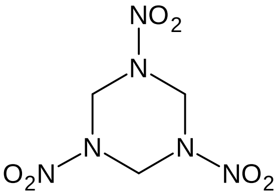
Sol.

A =



35. 6

Sol. Compound (Z) is



36. 5

Sol. Fructose is a ketose sugar.

Mathematics PART – III

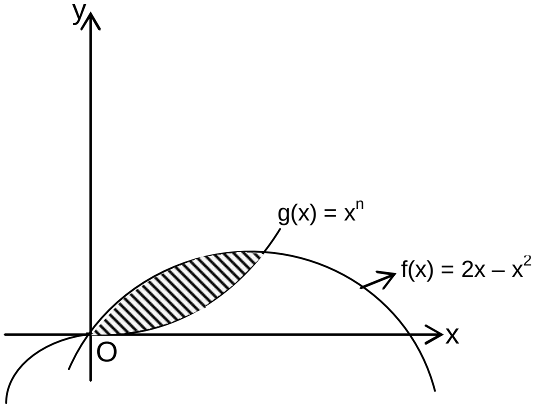
SECTION – A

37. BCD

Sol. Solving $f(x) = 2x - x^2$ and $g(x) = x^n$

We have $2x - x^2 = x^n \Rightarrow x = 0$ and $x = 1$

$$A = \int_0^1 \left(2x - x^2 - x^n\right) dx = x^2 - \frac{x^3}{3} - \frac{x^{n+1}}{n+1}\Bigg]_0^1$$



$$= 1 - \frac{1}{3} - \frac{1}{n+1} = \frac{2}{3} - \frac{1}{n+1}$$

Hence, $\frac{2}{3} - \frac{1}{n+1} = \frac{1}{2} \Rightarrow \frac{2}{3} - \frac{1}{2} = \frac{1}{n+1}$

$\Rightarrow \frac{4-3}{6} = \frac{1}{n+1} \Rightarrow n + 1 = 6 \Rightarrow n = 5$

Hence n is a divisor of 15, 20, 30

38. AC

Sol. $f(x) = 2x^4 + x^4 \sin\frac{1}{x}$ $\quad x \neq 0$

$= 0$ $\quad x = 0$

$f'(x) = 8x^3 + 4x^3 \sin\frac{1}{x} - x^2 \cos\frac{1}{x}$

39. AC

Sol. $\sqrt{(x-5)^2 + (y-7)^2} + \sqrt{(x+1)^2 + (y+1)^2} = 12$

$SP + S'P = 2a \Rightarrow$ conic is ellipse

$2ae = \sqrt{36 + 64}$

$2a = 12 \Rightarrow e = \frac{5}{6}$

Major axis $y - 7 = \frac{7+1}{5+1}(x - 5)$

$\Rightarrow 4x - 3y + 1 = 0$

40. BD

Sol. All roots of equation $ax^4 + bx^2 + c = 0$ will be real if both roots of $ay^2 + by + c = 0$ will be positive (let $x^2 = y$)

i.e. sum of roots $= -\frac{b}{a} > 0$ and product of roots $= \frac{c}{a} > 0$.

Hence, a and b are of opposite sign, while a and c are of same sign.

41. ACD

Sol. Let common difference is α

(A) $a(a+3\alpha) < (a+\alpha)(a+2\alpha)$

$a^2 - 3a\alpha < a^2 + 3a\alpha + 2\alpha^2$

$\Rightarrow 2\alpha^2 > 0,$ which is true.

(B) $a + a + 2\alpha < a + \alpha + a + 3\alpha$

$0 < 2\alpha,$ false is $a > b > c > d > 0$

(C) $a + a + 3\alpha = a + \alpha + a + 2\alpha$

(D) $(a+1),(b+1),(c+1),(d+1)$ all in A.P.

$\Rightarrow (a+1)(d+1) < (b+1)(c+1)$

42. AD

Sol. $\because 3^{4n} = 81^n = (1+80)^n = 1 + 80\lambda,\ \lambda \in N$

$\therefore 3^{3^{4n}} = 3^{1+80\lambda} = 3.3^{80\lambda}$

$= 3.(9)^{40\lambda} = 3(10-1)^{40\lambda}$

$= 3(1+10\mu) = 3 + 30\mu$

$\therefore$ Last digit of $3^{3^{4n}} + 1$ is 4.

43. AC

Sol. Suppose the two players did not play at all so that the remaining (n – 2) players played ${}^{n-2}C_2$ matches. Since, these two players played 3 matches each, hence the total number of matches is ${}^{n-2}C_2 + 3 + 3 = 84$ (given)

$\Rightarrow\ {}^{n-2}C_2 = 78 = {}^{13}C_2$

$\Rightarrow\ n - 2 = 13$

$\therefore\ \ n = 15 = {}^6C_2$

44. C

45. D

46. B

(Sol. 44 to 46)

(I) For domain of $f(x) = \ell n\left(x^2 - 6x + 5\right)$

$x^2 - 6x + 5 > 0$

$(x-5)(x-1) > 0$

$x > 5$ or $x < 1$

(II) $y = \frac{\{x\}}{1+\{x\}}$.

$\Rightarrow \{x\} = \dfrac{y}{1-y}$. Hence $0 \le \dfrac{y}{1-y} < 1$

(III) Given, $f(x) = \sin\left(2\pi\left(\dfrac{\sqrt{x+7}-4}{x-9}\right)\right)$

domain of $f(x) = [-7, \infty) - \{9\}$

$g(x) = \dfrac{\pi(x+7-16)}{(x-9)\left(\sqrt{x+7}+4\right)}$ (Rationalise)

$= \dfrac{\pi}{\sqrt{x+7}+4}$

So, range of $g(x)$ is $\left(0, \dfrac{\pi}{4}\right] - \left\{\dfrac{\pi}{8}\right\}$.

Hence, range of $f(x)$ is $(0,1] - \left\{\dfrac{1}{\sqrt{2}}\right\}$.

(IV) Let $x^2 = 4\cos^2\theta + \sin^2\theta$ then $\left(4-x^2\right) = 3\sin^2\theta$ and $\left(x^2-1\right) = 3\cos^2\theta$

$\therefore \quad f(x) = \sqrt{3}\left|\sin\theta\right| + \sqrt{3}\left|\cos\theta\right|$

$\Rightarrow \quad y_{\min} = \sqrt{3}$ and $y_{\max}$

$= \sqrt{3}\left(\dfrac{1}{\sqrt{2}} + \dfrac{1}{\sqrt{2}}\right) = \sqrt{6}$

Hence range of $f(x)$ is $\left[\sqrt{3}, \sqrt{6}\right]$

47. B
48. D
49. A

(Sol. 47 to 49)

(I) Let P (x) = 6 + x, for x = 0, 1, 2, 3

Let $f(x) = P(x) - x - 6$

$\Rightarrow f(x)$ is also a polynomial of degree 4.

$\Rightarrow f(x) = x(x-1)(x-2)(x-3)$

As $f(x)$ vanishes at x = 0, 1, 2, 3, so $f(x) = P(x) - x - 6 \equiv (x-0)(x-1)(x-2)(x-3)$

$\Rightarrow P(x) = x + 6 + x(x-1)(x-2)(x-3)$

Hence $P(4) = 10 + (4.3.2.1) = 10 + 24 = 34$

(II) $\displaystyle\sum_{n=1}^{\infty} \tan^{-1}\left(\frac{2}{n^2+n+4}\right) = \sum_{n=1}^{\infty} \tan^{-1}\left\{\frac{\frac{2}{n(n+1)}}{1+\frac{4}{n(n+1)}}\right\}$

$$= \sum_{n=1}^{\infty} \tan^{-1}\left\{\frac{\frac{2}{n} - \frac{2}{n+1}}{1 + \frac{2}{n}.\frac{2}{n+1}}\right\}$$

$$=\sum_{n=1}^{\infty}\left\{\tan^{-1}\left(\frac{2}{n}\right)-\tan^{-1}\left(\frac{2}{n+1}\right)\right\}$$

$$=\left\{\tan^{-1}\left(\frac{2}{1}\right)-\tan^{-1}\left(\frac{2}{2}\right)\right\}+\left\{\tan^{-1}\left(\frac{2}{2}\right)-\tan^{-1}\left(\frac{2}{3}\right)\right\}+.....\infty \text{ terms}$$

$$=\tan^{-1}2=\tan^{-1}\left(\frac{a}{b}\right)$$

$$\Rightarrow a=2;\ b=1\ \Rightarrow (a+b)=3$$

(III) $P=\frac{1}{1^4}+\frac{1}{2^4}+\frac{1}{3^4}+\frac{1}{4^4}+\frac{1}{5^4}+\frac{1}{6^4}......\infty$

$$P=\left(\frac{1}{1^4}+\frac{1}{3^4}+\frac{1}{5^4}+...\right)+\frac{1}{2^4}\left(\frac{1}{1^4}+\frac{1}{2^4}+\frac{1}{3^4}+...\right)$$

$$P=q+\frac{1}{16}p$$

$$\frac{15}{16}p=q\ \Rightarrow \frac{p}{q}=\frac{16}{15}$$

(IV) Given $s_1+s_2+s_3+.....+s_{10}=t_1+t_2+t_3+.......+t_{15}$ Let 1st sequence is $a_1, a_1+d_1, a_1+2d_1, ...$ and 2nd is $a_1, a_1+d_2, a_1+2d_2.....$ (since $s_1=t_1$)

Given $s_2=2t_2$

$\therefore\quad a_1+d_1=2(a_1+d_2)$

$\therefore\quad a_1=d_1-2d_2$ ………(i)

We have to find $\frac{s_2-s_1}{t_2-t_1}=\frac{d_1}{d_2}=?$

Now $\frac{10}{2}[2a_1+9d_1]=\frac{15}{2}[2a_1+14d_2]$

This gives $a_1=9d_1-21d_2$ ……….(ii)

From equation (i) and (ii) $\frac{d_1}{d_2}=\frac{19}{8}$

SECTION – C

50. 2

Sol. Since $x(1-x)=\frac{1}{4}-\left(x-\frac{1}{2}\right)^2$, so put $x=\frac{1}{2}+\left(\frac{1}{2}\right)\sin\theta$.

Therefore, $\int_0^1\frac{dx}{(1+x)(2+x)\sqrt{x(1-x)}}$

$$=\int_{-\pi/2}^{\pi/2}\frac{\left(\frac{1}{2}\right)\cos\theta\, d\theta}{\left(\frac{1}{4}(1+\sin\theta)^2+\frac{3}{2}(1+\sin\theta)+2\right)\frac{1}{2}\cos\theta}$$

$$= 4\int_0^{\pi} \frac{d\phi}{\cos^2\phi - 8\cos\phi + 15} \text{ where, } \phi = \theta + \frac{\pi}{2}$$

$$= \frac{4}{2}\left[\int_0^{\pi} \frac{d\phi}{\cos\phi - (4+1)} - \int_0^{\pi} \frac{d\phi}{\cos\phi - (4-1)}\right]$$

Let $I_1 = \int_0^{\pi} \frac{d\phi}{\cos\phi - a}$ where $a > 1$

Put $\tan\left(\frac{\phi}{2}\right) = t,\ d\phi = 2\frac{dt}{\left(1+t^2\right)}$.

$$\therefore I_1 = \int_0^{\infty} \frac{\frac{2dt}{\left(1+t^2\right)}}{\frac{\left(1-t^2\right)}{\left(1+t^2\right)-a}} = \frac{-2}{1+a}\int_0^{\infty} \frac{dt}{r^2 + \frac{(a-1)}{(a+1)}}$$

$$= \frac{-2}{1+a}\sqrt{\frac{a+1}{a-1}}\left(\tan^{-1}\frac{t\sqrt{a+1}}{\sqrt{a-1}}\right)\Bigg]_0^{\infty}$$

$$= \frac{-2}{\sqrt{a^2-1}}.\frac{\pi}{2} = \frac{-\pi}{\sqrt{a^2-1}}$$

Thus $I = 2\left[-\frac{\pi}{\sqrt{24}} + \frac{\pi}{\sqrt{8}}\right] = \pi\left(\frac{1}{\sqrt{2}} - \frac{1}{\sqrt{6}}\right) = \pi\frac{\left(\sqrt{3}-1\right)}{\sqrt{6}}$

51. 1

Sol. Let $y = \frac{e^x - e^{-x}}{2} \Rightarrow e^{2x} - 1 = 2ye^x$

Therefore, $t^2 - 2yt - 1 = 0,\ t = e^x$

$$\Rightarrow t = \frac{2y \pm \sqrt{4y^2+4}}{2} = y \pm \sqrt{y^2+1}$$

$$\Rightarrow x = \log\left(y + \sqrt{y^2+1}\right) \text{ (since } e^x > 0\text{)}$$

$$\therefore\ f^{-1}(x) = g(x) = \log\left(x + \sqrt{x^2+1}\right)$$

$$g\left(\frac{e^{1002}-1}{2e^{501}}\right) = \log\left(\frac{e^{1002}-1}{2e^{501}} + \frac{e^{1002}+1}{2e^{501}}\right) = \log e^{501} = 501$$

52. 3

Sol. Taking logarithm of both sides, we get $\log y = x\left[\log\left(1+\frac{1}{x}\right)\right]$

$$\Rightarrow \frac{1}{y}y_1(x) = \frac{x^2}{x+1}\left(-\frac{1}{x^2}\right) + \log\left(1+\frac{1}{x}\right)$$

$$= -\frac{1}{x+1} + \log\left(1+\frac{1}{x}\right) \quad \text{(i)}$$

Since $y(2)=\left(1+\frac{1}{2}\right)^2=\frac{9}{4}$ so $y_1(2)=\left(\frac{9}{4}\right)\left(-\frac{1}{3}+\log\frac{3}{2}\right)$

Multiplying (i) by y and then differentiating, we get

$$y_2(x)=y_1(x)\left(-\frac{1}{x+1}+\log\left(1+\frac{1}{x}\right)\right)+y(x)\times\left(\frac{1}{(x+1)^2}+\frac{x}{x+1}\left(-\frac{1}{x^2}\right)\right)$$

So $y_2(2)=y_1(2)\left(-\frac{1}{3}+\log\frac{3}{2}\right)+y(2)\left(\frac{1}{9}-\frac{1}{6}\right)=\left(\frac{9}{4}\right)\left(-\frac{1}{3}+\log\frac{3}{2}\right)^2-\frac{1}{8}$.

53. 5

Sol. The probability of getting at least one head

= 1 – probability of getting no heads

$$=1-{}^nC_0\left(\frac{1}{2}\right)^0.\left(\frac{1}{2}\right)^n=1-\frac{1}{2^n}$$

The probability of getting at least two tails

= 1 – probability of getting no tails – probability of getting 2 tails

$$=1-{}^nC_n\left(\frac{1}{2}\right)^n.\left(\frac{1}{2}\right)^0-{}^nC_{n-1}\left(\frac{1}{2}\right)^{n-1}.\frac{1}{2}=1-\frac{1}{2^n}-n\frac{1}{2^n}$$

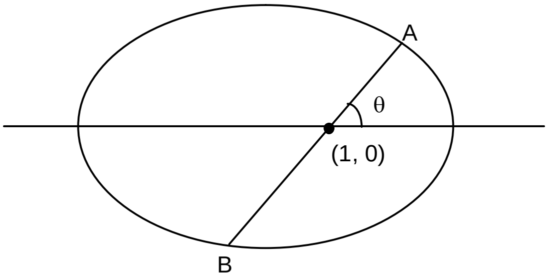
From the question,

$$\left(1-\frac{1}{2^n}\right)-\left(1-\frac{1+n}{2^n}\right)=\frac{5}{32}$$

or $\frac{n+1}{2^n}-\frac{1}{2^n}=\frac{5}{32}$ or $\frac{n}{2^n}=\frac{5}{32}\Rightarrow n=5$

54. 7

Sol. Let $AB=l_1$



Equation of $AB=\frac{x-1}{\cos\theta}=\frac{y-0}{\sin\theta}=r$

$\Rightarrow\ \frac{(1+r\cos\theta)^2}{4}+\frac{(r\sin\theta)^2}{3}=1$

$\Rightarrow\ r^2\left(3+\sin^2\theta\right)+6r\cos\theta-9=0$

$\Rightarrow\ r_1-r_2=-\frac{6\cos\theta}{3+\sin^2\theta}, r_1r_2=\frac{9}{3+\sin^2\theta}$

$$l_1=|r_1|+|r_2|=\sqrt{(r_1-r_2)^2+4r_1r_2}=\frac{12}{3+\sin^2\theta}$$

$$l_2=\frac{12}{3+\sin^2\left(\frac{\pi}{2}+\theta\right)}=\frac{12}{3+\cos^2\theta}$$

$$\Rightarrow\frac{1}{l_1}+\frac{1}{l_2}=\frac{7}{12}$$

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - II

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 231**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-C & Section-D**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01 – 03, 24 – 26, 47 – 49)*** *contains 9 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (04 – 08, 27 – 31, 50 – 54) *contains 15 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (09 – 10, 32 – 33, 55 – 56) *contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer. There is no negative marking.*

2. ***Section-C (11 – 20, 34 – 43, 57 – 66)*** *contains 30 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

3. ***Section-D (21 – 23, 44 – 46, 67 – 69)*** *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant R = $8.314\ J\ K^{-1}\ mol^{-1}$
= 0.0821 Lit atm $K^{-1}\ mol^{-1}$
= $1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

PART – I (Physics), PART – II (Chemistry), PART – III (Mathematics):

(SECTION – D)

For questions **21 to 23, 44 to 46, 67 to 69.**
Numerical answer type questions with answer XXXXX. XX

If answer is 348.4 / 251.37 / 213

Correct Method :

0	0	3	4	8	.	4	0
0	0	2	5	1	.	3	7
0	0	2	1	3	.	0	0

Wrong Method :

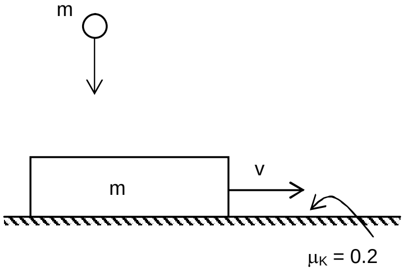
	3	4	8		.	4	
3	4	8			.		4
		3	4	8	.		4
	3		4	8	.	4	
	2		5	1	.	3	7
		2	1	3	.		
		2	1	3	.	0	
		2	1	3	.		0
		3	4	8	.	4	0
		2	5	1	.	3	7
		2	1	3	.	0	0

Physics PART – I

SECTION – A
(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A ball of mass m falls vertically from a height h and collides with a block of equal mass m moving horizontally with a velocity v on a surface. The coefficient of kinetic friction between the block and the surface is $\mu_k = 0.2$, while the coefficient of restitution (e) between the ball and the block is 0.5. There is no friction acting between the ball and the block. The velocity of the block just after the collision decreases by (if it is still in motion)



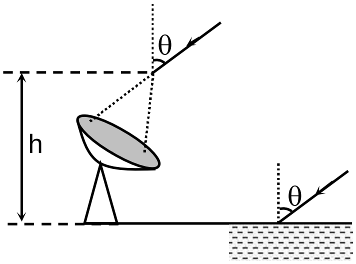
(A) $0.5\sqrt{2gh}$

(B) 0

(C) $0.1\sqrt{2gh}$

(D) $0.3\sqrt{2gh}$

2. Radio waves of wavelength λ at an angle θ to vertical are received by a radar after reflecting from a nearby water surface and directly. If the radar records a maximum intensity, the height of antenna *h* from water surface can be

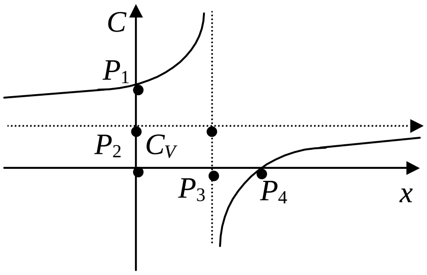


(A) $\frac{\lambda}{2\cos\theta}$ (B) $\frac{\lambda}{2\sin\theta}$

(C) $\frac{\lambda}{4\sin\theta}$ (D) $\frac{\lambda}{4\cos\theta}$

Space for Rough work

3. The following graph gives the variation of molar heat capacity C a function of x where x is given by the expression PV^x = constant. If gas is monoatomic what are the coordinates of P_1 and P_4



(A) $\left(0, \frac{5}{2}R\right)$ & $\left(\frac{5}{3}, 0\right)$

(B) $\left(0, \frac{3}{2}R\right)$ & $\left(\frac{7}{5}, 0\right)$

(C) $\left(0, \frac{5}{2}R\right)$ & $\left(\frac{7}{5}, 0\right)$

(D) $\left(0, \frac{7}{5}R\right)$ & $\left(\frac{5}{3}, 0\right)$

(One or More than one correct type)

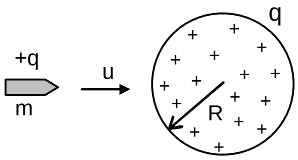
This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

4. A closed organ pipe of length 28 cm closed at one end is found to be at resonance when a tuning fork of frequency 850 Hz is sounded near the open end. If velocity of sound in air is 340 m/s, then the

(A) air in the pipe is vibrating in fundamental mode
(B) air in the pipe is vibrating in first overtone
(C) end correction of the pipe is 1 cm
(D) end correction of the pipe is 2 cm

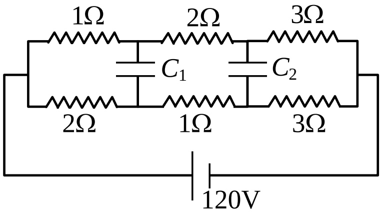
Space for Rough work

5. Which of these options are correct?



(A) A bullet of mass m and charge q is fired towards a solid uniformly charged sphere of radius R and total charge +q. If it strikes the surface of sphere with speed u. The minimum speed u so that it can penetrate through the sphere. (Neglect all resistance forces or friction acting on bullet except electrostatic forces) is $\frac{q}{\sqrt{4\pi\varepsilon_0 mR}}$

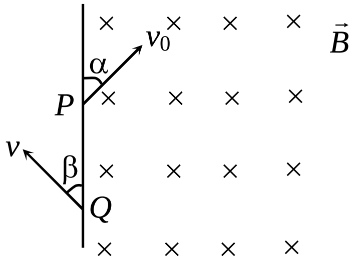
(B) In the above diagram the minimum speed u so that it can penetrate through the sphere. (Neglect all resistance forces or friction acting on bullet except electrostatic forces) is $\frac{q}{\sqrt{2\pi\varepsilon_0 mR}}$



(C) In the circuit shown in figure $C_1 = C_2 = 2\mu F$. Then charge stored in capacitor C_2 is zero

(D) In the above circuit charged stored in capacitor C_1 is 40 μC.

6. A particle of charge –*q* and mass *m* enters a uniform magnetic field $\vec{B}$ (perpendicular to paper inwards) at *P* with a velocity v_0 at an angle α and leaves the field at *Q* with velocity *v* at angle β as shown in the figure. Then



(A) $\alpha = \beta$

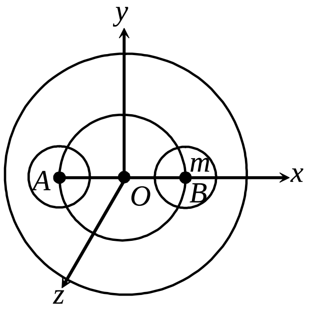
(B) $v = v_0$

(C) $PQ = \frac{2mv_0 \sin\alpha}{Bq}$

(D) particle remains in the field for time $t = \frac{2m(\pi - \alpha)}{Bq}$

Space for Rough work

7. A solid sphere of uniform density and radius 4 units is located with its centre at the origin *O* of co-ordinates. Two spheres of equal radii 1 units, with their centres at *A*(–2,0,0) and *B* (2, 0 ,0) respectively, are taken out of the solid leaving behind spherical cavities as shown in figure. Then



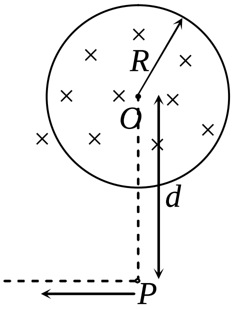
(A) the gravitational field due to this object at the origin is zero.

(B) the gravitational field at the point *B*(2, 0, 0)is zero

(C) the gravitational potential is same at all points on the circle $y^2 + z^2 = 36$

(D) the gravitational potential is same at all points on the circle $y^2 + z^2 = 4$

8. In a cylindrical region of radius *R*, there exists a time varying magnetic field *B* such that $\frac{dB}{dt} = k(>0)$. A charged particle having charge q is placed at the point *P* at a distance *d* (> R) from its centre O. Now, the particle is moved in the direction perpendicular to OP (see figure) by an external agent upto infinity so that there is no gain in kinetic energy of the charged particle. Choose the correct statement/s.



(A) Work done by external agent is $\frac{q\pi R^2}{4}k$ if d = 2R

(B) Work done by external agent is $\frac{q\pi R^2}{8}k$ if d = 4R

(C) Work done by external agent is $\frac{q\pi R^2}{4}k$ if d = 4R

(D) Work done by external agent is $\frac{q\pi R^2}{4}k$ if d = 6R

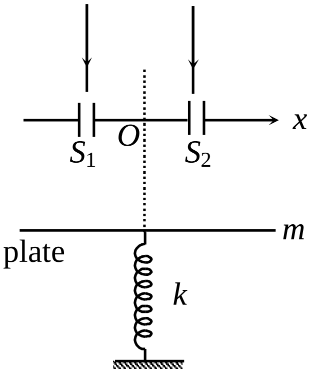
Space for Rough work

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 9 and 10

Two slits S_1 and S_2 lie on the *x*-axis and symmetric with respect to *y*-axis are illuminated by a parallel monochromatic light beam of wavelength λ as shown. The distance between slits is *d* (>> λ). Point *O* is the mid point of the line S_1S_2 and this point is considered as the origin. The slits are in horizontal plane. The interference pattern is observed on a horizontal plate (acting as screen) of mass *m* which is connected to one end of a vertical massless spring of spring constant *k*. The other end of the spring fixed to ground. At *t* = 0, the plate is at a distance *D* (>> *d*) below the plane of slits and spring is in its natural length. The plate is released from rest from its initial position.



9. The rate by which fringe, width will increase when acceleration of plate is zero, is

(A) $\frac{\lambda g}{d}\sqrt{\frac{m}{k}}$ (B) $\frac{\lambda g}{3d}\sqrt{\frac{m}{k}}$

(C) $\frac{\lambda g}{4d}\sqrt{\frac{m}{k}}$ (D) $\frac{\lambda g}{2d}\sqrt{\frac{m}{k}}$

10. A thin slab of refractive index μ is kept in front of one of slits such that position of first maxima shift to the position of central maxima at the instant when plate has been held at rest initially. The thickness of slab is

(A) $\frac{d}{(\mu-1)}$ (B) $\frac{d\lambda}{D(\mu-1)}$

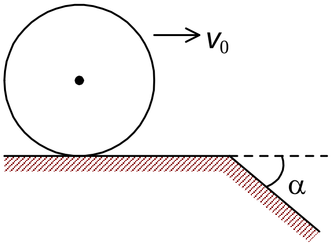
(C) $\frac{D\lambda}{d(\mu-1)}$ (D) $\frac{\lambda}{\mu-1}$

Space for Rough work

SECTION – C
(Single digit integer type)

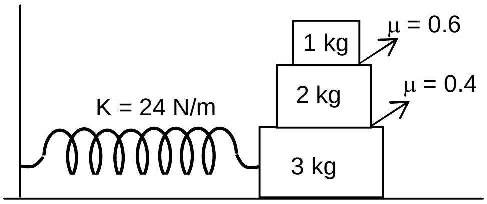
This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

11. A uniform solid cylinder of radius, R = 15 cm rolls over a horizontal plane passing into an inclined plane forming an angle α = 30° with the horizontal as in Figure. Find the maximum integral value of the velocity v_0 (in m/s) which still permits the cylinder to roll on to the inclined plane section without a jump. The sliding is assumed to be absent.



12. A uniform disc of radius R having charge Q distributed uniformly all over its surface is placed on a smooth horizontal surface. A magnetic field, $B = kxt^2$, where k is a constant, x is the distance (in metre) from the centre of the disc and t is the time (in second), is switched on perpendicular to the plane of the disc. Find the torque (in N-m) acting on the disc after 15 sec. (Take $4kQ$ = 1 S.I. unit and R = 1m)

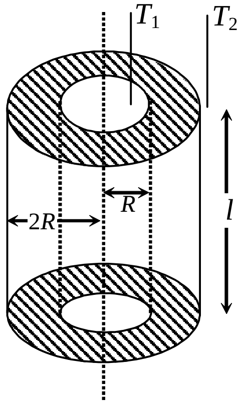
13. What can be the maximum amplitude (in m) of the system so that there is no slipping between any of the blocks



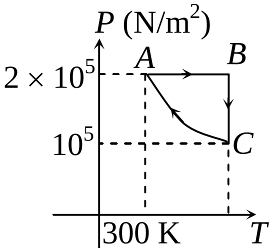
14. A hydrogen-like atom of atomic number Z is in an excited state of quantum number 2n. It can emit a maximum energy photon of 204 eV. If it makes a transition to quantum state n, a photon of energy 40.8 eV is emitted. Ground state energy of hydrogen atom is -13.6 eV. Find the value of n + Z.

Space for Rough work

15. Inner surface of a cylindrical shell of length l and of material of thermal conductivity k is kept at constant temperature T_1 and outer surface of the cylinder is kept at constant temperature T_2 such that $(T_1 > T_2)$ as shown in figure. Heat flows from inner surface to outer surface radially outward. Inner and outer radii of the shell are R and 2R respectively. Due to lack of space this cylinder has to be replaced by a smaller cylinder of length $\frac{l}{2}$, inner and outer radii $\frac{R}{4}$ and R respectively and thermal conductivity of material nk. If rate of radial outward heat flow remains same for same temperatures of inner and outer surface i.e. T_1 and T_2, then find the value of n.

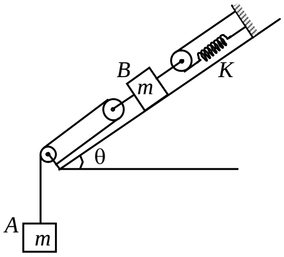


16. Two moles of a monatomic ideal gas is taken through a cyclic process shown on pressure (P)-temperature (T) diagram in figure. Process CA is represented as PT = Constant. If efficiency of given cyclic process is $1-\frac{3x}{12\ln 2+15}$, then find the value of 'x'.



17. A bus is moving towards a huge wall with a velocity of 5 m/s. the driver sounds a horn of frequency 200 Hz. What is the frequency of beats heard by a passenger of the bus (to the nearest integer), if the speed of sound in air is 330 m/s.

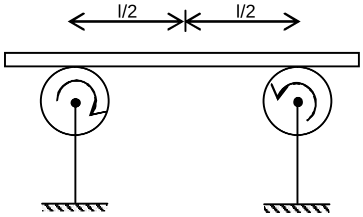
18. Two blocks *A* and *B*, each of mass *m* are connected by means of a pulley-spring system on a smooth inclined plane of inclination θ as shown in the figure. All the pulleys and spring are ideal. Now, *B* is slightly displaced from its equilibrium position. It starts to oscillate. Time period of oscillation of *B* will be nπ seconds. Find the value of 'n'. (Take *m* = 4 kg, *K* = 5 N/m, π = 3.14)



Space for Rough work

19. A drop of water of mass m = 0.4 g is placed between two clean glass plates, the distance between which is 0.01 cm. The force of attraction between the plates is F. Surface tension of water = 0.08 N/m and density of order = 1000 kg/m^3. Find the value of [F], where [F] is greatest integer function of 'F'.

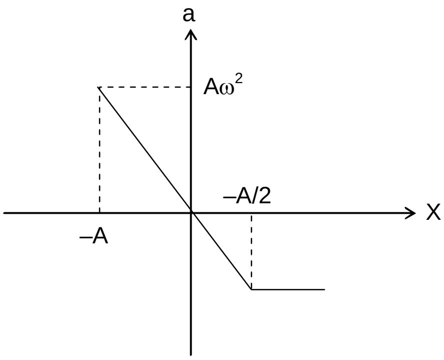
20. A uniform rod is placed on two spinning wheels as shown in the figure. The axes of the wheels are separated by l. The coefficient of friction between the rod and the wheel is μ. If the period of small oscillations is $\pi\sqrt{\frac{a\ l}{2\mu g}}$, a=



SECTION – D
(Numerical Based XXXXX.XX answer Type)

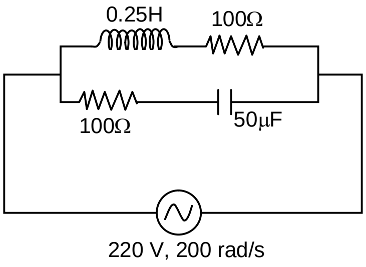
This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

21. Following is the acceleration vs position graph of a particle performing oscillatory motion along x-axis. ω = 2 rad/s. What is the time period of the given motion? (Take $\sqrt{3}$ = 1.73 and π = 3.00)



22. A train is moving along +ve x-axis with 20 m/s and its engine is located at (–400 m, 0) at an instant. It is sounding horn of frequency 600 Hz. A person is listening to the horn standing at (0, –300 m). If wind is blowing at 10 m/s towards +ve x-axis, then what is the apparent frequency heard by person? Speed of sound in air is 330 m/s.

23. In the given Ac circuit, what is the power developed in watts?



Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

---

24. How many maximum number of electrons of an atom will have the following set of quantum numbers?

$n = 4$

$\ell = 0, 1, 2$

$m = 0, \pm 1$

$s = \pm \frac{1}{2}$

(A) 18 (B) 12
(C) 14 (D) 16

25. The half-life of a chemical reaction is 20s, when the reaction starts with 0.4 M concentration of the reactant. The half-life remains the same when the reaction starts with 0.8 M concentration of the reactant. What is the unit of rate constant of the reaction?

(A) mol $L^{-1}s^{-1}$ (B) s^{-1}
(C) $mol^{-1} L^2s^{-1}$ (D) mol L^2s^{-1}

26. $2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$

The correct statement regarding the above reaction is(Assume that only NO_2 is initially taken in the reaction container).

(A) 'K_C' changes by changing the concentrations of the species NO_2, NO and O_2.
(B) $[NO] \alpha [O_2]$
(C) The reaction proceeds to backward direction by decreasing pressure at equilibrium
(D) Inert gas has no effect at constant pressure

Space for Rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

27. $MnO_4^- + H^+ + C_2O_4^{2-} \longrightarrow Mn^{2+} + CO_2 + H_2O$

Which of the following can be the stoichiometric coefficient(s) of the species involved in the above reaction, after balancing it?

(A) 2
(B) 10
(C) 8
(D) 6

28. Which of the following compound(s) can form buffer solution(s), when added to calculated amount of NaOH?

(A) CH_3COOH
(B) HCN
(C) H_2SO_4
(D) HNO_3

29. Which of the following contain(s) unpaired electrons?

(A) Oxygen atom
(B) Dioxygen molecule
(C) Nitric oxide
(D) Dinitrogen molecule

30. Which of the following compounds can form silicates with SiO_2?

(A) NaOH
(B) Na_2CO_3
(C) NaCl
(D) $NaNO_3$

31. Which of the following exists as polymer(s)?

(A) B_2H_6
(B) BN
(C) SiH_4
(D) H_3BO_3

Space for Rough work

(Paragraph Type)

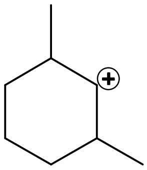
This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

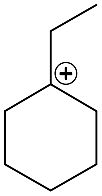
Paragraph for Question Nos. 32 and 33

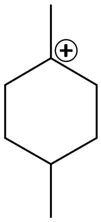
Carbocations are formed as reaction intermediates in many organic reactions. They are stabilized by resonance, hyperconjugation and inductive effects. A less stable carbocation can undergo rearrangement to a more stable carbocation by hydrogen or methyl shifts. They are formed by heterolytic fission of covalent bonds assisted by heat or polar solvents.

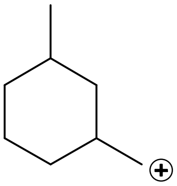
Answer the following questions on the basis of above write up.

32. Which of the following carbocation will be most stable if only hyperconjugation is considered as the deciding factor?

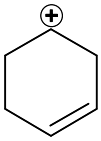
(A)


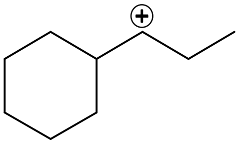
(B)


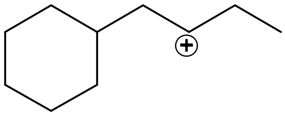
(C)


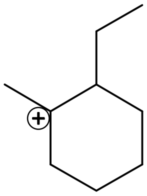
(D)


33. Which of the following carbocation does not undergo rearrangement?

(A)


(B)


(C)


(D)


Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

34. The colour of an inorganic compound(X), containing four elements is orange. On heating it forms a green solid(Y), a colourless gas(Z) and a liquid which pH at room temperature is seven. What is the sum of the total number of atom(s) present in (Y) and (Z)?

35. The normal boiling point of water increases by 4.16°C, if two moles of a salt is added to one kg water. What is the van't Hoff factor of the salt? [K_b of water = 0.52 K kg mol^{-1}]

36. How much heat is absorbed in Kcal mol^{-1} unit by heating one mole of an ideal gas from 300 K and 1300 K at constant volume? $\left[C_V = \frac{3}{2}R\right]$

37. $Zn(s) \mid Zn^{2+}(0.01\ M) \parallel H^+ \mid H_2(1\ atm), Pt$
The e.m.f of the above electrochemical cell is 0.6418 V. What is the pH of the cathode half-cell if $E^o_{Zn^{2+}/Zn} = -0.76\,V$

38. $NH_4NO_3 \longrightarrow N_2O + 2H_2O$
Let the molecular mass of NH_4NO_3 is M, What will be the value of 'n', if the equivalent mass of NH_4NO_3 is expressed as $\frac{M}{n}$?

39. Two containers contain equal moles of SO_2 and CH_4 gases separately at constant temperature and pressure. If the simplest ratio of their relative rates of effusion is expressed as x : y, the value of (x + y) is:
[Assume same area of orifice on the containers]

40. How many complete octahedral void(s) is/are occupied by Na^+ ions in NaCl unit cell?

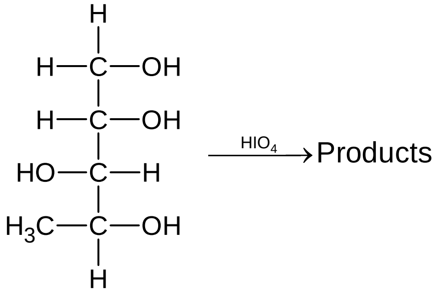
Space for Rough work

41. $Cr_2(SO_4)_3 \xrightarrow[\text{(ii) } Na_2O_2]{\text{(i) NaOH}}$ Yellow solution

If the oxidation number of chromium in the compound that provides yellow colour is +x, then 'x' is

42. What is the sum of the number of linkage isomers and ionization isomers possible for the octahedral complex with formula $Cr(NH_3)_4(CN)(Br)(Cl)$?

43.



How many different type of product(s) in the above reaction can give Tollen's test?

SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

44. $X(g) \rightleftharpoons Y(g) + Z(g)$

250 mole of 'X' is taken in a 100 L container at a certain temperature. 50 mole percentage of 'X' undergoes reaction at equilibrium. How many moles of 'X' should be added at equilibrium so that concentration of Y will become 1.3 M at the new equilibrium?

45. The pH of 0.1 M aqueous solution of the sodium salt of a weak monobasic acid(HA) is 12.8. What is the p^{K_a} value of the acid?

46. Two moles of glycol is dissolved in 891.24 g of water. The solution is cooled to -4.8°C. How many gram of ice is formed in the cooling process? [K_f of water = 1.86 K kg mol^{-1}]

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

47. If $\vec{r}.\vec{a}=0, \vec{r}.\vec{b}=1$ and $\left[\vec{r} \quad \vec{a} \quad \vec{b}\right]=1, \vec{a}.\vec{b}\neq 0, \left(\vec{a}.\vec{b}\right)^2-\left|\vec{a}\right|^2\left|\vec{b}\right|^2=1$ the value of $\vec{r}$ in terms of $\vec{a}$ and $\vec{b}$ is

(A) $\vec{a}\times\left(\vec{a}\times\vec{b}\right)+\vec{a}\times\vec{b}$

(B) $\vec{a}\times\left(\vec{a}\times\vec{b}\right)+\dfrac{\vec{a}\times\vec{b}}{\left|\vec{a}\times\vec{b}\right|^2}$

(C) $\vec{a}\times\left(\vec{b}\times\vec{a}\right)+\dfrac{\vec{b}\times\vec{a}}{\left|\vec{b}\times\vec{a}\right|^2}$

(D) $\dfrac{\vec{a}\times\left(\vec{a}\times\vec{b}\right)}{\left|\vec{a}\times\left(\vec{a}\times\vec{b}\right)\right|}+\vec{a}\times\vec{b}$

48. The solution of the differential equation $\dfrac{d^2y}{dx^2}=\sin 3x+e^x+x^2$ when $y_1(0)=1$ and $y(0)=0$ is

(A) $\dfrac{-\sin 3x}{9}+e^x+\dfrac{x^4}{12}+\dfrac{1}{3}x-1$

(B) $\dfrac{-\sin 3x}{9}+e^x+\dfrac{x^4}{12}+\dfrac{1}{3}x$

(C) $\dfrac{-\cos 3x}{3}+e^x+\dfrac{x^4}{12}+\dfrac{1}{3}x+1$

(D) none of these

49. The solution set of $\log_{|\sin x|}\left(x^2-8x+23\right)>\dfrac{3}{\log_2|\sin x|}$ contains

(A) $x\in(3, \pi)\cup\left(\pi, \dfrac{3\pi}{2}\right)\cup\left(\dfrac{3\pi}{2}, 5\right)$

(B) $x\in(3, \pi)\cup(\pi, 5)$

(C) $x\in\left(3, \dfrac{5\pi}{2}\right)$

(D) none of these

Space for Rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

50. The real values of a, b, p, q for which $(2x-1)^{20}-(ax+b)^{20}=\left(x^2+px+q\right)^{10}$ are

(A) $p=q=\frac{1}{2}$
(B) $b=-2a=\pm\left(2^{20}-1\right)^{1/20}$
(C) $2b=-a=\pm\left(2^{20}-1\right)^{1/20}$
(D) $4q=-p=1$

51. If $|z_1|=|z_2|=|z_3|=1$ and $S=|z_2-z_3|^2+|z_3-z_1|^2+|z_1-z_2|^2$. Let $\alpha=$ minimum value of S and $\beta=$ maximum value of S as z_1, z_2, z_3 vary on $|z|=1$, then

(A) $\alpha=0$
(B) $\beta=9$
(C) $\beta=3$
(D) $\alpha=2$

52. A four digit number (numbered from 0000 to 9999) is said to be lucky if the sum of first two digits is equal to the sum of its last two digits. If a four digit number is picked up at random, then the probability that it is lucky is

(A) >0.065
(B) <0.068
(C) 0.066
(D) 0.067

53. Let $\alpha(n)=1-\frac{1}{2}+\frac{1}{3}-............+(-1)^{n-1}\frac{1}{n}$

(A) $\frac{1}{n+1}+\frac{1}{n+2}+.......+\frac{1}{2n}=\alpha(2n)$
(B) $\alpha(2n)<1\forall n$
(C) $\alpha(2n)\geq 0.5\,\forall n$
(D) $0.5<\alpha(n)<1\forall n$

54. Let $f(x)=ax^2+bx+c$, where $a,b,c\in R$. Suppose $|f(x)|\leq 1\forall\, x\in[0,1]$, then

(A) $|a|\leq 8$
(B) $|b|\leq 8$
(C) $|c|\leq 1$
(D) $|a|+|b|+|c|\leq 17$

Space for Rough work

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 55 and 56

$\alpha, \beta, \gamma, \delta$ are angles in I, II, III and IV quadrant respectively and no one of them is an integral multiple of $\frac{\pi}{2}$. They form an increasing arithmetic progression.

55. Which of the following is correct?

(A) $\cos(\alpha+\delta) > 0$
(B) $\sin(\alpha+\delta) = 0$
(C) $\cos(\alpha+\delta) < 0$
(D) $\cos(\alpha+\delta) > 0$ or $\cos(\alpha+\delta) < 0$

56. If $\alpha+\beta+\gamma+\delta = \theta$ and $\alpha = 70^o$, then

(A) $400^o < \theta < 580^o$
(B) $470^o < \theta < 650^o$
(C) $680^o < \theta < 860^o$
(D) $540^o < \theta < 900^o$

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

57. Let $f(x) = \begin{vmatrix} 2\cos^2 x & \sin(2x) & -\sin x \\ \sin(2x) & 2\sin^2 x & \cos x \\ \sin x & -\cos x & 0 \end{vmatrix}$. Find $\frac{1}{\pi}\int_0^{\pi/2} [f(x) + f'(x)]dx$.

58. Let $A = \begin{bmatrix} 0 & \alpha \\ 0 & 0 \end{bmatrix}$ and $(A+I)^{50} - 50A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$, find $a+b+c+d$.

59. If $f(n) = \sum_{k=1}^{n}\sum_{j=k}^{n} \left({}^nC_j\right)\left({}^jC_k\right)$ find $f(6) - 660$

Space for Rough work

60. Tangent are drawn from any point on the hyperbola $\frac{x^2}{9}-\frac{y^2}{4}=1$ to the circle $x^2+y^2=9$. If the locus of the mid – point of the chord of contact is $a\left(x^2+y^2\right)^2=bx^2-cy^2$, then the value of $a^2+b^2+c^2-7870$ is equal to

61. Let $0\le\beta_r\le1$ and $\sum_{r=1}^{k}\cos^{-1}\beta_r=\frac{k\pi}{2}$ for any $k\ge1$ and $A=\sum_{r=1}^{k}(\beta_r)^r$, then $\lim_{x\to A}498.\frac{\left(1+x^2\right)^{1/3}-(1-2x)^{1/4}}{x+x^2}$ is equal to λ, where $\frac{\lambda}{83}=$

62. For the circle $x^2+y^2=r^2$, the value of r for which the area enclosed by the tangents drawn from the point (6, 8) to the circle and the chord of contact is maximum is

63. If $\int\frac{2e^{5x}+e^{4x}-4e^{3x}+4e^{2x}+2e^x}{\left(e^{2x}+4\right)\left(e^{2x}-1\right)^2}dx=\tan^{-1}\left(e^{x/2}\right)-\frac{K}{248\left(e^{2x}-1\right)}+C$ then K – 120 is equal to

64. If Q is the foot of the perpendicular from the point P (4, –5, 3) on the line $\frac{x-5}{3}=\frac{y+2}{-4}=\frac{z-6}{5}$ then $25(PQ)^2-450=2$

65. If $y=\left(1+\frac{1}{x}\right)^x$ then $\frac{2\sqrt{y_2(2)+\frac{1}{8}}}{\left(\log\frac{3}{2}-\frac{1}{3}\right)}$ is equal to (where $y_2(x)$ is $\frac{d^2y}{dx^2}$)

Space for Rough work

66. Let $f\left(x\right)=\dfrac{e^{x}-e^{-x}}{2}$ and if $f\left(g\left(x\right)\right)=x$ then $\dfrac{1}{501}g\left(\dfrac{e^{1002}-1}{2e^{501}}\right)$ is equal to

SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

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67. Let $P_n\left(x\right)$ be a function satisfying $\sum\limits_{n=0}^{\infty}h^{n}P_n\left(x\right)=\left(1-2hx+h^{2}\right)^{-1/2}$, $\left|x\right|\le 1$, $\left|h\right|<\dfrac{1}{3}$. Find $10P_3\left(10\right)$

68. If $\int_0^1\dfrac{dx}{\left(1+x\right)\left(2+x\right)\sqrt{x\left(1-x\right)}}=\dfrac{\pi A}{\sqrt{6}\left(\sqrt{3}+1\right)}$ then 13458.36A is equal to

69. One diagonal of a square is the portion of the line $\dfrac{x}{97}+\dfrac{y}{79}=1$ intercepted between the axes. p_1,p_2 are the lengths of the perpendiculars from the vertices of the other diagonal on the axis of y then $256.39\left(p_1+p_2\right)$ is

Space for Rough work

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PAPER-2

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**D**	24.	**C**	47.	**B**
2.	**D**	25.	**B**	48.	**A**
3.	**A**	26.	**B**	49.	**A**
4.	**BD**	27.	**ABC**	50.	**CD**
5.	**ACD**	28.	**AB**	51.	**AB**
6.	**ABCD**	29.	**ABC**	52.	**ABD**
7.	**ACD**	30.	**AB**	53.	**ABC**
8.	**ACD**	31.	**BD**	54.	**ABCD**
9.	**A**	32.	**C**	55.	**A**
10.	**D**	33.	**D**	56.	**C**
11.	**1**	34.	**7**	57.	**1**
12.	**1**	35.	**4**	58.	**2**
13.	**1**	36.	**3**	59.	**5**
14.	**6**	37.	**3**	60.	**3**
15.	**4**	38.	**4**	61.	**3**
16.	**7**	39.	**3**	62.	**5**
17.	**6**	40.	**4**	63.	**4**
18.	**2**	41.	**6**	64.	**7**
19.	**6**	42.	**7**	65.	**3**
20.	**4**	43.	**3**	66.	**1**
21.	**00003.73**	44.	**00015.20**	67.	**24850.00**
22.	**00629.81**	45.	**00012.60**	68.	**26916.72**
23.	**00629.20**	46.	**00116.24**	69.	**24869.83**

Physics

PART – I

SECTION – A

1. D

Sol. Impulse on ball

$I = (1+0.5)\sqrt{2gh}\ m$ (vertically)

Frictional impulse on block (horizontally)

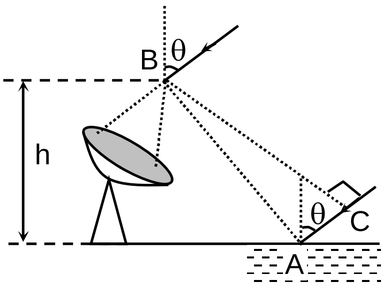
$= \mu I = 0.2 \times 1.5\ m\sqrt{2gh}$

Decrease in velocity

$$\Delta V = \frac{\mu I}{m} = 0.3\sqrt{2gh}$$

2. D

Sol. Path difference of the two rays (one coming directly to antenna and other after reflection from water surface



$$\Delta x = AB + AC + \frac{\lambda}{2}$$

$$\Rightarrow \quad \Delta x = \frac{h}{\cos\theta} + \frac{h}{\cos\theta}\cos 2\theta + \frac{\lambda}{2}$$

$$= \quad \frac{h}{\cos\theta}\left(1+\cos 2\theta\right) + \frac{\lambda}{2}$$

or $\quad \Delta x = 2h\cos\theta + \frac{\lambda}{2}$

For constructive interference $\Delta x = n\lambda$

$$\Rightarrow \quad 2h\cos\theta + \frac{\lambda}{2} = n\lambda \quad \text{or} \quad h = \frac{\left(n-\frac{1}{2}\right)\lambda}{2\cos\theta} = \frac{\lambda}{4\cos\theta}, \frac{3\lambda}{4\cos\theta}, \text{........ etc}$$

3. A

Sol. From first law of thermodynamics

$\Delta Q = \Delta U + \Delta W$

$$\Delta Q = nC_V\left(T_2 - T_1\right) + \frac{nR\left(T_1 - T_2\right)}{x-1}$$

$$\frac{1}{n}\left(\frac{\Delta Q}{\Delta T}\right) = C_V - \frac{R}{x-1}$$

$\therefore \quad \left(C - C_V\right)\left(x-1\right) = -R$

$\therefore$ graph is a rectangular, hyperbola

$\therefore$ co–ordinate of P_1 (O, C_P)

i.e. $\left(0, \frac{5}{2}R\right)$ and that of $P_4\left(\frac{5}{3}, 0\right)$

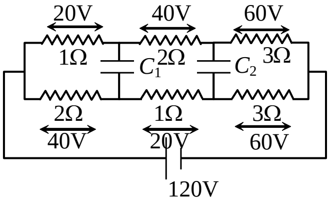
4. BD

Sol. For nth mode of vibration $\lambda_n = \frac{4\ell}{(2n-1)}$.

5. ACD

Sol. Now, potential difference across C_1 is 20 V and across C_2 is zero.

$\therefore$ charge stored in C_1 is 40 μC and in C_2 is zero.



6. ABCD

Sol. $x + \alpha = \beta + x = 90^0 \Rightarrow \alpha = \beta$

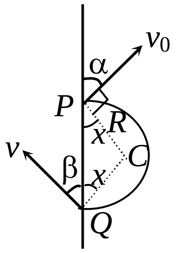
Also, *PQ* = $2R\cos(90-\alpha) = 2R\sin\alpha = \frac{2mv_0}{qB}\sin\alpha$

$|\vec{v}| = $ constant

$\therefore \quad v = v_0$

For 2π rotation it takes $\frac{2\pi m}{qB}$ time

For $(2\pi - 2\alpha)$ it takes $\frac{2m(\pi-\alpha)}{qB}$



7. ACD

Sol. The gravitational force due to these masses on a mass at *O* is equal and opposite.

So, the resultant force is zero hence, the resultant field is zero

Also, any point on *y-z* plane which is equidistant from two cavities will have zero field intensity hence constant potential.

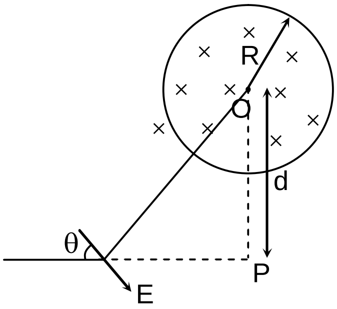
8. ACD

Sol. $\int \vec{E}\cdot d\vec{l} = A\frac{dB}{dt}$

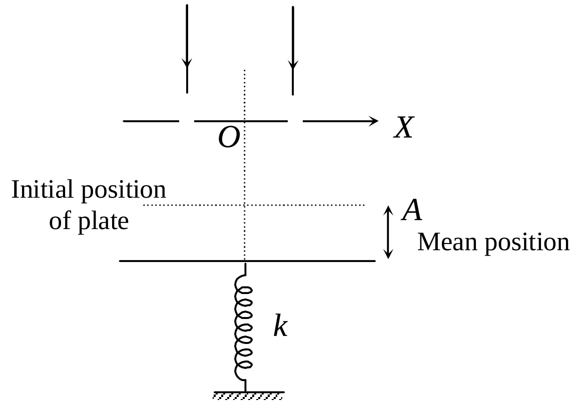
$E2\pi\sqrt{x^2+d^2} = \pi R^2 k$

$E = \frac{\pi R^2 k}{2\sqrt{x^2+d^2}}$

$W_{ext} = \int_0^{\infty} q\vec{E}\cdot dx = \frac{q\pi R^2}{4}k$



9. A



Sol. $\beta = \frac{(D+y)\lambda}{d}$

$\frac{d\beta}{dt} = \frac{\lambda}{d}\frac{dy}{dt} = \frac{\lambda}{d}v$

At mean position

$v = A\omega = \frac{mg}{k}\sqrt{\frac{k}{m}} = g\sqrt{\frac{m}{k}}$

$\frac{d\beta}{dt} = \frac{\lambda g}{d}\sqrt{\frac{m}{k}}$

10. D

Sol. Shift $\frac{D(\mu-1)t}{d} = \frac{D\lambda}{d}$

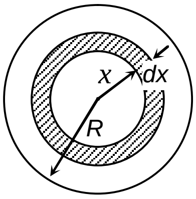
$t = \frac{\lambda}{\mu-1}$

SECTION – C

11. 1

Sol. $v_0 \le \frac{gR}{3}(7\cos\alpha - 4)$

12. 1



Sol. $d\phi = (2\pi x dx)kxt^2$

$\phi = \frac{2}{3}kt^2\pi x^3$

$\frac{d\phi}{dt} = \frac{4k\pi t x^3}{3}$

$E2\pi x = \frac{4\pi k t x^3}{3}$; $E = \frac{2}{3}ktx^2$; $d\tau = \left(\frac{2}{3}ktx^2\right)\frac{Q}{\pi R^2}(2\pi x dx)x$

$\int d\tau = \frac{4}{3}\frac{ktQ}{R^2}\int_0^R x^4 dx$ $\Rightarrow \tau = \frac{4}{3}\frac{ktQ}{R^2}\frac{R^5}{5}$

At *t* = 15sec, τ = 1 N-m

13. 1

Sol. $a = \omega^2 A$

$f_1 = (1)\omega^2 A \le 6$ …(1)

$f_2 = 3\omega^2 A \le 12$

$\omega^2 A \le 4$ …(2)

$\Rightarrow \omega^2 A = 4$

$$A = \frac{4}{\left(\frac{k}{m}\right)} = \frac{4\times 6}{24} = 1$$

14. 6

Sol. Energy in 2nth state will be $= -\frac{13.6Z^2}{4n^2}$eV

Max energy of photon = $13.6Z^2\left(1-\frac{1}{4n^2}\right) = 204$ ....(1)

Energy of photon when it makes transition to x in state will be

$$13.6Z^2\left(\frac{1}{n2}-\frac{1}{4n2}\right) = 40.8$$

.....(2)

Dividing equation (1) and (2)

$$\frac{4n^2-1}{3} = 5$$

$$\Rightarrow \quad n^2 = 4 \; n = 2$$

Putting of $n = 2$ in equation (2)

$$13.6Z^2\left(\frac{3}{4\times 4}\right) = 40.8$$

$$Z^2 = \frac{40.8\times 16}{3\times 13.6}$$

$$Z = 4$$

15. 4

Sol. Since rate of heat flow remains same in both the cases, so

$$\int_R^{2R}\frac{dx}{k2\pi x l} = \int_{\frac{R}{4}}^{R}\frac{dx}{nk(2\pi x)\frac{l}{2}} \quad \Rightarrow \; nk = 4k$$

$$\Rightarrow \; n = 4.$$

16. 7

Sol. For process AB $\quad T_A = 300\text{ K},\; T_B = 600\text{ K}$

$W = nR\Delta T = nR(T_B - T_A) = 300\text{ nR} = 600R.$

$$Q = n\,Cp\Delta T = 2\times\frac{5}{2}R\;(300) = 1500R.$$

For process BC $\quad W = nRT\ln\frac{v_f}{v_c} = nRT\ln\frac{p_i}{p_f} = nRT\ln 2 = 1200R\ln 2$

$$Q = W = 1200R\ln 2$$

For process CA $\quad W = \int P\,dV = \int_{600}^{300}\frac{K}{T}\frac{2nRT}{K}dT.$

$$= -2nR(300) = -1200R.$$

$$Q = nC_V\;\Delta\,T + W$$

$$= 2\times\frac{3}{2}R(-300) - 1200R.$$

$$= -900R - 1200R = -2100R$$

$$\eta = \frac{600R + 1200R\ln 2 - 1200R}{1500R + 1200R\ln 2}$$

$$= 1 - \frac{21}{12\ln 2 + 15} \quad \Rightarrow \text{ x = 7.}$$

17. 6

Sol. As source (horn of bus) is approaching stationary wall (say, listener), therefore, apparent frequency striking the wall is

$$\nu' = \frac{\upsilon\, \nu}{\upsilon - \upsilon_s} \qquad \ldots(1)$$

Sound of this frequency will be reflected by the wall (now, source). The passenger is the listener moving towards source. Therefore, frequency heard by the listener

$$\nu'' = \frac{(\upsilon + \upsilon_L)\nu'}{\upsilon}$$

using (1)

$$\nu'' = \frac{\upsilon + \upsilon_L}{\upsilon} \times \frac{\upsilon \nu}{\upsilon - \upsilon_s} = \frac{(\upsilon + \upsilon_L)\nu}{\upsilon - \upsilon_s}$$

$$= \frac{(330 + 5) \times 200}{330 - 5} = \frac{335}{325} \times 200$$

$$\nu'' = 206\,\text{Hz}$$

$\therefore$ Beat frequency = $(\nu'' - \nu)$

$$= 206 - 200 = 6\,\text{Hz}$$

18. 2

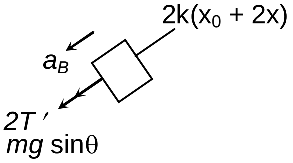
Sol. Let elongation of spring be x_0 in equilibrium. Then,

$$2T + mg\sin\theta = 2kx_0 \qquad \ldots(i)$$

and $T = mg$ …(ii)

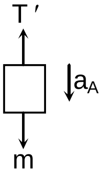
Let Block B is displaced by x down the inclination

F.B.D. of B



$$-ma_B = 2k(x_0 + 2x) - 2T' - mg\sin\theta \qquad \ldots(iii)$$

F.B.D. of *A*



mg – T′ = ma$_A$

Also, $a_A = 2a_B$

$$T' = mg - 2ma_B$$

$$-ma_B = 2kx_0 + 4kx - 2mg + 4ma_B - mg\sin\theta$$
$$-ma_B = 4kx + 4ma_B$$
$$a_B = -\frac{4k}{5m}x$$
$$\therefore\ T = 2\pi\sqrt{\frac{5m}{4k}}$$
T = 6.28 s.

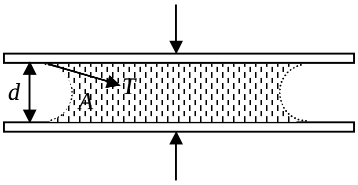
19. 6

Sol. Let R be the radius of the circular layer of water.

Then, $\pi R^2 d \times \rho = m$ …(1)

Pressure at $A = p_0 - \frac{2T}{d}$ …(2)

Thus pressure between the plates is less than the atmospheric pressure and so the plates are pressed together as though attracted towards each other.

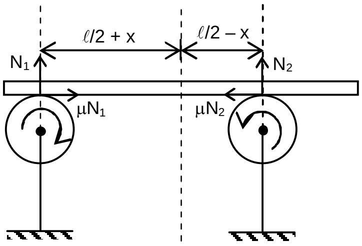


F, force of attraction = $\Delta p \times$ area $\Rightarrow F = \frac{2T}{d} \times \pi R^2$

$$\Rightarrow \qquad F = \frac{2T}{d} \times \frac{m}{d\cdot\rho} = \frac{2Tm}{d^2\cdot\rho} = \frac{2\times 0.4\times 10^{-3}\times 0.08}{0.01^2\times 10^{-4}\times 1000} = 6.4\text{ N}$$

20. 4

Sol. $N_1 + N_2 = mg$



$N_1\ell = mg(\ell/2 - x)$

$N_1 = \frac{mg}{\ell}\left(\ell/2 - x\right)$

$N_2 = \frac{mg}{\ell}\left(\ell/2 + x\right)$

$F_{res} = \mu N_2 - \mu N_1 = \mu\left(\frac{2mgx}{\ell}\right)$

$\Rightarrow\ \omega = \sqrt{\frac{2\mu g}{\ell}}$; $T = 2\pi\sqrt{\frac{\ell}{2\mu g}}$

SECTION – D

21. 00003.73

Sol. $V\left(x = \frac{A}{2}\right) = \sqrt{3}\,\omega\frac{A}{2}$

$T_1 = 2\times\left(\frac{T}{4} + \frac{T}{12}\right) = \frac{2T}{3}$ $\left(\text{SHM Part} : T = \frac{2\pi}{\omega}\right)$

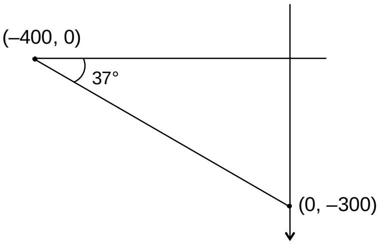
$T_2 = 2\times\frac{\sqrt{3}\,\omega\frac{A}{2}}{\frac{A\omega^2}{2}} = \frac{2\sqrt{3}}{\omega}$ (Constant acceleration part)

Time period $= T_1 + T_2$

$$= \frac{4\pi}{300} + \frac{2\sqrt{3}}{\omega}$$

22. 00629.81

Sol. $V_{source} = 10\,\hat{i}$, $V_{observer} = -10\,\hat{i}$



$$f_{app} = 600\ \text{Hz} \times \frac{330 + 10.\text{cs}\ 37^o}{330 - 10.\cos 37^o}$$

$= 629.81$ Hz

23. 00629.20

Sol. $X_L = 50\ \Omega$, $X_C = 100\ \Omega$

$Z_1 = 100 - 50\ I$; $Z_2 = 100 + 100\ i$ $(i = \sqrt{-1})$

$$Z = \frac{Z_1 Z_2}{Z_1 + Z_2} = \frac{100}{17}(13 + i)$$

$$|Z| = \frac{100}{17}\sqrt{170}\ ;\ \cos\theta = \frac{13}{\sqrt{170}}$$

$$P = \frac{V^2}{|Z|}.\cos\phi\ = 629.20$$

Chemistry PART – II

SECTION – A

24. C
Sol. The orbitals are 4s(one), 4p(three) and 4d(three). Total no. of electrons = 2 × 7 = 14.

25. B
Sol. It is a first order reaction.

26. B
Sol. Both NO and O_2 are formed at the same time.

27. ABC
Sol. The balanced equation is

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

28. AB
Sol Weak acids form buffer solutions with strong bases.

29. ABC
Sol. O and O_2 contain two unpaired electrons each. NO contains one unpaired electron. N_2 contains no unpaired electrons.

30. AB
Sol. Bases can form silicates with SiO_2(an acidic compound).

31. BD
Sol. $(BN)_x$ and H_3BO_3 form polymers.

32. C
33. D
(Sol. for 32 & 33)
It has maximum number of α-hydrogen atoms which display hyperconjugation.

SECTION – C

34. 7
Sol. X = $(NH_4)_2Cr_2O_7$, Y = Cr_2O_3, Z = N_2, the liquid is H_2O.

35. 4
Sol. $\Delta T_b = K_b \times i \times m$
or, $4.16 = 0.52 \times i \times 2$
or $i = 4$

36. 3
Sol. $\Delta H = nC_v\,\Delta T = 1 \times \frac{3}{2}R \times (1300 - 300) = \frac{3}{2} \times 2 \times 1000 = 3000$ cal = 3 Kcal.

37. 3

Sol. $E_{Cell} = E^{o}_{Cell} - \frac{0.0591}{n}\log\frac{\left[Zn^{2+}\right]}{\left[H^{+}\right]^{2}}$

or, $0.6418 = [0-(-0.76)] - \frac{0.0591}{n}\log\frac{10^{-2}}{\left[H^{+}\right]^{2}}$

on solving, $[H^{+}]^{2} = 10^{-6}$

$\therefore [H^{+}] = 10^{-3}$, pH = 3

38. 4

Sol. n-factor of NH_4NO_3 is 4.

39. 3

Sol. $\frac{r_{SO_2}}{r_{CH_4}} = \sqrt{\frac{M_{CH_4}}{M_{SO_2}}} = \sqrt{\frac{16}{64}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$

$\therefore$ x : y = 1 : 2, x + y = 3

40. 4

Sol. FCC contains four octahedral voids and eight tetrahedral voids.

41. 6

Sol. $Cr_2\left(SO_4\right)_3 \xrightarrow{NaOH} Cr\left(OH\right)_3 \xrightarrow{Na_2O_2} Na_2CrO_4$

42. 7

Sol. No. of ionization isomers = 3

No. of linkage isomers = 4

43. 3

Sol. The products those give Tollen's test are HCHO, HCOOH and CH_3CHO.

SECTION – D

44. 00015.20

Sol. $X(g) \rightleftharpoons Y(g) + Z(g)$

Initial conc. $\frac{250}{100} = 2.5$

At equ^{m} 2.5 – 1.25 1.25 1.25
= 1.25

$X(g) \rightleftharpoons Y(g) + Z(g)$

At equ^{m} 1.25 1.25 1.25

After addition (1.25 + x - y) (1.25 + y) (1.25 + y)

1.25 + y = 1.3

or, y = 0.05

$\therefore K_C = \frac{1.3 \times 1.3}{1.25 + x - 0.05} = 1.25$

On solving, x = 0.152

$0.152 = \frac{n}{V} = \frac{n}{100\,L}$

or, n = 15.20

45. 00012.60

Sol. $pH = \frac{1}{2}\left[p_{K_w} + p_{k_a} + \log C\right]$

$\text{or,}12.8 = \frac{1}{2}\left[14 + p_{k_a} + \log 10^{-1}\right]$

On solving, $p^{K_a} = 12.60$

46. 00116.24

Sol. $\Delta T_f = K_f \times m$

or, $0 - T_f = 1.86 \times 2 \times \frac{1000}{W}$

or, $0 - (-4.8) = 1.86 \times \frac{2000}{W}$

On solving, W = 775 g

$\therefore$ Mass of ice formed = 891.24 – 775 = 116.24 g

Mathematics PART – III

SECTION – A

47. B

Sol. Writing r as linear combination of a, b and $a \times b$, we have $r = xa + yb + z(a \times b)$ for solats x, y, z

$0 = r.a = x|a|^2 + ya.b$

$1 = r.b = xa.b + y|b|^2$

Solving we get $y = \frac{|a|^2}{|a|^2|b|^2 - (a.b)^2} = |a|^2$ and $x = \frac{a.b}{(a.b)^2 - |a|^2|b|^2} = a.b$

Also $1 = [r \quad a \quad b] = z|a \times b|^2$

$\Rightarrow \qquad z = \frac{1}{|a \times b|^2}$

Thus $r = \left((a.b)a - |a|^2 b\right) + \frac{a \times b}{|a \times b|^2}$

$= a \times (a \times b) + \frac{a \times b}{|a \times b|^2}$

48. A

Sol. Integrating the given differential equation, we have $\frac{dy}{dx} = \frac{-\cos 3x}{3} + e^x + \frac{x^3}{3} + C_1$ but

$y_1(0) = 1$ so $1 = \left(\frac{-1}{3}\right) + 1 + C_1 \Rightarrow C_1 = \frac{1}{3}$.

Again integrating, we get $y = \frac{-\sin 3x}{9} + e^x + \frac{x^4}{12} + \frac{1}{3}x + C_2$

but $y(0) = 0$ so $0 = 0 + 1 + C_2 \Rightarrow C_2 = -1$. Thus $y = \frac{-\sin 3x}{9} + e^x + \frac{x^4}{12} + \frac{1}{3}x - 1$

49. A

Sol. $x \neq (2n+1)\frac{\pi}{2}, n\pi, n \in I$. The given inequality can be written as

$\frac{\log_2(x^2 - 8x + 23)}{\log_2|\sin x|} > \frac{3}{\log_2|\sin x|}$

As $\log_2|\sin x| < 0$, we get $\log_2(x^2 - 8x + 23) < 3$

$\Rightarrow \qquad x^2 - 8x + 23 < 2^3 = 8$

$\Rightarrow \qquad x^2 - 8x + 15 < 0$

$\Rightarrow \qquad (x-5)(x-3) < 0 \Rightarrow 3 < x < 5$

For $x \in (3, 5), x \neq \pi, \frac{\pi}{2}, \frac{3\pi}{2}$. Hence

$x \in (3, \pi) \cup \left(\pi, \frac{3\pi}{2}\right) \cup \left(\frac{3\pi}{2}, 5\right)$

50. CD

Sol. Equating coefficients of x^{20}, we get $2^{20} - a^{20} = 1$

$\Rightarrow \quad a = \pm\left(2^{20} - 1\right)^{1/20}$

Next, putting $x = \frac{1}{2}$ we get $\left(\frac{a}{2} + b\right)^2 + \left(\frac{1}{4} + \frac{1}{2}p + q\right)^{10} = 0$

$\Rightarrow \quad b = \frac{-a}{2}$

The given equation can now be written as $2^{20}\left(x - \frac{1}{2}\right)^{20} - a^{20}\left(x - \frac{1}{2}\right)^{20}$

$= \left(x^2 + px + q\right)^{10}$

or $\left(x - \frac{1}{2}\right)^2 = x^2 + px + q$

$\Rightarrow \quad p = -1, q = \frac{1}{4}$

51. AB

Sol. Note that $S \geq 0$ and $S = 0$ for $z_1 = z_2 = z_3$

Thus, $\alpha = 0$

Since $|a - b|^2 = |a|^2 + |b|^2 - \bar{a}b - a\bar{b}$, we get

$|z_2 - z_3|^2 + |z_3 - z_1|^2 + |z_1 - z_2|^2$

$= 6 - \left(z_2\bar{z}_3 + \bar{z}_2 z_3 + z_3\bar{z}_1 + \bar{z}_3 z_1 + z_1\bar{z}_2 + \bar{z}_1 z_2\right)$

$= 6 - \bar{z}_1(z_2 + z_3) - \bar{z}_2(z_3 + z_1) - \bar{z}_3(z_1 + z_2)$ (1)

Also $\quad 0 \leq |z_1 + z_2 + z_3|^2$

$= |z_1|^2 + |z_2|^2 + |z_3|^2 \overline{z_1}(z_2 + z_3) + \overline{z_2}(z_3 + z_1) + \overline{z_3}(z_1 + z_3)$

$\Rightarrow \overline{z_1}(z_2 + z_3) + \overline{z_2}(z_3 + z_1) + \overline{z_3}(z_1 + z_2) \geq -3$ (2)

Thus, from (1) and (2), we get

$|z_2 - z_3|^2 + |z_3 - z_1|^2 + |z_1 - z_2|^2 \leq 9$

The value 9 is attained when $z_1 = 1 \quad z_2 = \omega \quad z_3 = \omega^2$

where $\omega \neq 1$ is a cube root of unity.

52. ABD

Sol. The total number of ways of choosing the ticket is 1000. Let the four digits number on the ticket is 1000.

Let the four digits number on the ticket be $x_1x_2x_3x_4$.

Note that $0 \le x_1 + x_2 \le 18$ and $0 \le x_3 + x_4 \le 18$.

Also, the number of non – negative integral solutions of $x + y = m$ (with $0 \le x,\ y \le 9$) is $m+1$ if $0 \le m \le 9$ and is $19 - m$ if $10 \le m \le 18$.

Thus, the number of favourable ways

$= 1\times1\times1 + 2\times2 + ... + 10\times10 + 9\times9 + 8\times8 + ... + 1\times1$

$= 2\left\{\frac{9\times10\times19}{6}\right\} + 100 = 670$

$\therefore$ Probability of required event $= \frac{670}{1000} = 0.067$

Note that $0.067 > 0.065$ and $0.067 < 0.068$.

53. ABC

Sol. $\frac{1}{n+1} + \frac{1}{n+2} + ... + \frac{1}{2n}$

$= \left(1 + \frac{1}{2} + \frac{1}{3} + ... + \frac{1}{2n}\right) - \left(1 + \frac{1}{2} + ... + \frac{1}{n}\right)$

$= \left(1 + \frac{1}{3} + ... + \frac{1}{2n-1}\right)$

$+ \frac{1}{2}\left(1 + \frac{1}{2} + ... + \frac{1}{n}\right) - \left(1 + \frac{1}{2} + ... + \frac{1}{n}\right)$

$= 1 - \frac{1}{2} + \frac{1}{3} - \frac{1}{4} - ..... + \frac{1}{2n-1} - \frac{1}{2n}$

$\alpha(2n) < \underbrace{\frac{1}{n} + \frac{1}{n} + ... + \frac{1}{n}}_{\text{n times}} = 1$ and $\alpha(2n) \ge \frac{1}{2n} \ge \frac{1}{2} \forall n$

(D) is not correct as $\alpha(1) = 1$

54. ABCD

Sol. Putting $x = 0, \frac{1}{2},$ we obtain $|c| \le 1, |a+b+c| \le 1, \left|\frac{1}{4}a + \frac{1}{2}b + c\right| \le 1$

$\Rightarrow \quad -1 \le c \le 1, -1 \le a + b + c \le 1$

$\quad -4 \le a + 2b + 4c \le 4$

$\Rightarrow \quad -4 \le 4a + 4b + 4c \le 4$

and $\quad -4 \le -a - 2b - 4c \le 4$

Adding we get $-8 \le 3a + 2b \le 8$

Also $\quad -8 \le a + 2b \le 8$

$\therefore \quad -16 \le 2a \le 16 \Rightarrow |a| \le 8$

Since $\quad -1 \le -c \le 1, -8 \le -a \le 8,$

We get $\quad -16 \le 2b \le 16 \Rightarrow |b| \le 8$

Thus, $\quad |a| + |b| + |c| \le 17$

55. A

56. C

Sol. (Q. 55 – 56)

$0 < \alpha < 90^o,\ \ 90^o < \beta < 180^o,\ \ 180^o < \gamma < 270^o,\ \ 270^o < \delta < 360^o$

$\Rightarrow 270^o < \alpha + \delta < 450^o \Rightarrow \alpha + \delta$ lies in the I or IV quadrant and cosine in both is positive.

If d is the common ratio of the A.P.

Then $\beta = \alpha + d,\ \gamma = \alpha + 2d,\ \delta = \alpha + 3d$.

$\Rightarrow \beta + \gamma = \alpha + \delta,\ 2(\alpha - \beta) = -2d = \beta - \delta$ and $\alpha + \gamma = 2\beta$.

Note $\beta - \gamma = -d,\ \alpha - \delta = -3d$

$270^o < \delta < 360^o$

$\Rightarrow \quad 270^o < \alpha + 3d < 360^o$

$\Rightarrow \quad 200^o < 3d < 290^o \qquad \left[\because \alpha = 70^o\right]$

$\Rightarrow \quad 400^o < 6d < 580^o$

$\Rightarrow \quad 680^o < 4\alpha + 6d < 860^o$

$\Rightarrow \quad 680^o < \theta < 860^o$

SECTION – C

57. 1

Sol. Applying $C_1 \to C_2 - 2\sin x\, C_3$ and $C_2 \to C_2 + 2\cos x\, C_3$, we obtain

$$f(x) = \begin{vmatrix} 2 & 0 & -\sin x \\ 0 & 2 & \cos x \\ \sin x & -\cos x & 0 \end{vmatrix}$$

$= 2\sin^2 x + 2\cos^2 x = 2 \Rightarrow f'(x) = 0$

$$\therefore \int_0^{\pi/2} \left[f(x) + f'(x)\right] dx = \int_0^{\pi/2} 2\,dx = 2\left(\frac{\pi}{2}\right) = \pi$$

58. 2

Sol. As $A^2 = O,\ A^k = O\ \forall k \ge 2$

Thus, $(A + I)^{50} = I + 50A$

$\Rightarrow (A + I)^{50} - 50A = I$

$\therefore\ a = 1,\ b = 0,\ c = 0,\ d = 1$

59. 5

Sol.
$$f(n) = \sum_{j=1}^{n} \left({}^nC_j\right)\left({}^jC_1\right) + \sum_{j=2}^{n} \left({}^nC_j\right)\left({}^jC_2\right) + \ldots\ldots + \sum_{j=n-1}^{n} \left({}^nC_j\right)\left({}^jC_{n-1}\right) + \left({}^nC_n\right)\left({}^nC_n\right)$$

$$= \left({}^nC_1\right)\left({}^1C_1\right) + \left({}^nC_2\right)\left({}^2C_1 + {}^2C_2\right) + \left({}^nC_3\right)\left({}^3C_1 + {}^3C_2 + {}^3C_3\right)$$

$$+ \ldots\ldots + \left({}^nC_n\right)\left({}^nC_1 + {}^nC_2 + \ldots\ldots + {}^nC_n\right)$$

$$= \left({}^nC_1\right)(2-1) + \left({}^nC_2\right)\left(2^2 - 1\right) + \left({}^nC_3\right)\left(2^3 - 1\right) + \ldots.. + {}^nC_n\left(2^n - 1\right)$$

$$=\left\{(2+1)^n-1\right\}+\left\{(1+1)^n-1\right\}=3^n-2^n$$

60. 3

Sol. Equation of the chord of contact of a point $P(3\sec\theta, 2\tan\theta)$ on the hyperbola with respect to the circle is $(3\sec\theta)x+(2\tan\theta)y=9$ (1)

Let M (h, k) be the mid point of (1), then equation of (1) in terms of the mid – point is

$hx+ky=h^2+k^2$ (2)

Since (1) and (2) represent the same line.

$\sec\theta=\frac{3h}{h^2+k^2}$, $\tan\theta=\frac{9k}{2\left(h^2+k^2\right)}$ s

$\Rightarrow$ locus of (h, k) is

$$\Rightarrow \frac{9x^2}{\left(x^2+y^2\right)^2}-\frac{81y^2}{4\left(x^2+y^2\right)^2}=1$$

or $4\left(x^2+y^2\right)^2=bx^2-cy^2$

$\Rightarrow$ $a=4, b=36, c=81$

$a^2+b^2+c^2=16+1296+6561=7873$

61. 3

Sol. Since maximum value of $\cos^{-1}x$ in $[0, 1]=\frac{\pi}{2}, \sum_{r=1}^{k}\cos^{-1}\beta_r=\frac{k\pi}{2}$ is possible if and only if each $\cos^{-1}\beta_r=\frac{\pi}{2}\Leftrightarrow\beta_r=0$.

$$A=\sum_{r=1}^{k}(\beta_r)^r=0$$

Thus, $\lim\limits_{x\to 0}\frac{(1+x)^{1/3}-(1-2x)^{1/4}}{x+x^2}$

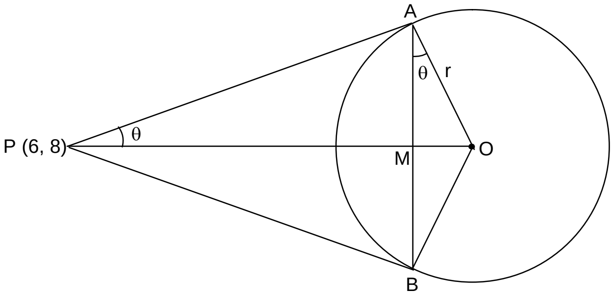
$$=\lim_{x\to 0}\frac{\left(1+\frac{x^2}{3}+0\left(x^4\right)\right)-\left(1-\frac{x}{2}+0\left(x^2\right)\right)}{x(1+x)}$$

$$=\lim_{x\to 0}\frac{\frac{1}{2}+\frac{x}{3}+0\left(x^2\right)}{1+x}=\frac{1}{2}$$. Thus the required limit is 249.

62. 5

Sol. Let O be the centre of the circle $x^2+y^2=r^2$ and P (6, 8) be the point outside the circle. Let θ be the angle between the tangent AP and OP. Clearly $\angle OAM=\theta$ so that $BM=r\cos\theta$ and $OM=r\sin\theta\left(0<\theta<\frac{\pi}{2}\right)$.

Also $OP=\sqrt{36+64}=10$ and $r=10\sin\theta$.



If A is the area of the triangle PAB, then

$A = 2$ (area of ΔPBM)

$= 2\left(\left(\frac{1}{2}\right)PM \times BM\right) = (OP - OM)BM$

$= (10 - r\sin\theta)r\cos\theta$

$= \left(10 - 10\sin^2\theta\right)(10\sin\theta\cos\theta)$

$(\because r = 10\sin\theta)$

$= 100\cos^3\theta\sin\theta$

$= 50\sin 2\theta\cos^2\theta$

$= \frac{25}{2}[\sin 4\theta + 2\sin 2\theta]$

So, $\frac{dA}{d\theta} = 50(\cos 4\theta + \cos 2\theta)$

$= 100\cos 3\theta\cos\theta$

For maximum value of θ, $\frac{dA}{d\theta} = 0$

$\Rightarrow \quad \cos 4\theta + \cos 2\theta = 0$

$\Rightarrow \quad 2\cos 3\theta\cos\theta = 0$

$\Rightarrow \quad 3\theta = \frac{\pi}{4}\left(0 < \theta < \frac{\pi}{2}\right)$

$\Rightarrow \quad \theta = \frac{\pi}{6}$

$$\frac{d^2A}{d\theta^2} = -100(2\sin 4\theta + \sin 2\theta)$$

$$\left.\frac{d^2A}{d\theta^2}\right|_{\theta=\pi/6} = -100\left(\sqrt{3} + \frac{\sqrt{3}}{2}\right) < 0$$

63. 4

Sol. (i) Putting $e^x = t$ in the given integral and taking e^x common in the integrand, we can write the given integral as $\int \frac{2t^4 + t^3 - 4t^2 + 4t + 2}{\left(t^2 + 4\right)\left(t^2 - 1\right)^2}dt$

$$= \int \frac{2t^4 - 4t^2 + 2}{\left(t^2 + 4\right)\left(t^2 - 1\right)^2}dt + \int \frac{t^3 + 4t}{\left(t^2 + 4\right)\left(t^2 - 1\right)^2}dt$$

$$= 2\int \frac{\left(t^2 - 1\right)^2}{\left(t^2 + 4\right)\left(t^2 - 1\right)^2}dt + \int \frac{t\left(t^2 + 4\right)}{\left(t^2 + 4\right)\left(t^2 - 1\right)^2}dt$$

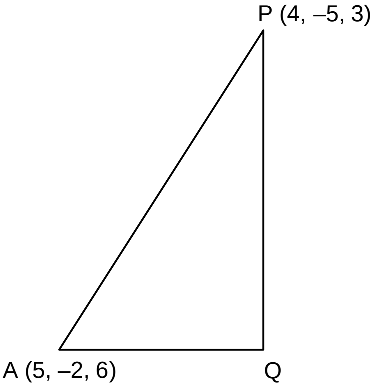
$$= 2\int \frac{dt}{t^2 + 4} + \frac{1}{2}\int \frac{2t}{\left(t^2 - 1\right)^2}dt$$

$$= \tan^{-1}\frac{t}{2} - \frac{1}{2\left(t^2-1\right)} + C$$

$$= \tan^{-1}\left(\frac{e^x}{2}\right) - \frac{1}{2\left(e^{2x}-1\right)} + C$$

64. 7

Sol. The given lines passes through A (5, –2, 6)



$$\left(PQ\right)^2 = \left(AP\right)^2 - \left(AQ\right)^2$$

$$\left(AP\right)^2 = \left(4-5\right)^2 + \left(-5+2\right)^2 + \left(3-6\right)^2 = 19$$

AQ is the projection of AP on the given line

$$\therefore AQ = \left(5-4\right)\frac{3}{\sqrt{50}} + \left(-2+5\right)\frac{\left(-4\right)}{\sqrt{50}} + \left(6-3\right)\left(\frac{-5}{\sqrt{50}}\right) = \frac{6}{\sqrt{50}}$$

$$\Rightarrow \left(PQ\right)^2 = 19 - \frac{36}{50} = \frac{457}{25}$$

$$\Rightarrow 25\left(PQ\right)^2 - 450 = 7$$

65. 3

Sol. Taking logarithm of both sides, we get $\log y = x\left[\log\left(1+\frac{1}{x}\right)\right]$

$$\Rightarrow \frac{1}{y}y_1(x) = \frac{x^2}{x+1}\left(-\frac{1}{x^2}\right) + \log\left(1+\frac{1}{x}\right)$$

$$= -\frac{1}{x+1} + \log\left(1+\frac{1}{x}\right) \quad \text{(i)}$$

Since $y(2) = \left(1+\frac{1}{2}\right)^2 = \frac{9}{4}$ so

$$y_1(2) = \left(\frac{9}{4}\right)\left(-\frac{1}{3} + \log\frac{3}{2}\right)$$

Multiplying (i) by y and then differentiating, we get

$$y_2(x) = y_1(x)\left(-\frac{1}{x+1} + \log\left(1+\frac{1}{x}\right)\right) + y(x) \times \left(\frac{1}{\left(x+1\right)^2} + \frac{x}{x+1}\left(-\frac{1}{x^2}\right)\right)$$

So $y_2(2) = y_1(2)\left(-\frac{1}{3} + \log\frac{3}{2}\right) + y(2)\left(\frac{1}{9} - \frac{1}{6}\right)$

$$= \left(\frac{9}{4}\right)\left(-\frac{1}{3} + \log\frac{3}{2}\right)^2 - \frac{1}{8}.$$

66. 1

Sol. Let $y = \frac{e^x - e^{-x}}{2} \Rightarrow e^{2x} - 1 = 2ye^x$

Therefore, $t^2 - 2yt - 1 = 0,\ t = e^x$

$$\Rightarrow t = \frac{2y \pm \sqrt{4y^2+4}}{2} = y \pm \sqrt{y^2+1}$$

$$\Rightarrow x = \log\left(y + \sqrt{y^2+1}\right) \text{ (since } e^x > 0\text{)}$$

$$\therefore\ f^{-1}(x) = g(x) = \log\left(x + \sqrt{x^2+1}\right)$$

$$g\left(\frac{e^{1002}-1}{2e^{501}}\right) = \log\left(\frac{e^{1002}-1}{2e^{501}} + \frac{e^{1002}+1}{2e^{501}}\right)$$

$$= \log e^{501} = 501$$

SECTION – D

67. 24850.00

Sol. $\left(1-2hx+h^2\right)^{-1/2} = \left(1-h(2x-h)\right)^{-1/2}$

$$= 1 + \frac{h}{2}(2x-h) + \frac{\left(\frac{-1}{2}\right)\left(\frac{-3}{2}\right)}{2}h^2(2x-h)^2 + \frac{1.3.5}{2.4.6}h^3(2x-h)^3 + ...$$

$$= 1 + xh + \frac{1}{2}\left(3x^2-1\right)h^2 + \frac{1}{2}\left(5x^3-3x\right)h^3 + ...$$

$P_3(x) =$ Coefficient of h^3 in $\left(1-2hx+h^2\right)^{-1/2}$

$$= \frac{1}{2}\left(5x^3-3x\right).$$

$$P_3(10) = \frac{1}{2}(5000-30) = 2485$$

68. 26916.72

Sol. Since $x(1-x) = \frac{1}{4} - \left(x - \frac{1}{2}\right)^2$, so put $x = \frac{1}{2} + \left(\frac{1}{2}\right)\sin\theta$.

Therefore, $\int_0^1 \frac{dx}{(1+x)(2+x)\sqrt{x(1-x)}}$

$$= \int_{-\pi/2}^{\pi/2} \frac{\left(\frac{1}{2}\right)\cos\theta\, d\theta}{\left(\frac{1}{4}(1+\sin\theta)^2 + \frac{3}{2}(1+\sin\theta) + 2\right)\frac{1}{2}\cos\theta}$$

$$= 4\int_0^{\pi} \frac{d\phi}{\cos^2\phi - 8\cos\phi + 15} \text{ where, } \phi = \theta + \frac{\pi}{2}$$

$$= \frac{4}{2}\left[\int_0^{\pi} \frac{d\phi}{\cos\phi - (4+1)} - \int_0^{\pi} \frac{d\phi}{\cos\phi - (4-1)}\right]$$

Let $I_1 = \int_0^{\pi} \frac{d\phi}{\cos\phi - a}$ where $a > 1$

Put $\tan\left(\frac{\phi}{2}\right) = t,\ d\phi = 2\frac{dt}{\left(1+t^2\right)}$.

$$\therefore I_1 = \int_0^{\infty} \frac{\frac{2dt}{\left(1+t^2\right)}}{\frac{\left(1-t^2\right)}{\left(1+t^2\right)} - a} = \frac{-2}{1+a}\int_0^{\infty} \frac{dt}{r^2 + \frac{(a-1)}{(a+1)}}$$

$$= \frac{-2}{1+a}\sqrt{\frac{a+1}{a-1}}\left(\tan^{-1}\frac{t\sqrt{a+1}}{\sqrt{a-1}}\right)\Bigg]_0^{\infty}$$

$$= \frac{-2}{\sqrt{a^2-1}}.\frac{\pi}{2} = \frac{-\pi}{\sqrt{a^2-1}}$$

Thus $I = 2\left[-\frac{\pi}{\sqrt{24}} + \frac{\pi}{\sqrt{8}}\right]$

$$= \pi\left(\frac{1}{\sqrt{2}} - \frac{1}{\sqrt{6}}\right) = \pi\frac{\left(\sqrt{3}-1\right)}{\sqrt{6}}$$

69. 24869.83

Sol. Let AB be the line whose equation is $\frac{x}{97} + \frac{y}{79} = 1$ where A is (97, 0) and B is (0, 79). Equation of the other diagonal passing through $\left(\frac{97}{2}, \frac{79}{2}\right)$, the mid point of AB and perpendicular to AB is $y - \frac{79}{2} = \frac{97}{79}\left(x - \frac{97}{2}\right)$ (1)

Let the coordinates of the vertex C of the other diagonal be $\left(x_1, y_1\right)$ then $\left(x_1, y_1\right)$ lies on (1) and $BC^2 = \frac{AB^2}{2}$

$$\Rightarrow 2\left[x_1^2 + \left(y_1 - 79\right)^2\right] = (97)^2 + (79)^2$$

$$\Rightarrow 2\left[\left(1 + \frac{97^2}{79^2}\right)x_1^2 - 2\times\frac{97}{79}\left(\frac{97^2+79^2}{2\times 79}\right)x_1 + \left(\frac{(97)^2 + (79)^2}{2(79)}\right)^2\right]$$

$$\Rightarrow 4x_1^2 - 4\times 97x_1 + (97)^2 + (79)^2 = 2\times(79)^2$$

$$\Rightarrow \left(2x_1 - 97\right)^2 = (79)^2$$

$$\Rightarrow 2x_1 = 97 \pm 79 \Rightarrow x_1 = \frac{97\pm 79}{2} y_1 = \frac{97\pm 79}{2}$$

$\therefore$ The coordinates of the vertices of the other diagonal are (88, 88) and (9, 9)

$\Rightarrow p_1 = 88,\ p_2 = 9$

$\Rightarrow p_1 + p_2 = 97$

FIITJEE **JEE (Main)-2018**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - II

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 – 30, 31 – 60, 61 – 90)** *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1 A spherical object of mass 1 kg and radius 1 m is falling vertically downward inside a viscous liquid in a gravity free space. At a certain instant the velocity of the sphere is 2 m/s. If the coefficient of viscosity of the liquid is $\frac{1}{18\pi}$ N-S/m^2, then velocity of ball will become 0.5 m/s after a time

(A) ln 4 s (B) 2 ln 4 s
(C) 3 ln 4 s (D) 2 ln 2 s

2 Two radioactive elements R and S disintegrate as

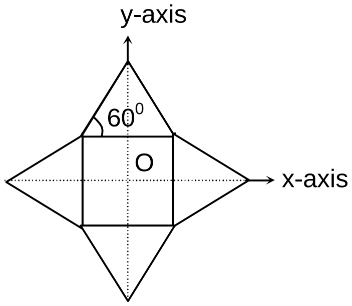
$$R \longrightarrow P + \alpha\,;\ \lambda_R = 4.5 \times 10^{-3}\ \text{years}^{-1}$$
$$S \longrightarrow Q + \beta\,;\ \lambda_S = 3 \times 10^{-3}\ \text{years}^{-1}$$

Starting with number of atoms of R and S in the ratio of 2 : 1, this ratio after the lapse of three half lives of R will be

(A) 3 : 2 (B) 1 : 3
(C) 1 : 1 (D) 2 : 1

3 Moment of inertia of a uniform symmetric plate as shown in figure about x-axis is I. Moment of inertia of this plate about an axis passing through centre of plate O and perpendicular to the plane of plate is

(A) 2I (B) I
(C) I/2 (D) I/4



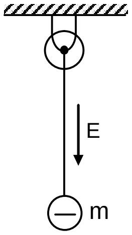
Space for Rough work

4. A body (solid sphere) of mass m makes an elastic collision with another identical body at rest. Just after collision the angle between the velocity vector of one body with the initial line of motion is 15° then the angle between velocity vector of the other body with the initial line of motion is

(A) 75^0 (B) 60^0

(C) 45^0 (D) 30^0

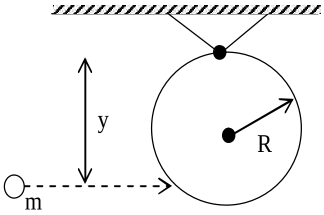
5. A simple pendulum charged negatively to q coulomb oscillates with a time period T in a downward electric field. If the electric field is with-drawn, the new time period is:



(A) = T (B) > T

(C) < T (D) $T\frac{mg}{qE}$

6. A small ball of mass m hits the cylinder which is hinged at top and free to rotate in vertical plane as shown in figure. Mass of cylinder is M. Liner momentum of system (ball + cylinder)



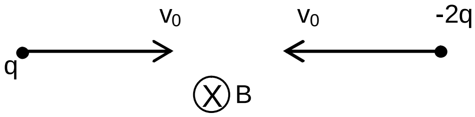
(A) Remains conserved if y = R

(B) Remains conserved if $y = \frac{3}{2}R$

(C) Remains conserved if $y = \frac{7}{5}R$

(D) Cannot be conserved for any value of y.

7. A charge particle q of mass m is placed at a distance d from another charge particle – 2q of mass 2m in a uniform magnetic field B as shown. If particles are projected towards each other with equal speed v_0, so that the two particles touches each other without collision during its motion. (Assume only force due to magnetic field acts on the particle)

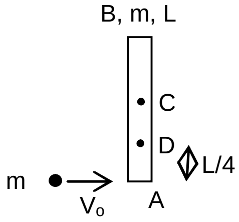


(A) $\frac{qBd}{m}$ (B) $\frac{qBd}{2m}$

(C) $\frac{2qBd}{m}$ (D) $\frac{3qBd}{2m}$

Space for Rough work

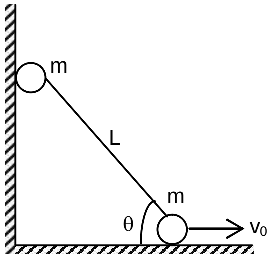
8. A thin, uniform rod of mass M and length L is at rest on a smooth horizontal surface. A particle of same mass M collides with the rod at one end perpendicular to its length with velocity V_o and sticks to it. C is the middle point of the rod and D is a point at a distance of L/4 from end A. The time taken by the rod turn through 90^o after collisions



(A) $\frac{L}{V_o}$ (B) $\frac{\pi L}{V_o}$

(C) $\frac{3\pi L}{5V_o}$ (D) $\frac{5\pi L}{12V_o}$

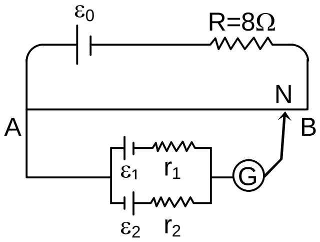
9. In the shown diagram two point masses m are joined by a massless rod of length 5.5 m. The lower end of the mass system is dragged with constant velocity v_0 rightwards. The magnitude of velocity of centre of mass when $\theta = 37^0$, will be



(A) $\frac{5v_0}{6}$ (B) $2v_0$

(C) $v_0\sqrt{2}$ (D) $\frac{6v_0}{5}$

10. A battery of emf $\varepsilon_0 = 12V$ is connected across a 4m long uniform wire having resistance 4Ω/m. The cells of small emfs $\varepsilon_1 = 2V$ and $\varepsilon_2 = 4V$ having internal resistance 2Ω and 6Ω respectively are connected as shown in the figure. If galvanometer shows no deflection at the point N, the distance of point N from the point A is equal to :



(A) $\frac{1}{6}$m (B) $\frac{1}{3}$m

(C) 25 cm (D) 50 cm

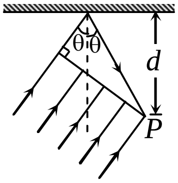
Space for Rough work

11. A uniform rod of length L and mass M is pivoted freely at one end and released as shown. The angular acceleration of the rod and the tangential linear acceleration of the free end when the rod is horizontal are
(A) 3g/2L, 3g/2 (B) 3g/2L, g
(C) g/2L, g/2 (D) 6g/L, 6g

12. A wheel of mass 2 kg and radius 10 cm is rotating about its axis at an angular velocity of 2π rad/s. The force that must be applied tangentially to the wheel to stop it in 5 revolutions is
(A) $3\pi\times10^{-2}$ kg-m^2/s (B) $4\pi \times 10^{-2}$ kg-m^2/s
(C) $\pi\times 10^{-2}$ kg-m^2/s (D) $2\pi\times 10^{-2}$ kg-m^2/s

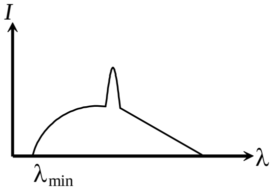
13. When a hydrogen atom emits a photon in going from n = 5 to n = 1 state, its recoil speed is almost (mass of H-atom = 1.67×10^{-27} kg)
(A) 10^{-4} m/s (B) 2×10^{-2} m/s
(C) 4 m/s (D) 8×10^{-2} m/s

14. A plane wave front of light is incident on a plane mirror. Intensity is maximum at P when



(A) $\cos\theta = \dfrac{\lambda}{2d}$ (B) $\cos\theta = \dfrac{3\lambda}{4d}$
(C) $\sec\theta - \cos\theta = \dfrac{3\lambda}{4d}$ (D) $\sec\theta - \cos\theta = \dfrac{\lambda}{2d}$

15. An X-ray tube has three main controls.
(i) the target material (its atomic number Z)
(ii) the filament current (I_f) and
(iii) the accelerating voltage (V)
Figure shows a typical intensity distribution against wavelength. Which of the following is incorrect?



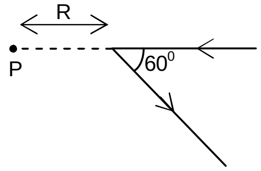
(A) The limit λ_{min} is proportional to V^{-1}
(B) The sharp peak shifts to the right as Z is increased
(C) The penetrating power of X ray increases if V is increased
(D) The intensity everywhere increases if filament current I_f is increased

Space for Rough work

16. The image of an object, formed by a plano-convex lens at a distance of 8 m behind the lens, is real and is one-third the size of the object. The wavelength of light inside the lens is $\frac{2}{3}$ times the wavelength in free space. The radius of the curved surface of the lens is

(A) 1 m (B) 2 m
(C) 3 m (D) 6 m

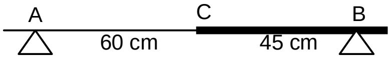
17. A long straight wire, carrying a current I is bent at its mid point to form an angle of 60^0. AT a point P, distance R from the point of bending the magnetic field is



(A) $\frac{\left(\sqrt{2}-1\right)\mu_0 i}{4\pi R}$ (B) $\frac{\left(\sqrt{2}+1\right)\mu_0 i}{4\pi R}$

(C) $\frac{\mu_0 i}{4\sqrt{3}\pi R}$ (D) $\frac{\mu_0 i}{8R}$

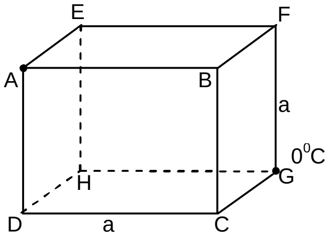
18. A steel wire of length 60 cm and area of cross section 10^{-6}m^2 is joined with an aluminium wire of length 45 cm and area of cross section $3\times10^{-6}\text{m}^2$. The composite string is stretched by a tension of 80 N. Density of steel is 7800 kg m^{-3} and that of aluminium is 2600 kg m^{-3}. The minimum frequency of turning fork, which can produce standing wave in it with node at joint is



(A) 357.3 Hz (B) 375.3 Hz
(C) 337.5 Hz (D) 325.3 Hz

Space for Rough work

19. A cubical frame is made by connecting 12 identical uniform conducting rods as shown in the figure. In the steady state the temperature of junction A is 100^0 C while that of the G is 0^0C. Then,



(A) B will be Hotter than H

(B) Temperature of F is 40^0C

(C) Temperature of D is 66.67^0C

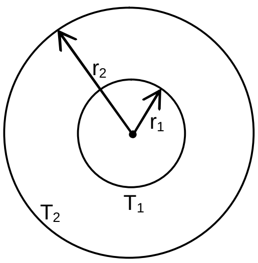
(D) Temperature of E is 50^0C

20. A body of mass 1kg is suspended from a massless spring having force constant 600 N/m. Another body of mass 0.5 kg moving vertically upwards hits the suspended body with a velocity 3 m/sec and gets embedded in it. The frequency of oscillation and the amplitude of motion are

(A) $\frac{10}{\pi}Hz, 10\,Cm$ (B) $\frac{10}{\pi}Hz, 5\,Cm$

(C) $\frac{5}{\pi}Hz, 5\,Cm$ (D) $\frac{5}{\pi}Hz, 10\,Cm$

21. The figure shows a hollow conducting sphere radius (r_2) with cavity radius (r_1) kept at temperatures T_1 and T_2 respectively. The radial rate of flow of heat in a substance between the two concentric spheres in proportional to



(A) $\frac{r_1 r_2}{r_2 - r_1}$ (B) $(r_2 - r_1)$

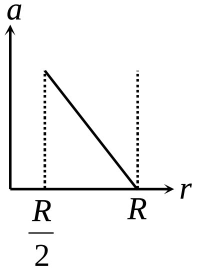
(C) $\frac{(r_2 - r_1)}{r_1 r_2}$ (D) $\log_e\left(\frac{r_2}{r_1}\right)$

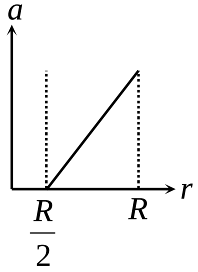
Space for Rough work

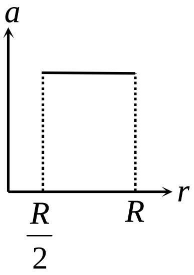
22. Two spherical bodies of masses M and 5M and radii R and 2R respectively are released in free space with initial separation between their centres equal to 12R. If they attract each other due to gravitational force only, then the distance covered by smaller body just before collision is

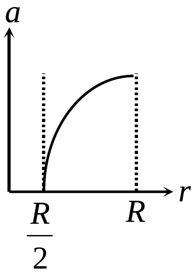
(A) 1.5 R (B) 2.5 R
(C) 4.5 R (D) 7.5 R

23. A frictionless tunnel is dug along a chord of the earth at a perpendicular distance $\frac{R}{2}$ from the centre of earth (where R is radius of earth). An object is released from one end of the tunnel. The correct graph, showing the variation of acceleration of particle with its distance r from centre of earth is

(A)


(B)


(C)


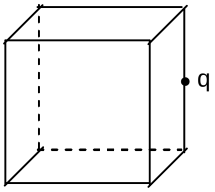
(D)


Space for Rough work

24. Two longitudinal waves propagating in the X and Y directions superimpose. The wave equations are as below $\psi_1 = A\cos(\omega t - kx)$ and $\psi_2 = A\cos(\omega t - ky)$. Trajectory of the motion of a particle lying on the line $y = x + \frac{(2n+1)\lambda}{2}$ will be

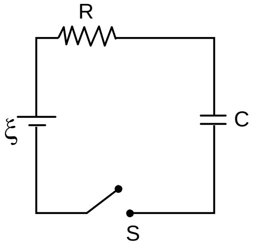
(A) straight line (B) circle
(C) ellipse (D) none of these

25. The total flux of electric lines of forces of a charge q placed at the mid point of the edge of a side of rectangular box, as shown in figure through the box is



(A) $\frac{q}{2\epsilon_0}$ (B) $\frac{q}{4\epsilon_0}$
(C) $\frac{q}{8\epsilon_0}$ (D) $\frac{q}{16\epsilon_0}$

26. As situation shown in figure the maximum value of rate of energy stored in the capacitor after the switch is closed



(A) $\frac{\xi^2}{2R}$ (B) $\frac{\xi^2}{4R}$
(C) $\frac{\xi^2}{8R}$ (D) none of these

27. If vectors P, Q and R have magnitude 5, 12 and 13 units and $\vec{P} + \vec{Q} = \vec{R}$, the angle between Q and R is

(A) $\cos^{-1}\frac{5}{12}$ (B) $\cos^{-1}\frac{5}{13}$
(C) $\cos^{-1}\frac{12}{13}$ (D) $\cos^{-1}\frac{7}{13}$

Space for Rough work

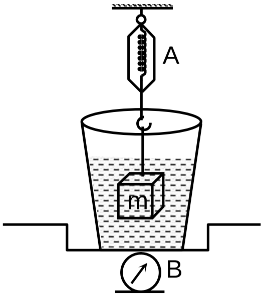
28. A particle is projected from ground At a height of 0.4 m from the ground, the velocity of a projectile in vector form is $\vec{v} = (6\hat{i} + 2\hat{j})$ m/s (the x-axis is horizontal and y-axis is vertically upwards). The angle of projection is (g = 10 m/s^2):

(A) 45° (B) 60°
(C) 30° (D) $\tan^{-1}(3/4)$

29. Force acting on a particle moving in a straight line varies with the velocity of the particle as $F = \frac{K}{v}$. Here, K is a constant. The work done by the this force in time t is:

(A) $\frac{K}{v^2}.t$ (B) 2Kt
(C) Kt (D) $\frac{2Kt}{v^2}$

30. The spring balance A reads 2 kg with a block m suspended from it. A balance B reads 5 kg when a beaker filled with liquid is put on the pan of the balance. The two balances are now so arranged that the hanging mass is inside the liquid as shown in figure. In this situation



(A) The balance A will read more than 2 kg.
(B) The balance B will read less than 5 kg.
(C) The balance A will read less than 2 kg and B will read more than 5 kg.
(D) The balances A and B will read 2 kg and 5 kg respectively

Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. How many electron(s) is/are present in 1.8 mL of water (density = 1 g/mL)?
(A) $0.1 \times 6.023 \times 10^{23}$ (B) $10 \times 6.023 \times 10^{23}$
(C) 6.023×10^{23} (D) $1.8 \times 10 \times 6.023 \times 10^{23}$

32. If the radius of first orbit of hydrogen atom is a_0, which of the following cannot be the radius of any other orbits of hydrogen?
(A) $4a_0$ (B) $6a_0$
(C) $9a_0$ (D) $16a_0$

33. Which of the following species has the largest bond angle?
(A) NH_4^+ (B) NO_2^+
(C) NO_2^- (D) NO_3^-

34. What is the oxidation number of iodine in KI_3?
(A) -1 (B) +1
(C) $-\frac{1}{3}$ (D) $+\frac{1}{3}$

Space for Rough work

35. $Cu^{2+} + 2e^{-} \longrightarrow Cu, \ E^{o} = +0.34\,V$

$Cu^{2+} + e^{-} \longrightarrow Cu^{+}, \ E^{o} = +0.15\,V$

The equilibrium constant for the reaction $Cu + Cu^{2+} \longrightarrow 2\,Cu^{+}$ at $25^{o}C$

(A) 2.9×10^{-8} (B) 3.72×10^{-7}
(C) 2.9×10^{-5} (D) 3.72×10^{-5}

36. At high pressure the van der Waal's equation for one mole of a real gas reduces to

(A) $PV = RT - \frac{a}{V}$ (B) PV = RT + Pb
(C) $\left(P + \frac{a}{V^2}\right)V = RT$ (D) PV = RT

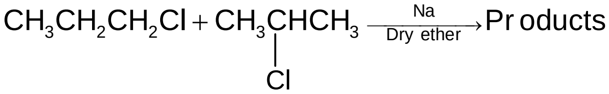
37. 100 mL of a sample of hard water requires 25.1 mL of 0.02 N H_2SO_4 for complete reaction. The hardness of water (density 1 g/mL) is:
(A) 200 ppm (B) 250 ppm
(C) 251 ppm (D) 258 ppm

38. Two grams of dihydrogen diffuse from a container in 10 minutes. How many gram of dioxygen would diffuse through the same container in the same time under similar conditions?
(A) 4 (B) 8
(C) 6 (D) 0.5

39. The electronegativity of phosphorus is maximum in
(A) PCl_5 (B) $PClF_4$
(C) PCl_2F_3 (D) PCl_3F_2

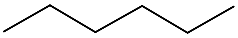
40. A one litre vessel contains 3 moles each of gases A, B, C and D at equilibrium. If one mole each of A and B are removed, K_C for $A(g) + B(g) \rightleftharpoons C(g) + D(g)$ will be
(A) 2.5 (B) 4
(C) 1 (D) ¼

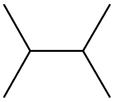
Space for Rough work

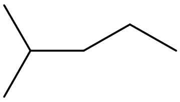
41. 

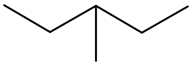
$$CH_3CH_2CH_2Cl + \underset{\displaystyle Cl}{CH_3CHCH_3} \xrightarrow[\text{Dry ether}]{\text{Na}} \text{Products}$$

Which of the following is not a product of above reaction?

(A) 

(B) 

(C) 

(D) 

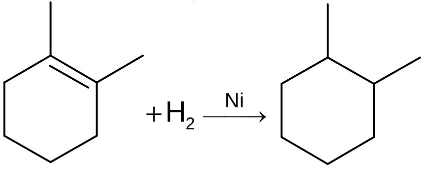
42. The half-life of a chemical reaction does not change by either increasing or decreasing the initial concentration of reactant. What is the order of the reaction?

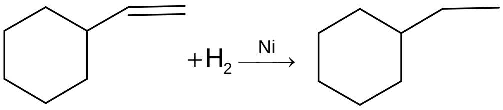
(A) Zero
(B) First
(C) Second
(D) Fractional

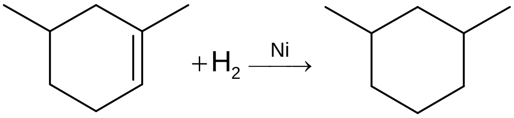
43. K_{sp} of AgCl in water at 25°C is 1.8×10^{-10}. If 10^{-5} mole of Ag^+ ions are added to this solution, K_{sp} will be:

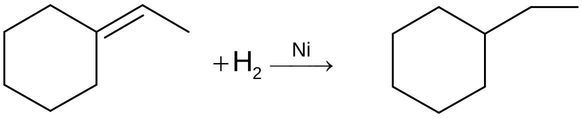
(A) 1.8×10^{-15}
(B) 1.8×10^{-5}
(C) 1.8×10^{-10}
(D) none of these

44. Which of the following reaction liberates maximum amount of heat energy?

(A) 

(B) 

(C) 

(D) 

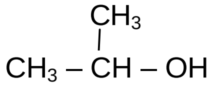
Space for Rough work

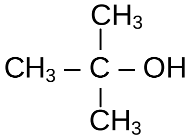
45. A diene on reductive ozonolysis produces two moles of ethanal and one mole of propan -1, 3-dial. How many geometrical isomer(s) is/are possible for the diene?
(A) 2 (B) 3
(C) 4 (D) 6

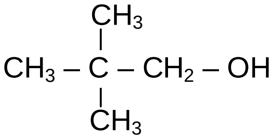
46. How much work in kJ mol^{-1} unit is done by reversible and isothermal expansion of 1.2 mole of an ideal gas to 10 times of its original volume at 27°C?
(A) 4.191 (B) 6.892
(C) -6.892 (D) -4.191

47. In which of the following alcohols C – O bond breaks (heterolytically) with greatest ease:

(A) $CH_3CH_2CH_2OH$

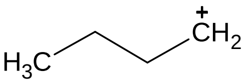
(B) 
$CH_3-CH(CH_3)-OH$

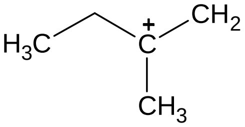
(C) 
$CH_3-C(CH_3)_2-OH$

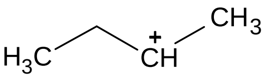
(D) 
$CH_3-C(CH_3)_2-CH_2-OH$

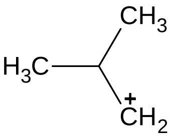
48. Which of the following has the most acidic hydrogen?
(A) 3-hexanone (B) 2, 4-hexanedione
(C) 2, 5-hexanedione (D) 2, 3-hexanedione.

49. Dehydration of 1-butanol gives 2-butene as a major product, by which of the following intermediate the compound 2-butene obtained.

(A) 

(B) 

(C) 

(D) 

Space for Rough work

50. In which of the following crystals, alternate tetrahedral voids are occupied?

(A) NaCl (B) ZnS

(C) CaF_2 (D) Na_2O

51. Molar heat capacity of an ideal gas at constant volume is given by $C_v = 2 \times 10^{-2}$ J (in Joule). If 3.5 mole of this ideal gas are heated at constant volume from 300 K to 400 K the change in internal energy will be

(A) 7 (B) 4

(C) 8 (D) 6

52. $BCl_3 + H_2 + C \xrightarrow{1700-1800^{o}C} \text{Product}(s)$

The product(s) of above reaction is/are

(A) $CCl_4 + B_2H_6$ (B) $B_4C + HCl$

(C) $B + Cl_2 + CH_4$ (D) $B_2H_6 + CHCl_3$

53. Atomic radii of Ti, Zr and Hf vary

(A) Ti > Zr > Hf (B) Ti < Zr < Hf

(C) Ti < Hf < Zr (D) Ti < Zr = Hf

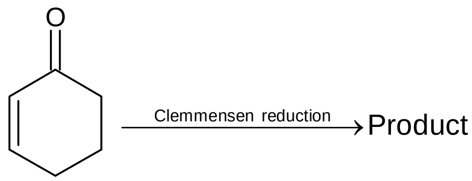
54. $C_6H_5CHO + CH_3COOCOCH_3 \xrightarrow[\Delta]{CH_3COONa} \text{Products}$

If one product of above reaction is $C_6H_5-CH=CH-COOH,$ the other organic product(side product) is:

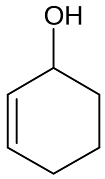
(A) CH_3CH_2OH (B) C_6H_5COOH

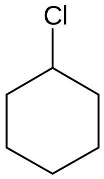
(C) CH_3CHO (D) $C_6H_5 - CH = CH_2$

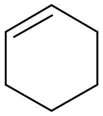
Space for Rough work

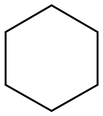
55. 
O
Clemmensen reduction
Product

The product of above reaction is:

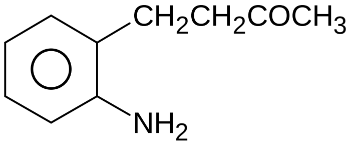
(A) 

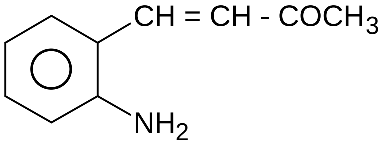
(B) 

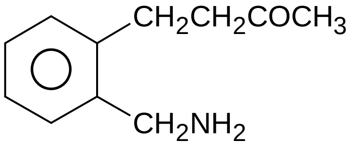
(C) 

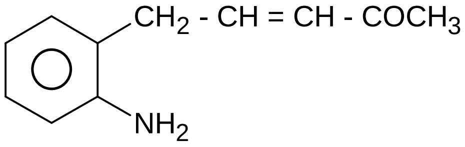
(D) 

56. Which forms aromatic compound on heating?

(A) 
CH2CH2COCH3
NH2

(B) 
CH = CH - COCH3
NH2

(C) 
CH2CH2COCH3
CH2NH2

(D) 
CH2 - CH = CH - COCH3
NH2

57. The shape of $[Co(NH_3)_6]^{3+}$ is:

(A) Tetrahdedral (B) Trigonal bipyramidal

(C) Octahedral (D) Square planar

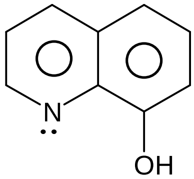
58. $AgNO_3$ solution will not give white precipitate with:

(A) $[Co(NH_3)_3Cl_3]$ (B) $[Co(NH_3)_4Cl_2]Cl$

(C) $[Co(NH_3)_5Cl]Cl_2$ (D) $[Co(NH_3)_6]Cl_3$

Space for Rough work

59. Which of the following two reagents form silicates when react with silica (SiO_2)?
(A) NaCl and Na_2S
(B) NaOH and Na_2CO_3
(C) Na_2SO_4 and $NaNO_3$
(D) NaBr and $NaHSO_4$

60. In which combinations, all the ligands are ambient in nature?
(A) $NO_2, \overline{S}CN$ and $\overline{C}N$
(B) EDTA, $\overline{S}CN$
(C) H_2O, 

(D) All of these

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. Let $u = (\log_2 x)^2 - 6\log_2 x + 12$ where x is a real number. Then the equation $x^u = 256$ has:
(A) no solution for x
(B) exactly one solution for x
(C) exactly two distinct solutions for x
(D) exactly three distinct solutions for x

62. The value of x satisfying the equation, $x = \sqrt{2+\sqrt{2-\sqrt{2+x}}}$ is:
(A) $2\cos 10^o$
(B) $2\cos 20^o$
(C) $2\cos 40^o$
(D) $2\cos 80^o$

63. If α, β are two real numbers satisfying $\alpha^2 + \beta^2 = 5$ and $3(\alpha^5 + \beta^5) = 11(\alpha^3 + \beta^3)$, then $\alpha\beta$ is:
(A) 2
(B) 1
(C) 7
(D) 9

64. $\frac{1}{4} + \frac{1(3)}{4(6)} + \frac{1(3)(5)}{4(6)(8)} + ...\infty$
(A) 1
(B) 2
(C) 3
(D) 4

Space for Rough work

65. For $x \in (1, \infty)$, if $P = x^3 - \frac{1}{x^3}$ and $Q = x - \frac{1}{x}$, then the minimum value of $\frac{P}{Q^2}$ equals:

(A) $2\sqrt{3}$ (B) $4\sqrt{3}$
(C) $\sqrt{3}$ (D) $3\sqrt{3}$

66. If the value of $\alpha \in [0, 2\pi]$ such that the inequality $\sin\left(\frac{\pi}{3} + x\right) + \sin(\alpha + x) \geq 0$ is true for all real numbers x, is equal to $\frac{p\pi}{q}$ where p and q are relatively prime positive integers, then the value of $(p + q)$ is

(A) 7 (B) 6
(C) 5 (D) 4

67. $\lim\limits_{N \to \infty} \lim\limits_{M \to \infty} \sum_{R=1}^{N} \sum_{K=1}^{MR} \frac{MN^2}{\left(M^2N^2 + K^2\right)\left(N^2 + R^2\right)} = ?$

(A) $\frac{\pi^2}{32}$ (B) $\frac{\pi^2}{16}$
(C) $\frac{\pi^2}{25}$ (D) $\frac{\pi^2}{8}$

68. Number of straight lines passing through the point P (4, 3) whose x – intercept is a prime number and whose y – intercept is a positive integer, is equal to:

(A) 0 (B) 1
(C) 2 (D) more than 2 but finite

69. If a circle of radius 3 units is touching the lines $\sqrt{3}y^2 - 4xy + \sqrt{3}x^2 = 0$ in the first quadrant then the length of chord of contact to this circle is:

(A) $\frac{\sqrt{3} + 1}{2}$ (B) $\frac{\sqrt{3} + 1}{\sqrt{2}}$
(C) $3\left(\frac{\sqrt{3} + 1}{\sqrt{2}}\right)$ (D) $3\frac{\left(\sqrt{3} + 1\right)}{2}$

Space for Rough work

70. Identify the correct statement

(A) If system of n simultaneous linear equation has a unique solution, then coefficient matrix is singular

(B) If system of n simultaneous linear equation has a unique solution, then coefficient matrix is non singular

(C) If A^{-1} exists, $(\text{adj}A)^{-1}$ may or may not exist

(D) $F(x)=\begin{bmatrix}\cos x & -\sin x & 0\\ \sin x & \cos x & 0\\ 0 & 0 & 0\end{bmatrix}$, then $F(x).F(y)=F(x-y)$

71. A four digit number is called a doublet if any of its digit is the same as only one neighbour. For example, 1221 is a doublet but 1222 is not. Number of such doublets are:

(A) 2259
(B) 2268
(C) 2277
(D) 2349

72. The constant term in the expansion of $\left(x^2+\frac{1}{x^2}+y+\frac{1}{y}\right)$ is:

(A) 4900
(B) 4950
(C) 5050
(D) 5151

73. The coefficient of x^{11} in the expression $(1+x)^5(3+x)^4(7+x)^3$ equals:

(A) 28
(B) 34
(C) 38
(D) 42

74. The function $f:R\to R$ defined as $f(x)=\ln\left(\sqrt{\sqrt{x^2+1}+x}+\sqrt{\sqrt{x^2+1}-x}\right)$ is:

(A) one – one and onto both
(B) one – one but not onto
(C) onto but not one – one
(D) neither one – one nor onto

Space for Rough work

75. Let $f(x) = \ln x$ and $g(x) = \dfrac{x^4 - 2x^3 + 3x^3 - 2x + 2}{2x^2 - 2x + 1}$. The domain of the composite function $fog(x)$ is:

(A) $(-\infty, \infty)$ (B) $[0, \infty)$

(C) $(0, \infty)$ (D) $[1, \infty)$

76. Let $S_n = \cot^{-1}\left(3x + \dfrac{2}{x}\right) + \cot^{-1}\left(6x + \dfrac{2}{x}\right) + \cot^{-1}\left(10x + \dfrac{2}{x}\right) + ... + n$ terms, where $x > 0$. If $\lim\limits_{n \to \infty} S_n = 1$, then x equals

(A) $\dfrac{\pi}{4}$ (B) 1

(C) $\tan 1$ (D) $\cot 1$

77. $\lim\limits_{n \to \infty}\left(\sqrt{n^2 + n + 1} - \left[\sqrt{n^2 + n + 1}\right]\right)(n \in I)$ where $[.]$ denotes the greatest integer function is:

(A) 0 (B) $\dfrac{1}{2}$

(C) $\dfrac{2}{3}$ (D) $\dfrac{1}{4}$

78. Let $f : R \to R$ be a continuous onto function satisfying $f(x) + f(-x) = 0, \forall x \in R$. If $f(-3) = 2$ and $f(5) = 4$ in $[-5, 5]$, then the equation $f(x) = 0$ has:

(A) exactly three real roots (B) exactly two real roots

(C) at least five real roots (D) at least three real roots

79. Let f be differentiable at x = 0 and $f'(0) = 1$. Then $\lim\limits_{h \to 0} \dfrac{f(h) - f(-2h)}{h} =$

(A) 3 (B) 2

(C) 1 (D) –1

Space for Rough work

80. Let $f(x)=\begin{vmatrix} x^3 & \sin x & \cos x \\ 6 & -1 & 0 \\ p & p^2 & p^3 \end{vmatrix}$ where p is a constant. Then $\frac{d^3(f(x))}{dx^3}$ at $x=0$ is:

(A) $6p^3$ (B) $p+p^2$

(C) $p+p^3$ (D) independent of p

81. If $\int u\frac{d^2v}{dx^2}dx = u\frac{dv}{dx}-v\frac{du}{dx}+w,$ then w is equal to:

(A) $\int v\frac{d^2u}{dx^2}dx$ (B) $\int u\frac{d^2v}{dx^2}dx$

(C) $\int v\left(\frac{du}{dx}\right)^2 dx$ (D) $\int u\left(\frac{dv}{dx}\right)^2 dx$

82. $\lim\limits_{n\to\infty}\frac{n}{(n!)^{1/n}}$ is equal to

(A) e (B) $\frac{1}{e}$

(C) 1 (D) $\int\limits_0^1 \ln x\, dx$

83. $\int\limits_0^1 x\ln\left(1+\frac{x}{2}\right)dx =$ _______

(A) $\frac{3}{4}\left(1-2\ln\frac{3}{2}\right)$ (B) $\frac{3}{2}-\frac{7}{2}\ln\frac{3}{2}$

(C) $\frac{3}{4}+\frac{1}{2}\ln\frac{1}{54}$ (D) $\frac{1}{2}\ln\frac{27}{2}-\frac{3}{4}$

Space for Rough work

84. Number of roots of the equation $x^2.e^{2-|x|}=1$ is:

(A) 2 (B) 4

(C) 6 (D) zero

85. A curve passing through (2, 3) and satisfying the differential equation $\int_0^x t\,y(t)\,dt = x^2y(x),(x>0)$ is:

(A) $x^2+y^2=13$ (B) $y^2=\frac{9}{2}x$

(C) $\frac{x^2}{8}+\frac{y^2}{18}=1$ (D) $xy=6$

86. The line $y=mx$ bisects the area enclosed by the curve $y=1+4x-x^2$ and the lines $x=0,\ x=\frac{3}{2}$ and $y=0$. Then the value of m is:

(A) $\frac{13}{6}$ (B) $\frac{6}{13}$

(C) $\frac{3}{2}$ (D) 4

87. Let $N=\begin{vmatrix}28 & 25 & 38\\ 42 & 38 & 65\\ 56 & 47 & 83\end{vmatrix}$, then the number of ways in which N can be roots as a product of two divisors which are relatively prime is:

(A) 4 (B) 8

(C) 9 (D) 16

Space for Rough work

88. The value of m for which straight line $3x-2y+z+3=0=4x-3y+4z+1$ is parallel to the plane $2x-y+mz-2=0$ is

(A) –2 (B) 8
(C) –18 (D) 11

89. For the line $\frac{x-1}{1}=\frac{y-2}{2}=\frac{z-3}{3}$, which one of the following is incorrect?

(A) it lies in the plane $x-2y+z=0$
(B) it is same as line $\frac{x}{1}=\frac{y}{2}=\frac{z}{3}$
(C) it passes through (2, 3, 5)
(D) it is parallel to the plane $x-2y+z-6=0$

90. The graph of the equation $x+y=x^3+y^3$ is the union of:

(A) line and an ellipse (B) line and a parabolas
(C) line and hyperbola (D) line and a point

Space for Rough work

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Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**C**	31.	**C**	61.	**B**
2.	**C**	32.	**B**	62.	**C**
3.	**A**	33.	**B**	63.	**A**
4.	**A**	34.	**C**	64.	**A**
5.	**B**	35.	**B**	65.	**A**
6.	**B**	36.	**B**	66.	**A**
7.	**B**	37.	**C**	67.	**A**
8.	**D**	38.	**B**	68.	**C**
9.	**A**	39.	**B**	69.	**C**
10.	**C**	40.	**C**	70.	**B**
11.	**A**	41.	**D**	71.	**B**
12.	**D**	42.	**B**	72.	**A**
13.	**C**	43.	**C**	73.	**C**
14.	**B**	44.	**B**	74.	**D**
15.	**B**	45.	**B**	75.	**A**
16.	**C**	46.	**C**	76.	**D**
17.	**C**	47.	**C**	77.	**B**
18.	**C**	48.	**B**	78.	**D**
19.	**B**	49.	**C**	79.	**A**
20.	**B**	50.	**B**	80.	**D**
21.	**A**	51.	**A**	81.	**A**
22.	**D**	52.	**B**	82.	**A**
23.	**D**	53.	**D**	83.	**A**
24.	**A**	54.	**D**	84.	**B**
25.	**B**	55.	**B**	85.	**D**
26.	**B**	56.	**B**	86.	**A**
27.	**C**	57.	**C**	87.	**B**
28.	**C**	58.	**A**	88.	**A**
29.	**C**	59.	**B**	89.	**C**
30.	**C**	60.	**A**	90.	**A**

Physics

PART – I

SECTION – A

1 C

Sol. $m\frac{dv}{dt} = -6\pi\eta rv$

$(1)\frac{dv}{dt} = 6\pi\left(\frac{1}{18\pi}\right)(1)v$

$\frac{dv}{dt} = -\frac{v}{3}$

$\frac{dv}{v} = -\frac{dt}{3}$

$[\ln v]_2^{0.5} = \left[-\frac{t}{3}\right]_{t_1}^{t_2}$

$\ln 4 = \frac{\Delta t}{3}$

$\Delta t = 3 \ln 4$

2 C

Sol. $\frac{\lambda_R}{\lambda_S}$=1.5

So, the rate of disintegration of R will be 1.5 times that of S. Thus, the half-life of S will be 1.5 times that of R. So, two half lives of S will be equal to the three half –lives of R.

$\frac{N_R}{N_S} = \frac{0.25}{0.25} = 1$

3. A

Sol. From perpendicular axis theorem $I_z = I_x + I_y = 2I$

4. A

Sol. Since collision is elastic $\frac{1}{2}mv^2 = \frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2$

$\Rightarrow v_1^2 + v_2^2 = v^2$ (i)

and momentum conservation given $m\vec{v} = m\vec{v}_1 + m\vec{v}_2$

$\Rightarrow \vec{v}_1 + \vec{v}_2 = \vec{v}$ (ii)

Equation (i) and (ii) shows that angle between the velocity of both bodes after collision is 90^0 thus angle made by another body = 90 – 15 = 75^0

5. B

Sol. $T = 2\pi\sqrt{\frac{\ell}{g_{ef}}}$, $g_{ef} = \left(\frac{mg + qE}{m}\right)$

6. B

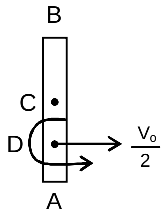
Sol. $muy = mVy + \frac{3}{2}MR^2\omega$ where u is speed of ball before collision, V speed of ball after collision and ω is angular speed of cylinder after collision.
$mu = mV + MR\omega$ (COM)
$\therefore\ y = \frac{3R}{2}$.

7. B

Sol. $d = \frac{mv_0}{qB} + \frac{2mv_0}{2qB}$

8. D

Sol. By COAM about point D (ie about new centre of mass)



$$MV_o\frac{L}{4} = \left[\frac{ML^2}{12} + \frac{ML^2}{16} + \frac{ML^2}{16}\right]\omega$$

or, $w = \frac{6v_o}{5L}$

Now, $t = \frac{\theta}{w} = \frac{(\pi/2)}{w} = \frac{5\pi L}{12v_o}$

9. A

Sol. $x^2 + y^2 = \ell^2$

$$\frac{dy}{dt} = -\frac{x}{y}\left(\frac{dx}{dt}\right)$$

If $\theta = 37°$

$$\frac{dy}{dt} = -\frac{x}{y}\frac{dx}{dt} = -\frac{4}{3}v_o$$

$$\vec{v}_{cm} = \frac{mv_0\hat{i} - m\frac{4v_0}{3}\hat{y}}{2m}$$

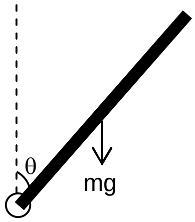
$$\left|\vec{V}_{cm}\right| = \frac{5v_0}{6}$$

10. C

Sol. $4\times\ell\frac{12}{24} = \frac{\varepsilon_1 r_2 - r_1\varepsilon_2}{r_1 + r_2}$

11. A

Sol. The figure shows the rod at an angle θ to the vertical. If we take torques about the pivot we need not be concerned with the force due to the pivot. The torque due to the weight is $1/2mgL\sin\theta$, so the second law for the rotational motion is



$$\frac{mgL}{2}\sin\theta = \frac{ML^2}{3}\alpha$$

Thus $\alpha = \frac{3g\sin\theta}{2L}$

When the rod is horizontal $\theta = \pi/2$ and $\alpha = 3g/2L$.

The tangential linear acceleration of the free end is $a_t = \alpha L = \frac{3g}{2}$

12. D

Sol. Moment of inertia of wheel about its axis,

$I = \frac{mR^2}{2} = \frac{2\times(0.1)^2}{2} = 0.01$ kg-m^2

Now angular displacement, $\Delta\theta = 2\pi n = 2\pi\times5 = 10\pi$ rad

$\therefore$ Angular retardation required, $\alpha = \frac{\omega^2}{2\Delta\theta} = \frac{(2\pi)^2}{2\times10\pi} = \pi/5$ rad/s^2

$\therefore$ Torque required $\tau = I\alpha \Rightarrow FR = I\alpha$

$\therefore F = \frac{I\alpha}{R} = \frac{0.01}{0.10}\times\frac{\pi}{5} = 2\pi\times10^{-2}$ N

13. C

Sol. Energy released from n = 5 to n = 1

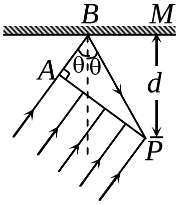
$$E = 13.6\left(\frac{1}{1^2}-\frac{1}{5^2}\right) = 13.6\times\frac{24}{25}\text{ eV}$$

Momentum of photon $= 13.6\times\frac{24}{25}\times\frac{1.6\times10^{-19}}{3\times10^8}$

Momentum of H-atom $= \frac{13.6\times24\times1.6\times10^{-19}}{25\times3\times10^8}$

Velocity of H-atom $= \frac{13.6\times24\times1.6\times10^{-19}}{75\times10^8\times1.67\times10^{-27}} = 4$ m/s

14. B



Sol. $BP = \frac{MP}{\cos\theta}$

$AB = BP\cos2\theta = \frac{MP}{\cos\theta}\cos2\theta$

$AB + BP = n\lambda + \frac{\lambda}{2}$

$\frac{d\cos2\theta}{\cos\theta} + \frac{d}{\cos\theta} = \frac{d}{\cos\theta}(2\cos^2\theta - 1 + 1) = 2d\cos\theta = n\lambda + \frac{\lambda}{2}$ for n = 1, $\cos\theta = \frac{3\lambda}{4d}$

15. B

Sol. As accelerating voltage is increased, energy increases; the λ_{min} decreases and X-rays are getting harder (less wavelength) and penetrating power increases if filament current increases, more electrons are emitted.

16. C

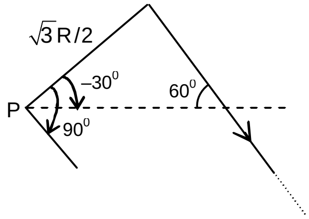
Sol. $\mu = \frac{3}{2}$; $V = 8$; $m = \frac{1}{3}$

$1 + m = \frac{V}{f} = \frac{V}{2R}$

17. C

Sol. $B = \frac{\mu_o I}{4\pi\sqrt{3}\,R/2}\left[\sin 90^o + \sin(-30^o)\right]$

$= \frac{\mu_o I}{4\sqrt{3}\,R}$



18. C

Sol. Mass per unit length, $\mu = \frac{m}{\ell} = \frac{\rho A\ell}{\ell} = \rho A$

$\mu_s = \mu_{A\ell} = 78 \times 10^{-4}$ kg/m

∴ Speed of wave is same in both wire

$V = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{80\times10^4}{78}} = \frac{2\times10^2}{\sqrt{3.9}}$

$\nu_{min} = \frac{V}{\lambda_{max}} = \frac{200}{\sqrt{3.9}\times0.3}$ $\left[\frac{\lambda_{max}}{2} = 15\text{ cm for C as a node}\right]$ = 337.5 Hz

19. B

Sol. $100°C - Ir - \frac{I}{2}r - Ir = 0°C$

$\Rightarrow$ $Ir = 40°C$; ∴ $t_F = 0° + Ir = 40°C$

20. B

Sol. $V = \frac{0.5\times3}{(0.5+1)} = 1\text{ m/s} \Rightarrow K_{max} = U_{max}$

$\frac{1}{2}\times1.5\times1^2 = \frac{1}{2}\times600\times A^2$

A= 5 cm

$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = \frac{1}{2\pi}\sqrt{\frac{600}{1.5}} = \frac{10}{\pi}$

$f = \frac{10}{\pi}$ Hz

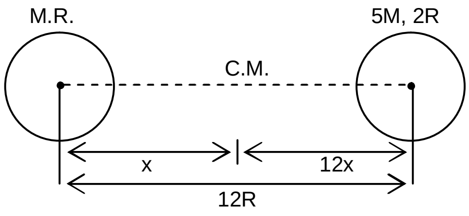
21. A

Sol. $H = -k4\pi r^2\frac{dT}{dr} \Rightarrow H \propto \frac{r_1r_2}{r_2 - r_1}$

22. D

Sol. Initially

$Mx = 5\ M(12\text{-}x) \Rightarrow x = 10R$

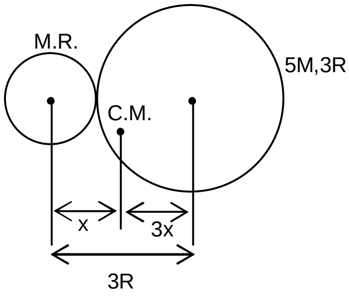


Finally

$Mx = 5M(3R - x)$

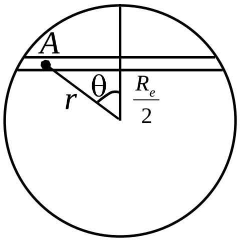
$x = 2.5R$

Distance travelled by smaller block = 10R – 2.5R = 7.5 R



23. D

Sol. Let mass of the earth is M_e and mass of object is m.



Force on object at $A = \left(\frac{GM_e m}{R^3} r\right)$ towards centre.

Force on object along the tunnel $= \left(\frac{GM_e m}{R^3} r\right) \frac{\sqrt{r^2 - \frac{R^2}{4}}}{r}$

Acceleration of object along the tunnel $= \left(\frac{GM_e}{R^3}\right) \sqrt{r^2 - \frac{R^2}{4}}$

24. A

Sol. $\psi_1 = A\cos(\omega t - kx)$ …(i)

$\psi_2 = A\cos(\omega t - ky)$ …(ii)

Put $y = x + \frac{(2n+1)}{2}\lambda$ in (ii)

$\psi_2 = A\cos\left[\omega t - k\left(x + (2n+1)\frac{\lambda}{2}\right)\right]$

$\therefore$ $\psi_2 = A\cos(\omega t - kx - (2n+1)\pi)$

$\therefore$ $\psi_2 = -A\cos(\omega t - kx) = -\psi_1$

$\therefore$ Shape of path is straight line.

25. B

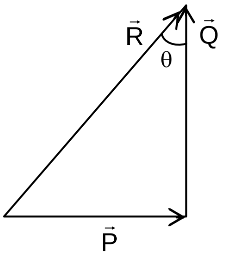
Sol. The charge q is completely closed by four identical given box. Therefore, the required flux = $\frac{1}{4}\frac{q}{\epsilon_0}$.

26. B

Sol. Required value = $(V_C \cdot i_C)_{max} = \frac{\xi}{2} \cdot \frac{\xi}{2R} = \frac{\xi^2}{4R}$

27. C

Sol. $\cos\theta = \frac{Q}{R}$



28. C

Sol. Let u be the initial speed of the particle

Then $v^2 = u^2 - 2gh$

or $u^2 = v^2 + 2gh$

or $u_x^2 + u_y^2 = v_x^2 + v_y^2 + 2gh$ $(v_x = u_x)$

or $u_y^2 = v_y^2 + 2gh$

or $u_y^2 = (2)^2 + (2)(10)(0.4) = 12$

$\therefore$ $u_y = \sqrt{12}$ or $2\sqrt{3}$ m / s

and $u_x = v_y = 6$ m/s

$\therefore$ $\tan\theta = \frac{u_y}{u_x} = \frac{2\sqrt{3}}{6} = \frac{1}{\sqrt{3}}$

or $\theta = 30°$

29. C

Sol. Power $P = F.v = \frac{K}{v}.v = K = \text{constant}$

$\therefore$ $W = P.t = Kt$

30. C

Sol. Liquid exerts force B on block in upward direction and on beaker in downward direction.

Chemistry PART – II

SECTION – A

31. C

Sol. Mass of 1.8 mL water = $1.8 \times 1 = 1.8$ g

No. of moles = $\frac{1.8}{18} = 0.1$

One molecule of H_2O contains 10 electrons

$\therefore$ No. of electrons in 0.1 mole = $0.1 \times 10 = 1$ mole = 6.023×10^{23}

32. B

Sol. $r_n = n^2 a_0$ for H – atom

33. B

Sol. The N atom in NO_2^+ undergoes sp-hybridization with bond angle 180°.

34. C

Sol. $KI_3 \longrightarrow K^+ + I_3^-$

$\therefore$ The oxidation number of iodine in I_3^- is $-\frac{1}{3}$

35. B

Sol. $Cu \longrightarrow Cu^{2+} + 2e^- \qquad \Delta G_1^0$

$2Cu^{2+} + 2e^- \longrightarrow 2Cu^+ \qquad \Delta G_2^0$

$\Delta G_f^0 = \Delta G_1 + \Delta G_2$

$\Delta G_f^0 = -2.303 RT \log K$

36. B

Sol. At high pressure 'a' is neglected due to repulsion between gas molecules.

$\therefore$ P(V – b) = RT or PV = RT + Pb

37. C

Sol. Milliequivalent of H_2SO_4 = 25.1 x 0.02 = 0.502

Equivalent = 0.502 x 10^{-3}

Eq of H_2SO_4 = Eq of $CaCO_3$

$\therefore$ Mass of $CaCO_3$ = Eq x 50 = 0.502 x 10^{-3} x 50 = 0.0251

100 mL H_2O = 100 g contains 0.0251 g $CaCO_3$

10^6 g of water will contain $\frac{0.0251}{10^2} \times 10^6$ = 251 g of $CaCO_3$

$\therefore$ The degree of hardness = 251 ppm

38. B

Sol. $$\frac{\frac{n_{H_2}}{10}}{\frac{n_{O_2}}{10}} = \sqrt{\frac{M_{O_2}}{M_{H_2}}}$$

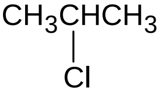
$$\text{or, } \frac{2/2}{10} \times \frac{10}{n_{O_2}} = \sqrt{\frac{32}{2}} = 4$$

$$\therefore \frac{1}{n_{O_2}} = 4 \Rightarrow n_{O_2} = \frac{1}{4} \Rightarrow W_{O_2} = \frac{1}{4} \times 32 = 8\,g$$

39. B
Sol. Phosphorus contains maximum positive charge in $PClF_4$

40. C
Sol. The value of K_C does not change either by adding or removing reactants or products from the equilibrium mixture.

41. D
Sol. The products are due to coupling of different alkyl groups. If $CH_3CH_2CH_2Cl$ is RCl and



$CH_3\underset{\displaystyle Cl}{\underset{|}{C}}HCH_3$ is R'Cl, the products will be RR, R'R' and RR'.

42. B
Sol. For first order reaction, the half-life time is given as: $t_{1/2} = \frac{0.693}{K}$

$\therefore$ The half-life is independent of the concentration of reactant.

43. C
Sol. K_{sp} changes only by changing temperature.

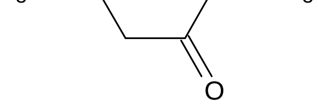
44. B
Sol. Heat of hydrogenation of the least substituted alkene is maximum.

45. B
Sol. The diene is $CH_3CH = CH - CH_2 - CH = CHCH_3$

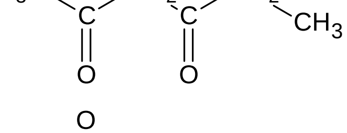
46. C
Sol. $W = -2.303n\,RT \log \frac{V_2}{V_1} = -2.303 \times 1.2 \times 8.314 \times 10^{-3} \times 300 \log \frac{10V_1}{V_1} = -6.892 \text{ kJ mol}^{-1}$

47. C
Sol. Breaking of C – O bond results in formation of most stable tertiary carbocation.

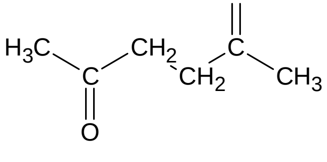
48. B
Sol. (A)



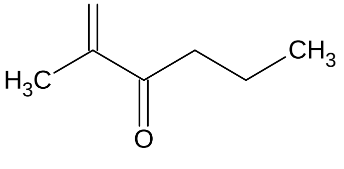
(B)



(C)

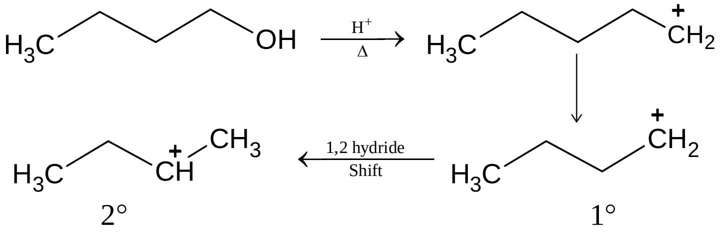


(D)



49. C

Sol.



H3C
OH
H+
Δ
H3C
CH2
+
H3C
CH2
+
1°
1,2 hydride
Shift
H3C
CH
+
CH3
2°

50. B

Sol. S^{2-} makes the CCP lattice where Zn^{2+} ions are present at the alternate tetrahedral voids.

51. A

Sol. Using

$\Delta U = nC_V \times \Delta T$

$\Delta T = 100$ $n = 3.5$

$C_V = 2 \times 10^{-2}$

$\Delta U = 7$

52. B

Sol. $4BCl_3 + 6H_2 + C \longrightarrow B_4C + 12HCl$

The reaction takes place in the preparation of bullet proof fabric B_4C.

53. D

Sol. This is due to lanthanoid contraction on 6th period.

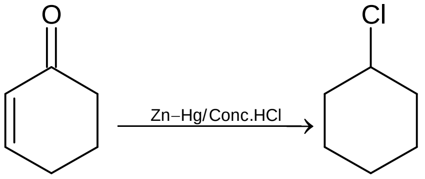
54. D

Sol. $C_6H_5CHO + CH_3COOCOCH_3 \xrightarrow[\Delta]{CH_3COONa} C_6H_5 - CH = CH - COOH + CH_3COOH$

$CO_2 + C_6H_5 - CH = CH_2 \xleftarrow{\Delta}$

55. B

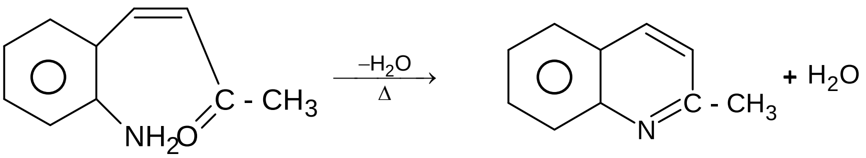
Sol.



O
Zn–Hg/Conc.HCl
Cl

56. B

Sol.



C - CH3
NH2O
–H2O
Δ
N
C - CH3
+ H2O

57. C

Sol. Octahedral complex with C.N number 6.

58. A
Sol. No free Cl^- in the ionisation sphere.

59. B
Sol. $SiO_2 + 2NaOH \longrightarrow Na_2SiO_3 + H_2O$

$SiO_2 + Na_2CO_3 \longrightarrow Na_2SiO_3 + CO_2$

60. A
Sol. Having two possible donating site but donate from one only.

Mathematics PART – III

SECTION – A

61. B

Sol. $x^{(\log_2 x)^2 - 6\log_2 x + 12} = 256$;

$\left(t^2 - 6t + 12\right)t = 8$ where $t = \log_2 x$;

$\Rightarrow \left(t-2\right)^3 = 0$

$\Rightarrow t = 2 \Rightarrow x = 4$

62. C

Sol. Note that $x \in \left[-2, 2\right]$ for x to be real.

Let $x = 2\cos\theta$ where $\theta \in \left[0, \pi\right]$.

[Note : $x + 2 \ge 0$ and $2 - \sqrt{2+x} \ge 0 \Rightarrow x \in \left[-2, 2\right]$]

$$x = \sqrt{2 + \sqrt{2 - 2\cos\frac{\theta}{2}}}$$

$$2\cos\theta = \sqrt{2 + \sqrt{2 - 2\cos\frac{\theta}{2}}}$$

$$= \sqrt{2 + \sqrt{2\left(1 - \cos\frac{\theta}{2}\right)}} = \sqrt{2 + 2\sin\frac{\theta}{4}}$$

$$= \sqrt{2 + 2\cos\left(\frac{\pi}{2} - \frac{\theta}{4}\right)}$$

$$= \sqrt{2\left(1 + \cos\left(\frac{\pi}{2} - \frac{\theta}{4}\right)\right)}$$

$$= \sqrt{4\cos^2\left(\frac{\pi}{4} - \frac{\theta}{8}\right)}$$

$$2\cos\theta = 2\cos\left(\frac{\pi}{4} - \frac{\theta}{8}\right);$$

$$\therefore \quad \theta = \frac{\pi}{4} - \frac{\theta}{8}$$

$$\Rightarrow \quad \frac{9\theta}{8} = \frac{\pi}{4} \Rightarrow \quad \theta = \frac{2\pi}{9}$$

Hence $x = 2\cos\frac{2\pi}{9} = 2\cos 40^{o}$

63. A

Sol. $\dfrac{\left(\alpha^5 + \beta^5\right)}{\left(\alpha^3 + \beta^3\right)} = \dfrac{11}{3}$

$$\frac{1}{\left(\alpha^2+\beta^2-\alpha\beta\right)}\left(\alpha^4+\beta^4-\alpha\beta\left(\alpha^2+\beta^2-\alpha\beta\right)\right)=\frac{11}{3}$$

$$\frac{\left(\alpha^4+\beta^4\right)}{\left(\alpha^2+\beta^2-\alpha\beta\right)}-\alpha\beta=\frac{11}{3}$$

$$\frac{25-2(\alpha\beta)^2}{5-\alpha\beta}-\alpha\beta=\frac{11}{3}$$

Let $\alpha\beta=t$; by coefficient $\alpha\beta=2$

64. A

Sol. $T_1=\frac{1}{4}(4-3)=1-\frac{3}{4}$

$$T_2=\frac{1(3)}{4(6)}[6-5]=\frac{3}{4}-\frac{1(3)(5)}{4(6)}$$

$$T_3=\frac{1(3)(5)}{4(6)(8)}[8-7]=\frac{1(3)(5)}{4(6)}-\frac{1(3)(5)(7)}{4(6)(8)}$$

$$\vdots$$

$$\therefore T_1+T_2+T_3.............=1$$

65. A

Sol. We have $\frac{P}{Q^2}=\frac{\left(x-\frac{1}{x}\right)\left(x^2+\frac{1}{x^2}+1\right)}{\left(x-\frac{1}{x}\right)^2}$

As $x\in(1,\infty)$, so $\left(x-\frac{1}{x}\right)>0$

Now $\frac{P}{Q^2}=\frac{\left(x-\frac{1}{x}\right)^2+3}{\left(x-\frac{1}{x}\right)}=\left(x-\frac{1}{x}\right)+\frac{3}{\left(x-\frac{1}{x}\right)}$

$\Rightarrow\frac{P}{Q^2}\geq 2\sqrt{\left(x-\frac{1}{x}\right)\left(\frac{3}{x-\frac{1}{x}}\right)}=2\sqrt{3}$ (Using A.M. $\geq$ G.M.)

66. A

Sol. $\sin\left(\frac{\pi}{3}+x\right)+\sin(\alpha+x)\geq 0$

$$2\sin\left(\frac{\pi}{6}+\frac{\alpha}{2}+x\right)\cos\left(\frac{\pi}{6}-\frac{\alpha}{2}\right)\geq 0 \qquad \ldots\ldots\ldots(i)$$

Now, $\sin\left(\frac{\pi}{6}+\frac{\alpha}{2}+x\right)\in[-1,1]$ for $x\in R$

Hence equation (i) will be true

$\forall x\in R$ if $\frac{\pi}{6}-\frac{\alpha}{2}=(2k+1)\frac{\pi}{2}$

Possible $k=-1$

$\therefore \quad \frac{\alpha}{2}=\frac{\pi}{6}+\frac{\pi}{2}=\frac{2\pi}{3}$

$\Rightarrow \quad \alpha=\frac{4\pi}{3}\equiv\frac{p\pi}{q}$

$\Rightarrow \quad (p+q)=7$

67. A

Sol. $$\sum_{R=1}^{N}\frac{1}{N^2+R^2}\sum_{K=1}^{MR}\frac{N^2}{N^2+\left(\frac{K}{M}\right)^2}$$

$$\lim_{N\to\infty}\lim_{M\to\infty}\sum_{R=1}^{N}\frac{1}{N^2+R^2}\int_0^2\frac{N^2}{N^2\times x^2}dx$$

$$\lim_{N\to\infty}\sum_{R=1}^{N}\frac{N\tan^{-1}\left(\frac{R}{N}\right)}{N^2+R^2}=\frac{\pi^2}{32}$$

68. C

Sol. We must have $m<0$

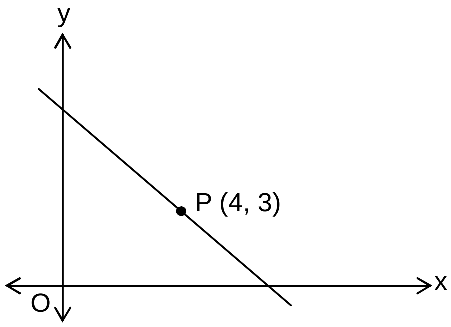
(If $m>0$ then either x or y intercept must be negative)

Let $(y-3)=m(x-4)$

Now, x – intercept $=4-\frac{3}{m}$

and y – intercept = 3 – 4m

For x intercept to be positive prime and y – intercept to be positive integer, possible values of m are i.e. m = –1 or m = –3.



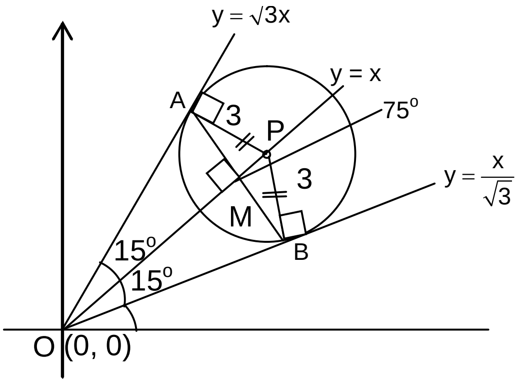
69. C

Sol. Given equation of lines

$\sqrt{3}y^2-4xy+\sqrt{3}x^2=0$

$\Rightarrow \quad \sqrt{3}x^2-3xy-xy+\sqrt{3}x^2=0$

$\Rightarrow \quad \left(\sqrt{3}y-x\right)\left(y-\sqrt{3}x\right)=0$



$\Rightarrow \quad y=\frac{x}{\sqrt{3}}, y=\sqrt{3}x$

$\therefore \quad \angle APO = 75^o$

In ΔAMP, $\sin 75^o = \frac{AM}{3}$

$\Rightarrow \quad AM = 3\sin 75^o$

Now, length of chord of contact $AB = 2AM$

$= 2\left(3\sin 75^o\right) = 6\sin 75^o$

$= 6\left(\frac{\sqrt{3}+1}{2\sqrt{2}}\right) = 3\frac{\left(\sqrt{3}+1\right)}{\sqrt{2}}$

70. B

Sol. (a) It should be non – singular

(c) since $A^{-1} = \frac{\text{adj}A}{|A|}$, hence $\text{adj}A$ must be a non singular matrix. Its inverse must exist.

(d) It should be $F(x+y)$

71. B

Sol. Case – 1 : abbc

We can choose a in 9 ways, b in 9 ways, and c in 9 ways. Hence, there are 9^3 possibilities for this case.

Case – 2 : bbac

There are 9 possibilities for b, and 9 possibilities for each a and c. Once again, we have that there are 9^3 possibilities for this case.

Case – 3 : acbb

Once again, there are 9 possibilities for a and c, and 9 possibilities for b. Hence, there are 9^3 possibilities for this case.

Case – 4 : aabb

We have 9 possibilities for a and 9 possibilities for b.

We thus have 81 possibilities for this case.

We can now sum up our answers, to get a total of 3.

$9^3 + 81 = 2268$ total ways.

72. A

Sol. Any element, is of the form of $\frac{8!}{t_1!t_2!t_3!t_4!}\left(x^2\right)^{t_1}\left(\frac{1}{x^2}\right)^{t_2}(y)^{t_3}\left(\frac{1}{y}\right)^{t_4}$ where

$t_1 + t_2 + t_3 + t_4 = 8;\ t_1 \ge 0$

The constant term occur when $t_1 = t_2$ and $t_3 = t_4$

So, $t_1 + t_3 = 4 \Rightarrow (0,4),(4,0);(1,3),(3,1);(2,2)$

$\Rightarrow$ Constant term:

$$\frac{8!}{0!0!4!4!}+\frac{8!}{4!4!0!0!}+\frac{8!}{1!1!3!3!}+\frac{8!}{3!3!1!1!}+\frac{8!}{2!2!2!2!}$$

$= (2\times 70) + (2\times 1120) + 2520 = 4900$

73. C

Sol. Coefficient of x^{11} in the expansion of $(1+x)^5(3+x)^4(7+x)^3$

$$=\left({}^5C_0+{}^5C_1.x+......+{}^5C_4.x^4+{}^5C_5.x^5\right)$$

$$\left({}^4C_0.3^4+{}^4C_1.3^3x+......+{}^4C_3.3x^3+{}^4C_4.x^4\right)$$

$$\left({}^3C_0.7^3+{}^3C_1.7^2x+{}^3C_2.7x^2+{}^3C_3+.x^3\right)$$

$$={}^5C_4.{}^4C_4.{}^3C_3+\left({}^4C_3.3\right){}^5C_5.{}^3C_3+\left({}^3C_2.7\right){}^5C_5.{}^4C_4$$

$$=5.1.1+4.3.1.1+3.7.1.1=38$$

74. D

Sol. $$f(x)=\frac{1}{2}\ln\left(\sqrt{\sqrt{x^2+1}+x}\pm\sqrt{\sqrt{x^2+1}-x}\right)^2$$

$$=\frac{1}{2}\ln\left\{\sqrt{x^2+1}+x+\sqrt{x^2+1}-x\pm2\sqrt{\sqrt{\left(x^2+1\right)^2}-x^2}\right\}$$

$$=\frac{1}{2}\ln\left\{2\sqrt{x^2+1}\pm2\right\}$$

An even function hence neither one – one nor onto.

75. A

Sol. Denominator $\neq 0$ and numerator

$$\left(x^4+3x^2+2\right)-2x\left(x^2+1\right)=\left(x^2+1\right)\left((x-1)^2+1\right)$$

76. D

Sol. As, $T_n=\cot^{-1}\left[\frac{(n+1)(n+2)}{2}x+\frac{2}{x}\right]$

$$\Rightarrow T_n=\tan^{-1}\left(\frac{2x}{(n+2)(n+1)x^2+4}\right)$$

$$\therefore T_n=\tan^{-1}\left(\left(\frac{n+2}{2}\right)x\right)-\tan^{-1}\left(\left(\frac{n+1}{2}\right)x\right)$$

So, $S_n=\tan^{-1}\left(\left(\frac{n+2}{2}\right)x\right)-\tan^{-1}x$

$$\Rightarrow \lim_{n\to\infty}S_n=\frac{\pi}{2}-\tan^{-1}x$$

$=\cot^{-1}x=1$ (given)

$\Rightarrow$ $x=\cot 1$

77. B

Sol. $n<\sqrt{n^2+n+1}<n+1$

Hence $\left[\sqrt{n^2+n+1}\right]=n$

$$\therefore I=\lim_{n\to\infty}\left(\sqrt{n^2+n+1}-n\right)=\frac{1}{2}$$

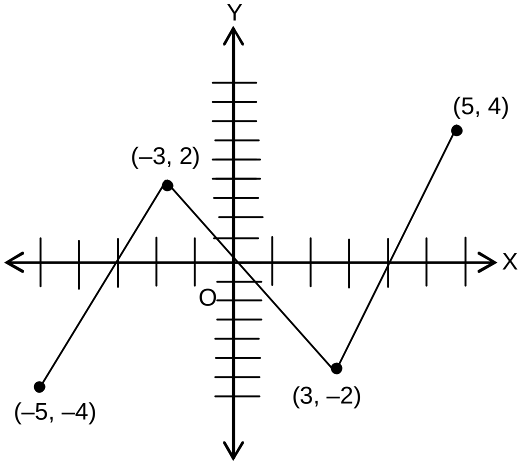
78. D

Sol. $f(x)+f(-x)=0$

$\Rightarrow f(x)$ is an odd function. Since points (–3, 2) and (5, 4) lie on the curve.

$\therefore$ $(3,-2)$ and $(-5,-4)$ will also lie on the curve

For minimum number of roots, graph of continuous function $f(x)$ is as follows.



From the above graphs of $f(x)$ it is clear that equation $f(x)=0$ has at least three real roots.

79. A

Sol. $\frac{f(h)-f(0)}{h}+\frac{2\left[f(-2h)-f(0)\right]}{-2h}=f'\left(0^{+}\right)+2f'\left(0^{-}\right)$

$=3f'(0)$

80. D

Sol. $f'(x)=\begin{vmatrix} 3x^2 & \cos x & -\sin x \\ 6 & -1 & 0 \\ p & p^2 & p^3 \end{vmatrix}$

$f''(x)=\begin{vmatrix} 6x & -\sin x & -\cos x \\ 6 & -1 & 0 \\ p & p^2 & p^3 \end{vmatrix}$

$f'''(x)=\begin{vmatrix} 6 & -\cos x & \sin x \\ 6 & -1 & 0 \\ p & p^2 & p^3 \end{vmatrix}$

$\Rightarrow f'''(0)=\begin{vmatrix} 6 & -1 & 0 \\ 6 & -1 & 0 \\ p & p^2 & p^3 \end{vmatrix}=0$ (two identical rows)

81. A

Sol. Differentiate the given integral with respect to x

$$u\frac{d^2v}{dx^2}=u\frac{d^2v}{dx^2}+\frac{du}{dx}.\frac{dv}{dx}-v\frac{d^2u}{dx^2}-\frac{dv}{dx}.\frac{du}{dx}+\frac{dw}{dx}$$

$$\Rightarrow \frac{dw}{dx}=v\frac{d^2u}{dx^2}$$

$$\therefore\ dw=v\frac{d^2u}{dx^2}dx$$

$$\therefore\ w=\int v\frac{d^2u}{dx^2}dx$$

82. A

Sol. $$L=\lim_{n\to\infty}\frac{n}{(n!)^{1/n}}=\lim_{n\to\infty}\frac{n}{(1.2.3......n)^{1/n}}$$

$$=\lim_{n\to\infty}\frac{1}{\left(\frac{1}{n}.\frac{2}{n}.\frac{3}{n}...\frac{n}{n}\right)^{1/n}}$$

$$\ln\ L=-\frac{1}{n}\left[\ln\left(\frac{1}{n}\right)+\ln\left(\frac{2}{n}\right)+\ln\left(\frac{3}{n}\right)+...+\ln\left(\frac{n}{n}\right)\right]$$

General term of ln L is

$$T_r=-\frac{1}{n}\ln\frac{r}{n}$$

$$\therefore S=\lim_{n\to\infty}-\frac{1}{n}\sum_{r=1}^{n}\ln\frac{r}{n}=-\int_0^1\ln x\,dx=-\left[x\ln x-x\right]_0^1$$

$$=\left[(0-1)-(0)\right]=1$$

$\therefore$ Hence ln L = 1

L = e

83. A

Sol. $$I=\int_0^1 x\ln\left(\frac{x+2}{2}\right)dx=\int_0^1 x\left(\ln(x+2)-\ln 2\right)dx$$

$$\therefore\ I=\int_0^1 x\ln(x+2)dx-\ln 2\int_0^1 x\,dx$$

$$\text{Hence } I=\left[\ln(x+2).\frac{x^2}{2}\right]_0^1-\int_0^1\frac{x^2}{x+2}dx-\frac{\ln 2}{2}$$

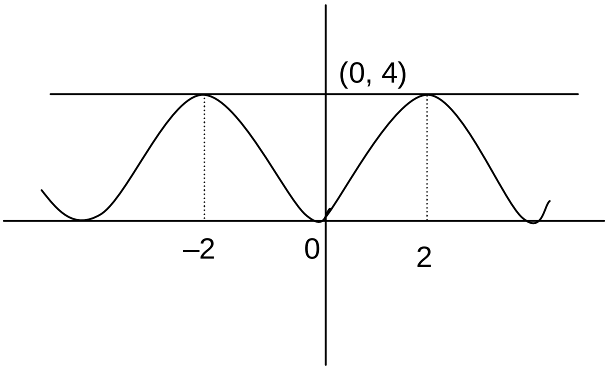
$$=\frac{1}{2}\ln 3-\int_0^1\frac{x^2-4+4}{x+2}dx-\frac{\ln 2}{2}$$

$$=\frac{1}{2}\ln\frac{3}{2}-\int_0^1\left((x-2)+\frac{4}{x+2}\right)dx\ \text{ now proceed}$$

84. B

Sol. Draw graphs of $y = x^2.e^{2-|x|}$ and $y = 1$

$$y = \begin{cases} x^2.e^{2-x} & \text{if } x \ge 0 \\ x^2.e^{2+x} & \text{if } x < 0 \end{cases}$$



85. D

Sol. Differentiate $xy(x) = x^2y'(x) + 2xy(x)$

or $xy(x) + x^2y'(x) = 0$

$$x\frac{dy}{dx} + y = 0$$

$$\ln y + \ln x = \ln c$$

$$xy = c$$

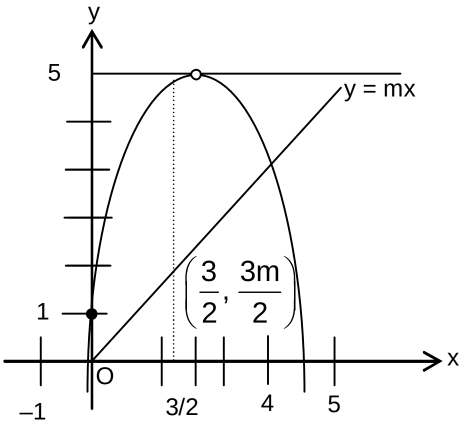
86. A

Sol. $$2.\frac{1}{2}\left(\frac{3}{2}.\frac{3m}{2}\right) = \int_0^{3/2}\left(1 + 4x - x^2\right)dx$$

$$\frac{9m}{4} = x + 2x^2 - \frac{x^3}{3}\Big]_0^{3/2}$$

$$= \frac{3}{2} + \frac{9}{2} - \frac{27}{8}.\frac{1}{3} = 6 - \frac{9}{8} = \frac{39}{8}$$

$$m = \frac{13}{6}$$



87. B

Sol. $N = 770 = 2 \times 5 \times 7 \times 11$

Hence number of ways $= 2^{n-1} = 2^3 = 8$

88. A

Sol. Vector $\left(3\hat{i} - 2\hat{j} + \hat{k}\right) \times \left(4\hat{i} - 3\hat{j} + 4\hat{k}\right)$ is perpendicular to $2\hat{i} - \hat{j} + m\hat{k}$.

$$\Rightarrow \begin{vmatrix} 3 & -2 & 1 \\ 4 & -3 & 4 \\ 2 & -1 & m \end{vmatrix} = 0$$

89. C

Sol. On (1, 2, 3) satisfies the plane $x - 2y + z = 0$ and also $\left(\hat{i} + 2\hat{j} + 3\hat{k}\right).\left(\hat{i} - 2\hat{j} + \hat{k}\right) = 0$

$\Rightarrow (a)$

Since the lines $\frac{x-1}{1} = \frac{y-2}{2} - \frac{z-3}{3}$ both satisfy $t+1, 2t+2$ and $3t+3$

Hence both are same $\Rightarrow (b)$.

Given lines is obviously $||$ to the plane $x - 2y + z = 6 \Rightarrow (d)$

90. A

Sol. Given $(x+y) = (x+y)\left(x^2 - xy + y^2\right)$

$\Rightarrow (x+y)\left(x^2 - xy + y^2 - 1\right) = 0$

$\therefore$ Either $x + y = 0$ or $x^2 - xy + y^2 - 1 = 0$

Now $x + y = 0$ represent a line:

Also $\Delta = \begin{vmatrix} a & h & g \\ h & b & f \\ g & f & c \end{vmatrix} = \begin{vmatrix} 1 & \frac{-1}{2} & 0 \\ \frac{-1}{2} & 1 & 0 \\ 0 & 0 & -1 \end{vmatrix} = \frac{-3}{4} \neq 0$ and $h = \frac{-1}{2}$, $a = 1 = b$, so $h^2 < ab$

$\therefore$ $x^2 - xy + y^2 - 1 = 0$ represent an ellipse.

Hence locus of $P(x, y)$ satisfying above equation is the union of line and an ellipse.

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - III

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 186**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into Two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01– 05, 19 – 23, 37 - 41)*** *contains 15 multiple choice questions which have* ***one correct*** *answer. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (06 – 13, 24 – 31, 42 - 49) *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.

2. ***Section-C (14 – 18, 32 – 36, 50 – 54)*** *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

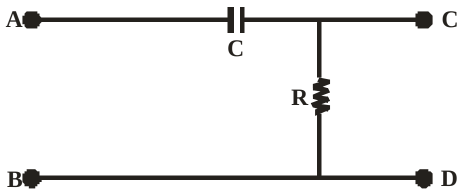
Physics

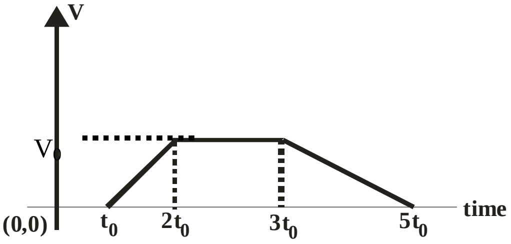
PART – I

SECTION – A
(One Options Correct Type)

This section contains **5 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

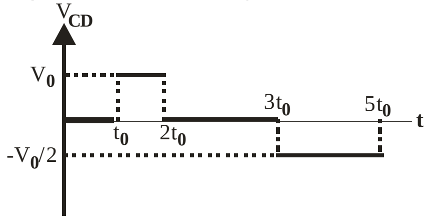
1. A varying voltage is applied to the clamps AB such that the voltage across the capacitor plates (V) varies as shown in figure



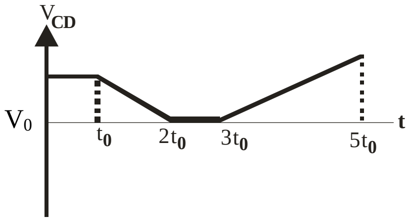


Time dependence of voltage across the clamp CD :

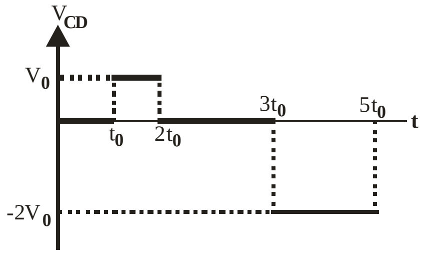
(A)



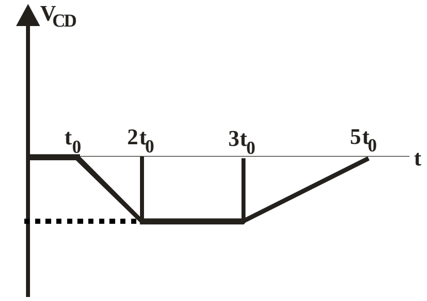
(B)



(C)

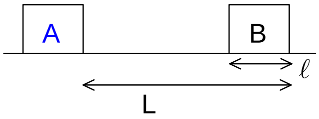


(D)



Space for Rough work

2. A block A of mass m and a box B of same mass are lying on a horizontal surface as shown in the figure. The coefficient of kinetic friction between the block and horizontal surface is μ_A, while that between the box and surface is μ_B. Given that $\mu_B > \mu_A$. At t = 0, the position is as shown in the figure and both are simultaneously given a velocity v_0 to the right. The time after which block will collide with the right end of the box is



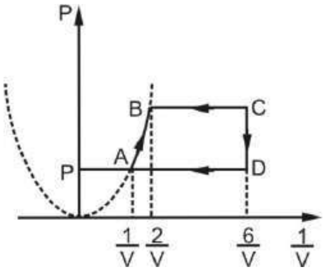
(A) $\sqrt{\frac{2(L-\ell)}{(\mu_B-\mu_A)g}}$ (B) $\sqrt{\frac{2(L+\ell)}{(\mu_B+\mu_A)g}}$

(C) $\sqrt{\frac{4(L+\ell)}{(\mu_B-\mu_A)g}}$ (D) $\sqrt{\frac{4(L-\ell)}{(\mu_B-\mu_A)g}}$

3. One mole of an ideal monatomic gas is taken through a thermodynamic cycle ABCDA as shown in the figure. The process AB is a part of a parabola. Whose vertex is at the origin.

$$\left(C_V = \frac{3}{2}R\right)$$

The total external work done on the gas in the whole process ABCDA is

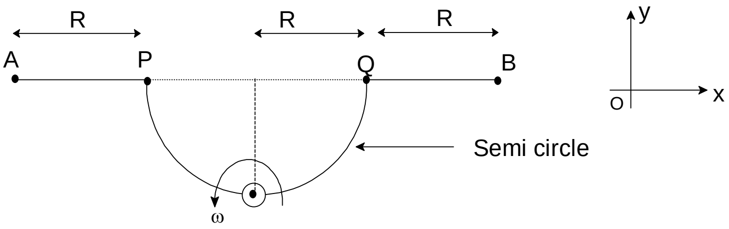


(A) $-\frac{3}{2}PV$ (B) $\frac{3}{2}PV$

(C) $\frac{5}{6}PV$ (D) $-\frac{7}{6}PV$

Space for Rough work

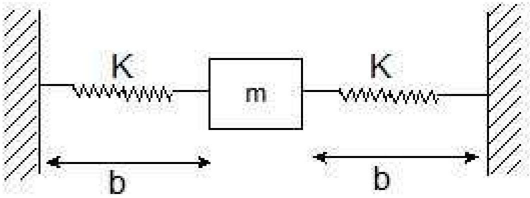
4. A conductor AB is rotated about O as shown in the figure such that its axis of rotation is parallel to the magnetic field $\vec{B} = B_0\hat{k}$ with uniform angular speed ω_0. The potential difference between points P and Q is



(A) $2B\omega_0R^2$ (B) $4B\omega_0R^2$

(C) zero (D) $B\omega_0\pi^2R^2$

5 In the adjacent figure, a block of mass m is rigidly attached to two identical spring of stiffness K each. The other ends of the spring are connected to the fixed wall. When the block is in equilibrium, length of each spring is b, which is greater than the natural length ℓ of the spring. The Time – period of the oscillation of the block if it is displaced by small distance X perpendicular to the length of the spring and released. (neglect gravity)



(A) $2\pi\sqrt{\frac{mb}{k(b-\ell)}}$ (B) $2\pi\sqrt{\frac{mb}{2k(b-\ell)}}$

(C) $2\pi\sqrt{\frac{m(b-\ell)}{kb}}$ (D) $2\pi\sqrt{\frac{m(b-\ell)}{2kb}}$

(One or More than one correct type)

This section contains **EIGHT** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

6. A dielectric slab of thickness '*d*' is inserted in the parallel plate capacitor whose negative plate is at $x = 0$ and positive plate is at $x = 3d$. The slab is equidistant from the plates. The capacitor is given some charge. As *x* goes from 0 to 3*d*.

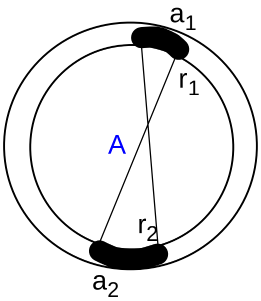
(A) the magnitude of the electric field remains the same
(B) the direction of the electric field remains the same
(C) the electric potential increases continuously
(D) the electric potential increases first, then decreases and again increases

Space for Rough work

7. The wavelength of k_α x-rays for lead isotopes $P_b^{208}, P_b^{206}, P_b^{204}$ and λ_1, λ_2 and λ_3 respectively. Then
(A) $\lambda_1 = \lambda_2 = \lambda_3$
(B) $\lambda_1 > \lambda_2 > \lambda_3$
(C) $\lambda_1 < \lambda_2 < \lambda_3$
(D) $\lambda_2 = \sqrt{\lambda_1 \lambda_3}$

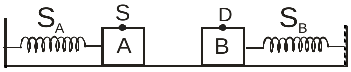
8. Radiations of monochromatic waves of wavelength 400 nm are made incident on the surface of metals Zn, Fe and Ni of work functions 3.4 eV, 4.8 eV and 5.9 eV respectively (take hc = 12400 eV- A^o) :
(A) Maximum KE associated with photoelectrons from the surface of any metal is 0.3 eV.
(B) No photoelectrons are emitted from the surface of Ni.
(C) If the wavelength of source of radiation is doubled then KE of photoelectrons is also doubled.
(D) Photoelectrons will be emitted from the surface of all the three metals if the wavelength of incident radiations is less than 200 nm

9. A wire having a uniform linear charge density λ, is bent in the form of a ring of radius *R.* Point *A* as shown in the figure, is in the plane of the ring but not at the centre. Two elements of the ring of lengths a_1 and a_2 subtend very small same angle at the point A. They are at distances r_1 and r_2 from the point A respectively. Then for $r_1 < r_2$, choose the correct option(s).



(A) the ratio of charge of elements a_1 and a_2 is $\frac{r_1}{r_2}$
(B) the elements a_1 produces greater magnitude of electric field at A than elements a_2.
(C) the elements a_1 and a_2 produce same potential at A.
(D) the direction of net electric field at A is towards element a_1.

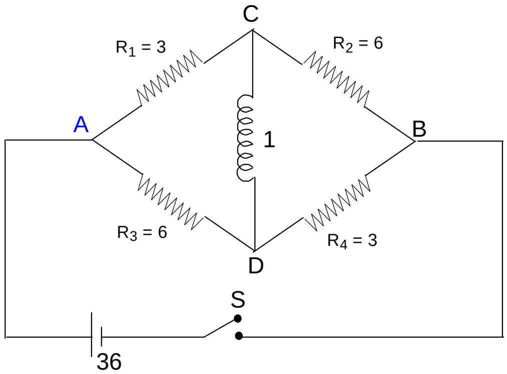
10. A source emitting a sound of frequency 300 Hz is fixed on block 'A' while detector is fixed on block B detects the sound. The blocks 'A' and 'B' are simultaneously displaced towards each other through a distance 1 m and then left to vibrate. Velocity of sound in air = 340 m/sec and S_A and S_B are identical. The frequency of vibration of S_A is 2 Hz.



(A) Maximum velocity of detector is $4\pi m / sec$
(B) Maximum frequency detect by detector is 323 Hz.
(C) Minimum frequency detect by detector is 278 Hz
(D) Phase difference between S and D is $\pi / 2$

Space for Rough work

11. The switch S is closed at t = 0 as shown in the figure.



(A) the current as function of time in the inductor is $3(1 - e^{-4t})$A.
(B) the current through R_1 just after closing of switch is 8A
(C) the power supply by the battery as function of time is $36(9 - e^{-4t})$
(D) the current through R_2 after long time closing of switch is 3A

12. In a certain series LCR A.C. circuit. It is found that $X_L = 2X_C$ and phase difference between the current and voltage is $\frac{\pi}{4}$. If now capacitance is made 1/4th & the inductance and resistance are doubled then which are not correct.

(A) Voltage will lead current by a phase of $\tan^{-1}\left(\frac{1}{2}\right)$
(B) Voltage will lay behind current by a phase of $\tan^{-1}\left(\frac{1}{2}\right)$
(C) Voltage will lag behind current by a phase of $\frac{\pi}{4}$
(D) Voltage and current will be in same phase

13. Two concentric metallic shell's of radius R and 2R, out of which the inner shell is having Q and outer shell is uncharged. If they are connected with a conducting wire. Then,

(A) Q amount of charge will flow from inner to outer shell
(B) Q/e no. of electrons will flow from outer to inner shell
(C) $\frac{KQ^2}{4R}$ amount of heat is produced in the wire
(D) $\frac{KQ^2}{2R}$ amount of heat is produced in the wire

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

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14. Find the energy E required (in MeV) to remove an alpha particle from $^{14}_{7}N$. The excess of mass of atom (in amu) is given below. (take 1 amu = 931 MeV)

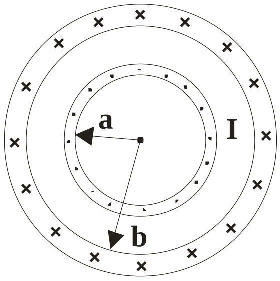
Atom	(Mass of atom – A. amu)
$^{4}_{2}He$	0.00260
$^{10}_{5}B$	0.01294
$^{14}_{4}N$	0.00307

Fill E/2 in OMR sheet after rounding off to nearest integer.

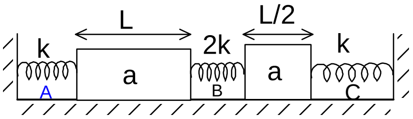
15. A thin hollow cylinder of radius a is surrounded co-axially by another hollow cylinder of radius b where b > a. Both the cylinder form part of an electric circuit and a current I flows through them as shown in figure.

Magnitude of pressure exerted on inner cylinder is $\frac{\mu_0 I^2}{K\pi^2 a^2}$.

Find K?

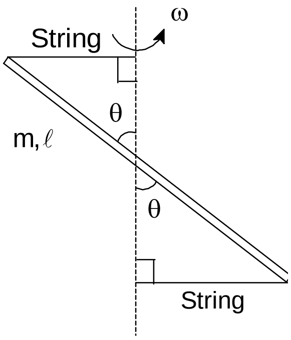


16. Two rigid rods of same material and of length L and $\frac{L}{2}$ are placed in equilibrium on a smooth horizontal plane at temperature T as shown in figure. Springs are in their natural length. If the temperature is increased by ΔT then the amount of energy stored in springs is $\frac{9}{5\beta} k\alpha^2 L^2 \Delta T^2$. Where *k* is the spring constant of spring (*A*) and α is the coefficient of linear expansion of material. Then find the value of β (in proper units) (Note: Neglect the change in spring constant due to increase in temperature).



Space for Rough work

17. A stick of mass m and length ℓ spins with frequency ω around an axis, as shown in figure. The stick makes an angle θ with the axis and is pivoted at its centre. It is kept in this motion by two strings which are perpendicular to the axis. Then tension in the string is $T = \frac{K}{24} m\ell\omega^2 \sin\theta$. Find K?



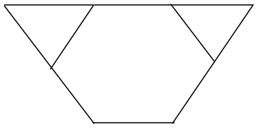
18. A spherical shell of radius R is filled with water. Temperature of atmosphere is $(-\theta)^0$ C, where θ is a positive constant. The shell is exposed to atmosphere and all water comes down to 0^0C and then its starts freezing from outer surface towards the centre of the shell. Assuming shell to be surface towards the centre of the shell. Assuming shell to be highly conducting, if time for whole mass of water at 0^0C to freeze is $t = \frac{\delta L R^2}{\alpha K T}$. Thermal conductivity of ice is K and latent of fusion is L. Density of water is δ. Neglect expansion during fusion. Find α?

Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **5 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.



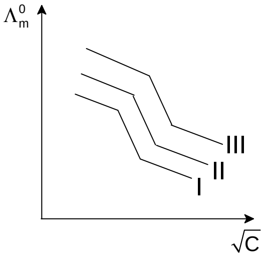
19. Correct statements regarding 'X' is:
(A) 2 chiral centre and 2 stereo isomer
(B) 4 chiral centre and 3 stereo isomer
(C) 4 chiral centre and 2 stereo isomer
(D) 2 chiral centre and 3 stereo isomer

20. A photon is emitted in $\beta -$ line of Balmer series in He^+. This photon is absorbed by an electron present in ground state of H – atom. If uncertainty in position is equal to De-Broglie wavelength then uncertainty in De-Broglie wavelength is:
(A) $0.529\overset{0}{A}$
(B) $2.116\overset{0}{A}$
(C) $4.232\overset{0}{A}$
(D) $0.265\overset{0}{A}$

21. For which of the following complex / ion total number of geometrical isomers is equal to total number of optical isomers?
(A) $\left[IrBr(en)(H_2O)_2\right]^+$
(B) $\left[CoBr_2(en)_2\right]^+$
(C) $\left[PtBr(NO_2)(SCN)(NH_3)_3\right]$
(D) None of these

22. Below three graphs are for $R(CH_2)_nCOONa$, correct value of 'n' may be correctly matched as:

	I	II	III
(A)	16	12	8
(B)	8	12	16
(C)	12	8	16
(D)	12	12	12



Space for Rough work

23. $FeS + H_2SO_4 \longrightarrow B$

which is **incorrect** about gas 'B' ?

(A) It produces white ppt. with $FeCl_3$

(B) It produces black ppt. with $(CH_3COO)_2Pb$.

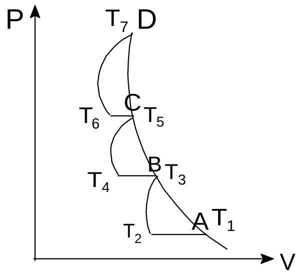
(C) It decolourises the purple colour of $KMnO_4$.

(D) It produces purple colour solution with sodium nitroprusside

(One or More than one correct type)

This section contains **EIGHT** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

24. Through a number of isobaric cooling and adiabatic compression 1 mol of helium (ideal gas) is compressed from 1 bar, 300 K to 32768 bar, 300 K. Let the process be accomplished in three steps (AB, BC and CD). At each step helium is first cooled and then compressed. At the end of each step the pressure increases 32 times and temperature returns to original value of 300 K. Which of the following is/are correct? $\left[R = 2\text{cal}/\text{mol}/\text{K}\right]$



(A) $T_1 = T_3 = T_5 = T_7$

(B) $T_2 = T_4 = T_6$

(C) $Q_{\text{total}} = -3375\,\text{cal}$

(D) $\Delta S_{\text{system}} = 15R\ln 2$

25. 34.3 g Pb_3O_4 is dissolved in 500 ml of 4 M HNO_3 then (Pb = 207)

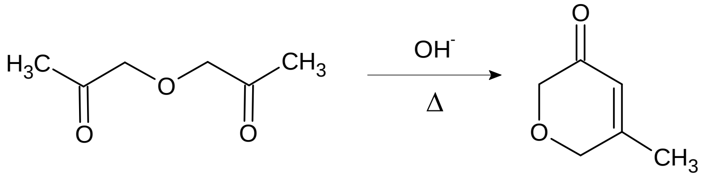
(A) there is no residue left

(B) the wt. of residue is 11.95 g

(C) 300 ml of 6 M NaOH is required to neutralise excess of HNO_3

(D) It is a redox reaction

26.



Which of the following step, mechanism is/are involved in above conversion?

(A) Acid base

(B) Nucleophilic addition

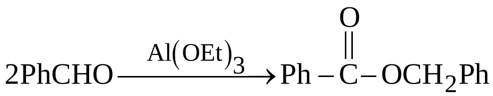
(C) E_1CB

(D) dehydration

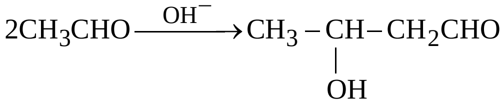
Space for Rough work

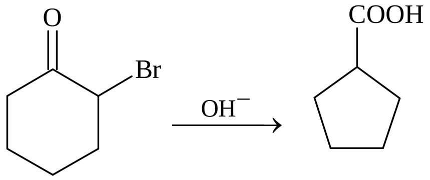
27. Select correct statement(s) for H_2O_2.
(A) It is prepared by air oxidation of 2-ethylanthraquionone
(B) It can reduce I_2 into I^- (aq) in alkaline medium
(C) It can act as reductant with $KMnO_4$
(D) Its melting point is lower than that of H_2O

28. Which of the following are disproportionation reactions?

(A)

$$2PhCHO \xrightarrow{Al(OEt)_3} Ph-\overset{\overset{\displaystyle O}{\|}}{C}-OCH_2Ph$$

(B) $2HCHO \xrightarrow{OH^-} CH_3OH + HCOO^-$

(C)

$$2CH_3CHO \xrightarrow{OH^-} CH_3-\underset{\underset{\displaystyle OH}{|}}{CH}-CH_2CHO$$

(D)


29. Select the incorrect choice from the following.
(A) ΔS_{mix} for all types of solutions (ideal & non-ideal solutions) is positive.
(B) ΔG_{mix} of ideal solutions is always negative
(C) Partially miscible solutions with $\Delta H_{mix} = +ve$ value, are completely miscible at upper consulate temperature at which $\Delta G_{mix} = -ve$
(D) Azeotrope contains only one component formed as a result of definite union of the two liquids and the composition of azeotrope does not change with pressure. (consider binary liquids)

Space for Rough work

30. Which among the following will give cinnamic acid?

(A) $Ph-CHO \xrightarrow[(2)H_3O^+]{(1)Ac_2O\,/\,AcONa,\ heat}$

(B) $Ph-CHO \xrightarrow[\substack{(2)H_3O^+ \\ (3)\Delta}]{(1)CH_2(COOC_2H_5)_2,\ Pyridine}$

(C) $Ph-CHO \xrightarrow[\substack{(2)H_3O^+ \\ (3)\Delta}]{BrCH_2COOEt + Zn + \Delta}$

(D) $Ph-CHO \xrightarrow[(2)H_3O^+]{(1)HCN}$

31. In normal spinel having one eighth of tetrahedral holes occupied by one type of metal ion and one half of the octahedral holes occupied by another type of metal ion and oxide ion forms F.C.C. lattice. Such spinel is formed by Mg^{2+}, Al^{3+}, O^{2-}. If oxide ion is replaced by $X^{-8/3}$ ion then:

(A) The number of anionic vacancies per unit cell is 2
(B) Formula of spinel becomes $MgAl_2X_3$
(C) Spinel becomes charged species
(D) Al^{3+} is in octahedral void

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

32. Suppose that at time 't' the state function of a one – particle system is:

$\psi = \left[2/\left(\pi C^2\right)\right]^{3/4} e^{-\left(x^2+y^2+z^2\right)/C^2}$ where C = 2 nm

The probability of finding the particle at any time in the tiny cubic region with its centre at x = 1.2 nm, y = -1 nm, z = 0 nm and with edges of each of length 0.004 nm is $X \times 10^{-Y}$ (in scientific notation), find Y. $\left[e^{-1.22} = 0.30,\ (1/2\pi)^{3/2} = 0.06\right]$

Space for Rough work

33. 12.5 milli moles of NH_4NO_3 is dissolved in enough water to make 25 ml of solution. The initial temperature is 25.8 ^{0}C and final temperature after solid dissolves is 21.8^{0}C. Calculate the enthalpy of solution for NH_4NO_3(s) in kcal/mol.
Give: $d_{solution}$ = 1 g/ml, specific heat capacity of solution = 1 cal/g/K

34. A hydrocarbon (X) contains 91.2% carbon and 8.8% hydrogen. The compound on chlorination using $Cl_2 / h\nu$ and $Cl_2 / AlCl_3$ gives three isomeric monochloro substituted products, then the value of $\frac{\text{Total number of atoms present in (X)}}{5} = ?$

35. Consider the following compounds: Na_2SO_3, NaCl, $Na_2C_2O_4$, Na_2HPO_4, $NaNO_2$, Na_2CrO_4, CH3COONa,
when treated separately with $AgNO_3$ solution, how many of them give a white precipitate?

36. If certain decomposition reaction found to obey equation in term of partial pressure (P) of reactant as:
$\frac{a - P^2}{P^2} = bkt$, what is order of reaction if a, b and k are constant (t represents time) ?

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **5 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. ABC and BDE are two equilateral triangles such that D is the mid-point of BC, AE intersect BC at F. If $2|z - z_d| = |z_a - z_c|$ and $\left(\frac{|z - z_a|_{max}}{|z - z_a|_{min}} - 2\right)^2 = k\frac{\text{area}(\Delta FED)}{\text{area}(\Delta AFC)}$ then value of k is {where z represents complex number, z_a, z_d & z_c are the affixes of A, D & C respectively}

(A) 21 (B) 22
(C) 23 (D) 24

38. The sum of series $\sum_{r=1}^{100}\left(\frac{1}{\cos\theta + \cos(2r+1)\theta}\right)$ is

(A) $\left(\frac{\sin(101\theta)}{\sin\theta.\cos(100\theta)}\right)$ (B) $\left(\frac{\sin(100\theta)}{\sin 2\theta.\cos(101\theta)}\right)$
(C) $\left(\frac{\tan(101\theta)}{\sin(100\theta)}\right)$ (D) none of these

39. If line through P (a, 2) meets the ellipse $\frac{x^2}{9} + \frac{y^2}{4} = 1$ at A and D and meets the axes at B and C, so that PA, PB, PC, PD are in G. P., then

(A) $a \in [5, \infty)$ (B) $a \in R$
(C) $a \in (-\infty, -6) \cup [6, \infty)$ (D) none of these

Space for Rough work

40. If , $\sum_{k=1}^{n}(k^2+5k+7)(k+2)! + 3.3! = 2003.2003!$ then the value of n is,

(A) 1000 (B) 2001
(C) 2002 (D) None of these

41. The value of $\int_0^{1/2} e^x\left(\sin^{-1}x - \frac{x}{(1-x^2)^{3/2}}\right)dx$ is

(A) $\frac{\sqrt{e}\pi}{6} - \frac{2}{3\sqrt{3}}$ (B) $\sqrt{e}\left(\frac{\pi}{6} - \frac{2}{\sqrt{3}}\right)+1$
(C) $\frac{\sqrt{e}\pi}{6} - \frac{4}{3\sqrt{3}}$ (D) 0

(One or More than one correct type)

This section contains **EIGHT** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

42. If f(x) be a continuous function for all real values of x and satisfies $\int_3^x f(t)dt = \frac{x^2}{2} + \int_x^8 t^2 f(t)dt,$ then

(A) $\int_{-1/2}^{1} f(x)dx$ is equal to $\ln\left(\frac{5}{8}\right)$ (B) $\int_{-1/2}^{1} f(x)dx$ is equal to $\frac{1}{2}\ln\left(\frac{8}{5}\right)$
(C) $f(x) = x - x^2 f(x)$ (D) $f(x) = x + x^2 f(x)$

43. A circle of radius 4 cm is inscribed in $\Delta ABC,$ which touches the side BC at D. if $BD = 6cm$: $DC = 8cm$ then

(A) The triangle is necessarily acute angled Δ
(B) $\tan\frac{A}{2} = \frac{4}{7};$
(C) Perimeter of the triangle ABC is 42 cm
(D) Area of ΔABC is 84 cm^2

Space for Rough work

44. If a, b, c $\in$ Q then which of the following equations has rational roots

(A) $ax^2+bx+c=0$, Where if a + b + c = 0

(B) $\left(a+c-b\right)x^2+2cx+\left(b+c-a\right)=0$

(C) $abc^2x^2+3a^2cx+b^2cx-6a^2-4ab-2b^2=0$

(D) $\left(a+b-c\right)x^2+\left(a+c-b\right)x+\left(b+c-a\right)=0$

45. The value of $\int\frac{dx}{1+e\cos x}$ must be same as

(A) $\frac{1}{\sqrt{1-e^2}}\tan^{-1}\left(\sqrt{\frac{1-e}{1+e}}\tan\frac{x}{2}\right)+c$ (e lies between 0 and 1)

(B) $\frac{2}{\sqrt{1-e^2}}\tan^{-1}\left(\sqrt{\frac{1-e}{1+e}}\tan\frac{x}{2}\right)+c$, (e lies between 0 and 1)

(C) $\frac{1}{\sqrt{e^2-1}}\log\frac{e+\cos x+\sqrt{e^2-1}\sin x}{1+e\cos x}$ + c, (e is greater than 1)

(D) $\frac{2}{\sqrt{e^2-1}}\log\frac{e+\cos x+\sqrt{e^2-1}\sin x}{1+e\cos x}+c$, (e is greater than 1)

46. A line passes through the points whose position vectors are $\hat{i}+\hat{j}-2\hat{k}$ and $\hat{i}-3\hat{j}+\hat{k}$. The position vector of a point on it at a unit distance from the first point is/are

(A) $\frac{1}{5}\left(5\hat{i}+\hat{j}-7\hat{k}\right)$

(B) $\frac{1}{5}\left(5\hat{i}+9\hat{j}-13\hat{k}\right)$

(C) $\frac{1}{5}\left(6\hat{i}+\hat{j}-7\hat{k}\right)$

(D) $\frac{1}{5}\left(4\hat{i}+9\hat{j}-13\hat{k}\right)$

Space for Rough work

47. A tangent is drawn to the curve y = f(x) at P(x, y), cuts the x-axis at A. Now a perpendicular drawn from P(x, y) to x-axis meets the x-axis at B. If B is mid-point of OA (O being origin) and f (1) = 1, then

(A) General point on the curve is $\left(t, \frac{1}{t}\right)$, where t is a real parameter (≠ 0)

(B) y = f(x) is a circle

(C) Tangent at P(1, 1) is x + y = 2

(D) f ′(2) = –1/4

48. If $\begin{vmatrix} a^2+1 & ab & ac \\ ab & b^2+1 & bc \\ ac & bc & c^2+1 \end{vmatrix}$ = 1, where a, b, c are real, then which of the following is not true,

(A) $a^2+b^2+c^2=1$ (B) a + b + c = 1 (C) $a^2 + b^2 + c^2 = 0$ (D) a + b + c = 2

49. P is a point inside a ΔABC of area K (K>0) .The lengths of perpendiculars drawn to the sides BC, CA, AB of lengths a,b,c are respectively P_1, P_2 , P_3.Then $\frac{a}{P_1}+\frac{b}{P_2}+\frac{c}{P_3}$ is minimum when

(A) P is incentre of ΔABC

(B) P is equidistant to all the 3 sides

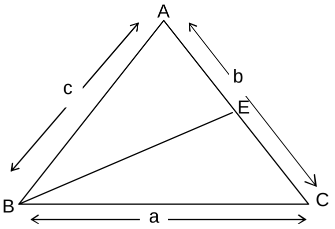
(C) $P_1=P_2=P_3=\frac{2K}{a+b+c}$

(D) P is orthocentre of ΔABC

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

50. In figure, a, b, c are sides of a triangle ABC such that a > b > c. If lengths of its medians are in geometric progression with median BE = $\frac{1}{2}$, then the least integral value of $\sqrt{a^2+b^2+c^2}$ is?



Space for Rough work

51. Let p, q, r and s are the probabilities of raining at four different places at some fixed moment, if M and N are the maximum and minimum value of $3(p^2 + q^2 + r^2 + s^2) - 2(p + q + r + s) + 4$, then value of [M – N] is (where [.] represent GIF)

52. If the number of ways in which 21 identical objects can be distributed among 5 persons such that each can get at least one object and no two person can get equal number of objects is $(k+1)5!$, then the value of 'k' is?

53. If α, β are two distinct real roots of the equation $ax^3 + x - 1 - a = 0$, $(a \neq -1, 0)$, none of which is equal to unity, and the value of $\lim\limits_{x \to \frac{1}{\alpha}} \dfrac{(1 + a)x^3 - x^2 - a}{(e^{1 - \alpha x} - 1)(x - 1)}$ is $\dfrac{a\lambda(k\alpha - \beta)}{\alpha}$, then the value of $k\lambda$ is?

54. Let equation $x^3 + px^2 + qx - q = 0$, where $p, q \in R - \{0\}$ has 3 real roots α, β, γ in H.P. and the minimum value of $\dfrac{1}{\alpha^2} + \dfrac{1}{\beta^2} + \dfrac{1}{\gamma^2}$ is $\dfrac{k}{12}$ then the value of k is ?

Space for Rough work

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CONCEPT RECAPITULATION TEST – III
PAPER-1

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**A**	19.	**B**	37.	**D**
2.	**A**	20.	**A**	38.	**B**
3.	**B**	21.	**D**	39.	**C**
4.	**C**	22.	**A**	40.	**D**
5.	**B**	23.	**C**	41.	**B**
6.	**BC**	24.	**ABC**	42.	**BC**
7.	**AD**	25.	**BC**	43.	**ABCD**
8.	**BD**	26.	**ABCD**	44.	**ABC**
9.	**ABC**	27.	**BCD**	45.	**BC**
10.	**ABC**	28.	**AB**	46.	**AB**
11.	**ACD**	29.	**D**	47.	**ACD**
12.	**ABC**	30.	**AB**	48.	**ABD**
13.	**ABC**	31.	**B**	49.	**ABC**
14.	**6**	32.	**9**	50.	**1**
15.	**8**	33.	**8**	51.	**5**
16.	**4**	34.	**3**	52.	**9**
17.	**2**	35.	**5**	53.	**1**
18.	**6**	36.	**3**	54.	**4**

Physics

PART – I

SECTION – A

1. A

During 0 to t_0, potential across capacitor is zero i.e., charge on it is zero. Therefore there is no current through it. It means $V_{CD} = 0$. During t_0 to $2t_0$, voltage, therefore charge on capacitor is increasing linearly hence direct current is flowing through it therefore V_{CD} = constant.
During $2t_0$ to $3t_0$, V = constant $\Rightarrow i = 0$ and during $3t_0$ to $5t_0$ voltage decreases.

2. A

$$\left.\begin{array}{l} S_A = v_0 t - \frac{1}{2}\mu_A.gt^2 \\ S_B = v_0 t - \frac{1}{2}\mu.gt^2 \end{array}\right] t = \sqrt{\frac{2(L-\ell)}{(\mu_B - \mu_A)g}}$$

$$S_A - S_B = L - \ell$$

3. B

$W = W_{AB} + W_{BC} + W_{CD} + W_{DA}$

$$W_{AB} = \int_{V_A}^{V_B} PdV = \int_{V_A}^{V_B} \frac{C}{V^2}dV = -\frac{C}{V}\bigg|_{V_A}^{V_B} = PV\big|_A^B = P_AV_A - P_BV_B = -PV$$

$$W_{BC} = P_B(V_C - V_B) = 4P\left[\frac{V}{6} - \frac{V}{2}\right] = -\frac{4}{3}PV$$

$W_{CD} = 0$

$$W_{DA} = P_A(V_A - V_D) = P_AV_A - P_AV_D = PV - P\frac{V}{6} = \frac{5PV}{6}$$

$$\therefore W = -PV - \frac{4}{3}PV + \frac{5}{6}PV = -\frac{3}{2}PV$$

$\therefore$ Work done on the gas is $\frac{3}{2}PV$

4. C

Because $V_P = V_Q$

5 B

$$2\pi\sqrt{\frac{mb}{2k(b-\ell)}}$$

6. B, C

7. A, D

characteristic x-rays depend only on the atomic number z.
$\therefore \lambda_1 = \lambda_2 = \lambda_3$

8. B,D

$$(K.E)_{max} = \frac{hc}{\lambda} - \phi$$

9. A,B,C

10. A, B, C

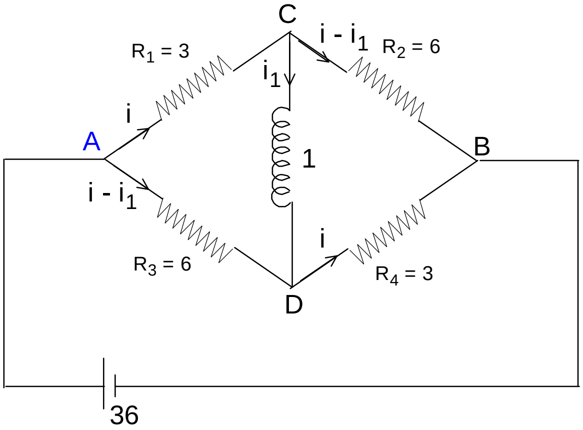
$$f_{max} = f_0\left(\frac{v+v_D}{v-v_s}\right), f_{min} = f_0\left(\frac{v-v_D}{v+v_S}\right)$$

$$v_s = v_D = a\omega = a2\pi f = 1\times 2\pi\times 2 = 4\pi$$

$$f_{max} = 323\text{Hz} \quad f_{min} = 278\text{ Hz}$$

$$\Delta\phi(\text{between S and D}) = \pi$$

11. (A), (C) & (D)



using Kirchhoff's loop law

$$-3i - 1\frac{di}{dt} - 3i + 36 = 0$$

$$\therefore \frac{di}{dt} = 36 - 6i \text{ ....}(i)$$

$$-3i - 6(i - i_1) + 36 = 0$$

$$\Rightarrow 3i - 2i_1 = 12 \text{ ....}(ii)$$

by (i) and (ii) $\frac{di_1}{dt} = 12 - 4i_1$

on solving

$$i_1 = 3\left(1 - e^{-4t}\right)$$

from (ii) $i = 2\left(1 - e^{-4t}\right) + 4$

∴ power supply by battery = 36(2i – i_1) = 36(9 – e^{-4t})

$$(i - i_1)_{t=\infty} = 3A$$

12. ABC

$$\left.\begin{array}{l} X_L = 2X_C \\ X_C' = 4X_C \\ X_L' = 2X_L \end{array}\right] X_L' - X_C' = 2X_L - 4X_C = 2\left[X_L - 2X_C\right] = 0$$

13. ABC

The potential of the two surface will be equal when charge Q flows from inner to outer shell.

SECTION – C

14. 6

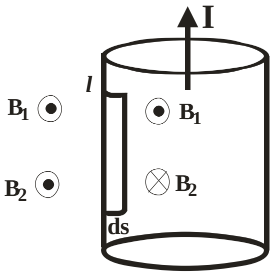
$$^{14}_{4}N \longrightarrow {}^{10}_{5}B + {}^{4}_{2}He$$

$$2 = (0.00307 - 0.01294 - 0.00260)931$$

$$2 = 2.01247 \times 931 = 11.60 \text{ MeV}$$

15. 8

Consider a small rectangular strip on the inner cylinder.
Let B_1, is magnetic field due to rest of the cylinder excluding the strip and B_2 is magnetic field due to strip.



$$B_2 - B_1 = 0 \text{ (Inside)}$$

$$B_2 + B_1 = \frac{\mu_0}{2\pi}\frac{I}{a}(\text{outside})$$

$$\Rightarrow \mathbf{B}_1 = B_2 = \frac{\mu_0}{4\pi}\frac{I}{a}$$

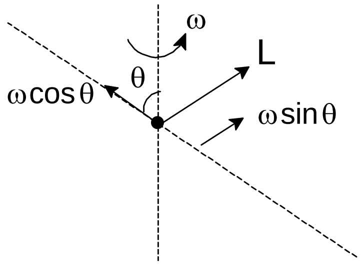
$$\therefore \quad F = (Jds)\vec{l} \times \overrightarrow{B_1}$$

$$F = \left(\frac{I}{2\pi a}\right) ds\, l \frac{\mu_0}{4\pi}\frac{I}{a}$$

$$\therefore \quad P = \frac{F}{l ds} = \frac{\mu_0 I^2}{8\pi^2 a^2}$$

16. (4)

17. K = 2



Magnitude of angular momentum at any time is L = $\left(\frac{1}{12}m\ell^2\right).\omega\sin\theta$.

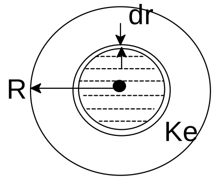
The tip of the vector L traces out a circle in a horizontal plane with frequency ω.
The radius of this circle is the horizontal component of L.
Which is $L_\perp = L\cos\theta$. The rate of change of L therefore has magnitude

$\left|\frac{dL}{dt}\right| = \omega L_\perp = \omega L\cos\theta = \omega\left(\frac{m\ell^2}{12}\omega\sin\theta\right)\cos\theta$ and it is directed into the page at the instant shown.

The torque due to the strings is $\tau = 2T\left(\frac{\ell}{2}\right)\cos\theta = \left|\frac{dL}{dt}\right|$

$$T = \frac{m\ell}{12}\omega^2\sin\theta$$

18. $\alpha = 6$



Thermal resistance of hollow sphere of inner radius r and outer radius R

$$R_{th} = \frac{(R-r)}{4\pi KRr}$$

If a shell of radius r and thickness dr freezes in time dt
Here

$$(dm)L_f = (q)dt$$

$$\delta_{\omega}\left(4\pi r^2 dr\right)L_f = \left(\frac{T}{\frac{(R-r)}{4\pi KRr}}\right)dt$$

$$\frac{\delta_{\omega}}{KT}\int_0^R r(R-r)dr = t$$

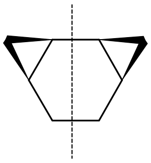
or $t = \frac{\delta LR^2}{6KT}$

Chemistry

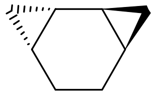
PART – II

SECTION – A

19. B



(1)



(2)

+ enantiomer

(3)

20. A

$$E_{photon} = 13.6 \times 4\left(\frac{1}{2^2} - \frac{1}{4^2}\right) = 10.2 \text{ eV}$$

$$10.2 = 13.6 \times 1\left(\frac{1}{12} - \frac{1}{n^2}\right) \Rightarrow n = 2$$

$$2\pi r = n\lambda$$

$$2\pi \times 0.529 \times \frac{n^2}{Z} = n\lambda$$

$$\lambda = 2\pi \times 0.529 \times \frac{2}{1} = 4\pi \times 0.529$$

$$\because (\Delta x)(\Delta\lambda) = \frac{\lambda^2}{4\pi}$$

$$\Delta\lambda = \frac{\lambda}{4\pi} = 0.529\,\overset{0}{A}$$

21. D

$$\left[\text{IrBr}_2(\text{en})(\text{H}_2\text{O})_2\right]^+ \Rightarrow \text{G.I} = 3,\ \text{O.A} = 2,\ \text{O.I} = 4$$

$$\left[\text{CoBr}_2(\text{en})_2\right]^+ \Rightarrow \text{G.I} = 2,\ \text{O.A} = 2,\ \text{O.I} = 3$$

$$\left[\text{PtBr}(\text{NO}_2)(\text{SCN})(\text{NH}_3)_3\right] \Rightarrow \text{G.I} = 4,\ \text{O.A} = 2,\ \text{O.I} = 5$$

22. A

$$\text{CMC} \propto \frac{1}{\text{size of tail of surfactant}}$$

23. C

$$\text{FeS} + \text{H}_2\text{SO}_4 \rightarrow \text{FeSO}_4 + \underset{(B)}{\text{H}_2\text{S}} \uparrow$$

$$2\text{FeCl}_3 + 3\text{H}_2\text{S} \longrightarrow 2\text{FeCl}_2 + 2\text{HCl} + \underset{(\text{White ppt.})}{\text{S}\downarrow}$$

$$(\text{CH}_3\text{COO})_2\text{Pb} + \text{H}_2\text{S} \longrightarrow \underset{(\text{Black ppt.})}{\text{PbS}\downarrow}$$

$$\text{MnO}_4^- + \text{H}_2\text{S} + \text{H}^+ \longrightarrow \text{Mn}^{2+} + \text{S}\downarrow + \text{H}_2\text{O}$$

$$\text{H}_2\text{S} + \text{Na}_2\left[\text{Fe}(\text{CN})_5\text{NO}\right] \longrightarrow \text{purple colour}$$

24. A, B, C

$$Q_{12} = C_p\left(T_2 - T_1\right)$$

$$Q_{34} = C_p\left(T_4 - T_3\right)$$

$$Q_{56} = C_p\left(T_6 - T_5\right)$$

$$T_1 = T_3 = T_5 = T_7 = 298\text{ K}$$

For adiabatic step $2 \to 3$

$$P_3^{1-\gamma}T_3^{\gamma} = P_2^{1-\gamma}T_2^{\gamma}$$

$$\left(\frac{32}{1}\right)^{\frac{1-\gamma}{\gamma}} T_3 = T_2$$

$$T_2 = \left(32\right)^{\frac{-2/3}{5/3}} T_3$$

$$= \left(32\right)^{\frac{-2}{5}} T_3 = \frac{1}{4}T_3 = \frac{1}{4}T_1$$

$$T_4 = \left(32\right)^{\frac{-2}{5}} T_5 = 2^{\frac{-2}{5}} T_3 = T_2 = T_6$$

$$Q_{\text{total}} = C_P \times 3\left(T_2 - T_1\right)$$

$$= \frac{5R}{2} \times 3\left(-\frac{3}{4} \times 300\right) = 45 \times 75 = -3375\,\text{cal}$$

$$\Delta S_{\text{system}} = 0 + 1 \times R\ln\frac{1}{\left(32\right)^3}$$

$$= -15R\ln 2$$

25. B, C

$$Pb_3O_4 + 4HNO_3 \longrightarrow 2Pb\left(NO_3\right)_2 + PbO_2 + 2H_2O$$

0.05	2	0	0	0	initial mols
0	1.8	0.1	0.05		final mol

$$HNO_3 + NaOH \longrightarrow NaNO_3 + H_2O$$

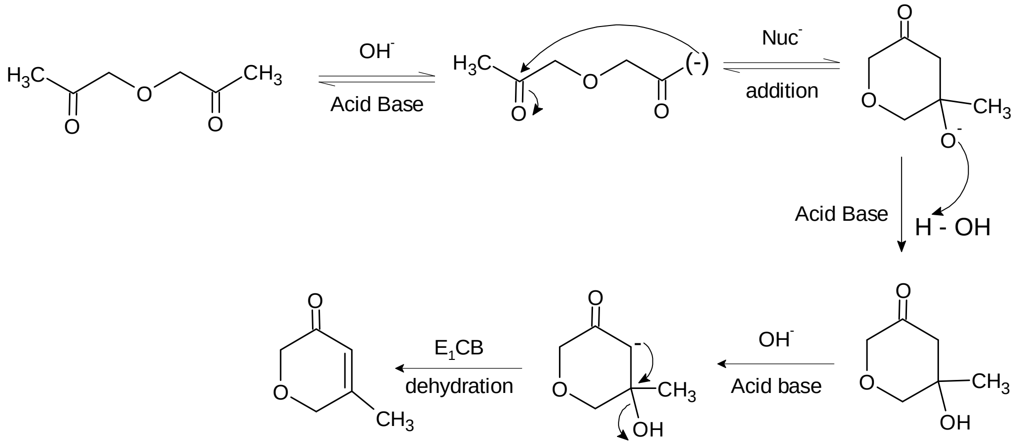
1.8 mol

$\therefore$ mols of NaOH required $= 1.8$

Residue is PbO_2. Its mols formed $= 0.05$

$\therefore$ mass of $PbO_2 = 0.05 \times 239 = 11.95\,\text{g}$

26. A, B, C, D


H3C
CH3
O
O
O
OH-
Acid Base
H3C
(-)
O
O
O
Nuc-
addition
O
O
CH3
O-
Acid Base
H - OH
O
O
CH3
OH
OH-
Acid base
O
O
-
CH3
OH
E1CB
dehydration
O
O
CH3

27. B, C, D

$H_2O_2 + 2 - \text{ethylanthraquione} \underset{O_2}{\overset{H_2/Pd}{\rightleftharpoons}} 2 - \text{ethylanthraquione}$

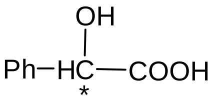
28. A, B

Fact

29. D

In azeotrope two liquids are behaving as separate individuals.

30. A, B

(A) It is perkin reaction
(B) It is knoevenagel reaction
(C) It is based on reformatsky reaction
(D)  $Ph-\underset{*}{\overset{\overset{OH}{|}}{HC}}-COOH$ will be product

31. B

Initial formula was $MgAl_2O_4$ and now formula is $MgAl_2X_3$, so anionic vacancy is 1.

SECTION – C

32. 9

$$\psi = \left[2/\left(\pi C^2\right)\right]^{3/4} e^{-\left(x^2+y^2+z^2\right)/C^2}$$

$$\left(\psi\right)^2 dx\,dy\,dz = \left(2/\pi C^2\right)^{3/2} e^{-2}\left(x^2+y^2+z^2\right)/C^2\,dx\,dy\,dz$$

$$= \left[2/\left(4\pi nm^2\right)\right]^{3/2} e^{-2}\left[(1.2)^2 + (-1)^2 + (0)^2\right]/4\times\left(0.004\text{ nm}\right)^3$$

$$= 1.2\times10^{-9} \qquad \therefore Y = 9$$

33. 8

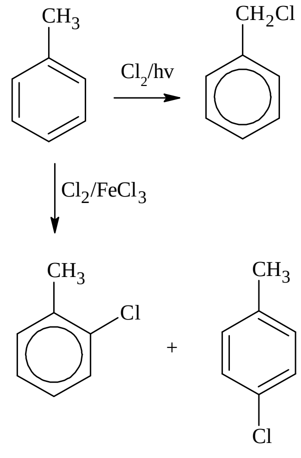
$$NH_4NO_3(s) + \text{heat} \xrightarrow{H_2O} NH_4^+(aq) + NO_3^-(aq)$$

$$\text{Heat abosorbed} = ms\Delta T = 25\times1\times4 = 100\text{ cal}$$

$$\Delta H_{solution} = \frac{100\times10^{-3}\text{k cal}}{12.5\times10^{-3}\text{mol}} = 8\text{ kcal/mol}$$

34. 3

X is



35. 5

Ag_2SO_3, AgCl, $Ag_2C_2O_4$, $AgNO_2$ & CH3COOAg are white ppt., while Ag_3PO_4 is yellow and $Ag_2C_2O_4$ is red.

36. 3

$$\frac{a-P^2}{P^2} = b\ kt$$

$$\frac{a}{P^2} - 1 = b\ kt$$

on differentiating

$$-\frac{2a}{P^3}dP = b\ k\ dt$$

$$-\frac{dP}{dt} = \frac{bk}{2a}P^3$$

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **5 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. (D)

$\Delta EFM \sim \Delta AFD$

$\Rightarrow \dfrac{\text{area }\Delta EFM}{\text{area }\Delta AFD} = \left(\dfrac{MF}{FD}\right)^2$

$\Rightarrow FD = 2MF$ …(1)

$\Rightarrow BF = 2FD$

Let BD = a then area $\Delta EFD = \dfrac{1}{2}\times\dfrac{a}{3}\times a\dfrac{\sqrt{3}}{2} = \dfrac{a^2}{4\sqrt{3}}$

Area $\Delta AFC = \dfrac{1}{2}\times\left(\dfrac{4a}{3}\right)\times 2a.\dfrac{\sqrt{3}}{2} = \dfrac{2a^2}{\sqrt{3}}$

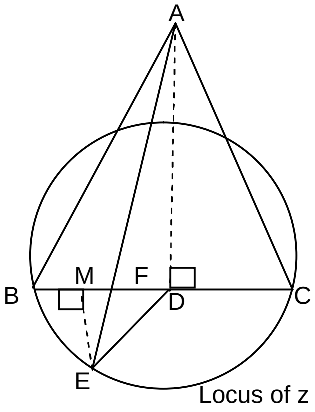
So $\dfrac{\text{area }\Delta FED}{\text{area }\Delta AFC} = \dfrac{1}{8}$ ….(2)

Now $|z - z_a|_{max} = a(1+\sqrt{3})$

$|z - z_a|_{min} = a\left(\sqrt{3}-1\right)$

$\Rightarrow \left(\dfrac{|z - z_a|_{max}}{|z - z_a|_{min}} - 2\right)^2 = 3$ …..(3)

from (2) & (3) k = 24.



38. (B)

$$S=\sum_{r=1}^{n}\left(\frac{\sin\theta}{2\cos(r+1)\theta\cos r\theta\sin\theta}\right)=\frac{1}{2\sin\theta}\sum_{r=1}^{n}\left(\frac{\sin(r+1)\theta\text{-}r\theta}{\cos(r+1)\theta\cos r\theta}\right)=\frac{1}{2\sin\theta}\left(\sum_{r=1}^{n}\left(\tan(r+1)\theta\text{-}\tan r\theta\right)\right)$$

$$=\frac{1}{2\sin\theta}\left(\left(\tan(n+1)\theta\text{-}\tan\theta\right)=\left(\frac{\sin n\theta}{\cos(n+1)\theta.\sin n\theta}\right)\right.$$

39. (C)

Any point on the line through $P(a,2)$ is $(a+r\cos\theta, 2+r\sin\theta)$ and meets the ellipse $\dfrac{x^2}{9}+\dfrac{y^2}{4}=1$ at two distinct points A and D

$\Rightarrow \dfrac{(a+r\cos\theta)^2}{9}+\dfrac{(2+r\sin\theta)^2}{4}=1$

$\Rightarrow (4\cos^2\theta+9\sin^2\theta)r^2+4(2a\cos\theta+9\sin\theta)r+4a^2=0$

$\Rightarrow PA.PD=\dfrac{4a^2}{(4\cos^2\theta+9\sin^2\theta)}$

also line meets the axes at B and C $\Rightarrow \mathrm{PB.PC}=\dfrac{2a}{\sin\theta.\cos\theta}$

since PA, PB, PC and PD are in G.P.

$$\Rightarrow \frac{4a^2}{4\cos^2\theta+9\sin^2\theta}=\frac{2a}{\sin\theta.\cos\theta}$$

$$\Rightarrow 2a\sin 2\theta+5\cos 2\theta=13$$

$$\Rightarrow -1\le\frac{13}{\sqrt{4a^2+25}}\le 1\Rightarrow a\le -6 \quad \text{or} \quad a\ge 6$$

40. (D)

$$\text{As} \sum_{k=1}^{n}[(k+3)^2\text{-}(k+2)](k+2)! + 3.3! = 2003.2003!$$

$$\Rightarrow \sum_{k=1}^{n}[(k+3)(k+3)!\text{-}(k+2)(k+2)!] + 3.3! = 2003.2003!$$

$$\Rightarrow (n+3)(n+3)! = 2003.2003! \Rightarrow n = 2000$$

41. (B)

$$\int_0^{1/2} e^x\left[\left(\sin^{-1}x-\frac{1}{\sqrt{1-x^2}}\right)+\left(\frac{1}{\sqrt{1-x^2}}-\frac{x}{(1-x^2)^{3/2}}\right)\right]dx$$

$$=e^x\left(\sin^{-1}x-\frac{1}{\sqrt{1-x^2}}\right)\Bigg|_0^{1/2}$$

$$=e^{1/2}\left(\frac{\pi}{6}-\frac{2}{\sqrt{3}}\right)-1(0-1)$$

42. (B), (C)

Applying Leibnitz rule, we get

$f(x) = x - x^2 f(x)$

$$f(x)=\frac{x}{1+x^2}$$

$$\int_{-\frac{1}{2}}^{1}\frac{x}{1+x^2}dx = \int_{-\frac{1}{2}}^{1}\frac{x}{1+x^2}dx$$

$$=\frac{1}{2}\ln\frac{8}{5}$$

43. (A),(B), (C), (D)

$$\tan\frac{B}{2}=\frac{2}{3},\tan\frac{C}{2}=\frac{1}{2}\Rightarrow \tan\frac{A}{2}=\frac{4}{7}$$

$$\tan\frac{B}{2}.\tan\frac{C}{2}=\frac{s-a}{s}\Rightarrow 2s=3a=42$$

$\therefore$ Perimeter=42

$\therefore \Delta = r.s. = 84cm^2$

$\therefore \tan\frac{A}{2},\tan\frac{B}{2},\tan\frac{C}{2}$ all are less than 1. All angles are acute.

44. (A), (B), (C)

(B) $(a + c - b)1^2 + 2c\ (-1) + (b + c - a) = 0$
-1 is root of the equation which is rational. 2nd must also be rational

(C) $x = \frac{2}{c}$ Satisfies given equation which is rational

45. (B), (C)

$$I=\frac{2}{1-e}\int\frac{dt}{t^2+\left(\frac{1+e}{1-e}\right)}$$ (t = tanx/2)

if 0 < e < 1, $\frac{1+e}{1-e}>0$, So, (B) is correct

If e > 1, $\frac{1+e}{1-e}<0$ So, (C) is correct.

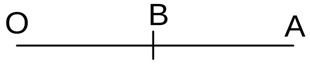
46. (A), (B),

$$\frac{x-1}{\frac{0}{5}}=\frac{y-1}{\frac{4}{5}}=\frac{z+2}{\frac{-3}{5}}=\pm1$$

47. (A), (C) ,(D)

$$Y-y=\frac{dy}{dx}(X-x)$$

$$A\left(x-\frac{\frac{y}{dy}}{dx},\ 0\right),\ \ B(x,\ 0)$$



$$x-\frac{y}{\frac{dy}{dx}}=2x,\ \ -y=x\frac{dy}{dx}$$

$$\frac{dy}{y}=-\frac{dx}{x}$$

LN |Y| = –LN|X| + C
CURVE IS PASSING FROM (1, 1), C = 0
XY = 1

48. (A), (B), (D)

Multiply R_1, R_2, R_3 respectively by a, b, c and take out a, b, c common from C_1, C_2, C_3 respectively.

$$\therefore\ D = \begin{vmatrix} a^2+1 & a^2 & a^2 \\ b^2 & b^2+1 & b^2 \\ c^2 & c^2 & c^2+1 \end{vmatrix}$$

Apply $R_1+R_2+R_3$ and take $1+\Sigma a^2$ common

$$\therefore D = \left(1+\Sigma a^2\right)\begin{vmatrix} 1 & 1 & 1 \\ b^2 & b^2+1 & b^2 \\ c^2 & c^2 & c^2+1 \end{vmatrix}$$

Make two zeros by C_2-C_1, C_3-C_1

$$\therefore D = a^2+b^2+c^2+1 = 1(\text{given})$$

$$\Rightarrow a^2+b^2+c^2 = 0 \ \Rightarrow (c)$$

49. (A), (B), (C),(D)

$$\text{GIVEN } \frac{1}{2}\left(aP_1+bP_2+cP_3\right)=K \Rightarrow y=\frac{a}{P_1}+\frac{b}{P_2}+\frac{c}{P_3} \text{ IS MINIMUM.}$$

WHEN $y = \dfrac{1}{2K}\left(aP_1+bP_2+cP_3\right)\left(\dfrac{a}{P_1}+\dfrac{b}{P_2}+\dfrac{c}{P_3}\right)$ IS MINIMUM.

BUT , $y=\dfrac{1}{2K}\left(a^2+b^2+c^2+ab\left(\dfrac{P_1}{P_2}+\dfrac{P_2}{P_1}\right)+bc\left(\dfrac{P_2}{P_3}+\dfrac{P_3}{P_2}\right)+ab\left(\dfrac{P_1}{P_3}+\dfrac{P_3}{P_1}\right)\right)$

$$\geq \frac{1}{2K}\left(a^2+b^2+c^2+2ab+2bc+2ac\right)$$

$$\Rightarrow y \geq \frac{(a+b+c)^2}{2K} \ \text{ when } \frac{P_1}{P_2}=\frac{P_2}{P_1}=\frac{P_2}{P_3}=\frac{P_3}{P_2}=\frac{P_1}{P_3}=\frac{P_3}{P_1}=1$$

$$\Rightarrow \text{i.e, when } P_1=P_2=P_3$$

$$\therefore \text{P is incentre of } \Delta ABC$$

SECTION – C

50. (1)

Let AD, BE & CF are medians M_1, M_2 & M_3 respectively

Clearly $M_1 = AD = \frac{1}{2}\sqrt{2(b^2+c^2)-a^2}$ $\quad M_2 = \frac{1}{2}\sqrt{2(a^2+c^2)-b^2}$ $\quad M_3 = \frac{1}{2}\sqrt{2(a^2+b^2)-c^2}$

$\Rightarrow M_1^2 + M_2^2 + M_3^2 = \dfrac{3\left(a^2 + b^2 + c^2\right)}{4}$

Now apply AM > GM on M_1^2, M_2^2, M_3^2

$\Rightarrow \dfrac{\frac{3}{4}(a^2 + b^2 + c^2)}{3} > (M_1M_2M_3)^{2/3}$

since a > b > c $\Rightarrow M_1 < M_2 < M_3$

$\therefore M_1, M_2, M_3$ are in G.P.

$\Rightarrow M_1M_2M_3 = (M_2)^3$

$\therefore M_2 = \dfrac{1}{2}$ so

$\dfrac{a^2 + b^2 + c^2}{4} > \left(\dfrac{1}{2}\right)^{\frac{2}{3}\times 3} \Rightarrow a^2 + b^2 + c^2 > 1$

51. (5)

The given expression can be re written as

$\sum\limits_{x\in\{p,q,r,s,\}} \left(2x^2 + (1-x)^2\right)$ where $0 \le x \le 1$

consider the function f(x) = $2x^2 + (1-x)^2$, $0 \le x \le 1$

So f′ (x) = 4x – 2 (1 – x)

For critical points

f′(x) = 0

or x = 1/3

Thus set of critical points is $\left\{0, \dfrac{1}{3}, 1\right\}$

Now f(0) = 1 , $f\left(\dfrac{1}{3}\right) = \dfrac{2}{3}$, f(1) = 2

Thus maximum value of f(x) is 2 and minimum value of f(x) is 2/3. Therefore maximum value of given expression is 4 × 2 = 8 and minimum value is 4× (2/3) = $\dfrac{8}{3}$

52. (9)

Let x_1, x_2, x_3, x_4, x_5 are the no of objects obtained by different person

Then $x_1 + x_2 + x_3 + x_4 + x_5 = 21$

$1 \le x_1 < x_2 < x_3 < x_4 < x_5$

Let $y_1 = x_1$

$y_2 = x_2 - x_1$

$y_3 = x_3 - x_2$

$y_4 = x_4 - x_3$

$y_5 = x_5 - x_4$

$\therefore 5y_1 + 4y_2 + 3y_3 + 2y_4 + y_5 = 21$

$5t_5 + 4t_4 + 3t_3 + 2t_2 + t_1 = 6$ ($t_i = y_i - 1$, 2,3,4,5)

$t_1, t_2, t_3, t_4, t_5 \ge 0$

the no. of solution of above equation is

Coeff. of x^6 in $(1 + x^5 + x^{10} + \ldots)(1 + x^4 + x^8 + \ldots)(1 + x^3 + x^6 + \ldots)(1 + x^2 + x^4 + \ldots)$
$(1 + x + x^2 + \ldots)$

=Coeff. of x^6 in $(1+x^5)(1+x^4)(1+x^3 + x^6)(1 + x^2 + x^4 + x^6)(1 + x + x^2 + \ldots + x^6)$

=Coeff , of x^6 in $(1+x^4 + x^5)$ ($1+ x^3 + x^6$) $(1+ x^2 + x^4 + x^6)$ ($1+x+ x^2+ \ldots. +x^6$)
= Coeff. of x^6 in ($1+ x^3 + x^4 + x^5 + x^6$) ($1+ x^2 + x^4 + x^6$) $(1+x + x^2 + \ldots + x^6)$
= Coeff. pf x^6 in ($1+ x^2 + x^3 + 2x^4 + 2x^5+ 3x^6$) $(1+x+ x^2+ \ldots + x^6)$
= 9
Now the variables $x_1, x_2, \ldots., x_5$ can permute in 5! ways
$\therefore$ Total no of ways = $9\times 5!$
= 1080

53. (1)

Roots of the equation $ax^3+x-1-a = 0$ are $1,\alpha,\beta$

$$\therefore \alpha + \beta = -1 \text{ and } \alpha\beta = \frac{1+a}{a}$$

$$\Rightarrow \lim_{x\to\frac{1}{\alpha}} \frac{(1 + a)x^3 - x^2 - a}{(e^{1 - \alpha x} -1)(x - 1)} = \lim_{x\to\frac{1}{\alpha}} \frac{(x-1)[(1 + a)\, x^2 + ax + a]}{(e^{1 - \alpha x} -1)(x - 1)} = \lim_{x\to\frac{1}{\alpha}} \frac{[a\alpha\beta x^2 + ax + a]}{(e^{1 - \alpha x} -1)}$$

$$\Rightarrow \lim_{x\to\frac{1}{\alpha}} \frac{a(1 - \alpha x)(1 - \beta x)}{(e^{1 - \alpha x} -1)} = \lim_{x\to\frac{1}{\alpha}} a(1 - \beta x) = \frac{a(\alpha - \beta)}{\alpha}$$

54. (4)

α, β, γ are the roots of equation $x^3 + px^2 + qx - q = 0$ …..(i)
then equation whose roots are $\frac{1}{\alpha},\frac{1}{\beta},\frac{1}{\gamma}$ will be

$$qx^3 - qx^2 - px - 1 = 0 \left(\text{after replacing } x \text{ by } \frac{1}{x}\right) \qquad \text{…..(ii)}$$

roots of this equation α', β', γ' are in A.P.
$2\beta' = \alpha' + \gamma'$
also $\alpha' + \beta' + \gamma' = 1$ $3\beta' = 1$
$\alpha'\beta' + \beta'\gamma' + \alpha'\gamma' = -\frac{p}{q}$ $\Rightarrow$ $\beta' = \frac{1}{3}$
$\alpha'\beta'\gamma' = \frac{1}{q}$ Put $x = \frac{1}{3}$ in equation (ii)
$9p + 2q = -27$

Using $\left(\frac{1}{\alpha}+\frac{1}{\beta}+\frac{1}{\gamma}\right)^2 = \frac{1}{\alpha^2}+\frac{1}{\beta^2}+\frac{1}{\gamma^2}+2\left(\frac{1}{\alpha\beta}+\frac{1}{\beta\gamma}+\frac{1}{\alpha\gamma}\right)$

Now $\frac{1}{\alpha}+\frac{1}{\beta}+\frac{1}{\gamma} = 1$ also $\frac{1}{\beta} = \frac{1}{3}$.

So $1 = \frac{1}{\alpha^2}+\frac{1}{\beta^2}+\frac{1}{\gamma^2}+2\left(\frac{1}{\beta}\left(\frac{1}{\alpha}+\frac{1}{\gamma}\right)+\frac{1}{\alpha\gamma}\right)$, $1 = \frac{1}{\alpha^2}+\frac{1}{\beta^2}+\frac{1}{\gamma^2}+2\left(\frac{2}{\beta^2}+\frac{1}{\alpha\gamma}\right)$

Now let $\frac{1}{\alpha} = \frac{1}{3} - d$, $\frac{1}{\gamma} = \frac{1}{3} + d$, $1 = \frac{1}{\alpha^2}+\frac{1}{\beta^2}+\frac{1}{\gamma^2}+2\left(\frac{2}{9}+\left(\frac{1}{3}-d\right)\left(\frac{1}{3}+d\right)\right)$

$1 = \frac{1}{\alpha^2}+\frac{1}{\beta^2}+\frac{1}{\gamma^2}+2\left(\frac{3}{9}-d^2\right)$, $2d^2 = \frac{1}{\alpha^2}+\frac{1}{\beta^2}+\frac{1}{\gamma^2}-\frac{1}{3} \ge 0$, so $\frac{1}{\alpha^2}+\frac{1}{\beta^2}+\frac{1}{\gamma^2} \ge \frac{1}{3}$

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - III

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 231**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-C & Section-D**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01 – 03, 24 – 26, 47 – 49)*** *contains 9 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (04 – 08, 27 – 31, 50 – 54) *contains 15 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (09 – 10, 32 – 33, 55 – 56) *contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer. There is no negative marking.*

2. ***Section-C (11 – 20, 34 – 43, 57 – 66)*** *contains 30 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

3. ***Section-D (21 – 23, 44 – 46, 67 – 69)*** *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

PART – I (Physics), PART – II (Chemistry), PART – III (Mathematics):

(SECTION – D)

For questions **21 to 23, 44 to 46, 67 to 69.**
Numerical answer type questions with answer XXXXX. XX
If answer is 348.4 / 251.37 / 213

Correct Method :

0	0	3	4	8	.	4	0
0	0	2	5	1	.	3	7
0	0	2	1	3	.	0	0

Wrong Method :

	3	4	8		.	4	
3	4	8			.		4
		3	4	8	.		4
	3		4	8	.	4	
	2		5	1	.	3	7
		2	1	3	.		
		2	1	3	.	0	
		2	1	3	.		0
		3	4	8	.	4	0
		2	5	1	.	3	7
		2	1	3	.	0	0

Physics PART – I

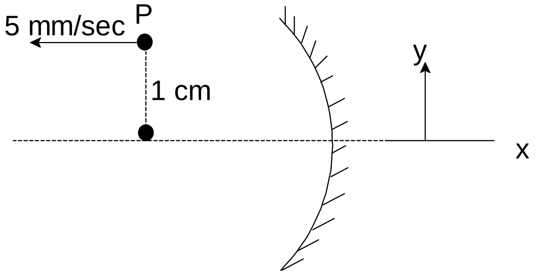
SECTION – A
(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE** option is correct.

1. The internal energy of a gas is given by U = 2PV. It expands from V_0 to $2V_0$ against a constant pressure P_0. The heat absorbed by the gas in the process is
   (A) $2P_0V_0$
   (B) $4P_0V_0$
   (C) $3P_0V_0$
   (D) P_0V_0

2. A metal rod of length ℓ & area of cross-section A is suspended to the celling by one of its end. The density of metal is ρ, young modulus of elasticity is Y. Choose the correct option
   (A) The stress at mid point is $\ell\rho g$
   (B) Extension in rod due to it's own weight $\Delta\ell = \frac{\rho g\ell^2}{2Y}$
   (C) potential energy stored in rod due to its own weight $U = \frac{\rho^2 AL^3}{3Y}$
   (D) The stress at mid point is $2\ell\rho g$

3. A point object P is moving towards left with speed 5 mm/sec parallel to optical axis of a concave mirror of focal length f = 20 cm. The vertical separation between object and optical axis is 1 cm. Find velocity of image of object in vector form, when foot of perpendicular from object on the optical axis is at a distance 30 cm from pole.



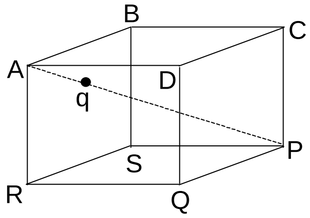
   (A) $\vec{V}_i = 20\hat{i} + 4\hat{j}$ mm / sec
   (B) $\vec{V}_i = 20\hat{i} + \hat{j}$ mm / sec
   (C) $\vec{V}_i = 20\hat{i} - \hat{j}$ mm / sec
   (D) $\vec{V}_i = 20\hat{i}$ mm / sec

Space for Rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

4. A charge ‘q’ is placed on the diagonal AP of a cube at a distance $\frac{AP}{3}$ from the point A. Choose the correct options.



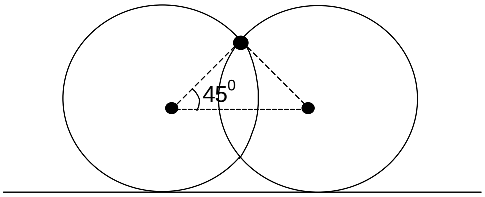
(A) The sum of electric flux passing through the surface ABCD and PQRS is $\frac{q}{3\varepsilon_0}$

(B) The sum of electric flux passing through the surface ABCD and PQRS is $\frac{q}{8\varepsilon_0}$

(C) The flux through both the surfaces ABCD and PQRS are same

(D) The flux through the surface ABCD is larger than the flux through surface PQRS

5. Two identical uniform large rings each of mass m are connected through a bead of same mass, which can move freely. When bead is released it starts sliding down. The large rings roll apart over a sufficiently rough horizontal surface. Whole system is released from rest as shown in figure.
Choose the correct Option(s). (Neglect friction between bead and large rings)



(A) Acceleration of the bead at the initial moments is $\frac{g}{9}$

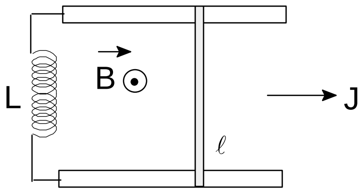
(B) Acceleration of the bead at the initial moment is $\frac{g}{5}$

(C) At the initial moment normal contact between bead and any of the ring is $\frac{4\sqrt{2}mg}{9}$

(D) Normal contact between bead and any of the ring is $\frac{2\sqrt{2}mg}{5}$

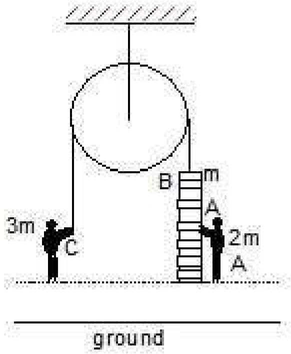
Space for Rough work

6. Two parallel resistance less rails are connected by an inductor of inductance L at one end as shown in the figure. A magnetic field B exists in the space which is perpendicular to the plane of the rails. Now a conductor of length ℓ, mass m and negligible resistance is placed transverse on the rails and given an impulse J towards the rightward direction. Then choose the correct option(s).



(A) Velocity of the conductor is half of the initial velocity after a displacement of the conductor $d = \sqrt{\frac{3J^2L}{4B^2\ell^2m}}$
(B) Current flowing through the inductor at the instant when velocity of the conductor is half of the initial velocity is $i = \sqrt{\frac{3J^2}{4Lm}}$
(C) Velocity of the conductor is half of the initial velocity after a displacement of the conductor $d = \sqrt{\frac{3J^2L}{B^2\ell^2m}}$
(D) Current flowing through the inductor at the instant when velocity of the conductor is half of the initial velocity is $i = \sqrt{\frac{3J^2}{Lm}}$

7. Man A of mass 2m is standing on a ladder of mass m. Ladder is attached with an inextensible light string and man C of mass 3m is holding the other end of string. Initially, the whole system is at rest. Assume whole system is at sufficient height and pulley is frictionless. Also A and C are at same horizontal level. Then choose the correct options. [g = 10 m/s^2].



(A) If man A starts climbing up on the ladder with a constant acceleration of 4 m/s^2 w.r.t ground then, the vertical distance between A and C after 1 sec is 1 m
(B) If man C starts climbing up on the rope (while A remain at rest with respect to ladder) with constant acceleration of 4 m/s^2 with respect to ground then, the vertical distance between A and C after 1 sec is 2m
(C) If both man A and C starts climbing up with constant acceleration 4 m/s^2 with respect to ground then, acceleration of ladder is 4 m/s^2 upward
(D) If both man A and C starts climbing up with constant acceleration 4 m/s^2 with respect to ground then, acceleration of ladder is 3 m/s^2 upward

Space for Rough work

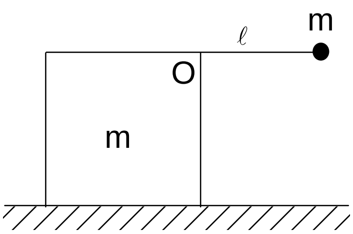
8. In the Searle's experiment, after every step of loading , why should we wait for two minutes before taking the readings?
(A) So that the wire can have its desired change in length.
(B) So that the wire can attain room temperature.
(C) So that vertical oscillations can get subsided.
(D) So that the wire has no change in its radius.

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 9 and 10

A particle of mass m is connected to a block of same mass by an inextensible string of length ℓ. The block is free to slide on the smooth horizontal surface. Size of the block is large enough so, that is doesn't topple and particle doesn't hit on the ground. Now the particle is released from the horizontal position of the string as shown in the figure. Answer the following two questions.



9. Speed of the block as function of θ (where θ is the angle made by the string with downward vertical) will be:

(A) $\sqrt{\frac{g\ell\cos\theta}{1+\tan^2\theta}}$
(B) $\sqrt{\frac{2g\ell\cos\theta}{1+\tan^2\theta}}$
(C) $V=\sqrt{\frac{g\ell\cos\theta}{1+2\tan^2\theta}}$
(D) $V=\sqrt{\frac{g\ell\cos\theta}{2+\tan^2\theta}}$

10. Normal reaction offered by ground onto the wedge as a function of θ. (where θ is the angle made by the string with downward vertical) will be:

(A) $mg\cos\theta\left(\frac{5+\sin^2\theta}{(1+\sin^2\theta)^2}\right)$
(B) $mg\left(1+\frac{\cos^2\theta(5+\sin^2\theta)}{(1+\sin^2\theta)^2}\right)$
(C) $mg\cos\theta\left(\frac{5+\sin^2\theta}{1+\sin^2\theta}\right)$
(D) $mg\left(1+\frac{\cos^2\theta(3+\sin^2\theta)}{(1+\sin^2\theta)^2}\right)$

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

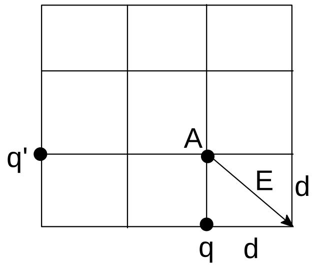
11. An ant with mass m is standing peacefully on top of a horizontal stretched rope. The rope has mass per unit length μ and is under tension F. Now starts a sinusoidal transverse wave of wavelength λ propagating along the rope. The motion of the rope is in a vertical plane. What minimum amplitude (in mm) will make the ant feel weight less momentarily? Assume that m is so small that the pressure of the ant has not effect on the propagation of the wave. (Given $\lambda = 0.5\text{m}$, $\mu = 0.1\,\text{kg/m}, F = 3.125\text{N}$, Take $g = \pi^2$)

12. A photon strikes a hydrogen atom in its ground state to eject the electron with kinetic with energy 16.4 eV. If 25% of the photon energy is taken up by the electron, the energy of the incident photon is $(24 \times X)$ eV then 'X' is;

13. Two men A and B, A standing at periphery of circle of radius R and B standing at centre of the circle. A starts moving on the periphery with constant acceleration "a" and B starts moving with constant velocity v at an angle θ, from the line joining initial position of A and centre, such that they meet during subsequent motion, for this purpose maximum possible value of v is $\sqrt{\frac{aR}{\alpha\theta}}$. Here α is an integer. Find α.

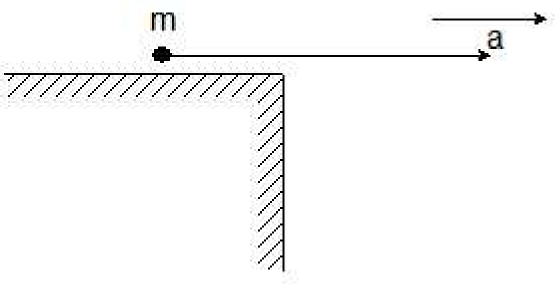
14. The range of voltage of a galvanometer used as a voltmeter can be changed to n times its original value with the help of a 27Ω resistance. Using the same galvanometer as an ammeter, its range of current can be changed to n times its original value using a 3Ω shunt. Find the internal resistance of the meter $(\text{in } \Omega)$.

15. In given arrangement side of each small square is d. Two point charges q and q' are placed as shown in the figure. If the total electric field at A is as shown in the figure below and potential at point A is given by $\frac{-nq}{8\pi\varepsilon_0 d}$ then find n.

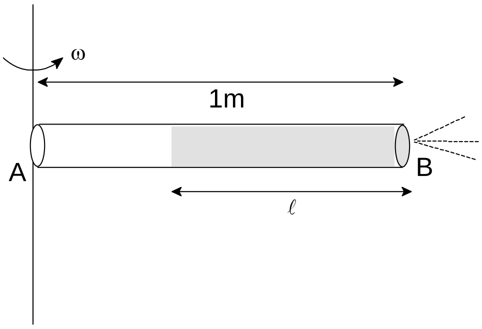


Space for Rough work

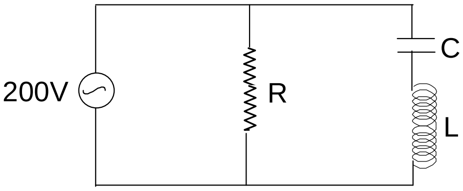
16. A small particle is attached to an inextensible string and placed on a table. The other end is pulled with constant acceleration $\frac{4g}{3}$ towards right. Initially the particle was at rest. After the particle leaves the edge of table, the maximum vertical displacement of the particle is from initial horizontal level is $\frac{48}{25}$m. Find the length of string in m.



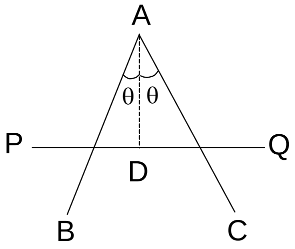
17. A narrow horizontal tube AB of length 1m open at A and closed at B is filled with an ideal fluid. The end B has a small orifice. The tube is set in rotation in horizontal plane with angular velocity $\omega = 10 \text{rad/sec}$. About a vertical axis passing through A. The efflux velocity of the fluid is V m/s. The length the fluid is $\ell = 0.4\text{m}$. Find the value of V.



18. In the circuit diagram shown, X_C = 100Ω, X_L = 200Ω & R = 100Ω. The effective current through the source is $\sqrt{X}$ ampere then find out value of X:

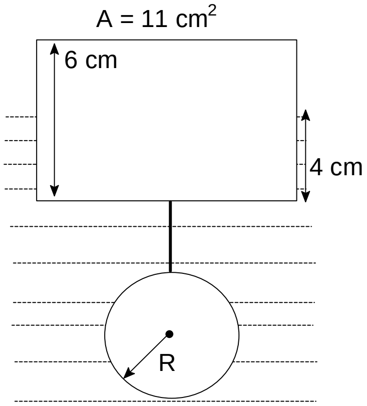


19. In the figure shown AB, AC and PQ are thin, smooth, rigid wires, AB and AC are joined at A and fixed in vertical plane. $\angle BAC = 2\theta = 90^0$ and line AD is angle bisector of angle BAC. A liquid of surface tension T = 0.025N/m forms a thin film in the triangle formed by intersection of the wires AB, AC and PQ. In the figure shown the uniform wire PQ of mass 1 gm is horizontal and in equilibrium under the action of surface tension and gravitational force. Find the time period of SHM of PQ in vertical plane for small displacement from its mean position. In the form $\frac{\pi}{X}$s and find value of X.



Space for Rough work

20. Figure shows a uniform metal ball suspended by thread of negligible mass from an upright cylinder that floats partially submerged in water. The cylinder has height 6 cm, face area 11 cm^2 on the top and bottom and density 0.5 g/cm^3. 4 cm of cylinder's height is inside the water surface. Density of the metal ball is 8gm/cm^3. R is the radius of the ball. It is found that $R^3 = \frac{3}{\alpha}\text{cm}^3$, where α is an integer $\left(\rho_W = 1\text{gm}/\text{cm}^3\right)$ (system is in equilibrium) [π = 22/7]. Find α



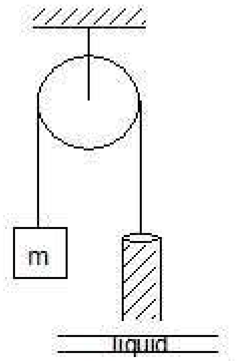
SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

21. A radionuclide with disintegration constant λ is produced in a reactor at a constant rate $\alpha(= 2\lambda)$ nuclei per second. At t = 0, there are no nuclei present in the reactor. During each decay energy E_0 is released. 20% of this energy is utilized in increasing the temperature of water. Find the increase in temperature of m mass of water in time t = $T_{1/2}$ if specific heat of water is s. Assume that there is no loss of energy through water surface. (Given E_0 = 100 times the energy required to raise the temperature of mass m of water from 0^0C to 100^0C)

22. A parachutist jumps from the top of a very high tower with a siren of frequency 800 Hz on his back. Assume his initial velocity to be zero. After falling freely for 12 s, he observes that the frequency of sound heard by him reflected from level ground below him is differing by 700 Hz w.r.t. the original frequency. What was the height of tower. Velocity of sound in air is 330 m/s, and g = 10 m/s^2.

23. A uniform cylinder of mass 2m and a block of mass m are connected by a light string passing over a fixed smooth pulley as shown in the figure. The system is released from rest when the lower edge of the cylinder just touches the surface of the liquid. The area of cross-section of the cylinder is A and its length is L. What should be the density of the liquid, if the cylinder stops at the instant when the upper edge of the cylinder just touches the surface of the liquid? Assume infinite extension of the liquid and the viscosity of the liquid to be zero. $\left(\text{Given m} = 1\,\text{kg, A} = 10^{-2}\text{m}^2\text{, L} = 1\text{m}\right)$



Space for Rough work

Chemistry

PART – II

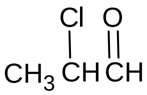
SECTION – A
(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE** option is correct.

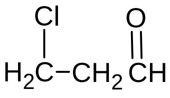
24. Which of the following is not a balanced chemical reaction?
(A) $2MnO_4^- + H_2O_2 + 6H^+ \longrightarrow 2Mn^{+2} + 3O_2 + 4H_2O$
(B) $3P_4S_3 + 38NO_3^- + 8H_2O + 20H^+ \rightarrow 12H_3PO_4 + 9SO_4^{-2} + 38NO$
(C) $5SO_3^{-2} + 2MnO_4^- + 6H^+ \rightarrow 5SO_4^{-2} + 2Mn^{+2} + 3H_2O$
(D) None of these

25. Which of the following is not a correct statement about $Al_2(CH_3)_6$?
(A) Maximum no. of atoms present in same plane = 10
(B) Maximum no. of C - atoms present in same plane = 4
(C) Maximum no. of atoms present in a plane which contain two C atom = 6
(D) None of these

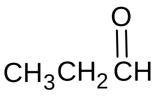
26. Arrange these compounds in orders of increasing equilibrium constant for hydrate formation.


$CH_3CH(Cl)CHO$

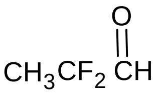
(I)


$ClH_2C{-}CH_2CHO$

(II)


CH_3CH_2CHO

(III)


CH_3CF_2CHO

(IV)

(A) I < II < III < IV
(B) III < II < I < IV
(C) IV < I < II < III
(D) None of these

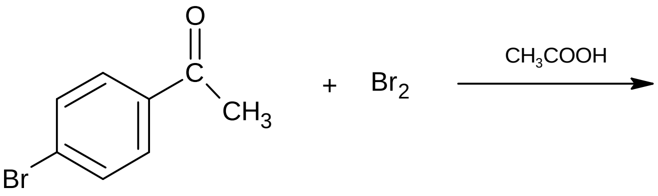
Space for Rough work

(One or More than one correct type)

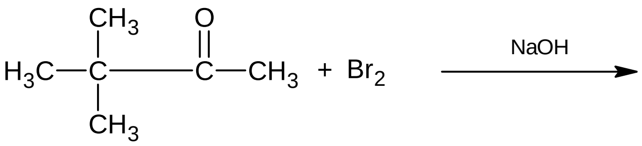
This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

27.

(I)



(II)



$$H_3C-\overset{CH_3}{\underset{CH_3}{C}}-\overset{O}{\overset{\|}{C}}-CH_3 + Br_2 \xrightarrow{NaOH}$$

Choose the incorrect statement(s) for mono halogenation.

(A) I is more suitable than II
(B) II is more suitable than I
(C) I and II are equally suitable
(D) None of two are suitable for mono halogenation

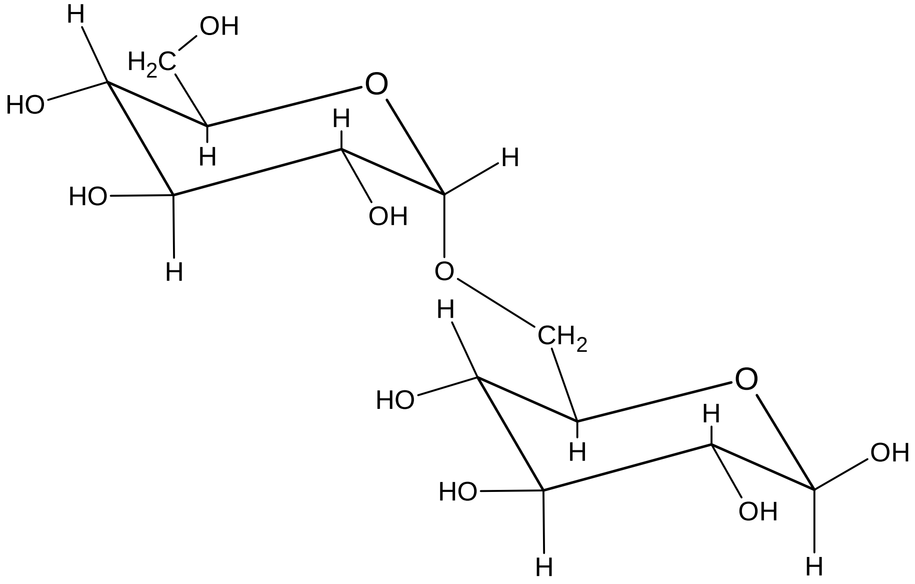
Space for Rough work

28. Which of the following is/are reducing sugar(s)?

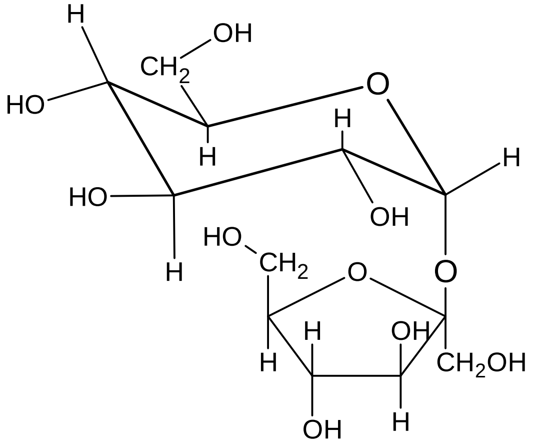
(A) Methyl $\alpha - D -$ galactopyranoside

(B) $\beta - L -$ idopyranose (an aldohexose)

(C)



(D)



Space for Rough work

29. $[Cr(CN)_6]^{3-}$ $[Mn(CN)_6]^{3-}$ $[Fe(CN)_6]^{3-}$ $[Co(CN)_6]^{3-}$

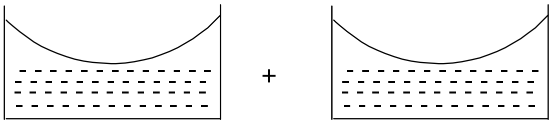
I II III IV

Choose the correct statements.

(A) $I < II < III < IV$ (strength of metal carbon bond)
(B) $I > II > III > IV$ (strength of metal carbon bond)
(C) $I < II < III < IV$ (strength of carbon nitrogen bond)
(D) $I > II > III > IV$ (strength of carbon nitrogen bond)

30. Which combinations behave as buffer solution?

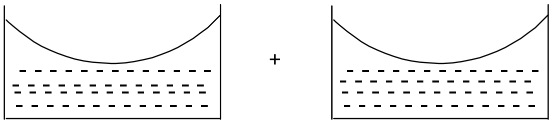
(A)



1 Lit
1 M NH_3

1 Lit
1 M CH_3COOH

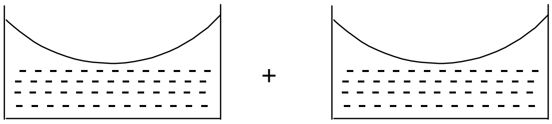
(B)



1
1 M NaHCO

1
1 M Na_2CO

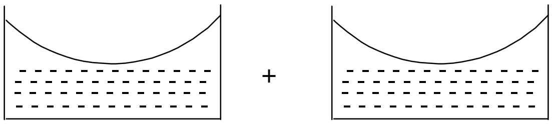
(C)



1 Lit
1 M HCl

1 Lit
2 M CH_3COONa

(D)

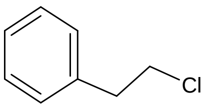
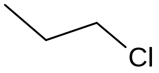


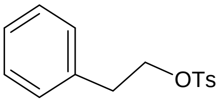
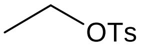
1 Lit
1 M NaOH

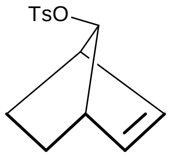
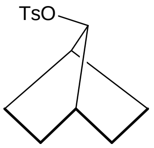
1 Lit
0.5 M NH_4Cl

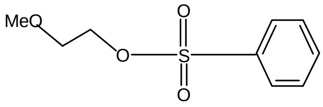
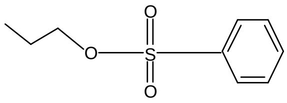
Space for Rough work

31. Choose the correct statements:

(A)  reacts with water faster than 

(B)  reacts with CF_3COOH faster than 

(C)  reacts with acetic acid faster than 

(D)  reacts with AcOH faster than 

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

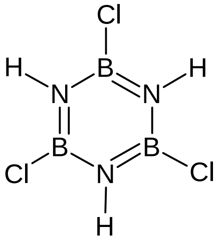
Paragraph for Question Nos. 32 and 33

Since boron has three valence-shell electrons and nitrogen has five, the molecule BN is isoelectronic with C_2. Also some of the allotropic forms that exist for carbon also exist for compounds that have the formula $(BN)_x$

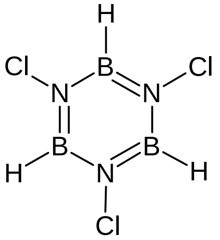
32. Choose the incorrect statement.
(A) borazon is one of the hardest compound known
(B) cubic form of $(BN)_x$ is called borazon
(C) $B_3N_3H_6$ is called borazon
(D) graphite form of $(BN)_x$ is used as a high temperature lubricant

Space for Rough work

33. Choose the incorrect statement.
(A) on large scale the reaction of $(NH_2)_2CO$ with $B(OH)_3$ at high temperature in an atmosphere of ammonia is used to produce borazine
(B) Trichloroborazine ($B_3N_3Cl_3H_3$) has the structure

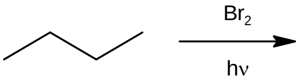


(C) reaction of $B_3N_3Cl_3H_3$ with $LiAlH_4$ gives borazine
(D) trichloroborazine ($B_3N_3Cl_3H_3$) has the structure



SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

34.  dibrominated products + monobrominated products

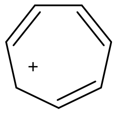
No of optically active products are ….

Space for Rough work

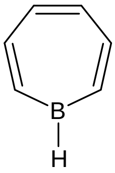
35. How many compounds/ions are aromatic?

(A) Borazine (B) Graphite (C) Borazon

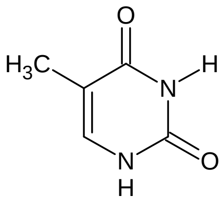
(D)



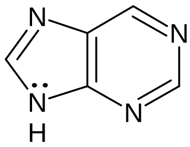
(E)



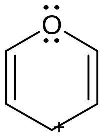
(F)



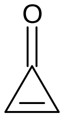
(G)



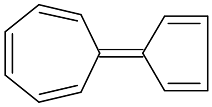
(H)



(I)



(J)



36. Number of carbohydrats which show mutarotation are …..

(A) α - D - (+) – glucopyranose (B) β - D – (+) – glucopyranose
(C) α - D – (–) – fructofuranose (D) β - D – (–) – fructofuranose
(E) sucrose (F) maltose
(G) lactose

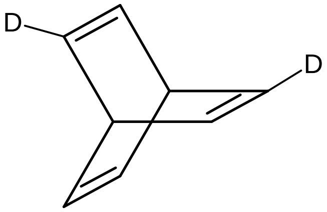
37. Number of compounds which show more basic character than NH_3 (in aqueous condition) are …

(A) $N(CH_3)_3$ (B) $NH(CH_3)_2$ (C) NH_2CH_3
(D) $N(C_2H_5)_3$ (E) $NH(C_2H_5)_2$ (F) $NH_2C_2H_5$
(G) $N(n\text{-}Pr)_3$ (H) $NH(n\text{-}Pr)_2$ (I) $NH_2(n\text{-}Pr)$
(where n-Pr = normal-propyl)

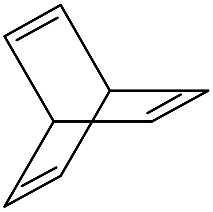
Space for Rough work

38. Number of compounds which show optical activity are …..

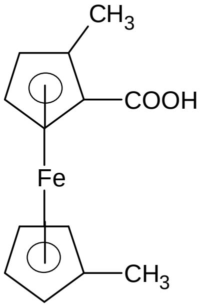
(A)



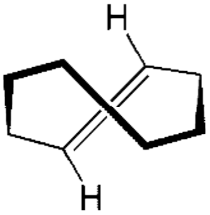
(B)



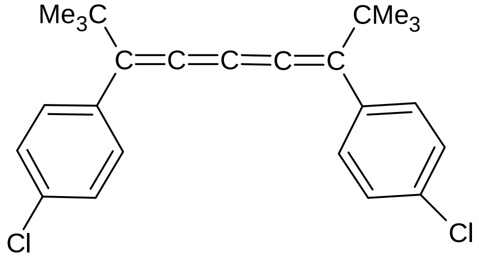
(C)


CH3
COOH
Fe
CH3

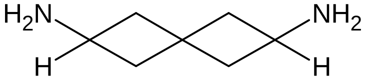
(D)



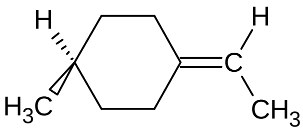
(E)


Me3C
CMe3
C=C=C=C=C
Cl
Cl

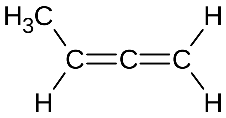
(F)



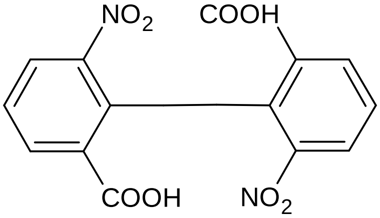
(G)



(H)



(I)


NO2
COOH
COOH
NO2

Space for Rough work

39. The percentage of Ni^{+2} and Ni^{+3} ions in $Ni_{0.98}O_{1.00}$ is x and y respectively then value of $\frac{x}{4y}$ is ….

40. An aqueous solution of glucose boils at 100.01°C. The molar elevation constant for water is 0.5 K kg mol^{-1}. If number of glucose molecule in the solution containing 100 g water is 1.2×10^x, then $\frac{x}{3}$ is

41. Find number of compound(s) in which atoms of anion are bonded by only one covalent bond.
$NaOH$, Na_2O, Na_2O_2, BaO_2, CaC_2, CaH_2, $BaCl_2$, Na_2S_2

42. Find number of yellow ppt from given below:
$AgCl$, $AgBr$, $PbCrO_4$, $Fe(SCN)_3$, Hg_2I_2, $PbBr_2$, PbI_2, $Fe(OH)_2$

43. Find number of order which is/are correctly arranged.
(I) $CH_4 < SiH_4 < SnH_4$ (boiling point)
(II) $SbH_3 > NH_3 > PH_3$ (boiling point)
(III) $H_2O > SeH_2 > H_2S$ (boiling point)
(IV) $HF > HBr > HCl$ (boiling point)
(V) $F_2 < Cl_2 < Br_2 < I_2$ (bond length)
(VI) $F_2 > Cl_2 > Br_2 > I_2$ (bond energy)
(VII) chair form of cyclohexane > half chair form of cyclohexane (stability)

Space for Rough work

SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

---

44. Two moles of an ideal gas were heated in a rigid container such that its internal energy rises by (40 × 8.314) J and temperature increase by 8 K. One mole of the same gas undergoes a reversible adiabatic expansion such that the ratio of final volume to initial volume is 32. If $\log\left(\frac{P_1}{P_2}\right) = x\log 2$, where P_1 & P_2 are initial & final pressure respectively then x is

(R = 8.314 J mol^{-1} K^{-1})

45. The following equilibrium was established at constant T in a rigid container starting with only AB(g).

$AB(g) \rightleftharpoons A(g) + B(g)$

The degree of dissociation of AB is 20% under these conditions & the relative vapour density of the equilibrium mixture is 'y'. Neon gas (inert) is added in the container such that its mole fraction is 0.4. The vapour density of the gaseous mixture in the container is 'z'. Then (y + z) is

(molar mass of AB(g) = 60 & neon = 20)

46. Out of the following wave-functions, only one is of the 2s orbital of H-atom

(a) $\psi = \left(\frac{1}{32\pi a_0^3}\right)^{\frac{1}{2}}\left(2-\frac{r}{a_0}\right)e^{-\frac{r}{2a_0}}$

(b) $\psi = \left(\frac{1}{24\pi a_0^3}\right)^{\frac{1}{2}}\left(6-\frac{6r}{a_0}+\frac{r^2}{a_0^2}\right)\left(e^{-\frac{r}{2a_0}}\right)$

(c) $\psi = \left(\frac{1}{32\pi a_0^3}\right)^{\frac{1}{2}}\left(2-\frac{r}{a_0}\right)e^{-\frac{r}{2a_0}}.\cos\theta$

(d) $\psi = \left(\frac{1}{32\pi a_0^3}\right)^{\frac{1}{2}}\left(\frac{r}{a_0}\right)e^{-\frac{r}{2a_0}}$

Using the correct wave-function, calculate the probability of find a 2s – electron in H atom on the spherical surface at a distance of twice the bohr's radius from the nucleus (a_0 = bohr's radius).

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE** option is correct.

47. There are 20 locks and their 20 corresponding keys. If each lock has exactly 1 matching key then the maximum number of trials to match the locks with their corresponding keys
(A) 20!
(B) 19!
(C) 1
(D) none of these

48. If a Δ ABC is formed by the lines $2x + y - 3 = 0$; $x - y + 5 = 0$ and $3x - y + 1 = 0$, then the cubic equation whose roots are the tangent of the interior angles of the triangle is
(A) $2x^3 + 3x^2 - 8x + 3 = 0$
(B) $2x^3 + 3x^2 + 8x + 3 = 0$
(C) $3x^3 + 3x^2 - 8x + 3 = 0$
(D) $3x^3 + 3x^2 + 8x + 3 = 0$

49. In ΔABC, $2x + 3y + 1 = 0$, $x + y = 1$ and $2x - y + 1 = 0$ are median through vertex A, altitude through vertex B and angle bisector of C respectively
(A) intercept made by BC on y-axis is $\frac{379}{59}$
(B) area of ΔABC is $\frac{401}{59}$
(C) intercept made by BC on x-axis is $\frac{379}{423}$
(D) none of these

Space for Rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

50. Let determinants $\Delta = \begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & b_3 \end{vmatrix}$, $\Delta_x = \begin{vmatrix} d_1 & b_1 & c_1 \\ d_2 & b_2 & c_2 \\ d_3 & b_3 & c_3 \end{vmatrix}$, $\Delta_y = \begin{vmatrix} a_1 & d_1 & c_1 \\ a_2 & d_2 & c_2 \\ a_3 & d_3 & c_3 \end{vmatrix}$ and $\Delta_z = \begin{vmatrix} a_1 & b_1 & d_1 \\ a_2 & b_2 & d_2 \\ a_3 & b_3 & d_3 \end{vmatrix}$ and consider the statements

(i) if $\Delta = \Delta_x = \Delta_y = \Delta_z = 0$ then the equations $a_i x + b_i y + c_i z = d_i$ $(i = 1,2,3)$ have infinitely many solutions

(ii) if $\Delta_x = \Delta_y = \Delta_z = 0 \neq \Delta$ then the equations $a_i x + b_i y + c_i z = d_i$ $(i = 1,2,3)$ have unique solution which of the following are wrong

(A) (i) and (ii) are always are wrong
(B) (i) may or may not be true but (ii) always true
(C) in both (i) & (ii) equations are always consistent
(D) (i) is false & (ii) is true.

51. Let $1.1.2 + 2.2.3 + 3.4.4 + 4.8.5 + 5.16.6 + \ldots n \text{ terms} = \left(an^2 - bn + 2\right)2^n - c, \left(a,b,c \in N\right)$ then

(A) a + b = c
(B) 3a – b = c
(C) a + b + c = 4
(D) None of these

52. The extremum values of the function $f(x) = \frac{1}{\sin x + 4} + \frac{1}{\cos x - 4}$, where $x \in R$ is :

(A) $\frac{4}{8-\sqrt{2}}$
(B) $\frac{2\sqrt{2}}{8-\sqrt{2}}$
(C) $\frac{2\sqrt{2}}{4\sqrt{2}+1}$
(D) $\frac{4\sqrt{2}}{8+\sqrt{2}}$

Space for Rough work

53. If roots of $f(x) = x^2 - bx + c = 0$, b is an odd integer & $c \in z$; are prime numbers, then

(A) c is an odd integer
(B) c is an even integer
(C) $2b - c = 4$
(D) $2b + c = 4$

54. Consider 10 sided convex polygon in which no two diagonals are parallel. 'S' is the set of distinct points of intersections of diagonals. A point is randomly picked up from 'S'. Which of the following is/are true.

(A) maximum value of probability that the point is outside the polygon is $\frac{35}{119}$

(B) maximum value of probability that the point is on the polygon is $\frac{2}{79}$

(C) maximum value of probability that the point is inside the polygon is $\frac{42}{79}$

(D) none of these

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 55 and 56

Let g be a continuous function on R and satisfies $g(x) + 2\int_0^{\frac{\pi}{2}} \cos x \sin t g(t) dt = \cos x$

55. The value of $g'(\frac{\pi}{6})$ is equal to

(A) $\frac{1}{2}$
(B) $\frac{1}{\sqrt{2}}$
(C) $-\frac{1}{4}$
(D) $\frac{\sqrt{3}}{2}$

Space for Rough work

56. The value of $\lim\limits_{x\to 0}\dfrac{g^{'}(x)}{xg(x)}$ is equal to

(A) 1 (B) $-\dfrac{1}{4}$

(C) 2 (D) -2

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

57. Let p be a positive integer and g(x) be a polynomial with integer coefficients satisfying $2\int_1^x \mathrm{g}(t)\,dt + x^p = x\,g\,(x),\ where\ x \ge 1$. The sum of all possible values of p is.

58. Suppose p_1 & p_2 are the point of maximum and the point of minimum respectively of the function f(x) = $2x^3 - 9\,ax^2 + 12\,a^2x + 1$ respectively, then for the equality $p_1^2 = p_2$ to be true the value of 'a' must be

59. If n be a positive integer such that n ≥ 3, and the value of the sum to n terms of the series $1.n - \dfrac{n-1}{1!}(n-1) + \dfrac{(n-1)(\mathrm{n}-2)}{2!}(n-2) - \dfrac{(n-1)(n-2)(n-3)}{3!}(n-3) + ...$ is 'S'. then the value of $\dfrac{2S}{19}$ is

---

Space for Rough work

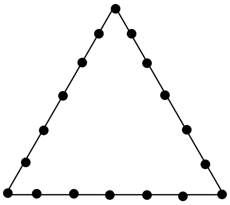
60. If the normals to the curve y = x^2 at the points P, Q and R pass through the point $(0, \frac{3}{2})$, then the radius of the circle circumscribing the triangle PQR is

61. The function *f* is one to one and the sum of all the intercepts of the graph is 5. The sum of all of the intercept of the graph of y = $f^{-1}(x)$ is

62. In any triangle, if 'A' is the maximum value of $\frac{r^3}{r_1 r_2 r_3}$ then '54A' is equal to

63. The equation $a_1x^2 + a_2y^2 + z^2 + a_3xy + a_4yz + a_5zx + a_6x + a_7y + a_8z + a_9 = 0,$ where $a_i \in Z, i = 1,2,3,4,5,6,7,8,9$ is locus of the point which moves so that its distance from the line x=y=z is twice its distance from the plane x + y+z=1. Then the value of $\sum_{i=1}^{9} a_i$ is

64. If 18 points are arranged in triangular form as shown in figure. The number of triangles formed by these points is abc where abc is three digit number, a, b, c $\in$ z & a $\geq$ 1, b $\geq$ 0, c $\geq$ 0. The value of a + b + c is



65. Consider the determinant $\Delta(x) = \begin{vmatrix} (1+x)^{a_1b_1} & (1+x)^{a_1b_2} & (1+x)^{a_1b_3} \\ (1+x)^{a_2b_1} & (1+x)^{a_2b_2} & (1+x)^{a_2b_3} \\ (1+x)^{a_3b_1} & (1+x)^{a_3b_2} & (1+x)^{a_3b_3} \end{vmatrix}$ where a_1, a_2, a_3, b_1, b_2 & $b_3 \in$ N. Sum of coefficients of x and constant term of $\Delta(x)$ is

66. If $\lim_{x\to 0}\left(\cos x + p^3 \sin q^3 x\right)^{\frac{1}{x}} = e^{\frac{5}{2}}$, then the value of (pq) is

Space for Rough work

SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

---

67. If $z^2 - z + 1 = 0$ then the value of $\sum_{i=1}^{24}(z_i + \frac{1}{z_i})^2$ is equal to

68. A sequence of equilateral triangle is drawn. The altitude of each is $\sqrt{3}$ times the altitude of the preceding traingle, the difference between the area of the first triangle and the sixth triangle is $968\sqrt{3}$ square unit. The perimeter of the first triangle is.

69. If $\Delta(a)$ is the area bounded by $xy^2 = 4a^2(2a - x)$ and its asymptotes then the value of $\Delta\left(S\sqrt{\frac{7}{22}}\right)$ is

Space for Rough work

FIITJEE **JEE(Advanced)-2018**

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CONCEPT RECAPITULATION TEST – III

PAPER-2

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	C	24.	A	47.	D
2.	B	25.	D	48.	A
3.	B	26.	B	49.	A
4.	AD	27.	BCD	50.	ACD
5.	BD	28.	BC	51.	ABC
6.	AB	29.	AD	52.	AC
7.	AC	30.	ABC	53.	BC
8.	ABC	31.	ABC	54.	BC
9.	C	32.	C	55.	C
10.	B	33.	D	56.	B
11.	2	34.	8	57.	7
12.	5	35.	9	58.	2
13.	2	36.	6	59.	0
14.	9	37.	9	60.	1
15.	2	38.	7	61.	5
16.	2	39.	6	62.	6
17.	8	40.	7	63.	7
18.	8	41.	4	64.	9
19.	5	42.	3	65.	0
20.	8	43.	6	66.	8
21.	00772.00	44.	00007.00	67.	00048.00
22.	01057.50	45.	00044.00	68.	00012.00
23.	00200.00	46.	00000.00	69.	00036.00

Physics

PART – I

SECTION – A

1. C

$W = P_0\Delta V = P_0V_0$

and $\Delta U = 2P_0\left(2V_0 - V_0\right) = 2P_0V_0$

$\therefore Q = W + \Delta U = 3P_0V_0$

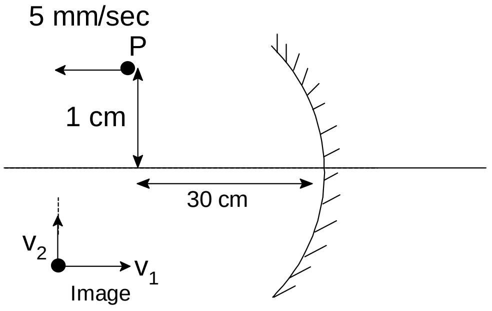
2. B

$T = Ax\rho g\left(x = \text{distance from lower end}\right)$

$\text{Stress} = \frac{T}{A} = x\rho g$

$\Delta\ell = \frac{\rho g\ell^2}{2Y}$

3. B



$\frac{1}{v} + \frac{1}{-30} = \frac{1}{-20}$

$v = -60$

$m = \frac{y_i}{y_0} = -\frac{v}{u}$

$y_i = -2\text{cm}$

for $\vec{v}_1$ $\quad \vec{v}_1 = -\frac{v^2}{u^2}\left(\vec{v}_P\right)$

$= -4\left(-5\right) = 20 \text{ mm / sec}$

for $\vec{v}_2 \Rightarrow \frac{y_i}{y_0} = -\frac{v}{u}$

$y_iu = -y_0v$

on differentiating the equation with respect to time

$$\frac{dy_i}{dt}\left(u\right) + y_i\frac{du}{dt} = y_0\frac{dv}{dt} \qquad \left(\frac{dy_0}{dt} = 0\right)$$

$$\frac{dy_i}{dt}\left(-30\right) + \left(-2\right)\left(-5\right) = -\left(20\right)$$

$$\frac{dy_i}{dt} = 1 \text{mm / sec}$$

$v_i = 20\hat{i} + \hat{j} \text{ mm / sec}$

4. AD

(a) We can easily see that charge q is placed symmetrically to surface ABCD, ABSR and ADQR. Charge q is also placed symmetrically to rest of the surfaces.

If the flux through the surface ABCD is x and through RSPQ is y

Now by Gauss law

$$\frac{q_{in}}{\varepsilon_0} = \phi$$

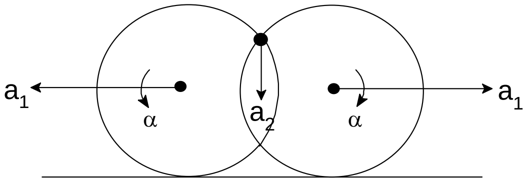
$$\Rightarrow 3x + 3y = \frac{q}{\varepsilon_0}$$

$$\Rightarrow x + y = \frac{q}{3\varepsilon_0}$$

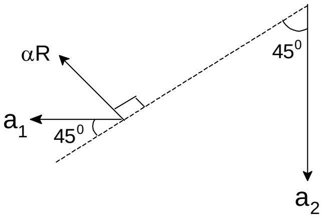
(d) Flux through two surfaces are not same flux via ABCD is larger.

Ans: (a) $\frac{q}{3\varepsilon_0}$ (b) Flux through two surfaces are not same flux via ABCD is larger.

5. BD

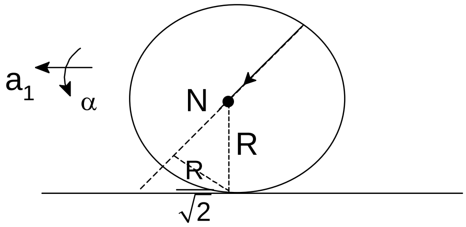


Constraint relation



$$a_1 \cos 45^0 = a_2 \cos 45^0$$

$$\Rightarrow a_1 = a_2 = a$$



$$\frac{NR}{\sqrt{2}} = 2mR^2\left(\frac{a}{R}\right)$$

$N = 2\sqrt{2}ma$ ....(1)

$mg - \sqrt{2}N = ma$ ....(2)

from (1) & (2)

we get $a = \frac{g}{5}$

6. AB

$$E_{ind} = L\frac{di}{dt} = Bv\ell \Rightarrow di = \frac{B\ell}{L},(vdt) = \frac{B\ell}{L}.dx$$

$$\therefore i = \frac{B\ell}{L}.x$$

$$F_{mag} = -Bi\ell = -\frac{B^2\ell^2}{L}.X(\longleftarrow)(\therefore \text{SHM of rod})$$

$$\omega = \sqrt{\frac{B^2\ell^2}{mL}}$$

using SHM equation $v^2 = v_{max}^2 - \omega^2 x^2$

$$\Rightarrow x^2 = \frac{3v_{max}^2}{4\omega^2}$$

$$x = \sqrt{\frac{3J^2L}{4mB^2\ell^2}}$$

$$\therefore i = \frac{B\ell}{L}.x = \sqrt{\frac{3J^2}{4mL}}$$

7. $N - 2mg = 2ma_1$ ....(i)

$N + mg - T = ma_2$ ....(ii)

$T - 3mg = 3ma_3$ ....(iii)

$a_1 = 4$ and $a_2 = a_3 \Rightarrow$ $N = 2mg + 2m$...........(iv)

$\Rightarrow a_2 = 2\ m/s^2$ (by equations)

$\Rightarrow a_{rel} = 2m/s^2 \Rightarrow S_{rel} = \frac{1}{2}a_{rel}t^2 = \frac{1}{2}\times 2\times 1 = 1m.$

$a_3 = 4;\ a_2 = -a_1$

$\Rightarrow T = 3mg + 12m$

by (ii) $N + mg - 3mg - 12m = -ma_1$

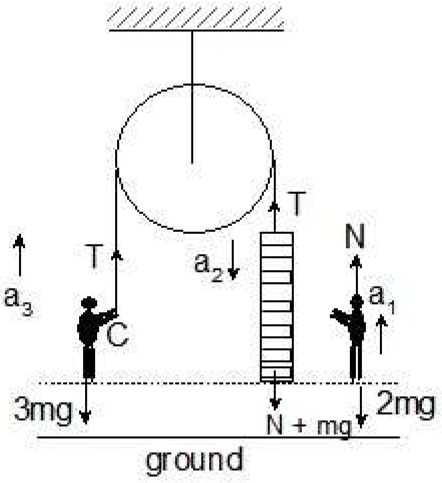
$\Rightarrow N = 2mg + 12m - ma_1$

by (i) $2mg + 12m - ma_1 - 2mg = 2ma_1 \Rightarrow a_1 = 4$

$\Rightarrow a_{rel} = 0 \Rightarrow S_{rel} = 0$

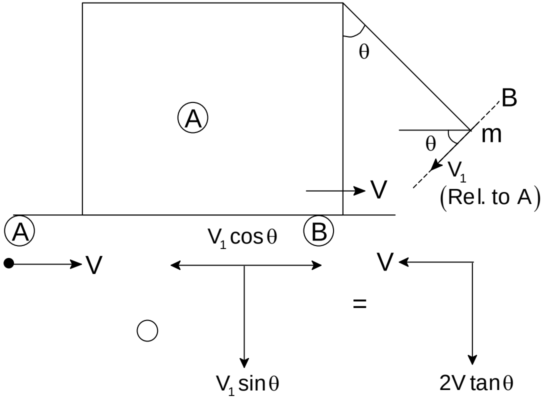
$a_3 = 4; a_1 = 4 \Rightarrow T = 3mg + 12m = ma_2 \Rightarrow 42$

$\Rightarrow a_2 = 4m/s^2$ upward



8. ABC

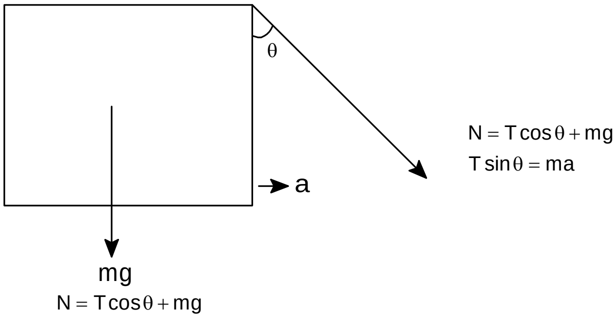
(Sol. 9 & 10)



Applying conservation of linear momentum.

$$mV = m\left(v_1\cos\theta - v\right) \Rightarrow V_1 = \frac{2V}{\cos\theta}\left[V_1 = \frac{2V}{\cos\theta}\right]$$

Applying conservation of mechanical energy

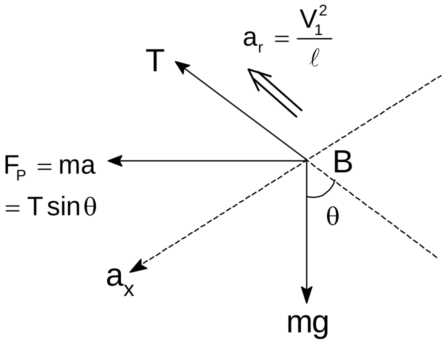


$$mg\ell\cos\theta = \frac{1}{2}mV^2 + \frac{1}{2}m\left(V^2 + 4V^2\tan^2\theta\right)$$

$$= \frac{1}{2}mV^2\left(2 + 4\tan^2\theta\right) = mV^2\left(1 + 2\tan^2\theta\right)$$

$$V = \sqrt{\frac{g\ell\cos\theta}{1 + 2\tan^2\theta}}$$

$$V_1 = 2\sqrt{\frac{g\ell}{\cos\theta\left(1 + 2\tan^2\theta\right)}} = 2\sqrt{\frac{g\ell\cos\theta}{1 + \sin^2\theta}}$$



$T\sin\theta = ma$

Motion B w.r.t. A

$$T + T\sin^2\theta - mg\cos\theta = \frac{mV_1^2}{\ell}$$

$$T\left(1 + \sin^2\theta\right) = mg\cos\theta + \frac{m}{\ell}\left(4.\frac{g\ell\cos\theta}{1 + \sin^2\theta}\right)$$

$$T\left(1 + \sin^2\theta\right) = mg\left(\cos\theta + \frac{4\cos\theta}{1 + \sin^2\theta}\right)$$

$$T\left(1 + \sin^2\theta\right) = mg\cos\theta\left(\frac{5 + \sin^2\theta}{1 + \sin^2\theta}\right)$$

$$T = mg\cos\theta\left(\frac{5 + \sin^2\theta}{\left(1 + \sin^2\theta\right)^2}\right)$$

$$N = T\cos\theta + mg = mg\left(1 + \frac{\cos^2\theta\left(5 + \sin^2\theta\right)}{\left(1 + \sin^2\theta\right)^2}\right)$$

SECTION – C

11. $a_{max} = \omega^2 A_{min} = g$

$$\omega = 2\pi f = \frac{2\pi v}{\lambda}$$

$$v = \sqrt{\frac{F}{\mu}}$$

$$A_{min} = \frac{g}{\omega^2}$$

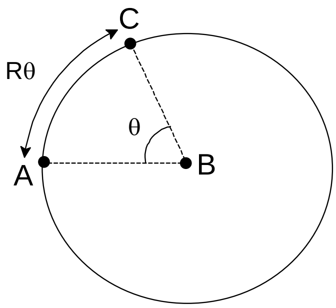
$$= g \times \frac{\mu\lambda^2}{4\pi^2 F} = 2 \times 10^{-3}\,m = 2\,mm$$

12. Energy required to just remove the electron = 13.6 eV
$\therefore$ Energy required = 13.6 + 16.4 =30 eV
If E be the photon energy 25%
E = 30 eV, E = 120 eV = $24 \times 5\,eV$
X = 5

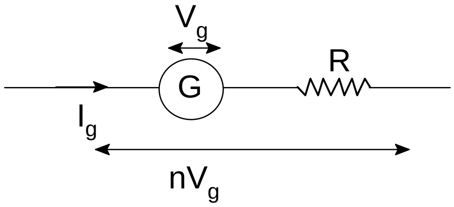
13. Let they meet at C

$$\frac{R}{v} = \sqrt{\frac{2R\theta}{a}}$$

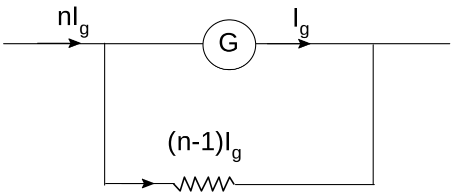
$$v = R\sqrt{\frac{a}{2R\theta}} = \sqrt{\frac{aR}{2\theta}}$$



14.



$$R = \frac{(n-1)V_g}{I_g} = (n-1)\times G$$



$$S = \frac{G}{n-1};\ G = \sqrt{RS}$$

15. Since the angle of E with horizontal and vertical is 45^0, magnitude of Eq and Eq' must be equal.

$$Eq' = k\frac{|q'|}{(2d)^2} = k\frac{|q'|}{4d^2} \qquad Eq = k\frac{|q|}{d^2}$$

$$q' = -4q$$

$$\text{potential of point A } V_A = V' + V = \frac{-k4q}{2d} + k\frac{q}{d} = -k\frac{q}{d}$$

$$= \frac{-q}{4\pi\varepsilon_0 d}$$

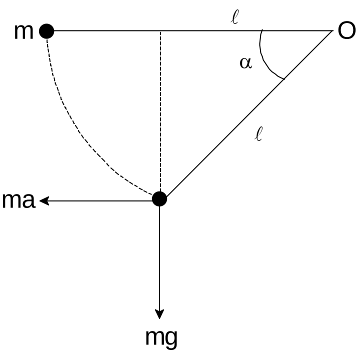
16. Applying W.E. T with respect to O.

$$mg\ell\sin\alpha = ma\ell(1-\cos\alpha)$$

$$\frac{2\sin\frac{\alpha}{2}\cos\frac{\alpha}{2}}{2\sin^2\frac{\alpha}{2}} = \frac{a}{g};\ \cot\frac{\alpha}{2} = \frac{4}{3};\ \tan\frac{\alpha}{2} = \frac{3}{4}$$

the maximum vertical displacement

$$= \ell\sin\alpha = \frac{24\ell}{25} = \frac{48}{25};\ \ell = 2m$$



17. For fluid in tube $\sum F = m\, a_{cm}$

$$\left(P - P_0\right)A = A\ell\rho\omega^2\left(L - \frac{\ell}{2}\right)$$

$$P = P_0 + \ell\rho\omega^2\left(L - \frac{\ell}{2}\right)$$

By applying Bernouli theorem at end of the tube

$$P_0 + \ell\rho\omega^2\left(L - \frac{\ell}{2}\right) = P_0 + \frac{1}{2}\rho v^2$$

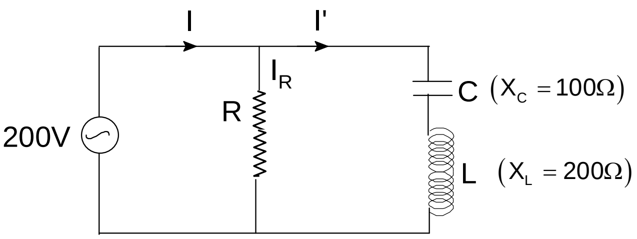
$$v = \sqrt{\frac{2\omega^2\ell^2}{2}\left(\frac{2L}{\ell} - 1\right)} = \omega\ell\sqrt{\frac{2L}{\ell} - 1}$$

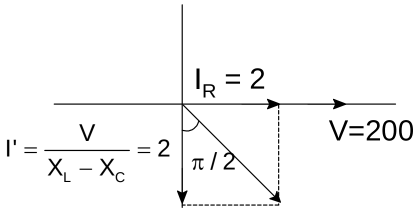
$$= 10 \times 0.4\sqrt{\frac{2\times 1}{0.4} - 1} = 8\text{m}/\text{sec}$$

18. $I_r = \frac{V}{R} = \frac{200}{100} = 2A$

$$I' = \frac{V}{X_L - X_C} = \frac{200}{100} = 2A$$

$$I = \sqrt{i_R^2 + I'^2} = 2\sqrt{2}\text{ Amp.}$$


I
I'
I_R
R
200V
C $\left(X_C = 100\Omega\right)$
L $\left(X_L = 200\Omega\right)$


$I_R = 2$
V=200
$I' = \frac{V}{X_L - X_C} = 2$
$\pi/2$

19. The F.B.D. of wire PQ is

The force due to surface tension = F_{ST} = 2T × 2 AD $\tan\theta$

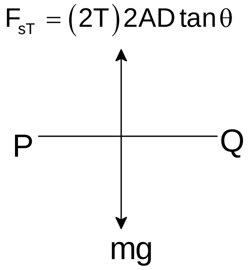

$F_{ST} = (2T)2AD\tan\theta$
P
Q
mg

Figure (a)

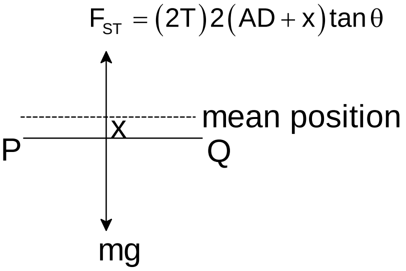

$F_{ST} = (2T)2(AD + x)\tan\theta$
mean position
x
P
Q
mg

Figure (b)

For wire to be in equilibrium (Figure (a))

$4T\ AD\ \tan\theta = mg$ ....(i)

If the wire PQ is at a distance x below the mean position, the restoring force on the wire is (Figure (b))

$$-ma = 4T\tan\theta\left(AD + x\right) - mg = 4T\tan\theta x$$

Hence the wire PQ executives SHM

$a = -\frac{4T}{m}\tan\theta x$

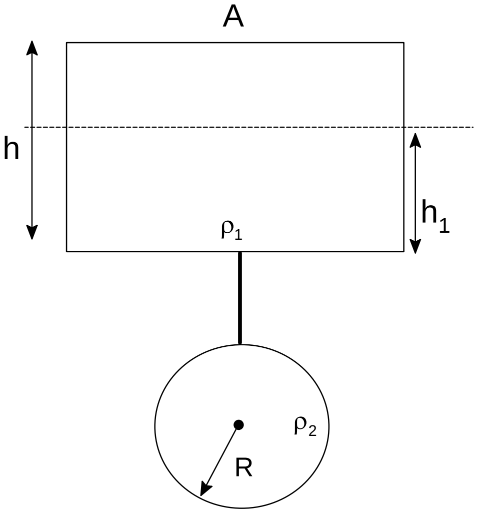
comparing with $a = -\omega^2 x$ we get

$\omega^2 = \frac{4T}{m}\tan\theta$

or $T = 2\pi\sqrt{\frac{m}{4T\tan\theta}} = 2\pi\sqrt{\frac{1\times10^{-3}}{4\times25\times10^{-3}}} = \frac{\pi}{5}s$

20. $\frac{4}{3}\pi R^3.\rho_2.g + Ah.\rho_1 g = \frac{4}{3}\pi R^3.\rho_W.g + Ah_1.\rho_w g$

$\rightarrow = \left[\frac{3A(h_1\rho_w - h\rho_1)}{4\pi(\rho_2 - \rho_w)}\right]^{1/3}$



Using values

A = 11 cm^2; h$_1$ = 4 cm; $\rho_w = 1\,gm/cm^3$;

$\rho_1 = 0.5\ gm/cm^3$; $\rho_2 = 8gm/cm^3$

$R = \left[\frac{3\times11(4\times1-6\times0.5)}{4\times\left(\frac{22}{7}\right)\times(8-1)}\right] = \left(\frac{3}{8}\right)^{1/3}$ cm

$\Rightarrow R^3 = \frac{3}{8}$

SECTION – D

21. Rate of formation of nuclei at time t is

$\frac{dN}{dt} = \alpha - \lambda N$, where N = number of nuclei at that time.

$N = \frac{\alpha}{\lambda}(1-e^{-\lambda t})$

Number of nuclei disintegrated in time t, $\left[\alpha t - \frac{\alpha}{\lambda}(1-e^{-\lambda t})\right]$

$\therefore$ Energy released till time t, $E = E_0 N_d = E_0\left[\alpha t - \frac{\alpha}{\lambda}(1-e^{-\lambda t})\right]$

20% of this energy is used for heating water,

$0.2E_0\left[\alpha t - \frac{\alpha}{\lambda}(1-e^{-\lambda t})\right] = ms\Delta\theta$

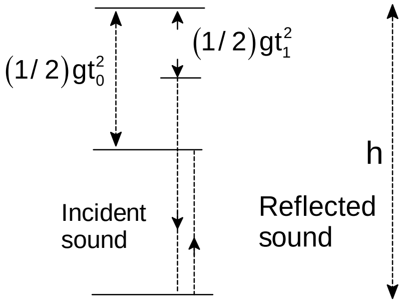
$\Delta\theta = \frac{0.2E_0\left[\alpha t - \frac{\alpha}{\lambda}(1-e^{-\lambda t})\right]}{ms}$

At $t = T_{1/2}$

$\Delta\theta = \frac{0.2E_0\left[2\lambda T_{1/2} - \frac{2\lambda}{\lambda}\left(1-\frac{1}{2}\right)\right]}{ms}$

$\Delta\theta = \frac{0.2E_0[0.386]}{ms} = 772K$

22. Let the sound observed by the parachutist at t_0 = 12s be produced at t_1s. velocity of source at the instant of emitting sound = gt_1 and velocity of observer at the instant of observing same sound = gt_0. Hence the relation between apparent frequency f' and original frequency f will be



$$f' = f\left(\frac{v+gt_0}{v-gt_1}\right)$$

Here $f = 800\text{Hz}, g = 10\text{m}/\text{s}^2, v = 330\ \text{m}/\text{s},$

$t_0 = 12\text{s}$ and $f' = 800 + 700 = 1500\text{Hz}$

Putting these, we get

$t_1 = 9\text{s}$

Now the distance traveled by sound in $(t_0 - t_1)$ sec

is $v(t_0 - t_1) = \left(h - \frac{1}{2}gt_0^2\right) + \left(h - \frac{1}{2}gt_1^2\right)$

Putting the values, we get

$h = 1057.5\ \text{m}$

23. $2mg - Ax\rho g - T = 2ma$ ....(i)

$T - mg = ma$ ...(ii)

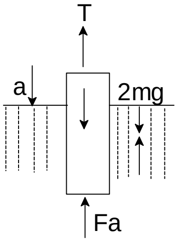
From (i) and (ii) $\Rightarrow mg - Ax\rho g = 3ma \Rightarrow a = \frac{g}{3} - \frac{A\rho x}{3m}g = k_1 - k_2x$

$v\frac{dv}{dx} = k_1 - k_2x$, where $k_1 = \frac{g}{3}$ and $k_2 = \frac{\rho gA}{3m}$

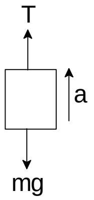
$\Rightarrow \int_0^0 vdv = \int_0^L (k_1 - k_2x)dx$

$\Rightarrow 0 = k_1L - \frac{k_2L^2}{2}$

$\Rightarrow \frac{g}{3} = \frac{A\rho g}{3m}.\frac{L}{2} \Rightarrow \rho = \frac{2m}{AL}$



F.B.D. of 2m



F.B.D of m

Chemistry

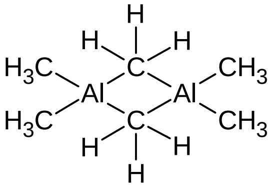
PART – II

SECTION – A

24. Correct balanced equation is:

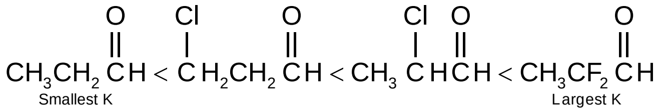
$$2MnO_4^- + 5H_2O_2 + 6H^+ \longrightarrow 2Mn^{+2} + 5O_2 + 8H_2O$$

25. A, B, C are correct statements



has banana bond

26.



$$\underset{\text{Smallest K}}{CH_3CH_2}\overset{O}{\overset{\|}{C}}H < \overset{Cl}{\overset{|}{C}}H_2CH_2\overset{O}{\overset{\|}{C}}H < CH_3\overset{Cl}{\overset{|}{C}}H\overset{O}{\overset{\|}{C}}H < \underset{\text{Largest K}}{CH_3CF_2}\overset{O}{\overset{\|}{C}}H$$

27. In acidic medium nucleophilicity of enol decide the rate of reaction, but in basic medium stability of enolate decide the rate of reaction.

28. (A) not reducing: an acetal ending in “oside”
(B) reducing: a hemiacetal ending in ose
(C) reducing: one of ring has a hemiacetal
(D) not reducing: all anomeric carbons are in acetal form

29.

$$\left.\begin{array}{l}\left[Cr(CN)_6\right]^{-3}\\ \left[Mn(CN)_6\right]^{-3}\\ \left[Fe(CN)_6\right]^{-3}\\ \left[Co(CN)_6\right]^{-3}\end{array}\right\downarrow$$

Synergic bonding

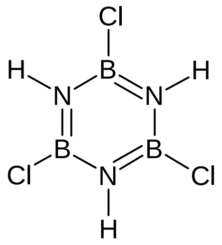
due to more e^- in d orbital

30. A (after combination) ⇒ 0.5 M NH_3 + 0.5 M CH_3COOH
B (after combination) ⇒ 0.5 M HCO_3^- + 0.5 M CO_3^{-2}
C (after combination) ⇒ 0.5 M CH_3COO^- + 0.5 M CH_3COOH

31. A → NGP
B → NGP
C → NGP

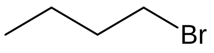
32. $B_3N_3H_6$ is called borazine. Borazon is the cubic form of $(BN)_x$

33. Structure of $B_3N_3Cl_3H_3$

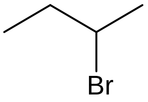

Cl
H
B
N
H
N
B
B
Cl
N
Cl
H

SECTION – C

34. Monobrominated products are

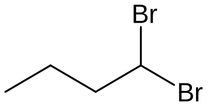


(1)

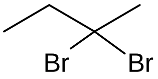


(d/l)
(2)

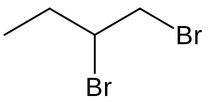
Dibrominated products are



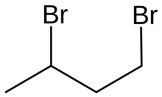
(1)



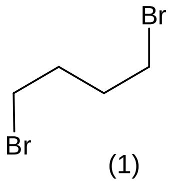
(1)



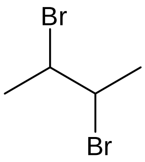
(d/l)
(2)



(d/l)
(2)



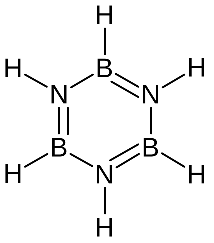
(1)



(d/l/Meso)
(3)

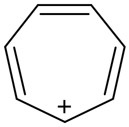
All d/l pairs are optically active.

35.

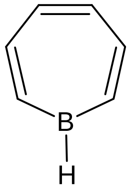

H
H
N
B
N
H
B
B
H
N
H
H

Borazine(aromatic)

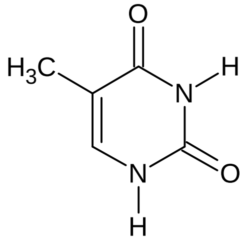
Graphite (aromatic)



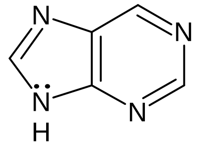
(aromatic)



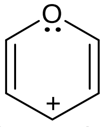
(aromatic)



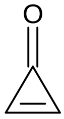
(aromatic)



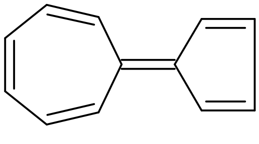
(aromatic)



(aromatic)



(aromatic)



(aromatic)

36. A, B, C, D, F, G show mutarotation because these molecules have OH group on anomeric (at least one) carbon.

37. all are more basic than NH_3 (in water)

38. A, B, C, D, E, F, G, I are optically active H is optically inactive (it has plane of symmetry)

39. $Ni^{+2} \rightarrow a$
$Ni^{+3} \rightarrow 0.98 - a$
then

$$a \times (+2) + (0.98 - a)(+3) - 2 \times 1.00 = 0$$
$$2a + 2.94 - 3a - 2 = 0$$
$$-a - 0.94 = 0$$
$$a = 0.94$$
$$\text{\% of } Ni^{+2} = \frac{0.94}{0.98} \times 100 \approx 96$$
$$\text{\% of } Ni^{+3} \approx 4$$
$$\text{Now } \frac{x}{4y} = \frac{96}{4 \times 4} = 6$$

40. $$\Delta T = \frac{1000 \times K_b \times w}{m \times W}$$
$$0.01 = \frac{1000 \times 0.5 \times w}{180 \times 100}$$
$$w = 0.36g$$
$\therefore$ no of molecules of glucose in 0.36 g = $(6.023 \times 10^{23} \times 0.36)/180$
= 1.2×10^{21} molecule

Hence $\frac{x}{3} = \frac{21}{3} = 7$

41. $$NaOH \Rightarrow Na^+ \ {}^-O - H$$
$$Na_2O_2 \Rightarrow 2Na^+ \ {}^-O - O^-$$
$$BaO_2 \Rightarrow Ba^{+2} \ {}^-O - O^-$$
$$Na_2S_2 \Rightarrow 2Na^+ \ {}^-S - S^-$$

42. yellow ppt: AgBr, $PbCrO_4$, PbI_2

43. I, II, III, IV, V & VII are correct
VI is incorrect, correct order is $Cl_2 > Br_2 > F_2 > I_2$

SECTION – D

44. $$C_{v,m} = \frac{\Delta U}{n\Delta T} = \frac{40 \times 8.314\ J}{2 \times 8\ mol\,K} = \frac{5}{2}R$$
$$C_{P,m} = \frac{7}{2}R \ \& \ \gamma = \frac{7}{5}$$
Reversible adiabatic process

$$P_1V_1^{\gamma} = P_2V_2^{\gamma}$$

$$\frac{P_1}{P_2} = \left(\frac{V_2}{V_1}\right)^{\gamma} = (32)^{\frac{7}{5}} = 2^7$$

$$\log\left(\frac{P_1}{P_2}\right) = 7\log 2 = x\log 2$$

$$\therefore x = 7$$

45. $$\frac{M_{eq}}{M_{initial}} = \left(\frac{1}{1+\alpha}\right)$$

$$M_{eq} = \frac{60}{1.2} = 50$$

$$V.D_{eq} = y = 25$$

After adding Ne(g)

$$M_{mix} = \frac{0.6\times 50 + 0.4\times 20}{1}$$

$$= 30 + 8$$

$$V.D_{eq} = z = \frac{38}{2} = 19$$

$$\therefore y + z = 44$$

46. (b) 2 radial nodes so can't be of 2s-orbital
(c) Ψ depends on 'θ' so can't be of s orbital
(d) no radial nodes for given Ψ, so can't be of 2s orbital
So only 'a' could be correct and at $r = 2a_0$: $\Psi = 0 \Rightarrow \Psi^2 = 0$ i.e. probability = 0

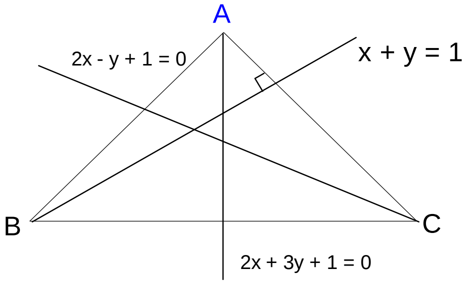
Mathematics PART – III

SECTION – A

47. maximum number of trials = 20 + 19 + … + 2 + 1 = $\frac{20\times 21}{2} = 210$

48. Now, Arranging the lines in decreasing order of their slopes, we get
$L_1 = 3x - y + 1 = 0$; $L_2 = x - y + 5 = 0$; $L_3 = 2x + y - 3 = 0$
tanA = $\frac{3-1}{1+3} = \frac{1}{2}$
tanB = -3
tanC = 1
the required cubic equation
(x – 1/2) (x + 3) (x–1) **=** 0
(2x – 1) (x + 3) (x–1) **=** 0

49. Slope of AC = - 1



Let slope of BC = m
Then $\left|\frac{2-1}{1+2}\right| = \left|\frac{m-2}{1+2m}\right| \Rightarrow m = 7$
Let equation of BC is y = 7x + C
So $B = \left(\frac{1-C}{8}, \frac{7+C}{8}\right), C \equiv \left(\frac{1-C}{5}, \frac{7-2C}{5}\right)$
Mid point of BC lie on 2x + 3y + 1 = 0
So $C = \frac{379}{59}$

50. Eg. x + y + z = 1
x + y + z = 2
x + y + z = 3
here $\Delta = \Delta_x = \Delta_y = \Delta_z = 0$ and equation have no solution.

51. $S = \left(n^2 - n + 2\right)2^n - 1$

52. f ′ (x) = 0 ⇒ (sin x + cos x) (non zero quantity) = 0
⇒ tan x = – 1 ⇒ x = 3π/4 or 7π/4 .
Global Min = x = 2 n π + (3π/4) ; global max = x = 2 n π + (7π/4)
M = $\frac{4}{8-\sqrt{2}}$; m = $\frac{2\sqrt{2}}{4\sqrt{2}+1}$]

53. One root is 2.

54. point of intersection of diagonal which are inside the polygon is ${}^{10}C_4 = 210$
Points on the polygon is 10 but each point is point of intersection of 21 pair of diagonals.
Points outside the polygon = ${}^{{}^{10}C_2 - 10}C_2 - 10.{}^{7}C_2 - {}^{10}C_4$
= 175

(Sol. Q. 55-56)

let $\int_0^{\frac{\pi}{2}} \sin t g(t) dt$ = A
So g(x) = (1-2A)cosx
Finally, g(x) = cosx/2

SECTION – C

57. $xg'(x) = g(x) + px^{p-1}$
It's a first order linear differential equation.
$$g(x) = \frac{p}{p-2}x^{p-1} - \frac{2}{p-2}x$$
So p= 3 or 4

58. p_1 and p_2 are roots of $f'(x) = 0$

59. S = 0

60. normal at (t, t^2) is $2t(y - t^2) = -x + t$.
Passes through $(0, \frac{3}{2})$

61. A one to one function and its inverse are symmetric across the line y = x. Thus x and y intercept are interchanged and the sum is the same i.e. 5.

62. Minimum value of $\frac{r_1 r_2 r_3}{r^3}$ is 9

63. locus is $x^2 + y^2 + z^2 + 5xy + 5yz + 5zx - 4x - 4y - 4z + 2 = 0$

64. ${}^{18}C_3 - {}^{7}C_3 - {}^{7}C_3 - {}^{7}C_3 = 711$

65. constant term = $\Delta(0) = 0$
Coefficient of x = $\Delta'(0) = 0$

66. $$\lim_{x \to 0} \frac{\cos x + p^3 \sin 2^3 x - 1}{x} = e^{\frac{5}{2}}$$
$$\lim_{x \to 0} \frac{p^3 \sin q^3 x - 2\sin^2 \frac{x}{2}}{x} = \frac{5}{2}$$
By L′hospital rule
$p^3 q^3 = 2^4 \Rightarrow pq = 8$

SECTION – D

67. $z = -\omega$ or $-\omega^2$, also $(z^3 + \frac{1}{z^3})^2 = 4$ etc

$\Rightarrow$ 32 + 16 = 48

68. Let the altitude of the 1st $\Delta = h$
altitude of the 2nd $\Delta = \sqrt{3}h$
altitude of the 3rd $\Delta = 3h$ etc.
now side of the 1st Δ is 'a_1' = $\frac{2h}{\sqrt{3}}$

$\therefore$ $a_2 = 2h$

$a_3 = 2\sqrt{3}\,h$

|||ly $a_6 = 18h$

perimeter = 12 Ans.

69. $\Delta(a) = 4\pi a^2$

FIITJEE **JEE (Main)-2018**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - III

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 – 30, 31 – 60, 61 – 90)** *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

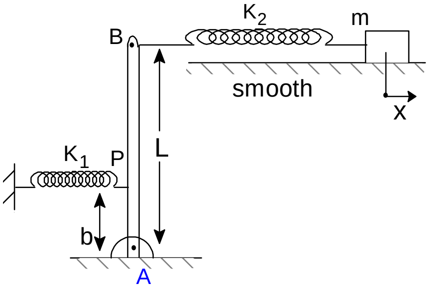
Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A massless Rod AB is hinged at point A. At point P, it is connected by a spring of stiffness K_1 and at point B it is connected to another spring of stiffness K_2 connected to mass m as shown in figure. The length of Rod AB is ℓ and point P is at a distance b from point A. if mass m is displaced by a distance x from its mean position as shown in figure then the time period of S.H.M. of mass is



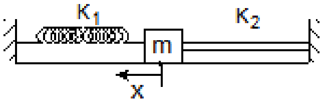
(A) $2\pi\sqrt{\frac{m\left(K_2b^2+K_1L^2\right)}{K_1K_2b^2}}$

(B) $2\pi\sqrt{\frac{m\left(K_2L^2+K_1b^2\right)}{K_1K_2b^2}}$

(C) $2\pi\sqrt{\frac{m\left(K_1K_2b^2\right)}{K_2b^2+K_1L^2}}$

(D) $2\pi\sqrt{\frac{m\left(K_2L^2+K_1b^2\right)}{K_2b^2}}$

2. A block of mass m is connected to an ideal spring of stiffness K_1 on left hand side and to an elastic string of stiffness K_2 on right hand side as shown in figure. The time period of motion if mass m is displaced by 'x' as shown in figure.



(A) $2\pi\sqrt{m/K_1}$

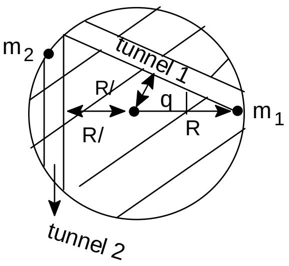
(B) $2\pi\sqrt{m/\left(K_1+K_2\right)}$

(C) $2\pi\sqrt{m\left(K_1+K_2\right)/K_1K_2}$

(D) $\pi\left(\sqrt{\frac{m}{K_1+K_2}}+\sqrt{\frac{m}{K_1}}\right)$

Space for Rough work

3. Two mass m_1 & m_2 are initially placed at rest inside two smooth tunnels in earth as shown in the figure. The minimum distance between the tunnels and the center of earth is R/2 as shown in the figure. Then



(A) m_1 will remain at rest and m_2 will perform SHM with

$$T.P._2 = 2\pi\sqrt{\frac{R}{2g}}$$

(B) m_1 will remain at rest and m_2 will perform SHM with

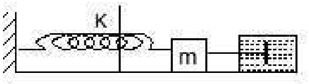
$$T.P._2 = 2\pi\sqrt{\frac{R}{g}}$$

(C) m_1 & m_2 both will perform S.H.M with same time period of

$$2\pi\sqrt{\frac{R}{g}}$$

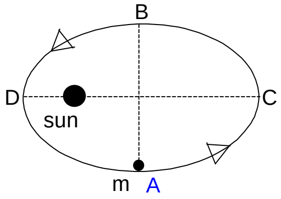
(D) m_1 will remain at rest and m_2 will move down to other side of tunnel then move outside the earth tunnel.

4. For a damped oscillator which follow the equation $\vec{F} = -K\vec{x} - b\vec{V}$ the mass of the block is 100gm K = 100 N / M and the damping constant is 20 gm / sec. Then find the time taken for its mechanical energy to drop to one – fourth of its initial value.



(A) 1.73
(B) 3.46
(C) 6.93
(D) 13.84

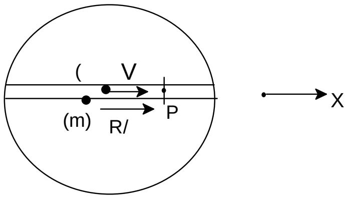
5. A planet of mass m moves in an elliptical orbit around sun with sun at its Focus. (e = eccentricity of ellipse). Then T_{ACB}/T_{BDA} is [T_{ACB} is time taken to travel from A to C to B & T_{BDA} is time taken to travel from B to D to A]



(A) $(\pi + 2e)/(\pi - 2e)$
(B) 1
(C) $(\pi + e)/(\pi - e)$
(D) $\pi/(\pi - 1)$

Space for Rough work

6. An object of mass is projected from center of earth along a smooth tunnel dug along the horizontal diameter as shown in the figure. Then choose the condition on values of v for the object to cross P at least twice.



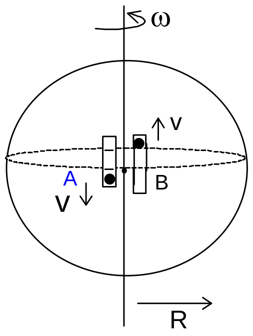
(A) $\frac{\sqrt{gR}}{2} < V < \sqrt{gR}$

(B) $\left(\sqrt{gR}\right) < V < \sqrt{3gR}$

(C) $\sqrt{gR}\,/\,2 < V < \sqrt{3gR}$

(D) $\sqrt{gR}\,/\,4 < V < \sqrt{3gR}$

7. Two trains A and B each of mass m are moving on a longitude of a spherical planet of mass M and radius R with velocity v relative to the planet. Train A & B presses the rail track with forces N_A & N_B respectively. [ω is angular velocity of planet about its vertical axis]Then



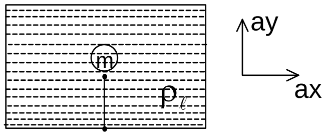
(A) $N_A = N_B = \frac{GmM}{R^2} - m\omega^2 R$

(B) $N_A = \frac{GmM}{R^2} - m\omega^2 R + \frac{mv^2}{R}$

(C) $N_B = \frac{GmM}{R^2} - m\omega^2 R - \frac{mv^2}{R}$

(D) $N_B = \frac{GmM}{R^2} + m\omega^2 R - \frac{mv^2}{R}$

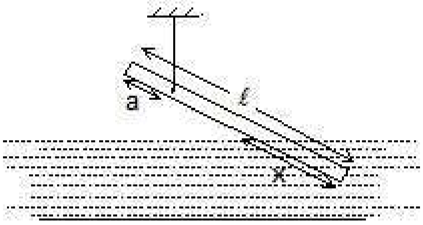
8. A mass m of volume V = 10cm^2 is tied with a string to the base of a container filled with a liquid of density $\left(P_\ell = 10^3 kg / m^3\right)$ as shown in the figure. The container is then accelerated with acceleration (a_x = 9 m /s^2) and (a_y = 2 m /s^2) s shown in the figure. [$g = 10\left(\frac{m}{s^2}\right)$ acceleration due to gravity] The net buoyancy force acting on the mass is



(A) 10N
(B) 12N
(C) 15N
(D) 9N

Space for Rough work

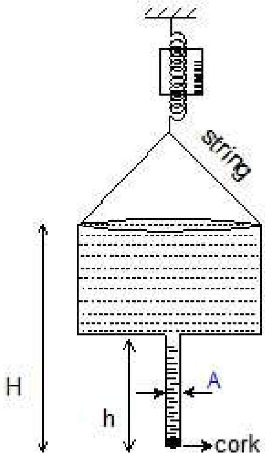
9. One end of a uniform stick having length ℓ = 1m is hung from a string as shown in figure. Length a = 20cm is above the point of suspension. The length of the stick below the surface of water is $\left[\rho_{stick} / \rho_{liquid} = 0.25\right]$



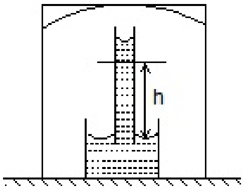
(A) x = 0.1 m
(B) x = 0.15 m
(C) x = 0.2 m
(D) x = 0.25 m

10. A vessel completely filled with water is suspended with help of strings from a spring balance as shown in figure. A cork is plugged at the bottom of the vessel. If the initial reading of the spring balance is W_0. Then the reading of the spring balance just after the cork is removed and the liquid begins to flow out will be [ρ = density of liquid & A = cross – sectional area of narrow pipe]

(A) $W_0 + \rho gHA$ (B) $W_0 + 2\rho gHA$
(C) $W_0 - \rho gHA$ (D) $W_0 - 2\rho gHA$



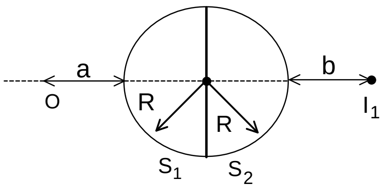
11. A capillary tube of inner radius r = 5mm is covered in a container with a liquid whose vapour pressure is negligible. The density of the liquid is ρ = 1000 kg / m^3. The container and the tube are in vacuum condition. The pressure inside liquid in the capillary tube at a height h = 20 cm as shown in figure is [g = 10 m / s^2]



(A) $+2000\,\text{N/m}^2$ (B) $-2000\,\text{N/m}^2$
(C) $\left(10^5 - 1000\right)\frac{\text{N}}{\text{m}^2}$ (D) $\left(10^5 - 2000\right)\frac{\text{N}}{\text{m}^2}$

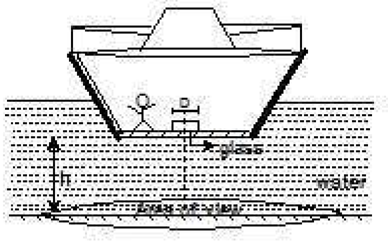
Space for Rough work

12. An object O kept a distance a = 10 cm from the surface of a glass hemisphere S_1 of radius R. S_2 is another glass hemisphere kept side by side of same radius R = 5cm as shown in figure. I_1 is the image formed due to object O (b = 6cm). Now, if S_2 is removed and S_1 is kept at the same place and its flat surface is silvered. Then find the distance I_1I_2. (where I_2 is image formed by silvered S_1 only). (μ glass = 3/2)



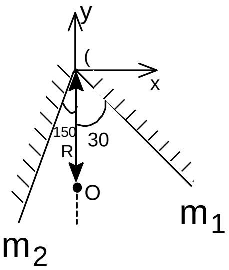
(A) 10 cm (B) 12 cm
(C) 11 cm (D) 22 cm

13. A glass slab of diameter D = 20 cm is made at the base of a ship as shown in figure. Diameter of glass slab is much larger than the thickness of the glass slab. The area 'S' of the field of view at the sea bottom if $\mu_{water} = 4/3$, $\mu_{glass} = 3/2$ & the depth of sea base below the slab is $h = \sqrt{7}m$ is



(A) $9\pi\ m^2$ (B) $\left(\frac{88}{5}\right)m^2$
(C) $\frac{1408}{17}m^2$ (D) $\frac{\pi}{100}m^2$

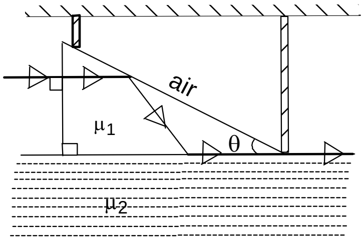
14. Two plane mirrors intersect at origin. An object 'O' is kept at a distance R on negative y axis as shown in the figure. The co – ordinates of images formed after three reflections will be (first reflection is considered at m_1)



(A) $\left(-R/2,+\sqrt{3}R/2\right)\left(-R,0\right)\&\left(+\sqrt{3}R/2,+R/2\right)$
(B) $\left(-\sqrt{3}R/2,+R/2\right)\left(+R,0\right)\&\left(+\frac{R}{\sqrt{2}},+\frac{R}{\sqrt{2}}\right)$
(C) $\left(\sqrt{3}R/2,-R/2\right)\left(-R,0\right)\&\left(+R/2,+\sqrt{3}R/2\right)$
(D) $\left(\frac{-R}{\sqrt{2}},\frac{R}{\sqrt{2}}\right)\left(+R,0\right)\&\left(+\frac{R}{2},+\sqrt{3}\frac{R}{2}\right)$

Space for Rough work

15. A right angled triangular prism of refractive index μ_1 is kept floating on a liquid (surface) having refractive index μ_2. The condition such that light incident normally passes through base of prism as shown in figure.



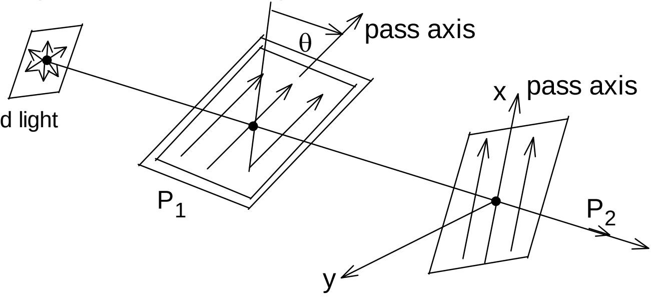
(A) $\mu_1 = \text{Cos}2\theta / \text{Cos}\theta$
(B) $\mu_2 = \text{Cos}2\theta / \text{Cos}\theta$
(C) $\mu_1 = \text{Sin}2\theta / \text{Cos}\theta$
(D) $\mu_2 = \text{Sin}2\theta / \text{Sin}\theta$

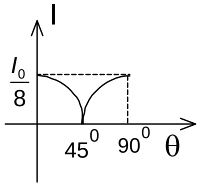
16. If $E = E_0 \sin(kz - \omega t)$ and $B = B_0(kz - \omega t)$ are electric and magnetic field produced by an electromagnetic wave travelling in +z direction in a medium. Then if $\eta = \frac{E_0}{B_0}$, then the value of η is

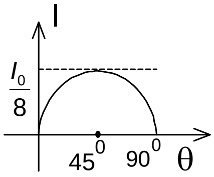
[μ = permeability of a medium, ε = permittivity of medium]

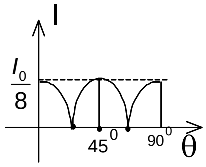
(A) $\sqrt{\in}/H$
(B) $\sqrt{\mu/\in}$
(C) $\sqrt{\mu\in}$
(D) $\frac{1}{\sqrt{\mu\in}}$

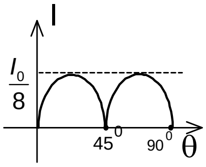
17. If an polarised light of intensity $I_0/2$ is passed through two polariods P_1 and P_2 as shown in figure. Then the intensity of light observed by an observer on other side of P_2 (if the polaroid P_1 is rotated clockwise) as a function of angle θ



(A)


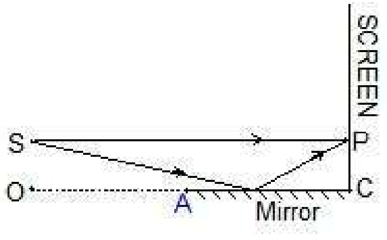
(B)


(C)


(D)


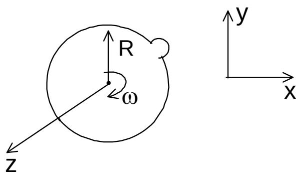
Space for Rough work

18. In a Lyod's mirror set up for interference of waves of frequency $6\times10^{14}s^{-1}$ emitted from point source S. Distance SO, OA & AC are 1mm, 50 cm and 50 cm respectively, Then the number of dark and bright fringes obtained on the screen will be
(A) Dark = 4 , Bright = 4
(B) Dark = 4 , Bright = 5
(C) Dark = 5 , Bright = 4
(D) Dark = 5 , Bright = 5



19. A point source of sound is vibrating with a frequency of 256 vibrations per second in air and propogating energy uniformly in all directions at the rate of 5 joules per second. Calculate the amplitude of the wave at a distance of 25 m from the source. Assume non–dissipative medium [c = 330 m / s & density of air = 1.29 kg / m^3]
(A) 0.8×10^{-2}m (B) 0.8×10^{-8}m
(C) 10^{-6}m (D) 10^{-4}m

20. A small pulse is generated on a ring rotating with a constant angular velocity ω as shown in the figure. Then the speed of pulse with respect to ground
(A) ωR (B) ωR/2
(C) 2ωR (D) zero



21. A sound detector is moving with a constant velocity towards a stationary sound source. The source emits a beep of sound of frequency f = 262 Hz that propogates with speed c = 330 m/s. The detector detects the beep of sound over a distance L = 78 m and registers a frequency f = 275 Hz. Find duration of the beep emitted by the source.
(A) 2s (B) 4s
(C) 5s (D) 6s

22. Two boats are anchored a distance 'd' apart in a sea, where seabed is at a uniform depth of D and consists of a flat rock bed. If a gun is fired at a boat, in how much time will the firing be heard at the other boat? (Given: speed of sound in air is v_a, in the water is v_w and in the rock is v_r)
(A) d/v_a (B) $2D/v_w + d/v_r$
(C) $\dfrac{dv_w + 2D\sqrt{v_r^2 - v_w^2}}{v_r v_w}$ (D) $\dfrac{d}{v_r} + \left(\dfrac{2Dv_r}{\sqrt{v_r^2 - v_w^2}}\right)\times\dfrac{1}{v_w}$

Space for Rough work

23. If photoelectrons emitted by a metal on irradiating it by a light of wave length λ cannot move away farther than a distance 'd' in presence of a retarding electric field E, find threshold wavelength of the metal

(A) $\lambda c / eEd$
(B) $\lambda + \frac{hc}{eEd}$
(C) $\lambda - \frac{hc}{eEd}$
(D) $\left[\frac{1}{\lambda} - \frac{eEd}{hc}\right]^{-1}$

24. A narrow beam of monochromatic light of wavelength λ emitted from a source of power P is propogating in the positive x–direction. After being reflected from a perfectly reflecting plane mirror of area vector $\vec{A} = A\left(-\hat{i} - \hat{j}\right)$, the beam falls on a metal plate of surface area A [$\vec{A}$ is along outward normal at mirror]. The force exerted by light beam on the mirror is $\vec{F}$ and $\Delta\vec{p}$ is change in momentum of each photon then[c is speed of light in vaccuum]

(A) $\Delta\vec{F} = \frac{P}{c}\left(\hat{i} + \hat{j}\right), \Delta\vec{p} = \frac{h}{\lambda}\left(-\hat{i} - \hat{j}\right)$
(B) $\Delta\vec{F} = \frac{P}{c}\left(\hat{i} + \hat{j}\right), \Delta\vec{p} = \frac{h}{\lambda}\left(\hat{i} + \hat{j}\right)$
(C) $\Delta\vec{F} = \frac{P}{c}\left(-\hat{i} - \hat{j}\right), \Delta\vec{p} = \frac{h}{\lambda}\left(-\hat{i} - \hat{j}\right)$
(D) $\Delta\vec{F} = \frac{P}{c}\left(-\hat{i} - \hat{j}\right), \Delta\vec{p} = \frac{h}{\lambda}\left(+\hat{i} + \hat{j}\right)$

25. A hydrogen molecule in excited state travelling in the x–direction with kinetic energy of 1.0 eV dissociate into two hydrogen atoms. If one of them moves perpendicular to the x–direction with a kinetic energy 1eV, then the energy released in the dissociation reaction will be

(A) 2.6 eV
(B) 2eV
(C) 3.6 eV
(D) 3 eV

26. Two resistors of resistance $R_1 = \left(6 \pm 0.09\right)\Omega$ and $R_2 = \left(3 \pm 0.09\right)\Omega$ are connected in parallel. The equivalent resistance R with error (in Ω)

(A) $R = \left(2 \pm 0.04\right)$
(B) $R = \left(2 \pm 0.05\right)$
(C) $R = \left(9 \pm 0.18\right)$
(D) $R = \left(2 \pm 0.18\right)$

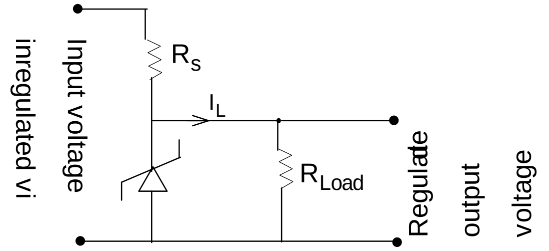
Space for Rough work

27. The diameter of a solid sphere is measured by vernier calipers (10 VSD = 9 MSD) and (1 MSD = 1 mm) the reading of main scale is 20 & Vernier scale reading is 1. The volume of sphere will be

(A) $4.23\,cm^3$ (B) $4.25\,cm^3$

(C) $4.232\,cm^3$ (D) $4.253\,cm^3$

28. In a zener diode (dc voltage regulator) circuit with V_{zener} = 7.0 V is used for regulation. The load current is to be 4.0 mA and the unregulated input is 11.0 V. What should be the value of series resistor R_S if zener diode current is five times the load current



(A) 120Ω (B) 167Ω

(C) 180Ω (D) 200Ω

29. Photo diodes are preferable used in reverse bias condition for measuring light intensity because

(A) Current in reverse bias is less which is easier to measure compared to higher currents in forward bias

(B) High fractional change due to photo effects in minority carrier dominated reverse bias current is more easily measurable than the high fractional change in the forward bias current

(C) Low fractional change due to photo–effects in minority carries dominated reverse bias current is more easily measurable than the high fractional change in the forward bias current

(D) Current is zero in reverse bias set–up

30. A transmitting antenna at the top of a tower has a height 64m and the height of the receiving antenna is 100 m. The maximum distance between them for satisfactory communication in LOS mode will be {approximately}

(A) 45.5 km (B) 91 km

(C) 136.5 km (D) 182.0 km

Space for Rough work

Chemistry

PART – II

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. Which of the following statements about photochemical smog is wrong?
(A) it has high concentration of oxidizing agents
(B) it has low concentration of oxidizing agents
(C) it can be controlled by controlling the release of NO_2, hydrocarbons, ozone etc
(D) plantation of some plants like pinus helps in controlling photochemical smog

32. Compound which is added to soap to impart antiseptic properties is
(A) sodium laurylsulphate
(B) sodium dodecylbenzenesulphonate
(C) Rosin
(D) Bithional

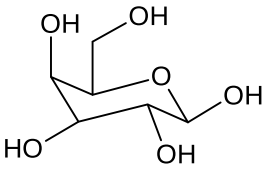
33. 1.0 mole of Fe reacts completely with 0.65 mole of O_2 to give a mixture of only FeO and Fe_2O_3. The mole ratio of ferrous oxide to ferric oxide is
(A) 2 : 2
(B) 4 : 3
(C) 1 : 2
(D) 2 : 7

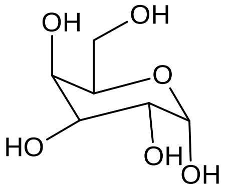
34. Gold number of haemoglobin is 0.03. Hence, 100 ml of gold sol will require haemoglobin so that gold is not coagulated by 10 ml of 10% NaCl solution
(A) 0.03 mg
(B) 30 mg
(C) 0.30 mg
(D) 3 mg

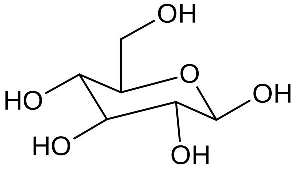
35. Which of the following statement is not true regarding rayon?
(A) it is pure regenerated cellulose
(B) it is obtained by dissolving wood pulp in alkaline CS_2
(C) it is obtained by passing Na – salt of cellulose Xanthate through spinneret into aqueous $NaHCO_3$ solution
(D) it is extracted as fibres of cellulose

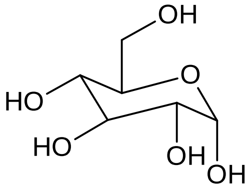
Space for Rough work

36. Galactose is epimeric with glucose at C4. Which of the following structures represents β-D-galactopyranose?

(A)


(B)


(C)


(D)


37. Iodate ions can be reduced to iodine by iodide ions as per the given redox reaction in acidic medium

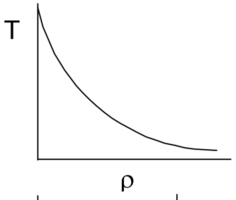
$IO_3^-(aq)+I^-(aq)\longrightarrow I_2(S)$.

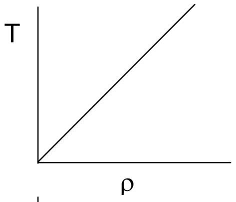
How many moles of iodine are produced for every mole of iodate ions consumed in the reaction?

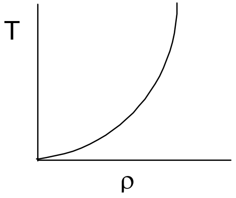
(A) 1 (B) 2.5

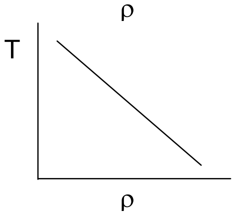
(C) 3 (D) 5

38. Which of the following is a graph of the relation of the density (ρ) of a gas sample to the absolute temperature keeping constant pressure

(A)


(B)


(C)


(D)


Space for Rough work

39. If m_p and m_α are masses of proton and α-particles, find ratio of momentum of a proton and an α-particle which are accelerated from rest by a potential difference of 200 V

(A) $\frac{m_p}{2m_\alpha}$ (B) $\frac{2m_\alpha}{m_p}$

(C) $\sqrt{\frac{m_p}{2m_\alpha}}$ (D) $\sqrt{\frac{2m_p}{m_\alpha}}$

40. Consider the cell $Ag\left|AgBr(s)Br^-\right|\left|AgCl(s)Cl^-\right|Ag$ at 298 K. The solubility product of AgCl and AgBr are 1×10^{-10} and 5×10^{-13} respectively. What should be the ratio of concentration of Br^- and Cl^- by which emf of the cell becomes zero?

(A) 200 (B) $\frac{1}{200}$

(C) $\frac{1}{300}$ (D) none of these

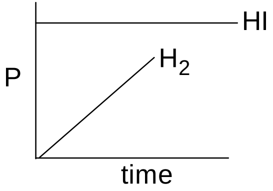
41. Calculate the entropy change for vaporization of water if latent heat of vaporization for water is 2.26 kJ/gram. The K_b for H_2O is 0.51 K/molality.

(A) 26.33 cal/mole (B) 23.33 cal/mole

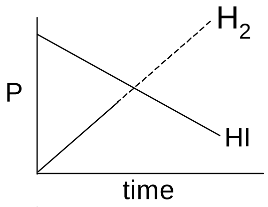
(C) 1 KJ/mole (D) 30 cal/mole

42. Which of the following plot of pressure (P) Vs time satisfy decomposition of HI on gold surface

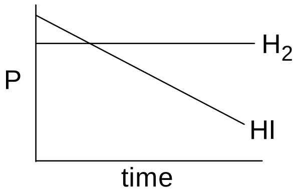
(A)



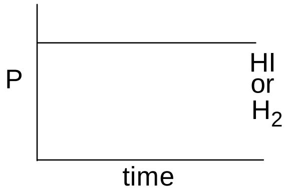
(B)



(C)

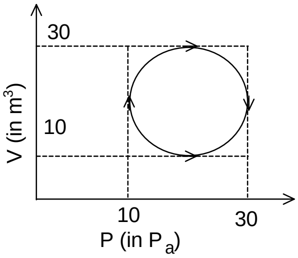


(D)



Space for Rough work

43. A system works under cyclic process as follows



Heat absorbed during the process is

(A) $\frac{22}{7}\times10^{2}\,J$ (B) $\frac{22}{7}\times10^{3}\,J$

(C) $\frac{22}{7}\times10^{4}\,J$ (D) $\frac{22}{7}\times10^{5}\,J$

44. Which of the following statement is correct about the cyclic silicate $[Si_6O_{18}]^{n-}$?

(A) the value of n is 12
(B) each Si atom is bonded with three oxygen atoms
(C) each oxygen atom is bonded with two Si atoms
(D) all of these

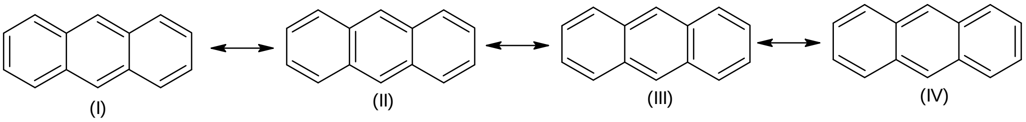
45. Ores of calcium are

(A) gypsum, colmanite, hydrolith (B) quick lime, limestone, pearl ash
(C) quick lime, fluorapatite, feldspar (D) carnallite, pearl ash, feldspar

46. Find the incorrect statement

(A) $TiH_2 > CaH_2 > BeH_2$, order of electrical conductance
(B) CsH > NaH > LiH, order of ionic character of hydrides
(C) $H_2 > D_2 > F_2$, order of bond dissociation enthalpy
(D) $NaH > MgH_2 > H_2O$, order of reducing character

47. The correct stability order of given resonating structure is

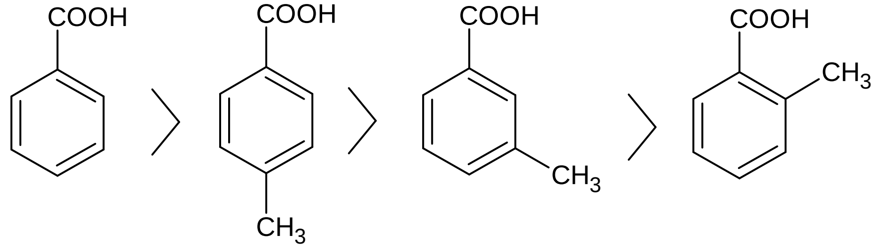


(A) I = II = III = IV (B) IV > III > II > I
(C) I > II > III > IV (D) II = III > I = IV

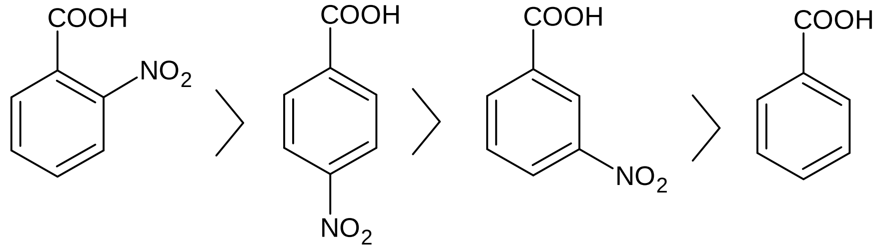
Space for Rough work

48. Find the incorrect order of acidic strength of following

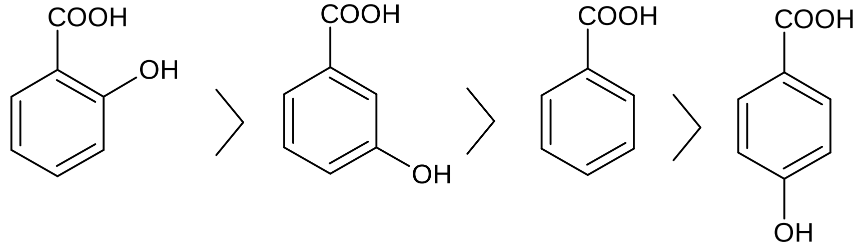
(A)



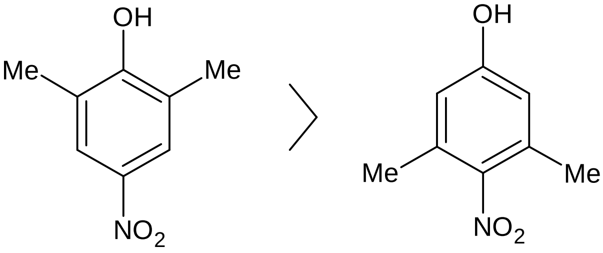
(B)



(C)

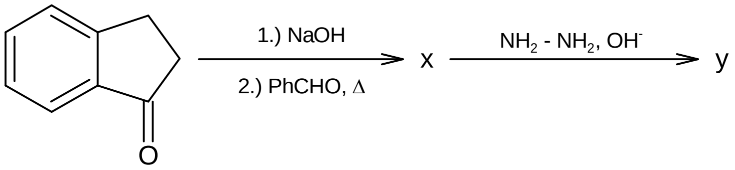


(D)

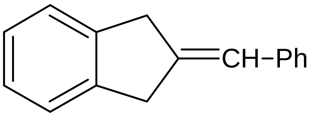


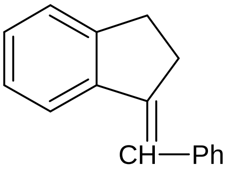
Space for Rough work

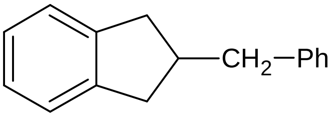
49.

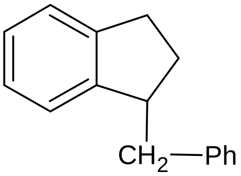

1.) NaOH
2.) PhCHO, Δ
x
NH2 - NH2, OH-
y
O

Product y is

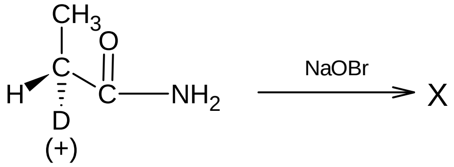
(A)


(B)


(C)


(D)


50.


CH3
O
H
C
C
NH2
D
(+)
NaOBr
X

X is

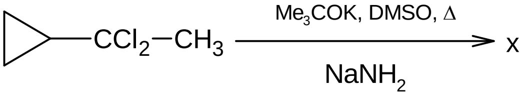
(A) $(-)CH_3-CHD-NH_2$

(B) $(+)CH_3-CHD-NH_2$

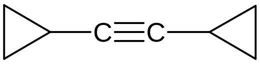
(C) $(\pm)CH_3-CHD-NH_2$

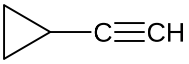
(D) $(+)\overset{Br}{C}H_3-CHD-NH_2$

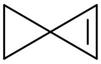
51.

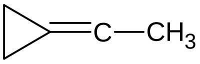

CCl2—CH3
Me3COK, DMSO, Δ
NaNH2
x

Product x is

(A)


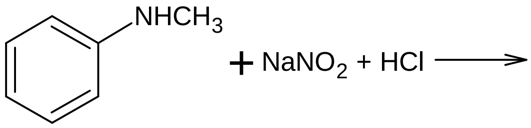
(B)


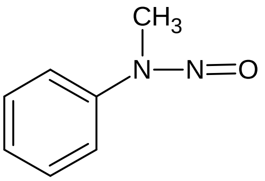
(C)


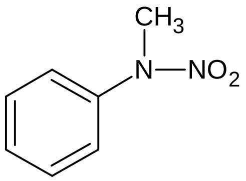
(D)


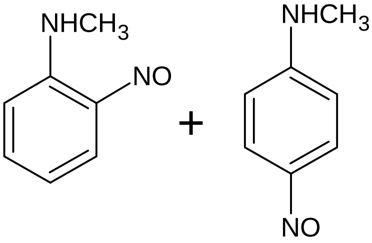
Space for Rough work

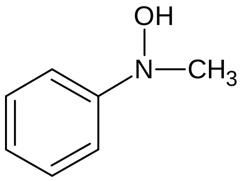
52. Predict the product


NHCH3
+ NaNO2 + HCl

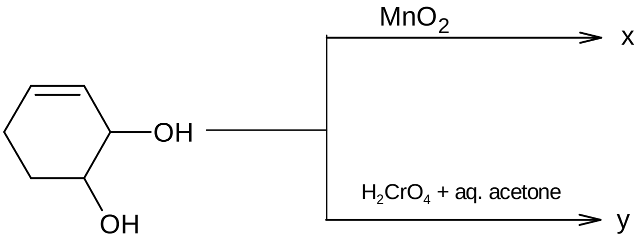
(A) 

(B) 

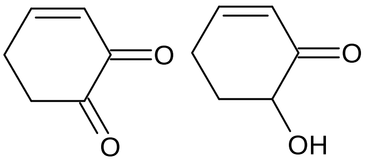
(C) 
NHCH3
NO
+
NHCH3
NO

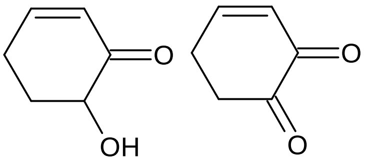
(D) 

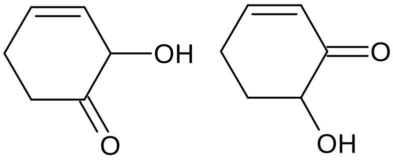
53.

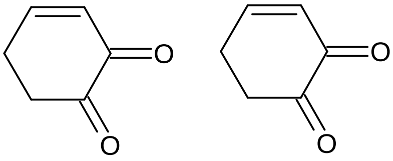

MnO2
x
OH
OH
H2CrO4 + aq. acetone
y

The compounds x and y are

(A) 

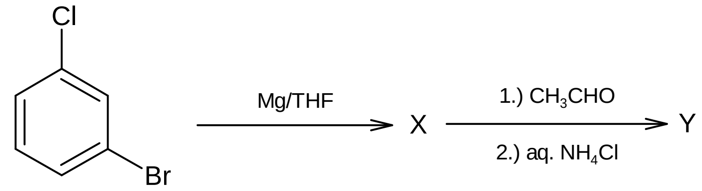
(B) 

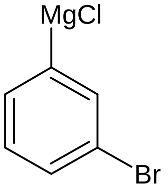
(C) 

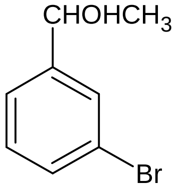
(D) 

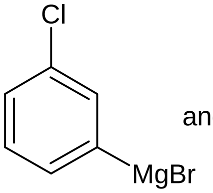
Space for Rough work

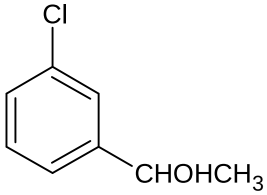
54. What are x and y in the following reaction?

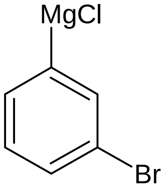

Cl
Br
Mg/THF
X
1.) CH₃CHO
2.) aq. NH₄Cl
Y

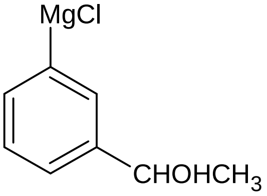
(A)


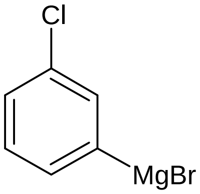
and


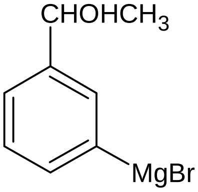
(B)


and


(C)


and

MgCl
CHOHCH₃

(D)


and

CHOHCH₃
MgBr

55. An acid base indicator has $K_a = 1.0 \times 10^{-5}$. The acid form of the indicator is red and the basic form is blue. Calculate the pH change required to change the colour of the indicator from 80% red to 80% blue.

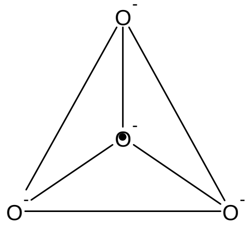
(A) 1.20 (B) 0.80
(C) 0.20 (D) 1.40

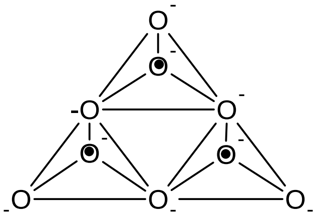
Space for Rough work

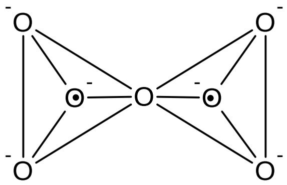
56. For 8 : 8 coordinated CsCl structure, how many Cs^+ ions occupy the second-nearest neighbour locations of a Cs^+ ion?
(A) 8 (B) 24
(C) 6 (D) 12

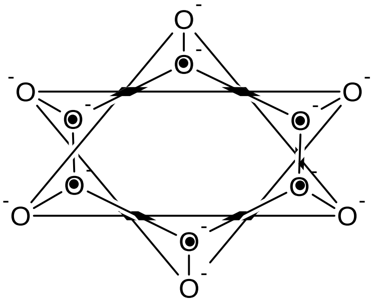
57. CO_3^{2-} and SO_3^{2-} can be distinguished from each other by the production of CO_2 and SO_2 respectively upon using
(A) Baryta water (B) Lime water
(C) acidified dichromate (D) sulphamic acid

58. Which of the following represents a pyrosilicate structure?

(A)


(B)


(C)


(D)


59. Nessler's reagent is used to detect NH_3. This reagent is prepared by mixing
(A) KI (excess) + $HgCl_2$ + KOH (B) KCl + HgI_2 + KOH
(C) KI (excess) + $HgCl_2$ + $NH_4^+OH^-$ (D) KI (excess) + Hg_2Cl_2 + I_2 solution

60. Ferrocene is a compound of
(A) one Fe^{2+} and two $C_5H_5^-$ ions (B) Two Fe^{2+} and two $C_5H_5^-$ ions
(C) one Fe^{3+} and two $C_5H_5^-$ ions (D) Two Fe^{3+} and six $C_5H_5^-$ ions

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. The range of the function $f(x) = \sqrt{4-x^2} + \sqrt{x^2-1}$ is

(A) $\left[\sqrt{3}, \sqrt{7}\right]$ (B) $\left[\sqrt{3}, \sqrt{5}\right]$

(C) $\left[\sqrt{2}, \sqrt{3}\right]$ (D) $\left[\sqrt{3}, \sqrt{6}\right]$

62. If the variable line $y = kx + 2h$ is tangent to an ellipse $2x^2 + 3y^2 = 6$, then locus of $P(h, k)$ is a conic C whose eccentricity equals

(A) $\frac{\sqrt{5}}{2}$ (B) $\sqrt{\frac{7}{3}}$

(C) $\frac{\sqrt{7}}{3}$ (D) $\sqrt{2}$

63. The number of solution(s) of the equation $z^2 = 4z + |z|^2 + \frac{16}{|z|^3}$ is

(A) 0 (B) 1

(C) 2 (D) 3

64. The area of the region bounded by the curve $C : y = \frac{x+1}{x^2+1}$ and the line $L : y = 1$, is

(A) $1 - \frac{1}{2}\ln 2 + \frac{\pi}{4}$ (B) $\ln 2 - \frac{\pi}{4} + 1$

(C) $\frac{1}{2}\ln 2 + \frac{\pi}{4} - 1$ (D) $\ln 2 - \frac{\pi}{2} + 1$

Space for Rough work

65. The solution set of inequality $(\cot^{-1}x)(\tan^{-1}x) + \left(2-\frac{\pi}{2}\right)\cot^{-1}x - 3\tan^{-1}x - 3\left(2-\frac{\pi}{2}\right) > 0$, is

(A) $x \in (\tan 2, \tan 3)$
(B) $x \in (\cot 3, \cot 2)$
(C) $x \in (-\infty, \tan 2) \cup (\tan 3, \infty)$
(D) $x \in (-\infty, \cot 3) \cup (\cot 2, \infty)$

66. Number of solutions of the equation tan x + sec x = 2 cos x in $(-\pi, 2\pi)$, is

(A) 1
(B) 2
(C) 3
(D) 4

67. Inside the unit circle $S = \{(x, y) \mid x^2 + y^2 = 1\}$ there are three smaller circles of radius equals to a, tangent to each other and to S. The value of a equals

(A) $\sqrt{2}\left(\sqrt{2}-1\right)$
(B) $\sqrt{3}\left(2-\sqrt{3}\right)$
(C) $\sqrt{2}\left(2-\sqrt{3}\right)$
(D) $\sqrt{2}\left(2-\sqrt{3}\right)$

68. If [x] and {x} denotes respectively, the greatest integer function less than or equal to x and fractional part function, then the number of real x, satisfying the equation $(x-2)[x] = \{x\} - 1$, is

(A) 0
(B) 1
(C) 2
(D) infinite

69. If $g(x) = \int_1^x e^{t^2}\,dt$ then the value of $\int_3^{x^3} e^{t^2}\,dt$ equals

(A) $g(x^3) - g(3)$
(B) $g(x^3) + g(3)$
(C) $g(x^3) - 3$
(D) $g(x^3) - 3g(x)$

70. For $\theta \in \left(0, \frac{\pi}{2}\right)$, the value of definite integral $\int_0^{\theta} \ln\left(1+\tan\theta\tan x\right)dx$ is equal to

(A) $\theta\, ln(\sec\theta)$
(B) $\theta\, ln(\text{cosec}\,\theta)$
(C) $\frac{\theta \ln 2}{2}$
(D) $2\theta\, ln \sec\theta$

71. If r, s are the roots of $a_0 + a_1x + a_2x^2 = 0$ ($a_0, a_1, a_2 \in R$ and $a_2 \neq 0$), then the equality $a_0 + a_1x + a_2x^2 = a_0\left(1-\frac{x}{r}\right)\left(1-\frac{x}{s}\right)$ holds

(A) for all values of x, $a_0 \neq 0$
(B) only when x = 0
(C) only when x = r or x = s
(D) only when x = r or x = s, $a_0 \neq 0$

Space for Rough work

72. The position vectors of vertices of ΔABC are (1, –2), (– 7, 6) and $\left(\frac{11}{5}, \frac{2}{5}\right)$ respectively. The measure of the interior angle A of the triangle is

(A) acute and lies in (75°, 90°)
(B) acute and lies in (60°, 75°)
(C) acute and lies in (45°, 60°)
(D) obtuse

73. Consider the graphs of $y = Ax^2$ and $y^2 + 3 = x^2 + 4y$, where A is a positive constant and $x, y \in R$. Number of points in which the two graphs intersect, is

(A) exactly 4
(B) exactly 2
(C) at least 2 but the number of points varies for different positive values of A.
(D) zero for atleast one positive A.

74. If $a^2 + b^2 + c^2 + ab + bc + ca \leq 0$, a, b, c $\in$ R then value of the determinant

$$\begin{vmatrix} (a+b+2)^2 & a^2+b^2 & 1 \\ 1 & (b+c+2)^2 & b^2+c^2 \\ c^2+a^2 & 1 & (c+a+2)^2 \end{vmatrix}$$

(A) 65
(B) $a^2 + b^2 + c^2 + 31$
(C) $4(a^2 + b^2 + c^2)$
(D) 0

75. Let $f'(x) = e^{x^2}$ and $f(0) = 10$ and $A < f(1) < B$ can be concluded from the Mean Value Theorem then largest value of (A – B) equals

(A) e
(B) 1 – e
(C) e – 1
(D) 1 + e

76. Water is dropped at the rate of 2m^3/sec. into a cone of semi-vertical angle 45°. The rate at which periphery of water surface changes when height of the water in the cone is 2 meter, is

(A) 2 m/sec.
(B) 1 m/sec.
(C) 3m/sec.
(D) 4 m/sec.

77. Let S denote sum of the series $\frac{3}{2^3} + \frac{4}{2^4 \cdot 3} + \frac{5}{2^6 \cdot 3} + \frac{6}{2^7 \cdot 5} + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\infty$. Compute the value of S^{-1}.

(A) 8
(B) 6
(C) 4
(D) 2

Space for Rough work

78. Two loaded dice each have the property that 2 or 4 is three times as likely to appear as 1, 3, 5 or 6 on each roll. When two such dice are rolled, the probability of obtaining a total of 7, is

(A) $\frac{1}{8}$ (B) $\frac{1}{7}$

(C) $\frac{7}{50}$ (D) $\frac{7}{25}$

79. A line passes through the point $A\left(\hat{i}+2\hat{j}+3\hat{k}\right)$ and is parallel to the vector $\vec{V}=\left(\hat{i}+\hat{j}+\hat{k}\right)$. The shortest distance from the origin, of the line is

(A) $\sqrt{2}$ (B) $\sqrt{4}$

(C) $\sqrt{5}$ (D) $\sqrt{6}$

80. If z is a complex number satisfying the equation $\left|z - (1+i)\right|^2 = 2$ and $\omega = \frac{2}{z}$, then the locus traced by 'ω' in the complex plane is

(A) $x - y - 1 = 0$ (B) $x + y - 1 = 0$

(C) $x - y + 1 = 0$ (D) $x + y + 1 = 0$

81. Let a and b be positive numbers not equal to 1 and $\frac{3\pi}{2}<\theta<2\pi$. If $a^{\tan\theta} > b^{\tan\theta} > 1$, then which one of the following is always **TRUE**?

(A) a > b > 1 (B) a < b < 1

(C) b < a < 1 (D) b > a > 1

82. If the equation $(x^2 + a|x| + a + 1)(x^2 + (a + 1)|x| + a) = 0$ has no real root, then the range of values of 'a' is

(A) (0, 1) (B) (–∞, 0)

(C) (0, ∞) (D) (–1, 0)

83. The area of the triangular region in the first quadrant bounded on the right by the y-axis, bounded above by the line 7x + 4y = 168 and bounded below by the line 5x + 3y = 121, is

(A) $\frac{50}{3}$ (B) $\frac{52}{3}$

(C) $\frac{53}{3}$ (D) 17

Space for Rough work

84. If p_1, p_2 are the roots of the quadratic equation $ax^2 + bx + c = 0$ and q_1, q_2 are the roots of the quadratic equation $cx^2 + bx + a = 0$ ($a, b, c \in R$) such that p_1, q_1, p_2, q_2 are in A.P. of distinct terms, then $a + c - 1$ equals

(A) – 1 (B) 1

(C) $\frac{1}{2}$ (D) 2

85. The locus of the middle point of the chord of the circle $x^2 + y^2 = 1$ such that the segment of the chord on the parabola $y = x^2 - x$ subtends a right angle at the origin, is a circle whose centre and radius respectively are

(A) (1, 1) and $\sqrt{2}$ (B) (1, 1) and 2

(C) $\left(\frac{1}{2}, \frac{1}{2}\right)$ and $\frac{1}{2}$ (D) $\left(\frac{1}{2}, \frac{1}{2}\right)$ and $\frac{1}{\sqrt{2}}$

86. If the roots of the equation $x^2 + 6x + l = 0$ are real and distinct and they differ by atmost 4, then the sum of all possible integral value(s) of l, is

(A) 16 (B) 26

(C) 36 (D) 35

87. A convex polygon has 44 diagonals. The polygon is

(A) 9 sided (B) 10 sided

(C) 11 sided (D) 12 sided

88. A class has three teachers, Mr. P, Ms. Q and Mrs. R and six students A,B,C,D,E,F. Number of ways in which they can be seated in a line of 9 chairs, if between any two teachers there are exactly two students, is k(6!) then the value of k is

(A) 18 (B) 12

(C) 24 (D) 6

89. Sixteen players $S_1, S_2, S_3, \ldots\ldots, S_{16}$ play in a tournament. Number of ways in which they can be grouped into eight pairs so that S_1 and S_2 are in different groups, is equal to

(A) $\frac{(14)!}{2^6 \cdot 6!}$ (B) $\frac{(15)!}{2^7 \cdot 7!}$

(C) $\frac{(14)!}{2^7 \cdot 6!}$ (D) $\frac{(14)!}{2^6 \cdot 7!}$

90. Find the minimum value of the expression $E = |z|^2 + |z - 3|^2 + |z - 6i|^2$ (where $z = x + iy$, $x, y \in R$).

(A) 10 (B) 20

(C) 30 (D) 40

Space for Rough work

FIITJEE **JEE(Main)-2018**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

CONCEPT RECAPITULATION TEST – III

(Main)

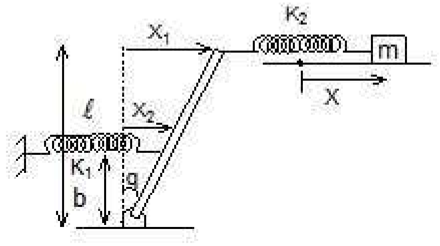
Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**B**	31.	**B**	61.	**D**
2.	**D**	32.	**D**	62.	**B**
3.	**C**	33.	**B**	63.	**B**
4.	**C**	34.	**C**	64.	**C**
5.	**A**	35.	**B**	65.	**B**
6.	**C**	36.	**A**	66.	**B**
7.	**C**	37.	**C**	67.	**B**
8.	**C**	38.	**A**	68.	**D**
9.	**A**	39.	**C**	69.	**A**
10.	**D**	40.	**B**	70.	**A**
11.	**B**	41.	**A**	71.	**A**
12.	**D**	42.	**B**	72.	**A**
13.	**A**	43.	**A**	73.	**A**
14.	**C**	44.	**A**	74.	**A**
15.	**B**	45.	**A**	75.	**B**
16.	**B**	46.	**C**	76.	**B**
17.	**D**	47.	**D**	77.	**D**
18.	**C**	48.	**A**	78.	**C**
19.	**C**	49.	**A**	79.	**A**
20.	**D**	50.	**B**	80.	**A**
21.	**C**	51.	**B**	81.	**B**
22.	**C**	52.	**A**	82.	**C**
23.	**D**	53.	**B**	83.	**A**
24.	**A**	54.	**B**	84.	**A**
25.	**D**	55.	**A**	85.	**D**
26.	**B**	56.	**C**	86.	**B**
27.	**B**	57.	**C**	87.	**C**
28.	**B**	58.	**C**	88.	**A**
29.	**B**	59.	**A**	89.	**A**
30.	**B**	60.	**A**	90.	**C**

Physics

PART – I

SECTION – A

1. $\frac{X_2}{b}=\frac{X_1}{\ell}\longrightarrow(1)$



Torque equation about Hinge

$K_2\left(x-x_1\right).\ell=K_1x_2.b\longrightarrow(2)$

Substituting X₂ from equation (1) & on Solving we get

$$X_1=\frac{K_2L^2x}{\left[K_2L^2+K_1b^2\right]}$$

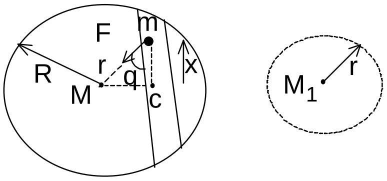
Equation of mass $F=ma=-K_2\left(x-x_1\right)$

On solving = $a=\frac{-K_1K_2b^2x^2}{m\left(K_2L^2+K_1b^2\right)}$

2. $T=\frac{T_{Left}}{2}+\frac{T_{Right}}{2}=\pi\sqrt{\frac{m}{K_1+K_2}}+\pi\sqrt{\frac{m}{K_1}}$

Note string becomes slack when mass pushes the string

3. $F_{net/c}=\frac{-GmM^1}{r^2}\cos\theta$



$$ma=-\frac{GmM}{\frac{4\pi R^3}{3}}\frac{4\pi}{3}\cdot\frac{r^3x}{r^2r}$$

$a=-\frac{GmM}{mR^3}x \quad or\ \omega=\sqrt{\frac{GM}{R^3}}=\sqrt{\frac{g}{R}}$

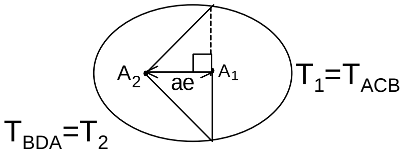
$\therefore$ T.P. in any earth tunnel is $T=2\pi\sqrt{R/g}$

4. $E=\frac{1}{2}KA^2.-\left(bt/m\right)$

$\therefore\frac{1}{4}=\frac{E\left(t=t\right)}{E\left(t=0\right)}=e^{-bt/m}$

Taking log and solving we get $t=\frac{2\times0.693}{b/m}=6.93\,\text{sec}$

5. $\because\frac{dA}{dt}=c\left[kepler's\,2nd\,law\right]$



$$\therefore\frac{T_1}{T_2}=\frac{A_1}{A_2}=\frac{\frac{\pi ab}{2}+\frac{1}{2}\times2b\times ae}{\frac{\pi ab}{2}-\frac{1}{2}\times2b\times ae}$$

$or\ \frac{T_1}{T_2}=\frac{\left(\pi+2e\right)}{\left(\pi-2e\right)}$

6. $$\frac{mv_E{}^2}{2}\frac{-3}{2}\frac{GmM}{R}=0\left[for\ escape\ velocity\ V_E\right]$$

$$V_E=\sqrt{3gR}$$

For S.H.M in tunnel $\left[\omega=\sqrt{g/R}\right]$

$$V_{Max}=\omega A=\left(\sqrt{\frac{g}{R}}\right)\frac{R}{2}=\frac{\sqrt{gR}}{2}$$

7. $$N_A=N_B=\frac{GmM}{R^2}-m\omega^2R-\frac{mv^2}{R}$$

$$\left(\frac{GmM}{R^2}-m\omega^2R-N_A=\frac{mv^2}{R}\right)$$

8. $$F_B=\sqrt{F_{B/x}{}^2+F_{B/y}{}^2}$$

$$F_B=\sqrt{\left[V\rho_\ell\left(g+a_y\right)\right]^2+\left[V\rho_\ell a_x\right]^2}$$

$$=10\times10^{-4}\times10^3\sqrt{(12)^2+(9)^2}=15N$$

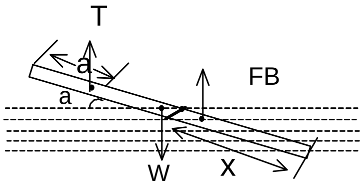
9. $$\tau_{net}=0\left[about\ point\ of\ suspension\right]$$

$$F_B\left(\ell-a-\frac{x}{2}\right)\cos\alpha=w\left(\frac{\ell}{2}-a\right)\cos\alpha$$

Putting $F_B=Ax\rho_\ell$ & $W=A\ell\rho_s$

$$x=\left(\ell-a\right)\pm\sqrt{\left(\ell-a\right)^2-\frac{\rho_\ell}{\rho_0}\ell\left(\ell-2a\right)}=0.1m$$

Since x < (ℓ - a), discard '+' sign in the solution



10. Momentum of water following out of the tube in time Δt = Δp = $\rho Av^2\Delta t$ where $v=\sqrt{2gH}$

$$\therefore F\Delta t=\Delta p=\rho Av^2\Delta t$$

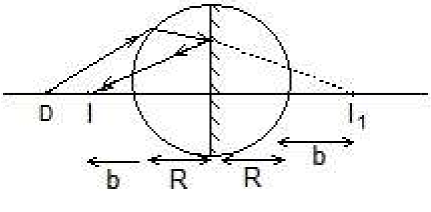
$$or\ F=\rho Av^2=2\rho gHA$$

∴ Reading of spring balance = $W_0-2\rho g\,HA$

11. $$P=P_{liquid\ surface}-\rho gh$$

$= 0-\rho gh$ = -2000 N / m^2

12. From symmetry $I_1I_2=2\left(b+R\right)=2\left(6+5\right)=22cm$



13. $$\sin\alpha=\frac{1}{\mu g}$$

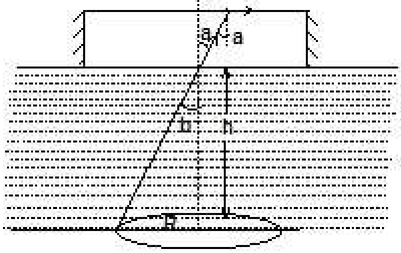
$$\mu_w\sin\beta=\mu_g\sin\alpha$$

$$\text{or } \mu_w \sin\beta = \mu_g \times \frac{1}{\mu_g} = 1$$

$$\beta = \sin^{-1}\left(\frac{1}{\mu_w}\right)$$

$$\therefore A_{base} = \pi R^2 = \pi h^2 \tan^2\beta = \frac{\pi h^2}{\left(\mu_w^{\,2}-1\right)}\left[\because \tan\beta = \frac{1}{\sqrt{\mu_w^{\,2}-1}}\right]$$

$$= 9\pi . m^2$$



14. $$I_{3R} = \left(-\frac{\sqrt{3}R}{2}, \frac{R}{2}\right) \& \left(\frac{+R}{2}, +\frac{\sqrt{3}R}{2}\right)$$

15. $$\sin(90-\theta) = \frac{1}{\mu_1} \Rightarrow \cos\theta = \frac{1}{\mu_1} \longrightarrow (1)$$

$$\sin(90-2\theta) = \frac{1}{(\mu_1/\mu_2)}$$

$$\cos 2\theta = \frac{\mu_2}{\mu_1} = \frac{\mu_2}{(1/\cos\theta)} \therefore \mu_2 = \frac{\cos 2\theta}{\cos\theta}$$

16. Dimensional analysis

17. $$I = \left(\frac{I_0}{2}\right)\cos^2\theta . \sin^2\theta = \frac{I_0}{2}\left[\frac{\sin 2\theta}{2}\right]^2 = \frac{I_0}{8}\sin^2 2\theta$$

18. F.O.V. = 1 mm

$$F.W. = \frac{D\lambda}{2d} = 0.25 mm$$

19. $$I = 2\pi^2 \rho v A^2 \upsilon^2 = \frac{w}{4\pi r^2}$$

$$\therefore A = \left[\frac{W}{8\pi^3 \rho v \upsilon^2}\right]^{1/2} . \frac{1}{r} \cong 10^{-6} m$$

20. $$2T\sin\theta = dm\omega^2 R$$

$$\approx 2T\theta = \mu d\ell \omega^2 R$$

$$\approx 2T\theta = \mu R^2 \theta \omega^2 R$$

$$\Rightarrow \frac{T}{\mu} = \omega^2 R^2$$

$$\text{or } v_{wave} = \omega R$$

Note v_{wave} obtained is always with respect to medium

$$\therefore v_{wave/ground} = \omega R - \omega R$$

$$= 0$$

21. Number of waves received by observation = f
Time taken by observer to receive all wave

$$\frac{Tfo}{\left(\frac{\Delta x}{v_{observer}}\right)} = f \xrightarrow{} (1)$$

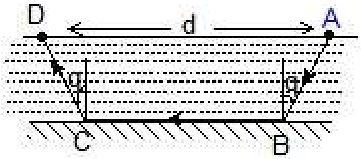
$[T = duration\ of\ \ beep]$

Also $f = \left(\frac{c + v_{obs}}{c}\right) fo \xrightarrow{} (ii)$

On solving (i) & (ii) we get

$$T = \frac{f\Delta x}{c(f - fo)} = 5\sec onds$$

22. Method 1



$$T = t_{AB} + t_{BC} + t_{CD}$$

$$T = \frac{2D}{\cos\theta V_w} + \frac{(d - 2D\tan\theta)}{v_R}$$

$$\frac{dT}{d\theta} = 0 \Rightarrow \frac{2D\sec\theta\tan\theta}{v_w} - \frac{2D\sec^2\theta}{v_R}$$

$$\Rightarrow \sin\theta = \frac{v_w}{v_R}$$

$$\therefore T = \frac{2D}{\sqrt{1 - \frac{v_w{}^2}{v_R{}^2}}.v_w} + \frac{\left(d - 2D\frac{v_w}{\sqrt{v_R{}^2 - v_w{}^2}}\right)}{V_R}$$

$$T = \frac{dv_w + 2D\sqrt{v_r{}^2 - v_w{}^2}}{v_r v_w}$$

Method 2

Assume critical angle deviation like in light $\therefore$ $\sin\theta\ \frac{1}{\mu R} = \frac{v_w}{v_R}$

Then solve $T = t_{AB} + t_{BC} + t_{CD}$

23. $\frac{hc}{\lambda} - \frac{hc}{\lambda_0} = eEd$

On solving we get $\frac{1}{\lambda_0} = \frac{1}{\lambda} - \frac{eEd}{hc}$

24. $\left|\vec{F}\right| = \frac{2P\cos\theta}{c}[\perp to\,mirror\,\&\,directed\,toward\,it]$

25. $\overset{v}{\bullet\!\rightarrow}$

2m

Before collision

$$pi = 2mv = \sqrt{4mk.\text{E}} = \sqrt{4m}\ units$$

$$p_1y = p_2y = \sqrt{2 \times m \times 1} = \sqrt{2m}\ units$$

$$=\left[\frac{p_2^2}{2m}+\frac{p_{1y^2}}{2m}-1\right]ev$$

Energy of dissociation = $$=\left[\frac{\left(\sqrt{4m}\right)^2+\left(\sqrt{2m}\right)^2}{2m}+\frac{\left(\sqrt{2m}\right)^2}{2m}-1\right]ev$$

$$=\left[3+1-1\right]ev$$

$$=3ev$$

26. $\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2} \quad \therefore R=2\Omega$

$\frac{dR}{R^2}=\frac{dR_1}{R_1^2}+\frac{dR_2}{R_2^2} \quad \Rightarrow dR=0.05\Omega$

$\therefore R=\left(2\pm0.05\right)\Omega$

27. $d=20.1\,mm\left[3\,significant\,figure\right]$

$v=\frac{4\pi}{3}\left(\frac{d}{2}\right)^3=\frac{\pi d^3}{6}=4.253648cm^3$

Taking 3 significant figures only, we get
V = 4.25 cm^3

28. $i_{zener}=5i_{load}=20mA$ & $i_{RS}=i_{zener}+i_{Load}=24mA$

$V_{Rs}+V_{zener}=11$

$V_{RS}+7=11$

$V_{RS}=4V$

$\therefore R_s=\frac{V_{Rs}}{i_{Rs}}=\frac{4}{24\times10^{-3}}\Omega=167\Omega$

29. Consider a case of an n type semi-conductor. The majority carries density (n) is considerably larger than the minority hole density $p\left(i.e.\ \mathrm{n}>>\mathrm{p}\right)$.On illumination, $n_f=n+\Delta n\ \&\ p_f=p+\Delta p$

Since $\Delta n=\Delta p$ {equal hole electron pair generation in bond breaking}

$\frac{\Delta n}{n}<<\frac{\Delta p}{p}$

$\therefore$ It is difficult to measure small $\frac{\Delta n}{n}$

Compared to $\Delta p\,/\,p$

$\therefore$ Photodiode is used in Reverse bios mode since it is easier to measure the higher fractional change of minority carriers

30. $d=\sqrt{2Rh_T}+\sqrt{2Rh_R}$

$=\ 288\times10^2\times\sqrt{10}=91km$

Chemistry

PART – II

SECTION – A

31. Photochemical smog has high concentration of oxidizing agents.

32. Bithionol / Bithional is added to the toilet soap to remove the bad odour produced by bacterial decomposition of organic matter on the skin.

33.
$$\begin{array}{cccc} 2Fe & + \; O_2 & \longrightarrow & 2FeO \\ a\ mole & \frac{a}{2} mole & & a \\ 4Fe & + \; 3O_2 & \longrightarrow & 2Fe_2O_3 \\ b & \frac{3b}{4} & & \frac{b}{2} \end{array}$$

$\therefore a + b = 1$

$\frac{a}{2} + \frac{3b}{4} = 0.65$

$\therefore a = 0.4\ mole$

$b = 0.6\ mole$

$\therefore moles\ of\ FeO = 0.4$

$moles\ of\ Fe_2O_3 = 0.3$

$\therefore ratio = 4:3$

34. gold number = 0.03
Gold sol volume = 100 ml
Let the amount of hemoglobin required is x mg
Since the gold number is the amount in miligrams required to prevent the coagulation of 10 ml of gold sol by 1 ml of 10% NaCl

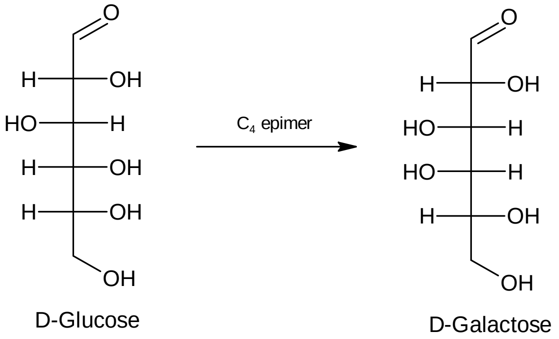
$\therefore \frac{x}{100} \times 10 = gold\ number$

$or\ \frac{x}{10} = 0.03$

$\therefore x = 0.30\ mg$

35. Wood-pulp, on dissolving in CS_2-- - alkali solution forms sodium salt of cellulose xanthate not the rayon.

36.



37. $IO_3^- + 5I^- + 6H^+ \longrightarrow 3I_2(s) + 3H_2O$

38. $PM = \rho RT$

$or\ \rho T = \frac{PM}{R}$

$or\ \rho T = cons\tan t$

39. $QV = \frac{1}{2}mv^2$

$\therefore v = \sqrt{\frac{2QV}{m}}$

$\therefore v_P = \sqrt{\frac{2QV}{m_P}}\ or\ v_\alpha = \sqrt{\frac{2\times 2QV}{m_\alpha}}$

$m_P.v_P = \sqrt{2QV.m_P}\ \&\ m_\alpha.v_\alpha = \sqrt{4QV.m_\alpha}$

$\therefore ratio = \sqrt{\frac{m_P}{2m_\alpha}}$

40. Let x and y are the concentration of Br$^-$ and Cl$^-$ at equilibrium when E$_{cell}$ = 0

$\therefore \left[Ag^+\right]_{LHS} = \frac{K_{sp}(ArBr)}{\left[Br^-\right]} = \frac{5\times 10^{-13}}{x}$

$\left[Ag^+\right]_{RHS} = \frac{K_{sp}(AgCl)}{\left[Cl^-\right]} = \frac{1\times 10^{-10}}{y}$

Also $E_{cell} = E^o_{Ag/Ag^+}(RHS) + E^o_{Ag/Ag^+}(LHS) + \frac{0.0591}{1}\log\frac{\left[Ag^+\right]_{RHS}}{\left[Ag^+\right]_{LHS}}$

$0 = 0 + \frac{0.0591}{1}\log\frac{1\times 10^{-10}\times x}{5\times 10^{-13}\times y}$

$\therefore \frac{x}{y} = \frac{1}{200}$

41. $\Delta S_V = \frac{RT_bM}{1000K_b}$

42. Decomposition of HI on Au surface is zero order reaction

$\therefore P_{HI} = -Kt + P^o_{HI}$

P_{H_2} increases continuously $2HI \xrightarrow{Au\ surface} H_2 + I_2$

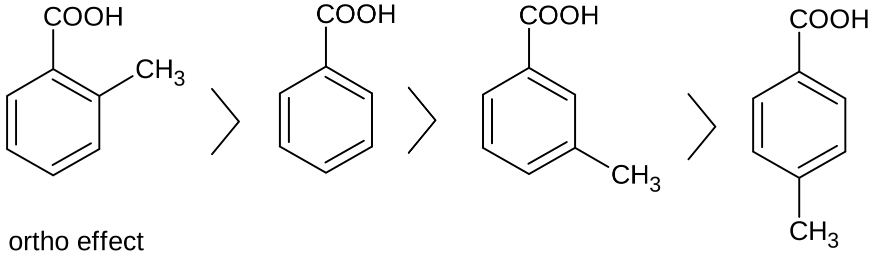
43. For cyclic process, du = 0
as, q = -ve
$\therefore$ work is done by the system
$\therefore$ q = - w = area occupied by circle

$= \pi r^2 = \frac{22}{7}\times 10^2$

44. A

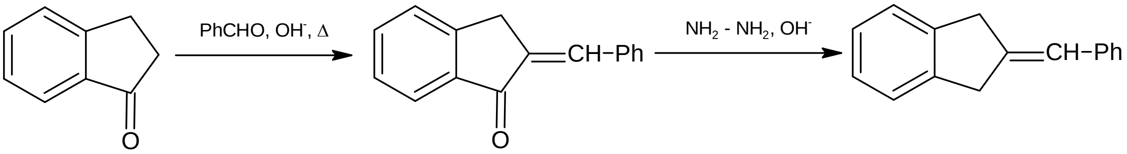
45. $CaSO_4.2H_2O$, $2CaO.3Ba_2O_3.5H_2O$, CaH_2 are ores of Ca.

46. $D_2 > H_2 > F_2$ is the order of BDE.
47. D
48. K_a order =



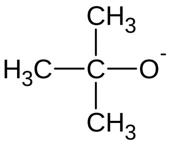
ortho effect

49.



50. Hofmann rearrangement occurs without altering the stereochemistry.

51.



$H_3C-\overset{CH_3}{\underset{CH_3}{C}}-O^-$ is bulkier base

52. Nitrous acid reaction with 2° amine.

53. MnO_2 oxidizes allylic | benzylic 1° | 2° alcohols while
Jones reagent oxidizes 1° | 2° alcohols with out affecting C = C bond | C ≡ C bond.

54. reactivity of – Br is higher than – Cl for RMgX formation.

55. for the indicator $HIn \rightleftharpoons H^+ + In^-$
According to the question, 20% of the final form of the indicator is blue (acidic) and 80% red (basic)

$$K_{In} = \frac{\left[H^+\right]\left[In^-\right]}{[HIn]}$$

$$\left[H^+\right] = K_{In}\frac{\left[In^-\right]}{[HIn]} = 1\times10^{-5}\left(\frac{80}{20}\right) = 4\times10^{-5}$$

$$pH = 4.4$$

For 80% blue $\left[H^+\right] = 1\times10^{-5}\left(\frac{20}{80}\right)$

pH = 6 – 0.4 = 5.6
∴ change in pH = 5.6 – 4.4 = 1.2

56. C

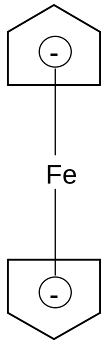
57. SO_2 turns acidified $K_2Cr_2O_7$ solution green whereas CO_2 will have no effect on such a solution.

58. C

59. Nessler's reagent is a mixture of $K_2[HgI_4]$ and KOH.

$$2KI + HgCl_2 \longrightarrow 2KCl + HgI_2$$
$$HgI_2 + 2KI \longrightarrow K_2[HgI_4] \xrightarrow{+KOH} Nessler's\ reagent$$

60.



Mathematics PART – III

SECTION – A

61. Let $x^2 = 4\cos^2\theta + \sin^2\theta$

then $(4 - x^2) = 3\sin^2\theta$ and $(x^2 - 1) = 3\cos^2\theta$

$\therefore \quad f(x) = \sqrt{3}\,|\sin\theta| + \sqrt{3}\,|\cos\theta|$

$\Rightarrow y_{\text{min.}} = \sqrt{3}$ and $y_{\text{max.}} = \sqrt{3}\left(\frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}}\right) = \sqrt{6}$.

Hence range of f(x) is $\left[\sqrt{3}, \sqrt{6}\right]$

62. By using condition of tangency, we get $4h^2 = 3k^2 + 2$

$\therefore$ Locus of P(h, k) is $4x^2 - 3y^2 = 2$ (which is hyperbola.)

Hence $e^2 = 1 + \frac{4}{3} \Rightarrow e = \sqrt{\frac{7}{3}}$

63. We have $|z|^2 + \frac{16}{|z|^3} = z^2 - 4z = \bar{z}^2 - 4\bar{z} \Rightarrow (z - \bar{z})\,(z + \bar{z} - 4) = 0$

$\Rightarrow z = \bar{z} = x \; (x \neq 2)$

So, $x^2 = 4x + x^2 + \frac{16}{|x|^3} \Rightarrow x = \frac{-4}{|x|^3} \Rightarrow x = -\sqrt{2}$

$\therefore z = -\sqrt{2}$

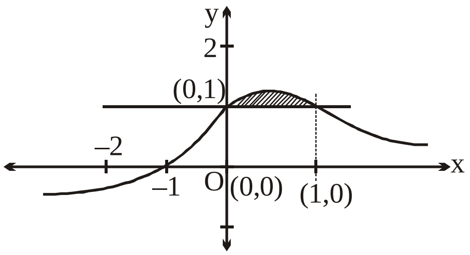
Hence only one z will satisfy above equation.]

64. On solving C : $y = \frac{x+1}{x^2+1}$ and the line L : y = 1,

we have

$\frac{x+1}{x^2+1} = 1 \Rightarrow x + 1 = x^2 + 1 \Rightarrow x(x-1) = 0 \Rightarrow x = 0, 1$

Thus, the points of intersection are at x = 0 and x = 1.



Required area = $\int_0^1 \left(\frac{x+1}{x^2+1} - 1\right) dx$ =

$\frac{1}{2}\int_0^1 \frac{2x}{x^2+1}dx + \int_0^1 \frac{1}{x^2+1}dx - \int_0^1 dx$

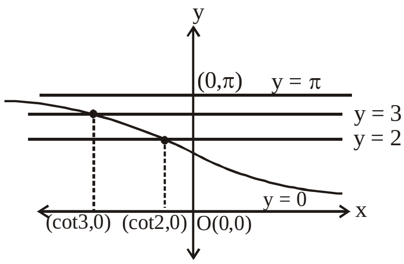
$= \left[\frac{1}{2}\ln(x^2+1) + (\tan^{-1}x) - x\right]_0^1 = \frac{1}{2}\ln 2 + \frac{\pi}{4} - 1$

65. Given $(\cot^{-1}x)\,(\tan^{-1}x) + \left(2 - \frac{\pi}{2}\right)\cot^{-1}x - 3\tan^{-1}x - 3\left(2 - \frac{\pi}{2}\right) > 0$

$\Rightarrow \cot^{-1}x\left(\tan^{-1}x + 2 - \frac{\pi}{2}\right) - 3\left(\tan^{-1}x + 2 - \frac{\pi}{2}\right) > 0$

$\left(As \; \tan^{-1}x - \frac{\pi}{2} = -\cot^{-1}x\right)$

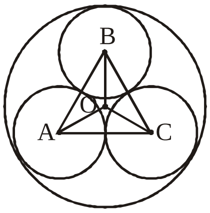
$\Rightarrow$ $(\cot^{-1}x - 3)\,(2 - \cot^{-1}x) > 0$
$\Rightarrow$ $(\cot^{-1}x - 3)\,(\cot^{-1}x - 2) < 0$
$\Rightarrow$ $2 < \cot^{-1}x < 3$ $\Rightarrow$ $\cot 3 < x < \cot 2$
(As $\cot^{-1}x$ is a decreasing function.)
Hence $x \in (\cot 3, \cot 2)$]



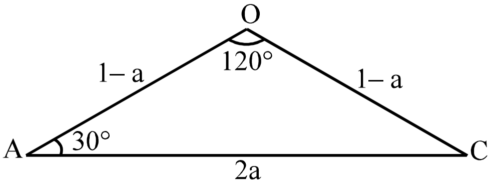
Graph of $y = \cot^{-1}x$

66. We have $(\tan x + \sec x) = 2\cos x$ $\Rightarrow$ $1 + \sin x = 2\cos^2 x$ $\Rightarrow$ $2\sin^2 x + \sin x - 1 = 0$
$\Rightarrow$ $(2\sin x - 1)(\sin x + 1) = 0$
$\therefore$ $\sin x = \frac{1}{2}$ or $\sin x = -1$ (Reject as $\sec x$ will not be defined.)
Hence $x = \frac{\pi}{6}, \frac{5\pi}{6}$.]

67. We have $\cos 30° = \dfrac{(2a)^2 + (1-a)^2 - (1-a)^2}{2(2a)(1-a)} = \dfrac{a}{1-a}$



$\Rightarrow$ $\dfrac{\sqrt{3}}{2} = \dfrac{a}{1-a}$
$\Rightarrow$ $2a = \sqrt{3} - \sqrt{3}a \Rightarrow \left(2 + \sqrt{3}\right)a = \sqrt{3}$
$a = \dfrac{\sqrt{3}}{2 + \sqrt{3}} = \sqrt{3}\left(2 - \sqrt{3}\right)$



68. For $x \ge 2$, L.H.S. is always non negative and R.H.S. is always – ve.
Hence for $x \ge 2$ no solution.
If $1 \le x < 2$ then $(x - 2) = (x - 1) - 1 = x - 2$, which is an identity $\Rightarrow$ **(D)**
For $0 \le x < 1$, LHS is '0' and RHS is (–) ve $\Rightarrow$ No solution.
For $x < 0$, LHS is (+) ve, RHS is (–) ve $\Rightarrow$ No solution.]

69. $\int_3^{x^3} e^{t^2}\,dt = \int_3^{1} e^{t^2}\,dt + \int_1^{x^3} e^{t^2}\,dt = \int_1^{x^3} e^{t^2}\,dt - \int_1^{3} e^{t^2}\,dt = g(x^3) - g(3)$

70. $I = \int_0^{\theta} \ln\left(1 + \tan\theta\tan(\theta - x)\right)dx$
$I = \int_0^{\theta} \ln\left(1 + \dfrac{\tan\theta(\tan\theta - \tan x)}{1 + \tan\theta\tan x}\right)dx = \int_0^{\theta} \ln\left(\dfrac{1 + \tan^2\theta}{1 + \tan\theta\tan x}\right)dx$
$I = \int_0^{\theta} \ln(1 + \tan^2\theta)\,dx - \int_0^{\theta} \ln\left(1 + \tan\theta\tan x\right)dx$
$I = 2\theta \ln \sec\theta - I$
$2I = 2\theta \ln \sec\theta$ $\Rightarrow$ $I = \theta \ln \sec\theta$

71. We have $r + s = -\frac{a_1}{a_2}$; $rs = \frac{a_0}{a_2}$

Simplifying the R.H.S. of the equation, we have

$$a_0\left(1-\frac{x}{r}\right)\left(1-\frac{x}{s}\right) = a_0\left(1-\frac{x}{r}-\frac{x}{s}+\frac{1}{rs}x^2\right) = a_0\left(1-\left(\frac{r+s}{rs}\right)x+\frac{1}{rs}x^2\right)$$

$$= = a_0 + a_1x + a_2x^2$$

Thus, the answer is (A) for all values of x, $a_0 \neq 0$]

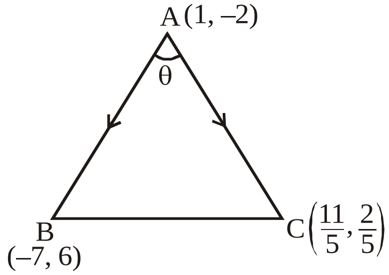
72. $\overrightarrow{AB} = \vec{V}_1 = -8\hat{i} + 8\hat{j} = 8(-\hat{i} + \hat{j})$

$\overrightarrow{AC} = \vec{V}_2 = \left(\frac{11}{5}-1\right)\hat{i} + \left(\frac{2}{5}+2\right)\hat{j}$

$= \frac{6}{5}\hat{i} + \frac{12}{5}\hat{j} = \frac{6}{5}(\hat{i} + 2\hat{j})$

$\cos\theta = \frac{(-\hat{i}+\hat{j})\cdot(\hat{i}+2\hat{j})}{(\sqrt{2})(\sqrt{5})} = \frac{-1+2}{\sqrt{10}} = \frac{1}{\sqrt{10}}$ = tan θ =3

⇒ (A)]



73. y = Ax^2 ; y^2 + 3 = x^2 + 4y ; A > 0

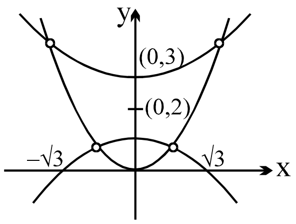
Now $y^2 - 4y = x^2 - 3$

$(y-2)^2 = x^2 + 1$

$(y-2)^2 - x^2 = 1$

if x = 0 y – 2 = 1 or – 1 ⇒ y = 3 or 1

Hence the two graphs of y = Ax^2 (A > 0)



and the hyperbola $(y-2)^2 - x = 1$ are as shown which can intersects in 4 points.]

74. $a^2 + b^2 + c^2 + ab + bc + ca \le 0$

$(a+b)^2 + (b+c)^2 + (c+a)^2 \le 0$

∴ a + b = 0

b + c = 0 a = b= c = 0

c + a = 0

Now, $\begin{vmatrix} 4 & 0 & 1 \\ 1 & 4 & 0 \\ 0 & 1 & 4 \end{vmatrix}$ = 4 (16 – 0) + 1 (1 – 0) = 65

75. using LMVT in [0, 1]

f ' (c) = $\frac{f(1)-f(0)}{1-0}$ for some c ∈ (0, 1)

$e^{c^2} = \frac{f(1)-f(0)}{1}$; f (1) – 10 = for some c ∈ (0, 1)

1 < f (1) – 10 < e; 11 < f (1) < 10 + e

∴ A = 11; B = 10 + e ⇒ A – B = 1 – e

76. We have

$\frac{dV}{dt} = 2 \Rightarrow \frac{d}{dt}\left(\frac{1}{3}\pi r^3\right)$ = 2 [Here r = h, as □ = 45°]

$\Rightarrow \pi r^2 \dfrac{dr}{dt} = 2 \;\Rightarrow \dfrac{dr}{dt} = \dfrac{2}{\pi r^2}$

Now, perimeter = $2\pi r$ = p(let)

$\Rightarrow \dfrac{d}{dt}(2\pi r) = 2\pi\left(\dfrac{2}{\pi r^2}\right) = \dfrac{4}{r^2}$ .... (1)

When h = 2 meters $\Rightarrow$ r = 2 meters

Hence $\dfrac{dp}{dt} = \dfrac{4}{4}$ = 1 m/sec.]

77. Let $S = \sum_{r=1}^{\infty}\dfrac{r+2}{2^{r+1}\cdot r\cdot(r+1)} = \sum_{r=1}^{\infty}\dfrac{2(r+1)-r}{2^{r+1}\cdot r\cdot(r+1)} = \sum_{r=1}^{\infty}\dfrac{1}{2^{r+1}}\left(\dfrac{2}{r}-\dfrac{1}{r+1}\right)$

$= \sum_{r=1}^{\infty}\left(\dfrac{1}{2^r\cdot r}-\dfrac{1}{2^{r+1}(r+1)}\right)$

$= \dfrac{1-a\pi}{b\pi^2}$

$= \lim\limits_{n\to\infty}\left[\left(\dfrac{1}{2^1\cdot 1}-\dfrac{1}{2^2\cdot 2}\right)+\left(\dfrac{1}{2^2\cdot 2}-\dfrac{1}{2^3\cdot 3}\right)\right]+\left(\dfrac{1}{2^3\cdot 3}-\dfrac{1}{2^4\cdot 4}\right)+....+\left(\dfrac{1}{2^n\cdot n}-\dfrac{1}{2^{n+1}\cdot(n+1)}\right)$

$= \lim\limits_{n\to\infty}\left(\dfrac{1}{2}-\dfrac{1}{2^{n+1}\cdot 9n+1}\right)$

$\therefore \quad S = \dfrac{1}{2}$

Hence $S^{-1} = 2$

78. Let the probability of the faces 1, 3, 5 or 6 be p for each face.
Hence probability of each of the faces 2 or 4 is 3p

$\therefore \quad 4p + 6p = 1 \quad \Rightarrow \quad p = \dfrac{1}{10}$

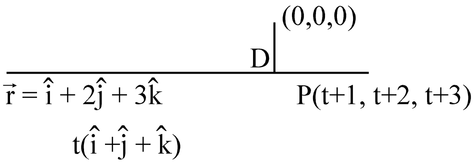
$\therefore \quad P(1) = P(3) = P(5) = P(6) = \dfrac{1}{10}$; $P(2) = P(4) = \dfrac{3}{10}$

P(total of 7 with a draw of dice) = P(16, 61, 25, 52, 43, 34)

$= 2\left(\dfrac{1}{10}\cdot\dfrac{1}{10}\right)+2\left(\dfrac{3}{10}\cdot\dfrac{1}{10}\right)+2\left(\dfrac{3}{10}\cdot\dfrac{1}{10}\right)$

$= \dfrac{2+6+6}{100} = \dfrac{14}{100} = \dfrac{7}{50}$

79. $D^2 = f(t) = (t+1)^2 + (t+2)^2 + (t+3)^2$
$f'(t) = 2[(1+t) + 2 + t + 3 + t]$
$f'(t) = 0 \quad \Rightarrow \quad t = -2$
hence $D^2(\text{min}) = 1 + 0 + 1 = 2$
$D_{\text{min}} = \sqrt{2}$


(0,0,0)
D
$\vec{r} = \hat{i} + 2\hat{j} + 3\hat{k}$
P(t+1, t+2, t+3)
$t(\hat{i} + \hat{j} + \hat{k})$

80. We have $|z - (1+i)|^2 = 2$

$\Rightarrow \quad (x-1)^2 + (y-1)^2 = 2$ (Put z = x + iy)

$\Rightarrow \quad x^2 + y^2 = 2(x+y)$ ......(1)

Let $\omega = h + ik = \dfrac{2}{z} = \dfrac{2}{x+iy} = \dfrac{2(x-iy)}{x^2+y^2}$, so

$h = \frac{2x}{x^2+y^2}$, $k = \frac{-2y}{x^2+y^2}$

$\Rightarrow$ $h - k = \frac{2(x+y)}{x^2+y^2} = 1$ (from equation (1))

$\therefore$ Locus of the point ω (h, k) will be x – y = 1

81. If $\theta \in \left(\frac{3\pi}{2}, 2\pi\right)$, then $\tan\theta < 0$

Given $a^{\tan\theta} > 1$ $\Rightarrow$ $0 < a < 1$

and $b^{\tan\theta} > 1$ $\Rightarrow$ $0 < b < 1$

Also $a^{\tan\theta} > b^{\tan\theta}$ (given) $\Rightarrow$ $b > a$

Hence $a < b < 1$

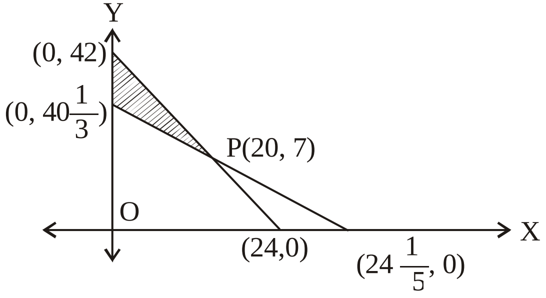
82. We have $(x^2 + a|x| + a + 1)(x^2 + (a + 1)|x| + a) = 0$

Clearly for a > 0,

$x^2 + a|x| + a + 1 > 0 \quad \forall x \in R$ and $x^2 + (a + 1)|x| + a > 0 \quad \forall x \in R$

Hence the given equation has no real root if $a \in (0, \infty)$

83. Clearly lines intersect at P(20, 7)



$\therefore$ Area of shaded region $= \frac{1}{2}\left(42 - 40\frac{1}{3}\right)20 = \frac{1}{2}\left(\frac{5}{3}\right)20 = \frac{50}{3}$ (square units)

84. Given that p_1, q_1, p_2 q_2 are in A.P.

$\therefore$ $(p_2 - p_1)^2 = (q_2 - q_1)^2$

$\Rightarrow$ $(p_2 + p_1)^2 - 4p_1p_2 = (q_2 + q_1)^2 - 4q_1q_2$

$\Rightarrow$ $\left(\frac{-b}{a}\right)^2 - 4\left(\frac{c}{a}\right) = \left(\frac{-b}{c}\right)^2 - 4\left(\frac{a}{c}\right)$

$\Rightarrow$ $\frac{b^2 - 4ac}{a^2} = \frac{b^2 - 4ac}{c^2}$

Since b^2 – 4ac is the discriminant of both the equations and roots are different

$\therefore$ $b^2 - 4ac > 0$

$\therefore$ $a^2 = c^2$

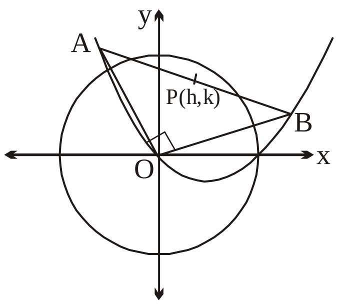
$\Rightarrow$ a = c (Not possible because two quadratic equations become identical)

or a = – c $\Rightarrow$ a + c -1 = – 1

85. Equation of chord of the circle with mid point (h, k) is

$hx + ky = h^2 + k^2$

On homogenising the parabola, we get



$$x^2 - \frac{(x+y)(hx+ky)}{h^2+k^2} = 0$$

$\Rightarrow$ $(h^2 + k^2)x^2 - (x + y)(hx + ky) = 0$

Now coefficient of x^2 + coefficient of $y^2 = 0$

$\therefore$ $h^2 + k^2 - h - k = 0$

$\Rightarrow$ $x^2 + y^2 - x - y = 0 \Rightarrow$ circle with centre $\left(\frac{1}{2}, \frac{1}{2}\right)$ and radius = $\sqrt{\frac{1}{4}+\frac{1}{4}} = \frac{1}{\sqrt{2}}$

86. Since root(s) are real and distinct, so

$36 - 4l > 0 \Rightarrow 9 > l$

If x_1, x_2 be roots then $x_1 + x_2 = -6$ and $x_1x_2 = l$

Also $|x_1 - x_2| \le 4$ i.e. $(x_1 - x_2)^2 \le 16$

or $(x_1 + x_2)^2 - 4x_1x_2 \le 16$

$\Rightarrow$ $36 - 4l \le 16$ or $5 \le l$

$\therefore$ $5 \le l < 9$ i.e. $l \in [5, 9)$

87. If number of sides is n, then

total number of diagonals of a convex polygon = ${}^nC_2 - n = 44$ (given)

$\Rightarrow$ $n(n - 1) - 2n = 88$ $\Rightarrow$ $n^2 - 3n - 88 = 0$ $\Rightarrow$ $(n - 11)(n + 8) = 0$

$\Rightarrow$ $n = 11$ $\Rightarrow$ undecagon

88. (i) T S S T S S T S S

(ii) S T S S T S S T S

(iii) S S T S S T S S T

Hence $3 \cdot (3!)6! = (18)6!$

k = 18

89. Required number of ways = (number of ways in which 16 players can be divided in 8 couples) – (number of ways when S_1 and S_2 are in the same group)

$$= \frac{16!}{2^8 \cdot 8!} - \frac{(14)!}{2^7 \cdot 7!} = \frac{16 \cdot 15 \cdot 14!}{2 \cdot 2^7 \cdot 8 \cdot 7!} - \frac{(14)!}{2^7 \cdot 7!}$$

$$= \frac{(14)!}{2^7 \cdot 7!}\left[\frac{16 \cdot 15}{16} - 1\right] = \frac{(14) \cdot (14)!}{14 \cdot (6!) \cdot 2^6} = \frac{(14)!}{2^6 \cdot 6!}$$ **Ans.**]

90. Let $z = x + iy$

$E = z\bar{z} + (z-3)(\bar{z}-3) + (z-6i)(\bar{z}+6i)$

$= 3z\bar{z} - 3(z+\bar{z}) + 9 + 6(z-\bar{z})i + 36$ $\left(z+\bar{z} = 2x;\ z-\bar{z} = 2iy\right)$

$= 3(x^2 + y^2) - 6x - 12y + 45$

$= 3[x^2 + y^2 - 2x - 4y + 15]$

$E = 3[(x - 1)^2 + (y - 2)^2 + 10]$

Hence $E_{min} = 30$ when $x = 1$ and $y = 2$ i.e. $z = 1 + 2i$]

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - IV

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 186**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into Two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01– 05, 19 – 23, 37 - 41)*** *contains 15 multiple choice questions which have* ***one correct*** *answer. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (06 – 13, 24 – 31, 42 - 49) *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.
2. ***Section-C (14 – 18, 32 – 36, 50 – 54)*** *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **5 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

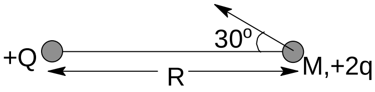
1. In a screw gauge there are 100 divisions in the circular scale and each main scale division is of 1 mm. When there is no gap between the jaws, 97th division coincides with the main scale zero and zero of main scale is not visible. While measuring the diameter of a ball, the circular scale is between the 3mm mark and the 4mm mark such that the 76th division of the circular scale coincides with the reference line. Then,
(A) the least count of the micrometer is 0.01 cm (B) the zero error is -0.04 mm
(C) the main scale reading is 4 mm (D) the diameter of the ball is 3.79 mm

2. A ball is projected from a point 10 m away from a wall. If the initial velocity with which the ball can be projected is 15 m/s, then in order to hit the wall at the highest possible point the angle with the horizontal that it must be projected is
(A) 45 (B) 90
(C) $\tan^{-1} 2.25$ (D) $\tan^{-1} 1.5$

3. A light thread is wound four times around a pulley disc of diameter 30 cm and mass 5 kg. We want to unwind the thread by pulling it in 1 s. The minimum constant force required to do so is:
(A) 12.25 N (B) 18.85 N
(C) 24.5 N (D) 37.7 N

Space for Rough work

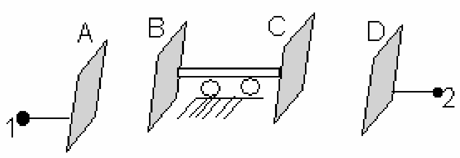
4. In the diagram shown, the charge +Q is fixed. Another charge +2q, is projected from a distance R from the fixed charge. The minimum separation between the two charges when the velocity becomes $\frac{1}{\sqrt{3}}$ times of the projected velocity, is (Assume gravity to be absent)



(A) $\frac{\sqrt{3}}{2}R$ (B) $\sqrt{3}R$

(C) $\frac{1}{2}R$ (D) $4R$

5. A, B, C and D are large conducting plates kept parallel to each other. A and D are fixed. Plates B and C, connected to each other by a rigid conducting rod, can slide over frictionless rails as shown. Initially the distance between plates A and B is the same as that between plates C and D. If now the rod (along with plates B and C)is slightly moved towards right, the capacitance between the terminals 1 and 2.



(A) remain unchanged (B) increases

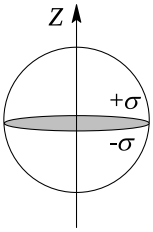
(C) decreases (D) nothing can be said

Space for Rough work

(One or More than one correct type)

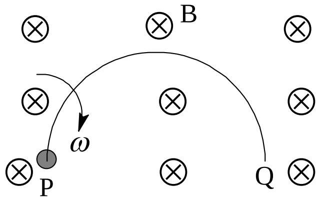
This section contains **EIGHT** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

6. A hollow, insulating spherical shell has a surface charge distribution placed upon it, such that the upper hemisphere has a uniform surface charge density $+\sigma$, while the lower hemisphere has a uniform charge density $-\sigma$, as shown in the figure. Their interface lies in x-y plane. Which of the following statement(s) is/are correct?



(A) The field at all points of x-y plane within the sphere points in the $-ve$ z-direction
(B) All points of the x-y plane within the sphere are equipotential
(C) The field at all points on z-axis outside the sphere point along positive z-direction
(D) The field at points on z axis which are on either side of origin outside the sphere is in opposite directions.

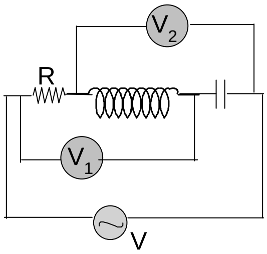
7. A wire is bent to form semi-circle of radius a. The wire rotates about its one end with angular velocity ω. Axis of rotation is perpendicular to plane of the semicircle. In the space, a uniform magnetic field of induction B exists along the axis of rotation as shown in figure. Then



(A) Potential difference between P and Q is equal to $2B\omega a^2$
(B) Potential difference between P and Q is equal to $2\pi^2 B\omega a^2$
(C) P is at higher potential Q
(D) P is at lower potential than Q

Space for Rough work

8. In an R-L-C series circuit shown in the figure, the readings of voltmeters $V_1 \text{ and } V_2$ are 100V and 120V, respectively. The source voltage is 130V. For this situation, mark out the correct statement(s).



(A) Voltage across resistor, inductor and capacitor are $50\text{V},\ 50\sqrt{3}\ \text{V and} 120+50\sqrt{3}\,\text{V}$, respectively

(B) Voltage across resistor, inductor and capacitor are $50\text{V},\ 50\sqrt{3}\ \text{V and} 120-50\sqrt{3}\,\text{V}$, respectively

(C) Power factor of the circuit is $\frac{5}{13}$

(D) The circuit is capacitive in nature

9. An α -particle of mass $m_\alpha \text{ and } q_\alpha$ moves a velocity $V_0 = \left(2\hat{i}+3\hat{j}-\hat{k}\right)\text{ms}^{-1}$ through a region, where both a uniform magnetic field and a uniform electric field. Which of the following statements is/are correct?

[Given, $B=\left(2i+4j+k\right)\text{T and } E=\left(4i-j-2k\right)\text{VM}^{-1}$]

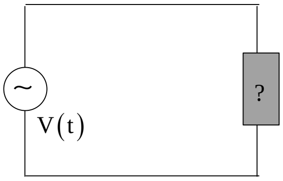
(A) Acceleration of α -particle is perpendicular to Z-axis
(B) Acceleration of α -particle is perpendicular to Z-axis
(C) de-Broglie's wavelength associated with α -particle is increasing with time
(D) de-Broglie's wavelength of α -particle keeps on decreasing with time

Space for Rough work

10. The polonium isotope ${}^{210}_{84}\mathrm{Po}$ is unstable, it emits an α-particle with energy of 5.30MeV. The atomic mass of ${}^{210}_{84}\mathrm{Po}$ is 209.9829 u and atomic mass of ${}^{4}_{2}\mathrm{He}$ is 4.0026 u. Then,

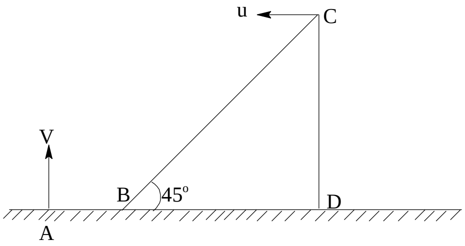
(A) Daughter nucleus is ${}^{206}_{82}\mathrm{Pb}$
(B) disintegration energy of α-decay is 5.30MeV.
(C) disintegration energy of α-decay is 5.40MeV.
(D) mass of daughter nucleus is 205.9745u.

11. An AC voltage source is connected to a "black box" which contains a circuit, as shown in Figure. The elements in the circuit and their arrangement, however, are unknown. Measurements outside the black box provide the following information
V(t) = (80V) sin ωt
I(t) = (1.6A) sin (ωt+π/4)
Based on the above information we can infer:



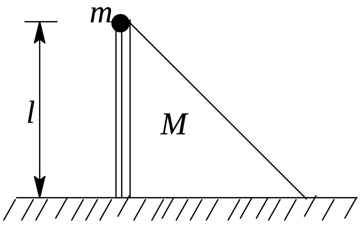
(A) The circuit is largely capacitative
(B) The circuit in the black box is in resonance
(C) The box must contain at least one resistor and one capacitor
(D) The average power delivered to the black box by the AC source is 45.25 W

12. A large wedge BCD, having its inclined surface at an angle $\theta = 45^o$ to the horizontal, is travelling horizontally leftwards with uniform velocity $\mathrm{u=10m/s}$. At some instant a particle is projected vertically up with speed $\mathrm{V=20m/s}$ from point A on ground lying at some distance right to the lower edge b of the wedge. The particle strikes the incline BC normally, while it was falling. $[\mathrm{g=10m/s^2}]$



(A) The distance AB at the instant the particle was projected from A is 15m
(B) The distance of lower edge B of the wedge from point A at the instant particle strikes the incline is 15m
(C) The distance of lower edge B of the wedge from point A at the instant particle strikes the incline is 30m
(D) The path of the particle in the reference frame attached to the wedge is parabolic

Space for Rough work



13. A weightless rod of length l with a small load of mass m at one of its end is held vertical with its lower end hinged on a horizontal surface. The load touches a wedge right sets the system in motion (see figure), with rod rotating freely in vertical plane about its lower end. There is no friction. If the rod forms an angle $\theta = \pi/3$ with the vertical at the moment the load separates from the wedge, then

(A) The mass ratio $\frac{M}{m}$ =3

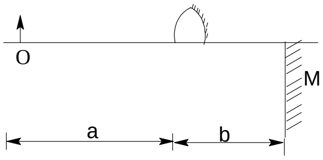
(B) The speed of the wedge at that moment will be $\sqrt{\frac{gl}{8}}$

(C) The mass ratio $\frac{M}{m}$ =4

(D) The speed of the wedge at that moment will be $\sqrt{\frac{gl}{2}}$

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.



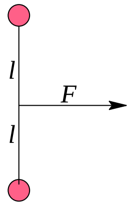
14. In figure, L is half part of an equiconvex glass lens ($\mu = 1.5$) whose surface have radius of curvature $R = 40cm$ and its right surface is silvered. Normal to its principle axis a plane mirror M is placed on right of the lens. Distance between lens L and mirror M is b. A small object O is placed on left of the lens such that there is no parallax between final images formed by the lens and mirror. If transverse length of final image formed by lens is twice that of image formed by the mirror, calculate distance 'a' in cm between lens and object.

Space for Rough work

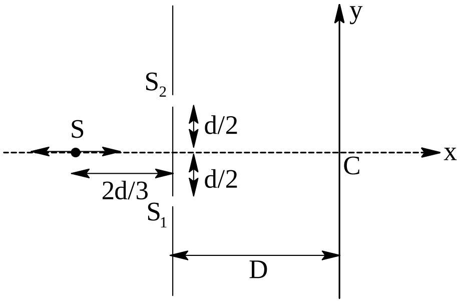
15. Binding energy per nucleon of a fixed nucleus X^A is 6Me V. It absorbs a neutron moving with $KE=2MeV$,and converts into Y, emitting a photon of energy $1\ MeV$ .If the Binding Energy per nucleon of Y (in MeV)is found to be $\frac{(xA-1)}{(A+1)}$. Find the value of x.

16. A neutral atom of atomic mass number 100 which is stationary at the origin in gravity free emits an α -particle (A) in z-direction. The product ion is P. A uniform magnetic field exists in the x-direction. Disregard the electromagnetic interaction between A and P. If the angle of rotation of A after which A and P will meet for the first time is $6n\pi/25$ radius, what is the value of n?

17. Two identical masses, placed on a smooth horizontal surface, are connected by a light string of length 2l. A constant force F starts acting on the system in the direction shown. After some time the masses collide inelastically. The energy lost in this collision is Fl / N . Find the value of N.



18. In Young's Double slit experiment, a symmetrically placed, long, linear and monochromatic source (S) of constant power is undergoing oscillations along x-axis with small amplitude A. Its mean position is shown in the figure. If I_0 is the intensity due to single slit near centre (C) of screen (y-z plane) when source is its mean position. If the amplitude of intensity variation ΔI_{max} at any of the bright fringe near centre is $\frac{8xAI_0}{25d}$, then find the value of x. [Assume D>>d]



Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **5 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

19. Two solid compounds 'X' and 'Y' dissociates at certain temperature as follows:

$X(s) \rightleftharpoons A(g) + 2b(g)$ $Kp_1 = 9 \times 10^{-3}$ atm^3

$Y(s) \rightleftharpoons 2B(g) + C(g)$ $Kp_2 = 4.5 \times 10^{-3}$ atm^3.

The total pressure (in atm) of gases over a mixture of 'X' and 'Y' is

(A) 1.5 (B) 0.45

(C) 0.6 (D) 0.9

20. The potential of an indicator electrode versus the standard hydrogen electrode, which originally contains 0.1 M MnO_4 and 0.8 M H^+ and which was treated with Fe^{2+} necessary to reduce 90% of MnO_4^- to Mn^{2+} $(E^o_{MnO_4^-/Mn^{2+}} = 1.51\,V)$, is

(A) 1.41 V (B) 2.42 V

(C) 1.04 V (D) 0.42 V

21. For the reaction $\frac{1}{2}N_2(g) + \frac{3}{2}H_2(g) \rightarrow NH_3(g)$, $\Delta G^0_{298K} = -16.45\,KJ/mol$ and $\Delta H^0_{298K} = -46.11\,KJ/mol$. Then the value of $\Delta G^0_{500\,K}$ is

(Assume $\Delta H°$ is independent of temperature).

(A) 3.66 KJ/mol (B) –12.79 KJ/mol

(C) –20.11 KJ/mol. (D) –10.55 kJ/mol

Space for Rough work

22. Match the following:

	Column I		**Column II**
P.	All except one have ns^2 configuration	1.	3d series transition metals
Q.	Only 3 elements have ns^2 configuration and	2.	4d series transition metals
R.	Only 2 elements with ns^1 configuration	3.	5d series transition metals
S.	Only 1 element with ns^0 configuration	4.	6d series transition metals

(A) P-4;Q-2,3;R-1;S-3,1 (B) P-4;Q-2,3;R-1,3;S-2
(C) P-4;Q-2;R-1,3;S-2 (D) P-2;Q-3;R-4;S-1,2

23. The distance between any two I atoms in BI_3 is found to be 3.54 Å. What is the covalent radius of boron, if covalent radius of I atom is 1.33 Å? (Assume all bonds are single bonds in BI_3)

(A) 0.71 Å (B) 1.77 Å
(C) 1.2 Å (D) 1.34 Å

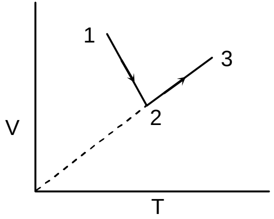
(One or More than one correct type)

This section contains **EIGHT** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

24. Which is/are correct
(A) Except Sc, among 3d series transition metals all can show $+2$ oxidation state.
(B) Sc (I) is more stable than Sc(II) and Sc(III)
(C) Ti (IV) is more stable than Ti(III) and Ti(II)
(D) Ferrates $[FeO_4]^{2-}$ are not stable, so decompose to give Fe_2O_3 and O_2.

Space for Rough work

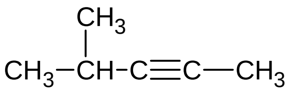
25. Following graph is constructed for the fixed amount of gas

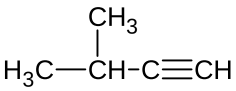


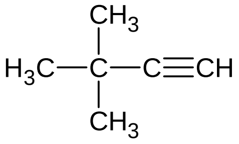
(A) From 1–2 pressure will decrease
(B) From 2–3 pressure remains constant
(C) Gas pressure at (3) is greater than at state (1)
(D) From 1–2 pressure will increase.

26. Which is /are correct
(A) Cr(VI) is more stable than Mo((VI) and W(VI)
(B) Sc does not exhibit variable oxidation states.
(C) The transition metal ions containing empty d-orbital's $[\text{e.g}\,Sc^{3+}\text{ and }Ti^{+4}\text{ions}]$ or completely filled d-orbital's $[\text{e.g}\,Cu^{+},Ag^{+},Zn^{2+},Cd^{2+},Hg^{2+}\text{etc}]$ in dry state are colourless
(D) $E^{o}_{Cu^{2+}/Cu}$ is +ve among $E^{o}_{M^{2+}/M}$ of 3d series elements as Energy required to transform $Cu(s) \rightarrow Cu^{2+}(g)$ is not balanced by hydration enthalpy.

27. Which of the following compounds gives optically inactive compound on isomerization when treated with sodamide in liquid NH₃ or with Na/NH_3.

(A)

$CH_3-\underset{}{\overset{CH_3}{\overset{|}{C}}}H-C\equiv C-CH_3$

(B)

$H_3C-\overset{CH_3}{\overset{|}{C}}H-C\equiv CH$

(C)

$H_3C-\underset{CH_3}{\underset{|}{\overset{CH_3}{\overset{|}{C}}}}-C\equiv CH$

(D) $H_3C-C\equiv C-CH_3$

Space for Rough work

28. Buffer solution A of a weak mono protic acid and its sodium salt in the concentration ratio x : y has pH = (pH)1. Buffer solution B of same acid and its sodium Salt in the concentration ratio y : x has pH = $(pH)_2$ If $(pH)_2 - (pH)_1 = 1$ unit and $(pH)_1 + (pH)_2 = 9.5$ units then

(A) pKa = 4.75
(B) $\frac{x}{y} = 2.36$
(C) $\frac{x}{y} = 3.162$
(D) pKa = 5.25

29. In a hypothetical reaction $A \to B$, the activation energies for the forward and backward reactions are 15 and 9 kJ/mol respectively. The potential energy of A is 10 kJ/mol, then which is/are correct
(A)the threshold energy of the reaction is 25 kJ/mol
(B)potential energy of B is 16 kJ
(C)heat of reaction is 6 kJ
(D)the reaction is endothermic

30. van't Hoff equation is
(A) $(d/dT)\ln K = (-\Delta E/RT^2)$
(B) $(d/dT)\ln K = +(E/RT^2)$
(C) $(d/dT)\ln K = -(\Delta E/RT)$
(D) $K=Ae^{-E/RT}$

31. For ideal gases which options are correct?

(A) Entropy change for isobaric (at constant pressure): $\Delta S = 2.303nC_p \log\left(\frac{T_2}{T_1}\right)$

(B) Entropy change for isobaric (at constant pressure): $\Delta S = 2.303nC_p \log\left(\frac{V_2}{V_1}\right)$

(C) Entropy change for isochoric (at constant volume): $\Delta S = 2.303nC_v \log\left(\frac{T_2}{T_1}\right)$

(D) Entropy change for isochoric (at constant volume): $\Delta S = 2.303nC_v \log\left(\frac{P_2}{P_1}\right)$

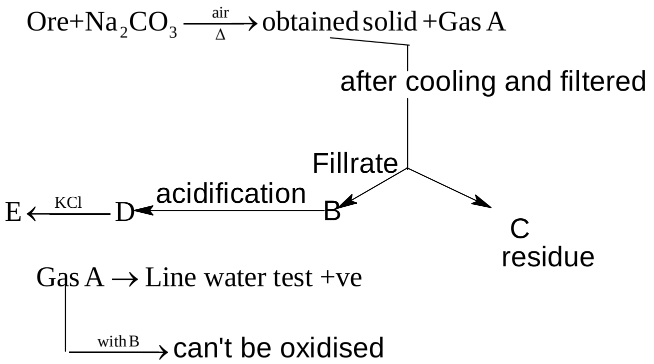
Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

32. A cation exchange regin RH_2 can replace Ca^{+2} in hard water as $RH_2 + Ca^{+2} \rightarrow RCa + 2H^+$. 1 L of Hard water (Hardness x ppm) after passing through RH_2 has pH = 2. Then the value of $\frac{x}{40}$ is.

33.



E is an oxidising agent and when a paper dipped in E solution comes in contact with SO_2 changes colour from orange to green.

Now, how many are correct about above flow diagram?

(A) Lime is added with Na_2CO_3, keeps the mass porous so that air becomes accessible to all parts reaction mixture and prevents fusion

(B) 'C' is mainly Fe_2O_3

(C) Filtrate is a yellow solution.

(D) During acidification a redox reaction is taking place.

(E) D contain 2 salts in solution and when fractional crystallisation occurs salt of lower molecular mass comes out first and is filtered off.

(F) Acidication gives two salts both hydrated. The one which has more water of hydration is less soluble

(G) When pH of solution is increased the colour of solution of E changes from orange to yellow

(H) The oxidising anions present in flow diagram can be distinguished by $AgNO_3$ One gives reddish-brown ppt and other gives brick red ppt.

Space for Rough work

34. How many of the following contain at least one tetrahedral unit formed by atoms.
$CrO_4^{2-}, K_2Cr_2O_7, KMnO_4, K_2MnO_4, Mn_2O_7, K_3VO_4$, pyrohosphoric acid, pyrosulpharic acid, Chloric acid, perchloric acid.

35. How many of the following are amphoteric
$V_2O_5, V_2O_3, CrO, Cr_2O_3, Mn_2O_7, ZnO$

36. An Ion 'M^{a+}', (at no : 26) has paramagnetic moment of 4.8 BM. Then the value of 'n' is

Space for Rough work

Mathematics

PART – III

SECTION – A
(One Options Correct Type)

This section contains **5 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

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37. Image of the curve $xy = 1$ in the curve $\left(x+\sqrt{x^2+1}\right)\left(y+\sqrt{y^2+1}\right)=1$ (on coordinate plane) is

(A) $xy = 1$ (B) $xy + 1 = 0$

(C) $xy = 0$ (D) $x^2 + y^2 = 1$

38. In a triangle ABC (with usual notations), if ex-radii r_1, r_2, r_3 are in H.P., then $\frac{a+c}{b}$ is-

(A) 1 (B) 2

(C) 3 (D) 4

39. If A is an invertible square matrix of order n such that $|\text{adj}(\text{adj } A)| = |A|^{(2n^2-7n+7)}$, then sum of possible values of n is-

(A) 3 (B) 4

(C) 5 (D) 6

40. Let $f(x)$ is an even function such that $f(x) + f(x-3) = x(x-3)+1$, then $\int_0^3 \frac{f(x)dx}{(x^2-3x+1)}$ is

(A) $-\frac{2}{3}$ (B) $-\frac{3}{2}$

(C) $\frac{2}{3}$ (D) $\frac{3}{2}$

Space for Rough work

41. The range of function $f(x)=e^{\left(\sin^{-1}x+\frac{\cos^{-1}x}{4}\right)}$ is

(A) $\left[e^{\frac{\pi}{4}},e^{\frac{\pi}{2}}\right]$ (B) $[0,1]$

(C) $\left[e^{-\frac{\pi}{2}},e^{\frac{\pi}{2}}\right]$ (D) $\left[e^{-\pi},e^{\pi}\right]$

(One or More than one correct type)

This section contains **EIGHT** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

42. Let S_n denotes the sum of first n term of an arithmetic progression whose first term is -4 and common difference is 1. If $V_n=2S_{n+2}-2S_{n+1}+S_n(n\in N)$, then

(A) $V_n=\frac{-9n^2+5n-12}{2},(n\in N)$ (B) $V_n=\frac{n^2+5n+12}{2},(n\in N)$

(C) Minimum value of V_n is -9 (D) Minimum value of V_n is $-\frac{73}{8}$

43. The value of x satisfying the equation $x^9+\frac{9}{8}x^6+\frac{27}{64}x^3-x+\frac{219}{512}=0$ is-

(A) $\frac{-1+\sqrt{13}}{4}$ (B) $-\frac{1}{2}$

(C) $\frac{-1-\sqrt{13}}{4}$ (D) more than two real and distinct values

Space for Rough work

44. If α, β, γ are roots of $x^3 + 2x^2 - 3x + 1 = 0$, then value of $\frac{\alpha\beta}{\alpha+\beta} + \frac{\alpha\gamma}{\alpha+\gamma} + \frac{\beta\gamma}{\beta+\gamma}$ is less than

(A) 2 (B) 3
(C) 4 (D) 5

45. The function $f(x)$ is defined by $f(x) = \frac{ax+b}{cx+d}$, where $a, b, c \, and \, d$ are non-zero real number such that $f(19) = 19, f(97) = 97 \, and \, f(f(x)) = x$ for all values except $-\frac{d}{c}$.If range of $f(x)$ is $R - \{\alpha\}$ (where R denotes real number set), than

(A) number of proper divisors of α is 2 (B) number of proper divisors of α is 3
(C) sum of all divisors of α is 180 (D) sum of all divisors of α is 90

46. It is given that there are two sets of real numbers $\mathrm{A} \equiv \{a_1, a_2, a_3, \ldots\ldots\ldots a_{100}\} \text{and } \{b_1, b_2, b_3, \ldots\ldots b_{50}\}$.If $f : A \to B$ is such that every element in B has an inverse image and $f(a_1) \le f(a_2) \le \ldots\ldots\ldots \le f(a_{100})$, then the number of such mapping is-

(A) ${}^{100}C_{51}$ (B) ${}^{99}C_{50}$
(C) ${}^{100}C_{49}$ (D) ${}^{99}C_{49}$

47. The real numbers x_1, x_2, x_3 satisfying the equation $x^3 - x^2 + bx + c = 0$ are in A.P. Which of the following are necessary?

(A) $b \le \frac{1}{3}$ (B) $c \ge -\frac{1}{27}$
(C) $b \le -\frac{1}{3}$ (D) $c \ge \frac{1}{27}$

Space for Rough work

48. The solution of differential equation $3\frac{dx}{dy}=\frac{x}{x^3-y}$ is $x^{\ell}=mx^n y+c$, then which of the following is/are **CORRECT**?{c is any arbitrary constant}

(A) $\ell+m+n=11$ (B) $\ell+n=9$

(C) $\ell+2m=10$ (D) $m+n=4$

49. All the 7-digit Numbers containing each of the digits 1, 2, 3, 4, 5, 6, 7 exactly once, and not divisible by 5, are arranged in increasing order. Then which of the following is/are **CORRECT**?

(A) 1993rd number in the list is 4312567 (B) 1996th number in the list is 4312756

(C) 2000th number in the list is 4315672 (D) 1999th number in the list is 43152763

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

50. Let z_1, z_2 and z_3 be complex numbers such that $|z_1|=|z_2|=|z_3|=|z_1+z_2+z_3|=2$. If $|z_1-z_2|=|z_1-z_3|$ *and* $z_2 \neq z_3$. Then find the value of $|z_1+z_2||z_1+z_3|$.

51. If $\lim\limits_{x\to1}\frac{100}{1-x^{100}}-\frac{50}{1-x^{50}}=5A$; find the value of A.

52. If $\sum_{i=0}^{\infty}\sum_{j=0}^{\infty}\sum_{k=0}^{\infty}\frac{1}{3^i3^j3^k}=\frac{27\times A}{208}$; where A is single digit natural, then find the value of A.

53. Let X be the set of all positive integer greater than or equal to 8 and let $f:X\to X$ be a function such that $f(x+y)=f(xy)$ for all $x\ge4, y\ge4$ .if $f(8)=9$ .Determine $f(9)$

54. The three different polynomials x^2+ax+b, x^2+x+ab and ax^2+x+b have exactly one common zero. Where a, b are non-zero real numbers. Find the value of $a+2b$.

Space for Rough work

FIITJEE **JEE(Advanced)-2018**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

CONCEPT RECAPITULATION TEST - IV
PAPER-1

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**D**	19.	**B**	37.	**A**
2.	**C**	20.	**A**	38.	**B**
3.	**B**	21.	**A**	39.	**C**
4.	**A**	22.	**C**	40.	**D**
5.	**A**	23.	**A**	41.	**A**
6.	**ABC**	24.	**ACD**	42.	**C**
7.	**AD**	25.	**BCD**	43.	**ACD**
8.	**ACD**	26.	**BCD**	44.	**ABCD**
9.	**AD**	27.	**ABCD**	45.	**AD**
10.	**ACD**	28.	**AC**	46.	**BD**
11.	**ACD**	29.	**ABCD**	47.	**AB**
12.	**ABD**	30.	**BD**	48.	**ABC**
13.	**BC**	31.	**ABCD**	49.	**ABC**
14.	**5**	32.	**5**	50.	**8**
15.	**6**	33.	**7**	51.	**5**
16.	**8**	34.	**9**	52.	**3**
17.	**1**	35.	**3**	53.	**9**
18.	**6**	36.	**2**	54.	**0**

Physics

PART – I

SECTION – A

1. D
2. C

From the equation of trajectory $y = 10\tan\theta - \frac{20}{9}\sec^2\theta$

$\frac{dy}{d\theta} = 0$ gives, $\tan\theta = \left(\frac{9}{4}\right)$

3. B

$$4 \times 2\pi = \frac{1}{2} \times \alpha \times 1^2, \quad \alpha = 16\pi$$

Also, $F = \frac{mr\alpha}{2}$

4. A

Applying conservation of angular momentum about Q

$$mvR\sin 30 = \left(\frac{mvd}{\sqrt{3}}\right)$$

$$\therefore d = \frac{\sqrt{3}}{2}R$$

5. A

6. ABC

7. AD

8. ACD

9. AD

10. ACD

11. ACD

12. ABD

13. BC

m, M will separate when a_x for $'m'$ becomes zero.

SECTION – C

14. [5]

15. [6]

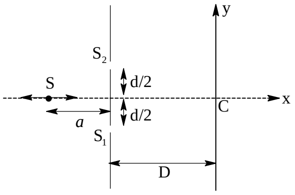
16. [8]

17. [1]

In the CM frame, work done by pseudo forces $= 2\left(\frac{F}{2}\times\ell\right) = F\ell$, this is the energy lost in collision.

18. [6]

$$I = \frac{P}{4\pi r^2}$$



$$I = \frac{P}{4\pi\left(a^2 + \left(\frac{d}{2}\right)^2\right)} \Rightarrow I_{\max} = 4I$$

Differentiate to find answer

Chemistry

PART – II

SECTION – A

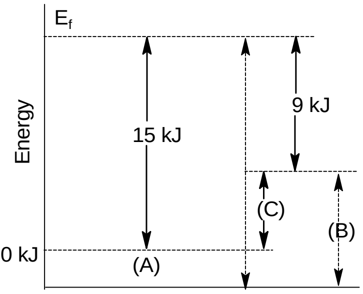
19. B
20. A
21. A
22. C
23. A
    Use trigonometry formulas
24. ACD
25. BCD
26. BCD
27. ABCD
28. AC

Sol: $p^H = 2 \Rightarrow [H^+] = 10^{-2}$ $[Ca^{+2}] = \frac{10^{-2}}{2} = 5\times10^{-3}$ moles.

$= 5\times10^{-3}$ x 40 = 200 mg.

X = 200 ppm.

26. ABCD



Hence, (A), (B), (C) and (D) are correct answer.

30. BD
31. ABCD

SECTION – C

32. [5]
33. [7]
    D is wrong other statements are correct
    This ore is $FeCr_2O_4$ and it is the prep. Of $K_2Cr_2O_7$ in figure
    $FeCr_2O_4 + O_2 + Na_2CO_3 \rightarrow Na_2CrO_4(\text{yellow}) + Fe_2O_3 + CO_2$ after acidification we have
    $NaCr_2O_7.2H_2O$ and $Na_2SO_4.10H_2O$
34. [9]
    Except chloric acid all have
35. [3]

$$\begin{array}{cccccc} V_2O_5, & V_2O_3, & CrO, & Cr_2O_3, & Mn_2O_7, & ZnO \\ (an) & (b) & (b) & (an) & (a) & (an) \end{array}$$

36. [2]

Mathematics PART – III

SECTION – A

37. A

$$x+\sqrt{x^2+1}=\frac{1}{y+\sqrt{y^2+1}}$$

$$\ell n(x+\sqrt{x^2+1})=\ell n\left(\frac{1}{y+\sqrt{y^2+1}}\right)$$

$$x+y=\sqrt{x^2+1}+\sqrt{y^2+1}..................(1)$$

Similarly, $y+\sqrt{y^2+1}=\frac{1}{x+\sqrt{x^2+1}}$

$$x+y=-\sqrt{x^2+1}-\sqrt{y^2+1}............(2)\ \ \text{ading}\,1\text{and}\ 2\ \text{x+y=0}$$

Image of xy=1in xy=1 itself

38. B

$\frac{1}{r_1},\frac{1}{r_2},\frac{1}{r_3}$ are in A.P.

$\frac{\text{(s-a)}}{\Delta},\frac{\text{(s-b)}}{\Delta},\frac{\text{(s-c)}}{\Delta}$ are in A.P.

A, b, c in A.P.

39. C

$$\left|A\right|^{(n-1)^2}=\left|A\right|^{(2n^2-7x+7)}$$

$$n^2-2n+1=2n^2-7n+7$$

$$n^2-5n+6=0$$

$$\Rightarrow n=3,2$$

40. D

Let $I=\int_0^3\frac{f(x)dx}{(x^2-3x+1)}.............(1)$

$$I=\int_0^3\frac{f(3-x)}{(x^2-3x+1)}.............(2)$$

$$(1)+(2)\Rightarrow 2I=3$$

$$I=\frac{3}{2}$$

41. A

$$y=e^{\frac{3\sin^{-1}x}{4}+\frac{\pi}{8}}$$

Maximum when $\sin^{-1}x=\frac{\pi}{2}$

Minimum when $\sin^{-1}x=-\frac{\pi}{2}$

$y=e^{\frac{-3\pi}{8}+\frac{\pi}{8}}=e^{-\frac{\pi}{2}}$

42. C

$V_n=2a_{n+2}+S_n$

$=2[-4+(n+1)]+\frac{n}{2}[-8+(n-1)]$

$=\frac{n^2-5n-12}{2}$

V_n is minimum at n=2 or n=3

$\Rightarrow$ Minimum value of V_n is -9

43. ACD

$8^3x^9+9.8^2x^6+27.8x^3-x+219=0$

$[8x^3+3]^3=512x-192$

$x^3+\frac{3}{8}=\left(x-\frac{3}{8}\right)^{1/3}$

$\Rightarrow f(x)=f^{-1}(x)$

$\Rightarrow f(x)=x[\because \text{f(x)is continuous and } \uparrow \text{fn}]$

$\Rightarrow x^3+\frac{3}{8}=x$

$x=\frac{1}{2},\frac{-1+\sqrt{13}}{4},\frac{-1-\sqrt{13}}{4}$

44. ABCD

$$x^3+2x^2-3x+1=0\begin{cases}\alpha\\ \beta\\ \gamma\end{cases}$$

$$x^3-3x^2-2x+1=0\begin{cases}1/\alpha\\ 1/\beta\\ 1/\gamma\end{cases}$$

Given expression $\frac{1}{3-\frac{1}{\alpha}}+\frac{1}{3-\frac{1}{\beta}}+\frac{1}{3-\frac{1}{\gamma}}$

$$=\frac{\sum\left(3-\frac{1}{\alpha}\right)\left(3-\frac{1}{\beta}\right)}{\left(3-\frac{1}{\alpha}\right)\left(3-\frac{1}{\beta}\right)\left(3-\frac{1}{\gamma}\right)}=\frac{27-6\sum\left[\frac{1}{\alpha}+\frac{1}{\beta}+\frac{1}{\gamma}\right]+\frac{1}{\alpha\beta}+\frac{1}{\beta\gamma}+\frac{1}{\gamma\alpha}}{\left(3-\frac{1}{\alpha}\right)\left(3-\frac{1}{\beta}\right)\left(3-\frac{1}{\gamma}\right)}=\frac{11}{7}$$

45. AD

Given $f(f(x))=x$

$$\Rightarrow \frac{af(x)+b}{cf(x)+d} = x$$

$$\Rightarrow f(x) = \frac{-dx+b}{cx-a}...........(1)$$

Given $f(x) = \frac{ax+b}{cx+d}...........(2)$

from(1)&(2)a=-d.............(3)

f(19)=19

$\Rightarrow$ 38a+b=97 $\times$ 97c.............(4)

f(97)=97

$\Rightarrow 194a + b = 97 \times 97c..........(5)$

from (5)-(4)

a=58c

$\therefore \alpha=58=2^1.29^1$

46. BD

$f(a_1) \le f(a_2) \le f(a_3) \le .... \le f(a_{100})$ It is equivalent to distribution of 100 objects to 50 persons such that each person get atleast one object.

$\therefore$ number of such mapings= ${}^{99}C_{49} = {}^{99}C_{50}$

47. AB

$x^3\text{-}x^2\text{+bx+c=0}............(1)$

Let the roots of the equation be a-d,a+d

Sum of the roots=1

a-d+a+a+d=1 or a=1/3.........(2)

(a-d)a+a(a+d)+(a-d)(a+d)=b

or $3a^2\text{-}d^2$=b

or 3(1/9)-d^2=b or 1/3-d^2=b

or d^2=1/3-b

Since d is real, 1/3-b>=0

b<=1/3

thus <b<=1/3

Product of roots=-c

(a-d)a(a+d)=-c

a(a^2-d^2)=-c

1/3(a/9-d^2)=-c

as d is real

d^2 >= 0

Or

$$\Rightarrow c \ge -\frac{1}{27} \Rightarrow -\frac{1}{27} \le c < \infty$$

48. ABC

$$3x^2\frac{dx}{dy}=\frac{x^3}{x^3-y} \qquad x^3=t$$

$$\Rightarrow \frac{dt}{dy}=\frac{t}{t-y} \quad \Rightarrow (t-y)dt=t\,dy$$

$$\Rightarrow t\,dt=y\,dt+t\,dt \Rightarrow \frac{t^2}{2}=t.y+\frac{c}{2}$$

$$\Rightarrow x^6=2x^3y+c$$

49. ABC

the 7-digit Numbers with 1 in the left most place and containing each of the digits $1,2,3,4,5,6,7$ exactly once is $6!=720$.

SECTION – C

50. [8]

The triangle has circumcentre at origin and its orthocentre laying on the circumcircle.

51. [5]

$$\lim_{y\to1}\frac{100y^{100}}{y^{100}-1}-\frac{50.y^{50}}{y^{50}-1}$$

$$\lim_{y\to1}100-50-\left(\frac{100}{1-y^{100}}-\frac{50}{1-y^{50}}\right)$$

$$\text{L=50-L} \therefore \text{L=}\frac{50}{2}=25$$

52. [3]

No condition on I, j, k

$$\frac{3}{2}\times\frac{3}{2}\times\frac{3}{2}=\frac{27}{8}$$

When any two of I, j, k are equal

$$\sum_{i=0}^{\infty}\sum_{j=0}^{\infty}\sum_{k=0}^{\infty}\frac{1}{3^{2i}}.\frac{1}{3^{j}}=\frac{3}{2}\left[1+\frac{1}{9}+.....\right]$$

$$\frac{3}{2}\times\frac{9}{8}=\frac{27}{16}$$

Where all three equal $\frac{27}{16}$

Required $\frac{27}{8}-3.\frac{27}{16}+\frac{2.27}{26}=\frac{81}{208}$

53. [9]

We observe that

f(9)=f(4+5)=f(4.5)=f(16+4)

=f(16.4)=f(64)=f(8.8)

=f(8+8)=f(16)=f(4.4)=f(4+4)=f(8)=9

54. [0]

Let $x=\alpha$ be common zero then

$\alpha^2+a\alpha+b=0............(1)$

$\alpha^2+\alpha+ab=0.............(2)$

$a\alpha^2+\alpha+b=0..............(3)$

$(1)\text{-}(2) \Rightarrow \alpha=b$ put in

(1) or (3)gives $ab^2+ab+b=0...........(4)$

& (3) give $ab^2+2b=0$ $b \neq 0 \Rightarrow ab=-2$

$a=-2, b=1 \, and \, a=1, b=-2$ (does not satisfy the mentioned condition polynomial will be same) $a+2b=0$.

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - IV

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 231**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-C & Section-D**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01 – 03, 24 – 26, 47 – 49)*** *contains 9 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (04 – 08, 27 – 31, 50 – 54) *contains 15 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (09 – 10, 32 – 33, 55 – 56) *contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer. There is no negative marking.*

2. ***Section-C (11 – 20, 34 – 43, 57 – 66)*** *contains 30 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

3. ***Section-D (21 – 23, 44 – 46, 67 – 69)*** *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

PART – I (Physics), PART – II (Chemistry), PART – III (Mathematics):
(SECTION – D)

For questions **21 to 23, 44 to 46, 67 to 69.**
Numerical answer type questions with answer XXXXX. XX

If answer is 348.4 / 251.37 / 213

Correct Method :

0	0	3	4	8	.	4	0

0	0	2	5	1	.	3	7

0	0	2	1	3	.	0	0

Wrong Method :

	3	4	8		.	4	

3	4	8			.		4

		3	4	8	.		4

	3		4	8	.	4	

	2		5	1	.	3	7

		2	1	3	.		

		2	1	3	.	0	

		2	1	3	.		0

		3	4	8	.	4	0

		2	5	1	.	3	7

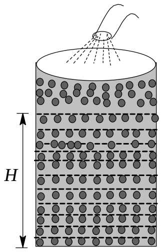
		2	1	3	.	0	0

Physics PART – I

SECTION – A
(One Options Correct Type)

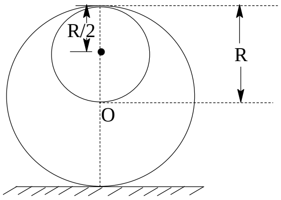
This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE** option is correct.

1. A cylindrical container having radius r = 0.3 m has perforated wall. There is large number of uniformly spread small holes on the vertical wall occupying a fraction $\eta = 0.02$ of the entire area of the wall. To container, water is being fed to it at a constant rate $Q(m^3s^{-1})$ and at steady state its height becomes 2 m. Find Q.



(A) 0.32 (B) 0.36
(C) 0.2 (D) 0.12

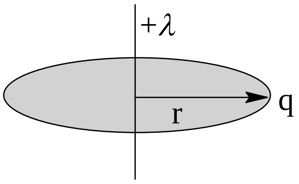
2. A spherical cavity of radius $\frac{R}{2}$ is removed from a solid sphere of radius R as shown in fig. The sphere is placed on a rough horizontal surface as shown. The sphere is given a gentle push. The sphere performs SHM and its time period is.



(A) $2\pi\sqrt{\frac{177R}{10g}}$ (B) $2\pi\sqrt{\frac{77R}{10g}}$
(C) $2\pi\sqrt{\frac{7R}{10g}}$ (D) $2\pi\sqrt{\frac{177R}{g}}$

Space for Rough work

3. A particle of charge -q and mass m moves in a circle of radius r around an infinitely long charge of linear charge density $+\lambda$.Then time period will be



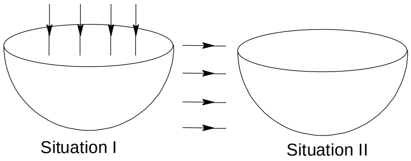
(A) $T=2\pi r\sqrt{\frac{m}{2k\lambda q}}$ (B) $T=2\pi r\frac{m}{k\lambda q}$

(C) $T=\frac{1}{2\pi r}\sqrt{\frac{2k\lambda q}{m}}$ (D) $T=\frac{1}{2\pi r}\sqrt{\frac{m}{2k\lambda q}}$

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

4. In the figure a hemispherical bowl of radius R is shown. Electric field of intensity E is present perpendicular to the circular cross section of the hemisphere.



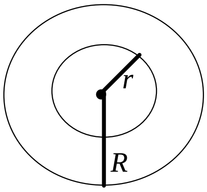
(A)The magnitude of electric flux through the hemispherical surface in situation I will be $E\pi R^2$

(B)The magnitude of electric flux through the hemispherical surface in situation I will be $2E\pi R^2$

(C)The magnitude of electric flux through the hemispherical surface in situation II will be $\frac{E\pi R^2}{2}$

(D)The magnitude of electric flux through the hemispherical surface in situation II will be zero

5. A soap bubble of radius r is formed inside another soap bubble of radius R(>r). The atmosphere pressure is P_0 and surface tension of the soap solution is T. Now the bigger bubble bursts. Assume that the excess pressure inside a bubble is small compared to P_0. For the smaller bubble choose the correct options:

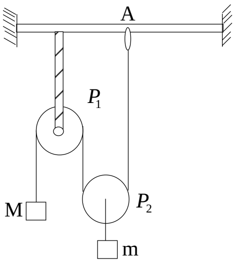


(A) The bubble shrinks (B) The bubble expands

(C) Change in its radius is $\frac{4Tr}{3P_0R}$ (D) Change in its radius is $\frac{3Tr}{4P_0R}$

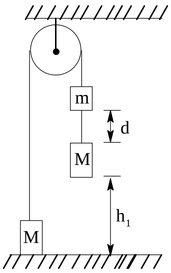
Space for Rough work

6. The arrangement shown in figure is in equilibrium with all strings vertical. The end A of the string is tied to a ring which can be slid slowly on the horizontal rod. Pulley P_1 is rigidly fixed but P_2 can move freely. A mass m is attached to the centre of pulley P_2 through a thread. Pulleys and strings are mass less.



(A) Block of mass M will move up as A is moved slowly to the right
(B) Block of mass m will move up as A is moved slowly to the right
(C) It is possible, for a particle position of A, that M has no acceleration but m does have acceleration
(D) The block of mass m will have a horizontal displacement

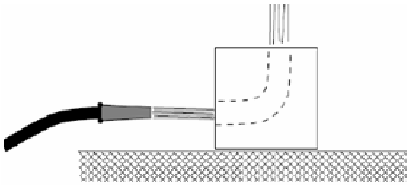
7. There are two weights of the same mass of 2.0 kg each attached to a string looped over a braked pulley. The left weight is lying on the floor, the right one is suspended 1.0 m above the floor. There is another weight of mass 0.5 kg attached to the string 20 cm above the right weight. The string except the part around the pulley is stretched vertically. We eventually release the pulley.



(A) The speed at which the lower right weight hits the floor is 1.48 m/s
(B) The height that the left weight rises to after the lower right weight falls inelastically to the floor is 1.185 m
(C) The maximum height that the lower right weight rises back to is 1.185 m
(D) The maximum height that the lower right weight rises back to is 0.31 m

Space for Rough work

8. A block of mass M, at rest on a frictionless surface, contains a curved channel. The channel is designed so that when a horizontal jet of fluid is aimed at it, the fluid is redirected 90 and shoots straight up and out of the top of the block. The flow of the jet is Q kg/s and has a velocity v m/s. Assuming no gravity and ignoring any viscous effects. [Density of fluid is ρ]



(A) Speed of the block as a function of time is $v_b = v\left(1-e^{-\frac{\rho Qt}{M}}\right)$

(B) Speed of the block as a function of time is $v_b = v\left(\frac{\rho Qt}{\rho Qt + M}\right)$

(C) Power delivered by the fluid to the block at $t = 0$ is zero

(D) Power delivered by the fluid to the block at $t = 0$ is ρQv

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 9 and 10

In a homogeneous, non-magnetic, highly insulating and viscous medium, a moving particle experiences a viscous drag given by the law $\vec{f} = -b\vec{v}$. Here b is a positive constant. A particle having charge q projected with an unknown velocity from a point in the medium almost stops (its speed becomes practically negligible) after travelling a distance of 10 m in a straight line. Now a uniform magnetic field is established in the region and the same particle is again launched with the same projection velocity directed perpendicular to the magnetic field.

9. In the presence of above magnetic field, if the particle almost stops at a point 6m away from the point projection the magnetic field is equal to:

(A) $\frac{4b}{3q}$

(B) $\frac{3b}{4q}$

(C) $\frac{4q}{3b}$

(D) $\frac{3q}{4b}$

Space for Rough work

10. The strength of the magnetic field is now doubled in magnitude. How far (in meters) from the point of projection will the particle come to an almost rest?

(A) $\frac{\sqrt{73}}{2}$

(B) $\frac{20}{\sqrt{73}}$

(C) $\frac{40}{\sqrt{73}}$

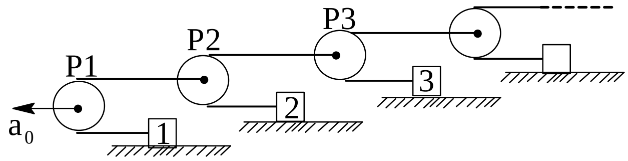
(D) $\frac{30}{\sqrt{73}}$

SECTION – C
(Single digit integer type)

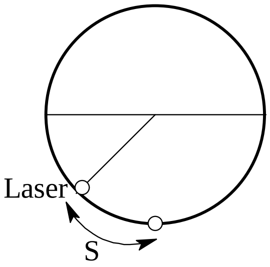
This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

11. A spherical planet of radius r, painted black, travels around the sun in a circular orbit at a distance D from its centre $(r<<<D)$. The sun, a sphere of radius R, radiates as a blackbody at a temperature $T_0=6000K$ and subtends an angle 0.01 rad as seen from the planet. The equilibrium temperature T of the planet is $x\times100$. Find x

12. In the figure all pulleys (P1, P2, P3…….) are massless and all the blocks (1, 2, 3…..) are identical, each having mass m. The system consists of infinite number of pulleys and blocks. Strings are light and in extension and horizontal surfaces are smooth. Pulley P1 is moved to left with a constant acceleration of a_0. The acceleration of block 1 will be (Assume the strings to remain horizontal) ka_0. Find 2k

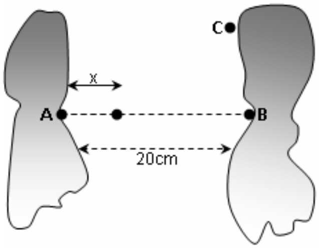


13. A horizontal cylindrical tank $6\pi m$ in diameter is half full of water. The space above the water is filled with a pressurized gas of unknown refractive index. A small laser can move all the curved bottom of the water and aims a light beam towards the centre of the water surface. When the laser has moved a distance $S=1m$ or more (measured along the curved surface) from the lowest point in the water, no light enters the gas. If the refractive index of the gas is $(\mu_{max}=4/3)$ $2/\sqrt{n}$, then n is

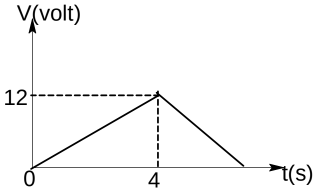


Space for Rough work

14. Two metallic bodies separated by a distance 20cm are given equal and opposite charges of magnitude $0.88\mu C$. The component of electric field along the line AB, between the plates, varies as $E_x = 3x^2 + 0.4 N/C$, where x (in meters) is the distance from one body towards the other as shown. The capacitance of the system is $n \times 10\mu F$. Find n



15. A pure inductor of inductance 3H is given across which a potential difference varying with time is shown in the adjoining figure. At t=0, current in the inductor is zero. If the current in the circuit at t=3s is N amperes. Find N



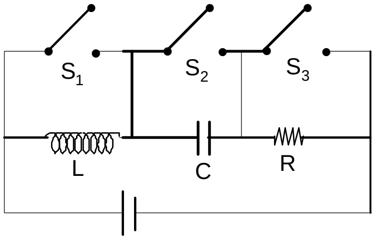
16. Nuclei of radioactive element A are produced at rate 't^2' at any time t. The element A has decay constant λ. Let N be the number of nuclei of element A at anytime t. AT time $t=t_0, \frac{dN}{dt}$, is minimum. Then the number of nuclei of element A at time $t=t_0$ is found to be $\frac{Nt_0 - \lambda t_0^2}{\lambda}$. Find the value of N

17. If 10000 V is applied across an X-ray tube, if the ratio of de-Broglie wavelength of the incident electrons to the shortest wavelength of X-ray produced (e/m for electron is $1.8 \times 10^{11} c\,kg^{-1}$) is r. Find 2/5r.

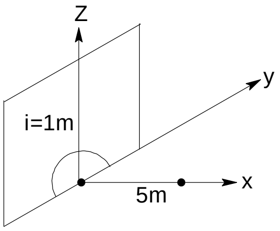
18. The internal energy of a monatomic ideal gas is 1.5 nRT. One mole of helium is kept in a cylinder of cross-section 8.5 cm^2. The cylinder is closed by a light frictionless piston. The gas is heated slowly in a process during which a total of 42 J heat is given to the gas. The temperature rises through 2°C. The distance moved by the piston is given as a × 10^b m in scientific notation. Find the value of a + b. [Take R=25/3 in SI unit, atmospheric pressure = 100 kPa]

Space for Rough work

19. Consider the circuit shown in figure. With switch S_1 closed and the other two switches open, the circuit has a time constant 0.05 sec. With switch S_2 closed and the other two switches open, the circuit has a time constant 2 sec. With switch S_3 closed and the other two switches open, the circuit oscillates with a period T. Find T (in sec). (Take $\pi^2 = 10$)



20. A plane mirror of semicircular shape (radius = 1m) is placed in y-z plane with its diameter along y-axis and centre at origin. An object is placed on the axis of mirror at point (5, 0, 0). At a distance of 10 m from plane mirror there is a wall also parallel to y-z plane. The ratio of area of spot of light on wall to that of mirror is

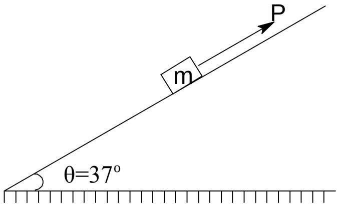


SECTION – D
(Numerical Based XXXXX.XX answer Type)

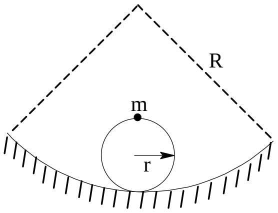
This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

21. Steel has density 7800 kg/m^3 and will break if tensile stress exceeds 7.0 × 10^8 N/m^2. A person wants to make a guitar string from 4.0 gm of this steel. The guitar string must be able to withstand a tension of 900 N. The maximum speed of transverse wave can be $\text{x.xx} \times 100$ m/s

22. A block of mass m is being pulled up the rough incline, inclined at an angle 37° with horizontal by an agent delivering constant power P. The coefficient of friction between the block and the incline is μ. Find the maximum speed (in km/hr) of the block during the course of ascent. Give the answer as x.xxx [Take : P = 60 W, m = 1 kg, μ = 0.5]



23. A ring of radius r and mass 2m, rests on a rough circular track of radius R.A small point mass of mass m is mounted on its periphery. If friction is sufficient to avoid any slipping then the minimum ratio of $\frac{r}{R}$ is x.xx



Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE** option is correct.

24. Give the correct order of initials T(True) or F(False) for following statements:
(I) In an antifluorite structure, anions form FCC lattice and cations occupy all tetrahedral voids
(II) If the radius of cations and anions are 0.2 and 0.95 then co-ordination number of cation in the crystal is 4
(III) An atom/ion is transferred from a lattice site to interstitial position in Frankel defect
(IV) Density of crystal always increase due to substitutional impurity defect
(A) TFFF (B) FTTF
(C) TFFT (D) TFTF

25. When one mole of A(g) is introduced in a closed rigid one litre vessel maintained at constant temperature, the following equilibria are established:

$$A(g) \rightleftharpoons B(g) + C(g); \quad K_{C_1}$$

$$C(g) \rightleftharpoons D(g) + B(g); \quad K_{C_2}$$

The pressure at equilibrium is twice the initial pressure if $\frac{[C]_{eq}}{[B]_{eq}} = \frac{1}{5}$, then $\frac{K_{c_2}}{K_{c_1}}$ is equal to
(A) 16/5 (B) 4
(C) 16 (D) 5/16

26. The specific conductivity of 0.5 M aq. solution of a monobasic acid (HA) after subtracting the specific conductance of water is found to be 0.006 Scm^{-1}. If its molar conductivity at infinite dilution is 200 Scm^2mol^{-1}, then the osmotic pressure of 0.1 M aq. solution of HA will be
(R = 0.0821 dm^3 atm $mol^{-1}K^{-1}$)whole experiment took at 1365K.
(A) 0.72 atm (B) 1.72 atm
(C) 12.72 atm (D) 7.72 atm

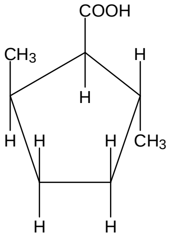
Space for Rough work

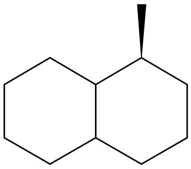
(One or More than one correct type)

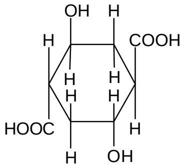
This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

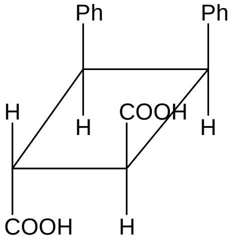
27. Copper glance to pure copper undergoes which of the following processes?
(A) Hydrometallurgy
(B) Electrolytic refining
(C) Roasting
(D) poling

28. Which species do not exhibit a plane of symmetry?

(A)

COOH
CH3
H
H
H H
H CH3
H H

(B)


(C)

OH H
H COOH
H H
H H
HOOC H
H OH

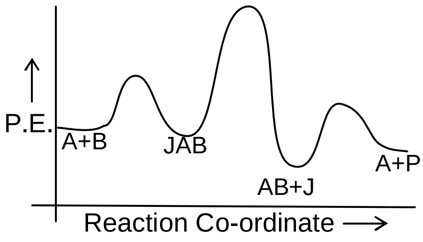
(D)

Ph Ph
H
H
COOH
H
COOH H

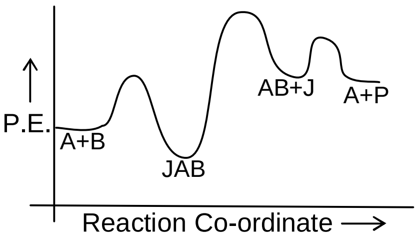
Space for Rough work

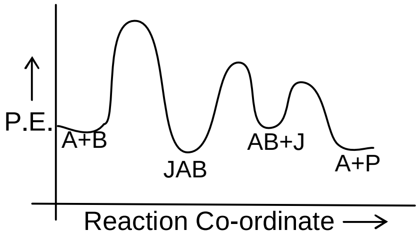
29. The following mechanism has been proposed for the exothermic catalysed complex reaction:

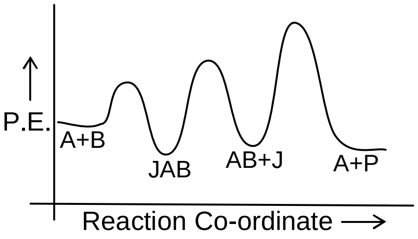
$$A + B \overset{\text{Fast}}{\rightleftharpoons} JAB \xrightarrow{k_1} AB + J \xrightarrow{k_2} P + A$$

if k_1 is much smaller than k_2, then the incorrect qualitative plot of potential energy (PE) vs reaction coordinate for the above reaction is/are

(A) 

(B) 

(C) 

(D) 

30. Which of the following statements are correct?
(A) The crystal lattice of ice is mostly formed by covalent as well as hydrogen bonds
(B) The density of water increases when heated from 0^oC to 4^oC due to the change in the structure of cluster of water molecules
(C) Above 4^oC, thermal agitation of water molecules increases and water starts expanding
(D) The density of water increases from 0^oC to a maximum at 4^oC and the entropy of the system increases

31. Elements of 15th group form hydrides of general formula MH_3. Which of the following characteristic(s) of these hydrides decreases regularly on moving down the group (from NH_3 to BiH_3)?
(A) decomposition temperature
(B) boiling temperature
(C) reducing character
(D) HMH bond angle

Space for Rough work

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 32 and 33

The concentration of potassium ions inside a biological cell is at least twenty times higher than the outside. The resulting potential difference across the cell is important in several processes such as transmission of nerve impulses and maintaining the ion balance. A simple model for such a concentration cell involving a metal M is:

$M(s) | M^+(aq; 0.05\text{ molar}) || M^+(aq), 1\text{ molar}) | M(s)$

For the above electrolytic cell the magnitude of the cell potential $|E_{cell}| = 70$ mV.

32. For the above cell

(A) $E_{cell} < 0; \Delta G > 0$ (B) $E_{cell} > 0; \Delta G < 0$

(C) $E_{cell} < 0; \Delta G^o > 0$ (D) $E_{cell} > 0; \Delta G^o > 0$

33. If the 0.05 molar solution of M^+ is replaced by 0.0025 molar M^+ solution, then the magnitude of the cell potential would be

(A) 35 mV (B) 70 mV

(C) 140 mV (D) 700 mV

SECTION – C
(Single digit integer type)

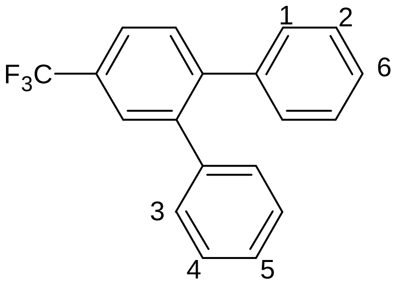
This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

34. How many is/are correct for Glycine.

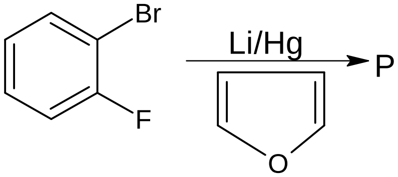
(A) Forms salt with strong inorganic acids
(B) It reacts with acetyl chloride to give acetyl derivative.
(C) When it is treated with HNO_2, N_2 is evolved.
(D) With Nitrosyl chloride $(NOCl)$ it forms chloro acetic acid.
(E) It can be esterified by an alcohol in presence of inorganic acid.
(F) It can form coordinated compounds with metal ions.
(G) Can be reduced to aminoalcohols by $LiAlH_4$.
(H) It is optically inactive.
(I) Can be prepared by the action of concentrated ammonium hydroxide solution on chloroacetic acid

Space for Rough work

35. Which is the most favoured position for the attack of an electrophile



36.



What is the degree of unsaturation in P.

37. Calculate the value of $\frac{Z}{10}$. Where

Z = Co-ordination number of 2D-square close packing
+
Coordination number of 2D-hcp
+
Co-ordination number of 3D-square close packing
+
Co-ordination number of 3D, ABCABC………Packing
+
Co-ordination number of 3D, ABAB……… packing

38. The standard reduction potential of a silver chloride electrode (metal-sparingly soluble salt electrode) is 0.209 V and for silver electrode is 0.80V. If the moles of AgCl that can dissolve in 10L of a 0.01M NaCl solution is represented as 10^{-z} then find the value of Z.

Space for Rough work

39. In the given radioactive disintegration series,

$${}^{232}_{90}\text{Th} \rightarrow {}^{208}_{82}\text{Pb}$$

Calculate value of (n+2)

Where value of n is number of isobars formed in this series, suppose there is successive emission of β-particles.

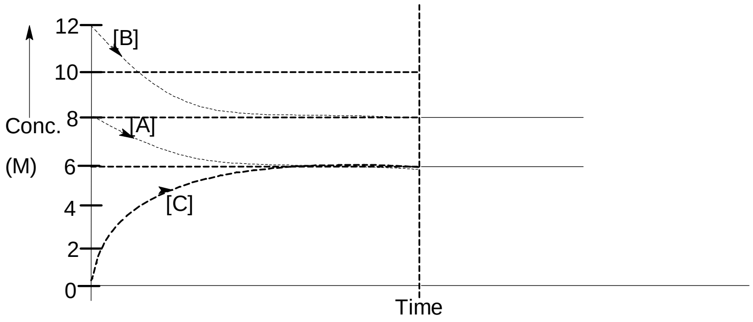
40. Among the following, the total number of compounds whose aqueous solution turns red litmus paper blue is:

NaCN	KCl	CH_3COONH_4	NaH_2PO_4	$ZnCl_2$	Na_3PO_4
$Fe(NO_3)_3$	Na_2CO_3	NH_4Cl	$NaHCO_3$	$Na_2C_2O_4$	Na_2HPO_4

Given:

Acid	Ka_1	Ka_2	Ka_3
H_3PO_4	10^{-3}	10^{-8}	10^{-12}
H_2CO_3	10^{-6}	10^{-11}	-
$H_2C_2O_4$	10^{-2}	10^{-5}	-

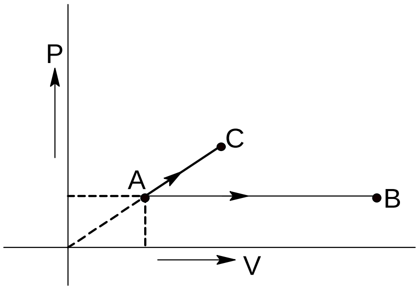
41. The gaseous reaction: $A(g)+nB(g) \rightleftharpoons mC(g)$ is represented by following curves



What is the value of $n+m$

Space for Rough work

42. One mole ideal monoatomic gas is heated gas is heated according to path AB and AC. If temperature of state B and C are equal. Calculate $\frac{q_{AC}}{q_{AB}} \times 10$.



43. How many of the following decompose easily as compared to $CaCO_3$ to evolve CO_2

$CdCO_3$, $PdCO_3$, $COCO_3$, $MnCO_3$, Na_2CO_3, $BaCO_3$, $FeCO_3$, $BeCO_3$, Ag_2CO_3

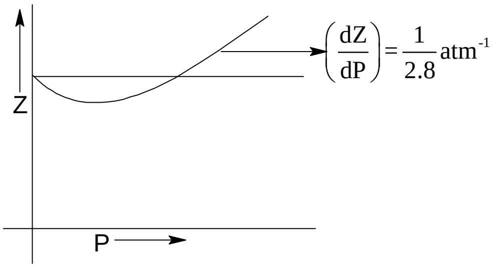
SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

44. When a liquid that is immiscible with water was steam distilled at $95.2^{o}C$ at a total pressure of 748torr, the distillate contained 1.25g of the liquid per gram of water. The vapour pressure of water is 648 torr at $95.2^{o}C$, what is the molar mass of liquid in g/mol.

45. The graph of compressibility factor (Z) vs. P for one mole of a real gas is shown in following diagram. The graph is plotted at constant temperature 273K. If the slope of graph at very high pressure $\left(\frac{dZ}{dP}\right)$ is $\left(\frac{1}{2.8}\right)atm^{-1}$, then calculate volume of one mole of real gas molecules (in L/mol) Given:

$N_A = 6\times10^{23}$ and $R = \frac{22.4}{273} L\,atm\,K^{-1}\,mol^{-1}$



46. $40g\,Ba(MnO_4)_2$ (mol.mass =375) sample containing some inert impurities in acidic medium completely reacts with 125mL of ''33.6 V'' of H_2O_2. What is the percentage purity of the sample?

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

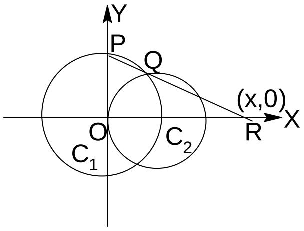
This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE** option is correct.

47. $I = \int \frac{x^2}{(x\cos x - \sin x)} \frac{dx}{(x\sin x + \cos x)}$

(A) $\ln\left|\frac{x\cos x - \sin x}{x\sin x + \cos x}\right| + c$
(B) $\ln\left|\frac{x\sin x + \cos x}{x\cos x - \sin x}\right| + c$
(C) $\frac{x\sin x + \cos x}{x\cos x - \sin x} + c$
(D) $\frac{x\cos x - \sin x}{x\sin x + \cos x} + c$

48. Find the minimum value of $(x_1 - x_2)^2 + \left(\sqrt{1-x_1^2} - 12 + 2\sqrt{x_2}\right)^2$

(A) $\left(\sqrt{70} - 2\right)^2$
(B) $\left(\sqrt{80} - 1\right)^2$
(C) $\left(\sqrt{70} - 1\right)^2$
(D) $\left(\sqrt{80} + 1\right)^2$

49.


Find the limiting value of OR as $r \to 0^+$

$C_1 : x^2 + y^2 = r^2$

$C_2 : (x-1)^2 + y^2 = 1^2$

(A) 2
(B) 4
(C) 8
(D) 16

Space for Rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

50. For the ellipse $12x^2 - 12xy + 7y^2 = 48$

(A)slope of major axis is $\frac{3}{2}$ and length =8

(B)slope of minor axis is $\frac{-2}{3}$ and length=6

(C)coordinate of foci are $(2,3)$ and $(-2,-3)$

(D)Equation of directrices are $2x+3y+14=0$ and $2x+3y-14=0$

51. Which of the following are correct

(A) If A and B are both symmetric or skew symmetric matrix and they are anticommutative and AB is skewsymmetric matrix

(B) $\left(\text{adjA}\right)^{-1} = \frac{A}{|A|}$ (where A is any square matrix)

(C) For a square matrix A to be orthogonal it is necessary and sufficient that its $|A| = \pm 1$ and that of each element be equal to its cofactor taken with sign if $|A| = 1$ and with sign reversed if $|A| = -1$

(D) The product of 2 orthogonal matrices is orthogonal matrices is orthogonal and inverse of an orthogonal matrix is orthogonal.

52. If $A_1, A_2, A_3, ...A_{1006}$ be independent events such that $P(Ai)=\frac{1}{2i}(i=1,2,3,....1006)$ and probability that none of the events occurs be $\frac{\alpha!}{2^{\alpha}(\beta!)^2}$ then

(A) β is of form $4k+2, k \in I$

(B) $\alpha = 2\beta$

(C) β is a composite number

(D) α is of form $4k, k \in I$

Space for Rough work

53. Consider the lines:

$L_1:\frac{x-2}{1}=\frac{y-1}{7}=\frac{z+2}{-5}$ $L_2:x-4=y+3=-z$

Then which of the following is/are correct?

(A) Point of entersection of L_1 and L_2 is (1,-6,3)

(B) Equation of plane containing L_1 and L_2 is $x+2y+3z+2=0$

(C) Acute angle between L_1 and L_2 is $\cos^{-1}\left(\frac{13}{15}\right)$

(D) Equation of plane containing L_1 and L_2 is $x+2y+3z+2=0$

54. Let z_1,z_2 and z_3 be three distinct complex numbers, satisfying $|z_1|=|z_2|=|z_3|=1$, which of the following is/are correct.

(A) If $\arg\left(\frac{z_1}{z_2}\right)=\frac{\pi}{2}$ then $\arg\left(\frac{z-z_1}{z-z_2}\right)>\frac{\pi}{4}$ where $|z|>1$

(B) $|z_1z_2+z_2z_3+z_3z_1|=|z_1+z_2+z_3|$

(C) $\operatorname{Im}\left(\frac{(z_1+z_2)(z_2+z_3)(z_3+z_1)}{z_1.z_2.z_3}\right)=0$

(D) If $|z_1-z_2|=\sqrt{2}|z_1-z_3|=\sqrt{2}|z_2-z_3|$, then $\operatorname{Re}\left(\frac{z_3-z_1}{z_3-z_2}\right)=0$

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 55 and 56

The centres of two circles c_1 and c_2 of radii 4 and 9 respectively are at a distance of 15units from each other. Let L_1 be one correct common tangent to these circles.

55. There are n circles which touches both the circle C_1 and C_2 and also the line L_1 then n is

(A) 2 (B) 4
(C) 3 (D) 8

56. Let $r_1,r_2,......r_n$ be the radii of these circles then find max $(r_1,r_2,......r_n)$?

(A) $\frac{25}{2}$ (B) $\frac{50}{9}$
(C) 50 (D) 1

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

57. Find the largest integer value of x satisfying the inequality $\log_{0.09}(x^2+2x) \geq \log_{0.3}\sqrt{x+2}$.

58. Let $H_n = 1+\frac{1}{2}+\frac{1}{3}+...+\frac{1}{n}$ and $T_n = \frac{1}{(n+1)H_n H_{n+1}}$, then the value of $(T_1+T_2+T_3+...+\infty)$ is:

59. Complex numbers a, b and c are zeroes of polynomials $P(z)=z^3+qz+r$ (where $q, r \in R$)and $|a^2|+|b^2|+|c^2|=250$. If the points corresponding to a, b and c in complex plane are the vertices of a right angled triangle with hypotenuse h, then $\left(\frac{h^2}{125}\right)$.

60. If N denotes the number of non-empty subsets of {1,2,3,…,12} having property that the sum of largest element and smallest element is 13, then number of divisors of N divisible by 5 is:

61. The number of distinct terms in expansion of $\left(x+y+z+\frac{1}{xy}+\frac{1}{yz}+\frac{1}{zx}\right)^2$ is m and that in expansion of $\left(x+y+z+\frac{1}{x}+\frac{1}{y}+\frac{1}{z}\right)^2$ is n, then $|m-n|$ is equal to:

Space for Rough work

62. There are 4 bowlers, 4 batsman and 1 all-rounder (who is bowler as well as batsman). Randomly a team of 4 players consisting of at least two bowlers and at least two batsman is formed. If the probability that all-rounder has been selected in team is $\frac{4}{p}$, then p is equal to:

63. Find the sum of all integral values of a values of a where $a \in [-10, 10]$ such that the graph of the function $f(x) = ||x-2|-a|-3$ has exactly three x-intercepts.

64. Let $f: R \to R$ be a function defined as

$$f(x) = \begin{cases} 1-|x|, & |x| \le 1 \\ 0, & |x| > 1 \end{cases} \text{and } g(x) = f(x-1) + f(x+1) \forall x \in R$$. Find number of points of non-differentiability of g(x) on R.

65. Suppose $\int \frac{1-7\cos^2 x}{\sin^7 x \cos^2 x} dx = \frac{g(x)}{\sin^7 x} + C$, where C is an arbitrary constant of integration. Then the value of $g'(0) + g''\left(\frac{\pi}{4}\right)$.

66. Let f be a differentiable function defined such that $f: [0, 27] \to \left[\frac{1}{3}, 6\right]$ *and* $f'(x) < 0 \forall x \in D_f$ .If $\int_0^{27} xf'(x)dx = \lambda - 3\int_0^3 x^2 f(x^3)dx$ then find the value of λ .

[Note: D_f denotes the domain of the function**.]**

Space for Rough work

SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

---

67. The polynomial R(x) is the remainder upon dividing x^{2007} by $x^2 - 5x + 6$. If R (0) can be expressed as $ab(a^c - b^c)$, find the value of $\frac{a+b}{20}$+c=?

68. Let C be the set of 6 consonants {b,c,d,f,g,h} and V be a set of 5 vowels {a,e,I,o,u} and W be the set of seven letter words that can be formed with these 11 letters using both the following rules:
(a)The vowels can be consonants in the word must alternate.
(b)No letter can be used more than once in a single word.
If the number of words in the set W are K then find K/7.

69. Let f be real function defined on R (the set of real numbers) such that $f'(x) = 100\ (x-1)(x-2)^2(x-3)^3.......(x-100)^{100}$, for all $x \in R$. If g is a function defined on R such that $\int_a^x e^{f(t)}dt = \int_0^x g(x-t)dt + 2x + 3$, If some of the all the values of x for which g(x) has a local extremum be λ then find $\frac{\lambda}{3}$

Space for Rough work

FIITJEE

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ANSWERS, HINTS & SOLUTIONS

CONCEPT RECAPITULATION TEST - IV

PAPER-2

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**A**	24.	**D**	47.	**B**
2.	**A**	25.	**B**	48.	**B**
3.	**A**	26.	**C**	49.	**B**
4.	**BD**	27.	**ABCD**	50.	**AC**
5.	**BC**	28.	**ABCD**	51.	**ABC**
6.	**ACD**	29.	**BCD**	52.	**ABC**
7.	**ABD**	30.	**ABCD**	53.	**ABCD**
8.	**BC**	31.	**AD**	54.	**BCD**
9.	**A**	32.	**B**	55.	**B**
10.	**D**	33.	**C**	56.	**C**
11.	**3**	34.	**9**	57.	**1**
12.	**3**	35.	**2**	58.	**1**
13.	**3**	36.	**7**	59.	**3**
14.	**1**	37.	**4**	60.	**8**
15.	**7**	38.	**7**	61.	**1**
16.	**2**	39.	**7**	62.	**7**
17.	**4**	40.	**6**	63.	**3**
18.	**1**	41.	**5**	64.	**5**
19.	**2**	42.	**8**	65.	**5**
20.	**9**	43.	**7**	66.	**9**
21.	**00002.99**	44.	**00145.80**	67.	**02011.25**
22.	**00001.66**	45.	**00002.00**	68.	**05142.85**
23.	**00000.25**	46.	**00070.31**	69.	**00833.33**

Physics

PART – I

SECTION – A

1. A

Rate of loss of water $= \int_0^2 \pi r^2 \left(dy\eta\sqrt{2gy}\right)$

2. A
3. A

$$\frac{2\lambda k}{r} = \frac{mv^2}{r}, T = \frac{2\pi r}{v}$$

4. BD
5. BC

For the bubble, $\mathrm{PV=const.}$

$$\therefore \frac{\mathrm{dV}}{V} = \frac{-dP}{P}$$

$$\frac{dV}{V} = \frac{3dr}{r}, dP \approx -\frac{4T}{R},\ P \approx P_0\left(\text{according to the question}\right)$$

$$\therefore\ dr = \frac{4Tr}{3P_0R}$$

6. ACD
7. ABD
8. BC
9. A
10. D

[9-10]

For the charge

$$\vec{F} = q\left(\vec{v}\times\vec{B}\right) - b\vec{v}$$

$$\therefore \frac{d\vec{v}}{dt} = \frac{q}{m}\left(\frac{d\vec{r}}{dt}\times\vec{B}\right) - \frac{b}{m}\left(\frac{d\vec{r}}{dt}\right)$$

$$\therefore \Delta\vec{v} = \frac{q}{m}\left(\Delta\vec{r}\times\vec{B}\right) - \frac{b\left(\Delta\vec{r}\right)}{m}$$

SECTION – C

11. 3
12. 3
13. 3
14. 1
15. 7
16. 2
17. 4
18. 1

Sol: The change in internal energy of the gas is DU = 1.5 nR (DT)= 1.5 (1 mol) (253J/mol-K) (2K)
= 25 J.
The heat given to the gas = 42 J
The work done by the gas is DW = DQ – DU= 42 J – 25 J = 17 J.
If the distance moved by the piston is x, the work done is DW = (100 kPa) (8.5 cm2) x.
Thus, (105 N/m2) (8.5 × 10–4 m2) x = 17 J or, x = 0.2m = 20 cm.

19. 2

t1 = RC; t2 = R/L

→LC = t1t2 = 0.1 sec -> T = 2pie $\sqrt{\frac{1}{LC}}$

T = 2 sec.

20. 9

SECTION – D

21. 00002.99

22. 00001.66

23. 00000.25

Chemistry PART – II

SECTION – A

24. D
25. B
26. C
27 ABCD
28. ABCD
29. BCD
30. ABCD
31. AD
32 B
33. C

Solutions

$$\underset{1}{A} \rightleftharpoons \underset{0}{B} + \underset{0}{C} \qquad \underset{\alpha}{C} \rightleftharpoons \underset{\alpha}{B} + \underset{0}{D}$$

$$1\text{-}\alpha \quad \alpha \quad \alpha \qquad \alpha\text{-}\beta \quad \alpha+\beta \quad \beta$$

$$1\text{-}\alpha \quad \alpha+\beta \quad \alpha\text{-}\beta$$

$$Kc_1 = \frac{(\alpha\text{-}\beta)(\alpha+\beta)}{1\text{-}\alpha} \qquad Kc_2 = \frac{\beta(\alpha+\beta)}{\alpha\text{-}\beta}$$

$$\frac{[C]}{[B]} = \frac{\alpha\text{-}\beta}{\alpha\text{-}\beta} = \frac{1}{5} \qquad \frac{\alpha}{\beta} = \frac{3}{2}$$

Final Press=2[initial Press]

$$\alpha+\beta=1$$

So, $\alpha=\frac{3}{5} \quad \beta=\frac{2}{5}$

$$Kc_1=\frac{1}{2} \quad Kc_2=2$$

$$\frac{Kc_2}{Kc_1} = 4$$

$$\wedge_m = \frac{1000\times 0.006}{0.5} = 12$$

$$\alpha=\frac{12}{200}=0.06$$

$$C_1\alpha_1^2=C_2\alpha_2^2$$

$$\alpha_2=0.135$$

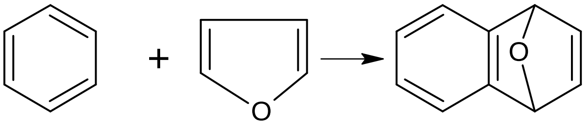
$$i=1.135$$

$$\pi=12.72\text{atm}$$

SECTION – C

34. 9
Sol. check structure of glycine amino acid
35. 2
Sol. due to – I effect

36. 7



(P)

Sol.

37. 4

Sol. 4+6+6+12+12=40

$\therefore z = 4$

38. 7

Sol. $E^0_{Cl^-/AgCl/Ag}=E^0_{Ag^+/Ag}+\frac{0.0591}{1}\log K_{sp}$

$\therefore K_{sp} = 10^{-10}$ then let x be solubility of $AgCl$ in 0.01M solution of $NaCl$

$\Rightarrow 10^{-10} = x(x+0.01)$

$x=10^{-8}$moles/L

39. 7

Sol. 4β and 6α particles are emitted.

40. 6

Sol. $NaCN$, Na_3PO_4, Na_2CO_3, $NaHCO_3$, $Na_2C_2O_4$, Na_2HPO_4 these are basic.

41. 5

Sol. m=3 and n=2

42. 8

Sol. Process AC=polytropic process P=KV

So molar heat capacity $C_m=C_v+\frac{R}{2}=2R$

Process AB is isobaric $C_m=C_p=\frac{5R}{2}$

$$\frac{q_{AC}}{q_{AB}}=\frac{\int_{T_A}^{T_C} nC_m dT}{\int_{T_A}^{T_B} nC_{p,m} dT}=0.8$$

43. 7

except Na_2CO_3 and $BaCO_3$ all other are correct

SECTION – D

44. 00145.80

Sol: $P^0_{liquid} = 748-648 = 100$ then $\frac{W_A}{W_B}=\frac{P^0_A M_A}{P^0_B M_B}$

$\therefore M_A = 145.8$

45. 00002.00

Sol. $Z=1+\frac{Pb}{RT}$ high pressure

So $\frac{\text{dz}}{\text{dp}}=\frac{\text{b}}{\text{RT}}=\frac{1}{2.8}\Rightarrow b=\frac{RT}{2.8}=\frac{22.4}{2.8}=4\left(N_A\times\frac{4}{3}\pi r^3\right)$

So $4\left(N_A\times\frac{4}{3}\pi r^3\right)$ for one mole of gas =2

46. 00070.31

Sol. m-eq. of $\text{Ba(MnO}_4)_2$=m-eq.of H_2O_2

$\left(\because M=\frac{33.6}{11.2}\Rightarrow 3\right)$

$\frac{w}{375}\times10\times1000=3\times125\times2;$

w=28.125

% purity=$\frac{w}{40}\times100$

$=\frac{28.125}{40}\times100=70.31$

Mathematics PART – III

SECTION – A

47. B

$$\int \frac{x^2}{\underbrace{(x\cos x-\sin x)}_{f}}\frac{dx}{\underbrace{(x\sin x+\cos x)}_{g}}$$

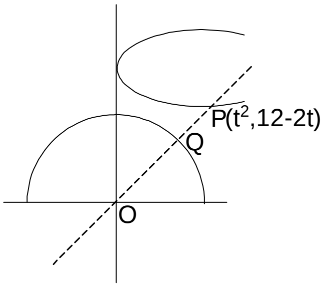
$$\frac{fg'-gf'}{fg}=\frac{g'}{g}-\frac{f'}{f}$$

$$=\ln\frac{g}{f}+c$$

48. B

$$A\left(x_1,\sqrt{1-x_1^2}\right)$$

$$B\left(x_2,12-2\sqrt{x_2}\right)$$



$$y=12-2\sqrt{x}$$

$$P\to(4,8)$$

$$\therefore OP=\sqrt{16+64}=\sqrt{80}$$

$$PQ=OP-OQ$$

$$=\sqrt{80}-1$$

49. B

50. AC

51. ABC

$A\to$ obvious

$$B\to(\text{adj}A)^{-1}$$

$$=\frac{adj(adjA)}{|adjA|}$$

$$\frac{|A|^{n-2}A}{|A|^{n-1}}=\frac{A}{|A|}$$

$$C\to A^{-1}=A^T$$

$$\frac{1}{A}(cofactor\,matrix)^T = A^T$$

$$\to again\,transpose$$

$$\frac{1}{|A|}(cofactor\,matrix) = A$$

$$\text{If, } |A| = 1 \Rightarrow aij = Aij$$

$$and\,|A| = -1 \Rightarrow aij = Aij$$

$$D \to AA^T = A^T A = I$$

$$BB^T = B^T B = I$$

$$LHS\,\underbrace{(AB)B^T}_{I}A^T$$

$$\therefore AIA^T = AA^T = I$$

$$Similarly\,(A^{-1})(A^{-1})^T = A^{-1}(A^T)^T = A^{-1}A = I$$

52. ABC

Sol. $\left(1-\frac{1}{2}\right)\left(1-\frac{1}{4}\right)\left(1-\frac{1}{6}\right)...\left(1-\frac{1}{2012}\right)$

$$= \frac{1}{2} \times \frac{3}{4} \times \frac{5}{6} \times \frac{7}{8} \times ...... \times \frac{2011}{2012} = \frac{2012!}{2^{2012}(1006!)^2}$$

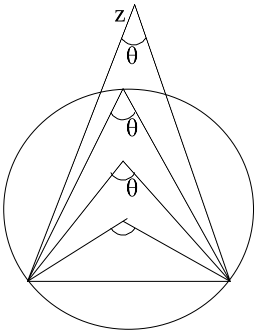
53. ABCD

Sol. point p on line L_1 $P(2+\lambda, 1+7\lambda, -2-5\lambda)$

Point P on line L_2 $P(4+r, -3+r, -r)$

$\Rightarrow \lambda = -1, r = -3$

54. BCD



(A) If $\arg\left(\frac{z_1}{z_2}\right) = \frac{\pi}{2}$ then z_1 and z_2

Subtend right angle at circum centre origin.

$\therefore$ the chord joining z_1 and z_2 will subtend an angle θ at z such that

$$\theta = \frac{\pi}{4} \text{ if } |z| = 1$$

$$\theta < \frac{\pi}{4} \text{ if } |z| > 1, \quad \theta > \frac{\pi}{4} \text{ if } |z| < 1$$

(B) $\left|z_1z_2+z_2z_3+z_3z_1\right| = |z_1||z_2||z_3|\left|\frac{1}{z_1}+\frac{1}{z_2}+\frac{1}{z_3}\right|$

$=\overline{\left|z_1+z_2+z_3\right|}$

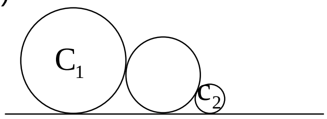
(C) $\left(\frac{(z_1+z_2)(z_2+z_3)(z_3+z_1)}{z_1z_2z_3}\right)\overline{\left(\frac{(z_1+z_2)(z_2+z_3)(z_3+z_1)}{z_1z_2z_3}\right)}$

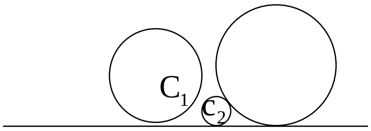
(D)The triangle formed by joining $z_1, z_3 \text{and} z_2$ is isosceles and right angled at z_3.

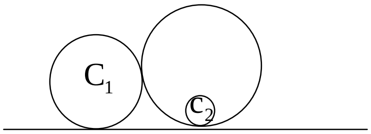
55. B

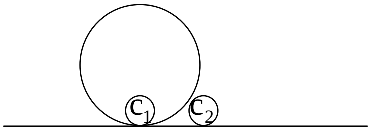
56. C

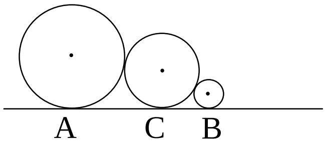
Sol. (1)







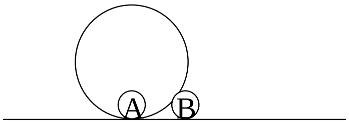


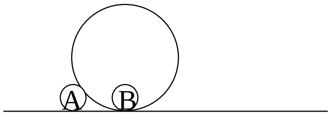


(2)

AB=AC+BC

$=\sqrt{225-25}=\sqrt{4r(9)}+\sqrt{4(r)(4)}$



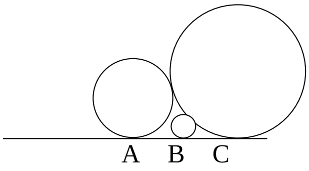


AB=AB

$\sqrt{200}=\sqrt{4(9)\text{r}}$

$\sqrt{4\text{r}(4)}=\sqrt{200},\text{r}=\frac{50}{9}$

$\text{r}=\frac{25}{2}$



AC-BC=AB

$\sqrt{4(9)\text{r}}-\sqrt{4(4)\text{r}}=\sqrt{200}$

$2\sqrt{\text{r}}=\sqrt{200}$

r=50

SECTION – C

57. 1

58. 1

Sol: $T_n = \frac{H_{n+1}\text{-}H_n}{H_n H_{n+1}}$

As $H_{n+1}\text{-}H_n = \frac{1}{n+1}$

$\Rightarrow T_n = \frac{1}{H_n} - \frac{1}{H_{n+1}} \quad \Rightarrow T_1 = \frac{1}{H_1} - \frac{1}{H_2}$

$T_2 = \frac{1}{H_2} - \frac{1}{H_3}$

$\vdots \quad \vdots \quad \vdots$

$T_n = \frac{1}{H_n} \text{-} \frac{1}{H_{n+1}}$

$T_1 + T_2 + ... + T_n = \frac{1}{H_1} \text{-} \frac{1}{H_{n+1}}$

$\text{As}\, n \to \infty, \quad T_1 + T_2 + ... + 0 = 1$

59. 3

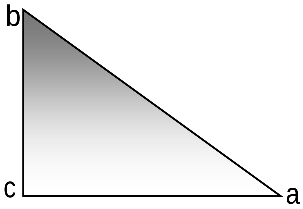
Sol. Given polynomial is a cubic with real coefficients $\Rightarrow$ at least one real root and other are conjugate complex zeroes.

Let $a = x + iy,\ b = x - iy,\ \ c = -2x$

$\because \quad a + b + c = 0$

$\therefore \quad \left|a^2\right| + \left|b^2\right| + \left|c^2\right| = 250$

$\Rightarrow \quad 3x^2 + y^2 = 125$



Using Pythagoras

$9x^2 + y^2 + 9x^2 + y^2 = 4y^2$

$\Rightarrow \quad 3x^2 = \frac{y^2}{3}$

$\therefore \quad \frac{4y^2}{3} = 125 \Rightarrow \frac{h^2}{125} = \frac{4y^2}{125} = 3$

60. 8

Sol. If a is the smallest element of such a set then 13-a is the largest and the remaining elements can be choosen from 12-2a elements i.e., 2^{12-2a}

Also, $13 - a \geq a \qquad \Rightarrow a < 7$

$\therefore$ Number of such set $= 2^{10} + 2^8 + 2^6 + ... + 2^0 = 1365$

$= 3 \times 5 \times 7 \times 13$

$\therefore$ Divisors divisible by 5 is 8.

61. 1

Sol. Number of distinct terms in $\left(x + y + z + \frac{1}{xy} + \frac{1}{yz} + \frac{1}{zx}\right)^2$ is 18 and number of distinct terms in

$\left(x+y+z+\frac{1}{x}+\frac{1}{y}+\frac{1}{z}\right)^2$ is 19

$\therefore \quad |m-n|=1$

62. 7

Sol. Clearly a team of 4 with two batsman and two bowler can be formed as

Case-I: 2 bowler+2batsman

Number of ways= ${}^4C_2 \times {}^4C_2 = 36$

Case-II: 2 bowler+1 batsman +1 all-rounder

${}^4C_2 \times {}^4C_1 \times {}^1C_1 = 24$

Case-III: 1bowler +2 batsman +1 all-rounder

${}^4C_1 \times {}^4C_2 \times {}^1C_1 = 24$

$\therefore$ Probability that all-rounder is selected= $\frac{24+24}{36+24+24}=\frac{4}{7}$

$\therefore \quad p=7$

63. 3

Sol. For x-intercept y=0

$\therefore \quad \left||x-2|-a\right|=3$

$\Rightarrow \quad |x-2|-a=3 or -3$

$\Rightarrow \quad |x-2|=a+3 or a-3$

For 3 x-intercepts

$a+3>0 \text{ and } a-3=0 \qquad .....(i)$

or $\quad a+3=0 \text{ and } a-3>0 \qquad .....(ii)$

From Eq. (i) a=3 and Eq. (ii) is rejected.

Hence, sum=3

64. 5

65. 5

66. 9

Sol. $\int_0^{27} xf'(x)dx=\lambda-3\int_0^3 x^2 f(x^3)dx$

$x^3=t$

$\Rightarrow 3x^2dx=dt$

$\int_0^{27} xf'(x)dx+\int_0^{27} f(x)dx=\lambda$

$\lambda=\int_0^{27}(f(x)+xf'(x))dx=(xf(x))_0^{27}$

$\lambda=27f(27)-0$

$=27\cdot\frac{1}{3}=9 \quad \{\because \text{f is decreasing} \therefore f(27)=\frac{1}{3}\}$

SECTION – D

67. 02011.25

Sol. dividend= x^{2007},

Divisor= x^2-5x+6

Let Q(x)be quotient, R(x)=ax+b be remainder

$$x^{2007}=Q(x).(x^2-5x+6)+ax+b$$

$$x^{2007}=Q(x).(x-2)(x-3)+\underbrace{ax+b}_{R(x)} \qquad .....(i)$$

Now R(0)=b=?

Put x=2 in Eq. (i)

$$2a+b=2^{2007} \qquad ....(ii)$$

Put x=3 in Eq. (i)

$$3a+b=3^{2007} \qquad ....(iii)$$

Eq. (iii)-Eq.(ii) gives

$$a=3^{2007}-2^{2007}$$

Now $b=2^{2007}-2a=2^{2007}-2(3^{2007}-2^{2007})=2^{2007}+2.2^{2007}-2.3^{2007}$

$$=2.3[2^{2006}-3^{2006}]=ab(a^c-b^c)$$

Hence $a=2;b=3;c=2006$

68. 05142.85

Sol. Consonants →b,c,d,f,g,h (6)

Vowels →a,e,i,o,u (5)

W:

Case I: If word begins with consonants

then $({}^6C_4\times 4!)\times({}^5C_3\times 3!)=360\times 60=21600$

Case II:If word begins with vowels

$$({}^5C_4\times 4!)\times({}^6C_3\times 3!)=120\times 120=12400$$

Total=3600

69. 00833.33

Sol. $\because \int_a^x e^{f(t)}dt=\int_0^x g(x-t)dt+2x+3$

$\Rightarrow \int_a^x e^{f(t)}dt=\int_0^x g(t)dt+2x+3$ (Using King Property)

Differential both sides, we get

$$e^{f(x)}=g(x)+2$$

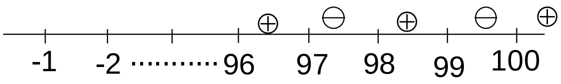
$$\Rightarrow g(x)=e^{f(x)}-2$$

$$\Rightarrow g'(x)=e^{f(x)}.f'(x)$$

$\because e^{f(x)}$ is always greater than zero.

$\therefore$ sign of g'(x) is same as sign of $f'(x)$.

$\therefore$ sign of g'(x)



Clearly, local extermum (maximum or minimum) will oxxur at x=99,97,95,….,3,1

$\therefore$ Sum of all the values=1+3+5+…+99= $\frac{50}{2}[2\times 1+(50-1)\times 2]=2500$

FIITJEE **JEE (Main)-2018**

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST - IV

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 – 30, 31 – 60, 61 – 90)** *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10 \text{ m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3 \text{ kg/m}^3$
Atmospheric pressure	$P_a = 10^5 \text{ N/m}^2$
Gas constant	$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

CHEMISTRY

Gas Constant R = $8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
= $0.0821 \text{ Lit atm K}^{-1} \text{ mol}^{-1}$
= $1.987 \approx 2 \text{ Cal K}^{-1} \text{ mol}^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

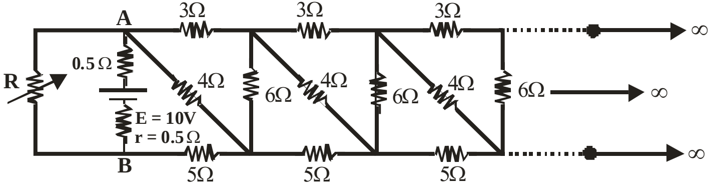
Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

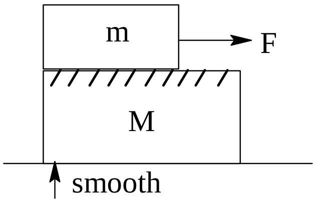
1. Maximum power transfer to external circuit in watt will be



(A) ∞ (B) 0

(C) Without value of R cannot be calculated (D) 50 watt

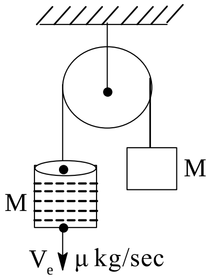
2. A plank having mass M is placed on smooth horizontal surface. Block of mass m is placed on it coefficient of friction between block and plank is $\mu_0 + kx$, where k is constant and x is relative displacement between block and plank. A force F is applied on block where F = at, where a = 10; t is in second. Find t_0 when relative motion will occur between block and plank



(A) $\mu_0 M + \dfrac{\mu_0 M^2}{m}$ (B) $\mu_0 m + \dfrac{\mu_0 M^2}{m}$

(C) $\mu_0 m + \dfrac{\mu_0 m^2}{M}$ (D) $\mu_0 M + \dfrac{\mu_0 m^2}{M}$

3. Velocity of water flow in downward direction relative to cylindrical tank is V_e acceleration at any time t will be

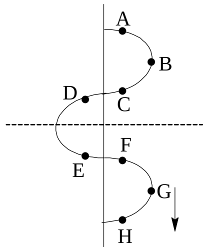


(A) $\dfrac{\mu(v_e + gt)}{(2M - \mu t)}$ (B) $\dfrac{\mu v_e}{(2M - \mu t)}$

(C) $\dfrac{\mu g t}{(2M - \mu t)}$ (D) None

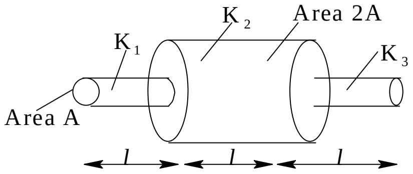
Space for Rough work

4. A transverse wave traveling along negative y-axis its snap shot is given at any instant of time t. Points which is having velocity in negative x-direction.



(A) A,E,F (B) C,D,H
(C) B,G,H (D) A,H

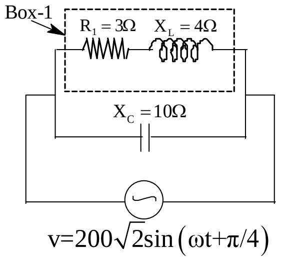
5. Equivalent thermal conductivity of figure given below will be. Given that length of each cylinder is l and area of cylinder having thermal conductivity $K_1 \& K_3$ is A while middle cylinder is having K_2.



(A) $\dfrac{5}{2\left[\dfrac{1}{K_1}+\dfrac{1}{2K_2}+\dfrac{1}{K_3}\right]}$ (B) $\dfrac{1}{\left(\dfrac{1}{K_1}+\dfrac{1}{2K_2}+\dfrac{1}{K_3}\right)}$

(C) $\dfrac{2}{5\left[\dfrac{1}{K_1}+\dfrac{1}{2K_2}+\dfrac{1}{K_3}\right]}$ (D) none of these

6. As shown in figure , Instantaneous current in branch having capacitor C will be :(given $\tan^{-1}(4/3) = 53°$)



(A) $20\sqrt{2}\sin(\omega t+3\pi/4)$
(B) $40\sqrt{2}\sin(\omega t+\pi/4)$
(C) $60\sqrt{2}\sin(\omega t-\pi/4)$
(D) None of above

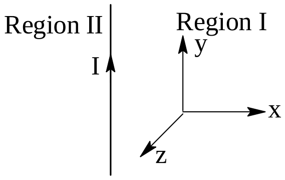
Space for Rough work

7. A thermodynamic process obeys the following relation $2dQ = dU + 2dW$ where dQ, dU, dW has usual meaning. Then at which statement is true [Given di-atomic gas; R = gas constant] then heat capacity for the process is:

(A) $\frac{5R}{2}$ (B) $\frac{7R}{2}$

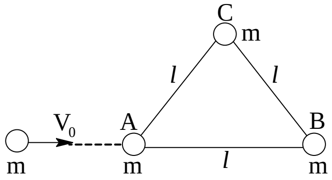
(C) $\frac{3R}{5}$ (D) infinite

8. A infinite length current carrying wire is placed in x, y plane parallel to y axis as shown in figure. (All charges are projected in region I)



(A) A positively charged particle projected along y axis will get deflected along z axis
(B) A positively charged particle projected along x axis will get deflected along y axis
(C) A negatively charged particle is projected along x axis will get deflected along +y axis
(D) A negatively charge particle is projected along x axis will get deflected along +z axis

9. Three (A,B,C) particle each of mass m are connected by three mass-less rod of length l. All three particle lies on smooth horizontal plane. A particle of mass moving along one of the rod with velocity v_0 strikes on a particle and stops as shown in diagram. Angular velocity of each particle after collision is :

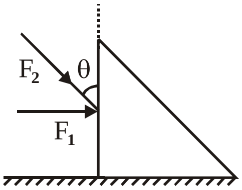


(A) $\frac{V_0}{\sqrt{3}l}$ (B) $\frac{V_0}{l}$

(C) $\frac{V_0}{2\sqrt{3}l}$ (D) $\frac{V_0}{3\sqrt{3}l}$

Space for Rough work

10. A wedge of mass m, lying on a rough horizontal plane, is acted upon by a horizontal force F_1 and another force F_2, inclined at an angle θ to the vertical. The block is in equilibrium, then minimum coefficient of friction between it and the surface is



(A) $(F_2\sin\theta)/(mg+F_2\cos\theta)$

(B) $(F_1\cos\theta+F_2)/(mg-F_2\sin\theta)$

(C) $(F_1+F_2\sin\theta)/(mg+F_2\cos\theta)$

(D) $(F_1\sin\theta-F_2)/(mg-F_2\cos\theta)$

11. A charge particle is projected in a region of magnetic field and electric field. If mass of charged particle is m and its speed changes from V_0 to $2V_0$ [W_E = work done by electric field ; W_B = work done by magnetic field]. Which statement is incorrect?

(A) $W_B = \frac{1}{2}mv_0^2$ (B) $W_B + W_E = \frac{3}{2}mv_0^2$

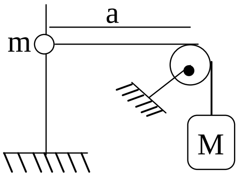
(C) $W_E = \frac{3}{2}mv_0^2$ (D) $W_E - W_B = \frac{3}{2}mv_0^2$

12. De-Broglie wavelength of the particle increases by 75% then kinetic energy of particle becomes

(A) $\frac{16}{49}$ times (B) $\frac{9}{16}$ times

(C) $\frac{16}{25}$ times (D) $\frac{4}{9}$ times

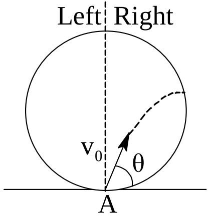
13. A ring of mass m can slide on the vertical smooth rod. Ring is connected by block with string as shown in figure. Pulley is of mass-less and smooth the system is released from rest. Initial tension in string is



(A) T = Mg (B) T > Mg

(C) T < Mg (D) T = Mg + Mg

Space for Rough work



14. A hollow sphere of mass m and radius R is placed on smooth ground. A particle of mass m is projected with velocity v_0 and angle θ from lowest point A inside the sphere as shown in diagram. If particle strikes the sphere at a point which is on horizontal level of centre and at that moment particle is at highest point. The collision between particle and sphere is elastic. The value of v_0 is

(A) $v_0 = \sqrt{\frac{Rg}{\cos\theta}}$

(B) $v_0 = \frac{\sqrt{2Rg}}{\sin\theta}$

(C) $\frac{2\sqrt{Rg}}{\tan\theta}$

(D) $v_0 = \frac{\sqrt{Rg}}{2}\left[1+\cos^2\theta\right]$

15. A parent radioactive nucleus A (decay constant λ_a) converts into a radio-active nucleus B of decay constant λ_b, initially, number of atoms of B is zero. At any time N_a, N_b are number of atoms of nuclei A and B respectively then maximum value of N_b.

(A) $\frac{\lambda_a N_a}{\lambda_b}$

(B) $\frac{\lambda_b N_a}{\lambda_a}$

(C) $\frac{(\lambda_a + \lambda_b)N_a}{\lambda_b}$

(D) $\frac{\lambda_b}{(\lambda_a + \lambda_b)} N_a$

16. Fundamental note of a closed pipe of length l is f_0 at 0°C. First overtone of the same pipe at 273°C is (assume there is no effect of temperature on the dimension of the pipe).

(A) $3f_0$

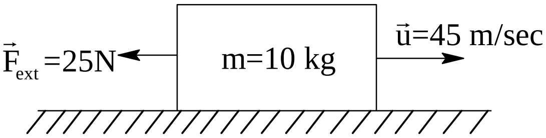
(B) f_0

(C) $\left(3\sqrt{2}\right)f_0$

(D) $3/\sqrt{2}\,f_0$

Space for Rough work

17. Initial velocity of the block $\vec{u} = 45\hat{i}$ while external force on it is $\vec{F} = 25(-\hat{i})$. It coefficient of static and kinetic friction are 0.3 and 0.2 respectively then distance travelled by the block in 12 sec. (g = 10 m/s^2) :

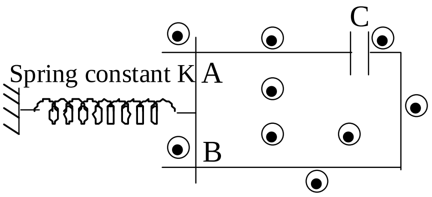


(A) 225 m
(B) 216 m
(C) 210 m
(D) 250 m

18. Time in which a layer of ice of thickness 10 cm will increase by 5 cm on the surface of a pond when temperature of the surrounding is – 10°C. Coefficient of thermal conductivity of ice $K = 0.005\left(\frac{\text{Cal}}{\text{cm}-\text{sec}-{}^{o}\text{C}}\right)$ and density $\rho = 0.9\,\text{gram}/\text{cm}^3$. (L = 80 cal/g)

(A) 20 Hours
(B) 25 Hours
(C) 30 Hours
(D) 5 Hours

19. In the arrangement shown in the figure, uniform magnetic field B is upward to the plane of paper. Connecter AB is smooth and conducting, having mass m and length l. Initially spring has extension X$_0$. Spring is non-conducting (neglect induction in spring). Connector is released at t = 0. Maximum charge on the capacitor is:

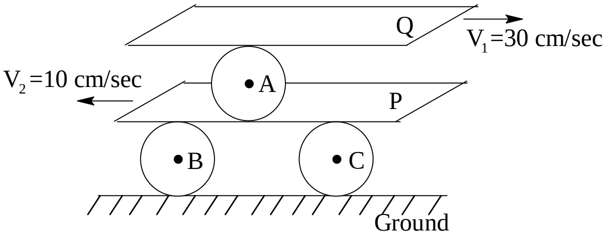


(A) $X_0\sqrt{\dfrac{KC}{1+\dfrac{B^2l^2C}{m}}}$
(B) $X_0\sqrt{\dfrac{KC}{1+\dfrac{m}{B^2l^2C}}}$
(C) $\sqrt{\dfrac{KC}{2+\dfrac{B^2l^2C}{m}}}$
(D) $\sqrt{\dfrac{4KC}{1+\dfrac{B^2l^2C}{2m}}}$

Space for Rough work

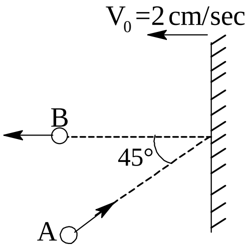
20. All three spheres are identical having radius 10 cm. There is no slipping at any point of contact. Plank P and Q are moving in opposite direction with speed 10 and 30 cm/sec. height of instantaneous axis of rotation of sphere A from the ground is :

(A) 20 cm
(B) 30 cm
(C) 15 cm
(D) 25 cm



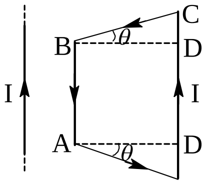
21. Mirror is moving towards the particle with speed 2 cm/sec. Speed of A and B are $10\sqrt{2}$ and 5 cm/sec respectively in the direction shown in figure. Magnitude of velocity of image of the particle B with respect to image of A.

(A) $\sqrt{325}\,\text{cm/sec}$ (B) $15\,\text{cm/sec}$
(C) $13\,\text{cm/sec}$ (D) $\sqrt{269}\,\text{cm/sec}$

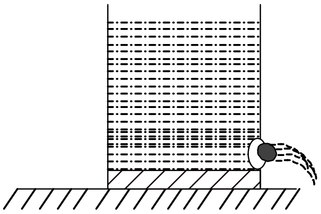


22. Loop ABCD and long straight wire are in the same plane. Side CD = 2AB. Distance between long straight wire and AB is equal to distance BD. Net force on the loop is:

(A) Towards the long straight wire
(B) Away from the long straight wire
(C) Parallel to the long straight wire
(D) Net force on the loop will be zero



Space for Rough work

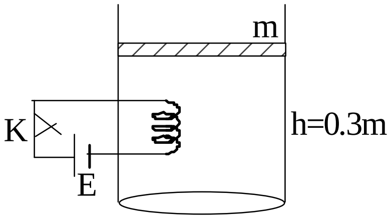


23. Liquid of density ρ is filled in the container of negligible mass having area A. Area of hole 'a' is very small (a << A). Co-efficient of friction between container and surface is equal to $\left(\frac{a}{A}\right)$. As liquid is coming out of vessel, instantaneous acceleration of the container.

(A) $\left(\frac{A}{a}g\right)$ (B) $\frac{3g}{2}$

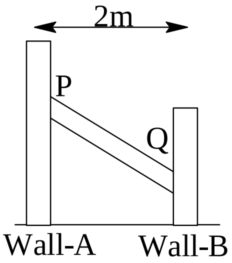
(C) $\left(\frac{ag}{A}\right)$ (D) zero

24. An insulated cylinder contains nitrogen gas which is sealed on the top by a heavy metal piston of mass m. Piston is free to move with negligible friction. Initial height of the piston is 0.3 m at temperature 27°C when it is given some heat with the help of an electrical circuit piston slowly rises to height 0.5 m above the bottom of the cylinder. During expansion of the gas, net heat absorbed by the nitrogen gas:



(A) Equal to work done by nitrogen gas on the piston
(B) Greater to work done by nitrogen gas on the piston
(C) Less to work done by nitrogen gas on the piston
(D) Will be always twice of the work done by the gas on the piston

25. Two vertical walls are separated by a distance of 2 metres. Wall 'A' is smooth while wall B is rough with a coefficient of friction $\mu = 0.5$. A uniform rod is propped between them. The length of the longest rod that can be probed between the walls is equal to :

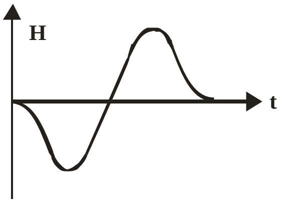


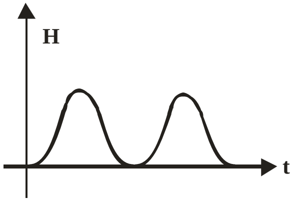
(A) 2 metres (B) $2\sqrt{2}$ metres

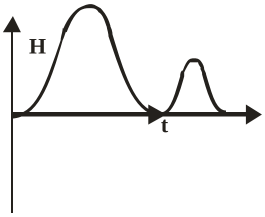
(C) $\sqrt{5}$ metres (D) $\frac{\sqrt{17}}{2}$ metres

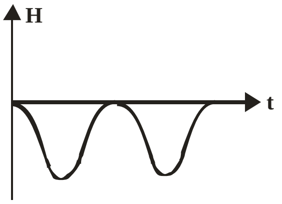
Space for Rough work

26. A bar magnet is pulled along axis of a coil with uniform velocity with South Pole entering into the coil. The sketch of Joule's heat with time is represented by:

(A)


(B)


(C)


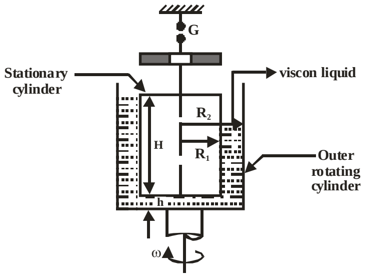
(D)


27. A satellite is revolving round the earth at a height (R/2) from surface of earth in circular orbit. The change in speed required for the satellite to escape to infinity for the satellite to escape to infinity is: [Take R as radius of earth ; and M as mass of earth]

(A) $\sqrt{\frac{2GM}{3R}}$ (B) $\sqrt{\frac{GM}{3R}}\left(2-\sqrt{2}\right)$

(C) $\sqrt{\frac{GM}{3R}}\left(\sqrt{2}-1\right)$ (D) $\sqrt{\frac{4GM}{3R}}$

28. There are two concentric cylinders of radii R_1 and R_2 as shown. The narrow space between the two cylinders is filled with liquid of viscosityμ. The inner cylinder is held stationary by means of a Torsional spring of stiffness G. The outer cylinder is rotated with constant angular speedω. The torque acting on the inner cylinder due to shearing action of the liquid:

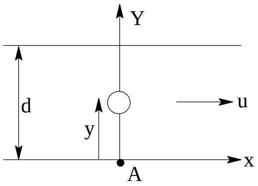


(A) $\frac{\pi\mu\omega R^4}{2h}+\frac{2\pi\mu\omega HR_1^2R_2}{R_2-R_1}$ (B) $\frac{\pi\mu\omega HR_1^2R_2}{R_2-R_1}$

(C) $\frac{\pi\mu\omega HR_1^2R_2}{R_2-R_1}+\frac{\mu\omega R^4}{3h}$ (D) $\frac{\pi\mu\omega R^4}{2h}$

Space for Rough work

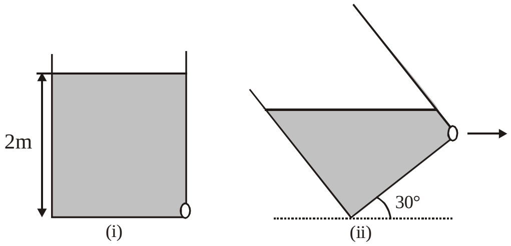
29. A river of width d is flowing with a velocity u. A person starts from point A. He always try to keep himself along y axis. Speed of man w.r.t. to river at any position is given by $v = k\sqrt{y}$ (k → +ve constant). Time taken by man to cross the river is (Assume that at t = 0, y = 0)



(A) $\sqrt{\frac{d}{k}}$ (B) $2\sqrt{\frac{d}{k}}$

(C) $\frac{2\sqrt{d}}{k}$ (D) $\frac{2d}{\sqrt{k}}$

30. Velocity of efflux in Torricelli's theorem is given by $v = \sqrt{2gh}$, here h is the height of hole from the top surface, After that, motion of liquid can be treated as projectile motion. Liquid is filled in a vessel of square base (2m × 2m) upto a height of 2m as shown in figure (i). In figure (ii) the vessel is tilted from horizontal at 30°. What is the velocity of efflux in this case? Liquid does not spills out?



(A) 3.29 m/s (B) 4.96 m/s

(C) 5.67 m/s (D) 2.68 m/s

Space for Rough work

Chemistry

PART – II

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

---

31. Which of the following statement is incorrect:

(A) H^+ is the smallest size cation in the periodic table
(B) Van der waals radius of chlorine is more than covalent radius
(C) Ionic mobility of hydrated Li^+ is greater than that of hydrated Na^+
(D) He atom has the highest ionisation enthalpy in the periodic table

32. According to VSEPR model, the shape of $\left[XeOF_5\right]^-$ is

(A) Octahedral (B) Triagonal bipyramidal
(C) Square pyramidal (D) Pentagonal monopyramidal

33. Identify the statement(s) which is not correct with respect to surface phenomenon.

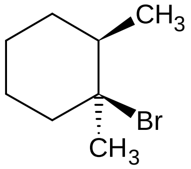
(A) If on adding electrolyte in an emulsion, the conductivity increases then it will be oil in water type emulsion.
(B) Tyndall effect is observed when refractive indices of dispersed phase and dispersion medium differ largely.
(C) Macromolecular colloids are generally lyophobic in nature
(D) Gases which can react with adsorbents are generally chemisorbed

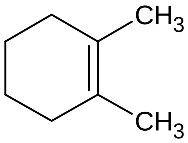
34. How many dichloride cyclopentanes (including stereoisomers) are obtained when cyclopentane reacts with excess chlorine at high temperature?

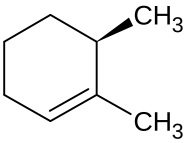
(A) 7 (B) 5
(C) 4 (D) 9

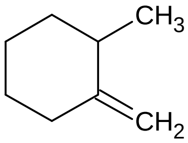
Space for Rough work

35. The major product obtained when following substrate is subjected to $E2$ reaction will be:



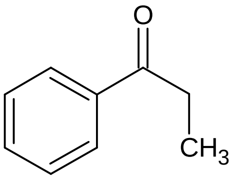
(A)


(B)


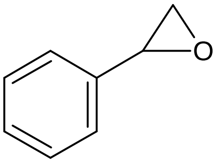
(C)


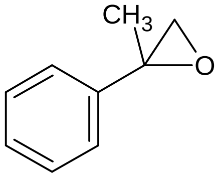
(D) None of these

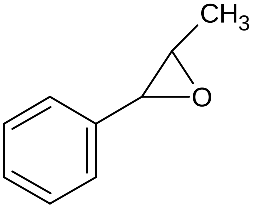
36. The end product of the reaction is:



$\xrightarrow{Cl_2(1eq)} (A) \xrightarrow[OH^-]{NaBH_4} (B)$

(A)


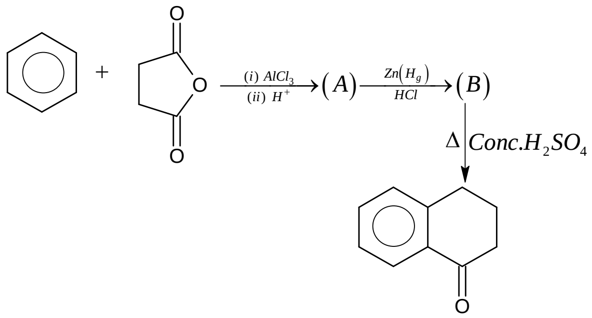
(B)


(C)


(D) None of these

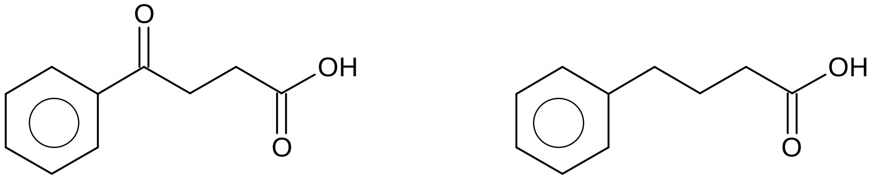
Space for Rough work

37.

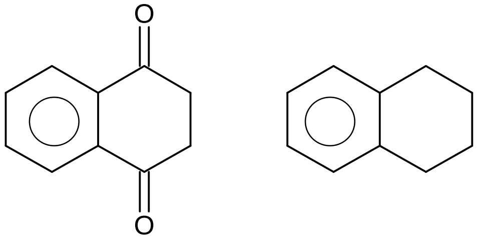

+
O
O
O
(i) AlCl3
(ii) H+
(A)
Zn(Hg)
HCl
(B)
Δ
Conc.H2SO4
O

Structure of (A) and (B) respectively are:

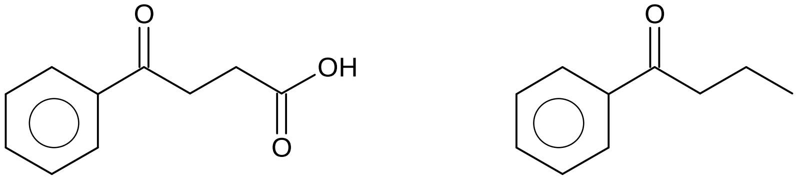
(A)



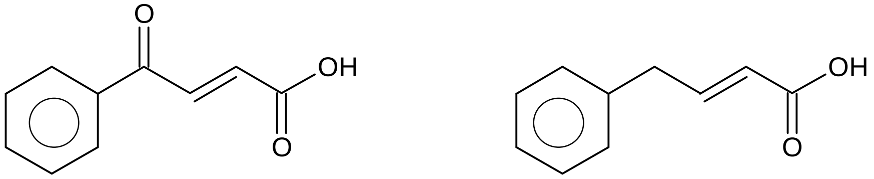
(B)



(C)



(D)



Space for Rough work

38. An aqueous solution of a metal ion (A) on reaction with KI gives a black brownish ppt (B) and this aqueous suspension on treatment with excess KI gives orange yellowish solution. Then A is

(A) pb^{2+} (B) Bi^{3+}

(C) Hg_2^{2+} (D) Hg^{2+}

39. Which of the following compounds consist of a P – P linkage?

(A) Hypo phosphoric acid (B) Pyrophosphorous acid

(C) Dipolyphosphoric acid (D) Metaphosphoric acid

40. Which of the following elements of lanthanide series have highest tendency to show $+2$ oxidation state?

(A) Eu (B) Gd

(C) Tb (D) None of these

41. The specific conductance of a saturated solution of silver bromide is $K\,Scm^{-1}$. The limiting ionic conductivity of Ag^+ and Br^- ions are $x\,and\,y$ respectively. The solubility of silver bromide in g/L is (molar mass of $AgBr=188$)

(A) $\frac{K\times 1000}{x-y}$ (B) $\frac{K}{x+y}\times 188$

(C) $\frac{K\times 1000\times 188}{x+y}$ (D) $\frac{x+y}{k}\times\frac{1000}{188}$

42. Which of the following is diamagnetic?

(A) $\left(Ni\left(CN\right)_4\right)^{2-}$ (B) $\left(NiCl_4\right)^{2-}$

(C) $\left(CoCl_4\right)^{2-}$ (D) $\left(CoF_6\right)^{2-}$

Space for Rough work

43. A certain amount of reducing agent reduces x mole of $KMnO_4$ & y mole of $K_2Cr_2O_7$ in different experiments in acidic medium. If the change in oxidation state of reducing agent is same in both experiments then $x:y$ is.

(A) $5:3$ (B) $3:5$
(C) $5:6$ (D) $6:5$

44. The activation energies of two reactions are E_1 & E_2 with $E_1 > E_2$. If temperature of reacting system is increased from T_1 (rate constant are $k_1\ and\ k_2$) to T_2 (rate constant are $k_1^1\ and\ k_2^1$) predict which of the following alternative is correct.

(A) $\frac{k_1^1}{k_1} = \frac{k_2^1}{k_2}$ (B) $\frac{k_1^1}{k_1} > \frac{k_2^1}{k_2}$
(C) $\frac{k_1^1}{k_1} < \frac{k_2^1}{k_2}$ (D) $k_1^1 < k_2^1$

45. The wavelength of the first Lyman lines of hydrogen, $He^+\ and\ Li^{2+}$ ions and λ_1, λ_2 & λ_3. The ration of these wavelengths is

(A) $1:4:9$ (B) $9:4:1$
(C) $36:9:4$ (D) $6:3:2$

46. Number of electrons having $m_l = 0$ for sodium atom is

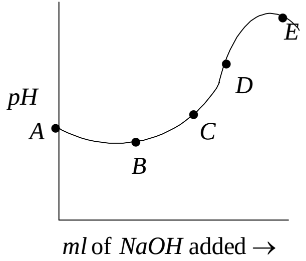
(A) 2 (B) 5
(C) 7 (D) 3

47. Two system $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)\ and\ COCl(g) \rightleftharpoons CO(g) + Cl_2(g)$ are simultaneously in equilibrium in a vessel at constant volume. If some CO is introduced in the vessel, then at new equilibrium, the modes of

(A) PCl_5 increase (B) PCl_5 remain unchanged
(C) PCl_5 decrease (D) Cl_2 increase

Space for Rough work

48. The curve in the figure shows the variation of pH during the course of titration of weak acid HA with a strong base NaOH. At which point in the titration curve is the concentration of acid equal to that of its conjugate base.



(A) Point D (B) Point E
(C) Point C (D) Point B

49. The minimum mass of NaBr which should be added in 200 ml of 0.0004 $M - AgNO_3$ solution just to start precipitation of $AgBr.K_{sp}\ of\ AgBr = 4\times10^{-13}$. (Br = 80)

(A) $1.0\times10^{-9}\,g$ (B) $2\times10^{-10}\,g$
(C) $2.06\times10^{-8}\,g$ (D) $1.03\times10^{-7}\,g$

50. In which of the following cases is the value of x maximum?

(A) $CaSO_4\bullet xH_2O$
(B) $BaSO_4\bullet xH_2O$
(C) $MgSO_4\bullet xH_2O$
(D) All have same values of x as all metal ions belong to same group

51. In the following statement, which combination of true (T) and false (F) options in correct?

(A) Ionic mobility is highest for I^- in water as compared to other halides.
(B) IF_5 is square pyramidal and IF_7 is pentagonal bipyramidal in shape
(C) Reactivity order is $F_2 < Cl_2 < Br_2 < I_2$
(D) Oxidising power order is $F_2 < Cl_2 < Br_2 < I_2$

(A) TFTF (B) TTFT
(C) TTTT (D) TTFF

Space for Rough work

52. Xenon fluorides are very good oxidising and fluorinating agents. They also act as F^- donors and acceptors. When XeF_4 donates its fluoride to SbF_5, then the states of hybridisation of central atom of cationic part and anionic part of product are:

(A) sp^3d, sp^3d^2
(B) sp^3d^2, sp^3d
(C) sp^3d^2, sp^3d^2
(D) dsp^2, sp^3

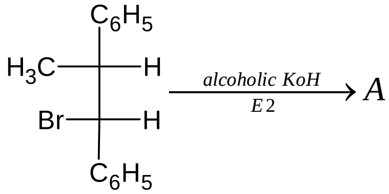
53. Correct order of bond angle is

(A) $(\bullet CH_3) > (\bullet CF_3)$
(B) $CH_3^- > CH_3^+$
(C) $CH_4 > CF_4$
(D) $CH_4 > (\bullet CH_3)$

54. Which of the following is a polar molecule?

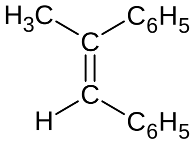
(A) XeF_4
(B) BF_3
(C) C_2F_4
(D) PCl_2F_3

55.

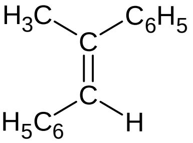

C6H5
H3C
H
Br
H
C6H5
alcoholic KoH
E2
A

A is

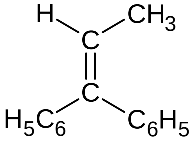
(A)


H3C
C6H5
C
C
H
C6H5

(B)


H3C
C6H5
C
C
H5C6
H

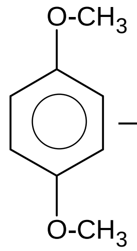
(C)


H
CH3
C
C
H5C6
C6H5

(D) None of these

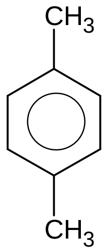
Space for Rough work

56.



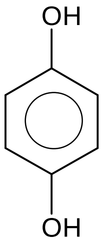
$\xrightarrow[(excess)]{Conc.HI}$ Products, Products of reaction are

(A)



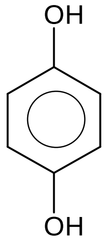
$+2CH_3I$

(B)



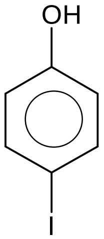
$+2CH_3OH$

(C)



$+2CH_3I$

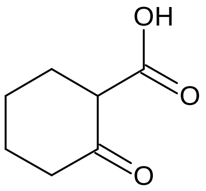
(D)



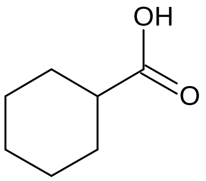
$+2CH_3I$

57. Which of the following compound loses CO_2 upon heating to $100°C$

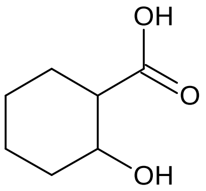
(A)



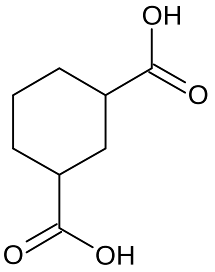
(B)



(C)

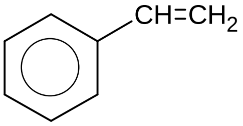


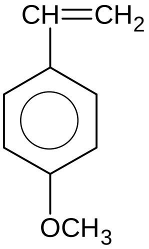
(D)

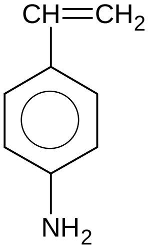


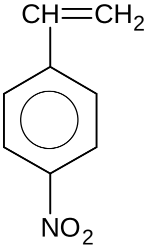
Space for Rough work

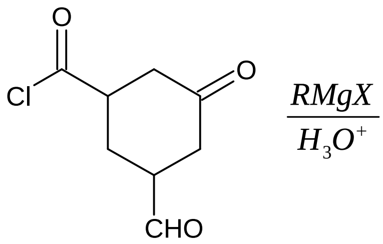
58. Which of the following monomers has greatest ability to undergo cationic polymerisation?

(A)


(B)


(C)


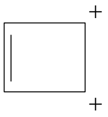
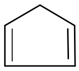
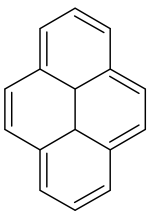
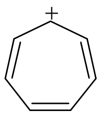
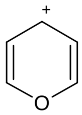
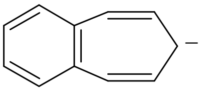
(D)


59.

O
Cl
O
CHO
RMgX
H3O+

How many molecules of $RMgX$ are consumed in the above reaction

(A) 2 (B) 4
(C) 5 (D) 6

60. Amongst the following, total no of aromatic compounds are

(A) 5 (B) 4
(C) 3 (D) 6

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. If $a\alpha^2+b\alpha+c=3\alpha^2-4\alpha+1, a\beta^2+b\beta+c=3\beta^2-4\beta+1$ and $a\gamma^2+b\gamma+c=3\gamma^2-4\gamma+1$ (where $\alpha, \beta, \gamma \in R$ and distinct) these sum of root of the equation $3ax^2+9bx+7c=0$.

(A) 1 (B) 2
(C) 3 (D) 4

62. If k denotes the sum of the imaginary parts of the roots of the equation $z^2-8(1-i)z+63-16i=0$ then k is

(A) 6 (B) -6
(C) 8 (D) -8

63. $\int\limits_0^{\frac{\pi}{2}} \frac{1-\sin 2x}{(1+\sin 2x)^2}dx=\frac{a}{b}$ (a & b are coprime) these $a+b+ab$ is

(A) 7 (B) 8
(C) 6 (D) None of these

64. The sum $\sum\limits_{k=0}^{49}(-1)^k \; {}^{99}C_{2k}$ equals

(A) -2^{98} (B) 2^{98}
(C) -2^{49} (D) 2^{49}

Space for Rough work

65. For differential equation $\left(x^4y^2 - y\right)dx + \left(x^2y^4 - x\right)dy = 0$

(A) $\left(x^3 - y^3\right) + \frac{3}{xy} = c$ (B) $x^3 - y^3 + \frac{1}{xy} = c$

(C) $x^3 + y^3 + \frac{3}{xy} = c$ (D) $x^3 + y^3 + \frac{1}{xy} = c$

66. Sum of roots of the equation $2^{333x-2} + 2^{111x+1} = 2^{222x+2} + 1$ is.

(A) $\frac{111}{2}$ (B) $\frac{2}{111}$

(C) 2 (D) 111

67. $\int \frac{e^{\tan^{-1}x}}{\left(1+x^2\right)}\left(\left(\sec^{-1}\sqrt{1+x}\right)^2 + \cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)\right)dx$ is $\left(x > 0\right)$

(A) $e^{\tan^{-1}x} \cdot \tan^{-1}x + c$ (B) $e^{\tan^{-1}x} \cdot \frac{\left(\tan^{-1}x\right)^2}{2} + c$

(C) $e^{\tan^{-1}x}\left(\sec^{-1}\sqrt{1+x^2}\right)^2 + c$ (D) $e^{\tan^{-1}x}\left(\operatorname{cosec}^{-1}\sqrt{1+x^2}\right)^2 + c$

68. If $\left(x - 2y - 4\right)^2 = 24x + 12y$ then length of latus rectum is

(A) $\frac{5}{\sqrt{12}}$ (B) $\frac{\sqrt{5}}{12}$

(C) $\frac{12}{\sqrt{5}}$ (D) None of these

Space for Rough work

69. IF $P(a\sec\theta, b\tan\theta), Q(a\sec\phi, b\tan\phi)$ are the ends of a focal chord of $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ then $\tan\frac{\theta}{2}\tan\frac{\phi}{2}$ can be

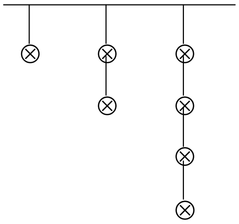
(A) $\frac{e-1}{e+1}$ (B) $\frac{e+1}{e-1}$

(C) $\frac{1+e}{1-e}$ (D) None of thee

70. 7 clay balls (shown as ⊗). If N be the number of different ways these can be shot (lone at a time). If no ball can be shot unit the ball (s) below it, have been shot, then N is.

(A) 15 (B) 105

(C) 104 (D) None of these



71. Consider the function $f(x)=\frac{\sqrt{1+\cos x}+\sqrt{1-\cos x}}{\sqrt{1+\cos x}-\sqrt{1-\cos x}}\left(x\in(x,2\pi)\right)$ then $f(x)$ is

(A) $\cot\left(\frac{\pi}{4}+\frac{x}{2}\right)$ (B) $\tan\left(\frac{\pi}{4}+\frac{x}{2}\right)$

(C) $\cot\left(\frac{\pi}{4}-\frac{x}{2}\right)$ (D) None of these

Space for Rough work

72. In $\left[-\frac{\pi}{2},\frac{\pi}{2}\right]$ the equation $\log_{\sin\theta}\cos 2\theta = 2$ has

(A) No solution
(B) One solution
(C) 2 solutions
(D) None of these

73. Let $f(x)=\cos x, g(x)=\begin{bmatrix} \min\{f(t):0\le t\le x\} & x\in[0,\pi] \\ \sin x-1 & x>\pi \end{bmatrix}$ then

(A) $g(x)$ is discontinuous at $x=\pi$
(B) $g(x)$ is continuous for $x\in[0,\infty)$
(C) $g(x)$ is differentiable at $x=\pi$
(D) $g(x)$ differentiable for $x\ge 0$

74. If $f(x)\,and\,g(x)$ are two functions such that $f(x)=[x]+[-x]\,and\,g(x)=\{x\}\,\forall x\in R\ and\ h(x)=f(g(x))$ these incorrect statement is($[.]$ is G.I.F and $\{.\}$ is F Part of x)

(A) $f(x)\,and\,g(x)$ are identical function
(B) $f(x)=g(x)$ has no solution
(C) $f(x)+h(x)>0$ has no solution
(D) $f(x)-h(x)$ is periodic function

75. Let $f(x)$ be a polynomial $f:R\to R$ such that $f(2x)=f'(2x)f''(x)$ these $f(x)$ is

(A) One – One onto
(B) One – One into
(C) Many One – Onto
(D) Many – One into

76. Consider three planes $2x+py+6z=8, x+2y+qz=5\,and\,x+y+3z=4$ then 3 planes intersect at a point if

(A) $p=2,q\ne 3$
(B) $p\ne 2,q\ne 3$
(C) $p\ne 2,q=3$
(D) None of these

Space for Rough work

77. If a^2, b^2, c^2 are in AP then $\cot A, \cot B\, and\, \cot C$ in

(A) GP (B) AP
(C) HP (D) None of these

78. A regular pyramid on a square base has an edge 150m long and the length of the side of its base is 200m. Then height of pyramid is

(A) 25m (B) 50m
(C) 75m (D) 100m

79. R is relation over the set of integers and it is given by $(x, y) \in R \Leftrightarrow |x-y| \le 1$. Then R is

(A) Reflective and transitive (B) Reflective and symmetric
(C) Symmetric and transitive (D) An equivalence relation

80. 20 teachers of a school either teach maths or physics 12 of them teach maths while 4 teach both the subjects then the no. of teachers teaching only physics is

(A) 12 (B) 8
(C) 16 (D) None of these

81. If $a_r = (\cos 2r\pi + \sin 2r\pi)^{1/9}$ then $\Delta = \begin{vmatrix} a_1 & a_2 & a_3 \\ a_4 & a_5 & a_6 \\ a_7 & a_8 & a_9 \end{vmatrix}$ is

(A) 1 (B) 2
(C) 3 (D) None of these

82. If $A = \begin{bmatrix} a & b & c \\ c & a & b \\ b & c & a \end{bmatrix}$ and a, b, c are roots of the equation $x^3 + x^2 - 4 = 0$ then $A\ A^T$ is

(A) I (B) $I + A$
(C) A^2 (D) $A - I$

Space for Rough work

83. $\left[\sqrt{1}\right]+\left[\sqrt{2}\right]+\left[\sqrt{3}\right]+\left[\sqrt{4}\right]+\left[\sqrt{5}\right]+.......+\left[\sqrt{224}\right]-1112$,is ([.] is G.I.F)

(A) 1021 (B) 1022

(C) 1024 (D) None of these

84. $2\tan^{-1}x+\sin^{-1}\frac{2x}{1+x^2}\left(x>1\right)$ is

(A) 2π (B) $-\pi$

(C) π (D) None of these

85. If $a>b>c$ and the system of equations $ax+by+cz=0, bx+cy+az=0, cx+ay+bz=0$ has a non-trivial solution these both the roots of equation $at^2+bt+c=0$ are

(A) Cereal (B) Negative

(C) Positive (D) None of these

86. If A and B are non-zero square metrics of order 3 there incorrect statement is

(A) $adj\left(AB\right)=adjA.adjB$ (B) $\left(AB\right)^{-1}=B^{-1}.A^{-1}$

(C) $\left(AB\right)^T=B^T A^T$ (D) $AB=0\Rightarrow\left|A\right|=0 \; and \; \left|B\right|=0$

87. $\int_{-1}^{3}\left(\tan^{-1}\left(\frac{x}{1+x^2}\right)+\tan^{-1}\left(\frac{x^2+1}{x}\right)\right)dx$ is

(A) $\frac{3\pi}{2}$ (B) π

(C) 2π (D) None of these

Space for Rough work

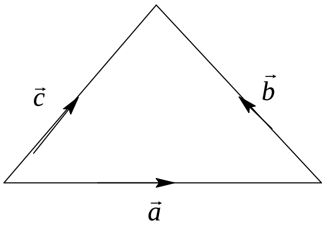
88. Number of integral values of k for which the equation $4\cos^{-1}\left(-|x|\right) = k$ has exactly two solutions, is

(A) 4 (B) 5
(C) 6 (D) 7

89. The only statement among the following that is tautology is

(A) $A \cap \left(A \cup B\right)$ (B) $A \cup \left(A \cap B\right)$
(C) $\left[A \cap \left(A \to B\right)\right] \to B$ (D) $B \to \left[A \cap \left(A \to B\right)\right]$

90. If $\vec{a} = \lambda x\hat{i} + y\hat{j} + 4z\hat{k}, \vec{b} = y\hat{i} + x\hat{j} + \left(3y\right)\hat{k}, \vec{c} = -z\hat{j} - 2z\hat{j} - \left(\lambda + 1\right)x\hat{k}$ are sides of triangle then the value of α is



(A) 0 (B) 1
(C) 2 (D) None of these

Space for rough work

FIITJEE **JEE(Main), 2018**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

CONCEPT RECAPITULATION TEST - IV
(Main)

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**D**	31.	**C**	61.	**D**
2.	**C**	32.	**D**	62.	**D**
3.	**A**	33.	**C**	63.	**A**
4.	**A**	34.	**A**	64.	**C**
5.	**A**	35.	**A**	65.	**C**
6.	**A**	36.	**C**	66.	**B**
7.	**D**	37.	**A**	67.	**C**
8.	**B**	38.	**B**	68.	**C**
9.	**C**	39.	**A**	69.	**C**
10.	**C**	40.	**A**	70.	**B**
11.	**A**	41.	**C**	71.	**D**
12.	**A**	42.	**A**	72.	**B**
13.	**A**	43.	**D**	73.	**B**
14.	**B**	44.	**B**	74.	**D**
15.	**A**	45.	**C**	75.	**C**
16.	**C**	46.	**C**	76.	**B**
17.	**A**	47.	**C**	77.	**B**
18.	**B**	48.	**D**	78.	**B**
19.	**B**	49.	**C**	79.	**B**
20.	**D**	50.	**C**	80.	**B**
21.	**A**	51.	**D**	81.	**D**
22.	**B**	52.	**A**	82.	**A**
23.	**C**	53.	**A**	83.	**D**
24.	**B**	54.	**D**	84.	**C**
25.	**D**	55.	**A**	85.	**D**
26.	**B**	56.	**C**	86.	**A**
27.	**B**	57.	**A**	87.	**C**
28.	**A**	58.	**C**	88.	**C**
29.	**C**	59.	**B**	89.	**C**
30.	**B**	60.	**B**	90.	**A**

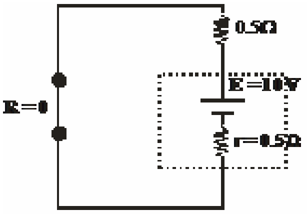
Physics

PART – I

SECTION – A

1. D

Sol. For maximum power transfer in external circuit R = 0;
Now circuit will become



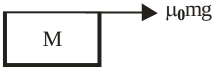
Power transfer in external resistance 0.5 Ω is same as power transfer in external circuit

$$=\left(\frac{10}{0.5+0.5}\right)^2\times 0.5=50\,\text{watt}$$

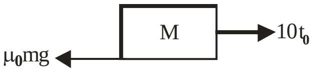
So, correct answer (D)

2. C

Sol. Let at time t_0 relative motion will occur



$$\mu_0 mg = Ma \quad ..... (1)$$



$$10t_0-\mu_0 mg = ma \quad ..... (2)$$

From (1) and (2) ;

$$t_0=\mu_0 m+\frac{\mu_0 m^2}{M}$$

3. A

Sol. $$Mg-T=M\frac{dv}{dt} \quad ..... (1)$$

$$T+\mu v_e-(M_0-\mu t)g=\left(M_0-\mu t\right)\frac{dV}{dt} \quad ..... (2)$$

From (1) and (2), we get

$$Mg+\mu V_e-(M-\mu t)g=(2M-\mu t)\frac{dv}{dt} \quad ..... (3)$$

$$\left(\mu v_e+\mu gt\right)=\left(2M-\mu t\right)\frac{dv}{dt} \quad ..... (4)$$

$$\frac{dv}{dt}=\frac{\mu(v_e+gt)}{(2M-\mu t)}$$

$$\therefore \quad \frac{dv}{dt}=\frac{\mu(v_e+gt)}{(2M-\mu t)}$$

So, correct answer is (A)

4. A

5. A

Sol. $$\frac{l}{K_1A}+\frac{l}{2K_2A}+\frac{l}{K_3A}=\frac{l}{KA}+\frac{l}{2K_A}+\frac{l}{KA}$$

$$\frac{5}{2K}=\left(\frac{1}{K_1}+\frac{1}{2K_2}+\frac{1}{K_3}\right)$$

$$K_{eq}=\frac{5}{2\left(\frac{1}{K_1}+\frac{1}{2K_2}+\frac{1}{K_3}\right)}$$

6. A

Sol. Voltage across capacitor will lag current by 90° ;

$$\therefore\ \ i_C=\frac{200\sqrt{2}}{10}\sin\left(\omega t+\frac{\pi}{4}+\frac{\pi}{2}\right)$$

$$i=20\sqrt{2}\sin\left(\omega t+\frac{3\pi}{4}\right)$$

$\therefore$ Correct answer is (A)

7. D

Sol. 2dQ = dU + 2dW

dQ = dU + dW

dQ = dW

$\Rightarrow$ dU = 0

Process is isothermal.

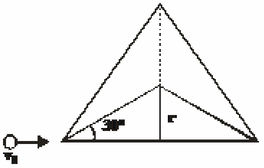
8. B

Sol. F = q v × B

= q v_0i × B (–k) = qv_0 B j

9. C

Sol. Initial angular momentum = final angular momentum



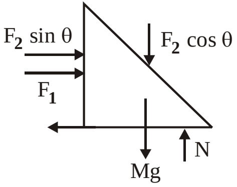
$$L_I=mv_0\frac{l}{2\sqrt{3}}=I_{cm}\omega$$

$$mv_0\frac{l}{2\sqrt{3}}=3m\left(\frac{l}{\sqrt{3}}\right)^2\omega\ ;\ \omega=\frac{v_0}{2\sqrt{3}\,l}$$

$$y=\frac{l}{2}\tan 30^\circ=\frac{l}{2\sqrt{3}}$$

10. C

Sol. f = μN ; (F_1 + F_2 sin θ) = μ (mg + F_2 cos θ)



$$\mu = \frac{F_1 + F_2 \sin\theta}{mg + F_2 \cos\theta}$$

11. A

Sol. $\mathrm{W_B = 0}$

$\mathrm{W_E = \Delta KE}$; $\mathrm{W_B + W_E = \Delta KE}$

12. A

K.E. = $p^2/2m$ and $p = h/\lambda$

13. A

14. B

Sol. Conservation of energy

$$\frac{1}{2}\mathrm{mv_0^2 = mgR} + \frac{1}{2}\mathrm{mv^2, v = v_0 \cos\theta}$$

$$\frac{1}{2}\mathrm{v_0^2 = gR} + \frac{\mathrm{v_0^2 \cos^2\theta}}{2}$$

$$\mathrm{v_0^2\left[1 - \cos^2\theta\right] = gR}$$

$$\mathrm{v_0} = \frac{\sqrt{\mathrm{2gR}}}{\sin\theta}$$

15. A

Sol. $\mathrm{N_b}$ reaches maximum when activity of A will be equal to activity of B.

i.e., $\lambda_a \mathrm{N_a} = \lambda_b \mathrm{N_b} \Rightarrow \mathrm{N_b} = \frac{\lambda_a \mathrm{N_a}}{\lambda_b}$

16. C

Sol. $\mathrm{f_0} = \frac{\mathrm{c}}{\lambda} = \frac{\mathrm{c}}{4(l + \mathrm{e})}$ and $\frac{\mathrm{c}}{\mathrm{c_0}} = \sqrt{\frac{273 + \theta}{273}}$

$$\therefore\ \mathrm{f_0'} = \frac{\mathrm{c_0}}{4(l + \mathrm{e})}\sqrt{1 + \frac{\theta}{273}}$$

If temperature is same, first overtone will be $3\mathrm{f_0}$

$\therefore$ at 273°C first overtone is $3\sqrt{2}\,\mathrm{f_0}$.

17. A

Sol. Net retardation $a = \frac{\mathrm{F_{ext}} + \mu_k \mathrm{mg}}{\mathrm{m}} = 4.5$

If body stop at time t, then

$\mathrm{V = u + at}$

$\mathrm{0 = 45 - 4.5t \Rightarrow t = 10\,sec}$

When block stops, $\mathrm{F_{ext}}$ will try to bring the block back ward while frictional force will oppose its motion, since block is stationary therefore at this moment, frictional force will be static. Whose maximum value will be $\mu_s \mathrm{mg = 30N}$. Since static frictional force is self adjusting therefore it will be 25 N and block will not move after t = 10 sec.

$$\mathrm{S} = \frac{\mathrm{u}^2}{2a} = 225\,\mathrm{m}$$

18. B

Sol. Time taken by the layer of ice to increase its thickness by $x = x_2 - x_1$

$$t = \frac{\rho L}{2K\theta}(x_2^2 - x_1^2) = \frac{.9\times 80}{2\times .005\times 10}\left[(15)^2 - (10)^2\right]$$

$t = 9\times 10^4\,\text{sec}$; t = 25 Hours

19. B

Sol. At any time

$Kx - IlB = ma$ ….. (1)

$$\frac{q}{C} = Bvl$$

$I = BlCa$ ….. (2)

From (1) and (2)

$$kx = a(B^2l^2C + m)$$

$a = \left(\frac{K}{B^2l^2C + m}\right)x$ ….. (3)

Since motion of connector will be opposite to the displacement from equilibrium. Therefore equation (3) represents S.H.M.

$$\omega = \sqrt{\frac{K}{B^2l^2C + m}}$$

$$V_{max} = X_0\omega$$

$\therefore$ $q_{max} = BlCV_{max}$

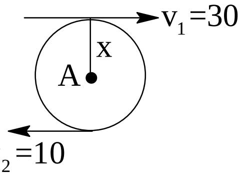
$$q_{max} = BlCX_0\omega$$

$$X_0\sqrt{\frac{KC}{1 + \frac{m}{B^2l^2C}}}$$

20. D

Sol. Let x be the distance of axis of rotation from the top of sphere A (downward). Since angular velocity of the top and bottom point of sphere A will be same, therefore,

$$\omega = \frac{30}{x} = \frac{10}{(2R - x)}$$



$$\frac{30}{x} = \frac{10}{20 - x}$$

$\Rightarrow$ x = 15

$\therefore$ Distance from ground

= 2R + (2R – x)

= 20 + 5 = 25 cm

21. A

Sol. Velocity of image of particle B

$$\overline{v}_B = 5(\hat{i}) + 4(-\hat{i}) = \hat{i}$$

velocity of image of particle A

$$v_A = 10(-\hat{i}) + 4(-\hat{i}) - 10\hat{j}$$

$$= 14(-\hat{i}) - 10\,\text{j}$$

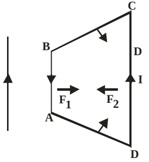
Relative velocity of image

$$\overline{V}_{BA} = \overline{V}_B - \overline{V}_A \;= \hat{i} - \left[14(-\hat{i}) - 10\hat{j}\right] \;= 15\hat{i} + 10\,\hat{j}$$

$$|\,\overline{V}_{BA}\,| = \sqrt{325}\,\text{cm/sec}$$

22. B

Sol. Magnitude of force on AB (F_1) and magnitude of force on CD (F_2) will be equal in magnitude and opposite in direction.



Hence $\overline{F}_1 + \overline{F}_2 = 0$ resultant of $\overline{F}_3 + \overline{F}_4$ will be away from the long straight wire.

23. C

Sol. At any time

$$F_{\text{thrust}} - F_{\text{friction}} = ma$$

$$\rho a v^2 - \mu mg = ma$$

$$\rho a\left(2gh\right) - \left(\frac{a}{A}\right)\left(\rho Ah\right)g = \left(\rho Ah\right)a'$$

$$2\rho agh - \rho agh = \rho Aha' \;;\; \frac{a}{A}g = a'$$

24. B

25. D

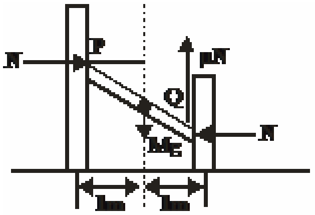
Sol. Drawing F.B.D. of rod PQ

ΣFx = 0

ΣFy = 0 ⇒ μN = mg ….. (1)

Στ about centre of mass = 0

$$\left[N \times \frac{l}{2}\sin\theta\right]\left[2\right] = \mu N \times \frac{l}{2}\cos\theta \Rightarrow \tan\theta = \frac{\mu}{2}$$



Hence $\sec\theta = \left(\sqrt{\mu^2 + 4}\right)/2$

Thus, $\left(\frac{l/2}{1}\right) = \frac{\sqrt{\mu^2+4}}{2} \Rightarrow l = \sqrt{\mu^2+4}$

$$\Rightarrow \; l = \sqrt{0.25+4} = \frac{\sqrt{17}}{2}\text{metres}$$

26. B

Sol. $e = -\frac{d\phi}{dt}$

$i = \frac{e}{R}$ where R is resistance

$H = i^2Rt$

The emf will induce from zero to some maximum value and then from maximum to zero.

27. B

Sol. $V_0 = \sqrt{\frac{GM}{3R/2}} = \sqrt{\frac{2GM}{3R}}$

In order to escape to infinity let (V – V_0) is the speed change required. Thus,

$$\frac{-GMm}{(3R/2)} + \frac{1}{2}m(v)^2 = 0$$

Thus, $v = \sqrt{\frac{4GM}{3R}}$

Thus speed change required = v – v_0

$$\Delta V = \sqrt{\frac{4GM}{3R}} - \sqrt{\frac{2GM}{3R}} \;;\; \Delta V = \sqrt{\frac{GM}{3R}}\left(2-\sqrt{2}\right)$$

28. A

Sol. The torque due to liquid in annular space is

$$\left(2\pi R_1 H\right)\times\mu\left(\frac{\omega R_2}{R_2-R_1}\right)\times R_1$$

where velocity gradient $= \frac{\omega R_2}{R_2-R_1}$

Also torque due to liquid in between space in bottom of thickness ‘h’

$$\int_0^{R_1}(x)\left(2\pi x dx\right)\cdot\frac{\omega x}{h} = \frac{\pi\mu\omega R^4}{2h}$$

29. C

Sol. $t = \int\frac{dy}{V_y} = \int_0^d \frac{dy}{Ky^{1/2}} = \frac{2\sqrt{d}}{k}$.

30. B

Sol. The volume of liquid should remain unchanged.

Hence, $2\times2\times2 = 2\times\frac{1}{2}\left[x + x + \frac{2}{\sqrt{3}}\right]\times2$

$\therefore \quad x \approx 1.42\,m$

Now, h = x sin 60° = 1.23 m

$\therefore \quad v = \sqrt{2gh} = \sqrt{2\times10\times1.23} = 4.96\,m/s$

Chemistry PART – II

SECTION – A

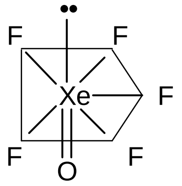
31. C

Sol. Ionic mobilities of hydrated alkali metal ions are as:

$$Cs^+ > Rb^+ > K^+ > Na^+ > Li^+$$

32. D

Sol.



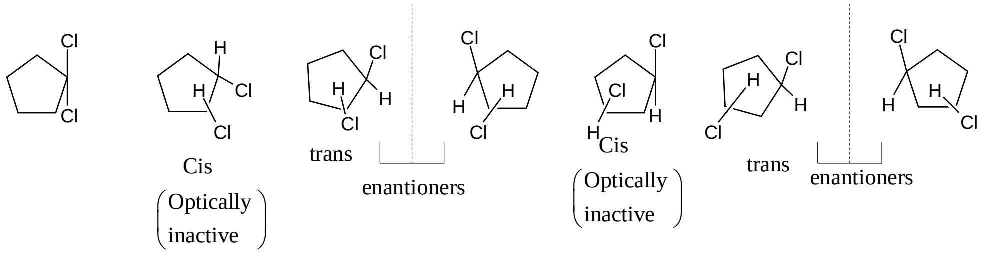
Hybridisation $-sp^3d^3$

Shape – pentagonal monopyramidal

33. C

Sol. Macromolecular colloids like starch, gelatin are generally lyophilic.

34. A



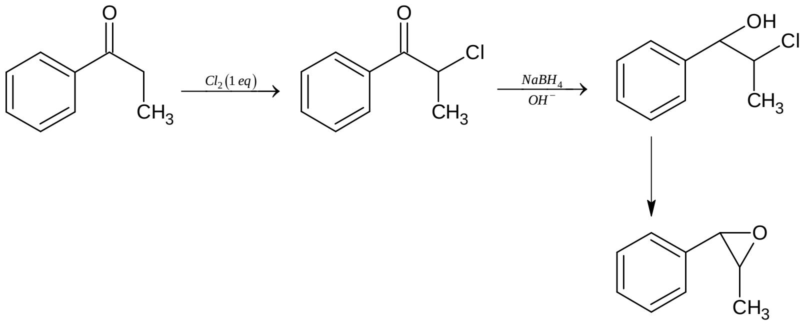
Cl
Cl
H
H
Cl
Cl
Cis
Optically inactive
Cl
H
H
Cl
trans
enantioners
Cl
H
H
Cl
Cl
Cl
H
H
Cis
Optically inactive
Cl
H
H
Cl
trans
Cl
H
H
Cl
enantioners

Total isomers = 7

35. A

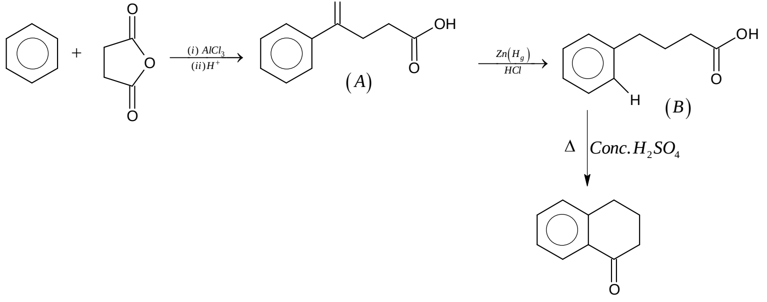
Sol. Groups to be eliminated should be trans diaxial in chair conformation.

36. C



O
CH3
Cl2 (1 eq)
O
Cl
CH3
NaBH4
OH−
OH
Cl
CH3
O
CH3

37. A



+
O
O
O
(i) AlCl3
(ii) H+
O
OH
O
(A)
Zn(Hg)
HCl
OH
O
H
(B)
Δ
Conc. H2SO4
O

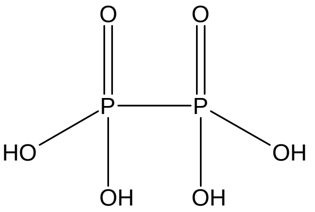
38. B

$$Bi^{3+} \xrightarrow{KI} BiI_3 \xrightarrow[KI]{excess} [BiI_4]^-$$

(A) (B)

Black ppt yellow brown solution

39. A



$H_4P_2O_6$

40. A

Because of stability of half filled f-subshell configuration.

41. C

$AgBr = x + y$

$$AgBr = \frac{K \times 1000}{M}$$

M – molarity of $AgBr$ solution

8 (solubility in g/L) = $\frac{K \times 1000}{(x+y)} \times 188$

42. A

$\left(Ni(CN)_4\right)^{2-}$ is dsp^2 hybridised and diamagnetic

43. D

Equivalents of $KMnO_4 = 5x$

Equivalents of $K_2Cr_2O_7 = 6y$

Equivalents of oxidising agent must be same $5x = 6y$

$x : y = 6 : 5$

44. B

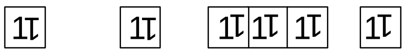
Greater the activation energy of a reaction, greater is the temperature dependence of rate constant of reaction.

45. C

$\frac{1}{\lambda} = RZ^2\left(1 - \frac{1}{4}\right)$ for lyman line

46. C

$Na - 1s^2$ $2s^2$ $2p^6$ $3s^1$



$m_l - 0$ 0 $+1$ 0 -1 0

47. C

Cl_2 is present simultaneously in two equilibria. Decrease in its concentration shift both equilibria forward.

48. D

Point B represents exactly half neutralisation of acid. At this point concentration acid left and its conjugate base are equal.

49. C

$$\left[Br^-\right] = \frac{4\times10^{-13}}{4\times10^{-4}} = 10^{-9}M$$

Mass of $NaBr$ added of $200\,ml = 103\times\frac{10^{-9}}{1000}\times200$

$$= 2.06\times10^{-8}\,g$$

50. C

Greater the charge density, greater is hydration.

51. D

Fluorine is most reactive amongst halides and has highest oxidising power

52. A

$$\begin{array}{cc} [XeF_3]^+ & [SbF_6]^- \\ \downarrow & \downarrow \\ sp^3d & sp^3d^2 \end{array}$$

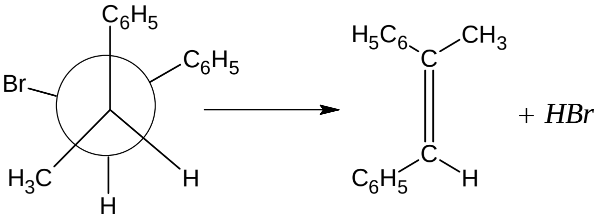
53. A

In $(\bullet CF_3)$, % p-character because of which bond angle decreases.

54. D

In PCl_2F_3, net dipole moment does not cancel out.

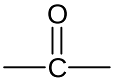
55. A



56. C

$-OH$ group of phenol cannot be replaced by iodine as it does not undergo nucleophilic substitution reaction under normal conditions.

57. A


$$-\overset{\overset{\displaystyle O}{\|}}{C}-$$

Group stabilise the carbanion character on $\alpha-$carbon

58. C

Methoxy group stabilises the cationic intermediate by $+M$ effect

59. B

2 molecules of $RMgX$ are consumed by acid chloride group as it undergoes addition elimination first and then addition. The other aldehydic & ketonic group consume one $RMgX$ molecule each.

60. B

Structure containing a ring of $(4n+2)\pi e^- s$ is aromatic

Mathematics PART – III

SECTION – A

61. D

$a=3, b=-4, c=1$

62. D

63. A

$$\int_0^{\frac{\pi}{2}} \frac{(1-\tan x)^2}{(1+\tan x)^4}\sec^2 x\, dx=\frac{1}{3}$$

64. C

Put $x=i$ and equate the real part

65. C

$$x^2dx+y^2dy=\frac{d(xy)}{(xy)^2}$$

66. B

Let $x=\frac{\log_2 y}{111}$ these $y^3-16y^2+8y-4=0$

67. C

$$\sec^{-1}\sqrt{1+x^2}=\tan^{-1}x, \cos^{-1}\frac{1-x^2}{1+x^2}=2\tan^{-1}x$$

68. C

$\left(\frac{x-2y-4}{\sqrt{5}}\right)^2=\frac{12}{\sqrt{5}}\left(\frac{2x+y}{\sqrt{5}}\right)$ (if is parabola)

69. C

$\tan\frac{\theta}{2}\tan\frac{\theta}{2}=\frac{1+e}{1-e}$ if focus is $(-ae,\theta)$

70. B

$$\frac{\underline{|7}}{\underline{|4}\ \underline{|2}}=105$$

71. D

$$f(x)=\tan\left(\frac{\pi}{4}-\frac{x}{2}\right)$$

72. B

73. B

74. D

75. C

76. B

77. B

$b^2+c^2-a^2, c^2+a^2-b^2, a^2+b^2-c^2$ are in AP.

78. B

$$OM=\sqrt{\left(50\sqrt{5}\right)^2-(100)^2}=50m$$

79. B
80. B
81. D

$\Delta = 0$

82. A
83. D

$3+5+7+....\text{upto}\,32\text{nd terms}=1023$

84. C

$$\sin^{-1}\frac{\frac{2}{x}}{1+\left(\frac{1}{x}\right)^2} = 2\tan^{-1}\frac{1}{x}$$

85. D

Both the roots opposite in sign

86. A

$adj\left(AB\right) = adjB.adjA$

87. C

$$\int_1^3\left(\tan^{-1}\left(\frac{x}{1+x^2}\right)+\tan^{-1}\left(\frac{x^2+1}{x}\right)\right)dx = 2\pi$$

88. C
89. C
90. A

$\vec{a}+\vec{b}=\vec{c}$

FIITJEE **JEE (Advanced), 2018**

ALL INDIA TEST SERIES

FULL TEST – I

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 234**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 – 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **–1 mark** for wrong answer.

   Section-A (09 – 12) contains 4 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

   Section-A (13 to 18) contains 3 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **–1 mark** for wrong answer.

2. **Section-C (01 – 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

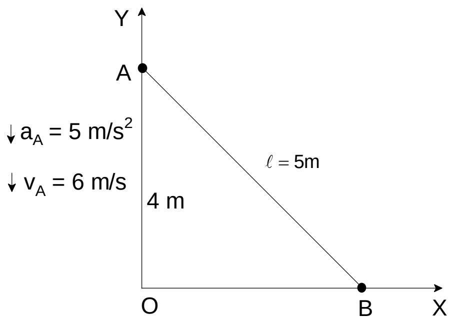
Physics

PART – I

SECTION – A
Straight Objective Type

This section contains **08 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct.

1. Point A on the rod AB has an acceleration of 5 m/s^2 and a velocity of 6 m/s at an instant as shown in the figure. The acceleration of the end B at the same moment is:


Y
A
↓a_A = 5 m/s^2
↓v_A = 6 m/s
ℓ = 5m
4 m
O
B
X

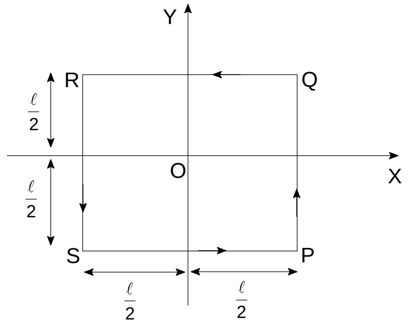
(A) $-\frac{80}{3}\hat{i}\ \text{m/s}^2$

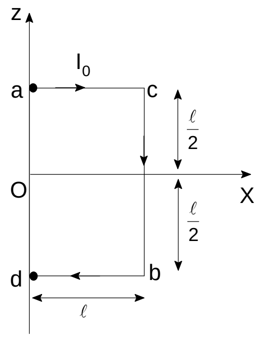
(B) $\frac{80}{3}\hat{i}\ \text{m/s}^2$

(C) $-\frac{40}{3}\hat{i}\ \text{m/s}^2$

(D) $-\frac{75}{6}\hat{i}\ \text{m/s}^2$

2. Current I₀ is flowing through a bent wire $a \rightarrow b \rightarrow c \rightarrow d$ in z – x plane as shown in figure, then $\oint \vec{B}.\vec{d\ell}$ over the loop PQRS lying in the X-Y plane as shown in figure, due to the bent wire abcd


Y
R
Q
$\frac{\ell}{2}$
$\frac{\ell}{2}$
O
X
S
P
$\frac{\ell}{2}$
$\frac{\ell}{2}$


z
I_0
a
c
$\frac{\ell}{2}$
O
X
$\frac{\ell}{2}$
d
b
ℓ

(A) $\frac{\mu_0 I_0}{8}$

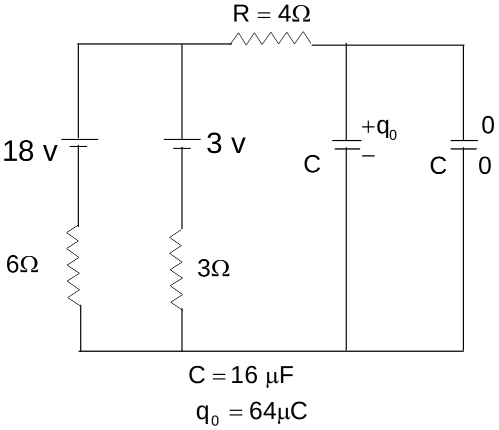
(B) $\frac{\mu_0 I_0}{7}$

(C) $\frac{\mu_0 I_0}{5}$

(D) $\frac{\mu_0 I_0}{3}$

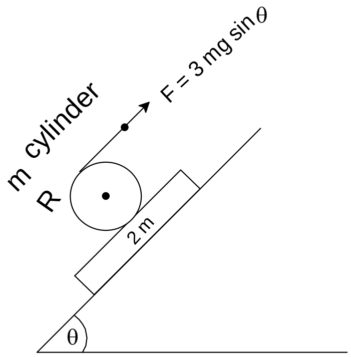
Space for rough work

3. The circuit is completed at t = 0, then heat loss in $R = 4\Omega$ resistance, till the capacitor gets fully charged:
(A) $64\mu J$
(B) $384\mu J$
(C) $320\mu J$
(D) $576\ \mu J$



4. A simple harmonic plane progressive wave is travelling along the +ve x – axis having amplitude A and $\omega = \pi$ rad/s. At t = 1 sec, particle at x = 2 m and x = 3 m are moving in downward and upward direction respectively at the position $y = +\frac{A}{2}$. The time when maximum power transfer will takes place at $x = \frac{11}{4}m$?
(A) $\frac{5}{4}$sec
(B) $\frac{5}{3}$ sec
(C) $\frac{7}{4}$ sec
(D) $\frac{7}{5}$ sec

5. There is sufficient friction between long plank of mass 2 m and cylinder of mass m and radius R to prevent slipping. Whole system is placed on the smooth inclined surface. Now, force $F = 3mg\sin\theta$ is applied on the ideal string wrapped over the cylinder as shown in figure. Choose correct option:
(A) If the plank moves down a distance of S m, work done by the applied force F on the string is 5 mg $\sin\theta$ S
(B) if the plank moves down a distance of S m, work done by the applied force F on the string is 6 mg $\sin\theta$ S
(C) If the plank moves down a distance of S m, work done by the applied force F on the string is 12 mg $\sin\theta$ S
(D) If the plank moves down a distance of S m, work done by the applied force F on the string is 15 mg $\sin\theta$ S



Space for rough work

6. A vertical thermally insulated cylinder of volume V contain n moles of an ideal monoatomic gas under a weightless piston. A load of weight W is placed on the piston as a result of which the piston is displaced. If the initial temp of the gas is 300 K, area of piston is A and atmospheric pressure P_0. (take $W = P_0A$). Determine the value of final temperature of the gas.

(A) 375 K	(B) 425 K
(C) 475 K	(D) 515 K

7. A open organ pipe containing air resonates in fundamental mode due to a tuning fork. The measured value of length $\ell(\text{in cm})$ of the pipe and radius $r(\text{in cm})$ of the pipe are $\ell = 94.0 \pm 0.1, r = 5.0 \pm 0.05$. The velocity of the sound in air is accurately known. The maximum percentage error in the measurement of the frequency of that tuning fork by thus experiment, will be:

(A) 0.16	(B) 0.64
(C) 1.2	(D) 1.6

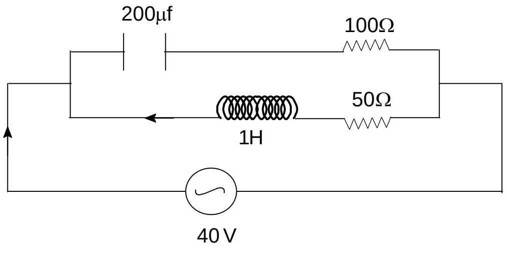
8. A metallic spherical shell has mass m, radius R and Bulk modulus of elasticity B. The change in radius of the shell due to gravitational pressure

(A) $\frac{Gm^2}{3B\pi R^3}$	(B) $\frac{Gm^2}{8B\pi R^3}$
(C) $\frac{Gm^2}{24B\pi R^3}$	(D) $\frac{Gm^2}{36B\pi R^3}$

Multiple Correct Choice Type

This section contains **04 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

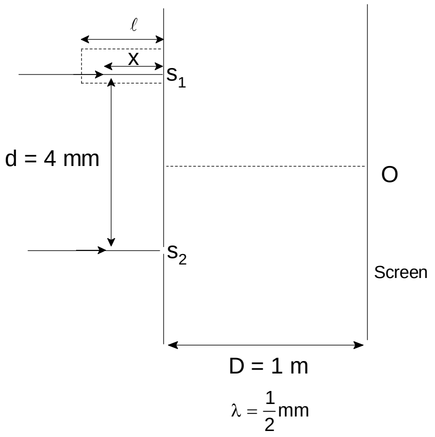
9. In the given circuit, the AC source has $\omega = 50\text{ rad/s}$ considering the inductor and capacitor to be ideal, the correct choice(s) is/are



(A) The voltage across 100Ω resistor $= 20$
(B) The voltage across 50Ω resistor $= 20$
(C) The current through the circuit is $I = \frac{\sqrt{5}}{\sqrt{2}}A$
(D) The current through the circuit is $I = 1.2A$

Space for rough work

10. In YDSE, D = 1 m, d = 4 mm and $\lambda = \frac{1}{2}$mm In the figure shown, a parallel beam of light is incident on the plane of the slits of YDSE. Light incident on the slit s₁, passes through a medium of variable refractive index $\mu = (2x+1)$ (where x is the distance from the plane of slits in mm) up to a distance $\ell = 1$ mm before falling on s₁. Rest of the space filled with air. Then choose the correct option(s):



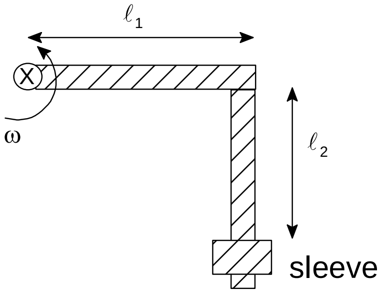
(A) Position of central bright fringe is at a distance $y = \frac{1}{\sqrt{3}}$m above the central line

(B) Position of central bright fringe is at a distance $y = \frac{1}{2}$m above the central line

(C) Number of maxima obtaining on the screening is 7

(D) Number of maxima obtaining on the screening is 8

11. A rough L – shaped rod is located in a horizontal plane and a sleeve of mass m is inserted in the rod. The rod is rotated with a constant angular velocity ω in the horizontal plane. The lengths ℓ_1 and ℓ_2 are shown in figure. The normal reaction and frictional force acting on the sleeve when it starts slipping are $(\mu$: coefficient of friction between rod and sleeve$)$.



(A) $N = m\omega^2\ell_1$

(B) $\omega^4 = \frac{\mu^2 g^2}{\ell_2^2 - \mu^2\ell_1^2}$

(C) $N = m\sqrt{g^2 + \omega^4\ell_1^2}$

(D) $f = \mu N$

Space for rough work

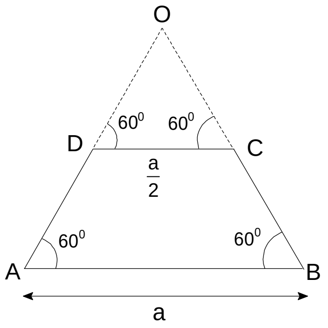
12. Consider a uniformly charged sheet ABCD, which is a part of an equilateral triangular sheet of a side a as shown in the figure. Choose the correct options regarding the electric field E at point O due to this sheet.

(A) Magnitude of $\vec{E}$, increases with the increase in a (Keeping charge density same)

(B) Magnitude of E, decreases with increase in a (keeping total charge same)

(C) If charge density is σ and a = 1 m, magnitude of E is equal to $\frac{7\sigma}{44\varepsilon_0}\text{In}\sqrt{2}$

(D) If charge density is σ and a = 2 m, magnitude of E is equal to $\frac{7\sigma}{22\varepsilon_0}\text{In}\sqrt{2}$

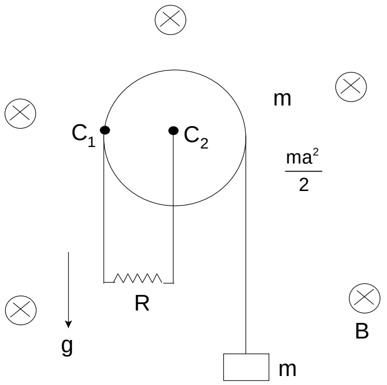


Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

Paragraph for Questions 13 & 14

Consider a perfectly conducting uniform disc of mass m and radius ‘a’ hinged in a vertical plane from its centre and free to rotate with respect to hinge. A resistance R is connected between centre of the disc and periphery by using two sliding contacts C_1 & C_2. A long non – conducting massless string is wrapped around the disk, whose another end is attached with a block of mass m. There exists a uniform horizontal magnetic field B, whose arrangement is shown in figure.
Given system is released from rest at t = 0. Assume friction between string and disc is sufficient so that there is no slipping between them let at any instant t, velocity of block is v, angular velocity of the disc is ω and current in resistance is i.



13. Find the terminal speed of the block of mass m is (Terminal speed = constant speed attained by the block after very long time)

(A) $\frac{mgR}{B^2a^2}$

(B) $\frac{2mgR}{B^2a^2}$

(C) $\frac{3mgR}{B^2a^2}$

(D) $\frac{4mgR}{B^2a^2}$

Space for rough work

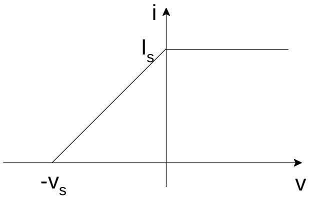
14. Just after t = 0, the acceleration of block is:

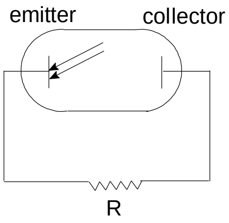
(A) g
(B) $\frac{g}{2}$
(C) $\frac{2g}{3}$
(D) $\frac{g}{5}$

Paragraph for Questions 15 & 16

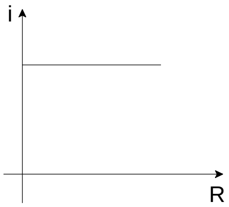
Let us assume that the current voltage graph for photoelectric tube consists of two straight lines as shown.

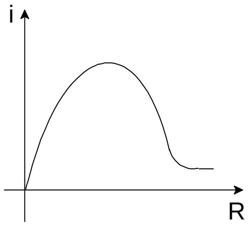
On such a photoelectric tube, light of wavelength 310 nm is incident. The work function of the emitter plate is 2eV. The tube effectively acts as a solar cell to supply current to an external resistor R. Saturation current is 2A.

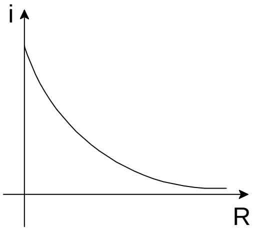


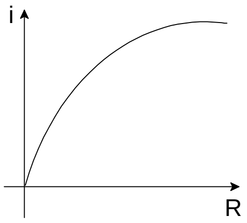


15. How does the current depend for R

(A)


(B)


(C)


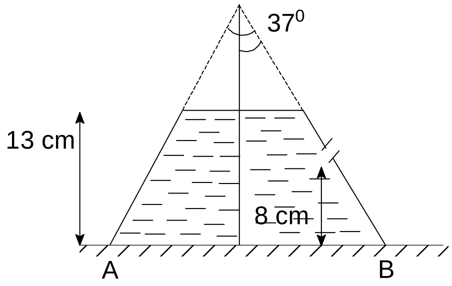
(D)


Space for rough work

16. At the what value of R will be the power dissipated in R maximum
(A) 1Ω (B) 2Ω
(C) $\frac{1}{2}\Omega$ (D) $\frac{1}{4}\Omega$

Paragraph for Questions 17 & 18

Curved surface of a vessel has shape of truncated cone having semi – vertex angle 37^0. Vessel is full of water (density $\rho = 1000\ kg/m^3$) upto a height of 13 cm and is placed on a smooth horizontal plane. Upper surface is opened to atmosphere. A hole of 1.5 cm is made on curved wall of a height of 8 cm from bottom as shown in figure. Area of water surface in the vessel is large as compared to the area of the hole.



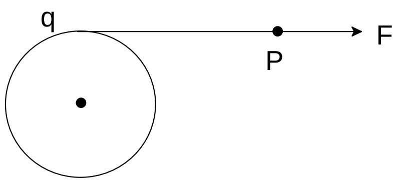
17. The initial horizontal force required to keep the vessel in static equilibrium
(A) 0.12N (B) 0.15 N
(C) 0.25 N (D) 0.35 N

18. The initial horizontal range of water from point B is
(A) 16 cm (B) 12 cm
(C) 10 cm (D) 8cm

SECTION – C
(One Integer Value Correct Type)

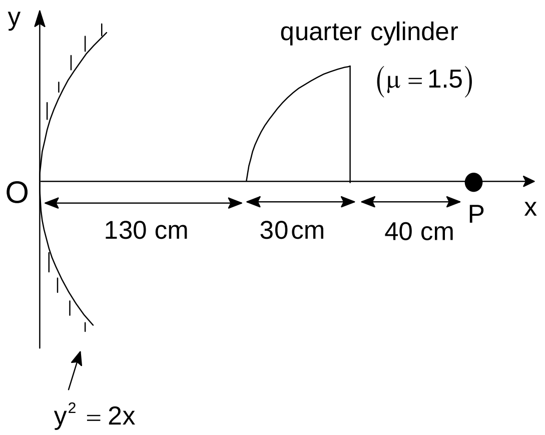
This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

19. A very long non- conducting cylindrical shell of length $\ell = 10m$ is free to rotate about its fixed axis. A light inextensible thread is wrapped over non – conducting cylindrical surface and one end P is pulled with constant acceleration of $\frac{F}{2m}$. F is the force applied at P and m is the mass of cylinder. Then charge on the cylinder will be $5 \times 10\ K$ coulomb. $\left[\text{Given } m = 25\ kg,\ \ell = 10m\right]$. Find the value of K?

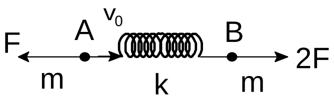


Space for rough work

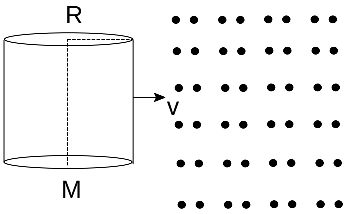
20. A point object is kept at a distance of 2 m from origin on x – axis. A quarter cylinder of radius R = 30 cm and refractive index $\mu = 1.5$ having its axis $\perp_r$ to plane of paper is placed between the object and the parabolic reflector at a distance of 130 cm from origin as shown in figure. The position of the image after reflection from the parabolic reflector $y^2 = 2x$ is 25 λ cm. Find the value of λ?



21. Two identical particles A & B of mass m = 2 kg is connected at the end of the spring $(K = 50\,N/m)$ and placed on a smooth horizontal surface. Now, force F = 10 N and 2 F are applied on the particles in opposite direction as shown in figure. Initially spring is in natural length.
Simultaneously particle A receives an impulse towards B which imparts speed v_0 to it, find v_0 in m/s for which length of elongation is two times the length of compression in the spring during subsequent motion?



22. A cylinder of mass M and radius R moves with constant speed v through a region of space that contains dust particles of mass m which is at rest. There are n number of particles per unit volume. The cylinder moves in a direction perpendicular to its axis. Assume m <<M, and assume the particles do not interact with each other. All the collision takes place is perfectly elastic and the surface of the cylinder is smooth. The drag force per unit length of the cylinder require to maintain the speed v constant for the cylinder is $\frac{K}{3}nmRv^2$. Find the value of K?



23. In a hydrogen like atom an electron is orbiting in an orbit having quantum number n. Its frequency of revolution is found to be 13.2×10^{15} Hz. Energy required to free the electron from the atom from the above orbit is 54.4 eV. In time 7 nano – second the electrons jumps back to orbit having quantum number $\frac{n}{2}$. τ be the average torque acted on the electron during the above process, then find $\frac{\tau}{5} \times 10^{27}$ in N – m.

$\left(\text{Given } \frac{h}{\pi} = 2.1 \times 10^{-34}\,J-s\right)$ Frequency of revolution of electron in the ground state of H – atom $f_0 = 6.6 \times 10^{15}$ Hz and ionization energy of H – bond $E_0 = 13.6$ eV

Space for rough work

Chemistry

PART – II

SECTION – A
Straight Objective Type

This section contains **08 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct.

24. A gas X is passed through water to form a saturated solution. The aqueous solution on treatment with $AgNO_3$ gives white precipitate. The saturated aqueous solution also dissolves magnesium ribbon with evolution of a colourless gas Y.

(A) X is CO_2 and Y is Cl_2	(B) X is Cl_2 and Y is CO
(C) X is Cl_2 and Y is H_2	(D) X is H_2 and Y is Cl_2

25. The method of zone refining of metals is based on the principle of:
(A) Greater mobility of the pure metal than that of impurity
(B) Higher melting point of the impurity than that of the pure metal
(C) Greater noble character of the solid metal than that of the impurity
(D) Greater solubility of the impurity in the molten state than in the solid

26. 50 ml of 0.2 M solution of a compound with empirical formula $CoCl_3.4NH_3$ on treatment with excess of $AgNO_3$(aq) yields 1.435 gm of AgCl. Ammonia is not removed by treatment with concentrated H_2SO_4. The formula of compound is:

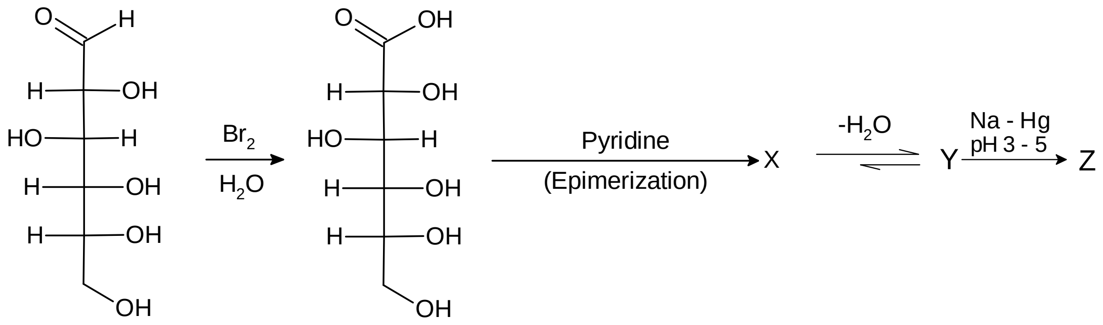
(A) $\left[Co(NH_3)_4Cl_3\right]$	(B) $\left[Co(NH_3)_3Cl\right]Cl_2$
(C) $\left[Co(NH_3)_4Cl_2\right]Cl$	(D) $\left[Co(NH_3)Cl_3\right]NH_3$

27. Determine the amount of AgI which may be dissolved in 1.0 litre of 1.0 M CN^- solution. K_{sp} for AgI and equilibrium constant for $\left[Ag(CN)_2\right]^-$ formation are $1.19\times10^{-17}M^2$ and $7.11\times10^{19}M^{-2}$ respectively.

(A) 1.0 mole	(B) 0.5 mole
(C) 4.0 mole	(D) 2.5 mole

Space for rough work

28.


O
H
OH
HO
Br2
H2O
Pyridine
(Epimerization)
X
-H2O
Y
Na - Hg
pH 3 - 5
Z

What is Z

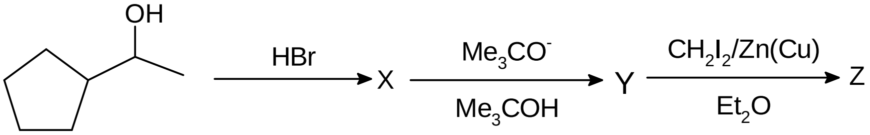
(A) D - Mannose

(B) D - Xylose

(C) D - Xylitol

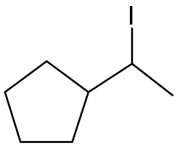
(D) D - Talose

29.

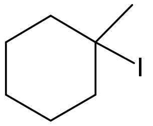

OH
HBr
X
Me3CO-
Me3COH
Y
CH2I2/Zn(Cu)
Et2O
Z

Z is

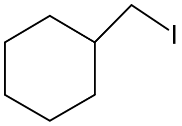
(A)



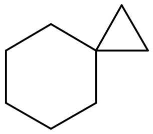
(B)



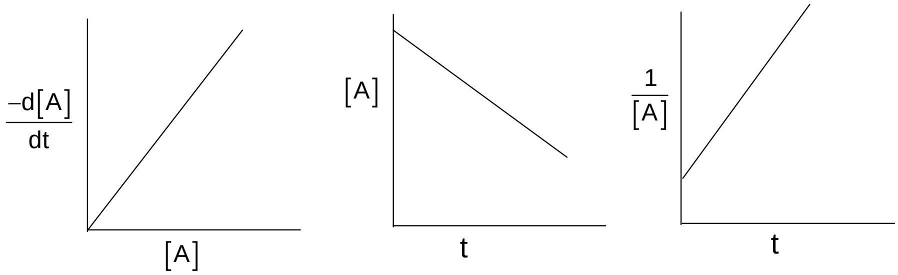
(C)



(D)



30. For a reaction $nA \longrightarrow B$, following plots are given:



The order of reaction for above plots are -

(A) 1, 0, 2

(B) 0, 1, 2

(C) 1, 1, 2

(D) 0, 2, 1

Space for rough work

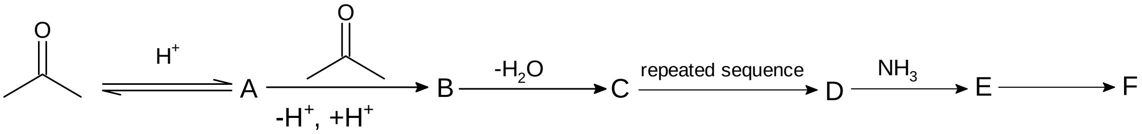
31. Which of the following products are formed when potassium bromide reacts with potassium permagnate in alkaline pH?

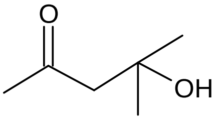
(A) BrO_3^-, MnO_2
(B) BrO_4^-, Mn^{2+}
(C) Br_2, MnO_2
(D) BrO^-, MnO_4^{2-}

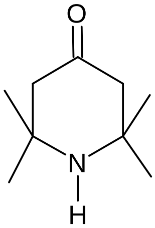
Multiple Correct Choice Type

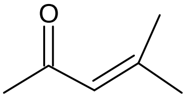
This section contains **04 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

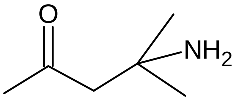
32.



(A) B is 

(B) F is 

(C) B is 

(D) E is 

33. For an isothermal irreversible expansion of 1 mole of a perfect gas, identify the correct relation, where symbols have their usual meaning

(A) $\Delta U = 0$
(B) $\Delta H = 0$
(C) $q = RT\left(1 - \frac{P_2}{P_1}\right)$
(D) $w = RT\,\ell n\left(\frac{P_2}{P_1}\right)$

Space for rough work

34. The vander waal gas constant 'a' is given by

(A) $\frac{1}{3}V_c$ (B) $3P_cV_c^2$

(C) $\frac{1}{8}\frac{RT_c}{P_c}$ (D) $\frac{27}{64}\frac{R^2T_c^2}{P_c}$

35. Degree of hydrolysis of a salt of strong acid and weak base is:

(A) Independent of dilution (B) Increases with dilution

(C) Decreases with increase in K_b value (D) Increases with increase in K_b value

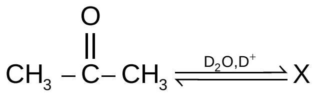
Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct.

Paragraph for Questions 36 & 37

Deuterium is the isotope of hydrogen of mass number 2, with a proton and a neutron in its nucleus. The chemistry of deuterium is nearly identical to the chemistry of hydrogen, except that C – D bond is slightly (5.0 KJ/mole) stronger than the C – H bond. Reaction rates tend to be slower if a C – D bond as opposed to a C – H bond is broken in a rate limiting step. This effect on the rate is called a kinetic isotope effect.

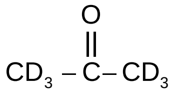
36.



$CH_3-\overset{\overset{O}{\|}}{C}-CH_3 \overset{D_2O,D^+}{\rightleftharpoons} X$

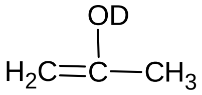
X is

(A)



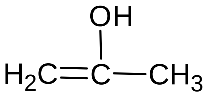
$CD_3-\overset{\overset{O}{\|}}{C}-CD_3$

(B)



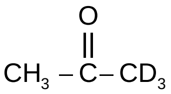
$H_2C=\overset{\overset{OD}{|}}{C}-CH_3$

(C)



$H_2C=\overset{\overset{OH}{|}}{C}-CH_3$

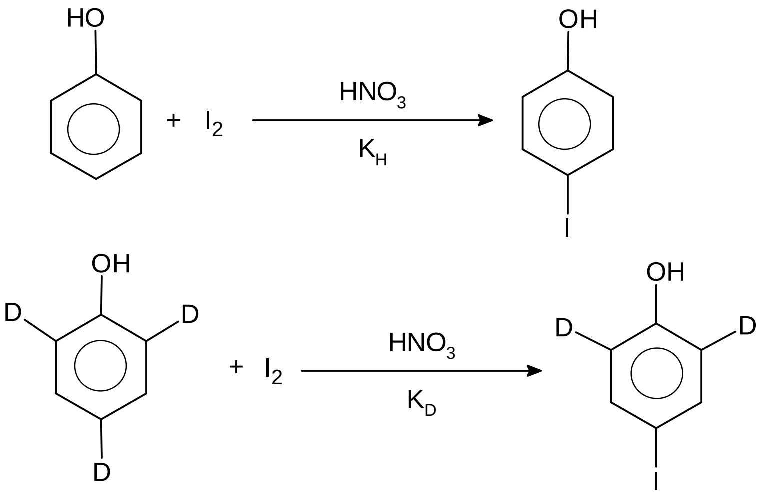
(D)



$CH_3-\overset{\overset{O}{\|}}{C}-CD_3$

Space for rough work

37.



(A) $\frac{K_H}{K_D} = 1$ (B) $\frac{K_H}{K_D} \approx 4$

(C) $\frac{K_D}{K_H} \approx 4$ (D) $\frac{K_D}{K_H} \approx 2$

Paragraph for Questions 38 & 39

Galvanic cells generate electrical energy at the expense of a spontaneous redox reaction. In an electrode concentration cell two like electrodes having different concentrations, either because they are gas electrodes operating at different pressures or because they are amalgams (solutions in mercury) with different concentrations are dipped into the same solution.

Eg. An example is a cell composed of two chlorine electrodes with different pressure of Cl_2:

$Pt_L \left| Cl_2(P_L) \right| HCl(aq) \left| Cl_2(P_R) \right| Pt_R$

Where P_L and P_R are the Cl_2 pressure at the left and right electrodes.

38. Calculate the EMF of the electrode concentration cell represented by:

$Hg - Zn(c_1) \left| Zn^{+2}(aq) \right| Hg - Zn(c_2)$

At 25^0 C. c_1 = 2g of Zn per 100 g of Hg and c_2 = 1 g of Zn per 50 g of Hg

(A) 0.059 V (B) 3

(C) 0 (D) data insufficient

Space for rough work

39. A cell represented by the following cell diagram is generated to measure the solubility product of AgCl.

$\mathrm{Ag}\left|\mathrm{Ag^+}(aq)\right|\mathrm{Cl^-}(aq)\left|\mathrm{AgCl}(s)\right|\mathrm{Ag}$

$K_{sp}^{0}(\mathrm{AgCl})$ at 298 K and 1 bar pressure is:

Given:

$\mathrm{AgCl} + e^- \rightarrow \mathrm{Ag} + \mathrm{Cl^-}$ $\quad E^0 = 0.22\ \mathrm{V}$

$\mathrm{Ag^+} + e^- \rightarrow \mathrm{Ag}$ $\quad E^0 = 0.79\mathrm{V}$

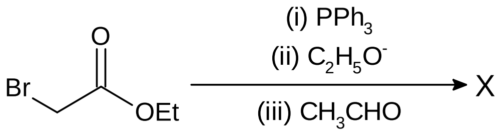
$$\left(\text{Take}\sqrt{10} = 3.16\ \&\ \frac{RT.(2.303)}{F} = 0.06\right)$$

(A) 3.16×10^{-10}
(B) 3.16×10^{-11}
(C) 3.16×10^{-9}
(D) data insufficient

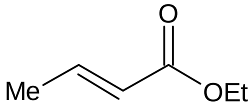
Paragraph for Questions 40 & 41

Aldehyde and Ketone molecules having $\alpha-$hydrogen atoms undergo aldol condensation reaction. Aldol condensation reaction proceeds in acidic and basic conditions. In basic medium, aldol condensation product will be formed involving enolate ion formation. Here the enolate ion acts as nucleophile. Other carbonyl group containing compounds also perform similar type of reactions.

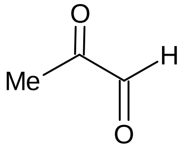
40.



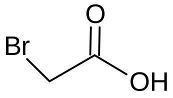
Final product X is

(A) 

(B) CH_3CHO and CH_3COOH

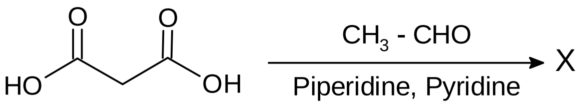
(C) 

and C_2H_5OH

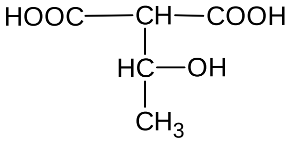
(D) 

and C_2H_5OH

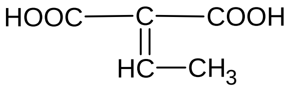
Space for rough work

41. 

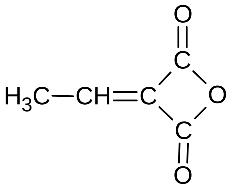
Final product X is

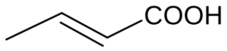
(A) 

$HOOC-CH(COOH)-CH(OH)-CH_3$

(B) 

$HOOC-C(COOH)=CH-CH_3$

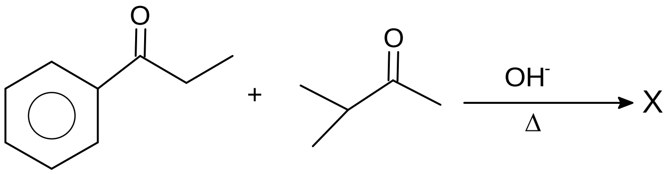
(C) 

(D) 

SECTION – C
(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

42. Let (+) tartaric acid has a specific rotation of + 11.1. Calculate the specific rotation of a mixture of 68% (+) tartaric acid and 32% (-) tartaric acid.

43. 

Total number of π bonds in X is

44. Find the number of molecules having two lone pair of electrons on central atom.
$I_3^+, XeF_2, XeF_4, H_2O, NH_2^-, H_2S, H_2SO_4, NF_3$

45. A Boron mineral have pentaborate anion whose molecular formula is $\left[B_5O_6\left(OH\right)_4\right]^-$. The number of B – O - B linkage present are?

46. The electron in the first excited state ($n_1 = 2$) of H – atom absorbs a photon and is further excited to nth shell. The de-Broglie wavelength of the electron in this excited state is 1340 pm. Find the value of n.

Space for rough work

Mathematics PART – III

SECTION – A
Straight Objective Type

This section contains **08 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct.

47. The sum of abscissa of the points of inflexions of curve y =
$f(x)=\frac{x^7}{42}-\frac{2x^6}{15}+\frac{3x^5}{20}+\frac{x^4}{3}-\frac{2x^3}{3}+99x+2010$ is,
(A) -1 (B) 0
(C) 2 (D) none of these

48. In triangle ABC, if y = x+1 & y = 2x + 3 are altitude through A & angle bisector of B respectively. If vertex C ≡ (3 , 4) then equation of median through C is
(A) x + 7y = 25 (B) 7x + 2y = 25
(C) 7x + y = 25 (D) 2x + 7y = 25

49. Equation of curve passing through (1, 1) & satisfying the differential equation
$\left(xy^2+y^2+x^2y+2xy\right)dx+\left(2xy+x^2\right)dy=0$ Is
(A) $xy(x+y)=2e^{1-x}$ (B) $xy\left(x^2+y^2\right)=2e^{x-1}$
(C) $x^2y^2(x+y)=2$ (D) $x^2y^2\left(x^2+y^2\right)=2$

50. In a bag there are 10 black & 10 white balls. A ball is drawn at random & 5 extra balls of same color as of drawn ball are added in the bag along with the drawn ball. Now another ball is drawn and replaced in the bag but 4 balls of color same as drawn ball are removed from the bag. Again a ball is drawn and found to be white find the probability that the second drawn ball was black.
(A) $\frac{4}{7}$ (B) $\frac{3}{7}$
(C) $\frac{2}{7}$ (D) $\frac{1}{7}$

Space for rough work

51. Let $f(x) = x + \{x\}^2$ where {x} is fractional part of x. The area between the curves y = f(x), $y = f^{-1}(x)$, x = 0 and x = $\frac{3}{2}$ is,

(A) $\frac{1}{2}$
(B) 1
(C) $\frac{3}{2}$
(D) 2

52. f & g are two real valued continuous functions and let $\int g(x)dx = f^{-1}(x)\, and\, f(x) = x^3 + x + \sin \pi x + 2$ then the value of $\int_2^4 xg(x)dx$ is

(A) $\frac{-11}{4} - \frac{2}{\pi}$
(B) $\frac{11}{4} - \frac{2}{\pi}$
(C) $\frac{-11}{4} + \frac{2}{\pi}$
(D) $\frac{11}{4} + \frac{2}{\pi}$

53. The value of the limit $\lim\limits_{x \to \frac{1}{\sqrt{2}}^+} \frac{\cos^{-1}\left(2x\sqrt{1-x^2}\right)}{x - \frac{1}{\sqrt{2}}}$ is equal to

(A) $\sqrt{2}$
(B) $-2\sqrt{2}$
(C) $2\sqrt{2}$
(D) doesn't exist

54. If $\left[1 + x + x^2\right]^n = \sum_{r=0}^{2n} a_r x^r$, then the value of $\sum_{k=0}^{3r} (-1)^k a_k\, {}^nC_{3r-k}$ $(where\ 3r \le n)\ is\ a_1{}^{a_2}C_{a_3}$. Then value of $a_1 + a_2 + a_3$ is

(A) n+1
(B) r+1
(C) n+r+1
(D) n + r

Space for rough work

Multiple Correct Choice Type

This section contains **04 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

55. x + y = 2 and x – y = 2 are tangents on a parabola at (1, 1) and (4, 2) respectively. Which of the followings is/are correct.

(A) Equation of directrix is x + 3y = 2
(B) Equation of axis is 3x – y = 5
(C) Focus of the parabola is at $\left(\frac{8}{5},\frac{6}{5}\right)$
(D) Vertex of the parabola is at $\left(\frac{33}{20},\frac{13}{20}\right)$

56. Line OQ is angle bisector of angle O of right angle triangle OPR, right angled at P. Point Q is such that ORQP is concyclic. If point O is origin and points P, Q, R are represented by the complex numbers z_3, z_2, z_1 respectively. If $\frac{z_2^{\,2}}{z_1 z_2}=\frac{3}{2}$ then (R is circum radius of ΔOPR)

(A) Angles of ΔOPR are $\frac{\pi}{6},\frac{\pi}{3},\frac{\pi}{2}$
(B) Angles of ΔOPR are $\frac{\pi}{4},\frac{\pi}{4},\frac{\pi}{2}$
(C) Area of ΔOPR is $2\sqrt{2}R^2$
(D) Area of ΔOPR is $2R^2$

57. In ΔABC, X and Y are foot of perpendicular from A and C respectively on median BE. If $\frac{area\left(\Delta BYC\right)}{area\left(\Delta AXE\right)}=4$, then which of the following is/are correct.

(A) $\frac{area\left(\Delta ABC\right)}{area\left(\Delta AXB\right)}=3$
(B) BX = 2XY
(C) 2 area (ΔAXB) = area (ΔXYC)
(D) none of these

Space for rough work

58. If a, b, c are in AP and A, B, C are in GP (common ratio $\neq 1$). Then which of the following is/are correct.

(A) $\frac{A}{a}, \frac{B}{b}, \frac{C}{c}$ are in HP if common ratio of GP is c/a.

(B) $\frac{a}{A}, \frac{b}{B}, \frac{c}{C}$ are in HP if common ratio of GP is equal to common difference of AP.

(C) $\frac{A^2}{a}, \frac{B^2}{b}, \frac{C^2}{c}$ are in HP if common ratio of GP is $\sqrt{\frac{c}{a}}$

(D) $\frac{a}{A^2}, \frac{b}{B^2}, \frac{c}{C^2}$ are in HP if common ratio of GP is equal to square root of common difference of AP.

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct.

Paragraph for Questions 59 & 60

Lines $L_1 : \frac{x-6}{3} = \frac{y-4}{2} = z-2$ and $L_2 : \frac{x-8}{4} = y-2 = \frac{z-4}{2}$ meets the plane $\pi : \vec{r}.\left(2\hat{i} + \hat{j} - \hat{k}\right) = 7$ at points A and B.

59. Area of the triangle formed by the lines L_1, L_2 & AB is

(A) $\frac{7}{2}\sqrt{\frac{19}{2}}$

(B) $\sqrt{\frac{19}{2}}$

(C) $\frac{\sqrt{11}}{4}$

(D) $6\sqrt{5}$

Space for rough work

60. Equation of line joining the images of the point of intersection of L_1 & L_2 with respect to the plane π and the line AB is

(A) $\frac{3x-14}{4}=\frac{3y-7}{5}=\frac{3z+7}{1}$ (B) $\frac{3x-14}{3}=\frac{3y-7}{3}=\frac{3z+7}{6}$

(C) $\frac{3x-14}{0}=\frac{3y-7}{3}=\frac{3z+7}{4}$ (D) $\frac{3x-14}{0}=\frac{3y-7}{3}=\frac{3z+7}{3}$

Paragraph for Questions 61 & 62

Let $x_i \in R,\ i=1,2,3.......n$ are numbers such that $\sum_{i=1}^{n} i\sqrt{x_i-i^2}=\frac{\sum_{i=1}^{n} x_i}{2}$ and $x_1+x_2+......+x_n=280$

61. No. of ways of distribution of n identical objects among 3 persons such that each get at least 1 object is
(A) 4 (B) 10
(C) 20 (D) 140

62. Probability that a randomly selected triangle formed by vertices of a 2n + 1 sided regular polygon is isosceles is
(A) $\frac{3}{13}$ (B) $\frac{5}{13}$
(C) $\frac{7}{13}$ (D) $\frac{9}{13}$

Paragraph for Questions 63 & 64

Let p (n) denotes the number of different ways the positive integer n (n>1) can be expressed as the sum of 1's and 2's. For example P (5) = 8, i – e
i.e. 5 =1 + 1 + 1 + 1 +1
=1 + 1 + 1 + 2 = 1+ 1+ 2+1 = 1 + 2 + 1 + 1 = 2 + 1 + 1 + 1
=1 + 2 + 2 = 2 + 1 + 2 =2 + 2 + 1

63. The value of p(p(6)) is
(A) 356 (B) 377
(C) 389 (D) 427

Space for rough work

64. The number of solutions of the equation p(n) = n + 1 where n = N is

(A) 1 (B) 2

(C) 3 (D) 4

SECTION – C
(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

65. Number of triangle ABC $\angle B = 90^0$ such that point B is vertex and A & C are point of zeros of a Quadratic expression $y = ax^2 + bx + c$ where b is an odd integer & $a, c \in z$, is

66. The value of $\left[\int_{-\pi}^{\pi}\sqrt{\frac{|\sin x|}{1+\tan^2 x}}dx\right]$ is (where [.] is greatest integer).

67. Two circles of unequal radii have four common tangents. A transverse common tangent meets the direct common tangents at the points P & Q. If length of direct tangent (between the point of contacts) is 8 then length of PQ is

68. If $A = \begin{bmatrix} 5 & -6 \\ 1 & -1 \end{bmatrix}$ then the value of $\frac{\det\left(A^m - 5A^{m-1}\right)}{\det\left(A^n - 5A^{n-1}\right)}\left(\mathrm{m}, n \in N\right) is$

69. Integral part of the area of figure bounded by the tangents at the end of latus rectum of ellipse $\frac{x^2}{9}+\frac{y^2}{4}=1$ and directrices of hyperbola $\frac{x^2}{9}-\frac{y^2}{72}=1$ is

Space for rough work

FIITJEE **JEE(Advanced)-2018**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – I

PAPER-1

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**A**	24.	**C**	47.	**B**
2.	**D**	25.	**D**	48.	**C**
3.	**B**	26.	**C**	49.	**A**
4.	**B**	27.	**B**	50.	**A**
5.	**D**	28.	**A**	51.	**B**
6.	**A**	29.	**D**	52.	**A**
7.	**A**	30.	**A**	53.	**C**
8.	**C**	31.	**A**	54.	**C**
9.	**ABC**	32.	**AB**	55.	**AC**
10.	**AD**	33.	**ABC**	56.	**AD**
11.	**BCD**	34.	**BD**	57.	**AC**
12.	**BC**	35.	**BC**	58.	**ABD**
13.	**D**	36.	**A**	59.	**B**
14.	**C**	37.	**B**	60.	**D**
15.	**C**	38.	**C**	61.	**C**
16.	**A**	39.	**A**	62.	**A**
17.	**A**	40.	**A**	63.	**B**
18.	**C**	41.	**D**	64.	**D**
19.	**4**	42.	**4**	65.	**0**
20.	**2**	43.	**5**	66.	**2**
21.	**6**	44.	**5**	67.	**8**
22.	**8**	45.	**6**	68.	**1**
23.	**3**	46.	**4**	69.	**7**

Physics

PART – I

SECTION – A

1. $\overrightarrow{a_B} = \overrightarrow{a_A} + \left(\vec{\alpha} \times \overrightarrow{r_{B,A}}\right) - \omega^2 \overrightarrow{r_{B,A}}$

$= -5j + 4\alpha i + 3\alpha j - (12i - 16j)$

a_B along y – axis should be zero.

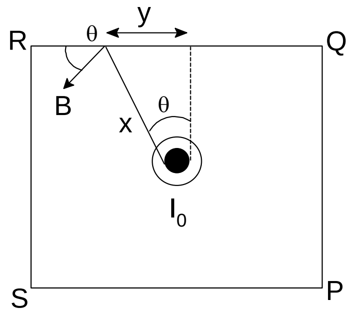
$\Rightarrow 11 + 3\alpha = 0$

$\Rightarrow \alpha = -\frac{4}{3} \text{rad}/\text{s}^2$

$a_B = (4\alpha - 12)i = -\frac{80}{3} i \ \text{m}/\text{s}^2$

2. $y = \frac{\ell}{2}\tan\theta$

$dy = \frac{\ell}{2}\sec^2\theta d\theta$



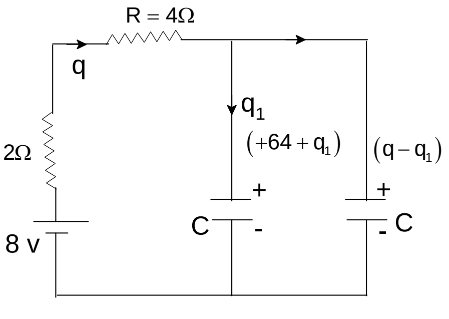
$$8\int_0^{\frac{\pi}{4}} B dy \cos\theta + \oint_{a\to b\to c\to d} \vec{B} \ .\overrightarrow{d\ell} = \mu_0 I_0$$

$$\int_0^{\frac{\pi}{4}} \frac{8\mu_0 I_0}{4\pi x} . \frac{2\frac{\ell}{2}}{\sqrt{x^2 + \frac{\ell^2}{4}}} . \frac{\ell}{2}\sec^2\theta\cos\theta + \oint_{a\to b\to c\to d} \vec{B}.\overrightarrow{d\ell} = \mu_0 I_0$$

$$\frac{2}{3}\mu_0 I_0 + \oint_{a\to b\to c\to d} \vec{B}.d\ell = \mu_0 I_0$$

$$\oint_{a\to b\to c\to d} \vec{B}.\overrightarrow{d\ell} = \mu_0 I_0 - \frac{2}{3}\mu_0 I_0 = \frac{\mu_0 I_0}{3}$$

3. Let $R + 2 = R_1$



$q(t) = \frac{3CE}{2}\left(1 - e^{-\frac{t}{2R_1C}}\right)$

$I = \frac{dq}{dt} = \frac{3E}{4R_1}e^{-\frac{t}{2R_1C}}$

Heat loss in $R_1 = \int I^2 R_1 dt$

$= 576\mu J$

so, heat loss in $R = 4\Omega$ is $= 576 \times \frac{2}{3} = 384\mu J$

4. Maximum power transfer will takes place when v_P is maximum.

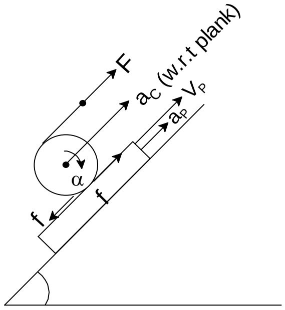
5. $a_C = R\alpha$ (for no slipping)

$V_C = R\omega$ $\quad (V_C$ is the speed of cylinder w.r.t plank$)$

$a_C + 3a_P = 0$

$V_C + 3V_P = 0$

$S_C + 3S_P = 0$



6. Let T_1 and T_2 be the initial and final temperature, then

$$P_0V = nRT_1 \qquad ......(i)$$

$$\left(P_0 + \frac{W}{A}\right)(V - Ah) = nRT_2 \qquad ....(ii)$$

Where h is the displacement of piston.

Also, work done on gas $= \Delta U$

$$Wh = nC_V\Delta T = \frac{3}{2}nR(T_2 - T_1) \qquad ....(iii)$$

From euqation (i), (ii) and (iii)

$$\frac{2}{3}Wh = \frac{WV}{A} - Wh - P_0Ab$$

$$\text{or, } Ah = \frac{WV}{P_0A + \frac{5}{3}W}$$

$$T_2 = \left(P_0 + \frac{W}{A}\right)\left(V - \frac{Wv}{P_0A + \frac{5}{3}W}\right)$$

$$T_2 = \frac{5}{4}T_1 = \frac{5}{4} \times 300 = 5 \times 75K.$$

7. $$f = \frac{v}{2(\ell + 2 \times 0.6r)} = \frac{v}{2(\ell + 1.2r)}$$

$$\therefore \frac{\Delta f}{f} = \frac{\Delta v}{v} - \frac{\Delta(\ell + 1.2r)}{(\ell + 1.2r)}$$

Here $\frac{\Delta v}{v} = 0$

$$\frac{\Delta f}{f} \times 100 = -\frac{(\Delta\ell + 1.2\Delta r)}{(\ell + 1.2r)} \times 100$$

$= 0.16$

8. $$\Delta P = \frac{Gm^2}{8\pi R^4}$$

$$B = -\frac{\Delta P}{\Delta V / V}$$

$$B.\frac{3dR}{R} = \frac{Gm^2}{8\pi R^4}$$

$$dR = \frac{Gm^2}{24B\pi R^3}$$

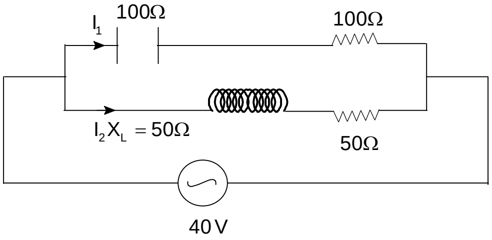
9. $I_1 = \frac{20}{z_1} \times 2$

$= \frac{2}{5\sqrt{2}}$ A at 45^0 leading

$I_2 = \frac{20}{z_2} = \frac{\sqrt{2}}{5}$ A at 45^0 lagging

$I_{1_{R.M.S}} = \frac{1}{5}$ A

$I_{2_{R.M.S}} = \frac{2}{5}$ A


I_1
100Ω
100Ω
I_2 $X_L = 50\Omega$
50Ω
40 V

10. For central height fringe

$d\sin\theta = 2mm$

$4mm\ \sin\theta = 2mm$

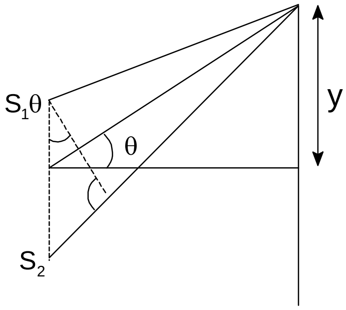
$\theta = 30^0$

$\tan 30^0 = \frac{y}{2}$

$y = \frac{1}{\sqrt{3}}$m.

For bright fringe $(d\sin\theta \pm 2) = n\lambda$

where n is 0,1,2,3.........


$S_1\theta$
θ
y
S_2

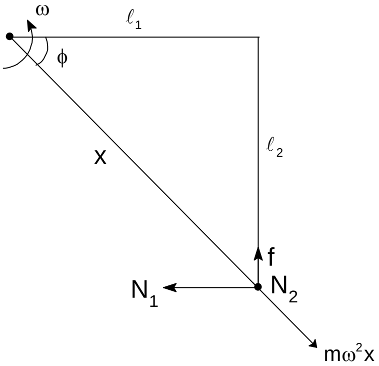
11. $N_1^2 + N_2^2 = N^2$

$N_2 = mg$

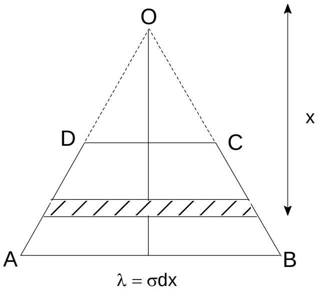
$m\omega^2 \times \sin\phi = f$

$f = m\omega^2 \ell_2$

$N_1 = m\omega^2 \ell_1$

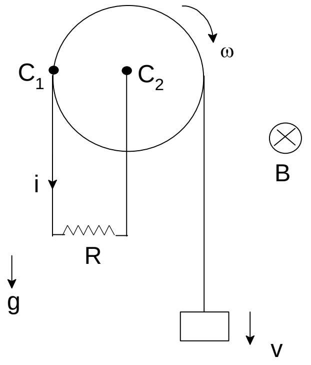

ω
ℓ_1
ϕ
x
ℓ_2
f
N_1
N_2
$m\omega^2 x$

12.
$$dE = 2\left(\frac{1}{4\pi\varepsilon_0}\right)\frac{\sigma dx}{x}\left(\frac{1}{2}\right)$$
$$dE = \frac{\sigma}{4\pi\varepsilon_0}\frac{dx}{x}$$
$$E = \frac{7\sigma}{44\varepsilon_0}\ln\sqrt{2}$$

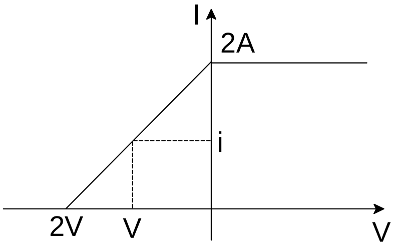


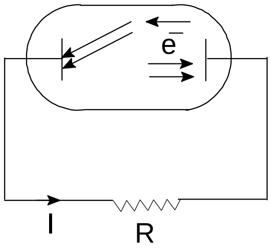
13. & 14.

Writing energy equation
$$mgv = mv\frac{dv}{dt} + I\frac{\omega d\omega}{dt} + i^2R \quad .....(i)$$
$$v = a\omega$$
$$\frac{dv}{dt} = a\frac{d\omega}{dt}$$
$$i = \frac{B\omega a^2}{2R} = \frac{Bva}{2R} \quad .....(ii)$$
From equation (i) and (ii)
$$\frac{3m}{2}\frac{dv}{dt} = mg - \frac{B^2a^2}{6mR}v$$
$$v = \frac{4mgR}{B^2a^2}\left(1 - e^{-\left(\frac{B^2a^2}{6mR}\right)t}\right)$$
$$\frac{dv}{dt} = \frac{2g}{3}e^{-\frac{B^2a^2}{6mR}t}$$

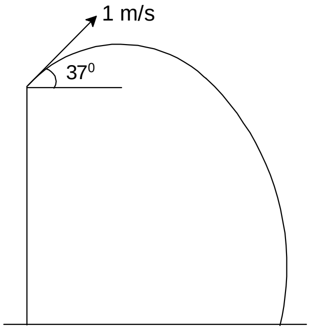


15. & 16.
$$V_{emit} > V_{collector}$$
$$V = -iR$$
$$V_{stop} = \frac{hc}{e\lambda} - \frac{\phi}{e} = 2v$$
$$i = 2 + V$$
$$I = 2 - iR$$
$$i(1+R) = 2$$
$$i = \frac{2}{1+R}$$
$$P = i^2R = \frac{4R}{(1+R)^2}$$
$$\frac{dP}{dR} = 0$$
$$4(1+R)^2 - 4R \times 2(1+R) = 0$$
$$4 + 4R = 8R$$
$$R = 1\Omega$$





17. & 18.



$$V=\sqrt{2gh}=1\,m/s$$

$$-\frac{8}{100}=\frac{3}{5}t-\frac{1}{2}\times 10Xt^2$$

$$t=\frac{1}{5}sec$$

$$\therefore x=\frac{4}{5}\times\frac{1}{5}\times 100=16\text{ cm}$$

horizontal range from point B $= 16-6=10\,cm$

Force required to keep the vessel in equlibrium $= \rho AV^2\cos 37^0$

$= 0.12$ N

SECTION – C

19. $$FR-\frac{\mu_0 q^2R^2}{4\pi\ell}\alpha=mR^2\alpha$$

$$F=R\alpha\left[m+\frac{\mu_0q^2}{4\pi\ell}\right]$$

$$\frac{F}{2m}=R\alpha=\frac{F}{m+\frac{\mu_0q^2}{4\ell\pi}}$$

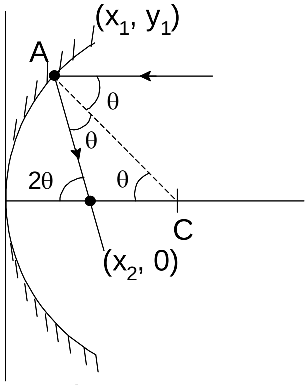
$$q=\sqrt{\frac{m\ell 4\pi}{\mu_0}}=5\times 10^4$$

20. After refraction through the quarter cylinder the emergent ray falls on the parabolic reflector parallel to x – axis.

$$\tan(\pi-\theta)=-\frac{1}{\left.\frac{dy}{dx}\right|_{(x_1,y_1)}}=y_1$$

$$\tan 2\theta=\frac{2\tan\theta}{1-\tan^2\theta}=\frac{y_1}{x_2-x_1}$$

$$\Rightarrow x_2=\frac{1}{2}m=50\text{ cm.}$$



Ac is a normal at A

21. $$\frac{1}{2}.\frac{m}{2}v_0^2=\frac{1}{2}K\left(\frac{3F}{K}\right)^2+\frac{3F}{2}.\frac{3F}{K}$$

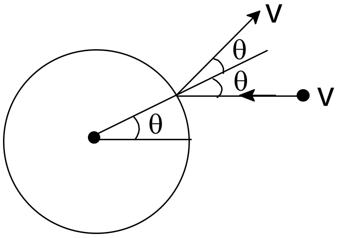
$$v_0^2=\frac{4\times 9F^2}{Km}$$

$$v_0=6\text{ m/s}$$

22. In the frame of the heavy cylinder the particle comes in with speed V and then bounces off.

$$f = \int_{-\frac{\pi}{2}}^{+\frac{\pi}{2}} 2mv\cos^2\theta\left(Rd\theta\cos\theta\right)\ell vn$$

$$\frac{f}{\ell} = \frac{8}{3}mv^2nR.$$



23. $f = f_0\frac{z^2}{n^3} \Rightarrow \frac{z^2}{n^3} = 2 \qquad ......(i)$

$E = E_0\frac{z^2}{n^2} \Rightarrow \frac{z^2}{n^2} = 4 \qquad (ii)$

Solving (i) and (ii) n = 2 z = 4

$L = mvr = \frac{nh}{2\pi}$

$\Delta L = \tau\Delta t = \Delta n\frac{h}{2\pi}$

$\tau = \frac{\Delta n}{\Delta t}.\frac{h}{2\pi}$

$\tau \times 10^{27} = 15$

Chemistry PART – II

SECTION – A

24. **(C)**
Fact based

25. **(D)**
Zone refining is based on difference in solubility of impurity in its molten as well as solid state.

26. **(C)**
No. of moles of AgCl = $\frac{1.435\ gm}{M_{AgCl}} = 0.01\,moles$
No. of moles of $CoCl_3.4NH_3$ = 0.01 moles
$\therefore$1 ionizable Cl per mole of $CoCl_3.4NH_3$

27. **(B)**

$$AgI(s) \rightleftharpoons Ag^+(aq) + I^-(aq)$$

$$K_{sp} = \left[Ag^+(aq)\right]\left[I^-(aq)\right]$$

$$Ag^+(aq) + 2CN^-(aq) \rightleftharpoons \left[Ag(CN)_2\right]^-_{(aq)}$$

$$K_f = \frac{\left[Ag(CN)_2\right]^-}{\left[Ag^+\right]\left[CN^-\right]}$$

Now, let a moles of AgI dissolved in CN^- solution

$$AgI(s) + \underset{\substack{1\,mole \\ (1-2x)mole}}{2CN^-_{(aq)}} \rightleftharpoons \underset{\substack{0 \\ x\ mole}}{\left[Ag(CN)_2\right]^-_{(aq)}} + \underset{\substack{0 \\ x\,mole}}{I^-_{(aq)}}$$

$$\text{As } \left[CN^-\right] = M.V = 1\times1 = 1\,mole$$

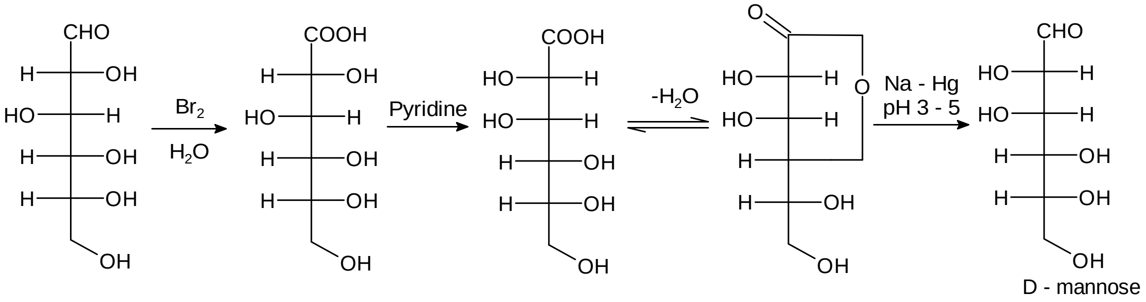
$$\therefore K_c = \frac{x.x}{(1-2x)^2}$$

$$\text{also } K_c = K_f.K_{sp}$$

$$\therefore \frac{x^2}{(1-2x)^2} = 1.19\times10^{-17}M^2 \times 7.11\times10^{19}M^{-2}$$

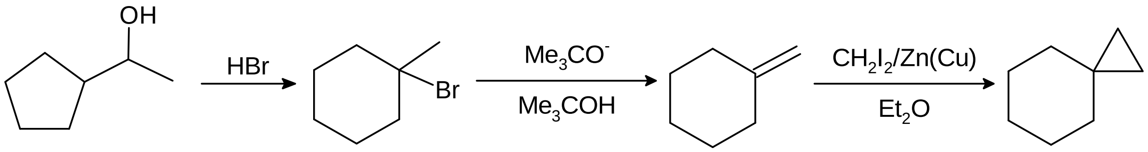
$$\therefore x = 0.5$$

28. **(A)**



D - mannose

29. **(D)**


OH
HBr
Br
Me3CO-
Me3COH
CH2I2/Zn(Cu)
Et2O

30. **(A)**

$-\frac{d[A]}{dt} = k.[A]$; *for first order reaction*

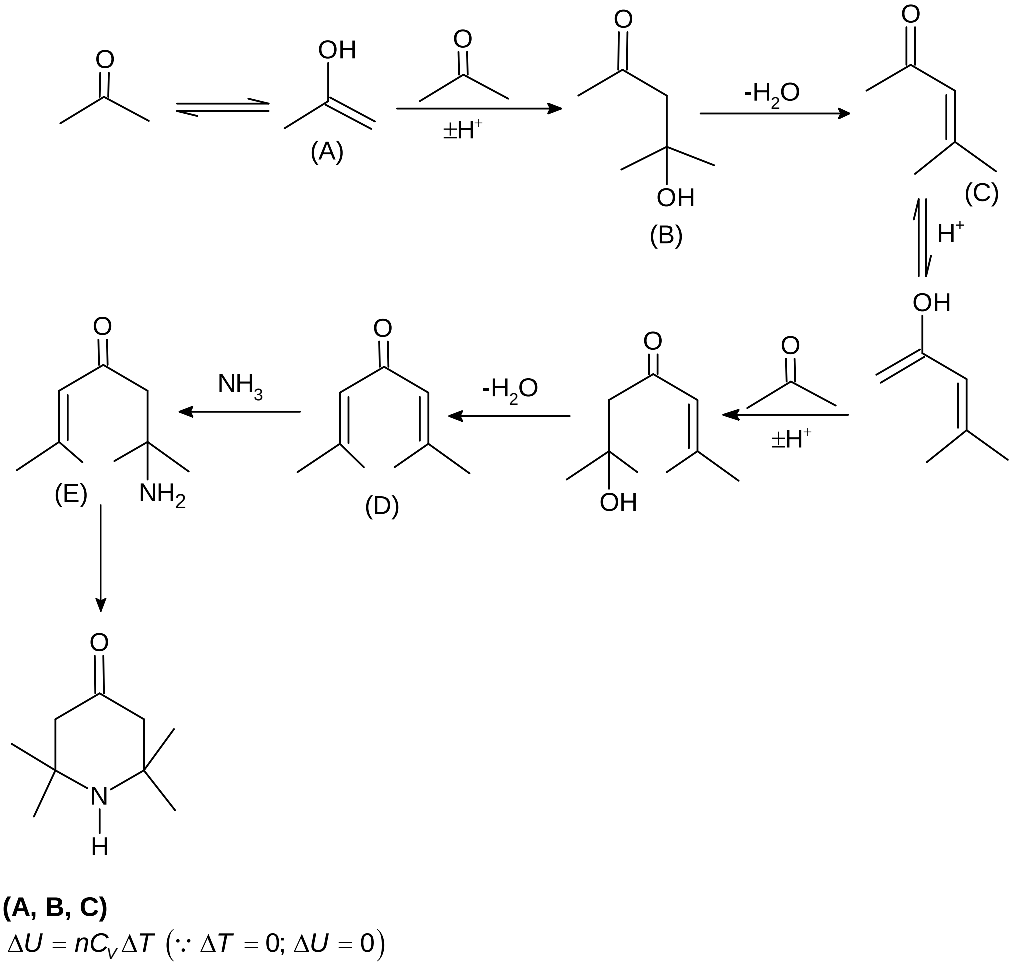
$[A] = [A]_0 - kt$; *for zero order reaction*

$\frac{1}{[A]_t} = \frac{1}{[A]_0} + kt$ *for second order reaction*

31. **(A)**

$2KMnO_4 + KBr + H_2O \longrightarrow KBrO_3 + 2KOH + 2MnO_2$

32. **(A, B)**


O
OH
(A)
O
±H+
O
OH
(B)
-H2O
O
(C)
H+
OH
O
±H+
O
OH
-H2O
O
(D)
NH3
O
(E)
NH2
O
N
H

33. **(A, B, C)**

$\Delta U = nC_V\Delta T \ (\because \Delta T = 0;\ \Delta U = 0)$

$\Delta H = nC_P\Delta T \ (\because \Delta T = 0;\ \Delta H = 0)$

1^{st} *law* $\Delta U = q + w = 0$

$$\therefore q = -w$$

$$w = -\int_{V_1}^{V_2} P_{ext}\, dv$$

$$P_{ext} = P_2;\ w = -P_2\left(V_2 - V_1\right)$$

$$w = -P_2\left[\frac{RT}{P_2} - \frac{RT}{P_1}\right]$$

$$= -RT\left[1 - \frac{P_2}{P_1}\right]$$

$$\therefore q = RT\left[1 - \frac{P_2}{P_1}\right]$$

34. **(B, D)**

$$P_C = \frac{1}{27}\frac{a}{b^2}$$

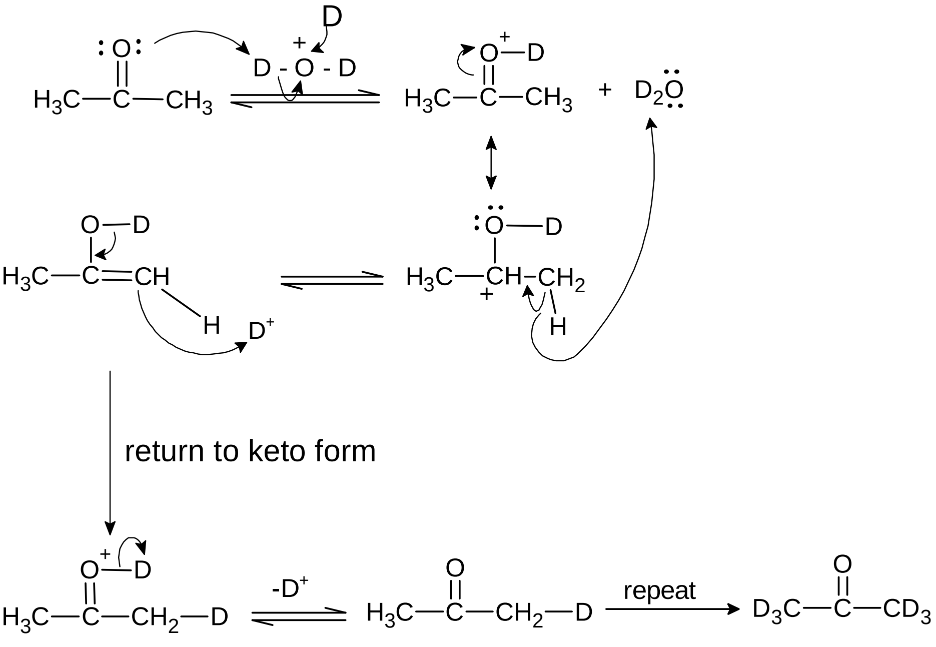
$$V_C = 3V_b$$

$$T_C = \frac{8}{27}\frac{a}{Rb}$$

35. **(B, C)**

As for salt of strong acid and weak base degree of hydrolysis, $h = \sqrt{\frac{K_w}{K_b.C}}$

36. **(A)**



37. **(B)**

As deprotonation step in case of iodination is rate determining.

38. **(C)**

$$E_{cell} = E^{o}_{cell} - \frac{RT}{nF}\ln Q$$

$$E_{cell} = 0 - \frac{RT}{nF}\ln\left[\frac{C_2}{C_1}\right]$$

$$= -\frac{RT}{nF}\ln\left[\frac{\frac{1}{50}}{\frac{2}{100}}\right]$$

$$= 0V$$

39. **(A)**

oxidation half − cell reaction

$$\mathrm{Ag(s) \rightarrow Ag^{+}(aq) + e^{-}}$$

Reduction half − cell reaction

$$\mathrm{AgCl(s) + e^{-} \longrightarrow Ag(s) + Cl^{-}(aq)}$$

Net cell Reaction :−

$$\mathrm{AgCl(s) \longrightarrow Ag^{+}(aq) + Cl^{-}(aq)}$$

At equilibrium :−

$$\mathrm{E_{cell} = 0 \Rightarrow E^{0}_{cell} = \frac{RT}{nF}\ell n\, K_{sp}}$$

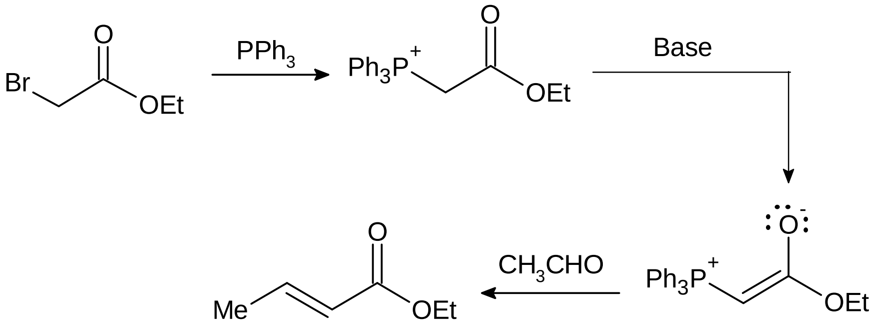
$$\text{and } \mathrm{E^{0}_{cell} = E^{0}_{Cl^{-}/AgCl/Ag} - E^{0}_{Ag^{+}/Ag}}$$

$$= -0.57\mathrm{V}$$

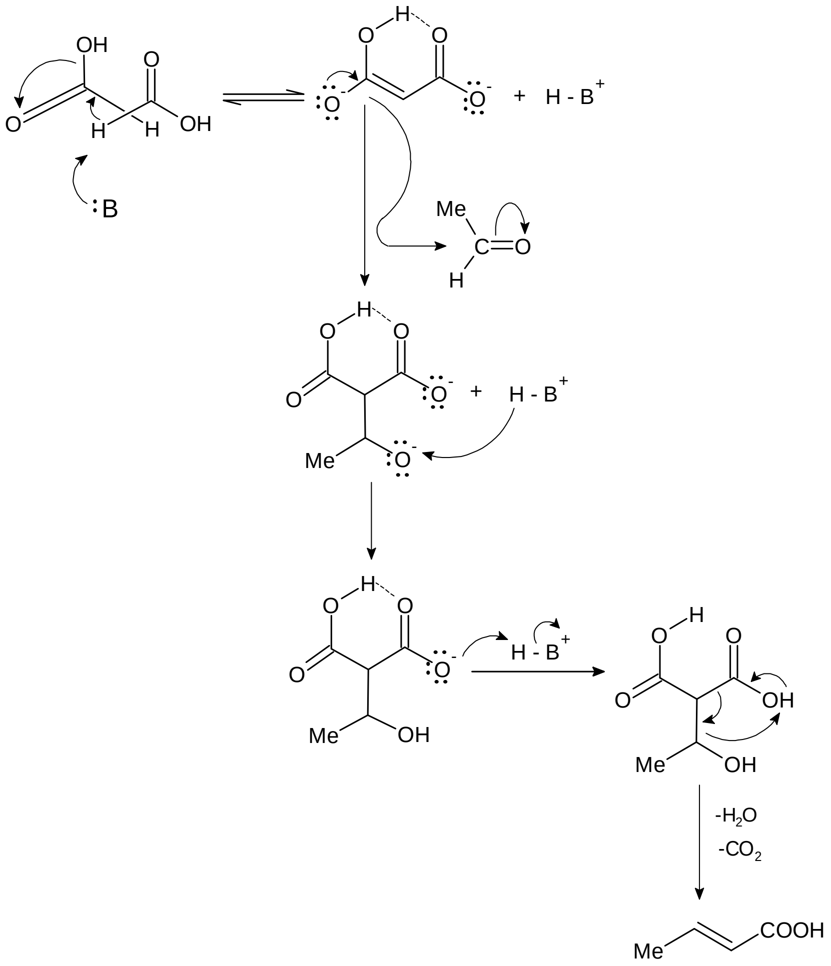
$$\mathrm{K_{sp}} = 10^{-10} \times \sqrt{10}$$

$$= 3.16 \times 10^{-10}$$

40. (A)



41. (D)


OH
O
O
H
H
OH
:B
O
H
O
O
O
+ H - B+
Me
C=O
H
Me
OH
-H2O
-CO2
Me
COOH

SECTION – C

42. 4

Enantiomeric excess = $\frac{d-\ell}{d+\ell}\times 100 = \frac{68-32}{68+32}\times 100 = 36\%$

$\therefore$ Optical rotation of this mixture = $36\% \times +\left(11.1^0\right)$ = 4

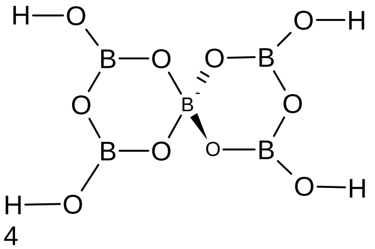
43. 5

Aldol condensation

44. 5

I_3^+, XeF_4, H_2O, NH_2^-, H_2S

45. 6


H—O
O—H
B—O
O—B
O
B
O
B—O
O—B
H—O
O—H

46. 4

$$n = \frac{\lambda}{2\pi r_1} = \frac{1340}{2\times 3.14\times 53} = 4$$

Mathematics

PART – III

SECTION – A

47. $f^{'}(x)=\frac{x^6}{6}-\frac{12}{15}x^5+\frac{5x^3}{20}x^4+\frac{4x^3}{3}-2x^2+99$

$f''(x)=x^5-4x^4+3x^3+4x^2-4x$

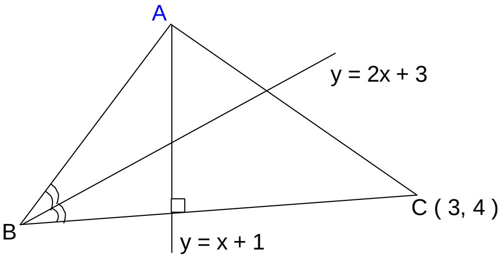
$x\left(x^4-4x^3+3x^2+4x-4\right)$

$x(x-1)(x-2)^2(x+1)$

Pt of inflexion at X = -1, 0 &1

So -1+0+1 = 0

48. Equation of BC is x + y = 7 so B = $\left(\frac{4}{3},\frac{17}{3}\right)$



Let slope of AB is m so,

$$\left|\frac{m-2}{1+2m}\right|=\left|\frac{2+1}{1-2}\right|$$

$$m=-\frac{1}{7}$$

So equation of AB is 3x + 21y – 123 = 0

So A ≡ $\left(\frac{17}{4},\frac{21}{4}\right)$ mid-point of AB = $\left(\frac{67}{24},\frac{131}{24}\right)$

Equation of medium through C is 7x + y = 25

49. $\left[xy^2dx+\left(y^2dx+2xydy\right)\right]+x^2ydx+\left(2xydx+x^2dy\right)=0$

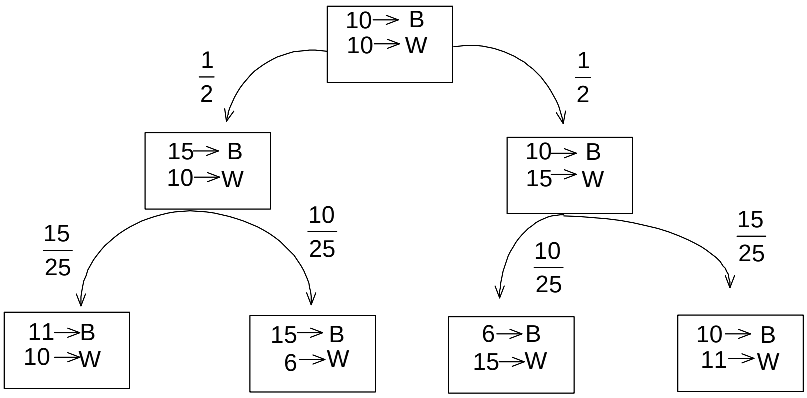
$e^xxy^2dx+e^x\left(y^2dx+xd\left(y^2\right)\right)+e^xx^2ydx+e^x\left(2xydx+x^2dy\right)=0$

$d\left(e^xxy^2\right)+d\left(e^xx^2y\right)=0$

$e^xxy^2+e^xx^2y=C$

Passing through (1, 1) so C = 2e so, curve is $xy(x+y)=2e^{1-x}$ $xy(x+y)=2e^{1-x}$

50.



Required probability,

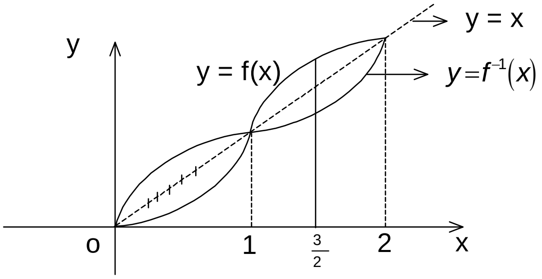
$$\frac{\frac{1}{2}\times\frac{15}{25}\times\frac{10}{21}+\frac{1}{2}\times\frac{10}{25}\times\frac{15}{21}}{\frac{1}{2}\times\frac{15}{25}\times\frac{10}{21}+\frac{1}{2}\times\frac{10}{25}\times\frac{6}{21}+\frac{1}{2}\times\frac{10}{25}\times\frac{15}{21}+\frac{1}{2}\times\frac{15}{25}\times\frac{11}{21}}$$

$$=\frac{2}{1+\frac{2}{5}+1+\frac{11}{10}}=\frac{20}{11+20+4}=\frac{4}{7}$$

51. Required area is $\frac{3}{2}$ times the area of loop

$$\frac{3}{2}\times 2\int_0^1\left[\left(x+x^2\right)-x\right]dx$$

1



52. Let $I=\int_2^4 \times g(x)dx$

Using by parts

$I = x.f^{-1}(x)\int_2^4-\int_2^4 f^{-1}(x)dx$ $\rightarrow 1$

$I = 4f^{-1}(4)-2f^{-1}(2)-\int_2^4 f^{-1}(x)dx$

Now,

$f^{-1}(f(x))=x$

$f^{-1}(f(0))=0 \Rightarrow f^{-1}(2)=0$

$also f^{-1}(f(1))=1 \Rightarrow f^{-1}(4)=1$

$\int_a^b f(x)dx+\int_{f(a)}^{f(b)} f^{-1}(x)dx = bf(b)-af(\text{a})$

$\int_0^1 f(x)dx+\int_2^4 f^{-1}(x)dx = 1.f(1)-0.f(0)$

$\int_0^1\left(x^3+x+\sin\pi x+2\right)dx+\int_2^4 f^{-1}(x)dx = 4$

$also\ \int_2^4 f^{-1}(x)dx = 4-\left(\frac{x^4}{4}+\frac{x^2}{2}-\frac{\cos\pi x}{\pi}+2x\right)_0^1$

53. Let x = cosθ

$x\rightarrow\frac{1}{\sqrt{2}}+,\theta\rightarrow\frac{\pi}{4}^-$

As $\lim\limits_{\theta\to\frac{\pi}{4}^-}\frac{\cos^{-1}\cos2\theta}{\cos\theta-\frac{1}{\sqrt{2}}}=\lim\limits_{\theta\to\frac{\pi}{4}^-}\frac{\frac{\pi}{2}-2\theta}{\cos\theta-\frac{1}{\sqrt{2}}}$

$\lim\limits_{\theta\to\frac{\pi}{4}^-}\frac{-2}{-\sin\theta}=2\sqrt{2}$

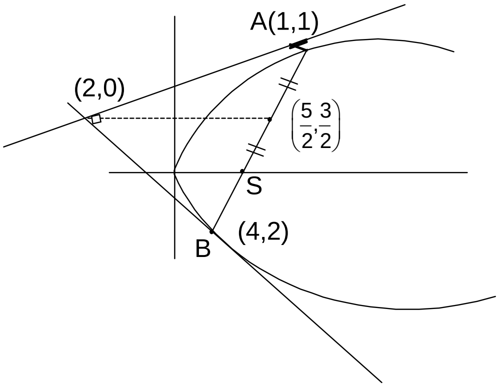
54. Coeff. X^{3r} in $\left[\left(1+x+x^2\right)^n.(1-x)^n\right]$

$$\Rightarrow coeff.of\ x^{3r} in\left[\left(a_0 + a_1x + ...a_2x^{2n}\right)\left(n_{c_0} - n_{c_1} \times .....\right)\right]$$

$$= {}^nC_r$$

55. $\because$ Tangents are $\perp r$. so, they intersect on directrix.

Point of intersection = (2,0) mid-point of (1,1) & (4,2) is $\left(\frac{5}{2}, \frac{3}{2}\right)$



Slope of axis = $\frac{\frac{3}{2} - 0}{\frac{5}{2} - 2} = 3$

Equation of directrix, $y = -\frac{1}{3}(x - 2)$

$x + 3y = 2$

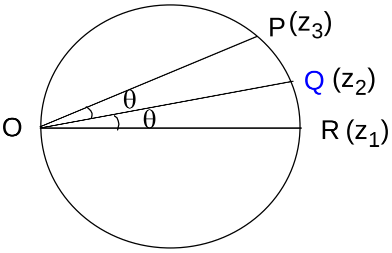
AB is focal chord,

BS = ($\perp_r$ distance from B on directrix) = $\frac{4 + 6 - 2}{\sqrt{10}} = \frac{8}{\sqrt{10}}$

AS = ($\perp_r$ distance from A on directrix) = $\frac{1 + 3 - 2}{\sqrt{10}} = \frac{2}{\sqrt{10}}$

So, focus divides AB in 1: 4 ratios. So S = $\left(\frac{8}{5}, \frac{6}{5}\right)$

56. By Rotation theory



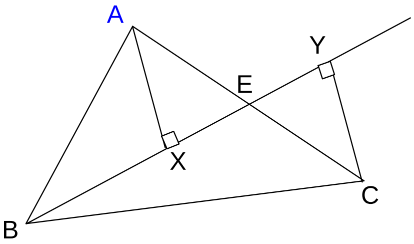
$$\frac{z_2}{z_1} = \cos\theta e^{i\theta}$$

$$\frac{z_3}{z_2} = \frac{\cos 2\theta}{\cos\theta} . e^{i\theta}$$

$$so \frac{{z_2}^2}{z_3 z_1} = \frac{\cos^2\theta}{\cos 2\theta} = \frac{3}{2}$$

$$\theta = \frac{\pi}{6}$$

57. $\Delta AXE \simeq \Delta CYE$



$so, ar\left(\Delta AXE\right) = ar\left(\Delta CYE\right) = \Delta_1$

$ar\left(\Delta BYC\right) = ar\left(\Delta BEC\right) + \Delta_1$

$4\Delta_1 = ar\left(\Delta BEC\right) + \Delta_1$

$ar\left(\Delta BEC\right) = 3\Delta_1 = ar\left(\Delta ABE\right) = ar\left(\Delta AXB\right) + ar\left(\Delta AXE\right)$

$\Rightarrow so, ar\left(\Delta AXB\right) = 2\Delta_1$

$ar\left(\Delta ABC\right) = 2ar\left(\Delta BEC\right) = 6\Delta_1$

58. $\frac{A}{a}, \frac{B}{b}, \frac{C}{c} HP$

$$\Rightarrow \frac{2b}{B} = \frac{a}{A} + \frac{c}{C}$$
$$\Rightarrow 2bB = aC + cA$$
$$\Rightarrow aB + cB = aC + cA$$
$$\Rightarrow a[B - C] = c[A - B]$$
$$so, r = \frac{c}{a}$$
$$\frac{A^2}{a}, \frac{B^2}{b}, \frac{C^2}{c} areinHP \Rightarrow r^2 = \frac{c}{a}$$

59 – 60. A ≡ (3, 2, 1), B ≡ (4, 1, 2) point of intersection ≡ (0, 0, 0)

Area of triangle = $\frac{1}{2}\left|(3\hat{i} + 2\hat{j} + \hat{k}) \times (4\hat{i} + \hat{j} + 2\hat{k})\right| = \sqrt{\frac{19}{2}}$

Also image of (0, 0, 0) w.r.t plane π is $\left(\frac{14}{3}, \frac{7}{3}, \frac{-7}{3}\right)$

Image of (0, 0, 0) w.r.t AB is $\left(\frac{14}{3}, \frac{16}{3}, \frac{2}{3}\right)$

Equation of line joining these two points = $\frac{3x - 14}{0} = \frac{3y - 7}{3} = \frac{3z + 7}{3}$

61 – 62. $\sum_{i=1}^{n-1}\left(x_i - 2i\sqrt{x_i - i^2}\right) = 0$

$$\sum_{i=1}^{n-1}\left(\sqrt{x_i - i^2}\right)^2 - 2i\sqrt{x_i - i^2} + i^2 = 0$$
$$\sum_{i=1}^{n-1}\left(\sqrt{x_i - i^2} - i\right)^2 = 0$$
$$so, x_i = 2i^2$$

Now, $x_1^2 + \ldots\ldots + x_n^2$ = 280

$$2\left[1^2 + 2^2 + \ldots\ldots.n^2\right] = 280$$
$$n = 7$$
$$y_1 + y_2 + y_3 = 7$$
$$y_1^1 + y_2^1 + y_3^1 = 4$$
$$^{4+3-1}C_3 = {}^6C_3 = 20$$

Total triangles formed = ${}^{15}C_3 = \frac{15 \times 14 \times 13}{6}$

N of isosceles triangles formed = 15 × 7

probalality = $\frac{15 \times 7}{15 \times 14 \times 13} \times 6$

$$\frac{3}{13}$$

63 – 64. p (n) = p(n - 1) + p(n - 2)

SECTION – C

65. Consider y = ax^2+bx+c

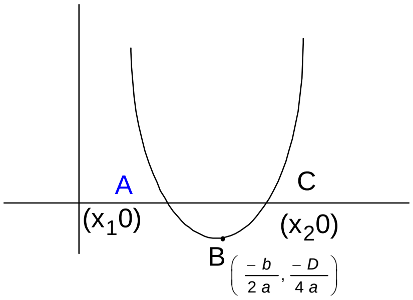
Slope of BA. Slope of BC = -1

$$\frac{\frac{D}{4a}}{x_1+\frac{b}{2a}}\cdot\frac{\frac{D}{4a}}{x_2+\frac{b}{2a}}=-1$$

$$\Rightarrow \frac{D^2}{16a^2}+\frac{b^2}{4a^2}+\left(x_1+x_2\right)\frac{b}{2a}+x_1x_2=0$$

$$\Rightarrow \frac{D^2}{16a^2}+\frac{b^2}{4a^2}-\frac{b}{a}\left(\frac{b}{2a}\right)+\frac{c}{a}=0$$

$$\Rightarrow D=0 or 4$$



66. $$I=\int_{-\pi}^{\pi}\sqrt{\frac{|\sin x|}{1+\tan^2 x}}dx$$

$$I=2\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}}\sqrt{\frac{\sin x}{1+\cot^2 x}}dx$$

$$=4\int_0^{\frac{\pi}{2}}\sqrt{\cos x}\sin x dx$$

$$=\frac{8}{3}$$

$$[I]=2$$

67. PA = PR = 8 – a

So PQ = 8 – a + b

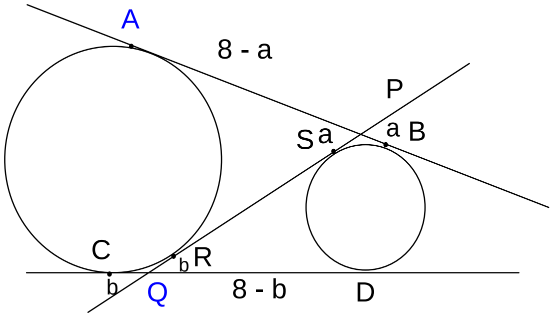
Also QD = QR = 8 – b

So QP = 8 – b + a

8 – a + b = 8 – b + a

$\Rightarrow a=b$

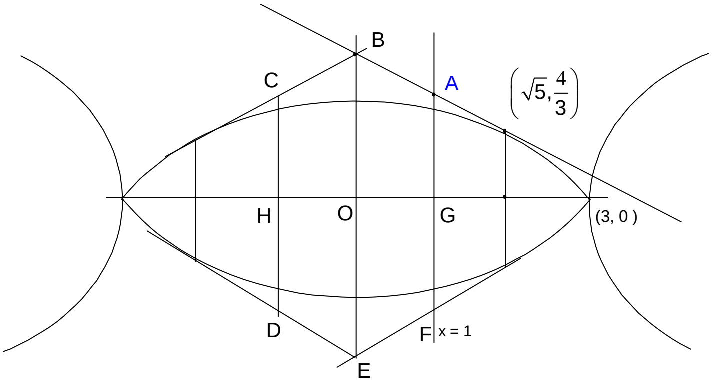
$PQ=8$



68. $$\det\left(A^{\mu-1}\left(A-5I\right)\right)=\det(A^{\mu-1}).de\left(A-51\right)$$

69. Tangent at $\left(\sqrt{5},\frac{4}{3}\right)$ is $\sqrt{5}x+3y=9$ x=1 is directrix of Hyperbola.

So, A = $\left(1,\frac{9-\sqrt{5}}{3}\right)$ & B = (0, 3)



Area of figure OGAB is

$$1\times\left(\frac{9-\sqrt{5}}{3}\right)+\frac{1}{2}\times 1\times\left(3-\frac{9-\sqrt{5}}{3}\right)$$

$$=\frac{9-\sqrt{5}}{3}+\frac{\sqrt{5}}{6}$$

$$=\frac{18-\sqrt{5}}{6}$$

Area of required figure is

$$4\left\{\frac{18-\sqrt{5}}{6}\right\}=\frac{36-2\sqrt{5}}{3}$$

Integral part of area is 7.

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

FULL TEST – I

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 234**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 – 08)** contains 8 multiple choice questions which have only one correct answer. Each question carries **+3 marks** for correct answer and **–1 mark** for wrong answer.

   Section-A (09 – 12) contains 4 multiple choice questions which have more than one correct answer. Each question carries **+4 marks** for correct answer. There is no negative marking.

   Section-A (13 to 18) contains 3 paragraphs with each having 2 questions. Each question carries **+3 marks** for correct answer and **–1 mark** for wrong answer.

2. **Section-C (01 – 05)** contains 5 Numerical based questions with answers as numerical value and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Straight Objective Type

This section contains **08 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct.

1. A ball is dropped from rest at height 4h. After it has fallen a distance d, a second ball is dropped from rest at height h. What should d be (in terms of h) so that the balls hit the ground at the same time?

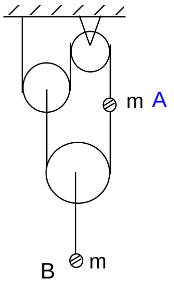
(A) $d = \frac{3H}{2}$ (B) $d = \frac{H}{3}$

(C) d = H (D) d = 3H

2. What is the acceleration of the upper block of the system as shown in the figure? Assume pullies and strings are ideal. Given $m_A \simeq 0$

(A) 4g (B) 2g

(C) g (D) $\frac{g}{2}$



3. The pitch of a screw gauge is 0.5 mm and there are 50 divisions on its circular scale and one main scale division = 0.5 mm. Before starting the measurement it is found that when jaws of the screw gauge are brought in contact, the zero of the circular scale lies 4 division above the reference line. When a metallic wire is placed between the jaws, five main scale divisions are clearly visible and 18th division on the circular scale coincides with the reference line. The diameter of the wire is

(A) 2.68 mm (B) 2.72 mm

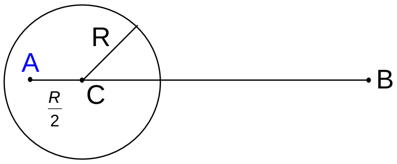
(C) 2.64 mm (D) 2.62 mm

Space for rough work

4. A point like particle of mass 'm' (very small) is projected in the vertically upward direction where already exist, a uniform horizontal electric field$\overline{E}$. The field strength is such that qE= $\frac{3}{4}$ mg, where q is the charge on the particle. After what time the radius of curvature of the charged particle will be minimum.

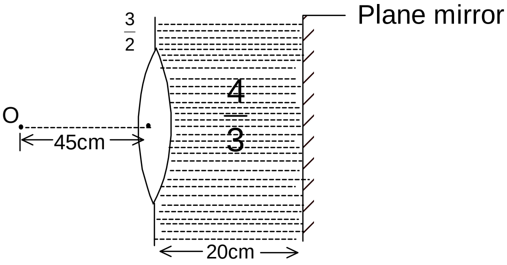
(A) $\frac{V_0}{g}$
(B) $\frac{8V_0}{25g}$
(C) $\frac{16V_0}{25g}$
(D) $\frac{25V_0}{16g}$

5. Consider a thin conducting shell of radius R carrying total charge Q .Two Point charges Q and 2Q are placed on points A and B, which are at a distances of $\frac{R}{2}$ and 2R from the center of the cell respectively as shown in the figure. If the cell is earthed how much charge will flow to the earth?



(A) 3Q
(B) Q
(C) 2Q
(D) $\frac{Q}{2}$

6. Figure shows an object 'o' placed in front of a biconvex lens $\left(\mu = \frac{3}{2}\right)$ behind which there is water $\left(\mu = \frac{4}{3}\right)$ and a plane mirror at a distance of 20m. A point object 'O' is placed at a distance of 45 cm from the lens as shown in the figure .The position of the image of the object coincides with the object itself, then radius of curvature of the lens is.



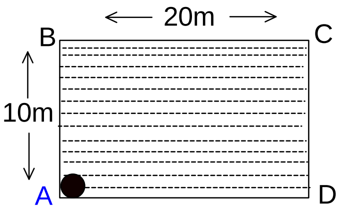
(A) 20cm
(B) 45cm
(C) 60cm
(D) 30cm

Space for rough work

7. A satellite of mass m is orbiting the earth in a circular orbit of radius r. It starts losing its mechanical energy due to small air resistance at the rate of k joule/sec .The time taken by the satellite to hit the surface of the earth is (M and R are the mass and radius of the earth)

(A) $\frac{GMm}{K}\left(\frac{1}{R}-\frac{1}{r}\right)$
(B) $\frac{GMm}{2K}\left(\frac{1}{R}-\frac{1}{r}\right)$
(C) $\frac{2GMm}{K}\left(\frac{1}{R}-\frac{1}{r}\right)$
(D) $\frac{GMm}{K}\left(\frac{1}{R}+\frac{1}{r}\right)$

8. There is a container ABCD which is accelerating towards right, at the rate of $\frac{g}{2} m/s^2$. Container is filled completely by a liquid of relative density 3. A small ball of relative density 1 is released from rest with respect to the container at point A of the container. At what distance from the end point B, the ball will hit to the top surface of the container.

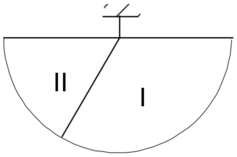


(A) 2m
(B) 5m
(C) 15m
(D) 10m

Multiple Correct Choice Type

This section contains **04 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

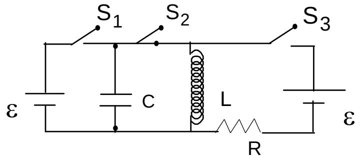
9. A pendulum swings back & forth between two horizontal positions as shown in the figure, under uniform gravity, then



(A) There are more than one points in the part I where acceleration is vertical.
(B) There is at least one point in part I where acceleration is horizontal.
(C) During the motion in both parts tension is maximum only once.
(D) Acceleration of the bob is never directed towards the point of suspension O.

Space for rough work

10. In the arrangement as shown in the figure, S_1 and S_3 are already closed for a long time. Now at t = 0 the S_2 is closed and S_1, S_3 are opened. [ε = 1 volt, L = 1 henry, R = 1 Ω & C = 1 Faraday]

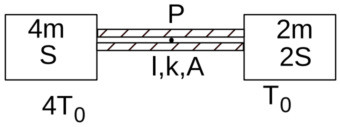


(A) After S_2 is closed the maximum current through the indictor is 2A.
(B) After S_2 is closed the maximum current through the indictor is $\sqrt{2}A$
(C) Maximum charge on the capacitor is $2+\sqrt{2}$ coulomb
(D) Maximum charge on the capacitor is $\sqrt{2}$ coulomb

11. A particle of mass m = 3 kg is moving on a straight line in a conservative force field in which the potential energy associated with the particle is given by $U(y) = 2y^2 - 30y + 450$. At t = 0, particle is at y = 8 m and moving towards positive y-axis with 1 m/s.

(A) During the course of its motion the maximum speed of the particle will be $\sqrt{\frac{4}{3}}$ m/s.
(B) Particle will never cross the origin.
(C) Particle will come to its equilibrium position for the first time at $\frac{5\pi}{4\sqrt{3}}$*second*
(D) The amplitude of oscillation for the particle is 1m.

12. Figure shows two reservoirs containing two liquids of masses 4 m and 2 m and their specific heat capacities are S and 2S respectively. Their initial temperatures are $4T_0$ and T_0 respectively. The containers are joined by a conducting rod of thermal conductivity K, length l and cross section area A specific heat capacity of the rod is negligible.



(A) The temperature of mid-point 'P' of the rod is always constant.
(B) Heat extracted from container 1 = Heat supplied to container 2
(C) After time $t_0 = \frac{2msl}{ka}\ln 2$ the temperature difference between containers becomes half of the initial temperature difference.
(D) After time $t_0 = \frac{msl}{ka}\ln 2$ the temperature difference between containers becomes half of the initial temperature difference.

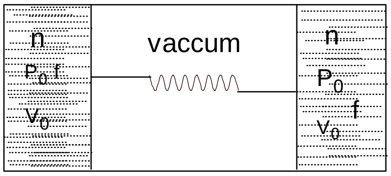
Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct.

Paragraph for Questions 13 & 14

In the arrangement shown in the fig the cylinder is insulating one. Both sides same diatomic gas is trapped by two insulting massless pistons with the help of an ideal spring. The natural length of the spring is equal to the length of the cylinder. Initial state of the gases are as shown in the figure.



13. What is the value of energy stored in the spring?
(A) P_0V_0 (B) $2P_0V_0$
(C) $4P_0V_0$ (D) $\frac{P_0V_0}{2}$

14. Now the gases are heated slowly, such that their temperature becomes three times to their initial temperature. The total heat given to the system is
(A) $12P_0V_0$ (B) $8P_0V_0$
(C) $5P_0V_0$ (D) $6P_0V_0$

Paragraph for Questions 15 & 16

Initially the nucleus of radium-226 is at rest. It decays due to which and α particle and the nucleus of radon are created. The released energy during the decay is 4.87 Mev, which appears as the kinetic energy of the two resulted particles. $\left[m_\alpha = 4.002amu, m_{Rn} = 222.017amu,\right]$

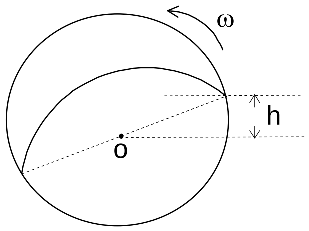
15. Kinetic energies of α particle & radon nucleus are respectively
(A) 0.09 Mev, 4.08 Mev (B) 4.78 Mev , 0.09 Mev
(C) 4.08 Mev , 0.09 Mev (D) 3.68 Mev , 0.08 Mev

16. What is the linear momentum of the α – particle?
(A) $2.01\times10^{-19}\text{kgms}^{-1}$ (B) $1.01\times10^{-19}\text{kgms}^{-1}$
(C) $4.01\times10^{-19}\text{kgms}^{-1}$ (D) $8.01\times10^{-19}\text{kgms}^{-1}$

Space for rough work

Paragraph for Questions 17 & 18

There is a hollow cylinder of radius R and it is rotating with constant angular speed ω. There is a point mass which rotates along with the cylinder and gets carried upward. Friction is enough such that the point mass does not slip with respect to the cylinder as long as the normal force is becomes zero. If the path of the particle after it lost contact with the cylinder is as shown in the figure then,



17. In Order to happen this where most the particle lose contact with the cylinder?

(A) $h = \frac{R}{2}$ (B) $h = \frac{R}{\sqrt{3}}$

(C) $h = \frac{R}{\sqrt{2}}$ (D) $h = \frac{R}{\sqrt{\pi}}$

18. What is the value of ω (in terms of g and R)

(A) $\sqrt{\frac{g}{\sqrt{3}R}}$ (B) $\sqrt{\frac{g}{2\sqrt{\pi}R}}$

(C) $\sqrt{\frac{g}{2R}}$ (D) $\sqrt{\frac{g}{\sqrt{2}R}}$

SECTION – C
(One Integer Value Correct Type)

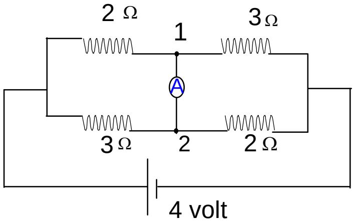
This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

19. A square of elastic sheet of dimension (a × a) has a mass 125 gm. A force of 2.5 N is applied to each of the four edges. What is the velocity of waves on the sheet? a = 0.75 m.

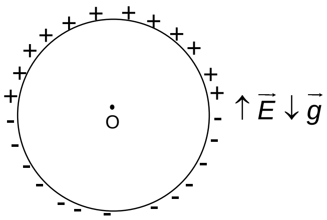
20. In a Young's double slit experiment, the angular separation of the interference fringes on a distant screen is $0.04A^0$. The angular separation if the entire apparatus is immersed in a liquid of R.I. $\frac{4}{3}$ is $0.0n\ A^0$, then what is the value of n?

Space for rough work

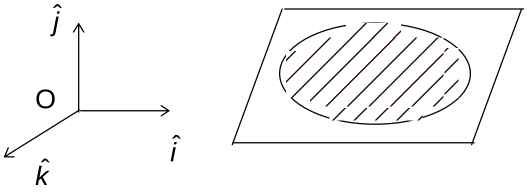
21. In the circuit shown, the reading of the ammeter is $\frac{p}{q}$ amp. What is the value of p + q?



22. In the figure shown there is non- conducting disc of mass M = 2kg and radius R = 4 m. On its upper & lower part of circumference +Q and –Q charge are uniformly attached such that liner charge density is $\frac{Q}{\pi R}$. The disc can freely rotate about an horizontal axis passing through O. There is a uniform electric field $\overline{E}$ in the vertical direction such that QE= mg. If the disc is rotated by a small angle it performs S.H.M. its time period is given by $T \simeq \sqrt{\frac{p\pi}{n}}$ then, P + n is. (Take $\pi^2 = g$)



23. There is a non-conducting disc of mass 4kg and radius 1m placed on a rough non conducting surface. A conducting ring of same mass is tightly fixed around the disc. There exists a magnetic field $\vec{B} = 4\hat{i} + 4t^2\hat{j}$. The resistance of the ring is 8Ω. Find the time after which the system will start toppling.



Space for rough work

Chemistry

PART – II

SECTION – A

Straight Objective Type

This section contains **08 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct.

24. Which of the following is/are incorrect statement (s):

(I) $CHCl_3$ is less acidic than CHF_3

(II) Dipole moment of chlorobenzene is more than chlorocyclohexane

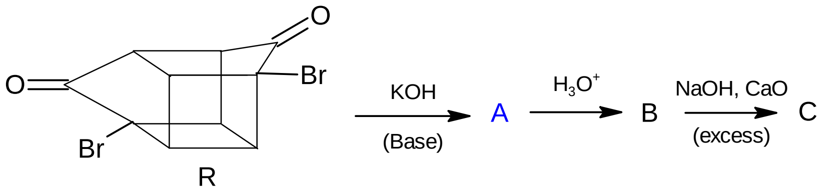
(III) Dipole moment of fluoromethane is more than chloromethane

(IV) $NH_2NH_2.HCl$ show positive test for nitrogen in lassaigne's test

(V) Dipole moment of difluoromethane is more than dichloromethane.

(A) I Only
(B) II Only
(C) I, II, III and IV
(D) I, II, III, IV and V

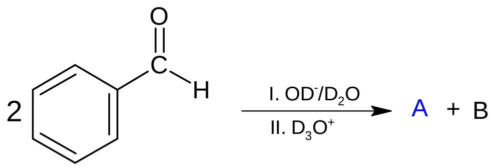
25.



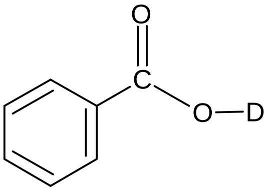
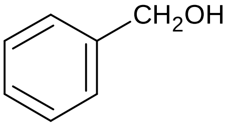
Which of the following is correct statement?

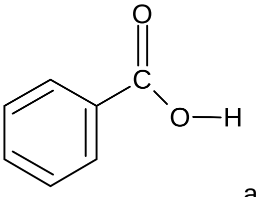
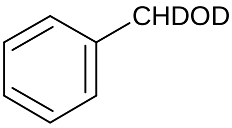
(A) Monobromination of C gives two product.
(B) Degree of unsaturation of C is five.
(C) Degree of unsaturation of B is 8
(D) None of these.

Space for rough work

26. 

Which of the following statement is correct?

(A) A is  and B is 

(B) A is  and B is 

(C) Order of reaction of I is 4 at very high concentration of OD^-

(D) Order of reaction of I is 3 at very high concentration of OD^-

27. Which of the following statement is incorrect?

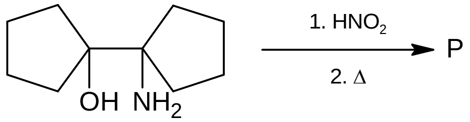
(A) $Cr(CO)_6 < Fe(CO)_5 < Ni(CO)_4$ (Order of increasing CO bond strength.)

(B) $\left[V(CO)_6\right]^- < \left[Cr(CO)_6\right] < \left[Mn(CO)_6\right]^+$ (order of increasing M – C bond strength where M is central metal atom/ion)

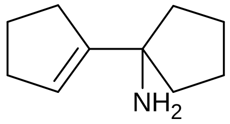
(C) $\left[V(CO)_6\right]^- = \left[Cr(CO)_6\right] = \left[Mn(CO)_6\right]^+$ (Effective atomic no)

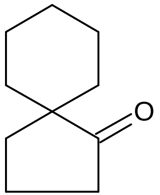
(D) $\left[V(CO)_6\right]^- < \left[Cr(CO)_6\right] < Mn(CO)_6]^+$ (Order of increasing CO bond strength)

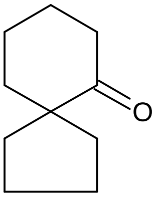
Space for rough work

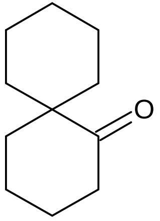
28. 

The P is

(A) 

(B) 

(C) 

(D) 

29. An element undergoes a reaction as shown

$x + 2e^{-} \rightarrow x^{-2}$

Energy released = 30.87 ev/atom. If the energy released, is used to dissociate 4 g of H_2 molecules equally into H^+ and H^* where H^* is excited state of H atoms where the electron travels in orbit whose circumference equal to four times its de – Broglie's wavelength. Determine the minimum number of moles of x that would be required

Given: IE of H = 13.6 ev/atom, bond energy of H_2 = 4.526ev/molecule

(A) 1
(B) 2
(C) 3
(D) 4

30. How much Ag Br could be dissolved in 1 litre of 0.40 M NH_3? Assume that only complex formed is $[Ag(NH_3)_2]^+$. Given $K_{sp}(AgBr) = 5.0 \times 10^{-13}$; K_f of $[Ag(NH_3)_2]^+ = 1.0 \times 10^8$

(A) 2.82×10^{-3} M
(B) 2.22×10^{-4}
(C) 2.22×10^{-3}
(D) 2.82×10^{-4}

31. If E_1^0 is standard electrode potential for Fe/Fe^{+2} and E_2^0 is for Fe^{+2}/Fe^{+3} and E_3^0 for Fe/Fe^{+3}. which of the following relation is correct?

(A) $E_3^0 = E_1^0 + E_2^0$
(B) $E_3^0 = \left(E_1^0 + E_2^0\right)/2$
(C) $E_3^0 = E_2^0 + 2E_1^0$
(D) $E_3^0 = \left(E_2^0 + 2E_1^0\right)/3$

Space for rough work

Multiple Correct Choice Type

This section contains **04 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

32. A salt MX has NaCl type lattice in which r is the minimum distance between M^{z+} and X^{z-}. Each M^{z+} ion is surrounded by

(A) 6 X^{z-} ions, each at a distance r
(B) 12 M^{z+} ions, each at a distance $\sqrt{2}$ r.
(C) 8 X^{z-} ions, each at a distance $\sqrt{3}$ r.
(D) 12 M^{z+} ions, each at a distance $\sqrt{4}$ r.

33. "$a\ MnO_4^- + b\ H_2O_2 + c\ H^+ \rightarrow d\ Mn^{+2} + e\ O_2 + f\ H_2O$" is a balanced chemical equation (reaction). The values of a, b, c, d, e and f are

(A) 2, 1, 6, 2, 3 and 4 respectively
(B) 2, 3, 6, 2, 4 and 6 respectively
(C) 2, 7, 6, 2, 6 and 10 respectively
(D) None of these

34. $O^-_{(g)} + e^- \rightarrow O^{-2}_{(g)} \quad \Delta H_1$

$O_{(g)} + e^- \rightarrow O^-_{(g)} \quad \Delta H_2$

$O_{2(g)} \rightarrow O^+_{2(g)} + e^- \quad \Delta H_3$

$O_{(g)} \rightarrow O^+_{(g)} + e^- \quad \Delta H_4$

$H_{2(g)} \rightarrow H^+_{2(g)} + e^- \quad \Delta H_5$

$H_{(g)} \rightarrow H^+_{(g)} + e^- \quad \Delta H_6$

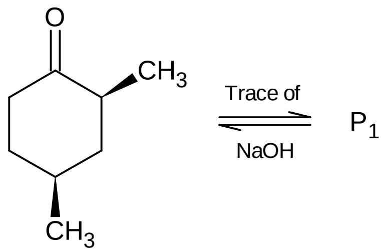
$O_{(g)} + 2e^- \rightarrow O^{-2} \quad \Delta H_7$

Which of the following option(s) is/are correct?

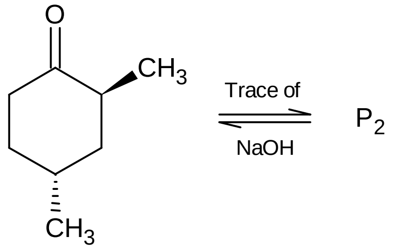
(A) $|\Delta H_1| > |\Delta H_2|$
(B) $|\Delta H_4| > |\Delta H_3|$
(C) $|\Delta H_5| > |\Delta H_6|$
(D) ΔH_7 is +ve

Space for rough work

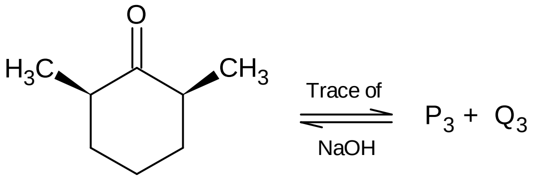
35. (i)


O
CH3
CH3
Trace of
NaOH
P1

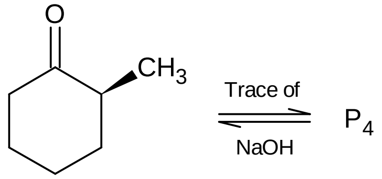
(ii)


O
CH3
CH3
Trace of
NaOH
P2

(iii)


O
H3C
CH3
Trace of
NaOH
P3 + Q3

(iv)


O
CH3
Trace of
NaOH
P4

All products are in keto form .The correct statement(s) is/are.

(A) P_1 and P_2 are diastereomeric pair.

(B) P_1 and P_2 are identical compound.

(C) In reaction (iv) reactant and product are enantiomeric pair.

(D) P_3 and Q_3 are optically active stereo isomers and both are enantiomeric pair.

Space for rough work

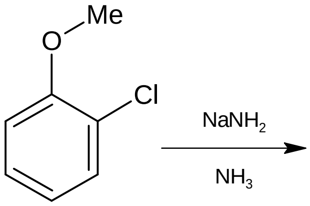
Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

Paragraph for Questions 36 & 37

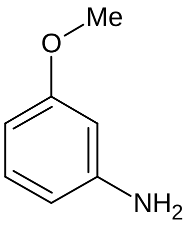
Aryl halides undergo nucleophilic substitution reaction only in extreme condition. Except to certain industrial processes where very severe conditions are feasible, one does not ordinarily prepare phenols (ArOH), ethers (ArOR), amines ($ArNH_2$) or nitriles (ArCN) by nucleophilic attack on aryl halides . The presence of electron withdrawing groups like $-NO_2$, $-CF_3$ at ortho or para position to the halogen atom makes the aryl halides more susceptible to nucleophilic attack. The reaction of unactivated or deactivated aryl halide with strong bases or at high temperature proceed via the benzyne intermediate.

36.

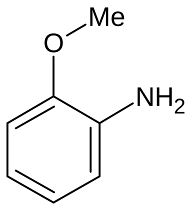


Product. The predominant product is

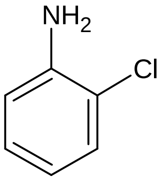
(A)



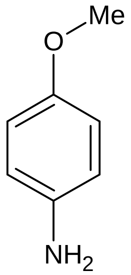
(B)



(C)



(D)



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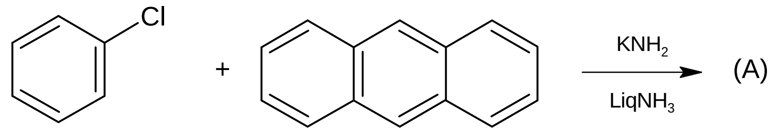
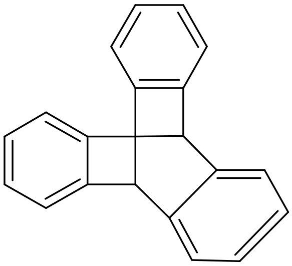
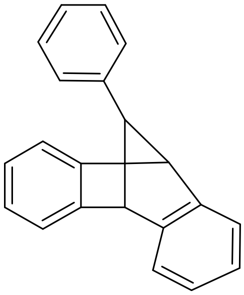
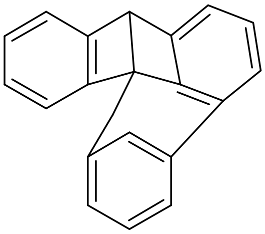
37. 

Identity A in the above reaction

(A) 

(B) 

(C) 

(D) none of these

Space for rough work

Paragraph for Questions 38 & 39

Ideal gas equation is represented as PV = nRT. Gases present in universe were found ideal in the Boyle's temperature range only and deviated more from ideal gas behavior at high pressure and low temperature. The deviation are explained in term of compressibility factor z. For ideal behavior $Z = \frac{PV}{nRT} = 1$. The main cause to show deviation were due to wrong assumptions made about forces of attractions (which becomes significant at high pressure) and volume V occupied by molecules in PV = nRT is supposed to be volume of gas or the volume of container in which gas is placed by assuming that gaseous molecules do not have appreciable volume. Actually volume of the gas is that volume in which each molecule of gas can move freely. If volume occupied by gaseous molecule is not negligible, then the term V would be replaced by the ideal volume which is available for free motion of each molecule of gas in 1 mole gas.

V_{actual} = volume of container – volume occupied by molecules

= v – b

Where, b represent the excluded volume occupied by molecules present in one mole of gas.

Similarly for n mole gas

V_{actual} = v - nb

38. As the pressure approaching zero ie. at very low pressure. The curves plotted between compressibility factor Z and P for n mole of gases have the following characteristics.

(I) The intercept on y axis leads to a value of unity
(II) The intercept on y axis leads to a value of 'n'.
(III) The curves possess same slope for different gases at same temperature.
(IV) The curves possess different slopes for different gases at same temperature.
(V) The curves possess same slope for a gas at different temperature.

(A) I, IV, V
(B) II, III
(C) I, II, III, IV
(D) II, III, V

39. The ratio of coefficient of thermal expansion $\alpha = \frac{\left(\frac{\partial V}{\partial T}\right)_P}{V}$ and the isothermal compressibility $\beta = -\frac{\left(\frac{\partial V}{\partial P}\right)_T}{V}$ for an ideal gas is:

(A) $-\frac{P}{T}$
(B) $\frac{P}{T}$
(C) $\frac{T}{P}$
(D) $-\frac{T}{P}$

Space for rough work

Paragraph for Questions 40 & 41

A Colorless solid A liberates a brown gas B on acidification, a colorless alkaline gas (C) on treatment with NaOH and a colorless non-reactive gas D on heating. If heating of the solid is continued, it completely disappears.

40. The compound A is
(A) NH_4NO_2 (B) PH_4NO_3
(C) NH_4NO_3 (D) none of these

41. Which one of the following is correct?
(A) Bond order of D is 2.5
(B) D is a paramagnetic gas
(C) Smell of gas c is like rotten fish
(D) Ionization energy of gas D is more than N atom

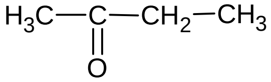
SECTION – C

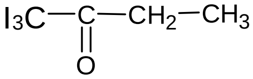
(One Integer Value Correct Type)

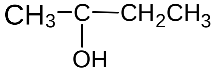
This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

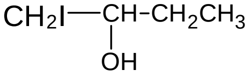
---

42. Find out no of compounds that gives positive iodoform test (either in cold or hot condition)

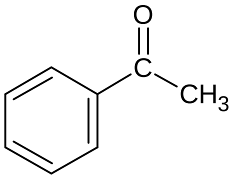
(A)

$H_3C-C(=O)-CH_2-CH_3$

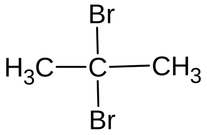
(B)

$I_3C-C(=O)-CH_2-CH_3$

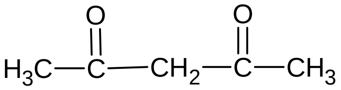
(C)

$CH_3-CH(OH)-CH_2CH_3$

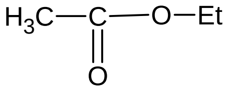
(D)

$CH_2I-CH(OH)-CH_2CH_3$

(E) CH_3CH_2OH

(F)


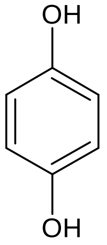
(G)

$H_3C-CBr_2-CH_3$

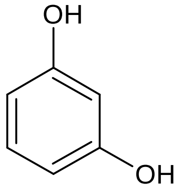
(H)

$H_3C-C(=O)-CH_2-C(=O)-CH_3$

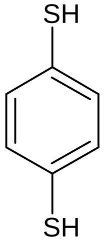
(I)

$H_3C-C(=O)-O-Et$

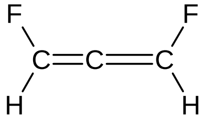
Space for rough work

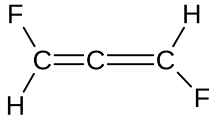
43. Find out no of compound which has non zero Dipole moment

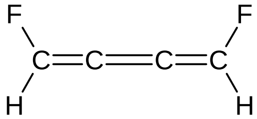
(A)


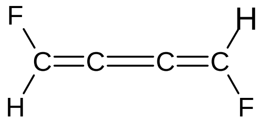
(B)


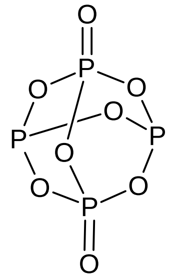
(C)


(D)


(E)


(F)


(G)


(H)


(I) PCl_2F_3

(J) I_2Cl_6

Space for rough work

44. Find out no of correct statements.

(A) $N_2 > N$ (Ist ionization Energy)

(B) $O_2 > O$ (Ist ionization Energy)

(C) $H_2 > H$ (Ist ionization Energy)

(D) $N_2^+ > N_2^-$ (Stability)

(E) $O_2 > O$ (Ist Electron affinity)

(F) $H_2 > H$ (Ist Electron affinity)

(G) $Na_2CO_3 > Li_2CO_3$ (Thermal stability)

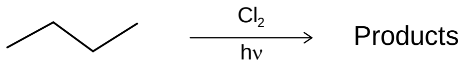
(H) No of co-ordinate bond in P_4O_{10} is 4

(I) No of π bond in P_4O_8 is 2

45. Find out no of compounds which show mutarotation

(A) Cellobiose
(4 – O – (β – D – glucopyranosyl) – D – glucopyranose)
(B) Maltose
(4 – O – (α – D – glucopyranosyl) – D – glucopyranose)
(C) Lactose
(4 – O – (β – D - galactopyranosyl) – D – glucopyranose)
(D) Gentiobiose
(6 – O – (β – D - glucopyranosyl) – D - glucopyranose)
(E) Sucrose
(α – D – glucopyranosyl – β – D - fructofuranoside)
(F) Methyl α – D – galactopyranoside.
(G) α –D – allopyranose
(H) β – D – glucopyranose
(I) α – D - fructofuranose

46.



Find out no of correct statements about above reaction.
(A) No of monochlorinated products are three
(B) No of optically active monochlorinated products are two
(C) No of optically inactive monochlorinated product is one
(D) No of dichlorinated products are ten
(E) No of optically active dichlorinated product are six
(F) No of optically inactive dichlorinated products are 4
(G) No of meso dichlorinated products are two
(H) No of dichlorinated products are six
(I) No of optically active dichlorinated products are seven
(J) No of meso dichlorinated products is one

Space for rough work

Mathematics PART – III

SECTION – A
Straight Objective Type

This section contains **08 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct.

47. If $S_n = 3 + \frac{1+3+3^2}{3!} + \frac{1+3+3^2+3^3}{4!}$.......................... upto n – terms

Then the value of $\left[\lim\limits_{n\to\infty} S_n\right]$ is, (where [.] represent G.I.F)

(A) 6 (B) 7
(C) 8 (D) 9

48. Let f(x) be a polynomial of degree 4,
with $f(2) = -1, f'(2) = 0, f''(2) = 2, f'''(2) = -12, f''''(2) = 24$, then the value of $f''(1)$ is

(A) 24 (B) 26
(C) 28 (D) 30

49. A person whose hobby is tossing a fair coin is to score one point for every tail and two points for every head. The person goes on tossing the coin, till his score reaches 100 or exceeds 100. Then the probability that his score attains exactly 100 is,

(A) $\frac{2}{3} - \frac{1}{3.2^{100}}$ (B) $\frac{2}{3} + \frac{1}{3.2^{100}}$
(C) $\frac{2}{3} - \frac{1}{2^{100}}$ (D) $\frac{2}{3} + \frac{1}{2^{100}}$

50. Let $f(x) = x^5\left[\frac{1}{x^3}\right], x \neq 0$ & $f(0) = 0$ (where [.] represent G.I.F), Then $\lim\limits_{x\to 0} f(x)$

(A) Does not exist (B) 1
(C) -1 (D) None of these

Space for rough work

51. In an examination of the maximum marks for each of the three papers are 50 each and maximum marks for the fourth paper is 100. Then the number of ways in which a candidate secure 60% marks in aggregate is

(A) 110551 (B) 40375

(C) 6176 (D) None of these

52. If the solution of the differential equation $e^{\frac{x}{y}(1-y^2)}\left[y\frac{dx}{dy}-x\right]+\left[xy^2+y^3\frac{dx}{dy}\right]=0$ is

$Ae^{xy}+Be^{\frac{x}{y}}+C=0,$ Then A + B is

(A) -1 (B) 0

(C) 2 (D) None of these

53. If the line $x+y+1=0$ and $y-2x+5=0$ are tangents to a parabola whose focus at (1, 2), then the equation of normal to the parabola through $\left(\frac{29}{17},-\frac{14}{17}\right)$ is,

(A) $2x+4y-1=0$ (B) $y-3x+2=0$

(C) $4x+y-5=0$ (D) None of these

54. If $a+b+c=5, a^2+b^2+c^2=12$ and $a^3+b^3+c^3=25$ Then the value of $a^4+b^4+c^4$ is

(A) $\frac{251}{6}$ (B) $\frac{253}{6}$

(C) $\frac{255}{6}$ (D) $\frac{257}{6}$

Multiple Correct Choice Type

This section contains **04 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

55. If C_1 and C_2 are two concentric circles of radii 4 and 5 respectively with centre at origin. A tangents is drawn to circle C_2 at a given point 'P'. This tangent is the diameter of a variable circle C_3, which touches C_1 externally. Also this tangent meet C_3 in Q & R. If the diameter QR subtends a constant non – zero angle at a fixed point T on line joining O & P. Then the locus of the point 'T' for various positions of P on C_2 is

(A) $x^2+y^2=2$ (B) $x^2+y^2=4$

(C) $x^2+y^2=64$ (D) $x^2+y^2=36$

Space for rough work

56. If g(x) is a continuous function such that $\int_0^x g(t)dt \to \infty$, as $|x| \to \infty$, Then the value of K for which line y = Kx intersect the curve $\int_0^x g(t)dt = 2 - y^2$

(A) -1
(B) $\sqrt{2}$
(C) 3
(D) 1

57. ABCD is a regular tetrahedron. P & Q are the mid – points of the edges AC and AB respectively, G is the centroid of the face BCD and θ is the angle between the vectors $\overrightarrow{PG}$ and $\overrightarrow{DQ}$, then

(A) The angle between $\overrightarrow{AB}$ and $\overrightarrow{CD}$ is 90^0

(B) The angle θ is $\pi - \cos^{-1}\left(\frac{5}{3\sqrt{3}}\right)$

(C) The angle θ is $\pi - \cos^{-1}\left(\frac{5}{6\sqrt{3}}\right)$

(D) The angle between $\overrightarrow{AB}$ and $\overrightarrow{CD}$ is 120^0

58. If $P = \sum_{r=3n}^{r=4n-1}\left[\frac{r^2 + 13n^2 - 7rn}{n^3}\right]$

& $Q = \sum_{r=3n+1}^{r=4n}\left[\frac{r^2 + 13n^2 - 7rn}{n^3}\right]$ Then

(A) $P > \frac{5}{6}$
(B) $Q < \frac{5}{6}$
(C) $Q > \frac{5}{6}$
(D) $P < \frac{5}{6}$

Space for rough work

Comprehension Type

This section contains **3 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

Paragraph for Questions 59 & 60

If n be a natural number define polynomial $f_n(x)$ of nth degree as follows

$f_n(\cos\theta) = \cos n\theta$

i.e $f_2(x) = 2x^2 - 1$ $f_3(x) = 4x^3 - 3x$,

Then

59. $\left(x+\sqrt{x^2-1}\right)^{10} + \left(x-\sqrt{x^2-1}\right)^{10}$ is equal to

(A) $f_{10}(x)$ (B) $f_{11}(x)+f_9(x)$

(C) $f_{11}(x)$ (D) $2f_{10}(x)$

60. $f_6(x)$ is equal to

(A) $36x^6 - 48x^4 + 18x^2 - 5$ (B) $32x^6 - 48x^4 + 18x^2 - 1$

(C) $36x^6 - 45x^4 + 18x^2 - 8$ (D) $36x^6 - 48x^4 + 18x^2 - 7$

Paragraph for Questions 61 & 62

If the integrand is a rational function of x and fractional powers of a linear fractional function of the form $\frac{Ax+B}{Cx+D}$, then rationalization of the integral is affected by the substitution

$\frac{Ax+B}{Cx+D} = t^m$

61. If $\int \frac{(2x-3)^{\frac{1}{2}}}{(2x-3)^{\frac{1}{3}}+1}dx = 3\left[\frac{1}{7}(2x-3)^{\frac{7}{6}} - \frac{1}{5}(2x-3)^{\frac{5}{6}} + \frac{1}{3}(2x-3)^{\frac{1}{2}} - (2x-3)^{\frac{1}{6}} + g(x)\right] + C$

Then g(x) is,

(A) $\tan^{-1}(2x-3)^{\frac{1}{6}}$ (B) $(2x-3)^{\frac{1}{6}}$

(C) $3\tan^{-1}(2x-3)^{\frac{1}{6}}$ (D) $4(2x-3)^{\frac{1}{6}}$

Space for rough work

62. If $\int \frac{dx}{\sqrt[3]{(x+1)^2 (x-1)^4}} = K\sqrt[3]{\frac{1+x}{1-x}} + C,$

Then K is equal to,

(A) $\frac{2}{3}$
(B) $-\frac{3}{2}$
(C) $\frac{1}{3}$
(D) $\frac{1}{2}$

Paragraph for Questions 63 & 64

Consider a plane $P \equiv 2x + y - z - 5 = 0$, a line $\frac{x-3}{2} = \frac{y+1}{-3} = \frac{z-2}{-1}$ and a point $A(3,-4,1)$. L_2 is a line passing through A intersecting L_1 an parallel to the plane P.

63. Plane containing L_1 and L_2 is,

(A) Parallel to yz - plane
(B) Parallel to x-axis
(C) Parallel to y-axis
(D) Passing through origin

64. Line L_1 intersect plane P at Q and xy – plane at R, then the volume of tetrahedron OAQR is, (where ‘o’ is origin)

(A) 0
(B) $\frac{14}{3}$
(C) $\frac{3}{7}$
(D) $\frac{7}{3}$

SECTION – C
(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

65. If the set of ‘K’ for which two distinct chords of the ellipse $\frac{x^2}{8} + \frac{y^2}{2} = 1$ passing through (2, -1) are bisected by the line x + y = K is [a, b], then (a + b) is……………..

Space for rough work

66. If $ax^3 - cx + b \geq 0\ \forall x \in R^+ - \{0\}$, where a, b, c $\in$ R^+. Then the minimum value of $\left(\frac{27ab^2}{c^3}\right)$ is….

67. If x, y, z are positive real number, such that x + y + z = 1, If the minimum value of $\left(1+\frac{1}{x}\right)\left(1+\frac{1}{y}\right)\left(1+\frac{1}{z}\right)$ is K^2, then $|K|$ is………………….

68. Let A be a square matrix of order 3 satisfies $A^3 - 6A^2 + 12A - 8I = 0$ & $B = A - 2I$
If $|A| = 8$ & $\left|adj\left(I - 2A^{-1}\right)\right| = K,$ then $[K]$ ……………..where [.] represents G.I.F

69. If $\frac{9a}{\cos\theta} + \frac{5b}{\sin\theta} = 56$ and $\frac{9a\sin\theta}{\cos^2\theta} - \frac{5b\cos\theta}{\sin^2\theta} = 0$
If the value of $\left[(9a)^{\frac{2}{3}} + (5b)^{\frac{2}{3}}\right]^3 = (8K)^2$ Then K is…………………

Space for rough work

FIITJEE **JEE(Advanced)-2018**

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FULL TEST – I

PAPER-2

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**C**	24.	**C**	47.	**C**
2.	**A**	25.	**B**	48.	**B**
3.	**C**	26.	**C**	49.	**B**
4.	**C**	27.	**D**	50.	**D**
5.	**A**	28.	**C**	51.	**A**
6.	**D**	29.	**B**	52.	**C**
7.	**B**	30.	**A**	53.	**D**
8.	**B**	31.	**D**	54.	**D**
9.	**ABC**	32.	**ABC**	55.	**BC**
10.	**BD**	33.	**D**	56.	**ABCD**
11.	**ABCD**	34.	**ABCD**	57.	**AC**
12.	**ABC**	35.	**ACD**	58.	**AB**
13.	**A**	36.	**A**	59.	**D**
14.	**A**	37.	**A**	60.	**B**
15.	**B**	38.	**A**	61.	**A**
16.	**B**	39.	**B**	62.	**B**
17.	**C**	40.	**A**	63.	**A**
18.	**D**	41.	**D**	64.	**D**
19.	**4**	42.	**9**	65.	**1**
20.	**3**	43.	**9**	66.	**4**
21.	**4**	44.	**6**	67.	**8**
22.	**3**	45.	**7**	68.	**1**
23.	**2**	46.	**7**	69.	**7**

Physics

PART – I

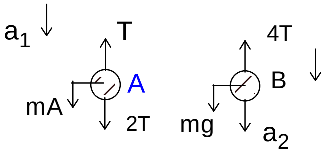
SECTION – A

1. For the 1st ball, 4h = $\frac{gt_1^2}{2} \Rightarrow t_1 = 2\sqrt{\frac{2h}{g}}$ & For second ball $t_2 = \sqrt{\frac{2h}{g}}$

also $\sqrt{\frac{2h}{g}} + \sqrt{\frac{2d}{g}} = 2\sqrt{\frac{2h}{g}} \Rightarrow 2\sqrt{h} = \sqrt{d} + \sqrt{h} \Rightarrow d = h$

2. From F.B.D. we get

$$mA - 4T = mA_2$$
$$mA + 2T - T = mA_1$$



On solving these two we get

$$a_A = 4g$$

3. Zero error = +4 × 0.01 = +0.04 mm
Measured diameter = M.S.R. + L.C. × C.S.R.
= (5×0.5) mm + (0.01mm) × 18 = 2.68 mm
∴ Actual diameter = 2.68 - (0.04) = 2.64 mm

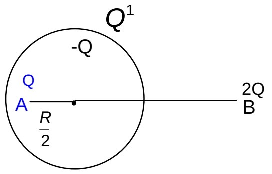
4. When radius of curvature is minimum $\bar{v}$ is $\perp$ to $\bar{a}$ & it is at t = $\frac{16V_0}{25g}$

5. Since shell is earthed its potential is zero

$$\frac{KQ^1}{R} + \frac{K(2Q)}{2R} = 0$$

$\therefore Q^1 = -Q$

Hence 3Q will flow to the earth.



6. $$\frac{3}{2v_1} + \frac{1}{45} = \frac{1}{2R} \longrightarrow (1)$$

$$-\frac{3}{2v_1} = \frac{1}{6R} \longrightarrow (2)$$

from (1) and (2)

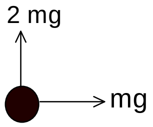
R = 30 cm

7. $F.v = k \Rightarrow .m\frac{dv}{dt}.v = k$

$$\int_0^t dt = \frac{m}{k}\int_{v_i}^{v_t} v\,dv = \frac{m}{2k}\left(\frac{6M}{R} - \frac{6M}{r}\right)$$

$$t = \frac{6Mm}{2k}\left(\frac{1}{R} - \frac{1}{r}\right)$$

8. F.B.D. of the ball in the frame of the container is as shown in the figure



$\therefore$ Distance from B = 5m

10. $\frac{Q_i^2}{2c} + \frac{1}{2}Li_i^2 = \frac{1}{2}Li_{\max}^2$

$I_{\max} = \sqrt{2}\ amp$

$Also,\ \frac{Q_i^2}{2c} + \frac{1}{2}Li_i^2 = \frac{Q_{\max}^2}{2c}$

11. $\because\ F = \frac{-du}{dy} = 0$ (For equilibrium)

Particle is performing simple harmonic motion

12. $dQ = (4m)s(-dT_1) = (2m)(2s)dT_2$

On solving we get $\Delta T_f = \Delta T_i e^{\frac{-KAt}{2msl}}$

Temperature of point P remains constant

13. If x be the initial length of the gas chambers & A be the area of cross section of the cylinder then,

$x = \frac{V_0}{A}$ Also $P_0A = 2kx$

$\frac{P_0}{x} = 2kx \Rightarrow P_0V_0 = 2kx^2$

$\therefore \frac{1}{2}k(2x)^2 = \frac{1}{2}K4x^2 = 2kx^2 = P_0V_0$

14. Similarly, $P_fA = 2k\frac{v_f}{A}$

$P_0A = 2k\frac{V_0}{A}$

$\Rightarrow \frac{P_f}{P_0} = \frac{V_f}{V_0} \Rightarrow P = \frac{P_0}{V_0}v$

Now $\therefore$ Q = dU + W

$= 2\frac{5}{2}(P_1V_1 - P_0V_0) + w$

$= 12P_0V_0$

15 – 16. P= mv &

$\frac{P^2}{2m} = \frac{1}{2}mV^2$

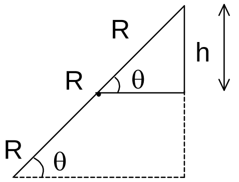
$E_\alpha = \frac{P^2}{2m}$

$E_{radon} = \frac{P^2}{2M}$

Also

$$\frac{P^2}{2m}+\frac{P^2}{2M}=\Delta E \Rightarrow P=\sqrt{2\Delta E\frac{mM}{m+M}}$$
$$m=4.002mu, M=222.017mu$$
$$m=6.64\times10^{-27}kg$$

17 – 18. $\frac{1}{2}g\sin\theta.\frac{4v^2}{g^2\cos^2\theta}=2R \quad .....(I)$



$v^2=Rg\sin\theta \; .....(2)$

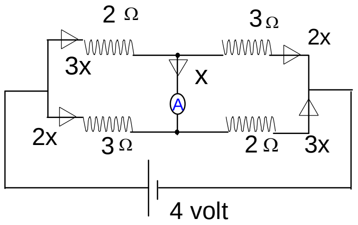
From (1) and (2) $\tan\theta=1$

SECTION – C

19. $v=\sqrt{\frac{T}{\sigma}}=\sqrt{\frac{\frac{2.5}{0.75}}{\frac{0.125}{0.75}}}=3.9m/s\simeq 4m/s$

20. $\because$ Angular separation is directly proportional to wave length

21.



$2x=4$

$x=\frac{1}{3}=\frac{p}{q}$

$p+q=4$

22. $\because \tau=I\alpha \Rightarrow \omega=\sqrt{\frac{8QE}{\pi mR}} \Rightarrow \omega=\sqrt{2\pi}=\frac{2\pi}{T}$

$\therefore T=\sqrt{2\pi}$

$\therefore$ P + n is 3

23. Now $i=\frac{\varepsilon}{R}=\frac{\pi r^2}{R}\frac{dB}{dt}$

$|\bar{\tau}|=|\bar{M}\times\bar{B}|=2mgr$

$\frac{\pi r^2}{R}\frac{dB}{dt}.\pi r^2.4=2mg.r$

$4\frac{\pi^2r^4}{R}.8t=2mg.r$

$t=2\sec$

Chemistry PART – II

SECTION – A

24. $CHCl_3 \to \bar{C}Cl_3 + H^+$

$CHF_3 \to \vec{C}F_3 + H^+$

$\Rightarrow$ $\bar{C}Cl_3$ is more stable than $\bar{C}F_3$ due to $P_\pi - d_\pi$ bonding hence $CHCl_3$ is more acidic, not CHF_3 so, (I) is incorrect.

$\Rightarrow$ In chlorobenzene $C-Cl$ bond length decreases due to resonance and hence its dipole moment is lesser than chlorocyclohexane ii is also incorrect.

$\Rightarrow$ Dipole moment of fluoromethane is lesser than chloromethane due to very small size of F. ii is also incorrect.

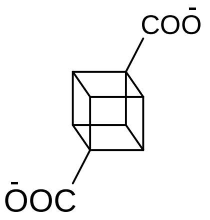
$\Rightarrow$ Carbon and nitrogen atom containing organic compound gives positive test for nitrogen in lassaigne's test

$\Rightarrow$ Dipole moment of difluoromethane is more than dichloromethane .

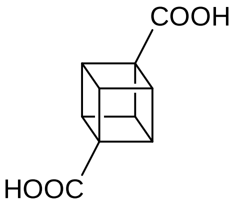
CH_2F_2	CH_2Cl_2
$\mu = 1.97D$	$1.60D$

25.

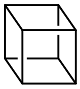
A.



B.

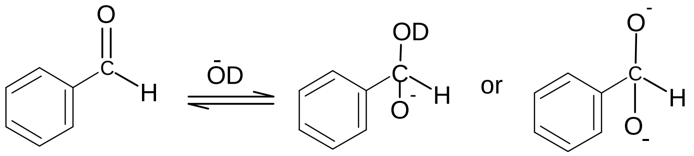


C.

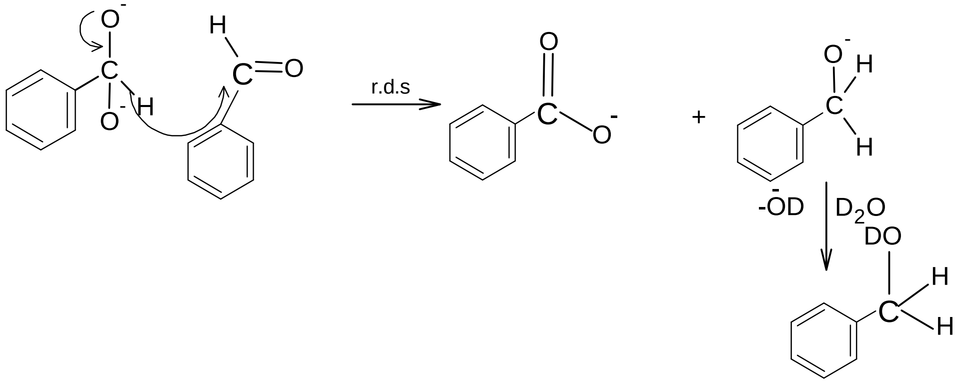


26. At very high concentration R. O. R = $K\left[RCHO\right]^2[OD^-]^2$

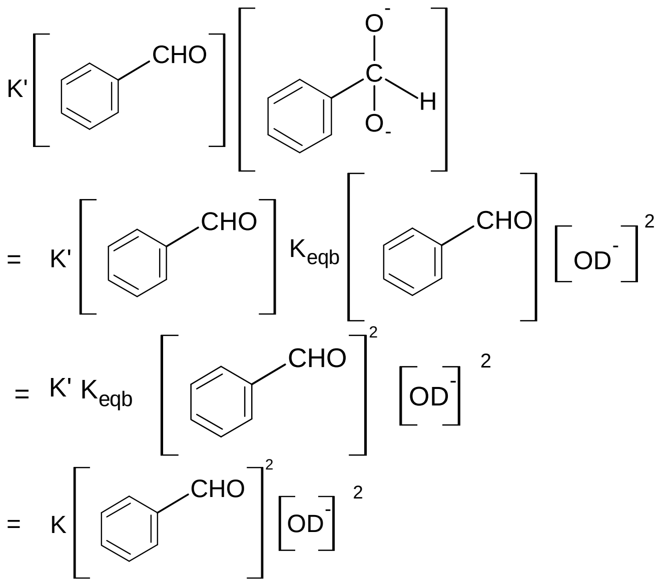
Mech.



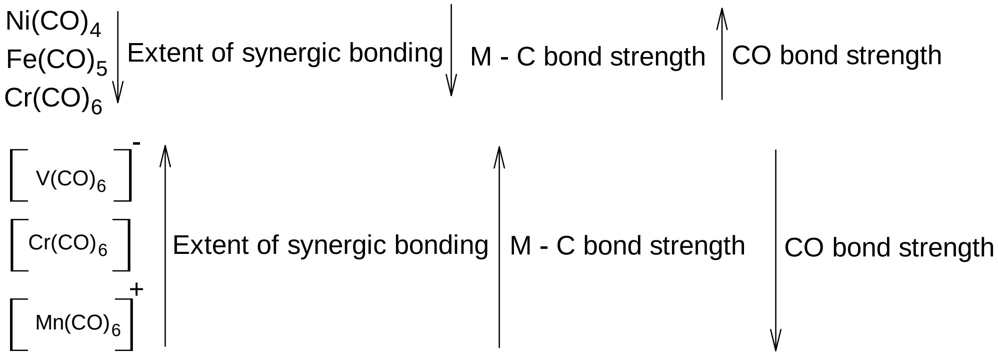
(At very high concentration of OD⁻)



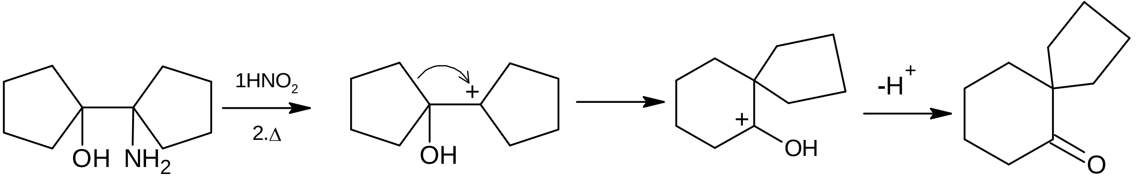
At very high concentration =
r. o. r =


K'
CHO
O⁻
C
H
O⁻
= K'
CHO
K_eqb
CHO
OD⁻
2
= K' K_eqb
CHO
2
OD⁻
2
= K
CHO
2
OD⁻
2

27.


Ni(CO)4
Fe(CO)5
Cr(CO)6
Extent of synergic bonding
M - C bond strength
CO bond strength
[V(CO)6]⁻
[Cr(CO)6]
[Mn(CO)6]⁺
Extent of synergic bonding
M - C bond strength
CO bond strength

28. It is a semi pinacol – pinacolone type reaction and product is formed after formation of carbocation and its rearrangement by ring expansion.


OH NH2
1HNO2
2.Δ
+
OH
+
OH
-H⁺
O

29. $2\pi r = 4\lambda; n = 4$

Total energy required + Total energy released = 0

$$\left(2\times 4.526ev\times N_A\right)+\left(2\times 13.6N_A\right)+\left(2\times 13.6\times\left(1-\frac{1}{16}\right)\times N_A\right)-\left(30.87\times x\times N_A\right)=0$$

$x = 2$

30. $AgBr \rightleftharpoons Ag^{+}_{(aq.)} + Br^{-}_{(aq.)}$

$K_{sp} = \left[Ag^{+}\right]\left[Br^{-}\right]$

$Ag^{+} + 2NH_3 \rightleftharpoons \left[Ag\left(NH_3\right)_2\right]^{+}$

$$K_f = \frac{\left[Ag(NH_3)_2\right]^+}{\left[Ag^+\right]\left[NH_3\right]^2} = 1\times 10^8$$

Let s be the solubility of AgBr in NH_3, then $[Br^-] = [Ag^+] + [Ag(NH_3)_2]^+ = S$

Since , almost all Ag^+ in solution state passes to $[Ag(NH_3)_2]^+$ as K_f is very high. Thus $[Ag^+] <<< [Ag(NH_3)_2]^+$

$\therefore$ $[Br^-] = [Ag(NH_3)_2]^+ = S$

Now $K_{sp} = [Ag^+][Br^-] = \dfrac{\left[\left[Ag(NH_3)_2\right]^+\right]}{K_f \times \left[NH_3\right]^2} \times \left[Br^-\right]$

Since $[NH_3] = 0.4$ M

$$5\times 10^{-13} = \frac{S\times S}{1.0\times 10^8 \times (0.4)^2}$$

$$S^2 = 8\times 10^{-6}$$

$$S = 2.82\times 10^{-3} M$$

31. $Fe \to Fe^{+2} + 2e$ $\qquad -\Delta G_1^0 = 2\times E_1^0 \times F$...........(i)

$Fe^{+2} \to Fe^{+3} + e$ $\qquad -\Delta G_2^0 = 1\times E_2^0 \times F$............(ii)

$Fe \to Fe^{3+} + 3e$ $\qquad -\Delta G_3^0 = 3\times E_3^0 \times F$...........(iii)

Subtracting equation (i) from equation (ii), we get

$Fe^{+2} \to Fe^{+3} + e$

$-\Delta G_3^0 + \Delta G_1^0 = 3E_3^0 F - 2E_1^0 F$...........(iv)

Comparing (ii) and (iv)

$-\Delta G_2^0 = -\Delta G_3^0 + \Delta G_1^0$

$E_2^0 F = 3E_3^0 F - 2E_1^0 F$

$E_3^0 = \left(E_2^0 + 2E_1^0\right)/3$

32. Crystal is FCC

33. $2MnO_4^- + 5H_2O_2 + 6H^+ \to 2Mn^{+2} + 5O_2 + 8H_2O$

34. $O_{(g)} + e^- \to O_{(g)}^-$ $\qquad \Delta H = -ve$

$O_g^- + e^- \to O_{(g)}^{-2}$ $\qquad \Delta H = +ve$

$O_{(g)} + 2e^- \to O_{(g)}^{-2}$ $\qquad \Delta H = +ve$

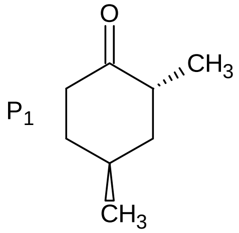
$O_{2(g)} \to O_{2(g)}^+ + e^-$ $\qquad$ (Electron removed from $\pi^* 2P_y$ or $\pi^* 2P_x$)

$O_{(g)} \to O_{(g)}^+ + e^-$ $\qquad$ (Electron removed from $2P$)

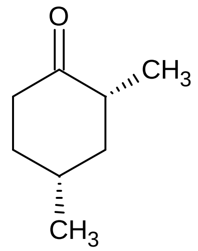
$H_{2(g)} \to H_{2(g)}^+ + e^-$ $\qquad$ (Electron removed from $\sigma 1s$)

$H_{(g)} \to H_{(g)}^+ + e^-$ $\qquad$ (Electron removed from $1s$)

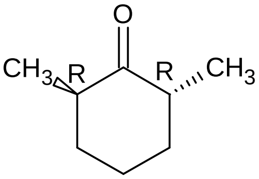
35.



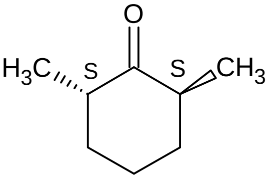
P_2



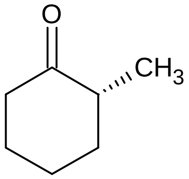
P_3



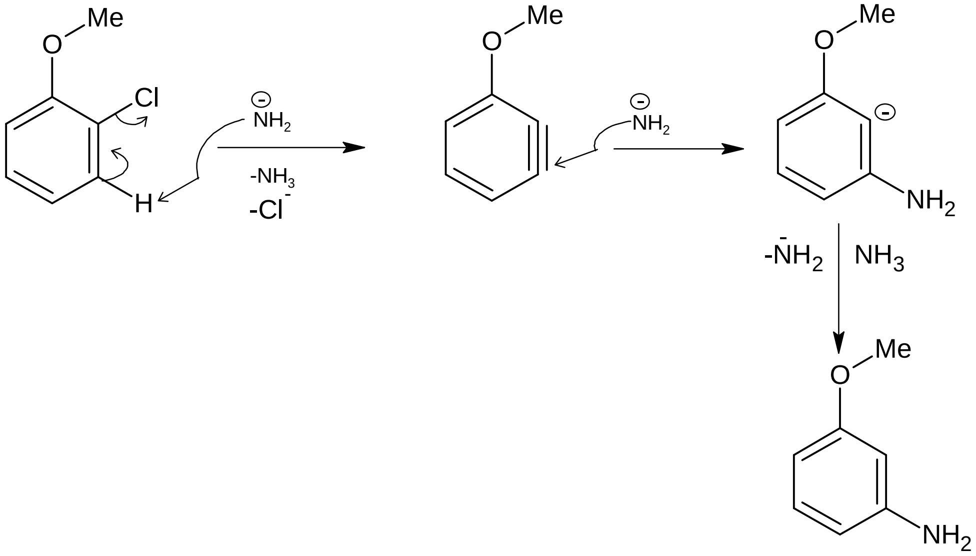
Q_3



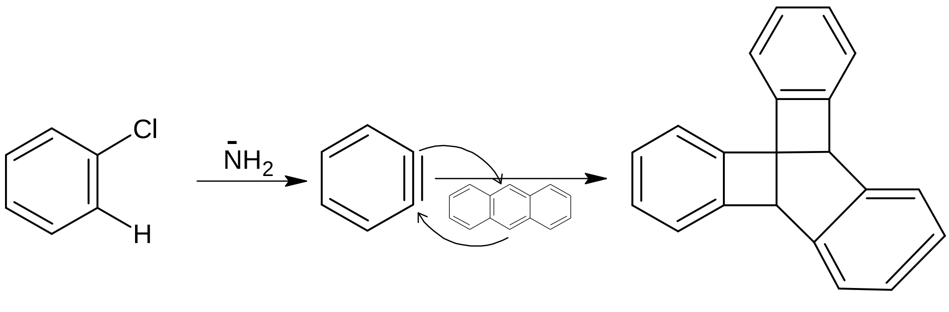
P_4



36.


Me
O
Cl
H
NH2
-NH3
-Cl-
Me
O
NH2
Me
O
NH2
-NH2
NH3
Me
O
NH2

37.



38. $\frac{PV}{nRT} = Z$ At very low P or P → 0, Z = 1

39. $PV = RT$ (for 1 mole of gas)

$$\therefore P\partial V = R\partial T$$

$$or \ \left(\frac{\partial V}{\partial T}\right)_P = \frac{R}{P} = \frac{R.V}{RT}$$

$$or \ \ \alpha = \frac{\left(\frac{\partial V}{\partial T}\right)_P}{V} = \frac{1}{T}$$

$$P.\partial V + V.\partial P = 0$$

$$\left(\frac{\partial V}{\partial P}\right)_T = -\frac{V}{P}$$

Also

$$or \ \ \beta = -\frac{\left(\frac{\partial V}{\partial P}\right)_T}{V} = \frac{1}{P}$$

$$\frac{\alpha}{\beta} = \frac{P}{T}$$

40-41. Alkaline gas C with NaOH indicates that solid should be ammonium salt. Heating the salt, a colorless non-reacting gas D is formed. The gas D may be nitrogen . The compound may thus be NH_4NO_2 . Reactions involved are as follows.

$$\underset{A}{NH_4NO_2} \xrightarrow{HCl} NH_4Cl + HNO_2$$

$$2HNO_2 \longrightarrow H_2O + 2NO + [O]$$

$$2NO + 2[O] \longrightarrow \underset{\substack{B \\ Brown\,Gas}}{2NO_2 \uparrow}$$

$$NH_4NO_2 + NaOH \longrightarrow NaNO_2 + H_2O + \underset{C}{NH_3 \uparrow}$$

$$\underset{A}{NH_4NO_{2_{(s)}}} \xrightarrow{heat} \underset{D}{N_{2_{(gas)}}} \uparrow + 2H_2O_{(gas)} \uparrow$$

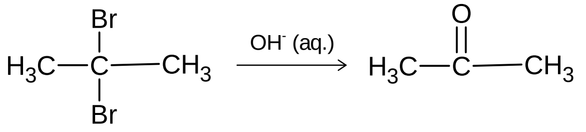
$$\Rightarrow N_2 \ is\ a\ diamagnetic\ Gas$$

$$\Rightarrow Bond\ order\ of\ N_2 = 3$$

SECTION – C

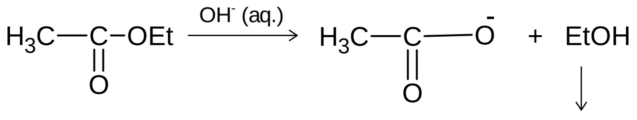
42. (A), (B), (C), (D), (E), (F), (G), (H) & (I) gives iodoform test

(G)



$$H_3C-\underset{Br}{\overset{Br}{C}}-CH_3 \xrightarrow{OH^- (aq.)} H_3C-\overset{\overset{O}{\|}}{C}-CH_3$$

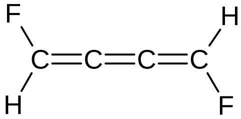
(I)



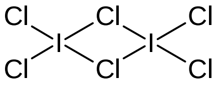
$$H_3C-\underset{\underset{O}{\|}}{C}-OEt \xrightarrow{OH^- (aq.)} H_3C-\underset{\underset{O}{\|}}{C}-\overset{-}{O} + EtOH \downarrow$$

it show iodoform test

43. G & J have zero dipole moment



$\mu = 0$


Cl
Cl
Cl
I
I
Cl
Cl
Cl

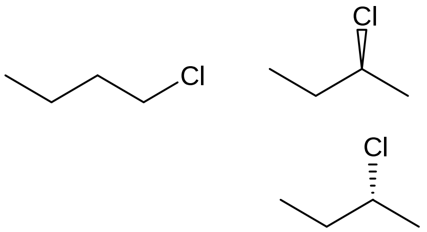
$\mu = 0$

A, B, C, D, E, F, H, I have nonzero dipole moment

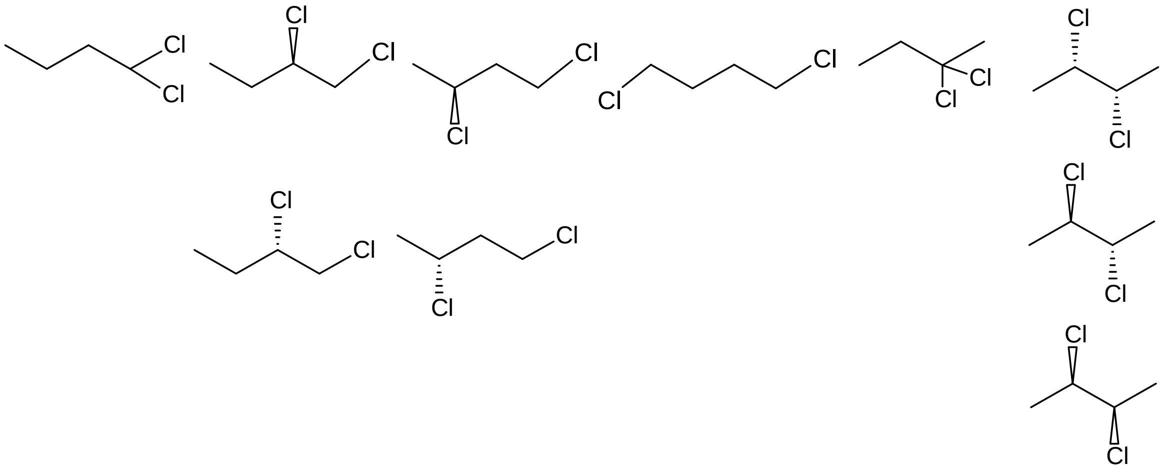
44. Correct statements: A, C, D, G, H, I
Incorrect statements: B, E, F

45. A, B, C, D, G, H, I show mutarotation. A sugar whose IUPAC name ends with the suffix ose is a reducing sugar and they do mutarotation

46. Monochlorination



Dichlorination


Cl
Cl
Cl
Cl
Cl
Cl
Cl
Cl
Cl
Cl
Cl
Cl
Cl
Cl
Cl
Cl
Cl
Cl
Cl
Cl
Cl
Cl

A, B, C, D, E, F, J are correct.

Mathematics PART – IIII

SECTION – A

47. $S_\eta = 1 + \frac{1+3}{2!} + \frac{1+3+3^2}{3!}.................... = \sum \frac{3^n - 1}{(3-1)n!}$

$\frac{1}{2}\sum_{r=1}^{n}\frac{3^r - 1}{r!} = \frac{1}{2}\left[\sum \frac{3^r}{r!} - \frac{1}{r!}\right]$

$\lim_{n\to\infty}(S_n) = \frac{1}{2}\left[\left(e^3 - 1\right) - (e - 1)\right] = \frac{1}{2}\left[e^3 - e\right] \approx 8.59$

$[S_n] = 8$

48. Let $f(x) = a(x-2)^4 + b(x-2)^3 + C(x-2)^2 + d(x-2) - 1$

$f(x) = 12(x-2)^2 - 12(x-2) + 2$

$f''(1) = 26$

49. Let E_n denote the event that the score is n

$E_n = (E_{n-2} \cap H) \cup (E_{n-1} \cap T)$

$P(E_n) = \frac{1}{2}[P_{n-2} + P_{n-1}]$

$P_n + \frac{1}{2}P_{n-1} = P_{n-1} + \frac{1}{2}P_{n-2}$

$= P_{n-2} + \frac{1}{2}P_{n-3} = P_2 + \frac{1}{2}P_1$

As, $P_1 = P(T) = \frac{1}{2} \Rightarrow P_2 = P((T \cap T) \cup H) = \frac{3}{4}$

$\Rightarrow P_n + \frac{1}{2}P_{n-1} = 1$

$\Rightarrow P_n - \frac{2}{3} = -\frac{1}{2}\left[P_{n-1} - \frac{2}{3}\right] = \left(-\frac{1}{2}\right)^2\left[P_{n-2} - \frac{2}{3}\right]$

$= \left(-\frac{1}{2}\right)^{n-2}\left[P_1 - \frac{2}{3}\right] = -\frac{1}{2}\left[\frac{1}{2} - \frac{2}{3}\right]$

$P_{100} = \frac{2}{3} + \frac{1}{3.2^{100}}$

50. $x - 1 < [x] \le x$

$\frac{1}{\eta^3} - 1 < \left[\frac{1}{\eta^3}\right] \le \frac{1}{\eta^3}$

$x^5\left(\frac{1}{\eta^3} - 1\right) < x^5\left[\frac{1}{x^3}\right] \le x^2$

$\Rightarrow \lim_{x\to 0} x^5\left[\frac{1}{x^3}\right] = 0$

51. Required number of ways = coefficiant of x^{150} in

$$\left(x^0+x+x^2............x^{50}\right)^3\ \left(x^0+x+x^2.......x^{100}\right)$$

$$^{153}c_{150}-3\ ^{102}c_{99}-^{52}c_{49}+3.^{51}c_{48}$$

$$=70176+40375=110551$$

52. $$e^{xy}\left[xy^2+y^3\frac{dx}{dy}\right]+e^{\frac{x}{y}}\left[y\frac{dx}{dy}-x\right]=0$$

$$d\left(e^{xy}\right)+d\left(e^{\frac{x}{y}}\right)=0$$

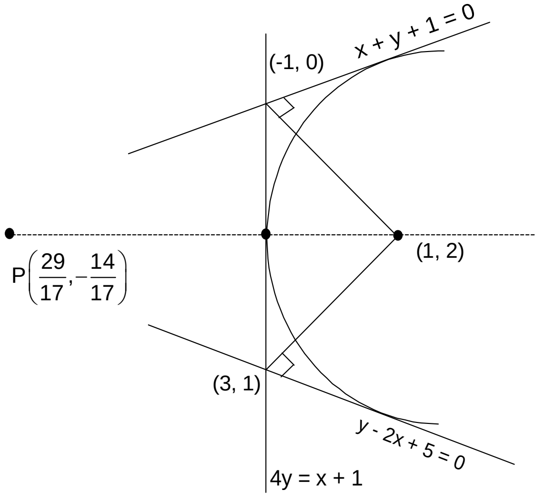
$$e^{xy}+e^{\frac{x}{y}}+c=0$$

$$A+B=1$$

53. Normal through given point be the axis of parabola,

$y - 2 = -4(x - 1)$

$4x + y = 6$



54. Let a, b, c are the roots of equation

$$a_0x^3+a_1x^2+a_2x+a_3=0$$

Then, $s_1=5\quad s_2=12,\quad s_3=25$

Now, $a_0s_1+a_1=0\quad\Rightarrow a_1=-5a_0$

$$a_0s_2+a_1s_1+2a_2=0\Rightarrow a_2=\frac{13}{2}a_0$$

$$a_0s_3+a_1s_2+a_2s_1+3a_3=0\Rightarrow a_3=\frac{5}{6}a_0$$

$$x^3-5x^2+\frac{13}{2}x+\frac{5}{6}=0$$

$$6x^3-30x^2+39x+5=0$$

$$\Rightarrow 6x^4-30x^3+39x^2+5x=0$$

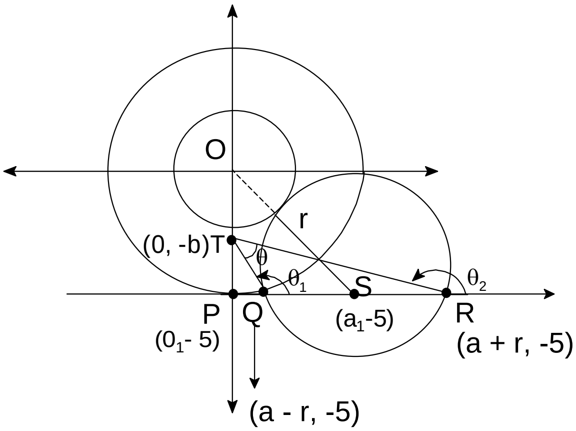
$$6s_4-30s_3+39s_2+5s_1=0\Rightarrow s_4=\frac{257}{6}$$

55. $\tan\theta = \dfrac{\dfrac{-5+b}{a+r} - \dfrac{-5+b}{a-r}}{1 - \dfrac{(b+5)^2}{a^2-r^2}}$

$\text{Now,} a^2 = (r+4)^2 - 5^2$

$= r^2 - 9 + 8r$

$(b-5)^2 = 9$



56. $\int_0^x g(t)dt = 2 - K^2x^2 = 2 - \int_0^x 2K^2 t dt$

$\text{Let } f(x) = \int_0^x \left[2k^2 t + g(t)\right]dt - 2$

As, $2K^2t$ and $g(t)$ are continuous

$\Rightarrow \left[2K^2t + g(t)\right]$ is also continuous

$f(0) = -2, \lim\limits_{x\to\infty} f(x) \to \infty$

As $f(x)$ changes its sign

$\Rightarrow f(x) = 0$ for some $x \in R$ & $\forall K \in R$

57. $\overrightarrow{DA} = \vec{a}, \overrightarrow{DB} = \vec{b}, \overrightarrow{DC} = \vec{c}$

$\overrightarrow{AD}.\overrightarrow{BC} = \left(-\vec{a}\right).\left(\vec{c} - \vec{b}\right)$

$= -\vec{a}.\vec{c} + \vec{a}.\vec{b}$

$= 0$

Hence, $\overrightarrow{AD} \perp^r \overrightarrow{BC} \Rightarrow \overrightarrow{AB} \perp \overrightarrow{CD}$

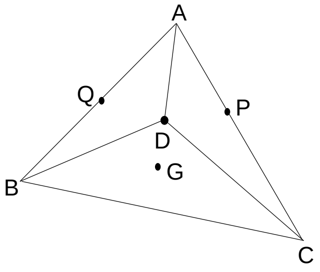
Now, $\overrightarrow{PG} = -\dfrac{1}{6}\left(3\vec{a} - 2\vec{b} + \vec{c}\right)$ & $\overrightarrow{DQ} = \dfrac{1}{2}\left(\vec{a} + \vec{b}\right)$

Let $\left|\vec{a}\right| = \left|\vec{b}\right| = \left|\vec{c}\right| = K$

$\Rightarrow \left|\overrightarrow{PG}\right| = \dfrac{K}{2}$ & $\left|\overrightarrow{DQ}\right| = \dfrac{\sqrt{3}}{2}K$

$\Rightarrow \overrightarrow{PG}.\overrightarrow{DQ} = -\dfrac{1}{6}\left(3\vec{a} - 2\vec{b} + \vec{c}\right).\dfrac{1}{2}\left(\vec{a} + \vec{b}\right)$

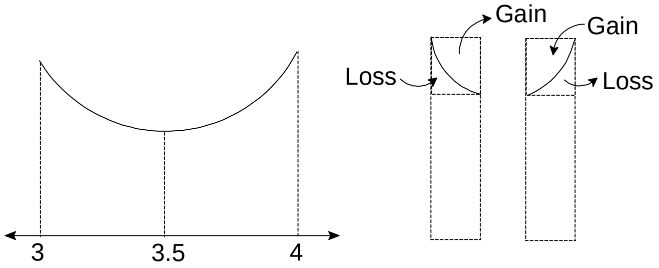
$\cos\theta = -\dfrac{5}{6\sqrt{3}} \Rightarrow \theta = \pi - \cos^{-1}\left(\dfrac{5}{6\sqrt{3}}\right)$



58. $f(x) = x^2 - 7x + 13$

In both cases gain > loss

$\Rightarrow P > \int_3^4 f(x)dx \quad \& \quad Q > \int_3^4 f(x)dx$



59. & 60.

As, $f(x) = x \;\&\; \cos(n+1)\theta + \cos(n-1)\theta = 2\cos(n\theta).\cos\theta$

$f_{(n+1)}(x) + f_{(n-1)}(x) = 2x.f_n(x)$

$f_n(x) = \dfrac{1}{2x}\left[f_{n+1}(x) + f_{n-1}(x)\right]$

Now, Put $x = \cos\theta, \Rightarrow \sqrt{x^2-1} = i\sin\theta$

$\left(x+\sqrt{x^2-1}\right)^{10} + \left(x-\sqrt{x^2-1}\right)^{10} = (\cos\theta + i\sin\theta)^{10} + (\cos\theta - i\sin\theta)^{10}$

$= 2\cos(10\theta) = 2f_{10}(\cos\theta) = 2f_{10}(x)$

61. & 62.

(1) Put $(2x-3)^{\frac{1}{6}} = t$

(2) Put $\dfrac{x+1}{1-x} = t^3$

63. & 64.

equation of line L_2 is $\dfrac{x-3}{1} = \dfrac{y+4}{-3} = \dfrac{z-1}{-1}$

(1) equation of plane containing L_1 & L_2

$$\begin{vmatrix} x-3 & y+1 & z-2 \\ 0 & 3 & 1 \\ -1 & 6 & 2 \end{vmatrix} = 0 \Rightarrow y + 3z - 5 = 0$$

(2) volume of tetrahedron $= \dfrac{1}{6}\begin{vmatrix} 3 & -4 & 1 \\ 5 & -4 & 1 \\ 7 & -7 & 0 \end{vmatrix} = \dfrac{7}{3}$

SECTION – C

65. equation of chord whose mid – point is $(t, K-t)$

$\dfrac{tx}{8} + \dfrac{(K-t)y}{2} = \dfrac{t^2}{8} + \dfrac{(K-t)^2}{2}$ ......(i)

$(2,-1)$ satisfy (i)

$\Rightarrow 5t^2 - (6+8K)t + 4\left(K^2+K\right) = 0$

For two distinct chords,

$D > 0$

$(6+8K)^2 - 4.4.5(K^2+K) > 0$

$\Rightarrow 4K^2 - 4K - 9 < 0$

$K \in \left[\frac{1-\sqrt{10}}{2}, \frac{1+\sqrt{10}}{2}\right] \Rightarrow a+b=1$

66. Let $f(x) = ax^2 + \frac{b}{x} - c \qquad f'(x) = 2ax - \frac{b}{x^2}$

$f'(x)=0, \quad x = \left(\frac{b}{2a}\right)^{\frac{1}{3}} \Rightarrow a\left(\frac{b}{2a}\right)^{\frac{2}{3}} + \frac{b}{\left(\frac{b}{2a}\right)^{\frac{1}{3}}} \geq c \quad \Rightarrow \frac{27ab^2}{c^3} \geq 4$

67. $x+y+z=1$

$(y+z)+(z+x)+(x+y)=2$

Let $y+z=A,\ z+x=B, \quad x+y=C$

$(1+x)(1+y)(1+z) = (B+C)(C+A)(A+B)$

$\Rightarrow (1+x)(1+y)(1+z) \geq 8(x+y)(y+z)(z+x)$ ......(i)

As, $(x+y)(y+z)(z+x) = (1-x)(1-y)(1-z)$

$= 1-(x+y+z)+(xy+yz+zx)-xyz$

$= xy+yz+2x-xyz$

$(x+y)(y+z)(z+x) = xyz\left[\frac{1}{x}+\frac{1}{y}+\frac{1}{z}-1\right]$

$= xyz\left[x^{-1}+y^{-1}+z^{-1}-1\right]$

Now, $\frac{x^{-1}+y^{-1}+z^{-1}}{3} \geq \left(\frac{x+y+z}{3}\right)^{-1}$

$\Rightarrow (x+y)(y+z)(z+x) \geq 8xyz$ ....(ii)

$\Rightarrow (1+x)(1+y)(1+z) \geq 8.8xyz$

$\left(1+\frac{1}{x}\right)\left(1+\frac{1}{y}\right)\left(1+\frac{1}{z}\right) \geq 64$

68. $\left|adj\left(I-2A^{-1}\right)\right| = \left(\frac{|B|}{|A|}\right)^2 = \left(\frac{10}{8}\right)^2$

69. $\frac{\cos^3\theta}{9a} = \frac{\sin^3\theta}{5b} = \lambda^3$

$\frac{9a}{\cos\theta} + \frac{5b}{\sin\theta} = 56$

$\frac{9a}{\lambda(9a)^{\frac{1}{3}}} + \frac{5b}{\lambda(5b)^{\frac{1}{3}}} = 56$

$\left[(9a)^{\frac{2}{3}} + (5b)^{\frac{2}{3}}\right]^3 = (56)^2$

FIITJEE **JEE (Main), 2018**

ALL INDIA TEST SERIES

FULL TEST – I

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 to 30)** contains 30 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

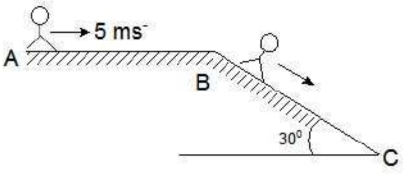
Physics

PART – I

SECTION – A
Straight Objective Type

This section contains **30 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct.

1. A man moving on track ABC, getting rain drops vertical for the path AB, and along same line of its motion for path BC then actual speed of rain drop is

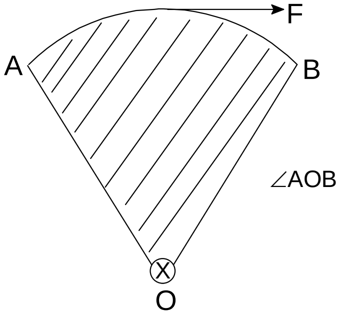


(A) $10\sqrt{3}\text{ms}^{-1}$
(B) $\frac{10}{\sqrt{3}}\text{ms}^{-1}$
(C) $5\sqrt{3}\text{ms}^{-1}$
(D) Can't find

2. Two bodies A and B are at positions (2, 3) m and (5, 7) m respectively. These two are moving with constant velocity 3 ms^{-1} along –ve y axis and 4ms^{-1} along +ve x axis respectively. Minimum separation between them during their motion is

(A) 5 m
(B) 3 m
(C) 4 m
(D) 10 m

3. A force F acts tangentially on a part of a uniform disc of mass 'm' and radius 'R' hinged at point O. The force exerted by hinge on the portion of disc initially.



$\angle AOB = 60^0$ and $OA = OB = R$

(A) $\left(\frac{4-\pi}{\pi}\right)F$
(B) $\frac{4F}{\pi}$
(C) $F\left(\frac{\pi-2}{\pi}\right)$
(D) $\frac{F}{2}$

Space for rough work

4. If acceleration gradient of a moving body along positive x-axis is $-4s^{-2}$ and body starts its motion from rest from x = 5m, having maximum acceleration (magnitude) then velocity of moving body at x = -3m is

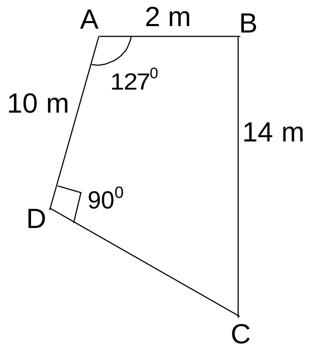
(A) 6 ms^{-1} (B) 4 ms^{-1}

(C) 8 ms^{-1} (D) Cant reach at x = -3m

5. In the figure shown ABCD is a lamina of mass 12 kg. The moment of inertia of the given body about an axis passing through D, and perpendicular to the plane of the body is

(A) 256 kg m^2 (B) 512 kg m^2

(C) 200 kg m^2 (D) 100 kg m^2



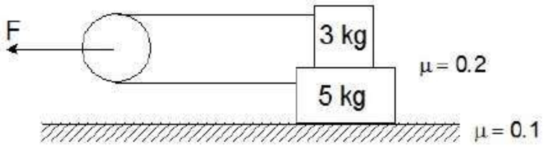
6. For the arrangement as shown in the figure, the maximum force F, for no relative motion between blocks is

(A) 12 N

(B) 8 N

(C) 20 N

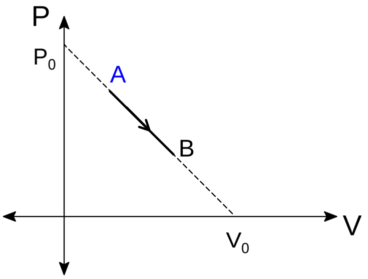
(D) 24 N



7. One mole of a monoatomic gas undergoes a linear process $A \to B$ in P – v diagram. The volume of the gas when the process turns from an endothermic to an exothermic one is

(A) $\frac{5}{8}v_0$ (B) $\frac{v_0}{2}$

(C) $\frac{8v_0}{15}$ (D) $\frac{3v_0}{5}$



Space for rough work

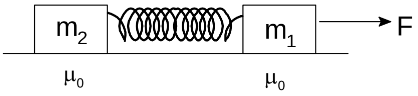
8. Two coaxial solenoids having same number of turns per unit length n, and radius R and 2R respectively have no current initially. Current in both grows uniformly such that current in the inner one is twice that of the outer one, at any instant of time in the same direction. Current in outer one at time t is Kt then induced electric field at a distance r from axis is (R < r < 2R).

(A) Not possible
(B) $\frac{\mu_0 nK}{2r}\left(2R^2 + r^2\right)$
(C) $\frac{2\mu_0 nK.R^2}{r}$
(D) $\frac{2\mu_0 nK}{r}\left(2R^2 - r^2\right)$

9. A particle of mass m moves in a force field such that its potential energy in force field is defined by the equation $U = +A\left(x-a\right)^2\left(x-b\right)^2$. Where A, a and b are +ve constants then body may oscillate simple harmonically about point.

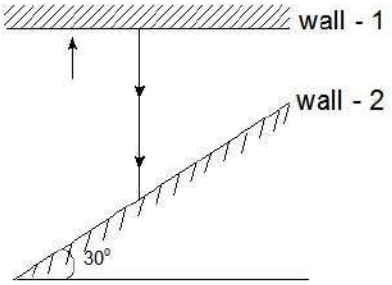
(A) a only
(B) a and b both
(C) only $\frac{a+b}{2}$
(D) b only

10. Find minimum value of F such that m₂ starts its motion on the ground



(A) $\frac{\mu_0\left(2m_1 + m_2\right)g}{2}$
(B) $\mu_0\left(2m_1 + m_2\right)g$
(C) $\mu_0\left(m_1 + m_2\right)g$
(D) $\frac{\mu_0\left(m_1 + m_2\right)g}{2}$

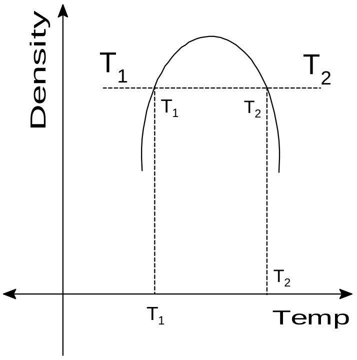
11. Molecule of a gas in a container hits one wall (1) normally and rebounds back. It suffers number of collision and hits the opposite wall (2) which is at angle of 30^0 with wall 1. Assuming the collision to be elastic and the small collision time to be the same for both the walls. The magnitude of average force by walls and 2 are F_1 and F_2 provide to molecule during collision satisfy



(A) $F_1 > F_2$
(B) $F_1 < F_2$
(C) $F_1 = F_2$ both non zero
(D) $F_{12}F_{220}$

Space for rough work

12. A thermometer uses density of water as thermometric property. Actual reading in thermometer is height of water (h) which inversely proportional to the density of water (d). In certain temp range density of water varies with temp as shown in the graph is symmetrical about maximum.
Two identical bodies (of same mass and specific heat) at different temp T_1 and T_2 show the same reading of height $h_1 = h_2$ in the thermometer. The bodies are brought in contact and allowed to reach the equilibrium. The thermometric reading height of water for final equilibrium state h_f satisfies



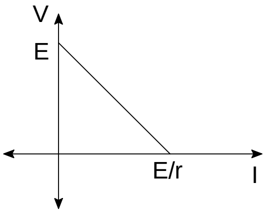
(A) $h_f = \frac{h_1 + h_2}{2} = h_1 = h_2$

(B) $h_f > h_1 = h_2$

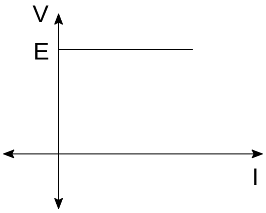
(C) $h_f, h_1 = h_2$

(D) h_f may be greater or less than $h_1 - h_2$

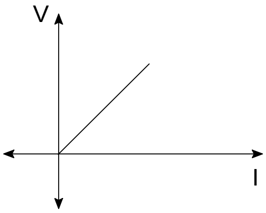
13. A power supply of fixed emf E is connected to a variable resistor (resistance = R) and an ammeter of resistance R_A. The internal resistance of supply is r. The potential difference between the terminals of the power supply in closed circuit is denoted by V and current in circuit denoted by I. A graph is obtained between V and I by drawing varying amount of current from the supply. The correct V – I graph for the given situation is



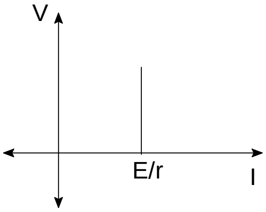
I



II



III

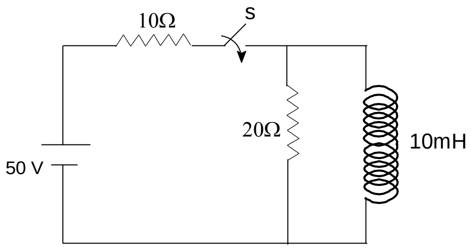


IV

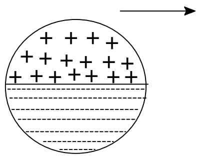
(A) Graph I
(B) Graph II
(C) Graph III
(D) Graph IV

Space for rough work

14. If the switch is closed for long time and then open at t = 0, the P.D across indicator at t = 0 is
(A) OV
(B) 50 V
(C) 20 V
(D) 100 V

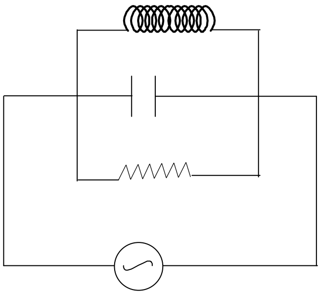


15. A disc having uniform surface charge density in upper part $+\rho$ and $-\rho$ in lower half placed on rough horizontal surface as shown in figure. A uniform electric field is set up as shown if mass of disc is M and its radius is R as well sufficient friction is present to prevent slipping. The acceleration of disc is



(A) $\frac{8}{9}\frac{\rho R^2 E_0}{M}$
(B) $\frac{9}{8}\frac{\rho R^2 E_0}{M}$
(C) $\frac{4}{3}\frac{\rho R^2 E_0}{M}$
(D) $\frac{3}{4}\frac{\rho R^2 E_0}{M}$

16. If L = 25 mH, C = 1 mF and R = 10Ω then R.M.S current across source is
(A) $5\sqrt{2}$ A
(B) $2.5\sqrt{2}$A
(C) $12.5\sqrt{2}$A
(D) $25\sqrt{2}$ A

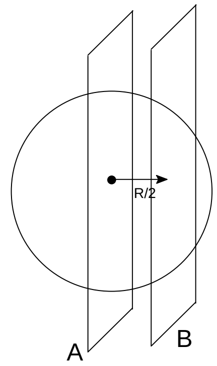

50 sin(200t)V

Space for rough work

17. From a sphere of electrical conductivity K two planes cut a piece such that first plane passes through the centre of sphere and second parallel to first one at distance R/2 from centre then resistance between A and B

(A) $\frac{1}{\pi KR}$ (B) $\frac{\sqrt{3}}{\pi KR}$

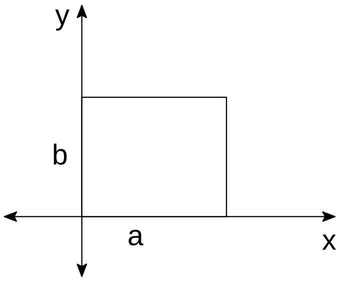
(C) $\frac{\ell n3}{2\pi KR}$ (D) None



18. A thin rectangular plate with sides of length 'a' and 'b' has mass per unit area varying as $\alpha = \alpha_0\left(\frac{xy}{ab}\right)$ where α_0 is a constant. The co-ordinate of centre of mass of the plate is

(A) $\left(\frac{a}{3},\frac{b}{3}\right)$ (B) $\left(\frac{a}{2}.\frac{b}{2}\right)$

(C) $\left(\frac{4a}{3},\frac{4b}{3}\right)$ (D) $\left(\frac{2a}{3},\frac{2b}{3}\right)$



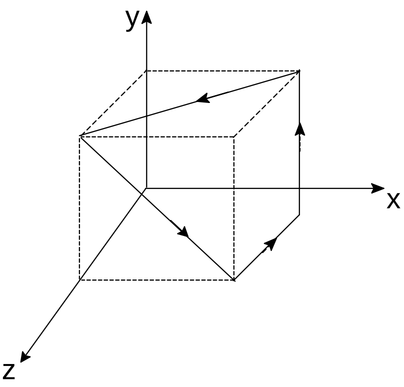
19. A wire carrying 10 A current is bent to pass through various side of a cube of side 10 cm as shown in figure. A magnetic field $\vec{B} = 2\hat{i} - 3\hat{j} + \hat{k}$ is present in region then torque on the loop.

(A) $\sqrt{20} \times 10^{-1}$Nm

(B) $\sqrt{20} \times 10^{-2}$Nm

(C) $\sqrt{150} \times 10^{-2}$Nm

(D) $\sqrt{150} \times 10^{-2}$Nm

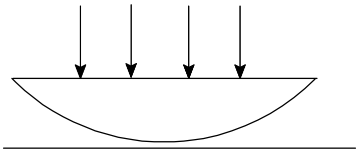


Space for rough work

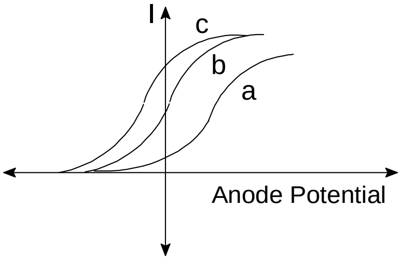
20. Above Curie temp
(A) Paramagnetic materials become ferromagnetic
(B) Ferromagnetic materials becomes diamagnetic
(C) Ferromagnetic materials becomes paramagnetic
(D) Paramagnetic materials becomes diamagnetic

21. If a single slit fraunhoffer diffraction set up is used with light of wavelength 4000 $\overset{0}{A}$. Distance D between central maximum and first minimum found to be 0.3 cm in set up if the wavelength changed to 6000 $\overset{0}{A}$ the corresponding value of D will be
(A) 0.20 cm
(B) 0.24 cm
(C) 0.30 cm
(D) 0.45 cm

22. A thin slice is cut – out of a cylindrical glass along the plane parallel to its axis. The slice is placed on a flat glass plate as shown. The observed interference fringes from this combination shall be
(A) Straight
(B) Circular
(C) equally spaced
(D) having fringe spacing which increases as go out ward



23. Above figure shows variation of current with anode potential for a photo sensitive surface for there different radiation. Let I_a , I_b and I_C be intensities and f_a f_b and f_c the frequencies for curve a, b and c respectively
(A) $f_a = f_b, I_a \neq I_b$
(B) $f_a = f_c, I_a = I_c$
(C) $f_a = f_b, I_a = I_b$
(D) $f_b = f_c, I_b = I_c$



24. Lead is a good absorber of x rays. Specific gravity of Pb = 11.5. To cut down the initial radiation I_0 to $\frac{I_0}{2}$ a shield of 1.5 cm was used. The mass absorption co-efficient is
(A) $0.06\ cm^2 / g$
(B) $0.462\ cm^{-1}$
(C) $0.21\,cm^{-1}$
(D) $0.040\ cm^2 / g$

Space for rough work

25. M_x and M_y denote the atomic masses of the parent and daughter nuclei respectively in a radio active decay. The Q value of a β^- decay is Q_1 and for β^+ decay is Q_2. If m_e denote the masses of electron then which of following statement is correct.

(A) $Q_1 = \left(M_x - M_y\right)C^2 \qquad Q_2 = \left(M_x - M_y - 2m_e\right)C^2$

(B) $Q_1 = \left(M_x - M_y\right)C^2 \qquad Q_2 = \left(M_n - M_y\right)C^2$

(C) $Q_1 = \left(M_x - M_y - 2m_c\right)C^2 \qquad Q_2 = \left(M_x - M_y + 2m_c\right)C^2$

(D) $Q_1 = \left(M_x - M_y + 2m_c\right)C^2 \qquad Q_2 = \left(M_x - M_y - 2m_c\right)C^2$

26. Power emitted per unit area of a black body is R watt/m^2. At what wavelength will the power radiated by black body be maximum if stefan's constant is σ and Wien's constant is b then.

(A) $\lambda = \left(\frac{b\sigma}{R}\right)^{\frac{1}{4}}$

(B) $\lambda = \left(\frac{b}{R}\right)^{\frac{1}{4}}$

(C) $\left(\frac{bR}{\sigma}\right)^{\frac{1}{4}} = \lambda$

(D) $\lambda = b\left(\frac{\sigma}{R}\right)^{\frac{1}{4}}$

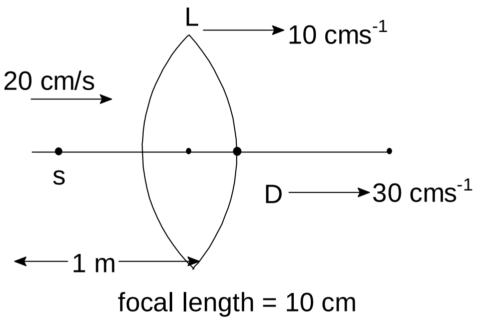
27. The figure shows the initial position of a point source of light s, a detector D and Lens L. Now at t = 0 all three starts moving toward right with different velocity as shown in figure. The times at which detector receives the maximum light.

(A) 0.56 s and 4.45 s

(B) 3.8 s

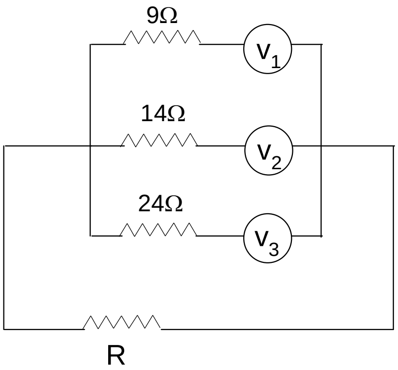
(C) 8.94 s and 19.62 s

(D) 0.56 s



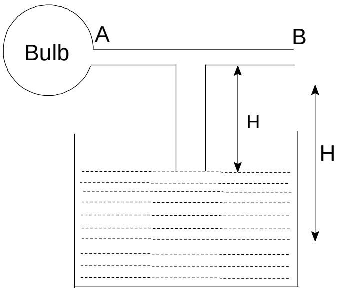
Space for rough work

28. The figure shows a portion of a circuit. Resistor are known and indicated on diagram and voltmeter are identical. If voltmeters v_1 and v_2 reads 7.5v and 5v respectively then reading of v_3.



(A) 0v
(B) 10v
(C) 2.5v
(D) 3.0v

29. A liquid of density ρ has to spray with help of aspirator pump at height H from liquid level as shown in figure. If gauge pressure inside bulb is P and density of air is σ then velocity of air in tube AB is



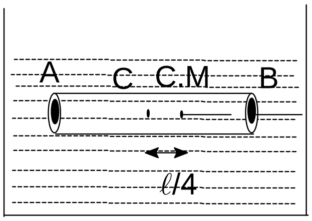
(A) $\left\{\frac{P+\rho gH}{\frac{\sigma}{2}}\right\}^{\frac{1}{2}}$

(B) $\left\{\frac{P-\rho gH}{\frac{\sigma}{2}}\right\}^{\frac{1}{2}}$

(C) $\left\{\frac{P+\alpha gH}{\frac{\sigma}{2}}\right\}^{\frac{1}{2}}$

(D) $\left\{\frac{P+\rho gH}{\sigma}\right\}^{\frac{1}{2}}$

30. A non uniform cylinder of mass m, length ℓ and radius r having its C.O.M at a distance $\frac{\ell}{4}$ from centre and lying on axis of cylinder. The cylinder is kept in a liquid of uniform density ρ. The moment of inertia of the rod about C.O.M is I. The angular acceleration of point A relative to point B just after the rod is released from position shown in figure is.



(A) $\frac{\pi\rho g\ell^2 r^2}{2I}$

(B) $\frac{3\pi\rho g\ell^2 r^2}{4I}$

(C) $\frac{\pi\rho g\ell^2 r^2}{I}$

(D) $\frac{\pi\rho g\ell^2 r^2}{4I}$

Space for rough work

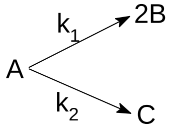
Chemistry

PART – II

SECTION – A
Straight Objective Type

This section contains **30 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct.

31. For the following elementary first order reaction:



If $k_2 = 2k_1$, then % of B in overall product is:

(A) 25%	(B) 50%
(C) 75%	(D) 100%

32. One of the allotropic form of boron is $\alpha -$ rhombohedral boron. Number of faces and corners in its basic building B_{12} icosahedral unit are:

(A) 20 and 12 respectively	(B) 12 and 20 respectively
(C) 12 and 12 respectively	(D) 20 and 20 respectively

33. Which of the following is bio-degradable polymer?

(A) Nylon – 6, 6	(B) Nylon – 6, 10
(C) Nylon - 6	(D) Nylon – 2-Nylon -6

34. White phosphorus is a tetra atomic solid P_4 (s) at room temperature. Find average (P – P) bond enthalpy (in kJ/mol).

Given : $\Delta H_{\text{sublimation}}$ of $P_4(s) = 59\ \text{kJ/mol}$

$\Delta H_{\text{atomization}}$ of $P_4(s) = 1265\ \text{kJ/mol}$

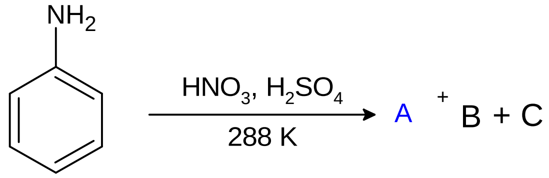
(A) 201	(B) 1206
(C) 301.5	(D) 210.83

Space for rough work

35. In extraction of copper from its sulphide ore, the metal is obtained by reduction of Cu_2O with:

(A) CO	(B) FeS
(C) SO_2	(D) Cu_2S

36.



Order of basic nature is A > B > C.
Order of % of A, B and C in overall product is:

(A) A > B > C	(B) C > A > B
(C) B > A > C	(D) A > C > B

37. A cell contains two hydrogen electrodes. The negative electrode is in contact with a solution of pH = 5.5. The emf of the cell is 0.118 V at 25^0 C. Calculate the pH of solution at positive electrode. (assume pressure of H_2 in both electrodes = 1 bar)

(A) 3.5	(B) 7.5
(C) 4.5	(D) 6.5

38. The image formed, when a photographic film is exposed and developed, is due to formation of

(A) $\left[Ag\left(S_2O_3\right)_2\right]^{-3}$	(B) AgBr
(C) Ag	(D) Ag_2O

39. Wood spirit is obtained by catalytic reaction of water gas with hydrogen at 200 – 300^0C. The catalyst used is:

(A) Ni	(B) $ZnO – Cr_2O_3$
(C) Cu	(D) $Pd – BaSO_4$

40. The compressibility factor (Z) of real gas is usually less than 1 at low temperature and low pressure because

(A) a is negligible while b is not	(B) b is negligible while a is not
(C) both a and b are negligible	(D) neither a nor b are negligible

Space for rough work

41. $Zn + \text{conc. } HNO_3 \rightarrow Zn(NO_3)_2 + X + H_2O$

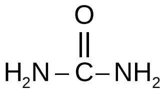
$Zn + \text{dil. } HNO_3 \longrightarrow Zn(NO_3)_2 + Y + H_2O$

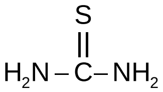
Compounds X and Y are respectively:

(A) N_2O, NO (B) NO_2, N_2O

(C) N_2O, NO_2 (D) NO_2, NO

42. Which of the following compound will give blood red colour while doing the Lassaigne's test:

(A) 
$H_2N-\overset{\overset{\displaystyle O}{\|}}{C}-NH_2$

(B) 
$H_2N-\overset{\overset{\displaystyle S}{\|}}{C}-NH_2$

(C) $C_6H_5-SO_3H$ (D) $CHCl_3$

43. On mixing which of the following solutions, observed boiling point of mixture is higher than theoretical boiling point?

(A) n – butylchloride + n - butylbromide (B) water + ethanol

(C) chloroform + diethyl ether (D) acetone + benzene

44. The electro negativity of H, X and O are 2.1, 0.8 and 3.5 respectively on Pauling scale. The nature of compound HOX is:

(A) acidic (B) basic

(C) neutral (D) amphoteric

45. Acetylene on passing through excess of HOCl solution forms

(A) ethylene chlorohydrin (B) glyoxal

(C) ethylene glycol (D) dichloroacetaldehyde

46. 50 ml, 0.1 M $NaHCO_3$ aqueous solution is mixed with 50 ml, 0.8 M Na_2CO_3 aqueous solution at 25^0C. The pH of resulting solution exists between colour transition range of an indicator which is:

$\left(K_{a_1} = 4\times10^{-7}, K_{a_2} = 2\times10^{-11} \text{ for } H_2CO_3\right)$

(A) Phenol red (6.8 to 8.4) (B) Propyl red (4.6 to 6.4)

(C) Phenolphthalein (8.3 to 10.1) (D) Malachite green (11.4 to 13)

Space for rough work

47. In which of the following complexes of Co, the magnitude of CFSE $\left(\Delta_0\right)$ is maximum?

(A) $\left[Co\left(NH_3\right)_6\right]^{+2}$ (B) $\left[CoCl_6\right]^{-3}$

(C) $\left[Co\left(C_2O_4\right)_3\right]^{-3}$ (D) $\left[Co\left(CN\right)_6\right]^{-3}$

48. In simplified version of nucleic acid chain, nucleotides are joined together by

(A) $\beta-$ glycosidic linkage (B) phosphodiester linkage

(C) $\alpha-$ glycosidic linkage (D) peptide linkage

49. The tetrahedral voids formed by ccp arrangement of Cl^- ions in rock salt structure are:

(A) occupied by Na^+ only (B) occupied by Cl^- only

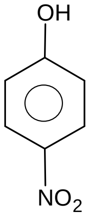
(C) occupied by either Na^+ or Cl^- (D) neither occupied by Na^+ nor Cl^-

50. Which of the following species are incorrectly matched with their shape?

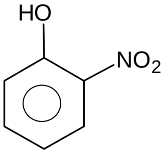
(A) ClF_3 = trigonal planar (B) SF_4 = folded square

(C) $[XeF_5]^-$ = pentagonal planar (D) I_2Cl_6 = rectangular planar

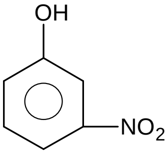
51. Correct order of pK_a values of



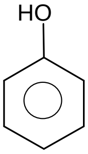
I,



II,



III,



IV is:

(A) I < II < III < IV (B) I > II > III > IV

(C) II < I < III < IV (D) II > I > III > IV

52. Isoelectric point of gelatin solution is 4.7. Then correct option is:

(A) If pH < 4.7, it is (-)vely charged, move towards cathode

(B) If pH < 4.7, it is (+)vely charged, move towards anode

(C) If pH > 4.7, it is (+)vely charged, move towards cathode

(D) If pH > 4.7, it is (-)vely charged, move towards anode

Space for rough work

53. $Mg(s)+C(s)\xrightarrow[\text{high T}]{\Delta}X\xrightarrow{H_2O}Mg(OH)_2+Y$

X and Y are respectively:

(A) Mg_2C and CH_4 (B) Mg_4C_3 and CH_4

(C) Mg_2C_3 and C_3H_4 (D) MgC_2 and C_2H_2

54. In the reaction

$CF_3-CHCl_2\xrightarrow[\Delta]{LDA}CF_2=CCl_2$

Intermediate formed is:

(A) carbocation (B) carbanion

(C) free radical (D) No intermediate formed

55. For an ideal diatomic gas, during any process T = KV, find out the molar heat capacity of the gas during process (neglecting vibrational degree of freedom)

(A) $\frac{3R}{2}$ (B) $\frac{5R}{2}$

(C) $\frac{7R}{2}$ (D) 2R

56. $Cu^{+2}(aq)+K_4[Fe(CN)_6](aq)\longrightarrow \underset{(ppt.)}{X}$

Colour of precipitate (X) is:

(A) green (B) blue

(C) white (D) reddish - brown

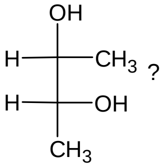
57. In which of the following set of orbitals, nodal plane is absent?

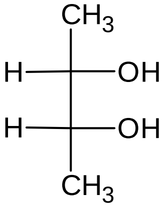
(A) $4s, 4d_{z^2}$ (B) $4s, 4d_{x^2-y^2}$

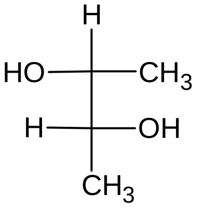
(C) $4p_z, 4s$ (D) $4d_{yz}, 4d_{zx}$

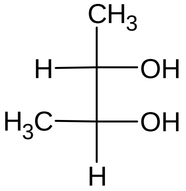
Space for rough work

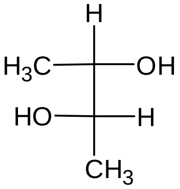
58. Which of the following is enantiomer of


OH
H
CH3
?
H
OH
CH3

(A)

CH3
H
OH
H
OH
CH3

(B)

H
HO
CH3
H
OH
CH3

(C)

CH3
H
OH
H3C
OH
H

(D)

H
H3C
OH
HO
H
CH3

59. Correct statement about classical smog (I) and photochemical smog (II) is:
(A) I = reducing smog, II = oxidizing smog
(B) I = oxidizing smog, II = reducing smog

(C) Both I and II are oxidizing smog
(D) Both I and II are reducing smog

60. Which of the following reaction will not proceed via carbanion intermediate?
(A) Perkin reaction
(B) Cannizaro reaction
(C) Claisen condensation
(D) Aldol condensation

Space for rough work

Mathematics

PART – III

SECTION – A
Straight Objective Type

This section contains **30 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct.

61. The maximum value of K for which $\sin x + 2x \geq kx\left(x+1\right) \ \forall \ x \in \left[0, \frac{\pi}{2}\right]$ equals

(A) $\frac{4\left(\pi+2\right)}{\pi\left(\pi+1\right)}$
(B) $\frac{4\left(\pi+1\right)}{\pi\left(\pi+2\right)}$
(C) $\frac{4\pi\left(\pi+1\right)}{\pi+2}$
(D) $\frac{4\pi\left(\pi+2\right)}{\pi+1}$

62. Differential co-efficient of $\log_{10} x$ w.r.t $\log_x 10$ is

(A) $\frac{-\left(\log x\right)^2}{\left(\log 10\right)^2}$
(B) $\frac{\left(\log_{10} x\right)^2}{\left(\log 10\right)^2}$
(C) $\frac{\left(\log_x 10\right)^2}{\left(\log 10\right)^2}$
(D) $\frac{-\left(\log 10\right)^2}{\left(\log x\right)^2}$

63. The value of $\lim\limits_{x \to \frac{\pi}{4}} \frac{\int_{2}^{\sec^2 x} f\left(t\right)dt}{x^2 - \frac{\pi^2}{16}}$ is equal to

(A) $\frac{8}{\pi}f\left(2\right)$
(B) $\frac{2}{\pi}f\left(2\right)$
(C) $\frac{8}{\pi}f\left(\frac{1}{2}\right)$
(D) $4f\left(2\right)$

Space for rough work

64. Let $a_{n+1} = \sqrt{2 + a_n}$, n = 1, 2, 3 …. & a_1 = 3 then $\lim\limits_{n\to\infty} a_n$ is

(A) π (B) 2

(C) $\sqrt{5}$ (D) 3

65. The maximum value of area of rectangle OABC, where O is origin, A lies on positive y-axis & B lies on the curve $y = \frac{\ln x}{x^2}$ is

(A) e^{-1} (B) $e^{\frac{-1}{2}}$

(C) 1 (D) $e^{\frac{1}{2}}$

66. x > –1, let $f(x) = \int_0^{\frac{\pi}{4}} \log_e(1 + x\tan z)dz$, then value of $f\left(\frac{1}{2}\right) - f\left(\frac{1}{3}\right)$ equals

(A) $\frac{\pi}{4}\log_e\left(\frac{9}{8}\right)$ (B) $\frac{\pi}{8}\log_e\left(\frac{9}{8}\right)$

(C) $\frac{\pi}{9}\log_e\left(\frac{9}{8}\right)$ (D) $\frac{\pi}{8}\log_e\left(\frac{3}{2}\right)$

67. For t $\in$ R & f be a continuous function. Let $I_1 = \int_{\sin^2 t}^{1+\cos^2 t} x.f\left(x(2-x)\right)dx$ & $I_2 = \int_{\sin^2 t}^{1+\cos^2 t} f\left(x(2-x)\right)dx$, then $\frac{I_1}{I_2}$

(A) 1 (B) 3

(C) $\frac{1}{3}$ (D) $\frac{2}{5}$

Space for rough work

68. The general solution of the differential equation $x\left(y^2.e^{xy}+e^{\frac{x}{y}}\right)dy=y\left(e^{\frac{x}{y}}-y^2e^{xy}\right)dx$ is

(A) $e^{xy}=e^{\frac{x}{y}}+c$ (B) $e^{xy}=e^{\frac{y}{x}}+c$

(C) $e^{xy}+e^{\frac{x}{y}}=c$ (D) $e^{xy}+e^{\frac{y}{x}}=c$

69. Let z_1, z_2 & z_3 are vertices of acute angled ΔABC in anticlockwise order and origin be the circumcenter of the triangle. If bisector of ∠A meets the circumcircle at point P(z), then $\arg\left(\frac{z}{z_3-z_2}\right)$ is

(A) $\frac{\pi}{2}$ (B) $\frac{-\pi}{2}$

(C) $\frac{\pi}{6}$ (D) none of these

70. If from each of the three boxes containing 3 white & 1 black, 2 white & 2 black, 1 white & 3 black balls, one ball is drawn at random, then the probability that 2 white & 1 black ball will be drawn is

(A) $\frac{13}{32}$ (B) $\frac{1}{4}$

(C) $\frac{1}{32}$ (D) $\frac{3}{16}$

71. The set of exhaustive values of 'α' for which the equation $|\alpha x-1|=x^2+\alpha x+2$ has at least one positive root, is

(A) $(-\infty,-1]\cup[1,\infty)$ (B) R

(C) $(-\infty,-1]$ (D) $[1,\infty)$

Space for rough work

72. Consider the points $A \equiv (0,1)$ & $B \equiv (2,0)$, P be a point on the line 4x + 3y + 9 = 0. Co-ordinates of the point 'P' such that |PA – PB| is maximum is

(A) $\left(\frac{-12}{5}, \frac{17}{5}\right)$ (B) $\left(\frac{-84}{5}, \frac{13}{5}\right)$

(C) $\left(\frac{-6}{5}, \frac{17}{5}\right)$ (D) $\left(\frac{-24}{5}, \frac{17}{5}\right)$

73. If the tangent at the point P(2, 4) to the parabola $y^2 = 8x$ meets the parabola $y^2 = 8x + 5$ at Q & R, then the mid point of QR is

(A) (2, 4) (B) (4, 2)

(C) (7, 9) (D) none of these

74. For an ellipse $\frac{x^2}{25} + \frac{y^2}{16} = 1$, θ_1 & θ_2 are the eccentric angle of points P & Q respectively, if $|\theta_1| + |\theta_2| = \pi$ then

(A) point P & Q are in opposite quadrant

(B) line PQ is parallel to major axis

(C) line PQ always passes through centre of ellipse

(D) none of these

75. The locus of point of intersection of perpendicular tangents of the hyperbola $4y^2 = x^2 - 1$ is

(A) $4x^2 + 4y^2 - 3 = 0$ (B) $2x^2 + 2y^2 - 5 = 0$

(C) $3x^2 + 3y^2 - 4 = 0$ (D) none of these

76. If $\left(1 - \frac{r_1}{r_2}\right)\left(1 - \frac{r_1}{r_3}\right) = 2$, where r_1, r_2, r_3 are the ex radii, then the triangle is

(A) equilateral (B) isosceles

(C) right-angled (D) none of these

77. Volume of tetrahedron formed by the planes x + y = 0, y + z = 0, z + x = 0, x + y + z = 1 is

(A) $\frac{1}{6}$ (B) $\frac{1}{3}$

(C) $\frac{2}{3}$ (D) none of these

Space for rough work

78. The position vectors of three points are $2\vec{a}-\vec{b}+3\vec{c}$, $\vec{a}-2\vec{b}+\lambda\vec{c}$ & $\mu\vec{a}-5\vec{b}$ where $\vec{a}, \vec{b}$ & $\vec{c}$ are non-coplanar vectors. The points are collinear when

(A) $\lambda = -2, \mu = \frac{9}{4}$
(B) $\lambda = \frac{9}{4}, \mu = 2$
(C) $\lambda = \frac{9}{4}, \mu = -2$
(D) none of these

79. The value of the definite integral $\int_{e}^{e^{2010}} \frac{1}{x}\left(1+\frac{1-\ln x}{\ln x.\ln\left(\frac{x}{\ln x}\right)}\right)dx$, equals

(A) $2009-\ln\left(\left(2010\right)-\ln 2010\right)$
(B) $2010-\ln\left(\left(2009\right)-\ln 2009\right)$
(C) $2009-\ln\left(\left(2010\right)-\ln 2009\right)$
(D) $2010-\ln\left(\left(2010\right)-\ln 2010\right)$

80. Let the equation of the plane containing the line x – y – z – 4 = 0, x + y + 2z – 4 = 0 & is parallel to the line of intersection of the planes 2x + 3y + z = 1 & x + 3y + 2z = 2 be x + Ay + Bz + C = 0 then value of |A + B + C| is

(A) 9
(B) 10
(C) 4
(D) 11

81. Equation of the image of the line $x+y=\sin^{-1}\left(a^6+1\right)+\cos^{-1}\left(a^4+1\right)-\tan^{-1}\left(a^2+1\right), a \in R$ about x-axis is given by

(A) x – y = 0
(B) $x-y=\frac{\pi}{2}$
(C) x – y = π
(D) $x-y=\frac{\pi}{4}$

82. If the sum of roots of the equation $\cos 4x - 6 = 7\cos 2x$ in the interval [0, 314] is kπ, k ∈ R, then k =

(A) 4930
(B) 4940
(C) 4950
(D) None of these

Space for rough work

83. Let $g(x) = f(x)\sin x$, where f(x) is a twice differentiable function on (–∞, ∞), such that $f'(-\pi) = 1$. The value of $g''(-\pi)$ equals

(A) 1
(B) 2
(C) –2
(D) 0

84. The line 3x + 6y = k intersect the curve $2x^2 + 3y^2 + 2xy = 1$ at points A & B. The circle on AB as diameter passes through the origin. The possible value of k is

(A) 3
(B) 4
(C) – 4
(D) 5

85. Let a function f defined from R → R as $f(x) = \begin{cases} x + m, & x < 1 \\ 2mx - 1, & x \geq 1 \end{cases}$. If the function is surjective on R then m must lie in

(A) $[-1, 0)$
(B) [–2, –1]
(C) {2}
(D) (0, 2]

86. A man wants to divide 101 coins, a rupee each, among his 3 sons with the condition that no one receives more money than the combined total of other two. The number of ways of doing this is:

(A) ${}^{100}C_2 - 2.{}^{52}C_2$
(B) $\frac{100_{C_2}}{3}$
(C) 1275
(D) $\frac{103_{C_2}}{6}$

87. If $Z_n = \cos\frac{\pi}{n(n+1)(n+2)} + i\sin\frac{\pi}{n(n+1)(n+2)}, n \in N.$ then the value of $\lim_{k\to\infty}(z_1.z_2.z_3......z_k)$is.

(A) $\frac{1}{\sqrt{2}} - \frac{i}{\sqrt{2}}$
(B) $\frac{-1}{2} + i\frac{\sqrt{3}}{2}$
(C) $\frac{-1}{2} - i\frac{\sqrt{3}}{2}$
(D) $\frac{1}{\sqrt{2}} + \frac{i}{\sqrt{2}}$

Space for rough work

88. F: R →R be a differentiable function V x∈R. if tangent drawn to the curve at any point ∀ x ∈ (a, b) always lie below the curve then

(A) $f'(x) > 0, f''(x) < 0 \forall x \in (a,b)$ (B) $f'(x) < 0, f''(x) < 0 \forall x \in (a,b)$

(C) $f'(x) > 0, f''(x) > 0 \forall x \in (a,b)$ (D) None of these

89. If $x^2 y^3 = (x+y)^n, \frac{dy}{dx} = \frac{y}{x}$ then n =

(A) 2 (B) 3

(C) 5 (D) 6

90. Number of integral value of a such that $x^2 + ax + a + 1 = 0$ has integral root is

(A) 1 (B) 2

(C) 3 (D) more than 3

Space for rough work

FIITJEE

JEE(Main), 2018

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – I
(Main)

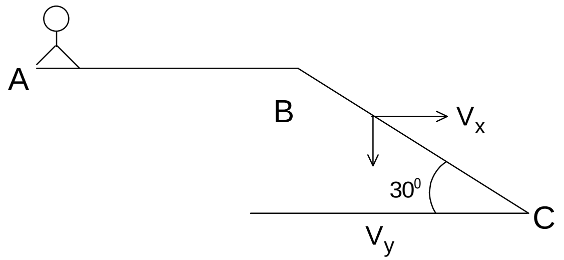
Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	B	31.	B	61.	B
2.	A	32.	A	62.	A
3.	A	33.	D	63.	A
4.	C	34.	A	64.	B
5.	B	35.	D	65.	A
6.	D	36.	C	66.	B
7.	A	37.	A	67.	A
8.	B	38.	C	68.	A
9.	B	39.	B	69.	B
10.	A	40.	B	70.	A
11.	A	41.	B	71.	C
12.	A	42.	B	72.	D
13.	A	43.	C	73.	A
14.	D	44.	B	74.	B
15.	A	45.	D	75.	A
16.	B	46.	D	76.	C
17.	C	47.	D	77.	C
18.	D	48.	B	78.	C
19.	A	49.	D	79.	A
20.	C	50.	A	80.	D
21.	D	51.	A	81.	D
22.	A	52.	D	82.	C
23.	A	53.	C	83.	C
24.	B	54.	B	84.	A
25.	A	55.	C	85.	D
26.	D	56.	D	86.	C
27.	A	57.	A	87.	D
28.	D	58.	C	88.	D
29.	A	59.	A	89.	C
30.	D	60.	B	90.	B

Physics

PART – I

SECTION – A

1. $\overrightarrow{V_R} = V_x i + V_y i$



For path AB $V_x = 5\ ms^{-1}$

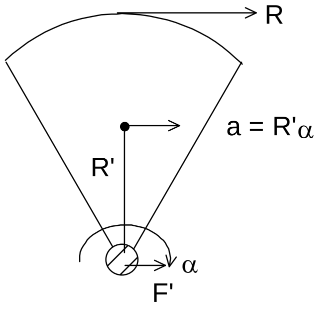
For path BC velocity of rain ⊥r to BC should be zero hence

$V_x \sin 30^o = V_y \cos 30^o \quad V_y = \frac{5}{\sqrt{3}} ms^{-1}$

$V_R = \sqrt{V_x^2 + V_y^2} = \frac{10}{\sqrt{3}} ms^{-1}$

2. since $\overrightarrow{V_{AB}}$ and $\overrightarrow{R_{BA}}$ are antiparallel to each other initial separation is minimum at initial state

3. $\tau = I\alpha \Rightarrow \alpha = \frac{FR}{mR^2}.2 = \frac{2F}{mR}$



Position of C.O.M = $\frac{2R}{3}.\frac{\sin\left(\frac{\pi}{6}\right)}{\left(\frac{\pi}{6}\right)} = \frac{2R}{\pi} = R'$

Acceleration of C.O.M = $\frac{4F}{m\pi}$

Hence $F + F' = \frac{4R}{m\pi}.m$

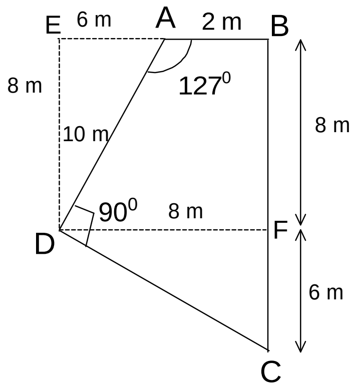
$F' = \left(\frac{4-\pi}{\pi}\right)F$

4. a = –Kx ⇒ K = 4 s^{-2}

Then $\int vdv = K\int xdx$

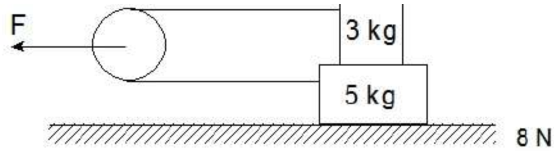
$v = 8ms^{-1}$

5. portion DEA and DFC are identical hence moment of inertia of ABCD is same as ABFDEA

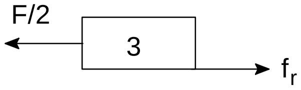


$$I = 2.\frac{M \times (BE)^2}{3}$$
$$= 512\ kgm^2$$

6. To start motion F > 8 M

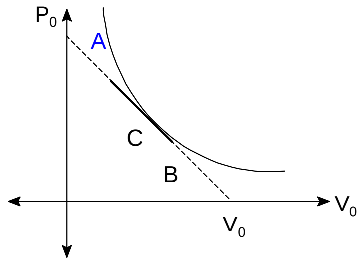


Acceleration = $\frac{F-8}{8}$



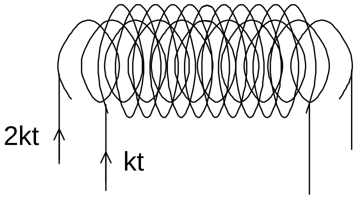
$$\frac{F}{2} - f_r = 3\left(\frac{F-8}{8}\right) \Rightarrow \frac{F}{8} + 3 = f_r$$
$$\frac{F_{\max}}{8} + 3 = f_{Lm} = 6N \Rightarrow F_{\max} = 24Nx$$

7. the point where adiabatic curve touch the line AB the nature of process will change from endo thermic to exothermic.



$$-\frac{P_0}{V_0} = -\gamma\frac{P}{V}$$
$$-m = -\frac{\gamma(-mv + P_0)}{V} \qquad m = +\frac{P_0}{V_0}$$
$$mv(1+\gamma) = \gamma P_0 \qquad V = \frac{\gamma P_0}{m(1+\gamma)} = \frac{5}{8}V_0$$

8. $\phi = \mu_0 nkt\pi r^2 + \mu_0 n2kt.\pi R^2$



$$E.2\pi r = \frac{d\phi}{dt} = \mu_0 nk\pi\left(2R^2 + r^2\right)$$

9. the point x = a and b are stable equilibrium point.

10. $Fx - \mu_0 m_1 gx - \frac{1}{2}kx^2 = 0$

$$x = \frac{\mu_0 m_2 g}{k}$$

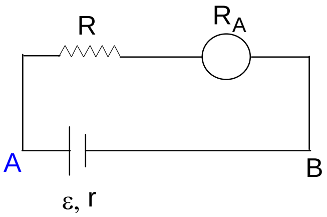
11. $F_1 = \frac{2mv}{\Delta t}$ $\quad F_2 = \frac{2mv\cos 30^o}{\Delta t}$

Hence F1 > F2

12. since mass and specific heat of two different bodies are same

$$h_f = \frac{h_1 + h_2}{2} = h_1 = h_2$$

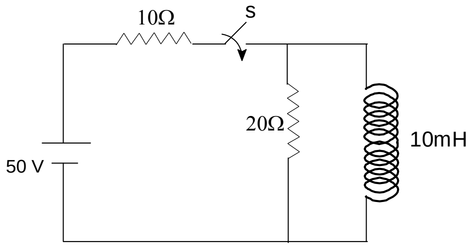
13. $\mathrm{I} = \frac{\varepsilon}{R + R_A + r}$



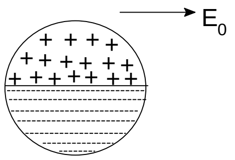
$$V = \varepsilon - \frac{\varepsilon_r}{\left(R + R_A + r\right)} = \varepsilon - \mathrm{I}r = \frac{\varepsilon\left(R + R_A\right)}{\left(R + R_A + v\right)}$$

14. at steady state 5A current through inductor hence P.D across indicator at t = 0

20 × 5 = 100 V



15. Dipole moment $\left(\frac{\sigma\pi R^2}{2}\right)\left(2.\frac{4R}{3\pi}\right)$



$$\frac{4R^3\sigma}{3}$$

$f_r = Ma$

$$\frac{4R^3\sigma}{3}E - f_rR = \frac{MR^2}{2}\alpha$$

$$\alpha = \frac{a}{R}$$

For pure rolling

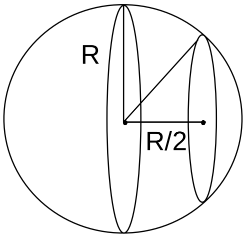
$$a = \frac{8}{9}\frac{\sigma ER^2}{M}$$

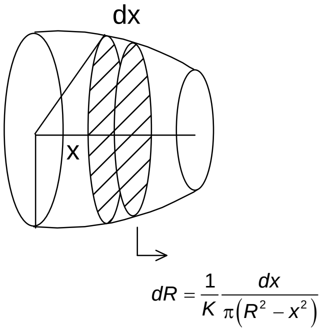
16. current across inductor and capacitor are out of phase and same magnitude hence only resistance will be operated.

$2.5\sqrt{2}\ A$

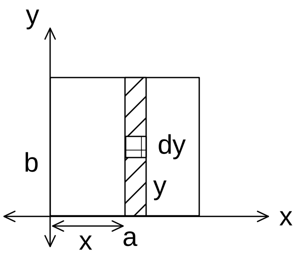
17. $$\int \frac{1}{K}.\frac{dx}{\pi\left(R^2 - x^2\right)}$$

$$R_T = \frac{1}{K\pi}\int\frac{dx}{\left(R^2 - x^2\right)} = \frac{1}{2K\pi R}\ln(3)$$





18. $$dm = \left(\frac{\alpha_0 x}{ab}\right)y\left(dy\right)\left(dx\right)$$



$\vec{R} = (x, y)$

$$\frac{\int \vec{R}.dm}{\int dm} = \frac{\int \frac{\alpha_0 xy}{ab}(dxdy)\left(x\hat{i} + y\hat{j}\right)}{\int \frac{\alpha_0 xy}{ab}dx.dy}$$

$$\frac{\int \frac{\alpha_0 xy}{ab} x\ dx.dy\hat{i}}{\int \frac{\alpha_0 xy}{ab} dx,yd} + \frac{\int \frac{\alpha_0 xy}{ab} dx.dy\left(y\right)\hat{j}}{\int \frac{\alpha_0 xy}{ab} dx.dy}$$

$y = COM \qquad x =$

$dy = \qquad dx =$

$$\frac{\int_0^a x^2 dx}{\int_0^a x dx}\hat{i} + \frac{\int_0^b y^2 dy}{\int_0^b y dx}\hat{j}$$

$$\frac{2a}{3}\hat{i} + \frac{2b}{3}\hat{j}$$

19. $\overrightarrow{M} = 10\left\{100 \times 10^{-4}\hat{i} + 50 \times 10^{-4}\hat{j} + 50 \times 10^{-4}\hat{k}\right\}$

$= \left(10\hat{i} + 5\hat{j} + 5\hat{k}\right) \times 10^{-3}\ Am^2$

$\vec{B} = 2\hat{i} - 3\hat{j} + \hat{k}$

$\vec{\tau} = \overrightarrow{M} \times \vec{B} = 10 \times \sqrt{20} \times 10^{-2}\ Nm = \sqrt{20} \times 10^{-1}\ Nm$

20. C

21. Distance between central bright and first minimum,

$y = \frac{D\lambda}{d}$

$\frac{y_1}{y_2} = \frac{\lambda_1}{\lambda_2}$

22. A

23. stopping potential for a and b are same. Hence $f_a = f_b$ but current I_b is more than I_r at zero potential.

24. $I_2 = I_0\left(1 - e^{-\mu x}\right)\ I = \frac{I_0}{2},\ x = 1.5\ cm^{-1}$

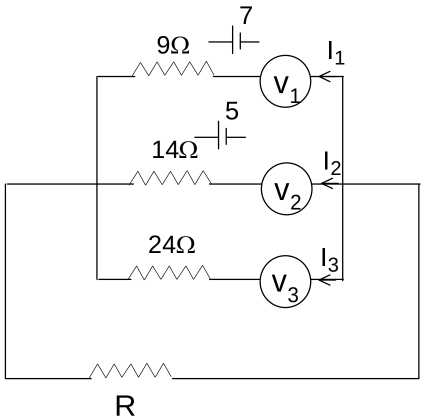
$\mu = 0.462\ cm^2 / g$

25. A

26. $R = \sigma T^4 \Rightarrow T^4 = \frac{R}{\sigma}$

$\lambda T = b$

27. A
28. since voltmeter are identical



$$\frac{I_1}{I_2} = \frac{3}{2} \quad let\ I_2 = x \quad I_1 = \frac{3}{2}x$$

$$9 \times \frac{3}{2}x - 14x + 5 - 7.5 = 0$$

$$x = -5.0A = I_2$$

$$-7.5A = I_1$$

$$\frac{27x - 28x}{2} = 2.5$$

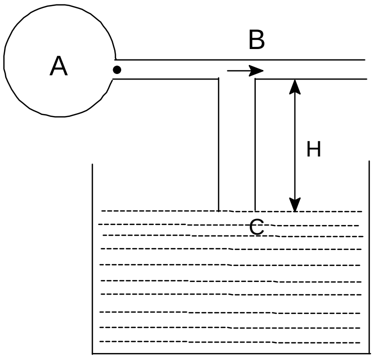
Hence resistance of voltmeter is 1 Ω

$$25I_3 = -7.5 - 7.5 \times 9 = -75$$

$$I_3 = -3A$$

Hence V_3 = 3.0 V

29. $$P_B + \frac{1}{2}\sigma V^2 = P_A + P$$

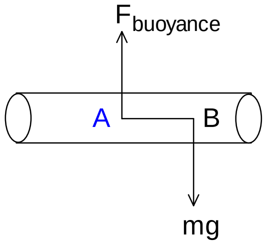


$$P_B = \frac{P}{A} + P - \frac{1}{2}\sigma V^2$$

$$= \frac{P}{A} - \rho g H$$

$$V = \sqrt{\frac{2(P + \rho g H)}{\sigma}}$$

30. $F_{Buoyancy} = \pi r^2 \ell \rho g$



$$\text{Torque} = \frac{\pi r^2 \ell^2 \rho g}{4}$$

$$\alpha = \frac{\pi^2 \ell^2 \rho g r^2}{4I}$$

Chemistry

PART – II

SECTION – A

31. $\frac{1}{2}\frac{d[B]}{dt} = k_1[A] \Rightarrow \frac{d[B]}{dt} = 2k_1[A]$

$\frac{d[C]}{dt} = k_2[A]$

$\Rightarrow \frac{[B]}{[C]} = \frac{2k_1}{k_2} = 1$

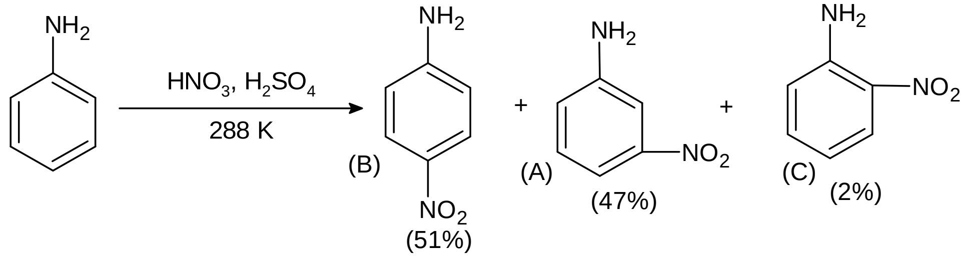
$\Rightarrow \%[B] = \frac{1}{1+1} \times 100 = 50\%$

32. $B_{12} = 12$ corners
Icosahedral = 20 faces.

33. Nylon – 2 – Nylon – 6
-copolymer of glycine and amino caproic acid
-biodegrable.

34. Average (P – P) bond enthalpy
$= \frac{1265 - 59}{6} = 201\,kJ/mol$

35. Self reduction:
$Cu_2O + Cu_2S \longrightarrow Cu + SO_2$

36.


Order of basic nature: A > B > C

37. Anode$(-) \Rightarrow \underset{1\,atm}{H_2(g)} \longrightarrow \underset{10^{-5.5}M}{2H^+}(aq.) + 2e^-$

Cathode$(+) \Rightarrow \underset{xM}{2H^+}(aq.) + 2e^- \longrightarrow \underset{(1\,atm)}{H_2(g)}$

$0.118\,V = 0 - \frac{0.059}{2}\log_{10}\frac{(10^{-5.5})^2}{(x)^2} \Rightarrow x = 10^{-3.5}M$

$\Rightarrow pH = 3.5$

38. Reaction involved in developer:
$K_2Fe^{II}(C_2O_4)_2 + AgBr \longrightarrow KFe^{III}(C_2O_4)_2 + Ag\downarrow + KBr$

39. $CO + 3H_2 \xrightarrow{Ni} CH_4 + H_2O$

$$CO + 2H_2 \xrightarrow{ZnO-Cr_2O_3} CH_3OH$$
$$CO + H_2 \xrightarrow{Cu} HCHO(g)$$

40. Z < 1 means attraction forces are dominating $\Rightarrow$ a is considerable, b can be negligible at low temperature and low pressure.

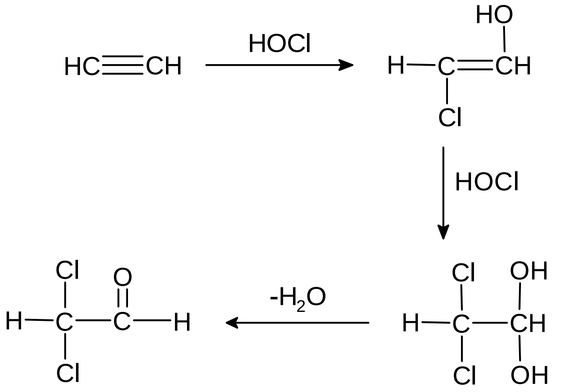
41. $X = NO_2,\ Y = N_2O$

42. Organic compound having C, N and S give blood colour in Lassaigne's test with neutral $FeCl_3$, due to formation of $Fe(SCN)_3$.

43. Chloroform and diethylether on mixing show –ve deviation from Raoult's law, in which V.P. decreases and b.p. increases.

44. E.N difference $\Rightarrow O-X > O-H$
$\Rightarrow H-O-X \longrightarrow H-O^- + X^+$
$\Rightarrow$ basic nature.

45.



46. Buffer solution
$$pH = pK_{a_2} + \log\frac{\left[CO_3^{-2}\right]}{\left[HCO_3^-\right]} = (11 - \log 2) + \log\left(\frac{40}{5}\right)$$
$$= 11 + 2\log 2 = 11.6$$

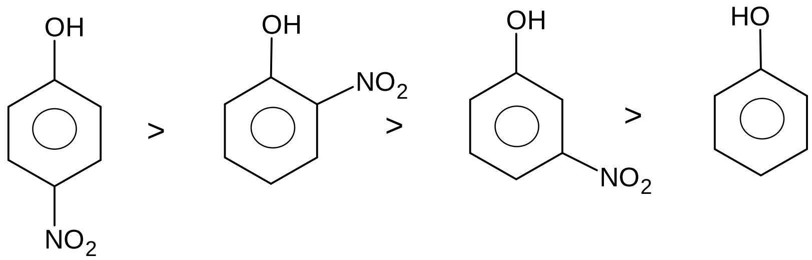
47. $\Delta_0\ \alpha\ \underset{(\text{maximum for } CN^-)}{\text{Strength of ligand}}$

48. Representation:
$$\begin{array}{c}\text{Base}\\ |\\ -\text{sugar}-\text{phosphate}-\end{array}\left(\begin{array}{c}\text{Base}\\ |\\ \text{sugar}-\text{phosphate}\\ \\ \end{array}\right)_n \begin{array}{c}\text{Base}\\ |\\ -\text{sugar}-\end{array}$$

49. Na^+ occupies octahedral voids formed by close packing of Cl^- in ccp in which all tetrahedral voids are vacant.

50. $ClF_3 \Rightarrow$ T – shaped

51. Acidic strength: $\propto \dfrac{1}{pK_a}$

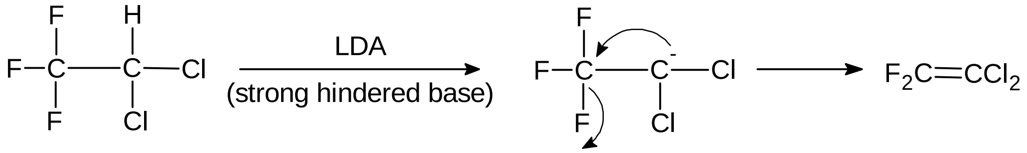

OH
NO2
>
OH
NO2
>
OH
>
NO2
HO

(acidic strength)

52. Below pI, cationic species, goes to cathode.
Above pI, anionic species, goes to anode.

53.
$$Mg + C \xrightarrow{\Delta} MgC_2 \xrightarrow{\text{high T}} Mg_2C_3 \xrightarrow{H_2O} Mg(OH)_2\downarrow + C_3H_4\uparrow$$

54.


F
H
F
C
C
Cl
F
Cl
LDA
(strong hindered base)
F
F
C
C
Cl
F
Cl
F2C=CCl2

55. $T = KV \Rightarrow PV^0 = \text{constant}$

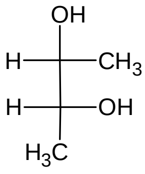
$$C = \frac{R}{\gamma - 1} - \frac{R}{n-1} = \frac{R}{\frac{7}{5} - 1} - \frac{R}{0-1} = \frac{5R}{2} + R$$

$$= \frac{7R}{2}$$

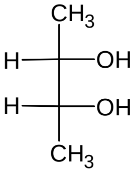
56. $Cu^{+2} + \left[Fe(CN)_6\right]^{-4} \longrightarrow \underset{\text{Chocolate brown/reddish brown ppt.}}{Cu_2\left[Fe(CN)_6\right]}$

57. For s-orbital, $\ell = 0 \Rightarrow$ no nodal plane
For d_{z^2} – orbital, $\ell = 2 \Rightarrow$ 2 conical node, no nodal plane.

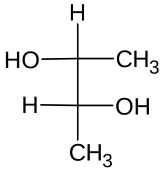
58.


OH
H
CH3
H
OH
H3C

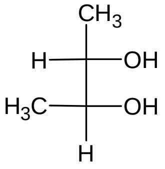
(2R, 3R)


CH3
H
OH
H
OH
CH3

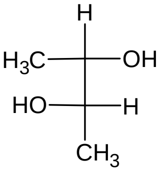
(2S, 3R)
diastereomer


H
HO
CH3
H
OH
CH3

(2S, 3R)
diastereomer


CH3
H
OH
H3C
OH
H

(2S, 3S)
enantiomer


H
H3C
OH
HO
H
CH3

(2R, 3S)
diastereomer

59. Classical smog is a reducing mixture, while photochemical smog has high concentration of oxidizing agents.

60. Cannizaro reaction involves attack of OH^- on carbonyl carbon and H^- shift on another carbonyl carbon, no carbanion intermediate.

Mathematics

PART – III

SECTION – A

61. Let $f\left(x\right) = \text{sinx} + 2x - kx^2 - kx$

$f'\left(x\right) = \cos x + 2 - 2kx - k$

$f''\left(x\right) = -\sin x - 2k$

The inequality is trivially true for k < 0

For $k \geq 0$, we have $f''(x) < 0$

The curve y = f(x) is concave downwards

$\Rightarrow f\left(\frac{\pi}{2}\right) \geq 0 \Rightarrow k \leq \frac{4\left(\pi+1\right)}{\pi\left(\pi+2\right)}$

62. $y = \log_{10} x \;\&\; z = \log_x 10 = \frac{1}{\log_{10} x} = \frac{1}{y}$

$\Rightarrow y = \frac{1}{z} \because \frac{dy}{dz} = \frac{-1}{z^2} = -\frac{1}{\left(\log_x 10\right)^2} = \frac{-\left(\text{logx}\right)^2}{\left(\text{log10}\right)^2}$

63. $\lim\limits_{x\to\frac{\pi}{4}} \frac{\int\limits_2^{\sec^2 x} f\left(t\right)dt}{x^2 - \frac{\pi^2}{16}} = \lim\limits_{x\to\frac{\pi}{4}} \frac{f\left(\sec^2 x\right) \times 2\sec^2 x.\tan x}{2x} = \frac{8}{\pi} f\left(2\right)$

64. $\lim\limits_{n\to\infty} a_n = \lim\limits_{n\to\infty} a_{n+1} = L$

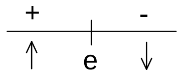
$\therefore \lim\limits_{n\to\infty} a_{n+1} = \lim\limits_{n\to\infty} \sqrt{2 + a_n}$

$\Rightarrow L = \sqrt{2+L} \Rightarrow L = 2 \;\&\; L = -1 \Rightarrow N.D$

65. Area = A = xy

$\Rightarrow A = \frac{\ln x}{x} \Rightarrow \frac{dA}{dx} = \frac{1 - \ln x}{x^2}$

$\frac{dA}{dx} = 0 \Rightarrow x = e$

$\Rightarrow$ 

Hence x = e is point of maxima; $A_{\max} = e.\frac{1}{e^2} = \frac{1}{e}$

66. let $I = f\left(\frac{1}{2}\right) - f\left(\frac{1}{3}\right) = \int\limits_0^{\frac{\pi}{4}} \log_e \left(\frac{1 + \frac{1}{2}\tan z}{1 + \frac{1}{3}\tan z}\right) dz$

$= \int\limits_0^{\frac{\pi}{4}} \log_e \left(\frac{3}{2}\frac{2 + \tan z}{3 + \tan z}\right) dz$

Replacing $z \to \frac{\pi}{4} - z$

We get $I = \int_0^{\frac{\pi}{4}} \log_e \left(\frac{3}{4} \frac{3+\tan z}{2+\tan z} \right) dz$

$\Rightarrow 2I = \int_0^{\frac{\pi}{4}} \log_e \left(\frac{9}{8} \right) dz \Rightarrow I = \frac{\pi}{8} \log_e \left(\frac{9}{8} \right)$

67. $\int_a^b f(x)dx = \int_a^b f(a+b-x)dx$

$I_1 = \int_{\sin^2 t}^{1+\cos^2 t} x.f\left(x(2-x)\right)dx = \int_{\sin^2 t}^{1+\cos^2 t} (2-x)f\left(x(2-x)\right)dx = 2\int_{\sin^2 t}^{1+\cos^2 t} f\left(x(2-x)\right) - I_1$

$\Rightarrow 2I_1 = 2\int_{\sin^2 t}^{1+\cos^2 t} f\left(x(2-x)\right)dx \Rightarrow 2I_1 = 2I_2 \Rightarrow \frac{I_1}{I_2} = 1$

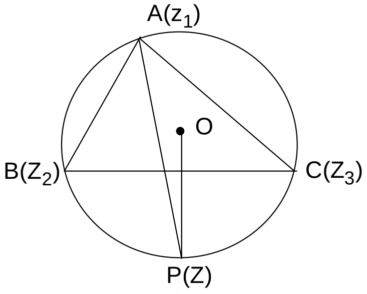
68. $x\left(y^2.e^{xy} + e^{\frac{x}{y}} \right)dy = y\left(e^{\frac{x}{y}} - y^2.e^{xy} \right)dx$

$\Rightarrow y^2 \left(xdy + ydx \right) e^{xy} = e^{\frac{x}{y}} \left(ydx - xdy \right)$

$\Rightarrow e^{xy} d\left(xy \right) = e^{x/y} \frac{ydx - xdy}{y^2} = e^{\frac{x}{y}}.d\left(\frac{x}{y} \right)$

$\Rightarrow e^{xy} = e^{\frac{x}{y}} + c$

69. since OP ⊥ BC



$\Rightarrow \arg\left(\frac{z}{z_3 - z_2} \right) = -\frac{\pi}{2}$

70. you can have W, W, B or W, B, W or B, W, W

Required probability = $\frac{3}{4}.\frac{2}{4}.\frac{3}{4} + \frac{3}{4}.\frac{2}{4}.\frac{1}{4} + \frac{1}{4}.\frac{2}{4}.\frac{1}{4} = \frac{9}{32} + \frac{3}{32} + \frac{1}{32} = \frac{13}{32}$

71. $x^2 + \alpha x + 2 = \alpha x - 1$ (Let $\alpha x - 1 \ge 0$)

$\Rightarrow x^2 + 3 = 0$ (No solution)

Now,

$x^2 + \alpha x + 2 = 1 - \alpha x \left(\alpha x - 1 < 0 \right)$

$\Rightarrow x^2 + 2\alpha x + 1 = 0$

Let $f(\mathrm{x}) = \mathrm{x}^2 + 2\alpha x + 1$

$\Rightarrow D \geq 0 \Rightarrow \alpha \in (-\infty,-1] \cup [1,\infty)$

If both roots –ve, then $f(0) > 0 \,\&\, \frac{-b}{2a} \leq 0 \Rightarrow \alpha \geq 0$

So for α ≥ 1 both roots of this equation are –ve & α ≤ 1 at least one root is +ve and for –ve value afx αx- 1 < 0 for positive values of x.

72. $|AB| \geq |PA - PB|$

So PA – PB is maximum when P is collinear with AB.

Equation of $AB \Rightarrow y - 1 = \frac{-1}{2}(x - 0)$

$\Rightarrow x + 2y = 2 \rightarrow (i)$

& solve with 4x + 3y + 9 = 0 → (ii)
(I) & (ii)

$P \equiv \left(\frac{-24}{5}, \frac{17}{5}\right)$

73. A

74. As eccentric angle $\theta \in (0,2\pi)$

$\Rightarrow |\theta_1| + |\theta_2| = \pi \Rightarrow \theta_2 = \pi - \theta_1$

$P \equiv (5\cos\theta, 4\sin\theta) Q \equiv (5\cos\theta_2, 4\sin\theta_2)\, or\; Q(5\cos\theta, 4\sin\theta)$

$\Rightarrow PQ \equiv y = 4\sin\theta_1$

75. equation of director circle.

76. $\left(1 - \frac{s-b}{s-a}\right)\left(1 - \frac{s-c}{s-a}\right) = 2 \Rightarrow a^2 = b^2 + c^2$

77. solving the planes taking 3 at a time vertices of tetrahedron are
$0 \equiv (0,0,0), A \equiv (1,1,-1), B \equiv (1,-1,1), C \equiv (-1,1,1)$

Volume of tetrahedron = $\frac{1}{3}$ × (area of base) (height)

78. if the points be A, B, & C respectively then
$\overrightarrow{AB} = \overrightarrow{OB} - \overrightarrow{OA} = \vec{a} - 2\vec{b} + \lambda\vec{c} - (2\vec{a} - \vec{b} + 3\vec{c}) = -\vec{a} - \vec{b} + (\lambda - 3)\vec{c}$

$\overrightarrow{AC} = \overrightarrow{OC} - \overrightarrow{OA} = \mu\vec{a} - 5\vec{b} - (2\vec{a} - \vec{b} + 3\vec{c}) = (\mu - 2)\vec{a} - 4\vec{b} - 3\vec{c}$

Points are collinear if $\overrightarrow{AB} = t\overrightarrow{AC}$

$\Rightarrow \lambda = \frac{9}{4}, \mu = -2$

79. put $\ln x = t$.

80. Plane containing the line of intersection of the given planes is
$(x - y - z - 4) + \lambda(x + y + 2z - 4) = 0$

$s.e. (\lambda + 1)x + (\lambda - 1)y + (2\lambda - 1)z - 4(\lambda + 1) = 0$

Vector normal to it

$V = (\lambda + 1)\hat{i} + (\lambda - 1)\hat{J} + (2\lambda - 1)\hat{K}$

Vector along the line of intersection of the planes
$2x+3y+z-1=0\,\&\,x+3y+2z-2=0$ is
Given by $\vec{n}=3\left(\hat{i}-\hat{J}+\hat{K}\right)$
& $\vec{n}$ is parallel to the pane → (i)
$\Rightarrow \vec{n}.\vec{v}=0\Rightarrow \lambda=\frac{-1}{2}$
& hence the required plane is
$x-3y-4z-4=0$
$\Rightarrow \left|A+B+C\right|=11$

81. $\sin^{-1}$ is defined for [-1, 1] $\Rightarrow a=0$
$\therefore$ x + y = $\sin^{-1}1+\cos^{-1}1-\tan^{-1}1=\frac{\pi}{4}$
Clearly image about x – axis will be x – y = $\pi/4$.

82. $\cos 4x+6-7cos2x=0$
$\Rightarrow\left(cos2x-1\right)\left(2cos2x-5\right)=0$
$\Rightarrow cos2x=\frac{5}{2}\,\&\cos 2x=1$
2x = 2nπ ⇒ x = nπ
Sum in [0,314].
$=\pi[1+2+.......+100]-100\pi=5050\pi-100\pi=4950\pi$

83. we have g(x) = f(x) Sinx → (i)
Diff. w.r to x.
g’(x) = f(x) Cosx + f’(x) Sinx → (ii)
Again diff.
g”(x) = f(x) (-Sinx)+ f’(x) Cosx + f’(x) Cosx +f”(x) Sinx
$\Rightarrow g''(-\pi)=2f'(-\pi).\text{Cos}(-\pi)=2\times1\times-1=-2$
Hence $g''(-\pi)=-2$

84. we have $\frac{3x+6y}{k}=1\rightarrow$ (i)
& $2x^2+2xy+3y^2-1=0\rightarrow$ (ii)
Now Homogenising (2) with the help of (1),
We get

$$2x^2+2xy+3y^2-\left(\frac{3x+6y}{k}\right)^2=0$$

$$\Rightarrow K^2\left(2x^2+3x+3y^2\right)-\left(3x+6y\right)^2=0$$

Now coff. of x^2 + coff. of y^2 = 0
$\Rightarrow K^2=9\Rightarrow K=\pm3$

85. D

86. Let the amount received by sons be Rs. X, Rs. Y & Rs. Z respectively, then
$x\le y+z=101-x$
$i.e\ 2x\le101\Rightarrow x\le50,y\le50\,\&\,z\le50\,\&\,x+y+z=101$
$\therefore$ Coff. of x^{101} in the expansion of $(1 + x + x^2 + \text{.....}+ x^{50})^3$
$={}^{1\times103}C_{101}-3.{}^{52}C_{50}={}^{103}C_2-3.{}^{52}C_2$

87. $z_1, z_{2,} z_3 .... z_k = cos\left(\sum_{n=1}^{n=k}\frac{1}{n(\text{n}+1)(\text{n}+2)}\right) + i\,sin\left(\sum_{n=1}^{n=k}\frac{1}{n(\text{n}+1)(\text{n}+2)}\right)$

$= cos\frac{\pi}{4} + i\,sin\frac{\pi}{4} = \frac{1}{\sqrt{2}} + i\frac{1}{\sqrt{2}}$

88. Since the tangent at any point ∀ x (a, b) lies below the curve
∴ the curve is concave upward in the interval (a, b)
∴ f"(x) > 0 ∀ x ∈ (a, b)

89. $x^2y^3 = (x+y)^n$

$2xy^3 + 3x^2y^2\frac{dy}{dx} = n(\text{x}+\text{y})^{n-1}\left(1+\frac{dy}{dx}\right)$

$\Rightarrow 5xy^3 = \frac{n(x+y)^n}{x}\left\{\because \frac{dy}{dx} = \frac{y}{x}\right\}$

$\Rightarrow 5(x+y)^n = n(x+y)^n$

$\Rightarrow n = 5$

90. $\alpha + \beta = -a \rightarrow \text{(i)}$

$\alpha.\beta = \text{a}+1 \rightarrow \text{(ii)}$

Adding (I) & (ii)

$\alpha + \beta + \alpha\beta = 1 \Rightarrow (\alpha+1)(\beta+1) = 2$

α & β are integral

$\alpha + 1 = 1, \beta + 1 = 2$

$\alpha + 1 = -1, \beta + 1 = -2$

$\alpha = 0, \beta = 1$

Or

$\alpha = -2 \,\&\, \beta = -3$

$\Downarrow$

$a = -1\, or\ 5$

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

FULL TEST – II

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 – 10)** contains 10 multiple choice questions which have one or more than one correct answer. Each question carries **+3 marks** for correct answer. There is no negative marking.

2. **Section-C (01 – 10)** contains 10 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+3 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10 \text{ m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3 \text{ kg/m}^3$
Atmospheric pressure	$P_a = 10^5 \text{ N/m}^2$
Gas constant	$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
		=	$0.0821 \text{ Lit atm K}^{-1} \text{ mol}^{-1}$
		=	$1.987 \approx 2 \text{ Cal K}^{-1} \text{ mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

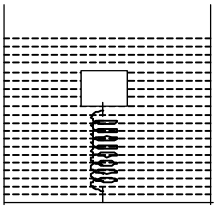
Physics

PART – I

SECTION – A
(One or More than One Options Correct Type)

This section contains **10 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** is/are correct.

1. The block shown in the figure is in equilibrium in a liquid and one end of the spring is connected to the base of the vessel. Now the vessel is made to fall freely under gravity. The length of the spring from the equilibrium situation may:



(A) Increase
(B) Decrease
(C) Remains constant
(D) Data insufficient

2. An electric dipole is placed along x-axis with its centre at origin:
(A) The electric field is perpendicular to each and every point on y-z plane
(B) y-z plane is an equipotential surface
(C) y-z plane is not an equipotential surface
(D) Flux of electric field enclosing dipole is zero

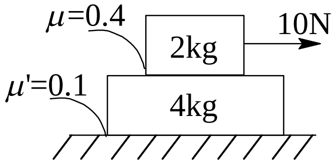
3. A particle of mass *m* makes a head-on elastic collision with a particle of mass 2 m initially at rest. The velocity of the first particle before and after collision are given to be u_1 and v_1. Then which of the following statements is true in respect of this collision?
(A) For all values of u_1, v_1 will always be less than u_1 in magnitude and $\left|v_1\right| = \frac{u_1}{3}$.
(B) The fractional loss in kinetic energy of the first particle is $\frac{8}{9}$.
(C) The gain in kinetic energy of the second particle is $\frac{8}{9}th$ of the initial kinetic energy of the first particle
(D) There is a net loss in the energy of the two

Space for Rough work

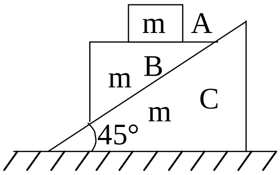
4. A person of mass 70 kg jump from a 3.0 m height.
(A) impulse on the man by ground will be 539 N-s
(B) average force on man if the landing is with stiffed leg and body moves by 1.0 cm during impact is 2.1 × 10^5 N
(C) average force on man feet by ground if he land with bent legs and body moves by 50 cm is 4.2 × 10^3 N
(D) average force on man feet by ground if he land with bent legs and body moves by 50 cm is (4.9 × 10^3 N)

5. Capacitors C_1 = 1 μF and C_2 = 2 μF are separately charged from the same battery. They are allowed to discharge separately through equal resistors
(A) The currents in the two discharging circuits at t = 0 is zero.
(B) The currents in the two discharging circuits at t = 0 are equal but not zero.
(C) The currents in the two discharging circuits at t = 0 are unequal.
(D) C_1 loses 50% of its initial charge sooner than C_2 loses 50% of its initial charge.

6. For the given two blocks system shown in figure (g=10 m/s^2):
(A) Acceleration of 2kg block is 1m/s^2
(B) Acceleration of 4kg block is $2\,\text{m/s}^2$
(C) Friction force between blocks is 8N
(D) Friction force between lower block and ground is 6N

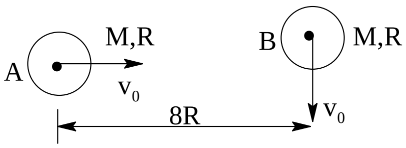


7. The system of block and wedges all of same mass shown in the figure is released from rest. All surfaces are smooth. Then:
(A) The speed of block A when it falls 50 cm is $2\sqrt{2}\text{m/s}$
(B) The speed of block B when A falls 50 cm is 4m/s
(C) The speed of block B when A falls 50 cm is $\sqrt{10}\,\text{m/s}$
(D) The speed of block C when A falls 50 cm is $\sqrt{2}\text{m/s}$



Space for Rough work

8. Two spheres are moving as shown. Velocity v_0 is such that spheres are at minimum separation when they touch each other. Then:



(A) $v_0 = \sqrt{\frac{3}{28}\frac{GM}{R}}$

(B) $v_0 = \sqrt{\frac{6}{28}\frac{GM}{R}}$

(C) Speed of sphere A at the time of minimum separation is $\sqrt{\frac{3}{7}\frac{GM}{R}}$

(D) Speed of sphere B at the time of minimum separation is $\sqrt{\frac{6}{7}\frac{GM}{R}}$

9. Two identical fuses are rated at 10A. If they are joined
(A) In parallel, the combination acts as a fuse of rating 20A
(B) In parallel, the combination acts as a fuse of rating 5A
(C) In series, the combination acts as a fuse of rating 10A
(D) In series, the combination acts as a fuse of rating 20A

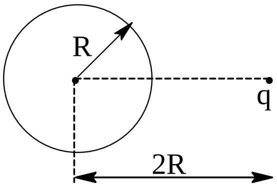
10. Velocity and acceleration vector of a charged particle moving in a magnetic field at some instant are $\vec{v} = 3\hat{i} + 4\hat{j}$ and $\vec{a} = 2\hat{i} + x\hat{j}$. Select the correct alternative (s)
(A) x = -1.5
(B) x = 3
(C) Magnetic field is along z-direction
(D) Kinetic energy of the particle is constant

Space for Rough work

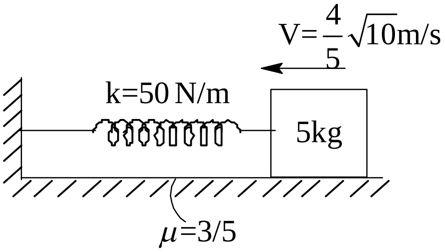
SECTION – C
(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

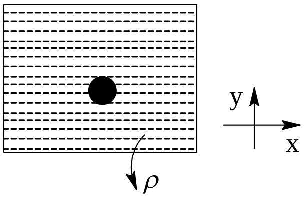
11. A point charge is placed outside a spherical shell as shown in the figure. Find the electric potential (in kilo volt) on the surface of shell (Take: $q = 1\mu c$ and $R = 50cm$)



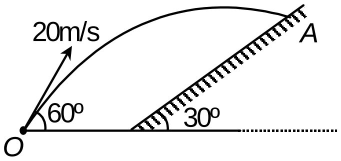
12. A spring block system is placed on a horizontal rough surface as shown in the figure. The block is given velocity when the spring is in natural length. The total distance travelled by the block before it finally comes to rest is $\frac{2}{k}$ meters. Find the value of k



13. A small spherical ball of density same as that of liquid is released from rest in a vessel filled completely with a liquid and accelerating with acceleration $5\hat{i}+5\hat{j}\,m/s$ as shown in the figure. Find the initial acceleration of ball just after the release with respect to vessel.

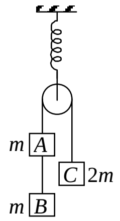


14. A ball is projected from the point *O* with velocity 20 m/s at an angle of $60°$ with horizontal as shown in figure. At highest point of its trajectory it strikes a smooth plane of inclination $30°$ at point *A*. The collision is perfectly inelastic. The maximum height from the ground attained by the ball is $\frac{75}{k}$ meter. Find the value of k? (g = 10 m/s^2)

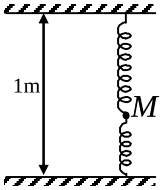


Space for Rough work

15. In the figure shown, pulley and spring are ideal and strings are light and inextensible. Initially all the bodies are at rest when string connecting A and B is cut. Find initial acceleration of C.



16. A small ball of mass $M = 1\text{kg}$ is attached to two identical springs of constant 100N/m, which are attached to floor and roof. The springs are initially unstretched. By what distance ball comes down to attain equilibrium? (in cm)

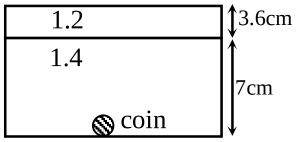


17. In *YDSE*, when a glass plate of refractive index 1.5 of thickness *t* is placed in the path of one of the interfering beams of wavelength λ, intensity at the position where central maximum occurred previously remain unchanged. If the minimum thickness of the glass plate is $k\lambda$. Find the value of k....

18. If the ionization potential of hydrogen atom is 13.6eV, the energy required to remove from the third orbit of hydrogen atom is $k/2\text{eV}$. Find the value of k.....

19. When an object is at a distance 3meters and 1meters from the optical centre of a convex lens, a real and virtual images are formed respectively, with the same magnification. Find the focal length of the lens (in meters)

20. A man observes a coin placed at the bottom of a beaker which contains two immiscible liquids of refractive indices 1.2 and 1.4 as shown in the figure. Find the depth of the coin below the surface, as observed from above.



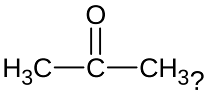
Space for Rough work

Chemistry PART – II

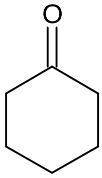
SECTION – A
(One or More than One Options Correct Type)

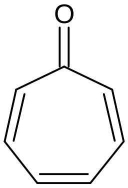
This section contains **10 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** is/are correct.

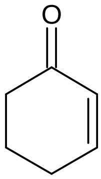
21. Which of the following compound have larger $C-O$ bond length than $C-O$ bond length of

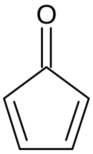


$H_3C-\overset{\overset{O}{||}}{C}-CH_3$?

(A)


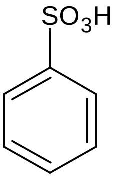
(B)


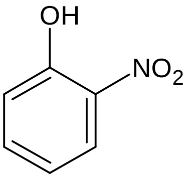
(C)


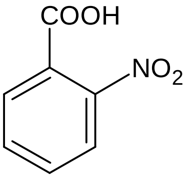
(D)


22. Which of the following compounds are soluble in $NaHCO_3$?

(A) Picric acid

(B)


(C)


(D)


Space for Rough work

23. Which of the following statement/statements is/are correct?

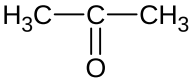
(A) in the $NaCl$ structures, each Na^+ ion is surrounded by $6Cl^-$ ions as nearest neighbours and twelve Na^+ ions as next nearest neighbours.

(B) the co-ordination number of cation generally increases as the radius ratio increases

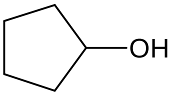
(C) packing efficiencies higher than 0.74 are possible only with cation and anion of different sizes

(D) during a crystal defect electrical neutrality should be maintained.

24. An optically active alcohol $A(C_8H_{16}O)$ on oxidation gives B. A on acidic heating gives $C(C_8H_{14})$ as major product. C on ozonolysis produces $D(C_5H_8O)$ and


$H_3C-\underset{\underset{O}{\|}}{C}-CH_3$

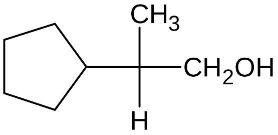
. D on reduction with $LiAlH_4$ gave



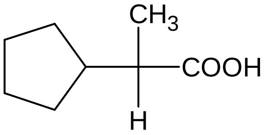
·

Identify correct answer:

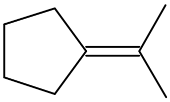
(A) A is



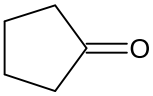
(B) B is



(C) C is

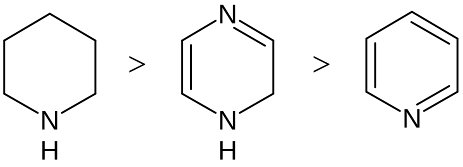


(D) D is

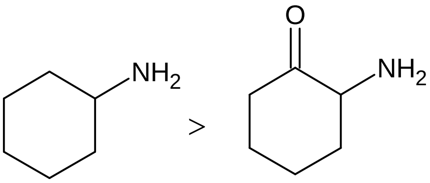


25. Which of the following order for basic strength is/are correct?

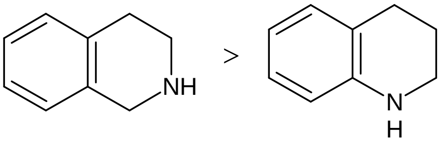
(A)



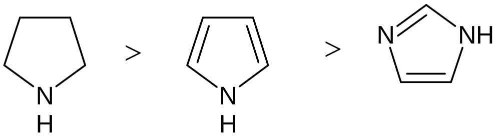
(B)



(C)



(D)



Space for Rough work

26. When 5 mL of a 1.0 M HCl solution is mixed with 5 mL of a $0.1M$ $NaOH$ solution, temperature of solution increases by $t°C$. Which of the following(s) can be predicted from this observation:

(A) If $5\,mL$ of $0.1M$ HCl is mixed with 5 mL 0.1 M NH_3 solution, the temperature rise will be less than $t°C$

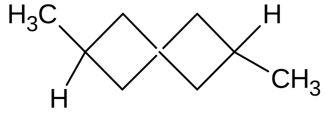
(B) If 5 mL 0.1 M CH_3COOH is mixed with 5 mL 0.1 M $NaOH$, the temperature rise will be less than $t°C$

(C) If 10 mL of 1.0 M HCl is mixed with 10 mL of 0.1 M NaOH, the temperature rise will be $2t°C$.

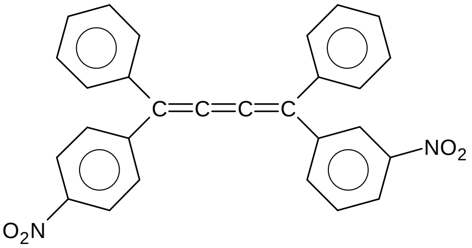
(D) If 10 mL of 0.1 M HCl is mixed with 10 mL of 0.1 M NaCl, the temperature rise will be $t°C$

27. Identify the chiral molecule/molecules:

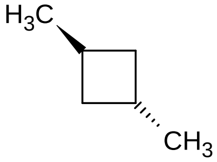
(A)



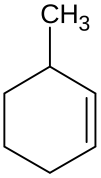
(B)



(C)



(D)



28. Which of the following is/are can produce H_2O_2 on hydrolysis?

(A) BaO_2

(B) PbO_2

(C) MnO_2

(D) Na_2O_2

Space for Rough work

29. The correct statement/statements is/are:
(A) The distance between two octahedral voids of a cubic close packing of atoms with radius r is 2r
(B) The distance between two tetrahedral voids of a cubic close packing of atoms with radius r is $\sqrt{6}\times r$ at the body diagonal axes
(C) The distance between tetrahedral and octahedral void is $\sqrt{\frac{3}{2}}\times r$, where is the radius of atom forming the close packing
(D) The distance between the surfaces of atoms fcc arrangement along an edge is $2\left(\sqrt{2}-1\right)r$

30. Identify the correct relationship:
(A) In $\left[Cu\left(NH_3\right)_4\right]^{2+}$ complex Hybridization of $Cu = dsp^2$
(B) $Fe\left(CO\right)_x$ where x is generally 5
(C) Zn^{2+} Complexes with sp^3d^2 hybridization are diamagnetic in nature
(D) Cr^{3+} Complexes are paramagnetic in nature

SECTION – C
(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

31. If four atoms of same radius are placed at the alternate corner of a cube touching each other, than the length of body diagonal of the cube is equal to $\sqrt{x}\times R$, where R is the radius of atom. Find the value of x?

32. The cost of electricity required to deposit 1 g Mg is Rs. 5.00. The cost of 30 g of Al to be deposited is Rs. X. Find the value of $\frac{x}{40}$?

33. A certain buffer solution contains equal concentration of X^- and HX. The K_b for X^- is 10^{-10}. Find the pH of this buffer solution?

Space for Rough work

34. Co forms dinuclear complex with a sigma bond within two Co atoms. Consider that metal carbonyls follows EAN rule. The complex can be written as $\mathrm{CO}_2\left(CO\right)_x$. Find the value of x?

35. Diethyl $-\beta$, $\beta-$dimethylglutaric acid $\left(ester\right)$ is condensed with diethyl oxalate in presence of sodium ethoxide and ethanol to form a major product $\left(P\right)$, which on acidic hydrolysis followed by heating gives another product $\left(Q\right)$. Calculate total number of C=O bonds in $\left(P\right)$ and $\left(Q\right)$ compounds?

36. At 298 K, if ΔG_f° of $HCl_{(g)}$ is $1.72\,kJ\,mol^{-1}$, then calculate K_p for the following reversible reaction: $2HCl_{(g)} \rightleftharpoons H_{2(g)} + Cl_{2(g)}$
(Use: at $298\,K : 2.303\,RT = 5700\,J\,mol^{-1}\,and \log 2 = 0.30$)

37. Calculate the pH of the following mixture
$50mL$ of $0.05M\ CH_3COOH + 50mL$ of $0.05M\ NH_4OH$
Given : $pK_a = pK_b = 4.74$

38. The dissociation constant of a substituted benzoic acid at $25^{\circ}C$ is 1×10^{-4}. Find the pH of a $0.01\left(M\right)$ solution of its sodium salt.

39. Total no of lone pairs in XeO_3F_2 is $2x$. Find the value of x.

40. The number of water of crystallization in green vitriol is........

Space for Rough work

Mathematics

PART – III

SECTION – A

(One or More than One Options Correct Type)

This section contains **10 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE THAN ONE** is/are correct.

41. Let $f(x)=\begin{cases} \lim\limits_{n\to\infty}\left(\dfrac{px}{n}\displaystyle\sum_{r=1}^{n}\dfrac{\left[r^2-e^{-x}+r-1\right]}{r(r+1)}\right)+\lambda, x>0 \\ q, \qquad x=0 \\ \lim\limits_{n\to\infty}\displaystyle\sum_{r=1}^{n}\dfrac{\left\{r^2+r+e^{x}-1\right\}}{r(r+1)}, \quad x<0 \end{cases}$

Is differentiable is R:

$\left([.]\,\text{is G.I.F. and}\,\{.\}\,\text{is F.P. of x}\right)$ Then:

(A) $\text{p}=1$ (B) $\text{q}=1$

(C) $\text{p}+\text{q}+\lambda=3$ (D) if g is inverse of F then $g'(1/2)=2$

42. Consider $f(x)=4x^4-24x^3+31x^2+6x-8$ be a polynomial function and $\alpha,\beta,\gamma,\sigma$ are the roots. $(\alpha<\beta<\gamma<\sigma)$. So:

(A) $\sigma^p+\dfrac{1}{\sigma^\alpha}+\sigma^r+r^\sigma=36$

(B) $\sigma^p+\dfrac{1}{\sigma^\alpha}+\sigma^r+r^\sigma=18$

(C) $\displaystyle\int_{2\alpha}^{2\beta}\dfrac{x^{\sigma+1}-5x^{r+1}+2\beta|x|+1}{x^2+4\beta|x|+1}dx=2\ln 2$

(D) $\displaystyle\int_{2\alpha}^{2\beta}\dfrac{x^{\sigma+1}-5x^{r+1}+2\beta|x|+1}{x^2+4\beta|x|+1}dx=\ln 2$

Space for Rough work

43. Each of 2010 boxes in a line contains one red marble and for $1 \le k \le 2010$, the box is the k^{th} position also contain k white marbles. A child begins at the fist box and successively drawn a single marble at random from each box in order. The stops when be fist draws a red marble. Let $p(n)$ be the probability that he stops after drawing exactly n marbles. The possible value(s) of n for which $p(n) < \frac{1}{2010}$ is:

(A) 44 (B) 45

(C) 46 (D) 47

44. If the normals at four points $(x_1, y_1), (x_2, y_2), (x_3, y_3)$ and (x_4, y_4) on the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ are concurrent then $\sum \cos\alpha . \sum \sec\alpha$ is (where $\alpha, \beta, , \gamma, \delta$ are the eccentric angles of the points):

(A) 1 (B) 2

(C) 3 (D) 4

45. Consider the equation $z^2 - (3+i)z + (m+2i) = 0 \, (m \in R)$. If the equation has exactly one real and one-non-real complex root, then which of the following hold(s) good:

(A) Modulus of the non-real complex root is 2

(B) The value of m is 3

(C) Additive inverse of non-real root is $(-1-i)$

(D) Product of real root and imaginary part of non-real complex root is 2

46. Consider a function $f(x) = \sin^{-1}\frac{2x}{1+x^2} + \cos^{-1}\frac{1-x^2}{1+x^2} + \tan^{-1}\frac{2x}{1-x^2} - a\tan^{-1}x \, (a \in R)$, the value of a if $f(x) = 0$ for all x:

(A) 6 (B) -6

(C) 2 (D) -2

Space for Rough work

47. Solution of differential equation $f'\left(x\right)f'''\left(x\right)=3\left(f''\left(x\right)\right)^2,\left(y=f\left(x\right)\right)$ is:

(A) $x=k_1y^2+k_2y+k_3$
(B) $y=k_1x^2+k_2+k_3$
(C) $x=\sin y$
(D) None of these

48. $f\left(x\right)=\begin{bmatrix} e^{-\sqrt{\left|\ln\{x\}\right|}}-\{x\}\sqrt{\frac{1}{\left|\ln\{x\}\right|}} \\ 0 \qquad \text{otherwise}\end{bmatrix.$ Where ever it is defined is:

(A) not a periodic function
(B) even function
(C) range of $f\left(x\right)$ contains more than 1 element
(D) None of these

49. $\sum_{m=1}^{\infty}\sum_{n=1}^{\infty}\frac{m^2n}{\left(n.3^m+m.3^n\right)}=\frac{p}{q}$ (Where $p\,\&\,q$ are coprime) then:

(A) $p+q=41$
(B) $p<q$
(C) p is perfect square
(D) q is perfect square

50. If $f\left(x\right)=\sum_{r=0}^{20}{}^{20}C_r\left(\ln\left(1+x\right)\right)^r,g\left(x\right)=\sum_{r=0}^{20}\left(-1\right)^r\,{}^{20}C_r\left(1+3\sin x\right)^{20-r}$ then:

(A) $\sum_{r=0}^{\infty}\left(g\left(\pi/6\right)\right)^r=\frac{6^{20}}{2^{20}-1}$

(B) $\sum_{r=0}^{\infty}\left(g\left(\pi/6\right)\right)^r=\frac{6^{30}}{2^{20}-1}$

(C) If $h\left(x\right)=\left[f\left(x\right)\right]^{1/20}\,then\sum_{r=0}^{\infty}\left[h\left(x^{2^r}\right)-1\right](where\left|x\right|<1)=-\ln\left(1-x\right)$

(D) $h\left(x\right)=\left[f\left(x\right)\right]^{1/20}\,then\sum_{r=0}^{\infty}\left[h\left(x^{2^r}\right)-1\right](where\left|x\right|<1)=\ln\left(1-x\right)$

Space for Rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

51. Let $p(x)$ be a polynomial of degree 6 with leading coefficient unity and $p(-x)=p(x)\forall x\in R$. Also $(p(1)+3)^2+p^2(2)+(p(3)-5)^2=0$ then $\sqrt{\text{-4-p}(0)}$ is….

52. $\lim\limits_{n\to\infty}\left[\left((2009)^{2010}\right)^n+\left((2010)^{2009}\right)^n\right]^{1/n}$ is equal to $\left|a^b\right|$ where $a,b\in N$ then $a-b$ is….

53. The value of x, where $f(x)=\sqrt{x+\sqrt{8x-16}}+\sqrt{x-\sqrt{8x-16}}$ is not differentiable, is….

54. A and B are two square matrices such that $A^2B=BA$ and if $(AB)^{10}=A^kB^{10}$ then the value of $k-1020$ is….

55. $AI_1I_2I_3$ is an excentral triangle of equilateral triangle ΔABC such that $I_1I_2=4$ unit, if ΔDEF is pedal triangle of ΔABC then $\sqrt{\dfrac{Ar(\Delta I_1I_2I_3)}{Ar(\Delta DEF)}}=$

56. If two points P and Q on $9x^2-5y^2=1$ (whose centre is C) be such that CP is perpendicular to CQ then value of $\dfrac{1}{\text{CP}^2}+\dfrac{1}{\text{CQ}^2}$ is…..

57. If the equation $\text{x}^3-3x+1=0$ has three roots x_1,x_2,x_3 where $x_1<x_2<x_3$ then the value of $(\{x_1\}+\{x_2\}+\{x_3\})$ is $(\{.\}\text{ F.P.of x})$

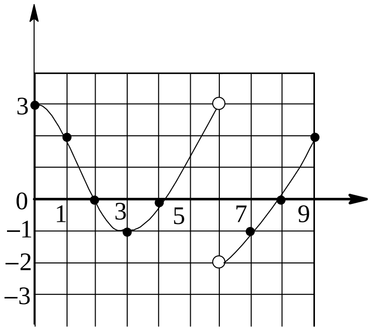
Space for Rough work

58. Let $S = \left\{(x, y); x^2 + y^2 - 6x - 8y + 21 \le 0\right\}$ then

$$\max\left\{\frac{12x}{7} - \frac{5y}{7}; (x, y) \in S\right\} + \min\left\{\frac{1}{2}\left(x^2 + y^2 + 1\right) + (x - y); (x - y) \in S\right\}$$

$$-\min\left\{\frac{\sqrt{3}y + |x-3|}{|x-3|}; (x, y) \in S\right\}$$

59. The graph of the derivative f of a continous function f is shown with f(0) = 0



If $f(x)$ has local minima at $x = x_1$ and $x = x_2$; f has inflection point at $x = k$; number of critical points of $y = f(x)$ is w then $x_1 + x_2 - k - w$ is…..

60. If $f(x) = \int_{-2}^{x} \left(t^4 - bt^3 + (b+1)t^2 - bt + b\right) dt$ strictly increases $\forall x \in R$ then no. of is integers in range of b is.

Space for Rough work

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ANSWERS, HINTS & SOLUTIONS

FULL TEST – II

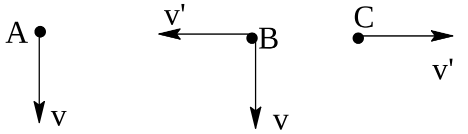
PAPER-1

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**ABC**	21.	**BC**	41.	**ABCD**
2.	**ABD**	22.	**ABD**	42.	**AC**
3.	**ABC**	23.	**ABCD**	43.	**BCD**
4.	**ABD**	24.	**ABCD**	44.	**D**
5.	**BD**	25.	**ABC**	45.	**CD**
6.	**ACD**	26.	**AB**	46.	**ACD**
7.	**ACD**	27.	**AD**	47.	**A**
8.	**AC**	28.	**AD**	48.	**B**
9.	**AC**	29.	**ABCD**	49.	**ABC**
10.	**ACD**	30.	**ABCD**	50.	**AC**
11.	**9**	31.	**6**	51.	**6**
12.	**5**	32.	**5**	52.	**1**
13.	**0**	33.	**4**	53.	**4**
14.	**4**	34.	**8**	54.	**3**
15.	**0**	35.	**6**	55.	**4**
16.	**5**	36.	**4**	56.	**4**
17.	**2**	37.	**7**	57.	**1**
18.	**3**	38.	**8**	58.	**6**
19.	**2**	39.	**6**	59.	**1**
20.	**8**	40.	**7**	60.	**3**

Physics PART – I

SECTION – A

1. ABC
Spring can be in the state of extension, compression or natural length in equilibrium
2. ABD
3. ABC
4. ABD
5. BD
6. ACD
7. ACD
Velocity direction of A, B and C



$$\frac{1}{2}mv^2+\frac{1}{2}m\left(v^2+\frac{v^2}{4}\right)+\frac{1}{2}\frac{mv^2}{4}=2mgh$$

$$v=\sqrt{\frac{8}{5}gh}=2\sqrt{2}m/s$$

8. AC
9. AC
10. ACD

SECTION – C

11. [9]
Field inside the shell is zero, so potential is uniform

$$\text{V}=\frac{\text{kq}}{\text{2R}}=9\,\text{kilo volts}$$

12. [5]

$$\frac{-3}{5}(50)x-\left(\frac{1}{2}\times 50x^2\right)=0-\frac{1}{2}\times 5\left(\frac{4}{5}\sqrt{10}\right)^2$$

$$25x^2+30x-16=0\Rightarrow \text{x}=\frac{2}{5}\text{meters}$$

So at maximum compression spring force $=50\left(\frac{2}{5}\right)=20\text{N}$ and friction force $=\frac{3}{5}(50)=30N$.

Hence the block will not move so distance $=\frac{2}{5}m$.

13. [0]
14. [4]
15. [0]
16. [5]
17. [2]

$$t(\mu-1)=\lambda \quad\Rightarrow\quad t(1.5-1)=\lambda \quad\Rightarrow t=2\lambda$$

18. [3]

Energy required to remove the electron from the third orbit

$$=\frac{13.6}{3^2}\text{eV}=1.5\ \text{eV} = 1.5 \times 1.6 \times 10^{-19}\text{J} = 3\ \text{eV}$$

19. [2]

$$\frac{f}{-u_1+f}=-\frac{f}{(-u_2+f)} \Rightarrow -u_2+f=u_1-f \Rightarrow f=\frac{u_1+u_2}{2}=2$$

20. [8]

$$d=\frac{3.6}{1.2}+\frac{7}{1.4}=8$$

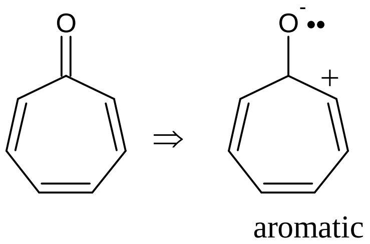
Chemistry PART – II

SECTION – A

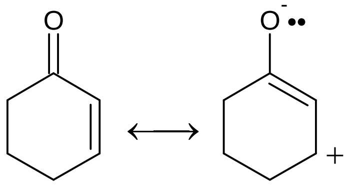
21. BC

(A)

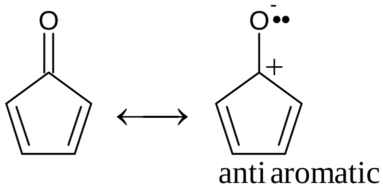
(B)


O
O
⇒
+
aromatic

(C)



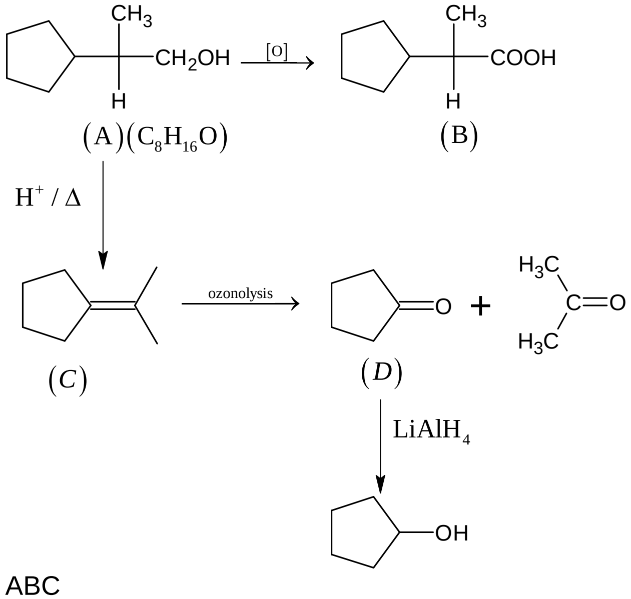
(D)


O
O
⟷
+
anti aromatic

22. ABD
Facts

23. ABCD
Facts

24. ABCD


CH3
CH2OH
H
[O]
CH3
COOH
H
(A)(C8H16O)
(B)
H+ / Δ
ozonolysis
O
+
H3C
C=O
H3C
(C)
(D)
LiAlH4
OH

25. ABC
A lone pair of N-atom participating in resonance will be less basic

26. AB
Reaction proceeds by limiting reagent only. Enthalpy of neutralization decreases, when acid or base or both are weak:

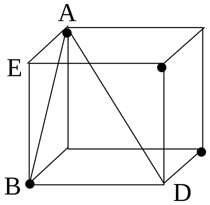
27. AD
Chiral molecules do not have plane of symmetry

28. AD
BaO_2 and Na_2O_2 are peroxides

29. ABCD
30. ABCD

SECTION – C

31. [6]



Face diagonal of cube $\left(\mathrm{AB}\right)=2\mathrm{R}$

Edge length of cube $\left(\mathrm{BE}\right)=\dfrac{2\mathrm{R}}{\sqrt{2}}$

Body diagonal of cube $\left(\mathrm{AD}\right)=\sqrt{3}\times\dfrac{2\mathrm{R}}{\sqrt{2}}$

$=\sqrt{6}\times R$

32. [5]

$$\mathrm{Mg}^{2+}+2e^{-}\longrightarrow Mg\left(E_{Mg}=\frac{24}{2}=12g\right)$$

Charge required for the deposition of $12g\ Mg=1F$

Charge required for the deposition of $1g\ Mg=\dfrac{1}{12}F$

$\therefore$ cost for $\dfrac{F}{12}$charge=Rs.5

$$Al^{3+}+3e^{-}\longrightarrow Al\left(E_{Al}=\frac{27}{3}=9g\right)$$

Charge required for $9\,g=1F$

Charge required for $30\,g=\dfrac{30}{9}F=\dfrac{10F}{3}$

Cost for $\dfrac{10F}{3}$charge$=5\times12\times\dfrac{10F}{3}$

$=Rs.200$

33. [4]

$pKa\,of\ HX=14-10=4$

$pH=pK_a+\log\dfrac{1}{1}=4$

34. [8]

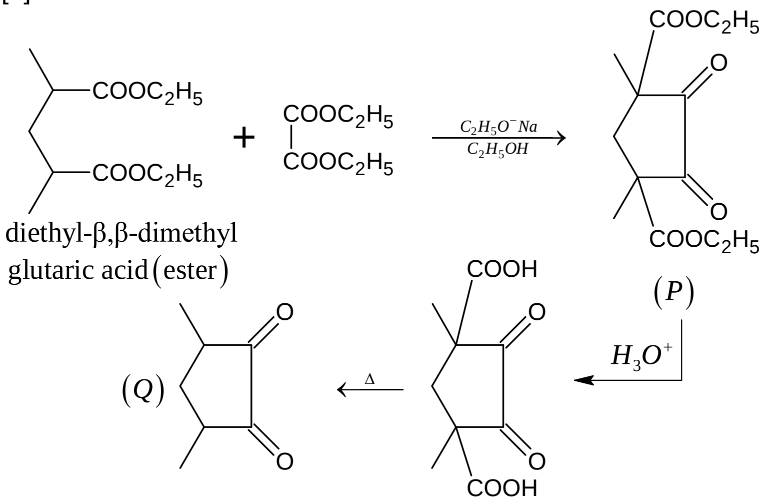
$\left(CO\right)_{x/2}Co-Co\left(CO\right)_{x/2}$

$EAN\left(=36\right)=27+1+2\times\dfrac{x}{2}$

$\Rightarrow 28+x=36$

$x=8$

35. [6]


COOC2H5
COOC2H5
+
COOC2H5
COOC2H5
C2H5O⁻Na
C2H5OH
COOC2H5
O
O
COOC2H5
diethyl-β,β-dimethyl glutaric acid(ester)
(P)
H3O+
COOH
O
O
COOH
Δ
O
O
(Q)

36. [4]

$$\frac{1}{2}H_2(g)+\frac{1}{2}Cl_2(g)\rightleftharpoons HCl(g)\,\Delta G^\circ=1.72\,kJ\ mol^{-1}$$

ΔG° for $2HCl(g)\rightleftharpoons H_2(g)+Cl_2(g)$ is $[2\times(-1.72)]\,kJ$

$$\Delta G^\circ=-2.303RT\log K_p$$

$$-3.44\times10^3=-5700\log K_p$$

$$\log K_p=0.6$$

$$K_p=4$$

37. [7]

Salt of $WA\&WB$

$$pH=7+\frac{1}{2}(pK_a-pK_b)$$

38. [8]

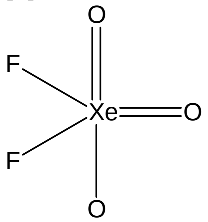
For salt of weak acid and strong base

$$pH=7+\frac{1}{2}[pK_a,\log C],$$

$$=7+\frac{1}{2}\left[\left(-\log1\times10^{-4}\right)+\log(0.01)\right]$$

$$=7+\frac{1}{2}(4-2)=8$$

39. [6]



40. [7]

Green vitriol is $FeSO_4.7H_2O$

Mathematics PART – III

SECTION – A

41. ABCD

$$f(x)=\begin{cases} px+\lambda, x>0 \\ q, x=0 \\ e^x, x<0 \end{cases}$$

42. AC

$$f(x)=(2x-1)(2x+1)(x-2)(x-4)$$

43. BCD

$p(n)=$ Probability that child stops after drawing exactly n marbles

$$p(n)=\frac{1}{2}.\frac{2}{3}.\frac{3}{4}.......\left(\frac{n-1}{n}\right)\left(\frac{1}{n+1}\right)=\frac{1}{n(n+1)}$$

44. D

$$\left(a^2-b^2\right)x^4-2ha^2\left(a^2-b^2\right)x^3-x^2+2a^4h\left(a^2-b^2\right)-a^6h^2=0 \Rightarrow \left(\sum x_1\right)\left(\sum \frac{1}{x_1}\right)=4$$

45. CD

If α is real root then $\alpha=2, m=\pm 2,$ non-real root = $1+i$

46. ACD

If $0<x<1, a=6;$ if $x>1, a=2,$ if $x<-1, a=-2$

47. A

$$\frac{3f''(x)}{f'(x)}=\frac{f'''(x)}{f''(x)}$$

$$\Rightarrow 3\ln f'(x)=\ln f''(x)+k$$

$$\Rightarrow \frac{d^2x}{dy^2}=c$$

48. B

$$e^{-\sqrt{-\ln t}}=t^{\frac{1}{\sqrt{-\ln t}}}, t\in(0,1)$$

49. ABC

$$2S=\sum_{m=1}^{\infty}\sum_{n=1}^{\infty}\left(\frac{m.n}{m.3^n+n.3^n}\right)\left(\frac{n}{3^m}+\frac{m}{3^n}\right)$$

50. AC

SECTION – C

51. [6]

$$\mathrm{p}(x)=\left(x^2-4\right)\left(x^4-10x^2+10\right)$$

52. [1]
53. [4]
54. [3]

55. [4]
56. [4]
57. [1]
58. [6]
$6+4-4$
59. [1]
$x_1 = 4, x_2 = 8,\ k = 3,\ w = 4$
60. [3]
$\Rightarrow \left(x^2+1\right)\left(x^2-bx+1\right) > 0$
So $b^2-4<0 \Rightarrow b \in \left(-2,2\right)$

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

FULL TEST – II

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 231**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-C & Section-D**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01 – 03, 24 – 26, 47 – 49)*** *contains 9 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (04 – 08, 27 – 31, 50 – 54) *contains 15 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (09 – 10, 32 – 33, 55 – 56) *contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer. There is no negative marking.*

2. ***Section-C (11 – 20, 34 – 43, 57 – 66)*** *contains 30 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

3. ***Section-D (21 – 23, 44 – 46, 67 – 69)*** *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

PART – I (Physics), PART – II (Chemistry), PART – III (Mathematics):

(SECTION – D)

For questions **21 to 23, 44 to 46, 67 to 69.**
Numerical answer type questions with answer XXXXX. XX

If answer is 348.4 / 251.37 / 213

Correct Method :

0	0	3	4	8	.	4	0
0	0	2	5	1	.	3	7
0	0	2	1	3	.	0	0

Wrong Method :

	3	4	8		.	4	
3	4	8			.		4
		3	4	8	.		4
	3		4	8	.	4	
	2		5	1	.	3	7
		2	1	3	.		
		2	1	3	.	0	
		2	1	3	.		0
		3	4	8	.	4	0
		2	5	1	.	3	7
		2	1	3	.	0	0

Physics

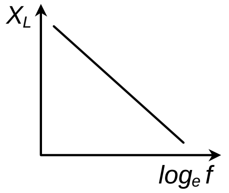
PART – I

SECTION – A
(One Options Correct Type)

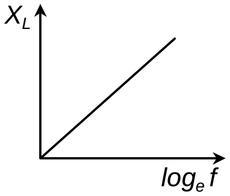
This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. The correct curve between X_L and log *f* is

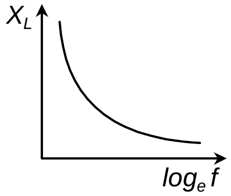
(A)



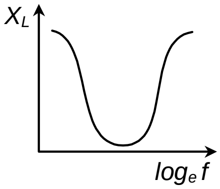
(B)



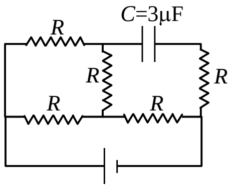
(C)



(D)



2. In the given circuit, the potential difference across the capacitor is 12 V in steady state. Each resistor have 3Ω resistance. The emf of the ideal battery is



(A) 15 V
(B) 9 V
(C) 12 V
(D) 24 V

3. A current of (2.5 ± 0.05)A flows through a wire and develops a potential difference of (10 ± 0.1) volt. Resistance of the wire in ohm, is

(A) 4 ± 0.12
(B) 4 ± 0.04
(C) 4 ± 0.08
(D) 4 ± 0.02

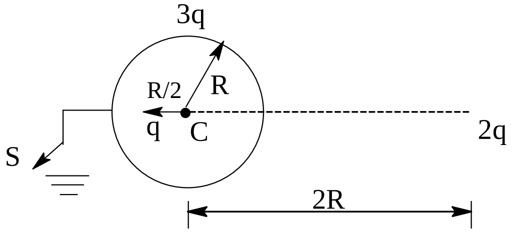
Space for Rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

4. Two identical spheres S_1 and S_2, out of which S_1 is placed on the insulating horizontal surface and S_2 hangs from an insulating string. If both were given same quantity of heat. Then:
(A) temperature of S_1 will increase more than S_2
(B) temperature of S_2 will increase more than S_1
(C) Heat given only increases internal energy
(D) Heat given not only increases internal energy but goes in other forms also.

5. A spherical shell of radius R is given charge 3q on its surface and a point charge q is placed at distance R/2 from its centre C. Also there is a charge 2q placed outside the shell at a distance of 2R as shown. Then



(A) The magnitude of electric field at the centre C due to charges on the outer surface of shell is $\frac{Kq}{2R^2}$ before closing the switch S.
(B) The electric potential at the centre C due to charges on the outer surface of shell is $\left(\frac{-Kq}{R}\right)$ before closing the switch S.
(C) The electric potential at the centre C due to charges on the outer surface of shell is $\left(\frac{-Kq}{R}\right)$ after closing the switch S.
(D) Charge flown through the switch in to earth after closing the switch S is $5q$

Space for Rough work

6. The natural length of a metallic rod at 0^0C is l_1, at θ^0C is l_2. The given lengths of the rod at θ^0 is l_3, then:
   (A) The thermal stress in the rod is non zero if $l_3 > l_2$
   (B) The strain in the rod is zero if $l_2 \neq l_3$
   (C) The thermal stress in the rod is non-zero if $l_3 < l_2$
   (D) The thermal stress and strain will be zero if $l_2 = l_3$

7. Which of the following is/are correct?
   (A) If centre of mass of three particles is at rest and it is known that two of them are moving along different lines then the third particle must also be moving.
   (B) If centre of mass remains at rest then the net work done by the forces acting on the system must be zero.
   (C) If the centre of mass remains at rest then the net external force must be zero.
   (D) If the velocity of the centre of mass is changing then there must be some net work being done on the system.

8. A spring balance reads W_1 when a ball is suspended from it. A weighing machine reads W_2 when a tank of liquid is kept on it. When the ball is immersed in the liquid, the spring balance reads W_3 and the weighing machine reads W_4
   (A) $W_1 > W_3$ (B) $W_1 < W_3$
   (C) $W_2 < W_4$ (D) $W_2 > W_4$

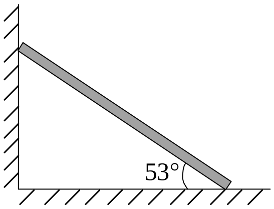
Space for Rough work

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 9 and 10

A rod of length 10 meter has one end on smooth floor and the other end on smooth wall is released from the rest from the position shown in figure. When the rod makes an angle of 37° with the horizontal, answer the following:



9. The angular velocity of rod is:
(A) $\sqrt{3}$ rad/sec (B) $\sqrt{5}$ rad/sec
(C) $\sqrt{\frac{5}{3}}$ rad/sec (D) $\sqrt{\frac{3}{5}}$ rad/sec

10. The velocity of centre of mass of rod is:
(A) $\sqrt{5}\,\text{m/s}$ (B) $\sqrt{10}\,\text{m/s}$
(C) $\sqrt{15}\,\text{m/s}$ (D) $\sqrt{20}\,\text{m/s}$

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

11. For a given velocity of projection from a point on the inclined plane, the maximum range down the plane is three times the maximum range up the incline. The angle of inclination of incline plane is $\text{K}\times 10$ [in degrees].

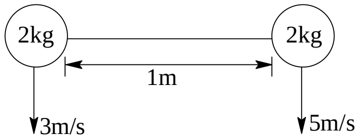
12. In L-R circuit, the A.C. source has voltage 220V. If potential difference across inductor is 176V, the potential difference across the resistor (in Volts) is $\text{K}\times 33$. Find the value of K

Space for Rough work

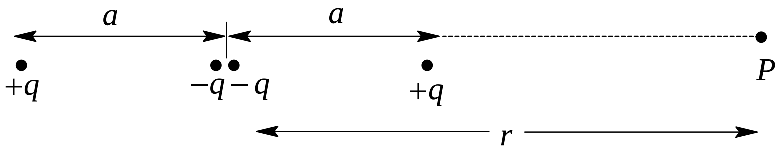
13. Two particles are performing SHM with same amplitude and time period. At an instant two particles are having velocity 1 m/s but one is on the right and the other is on the left of their mean position. When the particles have same position there speed is $\sqrt{3}\text{m/s}$. Find the maximum speed (in m/s) of particles during SHM.

14. A small ball is kept on the top of a sphere of radius R. The sphere start accelerating with constant acceleration of 10 m/s^2 horizontally. The angle of radial line with the vertical at which small ball leaves the sphere is $\frac{1}{2}\sin^{-1}(\text{K}/9)$. Find the value of K. [take g = 10 m/s^2]

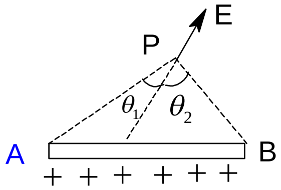
15. Two balls of masses are connected with a massless rod of length 1 meter and are given velocities on a horizontal surface parallel to surface as shown in the figure. Then the tension in the rod at the given instant is:



16. Figure shows a charge array known as an "electric quadrupole". For a point on the axis of the quadruple, the dependence of potential on r $\left(\frac{r}{a} >> 1\right)$ is $\frac{1}{r^n}$. Find n ?



17. The net electric field $\vec{E}$ due to the uniformly charged rod at P makes angles θ_1 and θ_2 with AP and BP respectively. Then find the value of θ_1 / θ_2.



18. A point object is placed at a distance $25\,cm$ from a convex lens of focal length $22\,cm$. If a glass slab of refractive index 1.5 is inserted between the lens and object, then the image is formed at infinity. Find the thickness of glass slab (in cm.)

Space for Rough work

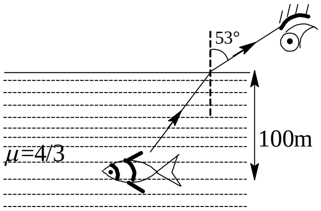
19. Two radioactive materials X_1 and X_2 have decay constants 10λ and λ respectively. If initially they have the same number of nuclei, if the ratio of the number of nuclei of X_1 to that of X_2 will be 1/e after a time $\frac{n}{9\lambda}$. Find the value of n?

20. Two wires are made of the same material and have the same volume. However, wire 1 has cross-sectional area A and wire-2 has cross-sectional area 3A. If the length of wire 1 increases by Δx on applying force 1 newton, how much force is needed to stretch wire 2 by the same amount?

SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

21. Find the apparent depth of a fish (in meter) whose real depth is 100m and is observed at an angle of vision 53° as shown in the figure



22. In a resonance column experiment the frequency of tuning fork used is 1000 Hz and the length of pipe is 100m. Ignoring end correction find the length (in cm) of air column at which second resonance is observed. [Take speed of sound = 330 m/s]

23. Find the minimum kinetic energy (in joule) with which a particle of mass 2kg should be projected from ground so that it crosses a cylindrical drum (placed on ground) of radius 1 meter and fall on the other side following a parabolic path. [Take g = 10 m/s^2 and $\sqrt{2}=1.414$]

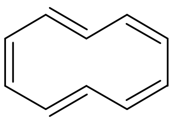
Space for Rough work

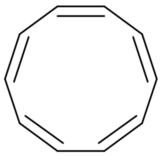
Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

24. The following two compound are:


(I)


(II)

(A) Identical isomers	(B) conformational isomers
(C) geometrical isomers	(D) Optical isomers

25. If mercuric iodide is added to an aqueous solution of KI, the:

(A) freezing point increased	(B) freezing point is lowered
(C) boiling point does not change	(D) Osmotic pressure increased

26. Which of the following is weaker base?

(A) $N\left(SiH_3\right)_3$	(B) $N\left(CH_3\right)_3$
(C) $NH\left(CH_3\right)_3$	(D) All are equally basic

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

27. Choose the incorrect methods for each:
(A) Ni: electrolysis process, Cu: van Arkel process, Zn: zone refinining, Ga: zone refining
(B) Ni: mond's process, Cu: electrolysis, Zr: van Arkel process, Ga: zone refining
(C) Ni: electrolysis process, Cu: zone refining, Zr: van Arkel process, Ga: electrolysis
(D) Ni: electrolysis process, Cu: zone refining, Zr: van Arkel process, Ga: mond's process

Space for Rough work

28. Which of the following have transition metal?

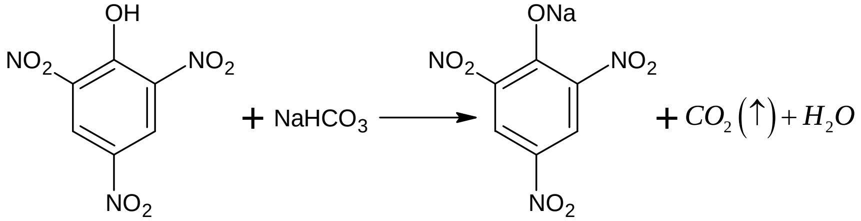
(A) Haemoglobin (B) Vitamin B_{12}

(C) Cis – platin (D) Chlorophyll

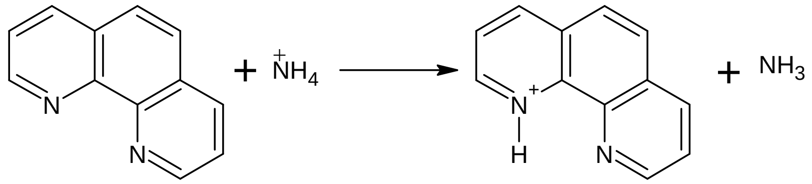
29. Which one of the following reactions is/are correct?

(A) $CH_3COOK + CF_3COOH \longrightarrow CH_3COOH + CF_3COOK$

(B)



(C)



(D) $CH_3CH_2OH + NaHCO_3 \longrightarrow CH_3CH_3ONa + H_2O + CO_2(\uparrow)$

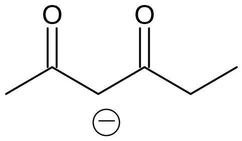
30. Which of the following is/are the compound of aluminium?

(A) horn silver (B) bauxite

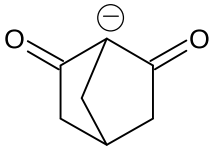
(C) corundum (D) Diaspore

31. Which of the following carbanions are not resonance stabilized?

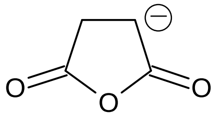
(A)



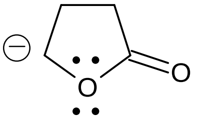
(B)



(C)



(D)



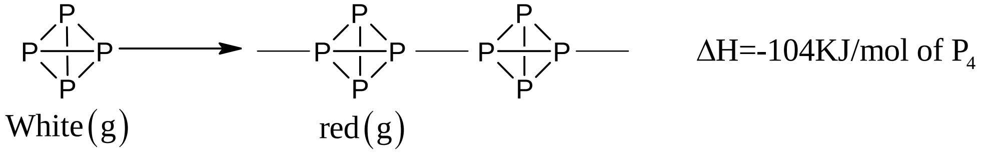
Space for Rough work

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 32 and 33

White phosphorus is a tetra atomic solid $\left[P_4(s)\right]$ at room temperature and on strong heating in absence of oxygen, it polymerizes into red phosphorus as:



The enthalpy of sublimation $\left[P_4(s) \longrightarrow P_4(g)\right]$ white is 59 KJ/mol and enthalpy of atomization is 316.25 KJ/mol of $P(g)$.

Now give the answers of following questions:

32. The average $P-P$ bond enthalpy in P_4 molecule is:

(A) $102KJ$ (B) $201KJ$

(C) $104KJ$ (D) $120KJ$

33. The $P-P$ bond enthalpy in red phosphorus joining the two tetrahedral is:

(A) $201KJ$ (B) $104KJ$

(C) $305KJ$ (D) $80KJ$

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

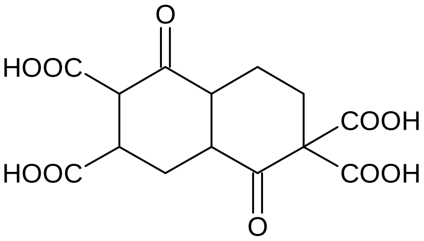
34. An orbital has only positive values of wave function at all distances from the nucleus. Find the value of $(n+l)$ for this orbital.

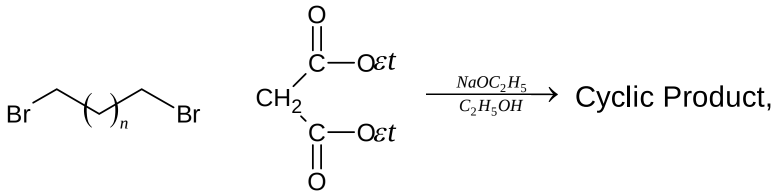
35. Isotopic number of ${}^{58}_{26}Fe$ is:

36. The Henry's law constant for the solubility of N_2 gas in water at $298K$ is $1\times10^5\,atm.$ The mole fraction of N_2 air is 0.8. The number of mole of N_2 of dissolved in 10 mole of water at $298K\ and\ 5\,atm.$ are $x\times10^{-4.}$. Find the value of x.

37. The mass of a non-volatile solute (Molar mass 40) which should be dissolved in 114 g octane to reduce its vapour pressure to 80 % is $2x\ g$. Find the value of x

38. How many moles of CO_2 will released when following compound is heated

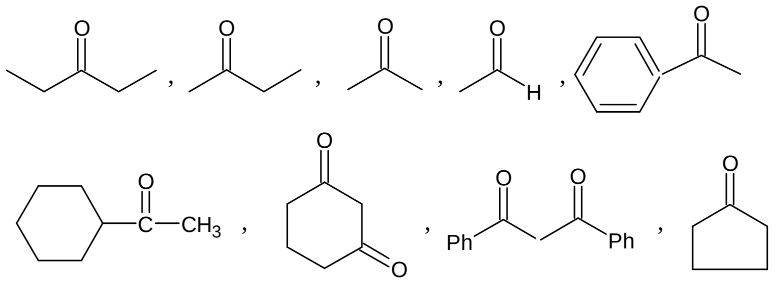


39. 

At what value of $'n'$ the formation of six membered ring take place.

Space for Rough work

40. Examine the structural formulas of compounds given below and identify number of compounds which show positive iodoform test.



41. Calculate the value $X - Y$, for $XeOF_4$. (X=Number of σ bond pair and Y=Number of lone pair on central atom).

42. For oxyacid $HClO_x$, if $x = y = z$ ($x, y\ and\ z$ are natural numbers), then calculate the value of $|x + y + z|$. Where $x =$ Number of 'O' atoms.
y= Total number of lone pairs at central atom
z= Total number of $\mathrm{pi}(\pi)$ electrons in the oxyacid

43. The number of electrons for Zn^{2+} cation that have the value of azimuthal quantum number $= 0$ is:

Space for Rough work

SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

44. One male of nitrogen gas at 0.8 atm takes 38 seconds on diffuse through a pinhole, whereas one mole of a compound of xenon with fluorine at 1.6 atm takes 57 seconds to diffuse through the same hole. Calculate molecular weight of the compound.

45. Calculate $\Delta_f H^\circ$ (magnitude only) for chloride ion (aq.) from the following data:

$$\frac{1}{2}H_2(g)+\frac{1}{2}Cl_2(g)\rightarrow HCl(g); \qquad \Delta_f H^\circ = -92.4\,kJ$$

$$HCl(g)+H_2O(\ell)\rightarrow H_3O^+(aq)+Cl^-(aq); \qquad \Delta H^\circ = -74.8\,kJ$$

$$\Delta_f H^\circ \,of\; H^+(aq) = 0.0\,kJ$$

46. K_{sp} of $PbBr_2$ (Molar mass $= 367$) is 3.2×10^{-5}. If the salt is 80% dissociated in solution, calculate the solubility of salt in g per litre.

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

47. Maximum value of function $f(x) = \left(\sin^{-1}(\sin x)\right)^2 - \sin^{-1}(\sin x)$ is:

(A) $\frac{\pi}{4}(\pi + 2)$
(B) $\frac{\pi}{4}(\pi - 2)$
(C) $\frac{\pi}{4}$
(D) None of these

48. For a parabola $x^2 - 4xy + 4y^2 - 32x + 4y + 16 = 0$, focus is:

(A) $(2,1)$
(B) $(-2,1)$
(C) $(-2,-1)$
(D) $(2,-1)$

49. Let $f(x) = ax^4 + bx^2 + 3x + 7$ and $f(-4) = 2286$ and $f(4) = N$. The number of ways in which N can be resolved as a product of two divisors which are relatively prime:

(A) 15
(B) 16
(C) 17
(D) None of these

Space for Rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

50. The volume of a right triangular prism $ABCA_1B_1C_1$ is equal to 3. If the position vectors of the vertices of the base ABC are A(1, 0, 1) ; B(2,0, 0) and C(0, 1, 0) the position vectors of the vertex A_1 can be:

(A) (2, 2, 2) (B) (0, 2, 0)
(C) (0, - 2, 2) (D) (0, - 2, 0)

51. If the equation $|z|(z+1)^8 = z^8|z+1|$ where $z \in C$ and $z(z+1) \neq 0$ has distinct roots $z_1, z_2, z_3, \ldots, z_n$ (where $n \in N$) then which of the following is/are true?

(A) $z_1, z_2, z_3, \ldots, z_n$ are concyclic points (B) $z_1, z_2, z_3, \ldots, z_n$ are collinear points
(C) $\sum_{r=1}^{n} \text{Re}(z_r) = \frac{-7}{2}$ (D) $\sum_{r=1}^{n} \text{Im}(z_r) = 0$

52. If in a ΔABC, a, b, c are in A.P. and P_1, P_2, P_3 are the altitudes from the vertices A, B and C respectively, then

(A) P_1, P_2, P_3 are in A.P. (B) P_1, P_2, P_3 are in H.P.
(C) $P_1 + P_2 + P_3 \leq \frac{3R}{\Delta}$ (D) $\frac{1}{P_1} + \frac{1}{P_2} + \frac{1}{P_3} \leq \frac{3R}{\Delta}$

53. Suppose a_1, a_2, a_3 are in A.P. and b_1, b_2, b_3 are in H.P. and let $\Delta = \begin{vmatrix} a_1 - b_1 & a_1 - b_2 & a_1 - b_3 \\ a_2 - b_1 & a_2 - b_2 & a_2 - b_3 \\ a_3 - b_1 & a_3 - b_2 & a_3 - b_3 \end{vmatrix}$, then

(A) Δ is independent of $a_1, a_2, a_3, b_1, b_2, b_3$
(B) $a_1 - \Delta$, $a_2 - 2\Delta$, $a_3 - 3\Delta$ are in A.P.
(C) $b_1 + \Delta$, $b_2 + \Delta^2$, $b_3 + \Delta$ are in H.P
(D) none of these

Space for Rough work

54. Given three non – zero, non – coplanar vectors, and $\vec{a}, \vec{b}$ and $\vec{c}$ and $\vec{r}_1 = p\vec{a} + q\vec{b} + \vec{c}$ and $\vec{r}_2 = \vec{a} + p\vec{b} + q\vec{c}$ if the vectors $\vec{r}_1 + 2\vec{r}_2$ and $2\vec{r}_1 + \vec{r}_2$ are collinear then (p, q) is

(A) (0, 0)
(B) (1, –1)
(C) (–1, 1)
(D) (1, 1)

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 55 and 56

Let t be a real number satisfying $2t^3 - 9t^2 + 30 - \lambda = 0$ where $t = x + \frac{1}{x}$ and $\lambda \in R$ then

55. If the cubic equation has three real and distinct solution for x then λ

(A) Is greater than 9
(B) Is greater than 11
(C) Is less than 8
(D) Is not equal to 10

56. If the cubic equation has exactly two real and distinct roots of x then exhaustive set of values of λ is

(A) $\lambda \in (-\infty, 3) \cup (30, \infty)$
(B) $\lambda \in (-\infty, -22) \cup (10, \infty) \cup \{3\}$
(C) $\lambda \in \{3, 30\}$
(D) None of these

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

57. Consider on equation with x as variable $7\sin 3x - 2\sin 9x = \sec^2\theta + 4\operatorname{cosec}^2\theta$ then the value of $\frac{15}{2\pi}$ [minimum positive root – maximum negative root] is:

Space for Rough work

58. Let $P(x) = Q_0 + a_1x + a_2x^2 + ...a_nx^n$ be a non zero polynomial with integer coefficients. If one of the root is $\sqrt{2}+\sqrt{3}+\sqrt{6}$ then the smallest possible value of n is

59. $f(x) = \max|2\sin y - x|$ where $y \in R$ then minimum value of $f(x)$ is:

60. Let $f(x)(x > 1)$ be a differentiable function satisfying $f(x) = (\ln x)^2 - \int_1^e \frac{f(t)}{t}dt$. Then if Area bounded by tangent line of $y = f(x)$ at $(e, f(e))$, then curve $y = f(x)$ and $x = 1$ is A then $[A]$ is ($[.]$ is G. I. F)

61. If the area enclosed by $g(x), x = -3, x = 5$ and x-axis where $g(x)$ is the inverse of $f(x) = x^3 + 3x + 1$ is A, then $[A]$ is ($[.]$ is G. I. F)

62. Let $f(x) = \cos 2x.\cos 4x.\cos 6x.\cos 8x.\cos 10x$ then $\lim\limits_{x \to 0} \frac{1-(f(x))^3}{55\sin^2 x}$ equals

63. Number of values of $x \in [0, \pi]$ where $f(x) = [4\sin x - 7]$ is non derivable is ($[.]$ is G. I. F)

64. If the equation on reflection of $\frac{(x-4)^2}{16} + \frac{(y-3)^2}{9} = 1$ about the line $x - y - 2 = 0$ is $16x^2 + 9y^2 + k_1x - 36y + k_2 = 0$ then $\frac{k_1 + k_2}{22}$ is

Space for Rough work

65. Let $A\left(\frac{1}{2},0\right),B\left(\frac{3}{2},0\right),C\left(\frac{5}{2},0\right)$ be the given points and P be point sashaying $\max\left(PA+PB,PB+PC\right)<2$. If area of region of point P is $\sqrt{3}\left(\frac{\pi}{a}-\frac{\sqrt{3}}{b}\right)$ then $a+b$ is

66. Find the absolute value of (tan A tan 2A) + (tan 2A tan 4A) + (tan 4A tan A), where $A=\frac{2\pi}{7}$.

SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

---

67. Complex number a, b and c are zeros of polynomials $p(z)=z^3+qz+r\,(q,r\in R)$ and $|a|^2+|b|^2+|c|^2=250$. If the points corresponding to a, b and c is complex planes are vertices of a right angle triangle with hepotencese $'h'$ then h^2 is:

68. Mr. A lists all the positive divisors of the number $N(2010)^2$ and selects two divisors from the list then the probability that exactly one of the selected divisors is a perfect squares is:

69. If $\frac{(x-3)^{\frac{-|x|}{x}}\sqrt{(x-4)^2}\,(17-x)}{\sqrt{-x}\left(-x^2+x-1\right)\left(|x|-32\right)}<0$ then no. of integers x satisfying the inequality is:

Space for Rough work

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FULL TEST – II

PAPER-2

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	C	24.	C	47.	A
2.	A	25.	A	48.	D
3.	A	26.	A	49.	B
4.	BD	27.	ACD	50.	A,D
5.	ACD	28.	ABC	51.	BCD
6.	ACD	29.	ABC	52.	BD
7.	AC	30.	BCD	53.	ABC
8.	AC	31.	BD	54.	D
9.	D	32.	B	55.	A
10.	C	33.	C	56.	B
11.	3	34.	1	57.	5
12.	4	35.	6	58.	4
13.	2	36.	4	59.	2
14.	5	37.	5	60.	0
15.	4	38.	3	61.	4
16.	3	39.	3	62.	6
17.	1	40.	6	63.	7
18.	9	41.	4	64.	6
19.	1	42.	6	65.	7
20.	9	43.	6	66.	7
21.	00031.64	44.	00252.00	67.	00375.00
22.	00024.75	45.	00167.20	68.	00000.32
23.	00048.28	46.	00009.175	69.	00031.00

Physics

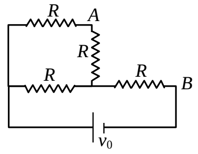
PART – I

SECTION – A

1. C

2. A

In steady state current will not flow from the capacitor.
If emf of battery is v_0, then potential difference between *A* and *B*.



$$V_A - V_B = \frac{0.4v_0}{5} = 12\text{ V} \quad \Rightarrow \quad v_0 = 15\text{ V}$$

3. A

$$V = iR \;\Rightarrow R = \frac{V}{i}, \Delta R = \left[\frac{\Delta V}{V} + \frac{\Delta i}{i}\right] \quad \therefore \quad R = (4 \pm 0.012)\Omega$$

4. BD
5. ACD
6. ACD
7. AC
8. AC
9. D

10. C

Using IAOR

$$\text{mg}\frac{\ell}{2}\sin 53° = mg\frac{\ell}{2}\sin 37° + \frac{1}{2}I\omega^2$$

$$\omega = \sqrt{\frac{3}{5}} \Rightarrow V_{cm} = 5\sqrt{\frac{3}{5}} = \sqrt{15}$$

SECTION – C

11. 3

$$\frac{u^2}{g[1-\sin\beta]} = \frac{3u^2}{g[1+\sin\beta]} \;\Rightarrow\; 1+\sin\beta = 3 - 3\sin\beta \;\Rightarrow \sin\beta = \frac{1}{2} \;\Rightarrow\; \beta = 30^0$$

12. 4

$$220V = \sqrt{(176)^2 + V_0^2} \Rightarrow V_0 = \sqrt{(220)^2 - (176)^2}\; V = 132\text{ V}$$

13. 2
14. 5
15. 4

As $\omega = \frac{\text{V}_{\text{rel}}}{\text{r}} = \frac{\text{5-3}}{1} = 2\text{rad/sec}$

$$\text{T} + 2\left(\frac{\text{T}}{2}\right) = \frac{2\times 2^2}{1} \Rightarrow \text{T=4Newton}$$

16. 3
17. 1
18. 9
19. 1
20. 9

SECTION – D

21. 00031.64

22. 00024.75

$$f = \frac{3v}{4\ell} = 1000 \Rightarrow \ell = 24.75\,cm$$

23. 00048.28

Chemistry PART – II

SECTION – A

24. C

(I) is trans and (II) is cis form

25. A

$$\underbrace{2\text{KI}+\text{HgI}_2}_{\text{Four ions}} \longrightarrow \underbrace{\text{K}_2\left[\text{HgI}_4\right]}_{\text{three ions}}$$

26. A

Due to back bonding (A) is a weaker base.

27. ACD
28. ABC
29. ABC
30. BCD
31. BD
32. B

$$P_4(s) \longrightarrow P_4(g) \qquad \Delta H = 59\,KJ$$

$$P_4(s) \longrightarrow 4P(g) \qquad \Delta H = 1265\,KJ$$

$$P_4(g) \longrightarrow 4P(g) \qquad \Delta H = 1206\,KJ$$

Average $P-P$ bond enthalpy $= \frac{1206}{6} = 201\,KJ$

33. C

On an average, one $P-P$ bond of tetrahedral is broken and one new $P-P$ bond joining the two tetrahedral units is formed.

$$201 - x = -104$$

$$\therefore x = 305\,KJ\ mol^{-1}$$

SECTION – C

34. 1

It is orbital

35. 6

Isotopic no $= n - p = (58-26) - (26) = 32 - 26 = 6$

36. 4

$$X_{N_2} = \frac{P'_{N_2}}{K_H} = \frac{5\times 0.8}{1\times 10^5} \qquad (P'_{N_2} = P_{air} \times \text{mole fraction of } N_2)$$

$$= 4\times 10^{-4}$$

$$\therefore \quad \frac{n_{N_2}}{n_{N_2} + n_{H_2O}} = 4\times 10^{-5} = \frac{n_{N_2}}{n_{N_2} + 10} \qquad \left(n_{N_2} <<< 10\right)$$

$$\therefore \quad n = 4\times 10^{-4}$$

37. 5

$$P_S = \left(\frac{80}{100}\right)P^0,\quad w = ?,\quad m = 40$$

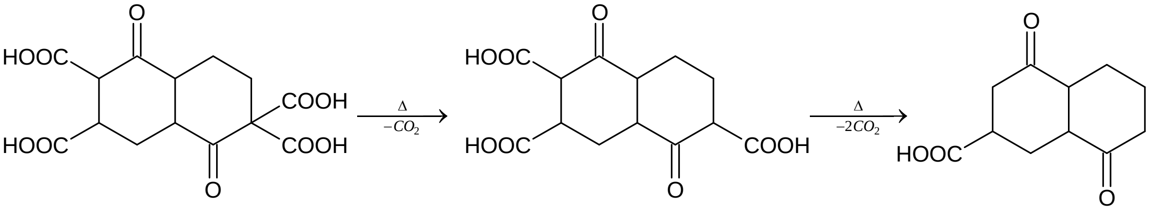
$$W = 114g,\quad M_{C_8H_{18}} = 114$$

$$\frac{P^0 - P_s}{P_s} = \frac{w \times M}{m \times W}$$

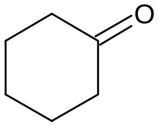
Or $$\frac{P^\circ - \left(\frac{80}{100}\right)P^\circ}{\left(\frac{80}{100}\right)P^\circ} = \frac{w \times 114}{40 \times 114}$$

$$w = 10g$$

38. 3

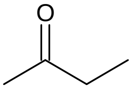

HOOC
HOOC
O
O
COOH
COOH
Δ
$-CO_2$
HOOC
HOOC
O
O
COOH
Δ
$-2CO_2$
O
HOOC
O

39. 3

Product:


40. 6

These compounds will give iodoform test



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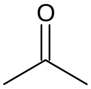

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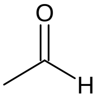

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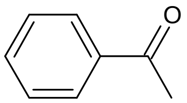

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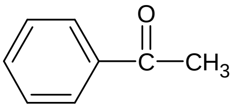

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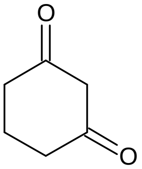

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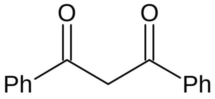
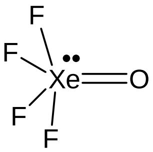


41. 4

$XeOF_4$



42. 6

The compound is $HClO_2$

43. 6

Azimuthal quantum number is zero for s-subshell

SECTION – D

44. 00252.00

$$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}} \times \frac{P_1}{P_2}$$

Or $$\frac{n_1}{t_1} \times \frac{t_2}{n_2} = \sqrt{\frac{M_2}{M_1}} \times \frac{P_1}{P_2}$$

Or $$\frac{1}{38} \times \frac{57}{1} = \sqrt{\frac{M}{28}} \times \frac{0.8}{1.6}$$

$\therefore \quad M = 252$

45. 00167.20

Given,

$$\frac{1}{2}H_2(g) + (Aq) \rightarrow H^+(aq); \qquad \Delta H^\circ = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots (\text{i})$$

$$\frac{1}{2}H_2(g) + \frac{1}{2}Cl_2(g) \rightarrow HCl(g); \qquad \Delta H^\circ = -92.4kJ \ldots\ldots\ldots (\text{ii})$$

$$HCl(g) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq); \qquad \Delta H = -74.8kJ \ldots\ldots\ldots\ldots (\text{iii})$$

By inspection method: $\text{Eqs.}(\text{ii}) + (\text{iii}) - (\text{i})$ reveals that

$$\frac{1}{2}Cl_2(g) + (Aq) \rightarrow Cl^-(aq); \qquad \Delta H = -167.2kJ$$

$i.e.$ Heat of formation of $Cl^-(aq) = -167.2kJ$

46. 0000 9.175

Let solubility of $PbBr_2$ is $S \ mol \ litre^{-1}$

$$PbBr_2(s) + Aq \rightleftharpoons PbBr_2(aq) \rightleftharpoons \underset{\frac{S\times 80}{100}}{Pb^2} + \underset{\frac{2S\times 80}{100}}{2Br^-}$$

Since, $PbBr_2$ ionises to 80% only.

Now $$K_{sp} = \left[Pb^{2+}\right]\left[Br^-\right]^2$$

Or $$3.2\times 10^{-5} = \left[\frac{S\times 80}{100}\right]\left[\frac{2S\times 80}{100}\right]^2$$

$$S = 0.025\, mol\, litre^{-1}$$

$$= 0.025 \times 367\, g\, litre^{-1}$$

$$= 19.175\, g\, litre^{-1}$$

Mathematics PART – III

SECTION – A

47. A

$\left(\sin^{-1}\sin x-1/2\right)^2-1/4$

48. D

$\left(x-2y-4\right)^2=12\left(2x+y\right)$

49. B

50. A,D

knowing the volume of the prism we find its altitude H = (A A_1) = and designating the vertex A_1 (x_1, y_1, z_1) relate the co-ordinates of the vector $\overrightarrow{AA_1}$ = (x - 1, y, z - 1) and its length. We get the other equation from the condition $\overrightarrow{AA_1}$ perpendicular to $\overrightarrow{AC}$]

51. BCD

52. BD

53. ABC

54. D

55. A

For $\lambda=10\Rightarrow t_1=2,\ t_2>2$ and if $x+1/x=2\Rightarrow x=1$ and $x+1/x=t_2$ so there will be two distinct values of x

56. B

Since domain of $f\left(t\right)=2t^3-9t^2+30,\ t=x+1/x,\ \left|t\right|\geq 2\,f\left(-2\right)=-22,\ f\left(2\right)=10,$ critical points at $t=0\,\&\,3;\ f\left(3\right)=3$

SECTION – C

57. 5

58. 4

59. 2

60. 0

61. 4

62. 6

$$\lim_{x\to 0}\frac{\ln\cos 2x}{x^2}=-\frac{2^2}{2},\lim_{x\to 0}\frac{\ln\cos 4x}{x^2}=-\frac{4^2}{2}$$

63. 7

64. 6

65. 7

66. 7

SECTION – D

67. 375.00

68. 00000.32

69. 00031.00

FIITJEE **JEE (Main)-2018**

ALL INDIA TEST SERIES

FULL TEST – II

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 to 30)** contains 30 multiple choice questions which have only one correct answer. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

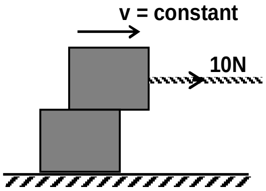
SECTION – A

Straight Objective Type

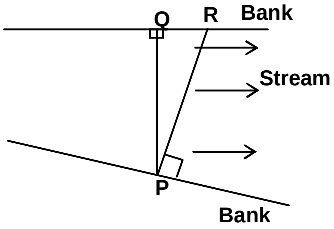
This section contains **30 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct.

1. A solid object is rotating freely without experiencing any external torque. In this case
(A) both the angular momentum and angular velocity have constant direction.
(B) the direction of the angular momentum is constant but the direction of the angular velocity might not be constant.
(C) the direction of the angular velocity is constant but the direction of the angular momentum might not be constant.
(D) neither the angular momentum nor the angular velocity necessarily has constant direction.

2. A 10-cm cube of metal is fastened rigidly in place. A second, identical cube of metal is pulled across the top of the first cube at a constant speed by a constant 10 N force, as shown. The frictional force between the cubes
(A) is less than 10 N.
(B) is equal to 10 N.
(C) is greater than 10 N.
(D) cannot be determined without a detailed model of the two surfaces.



3. In a lake, stream direction is as shown in the figure. A man starting from the point P on the bank 1 wants to move to the bank 2 in shortest time. He should swim
(A) along PQ
(B) along PR
(C) In a direction in-between PQ and PR
(D) in all cases he would reach at the same time



Space for rough work

4. A particle is projected vertically upwards from the ground with a speed v and a second particle is projected at the same instant from a height h directly above the first particle with the same speed v at an angle of projection θ with the horizontal in upward direction. The time when the distance between them is minimum is

(A) $\dfrac{h}{2v\sin\theta}$ (B) $\dfrac{h}{2v\cos\theta}$

(C) $\dfrac{h}{\sqrt{2}\,v}$ (D) $\dfrac{h}{2v}$

5. Which of the following forces is non conservative one?

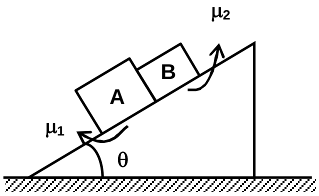
(A) $3\hat{i}+4\hat{j}$ (B) $4x\hat{i}+3y\hat{i}$

(C) $3x^2\hat{i}+4y^2\hat{j}$ (D) $y^2\hat{i}+x^2\hat{j}$

6. In the figure shown, the wedge is fixed and the masses are released from rest. The coefficient of friction between A and the incline is μ_1 and B and the incline is μ_2. Then which of the following sentences is (are) correct

I. normal reaction between A and B can never be zero

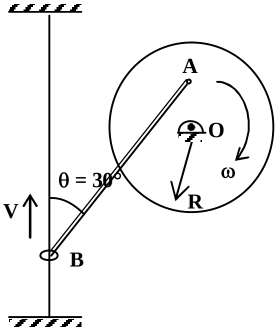
II. normal reaction between A and B is zero only if $\mu_1 = \mu_2$



(A) I only (B) II only

(C) both I and II (D) none

7. A disk is fixed at its centre O and rotating with constant angular velocity ω. There is a rod whose one end is connected at A on the disc and the other end is connected with a ring which can freely move along the fixed vertical smooth rod. At an instant when the rod is making an angle 30° with the vertical the ring is found to have a velocity v in the upward direction. Find ω of the disk. Given that the point A is R/2 distance above point O and length of the rod AB is ℓ

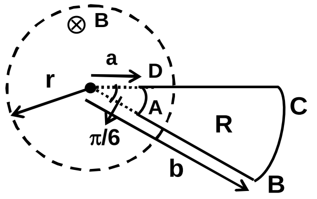


(A) $\dfrac{v\sqrt{3}}{2\ell}$ (B) $\dfrac{v\sqrt{3}}{2R}$

(C) $\dfrac{2\sqrt{3}v}{R}$ (D) $\dfrac{2v}{\ell\sqrt{3}}$

Space for rough work

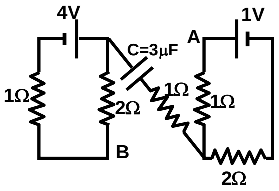
8. Magnetic field B in a cylindrical region of radius r varies according to the law $B = B_0t$ as shown in the figure. A fixed conducting loop ABCDA of resistance R is lying in the region as shown. The current flowing through the loop is



(A) $\frac{\pi a^2 B_0}{12R}$ (B) $\frac{\pi(r^2 - a^2)B_0}{12R}$

(C) $\frac{\pi(b^2 - a^2)B_0}{12R}$ (D) none of the above

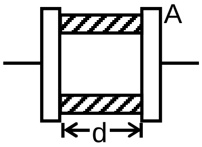
9. In the circuit shown in the adjacent figure, the batteries are ideal. The charge on the capacitor C is



(A) 10 μC (B) 20 μC

(C) 30 μC (D) zero

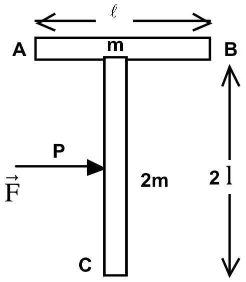
10. A parallel plate capacitor of area A and separation d is provided with thin insulating spacers to keep its plates aligned in an environment of fluctuating temperature. If the coefficient of thermal expansion of material of the plate is α, find the coefficient of thermal expansion (α_s) of the spacers in order that the capacitance does not vary with temperature. (Ignore effect of the spacers on capacitance.)



(A) $\alpha_s = \frac{\alpha}{2}$ (B) $\alpha_s = 3\alpha$

(C) $\alpha_s = 2\alpha$ (D) $\alpha_s = \alpha$

11. A T shaped object with dimensions shown in the figure is lying on a smooth floor. A force $\vec{F}$ is applied at the point P parallel to AB such that the object has only the translational motion without rotation. Find the location of P with respect to C.

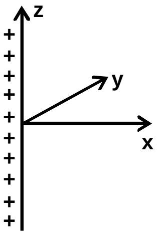


(A) $\frac{3}{4}\ell$ (B) ℓ

(C) $\frac{4}{3}\ell$ (D) $\frac{3}{2}\ell$

Space for rough work

12. An infinite thread of charge density λ lies along z-axis. The potential difference between points A (4, 3, 4) and B (3, 4, 0) is

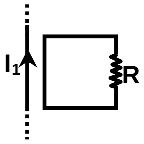


(A) $\frac{\lambda}{2\pi\in_0}\ln\left(\frac{\sqrt{41}}{5}\right)$
(B) $\frac{\lambda}{2\pi\in_0}\ln(5)$
(C) zero
(D) $\frac{\lambda}{2\pi\in_0}$

13. The sun having surface temperature T_S radiates like a black body. The radius of sun is R_S and earth is at a distance R from the surface of sun. Earth absorbs radiations falling on its surface from sun only and is at constant temperature T. If radiations falling on earth's surface are almost parallel and earth also radiates like a blackbody, then

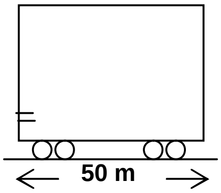
(A) $T = T_s\sqrt{\frac{R_s}{2R}}$
(B) $T = T_S$
(C) $T = \frac{T_s}{2}\sqrt{\frac{R_s}{R}}$
(D) $T = T_s\sqrt{\frac{R_s}{R}}$

14. In the adjacent figure, the mutual inductance of the infinite straight wire and the coil is M, while the self inductance of the coil is L. The current in infinite wire is varying according to the relation $I_1 = \alpha t$, where α is a constant and t is the time. The time dependence of current in the coil is



(A) $\frac{M\alpha}{R}$
(B) $\frac{M\alpha L}{R}e^{-Rt/L}$
(C) $\frac{\alpha}{R}\left(1-e^{-Rt/L}\right)$
(D) none of the above

15. A cannon-ball is fired with a speed 50 m/sec with respect to ground from one end of a stationary railroad car which rests on a smooth track. The ball collides with the opposite wall and stops. How much distance did the railroad car cover just before the collision? Given that the ratio of the mass of the ball to that of the railroad car is 1/99 and the length of the car is 50 m



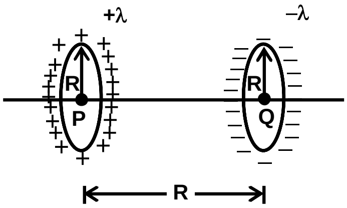
(A) 2 m
(B) $\frac{1}{2}$m
(C) 0 m
(D) cannot be calculated from acts

Space for rough work

16. A cubical box of side 1 m contains an ideal gas at pressure 100 N/m^2. If $\Sigma v_x^2 = \Sigma v_y^2 = \Sigma v_z^2 = 10^{28}\ m^2/s^2$, where v_x, v_y and v_z are the x, y and z components, respectively, of the gas molecule, then the mass of each gas molecule is

(A) 10^{-20} g (B) 10^{-23} g
(C) 10^{-18}g (D) 10^{-26} g

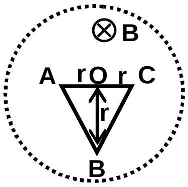
17. Two fixed insulating rings A and B carry charges with uniform linear charge density +λ and –λ, respectively, as shown in the adjacent figure. The planes of the rings are parallel to each other and their axes are coinciding. A particle of charge "q" and mass "m" is released with zero velocity from centre P of the positively charged ring. The kinetic energy of the particle when it reaches centre Q of the negatively charged ring will be



(A) $\sqrt{\dfrac{2\lambda q}{m\epsilon_0}\left(1-\dfrac{1}{\sqrt{2}}\right)}$ (B) $\dfrac{\lambda}{\epsilon_0}\left(1-\dfrac{1}{\sqrt{2}}\right)q$

(C) $\dfrac{\lambda}{2\epsilon_0}\left(1-\dfrac{1}{\sqrt{2}}\right)q$ (D) none of the above

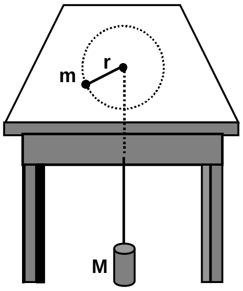
18. Magnetic field in the cylindrical region with its axis passing through O varies at a constant rate $\dfrac{dB}{dt}$. A triangular imaginary loop ABC, with AB = BC, is lying in this region as shown in the adjacent figure. The work done to move unit positive charge from A to B along the side AB is



(A) $r^2\dfrac{dB}{dt}$ (B) $\pi r^2\dfrac{dB}{dt}$

(C) $\dfrac{r^2}{2}\dfrac{dB}{dt}$ (D) $\dfrac{3r^2}{4}\dfrac{dB}{dt}$

19. A puck is moving in a circle of radius r_0 with a constant speed v_0 on a level frictionless table. A string is attached to the puck, which holds it in the circle; the string passes through a frictionless hole and is attached on the other end to a hanging object of mass M. The puck is now made to move with a speed $v' = 3v_0$, but still in circle. The mass of the hanging object is left unchanged. The acceleration a' of the puck and the radius r' of the circle are now given by



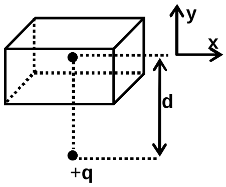
(A) $a' = 9a_0$ and $r' = r_0$. (B) $a' = a_0$ and $r' = 9r_0$
(C) $a' = 9a_0$ and $r' = 9r_0$ (D) $a' = a_0$ and $r' = r_0$

Space for rough work

20. Two spherical black bodies A and B are emitting radiations at same rate. The radius of B is doubled keeping radius of A fixed. The wavelength corresponding to maximum intensity becomes half for A while it remains same for B. Then, the ratio of rate of radiation energy emitted by A and B is

(A) 2
(B) 1/2
(C) 4
(D) 1/4

21. A charge +q is placed at a distance 'd' from the centre of the uncharged metallic cube of side 'a'. The electric field at the centre of the cube due to induced charges on the cube will be

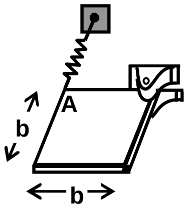


(A) zero
(B) $\frac{q}{4\pi\epsilon_0 d^2}\left(-\hat{j}\right)$
(C) $\frac{q}{4\pi\epsilon_0 d^2}\left(\hat{j}\right)$
(D) $\frac{q}{4\pi\epsilon_0\left(d-\frac{a}{2}\right)^2}\left(-\hat{j}\right)$

22. A physical quantity ρ is calculated by using the formula $\rho = \frac{1}{10}\frac{xy^2}{z^{1/3}}$, where x, y and z are experimentally measured quantities. If the fractional error in the measurement of x, y and z are 2%, 1% and 3%, respectively, then the maximum fractional error in the calculation of ρ is

(A) 0.5%
(B) 5%
(C) 6%
(D) 7%

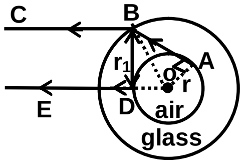
23. A uniform square plate of mass m is supported in a horizontal plane by a vertical pin at B and is attached at A to a spring of constant K. If corner A is given a small displacement and released, determine the period of the resulting motion.



(A) $2\pi\sqrt{\frac{2Mb}{3K}}$
(B) $2\pi\sqrt{\frac{Mb}{6K}}$
(C) $\pi\sqrt{\frac{Mb}{3K}}$
(D) none of the above

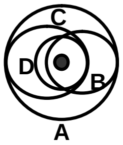
Space for rough work

24. The adjacent figure shows cross section of a hollow glass tube of internal radius r, external radius R and index of refraction n. For two rays DE and ABC (in which DE lies on ODE and DE and BC are parallel), the separation r_1 will be



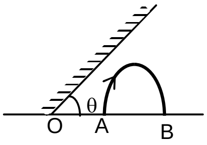
(A) $r_1 = (n - 1)R$
(B) $r_1 = n^2R$
(C) $r_1 = nr$
(D) $r_1 = n^2r$

25. The given figure shows several possible elliptical orbits of a satellite. On which orbit will the satellite acquire the largest speed?

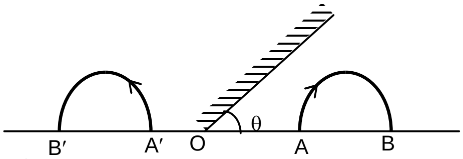


(A) A
(B) B
(C) C
(D) D

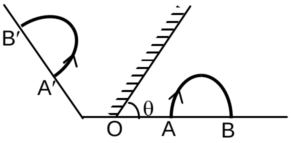
26. An object is projected from A and reaches B on the same horizontal surface. A plane mirror inclined at an angle θ to the horizontal is placed on the ground as shown in the figure. Which of the following best describes the path of the image?



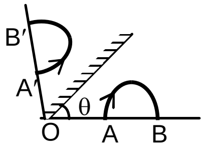
(A)



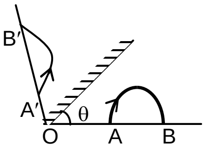
(B)



(C)



(D)

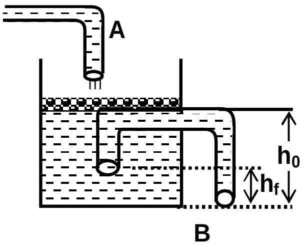


27. A solid uniform ball of volume V floats on the interface of two immiscible liquids [The specific gravity of the upper liquid is γ/2 and that of the lower liquid is 2γ, where γ is the specific gravity of the solid ball.] The fraction of the volume of the ball that will be in upper liquid is

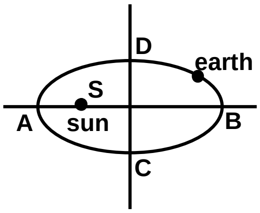
(A) $\frac{2}{3}V$
(B) $\frac{1}{3}V$
(C) $\frac{V}{4}$
(D) $\frac{3V}{4}$

Space for rough work

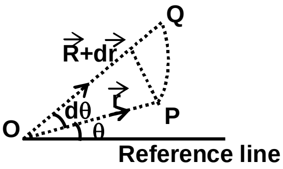
28. In the figure shown, water flows into the open vessel through pipe A at a constant rate. The water can flow out of the vessel by pipe B. The maximum flow-rate of the water in pipe B is slightly more than that in pipe A. Final height of the water level in the vessel would be
(A) h_0
(B) h_f
(C) somewhere in-between h_0 and h_f
(D) The water level will keep oscillating in the vessel



29. The earth is moving on an elliptical path, whose one focus sun is situated as shown in figure. If AS = r_{min} and SB = r_{max}, the sun and earth system obey the Kepler's law, the square of time-period is directly proportional to
(A) $(r_{min})^3$
(B) $(r_{max})^3$
(C) $\left(\frac{r_{min}+r_{max}}{2}\right)^3$
(D) $\left(\frac{r_{min}r_{max}}{r_{min}+r_{max}}\right)^3$



30. A body is moving under the action of central force $\vec{F}(r)\hat{e}_r$ such that its position vector is $\vec{r} = r\hat{e}_r$. Then, choose the correct statement (symbols are having usual meaning and $\hat{e}_r$, $\hat{e}_\theta$ denote unit vectors along the radial and tangential direction, respectively) from the following.



(A) $\vec{v} = \frac{dr}{dt}\hat{e}_r + r\frac{d\theta}{dt}\hat{e}_\theta$, $\vec{a} = \left[\frac{d^2r}{dt^2} - r\left(\frac{d\theta}{dt}\right)^2\right]\hat{e}_r$, $2\frac{dr}{dt}\frac{d\theta}{dt} + r\frac{d^2\theta}{dt^2} = 0$

(B) $\vec{v} = \frac{dr}{dt}\hat{e}_r + r\frac{d\theta}{dt}\hat{e}_\theta$, $\vec{a} = \left[\frac{d^2r}{dt^2} + r\left(\frac{d\theta}{dt}\right)^2\right]\hat{e}_r$, $2\frac{dr}{dt}\frac{d\theta}{dt} - r\frac{d^2\theta}{dt^2} = 0$

(C) $\vec{v} = \frac{dr}{dt}\hat{e}_r - r\frac{d\theta}{dt}\hat{e}_\theta$, $\vec{a} = \left[\frac{d^2r}{dt^2} + r\left(\frac{d\theta}{dt}\right)^2\right]\hat{e}_r$, $2\frac{dr}{dt}\frac{d\theta}{dt} + r\frac{d^2\theta}{dt^2} = 0$

(D) $\vec{v} = \frac{dr}{dt}\hat{e}_r - r\frac{d\theta}{dt}\hat{e}_\theta$, $\vec{a} = \left[\frac{d^2r}{dt^2} - r\left(\frac{d\theta}{dt}\right)^2\right]\hat{e}_r$, $2\frac{dr}{dt}\frac{d\theta}{dt} + r\frac{d^2\theta}{dt^2} = 0$

Space for rough work

Chemistry

PART – II

SECTION – A
Straight Objective Type

This section contains **30 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct.

31. The following electronic transition occurs when lithium atoms are sprayed into a hot flame;

$$2s \xrightarrow{\text{I}} 2p \xrightarrow{\text{II}} 3d \xrightarrow{\text{III}} 3p \xrightarrow{\text{IV}} 4s \xrightarrow{\text{V}} 3p,$$

Which of the transition would result in the emission of light?

(A) I,II and IV
(B) III and V
(C) III,IV and V
(D) All of these steps

32. The rate law for a reaction between the substances A and B is given by rate $= k[A]^n[B]^m$. On doubling the concentration of A and halving the concentration of B, the ratio of the new rate to the earlier rate of the reaction will be:

(A) $1/2^{m+n}$
(B) $2^{(m+n)}$
(C) $1/2^{n-m}$
(D) $2^{(n-m)}$

33. Consider the following sequence of reaction:

$$\begin{tikzcd} X^{-} \arrow[r, bend left, "\Delta H_5"] & X \arrow[l, "\Delta H_4"'] \arrow[r, "\Delta H_1"] & X^{+} \arrow[l, bend left, "\Delta H_6"] \arrow[r, "\Delta H_2"] & X^{2+} \arrow[r, "\Delta H_3"] & X^{3+} \end{tikzcd}$$

If electronic configuration of element X is $[Ne]3s^1$, then which of the following order is incorrect regarding given enthalpies?

(A) $|\Delta H_4| = |\Delta H_5|$
(B) $|\Delta H_2| > |\Delta H_1|$
(C) $|\Delta H_2| > |\Delta H_3|$
(D) $|\Delta H_1| = |\Delta H_6|$

Space for rough work

34. The bond angle of Cl_2O is:

(A) Smaller than that of F_2O
(B) Greater than that of H_2O
(C) Smaller than that of H_2O
(D) Same as that of F_2O

35. For the reaction: $2NO(g)+Cl_2(g) \rightleftharpoons 2NOCl(g)$, NO and Cl_2 are initially taken in mole ratio $2:1$. The total pressure at equilibrium is found to be 1 atm. If mole of $NOCl$ are one fourth of that of Cl_2 at equilibrium, K_p for the reaction is:

(A) 13/36
(B) 13/256
(C) 13/512
(D) 13/128

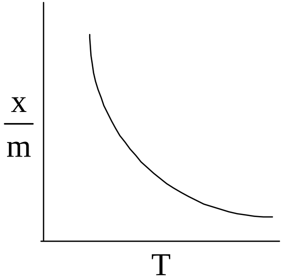
36. Suppose that in any Bohr atom or ion orbits are only in even numbers like 2,4,6……. The maximum wavelength of radiation emitted in the visible region of hydrogen spectrum should be:

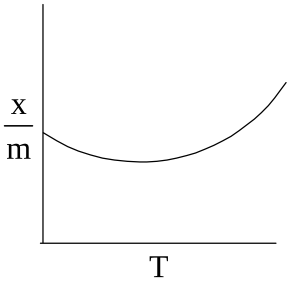
(A) 4/R
(B) R/4
(C) 36/5R
(D) 16/3R

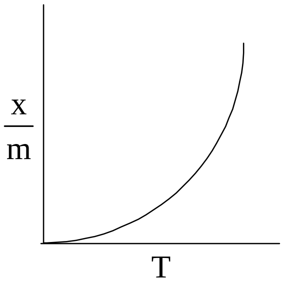
37. The overall charge present on the cyclic silicate anion $[Si_6O_{18}]^{n-}$ is:

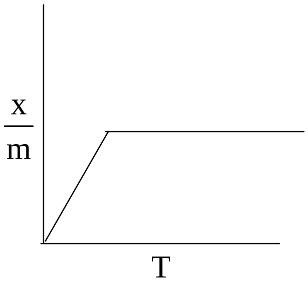
(A) 6
(B) 12
(C) 18
(D) 24

38. Which plot is the adsorption isobar for chemisorption?

(A)


(B)


(C)


(D)


Space for rough work

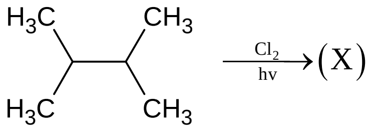
39. The solubility product of PbI_2 is 7.2×10^{-9}. The maximum mass of NaI which may be added in 500ml of 0.005M $Pb(NO_3)_2$ solution without any precipitation of PbI_2 is $(I=127)$:

(A) 0.09g
(B) 1.2×10^{-3}g
(C) 6×10^{-4}g
(D) 1.08×10^{-5}g

40. The number of moles of $Cr_2O_7^{2-}$ needed to oxidise 0.136 equivalent of $N_2H_5^+$ through the reaction:

$N_2H_5^+ + Cr_2O_7^{2-} \longrightarrow N_2 + Cr^{3+} + H_2O$ is:

(A) 0.0226
(B) 0.087
(C) 0.136
(D) 0.488

41. 

Mono chloro products: (including stereoisomers)

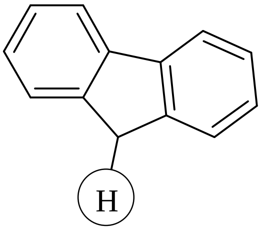
(A) 2
(B) 3
(C) 4
(D) 5

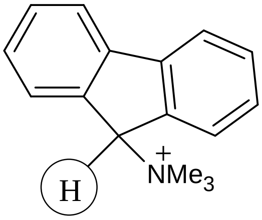
42. Which of the following reaction is non-redox?

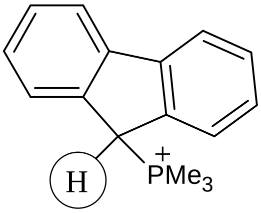
(A) $2NaNO_3 \longrightarrow 2NaNO_2 + O_2$
(B) $KCl + NaNO_3 \longrightarrow KNO_3 + NaCl$
(C) $Fe + H_2SO_4 \longrightarrow FeSO_4 + H_2$
(D) $4Ag + 8CN^- + O_2 + H_2O \longrightarrow 4\left[Ag(CN)_2\right]^- + 4OH^-$

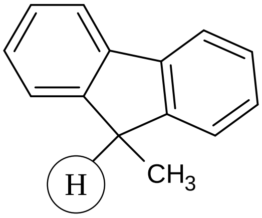
Space for rough work

43. Which of the following circled hydrogen is most acidic?

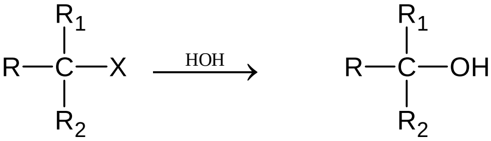
(A)


(B)

H
$\overset{+}{N}Me_3$

(C)

H
$\overset{+}{P}Me_3$

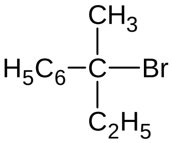
(D)


44. For the given reaction,

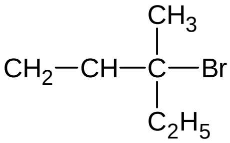


$$R-\underset{R_2}{\overset{R_1}{C}}-X \xrightarrow{HOH} R-\underset{R_2}{\overset{R_1}{C}}-OH$$

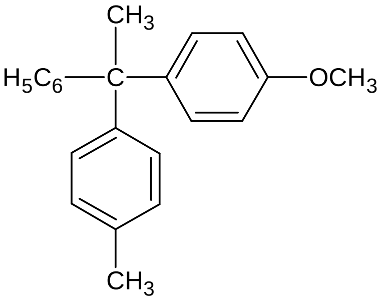
Which substrate will give maximum racemisation?

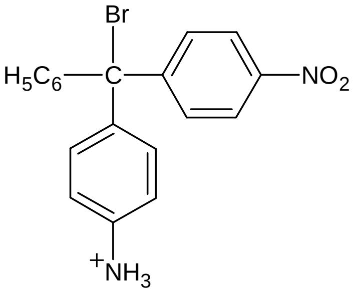
(A)


$$H_5C_6-\underset{C_2H_5}{\overset{CH_3}{C}}-Br$$

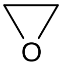
(B)


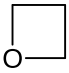
$$CH_2-CH-\underset{C_2H_5}{\overset{CH_3}{C}}-Br$$

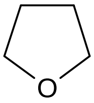
(C)

CH3
H5C6
C
OCH3
CH3

(D)

Br
H5C6
C
NO2
+NH3

45. Compare the rate of reaction of following species with OH^- :

(i) 

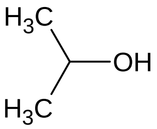
(ii) 

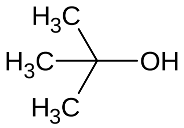
(iii) 

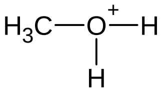
(A) i>ii>iii
(B) i>iii>ii
(C) iii>ii>i
(D) ii>i>iii

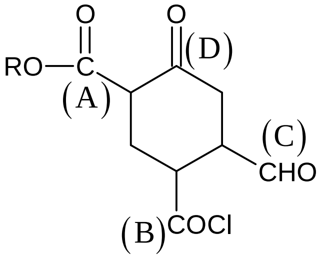
46. Which of the following is stronger acid than methanol?

(A) $CH_3 - C \equiv CH$

(B) 

(C) 

(D) 
$H_3C-\overset{+}{O}(H)-H$

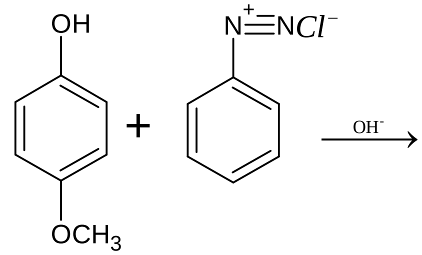
47. 

Find the correct order of reactivity of carbonyl groups with $LiAlH_4$:

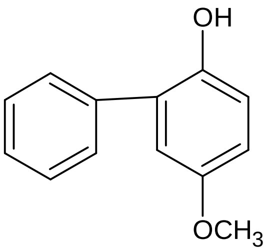
(A) A>B>C>D
(B) B>C>D>A
(C) D>C>B>A
(D) B>D>C>A

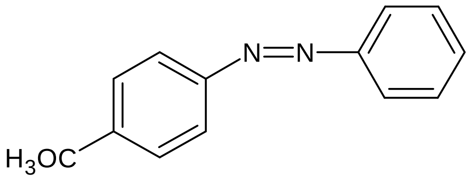
Space for rough work

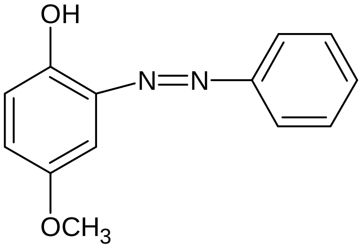
48.

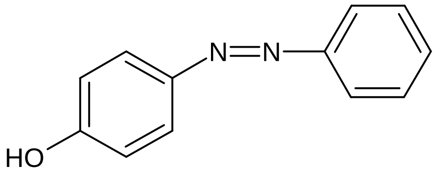


Product of reaction is:

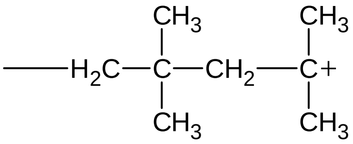
(A) 

(B) 

(C) 

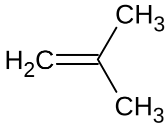
(D) 

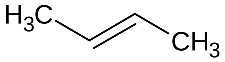
49. The monomer of the polymer



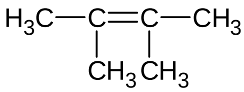
$$-H_2C-\underset{CH_3}{\overset{CH_3}{C}}-CH_2-\underset{CH_3}{\overset{CH_3}{C}}+$$

is:

(A) 

(B) 

(C) $H_3C-CH=CH_2$

(D) 

$$H_3C-\underset{CH_3}{C}=\underset{CH_3}{C}-CH_3$$

Space for rough work

50. The correct order of matching of complex compound in column I with the properties in column II:

	Column I		Colum II
(A)	$\left[Cr\left(NH_3\right)_6\right]^{3+}$	(P)	Tetrahedral and paramagnetic
(B)	$\left[Co\left(CN\right)_6\right]^{3-}$	(Q)	Octahedral and diamagnetic
(C)	$\left[Ni\left(CN\right)_4\right]^{2-}$	(R)	Octahedral and paramagnetic
(D)	$\left[Ni\left(Cl\right)_4\right]^{2-}$	(S)	Square planar and diamagnetic

(A) A-R, B-Q, C-P, D-S
(B) A-Q, B-R, C-P, D-S
(C) A-R, B-Q, C-S, D-P
(D) A-Q, B-R, C-S, D-P

51. Which of the following statements ore incorrect regarding roasting?
(A) Impurities are removed in the form of their elemental vapours
(B) Lower oxidation states are oxidised further
(C) Sulphide ores are converted to their oxides
(D) The temperature of the process is maintained just above the melting point of mixture

52. A sulphide of a metal (M) with formula MS is white coloured ppt which is soluble in acidic solution $(PH<6)$. Metal cation M is:
(A) Pb^{2+}
(B) Zn^{2+}
(C) Hg^{2+}
(D) Cu^{2+}

53. Which of the following is not correct regarding the diagonal relationship between Al and Be?
(A) Oxides of both are amphoteric in nature
(B) Carbides of both produce same gas an hydrolysis
(C) Hydrides of both are electron deficient covalent compounds
(D) Both show +2 oxidation states in their compounds

54. The final product obtained from the electrolysis of 50% H_2SO_4 with high current density has:
(A) $S\text{-}O\text{-}O\text{-}S$ linkage
(B) $S=S$ linkage
(C) $S\text{-}S$ linkage
(D) $S\text{-}O\text{-}S$ linkage

55. The gradual decrease in atomic radius for lanthanoids elements in not obeyed by:
(A) Eu only
(B) Yb only
(C) Both Eu & Yb
(D) None of these

Space for rough work

56. A fixed mass of an ideal gas contained in a 24.63L sealed rigid vessel at 1 atm is heated from $-73°C$ to $27°C$. Calculate change in Gibb's energy if entropy of gas is a function of temperature as $S=2+10^{-2}T\left(J/k\right)$: [Use 1atm L = 0.1 kJ]

(A) $1231.5J$ (B) $1281.5J$
(C) $781.5J$ (D) 0

57. The dissociation constant of a weak acid is 1.6×10^{-5} and molar conductivity at infinite dilution is $380\times10^{-4}\ Sm^2mol^{-1}$. If the cell constant is $0.01m^{-1}$ the conductance of $0.01M$ acid solution is:

(A) $1.52\times10^{-5}\ S$ (B) $1.52\ S$
(C) $1.52\times10^{-3}\ S$ (D) $1.52\times10^{-4}\ S$

58. CdO has $NaCl$ like structure with density $8.27g/cc$. If the ionic radius of O^{2-} is $1.24\,A°$, determine the ionic radius of Cd^{2+}:

(A) $1.5A°$ (B) $1.1A°$
(C) $1.9A°$ (D) $1.5A°$

59. Which of the following is a character of a gas at Boyle temperature?
(A) The effects of the repulsive and attractive intermolecular forces offset each other
(B) The repulsive intermolecular forces are stronger than the attractive intermolecular forces
(C) The repulsive intermolecular forces are weaker than attractive forces
(D) $b-\frac{a}{RT}>0$

60. An unknown oxide of manganese is reacted with carbon to form manganese metal and CO_2. Exactly $31.6g$ of the oxide, Mn_xO_y, yielded $13.2g$ of CO_2. The simplest formula of the oxide is $\left(Mn=55\right)$:

(A) MnO (B) MnO_2
(C) Mn_2O_3 (D) Mn_3O_4

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct.

61. $\sum_{\lambda=1}^{10} \sin^{-1}\left(\sin\left(\lambda\pi - \frac{\pi}{6}\right)\right)$ is equal to-

(A) $\frac{5\pi}{3}$
(B) $\frac{\pi}{2}$
(C) 0
(D) 5π

62. If $f(x) = \frac{\sin\frac{\pi x}{4}}{x+1}$, then $\lim_{h\to 0}\frac{f(1+h)-f(1)}{h^2+2h}$ is-

(A) $\frac{\pi-4}{2\sqrt{2}}$
(B) $\frac{\pi}{16\sqrt{2}}$
(C) $\frac{\pi-2}{8\sqrt{2}}$
(D) $\frac{\pi-2}{16\sqrt{2}}$

63. Number of solution of the equation $2^x + x = 2^{\sin x} + \sin x$ in $[0,10\pi]$ is-

(A) 5
(B) 6
(C) 11
(D) 1

64. Let ABCD is a parallelogram where $\overrightarrow{AB}=\vec{a}, \overrightarrow{AD}=\vec{b}, |\vec{a}| = |\vec{b}| = 2$ and $|\vec{a}\times\vec{b}| + \vec{a}.\vec{b} = \sqrt{2}\,|\vec{a}||\vec{b}|\left(\vec{a}.\vec{b}>0\right)$, then area of this parallelogram, is (in square units)-

(A) $2\sqrt{2}$
(B) 2
(C) $\sqrt{2}$
(D) $8\sqrt{2}$

Space for rough work

65. Let the volume of tetrahedron ABCD is 81 cubic & G_1,G_2,G_3 are centroid of triangular faces ABC, ABD & ACD respectively, then volume of tetrahedron $AG_1G_2G_3$,is(in cubic units)

(A) 3
(B) 6
(C) $\frac{81}{4}$
(D) 54

66. Equation of plane containing the line $x+2y+3z-5=0=3x+2y+z-5$ which is parallel to line which is parallel to line $x-1=2-y=z-3$, is-

(A) $x+2y+z=0$
(B) $x-z=0$
(C) $2y+2z=1$
(D) $x+4y+3z=0$

67. Let A & B are two non singular matrices of order 3 such that $A+B=I \& A^{-1}+B^{-1}=2I$,then $|adj(4AB)|$, is (where adj (A) is adjoin of matrix A)-

(A) 4
(B) 16
(C) 64
(D) 128

68. If $r,k,p \in W$, then $\sum\limits_{r+k+p=10} {}^{30}C_r,{}^{20}C_k.{}^{10}C_p$ is equal to-

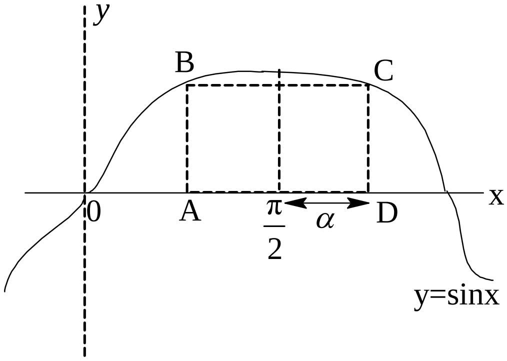
(A) $\binom{60}{50}$
(B) $\binom{60}{30}$
(C) $\binom{60}{20}$
(D) $\binom{30}{10}\binom{30}{20}$

69. Function $f(x)=\begin{cases} \text{sgn}([x]);x \neq I \\ [\text{sgn}(x)];x = I \end{cases}$ is {where sign () donates signum function & [.] denotes greatest integer function}

(A) Continuous but not differentiable at x=2
(B) Discontinuous at every integer
(C) Non differentiable at x=0 & 1 only
(D) Non differentiable at every natural number

Space for rough work

70. A rectangle ABCD is inscribed in the region bounded by $y = \sin x$, x-axis where $x \in [0, \pi]$ (as shown in figure), then area of rectangle is maximum when $'\alpha'$ satisfies



(A) $\tan\alpha=\alpha$ (B) $\cot\alpha=\alpha$
(C) $\sin\alpha=\alpha$ (D) $\cos\alpha=\alpha$

71. If $f(0) = 2$, then $\lim_{x\to 0} \frac{\int_0^x \left(tf(x) + xf(t)\right) dt}{x^2}$ is equal to-

(A) 1 (B) 2
(C) 3 (D) 4

72. If $\mathrm{f(x)}$ & $\mathrm{g(x)}$ are inverse function of each other such that $\mathrm{f(1)=3}$ & $\mathrm{f(3)=1}$, then $\int_1^3 \left(g(x) + \frac{x}{f'(g(x))} \right) dx$ is equal to-

(A) 0 (B) 8
(C) -8 (D) 3

73. If solution of differential equation $\frac{dy}{dx} = \frac{1+x}{2y}$ is a conic passing through point $(1,1)$, then its eccentricity, is-

(A) 0 (B) $\sqrt{\frac{3}{2}}$

(C) 1 (D) $\sqrt{\frac{5}{3}}$

Space for rough work

74. Let tangents drawn from point $\mathrm{C(0,-b)}$ to hyperbola $\frac{\mathrm{x^2}}{\mathrm{a^2}}-\frac{\mathrm{y^2}}{\mathrm{b^2}}=1$ touches hyperbola at points A & B. If $\Delta\mathrm{ABC}$ is a right angled triangle, then $\frac{\mathrm{a^2}}{\mathrm{b^2}}$ is equal to-

(A) 1
(B) $\frac{1}{2}$
(C) 2
(D) $\frac{3}{2}$

75. If normal at point P(t) to parabola $y^2 = 16x$ meets it again at point $Q(36, -24)$, then maximum possible focal distance of point P is-

(A) 8
(B) 16
(C) 32
(D) 20

76. If curves $y = ax^2 + bx + c \; and \; y = px^2 + qx + r$ do not intersect each other and a $\mathrm{a, b, c, p, q, r} \in \{1,2,3,4.......,10\}$ then maximum value of $\mathrm{(aq\text{-}bp)^2(c\text{-}r)^2}$ is-

(A) 81
(B) 200
(C) 162
(D) 100

77. Let $\mathrm{n(A)=3, n(B)=3}$ (where n(S) denotes number of elements in set S), then number of subsets of $\mathrm{(A \times B)}$ having odd number of elements is-

(A) 64
(B) 128
(C) 256
(D) 512

78. Let A & B are two independent events such that $\mathrm{P(A)+P(B)}=\frac{3}{4}\,\&\,\mathrm{P(\vec{\bar{A}}/B)}=\frac{2}{5}$, then $\mathrm{P(A \cap B)}$ is-

(A) $\frac{9}{20}$
(B) $\frac{9}{100}$
(C) $\frac{5}{17}$
(D) $\frac{6}{20}$

Space for rough work

79. If complex numbers z_1 and z_2 both satisfy $z+\overline{z}=2|z-1|$ and arg $(z_1-z_2)=\frac{\pi}{3}$, then value of $\text{Im}(z_1+z_2)$ is, where $\text{Im}(z)$ denotes imaginary part of z-

(A) $\sin\frac{\pi}{3}$ (B) $\text{cosec}\frac{\pi}{3}$

(C) $\tan\frac{\pi}{3}$ (D) $\cot\frac{\pi}{3}$

80. If ω is complex cube root of unit whose imaginary part is positive and $|z-\omega|=|z+\omega|$ arg(z) can be-

(A) $\frac{\pi}{3}$ (B) $\frac{5\pi}{6}$

(C) $\frac{\pi}{6}$ (D) $\frac{\pi}{4}$

81. A variable circle is drawn passing through the origin ‘O’. It intersects X & Y axis respectively at point A & B such that OA+2OB=K (non zero constant), then circle always passes through a fixed point P other origin. P lies on-

(A) the x-axis (B) the line y=2x

(C) the line x=2y (D) the y-axis

82. Area bounded by curves $x=\sqrt{2-y^2}\ and\ |x|=|y|$,is-

(A) $\frac{\pi}{2}$ (B) π

(C) $\frac{3\pi}{2}$ (D) 2π

83. The angle of elevation of a tower from point P due north of it is 30^{o} and from a point Q due east of point P is θ. If distance of foot of tower from point P is 3m & $\text{PQ}=\sqrt{3}\text{m}$, then $'\theta'$ is equal to-

(A) $\tan^{-1}2$ (B) $\cot^{-1}2$

(C) $\frac{\pi}{6}$ (D) $\frac{\pi}{4}$

Space for rough work

84. Let M denotes set of all 3×3 non singular matrices. Define the relation R by $R=\{(A,B)\in M\times M : AB=BA\}$, then R is-

(A) Reflexive, symmetric but not transitive
(B) Reflexive, symmetric & transitive
(C) Reflexive transitive but not symmetric
(D) Neither reflexive nor symmetric nor transitive

85. Interval in which function $y=\left|x^2-|x|-2\right|$ is non monotonic ,can be-

(A) $x\in(-2,-1)$
(B) $x\in(-4,-2)$
(C) $x\in(0,2)$
(D) $x\in(2,10)$

86. If $f(x)=x^4+\lambda x^3+x^2(\lambda\in R)$ has local maximum at $x=\frac{1}{2}$,then absolute minimum value of $f(x)$ is-

(A) -4
(B) 0
(C) 4
(D) -16

87. Let $x_1,x_2,.......,x_{100}$ are 100 observation such that $\sum x_i=0, \sum_{l\le i<j\le 100}\left|x_ix_j\right|=80000$ &mean deviation from their mean is 5, then their standard deviation, is-

(A) 10
(B) 30
(C) 40
(D) 50

88. If statement $(p\to q)\to(q\to r)$ is false, then truth values of statement p,q,r respectively, can be-

(A) FTF
(B) TTT
(C) FFF
(D) FTT

89. Let $f(x)=\max(\sin x,\cos x)$

$g(x)=\min(\cos x,\sin x)$

$h(y)=f(x)y^2+ay+g(x)$

If equation $h(y)=0$ has roots $\forall x\in R$, then complete set of values of a is-

(A) $a\in\left(-\infty,-\sqrt{2}\right]\cup\left[\sqrt{2},\infty\right)$
(B) $a\in\left[-\sqrt{2},\sqrt{2}\right]$
(C) $a\in R$
(D) None of these

90. Let x_n,y_n,z_n,w_n denotes n^{th} terms of four different arithmetic progressions with positive terms. If $\text{x}_4+\text{y}_4+\text{z}_4+\text{w}_4=8$ and $\text{x}_{10}+\text{y}_{10}+\text{z}_{10}+\text{w}_{10}=20$, then maximum value of $\text{x}_{20}.\text{y}_{20}.\text{z}_{20}.\text{w}_{20}$ is-

(A) 10^4
(B) 10^6
(C) 10^8
(D) 10^{10}

Space for rough work

FIITJEE

JEE(Main)-2018

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – II
(Main)

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**A**	31.	**B**	61.	**C**
2.	**B**	32.	**D**	62.	**D**
3.	**A**	33.	**C**	63.	**D**
4.	**D**	34.	**B**	64.	**A**
5.	**D**	35.	**B**	65.	**B**
6.	**D**	36.	**D**	66.	**B**
7.	**C**	37.	**B**	67.	**C**
8.	**B**	38.	**C**	68.	**A**
9.	**D**	39.	**A**	69.	**C**
10.	**C**	40.	**A**	70.	**B**
11.	**C**	41.	**B**	71.	**C**
12.	**C**	42.	**B**	72.	**A**
13.	**A**	43.	**C**	73.	**B**
14.	**D**	44.	**C**	74.	**C**
15.	**B**	45.	**A**	75.	**D**
16.	**B**	46.	**D**	76.	**A**
17.	**B**	47.	**B**	77.	**C**
18.	**C**	48.	**C**	78.	**B**
19.	**B**	49.	**A**	79.	**B**
20.	**C**	50.	**C**	80.	**C**
21.	**B**	51.	**A**	81.	**B**
22.	**B**	52.	**B**	82.	**A**
23.	**A**	53.	**D**	83.	**B**
24.	**C**	54.	**A**	84.	**A**
25.	**B**	55.	**C**	85.	**C**
26.	**C**	56.	**C**	86.	**B**
27.	**A**	57.	**B**	87.	**B**
28.	**C**	58.	**B**	88.	**A**
29.	**C**	59.	**A**	89.	**A**
30.	**A**	60.	**B**	90.	**A**

Physics

PART – I

SECTION – A

1. A

$\tau = 0 \Rightarrow \alpha = 0 \Rightarrow \vec{\omega} =$ constant & $\vec{L} = I\vec{\omega} =$ constant

2. B

$\vec{v} =$ constant $\therefore\ \vec{a} = 0\ \therefore\ \sum \vec{F} = 10 - f = 0 \Rightarrow f = 10N$

3. A

The man must swim along the direction of shortest distance.

4. D

In the relative frame

$\vec{S}_0 = -h\hat{j},\quad \vec{u}_{rel} = v\cos\theta\,\hat{i} + \left(v\sin\theta - v\right)\hat{j};\quad \vec{a}_{rel} = 0$

5. D

for conservative force $F_x = \frac{-dU}{dx}; F_y = \frac{-dU}{dy}$

$$\frac{\delta F_x}{\delta y} = \frac{\delta F_y}{\delta x} = \frac{\delta^2 U}{\delta x \delta y}$$

6. D

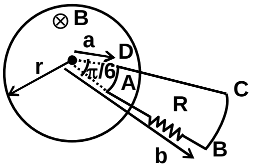
if $\mu_1 < \mu_2$, then also N > 0

7. C

8. B

$$e = \frac{d\phi}{dt} = \frac{\left(r^2 - a^2\right)}{2}\frac{\pi}{6}\frac{dB}{dt}$$

$$\therefore i = \frac{\left(r^2 - a^2\right)\pi B_0}{12R}$$



9. D

No current will flow through the capacitor, so charge will be zero.

10. C

$C = \frac{\epsilon_0 A}{x}$, where x is separation between plates.

$$\frac{1}{C}\frac{dC}{dT} = \frac{1}{A}\frac{dA}{dT} - \frac{1}{x}\frac{dx}{dT}$$

For $\frac{dC}{dT} = 0$, $\frac{1}{x}\frac{dx}{dT} = \frac{1}{A}\frac{dA}{dT}$

$\Rightarrow\ \alpha_S = 2\alpha$

11. C

For pure translatory motion of object, the force should act at the centre of mass of the object

$$y_{cm} = \frac{m \times 2\ell + 2m \times \ell}{3m} = \frac{4\ell}{3}$$

12. C

Equipotential surfaces are coaxial cylinders, therefore (4, 3, 4) and (3, 4, 0) lie on equipotential surface.

13. A

Energy absorbed per unit time by earth's surface, if its radius is r, is

$$\dot{Q}_{abs} = \frac{\sigma 4\pi R_S^2 T_S^4}{4\pi R^2} \times \pi r^2$$

Energy radiated per unit time by earth's surface, $\dot{Q}_{rad} = \sigma(4\pi r^2)T^4$

In equilibrium,

$$\dot{Q}_{abs} = \dot{Q}_{rad}$$

$$\Rightarrow \quad T^4 = \frac{T_S^4}{4}\frac{R_S^2}{R^2}$$

14. D

15. B

CM will be at rest, m (50 – x) = 99 m (x)

$$\Rightarrow x = \frac{1}{2}m$$

16. B

PV = $m\Sigma v_x^2$

$$\Rightarrow m = \frac{100 \times 1}{10^{28}} = 10^{-26} \text{ kg} = 10^{-23} \text{ g}$$

17. B

Potential at P due to rings

$$V_P = \frac{\lambda 2\pi R}{4\pi \in_0 R} - \frac{\lambda 2\pi R}{4\pi \in_0 \sqrt{2}R} = \frac{\lambda}{2 \in_0}\left(1 - \frac{1}{\sqrt{2}}\right)$$

Potential at Q due to rings is

$$V_Q = -\frac{\lambda}{2 \in_0}\left(1 - \frac{1}{\sqrt{2}}\right)$$

Δ(K.E.) + $\left(V_Q - V_P\right)q = 0$

$$\Rightarrow \frac{1}{2}mv^2 = \frac{\lambda}{\in_0}\left(1 - \frac{1}{\sqrt{2}}\right)q$$

18. C

No e.m.f. will be induced in AC because electric lines of force are perpendicular to AC and e.m.f. induced in AB = e.m.f. induced in BC.

$$\therefore \text{ e.m.f induced in AB } = \frac{1}{2}\left|\frac{d\phi}{dt}\right| = \frac{1}{2}r^2\frac{dB}{dt}$$

19. B

$T = \frac{mv^2}{R}$, and T = mg

20. C

Initially $\sigma\, 4\pi\, r_A^2 T_A^4 = \sigma 4\pi r_B^2 T_B^4$

Now $\frac{Q_A}{Q_B} = \frac{\sigma(4\pi)(r_A)^2(2T_A)^4}{\sigma 4\pi(2r_B)^2(T_B)^4} = \frac{4r_A^2T_A^4}{r_B^2T_B^4} = 4$

21. B

Net field at the centre of cube = 0

$\therefore \quad E_i + E_q = 0$

$\Rightarrow \quad E_i = -\dfrac{q}{4\pi \in_0 d^2}$

$\therefore \ \left|E_i\right| = \dfrac{q}{4\pi \in_0 d^2}$

22. B

23. A

$-kbx = \dfrac{2Mb^2\alpha}{3}$

$\alpha = -\dfrac{3}{2}\dfrac{kx}{Mb}$

24. C

Use Snell's law: $\mu \sin\theta$ = constant

25. B

$mv^2/r = GMm/r^2$

26. C

27. A

$V = V_1 + V_2$ and $V\gamma = V_1\gamma_1 + V_2\gamma_2$

28. C

At first, the level of water will gradually rise to height h_0. After reaching height h_0, some of the water will get drained through the siphon. As soon as the entire cross section of the top of the siphon pipe is filled with water, the water level will begin to drop since, from given conditions, the flow-rate of the water flowing from pipe B is greater than from pipe A. As the water level drops, the pressure that drives the siphon decreases and as a result the velocity of water in pipe B decreases. Level will continue to sink until the flow rate of water through pipe B becomes equal to that through pipe A.

29. C

$T^2 \propto$ (semi-major axis)^3

30. A

Use $\dfrac{d\hat{e}_r}{dt} = \dfrac{d\theta}{dt}\hat{e}_\theta$ and $\dfrac{d\hat{e}_\theta}{dt} = -\dfrac{d\theta}{dt}\hat{e}_r$

Chemistry

PART – II

SECTION – A

31. B

Subshell with lower $(n+\ell)$ value is lower in energy and energy is emitted in transition from a subshell of higher energy to lower energy subshell.

32. D

$$r_1 = k[A]^n[B]^m$$

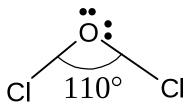
$$r_2 = k[2A]^n\left[\frac{B}{2}\right]^m = 2^{n-m}k[A]^n[B]^m$$

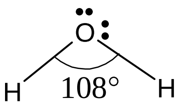
$$\frac{r_1}{r_2} = 2^{n-m}$$

33. C

When a reaction is reversed, magnitude of enthalpy change remains same.

34. B





35. B

$p\alpha n$ at constant volume of temperature.

$$2NO(g)+Cl_2(g) \rightleftharpoons 2NOCl(g)$$

$$2p \qquad p \qquad O$$

$$2p-2x \qquad p-x \qquad 2x$$

$$p_T = 2p-2x+p-x+2x = 1$$

$$3p-x=1 \;\; \& \; 2x = \frac{p-x}{4}$$

Solving $x = \dfrac{1}{26}$ & $p = \dfrac{9}{26}$

$$k_p = \frac{2(x)^2}{(p-x)(2p-2x)^2}$$

36. D

$$E\alpha\frac{1}{\lambda}$$

Maximum wavelength radiation means minimum energy radiation which is emitted when transition occurs from $4 \longrightarrow 2$.

$$\frac{1}{\lambda} = R\left(\frac{1}{4}-\frac{1}{16}\right)$$

37. B

Given silicate anion is $\left[\left(SiO_3\right)^{2-}\right]_6$

$$\therefore n = 12$$

38. C

Chemisorption increases with increase in temperature initially and then decrases.

39. A

$$\left[I^-\right]=\sqrt{\frac{7.2\times10^{-9}}{0.005}}=1.2\times10^{-3}M$$

Maximum moles of NaI that can be added to 500 ml of $Pb\left(NO_3\right)_2$ are

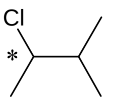
$$\frac{1.2\times10^{-3}}{1000}\times500=6\times10^{-4}moles\Rightarrow0.09g$$

40. A

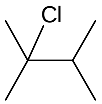
Equivalents of $Cr_2O_7^{2-}=0.136$

$$n_b\times n=0.136\Rightarrow n=\frac{0.136}{6}=0.226$$

41. B



two stereoisomers
(R)&(S)



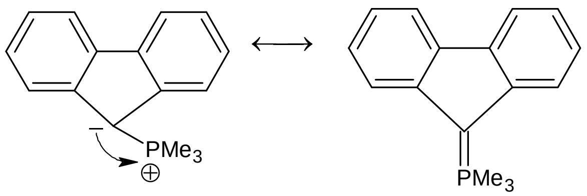
only one
product

Total products = 3

42. B

Oxidation state of all species remain unchanged so it is not redox

43. C



Negative charge can be delocalised on phosphorous also in addition to phenyl rings. So the anion is more stabilised by resonance.

44. C

The substrate which can form most stable carbocation will give maximum racemisation

45. A

Epoxide undergo ring opening with bases. Greater the ring strain, greater is the reactivity towards base.

46. D

Protonated methanol is a stronger acid than methanol.

47. B

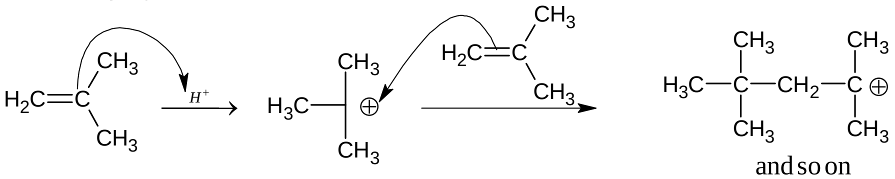
Reactivity of carbonyl compounds follow the order acid chlorides > aldehydes > ketones > ester

48. C

OH^- Converts phenol to phenoxide ion which is strongly activating so attack occurs at ortho position w.r.t. hydroxyl group

49. A

Cationic polymerisation occurs as:



and so on

50. C

$$\left[Cr\left(NH_3\right)_6\right]^{3+} \text{ - } \left(\mathrm{d}^3\right)\text{-}\mathrm{d}^2\mathrm{sp}^3 \text{ hybridised \& paramagnetic}$$

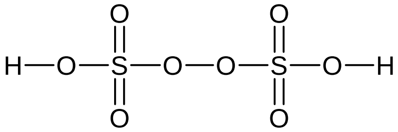
$$\left[Co\left(CN\right)_6\right]^{3-} \text{ - } \left(\mathrm{d}^6\right)\text{-}\mathrm{d}^2\mathrm{sp}^3 \text{ hybridised (CN}^{-}\text{ is a strong field ligand)}$$

51. A
Fact based

52. B
ZnS is white coloured ppt which is soluble in acidic solution below $\mathrm{pH{=}6}$

53. D
Aluminium is trivalent & Be is divalent

54. A
$\mathrm{H_2SO_4}$ on electrolysis forms $\mathrm{H_2S_2O_8}$



$$\mathrm{H{-}O{-}\overset{\overset{\displaystyle O}{||}}{\underset{\underset{\displaystyle O}{||}}{S}}{-}O{-}O{-}\overset{\overset{\displaystyle O}{||}}{\underset{\underset{\displaystyle O}{||}}{S}}{-}O{-}H}$$

55. C
Atomic radii increases for Eu & $\mathrm{4b}$ in lanthanoids series.

56. C
At constant volume $\dfrac{p_1}{T_1} = \dfrac{p_2}{T_2} \Rightarrow p_2 = p_1\dfrac{T_2}{T_1} = \dfrac{3}{2}$

$$\Rightarrow \ dG = Vdp - SdT$$

$$=\mathrm{V\Delta p\text{-}}\int_{200\mathrm{k}}^{300\mathrm{k}} 2+10^{-\mathrm{T}}\mathrm{T\,dT}$$

57. B

$$\alpha = \sqrt{\frac{K_a}{C}} = \sqrt{\frac{1.6\times10^{-5}}{0.01}}$$

$$\lambda_\mathrm{m}=\alpha\lambda^{\circ}_\mathrm{m}=\frac{\mathrm{K\times1000}}{\mathrm{molarity}}\text{ when }\lambda_\mathrm{m}\text{ is in S cm}^2\text{mol}^{-1}$$

$$\mathrm{G}=\frac{\mathrm{K}}{\text{cell constant}}$$

58. B

$$\rho=\frac{Z\times M}{N_A\times a^3} \Rightarrow a = \left(r_{Cd^{2+}} + r_{O^{2-}}\right)$$

59. A
At Boyle’s temperature, a real gas behaves approximately ideally for an appreciable range of pressure.

60. B

$$\mathrm{Mn_xO_y}+\frac{\mathrm{y}}{2}\mathrm{C}\longrightarrow\frac{\mathrm{y}}{2}\mathrm{CO_2}+\mathrm{x\,M_n}$$

$$\frac{y}{2}=\frac{13.2}{44}\Rightarrow y=0.6$$

$$55x+0.6\times16=31.6\Rightarrow x=0.4\Rightarrow x:y=2:3$$

Mathematics PART – III

SECTION – A

61. C

$$\sum_{n=1}^{5}\sin^{-1}\left(\sin\left(2n\pi-\frac{\pi}{6}\right)\right)+\sum_{n=1}^{5}\sin^{-1}\left(\sin\left(2n-1\right)\pi-\frac{\pi}{6}\right)$$

$$\sum_{n=1}^{5}\sin^{-1}\left(-\sin\frac{\pi}{6}\right)+\sum_{n=1}^{5}\sin^{-1}\left(\sin\frac{\pi}{6}\right)$$

$$=-\frac{5\pi}{6}+\frac{5\pi}{6}=0$$

62. D

$$\lim it=\frac{f'(1)}{2}=\frac{\pi-4}{16\sqrt{2}}$$

63. D

$$\because x\ge\sin x\,\forall x\in\left[0,10\pi\right]$$

$$\Rightarrow x+2^{x}\ge\sin x+2^{\sin x}\,\forall x\in\left[0,10\pi\right]$$

& equality holds only at x=0

64. A

65. B

Let $A\left(\vec{0}\right),B\left(\vec{a}\right),c\left(\vec{b}\right)\&D\left(\vec{c}\right)$

$$\Rightarrow G_1\left(\frac{\vec{a}+\vec{b}}{3}\right),G_2\left(\frac{\vec{b}+\vec{c}}{3}\right),G_3\left(\frac{\vec{c}+\vec{a}}{3}\right)$$

$$\Rightarrow \text{volume of } AG_1G_2G_3=\frac{1}{6}\left(\frac{\vec{a}+\vec{b}}{3}\,\frac{\vec{b}+\vec{c}}{3}\,\frac{\vec{c}+\vec{a}}{3}\right)$$

$$=\frac{2}{27}\frac{1}{6}\left[\vec{a}\vec{b}\vec{c}\right]=\frac{2}{27}\times 81$$

66. B

Let plane is

$(x+2y+3z-5)+\lambda(3x+2y+z-5)=0$

$\because$ plane is parallel to $\frac{x-1}{1}=\frac{y-2}{-1}=\frac{z-3}{1}$

$$\Rightarrow 1(1+3\lambda)-1(2+2\lambda)+1(3+\lambda)=0$$

$$\Rightarrow \lambda=-1$$

67. C

$$A^{-1}+B^{-1}=2I$$

$$\Rightarrow I+AB^{-1}=2A$$

$$\Rightarrow B+A=2AB \text{ or } 2AB=I$$

68. A

Required sum is coefficient of x^{10} in the expansion of $(1+x)^{30}(1+x)^{20}(1+x)^{10}$ i.e ${}^{60}C_{10}$

69. C

70. B

$$\text{Area}=\left(2\alpha\right)\sin\left(\frac{\pi}{2}+\alpha\right)=2\alpha\cos\alpha$$

$$\frac{dA}{d\alpha}=2\left(-\alpha\sin\alpha+\cos\alpha\right)=2\sin\alpha(-\alpha+\cot\alpha$$

$$\frac{dA}{d\alpha}=0\Rightarrow\alpha=\cot\alpha\left\{\because\alpha\in\left(0,\frac{\pi}{2}\right)\right\}$$

71. C

$$\lim_{x\to0}\frac{f(x).\frac{x^2}{2}+x\int_0^x f(t)dt}{x^2}$$

$$=\frac{f(0)}{2}+\lim_{x\to0}\frac{\int_0^x f(t)dt}{x}=1+f(0)=3$$

72. A

$$f^{-1}(x)=g(x)\Rightarrow x=f(g(x))$$

$$\Rightarrow f'(g(x))g'(x)=1$$

$$\Rightarrow\int_1^3\left(g(x)+\frac{x}{f'\left(g\left(x\right)\right)}\right)dx$$

$$=\int_1^3\left(g\left(x\right)\right)dx=xg\left(x\right)\Big|_1^3=0$$

73. B

$$\int 2ydy=\int\left(1+x\right)dx\Rightarrow\frac{\left(x+1\right)^2}{2}-\frac{y^2}{1}=1$$

$$\Rightarrow e=\sqrt{1+\frac{1}{2}}=\sqrt{\frac{3}{2}}$$

74. C

Let A(asecθ,btanθ)

tangent at A is $\frac{\text{xsec}\theta}{\text{a}}-\frac{\text{ytan}\theta}{\text{b}}=1$

$\because$ tangent passes through $(0,\text{-b})\Rightarrow\tan\theta=1$

$$\therefore A\left(a\sqrt{2},b\right)$$

$$\Rightarrow \text{CA}\cos45^{\circ}=\text{CM}$$

$$\Rightarrow\sqrt{2\text{a}^2+4\text{b}^2}.\frac{1}{\sqrt{2}}=2b$$

$$\Rightarrow a^2=2b^2$$

75. D

$$(36,-24)\equiv(at_2^2,2at_2)\Rightarrow t_2=-3$$

$\because\ t_2 = -t - \frac{2}{t} \Rightarrow t^2 - 3t + 2 = 0 \Rightarrow t = 1 or\, 2$

Focal distance = $a + at^2 = 8 or\, 20$

76. A

Two parabolas opening upwards do not intersect, if they have same axis

$\Rightarrow -\frac{b}{2a} = \frac{-q}{2p}$ or aq=bp

$\Rightarrow$ maximum value is given by $(c-r)^2$

77. C

$n(A\times B)=9$

${}^9C_1 + {}^9C_3 + ... + {}^9C_9 = 2^8 = 256$

78. B

$P\left(\frac{\bar{A}}{B}\right) = \frac{2}{5} \Rightarrow \frac{P(\bar{A})P(B)}{P(B)} = \frac{2}{5}$

$\Rightarrow P(A) = \frac{3}{5}$

$P(A\cap B)=P(A)P(B)=\frac{3}{5}\left(\frac{3}{4}-\frac{3}{5}\right) = \frac{9}{100}$

79. B

$\frac{z+\bar{z}}{2} = |z-1|$

$\Rightarrow x^2 = (x-1)^2 + y^2\ or\ y^2 = 2x-1$

$\text{Let } z_1\left(\frac{t_1^2+1}{2}, t_1\right) \& z_2\left(\frac{t_2^2+1}{2}, t_2\right)$

$\because \arg(z_1 - z_2) = \frac{\pi}{3} \Rightarrow \frac{t_2 - t_1}{\frac{t_2^2 - t_1^2}{2}} = \sqrt{3}$

$\Rightarrow \text{Im}(z_1 + z_2) = \frac{2}{\sqrt{3}}$

80. C

Locus of z is perpendicular bisector of line segment joining $\omega \,\&\, -\omega$

81. B

Let circle is $x^2 + y^2 - 2\alpha x - 2\beta y = 0$

$\because OA + 2OB = K \Rightarrow 2\alpha + 4\beta = k$

$\Rightarrow$circle is $x^2 + y^2 - (k - 4\beta)x - 2\beta\gamma = 0$

$(x^2 + y^2 - kx) + 2\beta(2x - y) = 0$

$\Rightarrow$Fixed point lies on $2x = y$

82. A

Area= $\frac{1}{4}$ area of circle $\frac{\pi}{2}$

83. B

$$\tan 30^{\circ} = \frac{AB}{3} \;\&\; \tan\theta = \frac{AB}{AQ}$$

$$\Rightarrow AB = \sqrt{3} \;\&\; \tan\theta = \frac{AB}{\sqrt{AP^2 + PQ^2}}$$

$$\Rightarrow \tan\theta = \frac{\sqrt{3}}{2\sqrt{3}} = \frac{1}{2}$$

84. A

Reflexive because $A^2 = A^2$

Symmetric because $AB = BA \Rightarrow BA = AB$

Not transitive because $AB = BA \;\&\; BC = CB \not\Rightarrow AC = CA$

85. C

86. B

$$f'(x) = 4x^3 + 3\lambda x^2 + 2x$$

$$\because f'\left(\frac{1}{2}\right) = 0 \Rightarrow \lambda = -2$$

$$\Rightarrow f'(x) = 2x(2x-1)(x-1)$$

Minimum value $= f(0) = f(1) = 0$

87. B

$$\overline{x} = \frac{\sum x_i}{100} = 0 \;\&$$

$$\frac{\sum |x_i - \overline{x}|}{100} = 5 \Rightarrow \sum_{l \le i < j \le 100} |x_i x_j| = (500)^2$$

$$\Rightarrow \frac{\sum x_i^2}{100} = \frac{(500)^2 - 2\sum |x_i x_j|}{100} = 2500 - 1600$$

$$S.D. = \sqrt{\frac{\sum (x_i - \overline{x})^2}{100}} = \sqrt{900} = 30$$

88. A

$p \to q$ must be true & q→r must be false

$\therefore$ q must be true, r must be false but p can be true or false.

89. A

$\because f(x)y^2 + ay + g(x) = 0$ has real roots.

$$\therefore D \ge 0 \Rightarrow a^2 \ge 4f(x)g(x)$$

$$\Rightarrow a^2 \ge 4\sin x \cos x$$

$$\Rightarrow a^2 \ge 2\sin 2x \cos x$$

$$\Rightarrow a \in \left(-\infty, -\sqrt{2}\right] \cup \left[\sqrt{2}, \infty\right)$$

90. A

∵ sum of two A.P's also an A.P.

$x_4+y_4+z_4+w_4=A+3D=8$ &

$x_{10}+y_{10}+z_{10}+w_{10}=A+9D=20$

$\Rightarrow A=2, D=2$

$\Rightarrow x_{20}+y_{20}+z_{20}+w_{20}=A+19D=40$

Now $\dfrac{x_{20}+y_{20}+z_{20}+w_{20}}{4} \geq \left(x_{20}.y_{20}.z_{20}.w_{20}\right)^{1/4}$

$\Rightarrow \left(x_{20}.y_{20}.z_{20}.w_{20}\right) \leq 10^4$

FIITJEE

JEE (Advanced)-2018

ALL INDIA TEST SERIES

FULL TEST – III

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 264**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into Three sections: **Section-A Section-B & Section-C.**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section–A (01 – 10, 21 – 30, 41 – 50)** contains 30 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer and **–2 marks** for wrong answer.

2. **Section–B (11 – 12, 31 – 32, 51 – 52)** contains 6 Match the following Type questions. Each question having 4 statements in Column I & 5 statements in Column II with any given statement in Column I having correct matching with 1 or more statement (s) given in Column II. Each statement carries **+2 marks** for correct answer and **–1 mark** for wrong answer.

3. **Section–C (13 – 20, 33 – 40, 53 – 60)** contains 24 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\text{ m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

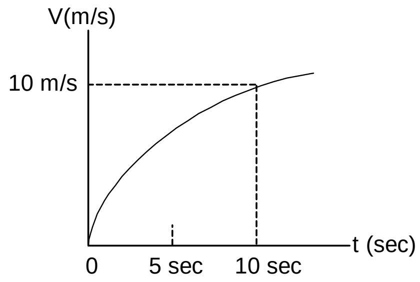
PART – I

SECTION – A

(One or More than one correct type)

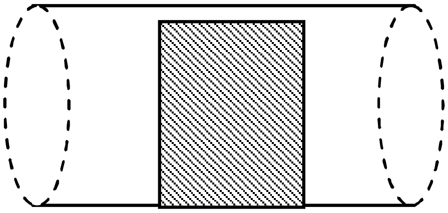
This section contains **10** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A particle is moving in such a way that its velocity versus time graph is a parabola ($t = kv^2$, k is constant) as shown in the figure. Choose the correct option(s)

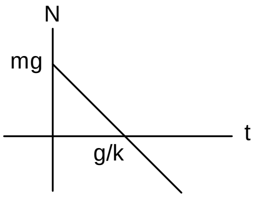


(A) acceleration of the particle is $\sqrt{3} m/s^2$ throughout the journey
(B) average acceleration of particle is 1 m/s^2 for the interval of first 5 sec.
(C) average acceleration of particle is less than $\sqrt{3} m/s^2$ for the interval of first 5 sec.
(D) average acceleration of particle is less than 1 m/s^2 for the interval of 5 sec to 10 sec.

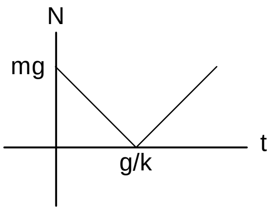
2. A block of mass m is resting inside a smooth horizontal tube. If the tube accelerates vertically downward with acceleration a = kt where k is a positive constant, then correct plot showing the variation of normal reaction received by the block as a function of time (considering that upward direction of normal reaction is positive and taken towards positive direction of y axis) will be



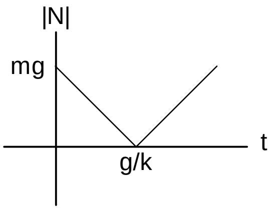
(A)



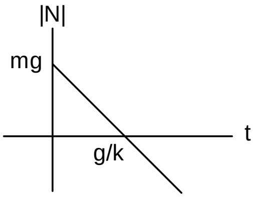
(B)



(C)

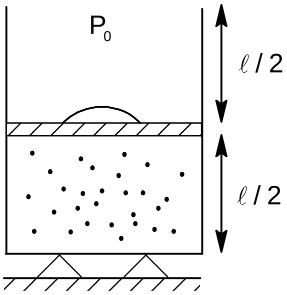


(D)



Space for Rough work

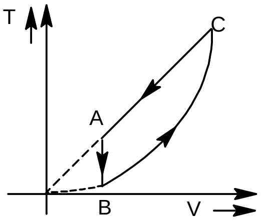
3. Figure shows initial state of an ideal gas trapped in a container with conducting walls and a piston (mass m) which can move without any friction. The container is placed on point supports and its walls are conducting. Assuming that atmospheric pressure is P_0 and the mass of the ideal gas is negligible as compared to the mass of the piston and the mass of container. Take the cross section area of piston to be A. The piston is slowly lifted by an external agent and held in its position. Let M be the maximum mass of container so that it may "lift off" while pulling the piston upwards and P_i be the pressure of ideal gas in initial state. Pick the correct choice:



(A) $P_i = P_0 + \frac{mg}{A}$ (B) $P_i = \frac{P_0}{2} + \frac{mg}{2A}$

(C) $M = \frac{m}{2}$ (D) $M = \frac{P_0 A}{2g} - \frac{m}{2}$

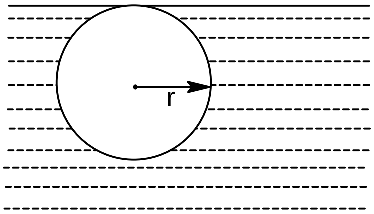
4. A monoatomic gas undergoes a cyclic process as shown in the figure. The ideal gas follows the equation $T = bV^2$ for the process B → C. During the cycle; the ratio of maximum to minimum pressure is 2 and heat supplied to the gas in B → C is $Q_{B \to C}$ = 120J. Assuming usual meanings for the symbols, pick correct option(s):—



(A) $P_A = P_C$ (B) $\frac{T_A}{T_B} = 2$

(C) $\frac{T_C}{T_B} = 2$ (D) $Q_{C \to A \to B}$ = –130J.

5. Figure shows a solid sphere positioned just below the surface of a fluid and held there. Let the density of the fluid be σ, force applied by fluid on the upper half of the sphere be F_1 and the force on lower half be F_2 (excluding the contribution due to atmospheric pressure). Pick correct option(s):-

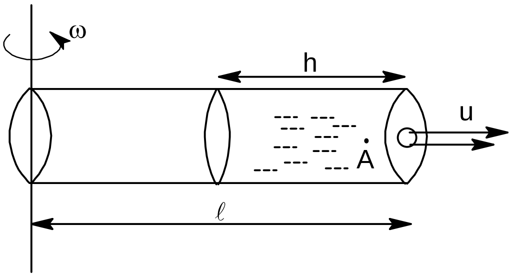


(A) $F_1 = \frac{1}{3}\pi r^3 \sigma g$ (B) $F_2 = \frac{5}{3}\pi r^3 \sigma g$

(C) $F_1 = \frac{2}{3}\pi r^3 \sigma g$ (D) $F_2 = \frac{6}{3}\pi r^3 \sigma g$

Space for Rough work

6. Figure shows a thin tube open at one end rotating with constant angular speed ω. The other end of the tube has a small opening. Tube contains a fluid of density ρ which effuses with a speed u relative to the tube. Let p_A be the pressure at the point in the tube just behind the opening. Assume the atmospheric pressure to be p_0 and pick correct option(s) for the instant when $h = \frac{\ell}{2}$.



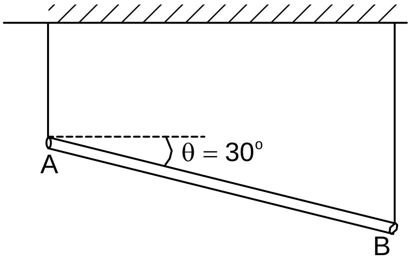
(A) $p_A = p_0 + \frac{\rho\omega^2\ell^2}{4}$

(B) $p_A = p_0 + \frac{3}{8}\rho\omega^2\ell^2$

(C) $u = \frac{\omega\ell}{2}$

(D) $u = \frac{\sqrt{3}}{2}\omega\ell$

7. Figure shows a thin rod (mass M, length L) suspended in a vertical plane by tying ideal strings at ends A and B. Initially, rod makes an angle 30° with horizontal and is at rest. Now; the string connected to the end B is cut. Let T be the tension in the string connected to A and a_A be the magnitude of acceleration of point A just after the "cutting" event. Pick correct option(s):—



(A) $T = \frac{3mg}{13}$

(B) $a_A = \frac{3g}{13}$

(C) $T = \frac{4mg}{13}$

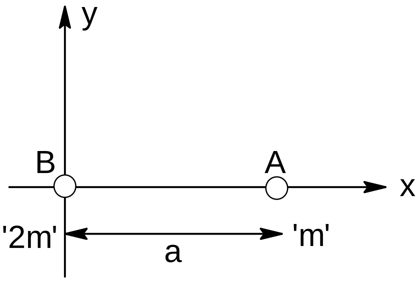
(D) $a_A = \frac{3\sqrt{3}g}{13}$

Space for Rough work

8. Figure shows the initial position of a system of two particles. Given that centre of mass of the system remains at rest and particle A moves in a trajectory given by

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$$

Pick the correct option(s) for the nature of B's trajectory and the coordinates of B at the instant when A was at the position (0, b).

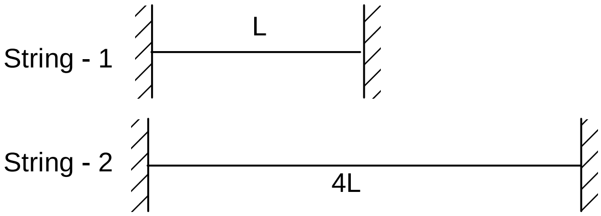


(A) Trajectory of B is elliptical
(B) Trajectory of B is circular
(C) $\left(0,\frac{-b}{2}\right)$
(D) $\left(\frac{a}{2},\frac{-b}{2}\right)$

9. A and B are two hydrogen like atoms such that $m_B = 2m_A$. Also; the number of protons and neutrons in the two nuclei are equal. Given that difference of photon energy corresponding to the first Balmer lines emitted by A and B is 5.667 eV. Let Z_A and Z_B be the atomic numbers of A and B respectively.

(A) $Z_A = 4$
(B) $Z_A = 1$
(C) $Z_B = 2$
(D) $Z_B = 8$

10. Two strings made of same material, same cross-section but different lengths are fixed at both ends and excited in their respective fundamental modes such that total oscillation energy is the same in both cases. let f_1, f_2 be the oscillation frequencies and A_1, A_2 be the amplitudes of oscillation of the antinodes in the two cases. Assuming both strings to be under same tension, pick the correct option(s).



(A) $\frac{f_1}{f_2}=\frac{1}{4}$
(B) $\frac{A_1}{A_2}=\frac{1}{2}$
(C) $\frac{f_1}{f_2}=\frac{4}{1}$
(D) $\frac{A_1}{A_2}=\frac{2}{1}$

Space for Rough work

SECTION - B

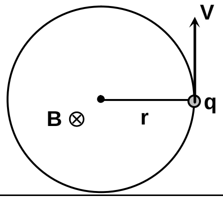
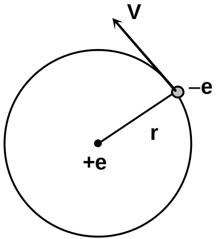
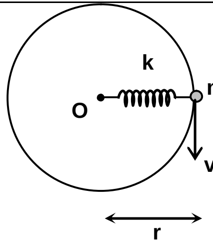
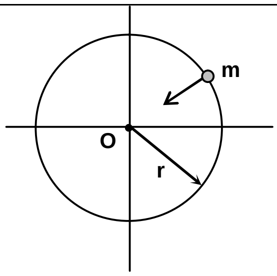
Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in ***Column I*** *are labelled A, B, C and D, while the statements in* ***Column II*** *are labelled p, q, r, s and t. Any given statement in* ***Column I*** *can have correct matching with* ***ONE OR MORE*** *statement(s) in* ***Column II.*** *The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

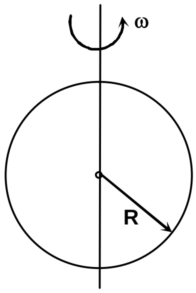
	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

11. Assume Bohr's law of quantization to be true. Column-I lists four situations where a particle is revolving in a circular orbit. Column-II lists the dependence of orbital radius and orbital speed on the order of orbit 'n'.

Column –I			Column -II	
(A)		Charge particle (q, m) revolving in a uniform magnetic field B.	(p)	$r \propto n^2$
(B)		An electron revolving around a hydrogen nucleus with constant speed.	(q)	$v \propto \sqrt{n}$
(C)		A particle connected to a hypothetical spring (with zero natural length) and revolving on a smooth surface.	(r)	$v \propto \frac{1}{n}$
(D)		A small particle revolving about origin with constant speed under a central force given by F = $\alpha\frac{v}{r}$ (α a constant)	(s)	$r \propto \sqrt{n}$
			(t)	$r \propto n$

Space for Rough work

12. Figure shows a solid sphere (M, R) rotating with an angular speed ω. Coefficient of linear expansion is $\alpha = 10^{-5}/°C$. The temperature is increased by 10°C. Column-I lists four quantities and column –II lists the corresponding values/nature of changes in these quantities.



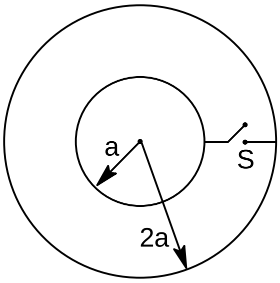
	Column – I		Column - II
(A)	Kinetic energy.	(p)	0%
(B)	Angular speed	(q)	Increases
(C)	Angular momentum	(r)	Decreases
(D)	Moment of inertia	(s)	0.02%
		(t)	0.01%

Space for Rough work

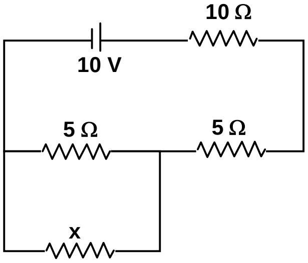
SECTION – C
(Single digit integer type)

This section contains **8** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

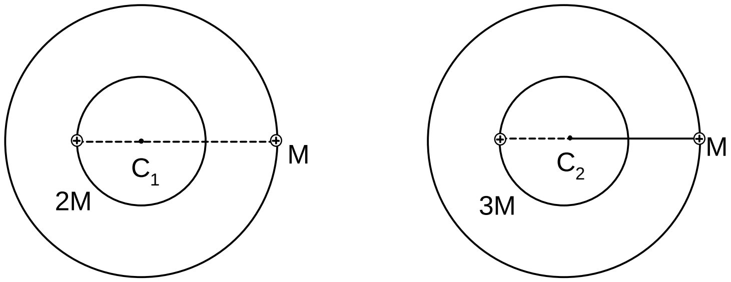
13. Figure shows two concentric conducting spherical shells, each initially carrying a charge Q. The amount of heat generated in the system when the two shells are joined by a conducting wire by closing the switch S is $\frac{(Q/n)^2}{\pi\varepsilon_0 a}$ where n is an integer. Calculate the value of n.



14. Figure shows a battery circuit with an unknown resistance x. If the value of x for maximum power dissipation in unknown resistance is $\frac{5}{n}\Omega$ (n is an integer); find n.



15. Figure shows two binary star systems such that the distance of lighter star from the centre of rotation is same in both cases. If the ratio of time periods of rotation is $\frac{T_1}{T_2} = \frac{n}{8}\sqrt{\frac{3}{2}}$, where n is an integer, find n.



16. Consider the following nuclear reaction

$${}_1^2D + {}_1^2D \longrightarrow {}_1^3T + {}_1^1P$$

Given that $m({}_1^2D) = 2.01458$ amu,

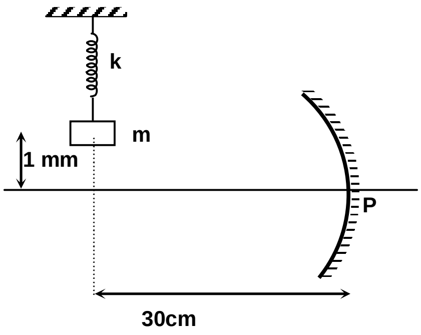
$m({}_1^3T) = 3.01605$ amu,

$m({}_1^1p) = 1.00728$ amu.

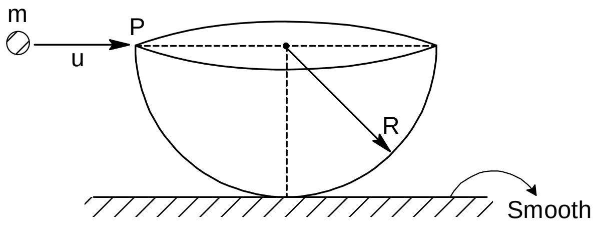
The mass of deuterium $({}_1^2D)$ required per day in order to produce a power output of 10^9W (with 50% efficiency) is $n \cdot 3$ kg where n is a digit. Find n.

Space for Rough work

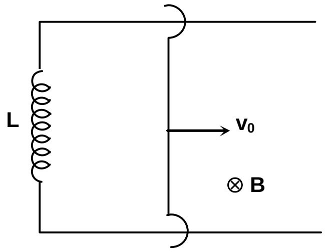
17. Figure shows a small block suspended vertically using an ideal spring. Initially spring is in natural length and the mass is 1 mm above the principal axis of a concave mirror whose focal length is 20 cm. Given that mass m = 10 grams, k = 100 N/m, g = 10 m/s^2; the amplitude of the image of the block formed by concave mirror is A millimetres, find the integer value 'A'.



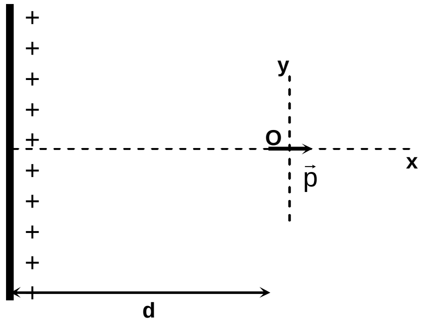
18. A hollow hemispherical bowl of mass m, radius R is placed on a smooth horizontal surface. A particle (also of mass m) strikes the hemi spherical bowl at point P and sticks to it. The velocity of particle just after the collision in vertically upwards direction is $\frac{ku}{25}$; where k is an integer. Find k.



19. A conducting rod of mass m = 0.3 kg and length ℓ = 4m can slide without friction on two parallel conducting rails. The conducting rails are connected via an inductance L = 3mH. This system is placed in a region containing uniform magnetic field B = 1T pointing into the plane. If the rod is given an initial velocity v_0 =2 m/s, it oscillates with an amplitude A cm. Find the value of 2A.



20. An infinite non-conducting plane with uniform charge density σ is kept parallel to yz plane and at a distance 'd' from a dipole $\vec{p}$ which itself is located at the origin. An equipotential surface for this system is spherical, centred at origin, having radius R(<d). Given that $R = \left(\frac{p}{n\pi\sigma}\right)^{1/3}$; find the integer n.



Space for Rough work

Chemistry

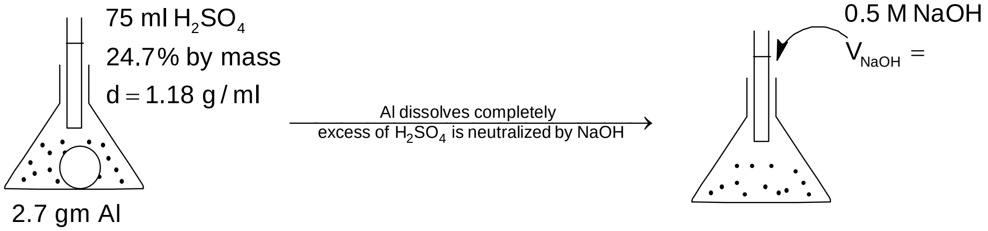
PART – II

SECTION – A

(One or More than one correct type)

This section contains **10** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

21. Value of V_{NaOH} is



(A) 291 ml
(B) 145.5 ml
(C) 75 ml
(D) 582 ml

22. According to Charle's law:

(A) $V \propto \frac{1}{T}$
(B) $\left(\frac{dV}{dT}\right)_P = K$
(C) $\left(\frac{dT}{dV}\right)_P = K$
(D) $\left(\frac{1}{T} - \frac{V}{T^2}\right)_P = 0$

23. FeO crystal has a simple cubic structure and each edge of the unit cell is 5 $\overset{o}{A}$. Taking density of crystal as 4 gm/cc the number of Fe^{2+} and O^{2-} ions present in each unit cell are:

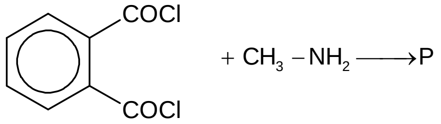
(A) $4Fe^{2+}$ and $4O^{2-}$
(B) $6Fe^{2+}$ and $6O^{2-}$
(C) $2Fe^{2+}$ and $2O^{2-}$
(D) $1Fe^{2+}$ and $1O^{2-}$

24. Photo electric emission is observed from a surface for frequencies ν_1 and ν_2 of the incident radiation $(\nu_1 > \nu_2)$. If the maximum kinetic energies of the photo electrons in the two cases are in the ratio of 1 : K then the threshold frequency ν_o is given by

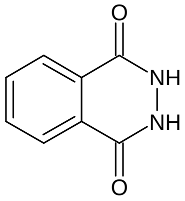
(A) $\frac{\nu_2 - \nu_1}{K - 1}$
(B) $\frac{K\nu_1 - \nu_2}{K - 1}$
(C) $\frac{K\nu_2 - \nu_1}{K - 1}$
(D) $\frac{\nu_2 - \nu_1}{K}$

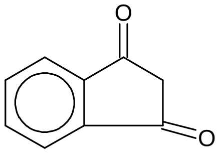
Space for Rough work

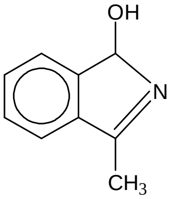
25. Select the correct statement(s)
(A) An adiabatic system can exchange energy with its surroundings.
(B) A thermodynamic property which is intensive is additive.
(C) Work done in free expansion is zero.
(D) For an isolated system, the entropy can never decrease.

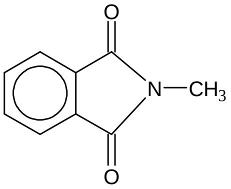
26.

COCl
COCl
$+ CH_3 - NH_2 \longrightarrow P$

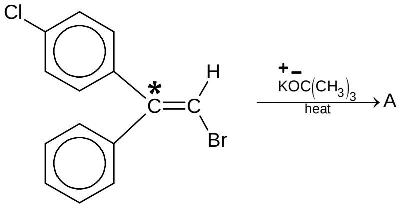
P is?

(A)


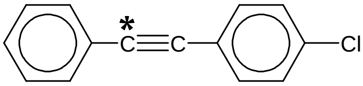
(B)


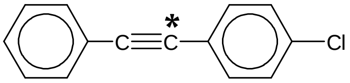
(C)


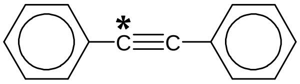
(D)


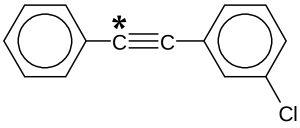
27.

Cl
*
H
C=C
Br
$\xrightarrow[\text{heat}]{\overset{+\,-}{K\,OC(CH_3)_3}}$ A

A is?

(A)


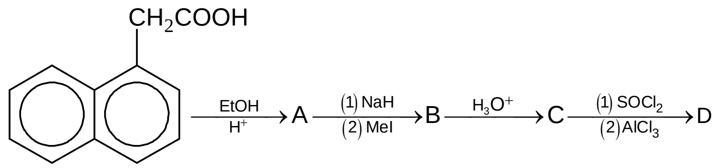
(B)


(C)


(D)


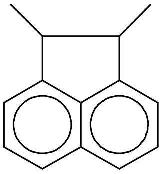
Space for Rough work

28.

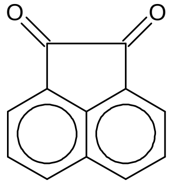


D is?

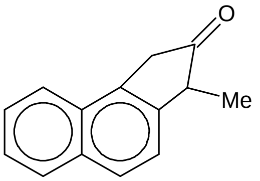
(A)



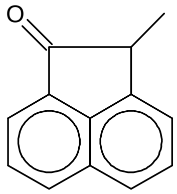
(B)

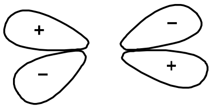


(C)



(D)



29. Choose the correct statement(s) for O_2 molecule.
As per molecular orbital theory both the unpaired electrons of O_2 molecule are:
(A) in degenerated molecular orbitals
(B) in molecular orbitals which have given shape 

(C) in molecular orbitals which are perpendicular to each other.
(D) all are incorrect.

30. Electron affinity of the elements or ions is correctly shown in

(A) $S > O^-$

(B) $O > S^-$

(C) $O^- > S^-$

(D) $N^- > S$

Space for Rough work

SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in ***Column I*** *are labelled A, B, C and D, while the statements in* ***Column II*** *are labelled p, q, r, s and t. Any given statement in* ***Column I*** *can have correct matching with* ***ONE OR MORE*** *statement(s) in* ***Column II.*** *The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

If the correct matches are A – p, s and t; B – q and r; C – p and q; and D – s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

31. Match the following Column, Column I with Column II:

Column – I		**Column – II**	
(A)	$\underline{N}(SiH_3)_3$	(p)	$p\pi - d\pi$ back bonding
(B)	$\underline{N}(CH_3)_3$	(q)	sp^3 – hybridization for underlined atom
(C)	$\underline{B}_2H_6$	(r)	$p\pi - p\pi$ back bonding
(D)	$\underline{B}F_3$	(s)	Neither $p\pi - p\pi$ nor $p\pi - d\pi$ back bonding
		(t)	Underlined atom combines with Lewis base

32. Match the following Column, Column I with Column II:

Column – I		**Column – II**	
(A)	$[Ma_3b_2c]$	(p)	All stereoisomers are optically inactive
(B)	$[Ma_3b_3]$	(q)	Number of geometrical isomers = 2
(C)	$[Ma_3bcd]$	(r)	Number of geometrical isomers = 4
(D)	$[Ma_4bc]$	(s)	Total 3 stereoisomers
		(t)	Only one enantiomeric pair is possible

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **8** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

33. 60 ml of mixture of equal volumes of Cl_2 and an oxide of chlorine, i.e. Cl_2O_n was heated and then cooled back to the original temperature. The resulting gas mixture was found to have volume of 75 ml. On treatment with KOH solution, the volume contracted to 15 ml. Assume that all measurements are made at the same temperature and pressure. Deduce the value of n in Cl_2O_n. The oxide of Cl_2 on heating decomposes quantitatively to O_2 and Cl_2.

34. A hydrogen-like atom (atomic number z) is in a higher excited state of quantum number n. This excited atom can make a transition to the first excited state by successively emitting two photons of energies 10.2 eV and 17.0 eV respectively. Alternatively, the atom from the same excited state can make a transition to the second excited state by successively emitting 2 photons of energy 4.25 eV and 5.95 eV respectively. Determine the value of (n + z).

35. By passing a certain amount of charge through NaCl solution, 9.2 lit. of Cl_2 were liberated at STP. When the same charge is passed through a nitrate solution of metal M, i.e. $M(NO_3)x$, 7.467 gm of the metal was deposited. If the specific heat of metal is 0.216 cal/gm, what is the value of x (x is integer).

36. A solution containing 28 gm phosphorus (P_n) in 315 gm CS_2 (boiling point 46.3^oC) boils at 47.98^oC. K_b' for CS_2 is 2.34 K mol^{-1} kg. Calculate value of n. Assume its complete association.

Space for Rough work

37. Find number of species which produce elemental sulphur when treated with H_2S:
$Fe^{3+}, Fe^{2+}, SO_2, H_2O_2, O_3, HNO_3$

38. Out of Be, Mg, Ca, Sr and Ba, total number of metals whose nitrates are decomposed according to following reaction
$2M(NO_3)_2 \xrightarrow{\Delta} 2MO + 4NO_2 + O_2$

39. $\underset{\text{(All isomers)}}{C_2FClBrI} \xrightarrow{H_2/Ni} X\text{(excluding stereoisomers)}$

$\underset{\text{(All isomers)}}{C_4H_8\text{ (alkene)}} \xrightarrow{H_2/Ni} Y\text{(excluding stereoisomers)}$

Find the value of X + Y.

40. How many isomers ‘X’ of C_8H_{10} give only aromatic dicarboxylic acid when react with hot alkaline $KMnO_4$.
How many isomers ‘Y’ of C_4H_8 give CO_2 when reacts with hot alkaline $KMnO_4$. Find the value of X + Y?

Space for Rough work

Mathematics

PART – III

SECTION – A

(One or More than one correct type)

This section contains **10** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

41. Let $A_1, A_2 \ldots\ldots A_7$ be a polygon and $a_1, a_2 \ldots\ldots a_7$ be the complex numbers representing vertices $A_1, A_2 \ldots\ldots A_7$. If, $|a_1| = |a_2| = \ldots\ldots |a_7| = R$, then $\sum\limits_{1\le i<j\le 7}\left|a_i + a_j\right|^2$

(A) greater than $30R^2$
(B) has minimum value as $35R^2$
(C) has its minimum value in $(25R^2, 45R^2)$
(D) is less than $45R^2$

42. Let $A_1, A_2 \ldots\ldots A_{26}$ be a regular polygon with 26 sides inscribed in a circle of radius R. Now, $A_1^{'}$, $A_7^{'}$, $A_9^{'}$ be the projections of the orthocentre H of $\Delta A_1A_7A_9$ onto sides A_7A_9, A_1A_9, A_1A_7 respectively. Then

(A) $HA_1^{'} - HA_7^{'} + HA_9^{'} = \frac{2R}{3}$
(B) $HA_7^{'} = 2R\cos A_1 \cos A_9$
(C) $HA_9^{'} = -2R\cos A_1 \cos A_7$
(D) $HA_1^{'} - HA_7^{'} + HA_9^{'} = \frac{R}{2}$

43. Consider f: [0, 1] → R has a continuous derivative and $\int_0^1 f(x)dx = 0$, then for every $\alpha \in (0, 1)$ $\left|\int_0^1 f(x)dx\right| \le k \,.\, \underset{0\le x\le 1}{\text{Max}}\left|f'(x)\right|$ then

(A) $\left[\frac{1}{k}\right] > 5$
(B) $\frac{1}{8}\left[\frac{1}{k}\right] \in [0, 1]$
(C) $k \in \left(0, \frac{1}{5}\right)$
(D) $\frac{1}{2k} + 1$ is an odd number

44. Consider the lines, $L_1 : \frac{x}{2} = \frac{y}{-3} = \frac{z}{1}$ and $L_2 : \frac{x-2}{3} = \frac{y-1}{-5} = \frac{z+2}{2}$, then the line along shortest distance can be, constituted by the line of intersection of planes

(A) $4x + y - 5z = 0$
(B) $x - 3y + 5z = 0$
(C) $5x - 7y + 2z = -1$
(D) $7x + y - 8z = 31$

Space for rough work

45. $\vec{p}, \vec{q}, \vec{r}$ be vectors such that $\vec{q}\cdot\vec{r} = 0$ and $\vec{p}\cdot\vec{q} \neq 0$. Let α is real constant such that $\vec{x}\cdot\vec{p} = \alpha$; $\vec{x}\times\vec{q} = \vec{r}$, then $\vec{x} = \lambda_1\vec{q} + \lambda_2\left(\vec{p}\times\vec{r}\right)$ where

(A) $\lambda_1 = \frac{\alpha}{\vec{p}\cdot\vec{q}}$
(B) $\lambda_2 = \frac{1}{\vec{p}\cdot\vec{q}}$
(C) $\lambda_2 = \frac{1}{\vec{r}\cdot\vec{q}}$
(D) $\lambda_1 = \frac{\alpha}{\vec{r}\cdot\vec{q}}$

46. Consider a hyperbola $\frac{x^2}{36} - \frac{y^2}{25} = 1$. A chord QPL meets an asymptote in L and a tangent from L is drawn touching at R. If PM, RE, QN be drawn parallel to the asymptote to meet the other asymptote
PM + QN = λ·RE where

(A) λ is less than 1
(B) λ is less than $\frac{5}{2}$
(C) $[\lambda]$ is 2
(D) $[\lambda]$ is zero

47. If 4 – horses participate in race. The number of ways in which they can go through finish line is α (Dead heat is possible), then

(A) $\left[\frac{\alpha}{6}\right] = 12$
(B) $\left[\frac{\alpha+1}{10}\right] = 7$
(C) $\left[\frac{100}{\alpha}\right] = 2$
(D) $\frac{\alpha}{12} = \beta$, $\beta \in I$

48. Consider an ellipse $\frac{x^2}{25} + \frac{y^2}{16} = 1$. A circle passes through a focus and has its centre on y = 0 and touches the ellipse at A and S is focus, then

(A) [|AS|] is less than 7
(B) |AS| < 4
(C) 5 < |AS| < 6
(D) |AS| > 4

49. Consider 18 – objects (distinct) then the probability that we can take odd number of objects in a draw is

(A) $\frac{1}{2}$
(B) $\frac{1}{4}$
(C) $\frac{1}{8}$
(D) $\frac{1}{16}$

50. If f(x) is a polynomial such that $(\alpha + 1)f(\alpha) - \alpha = 0\ \forall\ \alpha \in N \cup \{0\}$, $\alpha \le n$, then

(A) f(76) is 1
(B) f(21) is $\frac{10}{11}$
(C) f(37) is $\frac{1}{7}$
(D) f(148) is $\frac{9}{13}$

Space for rough work

SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in ***Column I*** *are labelled A, B, C and D, while the statements in* ***Column II*** *are labelled p, q, r, s and t. Any given statement in* ***Column I*** *can have correct matching with* ***ONE OR MORE*** *statement(s) in* ***Column II.*** *The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example:*

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	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

---

51. Consider lines as shown $L_1 : y = ax,\ z = c$; $L_2 : y = -ax,\ z = -c$; $L_3 : y = z,\ ax = -c$. Then L is a variable line which intersects the given lines ($a \neq b \neq c$), match the following Column-I with Column-II

Column – I		Column – II	
(A)	Locus of L passes through point P where P is	(p)	$(a^2, 1, -c^2)$
(B)	Locus of L is $k_1x^2 - y^2 + k_2z^2 + k_3 = 0$, then (k_1, k_2, k_3) is	(q)	$(0, 0, c)$
(C)	Locus L intersects the xz-plane in locus L′ which is an ellipse with major axis α, minor axis β, centre as (α_1, β_1) where $(\alpha, \beta, \alpha_1 + \beta_1)$ is $(a^2 > 1)$	(r)	$\left(\frac{2c}{a}, 1, 0\right)$
(D)	Locus L intersects the xy-plane in hyperbola with transverse axis α', conjugate is β', centre as $\left(\alpha_1', \beta_1'\right)$ where $\left(\alpha', \beta', \alpha_1', \beta_1'\right)$ is $\left(\frac{c^2}{a^2} > 1\right)$	(s)	$\left(2c, \frac{2c}{a}, 0\right)$
		(t)	$\left(\frac{c}{a}, 0, 0\right)$

Space for rough work

52. Consider a ΔABC and points K, L, M on the sides AB, BC, CA respectively such that $\frac{AK}{AB} = \frac{BL}{BC} = \frac{CM}{CA} = \frac{1}{3}$, match the following Column-I with Column-II

Column – I		**Column – II**	
(A)	$\frac{\text{Area}(\Delta AKM)}{\text{Area}(\Delta ABC)}$ is	(p)	$\frac{1}{3}$
(B)	$\frac{\text{Area}(\Delta KML)}{\text{Area}(\Delta ABC)}$ is	(q)	$\frac{1}{\sqrt{3}}$
(C)	$\frac{\text{Radius of incircle of } \Delta BAC}{\text{Radius of circumcircle of } \Delta ABC}$ is	(r)	3
(D)	$\angle ABC = \frac{\pi}{K}$	(s)	$\frac{2}{9}$
		(t)	greater than 1

Space for rough work

SECTION – C
(Single digit integer type)

This section contains **8** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

53. If A is 5 × 4 matrix and B is 4 × 5 matrix, then $2(|AB - I_5| + |BA - I_4|) + 1$ is _____

54. Consider a straight line $\frac{x}{a} + \frac{y}{b} = 1$, such that it cuts the asymptotes of hyperbola xy = 1 in points A and B & the hyperbola itself in P and Q, then $\frac{AP}{BQ} = \lambda$ where $2\lambda + 1$ is _____

55. If $\alpha, \beta, \gamma \in R^+$ such that $\alpha\gamma = \frac{1}{\beta}$, then maximum value of $\alpha^{\beta+\gamma} \cdot \beta^{\alpha+\gamma} \cdot \gamma^{\alpha+\beta}$ is _____

56. If $a_1 = a$, $a_2 = b$, $a_{n+2} = \frac{a_{n+1} + a_n}{2}$, $n \geq 0$ then, $\lim\limits_{n\to\infty} a_n$ is $\frac{a + \lambda_1 b}{\lambda_2}$; ($\lambda_1, \lambda_2 \in I$) where $\lambda_1 + \lambda_2$ is _____

57. Let z_1, z_2, z_3 be complex numbers (not all real) such that $|z_1| = |z_2| = |z_3| = 1$ and $2(z_1 + z_2 + z_3) - 3z_1z_2z_3$ is real. Then, Max(arg(z_1), arg(z_2), arg(z_3)) (Given that argument of z_1, z_2, z_3 is positive) has minimum value as $\frac{k\pi}{6}$ where (k + 2) is _____

58. A bag contains 2017 red balls and 2017 black balls. We remove two balls at a time repeatedly and (1) discard them if they are of same colour (2) discard the black ball and return to the bag the red ball if they are of different colours. Then the probability that this process will terminate with one red ball is 'p' where 3p is _____

59. If $I = \int_0^{\pi} \ln\left(1 - 2a\cos x + a^2\right)dx$ where $I = \lambda \ln a$, then $[\lambda]$ is _____

60. Consider a function f: [0, 1] → R satisfying $\int_0^1 \left(f(x)\left(x - f(x)\right)\right)dx = \frac{1}{12}$ then, f′(1) is k where $\left[\frac{1}{k}\right]$ is _____

Space for rough work

FIITJEE **JEE(Advanced)-2018**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – III

PAPER-1

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**C, D**	21.	**A**	41.	**A, B, C**
2.	**A, C**	22.	**B, C, D**	42.	**B, C, D**
3.	**A, D**	23.	**A**	43.	**A, B, C, D**
4.	**A, B, D**	24.	**B**	44.	**A, D**
5.	**A, B**	25.	**A, C, D**	45.	**A, B**
6.	**B, D**	26.	**D**	46.	**B, C**
7.	**C, D**	27.	**A**	47.	**A, B**
8.	**A, D**	28.	**D**	48.	**A, D**
9.	**B, C**	29.	**A, B, C**	49.	**A**
10.	**B, C**	30.	**A, B**	50.	**A, B**
11.	**(A) → (q, s)** **(B) → (p, r)** **(C) → (q, s)** **(D) → (t)**	31.	**A → p** **B → q, s** **C → q, s, t** **D → r, t**	51.	**(A) → (q, t)** **(B) → (p)** **(C) → (s)** **(D) → (r)**
12.	**(A) → (r, s)** **(B) → (r, s)** **(C) → (p)** **(D) → (q, s)**	32.	**A → p, s** **B → p, q** **C → r, t** **D → p, q**	52.	**(A) → (s)** **(B) → (p)** **(C) → (q)** **(D) → (r, t)**
13.	**4**	33.	**1**	53.	**1**
14.	**4**	34.	**9**	54.	**3**
15.	**9**	35.	**3**	55.	**1**
16.	**1**	36.	**4**	56.	**5**
17.	**2**	37.	**5**	57.	**3**
18.	**3**	38.	**5**	58.	**3**
19.	**3**	39.	**5**	59.	**6**
20.	**2**	40.	**5**	60.	**2**

Physics

PART – I

SECTION – A

1. Avg. acceleration $= \dfrac{\text{change in velocity}}{\text{Time interval}}$

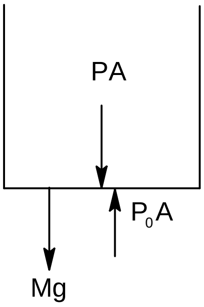
2. Upto time t = g/k, N will be along upwards direction after that it will be along downward direction.

3. $Mg + PA = P_0A$

$$M = \frac{P_0A}{g} - \frac{PA}{g}$$

$$P = \frac{P_i}{2} = \frac{P_0 + \frac{mg}{A}}{2}$$

$$\Rightarrow \quad M = \frac{P_0A}{2g} - \frac{m}{2}$$



4. $B \to C;\ C = C_v + R/2 = 2R$

So; $Q_{B\to C} = nC\,(T_C - T_B) = 2nR(T_C - T_B)$

Also; $\dfrac{T_C}{T_B} = 4, \dfrac{T_A}{T_B} = 2$

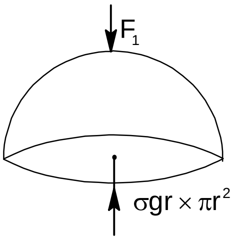
Thus; $Q_{B\to C} = 6nR\,T_B$.

$$Q_{net} = \frac{-nRT_B}{2} \Rightarrow Q_{C\to A\to B} = -130J$$

5. $F_B = \pi r^3\sigma g - F_1 = \dfrac{2}{3}\pi r^3\sigma g$

$$\Rightarrow \quad F_1 = \frac{1}{3}\pi r^3\sigma g$$

Thus; $F_2 = \dfrac{5}{3}\pi r^3\sigma g$



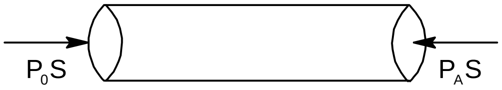
6. By Newton's second law;

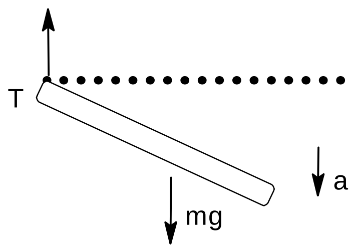
$(p_A - p_0)s = \rho sh\omega^2\left(\ell - \dfrac{h}{2}\right)$

$$\Rightarrow \quad p_A = p_0 + \rho\omega^2 h\left(\ell - \frac{h}{2}\right).$$

By Bernoulli's equation;

$$u = \omega\sqrt{2h\left(\ell - \frac{h}{2}\right)}$$





7. $mg - T = ma$

$T\frac{\ell}{2}\cos\theta = \frac{m\ell^2}{12}\alpha$

By constraints;

$a = \frac{\alpha\ell}{2}\cos\theta$

Thus; $T = \frac{mg}{1+3\cos^2\theta}$ and $a_A = \frac{3g\sin\theta\cos\theta}{1+3\cos^2\theta}$

8. $\frac{2mx_B + mx_A}{3m} = \frac{a}{3} \Rightarrow x_A = a - 2x_B$

$\frac{2my_B + my_A}{3m} = 0 \Rightarrow y_A = -2y_B$

Trajectory of B is $\frac{(a-2x)^2}{a^2} + \frac{(2y)^2}{b^2} = 1$

9. $m_B = 2m_A \Rightarrow Z_B = 2Z_A$. Let $Z_A = Z$, $Z_B = 2Z$

So; $E_B - E_A = \frac{13.6\times5}{36}\times3Z^2 = 5.667$

$\Rightarrow Z = 1$

10. $E = m_1\omega_1^2A_1^2 = m_2\omega_2^2A_2^2$

$f = \frac{V}{2L} \Rightarrow \frac{f_1}{f_2} = \frac{\omega_1}{\omega_2} = \frac{L_2}{L_1} = \frac{4}{1}$

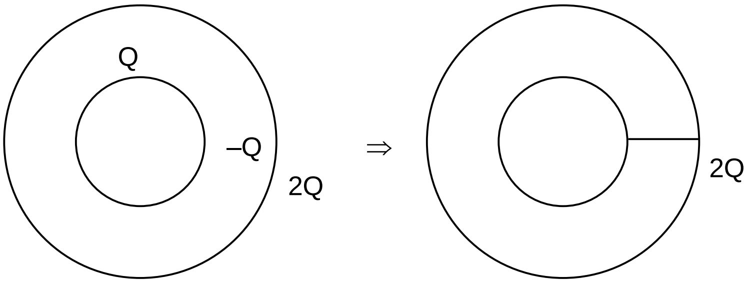
$\frac{A_1}{A_2} = \sqrt{\frac{m_2}{m_1}\times\left(\frac{\omega_2}{\omega_1}\right)^2}$

$= \sqrt{\frac{L_2}{L_1}\times\left(\frac{L_1}{L_2}\right)^2} = \frac{1}{2}$

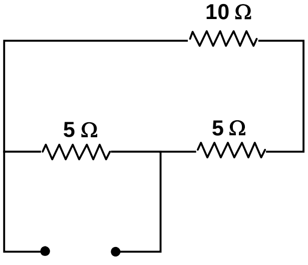
SECTION – C

13. Heat generated = $\frac{Q^2}{2C}$

$= \frac{Q^2}{2\times\frac{4\pi\varepsilon_0}{\frac{1}{a}-\frac{1}{2a}}} = \frac{Q^2}{16\pi\varepsilon_0 a}$



14. $x = \frac{15\times5}{15+5} = \frac{5}{4}\Omega$



15. $\frac{2}{3}\ell_1 = \frac{3}{4}\ell_2 \Rightarrow \frac{\ell_1}{\ell_2} = \frac{9}{8}$.

$M_1 = 3M$, $M_2 = 4M$.

$$\left(\frac{T_1}{T_2}\right)^2 = \left(\frac{\ell_1}{\ell_2}\right)^3 \times \frac{M_2}{M_1} = \left(\frac{9}{8}\right)^3 \times \frac{4}{3}$$

$$\Rightarrow \frac{T_1}{T_2} = \frac{9}{8}\sqrt{\frac{3}{2}}$$

16. Required mass = $\frac{10^9}{Q - \text{value} \times 0.5} \times 2 \times m\left({}_1^2D\right) \times 24 \times 3600 = 1.3 \text{ kg}$

17. Amplitude of block = $\frac{mg}{k} = 1 \text{ mm}$

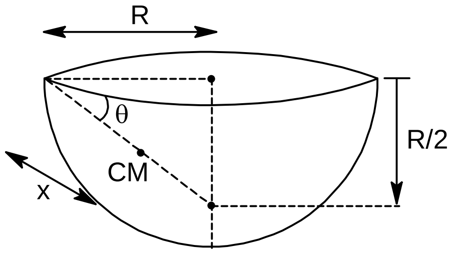
$$\frac{1}{v} + \left(\frac{1}{-30}\right) = \frac{-1}{20}$$

$\Rightarrow v = -60$ cm

Magnification, $m = -\frac{v}{u} = -2$

This; amplitude of image = 2mm.

18. $V_y = \omega x \cos\theta = \frac{\omega R}{2}$



Using conservation of angular momentum about centre of mass.

$$mu\frac{R}{4} = \left\{\frac{2}{3}mR^2 - \frac{mR^2}{4} + \frac{5mR^2}{16}\right\}\omega + \frac{5mR^2}{16}\omega$$

$$= \frac{25}{24}mR^2\omega$$

$$\Rightarrow \quad \omega = \frac{6u}{25R}$$

$$\Rightarrow \quad V_y = \frac{3u}{25}$$

19. $L\frac{di}{dt} = B\ell v$

$$m\frac{dv}{dt} = -iB\ell$$

$$\Rightarrow \frac{d^2v}{dt^2} = -\left(\frac{B^2\ell^2}{mL}\right)v$$

$\Rightarrow v = v_0 \cos(\omega t)$

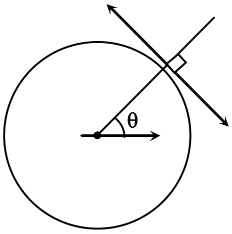
with $\omega = \frac{B\ell}{\sqrt{mL}}$

Thus, $\frac{dx}{dt} = v_0\cos(\omega t)$

$$\Rightarrow x = \frac{v_0}{\omega}\sin\omega t$$

$$2A = \frac{2v_0}{\omega} = 3 \text{ cm}$$

20. Tangential components must cancel.



$$\Rightarrow \frac{\sigma}{2\varepsilon_0}\sin\theta = \frac{1}{4\pi\varepsilon_0}\frac{p\sin\theta}{R^3}$$

$$\Rightarrow R^3 = \frac{p}{2\pi\sigma}$$

$\Rightarrow$ n = 2

Chemistry

PART – II

SECTION – A

21. $M_{H_2SO_4} = \frac{24.7}{98} \times \frac{1000 \times 1.18}{100} = 2.97$

$N_{H_2SO_4} = 5.94$

Meq. of H_2SO_4 = meq. of NaOH + meq. of Al

$5.94 \times 75 = 0.5 \times V_{NaOH} + 300$

$V_{NaOH} = 291$ ml

22. According to Charle's law $V \propto T \Rightarrow V = KT$

$$\left(\frac{dV}{dT}\right)_P = K$$

$$\left(\frac{dT}{dV}\right)_P = K$$

$$\frac{d}{dT}\left(\frac{V}{T} - K\right)_P = 0$$

$$\left(\frac{1}{T} - \frac{V}{T^2}\right)_P = 0$$

23. Volume of unit cell = 1.25×10^{-22} cc

Mass of unit cell = $1.25 \times 10^{-22} \times 4$

= 5×10^{-22} gm

For one molecule $= \frac{72}{6.022 \times 10^{23}} = 1.195 \times 10^{-22}$ g

Hence number of FeO molecules per unit cell $= \frac{5 \times 10^{-22}}{1.195 \times 10^{-22}} = 4.19 \approx 4$

Hence there are $4Fe^{2+}$ and $4O^{2-}$ in each unit cell.

24. $h\nu_1 = h\nu_o - \frac{1}{2}mu_1^2$ … (1)

$h\nu_2 = h\nu_o - \frac{1}{2}mu_2^2$ … (2)

$$\frac{1}{2}mu_1^2 = \frac{1}{K}\left(\frac{1}{2}mu_2^2\right)$$

From equation (1)

$h\nu_1 = h\nu_o - \frac{1}{2k}mu_2^2$ … (3)

$\frac{1}{2}mu_2^2 = Kh\nu_o - Kh\nu_1$ … (4)

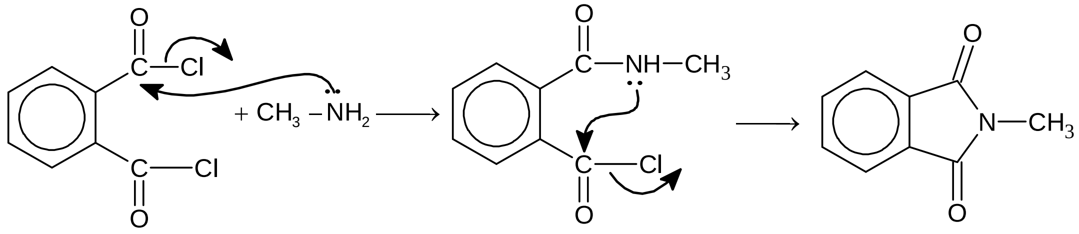
From Eqn. (4) & (2)

$$h\nu_2 = h\nu_o - Kh\nu_o + Kh\nu_1$$

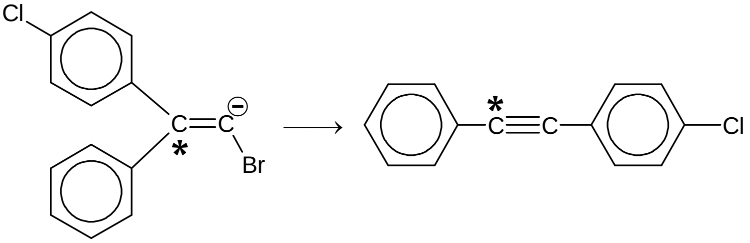
$$\nu_o = \frac{K\nu_1 - \nu_2}{(K-1)}$$

25. Work is a form of exchange energy between system and surrounding in adiabatic process.
    - Intensive property is not additive.
    - In free expansion work done is zero.
    - For an isolated system the entropy either increases or remains constant.

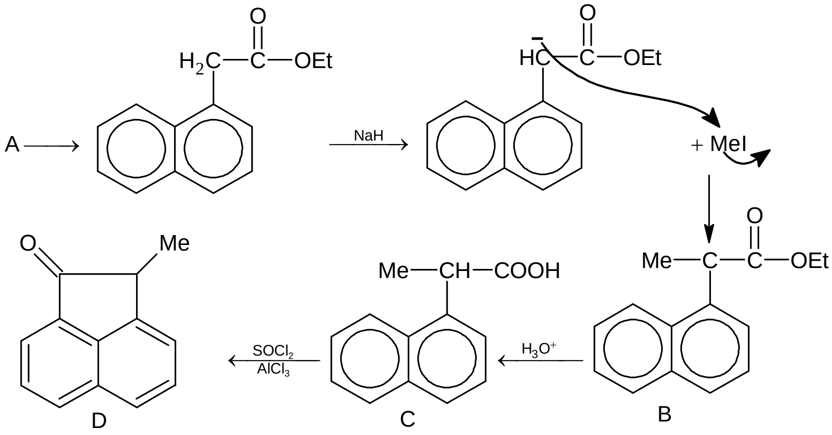
26.


O
C—Cl
C—Cl
O
+ $CH_3-\ddot{N}H_2$
O
C—NH—CH_3
C—Cl
O
O
N—CH_3
O

27. Anti group migrates


Cl
C=C
*
Br
*
C≡C
Cl

28.

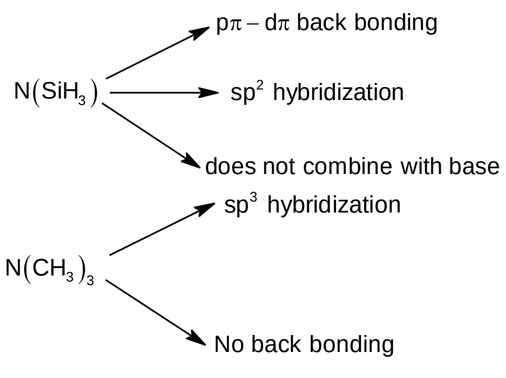

A
O
H_2C—C—OEt
NaH
O
HC—C—OEt
+ MeI
O
Me—C—C—OEt
B
H_3O^+
Me—CH—COOH
C
$SOCl_2$
$AlCl_3$
O
Me
D

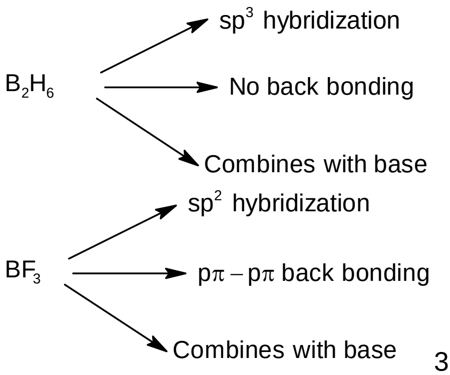
29. Fact based question.

30. Fact based question.

SECTION-B

31.


$N(SiH_3)$
$p\pi-d\pi$ back bonding
sp^2 hybridization
does not combine with base
$N(CH_3)_3$
sp^3 hybridization
No back bonding


B_2H_6
sp^3 hybridization
No back bonding
Combines with base
BF_3
sp^2 hybridization
$p\pi - p\pi$ back bonding
Combines with base

32.

[Ma_3b_2c]	Geometrical isomerism → 3	Stereoisomer → 3
[Ma_3b_3]	Geometrical isomerism → 2	Stereoisomer → 2
[Ma_3bcd]	Geometrical isomerism → 4	Stereoisomer → 5
[Ma_4bc]	Geometrical isomerism → 2	Stereoisomer → 2

SECTION – C

33.
$$\underset{\substack{30\\0}}{Cl_2} + \underset{\substack{30\\0}}{Cl_2O_n} \longrightarrow \underset{\substack{0\\60}}{2Cl_2} + \frac{n}{2}\underset{\substack{0\\15n}}{O_2}$$

KOH absorbs Cl_2

So, 15n = 15

n = 1

34.
$$27.2 \times 1.602 \times 10^{-12} = R_H z^2 hc\left[\frac{1}{2^2} - \frac{1}{n^2}\right] \quad \dots (1)$$

$$10.2 \times 1.602 \times 10^{-12} = R_H z^2 hc\left[\frac{1}{3^2} - \frac{1}{n^2}\right] \quad \dots (2)$$

After solving (1) and (2)

n = 6, z = 3

n + z = 9

35. Specific heat × At. Wt. = 6.4

Atomic weight = 29.63

Eq. of metal = Eq. of Cl_2

$$\frac{7.467 \times x}{29.63} = \frac{71 \times 9.2}{22.4 \times 35.5}$$

x = 3.25

x = 3 (x is an integer)

36.
$$\Delta T = \frac{1000 \times K_b' \times w}{m \times W}$$

m_{exp} = 123.8

$$\frac{m_N}{m_{exp}} = 1 - \alpha + \frac{\alpha}{n}$$

$$\because \alpha = 1 \Rightarrow \frac{m_N}{m_{exp}} = \frac{\alpha}{n}$$

$$\frac{31}{123.8} = \frac{1}{n} \Rightarrow n \approx 4$$

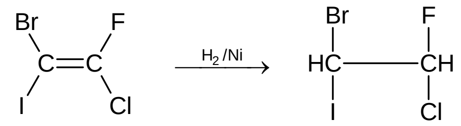
37.
$$Fe^{3+} + H_2S \longrightarrow S + Fe^{2+}$$

$$SO_2 + 2H_2S \longrightarrow 3S + 2H_2O$$

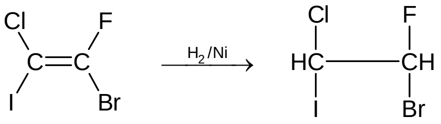
$$H_2O_2 + H_2S \longrightarrow 2H_2O + S$$
$$H_2S + O_3 \longrightarrow H_2O + S + O_2$$
$$2HNO_3 + H_2S \longrightarrow 2NO_2 + S + 2H_2O$$

38. All nitrates of alkali earth metal decompose like this.

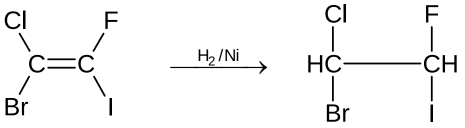
39.


Br
F
C=C
I
Cl
H2/Ni
Br
F
HC
CH
I
Cl

E (or) z give same product.

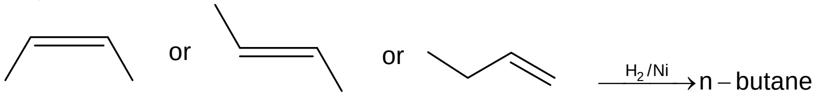

Cl
F
C=C
I
Br
H2/Ni
Cl
F
HC
CH
I
Br

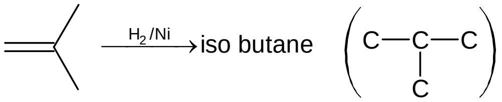
E (or) z give same product.


Cl
F
C=C
Br
I
H2/Ni
Cl
F
HC
CH
Br
I

E (or) z give same product.

So, x = 3

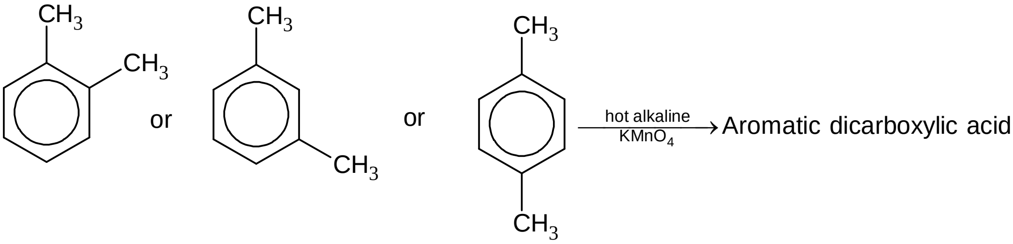

or
or
H2/Ni
n – butane


H2/Ni
iso butane
C—C—C
C

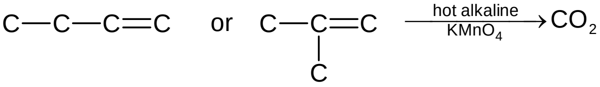
Y = 2

$\therefore X + Y = 5$

40.


CH3
CH3
or
CH3
CH3
or
CH3
CH3
hot alkaline
KMnO4
Aromatic dicarboxylic acid

So X = 3



$$C-C-C=C \quad \text{or} \quad C-\underset{\substack{|\\ C}}{C}=C \xrightarrow[KMnO_4]{\text{hot alkaline}} CO_2$$

Y = 2

X + Y = 5

Mathematics

PART – III

SECTION – A

41. $$\sum_{1\le i<j\le 7}\left|a_i+a_j\right|^2 = \sum_{1\le i<j\le 7}\left(\left|a_i\right|^2+\left|a_j\right|^2+a_i\bar{a}_j+\bar{a}_i a_j\right)$$
$$= 2R^2\cdot{}^7C_2 + \sum_{i\ne j}a_i\bar{a}_j = 42R^2+\sum_{i=1}^{7}\sum_{j=1}^{7}a_i\bar{a}_j-\sum_{i=1}^{7}a_i\bar{a}_i$$
$$= 35R^2 + \left(\sum_{i=1}^{7}a_i\right)\left(\sum_{i=1}^{7}\bar{a}_i\right)-7R^2$$
$$= 35R^2 + \left|\sum_{i=1}^{7}a_i\right|^2 \ge 35R^2$$

42. $HA_1^{'} = -2R\cos A_7\cos A_9$
$HA_7^{'} = -2R\cos A_1\cos A_7$
$HA_9^{'} = -2R\cos A_1\cos A_7$
$\angle A_1 = \dfrac{\pi}{13}$, $\angle A_7 = \dfrac{9\pi}{13}$, $\angle A_9 = \dfrac{3\pi}{13}$ so on using, we get $HA_1^{'} - HA_7^{'} + HA_9^{'} = \dfrac{R}{2}$

43. $$\left|\int_0^a f(x)dx\right| = \left|a\int_0^1 f(at)dt\right| \le \frac{1}{8}M$$

44. $$\begin{vmatrix} x & y & z \\ 2 & -3 & 1 \\ 1 & 1 & 1 \end{vmatrix} = 0\,;\ \begin{vmatrix} x-2 & y-1 & z+2 \\ 3 & -5 & 2 \\ 1 & 1 & 1 \end{vmatrix} = 0$$

45. $$\vec{p}\times(\vec{x}\times\vec{q}) = (\vec{p}\cdot\vec{q})\vec{x}-(\vec{p}\cdot\vec{x})\vec{q} = \vec{p}\times\vec{r}$$
$$\vec{x} = \frac{(\vec{p}\cdot\vec{x})\vec{q}}{\vec{p}\cdot\vec{q}}+\frac{(\vec{p}\times\vec{r})}{\vec{p}\cdot\vec{q}} = \frac{\alpha}{\vec{p}\cdot\vec{q}}\vec{q}+\frac{(\vec{p}\times\vec{r})}{\vec{p}\cdot\vec{q}}$$

46. Property

47. $$1+{}^4C_1\times 2+\frac{\underline{|4}}{\underline{|2}\,\underline{|2}\,\underline{|2}}\times\underline{|2}+\frac{\underline{|4}\times\underline{|3}}{\underline{|2}\,\underline{|1}\,\underline{|1}\,\underline{|2}}+\underline{|4} = 75$$

48. Using property and simplifying

49. Odd and even object draw is a bijection
$\therefore\ \dfrac{1}{2}$

50. g(x) = (x + 1)f(x) – x
g(x) = 0 for x = 0, 1, 2, ... n
g(x) = a x(x – 1) ..... (x – n)

$$\therefore\ \frac{f(x) = \dfrac{(-1)^{n+1}x.(x-1).....(x-n)}{\underline{|n+1}} + x}{x+1}$$

$$\Rightarrow\ f(n+1) = \begin{cases} 1 & ,\ \text{odd 'n'} \\ \dfrac{n}{n+2} & ,\ \text{even 'n'} \end{cases}$$

SECTION – B

51. Plane through line y = ax, z = c is $(y - ax) + \lambda_1(z - c) = 0$

Similarly, $(y + ax) + \lambda_2(z + c) = 0$

$\Rightarrow (y + c) + \lambda_1(y - c) = 0$ and $(y - c) + \lambda_2(y + c) = 0$

$\Rightarrow\ -\lambda_1 = \dfrac{y+c}{y-c},\ \dfrac{-1}{\lambda_2} = \dfrac{y+c}{y-c};\ \lambda_1\lambda_2 = 1$

$\therefore$ Locus is $\left(\dfrac{y-ax}{z-c}\right)\left(\dfrac{y+ax}{z+c}\right) = 1$

$a^2x^2 - y^2 + z^2 - c^2 = 0$

52. KL = 2R sin A

LM = 2R sin B

MK = 2R sin C

Δ KLM ~ ΔABC

$\Rightarrow$ Ar(ΔAKM) = Ar(ΔBLK) = Ar(CLM) = $\dfrac{2}{9}\text{Ar}(\Delta ABC)$

$\Rightarrow\ \text{Ar}(\Delta KLM) = \dfrac{1}{3}\text{Ar}(\Delta ABC)$

$\therefore\ a^2 = b^2 + c^2 - 2bc\cos A$

$\Rightarrow\ \dfrac{1}{3}a^2 = \left(\dfrac{2b}{3}\right)^2 + \left(\dfrac{c}{3}\right)^2 - 2\cdot\dfrac{2b}{3}\cdot\dfrac{c}{3}\cos A$

$\Rightarrow a^2 = 2b^2 - c^2$

Similarly, $b^2 = 2c^2 - a^2$ and $c^2 = 2a^2 - b^2$

$\Rightarrow a^2 = b^2 = c^2$

$\therefore$ a = b = c

SECTION – C

53. Using property of matrix and expanding

54. A(a, 0), B(0, b)

Put $y = \dfrac{1}{x}$

$x^2 - ax + \dfrac{a}{b} = 0$ and $x = \dfrac{1}{y}$

$y^2 - by + \dfrac{b}{a} = 0$

$AP^2 = (x_1 - a)^2 + y_1^2 = (a - x_2 - a)^2 + (b - y_2)^2 = x_2^2 + (b - y_2)^2 = BQ^2$

55. $\beta = \dfrac{1}{\alpha\gamma}$

Assume, $\alpha \ge \beta \ge \gamma$ (Say)

$\Rightarrow \alpha \ge 1$ and $\gamma \le 1$

$\therefore \ \dfrac{\alpha^{\beta+\gamma}\cdot\gamma^{\alpha+\beta}}{(\alpha\gamma)^{\alpha+\gamma}} = \dfrac{\gamma^{\beta-\gamma}}{\alpha^{\alpha-\beta}} \le 1$

56. $\lim\limits_{n\to\infty} a_n = a + \dfrac{b-a}{2} + \dfrac{b-a}{8} + \ldots\ldots = a + \dfrac{2}{3}(b-a) = \dfrac{a+2b}{3}$

57. Assume $\alpha_i < \dfrac{\pi}{6}$

$2(\sin\alpha_1 + \sin\alpha_2 + \sin\alpha_3) = 3\sin(\alpha_1+\alpha_2+\alpha_3)$

Also, $\dfrac{\sin\alpha_1+\sin\alpha_2+\sin\alpha_3}{3} \le \sin\left(\dfrac{\alpha_1+\alpha_2+\alpha_3}{3}\right)\ \left[\alpha_i \in \left(0, \dfrac{\pi}{2}\right)\right]$

$\Rightarrow \dfrac{\sin(\alpha_1+\alpha_2+\alpha_3)}{2} \le \sin\left(\dfrac{\alpha_1+\alpha_2+\alpha_3}{3}\right)$

$\Rightarrow \sin 3t \le 2\sin t$

$\Rightarrow 4\sin^3 t - \sin t \ge 0$

$\Rightarrow \sin^2 t \ge \dfrac{1}{4}$, which contradicts assumption

58. It's a sure event so, $p = 1$

59. $I = \lim\limits_{n\to\infty}\dfrac{\pi}{n}\left[\ln\left(a^2 - 2a\cos\dfrac{\pi}{n}+1\right)+\ln\left(a^2-2a\cos\dfrac{\pi}{n}+1\right)\ldots\ldots+\ln\left(a^2-2a\cos\dfrac{(n-1)\pi}{n}+1\right)\right]$

$= \lim\limits_{n\to\infty}\dfrac{\pi}{n}\ln\left(\left(a^2-2a\cos\dfrac{\pi}{n}+1\right)\left(a^2-2a\cos\dfrac{2\pi}{n}+1\right)\ldots\ldots\left(a^2-2a\cos\dfrac{(n-1)\pi}{n}\right)+1\right)$

$= \lim\limits_{n\to\infty}\prod\limits_{k=1}^{n-1}\left(\left(a-e^{\frac{ik\pi}{n}}\right)\left(a-e^{\frac{-ik\pi}{n}}\right)\right) = \lim\limits_{n\to\infty}\prod\left(\dfrac{a^{2n}-1}{a^2-1}\right)^{\frac{1}{n}} = 2\pi\ln a$

60. $\displaystyle\int_0^1\left(f(x)\cdot x - (f(x))^2\right)dx = \int_0^1\frac{x^2}{4}dx$

$\displaystyle\int_0^1\left[(f(x))^2 - x\cdot f(x) + \frac{x^2}{4}\right]dx = 0$

$\displaystyle\int_0^1\left(f(x)-\frac{x}{2}\right)^2 dx = 0$

$\Rightarrow f(x) = \dfrac{x}{2}$

$\therefore f'(x) = \dfrac{1}{2}$

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

FULL TEST – III

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 240**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C.**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section–A (01 – 08, 21 – 28, 41 – 48)** contains 24 multiple choice questions which have one or more correct answer. Each question carries **+4 marks** for correct answer and **–2 marks** for wrong answer.

   Section–A (09 – 12, 29 – 32, 49 – 52) contains 12 paragraphs with each having 2 questions with one correct answer. Each question carries **+4 marks** for correct answer and **–2 marks** for wrong answer.

2. **Section–C (13 – 20, 33 – 40, 53 – 60)** contains 24 Numerical based questions with answers as numerical value from 0 to 9 and each question carries +4 marks for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

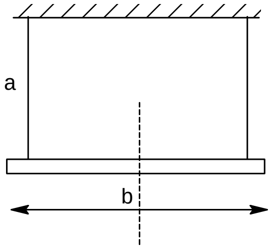
Physics

PART – I

SECTION – A
(One or More than one correct type)

This section contains **8** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

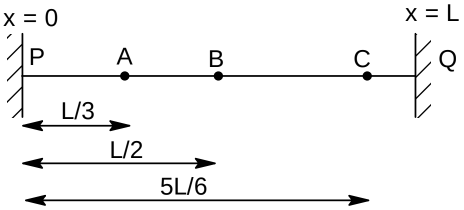
1. A thin rod of length ‘b’ is suspended horizontally using ideal strings tied to both ends of the rod. The length of the strings is ‘a’. The rod is given an initial angular speed ω about its central axis. Let δy be the upwards displacement of rod’s centre in a small time interval δt and δF be the total increment in the tension forces just after the rod was given the angular speed.



(A) $\delta y = \frac{b^2}{8a}(\omega\delta t)^2$ (B) $\delta y = \frac{b^2}{2a}(\omega\delta t)$

(C) $\delta F = \frac{mb^2}{4a}\omega^2$ (D) $\delta F = \frac{mb^2\omega^2}{8a}$

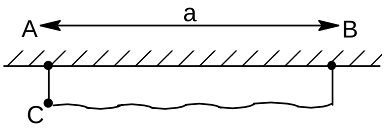
2. Standing waves are established on a string of length L such that A is a node and B is an immediate anti node. Oscillation amplitude for point B is a_0. Let a' be the oscillation amplitude for point C. Pick the suitable option(s) for correct value of a' and the possible equation(s) for standing waves on the string.



(A) $a' = \frac{a_0}{2}$ (B) $y = a_0 \sin\left(\frac{6\pi}{L}x\right)\cos(\omega t)$

(C) $a' = a_0$ (D) $y = a_0 \sin\left(\frac{3\pi x}{L}\right)\sin(\omega t)$

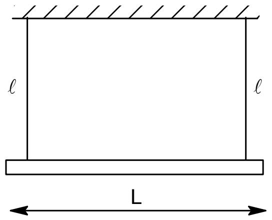
Space for Rough work



3. A string of length ‘2a’ has been tied at A and B such that AB = ‘a’. The string is passing through a bead C and initially the bead is very close to A. Now the bead is allowed to fall. Let h be the height by which the bead falls when the string becomes taut and v be the speed of the bead just after the string becomes taut. Pick correct option(s):—

(A) $v = \sqrt{3ag}\sin(26.5^\circ)$ (B) $v = \sqrt{1.5ag}\sin(26.5^\circ)$

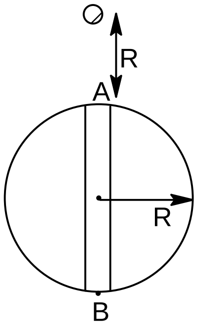
(C) $h = \frac{3a}{5}$ (D) $h = \frac{3a}{4}$



4. A rod of lengths L is supported by two ideal strings of length ℓ such that the system hangs in a vertical plane.
Case 1: Rod is kept horizontal, displaced slightly perpendicular to the plane and allowed by oscillate.
Case 2: Rod is given a small twist about central axis and then allowed to oscillate.
Let T_1, T_2 be the periods of oscillations in the two respective cases.

(A) $T_1 = 2\pi\sqrt{\frac{\ell}{g}}$ (B) $T_1 = 2\pi\sqrt{\frac{\ell}{2g}}$

(C) $T_2 = 2\pi\sqrt{\frac{L}{6g}}$ (D) $T_2 = 2\pi\sqrt{\frac{\ell}{3g}}$



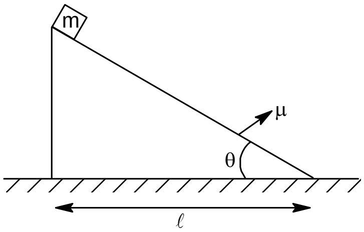
5. A small particle is dropped from a height R in front of a narrow tunnel dug inside the earth (along a diameter). Let M be the mass of earth, R be radius of earth. Let v_0, T be speed of particle when it reaches A and time taken by particle to go from A to B respectively. Assuming mass of particle to be negligible as compare to mass of earth, pick the correct option(s)

(A) $V_0 = \sqrt{\frac{GM}{2R}}$ (B) $V_0 = \sqrt{\frac{GM}{R}}$

(C) $R = \frac{\pi}{2}\sqrt{\frac{R^3}{GM}}$ (D) $T = \pi\sqrt{\frac{R^3}{GM}}$

Space for Rough work

6. A block of mass m slides down an incline plane. The incline plane has fixed base length 'ℓ' and coefficient of friction on the incline plane is 'μ'. The plane is fixed and block slides from top to bottom. Let θ_0 be the inclination angle for minimum sliding time and v_0 be the block's speed when it reaches the bottom in that case. Pick the correct option(s):—



(A) $v_0 = \sqrt{2g\ell(\tan\theta_0 - \mu)}$
(B) $v_0 = \sqrt{2g\ell\tan\theta_0}$
(C) $\tan(2\theta_0) = \frac{-1}{\mu}$
(D) $\tan(\theta_0) = \frac{1}{\mu}$

7. In Bohr model of hydrogen atom, let R, v and E represent the radius of robit, speed of the electron and total energy of electron respectively. Which of following quantities are directly proportional to quantum number n?

(A) vR
(B) RE
(C) $\frac{v}{E}$
(D) $\frac{R}{E}$

8. A neutron having kinetic energy E_0 collides with singly ionised He atom at rest and move along initial direction. Which of the following statement(s) is/are true for the above mentioned collision.

(A) Collision will be perfectly inelastic if E_0 = 17 eV
(B) Collision will be perfectly inelastic is E_0 = 8.16 eV
(C) If E_0 = then ploton of wavelength λ = 500 nm is observed just after the collision if E_0 = 8.16 eV.
(D) Perfectly elastic collision is not possible.

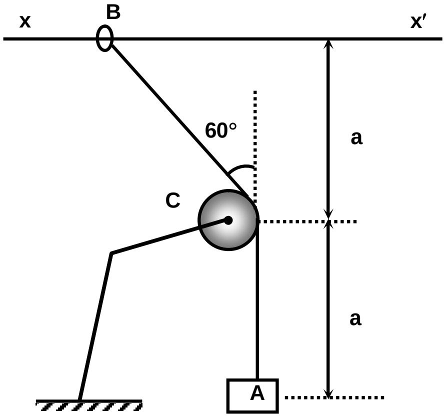
Space for Rough work

Paragraph type

This section contains **2 paragraphs**, each describing theory, experiments, data etc. Four questions relate to the two paragraphs with **two questions on each paragraph**. Each question has **ONLY ONE** correct answer among the four given options **(A), (B), (C) and (D).**

Paragraph for Question Nos. 09 and 10

A bead B of mass ‘m’ can travel without friction on a smooth horizontal wire xx′. The bead is connected to a block of identical mass by an ideal string passing over an ideal pulley. The system, as shown, is in vertical plane.



9. System is initially released from rest in the position shown. Initial acceleration of block A is:

(A) zero
(B) $\frac{g}{2}$
(C) $\frac{3g}{7}$
(D) $\frac{4g}{7}$

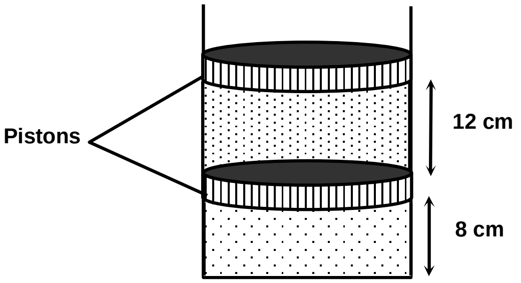
10. The system is allowed to fall. Find the speed of block A at the instant when string connected to the bead B makes an angle 37° with vertical.

(A) $\sqrt{ag}$
(B) $\sqrt{\frac{5ag}{17}}$
(C) $\sqrt{\frac{27ag}{68}}$
(D) $\sqrt{\frac{ag}{2}}$

Space for Rough work

Paragraph for Question Nos. 11 and 12

Figure shows a long cylindrical container with ideal gas in two chambers. Lower chamber is filled with one mole of a mono atomic gas, while upper chamber has one mole of a diatomic gas. The gases initially are at temperature 300 K, the container walls as well as pistons are conducting. Both the pistons are identical with mass 'M' and area 'A' such that $\frac{Mg}{A} = P_0$ (atmospheric pressure). Assuming the ideal gas constant to be R, answer the following questions:



11. The upper piston is pulled up slowly by 16 cm and held there. The displacement of the lower piston till it reaches new equilibrium state is:
(A) 2 cm
(B) 4 cm
(C) 8 cm
(D) 12 cm

12. Total work done by the ideal gases in this process is
(A) $300\,R\ell n(3)$
(B) $300R\ell n\left(\frac{9}{5}\right)$
(C) zero
(D) $300\,R\ell n(2)$

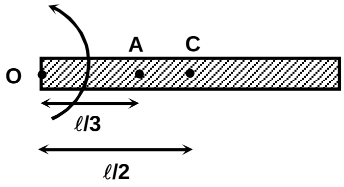
Space for Rough work

SECTION – C

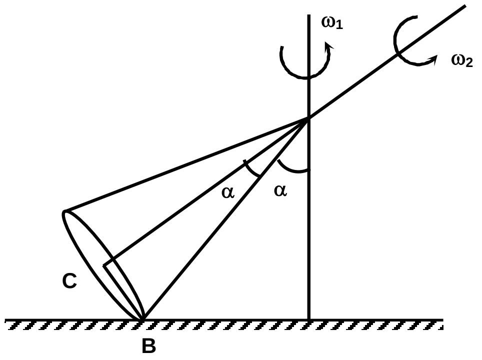
(Single digit integer type)

This section contains **8** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

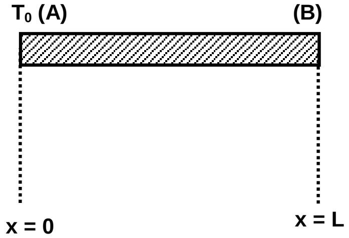
13. A uniform rod of mass m, length ℓ rotates about its end point O in horizontal plane. If the rod is rotating with a constant angular speed on a frictionless surface and the ratio of restoring force developed in the rod at points A and C is $\frac{F_A}{F_C} = 1 + \frac{n}{27}$, where ‘n’ is an integer value, find n.



14. A uniform solid cone (height h = 4m, α = 30°) is inclined against a vertical axis as shown in the figure. The cone rotates about its own axis as well as rotates about the vertical axis with angular speeds marked in the diagram. If the cone does not slip at point B; find $\frac{\omega_1}{\omega_2}$.

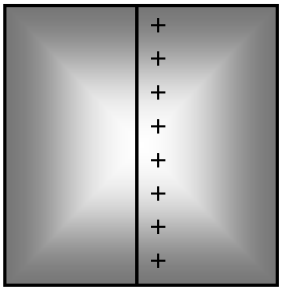


15. Figure shows a metal rod of uniform cross section area A, with variable thermal conductivity given by $k(x) = k_0 \sec\left(\frac{\pi}{6L}x\right)$. If the end A is maintained at temperature T_0, the rod carries a thermal current I_0 (from B to A) in steady state and $\frac{I_0 L}{k_0 A T_0} = \frac{\pi}{3}$; find the temperature of the end B of the rod. Let’s say this temperature is kT_0, find integer value k.

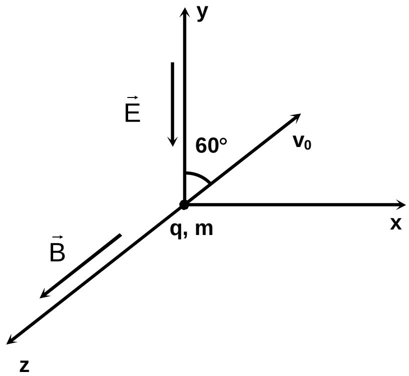


Space for Rough work

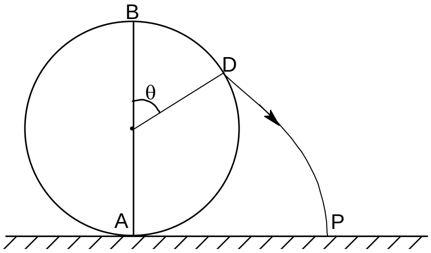
16. A very large non-conducting plane carrying charge Q uniformly distributed over it is placed in a medium with resistively ρ and permittivity ε. The plane leaks charge through the surrounding medium and the charge becomes $\frac{1}{n}$ times the initial value after a time $t = 6\rho\,\varepsilon\,\ell n(2)$ elapses. Find the integer value n. (Neglect the end effects).



17. A positively charged particle is given an initial velocity v_0 in XY plane as shown in diagram. Initially the particle was at origin and the region contains uniform, mutually perpendicular electric and magnetic field. Let $\vec{E} = -E\hat{j}$ and $\vec{B} = B\hat{k}$. The minimum magnitude of the magnetic field so that the charge particle crosses the origin again during its subsequent motion is $B_{min} = \frac{n\pi E}{v_0}$, find the integer value n.

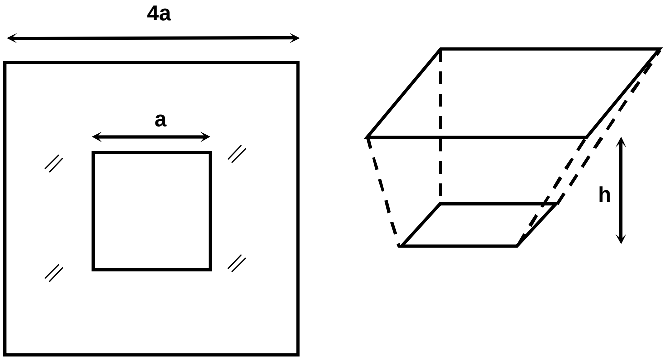


18. A particle slides down the surface of a smooth fixed sphere of radius R starting from rest at the highest point B. Particle leaves the sphere at some point and then strikes the horizontal plane passing through the lowest point A of the sphere, at point P. The distance AP is given by $AP = \frac{n}{27}[\sqrt{n} + 4\sqrt{2}]R$ where 'n' is an integer, find n. (Take $g = 10\ m/s^2$).

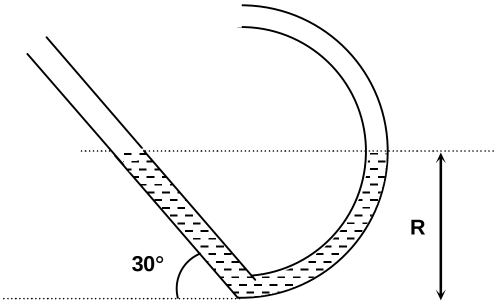


Space for Rough work

19. Figure shows a soap film formed between two square figures made of a uniform wire. The bigger square is held while keeping it in a horizontal plane and the smaller square is slowly allowed to drop vertically. It reaches an equilibrium state after dropping a height h. Let surface tension of soap = T. Mass per unit length of wire = λ. Acceleration due to gravity = g. Given that $h = \frac{n\lambda ga}{2\sqrt{4T^2 - \lambda^2 g^2}}$; find the integer value n.



20. A tube with thin but uniform cross section has two arms, one straight, other shaped as a semicircle of radius r. Initially both arms carry an ideal fluid upto a height R. Now the equilibrium is disturbed by pushing the fluid in the left arm by a small amount. Fluid is then released and allowed oscillate. Neglect any friction or viscous forces. If the time period of oscillations is found to be $T = \pi\sqrt{\frac{nR}{3g}(\pi + n)}$; find the integer value n.



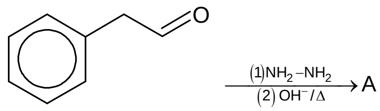
Space for Rough work

Chemistry PART – II

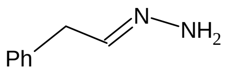
SECTION – A

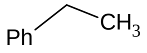
(One or More than one correct type)

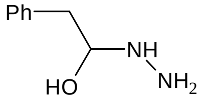
This section contains **8** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

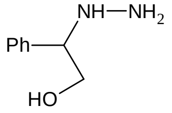
21. 
O
(1) NH2 –NH2
(2) OH⁻ / Δ
A

A is

(A) 

(B) 

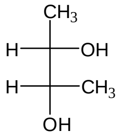
(C) 

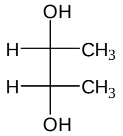
(D) 

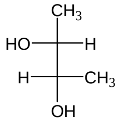
22. 100 ml of 0.05 M $CuSO_4$(aq) solution was electrolysed using inert electrodes by passing current till pH of the resulting solution was 2. The solution after electrolysis was neutralized and then treated with excess of KI and formed I_2 titrated with 0.04 M $Na_2S_2O_3$. Calculate the required vol. in ml of $Na_2S_2O_3$.

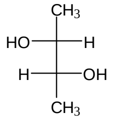
(A) 112.5 ml
(B) 100 ml
(C) 125 ml
(D) none of these

23. Which of the following structure(s) is/are meso-2,3 butanediol?

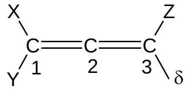
(A) 
CH3
H
OH
H
CH3
OH

(B) 
OH
H
CH3
H
CH3
OH

(C) 
CH3
HO
H
H
CH3
OH

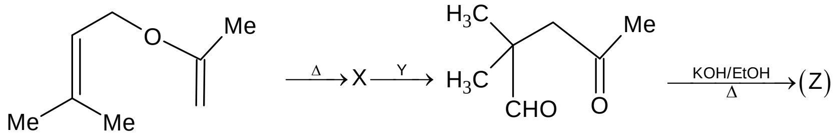
(D) 
CH3
HO
H
H
OH
CH3

Space for Rough work

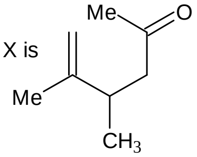
24. 

The π electron cloud of $C_1 - C_2$ is present in the plane of paper than which of the following is incorrect?

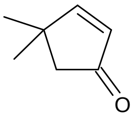
(A) Z is perpendicular to the plane of paper.
(B) X is present in the plane of paper.
(C) σ bond of $C_2 - C_3$ is perpendicular to the plane of paper.
(D) π electron cloud of $C_2 - C_3$ bond and X is present in same plane.

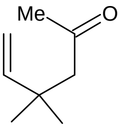
25. 

Choose the correct option (s)

(A) X is 

(B) Y is $O_3/(CH_3)_2S$

(C) Z is 

(D) X is 

26. How many of the following reaction(s) have sum of co-efficient of reactants after balancing either 3 or 4.

(A) $FeSO_4 \longrightarrow Fe_2O_3 + SO_2 + SO_3$
(B) $Br_2 + \overset{-}{O}H \longrightarrow BrO^- + Br^- + H_2O$
(C) $Cl_2 + SeO_3^{2-} + H_2O \longrightarrow SeO_4^{2-} + Cl^- + H^+$
(D) $Cl_2 + IO_3^- + OH^- \longrightarrow Cl^- + IO_4^- + H_2O$

27. $(COOH)_2 \xrightarrow{heat} X(gas) + Y(gas) + Z(gas)$

Y and Z both are polar and neutral, X is non polar and acidic. Z gas is condensed and formed liquid having pH = 7. The hybridization state of X, Y and Z are respectively.

(A) sp, sp^2, sp^3
(B) sp^2, sp^3, sp^3d
(C) sp, sp, sp^3
(D) sp^2, sp^2, sp^3

28. Which of the following give no residue on heating?

(A) NH_4NO_3
(B) NH_4NO_2
(C) $(NH_4)_2Cr_2O_7$
(D) NH_4Cl

Space for Rough work

Paragraph type

This section contains **2 paragraphs**, each describing theory, experiments, data etc. Four questions relate to the two paragraphs with **two questions on each paragraph**. Each question has **ONLY ONE** correct answer among the four given options **(A), (B), (C) and (D).**

Paragraph for Question Nos. 29 to 30

When triatomic gas X_3 reacts with an excess of potassium iodide solution buffered with a borate buffer (pH = 9.2), diatomic product Y_2 is liberated which can be titrated against a standard solution of sodium thiosulphate. This is a quantitative method for the estimation of X_3 gas in the mixture of X_3 and X_2 of some atom X.

29. X_2 and Y_2 are respectively?
(A) Cl_2 and I_2 (B) O_2 and I_2
(C) N_2 and I_2 (D) O_2 and H_2

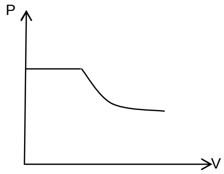
30. Select the incorrect statement?
(A) Y_2 produces blue colour with starch
(B) X_2 is thermodynamically more stable as compared to X_3
(C) Y_2 can produce brown colouration due to the presence of excess KI
(D) X_2 and X_3 both are colourless and odourless gases

Paragraph for Question Nos. 31 to 32

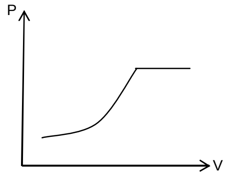
2 moles of He gas $\left(r=\frac{5}{3}\right)$ are initially at a temperature of $27^{o}C$ and occupy a volume of 20 L. The gas is first expanded at constant pressure until the volume is doubled, then undergoes reversible adiabatic change until the temperature returns to its initial value.

31. Which curve is correct for P vs V?

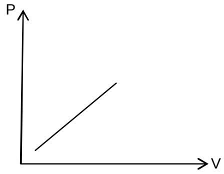
(A)



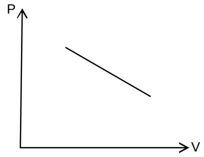
(B)



(C)



(D)



32. What are the initial pressure and final volume of gas?
(A) 2.46 atm, 110 L (B) 4.9 atm, 113.13 L
(C) 2.46 atm, 113.13 L (D) 4.9 atm, 110 L

Space for Rough work

SECTION – C

(Single digit integer type)

This section contains **8** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

33. Total number of moles of $EDTA^{4-}$ required to produce octahedral complex with Mg^{2+} is

34. Number of moles of NaOH required for complete neutralization of H^+ in solution which is formed by complete hydrolysis of 1 mole of PCl_5.

35. If 2s – 2p mixing is not operative the diamagnetic species among the following is/are
$H_2, H_2^+, Li_2, B_2, C_2, N_2, O_2^-, F_2$

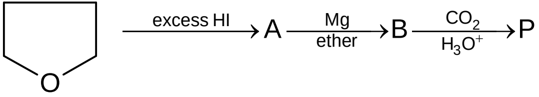
36. Find total number of d-electron(s) in metal ion complex $[M(NH_3)_4]^{2+}$. [EAN of metal = 35]

Space for Rough work

37. Equal volumes of 0.2 M KI solution and 0.1 M HgI_2 solution are mixed. Find the van’t Hoff factor of the resulting solution.

38. In the monochlorination of 3-methylpentan, let x be the number of pairs of isomers which exist as enantiomers, y be the number of pairs of isomers which exist as diastereomers, z be the number of isomers which are achiral. Calculate the value of x + y + z.

39. What is the number of carbon present in the final product of given synthesis?



40. In 1 litre saturated solution of AgCl [$K_{sp} = 1.6 \times 10^{-10}$], 0.1 mole of CuCl [$K_{sp} = 1 \times 10^{-6}$] is added. The resultant concentration of Ag^+ in the solution is 1.6×10^{-x} M. The value of x is

Space for Rough work

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **8** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

41. Consider f as a twice differentiable function such that $f(x) + f''(x) = -x\, g(x)f'(x)\ \forall\ x \geq 0$ where, $g(x) \geq 0\ \forall\ x \geq 0$, then ($\forall\ x \geq 0$)
(A) $(f(x))^2 + (f'(x))^2$ is a non increasing function
(B) $(f(x))^2 < 3(f(0))^2 + (2f'(0))^2$
(C) $|f(x)| \leq \alpha$, α is a fixed real constant
(D) $\lim\limits_{x\to\infty} f(x)\cdot\sin\left(\frac{1}{x}\right)$ exist

42. Consider P, Q, R to be vertices with integral coordinates and $(|PR| + |RQ|)^2 < 8$. Area (ΔPQR) + 1, then
(A) $\angle R$ can be a right angle
(B) ΔPQR can be isosceles
(C) P, Q, R can lie on a square
(D) P, Q, R can lie on circle centred on midpoint of line segment PQ

43. Consider vectors $\vec{a}$, $\vec{b}$, $\vec{c}$; $\vec{p} = (\vec{b}\cdot\vec{c})\vec{a} - (\vec{c}\cdot\vec{a})\vec{b}$; $\vec{q} = (\vec{a}\cdot\vec{c})\vec{b} - (\vec{a}\cdot\vec{b})\vec{c}$; $\vec{r} = (\vec{b}\cdot\vec{a})\vec{c} - (\vec{b}\cdot\vec{c})\vec{a}$, then
(A) $\vec{p}\cdot\vec{c} = 0$
(B) $\vec{p}, \vec{q}, \vec{r}$ can form a triangle
(C) $\Delta A(\vec{a})B(\vec{b})C(\vec{c})$ and $\Delta P(\vec{p})Q(\vec{q})R(\vec{r})$ are similar
(D) $\vec{p}, \vec{q}, \vec{r}$ are collinear

Space for rough work

44. Consider an equation $z^{1997} = 1$ (z is a complex number). If α, β are its two randomly chosen roots. 'p' denotes the probability that $\sqrt{2+\sqrt{3}} \le |\alpha+\beta|$, then

(A) $p = \frac{a}{1996}$, $a \in I$
(B) $\left[\frac{1}{p}\right]$ lies in [5, 15)
(C) $\left[\frac{1}{p}\times\frac{83}{50}\right]$ is 8 is divisible by 2
(D) $\left[\frac{1}{p}\right]+2$ is 6

45. Let ABCD be a quadrilateral with $\angle CBD = 2\angle ADB$, $\angle ABD = 2\angle CDB$, AB = BC, then
(A) AD = CD
(B) $\angle ADB = \angle CDB$
(C) $\angle CBD = \angle ABD$
(D) $\angle ADC$ is $\frac{2\pi}{3}$

46. If, f: $(0, \infty) \to (0, \infty)$ for which there is a positive real number 'a' such that it satisfies differential equation $f'\left(\frac{a}{x}\right) = \frac{x}{f(x)}$, then
(A) f(x) can be linear
(B) f(x) can be a functional of the type $m(x)^{1/n}$; $m \in R^+$, $n \in I^+$
(C) $f'(x)$ can be positive
(D) f(x) can be twice differentiable

47. A variable plane passes through the point (1, 2, 3) and meets the coordinate axis is P, Q, R. Then, the locus of the point common to the planes through P, Q, R parallel to coordinate planes
(A) contains point (3, 6, 9)
(B) passes through (0, 0, 0)
(C) is $\frac{1}{x}+\frac{1}{y}+\frac{1}{z}=1$
(D) contains line $\frac{x-1}{2}=\frac{y-2}{4}=\frac{z+6}{15}$

48. Consider a, b, c, d, e, f, g, h to be eight distinct alphabets then the number of ways in which they can be divided in 4 – parts is
(A) 1260 if exactly 2 – parts are equal
(B) 1701 in total
(C) 280 if its divided into two partitions of 3 and two of 1
(D) 210 if all parts are equal

Space for rough work

Paragraph type

This section contains **2 paragraphs**, each describing theory, experiments, data etc. Four questions relate to the two paragraphs with **two questions on each paragraph**. Each question has **ONLY ONE** correct answer among the four given options **(A), (B), (C) and (D).**

Paragraph for Question Nos. 49 to 50

Read the following write up carefully and answer the following questions:
Consider a function f: R → R; $f(x^2 + y\,f(z)) = x\,f(x) + z\,f(y)\ \forall\ x, y, z \in R$

49. If $f(x) = 0,\ \forall\ x \in R$ is not considered a part of solution set, then
(A) $f(\alpha) < \alpha^4\ \forall\ \alpha \in (0, 1)$
(B) $f(\alpha) < \alpha^2\ \forall\ \alpha \in (0, 1)$
(C) $f(\alpha) = \alpha^3$ for some $\alpha \in R^+$
(D) $\lim\limits_{\alpha\to 0^+} \frac{f(\alpha)}{\alpha} < \lim\limits_{\alpha\to 0^+} \frac{\sin\alpha}{\alpha}$

50. If $g(x) = |f(x)| + f(|x|)$ then ($f(x) = 0\ \forall\ x \in R$ is not considered part of solution set)
(A) g(x) is not continuous $\forall\ x \in R$
(B) g(x) is differentiable except at two points $\forall\ x \in R$
(C) g(x) is differentiable at $x = \sin\alpha$ ($\alpha \neq n\pi$, $n \in I$)
(D) g(x) is non differentiable at integers

Paragraph for Question Nos. 51 to 52

Read the following write up carefully and answer the following questions:
Let $A_0, A_1, ... A_{n-1}$ be a n-sided polygon with vertices as $1, \omega, \omega^2, ..., \omega^{n-1}$. Let $B_0, B_1, ..., B_{n-1}$ be another polygon with vertices $1, 1 + \omega, 1 + \omega^2, ..., 1 + \omega^{n-1}$ $\left[\omega = \cos\frac{2\pi}{n} + i\sin\frac{2\pi}{n}\right]$

51. For n = 4, $\frac{Ar.(A_0, A_1, A_2, A_3)}{Ar.(B_0, B_1, ..., B_3)}$ is λ, then
(A) $[\lambda] > 3$
(B) $\frac{3\lambda}{2} \in I^+$
(C) $\frac{[\lambda]}{3} \in I^+$
(D) λ is irrational

52. $\frac{Ar.(A_0\ A_1\ A_2)}{Ar.(B_0\ B_1\ B_2)}$ is
(A) less than 1
(B) an irrational number
(C) lies in $(0, \pi)$
(D) less than $\frac{\pi}{2}$

Space for rough work

SECTION – C

(Single digit integer type)

This section contains **8** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

53. For continuous function f: [0, 1] → R; A = $\int_0^1 \left(x^2 \cdot f(x)\right) dx$; B = $\int_0^1 x \cdot \left(f(x)\right)^2 dx$ then, maximum value of A – B is λ where $\left[\frac{1}{4\lambda}\right]$ is _____

54. Let A be an n × n matrix such that $A + A' = O_{n \times n}$, then $|I + \lambda A^2| \ge M$ where 3M + 1 is _____

55. Consider a equation $x^3 - 3x = \sqrt{x+2}$ such that x is a real number then sum of its positive roots is λ where $\left[\frac{\lambda}{2}\right]$ is _____

56. Consider A and B as 2 × 2 matrices with determinant equal to 1, then $\text{tr}(AB) - \text{tr}(A)\cdot\text{tr}(B) + \text{tr}(AB^{-1}) + 2$ is _____

57. Consider an ellipse $\frac{x^2}{25} + \frac{y^2}{16} = 1$ and ABCD be a quadrilateral circumscribing the ellipse. Let S be one of its focii, then $\angle ASB + \angle CSD = \frac{3\pi}{\lambda}$ where, λ is _____

58. Consider a parabola $y^2 = 8x$. If PSQ is a focal chord of the parabola whose vertex is A and focus S, V being the middle point of the chord such that $PV^2 = AV^2 + \lambda \cdot AS^2$ where λ is _____

59. If $\alpha \in (0, 1)$ and f: R →R and $\lim_{x\to\infty} f(x) = 0$, $\lim_{x\to\infty} \frac{f(x) - f(\alpha x)}{x} = 0$, then $\lim_{x\to\infty} \frac{f(x)}{x} = \lambda$ where $2\lambda + 7$ is _____

60. Let f: [a, b] → R be a function, continuous on [a, b] and twice differentiable on (a, b). If, f(a) = f(b) and f′(a) = f′(b), then consider the equation $f''(x) - \lambda(f'(x))^2 = 0$. For any real λ the equation has atleast M roots where 3M + 1 is _____

Space for rough work

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FULL TEST – III

PAPER-2

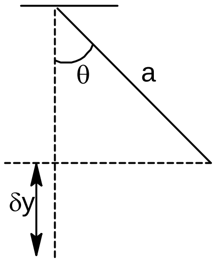
Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**A, C**	21.	**B**	41.	**A, B, C, D**
2.	**C, D**	22.	**A**	42.	**A, B, C, D**
3.	**B, D**	23.	**B, C**	43.	**A, B, C**
4.	**A, D**	24.	**A, B, C**	44.	**A, B, C**
5.	**B, C**	25.	**B, C, D**	45.	**A, B, C**
6.	**A, C**	26.	**B, C, D**	46.	**A, B, C, D**
7.	**A, C**	27.	**C**	47.	**A**
8.	**A, B, D**	28.	**A, B, D**	48.	**A, B, C**
9.	**C**	29.	**B**	49.	**C**
10.	**C**	30.	**D**	50.	**C**
11.	**B**	31.	**A**	51.	**B**
12.	**A**	32.	**C**	52.	**C**
13.	**5**	33.	**1**	53.	**4**
14.	**1**	34.	**8**	54.	**1**
15.	**2**	35.	**5**	55.	**1**
16.	**8**	36.	**9**	56.	**2**
17.	**2**	37.	**3**	57.	**3**
18.	**5**	38.	**9**	58.	**3**
19.	**3**	39.	**6**	59.	**7**
20.	**4**	40.	**7**	60.	**4**

Physics

PART – I

SECTION – A

1. $\delta y = a(1-\cos\theta) = \frac{a\theta^2}{2}$



and $\theta_a = \frac{b\phi}{2}$

$\Rightarrow \quad \delta y = \frac{a}{2}\left(\frac{b\phi}{2a}\right)^2 = \frac{b^2}{8a}\phi^2$

$\Rightarrow \quad \delta y = \frac{b^2}{8a}(\omega\delta t)^2$

acc. of rod's centre = $\frac{b^2}{4a}\omega^2$

$\Rightarrow \quad \delta F = \frac{mb^2}{4a}\omega^2$

2. $y = a_0 \sin(kx)\sin(\omega t + \phi)$

$\frac{kL}{3} = n\pi$ and $\frac{kL}{2} = \left(n+\frac{1}{2}\right)\pi$

$\Rightarrow \quad n = 1,\ k = \frac{3\pi}{L}$

Also; $a' = \left|a_0 \sin\left(\frac{3\pi}{L}\times\frac{5L}{6}\right)\right| = a_0$

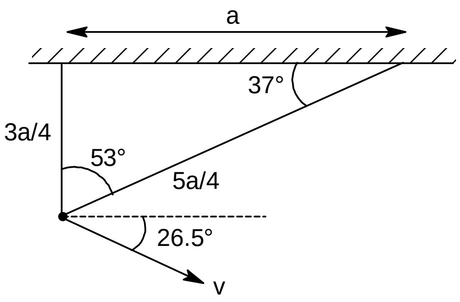
3. $h = \frac{3a}{4}$

$v_0 = \sqrt{2gh}$

$v_0 = \sqrt{1.5ag}$ and $v = v_0\cos(90° - 26.5°)$

$= v_0\sin(26.5°)$

$\Rightarrow \quad v = \sqrt{1.5ag}\ \sin(26.5°)$



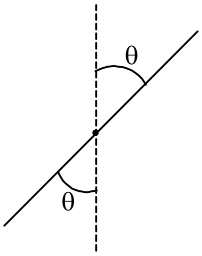
4. Let θ be the angle that the rod rotates about its central axis and ϕ be the angle made by string with the vertical.

$-(2T\phi)\ \frac{L}{2} = \frac{mL^2}{12}\frac{d^2\theta}{dt^2}$

$\Rightarrow \quad \frac{d^2\theta}{dt^2} = -\left(\frac{6g}{L}\right)\phi$

or $\frac{d^2\theta}{dt^2} = -\left(\frac{3g}{\ell}\right)\theta$

$\Rightarrow \quad T_2 = 2\pi\sqrt{\frac{\ell}{3g}}$



5. $\frac{-GMm}{2R} = \frac{-GMm}{R} + \frac{1}{2}mv_0^2$

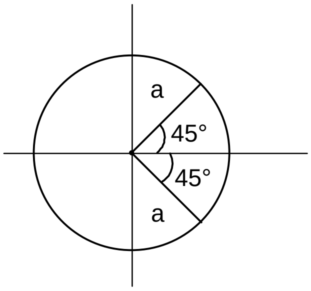
$\Rightarrow \quad v_0 = \sqrt{\frac{GM}{R}}$

While in the tunnel;

$\frac{d^2x}{dt^2} = -\left(\frac{GM}{R^3}\right)x$

$v_0^2 = \frac{GM}{R} = \omega^2(a^2 - R^2) \;\Rightarrow\; a = \sqrt{2}R$

$\Rightarrow \quad T_{A\to B} = \frac{1}{4}\times 2\pi\sqrt{\frac{R^3}{GM}}$



6. $t^2 = \frac{2\ell}{g[\cos\alpha\sin\alpha - \mu\cos^2\alpha]}$

For min. time; $\frac{d}{d\alpha}(\cos\alpha\sin\alpha - \mu\cos^2\alpha) = 0$

$\Rightarrow \quad \tan 2\alpha = \frac{-1}{\mu}$

$\Delta K + \Delta U = W_{friction}$

$\Rightarrow \quad v_0 = \sqrt{2g\ell(\tan\theta_0 - \mu)}$

7. $v \propto \frac{Z}{n},\; R \propto \frac{n^2}{Z}$ and $E \propto \frac{Z^2}{n^2}$

$\Rightarrow \quad vR \propto n$ and $\frac{v}{E} \propto n$

8. $mv_0 = (4m + m)v$

$v = \frac{v_0}{5}$

$\frac{1}{2}mv_0^2 = \frac{1}{2}.(5m).\frac{v_0^2}{25} + \Delta E$

$\frac{1}{2}mv_0^2 - \frac{1}{2}.\frac{v^2}{25}m = \Delta E$

$\Rightarrow \quad \frac{1}{2}mv_0^2\left\{\frac{4}{5}\right\} = \Delta E$

$\frac{1}{2}mv_0^2 = \frac{5}{4}\Delta E$

$\Delta E = 13.6$

$\Delta E = 13.6\left\{1 - \frac{1}{4}\right\} = \frac{3}{4}.(13.6)$

$\frac{1}{2}mv_0^2 = \frac{5}{4}\times 13.6,\; \frac{3}{5}\times 13.6$

= 17 eV, 8.16 eV

9. $mg - T = ma_1$

$T\cos 30° = ma_2$

and $a_2 \cos 30° = a_1$

$$\Rightarrow mg = ma_1\left(1+\frac{1}{\cos^2 30°}\right)$$

$$\Rightarrow a_1 = \frac{3g}{7}$$

10. Height dropped by A

$$h = \frac{a}{\cos 60°} - \frac{a}{\cos 37°} = \frac{3a}{4}$$

$$mgh = \frac{1}{2}mv_A^2 + \frac{1}{2}mv_B^2$$

Also, $v_B \sin 37° = v_A$

$$\Rightarrow \frac{3ag}{4} = \frac{v_A^2}{2}\left[1+\left(\frac{5}{2}\right)^2\right]$$

$$v_A = \frac{3}{2}\sqrt{\frac{3ag}{17}}$$

11. $P_{lower} - P_{upper} = P_0$

$$\Rightarrow \frac{3P_0 \times (8)}{(8+x)} - \frac{2P_0 \times 12}{(28-x)} = P_0$$

$\Rightarrow x = 4$ cm

12. $W_{total} = W_{upper} + W_{lower}$

$$= 300R\left[\ell n\left(\frac{24}{12}\right) + \ell n\left(\frac{12}{8}\right)\right] = 300R\ell n(3)$$

SECTION – C

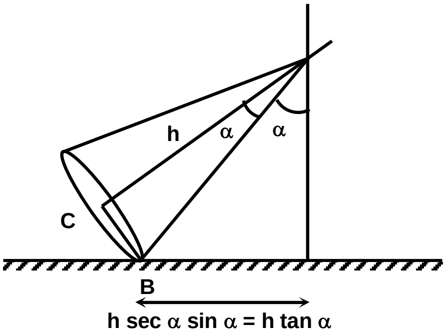
13. $F_A = \frac{2m}{3}\omega^2 \times \frac{2\ell}{3}$, $F_C = \frac{m}{2}\omega^2 \times \frac{3\ell}{4}$

$$\Rightarrow \frac{F_A}{F_C} = \frac{32}{27}$$

$\Rightarrow n = 5$

14. $\omega_1 h\tan\alpha = \omega_2 R$

$$\Rightarrow \frac{\omega_1}{\omega_2} = \frac{R/h}{\tan\alpha} = 1$$



15. $$I_0 = \frac{k_0 A}{\cos\left(\frac{\pi}{6L}x\right)}\frac{dT}{dx}$$

$$\Rightarrow T = T_0 + \frac{6I_0 L}{\pi k_0 A}\sin\left(\frac{\pi}{6L}x\right)$$

$\Rightarrow$ T = $2T_0$ at x = L

16. $$j = \frac{1}{\rho}E = \frac{\sigma}{2\rho\varepsilon}$$

$$I = jA = \frac{q}{2\rho\varepsilon} \Rightarrow \frac{dq}{dt} = -\frac{q}{2\rho\varepsilon}$$

$$\Rightarrow \quad q = Qe^{-\left(\frac{t}{2\rho\varepsilon}\right)}$$

Or $q = \frac{Q}{8}$ at t = $6\rho\varepsilon\,\ell n(2)$

17. $$\vec{v} = \frac{v_0}{2}\left(\sqrt{3}\hat{i} + \hat{j}\right)$$

For crossing origin,

$k\frac{2\pi m}{qB} = \frac{2(v_0/2)}{qE/m}$; k is an integer

$$\Rightarrow B = \left(\frac{2\pi E}{v_0}\right)k$$

For minimum value; k = 1

$$\Rightarrow B_{min} = \frac{2\pi E}{v_0}$$

18. For leaving the surface, $\cos\theta = 2/3$

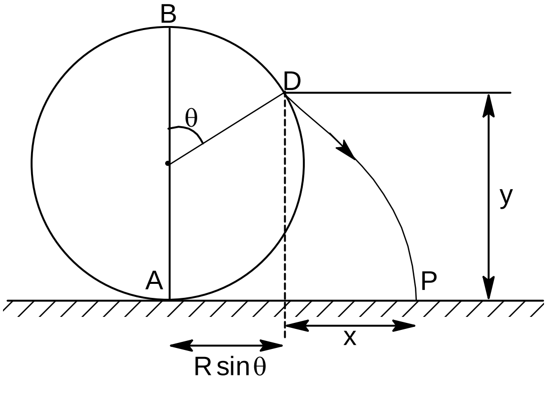
$y = (v\sin\theta)t + \frac{1}{2}gt^2 = R(1 + \cos\theta)$ … (1)

and $x = (v\cos\theta)t$ … (2)

and $v^2 = \frac{2}{3}gR$ … (3)

On solving;

$AP = R\sin\theta + x = \frac{5}{27}(\sqrt{5} + 4\sqrt{2})R$

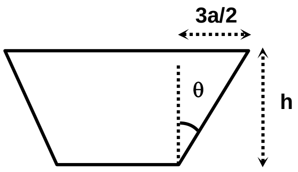


19. $$\tan\theta = \frac{3a}{2h}$$

$2 \times 4a\,T \times \cos\theta = 4a\lambda g$

$\cos\theta = \frac{\lambda g}{2T}$

$$\Rightarrow h = \frac{3\lambda g a}{2\sqrt{4T^2 - \lambda^2 g^2}}$$



20. $-A\rho g\, x\,(1 + \sin 30^\circ) = A\rho R\left[\frac{\pi}{2} + \operatorname{cosec}30^\circ\right]\frac{d^2x}{dt^2}$

$$\Rightarrow \frac{d^2x}{dt^2} = -\left(\frac{gx}{R}\right)\left(\frac{3/2}{\frac{\pi}{2}+2}\right)$$

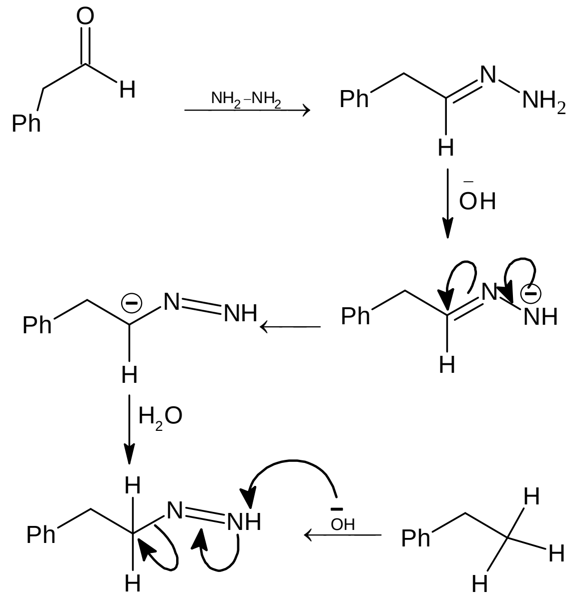
$$\Rightarrow T = \pi\sqrt{\frac{4R(\pi+4)}{3g}}$$

Chemistry

PART – II

SECTION – A

21.

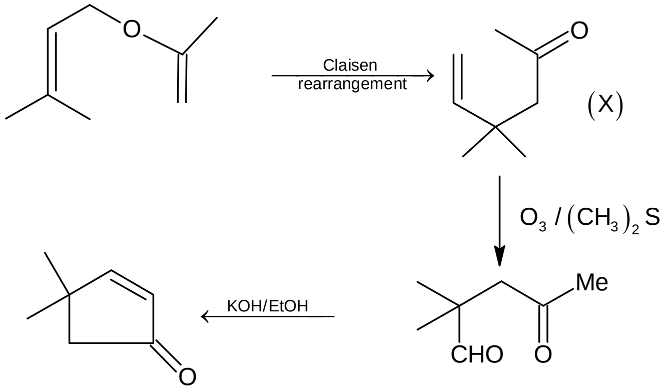

O
H
Ph
NH2–NH2
Ph
N
NH2
H
OH
Ph
N
NH
H
Ph
N
NH
H
H2O
H
Ph
N
NH
H
OH
Ph
H
H
H

22. Initial m. mole of Cu^{2+} = 5
m. mole of H^+ produced = 1
m. mole of Cu^{2+} converted to Cu = $\frac{1}{2} = 0.5$
m. mole of Cu^{2+} remaining in solution = 5 – 0.5 = 4.5
$2Cu^{2+} + 4I^- \longrightarrow Cu_2I_2 + I_2$
$I_2 + 2Na_2S_2O_3 \longrightarrow 2NaI + Na_2S_4O_6$
4.5 = 0.04 × V
V = 112.5 mol

23. $\left.\begin{array}{l} B \longrightarrow 2R,3S \\ C \longrightarrow 2R,3S \end{array}\right\}$ Both are meso.

24. Only (D) option is correct. π electron cloud of $C_2 – C_3$ is present in same plane.

25.


O
Claisen
rearrangement
O
(X)
$O_3/(CH_3)_2S$
KOH/EtOH
Me
CHO
O
O

26. $2FeSO_4 \longrightarrow Fe_2O_3 + SO_2 + SO_3$

$Br_2 + 2\overset{-}{O}H \longrightarrow BrO^- + Br^- + H_2O$

$Cl_2 + SeO_3^{2-} + H_2O \longrightarrow SeO_4^{2-} + 2Cl^- + 2H^+$

$Cl_2 + IO_3^- + 2OH^- \longrightarrow 2Cl^- + IO_4^- + H_2O$

27. $(COOH)_2 \xrightarrow{\Delta} \underset{X}{CO_2} + \underset{Y}{CO} + \underset{Z}{H_2O}$

CO_2 → non polar and acidic → sp
CO → polar and neutral → sp
H_2O → polar, pH = 7 → sp^3

28. $NH_4NO_3 \xrightarrow{\Delta} N_2O + 2H_2O$

$NH_4NO_2 \xrightarrow{\Delta} N_2 + 2H_2O$

$(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + +Cr_2O_3(s) + 4H_2O$

$NH_4Cl \xrightarrow{\Delta} NH_3 + HCl$

Solution for the Q. No. 29 to 30.

$X_2 = O_2$, $X_3 = O_3$, $Y_2 = I_2$

$2I^- + H_2O + O_3 \longrightarrow 2OH^- + I_2 + O_2$

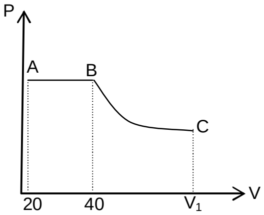
$I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-}$

$I_2 + \text{Starch solution} \longrightarrow \text{Blue colouration}$

$I_2 + I^-(\text{excess}) \longrightarrow \text{Brown coloured } I_3^- \text{ ion}$

O_2 is thermodynamically more stable as compared to O_3
O_3 is pale blue gas which has characteristic smell.

32.



A → P_1, 300 K
B → P_1, T_2
C → P_2, 300 K

For state A $P_1 = \dfrac{nRT}{V} = 2.46$ atm

For isobaric process AB $\dfrac{V_1}{T_1} = \dfrac{V_2}{T_2}$

T_2 = 600 K

For adiabatic process BC $TV^{\gamma-1} = \text{Constant}$

$600(40)^{\gamma-1} = 300\,(V_1)^{\gamma-1}$

V_1 = 113.13 lit.

SECTION – C

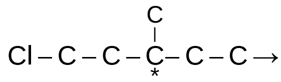
33. $Mg^{2+} + \underset{(\text{Hexadentate ligand})}{EDTA^{4-}} \longrightarrow \underset{\text{Octahedral complex}}{\left[Mg(EDTA)\right]^{2-}}$ $\quad CN = 6$

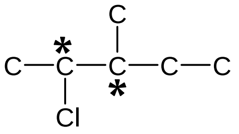
34. $PCl_5 + 4H_2O \longrightarrow H_3PO_4 + 5HCl$

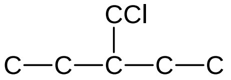
35. H_2, Li_2, B_2, N_2, F_2

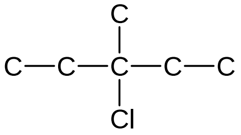
36. Atomic number of metal = 29
$Cu = 3d^{10}4s^1$
$Cu^{2+} = 3d^9$

37. $2KI + HgI_2 \longrightarrow K_2[HgI_4] \longrightarrow 2K^+ + [HgI_4]^{2-}$
i = 3

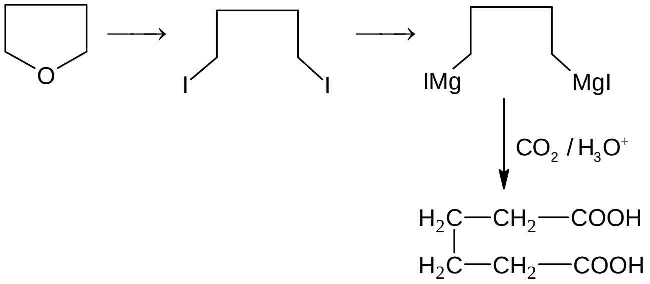
38. 
$Cl-C-C-\overset{\overset{C}{|}}{\underset{*}{C}}-C-C \rightarrow$ one chiral carbon pair of enantiomers.


$C-\underset{\underset{Cl}{|}}{\overset{*}{C}}-\overset{\overset{C}{|}}{\underset{*}{C}}-C-C \longrightarrow$ 2 chiral carbon
2 pair of enantiomers
4 pair of diastereoisomers


$C-C-\overset{\overset{CCl}{|}}{C}-C-C \longrightarrow$ achiral molecule


$C-C-\overset{\overset{C}{|}}{\underset{\underset{Cl}{|}}{C}}-C-C \longrightarrow$ achiral molecule

x = 3, y = 4, z = 2
x + y + z = 9

39. 

40. $\because K_{sp}(CuCl) >> K_{sp}(AgCl)$
Thus assume $[Cl^-]$ in solution comes from CuCl only.
$[Cl^-] = \sqrt{K_{sp}CuCl} = 10^{-3}$ M
For AgCl $[Ag^+][Cl^-] = 1.6 \times 10^{-10}$
$[Ag^+] = 1.6 \times 10^{-7}$
x = 7

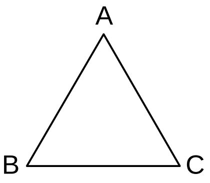
Mathematics

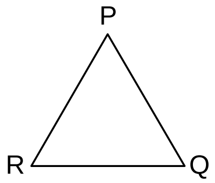
PART – III

SECTION – A

41. $\frac{d}{dx}\left(\left(f\left(x\right)\right)^2+\left(f'\left(x\right)\right)^2\right)=2f'\left(x\right)\cdot f\left(x\right)+2f'\left(x\right)\cdot f''\left(x\right)$ = $-2x\, g(x)(f'(x))^2 \le 0$

42. $|PR|^2 + |RQ|^2 \ge 2|PR|\,|RQ|$
$|PR|\cdot|RQ| \ge 2Ar(\Delta PQR)$
$\Rightarrow 8Ar(\Delta PQR) \le |PR|^2 + |RQ|^2 + 4Ar(\Delta PQR)$
$\le |PR|^2 + |RQ|^2 + 2\cdot|PR|\cdot|RQ| < 8Ar(\Delta PQR) + 1$
$\Rightarrow 8Ar(\Delta PQR) = |PQ|^2 + |QR|^2 + 4Ar(\Delta PQR)$ and
$|PQ|^2 + |QR|^2 = 2|PQ|\cdot|QR| = 4Ar(\Delta PQR)$
$\therefore \angle R = 90^o$ and RP = RQ

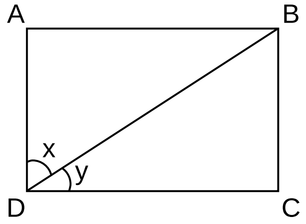




43. $\vec{p}+\vec{q}+\vec{r}=0$
So, $\vec{p}, \vec{q}, \vec{r}$ can form a triangle
$\vec{p}\cdot\vec{c}=\left(\vec{b}\cdot\vec{c}\right)\left(\vec{a}\cdot\vec{c}\right)-\left(\vec{c}\cdot\vec{a}\right)\left(\vec{b}\cdot\vec{c}\right)=0$
$\therefore\ \vec{p}\perp\vec{c}$
$\Rightarrow\ \vec{q}\perp\vec{a}$ and $\vec{r}\perp\vec{b}$

44. Take, $\beta = 1$
$\Rightarrow |1 + \alpha|^2 = |(1 + \cos\theta) + i\sin\theta|^2 = 2 + 2\cos\theta \ge 2+\sqrt{3}$
$\Rightarrow\ \cos\theta\ge\frac{\sqrt{3}}{2}$ so, we get 332 angles
$\therefore\ p=\frac{332}{1996}$

45. $2x = \angle CBD$
$2y = \angle ABD$
In ΔCBD
$\frac{\sin\left(\pi-\left(2y+x\right)\right)}{\sin x}=\frac{BD}{BA}=\frac{BD}{BC}=\frac{\sin\left(\pi-\left(2x+y\right)\right)}{\sin y}$
$\Rightarrow \sin(2y + x)\sin y = \sin(2x + y)\sin x$
$\Rightarrow\ \frac{1}{2}\left[\cos\left(y+x\right)-\cos\left(3y+x\right)\right]=\frac{1}{2}\left[\cos\left(x+y\right)-\cos\left(3x+y\right)\right]$
$0 < x + y = \frac{1}{2}ABC<\frac{\pi}{2}$
$0 < (3y + x) + (3x + y) < 2\pi$
$\therefore\ 3y + x = 3x + y \Rightarrow x = y$
$\Rightarrow \angle ABD = \angle CBD \Rightarrow AD = CD$



46. $g\left(x\right)=f\left(x\right)\cdot f\left(\frac{a}{x}\right)$
$g'\left(x\right)=f'\left(x\right)\cdot f\left(\frac{a}{x}\right)-f\left(x\right)f'\left(\frac{a}{x}\right)\left(\frac{a}{x^2}\right)$ = $\frac{a}{x}-x\left(\frac{a}{x^2}\right)=0$
$\Rightarrow g(x) = b$

$$\Rightarrow f(x)\cdot f\left(\frac{a}{x}\right) = b$$

$$\Rightarrow f(x) = \sqrt{b}\left(\frac{x}{\sqrt{a}}\right)^{\frac{a}{b}}$$

47. Let, OA = x_1, OB = y_1, OC = z_1 be points on X, Y, Z axis then equation of plane is

$$\frac{x}{x_1} + \frac{y}{y_1} + \frac{z}{z_1} = 1$$

$$\Rightarrow \frac{1}{x_1} + \frac{2}{y_1} + \frac{3}{z_1} = 1$$

$$\therefore \text{ Locus is } \frac{1}{x} + \frac{2}{y} + \frac{3}{z} = 1$$

48. Total ways = ${}^8C_3 + {}^8C_4 \times {}^4C_2 + {}^8C_2 \times \frac{{}^6C_3}{2} + {}^8C_3 \times {}^5C_1 \times \frac{{}^4C_2}{2} + \frac{\lfloor\underline{8}}{(2)^4 \lfloor\underline{4}}$

49.-50. $f(x^2 + y\,f(z)) = x\cdot f(x) + z\,f(y)$

$x = y = z = 0$

$f(0) = 0$

$x = 0$

$f(y\cdot f(z)) = z\cdot f(y)$

$y = z = t$

$f(t\cdot f(t)) = t\cdot f(t)$

Using this and substitution, we get $f(x) = x$ and $f(x) = 0$

51.-52. Ar.($B_0, B_1, \ldots\ldots, B_{n-1}$) = $\frac{n}{4}\cot\left(\frac{\pi}{n}\right)$

Ar.($A_0\ A_1 \ldots\ldots A_{n-1}$) = $\frac{n}{2}\sin\frac{2\pi}{n}$

$$\therefore \frac{\text{Ar.}(A_0\ A_1 \ldots\ldots A_n)}{\text{Ar.}(B_0\ B_1 \ldots\ldots B_n)} = \frac{n\sin\frac{\pi}{n}\cos\frac{\pi}{n}}{\frac{n}{4}\cot\frac{\pi}{n}} = 4\sin^2\frac{\pi}{n}$$

SECTION – C

53. $x(f(x))^2 - x^2 f(x) = \left(\sqrt{x}f(x)\right)^2 - 2\cdot\sqrt{x}\times f(x)\cdot\frac{x^{3/2}}{2} + \frac{x^3}{4} - \frac{x^3}{4}$

$$\left(\sqrt{x}\,f(x) - \frac{x^{3/2}}{2}\right)^2 - \frac{x^3}{4}$$

$$\therefore B - A = \int_0^1 \left(\sqrt{x}\ f(x) - \frac{x^{3/2}}{2}\right)^2 dx - \int_0^1 \frac{x^3}{4}dx$$

$$\therefore A - B \le \frac{1}{16}$$

54. Say, $\lambda < 0$

$\omega = \sqrt{-\lambda}$
$\therefore |I + \lambda A^2| = |I - \omega^2 A^2| = |I - \omega A||I + \omega A|$
As, $A = -A'$
$I - \omega A = I + \omega A' = (I + \omega A)' \Rightarrow |I + \lambda A^2| = |I + \omega A||I + \omega A|' = |I + \omega A|^2 \geq 0$
Same, can be seen for $\lambda \geq 0$

55. If $x > 2$ then $x^3 - 3x > 4x - x = x > \sqrt{x+2}$
$\Rightarrow |x| \leq 2$ take $x = 2\cos\theta$ for some $\theta \in [0, \pi]$
$\Rightarrow 2\cos 3\theta = \sqrt{2(1+\cos\theta)}$
$\Rightarrow 2\sin\frac{7\theta}{4} \cdot \sin\frac{5\theta}{4} = 0$
$\Rightarrow \theta = 0, \frac{4\pi}{7}, \frac{4\pi}{5}$
$\therefore x = 2, 2\cos\frac{4\pi}{7}, -\frac{1}{2}\left(1+\sqrt{5}\right)$

56. $B^2 - \text{tr}(B)\cdot B + I = 0$
$\Rightarrow AB - (\text{tr}(B)A + AB^{-1} = 0$
$\therefore \text{tr}(AB) - \text{tr}(A)\text{tr}(B) + \text{tr}(AB^{-1}) = 0$

57. Using property

58. Using property of parabola

59. $\lim\limits_{x\to\infty} \frac{f(x) - f(\alpha x)}{x} = 0$
$\Rightarrow$ For any $\in > 0$ there is $\delta > 0$ such that $|x| < \delta$ and $|f(x) - f(\alpha x)| < \in |x|$ using triangle inequality
$|f(x) - f(\alpha^n x) \leq |f(x) - f(\alpha x)| + |f(\alpha x) - f(\alpha^2 x)| + \ldots.. + |f(\alpha^{n-1} x) - f(\alpha^n x)|$
$< \in |x|(1 + \alpha + \alpha^2 + \ldots.. + \alpha^{n-1}) = \in \frac{1-\alpha^n}{1-\alpha}|x| \leq \frac{\in |x|}{1-\alpha}$
As, $n \to \infty$
$|f(x)| \leq \frac{\in}{1-\alpha}|x|$
$\Rightarrow \lim\limits_{x\to\infty} \frac{f(x)}{x} = 0$

60. Let $g(x) = f'(x)e^{-\lambda f(x)}$
$g(a) = g(b)$ so using Rolle's theorem in $C \in (a, b)$
$g'(c) = 0$
$\Rightarrow g'(x) = e^{-\lambda f(x)}\,(f''(x) - \lambda(f'(x)^2)$
$\Rightarrow f''(c) - \lambda(f'(c))^2 = 0$

FIITJEE

JEE (Main)-2018

ALL INDIA TEST SERIES

FULL TEST – III

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 – 30, 31 – 60, 61 – 90)** *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

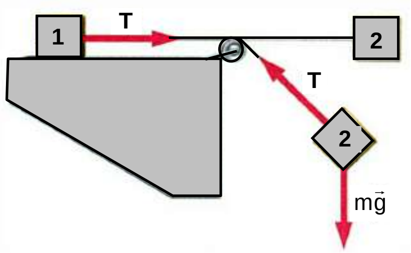
1. The range for a projectile that lands at the same elevation from which it is fired is given by $R = (u^2/g) \sin 2\theta$. Assume that the angle of projection = 30°. If the initial speed of projection is increased by 1%, while the angle of projection is decreased by 2% then the range changes by

(A) -0.3%	(B)+ 4.3%
(C) +0.65%	(D) 0.85%

2. Two highways are perpendicular to each other: imagine them to be along the x-axis and the y-axis, respectively. At the instant t = 0, a police car P is at a distance d = 400 m from the intersection and moving at speed of 80 km/h towards it along the x-axis. Motorist M is at a distance of 600 m from the intersection and moving towards it at a speed of 60 km/h along the y-axis. The minimum distance between the cars is

(A) 300 m	(B) 240 m.
(C) 180m.	(D) 120 m

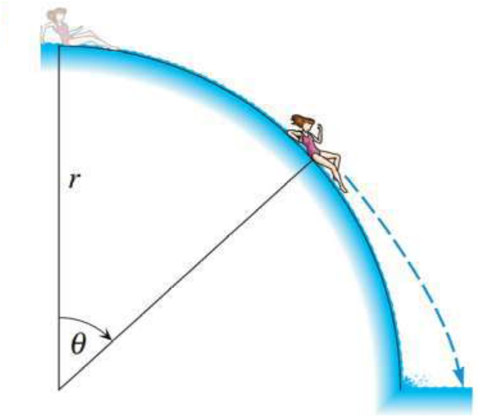
3. Two identical blocks are attached by a massless string running over a pulley as shown in Figure. The rope initially runs over the pulley at its (the rope's) midpoint, and the surface that block 1 rests on is frictionless. Blocks 1 and 2 are initially at rest when block 2 is released with the string taut and horizontal. Assume that the initial distance from block 1 to the pulley is the same as the initial distance from block 2 to the wall.



(A) Block 1 hits the pulley before Block 2 hits the wall
(B) Block 2 hits the wall before block 1 hits the pulley
(C) Block 1 hits pulley simultaneously with block 2 hitting the wall
(D) Which block hits the obstruction first depends on the actual mass of the blocks and the length of the string.

Space for Rough work

4. A person starts with a speed of $\sqrt{(0.5gr)}$ at the top of a large frictionless spherical surface, and slides into the water below (see the drawing). Then, the person
(A) loses contact when $\cos\theta = 1/3$
(B) slides through a height of r/6 before losing contact
(C) slides through a height of r/3 before losing contact
(D) never loses contact with the surface



5. Suppose that water drops are released from a point at the edge of a roof with a constant time interval Δt between one water drop and the next. The drops fall a distance h to the ground. If Δt is very short ie the number of drops falling though the air at any given instant is very large then the CM of the drops is very nearly at a height (above the ground) of

(A) h/2	(B) h/3
(C) 2h/3	(D) 3h/4

6. The moment of inertia of a uniform solid regular tetrahedron of mass m and edge a, about its symmetry axis (i.e. an axis passing through one vertex and the centre of the opposite face) is:

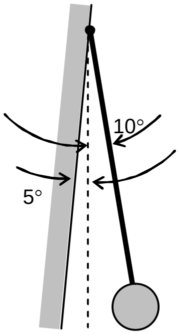
(A) $ma^2/10$	(B) $3ma^2/10$
(C) $ma^2/15$	(D) $ma^2/20$

7. A uniform rod lies at rest on a frictionless horizontal surface. A particle, having a mass equal to that of the rod, moves on the surface perpendicular to the rod collides with it, and finally sticks to it. The minimum loss of KE in the collision, under the given conditions, is

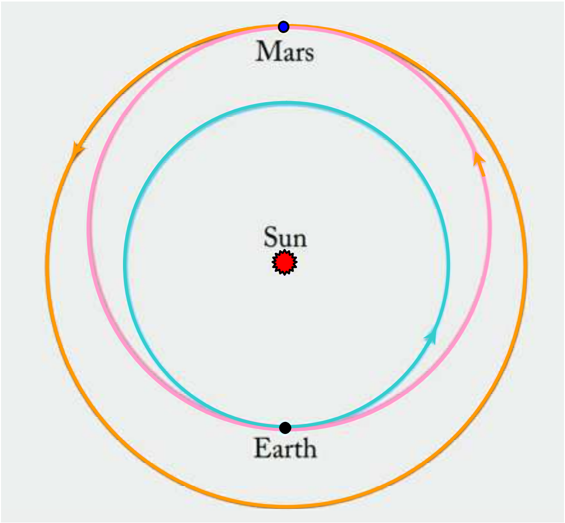
(A) 5%	(B) 10%
(C) 20%	(D) 30%

Space for Rough work

8. A pendulum of length 1m hangs from an inclined wall. Suppose that this pendulum is released at an initial angle of 10° and it bounces off the wall elastically when it reaches an angle of -5° as shown in the figure. Take $g = \pi^2$ m/s^2. The period of this pendulum is (in second)
(A) 2/3
(B) 3/2.
(C) 3/4.
(D) 4/3



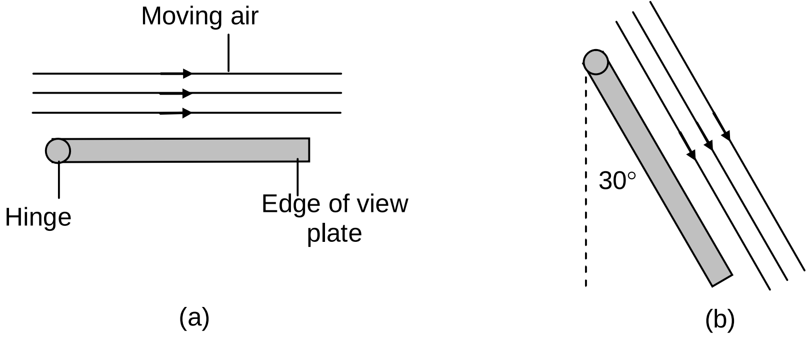
9. The Earth has a circular orbit of radius r and period t around the Sun; Mars has a circular orbit of radius R and period T. In order to send a spacecraft from the Earth to Mars, it is convenient to launch the spacecraft into an elliptical orbit whose perihelion coincides with the orbit of the Earth and whose aphelion coincides with the orbit of Mars; this orbit requires the least amount of energy for a trip to Mars. The time t' taken by a spacecraft to reach Mars from the Earth satisfies:
(A) $t' = (t + T)/2$
(B) $t'^2 = (t^2 + T^2)/2$
(C) $t'^{2/3} = (t^{2/3} + T^{2/3})/2$
(D) $(2t')^{2/3} = (t^{2/3} + T^{2/3})/2$



10. When a force accelerates a body immersed in a fluid, some of the fluid must also be accelerated, since it must be pushed out of the way of the body and flow around it. Thus, the force must overcome not only the inertia of the body, but also the inertia of the fluid pushed out of the way. It can be shown that for a spherical body completely immersed in a nonviscous fluid, the extra inertia is that of a mass of fluid half as large as the fluid displaced by the body. The acceleration of a small spherical air bubble in water is nearly
(A) zero. (B) g
(C) g/2. (D) 2g

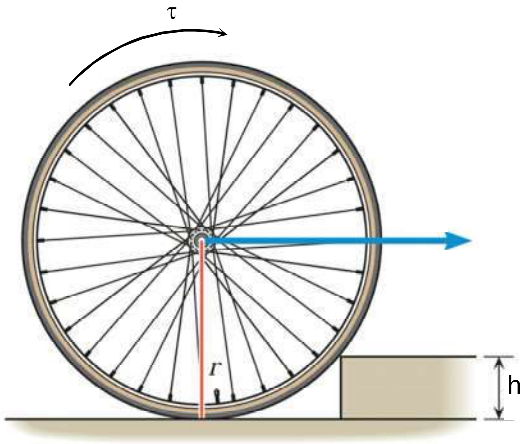
Space for Rough work

11. A uniform rectangular plate is hanging vertically downward from a hinge that passes along its left edge. By blowing air at 12 m/s over the top of the plate only, it is possible to keep the plate in a horizontal position, as illustrated in part (a) of the drawing. To what value of speed should the air be blown so that the plate is kept at a 30° angle with respect to the vertical, as in part (b) of the drawing?



(A) 12m/s
(B) 6 m/s
(C) 6√2 m/s
(D) 12√2 m/s

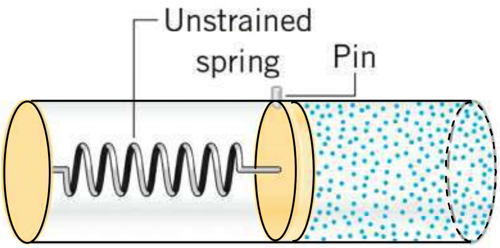
12. The drawing shows a bicycle wheel of radius r, resting against a small step whose height is h=r/5. A clockwise torque is applied to the axle of the wheel. As the magnitude of torque increases, there comes a time when the wheel just begins to rise up and loses contact with the ground. Let this torque be τ. What is the magnitude of the horizontal component of the acceleration of the centre of the wheel when a torque of 2τ is applied? Assume that the wheel doesn't slip at the edge of the step when this torque is applied (ignore the mass of the spokes).



(A) 4.8 m/s²
(B) 3 m/s²
(C) 2.4 m/s²
(D) 1.5 m/s²

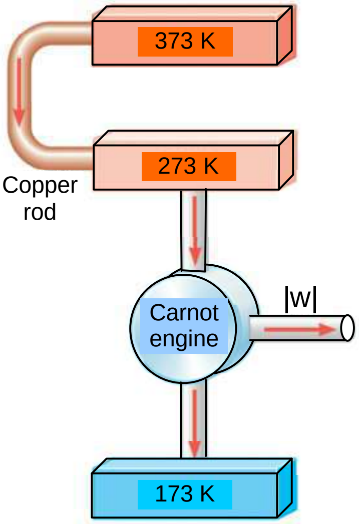
Space for Rough work

13. A gas fills the right portion of a horizontal cylinder whose radius is 5.00 cm. The initial pressure of the gas is 101 kPa. A frictionless movable piston separates the gas from the left portion of the cylinder, which is evacuated and contains an ideal spring, as the drawing shows. The piston is initially held in place by a pin. The spring is initially unstrained, and the length of the gas-filled portion is 20.0 cm. When the pin is removed and the gas is allowed to expand, the length of the gas-filled chamber doubles when it finally reaches equilibrium. The initial and final temperatures are equal. Determine the spring constant of the spring.



(A) 200 N/m
(B) 20 N/m
(C) 2 N/cm
(D) 2 N/mm

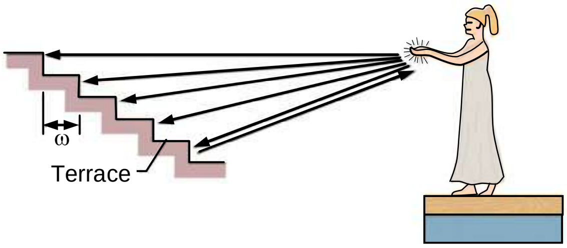
14. Heat flows from a reservoir at 373 K to a reservoir at 273 K through a copper rod as shown in the figure. The heat then leaves the 273 K reservoir and enters a Carnot engine, which uses part of this heat to do work and rejects the remainder to a third reservoir at 173 K. What fraction of the heat leaving the 373 K reservoir is rendered unavailable for doing work, as compared to the situation where a Carnot engine is connected directly between the 373 K and 173 K reservoirs?



(A) 3%
(B) 10%
(C) 17 %
(D) 35 %

Space for Rough work

15. A handclap on stage in an amphitheater sends out sound waves that scatter from terraces of width w = 0.75 m (see figure). The sound returns to the stage as a periodic series of pulses, one from each terrace; the parade of pulses sounds like a played note. Assuming that all the rays in Figure are horizontal, find the frequency at which the pulses return (that is, the frequency of the perceived note). Take the speed of sound to be 330m/s.



(A) 248Hz
(B) 220 Hz
(C) 456 Hz
(D) 440Hz

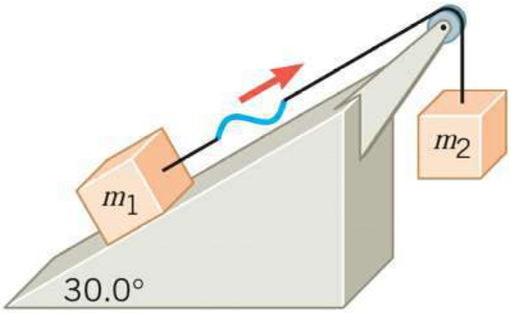
16. An RC- circuit, with R = 600kΩ and C= 10μF, is connected to a 5.0-V battery until the capacitor is fully charged. Then, the battery is suddenly replaced with a new 3.0-V battery of opposite polarity. At what time after this replacement will the energy stored in the capacitor be zero?

(given that $e \approx \frac{8}{3}$)

(A) 12 s
(B) 6 s
(C) 3 s
(D)1.5 s

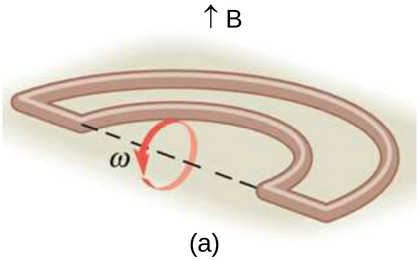
17. The drawing shows a frictionless incline and pulley. The two blocks are connected by a wire (mass per unit length, μ = 25 g/m) and remain stationary. A transverse wave on the wire has a speed of 60 m/s relative to it. Neglect the weight of the wire relative to the tension in the wire. If the mass m_2 be increased by 1%, the speed of the transverse wave will be

(A) 60.2 m/s
(B) 60.3 m/s
(C) 60.4 m/s
(D)60.6 m/s

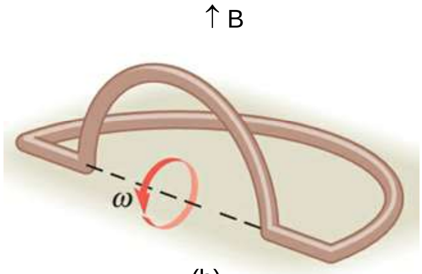


Space for Rough work

18. The drawing shows a coil of copper wire that consists of two semicircles joined by straight sections of wire. In part (a) the coil is lying flat on a horizontal surface. The dashed line also lies in the plane of the horizontal surface. Starting from the orientation in part (a) the smaller semicircle rotates at an angular frequency ω about the dashed line, until its plane becomes perpendicular to the horizontal surface, as shown in part (b). A uniform magnetic field B, constant in time and is directed upward, perpendicular to the horizontal surface. The field completely fills the region occupied by the coil in either part of the drawing. The magnitude of the magnetic field is B= 2 T.



(a)



(b)

The resistance of the coil is 0.4 Ω, and the smaller semicircle has a radius of 20 cm while the bigger one has a radius of 40 cm. The angular frequency at which the small semicircle rotates is ω = 15 rad/s. Determine the average current I, if any, induced in the coil as the coil changes shape from that in part (a) of the drawing to that in part (b).

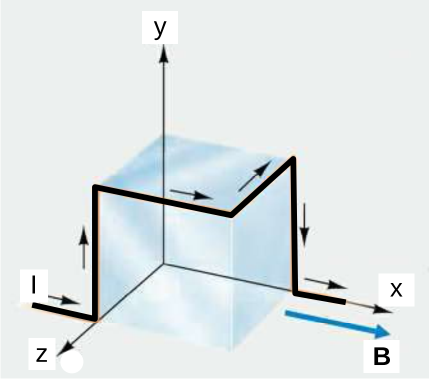
(A) 0 A. (B) 1A
(C)2A. (D) 3A

19. If a hole is punctured in a tire, the gas inside will gradually leak out of it. Let's assume the following: the area of the hole is A; the tire volume is V; and the time it takes for most of the air to leak out of the tire be t. This time can be expressed in terms of the ratio A/V, the temperature T, the Universal gas constant R, and the mass of the gas molecules inside the tire, m. Under these assumptions, we can use dimensional analysis to find an estimate for t. Assuming this estimate to be correct, if the mass of air within a tyre is increased by 70%, the absolute tyre temperature increased by 20%, while the area of the punctured hole is doubled (but still small) then the time in which a tyre will go flat will

(A)increase by 10% (B) increase by 25%
(C) decrease by 25%. (D) decrease by 40%

Space for Rough work

20. A long wire carries current of 25 A parallel to the positive x axis, except for three of the four segments that follow the edges of a cube of side 0.4 m, as shown in figure. The wire is in a uniform magnetic field of 2.0 T directed parallel to the positive x axis. What is the net magnetic force on the wire (in newton) ?



(A) $20\hat{j}$ (B) $20\hat{k}$

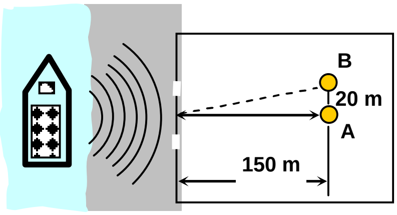
(C) $20(\hat{j}-\hat{k})$ (D) $-20\hat{j}$

21. A uniformly charged square plate having side L carries a uniform surface charge density σ. The plate lies in the y-z plane with its center at the origin. A point charge q lies on the x-axis. The flux of the electric field of q through the plate is ϕ_0; while the force on the point charge q due to the plate is F_0, along the x-axis. Then,

(A) $\sigma = \frac{F_0}{\phi_0 L}$ (B) $\sigma = \frac{F_0}{\phi_0}$

(C) $\sigma = \frac{F_0 L}{\phi_0}$ (D) $\sigma = \frac{\phi_0}{F_0}$

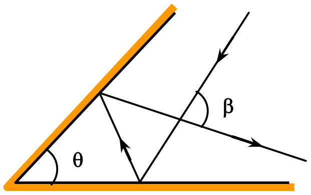
22. A riverside warehouse has two open doors as shown in Figure. Its walls are lined with sound-absorbing material. A boat on the river sounds its horn. To person A the sound is loud and clear. To person B the sound is barely audible. The principal wavelength of the sound waves is 2 m. Assuming person B is at the position of the first minimum, determine the distance between the doors, center to center. Distance AB = 20 m and the distance of A from the doors is 150 m.



(A) 7.5 m (B) 15 m
(C) 5 m (D) 10 m

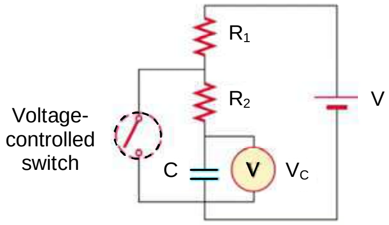
Space for Rough work

23. The reflecting surfaces of two intersecting flat mirrors are at an angle θ ($0° < \theta < 90°$), as shown in Figure. For a light ray that strikes the horizontal mirror, the emerging ray intersects the incident ray at an angle β. If one of the mirrors is rotated at $\frac{d\theta}{dt} = 1°/s$, then the angle β changes at the rate of

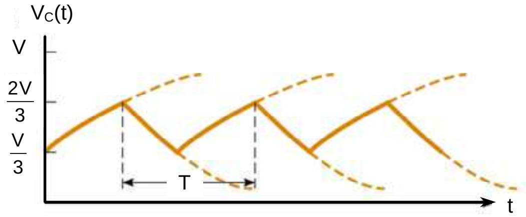


(A) 1°/s
(B) 2°/s
(C) –1°/s
(D) –2°/s

24. The switch in Figure (a) closes when $V_C = 2V/3$ and opens when $V_C = V/3$. The voltmeter reads a voltage as plotted in figure (b). What is the period T of the waveform? (take $R_1 = 6R$ and $R_2 = 3R$; and $\ell n2 = 0.7$ if required)



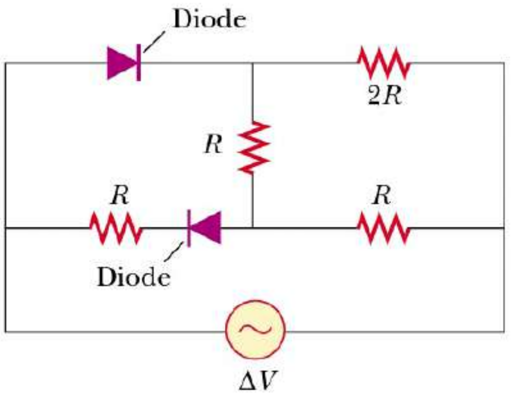
(a)



(b)

(A) 12 RC
(B) 8.4 RC
(C) 11 RC
(D) none of these

25. A diode is a device that allows current to be carried in only one direction (the direction indicated by the arrowhead in its circuit symbol). Find (approximately) in terms of ΔV and R the average power delivered to the diode circuit of the figure. Assume that the diodes are ideal and ΔV is the rms voltage applied to the circuit.



(A) $\frac{(\Delta V)^2}{R} \times 0.6$

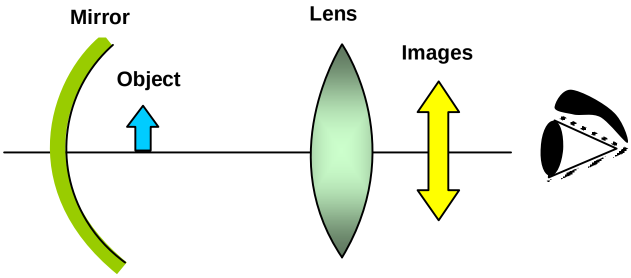
(B) $\frac{(\Delta V)^2}{R} \times 0.8$

(C) $\frac{(\Delta V)^2}{R} \times 1.1$

(D) $\frac{(\Delta V)^2}{R} \times 1.4$

Space for Rough work

26. An observer to the right of the mirror–lens combination shown in Figure sees two real images that are the same size and in the same location. One image is upright and the other is inverted. Both images are 1.50 times larger than the object. The lens has a focal length of 10.0 cm. The lens and mirror are separated by 40.0 cm. Determine the focal length of the mirror. Do not assume that the figure is drawn to scale.

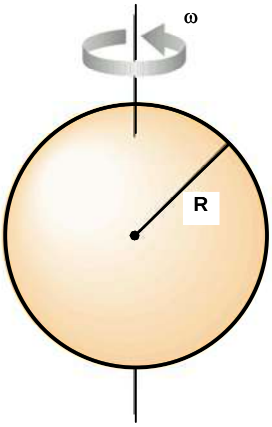


(A) 35/6 cm (B) 35/3 cm
(C) 20 cm (D) 10 cm

27. The angle of incidence of a light beam onto a reflecting surface is continuously varied. The reflected ray is found to be completely polarized when the angle of incidence is 60°. What is the index of refraction of the reflecting material?

(A) $\frac{\sqrt{3}}{2}$ (B) $\frac{2}{\sqrt{3}}$
(C) $\sqrt{3}$ (D) 2

28. A sphere of radius R has a uniform volume charge density. Determine the magnetic dipole moment of the sphere when it rotates as a rigid body with angular speed ω about an axis through its center. The total charge of the sphere is q.



(A) $\frac{2q}{3}R^2\omega$

(B) $\frac{q}{3}R^2\omega$

(C) $\frac{2q}{5}R^2\omega$

(D) $\frac{q}{5}R^2\omega$

Space for Rough work

29. A Rydberg atom is a single-electron atom with a large quantum number n. Rydberg states are close together in energy, so transitions between adjacent Rydberg states produce long-wavelength photons. Consider a transition from a state n + 1 to a state n in hydrogen. The wavelength of the emitted photon varies with quantum number n as

(A) $\frac{1}{n^2}$ (B) n

(C) $\frac{1}{n^3}$ (D) n^3

30. As part of his discovery of the neutron in 1932, James Chadwick determined the mass of the neutron (newly identified particle) by firing a beam of fast neutrons, all having the same speed, as two different targets and measuring the maximum recoil speeds of the target nuclei. The maximum speed arise when an elastic head-on collision occurs between a neutron and a stationary target nucleus. Represent the masses and final speeds of the two target nuclei as m_1, v_1, m_2 and v_2 and assume Newtonian mechanics applies. The neutron mass can be calculated from the equation:

$$m_n = \frac{m_1v_1 - m_2v_2}{v_2 - v_1}$$

Chadwick directed a beam of neutrons on paraffin, which contains hydrogen. The maximum speed of the protons ejected was found to be 3.3×10^7 m/s. A second experiment was performed using neutrons from the same source and nitrogen nuclei as the target. The maximum recoil speed of the nitrogen nuclei was found to be 4.7×10^6 m/s. The masses of a proton and a nitrogen nucleus were taken as 1 u and 14 u, respectively. What was Chadwick's value for the neutron mass?

(A) 1.16 u (B) 1.47 u

(C) 0.95 u (D) 1.80 u

Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. A saturated solution of CaF_2 is found to contain 2×10^{-4} M of F^- ions. K_{sp} of CaF_2 is :

(A) 8×10^{-12} (B) 4×10^{-12}
(C) 2×10^{-12} (D) 10^{-12}

32. In the absence of external magnetic field, d-orbital is

(A) 3-fold degenerate (B) Non-degenerate
(C) 5-fold degenerate (D) 7-fold degenerate

33. Identify the correct statement:

(A) 0.1 M NaCl and 0.1 M glucose solution are isotonic.
(B) 0.1 M NaCl and 0.3 M glucose solution are isotonic.
(C) The boiling point of 0.1 m aqueous urea solution is less than 0.1 m aqueous KCl solution.
(D) The freezing point of 0.1 m glucose solution is less than 0.1 m KCl solution.

34. A reaction is carried out at 600 K. If the same reaction is carried out in the presence of catalyst at the same rate and same frequency factor, the temperature required is 500 K. What is the activation energy of the reaction, if the catalyst lowers the activation energy barrier by 20 kJ/mol?

(A) 100 (B) 120
(C) 80 (D) None of these

35. When pressure is applied to equilibrium system:

$\text{Ice} \rightleftharpoons \text{Water}$

Which of the following statement is correct?

(A) More amount of ice will form. (B) Melting point of ice decreases.
(C) Equilibrium will not disturb. (D) Both (A) and (B).

36. The enthalpy of neutralization of a strong acid by a strong base is – 57.32 kJ/mol. The enthalpy of formation of water is – 285.84 kJ/mol. The enthalpy of formation of aqueous hydroxyl ion is:

(A) +228.52 kJ/mol (B) -114.26 kJ/mol
(C) -228.52 kJ/mol (D) +114.2 kJ/mol

Space for Rough work

37. The ratio of coefficient of HNO_3, $Fe(NO_3)_2$ and NH_4NO_3 in the following redox reaction

$$Fe + HNO_3 \longrightarrow Fe(NO_3)_2 + NH_4NO_3 + H_2O$$

are respectively

(A) 10 : 1 : 4 (B) 4 : 10 : 1
(C) 4 : 1 : 10 (D) 10 : 4 : 1

38. An electron is revolving round the nucleus of He^+ ion with speed 2.2×10^6 m/s. The potential energy of the electron is (if atomic number of He = 2, 1 eV = 1.6×10^{-19} J. Mass of electron = 9×10^{-31} kg)

(A) - 13.61 eV (B) - 6.8 eV
(C) - 27.22 eV (D) zero

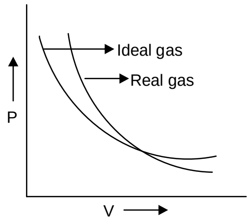
39. In a compound XY_2O_4, the oxide ions are arranged in CCP arrangement and cations X are present in octahedral. Cations Y are equally distributed between octahedral and tetrahedral voids. The fraction of the octahedral voids occupied is

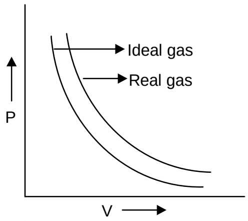
(A) $\frac{1}{2}$ (B) $\frac{1}{4}$
(C) $\frac{1}{6}$ (D) $\frac{1}{8}$

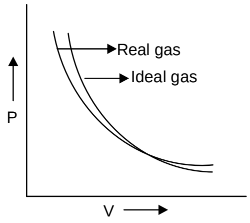
40. The conductivity of saturated solution of $Ba_3(PO_4)_2$ is $1.2 \times 10^{-5}\,\Omega^{-1}cm^{-1}$. The limiting equivalent conductivities of $BaCl_2$, K_3PO_4 and KCl are 160, 140 and 100 $\Omega^{-1}cm^2eq^{-1}$, respectively. The solubility product of $Ba_3(PO_4)_2$ is

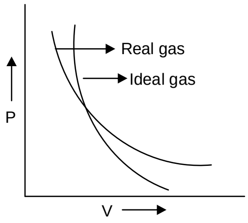
(A) 10^{-5} (B) 1.08×10^{-23}
(C) 1.08×10^{-25} (D) 1.08×10^{-27}

41. Which of the following graph is correct for real gases other than hydrogen and helium at 0°C?

(A)


(B)


(C)


(D)


Space for Rough work

42. $[Co(NH_3)_4(NO_2)_2]Cl$ exhibits
(A) linkage isomerism, geometrical isomerism and optical isomerism.
(B) linkage isomerism, ionisation isomerism and optical isomerism.
(C) linkage isomerism, ionisation isomerism and geometrical isomerism.
(D) ionisation isomerism, geometrical isomerism and optical isomerism.

43. In which of the following species $p\pi - d\pi$ bond is present but $p\pi - p\pi$ bond is absent?
(A) SO_3
(B) SO_2
(C) CS_2
(D) SO_2Cl_2

44. Which of the following statement is incorrect about the structure of B_2H_6 is
(A) It has four $2C - 2e^-$ bond and two $3C - 2e^-$ bond.
(B) The hybridization of each boron atom is sp^3.
(C) All hydrogens in B_2H_6 lie in the same plane.
(D) Terminal bonds are shorter than bridged bonds.

45. Which of the following can't be separated by H_2S in dil. HCl?
(A) Bi^{3+}; Mn^{2+}
(B) Pb^{2+}; Hg^{2+}
(C) Zn^{2+}; Cu^{2+}
(D) Ni^{2+}; Cu^{2+}

46. The correct order of increasing oxidizing power in the following series is:
(A) $VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$
(B) $Cr_2O_7^{2-} < VO_2^+ < MnO_4^-$
(C) $Cr_2O_7^{2-} < MnO_4^- < VO_2^+$
(D) $MnO_4^- < Cr_2O_7^{2-} < VO_2^+$

47. Aqueous solution of $Na_2S_2O_3$ on reaction with Cl_2 gives
(A) $Na_2S_4O_6$
(B) $NaHSO_4$
(C) NaCl
(D) NaOH

48. Which one of the following is an incorrect statement?
(A) Ozone is diamagnetic in nature.
(B) Ozone oxidizes PbS to $PbSO_4$.
(C) Ozone oxidizes acidic solution of KI.
(D) Ozone is used an oxidizing agent in the manufacture of $KMnO_4$.

49. Which of the following statement is correct?
(A) LiOH > NaOH > KOH > RbOH (solubility order)
(B) $Be(OH)_2 > Mg(OH)_2 > Ca(OH)_2 > Sr(OH)_2$ (basic strength order)
(C) Li < K < Na < Rb < Cs (density order)
(D) $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$ (ionic mobility in aqueous medium)

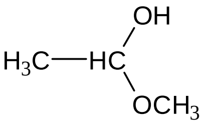
50. Coagulation is not done by
(A) Persistant dialysis
(B) Boiling
(C) Electrophoresis
(D) Peptisation

Space for Rough work

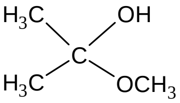
51. $F_2C = CF_2$ is a monomer of
(A) Nylon (B) Teflon
(C) Glyptal (D) Buna-S

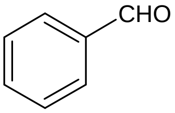
52. Which of the following test is used for identifying carbohydrates?
(A) Millon's test (B) Molisch's test
(C) Biuret test (D) Nihydrin test

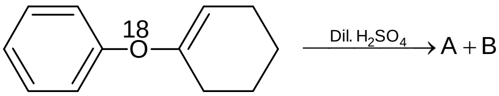
53. Which of the following compound does not give Tollen' test?

(A)

$H_3C-HC(OH)(OCH_3)$

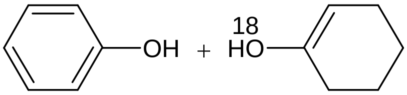
(B) H – COOH

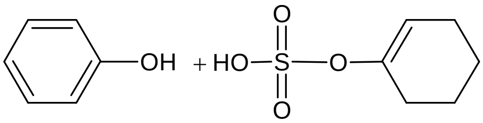
(C)

H3C
OH
C
H3C
OCH3

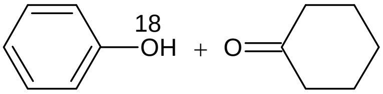
(D)


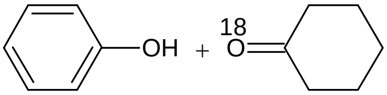
54.

18
O
Dil. H2SO4
A + B

Identify the major products of the above reaction?

(A)


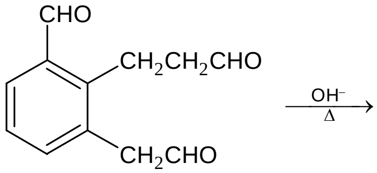
(B)


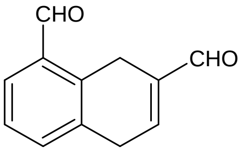
(C)


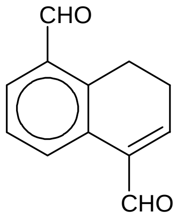
(D)


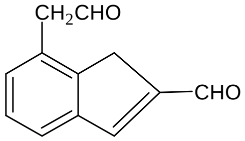
Space for Rough work

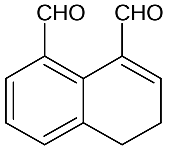
55. Which product can't be obtained in following reaction?


CHO
CH2CH2CHO
CH2CHO
OH–
Δ

(A)


(B)


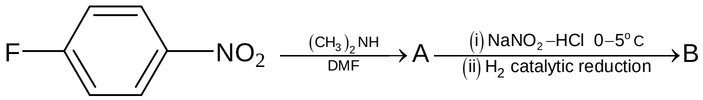
(C)


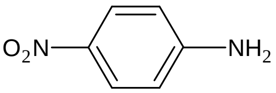
(D)


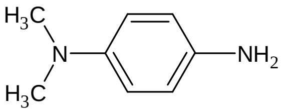
56. Which of the following orders is true regarding the acidic nature of phenols?

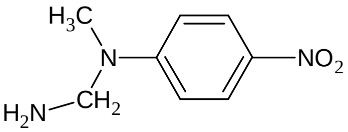
(A) Phenol > o-cresol < o-nitrophenol
(B) Phenol < o-cresol < o-nitrophenol
(C) Phenol > o-cresol > o-nitrophenol
(D) phenol < o-cresol > o-nitrophenol

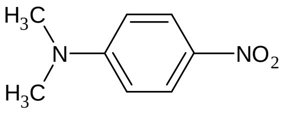
57.


F
NO2
(CH3)2NH
DMF
A
(i) NaNO2–HCl 0–5°C
(ii) H2 catalytic reduction
B

(A)


(B)

H3C
N
H3C
NH2

(C)

H3C
N
H2N
CH2
NO2

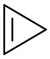
(D)

H3C
N
H3C
NO2

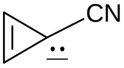
Space for Rough work

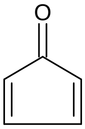
58. When benzamide is treated with $POCl_3$ the product is

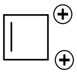
(A) Aniline (B) Chlorobenzene
(C) Benzylamine (D) Benzonitrile

59. Which of the following species is aromatic?

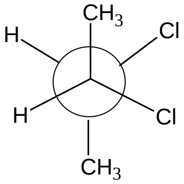
(A) 

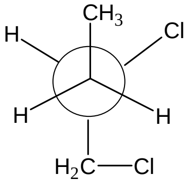
(B) 

(C) 

(D) 

60. The following pair is related as





(A) Same compound (B) Diastereomers
(C) Enantiomers (D) Structural isomers

Space for Rough work

Mathematics PART – III

SECTION – A

(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. Sum of series of $\cot^{-1}\frac{5}{\sqrt{3}}+\cot^{-1}\frac{9}{\sqrt{3}}+\cot^{-1}\frac{15}{\sqrt{3}}+\cot^{-1}\frac{23}{\sqrt{3}}+.....\infty$ is equal to

(A) $\frac{\pi}{4}$ (B) $\frac{\pi}{3}$

(C) $\frac{\pi}{6}$ (D) $\frac{\pi}{12}$

62. From any point R two normals which are right angled to one another are drawn to the hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ (a > b). If the feet of the normals are P and Q then the locus of the circumcentre of the ΔPQR is

(A) $\frac{x^2+y^2}{a^2-b^2}=\left(\frac{x^2}{a^2}+\frac{y^2}{b^2}\right)^2$ (B) $\frac{x^2-y^2}{a^2-b^2}=\left(\frac{x^2}{a^2}-\frac{y^2}{b^2}\right)^2$

(C) $\frac{x^2+y^2}{a^2-b^2}=\left(\frac{x^2}{a^2}-\frac{y^2}{b^2}\right)^2$ (D) $\frac{x^2+y^2}{a^2+b^2}=\left(\frac{x^2}{a^2}-\frac{y^2}{b^2}\right)^2$

63. If point P lies on the plane of ΔABC such that $\angle$BAC = $\angle$BPC and H is orthocentre of ΔABC. D is midpoint of BC and E is the midpoint of PH, then

(A) DE is perpendicular to AP (B) DE is parallel to AH

(C) DE is perpendicular to PB (D) none of these

Space for rough work

64. Let f: [0, 1] → R be a continuous function then which of the following is maximum value of $\int_0^1 x^2 f(x)dx - \int_0^1 x(f(x))^2 dx$ for all such functions

(A) $\frac{1}{12}$ (B) $\frac{1}{16}$

(C) $\frac{1}{8}$ (D) $\frac{1}{20}$

65. If f(x) is a polynomial function with positive integral coefficients (degree of f(x) ≥ 1) and for x ≥ 1, $\frac{f(f[x]+1)}{f([x])}$ is an integer then (where [.] denotes the greatest integer function)

(A) $x \in [1, 2)$ (B) $x \in [2, 3)$

(C) $x \in [3, 4)$ (D) none of these

66. A five digits number has to be formed by using the digits 1, 2, 3, 4 and 5 without repetition such that the even digits occupy odd places. Find the sum of all such possible numbers

(A) 1199988 (B) 1166688

(C) 1266688 (D) none of these

67. Suppose two complex numbers z = a + ib, ω = c + id satisfy the equation $\frac{z+\omega}{z} = \frac{\omega}{z+\omega}$ then

(A) both a and c are zero (B) both b and d are zero

(C) both b and d must be non zero (D) at least one of b and d is non zero

68. Let OP, OQ, OR are three edges of a regular tetrahedron of edge length a. If $\vec{p}, \vec{q}$ and $\vec{r}$ are the position vectors of the points P, Q and R & O is the origin then $\left|\vec{p}\times\vec{q}+\vec{q}\times\vec{r}+\vec{r}\times\vec{p}\right|$ is equal to

(A) $\frac{\sqrt{3}a^2}{2}$ (B) $\frac{a^2}{2}$

(C) $\frac{3\sqrt{3}a^2}{2}$ (D) $\frac{7\sqrt{3}a^2}{3}$

69. Find the number of terms in the expansion of $(x + y + z)^6$ which must contain x

(A) 28 (B) 24

(C) 22 (D) 21

Space for rough work

70. If $\vec{a}, \vec{b}, \vec{c}$ are three non coplanar unit vectors, the angle between them pair wise are $\frac{\pi}{6}, \frac{\pi}{4}$ and $\frac{\pi}{3}$ then the $\left|\left[\vec{a}\ \vec{b}\ \vec{c}\right]\right|$ is

(A) $\frac{\sqrt{3}-1}{2\sqrt{2}}$ (B) $\frac{\sqrt{3}+1}{2\sqrt{2}}$

(C) $\frac{\sqrt{2+\sqrt{6}}}{2}$ (D) $\frac{\sqrt{\sqrt{6}-2}}{2}$

71. If $\omega \neq 1$ is cube root of unity and $x + y + z \neq 0$, then $\begin{vmatrix} \frac{x}{1+\omega} & \frac{y}{\omega+\omega^2} & \frac{z}{\omega^2+1} \\ \frac{y}{\omega+\omega^2} & \frac{z}{\omega^2+1} & \frac{x}{1+\omega} \\ \frac{z}{\omega^2+1} & \frac{x}{1+\omega} & \frac{y}{\omega+\omega^2} \end{vmatrix}$ is equal to zero if

(A) $x^2 + y^2 + z^2 = 0$ (B) $x + yz + z\omega^2 = 0$ or $x = y = z$

(C) $x \neq y \neq z \neq 0$ (D) $x = 2y = 3z$

72. If $a_1, a_2, a_3, \ldots\ldots a_{2n+1}$ are in A.P., then $\frac{a_{2n+1}-a_1}{a_{2n+1}+a_1} + \frac{a_{2n}-a_2}{a_{2n}+a_2} + \ldots\ldots + \frac{a_{n+2}-a_n}{a_{n+2}+a_n}$ is equal to

(A) $\frac{n(n+1)}{2}\frac{(a_2-a_1)}{a_{n+1}}$ (B) $\frac{n(n+1)}{2}$

(C) $\frac{(n-1)n(a_2-a_1)}{a_{n+1}}$ (D) $\frac{n(n-1)(n+1)(a_2-a_1)}{a_{n+1}}$

73. ABC is right triangle in which $\angle B = 90^\circ$ and BC = a. If n points $L_1, L_2, L_3, \ldots\ldots, L_n$ on AB is divided in (n + 1) equal parts and $L_1M_1, L_2M_2, L_3M_3, \ldots\ldots, L_nM_n$ are line segments parallel to BC and $M_1, M_2, M_3, \ldots\ldots, M_n$ are on AC, then the sum of the lengths $L_1M_1, L_2M_2, \ldots\ldots, L_nM_n$ is

(A) $\frac{a(n+1)}{2}$ (B) $\frac{a(n-1)}{2}$

(C) $\frac{an}{2}$ (D) none of these

Space for rough work

74. Find the sum of the series $\frac{{}^nC_0}{2.3}-\frac{{}^nC_1}{3.4}+\frac{{}^nC_2}{4.5}-\frac{{}^nC_3}{5.6}+.....+(-1)^n\frac{{}^nC_n}{(n+2)(n+3)}$

(A) $\frac{1}{(n+3)(n+2)}$
(B) $\frac{1}{(n+1)(n+2)(n+3)}$
(C) $\frac{2}{(n+1)(n+2)}$
(D) $\frac{2}{(n+1)(n+2)(n+3)}$

75. If x + 2y + 3z = n and x, y, z are positive integers then the number of ordered trip lets (x, y, z) satisfying the equation are

(A) ${}^nC_{n-6}$
(B) ${}^nC_{n-3}$
(C) ${}^{n+2}C_3$
(D) none of these

76. px + qy = 40 is a chord of minimum length of circle $(x-10)^2 + (y-20)^2 = 729$. If the chord passes through (5, 15), then $p^{2013} + q^{2013}$ is equal to

(A) 0
(B) 2
(C) 2^{2013}
(D) 2^{2014}

77. The area enclosed by the curve max{|x – 1|, |y|} = k is 100, then k is equal to

(A) 5
(B) 8
(C) 10
(D) none of these

78. The value of $\lim\limits_{x\to\infty} x^2\ell n\left(x\cot^{-1}x\right)$ is

(A) $-\frac{1}{3}$
(B) $\frac{1}{3}$
(C) $\frac{2}{3}$
(D) $\frac{-2}{3}$

79. $\int\frac{\cos x+\sqrt{3}}{1+4\sin\left(x+\frac{\pi}{3}\right)+4\sin^2\left(x+\frac{\pi}{3}\right)}dx$ is

(A) $\frac{\cos x}{1+2\sin\left(x+\frac{\pi}{3}\right)}+c$
(B) $\frac{\sec x}{1+2\sin\left(x+\frac{\pi}{3}\right)}+c$
(C) $\frac{\sin x}{1+2\sin\left(x+\frac{\pi}{3}\right)}+c$
(D) $\frac{1}{2}\tan^{-1}\left(1+2\sin\left(x+\frac{\pi}{3}\right)\right)+c$

Space for rough work

80. The minimum value of the function $f(x) = \frac{1}{2\{-x\}} - \{x\}$ occurs at x equal to

(A) $n + \frac{1}{\sqrt{2}}$, $n \in I$ (B) $n - \frac{1}{\sqrt{2}}$, $n \in I$

(C) $n + \frac{1}{2\sqrt{2}}$, $n \in I$ (D) $n + \frac{1}{2}$, $n \in I$

81. $\int \frac{x^3 - x^2 + x - 1}{x^5 + 1} dx$ is

(A) $\frac{1}{5} \ell n \left(\frac{1 + x^5}{\left(1 + x^3\right)^5} \right) + c$ (B) $\frac{1}{5} \ell n \left(\frac{1 + x^5}{1 + x^3} \right) + c$

(C) $\frac{1}{5} \ell n \left(\frac{1 + x^5}{(1 + x)^5} \right) + c$ (D) $\frac{1}{5} \ell n \left(\frac{1 + x^5}{1 + x} \right) + c$

82. If A is skew symmetric matrix and n is odd positive integer then A^n is

(A) a symmetric matrix (B) a skew symmetric matrix

(C) a diagonal matrix (D) none of these

83. A random variable x has probability distribution

x	1	2	3	4	5	6	7	8
P(x)	0.13	0.22	0.12	0.21	0.13	0.08	0.06	0.05

For the event E = {x is an odd number}, F = {x is divisible by 3} and G = {x is less than 7} the probability $P(E \cup (F \cap G))$ is equal to

(A) 0.87 (B) 0.77

(C) 0.52 (D) none of these

84. A plane containing the line $\frac{x-3}{2} = \frac{y-1}{4} = \frac{z-2}{5}$ and it is passing through the point (4, 3, 7). The equation of the plane is

(A) 4x + 8y + 8z = 4 (B) 4x – 8y – 8z = 4

(C) 4x – 2y – 10 = 0 (D) 4x – 8y + 8z = 4

Space for rough work

85. If $f(x) = \sin^4 x + \cos^4 x - \frac{1}{2}\sin 2x$ then the range of f(x) is

(A) $\left[0, \frac{3}{2}\right]$ (B) $\left[-\frac{1}{2}, \frac{7}{2}\right]$

(C) $\left[0, \frac{9}{8}\right]$ (D) $\left[\frac{3}{4}, \frac{7}{8}\right]$

86. The exhaustive interval of real values of x such that $\sqrt{12-4x} > 1 + \sqrt{4x+4}$ is

(A) $\left[1-\frac{\sqrt{31}}{8}, 1+\frac{\sqrt{31}}{8}\right)$ (B) $\left[-1, 1+\frac{\sqrt{31}}{8}\right)$

(C) [–1, 3] (D) $\left[-1, 1-\frac{\sqrt{31}}{8}\right)$

87. Let 1, α, α^2, α^3, ..., α^{n-1} are nth roots of unity and for a natural number P, $A_P = \left\{x : x = \left(\alpha^P\right)^k\right\}$, $k \in I$, then

(A) A_P has n elements if P is a divisor of n
(B) number of elements in A_P is one less than the highest proper divisor of n (if P is divisor of n)
(C) number of elements in A_P is always a divisor of n
(D) none of these

88. Triangle ABC is formed by the lines 7x – y + 3 = 0, x + y – 3 = 0 and x – 3y – 31 = 0. Three new lines are drawn parallel to BC, CA, AB passing through A, B and C intersecting each other at P, Q and R respectively the circum centre of ΔPQR lies on

(A) 6x + 2y = 5 (B) 3x + y = 3

(C) 5x + y = 0 (D) none of these

89. If atleast one root of quadratic equation with integral coefficients $ax^2 + bx + c = 0$ (where a, b and c are sides of a triangle) is same as one of the roots of the quadratic equation $x^2 + kx + 2 = 0$ (k > 12), then $\tan\left(\frac{A+C}{2}\right)\cot\left(\frac{C-A}{2}\right)$ is equal to

(A) 1 (B) $\sqrt{2}$

(C) $\sqrt{3}$ (D) 3

90. If $f''(x) + f'(x) + f^2(x) = x^2$ be differential equation of a curve and let P be the point of maxima then the number of tangents which can be drawn from P to $x^2 - y^2 = a^2$ is/are

(A) 1 (B) 2

(C) 3 (D) none of these

Space for rough work

FIITJEE **JEE(Main)-2018**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS
FULL TEST – III
(Main)

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**D**	31.	**B**	61.	**B**
2.	**B**	32.	**C**	62.	**C**
3.	**A**	33.	**C**	63.	**A**
4.	**B**	34.	**B**	64.	**B**
5.	**C**	35.	**B**	65.	**A**
6.	**D**	36.	**C**	66.	**A**
7.	**C**	37.	**D**	67.	**D**
8.	**D**	38.	**C**	68.	**A**
9.	**D**	39.	**A**	69.	**D**
10.	**D**	40.	**B**	70.	**D**
11.	**C**	41.	**C**	71.	**B**
12.	**C**	42.	**C**	72.	**A**
13.	**D**	43.	**D**	73.	**C**
14.	**C**	44.	**C**	74.	**A**
15.	**B**	45.	**B**	75.	**D**
16.	**B**	46.	**A**	76.	**D**
17.	**A**	47.	**B**	77.	**A**
18.	**D**	48.	**C**	78.	**A**
19.	**D**	49.	**C**	79.	**C**
20.	**D**	50.	**D**	80.	**B**
21.	**B**	51.	**B**	81.	**C**
22.	**A**	52.	**B**	82.	**B**
23.	**D**	53.	**C**	83.	**C**
24.	**B**	54.	**C**	84.	**C**
25.	**B**	55.	**D**	85.	**C**
26.	**B**	56.	**A**	86.	**D**
27.	**C**	57.	**B**	87.	**C**
28.	**D**	58.	**D**	88.	**B**
29.	**D**	59.	**D**	89.	**D**
30.	**A**	60.	**D**	90.	**B**

Physics

PART – I

SECTION – A

1. $\delta R/R = 2\delta u/u + 2\cot 2\theta\, \delta\theta$

2. If s be their separation at time t then,

$$s^2 = (0.4-80t)^2 + (0.6-60t)^2$$

where t is in hour, s in km. Minimise s using calculus.

3. The horizontal acceleration of Block 1 is always greater than that of block 2.

4. The normal reaction vanishes when the person loses contact with the surface:

$$mv^2/r = mg\cos\theta;$$

Conservation of energy gives:

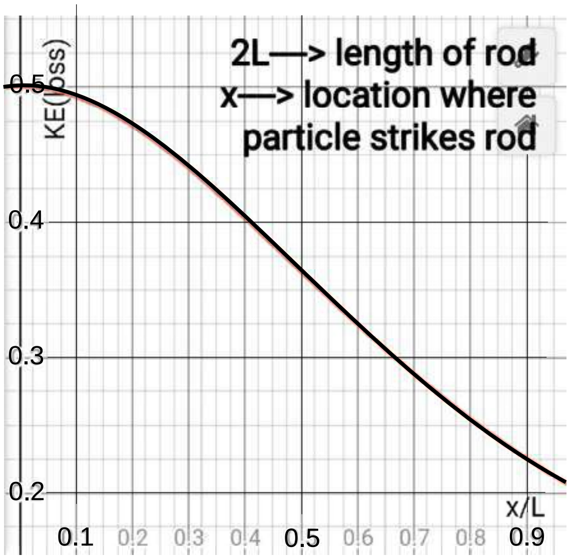
$$1/2\, mv^2 + mgr\cos\theta = 1/2\, mu^2 + mgr; \text{ where } u^2 = 0.5gr$$

5. The droplets fall a distance $\frac{1}{2}gt^2$ in time t, and the number of the droplets and hence their mass is proportional to dt. Computing the CM of the droplets using the definition, we get the result.

6. For an equilateral triangle of side a, moment of inertia is $\frac{ma^2}{12}$ about an axis passing through its CM and perpendicular to plane - the result of the integration is similar to that of a solid cone along its axis: a factor of 3/5.

$$I = \frac{3}{5}\left(\frac{ma^2}{12}\right)$$

7. The maximum loss occurs when the collision is "head-on" and the minimum is when it collides at an end. Assume that the particle strikes the rod (of length 2L) perpendicularly at a distance x from its centre. Apply conservation of momentum and angular momentum to calculate the final velocity of the rod and also its angular velocity. The fractional loss in KE = $1/[3(x/L)^2 + 2]$



8. We take $\theta = (10^\circ)\cos(\pi t)$; calculate t when $\theta = -5^\circ$. This gives t = 2/3 (s). The period is 2 times this.

9. Use Kepler's Law of Periods.

10. If m be the mass of water displaced, the buoyant force is mg, while the mass of the extra water that has to be pushed "out of the way" is effectively m/2.

11. Taking torques about the hinge, we get:
In the 1st case, mgL/2 =p AL/2
In the second case, mgL/4 = p' AL/2

12. When the wheel gets just lifted $\tau = mg(3r/5)$. But when a torque of 2τ is applied, we can write: $mg(3r/5) = I\alpha$,
where $I = 2mr^2$.
The horizontal acceleration is $r\alpha(4/5)$.

13. The final pressure is $p = \frac{101}{2}\text{kPa}$; $kx = p\pi r^2$ where x = 0.2, the compression in the spring and r = 0.05 the radius of cylinder.

14. With reservoirs at 273 K, 173 K:
$$\frac{W}{Q} = \frac{273 - 173}{273} = 0.37$$
With reservoirs at 373 K, 173 K:
$$\frac{W'}{Q} = \frac{373 - 173}{373} = 0.54$$
$W' - W = (0.54 - 0.37)Q = 0.17\ Q$

15. $T = \frac{2w}{v}$; $f = \frac{1}{T}$

16. $\frac{3\ \text{volt}}{(3+5)\text{volt}} = e^{-t/\tau}$; $\tau = RC = 6$ s
$\therefore\ t \approx 6$ s.

17. Tension, $T = \frac{3m_1m_2}{2(m_1+m_2)}g$; $v = \sqrt{\frac{T}{\mu}}$; $\frac{\delta v}{v} = \frac{1}{2}\frac{\delta T}{T} = \frac{1}{3}\frac{\delta m_2}{m_2}$ (where, $m_1 \approx 2m_2$)

18. The change in flux $\Delta\phi = \frac{\pi}{2}r^2B$, where r = 0.2 m
Average emf = $\frac{\Delta\phi}{\pi/2\omega}$
Current = average emf / resistance

19. Using dimensional analysis or otherwise $t = \frac{V}{A}\sqrt{\frac{m}{RT}} \times$ some numerical factor
Substituting the values we get $\frac{t'}{t} = \frac{1}{2}\sqrt{\frac{1.7}{1.2}} \approx 0.6$

20. $\text{Force} = 25(0.4\hat{i} - 0.4\hat{k}) \times 2\hat{i} = -20\hat{j}$

21. The correct answer can be determined by dimensional analysis.

22. $\frac{\lambda D}{2d}$ = AB = 20 m

where λ = 2 m

D = 150 m

$\therefore$ d = 7.5 m

23. From geometry $\beta = (180^\circ - 2\theta)$

So, $\frac{d\beta}{dt} = -\frac{2d\theta}{dt}$

24. When the switch closes at $V_C = 2V/3$ the capacitor discharges through $R_2 = 3R$

T(discharge) = 3RC ℓn 2 (since the voltage halves).

The charging occurs through $R_1 + R_2 = 9R$

T (charge) = 9RCℓn2

T = 12 RC ℓn 2 $\approx$ 8.4 RC

25. When the left end is positive, upper diode conducts and lower diode is cut off.

$R_{eq} = R$

When right end is positive the lower diode conducts.

$R_{eq} = R + \frac{3R}{4} = \frac{7R}{4}$

$\therefore$ Power = $\frac{(\Delta V)^2}{R}\left[1+\frac{4}{7}\right]\times\frac{1}{2} \approx \frac{(\Delta V)^2}{R}\times 0.8$

26. The object must be located at the centre of the curvature of the mirror for this to happen.

For the inverted image formed directly by the lens we can write

$\frac{1}{v} - \frac{1}{u} = \frac{1}{10}$, $\frac{v}{u} = -\frac{3}{2}$

27. This occurs when the angle of incidence is equal to the Brewster angle: tan $\theta_\beta = \mu$.

28. If the sphere has a uniform mass density (total mass m), then $\frac{\mu}{L} = \frac{q}{2m}$, where L = $\frac{2}{5}mR^2\omega$.

29. $h\nu = E_{n+1} - E_n = E_0\left(\frac{1}{n^2} - \frac{1}{(n+1)^2}\right) \approx \frac{E_0 2n}{n^4}$, for large n.

30. $m_n = \frac{m_1v_1 - m_2v_2}{v_2 - v_1}$

$= \frac{14\times(4.7\times10^6) - 1\times(3.3\times10^7)}{3.3\times10^7 - 4.7\times10^6} = 1.16$

Chemistry PART – II

SECTION – A

31. $CaF_2 \rightleftharpoons \underset{s}{Ca^{2+}} + \underset{2s}{2F^-}$

$2s = 2\times 10^{-4}$

$s = 10^{-4}$

$K_{sp} = 4s^3 = 4\times 10^{-12}$

32. d-orbital is 5-fold degenerate in absence of magnetic field.

33. $\pi_{NaCl} = i\times CRT \qquad \pi_{glucose} = 1\times 0.1\times RT$

$= 2\times 0.1RT \qquad = 0.1\,RT$

$= 0.2\ RT \quad \pi_{NaCl} \neq \pi_{glucose}$

$\Delta T_{b(NaCl)} = 2\times 0.1K_f \qquad \Delta T_{b(urea)} = 0.1\,K_f$

Hence $\Delta T_{b(urea)} < \Delta T_{b(NaCl)}$

$\Delta T_{f(glucose)} = 0.1\times K_f \qquad \Delta T_{f(KCl)} = 2\times 0.1\times K_f$

$\Delta T_f = 0.2\ K_f$

$T_{f(glucose)} > T_{f(KCl)}$

34. $k = Ae^{-Ea/R\times 600}$

$k^c = Ae^{-\frac{(Ea-20)}{R\times 500}}$

$k = k^c$

$\frac{Ea}{R\times 600} = \frac{(Ea-20)}{R\times 500}$

$\frac{Ea}{6} = \frac{Ea-20}{5}$

$\frac{5}{6}Ea = Ea - 20$

$20 = Ea - \frac{5}{6}Ea$

$Ea = 20\times 6$

$Ea = 120\ kJ/mol$

35. Melting point of ice decreases hence more amount of $H_2O(\ell)$ will form on increasing pressure.

36. $H^+(aq.) + OH^-(aq.) \longrightarrow H_2O(\ell)$

$\Delta_r H = \Delta_f H_{(H_2O)} - \left(\Delta_f H_{(H^+(aq.))} + \Delta_f H_{(OH^-)}\right)$

$-57.32 = -285.84 - \left(0 + \Delta_f H_{(OH^-(aq))}\right)$

$\Delta_f H_{(OH^-(aq))} = -228.52\ kJ/mol$

37. $4Fe + 10HNO_3 \longrightarrow 4Fe\left(NO_3\right)_2 + NH_4NO_3 + 3H_2O$

38. $KE = \frac{1}{2}m \times v^2 = \frac{1}{2} \times 9 \times 10^{-31} \times \left(2.2 \times 10^6\right)^2$

$KE = \frac{1}{2} \times \frac{9 \times 10^{-31} \times \left(2.2 \times 10^6\right)^2}{1.6 \times 10^{-19}}$

$KE = 13.61\ eV$

$PE = -2 \times KE = -2 \times 13.61 = -27.22\ eV$

40. $\Lambda_M^o = \Lambda_N^o \times n - \text{Factor}$

$\Lambda_M^o\left(BaCl_2\right) = 160 \times 2 = 320$

$\Lambda_M^o\left(K_3PO_4\right) = 140 \times 3 = 420$

$\Lambda_M^o\left(KCl\right) = 100 \times 1 = 100$

$\Lambda^o_{M\left[Ba_3(PO_4)_2\right]} = 3\Lambda^o_{M(BaCl_2)} + 2\Lambda^o_{M(K_3PO_4)} - 6\Lambda^o_{M(HCl)}$

$= 3 \times 320 + 2 \times 420 - 6 \times 100$

= 1200

$\Lambda_M^o = \frac{K \times 1000}{s}$

$s = \frac{1.2 \times 10^{-5} \times 1000}{1200}$

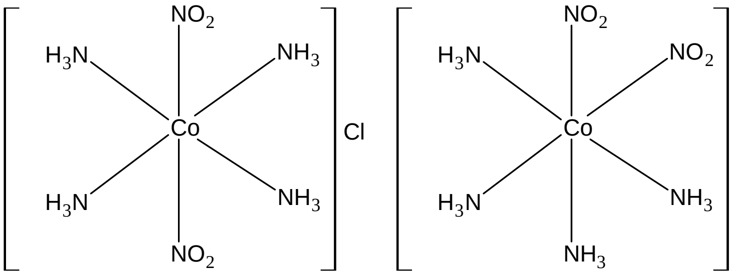
1×10^{-5}

$K_{sp\left[Ba_3(PO_4)_2\right]} = 108\ s^5$

$= 108 \times \left(10^{-5}\right)^5$

$= 1.08 \times 10^{-23}$

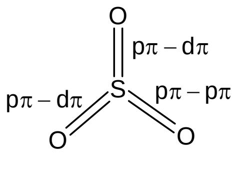
42. [Co(NH3)4(ONO)2]Cl [Co(NH3)4(NO2)2]Cl linkage

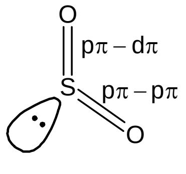

NO2
H3N
NH3
Co
H3N
NH3
NO2
Cl
NO2
H3N
NO2
Co
H3N
NH3
NH3
Cl

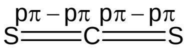
geometrical

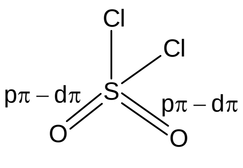
[Co(NH3)4(ONO)Cl]ONO [Co(NH3)4(ONO)2]Cl ionization.

43.


O
pπ – dπ
pπ – dπ
S
pπ – pπ
O
O


O
pπ – dπ
S
pπ – pπ
O


pπ – pπ pπ – pπ
S
C
S

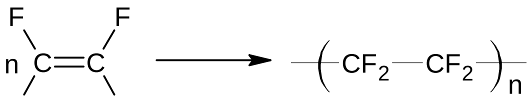

Cl
Cl
pπ – dπ
S
pπ – dπ
O
O

45. Pb^{2+} and Hg^{2+} both will precipitate out by H_2S in dil. HCl.

46. Oxidising power increases with increase of oxidation number of central atom.
Mn (O.S.) in $MnO_4^- = +7$
Cr (O.S.) in $Cr_2O_7^{2-} = +6$
V (O.S.) in $VO_2^+ = +5$

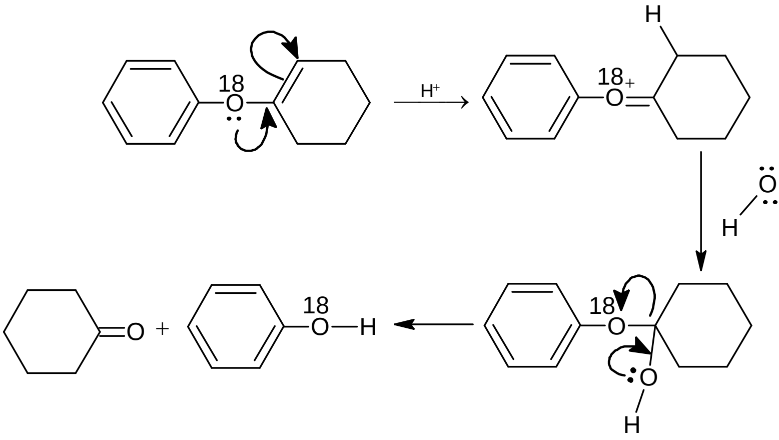
47. $Na_2S_2O_3 + Cl_2 + H_2O \longrightarrow NaHSO_4 + HCl$

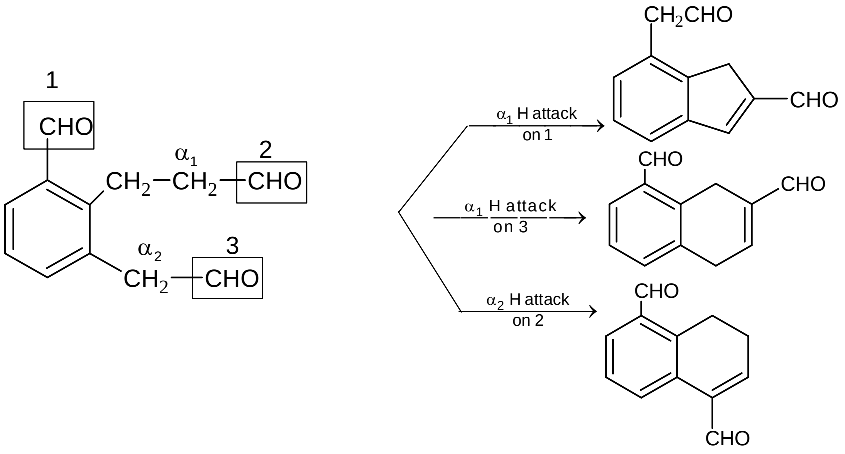
48. Ozone oxidizes alakaline solution of KI.

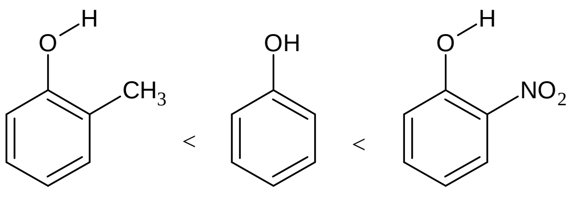
51.

F
F
n C=C
F
F
CF2
CF2
n

Teflon

52. Millon’s test, Biuret test, Ninhydrin test are used for protein.

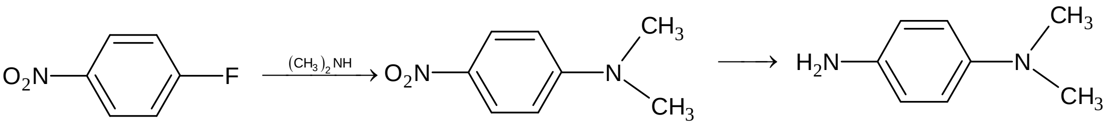
54.

18
O
H⁺
H
18+
O
O
H
H
18
O
H
18
O
O
H
+

55.

1
CHO
α1
2
CH2–CH2–CHO
α2
3
CH2–CHO
α1 H attack on 1
α1 H attack on 3
α2 H attack on 2
CH2CHO
CHO
CHO
CHO
CHO
CHO

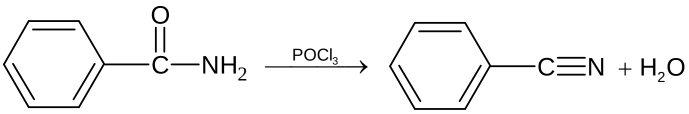
56.

O
H
CH3
<
OH
<
O
H
NO2

(acidic strength)

57.


O_2N
F
$(CH_3)_2NH$
O_2N
N
CH_3
CH_3
H_2N
N
CH_3
CH_3

58.


O
C
NH_2
$POCl_3$
C
N
$+ H_2O$

Mathematics PART – III

SECTION – A

61. $\cot^{-1}\frac{5}{\sqrt{3}}+\cot^{-1}\frac{9}{\sqrt{3}}+\cot^{-1}\frac{15}{\sqrt{3}}+\cot^{-1}\frac{23}{\sqrt{3}}+.....\infty$

$$= \tan^{-1}\left(\frac{\frac{2}{\sqrt{3}}-\frac{1}{\sqrt{3}}}{1+\frac{2}{\sqrt{3}}\times\frac{1}{\sqrt{3}}}\right)+\tan^{-1}\left(\frac{\frac{3}{\sqrt{3}}-\frac{2}{\sqrt{3}}}{1+\frac{3}{\sqrt{3}}\times\frac{2}{\sqrt{3}}}\right)+.....+.....+\tan^{-1}\left(\frac{\frac{n+1}{\sqrt{3}}-\frac{n}{\sqrt{3}}}{1+\frac{n+1}{\sqrt{3}}\times\frac{n}{\sqrt{3}}}\right)+.....$$

$$\Rightarrow S_n = \tan^{-1}\frac{n+1}{\sqrt{3}}-\tan^{-1}\frac{1}{\sqrt{3}}$$

$$\lim_{n\to\infty} S_n = \frac{\pi}{2}-\frac{\pi}{6}=\frac{\pi}{3}$$

62. Clearly tangents at P and Q intersect at right angle. Let S is point of intersection

$\Rightarrow$ P, Q, R, S are cyclic

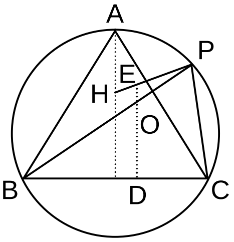
$\Rightarrow$ S lies on the director circle of hyperbola

$\Rightarrow S \equiv \left(\sqrt{a^2-b^2}\cos\theta, \sqrt{a^2-b^2}\sin\theta\right)$

$\Rightarrow$ The chord with midpoint (h, k) i.e. circumcentre will be same as equation of the chord of contact w.r.t. S

$\Rightarrow \frac{xh}{a^2}-\frac{yk}{b^2}=\frac{h^2}{a^2}-\frac{k^2}{b^2}$ and $\frac{x\sqrt{a^2-b^2}\cos\theta}{a^2}-\frac{y\sqrt{a^2-b^2}\sin\theta}{b^2}=1$ are identical comparing and removing Q locus i $\frac{x^2+y^2}{a^2-b^2}=\left(\frac{x^2}{a^2}-\frac{y^2}{b^2}\right)^2$

63. Let O (origin) is circumcentre of ΔABC and position vectors of A, B, C and P are $\vec{a}$, $\vec{b}$, $\vec{c}$ and $\vec{p}$



Hence $\overrightarrow{OH}=\vec{a}+\vec{b}+\vec{c}$, $\overrightarrow{OD}=\frac{\vec{b}+\vec{c}}{2}$, $\overrightarrow{OE}=\frac{\vec{a}+\vec{b}+\vec{c}+\vec{p}}{2}$

$\overrightarrow{DE}=\overrightarrow{OE}-\overrightarrow{OD}=\frac{\vec{a}+\vec{p}}{2}$, $\overrightarrow{AP}=\vec{p}-\vec{a}$

$\Rightarrow \overrightarrow{DE}\cdot\overrightarrow{AP}=\frac{|\vec{p}|^2-|\vec{a}|^2}{2}$ = 0 since $|\vec{p}|=|\vec{a}|$

64. It is equal to $\int_0^1\left(\frac{x^3}{4}-x\left(f(x)-\frac{x}{2}\right)^2\right)dx$ which is less than $\int_0^1\frac{x^3}{4}dx=\frac{1}{16}$

65. $f(x) = a_nx^n + a_{n-1}x^{n-1} + a_{n-2}x^{n-2} + ... + a_0$, $[x] = m$ then $f(m) = a_nm^n + a_{n-1}m^{n-1} + ... + a_0$

$f(f(m) + 1) = a_n(f(m) + 1)^n + a_{n-1}(f(m) + 1)^{n-1} + ... + a_0$

$kf(m) + a_n + a_{n-1} + ... + a_0 = kf(m) + f(1)$

Since $\frac{f(f(m)+1)}{f(m)}=k+\frac{f(1)}{f(m)}$ = integer

$\Rightarrow$ m = 1 hence x $\in$ [1, 2)

66. Total such numbers are $(3 \times 2) \times (3!) = 36$
Sum of all such numbers $66666 \times 18 = 1199988$

67. $(z + \omega)^2 = z\omega \Rightarrow z^2 + \omega^2 + z\omega = 0$
$\Rightarrow \frac{z}{\omega} = \frac{-1 \pm \sqrt{3}i}{2} \Rightarrow \arg(z) - \arg(\omega) = \frac{2\pi}{3}$ or $\frac{4\pi}{3}$

68. $\left|\vec{p} \times \vec{q} + \vec{q} \times \vec{r} + \vec{r} \times \vec{p}\right| = \left|\left(\vec{q} - \vec{p}\right) \times \left(\vec{r} - \vec{p}\right)\right| = \left|\vec{q} - \vec{p}\right|\left|\vec{r} - \vec{p}\right| \sin 60^o = \frac{a^2\sqrt{3}}{2}$

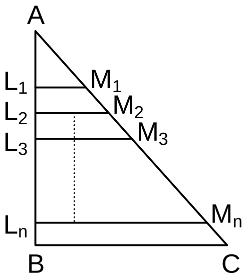
69. $(x + y + z)^6 \rightarrow$ general term $\frac{\lfloor 6}{\lfloor \alpha \lfloor \beta \lfloor \gamma} x^\alpha y^\beta z^\gamma$
$\alpha + \beta + \gamma = 6$, $\alpha \neq 0$ then total number of solution $= {}^8C_2 - 7 = 21$

70. $$\left[\vec{a}\ \vec{b}\ \vec{c}\right]^2 = \begin{vmatrix} \vec{a}\cdot\vec{a} & \vec{a}\cdot b & \vec{a}\cdot\vec{c} \\ \vec{b}\cdot a & \vec{b}\cdot\vec{b} & \vec{b}\cdot\vec{c} \\ \vec{c}\cdot\vec{a} & \vec{c}\cdot b & \vec{c}\cdot\vec{c} \end{vmatrix}$$

71. $1 + \omega + \omega^2 = 0$ and $\begin{vmatrix} \frac{-x}{\omega^2} & -y & \frac{-z}{\omega} \\ -y & \frac{-z}{\omega} & \frac{-x}{\omega^2} \\ \frac{-z}{\omega} & \frac{-x}{\omega^2} & -y \end{vmatrix} = x^3 + y^3 + z^3 - 3xyz$
$= (x + y + z)(x + y\omega + z\omega^2)(x + y\omega^2 + z\omega) = 0$
$= (x + y + z)((x - y)^2 + (y - z)^2 + (z - x)^2) = 0$
$\Rightarrow$ Either $x = y = z$ or $x + y\omega + z\omega^2 = 0$

72. Denominator of all terms equal to $\left(2a_{n+1}\right)$
Numerator $= (2nd + (2n - 2)d + ... + 2d) = \frac{2\left(n\left(n+1\right)\right)}{2}d$

73. $\frac{AL_1}{AB} = \frac{L_1M_1}{BC}$
$\Rightarrow \frac{1}{n+1} = \frac{L_1M_1}{a} \Rightarrow L_1M_1 = \frac{a}{n+1}$
$\frac{AL_2}{AB} = \frac{L_2M_2}{BC} \Rightarrow \frac{2}{n+1} = \frac{L_2M_2}{a} \Rightarrow L_2M_2 = \frac{2a}{n+1}$
$\Rightarrow$ The required sum is $\frac{a}{n+1} + \frac{2a}{n+1} + \frac{3a}{n+1} + ... + \frac{na}{n+1} = \frac{an}{2}$



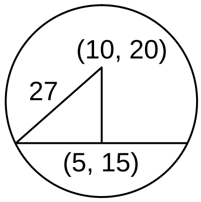
74. ${}^nC_0\left(\frac{1}{2} - \frac{1}{3}\right) - {}^nC_1\left(\frac{1}{3} - \frac{1}{4}\right) + {}^nC_2\left(\frac{1}{4} - \frac{1}{5}\right) - ..... + {}^nC_n\left(-1\right)^n\left(\frac{1}{n+2} - \frac{1}{n+3}\right)$
$\int_0^1 \left(1 - x\right)^n x\,dx = \int_0^1 \left({}^nC_0 x - {}^nC_1 x^2 + {}^nC_2 x^3 + ... + \left(-1\right)^n\ {}^nC_n x^{n+1}\right)dx$

$$\int_0^1 (1-x)^n x^2 dx = \int_0^1 \left({}^nC_0 x^2 - {}^nC_1 x^3 + {}^nC_2 x^4 + ... + (-1)^n\, {}^nC_n x^{n+2}\right)dx$$

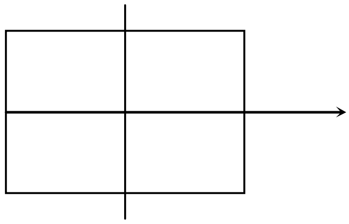
$$= \frac{1}{(n+1)(n+2)} - \frac{2}{(n+2)(n+1)(n+3)} = \frac{1}{(n+1)(n+2)}\left[1-\frac{2}{n+3}\right) = \frac{1}{(n+2)(n+3)}$$

75. Coefficient of x^n in $(x + x^2\ .....)(x^2 + x^4 + x^6\ .....)(x^3 + x^6 + x^9 + ...)$
$= x^6(1 - x)^{-1}(1 - x^2)^{-1}(1 - x^3)^{-1}$
⇒ None of the option can satisfy

76. Clearly (5, 15) is the mid point of the chord hence slope of normal to the chord is $\frac{20-15}{10-5} = 1$, slope of chord = –1
Equation of chord $(y - 15) = -(x - 5)$
⇒ $x + y = 20$
⇒ $2x + 2y = 40$
⇒ $p^{2013} + q^{2013} = (2)^{2013} + (2)^{2013} = 2^{2014}$



77. Let origin is shifted to (1, 0) after this the equation will be max{|x|, |y|} = k
Area = $4k^2 = 100$
⇒ k = 5



78. $$\lim_{x\to\infty} x^2 \ell n\left(x\cot^{-1}x\right) = \lim_{h\to0} \ell n\left(\frac{\tan^{-1}h}{h}\right)^{\frac{1}{h^2}} = \lim_{h\to0}\frac{1}{h^2}\left(\frac{\tan^{-1}h}{h}-1\right) = \lim_{h\to 0}\frac{\left(h-\frac{h^3}{3}+\frac{h^5}{5}.....\right)-h}{h^3} = \frac{1}{3}$$

79. $$I = \int \frac{\cos x + \sqrt{3}}{\left(1+2\sin\left(x+\frac{\pi}{3}\right)\right)^2}dx = \int \frac{\cos x + \sqrt{3}}{\left(1+\sin x+\sqrt{3}\cos x\right)^2}dx$$

Dividing by $\sin^2 x$, we get $I = \int \frac{\operatorname{cosec} x\cot x + \sqrt{3}\ \operatorname{cosec}^2 x}{\left(\operatorname{cosec} x + 1 + \sqrt{3}\cot x\right)^2}dx = \frac{1}{\operatorname{cosec} x + 1 + \sqrt{3}\cot x} + c$

$$= \frac{\sin x}{1+2\sin\left(x+\frac{\pi}{3}\right)} + c$$

80. $$f(x) = \frac{1}{2\{-x\}} - \left(1-\{-x\}\right) = \{-x\} + \frac{1}{2\{-x\}} - 1$$

⇒ $f(x) \ge 2\sqrt{\frac{1}{2}} - 1$ (A.M. ≥ G.M.)

⇒ $f_{\min} = \sqrt{2} - 1$ which occurs when $\{-x\} = \frac{1}{\sqrt{2}}$

⇒ $-x = n + \frac{1}{\sqrt{2}}$ ⇒ $n - \frac{1}{\sqrt{2}}, n \in I$

81. $\int \frac{x^3 - x^2 + x - 1}{x^5 + 1}dx = \int \frac{x^4 - 1}{\left(x^5 + 1\right)\left(x + 1\right)}dx = \int \frac{x^4}{x^5 + 1}dx - \int \frac{1}{x + 1}dx$

$= \frac{1}{5}\ell n\left|x^5 + 1\right| - \ell n\left|x + 1\right| + c$

82. Odd power of a skew symmetric matrix is always a skew symmetric matrix

83. $F \cap G = \{3, 6\}$, $E \cup \{F \cap G\} = \{1, 3, 6, 5, 7\}$
$\Rightarrow P\{E \cup \{F \cap G)\} = 0.13 + 0.12 + 0.13 + 0.08 + 0.06 = 0.52$

84. Plane containing the line will be given as $(4x - 2y - 10) + \lambda(5y - 4z + 3) = 0$
$\Rightarrow 4x + (5\lambda - 2)y + 4\lambda z + 3\lambda - 10 = 0$
The plane passing through (4, 3, 7) will give λ
$\Rightarrow 16 + (5\lambda - 2)y + 4\lambda z + 3\lambda - 10 = 0$
$\Rightarrow -10\lambda = 0 \Rightarrow \lambda = 0$
i.e., $4x - 2y - 10 = 0$

85. Let $f(x) = \sin^4 x - \sin x \cos x + \cos^4 x = 1 - \frac{1}{2}\sin 2x - \frac{1}{2}\sin^2 2x$

Let $\sin 2x = t$, $f(x) = g(t) \Rightarrow g(t) = \frac{-1}{2}t^2 - \frac{1}{2}t + 1$

Since $t \in [-1, 1] \Rightarrow f\left(x\right) \in \left[0, \frac{9}{8}\right]$

86. $f\left(x\right) = \sqrt{3 - x} - \sqrt{x + 1}$ is well defined for $x \in [-1, 3]$

$f'\left(x\right) = \frac{-1}{2\sqrt{3 - x}} - \frac{1}{2\sqrt{x + 1}} < 0 \ \forall x \in R$

$f(-1) = 2$ and $\sqrt{12 - 4x} = 1 + \sqrt{4x - 4}$ gives $x = 1 - \frac{\sqrt{31}}{8}$

Hence, $\left[x \in \left[-1, 1 - \frac{\sqrt{31}}{8}\right]\right)$

87. $\alpha^n = 1$, $\alpha^{n+1} = \alpha$ ..... etc.
$\left(\alpha^P\right)^{n/P} = 1$ is P is divisor of n

88. ΔABC is isosceles and circumcentre of ΔPQR is orthocentre of ΔABC and lies on a line $\perp$ to $x - 3y - 31 = 0$ passing through (0, 3)

89. Roots of the equation $x^2 + kx + 2$ are irrational since $k^2 - 8$ is not a perfect square as $k > 12$
So $\frac{a}{1} = \frac{c}{2} = \frac{\sin C + \sin A}{\sin C - \sin A} = 3$

90. At point of maxima $f'(x) = 0$ and $f''(x) < 0$
$\Rightarrow f''(x) = x^2 - f^2(x) \le 0$
Since the curve $x^2 - y^2 = a^2$ and $x^2 - f^2(x) \le 0$
$x_1^2 - y_1^2 < a^2 \Rightarrow$ Point lies outside hyperbola
Hence, 2 tangents

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

FULL TEST – IV

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 264**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into Three sections: **Section-A Section-B & Section-C.**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section–A (01 – 10, 21 – 30, 41 – 50)** contains 30 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer and **–2 marks** for wrong answer.

2. **Section–B (11 – 12, 31 – 32, 51 – 52)** contains 6 Match the following Type questions. Each question having 4 statements in Column I & 5 statements in Column II with any given statement in Column I having correct matching with 1 or more statement (s) given in Column II. Each statement carries **+2 marks** for correct answer and **–1 mark** for wrong answer.

3. **Section–C (13 – 20, 33 – 40, 53 – 60)** contains 24 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

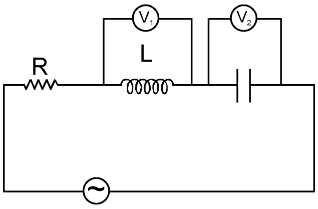
PART – I

SECTION – A

One OR More Than One Choice Type

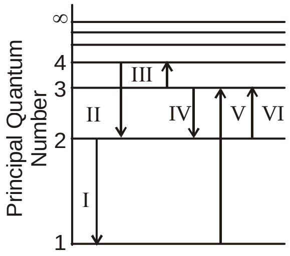
This section contains **10 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

1. In the figure shows $R = 100\ \Omega$, $L = \frac{2}{\pi}$ H and $C = \frac{8}{\pi}$ μF are connected in series with an a.c. source of 200 volt and frequency f. V_1 and V_2 are two hot-wire voltmeters. If the reading of V_1 and V_2 are same, then



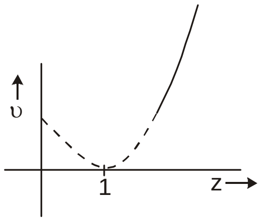
(A) f = 125 Hz
(B) $f = 250\pi$ Hz
(C) Current through R is 2 A
(D) $V_1 = V_2 = 1000$ volt

2. The figure shows an energy level diagram for the hydrogen atom. Several transitions are marked as I, II, III, ……… The diagram is only indicative and not to scale.



(A) The transition in which a Balmer series photon absorbed is VI
(B) The wavelength of the radiation involved in transition II is 486 nm
(C) IV transition will occur when a hydrogen atom is irradiated with radiation of wavelength 103 nm
(D) IV transition will emit the longest wavelength line in the visible portion of the hydrogen spectrum

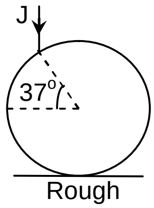
3. Figure shows the variation of frequency of a characteristic X-ray and atomic number.



(A) The characteristic X-ray is K_α
(B) The characteristic X-ray is K_β
(C) The energy of photon emitted when this X-ray is emitted by a metal having z = 101 is 204 keV
(D) The energy of photon emitted when this X-ray is emitted by a metal having z = 101 is 102 keV

Space for Rough work

4. A sharp vertical impulse J is given to a uniform solid sphere of mass m and radius R placed on a rough horizontal surface. Choose the correct options.



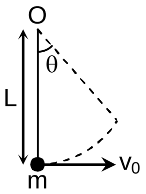
(A) Impulse imparted to the sphere by the surface perpendicular to the surface will also have magnitude J

(B) Minimum value of coefficient of friction between sphere and surface to avoid slipping is $\mu = \frac{4}{7}$

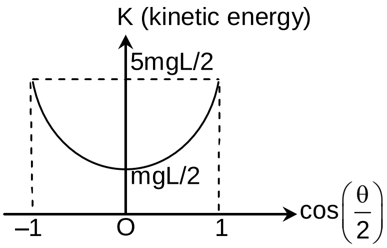
(C) If $\mu = \frac{11}{20}$, sphere rolls with backward slipping

(D) If $\mu = \frac{13}{20}$, sphere rolls with forward slipping

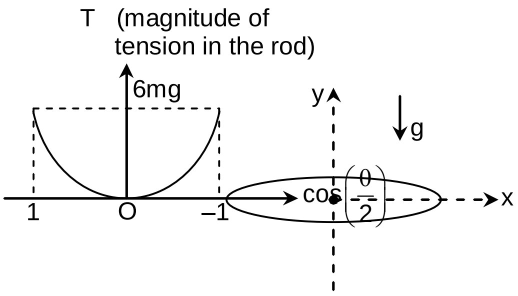
5. A massless rod hinged at one end free to rotate in vertical plane has a bob of mass m attached to it. Bob is given a velocity v_0 at the bottom most point. Choose the correct curves from the below options. $\left(v_0 = \sqrt{5gL}\right)$



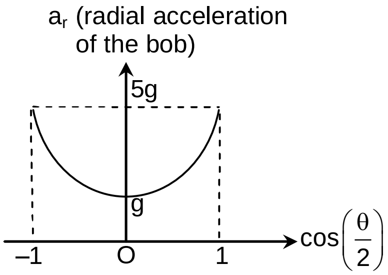
(A)



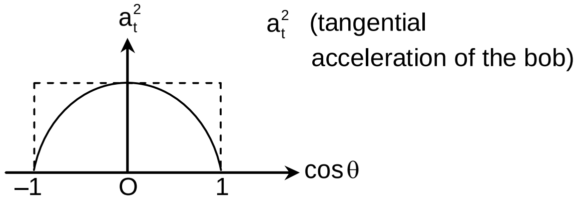
(B)



(C)



(D)



Space for Rough work

6. A uniformly charged ring having total charge Q and of radius R is fixed in such a way so that plane of the ring is horizontal. A charged particle of charge q and mass m is in equilibrium at any point lying on y-axis under the combined forces of electric field and earth's gravitational field. Choose the correct statements.

(A) If $qQ > 0$, particle must be on +y-axis

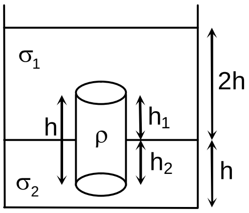
(B) If $qQ < 0$, particle must be on –y-axis

(C) If the particle is in stable equilibrium magnitude of y-coordinate of particle must be greater than $\frac{R}{\sqrt{2}}$

(D) If the particle is at y distance from centre of the ring. Specific charge of the particle is

$$\frac{4\pi\varepsilon_0\left(y^2+x^2\right)^{\frac{3}{2}}g}{Qy}$$

7. A cylinder of uniform mass density ρ is in equilibrium under the pressure forces acting due to two ideal liquids of density σ_1 and σ_2. Choose the correct alternative.



(A) This is only possible if $\sigma_1 > \rho > \sigma_2$

(B) $\frac{h_2}{h_1} = \left|\frac{\sigma_1 - \rho}{\rho - \sigma_2}\right|$

(C) If the cylinder is pressed slightly towards the bottom surface, it performs periodic motion

(D) If the cylinder is pressed slightly towards the bottom surface, it reaches at the bottom surface with velocity $\sqrt{\left|\frac{\sigma_1 - \sigma_2}{\rho}\right|\frac{gh_1^2}{h}}$

8. Decay constant of a radioactive sample is 4.9 x 10^{-18} s^{-1}. Choose the correct statements regarding this sample.

(A) Average life is 6.49 x 10^9 years

(B) Half life is 4.5 x 10^9 years

(C) Activity of the sample decreases by 4 in 9 x 10^9 years

(D) 87.5% of the initial number of nuclei is decayed in time 13.5 x 10^9 years

Space for Rough work

9. A drum of mass m_1 and radius r_1 rotates freely with initial angular velocity ω_0. A second drum with mass m_2 and radius r_2 $(r_2 > r_1)$ is mounted on same axle and is at rest although it is free to rotate. A thin layer of sand with mass m is distributed on inner surface of smaller drum. At t = 0, small perforations in the inner drum are opened. The sand starts to fly out at a constant rate λ kg/sec and sticks to the outer drum. Ignore the transit time of the sand. Choose the correct alternatives.

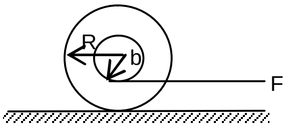
(A) Angular speed of outer drum at time t is $\frac{\lambda t \omega_0}{m_2 + \lambda t}\left(\frac{r_1}{r_2}\right)^2$

(B) Difference in final angular speeds of two drums is 0.

(C) Difference in final angular speeds of two drums is $\left(\frac{m\left(r_2^2 - r_1^2\right) + m_2 r_2^2}{\left(m + m_2\right) r_2^2}\right)\omega_0$

(D) Angular speed of inner drum remains constant.

10. A Yo-Yo of mass m has an axle of radius b and a spool of radius R. The Yo-Yo is placed upright on a table and string is pulled with a horizontal force $\vec{F}$ to the right as shown in figure.
The static friction coefficient between Yo-Yo and table is μ_s. Now there are two cases.
case (a): The string is pulled very gently?
case (b): The string is jerked hard?
The Yo – Yo will rotate:



(A) Clockwise in case (a),
(B) Anticlockwise in case (a)
(C) Clockwise in case (b)
(D) Anticlockwise in case (b)

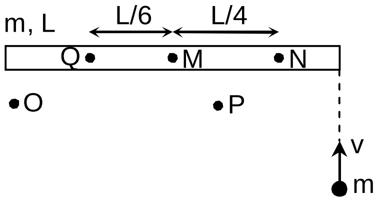
Space for Rough work

SECTION – B

(Matching Type)

This section contains **2 multiple choice questions.** Each question has matching Column(s). The Column(s) have choices (A), (B), (C) and (D) out of which only **ONE OR MORE THAN ONE** is/are correct.

11. A uniform rod of length L lies on smooth horizontal table. A particle of same mass moving on table strikes the rod perpendicularly as shown in figure. Q, M, N are points on the rod and O & P are fixed at ground.



After collision if particle comes in rest,

Column I		**Column II**	
(A)	Angular momentum of system will be conserved about points	(p)	Q
(B)	Linear momentum conserved from points	(q)	M
(C)	Speed of point Q just after collision is greater than speed of points	(r)	N
(D)	If coefficient of restitution of collision is $e = \frac{1}{2}$, then angular momentum is conserved about points	(s)	O
		(t)	P

Space for Rough work

12. Match Column I with Column II:

Column I		Column II	
(A)	A circular conducting loop rotating about its axis in a uniform constant magnetic field perpendicular to its plane	(p)	Net induced emf in the loop is non zero
(B)	A circular conducting loop moving along its plane in pure translation in a uniform constant magnetic field perpendicular to its plane	(q)	Net induced emf is zero but a small part of the loop may have some emf induced across it
(C)	A circular conducting loop placed in a magnetic field perpendicular to its plane which is decreasing with time	(r)	Induced emf in any small part of the loop is zero
(D)	A square conducting loop rotating about its side in a uniform constant magnetic field perpendicular to its axis. Consider a time when the plane of the loop is parallel to the magnetic field	(s)	Induced electric field outside the conductor is zero
		(t)	Current flows in the loop

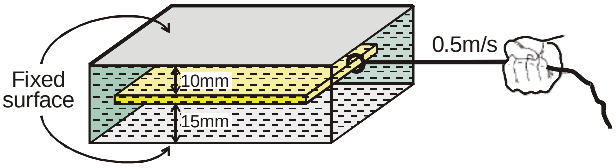
SECTION – C

(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

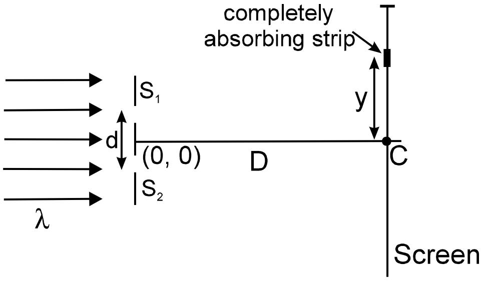
13. 1 kg ice at –10ºC is mixed with 0.1 kg of steam at 200ºC. If final temperature of mixture at equilibrium is $T_{eq} = \frac{58x}{11}$, then fill the value of x.
Latent heat of fusion of ice = 80 cal/gram, latent heat of vaporization of water = 540 cal/gram, specific heat capacity of ice $\cong$ specific heat of water = 0.5 cal/gram-K.

14. Glycerine is filled in 25 mm wide space between two large plane horizontal surfaces. Calculate the force required to drag a very thin plate 0.75 m^2 in area between the surface at a constant speed of 0.5 m/s if it is at a distance of 10 mm from one of the surfaces in horizontal position? Take coefficient of viscosity η = 0.5 Ns/m^2. Fill the value of X where X = force required to drag/6.25.

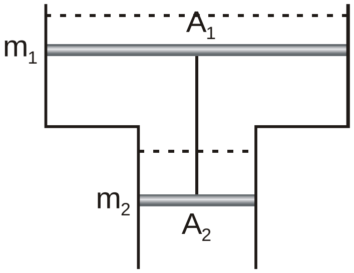


Space for Rough work

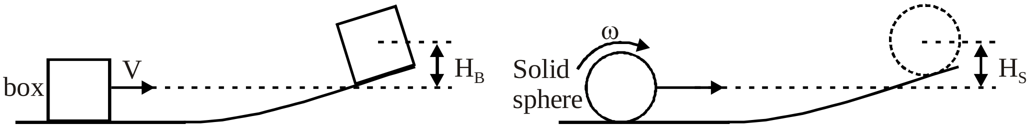
15. Figure shows two, identical narrow slits S_1 and S_2. A very small completely absorbing strip is placed at distance y from the point C. C is the point on the screen equidistant from S_1 and S_2. Assume $\lambda << d << D$, where λ, d and D have usual meaning. When S_2 is covered the force due to light acting on strip is f and when both slits are opened the force acting on strip is 2f. Find the minimum positive y (<< D) coordinate (in cm) of the strip if $\frac{\lambda D}{d}$ = 4 cm.



16. Consider a vertical tube open at both ends. The cube consists of two parts, each of different cross-sections and each part having a piston which can move smoothly in respective tubes. The two pistons are joined together by an inextensible wire. The combined mass of the two piston is 5 kg and area of cross-section of the upper piston is 10 cm^2 greater than that of the lower piston. Amount of gas enclosed by the pistons is one mole. When the gas is heated slowly, pistons move by 50 cm. Find rise in the temperature of the gas, in the form 25X/R K where R is universal gas constant. Use g = 10 m/s^2 and outside pressure = 10^5 N/m^2). Fill value of X in the answer sheet.

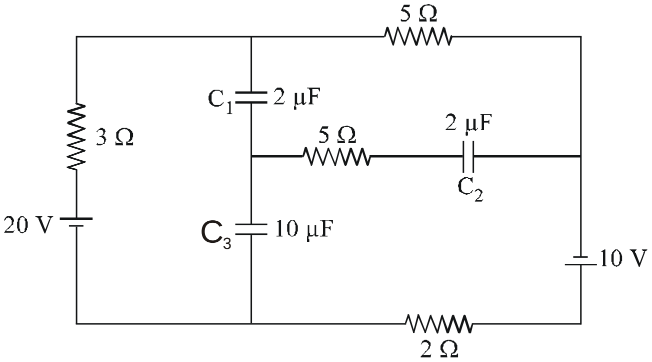


17. A box and a solid sphere of equal mass are moving with the same velocity across a horizontal floor. The sphere rolls without slipping and the box slides without friction. They encounter an upward slope in the floor and each move up the slope some distance before momentarily stopping and then moving down again. The maximum vertical heights reached by the box and the sphere are H_B and H_S respectively. What is the ratio $\frac{5H_S}{H_B}$?

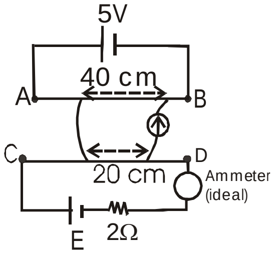


Space for Rough work

18. In the circuit shown in figure, if the charge on capacitor C2 in steady state is $\frac{10x}{3}\ \mu C$, then find value of x.



19. AB and CD are two uniform resistance wires of lengths 100 cm and 80 cm respectively. The connections are shown in the figure. The cell of emf 5 V is ideal while the other cell of emf E has internal resistance $2\,\Omega$. A length of 20 cm of wire CD is balanced by 40 cm of wire AB. If emf E in volt is 2x, then find the value of x, if the reading of the ideal ammeter is 2A. The other connecting wires have negligible resistance.



20. A radioactive nucleus can decay by three different processes. Half life for first process is 2 hours. Effective half life of the nucleus is $\frac{4}{3}$ hours. Find the half life for second process in hours.

Space for Rough work

Chemistry

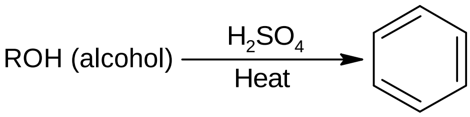
PART – II

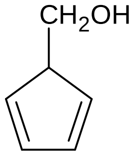
SECTION – A

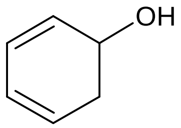
One OR More Than One Choice Type

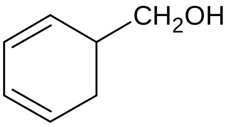
This section contains **10 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

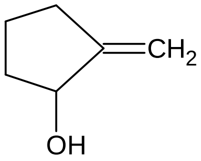
21. The possible structure of the alcohol is



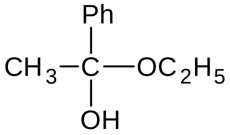
(A) 

(B) 

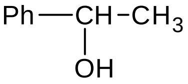
(C) 

(D) 

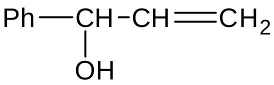
22. Which of the following alcohol gives the white turbidity immediately with HCl + $ZnCl_2$ (anhy.)?

(A) 

$CH_3-\underset{OH}{\overset{Ph}{C}}-OC_2H_5$

(B) 

$Ph-\underset{OH}{CH}-CH_3$

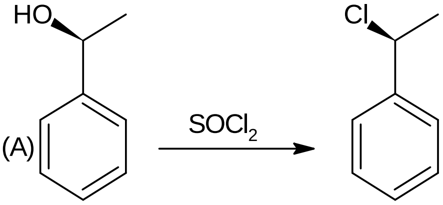
(C) 

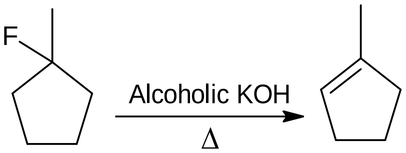
$Ph-\underset{OH}{CH}-CH=CH_2$

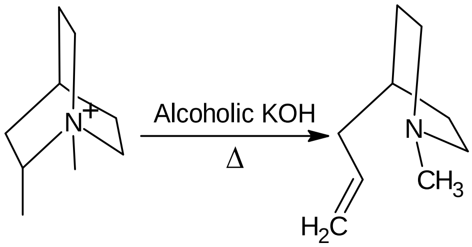
(D) $CH_3-CH_2CH_2OH$

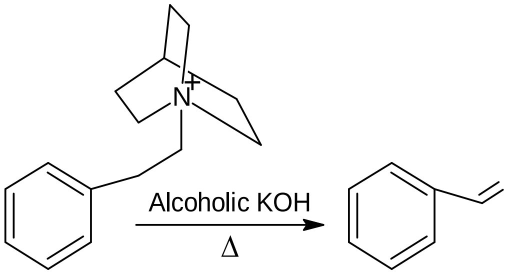
Space for Rough work

23. Identify reactions that correctly match with their products:

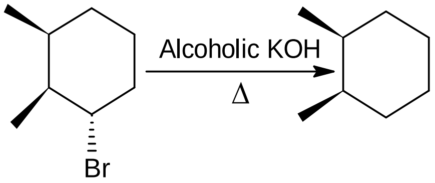
(A)


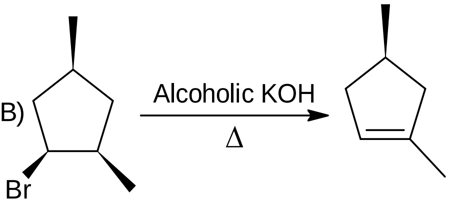
(B)

F
Alcoholic KOH
Δ

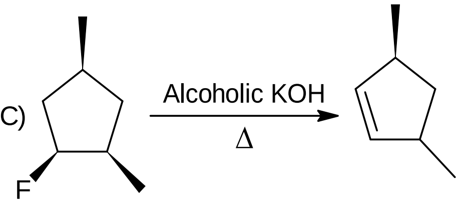
(C)

N+
Alcoholic KOH
Δ
N
CH$_3$
H$_2$C

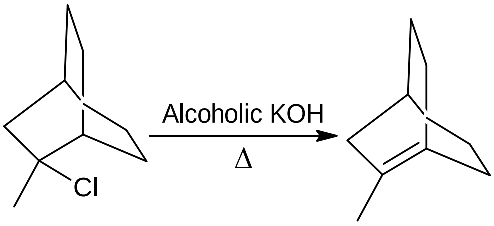
(D)

N+
Alcoholic KOH
Δ

24. Identify reactions that correctly match with their products:

(A)

Alcoholic KOH
Δ
Br

(B)

Alcoholic KOH
Δ
Br

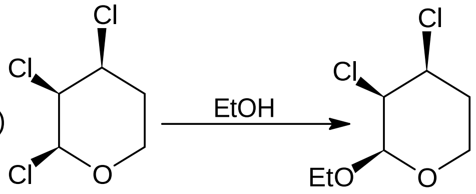
(C)

Alcoholic KOH
Δ
F

(D)

Alcoholic KOH
Δ
Cl

Space for Rough work

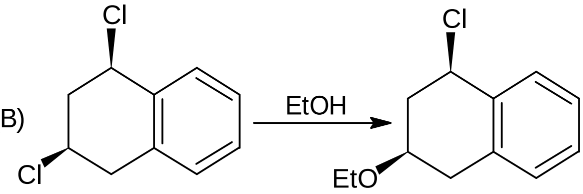
25. Identify reactions that correctly match with their products?

(A)


Cl
Cl
Cl
O
EtOH
Cl
Cl
EtO
O

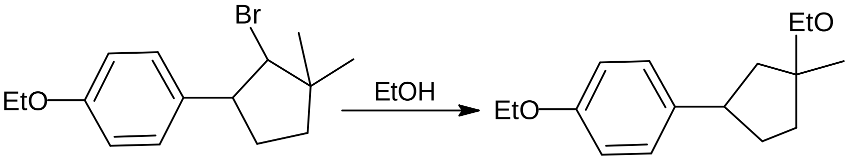
Monosubstitued product

(B)

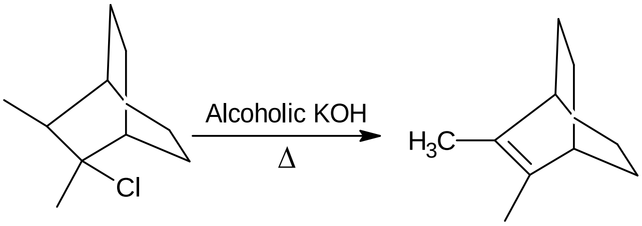

Cl
Cl
EtOH
Cl
EtO

Monosubstitued product

(C)

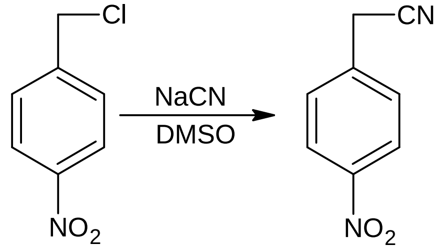
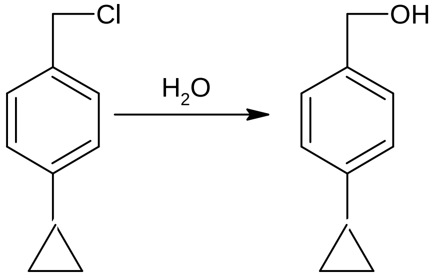
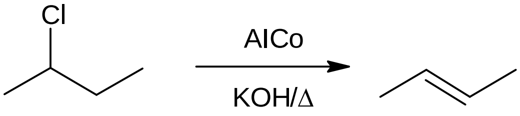
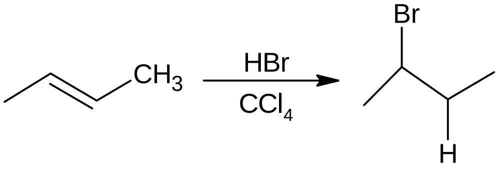

EtO
Br
EtOH
EtO
EtO

(D)

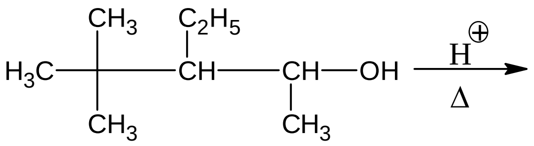

Cl
Alcoholic KOH
Δ
H3C

Space for Rough work

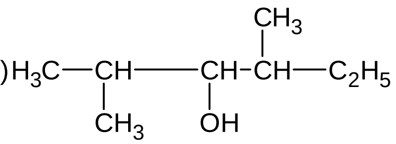
26. Which of the following is/are correctly matched?

Column I		**Column II**	
(A)	 Cl NaCN DMSO CN NO2 NO2	(P)	Carbocation intermediate is formed
(B)		(Q)	S_N1
(C)	 Cl AlCo KOH/Δ	(R)	S_N2
(D)	 CH3 HBr CCl4 Br H	(S)	Addition reaction

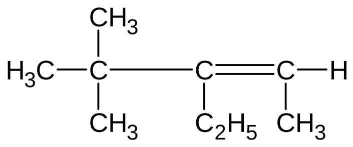
Space for Rough work

27. 

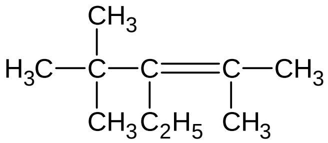
$H_3C-C(CH_3)_2-CH(C_2H_5)-CH(CH_3)-OH \xrightarrow[\Delta]{H^{\oplus}}$ Product mixture, the product's mixture contains

(A) 

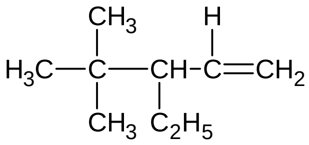
$H_3C-CH(CH_3)-CH(OH)-CH(CH_3)-C_2H_5$

(B) 

$H_3C-C(CH_3)_2-C(C_2H_5)=C(CH_3)-H$

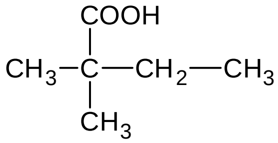
(C) 

$H_3C-C(CH_3)_2-C(C_2H_5)=C(CH_3)-CH_3$

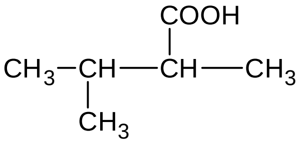
(D) 

$H_3C-C(CH_3)_2-CH(C_2H_5)-C(H)=CH_2$

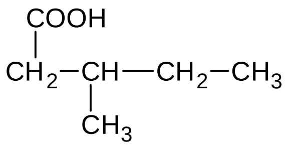
28. Which of the following acid will give isopentane on decarboxylation with soda lime?

(A) 

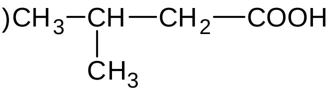
$CH_3-C(COOH)(CH_3)-CH_2-CH_3$

(B) 

$CH_3-CH(CH_3)-CH(COOH)-CH_3$

(C) 

$CH_2(COOH)-CH(CH_3)-CH_2-CH_3$

(D) 

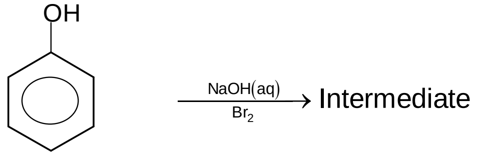
$CH_3-CH(CH_3)-CH_2-COOH$

29. On treated with dilute H_2SO_4, a salt gives a gas which turns lime water milky. The salt can be

(A) $NaHCO_3$
(B) Na_2CO_3
(C) Na_2SO_3
(D) $NaNO_2$

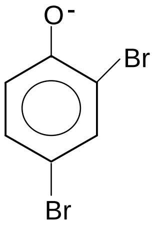
Space for Rough work

30. In the reaction

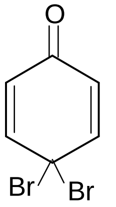


the intermediate are

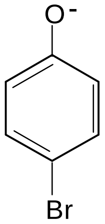
(A)



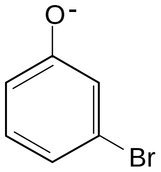
(B)



(C)



(D)



SECTION – B

(Matching Type)

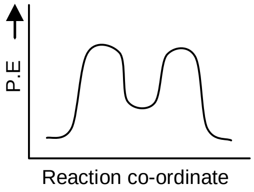
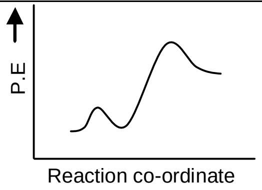
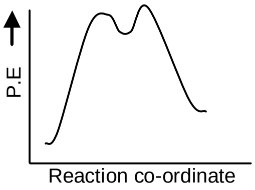
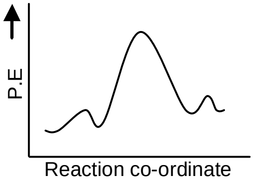
This section contains **2 multiple choice questions.** Each question has matching Column(s). The Column(s) have choices (A), (B), (C) and (D) out of which only **ONE OR MORE THAN ONE** is/are correct.

31. Match the Column I and Column II:

Column I (Observation)		**Column II (Possible nuclear reaction)**	
(A)	α-emission	(p)	Z increase
(B)	β-emission	(q)	n/p increase
(C)	β^+-emission	(r)	n/p decrease
(D)	K-electron capture	(s)	X-ray emission
		(t)	Z decrease

Space for Rough work

32. Match the Column I and Column II:

Column I		**Column II**	
(A)		(p)	The intermediate are the final products
(B)		(q)	The reactants quickly form intermediate that slowly form products
(C)		(r)	The presence of intermediate is difficult to determine kinetically although the two step reaction is not ultra fast
(D)		(s)	The intermediate accumulate in measurable quantities and the reaction is easily resolved in two steps
		(t)	Mechansim like $\mathrm{E+S} \xrightleftharpoons{\text{fast}} \mathrm{Es}$ $\mathrm{ES} \rightleftharpoons \mathrm{EP}$ $\mathrm{EP} \rightleftharpoons \mathrm{E+P}$

Space for Rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

33. In diamond, effective number of carbon atoms along any body diagonal of unit cell is n/4. What is the value of n.

34. One mole of SO_2Cl_2 on hydrolysis gives acids which can be neutralized by x moles of NaOH. The value of x is?

35. Ambidentate ligands out of
Py, en, CNS, CN, CNO, $C_2O_4^{--}$, NO_2 are

36. Brown coloured ring formed in nitrate test has formula $\left[Fe\left(H_2O\right)_5NO\right]SO_4$. Unpaired electron in Fe is

37. Taking one mole of $N_{2(g)}$ and excess of $H_2(g)$, under suitable conditions, formation of NH_3 is completed when $NH_3(g)$ has mole fraction of 0.5. The initial moles of H_2 are?

38. The mole fraction of solute in some solution is 1/n. If 50% of the solute molecules dissociates into two parts and remaining 50% get dimerized now mole fractions of solvent become 4/5. Find value of n.

39. Calculate the weight of MnO_2 required to react with HCl having specific gravity 1.2 gm/ml. 4% by mass necked to produce 1.8 L of Cl_2, at STP by reaction:

40. Total number of OH groups present on all boron atoms in colemanite $Ca_2B_6O_{11}.5H_2O$ is

Space for Rough work

Mathematics PART – III

SECTION – A
One OR More Than One Choice Type

This section contains **10 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

41. If $f(x_0-x_2), f(x_1)f(x_2) \,\&\, f(x_1+x_2)$ are in A.P for all x_1, x_2 and $f(0)\neq 0$ then
(A) $f^{'}(5)=f(-5)$
(B) $f(5)=f(-5)$
(C) $f'(5)-f'(-5)=0$
(D) $f'(5)+f'(-5)=0$

42. Consider a sequence $\{a_n\}$ with $a_1=2 \,\&\, a_n=\dfrac{a_{n-1}^2}{a_{n-2}}$ for all $n\geq 3,$ terms of the sequence being distinct. If a_2 & a_5 are + ve integers and $a_5\leq 162,$ then the possible value (s) of a_5 can be
(A) 162
(B) 64
(C) 32
(D) 2

43. If $f_n(x)=e^{f_{n-1}(x)}\forall n\in N \,\&\, f_o(x)=x,$ then $\dfrac{d}{dx}f_n(x)$ is equal to
(A) $f_n(x)\dfrac{d}{dx}\left(f_{n-1}(x)\right)$
(B) $f_n(x)f_{n-1}(x)$
(C) $f_n(x)f_{n-1}(x).......f_2(x)f_1(x)$
(D) None of the above

44. Let ABC be a Δ with in centre at I. If P and Q are foot of the perpendicular from A to BI & CI resp. then which of the following results are correct?
(A) $\dfrac{AP}{BI}=\dfrac{\sin B/2\cos C/2}{\sin A/2}$
(B) $\dfrac{AQ}{CI}=\dfrac{\sin C/2\cos B/2}{\sin A/2}$
(C) $\dfrac{AP}{BI}=\dfrac{\sin C/2\cos B/2}{\sin A/2}$
(D) $\dfrac{AP}{BI}+\dfrac{AQ}{CI}=\sqrt{3}$ if $\angle A=60^o$

Space for Rough work

45. Let $\hat{u}, \hat{v}, \hat{w}$ be three unit vectors such that $\hat{u} + \hat{v} + \hat{w} = \hat{a},\ \hat{a}.\hat{u} = \frac{3}{2},\ \hat{a}.\hat{v} = \frac{7}{4}$ & $|\hat{a}| = 2$, then

(A) $\hat{u}.\hat{v} = \frac{3}{4}$
(B) $\hat{u}.\hat{w} = 0$
(C) $\hat{u}.\hat{v} = \frac{1}{4}$
(D) $\hat{u}.\hat{w} = -\frac{1}{4}$

46. Consider the integral $I_1 = \int_1^e (1+x)(x+\ln x)^{100}\, dx$ $I_2 = \int_{\sin^{-1}(1/e)}^{\pi/2} (1+e\sin x+\ln\sin x)^{101}\cos\ x\ dx$

If $I_1 + \frac{e}{101} I_2 = \frac{e(1+e)^{101} - k}{101}$ then k $\geq$

(A) 0
(B) 1
(C) 2
(D) – 1

47. The equation $k + x^3 e^{x+3} = 0$ has 2 distinct real roots & k is a prime natural number, then the possible value of k is/are

(A) 11
(B) 13
(C) 31
(D) 37

48. If the equation $\left(2^{\left(\frac{1}{\cos^{-1}x}\right)}\right)^{2\pi} - \left(a + \frac{1}{2}\right)\left(2^{\left(\frac{1}{\cos^{-1}x}\right)}\right)^{\pi} - a^2 = 0$ has only one real solution then subsets of values of 'a' are

(A) $(-3, 1)$
(B) $(-\infty, -3]$
(C) $[1, \infty)$
(D) $[-3, \infty)$

Space for Rough work

49. Equation of the circles $|z-1-i|=1 \& |z-1+i|=1$ touches internally a circle of radius 2. The equation of the circle touching all the three circles can be

(A) $3z\bar{z}+z+\bar{z}-1=0$
(B) $3z\bar{z}-7(z+\bar{z})+15=0$
(C) $z\bar{z}-z-\bar{z}-3=0$
(D) $3z\bar{z}+(z+\bar{z})+1=0$

50. Let a = $\sin^{-1}(\sin 3)+\sin^{-1}(\sin 4)+\sin^{-1}(\sin 5)$, $f(x)=e^{x^2+|x|}$, domain of $f(x)$ be $[\alpha,\infty)$ & range of $f(x)$ be $[b,\infty)$ and $g(x)=\left(4\cos^4 x-2\cos 2x-\frac{1}{4}\cos 4x-x^7\right)^{1/7}$, domain & range of g(x) is set of real numbers. Which of the following are correct?

(A) $a=-2$
(B) $a+b=-1$
(C) $f(g(g(b)))=e^2$
(D) Both f(x), g(x) are non invertible fns

SECTION – B

(Matching Type)

This section contains **2 multiple choice questions.** Each question has matching Column(s). The Column(s) have choices (A), (B), (C) and (D) out of which only **ONE OR MORE THAN ONE** is/are correct.

51. Base of a pyramid is rectangular, three of its vertices of the base are $A(2,2,-1), B(3,1,2) \& C(1,1,1)$

Its vertex at the top is $P\left(4,\frac{-26}{3},\frac{-10}{3}\right)$ & fourth vertex of the base is D. Then

Column I		**Column II**	
(A)	Magnitude of position vector of D is	(p)	$\sqrt{120}$
(B)	Height of pyramid	(q)	$\sqrt{20}$
(C)	Volume of pyramid is	(r)	20
(D)	Area of base of pyramid is	(s)	60
		(t)	$\sqrt{60}$

Space for Rough work

52. Match the following

Column – I		**Column – II**	
(A)	$\dfrac{\prod_{k=1}^{100}\left(1-\tan^2\dfrac{2^k\pi}{2^{100}+1}\right)}{2^{100}}$ is equal to	(p)	+ 1
(B)	$\prod_{k=1}^{100}\left(1+2\cos\dfrac{2\pi.3^k}{3^{100}+1}\right)$ is equal to	(q)	- 1
(C)	Let n be a +ve integer and let x be a real number different from $2^{k+1}\left(\dfrac{\pi}{3}+l\pi\right)$, $k=1,2,.......n,l$ an integer then $\left[\left(1+2\cos\dfrac{x}{2^{100}}\right)\prod_{k=1}^{100}\left(1-2\cos\dfrac{x}{2^k}\right)\right]-2\cos x$ is equal to	(r)	2
(D)	The value of $\sum_{n=1}^{\infty}\dfrac{1}{2^n}\tan\dfrac{2}{2^n}+\cot 2$ is equal to	(s)	3
		(t)	1/2

SECTION – C

(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

53. A tosses 2 fair coins & B tosses 3 fair cons after game is won by the person who throws greater number of heads. In case of a tie, the game is continued under identical rules until someone finally wins the game. The probability that A finally wins the game is $K/11$, then K is

54. The vertices of a triangle OBC are $0(0,0), B(-3,-1), C(-1,-3)$. Equation of line parallel to BC & intersecting the sides OB & OC whose perpendicular distance from the point (0, 0) is $\dfrac{1}{\sqrt{2}}$ $ax+by+2=0$ then the value of $\dfrac{a^4+b^4}{4}$ is

Space for Rough work

55. 8 Children are standing in a line outside a ticket counter at zoo. 4 of them have a 1 rupee coin each & the remaining four have a 2 rupee coin each. The entry ticket costs 1 rupee each. If all the arrangements of the 8 children are random, the probability that no child will have to wait for a change, if the cashier at the tickets window has no-change to start with is K. Then 15K is equal to

56. In $\Delta ABC, \angle ABC = 45^o$, point D is on segment BC such that $2|BD| = |CD|$ and $\angle DAB = 15^o$ $\& \angle ACB$ is $(25\,k)^o$ then $k =$

57. Let n be a positive integer if $1 \le l < K \le n$, such that $\frac{\sin^2 nx}{\sin^2 x} = a_o + \sum\limits_{1 \le l < k \le n} a_{l,k} \cos 2(k - l)$ for all real numbers x with x not an integer multiple of π, then the value of $a_{l,k}$ is

58. Given A = $\left\{ f : C[0,1] : \int_0^1 f(x)\,dx = 1 \right\}$ then minimum value of $\int_0^1 (1 + x^2) f^2(x)\,dx, f \in A$ is $\frac{k}{\pi}$ then k is

59. Straight lines $3x - 4y = \frac{4}{\pi}\sin^{-1}(a^8 + 1) + 2\cos^{-1}(a^{12} + 1) - \sec^{-1}(a^2 + 1), a \in R$ & $6x - 8y = 7$ are tangents to a circle then the length of arc of this circle which makes on angle of $\frac{40}{3}$ at its centre is

60. If $f(x)$ be a twice different able function from $R \to R$ such that $t^2 f(x) - 2tf'(x) + f''(x) = 0$ has two equal values of $t \forall x$ & $f(0) = 1, f'(0) = 2$ then $\lim\limits_{x \to 0}\left(\frac{f(x) - 1}{x} - \frac{t}{2} \right)$ is

Space for Rough work

FIITJEE

JEE(Advanced)-2018

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – IV
(Paper-1)

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**A, C, D**	21.	**A, B**	41.	**B, D**
2.	**A, B, D**	22.	**A, B, C**	42.	**A, C**
3.	**A, D**	23.	**A, C, D**	43.	**A, C**
4.	**A, B, C**	24.	**B, C**	44.	**A, B, D**
5.	**A, B, C, D**	25.	**A, D**	45.	**A, D**
6.	**A, B, C, D**	26.	**B**	46.	**A, B, D**
7.	**A, B, D**	27.	**A, B, D**	47.	**A, B**
8.	**A, B, C, D**	28.	**A, B, C**	48.	**B, C**
9.	**A, C, D**	29.	**A, B, C**	49.	**A, B**
10.	**A, D**	30.	**A, C**	50.	**A, B, C**
11.	**(A) – (p, r, s, t); (B) – (p, s, t); (C) – (q, r); (D) – (r, s, t)**	31.	**(A) – (q); (B) – (p, r,s); (C) – (q); (D) – (s)**	51.	**(A) – (q); (B) – (p); (C) – (r); (D) – (s)**
12.	**(A) – (r, s); (B) – (q, s); (C) – (p, t); (D) – (p, s, t)**	32.	**(A) – (s); (B) – (q); (C) – (r); (D) – (t)**	52.	**(A) – (q), (B) – (p), (C) – (p), (D) - (t)**
13.	**5**	33.	**5**	53.	**3**
14.	**5**	34.	**4**	54.	**8**
15.	**1**	35.	**4**	55.	**3**
16.	**3**	36.	**5**	56.	**3**
17.	**7**	37.	**5**	57.	**2**
18.	**3**	38.	**6**	58.	**4**
19.	**6**	39.	**8**	59.	**2**
20.	**4**	40.	**6**	60.	**1**

Physics

PART – I

SECTION – A

1. **A, C, D**

$V_1 = V_2 \Rightarrow x_L = x_C$

$\Rightarrow f = \dfrac{1}{2\pi\sqrt{LC}} = 125\text{ Hz}$

$I_0 = \dfrac{v_0}{R} = \dfrac{200}{100} \qquad (\because x = 0,\ \therefore z = R)$

$= 2\text{ A}$

$V_1 = V_2 = IX_L = I.(\omega L) = I.L.\dfrac{1}{\sqrt{LC}} = I\sqrt{\dfrac{L}{C}} = 2\sqrt{\dfrac{(2/\pi)}{(8\times10^{-6}/\pi)}}$ = 1000 volt

2. **A, B, D**

For Balmer series, $n_1 = 2$ $n_2 = 3, 4, \ldots\ldots\ldots$
(lower) (higher)

$\therefore$ In transition (VI), photon of Balmer series is absorbed.

In transition II

$E_2 = -3.4$ eV, $E_4 = -0.85$ eV

$\Delta E = 2.55$ eV

$\Delta E = \dfrac{hc}{\lambda} \Rightarrow \lambda = \dfrac{hc}{\Delta E}$

$\lambda = 486$ nm

Wavelength of radiation = 103 nm = 1030 $\overset{\circ}{A}$

$\therefore \Delta E = \dfrac{12400}{1030} \simeq 12.0\text{ eV}$

So difference of energy should be 12.0 eV (approx.)

Hence $n_1 = 1$ and $n_2 = 3$
(–13.6) eV (–1.51) eV

$\therefore$ Transition is V.

For longest wavelength, energy difference should be minimum.

So, in visible portion of hydrogen atom, minimum energy emitted is in transition IV.

3. **A, D**

(i) From Moseley's law $\sqrt{\upsilon} = a(z - b)$

$\upsilon = 0$ at z = b. From graph, $\upsilon = 0$ at z = 1

$\therefore b = 1$ $\therefore$ K_α Ans.

(ii) For K_α, $\sqrt{\upsilon} = \sqrt{\dfrac{3RC}{4}}(z-1)$

Put z = 101 $\Rightarrow \sqrt{\upsilon} = \sqrt{\dfrac{3RC}{4}}.100$

Photon energy = $h\upsilon = \dfrac{3}{4}hRC.100^2 = \dfrac{3}{4}\times13.6\times100^2$ = 102 keV

4. **A, B, C**

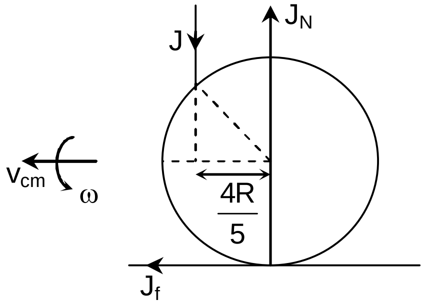
$J_N = J \qquad J_f = mv_{cm}$

$J\frac{4R}{5} - J_fR = \frac{2}{5}mR^2\omega$

$\frac{4}{5}J - J_f = \frac{2}{5}mv_{cm} = \frac{2}{5}J_f$

$\Rightarrow \frac{4}{5}J = \frac{7}{5}J_f \Rightarrow J_f = \frac{4}{7}J$

$\mu J > \frac{4}{7}J \Rightarrow \mu > \frac{4}{7}$ for rolling



$J_f \le \mu J_N$

5. **A, B, C, D**

$\frac{1}{2}mv_0^2 = \frac{5mgL}{2} = K + mgL\left(1-\cos\theta\right)$

$\Rightarrow K = 2mgL\cos^2\frac{\theta}{2} + \frac{mgL}{2}$

$T = 6mg\cos^2\frac{\theta}{2}$

$a_r = g + 4g\cos^2\frac{\theta}{2}$

$a_t = g\sin\theta = g\sqrt{1-\cos^2\theta}$

$\Rightarrow a_t^2 = g^2 - g^2\cos^2\theta$

6. **A, B, C, D**

$$mg = \frac{KQqx}{\left(y^2+x^2\right)^{\frac{3}{2}}} \Rightarrow \frac{q}{m} = \frac{4\pi\varepsilon_0\left(y^2+x^2\right)^{\frac{3}{2}}g}{Qy}$$

7. **A, B, D**

$\rho gAh = \left(\sigma_1Ah_1 + \sigma_2Ah_2\right)g$

$\Rightarrow \sigma_1h_1 + \sigma_2h_2 = \rho h$

$\sigma_1h_1 + \sigma_2h_2 = \left(h_1 + h_2\right)\rho \qquad \left(\because h_1 + h_2 = h\right)$

$\Rightarrow \frac{h_2}{h_1} = \frac{\sigma_1 - \rho}{\rho - \sigma_2}$

If the cylinder is displace down by y

$F_{net} = \rho Ahg - \left(\sigma_1A\left(h_1 - y\right) + \sigma_2A\left(h_2 + y\right)\right)g$

$= \rho Ahg - \left(\sigma_1h_1A + \sigma_2h_2A\right)g + \left(\sigma_1 - \sigma_2\right)Agy = \left(\sigma_1 - \sigma_2\right)Agy$

$W = \left(\sigma_1 - \sigma_2\right)Ag\frac{h_1^2}{2} = \frac{1}{2}\rho Ahv^2$

$\Rightarrow v = \sqrt{\left|\frac{\sigma_1 - \sigma_2}{\rho}\right|\frac{gh_1^2}{h}}$

8. **A, B, C, D**

λ = 4.9 x 10^{-18} s^{-1}

$\tau_{avg} = \frac{1}{\lambda}$ = 6.49 x 10^9 years

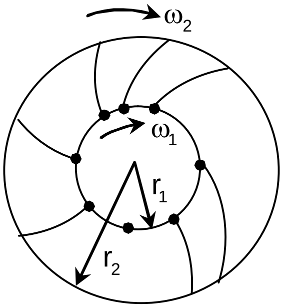
$t_{1/2} = \frac{0.693}{\lambda}$ = 4.5 x 10^9 years

No. of nuclei's remaining after 9 x 10^9 hrs is $\frac{N_0}{4}$

$\Rightarrow$ activity reduces to $\frac{1}{4}$

After 3 half lives nuclei decayed is 87.5%.

9. **A, C, D**



As the sand leaves the inner drum through the open holes, it does not exert any force of the drum, angular momentum remains conserved.

At time t,

$$m_1 r_1^2 \omega_0 = (m_1 - \lambda t) r_1^2 \omega_0 + (m_2 + \lambda t) r_2^2 \omega_2$$

$$\omega_2 = \frac{\lambda t r_1^2 \omega_0}{(m_2 + \lambda t) r_2^2}$$

The speed of inner drum does not change.

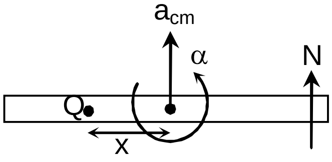
10. **A, D**

In first case, we can write torque equation about bottom point because it coincides with instantaneous axis of rotation while in second case, you will write torque equation of centre of mass.

SECTION – B

11. **(A) – (p, r, s, t); (B) – (p, s, t); (C) – (q, r); (D) – (r, s, t)**

During collision:



$a_{cm} = \frac{N}{m}$

$$\frac{m^2}{12}\alpha = \frac{NL}{2} \qquad \alpha = \frac{6N}{L}$$

Acceleration of point Q is $a_Q = a_{cm} - \frac{L}{6}\alpha = 0$

Hence, angular momentum will be conserved about point Q.
During collision:
Torque about point N on rod
$\tau_{ext.} + \tau_{pseudo\ force} = 0$
Hence, angular momentum will be conserved about point N also.

12. **(A) – (r, s); (B) – (q, s); (C) – (p, t); (D) – (p, s, t)**

SECTION – C

13. **5**

$$1\times\frac{1}{2}\times10 + 1\times80 + 1\times1\times T_{eq} = 0.1\times\frac{1}{2}\times100 + 0.1\times540 + 0.1\times1\left(100 - T_{eq}\right)$$

$$T_{eq} = \frac{290}{11}K = \frac{58}{11}\times5$$

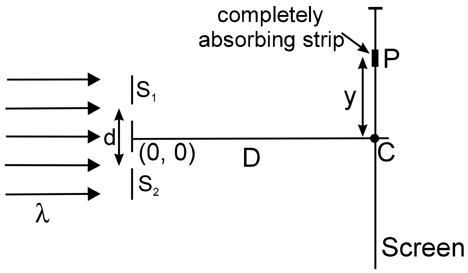
14. **5**

$$F = \sum\eta A\frac{dv}{dr} = 0.5\times0.75\left[\frac{0.5}{10\times10^{-3}} + \frac{0.5}{15\times10^{-3}}\right] = 31.25$$

15. **1**

Let I_0 be the intensity at P due to individual slits S_1 or S_2.
When waves due to both the sources superpose at P, the net intensity at P is $I = 4I_0\cos^2\frac{\pi y}{\beta}$, where $\beta = \frac{\lambda D}{d}$
Since force on strip at P is twice due to individual source
Hence $I = 2\ I_0$

$$\therefore \cos^2\frac{\pi y}{\beta} = \frac{1}{2} \text{ or } \frac{\pi y}{\beta} = \frac{\pi}{4} \text{ or } y = \frac{\beta}{4} = \frac{\lambda D}{4d}$$



16. **3**

Due to the heating pressure inside is not changed. Let inside pressure be ρ. Then for equilibrium of the system:

$$P\left(A_1 - A_2\right) = P_0\left(A_1 - A_2\right) + \left(m_1 + m_2\right)g$$

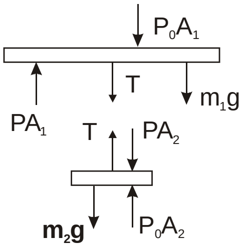
$$\Rightarrow P\Delta V = \left(P_0\Delta A + mg\right)L$$

L is displacement of the piston.

$$P.\Delta V = nR\Delta T$$

$$\Delta T = \frac{P\Delta V}{nR} = \frac{\left(P_0\Delta V + mg\right)L}{nR}$$

$$= \frac{\left(10^5P_a\times10^{-3}m^2 + 5\times10\right)\left(50\times10^{-2}\right)}{1\times R} = \frac{75}{R}\ K$$



17. **7**

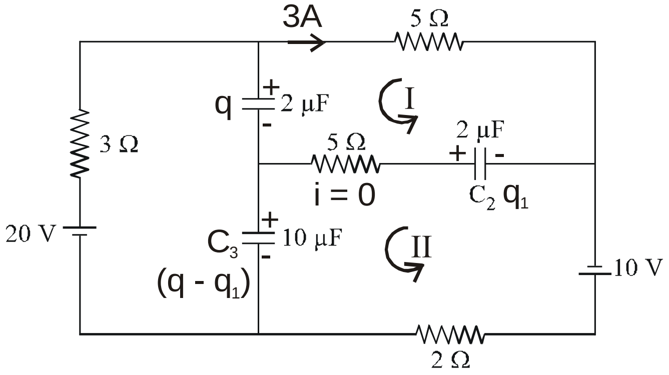
$$mgH_B = \frac{1}{2}mv^2$$

$$mgH_S = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = \frac{1}{2}mv^2 + \frac{1}{2}\times\frac{1}{2}mr^2\omega^2 = \frac{1}{2}\times\frac{7}{5}mv^2$$

$$\frac{H_S}{H_B} = \frac{7}{5} \Rightarrow \frac{5H_S}{H_B} = 7$$

18. **3**

During the steady state the capacitors are fully charged and will behave like open circuit. So the current will flow outer loop only. The current in the outer loop will be $= \frac{30}{10}$ = 3 Amp. in clockwise direction. Charge distribution on the plates of capacitors are as shown in figure.



Applying KVL in loop – I

$$\frac{q}{2} + \frac{q_1}{2} - 15 = 0 \Rightarrow q + q_1 = 30 \quad \text{..... (1)}$$

Applying KVL in loop – II

$$\frac{q - q_1}{10} - 6 + 10 - \frac{q_1}{2} = 0 \quad \text{........ (2)}$$

On solving equation (1) and (2) we get $q_1 = 10\ \mu C$

19. **6**

Potential difference across wire AB = 5 V

$\therefore$ p.d. across 40 cm of this wire = $\frac{5}{100}\times 40$ = 2 V

$\therefore$ p.d. across 20 cm of wire CD = 2 V

$\therefore$ p.d. across wire CD = $\frac{2}{20}\times 80$ = 8 V

p.d. across $2\,\Omega$ resistor = 2 x 2 = 4 V

$\therefore$ emf of the cell = 12 V

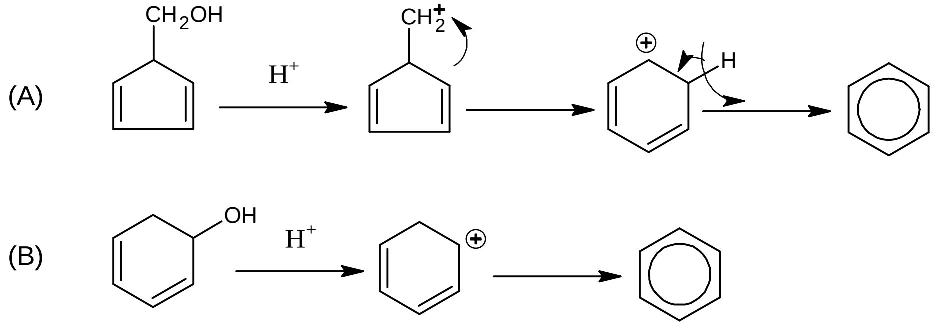
20. **4**

$$\lambda = \lambda_1 + \lambda_2 \Rightarrow \frac{1}{t} = \frac{1}{t_1} + \frac{1}{t_2} \Rightarrow \frac{3}{4} = \frac{1}{2} + \frac{1}{t_2} \Rightarrow t_2 = 4 \text{ years}$$

Chemistry PART – II

SECTION – A

21. **A, B**



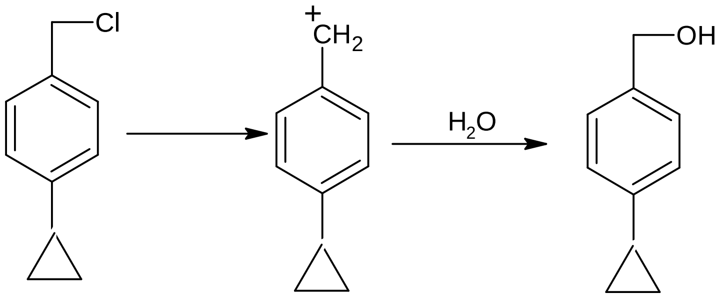
22. **A, B, C**
Alcohols that can form stable carbocation.

23. **A, C, D**
(A) $SOCl_2$ gives retention in configuration
(B) Hoffmann product
(C) Hoffmann product
(D) E_1 CB

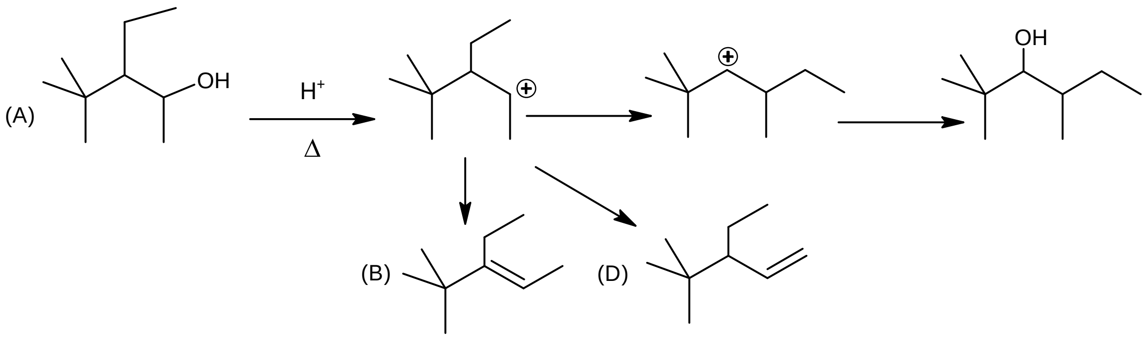
24. **B, C**
(A) Alkene should form
(B) More substituted product
(C) less substituted product
(D) More substituted product

25. **A, D**
(A) Most stable cation
(D) More substituted alkene final product.

26. **B**

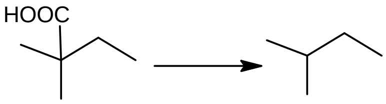


27. **A, B, D**

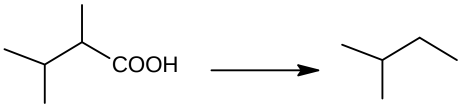


28. **A, B, C**

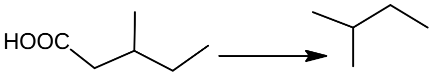
(A)



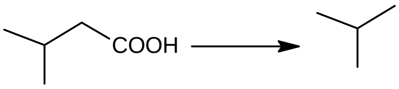
(B)



(C)



(D)



29. **A, B, C**

$NaHCO_3 \xrightarrow{H^+} CO_2$

$Na_2CO_3 \xrightarrow{H^+} CO_2$

$Na_2SO_3 \xrightarrow{H^+} SO_2$

30. **A, C**
Fact.

SECTION – B

31. **(A) – (q); (B) – (p, r, s); (C) – (q); (D) – (s)**
Fact

32. **(A) – (s); (B) – (q); (C) – (r); (D) – (t)**
A - Ea is significant & intermediate is also stable.
B – The Ea of IInd step is more than first step.
C - Ea of IInd step is very small so intermediate will convert into product immediately.
D – There are three TS so it must be three step reaction.

SECTION – C

33. **5**
Unit cell is fcc with half of the tertreahedical voids are occupied by C – atoms hence effective no is $=1+2\times\frac{1}{8}=\frac{5}{4}$

34. **4**

$$SO_2Cl_2 + H_2O \longrightarrow H_2SO_4 + 2HCl \xrightarrow{4NaOH} Na_2SO_4 + 2NaCl$$

35. **4**

CNS, CN, CNO, NO_2

36. **5**

Present as Fe^+

37. **5**

$$\begin{array}{lll} N_2 + & 3H_2 \longrightarrow & 2NH_3 \\ 1 & a & 0 \\ 0 & a-3 & 2 \end{array}$$

$$\frac{2}{a-1} = \frac{1}{2}$$
$$4 = a - 1$$
$$a = 5$$

38. **6**

$i = 1.25$

Original mole fraction $= \frac{1}{n} = \frac{1}{1+(n-1)} = \frac{1.25}{1.25+(n-1)} = \frac{1}{5} \Rightarrow n = 6$

39. **8**

$$MnO_2 + 4HCl \longrightarrow MnCl_2 + Cl_2 + 2H_2O$$

100 gm sol contains 4 gm HCl

$\frac{100}{1.2}$ ml sol contains 4 gm HCl

$$nCl_2 = \frac{1.8}{22.4} = 0.0805$$
$$W_{MnO_2} = 0.0805 \times 87 = 8 \text{ gm}$$

40. **6**

In colemanite every boron carry one OH groups as in borane.

Mathematics PART – III

SECTION – A

41. **B, D**

$f(x_1+x_2)+f(x_1-x_2)=2f(x_1).f(x_2)\forall x_1,x_2$

on putting $x_1=0, x_2=0$ in above equation $f(0)+f(0)=2(f(0))^2$

$f(0)=1$

on putting $x_1=0, x_2=x_1$ in eqation (i) we get $f(x_1)+f(-x_1)=2f(0)f(x_1)$

$f(x_1)=f(-x_1)$ ....(ii)

$f(5)=f(-5)$

Differentiating equation (ii) w.r.t x_1 we get $f'(x_1)+f'(-x_1)=0 \Rightarrow f'(5)+f'(-5)=0$

42. **A, C**

$$\frac{a_n}{a_{n-1}}=\frac{a_{n-1}}{a_{n-2}}$$

Here a_1, a_2, a_3............are in G.P

Let $a_2=x$ then for n = 3

$$\frac{a_3}{a_2}=\frac{a_2}{a_1} \Rightarrow a_2^2=a_1a_3 \Rightarrow a_3=\frac{x^2}{2}$$

$\therefore$ G.P is 2, x, $\frac{x^2}{2}, \frac{x^3}{4}$,.........

Common ratio r = $\frac{x}{2}$

Given $\frac{x^4}{8}\le 162 \Rightarrow x^4 \le 1296 \Rightarrow x\le 6$

Also, x & $\frac{x^4}{8}$ are integers

so, if x is even, then only $\frac{x^4}{8}$ will be an integer

Hence, the possible values of x are 4 & 6, because $x\ne 2$ as terms are distinct hence possible values of $a_5=\frac{x^4}{8}$ are $\frac{4^4}{8}$ & $\frac{6^4}{8}$.

43. **A, C**

$$\frac{d}{dx}f_n(x)=\frac{d}{dx}\left\{e^{f_{n-1}(x)}\right\}$$

$$=e^{f_{n-1}(x)}\frac{d}{dx}f_{n-1}(x)$$

$$=f_n(x)\frac{d}{dx}(f_{n-1}(x))$$

$$= f_n(x)\frac{d}{dx}\left(e^{f_{n-2}(x)}\right)$$

$$= f_n(x)e^{f_{n-2}(x)}\frac{d}{dx}f_{n-2}(x)$$

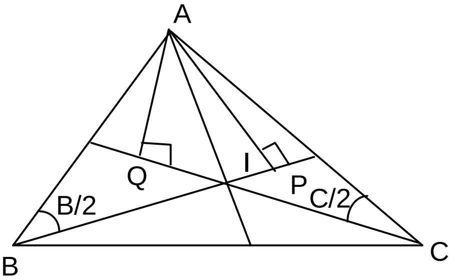
$$= f_n(x)f_{n-1}(x)\frac{d}{dx}f_{n-2}(x)$$

$$= f_n(x)f_{n-1}(x)......f_2(x)\frac{d}{dx}f_1(x)$$

$$= f_n(x)f_{n-1}(x).........f_2(x)e^{f_o(x)}\frac{d}{dx}f_o(x)$$

44. **A, B, D**

In ΔAPB, we have AP = AB sin B/2



In ΔAIB, we have $\frac{BI}{AB} = \frac{\sin(A/2)}{\cos(C/2)}$

$$\Rightarrow \frac{AP}{BI} = \frac{\sin B/2 \cos C/2}{\sin A/2}$$

Similarly, $\frac{AQ}{CI} = \frac{\sin C/2 \cos B/2}{\sin A/2}$

Now, $\frac{AP}{BI} + \frac{AQ}{CI} = \frac{\sin\left(\frac{B+C}{2}\right)}{\sin A/2} = \cot(A/2)$

$\cot(A/2) = \sqrt{3}, \angle A = 60^o$

45. **A, D**

$\hat{u}.\hat{v} + \hat{u}.\hat{w} = \frac{1}{2}$ ....(ii) (taking dot product with $\hat{u}, \hat{v}$ & $\hat{a}$)

$\hat{u}.\hat{v} + \hat{v}.\hat{w} = \frac{3}{4}$ ....(iii)

$\hat{a}.\hat{w} = \frac{3}{4}$ ....(iv)

Again taking dot product with $\hat{w}$, we get $\hat{u}.\hat{w}$ + $\hat{v}.\hat{w}$ + $|\hat{w}|^2 = \hat{a}.\hat{w}$

$\hat{u}.\hat{w} + \hat{u}.\hat{w} + 1 = \frac{3}{4}$

$\hat{u}.\hat{w} + \hat{u}.\hat{w} = \frac{-1}{4}$ ....(v)

on. adding (ii),(iii),(v)

$\hat{u}.\hat{v} + \hat{v}.\hat{w} + \hat{u}.\hat{w} = \frac{1}{2}$

on subtrating equation (ii)from(iv)

$\hat{v}.\hat{w} = 0$

46. **A, B, D**

$$I_1 = \int_1^e x\left(\frac{1+x}{x}\right)(x + \ln x)^{100}dx$$

$$= \frac{e(e+1)^{101}-1}{101} - \frac{1}{101}\int_1^e (x+\ln x)^{101}\,dx$$

$$I_2 = \frac{1}{e}\int_1^e (t+\ln t)\,dt \text{ on taking e sin x = t}$$

$$\Rightarrow I_1 + \frac{eI_2}{101} = \frac{e(e+1)^{101}-1}{101} \Rightarrow K = 1$$

47. **A, B**

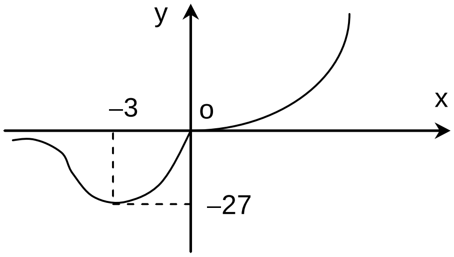
$$y = x^3e^{x+3} = -k$$

$$y = x^3e^{x+3}$$

$$\frac{dy}{dx} = e^{x+3}\left(3x^2 + x^3\right) = 0$$

$$\Rightarrow x = 0, x = -3$$

$$\text{at } x = -3, y = -27$$



For 2 distinct real roots, $k \in (0, 27)$

So, prime value of k will be

$2, 3, 5, 7, 11, 13, 17, 19, 23 = 9$

48. **B, C**

Let $2^{\frac{\pi}{\cos^{-1}x}} = t \Rightarrow t \ge 2$

$\therefore$ equation becomes $t^2 - \left(a + \frac{1}{2}\right)t - a^2 = 0$

has one root 2 or greater than 2 & other root less than 2 $\Rightarrow f(2) \le 0$

$$\Rightarrow 4 - \left(a + \frac{1}{2}\right):2 - a^2 \le 0$$

$$a^2 + 2a - 3 \ge 0$$

$$(a+3)(a-1) \ge 0$$

$$\Rightarrow a \le -3 \text{ or } a \ge 1$$

49. **A, B**

Given circle touches externally at real axis So, the centre C of the described circles lies on real axis which has radius r then $CC_1 = CC_2 = 1 + r$

$$C_1C_3 = C_2C_3 = 1$$

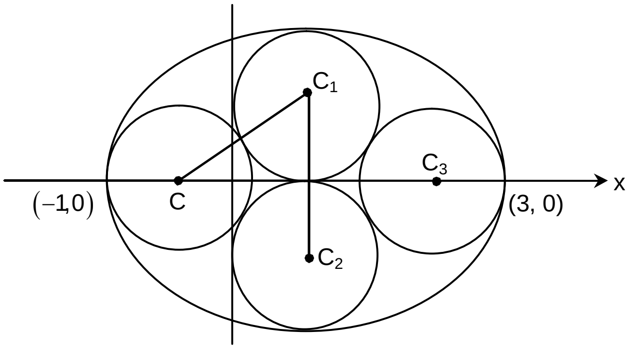
$$CC_3 = 2 - r$$

$$\therefore (1+r)^2 = 1^2 + (2-r)^2$$

$$\Rightarrow r = 2/3$$

$\therefore$ Centre of described circle is

$$-1 + \frac{2}{3} = \frac{-1}{3} \text{ or } 3 - \frac{2}{3} = \frac{7}{3}$$



$\therefore$ Required equation of circle are

$$\left|z+\frac{1}{3}\right|=\frac{2}{3}\ \&\ \left|z-\frac{7}{3}\right|=\frac{2}{3}$$

50. **A, B, C**

$a=(\pi-3)+(\pi-4)+(5-2\pi)=-2$

$f(-2)=f(2)\Rightarrow f(x)$ is many one $\Rightarrow$ non invertible

Let t = $x^2+|x|, t\in[0,\infty)$

$f(x)\in[1,\infty)$

$\Rightarrow b=1\ \&\ a+b=-1$

$$g(x)=\left[(1+\cos 2x)^2-2\cos x-\frac{1}{2}\left(2\cos^2 2x-1\right)-x^7\right]^{1/7}$$

$$g(x)=\left(\frac{3}{2}-x^7\right)^{1/7}$$

$$g(g(x))=\left[\frac{3}{2}-\left(\frac{3}{2}-x^7\right)\right]^{1/7}$$

$$f(g(g(b)))=f(b)=e^2$$

SECTION – B

51. **(A) – (q); (B) – (p); (C) – (r); (D) – (s)**

$A(2,2,-1), B(3,1,2) C(1,1,1)$

$\overline{AB}=\hat{i}-\hat{j}+3\hat{k}$

$\overline{AC}=-\hat{i}-\hat{j}+2\hat{k}$

$\overline{BC}=-2\hat{i}-\hat{k}$

$\overline{AC}\perp\overline{BC}$

$\therefore$ D is $(4,2,0)$

equation of base is $x-5y-2z+6=0$

Let E be foot of $\perp$ drawn from P to the base

Equation of EP is $\dfrac{x-y}{1}=\dfrac{y+\frac{26}{3}}{-5}=\dfrac{z+\frac{10}{3}}{-2}=D$

Let coordinates of E be

$\left(4+D,\dfrac{-26}{3}-5D,\dfrac{-10}{3}-2D\right)$ since it lies on base

$\therefore 4+D-5\left(\dfrac{-26}{3}-5D\right)-2\left(\dfrac{-10}{3}-2D\right)+6=0$ i.e $D=-2$

Coordinates of E are $\left(2,\dfrac{4}{3},\dfrac{2}{3}\right)$

$\left|\overline{EP}\right|=\sqrt{120}$

Volume $= \frac{1}{3}\left|\overline{AC}\times\overline{BC}\right|.\ EP = 20$ cubic units

52. **(A) – (q), (B) – (p), (C) – (p), (D) - (t)**

$(A) 1-\tan^2 x = \frac{2\tan x}{\tan 2x}$

$$\frac{1-\tan^2 2^k\pi}{2^n+1} = \frac{2\tan\frac{2^k\pi}{2^n+1}}{\tan\frac{2^{k+1}\pi}{2^n+1}}$$

On taking product we get

$(B) 1+2\cos 2a_k = 1+2\left(1-2\sin^2 a_k\right)$

$= 3-4\sin^2 a_k$

$= \frac{\sin 3a_k}{\sin a_k}$

where $a_k = \frac{3^k\pi}{3^n+1}$

$$\frac{\sin 3a_n}{\sin a_1} = \frac{\sin\frac{3^{n+1}\pi}{3^n+1}}{\sin\frac{3\pi}{3^n+1}}$$

$\therefore$ The numeration of last fraction is equal to $\sin\left(3\pi - \frac{3\pi}{3^n+1}\right) = \sin\frac{3\pi}{3^n+1}$

$\therefore$ Ans is 1

$(C) 1-\cos a = \frac{1-4\cos^2 a}{1+2\cos a} = \frac{1-2(1+\cos 2a)}{1+2\cos a}$

$= -\left(\frac{1+2\cos 2a}{1+2\cos a}\right)$

$\therefore$ the product becomes $(-1)^n\frac{1+2\cos x}{1+2\cos\frac{x}{2^n}}$

$(D)\ \tan x = \frac{1}{\tan x} - \frac{1-\tan^2 x}{\tan x} = \frac{1}{\tan x} - \frac{2}{\tan 2x} = \cot x - 2\cot 2x$

$\Rightarrow \frac{1}{2^n}\tan\frac{a}{2^n} = \frac{1}{2^n}\cot\frac{a}{2^n} - \frac{1}{2^{n-1}}\cot\frac{a}{2^{n-1}}$

$\Rightarrow$ on adding $\lim\limits_{n\to\infty}\frac{1}{2^n}\cot\frac{a}{2^n} - \cot a$

$= \frac{1}{a} - \cot a$

$a = 2$

$\Rightarrow$ Ans is $\frac{1}{2}$.

SECTION – C

53. **3**

A_i = no. of heads obtained by A when tosses two coins
B_i = no. of heads obtained by B when tosses 3 coins

$$P(E)=P\{(A_1\cap B_0)\cup(A_2\cap B_2)\cup(A_2\cap B_1)\}$$

$$=2C_1\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)^3+\left(\frac{1}{2}\right)^2\left(\frac{1}{2}\right)^3+\left(\frac{1}{2}\right)^2 3C_1\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)^2$$

$$=\frac{2}{32}+\frac{1}{32}+\frac{3}{32}=\frac{3}{16}$$

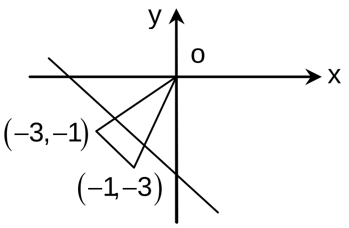
F = {A & B tie a particular game} then $P(F)=P\{(A_0\cap B_0)\cup(A_1\cap B_1)\cup(A_2\cap B_2)\}=\frac{5}{16}$

$P(\text{A finally wins the game})$

$$=P(\text{E or FE or FFE or ....})=\frac{3}{11}$$

54. **8**

Slope of BC = - 1 slope of line parallel to BC $=-\frac{a}{b}$



$\therefore \frac{-a}{b}=-1$

$\Rightarrow a=b$

Distance of line $ax+by+2=0$ from the origin

$$=\frac{2}{\sqrt{a^2+b^2}}=\frac{1}{\sqrt{2}}\Rightarrow a^2+b^2=8$$

$\therefore a^2=b^2=4$

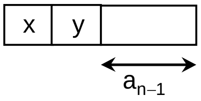
$\therefore a=b=2$

55. **3**

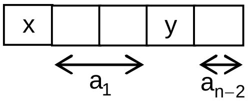
Total arrangements (holding 2 types of coins) $=\frac{8!}{4!4!}=70$

Let a_n denote the ways of arranging 2 n children out of which n have one Rs.1 coin & rest have Rs.2 coin such that no one waits for change at the counter. Let x denote the child having Rs.1 coins & y denote child having Rs.2 coin in hand.

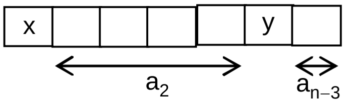
Case - 1



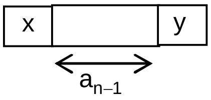
Case - 2



Case - 3



Case - n



So, $a_n=a_{n-1}+a_1a_{n-2}+a_2a_{n-3}+...........+a_{n-1}$

$a_1=1$

$a_2=2$

$a_3=2+1+2=5$

$a_4=14$

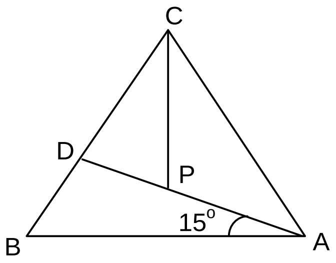
$\therefore$ required probability $(K)= \frac{14}{70}=\frac{1}{5}\Rightarrow 15K=3$

56. **3**

F in segment BC choose point D on segment BC such that $2\ |BD|=|CD|$ & construct ray BP such that $\angle PBC=45^o$ & let A be point on ray BP that moves from B in the direction of the ray. Applying sine rule in ΔACD & ΔABC Let $\alpha=\angle CAD$ & $\angle CDA=\angle CBA+\angle DAB=60^o$ we have

$\frac{CD}{\sin\alpha}=\frac{CA}{\sin 60^o}$ & $\frac{BC}{\sin(\alpha+15^o)}=\frac{CA}{\sin 45^o}$ Dividing the first equation by second equation gives

$$\frac{|CD|\sin(\alpha+15^o)}{|BC|\sin\alpha}=\frac{\sin 45^o}{\sin 60^o}$$



$$\left|\frac{CD}{BC}\right|=\frac{2}{3}=\left(\frac{\sin 45^o}{\sin 60^o}\right)^2$$

$$\left(\frac{\sin 45^o}{\sin 60^o}\right)^2=\frac{\sin\alpha}{\sin(\alpha+15^o)}.\frac{\sin 45^o}{\sin 60^o}$$

Clearly $\alpha=45^o$ satisfies the equation $\angle ABC=45^o, \angle CAB=60^o$ & $\angle ACB=75^o$

57. **2**

$$s=\sin 2x+\sin 4x+...........+\sin 2nx$$
$$=\frac{\sin nx-\sin(n+1)x}{\sin x}$$
$$c=\cos 2x+\cos 4x+...........+\cos 2nx$$
$$=\frac{\sin nx\ \ \cos(n+1)x}{\sin x}$$
$$\left(\frac{\sin^2 nx}{\sin^2 x}\right)^2=\left(\frac{\sin nx\sin(n+1)x}{\sin x}\right)^2+\left(\frac{\sin nx\cos(n+1)x}{\sin x}\right)^2=s^2+c^2$$

On the other hand $s^2+c^2=(\sin 2x+\sin 4x+..........\sin 2nx)^2+(\cos 2x+\cos 4x+........+\cos 2nx)^2$

$$=n+\sum_{1\le l\ \ k\le n}(2\sin 2l\ \ x\sin 2kx+2\cos 2l\ \ x\cos 2kx)$$
$$=n+2\sum_{1\le l\ <k\le n}\cos 2(k-l\ )x$$
$$\Rightarrow a_{l\ ,k}=2$$

58. **4**

By Schwartz's inequality $1=\left|\int_0^1 f(x)dx\right|=\left|\int_0^1\frac{f(x)\sqrt{1+x^2dx}}{\sqrt{1+x^2}}\right|$

$$1\le\sqrt{\int_0^1(1+x^2)f^2(x)dx}\sqrt{\int_0^1\frac{dx}{1+x^2}}$$

i.e $1\le\sqrt{\int_0^1(1+x^2)f^2(x)dx}.\frac{\sqrt{\pi}}{2}$

$\therefore$ Required minimum is $\frac{4}{\pi}$ which is attained for $f(x) = \frac{4}{\pi(1+x^2)}$

59. **2**

For $\frac{4}{\pi}\sin^{-1}(a^8+1) + 2\cos^{-1}(a^{12}+1) - \sec^{-1}(a^2+1)$ to be defined a = 0

$\therefore 3x - 4y = \frac{4}{\pi}.\frac{\pi}{2} + 2.0 - 0 = 2$

$3x - 4y = 2$

$6x - 5y = 7$

$$d = \left|\frac{\frac{7}{2} - 2}{5}\right| = \frac{3}{10}$$

$$r = \frac{3}{20}$$

$$l = r\theta = \frac{3}{20} \times \theta = 2$$

60. **1**

$t^2 f(x) - 2tf'(x) + f''(x) = 0$ has equal roots

$D = 0 \Rightarrow \frac{f''(x)}{f'(x)} = \frac{f'(x)}{f(x)}$

$\Rightarrow \ln(f'(x)) = \ln(f(x)) - \ln C$

$\Rightarrow f(x) = Cf'(x)$

$\Rightarrow f(0) = C.f'(0)$

$\Rightarrow C = \frac{1}{2}$

$\therefore \frac{f'(x)}{f(x)} = 2 \Rightarrow \ln f(x) = 2x + k$

$\Rightarrow \ln(f(0)) = k \Rightarrow k = 0$

$\Rightarrow \ln(f(x)) = 2x \Rightarrow f(x) = e^{2x}$

$t^2 e^{2x} - 4te^{2x} + 4e^{2x} = 0$

$$\lim_{x\to 0}\left(\frac{f(x)-1}{x} - \frac{t}{2}\right) = \lim_{x\to 0}\left(\frac{e^{2x}-1}{2x} \times 2 - \frac{2}{2}\right) = 1$$

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

FULL TEST – IV

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 240**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C.**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section–A (01 – 08, 21 – 28, 41 – 48)** contains 24 multiple choice questions which have one or more correct answer. Each question carries **+4 marks** for correct answer and **–2 marks** for wrong answer.

   Section–A (09 – 12, 29 – 32, 49 – 52) contains 12 paragraphs with each having 2 questions with one correct answer. Each question carries **+4 marks** for correct answer and **–2 marks** for wrong answer.

2. **Section–C (13 – 20, 33 – 40, 53 – 60)** contains 24 Numerical based questions with answers as numerical value from 0 to 9 and each question carries +4 marks for correct answer. There is no negative marking.

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	g = 10 m/s^2
Planck constant	h = 6.6 $\times 10^{-34}$ J-s
Charge of electron	e = 1.6 $\times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N-m^2
Density of water	$\rho_{water} = 10^3$ kg/m^3
Atmospheric pressure	$P_a = 10^5$ N/m^2
Gas constant	R = 8.314 J K^{-1} mol^{-1}

CHEMISTRY

Gas Constant	R	=	8.314 J K^{-1} mol^{-1}
		=	0.0821 Lit atm K^{-1} mol^{-1}
		=	1.987 $\approx$ 2 Cal K^{-1} mol^{-1}
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

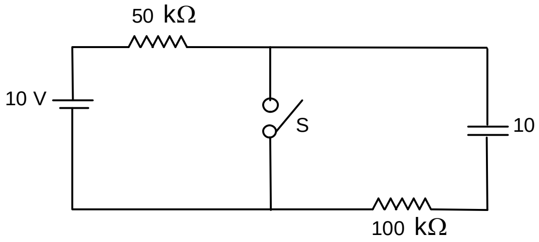
One OR More Than One Choice Type

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

1. The equation of a transverse wave travelling along a string is given by $y = 0.4\sin\left[\pi\left(0.5x - 200t\right)\right]$ where y and x are measured in cm and t in seconds. Suppose that you clamp the string at two points L cm apart and you observe a standing wave of the same wavelength as above transverse wave. For what values of L less than 10 cm is this possible?

(A) 2 cm
(B) 4 cm
(C) 9 cm
(D) 8 cm

2. In the circuit shown, the switch S has been closed for a long time. At time t = 0, the switch is opened. It remains open for a long time T, after which it is closed again.



(A) voltage drop across 100 kΩ resister is $10e^{-t/1.5}$V for t < T

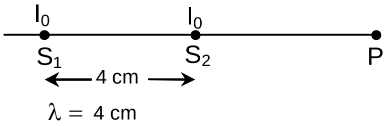
(B) voltage drop across 100 kΩ resister is $\dfrac{20\ e^{-t/1.5}}{3}$ V for t < T

(C) voltage drop across 100 kΩ resister is $100\left(e^{T-t} - e^{(T-3t)/3}\right)$ for t > T

(D) The time constant of the circuit is 1.5 sec for t > T

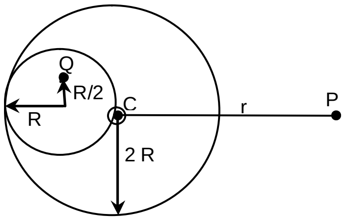
Space for Rough work

3. Two coherent sources S_1 and S_2 are situated as shown in figure. Here S_1 is fixed but S_2 is performing SHM with amplitude 2 cm. Initially S_2 is at right extreme. At time $t = \frac{\pi}{2\omega}$ (where ω = angular frequency of SHM):



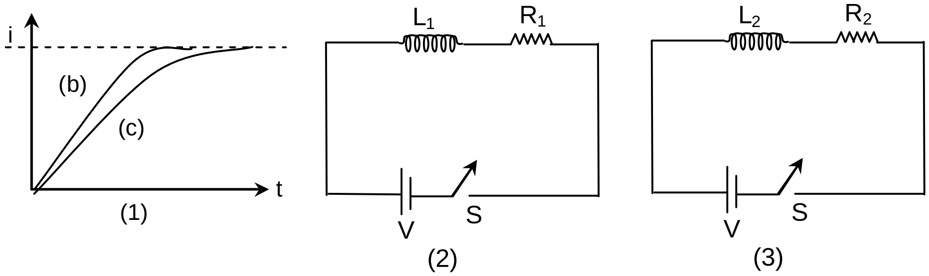
(A) Phase difference between waves produce by S_1 and S_2 at point P is $\frac{\pi}{2}$.
(B) Intensity at point P is $2I_0$.
(C) Intensity at point P is $4I_0$
(D) Intensity at point P is zero

4. There is a conductor with cavity of radius R as shown in figure. A point charge Q is placed at R/2 distance from centre of cavity. A point P is at r distance from centre of conductor. Then,



(A) charge density at inner surface of cavity will be non uniform
(B) charge density at surface of conductor will be uniform
(C) electric field at point P is $\frac{Q}{4\pi\varepsilon_0 r^2}$
(D) force on charge Q is non zero

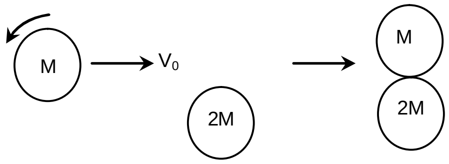
5. Current growth in two L – R circuits (2) and (3) is shown in figure (1) after switch S closed. Then



(A) $R_1 > R_2$
(B) $R_1 = R_2$
(C) $L_1 > L_2$
(D) $L_1 < L_2$

Space for Rough work

6. A uniform disc of mass m and diameter 2 R moves forward towards another uniform disc of mass 2 m & diameter 2 R on a frictionless surface as shown in figure



When the first disc contacts the second, they stick to each other and move as a single object.

(A) the velocity of combined disc after the collision is $\frac{V_0}{3}$.

(B) the angular velocity of combined disc after the collision is $\frac{\omega_0}{3}$.

(C) If $\omega_0 = \frac{8}{3}\frac{V_0}{R}$, the combined disc will not rotate

(D) If combined disc does not rotate, the energy loss is $\frac{19}{9}MV_0^2$.

7. Two strings with linear mass densities $\mu_1 = 0.1$kg/m and $\mu_2 = 0.3$ kg/m are joined seamlessly. They are under tension of 20 N. A travelling wave of triangular shape is moving from lighter to heavier string.
(A) The reflection coefficient at interface is zero
(B) The reflection coefficient at interface is $2-\sqrt{3}$
(C) The transmission coefficient at interface is 1
(D) The transmission coefficient at interface is $\sqrt{3}-1$

8. Consider a piston – cylinder arrangement with spring in its natural length. Due to heat transfer, the gas expands until the piston hits the stop. The mass of piston is 10 kg and area is 78 cm^2. Initial and final specific internal energies are 214 and 337 k J / kg.
(A) Initial pressure of gas is 112 k Pa
(B) Work done by gas on the piston is 56.5 J
(C) Work done by gas on the piston is 100 J
(D) Heat transfer for 0.5 gas is 118 J

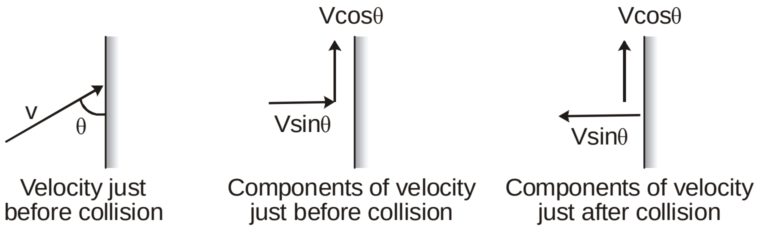
Space for Rough work

Comprehension Type

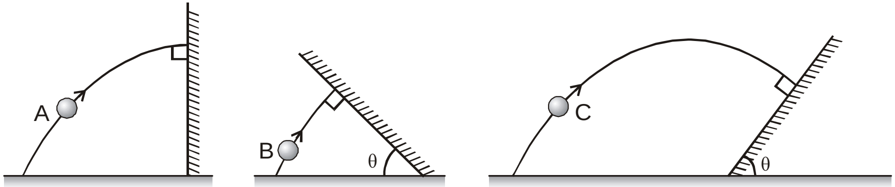
This section contains **2 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct.

Paragraph for Question Nos. 09 and 10

We know how by neglecting the air resistance, the problems of projectile motion can be easily solved and analysed. Now we consider the case of the collision of a ball with a wall. In this case the problem of collision can be simplified by considering the case of elastic collision only. When a ball collides with a wall we can divide its velocity into two components, one perpendicular to the wall and other parallel to the wall. If the collision is elastic then the perpendicular component of velocity of the ball gets reversed with the same magnitude.


v
θ
Velocity just before collision
Vcosθ
Vsinθ
Components of velocity just before collision
Vcosθ
Vsinθ
Components of velocity just after collision

The other parallel component of velocity will remain constant if wall is given smooth.
Now, let us take a problem. Three balls A, B and C are projected from ground with same speed at same angle with the horizontal. The ball A, B and C collide with the wall during their flight in air and all three collide perpendicularly with the wall as shown in figure.



9. If the total time taken by the ball A to fall back on ground is 4 seconds and that by ball B is 2 seconds. Then, the maximum height attained by ball B from ground will be
(A) 15 m
(B) 5 m
(C) 3 m
(D) 25 m

Space for Rough work

10. The vertical component of velocity of balls with which they are projected is
(A) 20 m/s
(B) 10 m/s
(C) $10\sqrt{3}$ m/s
(D) Undeterminable

Paragraph for Question Nos. 11 and 12

We have a disc of negligible thickness and whose surface mass density varies as radial distance from centre as $\sigma = \sigma_0\left(1+\frac{r}{R}\right)$, where R is the radius of the disc. Specific heat of the material of the disc is C. Disc is given an angular velocity ω_0 and placed on a horizontal rough surface such that the plane of the disc is parallel to the surface. Coefficient of friction between disc and surface is μ. The temperature of the disc is T_0.
Answer the following 3 questions on the base of information provided in the above paragraph.

11. Magnitude of angular acceleration of disc is
(A) $\alpha = \frac{7\mu g}{27R}$
(B) $\alpha = \frac{21\mu g}{27R}$
(C) $\alpha = \frac{35\mu g}{27R}$
(D) $\alpha = \frac{42\mu g}{27R}$

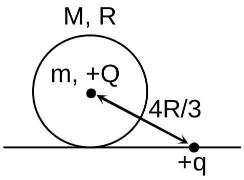
12. If the kinetic energy lost due to the friction between disc and surface is absorbed by the disc the moment heat is generated, by the mass lying at the point where the energy is lost. Assume that there is no radial heat flow in between disc particles. Rate of change in temperature at a point lying at r distance away from centre with time, before disc stops rotating, will be (α - magnitude of angular acceleration of rod)
(A) $\frac{\mu gr}{C}(\omega_0 - \alpha t)$
(B) $\frac{\mu gr}{2C}(\omega_0 - \alpha t)$
(C) $\frac{\mu gr}{3C}(\omega_0 - \alpha t)$
(D) $\frac{\mu gr}{4C}(\omega_0 - \alpha t)$

Space for Rough work

SECTION – C
(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

13. There is a disc of mass M and radius R. A point charge +Q and of mass m is fixed at the centre of the disc. The disc is held on a fixed horizontal rough surface. Another point charged +q is fixed on the surface such that distance between +q and +Q is $\frac{4R}{3}$. Now the disc is set free. If the disc does not loose contact with the ground at the same intent the relation must hold is $M > \eta m$. Find η. (Use $\frac{27Qq}{256\pi\varepsilon_0 R^2} = 3mg$)



14. Two identical containers contain same amount of ideal gas at identical condition. Gas in one container is expanded to 4 times of its volume at constant pressure and gas in another container is expanded to four times of its volume by isothermal process. If W_1 and W_2 be the respective work done, then $\frac{W_1}{W_2} = \frac{\alpha}{\ln 2}$. Find $\frac{2}{3}\alpha$.

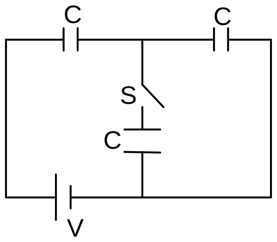
15. A hydrogen atom moving at a speed v_0 absorbs a photon of wavelength 61 nm and stops. Mass of the hydrogen atom is 1.67 x 10^{-27} kg. When calculated v_0 comes out to be $\frac{13}{n}$ m/s. Find n nearly.

16. An inductor coil stores 16 joules of energy and dissipates energy as heat at the rate of 320 W when a current of 2 Amp. is passed through it. When the coil is joined across a battery of emf 20 V and internal resistance 20Ω, the time constant for the circuit is τ. Find 100τ (in seconds).

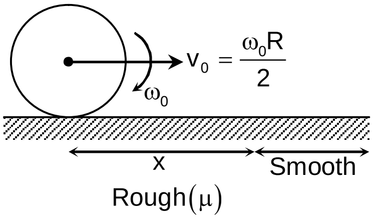
17. ABCDEF is a regular hexagon of side a. At each vertex A, B and C a point charge +q is fixed and D, E, F a point charge –q is fixed. Intensity of electric field at a point lying on the line joining FC at a distance x away from the centre of hexagon (x >>>> a) is found to be $\frac{\sqrt{\alpha}aq}{2\pi\varepsilon_0 x^3}$, where α is an integer. Find α.

Space for Rough work

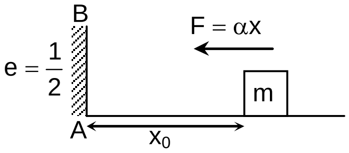
18. Initially switch S is opened and energy stored between the plates of capacitor is E. Now the switch S is closed. Work done by battery after the switch S is closed is W. Find $\frac{2E}{W}$.



19. A uniform disc of mass m and radius R is given a velocity v_0 and angular velocity ω_0 as shown and released of a fixed horizontal surface. Only the x length of the surface is rough. Find minimum value of x (in metres) so that disc starts pure rolling. Use $\frac{\omega_0^2R^2}{72\mu g} = 1\,m$.



20. Consider a hypothetical field in which force acting on a particle varies with its horizontal distance from wall AB is $F = \alpha x$ and always towards wall. Coefficient of restitution for collision between particle and wall is $e = \frac{1}{2}$. Find the maximum force (in N) acting on the particle after 3^{rd} collision. (use αx_0 = 16 N)



Space for Rough work

Chemistry

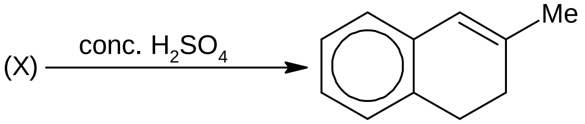
PART – II

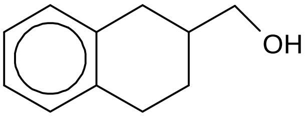
SECTION – A

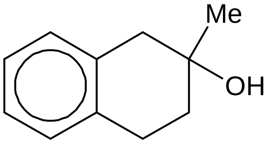
One OR More Than One Choice Type

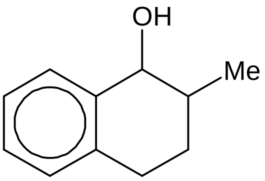
This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

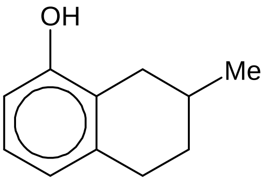
21. In the given reaction, the possible structure of compound (X) is



(A)


(B)


(C)


(D)


22. Which of the following reaction will give an alkyne?

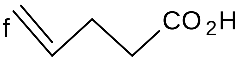
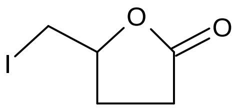
(A) Potassium fumarate $\xrightarrow{\text{Electrolysis}}$

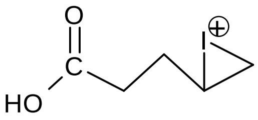
(B) $CH_3CBr_2CHBr_2 \xrightarrow{\text{Zn dust}}$

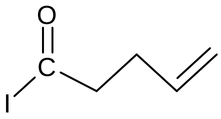
(C) $CH_3CH_2CHBr_2 \xrightarrow{\text{alc.KOH/NaNH}_2/\Delta}$

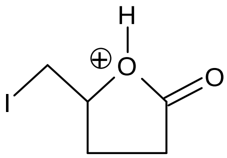
(D) $CH_3CHBrCH_2Br \xrightarrow{\text{NaNH}_2/\Delta}$

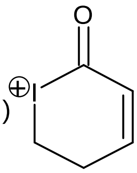
Space for Rough work

23. The iodo lactisation of  with I_2 gives the compound  + HI. The different intermeidates are

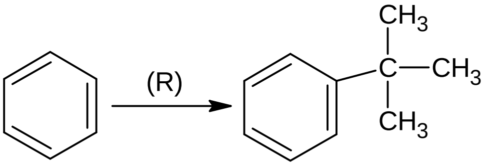
(A) 

(B) 

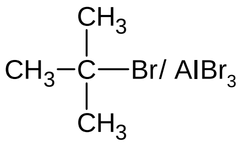
(C) 

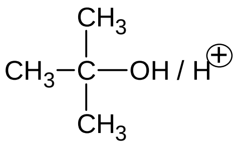
(D) 

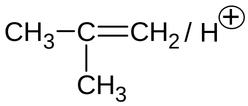
24. For the given reaction

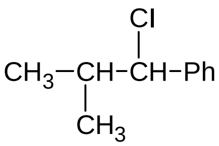


(R) will be

(A) 
$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-Br/\ AlBr_3$

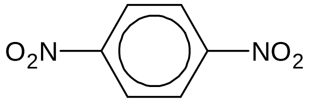
(B) 
$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-OH\ /\ H^{\oplus}$

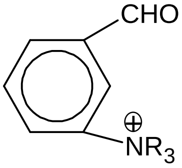
(C) 
$CH_3-\underset{CH_3}{C}=CH_2\ /\ H^{\oplus}$

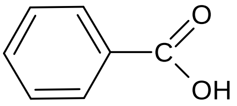
(D) 
$CH_3-\underset{CH_3}{CH}-\overset{Cl}{CH}-Ph$

Space for Rough work

25. Which of the following compound will not give Friedel-Crafts reaction?

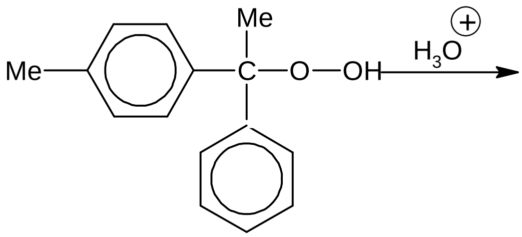
(A) 

(B) 

(C) 

(D) C_5H_5N

26.


P_1+P_2 ; ($P_2+FeCl_3 \longrightarrow$ Violet colour)

$$P_1 + NaOI \to \underset{\text{Yellow}}{P_3 \downarrow} + P_4$$

Correct statement for the above sequence is

(A) P_3 on reaction with Ag gives acetylene

(B) P_4 on reaction with sodalime gives toluene

(C) P_4 on reaction with sodalime gives benzene

(D) P_1 on reaction with 2,4-DNP gives yellow compound

27. The state of hybridization in the anionic Part of solid Cl_2O_6 is

(A) sp^3d^2 (B) sp^3d

(C) sp^3 (D) sp^2

28. In the reaction: $3Br_2 + 6CO_3^{2-} + 3H_2O \to 5Br^- + BrO_3^- + 6HCO_3^-$

(A) Bromine is oxidised and carbonate is reduced

(B) Bromine is oxidised

(C) Bromine is reduced

(D) It is disproportionation reaction or autoredox change

Space for Rough work

Comprehension Type

This section contains **2 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct.

Paragraph for Question Nos. 29 and 30

In iodometric titrations, an oxidizing agent such as $KMnO_4$, $K_2Cr_2O_7$, $CuSO_4$, H_2O_2 is allowed to react in neutral medium or in acidic medium with excess of potassium iodide to liberate free iodine KI+ oxidizing agent → I_2

Free iodine is titrated against standard reducing agent usually with sodium thiosulphate i.e.,

$$K_2Cr_2O_7 + 6KI + 7H_2SO_4 \longrightarrow Cr_2(SO_4)_3 + 4K_2SO_4 + 7H_2O + I_2$$

$$2CuSO_4 + 4KI \longrightarrow Cu_2I_2 + 2K_2SO_4 + I_2$$

$$I_2 + Na_2S_2O_3 \longrightarrow 2NaI + Na_2S_4O_6$$

In iodometric titrations, starch solution is used as an indicator. Starch solution gives blue or violet colour with free iodine. At the end point, blue or violet colour disappears when iodine is completely changed to iodide.

29. What volume of 0.40 M $Na_2S_2O_3$ would be required to reach with I_2 liberated by adding 0.04 mole of KI to 50 mL of 0.20 M $CuSO_4$ solution?

(A) 12.5 mL	(B) 25 mL
(C) 50 mL	(D) 2.5 mL

30. A 1.1 g sample of copper ore is dissolved and Cu^{2+}(aq.) is treated with KI. I_2 liberated required 12.12 mL of 0.1 M $Na_2S_2O_3$ solution for titration. The % Cu in the ore in the ore is:

(A) 2.5%	(B) 7%
(C) 5.8%	(D) 4.2%

Space for Rough work

Paragraph for Question Nos. 31 and 32

Suppose 50 bacteria are placed in a flask containing nutrients for the bacteria so that they can multiply. A study at 35^{o}C gave the following results:

Time (minutes)	0	15	30	45	60
Number of bacteria	100	200	400	800	1600

31. The rate of the reaction initially is:
(A) 4.62 bacterias per minute
(B) 23.1 bacterias per minute
(C) 23.1 bacterias per sec
(D) 0.231 bacterias per sec

32. The $t_{1/2}$ for the reaction is:
(A) 1.5 sec
(B) 1.5 min
(C) 150 min
(D) 15 min

SECTION – C
(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

33. The maximum number of atoms that may lie in the same plane in $(CH_3)_2C = SF_2(CH_3)_2$ is……

34. H_2S can be dried by how many of the following reagents? Anhydrous $CaCl_2$ conc. H_2SO_4, P_2O_3, KOH solution, Na_2CO_3 solution.

35. Ferrous oxide (FeO) crystal has a cubic structure and each edge of the unit cell is 5.0 Å. Taking density of the oxide as 4.0 g cm^{-3}. The number of Fe^{2+} and O^{2-} ions present in each unit cell is:

36. A closed vessel with rigid walls contains 1 mole of $^{238}_{92}U$ and 1 mole of air at 298 K. Considering complete decay of $^{238}_{92}U$ to $^{206}_{82}Pb$, the ratio of the final pressure to initial pressure the system at 298 K is:

Space for Rough work

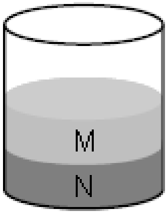
37. For a saturated solution of AgCl at 25ºC, specific conductance is 3.41×10^{-6} ohm^{-1} cm^{-1} and that of water used for preparing the solution is $1.60 \times 10^{-6} ohm^{-1} cm^{-1}$. If $\lambda^{\infty}_{AgCl} = 138.3$ $ohm^{-1} cm^2 eq^{-1}$, the K_{sp} of AgCl is $0.17 \times 10^{-x} M^2$. The value of x is:

38. The half-cell potential of a half cell $A^{(x+n)+}, A^{x+}$ | Pt were found to be as follows:

% of reduced form	24.4	48.8
Half-cell potential(V)	0.101	0.115

The value of n is:

39. Two liquids 'A' (molecular mass = 20) and 'B' (molecular mass = 40) are partially miscible. When 1 mol of A, 3 mol of B are shaken together and allowed to settle, two layer 'M' and 'N' are formed as shown in diagram.



Layer 'M' contains 0.2 mole fraction of 'A' and layer 'N' contains 0.6 mole fraction of A. Calculate the ratio of masses of layer M to layer N.

40. In an organic compound of molar mass greater than 100 g/mol containing only C, H & N the mass % of C is six times the mass % of H, while the sum of mass % of C & H is 1.5 times the mass % of N. What is $\frac{\text{least molecular mass}}{28}$ of compound?

Space for Rough work

Mathematics PART – III

SECTION – A
One OR More Than One Choice Type

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct.

41. If the sides a, b & c of ΔABC is such that $\frac{a}{1+\alpha^2\beta^2}=\frac{b}{\alpha^2+\beta^2}=\frac{c}{\left(1-\alpha^2\right)\left(1+\beta^2\right)}$ then

(A) $A=2\tan^{-1}\left(\alpha/\beta\right)$ (B) $\beta=2\tan^{-1}\left(\alpha\beta\right)$

(C) area of $\Delta ABC=\frac{\alpha\beta ab}{\alpha^2+\beta^2}$ (D) area of $\Delta ABC=\frac{\alpha\beta bc}{\alpha^2+\beta^2}$

42. If A_i is the area bounded by $\left|x-a_i\right|+\left|y\right|=b_i,\ i\in N,$ where $a_{i+1}=a_i+\frac{3}{2}b_i$ & $b_{i+1}=\frac{b_i}{2}, a_1=0, b_1=32,$ then

(A) $A_3=128$ (B) $A_3=256$

(C) $\lim\limits_{n\to\infty}\sum\limits_{i=1}^{n}A_i=\frac{8}{3}(32)^2$ (D) $\lim\limits_{n\to\infty}\sum\limits_{i=1}^{n}A_i=\frac{4}{3}(16)^2$

43. $\bar{a}$ & $\bar{b}$ be two vectors such that $|a|=1, |b|=4$ & $\bar{a}.\bar{b}=2.$ If $\bar{c}=\left(2\bar{a}\times\bar{b}\right)-3\bar{b},$ then which of the following is/are correct?

(A) $\bar{b}.\bar{c}=48$ (B) $\bar{b}.\bar{c}=-48$

(C) Angle between $\bar{b}$ & $\bar{c}$ is $\frac{5\pi}{6}$ (D) Angle between $\bar{b}$ & $\bar{c}$ is $\frac{\pi}{6}$.

44. $f(x)$ is defined for $x\geq 0$ & has a continuous derivative. It satisfies $f(0)=1,\ f'(0)=0$ & $\left(1+f(x)\right)f''(x)=1+x$. The values f(1) can't take is/are

(A) 2 (B) 1.75
(C) 1.5 (D) 1.35

Space for Rough work

45. If $\bar{a}$ & $\bar{b}$ are any two unit vectors then possible integers in the range of $\frac{3\left|\bar{a}+\bar{b}\right|}{2}+2\left|\bar{a}-\bar{b}\right|$ is

(A) 2
(B) 3
(C) 4
(D) 5

46. If $f(k)=\sum_{r=1}^{k}\frac{1}{r}$ and $\sum_{r=1}^{2017}f(r)=a\,f(b)+c$ then

(A) b = c
(B) $a-b=1$
(C) $b+c=0$
(D) $a+c=0$

47. If $\alpha(\theta)\in R\ \&\ \beta(\theta),\theta\in R-\left\{2n\pi-\frac{\pi}{2},n\in I\right\}$ are functions satisfying

$(1+x)\sin^2\theta-\left(1+x^2\right)\sin\theta+\left(x-x^2\right)=0$ then which of the following is/are correct?

(A) $\lim_{\theta\to0^+}\left\{(\alpha(\theta))^{\frac{1}{\sin\theta}}+(\beta(\theta))^{\frac{1}{\sin\theta}}\right\}=\frac{1}{e^2}$
(B) $\ln(\beta(\theta))$ is an odd fn
(C) $\lim_{\theta\to0}\left(\sum_{r=1}^{n}r^{\frac{1}{\alpha^2(\theta)}}\right)^{\alpha^2(\theta)}=n,n\in N,h\geq2$
(D) $\lim_{\theta\to\pi/2}\frac{\alpha(\theta)-(\alpha(\theta))^{\alpha(\theta)}}{1-\alpha(\theta)+\ln(\alpha(\theta))}=2$

48. The product of 13×5 matrix & 5×13 matrix contains a variable entry x in exactly 2 places. If D(x) is the determinant of the matrix product such that $D(0)=1, D(-1)=1\ \&\ D(2)=7$ which of the following is/are correct?

(A) $D(-2)=3$
(B) $D(1)=3$
(C) $D(-3)=7$
(D) $D(1)=2$

Space for Rough work

Comprehension Type

This section contains **2 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct.

Paragraph for Question Nos. 49 and 50

Let ABCD is a rectangle with AB = a & BC = b & circle is drawn passing through A & B and touching side CD. Another circle is drawn passing though B & C and touching side AD. Let r_1 & r_2 be the radii of these two circle respectively.

49. $\frac{r_1}{r_2}$ equals

(A) $\frac{a}{b}\left(\frac{4b^2+a^2}{4a^2+b^2}\right)$ (B) $\frac{b}{a}\left(\frac{4a^2+b^2}{4b^2+a^2}\right)$

(C) $\frac{a}{b}\left(\frac{4b^2-a^2}{4a^2-b^2}\right)$ (D) $\frac{b}{a}\left(\frac{a^2-4b^2}{4a^2-b^2}\right)$

50. Minimum value of (r_1+r_2) equals

(A) $\frac{5}{8}(a-b)$ (B) $\frac{5}{8}(a+b)$

(C) $\frac{3}{8}(a-b)$ (D) $\frac{3}{8}(a+b)$

Paragraph for Question Nos. 51 and 52

If $f:R\rightarrow[0,\infty)$ be a function satisfying the property $f(x+y)-f(x-y)=f(x)[f(y)-f(-y)]\ \forall y,x\in R$, $f'(0)=\ln a,\ f(0)=1$

51. f(x) is

(A) e^x (B) 2 In x

(C) 4 x (D) a^x

Space for Rough work

52. The solution of differential equation $\frac{dy}{dx}=\frac{(\log_a f(x)+\log_a f(y))^2}{[\log_a f(x)+2][\log_a f(y)-2]}$ is

(A) $\frac{y-2}{x+2}-\frac{1}{2}\ln\left|1+2\left(\frac{y-2}{x+2}\right)\right|=2\ \ln(x+2)+c$

(B) $\frac{y+2}{y-2}-\ln\left|1+\frac{y+2}{x-2}\right|=c$

(C) $(x+2)(y-2)=\ln\left(\frac{x+2}{y-2}\right)+c$

(D) None of these

SECTION – C
(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

53. If $P(x)=x^6-x^5-x^3-x^2-x$ & $\alpha,\beta,\gamma,\delta$ are the roots of the equation $Q(x)=x^4-x^3-x^2-1=0$ Then $P(\alpha)+P(\beta)+P(\gamma)+P(\delta)=$

54. Let x be chosen at random from the interval $(0,1)$. The probability that $[\log_{10}4x]=[\log_{10}x]$ is k/12 ($[.]$ denotes G.I.F), then k is

55. Let f(x) be a differentiable function on [0, 8] such that $f(1)=3,\ f(2)=1/2, f(3)$
$=4, f(4)=-2, f(5)=6$
$f(6)=1/3, f(7)=-1/4.$ Then the minimum no. of points of interaction of the curve
$y=f'(x)$ and $y=f'(x)(f(x))^2$ is K then $K\ -5=$

56. Consider continuous function f on the interval [0, 1] which satisfy the following two condition
(i) $f(x)\le\sqrt{5}\ \forall x\in[0,1]$ (ii) $f(x)\le\frac{2}{x}\forall x\in\left[\frac{1}{2},1\right]$

Then the smallest real number α each that the inequality $\int_0^1 f(x)dx\le\alpha$ holds for any such f is

$2+2\ln\left(\frac{\sqrt{k}}{2}\right)$ then k is

Space for Rough work

57. 40 slips are placed in a box, each bearing a number 1 to 10 with each number entered on 4 slips. 4 slips are drawn from the box at random without replacement. The probability that two of the slips bear a number 'a' & other two bear a number 'b' $(\neq a)$ is $\frac{k}{9}\times\frac{{}^{10}C_2}{{}^{40}C_4}$ where k = ...

58. Suppose f is continuous on $[a,b]$ & $f(a)=f(b)=0$ & $\int_a^b f^2(x)dx = 1$ then the minimum value of $\int_a^b (f'(x))^2 dx \int_a^b x^2 f^2(x) dx$ is k, then 8k is

59. The number of solutions of the equation $\left|\sin\frac{\pi x}{2}+\cos\frac{\pi x}{2}\right| = \sqrt{\left(\ln|x|^3+1\right)}$ is

60. Using the digits 0, 1, 2, 3 & 4, the number of ten digit sequences can be written so that the difference between any two consecutive digits is 1, is equal to k, then $\frac{k}{72}$ is equal to

Space for Rough work

FIITJEE

JEE(Advanced)-2018

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – IV
(Paper-2)

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**A, B, D**	21.	**A, B, C**	41.	**A, B, D**
2.	**B, C**	22.	**A, B, C, D**	42.	**A, C**
3.	**A, B**	23.	**A, C**	43.	**B, C**
4.	**A, B, C, D**	24.	**A, B, C**	44.	**A, B, C, D**
5.	**B, D**	25.	**A, B, C**	45.	**B, C, D**
6.	**A, C, D**	26.	**A, C, D**	46.	**B, C**
7.	**B, D**	27.	**C**	47.	**A, B, C, D**
8.	**A, B, D**	28.	**B, C, D**	48.	**A, B, C**
9.	**A**	29.	**A**	49.	**A**
10.	**A**	30.	**B**	50.	**B**
11.	**C**	31.	**A**	51.	**D**
12.	**A**	32.	**D**	52.	**A**
13.	**2**	33.	**8**	53.	**6**
14.	**1**	34.	**2**	54.	**2**
15.	**2**	35.	**4**	55.	**6**
16.	**8**	36.	**9**	56.	**5**
17.	**7**	37.	**9**	57.	**4**
18.	**3**	38.	**2**	58.	**2**
19.	**7**	39.	**9**	59.	**6**
20.	**2**	40.	**5**	60.	**9**

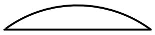
Physics

PART – I

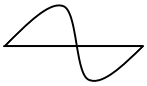
SECTION – A

1. **A, B, D**

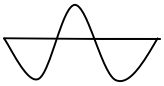
$K = 0.5\pi = \frac{2\pi}{\lambda} \Rightarrow \lambda = 4\text{cm}$



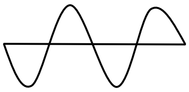
$\Rightarrow L = \frac{\lambda}{2} = 2\text{cm}$



$\Rightarrow L = \lambda = 4\text{cm}$



$\Rightarrow L = \frac{3\lambda}{2} = 6\text{cm}$



$\Rightarrow L = 2\lambda = 8\text{cm}$

2. **B, C**

When the switch 'S' is opened,

$\tau = RC = 1.5\,\text{sec}$

Voltage across the capacitor,

$V_c = 10\left(1 - e^{-t/1.5}\right)$ for t < T

The current, $i = \frac{dQ}{dt} = C\,\frac{dV_c}{dt}$

$= \frac{200}{3} \times 10^{-6}\left(e^{-t/1.5}\right)$ for t < T

Voltage drop across 100 k μ resister,

$V = iR = \frac{20}{3} e^{-t/1.5}$ for t < T

After t = T,

$\tau = 100\ k\Omega \times 10\ \mu F = 1\ \text{sec}$

Voltage across capacitor,

$V_c = V_o t^{-\left[(t-T)/\tau\right]} = 10\left(1 - e^{-(T/1.5)}\right), e^{-\left[(t-T)/1\right]}$

The charge on capacitor, $Q = V_c \cdot C$

The current through 100 k μ resistor, $i = -C\frac{dV_c}{dt} = 10^{-3}\left(1 - e^{-T/1.5}\right)\left(1 - e^{-(t-T)/1}\right)$

3. **A, B**

$\Delta\phi = \frac{2\pi}{\lambda}\Delta X$

$\Delta\phi = \frac{2\pi}{16} \times 4 = \frac{\pi}{2}$

$I = 4I_0 \cos^2\frac{\pi}{4} = 2I_0$

4. **A, B, C, D**

Electric field lines kill off on surface of conductor

5. **B, D**

Since maximum current passing through two circuits is same and equal to V/R$_1$ in (b) and V/R$_2$ in (c) then R$_1$ = R$_2$

Current growth equation of L – R circuit is :

$$i = i_0\left(1 - e^{-t/\tau}\right)$$

$$i = i_0\left(1 - e^{\frac{-tR}{L}}\right)$$

Now, $\frac{di}{dt} = \frac{i_0 R}{L} e^{-tR/L}$

At t = 0 slope of I vs t curve:

$$\frac{di}{dt} = \frac{i_0 R}{L}$$

From graph (a) : slope of curve (b) > slope of curve (c)

$$\frac{R_1}{L_1} > \frac{R_2}{L_2}$$

Since, R$_1$ = R$_2$

L$_1$ < L$_2$

6. **A, C, D**

Momentum conservation.

$$MV_0 = 2MV$$

$$V = \frac{V_0}{3}$$

Angular momentum conservation about centre of mass,

$$\frac{1}{2}MR^2 \cdot \omega_0 - \frac{4}{3}MV_0 R = \left[\frac{MR^2}{2} + M\left(\frac{4}{3}R\right)^2 + \frac{1}{2}(2M)R^2 + 2M\left(\frac{2}{3}R^2\right)\right]\omega$$

$$\omega = \frac{3}{25}\omega_0 - \frac{8}{25}\frac{V_0}{R}$$

For $\omega = 0$

$$\omega_0 = \frac{8V_0}{3R}$$

The energy loss,

$$\Delta E = E_i - E_f$$

$$= \frac{1}{2}MV_0{}^2 + \frac{1}{2}\left(\frac{MR^2}{2}\right)\cdot \omega^2 - \frac{1}{2}(3M)V^2 = \frac{19}{9}MV_0{}^2$$

7. **B, D**

$$V_1 = \sqrt{\frac{T}{\mu_1}} = 10\sqrt{2}$$

$$V_2 = \sqrt{\frac{T}{\mu_2}} = \frac{10\sqrt{2}}{\sqrt{3}}$$

Reflection coefficient

$$R = \frac{V_2 - V_1}{V_1 + V_2} = 2 - \sqrt{3}$$

Transmission coefficient,

$$T = \frac{2V_2}{V_1 + V_2} = \sqrt{3} - 1$$

8. **A, B, D**

Initially,

$$P_{gas} = P_0A + mg = 112.5 \text{ kPa}$$

$$w = \int_0^x P_{gas}A\, dx$$

$$= \int_0^x (P_0A + mg + kx)dx = 56.5 \text{ J}$$

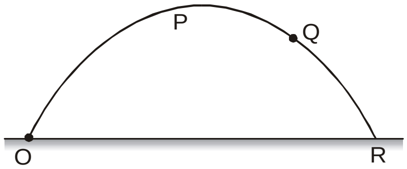
$$Q = m\Delta u + w = 118 \text{ J}$$

9. **A**

Time of flight of A is 4 seconds which is same as the time of flight if wall was not there.

Time taken by B to touch the inclined roof is 1 second.

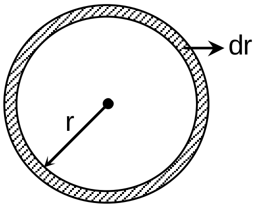
Hence, $S = 20t - \frac{1}{2}gt^2 = 20\times1 - 5\times1^2 = 15$ m



10. **A**

Vertical component = $u\sin\theta$ = 20 m/s

11. **C**



$$dm = (2\pi r dr)\sigma_0\left(1+\frac{r}{R}\right) = 2\pi\sigma_0\left(r+\frac{r^2}{R}\right)dr$$

$$M = \int_0^R dm = 2\pi\sigma_0\left(\frac{R^2}{2}+\frac{R^2}{3}\right) = \frac{5\pi\sigma_0R^3}{3}$$

$$dI = dmr^2 = 2\pi\sigma_0\int_0^R\left(r^3+\frac{r^4}{R}\right)dr = 2\pi\sigma_0\left(\frac{R^4}{4}+\frac{R^4}{5}\right) = \frac{9}{10}\pi\sigma_0R^4$$

$$d\tau = g\mu r dm = 2\mu\pi\sigma_0 g\left(r^2+\frac{r^3}{R}\right)dr$$

$$\tau = 2\pi\sigma_0\mu g\int_0^R\left(r^2+\frac{r^3}{R}\right)dr = 2\pi\sigma_0\left(\frac{R^3}{3}+\frac{R^3}{4}\right)\mu g = \frac{7}{6}\pi\mu\sigma_0 gR^3$$

$$\tau = I\alpha \Rightarrow \frac{7}{6}\pi\mu\sigma_0 gR^3 = \frac{9}{10}\pi\sigma_0R^4\alpha$$

$$\alpha = \frac{35\mu g}{27R}$$

12. **A**

$$\omega = \omega_0 - \alpha t$$

$$dE = (\mu dmgr)(\omega_0 - \alpha t)dt = dmCdT$$

$$\Rightarrow \frac{dT}{dt} = \frac{\mu gr}{C}(\omega_0 - \alpha t)$$

SECTION – C

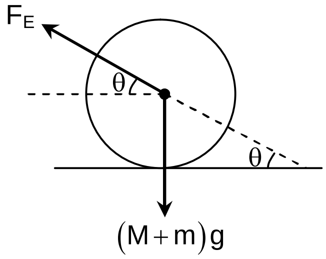
13. **2**

$(M+m)g > F_E \sin\theta$

$> \dfrac{27Qq}{256\pi\varepsilon_0 R^2}$

$(M+m)g > 3mg$

$M > 2m \Rightarrow \eta = 2$



14. **1**

$P_0V_0 = nRT_0$

$W_1 = P_0(4V_0 - V_0) = 3nRT_0$

$W_2 = mRT_0 \ln 4 = 2nRT_0 \ln 2$

$\dfrac{W_1}{W_2} = \dfrac{3nRT_0}{2nRT_0 \ln 2} = \dfrac{3}{2\ln 2} \Rightarrow \alpha = \dfrac{3}{2} \Rightarrow \dfrac{2}{3}\alpha = 1$

15. **2**

$1.67\times10^{-27} v_0 = \dfrac{6.62\times10^{-34}}{61\times10^{-9}} \Rightarrow v_0 = 6.5 \text{ m/s} \Rightarrow n = 2$

16. **8**

$\dfrac{1}{2}L(4) = 16 \Rightarrow$ L = 8 H

4R = 320 $\Rightarrow R = 80\Omega$

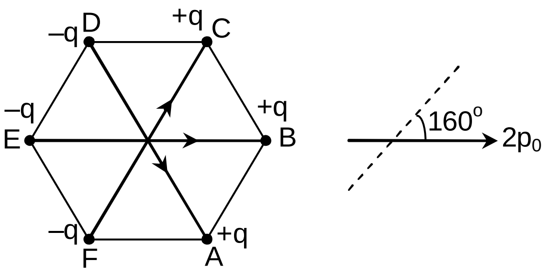
When connected to the battery, $R_{net} = 100\,\Omega$, L = 8 H

$\tau = \dfrac{8}{100} \Rightarrow 100\tau = 8$

17. **7**

$E = \dfrac{K(2P_0)}{x^3}\sqrt{1+\dfrac{3}{4}} = \dfrac{1}{4\pi\varepsilon_0}\dfrac{4aq}{x^3}\dfrac{\sqrt{7}}{2} = \dfrac{\sqrt{7}aq}{2\pi\varepsilon_0 x^3}$

$\Rightarrow \alpha = 7$



18. **3**

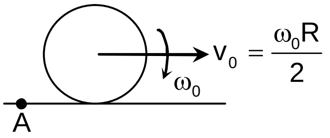
$$E = \frac{1}{2}\left(\frac{C}{2}\right)V^2 \qquad Q_i = \frac{CV}{2} \qquad Q_f = \frac{2CV}{3}$$

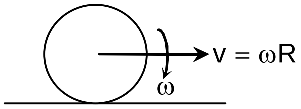
$$Q_f - Q_i = \frac{2CV}{3} - \frac{CV}{2} = \frac{CV}{6}$$

$$\frac{E}{W} = \frac{CV^2/4}{CV^2/6} = \frac{3}{2} \Rightarrow \frac{2E}{W} = 3$$

19. **7**

$$\frac{m\omega_0 R^2}{2} + \frac{mR^2}{2}\omega_0 = m\omega_0 R^2 = m\omega R^2 + \frac{mR^2}{2}\omega$$





$$\Rightarrow \omega_0 = \frac{3}{2}\omega \Rightarrow \omega = \frac{2\omega_0}{3}$$

$$\Rightarrow v = \omega R = \frac{2}{3}\omega_0 R = \frac{4v_0}{3}$$

$$\Rightarrow \frac{16v_0^2}{9} = v_0^2 + 2\mu g x$$

$$2\mu g x = \frac{7v_0^2}{9} \Rightarrow x = \frac{7v_0^2}{18\mu g} = \frac{7\omega_0^2 R^2}{72\mu g} = 7 \text{ m}$$

20. **2**

$$K_0 = \frac{1}{2}\alpha x_0^2$$

Kinetic energy just after 3rd collision = $\left(\frac{1}{2}\right)^6 K_0 = \frac{1}{64}K_0$

$$\frac{1}{64}\left(\frac{1}{2}\alpha x_0^2\right) = \frac{1}{2}\alpha x^2$$

$$\Rightarrow x^2 = \frac{x_0^2}{64} \Rightarrow x = \frac{x_0}{8}$$

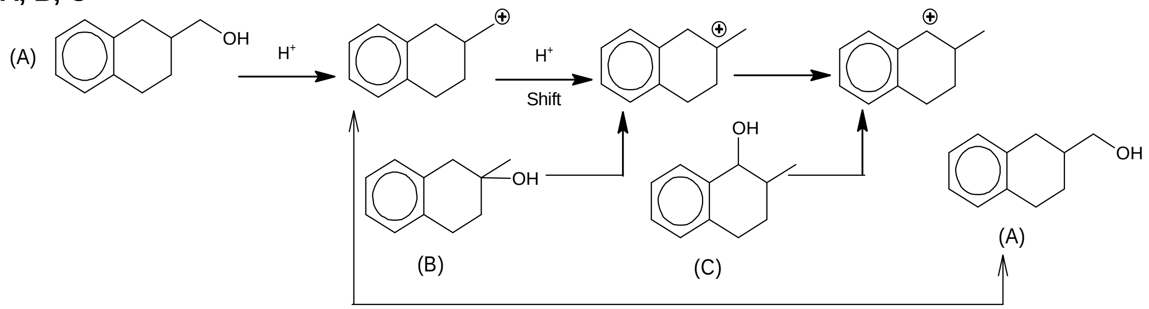
$$F = \alpha x = \frac{\alpha x_0}{8} = 2 \text{ N}$$

Chemistry

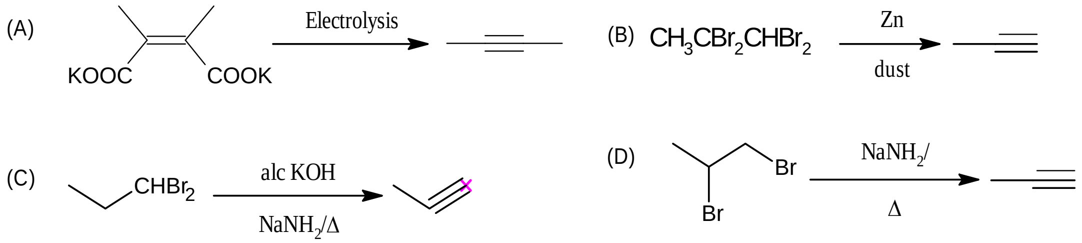
PART – II

SECTION – A

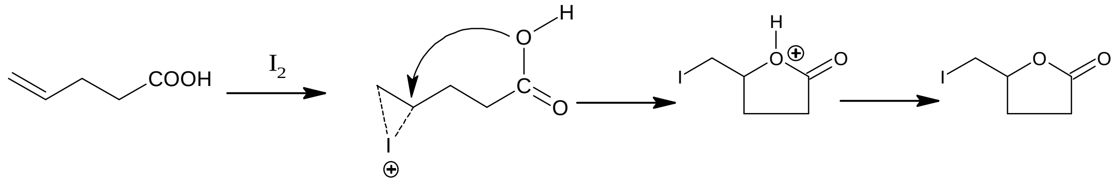
21. **A, B, C**


(A)
OH
H⁺
H⁺
Shift
OH
OH
OH
(B)
(C)
(A)

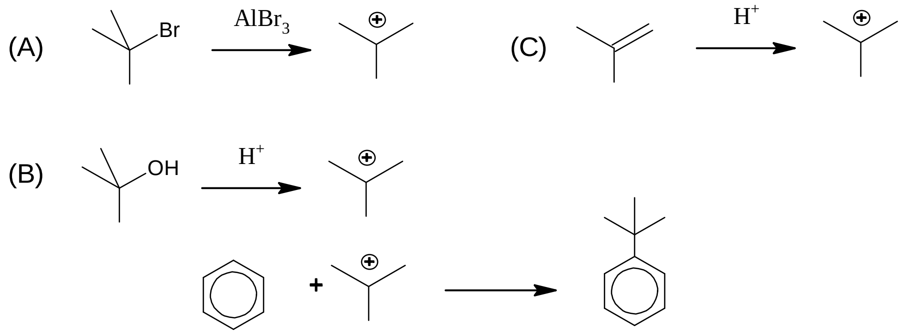
22. **A, B, C, D**


(A)
KOOC
COOK
Electrolysis
(B) CH₃CBr₂CHBr₂
Zn
dust
(C)
CHBr₂
alc KOH
NaNH₂/Δ
(D)
Br
Br
NaNH₂/
Δ

23. **A, C**

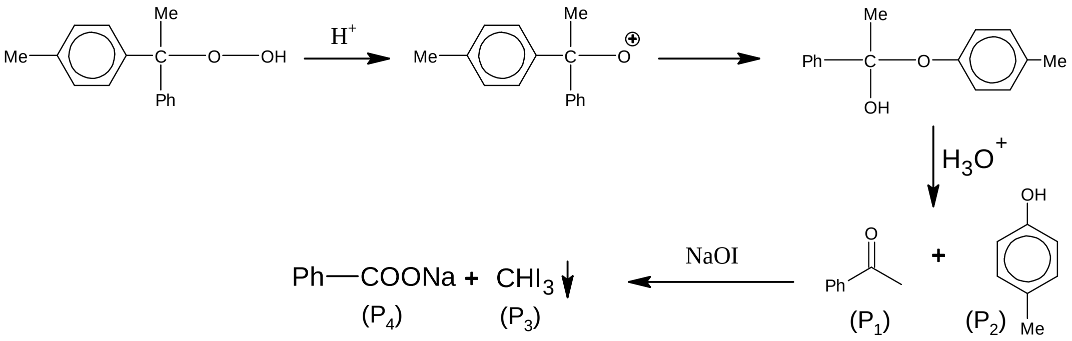

COOH
I₂
H
O
C
O
I
H
O
O
I
I
O
O

24. **A, B, C**


(A)
Br
AlBr₃
(C)
H⁺
(B)
OH
H⁺
+

25. **A, B, C**
Presence of strong electron withdrawing group inhabitants the fried craft alkylation.

26. **A, C, D**



$$CHI_3 + Ag \longrightarrow HC\equiv CH$$

$$Ph—COONa \xrightarrow{\text{sodalime}} Ph—H$$

27. **C**
Fact

28. **B, C, D**
$Br_2\left(ON = 0\right)$ reduces to $Br^-\left(ON = -1\right)$ and oxidises to $BrO_3^-\left(ON = +5\right)$

29. **A**
Meq. Of KI $\equiv$ meq. of $CuSO_4$ $\equiv$ meq. of I_2 $\equiv$ meq. of hypo
$0.4\times 10^3\times 1$ $\quad$ $50\times 0.2\times 1$
$= 40$ $\quad$ $= 10$ $\quad$ (limiting reagent)
$\therefore$ meq. of hypo $= 10 = M\times x\times V_{mL}$
$= 0.4\times 2\times V_{mL} = 12.5mL$

30. **B**
meq. of hypo $\equiv$ meq. of Cu^{2+} $\equiv$ meq. of Cu
$$12.12 \times 0.1 = \frac{w_{Cu}}{63.5/2}\times 1000 \Rightarrow w_{Cu} = 0.076g$$
$$\therefore \quad \%\ \text{purity} = \frac{0.076}{1.1}\times 1000 = 6.99 \approx 7\%$$

31. **A**
The rate of the reaction = Rate = K $[A_0]$
= 0.0462 × 100 = 4.62 bacterias per minute

32. **D**
$$t_{1/2} = \frac{0693}{K} = \frac{0.693}{0.0462} = 15\,\text{min}$$

SECTION – C

33. **8**
Fact

34. **2**

Fact.

35. **4**

Volume of the unit cell, $a^3 = \left(5\times10^{-8}\right)^3$

$= 1.25\times10^{-22}\text{cm}^3 \qquad (\because\ a = 5\overset{o}{A})$

Density (ρ) = 4.0 g cm^{-3}

Mass of unit cell $= V\times\rho = 1.25\times10^{-22}\times4.0$

$= 5.0\times10^{-22}\text{g}$

Number of FeO molecules per unit cell $= \dfrac{5.0\times10^{-22}\text{g}}{1.195\times10^{-22}\text{g}}$

= 4.19 $\approx$ 4

Thus, there are four Fe^{2+} ions and four O^{2-} ions in each unit cell.

36. **9**

In conversion of ${}^{238}_{92}U$ to ${}^{206}_{82}Pb, 8\alpha$-particles and 6β particles are ejected.

The number of gaseous moles initially = 1 mole

The number of gaseous moles finally = 1 + 8 moles; (1 mole from air and 8 mole of ${}_2He^4$)

So the ratio = 9/1 = 9

37. **9**

For AgCl, molarity = normality

$\kappa = 3.41\times10^{-6} - 1.60\times10^{-6} = 1.81\times10^{-6}\,\Omega^{-1}\text{cm}^{-1}$

For saturated solution of sparingly soluble salt,

$\lambda_V = \lambda^\infty$ and solubility = normality

$\therefore \qquad \lambda_V = \lambda^\infty = \dfrac{1000\times\kappa}{s}$

$\therefore \qquad s = \dfrac{1000\times\kappa}{\lambda^\infty} = \dfrac{1000\times1.81\times10^{-6}}{138.3} = 1.31\times10^{-5}$

Now,

$K_{sp(AgCl)} = s^2 = \left(1.31\times10^{-5}\right)^2 = 0.1716\times10^{-9}$

$\therefore \qquad x = 9$

38. **2**

Considering the reduction reaction

$$\underset{\text{Oxidized form}}{A^{(x+n)+}} + ne \longrightarrow \underset{\text{Reduced form}}{A^{x+}}$$

$\because \qquad [A^{x+}] = 24.4 \qquad \therefore \qquad [A^{(x+n)+}] = 75.6,\ E_{RP} = 0.101\text{V}$

Now from Nernst's equation

$$E_{RP} = E^0_{RP} + \frac{0.059}{n}\log\frac{[OF]}{[RF]}$$

$$0.101 = E^0_{RP} + \frac{0.059}{n}\log\frac{75.6}{24.4} \qquad ....(i)$$

If $[A^{x+}] = 48.8$; $[A^{(x+n)+}] = 51.2$, $E = 0.115$

$$\therefore \quad 0.115 = E^0_{RP} + \frac{0.059}{n}\log\frac{51.2}{48.8} \qquad ...(ii)$$

By eqs. (ii) – (i),

$$\therefore \quad 0.0014 = \frac{0.059}{n}\left[\log\frac{51.2}{48.8} - \log\frac{75.6}{24.4}\right]$$

$$\therefore \quad n = \frac{0.059}{0.014}[0.49 - 0.020]$$

$$n = 1.98 \approx 2$$

39. **9**

In Layer M

$n_A = x \quad n_B = y$

$$\frac{x}{x+y} = 0.2 \Rightarrow \frac{y}{x} + 1 = 5 \Rightarrow \frac{y}{x} = 4 \Rightarrow y = 4x$$

In layer N

$$\frac{(i-x)}{(1-x)(3-y)} = 0.6$$

$$\frac{3-y}{1-x} + 1 = \frac{1}{0.6} \Rightarrow \frac{3-y}{1-x} = \frac{4}{6} = \frac{2}{3}$$

$$9 - 3y = 2 - 2x$$

$$9 - 12x = 2 - 2x$$

$$7 = 10x \Rightarrow x = 0.7, y = 2.8$$

$$w_M = 0.7 \times 20 + 0.7 \times 4 \times 40 = 14 + 7 \times 16 = 126$$

$$w_N = 0.3 \times 20 + 0.2 \times 40 = 14$$

$$w_M / w_N = 9$$

40. **5**

	mass	mole	moler ratio
C	6w	$\frac{6w}{12}$	0.5=3
H	w	$\frac{w}{1}$	1 = 6
N	$\frac{7w}{1.5}$	$\frac{7w}{1.5 \times 14}$	$\frac{1}{3} = 2$

M.wt.$\left[(C_3H_6N_2)_n > 100 \Rightarrow n = 2\right]$

Mathematics

PART – III

SECTION – A

41. **A, B, D**

$$\frac{a}{1+\alpha^2\beta^2}=\frac{b}{\alpha^2+\beta^2}=\frac{c}{\left(1-\alpha^2\right)\left(1+\beta^2\right)}=\frac{2s}{2+2\beta^2}$$

$$\Rightarrow \frac{s}{1+\beta^2}=\frac{a}{1+\alpha^2\beta^2}\Rightarrow \frac{s-a}{\beta^2\left(1-\alpha^2\right)}=\frac{a}{1+\alpha^2\beta^2}$$

$$\Rightarrow s-a=\frac{a\left(1-\alpha^2\right)\beta^2}{1+\alpha^2\beta^2}$$

similarly $s - b=\frac{b\left(1-\alpha^2\right)}{\alpha^2+\beta^2}$

$s-c=\frac{c\alpha^2}{1-\alpha^2}$ & $s=\frac{b\left(1+\beta^2\right)}{\alpha^2+\beta^2}$

$$\therefore \tan^2\left(A/2\right)=\frac{(s-b)(s-c)}{s(s-a)}=\frac{\frac{b\left(1-\alpha^2\right)}{\alpha^2+\beta^2}.\frac{c\alpha^2}{1-\alpha^2}}{\frac{b\left(1+\beta^2\right)}{\alpha^2+\beta^2}\frac{a\left(1-\alpha^2\right)\beta^2}{1+\alpha^2\beta^2}}$$

$$\left[\because a=\frac{c\left(1+\alpha^2\beta^2\right)}{\left(1-\alpha^2\right)\left(1+\beta^2\right)}\right]$$

$$=\frac{\alpha^2}{\beta^2}$$

$A=2\tan^{-1}\left(\alpha/\beta\right)$

$B=2\tan^{-1}\left(\alpha\beta\right)$

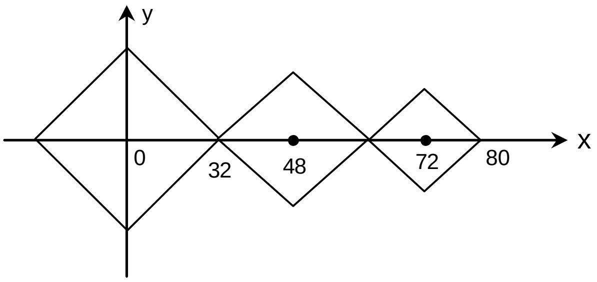
$\therefore$ Reqd area = $\frac{1}{2}bc\ \sin A$ = $\frac{1}{2}bc.\frac{2\tan\left(A/2\right)}{1+\tan^2\left(A/2\right)}=\frac{bc\alpha\beta}{\alpha^2+\beta^2}$

42. **A, C**

$a_2=a_1+\frac{3}{2}b_1=48,\ b_2=\frac{b_1}{2}=16$

$a_3=48+\frac{3}{2}\times 16=72,\ b_3=\frac{16}{2}=8$

So, the three loops from i = 1 to i = 3 are alike Now, area of ith loop (square) = $\frac{1}{2}\left(\text{diagonal}\right)^2$



$$A_i = \frac{1}{2}(2b_i)^2 = 2b_i^2$$

$$\therefore \frac{A_{i+1}}{A_i} = \frac{2(b_{i+1})^2}{2(b_i)^2} = \frac{1}{4}$$

So, the areas form a G.P series

$\therefore$ sum of the G.P up to infinite term is

$$\frac{A_i}{1-r} = 2(32)^2 \times 1\frac{1}{1-\frac{1}{4}} = \frac{8}{3}(32)^2 \text{ sq. units}$$

43. **B, C**

$$|\bar{a}| = 1, |\bar{b}| = 4, \bar{a}.\bar{b} = 2 \ \& \ \bar{c} + 3\bar{b} = 2\bar{a} \times \bar{b}$$

$$Q\, \bar{a}.\bar{b} = 2$$

$$\Rightarrow |\bar{a}||\bar{b}|\cos\theta = 2$$

$$\Rightarrow \cos\theta = \frac{2}{|\bar{a}||\bar{b}|} = \frac{1}{2} \Rightarrow \theta = \frac{\pi}{3}$$

Again $|\bar{c} + 3\bar{b}|^2 = |2\bar{a} \times \bar{b}|^2$

$$\Rightarrow |\bar{c}|^2 + 9|\bar{b}|^2 + 2\bar{c}.3\bar{b} = 4|\bar{a}|^2|\bar{b}|^2 \sin^2\theta$$

$$\Rightarrow |\bar{c}|^2 + 144 + 6\bar{b}.\bar{c} = 48$$

Also, $\bar{c} = 2\bar{a} \times \bar{b} - 3\bar{b}$

$$\Rightarrow \bar{b}.\bar{c} = \bar{b}.(2\bar{a} \times \bar{b}) - 3|\bar{b}|^2$$

$$\Rightarrow \bar{b}.\bar{c} = 0 - 3 \times 16 = -48$$

$$\therefore |\bar{c}|^2 + 96 - 6 \times 48 = 0$$

$$\Rightarrow |\bar{c}|^2 = 192$$

$$\Rightarrow |\bar{c}| = 8\sqrt{3}$$

$$\bar{b}.\bar{c} = |\bar{b}||\bar{c}|\cos\alpha \Rightarrow -48 = 4 \times 8\sqrt{3}\cos\alpha$$

$$\Rightarrow \cos\alpha = -\frac{6}{4\sqrt{3}} = -\frac{\sqrt{3}}{2}$$

$$\Rightarrow \alpha = \frac{5\pi}{6}$$

44. **A, B, C, D**

1 + x is never zero, so 1 + f(x) is never zero. It is 1 for x = 0, so it is always positive. Hence $f''(x)$ is always positive $f'(0) = 0$ so $f'(x) > 0, \ \forall x > 0$

Hence so in particular, $1 + f(x) \geq 2, \ \forall x$

$$f''(x) \leq \frac{1+x}{2}$$

Integrating $f'(x) \le f'(0) + \frac{x}{2} + \frac{x^2}{4} = \frac{x}{2} + \frac{x^2}{4}$

Again integrating

$f(x) \le f(0) + \frac{x^2}{4} + \frac{x^3}{12}$

Hence $f(1) \le 1 + \frac{1}{4} + \frac{1}{12} = \frac{4}{3}$

45. **B, C, D**

Let angle between $\bar{a}$ & $\bar{b}$ be $\theta \left|\bar{a}\right| = \left|\bar{b}\right| = 1, \frac{\theta}{2}$

$\left|\bar{a} + \bar{b}\right| = 2\cos\frac{\theta}{2}$

$\left|\bar{a} - \bar{b}\right| = 2\sin\frac{\theta}{2}$

$F(\theta) = \frac{3}{2}\left(2\cos\frac{\theta}{2}\right) + 2\left(2\sin\frac{\theta}{2}\right)$

$= 3\cos\frac{\theta}{2} + 4\sin\frac{\theta}{2}, \theta \in [0, \pi]$

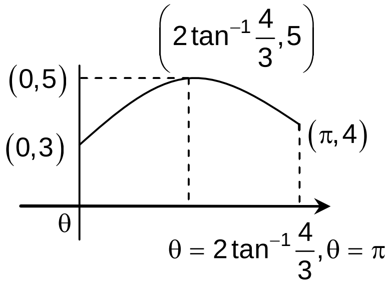
$F'(\theta) = -\frac{3}{2}\sin\frac{\theta}{2} + 2\cos\frac{\theta}{2}$

$F'(\theta) = 0 \Rightarrow \tan\left(\frac{\theta}{2}\right) = \frac{4}{3}$

$\therefore F(0) = 3$

$F\left(2\tan^{-1}\frac{4}{3}\right) = 3\left(\frac{3}{5}\right) + 4\left(\frac{4}{5}\right) = 5$

$F(\pi) = 4 \therefore$ Range $[3, 5]$



Hence possible integer (s) in the range of $F(\theta)$in$[0, \pi]$are 3

46. **B, C**

$f(k) = 1 + \frac{1}{2} + \frac{1}{3} + ... + \frac{1}{k}$

$f(1) = 1$

$f(2) = 1 + \frac{1}{2}$

$f(2017) = 1 + \frac{1}{2} + \frac{1}{3} + ...\frac{1}{2017}$ on adding

$= 1 \times 2017 + \frac{1}{2} \times 2016 + \frac{1}{3} \times 2015 + ... + \frac{1}{2017} \times 1$

$= 1 \times 2017 + \frac{1}{2}(2017 - 1) + \frac{1}{3}(2017 - 2) + ... + \frac{1}{2017}(2017 - 2016)$

$= 2017\left(1 + \frac{1}{2} + \frac{1}{3} + ... + \frac{1}{2017}\right) - \left(\frac{1}{2} + \frac{2}{3} + ... + \frac{2016}{2017}\right)$

$= 2017 f(2017) - \left\{1 - \frac{1}{2} + 1 - \frac{1}{3} + 1 - \frac{1}{4} + ... + 1 - \frac{1}{2017}\right\}$

$$= 2017f(2017) - 1 \times 2016 + \left(1 + \frac{1}{2} + ... + \frac{1}{2017}\right)$$
$$= 2017f(2017) - 2016 + f(2017)$$
$$= 2018f(2017) - 2017$$
$$a = 2018,\ b = 2017,\ c = -2017$$

47. **A, B, C, D**

$$x^2 - x\left(\frac{1+\sin^2\theta}{1+\sin\theta}\right) + \frac{\sin\theta - \sin^2\theta}{1+\sin\theta} = 0$$
$$x^2 - x\left(\sin\theta + \frac{1-\sin\theta}{1+\sin\theta}\right) + \sin\theta\left(\frac{1-\sin\theta}{1+\sin\theta}\right) = 0$$
$$\Rightarrow x = \sin\theta, \frac{1-\sin\theta}{1+\sin\theta}$$
$$\Rightarrow \alpha(\theta) = \sin\theta, \beta(\theta) = \frac{1-\sin\theta}{1+\sin\theta}$$

Hence the results follows.

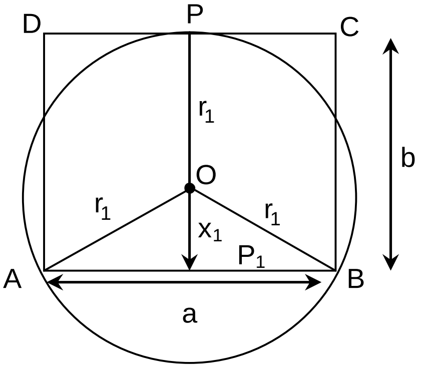
48. **A, B, C**

D(x) can at most be polynomial of degree 2
$$D(x) = ax^2 + bx + c$$
$$D(x) = x^2 + x + 1$$
$$D(1) = 3$$
$$D(-2) = 4 - 2 + 1 = 3$$
$$D(-3) = 9 - 3 + 1 = 7$$

49. **A**

50. **B**

$$r_1 = b - x_1 = OP = OA$$
$$AP_1 = a/2$$



$$r_1^2 = x_1^2 + \left(\frac{a}{2}\right)^2 = (b - x_1)^2$$
$$x_1^2 + \frac{a^2}{4} = b^2 + x_1^2 - 2bx_1$$
$$x_1 = \frac{4b^2 - a^2}{8b}$$
$$r_1 = b - x_1 = \frac{4b^2 + a^2}{8b}$$
$$\text{similarly } r_2 = \frac{4a^2 + b^2}{8a}$$

$$r_1 + r_2 = \frac{a^3 + b^3 + 4ab(a+b)}{8\ ab}$$

$$= \frac{(a+b)\left(a^2 + 3ab + b^2\right)}{8\ ab}$$

$$= \left(\frac{a+b}{8}\right)\frac{\left[(a-b)^2 + 5ab\right]}{ab}$$

But $(a-b)^2 \geq 0$

$$r_1 + r_2 \geq \frac{(a+b)}{8}.\frac{5ab}{ab}$$

$$\Rightarrow r_1 + r_2 \geq \frac{5(a+b)}{8}$$

51. **D**

52. **A**

$$f'(0) = \lim_{h\to 0}\frac{f(h)-1}{h} = \ln a$$

$$f'(x) = \lim_{h\to 0}\frac{f(x)}{2}\left[\frac{f(h)-1}{h} + \frac{f(-h)-1}{-h}\right] = \frac{f(x)}{2}\ 2\ \ln a$$

$$\frac{f'(x)}{f(x)} = \ln a \ \Rightarrow \ln f(x) = \ln a^x + C$$

$$f(0) = 1 \Rightarrow C = 0 \Rightarrow f(x) = a^x$$

$$\frac{dy}{dx} = \frac{(x+y)^2}{(x+2)(y-2)} \ \left(\text{put } x+2 = X,\ y-2 = Y\right)$$

$$\frac{dY}{dX} = \frac{(X+Y)^2}{XY}$$

$$\Rightarrow \frac{y-2}{x+2} - \frac{1}{2}\ln\left|1 + \frac{2(y-2)}{x+2}\right| = 2\ \ln\ (x+2) + C$$

SECTION – C

53. **6**

$$Q(x) = \left(x^3 - 2x^2 + x - 1\right)(x+1) = 0 \Rightarrow \delta = -1$$

$$\alpha + \beta + \gamma = 2,\ \alpha\beta + \beta\gamma + \gamma\alpha = 1$$

$$p(x) = \left(x^2 + 1\right)Q(x) + x^2 - x + 1$$

$$p(\alpha) + p(\beta) + p(\gamma) + p(-1) = \alpha^2 + \beta^2 + \gamma^2 + 1 - (\alpha + \beta + \gamma - 1) + 4$$

54. **2**

Let $\left[\log_{10} 4x\right] = k = \left[\log_{10} x\right]$ then x $\in \left[10^k, \frac{10^{k+1}}{4}\right]$, for k > 0 & k = 0 $\left(10^k, \frac{10^{k+1}}{4}\right)$ is beyond (0, 1) but for k < 0, the whole interval is in (0, 1).

So favourable x is obtained for $k = -1, -2, -3, ...$

for $k = -1, x \in \left[\frac{1}{10}, \frac{1}{4}\right)$

for $k = -2, x \in \left[\frac{1}{100}, \frac{1}{40}\right)$.........

sum of lenght of these intervals

$$= \left(\frac{1}{4} - \frac{1}{10}\right) + \left(\frac{1}{40} - \frac{1}{100}\right) + ...$$

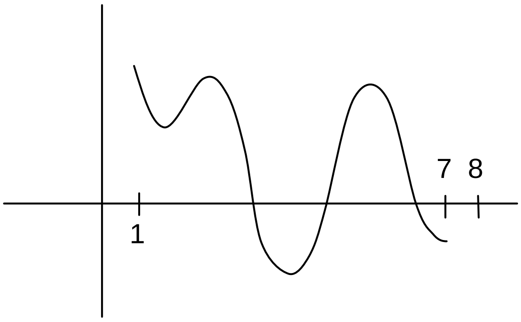
$$= \frac{3}{20}\left(1 + \frac{1}{10} + \frac{1}{100} + ...\right) = \frac{1}{6}$$

Required probability $= \frac{\frac{1}{6}}{1-0} = \frac{1}{6}$

55. **6**

$f'(x) = f'(x)\left(f(x)\right)^2$

Either f'(x) = 0 at least 4 roots
f(x) = 1 at least 5 roots
f(x) = - 1 at least 2 roots
at least 11 roots.



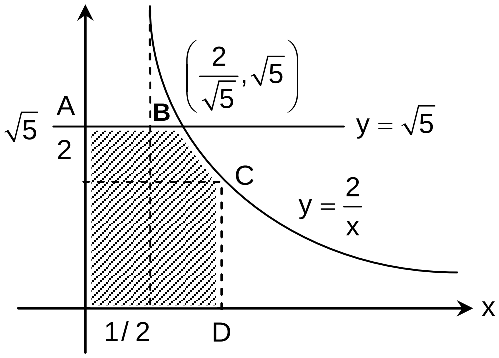
56. **5**

f(x) will be below $y = \sqrt{5}$ & $y = \frac{2}{x}$

$$\therefore I \le \int_0^{2/\sqrt{5}} \sqrt{5}dx + \int_{\frac{2}{\sqrt{5}}}^{1} \frac{2}{x}dx$$

$$= \sqrt{5}\left(\frac{2}{\sqrt{5}}\right) + 2 \ln 1 \ - 2 \ \ln\left(\frac{2}{\sqrt{5}}\right)$$

$$= 2 + 2 \ln \left(\frac{\sqrt{5}}{2}\right)$$



57. **4**

There are ${}^{40}C_4$ ways of drawing 4 slips ${}^{10}C_2$ ways to choose a & b. After a & b have been chosen there are ${}^{4}C_2$ ways of choosing 2 slips labelled a & ${}^{4}C_2$ ways of choosing 2 slips labelled b

$\therefore$ Required Probability $= \frac{{}^{10}C_2 \times {}^4C_2 \times {}^4C_2}{{}^{40}C_4} = \frac{36.{}^{10}C_2}{{}^{40}C_4}$

58. **2**

Since

$$\left(\int_a^b f(x)g(x)dx\right)^2 \le \int_a^b f^2(x)dx\int_a^b g^2(x)dx$$

$$\therefore \int_a^b xf(x)f'(x)dx = \frac{1}{2}\int_a^b x\left(f^2(x)\right)'dx$$

$$= \frac{1}{2}\left[\left[xf^2(x)\right]_a^b - \int_a^b f^2(x)dx\right] = \frac{1}{2}$$

Hence by Schwartz's inequality

$$\frac{1}{4} \le \int_a^b \left(f'(x)\right)^2 dx.\int_a^b x^2f^2(x)dx$$

59. **6**

$$\sin \pi x + 1 = \left|\ln|x|^3\right| + 1$$

$$\sin \pi x = \left|\left(\ln|x|\right)^3\right|$$

No of solutions 6

60. **9**

A_n denotes no. of n digit sequence that end in 0 or 4
B_n denotes no. of n digit sequence that end in 1 or 3
C_n denotes no. of n digit sequence that end in 2
$A_{n+1} = B_n$ ($\because$ each sequence in A_{n+1}can be converted into a sequence in B_n by deleting its last digit). B_{n+1}= A_n + 2 C_n ($\because$ each sequence in A_n can be converted into a sequence in B_{n+1} by adding a 1 (if it ends with 0) or a 3 (if it ends with 4) to its end, 8 each sequence in C_n can be converted into a sequence in B_{n+1} by adding a 1 or a 3 to it. $C_{n+1} = B_n$ (by deleting 2 at its end)
$B_{n+1} = 3B_{n-1}$ for $n \ge 2$, $B_1 = 2$, $B_2 = 4$

$$\therefore \quad A_{10} + B_{10} + C_{10} = 2B_9 + B_{10} = 4.3^4 + 4.3^4 = 648$$

FIITJEE **JEE (Main)-2018**

ALL INDIA TEST SERIES

FULL TEST – IV

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 – 30, 31 – 60, 61 – 90)** *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Straight Objective Type

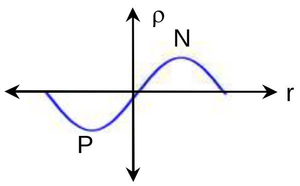
This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A T.V. tower has a height 150 m. The population density around the T.V. tower will be, if the population covered is 50 lacs? (Radius of earth = $6.4\times10^{6}\text{m}$)

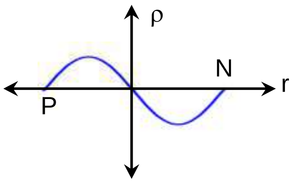
(A) 708.5 km^{-2} (B) 828.6 km^{-2}
(C) 856.8 km^{-2} (D) 454 km^{-2}

2. The curve between charge density ρ and distance r near p – N junction will be

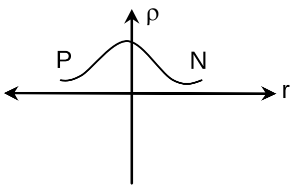
(A)



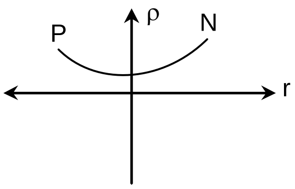
(B)



(C)



(D)



3. The potential of an atom is given by $V = V_o \log\rho\left(r / r_o\right)$ where r_o is the constant and r is the radius of the orbits. Assuming Bohr's model to be applicable, which variation of r_n with n is possible (n being principal quantum number).

(A) $r_n \propto n$ (B) $r_n \propto= \frac{1}{n}$

(C) $r_n \propto n^2$ (D) $r_n \propto \frac{1}{n^2}$

Space for Rough work

4. Magnets A and B are geometrically similar but the magnetic moment of A is twice that of B. If T_1 and T_2 be the time periods of the oscillation when their poles and unlike poles are kept together respectively, then T_1/T_2 will be

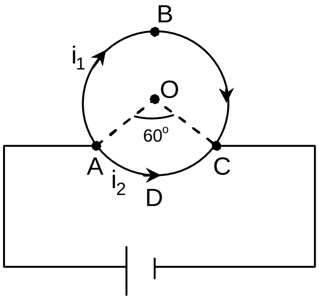
(A) $\frac{1}{3}$ (B) $\frac{1}{2}$

(C) $\frac{1}{\sqrt{3}}$ (D) $\sqrt{3}$

5. A cell is connected between the points A and C of a circular conductor ABCD of centre O, $\angle AOC = 60^o$. If B_1 and B_2 are the magnitude of magnetic fields at O due to the currents in ABC and ADC respectively, the ratio of B_1/B_2 is.

(A) 5 (B) 1/5

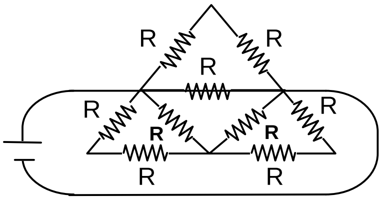
(C) 6 (D) 1



6. For maximum power from battery the internal resistance of battery r is

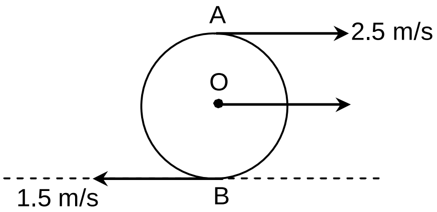
(A) 10 R (B) $\frac{4R}{9}$

(C) $\frac{R}{8}$ (D) $\frac{10R}{9}$



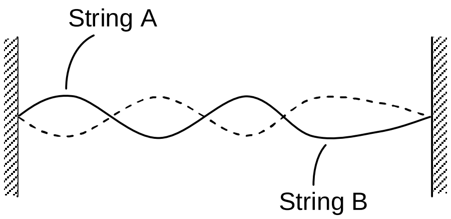
7. A disc having radius r = 2 m is placed on smooth horizontal surface. Velocity of point A and B is given as shown in fig. Distance between point O and axis of rotation at that particular instant is

(A) 1 m
(B) 0.5 m
(C) 0.25 m
(D) 2 m



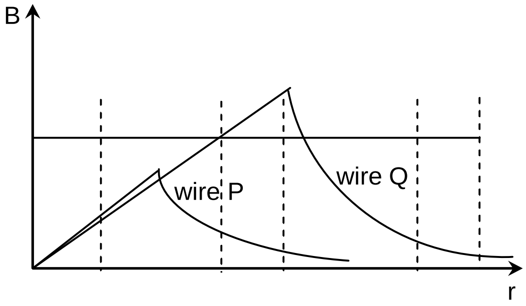
Space for Rough work

8. Two strings A and B of equal length but un equal linear mass density are tied together with a knot and stretched between two supports. A particular frequency happens to produce a standing wave on each part, with node at the knot as shown. If linear mass density of the two strings A and B are μ_1 and μ_2 respectively, then



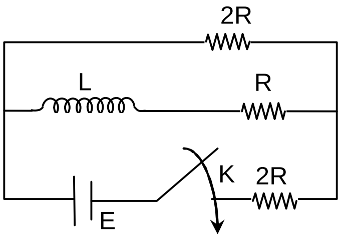
(A) $\mu_1 = \mu_2$
(B) $\mu_1 < \mu_2$
(C) $\mu_1 > \mu_2$
(D) can't be decided

9. Figure shown variation of magnetic field inside and outside two cylindrical wires P and Q carrying currents that are uniformly distributed across the cross section of wires. If current density for two wires are J_P and J_Q then



(A) $J_P = J_Q$
(B) $J_P < J_Q$
(C) $J_P > J_Q$
(D) can't be decided

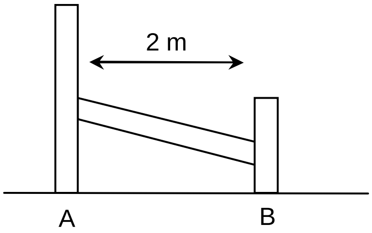
10. Time constant of LR circuit will be



(A) $\frac{L}{R}$
(B) $\frac{2L}{R}$
(C) $\frac{L}{2R}$
(D) None of these

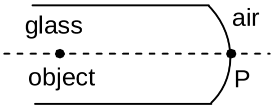
Space for Rough work

11. Two vertical walls separated by a distance of 2 metres wall A is smooth while wall B is rough with a coefficient of friction $\mu = 0.5$. A uniform rod is propped between them the length of the longest rod that can be probed between the walls is equal to



(A) 2 m
(B) $2\sqrt{2}$m
(C) $\sqrt{5}$ m
(D) $\frac{\sqrt{17}}{2}$m

12. Radius of curvature of a concave spherical surface separating air-glass medium is R. A point object is placed on the principal axis in the glass $(\mu_g = 1.5)$. For the image to be real seen by observer in air, distance of the object from P should be

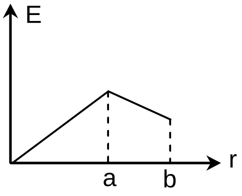


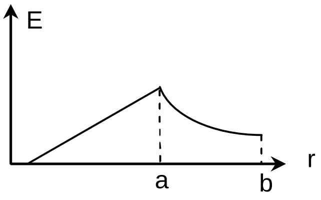
(A) 2 R < u < 3 R
(B) u < 2R
(C) u = R
(D) u > 3R

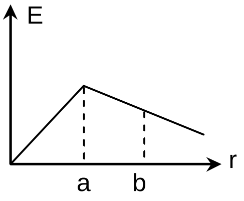
13. A parent radioactive a nucleus A (decay constant D_A) converts into a radioactive nucleus B of decay constant D_B, initially number of atom of B is zero. At any time N_A, N_B are number of atoms of nuclei A and B respectively then maximum value of N_B is

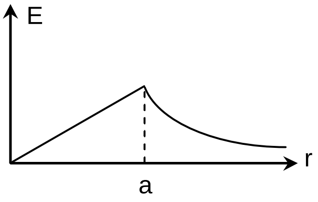
(A) $\frac{D_A N_A}{D_B}$
(B) $\frac{D_B N_A}{D_A}$
(C) $\frac{(D_A + D_B)N_A}{D_B}$
(D) $\frac{D_B}{(D_A + D_B)}N_A$

14. A capacitor is made of two concentric spherical shells A and B of radii a and b respectively. Where a < b. The external shell B is grounded $(V_B = 0)$ Inner shell i.e$(r \le a)$ is filled with a uniform positive charge of density ρ. Variation of electric field versus distance from the centre.

(A)


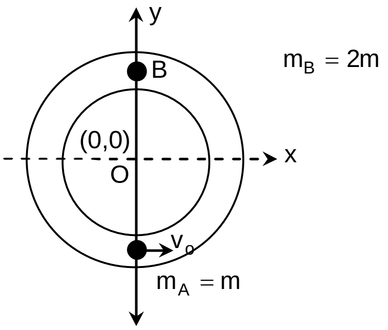
(B)


(C)


(D)


Space for Rough work

15. A hollow circular tube of radius R and negligible internal diameter is fixed on horizontal surface ball A of mass m is given velocity v_o in the shown direction. It collides with ball B of mass 2 m. collision is perfectly elastic. If centre of loop is origin of co-ordinates system, then co-ordinate of next collision is



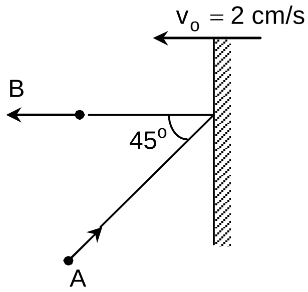
(A) $\left(\frac{\sqrt{3}}{2}R, \frac{-R}{2}\right)$

(B) $\left(\frac{-\sqrt{3}}{2}R, \frac{R}{2}\right)$

(C) $\left(\frac{R}{2}, \frac{-\sqrt{3}}{2}R\right)$

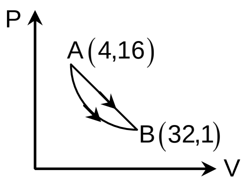
(D) $\left(\frac{R}{2}, \frac{R}{2}\right)$

16. Mirror is moving towards the particle with Speed 2 cm/sec speed of A and B are $10\sqrt{2}$ and 5 cm/sec respectively in the direction shown in figure. Magnitude of velocity of image of the particle B with respect to image of A.



(A) $\sqrt{325}$ cm/sec
(B) 15 cm/sec
(C) 13 cm/sec
(D) $\sqrt{269}$ cm/sec

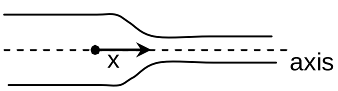
17. An ideal mono atomic gas is taken through the cyclic process shown in fig. Linear expansion from A to B followed by adiabatic compression back to original state

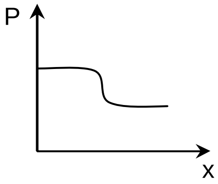


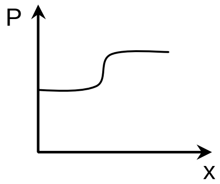
(A) Efficiency of cyclic process is zero.
(B) During process A to B heat is released only
(C) During process A to B heat is absorbed only
(D) During linear process heat enters and leaves the process

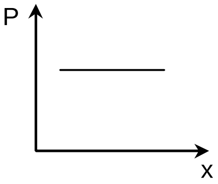
Space for Rough work

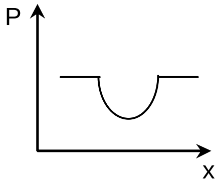
18. An ideal liquid is streamline motion flows through a friction less duct with varying cross section as shown in figure. Pressure P at points along x axis of duct is most likely to be represented by.



(A)


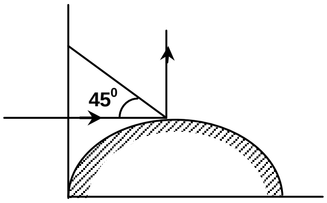
(B)


(C)


(D)


19. If error in the measurement of mass is 0.8 of and in volume it is 0.4% then error in the measurement of density is
(A) 1.2 %
(B) 0.4 %
(C) 0.8 %
(D) 1 %

20. A reflecting surface is represented by the equation $y = \frac{2L}{\pi}\sin\left(\frac{\pi x}{L}\right)$, where $0 \le x \le L$. A ray of light travelling horizontally becomes vertical after reflection with the surface. The co-ordinates of the point where this ray is incident is.



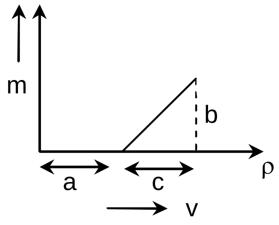
(A) $\left(\frac{L}{4}, \frac{\sqrt{2}L}{\pi}\right)$
(B) $\left(\frac{L}{3}, \frac{\sqrt{3}L}{\pi}\right)$
(C) $\left(\frac{3L}{4}, \frac{\sqrt{2}L}{\pi}\right)$
(D) $\left(\frac{2L}{3}, \frac{\sqrt{3}L}{\pi}\right)$

Space for Rough work

21. Kundt's tube can be used to
(A) Produce standing wave
(B) Determine viscosity of water
(C) Produce Doppler's effect in sound
(D) Determine velocity of the source of the disturbance.

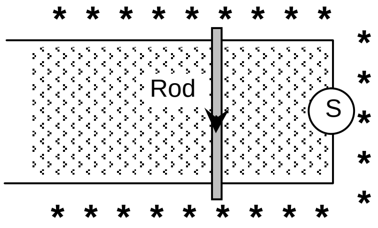
22. The acceleration of electron in the first orbit of hydrogen atom is
(A) $\frac{4\pi^2 m}{h^3}$ (B) $\frac{h^2}{4\pi^2 mr}$
(C) $\frac{h}{4\pi^2 m^2 r^3}$ (D) $\frac{m^2 h^2}{4\pi^2 r^3}$

23. The graph shows how the magnification m produced by a convex thin lens varies with image distance v. What was the focal length of the lens used?
(A) b/c (B) b/ca
(C) bc/a (D) c/b



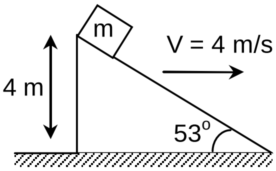
24. Two sound waves of slightly different frequently have amplitude ratio 11/9. What is the different of sound levels in decibels of maximum and minimum intensities head at a point?
(A) 100 (B) 10
(C) 16 (D) 20

25. A conducting rod of mass 50 gm and length 10 cm can slide without friction on two long, horizontal rails. A uniform magnetic field of magnitude 5 MT exists in the region, as shown. A source S is used to maintain a constant current 2A through the rod. If motion of the rod starts from the rest, its speed after 10 sec from the start of the motion will be
(A) 2 cm/s
(B) 8 cm/s
(C) 12 cm/s
(D) 20 cm/s



Space for Rough work

26. An inclined plane is moving with Constant velocity v = 4 m/s on a horizontal surface as shown in figure. If a block of mass 2 kg is kept at top of the incline and their is no friction between the block and the incline, then the distance travelled by the incline till the block reaches bottom of the inclined is $\left(g = 10\ m/s^2\right)$

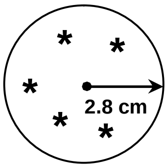


(A) 4 m
(B) 5 m
(C) $1.6\sqrt{5}$ m
(D) $2\sqrt{5}$ m

27. A particle is moving in x-y plane. At certain instant the components of its velocity and acceleration are as follows $V_x = 3 m/s$, $V_y = 4 m/s$, $a_x = 2\ m/s^2$ and $a_y = 1\ m/s^2$. The rate of change of speed at this moment is.
(A) 4 m/s^2
(B) 2 m/s^2
(C) $\sqrt{3}$ m/s^2
(D) $\sqrt{5}$ m/s^2

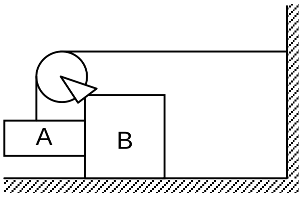
28. In a tug of war, the team that exerts a larger tangential force on the ground wins. Consider the period in which a team is dragging the opposite team by applying a larger tangential force on the ground. Which of the following works are negative?
(A) work by the loosing team on the winning team
(B) work by the ground on the winning team
(C) work by the ground on the loosing team
(D) none of these

29. The magnetic field of a cylindrical magnet that has a pole – face radius 2.8 cm can be varied sinusoidally between minimum value 16.8 T and maximum value 17.2 T at a frequency of $\frac{60}{\pi}$ Hz. Cross section of the magnetic field created by the magnet is shown. At a radial distance of 2 cm from the axis find the amplitude of the electric field (in m N/C) induced by the magnetic field variation.



(A) 140 m N/c
(B) 245 m N/C
(C) 180 m N/C
(D) 240 m N/C

30. The system is released from rest from the position shown in the diagram. If A and B has mass m and M respectively and all surfaces are smooth, then the normal reaction between A and B is



(A) $\frac{2M}{M+m}$
(B) $\frac{Mmg}{2(M+m)}$
(C) $\frac{Mmg}{(M+m)}$
(D) zero

Space for Rough work

Chemistry

PART – II

SECTION – A

Straight Objective Type

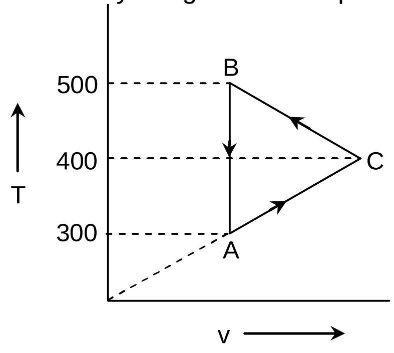
This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. Micelles are formed only
(A) Above CMC and above Krafft temperature
(B) Below CMC and below Krafft temperature
(C) Above CMC and below krafft temperature
(D) Below CMC and above krafft temperature

32. On mixing 10 ml of acetone with 40 ml of chloroform the total volume of solution is
(A) < 50 ml (B) > 50 ml
(C) = 50 ml (D) can not predict

33. A Radioactive element A says to B "I am half of what you were when you are one fourth of what I was moreover I was 1.414 time than what you were" If the half life of A is 8 days, what is the half life of 'B' is
(A) 4 days (B) 8 days
(C) 16 days (D) 2 days

34. What will be the work done in process CB for 1 mol of an ideal gas if total 600 cal heat is released by the gas in whole process.



(A) 400 cal (B) 600 cal
(C) 800 cal (D) 1000 cal

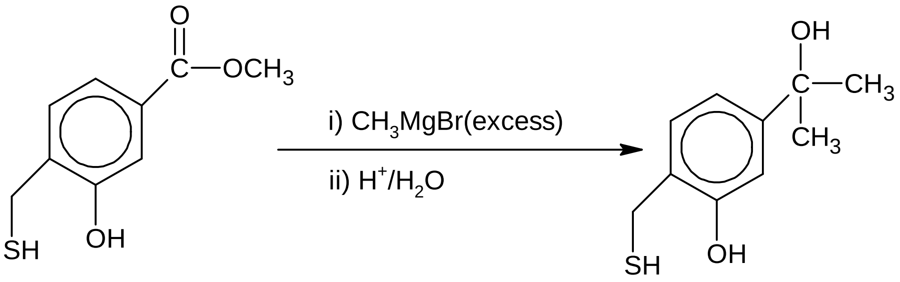
Space for Rough work

35. Calculated E_{cell} for the cell will be:

$$P_t\,\Big|\begin{matrix}H_{2(g)}\\1\text{ atm}\end{matrix}\Big|\begin{matrix}1\text{ N KOH}_{(aq)}\\\propto=75\%\end{matrix}\Big\|\begin{matrix}\frac{N}{10}HCl_{(aq)}\\\propto=90\%\end{matrix}\Big|\begin{matrix}H_{2(g)}\\\text{atm}\end{matrix}\Big|\,Pt$$

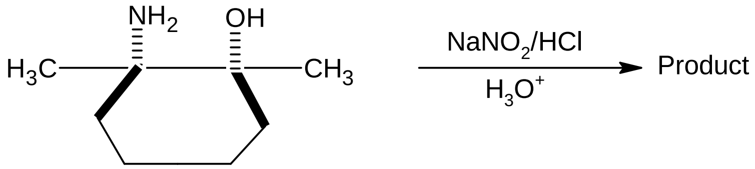
(A) – 0.68 v
(B) + 0.68 v
(C) – 0.378 v
(D) + 0.378 v

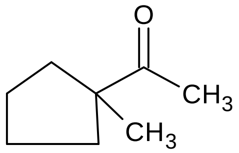
36.

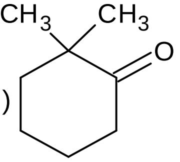

O
C—OCH3
SH
OH
i) CH3MgBr(excess)
ii) H+/H2O
OH
C—CH3
CH3
SH
OH

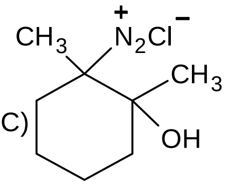
Moles of CH_3MgBr consumed per mol of reactant will be
(A) 4
(B) 2
(C) 6
(D) 3

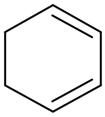
37.


NH2
OH
H3C
CH3
NaNO2/HCl
H3O+
Product

(A)


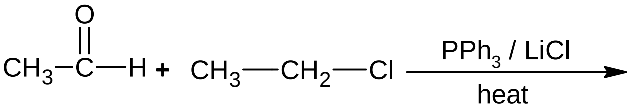
(B)


(C)

CH3
+ N2Cl –
CH3
OH

(D)


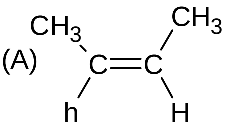
Space for Rough work

38.

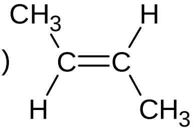


$CH_3-\overset{O}{\overset{\|}{C}}-H + CH_3-CH_2-Cl \xrightarrow[\text{heat}]{PPh_3\,/\,LiCl}$ 'X' ; X will be

(A)

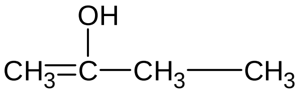

CH3
CH3
C=C
h
H

(B)


CH3
H
C=C
H
CH3

(C) $CH_3-CH-O-CH_3$

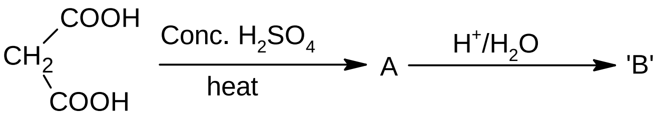
(D)



$CH_3=\overset{OH}{\overset{|}{C}}-CH_3-CH_3$

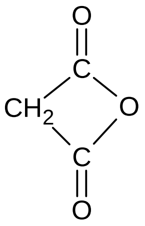
39. Select the incorrect statement for the metallurgy of aluminum:
(A) Bauxite can be enriched by Bayer’s process
(B) ‘Al’ is produced by electro lytic reduction of Al_2O_3
(C) Refining of ‘Al’ is process by Hoope’s electrolysis.
(D) Electrolysis of ‘Al’ has mixture of Al_2O_3 + Na_3Alf_6 + CaF_2 as electrolyte.

40.


COOH
CH2
COOH
Conc. H2SO4
heat
A
H+/H2O
'B'

compound 'B' will be

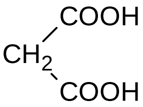
(A)



(B) CH_3-COOH

(C) H_2CO_3

(D)


COOH
CH2
COOH

Space for Rough work

41. Choose the correct code in which all the molecules have dative π bond.
$I - P_4O_{10}$, $II - (SiH_3)_3N$, $III - P_4O_6$, $IV - BF_3$
(A) I, II, III, IV (B) II & IV
(C) I, III & IV (D) I, II & IV

42. When K_2CrO_4 is added to $CuSO_4$ solution, there is formation of $CuCrO_4$ as well as $CuCr_2O_7$. Formation of $CuCr_2O_7$ is due to
(A) Basic nature of $CuSO_4$ solution (B) Acidic nature of $CuSO_4$ solution
(C) $CuSO_4$ oxidizes CrO_4^{2-} or $Cr_2O_7^{2-}$ (D) It is the typical property of $CuSO_{4s}$

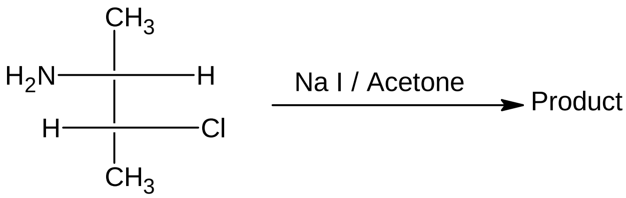
43. Which of the following is low spin to strong field ligands.
(A) $d_{xy}^2 d_{zx}^2 d_{yz}^1$ (B) $d_{xy}^2, d_{yz}^1, d_{zx}^1, d_{x^2y^2}^1, d_{z^2}^1$
(C) $d_{xy}^2, d_{yz}^1, d_{zx}^1, d_{z^2}^1$ (D) $d_{x^2-y^2}^1, d_{z^2}^1$

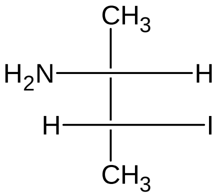
44. The configuration of the C – 2 epimer of D – glucose is
(A) 2 R, 3 S, 4 R, 5 S (B) 2 S, 3 S, 4 R, 5 R
(C) 3 S, 4 R, 4 S, 5 R (D) 2 R, 3 S, 4 R, 5 R

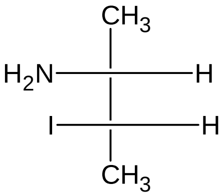
45. $XeF_2 + PF_5 \longrightarrow (A^+B^-)$
$XeF_4 + 5bF_5 \longrightarrow (C^+D^-)$; choose the correct statement about the equations -
(A) The geometry of A^+ and C^+ is same (B) The geometry of A^+ and D^- is same
(C) The geometry of B^- and D^- is same (D) The geometry of B^- and C^- is same

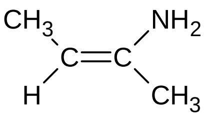
Space for Rough work

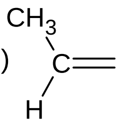
46.


CH3
H2N
H
H
Cl
CH3
Na I / Acetone
Product

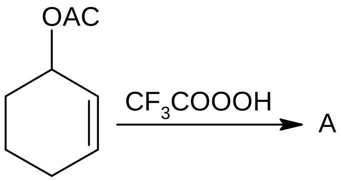
(A) 
CH3
H2N
H
H
I
CH3

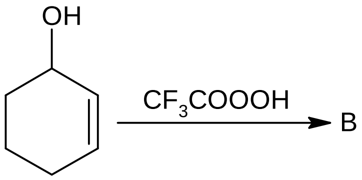
(B) 
CH3
H2N
H
I
H
CH3

(C) 
CH3
NH2
C=C
H
CH3

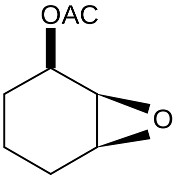
(D) 

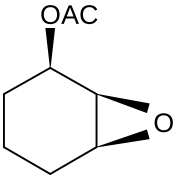
47.

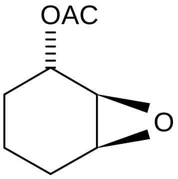

OAC
CF3COOOH
A

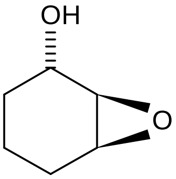

OH
CF3COOOH
B

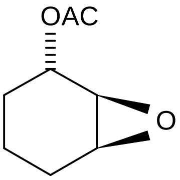
A and B in the above reactions will be:

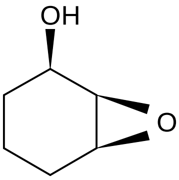
(A) A = 

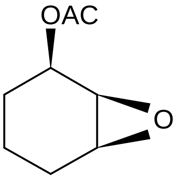
B = 

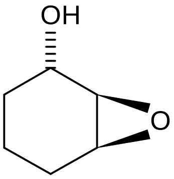
(B) A = 

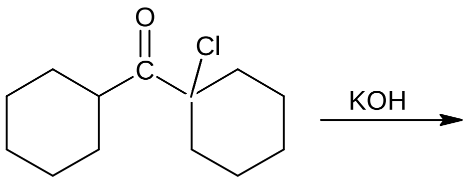
B = 

(C) A = 

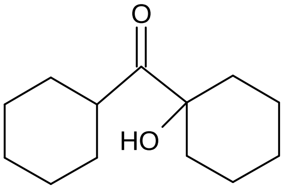
B = 

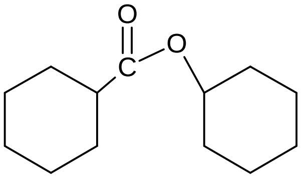
(D) A = 

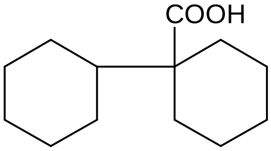
B = 

48. 

'X' ; Product 'X' is -

(A) 

(B) 

(C) 

(D) No reaction

49. Choose the incorrect statement/s among the following:
(1) Then are five heterocyclic bases in DNA & RNA
(2) All the bases except adenine have primary amine grow
(3) Double helix of Nucleic acid is spiraled together by H – bonding
(4) Proteins have no nitrogen content in them.

(A) 1, 2, 4	(B) 2, 3 & 4
(C) 1, 3	(D) 2, 4

50. One gram of charcoal absorbs 100 ml of 0.5 M CH_3COOH to form a mono-layer and thereby the molarity of acetic acid is reduced to 0.49 M. What will be the area of the charcoal absorbed by each molecule of acetic acid?
[given – surface area of charcoal = $3.01\times10^{2}\ m^{2}/gm$]

(A) $5\times10^{-19}m^{2}$	(B) $5\times10^{-20}\ m^{2}$
(C) $5\times10^{-21}\ m^{2}$	(D) $5\times10^{-23}\ m^{2}$

Space for Rough work

51. $$\begin{tikzcd} Na_2B_4O_7 + H_2SO_4 \arrow[r] & A \arrow[r, "H_2O"] & {} \arrow[d] \\ & D & C \arrow[l, "Na"'] \end{tikzcd}$$

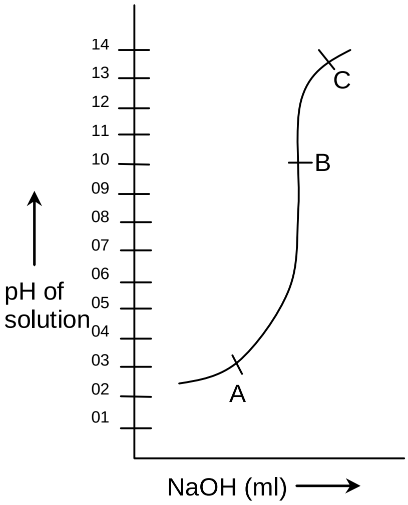
The incorrect statement regarding substance ‘D’ is
(A) ‘D’ will not react with HCl
(B) ‘D’ will not react with dil H_2SO_4
(C) ‘D’ will react with conc. H_2SO_4 to form substance ‘B’
(D) ‘D’ will react with conc. H_2SO_4 to form substance ‘A’.

52. The energy produced by the de-excitation of $\frac{1}{1000}$ moles of H – atoms from 1st excited to ground state is supplied to 2 moles of an ideal gas. 10 litres of that gas at 27°C are allow to expand reversibly & isothermally. The final volume of the gas will be
(A) $15l$
(B) $-20l$
(C) $-25l$
(D) $-30l$

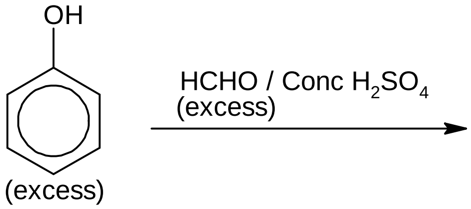
53. The composition of sample is $F_{0.93}O_{1.00}$. Find the correct code for correct statements.
(i) The %of Fe^{+3} by mass is 11.5%
(ii) The ratio of Fe^{+3};Fe^{+2}ion is 0.17
(iii) Fe^{+3} is 7.84 gm.
(A) I, II & III
(B) I & II
(C) I & III
(D) II & III

Space for Rough work

54. A 0.1 M solution of a weak acid HA is titrated by NaOH slowly. The titration curve observed is given. $ka = 4 \times 10^{-5}$ at 25^oC. The correct observation for the curve will be:



(A) Solution will make buffer before equivalence point
(B) pH of solution at equivalence point is 5.6
(C) pH of solution at equivalence point is 7
(D) Salt hydrolysis cannot suitable to predict the pH of equivalence point

55. 

'X'. The true statement about product 'X' will be:

(A) Product have alcoholic group
(B) Product is brownish mass with no alcoholic group
(C) The Product has para substitution
(D) The product has ortho substitution

Space for Rough work

56. The position of equilibrium lies to the right in each of these reactions

$N_2H_5^+ + NH_3 \rightleftharpoons NH_4^+ + N_2H_4$

$NH_3 + HBr \rightleftharpoons NH_4^+ + Br^-$

$N_2H_4 + HBr \rightleftharpoons N_2H_5^+ + Br^-$

Based on above information, what is the order of acidic strength?

(A) $HBr > N_2H_5^+ > NH_4^+$ (B) $N_2H_5^+ > N_2H_4 > NH_4^+$

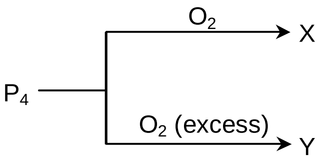
(C) $NH_3 > N_2H_4 > Br^-$ (D) $N_2H_5^+ > HBr > NH_4^+$

57. Considering no electronic repulsion in Helium atom what will be Bohr's energy for both the electrons? Bohr's energy of ground state of H-atom is – 13.6 eV.

(A) – 13.6 eV (B) – 27.2 eV

(C) – 108.8 eV (D) – 54.4 eV

58.



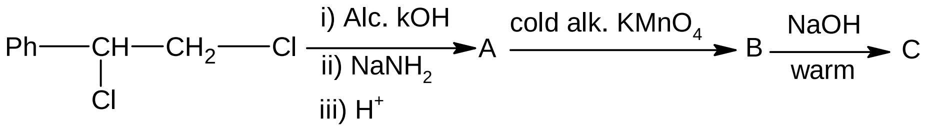
Choose the correct option regarding $d_{p\text{-}o}$ (single bond length)

(A) x < y (B) x > y

(C) x = y (D) can not compare

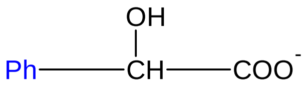
Space for Rough work

59.

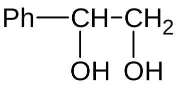


$$Ph-\underset{\underset{Cl}{|}}{CH}-CH_2-Cl \xrightarrow[\text{ii) NaNH}_2 \text{ iii) H}^+]{\text{i) Alc. kOH}} A \xrightarrow{\text{cold alk. KMnO}_4} B \xrightarrow[\text{warm}]{\text{NaOH}} C$$

The product 'C' will be

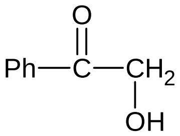
(A) 

$$Ph-\overset{\overset{OH}{|}}{CH}-COO^-$$

(B) 

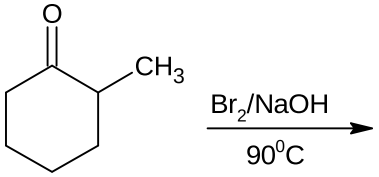
$$Ph-\underset{\underset{OH}{|}}{CH}-\underset{\underset{OH}{|}}{CH_2}$$

(C) $Ph-CH_2-COO^-$

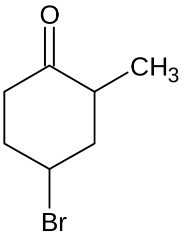
(D) 

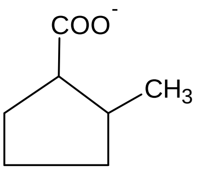
$$Ph-\overset{\overset{O}{||}}{C}-\underset{\underset{OH}{|}}{CH_2}$$

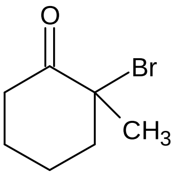
60.

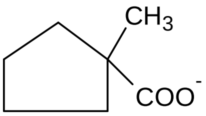


A; The product 'A' will be

(A) 

(B) 

(C) 

(D) 

Space for Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. If the asymptote of the hyperbola $(x+y+1)^2-(x-y-3)^2 = 5$ cuts each other at A and the coordinate axis at B and C then radius of circle passing through the points A, B, C is

(A) 3
(B) $\frac{\sqrt{5}}{2}$
(C) $\frac{\sqrt{3}}{2}$
(D) $\sqrt{2}$

62. A variable line $\frac{x}{a}+\frac{y}{b}=1$ moves in such a way that the H.M. of a and b is 8. If c be the least area of triangle made by the line with the coordinate axis then the last digit of c^c is

(A) 2
(B) 4
(C) 1
(D) 6

63. If $\tan^{-1}\alpha = \tan^{-1}(\alpha+k)+\frac{\pi}{4}$ is true for atleast one $\alpha \in [0, 2]$ and $\alpha \in I$, then number of all possible integral values of k is

(A) 0
(B) 1
(C) 2
(D) 3

64. If the angle between the normal chord of parabola which subtends right angle at the vertex is 0 then the maximum value of $f(\alpha) = \sin\theta\cos\alpha + \tan\theta\sin\alpha$ is

(A) $\sqrt{5}$
(B) $\sqrt{3}$
(C) $\frac{4\sqrt{5}}{3}$
(D) 2

Space for Rough work

65. If the straight lines $x+y-2=0, 2x-y+1=0$ and $px+qy-r\ =0$ are concurrent then the slope of member of family of lines $2px+3qy++4r=0$ which is farthest from origin is

(A) $-\frac{1}{2}$ (B) -2

(C) $-\frac{2}{3}$ (D) $-\frac{3}{10}$

66. Let $a=\cos^{-1}\cos 20, b=\cos^{-1}\cos 30$ and $c=\sin^{-1}\sin(a+b)$ then maximum value of $\sin(2(a+b+c)x)+\cos^2((a+b+c)x)$ is

(A) $\frac{\sqrt{5}+1}{2}$ (B) $\frac{\sqrt{5}-1}{2}$

(C) $\frac{\sqrt{3}-1}{2}$ (D) none of these

67. A chord AB which bisected at (1, 1) is drawn to the hyperbola $7x^2+8xy-y^2-4=0$ with centre C. which intersects its asymptotes in E and F. If equation of circumcircle of ΔCEF is $x^2+y^2-ax-by+c=0$, then value of $\frac{23(a-b+c)}{12}$ is equal to

(A) 1 (B) 2

(C) 3 (D) 4

68. If normal at (5, 3) of hyperbola xy – y – 2x – 2 = 0 intersects the curve again at $(\alpha, \beta-29)$, then $\frac{\beta}{\alpha}$ is

(A) 10 (B) 20

(C) 30 (D) 40

69. If the shortest distance between $2y^2-2x+1=0$ and $2x^2-2y+1=0$ is d then the number of solution of $|\sin\alpha|=2\sqrt{2}d(\alpha\in[-\pi,2\pi])$ is

(A) 3 (B) 4

(C) 5 (D) none of these

Space for Rough work

70. From a point perpendicular tangents are drawn to the ellipse $x^2 + 2y^2 = 2$. The chord of contact touches a circle which is concentric with the given ellipse, the ratio of maximum and minimum area of circle is

(A) 3
(B) 4
(C) 5
(D) none of these

71. Vertices of a variable acute angle triangle ABC lies on a fixed circle. If a, b, c are length of sides and angles of triangle ABC and x_1,x_2, x_3 are distances of orthocenter from A, B, C respectively then find the maximum value of $\sqrt{3}\left(\frac{dx_1}{da} + \frac{dx_2}{db} + \frac{dx_3}{dc}\right) + 11$

(A) 1
(B) 2
(C) 3
(D) none of these

72. Let x and y represent the sum and product of two sides of a triangle such that $x^2 = y + z^2$ where z is the third side then Inradius of the triangle is

(A) $\frac{y}{2(z+x)}$
(B) $\frac{z}{2(x+y)}$
(C) $\frac{y\sqrt{3}}{x+y}$
(D) $\frac{z\sqrt{3}}{x+y}$

73. If ellipse E_n is drawn such that it touches ellipse E_{n-1} at the extremities of its major axis, and to have its foci at the extremities of the minor axis of E_{n-1}. If eccentricity e_n of ellipse E_n is independent of n, then the eccentricity of ellipse E_{n-3} is

(A) $\frac{\sqrt{3}-1}{2}$
(B) $\frac{2-\sqrt{3}}{2}$
(C) $\frac{\sqrt{5}-1}{2}$
(D) $\frac{3-\sqrt{5}}{2}$

74. The value of $\left(\sqrt{3}+\tan 1^\circ\right)\left(\sqrt{3}+\tan 2^\circ\right)\left(\sqrt{3}+\tan 3^\circ\right)....\left(\sqrt{3}+\tan 28^\circ\right)\left(\sqrt{3}+\tan 29^\circ\right)$ is

(A) 2^{28}
(B) $2^{15}+2-\sqrt{3}$
(C) 2^{29}
(D) $2^{14}+2-\sqrt{3}$

Space for Rough work

75. Let $f(x) = 1 - x + x^2 - x^3 + ... + x^{16} - x^{17} = \alpha_0 + \alpha_1(1+x) + \alpha_2(1+x)^2 + ... + \alpha_{17}(1+x)^{17}$ then α_2 is

(A) 204 (B) 408
(C) 1632 (D) 816

76. Let f(x) be a periodic function such that: $f(x+1)f(x) + f(x+1) + 1 = f(x), \forall x \in R$ then

(A) $f(x+2) = f(x)$ (B) $f(x+4) = f(x)$
(C) $f(x+6) = f(x)$ (D) $f(x+10) = f(x)$

77. If $xf'(x) - 2f(x) = x^4 f^2(x), \forall x > 0, f(1) = -6,$ then $f(\sqrt{2})$ is

(A) $-\frac{3}{2}$ (B) $\frac{1}{2}$
(C) $\frac{3}{2}$ (D) $-\frac{1}{2}$

78. For all real $\alpha > 0$, $\int_0^{2\alpha} \frac{\sqrt[4]{\sin(3\alpha - x)}}{\sqrt[4]{\sin(3\alpha - x)} + \sqrt[4]{\sin(\alpha + x)}} dx$ equals

(A) $\frac{\alpha}{2}$ (B) α
(C) $\frac{\alpha}{4}$ (D) 2α

79. In the ΔABC, given $AB = c, AC = b$ and BC=a. Such that: $\frac{2a}{\tan A} = \frac{b}{\tan B}$. The value of $\frac{\sin^2 A - \sin^2 B}{\cos^2 A + \cos^2 B}$ is

(A) 1 (B) $\frac{4}{5}$
(C) $\frac{2}{5}$ (D) $\frac{3}{5}$

Space for Rough work

80. Let z satisfies $\left|\arg z\right| < \frac{\pi}{2}$ and $3\bar{z} + 2\left|z + 2i\right| + 9i = 0$ then real part of lnz is

(A) $\sqrt{20}$ (B) ln $\sqrt{20}$
(C) ln $\sqrt{29}$ (D) ln $\sqrt{40}$

81. A square matrix P satisfies $P^2 = I - P$ where I is identify matrix. If $P^n = 5I - 8P$ then n is
(A) 4 (B) 5
(C) 6 (D) 7

82. The term independent of x in $\left(1 + x + x^{-2} + x^{-3}\right)^{10}$ is n then last digit of $\left(n + 2\right)^n$ is
(A) 1 (B) 3
(C) 7 (D) 9

83. Different words are formed using the letters of word FIITJEE, then the probability that the word contains all consonants together is
(A) $\frac{1}{6}$ (B) $\frac{1}{7}$
(C) $\frac{1}{4}$ (D) none of these

84. Let a, b > 0 and $\bar{\alpha} = \frac{\hat{i}}{a} + \frac{4\hat{j}}{b} + b\hat{k}$ and $\bar{\beta} = b\hat{i} + a\hat{j} + \frac{1}{b}\hat{k},$ then the maximum value of $\frac{10}{5 + \bar{\alpha}.\bar{\beta}}$ is
(A) 1 (B) 2
(C) 4 (D) 8

85. If A denotes the area bounded by $f\left(x\right) = \left|\frac{\sin x + \cos x}{x}\right|, x - \text{asis},\ x = \pi$ and $x = 3\pi,$ then
(A) 1 < A < 2 (B) 0 < A < 2
(C) 2 < A < 3 (D) none of these

86. If $f\left(x\right) = \left(x - 1\right)\left|x^2 - 2007x + 2010\right| + \sin\left(x - 1\right).\ln x$ has
(A) local min at x = 1 (B) local max at = 1
(C) no local extremum at x = 1 (D) none of these

Space for Rough work

87. If $f(x) \geq 0 \forall\ x \in (0, 2)$ and $y = f(x)$ makes positive intercepts of 2 and 1 unit on x and y-axis respectively and encloses an area of $\frac{3}{4}$ units with axes, then $\int_0^2 xf'(x)dx$ is

(A) $\frac{3}{4}$
(B) 1
(C) $\frac{5}{4}$
(D) $-\frac{3}{4}$

88. Let $x_1 = \tan^{-1}\frac{2}{\sqrt{3}} > x_2 > x_3...$ are positive real numbers satisfying $\sin(x_{n+1} - x_n) + 3^{\frac{1-2n}{2}}$ $\sin x_n \text{Sin}\, x_{n+1} = 0$ for $n \geq 1$ then $\lim\limits_{x\to\infty} x_n$ equals

(A) $\frac{-\pi}{8}$
(B) $\frac{\pi}{6}$
(C) $\frac{\pi}{10}$
(D) $\frac{\pi}{12}$

89. The area of the region including between the regions satisfying min $(|x|, |y|) \geq 1$ and $x^2 + y^2 \leq 5$ is

(A) $\frac{5}{2}\left(\sin^{-1}\frac{2}{\sqrt{5}} - \sin^{-1}\frac{1}{\sqrt{5}}\right) - 4$
(B) $10\left(\sin^{-1}\frac{2}{\sqrt{5}} - \sin^{-1}\frac{1}{\sqrt{5}}\right) - 4$
(C) $\frac{2}{5}\left(\sin^{-1}\frac{2}{\sqrt{5}} - \sin^{-1}\frac{1}{\sqrt{5}}\right) - 4$
(D) $15\left(\sin^{-1}\frac{2}{\sqrt{5}} - \sin^{-1}\frac{1}{\sqrt{5}}\right) - 4$

90. The integer $\int_{\pi/4}^{\pi/2} e^x\ (\ell n(\cos x))(\cos x \sin x - 1)\cos ec^2 x dx$ is

(A) $e^{\pi/4}\left(e^{\frac{\pi}{4}} + \frac{1}{2}\ell n2 - 1\right)$
(B) $e^{\pi/4}\left(e^{\frac{\pi}{2}} + \frac{1}{2}\ell n2 - 2\right)$
(C) $e^{\frac{\pi}{4}}\left(e^{\frac{\pi}{4}} + \frac{1}{2}\ell n2 - 1\right)$
(D) $ee^{\pi/4}\left(e^{\frac{\pi}{4}} + \frac{1}{2}\ell n2 - 1\right)$

Space for Rough work

FIITJEE **JEE(Main)-2018**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – IV
(Main)

S. No.	PHYSICS	S. No.	CHEMISTRY	S. No.	MATHEMATICS
1.	**B**	31.	**A**	61.	**B**
2.	**A**	32.	**A**	62.	**D**
3.	**A**	33.	**B**	63.	**B**
4.	**C**	34.	**C**	64.	**C**
5.	**D**	35.	**D**	65.	**D**
6.	**B**	36.	**A**	66.	**A**
7.	**B**	37.	**A**	67.	**D**
8.	**C**	38.	**B**	68.	**B**
9.	**C**	39.	**B**	69.	**A**
10.	**C**	40.	**D**	70.	**B**
11.	**D**	41.	**D**	71.	**B**
12.	**D**	42.	**B**	72.	**C**
13.	**A**	43.	**A**	73.	**C**
14.	**B**	44.	**B**	74.	**C**
15.	**C**	45.	**C**	75.	**D**
16.	**A**	46.	**A**	76.	**B**
17.	**D**	47.	**C**	77.	**A**
18.	**A**	48.	**C**	78.	**B**
19.	**A**	49.	**D**	79.	**D**
20.	**B**	50.	**A**	80.	**C**
21.	**A**	51.	**D**	81.	**C**
22.	**C**	52.	**B**	82.	**C**
23.	**A**	53.	**D**	83.	**B**
24.	**D**	54.	**A**	84.	**A**
25.	**D**	55.	**B**	85.	**B**
26.	**D**	56.	**A**	86.	**C**
27.	**B**	57.	**C**	87.	**D**
28.	**C**	58.	**B**	88.	**B**
29.	**D**	59.	**A**	89.	**B**
30.	**D**	60.	**D**	90.	**A**

Physics

PART – I

SECTION – A

1. **B**

Population covered = $\rho\pi d^2$

$$50\times10^5 = \rho(\pi hR)$$

$$\therefore \rho = \frac{50\times10^5}{3.14\times2\times150\times\left(6.4\times10^6\right)} = 828.6\ \text{km}^{-2}$$

2. **A**

Fact about P – N junction.

3. **A**

Given that $v = v_o \log_e(r/r_o)$

field E = $\frac{-dv}{dr}$ or $E = -V_o\left(\frac{r_o}{r}\right)$

Now $eE = \frac{mv^2}{r}$ or $\frac{eV_o r_o}{r} = \frac{mv_o^2}{r}$

$$\therefore v = \left(\frac{ev_o r_o}{m}\right)^{1/2}$$

Now $mv = (mev_o r_o)^{1/2} = \text{constant}$

$\therefore mvr = \frac{nh}{2\pi}$ Bohr's quantum condition

or $r \propto n$

4. **C**

$$T = 2\pi\sqrt{I/MB_H}\ \therefore T_1 = 2\pi\sqrt{\left[\frac{2I}{(P_m+2P_m)B_H}\right]}$$

$$T_2 = 2\pi\sqrt{\left[\frac{2I}{(2P_m+P_m)B_H}\right]}$$

$$\therefore \frac{T_1}{T_2} = \frac{1}{\sqrt{3}}$$

5. **D**

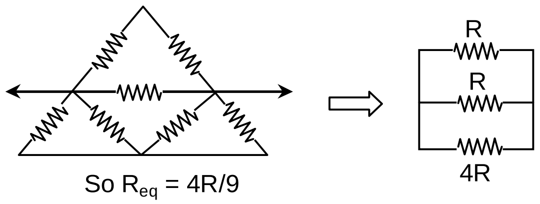
Let lengths of ABC and ADC is l_1 and l_2 respectively. Then

$\frac{l_1}{l_2} = \frac{360-60}{60} = 5$ Now $\frac{i_1}{i_2} = \frac{l_1}{l_2} = \therefore i_2 = 5i_1$

Now $B_1 = \frac{5}{6}\left(\frac{\mu_o i_1}{2r}\right)$ and $B_2 = \frac{1}{6}\left(\frac{\mu_o i_2}{2r}\right)$

$\therefore B_1 = B_2$

6. **B**



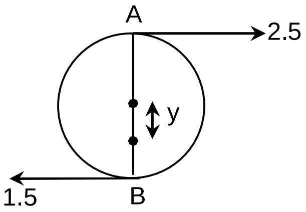
So $R_{eq} = 4R/9$

For Pmax, r = Reg. $\therefore r = 4R/9$

7. **B**

$$\frac{2.5}{2+y} = \frac{1.5}{2-y}$$

$\therefore y = 0.5$ m



8. **C**

$f_1 = f_2$

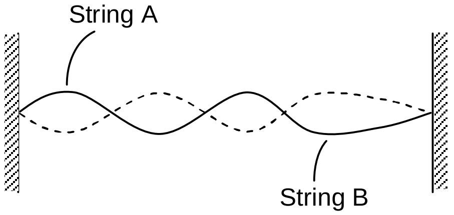
$D_1 < D_2$

$C = fD$

$\therefore C_1 < C_2$

but $C = \sqrt{\frac{T}{\mu}}$

$\therefore \mu_1 > \mu_2$



9. **C**

At the surface of a current carrying wire

$B = \frac{1}{2}\mu_o Jr$

$J \propto \frac{B}{r}$

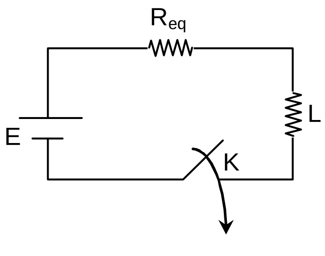
$\therefore$ as slope of wire P > slope of wire Q

10. **C**

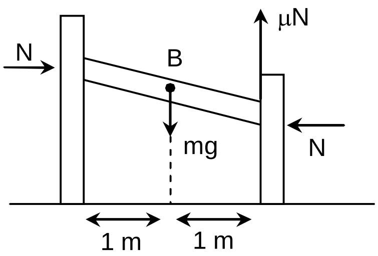
Equivalent circuit

$$Req = R + \frac{2R \times 2R}{4R} = 2R$$

$\therefore$ time constant t = $\frac{L}{reg} = \frac{L}{2R}$



11. **D**



$\sum F_x = 0, \sum F_y = 0 \therefore \mu N = Mg$

$\sum \tau$ about O = 0

$\therefore \left[N\frac{l}{2}\sin\theta\right](2) = \mu N\frac{l}{2}\cos\theta$

$\therefore \tan\theta = \mu / 2$

$\sec\theta = \left(\sqrt{\mu^2+4}\right)/2$

thus $\left(\frac{l}{2}/1\right) = \sqrt{\frac{\mu^2+4}{2}} \therefore l = \sqrt{\mu^2+4}$

$l = \sqrt{0.25+4} \therefore l = \frac{\sqrt{17}}{2}$m

12. **D**

$\frac{\mu_2}{v} - \frac{\mu_1}{v} = \frac{\mu_2-\mu_1}{R}$

$\frac{1}{v} - \frac{1.5}{-u} = \frac{1-1.5}{-R}$

for v to be +ve, $\frac{1}{2R} - \frac{3}{2u} > 0$ or u > 3 R

13. **A**

N_B reaches maximum when activity of A and B will be same

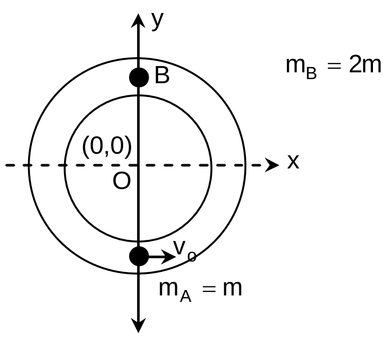
i.e $D_A N_A = D_B N_B \therefore N_B = \frac{D_A N_A}{D_B}$

14. **B**

$V_B = 0 \therefore \frac{K_Q}{b} + \frac{K_{Q'}}{b} = 0$ or $Q' = -Q$

Where Q is total charge inside A and Q^1 is charge on shell B therefore field outside B will be zero and electric field inside A will be $E = \frac{KQ}{a^3}r$ (linearly increase) between spherical shell A and B $E = KQ/r^2$.

15. **C**



$-mv_o + o = mv_1 + 2mv_2$

$-v_o = v_1 + 2v_2......(i)$ & $e = \frac{v_2 - v_1}{-v_0} = 1$

$\therefore v_2 - v_1 = -v_o....(ii)$ from $(i)\&(ii) v_1 = \frac{v_o}{3}, v_2 = \frac{-2v_o}{3}$

$\therefore T = \frac{2\pi R}{v_o}$

Angle rotated by by A = $\frac{2\pi}{3}$, Angle rotated by B = $\frac{4\pi}{3}$rad.

16. **A**

Velocity of image of particle B,

$\vec{V}_B = 5i + 4(-i) = i$

Velocity of image of particle A,

$\vec{V}_A = 10(-i) + 4(-i) - 10j$

$\therefore \vec{V}_A = -14i - 10j$

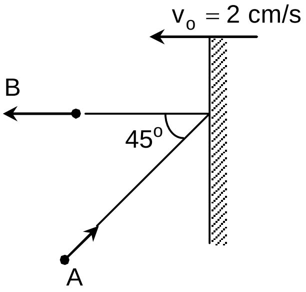
Relative velocity of image

$\vec{V}_{BA} = \vec{V}_B - \vec{V}_A$

$= i - [14(-i) - 10j]$

$= 15i + 10j$

$\therefore \vec{V}_{BA} = \sqrt{325}$ cm/sec



17. **D**

Since $P_1V_1 > P_2V_2 \Rightarrow T_A > T_B$ work done is +ve and efficiency is positive quantity

$$\eta = \frac{\text{work done}}{\text{Heat given}} = 1 - \frac{Q_{\text{released}}}{Q_{\text{absrobed}}}$$

Therefore there must be some heat absorbed in the process. During adiabatic process $\Delta Q = 0$, therefore during linear process heat will enter and leaves system at different times.

18. **A**

AV = const.

$P + \frac{1}{2}\rho v^2 = \text{constt}$

If velocity increases then pressure decreases.

19. **A**

By $\rho = m/v$ so percentage error can find.

20. **B**

$$\left(\frac{dy}{dx}\right)_{\text{tan gent}} = 2\cos\frac{\pi x}{L}$$

and $\tan(90 + 45^o) = \left(\frac{dy}{dx}\right)_{\text{normal}}$

$\Rightarrow x = \frac{L}{3}, y = \frac{\sqrt{3}L}{\pi}$

21. **A**

Fact

22. **C**

$mvr = \frac{h}{2\pi}$ in first orbit

$v = \frac{h}{2\pi mr}$

$\therefore a = \frac{v^2}{r} = \frac{h^2}{4\pi^2 m^2 r^3}$

23. **A**

$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}\therefore u=\frac{fv}{f-v}$

$\therefore \frac{v}{u}=\frac{f-v}{f}=1-\frac{v}{f}$

$|m|=\left|1-\frac{v}{f}\right| \therefore \text{slope}\frac{1}{f}=b/c$

24. **D**

$$SL_2-SL_1=10\log\frac{I_{max}}{I_{min}}=10\log\left[\frac{\left(\sqrt{I_1}+\sqrt{I_2}\right)^2}{\left(\sqrt{I_1}-\sqrt{I_2}\right)^2}\right]$$

$$=10\log\frac{\left(\frac{a_1}{a_2}+1\right)^2}{\left(\frac{a_1}{a_2}-1\right)^2}=20\text{ dB}$$

25. **D**

$a=\frac{iBl}{m}$

and v = $\left(\frac{iBl}{m}\right)t$

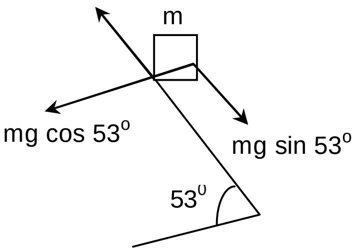
$\therefore v=20$ cm/s

26. **D**

$a=g\sin 53^o=\frac{4g}{5}$ time taken by block to reach the bottom

$\therefore t=\sqrt{\frac{25}{a}}=\sqrt{\frac{25}{2\times 10}}=\sqrt{\frac{5}{4}}$

$\therefore$ Distance travelled by the inclined $=vt=4\sqrt{\frac{5}{4}}=2\sqrt{5}$ m



27. **B**

speed v = $\sqrt{v_{x^2}+v_{y^2}}\therefore 2v\frac{dv}{dt}=2v_xa_x+2v_ya_y$

$\frac{dv}{dt}=\frac{v_xa_x+v_ya_y}{v}=\frac{3\times 2+4\times 1}{\sqrt{3^2+4^2}}=2\text{ m/s}^2$

28. **C**

Displacement of the winning team is zero. Hence work done by loosing team on the winning team is zero.

Ground applies a frictional force on the losing team in a direction opposite to its displacement hence work done by ground on losing team is zero.

29. **D**

$$\int \vec{E}.\,d\vec{l} = -A.\frac{dB}{dt}$$

$$E(2\pi r) = -17\left[\frac{d}{dt}\{17 + 0.2\sin(\omega t + \phi)\}\right]$$

$$\therefore E = \frac{-r}{2}(0.2)\omega\cos(\omega t + \phi)$$

$\therefore$ magnitude of amplitude = $\frac{r}{2}(0.2) = 240$ m N/C

30. **D**

Zero in fact A will be inclined away from the vertical at some angle.

Chemistry

PART – II

SECTION – A

31. **A**
Factual

32. **A**
They make non ideal solution with negative deviation so $\Delta V_{mix} < 50$.

33. **B**
Initial nuclides of X and Y $\Rightarrow X_o$ and Y_o
After time 't' nuclides of X and Y $\Rightarrow X_t$ and Y_t
$X_t = 1/2Y_o, Y_t = 1/4X_o$
$X_o = 1.414Y_o, Y_t = 1/4X_o$
$\text{Now}, X_t = X_o e^{-D_1/t} = 1/2Y_o; Y_t = Y_o e^{-D_2/t} = 1/4Y_o$
Dividing equation (i) by (ii) ; we get
$X_o = \sqrt{2}Y_o \therefore 2 = 2e^{(D_2 - D_1)t}$
$\therefore e^{(D_2 - D_1)t} = 1$
$\because$ since t is not zero so $D_2 = D_1 \Rightarrow$ 8 days.

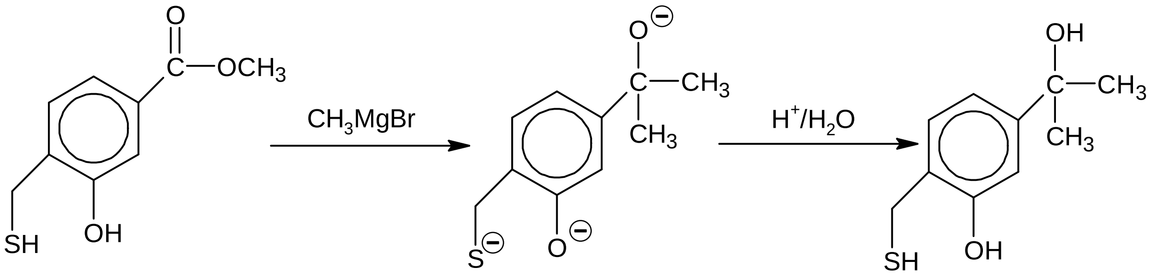
34. **C**
For cyclic process du = 0
$q = -w$
$pv_1 = 1 \times R \times 300$
$pv_2 = 1 \times R \times 400$
$\therefore p(v_2 - v_1) = R(400 - 300)$
$q = -(w_{BA} + w_{AC} + w_{CB})$
$-600 = -[0 - 2(400 - 300) + w_{CB}]$
$w_{CB} = 800$ cal.

35. **D**
Anodic reaction –
$KOH \rightleftharpoons K^+ + OH^-$
$1 - 0.75 \quad 0.75 \quad 0.75$
$$[H^+]_a = \frac{10^{-14}}{0.75}$$
Cathodic reaction
$HCl \rightleftharpoons H^+ + Cl^-$
$0.1 \quad 0 \quad 0$
$0.1 \times 0.9 \quad 0.1 \times 0.9$
$(H^+)_C = 0.09$

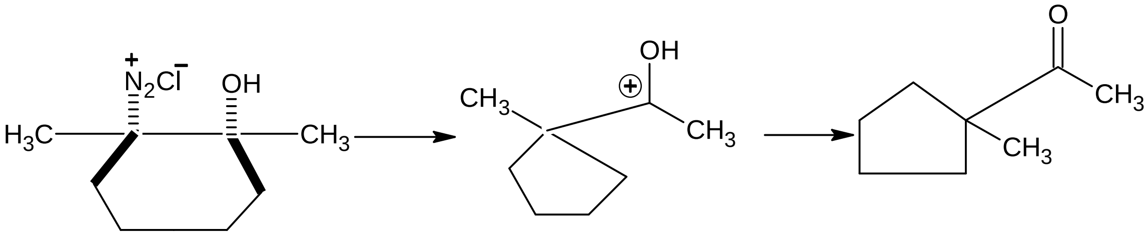
$$E_{cell} = 0 - \frac{0.0591}{2}\log\frac{\left[H^+\right]_a}{\left[H^+\right]_c} \quad \left[E^o_{cell} = 0, \text{ it is concentration cell}\right]$$

on solving $E_{cell} = 0.378$ v

36. **A**


O
C—OCH3
SH
OH
CH3MgBr
O⊖
C—CH3
CH3
S⊖
O⊖
H+/H2O
OH
C—CH3
CH3
SH
OH

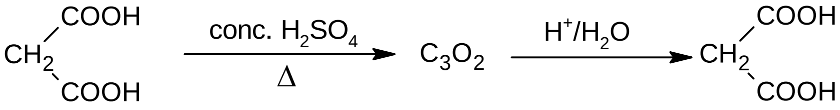
37. **A**


N2Cl−
OH
H3C
CH3
CH3
OH
⊕
CH3
O
CH3
CH3

38. **B**
Witting Reaction, in presence of lithium salt trans alkene is formed.

39. **B**
'Al' is produce by electrolytic reduction of Al_2O_3

40. **D**



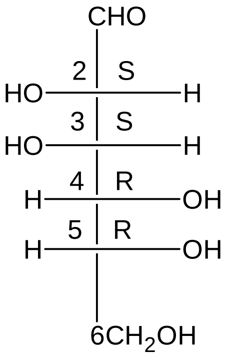
$$CH_2(COOH)_2 \xrightarrow[\Delta]{\text{conc. } H_2SO_4} C_3O_2 \xrightarrow{H^+/H_2O} CH_2(COOH)_2$$

41. **D**
Conceptual.

42. **B**
Conceptual.

43. **A**
$\left[t_{2g}^{\;2,2,1}\ell_g^{\;0,0}\right]$

44. **B**
C – 2 epimer of D – glucose



45. **C**

$$XeF_2 + PF_5 \longrightarrow XeF^+ + PF_6^-$$

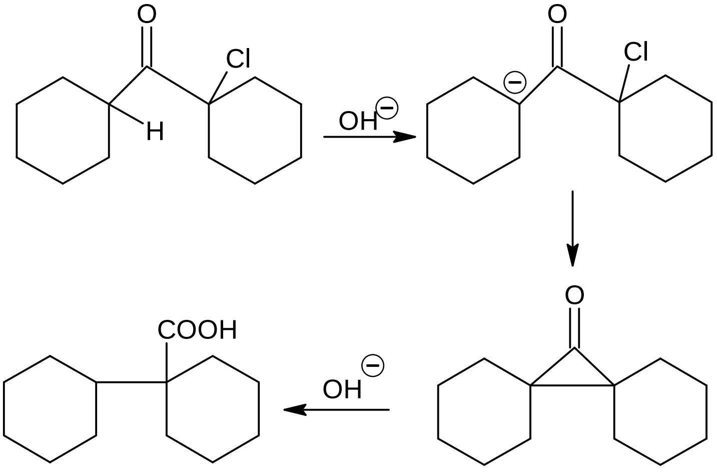
$$XeF_4 + SbF_5 \longrightarrow XeF_3^+ + SbF_6^-$$

46. **A**

Due to NGP reaction proceeds with retention of configuration.

47. **C**

48. **C**



49. **D**

Factual.

50. **A**

Initial moles of acetic acid $= \dfrac{0.5 \times 100}{1000} = 0.05$

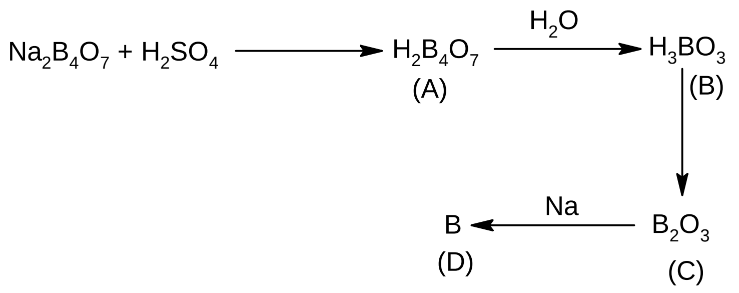
Moles of acetic acid left $= \dfrac{0.49 \times 100}{1000} = 0.049$

Moles of acetic acid absorbed $0.05 - 0.049 = 0.01$ mol in a litre

Molecules $6.022 \times 10^{23} \times 0.001 = 6.022 \times 10^{2}$ in 100 ml

Area occupied by single molecule of acetic acid $= \dfrac{\text{Total area}}{\text{no. of molecules}} = \dfrac{3.01 \times 10^{2}}{6.022 \times 10^{20}} = 5 \times 10^{-19}\ m^2$

51. **D**



∴ Boron does not react with HCl, dil H_2SO_4 but react with conc. H_2SO_4 to form H_3BO_3

$$2B + \underset{(conc.)}{3H_2SO_4} \longrightarrow 2H_3BO_3 + 3SO_2$$

52. **B**

$$DE = -2.18 \times 10^{-18}\left[1 - \frac{1}{4}\right]$$

$$= -2.18 \times 10^{-18} \times \frac{3}{4} J / atom$$

$$= -2.18 \times 10^{-18} \times \frac{3}{4} \times 6.022 \times 10^{20} \text{Jouls for } \frac{1}{100} \text{moles}$$

$$= -2.18 \times \frac{3}{4} \times 6.022 \times 10^{2} J.$$

$$= -3940 \text{ J}$$

Now for isothermal expansion $\Delta U = 0$

$\therefore dq = -dw$

$$\text{so } w = -2.303 \text{ nRT } \log\frac{v_2}{v_1}$$

$$-39400 = -2.303 \times 2 \times 8.314 \times 300 \times \log\frac{v_2}{v_1}$$

$$\log\frac{v_2}{v_1} = \frac{39400}{11488.3}$$

$$\log\frac{v_2}{10} = 0.3$$

$$\text{or } \frac{v_2}{10} = 2$$

$$v_2 = 20 \text{ litre}$$

53. **D**

Let no. of $Fe^{2+} = x$

no. of $Fe^{2+} = 0.93 - x$

then $2x + 3(0.93 - x) = 2$

$x = 0.79$

54. **A**

Solution will make buffer before equation point since before equation point both HA and NaA are present.

55. **B**
The Product is phenol – for aldehyde resin which is brownish mass with no alcoholic group.

56. **A**
Conceptual.

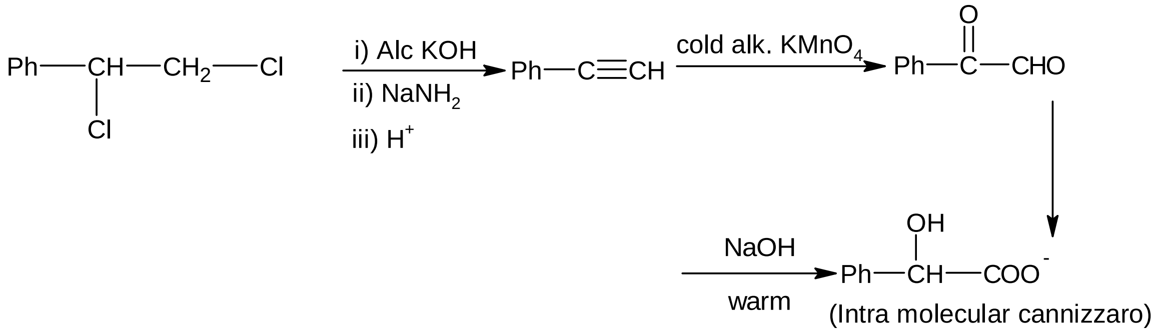
57. **C**
If no electronic repulsion is there than He can be treated as two mono electronic atoms so

$$E_{He} = -13.6 \times \frac{z^2}{n^2} \Rightarrow -13.6 \times 4 = -54.4 \text{ eV}$$

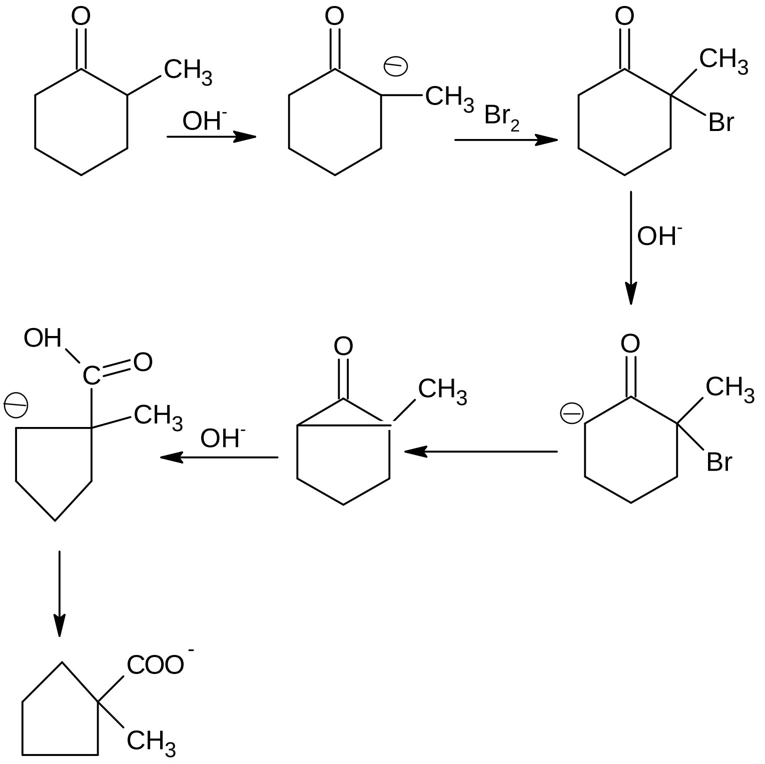
For both electronic system $\Rightarrow -54.4 \times 2 = -108.8$ eV.

58. **B**
Conceptual.

59. **A**


Ph—CH—CH2—Cl
Cl
i) Alc KOH
ii) NaNH2
iii) H+
Ph—C≡CH
cold alk. KMnO4
O
Ph—C—CHO
NaOH
warm
OH
Ph—CH—COO-
(Intra molecular cannizzaro)

60. **D**


O
CH3
OH-
O
CH3
Br2
O
CH3
Br
OH-
O
CH3
Br
O
CH3
OH-
OH
C=O
CH3
COO-
CH3

Mathematics **PART – III**

SECTION – A

61. **B**

Centre of rectangular hyperbola = (1, -2)
So equation of asymptotes are x = -1; y = -2

So radius of circle = $\frac{\sqrt{5}}{2}$

62. **D**

$\frac{1}{a}+\frac{1}{b}=\frac{1}{4} \Rightarrow b=\frac{4a}{a-4}$

so $A=\frac{4a^2}{2(a-4)}$

$A_{min} = 32 = c$
So last digit of $c^c = 6$

63. **B**

We have $k=1-\frac{2}{\alpha+1}-\alpha^2$
Gives k = -1 only

64. **C**

$t_2=-t_1-\frac{2}{t_1}$ also $t_1t_2=-4$

$\Rightarrow t_1=\pm\sqrt{2}$

so, $m_1 = \sqrt{2}$ and $m_2 = -\sqrt{2}$

$\tan\theta=\left|\frac{m_1-m_2}{1+m_1m_2}\right|=2\sqrt{2}$

$\sin\theta=\frac{2\sqrt{2}}{3}$

so, $(f(\alpha))_{max}=\sqrt{\frac{8}{9}+8}=\frac{4\sqrt{5}}{3}$

65. **D**

$$\begin{vmatrix} 1 & 1 & -2 \\ 2 & -1 & 1 \\ p & q & -r \end{vmatrix}=0 \Rightarrow p+5q-3r=0$$

so, $2px+3qy+\frac{4}{3}(p+5q)=0$

$p\left(2x+\frac{4}{3}\right)+q\left(3y+\frac{20}{3}\right)=0$

so fixed point is $\left(-\frac{2}{3},-\frac{20}{9}\right)$

so the slope of required line = $-\frac{3}{10}$

66. **A**

$a = 20 - 6\pi,\ b = 10\pi - 30,\ c = \sin^{-1}\sin(4\pi - 10) = 10 - 3\pi$

$f(x) = \sin(2(a+b+c)x) + \cos^2((a+b+c)x)$

$= \sin 2\pi x + \cos^2 \pi x$

$= \sin 2\pi x + \frac{1+\cos 2\pi x}{2}$

maximum value of $f(x) = \frac{\sqrt{5}+1}{2}$

67. **D**

Clearly $C \equiv (0,0)$, let the equation of circle be $x^2 + y^2 - ax - by = 0$.

On homogenizing with chord $11x + 3y - 14 = 0$

and comparing with pair of asymptotes we get equation of circle as

$x^2 + y^2 - \frac{112x}{23} - \frac{64y}{23} = 0$

68. **B**

Equation of hyperbola $(x-1)(y-2) = 4$

$\Rightarrow XY = 4$

If normal at $\left(ct, \frac{c}{t}\right)$ intersect curve again at $\left(ct', \frac{c}{t'}\right)$ then t' = $-\frac{1}{t^3}$

$2t = 4 \Rightarrow t = 2$

$(X', Y') = \left(-\frac{1}{4}, -16\right)$

$\Rightarrow (\alpha, \beta - 29) = \left(\frac{3}{4}, -14\right)$

$\Rightarrow \alpha = \frac{3}{4}, \beta = 15$

so $\frac{\beta}{\alpha} = \frac{15 \times 4}{3} = 20$

69. **A**

$2y\frac{dy}{dx} = 1$

$\Rightarrow \frac{dy}{dx} = \frac{1}{2y} = 1$

$\Rightarrow y = \frac{1}{2}$

so, $d = \sqrt{\frac{1}{16} + \frac{1}{16}} = \frac{1}{2\sqrt{2}}$

so $|\sin\alpha| = 1$

so number of solution is 3

70. **B**

The director circle of $\frac{x^2}{2}+\frac{y^2}{1}=1$ is $x^2+y^2=3$

Let $P\left(\left(\sqrt{3}\cos\theta, \sqrt{3}\sin\theta\right)\right)$

Chord of contact is $x\sqrt{3}\cos\theta+2y\sqrt{3}\sin\theta-2=0$

It touches $x^2+y^2=r^2$

$\Rightarrow r=\frac{2}{\sqrt{3\cos^2\theta+12\sin^2\theta}}=-\frac{2}{\sqrt{3+9\sin^2\theta}}$

$r_{max}=\frac{2}{\sqrt{3},}r_{min}=\frac{2}{\sqrt{12}}$

So, $\frac{A_{max}}{A_{min}}=4$

71. **B**

$x_1=2R\cos A,\ x_2=2R\cos B, x_3=2R\cos C$

$\frac{dx_1}{dA}=-2R\sin A$ also $a=2\sin A \Rightarrow \frac{da}{dA}=2R\cos A$

so, $\frac{dx_1}{da}=-\tan A, \frac{dx_2}{db}=-\tan B, \frac{dx_3}{dc}=-\tan C$

$\tan A+\tan B+\tan C\geq 3\sqrt{3}$

So,$\left(\frac{dx_1}{da}+\frac{dx_2}{db}+\frac{dx_3}{dc}\right)+11\leq 2$

72. **C**

Let $b+c=x$ and $bc=y$ and $a=z$

Then $(b+c+a)(b+c-a)=bc$

$\Rightarrow \sqrt{\frac{s(s-a)}{bc}}=\frac{1}{2}\Rightarrow \cos\frac{A}{2}=\cos\frac{\pi}{3}\Rightarrow A=120°$.

$r=\frac{\Delta}{s}=\frac{\frac{1}{2}bc\sin A}{\frac{a+b+c}{2}}=\frac{y\sin120°}{\frac{x+y}{2}}=\frac{y\sqrt{3}}{x+z}$

73. **C**

Let $\frac{x^2}{a_n^2}+\frac{y^2}{b_n^2}=1, a_n>b_n$ be the ellipse with eccentricity = e_n

$\Rightarrow b_n^2=a_n^2\left(1-e_n^2\right)$ ......(1)

According to question $b_n=b_{n-1}$ ....(2)

And $a_{n-1}=a_ne_n$ …..(3)

Again for ellipse $a_n^2e_n^2=a_n^2\left(1-e_n^2\right)\left(1-e_{n-1}^2\right)$ ….(4)

Solving we have $a_n^2e_n^2=a_n^2\left(1-e_n^2\right)\left(1-e_{n-1}^2\right)$

$\Rightarrow e_n^2=\left(1-e_n^2\right)\left(1-e_{n-1}^2\right)$ ...(5)

eccentricity e_n is independent of n ⇒ $e_n = e_{n-1} = e$

$$e^2 = \left(1-e^2\right)^2 \Rightarrow e = \frac{\sqrt{5}-1}{2}$$

74. **C**

$$\tan\left(\left(\theta^\circ\right)+\left(30-\theta\right)^\circ\right)$$

$$= \frac{\tan\theta^\circ + \tan\left(30-\theta\right)^\circ}{1-\left(\tan\theta^\circ\right)\left(\tan\left(30-\theta\right)^\circ\right)} = \frac{1}{\sqrt{3}} \Rightarrow \sqrt{3}\left(\tan\theta^\circ + \tan\left(30-\theta\right)^\circ\right) = 1-\left(\tan\theta^\circ\right)\left(\tan\left(30-\theta\right)^\circ\right)$$

$$\left(\sqrt{3}+\tan\theta^\circ\right)\left(\sqrt{3}+\tan\left(30-\theta\right)^\circ\right)$$

$$= 4^{14}\left(\sqrt{3}+\tan 15^\circ\right) = 4^{14}\left(\sqrt{3}+\left(2-\sqrt{3}\right)\right) = 2^{29}$$

75. **D**

$$f\left(x\right) = 1-x+x^2-x^3+....+x^{16}-x^{17} = \alpha_0+\alpha_1\left(1+x\right)+\alpha_2\left(1+x\right)^2+....+\alpha_{17}\left(1+x\right)^{17}$$

$$\Rightarrow f''\left(-1\right) = 2.1+3.2+4.3+.....+17.16 = 2.1\alpha_2$$

$$\Rightarrow 2\alpha_2 = \sum_{r=1}^{16} r\left(r+1\right) = \frac{1}{3}\sum_{r=1}^{16}\left(r\left(r+1\right)\left(r+2\right)-\left(r-1\right)r\left(r+1\right)\right) = \frac{1}{3}\left(16.17.18\right)$$

$$\Rightarrow \alpha_2 = 816$$

76. **B**

We have $f\left(x+1\right) = \frac{f\left(x\right)-1}{f\left(x\right)+1}$. For convenience, let $f\left(x\right) = \alpha_x$

We have $\alpha_{n+1} = \frac{\alpha_n - 1}{\alpha_n + 1}$

Thus $\alpha_{n+2} = \frac{\alpha_{n+1}-1}{\alpha_{n+1}+1} = \frac{\alpha_n - 2}{2\alpha_n}$

Continuing on, we have $\alpha_{n+3} = \frac{\alpha_{n+2}-1}{\alpha_{n+2}+1} = \frac{-\alpha_n - 2}{3\alpha_n - 2}$

$$\alpha_{n+4} = \frac{\alpha_{n+3}-1}{\alpha_{n+3}+1} = \frac{-4\alpha_n}{-4} = \alpha_n$$

Thus the function is periodic with length 4

77. **A**

$$xy' - 2y = x^4y^2, y\left(1\right) = -6$$

Divide by x: $y' - \frac{2y}{x} = x^3y^2$

Let $y = u^{-1}, \frac{dy}{dx} = -u^{-2}\frac{du}{dx}$ chain rule

This gives: $-u^{-2}\frac{du}{dx} - \frac{2}{x}u^{-1} = x^3u^{-2}$

$$\frac{du}{dx} + \frac{2}{x}u = -x^3$$

The integrating factor is $e^{\int \frac{2}{x}dx} = x^2$

But, $u = y^{-1}$, therefore: $y = \frac{-6x^2}{x^6 - 6C}$

So $y = \frac{-6}{x^4}$

78. **B**

Let $I = \int_0^{2\alpha} \frac{\sqrt[4]{\sin(3\alpha - x)}}{\sqrt[4]{\sin(3\alpha - x)} + \sqrt[4]{\sin(\alpha + x)}}dx$

$$= \int_0^{\alpha} \frac{\sqrt[4]{\sin(3\alpha - x)}}{\sqrt[4]{\sin(3\alpha - x)} + \sqrt[4]{\sin(\alpha + x)}} + \frac{\sqrt[4]{\sin(3\alpha - (2\alpha - x))}}{\sqrt[4]{\sin(3\alpha - (2\alpha - x))} + \sqrt[4]{\sin(\alpha + (2\alpha - x))}}dx$$

$$\Rightarrow I = \int_0^{\alpha} dx = \alpha$$

79. **D**

$$\frac{2a}{\tan A} = \frac{b}{\tan B}$$

$$\frac{2a\cos A}{\sin A} = \frac{b\cos B}{\sin B}$$

$2\cos A = \cos B$, by the sine rule

Therefore,

$$\frac{\sin^2 A - \sin^2 B}{\cos^2 A + \cos^2 B} = \frac{(1 - \cos^2 A) - (1 - \cos^2 B)}{\cos^2 A + \cos^2 B}$$

$$= \frac{1 - \cos^2 A - 1 + 4\cos^2 A}{\cos^2 A + 4\cos^2 B} = \frac{3\cos^2 A}{5\cos^2 A} = \frac{3}{5}$$

80. **C**

Let z = x + iy

$$3(x - iy) + 2\sqrt{x^2 + (y + 2)^2} + 9i = 0$$

$$\Rightarrow y = 3 \text{ and } 3x + 2\sqrt{x^2 + (y+2)^2} + 9i = 0$$

$$9x^2 = 4x^2 + 100$$

$x^2 = 20$

$x = \sqrt{20}$ $(\text{as } |\arg z| < \pi/2)$

so $z = \sqrt{20} + 3i$

$\ln \sqrt{20} + 3i = e^a.e^{ib}$

$$e^a = \sqrt{29} \Rightarrow a = \ln\sqrt{29}$$

81. **C**

$$P^3 = P(I-P) = P - P^2 = P - (I-P) = 2P - I$$

$$P^4 = P(2P-I) = 2(I-P) - P = 21 - 3P$$

$$P^5 = P(2I - 3P) = 2P - 3(IP) = 5P - 31$$

$$P^6 = P(5P - 3I) = P(I-P) - 3P = 5I - 8P$$

82. **C**

$$\left(1 + \frac{1}{x} + \frac{1}{x^2} + \frac{1}{x^3}\right)^{10} \frac{\left(1 + x + x^3 + x^4\right)^{10}}{x^{30}}$$

coefficient of x^{30} in $\left(1 + x + x^3 + x^4\right)$

$= {}^{10}C_{10}\,{}^{10}C_0 + {}^{10}C_9 + {}^{10}C_3 + {}^{10}C_8\,{}^{10}C_6 + {}^{10}C_7\,{}^{10}C_9$

= 1 + 1200 + 9450 + 1200

= 11851

last digit of $(11853)^{11851}$ = 7

83. **B**

$$n(S) = \frac{7!}{(2!)^2}$$

$$n(A) = \frac{5!3!}{7!} = \frac{1}{7}$$

84. **A**

$$\vec{\alpha}.\vec{\beta} = \frac{b}{a} + \frac{4a}{b} + 1$$

as $\dfrac{b}{a} + \dfrac{4a}{b} + 1 \geq 5$

so $\left(\dfrac{10}{5 + \vec{\alpha}.\vec{\beta}}\right)_{\max} = 1$

85. **B**

$$\frac{2\sqrt{2}}{2\pi} < \int_{\pi}^{2\pi} \frac{|\sin x + \cos x|}{x} dx < \frac{2\sqrt{2}}{2\pi} \qquad \text{….. (i)}$$

$$\pi < x < 2\pi \Rightarrow \frac{1}{2\pi} < \frac{1}{\pi} < \frac{1}{\pi}$$

$$\frac{2\sqrt{2}}{3\pi} < \int_{2\pi}^{3\pi} \frac{|\sin x + \cos x|}{x} dx < \frac{2\sqrt{2}}{2\pi} \qquad \ldots\ldots(ii)$$

adding (i) and (ii)

$$\frac{5\sqrt{2}}{3\pi} < AM\frac{3\sqrt{2}}{\pi}0.75 < A < 1.3$$

86. **C**

As f(1) = 0

$f\left(1^+\right) > 0$

$f\left(1^+\right) < 0$

$\Rightarrow$ no local extremum at x = 1

87. **D**

$$I = xf(x)\Big|_0^2 - \int_0^2 f(x)dx$$

$$= 0 - \frac{3}{4} = -\frac{3}{4}$$

88. **B**

$$\frac{\sin(x_n - x_{n+1})}{\sin x_n \sin_{n+1}} = \frac{1}{3^{\frac{2n+1}{2}}} \Rightarrow \sum_{n=1}^{\infty} \cot x_{n+1} - \cot x_n = \sum_{n=1}^{\infty} \frac{1}{3^{\frac{2n-1}{2}}}$$

$$\Rightarrow \lim_{n\to\infty} \cot x_n - \cot x_1 = \frac{\sqrt{3}}{2}$$

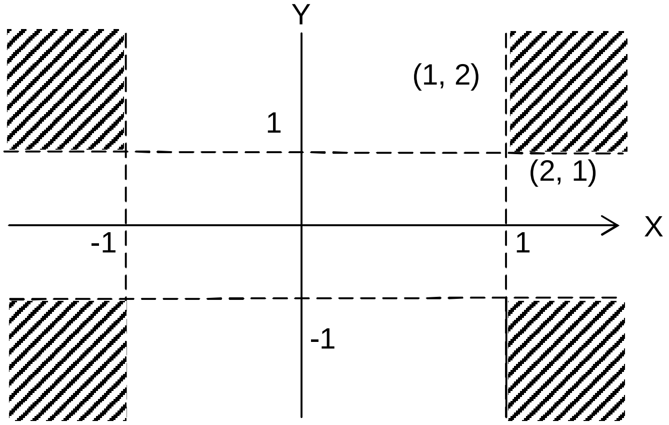
$$\Rightarrow \lim_{n\to\infty} x_n = \frac{\pi}{6} \text{as } \cot x_1 = \frac{\sqrt{3}}{2}$$

89. **B**

Shaded region depicts min $\left(|x|, |y|\right) \geq 1$

Required area = $4\int_1^2 \left(\sqrt{5 - x^2} - 1\right)dx$

$$= 10\left(\sin^{-1}\frac{2}{\sqrt{5}} - \sin^{-1}\frac{1}{\sqrt{5}}\right) - 4$$



90. **A**

$$\int_{\pi/4}^{\pi/2}(\ell n(\cos x))e^{x}\left(\cot x-\operatorname{cosec}^{2}x\right)dx=\left[\ell n(\cos x).e^{x}\cot x+e^{x}\right]_{\pi/4}^{\pi/2}$$

$$=\left[e^{x}\left(\ell n(\cos x).\cot x+1\right)\right]_{\frac{\pi}{4}}^{\frac{\pi}{2}}=e^{\frac{\pi}{2}}-e^{\frac{\pi}{4}}\left(\ell n\frac{1}{\sqrt{2}}+1\right)$$

$$=e^{\pi/4}\left[e^{\pi/4}+\frac{1}{2}\ell n2-1\right]$$

FIITJEE

JEE (Advanced)-2018

ALL INDIA TEST SERIES

FULL TEST – IX

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 183**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into Two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01– 07, 19 – 25, 37 - 43)*** *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (08 – 13, 26 – 31, 44 - 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S).*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (14 – 18, 32 – 36, 50 - 54)*** *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

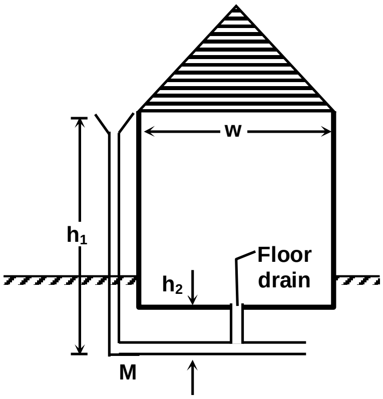
Physics PART – I

SECTION – A

Straight Objective Type

This section contains **7 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

1. A very simplified schematic of the rain drainage system for a home is shown in figure. Rain falling on the slanted roof runs off into gutters around the roof edge; it then drains through downspouts (only one is shown) into a main drainage pipe M below the basement, which carries the water to an even larger pipe below the street. In figure, a floor drain in the basement is also connected to drainage pipe M. Suppose the following apply:



(1) the downspouts have some height but water trickles slowly and many such spouts connect to the drainage pipe M,
(2) the floor drain has height $h_2 = 1.2$ m,
(3) pipe M has radius 3 cm,
(4) the house has side width w = 25 m and front length L = 80 m,
(5) all the water striking every part of the roof goes through pipe M,
(6) the speed of the water in a downspout is negligible, and
(7) the wind speed is negligible (the rain falls vertically). The possible rainfall rate, in centimeters per hour, when water from pipe M crosses the height of the floor drain and threatens to flood the basement, is

Note: For calculations, you may assume $\pi \approx \frac{22}{7}$ and $\sqrt{6} \approx \frac{4.9}{2}$

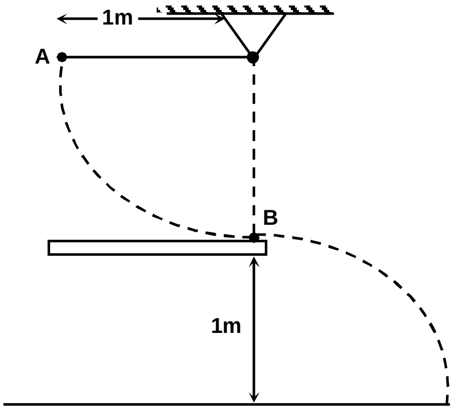
(A) 8
(B) 11
(C) 14
(D) 17

Space for rough work

2. Mark out the correct statement(s)
   (A) In alpha decay, the energy released is shared between alpha particle and daughter nucleus in the form of kinetic energy and share of alpha particle is more than that of the daughter nucleus.
   (B) In beta decay, the energy released is shared between electron and antineutrino.
   (C) A nuclide undergoes α decay then all the α particles emitted by that nuclide will have almost the same speed.
   (D) A nuclide undergoes β decay then all the β particles emitted by that nuclide may have widely different speeds.

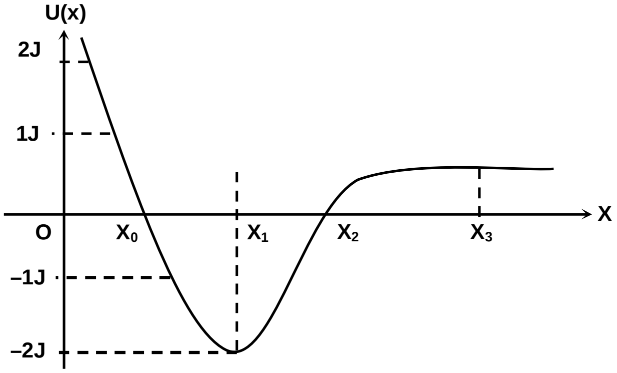
3. A bead is connected with a fixed disc of radius R by an inextensible massless string of length $\ell = \frac{\pi R}{2}$ in a smooth horizontal plane. If the bead is pushed with a velocity v_0 perpendicular to the string, the bead moves in a horizontal curve, and consequently collapses on the disc after a time t. Then
   (A) work done by the string on the bead is mv_0^2.
   (B) The average speed of the bead is v_0 and its average velocity for time t is $\frac{4v_0}{\pi}$
   (C) Tension in the string will increase continuously.
   (D) Kinetic energy of the bead increases gradually.

4. A small steel ball B is at rest on the edge of a plank at a height of 1m above the ground. Another steel ball A, used as the bob of a meter long simple pendulum, is released from rest with the pendulum horizontal, and swings against B as shown. The masses of the balls are identical and the collision is elastic.
   Consider the motion of B only until it first hits the ground.
   (A) Ball A is in motion for the longer time
   (B) Ball B is in motion for the longer time
   (C) Ball A has the greater path length
   (D) Ball B has the greater path length



Space for rough work

5. A conservative force has the potential energy function U(x) as shown. A particle moving in one dimension under the influence of this force has kinetic energy 1.0 J when it is at position X_1. Which of the following is/are correct statement(s) about the motion of the particle?



(A) It oscillates.
(B) It moves to the right of X_3 and never returns.
(C) It comes to rest at either X_0 or X_2.
(D) It cannot reach either X_0 or X_2.

6. Three charged particles are in equilibrium under their electrostatic forces only.
(A) The particle must be collinear.
(B) All the charges cannot have the same magnitude.
(C) All the charges cannot have the same sign.
(D) The equilibrium is unstable.

7. A straight segment OP of length L of a circuit carrying current I ampere is placed along x-axis. Two infinitely long straight wires A and B each extending from z = $-\infty$ to $+\infty$ are fixed at y = $-\ell$ meter to y = $+\ell$ meter respectively. Wires A and B, each carry current I ampere. Given that O is origin of the coordinate system. Possible values of magnitude of force on segment OP is/are:

(A) $\frac{\mu_0}{\pi} I^2 \ell n\left(1+\frac{L^2}{\ell^2}\right)$
(B) $\frac{\mu_0}{2\pi} I^2 \ell n\left(1+\frac{L^2}{\ell^2}\right)$
(C) $\frac{\mu_0}{\pi} I^2 \ell n\left(1+\frac{\ell^2}{L^2}\right)$
(D) zero

Space for rough work

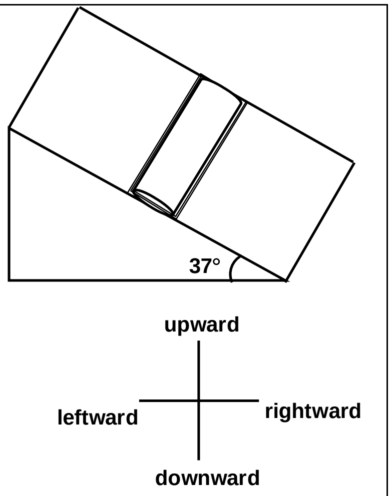
Matrix Match Types

Each of 2 tables with 3 Columns and 4 Rows has three questions. Column-1 will be with 4 rows designated (I), (II), (III) and (IV). Column-2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column-3 will be with 4 rows designated (P), (Q), (R) and (S). Each question has four options with only **ONE** correct

Answer questions 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

Figure shows a solid wooden cylinder of mass m = 0.250 kg and length L = 0.100 m with N = 10 turns of wire wrapped around it longitudinally, so that the plane of wire coil contains the long central axis of the cylinder. The cylinder is released on a plane inclined at an angle θ to the horizontal, with the plane of the coil parallel to the inclined plane. A magnetic field B of different magnitudes and directions as per column-1 is applied in the region. The value of current through the coil is I and such that the direction of field in all cases produced by coil makes an acute angle with vertically upward direction. There is enough friction to ensure that the cylinder rolls without slipping. (take g = 10 m/s^2)

Answer the questions given below on the basis of given matrix.



Column - 1 B		Column - 2 I		Column - 3 Acceleration of CM of cylinder	
(I)	0 T	(i)	0 Amp	(P)	0 m/s^2
(II)	0.5 T upward	(ii)	1 Amp	(Q)	$\frac{2g}{15}$ m / s^2
(III)	0.5 T downward	(iii)	15/8 Amp	(R)	$\frac{4g}{5}$ m / s^2
(IV)	0.5 T leftward	(iv)	5/2 Amp	(S)	$\frac{5.6g}{3}$ m / s^2

8. In which case among the following cases will the cylinder remain stationary
(A) (II) (iii) (P)
(B) (III) (ii) (P)
(C) (II) (iv) (P)
(D) (III) (iv) (P)

9. In which case will the induced emf rise at the maximum rate initially?
(A) (III) (iv) (R)
(B) (III) (iii) (S)
(C) (III) (iv) (S)
(D) (II) (iv) (Q)

10. Among the given situations, when will the friction be a maximum?
(A) (IV) (iii) (P)
(B) (III)(iv) (S)
(C) (II) (iii) (S)
(D) (IV) (iv) (Q)

Space for rough work

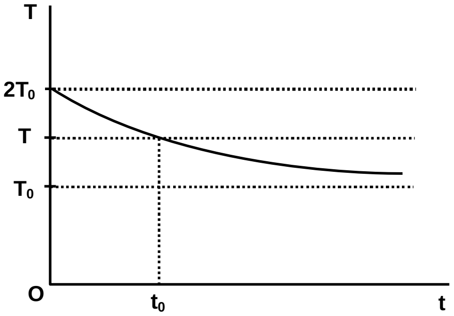
Answer questions 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

Column - 1		Column - 2		Column - 3	
(I)	Wien's displacement law	(i)	$\lambda_m T = b$	(P)	0.5
(II)	Stefan's law	(ii)	$E = e\sigma T^4$, E is emissive power	(Q	0.25
(III)	Kirchhoff's Law	(iii)	e = a, a is absorptivity	(R)	0.7
(IV)	Newton's law of cooling	(iv)	$-\frac{dT}{dt} = k(T - T_s)$	(S)	0.4

11. An object reflects a fraction of energy incident on it. The reflectivity of the object is 0.3. Which is the most suitable combination for the emissivity of that object?
(A) (II) (iii) (Q)
(B) (I) (iv) (S)
(C) (III) (ii) (P)
(D) (III) (iii) (R)

12. The filament of an incandescent bulb has length ℓ and radius of cross section r. It radiates a power $P = \frac{\pi\sigma e r \ell}{8}$, where σ and e are stefan's constant and emissivity. Which of the following is the most suitable combination for the temperature of the filament?
(A) (II) (ii) (P)
(B) (IV)(iii) (R)
(C) (I) (iv) (Q)
(D) (II) (ii) (S)

13. The temperature of a body in the surrounding of temperature T_0 versus time graph is shown. If $T = T_0[1 + 4xe^{-kt}]$, then the most appropriate combination for the value of x is
(A) (II) (iii) (S)
(B) (III)(i) (P)
(C) (IV) (iv) (Q)
(D) (IV) (iv) (R)



Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

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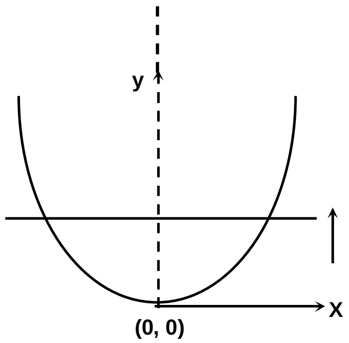
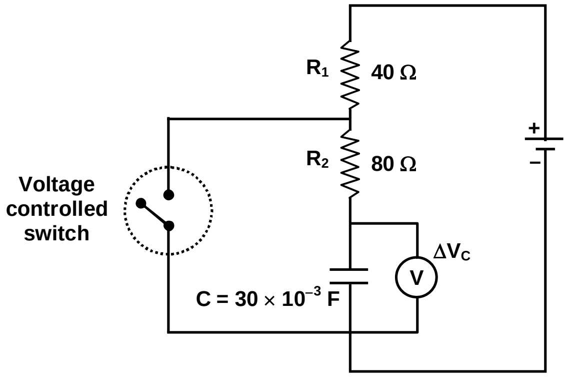
14. A uniform metallic wire is bent in the form of a parabola and is placed on a horizontal non-conducting floor. A vertical uniform magnetic induction B = 0.5 T exists in the region containing the parabolic wire. A straight conducting rod as shown in figure starts from rest at the vertex of the parabola at time t = 0, slides along the parabolic wire with its length perpendicular to the axis of symmetry of the parabola with a constant speed v = 2 m/s. Equation of parabolic wire is $y = x^2$ and consider that rod always touches wire. Induced emf in the rod at t = 2 will be (measured in volt).



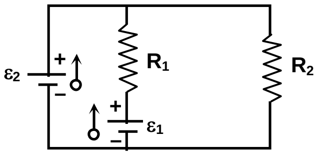
15. A horizontal oriented copper rod of length $\ell = \frac{2\sqrt{2}}{3\pi}$m is rotated about a vertical axis passing through its middle. Breaking strength of copper is $\sigma = 2.5\times10^8$ Pa and density of copper $\rho = 9\times10^3\ \text{Kg}/\text{m}^3$. Rotation frequency measured in $\left(\sec^{-1}\right)$ at which the rod ruptures; is given by 50n, n is equal to

16. The switch shown in figure closes when $\Delta V_C > \frac{2V}{3}$ and opens when $\Delta V_C < \frac{V}{3}$. The ideal voltmeter reads a voltage as plotted in graph.
Given that
$R_1 = 40\Omega; R_2 = 80\Omega$ and $C = 30\times10^{-3}$F
Period of waveform is given by T = xℓn2. x is equal to

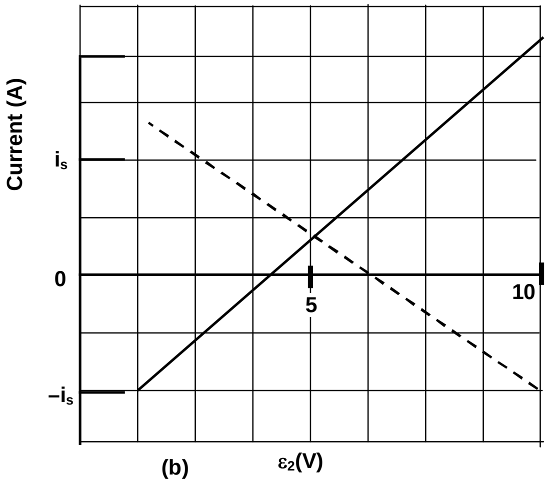


Space for rough work

17. Both batteries in figure (a) are ideal. Emf E_1 of battery 1 has a fixed value, but emf E_2 of battery 2 can be varied between 1 V and 10 V. The plots in figure (b) give the currents through the two batteries as a function of E_2. The vertical scale is set by i_s = 0.20 A. You must decide which plot corresponds to which battery, but for both plots, a negative current occurs when the direction of the current through the battery is opposite the direction of that battery's emf. Find E_1 in volts to the nearest integer.

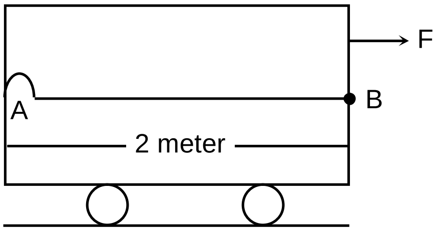


(a)



(b)

18. A string of mass m = 50 gm is tied at the point B; in a smooth trolley car which is acted upon by a horizontal force F = 20 N. At t = 0 let the car start from rest and a transverse pulse is generated at the free end, neglecting the effect of gravity at A. Mass of the trolley and length of the string are M = 9.950 Kg and $\ell = 2$ meter. Acceleration of the pulse with respect to ground is (in m/s^2)



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Chemistry PART – II

SECTION – A

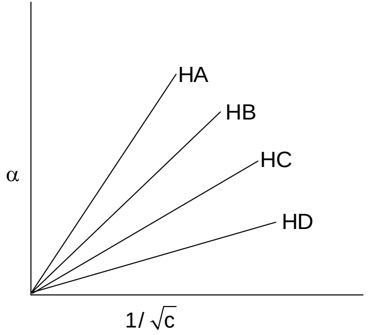
Straight Objective Type

This section contains **7 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

19. What is the number of angular nodes in the second excited state of a hydride ion?

(A) 2 (B) 3
(C) 0 (D) 1

20. From the following plot, say which is the strongest electrolyte?



(A) HA (B) HB
(C) HC (D) HD

21. Which of the following structure is most stable?

(A) $H_2B - CH = CH - NH_2$ (B) $H_2B - CH - \overset{-}{\ddot{C}}H = \overset{+}{N}H_2$

(C) $H_2\overset{-}{B} = CH - \overset{+}{C}H - NH_2$ (D) $H_2\overset{-}{B} = CH - CH = \overset{+}{N}H_2$

22. Which of the following statement is/are incorrect?

(A) For solid and liquid $\left(\frac{\delta H}{\delta T}\right)_P > \left(\frac{\delta U}{\delta T}\right)_V$.
(B) The gas following the equation P(V – b) = RT can not be liquefied.
(C) The total energy of the ideal gas molecule is the kinetic energy.
(D) Below critical temperature, $z > 1$.

Space for rough work

23. Which of the following statement is/are wrong?
(A) Boron atom in borazine is sp^2 hybridised.
(B) Silicon does not form effective $p\pi$ - $p\pi$ bond with oxygen.
(C) In borax, boron atom is sp^2 hybridised only.
(D) Borax bead test is performed to identity transition metal cation.

24. Which of the following species are paramagnetic?
(A) KO_2
(B) NO
(C) Singlet carbene
(D) O_2

25. Which of the following statement(s) are correct?
(A) $CH_3CHO \xrightarrow[I_2]{OH^-} CHI_3 + HCOO^-$
Total four molecules of OH^- is consumed by one molecule of CH_3CHO.
(B) 1, 3, 5 trihydroxy phenol performs haloform reaction
(C) Rate of haloform reaction follows the given order : $Cl_2 > Br_2 > I_2$
(D) F_2 does not participate in haloform reaction.

Space for rough work

Matrix Match Types

Each of 2 tables with 3 Columns and 4 Rows has three questions. Column-1 will be with 4 rows designated (I), (II), (III) and (IV). Column-2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column-3 will be with 4 rows designated (P), (Q), (R) and (S). Each question has four options with only **ONE** correct

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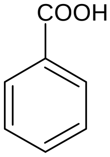
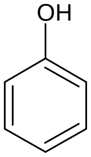
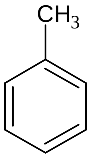
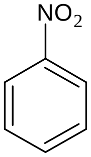
Answer Q. 26, Q. 27 and Q. 28 by appropriately matching the information given in the three columns of the following table.

Column - 1		Column - 2		Column - 3	
(I)		(i)	Strongly activated	(P)	Bromination in aqueous medium gives tribromo derivative
(II)		(ii)	Weakly activated	(Q)	Bromination gives para product (major)
(III)		(iii)	Weakly deactivated	(R)	Can be formed by oxidation of toluene
(IV)		(iv)	Strongly deactivated	(S)	Nitration with mixed acid gives the mixture of ortho and para product

26. Which of the following combination is CORRECT?
(A) (I) (i) (R)
(B) (II)(i) (P)
(C) (III) (iii) (S)
(D) (IV) (iv) (R)

27. Which of the following combination is CORRECT?
(A) (I) (iv) (R)
(B) (II) (ii) (Q)
(C) (III) (iv) (P)
(D) (IV) (iii) (R)

28. Which of the following combination is INCORRECT?
(A) (IV) (iv) (Q)
(B) (III) (ii) (S)
(C) (III) (iv) (P)
(D) None of the above

Space for rough work

Answer Q. 29, Q. 30 and Q. 31 by appropriately matching the information given in the three columns of the following table.

Column - 1		**Column - 2**		**Column - 3**	
(I)	Molar kinetic energy	(i)	$\frac{a}{V^2}$	(P)	H_2 and He at room temperature
(II)	$\left(\frac{\delta U}{\delta V}\right)_T$	(ii)	Force of attraction is predominant	(Q)	Potential energy is negative
(III)	$Z < 1$	(iii)	Force of repulsion is predominant	(R)	Does not depend on the nature of gas at constant temperature
(IV)	$Z > 1$	(iv)	$\frac{3}{2}RT$	(S)	Potential energy is positive

29. Which of the following combination is CORRECT?
(A) (I) (i) (P)
(B) (II)(i) (R)
(C) (III) (ii) (Q)
(D) (II) (iv) (S)

30. Which of the following combination is CORRECT?
(A) (II) (iii) (R)
(B) (III) (i) (P)
(C) (I) (iv) (R)
(D) (IV) (iv) (R)

31. Which of the following combination is INCORRECT?
(A) (IV) (iii) (P)
(B) (I) (iv) (R)
(C) (I) (i) (R)
(D) (III) (ii) (Q)

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

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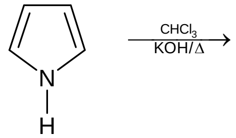
32. What is the degree of unsaturation of the product formed?

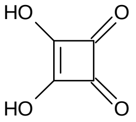


33. $XeF_6 \xrightarrow[\text{hydrolysis}]{\text{Partial}} A$

$XeF_6 \xrightarrow[\text{hydrolysis}]{\text{Complete}} B$

The sum of lone pairs on the central atoms in compound A and B are

34. How many of the following can react with NaOH and $NaHCO_3$ both?



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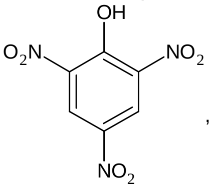

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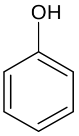

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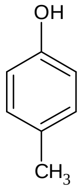
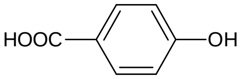


, HCOOH,



35. What is the pH of the solution if 6 gm NaOH is added to a mixture of 500 ml 0.2 M CH_3COOH and 500 ml 0.2 M HCl. (Given pK_a of $CH_3COOH = 5$)

36. When 1 mole of glucose is treated with HIO_4, how many moles of HIO_4 is consumed?

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **7 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

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37. Let $f(x) = \dfrac{x^2 - 6x + 5}{x^2 - 5x + 6}$ then which of the following statement is true for 'f'

(A) f : $(-\infty, 2) \to \left(-\infty, 8 - 4\sqrt{3}\right)$ f is one-one onto

(B) f : $(2, 3) \to (12, \infty)$ f is many one into

(C) f : $(-\infty, 2) \to \left(-\infty, 8 - 4\sqrt{3}\right)$ f is many one onto

(D) f : $(3, \infty) \to (-\infty, 1]$ f is one-one onto

38. Let f: R → R, g: R → R be two continuous function satisfying equation $f(x) + f(x + 1) = x + \{x\}$; $g(x) + g(2 - x) = 2$, then

(A) $\int_{-1}^{1} f(x+1)dx = 2$
(B) $\int_{-1}^{1} f(x+1)dx = 1$
(C) $\int_{1/2}^{3/2} g(g(x))dx = 2$
(D) $\int_{1/2}^{3/2} g(g(x))dx = 1$

39. Let g be a continuous and differentiable function defined as g: [0, 1] → R; $g(x) = 4x(1 - x)$, and if the number of the solution of $g(g(x)) = 0$ is n_1 and the number of solution of $g(g(x)) = \dfrac{x}{2}$ is n_2, then

(A) $n_1 + n_2 = 6$
(B) $n_1 + n_2 = 7$
(C) $n_1 \times n_2 = 6$
(D) $n_1 \times n_2 = 12$

Space for rough work

40. A line 3x + y = 8 touches a hyperbola H = 0 at P(1, 5) meets its asymptotes at A and B. If AB = $2\sqrt{10}$, C(1, 1) be the centre of hyperbola, e and ℓ are eccentricity and latus rectum of hyperbola then

(A) $e = \frac{\sqrt{7}}{2}$ (B) $e = \frac{\sqrt{5}}{2}$

(C) $\ell = \sqrt{2}$ (D) $\ell = 2\sqrt{2}$

41. Let m and n be the number of red and black balls in an urn. A ball is drawn at random and is put back into the urn along with 5 additional balls of the same colour as that of the ball drawn. A ball is again drawn at random. If probability that the ball drawn is red is $\frac{1}{5}$ then correct options with possible values of m + n can be

(A) 10 (B) 12

(C) 15 (D) 18

42. Two tangents 2x + y = 2 and x – 2y = 3 to a parabola touching it at A(2, –2) and B(5, 1) respectively. If focus of parabola is S(α, β) and latus rectum length is L then

(A) $\alpha - \beta = 3$ (B) $\alpha - \beta = 4$

(C) $L = \frac{27\sqrt{3}}{25}$ (D) $L = \frac{27\sqrt{2}}{25}$

43. The projection of line 3x – y + 2z – 1 = 0 = x + 2y – z – 2 on the plane 3x + 2y + z = 0 is/are

(A) $\frac{x+1}{11} = \frac{y-1}{-9} = \frac{z-1}{-15}$ (B) $\frac{x+12}{11} = \frac{y+8}{-9} = \frac{z+14}{15}$

(C) 3x – 8y + 7z + 4 = 0 = 3x + 2y + z (D) 3x – 8y + 7z + 4 = 0 = 3x + 2y + 2z

Space for rough work

Matrix Match Types

Each of 2 tables with 3 Columns and 4 Rows has three questions. Column-1 will be with 4 rows designated (I), (II), (III) and (IV). Column-2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column-3 will be with 4 rows designated (P), (Q), (R) and (S). Each question has four options with only **ONE** correct

Answer Q.44, Q.45 and Q.46 by appropriately matching the information given in the three columns of the following table.

Column-1: locus of centre C of moving circle S
Column-2: locus of complex number Z
Column-3: required locus, match the following Column(s)
(**Note:** Here correct combination means if Column-1 is circle then Column-2 is also circle and Column-3 is also circle)

Column - 1	Column - 2	Column - 3
(I) If S touches always a line $x = 4$ and circle $(x-1)^2 + (y-2)^2 = 1$	(i) $\lvert z\rvert = \lvert z - 3 - 4i\rvert$	(P) ellipse
(II) If S touches both circles $(x-1)^2 + (y-2)^2 = 9$ and $(x-1)^2 + (y-1)^2 = 1$	(ii) $\lvert\lvert z\rvert - \lvert z - 4 - 5i\rvert\rvert = 3$	(Q) hyperbola
(III) If S touches both circles $x^2 + y^2 = 1$ and $(x-4)^2 + (y-5)^2 = 4$	(iii) $\lvert z - 1 - i\rvert + \lvert z - 1 - 2i\rvert = 4$	(R) parabola
(IV) If S touches both circles $x^2 + y^2 = 1$ and $(x-3)^2 + (y-4)^2 = 1$	(iv) $\lvert z - 1 - 2i\rvert = \lvert \text{Re}(z-4) + 1\rvert$	(S) line

44. Which of the following is **CORRECT** combination?
(A) (I) (i) (P) (B) (I) (iv) (P)
(C) (I) (iv) (R) (D) (I) (ii) (R)

45. Which of the following is **CORRECT** combination?
(A) (II) (ii) (R) (B) (II) (iii) (P)
(C) (II) (iv) (P) (D) (II) (i) (R)

46. Which of the following is **CORRECT** combination?
(A) (III) (iii) (Q) (B) (III) (ii) (P)
(C) (III) (ii) (Q) (D) (IV) (i) (R)

Space for rough work

Answer Q.47, Q.48 and Q.49 by appropriately matching the information given in the three columns of the following table.

Match the following Column(s)
(**Note:** Correct combination means a correct option of each of Column-1, Column-2 and Column-3)

Column - 1	Column - 2	Column - 3
(I) If $\left[\vec{a}\ \vec{b}\ \vec{c}\right]=2$ then $\left[\vec{a}+2\vec{b}-\vec{c}\quad \vec{a}-\vec{b}\quad \vec{a}-\vec{b}-\vec{c}\right]=6$	(i) the number of solution of $3xe^{x}+1=0$ is equal to 2	(P) If f(x) = x cos $\frac{1}{x}$ then $\lim\limits_{x\to\infty} f'(x)=0$
(II) $\int_0^1 \frac{\tan^{-1}x}{\cot^{-1}\left(1-x+x^2\right)}dx=\frac{1}{2}$	(ii) the number of solution of 2 cos x – |sin x| = 0 in [0, 4π] is 2	(Q) if $f(x)=x\cos\frac{1}{x}$ then $\lim\limits_{x\to\infty} f'(x)=1$
(III) Range of $f(x)=\sqrt{x^2+5x+8}-\sqrt{x^2-3x+4}$ is [–4, 4], $x\in R$	(iii) the number of solution of sin πx = |ln|x|| is 6	(R) if $\lim\limits_{x\to 0}\frac{x(1+a\cos x)-b\sin x}{\sin^3 x}=1$ then |a – b| = 1
(IV) max{x^2, 1 – x^2} + min{x^2, 1 – x^2} = 1	(iv) the number of solution of $2^{\cos x}$ = |sin x| in [0, 2π] is 2	(S) if $L=\lim\limits_{x\to 0}\frac{\sin 2x+a\sin x}{x^3}$ is finite then $\frac{a}{L}=3$

47. Which of the following option is the only **CORRECT** combination?
(A) (I) (ii) (Q)
(B) (I) (ii) (P)
(C) (I) (i) (Q)
(D) (I) (i) (S)

48. Which of the following option is the only **CORRECT** combination?
(A) (II) (iv) (Q)
(B) (II) (iii) (S)
(C) (II) (iii) (R)
(D) (III) (i) (P)

49. Which of the following option is the only **INCORRECT** combination?
(A) (I) (iii) (R)
(B) (II) (i) (Q)
(C) (III) (iii) (P)
(D) (IV) (i) (R)

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

50. If $\sum_{k=1}^{2017}\left(k^2+1\right)\underline{|k} = \underline{|a} - b\cdot\underline{|c}$ where a, b, c $\in$ N then the least value of a + b – c is _____

51. The coefficient of x^4 in the expansion of $(1 + 2x + 3x^2 + 4x^3 + ... \infty)^2$ (where $|x| < 1$) is m then number of total divisors of m is _____

52. If z = x + iy is a complex number satisfying $\left(z+\bar{z}\right)^2 = 12-4\left|z\right|^2$ then maximum value of 2Re(z) + Im(z) is _____

53. The number of solution of $x^3 - x^2(1 + \sin x) + x(\sin x - \cos x) + \cos x = 0$ in $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$ is _____

54. Let P be a 2 × 2 matrix such that $P\begin{bmatrix}1\\-1\end{bmatrix} = \begin{bmatrix}-1\\2\end{bmatrix}$ and $P^2\begin{bmatrix}1\\-1\end{bmatrix} = \begin{bmatrix}1\\0\end{bmatrix}$. If x_1 and x_2 are two values of x for which det(P – xI) = 0 where I is an identity matrix of order 2 then value of $x_1^2 + x_2^2$ is equal to _____

Space for rough work

FIITJEE

JEE(Advanced)-2018

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – IX

PAPER-1

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**B, C, D**	19.	**D**	37.	**B, C**
2.	**A, B, C, D**	20.	**A**	38.	**B, D**
3.	**C**	21.	**D**	39.	**B, D**
4.	**A, D**	22.	**A, D**	40.	**B, C**
5.	**A, D**	23.	**B, C**	41.	**A, C**
6.	**A, B, C, D**	24.	**A, B, D**	42.	**B, D**
7.	**B, D**	25.	**A, B, D**	43.	**A, C**
8.	**C**	26.	**B**	44.	**C**
9.	**A**	27.	**A**	45.	**B**
10.	**D**	28.	**C**	46.	**C**
11.	**D**	29.	**C**	47.	**C**
12.	**A**	30.	**C**	48.	**C**
13.	**C**	31.	**C**	49.	**C**
14.	**4**	32.	**4**	50.	**3**
15.	**5**	33.	**2**	51.	**4**
16.	**6**	34.	**4**	52.	**3**
17.	**6**	35.	**5**	53.	**3**
18.	**3**	36.	**5**	54.	**5**

Physics PART – I

SECTION – A

1. In order to flow up the floor drain, the KE of the fluid must be just sufficient to provide for the gravitational P.E. required:

$v_M^2 = 2gh_2$

The flow rate through M is :

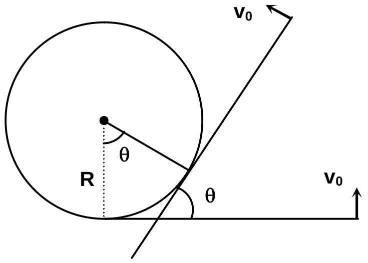
$V = \left(\pi r_M^2\right)v_M;\ r_M = 3\,\text{cm} = 0.03\,\text{m}$

and this is the total discharge from the roof.

The rainfall rate is $\frac{V}{wL}$ (in m/s) and it can be converted to cm/h by multiplying by (100×3600).

2. All are based on true facts.

3. T and v are perpendicular so speed is constant.



$\theta = \frac{\ell - x}{R}$

$\Rightarrow \frac{d\theta}{dt} = -\frac{dx}{Rdt}$

$\Rightarrow \frac{v_0}{x} = -\frac{dx}{Rdt}$

$\Rightarrow xdx = -Rv_0dt$

$\Rightarrow t = \frac{\ell^2}{2Rv_0}$

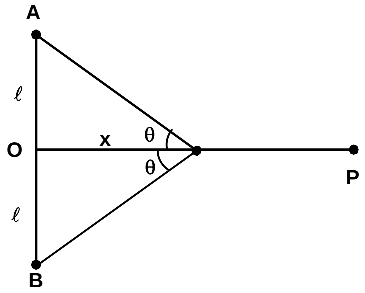
Now check the options.

4. Use horizontal & vertical velocity components for comparison.

5. Kinetic energy can never be negative.

6. Use of coulomb forces.

7. Net B at distance x from O along x-axis



$= \frac{\mu_0}{2\pi}\frac{I}{r}2\cos\theta$

$\Rightarrow \int dF = \int I\frac{\mu_0}{2\pi}\frac{I}{r}2\cos\theta dx$

$= \frac{\mu_0}{2\pi}I^2\ell n\left(1 + \frac{L^2}{\ell^2}\right)$

8-10. Along the incline plane net torque on the cylinder should be zero.

For emf $e = \frac{d\phi}{dt}$ and $\frac{de}{dt} = \frac{d}{dt}\left(\frac{d\phi}{dt}\right)$

11-13. In first column there are some laws and in second column associated formulae. By using these formulae solve the problems.

SECTION – C

14. at t = 2

$y = 2 \times 2 = 4$

so $y = x^2$

$\Rightarrow \; 4 = x^2$

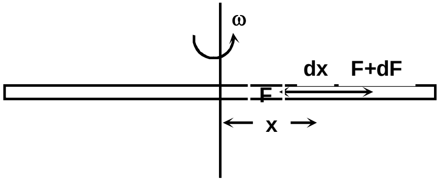
$\Rightarrow \; x = 2$

$\Rightarrow$ emf $\; e = vB\ell$

$= 2 \times 0.5 \times 4 = 4$ Volt

15. Stress are zero at free ends and maximum at middle so rod will rupture at middle.

By Newton's second law



$$F - (F + dF) = dm x\omega^2$$

$$-\int dF = \int \rho A\omega^2 \times dx$$

Where ω is the speed of rotation

$$-[F]_0^F = \rho A\omega^2 \left[\frac{x^2}{z}\right]_{\ell/2}^{x}$$

$$+F = +\rho\frac{A\omega^2}{z}\left[\left(\frac{\ell}{2}\right)^2 - x^2\right]$$

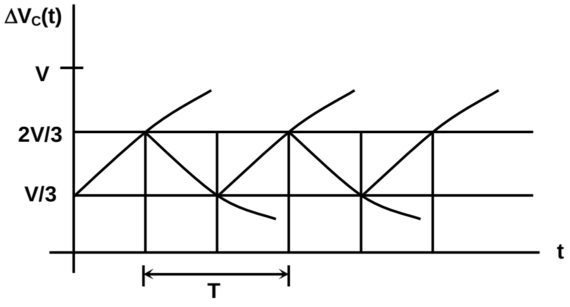
At $x = 0$ $F = \dfrac{\rho A\omega^2\ell^2}{8}$

$$\Rightarrow \; \frac{F}{A} = \frac{\rho\omega^2\ell^2}{8}$$

For rupture $\dfrac{F}{A} = \sigma \; \Rightarrow \; \dfrac{\rho\omega^2\ell^2}{8} = \sigma$

$$\Rightarrow \; n = \frac{1}{2\pi}\sqrt{\frac{8\sigma}{\rho\ell^2}}$$

16. Start with $\Delta V_C = \dfrac{2V}{3}$; By discharging formula



$$\Delta V_C(t) = \frac{2}{3}Ve^{-t_1/R_2C}$$

For $\Delta V_C(t) = \dfrac{V}{3}$ we get $t_1 = R_2C\ln 2$

After the switch opens voltage is $\dfrac{V}{3}$; increasing towards V with time constant $(R_1 + R_2)C$ so

$$\Delta V_C(t) = \Delta V - \frac{2}{3}\Delta V\, e^{-t_2/(R_1+R_2)C}$$

$$\Rightarrow \; t_2 = (R_1 + R_2)C\ln 2$$

17. The current through E_2 is given by the solid line, while that through E_1 is given by the dotted line. We can choose points on the graph, apply KVL and KCL to the circuit and substitute these values to determine the unknowns. This gives $E_1 = 6\,V$.

18. Acceleration of system = $\frac{F}{M+m}$

Tension at distance x from A at t = t

$$T = m'a = \frac{Fmx}{\ell(M+m)}$$

$\Rightarrow$ Speed of pulse at x distance from A is

$$v = \sqrt{\frac{Fmx}{\ell(M+m)}\frac{\ell}{m}} = \sqrt{\frac{Fx}{M+m}}$$

$$\Rightarrow \quad a = \frac{F}{2(M+m)}$$

Chemistry PART – II

SECTION – A

19. Second excited state of H^- is 2p, which has one angular node.

20. $\alpha = \sqrt{\frac{K}{C}}$, greater be the value of K, stronger be the electrolyte.

21. Greater be the number of covalent bonds, greater be the stability.

22. For solid and liquid $C_P \approx C_V$.
Below critical point, gases may be liquefied through the application of pressure.
Thus, $z < 1$.

23. Si cannot form effective $p\pi$ - $p\pi$ bond with oxygen due to larger size of 3p orbital of Si. In borax, both sp^2 and sp^3 hybridised 'B' atoms are present.

24. Due to presence of unpaired electron.

25. In the haloform reaction, extraction of proton is RDS. The reaction does not depend on nature and concentration of halogen.

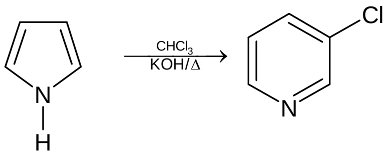
26. - OH group of phenol is strongly activating and bromination in aqueous medium gives tribromo derivative.

27. - COOH is strongly deactivating and formed by oxidation of toluene.

28. - CH_3 is weakly activating.

SECTION – C

32.



33. $XeF_6 + H_2O \longrightarrow XeOF_4 + 2HF$ (partial hydrolysis)
$XeF_6 + 3H_2O \longrightarrow XeO_3 + 6HF$ (complete hydrolysis)
Number of lone pair in $XeOF_4$ = 1
Number of lone pair in XeO_3 = 1
Total number of lone pairs = 2.

Mathematics PART – III

SECTION – A

37. $f(x) = 1 - \dfrac{x+1}{x^2-5x+6}$

$f'(x) > 0 \Rightarrow x^2 + 2x - 11 > 0$

$x > 2\sqrt{3} - 1$ or $x < -2\sqrt{3} - 1$

$f \uparrow$ in $\left(-\infty, -2\sqrt{3}-1\right) \cup \left(2\sqrt{3}-1, 3\right) \cup (3, \infty)$

$f \downarrow$ in $\left(-2\sqrt{3}-1, 2\right) \cup \left(2, 2\sqrt{3}-1\right)$

$f\left(2\sqrt{3}-1\right) = 8 + 4\sqrt{3}$

$f\left(-2\sqrt{3}-1\right) = 8 - 4\sqrt{3}$

$\lim\limits_{x \to -\infty} f(x) = \lim\limits_{x \to \infty} f(x) = 1$

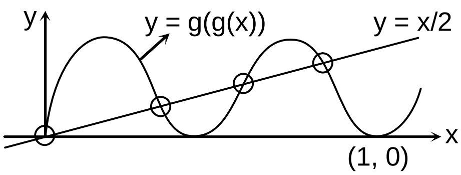
38. $\int\limits_{-1}^{1} f(x+1)\,dx = \int\limits_{-1}^{0} f(x+1)\,dx + \int\limits_{0}^{1} f(x+1)\,dx = \int\limits_{0}^{1} \left(f(x) + f(x+1)\right)dx = \int\limits_{0}^{1} \left(x + \{x\}\right)dx = 1$

$I = \int\limits_{1/2}^{3/2} g\left(g(x)\right)dx = \int\limits_{1/2}^{3/2} g\left(g(2-x)\right)dx = \int\limits_{1/2}^{3/2} g\left(2 - g(x)\right)dx = \int\limits_{1/2}^{3/2} \left(2 - g\left(g(x)\right)\right)dx$

$I = \int\limits_{1/2}^{3/2} dx = \dfrac{3}{2} - \dfrac{1}{2} = 1$

39. Now g(x) = 0 $\Rightarrow$ x = 0, 1 also, $g\left(\dfrac{1}{2}\right) = 1$

So, g(g(0)) = g(g(1)) = $g\left(g\left(\dfrac{1}{2}\right)\right) = 0 \Rightarrow n_1 = 3$



Also, g′(g(x))g′(x) = 0

$\Rightarrow x = \dfrac{1}{2},\ g(x) = \dfrac{1}{2} \Rightarrow x = \dfrac{1}{2} \pm \dfrac{1}{2\sqrt{2}}$

$gg\left(\dfrac{1}{2} + \dfrac{1}{2\sqrt{2}}\right) = 1$

So, the number of solution is 4 $\Rightarrow n_2 = 4$

40. By properties PA = PB = $\sqrt{10}$

$\dfrac{x-1}{-1/\sqrt{10}} = \dfrac{y-5}{3/\sqrt{10}} = \pm\sqrt{10}$

$\Rightarrow$ A ≡ (0, 8); B ≡ (2, 2)

Slopes of asymptotes are –7, and 1

If angle between asymptotes be θ then $\tan\theta = \left|\dfrac{-7-1}{1-7}\right| = \dfrac{4}{3}$

Now, $2\tan^{-1}\dfrac{b}{a} = \tan^{-1}\dfrac{4}{3} \Rightarrow \dfrac{\frac{2b}{a}}{1 - \frac{b^2}{a^2}} = \dfrac{4}{3}$

$\Rightarrow \frac{b}{a} = \frac{1}{2}$ ..... (1)

$\frac{b^2}{a^2} = e^2 - 1 \Rightarrow e = \frac{\sqrt{5}}{2}$

Also, area of ΔCAB = ab

$ab = \left|\frac{1}{2}\left[1(8-2)+0(2-1)+2(1-8)\right]\right| = 4$ ..... (2)

$b^2 = 2$, $a = 2b = 2\sqrt{2}$ length of latus rectum = $\frac{2b^2}{a} = \frac{4}{2\sqrt{2}} = \sqrt{2}$

41. Required probability = $\frac{m}{m+n} \times \frac{m+5}{m+n+5} + \frac{n}{m+n} \times \frac{m}{m+n+5} = \frac{1}{5}$

$\frac{m(m+5)+mn}{(m+n)(m+n+5)} = \frac{1}{5}$

$4m^2 + 20m + 3mn = n^2 + 5n$

$m = 2 \Rightarrow n = 8$

$m = 3 \Rightarrow n = 12$

$m = 4 \Rightarrow n = 16$

42. As tangents are perpendicular to each other and its points of intersections $P\left(\frac{7}{5}, -\frac{4}{5}\right)$ lies on directrix. AB is focal chord

Equation of AB is $x - y = 4$, as focus is (α, β) so $\alpha - \beta = 4 \Rightarrow \beta = \alpha - 4$

Now $\angle ASP = 90^o$

$$\Rightarrow \frac{-2-\alpha+4}{2-\alpha} \cdot \frac{-\frac{4}{5}-\alpha+4}{\frac{7}{5}-\alpha} = -1$$

$$\Rightarrow \frac{2-\alpha}{2-\alpha} \cdot \frac{\frac{16}{5}-\alpha}{\frac{7}{5}-\alpha} = -1$$

$$\Rightarrow \frac{16}{5} - \alpha = \alpha - \frac{7}{5};\ \alpha = \frac{23}{10}$$

$\Rightarrow$ Focus is $\left(\frac{23}{10}, -\frac{17}{10}\right)$

Also, $\ell_1 = AS = \frac{3\sqrt{2}}{10}$, $\ell_2 = BS = \frac{27\sqrt{2}}{10}$

$$\frac{1}{a} = \frac{1}{\ell_1} + \frac{1}{\ell_2} \Rightarrow a = \frac{27\sqrt{2}}{100} \Rightarrow 4a = \frac{27\sqrt{2}}{25}$$

43. Let plane containing line $3x - y + 2z - 1 = 0 = x + 2y - z - 2$ is

$3x - y + 2z - 1 + \lambda(x + 2y - z - 2) = 0$ ..... (1)

(1) must be perpendicular to $3x + 2y + z = 0$ ..... (2)

So that (1) and (2) will give required projected line

$(3 + \lambda)3 + (2\lambda - 1)2 + (2 - \lambda)1 = 0$

$9 + 3\lambda + 4\lambda - 2 + 2 - \lambda = 0$

$6\lambda + 9 = 0$

$\lambda = -\frac{3}{2}$

(1) becomes 3x – y + 2z – 1 – $\frac{3}{2}\left(x + 2y - z - 2\right) = 0$

6x – 2y + 4z – 2 – 3x – 6y + 3z + 6 = 0

3x – 8y + 7z + 4 = 0

So, projected line 3x – 8y + 7z + 4 = 0 = 3x + 2y + z

Also, its symmetrical form $\frac{x+1}{11} = \frac{y-1}{-9} = \frac{z-1}{-15}$

44. (I) Locus of centre of circle S is parabola

(iv) Put z = x + iy

$\sqrt{\left(x-1\right)^2 + \left(y-2\right)^2} = \left|x - 4 + 1\right|$

$x^2 - 2x + 1 + y^2 - 4y + 4 = x^2 - 6x + 9$

$\Rightarrow (y-2)^2 = -4x + 8$ represents parabola

45. (II) S touches one circle externally and other circle internally so centre of S lies on ellipse. So locus is ellipse

(iii) |z – 1 – i| + |z – 1 – 2i| = 4

Represents ellipse whose foci are (1, 1), (1, 2) and major axis length 2a = 4

46. (III) S touches given two isolated circle externally so locus of centre of S is hyperbola

(ii) ||z| – |z – 4 – 5i|| = 3 represents hyperbola whose foci are (0, 0), (4, 5) and transverse axis length (2a) = 3

(IV) Represents line

(i) Represents line

47.-49. (I) $\left(\vec{a} + 2\vec{b} - \vec{c}\right)\cdot\left(\vec{a} - \vec{b}\right)\times\left(\vec{a} - \vec{b} - \vec{c}\right) = 3\left[\vec{a}\ \vec{b}\ \vec{c}\right] = 6$

(II) Let $I = \int_0^1 \frac{\tan^{-1}x}{\cot^{-1}\left(1 - x + x^2\right)}dx = \int_0^1 \frac{\tan^{-1}x}{\tan^{-1}x - \tan^{-1}\left(x-1\right)}dx = \int_0^1 \frac{\tan^{-1}\left(1-x\right)}{\tan^{-1}\left(1-x\right) + \tan^{-1}x}dx$

$\Rightarrow I = \frac{1}{2}$

(III) Range of $f\left(x\right) = \sqrt{x^2 + 5x + 8} - \sqrt{x^2 - 3x + 4}$ is (–4, 4)

(IV) True

(ii) Number of solution of 2 cos x – |sin x | = 0 in [0, 4π] is 4

(iv) Number of solution of $2^{\cos x}$ = |sin x| is [0, 2π] is 4

(P) is false

(Q) is true

(R) is true

(S) is false, correct answer $\frac{a}{L} = 2$

SECTION – C

50. $\sum_{k=1}^{2017}\left(k^2 + k - \left(k-1\right)\right)\underline{|k}$

$= \sum_{k=1}^{2017}\left(k\underline{|k+1} - \left(k-1\right)\underline{|k}\right)$

$= \left(1\cdot\underline{|2} - 0\right) + \left(2\underline{|3} - 1\cdot\underline{|2}\right) + \left(3\underline{|4} - 2\underline{|3}\right) + ...\left(2017\underline{|2018} - 2016\underline{|2017}\right)$

$= 2017\underline{|2018} = \underline{|2019} - 2\underline{|2018}$
a = 2019; b = 2; c = 2018
a + b – c = 3

51. $(1 + 2x + 3x^2 + 4x^3 + \ldots\ldots \infty)^2$

$$= \frac{1}{(1-x)^4} = (1-x)^{-4} = 1 + {}^4C_1x + {}^5C_2x^2 + {}^6C_3x^3 + {}^7C_4x^4 + \ldots\ldots$$

Coefficient of $x^4 = {}^7C_4 = 35 = m$
Number of divisors of m is 4

52. $(2x)^2 = 12 - 4(x^2 + y^2)$
$8x^2 + 4y^2 = 12$

$$\frac{x^2}{3/2} + \frac{y^2}{3} = 1$$

$$x = \sqrt{\frac{3}{2}}\cos\theta\ ;\ y = \sqrt{3}\sin\theta$$

$2\text{Re}(z) + \text{Im}(z) = 2x + y = \sqrt{6}\cos\theta + \sqrt{3}\sin\theta \le 3$

53. Given equation can be written as $(x - 1)(x^2 - x\sin x - \cos x) = 0$
Let $f(x) = x^2 - x\sin x - \cos x$
$f'(x) = x(2 - \cos x) = 0;\ x = 0$
$f(0) = -1$

$$f\left(\frac{\pi}{2}\right) = \frac{\pi^2}{4} - \frac{\pi}{2} = \frac{\pi^2 - 2\pi}{4} > 0\ ;\ f\left(-\frac{\pi}{2}\right) = \frac{\pi^2}{4} - \frac{\pi}{2} = \frac{\pi^2 - 2\pi}{4} > 0$$

Total number of roots in $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$ is 3

54. Let $P = \begin{bmatrix} \alpha_1 & \alpha_2 \\ \beta_1 & \beta_2 \end{bmatrix}$

Now $P\begin{bmatrix} 1 \\ -1 \end{bmatrix} = \begin{bmatrix} -1 \\ 2 \end{bmatrix} \Rightarrow \begin{bmatrix} \alpha_1 & \alpha_2 \\ \beta_1 & \beta_2 \end{bmatrix}\begin{bmatrix} 1 \\ -1 \end{bmatrix} = \begin{bmatrix} -1 \\ 2 \end{bmatrix}$

$\Rightarrow \alpha_1 - \alpha_2 = -1$ ..... (1)
$\Rightarrow \beta_1 - \beta_2 = 2$ ..... (2)

Also, $P^2\begin{bmatrix} 1 \\ -1 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

$\Rightarrow P\left(P\begin{bmatrix} 1 \\ -1 \end{bmatrix}\right) = \begin{bmatrix} 1 \\ 0 \end{bmatrix} \Rightarrow P\begin{bmatrix} -1 \\ 2 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

$\Rightarrow -\alpha_1 + 2\alpha_2 = 1$ ..... (3)
$\Rightarrow -\beta_1 + 2\beta_2 = 0$ ..... (4)
From equation (1), (2), (3) and (4)
$\alpha_1 = -1;\ \alpha_2 = 0;\ \beta_1 = 4;\ \beta_2 = 2$
Now $\det(P - xI) = 0$

$$\Rightarrow \det\left(\begin{bmatrix} -1 & 0 \\ 4 & 2 \end{bmatrix} - x\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}\right) = 0 \Rightarrow \begin{vmatrix} -1-x & 0 \\ 4 & 2-x \end{vmatrix} = 0$$

$\Rightarrow x = 2, -1$
$x_1^2 + x_2^2 = 4 + 1 = 5$

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

FULL TEST – IX

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 231**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-C & Section-D**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01 – 03, 24 – 26, 47 – 49)*** *contains 9 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (04 – 08, 27 – 31, 50 – 54) *contains 15 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (09 – 10, 32 – 33, 55 – 56) *contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer. There is no negative marking.*

2. ***Section-C (11 – 20, 34 – 43, 57 – 66)*** *contains 30 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

3. ***Section-D (21 – 23, 44 – 46, 67 – 69)*** *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

PART – I (Physics), PART – II (Chemistry), PART – III (Mathematics):
(SECTION – D)

For questions **21 to 23, 44 to 46, 67 to 69.**
Numerical answer type questions with answer XXXXX. XX

If answer is 348.4 / 251.37 / 213

Correct Method :

0	0	3	4	8	.	4	0

0	0	2	5	1	.	3	7

0	0	2	1	3	.	0	0

Wrong Method :

	3	4	8		.	4	

3	4	8			.		4

		3	4	8	.		4

	3		4	8	.	4	

	2		5	1	.	3	7

		2	1	3	.		

		2	1	3	.	0	

		2	1	3	.		0

		3	4	8	.	4	0

		2	5	1	.	3	7

		2	1	3	.	0	0

Physics PART – I

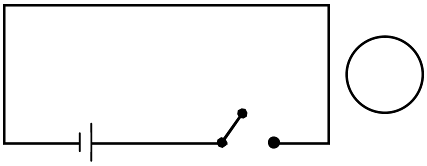
SECTION – A

Straight Objective Type

This section contains **3 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

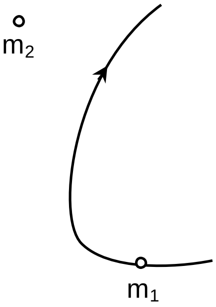
---

1. Consider the situation as shown in figure.
If the switch is closed and after some time it is open again, the closed circuit loop will show

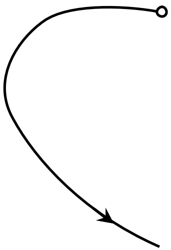


(A) A clockwise current pulse then anticlockwise current pulse.
(B) An anticlockwise current pulse then a clockwise current pulse;
(C) An anticlockwise current pulse then no current then a clockwise current pulse;
(D) A clockwise current pulse then no current then an anticlockwise current pulse;

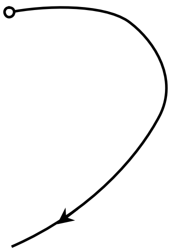
2. Two interacting particles form a closed system whose center of mass is at rest. Figure illustrates the positions of both particles at a certain moment and the trajectory of the particle of mass m_1. Select the trajectory of the particle of mass m_2 if $m_2 = m_1$.



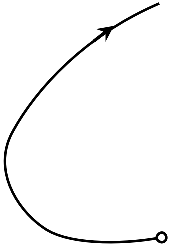
(A)



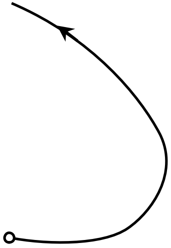
(B)



(C)

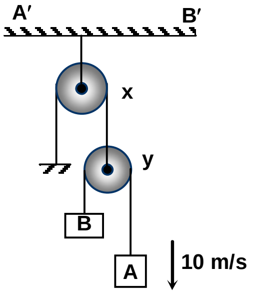


(D)



Space for rough work

3. In given diagram A′B′ frame is moving with speed 5 m/s in downward direction. Block A is moving with speed 10 m/s in downward direction. Speed of block B will be:
(A) 5 m/s in downward direction
(B) 5 m/s in upward direction
(C) 10 m/s in downward direction
(D) 10 m/s in upward direction

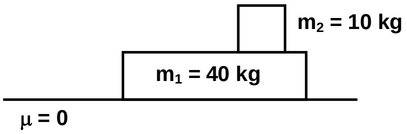


Multiple Correct Choice Type

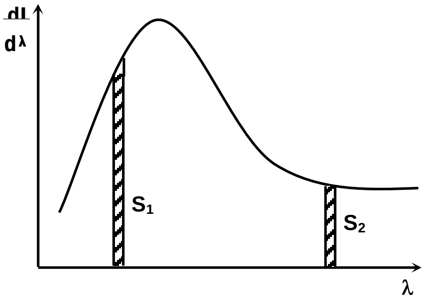
This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

---

4. In the figure, a slab of mass m_1 = 40 kg rest on a frictionless floor, and a block of mass m_2 = 10 kg rests on top of the slab. Between block and slab, the coefficient of static friction is 0.60; and the coefficient of kinetic friction is 0.40. Possible value of forces that should be applied to the block m_2 (upper block), so that it causes slipping between the blocks is
(A) 60 N (B) 70 N
(C) 75 N (D) 90 N



5. Two separate segments of equal area are isolated in the energy distribution of black body radiation as shown in figure. Let us assume that the number of photons emitted by the body per unit time in the segments are n_1 and n_2 and the energy of the photons are E_1 and E_2 respectively. Then

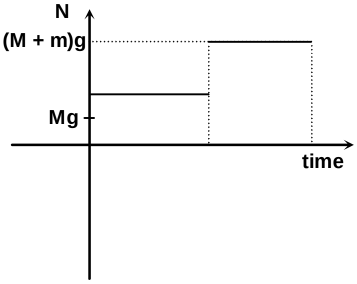


(A) $n_1 > n_2$ (B) $E_1 > E_2$
(C) $n_2 > n_1$ (D) $E_2 > E_1$

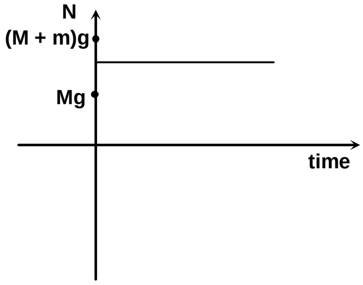
Space for rough work

6. In a long cylindrical container of mass M (including liquid) a solid ball of mass m is released with zero initial speed from the top of container. Viscosity of the liquid is zero and density of the material of ball and that of liquid are ρ_m and ρ_ℓ. N denotes magnitude of normal reaction of the bottom of the cylinder to the liquid. v denotes velocity and upward direction of velocity is drawn along positive direction of y-axis. (given $\rho_m > \rho_l$ and collision of ball with bottom of cylinder is elastic and ignore impulse due to impact with bottom). Choose the correct option(s).

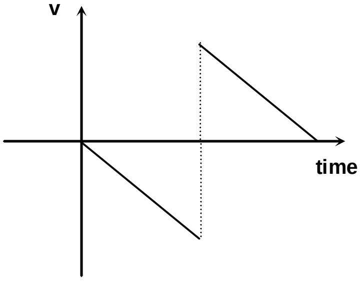
(A)



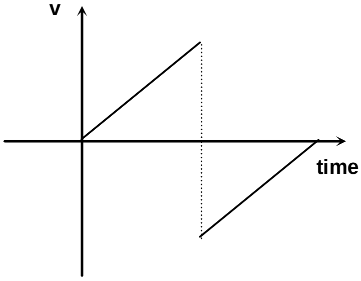
(B)



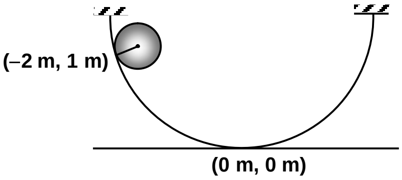
(C)



(D)



7. A disc of mass 3 kg and radius of 7 cm is placed on a rigid parabolic path ($x^2 = 4y$) at position (–2, 1) as shown. It starts from this point at t = 0. If friction is sufficient for pure rolling of the disc. Then (take g = 9.8 m/s^2 and $\sqrt{2} = 1.4$)



(A) Velocity of disc at the position (0, 0) is $9.8\sqrt{\frac{2}{15}}$ m/s

(B) Angular velocity of disc at (0, 0) is $140\sqrt{\frac{2}{15}}$ rad/s.

(C) Normal reaction at bottom point of the path is 49 N approx.

(D) Normal reaction at bottom point of the path is 98 N approx.

8. In a moving coil galvanometer the number of turns N = 30, area of the coil A = 4×10^{-3} m^2 and the magnetic field strength B = 0.3T. To increase its voltage sensitivity by 50% we

(A) increase number of turns to 45

(B) increase area to 9×10^{-3} m^2

(C) increase magnetic field to 0.45 T

(D) Change the material of wire such that its specific resistance would be 2/3rd of the sepecific resistance of the present wire.

Space for rough work

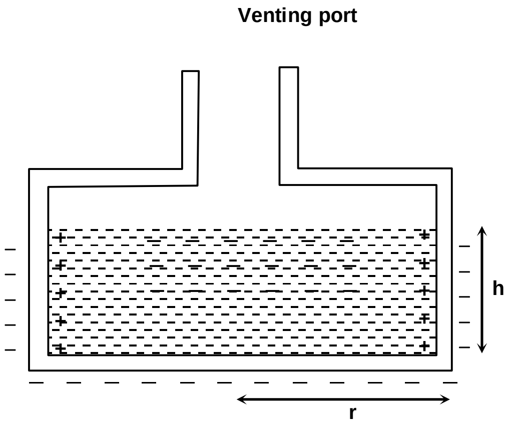
Comprehension Type

This section contains **1 group of questions.** The group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

---

Paragraph for Question Nos. 9 and 10

A safety engineer needs to evaluate the practice of storing inflammable conducting liquids in non-conducting containers. The company supplying the liquid uses a cylindrical plastic container of radius r = 20 cm and fills it to a height of h = 20 cm, which is not equal to its full height. During handling, the exterior surface acquires a charge density of $\sigma = 2\times10^{-6}\,C/m^2$, approximately uniform. This induces a charge separation within the liquid, because it is conducting (see figure).



9. How much charge is induced within the bulk of the liquid? Take $\pi \approx 3$.

(A) 0.36 μC	(B) 0.72 μC
(C) 0.18 μC	(D) 0.54 μC

10. The minimum potential energy required to cause a spark is 10 mJ. Assume that the capacitance of the central part relative to ground is nearly 36 pF. Calculate the potential energy stored in the capacitor. Take $\pi \approx 3$.

(A) 1.8 mJ	(B) 3.6 mJ
(C) 5.4 mJ	(D) 7.2 mJ

Space for rough work

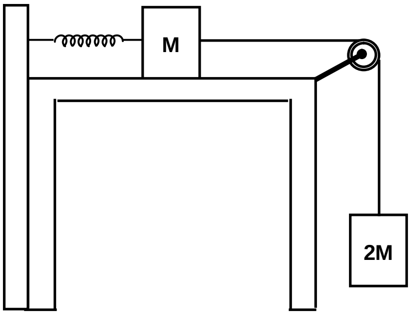
SECTION – C

(One Integer Value Correct Type)

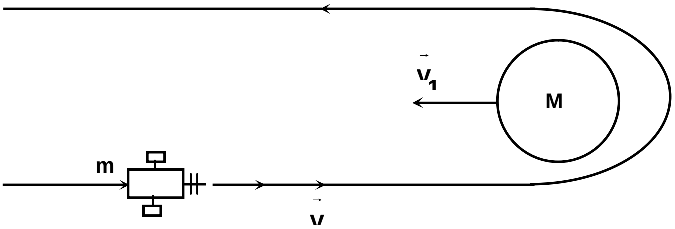
This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

11. Two blocks, of masses M = 3 kg and 2M, are connected to a spring of spring constant k = 200 N/m that has one end fixed, as shown in figure. The horizontal surface and the pulley are frictionless, and the pulley has negligible mass. The blocks are released from rest with the spring relaxed. The tension in the connecting string when the block 2M has fallen to the maximum extent is 20 k newton, where k is an integer. Find the value of k.



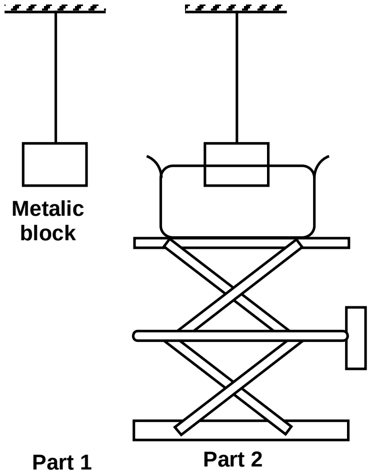
12. An unmanned space probe (of mass m) and speed v = 2 km/s relative to the Sun, approaches the planet Jupiter (of mass M >>m) and speed V_J relative to the Sun as shown in the figure. The spacecraft rounds the planet and departs in the opposite direction. The mass of Jupiter is very much greater than the mass of the spacecraft (M >>m), and it orbits the sun at a distance of 5.29 AU, where 1 AU is the orbital radius of the earth around the sun: 1 AU = 1.5 × 10^8 km, 1 earth year = $\pi \times 10^7$ s, nearly. The speed of the space probe after it leaves the solar system, relative to the sun is nearly (20 + n) km/s, where n is an integer. Find the value of n.



Space for rough work

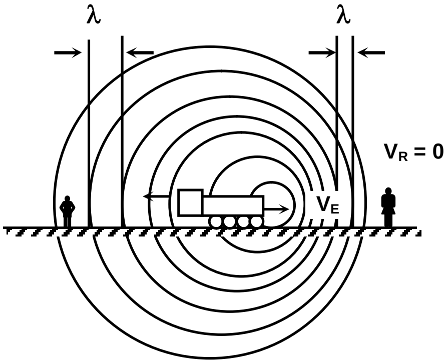
13. A series LCR circuit containing a resistance of 120 Ω has angular frequency 4×10^5 rad/sec. At resonance the voltages across resistance and inductance are 60 V and 40 V respectively. At angular frequency ω the current in the circuit lags the voltage by π/4. If $\omega = n \times 10^5 \frac{\text{rad}}{\text{sec}}$; the value of n is

14. A metallic block is suspended from a wire, as in part 1 of the drawing. A container of mercury is then raised up around the block, as in part 2, so that 50% of the block's volume is submerged in the mercury. The specific gravities of metal is 9.1, and that of mercury is 13.6. Find the ratio of the 1st overtone frequency of the wire in part 1 to the fundamental frequency of the wire in part 2 to the nearest integer.

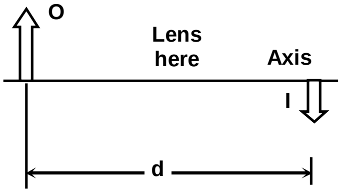


Space for rough work

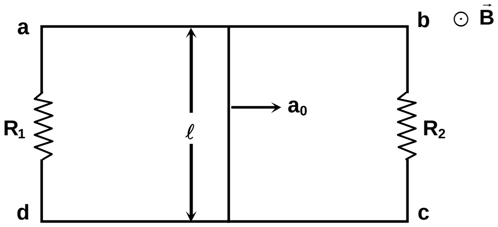
15. Consider sound waves emitted by a moving emitter like the whistle of a moving train as shown in the figure. If the observer were standing on the ground so that sound waves reach him at an angle 60° with the direction of the moving train then:
Let the change in frequency due to the Doppler effect be Δf, and the change in wavelength due to Doppler effect be $\Delta\lambda$. Assume that the speed of sound in air is 1200 km/h, the speed of the engine (emitter) is 400 km/h. The product $\Delta f . \Delta\lambda = \left(\frac{200}{n}\right) km/h$, where n is an integer. Find the value of n



16. In figure, a real inverted image *I* of an object *O* is formed by a particular lens (not shown); the object–image separation is d = 40 cm, measured along the central axis of the lens. The image is just half the size of the object.
Find the focal length of the lens in cm, to the closest integer.

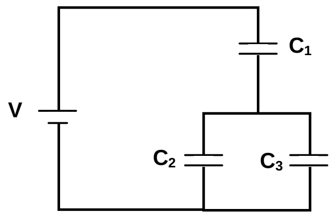


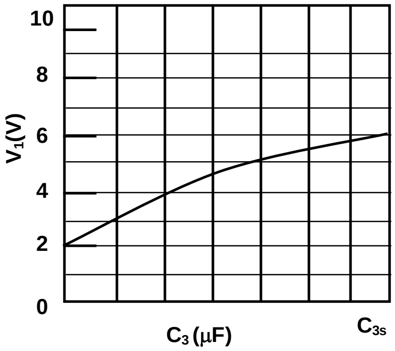
17. A rectangular loop with a sliding conductor of length $\ell = 0.5$ meter is located in a uniform magnetic field B = 0.5 T perpendicular to the plane of loop. The part ad and bc has electrical resistance $R_1 = 50\Omega$ and $R_2 = 50\Omega$ respectively. The conductor of mass m = 1 kg starts moving with constant acceleration $a_0 = 1 m/s^2$. Neglecting the self inductance of the loop and resistance of conductor, the external force required to move the conductor with given acceleration after n sec. of start is 1.01N. n is



Space for rough work

18. Capacitor 3 in figure (a) is a variable capacitor (its capacitance C_3 can be varied). figure (b) gives the electric potential V_1 across capacitor 1 versus C_3. The horizontal scale is set by C_{3s} = 12 mF. Electric potential V_1 approaches an asymptote of 10 V. Find the ratio C_1/C_2 to the nearest integer.

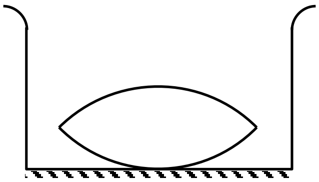




19. The potential energy of a particle of mass 1 gm is given by $U(x) = \begin{cases} a & \text{for } 0 \le x \le 1 \quad \text{Region 1} \\ 0 & \text{for } x > 1 \quad \text{Region 2} \end{cases}$

λ_1 and λ_2 are the de Broglie wavelengths of the particle in Region 1 and Region 2 respectively. If total energy of the particle is 3a and $\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{6}{n}}$. Then n is

20. A thin biconvex lens of refractive index $\frac{9}{5}$ is placed on a horizontal plane mirror as shown. The space between the lens and the mirror is then filled with a liquid of refractive index $\frac{5}{4}$. It is found that when a point object is placed 20 cm above the lens on its principal axis, the object concides with its own image. On repeating with another liquid, the object and the image again concide at a distance 40 cm from the lens. Refractive index of the liquid is $\frac{11n}{40}$ then n is



Space for rough work

SECTION – D

(Numerical Answer Type)

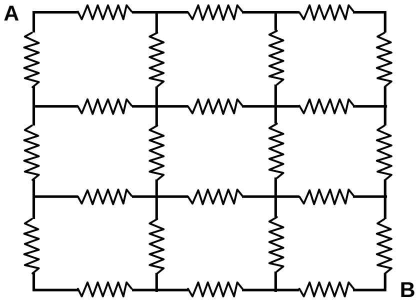
This section contains **3 questions**. Each question, when worked out will result in **numerical answer type** (XXXXX.XX)

---

21. A uniform circular ring of radius R = 2.5 cm and mass 10 gm is made of an elastic material. Symmetrical radially outward forces are applied on the ring to increase its radius from R = 2.5 cm to 2.7 cm. Young's modulus of material of the ring is $2\times10^{11}\frac{\text{N}}{\text{m}^2}$ and radius of cross section of the ring is 1 mm. If all the external forces are removed; in how much time will the ring come to its original radius for the first time (in mili second).

22. An ant with negligible mass is standing peacefully on top of a horizontal stretched rope. The rope has mass per unit length μ = 0.01 kg/meter and is under tension of 0.1 Newton. Without warning a boy starts a sinusoidal transverse wave of wavelength λ = 5 cm propagating along the rope. The motion of the rope is in the vertical plane. Assume that the mass of ant is so small that the presence of the ant has no effect on the propagator of the wave. What minimum wave amplitude measured in micrometer will make the ant become momentarily weightless (acceleration due to gravity is g = π^2 m/s^2).

23. 24 resistors of $\frac{28}{65}\Omega$ are arranged in a square as shown. Equivalent resistance of the network between points A and B is



Space for rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **3 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

24. At 48°C, the vapour pressure of pure CS_2 is 850 torr. A solution of 2 gm of sulphur in 100 gm of CS_2 has a vapour pressure 844.9 torr. Determine the atomicity of sulphur molecule

(A) 1
(B) 2
(C) 4
(D) 8

25. Which of the following will act as the best protective.

(A) Gelatin (Gold number = 0.005)
(B) Starch (Gold number = 25)
(C) Gum Arabic (Gold number = 0.15)
(D) Egg Albumin (Gold number = 0.08)

26. Which of the following is the correct statement?

(A) Physical adsorption takes place due to covalent bonding between adsorbate and adsorbent.
(B) Physical adsorption increases at high temperature.
(C) Physical adsorption is irreversible.
(D) Adsorption enthalpy is generally greater for chemical adsorption than for physical adsorption.

Space for rough work

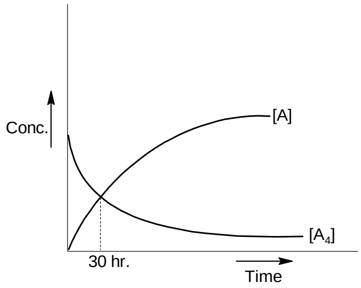
Multiple Correct Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

27. Consider the following 1st order reaction and the accompanying concentration time plot.

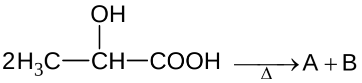
$A_4(g) \longrightarrow 4A(g)$

Which of the following regarding decomposition reaction is/are correct?



(A) At 30 hr, 20% reaction is complete
(B) Half-life of the reaction is 90 hr (approximate)
(C) Rate of decomposition decreases linearly with time.
(D) Changing initial concentration will change the time at which two curve intersect. [Given ln 1.25 = 0.223]

28. Consider the following option is correct



$$2H_3C-\overset{\overset{\large OH}{|}}{C}H-COOH \xrightarrow[\Delta]{} A + B$$

Lactic acid

Which of the following option is correct?
(A) A and B are geometrical isomers. (B) A and B are enantiomers.
(C) A is optically active and B is optically inactive.(D)A is a chiral dissymmetric molecule.

29. Which of the following option is correct?
(A) White phosphorus produce PH_3 with conc. NaOH.
(B) $\overset{-}{S}CN$ is a pseudo halide ion which produces blood red colouration with Fe^{3+}.
(C) He is mixed with O_2 for scuba divers.
(D) Standard hypo solution is used for iodine titrations.

30. An aqueous solution of 6.3 gm of a hydrated oxalic acid ($H_2C_2O_4.xH_2O$) is made up to 250 ml. The 40 ml of 0.1 N NaOH was required to completely neutralize 10 ml of the above prepared stock solution. Which of the following statement(s) are correct?
(A) The acid is dihydrated.
(B) Equivalent weight of the hydrated salt is 45.
(C) Equivalent weight of anhydrous acid is 45.
(D) 20 ml of the same stock solution would require 40 ml 0.1 M $Ca(OH)_2$ for complete neutralization.

31. Which of the following statement is correct?
(A) For any cyclic process, $\Delta U = 0$.
(B) $\left(\frac{\delta U}{\delta V}\right)_T = \frac{a}{V^2}$ for 1 mole of a gas obeying van der Waal's equation.
(C) $\bar{C}_P = \infty$ for water when it is in equilibrium with vapour at 1 atm pressure and 373 K.
(D) For any real gas, the molar internal energy can be given as $\frac{3}{2}R$.

Space for rough work

Comprehension Type

This section contains **1 group of questions.** The group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

---

Paragraph for Question Nos. 32 to 33

An inorganic salt (A) is treated with KI solution which gives a white precipitate of compound (R) which further dissolve in excess of KI solution with the formation of soluble complex (S). ‘A’ gives white precipitate with KCN also which again dissolve in excess of KCN and the resulted solution give no precipitate with Na_2S. ‘A’ gives green precipitate (T) with $K_3\left[Fe\left(CN\right)_6\right]$. ‘A’ dissolve in excess of NH_4OH solution giving deep blue colouration. It also give chocolate brown precipitate (U) with $K_4\left[Fe\left(CN\right)_6\right]$ in acetic acid. Anionic part of salt A gives yellow precipitate with $Hg\left(NO_3\right)_2$, and its silver salt is soluble; calcium salt is partially soluble while its Barium salt is insoluble even in HNO_3, $HClO_4$ and HCl etc. solution also.

32. What are R and S respectively?

(A) $Cu_2I_2,\ CuI_4^{3-}$ (B) CuI_2, CuI_4^{3-}

(C) $CuI_2,\ CuI_3^{2-}$ (D) $Cu_2I_2,\ CuI_3^{2-}$

33. Anionic part (acidic radial) of salt A and compound T are ....

(A) $SO_4^{2-}, Cu_2\left[Fe\left(CN\right)_6\right]$ (B) $S^{-2},\ Cu_2\left[Fe\left(CN\right)_6\right]$

(C) $SO_4^{2-}Cu_3\left[Fe\left(CN\right)_6\right]_2$ (D) $S^{-2}, Cu_3\left[Fe\left(CN\right)_6\right]_2$

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

34. How many number of moles of $CH_3 - CH = CH_2$ is consumed by 1 mole of B_2H_6 in the following reaction?

35. The general formula of polythionate ion is $S_{n+2}O_6^{2-}$. If the average oxidation state of 'S' atom in any polythionate ion is equal to the bond order of 'S – O' bond, then calculate the value of 'n' for the corresponding polythionate ion.

36. Equivalent conductance of 0.2 M aqueous solution of a weak monobasic acid [HA] is 10 S cm^2 eqv^{-1}. and that at infinite dilution is 200 S cm^2 eqv^{-1}. Hence, what is the pH of the solution?

37. A definite amount of solid NH_4HS is placed in a flask already containing ammonia gas at a certain temperature and 0.1 atm pressure. NH_4HS decomposes to give NH_3 and H_2S and at equilibrium, the total pressure in flask is 1.1 atm. If the equilibrium constant K_P for the reaction $NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$ is represented on z × 10^{-1}, then z = ?

38. How many optically active isomers of dichlorocyclopentane are possible

Space for rough work

39. $CO + Cl_2 \longrightarrow COCl_2$

The reaction takes place in the following steps.

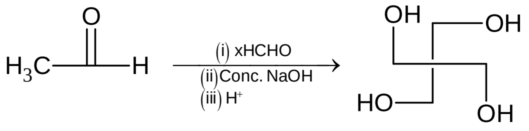
$Cl_2 \xrightleftharpoons{K_{eq1.}} 2Cl.(\text{fast})$

$Cl + CO \xrightleftharpoons{K_{eq2.}} COCl.(\text{fast})$

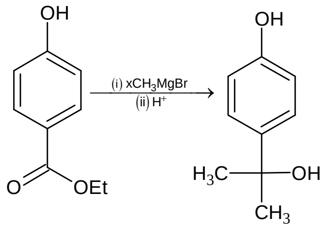
$COCl + Cl_2 \xrightarrow{\text{Slow}} COCl_2 + Cl$

If the order of the reaction is n, what is the value of 2n?

40. If x is the number of moles of formaldehyde consumed in the following reaction, find out the value of x?



41.



How many moles (x) of Grignard reagent is consumed in the above reaction?

42. Out of the given ions, how many give precipitate with H_2S in acidic medium?
Cr^{3+}, Zn^{2+}, Cd^{2+}, Hg^{2+}, Fe^{2+}, Br^{3+}, Pb^{2+}

43. Ti is purified by following method:

$Ti(\text{impure}) + I_2 \xrightarrow[\Delta]{} \underset{\text{vapour}}{TiI_x} \xrightarrow[\Delta]{} \text{Pure } Ti + I_2$

Find the value of x.

Space for rough work

SECTION – D

(Numerical Answer Type)

This section contains **3 questions**. Each question, when worked out will result in **numerical answer type** (XXXXX.XX)

---

44. If the density of vapour of a substance (X) at 1 atm pressure and 500 K is 0.8 kg/m^3. The vapour effuses through a small hole at a rate of $\frac{4}{5}$ times slower than oxygen under same condition. What is the compressibility factor of the vapour?

45. If the radiation corresponding to the second line of 'Balmer Series" of Li^{2+} ion, knocked the electron from the 1st excited state of H atom, what is the kinetic energy of electron in eV?

46. Determine the degree of association (for the reaction in the aqueous solution.)
$6HCHO \rightleftharpoons C_6H_{12}O_6$
If the observed molar mass of HCHO and $C_6H_{12}O_6$ is 150.

Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **3 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

---

47. If y is a function of x satisfies $\frac{dy}{dx} = \frac{y}{x} + \int_1^2 y dx$ and f(1) = 2 then $\int_1^2 y dx$ is equal to

(A) $\frac{12}{7 + 4\ln 2}$
(B) $\frac{12}{7 - 8\ln 2}$
(C) $\frac{12}{7 + 8\ln 2}$
(D) none of these

48. Let line x + 2y = 3 intersects a circle S = 0 at A and B. Let point of intersection of tangents to circle at A and B meet at P(3, 5). If S = 0 passes through origin then radius of circle S = 0 is

(A) $\frac{\sqrt{83}}{8}$
(B) $\frac{\sqrt{85}}{8}$
(C) $\frac{\sqrt{79}}{8}$
(D) $\frac{\sqrt{87}}{8}$

49. A parabola having directrix 2x + y = 3 touches a line x + y = 2 at (3, –1). If focus of parabola is (α, β), then $\alpha + 2\beta$ is equal to

(A) 1
(B) 2
(C) 3
(D) 4

Space for rough work

Multiple Correct Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

50. $\vec{a}$, $\vec{b}$, $\vec{c}$ are three unit vectors such that $\vec{a}\cdot\vec{b}=\vec{b}\cdot\vec{c}=\vec{c}\cdot\vec{a}=\frac{1}{3}$. If $\vec{a}\times\vec{b}=p\vec{a}+q\vec{b}+r\vec{c}$ where p, q, r are scalars then

(A) $p^2=\frac{1}{10}$ (B) $p^2=\frac{1}{15}$

(C) $q^2=\frac{1}{15}$ (D) $\frac{r^2}{q^2}=16$

51. $\int_0^{\pi/4} 2^{100}\left(\sec^{100}x+\operatorname{cosec}^{100}\left(x+\frac{\pi}{4}\right)\right)dx$ is equal to

(A) $\int_0^{\ln(1+\sqrt{2})} 2\left(e^u+e^{-u}\right)^{99}du$ (B) $\int_0^{\pi/4} 2^{101}\sec^{101}x\,dx$

(C) $\int_0^{\ln(\sqrt{2}+1)} 4\left(e^u+e^{-u}\right)^{99}du$ (D) $\int_0^{\pi/4} 2^{101}\sec^{100}x\,dx$

52. Let $f:\left[0,\frac{1}{2}\right]\to R$, $e^{-2x}f(x)$ is twice differentiable function having local minima at $x=\frac{1}{4}$ and $\frac{d^2}{dx^2}\left(e^{-2x}f(x)\right)>0\ \forall\ x\in\left(0,\frac{1}{2}\right)$. If f(0) = $f\left(\frac{1}{2}\right)=0$ then which of the following is/are correct?

(A) $\frac{f'\left(\frac{3}{8}\right)}{f\left(\frac{3}{8}\right)}>2$ (B) $\frac{f'\left(\frac{3}{8}\right)}{f\left(\frac{3}{8}\right)}<2$

(C) $\frac{f'\left(\frac{1}{8}\right)}{f\left(\frac{1}{8}\right)}>2$ (D) $\frac{f'\left(\frac{1}{8}\right)}{f\left(\frac{1}{8}\right)}<2$

Space for rough work

53. Let a, b and c be positive real numbers such that $a + b + c = 1$ then which of the following is/are true

(A) $a^2 + b^2 + c^2 \geq a^a b^b c^c$
(B) $a^2 + b^2 + c^2 \leq a^a b^b c^c$
(C) $a^2 + b^2 + c^2 \leq 1 - 18abc$
(D) $a^2 + b^2 + c^2 \geq 1 - 18abc$

54. If n_1 = number of ways of outcomes if 2 alike and 4 different dice are thrown, n_2 = number of ways of outcomes if 6 alike dice are thrown then n_3 = number of divisors of n_1 of form $4k + 1$, $k \in N$

(A) $n_1 + n_2 = 27678$
(B) $n_1 + n_2 = 27578$
(C) $n_3 = 5$
(D) $n_3 = 6$

Comprehension Type

This section contains **1 group of questions.** The group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

Paragraph for Question Nos. 55 to 56

Read the following write up carefully and answer the following questions:
A triangle ABC is such that a circle passing through vertex C, centroid G touches side AB at B. If AB = 6, BC = 4 then

55. The length of median through A is equal to

(A) $\frac{13}{2}$
(B) $\sqrt{42}$
(C) $2\sqrt{42}$
(D) none of these

56. Length of AC is equal to

(A) $\sqrt{17}$
(B) $2\sqrt{14}$
(C) $2\sqrt{17}$
(D) $\sqrt{14}$

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

57. For a function $f(x)=\frac{\ln(\{\sin x+3\}\{\cos x+2\}+1)}{\{\sin x+1\}\{\cos x+1\}}$ (where {.} denote the fractional part of x), then $f(0^-)+f\left(\frac{\pi^-}{2}\right)-f\left(\frac{\pi^+}{2}\right)$ is equal to _____

58. $\int_0^{\pi/4} e^{\sec x}\left(\frac{\cos x+\sin x}{2\cos x-\sin 2x}\right)dx=\frac{(1+\sqrt{2})}{2}e^{\sqrt{2}}+k$, then 3 ln(2|k|) is equal to _____

59. Dice A has 3 red, 3 white faces where as dice B has 2 red 4 white faces. A fair coin is tossed once. If it shows a head the game continues by dice A, if it shows tail then dice B is to be used. If the probability that dice B is used is $\frac{16}{25}$ where it is given that white throws up every time in first n throws then n is equal to _____

60. For the function f(x) = |x| + |x + 1| + |x – 2| – ||x| + |x + 1| – |x – 2||, the total number of critical points is _____

61. Let a complex number z = x + iy satisfies equation $|z|^4 - 16|z|^2 - 3z^2 - 3\bar{z}^2 + 9 = 0$. If a and b are the maximum and minimum value of |z| then ab is equal to _____

62. Let f: R → R f(x) = 3^{x-1} and g: R → R, g(x) = $2x^2 - 4x + 3$, then sum of all roots of equation f(x) = g(x) is _____

Space for rough work

63. If the perpendicular distance of A(1, 4,–2) from the line $\frac{x-2}{2}=\frac{y-1}{6}=\frac{z+2}{3}$ is p then $\frac{7p}{\sqrt{26}}$ is equal to _____

64. A ball moving around the circle $x^2 + y^2 - 2x - 4y - 20 = 0$ in anticlockwise direction leaves it tangentially at P(–2, –2). After getting reflected from a straight 'L' it passes through the centre of circle. If distance of P from line L is $\frac{5}{2}$ and 2α be the angle between incident ray and reflected say then $10 \cot 2\alpha \cot \alpha$ is equal to _____

65. If the line $3x + 4y = \sqrt{7}$ touches the ellipse $3x^2 + 4y^2 = 1$ at (x_1, y_1) then the value of $7x_1^2 + 14y_1^2 + 3$ is _____

66. The number of solution of trigonometric equation $\sin 5x = 16 \sin^5 x$ in $[0, 2\pi]$ is _____

SECTION – D

(Numerical Answer Type)

This section contains **3 questions**. Each question, when worked out will result in **numerical answer type** (XXXXX.XX)

---

67. Let ABC be right angle triangle, $\angle B = 90^o$. The median through A and C are $y = 3x + 1$ and $y = x + 1$ respectively. If AC = 8 and then area of triangle ABC is _____

68. Consider the cubic polynomial $P(x) = x^3 - ax^2 + bx + c$. If the equation $P(x) = 0$ has integral roots such that $P(6) = 3$ then sum of all possible values of a is _____

69. Six cards and six envelops are numbered 1, 2, 3, 4, 5, 6 and cards are placed in envelops so that each envelop contains exactly one card and no card is placed in the envelop bearing the same number. If card 1 and 2 is always placed in envelope numbered 3 and 4 respectively then number of ways is k then $\frac{k}{3}$ is equal to _____

Space for rough work

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FULL TEST – IX

PAPER-2

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**C**	24.	**D**	47.	**B**
2.	**B**	25.	**A**	48.	**B**
3.	**C**	26.	**D**	49.	**C**
4.	**A, B, C, D**	27.	**A, B**	50.	**B, C, D**
5.	**B, C**	28.	**A, C, D**	51.	**C, D**
6.	**B, C**	29.	**A, B, C, D**	52.	**B, C**
7.	**A, B, C**	30.	**A, C, D**	53.	**A, C**
8.	**B, C, D**	31.	**A, B, C**	54.	**A, C**
9.	**B**	32.	**A**	55.	**B**
10.	**D**	33.	**C**	56.	**B**
11.	**5**	34.	**6**	57.	**1**
12.	**1**	35.	**4**	58.	**3**
13.	**8**	36.	**2**	59.	**2**
14.	**4**	37.	**3**	60.	**4**
15.	**5**	38.	**4**	61.	**3**
16.	**9**	39.	**5**	62.	**6**
17.	**4**	40.	**4**	63.	**3**
18.	**4**	41.	**3**	64.	**5**
19.	**4**	42.	**4**	65.	**6**
20.	**7**	43.	**4**	66.	**7**
21.	**00001.25**	44.	**00001.52**	67.	**00010.66**
22.	**00062.50**	45.	**00019.55**	68.	**00051.00**
23.	**00001.60**	46.	**00000.96**	69.	**00004.66**

Physics PART – I

SECTION – A

1. An induced current will be developed in the loop due to change in flux.

2. Centre of mass will be at rest

3. Speed of pulley Y is 10 m/s and speed of block A is 10 m/s so speed of block B will be 10 m/s.

4. $F\cos\theta = 50a$ …(1)

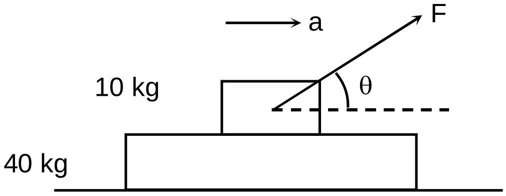
$N + F\sin\theta = 10g$ …(2)

$F\cos\theta - 0.6N = 10a$ …(3)

Solving for a, N from (1), (2) and Putting in (3), we get,

$F = \dfrac{30g}{4\cos\theta + 3\sin\theta}$

$\therefore \quad F_{max} = 60 = 15K$ & $K = 4$.



5. Segment S_1 has lower wavelength photons, so $E_1 > E_2$ and Intensity is equal, so $n_2 > n_1$.

6. Liquid will experience a force in downward direction always. So, N will be more than Mg. Magnitude of velocity will increase on downward journey and will decrease in upward journey.

7. By energy conservation

$\Rightarrow v = \sqrt{\dfrac{2}{15}}(9.8)$ m/s

$\omega = 140\sqrt{\dfrac{2}{15}}$ rad/sec

at bottom point $N - mg = \dfrac{mv^2}{(R-r)}$, where R is radius of curvature at (0, 0)

$\Rightarrow$ N = 49 Newton (approx)

8. voltage sensitivity = $\dfrac{\text{deflection}}{\text{voltage measured}}$

9. $Q = \sigma\left[\pi r^2 + 2\pi rh\right]$

$= 2\times10^{-6}\times\pi\left[\left(\dfrac{2}{10}\right)^2 + 2\left(\dfrac{2}{10}\right)\left(\dfrac{2}{10}\right)\right]$

$= \dfrac{24\pi}{100}\times10^{-6}$

$\simeq 0.72\ \mu C$

10. $U = \dfrac{Q^2}{2C} = \dfrac{\left(72\times10^{-8}\right)^2}{2\times36\times10^{-12}}$

$= 72\times10^{-4}$ J = 7.2 mJ

SECTION – C

11. At mean F = kx and at maximum extension spring energy = $\frac{1}{2}ky^2$.

12. Use momentum conservation principle.

13. At resonance $X_L = X_C$ and $Z = R$

So $I_{rms} = \frac{[V_R]_{rms}}{R} = \frac{60}{120} = \frac{1}{2}$ Amp;

$(V_L)_{rms} = I_{rms}X_L \Rightarrow 40 = \frac{1}{2}X_L \Rightarrow X_L = 80\,\Omega$

$\Rightarrow \quad L = 0.2\text{mH} = 0.2\times10^{-3}\text{H};$ and $C = 3.125\times10^{-8}\text{F};$

For the current to lag behind the voltage by $\frac{\pi}{4}$;

$$\tan\frac{\pi}{4} = \frac{\omega L - \frac{1}{\omega C}}{R}$$

$\Rightarrow \quad \omega = 8\times10^5\,\frac{\text{rad}}{\text{sec}};$

14. Use buoyancy principle for tension then calculate frequency.

15. Use formula for Doppler's effect in oblique case.

16. Based on lens formula.

17. $I = \frac{B\ell v}{R_{eq}} = \frac{B\ell a_0 n(R_1 + R_2)}{R_1R_2}$ (n is time in second)

So $F_{ext} - F_B = ma_0$

$\Rightarrow \quad F_{ext} = a_0\left[m + \frac{B^2\ell^2(R_1+R_2)n}{R_1R_2}\right]$

$\Rightarrow \quad F_{ext} = \left[1 + \frac{10^{-2}n}{4}\right]$

$\Rightarrow$ n = 4;

18. Use the graph to find the value of V_1 for C_3.

19. In Region 1 $K = 2a \Rightarrow \lambda_1 = \frac{h}{\sqrt{4ma}}$

In Region 2 $K = 3a \Rightarrow \lambda_2 = \frac{h}{\sqrt{6ma}}$

$\Rightarrow \quad \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{6}{4}}$

20. According to given condition

$$\left[\frac{9}{5}-1\right]\left[\frac{1}{R}+\frac{1}{R}\right]+\left[\frac{5}{4}-1\right]\left[-\frac{1}{R}-\frac{1}{\infty}\right]=\frac{1}{20}$$

$$\Rightarrow \frac{8}{5R}-\frac{1}{4R}=\frac{1}{20}$$

$$\Rightarrow \frac{27}{20R}=\frac{1}{20} \Rightarrow R=27\text{ cm}$$

and $\left(\frac{9}{5}-1\right)\left[\frac{1}{R}+\frac{1}{R}\right]+(\mu-1)\left(-\frac{1}{R}-\frac{1}{\infty}\right)=\frac{1}{40}$

$$\Rightarrow \frac{8}{5R}-\frac{\mu-1}{R}=\frac{1}{40}$$

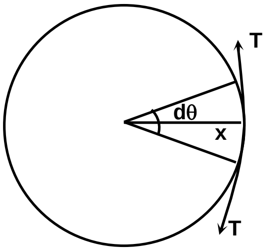
$$\Rightarrow \frac{13-5\mu}{5R}=\frac{1}{40}$$

$$\Rightarrow 13-5\mu=\frac{27}{8}$$

$$\Rightarrow 5\mu=\frac{77}{8} \Rightarrow \mu=\frac{77}{40};$$

SECTION – D

21. Let us suppose that mass per unit length of ring initially is λ; In given condition $0-2T\sin\frac{d\theta}{2}=\lambda R d\theta a$.



$$\Rightarrow a=\frac{-T}{\lambda R} \ \&\ T=\frac{YA}{R}(x-R)$$

$$\Rightarrow a=\frac{-YA}{\lambda R^2}x+\frac{YA}{\lambda R}$$

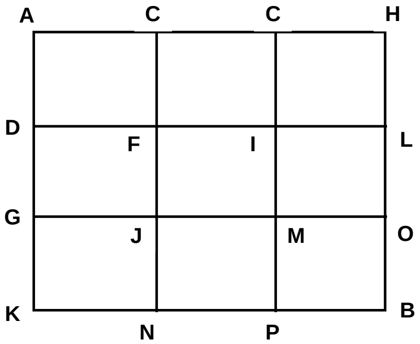
$$\Rightarrow t=\frac{1}{4}2\pi\sqrt{\frac{R^2\lambda}{AY}}$$

= 1.25 milisec

22. $A\omega^2 > g$

$$\Rightarrow A>\frac{g}{\omega^2}=\frac{g\lambda^2\mu}{4\pi^2F}=62.5\ \mu m;$$

23. By symmetry of network H; I; J and K are equipotential points.
Besides it potential of D and C; G and E are also same.



Chemistry PART – II

SECTION – A

24. $\frac{P^o - P}{P} = \frac{n}{N} \Rightarrow \frac{W}{M \times N}$

$\Rightarrow \frac{850 - 844.9}{844.9} = \frac{2 \times 76}{M \times 100} \Rightarrow 252$

$n = \frac{252}{32} = 8$

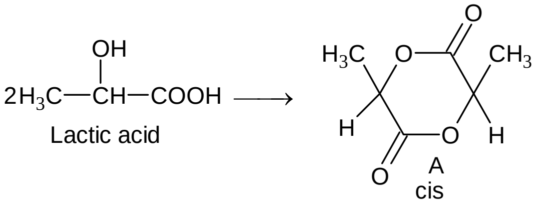
25. Lesser be the gold number, greater be the protective power of the colloid.

27. 4. $\underset{a-x}{A_4(g)} \longrightarrow \underset{4x}{4A(g)}$

At 30 hr, a – x = 4x $\Rightarrow x = \frac{a}{5}$,i.e. 20% A_4 decomposed.

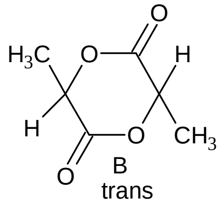
$K \times 30 = \ell n \frac{a}{a-x} = \ell n \frac{5}{4} \Rightarrow t_{1/2} = \frac{30 \ell n 2}{\ell n \frac{5}{4}} \approx 90$ hr

28.



A
cis

B is optically inactive
due to the presence
of a point of symmetry.



B
trans

A is optically active, but it is having a C_2 axis, thus, it is dissymmetric.

30. Meq. of oxalic acid $= 40 \times 0.1 \times \frac{250}{100} = 100$

$\therefore$ Eq. weight $= \frac{6.3 \times 1000}{100} = 63$ (hydrated salt.)

Molar mass = 63 × 2 = 126 = 90 + 18 x.

$\Rightarrow$ x = 2.

Equivalent weight of anhydrous acid $= \frac{90}{2} = 45$

Also 20 ml of stock solution $2 \times 40 \times 0.1$
= 8 meq. acid

8 meq. $Ca(OH)_2$ will be present in $= \frac{8}{0.2} = 40$ ml

31. (i) As U is a state function, for any cyclic process, $\Delta U = 0$.

(ii) $\left(\frac{\delta U}{\delta V}\right)_T = \frac{a}{V^2}$.

(iii) During phase transition, T is constant, $dT = 0, \bar{C}_P = \left(\frac{\delta H}{\delta T}\right)_P = \infty$.

(iv) Total molar kinetic energy $= \frac{3}{2}R$.

Internal energy = Total kinetic energy + Potential energy

33. $$Cu^{2+} + KI \longrightarrow CuI_2\,(\text{unstable}) \longrightarrow \underset{(\text{white ppt R})}{Cu_2I_2} + I_2 \xrightarrow{\text{excess KI}} CuI_4^{3-}\,(\text{clear solution})(S)$$

$$Cu^{2+} + KCN \longrightarrow \underset{\text{unstable}}{Cu(CN)_2} \longrightarrow \underset{\text{white}}{CuCN}\downarrow + \frac{1}{2}(CN)_2\uparrow$$

$$\underset{\text{white}}{CuCN} \xrightarrow{\text{excess KCN}} \underset{(\text{clear solution})}{\left[Cu(CN)_4\right]^{3-}} \xrightarrow{Na_2S} \text{No ppt}$$

$$Cu^{2+} + K_3\left[Fe(CN)_6\right] \longrightarrow \underset{(\text{Green})(T)}{Cu_3\left[Fe(CN)_6\right]_2}\downarrow + K^+$$

$$Cu^{2+} + \underset{\text{excess}}{NH_4OH} \longrightarrow \left[\underset{\text{deep blue}}{Cu(NH_3)_4}\right]^{2+}$$

$$U = Cu_2\left[Fe(CN)_6\right](\text{chocolate brown})$$

$$SO_4^{2-} + Hg^{2+} + H_2O \longrightarrow \underset{\text{yellow}}{HgSO_4.2H_2O}\downarrow \left(\text{specific test of } SO_4^{2-}\right)$$

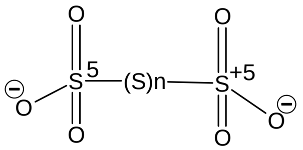
SECTION – C

34. $$CH_3-CH=CH_2 \xrightarrow[(ii)\ H_2O_2/\bar{O}H]{(i)\ B_2H_6/THF} CH_3-CH_2-CH_2OH$$

$$B_2H_6 \longrightarrow 2BH_3$$

$$\underset{(3\text{ mole})}{CH_3-CH=CH_2} \xrightarrow{BH_3} (CH_3CH_2CH_2)_3B \xrightarrow{H_2O_2/\bar{O}H} 3CH_3CH_2CH_2OH$$

35.



Bond order of S – O bond $= \frac{5}{3}$

Average oxidation state of ‘S’ atom $\frac{10}{2+n}$.

$$\frac{10}{2+n} = \frac{10}{6} \Rightarrow 2+n = 6 \Rightarrow n = 4.$$

36. $$\alpha = \frac{10}{200} = 0.05$$

$$HA \rightleftharpoons H^+ + A^-$$

$\left[H^+\right] = C\alpha = 0.2 \times 0.05 = 0.01$

pH = 2

37. $NH_4HS(s) \rightleftharpoons \underset{0.1+P}{NH_3(g)} + \underset{P}{H_2S(g)}$

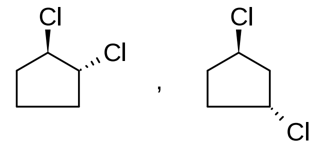
0.1 + 2P = 1.1, thus P = 0.5

$K_P = P_{NH_3}.P_{H_2S} = (0.1+P)\times P$

= 0.6 × 0.5 = 0.3

= 3 × 10^{-1}

Thus, z = 3.

38. 

and their enantiomers

39. $\text{Rate} = K[Cl_2][COCl]$

$$K_{eq_2} = \frac{[COCl]}{[Cl][CO]} \Rightarrow [COCl] = K_{eq_2}[Cl][CO]$$

$$\frac{[Cl]^2}{[Cl_2]} = K_{eq1} \Rightarrow [Cl] = \left\{K_{eq_1}[Cl_2]\right\}^{\frac{1}{2}}$$

i.e. $[COCl] = K_{eq_2}K_{eq_1}^{\frac{1}{2}}[CO][Cl_2]^{\frac{1}{2}}$

Rate $= K[Cl_2][COCl]$

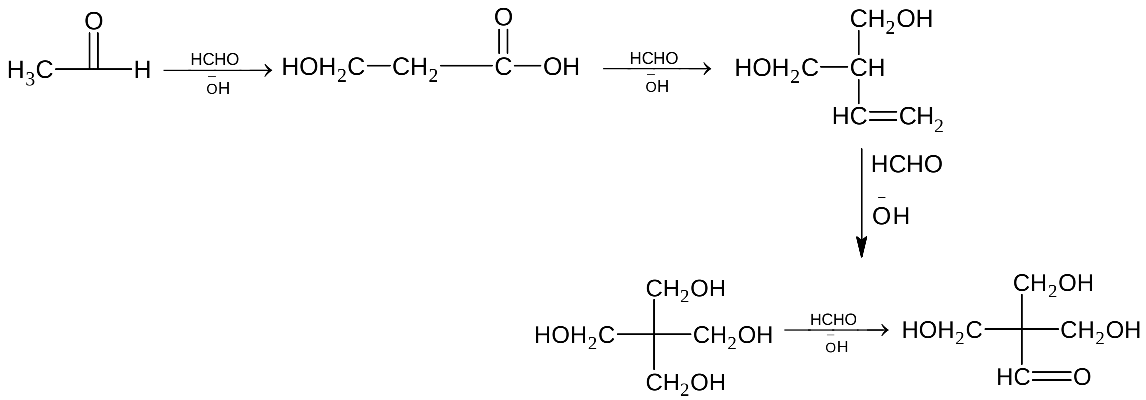
$$= K[Cl_2]K_{eq_2}K_{eq_1}[CO][Cl_2]^{\frac{1}{2}}$$

$$= K'[CO][Cl_2]^{\frac{3}{2}}$$

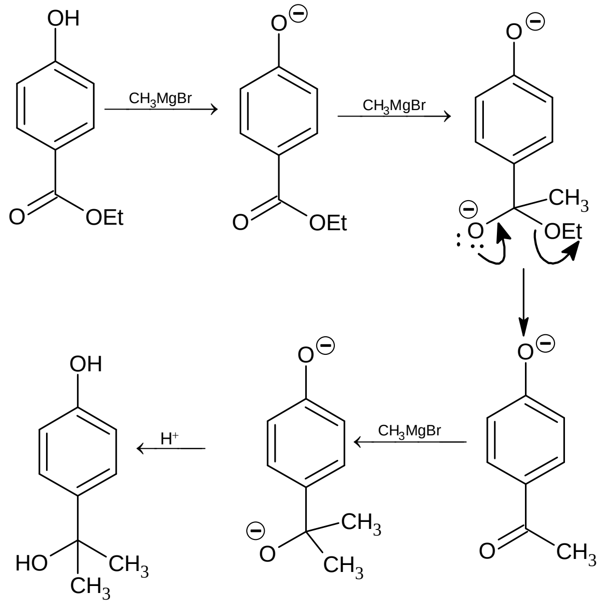
Total order $= \frac{3}{2} + 1 = \frac{5}{2}$

2n = 5

40.



41.


OH
CH3MgBr
O
OEt
CH3MgBr
CH3
H+

43. $\mathrm{Ti} + 2\mathrm{I}_2 \xrightarrow[\Delta]{} \mathrm{TiI}_4$

Mathematics PART – III

SECTION – A

47. $\frac{dy}{dx} - \frac{y}{x} = A$ when $A = \int_1^2 y\,dx$

I.F = $\frac{1}{x}$

So, $y \cdot \frac{1}{x} = \int A \cdot \frac{1}{x} dx + c = A \ln x + c$

y = A x ln x + cx

Now f(1) = 2 ⇒ 2 = c

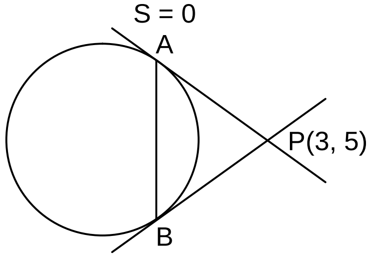
y = A x ln x + 2x

Also, $A = \int_1^2 y\,dx = \int_1^2 (Ax\ln x + 2x)\,dx$

$$= A\left[\ln x \cdot \frac{x^2}{2} - \frac{x^2}{4}\right]_1^2 + \left[x^2\right]_1^2 = A\left[\ln 2 \cdot 2 - 1 - \left(0 - \frac{1}{4}\right)\right] + 4 - 1 = A\left[2\ln 2 - \frac{3}{4}\right] + 3$$

$$A\left[\frac{7}{4} - 2\ln 2\right] = 3;\ A = \frac{12}{7 - 8\ln 2}$$

48. Let circle S = 0 is $x^2 + y^2 + 2gx + 2fy = 0$



Equation of AB as chord of contact

T = 0

3x + 5y + g(x + 3) + f(y + 5) = 0

x(3 + g) + y(5 + f) + 3g + 5f = 0 ..... (1)

Also, given equation of AB x + 2y = 3 ..... (2)

So, $\frac{3+g}{1} = \frac{5+f}{2} = \frac{3g+5f}{-3}$

6 + 2g = 5 + f and –9 – 3g = 3g + 5f

2g – f + 1 = 0 and 6g + 5f + 9 = 0

$g = -\frac{7}{8}$ and $f = -\frac{3}{4}$

49. Let foot of perpendicular from (3, –1) on the directrix be (x_1, y_1)

So, $\frac{x_1 - 3}{2} = \frac{y_1 + 1}{1} = \frac{-(6 - 1 - 3)}{5}$

$\frac{x_1 - 3}{2} = \frac{y_1 + 1}{1} = \frac{-2}{5}$

$x_1 = 3 - \frac{4}{5};\ y_1 = -1 - \frac{2}{5}$

$x_1 = \frac{11}{5};\ y_1 = -\frac{7}{5}$

Now image of (x_1, y_1) about tangent is focus, which is (x_2, y_2)

$$\frac{x_2 - \frac{11}{5}}{1} = \frac{y_2 + \frac{7}{5}}{1} = \frac{-2\left(\frac{11}{5} - \frac{7}{5} - 2\right)}{2} = \frac{6}{5}$$

$x_2 = \frac{17}{5}$; $y_2 = \frac{6}{5} - \frac{7}{5} = -\frac{1}{5}$

Focus is $\left(\frac{17}{5}, -\frac{1}{5}\right)$

50. $\vec{a} \times \vec{b} = p\vec{a} + q\vec{b} + r\vec{c}$

Taking dot product with $\vec{a}$, $\vec{b}$, $\vec{c}$

$0 = p + \frac{q}{3} + \frac{r}{3}$ ..... (1)

$0 = \frac{p}{3} + q + \frac{r}{3}$ ..... (2)

$\left[\vec{a}\ \vec{b}\ \vec{c}\right] = \frac{p}{3} + \frac{q}{3} + r$ ..... (3)

$$\left[\vec{a}\ \vec{b}\ \vec{c}\right]^2 = \begin{vmatrix} 1 & \frac{1}{3} & \frac{1}{3} \\ \frac{1}{3} & 1 & \frac{1}{3} \\ \frac{1}{3} & \frac{1}{3} & 1 \end{vmatrix} = 1\left(1 - \frac{1}{9}\right) + \frac{1}{3}\left(\frac{1}{9} - \frac{1}{3}\right) + \frac{1}{3}\left(\frac{1}{9} - \frac{1}{3}\right)$$

$= \frac{8}{9} - \frac{2}{27} - \frac{2}{27} = \frac{8}{9} - \frac{4}{27} = \frac{20}{27}$

From (1) and (2), we get p = q, r = –4q

From (3) $\left[\vec{a}\ \vec{b}\ \vec{c}\right] = \frac{q}{3} + \frac{q}{3} - 4q = -\frac{10q}{3}$

$\frac{20}{27} = \frac{100}{9}q^2 \Rightarrow q^2 = \frac{1}{15}$

51. $I = 2\int_0^{\pi/4} 2^{100} \sec^{100} x\,dx = \int_0^{\pi/4} (2\sec x)^{100}\,dx$

Put sec x + tan x = e^u

sec x(sec x + tan x)dx = e^u du

sec x dx = du

Also, 2 sec x = $e^u + e^{-u}$

$I = 4\int_0^{\ln\left(\sqrt{2}+1\right)} \left(e^u + e^{-u}\right)^{99} du$

52. Let $\phi(x) = e^{-2x}f(x)$

$\phi'(x) = e^{-2x}(f'(x) - 2f(x))$

Given $\phi''(x) > 0\ \forall\ x \in \left(0, \frac{1}{2}\right)$ and $\phi'\left(\frac{1}{4}\right) = 0$

$\Rightarrow f'\left(\frac{1}{4}\right) = 2f\left(\frac{1}{4}\right)$; $\phi(0) = \phi\left(\frac{1}{2}\right) = 0$

$\Rightarrow f(x) < 0\ \forall\ x \in \left(0, \frac{1}{2}\right)$

So, $f'\left(\frac{3}{8}\right) - 2f\left(\frac{3}{8}\right) > 0$

$\Rightarrow f'\left(\frac{3}{8}\right) > 2f\left(\frac{3}{8}\right);\ f'\left(\frac{1}{8}\right) < 2f\left(\frac{1}{8}\right)$

53. $\frac{a^2+b^2+c^2}{a+b+c} \geq \left(a^a\ b^b\ c^c\right)^{\frac{1}{a+b+c}}$

$a^2 + b^2 + c^2 \geq a^a\ b^b\ c^c$

Also, $\frac{1}{a}+\frac{1}{b}+\frac{1}{c} \geq 9$

$ab + bc + ac \geq 9abc$

Now $(a + b + c)^2 = 1$

$a^2 + b^2 + c^2 + 2ab + 2ac + 2bc = 1$

$2ab + 2ac + 2bc = 1 - (a^2 + b^2 + c^2)$

$1 - (a^2 + b^2 + c^2) \geq 18\ abc$

$a^2 + b^2 + c^2 \leq 1 - 18\ abc$

54. $n_1 = {}^{2+6-1}C_2 \times 6^4 = {}^7C_2 \times 36 \times 36 = 21 \times 36 \times 36 = 27216$

$n_2 = {}^{6+6-1}C_6 = 462$

Now $n_1 = 27216 = 2^4\ 3^5\ 7^1$

n_3 = number of divisors of from (4k + 1) (k ∈ N) will be 3^2, 3^4, 3 × 7, 3^3 × 7, 3^5 × 7 i.e., total 5

55.-56. Let median through A meet BC at D and circle at F

Let GD = x, DF = y then $AG \cdot AF = AB^2$

$2x(3x + y) = 36$ ..... (1)

$xy = 4$

$3x^2 + 4 = 18$

$x^2 = \frac{14}{3}$

So, AD = 3x = $\sqrt{42}$

Also, $AC^2 + AB^2 = 2(AD^2 + BD^2)$

$AC^2 + 36 = 2(42 + 4) = 2 \times 46 = 92$

$AC^2 = 56$

$AC = 2\sqrt{14}$

SECTION – C

57. $f(x) = \frac{\ln\left(\{\sin x\}\{\cos x\}+1\right)}{\{\sin x\}\{\cos x\}}$

$f\left(0^-\right) = \frac{\ln(1\times1+1)}{1\times1} = \ln 2$

$f\left(\frac{\pi^+}{2}\right) = \frac{\ln(1\times1+1)}{1\times1} = \ln 2$

$f\left(\frac{\pi^-}{2}\right) = \lim_{h\to0}\frac{\ln\left(\{\cosh\}\{\sinh\}+1\right)}{\{\cosh\}\{\sinh\}} = \lim_{h\to0}\frac{\ln(\cosh\sinh+1)}{\cosh\sinh} = 1$

58. $I = \int_0^{\pi/4} e^{\sec x}\frac{1}{2}\left[\frac{1+\tan x}{1-\sin x}\right]dx = \frac{1}{2}\int_0^{\pi/4} e^{\sec x}\left(\frac{1+\sin x}{\cos^2 x}+\frac{\tan x(1+\sin x)}{\cos^2 x}\right)dx$

$$= \frac{1}{2}\int_0^{\pi/4} e^{\sec x}\left(\sec^2 x + \tan x \sec x + \tan x \sec^2 x + \tan^2 x \sec x\right)dx$$

$$= \frac{1}{2}\int_0^{\pi/4} e^{\sec x}\left[\sec x \tan x\left(\sec x + \tan x\right) + \left(\sec x \tan x + \sec^2 x\right)\right]dx$$

$$= \frac{1}{2}\left[e^{\sec x}\left(\sec x + \tan x\right)\right]_0^{\pi/4} = \frac{1}{2}\left[e^{\sqrt{2}}\left(\sqrt{2}+1\right) - e\right] = \frac{e^{\sqrt{2}}\left(\sqrt{2}+1\right)}{2} - \frac{e}{2}$$

Here $k = -\frac{e}{2}$ ⇒ 3 ln (2|k|) = 3

59. $$\frac{P(T)P\left(\frac{W}{B}\right)}{P(T)P\left(\frac{W}{B}\right) + P(H)P\left(\frac{W}{A}\right)} = \frac{16}{25}$$

$$\frac{\frac{1}{2}\times\left(\frac{4}{6}\right)^n}{\frac{1}{2}\times\left(\frac{4}{6}\right)^n + \frac{1}{2}\left(\frac{3}{6}\right)^n} = \frac{16}{25}$$

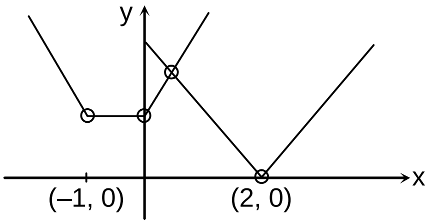
$$\frac{4^n}{4^n + 3^n} = \frac{16}{25} \Rightarrow n = 2$$

60. f(x) = 2 min{|x| + |x + 1|, |x – 2|}

Now, |x| + |x + 1| = 2x + 1, $x \ge 0$

= 1, $-1 \le x < 0$

= –2x – 1, $x < -1$



61. $$|z|^2 - 16 - 3\frac{z^2}{|z|^2} - 3\frac{\bar{z}^2}{|z|^2} + \frac{9}{|z|^2} = 0$$

$$|z|^2 + \frac{9}{|z|^2} - 3\left(\frac{z}{\bar{z}} + \frac{\bar{z}}{z}\right) = 16$$

$$\left(z - \frac{3}{z}\right)\left(\bar{z} - \frac{3}{\bar{z}}\right) = 16$$

$$\left|z - \frac{3}{z}\right| = 4$$

$$\left||z| - \frac{3}{|z|}\right| \le \left|z - \frac{3}{z}\right| \le |z| + \frac{3}{|z|}$$

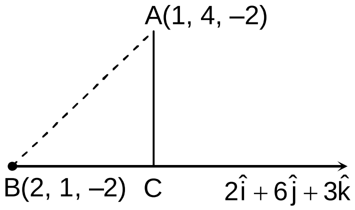
$$\left||z| - \frac{3}{|z|}\right| \le 4$$

$-4|z| \le |z|^2 - 3 \le 4|z|$

$\sqrt{7} - 2 \le |z| \le \sqrt{7} + 2$

62. $3^{x-1} = 2x^2 - 4x + 3 = 2(x-1)^2 + 1$ has total 3 solutions
i.e. $x = 1, 2, 3$
Sum of roots = 1 + 2 + 3 = 6

63. $\overrightarrow{BA} = -\hat{i} + 3\hat{j}$



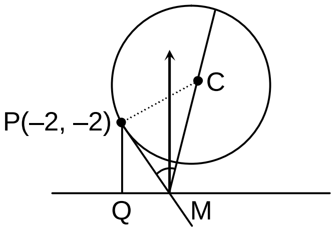
$$AC = \frac{\left|\overrightarrow{BA} \times \left(2\hat{i} + 6\hat{j} + 3\hat{k}\right)\right|}{\left|2\hat{i} + 6\hat{j} - 3\hat{k}\right|} = \frac{\left|-6\hat{k} + 3\hat{j} - 6\hat{k} + 9\hat{i}\right|}{\sqrt{4+36+9}}$$

$$= \frac{\left|9\hat{i} + 3\hat{j} - 12\hat{k}\right|}{\sqrt{49}} = \frac{\sqrt{81+9+144}}{7} = \frac{\sqrt{234}}{7} = \frac{3\sqrt{26}}{7}$$

$$p = \frac{3\sqrt{26}}{7}$$

$$\Rightarrow \frac{7p}{\sqrt{26}} = 3$$

64. $\tan 2\alpha = \frac{PC}{PM} = \frac{5}{PM}$ ..... (1)



$$\sin(90 - \alpha) = \frac{PQ}{PM}$$

$$PM = \frac{5/2}{\cos\alpha} = \frac{5}{2\cos\alpha} \quad \text{..... (2)}$$

$$5\cot 2\alpha = \frac{5}{2\cos\alpha}$$

$\Rightarrow 10 \cot 2\alpha \cos \alpha = 5$

65. The equation of tangent at (x_1, y_1)
$\Rightarrow 3xx_1 + 4yy_1 = 1$ ..... (1)
Comparing equation (1) with given equation
$3x + 4y = \sqrt{7}$

$$\frac{x_1}{1} = \frac{y_1}{1} = \frac{1}{\sqrt{7}}$$

$$x_1 = \frac{1}{\sqrt{7}}, y_1 = \frac{1}{\sqrt{7}}$$

66. $16 \sin^5 x - 20 \sin^3 x + 5 \sin x = 16 \sin^5 x$
Either $\sin x = 0$ or $\sin^2 x = \frac{1}{4}$

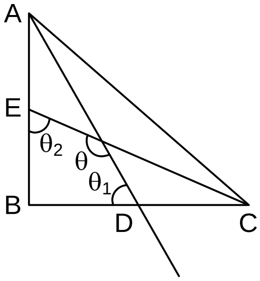
$$\Rightarrow \sin x = \pm\frac{1}{2}$$

$\Rightarrow x = n\pi$ or $x = n\pi \pm \frac{\pi}{6}$, $n \in I$

$0, \pi, 2\pi, \frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{11\pi}{6}$

Total number of solution = 7

SECTION – D



67. $\tan\theta_1 = \frac{AB}{BD} = \frac{2c}{a}$

$\tan\theta_2 = \frac{BC}{BE} = \frac{2a}{c}$

$\tan\theta_1, \tan\theta_2 = 4$

Angle between median = $\tan^{-1}\frac{3-1}{1+3} = \tan^{-1}\frac{1}{2}$

$\theta = \pi - \tan^{-1}\frac{1}{2}$

Now $\theta_1 + \theta_2 + \theta = \frac{3\pi}{2}$

$\theta_1 + \theta_2 + \pi - \tan^{-1}\frac{1}{2} = \frac{3\pi}{2}$

$\theta_1 + \theta_2 = \frac{\pi}{2} + \tan^{-1}\frac{1}{2}$

$\tan(\theta_1 + \theta_2) = -\cot\tan^{-1}\frac{1}{2} = -2$

$\frac{\tan\theta_1 + \tan\theta_2}{1 - \tan\theta_1\tan\theta_2} = -2$

$\tan\theta_1 + \tan\theta_2 = -2(1-4) = 6$

$\frac{2c}{a} + \frac{2a}{c} = 6 \Rightarrow \frac{c^2 + a^2}{ac} = 3 \Rightarrow \frac{64}{ac} = 3 \Rightarrow ac = \frac{64}{3}$

Area = $\frac{1}{2}ac = \frac{32}{3}$

68. Let α, β, γ are roots then $x^3 - ax^2 + bx + c = (x-\alpha)(x-\beta)(x-\gamma)$
Put x = 6
$(6-\alpha)(6-\beta)(6-\gamma) = 3$
Case-I: $6-\alpha = 1$, $6-\beta = 1$, $6-\gamma = 3$
$\Rightarrow \alpha = 5, \beta = 5, \gamma = 3$
So, a = 5 + 5 + 3 = 13
Case-III: $(6-\alpha) = -1$, $6-\beta = -1$, $6-\gamma = 3$
$\alpha = 7, \beta = 7, \gamma = 3$
a = 17
Case-III: $6-\alpha = -1$, $6-\beta = 1$, $6-\gamma = -3$
$\alpha = 7, \beta = 5, \gamma = 9$
a = 21

69. The number of ways = D(4) + 2D(3) + D(2) = 9 + 4 + 1 = 14 = k then $\frac{k}{3} = 4.66$

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

FULL TEST – V

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 186**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into Two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01– 05, 19 – 23, 37 - 41)*** *contains 15 multiple choice questions which have* ***one correct*** *answer. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (06 – 13, 24 – 31, 42 - 49) *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.

2. ***Section-C (14 – 18, 32 – 36, 50 – 54)*** *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

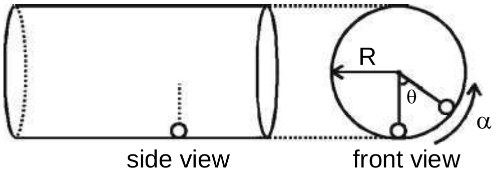
Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **5 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A small sphere of mass m and radius r is placed inside a horizontal hollow cylinder of radius R. Now cylinder rotating with some angular acceleration which slowly increases from zero to certain value α.



(A) Maximum angle θ formed by line joining centre will be $\theta = \sin^{-1}\left(\frac{2\alpha R}{5g}\right)$

(B) Angular velocity of sphere will be $\omega' = \frac{\omega r}{R}$ where ω is angular velocity of cylinder

(C) Sphere will keep rotating at lowest position

(D) K.E. of sphere becomes constant when it reaches maximum height.

2. You are holding a bottle of bubbled water inside a car moving forward. When the driver applies the brakes:

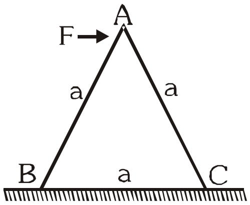
(A) Bubbles in the middle of the liquid will start to move forward with respect to the bottle.

(B) Bubbles will start to move backward with respect to the bottle.

(C) Bubbles will stay at the same horizontal location in the water

(D) Depending on the speed of the car, bubbles might move forward or backward.

3. A horizontal force F is applied at the top of an equilateral triangular block having mass m. The minimum coefficient of friction required to topple the block before translation will be



(A) $\frac{2}{\sqrt{3}}$

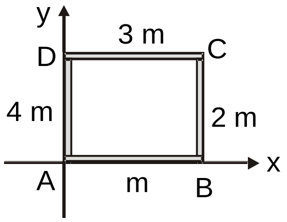
(B) $\frac{1}{2}$

(C) $\frac{1}{\sqrt{3}}$

(D) None of these

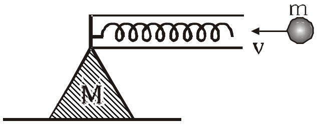
Space for Rough work

4. Four rods of equal lengths AB, BC, CD and DA have mass m, 2m, 3m and 4m respectively are place in x-y plane (see figure) given AB=BC=CD=DA=4 meters. The centre of mass of the system will satisfy (x and y are in meters)



(A) $x > 2$, $y > 2$
(B) $x > 2$, $y < 2$
(C) $x < 2$, $y < 2$
(D) $x < 2$, $y > 2$

5. A ball of mass m = 6 kg is shot with speed v = 20 m/s into a barrel of spring gun of mass M = 24 kg initially at rest. All surfaces are smooth & spring is massless. Speed of gun after ball stops relative to gun is

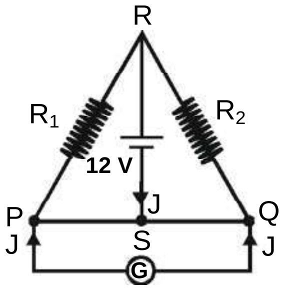


(A) 2 m/s
(B) 4 m/s
(C) 6 m/s
(D) 8 m/s

(One or More than one correct type)

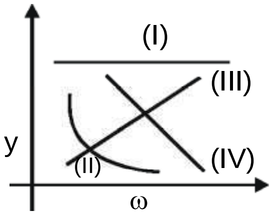
This section contains **EIGHT** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

6. In the circuit shown $R_1 = R_2 = 10\Omega$ and resistance per unit length of wire PQ = 1Ω/cm and length PQ = 10 cm. If R_2 is made 20Ω. then to get zero deflection in galvanometer. S is midpoint of wire PQ



(A) The jockey at P can be moved towards right 2 cm
(B) The jockey at Q can be moved towards left 2cm
(C) The jockey at S can be moved towards left a distance 5/3 m
(D) The jockey at all position fixed and R_1 should be made 20Ω

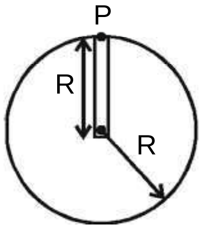
7. In a series LCR circuit, different physical quantities vary with frequency ω. Which of the following curves represent correct frequency variation of the corresponding quantity?



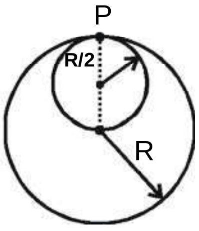
(A) Curve I for R
(B) Curve II for current I
(C) Curve III for X_L
(D) Curve IV for X_C

Space for Rough work

8. Consider two solid spherical asteroid of uniform density of mass M and radius R. In one asteroid a tunnel of very small size of depth R is bored to the centre and in other asteroid a spherical cavity of radius R/2 is made as shown in the figure. Now, identical particles of mass m dropped into the cavities of both asteroids from the top most point P. If force experienced by particle is F_I and F_{II}



Asteroid - I



Asteroid - II

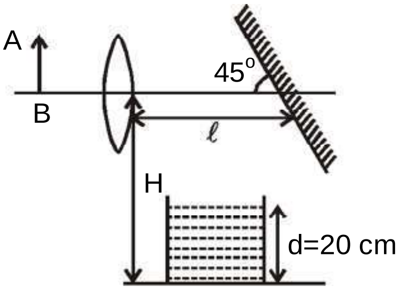
(A) The ratio of F_1 / F_{II} is equal to 2x/R
(B) The ratio of F_I / F_{II} is equal to x/R
(C) The ratio of T_I / T_{II} is equal to π/4
(D) The ratio of T_I / T_{II} is equal to π/2

9. Electric field in a region is given as $\vec{E} = (10 - 5x)\hat{i}$. A charge particle of mass 5kg and charge $Q(=1C)$ is situated at origin and free to move in given electric field. Then choose the correct options (Neglect gravity):-
(A) Motion of charge particle is Oscillatory
(B) Maximum displacement of charge particle from origin in 4 SI units
(C) Maximum velocity gain by charge particle is 2 SI units
(D) The position of charge particle, when velocity gained by particle is maximum, is 2 SI units

10. A proton and an electron are moving with the same de-Broglie wavelength (consider the non-relativistic case). Then
(A) In a magnetic field both the particles describe circles of equal radius
(B) Both the particles have the same momentum
(C) The speed of the proton and the electron are in the ratio m_e / m_p, where m_e is the electron mass and m_p, the proton mas
(D) The product of mas and kinetic energy is the same for both particles

Space for Rough work

11. A linear object AB is at a distance of 36 cm from an equal convex lens of focal length 30 cm. In front of lens there is a plane mirror which is inclined at an angle 45^o with the principal axis of the lens at a distance $l = 1$from the mirror as shown in figure. A container with water layer d = 20 cm is placed as shown in the figure. Then choose the **CORRECT** statement(s). Take the refractive index of water is $\frac{4}{3}$



(A) After reflection from the mirror the image of AB will be parallel to principal axis of the lens.
(B) After reflection from the mirror the image of AB will be perpendicular to principal axis of the lens.
(C) The value of H for which the sharp image of AB can be obtained at the bottom of the container is 80 cm.
(D) The value of H for which the sharp image of AB can be obtained at the bottom of the container is 85 cm.

12. Two identical objects A and B $\left(\text{emissivity } e_A \text{ and } e_B; e_A \neq e_B\right)$ are placed in an enclosure. Temperature of body A, B and enclosure are same and constant : -
(A) Heat emitted by body A is not equal to heat emitted by body B
(B) Heat absorbed by body A is not equal to heat absorbed by body B
(C) If $e_A > e_B$, body A absorbs more heat than body B
(D) If $e_A < e_B$, body A emits less heat than body B

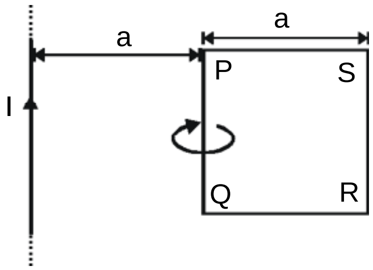
13. $_{92}U^{235}$ is 'α' active. Then in a large quantity of the element:-
(A) The probability of a nucleus disintegrating during one second is lower in the first half life and greater in the fifth life
(B) The probability of a nuelcues disintegrating during one second remains constant for all time.
(C) Quite an appreciable quantity of U^{235} will remain even the average life
(D) The energy of the emitted 'α' particle is less than the disintegration energy of the U^{235} nucleus.

Space for Rough work

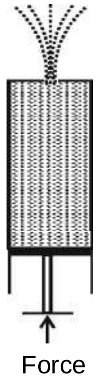
SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

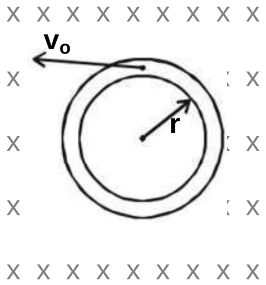
14. A square frame of resistance $\ell n(2)\Omega$ and side a = 20 cm and a long straight wire carrying a current I = 10 amp are located in the same plane. The frame is rotated through an angle of 120° about the side PQ. The amount of charge flown through the loop during this time is $q \times 10^{-7}$ coulomb, find the value q.



15. A syringe is filled with water up to volume 20 cm^3. The area of cross – section of the cylinder is 5 cm^2. The syringe is held vertically and its 90 gm piston is pushed upward by external agent with constant speed. A water beam coming out of the small nozzle (hole area 1 mm^2). Neglecting friction and viscous nature of water, find the work done by the agent [in 10^{-2}] in fully emptying the syringe. (take g = 10 m/s^2)

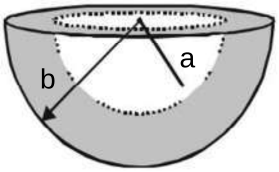


16. A horizontal tube of small thickness having inner radius r = R/2 is placed in gravity free space. Magnet field of strength B is present perpendicular to plane of circular tube. A charged particle (q. m) inside, the tube is given tangential velocity $v_o = \frac{qBR}{m}$. The work done by friction long after motion is $-\frac{Kq^2B^2R^2}{8m}$. Find the value of K. [inner surface of tube is rough]



Space for Rough work

17. A uniformly charged hemisphere of radius b and charge density ρ has a hemispherical cavity of radius $a\left(a=\frac{b}{2}\right)$ cut from its centre. If the potential at the centre of the cavity is $\frac{n\rho b^2}{16\in_0}$ then n = ?



18. Two sound waves of frequencies 100 Hz and 102 Hz and having same amplitude 'A' are interfering. At a stationary detector, which can detect resultant amplitude grater than or equal to A. So, in a given time interval of 12 seconds, find the total duration in which detector is active.

Space for Rough work

Chemistry

PART – II

SECTION – A

(One Options Correct Type)

This section contains **5 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

19. In an aqueous solution of volume 500 ml, when the reaction given below $2Ag^+ + Cu \rightleftharpoons Cu^{2+} + 2Ag$ reached at equilibrium, the $\left[Cu^{2+}\right]$ was x M. When 500 ml of water is further added, at the equilibrium, the $\left[Cu^{2+}\right]$ will be

(A) x
(B) 2x
(C) less than $\frac{x}{2}$
(D) $\frac{3x}{4}$

20. When Sulphur is boiled with Na_2SO_3, a compound (A) is produced. With excess of $AgNO_3$ solution, compound (A) gives a compound (B), which is dissolved in water and produces a black coloured compound (C) containing sulphur. 'C' is

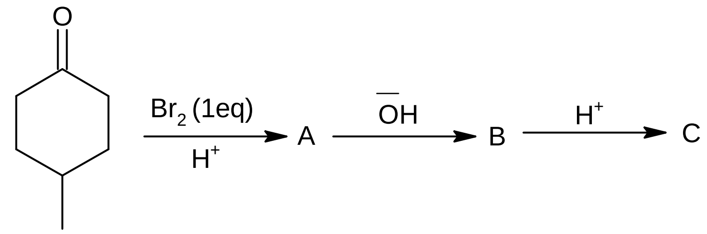
(A) $Ag_2S_2O_3$
(B) Ag_2SO_4
(C) $\left[Ag_2\left(S_2O_3\right)_4\right]^{6-}$
(D) Ag_2S

21. The rate of disintegration of a certain radioactive sample at any instant is 8100 dpm. Fifty minutes later, the rate becomes 2700 dpm. The half life of the radioactive sample will be (Take log2 = 0.3, log3 = 0.5, log5 = 0.7)

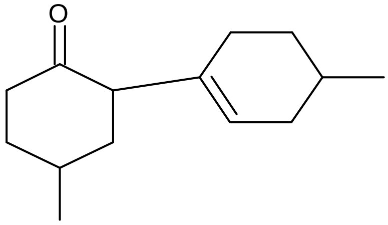
(A) 30 minutes
(B) 61 minutes
(C) 47.8 minutes
(D) 33.3 minutes

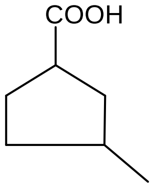
Space for Rough work

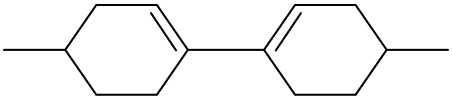
22.

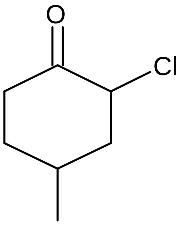


C is

(A) 

(B) 

(C) 

(D) 

23. The IUPAC name of C_2H_5NHCHO is

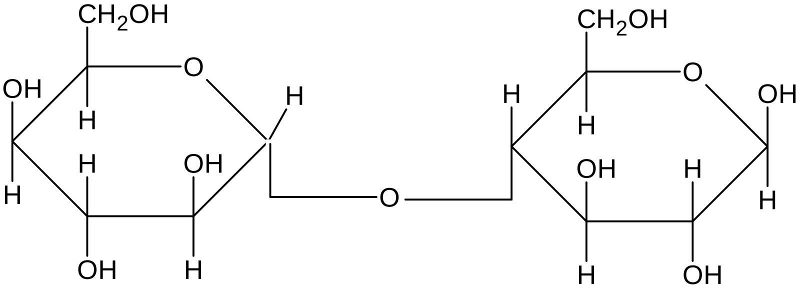
(A) N – aldoethanamine
(B) N - formylethanamine
(C) N - aldoaminoethane
(D) N – ethylmethanamide

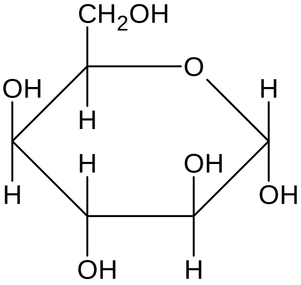
Space for Rough work

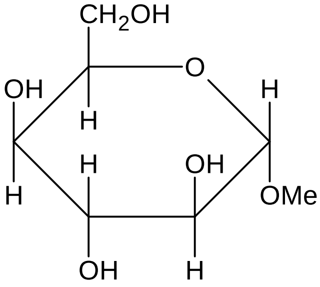
(One or More than one correct type)

This section contains **EIGHT** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

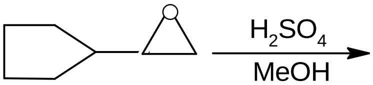
24. Which of the following can reduce Tollen's reagent?

(A)

CH$_2$OH
O
OH
H
H
H
OH
H
OH
H
O
CH$_2$OH
O
H
OH
H
OH
H
H
H
OH

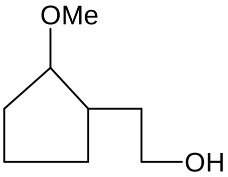
(B)

CH$_2$OH
O
OH
H
H
H
OH
H
OH
OH
H

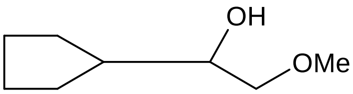
(C)

CH$_2$OH
O
OH
H
H
H
OH
H
OMe
OH
H

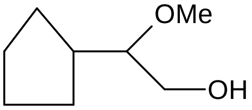
(D) fructose

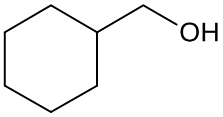
25.


Q (single) Q is

(A)


(B)


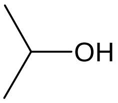
(C)


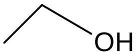
(D)


Space for Rough work

26. Which of the following will produce red color when treated with $(NH_4)_2[Ce(NO_3)_6]$?

(A) CH_3OH

(B)


(C)


(D) PhOH

27. Which of the following statement is/are correct?

(A) On adding excess of Ag NO_3 to 1 mole of each $PtCl_4$. 4 NH_3 and $[Ni(en)_3]Cl_2$, same weight of ppt (AgCl) is produced.

(B) Ma_3b_3 complexes do not show optical activity

(C) Oxidation number of central metal in Zeise's salt is + 2.

(D) $K_4[Fe(CN)_6]$ & $K_3[Fe(CN)_6]$ both have sp^3d^2 hybridisation.

28. Which of the following trend is/are correct?

(A) $ClO_2 > SO_2 > CO_2 > P_2O_5$ (acidic nature)

(B) $Na > Si > Al > Mg$ (second I. P.)

(C) $S > Se > Te > O$ (electron affinity)

(D) $H_3PO_2 > H_3PO_3 > H_3PO_4$ (Ka_1)

29. Which of the following will dissolve in liq. HF without any chemical reaction?

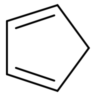
(A) XeF_2

(B) XeF_4

(C) XeF_6

(D) NaH

30.

(1)

$\xrightarrow[\text{(d)}]{\text{n - BuLi}}$ A + B (B does not contain π bond)

(2) $A \xrightarrow{Cl - CH_2O\ Me} C$

Which is/are true for above reactions?

(A) B can be prepared by corey house synthesis

(B) C after hydrogenation on treatment with 1 eq cold conc HI produces an alkyl halide with highest density

(C) C does not decolorizes Br_2 – water

(D) A is organometallic compound

Space for Rough work

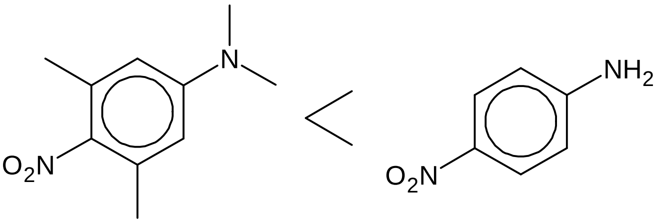
31. Which of the following is/are wrong statement(s)?
(A) The second I.P. is always less than the 1st I.P. of an atom
(B) If the addition of an electron to an ion leads to complete octet, then the process is always exothermic
(C) Chlorine has highest electronegativity
(D) 1st I.P. of N is higher than 1st I.P. of F, because N has half filled subshell

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

32. An Ester produces only one alcohol on treatment with CH_3MgBr followed by hydrolysis and this ester has minimum molecular weight, find the number of carbon atoms present in ester which satisfies above conditions.

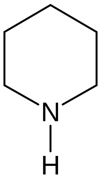
33. How many of the following is/are correct order of dipole moment?
(A) $CH_3-F > CH_3-Cl > CH_3-Br > CH_3-I$
(B) $H-F > H-Cl > H-Br > H-I$
(C) $CH_3-Cl > CH_2Cl_2 > CHCl_3 > CCl_4$
(D) $CH_2=CH-Cl < CH_3-CH_2-Cl$
(E)



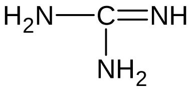
(F) $CH_3-Cl > CH_3-F > CH_3-Br$
(G) $H-Cl > H-F > H-Br$

Space for Rough work

34. How many of the following are more basic than aniline?
O – toluidine, O – anisidine, m – anisidine, P – anisidine, P – chloroaniline, m – toluidine,



,



$H_2N-\underset{NH_2}{\underset{|}{C}}=NH$

35. How many of the following carbides on reaction with water will produce a product capable of forming silver mirror, on treatment with Tollen's reagent?
Be_2C, CaC_2, Mg_2C_3, Al_4C_3, CH_4, SiC.

36. The distance between an octahedral and tetrahedral void in FCC lattice would be $\frac{\sqrt{3}a}{b}$. Find the value of b if a is edge length of cube.

Space for Rough work

Mathematics PART – III

SECTION – A

(One Options Correct Type)

This section contains **5 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. The length of focal chord AB of ellipse $\frac{x^2}{4}+\frac{y^2}{3}=1$ is: $\left(\text{Given } A=\left(\frac{8}{5}, \frac{3\sqrt{3}}{5}\right)\right)$

(A) $\frac{4}{5}$ (B) $\frac{16}{5}$

(C) $\frac{32}{5}$ (D) $\frac{64}{5}$

38. If $2x-y+1=0$ is a tangent on the parabola which intersect its directrix at (1, 3) and focus is (2, 1), then equation of axis of parabola is

(A) $11x-2y=24$ (B) $11x+2y+24=0$

(C) $2x-11y-24=0$ (D) $2y+11x=24$

39. If vectors $\hat{a}, \hat{b}, \hat{c}$ are in space such that $\hat{a}.\hat{b}=\hat{b}.\hat{c}=\hat{c}.\hat{a}=\frac{1}{2}$, then $\left(\hat{a}\times\hat{b}\right).\left(\hat{a}\times\left(\hat{b}\times\hat{c}\right)\right)$ is equal to

(A) $\frac{1}{\sqrt{2}}$ (B) $-\frac{1}{\sqrt{2}}$

(C) $\frac{1}{2\sqrt{2}}$ (D) $-\frac{1}{2\sqrt{2}}$

40. How many matrices X with entries {0, 1, 2} are there for which sum of diagonal entries of $X.X^T$ is 7?

(A) 560 (B) 562

(C) 504 (D) 540

Space for Rough work

41. If α and β are roots of equation $\frac{3}{4}\sin\left(\frac{\theta}{9}\right) = \sin^3\theta + 3\sin^3\left(\frac{\theta}{3}\right) + 9\sin^3\left(\frac{\theta}{9}\right) + \frac{1}{4\sqrt{2}}$ for $0 < \theta < \frac{\pi}{2}$, then $\tan\alpha + \tan\beta$ is equal to

(A) $2+\sqrt{3}$ (B) $3+\sqrt{3}$

(C) $3-\sqrt{3}$ (D) $2-\sqrt{3}$

(One or More than one correct type)

This section contains **EIGHT** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

42. If volume of a parallelepiped determined by the vectors $\bar{a}$, $\bar{b}$ & $\bar{c}$ is 2, then volume of parallelepiped determined by the vectors

(A) $3(\bar{a}+\bar{b})$, $(\bar{b}+\bar{c})$ and $(\bar{c}+\bar{a})$ is 24 (B) $2(\bar{a}\times\bar{b})$, $3(\bar{b}\times\bar{c})$ and $(\bar{c}\times\bar{a})$ is 24

(C) $(\bar{a}-2\bar{b})$, $(\bar{b}-2\bar{c})$ and $(\bar{c}-2\bar{a})$ is 14 (D) $3(\bar{a}-\bar{b})$, $(3\bar{b}-\bar{c})$ and $(3\bar{c}-\bar{a})$ is 52

43. If a point P is taken on xy = 2 and then a normal is drawn from P on the ellipse $\frac{x^2}{6}+\frac{y^2}{3}=1$ which is perpendicular to $x+y=8$, then P is

(A) (1, 2) (B) (–1, –2)

(C) (2, 1) (D) (–2, –1)

44. A circle S having centre (α, β) intersect at three points A, B and C such that normals at A, B and C are concurrent at (9, 6) for parabola $y^2 = 4x$ and O is origin. Then,

(A) Sum of modulus of slopes of normals at points A, B and C is 6

(B) $\alpha+\beta=4$

(C) Magnitude of normal having negative slope is 2

(D) Circle S also passes through O

Space for Rough work

45. If $f(x) = \left||x-1| + |x-3| - |2x-1|\right| + \left||x-1| + |x-3| + |2x-1|\right|$, then

(A) $f(x)$ is non-differentiable at x = 1
(B) $f(x)$ is non-differentiable at $x = \frac{3}{2}$
(C) $f(x)$ has minimum value is 2
(D) x = 1 is point of local minima

46. If $\int \cos 2018x \sin^{2016} x\, dx = f(x) + c$, where $f(0) = 0$, then

(A) $\int_0^{\pi} f(x)dx = f(\pi)$
(B) $f\left(\frac{\pi}{4}\right) = \frac{1}{2^{1009}} \cdot \frac{1}{2017}$
(C) $f\left(\frac{\pi}{4}\right) = \frac{1}{(2018)2^{1009}}$
(D) $f(x)$ is odd function

47. In a ΔABC, if $a^2 - b^2 - c^2 + (x-2)bc = 0$, then x can be equal to

(A) $\frac{1}{2}$
(B) $\frac{3}{2}$
(C) 2
(D) 4

48. If $f(x) = \{b^2 + (a-1)b + 2\}x - \int(\sin^2 x + \cos^4 x)dx$ be an increasing function of $x \in R$ and $b \in R$, then a can take value(s)

(A) 0
(B) 1
(C) 2
(D) 4

49. Let $f(x)$ be a continuous function which takes positive values for $x \geq 0$ and satisfy $\int_0^x f(t)dt = x\sqrt{f(x)}$ with $f(1) = \frac{1}{2}$. Then

(A) $f(x)$ is increasing function in domain
(B) $f(x)$ is decreasing function in domain
(C) $f(\sqrt{2}+1) = \frac{1}{2\sqrt{2}}$
(D) $f(\sqrt{2}+1) = \frac{1}{4}$

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

50. If $x+y=3$ is tangent at (2, 1) on hyperbola, intersects asymptotes at A and B such that $AB=8\sqrt{2}$. If centre of hyperbola is (–1, –1), then least possible value of sum of semi-transverse axis and semi-conjugate axis is $p\sqrt{q}$, where HCF (p, q) = 1 and $\sqrt{q}$ is irrational number. Then, $(p+q)$ is equal to

51. If $x^2+y^2=16$ is director circle of locus of centre of a moving ellipse touches both the axes in first quadrant, then if major axis and minor axis are not fixed, then maximum value of product of semi-major and semi-minor axis is

52. If θ is acute angle of intersect between two curves $x^2+5y^2=6$ and $y^2=x$, then $\cot\theta$ is equal to

53. If 8 harmonic means are inserted between two numbers a and b (a < b) such that arithmetic mean of a and b is $\frac{5}{4}$ times equal to geometric mean of a and b, then $\left(\frac{H_8-a}{b-H_8}\right)$ is equal to

54. If $f(x)=\sum_{i=1}^{\infty}\frac{x}{\{(i-1)x+1\}(ix+1)}$, then $f(2017)+f\left(\frac{1}{2017}\right)$ is equal to

Space for Rough work

FIITJEE

JEE(Advanced)-2018

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – V
(Paper-1)

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**A**	19.	**C**	37.	**B**
2.	**B**	20.	**D**	38.	**D**
3.	**C**	21.	**A**	39.	**D**
4.	**B**	22.	**B**	40.	**D**
5.	**B**	23.	**D**	41.	**C**
6.	**A, C, D**	24.	**A, B, D**	42.	**B, C, D**
7.	**A, C**	25.	**C**	43.	**B, C**
8.	**A, C**	26.	**A, B, C**	44.	**A, B, D**
9.	**A, B, C, D**	27.	**A, B, C**	45.	**A, B, C**
10.	**A, C, D**	28.	**C, D**	46.	**A, B, D**
11.	**A, D**	29.	**A, B**	47.	**A, B, C**
12.	**A, B, C, D**	30.	**A, B, D**	48.	**A, B, C**
13.	**B, C, D**	31.	**A, B, C, D**	49.	**B, D**
14.	**4**	32.	**4**	50.	**9**
15.	**8**	33.	**5**	51.	**4**
16.	**4**	34.	**4**	52.	**3**
17.	**3**	35.	**0**	53.	**2**
18.	**8**	36.	**4**	54.	**2**

Physics

PART – I

SECTION – A

1. **A**

Acceleration slowly increases from zero to α, so small sphere will be at rest w.r.t ground when maximum acceleration α is to be reached in frame of cylinder, small sphere will have αr downward acceleration applying condition of rolling

$$\alpha r = \frac{g\sin\theta + \alpha r}{1+\frac{2}{5}}$$

$$\frac{7}{5}\alpha r - \alpha r = g\sin\theta$$

$$\theta = \sin^{-1}\left(\frac{2\alpha r}{5g}\right)$$

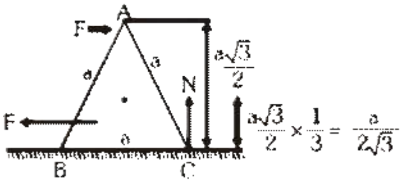
2. **B**

3. **C**

$$I = \frac{ma^2}{6} + m\left(\frac{a}{\sqrt{3}}\right)^2 \Rightarrow I = \left(\frac{ma^2}{2}\right)$$

$$\Rightarrow F\times\frac{a\sqrt{3}}{2} = (mg)\frac{a}{2} \Rightarrow F = \left(\frac{mg}{\sqrt{3}}\right)$$

$$F = F_{max} \Rightarrow \frac{mg}{\sqrt{3}}\mu mg \Rightarrow \mu = \frac{1}{\sqrt{3}}$$


A
F
a
a
N
$\frac{a\sqrt{3}}{2}$
F
a
$\frac{a\sqrt{3}}{2}\times\frac{1}{3} = \frac{a}{2\sqrt{3}}$
B
C

4. **B**

$$y_{cm} = \frac{\sum m_i y_i}{\sum m_i} \text{and } x_{cm} = \frac{\sum m_i x_i}{\sum m_i}$$

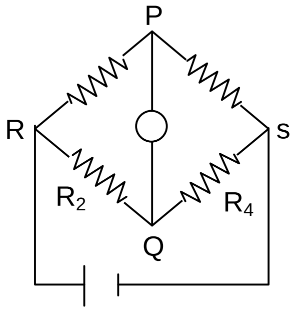
5. **B**

Momentum & energy conservation $6\times 20 = (24+6)v$

v = 4 m/s.

6. **A, C, D**

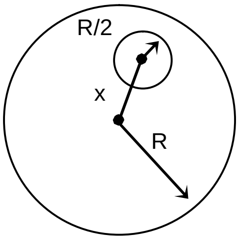
Equivalent diagram is as shown is P is moved 2 cm right them $R_1 = 12, R_3 = 3\ \frac{R_1}{R_3} = \frac{R_2}{R_4}$ (Hence wheat stone will be balanced) If s is moved left $\frac{5}{3}$ cm then $R_3 = \frac{10}{3}$ and $R_4 = \frac{20}{3}$ hence $\frac{R_1}{R_3} = \frac{R_2}{R_4}$ (hence Wheatstone will be balanced)



7. **A, C**
R is independent of freq,
(A) is true.
Current becomes maximum at resonance
(B) cannot be true
$X_L = L = 2\pi fL$
(C) is true
$Y = \frac{1}{C} = \frac{1}{2\pi fC}$
(D) can not be true.

8. **A, C**

Asteriod – I	**Asteriod – II**
Field E = $\frac{GM}{R^3}x$	Field $E_{II} = \frac{GM}{R^3}\left(\frac{R}{2}\right)$
$\frac{F_I}{F_{II}} = \frac{2x}{R}$	$R = \frac{1}{2}\frac{GM}{R^3}\left(\frac{R}{2}\right)T_{II}^2$
$T_I = \frac{2\pi}{4}\sqrt{\frac{R^3}{GM}}$	$T_{II} = 2\sqrt{\frac{R^3}{GM}}$

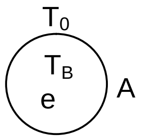


9. **A, B, C, D**
$\vec{E} = (10 - 5x)i$
$m = 5kg$
$\vec{F} = q\vec{E}$
$\vec{F} = (10 - 5x)i$
$(a)\ F \propto -x$
so motion of charge particle is oscillatory (b) F = 0 at x = 2
oscillation about x = 2
so maximum displacement is 4
F = 10 – 5x
$a = \frac{10 - 5x}{2}$
$a = 2 - x$
$a = -(x - 2)$
so $w^2 = 1$
$w = 1$
$(c) v_{max} = Aw$
$A = 2$
$w = 1$
$v_{max} = 2$
(d) velocity at mean position at x = 2

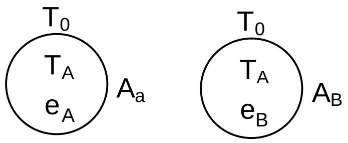
10. **A, C, D**

11. **A, D**

12. **A, B, C, D**



Emissivity of body e
Area of body A
Temperature of body T_B
Temperature of environment T_0
Heat energy radiated by body $= e\sigma A T_B^4$
Absorbed by body = $e\sigma A T_0^4$

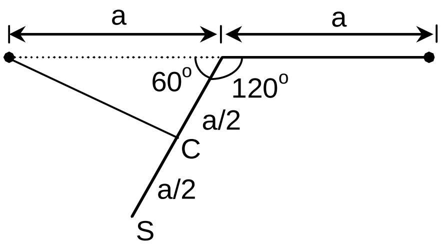


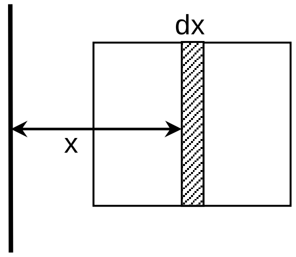
$e_A \neq e_B$
Then heat emitted by heat emitted by a body is not equal to B.

13. **B, C, D**
The probability of decay in 1 sec is the decay constant D, which remains constant after average life 37% of nuclei remain undecayed part of energy of disintegration is taken by the recoiling daughter nucleus.

SECTION – C

14. **4**
After moving the loop about side PQ through 120°, the normal on the side PS from the wire will be passing through midpoint C and the net magnetic flux through the loop in the new position will be zero.
∴ Changes is flux $\Delta f =$ Flux through the loop in the initial position.
Flux through area element dA





$$d\phi = \vec{B}.d\vec{A}\frac{\mu_0 I}{2\pi x}a.dx$$

$$\phi = \int_a^{2a}\frac{\mu_0 I a dx}{2\pi x} = \frac{\mu_0 I a}{2\pi}\ell n(2)$$

∴ Charge flown through the square loop $= \frac{\Delta\phi}{R} = \frac{\mu_0 I a}{2\pi R}\ell n(2)$

15. **8**

Height of water column $= \frac{20}{5} = 4$ cm

Mass of water = 20 gm

By work energy theorem

$$W_{ext} = \Delta U_{piston} + \Delta U_{water} + KE_{water} = 8 \times 10^{-2} \text{Joule}$$

16. **4**

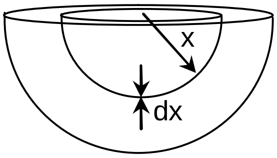
$$W_g + W_{mg} + W_{friction} = \Delta KE$$

$$W_{friction} = 0 - \frac{1}{2}m\left[\frac{qBR}{m}\right]^2$$

$$W_{friction} = -\frac{1}{2}\frac{q^2B^2R^2}{m} = \frac{-Kq^2B^2R^2}{8m}$$

K = 4

17. **3**



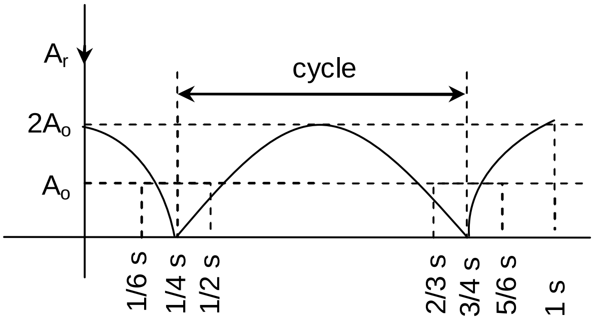
$$V = \int_a^b \frac{K\left(2\pi x^2 dx\right)\rho}{x}$$

$$V = 2\pi k\rho\left[\frac{b^2 - a^2}{2}\right] = \pi\rho k\left(b^2 - a^2\right)$$

$$b = 2a$$

$$v = 3\pi k\rho b^2$$

18. **8**



$$y_1 = A\sin\omega_1 t$$

$$y_2 = A\sin\omega_2 t$$

$$y_1 = 2A\cos\left\{\frac{(\omega_2 - \omega_1)}{2}\right\}\left\{\sin\frac{(\omega_2 + \omega_1)}{2}t\right\}$$

Resultant amplitude $A_r = 2A_0|\cos(\Delta\omega)t/2|$

$$(\Delta\omega)\frac{t}{2} = \frac{\pi}{2} \Rightarrow t = \frac{1}{4}s$$

$$(\Delta\omega)\frac{t}{2} = \frac{\pi}{3} \Rightarrow t = \frac{1}{6}s$$

In one cycle of intensity of ½ s, the detector remain idle for

$$2\left(\frac{1}{4} - \frac{1}{6}\right)s = \frac{1}{6}\text{sec}$$

$\therefore$ In 1/2 sec cyclem active time is $\left(\frac{1}{2} - \frac{1}{6}\right)$

$= 1/3\,\text{sec}$

$\therefore$ In 12 sec interval, active time is $12 \times \frac{(1/3)}{(1/2)} = 8\,\text{sec}$

Chemistry

PART – II

SECTION – A

19. **C**

After adding water equilibrium will shift backward and new concentration will be less than $\frac{x}{2}$.

20. **D**

A is $Na_2S_2O_3$, & C is Ag_2S.

21. **A**

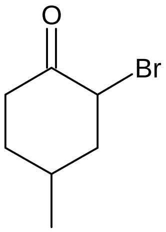
$r_1 = \lambda N_1$

$8100 = \lambda N_o$

$2700 = \lambda N_t$

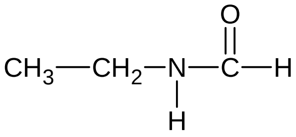
$$\lambda = \frac{2.303}{50}\log\frac{N_o}{N_t} = \frac{0.693}{t_{1/2}}$$

22. **B**



= A, $A \longrightarrow B$ favorskii rearrangement

23. **D**

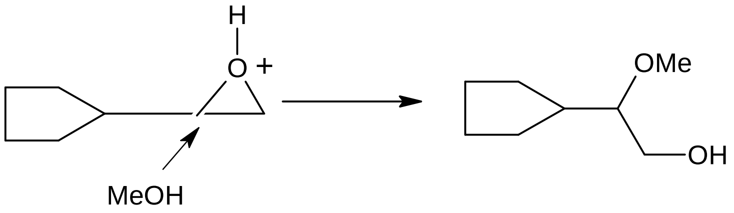


$CH_3-CH_2-\underset{\underset{H}{|}}{N}-\overset{\overset{O}{||}}{C}-H$ has acid amide functional gp

24. **A, B, D**

Hemiacetals give Tollen's test fructose $(\alpha-\text{hydroxy ketone})$ also gives Tollen's test.

25. **C**



26. **A, B, C**

In Cerric ammonium nitrate test alcohol produce red color due to formation of $(NH_4)_2\left[Ce(OR)(NO_3)_5\right]$ while phenol produces brown.

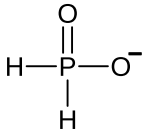
27. **A, B, C**

$\left[Pt(NH_3)_4Cl_2\right]Cl_2$, $\left[Ni(en)_3\right]Cl_2$ both have same number of Cl^- in ionization sphere, Zeise's salt is $K\left[PtCl_3(C_2H_4)\right]$, $K_4\left[Fe(CN)_6\right]$ & $K_3\left[Fe(CN)_6\right]$ both have d^2sp^3.

28. **C, D**

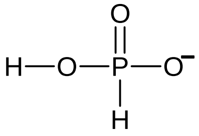
Cl is most electronegative among Cl, S, P & C so ClO_2 is most acidic and Ea of O is least in its

gp ;



$H-P(=O)(H)-O^-$

1



$H-O-P(=O)(H)-O^-$

2

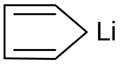
Due to cross conjugation in (2) ; 1 is weaker base than 2 so H_3PO_2 is stronger acid than H_3PO_3, similarly relate H_3PO_4 for option (b) refer e^- configuration & ENC $\Rightarrow$ Na > Al > Si > Mg.

29. **A, B**

XeF_2 & XeF_4 dissolve in liq HF without any chemical reaction while XeF_6 reacts with HF & $NaH + HF \longrightarrow H_2 + NaF$.

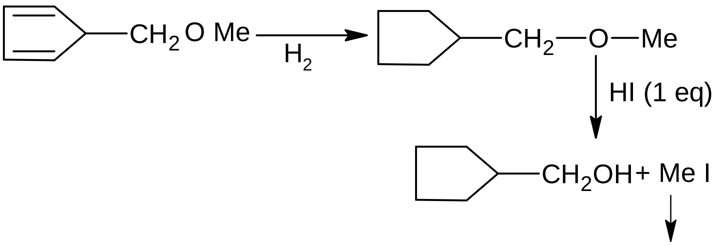
30. **A, B, D**

A is



; B is C_4H_{10}

C is



has highest density among R - X

31. **A, B, C, D**

$IE_2 > IE_1$ (as ENC increases)

$O^- + e^- \longrightarrow O^{2-}$

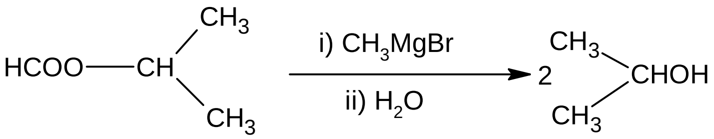
Due to FOR between O^- and e^- the process is endothermic.

F has highest electronegativity.

First I.P. of N is less than first I.P. of F.

SECTION – C

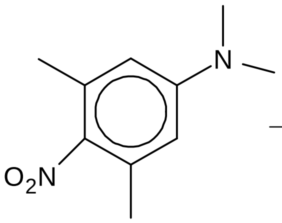
32. **4**



$HCOO-CH(CH_3)_2 \xrightarrow[\text{ii) } H_2O]{\text{i) } CH_3MgBr} 2\,(CH_3)_2CHOH$

33. **5**

$CH_3 - Cl > CH_3 - F(\mu = q \times d)$

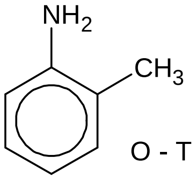


$\longrightarrow$ SIR of NO_2

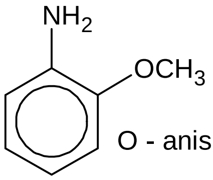
$CH_2 = CHCl \Rightarrow -I$ is opposed by + R of Cl

34. **4**

Refer ortho effect and resonance, inductive effect etc.



O - Toluidine



O - anisidine - ortho effect does not work.

35. **0**

Acetylene gives Tollen's test but not form silver mirror (Ag). (Ag_2C_2 - white ppt.)

36. **4**

Refer FCC.

Mathematics

PART – III

SECTION – A

37. **B**

$$\because 2\cos\theta_1 = \frac{8}{5} \Rightarrow \cos\theta_1 = \frac{4}{5} \Rightarrow \tan\frac{\theta_1}{2} = \sqrt{\frac{1-\frac{4}{5}}{1+\frac{4}{5}}} = \frac{1}{3} \text{ and } e = \frac{1}{2}$$

$$\therefore \tan\frac{\theta_2}{2} \times \frac{1}{3} = \frac{-\frac{1}{2}}{\frac{3}{2}}$$

$$\frac{\theta_2}{2} = \frac{3\pi}{4} \Rightarrow \theta_2 = \frac{3\pi}{2}$$

$$\therefore B = \left(0,\ -\sqrt{3}\right) \Rightarrow AB = 2 + 2 - \frac{1}{2} \times \frac{8}{5} = 4 - \frac{4}{5} = \frac{16}{5}$$

38. **D**

$\because$ Image of (2, 1) in $2x - y + 1 = 0$ is

$$\frac{x-2}{2} = \frac{y-1}{-1} = \frac{-2\left(4-1+1\right)}{4+1} = \frac{-8}{5}$$

$$\Rightarrow x = 2 - \frac{16}{5} = \frac{-6}{5}$$

$$y = \frac{8}{5} + 1 = \frac{13}{5}$$

$$\therefore \text{ Slope of directrix } = \frac{\frac{13}{5} - 3}{\frac{-6}{5} - 1} = \frac{-\frac{2}{5}}{-\frac{11}{5}} = \frac{2}{11}$$

$\therefore$ Equation of axis,

$$y - 1 = \frac{-11}{2}\left(x - 2\right)$$

$$\Rightarrow 2y - 2 = -11x + 22$$

$$\Rightarrow 11x + 2y = 24$$

39. **D**

$$\because \left(\hat{a} \times \hat{b}\right).\left\{\left(\hat{a}.\hat{c}\right)\hat{b} - \left(\hat{a}.\hat{b}\right)\hat{c}\right\} = 0 - \left(\hat{a}.\hat{b}\right)\left[\hat{a}\ \ \hat{b}\ \ \hat{c}\right]$$

$$= -\frac{1}{2} \times \frac{1}{\sqrt{2}}$$

$$\therefore \left[\hat{a}\ \ \hat{b}\ \ \hat{c}\right]^2 = \begin{vmatrix} 1 & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & 1 & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} & 1 \end{vmatrix} = \frac{1}{2}$$

40. **D**

$\because a_1^2 + b_1^2 + c_1^2 + a_2^2 + b_2^2 + c_2^2 + a_3^2 + b_3^2 + c_3^2 = 7$, where $\langle a_i,\ b_i,\ c_i \rangle$ are elements of ith row.

$\therefore$ Case I: All seven entries are 1 and rest of all zero

${}^9C_7 = {}^9C_2 = 36$

Case II: Only one entry is 2 & three entries are 1 and rest of all 0's.

${}^9C_4 \times {}^4C_1 = 504$

$\therefore$ Total = 540

41. **C**

$$\because \frac{1}{4}\sin 3\theta = \frac{3}{4}\sin\left(\frac{\theta}{9}\right) - \sin^3\theta - 3\sin^3\frac{\theta}{3} - 9\sin^3\left(\frac{\theta}{9}\right)$$

$$\Rightarrow \sin 3\theta = \frac{1}{\sqrt{2}} = \sin\frac{\pi}{4} \text{ or } \sin\frac{3\pi}{4}$$

$$\Rightarrow \theta = \frac{\pi}{12} \text{ or } \frac{\pi}{4}$$

$$\therefore \tan\frac{\pi}{12} = 2 - \sqrt{3} \text{ or } \tan\frac{\pi}{4} = 1$$

$$\therefore \tan\frac{\pi}{12} + \tan\frac{\pi}{4} = 3 - \sqrt{3}$$

42. **B, C, D**

$$\because \left[\bar{a}\ \ \bar{b}\ \ \bar{c}\right] = 2 \text{ and } 3\left(\bar{a} + \bar{b}\right).\left\{\left(\bar{b} + \bar{c}\right) \times \left(\bar{c} + \bar{a}\right)\right\}$$

$$= 3\left(\bar{a} + \bar{b}\right).\left\{\bar{b} \times \bar{c} + \bar{b} \times \bar{a} + 0 + \bar{c} \times \bar{a}\right\}$$

$$= 3\left\{2\left[\bar{a}\ \ \bar{b}\ \ \bar{c}\right]\right\} = 6\left[\bar{a}\ \ \bar{b}\ \ \bar{c}\right] = 12$$

$$\left[\bar{a} \times \bar{b}\ \ \bar{b} \times \bar{c}\ \ \bar{c} \times \bar{a}\right] = \left[\bar{a}\ \ \bar{b}\ \ \bar{c}\right]^2 = 4$$

$$\Rightarrow \left(\bar{a} - 2\bar{b}\right).\left\{\left(\bar{b} - 2\bar{c}\right) \times \left(\bar{c} - 2\bar{a}\right)\right\} = \left(\bar{a} - 2b\right)\left\{\bar{b} \times \bar{c} - 2\bar{b} \times \bar{a} + 4\bar{c} \times \bar{a}\right\}$$

$$= \left[\bar{a}\ \ \bar{b}\ \ \bar{c}\right] - 8\left[\bar{b}\ \ \bar{c}\ \ \bar{a}\right] = -7\left[\bar{a}\ \ \bar{b}\ \ \bar{c}\right]$$

$$\left(3\bar{b} - \bar{c}\right) \times \left(3\bar{c} + \bar{a}\right) = 9\bar{b} \times \bar{c} - 3\bar{b} \times \bar{a} + \bar{c} \times \bar{a}$$

$$\left(3\bar{a} - \bar{b}\right).\left\{3\bar{c} + \bar{a}\right\} = 27\left[\bar{a}\ \ \bar{b}\ \ \bar{c}\right] - \left[\bar{b}\ \ \bar{c}\ \ \bar{a}\right] = 26\left[\bar{a}\ \ \bar{b}\ \ \bar{c}\right]$$

43. **B, C**

$\because \sqrt{6}x\sec\theta - \sqrt{3}y\,\mathrm{cosec}\,\theta = 3$ is equation of normal,

then, slope $= \dfrac{-\sqrt{6}\sec\theta}{-\sqrt{3}\,\mathrm{cosec}\,\theta} = \sqrt{2}\tan\theta$

Given, $\sqrt{2}\tan\theta = +1$

$$\Rightarrow \tan\theta = \frac{1}{\sqrt{2}}$$

$\therefore$ normal is $x - y = 1$

Let $P\left(h,\ \dfrac{2}{h}\right)$

$\Rightarrow h - \frac{2}{h} = 1$

$\Rightarrow h^2 - h - 2 = 0$

$\Rightarrow h = 2 \text{ or } -1$

44. **A, B, D**

$\because y = mx - 2m - m^3$

$\Rightarrow 6 = 9m - 2m - m^3$

$\Rightarrow m^3 - 7m + 6 = 0 \Rightarrow m = 1, +2, -3$

$\therefore$ Centre is $\left(\frac{11}{2}, \frac{3}{2}\right)$

45. **A, B, C**

$\because f(x) = 2 \times \max\{|x-1| + |x-3|, |2x-1|\}$

$\therefore x = 1, \frac{3}{2}$ point of non-differentiability and minimum value is 2

46. **A, B, D**

$\because \int \cos(2017x + x)\sin^{2016} x\, dx = \int \cos 2017x \sin^{2016} x \cos x\, dx - \int \sin 2017x \sin^{2017} x\, dx$ ……. (i)

$\left\{\because \int \cos \underset{(I)}{2017x}\, \underbrace{\sin^{2016} x \cos x}_{(II)}\, dx = \frac{\cos 2017x \sin^{2017} x}{2017} + \int \frac{2017 \sin 2017x}{2017} \sin^{2017} x\, dx\right\}$

$\therefore \int \cos 2018x \sin^{2017} x\, dx = \frac{1}{2017} \cos 2017x \sin^{2017} x$

47. **A, B, C**

$\because a^2 - (b+c)^2 + xbc = 0$

$\therefore x = \frac{(a-b-c)(a+b+c)}{bc}$

$= \frac{4s(s-a)}{bc} = 4\cos^2 \frac{A}{2} \in (0, 4)$

$\because 0 < A < \pi$

$\Rightarrow 0 < \frac{A}{2} < \frac{\pi}{2}$

48. **A, B, C**

$\because f'(x) = b^2 + (a-1)b + 2 - \left(\sin^2 x + \cos^4 x\right) \geq 0$

$\left(f'(x)\right)_{\min} = b^2 + (a-1)b + 1 \geq 0$

$\therefore (a-1)^2 - 4 < 0 \Rightarrow a \in (-1, 3)$

49. **B, D**

$\because f(x) = \frac{xf'(x)}{2\sqrt{f(x)}} + \sqrt{f(x)}$

$$\Rightarrow \sqrt{f(x)} = \frac{1}{1-cx}$$

$$\Rightarrow f(x) = \frac{1}{(1-cx)^2}$$

$$\because f(1) = \frac{1}{2} \quad \therefore c = 1-\sqrt{2}$$

$$\Rightarrow f(x) = \frac{1}{\left[1+\left(\sqrt{2}-1\right)x\right]^2}$$

SECTION – C

50. **9**

$$\frac{x-2}{-\frac{1}{\sqrt{2}}} = \frac{y-1}{\frac{1}{\sqrt{2}}} = 4\sqrt{2} \text{ or } -4\sqrt{2}$$

$$\therefore A(-2,\ 5)\ \&\ B(6,\ -3)$$

$$\therefore \text{ area of } \Delta CAB = 20$$

$$\Rightarrow \text{sum} = 2\sqrt{20} = 4\sqrt{5}$$

51. **4**

$$\sqrt{2\left(a^2+b^2\right)} = 4 \Rightarrow a^2+b^2 = 8$$

$$\therefore \frac{a^2+b^2}{2} \ge ab$$

$$\Rightarrow ab \le 4$$

52. **3**

$$\because x^2+5x-6=0$$

$$\Rightarrow (x-1)(x+6)=0 \Rightarrow x=1$$

$$\therefore x+5y=6 \text{ .... (i) tangents}$$

$$\&\ y = \frac{1}{2}(x+1) \text{ .... (ii)}$$

$$\therefore \tan\theta = \left|\frac{-\frac{1}{5}+\frac{1}{2}}{1-\frac{1}{10}}\right| = \frac{3}{9} = \frac{1}{3}$$

53. **2**

$$\frac{a+b}{2} = \frac{5}{4}\sqrt{ab}$$

$$\Rightarrow \frac{a}{b} = \frac{1}{4}$$

$$\frac{H_8-a}{a-H_8} = 8\times\frac{a}{b} = 8\times\frac{1}{4} = 2$$

54. **2**

$$\because f(x) = \sum_{i=1}^{\infty}\left[\frac{1}{(i-1)x+1} - \frac{1}{ix+1}\right]$$

$$\Rightarrow f(x) = \lim_{n\to\infty}\left[1 - \frac{1}{nx+1}\right]$$

$$\Rightarrow f(x) = 1$$

$$\therefore f\left(\frac{1}{x}\right) = 1$$

$$\Rightarrow f(x) + f\left(\frac{1}{x}\right) = 2$$

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

FULL TEST – V

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 231**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-C & Section-D**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01 – 03, 24 – 26, 47 – 49)*** *contains 9 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (04 – 08, 27 – 31, 50 – 54) *contains 15 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (09 – 10, 32 – 33, 55 – 56) *contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer. There is no negative marking.*

2. ***Section-C (11 – 20, 34 – 43, 57 – 66)*** *contains 30 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

3. ***Section-D (21 – 23, 44 – 46, 67 – 69)*** *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

PART – I (Physics), PART – II (Chemistry), PART – III (Mathematics):

(SECTION – D)

For questions **21 to 23, 44 to 46, 67 to 69.**
Numerical answer type questions with answer XXXXX. XX

If answer is 348.4 / 251.37 / 213

Correct Method :

0	0	3	4	8	.	4	0

0	0	2	5	1	.	3	7

0	0	2	1	3	.	0	0

Wrong Method :

	3	4	8		.	4	

3	4	8			.		4

		3	4	8	.		4

	3		4	8	.	4	

	2		5	1	.	3	7

		2	1	3	.		

		2	1	3	.	0	

		2	1	3	.		0

		3	4	8	.	4	0

		2	5	1	.	3	7

		2	1	3	.	0	0

Physics

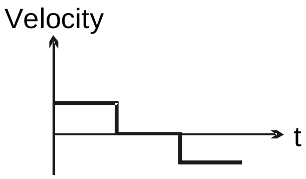
PART – I

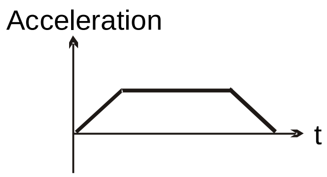
SECTION – A

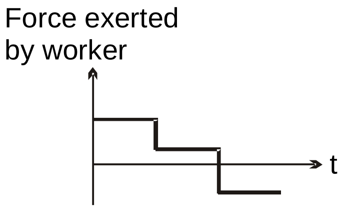
(One Options Correct Type)

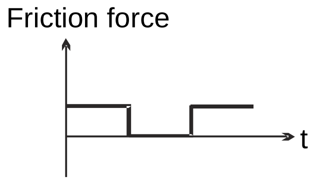
This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE** option is correct.

1. A boy is pushing a box on a horizontal floor from a position of rest to rest while moving on a straight line. Consider the three phases of motion. Floor is rough with a small friction coefficient.
(i) Initially a constant hard push on the box to get it moving and attain a maximum velocity.
(ii) Mild push to keep the box moving with constant velocity.
(iii) To pull back the box to bring it to stop with same retardation.
Which of the following graphs is **CORRECT?**

(A)


(B)


(C)


(D)


2. A light ray incident along vector $2\hat{i}+4\hat{j}+\sqrt{5}\,\hat{k}$ strikes on the x-z plane from medium of refractive index $\sqrt{3}$ and enters into medium II of refractive index is μ_2. The value of μ_2 for which the value of angle of refraction becomes 90^o, is

(A) $\frac{4\sqrt{3}}{5}$
(B) $\frac{3\sqrt{3}}{5}$
(C) $\frac{2\sqrt{3}}{5}$
(D) $\frac{\sqrt{3}}{5}$

Space for Rough work

3. According to Bohr's theory, the radius of the nth orbit of an atom of atomic number Z is proportional to

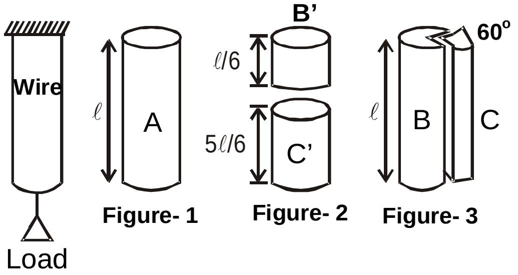
(A) $\frac{n^2}{z^2}$ (B) $\frac{n^2}{z}$

(C) $\frac{n}{z}$ (D) n^2z^2

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

4. A light wire of length l (figure - 1) is cut into two pieces in two different ways as shown in (figure – 2 & 3). Different pieces can be arranged in placed of wire as shown and a load can be placed on the massless hanger. Choose the correct statement(s).



(A) The load required to break the wire B' is 6 times that required to break B
(B) The stress required to break the wire B and C is same but to break B and B' is different
(C) The stress required to break C and C' is same
(D) The load required to break A and B' is same, but different for B and B'

5. Two blocks, A and B, of same masses, are resting in equilibrium on an inclined plane having inclination with horizontal $= \alpha(> 0)$. The blocks are touching and exerting non zero normal force on each other with block B higher than A. Coefficient of static friction of A with incline = 1.2 and of B = 0.8. If motions not imminent

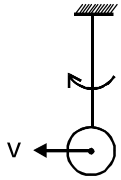
(A) $\alpha < 30^o$ (B) $(\text{Friction})_A > (\text{Friction})_B$

(C) $\alpha < 45^o$ (D) $(\text{Friction})_A = (\text{Friction})_B$

Space for Rough work

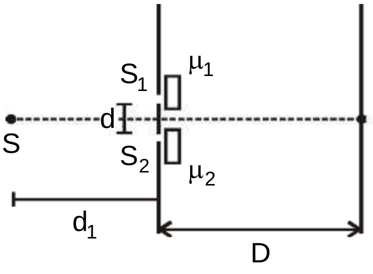
6. Two balls A & B of mass m_1 and m_2 are kept on a horizontal smooth surface. A is given a velocity towards B so that they perform head on collision
(A) If $m_1 = m_2$ and collision is elastic A stops and B moves with the velocity of A after collision
(B) Impulses on A and B during collision are same in magnitude whether it is elastic or inelastic collision
(C) Impulses on A and B during collision are equal in magnitude only if $m_1 = m_2$
(D) If $m_1 > m_2$, though impulses are same in magnitude velocity of A is still in the same direction.

7. A disc of radius a is rigidly attached at its circumference to a rod of length 3a and the combination suspended vertically from the other end of the rod. It is swinging in the plane of the disc such that the centre of disc has velocity v. If mass of disc and rod is m



(A) Kinetic energy of the disc is $\frac{1}{2}mv^2$
(B) Kinetic energy of the disc $\frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{ma^2}{2}\right)\left(\frac{v}{a}\right)^2$
(C) Kinetic energy of the system of disc and rod is $\left[\frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{ma^2}{2}\right)\left(\frac{v}{4a}\right)^2\right] + \frac{1}{2}\left[\frac{m(3a)^2}{3}\left(\frac{v}{4a}\right)^2\right]$
(D) Kinetic energy of the system of disc and rod is $\frac{1}{2}\left[\frac{m(3a)^2}{3} + \left(\frac{ma^2}{2} + m(4a)^2\right)\right]\left(\frac{v}{4a}\right)^2$

8. In young's experiment, the upper slit is covered by a thin glass plate of refractive index $\frac{4}{3}$ and of thickness 9λ, where λ is the wavelength of light used in the experiment. The lower slit is also covered by another glass plate of thickness 2D & refractive index $\frac{3}{2}$, as shown in figure. If I_0 is the intensity at point P due to slits S_1 & S_2 each, then:



$d_1, D >> d$

(A) Intensity at point P is $4I_0$
(B) Two fringes have been shifted in upward direction after insertion of both the glass plates together.
(C) Optical path difference between the waves from S_1 & S_2 at point P is 2λ.
(D) If the source S is shifted upwards by a small distance d_2 then the fringe originally at P after inserting the plates, shifts downwards by $D\left(\frac{d_2}{d_1}\right)$

Space for Rough work

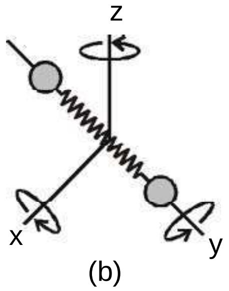
(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 9 and 10

Let us consider a diatomic gas whose molecules have the shape of a dumbbell. In this model, the center of mass of the molecule can translate in the x, y, and z directions. In addition, the molecule can rotate about three mutually perpendicular axes. We can neglect the rotation about the y-axis because the moment of inertia I_y and the rotational energy $\frac{1}{2}I_y\omega^2$ about this axis are negligible compared with those associated with the x and z axes. (If the two atoms are taken to be point masses, then I_y is identically zero). Thus, there are five degrees of freedom: three associated with the translational motion and two associated with the rotational motion. Because each degree of freedom contributes, on the average, $\frac{1}{2}k_BT$ of energy per molecule, the total internal energy for a system of N molecules is:

$$E_{int} = 3N\left(\frac{1}{2}k_BT\right) + 2N\left(\frac{1}{2}k_BT\right) = \frac{5}{2}Nk_BT = \frac{5}{2}nRT \qquad \text{.............(i)}$$



(b)

We can use this result to find the molar specific heat at constant volume:

$$C_v = \frac{1}{n}\frac{dE_{int}}{dT} = \frac{1}{n}\frac{d}{dT}\left(\frac{5}{2}nRT\right) = \frac{5}{2}R \qquad \text{.............(ii)}$$

From equation (i) and (ii), we find that

$$C_P = C_V + R = \frac{7}{2}R$$

$$\gamma = \frac{C_P}{C_V} = \frac{7/2R}{5/2R} = \frac{7}{5} = 1.40$$

In the vibratory model, the two atoms are joined by an imaginary spring. The vibrational motion adds two more degrees of freedom, which correspond to the kinetic energy and the potential energy associated with vibrations along the length of the molecule about its centre of mass.

9. The root mean square angular velocity of a diatomic molecule (with each atom of mass m and interatomic distance a) is given by:-

(A) $\sqrt{\frac{4k_BT}{ma^2}}$
(B) $\sqrt{\frac{2k_BT}{ma^2}}$
(C) $\sqrt{\frac{k_BT}{ma^2}}$
(D) $\sqrt{\frac{k_BT}{2ma^2}}$

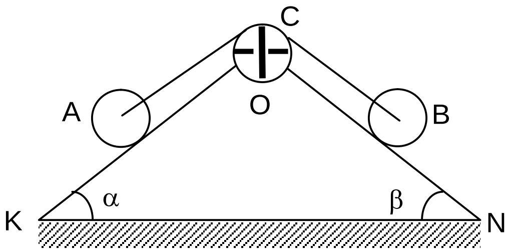
Space for Rough work

10. A diatomic molecule is moving without rotation or vibration with velocity v_{rms} such that it is oriented along x-axis. It strikes a wall in yz-plane while moving in +ve x direction. The spring constant can be assumed to be K and time of collision is negligible. After all collision are over:-
(A) The molecule is moving along – ve x-direction and oscillating about its centre of mass
(B) The molecule is moving along – ve x-direction, but not oscillating about its centre of mass
(C) The molecule is oscillating about it centre of mass but not moving at all.
(D) The molecule is neither rotating nor moving at all.

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

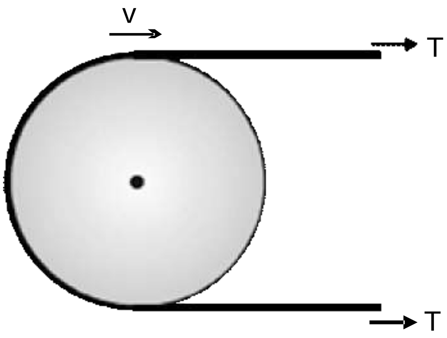
11. A wheel A is connected to a second wheel B by mean of inextensible string, passing over a pulley C. Which rotates about a fixed horizontal axle O, as shown in figure. The system is released from rest. The wheel A rolls down the inclined plane OK thus pulling up the wheel B which rolls along the inclined plane ON. Determine the velocity (in m/s) of the axle of the wheel A, when it has travelled a distance s = 3.5 m down the slope. Both wheels and the pulley are assumed to be homogeneous disks of identical weight and radius. Neglect the weight of the string. $\left[\text{Take } \alpha = 53^{o} \text{ and } \beta = 37^{o}\right]$



12. A ball is projected from a point on an inclined plane horizontally. It takes $\frac{1}{\sqrt{2}}$ seconds to strike the plane. If the incline plane makes an angle of 30° with horizontal, then find the range of the ball on incline plane in meters. $\left[g = 10 \text{ m/s}^2\right]$

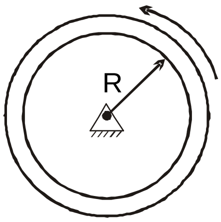
Space for Rough work

13. A flexible drive belt runs over a frictionless flywheel (see figure). The mass per unit length of the drive belt is 1 kg/m, and the tension in the drive belt is 10N. The speed of the drive belt is 2 m/s. The whole system is located on a horizontal plane. If the normal force (in N) exerted by the belt on the flywheel is N_f fill the value of $\frac{2}{3}N_f$ in OMR sheet.

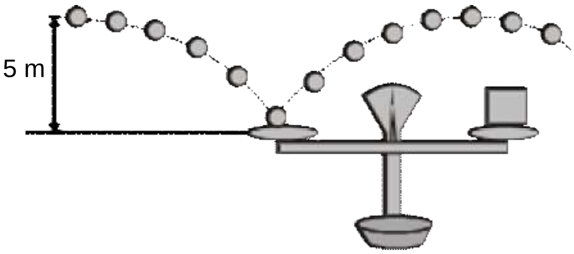


14. An elastic cord having an upstretched length l, force constant k and mass per unit length m_o is stretched around the drum of radius $r\left(2\pi r > l\right)$. Determine the speed of the cord, due to rotation of the drum, which will allow the cord to loosen its contact with the drum. Express value of $\frac{v^2}{11}\left(\text{in } m^2/s^2\right)$

$\left(\text{for the given data } m_0 = 40 \text{ g/cm, k = 100 N/m, } \pi = \frac{22}{7}, l = 400 \text{ cm, r} = 70 \text{ cm}\right)$.

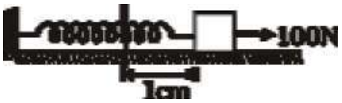


15. A stream of glass beads, each with a mass of 15 gram, comes out of a horizontal tube at a rate of 100 per second. The beads fall a distance of 5 m to a balance pan and bounce back to their original height. How much mass (in kg) must be placed in the other pan of the balance to keep the pointer at zero?

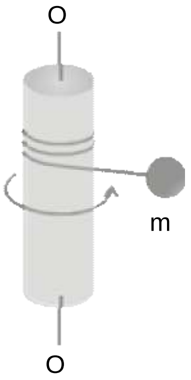


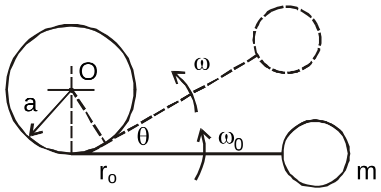
Space for Rough work

16. A block placed on a smooth horizontal floor is connected to a springs as shown. Initially an external force of 100 N keeps it stretched by 1 cm beyond natural length in equilibrium. This force is now removed and another force F is applied on this block, which slowly moves it from this position to a position where the spring is finally compressed by 3 cm. Find the work done by this force F (in joules).

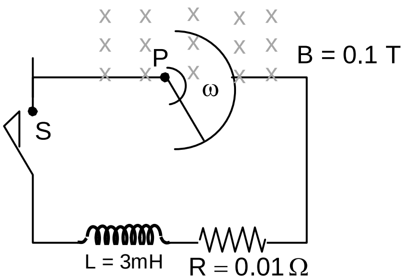


17. The small particle of mass m is given an initial high velocity in the horizontal plane and winds its cord around the fixed vertical shaft of radius 1 m. All motion occurs essentially in the horizontal plane. If the angular velocity of the cord is 0.8 rad/s when the distance from the particle to the tangency point is 5m., determine the angular velocity ω(in rad/s) of the cord after it has turned through an angle 1 rad.





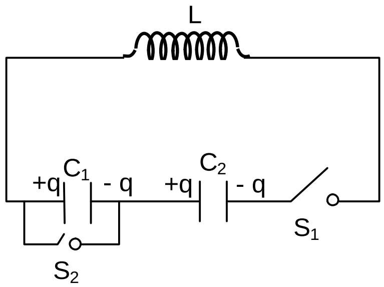
18. The circuit shows a resistance $R = 0.01\,\Omega$ and inductance L = 3 mH connected to a conducting rod PQ of length $l = 2$m which can side on a perfectly conducting circular arc of radius l with its centre at P. Assume that friction & gravity are absent and a constant uniform magnetic field B = 0.1 T exists as shown in the figure. At t = 0, the circuit is switched on and simultaneously an external torque is applied on the rod so that it rotates about P with a constant angular velocity $\omega = 2$ rad/sec. Find the magnitude of this torque (in N-m) at t = (0.3 In 2) second



Space for Rough work

19. Two identical equi-concave lenses made of glass of reflected index 1.5 placed in contact has power P. When a liquid of refractive index μ is filled in the gap between the concave lenses, the power becomes of initial value (P/3). The value of μ is $\frac{K}{3}$. Find the value of K.

20. Two capacitors $C_1 = C_2 = \frac{1}{\pi^2} \times 10^{-2}$F and inductor L = 2×10^{-2}H are connected in series as shown in the figure. Initially charge on each capacitors are $4\sqrt{3}$ μC. At t = 0 switch S_1 is closed and t = 1/400 sec, switch S_2 is also closed. The maximum charge on capacitor C_2 during LC oscillation is $k\sqrt{3}$ μC. Find k.

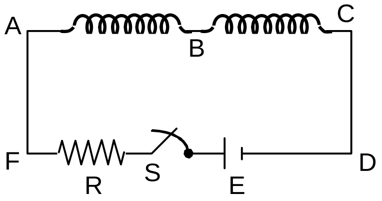


SECTION – D
(Numerical Based XXXXX.XX answer Type)

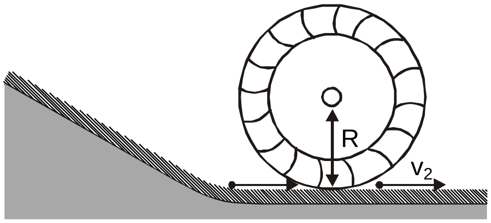
This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

21. Two particles A and B located at points $\left(0,-10\sqrt{3}\right)$ and $(0,0)$ in xy plane. They start moving simultaneously at time t = 0 with constant velocities $\vec{V}_A = 5\hat{i}$ m/s and $\vec{V}_B = -5\sqrt{3}\,\hat{j}$ m/s, respectively. Time when they are closest to each other is found to be K/2 second. Find K. All distance are given in meter.

22. Two ideal solenoids of same dimensions. One is air cored with 600 turns while other is Aluminium is cored with 200 turns (relative permeability of Aluminium is 3), are connected in a circuit as shown in the figure. The switch S is closed at t = 0. Find the ratio of potential difference across air-cored solenoid to that of Aluminium cored solenoid at any time t.



23. Water flowing along an open channel drives an undershot waterwheel of radius 2 m (figure). The water approaches the wheel with a speed of 5.0 m/s and leaves with a speed of 2.5 m/s; the amount of water passing by is 200 kg per second. At what rate does the water deliver angular momentum to the wheel (in J)?



Undershot water wheel

Space for Rough work

Chemistry

PART – II

SECTION – A
(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE** option is correct.

24.
$$\begin{tikzcd}
C_2H_5{\cdot}OC_2H_5 \arrow[r] & A + B \arrow[d, "Fe^{2+}"] \\
 & {} \arrow[d, "KCNS"] \\
 & \text{red color}
\end{tikzcd}$$

Which is not true for above reactions?
(A) A & B are explosives
(B) If A & B are present in ether, then prior to its use, A & B must be removed from ether
(C) A & B can not be removed by adding conc H_2SO_4
(D) When A & B are treated with Fe^{2+} followed by KCNS, no redox reaction is involved.

25. If 1 litre aq. solution of H_2SO_4 (10% by weight) with density 1.1 gm/ml, find the pH of solution.

(A) $-\log 2.244$	(B) $-\log 1.96$
(C) $-\log 1.86$	(D) $-\log 3.87$

26. Which of the following sequence is correct for solubility in H_2O?
(1) $BeSO_4 > MgSO_4 > CaSO_4 > BaSO_4$
(2) $Be(OH)_2 > Mg(OH)_2 > Ca(OH)_2 > Ba(OH)_2$
(3) $LiOH < NaOH < KOH < RbOH$
(4) $Li_2CO_3 < Na_2CO_3 < K_2CO_3 < Rb_2CO_3$

(A) 1, 3, 4	(B) 1, 2, 4
(C) 2, 4	(D) 1, 3, 4

Space for Rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

27. $Ag_{(s)}\left|AgBr_{(s)}\right|Br^{-}(0.01M)\,||\,Cl^{-}(0.2M)\,|\,AgCl_{(s)}\,|\,Ag_{(s)}$ if K_{sp} of AgBr & AgCl at 25^{o}C are 10^{-12} & 10^{-10} respectively find which is/are true for above cell at 25^{o}C (log 2 = 0.3)

(A) As $E^o_{Ag^+/Ag}$ is not given so E_{cell} can not be determined

(B) E_{cell} is 0.0413 volt

(C) $\Delta G < 0$

(D) $E^o = 0$

28. $PhNO_2 \xrightarrow[NH_4Cl]{Zn} A \xrightarrow[\text{Tollen's Reagent}]{\overset{AgNO_3}{NH_4OH}} B$ (organic compound). Which is/are incorrect?

(A) A gives Tollen's test
(B) A shows tautomerism
(C) A is aniline
(D) A forms complex with Tollen's reagent but not gives silver mirror

29. Which of the following is/are incorrect option(s)?

(A) $HOCl < HClO_2 < HClO_3 < HClO_4$ (acidic strength)

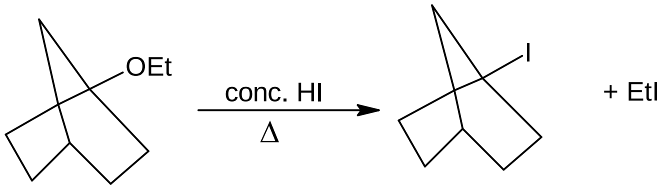
(B) $HOCl > HClO_2 > HClO_3 > HClO_4$ (thermal stability)

(C) $NH_3 > PH_3 > AsH_3$ (Basic strength)

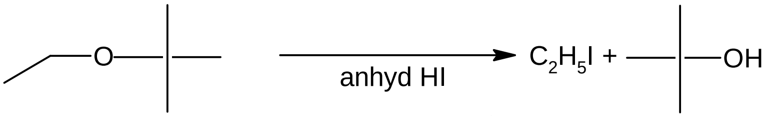
(D) $NH_3 > BiH_3 > SbH_3 > AsH_3 > PH_3$ (Boiling point)

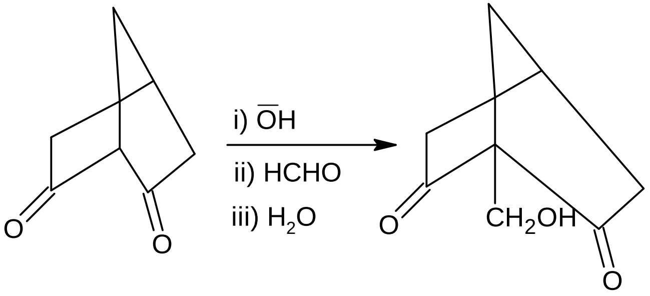
Space for Rough work

30. Which of the following is/are correct reaction?

(A)


(B) $PhCH_2OMe \xrightarrow[\Delta]{conc.HBr} PhCH_2Br + MeBr$

(C)


(D)


31. In which of the following case(s) at least one bond angle is less than 90°?

(A) ClF_3
(B) SF_4
(C) BrF_5
(D) P_4

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 32 and 33

Co-ordination complexes can show stereoisomerism square planar complexes of Ma_2b_2 type can show geometrical isomerism but not optical & octahedral complexes of $Ma_2b_2C_2$, Ma_3b_3 Mabcdef etc show stereoisomerism, for e.g., Mabcdef have 15 geometrical isomers & all are optically active so it has 15 pairs of enantiomers thus in totality it has 30 stereoisomers. (a, b, c, d etc. are monodentate ligands while AB is bidentate ligand)

32. How many pair of enantiomers exits for $Ma_2b_2c_2$?

(A) 0
(B) 2
(C) 1
(D) 4

Space for Rough work

33. Which of the following can show geometrical as well as optical isomerism?

(A) $M(AB)_3$ (B) Mabcd (tetrahedral)

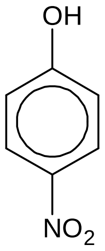
(C) Ma_3b_3 (D) Ma_4b_2

SECTION – C
(Single digit integer type)

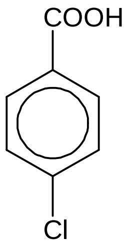
This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

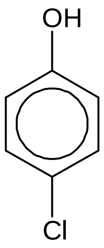
34. How many of the following are more acidic than HCOOH?

Picric acid, CH_3COOH,

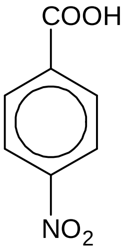


, HCl,





HCN, H_2CO_3,



35. In how many of the following cases more than four atoms are in same plane

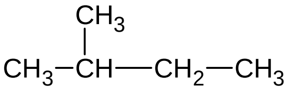
$XeF_4, PCl_5, [Ag(CN)_2]^-, [Pt(CN)_4]^{2-}, CH_3-CH=CH-C\equiv C-CH_3$

$[CO(NH_3)_6]^{3+}, CH_2=C=CH_2, [PtCl_6]^{2-}$

Space for Rough work

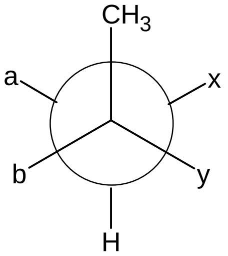
36. If EAN of metal in $K_4\left[M(CN)_6\right]$ is 36, find the number of d – electrons in complex.

37.



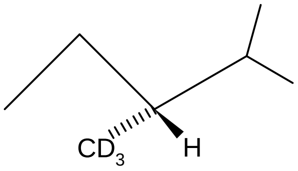
$CH_3-\underset{}{\overset{CH_3}{\overset{|}{C}H}}-CH_2-CH_3$

If the Newmann projection of above compound can be written as mentioned below



How many combinations for a, b respectively are possible?

38.



$\xrightarrow{\text{Monochlorination}}$ how many enantiomeric pairs can be formed.

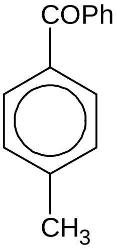
Optically pure

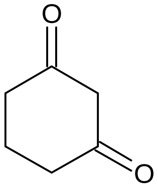
39. $H_2O_2 \longrightarrow H_2O + O_2$ the rate const. of this reaction is $2\times10^{-2}\,\text{min}^{-1}$(at certain temp.) & reaction is started with 0.5 M conc. of H_2O_2, after 23.03 min the reaction was suddenly stopped by lowering the temp & the remaining H_2O_2 was completely reacted with NaOCl, If no. of moles of O_2 produced in second reaction is $\frac{1}{a}$ find a. (log1.5 = 0.2)

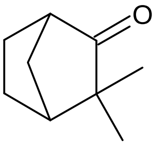
Space for Rough work

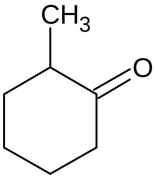
40. A 8 gm sample of iron are containing V%(by wt) of iron $\left(Fe^{2+}\right)$was present in 1 L solution. This solution required V ml of a $KMnO_4$ solution for oxidation of Fe^{2+} in acidic medium. If in another titration 20 ml of same $KMnO_4$ is required, for oxidation of 20 ml H_2O_2 in acidic medium. Find volume strength of H_2O_2

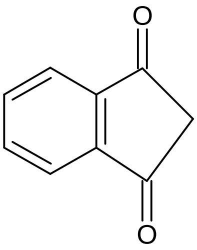
41. How many of the following can give yellow ppt. with I_2 / OH^- ?

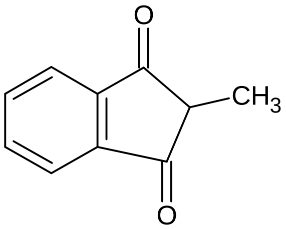




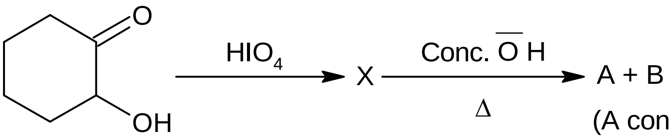








42.



(A contains 3 oxygen atom per molecule)

$$A \xrightarrow[\Delta]{\text{acidified with } H^+} C$$

DBE of C is

43. How many of the compounds are more acidic than phenol?
O – cresol, m – cresol, p – cresol, o – fluorophenol, o – chlorophenol, o – bromophenol

Space for Rough work

SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

44. A hydrocarbon with lowest molecular weight has only one chiral carbon. Find its molecular weight.

45. Electrolysis of aq. Solution of CH_3COOK is carried out. If 2 amp current is passed for 402 minutes, what volume (at STP) of gases could be produced if current efficiency is 80% (assume no absorption of gases)

46. An impure sample of As_2O_3 weighing 20 gm was dissolved in water containing 10 gm of $NaHCO_3$ and the final solution was diluted to 400 ml. 20 ml of this solution was oxidised by 25 ml of a solution of I_2. Another solution of hypo containing 1.24 gm of $Na_2S_2O_3.5H_2O$ in 40 ml was used to exactly reduce 25 ml of same I_2 solution (impurities inert) calculate % of AS_2O_3 in the sample (at. wt. of As = 75)

Space for Rough work

Mathematics

PART – III

SECTION – A
(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE** option is correct.

47. If tangent is drawn at (x_1, y_1) on the hyperbola $\frac{x^2}{4} - \frac{y^2}{3} = 1$ intersect the x-axis at C $(\alpha, 0)$ and y-axis at D $(0, \beta)$, then $\int_{2}^{4\sqrt{2}} \frac{\alpha}{\beta} dx_1$ is

(A) $\frac{3\pi}{8}$
(B) $\frac{-\pi}{4}$
(C) $\frac{-\pi}{8}$
(D) $\frac{\pi}{8}$

48. If $\int_0^x \frac{(t^3 + t)dt}{(1+3t^2)} = f(x)$, then $\int_0^1 f'(x)dx$ is equal to

(A) $\frac{1}{6} - \frac{1}{9}\ln 3$
(B) $\frac{1}{6} - \frac{1}{9}\ln 4$
(C) $\frac{1}{6} + \frac{1}{9}\ln 3$
(D) $\frac{1}{6} + \frac{1}{9}\ln 4$

49. If $y = f(x)$ is solution of differential equation $\frac{dy}{dx} = \frac{y}{x}\frac{(1-3x^2y^3)}{(2x^2y^3+1)}$, then $f^3(x).x^3$ is equal to

(A) $x + cy$
(B) $2x + cy$
(C) $x^2 + cy$
(D) $x^3 + cy^2$

Space for Rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

50. If $5x\left(1+\frac{1}{x^2+y^2}\right)=12$ and $5y\left(1-\frac{1}{x^2+y^2}\right)=4\ \forall x,y\in R$, then correct option is/are

(A) $|x|+|y|=3$ (B) $x+y=\frac{1}{5}$

(C) $|x|+|y|=\frac{3}{5}$ (D) $x^2+y^2=5$

51. If a tangent on ellipse at A (1, 1) intersect its directrix at B (7, –6) and S be the focus of ellipse and C $(\alpha,\ \beta)$ is the centre of ΔSAB, then

(A) $\alpha+\beta=1$ (B) $\alpha-\beta=7$

(C) $SC^2=20.5$ (D) $SC^2=21.25$

52. If $f(x)=\frac{\cos^{-1}\left(1-\{x\}\right).\sin^{-1}\left(1-\{x\}\right)}{\sqrt{2\{x\}}.\left(1-\{x\}\right)}$ here {.} denotes fractional part of x then;

(A) $\underset{x\to0^+}{Lt}f(x)=\sqrt{2}\underset{x\to0^-}{Lt}f(x)$ (B) $\underset{x\to0^-}{Lt}f(x)=\sqrt{2}\underset{x\to0^+}{Lt}f(x)$

(C) $\underset{x\to0^-}{Lt}f(x)=\frac{\pi}{2\sqrt{2}}$ (D) $\underset{x\to0^-}{Lt}f(x)=\pi\sqrt{2}$

53. If $\int_a^b|\sin x|dx=8\ \&\int_0^{a+b}|\cos x|dx=9$ then;

(A) $a+b=9\pi$ (B) $b-a=4\pi$

(C) $\int_a^b x\sin xdx=2\sqrt{2}\pi$ (D) $\int_a^b x\sin xdx=-2\sqrt{2}\pi$

54. If a, b, c are sides of an acute angled triangle satisfying $a^2+b^2+c^2=6$ then $(ab+bc+ca)$ can be equal to;

(A) 3 (B) 4

(C) 5 (D) 7

Space for Rough work

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 55 and 56

If locus of point $P(z)$ in complex plane is $|z+z_1|+|z+z_2|=4$, where A represents z_1 as (1, 0) and B represents z_2 as (–1, 0) and $Q(\omega)$ is moving point inside the locus of $P(z)$ such that all internal angle bisectors of triangle ΔPAB concurrent at Q. Then, answer the following questions if $|\omega-\omega_1|+|\omega-\omega_2|=2$.

55. $|\omega_1|+|\omega_2|$ is equal to

(A) $\frac{2}{\sqrt{3}}$
(B) $\sqrt{\frac{2}{3}}$
(C) $2\sqrt{\frac{2}{3}}$
(D) $\frac{2\sqrt{2}}{3}$

56. If minimum value of $|\omega-z_1|+|\omega-z_2|$ is equal to m, then $[m]$ is (where [.] denotes greatest integer part)

(A) 1
(B) 2
(C) 3
(D) 4

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

57. If $f(2+x)+f(x)=2$ for all $x\in[0,2]$ and $k=\int_0^4 f(x)dx-4$ such that both roots of $ax^2-bx+c=0$ lies between k & q where $q=\frac{\alpha}{\beta}$ such that $\alpha+\beta=1$ & $\alpha^2+\beta^2=\frac{1}{2}$ then least positive integral value of a_____.

Space for Rough work

58. There are “n” married couples at a party each parson shakes hand with every person other than her or his spouse then number of handshakes is $f(n)$, $\left(\sum_{n=4}^{\infty}\frac{1}{f(n)}\right)^{-1} = ?$

59. If $f(x) = x + \int_0^1 x^2.zf(z)dz + \int_0^1 xz^2(z)dz$ then, we have $\lim_{x\to\infty}\frac{f(x)}{\left(ax^2+7x\right)} = \frac{20}{119}$ then “a” = ?

60. If x is root of $\left(1+x^4\right) = 7(1+x)^4$ then $\left|x+\frac{1}{x}\right| = ?$

61. If y = 2 is directrix and (0, 1) be the vertex of parabola $x^2 + \lambda y + \mu = 0$ then; $(\lambda - \mu) = ?$

62. The minimum number of real roots of $\left(x^2+3x+a\right)\left(x^2+ax+1\right) = 0$ equals

63. If z_1, z_2, z_3 are three complex numbers, such that $|z_1| = |z_2| = |z_3| = 1$ & $z_1^2 + z_2^2 + z_3^2 = 0$ then $\left|z_1^3 + z_2^3 + z_3^3\right|$ is equal to________. (not equal to 1)

64. A variable plane is at constant distance 3 from origin and meets the axis in X, Y, Z planes through X, Y, Z parallel to coordinate planes are made. If P be the point of intersection of above made planes, given $P(\alpha,\beta,r)$ then $\frac{\alpha\beta r}{\sqrt{\alpha^2\beta^2+\beta^2r^2+r^2\alpha^2}} = ?$

65. If $\left[\bar{a}\ \ \bar{b}\ \ \bar{c}\right] = 2$ and $\left(\vec{a}.\vec{b}\right) = 2$, $\left(\vec{c}.\vec{a}\right) = 5$, then $\vec{a}$ is equal to $x\bar{b} + y\bar{c} + z\left(\bar{b}\times\bar{c}\right)$(where $\bar{b}$ & $\bar{c}$ are two non-coplanar orthogonal unit vectors) then (x + y – z) = ?

66. If $\cos^{-1}\left(2-x^2\right) + \sin^{-1}\left(2-x^2\right) + \tan^{-1}x \geq \frac{2\pi}{3}$ have no solution if $x < \alpha$ or $x > \beta$ $(\text{for } \alpha < \beta)$, then $\left\{\frac{1}{\max(\alpha)} + \left(\min(\beta)\right)^2\right\} = ...$

Space for Rough work

SECTION – D

(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

67. If $f(x) = \frac{3x^2+1}{\sqrt{x^4+x^2}}\ \forall 0 < x \le \sqrt{2}$, then $f(x)$ has minimum value M at x = m. Then, $\left(m^2 + \frac{1}{M^2}\right)$ is equal to

68. If $x = \int_0^\infty \frac{dt}{(1+t^2)(1+t^{2017})}$, then $\frac{3x}{\pi}$ is equal to

69. If $\log_{(3x+4)}(4x^2+x+1) + \log_{(2x+1)}(6x^2+11x+4)$ then x is ________.

Space for Rough work

FIITJEE

JEE(Advanced)-2018

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ANSWERS, HINTS & SOLUTIONS

FULL TEST – V
(Paper-2)

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**C**	24.	**D**	47.	**C**
2.	**B**	25.	**A**	48.	**B**
3.	**B**	26.	**A**	49.	**A**
4.	**C, D**	27.	**B, C**	50.	**A, B, C, D**
5.	**B, C**	28.	**B, C, D**	51.	**A, B, D**
6.	**A, B, D**	29.	**B, D**	52.	**A, C**
7.	**C, D**	30.	**B, C**	53.	**B, D**
8.	**A, B, C, D**	31.	**A, B, C, D**	54.	**B, C**
9.	**B**	32.	**C**	55.	**C**
10.	**B**	33.	**A**	56.	**B**
11.	**2**	34.	**3**	57.	**5**
12.	**5**	35.	**7**	58.	**6**
13.	**8**	36.	**6**	59.	**4**
14.	**1**	37.	**5**	60.	**3**
15.	**3**	38.	**1**	61.	**8**
16.	**4**	39.	**3**	62.	**2**
17.	**1**	40.	**8**	63.	**3**
18.	**4**	41.	**4**	64.	**3**
19.	**5**	42.	**2**	65.	**5**
20.	**6**	43.	**3**	66.	**4**
21.	**00003.00**	44.	**00080.00**	67.	**00001.12**
22.	**00003.00**	45.	**00017.92**	68.	**00000.75**
23.	**01000.00**	46.	**00049.50**	69.	**00000.75**

Physics PART – I

SECTION – A

1. **C**

(C) Direction of friction does not change.
(D) Friction is constant.

2. **B**

$$\sin\theta_C = \mu_2 / \mu_1$$

$$1 - \cos^2\theta_C = \left(\frac{\mu_2}{\mu_1}\right)^2$$

$$1 - (\hat{n}.\hat{p})^2 = \left(\frac{\mu_2}{\mu_1}\right)^2$$

$$1 - \left[\frac{4}{\sqrt{25}}\right]^2 = \left(\frac{\mu_2}{\mu_1}\right)^2 \Rightarrow \frac{\mu_2}{\mu_1} = \frac{3}{5}$$

$$\Rightarrow \mu_2 = \frac{3\sqrt{3}}{5}$$

3. **B**

$$r \propto \frac{n^2}{z}$$

4. **C, D**

Stress is the property of material.
Load = stress x cross – sectional area

5. **B, C**

$$\swarrow (f_A + f_B)_{max}$$

$$2mg\sin\alpha < 2mg\cos\alpha$$

$$\tan\alpha < 1 \Rightarrow \alpha < 45^o$$

$$f_A = mg\sin\alpha + N$$

$$f_B = mg\sin\alpha - N$$

To show $N \neq 0$

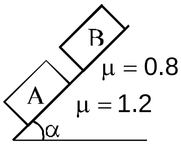
$$f_{b_{max}} = 0.8\ mg\cos\alpha$$

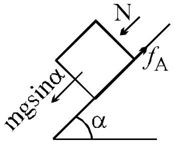
$$\Rightarrow N = mg[\sin\alpha - 0.8\cos\alpha]$$

$$N = mg\sec\alpha[\tan\alpha - 0.8]$$

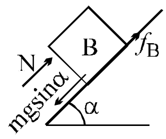
$$\text{For}\alpha > \tan^{-1}(0.8)$$

$$f_A > f_B \text{ for } \alpha \le \tan^{-1}(0.8) f_A = f_B$$





FBD of A



6. **A, B, D**

Impulse exist in action reaction pair during collision so magnitude will remain the same.
(a) Elastic collision principle
(b) Internal force
(d) If $m_1 >>> m_2$
Direction of velocity of motion does not change

$$\vec{v}_1 = (1+e)\vec{v}_c = e\vec{v}_1\left(\vec{v}_c \approx \vec{v}_1\right)$$

$$\vec{v}_1 = \vec{v}_c$$

7. **C, D**

KE of disc $= \frac{1}{2}MV_C^2 + \frac{1}{2}I_c\omega^2$

$$= \frac{1}{2}mv^2 + \frac{1}{2}\times\frac{1}{2}ma^2\left(\frac{v}{4a}\right)^2$$

KE or rod $= \frac{1}{2}I\omega^2 = \frac{1}{2}\frac{M(3a)^2}{3}\left(\frac{v}{4a}\right)^2$

KE of system = $\frac{1}{2}I$ system ω^2

$$= \frac{1}{2}\left[\frac{ma^2}{2} + m(4a)^2 + \frac{m(3a)^2}{2}\right]\left(\frac{v}{4a}\right)^2$$

8. **A, B, C, D**

Optical path difference due to

S_1 is $= t(\mu_1 - 1) = 9\lambda\left(\frac{4}{3} - 1\right) = 3\lambda$

Optical path differ due to S2 is $= t(\mu_2 - 1) = 2\lambda\left(\frac{3}{2} - 1\right) = \lambda$

Path diff. at point P$P = 3\lambda - \lambda = 2\lambda$

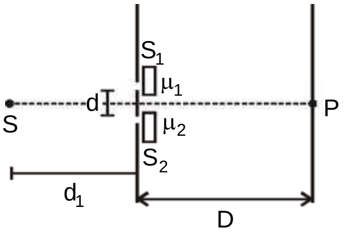
Phase diff. $\frac{2\pi}{\lambda}\times 2\lambda = 4\pi$

So net intensity at point P is

$$I_{net} = I_0 + I_0 + 2I_0\cos 4\pi$$

$$I_{net} = 4I_0$$

Optical path is conserved by S1 is more so fringe will shift at upper side.



$d_1, D >> d$

9. **B**

$$\frac{1}{2}I_x\omega^2 + \frac{1}{2}I_y\omega^2 = \frac{f}{2}kT\left\{f_{rotational} = 2\right\}$$

$$I_x = I_y \Rightarrow \mu r^2 = \frac{m}{2}a^2\left\{\mu = \frac{m_1m_2}{m_1 + m_2}\right\}$$

$$\frac{ma^2}{2}\omega^2 = \frac{2}{2}kT \quad \mu = \frac{m}{2}$$

$$\omega = \sqrt{\frac{2kT}{ma^2}}$$

10. **B**

SECTION – C

11. **2**

Applying conservation of energy

$$mgs(\sin\alpha - \sin\beta) = \frac{1}{2}I\omega^2 + 2\left(\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2\right)$$

where $\omega = v/r \;\&\; I = mr^2/2$

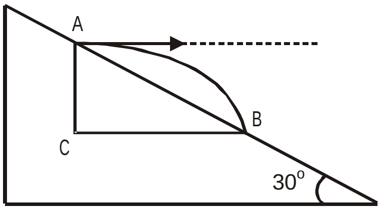
Putting values & solving

$$mgs(\sin\alpha - \sin\beta) = \frac{7}{4}mv^2$$

$$\therefore v = 2\sqrt{\frac{1}{7}gs(\sin\alpha - \sin\beta)}$$

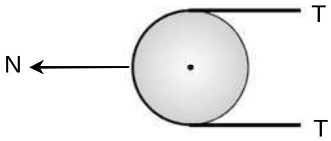
$$= 2\sqrt{\frac{10\times 3.5}{7}\left(\frac{4}{5} - \frac{3}{5}\right)} = 2 \text{ m/s.}$$

12. **5**



$$AC = \frac{1}{2}\times 10\times\left(\frac{1}{\sqrt{2}}\right)^2 = 2.5\text{m} \;\Rightarrow AB = 5\text{ m}$$

13. **8**



$$2T - N = m\omega^2 R_{cm} = \mu\times\pi R\times\left(\frac{V}{R}\right)^2\times\frac{2R}{\pi}$$

$$2T - N = 2\mu v^2$$

$$N = 2T - 2\mu v^2 = 2\times 10 - 2\times 1\times 4 = 12\text{ N}$$

14. **1**

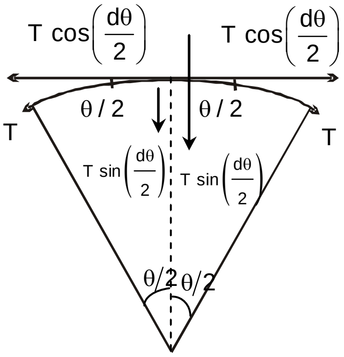
$$v = \sqrt{\frac{k(\Delta x)2\pi R}{m_o\ell}};\; k\Delta x = T$$

$$2T\sin\left(\frac{d\theta}{2}\right) = (dm)\frac{v^2}{R}$$

$$\text{or } T(2\pi) = m\frac{v^2}{R}$$

$$(k\Delta x)2\pi = (m_0\ell)\frac{v^2}{R}$$

$$v = \sqrt{\frac{k(\Delta x)2\pi R}{m_0\ell}} \;\&\; \Delta x = (2\pi r - l)$$



15. **3**

$\Delta\vec{p}$ (change in momentum per collision)

$= 2m\sqrt{2gh} = 2 \times 15 \times 10^{-3}(10) = 0.3$ kg ms^{-1}

Then in $\Delta\vec{p}_{100}$ (in 1 second) $= 30$ kg ms^{-1}.

Force exerted = 30 N

So weight required = 30 N. So mass = 3 kg

16. **4**

Force constant k = $\frac{100}{0.1}10^4\,\frac{N}{m}$

$W = \frac{1}{2}k\left(x_{\text{final}}^2 - x_{\text{initial}}^2\right) = 4$ J

17. **1**

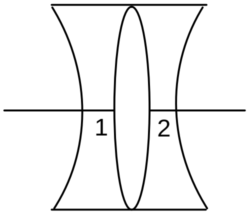
$\omega = \frac{\omega_o}{1 - a\theta / r_o}, T = mr_o\omega_o\theta$

18. **4**

The Half of the maximum current is equal to $i_1 = \frac{B\omega l^2}{4R}$ at t = $\frac{L}{R}\ln 2$

The torque at this instant $= \frac{B^2\omega l^4}{8R} = 4\text{N} - \text{m}$

19. **5**



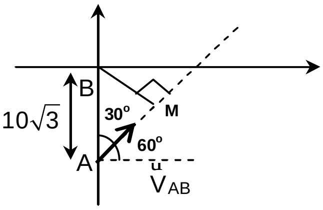
20. **6**

$$\omega = \frac{1}{\sqrt{LC_{eq}}} = 100\pi$$

$\Rightarrow T = 1/50$ sec

SECTION – D

21. **00003.00**



As observed by B motion of A is along AM and BM is the shortest distance between them. Relative displacement of A w.r.t to B is AM = AB cos 30° $\vec{V}_{AB} = 5i + 5\sqrt{3}\ \hat{j}$

Time taken $(t) = \left|\frac{\vec{S}_{AB}}{\vec{V}_{AB}}\right| = \frac{AM}{V_{AB}} = \frac{10\sqrt{3}\cos 30^o}{10} = 1.5\,\text{sec}$

22. **00003.00**

$$L_1 = \frac{\mu_o N_1^2 A}{l}, L_2 = \frac{\mu_o N_2^2 A \mu_r}{l}$$

Since V = $-L\frac{dI}{dt}$,So

$$\frac{V_1}{V_2} = \frac{L_1}{L_2} = \left(\frac{N_1}{N_2}\right)^2 \frac{1}{\mu_r} = \left(\frac{600}{200}\right)^2 \times \frac{1}{3} = 3$$

23. **01000.00**

$$\frac{dL}{dt} = \frac{dm}{dt}(v_1 - v_2)R = 200 \times (5 - 2.5) \times 2 = 1000\ \text{J}$$

Chemistry

PART – II

SECTION – A

24. **D**

A & B are peroxides & hydroperoxides which oxidizes Fe^{2+} to Fe^{3+}

25. **A**

Let us take 100 gm solution $\Rightarrow$ 10 gm H_2SO_4 in 90 gm H_2O

$\frac{100}{1.1}$ ml solution $= \frac{10}{98}$ mol. H_2SO_4

So, $M = \frac{10 \times 1.1}{98 \times 0.1} = \frac{110}{98} = 1.122 \Rightarrow N = 2.244$

$pH = -\log 2.244$

26. **A**

Use concept of lattice energy & hydration energy.

27. **B, C**

$$E^o_{cl^-/AgCl/Ag} = E^o_{Ag^+/Ag} + \frac{RT}{F}\ln K_{sp} \quad ....(i)$$

$$E^o_{Br^-} / AgBr / Ag = E^o_{Ag^+/Ag} + \frac{RT}{F}\ln K_{sp} \quad ....(ii)$$

as $E^o_{Ag^+/Ag}$ will be cancelled on subtractions (i) & (ii)

So E_{cell} can be determined

28. **B, C, D**

A is PhNHOH, B is PhNO

$PhNHOH \xrightarrow{T.R} Ag + PhNO$

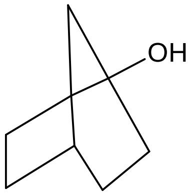
29. **B, D**

Thermal stability HOCl < $HClO_2$ < $HClO_3$ < $HClO_4$

B.P., $BiH_3 > SbH_3 > \underset{\Downarrow}{NH_3} > AsH_3 > PH_3$

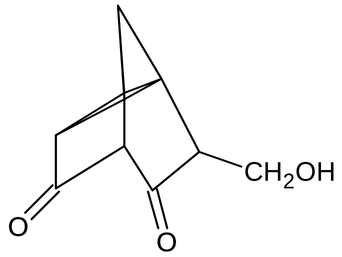
has hydrogen bonding

30. **B, C**

(A) 

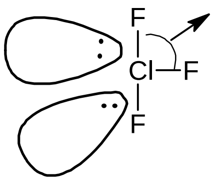
& EtI obtained

(C) HI is anhyd. So carbocation is not formed

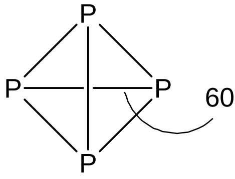
(D) 

is formed

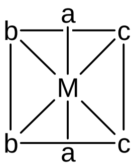
31. **A, B, C, D**



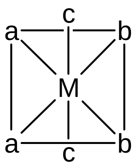
Less than 90^o due to lP - BP repulsion



32. **C**



1



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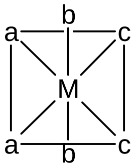

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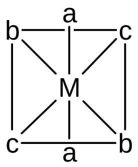
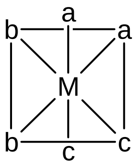


4

oppically inactive



5

only
optically
active

So str. (5) & its enantiomer is optically active.

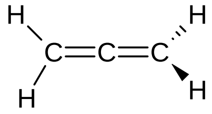
33. **A**
Mabcd (tehahedral) can not show G.I & Ma_3b_3 & Ma_4b_2 can not show optical activity.

SECTION – C

34. **3**
Picric acid, HCl, P-nitro benzoic acid are more acidic than formic acid.

35. **7**

In PCl_5, maximum four atoms are in same plane



- max five atoms are in same plane $\left[N \equiv C - Ag - C \equiv N\right]^-$ – five atoms are in same plane

36. **6**

Refer EAN rule

$36 = \text{At.No.} - 2 + 6 \times 2$

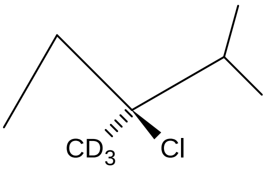
$\text{At.No} = 26$

$1S^2, 2S^2, 2P^6, 3S^2, 3P^6, 4S^2, 3d^6 \Rightarrow M^{2+} \Rightarrow 3d^6$

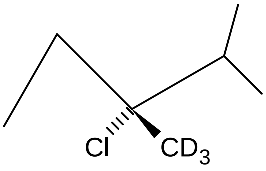
37. **5**

a, b can be H, H or H, CH_3 or CH_3, H or CH_3, CH_3 or H, C_2H_5 respectively.

38. **1**



&



39. **3**

$H_2O_2 \longrightarrow H_2O + O_2$

$NaOCl + H_2O_2 \longrightarrow O_2 + NaCl + H_2O$

In 1 min 0.02 mol/lt H_2O_2 decomposes so in 20 min

$$k = \frac{2.303}{t}\log\frac{a}{a-x}$$

$$0.02 = \frac{2.303}{23.03}\log\frac{0.5}{(a-x)}$$

$$0.2 = \log\frac{0.5}{a-x} \quad (\text{take log } 1.5 = 0.2)$$

$$1.5 = \frac{0.5}{a-x}$$

$$a - x = \frac{0.5}{1.5} = \frac{1}{3}$$

$\frac{1}{3}$mole H_2O_2 is left so $\frac{1}{3}$mole O_2 is produced in second reaction.

40. **8**

Meq of Fe^{2+} = meq of $KMnO_4$ = $\frac{8 \times V \times 1 \times 1000}{100 \times 56} = N_{KMnO_4} \times V$

$N = \frac{8}{5.6}$, as eq. wt. of $KMnO_4$ is same in both experiment so N_{KMnO_4} is same in both

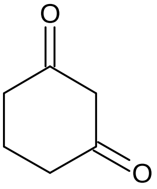
Meq of $KMnO_4$ = meq of H_2O_2

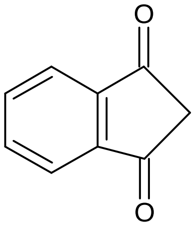
$$20\times\frac{8}{5.6}=20\times N=20\times\frac{\text{vol.strength}}{5.6}$$

so vol stre. of $H_2O_2=8$

41. **4**

acetophenone, resorcinol,

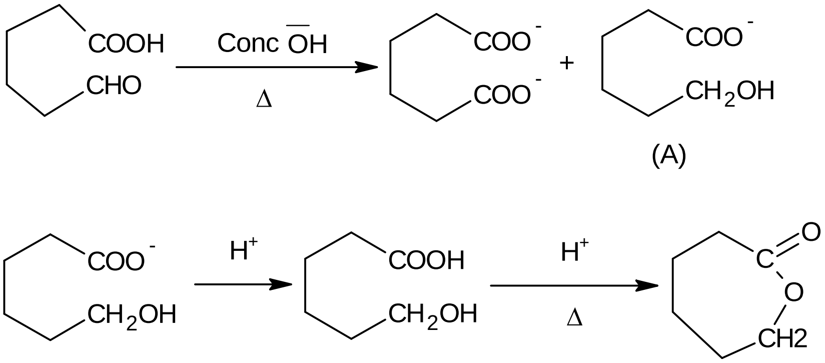




will give Iodoform test

42. **2**

X =

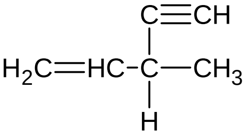


43. **3**

Given halophenols are more acidic than phenol.

SECTION – D

44. **00080.00**



$$H_2C{=}HC{-}\underset{\underset{H}{|}}{\overset{\overset{C\equiv CH}{|}}{C}}{-}CH_3$$

45. **00017.92**

$$2CH_3COOK\xrightarrow{\text{electrolysis}}C_2H_6+2CO_2+H_2+2KOH+2H_2O$$

$Q=2\times402\times60$

moles of $e^-=0.5$; used mole of $e^-=\dfrac{0.5\times80}{100}=0.4$

as 2 mole $e^-\longrightarrow$4 mole gases

so 0.4 mole $e^-\longrightarrow\dfrac{0.4\times4}{2}=0.8$ mole gases

$V=0.8\times22.4$ Lt. = 17.92 Lt.

46. **00049.50**

$M_{hypo} = \frac{1.24\times1000}{248\times40} = 0.125$

meq of hypo = meq of I_2 in 25 ml $= 0.125\times1\times40 = 5$

meq of I_2 $=$ meq of As_2O_3 $= 5$

meq of AS_2O_3 in 20 ml solution = 5

so meq of AS_2O_3 in 400 ml = $\frac{5\times400}{20} = 100$

mole of $AS_2O_3 = \frac{100\times10^{-3}}{2} = 50\times10^{-3} = 0.05$

wt. of $AS_2O_3 = 0.05\times198 = 9.9$ g

wt.% $= \frac{9.9}{20}\times100 = 49.5\%$

Mathematics

PART – III

SECTION – A

47. **C**

$\because \alpha = \frac{4}{x_1}$ and $\beta = \frac{-3}{y_1} = \frac{-4}{\sqrt{x_1^2 - 4}}$

$$\therefore \int_2^{4\sqrt{2}} \frac{4/x_1}{-4/\sqrt{x_1^2-4}} dx_1 = -\int_2^{4\sqrt{2}} \frac{dx_1}{x_1\sqrt{x_1^2-4}} \qquad \left(\text{Put } x_1 = 2\sec\theta,\ dx_1 = 2\sec\theta\tan\theta d\theta\right)$$

$$= -\int_0^2 \frac{\frac{\pi}{4} 2\sec\theta\tan\theta d\theta}{2\sec\theta.2\tan\theta} = -\frac{\pi}{8}$$

48. **B**

$$\because \int_0^x \frac{t^3}{1+3t^2} dt + \int_0^x \frac{tdt}{1+3t^2} = f(x)$$

Put $1+3t^2 = u^2 \Rightarrow$

$$= \int \frac{\frac{1}{3} udu \times \left(\frac{u^2-1}{3}\right)}{u^2} + \frac{1}{6}\ln\left(1+3t^2\right)\Big|_0^x$$

$$= \frac{1}{9}\int_1^{\sqrt{1+3x^2}} \left(u - \frac{1}{u}\right) du + \frac{1}{6}\ln\left(1+3x^2\right)$$

$$= \frac{1}{9}\left(\frac{u^2}{2} - \ln u\right)_1^{\sqrt{1+3x^2}} + \frac{1}{6}\ln\left(1+3x^2\right)$$

$$= \frac{1}{18}\left(\left(1+3x^2\right)-1\right) - \frac{1}{9}\ln\sqrt{1+3x^2} + \frac{1}{6}\ln\left(1+3x^2\right)$$

$$= \frac{1}{6}x^2 + \left(\frac{-1}{18} + \frac{1}{6}\right)\ln\left(1+3x^2\right)$$

$$= \frac{1}{6}x^2 - \frac{1}{9}\ln\left(1+3x^2\right)$$

49. **A**

$$x\left(2x^2y^3 + 1\right)dy = y\left(1 - 3x^2y^3\right)dx$$

$$\Rightarrow x^2y\left(2xdy + 3ydx\right) = \frac{ydx - xdy}{y^2}$$

$$\Rightarrow d\left(x^3y^2\right) = d\left(\frac{x}{y}\right)$$

$$\Rightarrow x^3y^2 = \frac{x}{y} + c$$

$$\Rightarrow x^3y^3 = x + cy$$

50. **A, B, C, D**

$$x = \frac{12}{15} \times \frac{1}{\left(1 + \frac{1}{x^2 + y^2}\right)} \quad \text{……… (i)}$$

and $$y = \frac{4}{5} \times \left(\frac{1}{1 - \frac{1}{x^2 + y^2}}\right) \quad \text{……. (ii)}$$

Put $x^2 + y^2 = \frac{1}{u}$ and add (i)^2 and (ii)^2

$$\Rightarrow \frac{1}{u} = \left(\frac{4}{5}\right)^2 \left(\frac{9}{(1+4)^2} + \frac{1}{(1-4)^2}\right)$$

$$\Rightarrow 25\left(u^2 - 2 + \frac{1}{u^2}\right) = 32\left\{5\left(4 + \frac{1}{4}\right) - 8\right\}$$

Put $u + \frac{1}{u} = v \Rightarrow v = \frac{6}{5}$ or $\frac{26}{5}$

$\Rightarrow 4 = 5$ or $\frac{1}{5}$

$\Rightarrow (x,\ y) = (2,\ 1)$ or $\left(\frac{2}{5},\ \frac{-1}{5}\right)$

51. **A, B, D**

$\because \Delta SAB$ is right angle at S

Centre C is $\left(\frac{1+7}{2},\ \frac{1-6}{2}\right) = (4,\ -3)$

$\therefore \alpha = 4$ and $\beta = -3$

$\therefore \alpha + \beta = 1$ and $\alpha - \beta = 7$

SC is radius and AB is diameter

$$\therefore SC = \frac{1}{2}\sqrt{36 + 49} = \frac{1}{2}\sqrt{85} = \sqrt{\frac{85}{4}} = \sqrt{21.25}$$

52. **A, C**

$\because \quad x \to 0^- \Rightarrow \{x\} = 1 + x$

$$\therefore \quad \lim_{x \to 0^-} f(x) = \lim_{x \to 0} \frac{\sin^{-1}(-x)\cos^{-1}(-x)}{\sqrt{2(1+x)}.(-x)} = \frac{\pi}{2\sqrt{2}}$$

& for $x \to 0^+ \Rightarrow \{x\} = x$

$$\lim_{x \to 0^+} f(x) = \lim_{x \to 0} \frac{\sin^{-1}(1-x)\cos^{-1}(1-x)}{\sqrt{2x}(1-x)} = \frac{\pi}{2}$$

53. **B, D**

$\because \quad \int_0^{\pi} \sin x dx = 2$

$\Rightarrow \quad b - a = 4\pi$

$\quad \int_0^{a+b} \cos x dx = 9$

$\Rightarrow \quad a + b = \frac{9\pi}{2}$

$\therefore \quad a = \frac{\pi}{4} \;\&\; b = \frac{7\pi}{4}$

54. **B, C**

$\because \quad ab + bc + ca \le \left(a^2 + b^2 + c^2\right)$ for all a, b, c $\in R$

$\Rightarrow \quad ab + bc + ca \le 6$

Again, $a^2 > b^2 + c^2 - 2bc \qquad (\because \cos A < 1)$

$\therefore \quad \frac{a^2 + b^2 + c^2}{2} < (ab + bc + ca)$

$\Rightarrow$ ab + b + ca > 3 So, (B) & (D)

55. **C**

56. **B**

Locus of Q is an ellipse whose vertices z1 and z2 don't lie on it and eccentricity is $\sqrt{\frac{2}{3}}$ for locus of Q.

Now, $2ae = 2 \times \sqrt{\frac{2}{3}}$

$|z_1 - z_2| = 2$

$\therefore [m] = 2 \;\; (\because m < |z_1 - z_2|)$

SECTION – C

57. **5**

$\because \quad k = \int_0^2 f(x)dx + \int_2^4 f(x)dx - 4$

$= \int_0^2 f(x)dx + \int_0^2 f(x+2)dx - 4$

$= \int_0^2 2.dx - 4 = 0$

& $\quad \alpha = \beta = \frac{1}{1} \Rightarrow q = 1$

$\therefore$ roots of $g(x) = ax^2 - bx + c$ lying in (0, 1)

$\Rightarrow \quad g(0).g(1) = C(a - b + c) \in N$ so least value is "1"

$= a^2\alpha_1\beta_1(1-\alpha_1)(1-\beta_1)$ as α_1, β_1 are roots of $ax^2 - bx + c = 0$

$g(0)g(1) < \frac{a^2}{16} \qquad ax^2 - bx + c = 0$

$\Rightarrow \quad \frac{a^2}{16} > 1 \qquad \because \quad \alpha_1(1-\alpha_1) \le \frac{1}{4}$

$\Rightarrow \quad a > 4$ or $a < -4$ & $\alpha_1 \ne \beta_1$

$\Rightarrow$ least value of a = 5

58. **6**

$$f(n) = {}^{2n}c_2 - n = \frac{2n(2n-1)}{2} - n$$

$$= n(2n-1-1) = 2n(n-1)$$

$$\frac{1}{f(n)} = \frac{1}{2}.\frac{1}{n(n-1)} = \frac{1}{2}\left[\frac{1}{n-1} - \frac{1}{n}\right]$$

$$\frac{1}{f(4)} = \frac{1}{2}\left[\frac{1}{3} - \frac{1}{4}\right]$$

$\Rightarrow$ $$\sum_{n=4}^{\infty}\frac{1}{f(n)} = \frac{1}{2}\left(\frac{1}{3}\right) = \frac{1}{6}$$

59. **4**

$\because$ $f(x) = x + \lambda.x^2 + \mu.x$

where $\lambda = \int_0^1 zf(z)dz \; \& \; M = \int_0^1 z^2 f(z)dz$

then

$$\lambda = \frac{80}{119} \qquad \& \qquad \mu = \frac{61}{119}$$

$\therefore$ $$f(x) = \frac{20}{119}\left(4x^2 + 9x\right)$$

$\Rightarrow$ $$\lim_{x\to\infty}\frac{f(x)}{ax^2 + 7x} = \frac{\frac{20}{119}\times 4}{a} = \frac{20}{119}$$

$\Rightarrow$ $a = 4$

60. **3**

$\because$ $$x^2\left(x^2 + \frac{1}{x^2}\right) = 7\left(x^2 + 2x + 1\right)^2$$

$$x^2 + \frac{1}{x^2} = 7\left(x + 2 + \frac{1}{x}\right)^2$$

Let $\alpha + \frac{1}{\alpha} = t$

$\Rightarrow$ $t^2 - 2 = 7(t+2)^2$

$\Rightarrow$ $t = -3$ or $-\frac{5}{3}$

$\Rightarrow$ $|t| = 3$ or $\frac{5}{3}$

61. **8**

$\because$ $x^2 = -4(y-1)$ has directrix

$y - 1 + 1$

$y = 2$

$\therefore$ $\lambda = 4$

$\mu = -4$

$\lambda - \mu = 8$

62. **2**

$\Delta_1 = 9 - 4a \quad \Rightarrow \quad \Delta_1 + \Delta_2 = a^2 - 4a + 5$

$\Delta_2 = a^2 - 4 \qquad\qquad = (a-2)^2 + 1 > 0$

63. **3**

$\therefore \quad z_1 = z \Rightarrow z_2^2 = z^2\omega^2, z_3 = z_2^2\omega^2$

$\therefore \quad \frac{z_2}{z_1} = +\omega$ or $-\omega$

$\frac{z_3}{z_1} = +\omega^2$ or $-\omega^2$

64. **3**

$\because$ Plane is $\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 1$

Distance from (0, 0, 0) = 3 is

$$\frac{1}{\sqrt{\frac{1}{a^2} + \frac{1}{b^2} + \frac{1}{c^2}}} = 3$$

$\therefore$ Locus of P is $\frac{1}{x^2} + \frac{1}{y^2} + \frac{1}{z^2} = \frac{1}{9}$

65. **5**

Let $\bar{a} = x\bar{b} + y\bar{c} + z\left(\bar{b} \times \bar{c}\right)$

$\Rightarrow \bar{a}.\bar{b} = x\left(\bar{b}.\bar{b}\right) + y\left(\bar{b}.\bar{c}\right) = 2$

$x + y\left(\bar{b}.\bar{c}\right) = 2$ .... (1)

$\bar{a}.\bar{c} = 0 + y \times 1 = 5$

$y = 5$

$\bar{a}.\left(\bar{b} \times \bar{c}\right) = 0 + 0 + z\left|\bar{b} \times \bar{c}\right|^2$

$z = 2$

66. **4**

$\because \tan^{-1} x \ge \frac{2\pi}{3} - \frac{\pi}{2}$ for $-1 \le 2 - x^2 \le 1$

$\Rightarrow \tan^{-1} x \ge \frac{\pi}{6} \qquad -3 \le -x^2 \le -1$

$x \ge \frac{1}{\sqrt{3}} \qquad 1 \le |x| \le \sqrt{3}$

$\therefore 1 \le x \le \sqrt{3}$

$\therefore$ have no solution for x < 1 or $x > \sqrt{3}$

So, $\alpha_{\max} = 1$ and $\beta_{\min} = \sqrt{3}$

SECTION – D

67. **00001.12**

$$\because \frac{2x}{\sqrt{x^2+1}}+\frac{\sqrt{x^2+1}}{x} \geq 2\sqrt{\frac{2x}{\sqrt{x^2+1}}\times\frac{\sqrt{x^2+1}}{x}} = 2\sqrt{2}$$

$\therefore M = 2\sqrt{2}$ & $m = \pm 1$, i.e., $m = 1$

68. **00000.75**

Put $t = \tan\theta$

$$\Rightarrow \int_0^{\pi/2} \frac{\sec^2\theta d\theta}{\sec^2\theta\left(1+\tan^{2017}\theta\right)} = \frac{\pi}{4}$$

$$\Rightarrow \frac{3x}{\pi} = \frac{3}{4} = 0.75$$

69. **00000.75**

Let $t = \log_{(3x+4)}(2x+1)$

$\Rightarrow \quad 2t+\frac{1}{t} = 3 \quad \Rightarrow \quad t = 1$ or $\frac{1}{2}$

$\log_{(3x+4)}(2x+1) = \frac{1}{2} \Rightarrow x = -1$ or $\frac{3}{4}$

$\therefore$ only solution is $x = \frac{3}{4}$

FIITJEE

JEE (Main)-2018

ALL INDIA TEST SERIES

FULL TEST – V

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 – 30, 31 – 60, 61 – 90)** *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

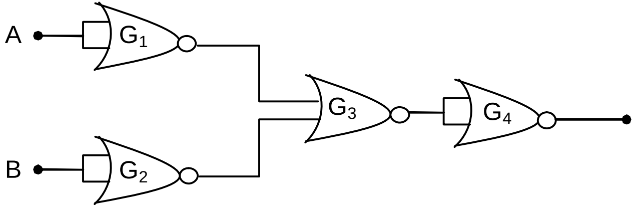
SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A transmitter supplies 9 kw to the aerial when unmodulated. The power radiated when modulation index is 60%, is

(A) 9.72 kw	(B) 9 kw
(C) 5.4 kw	(D) 10.62 kw

2. The combination of the gates shown in figure produces



(A) AND gate	(B) XOR gate
(C) NOR gate	(D) NAND gate

3. Two radioactive materials X_1 and X_2 have decay constants 10λ and λ respectively. If initially they have the same number of nuclei, then the ratio of number of nuclei of X_1 to that of X_2 will be $\frac{1}{e}$ after time

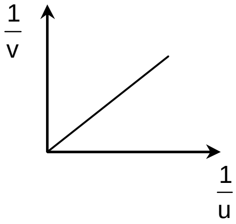
(A) $\frac{1}{10\lambda}$	(B) $\frac{1}{11\lambda}$
(C) $\frac{1}{9\lambda}$	(D) $\frac{11}{10\lambda}$

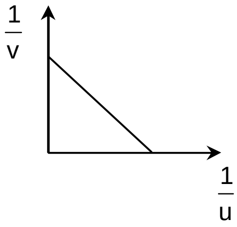
Space for Rough work

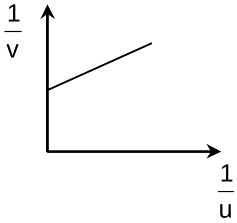
4. When the hydrogen atom is raised from the ground state to fifth state
(A) both K.E and P.E increases (B) both K.E and P.E decreases
(C) P.E increases and K.E decreases (D) P.E decreases and K.E increases

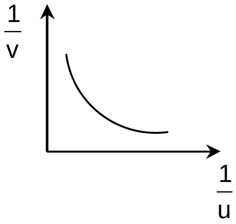
5. In an ideal parallel LC circuit, the capacitors is charged by connecting it to a dc source which is then disconnected. The current in the circuit
(A) becomes zero instantaneously (B) grows monotonically
(C) decays monotonically (D) oscillates instantaneously.

6. Which of the following graph is applicable between $\frac{1}{v}$ and $\frac{1}{u}$ for a concave mirror

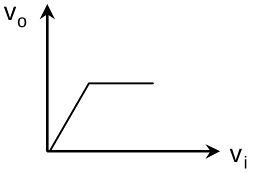
(A)


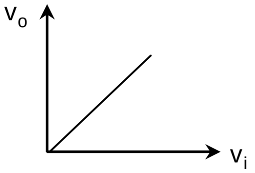
(B)


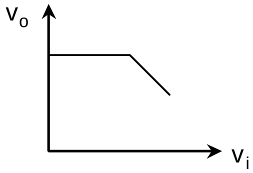
(C)


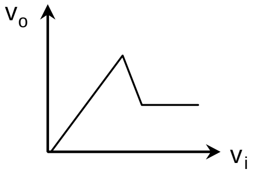
(D)


7. In a voltage regulating of zener diode, the graph of output voltage v_o versus input voltage v_i is

(A)


(B)


(C)


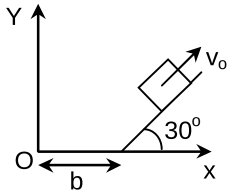
(D)


Space for Rough work

8. From ideal instruments, current measured is $i = 10.0$amp, potential difference measured is V = 100.0 volt, length of wire is 31.4cm, and diameter of wire is 2.00 mm, the resistivity of wire will be (in correct significant figures) $(\pi = 3.14)$

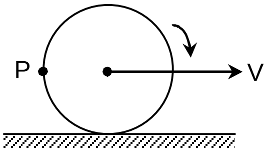
(A) $1.00 \times 10^{-4} \Omega - m$
(B) $1.0 \times 10^{-4} \Omega - m$
(C) $1 \times 10^{-4} \Omega - m$
(D) $1.000 \times 10^{-4} \Omega - m$

9. A cube of mass m and side a is moving along a plane with constant speed v_o as shown in figure. The magnitude of angular momentum of the cube about z -axis would be.



(A) $\frac{mv_o b}{2}$
(B) $\frac{\sqrt{3} mv_o b}{2}$
(C) $mv_o\left(b - \frac{a}{2}\right)$
(D) None of these

10. A disc of radius R is rolling purely on a flat horizontal surface, with constant angular velocity. The angle between the velocity and acceleration vectors of point P is



(A) zero
(B) 45^o
(C) 135^o
(D) $\tan^{-1}\left(\frac{1}{2}\right)$

11. A small mass slides down an inclined plane of inclination θ with the horizontal. The coefficient of friction is $\mu = \mu_o x$ where x is the distance through which the mass slides down and μ_o is constant. Then the distance covered by the mass before it stops is

(A) $\frac{2}{\mu_o}\tan\theta$
(B) $\frac{4}{\mu_o}\tan\theta$
(C) $\frac{1}{2\mu_o}\tan\theta$
(D) $\frac{1}{\mu_o}\tan\theta$

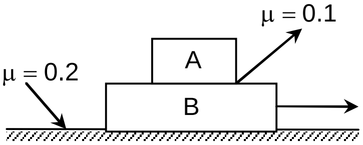
Space for Rough work

12. Acceleration of a particle moving in x-y plane varies with time t as. $\vec{a} = \left(t\hat{i} + 3t^2\hat{j}\right)$.

Here a is in m/s^2 and t in sec. At time t = 0 particle is at rest at origin. Mass of the particles is 1 kg. Find the net work done on the particle in first 2 sec.

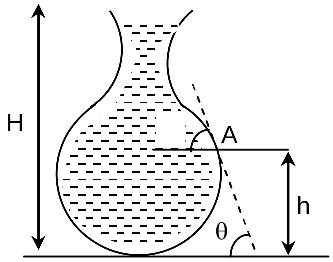
(A) 40 J
(B) 34 J
(C) 16 J
(D) 48 J

13. Both the blocks as shown in figure are given together a horizontal velocity towards right. The acceleration of the centre of mass of the system of blocks is $\left(m_A = 2m_B = 2\text{kg}\right)$.



(A) zero
(B) $\frac{5}{3}\text{m/s}^2$
(C) $\frac{7}{3}\text{m/s}^2$
(D) $2\ \text{m/s}^2$

14. Figure here shows the vertical cross section of a vessel filled with a liquid of density ρ. The normal thrust per unit area due to liquid on the walls of the vessel at point A as shown, will be



(A) $h\rho g$
(B) $H\rho g$
(C) $(H-h)\rho g$
(D) $(H-h)\rho g\cos\theta$

15. The volume thermal expansion coefficient of an ideal gas at constant pressure is

(A) T
(B) T^2
(C) $\frac{1}{T}$
(D) $\frac{1}{T^2}$

Space for Rough work

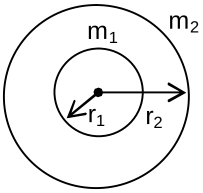
16. A heavy but uniform rope of length L is suspended from a ceiling. A particle is dropped from the ceiling at the instant when the bottom end is given a transverse wave pulse. Where will the particle meet the pulse

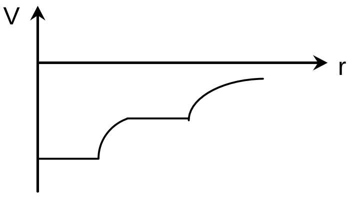
(A) at a distance $\frac{2L}{3}$ from the bottom
(B) at a distance $\frac{L}{3}$ from the bottom
(C) at a distance $\frac{3L}{4}$ from the bottom
(D) None of the above

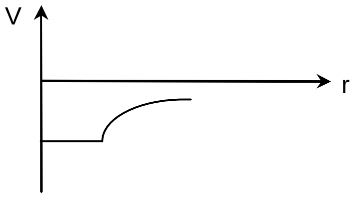
17. A particle moves according to the law $x = a\cos\frac{\pi t}{2}$. The distance covered by it in the time internal between t = 0 to t = 3 sec is.

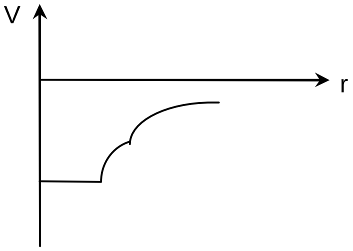
(A) 2a
(B) 3a
(C) 4a
(D) a

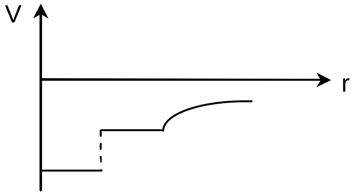
18. Two concentric spherical shells are as shown in figure. The V – r graph will be as



(A)


(B)


(C)


(D)


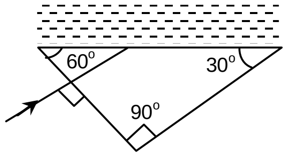
Space for Rough work

19. Two coherent point sources S_1 and S_2 vibrating in phase emit light of wavelength λ. The separation between the sources is 2λ. The smallest distance from S_2 on a line passing through S_2 and perpendicular to S_1S_2, where a minimum of intensity occurs is

(A) $\frac{7\lambda}{12}$ (B) $\frac{15\lambda}{4}$

(C) $\frac{\lambda}{2}$ (D) $\frac{3\lambda}{4}$

20. Light is incident normally on face AB of a prism as shown in figure. A liquid of refractive index μ is placed on face AC of the prism. The prism is made of glass of refractive index $\frac{3}{2}$. The limits of μ for which total internal reflection takes place on face AC is

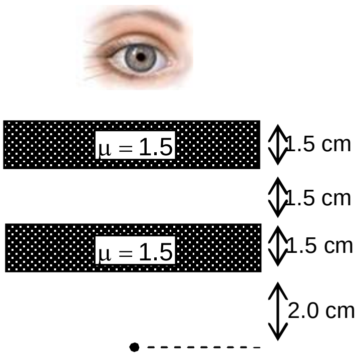


(A) $\mu > \frac{\sqrt{3}}{2}$ (B) $\mu < \frac{3\sqrt{3}}{4}$

(C) $\mu > \sqrt{3}$ (D) $\mu < \frac{\sqrt{3}}{2}$

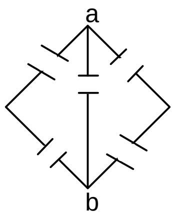
21. The image of point P when viewed from top of the slabs will be

(A) 2 cm above P
(B) 1.5 cm above P
(C) 2 cm below P
(D) 1 cm below P



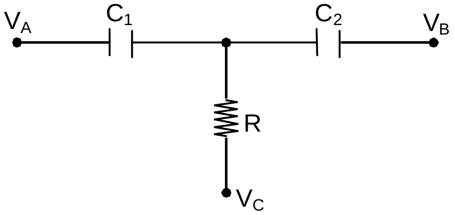
Space for Rough work

22. If the capacitance of each capacitor is C, then effective capacitance of the shown network across junction ab is



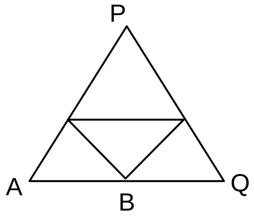
(A) 2 C
(B) C
(C) $\frac{C}{2}$
(D) 5 C

23. For given circuit charge on capacitor C, and C₂ in steady state will be equal to



(A) $C_1(V_A - V_C), C_2(V_C - V_B)$ respectively
(B) $C_1(V_A - V_B), C_2(V_A - V_B)$ respectively
(C) $(C_1 + C_2)(V_A - V_B)$ on each capacitor
(D) $\left(\frac{C_1C_2}{C_1 + C_2}\right)(V_A - V_B)$ on each capacitor

24. In the diagram resistance between any two junctions is R. Equivalent resistance across terminals A and B is (Assume P and Q across as a junction)



(A) $\frac{11\,R}{7}$
(B) $\frac{18\,R}{11}$
(C) $\frac{7\,R}{11}$
(D) $\frac{11R}{18}$

25. A particle of charge per unit mass α is released from origin with velocity $\vec{V} = v_o i$ in a magnetic field. $\vec{B} = -B_o\hat{K}$ for $x \le \frac{\sqrt{3}}{2}\frac{v_o}{B_o\alpha}$ and $\vec{B} = 0$ for $x > \frac{\sqrt{3}}{2}\frac{v_o}{B_o\alpha}$

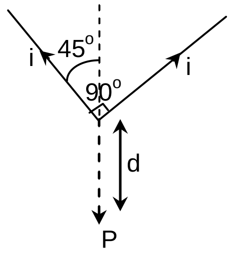
and $\vec{B} = 0$ for $x > \frac{\sqrt{3}}{2}\frac{v_o}{B_o\alpha}$

The x – coordinate of the particle at time $t > \left(\frac{\pi}{3B_o\alpha}\right)$ would be

(A) $\frac{\sqrt{3}}{2}\frac{v_o}{B_o\alpha} + \frac{\sqrt{3}}{2}v_o\left(t - \frac{\pi}{B_o\alpha}\right)$
(B) $\frac{\sqrt{3}}{2}\frac{v_o}{B_o\alpha} + v_o\left(t - \frac{\pi}{3B_o\alpha}\right)$
(C) $\frac{\sqrt{3}}{2}\frac{v_o}{B_o\alpha} + \frac{v_o}{2}\left(t - \frac{\pi}{3B_o\alpha}\right)$
(D) $\frac{\sqrt{3}}{2}\frac{v_o}{B_o\alpha} + \frac{v_o t}{2}$

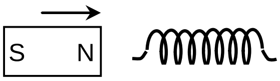
Space for Rough work

26. Find the magnetic field at P due to the arrangement shown in figure.

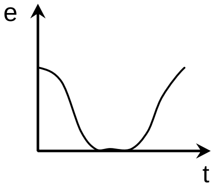


(A) $\frac{\mu_o i}{\sqrt{2}\pi d}\left(1-\frac{1}{\sqrt{2}}\right)\otimes$
(B) $\frac{2\mu_o i}{\sqrt{2}\pi d}\otimes$
(C) $\frac{\mu_o i}{\sqrt{2}\pi d}\otimes$
(D) $\frac{\mu_o i}{\sqrt{2}\pi d}\left(1+\frac{1}{\sqrt{2}}\right)\otimes$

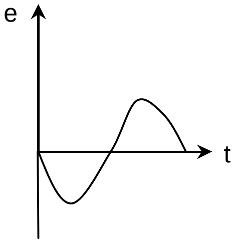
27. The variation of induced emf(e) with time (t) in a coil if a short bar magnet is along its axis with a constant velocity is best represented as



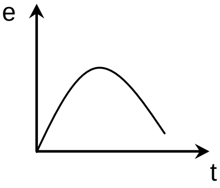
(A)



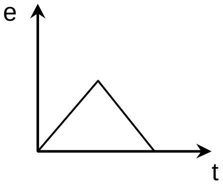
(B)



(C)

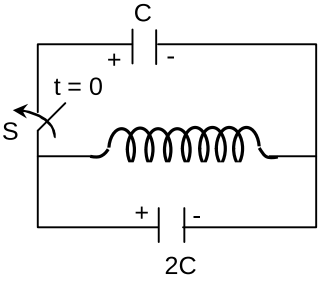


(D)



Space for Rough work

28. In the given LC circuit if initially capacitor C has charge Q on it and 2C has charge 2Q. The polarities are as shown in the figure. Then after closing the switch s at t = 0
(A) energy will get equally distributed in both the capacitor just after closing the switch
(B) Initial rate of growth of current in inductor will be $2Q/3CL$
(C) Maximum energy in the inductor will be $3Q^2/2C$
(D) None of these



29. In an insulator, the forbidden energy gap between the balance band and conduction band is of the order of
(A) 1 MeV (B) 0.1 MeV
(C) 1 eV (D) 5 eV

30. A TV tower has a height of 150 m. The area of the region covered by the TV broadcast is (Radius of earth = 6.4×10^6 m)
(A) $9.6\pi \times 10^8 m^2$ (B) $19.2\pi \times 10^8 m^2$
(C) $19.2\pi \times 10^{10} m^2$ (D) $1.92 \times 10^3 km^2$

Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. An aqueous solution has a density of 1.37 g/ml. If molecular wt of solute is 68.5 g/mol, then calculate molarity of solution.
(A) 2 M (B) 50 M
(C) 5 M (D) 20 M

32. Calculate the degree of ionisation of 0.04 M HOCl solution having ionisation constant 1.25×10^{-4}?
(A) 0.025 (B) 0.5
(C) 0.25 (D) 0.055

33. In a crystalline solid, X atoms occupy hcp and ¼ th of tetrahedral voids are occupied by Y atoms. Then empirical formula of crystalline solid is
(A) X_2Y (B) XY_2
(C) X_4Y (D) XY

34. Bohr's model is able to explain
(A) Zeeman effect (B) Stark effect
(C) Bond formation of H_2 (D) Hydrogens spectrum

35. On increasing temperature from 200 K to 220 K rate of reaction A increase by 3 times and rate of reaction B increases by 9 times then correct relationship between activation energy of A and B is
(A) $E_A = 3\,E_B$ (B) $3\,E_A = E_B$
(C) $E_B = 2E_A$ (D) $E_A = 2E_B$

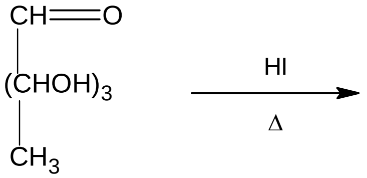
36. Calculate work done during isothermal reversible process when 5 mol ideal gas is expanded so that its volume is doubled at 400 K.
(A) – 11.5 kJ (B) – 344 kJ
(C) 0 (D) – 2.8 kJ

Space for Rough work

37. The K_{sp} of AgCl at 25°C is 2.56×10^{-10}. Then how much volume of H_2O is required to dissolve 0.01 mole of salt?
(A) 800 L
(B) 400 L
(C) 625 L
(D) 50 L

38. Aqua regia convert
(A) Pt to $[PtCl_4]^{-2}$
(B) Pt to $PtCl_2$
(C) Ag to AgCl
(D) Au to $[AuCl_4]^{-}$

39. Identify product of the reaction

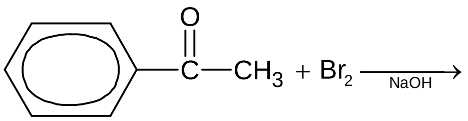


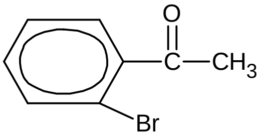
$$\begin{array}{l} CH{=}O \\ | \\ (CHOH)_3 \\ | \\ CH_3 \end{array} \xrightarrow[\Delta]{HI}$$

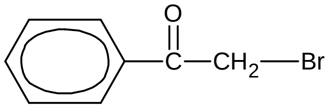
(A) n – Pentane
(B) 2 – Pentane
(C) 1, 3 Pentadiene
(D) 3 - Pentene

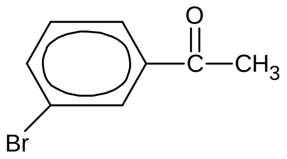
40. In extraction of a metal by bessemerization, Cu_2S is converted into
(A) Cu_2O
(B) CuO
(C) Cu
(D) $CuFeO_2$

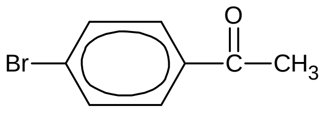
41.



(A)


(B)


(C)


(D)


42. Arrange the given compounds is order of their basic strength

(i) Histidine (ii) Lysine (iii) Arginine

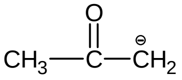
(A) i > ii > iii
(B) ii > i > iii
(C) iii > ii > i
(D) i > iii > ii

43. Arrange the following in their nucleophilicity order.

$C_6H_5O^{\ominus}$ (I)

$C_6H_5S^{\ominus}$ (II)

$C_6H_5-\overset{\ominus}{C}H_2$ (III)



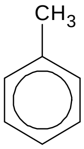
$CH_3-\overset{\overset{O}{\|}}{C}-\overset{\ominus}{C}H_2$

(IV)

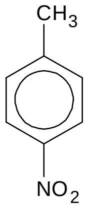
(A) II > III > IV > I
(B) I > IV > II > III
(C) II > IV > III > I
(D) III > IV > I > II

44. The best starting substrate to prepare 2-Bromobenzoic acid is

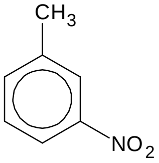
(A)



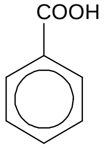
(B)



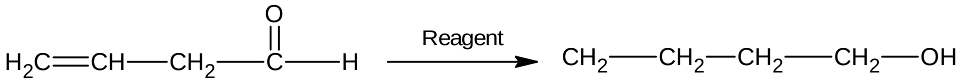
(C)



(D)



45.



$$H_2C{=}CH-CH_2-\overset{\overset{O}{\|}}{C}-H \xrightarrow{\text{Reagent}} CH_2-CH_2-CH_2-CH_2-OH$$

Appropriate reagent for above conversion will be

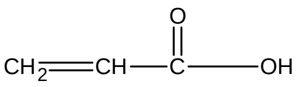
(A) Metal + H_2
(B) $LiAlH_4$
(C) $NaBH_4$
(D) All

Space for Rough work

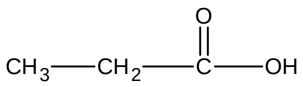
46. An octahedral complex having formula $Ma_2b_2C_2$, which of the following combination is possible to exhibit optical isomerism
(A) $a = Cl^-$, B & C = (en)
(B) a & b & c = EDTA
(C) a & b = $C_2O_4^{-2}$,c = en
(D) $a = H_2O$, $b = NH_3$, $C = Cl^-$

47. Which of the following statement is incorrect?
(A) It is possible to separate eclipsed and staggered form of ethane at room temperature
(B) Eclipsed form has torsional strain
(C) Ethane has infinite number of conformers
(D) Energy difference between staggered form & eclipsed form of ethane is 12.5 kJ/mole

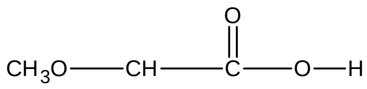
48. Arrange the following compounds in their acidic strength order.


$CH_2{=}CH-\overset{O}{\overset{\|}{C}}-OH$

(I)


$CH_3-CH_2-\overset{O}{\overset{\|}{C}}-OH$

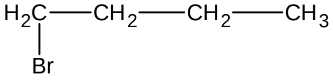
(II)


$CH_3O-CH-\overset{O}{\overset{\|}{C}}-O-H$

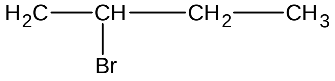
(III)

(A) I > II > III
(B) III > II > I
(C) I > III > II
(D) II > I > III

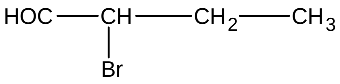
49. Arrange the following compound in order of reactivity towards SN^1 reaction.


$H_2\underset{Br}{\underset{|}{C}}-CH_2-CH_2-CH_3$

(I)


$H_2C-\underset{Br}{\underset{|}{CH}}-CH_2-CH_3$

(II)


$HOC-\underset{Br}{\underset{|}{CH}}-CH_2-CH_3$

(III)

(A) I > II > III
(B) II > I > III
(C) III > II > I
(D) I > III > II

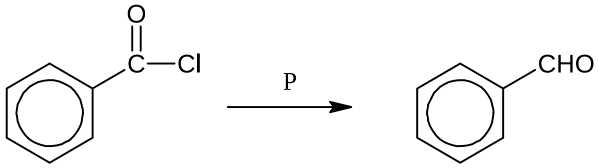
50. Which of the following statement is not true regarding B_2H_6?
(A) It reacts with NaH to form $NaBH_4$
(B) It is inflammable gas
(C) It contain four equal B – H bonds
(D) it reacts with Lewis base always to form always adduct

Space for Rough work

51. Regarding brown ring complex formation, which of the following statement is wrong?
(A) NO formation takes place
(B) $Fe_2(SO_4)_3$ is used in this process
(C) Fe^{+2} and NO_3^- both are reduced
(D) Formula of brown ring complex is $\left[Fe(H_2O)_5NO\right]^{+2}$

52. Identify incorrect statement regarding glucose.
(A) Pentaacetate of glucose does not react with hydroxyl amine
(B) Glucose forms cyclic hemiacetal
(C) Glucose exists in two crystalline forms
(D) α - form of glucose has higher melting point than its β-form

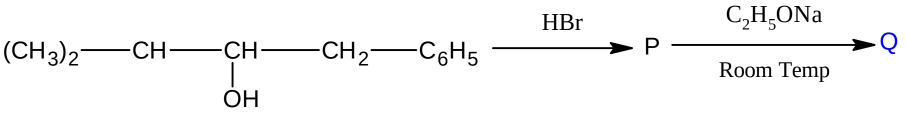
53.



P will be
(A) $Pd/BaSO_4 + H_2$
(B) $LiAlH_4$
(C) $NaBH_4$
(D) $Pd + H_2$

54. Amoxycillin is
(A) Broad spectrum antibiotic
(B) Bacteriostatic
(C) Synthetic modification of penicillin
(D) (a) & (c) both

55.

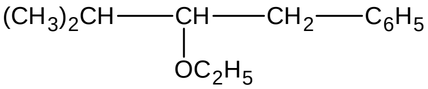


$$(CH_3)_2-CH-\underset{\underset{OH}{|}}{CH}-CH_2-C_6H_5 \xrightarrow{HBr} P \xrightarrow[\text{Room Temp}]{C_2H_5ONa} Q$$

. Then Q is

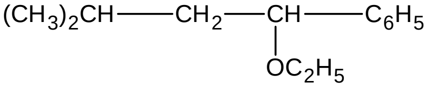
(A) $(CH_3)_2CH-CH=CH-C_6H_5$

(B)



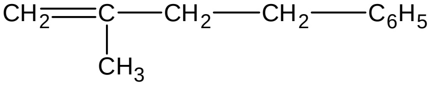
$$(CH_3)_2CH-\underset{\underset{OC_2H_5}{|}}{CH}-CH_2-C_6H_5$$

(C)



$$(CH_3)_2CH-CH_2-\underset{\underset{OC_2H_5}{|}}{CH}-C_6H_5$$

(D)



$$CH_2=\underset{\underset{CH_3}{|}}{C}-CH_2-CH_2-C_6H_5$$

56. If radius of octahedral void is r and radius of atoms which shows close packing is R, then what will be radius of void in terms of radius of atoms?

(A) $\left(\sqrt{2}-1\right)R$ (B) $\sqrt{2}R$

(C) $\frac{R}{\sqrt{2}}$ (D) $\frac{R}{2\sqrt{2}}$

57. For a first order reaction, rate constant is given is $\log k = 14 - \frac{1.2\times10^4}{T}$, then what will be value of temperature if its half life period is 6.93×10^{-3} min.?

(A) 100 K (B) 1000 K

(C) 720 K (D) 327 K

58. What will be solubility of A_2X_3 if its solubility product (K_{sp}) is equal to 1.08×10^{-23} ?

(A) 10^{-5} mol/L (B) 3.7×10^{-4} mol/L

(C) 1.2×10^{-3} mol/L (D) 7.5×10^{-4} mol/L

59. Which of the following is correct for repulsive process in real gas?

(A) Z > 1; repulsive forces are dominating (B) Z < 1; repulsive forces are dominating

(C) short range interaction (D) long range interaction

60. In solid phase, XeF_6 consists of

(A) $XeF_5^+ + F^-$ (B) $XeF_4 + F_2$

(C) $XeF_5^+ + XeF_2^-$ (D) $XeF_2 + 2F_2$

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. If α,β,γ are roots of equation $x^3-3x^2+3x+7=0$, then $\sum\frac{\alpha-1}{\beta-1}$ is

(A) 0
(B) 3ω
(C) $\frac{3}{\omega}$
(D) $2\omega^2$

62. If (x, y) satisfies the equation $x^2-xy+y^2=4(x+y-4)$, then value of $\frac{x}{y}+\frac{y}{x}$ is $(x,y\in R)$

(A) 1
(B) 2
(C) 4
(D) 0

63. Let ab^2c^3, $a^2b^3c^4$, $a^3b^4c^5$ are in A.P. (a, b, c > 0), then minimum value of $27a+8b+125c$ is

(A) 30
(B) 60
(C) 90
(D) 120

64. If $f(x)$ is not identically zero and $\int_{-5}^{5}f(x)dx=0$, then value of $\int_{-2}^{3}f(x)\left[\frac{1}{x^2+1}\right]dx$ equals to ([.] is G.I.F.)

(A) 0
(B) 1
(C) Depends on $f(x)$
(D) None of these

65. Value of $\lim\limits_{n\to\infty}\frac{1}{(n^3+1)}+\frac{2^2}{(n^3+2^3)}+........+\frac{1}{2n}$ is

(A) $\ln 2$
(B) $\frac{1}{2}\ln 3$
(C) $\frac{1}{4}\ln 3$
(D) $\frac{1}{3}\ln 2$

Space for Rough work

66. Total number of words using all the letters of word INDIA in which A doesn't come in middle is
(A) 36 (B) 48
(C) 60 (D) 12

67. If a, b, c are in A.P. and sum of coefficients of $\left(1+\left(ax^2-2bx+c\right)^2\right)^{2017}$ is equal to $-y^2-y$, then value of $y^{2018}+\frac{1}{y^{2018}}+1$ is
(A) 0 (B) 1
(C) 2 (D) None of these

68. In a triangle ABC, the value of $\Delta=\begin{vmatrix}\sin(A+B+C) & \sin B & \cos C \\ -\sin B & 0 & \tan A \\ \cos(A+B) & -\tan A & 0\end{vmatrix}$ is equal to
(A) –1 (B) 0
(C) 1 (D) 2

69. Value of $\int_{-3}^{3}\frac{x^2}{\left(1+|x|^3\right)\left(3^x+1\right)}dx$ is
(A) $3\ln 2$ (B) $\ln 3$
(C) $2\ln 3$ (D) None of these

70. Let f be a differential function satisfying $f(x)+f(x+1)+......+f(x+99)=50\ \forall x\in R,\ f(0)=\frac{1}{3}$, then the value of $\lim_{x\to\infty}\left(f\left(\frac{1}{x}\right)+f^2\left(\frac{1}{x}+100\right)+f^3\left(\frac{1}{x}+200\right)+.......\infty\right)$ is
(A) $\frac{1}{2}$ (B) 1
(C) $\frac{1}{3}$ (D) $\frac{2}{3}$

Space for Rough work

71. If $P(B)=\frac{3}{4}$, $P(A\cap B\cap \bar{C})=\frac{1}{3}$, $P(\bar{A}\cap B\cap \bar{C})=\frac{1}{3}$, then $P(B\cap C)$ is

(A) $\frac{1}{3}$ (B) $\frac{1}{4}$
(C) $\frac{1}{12}$ (D) $\frac{1}{9}$

72. Let A and B are two sets, then $(A\cup B)'\cup(A'\cap B)$ is equal to

(A) A' (B) A
(C) B' (D) None of these

73. If the relation $R: A\to B$, where A = {1, 2, 3, 4} and B = {1, 3, 5} is defined by $R=\{(x,\ y): x<y,\ x\in A,\ y\in B\}$, then $R^{-1}OR$ is

(A) $\{(1,\ 3)(1,\ 5)(2,\ 3)(2,\ 5)(3,\ 5)(4,\ 5)\}$ (B) $\{(3,\ 1)(5,\ 1)(5,\ 2)(5,\ 3)(5,\ 4)\}$
(C) $\{(3,\ 3)(3,\ 5)(5,\ 3)(5,\ 5)\}$ (D) None of these

74. If p, q, r are statements with truth values false, true and false respectively, then truth value of $(\sim p\vee \sim q)\vee r$ is

(A) True (B) False
(C) False, if r is true (D) False, if q is false

75. For a series if n = 10, $\sum x=60$ and $\sum x^2=1000$, then standard deviation is

(A) 8 (B) 64
(C) 24 (D) 128

76. If $1+\cot\theta\le\cot\frac{\theta}{2}$ for $0<\theta<\pi$, then θ is equal to

(A) $\frac{\pi}{6}$ (B) $\frac{\pi}{4}$
(C) $\frac{\pi}{2}$ (D) $\frac{\pi}{8}$

Space for Rough work

77. In a triangle ABC, if b = 2, $c = \sqrt{3}$, $\angle A = 30^{o}$, then area of incircle of triangle is

(A) $\pi\left(2-\frac{\sqrt{3}}{2}\right)$
(B) $\pi\left(1-\frac{\sqrt{3}}{2}\right)$
(C) $\sqrt{2}\pi$
(D) $\frac{\pi\sqrt{3}}{2}$

78. From the top of a cliff 50 m high, the angle of depressions of the top and bottom of a tower are observed to be 30° and 45°, then the height of tower is

(A) 50 m
(B) $50\sqrt{3}$ m
(C) $50\left(\sqrt{3}-1\right)$ m
(D) $50\left(1-\frac{\sqrt{3}}{3}\right)$ m

79. The matrix $\begin{bmatrix} 1 & 2 & 3 \\ 1 & 2 & 3 \\ -1 & -2 & -3 \end{bmatrix}$ is

(A) Idempotent
(B) Nilpotent
(C) Involutary
(D) Orthogonal

80. Equation of plane perpendicular to x = 0 and passing through (2, –1, 0) can be

(A) $x+3y+z+1=0$
(B) $2y-z+2=0$
(C) $y=-1$
(D) $2y+z+1=0$

81. The area of triangle formed by positive y-axis and the normal and tangent to $x^2+y^2=4$ at $\left(1, \sqrt{3}\right)$ is

(A) $\sqrt{3}$ sq. unit
(B) $\frac{2}{\sqrt{3}}$ sq. unit
(C) $2\sqrt{3}$ sq. unit
(D) $4\sqrt{3}$ sq. unit

82. Equation of tangent to $y = \int_{0}^{x^2} \frac{t^2-1}{t^2+1}dt$ at x = 1 is

(A) x = 0
(B) $x = \frac{1}{\pi}-1$
(C) $y = 1-\pi$
(D) $y = 1-\frac{\pi}{2}$

Space for Rough work

83. If $f(x) = |x-1| + |x-3| + |5-x|$ is symmetrical about the line $x = 1 + |\lambda|$, then λ can be
(A) 3 (B) –2
(C) –1 (D) 1

84. $\int \frac{e^{\tan\theta}\left(\tan^3\theta + 3\tan^2\theta + \tan\theta\right)}{1+\tan^2\theta} d\theta$ is equal to
(A) $e^{\tan\theta}\left(\tan^3\theta + \tan\theta\right) + c$ (B) $e^{\tan\theta}\left(\tan^3\theta + \tan^2\theta\right) - e^{\tan\theta} + c$
(C) $e^{\tan\theta}\left(\tan\theta\sec^2\theta - 1\right) + c$ (D) None of these

85. Solution of $y^5 x + y - x\frac{dy}{dx} = 0$ is
(A) $\frac{y^5}{5} + \frac{y^4}{4x^4} = c$ (B) $\frac{x^4}{4} + \frac{x^5}{5y^5} = c$
(C) $\frac{y^4}{4} + \frac{y^5}{5x^4} = c$ (D) $\frac{x^5}{5} + \frac{x^4}{4y^4} = c$

86. The points on the axis of parabola $3y^2 + 4y - 6x + 8 = 0$, from where 3 distinct normal can be drawn is given by
(A) $\left(\lambda, \frac{4}{3}\right)$, where $\lambda > \frac{19}{9}$ (B) $\left(\lambda, \frac{-2}{3}\right)$, where $\lambda > \frac{19}{9}$
(C) $\left(\lambda, \frac{1}{3}\right)$, where $\lambda > \frac{7}{9}$ (D) None of these

87. If (a, b) is a point on the ellipse $x^2 + 2y^2 = 6$ which is at a minimum distance from the line $x + y = 7$, then $a^2 + b^2$ is
(A) 4 (B) 5
(C) 6 (D) 8

Space for Rough work

88. If e is the eccentricity of the hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ and θ is angle between the asymptote, then $\cos\frac{\theta}{2}$ is equal to

(A) $\frac{1-e}{e}$
(B) $\frac{1}{e}$
(C) $\frac{1}{e}+1$
(D) None of these

89. The roots of $(z+\alpha\beta)^3=\alpha^3$ $(\alpha\neq 0)$ represent the vertices of triangle of the side length

(A) $\frac{1}{\sqrt{3}}(\alpha\beta)$
(B) $\sqrt{3}|\alpha|$
(C) $\sqrt{3}|\beta|$
(D) $\frac{|\alpha|}{\sqrt{3}}$

90. A set has $(2n+1)$ elements, then total number of non empty subsets of given set, containing at most n elements is

(A) 2^{2n-1}
(B) 2^{2n}
(C) $2^{2n}-1$
(D) $2^{2n+1}-1$

Space for Rough work

FIITJEE **JEE(Main)-2018**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – V
(Main)

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**D**	31.	**D**	61.	**C**
2.	**D**	32.	**D**	62.	**B**
3.	**C**	33.	**A**	63.	**C**
4.	**C**	34.	**D**	64.	**A**
5.	**C**	35.	**C**	65.	**D**
6.	**B**	36.	**A**	66.	**B**
7.	**A**	37.	**C**	67.	**A**
8.	**C**	38.	**D**	68.	**B**
9.	**D**	39.	**A**	69.	**D**
10.	**B**	40.	**A**	70.	**A**
11.	**A**	41.	**B**	71.	**C**
12.	**B**	42.	**C**	72.	**A**
13.	**D**	43.	**A**	73.	**C**
14.	**C**	44.	**B**	74.	**A**
15.	**C**	45.	**A**	75.	**A**
16.	**B**	46.	**D**	76.	**C**
17.	**B**	47.	**A**	77.	**B**
18.	**C**	48.	**A**	78.	**D**
19.	**A**	49.	**B**	79.	**B**
20.	**B**	50.	**D**	80.	**B**
21.	**D**	51.	**B**	81.	**B**
22.	**B**	52.	**D**	82.	**D**
23.	**A**	53.	**A**	83.	**B**
24.	**D**	54.	**D**	84.	**C**
25.	**C**	55.	**A**	85.	**D**
26.	**A**	56.	**A**	86.	**B**
27.	**B**	57.	**B**	87.	**B**
28.	**C**	58.	**A**	88.	**B**
29.	**D**	59.	**A**	89.	**B**
30.	**D**	60.	**A**	90.	**C**

Physics

PART – I

SECTION – A

1. **D**

$$P_t = P_c\left(1+\frac{m^2}{2}\right) = 9\left(1+\frac{(0.6)^2}{2}\right) = 9\left[1+\frac{0.36}{2}\right]$$

$$= 9[1+0.18] = 9[1.18] = 10.62 \text{ kw}$$

2. **D**

Out put of $G_1 = \overline{A}$, out put of $G_2 = \overline{B}$

Out put of G3 = AB

Now $Y = \overline{AB}(\text{NAND gate})$

3. **C**

$$N_1 = N_o e^{-10\lambda t}, N_2 = N_o e^{-\lambda t} \therefore \frac{N_1}{N_2} = \frac{1}{e^{9\lambda t}}$$

$$\therefore \frac{1}{e} = \frac{1}{e^{9\lambda t}} \therefore t = \frac{1}{9\lambda}$$

4. **C**

As the number of orbit increases the velocity decreases i.e K.E decreases the potential energy becomes less negative i.e P.E increase.

5. **C**

The current in the circuit decays monotonically.

6. **B**

$$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$$

Therefore, for a given mirror $\frac{1}{v}$ versus $\frac{1}{u}$ graph should be a straight line at u = f or

$\frac{1}{u}=\frac{1}{f}, v=\infty$ or $\frac{1}{v}=0$ and viceversa

7. **A**

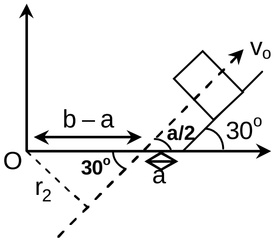
Fact

8. **C**

$$\rho = \frac{\pi D^2}{4L}\frac{v}{i} = \frac{(3.14)\left(2.00\times10^{-3}\right)^{-2}}{4(0.314)}\left(\frac{100.0}{10.0}\right)$$

$$\rho = 1.00\times10^{-4}\Omega - m$$

9. **D**



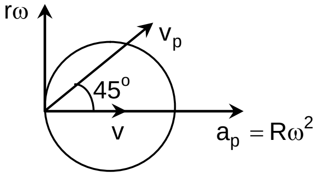
$r_1 = (b-a)\sin 30^o$

$= \left(\frac{b-a}{2}\right)$

$\therefore L = mv_o r_2 = \frac{mv_o(b-a)}{2}$

10. **B**

Angle is 45°



11. **A** $a = g\sin\theta - (\mu_o g\cos\theta)x \therefore \int_o^v v dv = \int_0^{x_{max}} [g\sin\theta - (\mu_o g\cos\theta)x]dx$

After solving we get $x_{max} = \frac{2\tan\theta}{\mu_o}$

12. **B**

$\frac{d\vec{v}}{dt} = ti + 3t^2 j \quad \therefore \int_0^{\vec{v}} d\vec{v} = \int_0^2 (ti + 3t^2 j)dt$

$\therefore \vec{v} = (2i + 8j) m/s.$

$\therefore v = \sqrt{68}$

by work energy theorem $\therefore w = \frac{1}{2}mv^2 \therefore w = 34J$

13. **D**

Net external force on the two blocks (whether they move with same retardation or not)

$f_{ext} = (0.2)(2+1)\times 10 = 6N$

$\therefore a_{cm} = \frac{f_{ext}}{2+1} = 2 \text{ m/s}^2$

14. **C**

Normal thrust per unit area is actually the pressure due to liquid

15. **C**

$PV = nRT \therefore pdv = nRdT \therefore dv = \left(\frac{v}{T}\right)dT \quad .....(i)$

$dv = \gamma v dT \quad ....(ii)$

from $(i)\&(ii)\gamma = \frac{1}{T}$

16. **B**

$$v = \sqrt{gh} \therefore \frac{dh}{dt} = \sqrt{gh} \therefore t = \int_0^h \frac{dh}{\sqrt{gh}} \text{ or } t = 2\sqrt{\frac{h}{g}}$$

Now at the time of meeting,

Time of fall of particle = time of wave pulse on reaching up to these

$$\sqrt{\frac{2(L-h)}{g}} = 2\sqrt{\frac{h}{g}} \therefore h = \frac{L}{3}$$

17. **B**

Comparing the given equation with $x = a\cos\omega t$

$$\therefore \omega = \frac{\pi}{2} \text{ or } \frac{2\pi}{T} = \frac{\pi}{2} \therefore T = 4\,\text{sec}$$

The given time t = 3 sec is really $\frac{3T}{4}$.

$\therefore$ distance covered will be 3 a

18. **C**

for $r \le r_1$ $V = \frac{Gm_1}{r_1} - \frac{Gm_2}{r_2} = \text{constant}$

for $r_1 \le r \le r_2$ $V = -\frac{Gm_2}{r_2} - \frac{Gm_1}{r_1}$

slope of V - x graph dV/dr = Gm_1 / r^2

for $r \ge r_2$ $V = -\frac{G}{r}(m_1 + m_2)$

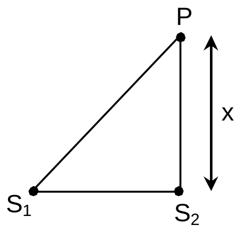
slope of V - r graph = $\frac{G}{r}(m_1 + m_2)$

At the boundary of outer shell slope of V – r graph changes from

$\frac{Gm_1}{r_2^2}$ to $\frac{G(m_1 + m_2)}{r_2^2}$ i.e slope increses

19. **A**

Path difference at S_2 is 2λ. Therefore for minimum intensity at P.

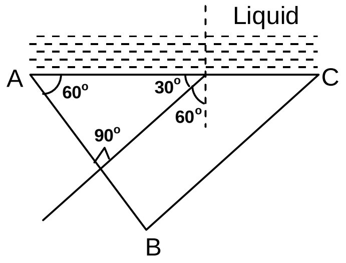


$$S_1P - S_2P = \frac{3\lambda}{2} \qquad ......(i)$$

or $\sqrt{4\lambda^2 + x^2} - x = \frac{3\lambda}{2}$

Solving equation, $x = \frac{7\lambda}{12}$

20. **B**



Critical angle between glass and liquid face is $\sin\theta_C = \frac{\mu}{3/2}$

$$\therefore \sin\theta_C = \frac{2\mu}{3}$$

Angle of incidence at face AC is 60°

For TIR to take plane $I > \theta_C$

Or $\sin 60^\circ > \frac{2\mu}{3}$ or $\mu < \frac{3\sqrt{3}}{4}$.

21. **D**

The two slabs will shift the image a distance

$$d = 2\left(1-\frac{1}{\mu}\right)t = 2\left(1-\frac{1}{1.5}\right)(1.5) = 1\,\text{cm}$$

22. **B**

The given network is a balanced Wheatstone bridge with one capacitor in parallel with this bridge.

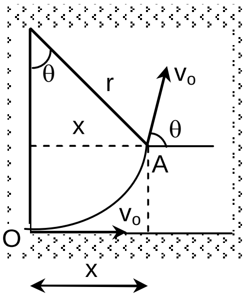
23. **A**

No current will flow through the resistance at steady state.

24. **D**

Series and parallel grouping of resistors.

25. **C**



$$r = \frac{mv_o}{B_o q} = \frac{v_o}{B_o \alpha}$$

$$\frac{x}{r} = \frac{\sqrt{3}}{2} = \sin\theta \therefore \theta = 60^o$$

$$t_{oA} = \frac{T}{6} = \frac{\pi}{3B_o\alpha}$$

Therefore x – coordinate of particle at any time $t > \frac{\pi}{3B_o\alpha}$ will be

$$x = \frac{\sqrt{3}}{2}\frac{v_o}{B_o\alpha} + v_o\left(t-\frac{\pi}{3B_o\alpha}\right)\cos 60^o \text{ So } x = \frac{\sqrt{3}}{2}\frac{v_o}{B_o\alpha} + \frac{v_o}{2}\left(t-\frac{\pi}{3B_o\alpha}\right)$$

26. **A**

$$B = 2\left[\frac{\mu_o}{4\pi}.\frac{i}{d/\sqrt{2}}\right]\left(\sin 90^o - \sin 45^o\right)$$

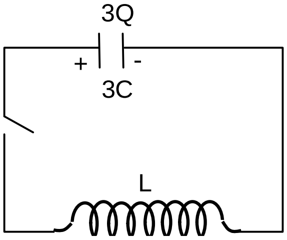
$$B = \frac{\mu_o i}{\sqrt{2}\pi d}\left(1-\frac{1}{\sqrt{2}}\right)\otimes$$

27. **B**

Polarity of emf will be opposite in the two cases while entering and while leaving the coil only in option (b) polarity is changing

28. **C**

The equivalent circuit is as shown in fig.



$$U_{L(max)} = U_{C(max)} = \frac{1}{2}\frac{(3Q)^2}{3C} = \frac{3Q^2}{2C}$$

29. **D**

A solid with completely filled valence band is an insulator, if the energy gap between the valence band and the empty conduction band is larger than about 5 eV

30. **D**

$$A = 2\pi Rh = 2(\pi)\left(6.4\times10^{6}\right)(150)\,m^{2}$$

$$= 1.96\pi\times10^{3}\,km^{2}$$

Chemistry

PART – II

SECTION – A

31. **D**

$$\text{Molarity} = \frac{d \times 1000}{Mw} = \frac{1.37 \times 1000}{68.5}$$

$$= \frac{125 \times 1000}{6250} = 20M$$

Note: In this question, % by wt should be given but it is missing therefore for calculation of molarity we consider 100% pure liquid.

32. **D**

$$HOCl \rightleftharpoons OH^{-} + Cl^{+}$$

$$C$$

$$C(1-\alpha) \quad C\alpha \quad C\alpha$$

$$K_a = \frac{C\alpha^2}{1-\alpha} = \frac{0.04 \times \alpha^2}{1-\alpha} \quad \begin{bmatrix} \text{As} & \alpha <<< 1 \\ \because & 1-\alpha \simeq 1 \end{bmatrix}$$

$$1.25 \times 10^{-4} = 0.04\alpha^2$$

$$\alpha^2 = \frac{1.25 \times 10^{-4}}{0.04} = \frac{125 \times 10^{-4}}{4}$$

$$\alpha = \frac{11}{2} \times 10^{-2} = \frac{0.11}{2} = 0.055$$

33. **A**

$$X \rightarrow 12 \times \frac{1}{6} + 3 + 2 \times \frac{1}{2} = 6$$

$$Y = 12 \times \frac{1}{4} = 3 \quad X_6Y_3 \Rightarrow X_2Y$$

34. **D**

A, B are explained by quantum mechanical model, C is explained by valence bond theory.

35. **C**

For a reaction $A \rightarrow P$

$$\ln \frac{k_2}{k_1} = \frac{E_A}{R}\left[\frac{1}{200} - \frac{1}{220}\right] = \ln 3$$

$$\ln \frac{k_2'}{k_1'} = \frac{E_B}{R}\left[\frac{1}{200} - \frac{1}{220}\right] = \ln 9$$

$$\frac{\ln 3}{\ln 3^2} = \frac{E_A}{E_B} \Rightarrow 2E_A = E_B$$

36. **A**

$$W_{\text{isoreversible}} = -2.303nRT\log\frac{V_2}{V_1}$$
$$= -2.303 \times 5 \times 8.314 \times 400 \times \log 2$$
$$= -2.303 \times 5 \times 8.314 \times 400 \times 0.3J$$
$$= -11488.28J$$

37. **C**

$$AgCl \rightleftharpoons \underset{s}{Ag^+(aq.)} + \underset{s}{Cl^-(aq.)}$$
$$K_{sp} = S^2 = 2.56 \times 10^{-10} = 256 \times 10^{-12}$$
$$S = 16 \times 10^{-6} = 1.6 \times 10^{-5} mol/L$$
$$1.6 \times 10^{-5} = \frac{0.01}{Vol(L)}$$
$$V = \frac{0.01}{1.6 \times 10^{-5}} = 625L$$

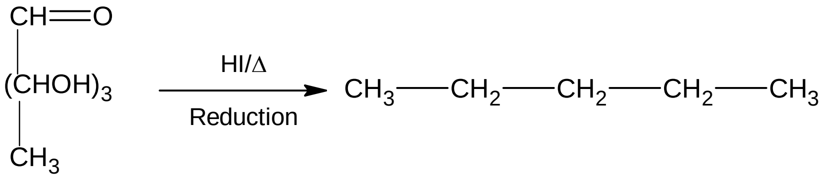
38. **D**

Aquaregia $\Rightarrow$ $HNO_3 + HCl[1:3]$

Pt + Aquaregia $\rightarrow$ $H_2[PtCl_6]$

Au + Aquaregia $\rightarrow$ $H[AuCl_4]$

39. **A**

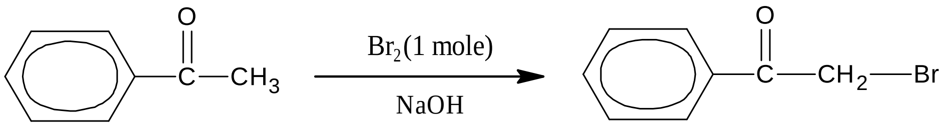


$$CH{=}O\text{–}(CHOH)_3\text{–}CH_3 \xrightarrow[\text{Reduction}]{HI/\Delta} CH_3{-}CH_2{-}CH_2{-}CH_2{-}CH_3$$

40. **A**

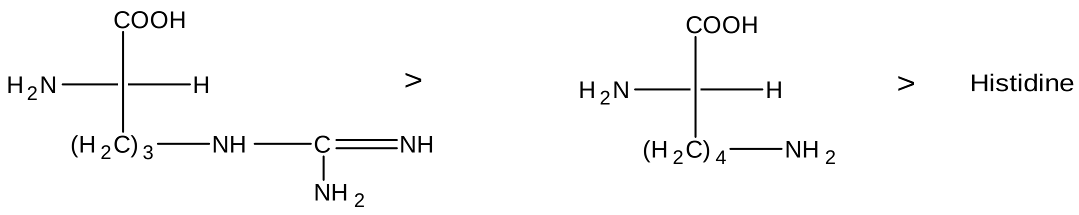
$Cu_2S \longrightarrow Cu_2O$

41. **B**



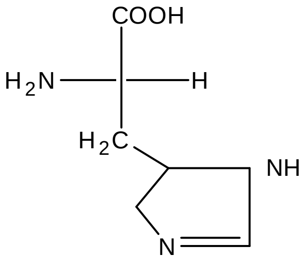
Halogenation reaction

42. **C**



Arginine

Lysine

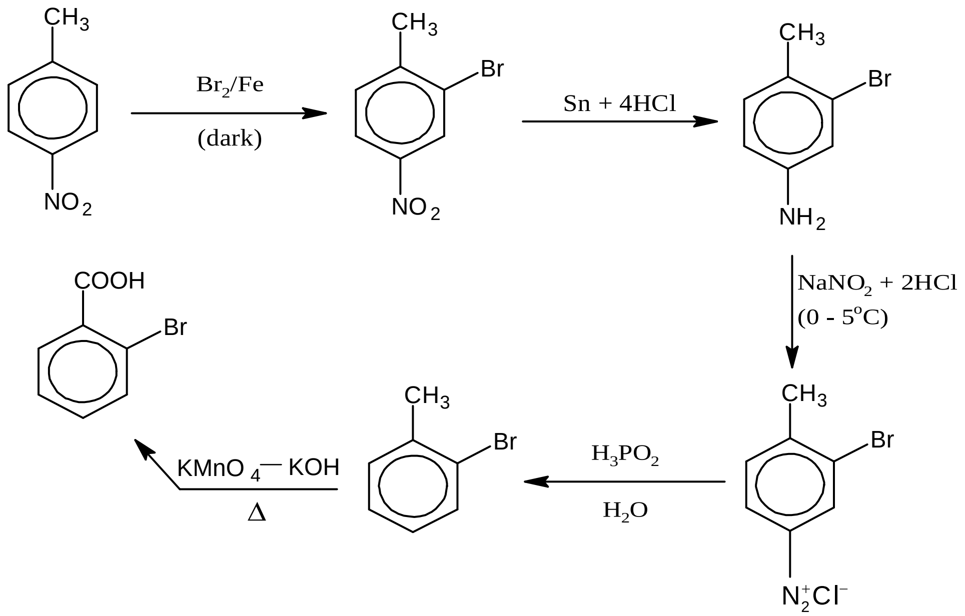


Histidine

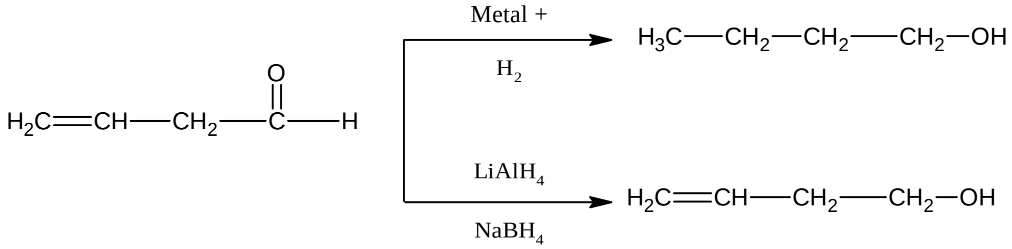
43. **A**

Nucleophilicity of S^- is more as it is weak base.

44. **B**


Br₂/Fe
(dark)
Sn + 4HCl
NaNO₂ + 2HCl
(0 - 5°C)
H₃PO₂
H₂O
KMnO₄ — KOH
Δ

45. **A**


Metal +
H₂
LiAlH₄
NaBH₄

46. **D**

$[M(H_2O)_2(NH_3)_2Cl_2)]$ - complex show optical isomerism

47. **A**

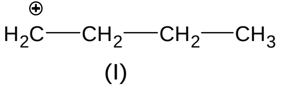
Not possible due to free rotation around C-C bond.

48. **A**

Electron withdrawing group increases acidic strength.

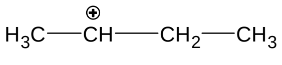
49. **B**

Reactivity towards $SN^1 \alpha$ stability of carbocation.



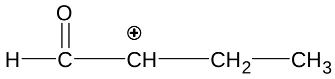
$\overset{\oplus}{H_2C}-CH_2-CH_2-CH_3$

(I)



$H_3C-\overset{\oplus}{CH}-CH_2-CH_3$

(II)

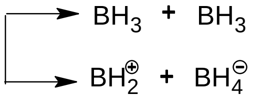


$H-\overset{O}{\overset{\|}{C}}-\overset{\oplus}{CH}-CH_2-CH_3$

(III)

50. **D**

B_2H_6 + Lewis base



$\longrightarrow BH_3 + BH_3$

$\longrightarrow BH_2^{\oplus} + BH_4^{\ominus}$

51. **B**

($FeSO_4$ is used)

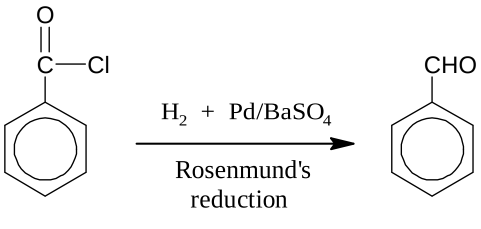
$Fe^{+2} + NO_3^- \longrightarrow F_e^{+3} + NO$

Brown ring complex $\left[Fe(H_2O)_5NO\right]^{+2}$

52. **D**

β-form has higher m.p. than α-form.

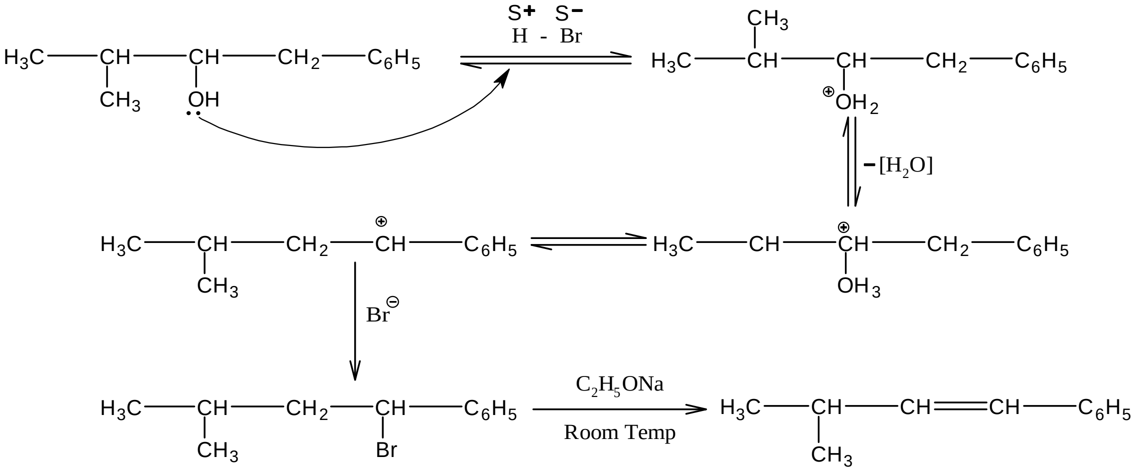
53. **A**



54. **D**

Fact.

55. **A**



56. **A**

$$\frac{r_{void}}{R} = 0.414$$

57. **B**

$$\log k = 14 - \frac{1.2\times10^4}{T}\text{.................(i)}$$

$$\log k = \log A - \frac{E_a}{2.303RT}$$

$$t_{1/2} = 6.93\times10^{-3}\text{ min}$$

$$k = \frac{0.693}{6.93\times10^{-3}} = 100$$

$$\log 100 = 14 - \frac{1.2\times10^4}{T}$$

$$\Rightarrow T = 1000K$$

58. **A**

$$A_2X_3 \rightleftharpoons \underset{2s}{2A^{+3}} + \underset{3s}{3X^{-2}}$$

$$K_{sp} = (2s)^2(3s)^3$$

K_{sp} = 108 S^5

$$S = \left(\frac{1.08\times10^{-23}}{108}\right)^{1/5} = 10^{-5}\text{mol/L}$$

59. **A**

Higher the value of z, difficult is to compress a gas.

60. **A**

$$XeF_6 \longrightarrow XeF_5^+ + F^-$$

Mathematics PART – III

SECTION – A

61. **C**

$(x-1)^3+8=0 \Rightarrow x-1=-2,-2\omega,-2\omega^2$

$\Rightarrow \alpha=-1,\ \beta=1-2\omega,\ \gamma=1-2\omega^2$

$\Rightarrow \sum\frac{\alpha-1}{\beta-1}=\frac{3}{\omega}$

62. **B**

$x^2-x(y+4)+y^2-4y+16=0$

$D\ge 0 \Rightarrow (y-4)^2\le 0 \Rightarrow y=4$

63. **C**

1, abc, $a^2b^2c^2$ also in A.P.

$\Rightarrow 2abc=1+a^2b^2c^2 \Rightarrow (abc-1)^2=0$

Now A.M. ≥ G.M., we get $27a+8b+125c\ge 90$

64. **A**

$f(x)$ is odd

So, $\int_{-2}^{2} f(x)\left[\frac{1}{x^2+1}\right]dx=0$

$\Rightarrow \int_{-2}^{3} f(x)\left[\frac{1}{x^2+1}\right]dx=\int_{2}^{3} f(x)\left[\frac{1}{x^2+1}\right]dx=0$

65. **D**

$\lim_{n\to\infty}\sum\frac{r^2}{n^3+r^3}=\int_0^1\frac{x^2}{1+x^3}dx=\frac{1}{3}\ln 2$

66. **B**

Number of words $=\frac{\underline{|5}}{\underline{|2}}-\frac{\underline{|4}}{\underline{|2}}=48$

67. **A**

$-y^2-y=1 \Rightarrow y^2+y+1=0 \Rightarrow y=\omega$

So, $\omega^{2018}+\frac{1}{\omega^{2018}}+1=\omega^2+\frac{1}{\omega^2}+1=0$

68. **B**

$A+B+C=\pi$

By expanding we get $\Delta=0$

69. **D**

$\int_0^3\frac{x^2}{1+|x|^3}\left(\frac{1+3^x}{3^x+1}\right)dx \Rightarrow \frac{1}{3}\ln 28$

70. **A**

$f(x+100) = f(x)$

So, required limit $= \frac{1}{3} + \frac{1}{3^2} + ...\infty = \frac{1}{2}$

71. **C**

$P(B \cap C) = \frac{3}{4} - \frac{1}{3} - \frac{1}{3} = \frac{9-8}{12} = \frac{1}{12}$

72. **A**

Using diagram it is equal to A'.

73. **C**

$R = \{(1, 3)(1, 5)(2, 3)(2, 5)(3, 5)(4, 5)\}$

$R^{-1} = \{(3, 1)(5, 1)(3, 2)(5, 2)(5, 3)(5, 4)\}$

Now, $ROR^{-1} = \{(3, 3)(3, 5)(5, 3)(5, 5)\}$

74. **A**

Let $S : (\sim p \text{ v} \sim q) \vee r$

$\Rightarrow S : (\sim F \vee \sim T) \vee F$

$\therefore S : (T \vee F) \vee F = T$

Hence, (A) is correct.

75. **A**

$M = \frac{\sum x}{n} = 6$

Now, $\sum (x-M)^2 = \sum x^2 - 2M\sum x + \sum M^2$

$\sigma = \frac{\sum (x-M)^2}{n} = \frac{640}{10} = 64 \Rightarrow \sigma = 8$

76. **C**

$$1 + \cot\theta - \cot\frac{\theta}{2} = \frac{-\left(\cot\frac{\theta}{2} - 1\right)^2}{2\cot\frac{\theta}{2}} \le 0$$

$\Rightarrow \cot\frac{\theta}{2} = 1 \Rightarrow \theta = \frac{\pi}{2}$

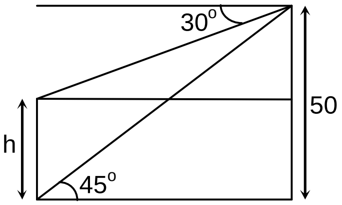
77. **B**

$a = \sqrt{b^2 + c^2 - 2bc\cos A} = 1$

$r = (s-a)\tan\frac{A}{2} = \frac{\sqrt{3}-1}{2}$

So, $\Delta = \pi r^2 = \pi\left(1 - \frac{\sqrt{3}}{2}\right)$

78. **D**



By using trigonometry, we get h = $50\left(1-\frac{\sqrt{3}}{3}\right)$ m

79. **B**

$$A^2 = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \Rightarrow \text{ A is nilpotent.}$$

80. **B**

Let the required plane $by + cz + d = 0$

Also, $-b + d = 0 \Rightarrow b = d$

81. **B**

Equation of tangent is $x + \sqrt{3}y = 4$

So, $\Delta = \frac{1}{2} \times 1.\frac{4}{\sqrt{3}} = \frac{2}{\sqrt{3}}$ sq. unit

82. **D**

$f'(1) = 0$ and $y(1) = 1 - \frac{\pi}{2}$

So, equation of tangent is $y = 1 - \frac{\pi}{2}$

83. **B**

It is symmetrical about x = 3.

84. **C**

Put $\tan\theta = t$

$\Rightarrow \int e^t\left(t^3 + 3t^2 + t + 1 - 1\right)dt = e^t\left(t^3 + t\right) - e^t + c$

85. **D**

$$x^4 dx + \frac{x^3}{y^3}\left(\frac{ydx - xdy}{y^2}\right) = 0 \Rightarrow \frac{x^5}{5} + \frac{(x/y)^4}{4} = c$$

86. **B**

$\left(y + \frac{2}{3}\right)^2 = 2\left(x - \frac{10}{9}\right)$

$Y^2 = 2X$

$X > 2a,\ Y = 0$

$x > \frac{19}{9},\ y = -\frac{2}{3}$

87. **B**

Let $\left(\sqrt{6}\cos\theta,\ \sqrt{3}\sin\theta\right)$ is point.

Then $\frac{x}{\sqrt{6}}\cos\theta+\frac{y}{\sqrt{3}}\sin\theta=1$ is parallel to x + y = 7

$\Rightarrow \frac{\cos\theta}{\sqrt{2}}=\frac{\sin\theta}{1}=\frac{1}{\sqrt{3}}$

Hence, $(a,\ b)\equiv(2,\ 1)$

88. **B**

$2\tan^{-1}\left(\frac{b}{a}\right)=\theta\Rightarrow\tan\frac{\theta}{2}=\frac{b}{a}$

So, $\cos\frac{\theta}{2}=\frac{a}{\sqrt{a^2+b^2}}=\frac{1}{e}$

89. **B**

$\left(\frac{z+\alpha\beta}{\alpha}\right)^3=1\Rightarrow z=\underset{A}{\alpha-\alpha\beta},\ \underset{B}{\alpha\omega-\alpha\beta},\ \underset{C}{\alpha\omega^2-\alpha\beta}$ are vertices.

Now, AB = BC = CA = $\sqrt{3}|\alpha|$

90. **C**

Number of subsets = ${}^{2n+1}C_1+{}^{2n+1}C_2+.......+{}^{2n+1}C_n$

$=\frac{2^{2n+1}}{2}-1=2^{2n}-1$

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

OPEN TEST

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 183**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into Two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01– 07, 19 – 25, 37 - 43)*** *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (08 – 13, 26 – 31, 44 - 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S).*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (14 – 18, 32 – 36, 50 - 54)*** *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10 \text{ m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3 \text{ kg/m}^3$
Atmospheric pressure	$P_a = 10^5 \text{ N/m}^2$
Gas constant	$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
		=	$0.0821 \text{ Lit atm K}^{-1} \text{ mol}^{-1}$
		=	$1.987 \approx 2 \text{ Cal K}^{-1} \text{ mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

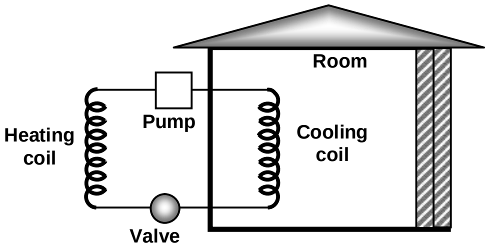
Physics PART – I

SECTION – A

(One or More than one correct type)

This section contains **SEVEN** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A room air conditioner is modelled as a heat engine run in reverse. An amount of heat Q_{in} is absorbed from the room at a temperature T_L by the cooling coils which contains a working gas; this gas is compressed adiabatically to a temperature T_H; then the gas is compressed isothermally in a coil outside of the house, giving off an amount of heat Q_{out}; the gas expands adiabatically back to a temperature T_L and the cycle is repeated. An amount of energy W is input into the system in every cycle through an electric pump. This model describes the air conditioner with the best possible efficiency.

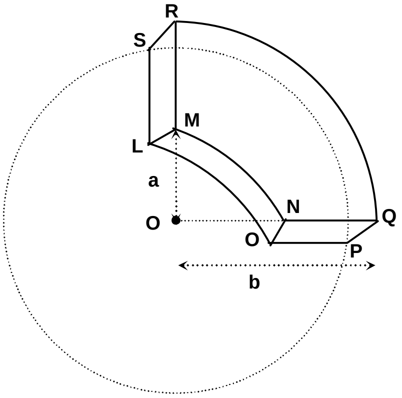


The outside air temperature is T_H and the inside air temperature is T_L. The air conditioner unit consumes electric power P. Assume that the air is dry sufficiently so that no condensation of water occurs in the cooling coils of the air conditioner. Which of the following may be the rate at which heat is removed from the room?

(A) $\frac{P}{2}\left(\frac{T_L}{T_H - T_L}\right)$ (B) $\frac{3P}{4}\left(\frac{T_L}{T_H - T_L}\right)$

(C) $P\left(\frac{T_L}{T_H - T_L}\right)$ (D) $\frac{3P}{2}\left(\frac{T_L}{T_H - T_L}\right)$

2. A conducting medium is shaped in a form of a quarter of an annulus of radii b and a (b > a) and thickness t. Specific resistance of the medium is ρ. The correct option(s) is/are



(A) Resistance between faces LMNO and PQRS is $\frac{2\rho}{\pi t}\ell n\frac{b}{a}$.

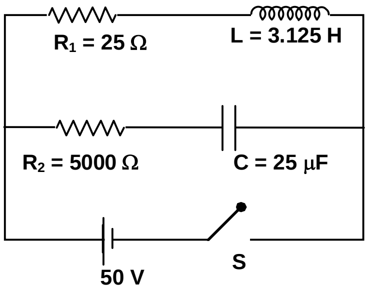
(B) Resistance between faces LMRS and ONQP is $\frac{\pi\rho}{2t\ell n\left(\frac{b}{a}\right)}$.

(C) Resistance between faces MRQN and LSPO is $\frac{4t\rho}{b^2 - a^2}$.

(D) Between faces LMNO & PQRS and LMRS & ONQP, resistance is same.

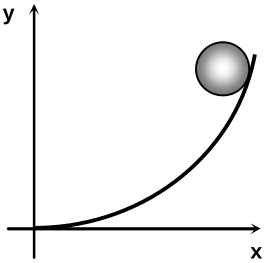
Space for Rough work

3. Two resistors, one inductor and a capacitor are connected in a circuit with a battery and switch as shown in figure. The charge on capacitor and current in inductor is zero at t = 0. Now switch is closed at t = 0, then choose the correct option(s).



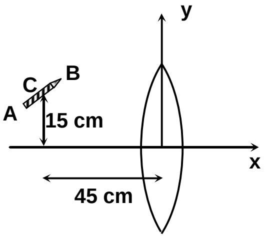
(A) The ratio of maximum current in the branch of inductor to the branch of capacitor is 200.
(B) At $t = \frac{\ell n2}{8}$, the current in the branch of capacitor is 200 times the current in the branch of inductor.
(C) At $t = \frac{1}{8}\ell n\left(\frac{5}{4}\right)$, the potential drop across inductor is 4 times the potential drop across capacitor.
(D) The potential drop across inductor is maximum at t = 0.

4. A small disc of mass m is released on a parabolic curve in a vertical plane such that gravity acts along negative y-axis. The equation of parabolic curve is $x^2 = \frac{2a}{\sqrt{3}}y$, where 'a' is a positive constant. Frictional force between disc and curve are sufficient for pure rolling. When disc is reached at x = a then choose the correct option(s).



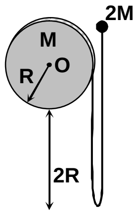
(A) acceleration of disc along the trajectory is $\sqrt{3}g$.
(B) acceleration of disc along the trajectory is $\frac{g}{\sqrt{3}}$.
(C) frictional force between disc and curve is $\frac{mg}{2\sqrt{3}}$.
(D) frictional force between disc and curve is $\frac{mg}{\sqrt{3}}$.

5. A $10\sqrt{2}$ cm long pencil is placed at an angle of 45° with optical axis. Its centre is 15 cm above the optics axis and 45.0 cm from a lens with 20.0 cm focal length as shown in the figure. Assume that the diameter of the lens is large enough for the paraxial approximation to be valid. For approximate position of image choose the correct option(s).



(A) The location of image of point A is (30 cm, –6.10 cm)
(B) The location of image of point B is (40.0 cm, –20.0 cm)
(C) The location of image of point C is (36.0 cm, –12.0 cm)
(D) The location of image of point A is (33.3 cm, –6.6 cm)

6. A light string is wrapped on a cylindrical shell and a fraction of length of string is unwrapped. A particle of mass 2M is attached on another end of string as shown. The system is kept in a vertical plane and cylinder can freely rotate about the axis of cylinder. Particle is released as shown in figure. Assuming thee is no slipping between cylinder and string. Choose the correct option(s).



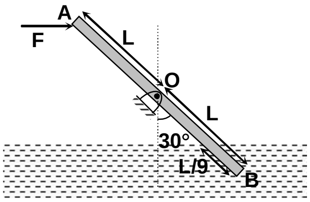
(A) The angular velocity of cylinder just after string taut is $\frac{8}{3}\sqrt{\frac{g}{R}}$.

(B) The angular velocity of cylinder just after string taut is $\frac{16}{3}\sqrt{\frac{g}{R}}$.

(C) Velocity of particle just after string taut is $\frac{8}{3}\sqrt{gR}$.

(D) Velocity of particle just after string taut is $\frac{16}{3}\sqrt{gR}$.

7. A rod of length 2L and cross section area A_0 is kept in a liquid of density ρ and pivoted at point O in a vertical plane. The rod makes angle 30° with the vertical. The mass density of rod is linearly increases from O on both side as given by equation $\lambda = \lambda_0\left(1+\frac{x}{L}\right)$, where λ_0 is constant. Rod is held in vertical plane by applying a force at end A in horizontal direction. Then



(A) Centre of mass of rod OA is at a distance $\frac{4L}{9}$ from point A.

(B) Mass of rod AB is $\frac{3\lambda_0 L}{2}$.

(C) Applied force at end A is $\frac{17}{162\sqrt{3}}LA_0\rho g$.

(D) Buoyant force will act at the centre of mass of rod inside the liquid.

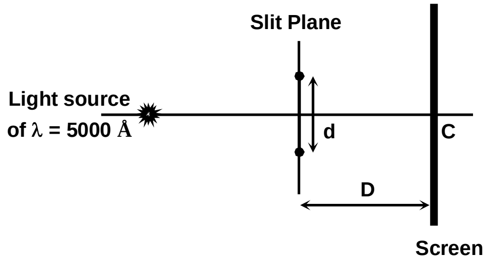
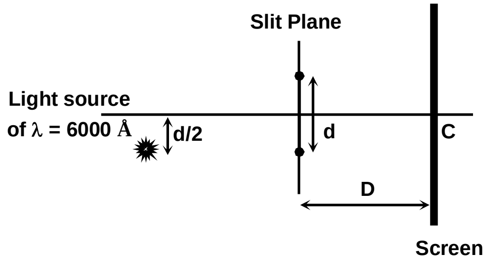
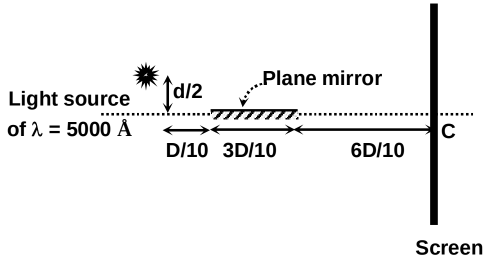
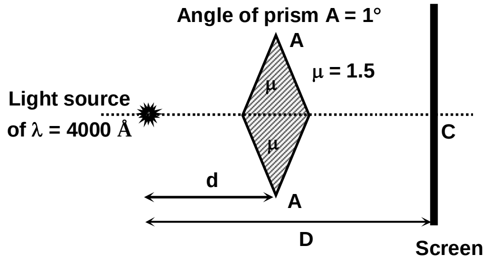
Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

Column 1 shows four different setups for observing interference on a screen for different values of D (in column 2) and d (in column 3). D and d are mention in the diagram.

Column 1 (Setup)		**Column 2 (D)**		**Column 3 (d)**	
(I)	 Slit Plane Light source of λ = 5000 Å d C D Screen	(i)	1/2 m	(P)	2mm
(II)	 Slit Plane Light source of λ = 6000 Å d/2 d C D Screen	(ii)	2 m	(Q)	1mm
(III)	 d/2 Plane mirror Light source of λ = 5000 Å D/10 3D/10 6D/10 C Screen	(iii)	3 m	(R)	4 mm
(IV)	 Angle of prism A = 1° A μ = 1.5 μ Light source of λ = 4000 Å μ C d A D Screen	(iv)	3/2 m	(S)	$\frac{9}{\pi}$ cm

Space for Rough work

8. For which of combination fringe width is maximum?

(A) (I) (iv) (S)
(B) (III) (i) (P)
(C) (II) (iii) (Q)
(D) (IV) (ii) (R)

9. For which of the combination $\frac{I_C}{I_{max}}$ is minimum, where I_C is the intensity at point C and I_{max} is the maximum intensity on the screen.

(A) (II) (iv) (P)
(B) (II) (i) (Q)
(C) (III) (ii) (R)
(D) (IV) (iii) (S)

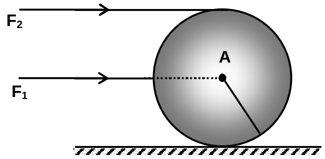
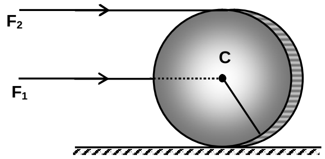
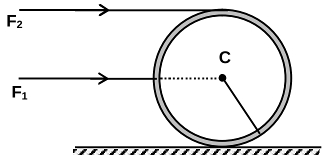
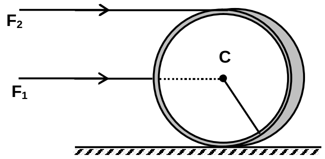
10. For which of the combination no. of fringes on the screen is minimum?

(A) (I) (iii) (P)
(B) (III)(i) (R)
(C) (II) (ii) (R)
(D) (IV) (iii) (S)

Space for Rough work

Answer questions 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

A sphere, a cylinder, a spherical shell and a cylindrical shell are kept on a horizontal surface. Two forces F_1 and F_2 are acting on each object F_1 passes through centre of mass F_2 acts on the top most point. All objects starts from rest on a smooth horizontal surface.

Column 1		**Column 2**		**Column 3**	
(I)	 Uniform solid sphere of mass m, radius R	(i)	$F_1 = F_2 = F$	(P)	Object will roll with out sliding
(II)	 Uniform solid cylinder of mass m, radius R	(ii)	$F_2 = 2F_1 = 2F$	(Q)	Object will roll on the horizontal surface with $a_{cm} < R\alpha$
(III)	 Uniform thin spherical shell of mass m, radius R	(iii)	$F_1 = 0, F_2 = F$	(R)	Object will roll on the horizontal surface with $2R\alpha > a_{cm} > R\alpha$
(IV)	 Uniform thin cylindrical shell of mass m, radius R	(iv)	$F_1 = \frac{3F_2}{2} = \frac{3F}{2}$	(S)	Object will roll on the horizontal surface with $a_{cm} \geq 2R\alpha$

11. Mark the correct statement.
(A) (I) (i) (P)
(B) (II)(ii) (Q)
(C) (III) (ii) (R)
(D) (IV) (iii) (S)

12. Mark the incorrect statement.
(A) (I) (ii) (Q)
(B) (II)(i) (P)
(C) (III) (iv) (R)
(D) (IV) (iii) (S)

13. From the given combination the kinetic energy for time t will be maximum.
(A) (I) (ii) (Q)
(B) (II)(iv) (R)
(C) (III) (iii) (P)
(D) (IV) (i) (S)

Space for Rough work

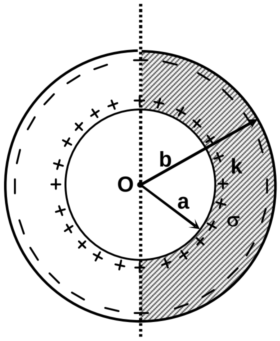
SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

14. A particle having specific charge σ is projected in xy plane with a speed v. There exists a uniform magnetic field in z-direction having a fixed magnitude B_0. The field is made to reverse its direction after every interval of $\frac{2\pi}{\sigma B_0}$. Calculate the maximum separation (in m) between two positions of the particle during its course of motion. (given $\frac{v}{\sigma B_0} = 2$ metre) (neglect any other force including gravity throughout the motion)

15. The half lives of two longest lived radioactive isotopes of phosphorus P^{32} and P^{33} are 14 days and 28 days respectively. A sample has been prepared by mixing the two isotopes in the ratio of 4 : 1 of their atoms. Initial activity of the mixed sample is 90 m curie. Find the activity (in m curie) of the sample after 80 days. (Approximately to nearest integer) Take $\ell n2 = 0.7$ and $e^{-2} = 0.14$

16. Half portion of a spherical capacitor is filled with a dielectric of dielectric constant k = 2 conductivity σ. The charge given to spherical capacitor is Q_0. Due to the conductivity of dielectric charge leaks the time constant for the discharge circuit is x time of $\frac{\varepsilon_0}{\sigma}$. Find the value of x.



17. Eight identical droplets of water were falling in air with constant velocity 2 cm/s. The initial acceleration of each droplet was ‘a_1’ at the time when they starts falling. At a time ‘t’ these droplets coalesce to form a big drop due to pressure difference developed, and just after the formation of combined drop its acceleration is found ‘a_2’. The ratio of $\frac{6a_1}{a_2}$ is

18. A pipe 20 cm long is closed at one end which harmonic mode of the pipe is resonantly exited by a source of 1237.5 Hz. Sound velocity in air 330 m/s.

Space for Rough work

Chemistry PART – II

SECTION – A

(One or More than one correct type)

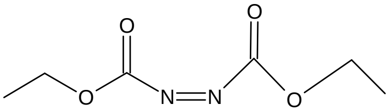
This section contains **SEVEN** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Choose the correct statements:
(A) temperature, enthalpy and entropy are state functions
(B) for reversible and irreversible both isothermal expansion of an ideal gas, change in internal energy is zero
(C) for a reaction in which $\Delta n_g = 0$, entropy change is not always zero
(D) the entropy change associated with reversible isothermal expansion of an ideal gas is equal to $2.303 \text{ R} \log_{10} \frac{P_1}{P_2}$

20. Carefully study the following 2 cases and choose the correct statements followed?
Case # I. All H atoms in ethene are substituted differently without significantly distorting the original geometry.
Case # II. All H atoms in ethane are substituted differently without significantly distorting the original geometry.
Choose the correct statement(s) from the following:

(A) Diastereomers will be produced only in Case I, not in Case II.
(B) Enantiomers will be produced only in Case II, not in Case I.
(C) Mixing equal weights of one dextro and one laevo molecule under Case II will necessarily yield an optically inactive mixture.
(D) Total number of space isomers possible under both cases = 86.

21. DEAD is an organic molecule standing for **D**i **E**thyl **A**zo **D**icarboxylate having the following structure:



Which of the following gas(es) will be evolved when DEAD is strongly heated with excess conc. H_2SO_4
(A) N_2
(B) C_2H_4
(C) CO
(D) CO_2

22. Inorganic benzene surpasses organic benzene in which property:
(A) melting point
(B) edge length of its hexagon
(C) molar mass
(D) total number of electrons in the molecule

Space for Rough work

23. If equatorial plane in PCl_5 molecule is the X—Y plane, the orbitals hybridizing to produce axial bonds will be:

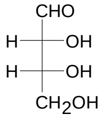
(A) p_z
(B) d_{yz}
(C) p_y
(D) d_{z^2}

24. Which of the following changes can be experimentally realized in the laboratory:

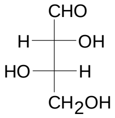
(A) combustion of Mg ribbon in CO_2
(B) reduction of $FeCl_3$ (aq.) on adding Zn granules
(C) dry heating of hydrated $MgCl_2$ to get anhydrous $MgCl_2$
(D) evolution of brown gas on heating $LiNO_3$

25. An optically active aldotetrose which retains its optical activity with aqueous Br_2 but loses it with conc. HNO_3 has the following structure:

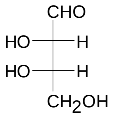
(A)



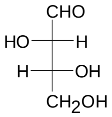
(B)



(C)



(D)



Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer Q. 26, Q. 27 and Q. 28 by appropriately matching the information given in the three columns of the following table.

Column 1 (Polymer)		**Column 2 (Monomer)**		**Column 3**	
(I)	Polystyrene	(i)	Caprolactum	(P)	Resonance stabilization
(II)	Poly Vinyl Chloride	(ii)	$PhCH = CH_2$	(Q)	1, 4 addition of HBr (mainly) at 40^oC
(III)	Natural rubber	(iii)	$CH_2 = CHCl$	(R)	1, 2 addtion of HBr at room temp. (mainly and as per traditional Markonikoff's rule)
(IV)	Nylon-6	(iv)	$CH_2 = C(CH_3) – CH = CH_2$	(S)	$CO_2(g)$ evolution with $KMnO_4/H^+$.

26. Which of the following combination is CORRECT?
(A) (III) (ii) (R)
(B) (II)(i) (P)
(C) (IV) (i) (P)
(D) (I) (iii) (S)

27. Which of the following combination is INCORRECT?
(A) (I) (ii) (P)
(B) (I)(ii) (R)
(C) (III) (iv) (P)
(D) (II) (iv) (R)

28. Which of the following combination is CORRECT?
(A) (II) (ii) (P)
(B) (II)(iii) (R)
(C) (III) (iii) (P)
(D) (IV) (ii) (P)

Space for Rough work

Answer Q. 29, Q. 30 and Q. 31 by appropriately matching the information given in the three columns of the following table.

Column 1		**Column 2**		**Column 3**	
(I)	Peptization	(i)	Colloid preparation technique	(P)	Sky is blue
(II)	Delta formation	(ii)	Colloid destabilization	(Q)	Gold number
(III)	Tyndall effect	(iii)	Colloid stabilization	(R)	Coagulation
(IV)	Protection power of colloids	(iv)	Optical property of colloid	(S)	Adsorption of common ion

29. Which of the following combination is CORRECT?
(A) (I) (i) (S)
(B) (II)(i) (R)
(C) (III) (ii) (S)
(D) (I) (ii) (S)

30. Which of the following combination is CORRECT?
(A) (II) (i) (S)
(B) (II)(ii) (R)
(C) (III) (ii) (S)
(D) (IV) (iii) (R)

31. Which of the following combination is INCORRECT?
(A) (III) (iv) (P)
(B) (II) (ii) (R)
(C) (IV) (i) (P)
(D) (I) (ii) (Q)

Space for Rough work

SECTION – C
(Single digit integer type)

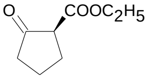
This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

32. Ammonium carbamate is heated at 227°C in a closed vessel of volume 8210 ml containing 0.2 mole of Argon gas. The manometer attached to the vessel shows a pressure of 1 atm. Find K_p for the decomposition of ammonium carbamate.

$$NH_2COONH_4(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$$

33. How many gases/vapours are involved either as reactants or products in Serpeck's process used for concentration of bauxite.

34.



When the above molecule is reduced with excess $LiAlH_4$ followed by dilute acid hydrolysis, how many organic products can be isolated by fractional distillation of product mixture.

35. The pH at which a 0.1 M Al^{+3} solution is 99.99% precipitated is : (K_{sp} $Al(OH)_3 = 1 \times 10^{-18}$ at 25°C)

36. 0.05 Faraday charge is passed in 100 ml, 0.1 M NaCl solution. Calculate the final pOH of the solution. Assume volume remains constant.

Space for Rough work

Mathematics PART – III

SECTION – A

(One or More than one correct type)

This section contains **SEVEN** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. Let $P = \sum_{n=1}^{10} n\left\{\frac{1^2}{1+n} + \frac{2^2}{2+n} + ... + \frac{10^2}{10+n}\right\}$ then which of the following is/are correct?

(A) 2P is perfect square
(B) 2P is divisible by 11^2
(C) Number of divisors of 2P is 9
(D) The remainder when 2P is divided by 6 is 1

38. Define a function $f(x) = \begin{cases} \sin x, \text{ if } x \text{ is irrational} \\ \tan x, \text{ if } x \text{ is rational} \end{cases}$. Then f(x) is

(A) not continuous at any point in the interval $(-\pi, \pi)$
(B) continuous at some point(s) , but not differentiable at any point in the interval $(-\pi, \pi)$
(C) continuous at some point(s) in the interval $(-\pi, \pi)$, but not differentiable at some of these point(s)
(D) continuous at some point(s) in the interval $(-\pi, \pi)$ and differentiable at all these point(s)

39. Let $A = \begin{bmatrix} 1 & 2 \\ -a^2 & a+2 \end{bmatrix}$ and B, C are 2 ×2 matrices such that $ABC = \begin{bmatrix} 4 & 2 \\ 1 & 3 \end{bmatrix}$. Let $(BC)^T = [p_{ij}]_{2\times2}$ and $p_{21} = -1$, then the value of a can be

(A) 0
(B) $-\frac{3}{2}$
(C) $\frac{1}{2}$
(D) $-\frac{1}{2}$

Space for rough work

40. A ray of light coming along the line y = x + 1 from positive x-direction strikes a concave mirror whose intersection with xy-plane is the parabola $(y - x)^2 = 16(x + y)$. Then which of the following is/are correct statement(s)

(A) reflected ray passes through (2, 2)
(B) slope of reflected ray is $\frac{47}{79}$
(C) reflected ray passes through (1, 1)
(D) slope of normal at point of contact is $\frac{7}{9}$

41. Let $L_1 : x + y = 1, z + 2y = 2$ and $L_2 : x - y = 1, z - 2y = 2$ be two straight lines, then which of the following is/are correct statement(s)?

(A) the lines L_1 and L_2 are coplanar
(B) the lines L_1 and L_2 are non-coplanar
(C) on the line $\vec{r} = 4\hat{j} + \lambda(\hat{i} + 2\hat{k})$, $\lambda \in R$, there exist infinite number of points such that an infinite number of lines passing through each of these points and intersecting both the lines L_1 and L_2 can be drawn
(D) there exists a unique line passing through the point $A(1, \mu, 3)$ which intersect both lines L_1 and L_2 $\forall \mu \in R$.

42. Let $I = \int_1^2 \frac{e^x + e^{4/x}}{x} dx$, then which of the following is/are correct statement(s)?

(A) $2I = \int_1^4 \frac{e^x + e^{4/x}}{x} dx$
(B) $4I = \int_1^4 \frac{e^x + e^{4/x}}{x} dx$
(C) $I > (e^2 - e)$
(D) $I < (e^2 - e)$

43. Let $S_n = \sum_{r=1}^{n} \cot^{-1}\left(\frac{9 + r(r-1)}{3}\right)$, then which of the following is/are correct statement(s)?

(A) $S_n = \sin^{-1}\left(\frac{3}{\sqrt{n^2 - 9}}\right)$
(B) $S_n = \sin^{-1}\left(\frac{n}{\sqrt{n^2 + 9}}\right)$
(C) $S_n > \frac{n}{3}$
(D) $S_n < \frac{n}{3}$

Space for rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer Q.44, Q.45 and Q.46 by appropriately matching the information given in the three columns of the following table.

Let f(x) = $\frac{(x-a)(x-b)}{(x-c)(x-d)}$ where a < b < c < d. Column-1: contains information about real roots of the equation; Column-2: contains information about limit of f(x); Column-3: contains information about increasing interval and decreasing interval of f(x) and f′(x) and information about local minimum value and local maximum value of f(x)

Column–1	Column–2	Column–3
(I) f(x) = 1 has exactly one real root	(i) $\lim_{x\to c^-} f(x) = -\infty$	(P) f(x) is increasing in the interval (b, c)
(II) f(x) = 2 has exactly two real roots	(ii) $\lim_{x\to d^+} f(x) = \infty$	(Q) f(x) is decreasing in the interval (d, ∞)
(III) f(x) = –10 has one real root	(iii) $\lim_{x\to d^-} f(x) = -\infty$	(R) f′(x) is increasing in the interval (b, c)
(IV) f(x) = 10 has two real roots	(iv) $\lim_{x\to \infty} f(x) = 1$	(S) local minimum value of f(x) is smaller than local maximum value of f(x)

44. Which of the following is the only **CORRECT** combination?
(A) (I) (ii) (S)
(B) (II) (iii) (Q)
(C) (I) (i) (R)
(D) (III) (iv) (S)

45. Which of the following is the only **INCORRECT** combination?
(A) (II) (ii) (P)
(B) (III) (i) (R)
(C) (IV) (iv) (P)
(D) (I) (iii) (Q)

46. Which of the following is the only **CORRECT** combination?
(A) (III) (iv) (P)
(B) (I) (ii) (R)
(C) (IV) (i) (S)
(D) (II) (iv) (S)

Space for rough work

Answer Q.47, Q.48 and Q.49 by appropriately matching the information given in the three columns of the following table.

Let f(x) be a double differentiable function with continuous second derivative defined on the interval [0, 1] satisfying the equation $\int_0^x \sqrt{1-\left(f''(t)\right)^2}\,dt = \int_0^x f'(t)\,dt$ $\forall$ x $\in$ [0, 1] and f(0) = f′(0) = 0. Column-1: contains the information about interval of value of f(x); Column-2: contains information about value of f(x) ; Column-3: contains information about interval of value of definite integral of f(x); Match the following Column(s)

Column–1	Column–2	Column–3
(I) $f\left(\frac{1}{2}\right) < \frac{1}{8}$	(i) $f\left(\frac{1}{3}\right) = \frac{1}{18}$	(P) $\int_0^1 f(x)\,dx > 1$
(II) $f\left(\frac{1}{2}\right) > \frac{1}{8}$	(ii) $f\left(\frac{1}{4}\right) = \frac{1}{8}$	(Q) $\int_0^1 f(x)\,dx > \frac{1}{6}$
(III) $f\left(\frac{1}{3}\right) < \frac{1}{18}$	(iii) $f\left(\frac{1}{6}\right) = 2\sin^2\left(\frac{1}{12}\right)$	(R) $\int_0^1 f(x)\,dx < \frac{1}{6}$
(IV) $f\left(\frac{1}{4}\right) < \frac{1}{4}$	(iv) $f\left(\frac{1}{8}\right) = -2\sin^2\left(\frac{1}{16}\right)$	(S) $\int_0^1 f(x)\,dx < \frac{1}{4}$

47. Which of the following is the only **CORRECT** combination?
(A) (I) (ii) (Q) (B) (II) (i) (S)
(C) (IV) (ii) (Q) (D) (III) (iii) (R)

48. Which of the following is the only **CORRECT** combination?
(A) (I) (iv) (Q) (B) (II) (iii) (S)
(C) (II) (iv) (P) (D) (IV) (iii) (S)

49. Which of the following is the only **CORRECT** combination?
(A) (III) (ii) (Q) (B) (IV) (ii) (P)
(C) (I) (iii) (R) (D) (III) (ii) (S)

Space for rough work

SECTION – C

(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

50. The number of x in $(0, 2\pi)$ satisfying the equation $1 + \sin 2x = \sin x + \sin^2 x$ is _____

51. If z_1, z_2 are complex numbers, then the maximum value of $\frac{z_1\bar{z}_2 + \bar{z}_1 z_2 + z_1 z_2 + \bar{z}_1\bar{z}_2}{|z_1 z_2|}$ is equal to _____

52. Let PQ be a focal chord of $\frac{x^2}{9} + \frac{y^2}{4} = 1$ passing through one focus S and S′ be its other focus, then the value of semi-perimeter of $\Delta S'PQ$ is _____

53. Let $f(x) = ax^2 + bx + c$, where $a \neq 0$, a, b, c are integers and $f(1) = 1$, $6 < f(3) < 8$ and $18 < f(5) < 22$. Then the number of solutions of equation $f(x) = e^x$ is _____

54. Let $L = \lim\limits_{x \to \infty}\left(\left(\frac{x+1}{x-1}\right)^x - e^2\right)x^2$, then the value of $\frac{9L}{2e^2}$ is equal to _____

Space for rough work

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PAPER-1

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	A, B, C	19.	A, B, C, D	37.	A, B, C, D
2.	A, B	20.	B	38.	D
3.	A, C, D	21.	A, B, C, D	39.	A, B
4.	B, C	22.	B, C	40.	A, B, D
5.	B, C, D	23.	A, D	41.	A, C, D
6.	A, C	24.	A, B, D	42.	A, C
7.	A, C	25.	A, C	43.	B, D
8.	D	26.	C	44.	B
9.	C	27.	D	45.	B
10.	D	28.	B	46.	B
11.	B	29.	A	47.	D
12.	D	30.	B	48.	D
13.	A	31.	D	49.	C
14.	8	32.	0	50.	2
15.	3	33.	5	51.	4
16.	3	34.	3	52.	6
17.	8	35.	9.	53.	1
18.	3	36.	1	54.	3

Physics

PART – I

SECTION – A

1. $\frac{Q_{out}}{Q_{in}} = \frac{T_{out}}{T_{in}}$ and $Q_{out} = Q_{in} + W$

$$\Rightarrow Q_{in} = W\left(\frac{T_L}{T_H - T_L}\right)$$

$$\frac{Q_{in}}{t} = P\left(\frac{T_L}{T_H - T_L}\right)$$

2. Between faces LMNO and PQRS

$$dR = \frac{\rho dr}{t\frac{\pi}{2}r}$$

$$R = \frac{2\rho}{t\pi}\ell n\frac{b}{a}$$

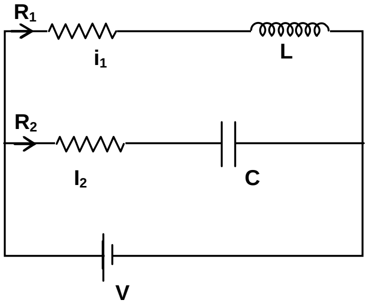
Between faces LMRS and ONQP for an element at distance r from O.

$$dR = \frac{\rho\frac{\pi}{2}r}{tdr}$$

So, $\frac{1}{R} = \int\frac{1}{dR} = \int_a^b\frac{tdr}{\rho\frac{\pi}{2}r} = \frac{2t}{\rho\pi}\ell n\left(\frac{b}{a}\right)$

$$R = \frac{\rho\pi}{2t\ell n\left(\frac{b}{a}\right)}$$

3. $(i_1)_0 = \frac{50}{25} = 2$ amp



$(i_2)_0 = \frac{50}{5000} = 0.01$amp

$\tau_1 = 0.125$ sec

$\tau_2 = 0.125$ sec

$i_1 = 200\ i_2$

$$2\left(1-e^{\frac{-t}{0.125}}\right) = \left(0.01\,e^{\frac{-t}{0.125}}\right)200$$

$$t = \frac{\ell n2}{8}$$

$$4\left(\frac{q}{C}\right) = L\frac{di_1}{dt}$$

$$4\times50\left(1-e^{\frac{t}{0.125}}\right) = 50e^{-\frac{t}{0.125}}$$

$$t = \frac{1}{8}\ell n\left(\frac{5}{4}\right)$$

4. $x^2 = \frac{2a}{\sqrt{3}}y$

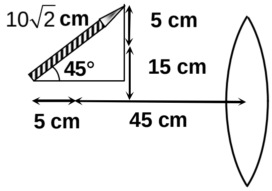
$2x = \frac{2}{\sqrt{3}}a\frac{dy}{dx}$

$\tan\theta = \sqrt{3}\frac{x}{a}$

$\theta = 60°$

$a = \frac{g\sin\theta}{1+\frac{I_{cm}}{mR^2}} = \frac{g}{\sqrt{3}}$

$f = \frac{mg\sin\theta}{1+\frac{mR^2}{I_{cm}}} = \frac{mg}{2\sqrt{3}}$



5. Length of pencil is $10\sqrt{2}$ cm.

Position of (A) [–(45+5), (15 – 5) ⇒ (–50, 10)

$\frac{1}{v} - \frac{1}{(-50)} = \frac{1}{20}$

v = 33.3 cm

magnification $\frac{h_i}{h_0} = \frac{-v}{u} \Rightarrow h_i = -h_0\frac{v}{u} = 10\frac{100/3}{50} = 6.6$ cm

Position of B (40 cm, 20 cm)

$\frac{1}{v} - \frac{1}{-40} = \frac{1}{20} \Rightarrow v = 40$ cm

magnification $h_i = 20 \times \frac{40}{40} = 20$ cm

Position of C (36 cm, 12 cm)

$\frac{1}{v} = \frac{1}{20} - \frac{1}{45} \Rightarrow v = 36$ cm

Magnification $h_i = 15\frac{36}{45} = 12$ cm

6. $v_0 = 4\sqrt{gR}$

$\vec{J} = \Delta\vec{P}$

$-\int Tdt = 2M\left(v - 4\sqrt{gR}\right)$

$-\int Tdt = 2M\left(R\omega - 4\sqrt{gR}\right)$ …(i)

$\left(\int Tdt\right)R = MR^2\omega$ …(ii)

From (i) and (ii)

$\omega = \frac{8}{3}\sqrt{\frac{g}{R}}$ and $v = \frac{8}{3}\sqrt{gR}$

7. $$x_{cm}=\frac{\int x\,dm}{\int dm}=\frac{\int_0^L x\lambda_0\left(1+\frac{x}{L}\right)}{\int_0^L \lambda_0\left(1+\frac{x}{L}\right)}=\frac{5L}{9}$$

$$m=\int dm=\frac{3\lambda_0 L}{2}$$

$$\left[\left(A\cdot\frac{L}{9}\right)\rho g\right]\frac{17}{10}L\sin\theta=F\cdot L\cos\theta$$

8-10. (1) For $\beta=\frac{D\lambda}{d}$ to be maximum, Dλ should be maxium and d should be minimum.

(2) In the Lloyd's experiment, there would not be any interference at point C.

(3) In option (A) and (C) no. Of fringes is much larger because the interference peattern is spread at the whole screen

In option (B) no. of fringes = $\frac{\text{Fringe pattern width}}{\text{Fringe width}}$

$$=\frac{\frac{d}{2}\left(9-\frac{3}{2}\right)d}{D\lambda}=\frac{15}{4}\frac{d^2}{D\lambda}=240$$

In option (D) no. Of fringes = $\frac{\text{Fringe pattern width}}{\text{Fringe width}}$

$$=\frac{2(\mu-1)A(D-d)}{\dfrac{D\lambda}{2(\mu-1)Ad}}\approx\frac{4(\mu-1)^2A^2d}{\lambda}=22$$

11-13. $\frac{1}{2}ma_{cm}^2t^2+\frac{1}{2}I_{I_{cm}}\alpha^2t^2$

In each configuration kinetic energy of solid sphere will be maximum.

When F_{net} = 3F the kinetic energy of sphere will be maximum.

$=\frac{14F^2}{m}t$

When $F_1 = F_2 = F$

$a_{cm}=\frac{2F}{m},\ R\alpha=\frac{FR^2}{I_{cm}}$

When $F_2 = 2F_1 = 2F$

$a_{cm}=\frac{3F}{m},\ R\alpha=\frac{2FR^2}{I_{cm}}$

When $F_1 = 0$ and $F_2 = F$

$a_{cm}=\frac{F}{m},\ R\alpha=\frac{FR^2}{I_{cm}}$

When $F_1=\frac{3F_2}{2}=\frac{3F}{2}$

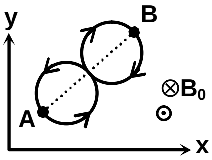
$a_{cm}=\frac{5F}{2m},\ R\alpha=\frac{FR^2}{I_{cm}}$

Rα

sphere	**cylinder**	**Spherical shell**	**Cylindrical shell**
$\frac{5F}{2m}$	$\frac{2F}{m}$	$\frac{3F}{2m}$	$\frac{F}{m}$
$\frac{5F}{m}$	$\frac{4F}{m}$	$\frac{3F}{m}$	$\frac{2F}{m}$
$\frac{5F}{2m}$	$\frac{2F}{m}$	$\frac{3F}{2m}$	$\frac{F}{m}$
$\frac{5F}{2m}$	$\frac{2F}{m}$	$\frac{3F}{2m}$	$\frac{2F}{m}$

SECTION – C

14. $AB = \frac{4mv}{qB_0} = 8$ metre



15. $\frac{\lambda_1}{\lambda_2} = \frac{\ell n2}{14\text{ days}} \frac{28\text{ days}}{\ell n2} = 2$

$\frac{A_{10}}{A_{20}} = \frac{\lambda_1 N_{10}}{\lambda_2 N_{20}} = 2 \times 4 = 8$

$\therefore\ A_{10} = 80$ m curie and $A_{20} = 10$ m curie

$A = 80e^{-\frac{\ell n2}{14}\times 80} + 10e^{-\frac{\ell n2}{28}\times 80}$

$= 80\ e^{-4} + 10\ e^{-2} = 3$ m curie

16. $C = \frac{2\pi ab\varepsilon_0(k+1)}{(b-a)}$

$R = \frac{1}{\sigma}\frac{(b-a)}{\pi ab}$

$RC = \frac{2\pi ab\varepsilon_0(k+1)}{(b-a)}\frac{(b-a)}{2\pi ab}$

$Q = Q_0 e^{-\frac{\pm\Sigma}{\varepsilon_0(k+1)}}$

17. $m_1a_1 = 6\pi\eta r_1v_1$

$m_2a_2 = 6\pi\eta r_2(v_2 - v_1)$

$\frac{a_1}{a_2} = \frac{r_1v_1m_2}{r_2(v_2 - v_1)m_1} = \frac{4}{3}$

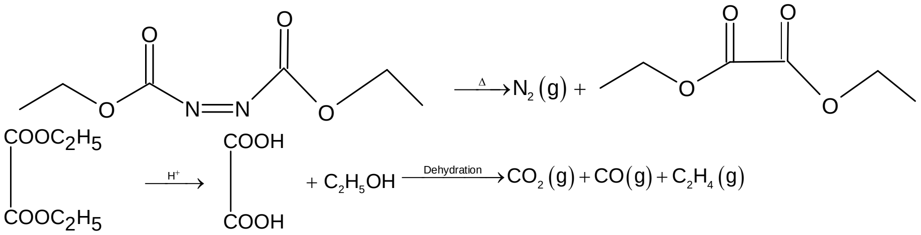
18. $\frac{v}{4\ell} = 412.5$ (3rd harmonic)

Chemistry PART – II

SECTION – A

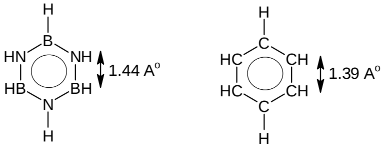
20. 6 geometrical isomers (Case I) + 40 optical isomers (Case II) = 46 space isomers.

21.



$$\underset{COOC_2H_5}{\overset{COOC_2H_5}{|}} \xrightarrow{H^+} \underset{COOH}{\overset{COOH}{|}} + C_2H_5OH \xrightarrow{\text{Dehydration}} CO_2(g) + CO(g) + C_2H_4(g)$$

22. Organic benzene being a more symmetrical molecule has higher melting point (6^oC) than inorganic benzene (melting point = -58^oC)



24. $MgCl_2.6H_2O \xrightarrow{\text{strong heating}} MgO(MgCl_2 \text{ reacts with water of crystallisation})$

$2Mg + \underset{(Dryice)}{CO_2} \xrightarrow{\text{Combustion}} 2MgO + C$

$LiNO_3 \xrightarrow{\Delta} Li_2O + NO_2$

Solution for the Q. No. 29 to 31.

Peptisation: Phenomenon in which a precipitate is passed into colloidal form by adsorption of common ions on its surface.

Delta formation: When river water (sol) meets sea water (electrolyte) coagulation occurs and delta is formed.

Tyndall effect: Scattering of light rays by suspended particles in a colloid is called Tyndall effect and sky looks blue due Tyndall effect.

Protection of colloids: Protective power of colloids is inversely related to Gold number.

SECTION – C

32. PV = nRT
1 × 8.21 = n × 0.0821 × 500
n = 0.2 = mole of Argon
This implies that no decomposition of $NH_2COONH_4(s)$ has taken place at 227^oC.
$\therefore K_p = 0$

33. $\underset{(impure)}{Al_2O_3} + N_2(g)\uparrow + 3C \longrightarrow AlN + 3CO(g)\uparrow$

$\underset{(impurity)}{SiO_2} + 2C \longrightarrow Si(v)\uparrow + 2CO(g)\uparrow$

$AlN + 3H_2O \longrightarrow Al(OH)_3 + NH_3(g)\uparrow$

$2Al(OH)_3 \xrightarrow{\Delta} \underset{(Pure)}{Al_2O_3} + 3H_2O(v)\uparrow$

35. $[Al^{+3}]\,[OH^-]^3 = 1 \times 10^{-18}$
$10^{-3}\,[OH^-]^3 = 1 \times 10^{-18}$
$[OH^-] = 10^{-5}$
pOH = 5
pH = 9

36. In given 100 ml 0.1 M NaCl solution,

No. of moles of $\overset{-}{Cl}$ present = $\frac{100}{1000} \times 0.1 = 0.01$

And 1 Faraday of charge can oxidize 1 mole of $\overset{-}{Cl}$ $\left(\because 2C\overset{-}{l} \longrightarrow Cl_2 + 2e^-\right)$

$\therefore$ Given 0.05 F is not utilized in electrolysis
Only 0.01 F will be utilized in electrolysis

$\therefore$ From $2H_2O \xrightarrow{+2e^-} 2O\overset{-}{H} + H_2$

2 F of charge can produce 2 moles of $O\overset{-}{H}$

$\therefore$ 0.01 F will produce 0.01 mole of $O\overset{-}{H}$

$\therefore$ Molarity of $O\overset{-}{H}$ in solution = $\frac{0.01 \times 1000}{100} = 0.1\,M$

$\therefore$ pOH = - log 10^{-1}
= 1

Mathematics PART – III

SECTION – A

37. $P = \frac{(1+2+3+.....+10)^2}{2} = \frac{1}{2}\left(\frac{10\times 11}{2}\right)^2 = \frac{55^2}{2}$

38. Function is continuous and differentiable at x = 0 and discontinuous everywhere else

39. $(BC)^T_{21} = BC_{12} = \frac{2a-2}{a+2+2a^2} = -1$

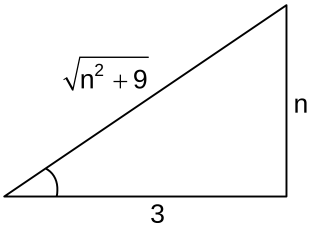
40. y = x + 1 is parallel to axis of the parabola so reflected ray will passes through its focus

41. Lines L_1 and L_2 are intersects at point (1, 0, 2)

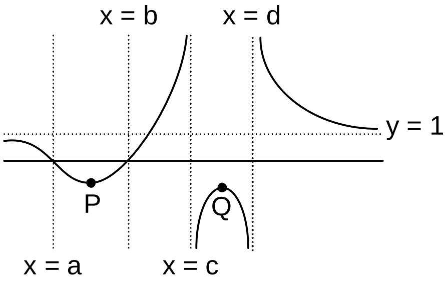
42. $\frac{e^x + e^{4/x}}{x} > e^x$ for $x \in (1, 2)$ and for option (A) put $x = \frac{4}{t}$

43. $T_r = \tan^{-1}\left(\frac{\frac{1}{3}}{1+\frac{r(r-1)}{9}}\right) = \tan^{-1}\left(\frac{r}{3}\right) - \tan^{-1}\left(\frac{r-1}{3}\right)$

$S_n = \sum_{r=1}^{n} T_r = \tan^{-1}\left(\frac{n}{3}\right)$



44.-46. We cannot be sure about the coordinates of P and Q as they depend on a, b, c and d



47.-49. $\int_0^x \sqrt{1-(f''(t))^2}\,dt = \int_0^x f'(t)\,dt \Rightarrow \sqrt{1-(f''(x))^2} = f'(x) \Rightarrow f''(x) = \pm\sqrt{1-(f'(x))^2}$

$\Rightarrow x = \pm\sin^{-1} f'(x) \Rightarrow f(x) = \pm(1-\cos x) = \pm 2\sin^2\frac{x}{2}$

$f(x) \le |f(x)| = 2\sin^2\frac{x}{2} < 2\cdot\frac{x^2}{4} = \frac{x^2}{2}$

$\int_0^1 f(x)\,dx \le \int_0^1 |f(x)|\,dx = \int_0^1 2\sin^2\frac{x}{2}\,dx < \frac{1}{2}\int_0^1 x^2\,dx = \frac{1}{6}$

SECTION – C

50. Two solutions exist in $(0, \pi)$

51. Let $z_1 = r_1 e^{i\theta_1}$ and $z_2 = r_2 e^{i\theta_2} \Rightarrow \frac{z_1\bar{z}_2 + \bar{z}_1 z_2 + z_1 z_2 + \bar{z}_1\bar{z}_2}{|z_1 z_2|}$ = 2 cos $(\theta_1 - \theta_2)$ + 2 cos $(\theta_1 + \theta_2)$

52. Semi-perimeter of $\Delta S'PQ$ is 2a

53. Given $a + b + c = 1$ ..... (1)
$9a + 3b + c = 7$ ..... (2)
$18 < 25a + 5b + c < 22$ ..... (3)
$\Rightarrow$ From above (1), (2) and (3) $4 < 7a - b - c < 8$
$4 < 7a - b + a + b - 1 < 8$
$5 < 8a < 9$
$\frac{5}{8} < a < \frac{9}{8}$ $(a = 1)$
$a = 1, b = -1, c = 1$
For question (2) $h(x) = \ln(x^2 - x + 1) - x$

54. $L = \frac{2}{3} \times e^2$

FIITJEE

JEE (Advanced)-2018

ALL INDIA TEST SERIES

OPEN TEST

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 231**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-C & Section-D**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01 – 03, 24 – 26, 47 – 49)*** *contains 9 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (04 – 08, 27 – 31, 50 – 54) *contains 15 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (09 – 10, 32 – 33, 55 – 56) *contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer. There is no negative marking.*

2. ***Section-C (11 – 20, 34 – 43, 57 – 66)*** *contains 30 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

3. ***Section-D (21 – 23, 44 – 46, 67 – 69)*** *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

PART – I (Physics), PART – II (Chemistry), PART – III (Mathematics):

(SECTION – D)

For questions **21 to 23, 44 to 46, 67 to 69.**
Numerical answer type questions with answer XXXXX. XX

If answer is 348.4 / 251.37 / 213

Correct Method :

0	0	3	4	8	.	4	0

0	0	2	5	1	.	3	7

0	0	2	1	3	.	0	0

Wrong Method :

	3	4	8		.	4	

3	4	8			.		4

		3	4	8	.		4

	3		4	8	.	4	

	2		5	1	.	3	7

		2	1	3	.		

		2	1	3	.	0	

		2	1	3	.		0

		3	4	8	.	4	0

		2	5	1	.	3	7

		2	1	3	.	0	0

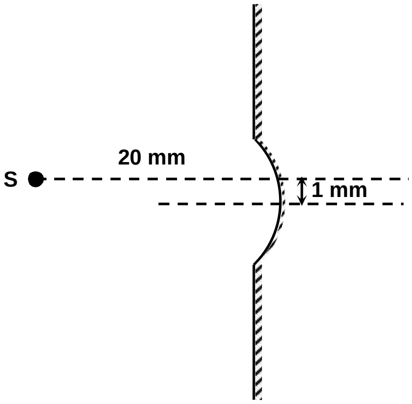
Physics

PART – I

SECTION – A
(One Options Correct Type)

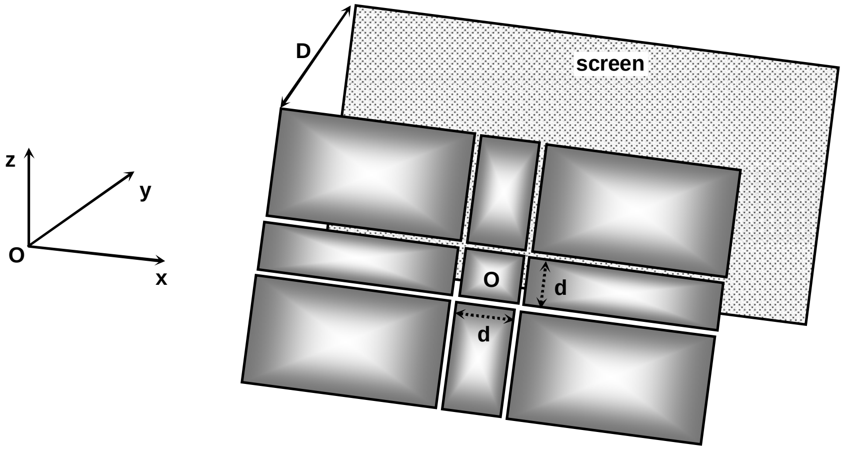
This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A practically very small source (S) of light is kept in front of a plane mirror. But due to imperfect manufacturing, there is a small spherical bulge (radius of curvature 80 mm). The situation is as shown in the figure. You can assume that principal axis of bulge is perpendicular to the plane mirror. Find the separation between the images formed.



(A) 10.025 mm
(B) 20.025 mm
(C) 40.025 mm
(D) 80.025 mm

2. Four slits are made in an infinitely large sheet as shown (O is the symmetrical point of the four slits):

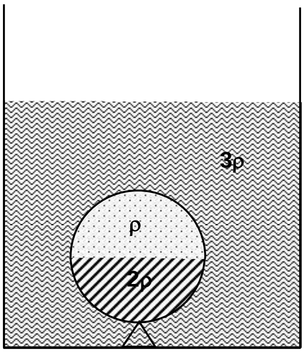


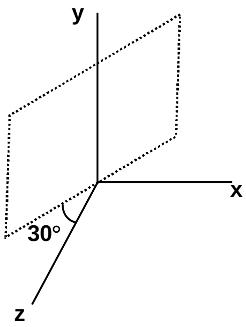
Find the co-ordinates of the black spots formed on the screen on performing interference experiment with this arrangement (using light of wavelength λ), (m and n are integers):

(A) $\left[\frac{m\lambda D}{d}, D, \frac{n\lambda D}{d}\right]$
(B) $\left[\frac{(2m+1)\lambda D}{2d}, D, \frac{(2n+1)\lambda D}{2d}\right]$
(C) $\left[\frac{(2m-1)\lambda D}{2d}, D, \frac{n\lambda D}{d}\right]$
(D) $\left[\frac{m\lambda D}{d}, D, \frac{(2n-1)\lambda D}{2d}\right]$

Space for Rough work

3. A solid sphere has density ρ in the top half and 2ρ in the bottom half. It is kept in a uniform fluid of density 3ρ with a hinge at the bottom (as shown) such that it can freely perform oscillations about any horizontal axis through the hinge (Radius of sphere is R). Find the period of small oscillations if all the points of the sphere are to oscillate in their respective planes parallel to the plane $x = -\sqrt{3}z$ (shown).





(A) $2\pi\sqrt{\frac{64R}{35g}}$

(B) $2\pi\sqrt{\frac{46R}{45g}}$

(C) $2\pi\sqrt{\frac{32R}{35g}}$

(D) $2\pi\sqrt{\frac{24R}{35g}}$

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

4. Two friends start cycling around a circular track (radius R) in the same sense starting from the same point with angular speed ω and 2ω. The slower one is continuously singing with his vocal cord frequency f_0 ($R\omega$ = 1% of v_{sound}). Then : (regarding the frequency of song heard by the faster one)

(A) Observed minimum frequency = $\frac{98}{99}f_0$.

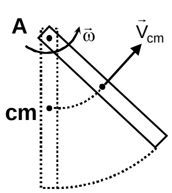
(B) Observed minimum frequency = $\frac{97}{99}f_0$

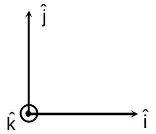
(C) Observed maximum frequency = $\frac{102}{101}f_0$

(D) The spectrum (of frequencies) repeats itself with a time period of $\frac{\pi}{\omega}$.

Space for Rough work

5. A uniform rod of length ℓ and mass m is rotating about a fixed axis perpendicular to the paper (xy-plane) and passing through its one of the end A. At the instant shown in the figure rod's angular velocity is $\vec{\omega}$ and velocity of the centre of mass of the rod is $\vec{v}_{cm}$. The moment of inertia of the rod about an axis passing through its centre of mass and parallel to $\hat{k}$ is I_{CM} and the moment of inertia of the rod about an axis passing through point A and parallel to $\hat{k}$ is I_A. $\vec{L}_A$ and k represent the angular momentum of the rod about point A and kinetic energy of rod respectively.





(A) $\vec{L}_A = I_A\vec{\omega} = \left(I_{cm} + \frac{m\ell^2}{4}\right)\vec{\omega},\ K = \frac{1}{2}mv_{cm}^2 + \frac{1}{2}I_{cm}\omega^2$

(B) $\vec{L}_A = I_A\vec{\omega} = m\vec{r}_{cm} \times \vec{v}_{cm} + I_{cm}\vec{\omega},\ K = \frac{1}{2}mv_{cm}^2 + \frac{1}{2}I_{cm}\omega^2$

(C) $\vec{L}_A = I_A\vec{\omega} = \left(I_{cm} + \frac{m\ell^2}{4}\right)\vec{\omega},\ K = \frac{1}{2}I_A\omega^2$

(D) $\vec{L}_A = I_A\vec{\omega} = m\vec{r}_{cm} \times \vec{v}_{cm} + I_{cm}\vec{\omega},\ K = \frac{1}{2}I_A\omega^2$

6. A uniform chain of mass m and length ℓ hangs from a hook in ceiling as shown in figure I. The bottom of link is now raised vertically with the help of upward external force F(y) very slowly as shown in figure II. Choose correct option(s)

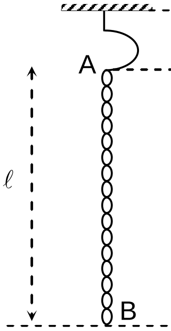


Figure I

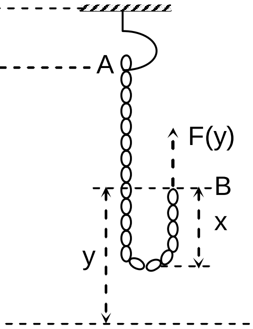


Figure II

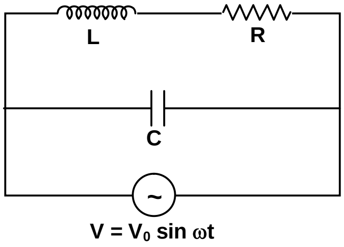
(A) $F(y) = \frac{mgy}{4\ell}$

(B) $F(y) = \frac{mgy}{2\ell}$

(C) Work done by F(y) in raising end B to the position of end A is $\frac{mg\ell}{4}$

(D) Work done by F(y) in raising end B to the position of end A is $\frac{mg\ell}{8}$

Space for Rough work



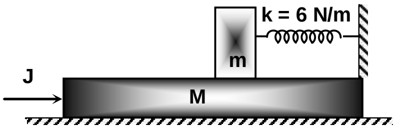
7. Choose the correct options regarding to the following A.C. circuit:

(A) Resonance occurs when $\omega = \frac{1}{\sqrt{LC}}$

(B) Resonance occurs when power factor is maximum.

(C) Resonance occurs when reactive power of circuit becomes equal to zero.

(D) Resonance occurs when $\omega = \sqrt{\frac{1}{LC} - \left(\frac{R}{L}\right)^2}$



8. A block of mass m = 1 kg is placed on a plank of mass M = 2 kg, which is placed on a horizontal frictionless surface. There is no friction between the block and the plank. Block and plank are connected by a spring of spring constant 6 N/m as shown in the figure. An impulse J = 5 newton-sec is applied on the plank. Possible magnitude of acceleration of the block is/are

(A) 1 m/s^2 (B) 3 m/s^2

(C) 5 m/s^2 (D) 7 m/s^2

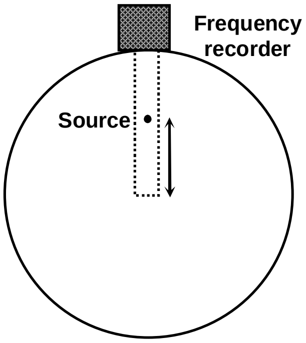
Space for Rough work

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 9 and 10

A point source (frequency f_0) is dropped (by an observer) inside a very thin tunnel made from the surface of the earth (where acceleration due to gravity is g_0), with radius R, to the centre. The observer, at the surface, records the frequency received (f') from the source. The situation is as shown. (speed of sound = v_0) :



9. If x is the distance of the source from the centre of earth and f' is the frequency of the sound received which was emitted when the source was at x, then x is given by

(A) $x = R\sqrt{1-\frac{1}{2g_0R}v_0^2\left(\frac{f'}{f_0}-1\right)^2}$
(B) $x = R\sqrt{1-\frac{4}{g_0R}v_0^2\left(\frac{f_0}{f'}-1\right)^2}$

(C) $x = R\sqrt{1-\frac{2}{g_0R}v_0^2\left(\frac{f_0}{f'}-1\right)^2}$
(D) $x = R\sqrt{1-\frac{1}{g_0R}v_0^2\left(\frac{f'}{f_0}-1\right)^2}$

10. Find the location of the source after reaching which all signals emitted by the source are not received by the recorder. Ignore any reflections for the tunnel.

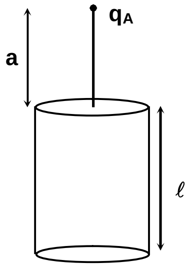
(A) $v_0\sqrt{\frac{R}{g}}$
(B) $\pi\sqrt{\frac{R}{g}}v_0$
(C) $\sqrt{R^2-\frac{v_0^2R}{g}}$
(D) $\sqrt{\frac{R}{g}}v_0$

Space for Rough work

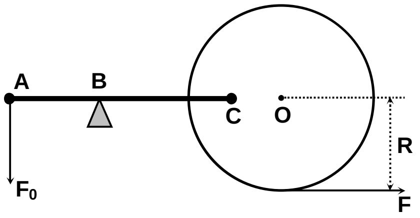
SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

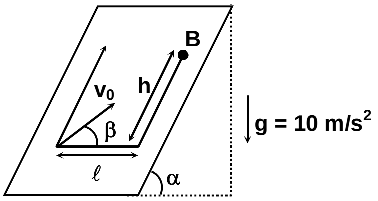
11. It is known that the electrically electrified bodies can attract the uncharged body. For example, the charged comb attracts the uncharged pieces of paper. One can estimate the force of interaction between charged body and uncharged body. For the estimation of force, consider an electrified body, localised at point A, having charge q and an uncharged body in form of conducting cylinder whose dimensions are considerably lower than distance from charge q ($a >> \ell$). The axis of cylinder is passing through point A. The volume of cylinder is V. If the force of interaction between them is $\frac{q^2}{\alpha\pi^2\varepsilon_0 a^5}V$. Find the value of α. (assume that no charge appears on the curved surface of cylinder)



12. A disc of radius 12 cm is free to rotate about point O, a rope is wound which is pulled with a force F = 10 N as shown in the figure. At point C, a light rod AC is attached to the disc, which rests on the fixed support at the point B. If force F_0 = 10k N is required to apply to the left end of the rod so that whole system remains in balance, find the value of k. Given BC = 30 cm, AB = 15 cm OC = 4 cm.

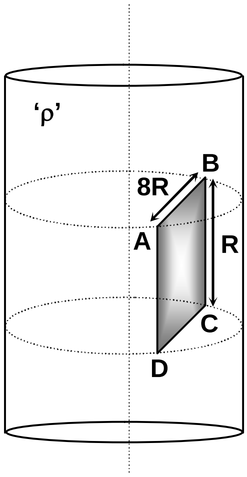


13. An inclined plane is located at angle $\alpha = 53°$ to the horizontal. There is a hole at point B in inclined plane as shown in the figure. A particle is projected along the plane with speed v_0 at an angle $\beta = 37°$ to the horizontal in such a way so that it get into the hole. Neglect any type of friction. Find the speed v_0 (in m/s) if h = 1 m, ℓ = 8m and $\sqrt{5} \cong 2.25$.

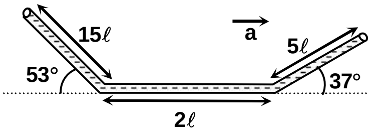


Space for Rough work

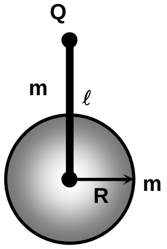
14. A non conducting solid cylinder of infinite length having charge density ρ and radius of cylinder is 5R. If the flux passing through the surface ABCD as shown in figure is $\frac{2\theta\rho R^3}{\varepsilon_0}$. Find the value of θ



15. In the given tube a liquid of density ρ is filled. If the acceleration of the tube towards right direction such that no liquid will falls out of the tube is $\frac{\eta g}{5}$. Find the value of η



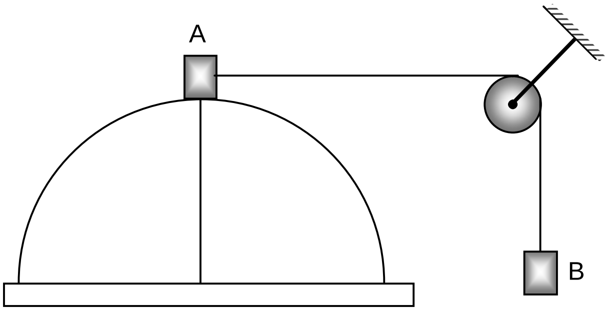
16. A meter stick connected with disc of same mass which is joined at one end of stick and disc can freely rotates about its joint. System swings in a vertical plane about a fixed horizontal axis passing through its one end, undergoes small oscillation of frequency ‘f_0’. If disc is removed from the stick, then its new frequency of small oscillation is $\sqrt{\frac{13}{k}}f_0$. Find the value of k (take $R = \ell/2$)



17. A trolley of mass 18 kg is pulled with a velocity which depends on time and given as $v = 3t$. Sand is falling vertically on the trolley at a rate of 18 kg/s. Assume sand sticks to the trolley. If rate of increase of Kinetic energy of the trolley at t = 2 sec is $\eta \times 324$. Find the value of η

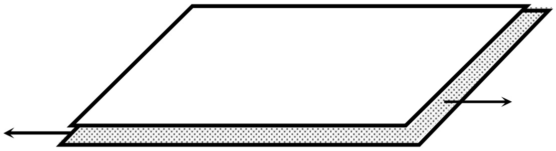
Space for Rough work

18. A block 'A' of mass 1 kg connected with a hanging mass 'B' of 1 kg by an inextensible light string, is kept on a massive hemispherical surface of radius 2 m which is moving with an upward acceleration 4 m/s^2. The coefficient of friction between block and hemispherical surface is 0.5. If block 'A' is projected towards left with a velocity 1.5 m/s and the hemispherical surface move with a velocity 0.5 m/s towards right at the given position (shown in figure) then acceleration of block 'A' is $\eta\sqrt{17}$ m/s^2. Find the value of η



19. A hopper drops gravel at a rate of 15 kg/s onto a conveyor belt moving at a constant speed 4 m/s. If the output power must motor have in order to drive the conveyor belt is 48 k. Find the value of k

20. A parallel plate capacitor (square plates) has a capacitance of 1 mF. It is completely filled with a solid dielectric (constant = 5) which is performing very small oscillations (SHM, of amplitude 0.1% of plate dimension) with a period of 1 ms as shown: At all times, a battery of 10 V remains connected to the capacitor. If the amount of charge that crosses the battery in one cycle is 40 α. Find the value of α



Space for Rough work

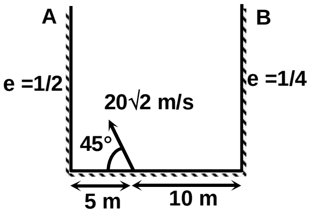
SECTION – D

(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

21. A lamp post of length ℓ and cross sectional area S = 10 cm^2 is made of material with linear expansion coefficient $\alpha = 1.1 \times 10^{-5}$ K^{-1} and Young's modulus Y = 2.0×10^{11} N/m^2. If temperature of lamp post is raised by ΔT = 10K, what mass (in kg) should be put on the lamp post, so that there is no change in the length of lamp post (g = 10 m/s^2)

22. A ball is projected with velocity $20\sqrt{2}$ m/s at an angle of 45° with horizontal as shown in figure. The ball collide with the wall, the coefficient of restitution between the ball and wall A is $\frac{1}{2}$ and with the wall B is $\frac{1}{4}$, distance of point where ball collide with the ground from the projection point is



23. A cubical block of wood (density = 800 kg/m^3) and side length ℓ = 50 cm is floating in a rectangular tank partially filled with water (density = 1000 kg/m^3). Work done to press the block slowly so that it is just immersed in water is W Joules (Area of the bottom of tank is 10000 cm^2) (take g = 10 m/s^2). Find the value of W

Space for Rough work

Chemistry PART – II

SECTION – A

(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

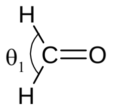
24. Correct trend of first ionisation energy in group-13 is:

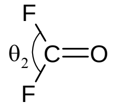
(A) B > Al > Ga > In > Tl
(B) B > Al > Ga > Tl > In
(C) B > Tl > Ga > Al > In
(D) B > Ga > Al > In > Tl

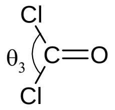
25. The self ionization constant for pure formic acid $K = \left[HCOOH_2^+\right]\left[HCOO^-\right]$ has been estimated as 10^{-6} at room temperature. The density of formic acid is 1.15 g/cm^3. What percentage of formic acid molecules convert to formate anion:

(A) 0.001%
(B) 0.002%
(C) 0.003%
(D) 0.004%

26.







Decreasing order of shown angles will be:

(A) $\theta_1 > \theta_2 > \theta_3$
(B) $\theta_1 > \theta_3 > \theta_2$
(C) $\theta_3 > \theta_2 > \theta_1$
(D) $\theta_1 = \theta_2 = \theta_3$

Space for Rough work

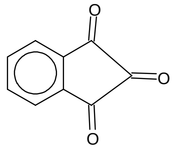
(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

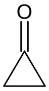
27. Between ClO_2 and Cl_2O:
(A) the Cl – O bond length would be larger in Cl_2O
(B) the bond angle would be larger in Cl_2O
(C) ClO_2 is likely to be a coloured compound
(D) Cl_2O is likely to be soluble in water

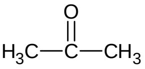
28. In the structure of **β,β′ -dichlorodiethyl sulphide,** more popularly known as *mustard gas:*
(A) all C-atoms are sp^3 hybridised
(B) S-atom is sp^2 hybridised
(C) there is a total of 2 lone pair of electrons on one molecule
(D) order of bond strength : C – C > C – Cl > C – S

29. Which of the following carbonyl compound(s) form (s) readily isolable hydrate?

(A)


(B) $CCl_3 – CHO$

(C)


(D)

$H_3C—\overset{O}{\overset{\|}{C}}—CH_3$

30. For the complex having the IUPAC name: *Dichloridotetrakis(ethylenediamine)chromium(III)tetrachloridopalladate(II),* which of the following shall be true: (atomic nos. of Cr and Pd are 24 and 46 respectively)
(A) transition metal in the cation supercedes nearest noble gas configuration
(B) transition metal in the anion falls short of nearest noble gas configuration
(C) 1 molal aqueous solution of this complex will have the same freezing point as 1 molal NaCl solution in water
(D) 1 molar aqueous solution of this complex will be isotonic with 3 molar sucrose solution in water

31. Which of the given statement is correct:
(A) The C–Cl bond length in CH_3CH_2Cl is 1.76 Å and $CH=CH-Cl$ is 1.69 Å
(B) The C = C bond length in $CH_2 = CH_2$ is 1.34 Å and $CH_2 = CHCl$ is 1.38 Å
(C) The C – C bond length in $CH_2 = CH_2$, $CH_3CH_2 – Cl$ and $CH_2 = CHCl$ is 1.54 Å
(D) The dipole moment of CH_3CH_2Cl is 2.05 D and $CH_2=CHCl$ is 1.44 D

Space for Rough work

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 32 to 33

Redox reaction involves transfer of electrons between 2 chemical species. An **unbalanced** and **incomplete** example is shown below:

$$N_2 + H_3PO_2 \longrightarrow HN_3 + P_4O_6$$

32. If the above reaction were possible in either direction, maximum equivalent weight would belong to:

(A) N_2 (B) H_3PO_2
(C) HN_3 (D) P_4O_6

33. If the above reaction were unidirectional towards right, what fraction of P_4O_6 would be left unreacted if reaction were started with stoichiometric amount of reactants.

(A) $\frac{1}{2}$ (B) $\frac{3}{4}$
(C) $\frac{1}{3}$ (D) $\frac{2}{3}$

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

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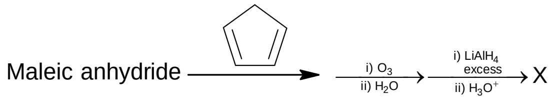
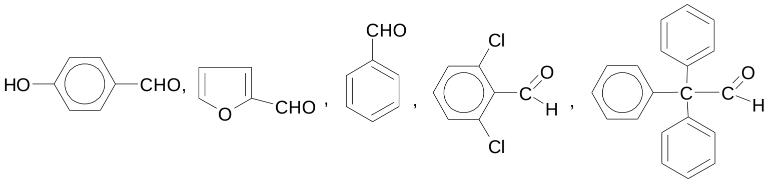
34. The pH range of a basic indicator (InOH) is 3.4 to 4.6. For what minimum ratio of $\frac{[In^+]}{[InOH]}$ does the solution appear in the colour of In^+.

35.



How many hydroxyl groups are present in X?

36. How many of the following compounds will give Cannizaro's reaction:



37. An aromatic compound $P(C_8H_{10})$ is heated with alkaline $KMnO_4$ to give a product which on heating with aqueous ammonia solution gives 'Q'. Compound 'Q' on heating with alkaline sodium hypochlorite gives a salt which on acidification gives product R $(C_7H_7O_2N)$. Compound 'R' is treated with $NaNO_2$ & HCl and then with a base to produce a dipolar ion 'S' which on heating produces an intermediate (T) which dimerises to produce the final product 'U'.
What is the degree of unsaturation of the compound (U)?

38. The number of alkenes (open chain as well as cyclic) of six carbon giving same product with HBr in presence of peroxide and absence of peroxide.

39. 0.092 g of compound with molecular formula $C_3H_8O_3$ on reaction with an excess of CH_3MgI gives 67 mL of methane at STP. What is the number of active hydrogen atoms present in a molecule of the compound?

40. The isomerisation of cyclopropane (C_3H_6) to propene is believed to occur by the following mechanism:

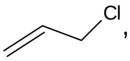
Step-1: $C_3H_6 + C_3H_6 \longrightarrow C_3H_6 + C_3H_6^*$

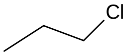
Step-2: $C_3H_6^* \longrightarrow CH_3 - CH = CH_2$

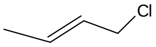
At high pressure, step-1 is bidirectional and fast whereas step-2 is unidirectional and slow. What is the order of the reaction?

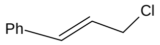
Space for Rough work

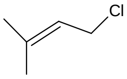
41. Ratio of frequency of revolution of electron in second excited state of He^+ and second state of H is $\frac{2^x}{3^y}$. What is the value of 'x + y'?

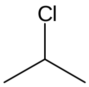
42. How many of the following undergo solvolysis by 50% aqueous ethanol, faster than , on mild heating.

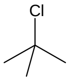
(a) 

(b) 

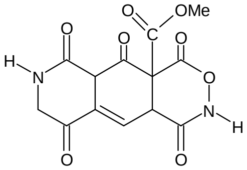
(c) 

(d) 

(e) 

(f) 

43. Consider the following compound (X):



If 0.5 moles of the compound (X) are hydrolysed in a alkaline medium and then heated. How many moles of CO_2 are produced?

Space for Rough work

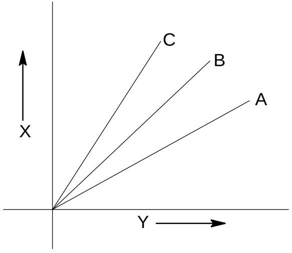
SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

44. Two inorganic compounds (A) and (B) are obtained by treating calcium orthophosphate with magnesium metal. (A) on hydrolysis produces a gas (C). The gas (C) reacts with $CuSO_4$ (aq) solution to give a black precipitate of compound (X). What is the molar mass of (X)? [Atomic mass of P = 31 g, Ca = 40 g, Mg = 24 g, O = 16 g, Cu = 63.55]

45. In an ABCABC packing of *Giant Buckies* (C – 240); *Bucky babies – Chotu* (C – 32) and *Motu* (C – 44) are doped in tetrahedral and octahedral voids respectively. In the unit cell thus created all balls along any one body diagonal are removed and *Bucky Onions* (C – 240 containing C – 60 suspended inside it, with their centres coinciding) are fitted at either extremes. The number of C atoms finally present in the unit cell are…….?

46. Following graph is plotted between characteristics 'X' and 'Y' for three species A, B and C:



Now consider the following statements, related to the above graph:

1. If 'X' is the velocity of electron and 'Y' is $\frac{1}{n}$(where 'n' is nth Bohr orbit of three hydrogen like species A, B and C), then radii of these species must increase in the order C < B < A.
2. If 'X' is the de-Broglie wavelength (λ) of three charged species A, B and C (having same amount of charge) and 'Y' is $\frac{1}{\sqrt{V}}$(where 'V' is accelerating potential difference), then the mass of these species must increase in the order C < B < A.
3. If 'X' is the volume of same amount of three ideal gases A, B & C and 'Y' is the temperature in Kelvin, then the pressure of these gases must increase in the order C < B < A.
4. If 'X' is the pressure of the same amount of ideal gases A, B & C and 'Y' is $\frac{1}{V}$(where V is the volume of these gases), then temperature of these gases must increase in the order: $T_C < T_B < T_A$.

What is the correct code for correct statements in increasing order of their codes given?

Space for Rough work

Mathematics PART – III

SECTION – A

(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

47. Solution of the differential equation $y^2\left(e^{x^3}+e^{y^3}\right)dy + x^2e^{x^3}\left(y^3-1\right)dx = 0$ is

(A) $e^{x^2}\left(y^3-1\right)+e^{y^3}=c$ (B) $e^{x^3}\left(y^3+1\right)-e^{y^3}=c$

(C) $e^{x^3}\left(y^3-1\right)+e^{y^3}=c$ (D) $e^{x^3}\left(y^2-1\right)+e^{y^2}=c$

(where c is arbitrary constant)

48. Number of positive integral solutions of $x_1x_2x_3x_4 = 3^{\alpha_1}\,5^{\beta_1}\,7^{\gamma_1}\,11^{\delta_1}$

(where α_1, β_1, γ_1, δ_1 are integers such that $0 \le \alpha_1 \le 1$, $0 \le \beta_1 \le 1$, $0 \le \gamma_1 \le 1$, $0 \le \delta_1 \le 1$), is

(A) 625 (B) 580

(C) 550 (D) 650

49. In ΔABC, a is the arithmetic mean and b, c are two geometric means of two positive distinct numbers, then the value of $4^4\left(\dfrac{\sin^{12}B+\sin^{12}C}{\left(\sin 2A+\sin 2B+\sin 2C\right)^4}\right)$ can be equal to

(A) $\dfrac{1}{2}$ (B) $\dfrac{1}{4}$

(C) 2 (D) 3

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

50. Let A_1, A_2, A_3, ..., A_n be n points in plane such that no three of them are collinear and no two lines obtained by joining any two points are parallel. The number of new points of intersection obtained by intersection of lines joining any of these two points, is

(A) $3\cdot{}^nC_4$ (B) ${}^{{}^nC_2}C_2 - {}^{n-1}C_2 n$

(C) $\dfrac{{}^nC_2\cdot{}^{n-2}C_2}{2}$ (D) ${}^{{}^nC_2}C_2 - n(n-1)$

Space for rough work

51. Let f(x) be a non-constant, twice differentiable function defined on R such that y = f(x) is symmetric about line x = 1 and f(–1) = $f'\left(\frac{1}{4}\right) = f'\left(\frac{1}{2}\right) = 0$, then which of following is/are correct statement(s)?
(A) $f''(x) = 0$ has atleast four roots in the interval (0, 2)
(B) $\int\limits_{-2}^{2}\left(x^5 + x^3\right)f\left(1+x\right)dx < \int\limits_{0}^{2}\frac{1}{1+2^{f(x)}}dx$
(C) there exist at least one C ∈ $\left(\frac{3}{2}, \frac{7}{4}\right)$ such that f′(C) + Cf″(C) = 0
(D) for some C ∈ $\left(1, \frac{3}{2}\right)$, f′(C) = Cf″(C)

52. Let $I = \int\limits_{0}^{\pi}\frac{\cos\theta}{10 - 6\cos\theta}d\theta$, then which of following is/are correct statement(s)
(A) I < 1 (B) I > 0
(C) I < 0 (D) I > 1

53. The line L is drawn through the point (1, 1) to intersect $L_1 : x + 2y = 1$ and $L_2 : x + 2y = 3$ at P and Q respectively. Line perpendicular to L from P intersects L_2 at R and line perpendicular to L from Q intersects L_1 and S. If the area of parallelogram PQRS is least, then which of the following is/are correct?
(A) the equation of line L can be y + 3x = 4 (B) the equation of line L can be 3y – x = 2
(C) the least area of PQRS is $\frac{8}{5}$ square unit (D) the equation of line L can be 3y – x = 4

54. Let ABCD be a rectangle inscribed in a circle whose one diameter is along line y = x. If coordinates of A and B are (0, 2) and (4, 3) respectively, then which of the following is/are correct?
(A) the coordinates of point D are $\left(\frac{1}{5}, \frac{6}{5}\right)$ (B) the coordinates of point D are (4, 6)
(C) the coordinates of C are $\left(\frac{21}{5}, \frac{11}{5}\right)$ (D) the coordinates of C are (6, 4)

Space for rough work

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 55 to 56

Read the following write up carefully and answer the following questions:
Five persons shoot each other such that no one shoots himself, every one shoots exactly once and no shot is wasted, then

55. The number of ways such that all persons are hit is
(A) 60 (B) 44
(C) 120 (D) 36

56. The number of ways in which exactly one person is not hit is
(A) 420 (B) 180
(C) 210 (D) 540

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

57. If the number of onto functions from {1, 2, 3, 4} $\to$ {2, 3, 4} such that $f(i) \neq i$ for $i = 1, 2, 3, 4$ is k, then $\frac{k}{4}$ is equal to _____

58. Let the area enclosed by the curve $x^4 + y^4 = 2xy$ be A square units, then the value of [A] is equal to _____ (where [.] denotes the greatest integer function)

59. Let the probability of arranging 8 boys ($B_1, B_2, \ldots.., B_8$) and 5 girls linearly such that B_1 and B_2 are not together and exactly four girls are together be p, then [99p] is equal to _____ (where [.] denotes the greatest integer function)

Space for rough work

60. If 3 sin α sin β + 4 cos β + 5 cos α sin β = $5\sqrt{2}$ $\forall$ α, $\beta \in$ R, then |adj adj A| is equal to _____

$$\left\{\text{where } A = \begin{bmatrix} \sin\alpha & -\frac{1}{2} \\ \frac{1}{2} & \tan\beta \end{bmatrix}\right\}$$

61. In ΔABC if $r_1 = 3r$, then the value of $9\left(\tan\frac{A}{2}\tan\frac{B}{2}+\tan\frac{A}{2}\tan\frac{C}{2}\right)$ is equal to _____

(where r_1 and r are the ex-radius opposite A and the inradius of ΔABC respectively)

62. If α, β, γ are the roots of $x^3 + x^2 - 2x + 1 = 0$, then the value of $\sqrt{\Delta}$ is equal to _____

$$\text{where } \Delta = \begin{vmatrix} \gamma^2 & \beta^2 & 2\beta\gamma-\alpha^2 \\ 2\alpha\gamma-\beta^2 & \alpha^2 & \gamma^2 \\ \alpha^2 & 2\alpha\beta-\gamma^2 & \beta^2 \end{vmatrix}$$

63. The value of $\dfrac{\sum_{r=1}^{k} 2^r\ {}^nC_r\ {}^{k-1}C_{r-1}}{\sum_{r=0}^{k} {}^nC_r\ {}^{n+k-r-1}C_{n-1}}$ (where $n \geq k$) is equal to _____

64. Let in ΔABC, $\angle A$ is $\frac{\pi}{2}$ and D is point on BC such that AD is altitude. If E, F and I are incentre of ΔABD, ΔADC and ΔABC respectively, then the value of $\frac{AI}{EF}$ is equal to _____

65. The value of $m^m - \sum_{r=1}^{m} \dfrac{(m+1)(r-1)m^{r-1}}{r\ {}^mC_r}$ is equal to _____

66. A variable chord of the hyperbola $\frac{x^2}{4} - \frac{y^2}{8} = 1$, subtends a right angle at the centre of the hyperbola. If this chord touches a fixed circle concentric with the hyperbola, then the square of radius of the fixed circle is equal to _____

Space for rough work

SECTION – D

(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

---

67. P_1, P_2, P_3, ..., P_8 are 8 players of equal strength who play with each other in a knockout tournament. The probability that P_1 wins against P_2 and P_3 to reach the final and also wins the tournament is p, then 42p is equal to _____

68. Let $\lim\limits_{n\to\infty}\sum\limits_{k=1}^{n}\left|e^{i\frac{2k\pi}{n}}-e^{i\frac{(k-1)2\pi}{n}}\right|$ = L, then $\frac{L}{10\pi}$ is equal to _____

69. The arithmetic mean of all integral values of real parameter α for which $\left|z-\left(\alpha^2-7\alpha+13+i\right)\right|=1$ and arg $z\geq\frac{\pi}{2}$ is satisfied for at least one z is equal to _____

Space for rough work

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PAPER-2

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	B	24.	C	47.	C
2.	B	25.	D	48.	A
3.	B	26.	B	49.	D
4.	A, C	27.	A, C, D	50.	A, B, C
5.	A, B, C, D	28.	A, D	51.	A, B, C, D
6.	B, C	29.	A, B, C	52.	A, B
7.	B, C, D	30.	A, B, D	53.	A, B, C
8.	A, B, C	31.	A, B, D	54.	A, C
9.	D	32.	C	55.	B
10.	C	33.	D	56.	A
11.	8	34.	4	57.	3
12.	6	35.	4	58.	1
13.	9	36.	2	59.	4
14.	6	37.	9	60.	1
15.	3	38.	7	61.	6
16.	3	39.	3	62.	7
17.	4	40.	1	63.	1
18.	2	41.	8	64.	1
19.	5	42.	4	65.	1
20.	4	43.	2	66.	8
21.	02200.00	44.	00252.65	67.	00000.25
22.	00004.37	45.	01299.00	68.	00000.20
23.	00009.37	46.	00123.00	69.	00003.50

Physics PART – I

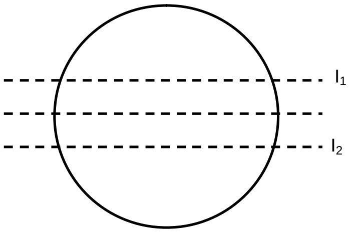
SECTION – A

1. $$\frac{1}{v}+\frac{1}{u}=\frac{1}{f} \Rightarrow \frac{1}{v}+\frac{1}{-20}=\frac{1}{-40} \Rightarrow v=+40\text{mm}$$

$$m=\frac{-v}{u}=-\left(\frac{+40}{-20}\right)=+2$$

$\Rightarrow$ separation between the two images formed = $\sqrt{(20)^2+(1)^2} \approx 20.025$ mm

2. Path difference at angular position θ is d sin θ.



3. Let $\rho\frac{V}{2}=m$

$$r_{CM}=\frac{m\left(R+\frac{3R}{8}\right)+2m\left(R-\frac{3R}{8}\right)}{3m}=\frac{7R}{8}$$

Moment of Inertia of sphere about a horizontal are passing through the hinge.

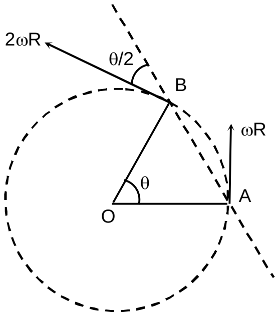
$$I=\left[I_1+m\left(R+\frac{3R}{8}\right)^2\right]+\left[I_2+2m\left(R-\frac{3R}{8}\right)^2\right]$$

$$I=\left[\frac{2}{5}mR^2-m\left(\frac{3R}{8}\right)^2+m\left(\frac{11R}{8}\right)^2\right]+\left[\frac{2}{5}(2m)R^2-2m\left(\frac{3R}{8}\right)^2+2m\left(\frac{5R}{8}\right)^2\right] \quad =\frac{69mR^2}{20}$$

$$\tau=6mgR\theta-3mg\times\frac{7R}{8}\theta=\frac{27}{8}mgR\theta$$

$$I\frac{d^2\theta}{dt^2}+\frac{27}{8}mgR\theta=0$$

$$\Rightarrow \quad T=2\pi\sqrt{\frac{46R}{45g}}$$



4. $$f'=f_0\left[\frac{1-\frac{1}{50}\cos\frac{\theta}{2}}{1-\frac{1}{100}\cos\frac{\theta}{2}}\right],\ \theta=\omega t$$

$$k=\frac{\omega R}{v}=\frac{1}{100}$$

$$t=\left[\frac{1-2k\cos\left(\frac{\theta}{2}\right)}{1-k\cos\left(\frac{\theta}{2}\right)}\right]$$

$$\frac{dt}{d\theta}=\frac{\left[1-k\cos\left(\frac{\theta}{2}\right)\right]\left[+k\sin\left(\frac{\theta}{2}\right)\right]-\left[1-2k\cos\left(\frac{\theta}{2}\right)\right]\left[\frac{k}{2}\sin\left(\frac{\theta}{2}\right)\right]}{\left[1-k\cos\left(\frac{\theta}{2}\right)\right]^2}$$

$$\Rightarrow \quad \frac{k}{2}\sin\left(\frac{\theta}{2}\right)=0 \Rightarrow \frac{\theta}{2}=0,\pi \Rightarrow \theta=0,\ 2\pi$$

$$f_{min} = \frac{98}{99}f_0 \text{ at } \theta = 0°$$

$$f_{max} = \frac{102}{101}f_0 \text{ at } \theta = 2\pi$$

5. Basic knowledge to write angular momentum and kinetic energy of the system.

6. $x = \frac{y}{2}$, and $F(y) = \frac{mgx}{\ell} = \frac{mgy}{2\ell}$

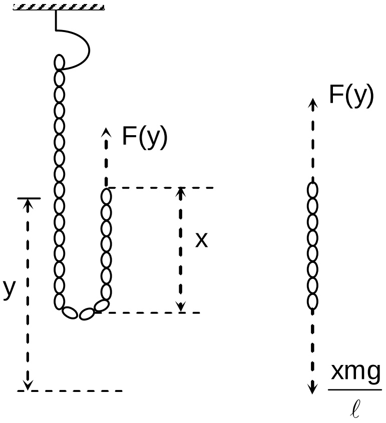
Work done by $F(y) = \int_0^{\ell} F(y)dy = \frac{mg}{2\ell}\int_0^{\ell} ydy = \frac{mg\ell}{4}$

Second method: Using WET, we can write

$K_f - K_i = W_F + W_{mg} = 0$

$\Rightarrow \quad W_F = -W_{mg} = -\left[-mg\left(\frac{\ell}{2} - \frac{\ell}{4}\right)\right] = \frac{mg\ell}{4}$

Concept: Work energy power



7. For resonance

$I_{20} = I_{10}\sin\theta$

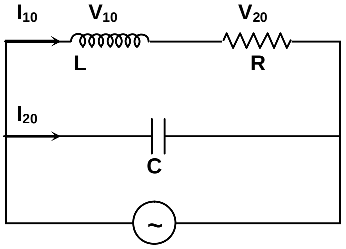
$$\frac{V_0}{X_c} = \frac{V_0}{\sqrt{X_L^2 + R^2}} \times \frac{X_L}{\sqrt{X_L^2 + R^2}}$$

$\Rightarrow \quad X_L^2 + R^2 = X_C X_L$

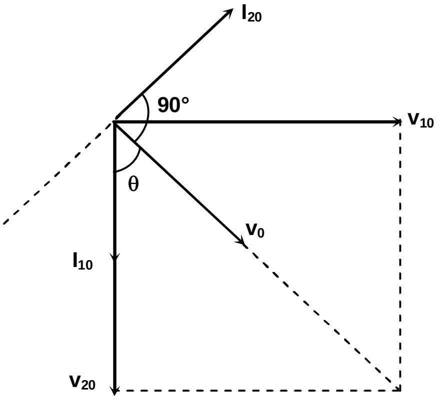
$\Rightarrow \quad L^2\omega^2 + R^2 = \frac{L}{C}$

$\Rightarrow \quad \omega^2 = \frac{1}{LC} - \left(\frac{R}{L}\right)^2$

$\Rightarrow \quad \omega = \sqrt{\frac{1}{LC} - \left(\frac{R}{L}\right)^2}$



$V = V_0 \sin \omega t$



8. By energy conservation

$$\frac{1}{2}\frac{Mm}{m+M}v^2 = \frac{1}{2}kx^2$$

$$\Rightarrow x = J\sqrt{\frac{m}{M(M+m)K}} = 5\sqrt{\frac{1}{2\times3\times6}} = \frac{5}{6}\text{ m}$$

9. $v^2 = \frac{GM}{R^3}(R^2 - x^2)$

10. The waves emitted from the source cease to reach the recorder after the source's speed exceeds that of sound:

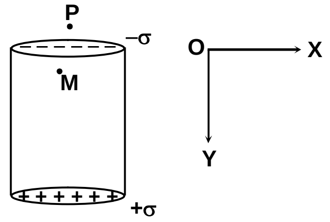
$v_0 = \omega R \sin\omega t;$

Where $\omega = \sqrt{\frac{g}{R}}$

The corresponding x = R cos ωt = $R\sqrt{1-\frac{v_0^2}{\omega^2}}$

SECTION – C

11. Assume that on circular face of cylinder, a charge q of surface charge density σ(in magnitude) appears. So,



$Q = s\sigma,\ \vec{E}_P = \frac{\sigma}{\varepsilon_0}\hat{j},\ \vec{E}_{M(Q^-)} + \vec{E}_{M(q)} + \vec{E}_{M(Q^+)} = 0$ …(1)

$\vec{E}_{P(q)} = \frac{q}{4\pi\varepsilon_0 a^2}(+\hat{j})$

$\vec{E}_{P(Q^-)} + \vec{E}_{P(q)} + \vec{E}_{P(Q^+)} = \frac{\sigma}{\varepsilon_0}\hat{j}$ …(2)

From equation (1) and (2)

$\vec{E}_{P(q)} = \frac{\sigma}{\varepsilon_0}\hat{j}$

$\Rightarrow \quad \sigma = \frac{q}{4\pi a^2} \Rightarrow Q = \frac{qS}{4\pi a^2}$

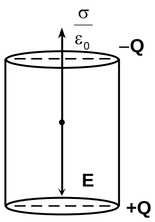
$\left|\vec{F}_{\text{cylinder}}\right| = \frac{qQ}{4\pi\varepsilon_0}\left[\frac{1}{a^2} - \frac{1}{(a+\ell)^2}\right] = \frac{qQ}{4\pi\varepsilon_0 a^2 (a+\ell)^2}\left[(a+\ell)^2 - a^2\right]$

$= \frac{qQ(\ell^2 + 2a\ell)}{4\pi\varepsilon_0 a^2 (a+\ell)^2} \approx \frac{2qQa\ell}{4\pi\varepsilon_0 a^4}$

$= \frac{q\ell}{2\pi\varepsilon_0 a^3} \times \frac{qS}{4\pi a^2} = \frac{q^2}{8\pi^2\varepsilon_0 a^5}V$

Second Method:

Due to induction, $-Q = -s\sigma$ and + Q = + σs will appear at upper surface and lower surface of conductor. These two charged system will act like a capacitor for region inside the conductor, so due these charges, net electrostatic field at inside the conductor has magnitude $\frac{\sigma}{\varepsilon_0}$

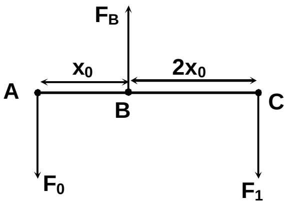


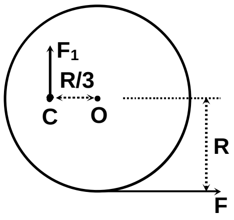
Since net field due to all charges inside the conductor is zero.

$E = \frac{\sigma}{\varepsilon_0} \Rightarrow \frac{q}{4\pi\varepsilon_0 a^2} = \frac{\sigma}{\varepsilon_0}$

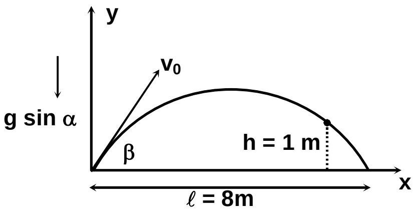
$\Rightarrow \quad \sigma = \frac{q}{4\pi a^2}$

12. $F_1 = 3F$ and $F_0 = 2F_1 = 6F = 60$ N

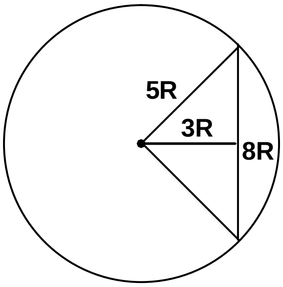




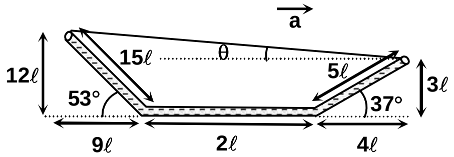
13.
$$h = \ell\tan\beta - \frac{1}{2}\frac{g\sin\alpha\ell^2}{v_0^2\cos^2\beta}$$
$$v_0 = \sqrt{\frac{g\sin\alpha\ell^2}{2\cos^2\beta(\ell\tan\beta - h)}}$$
$$= \sqrt{\frac{10\times\frac{4}{5}\times 8\times 8}{2\times\frac{4}{5}\times\frac{4}{5}\left(8\times\frac{3}{4}-1\right)}} = 9\ \text{m/s}$$



14.
$$\phi = \frac{q_{in}}{\varepsilon_0} = \frac{\rho\left(\frac{1}{2}8R\cdot 3R\right)R}{\varepsilon_0} = \frac{12\rho R^3}{\varepsilon_0}$$



15.
$$\frac{9\ell}{15\ell} = \frac{3}{5} = \frac{a}{g}$$
$$a = \frac{3}{5}g$$



16.
$$T = 2\pi\sqrt{\frac{I}{mgd}}$$
$$f = \frac{1}{2\pi}\sqrt{\frac{mgd}{I}}$$
$$f_0 = \frac{1}{2\pi}\sqrt{\frac{(2m)(g)(3\ell/4)}{\left(\frac{m\ell^2}{3}+m\ell^2\right)}} = \frac{1}{2\pi}\sqrt{\frac{18g}{13\ell}}$$

When disc is removed
$$f = \frac{1}{2\pi\sqrt{\frac{mg(\ell/2)}{m\ell^2/12}}} = \frac{1}{2\pi}\sqrt{\frac{6g}{\ell}}$$
$$\frac{f}{f_0} = \sqrt{\frac{6g}{\ell}}\sqrt{\frac{13\ell}{18g}} = \sqrt{\frac{13}{3}}$$

17. $K = \frac{1}{2}mv^2$

$$\frac{dK}{dt} = \frac{1}{2}v^2\frac{dm}{dt} + \frac{1}{2}m \times 2v\frac{dv}{dt}$$

$$= \frac{1}{2}9t^2 \times 18 + \frac{1}{2} \times 54 \times 2 \times 3t \times 3$$

$$\left.\frac{dK}{dt}\right|_{t=2} = 9 \times 2 \times 18 + 54 \times 18$$

= 1296 J/s

18. for block B

$m_2g - T = m_2a_2$ …(i)

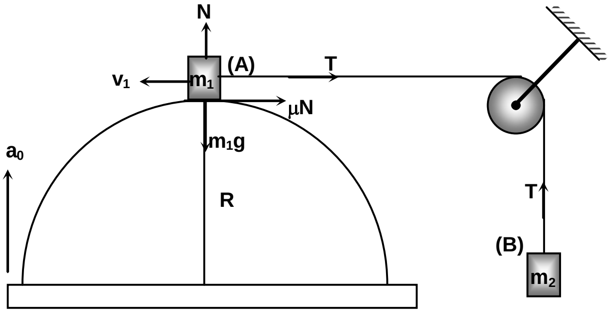
$T + \mu N = m_1a_2$ …(ii)

by circular motion dynamics

$m_1g + m_1a_0 - N = \frac{m_1v_{rel}^2}{R}$ (from hemisphere)

on solving these equation and putting of all variable we get $a_A = 2\sqrt{17}$ m/s^2

and $a_B = 8$ m/s^2



19. $F = u\frac{dm}{dt}$ and $P = Fv$

20. $i = \frac{\varepsilon_0 aV}{d}(k-1)A\omega \sin\omega t$

$q = \int |i|\,dt$

SECTION – D

21. $\Delta\ell_T = \alpha\ell\Delta T$ Extension …(i)

$$\frac{mg}{S} = \frac{F}{S} = Y\frac{\Delta\ell_e}{\ell}$$

$\Rightarrow \Delta\ell_e = \frac{mg\ell}{SY} \Rightarrow$ compression …(ii)

If there is no change in length, it means extension due to temperature raise must be equal to the elastic compression due to weight. So

$$\alpha\ell\Delta T = \frac{mg\ell}{SY}$$

$$\Rightarrow m = \frac{\alpha SY\Delta T}{g} = \frac{1.1\times10^{-5}\times10\times10^{-4}\times10\times2.0\times10^{11}}{10} = 2.2\times10^{3}\text{kg}$$

22. $T = \frac{2u\sin\theta}{g} = 4$ s

First collision occur after 5/20 sec

So, $\Delta t = 4 - \frac{5}{20} = 3.75\text{ s}$

$S_1 = 3.75 \times 10 = 37.5$ m

When ball collide with wall B, then total time elapse

t = 0.25 + 1.5 = 1.75 s

$\Delta t = 4 - 1.75 = 2.25$ s

$S = 2.25 \times 2.5 = 5.625$ m

23. Initially V800 = V′1000

$\Rightarrow V' = 0.8\,V$ (V′ is volume inside water)

$\Rightarrow H' = 0.8\,H = 0.8 \times 50\text{ cm} = 40\text{ cm}$

If we displace the block by dy inside water then

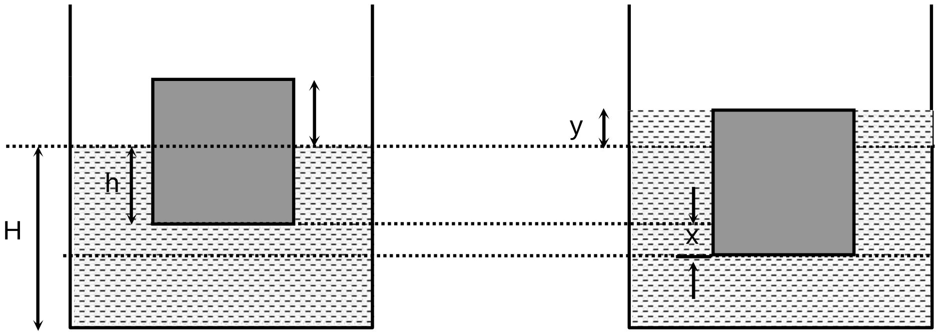
$$dy = dx\left[1 - \frac{a}{A}\right]$$

Where dx is the new dipped part of block on displacing the block by dy

$$\Rightarrow dW = \int_{0.4}^{0.5}\left[x(0.5)^2 1000g - (0.5)^3 800g\right]dx\frac{3}{4} \Rightarrow W = 9.375\text{ J}$$

Second Method:

a $\Rightarrow$ Area of cube A $\Rightarrow$ Base area of container.



$$AH - ah = A(H + y) - a(h + x + y)$$

$$\Rightarrow \quad y = \frac{a}{A - a}x \Rightarrow x + y = \frac{A}{A - a}x$$

$$F_{ex} = F_B - mg = \rho g a(h + x + y) - a^3\rho_B g$$

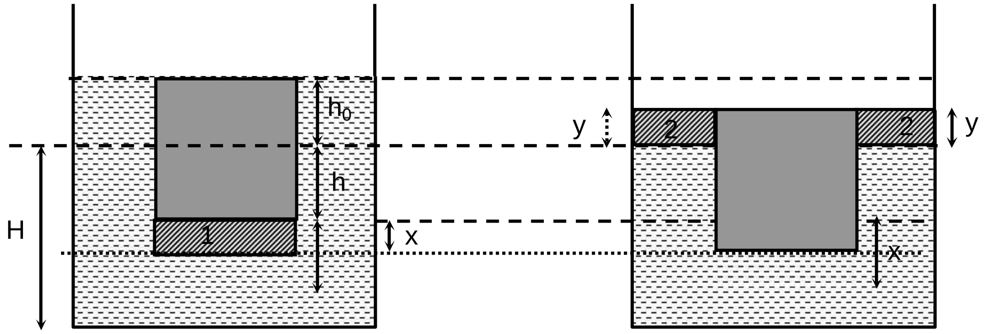
$$= a(x + y)\rho_\ell g = a\left(\frac{A}{A - a}\right)x\rho_\ell g$$

$$W = \int_0^{x_0} F_{ex}dx = \frac{aA\rho_\ell g}{(A - a)} \times \frac{x_0^2}{2} \text{ Here } x_0 = \frac{0.2\sqrt{a}(A - a)}{A}$$

$$\Rightarrow W = \frac{aA\rho_\ell g}{(A - a)} \times \frac{a^2}{2} \times \frac{0.04 \times a(A - a)^2}{A^2} = \frac{0.04a^2(A - a)}{2A}\rho_\ell g = \frac{0.04 \times \frac{1}{4} \times \frac{3}{4} \times \frac{1}{4} \times 1000 \times 10}{2 \times 1}$$

$$= \frac{300}{32} = \frac{75}{8} = 9.375\text{ Joule}$$

Third Method: $a = \ell \times \ell$



$h_0 = \frac{\ell}{5},\ x + y = \frac{\ell}{5},\ x = 3y \Rightarrow x = \frac{3\ell}{20}$

$m_0 \Rightarrow$ mass of liquid displace $= ax\rho_\ell = \frac{3a\rho_\ell}{20} = \frac{3V\rho_\ell}{20}$

Vertical displacement of liquid $= h + \frac{x+y}{2} = \frac{4\ell}{5} + \frac{\ell}{10} = \frac{9\ell}{10}$

$W_{FB} \Rightarrow$ work done by force of buoyancy to raise the liquid $= -m_0 g\frac{g\ell}{10} = -\frac{3V}{20}\rho_\ell \times g \times \frac{9\ell}{10}$

$= -\frac{3}{20} \times \frac{1}{8} \times 1000 \times 10 \times \frac{9}{10} \times \frac{1}{2} = -84.375$ J

$W_{mg} \Rightarrow$ Work done by weight to displace the body downward by distance x

$= mgx = \frac{120}{8} \times 800 \times 10 \times \frac{3}{20} \times \frac{1}{2} = 75$ J

According work energy theorem

$W_{Fex} + W_{FB} + W_{mg} = 0$

$\Rightarrow W_{Fex} = -W_{FB} - W_{mg} = 84.375 - 75 = 9.375$ Joule

Chemistry PART – II

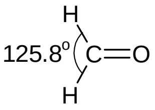
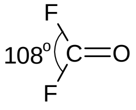
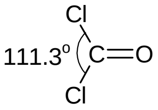
SECTION – A

24. $$\begin{array}{ll} & B > Tl > Ga > Al > In \\ \text{kJ / mole :} & 800\ \ 589\ \ 579\ \ 577\ \ 558 \end{array}$$

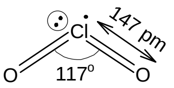
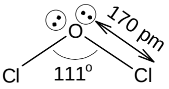
The last element (Tl) has exceptionally high first ionisation energy due to poor screening caused by f-electrons.
The second element (Al) has exceptionally low first ionisation energy due to good screening caused by s & p electrons.

25. $$\begin{array}{ccccccc} HCOOH & + & HCOOH & \rightleftharpoons & HCOOH_2^+ & + & HCOO^- \\ 25M & & 25M & & 0 & & 0 \\ & & 25-10^{-3} & & 10^{-3} & & 10^{-3} \end{array}$$

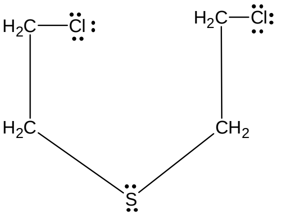
$$\% = \frac{10^{-3}}{25} \times 100 = 0.004\%$$

26. 



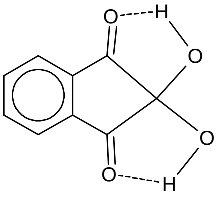
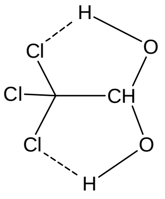
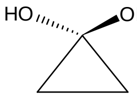
Higher the electronegativity of bonded atom, lesser is the bond angle between the bonds.

27. 


$Cl_2O + H_2O \longrightarrow 2HOCl$

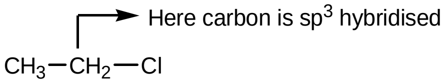
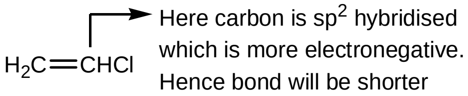
28. 

Mustard gas structure

29. 



(Driving force is relief in angle strain on hydration)

30. The formula of complex is:
$[CrCl_2(en)_4]_2\,[PdCl_4]$
Hence, *i = 3.*

31. (A) 


(B) $CH_2{=}CH_2$
1.34 Å
No resonance

$CH_2{=}CH{-}Cl$
1.38 Å
In vinylchloride C=C bond length is longer due to lone pair and double bond resonance

(C) C–C bond length are different in all three cases

(D) $CH_3–CH_2–Cl$
2.05 D

$CH_2 = CHCl$
1.44 D

In $CH_2 = CH – Cl$ charge separation is less.

32. E.W
$N_2 = 42$
$H_3PO_2 = 33$
$HN_3 = 43$
$P_4O_6 = 27.5$

33. $$12N_2 + 4H_3PO_2 \longrightarrow 8HN_3 + \left(P_4O_6 + 2H_2O\right)$$

$$P_4O_6 + 6H_2O \longrightarrow 4H_3PO_3$$

6 moles H_2O reacts with 1 mole P_4O_6

2 moles H_2O reacts with $\frac{1\times 2}{6} = \frac{1}{3}$ mole P_4O_6

$\therefore$ fraction of P_4O_6 left unreacted = $\frac{2}{3}$

SECTION – C

34. pH range of indicator = 3.4 – 4.6
$\therefore$ pOH range of indicator = 9.4 – 10.6

$\therefore$ pK_b of indicator $= \frac{9.4+10.6}{2} = 10$

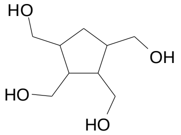
$$InOH \rightleftharpoons In^{+} + OH^{-}$$

$$pOH = pK_b + \log\frac{\left[In^{+}\right]}{[InOH]}$$

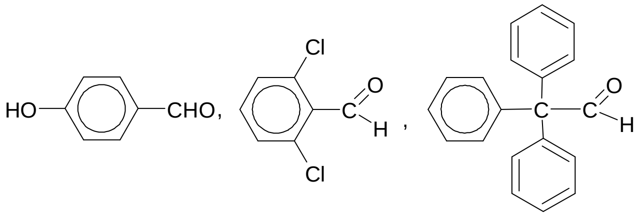
For solution to appear in the colour of In^+, $pOH \geq 10.6$

In limiting case; $10.6 = 10 + \log\frac{\left[In^{+}\right]}{[InOH]}$ $\quad\therefore \frac{\left[In^{+}\right]}{[InOH]} = 4$

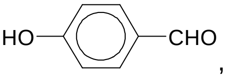
35. X =



36.


HO
CHO,
Cl
O
C
H
Cl
,
C
C
O
H

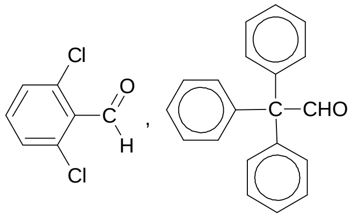
Do not contain any α-hydrogen but still fails to undergo Cannizaro reaction. In case of



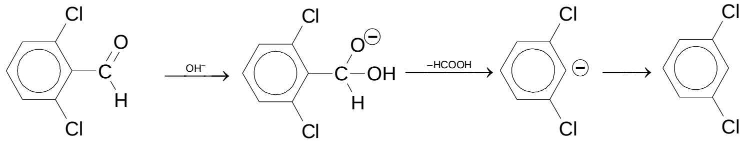
,

the corresponding hydroxide is strongly stabilised by –R effect of –CHO. Consequently, the electrophilicity of the carbonyl carbon is reduced and the OH^- does not attack the carbonyl group.

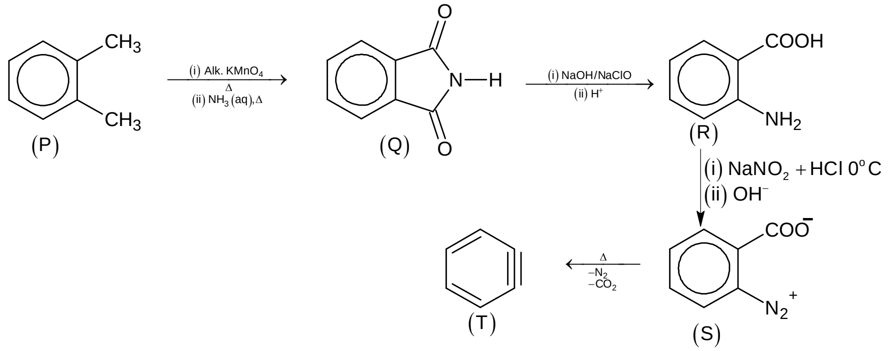
In case of

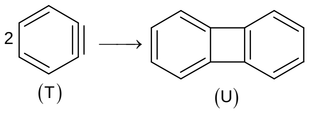

Cl
O
C
H
Cl
,
C
CHO

The intermediate formed due to attack of OH^- cleaves to give a stable anion.

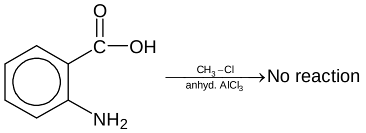

Cl
O
C
H
Cl
OH⁻
Cl
O⊖
C
OH
H
Cl
–HCOOH
Cl
⊖
Cl
Cl
Cl

37.

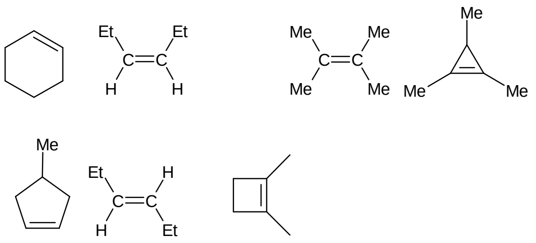

CH3
CH3
(P)
(i) Alk. KMnO4
Δ
(ii) NH3 (aq),Δ
O
N—H
O
(Q)
(i) NaOH/NaClO
(ii) H⁺
COOH
NH2
(R)
(i) NaNO2 + HCl 0°C
(ii) OH⁻
COO⁻
N2⁺
(S)
Δ
–N2
–CO2
(T)



Also,


O
C—OH
NH2
CH3–Cl
anhyd. AlCl3
No reaction

38.


Et
Et
C=C
H
H
Me
Me
C=C
Me
Me
Me
Me
Me
Me
Et
H
C=C
H
Et

39. $$C_3H_8O_3 + nCH_3MgI \longrightarrow nCH_4$$

mass $0.092\,g$

moles $\frac{0.92}{92}$ mole $\quad \frac{67}{22400}$ mole

$=1$ m mole $\quad = 3$ m mole

So, on comparing each molecule of $C_3H_8O_3$ must give 3 molecule of CH_4

40. $\text{Rate} = k\left[C_3H_6^*\right]$ (i)

$$Kc\left(\text{for step1}\right) = \frac{\left[C_3H_6\right]\left[C_3H_6^*\right]}{\left[C_3H_6\right]\left[C_3H_6\right]} = \frac{\left[C_3H_6^*\right]}{\left[C_3H_6\right]}$$

$\therefore \left[C_3H_6^*\right] = K_c\left[C_3H_6\right]$

Substituting in equation (i)

$R = k.\ K_c[C_3H_6]$

$R = k'[C_3H_6]$

41. $\nu = \frac{v}{2\pi r}$

$v \propto \frac{Z}{n}$

$r \propto \frac{n^2}{Z}$

$\nu \propto \frac{Z^2}{n^3}$

$\frac{\nu_{He^+}}{\nu_H} = \frac{4}{27} \div \frac{1}{8} = \frac{32}{27} = \frac{2^5}{3^3}$

$x = 5$

$y = 3$

$x + y = 8$

42. b, c, d, f

43. One mole of the above compound (X) on hydrolysis followed by heating produces 4 moles of CO_2.

Hence, 0.5 M of X produce 2 moles of CO_2.

SECTION – D

44. $$Ca_3\left(PO_4\right)_2 + 8Mg \longrightarrow \underset{(A)}{Ca_3P_2} + \underset{(B)}{8MgO}$$

$$\underset{(A)}{Ca_3P_2} + 6H_2O \longrightarrow 3Ca\left(OH\right)_2 + \underset{(C)}{2PH_3}$$

$$2PH_3 + 3CuSO_4 \longrightarrow \underset{(X,Black)}{Cu_3P_2}\downarrow + 3H_2SO_4$$

46. $\rightarrow v = \left(\frac{2\pi Ke^2}{h}\right) \times \frac{Z}{n}$, so, atomic no. (Z) $\propto$ slope of the graph.

So, statement (1) is True.

$\rightarrow \lambda = \frac{h}{\sqrt{2qVm}}$, slope of the graph $\propto \frac{1}{\sqrt{m}}$

So, statement (2) is True.

$\rightarrow$From, PV = nRT

$V = \left(\frac{nR}{P}\right)T$, so, slope of graph $\propto \frac{1}{P}$

So, statement (3) is also correct.

$\rightarrow P = (nRT)\frac{1}{V}$, so, slope $\propto$ T

So, statement (4) is incorrect.

Mathematics PART – III

SECTION – A

47. $\frac{1}{3}\frac{d}{dx}\left\{e^{x^3}\left(y^3-1\right)\right\}+\frac{1}{3}\frac{d}{dx}\left(e^{y^3}\right)=0$

48. Each prime can go in one of the five slots – x_1, x_2, x_3, x_4 and none of these.

49. $4^4\left(\frac{\sin^{12}B+\sin^{12}C}{\left(\sin 2A+\sin 2B+\sin 2C\right)^4}\right) = \frac{\alpha^4+\beta^4}{\left(\frac{\alpha+\beta}{2}\right)^4}$ where α, β are distinct positive real number whose AM is a and two GM's are b, c

50. Any combination of 4 points gives 3 new intersection points

51. $f(1-x)=f(1+x)$
$\Rightarrow f'(1+x) = -f'(1-x)$

52. $I<\int_0^{\pi/2}\frac{\cos\theta}{10-6\cos\theta}d\theta<\frac{1}{4}\int_0^{\pi/2}\cos\theta d\theta<1$
$\frac{\cos\theta}{10-6\cos\theta}>\left|\frac{\cos(\pi-\theta)}{10-6\cos(\pi-\theta)}\right|$ for $\theta\in\left[0,\frac{\pi}{2}\right)$ $\Rightarrow I > 0$

53. For area of parallelogram PQRS to be least line L makes angle $\frac{\pi}{4}$ with L_1 and L_2

54. Centre of the circle is at (a, a)
$a^2 + (a-2)^2 = (a-4)^2 + (a-3)^2$
$\Rightarrow a = \frac{21}{10}$

55. D_5

56. ${}^5C_1\left\{{}^4C_1\cdot D_4 + {}^4C_1\cdot\left({}^3C_1\cdot D_3 + {}^3C_1\times{}^2C_1\right)\right\}$

SECTION – C

57. $^{3}C_{1} \times D_{3} + {}^{3}C_{1} \times D_{2} \times {}^{2}C_{1}$

58. Let x = r cos θ; y = r sin θ

$$\Rightarrow r^{2} = \frac{\sin 2\theta}{\cos^{4}\theta + \sin^{4}\theta}$$

59. Exactly four girls are together – Exactly four girls are together and B_1 B_2 are together

$$p = \frac{5! \times 8! \times 58}{13!}$$

60. $\tan\alpha = \frac{3}{5}$, $\tan\beta = \frac{5}{4\cos\alpha} = \frac{\sqrt{34}}{4}$

61. $9\left(1 - \frac{1}{3}\right) = 9 \times \frac{2}{3} = 6$

62. $$\Delta = \begin{vmatrix} \gamma^{2} & \beta^{2} & 2\beta\gamma - \alpha^{2} \\ 2\alpha\gamma - \beta^{2} & \alpha^{2} & \gamma^{2} \\ \alpha^{2} & 2\alpha\beta - \gamma^{2} & \beta^{2} \end{vmatrix} = \left(\alpha^{3} + \beta^{3} + \gamma^{3} - 3\alpha\beta\gamma\right)^{2}$$

63. Denominator = $^{n}C_{0}\ {}^{n+k-1}C_{n-1} + {}^{n}C_{1}\ {}^{n+k-2}C_{n-1} + {}^{n}C_{2}\ {}^{n+k-3}C_{n-1} + \ldots {}^{n}C_{k-1}\ {}^{n}C_{n-1} + {}^{n}C_{k}\ {}^{n-1}C_{n-1}$
= coefficient of x^{n-1} in
$^{n}C_{0}(1+x)^{n+k-1} + {}^{n}C_{1}(1+x)^{n+k-2} + {}^{n}C_{2}(1+x)^{n+k-3} + \ldots {}^{n}C_{k-1}(1+x)^{n} + {}^{n}C_{k}(1+x)^{n-1}$
= coefficient of x^{n-1} in
$^{n}C_{0}(1+x)^{n+k-1} + {}^{n}C_{1}(1+x)^{n+k-2} + {}^{n}C_{2}(1+x)^{n+k-3} + \ldots {}^{n}C_{k-1}(1+x)^{n} + {}^{n}C_{k}(1+x)^{n-1}$
$+ {}^{n}C_{k+1}(1+x)^{n-2} + {}^{n}C_{k+2}(1+x)^{n-3} + \ldots {}^{n}C_{n}(1+x)^{k-1}$
= coefficient of x^{n-1}
$(1+x)^{n+k-1}(1+(1+x)^{-1})^{n} = (1+x)^{k-1}(x+2)^{n}$
= coefficient of x^{n-1} in

$$\sum_{r=1}^{n} {}^{n}C_{r}\ 2^{r}\ x^{n-r}(1+x)^{k-1} = \sum_{r=1}^{n} 2^{r}\ {}^{n}C_{r}\ {}^{k-r}C_{r-1}.$$

64. Let r_1, r_2 and r are in-radius of ΔABD, ΔADC and ΔABC respectively

$r_{1} = \frac{c}{a} \times r$; $r_{2} = \frac{b}{a} \times r$ and $EF = \sqrt{2\left(r_{1}^{2} + r_{2}^{2}\right)} = \sqrt{2}\,r = AI$

65. $$\sum_{r=1}^{m} \frac{(m+1)(r-1)m^{r-1}}{r\ {}^{m}C_{r}} = \sum_{r=1}^{m}\left(\frac{\left[mr - (m-r+1)\right]m^{r-1}}{r\ {}^{m}C_{r}}\right)$$

$$= \sum_{r=1}^{m}\left(\frac{m^r}{{}^mC_r} - \frac{m^{r-1}(m-r+1)\,r!\,(m-r)!}{r.\,m!}\right)$$

$$= \sum_{r=1}^{m}\left(\frac{m^r}{{}^mC_r} - \frac{m^{r-1}(m-r+1)\,!\,(r-1)!}{m!}\right) = \sum_{r=1}^{m}\left(\frac{m^r}{{}^mC_r} - \frac{m^{r-1}}{{}^mC_{r-1}}\right) = m^m - 1.$$

66. Let the variable chord be x cosα + y sinα = p. Let this chord intersect the hyperbola in A and B

The joint equation of OA and OB is $\frac{x^2}{4} - \frac{y^2}{8} = \left(\frac{x\cos\alpha + y\sin\alpha}{p}\right)^2$

$\Rightarrow \left(\frac{1}{4} - \frac{\cos^2\alpha}{p^2}\right)x^2 - \left(\frac{1}{8} + \frac{\sin^2\alpha}{p^2}\right)y^2 - \frac{2\sin\alpha\cos\alpha}{p^2}xy = 0$

$\Rightarrow \frac{1}{4} - \frac{\cos^2\alpha}{p^2} - \frac{1}{8} - \frac{\sin^2\alpha}{p^2} = 0 \Rightarrow p^2 = 8$.

The variable line touches the fixed circle, thus perpendicular distance of (0, 0) = Radius

$\therefore$ Equation of the circle is $x^2 + y^2 = 8$

SECTION – D

67. $p = \frac{{}^5C_1}{{}^7C_3}\cdot\frac{2}{3}\cdot\left(\frac{1}{2}\right)^4$

68. L = circumference of unit circle = 2π

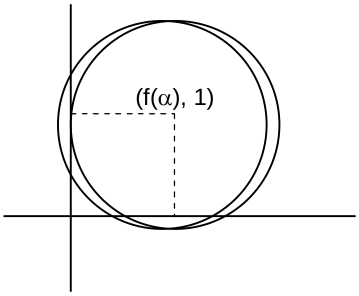
69. From the figure it is clear that for arg z $\geq \frac{\pi}{2}$ circle should either lie in second quadrant or touch the positive imaginary axis.

$\Rightarrow f(\alpha) \leq 1$

$\alpha^2 - 7\alpha + 13 \leq 1$

$\alpha^2 - 7\alpha + 12 \leq 0$

$3 \leq \alpha \leq 4$



FIITJEE **JEE (Main)-2018**

ALL INDIA TEST SERIES

OPEN TEST

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 – 30, 31 – 60, 61 – 90)** *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

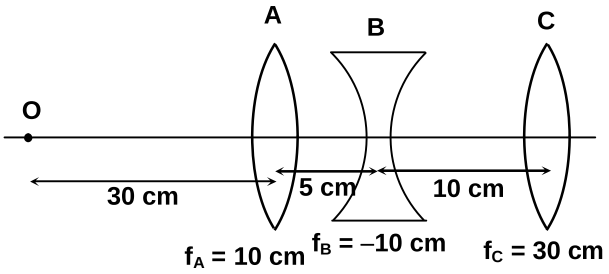
PART – I

SECTION – A

(One Options Correct Type)

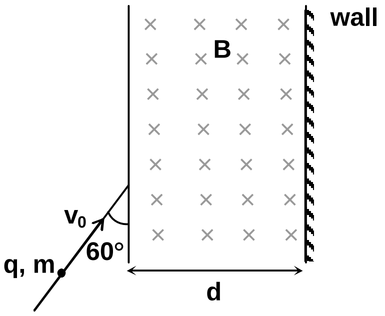
This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A point object 'O' lies in front of the lens as shown in figure. Find the final position of image formed by the combined lenses.
   (A) 10 cm to the right of the lens C
   (B) 15 cm to the right of the lens C
   (C) 20 cm to the right of the lens C
   (D) 30 cm to the right of the lens C

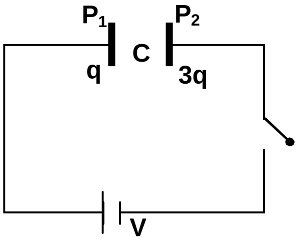


2. A positively charged particle (q, m) enters in a uniform magnetic field 'B' at an angle of 60° as shown in figure with speed v_0. Collision between the charge particle and the wall is perfectly elastic. Then find the time in which the charge particle comes out from the magnetic field. $\left(\text{take } d = \frac{(\sqrt{3}-1)mv}{2qB}\right)$

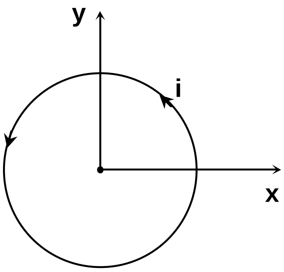
   (A) $\frac{\pi m}{2qB}$
   (B) $\frac{\pi m}{6qB}$
   (C) $\frac{\pi m}{3qB}$
   (D) $\frac{2\pi m}{3qB}$



Space for Rough work

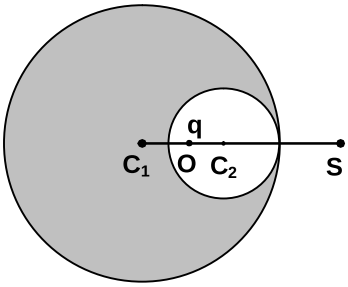


3. A capacitor of capacity C having charge q and 3q on the plate P$_1$ and P$_2$ respectively as shown in figure. Now switch 'S' is closed, find the work done by the battery. (take q = CV)
(A) qV (B) 2qV
(C) 3qV (D) 4qV



4. Magnetic field in a space is given as $\vec{B} = -\frac{B_0 x}{R}\hat{k}$. A circular ring of radius R having current I lies in the space with centre at origin as shown in the figure. Find the magnitude of net magnetic force acting on the circular ring due to the magnetic field.
(A) $2iB_0R$ (B) πiB_0R
(C) $2\pi iB_0R$ (D) zero

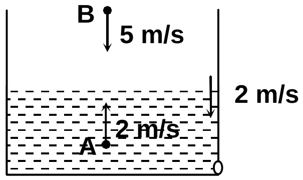
5. A charge particle is moving with a velocity $3\hat{i} + 4\hat{j}$ m/sec and it has electric field $\vec{E} = 10\hat{k}$ N/C at a given point. Find the magnitude of magnetic field at the same point due to the motion of the charge particle.
(A) $100\ \mu_0\varepsilon_0$ (B) $25\ \mu_0\varepsilon_0$
(C) $12.5\ \mu_0\varepsilon_0$ (D) $50\ \mu_0\varepsilon_0$



6. A charge q is placed in the cavity at 'O' in a spherical uncharged conducting conductor. Point 'S' is outside the conductor. If charge 'q' is displaced towards C$_2$. Then
(A) Electric field due to induced charge at S increases
(B) Electric field due to induced charge at S decreases
(C) Electric field due to induced charge at S first increase then decrease.
(D) Electric field due to induced charge at S will not change.

Space for Rough work

7. Two point objects are moving towards each other. Object ‘A’ is inside the waver (μ_w = 4/3) and object B is in the air. Water level is moving downward with a velocity 2 m/s as shown in figure. Find the speed of A with respect to B.



(A) 5 m/s (B) 7 m/s
(C) 8 m/s (D) 6 m/s

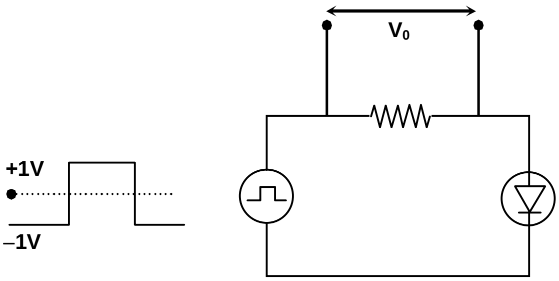
8. Light of wavelength 488 nm is produced by an Argon laser which is used in the photoelectric effect. When light from this spectral line is incident on the emitter, the stopping (cut-off) potential of photo electrons is 0.38 V. Find the work function of the material form which the emitter is made.

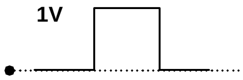
(A) 1.38 eV (B) 2.55 eV
(C) 2.17 eV (D) 2.93 eV

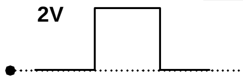
9. When an electric field is applied across a semiconductor
(A) Electrons move from higher energy level to the lower energy level in the conduction band.
(B) Electrons in conduction band remains in rest
(C) holes in the valance band move from higher energy level to lower energy level.
(D) holes in the valance band move from lower energy level to higher energy level.

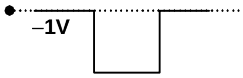
10. In a n-p-n transistor circuit, the collector current is 10 mA. If 80 percent of electrons emitted reach to the collector. Then which of the following statement is true.
(A) The emitter current will be 2.5 mA
(B) The emitter current will be 22.5 mA.
(C) The base current will be 2.5 mA.
(D) The base current will be 22.5 mA

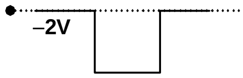
11. The output waveform across the resistor is



(A)


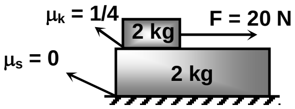
(B)


(C)


(D)


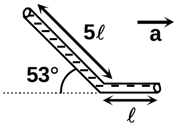
Space for Rough work

12. A force of 20 N is applied on upper block as shown in the figure. The total work done by frictional during the time interval in which the upper block has a displacement of 15 m with respect to the ground is (take g = 10 m/s^2)



(A) 50 J (B) –50 J
(C) 75 J (D) –75 J

13. In the given tube liquid density ρ is filled. Find the acceleration of the tube towards right direction such that no liquid will fall out of the tube.



(A) $\frac{3}{5}g$ (B) $\frac{4}{5}g$
(C) g (D) 4g

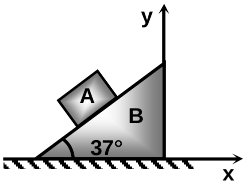
14. An artificial satellite is moving in a circular orbit around the earth with a speed equal to 3/8 times of the magnitude of escape velocity from the earth. If the satellite is stopped suddenly in its orbit and allowed to fall freely onto the earth, then the speed with which it hits the surface of the earth is (take g = 10 m/s and R_e = 6400 Km)

(A) $\sqrt{\frac{29}{4}}$ Km/s (B) $\sqrt{\frac{23}{2}}$ Km/s
(C) $\sqrt{\frac{29}{6}}$ Km/s (D) $\sqrt{\frac{29}{13}}$ Km/s

15. An unknown resistance r is determined in terms of a standard resistance R = 100 Ω by using potentiometer. The potential difference across r is balanced against 45 cm length of the wire and that (r + R) is obtained at 70 cm of the wire. Find the value of the unknown resistance.

(A) 200 Ω (B) 280 Ω
(C) 180 Ω (D) 100 Ω

16. In the figure shown the velocity of A with respect to ground is $(20\hat{i}+15\hat{j})$ m/s, then what will be the magnitude of velocity of the wedge 'B' with respect to ground frame. (A remains in contact with B)



(A) 12 m/s (B) 25 m/s
(C) 20 m/s (D) zero

Space for Rough work

17. An object is subjected to an acceleration a = 4 + 3v. It is given that the displacement S = 0 when v = 0. The value of displacement when v = 3 m/s is

(A) $1+\frac{4}{3}\ell n\left(\frac{13}{4}\right)$ (B) $1-\frac{4}{3}\ell n\left(\frac{13}{8}\right)$

(C) $1-\frac{4}{9}\ell n\left(\frac{13}{4}\right)$ (D) $1+\frac{4}{9}\ell n\left(\frac{13}{8}\right)$

18. A progressive wave travels in a medium M_1 and enters into another medium M_2 in which its speed decreases to 60%. Then the ratio of the amplitude of the transmitted and the incident waves is

(A) 3/5 (B) 3/4

(C) 3/10 (D) 1

19. A wave is travelling along x-axis. The disturbance at x = 0, and t = 0 is A/2 and is increasing, where A is amplitude of the wave. If $Y = A \sin (kx - \omega t + \phi)$, then the initial phase is

(A) $\frac{\pi}{6}$ (B) $\frac{5\pi}{6}$

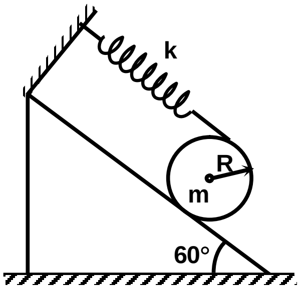
(C) $\frac{\pi}{3}$ (D) $\frac{11\pi}{6}$

20. A block of mass 'm' is attached by an inelastic string to a suspended spring of spring constant 'k'. Both the string and the spring have negligible mass and the string inextensible and of length 'L'. Initially, the block is at rest. The largest amplitude A_{max}, for which the string will remain taught in the motion.

(A) $\frac{mg}{2k}$ (B) $\frac{mg}{k}$

(C) L/2 (D) L

21. A uniform solid sphere of mass 'm' and radius R is in equilibrium on an inclined plane by the action of the light spring of stiffness k, gravity and on it. If the angle of inclination of the plane is 60°, then find the time period of oscillation for small displacement.



(A) $2\pi\sqrt{\frac{m}{10k}}$ (B) $2\pi\sqrt{\frac{7m}{10k}}$

(C) $2\pi\sqrt{\frac{7m}{20k}}$ (D) $2\pi\sqrt{\frac{7m}{40k}}$

Space for Rough work

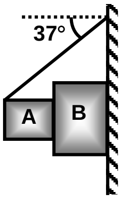
22. Two identical containers A and B having same volume of an ideal gas at same temperature have mass of the gas as m_1 and m_2 respectively and $2m_1 = 3m_2$. The gas in each cylinder expands isothermally to double of its volume. If change in pressure in A is 300 Pa, then the change in pressure in B is

(A) 200 Pa (B) 300 Pa
(C) 400 Pa (D) 500 Pa

23. The mass of a gas molecule can be computed from the specific heat at constant volume. C_V for argon is 0.15 Kcal/kg-k. The molecular weight of an argon atom is (approximately) (R = 2 cal/mol-K)

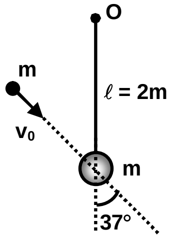
(A) 5×10^{-3} kg (B) 2.5×10^{-3} kg
(C) 40×10^{-3} kg (D) 20×10^{-3} kg

24. Two block A and B of mass 50 kg and 300 kg respectively are placed as shown in figure. Coefficient of friction between all surface is $\frac{1}{2}$. Then (take g = 10 m/s)



(A) Tension in the string is 2000 N
(B) Tension in the string is 3000 N
(C) Acceleration of block B is 5/3 m/s^2.
(D) Acceleration of block B is 10/3 m/s^2.

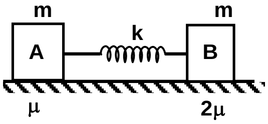
25. An elastic ball of mass 'm' is suspended from a fixed point 'O' by an inextensible string of length 2m. A small particle of mass m moving downward at angle of 37° with the vertical hits the ball with v_0. The coefficient of restitution for collision is 4/5. the velocity of the particle v_0 such that ball just complete one revolution after the collision.



(A) $\frac{170}{27}$ m/s (B) $\frac{85}{27}$ m/s
(C) $\frac{680}{27}$ m/s (D) $\frac{340}{27}$ m/s

Space for Rough work

26. Two block of same mass 'm' are joined with an ideal spring of spring constant k and kept on a rough surface as shown in figure. The spring is initially unstretched and coefficient of friction between the blocks and horizontal surface is μ and 2μ respectively. What should be the maximum speed of block 'A' such that the block 'B' does not move?



(A) $2\mu g\sqrt{\frac{2m}{k}}$ (B) $\mu g\sqrt{\frac{2m}{k}}$

(C) $\mu g\sqrt{\frac{m}{k}}$ (D) $2\mu g\sqrt{\frac{m}{2k}}$

27. A block weight is 15 Newton in air. It weight 12 Newton when immersed in water. When immersed in another liquid, it weight is 13 Newton. Then find the ratio of density of block and the other liquid. ($\rho_{block}/\rho_{liquid}$)

(A) $\frac{15}{2}$ (B) 15

(C) $\frac{15}{4}$ (D) $\frac{13}{12}$

28. A bar magnet having a magnetic moment of 1.0×10^4 J/T is free to rotate in a horizontal plane. A horizontal magnetic field $B = 4 \times 10^{-5}$ T exists in the space. The work done in rotating the magnet slowly from a direction parallel to a direction 60° from the field will be:

(A) 0.2 J (B) 0.1 J

(C) 0.4 J (D) 0.3 J

29. A person is viewing two red dots at a distance of 1000 m. What should be the minimum distance between dots so that his eye can resolve two dots separately.

(take : λ_{red} = 700 nm, pupil dia = 2.5 mm)

(A) 45 cm (B) 50 cm

(C) 35 cm (D) 10 cm

30. A parallel beam of light of wavelength λ passes through a slit of width d. The transmitted light is collected on a screen D away (D >> d). Find the distance between the two second order minima.

(A) $\frac{D\lambda}{d}$ (B) $\frac{D\lambda}{2d}$

(C) $\frac{2D\lambda}{d}$ (D) $\frac{4D\lambda}{d}$

Space for Rough work

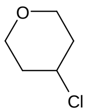
Chemistry

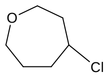
PART – II

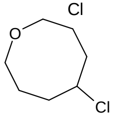
SECTION – A
Straight Objective Type

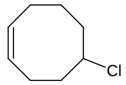
This section contains **30 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

31. Which of the following undergoes fastest solvolysis?

(A)


(B)


(C)


(D)


32. Which of the following is correct for various reversible reactions?

(A) In case of $liq. \rightleftharpoons gas$; systems the equilibrium is attained between both the phases, whether the system is closed or open.

(B) Boiling point of a liquid is independent of the altitude of the place of experiment.

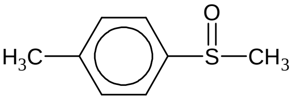
(C) The value of equilibrium constant is independent of concentration terms.

(D) If a reversible reaction has high value of its equilibrium constant, the reaction quickly attains the equilibrium.

33. Which of the following is chiral as well optically active?

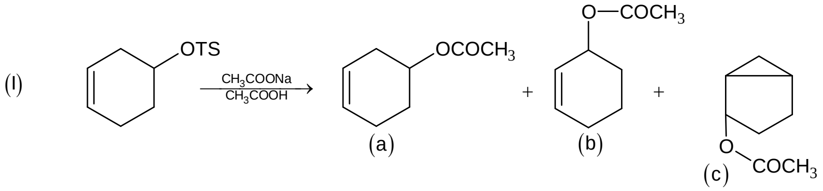
(A) Me – NH-Et

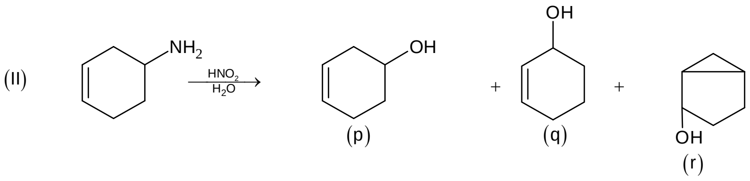
(B) cis-cyclooctene

(C)


(D) $Et.\dot{C}HMe$

34. Consider the following reactions:



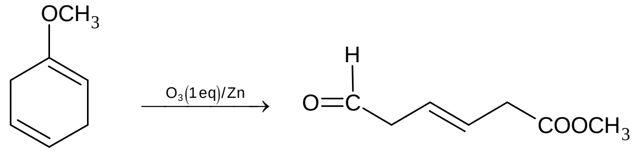


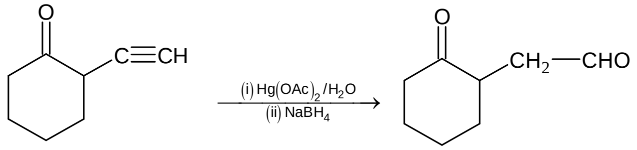
Which of the following is correct combination of major products, correspondingly?

(A) I – a, II – p
(B) I – a, II – q
(C) I – b, II – q
(D) I – b, II – p

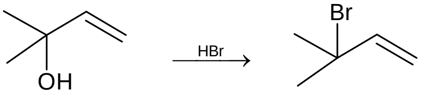
Space for Rough work

35. Consider the following reactions:

(I) 
OCH3
O3(1eq)/Zn
H
O=C
COOCH3

(II) 
O
C≡CH
(i) Hg(OAc)2/H2O
(ii) NaBH4
O
CH2—CHO

(III) $Ph-CH_2-CH_2-\overset{\oplus}{N}(Et)_3 \xrightarrow[\Delta]{\text{Moist } Ag_2O} PhCH=CH_2+Et_3N$

(IV) 

In which of the above reactions, the products written are major products.

(A) I, II, III & IV (B) I, III & IV only

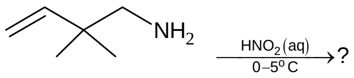
(C) I, II & III only (D) II & IV only

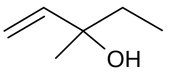
36. BrF_3 and IF_5 both exist in ionic form, in solid state. What are the hybridizations of cationic parts of both, respectively?

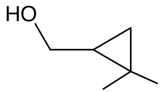
(A) sp^3, sp^3 (B) sp^3d, sp^3d

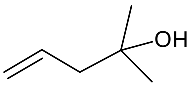
(C) sp^3, sp^3d (D) sp^2, sp^3

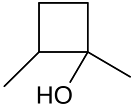
37. What is the major product of the following process?


NH2
HNO2(aq)
0–5° C
?

(A) 

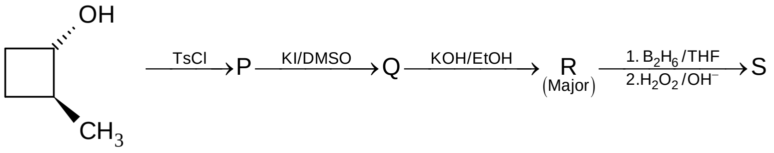
(B) 

(C) 

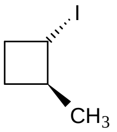
(D) 

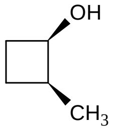
Space for Rough work

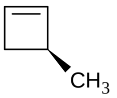
38. Consider the following reaction sequence:

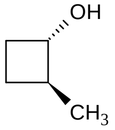

OH
CH3
TsCl
P
KI/DMSO
Q
KOH/EtOH
R
(Major)
1. B2H6/THF
2.H2O2/OH⁻
S

Choose the most correct of the following?

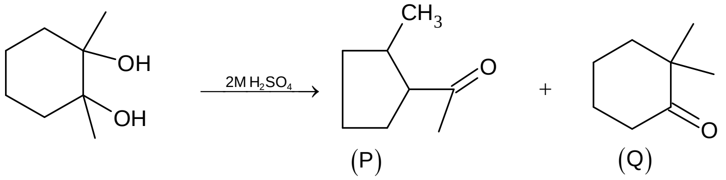
(A) Q is 

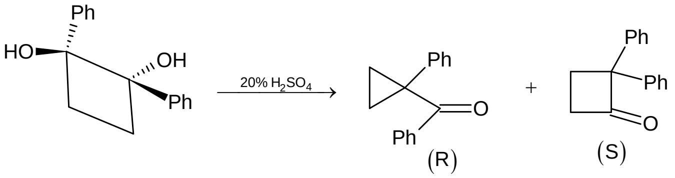
(B) S is 

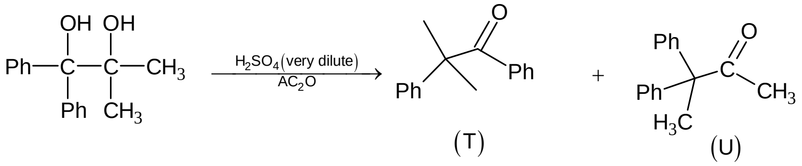
(C) R is 

(D) S is 

39. Consider the following reactions:

(I) 
OH
OH
2M H2SO4
CH3
O
(P)
+
O
(Q)

(II) 
Ph
HO
OH
Ph
20% H2SO4
Ph
O
Ph
(R)
+
Ph
Ph
O
(S)

(III) 
OH OH
Ph—C—C—CH3
Ph CH3
H2SO4(very dilute)
AC2O
O
Ph
Ph
(T)
+
O
Ph
C
Ph
CH3
H3C
(U)

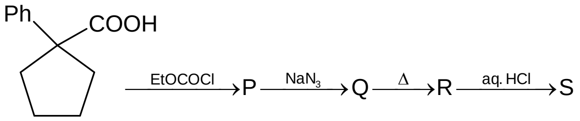
Select the correct statement from the following:
(A) P is more than Q.
(B) S is not formed in the reaction (II).
(C) T is almost 100% product of the reaction (III).
(D) All others are also correct.

40. Glucose and fructose can be distinguished by:

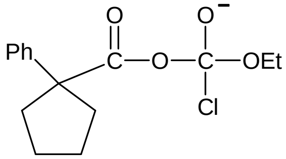
(A) Fehling solution (B) Osazone formation
(C) Bromine water (D) Conc. H_2SO_4/warming.

Space for Rough work

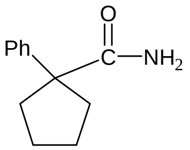
41. Consider the following reaction sequence and select the correct one from the given statements?



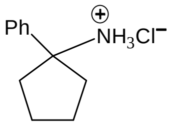
(A) P is



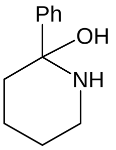
(B) Q is



(C) S is



(D) S is

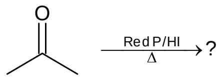


42. Which of the following reactions end with the same product?

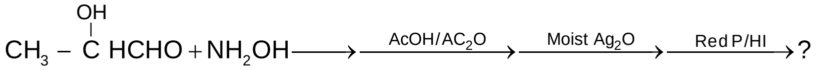
(I) $\left(CH_3\right)_2C=N-OH \xrightarrow[\Delta]{OH^-} ?$

(II) $\left(CH_3\right)_2C=N.NHSO_2Ph \xrightarrow{NaBH_4} ?$

(III)



(IV)



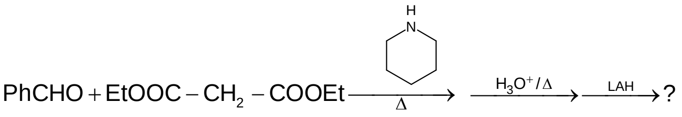
$CH_3-\overset{OH}{\overset{|}{C}}HCHO+NH_2OH \longrightarrow \xrightarrow{AcOH/AC_2O} \xrightarrow{\text{Moist } Ag_2O} \xrightarrow{\text{Red P/HI}} ?$

(A) I, III
(B) I, II, III, IV
(C) I, II, III
(D) II and III only

43. Which of the following reactions end with the same product?

(a) $PhCH=CHCH_2OH \xrightarrow{MnO_2} ?$

(b)



$PhCHO+EtOOC-CH_2-COOEt \xrightarrow[\Delta]{} \xrightarrow{H_3O^+/\Delta} \xrightarrow{LAH} ?$

(c) $PhCHO \xrightarrow[\Delta(5-6\text{ hr})]{AC_2O/ACO^-} \xrightarrow{LAH} \xrightarrow{MnO_2} ?$

(A) a, b, c
(B) a, c
(C) b, c
(D) a, b

44. 7.5 gm glycine is added to 500 ml water. What is the pH of the solution? (Given : $pK_{a_1}\left(\text{glycine}\right)=2.4;\ pK_{a_2}\left(\text{glycine}\right)=9.54$)

(A) 6.15
(B) 2.58
(C) 9.58
(D) 5.97

Space for Rough work

45. The cell reaction for the given cell is spontaneous if :

$\mathrm{Pt;H_2\left(P_1\ atm\right)|H^+\left(1M\right)|H_2\left(P_2\ atm\right);Pt}$

(A) $P_1 > P_2$ (B) $P_1 < P_2$

(C) $P_1 = P_2$ (D) $P_2 = 1$ atm

46. NaCl and NaCN can be distinguished by using the following reagents in the given sequence?

(A) (i) H_2O_2 / Δ (ii) $AgNO_3/HNO_3$ (B) $HgNO_3$(aq)

(C) (i) Conc. H_2SO_4 (ii) combustion of gas evolved (D) By all of A, B & C

47. Calculate the equilibrium constant for the following reaction:

$$3Sn + 2Cr_2O_7^{2-} + 28H^+ \longrightarrow 3Sn^{4+} + 4Cr^{3+} + 14H_2O$$

$E^o_{Sn/Sn^{4+}} = 0.009$ V; $E^o_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33$ V

(A) 10^{413} (B) $10^{1.8}$

(C) 10^{272} (D) 10^{317}

48. Which of the following is incorrect?

(A) For a perfect gas : at constant temperature, the product of pressure and specific volume $\left(\frac{V}{M}\right)$ is constant.

(B) The zero of absolute temperature is that temperature at which a perfect gas of finite volume has no pressure.

(C) On the basis of second law of thermodynamics, a definition of temperature completely independent of the properties of any individual substance and applicable to all stages of heat and cold.

(D) Other three are incorrect.

49. Which of the following statements is correct?

(A) Heat capacity of solids and liquids is almost independent of any variations of external pressure, that may take place during the process of heating.

(B) Dulong and Petits law (at. Wt. × Sp. Heat = 6.4) is better applicable to the substance/element of lower atomic/molecular mass.

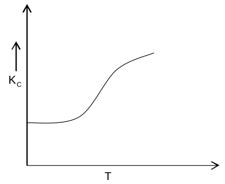
(C) Applicability of Dulong & Petits law to molecular species is independent of molecular structures/constitutions.

(D) Specific heat of a gas is not influenced considerably by the conditions of the heating process.

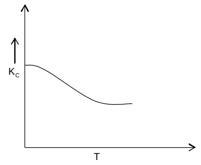
Space for Rough work

50. Which of the following is correct?

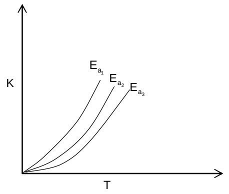
(A) For a reversible reaction for which $\Delta_r H = -ve$



(B) For reversible reaction for which $\Delta_r H = +ve$



(C)



; E_a = Activation energy.
$E_{a_1} > E_{a_2} > E_{a_3}$;
K = Specific rate constant

(D) Activation energy of a reaction is a barrier to energy transfer (KE to PE) between reacting molecules that must be overcome, which is due to need of bonds stretch as well as steric repulsions.

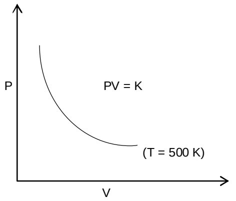
51. An ideal equimolar binary liquid solution of A and B has a vapour pressure of 900 mm of Hg. It is distilled at a constant temperature till $\frac{2}{3}$ $(\text{i.e.}66.67\%)$ of the original amount. If the mole fraction of A is 0.3 in residue and that of B in condensate is 0.4 and also the vapour pressure of residue is 860 mm Hg which of the following is correct?

(A) Mole fraction of A is more than that of B in vapour phase, above residue as well as above condensate.
(B) Vapour pressure of condensate is more than 900 mm Hg at same temperature.
(C) In vapour pressure of residue, vapours of A are more contributing.
(D) If the solution would be distilled till 50% of the original amount then mole fraction of B in liquid condensate would be more than that of A in same solution.

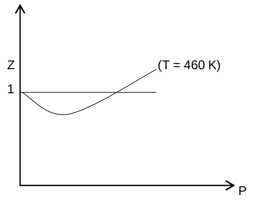
Space for Rough work

52. If the critical temperature of a gas is 500 K, then which of the following is correct for the same gas?

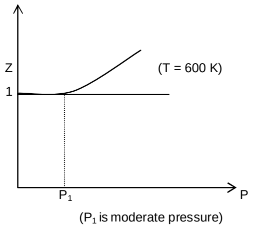
(A)



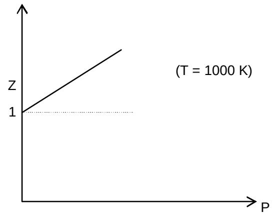
(B)



(C)



(D)



53. Consider the following reactions:

$Fe^{2+} \xrightarrow{\text{excess } CN^-} P;$

$Fe^{3+} \xrightarrow{\text{excess } CN^-} Q;$

Which of the following is correct about P and Q?

(A) $P + Fe^{2+} \longrightarrow$ Prussian blue coloured precipitate.

(B) Iron in both the P and Q, is d^2sp^3 hybridised.

(C) Complex P is paramagnetic.

(D) Complex 'Q' has smaller magnetic moment than P.

54. Which of the following order is correct regarding dipole moment?

(A) $CO_2 < SO_2 < SO_3$ (B) $PCl_5 < PCl_3F_2 < PCl_2F_3$

(C) $XeF_6 > XeF_4 = XeF_2$ (D) $CH_4 < CH_2Cl_2 < CH_3Cl < CHCl_3$

55. In a fcc lattice A, B, C and D atoms are arranged at corners, face centres octahedral voids and half of tetrahedral voids respectively and if the crystal deposited is defected such that all the particles at one body diagonal of each unit cell are missing, correspondingly then what is the resulted formula of the compound?

(A) $AB_3C_4D_4$ (B) $AB_4C_4D_4$

(C) $A_3B_3C_2D_4$ (D) $A_2B_3C_3D_4$

56. Which of the following lanthanoid ions, has zero magnetic moment? [Ce (z = 58); Sm (z = 62); Eu (z = 63); Yb (z = 70)]

(A) Sm^{2+} (B) Eu^{2+}

(C) Yb^{2+} (D) Ce^{2+}

Space for Rough work

57. Which of the following is correct?
(A) All alkali earth metal salts impart a characteristic colour to Bunsen flame.
(B) CsOH is most soluble hydroxide among LiOH, KOH, RbOH and CsOH.
(C) Among the alkali metals Li is most reactive under all the conditions.
(D) The reducing character of the alkali metal hydrides follow the following order:
$LiH > NaH > KH > RbH > CsH$

58. In the metallurgical process of iron, when lime stone is added to the blast furnace, the Ca^{2+} ions end-up in:
(A) Metallic calcium
(B) Gangue
(C) $CaSO_3$
(D) Slag

59. Which of the following cannot decolourise the iodine solution?
(A) Excess of Cl_2 water.
(B) Excess of $Na_2S_2O_3$ solution.
(C) Excess of Br^- solution.
(D) Excess of NaOH solution.

60. (i) Inorganic compound $'A'(aq) + \text{DeVarda's alloy} \xrightarrow{\Delta} B(g) + \text{salt}$
(ii) $'A'(aq.) + C \xrightarrow{\Delta} PH_3(g);$
(iii) $A(aq) + NH_4Cl \xrightarrow{\Delta} D(g) + Cl^- + H_2O;$
(iv) B is colourless combustible lightest gas.
(v) D-turns red litmus blue.
Which of the following combination is correct?
(A) A = KOH
B = H_2
C = H_3PO_3
D = NH_3
(B) A = NaOH
B = H_2
C = H_3PO_4
D = PH_3
(C) A = NaOH
B = H_2
C = H_3PO_4
D = NH_3
(D) A = NaOH
B = H_2
C = P_4
D = NH_3

Space for Rough work

Mathematics

PART – III

SECTION – A
Straight Objective Type

This section contains **30 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

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61. Let $\vec{a}, \vec{b}$ and $\vec{c}$ be three vectors such that $|\vec{a}| = 1$, $|\vec{b}| = 4$ and $|\vec{c}| = 9$ & $\vec{a}\cdot\vec{b} + \vec{b}\cdot\vec{c} + \vec{c}\cdot\vec{a} = -41$, then $|\vec{a}\times\vec{b}|$ is equal to

(A) 0
(B) 1
(C) 2
(D) none of these

62. The curve represented by the equation $\frac{x^2}{\sin\sqrt{2} - \sin\sqrt{3}} + \frac{y^2}{\cos\sqrt{2} - \cos\sqrt{3}} = 1$ is

(A) an ellipse with focus on x-axis
(B) a hyperbola with focus on x-axis
(C) an ellipse with focus on y-axis
(D) a hyperbola with focus on y-axis

63. Let $\alpha = e^{\frac{i9\pi}{19}}$, then $\text{Re}\left(\sum_{r=1}^{9} (-1)^{r+1} \cdot \alpha^r\right)$ is equal to

(A) $-\frac{1}{2}$
(B) 0
(C) $\frac{1}{2}$
(D) none of these

64. Sum of $\left(2 + \frac{10}{3} + \frac{20}{3} + \frac{68}{5} + \frac{416}{15} + \text{..... upto 31 terms}\right)$ is

(A) $2^{27}\cdot 27$
(B) $2^{31}\cdot 31$
(C) $2^{27}\cdot 31$
(D) $2^{31}\cdot 27$

65. In a triangle ABC, A ≡ (1, 3) and perpendicular bisector of AB is y = x and orthocentre of triangle ABC is (3, 1), then locus of vertex C is

(A) $y = x + 1$
(B) $y = x - 2$
(C) $2y = x + 4$
(D) $2y = x$

Space for rough work

66. Let roots of the equation $x^4 - 4x^3 + 6x^2 - 4x - 15 = 0$ are α, β, γ and δ, then the value of $\frac{\alpha-1}{\beta-1}+\frac{\beta-1}{\gamma-1}+\frac{\gamma-1}{\delta-1}+\frac{\delta-1}{\alpha-1}$ is equal to

(A) –4 (B) –2
(C) 0 (D) 4

67. Let shortest distance between a variable line and $\frac{x-1}{2}=\frac{y-2}{3}=\frac{z-3}{4}$ lies along the points A(3, 5, 7) and B(2, 3, 4), then locus of the points on the variable line is

(A) $3x + 2y + z = 16$ (B) $x + 2y + 3z = 20$
(C) $2x + y + 3z = 19$ (D) $x + 2y + 3z = 34$

68. Let f(x) and g(x) be two functions such that $g(x)=\frac{[x]f(x)}{[x]f(x)}$ and g(x) is periodic function with fundamental period 'T', then minimum value of 'T' is (where [.] denotes the greatest integer function)

(A) $\frac{1}{2}$ (B) 1
(C) $\frac{3}{2}$ (D) none of these

69. Let $f(x)=\int_0^4 \left|x^2-4x-t\right| dt$, $x \in (0, 4)$, then the range of f(x) is

(A) (8, 24) (B) [8, 24)
(C) (8, 24] (D) [0, 8)

70. Let 'r' be the radius of a circle which is inscribed in the region made by $y^2 = 4x$, $y = x + 1$ and $y = 0$, the [r] is (where [.] denotes the greatest integer function)

(A) 1 (B) 2
(C) 3 (D) none of these

71. Let there are 4 red, 3 yellow and 2 green balls, then total number of arrangements in a row such that no two balls of same colour are together (balls of same colour are identical) are

(A) 59 (B) 79
(C) 99 (D) none of these

Space for rough work

72. Let A(1, 0), B(3, 4) and C(–1, 1) are the vertices of a triangle ABC and circles are drawn taking AB, BC and CA as diameters. If 'D' is the radical centre of these circles then distance of 'D' from origin is

(A) 0
(B) 1
(C) 2
(D) 3

73. A flagstaff 5m high is placed on a building 25 m high. If the flag and building both subtend equal angles on the observer at a height 30 m, then the distance between observer and the top of flag is

(A) $\frac{5\sqrt{3}}{2}$
(B) $5\sqrt{\frac{2}{3}}$
(C) $5\sqrt{\frac{3}{2}}$
(D) $\frac{5\sqrt{2}}{3}$

74. Let p and q be two statements. Then $(\sim p \vee q) \wedge (\sim p \wedge \sim q)$ is a

(A) tautology
(B) contradiction
(C) neither tautology non contradiction
(D) none of these

75. The sum of squares of deviations for 10 observations taken from mean 50 is 250. The coefficient of variation is

(A) 10%
(B) 40%
(C) 50%
(D) none of these

76. Let $a + b = 3 - \cos 4\theta$ and $a - b = 4 \sin 2\theta$, then maximum value of 'ab' is equal to

(A) $\frac{1}{2}$
(B) 1
(C) $\frac{2}{3}$
(D) 3

77. In a triangle ABC, $\angle ABC = 45^o$ and a point D is on BC such that 2BD = CD and $\angle DAB = 15^o$, then $\angle ACB$ is equal to

(A) 15^o
(B) 30^o
(C) 60^o
(D) 75^o

78. A butterfly randomly lands on a face of a dice numbered from 1 to 6 and then moves to the adjacent face, then the probability that the butterfly ends up on face numbered 2 is

(A) $\frac{1}{6}$
(B) $\frac{1}{3}$
(C) $\frac{1}{2}$
(D) $\frac{2}{3}$

Space for rough work

79. In an examination consisting of four parts A, B, C and D, each part containing 25 questions. If a student randomly attempts the exam, then the probability that he attempts atleast 50 questions in the exam is

(A) $\frac{1}{2}+\frac{^{100}C_{50}}{2^{101}}$ (B) $\frac{1}{2}-\frac{^{100}C_{50}}{2^{101}}$

(C) $\frac{1}{2}+\frac{^{100}C_{50}}{2^{100}}$ (D) $\frac{1}{2}-\frac{^{100}C_{50}}{2^{100}}$

80. Let a circle taking foci of the hyperbola $3x^2 + by^2 + 8xy - 10x + 1= 0$ as end points of diameter, meet the asymptotes of the hyperbola at A, B, C and D, then $\frac{2b^2}{3}$ is equal to (ABCD is a square)

(A) 1 (B) 2

(C) 3 (D) none of these

81. From a point P(–4, 9) tangents PT_1 and PT_2 are drawn to the ellipse $\frac{x^2}{16}+\frac{y^2}{9}=1$ at points T_1 and T_2 respectively. If $F_1\left(-\sqrt{7}, 0\right)$ and $F_2\left(\sqrt{7}, 0\right)$ be two points and S_1 & S_2 be the images of F_1 about PT_1 and F_2 about PT_2 respectively, then

(A) $\angle PS_1F_2 = \angle PF_1S_2$ (B) $2\angle PS_1F_2 = \angle PF_1S_2$

(C) $4\angle PS_1F_2 = 3\angle PF_1S_2$ (D) none of these

82. Let differential equation of a curve f(x, y) = 0 is $\frac{dy}{dx}=\frac{-\left(xye^x \ln y + ye^y\right)}{xye^y \ln x + xe^x}$, and f(1, 1) = 0, then f(e, 1) is equal to

(A) e (B) e^2

(C) $\frac{1}{e}$ (D) none of these

83. Let $f(x) = 2x^3 - 9x^2 + 12x + 8$, the number of values of x for which y = f(f(x)) attains local extremum is/are

(A) 0 (B) 1

(C) 2 (D) 3

84. Let $\lim\limits_{x\to\pi}\frac{\sin\alpha x}{1-2\cos\beta x}=-\sqrt{3}$, $\alpha \in I^+$, $\beta > 0$, then least positive value of $\alpha\beta$ is

(A) $\frac{1}{6}$ (B) $\frac{1}{3}$

(C) $\frac{1}{2}$ (D) 1

Space for rough work

85. Let $\int \frac{\left(2x^2+3x-2\right)-\left(1+x^2-x\right)\ln\left(1+x^2-x\right)}{\left(x+2\right)^2\left(1+x^2-x\right)}dx = \frac{\lambda_1 \ln\left(1+x^2-x\right)}{2\lambda_2+\lambda_3 x}+\lambda_4 x+C$, then $\lambda_1 + \lambda_2 - \lambda_3 + \lambda_4$ is equal to

(A) 0 (B) 1
(C) 2 (D) 3

86. Let y = m(x – 2) + 1 and $y^2 = 4x$ bounds an area of A units, then the value of m if A is minimum is

(A) 1 (B) 2
(C) 3 (D) 4

87. Let $x^2+\frac{1}{x^2}=14$, then the value of $x^5+\frac{1}{x^5}$ is equal to (x > 0)

(A) 70 (B) 700
(C) 724 (D) 770

88. The number of skew-symmetric matrices of order 4 ×4, whose entries belong to the set {–2, –1, 0, 1, 2} is

(A) 5^9 (B) 5^3
(C) 3^6 (D) 5^6

89. The value of $\int_0^1 \left(2x^3-3x^2+3x-1\right)^{\frac{1}{5}}dx$ is equal to

(A) $7\sqrt{5}$ (B) $5\sqrt{7}$
(C) $3\sqrt{5}$ (D) none of these

90. The line x = 0 divides the area enclosed by the curves |x – 1| – y = 0, |x| + y – 3 = 0 into two areas A_1 and A_2, ($A_1 < A_2$), then $\frac{A_1}{A_2}$ is equal to

(A) $\frac{1}{2}$ (B) $\frac{1}{3}$
(C) $\frac{1}{4}$ (D) $\frac{1}{6}$

Space for rough work

FIITJEE

JEE(Main)-2018

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

OPEN TEST
(Main)

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**D**	31.	**C**	61.	**A**
2.	**C**	32.	**C**	62.	**C**
3.	**B**	33.	**C**	63.	**C**
4.	**B**	34.	**B**	64.	**C**
5.	**D**	35.	**C**	65.	**B**
6.	**A**	36.	**C**	66.	**B**
7.	**D**	37.	**C**	67.	**B**
8.	**C**	38.	**D**	68.	**D**
9.	**C**	39.	**D**	69.	**C**
10.	**C**	40.	**C**	70.	**D**
11.	**A**	41.	**C**	71.	**B**
12.	**B**	42.	**C**	72.	**B**
13.	**C**	43.	**B**	73.	**C**
14.	**B**	44.	**D**	74.	**C**
15.	**C**	45.	**A**	75.	**A**
16.	**D**	46.	**D**	76.	**B**
17.	**C**	47.	**C**	77.	**D**
18.	**B**	48.	**D**	78.	**A**
19.	**B**	49.	**A**	79.	**A**
20.	**B**	50.	**D**	80.	**D**
21.	**C**	51.	**B**	81.	**A**
22.	**A**	52.	**B**	82.	**A**
23.	**D**	53.	**B**	83.	**C**
24.	**D**	54.	**C**	84.	**B**
25.	**D**	55.	**B**	85.	**B**
26.	**A**	56.	**C**	86.	**B**
27.	**A**	57.	**B**	87.	**C**
28.	**A**	58.	**D**	88.	**D**
29.	**C**	59.	**C**	89.	**D**
30.	**D**	60.	**D**	90.	**B**

Physics

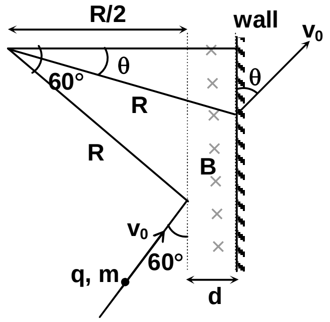
PART – I

1. For the lens 'A' $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$, $v_A = 15$ cm
For the lens 'B' $u_2 = 10$ cm, so $v_2 = \infty$
For the lens C $u_3 = \infty$ so $v_3 = 30$ cm

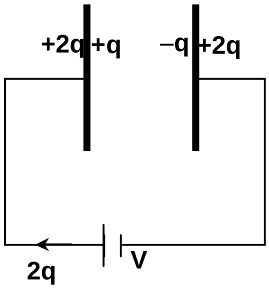
2. $R\cos\theta - R/2 = d = \frac{R(\sqrt{3}-1)}{2}$

$$\cos\theta-\frac{1}{2}=\frac{\sqrt{3}}{2}-\frac{1}{2}$$

$\theta = 30°$
So, total angle rotates inside the magnetic field = 30° + 30° = 60°
Time period = $\frac{m}{qB}\frac{\pi}{3}=\frac{\pi m}{3qB}$



3. The distribution of charge on the plate of capacitor.
$W_B = 2qV$

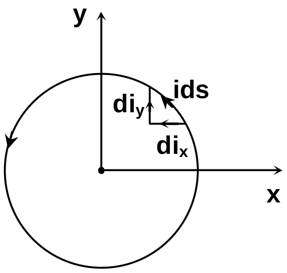


4. $F_{net} = \int \text{force on idy}$

$$= 4(idy)\left(\frac{B_0}{R}\right)(x)$$

$$= 4i\frac{B_0}{R}\int_0^R\sqrt{R^2-y^2}\,dy$$

$= \pi i B_0 R$



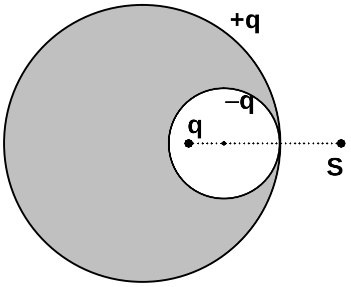
5. $\vec{E}=\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\hat{r}=10\hat{k}$

$\hat{r}=\hat{k}$

$$\vec{B}=\frac{\mu_0}{4\pi}\frac{q\vec{v}\times\hat{r}}{r^2}=\mu_0\varepsilon_0\left\{\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\right\}(\vec{v}\times\hat{r})$$

$$|\vec{B}|=\left|(10\mu_0\varepsilon_0)(\vec{v}\times\hat{r})\right|=\left|(10\mu\varepsilon_0)(4\hat{i}-3\hat{j})\right|=50\ \mu_0\varepsilon_0$$

6. Electric due '–q' at 'S' is equal to electric field due to charge particle 'q'.

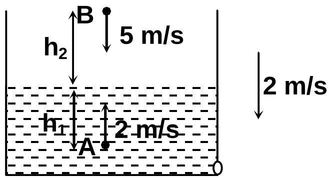


7. App. Position of A with respect of B.

$$P = 1\left(\frac{h_2}{1} + \frac{h_1}{\mu}\right)$$

$$P = h_2 + \frac{3}{4}h_1$$

$$V = \frac{dP}{dt} = \frac{dh_2}{dt} + \frac{3}{4}\frac{dh_1}{dt} = -3 + \frac{3}{4}(-4) = -6 \text{ m/s}$$



8. $$E = \frac{hC}{\lambda} = \frac{1242\text{eV}}{488} = 2.55 \text{ eV}$$

$$K_{max} = eV_0 = e \times 0.38 = 0.38 \text{ eV}$$

$$K_{max} = \frac{hC}{\lambda} - \phi_0 = E - \phi_0$$

$$\phi_0 = E - K_{max} = (2.55 - 0.38) = 2.17 \text{ eV}$$

9. Use basic concept

10. $$I_E = \left(\frac{100}{80}\right)I_C = \left(\frac{100}{80}\right)(10) = 12.5 \text{ mA}$$

$I_B = I_E - I_C = 12.5 - 10 = 2.5$ mA

11. The p-n junction diode acts as a half wave rectifier, so the output waveform across the resistor is positive half part.

12. Block and plank both slide

So, $a_{Block} = \frac{20-5}{2} = \frac{15}{2}$

$$a_{plank} = \frac{5}{2}$$

$$S = ut + \frac{1}{2}at^2$$

$$15 = 0 + \frac{1}{2}\frac{15}{2}t^2$$

$\Rightarrow$ t = 2 sec

Displacement of plane = $0 + \frac{1}{2}\frac{5}{2}2^2$

So, displacement of block with respect to plank = 15 – 5 = 10 m

$W_f = -10 \times 20 \times 1/4 = -50$ J

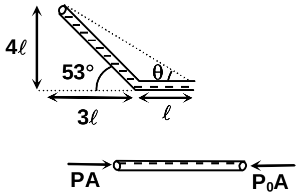
13. $\tan\theta = \frac{4\ell}{4\ell} = \frac{a}{g}$

$\Rightarrow a = g$

Or, $PA - P_0A = (\rho\ell A)a$

$(5\ell)\ (\rho A)\ \left(g\frac{4}{5} - \frac{3}{5}a\right) = \rho\ell\rho a$

$a = g$



14. $V_e = \sqrt{2gR_e}$

$$V_s = \frac{3}{8}\sqrt{2gR_e} = \sqrt{\frac{9gR_e}{32}} = \sqrt{\frac{R_e^2 g}{R_e + h}}$$

$9R_e + 9h = 32\ R_e$

$$h = \frac{23}{9}R_e$$

Now, total energy at height 'h' = total energy at the surface of the earth

$$0 - \frac{GM_e m}{R_e} = \frac{1}{2}mv^2 - \frac{GM_e m}{R_e}$$

$$\frac{1}{2}mv^2 = \frac{GM_e m}{R_e} - \frac{GM_e m}{R_e + \frac{23}{9}R_e}$$

$$\frac{1}{2}mv^2 = \frac{23}{32}\frac{GM_e m}{R_e}$$

$$v = \sqrt{\frac{23}{16}\frac{GM_e}{R_e}},\quad \sqrt{gR_e} = 8\ \text{Km/sec}$$

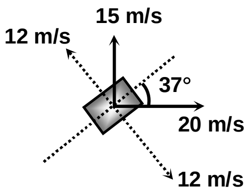
$$v = \sqrt{\frac{23}{16}gR_e} = \sqrt{\frac{23}{2}}\ \text{Km/s}$$

15. $\ell_1 = 45$ cm, $\ell_2 = 70$ cm

$R = 100\ \Omega$

$$r = R\left(\frac{\ell_1}{\ell_2 - \ell_1}\right) = 100\left(\frac{45}{75 - 45}\right) = 180\ \Omega$$

16.



17. $a = v\frac{dv}{dS} = 4 + 3v$

$$\int_0^v \frac{vdv}{4 + 3v} = \int_0^S dS$$

$$S = 1 - \frac{4}{9}\ell\left(\frac{13}{4}\right)$$

18. $v_2 = \frac{60}{100}v_1 = \frac{3}{5}v_1$

$\frac{A_t}{A_i} = \frac{2v_2}{v_1+v_2} = \frac{2(v_2/v_1)}{1+\left(\frac{v_2}{v_1}\right)} = \frac{2(3/5)}{1+(3/5)} = \frac{3}{4}$

19. At t = 0, x = 0

$\frac{A}{2} = A\sin\phi \Rightarrow \phi = \frac{\pi}{6}, \frac{5\pi}{6}$

Since, $\frac{dy}{dt}$ is positive for $\phi = \frac{5\pi}{6}$

20. In equilibrium extension in the string is $x_0 = \frac{mg}{k}$. For the string will remain taut in the motion maximum = $x_0 = \frac{mg}{k}$.

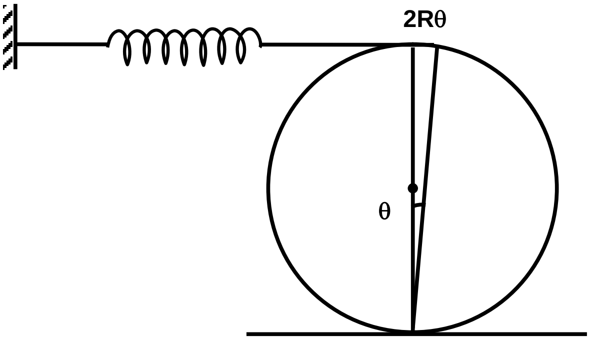
21. $\tau_P = k(2R\theta)\,2R$

$I_P\alpha = -4kR^2\theta$

$\frac{7}{5}mR^2\alpha = -4kR^2\theta$

$\alpha = -\left(\frac{20}{7}\frac{k}{m}\right)\theta$

$T = 2\pi\sqrt{\frac{7m}{20k}}$



22. $2m_1 = 3m_2$

$P_1V = \frac{m_1}{M}RT$ and $P_2V = \frac{m_2}{M}RT = \frac{2}{3}\frac{m_1}{M}RT$

$\frac{P_1}{P_2} = \frac{3}{2}$ …(i)

The process is isothermal ($P_1V_1 = P_2V_2$)

Hence, $\Delta P_1 = P_1 - \frac{P_1}{2} \Rightarrow P_1 = 2\Delta P_1$

$\Delta P_2 = P_2 - \frac{P_2}{2} = \frac{P_2}{2} = \frac{1}{2}\frac{2}{3}P_1 = \frac{P_1}{3}$

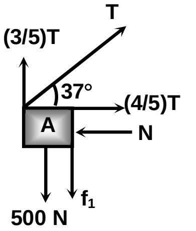
$\Delta P_2 = \frac{2}{3}\Delta P_1 = \frac{2}{3}\cdot 300$

$\Delta P_2 = 200$ Pa

23. $C_V = \frac{3}{2}R - J/mol\cdot K = \frac{3}{2}\frac{R}{M}J/kg\cdot K = \frac{3R}{2M\times 4.2}$ cal/kgK = 0.15 Kcal/kgK

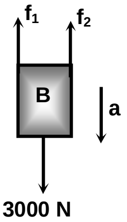
$M = \frac{3R}{2\times 4.2\times 0.15\times 10^3} = \frac{3\times\frac{25}{3}}{2\times 4.2\times 0.15\times 10^3} = 20\times 10^{-3}$ kg

24.



$$500+\frac{1}{2}\frac{4}{5}T=\frac{3}{5}T \text{ N}$$

$$T=2500$$



$$3000-f_1-f_2=300a$$

$$3000-\frac{1}{2}\frac{4}{5}T-\frac{1}{2}\frac{4}{5}T=3000a$$

$$3000-\frac{4}{5}2500=300a$$

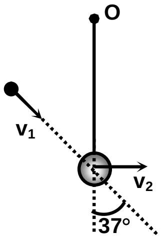
$$3000-2000=300\ a$$

$$a=\frac{1000}{300}=\frac{10}{3}\ \text{m/s}^2$$

25. v_1 and v_2 are the velocity after the collision.

$mv_0\sin 37° = mv_1\sin 37° + mv_2$ …(i)

$$e=\frac{4}{5}=\frac{v_2\cos 53°-v_1}{v_0} \quad \text{…(ii)}$$



From (i) and (ii)

$$v_2=\frac{27}{34}v_0=\sqrt{5g\ell}$$

$$\frac{27}{34}v_0=10$$

$$\Rightarrow \quad v_0=\frac{340}{27}\ \text{m/sec}$$

26. $$\frac{1}{2}mv^2=\mu mgx+\frac{1}{2}kx^2 \quad \text{…(i)}$$

$2\mu mg = kx$ …(ii)

From (i) and (ii)

$$v=\mu g\sqrt{\frac{8m}{k}}=2\mu g\sqrt{\frac{2m}{k}}$$

27. $\rho_b vg=15$ …(i)

$\rho_b vg-\rho_w vg=12$ …(ii)

$\rho_b vg-\rho_\ell vg=13$ …(iii)

From (i) and (iii)

$3=\rho_w vg$

$\Rightarrow vg= 3\times 10^{-3}$

$$\rho_b=\frac{15}{3\times10^{-3}}=5\times10^3$$

$$\rho_\ell vg=2$$

$$\rho_\ell=\frac{2}{3\times10^{-3}}=\frac{2}{3}\times10^3$$

$$\frac{\rho_b}{\rho_\ell}=\frac{15}{2}$$

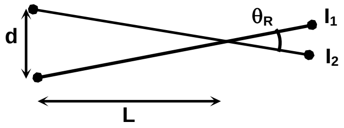
28. The work done by the external agent = change in potential energy

$= -(MB\cos\theta_2) - (-MB\cos\theta_1)$

$= -MB(\cos 60^\circ - \cos 0^\circ) = \frac{1}{2}MB$

$= \frac{1}{2}(1.0\times10^4 J/T)(4\times10^{-5}T) = 0.2J$

29. $\theta_R > \frac{1.22\lambda}{d}$



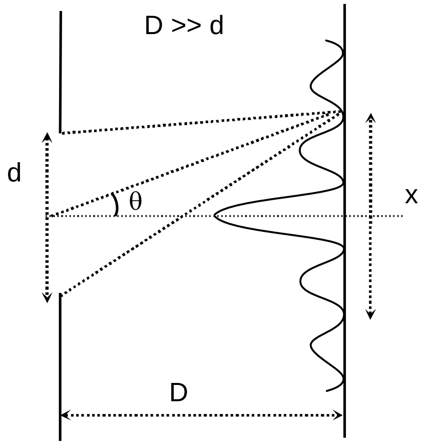
$\frac{d}{L} > \frac{1.22\lambda}{d}$

$d > \frac{1.22\lambda\times L}{d}$

$> \frac{1.22\times700\times10^{-9}\times1000}{2.5\times10^{-3}}$

$> \frac{1.22\times7}{25} = 35\,cm$

30. $\tan\theta = \frac{x}{2D}$



For second minima

$\sin\theta = \frac{2\lambda}{d} \approx \tan\theta$

$\Rightarrow \frac{x}{2D} = \frac{2\lambda}{d}$

$\Rightarrow x = \frac{4\lambda D}{d}$

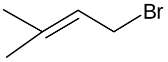
Chemistry PART – II

31. Ease of NGP : O – R > C = C
Also during NGP in case of 'C' both the rings of bicyclo oxonium ion have 5 members.

32. (A) In open system, said equilibrium is not attained.
(B) Atmospheric pressure changes with altitude.
(C) K_{eq} is the function of temperature only.
(D) K_{eq} does not give any information about the rate at which the equilibrium is reached.

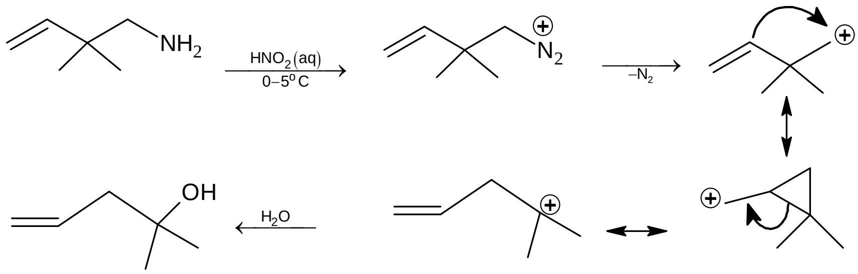
33. (A) - Chiral but optically inactive due to rapid inversion.
(B) - Achiral
(C) - Sulphur has lone pair also and no inversion occurs.
(D) - Planar and inversion occurs rapidly.

34. Reaction (I) undergoes NGP, S_N2 and S_N1; while reaction (II) follows mainly S_N1 path.

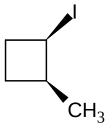
35. (IV) Major product is 

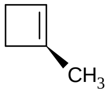
36. $BrF_3 \rightarrow [BrF_2]^+ \; [BrF_4]^-$
$IF_5 \rightarrow [IF_4]^+ \; [IF_6]^-$

37.



38.

Q is 

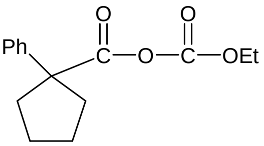
R is 

$R \xrightarrow[(2)\,H_2O_2/OH^-]{(1)\,B_2H_6/THF}$ syn addition occurs.

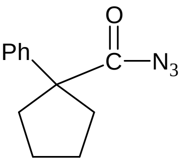
39. (I) Migratory aptitude of 1° alkyl > methyl group when carbocation is formed.
(II) Free carbocation formation is unfavourable in the given condition and in S, angle strain also increases much.
(III) Free carbocation is not formed under given conditions and departure of H_2O is assisted by phenyl group.

40. Bromine water can not oxidize fructose.

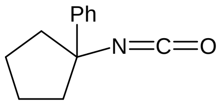
41. P is



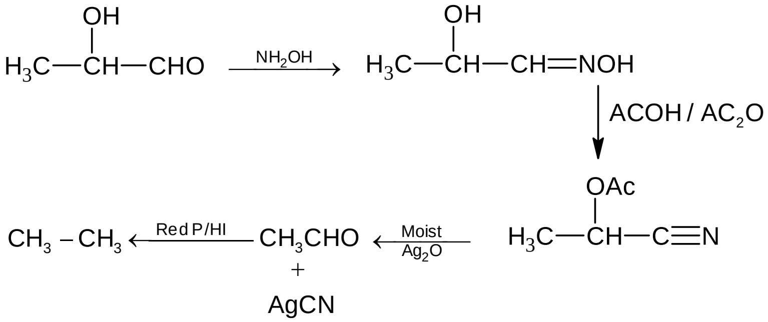
Q is



R is



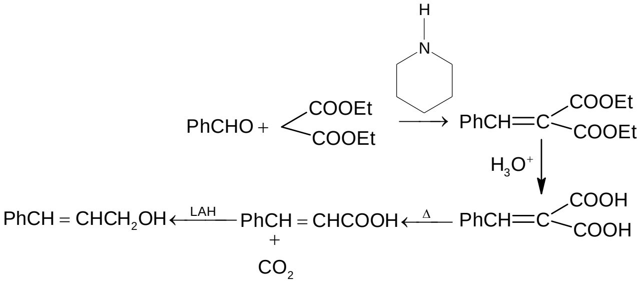
42. Products of reactions I, II & III is propane while that of reaction IV is ethane.



$$H_3C-\overset{OH}{CH}-CHO \xrightarrow{NH_2OH} H_3C-\overset{OH}{CH}-CH=NOH \xrightarrow{ACOH/AC_2O} H_3C-\overset{OAc}{CH}-C\equiv N$$

$$CH_3-CH_3 \xleftarrow{Red\ P/HI} \underset{AgCN}{\underset{+}{CH_3CHO}} \xleftarrow[Ag_2O]{Moist} H_3C-\overset{OAc}{CH}-C\equiv N$$

43. Product of (a) and (c) is PhCH = CH – CHO;
Product of (b) is PhCH = CHCH₂OH
(b)



(c) $PhCHO \xrightarrow[\Delta(5-6\ hr)]{Ac_2O/AcOH} PhCH=CHCOOH \xrightarrow{LAH} PhCH=CHCH_2OH \xrightarrow{MnO_2} PhCH=CH-C$

44. $\overset{\oplus}{N}H_3-CH_2-COO^-$ (glycine) is amphoteric.

Hence, pH = pI = $\frac{2.4+9.54}{2}=5.97$

45. If $P_1 > P_2$; E_{cell} = +ve
And the cell reaction will be spontaneous.

46. $CN^- + H_2O_2 \longrightarrow HCO_3^- + NH_3;$

$Cl^- + AgNO_3/HNO_3 \longrightarrow AgCl\downarrow;$

$CN^- + Hg_2^{2+} \longrightarrow \underset{(Grey)}{Hg}\downarrow + \underset{(Soluble)}{Hg(CN)_2};$

$Cl^- + Hg_2^{2+} \longrightarrow \underset{(White)}{Hg_2Cl_2}\downarrow;$

$NaCN + conc.\ H_2SO_4 \longrightarrow CO\uparrow + (NH_4)_2SO_4 + Na_2SO_4;$

$Cl^- + conc.H_2SO_4 \longrightarrow HCl + HSO_4^-$

CO(g) burns with blue flame.

47. Number of electrons exchanged = 12 (for 3Sn)

$$E^o_{cell} = 0.009 + 1.33 = 1.339 = \frac{0.0591}{12}\log K_{eq}.$$

$K_{eq.} = 10^{271.878}$

$\simeq 10^{272}$

48. All three statements are basic concepts of thermodynamics and are correct, as well.

49. (B) & (C) Dulong & Petits law is better applicable to heavier elements/molecules and dependent of molecular constitutions as specific heat is dependent of the same.
(D) Specific heats of gases varies with the process of heating (constant pressure or constant volume)

50. Graph in A is plotted for endothermic reaction and graph in B is plotted for exothermic reactions actually.
(C) $E_{a_1} < E_{a_2} < E_{a_3}$ is correct.

51. Using Rault's law
$P^o_A = 1000$ mm Hg and $P^o_B = 800$ mm Hg
As 'A' is more volatile, hence (A) and (D) are incorrect. In case of 'C' $P_A = 0.3 \times 1000 = 300$ mm Hg.

52. (A) at critical temperature, the gas does not follow Boyle's law.
(C) $T_B = 1687.5$ K as $T_C = 500 \text{ K} = \frac{8a}{27Rb}$
(D) It would be confirm correct above its inversion temperature (3375 K)

53.
$$Fe^{2+} + CN^- \longrightarrow \underset{\text{Yellowish brown}}{Fe(CN)_2}\downarrow \xrightarrow{CN^-(\text{exces})} \underset{\underset{(P)}{\text{Pale yellow solution}}}{\left[Fe(CN)_6\right]^{4-}} \xrightarrow{Fe^{2+}} \underset{\text{Bluish white}}{Fe\left[Fe(CN)_6\right]^{2-}}$$

$$Fe^{3+} + CN^- \longrightarrow \underset{(\text{Brown})}{Fe(CN)_3}\downarrow \xrightarrow{\text{Excess } CN^-} \underset{\underset{(Q)}{(\text{Yellow solution})}}{\left[Fe(CN)_6\right]^{3-}} \xrightarrow{Fe^{3+}} \underset{\text{Prussian blue}}{Fe_4\left[Fe(CN)_6\right]_3}\downarrow$$

54. Correct orders are:
(A) $CO_2 = SO_3 < SO_2$ (B) $PCl_3F_2 = PCl_5 < PCl_2F_3$
(D) $CH_4 < CHCl_3 < CH_2Cl_2 < CH_3Cl$

55. Without defect formula of the compound would be : $AB_3C_4D_4$.
Due to defect
Missing particles per unit cell are

A	B	C	D
$\frac{1}{4}$	0	1	1

Hence the formula is $A_{\frac{3}{4}}B_3C_3D_3$ or $AB_4C_4D_4$.

56. $Sm^{2+}\left[(Xe)4F^{6}\right]$; $Eu^{2+}\left[(Xe)4F^{7}\right]$

$Yb^{2+}\left[(Xe)4F^{14}\right]$; $Ce^{2+}\left[(Xe)4F^{1}5d^{1}\right]$

57. (A) Be & Mg don't give flame test.
(C) Ionisation energy and melting point of Li are higher.
(D) Correct reducing character order is:
CsH > RbH > KH > NaH > LiH

59. $I_2 + aq.Cl_2 \longrightarrow IO_3^- + Cl^-$;

$I_2 + S_2O_3^{2-} \longrightarrow I^- + S_4O_6^{2-}$

$I_2 + NaOH \longrightarrow NaIO_3 + NaI$

$I_2 + Br^- \longrightarrow$ No reaction.

60. Devarda's alloy contains Al, Zn & Cu

$\underset{(A)}{NaOH} + Al \xrightarrow{\Delta} NaAlO_2 + \underset{(B)}{H_2(g)}$;

$\underset{(A)}{NaOH} + Zn \xrightarrow{\Delta} Na_2ZnO_2 + \underset{(B)}{H_2(g)}$;

$\underset{(A)}{NaOH} + P_4 \xrightarrow{\Delta} NaH_2PO_2 + PH_3(g)$;

$\underset{(A)}{NaOH} + NH_4Cl \xrightarrow{\Delta} \underset{(D)}{NH_3} + NaCl + H_2O$;

Mathematics PART – III

61. $\left|\vec{a}+\vec{b}+\vec{c}\right|^2 = |\vec{a}|^2 + \left|\vec{b}\right|^2 + |\vec{c}|^2 + 2\left(\vec{a}\cdot\vec{b}+\vec{b}\cdot\vec{c}+\vec{c}\cdot\vec{a}\right) \geq 16$

$\Rightarrow\ 2\left(\vec{a}\cdot\vec{b}+\vec{b}\cdot\vec{c}+\vec{c}\cdot\vec{a}\right) \geq -82$

$\Rightarrow\ \vec{a}\cdot\vec{b}+\vec{b}\cdot\vec{c}+\vec{c}\cdot\vec{a} \geq -41$

$\Rightarrow\ \vec{a}\cdot\vec{b}+\vec{b}\cdot\vec{c}+\vec{c}\cdot\vec{a} = -41$ holds only if $\vec{a}\times\vec{b} = 0$

$\Rightarrow\ \left|\vec{a}\times\vec{b}\right| = 0$

62. $\cos\sqrt{2} - \cos\sqrt{3} > \sin\sqrt{2} - \sin\sqrt{3} > 0$

63. $\alpha - \alpha^2 + \alpha^3 - \alpha^4 + \ldots.. - \alpha^{18} = 1$

$\Rightarrow\ \left(\alpha+\frac{1}{\alpha}\right) - \left(\alpha^2+\frac{1}{\alpha^2}\right) + \left(\alpha^3+\frac{1}{\alpha^3}\right) - \ldots.. + \left(\alpha^9+\frac{1}{\alpha^9}\right) = 1$

$\Rightarrow\ 2\,\text{Re}\left(\sum_{r=1}^{9}(-1)^{r+1}\alpha^r\right) = 1$

$\Rightarrow\ \text{Re}\left(\sum_{r=1}^{9}(-1)^{r+1}\alpha^r\right) = \frac{1}{2}$

64. $\text{Sum} = \sum_{r=1}^{31}\frac{2^r\left(r^2+1\right)}{r(r+1)} = \sum_{r=1}^{31}\left(\frac{2^{r+1}\cdot r}{r+1} - \frac{2^r(r-1)}{r}\right) = \frac{2^{32}\cdot 31}{32} = 2^{27}\cdot 31$

65. The triangle ABC is right-angled triangle with orthocentre at vertex B
Locus of vertex C is $y = x - 2$

66. $(x - 1)^4 = 16$

$\Rightarrow x - 1 = 2, -2, 2i, -2i\ \left(i = \sqrt{-1}\right)$

67. Locus is a plane which is perpendicular to AB and passes through B(2, 3, 4)

68. $T > 1$

69. $f(x) = 24 - 4(x - 2)^2\ \forall\ x \in (0, 4)$

70. $r \in (0, 1)$

$\Rightarrow [r] = 0$

71. $\frac{5!}{2!\cdot 3!} + 2\cdot\frac{4!}{2!}\times 2! + \frac{3!}{2!}\times 2!\times 2! + \frac{3!}{2!} + 3!$

72. Radical centre is the orthocentre of ΔABC

73. Let distance be 'd' and angle subtended be θ

$\Rightarrow\ \tan\theta = \frac{5}{d}$ and $\tan 2\theta = \frac{30}{d}$

$\Rightarrow \tan\theta = \sqrt{\frac{2}{3}}$

$\Rightarrow d = 5\sqrt{\frac{3}{2}}$

74. Neither tautology nor contradiction

p	q	$\sim p \vee q$	$\sim p \vee \sim q$	$(\sim p \vee q) \wedge (\sim p \wedge q)$
T	T	T	F	F
T	F	F	T	F
F	T	T	T	T
F	F	T	T	T

75. $\sum (x_i - \bar{x})^2 = 250$

$\Rightarrow \bar{v} = \frac{250}{10} = 25$

$\Rightarrow \bar{v} = 5$

$\Rightarrow$ Coefficient of variation = $\frac{\bar{v}}{\bar{x}} \times 100 = 10\%$

76. a = $(1 + \sin 2\theta)^2$
b = $(1 - \sin 2\theta)^2$
$\Rightarrow$ ab = $\cos^4 2\theta \le 1$

77. Applying m – n theorem
(BD + DC) cot 60º = CD cot 45º – BD cot C
$\Rightarrow \cot C = 2 - \sqrt{3}$
$\Rightarrow$ C = 75º

78. Probability = $\frac{4}{6} \times \frac{1}{4} = \frac{1}{6}$

79. Required probability = $\frac{\sum_{r=50}^{100} {}^{100}C_r}{2^{100}} = \frac{1}{2} + \frac{{}^{100}C_{50}}{2^{101}}$

80. If ABCD is a square, then angle between Asymptotes is 90º
$\Rightarrow$ 3 + b = 0
$\Rightarrow$ b = –3
$\Rightarrow 2 \cdot \frac{b^2}{3} = 6$

81. ΔPS_1F_2 and ΔPF_1S_2 are similar

82. f(x, y) = 0
$\Rightarrow e^x \ln y + e^y \ln x = 0$
$\Rightarrow$ f(e, 1) = e

83. Let g(x) = f(f(x))
$g'(x) = 0 \Rightarrow x = 1, 2$
$g''(x) \neq 0$ for x = 1, 2

84. $\cos\beta\pi = \frac{1}{2}$

$\Rightarrow \beta = \pm\frac{1}{3} + 2k$, $k \in I$

$\Rightarrow \lim\limits_{x\to\pi} \frac{\alpha\cos\alpha x}{2\beta\sin(\beta x)} = -\sqrt{3}$

$\Rightarrow \frac{(-1)^{\alpha}\cdot\alpha}{2\beta\frac{\sqrt{3}}{2}} = -\sqrt{3}$

$\Rightarrow \alpha = 1$, $\beta = \frac{1}{3}$ for $(\alpha\beta)$ minimum

$\Rightarrow (\alpha\beta)_{\min} = \frac{1}{3}$

85. $\int \frac{(2x^2+3x-2)-(1+x^2-x)\ln(1+x^2-x)}{(x+2)^2(1+x^2-x)}dx = \frac{\ln(1+x^2-x)}{x+2} + C$

86. $y = 2x - 3$ bounds minimum area with $y^2 = 4x$
$\Rightarrow m = 2$

87. $\left(x+\frac{1}{x}\right)^2 - 2 = 14$

$\Rightarrow x + \frac{1}{x} = 4$

$x^5 + \frac{1}{x^5} = \left(x^3+\frac{1}{x^3}\right)\left(x^2+\frac{1}{x^2}\right) - \left(x+\frac{1}{x}\right) = 724$

88. For skew-symmetric matrix
$a_{ij} = -a_{ji}$
$\Rightarrow$ Only six positions are to be filled
$\Rightarrow$ Number of ways = 5^6

89. Let $A = \int_0^1 (2x^3-3x^2+3x-1)^{\frac{1}{5}}dx = -\int_0^1 (2x^3-3x^2+3x-1)^{\frac{1}{5}}dx$
$\Rightarrow A = 0$

90. Area bounded by the curves is a rectangle with vertices (–1, 2), (0, 3), (1, 0) and (2, 1)

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

FULL TEST – VII

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 183**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into Two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01– 07, 19 – 25, 37 - 43)*** *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (08 – 13, 26 – 31, 44 - 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S).*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (14 – 18, 32 – 36, 50 - 54)*** *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Name of the Candidate ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Enrolment No. ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

(One or More than one correct type)

This section contains **SEVEN** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. In a cylindrical room of radius ‘r’, A particle is projected at angle ‘α’ with horizontal from center of room floor. It was observed that particle returns to point of projection after three elastic collisions with walls and ceiling. If the particle remains in air for time ‘T’, then speed of projection is

(A) $\frac{3r}{T\cos\alpha}$ (B) $\frac{4r}{T\cos\alpha}$

(C) $2\sqrt{\frac{gr}{\sin 2\alpha}}$ (D) $> 2\sqrt{\frac{gr}{\sin 2\alpha}}$

2. Students I$_1$, I$_2$, I$_3$ and I$_4$ perform an experiment for measuring the acceleration due to gravity (g) using a simple pendulum, they use different lengths of the pendulum and record time for different number of oscillations. The observations are shown in table. Least count for length = 0.1 cm, least count for time is 1 sec.

Students	Length of pendulum (cm)	No. of oscillations (n)	Time period of pendulum (s)
I$_1$	100.0	20	20
I$_2$	400.0	10	40
I$_3$	100.0	10	20
I$_4$	400.0	20	40

If P$_1$, P$_2$, P$_3$ and P$_4$ are % error in g for students I$_1$, J$_1$, J$_3$ and I$_2$ respectively then

(A) $P_1 = P_3$ (B) P_3 is maximum

(C) P_4 is minimum (D) $P_2 = P_4$

3. A long thin non-conducting cylindrical pipe having surface charge density ‘σ’, radius ‘R’ rotating with angular velocity ω = kt about its axis, where k is a positive constant. Which of the following statement is/are correct for inside region of pipe?

(A) Magnetic and electric field are uniform throughout region and do not vary with time.

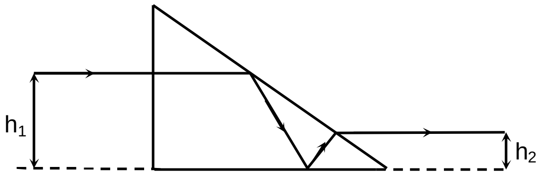
(B) Magnetic field is constant throughout region but vary with time and electric field is not constant throughout region and independent of time.

(C) Magnetic field is not constant throughout region but independent of time and electric field is constant throughout region and vary with time.

(D) Energy density (u) due to magnetic field varies with time as $u = bt^2$. (Where b is positive constant)

Space for Rough work

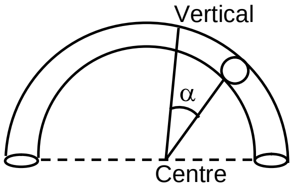
4. A right angle prism of refractive index ‘μ’ has TIR at two points as shown in diagram, then $\frac{h_1}{h_2}$ is



(A) $\frac{\sin\theta}{\sin 3\theta}$ (B) $\frac{2\mu}{(1+\mu)}$

(C) $\frac{\cos\theta}{\cos 3\theta}$ (D) $\frac{\mu}{(1+2\mu)}$

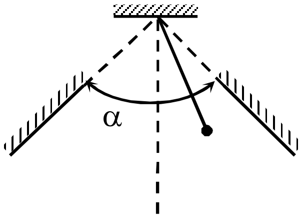
5. A semicircular glass tube filled with water containing an air bubble is sealed at its ends. The tube is held with its plane vertical and made to move in its plane with a constant acceleration, the bubble stays aside of the highest point as shown, than acceleration vector of the tube



(A) It points towards the left
(B) It points towards the right
(C) Its magnitude is g tan α
(D) It magnitude is g cot α

6. The internal energy U of an ideal gas depends on pressure P and Volume V of the gas according to equation U = 3PV, which of the following conclusion can you make regarding the gas
(A) The gas is not a mono-atomic gas
(B) The gas can be a di-atomic gas
(C) The gas can be a tri-atomic gas
(D) Molar specific heat of the gas in an isobaric process is 4R

7. A simple pendulum initially oscillating simple harmonically with angular amplitude α and time period T_0 is symmetrically confined between two rigid fixed planes P and Q making angle ‘α’ with each other as shown in figure. [Assume ‘α’ is small]



(A) If collision at both walls are elastic then time period is $\frac{T_0}{2}$
(B) If collision at both walls are inelastic then time period is T_0
(C) If collision at one wall is elastic and at other is inelastic, then 1 time period is T_0
(D) If collision at one wall is elastic and at other is inelastic, then 1 time period will be less than T_0.

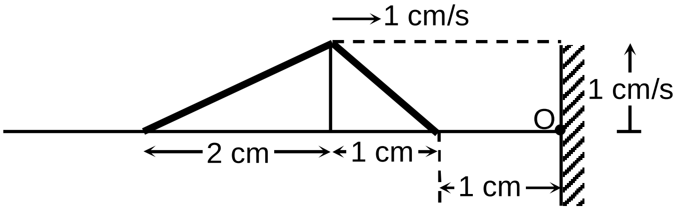
Space for Rough work

(Matching type - Single Correct Option)

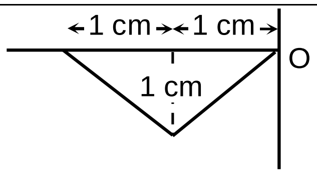
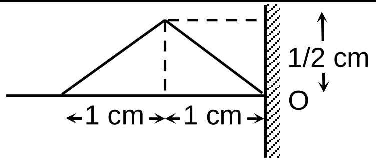
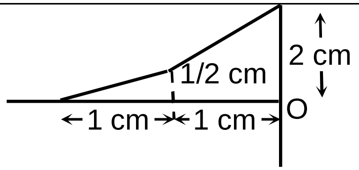
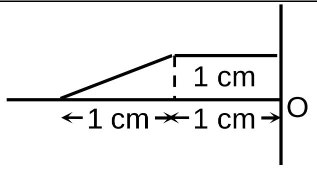
This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

A triangular wave pulse travelling on an elastic string along positive x-axis toward 'O' is as shown in figure at t = 0.



Answer the following questions based on the matrix below. Here, Column 1 shows different cases, Column 2 shows superimposed pulse of incident and reflected pulses while Column 3 shows speed of particle P at distance x = 0.5 cm from O towards left.

Column 1	Column 2		Column 3
(I) If O is free end, then at t = 2 sec.	(i)		(P) V_P = 1 cm/sec down
(II) If O is rigid end, then at t = 2 sec.	(ii)		(Q) V_P = 1.5 m/s up
(III) If O is free end, then at t = 3 sec.	(iii)		(R) V_P = 0.5 m/s down
(IV) If O is rigid end, then at t = 3 sec.	(iv)		(S) V_P = 0 m/s

8. Which of the following is correct sequential combination of Column 1 with Column 2.
   (A) (ii), (iii), (i), (iv) (B) (iii), (ii), (iv), (i)
   (C) (i), (iii), (ii), (iv) (D) (iv), (iii), (ii), (i)

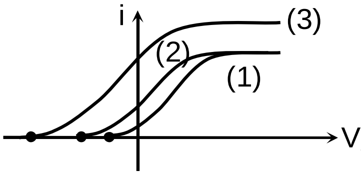
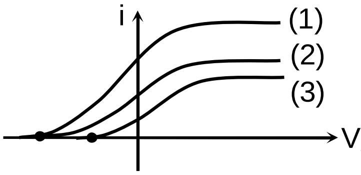
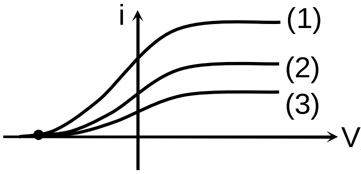
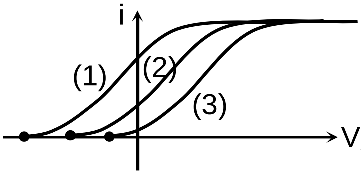
Space for Rough work

9. Which of the following is correct sequential combination of Column 1 with Column 3.
(A) QRPS (B) PQRP
(C) QQRP (D) PQRP

10. Which of the following is correct sequential combination of Column 2 with Column 3.
(A) PQRS (B) QPPR
(C) SPQR (D) SRQP

Answer questions 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

Three radiations are incident on a metal surface having threshold frequency less then frequencies of the three incident radiations. If I represents intensity, k is maximum kinetic energy, i photoelectric current and V stopping potential, answer the following questions, based on given matrix.

Column 1	Column 2	Column 3	
(I) $I_1 > I_2 > I_3$ $f_1 = f_2 = f_3$	(i) $k_1 < k_2 < k_3$	(P)	
(II) $I_1 = I_2 = I_3$ $f_1 > f_2 > f_3$	(ii) $k_1 > k_2 > k_3$	(Q)	
(III) $I_1 > I_2 > I_3$ $f_1 = f_2 > f_3$	(iii) $k_1 = k_2 > k_3$	(R)	
(IV) $I_1 = I_2 < I_3$ $f_1 < f_2 < f_3$	(iv) $k_1 = k_2 = k_3$	(S)	

11. Which of the following is correct sequential combination of Column 1 with Column 2.
(A) (iv), (ii), (i), (iii) (B) (ii), (i), (iii), (iv)
(C) (iii), (ii), (i), (iv) (D) (iv), (ii), (iii), (i)

Space for Rough work

12. Which of the following is correct sequential combination of Column 1 with Column 3.

(A) PQSR (B) QSPR

(C) RSQP (D) QPRS

13. Which of the following is correct sequential combination of Column 2 with Column 3.

(A) PQRS (B) PSQR

(C) QSPR (D) SPQR

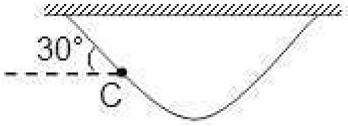
SECTION – C

(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

14. A rod of length l, cross-sectional area A and Young's modulus Y is subjected to two forces 'F' and '2F' at its two ends. The heat generated in the rod is found to be $\frac{(10a+b)F^2\ell}{12AY}$. Find a + b.
[a, b : Positive integers]

15. A rope is hanging vertically, with its two ends fixed to walls at same horizontal level (as shown). Tension at the bottom most point is 90 N. If the mass/unit length of rope is 4 kg/m, find radius of curvature (in metres) at point 'C'. [Take g = 10 m/s^2]



16. A source of frequency 1800 Hz is moving on a line, with speed 30 m/s. An observer is standing at a point far distant from the line. The wavelength of sound received by the observer when the source is nearest to the observer, is n/11 metres. Find 'n' (speed of sound in air = 330 m/s)

17. Rain drops of some initial mass start falling from rest. In their way, they gain mass from clouds with a rate proportional to the product of their instantaneous mass and instantaneous velocity, the proportionally constant being 2.5 SI units. Find the terminal velocity attained by drops (in m/s). Take g = 10 m/s^2.

18. A sinusoidal wave of wavelength 'λ', amplitude 'A' and angular frequency 'ω' travels on a string of mass/unit length 'μ'. The energy of wave in one wavelength is equal to $\frac{\mu\omega^2A^2\lambda}{b}$. Find 'b'.

Space for Rough work

Chemistry

PART – II

SECTION – A
(One or More than one correct type)

This section contains **SEVEN** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. $\underset{(s)}{CaCO_3} \rightleftharpoons \underset{(s)}{CaO} + \underset{(g)}{CO_2}$

Above equilibrium was established in close container. Which of the following will shift equilibrium towards right?

(A) Decrease in pressure
(B) Addition of $CaCO_3$
(C) Addition of N_2 at constant volume
(D) Increase in temperature

20. Ground state electronic configuration of P atom can be represented as

(A) $[\text{Ne}]\overset{3s}{\boxed{\uparrow\downarrow}}\ \overset{3p}{\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}}$
(B) $[\text{Ne}]\overset{3s}{\boxed{\uparrow\downarrow}}\ \overset{3p}{\boxed{\uparrow}\boxed{\downarrow}\boxed{\uparrow}}$
(C) $[\text{Ne}]\overset{3s}{\boxed{\uparrow\downarrow}}\ \overset{3p}{\boxed{\uparrow}\boxed{\downarrow}\boxed{\downarrow}}$
(D) $[\text{Ne}]\overset{3s}{\boxed{\uparrow\downarrow}}\ \overset{3p}{\boxed{\downarrow}\boxed{\downarrow}\boxed{\downarrow}}$

21. Which of the following molecules have intermolecular hydrogen bonds?

(A) NaH_2PO_2
(B) NaH_2PO_4
(C) H_3BO_3
(D) $(CH_3)_3BO_3$

22. When a hydrophilic sol like gelatine is subjected to electric field, the sol particles move

(A) towards cathode at pH less than the iso-electric point
(B) towards anode at pH greater than the iso-electric point
(C) in both direction at iso-electric pH
(D) in neither direction at iso-electric pH

23. Sodium nitrate decomposes above 800ºC to give

(A) N_2
(B) O_2
(C) NO_2
(D) Na_2O

Space for Rough work

24. NH_3 and its salts are identified by

(A) K_2HgI_4 and KOH (B) $HgCl_2 + KI(\text{excess}) + KOH$

(C) $HgCl_2 + KI(\text{excess}) + NH_4OH$ (D) $Hg_2Cl_2 + \text{excess of } NH_4OH$

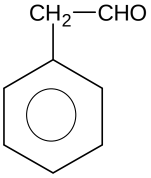
25. A freshly prepared aqueous solution of $Pd(NH_3)_2Cl_2$ does not conduct electricity. It suggests that

(A) the structure of the compound involves covalent bonding only
(B) the chlorine atoms must be in coordination sphere
(C) the van't Hoff factor of the compound would be unity
(D) on adding excess of aqueous $AgNO_3$ to 0.1 L of 0.1 M solution of the compound 0.02 moles of $AgCl_{(s)}$ would be obtained

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 26, 27 and 28 by appropriately matching the information given in the three columns of the following table.

Column 1 **Reactant**	**Column 2** **Reagent**	**Column 3** **Observation**
(I) But-1-yne	(i) $NaOH/I_2$	(P) Red ppt
(II) 	(ii) $\left[Ag(NH_3)_2\right]NO_3$	(Q) White ppt
(III) Acetone	(iii) $ZnCl_2 + HCl$	(R) Yellow solution
(IV) Benzaldehyde	(iv) Fehling solution	(S) Silver Mirror

26. For Tollens test the only correct combination is

(A) (IV) (ii) (S) (B) (I) (ii) (Q)
(C) (III) (ii) (S) (D) (IV) (iii) (Q)

Space for Rough work

27. Which combination gives red ppt?
(A) (I) (i)
(B) (IV) (iv)
(C) (II) (ii)
(D) (II) (iv)

28. Which of the following does not represent oxidation of column I compound?
(A) (I) (iv)
(B) (II) (ii)
(C) (IV) (ii)
(D) (III) (i)

Answer questions 29, 30 and 31 by appropriately matching the information given in the three columns of the following table.

Column 1 **Crystal system**	**Column 2** **Axial length & angle**	**Column 3** **Type of unit cell**
(I) Cube	(i) $a \neq b \neq c$ $\alpha = \beta \neq \gamma$	(P) Primitive, end centered
(II) Orthorhombic	(ii) $a = b = c$ $\alpha = \beta = \gamma$	(Q) Primitive, face centered & body centered
(III) Triclinic	(iii) $a \neq b \neq c$ $\alpha \neq \beta \neq \gamma$	(R) Only Primitive
(IV) Monoclinic	(iv) $a \neq b \neq c$ $\alpha = \beta = \gamma$	(S) Primitive, Face centered, body centred & end centered

29. Which of the following combination is correct?
(A) (I), (ii) (S)
(B) (II) (ii) (Q)
(C) (II), (iv) (S)
(D) (III), (ii), (R)

30. Which of the following combination is incorrect?
(A) (I) (ii)
(B) (III) (iii)
(C) (IV) (i)
(D) (II) (ii)

31. All four types of unit cells are observed in
(A) Cube
(B) Orthorhombic
(C) Triclinic
(D) Monoclinic

Space for Rough work

SECTION – C

(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

32. In acidic medium 4 mole of $KMnO_4$ quantitatively oxidise x mole of SnC_2O_4. The value of x is

33. The number of triangular faces present in truncated tetrahedron is

34. The number of neutrons accompanying the formation of ${}^{140}_{54}Xe$ & ${}^{92}_{38}Sr$ from adsorption of a slow neutron by ${}^{235}_{92}U$ followed by nuclear fission is

35. The total no. of aromatic compounds possible with molecular formula C_8H_{10} are

36. How many molecules of acetone will form mesitylene through aldol condensation?

Space for Rough work

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **SEVEN** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. Tangent's are drawn to parabola $y^2 = 16x$ at the point's A, B and C such that three tangents form a triangle PQR. If θ_1, θ_2 and θ_3 be the inclinations of these tangents with the axis of x such that their cotangents form an A.P. with common difference 3. Then which of following are correct:
(A) Area of ΔPQR is 432
(B) Area of ΔABC is 832
(C) Area of ΔPQR is 416
(D) Area of ΔABC is 864

38. Let A, B, C be three sets of complex number as defined below
$A = \{z : |z+1| \le 2 + \text{Re}(z)\}$,
$B = \{z : |z-1| \ge 1\}$ and
$C = \left\{z : \left|\frac{z-1}{z+1}\right| \ge 1\right\}$
Then which of following are correct
(A) AREA of region bounded by $A \cap B \cap C$ is $\sqrt{3}$
(B) AREA of region bounded by $A \cap B \cap C$ is $2\sqrt{3}$
(C) The real part of the complex no. in region $A \cap B \cap C$ and having maximum amplitude is $\frac{-3}{2}$
(D) The number of point is having internal coordinates in region $A \cap B \cap C$ is 7.

39. Let $A = \begin{bmatrix} 3x^2 \\ 1 \\ 6x \end{bmatrix}$, $B = \begin{bmatrix} a & b & c \end{bmatrix}$

$C = \begin{bmatrix} (x+2)^2 & 5x^2 & 2x \\ 5x^2 & 2x & (x+2)^2 \\ 2x & (x+2)^2 & 5x^2 \end{bmatrix}$ be three given matrices,

where a, b, c and $x \in R$ given $t_r(AB) = t_r(c)\ \forall\ x \in R$, where $t_r(A)$ denote trace of A.
Then which of following are correct
(A) $a + b + c = 7$
(B) if $\int_0^\infty \frac{\ln x}{cx^2 + ax + b} dx = \frac{\pi \ln p}{\sqrt{q}}$ where p and q are coprime then $p + q = 29$
(C) $a + b + c = 6$
(D) If $\int_0^\infty \frac{\ln x}{cx^2 + ax + b} dx = \frac{\pi \ln p}{\sqrt{q}}$ where p and q are coprime are $p + q = 27$

Space for Rough work

40. Let n be an integer $n \geq 3$. let $p_1, p_2, ...p_n$ be a regular n-sided polygon inscribed in a circle. Three points p_i, p_j, p_k are randomly chosen, where i, j, k are district integer's between 1 and n.

If $p(n)$ denotes probability that $\Delta p_i p_j p_k$ is obtuse angle triangle then which of the following are correct ?

(A) $p(5) = \frac{1}{2}$

(B) $p(8) = \frac{3}{7}$

(C) $p(6) = \frac{3}{10}$

(D) $p(7) = \frac{1}{2}$

41. Let $g : R \to \{4\}$ be a function given by $g(x) = x^3(f'(t) - 2) + x^2 f''(t) + 4x(f(0) + 6) + 4$ and h(x) is defined as

$$h(x) = \begin{cases} \int_0^x |f(t) - 2| dt, & 0 \leq x \leq 6 \\ (x - 6)^2 + 20 : & 6 < x \leq 12 \end{cases}$$

Then choose correct statement's

(A) $h(3) = 15$

(B) range of h(x) is [0, 56]

(C) h(x) is not continuous at $x = 4$

(D) h(x) is not differentiate at $x = 6$

42. $f : R \to R$ and $g : R \to R$ are two function such that

$f(x) = 3x - \sin\left(\frac{\pi x}{2}\right), g(x) = x^3 + 2x - \sin\left(\frac{\pi x}{2}\right)$ then choose correct statements

(A) $\frac{d}{dx}\left(f^{-1}\left(g^{-1}(x)\right)\right)$ at $x = -12$ is $\frac{2}{3(28 + \pi)}$

(B) $\frac{d}{dx}\left(f^{-1}\left(g^{-1}(x)\right)\right)$ at $x = -12$ is $\frac{2}{3(28 - \pi)}$

(C) The area bounded by $y = f^{-1}(x)$ and $y = g^{-1}(x)$ is 1

(D) The area bounded by $y = f^{-1}(x)$ and $y = g^{-1}(x)$ is $\frac{1}{2}$

Space for Rough work

43. In a ΔABC if median from B and C are perpendicular, then the value of $\cot B + \cot C$ cannot be

(A) $\frac{1}{2}$ (B) $-\frac{1}{2}$

(C) $\frac{2}{3}$ (D) $-\frac{2}{3}$

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 44, 45 and 46 by appropriately matching the information given in the three columns of the following table.

For the quadratic polynomial $f(x) = ax^2 + bx + c$ where $a, b, c \in R$ and $a > 0, D = b^2 - 4ac$

Column-1: Contains the information about curve $y = |f|x||$ behaviour on different condition of a, b, c and D.

Column-2: Contains number of points where curves $y = |f|x||$ are not differentiable.

Column-3: Contains number of roots of curves $y = |f(|x|)|$.

	Column-1		**Column-2**		**Column-3**
(I)	D>0, b<0 and c>0	(i)	1	(P)	1
(II)	D>0, b<0 and c<0	(ii)	2	(Q)	2
(III)	D<0 $b \neq 0$ and c>0	(iii)	3	(R)	4
(IV)	D>0 b = 0 and c<0	(iv)	5	(S)	0

44. Which of following option is only correct combination

(A) (I)(iv)(R) (B) (III)(iii)(S) (C) (II)(i)(Q) (D) (IV)(ii)(R)

45. Which of following is only correct combination

(A) (III)(iii)(R) (B) (II)(iii)(Q) (C) (IV)(ii)(R) (D) (I)(iii)(R)

46. Which of following is only incorrect combination

(A) (I)(iv)(R) (B) (II)(iii)(Q) (C) (III)(i)(S) (D) (IV)(ii)(R)

Space for Rough work

Answer questions 47, 48 and 49 by appropriately matching the information given in the three columns of the following table.

If three planes are given

$S_1 : 2x + 3y + 4z = 9$

$S_2 : 4x + 5y + 6z = 15$

$S_3 : y + az = b$

And two lines are given

$L_1 : \bar{r} = (\hat{i} + a_1\hat{j} + \hat{k}) + \lambda(b_1\hat{i} + b_2\hat{j} + \hat{k})$

$L_2 : \bar{r} = \mu(\hat{i} + \hat{j} + \hat{k})$

Where line L_1 is contained in S_1, S_2 and S_3
Then

	Column-1		Column-2		Column-3
(I)	$b_1 - b_2$ is -3	(i)	Acute angle between S_1&S_3 is $\cos^{-1}\left(\frac{11}{\sqrt{145}}\right)$	(P)	Image of a pt. (0, 0, 0) w.r.t S_3 is $\left(0, \frac{6}{\sqrt{5}}, \frac{12}{\sqrt{5}}\right)$
(II)	$a_1 + a$ is 3	(ii)	Acute angle between L_2& S_3 is $\cos^{-1}\left(\frac{\sqrt{3}}{\sqrt{5}}\right)$	(Q)	Image of point (0, 0, 0) w.r.t line L_1 is (1, 1, 1)
(III)	$b + b_1 + b_2$ is 2	(iii)	Distance between L_1& L_2 is zero	(R)	Distance of point (0, 0,0) from S_1 measured parallel to L_2 is $\frac{9}{\sqrt{29}}$
(IV)	$\int_{b_2}^{b_1} \{x\}\,dx$ is $\frac{1}{2}$ where { } represent fractional part	(iv)	Acute angle between L_2& S_1 is $\sin^{-1}\left(\frac{3\sqrt{3}}{\sqrt{29}}\right)$	(S)	Distance of a point (1, 0, 0) from S_3 measured || to L_2 is $\sqrt{3}$.

47. Which of following in only correct combination
(A) (I)(iii)(Q) (B) (II)(iii)(P) (C) (III)(ii)(S) (D) (IV)(iv)(R)

48. Which of following is correct combination
(A) (III)(iv)(S) (B) (III)(ii)(P) (C) (IV)(i)(P) (D) (II)(iii)(R)

49. Which of following is incorrect combination.
(A) (II)(i)(P) (B) (III)(iii)(S) (C) (III)(iv)(R) (D) (III)(iii)(P)

Space for Rough work

SECTION – C

(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

50. Let S_n and Δ_n be the sum of first n terms of 2A.P's, whose rth term are T_r and t_r respectively. If $\frac{S_n}{\Delta_n} = \frac{2n+5}{3n+2}$ then $\frac{T_{11}}{t_{10}} = \frac{m_1}{m_2}$ where m_1 and m_2 are coprime. Find the value of $\frac{m_2 - m_1}{2} =$

51. Let $f : A \to B$ be any function where A is set containing the positive integral solution of the inequality $\operatorname{cosec}^{-1}(\operatorname{cosec} 2) > x^2 - 3x$ and B is the set of all divisors of natural number 4020. If $f(i) \le f(j)\, \forall i < j$. if total no of function from A to B is λ. Then the $\lambda - 2598$ equal to

52. If the set of values of parameter α so that point $P\left(\alpha, \frac{1}{1+\alpha^2}\right)$ does not lie outside the triangle formed by lines $L_1 : 15y = x + 1,\ L_2 : 78y = 118 - 23x$ and $L_3 : y + 2 = 0$ is [a, b]
Then $a + b =$

53. The pages of a book are numbered from 1 to n. when the page numbers of the book were added together one of the page number was added twice, resulting in the incorrect sum of 1986.
If the number on the page that was added twice is λ, then $\lambda - 30$ is.

54. The ratios of the lengths of sides BC and AC of ΔABC to the radius of circumscribed circle are equal to 2 and $\frac{3}{2}$ respectively. If the ratio of the lengths of the bisectors of the interior angles B and C is $\frac{\alpha(\sqrt{\alpha} - 1)}{\beta\sqrt{\gamma}}$ where $\alpha, \beta, \gamma \in N$ Then find value of $\frac{(\alpha + \beta + \gamma)}{2}$:

Space for Rough work

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FULL TEST – VII

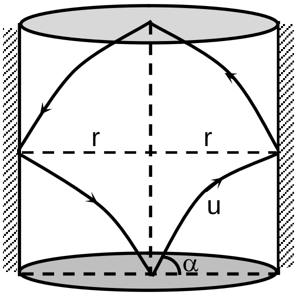
PAPER-1

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**B, D**	19.	**A, D**	37.	**A, D**
2.	**B, C**	20.	**A, D**	38.	**B, C**
3.	**B, D**	21.	**B, C**	39.	**A, B**
4.	**A, D**	22.	**A, B, D**	40.	**A, B, C**
5.	**B, C**	23.	**A, B, D**	41.	**A, B, D**
6.	**A, C, D**	24.	**A, B**	42.	**A, D**
7.	**B, C**	25.	**A, B, C**	43.	**A, B, D**
8.	**B**	26.	**A**	44.	**A**
9.	**A**	27.	**D**	45.	**B**
10.	**D**	28.	**A**	46.	**D**
11.	**D**	29.	**C**	47.	**B**
12.	**C**	30.	**D**	48.	**A**
13.	**B**	31.	**B**	49.	**C**
14.	**4**	32.	**5**	50.	**6**
15.	**3**	33.	**4**	51.	**2**
16.	**2**	34.	**4**	52.	**7**
17.	**2**	35.	**4**	53.	**3**
18.	**2**	36.	**3**	54.	**9**

Physics

PART – I

SECTION – A



1. B, D

During collision u_x will not change and range will be 4r.

$\therefore \quad 4r = (u\cos\alpha)T$

$\Rightarrow \quad u = \dfrac{4r}{T\cos\alpha}$

As particle will not be able to reach highest position of standard projectile path.

$\dfrac{2u\sin\alpha}{g} > T \qquad \Rightarrow \dfrac{2u\sin\alpha}{g} > \dfrac{4r}{u\cos\alpha}$ From (1)

$\Rightarrow \quad u > 2\sqrt{\dfrac{gr}{\sin 2\alpha}}$

2. B, C

$T = 2\pi\sqrt{\dfrac{\ell}{g}} \Rightarrow g \propto \ell T^2$

$\Rightarrow \quad \dfrac{\Delta g}{g} = \left(\dfrac{\Delta\ell}{\ell} + \dfrac{2\Delta T}{T}\right)$

Therefore $P = \left(\dfrac{\Delta\ell}{\ell} + \dfrac{2\Delta T}{T}\right)100\%$

$\Rightarrow \quad P_1 = \left(\dfrac{0.1}{100} + \dfrac{2(1)}{400}\right)\times 100 = 0.6\%$

$P_2 = \left(\dfrac{0.1}{400} + \dfrac{2(1)}{400}\right)\times 100 = 0.42\%$

$P_3 = \left(\dfrac{0.1}{100} + \dfrac{2(1)}{200}\right)\times 100 = 1.1\%$

$P_4 = \left(\dfrac{0.1}{400} + \dfrac{2(1)}{800}\right)\times 100 = 0.28\%$

3. B, D

$B = \dfrac{\mu_0 I}{\ell} = \dfrac{\mu_0}{\ell}\left[(\sigma)\dfrac{(2\pi R)\ell\omega}{2\pi}\right]$

$= \mu_0\sigma R\omega$

$= \mu_0\sigma Rkt \Rightarrow B \;\alpha\; 't'$

Consider loop of radius ‘r’ $\qquad r < R$

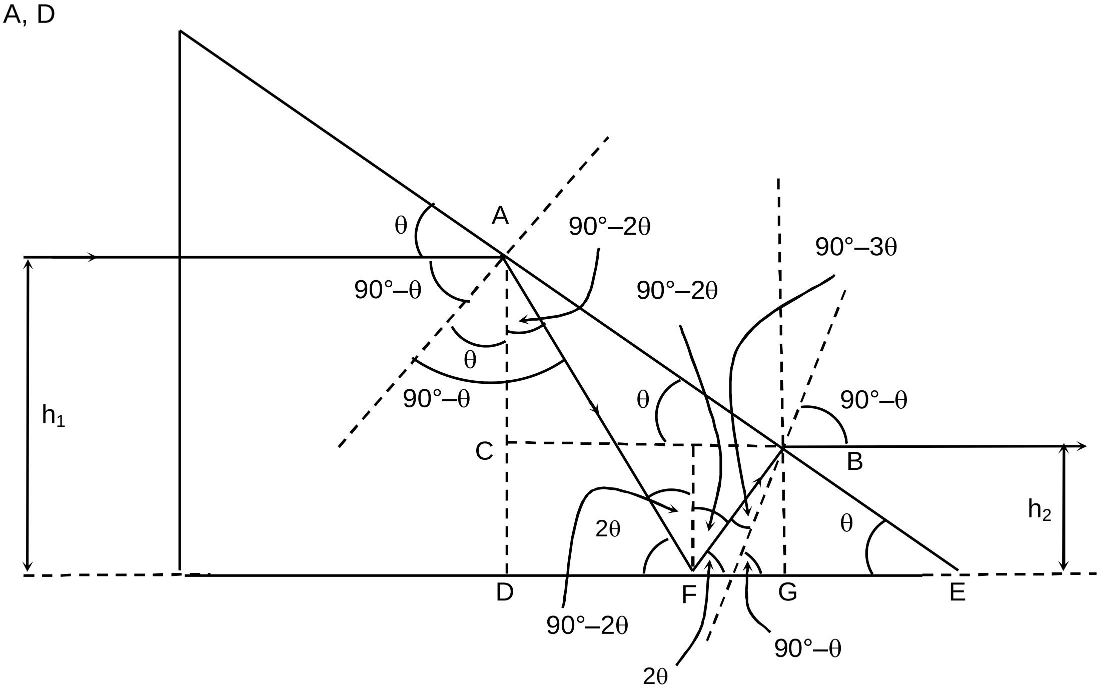
$E(2\pi r) = \pi r^2 \dfrac{dB}{dt}$

$E = \dfrac{r}{2}(\mu_0\sigma Rk) \qquad E \propto r$

For,

Energy density $= \dfrac{B^2}{2\mu_0}$

4. A, D


θ
A
90°–2θ
90°–3θ
90°–θ
90°–2θ
θ
90°–θ
h1
θ
90°–θ
C
B
h2
2θ
θ
D
F
G
E
90°–2θ
90°–θ
2θ

AC = $h_1 - h_2$

$$\tan\theta = \frac{AC}{CB}$$

$$= \frac{h_1 - h_2}{DF + FG}$$

$$\tan\theta = \frac{h_1 - h_2}{h_1 \cot 2\theta + h_2 \cot 2\theta}$$

$$\Rightarrow \quad \frac{\tan\theta}{\tan 2\theta} = \frac{h_1 - h_2}{h_1 + h_2}$$

$$\Rightarrow \quad \frac{h_1}{h_2} = \frac{\sin\theta}{\sin 3\theta}$$

$$\Rightarrow \quad \frac{h_2}{h_1} = \frac{\sin 3\theta}{\sin\theta} = 4\cos^2\theta - 1 \qquad (1)$$

Using Snel's law at 'B'

$$\mu \sin(90^\circ - 3\theta) = \sin(90^\circ - \theta)$$

$$\Rightarrow \quad \frac{1}{\mu} = \frac{\cos 3\theta}{\cos\theta} = 4\cos^2\theta - 3 \qquad (2)$$

From (1) and (2) $\dfrac{h_1}{h_2} = \dfrac{\mu}{1 + 2\mu}$

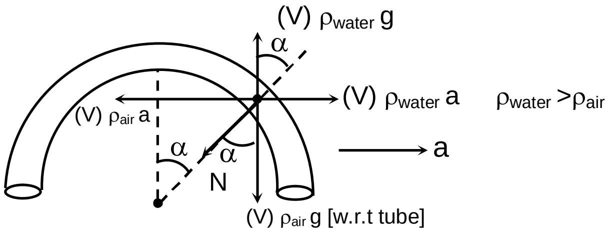
5. B, C

Use condition of equilibrium

$$N\cos\alpha = v(\rho_{water} - \rho_{air})g$$

$$N\sin\alpha = V(\rho_{water} - \rho_{air})a$$

$$\Rightarrow \quad \tan\alpha = \frac{a}{g}$$


(V) ρwater g
α
(V) ρwater a
ρwater >ρair
(V) ρair a
α
α
N
a
(V) ρair g [w.r.t tube]

6. A, C, D

U = 3 PV

$nC_vT = 3$ PV

$\Rightarrow \quad \gamma = \frac{4}{3}$

Tri-atmoic gas

$C_p = \frac{\gamma R}{\gamma - 1}$

$\Rightarrow \quad C_p = 4R$

7. B, C

Block will move between $\frac{-\alpha}{2}$ & $\frac{\alpha}{2}$.

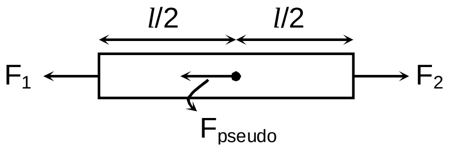
$T = 4\left(\frac{T_0}{6}\right) = \frac{2}{3}T_0$

If collision with atleast one wall is inelastic then amplitude will reduce and time period will remain same as T_0.

8. B
9. A
10. D
11. D
12. C
13. B

SECTION – C

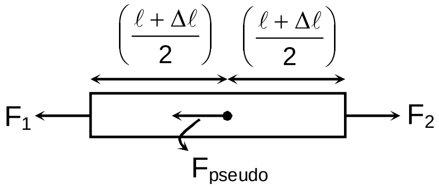
14. 4



From this frame, $W_{pseduo} = 0$

$W_1 = F_1 \times \left(\frac{\Delta\ell}{2}\right)$

And $W_2 = F_2 \times \left(\frac{\Delta\ell}{2}\right)$


$\left(\frac{\ell + \Delta\ell}{2}\right)$
$\left(\frac{\ell + \Delta\ell}{2}\right)$
F1
F2
Fpseudo

Thus, w.e.f. from COM frame

$W_1 + W_2 + W_{pseudo} = U + \kappa + \Delta$ [∴ k will remains zero finally from COM frame]

$\Rightarrow \quad W_1 + W_2 = U + \Delta$

$\Rightarrow \quad F_1.\frac{\Delta\ell}{2} + F_2.\frac{\Delta\ell}{2} = U + \Delta$

$\Rightarrow \quad (F_1 + F_2)\frac{\Delta\ell}{2} = U + \Delta$

So, Let's calculates heat now

$$\frac{1}{2}\left[(F_1+F_2)\frac{(F_1+F_2)\ell}{2AY}\right]=\frac{(F_1^2+F_2^2+F_1F_2)\ell}{6AY}+\Delta$$

$\Rightarrow \quad \Delta=\dfrac{(F_1^2+F_2^2+4F_1F_2)\ell}{12AY}$

Putting F_1 = F; F_2 = 2F, we get $\Delta=\dfrac{13F^2\ell}{12AY}$

$\Rightarrow \quad$ a = 1; b = 3

$\Rightarrow \quad$ a + b = 4

15. 3

$T\sin\theta=\lambda sg$ . ...(1)

$T\cos\theta=T_0$ ....(2)

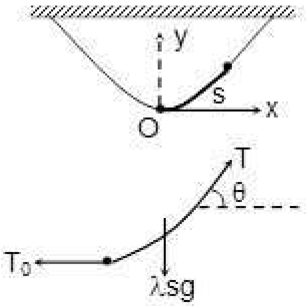
(i) and (ii) $\Rightarrow \tan\theta=\lambda sg/T_0 \quad \Rightarrow S=\left(\dfrac{T_0}{\lambda g}\right)\tan\theta.$

R.O.C. $=\dfrac{ds}{d\theta}$

$\Rightarrow \quad R=\left(\dfrac{T_0}{\lambda g}\right)\sec^2\theta$

Putting $T_0=90;\ \lambda=4; g=10$ and θ = 30°

R = 3 m



16. 2

The observer will hear sound, which has been emitted when source is slightly before point P.

Distance between two consecutive pubes emitted towards observer is $\dfrac{V-V_s\cos\theta}{f}$, as shown below.

$\Rightarrow \lambda'=\dfrac{V-V_s\cos\theta}{f}$

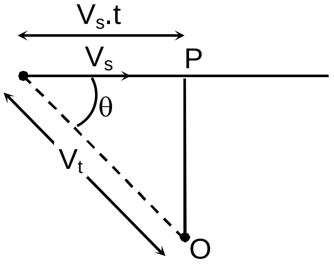
Putting $\cos\theta=\dfrac{V_s}{V}$

We get $\lambda'=\dfrac{V^2-V_s^2}{Vf}$

Putting the given values we get

$\lambda'=\dfrac{2}{11}m$

Hence n = 2



17. 2

$mv+(m+\Delta m)g\Delta t=(m+\Delta m)(v+\Delta v)$

$\Rightarrow \quad mv+mg\Delta t+\Delta mg\Delta t=mv+m\Delta v+\Delta m.v+\Delta m.\Delta v$

$\Rightarrow \quad mg\Delta t+\Delta mg\Delta t=m\Delta v+\Delta m.v+\Delta m.\Delta v$ ....(1)

Also, $\dfrac{\Delta m}{\Delta t}=kmv$ (given)

$\Rightarrow \quad \Delta m=kmv\Delta t$ Putting in (1)

We get $mg\Delta t+kmvg\Delta t^2=m\Delta v+kmv^2\Delta t+kmv\Delta t.\Delta v$

$\Rightarrow \quad mg\Delta t=m\Delta v+kmv^2\Delta t$ (Neglecting second differentials)

$\Rightarrow \quad \Delta v = (g - kv^2)\Delta t \qquad \Rightarrow \quad \frac{\Delta v}{\Delta t} = g - kv^2$

$\Rightarrow \quad \frac{dv}{dt} = g - kv^2$

At terminal velocity $g - kv^2 = 0$

$\Rightarrow \quad v = \sqrt{\frac{g}{k}}$

Putting g = 10; k = 2.5 $\Rightarrow$ v = 2 m/s

18. 2

Let $y = A\sin(\omega t - kx)$

P.E. stored in small element dx is

$$dU = \frac{T}{2}\left(\frac{\partial y}{\partial x}\right)^2 .dx = \frac{\mu v^2}{2}\left(\frac{\partial y}{\partial x}\right)^2 dx$$

$$= \frac{\mu}{2}\left[v.\frac{\partial y}{\partial x}\right]^2 dx$$

Since, $\frac{\partial y}{\partial t} = -v\frac{\partial y}{\partial x}$

Hence, $dU = \frac{\mu}{2}.\left(\frac{\partial y}{\partial t}\right)^2 dx$

Also, KE stored in small element 'dx' is

$$dK = \frac{1}{2}(\mu dx)\left(\frac{\partial y}{\partial t}\right)^2$$

$\Rightarrow$ Total energy dE = dU + dK = $\mu\left(\frac{\partial y}{\partial t}\right)^2 dx$

$$\frac{\partial y}{\partial t} = A\omega\cos(\omega t - kx)$$

$\Rightarrow \quad dE = \mu\omega^2 A^2 \cos^2(\omega t - kx)dx$

$\Rightarrow \quad E = \mu\omega^2 A^2 \int_{x=0}^{\lambda} \cos^2(\omega t - kx)dx = \frac{\mu\omega^2 A^2 \lambda}{2}$

Hence b = 2

Chemistry PART – II

SECTION – A

19. AD
Addition of $CaCO_3$ does not affect equilibrium as it is solid and inert gas addition at constant volume also does not affect the equilibrium but as reaction is endothermic and gaseous Stoichiometry of product is more than reactants that's why A and D are correct

20. AD
Both A and D are correct as both follows Hund's rule and B, C do not

21. BC
H-atom in $NaH_2\ PO_2$ is bonded with P (less electronegative), cannot involve in H-bonding and so also $(CH_3)_3 BO_3$

22. ABD
At pH < isoelectric pH, $-NH_2$ group is protonated to $-\overset{+}{N}H_3$ and the sol is positively charged. At pH > isoelectric pH, –COOH is deprotonated to $-COO^-$ and the sol is negatively charged. At isoelectric pH both groups are equally ionised, the sol particles carry no net charge.

23. ABD
Sodium nitrate on decomposition upto 500ºC gives $NaNO_2$ and oxygen
$2NaNO_3 \xrightarrow{\Delta} 2NaNO_2 + O_2 \uparrow$
While at higher temperature (i.e. above to 800ºC), $NaNO_2$ further decomposes into Na_2O, N_2 and O_2.
$2NaNO_2 \xrightarrow{800^\circ C} Na_2O + 3/2O_2 \uparrow + N_2 \uparrow$

24. AB
$[K_2HgI_4 + KOH]$ and $[HgCl_2 + KI(excess) + KOH]$ are Nessler's reagent which gives brown precipitate of $H_2N-Hg-O-Hg-I$ (iodide of Million's base).

25. ABC
Since there are no ions involved in this compound, the Cl^- atoms are covalently bonded to Pd in the coordination sphere
(d) No precipitate of AgCl would be formed as chlorine atoms are non-ionisable.

26. A
Tollen's test is given by all type of aldehyde by action of ammonical silver nitrate and observation is formation of silver mirror

27. D
Red ppt is observed by action of Fehling solution on aliphatic aldehyde

28. A
Tollen's test, Fehling's test and Haloform test all three involve oxidation of organic compound but action of Fehling solution on terminal alkynes do not

29. C

30. D

31. B

Sol. **(29 to 31)**

Crystal system	**Axial length & angle**	**Type of unit cell**
Cube	$a = b = c$ $\alpha = \beta = \gamma$	Primitive, face centred & body centered
Orthorhombic	$a \neq b \neq c$ $\alpha = \beta = \gamma$	Primitive, Face centred, body centered & end centered
Triclinic	$a \neq b \neq c$ $\alpha \neq \beta \neq \gamma$	Only Primitive
Monoclinic	$a \neq b \neq c$ $\alpha = \beta \neq \gamma$	Primitive, End centred

SECTION – C

32. 5

Moles ($KMnO_4$) × 5 = mole (SnC_2O_4) × 4 (n factor of SnC_2O_4)

$$SnC_2O_4 \xrightarrow{KMnO_4} Sn^{4+} + CO_2$$

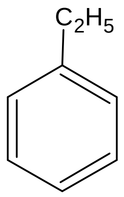
33. 4

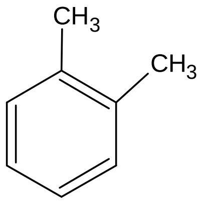
One triangular face will be found in place of each corner of tetrahedron

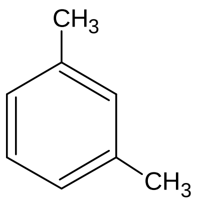
34. 4

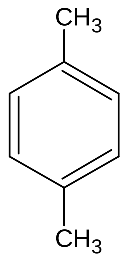
$$^{235}_{92}U + ^{1}_{0}n \rightarrow \ ^{140}_{54}Xe + \ ^{92}_{38}Sr + 4^{1}_{0}n$$

35. 4

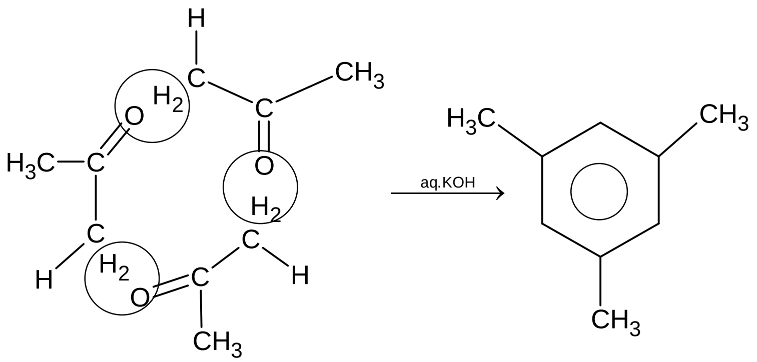








36. 3



Mathematics PART – III

SECTION – A

37. A, D

Sol. $y^2 = 16x \Rightarrow a = 4$

Slope of tangents at t is $\frac{1}{t}$

$\tan\theta_1 = \frac{1}{t_1}$, $\tan\theta_2 = \frac{1}{t_2}$; $\tan\theta_3 = \frac{1}{t_3}$

t_1, t_2, t_3 are in A. P. with $d = 3$

$t_2 - t_1 = 3$

$t_3 - t_2 = 3$

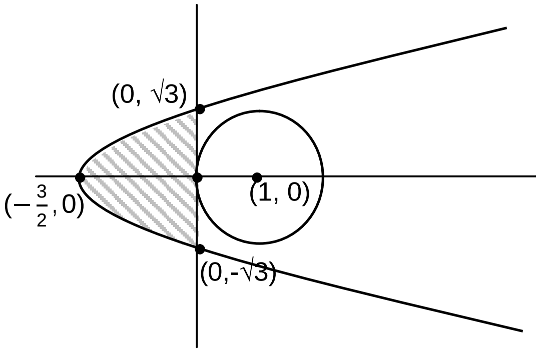
Area of $\Delta PQR = \frac{1}{2}\begin{vmatrix} at_1t_2 & a(t_1+t_2) & 1 \\ at_2t_3 & a(t_2+t_3) & 1 \\ at_3t_1 & a(t_3+t_1) & 1 \end{vmatrix}$

$= a^2d^3 = 16 \times 27 = 432$

Area of ΔABC is $= 2.\Delta PQR$

= 864.

38. B, C



Sol. For. A, $|z+1| \le 2 + \text{Re}(z)$

$\Rightarrow y^2 \le 2\left(x + \frac{3}{2}\right)$

For B, $|z-1| \ge 1 \qquad \Rightarrow (x-1)^2 + y^2 \ge 1$

For C

$|z-1|^2 \ge |z+1|^2$

$\Rightarrow (z-1)(\bar{z}-1) \ge (z+1)(\bar{z}+1)$

$\Rightarrow z + \bar{z} \le 0 \qquad \Rightarrow x \le 0$

B. Required area $2\int_{-\frac{3}{2}}^{0} \sqrt{2(x+\frac{3}{2})}\, dx = 2\sqrt{3}$

C. $z = -\frac{3}{2} + i0$ is complex number in region $A \cap B \cap C$ having max amplitude

D. $(-1,0), (-1,1), (-1,-1), (0,0), (0,1) (0,-1)$, are point but $z = -1$ is not in domain of C

so total points 5

39. A, B

Sol. $AB = \begin{bmatrix} 3ax^2 & 3bx^2 & 3cx^2 \\ a & b & c \\ 6ax & 6bx & 6cx \end{bmatrix}$

Now $t_r(AB) = t_r(c)$

$\Rightarrow 3ax^2 + b + 6cx = (x+2)^2 + 2x + 5x^2 : \forall x \in R$

$a = 2, c = 1, b = 4$

$$I = \int_0^{\infty} \frac{\ln x}{x^2 + 2x + 4} dx$$

Put $x = 2t$

$dx = 2dt$

$$= \int_0^{\infty} \frac{\ln(2t)}{4t^2 + 4t + 4} .2dt$$

$$= \int_0^{\infty} \frac{2.\ln 2}{4(t^2 + t + 1)} dt + \int_0^{\infty} \frac{2\ln t}{4(t^2 + t + 1)} dt$$

Put $t = \frac{1}{y}$ in second Integral we get zero

$$= \frac{1}{2}\int_0^{\infty} \frac{\ln 2}{t^2 + t + 1} dt + 0$$

$$= \frac{\pi \ln 2}{3\sqrt{3}}$$

$p = 2, q = 27$

$p + q = 29$

40. A, B, C

Sol. $\text{Probability} = \frac{3(n-4)}{4(n-1)}$: If n is even

$\text{Probability} = \frac{3(n-3)}{4(n-2)}$: If n is odd

41. A, B, D

Sol. $g(x) = 4$

$x^3\left(f'(t) - 2\right) + x^2 f''(t) + 4x\left(f(0) + 6\right) + 4 = 4$ for $\forall x$

$\Rightarrow x^3(f'(t) - 2) + x^2 f''(t) + 4x(f(0) + 6) = 0$ for $\forall x$

Hence $f'(t) - 2 = 0$ and $f''(t) = 0$

and $f(0) + 6 = 0 \Rightarrow f(0) = -6$

So, $f(t) = 2t - 6$

$$h(x) = \begin{cases} -x^2 + 8x & ;0 \le x < 4 \\ x^2 - 8x + 32 & ;4 \le x \le 6 \\ (x-6)^2 + 20 & ;6 < x \le 12 \end{cases}$$

42. A, D

Sol. (A) $\left(f^{-1}g^{-1}(x)\right) = \left(g\left(f(x)\right)\right)^{-1}$

$$\frac{d}{dx}\left(f^{-1}g^{-1}(x)\right)\Big|_{\text{at } x=-12} = \frac{1}{\frac{d}{dx}\left(gof(x)\right)_{\text{at } x=-1}}$$

(D) Area will be same as bounded by $y = f(x), y = g(x)$

$$\Rightarrow \int_{-1}^{1} \left|x^3 - x\right| dx = \frac{1}{2}$$

43. A, B, D

Sol. $\tan\theta = \frac{2y}{2x} = \frac{y}{x}$

$\tan\alpha = \frac{y}{2x}$

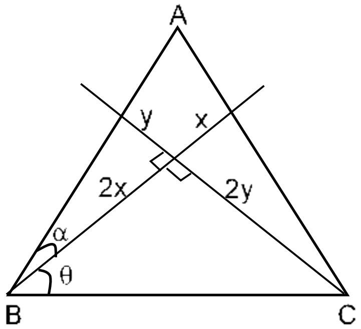
$\tan B = \frac{\frac{y}{x}+\frac{y}{2x}}{1-\frac{y^2}{2x^2}} = \frac{3xy}{2x^2-y^2}$

$\cot B = \frac{2x^2-y^2}{3xy}$;

Similarly,

$\cot C = \frac{2y^2-x^2}{3xy}$

$\cot B + \cot C = \frac{x^2+y^2}{3xy} \geq \frac{2}{3}$



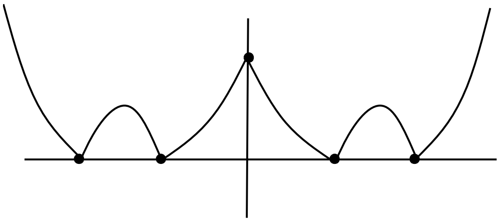
44. A

45. B

46. D

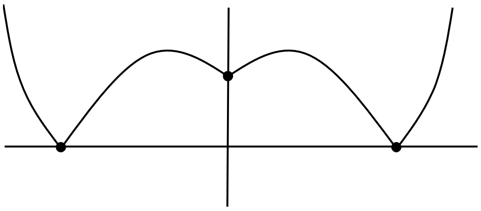
Sol.

I.



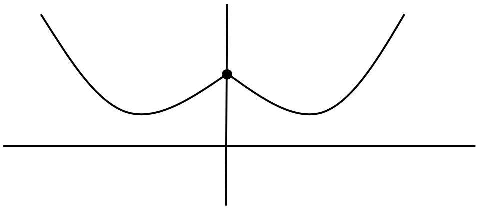
4 roots, 5 points not derivative

II.



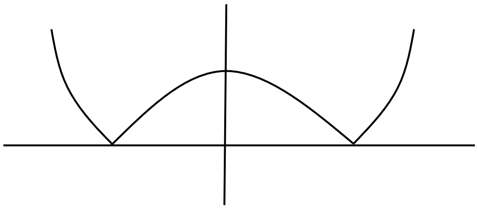
2 roots, 3 points not derivative

III.



No root's, 1 point of non-derivative

IV.



2 roots, 2 points non-derivative

47. B
48. A
49. C

Sol. Point (1, a_1, 1) lies on s_1 and s_2

$2+3a_1+4=9 \Rightarrow a_1=1$

$(b_1, b_2, 1)$ is $\perp$ to normal of planes s_1, s_2 and s_3

$2b_1+3b_2+4=0$

$4b_1+5b_2+6=0$

$\Rightarrow b_1=1, b_2=-2, a=2, b=3$

SECTION – C

50. 6

Sol. $\frac{S_n}{\Delta_n}=\frac{2n+5}{3n+2}=\lambda$

$S_n=\lambda n(2n+5) : \Delta_n=\lambda n(3n+2)$

$T_n=S_n-S_{n-1} : t_n=\Delta_n-\Delta_{n-1}$

$T_n=\lambda(4n+3) : t_n=\lambda(6n-1)$

$T_{11}=\lambda(47)$

$t_{10}=\lambda(59)$

$\frac{T_{11}}{t_{10}}=\frac{47}{59}=\frac{m_1}{m_2}$

$\frac{m_2-m_1}{2}=\frac{59-47}{2}=6$

51. 2

Sol. $\operatorname{cosec}^{-1}(\operatorname{cosec}2) > x^2-3x$

$\pi-2 > x^2-3x$ give integral solution of 1,2, 3.

4020 $=2^2.3.5.67$ given 24 divisors'

Now, $f(i) \le f(j) \forall i<j$

${}^{24+2}C_3=2600$

52. 7

Sol. $P\left(\alpha, \frac{1}{1+\alpha^2}\right)$ lie on

$y=\frac{1}{1+x^2}$

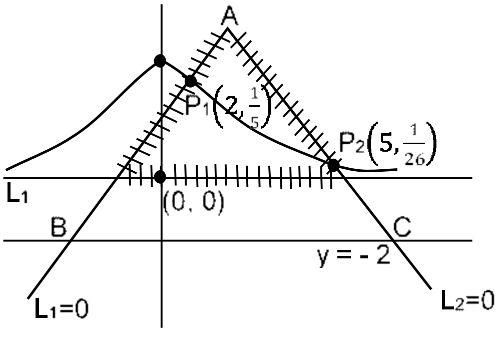
On solving $y=\frac{1}{1+x^2}$ with L_1

$P_1\left(2, \frac{1}{5}\right)$ ...(1)

And with L_2, $P_2\left(5, \frac{1}{26}\right)$ ...(2)

From (1) and (2)

$2 \le \alpha \le 5$



53. 3

Sol. Let k be number of page that was counted twice then $0 < K < n+1$

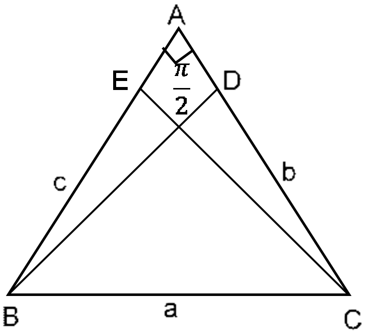
$$0+1+2+3+........n < 1986 < 1+2+....(n+1)$$

$$n(n+1) < 3972 < (n+1)(n+2)$$

On solving $n = 62$

So, $k = 1986 - \frac{62 \times 63}{2} = 1986 - 1953 = 33$

54. 9



Sol. We have $\frac{a}{R} = 2 : \frac{b}{R} = \frac{3}{2}$

$$\frac{2R\sin A}{R} = 2$$

$$\sin A = 1 \Rightarrow \angle A = \frac{\pi}{2}$$

And $\sin B = \frac{3}{4}$

$$c^2 = 4R^2 - \frac{9R^2}{4}$$

$$\Rightarrow c = \frac{\sqrt{7}}{2}R$$

$$l_1 = \frac{2ac}{a+c}\cos\frac{B}{2}$$

$$l_2 = \frac{2ab}{a+b}\cos\frac{C}{2}$$

$$\frac{l_1}{l_2} = \left(\frac{a+b}{a+c}\right)\frac{c}{b}.\sqrt{\frac{1+\cos B}{1+\cos C}}$$

$$= \frac{c(a+b)}{b(a+c)}.\sqrt{\frac{1+\frac{c}{a}}{1+\frac{b}{a}}}$$

$$= \frac{c}{b}.\sqrt{\frac{a+b}{a+c}}$$

Now put,

$a = 2R,$

$b = \frac{3}{2}R,$

$c = \frac{\sqrt{7}}{2}R$

$$\frac{l_1}{l_2} = \frac{7}{3}\left(\sqrt{\frac{4-\sqrt{7}}{16-7}}\right) = \frac{7}{9}.\sqrt{\frac{8-2\sqrt{7}}{2}} = \frac{7}{9.\sqrt{2}}(\sqrt{7}-1)$$

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

FULL TEST – VII

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 231**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-C & Section-D**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01 – 03, 24 – 26, 47 – 49)*** *contains 9 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (04 – 08, 27 – 31, 50 – 54) *contains 15 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (09 – 10, 32 – 33, 55 – 56) *contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer. There is no negative marking.*

2. ***Section-C (11 – 20, 34 – 43, 57 – 66)*** *contains 30 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

3. ***Section-D (21 – 23, 44 – 46, 67 – 69)*** *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10 \text{ m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3 \text{ kg/m}^3$
Atmospheric pressure	$P_a = 10^5 \text{ N/m}^2$
Gas constant	$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
		=	$0.0821 \text{ Lit atm K}^{-1} \text{ mol}^{-1}$
		=	$1.987 \approx 2 \text{ Cal K}^{-1} \text{ mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

PART – I (Physics), PART – II (Chemistry), PART – III (Mathematics):

(SECTION – D)

For questions **21 to 23, 44 to 46, 67 to 69.**
Numerical answer type questions with answer XXXXX. XX

If answer is 348.4 / 251.37 / 213

Correct Method :

0	0	3	4	8	.	4	0

0	0	2	5	1	.	3	7

0	0	2	1	3	.	0	0

Wrong Method :

	3	4	8		.	4	

3	4	8			.		4

		3	4	8	.		4

	3		4	8	.	4	

	2		5	1	.	3	7

		2	1	3	.		

		2	1	3	.	0	

		2	1	3	.		0

		3	4	8	.	4	0

		2	5	1	.	3	7

		2	1	3	.	0	0

Physics

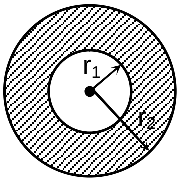
PART – I

SECTION – A

(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. In given diagram, their is a conducting sphere of radius r_1 which is surrounded by dielectric ($\in_r$). If conducting sphere is given charge 'q' then surface density of polarization charges on outer surface of dielectric layer is

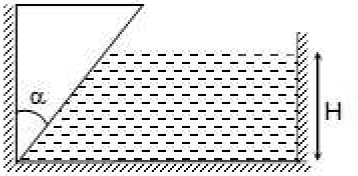


(A) $\frac{\in_r q}{4\pi r_2^2}$
(B) $\frac{q}{4\pi \in_r r_2^2}$
(C) $\frac{(\in_r - 1)q}{4\pi r_2^2}$
(D) $\frac{(\in_r - 1)q}{4\pi \in_r r_2^2}$

2. A parallel plate capacitor (plate Area : A) connected to battery of emf 'V' and negligible internal resistance, so that one of the plate is made to oscillate and distance between plate varies as $d = d_0 + a\cos(\omega t)$, $a << d_0$. If maximum current observed in circuit is I_0, then maximum possible amplitude of vibration (a) is

(A) $\frac{a^2 I_0}{VA\omega \in_0}$
(B) $\frac{I_0 d_0}{V\sqrt{A}\omega \in_0}$
(C) $\frac{I_0 d_0^2}{VA\omega \in_0}$
(D) $\frac{I_0 d_0}{VA\omega \in_0}$

3. A slit is cut along the left bottom edge of a rectangular tank. The slit is closed by a wooden wedge mass 'M' and apex angle 'α' as shown in diagram. The vertical plane surface of the wedge is in the contact with the left vertical wall of the tank. Coefficient of static friction between these surfaces in contact is 'μ'. To what maximum height, can water be filled in tank without any leakage through the slit? The width of tank is 'b' and density of water is 'ρ'.



(A) $\sqrt{\frac{2M}{\rho b(\tan\alpha - \mu)}}$
(B) $\sqrt{\frac{4M}{\rho b(\tan\alpha - \mu)}}$
(C) $\sqrt{\frac{2M}{\rho b(\sin\alpha - \mu\cos\alpha)}}$
(D) $\sqrt{\frac{2M\cos\alpha}{\rho b(\tan\alpha - \mu\cos\alpha)}}$

Space for Rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

4. A narrow beam of monochromatic light of wavelength 'λ' emitted by source of power 'P', propagating in x-direction gets reflected from perfectly reflecting plane mirror, having area vector $\vec{A} = A(-\hat{i} + \hat{j})$. The beam after reflection falls on metal plate of area A (placed in x-z plane), having work function ϕ and photo electric efficiency 'η'. If photoelectrons emitted are immediately removed from vicinity then (velocity of light is c)
(A) Magnitude of change in momentum of photon after reflection from mirror depends only on 'λ'
(B) Magnitude of change in momentum of photon after reflection from mirror depends on 'λ'
(C) Magnitude of force exerted by light beam on mirror depends only on 'P' & 'c'.
(D) Force exerted by light beam on mirror depends only on 'P' & 'c'.

5. A metallic ring of radius 'r', charged to potential $-V_0$ placed in free space is continuously irradiated by UV of wavelength (λ) [assume potential at infinity is zero] then, given : threshold wavelength is λ_0, C : speed of light, 'h' : planck's constant, m : mass of electron
(A) Maximum speed of photoelectron immediately after emission is $\sqrt{\frac{2hc}{m}\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)}$
(B) Maximum speed of photoelectron at great distance from ring is $\sqrt{\frac{2hc}{m}\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right) + \frac{eV_0}{2m}}$
(C) Potential of ring after prolonged irradiation is $\frac{2hc}{e}\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$
(D) Total number of photoelectrons emitted from ring is $\frac{4\pi \in_0 r}{e}\left\{\frac{hc}{e}\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right) + V_0\right\}$

Space for Rough work

6. If electric force $(\vec{F})$ on a point charge 'q' due to another charge 'Q' obeys following law

$$\vec{F} = \frac{Qq(1-\sqrt{\alpha r})\vec{r}}{4\pi \in_0 r^3}$$

Where α: positive constant, $\vec{r}$ is position vector of charge 'q' relative to 'Q'.

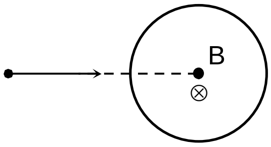
(A) Electric field to point charge Q is $\vec{E} = \frac{Q(1-\sqrt{\alpha r})}{4\pi \in_0 r^3}\vec{r}$

(B) $\oint \vec{E}.\vec{dl}$ over a closed path will be equal to zero.

(C) Gauss's law $\oint \vec{E}.\overrightarrow{ds} = \frac{q_{\text{enclosed}}}{\in_0}$ holds true

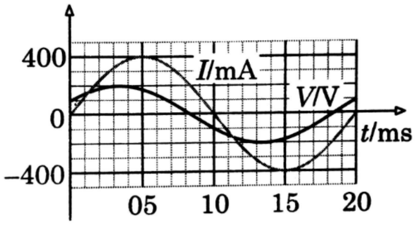
(D) All statements are correct.

7. Uniform magnetic field is confined into a cylindrical region, if α-particles with different speeds enter the region radially, then



(A) Faster the particle, lesser is the time spent in region
(B) Slower the particle, lesser is the time spent in region
(C) Slower the particle, greater is the time spent in region
(D) Time will be same for all particles

8. The graph shows variation of source voltage (V) and steady state current (I) drawn by a series RLC circuit. Identify correct statement(s).



(A) Current lags the voltage
(B) Resistance in circuit is $250\sqrt{3}\Omega$
(C) If capacitive reactance is 74Ω, then inductive reactance will be 324 Ω.
(D) Average power dissipated in circuit will be $20\sqrt{3}$W.

Space for Rough work

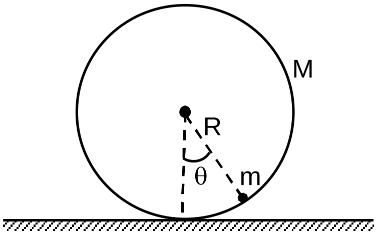
(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 9 and 10

A particle of mass 'm' slides without friction inside a hoop of radius 'R' and mass 'M'. The hoop rolls without slipping on a rough horizontal surface. Initially the particle is given small displacement (w.r.t. ring), the system performs SHM.

Now answer the following questions:



9. Angular frequency of small oscillations is

(A) $\sqrt{\frac{g}{R}\left(1+\frac{m}{M}\right)}$ (B) $\sqrt{\frac{g}{R}\left(1+\frac{m}{2M}\right)}$

(C) $\sqrt{\frac{g}{R}\left(1+\frac{2m}{M}\right)}$ (D) $\sqrt{\frac{mg}{2MR}}$

10. If the angular amplitude of oscillation of particle w.r.t. ring is 'θ', then the amplitude of oscillation of the centre of ring is

(A) $\frac{MR\theta}{M+m}$ (B) $\frac{MR\theta}{2M+m}$

(C) $\frac{mR\theta}{2M+m}$ (D) $\frac{mR\theta}{m+M}$

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

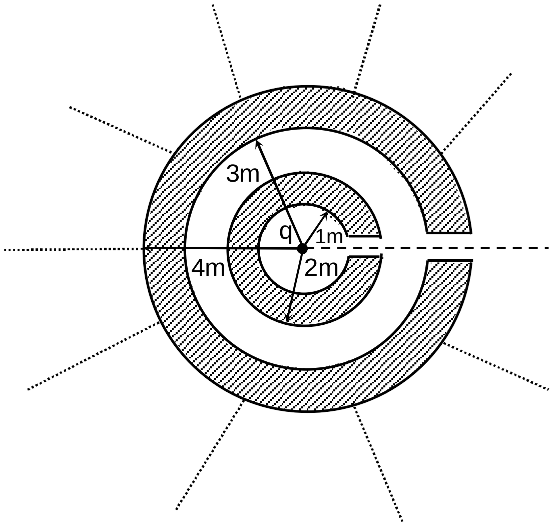
11. A liquid droplet of surface tension 4 N/m is introduced between two heavy plates of mass 1 kg and area 0.2 m^2. If the distance between these plates (which are put horizontally) is 2 cm, and angle of contact is 0°, the net normal force between the plates is found to be 10 n. Find 'n'. (take g = 10 m/s^2)

Space for Rough work

12. A particle of mass 1 kg and charge 0.5 C, is projected in a magnetic field of magnitude 2T, with a velocity 3 m/s making at angle of 30° with the field. Find radius of curvature of path traced out by the particle (in metres) [neglect gravity].

13. A battery of internal resistance 5Ω is connected across a capacitor of face area 0.1 m^2, distance between the plates as 1 cm and containing dielectric of relative permittivity 3 and resistivity 100 Ωm, fully inserted into it. The time constant of charging of capacitor is found to be $10n \in_0$. Then find the value of 'n'.

14. A charge 'q' is placed at the origin of an infinite chain of thick spherical conductors, whose inner and outer radii vary as (1m, 2m); (3m, 4m); (5m, 6m) and so on. The work needed to take the charge 'q' from centre of the system to infinite separation, through the orifice, is found to be $kq^2 \ell n\sqrt{n-4}$. Find 'n'.

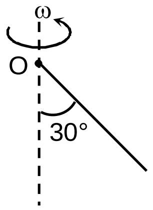


15. A tightly wound toroid (10,000 turns) has rectangular cross-section of thickness 2 cm and ratio of inner and outer radii as e^2. The self inductance of this toroid is x/10 H. Find x.

16. One mole of a monoatomic gas is supplied heat such that its molar heat capacity during the process is 2R. (R gas constant). If during heating, its volume gets doubled, by what factor does its temperature change?

Space for Rough work

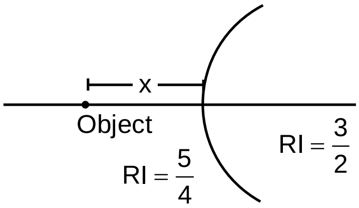
17. A rod of mass 6 kg and length 2 m, is rotating with an angular speed 1 rad/s about a point 'O' such that, the rod always makes an angle of 30° with vertical. What is the angular momentum of rod about 'O' [in SI units]?



18. Three sources of frequency 400 Hz, 401 Hz and 405 Hz respectively are emitting sound continuously is space. How many beats will be heard per second?

19. Atoms (may be in excited state) in a material ${}_{Z}^{A}X$ absorbs photons of energy 47.25 eV. We get 3 different photons in emission spectrum having energy greater than or equal to 47.25 eV. Find Z.

20. Radius of curvature of surface separating two media is 2m. To form real image of object, its distance from surface must be greater than x. Find $\frac{x}{2}$.

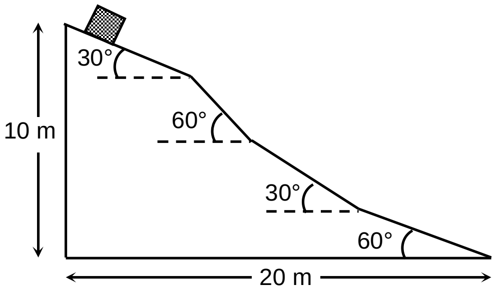


SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

21. Plate 1 of a capacitor having capacitance 1.5 μF is given a charge of 30 μc while the other plate is uncharged. The capacitor is now connected with a battery of potential 40 V with plate 1 connected to the positive terminal. Work done by battery is ___________ μJ.

22. A block of mass 18 kg is released from the top of the wedge as shown in the diagram. Coefficient of friction between block and surface of the wedge is μ = 0.2. Magnitude of work done by friction when the block reaches bottom of the wedge is .... (Assume that the block makes smooth transitions at all corners so that it never looses contact, g = 10 m/s^2)



23. One mole of an ideal gas undergoes a thermodynamic process whose molar specific heat is given by the equation $C = C_V + 4R$. Equation of such a process is given by VT^{-n}, value of n is

Space for Rough work

Chemistry

PART – II

SECTION – A

(One Options Correct Type)

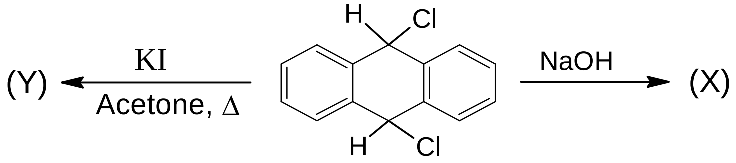
This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

24. Two liquids A and B are mixed at temperature T in a certain ratio to form an ideal solution. It is found that the partial pressure of A, i.e., P_A is equal to P_B, the pressure of B for liquid mixture. What is the total pressure of the liquid mixture in terms of P_A^0 and P_B^0?

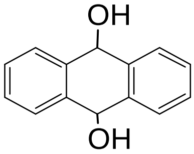
(A) $\frac{P_A^0 P_B^0}{P_A^0 + P_B^0}$ (B) $\frac{2P_A^0 P_B^0}{P_A^0 + P_B^0}$

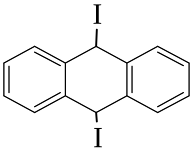
(C) $\frac{2P_A^0}{P_A^0 + P_B^0}$ (D) $\frac{2P_B^0}{P_A^0 + P_B^0}$

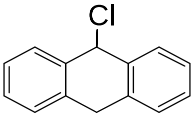
25.

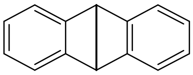


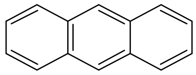
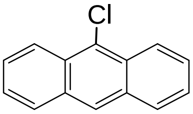
X and Y are, respectively.

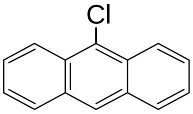
(A) 

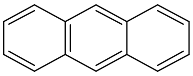
and 

(B) 

and 

(C) 
and 

(D) 

and 

Space for Rough work

26. Extraction of copper from copper pyrite $(CuFeS_2)$ does not involve:
(A) crushing followed by concentration of the ore by froth-floatation.
(B) removal of iron as slag
(C) self-reduction step to produce 'blister copper' following evolution of SO_2.
(D) refining of 'blister copper' by carbon reduction

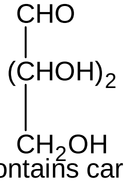
(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

27. Titration of 664 mg of a pure organic carboxylic acid, H_2A, showed a rapid change in pH at 40 ml. and at 80 ml of 0.1 M NaOH titrant. When 40 ml. of NaOH was added, the pH was 5.85 and at 60 ml of NaOH the pH was 8.08. Which of the following statements are correct
(A) the molecular weight of acid is 166
(B) the molecular weight of acid 664
(C) the pka_1 of acid is 3.62
(D) the pka1 of acid is 5.85

28. $\text{D}(-)\text{Glyceraldehyde} \xrightarrow[\text{HCl}]{\text{Me}_2\text{CO}} \text{A} \xrightarrow[\text{(ii)}H_2O]{\text{(i)}CH_2=CHMgCl} \text{B} \xrightarrow[\substack{\text{(ii)}Me_2S \\ \text{(iii)}H^+/H_2O}]{\text{(i)}O_3} \text{C}$

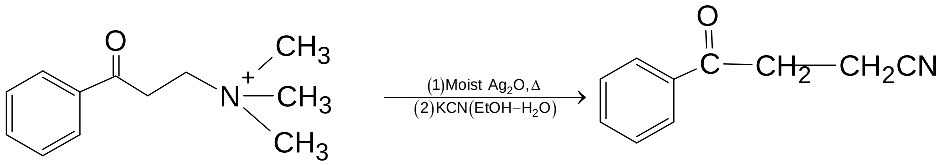
Which of the following statements are correct?
(A) C is



$$\begin{array}{c} CHO \\ | \\ (CHOH)_2 \\ | \\ CH_2OH \end{array}$$

(B) A contains carbonyl group as well as C–O–C linkage
(C) B can decolorize Br_2/H_2O
(D) three moles of HIO_4 will be consumed with C

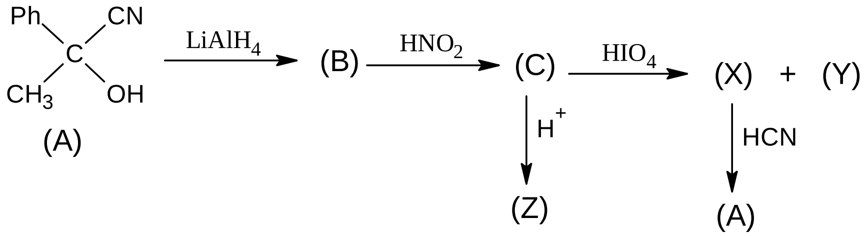
29.



Choose the correct statement (s)
(A) The reaction involves S_N2 attack followed by conjugate addition.
(B) the reaction involves $E_{CB}1$ path.
(C) It involves 1, 4-addition in α, β-unsaturated carbonyl compound.
(D) It involves nucleophilic attack on carbonyl carbon initially.

Space for Rough work

30.



Correct statements are
(A) X gives yellow precipitate with I_2 in presence of NaOH.
(B) Y is reduced by Fehling solution
(C) Z gives silver mirror with $[Ag(NH_3)_2]^+$
(D) X reduces Tollen's reagent

31. Select the correct statement (s) for positron emission by unstable nucleus
(A) X-ray emission takes place
(B) A neutron is formed
(C) $\frac{n}{p}$ of daughter nucleus increases
(D) A neutron is consumed

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 32 and 33

An inorganic salt (A) on heating upto 230^0C loses its colour and forms (B), the loss of water from salt (A) is 36.07% by weight. Small amount of salt (B) is dissolved in 1L of water. Assuming no volume change after the dissolution. 100mL of the solution is treated with excess KI solution, results a precipitate (C) with the evolution of I_2. The liberated I_2 requires 20 mL of 0.25 M sodium thiosulphate solution. [mol. wt. Cu = 63.5, Zn = 65.5, Fe = 56, Mg = 24]

32. Molecular formula of inorganic slat (A) is
(A) $FeSO_4 . 7H_2O$
(B) $ZnSO_4.7H_2O$
(C) $CuSO_4 .5H_2O$
(D) $MgSO_4.7H_2O$

33. What amount of salt (B) is dissolved in 1 L of water
(A) 0.199 gm
(B) 7.97 gm
(C) 0.235 gm
(D) 9.4 gm

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

34. A 50 ml 1.92% (w/v) solution of a metal ion M^{n+} (at. wt. = 60) was treated with 5.332 g hydrazinehydrate $(N_2H_4.H_2O)$ (90%pure) and the mixture was saturated with CO_2 gas when entire metal gets precipitated as a complex $[M(NH_2-NHCOO)_n]$ the complex was filtered of and the filtrate was titrated with M/10 KIO_3 in the presence of conc. HCl according to the following equation $N_2H_4 + IO_3^- + 2H^+ + Cl^- \rightarrow ICl + 3H_2O + N_2\uparrow$
The volume of M/10 KIO_3 solution needed for end point to arrive was 480 ml. Find the value of n.

35. Among the followings, total number of cations that tends to form soluble complex with excess of $NH_4OH(aq.)$ and NaCN(aq.)
Pb^{+2}, Cd^{+2}, Hg^{+2}, Bi^{+3}, Cu^{+2}, Ag^+

36. When a liquid (molecular mass = 378) that is immiscible with water was steam distilled at 95^{0}C at a total pressure of 750 torr, the distillate contained **x** gm of liquid per gm of water. Calculate the value of **x**. Where vapour pressure of water is 630 torr at 95^{0}C.

37. The vapour pressure of a solution containing 66. 9 gm of $M(NO_3)_n$ dissolved in 100 gm of water is 747 torr at 373 K. The degree of dissociation of the salt is 0.565. Molar mass of $M(NO_3)_n$ = 148.3 g/mol. Then n is.

38. $CH_3CH=CHCHO \xrightarrow[\text{dil}]{OH^-} A(C_8H_{12}O_2) \xrightarrow[H^+]{\Delta} B \xrightarrow[HCl]{Zn/Hg} C(C_8H_{12})$
No. of stereo isomers possible for compound (C) are

39. Find the number of acid(s) from the following in which X – H bond is/are present, Given X is central atom:
$H_3PO_2, H_4P_2O_7, H_4P_2O_5, H_2S_2O_6, H_3PO_3, H_3BO_3, H_4P_2O_6$

40. Diethyl oxalate is condensed with Diethyl pentan-1, 5-oate in the presence of sodium ethoxide to form a product (A), which on acidic hydrolysis followed by heating gives another product (B). Now (B) is treated with sodium in liquid ammonia to give (C). Find the degree of unsaturation in (C).

Space for Rough work

41. The rate of decomposition of NH_3(g) takes place at 10 atm on platinum surface. What is rate of formation (in M min^{-1}) of $H_2(g)$. If rate constant of reaction $2NH_3(g) \longrightarrow N_2(g) + 3H_2(g)$ is 2.0 M min^{-1}?

42. How many molecules in which dz^2 orbital involved in their hybridization of central atom?
$XeF_2, XeOF_4, BrCl_3, \left[Ni(CN)_4\right]^{2-}, [NiCl_4]^{-2}, \left[Fe(CN)_6\right]^{-4}$

43. (i) HgS, PbS, CuS, CdS, SnS, Bi_2S_3 among the given sulphides, the number of sulphides which are more soluble in water than MnS is x
(ii) $Pb(OH)_2$, $Ba(OH)_2$, $Zn(OH)_2$, $Ca(OH)_2$, $Cu(OH)_2$, $Fe(OH)_2$. Among the given hydroxides, the no. of hydroxides which are less soluble in water than $Mg(OH)_2$ is y.
Then calculate x + y

SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

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44. For the following cell
Pt, H_2 | H_2A || KCl, Hg_2Cl_2 | Hg ,
1atm (0.1 M, 100 mL) (1M)
what volume (mL) of 2. 5 M NaOH is required to be added to left hand half cell in order to maintain the emf of the cell 0.5164 volts.
Given K_{sp} $Hg_2Cl_2 = 4.2 \times 10^{-18}$; $E^0_{Cl^-, Hg_2Cl_2(s)|Hg(l)} = 0.28V$
For H_2A ($pK_1 = 2.8$, $pK_2 = 5.2$)

45. A compound [A] $C_xH_yO_z$ on catalytic hydrogenations gives [B] $C_xH_{14}O$. [A] on reaction with hot alk. $KMnO_4$ followed by acidification gives tricarboxylic acid [C], which on heating with sodalime gives cyclopentane. Acid [C] can also be obtained by oxidizing 1, 2, 4-cyclopentane tricarbaldehyde, find the value of $\frac{x+z}{2}$

46. An ideal gas having initial pressure P, volume V and temperature T is allowed to expand adiabatically until its volume becomes 5.66 V, while its temperature decreases to T/2. Work done by the gas during expansion is given by W = **X** PV. Find the value of **X**. (given $(5.66)^{0.4} = 2$)

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

47. A function is defined for all real numbers and satisfies $f(2+x)=f(2-x)$ and $f(7+x)=f(7-x)$ for all real x. If x = 0 is root of f(x) = 0, what is the least numbers of root f(x) = 0 must have in the interval $-1000 \le x \le 1000$

(A) 402 (B) 401
(C) 200 (D) 201

48. In $\{a_n\}$, $a_1 = 2$ $a_{n+1} = 1 - \frac{1}{a_n}$ for $n \ge 1$

Let P_n be the product of its first n terms, then the value of P_{2009} is

(A) $-\frac{1}{2}$ (B) –1
(C) $\frac{1}{2}$ (D) 1

49. In ΔABC, $\tan\angle CAB = \frac{22}{7}$ and the altitude from A divided BC into segment of length 3 and 17, the area of ABC is

(A) 110 (B) 112
(C) 95 (D) None of these

Space for Rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

---

50. Let $f(x)$ is a real valued function defined by :

$$f(x) = x^2 + x^2\int_{-1}^{1} t.f(t)dt + x^3\int_{-1}^{1} f(t)dt$$

Then which of the following holds good ?

(A) $\int_{-1}^{1} t.f(t) = \frac{10}{11}$
(B) $f(1) + f(-1) = \frac{30}{11}$
(C) $\int_{-1}^{1} t.f(t)dt > \int_{-1}^{1} f(t)dt$
(D) $f(1) - f(-1) = \frac{20}{11}$

51. Let A, B, C be n ×n real matrices and are pairwise commutative and ABC = O_n and if λ = det $(A^3 + B^3 + C^3)$. det(A + B + C) then

(A) $\lambda > 0$
(B) $\lambda < 0$
(C) $\lambda = 0$
(D) $\lambda \in (-\infty, \infty) - \{0\}$

52. If variable line $x(3+\lambda) + 2y(2-\lambda) - (7-\lambda) = 0$ always passes through a fixed point (a, b) where λ is parameter and $l = \lim\limits_{x \to (a-b)^-} \frac{[(\sin x) - 2] + \{\cos x\}}{x - [x] - 1}$ where [y] and {y} denotes greatest integer $\le$ y and fractional part of y respectively, then:

(A) $a + 2b = 3$
(B) $a - b + 2l = 2$
(C) $l = 1$
(D) l does not exist

53. If f: N →N, and for $x_2 > x_1$, $f(x_2) > f(x_1)$ $\forall$ $x_1, x_2 \in$ N and f(f(n)) = 3n, $\forall$ n $\in$N then

(A) f(1) = 2
(B) f(2) = 3
(C) f(1) = 3
(D) f(2) = 4

Space for Rough work

54. Let first and second row vectors of matrix A be $\vec{r}_1 = [1\,1\,3]$ and $\vec{r}_2 = [2\,1\,1]$ let the third row vector be in the plane of $\vec{r}_1$ and $\vec{r}_2$ perpendicular to $\vec{r}_2$ with magnitude $\sqrt{5}$, then which of the following is/are true?
(A) Tr. (A) = 3
(B) Volume of parallelepiped formed by $\vec{r}_2, \vec{r}_3$ and $\vec{r}_2 \times \vec{r}_3$ equals 30
(C) Row vectors are linearly dependent
(D) $\left[\vec{r}_1 \times \vec{r}_2 \; \vec{r}_2 \times \vec{r}_3 \;\; \vec{r}_3 \times \vec{r}_1\right] = 0$

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 55 and 56

A parabola passes through the points A and B, the ends of a diameter of a given circle of radius ‘a’. A tangent to the concentric circle of radius ‘b’ is the directrix of the parabola.

55. If AB and a perpendicular diameter are taken as coordinate axes, the locus of the focus of the parabola is
(A) $\frac{x^2}{a^2} + \frac{y^2}{b^2 - a^2} = 1$
(B) $\frac{x^2}{a^2} - \frac{y^2}{b^2 - a^2} = 1$
(C) $\frac{x^2}{b^2} + \frac{y^2}{b^2 - a^2} = 1$
(D) none of these

56. The length of the latus rectum of the locus of the focus of the parabola for a = 4 and b = 3 is
(A) $\frac{14}{3}$
(B) $\frac{7}{2}$
(C) $\frac{7}{3}$
(D) $\frac{7}{\sqrt{2}}$

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

57. Let L denotes the number of subjective functions $f : A \to B,$ where set A contains 4 elements and set B contains 3 elements.
M denotes number of elements in the range of the function.
$f(x) = \sec^{-1}(\operatorname{sgn} x) + \operatorname{cosec}^{-1}(\operatorname{sgn} x)$ where $\operatorname{sgn} x$ denotes signum function of x.
And N denotes coefficient of t^5 in $(1+t^2)^5(1+t^3)^8$.
The value of $(LM+N)$ is λ, then the value of $\frac{\lambda}{19}$ is.

58. Let $L = \prod_{n=3}^{\infty}\left(1-\frac{4}{n^2}\right); M = \prod_{n=2}^{\infty}\left(\frac{n^3-1}{n^3+1}\right)$ and $N = \prod_{n=3}^{\infty}\frac{(1+n^{-1})^2}{1+2n^{-1}},$
Then find the value of $L^{-1} + M^{-1} + N^{-1}$.

59. If $P = \frac{\sum_{n=1}^{99}\sqrt{10+\sqrt{n}}}{\sum_{n=1}^{99}\sqrt{10-\sqrt{n}}}$, then [P] is {where [.] is GIF}

60. For any non empty finite set A of real numbers, Let S(A) be the sum of the elements in A. There are exactly 61 of 3-element subsets A of {1,2 .....23} with S(A) = 36. The number of 3-element subsets of {1, 2, 3, ...23} with S(A) < 36 is m, then the value of $\frac{m}{171}$ is

61. The function $f : R \to R$ satisfies $f(x^2).f''(x) = f'(x).f'(x^2)$ for all real x. Given that $f(1) = 1$ and $f'''(1) = 8$, then the value of $f'(1) + f''(1)$ is.

62. The value of a, if a and b are integers such the $x^2 - x - 1$ is a factor of $ax^{17} + bx^{16} + 1$ is P, then the value of $\frac{P}{329}$.

Space for Rough work

63. Let $I = \int_0^1 (1 - x^{50})^{99} x^{100} dx$ and

$J = \int_0^1 (1 - x^{50})^{100} x^{100} dx$

If $\frac{I}{J}$ is equal to $\frac{m}{n}$ where m and n are co-prime then find the value of $\left(\frac{m - n - 1}{20}\right)$.

64. Let M$_n$ be the $n \times n$ matrix with entries as follow: for $1 \le i \le n$ $m_{i,i} = 10$; for $1 \le i \le n - 1$ $m_{i+1,i} = m_{i,i+1} = 3$ all other enteriesin M$_n$ are zero, Let D_n be the determinant of matrix M$_n$, then $\sum_{n=1}^{\infty} \frac{1}{8D_n + 1}$ can be represented as $\frac{p}{q}$, where p and q are relatively prime integers, the value of p + q is M, then value of $\frac{M}{73}$ is.

65. Let A, B, C, D be the vertices of a regular tetrahedron each of whose edges measures 1 meter. A bug, starting from vertex A, observes, the following rules, at each vertex it chooses one of the three edges meeting at that vertex, each edge being equally likely to be chosen, and crawls along that edge to the vertex at its opposite end. Let $p = \frac{n}{729}$ be the probability that the bug is at vertex A when it has crawled exactly 7 meters. The value of n is z, then the value of $\frac{z}{91}$ is.

66. The equation $z^6 + z^3 + 1 = 0$ has complex roots with argument between 90º and 180º in the complex plane, determine the degree measure of θ is p, then the value of $\frac{p}{40}$

Space for Rough work

SECTION – D

(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

67. For nonnegative integers a and b with $a+b \le 6$, let $T(a,b)=\binom{6}{a}\binom{6}{b}\binom{6}{a+b}$. {where $\binom{n}{r}={}^{n}C_{r}$}

Let S denote the sum of all T(a, b), where a and b are nonnegative Integers with $a+b \le 6$. Then the value of S is.

68. A circle is circumscribed around an isosceles triangle whose two congruent angles have degree measure x. Two points are chosen independently and uniformly at random on the circle, and a chord is drawn between them. The probability that the chord intersects the triangle is $\frac{14}{25}$. The difference between the largest and smallest possible values of x is.

69. The number of integer values of k in the closed interval [-500, 500] for which the equation $\log(kx)=2\log(x+2)$ has exactly one real solution.

Space for Rough work

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FULL TEST – VII

PAPER-2

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**D**	24.	**B**	47.	**B**
2.	**C**	25.	**D**	48.	**B**
3.	**A**	26.	**D**	49.	**A**
4.	**A, C**	27.	**A, C**	50.	**B, D**
5.	**A, D**	28.	**A, B, C, D**	51.	**A, C**
6.	**A, B**	29.	**B, C**	52.	**A, D**
7.	**A, C**	30.	**A, C**	53.	**A, B**
8.	**A, B, C, D**	31.	**B, C**	54.	**B, C, D**
9.	**B**	32.	**C**	55.	**C**
10.	**C**	33.	**B**	56.	**A**
11.	**9**	34.	**3**	57.	**4**
12.	**6**	35.	**3**	58.	**8**
13.	**2**	36.	**4**	59.	**2**
14.	**6**	37.	**2**	60.	**5**
15.	**8**	38.	**6**	61.	**6**
16.	**4**	39.	**3**	62.	**3**
17.	**4**	40.	**2**	63.	**5**
18.	**8**	41.	**6**	64.	**1**
19.	**5**	42.	**4**	65.	**2**
20.	**5**	43.	**4**	66.	**4**
21.	**01800.00**	44.	**00004.00**	67.	**18564.00**
22.	**00720.00**	45.	**00004.50**	68.	**00038.00**
23.	**00004.00**	46.	**00001.25**	69.	**00501.00**

Physics

PART – I

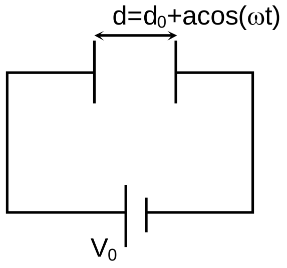
SECTION – A

1. D

Induced charge $= q\left(1-\frac{1}{\in_r}\right)$

Surface density $= \frac{q\left(1-\frac{1}{\in_r}\right)}{4\pi r_2^2} = \frac{q(\in_r - 1)}{4\pi \in_r r_2^2}$

2. C



$$I = \frac{d}{dt}Q = \frac{d}{dt}(CV) = V\frac{d}{dt}\left(\frac{\in_0 A}{d_0 + a\cos\omega t}\right)$$

$$I = \frac{V \in_0 A[a\omega \sin\omega t]}{(d_0 + a\cos\omega t)^2}$$

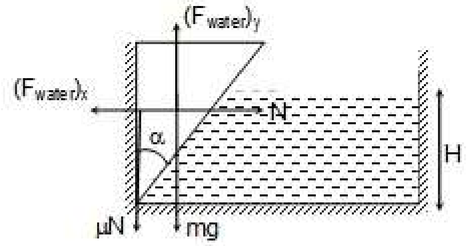
$$= \frac{V \in_0 A[a\omega \sin\omega t]}{[d_0 + a\cos\omega t]^2}$$

When $\sin\omega t = 1, \cos\omega t = 0$, ‘I’ becomes maximum

$$\therefore\ I_0 = \frac{V \in_0 A\omega a}{d_0^2}$$

$$a = \frac{I_0 {d_0}^2}{V \in_0 A\omega}$$

3. A

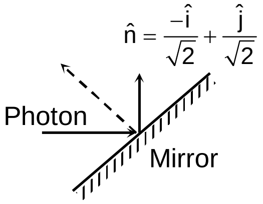


$$(F_{water})_y = \frac{H}{2}(H\tan\alpha)b\rho g$$

$$(F_{water})_x = \frac{H}{2}(\rho g)(Hb)$$

When ‘H’ is max friction will be maximum.
Use condition of equilibrium.

4. A, C


$\hat{n} = \frac{-\hat{i}}{\sqrt{2}} + \frac{\hat{j}}{\sqrt{2}}$
Photon
Mirror

Change in momentum of each photon $= \frac{h}{\lambda}\left(-\hat{i} + \hat{j}\right)$

Force exerted by light beam on mirror $= \frac{P}{C}\left(\hat{i} - \hat{j}\right)$

5. A, D

Ring is at (–)ve potential and V(∞) = 0, electric field due to this potential difference will accelerate electron away from ring for maximum speed of photoelectron immediately after emission

$$\frac{hc}{\lambda} = \frac{hc}{\lambda_0} + \frac{1}{2}mV_{max}^2 \quad \Rightarrow \quad V_{max} = \sqrt{\frac{2hc}{m}\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)}$$

For maximum speed of photoelectron at '∞'

$$\frac{hc}{\lambda}+eV_0=\frac{hc}{\lambda_0}+\frac{1}{2}mV'^2_{max}$$

$$V'_{max}=\sqrt{\frac{2hc}{m}\left(\frac{1}{\lambda}-\frac{1}{\lambda_0}\right)+\frac{2eV_0}{m}}$$

After prolong irradiation, potential of ring will change

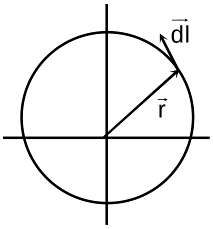
$$\frac{hc}{\lambda}=\frac{hc}{\lambda_0}+eV_{ring} \qquad \Rightarrow \qquad V_{ring}=\frac{hc}{e}\left(\frac{1}{\lambda}-\frac{1}{\lambda_0}\right)$$

'n' : Total no. of photo electrons emitted then

$$\frac{K(ne)}{r}=\frac{hc}{e}\left(\frac{1}{\lambda}-\frac{1}{\lambda_0}\right)-(V_0)\Rightarrow(D)$$

6. A, B

$$\vec{E}=\frac{\vec{F}}{q}\Rightarrow(A)$$



Assume Q is at origin, consider a circular loop of radius 'r', $\vec{r}$ will be perpendicular to $\vec{dl}$

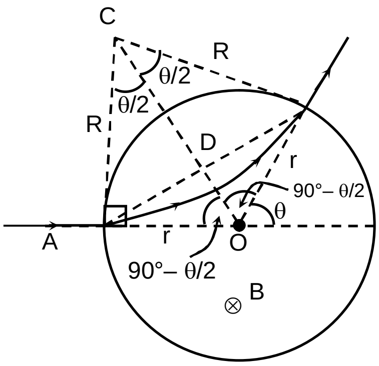
As $\vec{E}$ is along $\vec{r}$

So $\int \vec{E}.\vec{dl}=0$

Consider sphere of radius 'r', $\vec{E}$ will be along $\vec{ds}$ at any position

$$\oint \vec{E}.\vec{ds}=\phi(E)(ds)=E\oint ds=\frac{Q(1-\sqrt{\alpha r})}{4\pi\in_0 r^2}(4\pi r^2)=\frac{Q}{\in_0}(1-\sqrt{\alpha r})$$

7. A, C



$$AD=R\sin\frac{\theta}{2}=r\sin\left(90^\circ-\frac{\theta}{2}\right)$$

$$\Rightarrow \qquad \tan\frac{\theta}{2}=\frac{r}{R}$$

Also, $R=\frac{mv}{qB}$

$$\Rightarrow \qquad \tan\frac{\theta}{2}=\frac{rqB}{mv}$$

Angular velocity, $\omega=\frac{v}{R}=\frac{qB}{m}\rightarrow$ constant for all α-particles

So, time period will higher for the particle whose. 'θ' is higher, i.e., velocity is lower.

8. A, B, C, D

Voltage leads current (see at t = 0)

If I = 400 sin ωt	$[I_0 = 400]$	(in mA)
Then V = 200 sin (ωt + ϕ)	$[V_0 = 200]$	(in volt.)

At t = 0, V = 100 $\Rightarrow$ $\phi=\frac{\pi}{6}$

$$Z=\frac{V_{rms}}{I_{rms}}=\frac{200/\sqrt{2}}{4\sqrt{2}}=500\Omega$$

Also, $\frac{R}{Z} = \cos\phi \quad \Rightarrow \quad R = 250\sqrt{3}\Omega$

$R^2 + (X_L - X_C)^2 = Z^2 \;\Rightarrow\; X_L = 324\ \Omega$

Average power = $I_{rms}V_{rms}\cos\phi$

$= 20\sqrt{3}W$

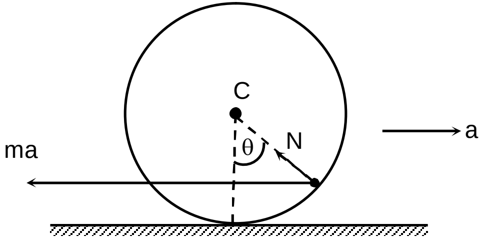
9. B

10. C

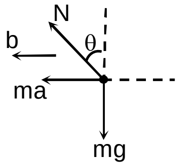
Sol. Centre of ring has are ‘a’

a : acceleration ring w.r.t. ground

b : acceleration of particles w.r.t. ring



Hence w.r.t. ‘C’, for the particle



$N\cos\theta = mg$ ....(i)

$N\sin\theta + ma = mb$ ....(ii)

And for the ring

$\Rightarrow$ $N\sin\theta - f = Ma$ ....(iii)

$f.R = MR^2\,.a/R$

$\Rightarrow$ $f = Ma$ ....(iv)

$\Rightarrow$ $N\sin\theta = 2Ma$

$N = mg$

$mg.\theta = 2\,Ma$

$\Rightarrow$ $a = \frac{mg}{2M}\theta$

From (ii)

$N\sin\theta + ma = mb$

$\Rightarrow$ $2Ma + ma = mb \Rightarrow a(2M + m) = mb$

$\Rightarrow$ $\frac{mg}{2M}(2M + m)\theta = m.b$

Put $\theta = \frac{x}{R}$ [x: displacement of particle w.r.t. ring]

$\Rightarrow$ $\frac{g}{2M}(2M + m)\frac{x}{R} = b \quad \Rightarrow \quad b = \frac{g}{R}\left(1 + \frac{m}{2M}\right).x$

$$\omega = \sqrt{\frac{g}{R}\left(1 + \frac{m}{2m}\right)}$$

Part – 2

$a = mb/(m + 2M)$

$\Rightarrow$ $y = \frac{mx}{m + 2M}$

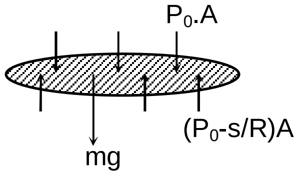
[y: displacement of ring w.r.t. ground]

$\Rightarrow$ $y = \frac{mR\theta}{m + 2M}$

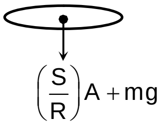
SECTION – C

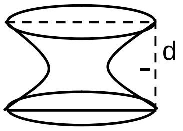
11. 9

If we draw the FBD of upper plate, we see



i.e.





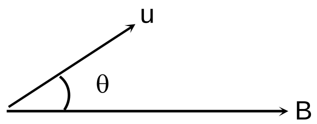
R=d/2

This force “(S/R) A + mg” must be balanced by normal reaction at same points from concern plate.

Hence N = (S/R)A + mg $\Rightarrow$ N = 90

Hence n = 9

12. 6

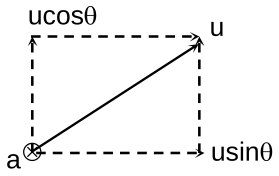


$$R=\frac{m(\sin\theta)}{qB}$$

Acceleration of particle w.r.t. an observer moving with u cos θ (along $\vec{B}$) is

$$a=\frac{(u\sin\theta)^2}{R}$$

Since this observer is not accelerated, hence net acceleration of particle is also $\frac{(u\sin\theta)^2}{R}$, which is perpendicular to its net speed ‘v’.

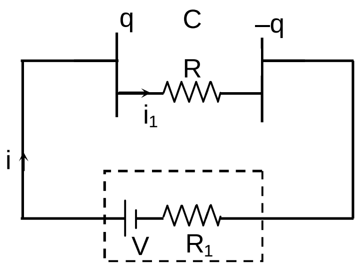


Hence ROC $=\frac{u^2}{a}$

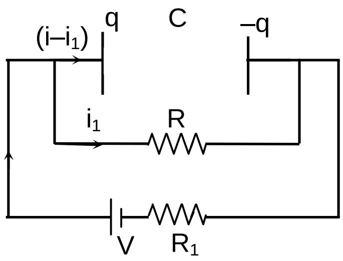
$$=\frac{R}{\sin^2\theta}=\frac{\frac{mu\sin\theta}{qB}}{\sin^2\theta}=\frac{mu}{qB\sin\theta}$$

Putting values, we get ROC as 6 m.

13. 2



$\Rightarrow$



Both the circuits are equivalent, since

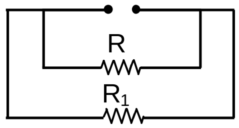
$q/c = i_1R$ (i) and $i – i_1 = dq/dt$ (ii)

Satisfies both

Hence, time constant of circuit will be

τ = Reff. C

Where Reff = $R.R_1 / R + R_1$



Thus $\tau=\left(\frac{RR_1}{R+R_1}\right)C$

Putting $C = \frac{\epsilon_0 \epsilon_r A}{d}$ and $R = \frac{\rho d}{A}$

We get $\tau = 100\,\epsilon_0$

$\Rightarrow$ n = 2

14. 6

Electrical energy is present everywhere except the space occupied by conductors. When the charge is taken to infinity, energy will be present in the entire space surrounding it. Hence work done by external will be equal to the energy in the missing space.

$$W_{ext} = \frac{kq^2}{2}\left(\frac{1}{1}-\frac{1}{2}\right)+\frac{kq^2}{2}\left(\frac{1}{3}-\frac{1}{4}\right)+.........$$

$$= \frac{kq^2}{2}\left(1-\frac{1}{2}+\frac{1}{3}-\frac{1}{4}+......\right)=\frac{kq^2}{2}\ell n2$$

$$= kq^2\ell n\sqrt{2}$$

Hence n = 6.

15. 8

$B \times 2\pi r = \mu_0 NI$

$\Rightarrow$ $B = \frac{\mu_0 NI}{2\pi r}$

Flux through small element = $\frac{\mu_0 NI}{2\pi r}.hdr$

$\Rightarrow$ Flux through a cross-section $= \frac{\mu_0 NIh}{2\pi}\int_a^b \frac{dr}{r}$

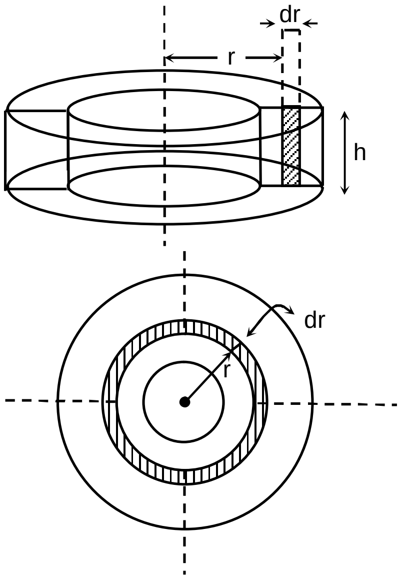
$$= \frac{\mu_0 NIh}{2\pi}\ell n\left(\frac{b}{a}\right)$$

$\Rightarrow$ Flux through 'N' turns $= \frac{\mu_0 N^2 Ih}{2\pi}\ell n\left(\frac{b}{a}\right)$

$\Rightarrow$ $L = \frac{\phi}{I} = \frac{\mu_0 N^2 h}{2\pi}\ell n\left(\frac{b}{a}\right)$

Putting values, we get L = 0.8

Hence n = 8



16. 4

$$dQ = dU + dW$$

$\Rightarrow$ $ncdT = nc_v dT + Pdv$

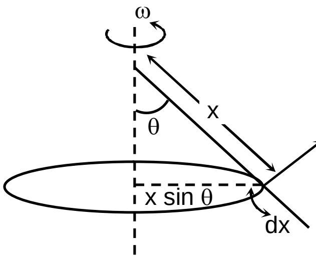
$\Rightarrow$ $n.2RdT = n.\frac{3}{2}RdT + \frac{nRT}{V}dv$

$\Rightarrow$ $\int \frac{dv}{v} = \int \frac{dT}{2T}$

$\Rightarrow$ $\frac{v^2}{T} = \text{constt.}$

Thus, on doubling volume, temperature changes 4 times.

17. 4



$$dL = (dm)(\omega . x\sin\theta)x$$

$$= \frac{m}{\ell}dx.\omega x^2\sin\theta$$

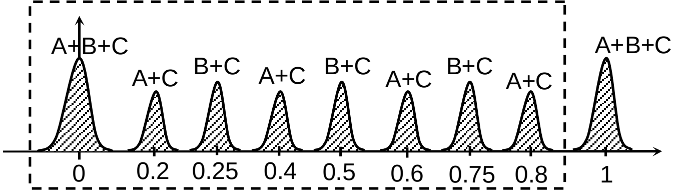
$$\Rightarrow \quad dL = \frac{m\omega\sin\theta}{\ell}\int_0^{\ell}x^2dx$$

$$\Rightarrow \quad L = \frac{m\ell^2\omega\sin\theta}{3}$$

Putting values, we get L = 4.

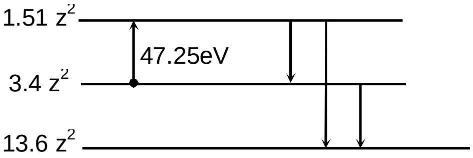
18. 8

A and C will produce 5 maxima per second (at an internal of 0.2 sec)
B and C will produce 4 maxima per second (at an internal 0.25 sec)
A and B will produce 1 maxima per second (at an internal 1 sec)



Total no. of maxima in 1 sec is 7 secondary + 1 primary = 8 maxima

19. 5



As we are getting 3 different photons so transition must be from n = 3 to n = 1 and energies of these photons are more than or equal to 47.25 so initially electrons must be in n = 2

$$3.4\,z^2 - 1.51z^2 = 47.25$$

$$\Rightarrow \quad z = 5$$

20. 5

$$\frac{n_2}{V} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$$

$$\frac{n_2}{V} = \frac{n_2 - n_1}{R} + \frac{n_1}{u}$$

$$u = -x \quad \Rightarrow \quad \frac{n_2}{v} = \frac{n_2 - n_1}{R} - \frac{n_1}{x}$$

For real image V must be +ve

$$\frac{n_2 - n_1}{R} - \frac{n_1}{x} > 0$$

$$\Rightarrow \quad x > \frac{n_1R}{n_2 - n_1}$$

SECTION – D

21. 01800.00

Charge is initially distributed as shown in figure. Now after connecting the battery, potential difference across the plates of the capacitor should also become 40 V in steady state.

Hence, $Q_f = CV$

$= (1.5)\,(40)\ \mu C$

$= 60\ \mu C$ (Charge on inner surface)

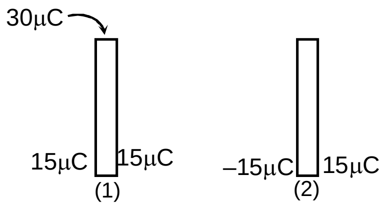
Hence, charge supplied by battery is $45\mu C$

So, work done by battery, $W = (Q)\,(V)$

$= (45\mu C)\,(40V)$

$= 1800\ \mu J$

So, answer is 1800.

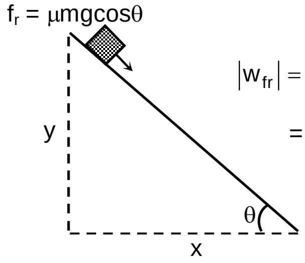


22. 00720.00

Hence, work done by friction is independent of angle of inclination. It only depends upon horizontal displacement.

So, $(W_{fr}) = (0.2)\,(18)\,(10)\,(20)$

$= 720$ J



$$|w_{fr}| = (\mu mg\cos\theta)\left(\frac{x}{\cos\theta}\right)$$

$$= \mu mg\,x$$

23. 00004.00

Given that $C = C_V + 4R$ .....(1)

Compare with $dQ = dU + PdV$

$CdT = C_V d_T + P d_V$

$$C = C_V + P\frac{dV}{dT} \quad .....(2)$$

We get, $4R = \dfrac{PdV}{dT}$

$$4R = \frac{RT}{V}\frac{dv}{dT}$$

$$4\int\frac{dT}{T} = \int\frac{dv}{v}$$

$$\ell nT^4 = \ell nV$$

$$VT^{-4} = \text{const}$$

Hence, n = 4

Chemistry PART – II

SECTION – A

24. B

$P_A = P_B$

XA . P_A^0 = X_B. P_B^0

$$\frac{X_A}{X_B} = \frac{P_B^0}{P_A^0}$$

$$1 + \frac{X_A}{X_B} = 1 + \frac{P_B^0}{P_A^0}$$

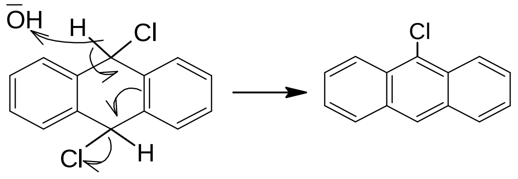
$$\frac{1}{X_B} = \frac{P_A^0 + P_B^0}{P_A^0}$$

$$X_B = \frac{P_A^0}{P_A^0 + P_B^0}$$

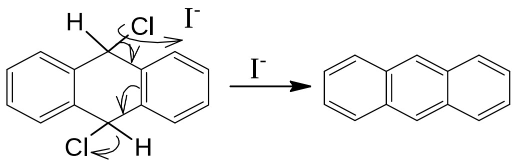
Similarly, $X_A = \dfrac{P_B^0}{P_A^0 + P_B^0}$

$$P_T = P_A^0.X_A + P_B^0.X_B = \frac{2P_A^0.P_{\mathbf{B}}^0}{P_A^0.P_{\mathbf{B}}^0}$$

25. D



(X)



(Y)

26. D

27. AC

Since 4 milli mole of NaOH was required to reach first equivalence point, the molecular wt. was

$$\frac{664\,mg}{4\,m\,mol} = 166$$

60 ml of NaOH is represented by a point midway to second equivalence point, at which

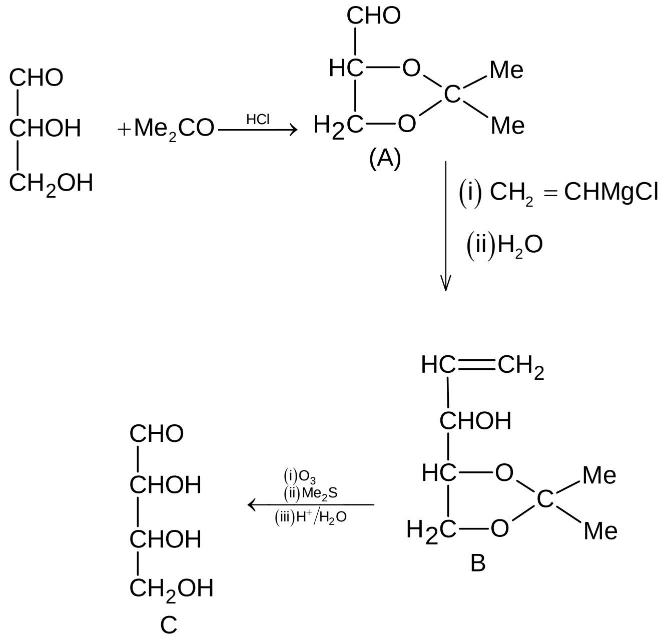
pH = Pka_2 = 8.08

At the first equivalence point,

pH = 5.85 = $\dfrac{Pka_1 + Pka_2}{2}$

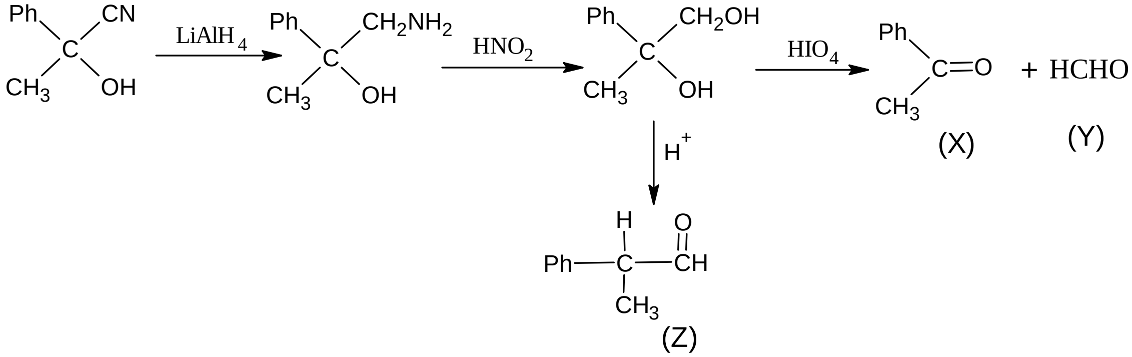
$\therefore$ Pka_1 = 3.62

28. A, B, C, D


CHO
CHOH
CH₂OH
+Me₂CO
HCl
CHO
HC—O
H₂C—O
C
Me
Me
(A)
(i) CH₂ = CHMgCl
(ii)H₂O
HC═CH₂
CHOH
HC—O
H₂C—O
C
Me
Me
B
(i)O₃
(ii)Me₂S
(iii)H⁺/H₂O
CHO
CHOH
CHOH
CH₂OH
C

29. B C

30. AC


Ph
CN
C
CH₃
OH
LiAlH₄
Ph
CH₂NH₂
C
CH₃
OH
HNO₂
Ph
CH₂OH
C
CH₃
OH
HIO₄
Ph
C═O
CH₃
+ HCHO
(X)
(Y)
H⁺
H
O
Ph—C—CH
CH₃
(Z)

31. BC
32. C
33. B

Sol. (for 32–33)

$CuSO_4.5H_2O$ (s) $\xrightarrow{\Delta}$ $CuSO_4$(s)
(A) Blue (B) white

$2CuSO_4 + 4KI \longrightarrow \underset{\text{ppt}}{Cu_2I_2\downarrow} + I_2\uparrow + 2K_2SO_4$

$I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-}$

millimoles of thiosulphate required = 0.25 × 20 = 5

$\therefore$ millimoles of I_2 used = 5/2

$\therefore$ millimoles of $CuSO_4$ dissolved = $\frac{5}{2}\times 2 = 5$

$\therefore\ (wt)_{CuSO_4}$ = 5 × 10^{-3} × 159.5 = 0.797 gm in 100 mL of solution.
Hence in 1 L solution (wt.) of $CuSO_4$ dissolved = 7.97 gm

SECTION – C

34. 3

$$n_{M^{n+}} = \frac{1.92}{2\times 60} mol = 0.016\, mol$$

$$nhydrazinehydrate = \frac{0.9\times 5.332}{50} mol = 0.096 mol$$

n_{eq}. KIO_3 = $4\times\frac{1}{10}N\times 0.48L$ = 0.192 eq. = $n_{eq.}$ hydrazine reacted with KIO_3

$\therefore$ n hydrazine left after reaction with M^{n+} = $\frac{0.192}{4} mol = 0.048 mol$

$\therefore$ n hydrazine hydrate reacted with M^{n+} = (0.096 – 0.048) mol = 0.048 mol
M^{n+} + n $H_2NNHCOO^-$ → $[M(H_2NNHCOO)_n]$

$$\frac{n_{M^{n+}}}{n_{hydrazine}} = \frac{1}{n} = \frac{0.016}{0.048} = \frac{1}{3}$$

$\therefore$ n = 3

35. 3
Cu^{+2}, Cd^{+2}, Ag^{+}

36. 4

$$\frac{y_A}{y_B} = \frac{P_A^\circ}{P_B^\circ}$$

$$\frac{n_A}{n_B} = \frac{P_A^\circ}{P_B^\circ}$$

$$\frac{\frac{x}{378}}{\frac{1}{18}} = \frac{120}{630}$$

Hence $x = \frac{378\times 4}{21\times 18} = 4$

37. 2

Mole fraction of solute (x) = $\dfrac{\left(\frac{66.9}{148.3}\right)}{\left(\frac{66.9}{148.3}\right)+\left(\frac{100}{18}\right)} = 8.03\times 10^{-3}$

Relative lowering of vapour pressure

$$\frac{P^0 - P_s}{P^0} = (x\times i) \Rightarrow \frac{\Delta P}{P^0} = x\times i$$

$$= \frac{760-747}{760} = 8.03\times 10^{-3}\times i$$

$M(NO_3)_n$ → M^{n+} + n NO_3^-

$1-\alpha \qquad\qquad \alpha \qquad\qquad n\alpha$

Van't Hoff Factor i = $(1 + n\alpha) = [1 + 0.565n]$

$$i = \frac{13}{760 \times 8.03 \times 10^{-3}} \simeq 2.13$$

$\therefore$ 1 + 0.565 n = 2.13

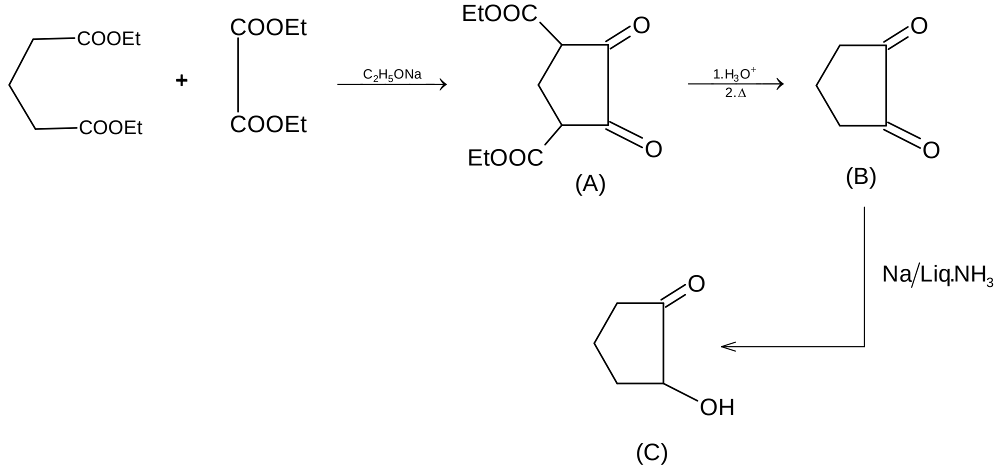
$\therefore$ n = 2

38. 6

39. 3

$H_3PO_2, H_4P_2O_5, H_3PO_3$

40. 2



41. 6

$$\frac{1}{3}\frac{d(H_2)}{dt} = k[NH_3]^0$$

$$\frac{d(H_2)}{dt} = 3 \times 2 = 6\,M\,min^{-1}$$

42. 4

$XeF_2, XeOF_4, BrCl_3, \left[Fe(CN)_6\right]^{-4}$

43. 4

(i) all given sulphides are less soluble than MnS, hence x = 0

(ii) $Pb(OH)_2$, $Zn(OH)_2$, $Cu(OH)_2$, $Fe(OH)_2$, are less soluble than $Mg(OH)_2$, y = 4

Hence ; x + y = 0+4 = 4

SECTION – D

44. 00004.00

Anode half cell $H_2 \rightarrow 2H^+ + 2e^-$

cathode half cell $\underline{Hg_2Cl_{2\,(s)} + 2e^- \rightarrow Hg(l) + 2Cl^-}$

Net cell reaction $Hg_2Cl_{2(s)} + H_2 \rightarrow 2H^+ + Hg(l) + 2Cl^-$

$$\therefore\ E_{cell} = E^0_{cell} - \frac{0.0591}{2}\log\frac{\left[H^+\right]^2 \times \left[Cl^-\right]^2}{P_{H_2}}$$

$$0.5164 = 0.28 - \frac{0.0591}{2}\log\left[H^+\right]^2;\quad P_{H_2} = 1atm,\quad Cl^- = 1M$$

$0.2364 = -0.0591 \log[H^+]$

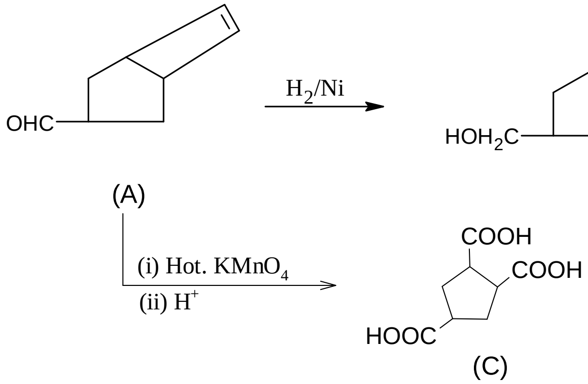
$$pH = \frac{0.2364}{0.0591} \simeq 4 = \frac{pk_1 + pk_2}{2}$$

In order to maintain the pH of left hand half cell the vol. of NaOH required

$\therefore$ $0.1 \times 100 = 2.5 \times V$ (1st equivalence point)

$$V = \frac{10}{2.5} = 4mL$$

45. 00004.50



$\therefore$ A is $C_8H_{10}O$

$\therefore$ x = 8, y = 10 and z = 1

46. 00001.25

For an adiabatic process,

$TV^{\gamma-1}$ = constant

$$\therefore \; T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1} = \frac{T_1}{2}(5.66V_1)^{\gamma-1}$$

Hence, $2 = (5.66)^{\gamma - 1}$

or $\log 2 = (\gamma - 1) \log 5.66$

$\therefore$ $\gamma = 1.4$

The gas is, therefore a diatomic gas and have five degrees of freedom.

The work done by a gas during an adiabatic process is

$$W = \frac{P_2V_2 - P_1V_1}{\gamma - 1}$$

Since $P_1V_1^{\gamma} = P_2V_2^{\gamma} = P_2(5.66V_1)^{\gamma}$

$$P_2 = \frac{P_1}{(5.66)^{\gamma}}$$

$$\therefore \; W = \left[\frac{P_1(5.66V_1)}{(5.66)^{\gamma}} - P_1V_1\right]\frac{1}{0.4} = 1.25\,P_1V_1$$

or W = 1.25 PV

Hence; x = 1.25

Mathematics PART – III

SECTION – A

47. B

Sol. f(x) = f(4-x), f(x) = f(x+10), f(x) = f(14-x). There are 201 multiple of 10 and 200 numbers that remainders have 4 divided by 10.

48. B

Sol. $a_{n+2} = 1 - \frac{1}{a_{n+1}} = 1 - \frac{a_n}{a_n - 1} = \frac{1}{1 - a_n}$

$a_{n+3} = 1 - \frac{1}{a_{n+2}} = 1 + (a_n - 1) = a_n$

So, $\{a_n\}$ is periodic sequence with period 3

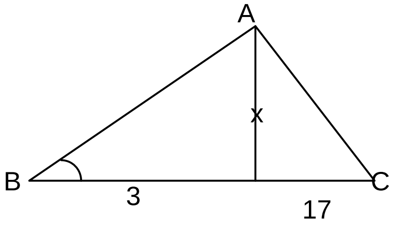
$a_1 = 2\ a_2 = \frac{1}{2}\ a_3 = -1$

$p_3 = -1$

$P_{2009} = (P_3)^{669}.P_2 = (-1)^{669} = -1$

49. A

Sol. $\tan^{-1}\left(\frac{22}{7}\right) = \tan^{-1}\frac{3}{x} + \tan^{-1}\frac{17}{x}$



$$\frac{22}{7} = \frac{\frac{3}{x} + \frac{17}{x}}{1 - \left(\frac{3}{x}\right).\left(\frac{17}{x}\right)}$$

$11x^2 - 70x - 56 = (x - 11)(11x + 51) = 0$

$\Rightarrow x = 11$

$\Delta = \frac{1}{2}(3 + 17)(11) = 110$

50. B, D

Sol. We have $f(x) = x^2 + ax^2 + bx^3$

Where $a = \int_{-1}^{1} t.f(t)dt$ and $b = \int_{-1}^{1} f(t)dt$

Now, $a = \int_{-1}^{1} t\left[(a+1)t^2 + bt^3\right]dt$

$a = 2b\int_0^1 t^4 dt = \frac{2b}{5}$ ...(1)

Again $b = \int_{-1}^{1} f(t)dt = \int_{-1}^{1}\left[(a+1)t^2 + bt^3\right]dt$

$= 2\int_0^1 (a+1)t^2\,dt$

$b = \frac{2(a+1)}{3}$ ...(ii)

From equations (1) and (ii)

$$\frac{5a}{2} = \frac{2(a+1)}{3}$$

$$\left(\frac{5}{2} - \frac{2}{3}\right)a = \frac{2}{3}$$

$$\frac{11}{6}a = \frac{2}{3}$$

$$a = \frac{4}{11} \text{ and } b = \frac{10}{11}$$

Hence $\int_{-1}^{1} t.f(t)\,dt = \frac{4}{11}$ and $\int_{-1}^{1} f(t)\,dt = \frac{10}{11}$

$$\therefore f(x) = (a+1)x^2 + bx^3$$

$$\left.\begin{aligned} f(1) &= (a+1)+b \\ f(-1) &= (a+1)-b \end{aligned}\right]$$

$$f(1) + f(-1) = 2(a+1) = \frac{30}{11}$$

And $f(1) - f(-1) - 2b = \frac{20}{11}$

51. A, C

Sol. $A^3 + B^3 + C^3 = A^3 + B^3 + C^3 - 3ABC$

$= (A + B + C)(A^2 + B^2 + C^2 - AB - BC - CA)$

$= (A + B + C)(A + \omega B + \omega^2 C)(A + \omega^2 B + \omega C)$ {ω = cube root of unity}

$= (A + B + C)(A + \omega B + \omega^2 C)\left(\overline{A + \omega B + \omega^2 C}\right)$

then $\det(A^3 + B^3 + C^3) \,.\, \det(A + B + C) = \det(A + B + C)^2 \,.\, \det(A + \omega B + \omega^2 C)\,\overline{\det\left(A + \omega B + \omega^2 C\right)}$

$= (\det(A + B + C))^2 \,.\, |\det(A + \omega B + \omega^2 C)|^2 \geq 0.$

52. A, D

Sol. The given variable line can be expressed as

$\Rightarrow 3x + 4y - 7 + \lambda(x - 2y + 1) = 0$

$\Rightarrow L_1 + \lambda L_2 = 0$

$L_1 \equiv 3x + 4y - 7 = 0,\ L_2 \equiv x - 2y + 1 = 0$

Point of intersection of $L_1 = 0$ and $L_2 = 0$ is (1, 1)

$\therefore$ a = b = 1 $\Rightarrow a + 2b = 3$

Now, $l = \lim_{x \to 0^-} \frac{[\sin x] - 2 + \{\cos x\}}{\{x\} - 1}$

$$= \lim_{h \to 0} \frac{[\sin(0-h)] - 2 + \{\cos(0-h)\}}{\{0-h\} - 1}$$

$$= \frac{-1-2+1}{1-1} = \frac{-2}{0}$$

Hence l does not exist

53. A, B

Sol. f(3n) = f(f(f(n))) = 3f(n), $\forall$ n $\in$ N

put n = 1, f(3) = 3f(1)

f(1) $\neq$ 1 as if f(1) = 1, then

f(f(1)) = 3 . 1 = 3 = f(1) = 1 which is incorrect, thus f(1) > 1 and f(f(1)) > f(1)
3 = f(f(1)) > f(1) > 1
so f(1) = 2
f(2) = f(f(1)) = 3.

54. B, C, D

Sol. As, $\vec{r}_3 = (\vec{r}_1 \times \vec{r}_2) \times \vec{r}_2 = (\vec{r}_1.\vec{r}_2)\vec{r}_2 - (\vec{r}_2.\vec{r}_2)\vec{r}_1$

$= 6(2\hat{i} + \hat{j} + \hat{k}) - 6(\hat{i} + \hat{j} + 3\hat{k}) = (6\hat{i} - 12\hat{k})$

$\therefore$ Row 3 vector $\pm \frac{6(\hat{i} - 2\hat{k})}{6\sqrt{5}}.\sqrt{5} = \hat{i} - 2\hat{k}$ or $-\hat{i} + 2\hat{k}$

$$A = \begin{bmatrix} 1 & 1 & 3 \\ 2 & 1 & 1 \\ 1 & 0 & -2 \end{bmatrix} \text{ or } \begin{bmatrix} 1 & 1 & 3 \\ 2 & 1 & 1 \\ -1 & 0 & 2 \end{bmatrix} = \text{Tr.}(A) = 0, 4.$$

Also, $[\vec{r}_2\ \vec{r}_3 \vec{r}_2 \times \vec{r}_3] = |\vec{r}_2||\vec{r}_3||\vec{r}_2 \times \vec{r}_3|$

$= \sqrt{6}.\sqrt{5}.\sqrt{6}.\sqrt{5} = 30$

Since $\vec{r}_1, \vec{r}_2$ and $\vec{r}_3$ are coplanar

$\Rightarrow$ they are linearly dependent

$\therefore \left[\vec{r}_1 \times \vec{r}_2\ \vec{r}_2 \times \vec{r}_3 \vec{r}_3 \times \vec{r}_1\right] = \left[\vec{r}_1\ \vec{r}_2\ \vec{r}_3\right]^2 = 0$

55. C

Let $A \equiv (-a, 0), B \equiv (a, 0)$, the equations of the circles are $x^2 + y^2 = a^2$ and $x^2 + y^2 = b^2$ ......(1)

Any tangent to (1) is $y = mx + b\sqrt{1+m^2}$

Let (h, k) be the coordinates of the focus, A and B lie on the parabola.

$\therefore \sqrt{1+m^2}\sqrt{(h+a)^2 + k^2} = -ma + b\sqrt{1+m^2}$

And $\sqrt{1+m^2}\sqrt{(h-a)^2 + k^2} = ma + b\sqrt{1+m^2}$

Eliminating m from the above equations, we get the locus as $\frac{x^2}{b^2} + \frac{y^2}{b^2 - a^2} = 1$

56. A

For $a = 4, b = 3$, the curve becomes $\frac{x^2}{9} - \frac{y^2}{7} = 1$

The length of LR = $\frac{2B^2}{A} = \frac{2 \times 7}{3} = \frac{14}{3}$.

SECTION – C

57. 4

Sol. $L : 3^4 - [{}^3C_1(2^4 - 2) + {}^3C_2] = 36$

M: If $x > 0, \text{sgn}(x) = 1$

$f(x) = 0 + \frac{\pi}{2} = \frac{\pi}{2}$

For $x = 0$ $f(x)$ is not defined

$\therefore$ For $x < 0$, $f(x) = \pi - \frac{\pi}{2} = \frac{\pi}{2}$

$\therefore$ M = 1

N : Coefficient of $t^5 =$ coefficient of t^2 in $(1+t^2)^5 \times$ coefficient of t^3 in $(1+t^3)^8$

$= 5 \times 8 = 40$

$\Rightarrow LM + N = 36 + 40 = 76$

58. 8

Sol. $L = \prod_{n=3}^{\infty}\left(1 - \frac{4}{n^2}\right) = \prod_{n=3}^{\infty}\left(\frac{n^2-4}{n^2}\right)$

$= \prod_{n=3}^{\infty}\left(\frac{n-2}{n}\right) \times \prod_{n=3}^{\infty}\left(\frac{n+2}{n}\right)$

$= \frac{n\left(1+\frac{1}{n}\right)n\left(1+\frac{2}{n}\right)}{n^2\left(1-\frac{1}{n}\right)} \times \frac{2}{3.4} = \frac{1}{6}$

$\Rightarrow L = \frac{1}{6}$

$M = \prod_{n=2}^{\infty}\left(\frac{n^3-1}{n^3+1}\right) = M = \prod_{n=2}^{\infty}\frac{n-1}{n+1}.\frac{(n^2+n+1)}{(n^2-n+1)}$

$= \lim_{x\to\infty}\frac{2}{n(n+1)}.\frac{n^2+n+1}{3} = \frac{2}{3}$

$\Rightarrow M = \frac{2}{3}$

$N = \prod_{n=1}^{\infty}\frac{(1+n^{-1})^2}{1+2n^{-1}} = \prod_{n=1}^{\infty}\left(\frac{n+1}{n}\right)^2\left(\frac{n}{n+2}\right)$

$= \frac{2(n+1)}{n+2} = 2$

$\Rightarrow N = 2$

$L^{-1} + M^{-1} + N^{-1} = 6 + \frac{3}{2} + \frac{1}{2} = 8$

59. 2

Sol. Let $S = \sum_{n=1}^{99}\sqrt{10+\sqrt{n}}$ $\qquad T = \sum_{n=2}^{99}\sqrt{10-\sqrt{n}}$

$\sqrt{2}S = \sum_{n=1}^{99}\sqrt{20+2\sqrt{n}} = \sum_{n=1}^{99}\left(\sqrt{10+\sqrt{100-n}} + \sqrt{10-\sqrt{100-n}}\right)$

$\sqrt{2}S = \sum_{n=1}^{99}\left(\sqrt{10+\sqrt{n}} + \sqrt{10-\sqrt{n}}\right) = S + T$

$\sqrt{2}S - S = T$

$\frac{S}{T} = \sqrt{2} + 1$

60. 5

Sol. For each 3-element subsets x = {a, b, c} of the set M = {1, 2, ...23} with a + b + c < 36, map f(x) = {24 – a, 24 – b, 24 – c} then f is a bijection the set C_1 of all three element subsets of M with a + b + c < 36 and set C_2 of all three element subsets M with a + b + c > 36, Hence $|C_1| = |C_2|$.

Total $= {}^{23}C_3 = 1771$ different 3 element subset of M, $|C_1| = \frac{1}{2}(1771 - 61) = 855$

61. 6

Sol. Given, $f(x^2).f''(x) = f'(x).f'(x^2)$

Put $x = 1$ in the given relation

$f(1).f''(1) = (f'(1))^2$

Let $f'(1) = a$ and $f''(1) = b$

$\therefore \quad b = a^2 \quad ....(1)$

Differentiating the given relation

$f(x^2).f'''(x) + f''(x).2x f'(x^2)$

$= f''(x) f'(x^2) + f'(x).(2x) f''(x^2)$

Put $x = 1$

$8 + 2ba = 2ab + ab$

$\Rightarrow \quad ab = 8 \quad ....(2)$

62. 3

Sol. Since roots of $x^2 - x - 1 = 0$, are $P = \frac{1}{2}(1+\sqrt{5})$ and $q = \frac{1}{2}(1-\sqrt{5})$

$ax^{17} + bx^{16} + 1 = 0$

$ap^{17} + bp^{16} = -1 \quad ...(1)$

$aq^{17} + bq^{16} = -1 \quad ...(2)$

Multiply (1) by q^{16} and (2) by p^{16}

$ap + b = -q^{16}$

$aq + b = -p^{16}$

$a = \frac{p^{16} - q^{16}}{p - q} = (p^8 + q^8)(p^4 + q^4)(p^2 + q^2)(p + q)$

$p + q = 1 \qquad p^4 + q^4 = (p^2 + q^2)^2 - 2(pq)^2 = 9 - 2 = 7$

$p^2 + q^2 = 3 \qquad p^8 + q^8 = (p^4 + q^4)^2 - 2(pq)^4 = 49 - 2 = 47$

$a = 47 \times 7 \times 3 \times 1 = 987$

63. 5

Sol. $J = \int_0^1 (1 - x^{50})^{100} x^{100}\, dx$

$= \left((1 - x^{50})^{100} \frac{x^{101}}{101} \right)_0^1 - \int_0^1 100(1 - x^{50})^{99} (-50x^{49}) \frac{x^{101}}{101} dx$

$= 0 + \frac{5000}{101} \int_0^1 (1 - x^{50})^{99} (1 - (1 - x^{50})) x^{100}\, dx$

$= \frac{5000}{101} \left(\int_0^1 (1 - x^{50})^{99} x^{100} dx - \int_0^1 (1 - x^{50})^{100} x^{100}\, dx \right)$

$\frac{5101}{101} J = \frac{5000}{101} I$

$\Rightarrow \frac{I}{J} = \frac{5101}{5000} = \frac{m}{n}$

$\therefore \quad \frac{m - 1 - n}{20} = \frac{5101 - 1 - 5000}{20} = 5$

64. 1

Sol. $D_1 = |10| \qquad D_2 = \begin{vmatrix} 10 & 3 \\ 3 & 10 \end{vmatrix} = 10 \times 10 - 3.3 = 91$

$$D_3 = \begin{vmatrix} 10 & 3 & 0 \\ 3 & 10 & 3 \\ 0 & 3 & 10 \end{vmatrix} = 10\begin{vmatrix} 10 & 3 \\ 3 & 10 \end{vmatrix} - 3\begin{vmatrix} 3 & 3 \\ 0 & 10 \end{vmatrix} + 0\begin{vmatrix} 3 & 10 \\ 0 & 3 \end{vmatrix}$$

$D_n = 10D_{n-1} - 9D_{n-2} = 10(D_{n-1} - D_{n-2}) + D_{n-2}$

$D_2 = 10D_1 - 9D_0 \Rightarrow D_0 = 1$ by recursion formula $D_4 = 7381$

$D_1 - D_0 = 10 - 1 = 9$

$D_2 - D_1 = 81 = 9^2$

$D_3 - D_2 = 820 - 91 = 729 = 9^3$

$D_4 - D_3 = 7381 - 820 = 6561 = 9^4$

$D_n = D_0 + 9^1 + 9^2 + ...9^n = \sum_{i=0}^{n} 9^i$

Desired sum

$$\sum_{n=1}^{\infty} \frac{1}{\frac{8.9^{n+1}-1}{8}+1} = \sum_{n=1}^{\infty} \frac{1}{9^{n+1}-1+1} = \sum_{n=1}^{\infty} \frac{1}{9^{n+1}} = \frac{1}{72}$$

p + q = 1 + 72 = 073

65. 2

Sol. For n = 0, 1, 2..... Let a_n be the prob. That bug is at vertex A after crawling exactly n meter's, then

$a_{n+1} = \frac{1}{3}(1 - a_n)$

Become the bug can be at vertex A after crawling n + 1 meter if and only if

(i) It was not at A following crawling of n meter (this has prob $1 - a_n$)

(ii) from one of other vertices it heads towards A (thes probability 1/3)

Since $a_0 = 1$ $a_1 = 0$ $a_2 = \frac{1}{3}$ $a_3 = \frac{2}{9}$

$a_4 = \frac{7}{27}$ $a_5 = \frac{20}{81}$ $a_6 = \frac{61}{243}$ $a_7 = \frac{182}{729}$

66. 4

Multiple the given equation by $z^3 - 1 = 0$

Yield $z^9 - 1 = 0$

$z_n = \cos n, 40^o + i \sin n\ 40^o n = 0, 1, 2......, 8$ of these only z_3 and z_4 are in the second quadrant. However, Since the solution of $z^9 - 1 = 0$ are distinct and since z_3 is a solution of $z^3 = 1$ It cannot be solution of the original equation. It follows that desired root in z_4 with of agree measure 160º.

SECTION – D

67. 18564.00

Sol. The sum as $\left(\binom{6}{0} + \binom{6}{1}x + \binom{6}{2}x^2 + \binom{6}{3}x^3 + ... + \binom{6}{6}x^6\right)^3$.

We can see the sum we wish to compute is just the coefficient of the x^6 term. However $P(x) = ((1+x)^6)^3 = (1+x)^{18}$. Therefore, the coefficient of the x^6 term is just $\binom{18}{6} = 18564$

68. 00038.00

Sol. The probability that the chord doesn't intersect the triangle is $\frac{11}{25}$.

The only way this can happen is if the two points are chosen on the same arc between two of the triangle vertices. The probability that a point is chosen on one of the arcs opposite one of the base angles is $\frac{x}{180}$, and the probability that a point is chosen on the arc between the two-page angles is $\frac{180-2x}{180}$. Therefore, we can write

$$2\left(\frac{x}{180}\right)^2+\left(\frac{180-2x}{180}\right)^2=\frac{11}{25}$$

This simplifies to

$x^2-120x+3024=0$

Which factors as

$(x-84)((x-36)=0$

So $x=84,36.$ The difference between.

69. 00501.00

The equation $\log(kx)=2\log(x+2)$ is valid for $kx>0$ and x> -2.

It is easy to seen that the all negative values of k make the equation $\log(kx)=2\log(x+2)$ have 500 integer values and for positive reason of x, k has only one value.

ALL INDIA TEST SERIES

FULL TEST – VII

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 – 30, 31 – 60, 61 – 90)** *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	g = 10 m/s^2
Planck constant	h = 6.6 $\times 10^{-34}$ J-s
Charge of electron	e = 1.6 $\times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N-m^2
Density of water	$\rho_{water} = 10^3$ kg/m^3
Atmospheric pressure	$P_a = 10^5$ N/m^2
Gas constant	R = 8.314 J K^{-1} mol^{-1}

CHEMISTRY

Gas Constant	R	=	8.314 J K^{-1} mol^{-1}
		=	0.0821 Lit atm K^{-1} mol^{-1}
		=	1.987 $\approx$ 2 Cal K^{-1} mol^{-1}
Avogadro's Number	N_a	=	6.023 $\times 10^{23}$
Planck's constant	h	=	6.625 $\times 10^{-34}$ J·s
		=	6.625 $\times 10^{-27}$ erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66 $\times 10^{-27}$ kg
1 eV		=	1.6 $\times 10^{-19}$ J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

SECTION – A

Straight Objective Type

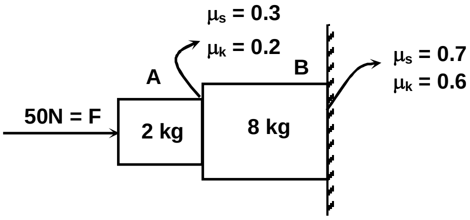
This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A particle moves along a circle of radius 'R' with speed varies as $v = a_0t$, where a_0 is a positive constant. Then the angle between the velocity vector and the acceleration vector of the particle when it has covered one fourth of the circle is

(A) $\tan^{-1}\left(\frac{\pi}{4}\right)$ (B) $\tan^{-1}\left(\frac{\pi}{2}\right)$

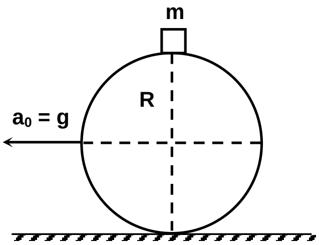
(C) $\tan^{-1}(\pi)$ (D) $\tan^{-1}(2\pi)$

2. Two blocks A and B of masses 2 kg and 8 kg respectively are kept in contact and pressed against a rough vertical wall by applying a horizontal force F = 50 N as shown. The frictional force acting between the two blocks is



(A) zero
(B) 6N
(C) 8 N
(D) 10 N

3. A small body of mass 'm' is placed at the top of a smooth sphere of radius 'R' placed on a horizontal surface as shown. Now the sphere is given a constant horizontal acceleration $a_0 = g$. The velocity of the body relative to the sphere at the moment when it loses contact with the sphere is

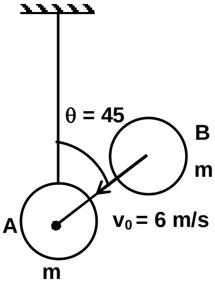


(A) $\sqrt{\frac{gR}{3}}$ (B) $\sqrt{\frac{2gR}{3}}$

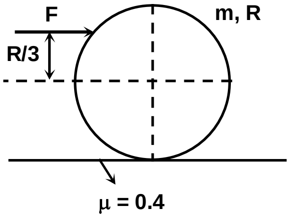
(C) $\sqrt{\frac{5gR}{3}}$ (D) $\sqrt{\frac{7gR}{3}}$

Space for rough work

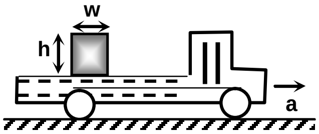
4. A ball of mass m is attached to the lower end of a vertical string whose upper end is fixed. An identical ball 'B' moving with a velocity v_0 = 6 m/s at an angle θ = 45° from vertical collides elastically with the ball 'A' as shown. The velocity of the ball 'B' just after collision is
(A) 5 m/s
(B) 4 m/s
(C) 3 m/s
(D) 2 m/s



5. A thin uniform spherical shell of mass m = 2 kg and radius R = 10 cm is placed on a rough horizontal surface with a coefficient of friction μ = 0.4. A horizontal force 'F' is applied to the spherical shell at a height R/3 above the centre as shown. The maximum magnitude of the applied force 'F' for which the spherical shell will be rolling without slipping is (take g = 10 m/s^2)
(A) 20 N (B) 30 N
(C) 40 N (D) 60 N

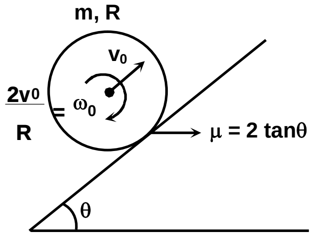


6. A block of mass 2 kg is kept on a truck moving with a constant acceleration. The height 'h' of the block is 60 cm and its width 'w' is 15 cm. The surface between the block and the truck is sufficiently rough to prevent slipping. The minimum acceleration of the truck at which the block will topple is (take g = 10 m/s^2)
(A) 2.5 m/s^2 (B) 3.5 m/s^2
(C) 4.5 m/s^2 (D) 5.5 m/s^2



Space for rough work

7. A uniform solid sphere of mass m and radius ‘R’ is imparted an initial velocity v_0 and angular velocity $\omega_0 = \frac{2v_0}{R}$ and then placed on a rough inclined plane of inclination ‘θ’ and coefficient of friction $\mu = 2\tan\theta$ as shown. The time after which the sphere will start rolling without slipping is



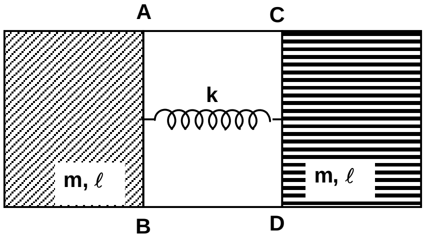
(A) $\frac{v_0}{2g\sin\theta}$

(B) $\frac{v_0}{4g\sin\theta}$

(C) $\frac{v_0}{6g\sin\theta}$

(D) $\frac{v_0}{8g\sin\theta}$

8. Two thin films of same liquid of surface tension ‘T’ are formed between a smooth rectangular wire frame and two thin uniform straight wires each of mass ‘m’ and length ‘l’ connected to a massless non-deformed spring of stiffness ‘k’ and then the system is released from rest. The maximum elongation produced in the spring is



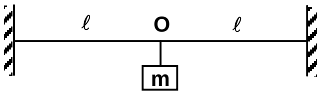
(A) $\frac{2T\ell}{K}$

(B) $\frac{4T\ell}{K}$

(C) $\frac{6T\ell}{K}$

(D) $\frac{8T\ell}{K}$

9. A steel wire of negligible mass, length 2l, cross sectional area ‘A’ and Young’s modulus ‘Y’ is held between two rigid walls. A small body of mass ‘m’ is suspended from its middle point ‘O’ as shown. The vertical descent of the middle point ‘O’ of the wire is



(A) $\ell\left(\frac{mg}{AY}\right)^{1/3}$

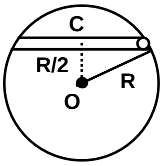
(B) $\ell\left(\frac{2mg}{AY}\right)^{1/3}$

(C) $\ell\left(\frac{4mg}{AY}\right)^{1/3}$

(D) $\ell\left(\frac{6mg}{AY}\right)^{1/3}$

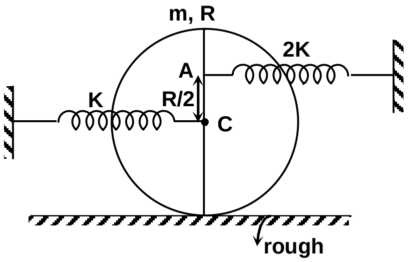
Space for rough work

10. A tunnel is dug across the earth of mass 'M' and radius 'R' at a distance R/2 from the centre 'O' of the Earth as shown. A body is released from rest from one end of the smooth tunnel. The velocity acquired by the body when it reaches the centre 'C' of the tunnel is



(A) $\sqrt{\frac{3GM}{2R}}$ (B) $\sqrt{\frac{3GM}{4R}}$
(C) $\sqrt{\frac{3GM}{8R}}$ (D) $\sqrt{\frac{3GM}{16R}}$

11. A uniform circular disc of mass 'm' and radius 'R' is placed on a rough horizontal surface and connected to the two ideal non-deformed springs of stiffness k and 2k at the centre 'C' and point 'A' as shown. The centre of the disc is slightly displaced horizontally from equilibrium position and then released, then the time period of small oscillation of the disc is (there is no slipping between the disc and the surface).



(A) $2\pi\sqrt{\frac{5m}{7k}}$ (B) $2\pi\sqrt{\frac{3m}{7k}}$
(C) $2\pi\sqrt{\frac{5m}{11k}}$ (D) $2\pi\sqrt{\frac{3m}{11k}}$

12. Two moles of an ideal monoatomic gas undergoes a process VT = constant. If temperature of the gas is increased by $\Delta T = 300$ K, then the ratio $\left(\frac{\Delta U}{\Delta Q}\right)$ is
(A) 2 (B) 3
(C) 4 (D) 6

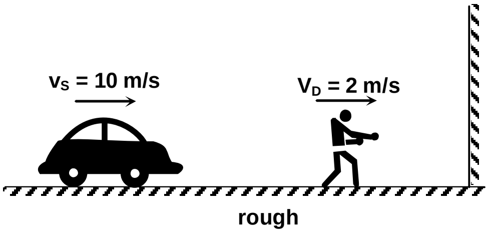
13. A heat engine employing a carnot cycle with an efficiency of $\eta = 10\%$ is used as a refrigerating machine with the same thermal reservoirs. Then its coefficient of performance is
(A) 3 (B) 5
(C) 7 (D) 9

Space for rough work

14. A string of length 50 cm and mass 2.5 g is fixed at both ends. A pipe closed at one end has a length of 85 cm. When the string vibrates in its second overtone and the air column in the pipe in its first overtone, they produce a beats frequency of 6 Hz. It is also observed that decreasing the tension in the string decreases beats frequency. Neglect the end correction in the pipe and velocity of sound in air is 340 m/s. then the tension in the string is

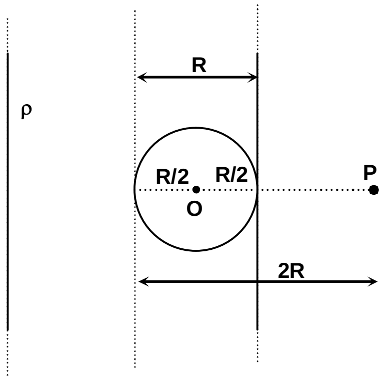
(A) 72 N (B) 52 N
(C) 26 N (D) 18 N

15. A car is moving with a constant velocity 10 m/s towards a stationary wall. An observer in between the car and the wall is moving with a constant velocity 2 m/s towards the stationary wall. The car blows a horn of frequency 320 Hz. The velocity of sound in air is 330 m/s. The beats frequency received by the observer is



(A) 2 Hz (B) 4 Hz
(C) 6 Hz (D) 8 Hz

16. Inside a uniformly charged infinitely long cylinder of radius 'R' and volume charge density 'ρ' there is a spherical cavity of radius 'R/2'. A point 'P' is located at a distance 2R from the axis of the cylinder as shown. Then the electric field strength at the point 'P' is



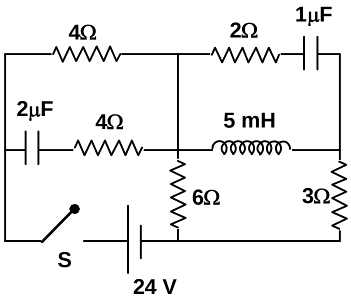
(A) $\frac{23\rho R}{54\varepsilon_0}$ (B) $\frac{23\rho R}{108\varepsilon_0}$
(C) $\frac{25\rho R}{54\varepsilon_0}$ (D) $\frac{25\rho R}{108\,\varepsilon_0}$

17. A parallel plate capacitor 'A' of capacitance 1 μF is charged to a potential drop 100 volt and then disconnected from the battery. Now the capacitor 'A' is completely filled with a dielectric slab of dielectric constant k = 4. Another parallel plate capacitor 'B' of capacitance 2 μF is charged to a potential drop 20 volt and then disconnected from the battery. Now the two capacitors 'A' and 'B' are connected with each other with opposite polarities. Then the heat dissipated after connecting the capacitors is

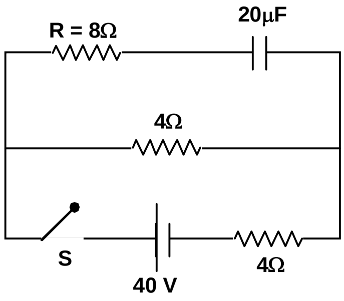
(A) 1.15×10^{-3} J (B) 1.25×10^{-3} J
(C) 1.35×10^{-3} J (D) 1.45×10^{-3} J

Space for rough work

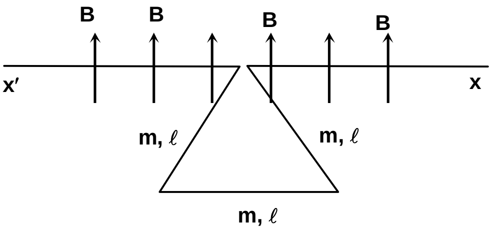
18. In the circuit shown, the switch ‘S’ is closed at t = 0. Then the current through the battery after steady state reached is
(A) 2A
(B) 4A
(C) 6A
(D) 8A



19. In the circuit shown, the switch ‘S’ is closed at t = 0. The capacitor is initially uncharged. Then the current through the resistor R = 8Ω at t = 0.4×10^{-3} sec is (Take $e^{-2} = 0.135$)
(A) 0.18 A
(B) 0.27 A
(C) 0.54 A
(D) 0.72 A



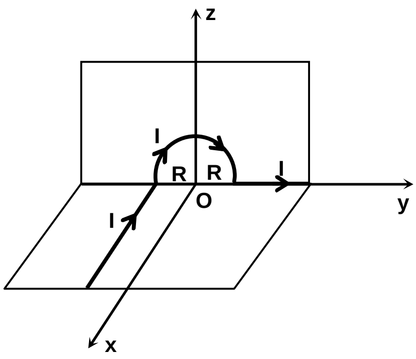
20. A uniform wire of mass ‘3m’ and length ‘3l’ is bent into the shape of an equilateral triangle and suspended from a horizontal axis X’X in a vertical plane as shown. A uniform vertical upward magnetic field ‘B’ is existing in the region. If charge ‘Q’ is passed almost instantaneously through the triangular loop, then the angular velocity acquired by the triangular loop immediately after charge passed is



(A) $\frac{\sqrt{3}BQ}{5m}$ (B) $\frac{2\sqrt{3}BQ}{5m}$
(C) $\frac{3\sqrt{3}BQ}{5m}$ (D) $\frac{4\sqrt{3}BQ}{5m}$

Space for rough work

21. A long wire carrying current ‘I’ is bent into the shape as shown in the figure. The net magnetic field intensity at the centre ‘O’ is



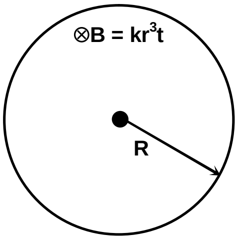
(A) $\frac{\mu_0 I}{4\pi R}\sqrt{1+\pi^2}$

(B) $\frac{\mu_0 I}{4\pi R}\sqrt{2+\pi^2}$

(C) $\frac{\mu_0 I}{4\pi R}\sqrt{4+\pi^2}$

(D) $\frac{\mu_0 I}{4\pi R}\sqrt{9+\pi^2}$

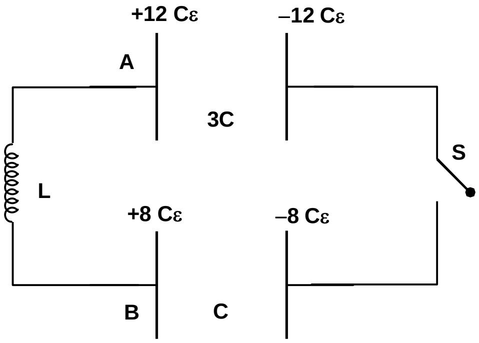
22. A time varying magnetic field $B = Kr^3t$ is existing in a cylindrical region of radius ‘R’ as shown (where k is a constant). The induced electric field ‘E’ at $r = \frac{R}{2}$ is



(A) $\frac{KR^4}{20}$ (B) $\frac{KR^4}{40}$

(C) $\frac{KR^4}{60}$ (D) $\frac{KR^4}{80}$

23. In the adjacent circuit, the capacitor ‘A’ of capacitance ‘3C’ and the capacitor ‘B’ of capacitance ‘C’ are initially charged by potential drops 4ε and 8ε respectively and connected through an inductor of inductance ‘L’ with zero initial current as shown. The switch ‘S’ is closed at t = 0. then the maximum current through the inductor is



(A) $\varepsilon\sqrt{\frac{3C}{L}}$

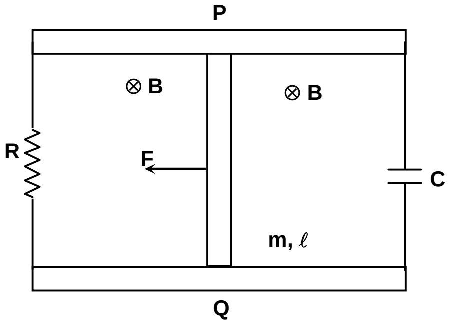
(B) $\varepsilon\sqrt{\frac{6C}{L}}$

(C) $\varepsilon\sqrt{\frac{12C}{L}}$

(D) $\varepsilon\sqrt{\frac{15C}{L}}$

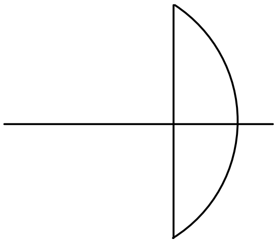
Space for rough work

24. Two smooth horizontal parallel conducting rails are connected with a capacitor and a resistor at the two ends as shown. A uniform conducting rod PQ of mass 'm' and length 'ℓ' is dragged with a constant horizontal force 'F'. The terminal velocity acquired by the conducting rod is

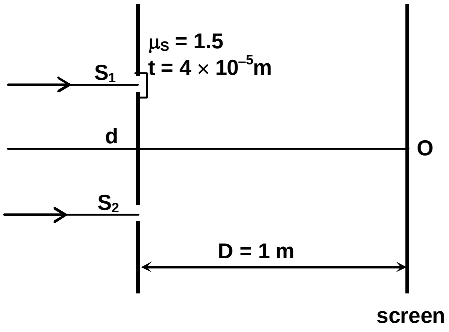


(A) $\frac{4FR}{B^2\ell^2}$
(B) $\frac{2FR}{B^2\ell^2}$
(C) $\frac{FR}{B^2\ell^2}$
(D) $\frac{FR}{2B^2\ell^2}$

25. A plano-convex lens $(\mu = 1.5)$ of aperture diameter 8 cm has a maximum thickness of 4 mm. The focal length of the lens relative to air is
(A) + 20 cm
(B) + 40 cm
(C) + 60 cm
(D) + 80 cm

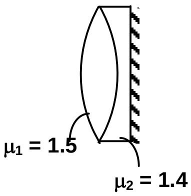


26. A coherent parallel beam of light of wavelength 5000 Å is incident normally on the plane of slits. The slit S_1 is covered with a slab of refractive index $\mu_s = 1.5$ and thickness $t = 4 \times 10^{-5}$m as shown. The separation between the slits is d = 1 mm and the separation between the plane of slits and screen is D = 1m. Then the position of the central maxima formed on the screen is
(A) 1 cm above point 'O'.
(B) 2 cm above point 'O'.
(C) 1 cm below point 'O'.
(D) 2 cm below point 'O'.



Space for rough work

27. A thin equiconvex glass lens $(\mu_1 = 1.5)$ of radius of curvature 'R' and a thin plano-concave lens $(\mu_2 = 1.4)$ are kept in contact and the plane surface is silvered. This lens system is placed in air. When a point object is placed at a distance 20 cm from the lens system on its principal axis, the image formed by the lens system coincides with the object. Then the value of radius of curvature 'R' is



(A) 12 cm (B) 18 cm
(C) 24 cm (D) 30 cm

28. When the light of wavelength 400 nm is incident on a metal surface of work function 2.3 eV, photoelectrons are emitted. A fastest photoelectron combines with a He^{2+} ion to form He^{+} ion in its third excited state and a photon is emitted in this process. Then the energy of the photon emitted during combination is
(A) 4.2 eV (B) 5.7 eV
(C) 6.5 eV (D) 6.8 eV

29. An unpolarised light of intensity 'I_0' is passed through the two Polaroid's placed parallel to each other and their transmission axes are inclined at an angle 45. The intensity of the polarised light after passing through the Polaroid's will be
(A) $\frac{I_0}{8}$ (B) $\frac{I_0}{4}$
(C) $\frac{I_0}{2}$ (D) $\frac{I_0}{\sqrt{2}}$

30. The pitch of a screw gauge is 1mm and its cap is divided into 100 divisions. When this screw gauge is used to measure the diameter of a wire, the main scale reading is 2mm and 58th division of circular scale coincides with the main scale. There is no zero error in the screw gauge. Then the diameter of the wire is
(A) 2.38 mm (B) 2.48 mm
(C) 2.58 mm (D) 3.58 mm

Space for rough work

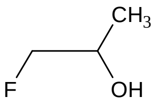
Chemistry PART – II

SECTION – A

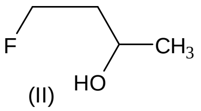
Straight Objective Type

This section contains **30 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

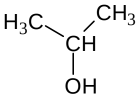
31. The order of reactivity of the following alcohols towards conc. HCl is



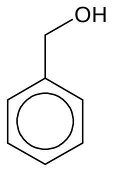
(I)



(II)



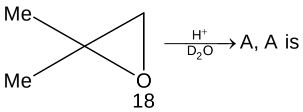
(III)



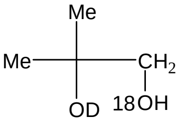
(IV)

(A) IV > III > I > II
(B) IV > III > II > I
(C) I > III > II > IV
(D) I > II > III > IV

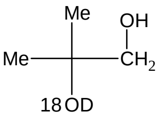
32.



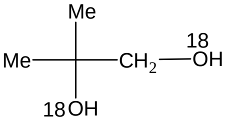
(A)



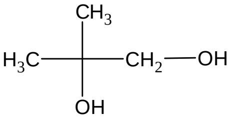
(B)



(C)



(D)

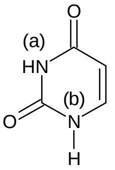


33. The major product formed by the reaction of a anisol with tert-butyl alcohol in presence of Li/Liq. NH_3 is
(A) 1-methoxy cyclohexa-1,4-diene
(B) 2-methoxy cyclohexa-1,3-diene
(C) 1-methoxy cyclohexa-1, 3-diene
(D) 3-methoxy cyclohexa-1,4-diene

34. Consider the following statements for monosaccharides
(1) They are optically active polyhydroxy carbonyl compounds.
(2) Fructose is a ketose sugar and hence it does not give red precipitate with Fehling solution.
(3) All monosaccharides show mutarotation.
(4) α-D-Glucose and β-D-Glucose are anomers.
Which one of the above statement(s) is/are correct?
(A) 1 and 2
(B) 1, 2 and 3
(C) 1 and 3
(D) 1, 2 and 4

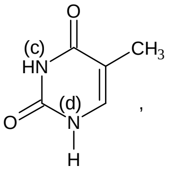
Space for rough work

35. Consider the following three bases of DNA and RNA:



Urasil

,



Thymine

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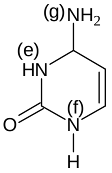


Cytosine

The order of acidic strength on different site will be

(A) a > b (B) d > c

(C) f > e > g (D) g > f

36. The Arrhenious equation for the decomposition of methyl nitrite and ethyl nitride are k_1 and k_2 respectively and the activation energy of second is 4 kJ/mole is more than that of first. At what temperature value of rate constant k_1 will be equal to k_2 if

$$k_1(s) = 10^{13}\left(e^{-\frac{E_{a_1}}{RT}}\right) \text{and } k_2\left(s^{-1}\right) = 10^{14}\left(e^{-\frac{E_{a_2}}{RT}}\right)$$

(A) 650 K (B) 230 K

(C) 325 K (D) 425 K

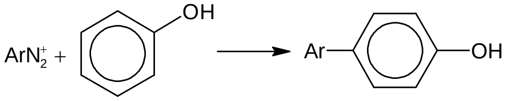
37. If the orbital angular momentum of iron chloride is $5\sqrt{6}\hbar$ then the correct options for this given fact are:

(A) $FeCl_3$ (B) $FeCl_2$

(C) Fe_2Cl_6 (D) None of these

38. Which of the following reactions are possible?

(1) $ArN_2^+ + CuBr \longrightarrow Ar - Br$

(2) 

(3) $ArN_2^+ + H_3PO_2 \xrightarrow{H_2O} ArH$

(4) $ArN_2^+ + I^- \longrightarrow ArI$

Select the answer using codes given below:

(A) 1, 2 & 4 (B) 1, 3 & 4

(C) 1, 2 & 3 (D) 1, 2, 3 & 4

39. The number of β-particle emitted during the change ${}_aX^c \longrightarrow {}_dY^b$ is

(A) $\frac{a-b}{4}$ (B) $d+\left(\frac{a-b}{2}\right)+c$

(C) $d+\left(\frac{c-b}{2}\right)-a$ (D) $d+\left(\frac{a-b}{2}\right)-c$

Space for rough work

40. In which type of voids magnesium and silicon is present respectively in asbestos ($Mg_3Si_2O_5$) if $r_{Mg^{2+}} / r_{O^{2-}} = 0.59$ and $\frac{r_{Si^{4+}}}{r_{O^{2-}}} = 0.29$

(A) octahedral and tetrahedral (B) Tetrahedral and octahedral
(C) both in tetrahedral (D) both in octahedral

41. Ferric ion forms a Prussian blue coloured precipitate due to formation of
(A) $KMnO_4$ (B) $K_4[Fe(CN)_6]$
(C) $Fe_4[Fe(CN)_6]_3$ (D) $[Fe(OH)_3]$

42. Arseneous sulphide is a negative sol. The reagent with least coagulation power in this sol is
(A) $AlCl_3$ (B) NaCl
(C) CaF_2 (D) Glucose

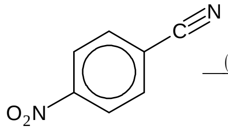
43. A 3 mole sample of a triatomic ideal gas at 300 K is allowed to expand under adiabatic reversible condition from 5 L to 40 L. The value of ΔH is
(A) - 12.46 kJ (B) - 14. 965 kJ
(C) - 24.62 kJ (D) - 10.24 kJ

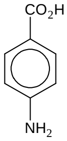
44. An aq. solution of a salt (x) is alkaline to litmus. On strong heating, it swell up to give a glassy material. When conc. H_2SO_4 is added to a concentrated solution of x, white crystal of a weak acid separates out. Hence compound (x) is
(A) $Na_2SO_4.10H_2O$ (B) $MgSO_4.7H_2O$
(C) $Na_2B_6O_{11}$ (D) $Na_2B_4O_7.10H_2O$

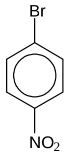
45. A gas is heated in such a way that its pressure and volume both become double. Now by decreasing temperature, some of air molecules were introduced into the container to maintain the increased volume and pressure. Assuming 1/4th of the initial number of moles has been given for this purpose. By what fraction of temperature has been raised finally of initial absolute temperature.
(A) $\frac{4}{5}$ times (B) $\frac{16}{7}$ times
(C) $\frac{16}{5}$ times (D) $\frac{8}{5}$ times

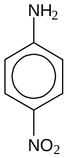
Space for rough work

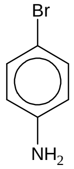
46. During the reduction of Gold(III) from $AuCl_4^-$ ion, the solution must be stirred rapidly during electrolysis. The stirring is important because
(A) It helps to separate gold from chlorine
(B) It increases the movement of $AuCl_4^-$ towards anode
(C) It overcomes the repulsion between the $AuCl_4^-$ and the excess e^- at the electrode and help in deposition of gold (III)
(D) It increases the conductivity of the solution.

47.  $\xrightarrow[(2)\,KOH/Br_2]{(1)\,KOH(1\,mol)}$ A, product A is

(A) 

(B) 

(C) 

(D) 

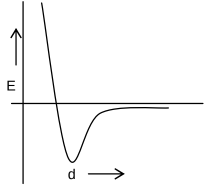
48. A well is dry in a bed of rock containing fluorspar (CaF_2). If the well contains 20,000 L of H_2O, what is the amount of F^- in it
K_{SP} of $CaF_2 = 4 \times 10^{-11}$.
(A) 4.3 mole (B) 6.8 mole
(C) 8.6 mole (D) 13.6 mole

49. The electronaffinity of F < Cl and ionization energy of F > Cl then which of the compound is possible?
(A) $\overset{\delta+}{F}-\overset{\delta-}{Cl}$ (B) $\overset{\delta+}{Cl}\overset{\delta-}{F}$
(C) F – Cl (D) $Cl-F_2$

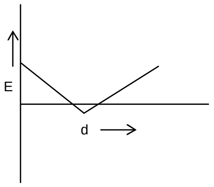
Space for rough work

50. Which plot best represent the potential energy (E) of two hydrogen atoms as they approach one another to form a hydrogen molecule?

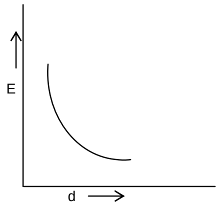
(A)



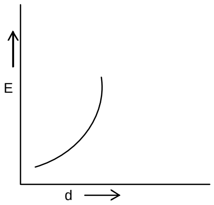
(B)



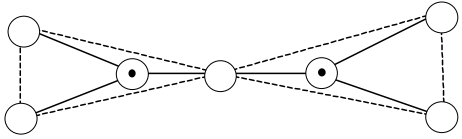
(C)



(D)



51. Formula of the following silicate anion is



(A) SiO_4^{4-} (B) $Si_2O_7^{6-}$
(C) $Si_2O_8^{6-}$ (D) $Si_3O_9^{6-}$

52. S – S bond is present in
(A) α - $(SO_3)_n$ (B) γ - (S_3O_9)
(C) $H_2S_2O_3$ (D) $H_2S_2O_8$

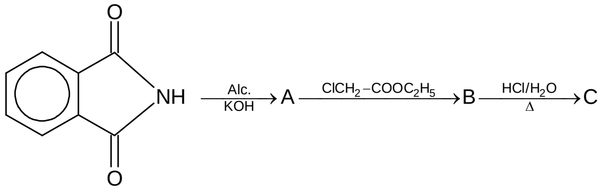
53. Main source of lead is PbS. It is converted to Pb by
(I) $PbS \xrightarrow[\Delta]{air} PbO + SO_2$
(II) $PbS \xrightarrow{air} PbO + PbS$
$\quad \xrightarrow{PbS} Pb + SO_2$

Self reduction process is
(A) I (B) II
(C) Both A & B (D) none of these

54. How many moles of HCl will be required to completely convert 1 moles of borax into boric acid?
(A) 1 (B) 2
(C) 3 (D) none of these

Space for rough work

55. Consider the following sequence of reaction:



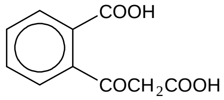
Which of the following is the structure of 'C'?

(A) $Cl^{-}\overset{+}{N}H_3CH_2-COOH$

(B) NH_2-CH_2-COCl

(C) $C_6H_5CONH_2$

(D)



56. Consider the following sequence of reactions:

$$HC \equiv CH \xrightarrow[2.\ HCl]{1.\ CuCl.NH_4Cl} A \xrightarrow{Polymerisation} B$$

The polymer 'B' obtained is:

(A) Neoprene
(B) Chloroprene
(C) Polyvinyl chloride
(D) Orlon

57. 50 ml of 1 M, oxalic acid is shaken with 0.6 gm of charcoal. The final concentration of this solution after adsorption has been found to be 0.4 M. The amount of oxalic acid absorbed per gm of charcoal is

(A) 2.02 gm
(B) 2.52 gm
(C) 3.02 gm
(D) 3.52 gm

58. $Na_2B_4O_7.\ 10H_2O$ (Borax) is correctly represented as

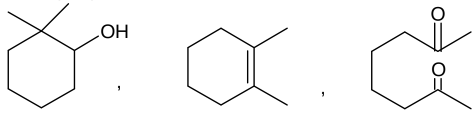
(A) $2Na.BO_2.\ Na_2B_2O_2.\ 10H_2O$
(B) $Na_2[B_4O_5(OH)_4].8H_2O$
(C) $Na_2[B_4(H_2O)_4].6H_2O$
(D) all of the above.

Space for rough work

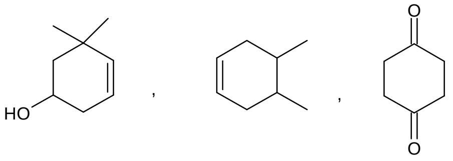
59. A compound 'D' ($C_8H_{16}O$) has following observation
(a) It reacts with Lucas reagent with in 5 min.
(b) On heating in presence of acid gives a compound X, which can decolorize $KMnO_4$ as well as Br_2/CCl_4.
(c) Compound $X \xrightarrow{\text{ozonolysis}} Y \xrightarrow{I_2/NaOH} 2$ moles of iodoform + sodium salt of dibasic acid $\xrightarrow{\text{Sodalime}}$ n – butane

Then D, X, Y are

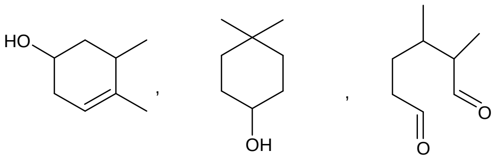
(A)



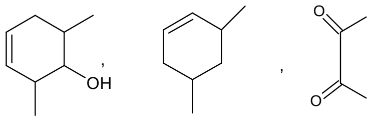
(B)



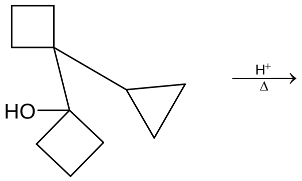
(C)



(D)

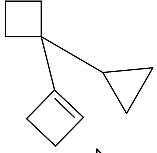


60.

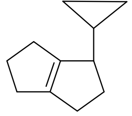


The rearranged alkene, product after rearrangement at low temperature will be mainly:

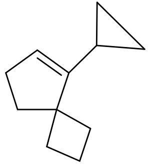
(A)



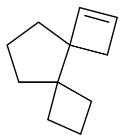
(B)



(C)



(D)



Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **30 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

61. $$\int \frac{(\log x)^2 \tan^{-1}(\log x) + 1 + \tan^{-1}(\log x)}{1+(\log x)^2}dx$$

(A) $\frac{x}{1+(\log x)^2}+c$
(B) $\frac{x}{\tan^{-1}(\log x)}+c$
(C) x $\tan^{-1}$(log x) + c
(D) log x($\tan^{-1}$(log x)) + c

62. $\int \frac{11x-18}{x^{11}\left(\sqrt[6]{x^{12}-2x+3}\right)}dx$ is equal to

(A) $\frac{6}{5}\frac{\left(x^{12}-2x+3\right)^{\frac{5}{6}}}{x^{10}}$
(B) $\frac{3}{5}\frac{\left(x^{12}-2x+3\right)^{\frac{5}{6}}}{x^{10}}+c$
(C) $\frac{3}{5}\left(x^{12}-2x+3\right)^{\frac{5}{6}}+c$
(D) $\frac{5}{3}\frac{\left(x^{12}-2x+3\right)}{x^{2}}+c$

63. Let $\frac{d}{dx}(g(x)) = \frac{e^{\cos x}}{x}$, x > 0, g(1) = 3a$_1$, g(2) = 6a$_2$, g(8) = 10a$_3$ (where a$_1$ a$_2$, a$_3$ are constants) then $\int_1^2 \frac{3e^{\cos x^3}}{x}dx$ is equal to

(A) 6a$_2$ – 3a$_1$
(B) 10a$_3$ – 6a$_2$
(C) 10a$_3$ – 3a$_1$
(D) 10a$_3$ – 6a$_2$ – 3a$_1$

Space for rough work

64. A circle with centre in the first quadrant has tangent as y = x + 10, y = x – 6 and y-axis. Let (h, k) be the centre of the circle. If $h+k=a+b\sqrt{a}$, where (a, b $\in$ Q), then a + b is equal to

(A) 8 (B) 10
(C) 12 (D) 0

65. If we add 1, 1, 7 to first three terms of an increasing A.P. whose common difference is an integer, then the resulting three terms are in an increasing G.P. whose common ratio is also an integer, then the number of possible values of d are

(A) 2 (B) 4
(C) 8 (D) infinite

66. If the line $\frac{x-2}{3}=\frac{y+1}{2}=\frac{z-3}{4}$ lies in the plane ax + by + 3z = 8, then a^2+b^2 is equal to

(A) 16 (B) 8
(C) 13 (D) 25

67. If the curve y = f(x) passes through (1, 1) and satisfies the differential equation
$2x^2y\,dx - x^3\,dy = y^2\,dx$, then f(2) is equal to

(A) $\frac{2}{(\log 2)+1}$ (B) $\frac{4}{\log 2}$
(C) $\frac{4}{\log 2e}$ (D) $\frac{16}{(\log 2)+1}$

68. If $\frac{1}{\sqrt{\alpha}}$ and $\frac{1}{\sqrt{\beta}}$ are the roots of the equation $px^2 + qx + 1 = 0$ ($p \neq 0$, p, q $\in$ R) then the equation $x(x + q^3) + (p^3 - 3pqx) = 0$ has roots

(A) $\alpha^{\frac{3}{2}}$ and $\beta^{\frac{3}{2}}$ (B) $\alpha\beta^{\frac{1}{2}}$ and $\alpha^{\frac{1}{2}}\beta$
(C) $\sqrt{\alpha\beta}$ and $\alpha\beta$ (D) $(\alpha\beta)^{\frac{1}{4}}$ and $(\alpha\beta)^{\frac{5}{4}}$

Space for rough work

69. If f(x) is continuous and $f\left(\frac{25}{2}\right)=4$ then $\lim_{x\to 0} f\left(\frac{1-\cos 5x}{x^2}\right)$ is equal to

(A) $\frac{1}{4}$ (B) 0
(C) 8 (D) 4

70. Let A = {(x, y) : $y^2 \le 8x$, $3y - 4x \ge 4$}. The area (in square units) of the region A is

(A) $\frac{1}{3}$ (B) $\frac{1}{6}$
(C) 1 (D) 2

71. If the point (2, 3) lies inside the circle $x^2 + y^2 - 6x - 10y + k = 0$ and the circle neither touches nor intersect the line y = 1 then the set of all possible value of k is in the interval

(A) no values of k (B) (9, 29)
(C) (18, 29) (D) (25, 31)

72. In a triangle ABC, angle C < angle B, angle B and angle C satisfy the equation $2\tan x - \alpha(1 + \tan^2 x) = 0$ (where $0 < \alpha < 1$). Then the measure of angle A is

(A) $\frac{\pi}{3}$ (B) $\frac{5\pi}{6}$
(C) $\frac{\pi}{4}$ (D) $\frac{\pi}{2}$

73. If A is a 3 × 3 matrix such that $A^T = 5A + 2I$, where A^T is the transpose of A and I is the 3 × 3 identity matrix, then there exist a column matrix $X = \begin{bmatrix} x \\ y \\ z \end{bmatrix} \ne \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$ then AX is equal to

(A) AX = X (B) $AX = -\frac{X}{2}$
(C) AX = –2X (D) AX = 0

74. The contrapositive of the converse of $\sim q \to p$ is

(A) $q \to \sim p$ (B) $p \to \sim q$
(C) $\sim p \to q$ (D) none of these

Space for rough work

75. The locus of the mid-point of the chords of the ellipse $49x^2 + 16y^2 = 784$, the tangents at the ends of which intersect on the circle $x^2 + y^2 = 100$ is

(A) $\left(49x^2+16y^2\right)^2=\left(\frac{784}{10}\right)^2\left(x^2-y^2\right)$ (B) $49x^2+16y^2=\frac{784}{10}$

(C) $\left(49x^2+16y^2\right)^2=\frac{784^2}{10^2}\left(x^2+y^2\right)$ (D) none of these

76. Box A contains four tickets numbered 1, 2, 3, 4, box B contains 7 tickets numbered 1, 2, 3, 4, 5, 6, 7. A ticket is drawn from each of the boxes. Let a_i be the number on the ticket drawn from Box A and let b_i be the number on the ticket drawn from box B. The probability that $a_i \times b_i$ is a multiple of 3 is

(A) $\frac{15}{28}$ (B) $\frac{13}{28}$

(C) $\frac{2}{3}$ (D) $\frac{11}{28}$

77. The sum $\sum_{r=0}^{30} {}^{30}C_r \sin rx \cos(30-r)x$ is equal to

(A) $2^{30}\cos 30x$ (B) $2^{29}\cos 30x$

(C) $2^{29}\sin 29x$ (D) $2^{29}\sin 30x$

78. Let A and B be two sets of two complex numbers defined as follows $A = \{z : |z + 6| + |z - 2| = 10\}$, $B = \{z : |z - 6| = 3\}$ then the number of elements common to both A and B is

(A) 1 (B) 2

(C) 0 (D) 4

79. If the tangent to the conic $y - 4 = x^2$ at (3, 13) touches the circle $x^2 + y^2 - 4x + 2y + \lambda = 0$ (for some fixed λ) at a point (a, b), then a + b is equal to

(A) $\frac{55}{37}$ (B) $\frac{3}{37}$

(C) $-\frac{55}{37}$ (D) $-\frac{3}{37}$

Space for rough work

80. The value of $\lim\limits_{n\to\infty}\sum\limits_{r=n^2}^{n^2+9+6n}\frac{1}{\sqrt{r}}$ is equal to

(A) 6
(B) 4
(C) $-2\sqrt{2}$
(D) cannot be determined

81. Let f: R → R be a continuous and differentiable function such f(x) = f(10 – x) and slope of tangent at x = –5 is 2 then f′(5) + f′(15) is equal to

(A) 0
(B) 2
(C) –2
(D) –4

82. Let f(2) = –5 and $f'(x) \geq 5.4$ for $2 \leq x \leq 7$. Then possible value of f(7) lies in the interval

(A) (–∞, 21]
(B) [12, 18]
(C) (0, 22)
(D) [22, ∞)

83. The value of $\sum\limits_{k=1}^{13}\tan\frac{k\pi}{12}\tan\frac{(k-1)\pi}{12}$ is

(A) 0
(B) –14
(C) –12
(D) $\frac{\sqrt{3}+1}{\sqrt{3}-3}-13$

84. Let a and b ∈ R and f: R → R be defined by $f(x)=ae^{|x|\sin|x|}+b\cos(|x|)$. Then which of the following is INCORRECT?

(A) differentiable at x = 0 if a = 1 and b = 0
(B) differentiable at x = π if a = 1 and b = 1
(C) non differentiable at x = 0 if a = 1 and b = 1
(D) differentiable at x = 2π if a = 1 and b ∈ R

85. Let $\vec{a}=a_1\hat{i}+a_2\hat{j}+a_3\hat{k}$ be a unit vector in R^3 and $\vec{b}=2\hat{i}+3\hat{j}+6\hat{k}$. Given that there exists a vector $\vec{c}$ in R^3 such that $|\vec{a}\times\vec{c}|=5$ and $\vec{b}\cdot(\vec{a}\times\vec{c})=35$. Which of the following statement(s) is correct?

(A) if a lies in yz plane then $|a_2| = |3a_3|$
(B) if a lies in xy plane, then $|a_1| = \left|\frac{3}{2}a_2\right|$
(C) if a lies in xz plane then $|a_1| = |2a_3|$
(D) $\vec{b}$ is always parallel to $\vec{c}$

Space for rough work

86. Let a, b $\in$ R consider the system of linear equations $2x + ay + 6z = 8$, $x + 2y + bz = 5$ and $x + y + 3z = 4$. Then which of the following statements is INCORRECT?
(A) if a = 2, then system of equations have infinitely many solution
(B) if a = 5 and b = 3 then the system of equations have no solution
(C) if $a \neq 2$ and b = 3, then the system of equations have infinitely many solution
(D) if $a \neq 2$ and $b \neq 3$, then the system of equations have a unique solution

87. If the mean deviation about the median of the numbers k, 3k, 7k, 9k, 11k, 13k is 11 then k is equal to (k > 0)

(A) $\frac{5}{3}$	(B) $\frac{22}{7}$
(C) 3	(D) 6

88. If e_1, e_2, e_3, e_4, e_5 are eccentricities of the conics $xy = 16$, $x^2 - y^2 = 36$, $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$, $\frac{x^2}{a^2} - \frac{y^2}{b^2} = -1$ and $y^2 = 32x$ and $\sqrt{\frac{1}{e_1^2} + \frac{1}{e_2^2} + \frac{1}{e_3^2} + \frac{1}{e_4^2} + \frac{1}{e_5^2}} = \tan\theta\left(0 < \theta < \frac{\pi}{2}\right)$ then θ is equal to

(A) $\frac{\pi}{6}$	(B) $\frac{\pi}{12}$
(C) $\frac{\pi}{3}$	(D) $\tan^{-1}\left(\sqrt{5}\right)$

89. An eight digit made up of all distinct digits 5, 7, 2, 4, 9, a, b, c is divisible by 3. Then the possible number of ordered triplets (a, b, c) is

(A) 12	(B) 24
(C) 1840	(D) 18

90. Let f: (–1, 1) → R be a continuous and differentiable function. If $\int_0^{\sin x} f(t)dt = x^2$ then $f\left(\frac{1}{2}\right)$ is equal to

(A) $\frac{2\pi}{3}$	(B) $\frac{\pi}{3}$
(C) $\frac{\pi}{6}$	(D) $\frac{2\pi}{3\sqrt{3}}$

Space for rough work

FIITJEE

JEE(Main)-2018

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – VII
(Main)

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**C**	31.	**B**	61.	**C**
2.	**B**	32.	**A**	62.	**B**
3.	**B**	33.	**A**	63.	**C**
4.	**D**	34.	**C**	64.	**B**
5.	**C**	35.	**C**	65.	**B**
6.	**A**	36.	**B**	66.	**C**
7.	**C**	37.	**A**	67.	**C**
8.	**B**	38.	**B**	68.	**A**
9.	**A**	39.	**C**	69.	**D**
10.	**B**	40.	**A**	70.	**B**
11.	**D**	41.	**C**	71.	**C**
12.	**B**	42.	**B**	72.	**D**
13.	**D**	43.	**B**	73.	**B**
14.	**B**	44.	**D**	74.	**A**
15.	**B**	45.	**C**	75.	**C**
16.	**D**	46.	**C**	76.	**B**
17.	**C**	47.	**C**	77.	**D**
18.	**B**	48.	**C**	78.	**A**
19.	**B**	49.	**B**	79.	**D**
20.	**A**	50.	**A**	80.	**A**
21.	**A**	51.	**B**	81.	**C**
22.	**D**	52.	**C**	82.	**D**
23.	**C**	53.	**B**	83.	**C**
24.	**C**	54.	**B**	84.	**C**
25.	**B**	55.	**A**	85.	**B**
26.	**B**	56.	**A**	86.	**C**
27.	**A**	57.	**B**	87.	**C**
28.	**A**	58.	**B**	88.	**C**
29.	**B**	59.	**A**	89.	**D**
30.	**C**	60.	**C**	90.	**D**

Physics PART – I

SECTION-A

1. Given $v = a_0t$

$$a_t = \frac{dv}{dt} = a_0$$

Now, $v^2 = u^2 + 2a_tS$

$$= 0 + 2a_0\frac{\pi R}{2}$$

$$v^2 = \pi a_0 R$$

So, $a_n = \frac{v^2}{R} = \pi a_0$

The angle between the velocity vector and the acceleration vector is

$$\phi = \tan^{-1}\left(\frac{a_n}{a_t}\right) = \tan^{-1}\left(\frac{\pi a_0}{a_0}\right) = \tan^{-1}(\pi)$$

2. The two blocks will move with a common acceleration

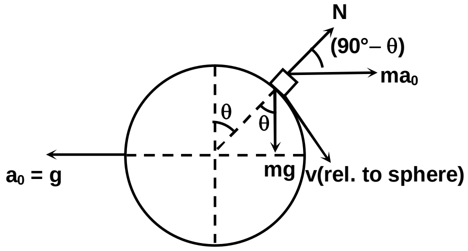
$$a = \frac{100-30}{10} = 7\ \text{m/s}^2$$

Now, for the block ‘A’

$20 - f_S = 2 \times 7$

$\therefore f_S = 6N$

3. Let v is the velocity of the body relative to the sphere when it loses contact with the sphere.



$$mg\cos\theta - N - ma_0\sin\theta = \frac{mv^2}{R}$$

To lose contact with the sphere, N = 0

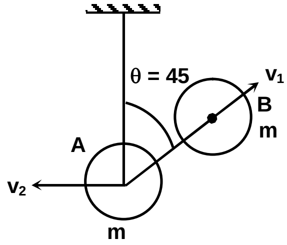
$$mg\cos\theta - ma_0\sin\theta = \frac{mv^2}{R}$$

Also, $mgR(1-\cos\theta) + ma_0R\sin\theta = \frac{1}{2}mv^2$

$$mg = \frac{3mv^2}{2R}$$

$$\therefore\ v = \sqrt{\frac{2gR}{3}}$$

4. Using conservation of momentum of the system along horizontal direction



$$\frac{mv_0}{\sqrt{2}} = mv_2 - \frac{mv_1}{\sqrt{2}}$$

$$\sqrt{2}v_2 - v_1 = v_0 \qquad \text{...(i)}$$

$v_2\cos 45° + v_1 = v_0$

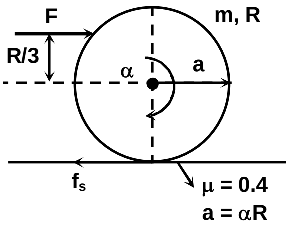
$$\frac{v_2}{\sqrt{2}} + v_1 = v_0$$

$$\sqrt{2}v_2 + 2v_1 = 2v_0 \qquad \text{..(ii)}$$

Solving (i) and (ii), we get

$3v_1 = v_0$

$v_1 = \frac{v_0}{3} = \frac{6}{3} = 2\ \text{m/s}$



5. $F - f_s = ma$ …(i)

$\frac{FR}{3} + f_s R = \frac{2}{3} mR^2\alpha$

$\frac{F}{3} + f_s = \frac{2}{3} ma$ [since, $a = R\alpha$] …(ii)

Solving (i) and (ii), we get

$\frac{4F}{3} = \frac{5}{3} ma$

$a = \frac{4F}{5m}$

Now, from equation (i)

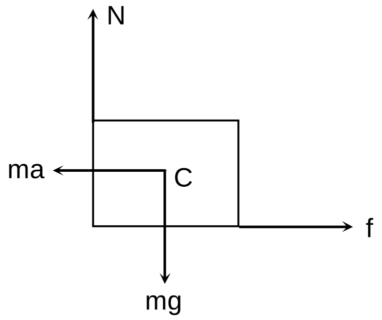
$f_S = F - ma = F - \frac{4F}{5} = \frac{F}{5}$

Hence, $f_S \le \mu N$

$F/5 \le \mu mg$

$F \le 5\,\mu mg$

$\therefore F_{max} = 5 \times 0.4 \times 20 = 40$ N



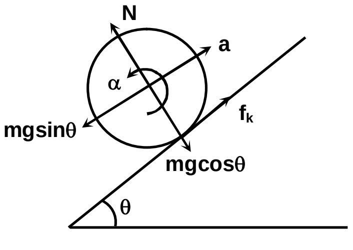
6. For toppling of the block

$ma\frac{h}{2} > mg\frac{w}{2}$

$a > \frac{w}{h} g$

$a > \frac{15}{60} \times 10$

$a > 2.5\ \text{m/s}^2$



7. $N = mg\cos\theta$

$f_k = \mu N = 2\tan\theta\, mg\cos\theta = 2mg\sin\theta$

$f_k - mg\sin\theta = ma$

$2mg\sin\theta - mg\sin\theta = ma$

$\therefore \quad a = g\sin\theta$

Now, $\tau_{cm} = I_{cm}\alpha$

$f_k R = \frac{2}{5} mR^2\alpha$

$2mg\sin\theta = \frac{2}{5} mR\alpha$

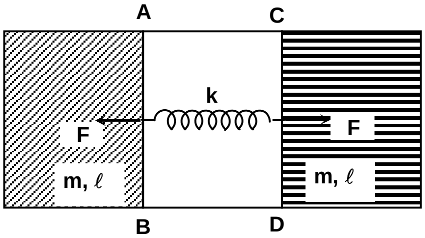
$\alpha = \frac{5g\sin\theta}{R}$

When the rolling without slipping starts

$v = \omega R$

$v_0 + at = (\omega_0 - \alpha t)R$

$$v_0 + g\sin\theta t = \omega_0 R - 5g\sin\theta t$$
$$v_0 + 6g\sin\theta t = 2v_0$$
$$\therefore \quad t = \frac{v_0}{6g\sin\theta}$$



8. Force of surface tension on each wire is $F = 2T\ell$

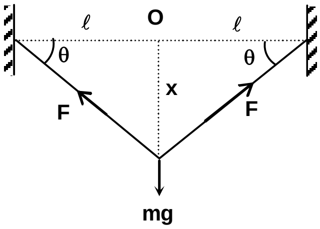
$$\frac{md^2x}{dt^2} = F - 2Kx$$
$$= -2K\left(x - \frac{F}{2k}\right)$$
$$\frac{d^2x}{dt^2} = -\frac{2k}{m}\left(x - \frac{F}{2k}\right)$$

$\therefore$ Amplitude of SHM,

$$A = \frac{F}{2k} = \frac{2T\ell}{2k} = \frac{T\ell}{k}$$

$\therefore$ Maximum elongation produced in the spring is

$$\Delta\ell_{\max} = 4A = \frac{4T\ell}{k}$$



9. $2F\sin\theta = mg$

$$F = \frac{mg}{2\sin\theta} = \frac{mg\ell}{2x} \quad [\because \theta \text{ is small}]$$
$$\Delta\ell = \left(\sqrt{\ell^2 + x^2} - \ell\right)$$
$$= \ell\left[\left(1 + \frac{x^2}{\ell^2}\right)^{1/2} - 1\right]$$
$$\Delta\ell = \ell\left[1 + \frac{1}{2}\frac{x^2}{\ell^2} - 1\right] \ [\because x << \ell]$$
$$\therefore \quad \frac{\Delta\ell}{\ell} = \frac{x^2}{2\ell^2}$$

Now $\frac{F}{A} = Y\frac{\Delta\ell}{\ell}$

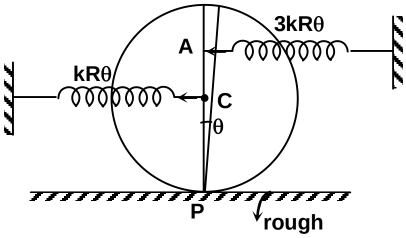
$$F = AY\frac{\Delta\ell}{\ell}$$
$$\frac{mg\ell}{2x} = AY\left(\frac{x^2}{2\ell^2}\right)$$
$$x^3 = \frac{mg\ell^3}{AY}$$
$$\therefore \quad x = \ell\left(\frac{mg}{AY}\right)^{1/3}$$

10. Using conservation of energy

$$\frac{1}{2}mv^2 = -\frac{GMm}{R} - \left(\frac{-11GMm}{8R}\right)$$

$$\frac{1}{2}mv^2 = \frac{3GMm}{8R}$$

$$\therefore\ v = \sqrt{\frac{3GM}{4R}}$$



11. $$\frac{3mR^2}{2}\frac{d^2\theta}{dt^2} = -kR^2\theta - 3kR\theta\left(\frac{3R}{2}\right)$$

$$\frac{3mR^2}{2}\frac{d^2\theta}{dt^2} = -\frac{11kR^2\theta}{2}$$

$$\frac{d^2\theta}{dt^2} = -\left(\frac{11K}{3m}\right)\theta$$

$\therefore$ Time Period, $T = 2\pi\sqrt{\frac{3m}{11k}}$

12. Given, VT = constant

PV^2 = constant

Polytropic constant, x = 2

$\therefore$ Molar heat capacity,

$$C = C_V + \frac{R}{1-x}$$

$$= \frac{3R}{2} + \frac{R}{1-2}$$

$$= \frac{R}{2}$$

$$\therefore\quad \Delta Q = nC\Delta T = 2\times\frac{R}{2}\times 300 = 300R$$

$$\Delta U = nC_v\Delta T = 2\times\frac{3R}{2}\times 300 = 900R$$

$$\therefore\quad \frac{\Delta U}{\Delta Q} = \frac{900R}{300R} = 3$$

13. Efficiency of carnot engine is, $\eta = 1 - \frac{T_2}{T_1}$

$$0.1 = 1 - \frac{T_2}{T_1}$$

$$\therefore\quad \frac{T_2}{T_1} = 0.9$$

Coefficient of performance (COP) of a refrigerator = $\frac{T_2}{T_1 - T_2} = \frac{0.9T_1}{T_1 - 0.9T_1} = 9$

$\therefore$ COP = 9

14. The frequency of vibration of air column in the pipe is $f_1 = \frac{3v}{4\ell} = \frac{3\times 340}{4\times 0.85} = 300$ Hz.

The frequency of vibration of string is $f_2 = f_1 + 6 = 300 + 6 = 306$ Hz

Now, $f_2 = \frac{3}{2\ell}\sqrt{\frac{F}{\mu}}$

$$306 = \frac{3}{2\times 0.5}\sqrt{\frac{F\times 0.5}{2.5\times 10^{-3}}}$$
$$306 = 30\sqrt{2F}$$
$$\sqrt{2F} = 10.2 \quad \therefore \quad F = 52\text{ N}$$

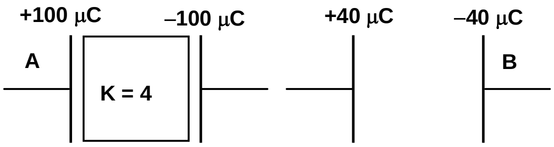
15. $f_1 = \left(\frac{v - v_D}{v - v_s}\right)f$ and the frequency of sound received by the observer after reflection from the stationary wall is $f_2 = \left(\frac{v + v_D}{v - v_s}\right)f$

$\therefore$ Beats frequency received by the observer, $f_b = f_2 - f_1 = \left(\frac{v + v_D}{v - v_s}\right)f - \left(\frac{v - v_D}{v - v_s}\right)f$

$$\therefore \quad f_b = \frac{(2v_D)f}{(v - v_s)} = \frac{2\times 2}{(330 - 10)}\times 320 = 4\text{Hz.}$$

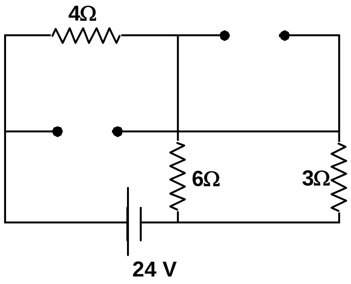
16. The electric field strength at point 'P' is
$$E = E_1 - E_2$$
$$= \frac{\rho R}{4\varepsilon_0} - \frac{\rho R}{54\varepsilon_0}$$
$$E = \frac{25\rho R}{108\varepsilon_0}$$

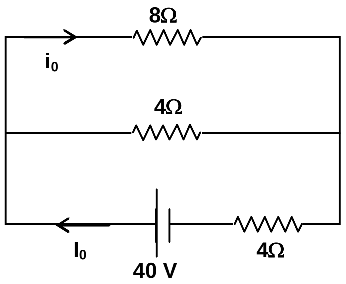
17. $Q_A = 1\times 100 = 100\mu C$
$Q_B = 2\times 20 = 40\mu C$
When the two capacitors are connected with opposite polarities.
$q_A = 40\mu C, q_B = 20\mu C$
The heat dissipated after the two capacitors connected



$$\Delta H = U_i - U_f = \left[\frac{(100)^2}{2\times 4} + \frac{(40)^2}{2\times 2}\right] - \frac{(60)^2}{2\times 6}$$
$$= (1250 + 400) - 300 = 1350\mu J = 1.35\times 10^{-3}\text{ J}$$

18. In steady state, the equivalent circuit is shown.
$$R_{eq.} = 4 + \left(\frac{6\times 3}{6+3}\right)$$
$$R_{eq} = 4 + 2 = 6\Omega$$
$$\therefore \quad I_S = \frac{\varepsilon}{R_{eq}} = \frac{24}{6} = 4A\ .$$





19. Time constant, $\tau = R_{eq}C_{eq}$

$= 10 \times 20 \times 10^{-6}$

$= 0.2 \times 10^{-3}$ sec

The current through the battery just after closing the switch is

$I_0 = \frac{40 \times 3}{20} = 6A$

The current through R = 8 Ω register at t = 0 is

$i_0 = \frac{1}{3} \times I_0 = \frac{1}{3} \times 6 = 2A$

The current through R = 8Ω resistor at time 't'

$i = i_0 e^{-t/\tau}$

$i = 2\ e^{-t/0.2\times10^{-3}}$

$\therefore$ at $t = 0.4 \times 10^{-3}$ sec.

$\ell = 2e^{-2} = 2 \times 0.135 = 0.27\,A$

20. $\tau = \frac{\sqrt{3}}{4}Bi\ell^2$

Now, $\int \tau dt = I\omega$

$\frac{\sqrt{3}}{4}B\ell^2 \int idt = \frac{5m\ell^2\omega}{4}$

$\frac{\sqrt{3}}{4}B\ell^2 Q = \frac{5m\ell^2}{4}\omega$

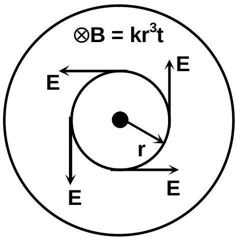
$\therefore \quad \omega = \frac{\sqrt{3}BQ}{5m}$

21. The net magnetic field intensity at the centre 'O' is

$\vec{B}_0 = \frac{\mu_0 I}{4\pi R}\left(-\hat{k}\right) + \frac{\mu_0 I}{4R}\left(-\hat{i}\right)$

$\therefore \quad B_0 = \frac{\mu_0 I}{4\pi R}\sqrt{1+\pi^2}$

22. Using Faraday's law



$E2\pi r = -\frac{d}{dt}\left[-\int_0^r B2\pi r dr\right]$

$= \frac{d}{dt}\left[\int_0^r Kr^3 t 2\pi r dr\right]$

$E2\pi r = \frac{d}{dt}\left(2\pi kt\frac{r^5}{5}\right)$

$E = \frac{Kr^4}{5}$, when $r \le R$

$\therefore$ at $r = \frac{R}{2}$, $E = \frac{KR^4}{80}$

23. When the current through the inductor is maximum,

$$V_L = L\frac{di}{dt} = 0$$

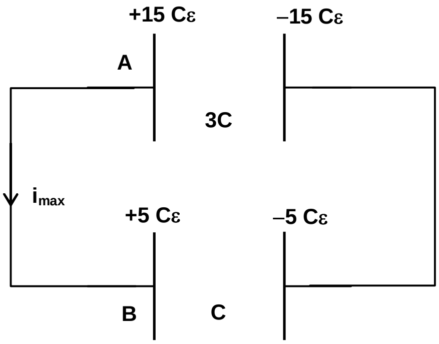
Now, using energy conservation

$$\frac{1}{2}Li_{max}^2 = \left(\frac{1}{2}\times 3C\times 16\varepsilon^2 + \frac{1}{2}C\times 64\varepsilon^2\right) - \frac{1}{2}(3C+C)25\,\varepsilon^2$$

$$\frac{1}{2}Li_{max}^2 = 56\,C\varepsilon^2 - 50C\varepsilon^2$$

$$\frac{1}{2}Li_{max}^2 = 6C\varepsilon^2$$

$$\therefore\quad i_{max} = \varepsilon\sqrt{\frac{12C}{L}}$$



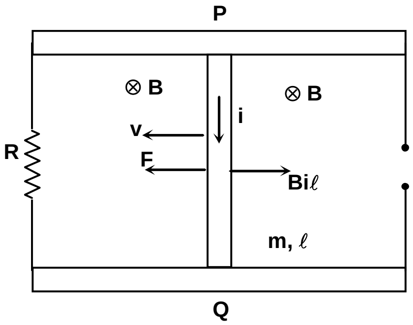
24. When the terminal velocity is acquired

$$i = \frac{Bv\ell}{R}$$

$$F = Bi\ell$$

$$F = \frac{B^2\ell^2 v}{R}$$

$$\therefore\quad v = \frac{FR}{B^2\ell^2}$$



25. $R^2 = (R-t)^2 + r^2$

$R^2 = R^2 + t^2 - 2Rt + r^2$

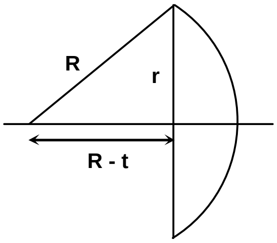
$r^2 = 2Rt$ (t^2 is neglected)

$R = \frac{r^2}{2t} = \frac{4\times 4}{2\times 0.4} = 20$ cm

R = 20 cm

$$\therefore\quad \frac{1}{f} = (1.5-1)\left(\frac{1}{\infty} - \frac{1}{-20}\right)$$

$\frac{1}{f} = \frac{0.5}{20}$ ∴ f = + 40 cm



26. For central maxima $d\sin\theta = (\mu_s - 1)t$

$1\times 10^{-3}\sin\theta = (1.5-1)4\times 10^{-5}$

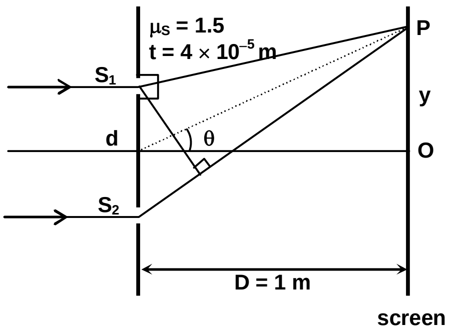
$1\times 10^{-3}\sin\theta = 2\times 10^{-5}$

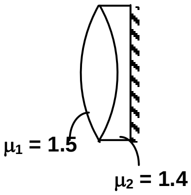
$\sin\theta = \frac{1}{50}$

$\tan\theta = \frac{1}{50}$ (for small 'θ')

$\frac{y}{D} = \frac{1}{50}$

$$\therefore\quad y = \frac{D}{50} = \frac{100}{50}\text{cm} = 2\text{ cm (above point 'O')}$$





27. $\frac{1}{f_1} = (1.5-1)\left(\frac{1}{R}+\frac{1}{R}\right) = \frac{1}{R}$

$\therefore \quad f_1 = R$

$\frac{1}{f_2} = (1.4-1)\left(\frac{1}{-R}-\frac{1}{\infty}\right)$

$\frac{1}{f_2} = -\frac{0.4}{R}$

$-\frac{1}{F} = \frac{2}{f_1}+\frac{2}{f_2}-\frac{1}{f_m}$

Since image coincides with the object,
F = – 10 cm

$\frac{-1}{-10} = \frac{2}{R}+2\left(\frac{-0.4}{R}\right)-\frac{1}{\infty}$

$\frac{1}{10} = \frac{2}{R}-\frac{0.8}{R}$

$\frac{1}{10} = \frac{1.2}{R}$

$\therefore$ R = 12 cm

28. Energy of each photon

$E = \frac{hC}{\lambda} = \frac{1240}{400} = 3.1\,\text{eV}$

Now, $K_{max} = E - \phi$
= 3.1 – 2.3

$\therefore \quad K_{max} = 0.8$ eV

Energy of He^+-ion in third excited state

$E_4 = -13.6 \times \frac{4}{(4)^2} = -3.4$ eV

Now, the energy of the photon emitted during combination,

$\Delta E = K_{max} - E_4$

$= 0.8 - (-3.4)$

= 4.2 eV

29. The intensity of the light after passing through the first Polarised = $\frac{I_0}{2}$. Now, the intensity of the light after getting passed through the second Polaroid will be

$I = \frac{I_0}{2}\cos^2\theta$

$= \frac{I_0}{2}\cos^2 45^\circ = \frac{I_0}{4}$

30. The pitch of the screw gauge, P = 1 mm

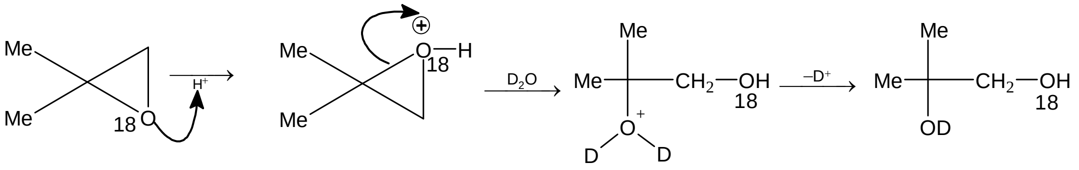
Least count, L.C. = $\frac{P}{N} = \frac{1\,\text{mm}}{100} = 0.01\,\text{mm}$

$\therefore$ Diameter of the wire, d = 2mm + 58 × L.C.
= 2mm + 58 × 0.01 mm
= 2.58 mm

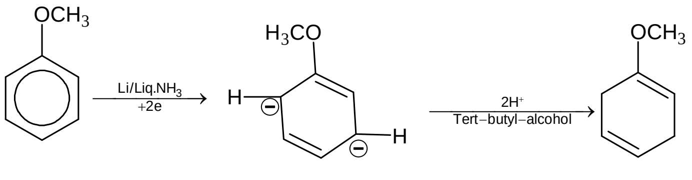
Chemistry PART – II

SECTION-A

32.


Me
Me
18
O
H⁺
Me
Me
O
H
18
D₂O
Me
Me
CH₂
OH
18
O
D
D
–D⁺
Me
Me
CH₂
OH
18
OD

33.


OCH₃
Li/Liq.NH₃
+2e
H₃CO
H
H
2H⁺
Tert–butyl–alcohol
OCH₃

1-methoxy cyclohexa-1,4-diene

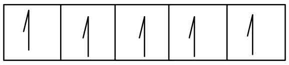
36. $10^{13}e^{-\frac{Ea_1}{RT}} = 10^{14}e^{-\frac{Ea_2}{RT}}$

T = 230 K

37. Orbital angular momentum per electron $= \sqrt{\ell(\ell+1)}\dfrac{h}{2\pi}$

$$\sqrt{2(2+1)}\frac{h}{2\pi}$$

$$\sqrt{6}\,\hbar$$



For Fe^{3+} :

$\therefore$ Total orbital angular momentum in Fe^{3+} salt (per molecule) $= 5\sqrt{6}\,\hbar$

40. $\dfrac{r_+}{r_-} = 0.414$ to 0.732 (C. N. = 6)

$\dfrac{r_+}{r_-} = 0.225$ to 0.414 (C. N. = 4)

Hence option (A) correct.

41. $4Fe^{3+} + K_4\left[Fe(CN)_6\right] \longrightarrow Fe_4\left[Fe(CN)_6\right]_3 + 4K^+$

42. According to Hardy-Schulze law coagulation power $\propto$ valency of the counter ion.

43. For triatomic gas

$\gamma = 1.33$, $C_P = 4R$

$$T_2 = T_1\left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

$= 300\left(\frac{5}{40}\right)^{\frac{1}{3}}$

$= 300\left(\frac{1}{8}\right)^{\frac{1}{3}} = 300 \times \frac{1}{2} = 150$

$\Delta H = n \times C_P (T_2 - T_1)$

= 3 × 4 × 8.314 (150 – 300)

= - 14.965 kJ

44. x is Borax

$Na_2B_4O_7.10H_2O$

$Na_2B_4O_7 + 7H_2O \longrightarrow 2NaOH + 4H_3BO_3$

$Na_2B_4O_4 \longrightarrow \underbrace{2NaBO_2 + B_2O_3}_{\text{Glassy bead}}$

$Na_2B_4O_7 + H_2SO_4 + 5H_2O \longrightarrow Na_2SO_4 + 4H_3BO_3$

45. $\frac{P_1V_1}{T_1} = \frac{2P_1 \times 2V_1}{T_2}$

$T_2 = 4T_1$

$4T_1 \times n_1 = T_2'n_2'$

$4T_1n_1 = T_2' \times \frac{5}{4}n_1 \quad \left(n_2 = n_1 + \frac{n_1}{4}\right)$

Therefore $T_2' = \frac{16}{5}T_1$

46. Gold in $AuCl_4^-$ has to be reduced at an electrode with excess electron. Hence, stirring is essential.

47. Hoffman Bromide reaction.

48. $CaF_2 \rightleftharpoons Ca^{2+} + 2F^-$

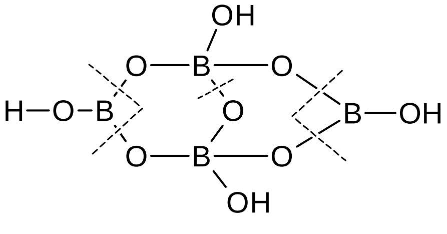
$K_{SP} = 4S^3 = 4 \times 10^{-11}$

$\Rightarrow S = 2.15 \times 10^{-4}$ M

Amount of F^- in 20,000 L Sol. = 2 × 20,000 × 2.15 × 10^{-4} = 8.6 mole

49. $\overset{\delta+}{Cl}\overset{\delta-}{F}$

54.



$+ 5H_2O \longrightarrow 2B(OH)_3 + 2B(OH)_4^- \xrightarrow{2H^+} 2B(OH)_3 + 3H_2O$

57. Moles of oxalic acid $= \frac{50 \times 1}{1000} = \frac{1}{20}$

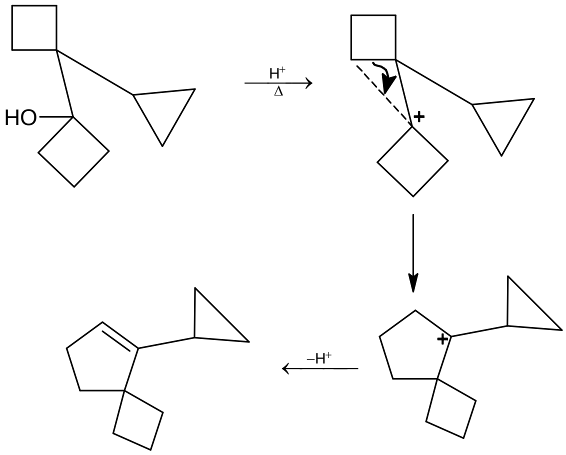
Weight of oxalic acid $= \frac{1}{20} \times 126 = 6.3$ gm

Conc. of solution after adsorption = 0.4 M

Moles of oxalic acid after adsorption $= \frac{50 \times 0.4}{1000} = \frac{1}{50}$

Wt. of oxalic acid left after adsorption $= \frac{1}{50} \times 126 = 2.52$ gm

60.



Mathematics PART – III

SECTION-A

61. Let log x = t

$$\frac{dt}{dx}=\frac{1}{x} \Rightarrow dx = x\,dt;\ dx = e^t\,dt$$

$$\int \frac{\left(t^2\tan^{-1}t+1+\tan^{-1}t\right)}{1+t^2}e^t dt$$

$$\int \frac{\tan^{-1}t\left(1+t^2\right)+1}{\left(1+t^2\right)}e^t dt = \int e^t\left(\tan^{-1}t+\frac{1}{1+t^2}\right)dt = e^t\tan^{-1}t + c = x\tan^{-1}(\log x) + c$$

62. $$\int \frac{11x-18}{x^{13}\sqrt[6]{1-\frac{2}{x^{11}}+\frac{3}{x^{12}}}}dx = \int \frac{\frac{11}{x^{12}}-\frac{18}{x^{13}}}{\sqrt[6]{1-\frac{2}{x^{11}}+\frac{3}{x^{12}}}}dx$$

Let $1-\frac{2}{x^{11}}+\frac{3}{x^{12}}=t$

$$\Rightarrow \frac{dt}{dx}=\frac{22}{x^{12}}-\frac{36}{x^{13}}$$

$$\Rightarrow \frac{1}{2}\int \frac{1}{t^{\frac{1}{6}}}dt$$

$$\Rightarrow \frac{1}{2}\times 6\frac{t^{\frac{5}{6}}}{5}+c$$

$$\Rightarrow \frac{3}{5}\left(1-\frac{2}{x^{11}}+\frac{3}{x^{12}}\right)^{\frac{5}{6}}+c = \frac{3}{5}\frac{\left(x^{12}-2x+3\right)^{\frac{5}{6}}}{x^{10}}+c$$

63. $$g(x)=\int \frac{e^{\cos x}}{x}$$

$$I=\int_1^2 \frac{3e^{\cos x^3}}{x}dx$$

Let $x^3 = t \Rightarrow \frac{dt}{dx}=3x^2$

$$\Rightarrow \int \frac{3e^{\cos t}}{3x^3}dt \Rightarrow \int_1^8 \frac{e^{\cos t}}{t}dt = g(8) - g(1) = 10a_3 - 3a_1$$

64. $PQ = \text{diameter} = \dfrac{|10-(-6)|}{\sqrt{2}} = 8\sqrt{2}$

$\Rightarrow$ Radius of circle is $4\sqrt{2}$

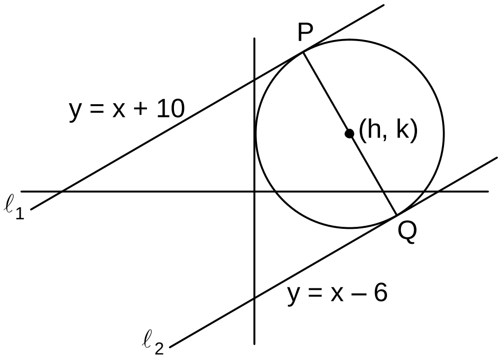
Centre lies on the line parallel to ℓ_1 and ℓ_2, i.e. it lies on the line y = x + b and at a distance of $4\sqrt{2}$ from ℓ_1 and ℓ_2 $\therefore$ b = 2

i.e. centre lies on y + x = 2

$\therefore$ Let centre be (α, α + 2) as it touches the y-axis, α = radius $\therefore$ $\alpha = 4\sqrt{2}$

$\therefore$ Centre is $\left(4\sqrt{2}, 4\sqrt{2}+2\right)$

h + k = $2+8\sqrt{2}$ $\therefore$ a + b = 10



65. Let the first three terms of an A.P. be a, a + d, a + 2d then $(a + d + 1)^2 = (a + 1)(a + 2d + 7)$

$\Rightarrow d^2 = 6a+6 \Rightarrow \dfrac{d^2}{6} = a+1$

Common ratio is $\dfrac{a+d+1}{a+1} = \dfrac{(a+1)+d}{a+1} = \dfrac{\frac{d^2}{6}+d}{\frac{d^2}{6}} = \dfrac{d+6}{d}$ for common ratio to be an integer d is equal to 1, 2, 3, 6

66. As line is perpendicular to normal of the plane

$\Rightarrow$ 3a + 2b + 12 = 0 and as (2, –1, 3) lies in the plane

$\Rightarrow$ 2a – b + 9 = 8

$\Rightarrow$ 2a – b + 1 = 0

On solving we get a = –2, b = –3

67. $2x^2 y\, dx - x^3\, dy = y^2\, dx$

$\Rightarrow \dfrac{2xy\, dx - x^2 dy}{y^2} = \dfrac{dx}{x}$

$\Rightarrow \int d\left(\dfrac{x^2}{y}\right) = \int \dfrac{dx}{x}$

$\Rightarrow y = \dfrac{x^2}{\log x + c}$

It passes through (1, 1)

$\Rightarrow$ c = 1

$\therefore y = \dfrac{x^2}{\log x + 1}$

$\therefore$ at x = 2; $y = \dfrac{4}{\log 2 + 1} = \dfrac{4}{\log(2e)}$

68. $\dfrac{1}{\sqrt{\alpha}} + \dfrac{1}{\sqrt{\beta}} = -\dfrac{q}{p}$

$\dfrac{1}{\sqrt{\alpha\beta}} = \dfrac{1}{p} \Rightarrow \sqrt{\alpha\beta} = p$

$\sqrt{\alpha}+\sqrt{\beta}=-q$

$x^2 - x(3pq - q^3) + p^3 = 0$

Let the roots be α_1, β_1

$\alpha_1\beta_1 = p^3 = (\alpha\beta)^{3/2}$

$\alpha_1 + \beta_1 = 3pq - q^3 = -3\sqrt{\alpha\beta}\left(\sqrt{\alpha}+\sqrt{\beta}\right)+\left(\sqrt{\alpha}+\sqrt{\beta}\right)^3 = \alpha^{\frac{3}{2}}+\beta^{\frac{3}{2}}$

$\Rightarrow\ \alpha_1=\alpha^{\frac{3}{2}}$ and $\beta_1=\beta^{\frac{3}{2}}$

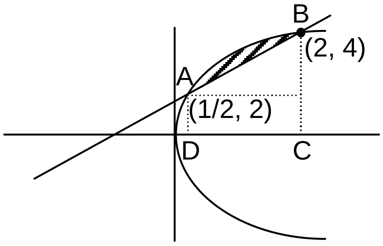
69. $\lim\limits_{x\to 0} f\left(\dfrac{1-\cos 5x}{x^2}\right)=f\left(\lim\limits_{x\to 0}\dfrac{1-\cos 5x}{x^2}\right)=f\left(\lim\limits_{x\to 0}\dfrac{5\sin 5x}{2x}\right) = f\left(\dfrac{25}{2}\right)=4$

70. $y^2 \le 8x$

$4x - 3y + 4 \le 0$

Area of shaded portion is equal to

$\int\limits_{\frac{1}{2}}^{2}\sqrt{8x}$ – Area of trapezium ABCD



$2\sqrt{2}\int\limits_{\frac{1}{2}}^{2}\sqrt{x}-\dfrac{9}{2}=2\sqrt{2}\left.\dfrac{x^{\frac{3}{2}}}{\frac{3}{2}}\right|_{\frac{1}{2}}^{2}-\dfrac{9}{2}$

$=\dfrac{4\sqrt{2}}{3}\left(2\sqrt{2}-\dfrac{1}{2\sqrt{2}}\right)-\dfrac{9}{2}$

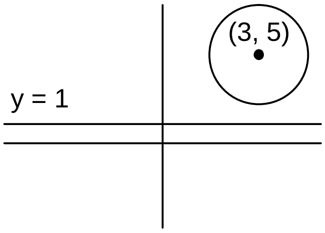
$=\dfrac{4\sqrt{2}}{3}\left(\dfrac{8-1}{2\sqrt{2}}\right)-\dfrac{9}{2}$

$=\dfrac{14}{3}-\dfrac{9}{2}=\dfrac{28-27}{6}=\dfrac{1}{6}$

71. $4 + 9 - 12 - 30 + k < 0$

$k < 29$

For the circle to not touch the line $y = 1$ the radius must be less than 4



$\therefore\ \sqrt{9+25-k}<4$

$34 - k < 16$

$k > 18$

72. $2\tan x = \alpha(1 + \tan^2 x)$

$\Rightarrow\ \dfrac{2\tan x}{1+\tan^2 x}=\alpha\ \Rightarrow \sin 2x = \alpha$

$\because$ $\angle B$ and $\angle C$ satisfy this equation

$\Rightarrow \sin 2B = \sin 2C$

But angle B > angle C

$\Rightarrow 2C = \pi - 2B$

$\Rightarrow\ B+C=\dfrac{\pi}{2}$

$\therefore\ \angle A=\dfrac{\pi}{2}$

73. $A^T = 5A + 2I$

Taking transpose both sides $A = 5A^T + 2I$

$\Rightarrow A = 5(5A + 2I) + 2I$

$\Rightarrow 24A + 12I = 0$

$\Rightarrow 2A + I = 0$

$\Rightarrow 2AX + X = 0$

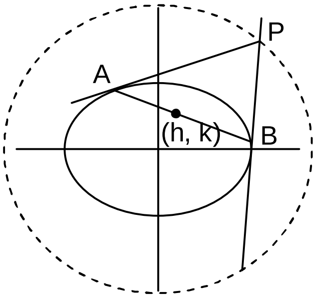
$\Rightarrow 2AX = -X$

$\Rightarrow AX = -\frac{1}{2}X$

74. Converse of $\sim q \to p$ is $p \to \sim q$

Its contrapositive statement is $q \to \sim p$

75. Let the mid-point of chord AB is (h, k)



Then equation of AB is T = S,

$\Rightarrow 49hx + 16ky - 784 = 49h^2 + 16k^2 - 784$

$\Rightarrow 49hx + 16ky = 49h^2 + 16k^2$

Any point on the circle $x^2 + y^2 = 100$ is

$P(10\cos\theta, 10\sin\theta)$

Equation of chord of contact AB is

$49x\cdot 10\cos\theta + 16y\cdot 10\sin\theta = 784$

$\because$ Both equation represent equation of same straight line AB

$$\therefore \frac{49h}{490\cos\theta} = \frac{16k}{160\sin\theta} = \frac{49h^2 + 16k^2}{784}$$

$$\cos\theta = \frac{784h}{10\left(49h^2 + 16k^2\right)},\ \sin\theta = \frac{784k}{10\left(49h^2 + 16k^2\right)}$$

$$\therefore \text{Locus } (49h^2 + 16k^2)^2 = \frac{784^2}{100}\left(h^2 + k^2\right)$$

76. $a_i \times b_i$ is a multiple of 3 if atleast one of a_i or b_i is a multiple of 3

If $a_i = 3$ then $b_i = 1, 2, 3, 4, 5, 6, 7$

If $b_i = 3$ or 6 then $a_i = 1, 2, 3, 4$

$\therefore$ Total possibilities = 7 + 4 + 4 – 2 = 13

$$\therefore \text{Probability} = \frac{13}{4C_1 \times 7C_1} = \frac{13}{28}$$

77. $S = {}^{30}C_0 \sin 0x \cos 30x + {}^{30}C_1 \sin x \cos 29x + {}^{30}C_2 \sin 2x \cos 28x + \ldots\ldots + 30C_{28} \sin 28x \cos 2x + {}^{30}C_{29} \sin 29x \cos x + {}^{30}C_{30} \sin 30x$

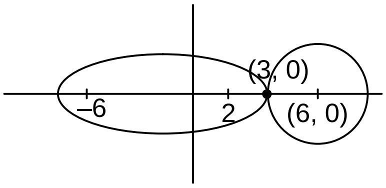
$S = {}^{30}C_{30} \sin 30x + {}^{30}C_{29} \sin 29x \cos x + {}^{30}C_{28} \sin 28x \cos 2x + \ldots\ldots + {}^{30}C_1 \sin x \cos 29x + {}^{30}C_0 \sin 0x \cos 30x$

$$2S = \sum_{r=0}^{30} {}^{30}C_r \left(\sin rx \cos(30 - r)x + \sin(30 - r)x \cos x\right)$$

$$2S = \sum_{r=0}^{30} {}^{30}C_r \sin\left(rx + (30 - r)x\right) = \sum_{r=0}^{30} {}^{30}C_r \sin 30x$$

$2S = 2^{30} \sin 30x$

$S = 2^{29} \sin 30x$



78. So just one point is common

$\Rightarrow |z + 6| + |z - 2| = 10$

$\Rightarrow \dfrac{(x+2)^2}{25} + \dfrac{y^2}{9} = 1$ ..... (1)

$|z - 6| = 3, \Rightarrow (x - 6)^2 + y^2 = 9$ ..... (2)

79. Slope of tangent to $\dfrac{dy}{dx} = 2x$

$\therefore$ Slope = 6

Equation of tangent $y - 13 = 6(x - 3)$

$\Rightarrow 6x - y - 5 = 0$

$\because$ It passes through (a, b)

$\Rightarrow 6a - b - 5 = 0$ ..... (1)

Slope of tangent to the circle at (a, b)

$2x + 2y\dfrac{dy}{dx} - 4 + 2\dfrac{dy}{dx} = 0 \Rightarrow \dfrac{dy}{dx} = \dfrac{2-x}{y+1}$

At (a, b), $\dfrac{dy}{dx} = \dfrac{2-a}{b+1} = 6 \Rightarrow 2 - a = 6b + 6$

$\Rightarrow 6b + a + 4 = 0$ ..... (2)

Solving equation (1) and (2) simultaneously $a = \dfrac{26}{37}$ and $b = -\dfrac{29}{37}$

$\therefore a + b = -\dfrac{3}{37}$

80. $f(n) = \lim\limits_{n\to\infty} \sum\limits_{r=n^2}^{(n+3)^2} \dfrac{1}{\sqrt{r}}$

$\Rightarrow f(n) = \dfrac{1}{\sqrt{n^2}} + \dfrac{1}{\sqrt{n^2+1}} + \dfrac{1}{\sqrt{n^2+2}} + ... + \dfrac{1}{\sqrt{n^2+6n+9}}$

Total number of terms are 6n + 10

$\dfrac{6n+10}{\sqrt{n^2+6n+9}} \le f(n) \le \dfrac{6n+10}{\sqrt{n^2}}$

$\lim\limits_{n\to\infty} \dfrac{6n+10}{n} = 6$ and $\lim\limits_{n\to\infty} \dfrac{6n+10}{\sqrt{n^2+6n+9}} = \lim\limits_{n\to\infty} \dfrac{6+\dfrac{10}{n}}{\sqrt{1+\dfrac{6}{n}+\dfrac{9}{n^2}}} = 6$

$\therefore \lim\limits_{n\to\infty} f(n) = 6$

81. f(x) = f(10 – x)

$\Rightarrow$ f(x) is symmetrical about x = 5

$f'(x) = -f'(10 - x)$

Put $x = 5 \Rightarrow f'(5) = 0$

Put $x = -5 \Rightarrow f'(-5) = -f'(15) \Rightarrow f'(15) = -2$

82. Let $f'(x) = k$ where $k \ge 5.4$

f(x) = kx + c

Put x = 2

We get –5 = 2k + c

c = –2k – 5

$f(7) = 7k + c = 5k - 5$
$\because\ k \geq 5.4$
$5k \geq 27$
$5k - 5 \geq 22$

83. $$\sum_{k=1}^{13}\left(1+\tan\left(\frac{k\pi}{12}\right)\tan\left(\frac{k-1}{12}\right)\pi\right)-1=\sum_{k=1}^{13}\frac{\tan\left(\frac{k\pi}{12}-\frac{(k-1)\pi}{12}\right)\left(1+\tan\frac{k\pi}{12}\tan\frac{(k-1)\pi}{12}\right)}{\tan\frac{\pi}{12}}-13$$

$$= \sum_{k=1}^{13}\frac{\tan\frac{k\pi}{12}-\tan\frac{(k-1)\pi}{12}}{\tan\frac{\pi}{12}}-13$$

$$= \sum_{k=1}^{13}\frac{T_k - T_{k-1}}{\tan\frac{\pi}{12}}-13 = \frac{T_{13}-T_0}{\tan\frac{\pi}{12}}-13 = \frac{\tan\frac{13\pi}{12}}{\tan\frac{\pi}{12}}-13$$

$= 1 - 13 = -12$

84. $f(x) = ae^{x\sin x} + b\cos x$
It is differentiable everywhere

85. $\left|\vec{b}\cdot\left(\vec{a}\times\vec{c}\right)\right| = 35$

$\left|\vec{b}\right|\left|\vec{a}\times\vec{c}\right|\cos\alpha = 35$

$7 \times 5 \times \cos\alpha = 35$
$\cos\alpha = 1 \Rightarrow \alpha = 0^{o}$
$\therefore\ \vec{b}$ is parallel to $\vec{a}\times\vec{c}$
$\Rightarrow\ \vec{b}$ is perpendicular to $\vec{a}$ and $\vec{b}$ is perpendicular to $\vec{c}$
$\Rightarrow\ \vec{a}\cdot\vec{b} = 0$
If a lies in xy plane then $\vec{a} = a_i\hat{i} + a_2\hat{j}$ and $\vec{a}\cdot\vec{b} = 0$
$\Rightarrow 2a_1 + 3a_2 = 0$
$\Rightarrow\ a_1 = -\frac{3}{2}a_2$

86. $D = (2 - a)(3 - b)$
$Dx = (4b - 15)(a - 2)$
$Dy = 0,\ Dz = a - 2$
If $a \neq 2$ and $b = 3$ then $D = 0,\ Dx \neq 0,\ Dz \neq 0$
$\therefore$ Given system of equation has no solution
$\therefore$ Option (C) is incorrect

87. Median = $\frac{7k+9k}{2} = 8k$
Mean deviation about median = 11
$\frac{\sum\left|x_i - 8k\right|}{6} = 11$
$7k + 5k + k + k + 3k + 5k = 66$
$\Rightarrow 22k = 66$
$\Rightarrow k = 3$

88. $e_1 = \sqrt{2}$, $e_2 = \sqrt{2}$ (both are rectangular hyperbolas

$e_5 = 1$ (parabola)

$\frac{1}{e_3^2} + \frac{1}{e_4^2} = 1$ (because both hyperbola are conjugate of each other)

$\therefore \tan\theta = \sqrt{3}$

$\therefore \theta = \frac{\pi}{3}$

89. For the number to be divisible by 3
a + b + c + 5 + 7 + 2 + 4 + 9 must be divisible by 3
$\Rightarrow$ a + b + c + 27 must divisible by 3
$\Rightarrow$ a + b + c must be divisible by 3
$\because$ Distinct digits should be there
Only possibilities for a, b, c are 0, 1, 3, 6, 8
If the possibilities of a, b, c are {0, 1, 8}, {0, 3, 6}, {1, 3, 8}
$\therefore$ Ordered pairs possible = 6 + 6 + 6 = 18

90. Differentiating both sides w.r.t. x
f(sin x) cos x = 2x
Put $x = \frac{\pi}{6}$ we get $f\left(\frac{1}{2}\right) = \frac{2\pi}{3\sqrt{3}}$

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

FULL TEST – VIII

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 183**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into Two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01– 07, 19 – 25, 37 - 43)*** *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (08 – 13, 26 – 31, 44 - 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S).*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (14 – 18, 32 – 36, 50 - 54)*** *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

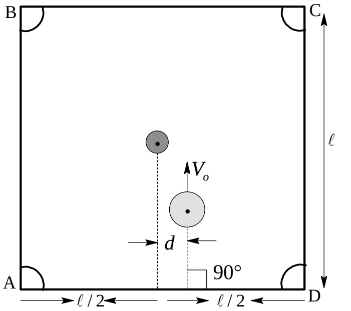
(One or More than one correct type)

This section contains **SEVEN** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

---

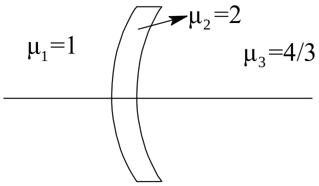
1. Which of the following statements is/are correct for mechanical standing wave on a stretched wire?
(A) Elastic potential energy of a small element at antinode is constant and minimum.
(B) Elastic potential energy of a small element at node is constant and maximum.
(C) Total energy of an element is constant.
(D) Total kinetic energy between two consecutive nodes become maximum twice in one time period.

2. The queen is put at the center of a perfectly smooth carom board (square with side ℓ). The striker strikes the queen with a speed V_o as shown in the figure. Radius of the queen is $\sqrt{10}cm$ and that of the striker is $2\sqrt{10}cm$. Coefficient of restitution for the collision between the queen and the striker is $1/2$ and that for the collision between the queen and the walls of the board is 1.
(Assume $\ell >>>$ radius of queen)



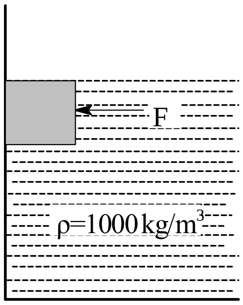
(A) The value of $'d'$ for which the queen gets in the hole A is 3 cm.
(B) The value of $'d'$ for which the queen gets in the hole A is 2 cm.
(C) The value of $'d'$ depends on the coefficient of restitution between the queen and the striker.
(D) The value of $'d'$ is independent of the coefficient of restitution between the queen and the striker.

3. A thin lens of same radius of curvature 20cm is having two different medium on its two sides extending upto infinity as shown in the figure. Then
(A) It may behave as a converging lens of focal length 60cm.
(B) It may behave as a diverging lens of focal length 60cm.
(C) It may behave as a converging lens of focal length 80cm.
(D) It may behave as a diverging lens of focal length 80cm.



Space for Rough work

4. A cubical block of mass 5kg and side 10cm is pressed against a rough wall $(\mu = 0.9)$ with a force F passing through the centre of cube inside a swimming pool as shown in the figure. Then:
(A) The cube will remain in equilibrium if the force $F \geq 355/9$ Newton.
(B) The cube will remain in equilibrium if the force is $F < 355/9$ Newton.
(C) The friction force acting on the cube is 40N if $F = 110/3\,\text{N}$.
(D) The friction force acting on the cube is 40N if $F = 50\text{N}$.

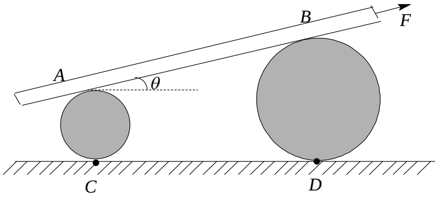


5. A typical fission reaction is

$${}_{92}U^{235} + {}_{0}n^{1} \rightarrow \left[{}_{92}U^{236}\right] \rightarrow {}_{z_1}X^{A_1} + {}_{z_2}Y^{A_2} + \in {}_{0}n^{1}$$

Which of the following statement(s) is/are correct for above reaction?
(A) $z_1 + z_2 = 92; A_1 + A_2 + \in = 236$
(B) The ratio of masses of $X \,\&\, Y$ is found experimentally to be roughly $3/2$
(C) The number of neutrons $(\in)$ released in the fission of a particular element will depend upon the final fragments that are produced.
(D) The two decay fragments usually have a neutron proton ratio approximately equal to that of the original nucleus.

6. A thin plank of mass m is kept on two rollers such that the centre of mass of the plank is midway between the points of contact with the rollers. Friction is sufficient everywhere to prevent slipping. A force 'F' whose magnitude can be varied is applied parallel to the plank as shown in figure.



(A) System cannot remain in equilibrium if F is greater than mg $\sin\theta$
(B) Friction on the plank on both contact points is always directed towards F, if the system is in equilibrium.
(C) Direction of friction on roller at points C and D is towards right if the system is in equilibrium.
(D) If the rollers are clamped to the surfaces below it so that they cannot move, the system cannot remain in equilibrium for $F \geq mg\sin\theta$

Space for Rough work

7. A hydrogen like atom is observed to emit six wavelengths originating from all possible transitions between a group of levels. These levels have energies between -0.85eV and $-0.544\,\text{eV}$ (including both these levels). Then

(A) The atomic number of the atom is 2
(B) The atomic number of the atom is 3
(C) The smallest wavelength emitted in these transitions is 4052nm.
(D) The difference of principal quantum number of the two levels is 3

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

The column – 1 below represent some wave phenomenon, column – 2 shows the information about frequency related to phenomenon and column – 3 gives the quantities on which phenomenon depends.

	Column 1		Column 2		Column 3
(I)	Interference	(i)	Different frequencies	(P)	Time
(II)	Beats	(ii)	Apparent frequency changes	(Q)	Relative motion
(III)	Doppler effects	(iii)	Constant frequency	(R)	Length of air column
(IV)	Resonance	(iv)	Same frequencies	(S)	position

8. Which combination is used for calculating speed of sound?

(A) $(\text{I})\ (\text{iv})\ (\text{P})$
(B) $(\text{IV})\ (\text{iv})\ (\text{R})$
(C) $(\text{IV})\ (\text{iv})\ (\text{Q})$
(D) $(\text{II})\ (\text{i})\ (\text{P})$

9. For which combination, phenomenon is not detected if the difference in frequencies is very large:

(A) $(\text{II})\ (\text{iv})\ (\text{Q})$
(B) $(\text{II})\ (\text{i})\ (\text{S})$
(C) $(\text{II})\ (\text{iii})\ (\text{P})$
(D) $(\text{II})\ (\text{i})\ (\text{P})$

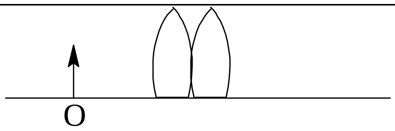
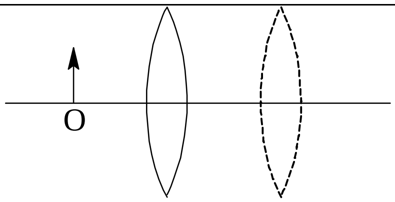
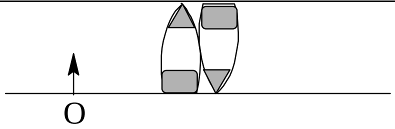
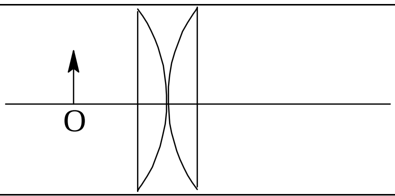
10. For which combination, phenomenon is not observed if the observer remains stationary:

(A) $(\text{III})\ (\text{ii})\ (\text{R})$
(B) $(\text{III})\ (\text{iv})\ (\text{P})$
(C) $(\text{I})\ (\text{iv})\ (\text{S})$
(D) $(\text{I})\ (\text{ii})\ (\text{Q})$

Space for Rough work

Answer questions 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

A thin biconvex lens of small a aperture and of focal length f forms image of an object having certain intensity. If this lens is cut into two equal parts in two ways and are used to form image of the same object placed at same distance. In the table below column – 1 represents certain ways in which lens or combination of lenses is placed, column – 2 represent the focal length of the lens or combination of lenses and column – 3 represent the intensity of image in comparison to formed by complete lens:

	Column 1		**Column 2**		**Column 3**
(I)		(i)	f	(P)	Decreases
(II)	 Same lens is shifted rightward to get two images at same position.	(ii)	$f/2$	(Q)	Increases
(III)		(iii)	$2f$	(R)	Remain same
(IV)		(iv)	Infinity	(S)	Indeterminate

11. Which combination is correct?

(A) (I) (iii) (Q)
(B) (II) (ii) (Q)
(C) (I) (ii) (P)
(D) (III) (iv) (R)

Space for Rough work

12. Which combination is used for calculating focal length of a convex lens?

(A) (IV) (ii) (Q) (B) (II) (i) (P)

(C) (II) (i) (R) (D) (III) (iii) (R)

13. Which combination is correct?

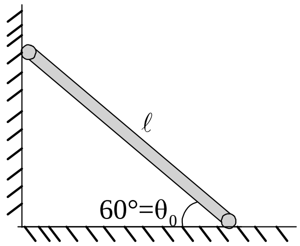
(A) (III) (iv) (S) (B) (III) (ii) (R)

(C) (IV) (iv) (P) (D) (IV) (i) (Q)

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

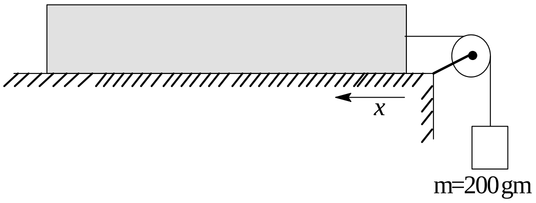
14. A ladder of mass m and length ℓ stands against a frictionless wall with its feet on a frictionless floor. If it is let go at an initial angle $\theta_0 = 60°$ then the angle 'θ' at which the ladder loses contact with the wall is given as $\sin^{-1}\left(1/\sqrt{N}\right)$, find 'N'



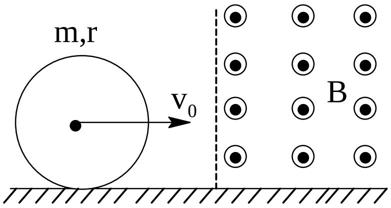
15. An electric charge distribution produces an electric field $\vec{E} = C\left(1 - e^{-\alpha r}\right)\frac{\hat{r}}{r^2}$ where $C = \frac{1}{4\pi\varepsilon_0}$ & α are constant. If the net charge within the radius $r = \frac{1}{\alpha}$ is $\left(1 - e^{-N}\right)$, then find the value of 'N' ?

Space for Rough work

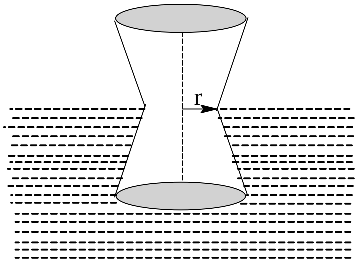
16. Uniform rope of mass = 5kg and length 1 meter is lying on a rough horizontal surface. Coefficient of static friction varies from right end of the rope as $\mu = \mu_0 x$ where $\mu_0 = 0.5$ per meter. A block of mass 200 gm is hanging from an ideal string which passes over an ideal pulley as shown in the figure. The minimum value of x (in cm) for which tension at some cross-section of rope becomes zero is $10 \times N$. Find N.



17. A ring of mass m and radius r is made of an insulating material carries uniformly distributed charge. Initially it rests on a frictionless horizontal tabletop with its plane vertical. The charge on the ring, such that it starts rolling on entering completely into the region of the magnetic field, is $\frac{\sqrt{N}mv_0}{rB}$,then find the value of 'N'



18. A solid object of mass $\frac{22}{7}$kg is in the shape of pellet drum is half submerged in water of density 1000 kg/m^3 with dimensions as shown in the figure. Find the time period (in seconds) of small vertical oscillations of the drum. [Take $r=\frac{22}{7}$cm]



Space for Rough work

Chemistry

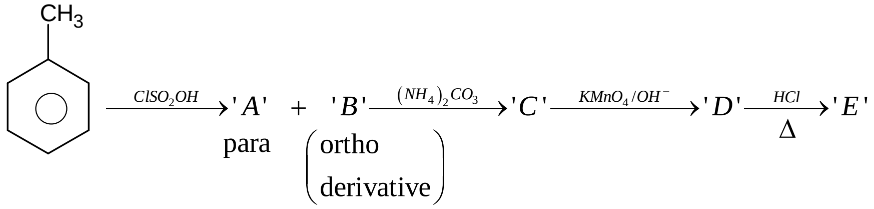
PART – II

SECTION – A

(One or More than one correct type)

This section contains **SEVEN** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

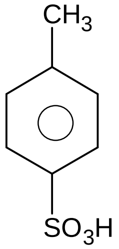
19.


CH3
ClSO2OH
'A'
+
'B'
(NH4)2CO3
'C'
KMnO4/OH−
'D'
HCl
Δ
'E'
para
ortho
derivative

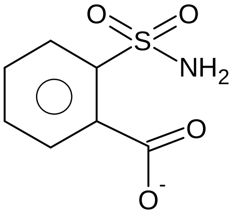
(A) 'E' is a non-fattening sweetener

(B) 'E' is saccharin

(C) 'A' is

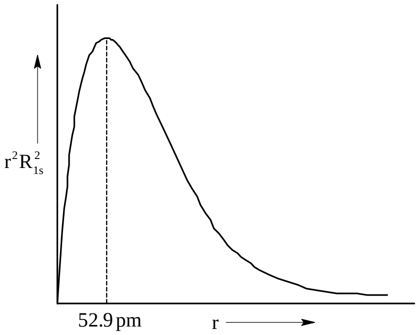


(D) 'D' is



Space for Rough work

20. Which of the following option is/are correct?
(A) Atomic orbitals are completely described as the regions where the probability of finding the electron is maximum.
(B)

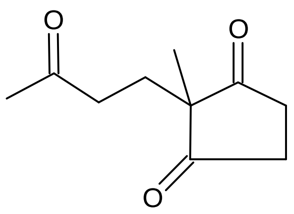


The weighted average of large number of observations for measuring the radius of 1s orbital is greater than $52.9\,pm$ (r^2R^2 dr represents the total probability of finding the electron between r and r+dr).
(C) The energy of 4s is always lower than 3d for multi electronic atom/ ion.
(D) Energy needed to excite an electron from $n=2$ to $n=4$ state is $\frac{25}{28}$ times the energy needed to excite an electron from n=2 to n=5 for a single electron atom / ion.

21. The correct statement(s) about the surface properties is (are):
(A) Soap lather is colloidal solution in which gas is dispersed in liquid.
(B) The surface coverage increases on increasing the pressure for chemisorption and the surface coverage is higher for undissociative process than the dissociative process (e.g. H_2 to 2H) under identical conditions.
(C) On increasing the concentration of cationic surfactant, surface tension decreases before CMC
(D) CMC for non-ionic surfactant is higher than anionic surfactant.

22. $NiO(Green)$ is doped with colorless Li_2O, to give black solid $Li_xNi_{1-x}O$ which acts as semiconductor:
(A) $Li_xNi_{1-x}O$ exhibit both cationic and anionic vacancies
(B) $Li_xNi_{1-x}O$ exhibit Schottky defect
(C) Doping of NiO with Li_2O induces mixed valency of Ni
(D) NiO becomes p-type semiconductor

Space for Rough work

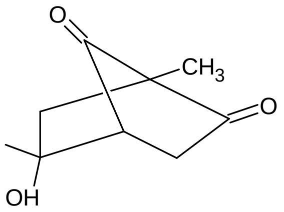
23. 

$$\xrightarrow[\Delta]{H^{\oplus}} 'A' \xrightarrow[80^\circ C]{NaCN, HCN} 'B' \xrightarrow[Cold]{HCl} 'C' \xrightarrow[Br_2]{NaOH} 'D'$$

(A) Compound ‘D’ gives positive iodoform test

(B) Compound ‘D’ gives positive carbylamines test

(C) Compound ‘C’ gives positive 2, 4-DNP test

(D) Compound 'A' is 

24. The correct option(s) is /are:

(A) F-F < Cl-Cl < Br-Br < I-I (Bond length)

(B) Bond angle of $F_{eq.}$ - S - $F_{eq.}$ bond is less in CH_2SF_4 than SOF_4

(C) $H_2S < O_3 < SO_2 < NO_2$ (Bond angle)

(D) $AsH_3 < SbH_3 < NH_3 < H_2O$ (boiling point)

25. $$Cl_2(g) \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} 2Cl(g)$$

$$Cl(g) + CHCl_3(g) \xrightarrow{k_2} HCl(g) + CCl_3(g)$$

$$CCl_3(g) + Cl(g) \xrightarrow{k_3} CCl_4(g)$$

$$k_1 = 4.8\times10^3 \qquad k_{-1} = 1.2\times10^3 \qquad k_2 = 1.3\times10^{-2} \qquad k_3 = 2.1\times10^2$$

(A) Order of reaction is 3/2

(B) Magnitude of overall rate constant is 2.6×10^{-2}

(C) If conc. of $CHCl_3$ is increased four times rate of reaction increase by a factor of two

(D) If conc. of Cl_2 is increased four time rate of reaction increase by a factor of two

Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 26, 27 and 28 by appropriately matching the information given in the three columns of the following table.

Consider all the gases as ideal and irreversible process is carried out at constant P_{Final}.

	Column 1		Column 2		Column 3
(I)	$A(g) \rightarrow A(g)$ (10atm, 1mol, (1atm, 1mol 300K,V, ideal gas) 10V)	(i)	q=0	(P)	$\Delta U=0$
(II)	$B(s) \xrightarrow{\text{At } 0^0\text{C, 1atm.}} B(liq)$ (melting)	(ii)	W=0	(Q)	$\Delta H=0$
(III)	$A(g) \rightarrow A(g)$ (10atm, 1mol, (1atm, 1mol) 300K, C_v=1.5R)	(iii)	$\Delta S_{\text{system}}>0$	(R)	$\text{Vol.}_{\text{Final}}<\text{Vol.}_{\text{Inital}}$
(IV)	Mixing of ideal gases at constant T and P in an isolated container	(iv)	$\Delta G=0$	(S)	$T_{\text{Final for irr. process}} > T_{\text{Final for rev. process}}$

26. Which of the following combination represents isothermal reversible process?

(A) (II) (ii) (Q)
(B) (I) (iii) (S)
(C) (I) (iii) (Q)
(D) (IV) (iv) (P)

27. Which of the following is correct combination when "B" as H_2O and others are gases as specified?

(A) (II) (ii) (Q)
(B) (II) (iv) (R)
(C) (IV) (iii) (S)
(D) (II) (iii) (S)

Space for Rough work

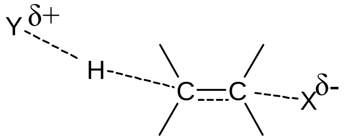
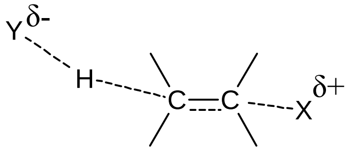
28. Which of the following combination represents the adiabatic process?

(A) (III) (i) (P) (B) (III) (i) (Q)

(C) (III) (i) (S) (D) (IV) (iii) (S)

Answer questions 29, 30 and 31 by appropriately matching the information given in the three columns of the following table.

Consider X as leaving group and Y as a nucleophile or base:

	Column 1 **(Activated complex of initial substrate)**		**Column 2** **(Mechanism)**		**Column 3** **(Effect)**
(I)	$\overset{\delta+}{Y}$-----R------$X^{\delta+}$	(i)	SN^2	(P)	Large decrease
(II)	$\overset{\delta-}{Y}$-----R------$X^{\delta+}$	(ii)	E_2	(Q)	Large increase
(III)		(iii)	SN^1	(R)	Small decrease
(IV)		(iv)	E_1	(S)	Small increase

29. A neutral nucleophile attacks on a substrate containing neutral leaving group. Which of the following represent the correct combination of effect of increased solvent polarity on reaction rate?

(A) (I) (i) (R) (B) (II) (i) (P)

(C) (I) (iii) (Q) (D) (II) (iii) (S)

30. A negatively charged nucleophile attacks on a substrate containing neutral leaving group. Which of the following represent the correct combination of effect of decreased solvent polarity on reaction rate?

(A) (I) (iii) (R)
(B) (II) (i) (P)
(C) (II) (i) (Q)
(D) (I) (iii) (S)

31. A neutral base attacks on a substrate containing an anion as leaving group. Which of the following represent the correct combination of effect of increased solvent polarity on reaction rate?

(A) (IV) (iv) (P)
(B) (III) (iv) (Q)
(C) (III) (ii) (S)
(D) (III) (ii) (R)

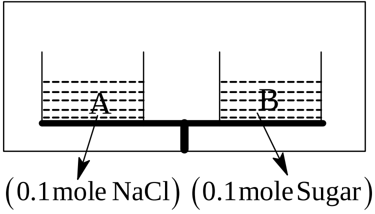
SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

32. On combustion, 1g of 'A' yields 2.9g CO_2. 'A' on easy dehydration with conc. H_2SO_4, gives a hydrocarbon 'B'. 'A' reacts with Na to liberate 0.00275 mole of $H_2(g)$. The empirical formula of 'A' is $C_xH_yO_z$. Then the value of $\frac{x+y}{17}$ will be:

33. Two beakers $A(0.1\text{mole NaCl in 1kg } H_2O)$ & $B(0.1\text{mole sugar in 1kg } H_2O)$ is placed in a small sized closed container. The molality of solution of Beaker A changes to $\frac{'x'}{40}$. The value of 'x' will be

(Assume solutions to be dilute)



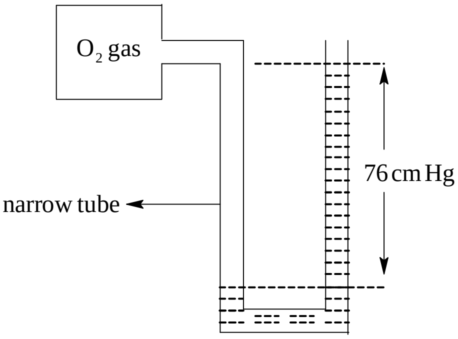
Space for Rough work

34. How many compounds show the cis-trans isomerism?

$\left[Co(NH_3)_4Cl_2\right]^+, \left[Pt(Cl)(Br)(H_2O)(NH_3)\right], \left[Cr(en)_2ClBr\right]^+$

$\left[Co(NH_3)_3Cl_3\right], \left[Co(en)_2Cl_2\right]^+, \left[Co(NH_3)_4(H_2O)(Br)\right]^+$

35.



In above figure, the gas filled in this bulb is subjected for the combustion of 10 moles of CH_4. Maximum number of moles of CO_2 formed in this process is 2. The volume of the bulb is "11.2 x" litre at 280K. Find the approximate integer value of x.

[R=0.08 litre atm $mol^{-1}K^{-1}$, Atmospheric pressure=1atm.]

36. Upon treatment with ammonical H_2S, the metal ion that precipitates as a sulphide is /are,

$Fe^{3+}, Fe^{2+}, Zn^{+2}, Mg^{2+}, Ni^{2+}, Al^{3+}, Cr^{3+}, Cu^{2+}, Ca^{2+}$

Space for Rough work

Mathematics **PART – III**

SECTION – A

(One or More than one correct type)

This section contains **SEVEN** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. $$I_n = \int_{\frac{n}{2}}^{\left(\frac{n+1}{2}\right)} \frac{\sin\left(\pi \sin^2 \pi x\right)}{\left(\sqrt{2}\right)^x} dx, \quad n \in I$$

(A) $\frac{I_n}{I_{n+4}} = 2$

(B) $\frac{I_n}{I_{n+4}} = \frac{1}{\sqrt{2}}$

(C) $\frac{\sum\limits_{n=0}^{\infty} I_{8n}}{I_0} = \frac{4}{3}$

(D) $\frac{\sum\limits_{n=0}^{\infty} I_n}{I_0} = 2$

38. A parabola $S = 0$ has its vertex at $\left(-9, 3\right)$ and it touches the x-axis at the origin then equation of axis of symmetry of the aforesaid parabola can be.

(A) $x - y + 12 = 0$

(B) $x - 2y + 15 = 0$

(C) $2x - y + 21 = 0$

(D) $x + y + 6 = 0$

39. The first term of an infinite geometric series is 21. The second term and the sum of the series are both positive integers. All possible values of the second term can be

(A) 12

(B) 14

(C) 18

(D) 20

Space for Rough work

40. Let $f:[0,1]\to[0,1]$ be a continuous function such that $f\left(f\left(x\right)\right)=1$ for all $x\in[0,1]$ then:

(A) $f\left(x\right)$ is many one function

(B) $y=f\left(x\right)$ intersects the line $y=x$ for some $x\in[0,1)$

(C) $\int_0^1 f\left(x\right)\,dx$ has maximum value 1

(D) $\int_0^1 f\left(x\right)dx$ can be less than $\frac{3}{4}$.

41. A parallelopiped is formed, using three non-zero non-coplanar vectors $\vec{a},\vec{b}\ \&\ \vec{c}$ with fixed magnitudes. Angles between any of the vector with normal of the plane determined by the other two is α and the volume of parallelopiped is T and its surface area is Y. If $\left(\frac{\mathrm{Y}}{\mathrm{T}}\right)=4\left(\frac{1}{|\vec{a}|}+\frac{1}{|\vec{b}|}+\frac{1}{|\vec{c}|}\right)$ then:

(A) $\cos^2\alpha+\cos\alpha=\frac{3}{4}$

(B) $\sin^2\alpha+\sin^4\alpha=\frac{21}{16}$

(C) $\cos^2\alpha+\cos\alpha=\frac{3+2\sqrt{3}}{4}$

(D) $\sin^2\alpha+\sin^4\alpha=\frac{5}{16}$

42. $f:R\to R,\ f\left(x\right)=\begin{cases}(-1)^n & x=\frac{1}{2^n},n\in I-\{0\}\\ 0 & \text{otherwise}\end{cases}$

Which of the statements are **incorrect**?

(A) $y=f\left(x\right)f\left(2x\right)$ is continuous at $x=0$

(B) $y=f\left(x\right)+f\left(2x\right)$ is continuous at $x=0$

(C) $y=f\left(x\right)$ is continuous at $x=2$

(D) $y=f\left(x\right)$ is continuous at $x=3$

43. z_1,z_2,z_3 are three non zero distinct points satisfying $|z-1|=1\ \&\ z_2^2=z_1z_3$ then

(A) $\frac{z_3-z_2}{z_2+z_3-2}$ is purely imaginary

(B) $\mathrm{Arg}\left(\frac{z_2-1}{z_1-1}\right)=2\mathrm{Arg}\left(\frac{z_3}{z_2}\right)$

(C) $\mathrm{Arg}\left(\frac{z_2-1}{z_1-1}\right)=2\mathrm{Arg}\left(\frac{z_3}{z_1}\right)$

(D) $\left|\frac{1}{z_2}-\frac{1}{z_3}\right|+\left|\frac{1}{z_1}-\frac{1}{z_2}\right|=\left|\frac{1}{z_1}-\frac{1}{z_3}\right|$

Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 44, 45 and 46 by appropriately matching the information given in the three columns of the following table.

Trips are taken from warehouse P to cities A, B, C to deliver goods. f_a , f_b , f_c are frequencies of trips to cities A, B, C from P, where overall large number of trips are made, say n in total. E_a , E_b , E_c are expenditure incurred per trip per km from warehouse to cities A, B, C respectively. d_{AB} stands for distance between cities A & B. **(Column 1 and Column – 2 are two given situations for which we have to choose optimum placing of warehouse P, provided in Column - 3)**

	Column 1 **(Frequencies of trip to various cities)**		**Column 2** **(Value of expenditure as per route)** **(**E_a, E_b, E_c are expenditure in rupees per km.**)**		**Column 3** **(Optimum placing of ware house to minimize overall costing)**
(I)	$f_a = f_b = f_c = \frac{n}{3}$	(i)	$E_a = E_b = E_c = \mu$ (Where μ is a constant)	(P)	P has infinitely many positions
(II)	$f_a = f_b = \frac{n}{2}, \quad f_c = 0$	(ii)	$E_a = d_{PA}, E_b = d_{PB}, E_c = d_{PC}$	(Q)	P must be the centroid of triangle of triangle formed by A, B, C (cities being vertices)
(III)	$f_a = f_c = \frac{n}{2}, \quad f_b = 0$	(iii)	$E_a = \frac{1}{d_{PA}}, E_b = \frac{1}{d_{PB}}, E_c = \frac{1}{d_{PC}}$	(R)	P is such that AB, BC, CA subtends $120°$ at P
(IV)	$f_a = \lambda d_{BC}, f_b = \lambda d_{AC}, f_c = \lambda d_{AB}$ $\left(\lambda = \frac{n}{d_{AB} + d_{BC} + d_{AC}}\right)$	(iv)	$E_a = E_b = \frac{E_c}{2} = \mu$ (Where μ is a constant)	(S)	P must be incentre of triangle ABC

44. Choose the **correct** option

(A) (I) (iii) (Q)
(B) (III) (i) (P)
(C) (II) (ii) (R)
(D) (IV) (i) (S)

45. Choose the **correct** option

(A) (III) (ii) (Q)
(B) (IV) (ii) (R)
(C) (I) (i) (R)
(D) (II) (iii) (S)

Space for Rough work

46. Choose the **incorrect** option

(A) $(\mathrm{II})\ (\mathrm{iv})\ (\mathrm{P})$ (B) $(\mathrm{I})\ (\mathrm{ii})\ (\mathrm{Q})$

(C) $(\mathrm{IV})\ (\mathrm{ii})\ (\mathrm{S})$ (D) $(\mathrm{I})\ (\mathrm{iv})\ (\mathrm{S})$

Answer questions 47, 48 and 49 by appropriately matching the information given in the three columns of the following table.

Match the following **Column(s)**

	Column 1		**Column 2**		**Column 3**
(I)	If A & B are two different matrices such that $A^3=B^3 \,\&\, A^2B=B^2A$ and B is non singular.	(i)	$\det(A)=\pm 1$	(P)	$\det A \neq \det B$
(II)	$A=\left[a_{ij}\right]_{4\times 4}$ such that $a_{ij}=\begin{cases}2 & \text{when } i=j\\ 0 & \text{when } i\neq j\end{cases}$	(ii)	A is non-Singular matrix	(Q)	If $\det(A)>0$ $\det(2A)-\det(\operatorname{adj}A)=7$
(III)	Let B be skew symmetric Matrix of order 3×3 with real entries given $I-B$ and $I+B$ are non singular matrices if $A=(I+B)(I-B)^{-1}$ here I represent Identity matrix	(iii)	A is orthogonal matrix	(R)	$\left\{\dfrac{\det(\operatorname{adj}(\operatorname{adj}A))}{7}\right\}=\dfrac{1}{7}$ where $\{.\}$ represent fractional part function
(IV)	Consider $I_{n,m}=\int_0^1 \dfrac{x^n}{x^m-1}dx$ and $J_{n,m}=\int_0^1 \dfrac{x^n}{x^m+1}dx\ \forall\, n>m,\ \ n,m\in N$ And consider the matrices $A=(a_{ij})_{3\times 3}$ where $a_{ij}=\begin{cases}I_{6+i,3}-I_{i+3,3} & i=j\\ 0, & i\neq j\end{cases}$ $B=\begin{bmatrix}J_{6,5} & 72 & J_{11,5}\\ J_{7,5} & 63 & J_{12,5}\\ J_{8,5} & 56 & J_{13,5}\end{bmatrix}$	(iv)	A is symmetric Matrix	(S)	$\det\left(A^2+B^2\right)=0$

47. Which of the following is the only **correct** combination?

(A) $(\mathrm{I})\ (\mathrm{iv})\ (\mathrm{P})$ (B) $(\mathrm{II})\ (\mathrm{iii})\ (\mathrm{Q})$

(C) $(\mathrm{III})\ (\mathrm{iii})\ (\mathrm{Q})$ (D) $(\mathrm{IV})\ (\mathrm{ii})\ (\mathrm{R})$

Space for Rough work

48. Which of the following is the only **incorrect** combination?

(A) $(\text{III})\ (\text{i})\ (\text{Q})$ (B) $(\text{II})\ (\text{iv})\ (\text{R})$

(C) $(\text{I})\ (\text{iv})\ (\text{P})$ (D) $(\text{IV})\ (\text{ii})\ (\text{P})$

49. Which of the following is the only **correct** combination?

(A) $(\text{I})\ (\text{ii})\ (\text{S})$ (B) $(\text{II})\ (\text{iv})\ (\text{Q})$

(C) $(\text{III})\ (\text{i})\ (\text{P})$ (D) $(\text{IV})\ (\text{i})\ (\text{P})$

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

50. A line through any point on the curve $x^2 - y^2 = 1, z = 0$ intersects two lines $y = x, z = 1$ and $y = -x, z = -1$. If the locus of this line is $\alpha x^2 + \beta y^2 + \gamma z^2 + \delta = 0$ there the value of $\alpha + \beta + \gamma + \delta$ is

51. Let three lines $L_1, L_2\ \&\ L_3$ belonging to the family $x - 2y + 6 + \lambda(x - y + 2) = 0$, where λ is a parameter, be interior angle bisectors of ΔABC. If the equation $x + 3y - 4 = 0$ represents side AB of the triangle, then find the value of

$$\left[\frac{\Delta}{\sum\left(r\cot\frac{A}{2} + a\right)}\right]$$

(Note: Symbols used have usual meaning in $\Delta ABC\ and\ [.]$ denotes G.I.F)

52. Let PT be a tangent from the point $P\left(5, 3 + \sqrt{3}\right)$ to the circle $x^2 + y^2 + 4x - 6y - 3 = 0$, with centre C, at T and AB is secant which passes through P such that BT is the normal at T. If $\mathrm{Ar}(\Delta CAB) + \mathrm{Ar}(\Delta CAT) = \frac{\lambda}{25}$, then find the value of $\left(\left[\sqrt{\lambda}\right] - 15\right)$ ($[.]$ denotes G.I.F)

Space for Rough work

53. If $y = \lambda_1 e^{ax} + \lambda_2 x e^{bx}$, where λ_1, λ_2 are arbitrary constants; is general solution of $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = 0$ then the value of $\frac{a}{b}$ is

54. Every ray of light, emerging from $(1,2)$, after striking at an elliptical curve, whose eccentricity is $\frac{2\sqrt{5}}{2+\sqrt{5}+\sqrt{45}}$, always passes though (3,6)after reflection . If $P(\alpha,\beta)$ is a point on this curve such that it is at unit distance from origin then $|2\alpha - \beta|$ is

Space for Rough work

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FULL TEST – VIII

PAPER-1

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**AD**	19.	**ABD**	37.	**AC**
2.	**AD**	20.	**BD**	38.	**AB**
3.	**AC**	21.	**ABCD**	39.	**ABCD**
4.	**AD**	22.	**CD**	40.	**AC**
5.	**ABCD**	23.	**BC**	41.	**AB**
6.	**AB**	24.	**ABC**	42.	**AC**
7.	**BCD**	25.	**ABD**	43.	**ABD**
8.	**B**	26.	**C**	44.	**B**
9.	**D**	27.	**B**	45.	**C**
10.	**C**	28.	**C**	46.	**D**
11.	**C**	29.	**A**	47.	**C**
12.	**B**	30.	**C**	48.	**C**
13.	**A**	31.	**C**	49.	**A**
14.	**3**	32.	**2**	50.	**0**
15.	**1**	33.	**3**	51.	**1**
16.	**4**	34.	**6**	52.	**4**
17.	**2**	35.	**4**	53.	**1**
18.	**2**	36.	**4**	54.	**0**

Physics

PART – I

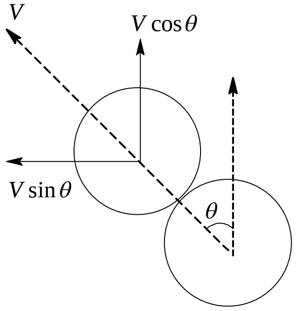
SECTION – A

1. AD

Elastic potential energy $\propto \left(\frac{\partial y}{\partial x}\right)^2$,kinetic energy $\propto \left(\frac{\partial y}{\partial t}\right)^2$. So for antinode elastic potential energy is constant & minimum. $\frac{\partial y}{\partial x}$ always changes for all other points.

2. AD

Let's assume, time taken by the queen to get into the hole is t



$$t = \frac{\ell}{2V\sin\theta} \text{ \& also } t = \frac{\ell}{2V\cos\theta} + \frac{\ell}{eV\cos\theta}$$

Therefore

$$\frac{\ell}{2V\sin\theta} = \frac{\ell}{2V\cos\theta} + \frac{\ell}{eV\cos\theta}$$

$$\therefore \tan\theta = \frac{1}{3}$$

$$\therefore \frac{d}{\sqrt{(r_1+r_2)^2 - d^2}} = \frac{1}{3}$$

$$d^2 = 9 \Rightarrow d = 3cm$$

3. AC

When parallel light falls from left side

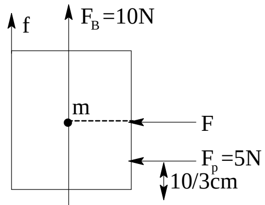
$$\frac{\mu_3}{f} = \frac{(\mu_3-\mu_2)}{R} + \frac{(\mu_2-\mu_1)}{R}$$

$$\frac{4/3}{f_1} = \frac{(4/3-2)}{R} + \frac{(2-1)}{R} \Rightarrow f_1 = 80cm$$

When parallel light falls from right side

$$\frac{1}{f_2} = \frac{(1-2)}{-R} + \frac{(2-4/3)}{-R} \Rightarrow f_2 = 60cm$$

4. AD



For translatory equilibrium $f + F_B = mg \Rightarrow f = 40N$

For rotational equilibrium $40\times5 + 5\times\frac{5}{3} = N(5)$

N'=125/3 newton as $F + F_p = N' \Rightarrow F = 110/3\,Newton$

But for $F = 110/3\,Newton$ object will not be in translational equilibrium so for translational equilibrium

$$\frac{9}{10}(F+5) = 40 \Rightarrow F = \frac{355}{9}\text{newton}$$

5. ABCD

6. AB
Normal Reaction on any of the roller always has a horizontal compound directed towards right. Therefore, friction acting on the rollers at every point at contact should have component towards left.
Hence option (C) is incorrect.
Since friction on roller is in opposite direction of F, friction on the plank is in the direction of F. Therefore, for the system to be in equilibrium, F should be less than $mg\sin\theta$ so option A and B are correct.
If rollers are clamped so they cannot move, friction on rollers can be towards left as well as right. Therefore friction on the plank at point A and B can be opposite to F, hence F can be greater then $mg\sin\theta$, so option D is incorrect.

7. BCD

$$0.85=\frac{13.6Z^2}{n_1^2}\,and\,0.544=\frac{13.6Z^2}{n_2^2}$$

As $n_2-n_1=3\Rightarrow n_1=12, n_2=15$

$$\frac{hc}{\lambda}=RhcZ^2\left(\frac{1}{12^2}-\frac{1}{15^2}\right)\Rightarrow\lambda=4052nm$$

8. B

9. D

10. C

11. C

12. B

13. A
Sol. **[Q. 11 – 13]**

Use $\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

SECTION – C

14. 3
x coordinate of centre of mass of the rod

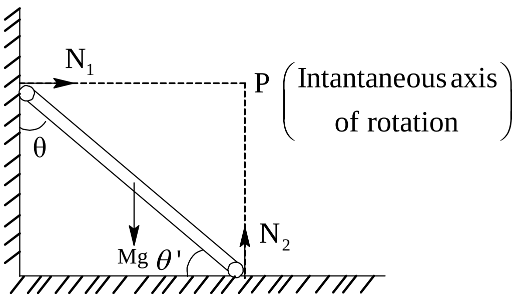
$$x=\frac{\ell}{2}\sin\theta$$

$$v_x=\frac{\ell}{2}\cos\theta\omega\,and\,a_x=\frac{\ell}{2}\left(\cos\theta\alpha-\sin\theta\omega^2\right)$$

When $N_1=0\Rightarrow\cos\theta\alpha=\sin\theta\omega^2 ---(1)$

Using COME:

$$mg\frac{\ell}{2}(\cos\beta-\cos\theta)=\frac{1}{2}m\frac{\ell^2}{4}\omega^2+\frac{1}{2}m\frac{\ell^2}{12}\omega^2$$


N$_1$
P
$\begin{pmatrix}\text{Intantaneous axis}\\ \text{of rotation}\end{pmatrix}$
θ
Mg
θ'
N$_2$

$$\left[v = \frac{\ell}{2}\omega \text{ from IAOR}\right]$$

$$\omega^2 = \frac{3g}{\ell}\left(\cos\beta - \cos\theta\right) --- (2)$$

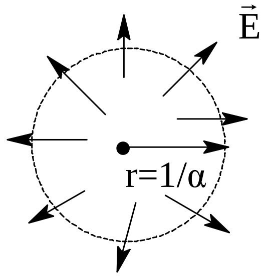
$$\alpha = \frac{3g}{2\ell}\sin\theta ---- (3)$$

Substituting the value of ω^2 and α in equation (1) gives

$$\Rightarrow \cos\theta = \frac{2}{3}\cos\beta \Rightarrow \cos\theta = \frac{1}{\sqrt{3}} \Rightarrow \sin\theta' = \frac{1}{\sqrt{3}} \text{ so N=3}$$

15. 1

As the electric field is radial, by applying gauss law, we can write $\int \vec{E}.d\vec{s} = \frac{Q}{\varepsilon_0}$



For $r = \frac{1}{\alpha}$, $\vec{E} = C\left(1 - e^{-\alpha\times 1/\alpha}\right)\frac{\hat{r}}{(1/\alpha)^2}$

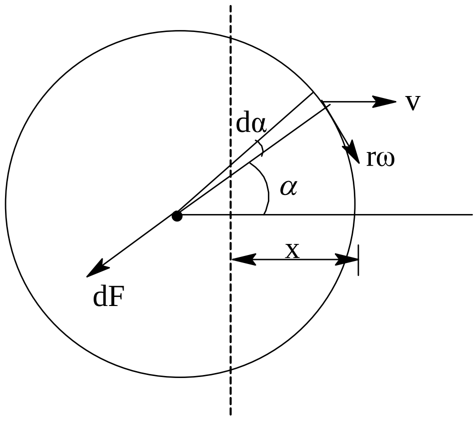
$$\therefore \oint \vec{E}.d\vec{s} = C\left(1 - e^{-1}\right)\alpha^2 \times 4\pi\left(1/\alpha\right)^2$$

$$\Rightarrow \frac{Q}{\varepsilon_0} = 4\pi C\left(1 - e^{-1}\right) \Rightarrow Q = \left(1 - e^{-1}\right) \Rightarrow \therefore N = 1$$

16. 4

$$\int_0^{x_{\min}} 0.5x\frac{mg}{\ell}dx = 2 \Rightarrow x_{\min} = 40\text{cm}$$

17. 2



x=r-rcosθ

dx=rsinθdθ

$$\text{mr}^2\beta = \int_0^\theta \frac{2q}{2\pi}d\alpha\, vBr\cos\alpha$$

$$\beta = \frac{dw}{dt} = \frac{qvB\sin\theta}{\pi\ mr} ---- (1)$$

$$-ma = \int_0^\theta 2\frac{q}{2\pi}d\alpha\, rwB\cos\alpha$$

$$a = \frac{dv}{dt} = \frac{qrwB\sin\theta}{\pi\ m} ---- (2)$$

$$= \frac{dw}{dv} = \frac{v}{r^2 w} \Rightarrow r^2\int_0^w w\,dw = -\int_{v_0}^v v\,dv$$

$$\Rightarrow v = \frac{v_0}{\sqrt{2}}$$

$$\frac{vdv}{dx} = \frac{qrwB\sin\theta}{\pi m}$$

$$\int_{v_0}^{v_0/\sqrt{2}} \frac{vdv}{\sqrt{v_0^2 - v^2}} = \frac{qrB}{m\pi}\int_0^{\pi} \sin^2 \theta d\theta$$

$$\Rightarrow q = \frac{\sqrt{2}mv_0}{Br}$$

18. 2

For slight displacement $\left(\pi r^2 x\right)\rho g = ma \Rightarrow T = 2\pi\sqrt{\frac{m}{\pi r^2 \rho g}} \Rightarrow T = 2\sec$

Chemistry

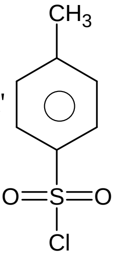
PART – II

SECTION – A

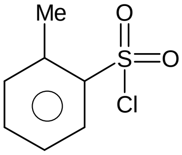
19. ABD

Sol.

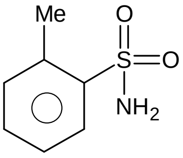
'A'



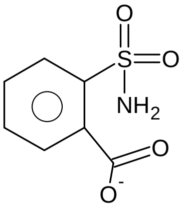
'B'



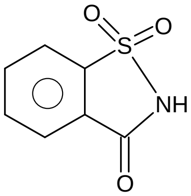
'C'



'D'



'E'



20. BD

A.O. is a single e^- wave function

Area of the plot for r<52.9 pm is smaller than the area of the plot of r>52.9pm.

At higher atomic number every of $3d<4s$

$$\Delta E_{2\to5} = RhcZ^2\left[\frac{1}{2^2}-\frac{1}{5^2}\right] = RhcZ^2\left[\frac{21}{100}\right]$$

$$\Delta E_{2\to4} = RhcZ^2\left[\frac{1}{2^2}-\frac{1}{4^2}\right] = RhcZ^2\times\frac{3}{16}$$

$$\Delta E_{2\to5} = \frac{28}{25}\Delta E_{2\to4}$$

21. ABCD

For dissociative process (e.g.H_2 to 2H), more pressure is required to get the same extent of chemisorption as two species have to be chemisorbed.

In anionic surfactant negatively charged $-COO^-$ group will repeal each other so at lower concentration micelles will form.

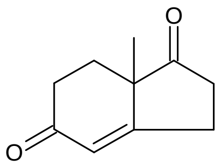
22. CD

Ni^{2+}	O^{2-}	Ni^{2+}	O^{2-}
O^{2-}	Ni^{2+}	O^{2-}	Li^+
Ni^{2+}	O^{2-}	Ni^{3+}	O^{2-}

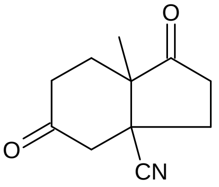
Li^+ ion occupy Ni^{2+} sites to form substitutional defects. In order to maintain the charge neutrality, every Li^+ ion is balanced by Ni^{3+} ion and it becomes a p-type semiconductor.

23. BC

'A'

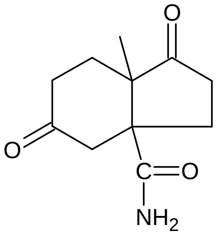


'B'

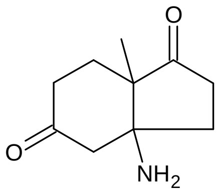


$(1,4\ addition)$

'C'

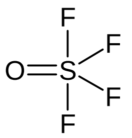


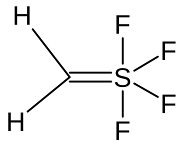
'D'

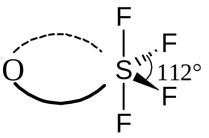


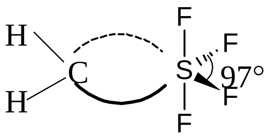
24. ABC

F-F < Cl-Cl < Br-Br < I-I (Bond length)



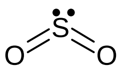


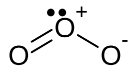




Oxygen being more EN, the electron density at S in $\mathrm{OSF_4}$ will decreases so it occupies less space so bond angle $\mathrm{F_{eq.}}$ - S - $\mathrm{F_{eq.}}$ will increased.

$H_2S(92°) < O_3(116.8°) \quad < SO_2(119.5°) \ < NO_2(134°)$





$\mathrm{AsH_3 < NH_3 < SbH_3 < H_2O\,(BP)}$

25. ABD

Rate of reaction = $\mathrm{k_2[Cl][CHCl_3]}$ and $\dfrac{k_1}{k_{-1}} = \dfrac{[Cl]^2}{[Cl_2]}$

$$[Cl] = \sqrt{\frac{k_1}{k_{-1}}[Cl_2]}$$

Rate of reaction = $k_2 . \sqrt{\dfrac{k_1}{k_{-1}}}[Cl_2]^{1/2}[CHCl_3]$

$$k = 1.3\times10^{-2} \times \sqrt{\frac{4.8\times10^3}{1.2\times10^3}} = 2.6\times10^{-2}$$

26. C
27. B
28. C

Sol. **(Q. 26 – 28)**

(I) Isothermal expansion

(II) Water & Ice will remain in equilibrium to 0°C & 1 atm pressure so $\Delta G=0$

(III) For adiabatic reversible $\mathrm{T_2}P_2^{\frac{1-\gamma}{\gamma}} = T_1 P_1^{\frac{1-\gamma}{\gamma}} \Rightarrow T_2 = 300\left(\frac{P_1}{P_2}\right)^{-2/5} = 300\left(\frac{10}{1}\right)^{-2/5} = 120K$

For adiabatic irreversible

$$\mathrm{C_v(T_2\text{-}T_1)=\text{-}P_{ext}(V_2\text{-}V_1)=\text{-}P_2\left[\frac{nRT_2}{P_2}\text{-}\frac{nRT_1}{P_1}\right]}$$

$$\mathrm{\frac{C_v}{nR}(T_2\text{-}T_1) = \text{-}P_2\left[\frac{T_2}{P_2}\text{-}\frac{T_1}{P_1}\right]}$$

$$\mathrm{\frac{(T_2\text{-}T_1)}{\gamma\text{-}1}=\text{-}T_2+\frac{T_1P_2}{P_1}}$$

$$\mathrm{T_2=T_1\left[\frac{(\gamma\text{-}1)}{\gamma}\frac{P_2}{P_1}+\frac{1}{\gamma}\right]}$$

$$\mathrm{T_2=192K}$$

(IV) Mixing of ideal gas at constant T & P in an isolated container

$\Rightarrow q = 0, w = 0, \Delta\mathrm{U} = 0, \Delta S_{system} > 0, \Delta G < 0$

29. A
30. C
31. C

Sol. **(Q. 29 to 31)**

Increasing in polarity of the solvent will increase the rate if T.S. has more charge density in comparison to reactant**.**

SECTION – C

32. 2

% of carbon $= \frac{12\times 2.9\times 100}{44} = 79.09$

$$\mathrm{R\text{-}OH+Na \longrightarrow R\text{-}ONa+\frac{1}{2}H_2\left(0.00275\,mole\right)}$$

Moles of oxygen $= 0.00275\times 2$

Mass of oxygen $= 0.00275\times 2\times 16 = 0.088g$

% of oxygen = 8.8

So % hydrogen $= 100 - 79.09 - 8.8 = 12.11$

Empirical = $\mathrm{C_{12}H_{22}O}$

So $\mathrm{\frac{x+y}{17}=\frac{12+22}{17}=2}$

33. 3

In equilibrium, vapour pressure of solution will remain same

$$\frac{\Delta p}{p*} = \left(\frac{n_{sugar}}{n_{sugar}+n_{H_2O}}\right)_{\text{Beaker B}} = \left[\frac{2\ n_{NaCl}}{2\ n_{NaCl}+n_{H_2O}}\right]_{\text{BeakerA}}$$

$$\frac{0.1}{0.1+\frac{(1-a)\times 1000}{18}}=\frac{2\times 0.1}{2\times 0.1+\frac{(1+a)\times 1000}{18}}$$

$$\Rightarrow a=1/3$$

So molarity of NaCl $=\frac{0.1}{\frac{4}{3}}=\frac{0.3}{4}=\frac{3}{40}$

34. 6

I,II,III,IV,V,VI shows cis & trans isomerism

35. 4

Sol. Pressure of O_2 gas filled inside bulb $=(76+76)\,cm\,Hg=2\,atm$

O_2 is a limiting reagent.

$$CH_4+\underset{\substack{\downarrow\\ \text{4 mole}}}{2O_2}\rightarrow \underset{\substack{\downarrow\\ \text{2 mole}}}{CO_2}+2H_2O_{(l)}$$

$$PV=nRT$$

$$2\times V=(4)(0.08)(280)$$

$$V=44.8L=11.2\times 4L$$

$$x=4$$

36. 4

$Fe^{2+}, Zn^{2+}, Ni^{2+}, Cu^{2+}$

Forms precipitate as FeS, ZnS, NiS, CuS respectively Al^{3+}, Cr^{3+} ions ppt as hydroxides

Fe^{3+} forms precipitate as FeS(not Fe_2S_3).

Mathematics

PART – III

SECTION – A

37. AC

$$I_{n+k} = \int_{\frac{n+k}{2}}^{\frac{n+k+1}{2}} \frac{\sin\left(\pi \sin^2 \pi x\right)}{\left(\sqrt{2}\right)^x} dx$$

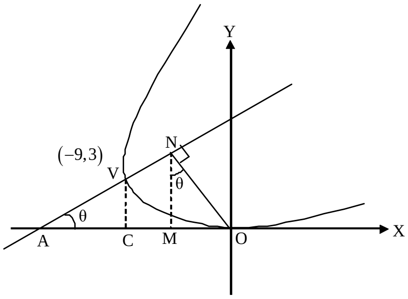
Let $x = \frac{k}{2} + t$

$$I_{n+k} = \int_{\frac{n}{2}}^{\frac{n+1}{2}} \frac{\sin\left(\pi \sin^2 \pi\left(\frac{k}{2}+t\right)\right)}{\left(\sqrt{2}\right)^{\frac{k}{2}+t}} dt$$

$$I_{n+k} = \frac{1}{2^{\frac{k}{4}}} \int_{\frac{n}{2}}^{\frac{n+1}{2}} \frac{\sin\left(\pi \sin^2 \pi t\right)}{\left(\sqrt{2}\right)^t} dt$$

$$I_{n+k} = \frac{I_n}{2^{\frac{k}{4}}}$$

38. AB



$VC = 3units, CO = 9units$

As per property: $AV = VN$ and $\frac{AN}{AV} = 2 = \frac{MN}{VC}$

$$\Rightarrow OM = 6\tan\theta, AC = CM = 3\cot\theta \Rightarrow 9 = 3\left(2\tan\theta + \frac{1}{\tan\theta}\right)$$

$$\Rightarrow m = 1 or\, m = \frac{1}{2}$$

$\Rightarrow Eq^n$ of Axis can be

$(y-3) = 1(x+9)$

or

$(y-3) = \frac{1}{2}(x+9)$

39. ABCD

Let the series be $21, 21r, 21r^2, ...$

$\text{Sum} = \frac{21}{1-r}$ is a positive integer

Also 21r is a positive integer

$S = \frac{(21)(21)}{21-21r}$ as $21r \in N$ hence $21-21$ r must be an integer

Also $21r < 21$

Hence 21-21r may be equal to 1, 3, 7 or 9

i.e must be a divisor of (21) (21)

hence $21 - 21r = 1$ or 3 or 7 or 9

21r=20, 18, 14 or 12

40. AC

$f(x)$ is continuous on a closed interval so it attains a minimum value α.

Since α is in the range of f, $\therefore f(\alpha) = 1$. If $\alpha = 1, f(x) = 1 \forall x$ and $\int_0^1 f(x)dx = 1$

Now, if $\alpha < 1$, by intermediate value theorem, since f is continuous it attains all values between α and 1. So for all $x \geq \alpha, f(x) = 1$.

There fore

$$\int_0^1 f(x)dx = \int_0^\alpha f(x)dx + (1-\alpha)$$

Since $f(x) \geq \alpha, \int_0^\alpha f(x)dx > \alpha^2$ and the equality is strict because f is continuous and thus cannot be α for all $x < \alpha$ and 1 at α. So

$$\int_0^1 f(x)dx > \alpha^2 + (1-\alpha) = \alpha\left[\alpha - \frac{1}{2}\right]^2 + \frac{3}{4} \geq \frac{3}{4}$$

$$\therefore \frac{3}{4} < \int_0^1 f(x)dx \leq 1$$

41. AB

$$T = |\vec{a}||\vec{b}||\vec{c}||\cos\alpha||\sin\theta_1|$$

$$= |\vec{a}||\vec{b}||\vec{c}||\cos\alpha||\sin\theta_2|$$

$$= |\vec{a}||\vec{b}||\vec{c}||\cos\alpha||\sin\theta_3|$$

$$Y = 2\left(\left|\vec{a}\times\vec{b}\right| + \left|\vec{b}\times\vec{c}\right| + \left|\vec{c}\times\vec{a}\right|\right)$$

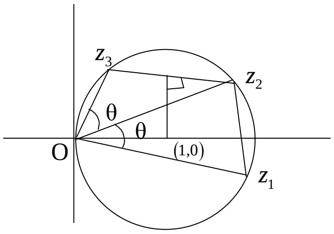
$$= 2\left(|\vec{a}||\vec{b}||\sin\theta_1| + |\vec{b}||\vec{c}||\sin\theta_2| + |\vec{c}||\vec{a}||\sin\theta_3|\right)$$

$$\frac{Y}{T} = \frac{2}{|\cos\alpha|}\left(\frac{1}{|\vec{a}|} + \frac{1}{|\vec{b}|} + \frac{1}{|\vec{c}|}\right) = 4\left(\frac{1}{|\vec{a}|} + \frac{1}{|\vec{b}|} + \frac{1}{|\vec{c}|}\right) \Rightarrow |\cos\alpha| = \frac{1}{2}$$

42. AC

$\lim_{x\to 0} f(x)f(2x)$ is -1 or 0 depending upon $x=\frac{1}{2^n}$ or $x\neq\frac{1}{2^n}$ but $f(x)+f(2x)$ always tends towards zero $f(2)=f\left(\frac{1}{2^{-1}}\right)=-1$ but $\lim_{x\to 2} f(x)$ is 0, $\lim_{x\to 3} f(x)=f(3)=0$

43. ABD



1st option – chord (Z_3-Z_2) is $\perp$ to line joining $\frac{z_2+z_3}{2}$ and 1.

2nd option – angle by chord (Z_3-Z_2) at $(1,0)$ is double of angle at $(0,0)$

4th option – Ptolemy's theorem

44. B

For option B total cost of all the n trips= $\frac{n\lambda}{2}(d_{PA}+d_{PB})$

i.e. we have to minimise $d_{PA}+d_{PB}$.

$d_{PA}+d_{PB}\geq d_{AB}$ where equality holds when p lies on line segment joining A & B

45. C

For option C total cost of all the n trips

$=\frac{n\lambda}{3}(d_{PA}+d_{PB}+d_{PC})$

$d_{PA}+d_{PB}+d_{PC}$ is minimum when P is interior point such that AB, BC, CA subtends $120°$ at P.

46. D

For option D total cost of all the n trips

$=\frac{n\lambda}{3}(d_{PA}+d_{PB}+2d_{PC})$

As $d_{PA}+d_{PC}\geq d_{AC}$ & $d_{PB}+d_{PC}\geq d_{BC}$

$\Rightarrow d_{PA}+d_{PB}+2d_{PC}\geq d_{AC}+d_{BC}$

Equality holds when P is vertex C

47. C

$A^3=B^3$ & $A^2B=B^2A$ subtracting both we get

$A^2(A-B)=B^2(B-A)$

$\Rightarrow (A^2+B^2)(A-B)=0$

$\Rightarrow \det.(A^2+B^2)=0$ (otherwise $A=B$ which is not true)

48. C

49. A

Sol. **(Q. 48 to 49)** By given information

$$a_{ij} = \begin{cases} 2 & \text{when } i=j \\ 0 & \text{when } i \neq j \end{cases}$$

$$A=\left[a_{ij}\right]$$

$$A=\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 2 \end{bmatrix}$$

$$|A|=2^4$$

$$|\text{adj A}|=|A|^{n-1}=(16)^3=2^{12}$$

$$\Rightarrow |\text{adj}(\text{adj A})|=|\text{adj A}|^3=2^{36}=\left(2^3\right)^{12}=(1+7)^{12}$$

$$={}^{12}C_0+{}^{12}C_1\,7^1+....+{}^{12}C_{12}\ \ 7^{12}$$

$$\Rightarrow \left\{\frac{2^{36}}{7}\right\}=\frac{1}{7}$$

Given $A=(I+B)(I-B)^{-1}$

Now, $AA^T=(I+B)(I-B)^{-1}(I+B)^{-1}(I-B)$

$$=(I+B)(I+B)^{-1}(I-B)^{-1}(I-B)=I\times I=I$$

$\therefore |AA^T|=|I| \Rightarrow \ |A|^2=1 \Rightarrow |A|=\pm 1$

Given $|A|>0 \therefore |A|=1$

$$\therefore \det(2A)-\det(\text{adj A})$$

$$=2^3\det A-(\det A)^2$$

$$=8\times 1-1^2=7$$

$$a_{ij} = \begin{cases} I_{6+i,3}-I_{i+3,3}, & i=j \\ 0, & i \neq j \end{cases}$$

$$I_{6+i,3}-I_{3+i,3}=\int_0^1\left(\frac{x^{i+6}}{x^3-1}-\frac{x^{i+3}}{x^3-1}\right)dx=\int_0^1 x^{i+3}dx=\frac{1}{i+4}$$

$$\Rightarrow A=\begin{bmatrix} \frac{1}{5} & 0 & 0 \\ 0 & \frac{1}{6} & 0 \\ 0 & 0 & \frac{1}{7} \end{bmatrix} \Rightarrow |A|=\frac{1}{5\times 6\times 7}=\frac{1}{210}$$

$$\text{For } B=\begin{bmatrix} J_{6,5} & 72 & J_{11,5} \\ J_{7,5} & 63 & J_{12,5} \\ J_{8,5} & 56 & J_{13,5} \end{bmatrix}$$

Applying $C_1 \to C_1+C_3$

$$|B|=\begin{vmatrix} J_{6,5}+J_{11,5} & 72 & J_{11,5} \\ J_{7,5}+J_{12,5} & 63 & J_{12,5} \\ J_{8,5}+J_{13,5} & 56 & J_{13,5} \end{vmatrix}$$

$$J_{6,5}+J_{11,5}=\int_0^1 \frac{x^6}{x^5+1}dx+\int_0^1 \frac{x^{11}}{x^5+1}dx=\int_0^1\left(x-\frac{x}{x^5+1}\right)dx+\int_0^1\left(x^6-x+\frac{x}{x^5+1}\right)dx=\frac{1}{7}$$

$$\begin{vmatrix} \frac{1}{7} & 72 & J_{11,5} \\ \frac{1}{8} & 63 & J_{12,5} \\ \frac{1}{9} & 56 & J_{13,5} \end{vmatrix}=\frac{1}{7\times 8\times 9}\begin{vmatrix} 72 & 72 & J_{11,5} \\ 63 & 63 & J_{12,5} \\ 56 & 56 & J_{13,5} \end{vmatrix}=0$$

SECTION – C

50. 0

The required line shall be represented by

$(y-x)+\lambda_1(z-1)=0 \,\&\, (y+x)+\lambda_2(z+1)=0$.............(1)

Where (x,y,z) is any general point on the line.

At $z=0, x^2-y^2=1$

$(y-x)=\lambda_1$....................(2)

$(y+x)=-\lambda_2$..................(3)

$(2)\times(3)$

$\Rightarrow y^2-x^2=-\lambda_1\lambda_2$

$\Rightarrow -1=-\lambda_1\lambda_2 \Rightarrow \lambda_1\lambda_2=1$

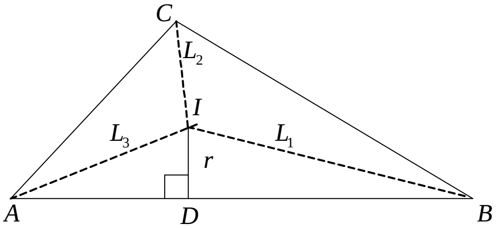
Substituting $\lambda_1 \,\&\, \lambda_2$ from (1)

$$\frac{(y-x)}{(z-1)}\times\frac{y+x}{z+1}=1\Rightarrow y^2-x^2=z^2-1$$

$x^2-y^2+z^2-1=0$

$\alpha+\beta+\gamma+\delta=0$

51. 1



Intersection point of $x-2y+6=0\, and\, x-y+2=0$ is the Incentre of the ΔABC

$I(2,4)$

$r=$ in radius = Perpendicular distance of I from the line AB

$$=\left|\frac{2+12-4}{\sqrt{10}}\right|$$

$$r=\sqrt{10}$$

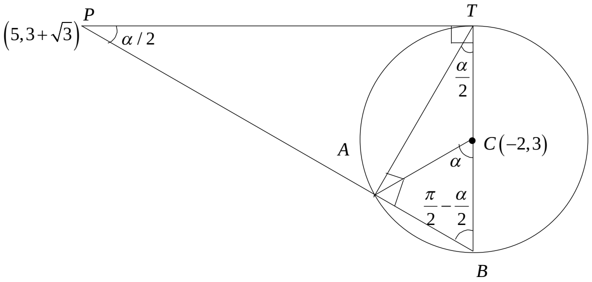
$$\sum\left(r\cot\frac{A}{2}+a\right)=r\cot\frac{A}{2}+a+r\cot\frac{B}{2}+b+r\cot\frac{C}{2}+c$$

$$=s-a+a+s-b+b+s-c+c$$

$$=3s$$

$$\left[\frac{\Delta}{\sum\left(r\cot\frac{A}{2}+a\right)}\right]=\left[\frac{rs}{3s}\right]=\left[\frac{\sqrt{10}}{3}\right]=1$$

52. 4



$$CT=CB=r=4$$

$$PT=\sqrt{5^2+\left(3+\sqrt{3}\right)^2+4\times5-6\left(3+\sqrt{3}\right)-3}$$

$$PT=6$$

Let $\angle ACB=\alpha$

$$Ar\left(\Delta CAB\right)=\frac{1}{2}\cdot r\cdot r\cdot\sin\alpha=8\sin\alpha$$

$$Ar\left(\Delta CAT\right)=\frac{1}{2}\cdot r\cdot r\cdot\sin\left(\pi-\alpha\right)=8\sin\alpha$$

In $\Delta\, PBT$

$$\tan\frac{\alpha}{2}=\frac{BT}{PT}=\frac{8}{6}$$

$$\Rightarrow \sin\alpha=\frac{2\tan\frac{\alpha}{2}}{1+\tan^2\frac{\alpha}{2}}=\frac{2\times\frac{4}{3}}{1+\frac{16}{9}}=\frac{24}{25}$$

$$Ar\left(\Delta CAB\right)+Ar\left(\Delta CAT\right)=16\sin\alpha=16\times\frac{24}{25}=\frac{384}{25}$$

$$\Rightarrow \lambda=384 \text{ hence}\left[\sqrt{384}\right]-15=19-15=4$$

53. 1

Satisfying then given solution in differential equation

get $\left(\lambda_1\left(a^2-2a+1\right)+\lambda_2\left(\left(b^2-2b+1\right)x+2\left(b-1\right)\right)\right)e^{ax}=0$ which must be true for every λ_1 & $\lambda_2\in R$ so $a^2-2a+1=0, b^2-2b+1=0\Rightarrow a=b=1$

54. 0

$(1,2)$ *and* $(3,6)$ are foci of ellipse

$$2ae=2\sqrt{5}\Rightarrow 2a=\frac{2\sqrt{5}}{e}=2+\sqrt{5}+\sqrt{45}$$

$$\sqrt{\left(\sin\theta-1\right)^2+\left(\cos\theta-2\right)^2}+\sqrt{\left(\sin\theta-3\right)^2+\left(\cos\theta-6\right)^2}=\left(1+\sqrt{45}\right)+\left(1+\sqrt{5}\right)$$

$\left(1+\sqrt{5}\right)$ *and* $\left(1+\sqrt{45}\right)$ are maximum distance of $(1,2)$ are $(3,6)$ from circle

$x^2+y^2=1\Rightarrow (1,2),(3,6),(\alpha,\beta)$ are collinear

$2\alpha-\beta=0$

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

FULL TEST – VIII

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 231**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-C & Section-D**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01 – 03, 24 – 26, 47 – 49)*** *contains 9 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (04 – 08, 27 – 31, 50 – 54) *contains 15 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (09 – 10, 32 – 33, 55 – 56) *contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer. There is no negative marking.*

2. ***Section-C (11 – 20, 34 – 43, 57 – 66)*** *contains 30 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

3. ***Section-D (21 – 23, 44 – 46, 67 – 69)*** *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

PART – I (Physics), PART – II (Chemistry), PART – III (Mathematics):
(SECTION – D)

For questions **21 to 23, 44 to 46, 67 to 69.**
Numerical answer type questions with answer XXXXX. XX

If answer is 348.4 / 251.37 / 213

Correct Method :

0	0	3	4	8	.	4	0
0	0	2	5	1	.	3	7
0	0	2	1	3	.	0	0

Wrong Method :

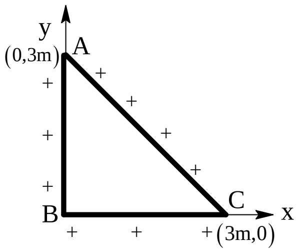
	3	4	8		.	4	
3	4	8			.		4
		3	4	8	.		4
	3		4	8	.	4	
	2		5	1	.	3	7
		2	1	3	.		
		2	1	3	.	0	
		2	1	3	.		0
		3	4	8	.	4	0
		2	5	1	.	3	7
		2	1	3	.	0	0

Physics PART – I

SECTION – A
(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

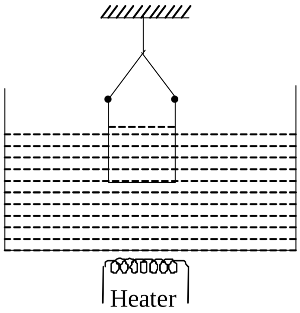
1. An isosceles triangular frame is made by three non conducting rods carrying charge of uniform charge density as shown in the figure. The co-ordinate of the point where electric field is zero is



(A) $\left(\frac{3}{2+\sqrt{2}}\text{m}, \frac{3}{2+\sqrt{2}}\text{m}\right)$ (B) $\left(\frac{3}{2-\sqrt{2}}\text{m}, \frac{3}{2-\sqrt{2}}\text{m}\right)$

(C) $\left(\frac{3}{2}\text{m}, \frac{3}{2}\text{m}\right)$ (D) $\left(\frac{5}{2}\text{m}, \frac{5}{2}\text{m}\right)$

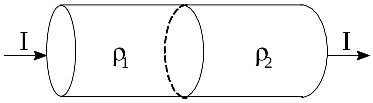
2. Water is boiling in a large vessel as shown in the figure. Another open vessel containing water which is below $100°C$ is dipped in the bigger vessel by the help of string as shown in figure. Choose the correct option regarding the situation.



(A) The temperature of water in the smaller vessel will gradually increase and it will start boiling below $100°C$.
(B) The temperature of water in the smaller vessel will gradually increase and it will start boiling above $100°C$.
(C) The temperature of water in the smaller vessel will gradually increase upto $100°C$ and it will not boil.
(D) The temperature of water in the smaller vessel will gradually increase and it will start boiling at $100°C$.

Space for Rough work

3. Two long straight cylindrical conductors with resistivities ρ_1 *and* ρ_2 respectively are joined together as shown in figure. If a current I flows uniformly through the cross section, then magnitude of the charge accumulated at the interface of the two conductors is



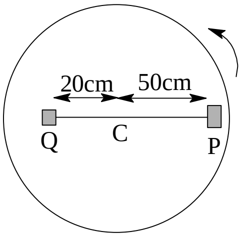
(A) $\frac{(\rho_1-\rho_2)I\in_0}{2}$ (B) $\in_0 I|\rho_1-\rho_2|$

(C) $\in_0 I|\rho_1+\rho_2|$ (D) 0

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

4. Two blocks P of mass 20kg and Q of mass 10kg are placed on a rough horizontal disk ($\mu = 2/3$) and are connected with a string which is along the diameter of disk as shown in the figure. Then (Here C is centre of the disc)

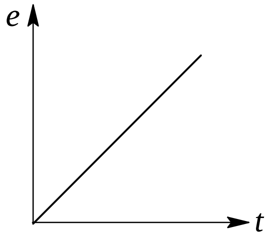


(A) The tension in the string when angular velocity of disc is 4 rad/second is 80/3 N.
(B) Friction on 10kg block is 16/3 N when angular velocity of disc is 4 rad/second.
(C) Friction on 20 kg block is 40/3 N when angular velocity of disc is 4 rad/second.
(D) Maximum angular velocity of disc for no slipping of block is 5 rad/second.

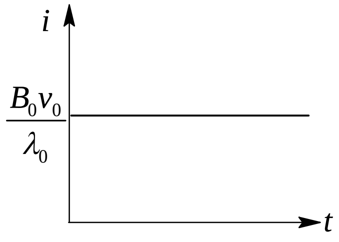
Space for Rough work

5. A long straight slider is moved with constant velocity $\vec{v} = v_0\hat{i}$ parallel to earth surface in the x-y plane in a uniform magnetic field $\vec{B} = B_0\hat{k}$ on a resistanceless rails in the form of curve $y^2=4x$. Here emf induced in the loop, current, power, resistance of slider per unit length and time are represented by e, i, p, λ_0 and t respectively. If at t = 0 slider starts from x = 0. Then which of the following option(s) is/are correct.

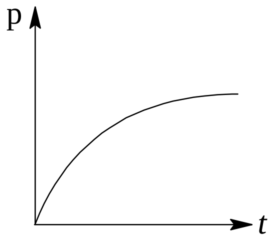
(A)



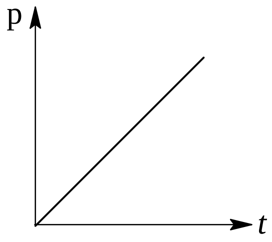
(B)



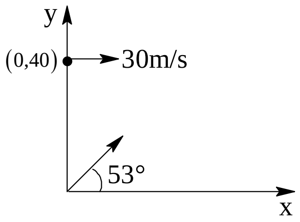
(C)



(D)



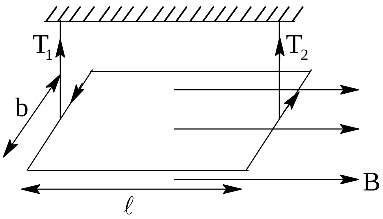
6. As soon as a monkey jumps horizontally with speed $30\,\text{m/s}$ from height 40m of a tree, an arrow is projected from the bottom of tree at an angle of $53°$ with the horizontal in the same plane. If the arrow hits the monkey. Then



(A) The angle at which arrow is approaching monkey with the horizontal with respect to monkey is $90°$.
(B) The angle at which arrow is approaching monkey with the horizontal with respect to monkey is $60°$.
(C) The time after which arrow hits the monkey is 1second.
(D) The time after which arrow hits the monkey is 2second.

Space for Rough work

7. A uniform conducting rectangular loop of sides ℓ, b and mass m carrying current i is hanging horizontally with the help of two vertical non conducting strings. There exists a uniform horizontal magnetic field B which is parallel to the longer side of loop. Choose the **CORRECT** option(s)



(A) The value of $T_1 = T_2 = \dfrac{mg}{2}$ (B) The value of $T_1 = \dfrac{mg-2ibB}{2}$

(C) The value of $T_2 = \dfrac{mg+2ibB}{2}$ (D) The value of $T_1 < \text{value of } T_2$

8. A bob of mass M is rotating on smooth horizontal table with constant angular speed ω on a circular path with the help of an elastic wire of mass m $(m<<M)$, length ℓ, specific heat s, area of cross-section A and young's modulus Y. Then:

(A) The increase in length of wire $\dfrac{\ell}{\left(\dfrac{YA}{M\ell\omega^2}-1\right)}$

(B) The increase in length of wire $\dfrac{\ell}{\left(\dfrac{YA}{2M\ell\omega^2}-1\right)}$

(C) If the bob snaps then the rise in temperature of wire is more than $\dfrac{YA\ell}{2ms}\left(\dfrac{1}{\dfrac{YA}{2M\ell\omega^2}-1}\right)^2$ (ignore radiation loses)

(D) If the bob snaps then the rise in temperature of wire is less than $\dfrac{YA\ell}{2ms}\left(\dfrac{1}{\dfrac{YA}{M\ell\omega^2}-1}\right)^2$ (ignore radiation loses)

Space for Rough work

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 9 and 10

Thick lenses are used in cameras whose focal length is defined as $\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}+\frac{(\mu-1)d}{\mu R_1R_2}\right)$ where R_1 and R_2 are radius of curvature, d is the thickness of lens and μ is refractive index of the material of lens.

9. Focal length of a convex lens having $R_1=20\text{cm}$, $R_2=40\text{cm}, d=1\text{cm and } \mu=3/2$

(A) 26.67cm	(B) 26.7cm
(C) 26.8cm	(D) 26.9cm

10. Focal length of a sphere of radius 30cm and having $\mu=3/2$

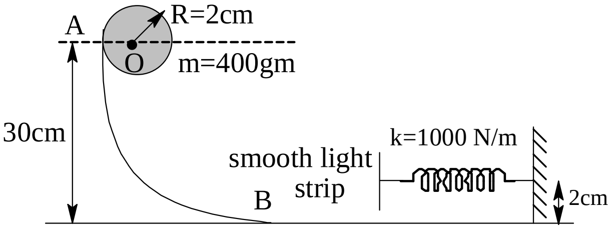
(A) 36cm	(B) 45cm
(C) 60cm	(D) 90cm

SECTION – C

(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

11. A uniform solid sphere of mass m=400gm and radius R=2cm is released from rest from a point A of a sufficiently rough slide AB. Initially, the centre O of the sphere is at the horizontal level of A. At the lower end B, the slide passes to smooth horizontal plane. A spring is attached to a wall on the horizontal plane. Find the maximum compression (in cm) of the spring in the process of motion of the sphere. (Take $g=10\text{m/s}^2$)

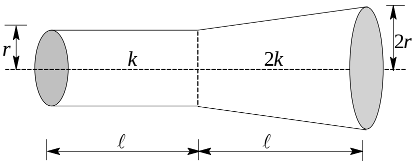


Space for Rough work

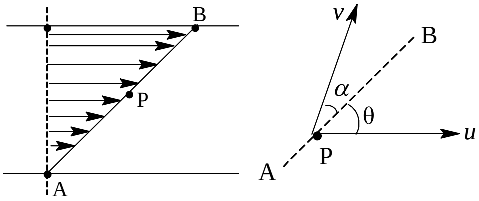
12. A conductor has a temperature independent resistance R & a total heat capacity 4 unit. At the moment $t = 0$ it is connected to a D.C. voltage V. If time dependence of the conductor's temperature assuming the thermal power dissipated in surrounding varies as $\text{q=4}\left(\text{T-T}_0\right)$ equal to $\text{T=T}_0 + \frac{\text{V}^2}{4\text{R}}\left(1 - e^{-\text{Nt}}\right)$ find value of N where T_0 is surrounding temperature equal to initial temperature of conductor.

13. A circular ring of radius R & mass m made by a uniform wire of cross-sectional area A is rotated about a stationary vertical axis passing through its centre & perpendicular to the plane of the ring. If young's modulus of material of ring is Y & increment in radius of ring equals to $\frac{\text{mR}^2\omega^2}{\text{N}\pi\text{AY}}$ without breaking find value of N. If breaking stress of ring is σ.

14. A composite object is formed by combining a uniform rod of circular cross-section with thermal conductivity k and a frustum with thermal conductivity 2k as shown in the figure. The equivalent thermal conductivity of the object is given as $\frac{\text{Nk}}{5}$, find $'\text{N}'$.

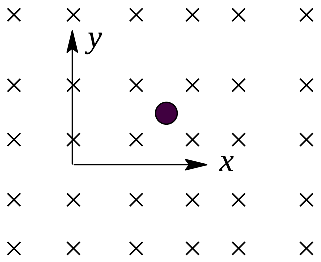


15. A river is flowing horizontally with a constant velocity gradient along its width. Its velocity from one bank to another varies from zero to u. A swimmer swims with a constant speed v w.r.t water such that he is always heading along the line AB w.r.t ground as shown. If the angle made by velocity of swimmer in still water varies from 45° to 75° with the river flow while going from A to B, if this angle is $\sin^{-1}\left(\frac{1}{\text{N}}\right)$ with line AB at the mid-point of the river, find $'\text{N}'$.

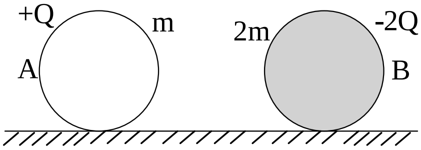


Space for Rough work

16. A neutral particle at rest in a uniform magnetic field B as shown in figure. The particle then spontaneously decays into two fragments, one with a positive charge $+q$ and mass $3m$ and other with a negative charge $-q$ and mass m. Neglecting the interaction between two charge particles and assuming speed is very much less than speed of light. The time $(in\,\mu s)$ after the decay at which two fragments meet(for first time) is $250\times N$. Find the value of N : (Neglect gravity) $\left(q=1\mu c, B=2\pi\mu T, m=10^{-15}kg\right)$. Both charges have velocity in xy plane



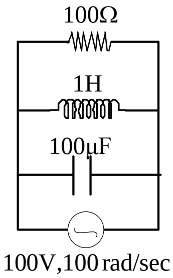
17. A hollow non conducting sphere A and a solid non conducting sphere B of equal radii R and masses m and $2m$ are kept at a large distance apart on a rough horizontal non conducting surface. Charges at A and B are Q and $-2Q$ respectively. Charges are uniformly distributed and remain constant and uniform as sphere come closer. Friction is sufficient to support pure rolling. Kinetic energy of the two spheres just before collision is K_A and K_B. Find $\left(\frac{K_B}{K_A}\times\frac{42}{5}\right)$.



18. The nozzle at the end of pipe has holes of equal area from which water ejects in all possible direction with speed $50\,m/s$. If in a park the nozzle is at a height of 8 meter above the ground. The maximum area (in km^2) which will get wet is nearly $\frac{N}{10}$. Find N.

Space for Rough work

19. An alternating current source is connected with three circuit elements as shown in the figure. Find the current $\left(\text{in Ampere}\right)$ passing through the AC source?



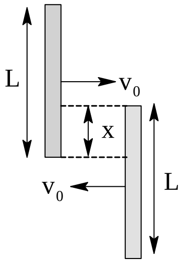
20. A charge particle having specific charge 1C/kg is projected parallel to x-axis from a point $\left(0,5\right)$ meters on the y-axis in the x-y plane with velocity $8\hat{i}\ m/s$ in a magnetic field which varies along x-axis as $\vec{B}=B_0\,x\hat{k}$ where $B_0=1$ tesla/meter. Find the maximum value of x (in meter) (neglect gravity).

SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

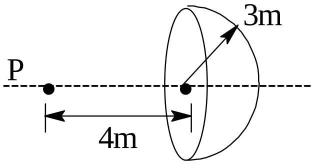
---

21. Two identical rigid rods, each of mass 1kg & length $\sqrt{3}\text{m}$, are moving opposite to each other without rotation on a smooth horizontal table as shown. For what maximum value of 'x' (after rounding off), the direction of motion of each rod would not change after collision, irrespective of the type of collision. Assume no sticking.

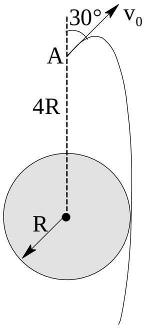


Space for Rough work

22. A point source of power 'P' is placed on the axis of a thin hemispherical shell as shown. The shell has a radius of 3m and behaves like a perfect black body. If the steady state temperature of shell is T. Find T^4 (after rounding off). (Take $P = 2400\pi\sigma$ W, σ = stefan's const.).



23. A particle is projected from point 'A', that is at a distance 4R from the centre of the Earth, with speed v_0 as shown. If the particle passes grazing the earth's surface, then it is found that $v_0 = 100 \times N$. Find the value of N (after rounding off). [Take $\frac{GM}{R} = 6.4 \times 10^7\ m^2/s^2$, $\sqrt{2} = 1.414$]



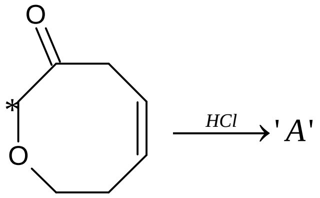
Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

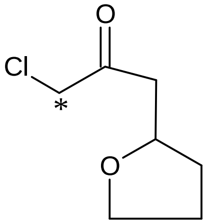
This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

24.

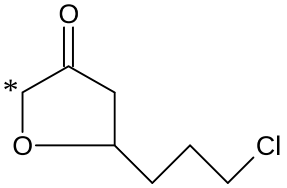


Which of the following is the correct structure of compound 'A' as major product?

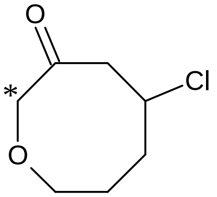
(A)



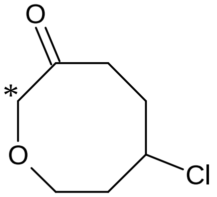
(B)



(C)



(D)



25. Which of the following solution will show positive deviation from ideal behaviour (Raoult's law)

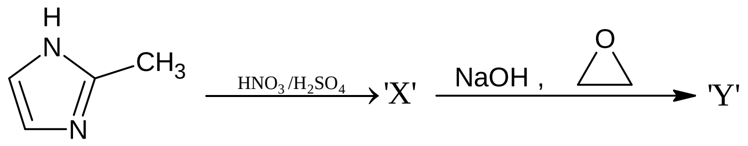
(A) Acetone+CS_2

(B) Benzene+toluene

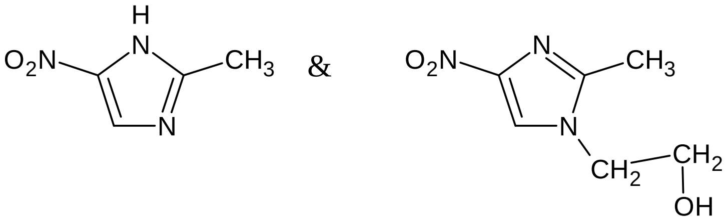
(C) Acetone+chloroform

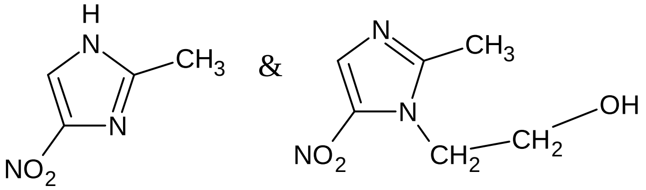
(D) Octanol+water

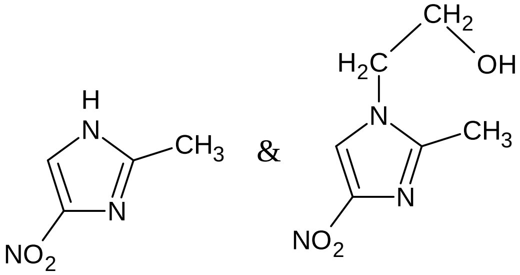
Space for Rough work

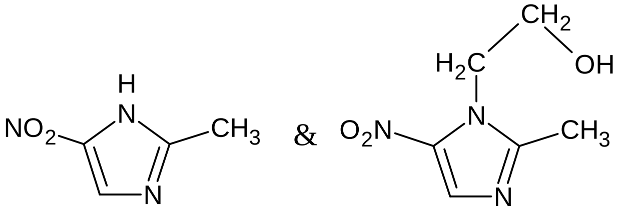
26. 

The respective structure of X & Y are?

(A) 

(B) 

(C) 

(D) 

Space for Rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

27. Which of the following statements are correct about nitrogen oxides and oxyions?

(A) Colourless, diamagnetic N_2O_4 has a weak $N\text{-}N$ bond that can readily dissociate to give the brown, paramagnetic NO_2

(B) N_2O_5 has $N\text{-}O\text{-}N$ bent bond in gaseous state and consists of NO_2^+ and NO_3^- ions in the solid state.

(C) Nitric oxide is formed by the action of lightening on atmospheric N_2 and O_2. In atmosphere, NO is oxidised to NO_2. These gases, often collectively designated as NO_x, contribute to the problem of acid rain, primarily because $3NO_2 + H_2O \to 2HNO_3 + NO$.

(D) Ammonia is reacted with oxygen using a Platinum-Rhodium gauze catalyst to form nitric oxide, however in absence of catalyst NH_3 can be oxidised to form N_2, as

$$4NH_3 + 3O_2 \longrightarrow 2N_2 + 6H_2O$$

28. The correct statements about some of the ions of 3d-series in aqueous solution

(A) Cr^{2+} is better reducing agent than Fe^{3+}

(B) Co^{3+} is better oxidising agent than Fe^{3+}.

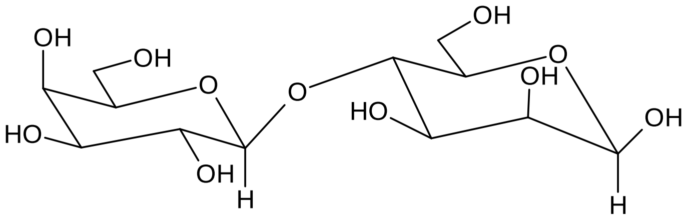
(C) When Fe^{3+} is used as oxidising agent, it attains $3d^7$ electronic configuration

(D) Cu is the only metal in 3d series, which is not having ability to displace hydrogen as H_2 from acidic solution (consider thermodynamic aspects).

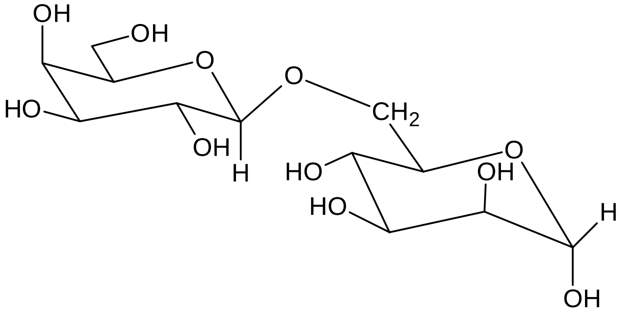
Space for Rough work

29. An unknown carbohydrate, formula $C_{12}H_{22}O_{11}$ reacts with Tollen's reagent to form a silver mirror. An α- glycosidase has no effect on the carbohydrate but a $\beta-$galactosidase hydrolyzes it to D-galactose (C_4-epimers of D-glucose) and D-mannose (C_2-epimers of D-glucose). When the carbohydrate is methylated (using methyl iodide and silver oxide) and then hydrolyzed with dilute HCl, the products are 2,3,4,6-tetra-O-methyl galactose and 2,3,4 tri-O-methyl mannose. Which of the following is not correct structure of unknown carbohydrate?

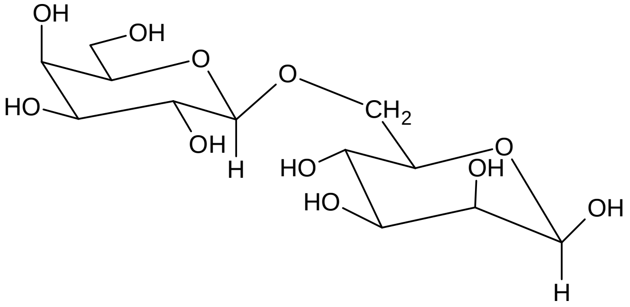
(A)


OH
OH
O
HO
OH
H
O
OH
O
OH
HO
OH
H

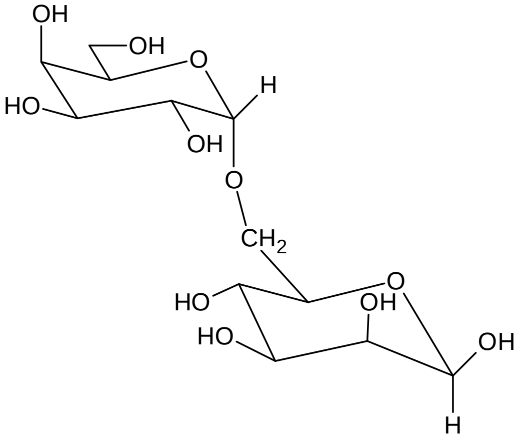
(B)


OH
OH
O
HO
OH
H
O
CH2
O
HO
OH
HO
H
OH

(C)


OH
OH
O
HO
OH
H
O
CH2
O
HO
OH
HO
OH
H

(D)


OH
OH
O
H
HO
OH
O
CH2
O
HO
OH
HO
OH
H

30. Step-I: 0.5ltr of saturated $\text{Mg}(\text{OH})_2(\text{aq.})$ is in contact with $\text{Mg}(\text{OH})_2(\text{s})$

Step-II: 0.5ltr of H_2O is added to 0.5ltr of solution in step (I) and the solution is vigorously stirred, undissolved $\text{Mg}(\text{OH})_2(\text{s})$ remains.

Step-III: 100ml of the clear solution in step (II) is removed and added to 0.5ltr of $0.1\text{M HCl}(\text{aq.})$

Step-IV: 25ml of the clear solution in step (II) is removed and added to 225ml of $0.060\text{M MgCl}_2(\text{aq.})$ $(\text{K}_{\text{SP}}, \text{Mg(OH)}_2 = 3.2\times10^{-11})$

Which of the following are correct choices about above steps:

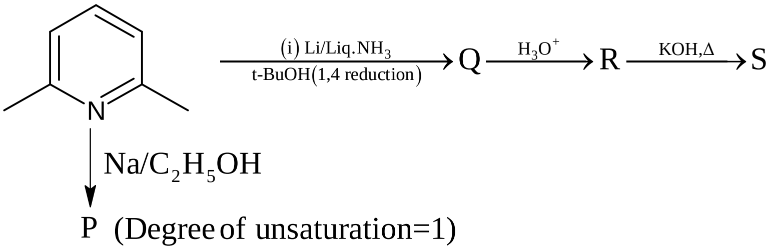
(A) Concentration of $\text{Mg}^{2+}(\text{aq.})$ in step (II) is $2\times10^{-4}\text{M}$

(B) Concentration of $\text{Mg}^{2+}(\text{aq.})$ in step (III) is $3.33\times10^{-5}\text{M}$

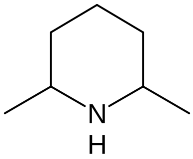
(C) Concentration of $\text{Mg}^{2+}(\text{aq.})$ in step (IV) is nearly equal to 0.054M

(D) Precipitation of $\text{Mg}(\text{OH})_2(\text{s})$ will occurs in step (III)

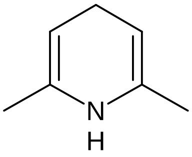
31. Which of the following are the correct statement(s) about the reaction given?



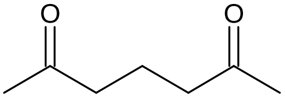
(A) 'P' is



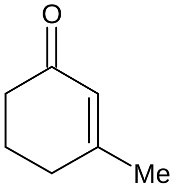
(B) 'Q' is



(C) 'R' is



(D) 'S' is



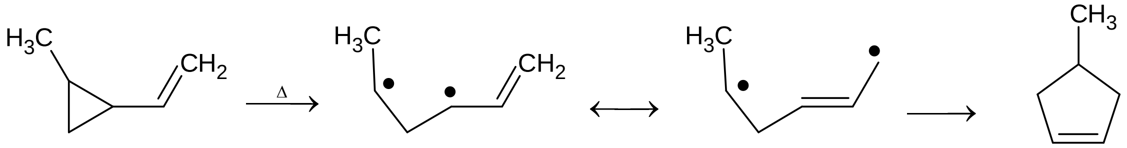
Space for Rough work

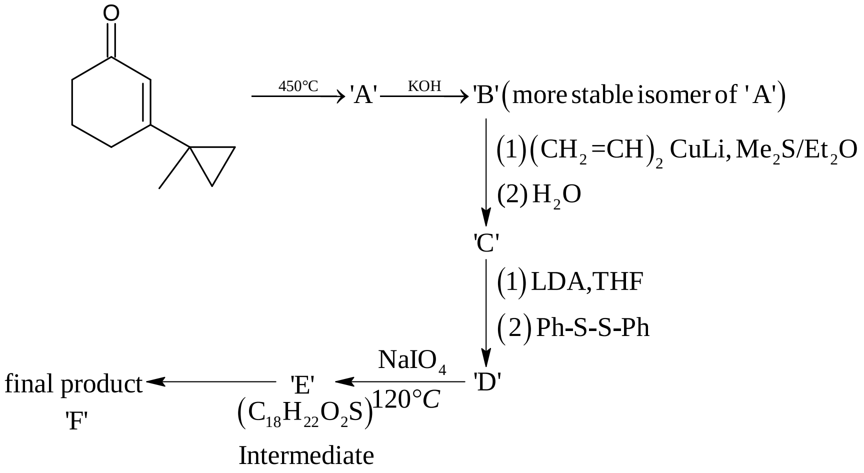
(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 32 and 33

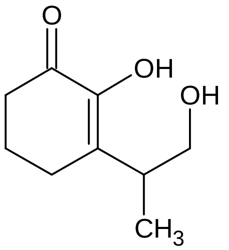
The vinyl cyclopropane undergoes the following rearrangement upon heating


H₃C
CH₂
Δ
H₃C
CH₂
H₃C
CH₃

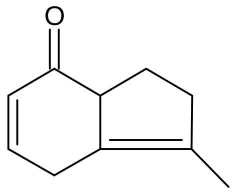

O
450°C
'A'
KOH
'B'(more stable isomer of 'A')
(1)(CH₂=CH)₂ CuLi, Me₂S/Et₂O
(2) H₂O
'C'
(1) LDA,THF
(2) Ph-S-S-Ph
'D'
NaIO₄
120°C
'E'
(C₁₈H₂₂O₂S)
Intermediate
final product
'F'

32. The compound 'B' will be:

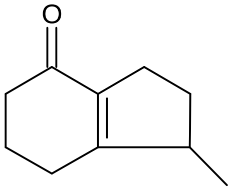
(A)



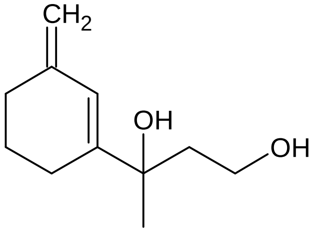
(B)



(C)

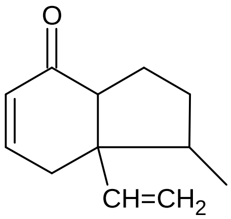


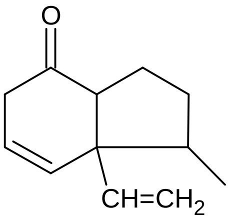
(D)

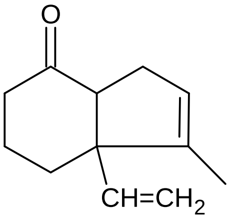


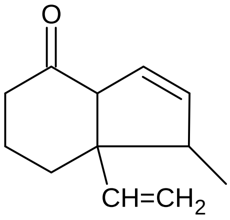
Space for Rough work

33. Compound 'F' will be:

(A)


(B)


(C)


(D)


SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

34. CH_3COOH and CF_3COOH in their aqueous solution ionises as:

(I) $CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

$K_{a_1}, \Delta G_1^\circ, \Delta S_1^\circ$ are acid dissociation constant, standard free energy change & standard entropy change respectively, for dissociation of acetic acid

(II) $CF_3COOH + H_2O \rightleftharpoons CF_3COO^- + H_3O^+$

$K_{a_2}, \Delta G_2^\circ, \Delta S_2^\circ$ are acid dissociation constant, standard free energy change & standard entropy change respectively, for dissociation of trifluoroacetic acid . If both solutions are $1M$ each then the number of correct statements amongst the following are? (enthalpy change for both reactions are almost same.)

(i) $K_{a_1} < K_{a_2}$

(ii) $\Delta G_1^\circ > \Delta G_2^\circ$

(iii) $\Delta G_1^\circ < \Delta G_2^\circ$

(iv) $\Delta S_1^\circ > \Delta S_2^\circ$

(v) $\Delta S_1^\circ = \Delta S_2^\circ$

(vi) ΔS_1° & ΔS_2° are both positive

(vii) ΔS_1° & ΔS_2° are both negative

(viii) $\Delta S_2^\circ > \Delta S_1^\circ$

Space for Rough work

35. 16 moles of $\mathrm{H_2}$ and 4 moles of $\mathrm{N_2}$ are sealed in one litre vessel. The vessel is heated at constant temperature until the equilibrium $N_2(g)+3H_2(g)\rightleftharpoons 2NH_3(g)$ is established; it is found that the pressure in the vessel has fallen to $\frac{9}{10}\mathrm{th}$ of its original value $(\mathrm{P\,atms})$. Now 'x' moles of an inert gas is added to the equilibrium mixture till the original pressure $(\mathrm{P\,atms})$ is attained. The value of 'x' is?

36. The CFSE $\left(\mathrm{E_{in\,octahedral\,field}\text{-}E_{symmetric\,field}}\right)$ for octahedral complex for d^7 electronic configuration is $'x'\,\mathrm{kJ/mol}$, the value of $\left|\frac{x}{10}\right|$

$[\Delta_0 = 87.5\,\mathrm{kJ/mole,\ Pairing\ energy{=}90\,kJ/mole}]$

37. Molar conductivity of 0.0625M KCl is $120\,\mathrm{S\,cm^2\,mol^{-1}}$. The molar conductivity of $\left(\frac{x}{100}\right)$ molar NaCl is $90\,\mathrm{S\,cm^2\,mol^{-1}}$. The value of $'x'$ will be:

$[\Lambda^0_{\mathrm{Na^+}} = 50\mathrm{Scm^2mol^{-1}},\ \Lambda^0_{\mathrm{Cl^-}} = 76\mathrm{Scm^2mol^{-1}},\ \Lambda^0_{\mathrm{K^+}} = 74\mathrm{Scm^2mol^{-1}}]$

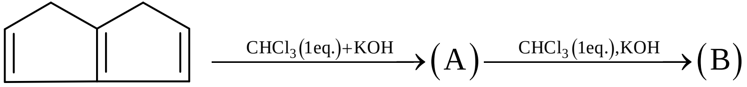
38. How many of the following chemical compound (s) / ion (s) has lone pair(s) at equatorial position of central atom?

$\mathrm{ClF_3, XeF_2, SF_4, IF_5, [SbF_4]^-, [SF_5]^-, IOF_4^-, SOF_4, XeOF_2}$

39. The degeneracy of 2nd excited state $(n=3)$ of H atom is 18 then the degeneracy of first excited state of $\mathrm{H^-}$ ion is?

Space for Rough work

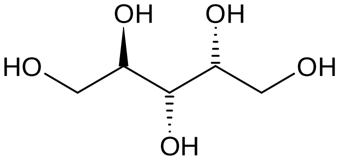
40. Number of plane (s) of symmetry in the product B is/are


$\xrightarrow{CHCl_3(1eq.)+KOH}(A)\xrightarrow{CHCl_3(1eq.),KOH}(B)$

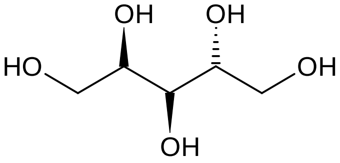
41. The total number of compounds whose aqueous solution turns Red litmus paper blue is:
$LiCN, NH_4Cl, KCl, Na_2CO_3, (NH_4)_2C_2O_4, AgNO_3, NaHSO_4, NaHCO_3$

42. How many of the following are carbonates or sulphides ores:
Chalcocite, Argentite, Horn silver, Siderite, Azurite, Limestone, Magnesite, Kieserite

43. The specific rotation of 'A' is +60^0. A sample made up of 1gm of 'A' and 0.5gm of 'B' present in 10 ml of solution and placed in 10 cm cell of the polarimeter. The observed rotation of this sample 'x 'degree. The value of 'x':



(A)



(B)

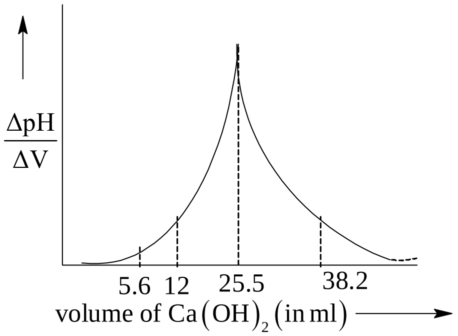
Space for Rough work

SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

44. A pellet of naphthalene of mass 1.28 g is burnt in a bomb calorimeter with heat capacity 14000 J/K. If the initial temperature is 300K and final temperature is 302K. The $\left|\Delta H_{\text{reaction}}\right|$ for 1 mole of Napthalene at 300 K in KJ/mole (consider reactant & products at 300K).
$[\text{At. wt. of C}=12, \quad C_{V,\,CO_2(g)}=35\text{Jmol}^{-1}\text{K}^{-1} \text{ and } R=8.3\text{Jmol}^{-1}\text{K}^{-1}$
$\text{At. wt. of H}=1,\ C_{V,\,H_2O(l)}=75\text{Jmol}^{-1}\text{K}^{-1}$, heat capacity of $CO_2(g)$ & $H_2O(\ell)$ are taken as constant in this temperature range].

45. A schematic graph of the first derivative of the pH curve is plotted for the titration of 10ml of unknown HCl solution by using $0.2\text{M}\ Ca(OH)_2$, as shown:



The concentration of HCl solution will be ______M .

46. Calcium crystallizes in FCC with unit cell length of $(0.18)^{1/3}$ nm. This sample of calcium is having 0.1% Schottky defect. The density of the crystal is ______ gm/cm^3.
$[\text{Atomic weight of Ca}=40, N_A=6\times10^{23}]$

Space for Rough work

Mathematics PART – III

SECTION – A

(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

47. The number of solution(s) of the equation $2\tan^{-1}\left(\sec^2 \pi x\right) = \sin^{-1}\left(x^3 - x^2 + x + 2\right)$ is:

(A) 0 (B) 1

(C) 2 (D) 3

48. If $W = 2^4.3^2.5$ then number of factors of W^2 which are less than W but are not factors of W is:

(A) 36 (B) 132

(C) 66 (D) 38

49. Let S_1 be the locus of the point $'P'$ which moves such that $\mathrm{OP}=1$ unit. The plane $x + y + z = 1$ cuts the curve S_1 in another curve S_2. Find the volume of solid formed by joining the point O with every point on the curve S_2. (O is origin)

(A) $\frac{2\pi}{27}\sqrt{3}$ (B) $\frac{3\pi}{\sqrt{2}}$

(C) 4π (D) $\frac{4\sqrt{3}\pi}{7}$

Space for Rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

50. Let $f:\mathbb{R}\to\mathbb{R}\, and\, g:\mathbb{R}\to\mathbb{R}$ be two functions,

$f(x)=|x|\left[x^2-1\right]$ & $g(x)=|x|+\left[x^2-1\right]$ then (where $[.]$ denotes G.I.F.)

(A) f is discontinuous exactly at five points in $[-1,2]$

(B) g is discontinuous exactly at five points in $[-1,2]$

(C) $\int_{-\frac{1}{2}}^{\frac{1}{2}}\left(f(x)-g(x)\right)dx=\frac{1}{2}$

(D) $\int_{-\frac{1}{2}}^{\frac{1}{2}}\left(f(x)-g(x)\right)dx=1$

51. Let A be a subset of set $S, S=\{1,2,.......7n\}$ having maximum possible elements, say m, such that sum of no two elements of it is divisible by 7. Which of the following option is/are correct?

(A) $\frac{m}{n}=3$

(B) $m-3n=1$

(C) The total number of ways in which A can be constructed is 8.

(D) The total number of ways in which A can be constructed is 8n

52. $P(x)\,\&\,Q(x)$ are two quadratic expressions with leading coefficients being one, such that $P(x)Q(x)=Q(P(x))\,\forall x\in R$ then.

(A) $Q(0)=0$

(B) $P(1)=1$

(C) $Q(x)=P(x)+Q'(0)$

(D) $P(1)=2$

Space for Rough work

53. Two triangles $\Delta \mathrm{ABC}$ & $\Delta \mathrm{DEF}$ are non congruent but have 5 elements equal (out of 3 side lengths & 3 angles). Which of the following statements are true?
(A) Side length of given triangles are in G.P
(B) It is possible to construct $\Delta \mathrm{ABC}$ with side lengths $1 \& 9$
(C) It is possible to construct $\Delta \mathrm{DEF}$ with side lengths $1 \& \sqrt{2}$
(D) It is not possible to have triangle ΔABC such that its sides are in A.P.

54. Let $\int_0^{\pi} \left(8\sin^2 x\cos x - f(x)\right) f(x)\,dx = \pi$, then which of the options are correct.

(A) $\int_0^{\pi/2} f(x)\,dx = \frac{4}{3}$
(B) $f(x)$ is periodic function with period 2π
(C) $f(x)$ is even function
(D) $\int_0^{\pi} f(x)\,dx = 0$

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 55 and 56

Let C be a variable point in the first quadrant on the line $x + y = 1$ which intersects X and Y axes at A and B respectively. D and E are foot of perpendiculars from C on X and Y axes respectively. Let P be a point on the line segment joining D and E.

55. For all its possible positions, P will satisfy the inequality:
(A) $xy \ge \frac{1}{16}$
(B) $xy \le \frac{1}{16}$
(C) $xy \ge \frac{1}{32}$
(D) $xy \le \frac{1}{32}$

56. The area of the region traced by the point P, is:
(A) $\frac{1}{16}\ln 2$
(B) $\frac{1}{2}$
(C) $\frac{1}{4}$
(D) $\frac{1}{6}$

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

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57. Let α_i be the solution of equation $\sin 2x = e^{-x}, \alpha_i \in [0, 2\pi] \,\&\, i = 1, 2, 3, 4$ also $f(x) = (x + \ln\sin 2\alpha_1)(x + \ln\sin 2\alpha_2)(x + \ln\sin 2\alpha_3)(x + \ln\sin 2\alpha_4) + \tan x$. The value of $\sum_{i=1}^{4} e^{-\alpha_i}\left(f(\alpha_i) + \frac{1}{f(\alpha_i)}\right)$ is.

58. The ordered triplet (α, β, γ) satisfies following equations
$x + y + 3z = 1, x - y + z = 1, ax + (a+b)y + 6z = 1, (a, b \in R)$
If $\alpha^2 + \beta^2 + \gamma^2$ is minimum, then minimum value of $a^2 + b^2$ is:

59. The value of $\frac{1}{3}\left(\sum_{k=0}^{14}(-1)^k (15-k)\ {}^{17}C_k\right)$ is.

60. If $r^{th}, (r+2)^{th}$, $(r+6)^{th}$ terms of an increasing A.P are last three terms of a G.P. and there lies exactly $2p+1$ number of terms of that G.P in the interval $(p,\ 2018p)(p \in N)$ then maximum value of p is____

61. $f : R \to R\ \ f(x) = x^4 - x^2 + 1$. The number of values of x for which $f(f(f(x))) \le x^8$ is.

Space for Rough work

62. Consider, $f\left(t\right)=\frac{1}{4}t^2\left|\sin x\right|-t\sin x+4,\ t,x\in R$.

If $I_1=\int\limits_0^{\pi/2}\left(\min\left\{f\left(t\right)\right\}\right)dx$ and $I_2=\min\left\{\int\limits_0^{\pi/2}f\left(t\right)dx\right\}$ then $\left|I_1-I_2\right|$

[Note: $\min\left(g\left(t\right)\right)$ denotes minimum value of $g\left(t\right)$ for $t\in R$]

63. The number of integral values of x for which $2x^2+x-6$ is a positive integral power of a positive prime is

64. If a,b,c are real numbers such that $a+b+c=0$, then value of

$$\frac{\left(ab\right)^2}{\left(a^2-bc\right)\left(b^2-ca\right)}+\frac{\left(bc\right)^2}{\left(b^2-ca\right)\left(c^2-ab\right)}+\frac{\left(ac\right)^2}{\left(a^2-bc\right)\left(c^2-ab\right)}$$ is:

65. Let $f:R\to R$ be a real function such that $f(x+1)+f(x-1)=\sqrt{3}f(x)\ \forall x\in R$ and $f(2)=4$. If $f(x)=\lambda\cos\left(\frac{\pi x}{k}\right)$ then find $\lambda-k$ (where k is the positive integer)

66. Let two lattice points are chosen at random from the set of $S=\left\{\left(x,y\right):0\le x,y\le 7,x,y\in I\right\}$ with replacement. If P is the probability that area of triangle formed by these two chosen points and $\left(0,0\right)$ is an integer, possibly zero, then the value of 8P is:

Space for Rough work

SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

---

67. Cylinderical beaker of radius 11.5 cm is filled with water upto height of 15.7 cm. A solid cuboid of height 15.7 cm & square base of length 10.1 cm is dipped in it. Water evaporates at the rate proportional to area of water exposed to air (Proportionality constant, $\mu\, cm/\sec, \mu > 0$). Where solid cuboid sublimate at the constant rate of $\lambda\, cm^3/\sec$. If both water & solid vanishes at the same time, then $\frac{\lambda}{\mu}$ is

68. if $|z_i| = 12, i = 1, 2, 3, 4, 5 \,\&\, \sum_{i=1}^{5} z_i = \sum_{i=1}^{3} z_i = 0$ then, maximum value of $\sum_{1 \le i < j \le 5} \sum |z_i - z_j|^2$ is equal to

69. Three coloured boxes, i.e. **Red(R)**, **Blue(B)**, **Green(G)**, contains 3 balls each, of the same colours as that of the box. A ball is chosen from the **'R'** box and put in one of other two boxes. Again a ball is chosen randomly from the box '**B'** and put in one of other boxes. Same process is repeated with box '**G'**. If given that each box have equal number of balls after this process and P is the probability that composition of balls is not exactly same as in the beginning of random experiment, then value of 8P is:

Space for Rough work

FIITJEE **JEE(Advanced)-2018**

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ANSWERS, HINTS & SOLUTIONS

FULL TEST – VIII

PAPER-2

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**A**	24.	**B**	47.	**A**
2.	**C**	25.	**A**	48.	**D**
3.	**B**	26.	**D**	49.	**A**
4.	**ABD**	27.	**ABCD**	50.	**ABC**
5.	**BC**	28.	**ABD**	51.	**BD**
6.	**AC**	29.	**AD**	52.	**ABC**
7.	**BCD**	30.	**ABC**	53.	**ACD**
8.	**AD**	31.	**ABCD**	54.	**ABCD**
9.	**C**	32.	**C**	55.	**B**
10.	**B**	33.	**A**	56.	**D**
11.	**4**	34.	**4**	57.	**8**
12.	**1**	35.	**2**	58.	**9**
13.	**2**	36.	**7**	59.	**5**
14.	**6**	37.	**9**	60.	**5**
15.	**4**	38.	**5**	61.	**2**
16.	**3**	39.	**4**	62.	**0**
17.	**5**	40.	**2**	63.	**3**
18.	**2**	41.	**3**	64.	**1**
19.	**1**	42.	**6**	65.	**2**
20.	**4**	43.	**9**	66.	**5**
21.	**00000.73**	44.	**02806.28**	67.	**00102.01**
22.	**00008.89**	45.	**00001.02**	68.	**03600.00**
23.	**00056.56**	46.	**00001.48**	69.	**00007.75**

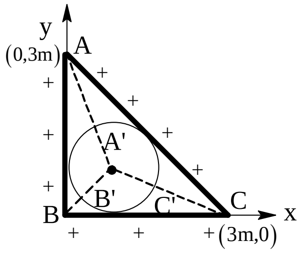
Physics

PART – I

SECTION – A

1. A

Field due to arc A'B' is equal to field due to side AB at the centre of arc. Similarly it will hold for other pairs also. So the field at the incentre is zero.



$$\text{x}=\frac{ax_1+bx_2+cx_3}{a+b+c}\Rightarrow y=\frac{ay_1+by_2+cy_3}{a+b+c}$$

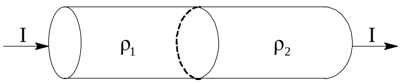
$$\text{x}=\frac{3}{2+\sqrt{2}}\text{m}\text{ , y}=\frac{3}{2+\sqrt{2}}\text{m}$$

2. C

Since water in the smaller vessel is taking heat from the water in the large vessel. It can reach to a temperature $100^\circ C$. Since the temperature of water in the large vessel cannot go beyond 100°C before boiling completely. Hence water in the smaller vessel will not take heat from the water outside, it will not boil.

3. B

Magnitude of flux



$$=\left|E_2-E_1\right|A=\left|\rho_2-\rho_1\right|\,I=\frac{q}{\in_0}$$

$$q=\in_0 I\left|\rho_1-\rho_2\right|$$

4. ABD

$$\text{T}+\frac{2}{3}(200)=20\left(\frac{1}{2}\right)16\Rightarrow T=80/3N \text{ and } \frac{80}{3}+f=10\left(\frac{1}{5}\right)4^2\Rightarrow f=\frac{16}{3}N$$

For maximum value

$$\text{of}\,\omega\Rightarrow T+400/3=20\left(\frac{1}{2}\right)\omega^2\ \&\ T-\frac{2}{3}\times 100=10\left(\frac{1}{5}\right)\omega^2\Rightarrow\omega=5\text{rad}/\sec$$

5. BC

$$\text{e}=\text{B}_0v_0(2y)=4B_0v_0^{3/2}\sqrt{t}$$

$$i=\frac{e}{\lambda(2y)}=\frac{Bv_0}{\lambda}\qquad where\Rightarrow y=\sqrt{4v_0t}$$

$$F=\left(\frac{B_0v_0}{\lambda}\right)(2y)B_0=\frac{2B_0^2v_0y}{\lambda}=\frac{4B_0^2v_0^{3/2}}{\lambda}\sqrt{t}$$

$$p=\vec{F}.\vec{v}=\frac{2B_0^2v_0^2y}{\lambda}=\frac{4B_0^2v_0^{5/2}}{\lambda}\sqrt{t}$$

6. AC

From monkey frame

$$\vec{\text{v}}_{am}=\vec{v}_a-\vec{v}_m=40\hat{j}\,m/s$$

$$\text{time}=\frac{40}{40}=1\text{sec}$$

7. BCD

Taking torque about R.H. side of loop

$$mg\frac{\ell}{2}-T_1\ell-ibB=0$$

$$=-\pi nir^2B\hat{k}$$

8. AD

$Y=\frac{T/A}{x/\ell}$ where $T=M\left(\ell+x\right)\omega^2 \Rightarrow x=\frac{\ell}{\left(\frac{YA}{M\ell\omega^2}-1\right)}$

And $ms\Delta\theta=\Delta U$

$$\Delta\theta=\frac{YA\ell}{2ms}\left(\frac{1}{\frac{YA}{M\ell\omega^2}-1}\right)^2$$

9. C

10. B

SECTION – C

11. 4

Sol: For solid sphere under pure rolling motion

$$KE_{\text{translation}}=\frac{5}{7}KE_{\text{total}}=\frac{1}{2}KX_{\max}^2$$

$$\therefore X_{\max}=4\text{cm}$$

12. 1

$$\frac{V^2}{R}=4\left(T-T_0\right)+4\left(\frac{dT}{dt}\right)$$

$$\int_{T_0}^{T}\frac{dT}{\frac{V^2}{R}-4\left(T-T_0\right)}=\int_0^t\frac{dt}{C}\Rightarrow T=T_0+\frac{V^2}{4R}\left(1-e^{-t}\right)\Rightarrow N=1$$

13. 2

Sol. Hence $dm = \frac{1}{2\pi} d\theta$

Hence radial component of tension,

$= 2F \sin \frac{d\theta}{2} \simeq Fd\theta$

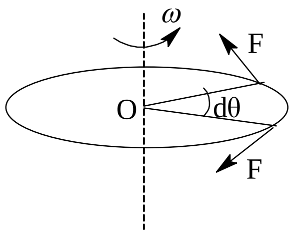
$Fd\theta = \frac{nd\theta}{2\pi}\omega^2 R \Rightarrow F = \frac{m\omega^2 R}{2\pi}$

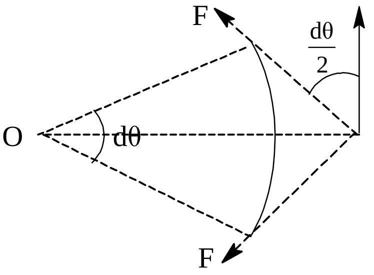
increment in radius is ΔR so elongation in length of ring

$\sigma = 2\pi\left(R+\Delta R\right) - 2\pi R = 2\pi\Delta R$

Strain $= \frac{\sigma}{2\pi R} = \frac{\Delta R}{R} \Rightarrow Y = \frac{\sigma}{\text{strain}} \Rightarrow \text{strain} = \frac{\sigma}{Y}$

$\frac{\Delta R}{R} = \frac{\sigma}{Y} \Rightarrow \Delta R = \frac{m\omega^2 R^2}{2\pi AY} = N = 2$





14. 6

Consider the object as two portion 'A uniform rod' and 'A frustum' with thermal resistance R_1 and R_2 respectively then

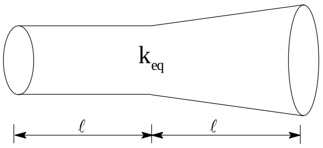
$R_1 = \frac{\ell_1}{k_1 A_1} = \frac{\ell}{k\pi r^2}$

And $R_2 = \frac{\ell_2}{k_2 A_2} = \frac{\ell}{(2k)(\pi r_1 r_2)} = \frac{\ell}{4k\pi r^2}$

$\therefore$ Equivalent thermal resistance $R_{eq} = R_1 + R_2$

$\Rightarrow R_{eq} = \frac{5\ell}{4k\pi r^2}$......................(1)

Now if we consider the same lamina with equivalent thermal conductivity K_{eq}, then



$R_{eq} = R_1 + R_2 = \frac{\ell}{k_{eq}\pi r^2} + \frac{\ell}{k_{eq}\left(2\pi r^2\right)} = \frac{3\ell}{2k_{eq}\pi r^2}$........(2)

By equating the terms of R_{eq} from eqn. (1) & (2), we get

$\frac{5\ell}{4k\pi r^2} = \frac{3\ell}{2k_{eq}\pi r^2}$

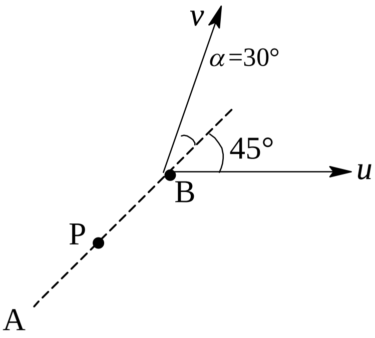
$k_{eq} = \frac{6k}{5}$

$\therefore N = 6$

15. 4

As initial angle of approach with horizontal is 45° whereas the river velocity is zero then θ=45°

At point B, $v_{S/G}$ along the perpendicular to line AB is zero



and $\alpha = 75° - 45° = 30°$

$$\therefore\ v\sin 30° = u\sin 45° \Rightarrow \frac{u}{v} = \frac{1}{\sqrt{2}}$$

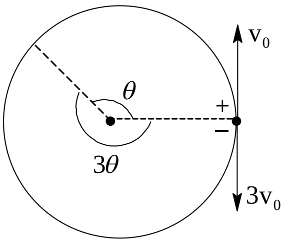
Also at midpoint P, $v_{river} = \dfrac{u}{2}$

$$\therefore\ v\sin\alpha = \frac{u}{2}\sin\theta \Rightarrow \sin\alpha = \frac{u}{2v}\sin 45° = \frac{1}{4}$$

$$\alpha = \sin^{-1}\left(\frac{1}{4}\right)$$

$$\therefore N = 4$$

16. 3



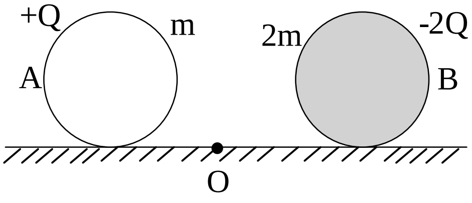
$$r = \frac{p}{qB} = same\ T_+ = \frac{2\pi\ m_+}{qB} T_- = \frac{2\pi\ m_-}{qB}$$

As $T_+ = 3T_-$ they will meet at $\theta = \pi/2$

Time is $\dfrac{T_+}{4} = \dfrac{6\pi m}{4qB} = (750\mu s) = 250\times 3\mu s$

17. 5

Let v_1 and v_2 the speed just before collision. Using COAM about point O on the ground



$$0 = mv_1R + \frac{2}{3}mR^2\frac{v_1}{R} - 2mv_2R - \frac{2}{5}2mR^2\left(\frac{v_2}{R}\right) \Rightarrow v_1 = \frac{42}{25}v_2$$

$$K_A = \frac{1}{2}mv_1^2 + \frac{1}{2}\frac{2}{3}mR^2\frac{v_1^2}{R^2} = \frac{1}{2}.mv_1^2\times\frac{5}{3}$$

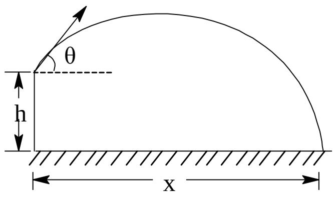
$$K_B = \frac{1}{2}2mv_2^2\left(1+\frac{2}{5}\right) = \frac{1}{2}mv_2^2\frac{14}{5}$$

$$\frac{K_B}{K_A} = \frac{42}{25}\left(\frac{v_2^2}{v_1^2}\right) = \frac{25}{42}$$

18. 2

$$\text{x=u}_x t - - - - - - (1)$$

$$-h = u_y t - \frac{1}{2}gt^2 - - - - (2)$$



Eliminating t and using $\sin\theta = \frac{u_y}{u}$ and $\cos\theta = \frac{u_x}{u}$ and substituting in equation (1) and (2)

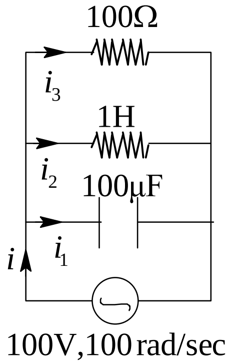
$$h\left(1+\cos 2\theta\right) = \frac{gx^2}{u^2} - x\sin 2\theta$$

Differentiating w.r.t.

$$\theta \text{ for maximum value of x} \Rightarrow \tan 2\theta = \frac{x}{h} \Rightarrow x = \sqrt{\frac{2u^2}{g}\left(h+\frac{u^2}{2g}\right)}$$

So maximum Area = $\pi x^2 = 209000m^2 \approx 0.2km^2$

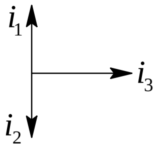
19. 1



$$\text{X}_L = wL = 100\Omega \Rightarrow X_C = \frac{1}{wc} = 100\Omega$$

$$\text{i}_1 = \frac{100}{100} = 1\text{A} \Rightarrow \text{i}_2 = \frac{100}{100} = 1\text{A} \Rightarrow \text{i}_3 = \frac{100}{100} = 1\text{A}$$

From phasor diagram



So $i = i_3 = 1\text{A}$

20. 4

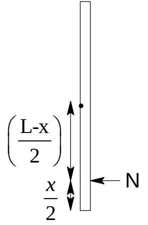
Using WET from a frame moving with velocity $8\left(-\hat{j}\right)m/s$

$$\int_0^{X_{\max}} qv_0 B_0 x\, dx \cos 180° = -\frac{1}{2}m\left(v_0\sqrt{2}\right)^2 \Rightarrow X_{\max} = 4\,meter$$

SECTION – D

21. 00000.73

Impulse due to 'N' would act at the centre of the colliding parts



Applying Impulse momentum theorem

$$-\int N.dt = M\left(v - v_0\right) \qquad ---(1)$$

& Applying Angular impulse, angular momentum theorem

$$\int N\left(\frac{L-x}{2}\right).dt = \frac{ML^2}{12}\omega \qquad ---(2)$$

Also $e = \dfrac{\omega\left(\dfrac{L-x}{2}\right) - v}{v_0}$ $\quad ---(3)$

From (1), (2) & (3)

$$v\left[1+3\left(\frac{L-x}{2}\right)^2\right] = v_0\left[3\frac{(L-x)^2}{L^2} - e\right]$$

$\therefore\ for\, v > 0$

$$x < L\left[1-\sqrt{\frac{e}{3}}\right]$$

For inequality to hold true for all ‘e’

$$x < L\left[1-\frac{1}{\sqrt{3}}\right]$$

$or\ x < \left(\sqrt{3}-1\right),\ \therefore x_{\max} = 0.732$

22. 00008.89

Power absorbed by shell

$$\Rightarrow \frac{\text{P}\times 2\pi\left(1\text{-}\cos 37\right)}{4\pi}$$

$$\Rightarrow \frac{\text{P}}{10}$$

For equilibrium

$$\Rightarrow \frac{P}{10} = 3\pi R^2 \sigma T^4$$

$$\therefore T^4 = \frac{P}{30\pi R^2\sigma} = \frac{2400\sigma\pi}{30\pi\times 9\times\sigma} \Rightarrow 8.89$$

23. 00056.56

Applying conservation of angular momentum w. r. t. the centre of earth,

$$4R\times mv_0 \sin 30 = mvR, v = 2v_0$$

Applying energy conservation

$$\frac{1}{2}m\left(2v_0\right)^2 - \frac{GMm}{R} = -\frac{GMm}{4R} + \frac{1}{2}mv_0^2$$

$$\therefore v_0 \Rightarrow \sqrt{\frac{GM}{2R}} \Rightarrow \sqrt{\frac{64\times 10^6}{2}} = 40\sqrt{2}\times 100 m/s$$

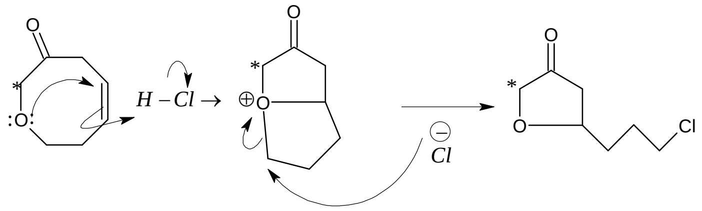
$$\therefore x = 40\sqrt{2} \Rightarrow 56.56$$

Chemistry PART – II

SECTION – A

24. B

Sol.

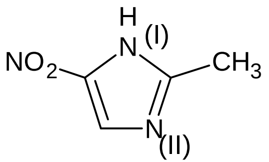


25. A

Octanol and water are insoluble.

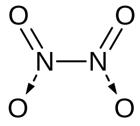
26. D

$'X' \quad =$

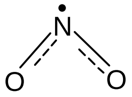


First step is EAS and in 2nd step $N^{(I)}$ is better nucleophile than other $N^{(II)}$.

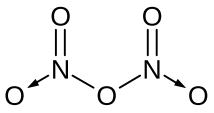
27. ABCD



diamagnetic because no unpaired electron



paramagnetic due to presence of unpaired electron.



HNO_3, H_2SO_4 etc. are responsible for acid rain

28. ABD

$$E^0_{Cr^{3+}/Cr^{2+}} < E^0_{Fe^{3+}/Fe^{2+}} < E^0_{Co^{3+}/Co^{2+}}$$

29. AD

Hydrolysis requires a $\beta-$galactosidase, showing that galactose and mannose are linked by a $\beta-$galactosidic linkage. For sugar to be reducing, one of the hexoses must have free hemiacetal form.

The methylation /hydrolysis procedure shows the point of attachment of the glycosidic bond to mannose. C_1 is anomeric carbon on mannose ring and both $\alpha-\beta$ forms satisfy the above conditions.

30. ABC

Step-I: $\left[Mg^{2+}\right]=\sqrt[3]{\frac{3.2\times10^{-11}}{4}}=2\times10^{-4}M$

Step-II: $\left[Mg^{2+}\right]=2\times10^{-4}M$

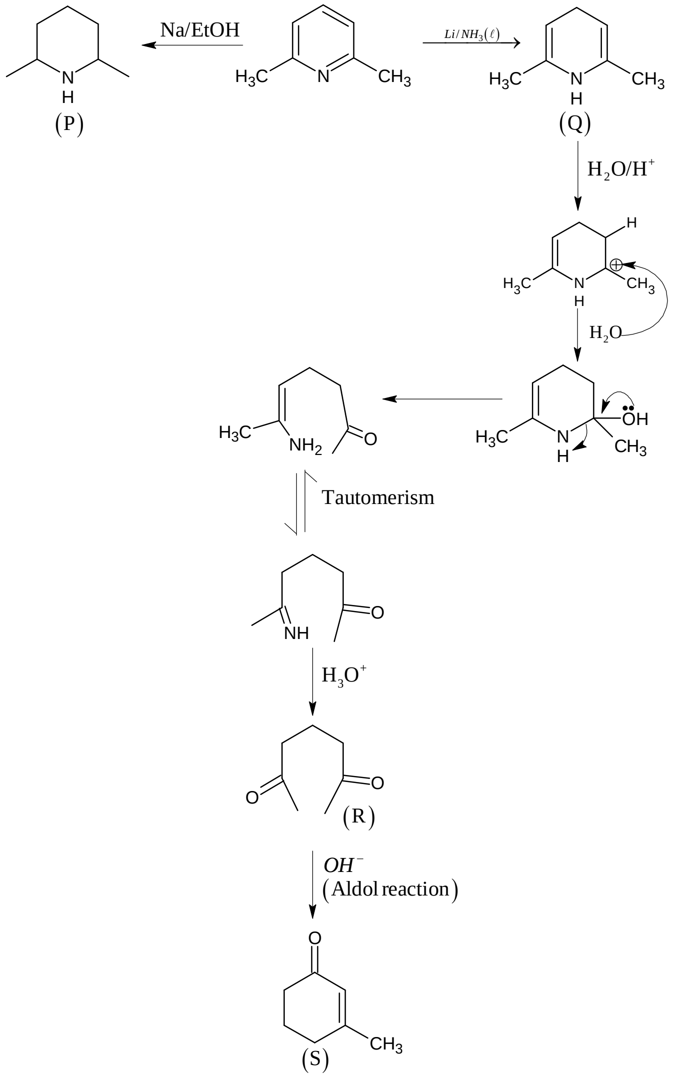
Step-III: $\left[Mg^{2+}\right]=2\times10^{-4}\times\frac{100}{\left(100+500\right)}=3.33\times10^{-5}M$

Step-IV:

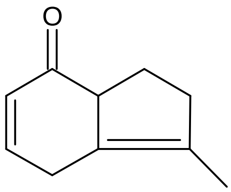
$Mg(OH)_2$ (25ml of 2×10^{-4}M or 0.005 mmole) is mixed with $MgCl_2$ (225ml of 0.06M or 13.5 mmole)

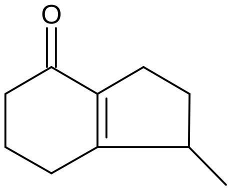
so $\left[Mg^{2+}\right]_{\text{mainly from } MgCl_2} \simeq \frac{13.5}{250}M$

31. ABCD

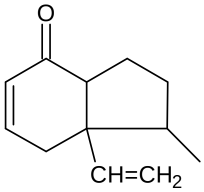

Na/EtOH
H$_3$C
N
CH$_3$
$Li/NH_3(\ell)$
N
H
(P)
H$_3$C
N
H
CH$_3$
(Q)
H$_2$O/H$^+$
H
H$_3$C
N
H
CH$_3$
H$_2$O
H$_3$C
NH$_2$
O
H$_3$C
N
H
OH
CH$_3$
Tautomerism
NH
O
H$_3$O$^+$
O
O
(R)
OH$^-$
(Aldol reaction)
O
CH$_3$
(S)

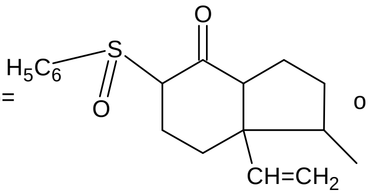
32. C

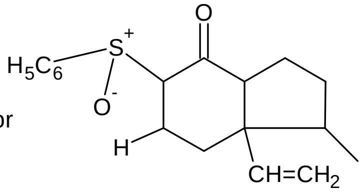
A=


B=


33. A

F=


(E)=


or


SECTION – C

34. 4

$$K_{a_2} > K_{a_1}$$

$$\Delta G^\circ = -RT \ln K_a$$

$\Delta G_1^\circ > \Delta G_2^\circ$, ΔG_1° and ΔG_2° are both +ve due to $K_a < 1$

$\Delta G_1^0 = \Delta H_1^0 - T\Delta S_1^0$ and $\Delta G_2^0 = \Delta H_2^0 - T\Delta S_2^0$

$$\Delta H_1^0 \simeq \Delta H_2^0$$

$\Rightarrow \Delta S_1^0$ is more negative than ΔS_2^0.

ΔS_1^0 and ΔS_2^0 both are negative because water is more organised due to hydration.

35. 2

$$\begin{array}{llll} & N_2 + & 3H_2 \rightleftharpoons & 2NH_3 \\ t=0 & 4 & 16 & - \\ t=t_{eq.} & 4-a & 16-3a & 2a \end{array}$$

$$P \times 1 = 20 \times R \times T$$

$$\frac{9}{10} P \times 1 = (20-2a) \times R \times T \Rightarrow a = 1$$

On adding 'x' moles of inert gas at constant volume, equilibrium composition does not change

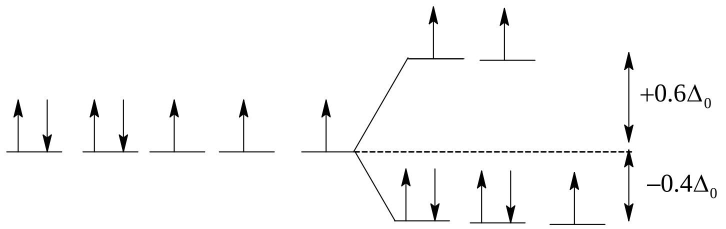
$$\frac{9}{10} \times P \times 1 = 18 \times R \times T$$

$$P \times 1 = (18 + x) RT$$

$$x = 2$$

36. 7

$$\text{CFSE} = E_{\text{ligand field}} - E_{\text{symmetric field}}$$



$$=\left[5\times\left(\frac{-2}{5}\Delta_0\right)+\left(2\times\frac{3}{5}\Delta_0\right)+2P\right]-2P$$

$$=\frac{-4}{5}\Delta_0$$

$$=\frac{-4}{5}\times 87.5=x=-70$$

$$\Rightarrow\left|\frac{x}{10}\right|=7$$

37. 9

$$\Lambda_m=\Lambda_m^0-A\sqrt{C}$$

For KCl

$$120=150-A\sqrt{0.0625}$$

$$A=120$$

'A' will remains same for KCl and NaCl (1:1 electrolyte)

For NaCl

$$90=126-120\sqrt{\frac{x}{100}}$$

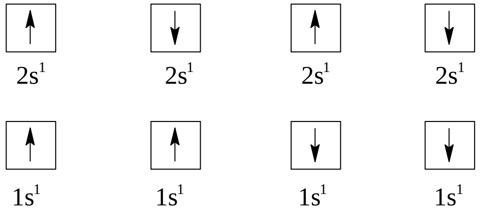
$$x=9$$

38. 5

$ClF_3, XeF_2, SF_4, [SbF_4]^-, XeOF_2$ are having lone pairs at equitorial position.

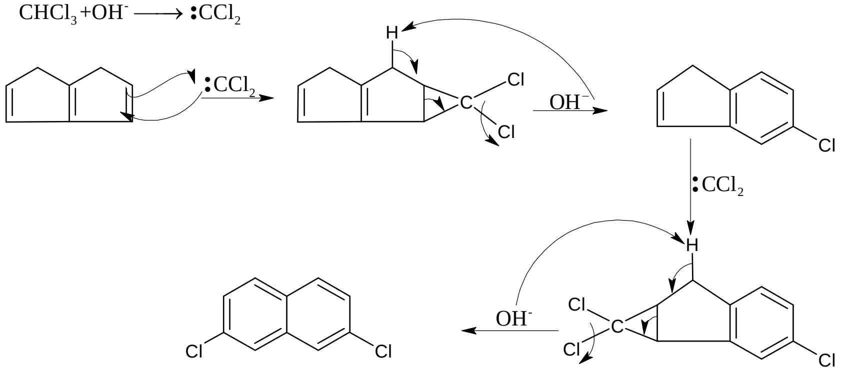
39. 4

degenerate states are



40. 2

$CHCl_3 + OH^- \longrightarrow :CCl_2$



It has two plane of symmetry

41. 3

$LiCN, Na_2CO_3, NaHCO_3$

42. 6

Chalcocite Cu_2S, Argentite Ag_2S, Horn silver AgCl, Siderite $FeCO_3$, Azurite $2CuCO_3.Cu(OH)_2$, Limestone $CaCO_3$. $MgCO_3$, Magnesite $MgCO_3$, Kieserite $MgSO_4.H_2O$

43. 9

A and B are same

$$[\alpha]_{sp.rot.} = \frac{\alpha_{obs.}}{c(g/ml)\times l(dm)}$$

$$60 = \frac{\alpha_{obs.}}{\frac{1.5}{10}\times 1}$$

$$\alpha_{obs.} = 9^0$$

SECTION – D

44. 02806.28

$$C_{10}H_8(s) + 12O_2(g) \longrightarrow 10CO_2(g) + 4H_2O(\ell)$$

For 1 mole Napthalene, heat liberated = $\frac{14000\times 2}{0.01} = 28\times 10^5$ J/mole

$$\Delta U = -28\times 10^5 \text{ J/mol}$$

$$\Delta U_{at300K} = -28\times 10^5 - [10\times 2\times 35 + 4\times 75\times 2]$$

(but here product and reactant both are at 300K)

$$= (-28\times 10^5 - 1300)J$$

$$= (-2800 - 1.3)kJ = -2801.3kJ$$

$$\Delta H = \Delta U + (\Delta n)_g RT$$

$$= -2801.3 + (-2)8.3\times 300\times 10^{-3}$$

$= -2801.3 - 4.98$

$= -2806.28$ KJ/mol

45. 00001.02

The rate of change of pH with the volume of alkali added is maximum at equivalence point.

So volume required to neutralisation = 25.5ml

$25.5 \times 2 \times 0.2 = M \times 1 \times 10$

So, $M = 1.02$

46. 00001.48

$Z = 4 \times 0.999$

$$d = \frac{4 \times 0.999 \times 40}{6 \times 10^{23}\left[(0.18)^{1/3} \times 10^{-7}\right]^3} \text{ gm/cm}^3$$

$= 1.48 \text{ g/cm}^3$

Mathematics PART – III

SECTION – A

47. A

$$2\tan^{-1}\left(\sec^2 \pi x\right) \geq \frac{\pi}{2} \ \ \& \ \sin^{-1}\left(x^3 - x^2 + x + 2\right) \leq \frac{\pi}{2}$$

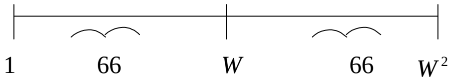
Equality holds if $x^3 - x^2 + x + 2 = 1$ & $\sec^2 \pi x = 1$

$\Rightarrow x^3 - x^2 + x + 1 = 0, \qquad x = n, n \in N$ but equation has no integral roots.

48. D

Sol. Factor of $W = 2^4.3^2.5^1 = 5 \times 3 \times 2 = 30$

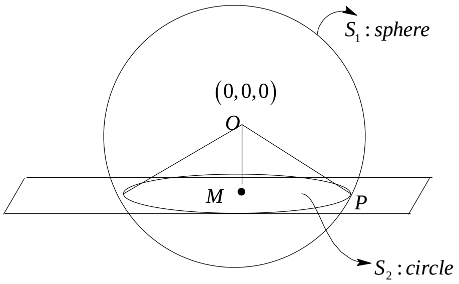
Factor of $W^2 = 2^8.3^4.5^2 = 9 \times 5 \times 3 = 135$



Hence $66 - 28 = 38$

49. A

Sol.



Plane: $x + y + z = 1$

Let OM be $\perp$ distance from 'O' to plane

$$\Rightarrow OM = \frac{1}{\sqrt{1^2 + 1^2 + 1^2}} = \frac{1}{\sqrt{3}}$$

$OP = 1(given)$

ΔOMP is a right angled triangle

$$\therefore MP = \sqrt{1 - \frac{1}{3}} = \sqrt{\frac{2}{3}}$$

The required curve is the cone with S_2 as circular base and vertex at $O(0,0,0)$

$$V = \frac{1}{3}\pi r^2 h = \frac{1}{3} \times \pi \times \left(\sqrt{\frac{2}{3}}\right)^2 \times \frac{1}{\sqrt{3}}$$

$$= \frac{2}{9\sqrt{3}}\pi = \frac{2\sqrt{3}}{27}\pi$$

50. ABC

Sol.

$$\left[x^2-1\right]=\begin{cases}0 & x=-1\\ -1 & -1<x<1\\ 0 & 1\le x<\sqrt{2}\\ 1 & \sqrt{2}\le x<\sqrt{3}\\ 2 & \sqrt{3}\le x<2\\ 3 & x=2\end{cases}$$

$$|x|\left[x^2-1\right]=\begin{cases}0 & x=-1\\ x & -1<x<0\\ -x & 0\le x<1\\ 0 & 1\le x<\sqrt{2}\\ x & \sqrt{2}\le x<\sqrt{3}\\ 2x & \sqrt{3}\le x<2\\ 3x & x=2\end{cases}$$

$$|x|+\left[x^2-1\right]=\begin{cases}-x & x=-1\\ -x-1 & -1<x<0\\ x-1 & 0\le x<1\\ x & 1\le x<\sqrt{2}\\ x+1 & \sqrt{2}\le x<\sqrt{3}\\ x+2 & \sqrt{3}\le x<2\\ x+3 & x=2\end{cases}$$

$$\int_{-1/2}^{1/2}\left(f(x)-g(x)\right)dx=\int_{-1/2}^{0}(2x+1)dx+\int_{0}^{1/2}(-2x+1)dx=\frac{1}{2}$$

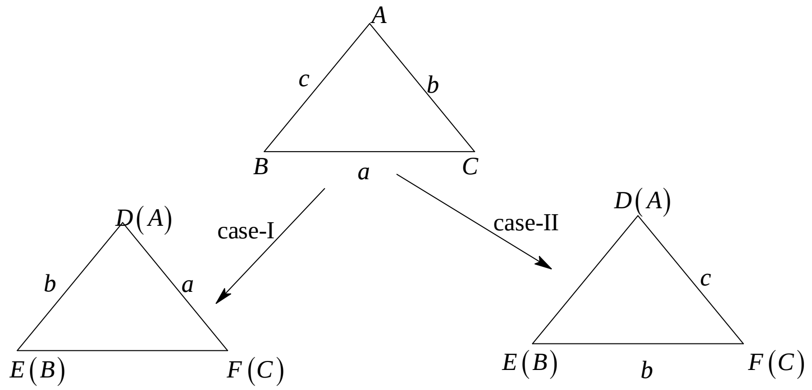
51. BD

Sol. Divide S in 7 partition of form $7k+r\left(r=0,.....,6\right)$ we can choose a element from partition of form $7k+r$. We cannot use $7\left(k+1\right)-r.\left\{r=1,.....,6\right\}$ and we can select 1 element from partition of form $7k$.

52. ABC

Let $Q(x)=x^2+bx+c, Q\left(P(x)\right)=\left(P(x)\right)^2+bP(x)+c$ as $P(x)\,|\,Q\left(P(x)\right)\Rightarrow c=0$ and $Q(x)=P(x)+b$

53. ACD


A
c
b
B
a
C
case-I
case-II
D(A)
b
a
E(B)
F(C)
D(A)
c
E(B)
b
F(C)

case-I

Let $a > b > c$, $\frac{\sin C}{\sin B} = \frac{c}{b} = \frac{b}{a} \Rightarrow b^2 = ac$

case-II

Let $a > b > c$, $\frac{\sin A}{\sin B} = \frac{b}{c} = \frac{a}{b} \Rightarrow b^2 = ac$

Let $(a, b, c) \equiv (c\lambda^2, c\lambda, c)$ as triangle is

formed $b + c > a \Rightarrow \lambda^2 - \lambda - 1 < 0 \Rightarrow \frac{2}{1+\sqrt{5}} < \lambda < \frac{1+\sqrt{5}}{2}$

54. ABCD

$$\int_0^{\pi} 16\sin^4 x \cos^2 x - \left(f(x) - 4\sin^2 x \cos x\right)^2 dx$$

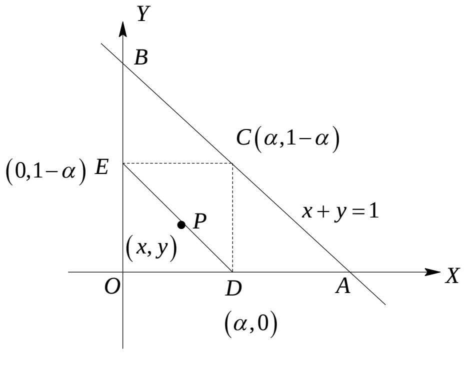
$$= \pi - \int_0^{\pi} \left(f(x) - 4\sin^2 x \cos x\right)^2 = \pi$$

$$f(x) = 4\sin^2 x \cos x$$

55. B

56. D

Sol. (55 – 56)


Y
B
C(α,1−α)
(0,1−α) E
P
(x,y)
x+y=1
X
O
D
A
(α,0)

$$\frac{x}{\alpha}+\frac{y}{1-\alpha}=1$$
$$AM \geq GM$$
$$\frac{\frac{x}{\alpha}+\frac{y}{1-\alpha}}{2} \geq \sqrt{\frac{xy}{\alpha(1-\alpha)}}$$
$$\Rightarrow xy \leq \frac{\alpha(1-\alpha)}{4}$$
$$xy \leq \frac{1}{16}$$

Region traced by point P is $(y-x-1)^2 \geq 4x$

$$\therefore Area = \int_0^1 \left(x+1-2\sqrt{x}\right)dx = \frac{1}{6}$$

SECTION – C

57. 8

Sol. $f(\alpha_i)=\tan\alpha_i \quad e^{-\alpha_i}\left(f(\alpha_i)+\frac{1}{f(\alpha_i)}\right)=\frac{2e^{-\alpha_i}}{\sin 2\alpha_i}=2$

$$\sum_{i=1}^{4} e^{-\alpha_i}\left(f(\alpha_i)+\frac{1}{f(\alpha_i)}\right)=8$$

58. 9

Sol. $(2\lambda+1,\lambda,-\lambda)$ is the ordered triplet which satisfy first two equations so it must satisfy third equation & $(2\lambda+1)^2+\lambda^2+\lambda^2$ must be minimum which happens at $\lambda=-\frac{1}{3}$ so $(\alpha,\beta,\gamma)\equiv\left(\frac{1}{3},-\frac{1}{3},\frac{1}{3}\right)$ which satisfies third equation, i.e.

$$a\times\frac{1}{3}+(a+b)\left(-\frac{1}{3}\right)+6\times\frac{1}{3}=1$$
$$b=3 \,\&\, a\in R$$

59. 5

Sol. Coeff. of x^{14} in $(1-x)^{17}\left(1+2x+3x^2+.......+15x^{14}+.........\right)$ is $\sum_{k=0}^{14}(-1)^k(15-k)\ {}^{17}C_k$.

Which is same as coeff. of x^{14} in $(1-x)^{15}$ $={}^{15}C_{14}=15$

60. 5

Sol. Let $r^{th},(r+2)^{th},(r+6)^{th}$ terms be $a, a+2d, a+6d$ respectively.

$$\Rightarrow (a+2d)^2=a(a+6d)\Rightarrow a=2d.$$

Terms are $(2d, 4d, 8d)$ so common ratio of G.P is $\frac{1}{2}$.

Let $u, \frac{u}{2}, \frac{u}{2^2}, ... \frac{u}{2^{2p}}$ are $2p+1$ terms in $(p, 2018p)$

i.e.

$$u < 2018p \,\&\, \frac{u}{2^{2p}} > p$$

$$p.2^{2p} < u < 2018p$$

$$4^p < 2018$$

$$p \le 5$$

61. 2

Sol. $f(x) > x^2 \;\; \forall x \in R - \{\pm 1\}$

$$f(f(x)) > f^2(x) \;\; \forall x \in R - \{\pm 1, 0\}$$

$$f(f(x)) > f^2(x) > (x^2)^2 \quad \forall x \in R - \{\pm 1, 0\}$$

$$f(f(f(x))) > f^2(f(x)) > f^4(x) > x^8 \quad \forall x \in R - \{\pm 1\}$$

$f(f(f(x))) \le x^8$ has solution only at $x = \pm 1$

62. 0

Sol. $\min(f(t)) = -\left(\dfrac{\sin^2 x - 4 \cdot \frac{1}{4}|\sin x| \cdot 4}{4 \cdot \frac{1}{4}|\sin x|}\right)$

$$= 4 - |\sin x|$$

$$\therefore I_1 = \int_0^{\pi/2} (4 - |\sin x|)\,dx = [4x + \cos x]_0^{\pi/2}$$

$$I_1 = 2\pi - 1$$

$$I_2 = \min\left(\int_0^{\pi/2}\left(\frac{1}{4}t^2|\sin x| - t\sin x + 4\right)dx\right)$$

$$= \min\left(\left[-\frac{1}{4}t^2\cos x + t\cos x + 4x\right]_0^{\pi/2}\right)$$

$$= \min\left(2\pi + \frac{1}{4}t^2 - t\right)$$

$$= \min\left(2\pi + \frac{1}{4}(t-2)^2 - 1\right)$$

$$I_2 = 2\pi - 1$$

$$\therefore |I_1 - I_2| = 0$$

63. 3

$(x+2)(2x-3) = p^n$

Case 1: One of the factors is ± 1 which is possible only when $x = 2, -3$

Case 2: Let $x+2 = p^r$ $\& 2x-3 = p^s$

$$\Rightarrow p^s\left(2p^{r-s} - 1\right) = 7$$

$$\Rightarrow p = 7 \,\&\, x = 5$$

64. 1

Sol. $a^2 - bc = b^2 - ca = c^2 - ab = -(ab+bc+ca)$

So given expression reduces to

$$\frac{(ab)^2 + (bc)^2 + (ca)^2}{(ab+bc+ca)^2} = \frac{(ab+bc+ca)^2 - 2abc(a+b+c)}{(ab+bc+ca)^2}$$

$= 1$

65. 2

$$\frac{\cos\pi(x+1)}{k} + \frac{\cos\pi(x-1)}{k} = \sqrt{3}\frac{\cos\pi(x)}{k}$$

$$\Rightarrow \frac{\cos\pi(x)}{k}\left(2\frac{\cos\pi}{k} - \sqrt{3}\right) = 0$$

$$\Rightarrow \frac{\pi}{k} = \frac{\pi}{6} \Rightarrow k = 6$$

$$\lambda\cos\frac{\pi}{3} = 4 \Rightarrow \lambda = 8$$

66. 5

Let chosen points be $(\alpha_1, \beta_1) \& (\alpha_2, \beta_2)$. The area of the triangle $\frac{1}{2}\left|\alpha_1\beta_2 - \alpha_2\beta_1\right|$ must be integer.

$\Rightarrow \alpha_1\beta_2 - \alpha_2\beta_1$ is even integer. Total probability $= \left(1 - \frac{2(64-16).16}{64\times 64}\right) = \frac{5}{8}$

SECTION – D

67. 00102.01

$$\frac{dv}{dt} = -\mu A \Rightarrow \frac{Adh}{dt} = -\mu A$$

$$\int_{15.7}^{0} dh = \int_{0}^{t} -\mu dt \qquad \Rightarrow 15.7 = \mu t$$

$$\frac{dv}{dt} = -\lambda \ \Rightarrow (10.1)^2\frac{dh}{dt} = -\lambda$$

$$\int_{15.7}^{0} (10.1)^2\, dh = \int_{0}^{t} -\lambda dt$$

$$\lambda t = (10.1)^2(15.7)$$

As t is same in both case $\frac{(10.1)^2(15.7)}{\lambda} = \frac{(15.7)}{\mu} \Rightarrow \frac{\lambda}{\mu} = (10.1)^2$

68. 03600.00

As $z_1 + z_2 + z_3 = 0 \Rightarrow z_1, z_2, z_3$ are vertices of an equilateral triangle and z_4, z_5 are end points of diameter. So $|z_i - z_j|^2 = 3r^2$ if $i, j \in \{1,2,3\}$; $|z_i - z_j|^2 = 4r^2$ if $i \in \{1,2,3\}$ & $j \in \{4,5\}$ & $|z_4 - z_5|^2 = 4r^2$

$$\Rightarrow \sum_{1\le i<j\le 5} \sum |z_i - z_j|^2 = 25r^2 = 3600$$

69. 00007.75

Let A denotes the probability that every box have three balls each. B is the probability that each box has balls of the colour as that of the box.

Required probability $= \mathrm{P}(\overline{\mathrm{B}}/\mathrm{A}) = 1 - \mathrm{P}(\mathrm{B}/\mathrm{A})$

Cases: $\mathrm{R} \to \mathrm{B}, \mathrm{B} \to \mathrm{G}, \mathrm{G} \to \mathrm{R}$ or $\mathrm{R} \to \mathrm{G}, \mathrm{B} \to \mathrm{R}, \mathrm{G} \to \mathrm{B}$

$$P(A) = \frac{1}{2}.\frac{1}{2}.\frac{1}{2} + \frac{1}{2}.\frac{1}{2}.\frac{1}{2}$$

$$P(A \cap B) = \frac{1}{2}.\left(\frac{1}{2}.\frac{1}{4}\right).\left(\frac{1}{2}.\frac{1}{4}\right)$$

So $$P(B/A) = \frac{\frac{1}{8}.\frac{1}{16}}{\frac{1}{8} + \frac{1}{8}} = \frac{1}{32}$$

$$P(\overline{B}/A) = \frac{31}{32}$$

FIITJEE **JEE (Main)-2018**

ALL INDIA TEST SERIES

FULL TEST – VIII

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 – 30, 31 – 60, 61 – 90)** *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate

Enrolment No.

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10$ m/s^2
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N-m^2
Density of water	$\rho_{water} = 10^3$ kg/m^3
Atmospheric pressure	$P_a = 10^5$ N/m^2
Gas constant	$R = 8.314$ J K^{-1} mol^{-1}

CHEMISTRY

Gas Constant	R	=	8.314 J K^{-1} mol^{-1}
		=	0.0821 Lit atm K^{-1} mol^{-1}
		=	1.987 ≈ 2 Cal K^{-1} mol^{-1}
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

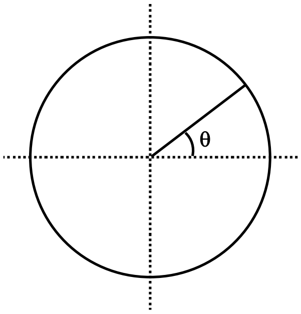
SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

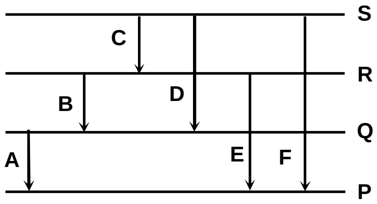
1. A nucleus is kept at rest. It breaks into two parts which fly off with velocity in the ratio 27 : 8. Then the ratio of radii of the parts is
(A) 27 : 8 (B) 8 : 27
(C) 2 : 3 (D) 3 : 2

2. A monochromatic light of wavelength 6500 Å is used in YDSE. Now both slits are covered by two thin slits of refractive index 3.2 and 2.7 respectively. By doing so central bright fringe shifts to original 7th bright fringe. If both slits have same thickness then it is equal to
(A) 7.8 μm (B) 9.1 μm
(C) 6.5 μm (D) 9.8 μm

3. A non conducting ring of radius 4 cm has varying linear charge density which is given by $\lambda = 3 \cos \theta$ C/m. The net electric dipole moment of ring is give by
(A) 48 π Coulomb-meter
(B) 12 $\pi \times 10^{-4}$ Coulomb-meter
(C) 12 π Coulomb-meter
(D) 48 $\pi \times 10^{-4}$ Coulomb-meter



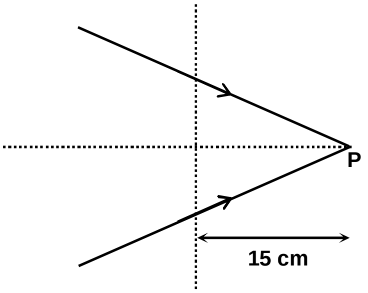
4. Figure shows six spectral lines in a emission spectrum level 'P' is a ground state and Q, R, S are upper excited state. The spectral line also occur in absorption spectrum are
(A) A, B, C, D, E, F
(B) A, B, C
(C) A, E, F
(D) B, C, D



Space for Rough work

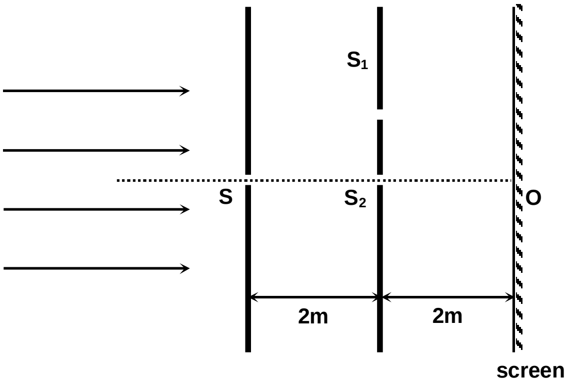
5. E, L, p and r are the energy, angular momentum, linear momentum and orbital radius of an electron in a atom corresponding to the quantum number n. Then EprL is
(A) proportional to n^2 (B) proportional to n.
(C) proportional to 1/n (D) independent of n.

6. A beam of light is converging at a point 'P'. A plano concave lens of refractive index 4/3 and radius of curvature 10 cm is placed in the path of beam at O such that line OP is the principal axis of lens. Then



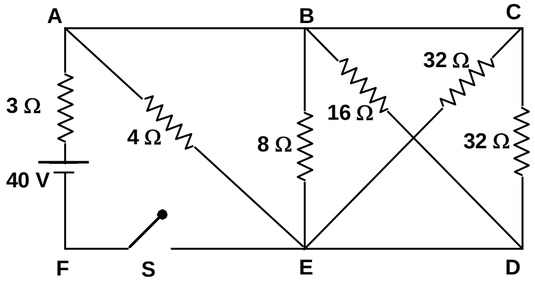
(A) Light rays will diverge
(B) Light rays will converge before point 'P' at a distance 10 cm from O.
(C) Light rays will converge after point P at 30 cm from the point P.
(D) Light rays will converge after point P at 15 cm from the point P.

7. A parallel beam of light of wavelength 5000 Å is incident on slit S. Another two slits S_1 and S_2 are illuminated at a distance 2 meter as shown in the figure. The minimum distance between S_1 and S_2 such that maximum intensity will occur at O is



(A) $\sqrt{10}$ mm
(B) 1 mm
(C) $\frac{1}{2}$ mm
(D) $\sqrt{5}$ mm

8. Six resistors and a battery are connected as shown in the figure. Now switch S is closed then find the ratio of current in branch CD to current in branch AF.



(A) 16
(B) 8
(C) $\frac{1}{16}$
(D) $\frac{1}{8}$

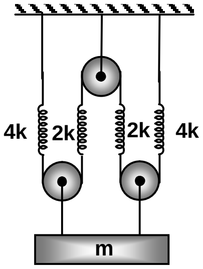
Space for Rough work

9. The field normal to the plane of coil of N turns, radius r carrying current i at a point lying a small distance h (<< r) from the centre of coil is B_1 and field at the centre of coil is B_2. Then the value of $\frac{B_2 - B_1}{B_2}$ is

(A) $\frac{2h^2}{3r^2}$ (B) $\frac{2h^2}{r^2}$

(C) $\frac{h^2}{3r^2}$ (D) $\frac{3h^2}{2r^2}$

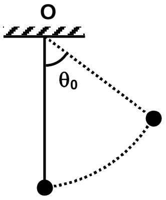
10. A plank of mass M is connected with three massless pulleys and four massless springs as shown in the figure in vertical plane. Plank is slightly displaced from its mean position. Assuming plank remain in horizontal orientation throughout the motion, the frequency of oscillation of plank is



(A) $\frac{1}{2\pi}\sqrt{\frac{32K}{3m}}$ (B) $\frac{1}{2\pi}\sqrt{\frac{8K}{3m}}$

(C) $\frac{1}{2\pi}\sqrt{\frac{4K}{3m}}$ (D) $\frac{1}{2\pi}\sqrt{\frac{16K}{3m}}$

11. A small bob hangs from a support 'O' in a vertical plane if the bob is slightly displaced then it oscillate about its mean position as shown in figure. The angular amplitude of the pendulum is θ_0. If the ratio of maximum tension to minimum tension during the motion is 4 than angular amplitude is given by

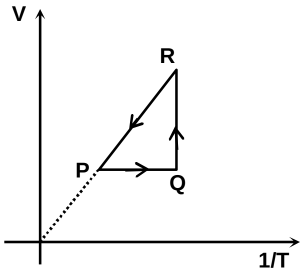


(A) $\theta_0 = \cos^{-1}\left(\frac{1}{4}\right)$ (B) $\theta_0 = \cos^{-1}\left(\frac{3}{4}\right)$

(C) $\theta_0 = \cos^{-1}\left(\frac{1}{2}\right)$ (D) $\theta_0 = \cos^{-1}\left(\frac{3}{5}\right)$

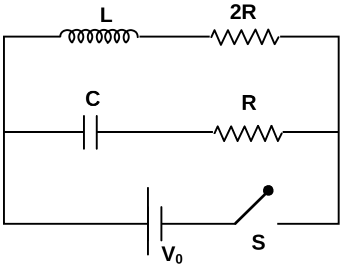
12. An ideal gas undergoes a cyclic process as shown in figure. Regarding the process choose the correct statement.

(A) Heat energy is rejected in process PQ and QR.
(B) Pressure of gas decreases in process RP.
(C) Heat energy must be rejected in process RP.
(D) Heat energy may be absorbed in process RP.



Space for Rough work

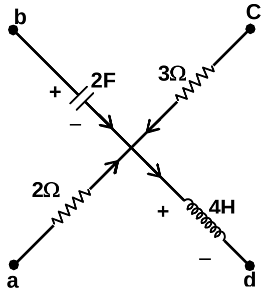
13. An inductor of inductance L and two resistors of resistance R and 2R are connected in a circuit as shown in figure. Now, switch 'S' is closed at t = 0. The time at which potential drop across inductor is half of the potential drop across R is



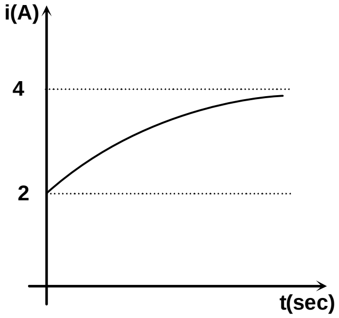
(A) $\frac{LRC\ell n2}{2R^2C+L}$ (B) $\frac{LCR\ell n2}{2R^2C-L}$

(C) $\frac{LCR\ell n2}{R^2C+2L}$ (D) $\frac{LCR\ell n2}{R^2C-2L}$

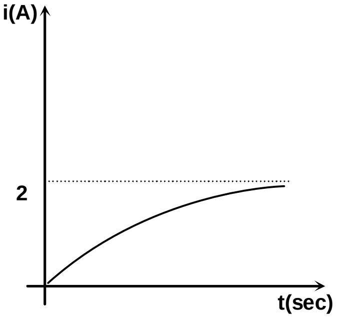
14. Figure shown is a part of a given circuit. The current in 3 Ω resistor and 2 Ω resistor is given by 4 amp and $10e^{-2t}$ amp respectively. The voltage across the capacitor is given by $3e^{-2t}$ volt. The graph between current versus time in the inductor is given by



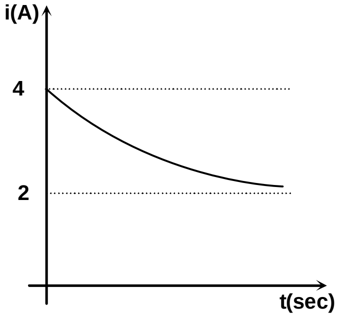
(A)



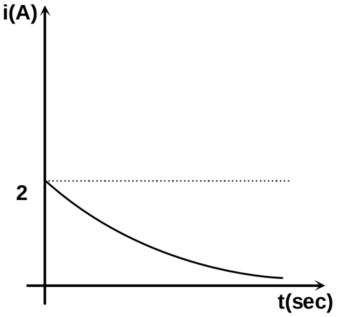
(B)



(C)

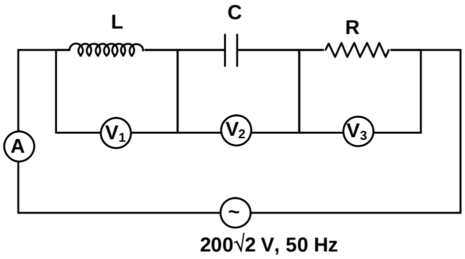


(D)



Space for Rough work

15. A inductor of inductive reactance 100 Ω, a capacitor of capacitive reactance 50 Ω and resistor of resistance R Ω are connected in a series as shown in figure. All voltmeters and ammeter connected in circuit are ideal. The reading of voltmeter V_1 and V_2 is 400 Volt and 200 Volt respectively and reading of ammeter is 4 amp. The reading of voltmeter V_3 and resistance of resistor are



(A) 100 V, 100 Ω
(B) $100\left(2\sqrt{2}-1\right)$V, 50Ω
(C) $100(2\sqrt{2}-1), 100\Omega$
(D) 200 V, 50 Ω

16. A plane longitudinal wave having angular frequency ω = 500 rad/sec is travelling in negative x-direction in a medium of density ρ = 1 kg/m^3 and bulk modulus 4 × 10^4 N/m^2. The loudness at a point in medium is observed to be 20 dB. Assuming at x = 0 initial phase of the medium particles to be zero. The maximum pressure charge in the medium and equation of wave is given by

(A) 2×10^{-4} N/m^2, $y = 2 \times 10^{-9}\sin\left(500t + \frac{5}{2}x\right)$
(B) 10^{-4} N/m^2, $y = 2 \times 10^{-9}\sin\left(500t + \frac{5}{2}x\right)$
(C) 4×10^{-4} N/m^2, $y = 4 \times 10^{-9}\sin(500\,t + 5x)$
(D) 2×10^{-4} N/m^2, $y = 4 \times 10^{-9}\sin\left(500t + \frac{5}{2}x\right)$

17. Two resistors of resistance 400 Ω and 800 Ω at 0°C, having thermal coefficient of resistance α and 4 α respectively are connected in parallel. The equivalent thermal coefficient of resistance is

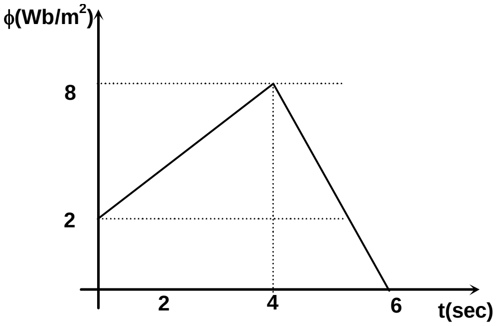
(A) 5 α
(B) $\frac{3\alpha}{2}$
(C) 2 α
(D) $\frac{4\alpha}{5}$

18. If $\oint \vec{E}\cdot d\vec{s} = 0$ over a surface then

(A) the electric field inside the surface and on it must be zero.
(B) the electric field inside the surface is necessarily uniform.
(C) all charges may be inside the surface.
(D) The number of flux lines entering the surface must be equal to the number of flux lines leaving it.

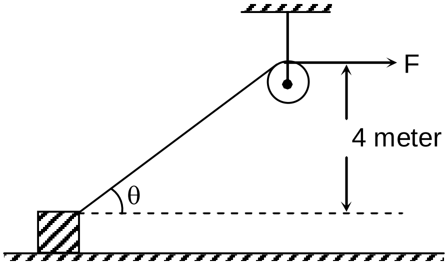
Space for Rough work

19. The magnetic flux (ϕ) versus time (t) graph for a coil is shown in the figure. The magnitude of average emf induced in the coil for a time interval of 0 to 6 sec is
(A) 1 Volt
(B) 1/3 Volt
(C) 2/3 Volt
(D) 2 Volt



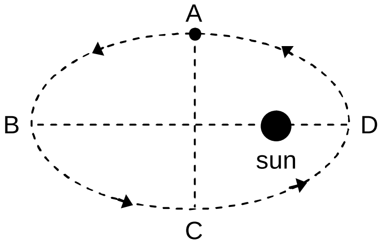
20. If the gravitational constant 'G'. Plank's constant 'h' and velocity of light 'v' are assumed to be as fundamental units then dimension of length in new system is given by
(A) G^2, h^2, $v^{3/2}$ (B) $G^{1/2}$, $h^{1/2}$, $v^{3/2}$
(C) $G^{1/2}$, $h^{1/2}$, $v^{-3/2}$ (D) G^2, h^2, $v^{-3/2}$

21. A block of mass 2 kg is kept at rest on a rough horizontal surface as shown in the figure. A constant force of magnitude 20N is applied at other end of string in horizontal direction. Initially angle made by string with horizontal is 30°. The work done by applied force till the angle become 45° is



(A) $80\left(2-\sqrt{2}\right)$Joule (B) $80\sqrt{2}$ Joule
(C) $40\left(2-\sqrt{2}\right)$Joule (D) $40\sqrt{2}$ Joule

22. A satellite is moving around the sun in an elliptical orbit. 'M' is the mass of sun and 'a' is semi major axis of elliptical orbit. The velocity of satellite when it reaches at A is



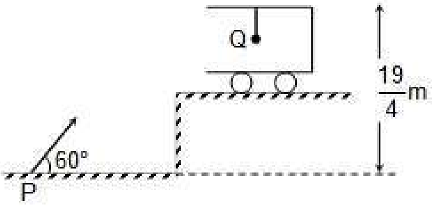
(A) $\sqrt{\frac{4GM}{a}}$ (B) $\sqrt{\frac{2GM}{a}}$
(C) $\sqrt{\frac{GM}{2a}}$ (D) $\sqrt{\frac{GM}{a}}$

Space for Rough work

23. A particle is projected from the ground at an angle with the horizontal. The velocity of the projectile when it is at the greatest height is $\sqrt{\frac{3}{5}}$ times when it is at one third of its greatest height. The angle of projection should be

(A) 37° (B) 45°
(C) 53° (D) 60°

24. A small ball 'P' of mass 2 kg is projected with velocity 10 m/s at an angle 60° with horizontal. It collides inelastically with another ball 'Q' of same mass. Ball 'Q' is suspended through an inelastic string of length 1m with the ceiling of a trolley of mass 16 kg as shown in figure. Initially trolley is at rest and it can move without friction on the surface. The maximum angle made by thread with vertical is



(A) $\cos^{-1}(2/5)$ (B) $\cos^{-1}(2/3)$
(C) $\cos^{-1}(3/4)$ (D) $\cos^{-1}(3/5)$

25. In forced oscillations, sometimes it is important to analyze the effect of periodically varying force (say, $F = F_0 \cos \omega t$). So the equation becomes

$$(F_0 \cos \omega t) + (-kx) = Ma$$

A steady state solution of the above equation takes the form $x(t) = A \cos \omega t$. Let δ be a real number such that $\delta \to 0^+$. Then

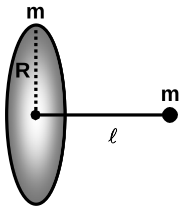
(A) If $\omega = \delta$, force and displacement will be in phase.
(B) If $\omega = \sqrt{\frac{k}{m}} - \delta$, force and displacement will be out of phase.
(C) If $\omega = \sqrt{\frac{k}{m}} + \delta$, force and displacement will be in phase.
(D) If $\omega \to \infty$, force and displacement will be out of phase.

Space for Rough work

26. A uniform disc (mass M, radius R, thickness t) is kept on a rough surface with angular speed ω (without any translation) such that its plane is horizontal. Due to heat generated by friction, the disc gets heated up from an initial temperature T. Since different parts of the disc have different energies, the disc gets heated up non-uniformly (assuming no heat exchange between concentric layers). Once the disc stops, a point on the perimeter has temperature of T + ΔT. If there are no losses to the environment, then what is the temperature at a point exactly midway between centre and perimeter?

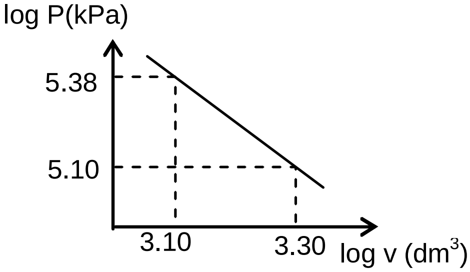
(A) $T + \frac{\Delta T}{4}$
(B) $T + \frac{\Delta T}{8}$
(C) $T + \frac{\Delta T}{2}$
(D) $T + \frac{\Delta T}{16}$

27. A thin homogeneous disc of radius R and mass m and a small sphere of same mass is placed at a distance ℓ from the disc on its axis of symmetry. Initially both are in rest and then released from rest. They collide because of gravitation attraction. Assume $\ell \gg R$, Find the magnitude of relative velocity of approach just before the collision.



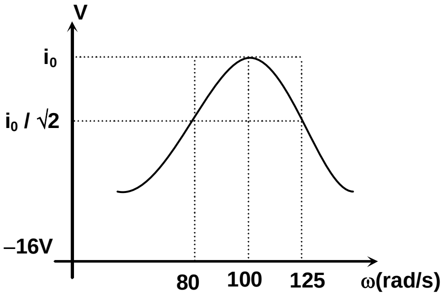
(A) $\sqrt{4Gm\left(\frac{2}{R}-\frac{1}{\ell}\right)}$
(B) $\sqrt{2Gm\left(\frac{2}{R}-\frac{1}{\ell}\right)}$
(C) $\sqrt{Gm\left(\frac{2}{R}-\frac{1}{\ell}\right)}$
(D) $\sqrt{\frac{Gm}{2}\left(\frac{2}{R}-\frac{1}{\ell}\right)}$

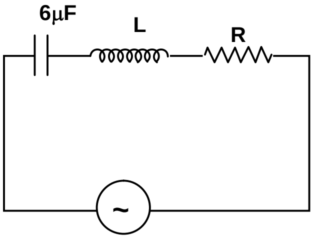
28. Logarithms of reading of pressure and volume for an ideal gas were plotted in the graph. By measuring the gradient it can be shown that the gas may be
(A) Mono atomic and undergoing an adiabatic change
(B) Mono atomic and undergoing an isothermal change
(C) Diatomic and undergoing an adiabatic change
(D) Triatomic and undergoing an isothermal change.



Space for Rough work

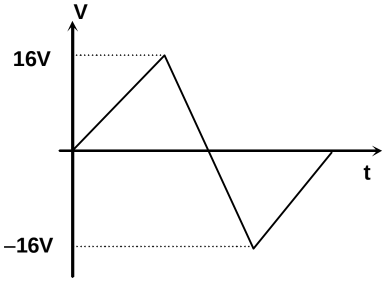
29. An LCR series circuit is connected to an sinusoidal AC voltage and the graph between current and angular frequency is plotted as shown in the figure. If capacitance of capacitor used is 6 μF, then choose the correct alternative.

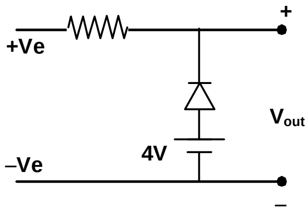




(A) L = 16.6 H, R = 1.5 kΩ (B) L = 3.34 H, R = 1.5 kΩ
(C) L = 16.67 H, R = 0.75 kΩ (D) can't be calculated

30. A circuit is designed using ideal diode and input voltage is fed as shown in figure. Maximum and minimum value across output terminal will be





(A) +16V, –16V (B) +16V, –4V
(C) +12V, –4V (D) +16V, +4V

Space for Rough work

Chemistry

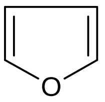
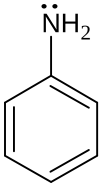
PART – II

SECTION – A

(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. Which of the following is correctly matched?

	Molecule	Direction of dipole moment
(A)		↑
(B)		↑
(C)	$H-C\equiv C-Cl$	←
(D)	None of these	

32. Electronic configuration of Pd is $[Kr]4d^{10}$. It belongs to

(A) 4th period and 10th group
(B) 5th period and 10th group
(C) 6th period and 10th group
(D) 4th period and 8th group

33. What is the maximum number of electrons in an atom whose highest energy electrons have the principal quantum number n = 5?

(A) 38
(B) 138
(C) 54
(D) None of these

34. A saturated solution of an ionic salt MX exhibits an osmotic pressure of 74.4 mm Hg at 25°C. Assuming that MX is completely dissociated in solution, what is the value of its K_{sp}?

(A) 2×10^{-3}
(B) 2×10^{-6}
(C) 4×10^{-6}
(D) 4×10^{-3}

35. Which of the following statement is incorrect about the six-coordinated complex $[Fe(ox)_x(H_2O)_y]^z$? (Z may have any value to maintain Fe in +3 oxidation state)

(A) Complex shows optical isomerism, not geometrical isomerism when x = 3, y = 0
(B) Complex shows geometrical isomerism, not optical isomerism when x = 1, y = 4
(C) Complex can show optical and geometrical isomerism both when x = 2, y = 2
(D) Value of z will be – 3 when x = 3, and y = 0

Space for Rough work

36. Human insulin is composed of two polypeptide chains. One chain contains 21 amino acids and the other contains 30 amino acids. How many nucleotides are present in the DNA to code for each chain?

(A) 42, 60	(B) 21, 30
(C) 63, 90	(D) 84, 120

37. Consider the following statements:
(i) All the bond lengths in IF_5 are not equal.
(ii) Equatorial bonds are longer than axial bonds in PCl_3F_2.
(iii) Inorganic benzene is a non polar molecule.
(iv) Order of oxidizing power of oxoacids of chlorine is $HOCl > HClO_2 > HClO_3 > HClO_4$
(v) O – O bond order will be in the order $O_2^+ > O_2 > H_2O_2 > O_3$
(vi) Hydrolysis of XeF_6 is an example of disproportionation reaction.
The correct statements are:

(A) (i) (ii) (iii) (iv) (v) (vi)	(B) (i) (ii) (iii) (iv)
(C) (i) (ii) (iii) (iv) (v)	(D) (i) (ii) (iii) (iv) (vi)

38. Which of the following is correct order for indicated property?

(A) $PH_3 > PF_3$	bond angle
(B) $LiCl > NaCl$	Solubility in water
(C) F – F > Cl – Cl	Bond dissociation enthalpy
(D) S > O > Se	Order of $\Delta_{eg}H$

39. Which of the following has the highest boiling point?

(A) H_2	(B) Xe
(C) Ne	(D) CH_4

40. Consider the following statements:
(a) Dipole moment order $SO_2 > NH_3$
(b) Ionization energy $O_2 < O$
(c) In naphthalene, all C – C bond lengths are equal
(d) $CF_2 = C = CF_2$ is a non-polar molecule
(e) Cl – CH = C = CH – Cl shows geometrical isomerism
(f) Boiling point $CH_3CH_2OH > CH_3CH_2SH$
(g) Melting point KCl > CuCl
(h) Oxidation number of Cr in $[CrO_8]^{-3}$ is +6.
How many statements are correct?

(A) 5	(B) 4
(C) 7	(D) 6

Space for Rough work

41. A certain reaction $A + B \longrightarrow \text{Products}$ is first order with respect to each reactant with K = 5.0 × 10^{-3} M^{-1} s^{-1}. Calculate the conc. of A remaining after 100 s. If the initial concentration of A was 0.1 M and that of B was 6.0 M. (Use approximation of pseudo first order reaction) [$\log_{10}2 = 0.3010$]

(A) 5 × 10^{-3} M (B) 5 × 10^{-2} M
(C) 2.5 × 10^{-4} M (D) 2. 5 × 10^{-2} M

42. Predict the effects upon the following reaction equilibria of increased pressure,

(1) $H_2O(g) \rightleftharpoons H_2(g) + \frac{1}{2}O_2(g)$

(2) $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$

(3) $C(s) + H_2O(g) \rightleftharpoons H_2(g) + CO(g)$

(4) $\underset{(\text{Diamond})}{C(s)} \rightleftharpoons \underset{(\text{Graphite})}{C(s)}$

(A) Left, Left, Left, Left (B) Right, Right, Right, Right
(C) Left, Right, Left, Right (D) Right, Left, Right, Left

43. Which of the following represent a correct crystal field splitting order for a complex in a linear field. Assume that the ligands lie on the z-axis?

(A) $d_{z^2} < d_{xy} = d_{xz} < d_{x^2-y^2} = d_{yz}$ (B) $d_{xy} = d_{x^2-y^2} < d_{xz} = d_{yz} < d_{z^2}$
(C) $d_{xz} = d_{yz} < d_{z^2} < d_{xy} = d_{x^2-y^2}$ (D) $d_{xy} = d_{x^2-y^2} < d_{xz} = d_{yz} = d_{z^2}$

44. Diborane (B_2H_6) reacts with water to form boric acid and hydrogen. What is the pH of the solution which results when 1.0 g B_2H_6 reacts with 100 mL water? Assume the final volume to be 100 mL. Given K_{a_1} for boric acid = 7.3 × 10^{-10}. (At. Mass of B = 11) [$\log_{10}57 = 1.755$]

(A) 4.64 (B) 5.64
(C) 2.64 (D) 7

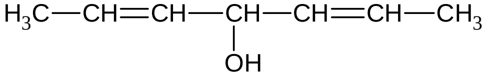
45. How many of the following are very good oxidizing agents?

MnO_4^-, I^-, $Cl^{-1}, Ce^{+4}, Cr_2O_7^{-2}, Na, Na^+, CrO_4^{-2}, HNO_3, Fe^{+2}, F_2, F^-$

(A) 5 (B) 6
(C) 7 (D) 4

Space for Rough work

46. Total number of stereoisomers for the following molecule will be:

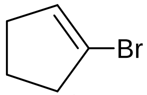


$$H_3C-CH=CH-\underset{\displaystyle OH}{\underset{|}{CH}}-CH=CH-CH_3$$

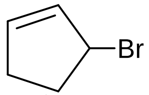
(A) 4 (B) 3
(C) 2 (D) 6

47. Correct order of reactivity of following molecules towards S_N2 mechanism?

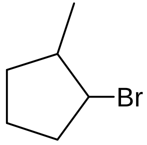
(I)



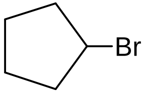
(II)



(III)

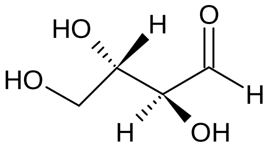


(IV)

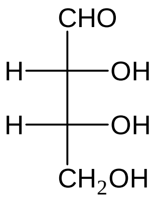


(A) I > II > III > IV (B) II > IV > III > I
(C) IV > III > II > I (D) IV > II > III > I

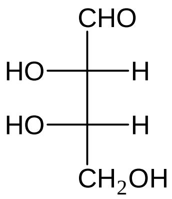
48. Which of the Fischer projection formula correspond to the following stereo structure?


HO
H
O
HO
H
H
OH

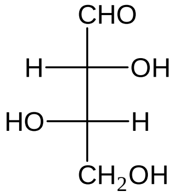
(A)


CHO
H
OH
H
OH
CH2OH

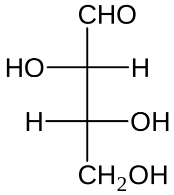
(B)


CHO
HO
H
HO
H
CH2OH

(C)

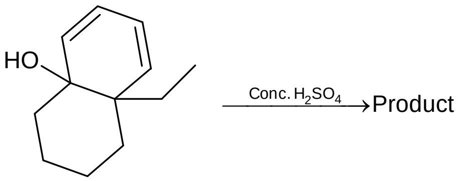

CHO
H
OH
HO
H
CH2OH

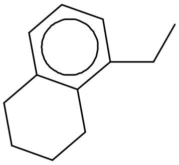
(D)

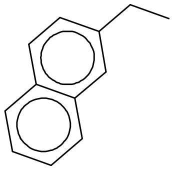

CHO
HO
H
H
OH
CH2OH

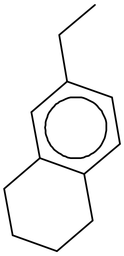
Space for Rough work

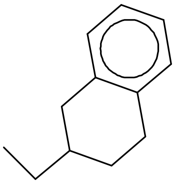
49. Identify the major product



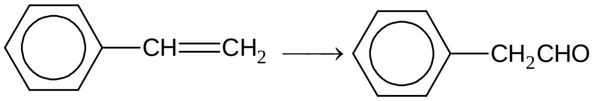
(A)


(B)


(C)


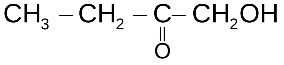
(D)


50. Which one of the following works best as the reaction steps to carry out conversion below?



(A) Br_2; $NaNH_2$ (2 mole); H_2O, $HgSO_4$ | H_2SO_4 (B) B_2H_6|H_2O_2, NaOH; PCC|CH_2Cl_2
(C) H_2O, H_2SO_4; CrO_3 | H_2SO_4 (D) CH_3COOOH; NaOH | H_2O

51. Which of the following gives silver mirror test?

(I) HCOOH, (II) HCHO, (III)

$CH_3-CH_2-\underset{\underset{O}{\|}}{C}-CH_2OH$ (IV) $CH_3-C\equiv CH$, (V) H_3PO_2,

(VI) $CH_2=CH_2$

(A) I, II, III only (B) I, II, III, IV, V only
(C) I, II, III, V only (D) I, II only

52. A chloro compound (A) showed the following properties:
(i) decolourized Bromine in CCl_4
(ii) absorbed hydrogen catalytically
(iii) gave a precipitate with ammonical cuprous chloride
(iv) when vaporized, 1.49 g of (A) gave 448 mL of vapour at STP.
A is?
(A) $Cl-CH_2-C\equiv CH$ (B) $CH_3-C\equiv C-Cl$
(C) $CH_3-CH=CH-Cl$ (D) $CH_3-CH_2-CH_2-Cl$

Space for Rough work

53. How many of the following can acts as an antiseptic?
(I) C_6H_5COONa (II) 0.1% solution of phenol, (III) Ibuprofen
(IV) potassium stearate, (V) Bithional, (VI) Tincture of iodine
(VII) H_2SO_4, (VIII) $B(OH)_3$, (IX) iodoform, (X) mixture of chloroxylenol and terpeneol
(A) 8 (B) 6
(C) 5 (D) 4

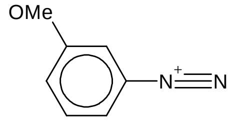
54. Which of the following is an example of condensation homopolymer?
(A) Bakelite (B) Nylon-6,6
(C) Nylon-6 (D) PMMA

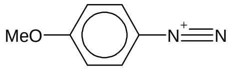
55. Diborane shows unsymmetrical cleavage with
(A) Me_3N (B) CO
(C) NH_3 (D) All of these

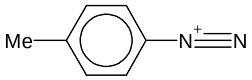
56. Which of the following statements is incorrect?
(A) The decrease in atomic radii in lanthanide series is not quite regular as it is regular in its M^{+3} ions.
(B) Actinoid contraction is more sharper than lanthanoid contraction.
(C) Ce^{+4} is more stable than Ce^{+3} in aqueous medium.
(D) d-Block elements have greater tendency to show variable oxidation state than f-Block elements.

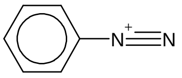
57. A current of 3.7 A is passed for 6 hours between Ni electrodes in 0.5 L of 2 M solution of $Ni(NO_3)_2$. The molarity of Ni^{+2+} at the end of electrolysis is
(A) 1.172 M (B) 0.172 M
(C) 0.586 M (D) 2 M

58. In $SH^-, I^-, R-NH_2, NH_3$ the order of proton accepting tendency will be
(A) $I^- > NH_3 > R-NH_2 > SH^-$ (B) $NH_3 > R-NH_2 > SH^- > I^-$
(C) $R-NH_2 > NH_3 > SH^- > I^-$ (D) $SH^- > R-NH_2 > NH_3 > I^-$

59. Which of the following diazonium salt when boiled with dil. H_2SO_4 give the corresponding phenol most readily?
(A)


(B)


(C)


(D)


60. An organic compound A has the molecular formula C_3H_6O. It undergoes iodoform test. When saturated with HCl, it gives B of molecular formula $C_9H_{14}O$. A and B respectively are:
(A) Propanal and mesitylene
(B) Propanone and mesityl oxide
(C) Propanone and 2, 6-dimethyl- 2,5-heptadien-4-one
(D) Propanone and mesityl oxide

Space for Rough work

Mathematics PART – III

SECTION – A

(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. If roots of an equation $y^n - 1 = 0$ are 1, $\lambda_1, \lambda_2, \lambda_3 \, ... \, \lambda_{n-1}$, then the value of $(1 - \lambda_1)(1 - \lambda_2)(1 - \lambda_3) \, ... \, (1 - \lambda_{n-1})$ will be
(A) n^n (B) n^2
(C) n (D) 0

62. If $\frac{z_3 - z_1}{z_3 - z_2} = i$, then points z_1, z_2 and z_3
(A) are collinear (B) forms equilateral triangle
(C) forms isosceles right angled triangle (D) forms obtuse angled triangle

63. If α, β and γ are non zero rational numbers, and S is the set of values of $\frac{|\alpha|}{\alpha} + \frac{|\beta|}{\beta} + \frac{|\gamma|}{\gamma}$, then S is
(A) {3, 1} (B) {–3, 1, –1}
(C) {3, –3, 0, 1, –1} (D) {3, –3, 1, –1}

64. If $P = \begin{bmatrix} 1 & 2 \\ -1 & 0 \end{bmatrix}$, $R = \begin{bmatrix} 1 & 1 \\ 3 & 5 \end{bmatrix}$ and $PQR = \begin{bmatrix} 1 & 0 \\ 2 & 3 \end{bmatrix}$ (where Q is a square matrix of order 2), then |Q| is equal to
(A) $\frac{3}{8}$ (B) $\frac{3}{4}$
(C) $\frac{3}{2}$ (D) 0

65. Let $\cos^2 \alpha + p$ and $\sin^2 \alpha + p$ are the roots of the equation $x^2 + 4x + \frac{61}{16} = 0$. The equation whose roots are $\tan^2 \alpha$ and $\cot^2 \alpha$ is
(A) $x^2 - 4x + 1 = 0$ (B) $x^2 - 10x + 1 = 0$
(C) $x^2 + 10x + 1 = 0$ (D) $x^2 - 14x + 1 = 0$

Space for rough work

66. If n is even number and α, β are the roots of the equation $x^2 + px + q = 0$ and also of the equation $x^{2n} + p^n x^n + q^n = 0$ and $f(x) = \frac{(1+x)^n}{1+x^n}$, then $f\left(\frac{\alpha}{\beta}\right)$ is

(A) –1 (B) 0
(C) 1 (D) 2

67. A 8 ft. tall man finds that the angle of elevation of the top of a 26 ft. high pillar and the angle of depression of its base are complementary angles, the distance of the man from the pillar is

(A) 6 ft. (B) $6\sqrt{3}$ ft.
(C) 12 ft. (D) $12\sqrt{3}$ ft.

68. Number of solution of the $\cos^4 2\alpha + 2\sin^2 2\alpha = 17(\cos\alpha + \sin\alpha)^8$, $\alpha \in (0, 2\pi)$ is

(A) 10 (B) 6
(C) 4 (D) 2

69. If two sides of triangle are roots of $x^2 - 7x + 8 = 0$ and the angle between these sides is 60º then product of inradius and circumradius of triangle is

(A) 8 (B) $\frac{5\sqrt{2}}{3}$
(C) $\frac{5}{3}$ (D) $\frac{8}{7}$

70. Number of ordered pair (α, β), satisfying the condition $\alpha^8 + \beta^8 = 8\alpha\beta - 6$ is

(A) 64 (B) 16
(C) 4 (D) 2

71. If $p_1, p_2, p_3, \ldots\ldots, p_{4001}$ are in A.P. such that $\sum_{i=1}^{4000} \frac{1}{p_i p_{i+1}} = 10$ and $p_1 + p_{4001} = 50$, then $|p_1 - p_{4001}|$ is

(A) 20 (B) 25
(C) 30 (D) 40

72. In a triangle ABC, $R(b + c) = a\sqrt{bc}$ whose R is the circum radius of the triangle, then the triangle is

(A) isosceles but not right angle triangle (B) right angled but not isosceles triangle
(C) right angled isosceles triangle (D) equilateral triangle

Space for rough work

73. If $\vec{v}_1$, $\vec{v}_2$, $\vec{v}_3$, $\vec{v}_4$ are non-zero coplanar vectors and $2\lambda_1\vec{v}_1 + 2\lambda_2\vec{v}_2 - \vec{v}_3 + 3\lambda_3\vec{v}_4 = 0$, then

(A) $\lambda_1^2 + \lambda_2^2 + \lambda_3^2 \ge \frac{1}{2}$ (B) $\lambda_1^2 + \lambda_2^2 + \lambda_3^2 \ge \frac{1}{17}$

(C) $\lambda_1^2 + \lambda_2^2 + \lambda_3^2 \ge \frac{1}{20}$ (D) $\lambda_1^2 + \lambda_2^2 + \lambda_3^2 \ge \frac{1}{34}$

74. Equation of a plane which passes through the point of intersection of lines $\frac{x-1}{3} = \frac{y-2}{1} = \frac{z-3}{2}$ and $\frac{x-3}{1} = \frac{y-1}{2} = \frac{z-2}{3}$ and at greatest distance from the origin is

(A) $7x + 2y + 4z = 54$ (B) $4x + 3y + 5z = 50$

(C) $3x + 4y + 5z = 49$ (D) $x + y + z = 12$

75. Let $x_1, x_2, x_3, \ldots, x_n$ be n observations and 5 be its variance, then variance of $2x_1 + 1, 2x_2 + 1, 2x_3 + 1, \ldots, 2x_n + 1$ is equal to

(A) 20 (B) 6

(C) 5 (D) 25

76. The coefficient of $a^7b^4c^3$ in $(2ab + bc - ca)^7$ is

(A) –560 (B) 560

(C) –280 (D) 280

77. The range of 'k' such that the angles 'α' between the pair of tangents drawn from the point (k, 0) to the circle $x^2 + y^2 = 25$ satisfies $\frac{\pi}{2} < \alpha < \pi$ is

(A) $k \in \left(-\sqrt{2}, -1\right) \cup \left(1, \sqrt{2}\right)$ (B) $k \in \left[-5\sqrt{2}, -5\right] \cup \left[5, 5\sqrt{2}\right]$

(C) $k \in \left(-5\sqrt{2}, -5\right) \cup \left(5, 5\sqrt{2}\right)$ (D) $k \in \left[-\sqrt{2}, -1\right] \cup \left[1, \sqrt{2}\right]$

78. Which of the following statements is a tautology?

(A) $(p \wedge q) \wedge (\sim(p \wedge q))$ (B) $(\sim q \wedge p) \vee (p \vee \sim p)$

(C) $(\sim q \wedge p) \wedge q$ (D) $(\sim q \wedge p) \wedge (p \wedge \sim p)$

79. The number of ways in which 12 identical balls can be grouped in four marked non-empty sets P, Q, R, S such that n(P) < n (Q) (where n(P) is number of balls in group P) is

(A) 70 (B) 60

(C) 45 (D) 25

Space for rough work

80. An ellipse with axes parallel to coordinate axes cuts the parabola $y^2 = 4x$ at (1, –2) and touches it at (4, 4) then the coordinate of other point of intersection is
(A) (4, –4) (B) (3, –2)
(C) (3, 2) (D) (9, –6)

81. An integer a is chosen from {–5, –4, –3, –2, –1, 0, 1, 2, 3, 4, 5}, then the probability that $|a^2 - 3a - 3| > |a^2 + 7a - 13|$ is
(A) $\frac{1}{11}$ (B) $\frac{2}{11}$
(C) $\frac{3}{11}$ (D) $\frac{4}{11}$

82. The number of 3-digit number pqr formed such that $p \neq q \neq r$ and $2q = p + r$ is
(A) 12 (B) 32
(C) 36 (D) 256

83. If $a, b, c \in R$ satisfy the equations $a + [b] + \{c\} = 3{\cdot}1$, $\{a\} + b + [c] = 4{\cdot}3$ and $[a] + \{b\} + c = 5{\cdot}4$ (where [.] denotes the greatest integer function and {.} is fractional part), then $6a + b - 3c$ is
(A) 0 (B) 2
(C) 4 (D) 6.3

84. If $xf(x) + \int_0^x f(t)dt = \frac{3x^2}{2}$ and f(1) = 1, then f(3) is equal to
(A) 1 (B) 3
(C) 9 (D) 28

85. The value of definite integral $\dfrac{2^{2010}\int_0^1 t^{1004}(1-t)^{1004}dt}{\int_0^1 t^{1004}\left(1-t^{2010}\right)^{1004}}$ is
(A) 4000 (B) 4001
(C) 4020 (D) 4021

86. Consider the function $f(x) = \begin{cases} \dfrac{g(x)}{x-2} & ; \quad x \neq 2 \\ 7 & ; \quad x = 2 \end{cases}$ where g(x) is a polynomial function such that $g'''(x)$ is identically equal to zero and g(3) = 9. If f(x) is continuous at x = 2, then g(x) is
(A) $2x^2 + x + 6$ (B) $2x^2 - x - 6$
(C) $x^2 + 3$ (D) $x^2 - x + 7$

Space for rough work

87. If $\lim\limits_{t\to\lambda}\left[f(t)+g(t)\right]=2$ and $\lim\limits_{t\to\lambda}\left[f(t)-g(t)\right]=1$, then $\lim\limits_{t\to\lambda} f(t)\cdot g(t)$ is

(A) exist and is $-\frac{3}{4}$ (B) exist and is $\frac{3}{4}$

(C) exist and is $\frac{4}{3}$ (D) does not exist

88. The value of $\lim\limits_{n\to\infty}\sum\limits_{r=0}^{n}\frac{{}^{n}C_{r}}{n^{r}}\left(\frac{1}{r+3}\right)$ is

(A) e (B) e – 1
(C) e – 2 (D) 0

89. If $0 < \cos^{-1} x < \frac{\pi}{2}$ and $1 + \sin(\cos^{-1} x) + \sin^2(\cos^{-1} x) + ... + \infty = 2$, then x is

(A) $\frac{3}{2}$ (B) $\frac{\sqrt{3}}{2}$

(C) $\frac{1}{2}$ (D) $\frac{2}{\sqrt{3}}$

90. The centre of an ellipse $\frac{x^2}{25}+\frac{y^2}{16}=1$ is C and PN is any ordinate & A, A′ are the end points of major axis, then the value of $\frac{PN^2}{AN\cdot A'N}$ is

(A) 9 (B) $\frac{16}{25}$

(C) $\frac{25}{16}$ (D) 41

Space for rough work

FIITJEE

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FULL TEST – VIII
(Main)

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**C**	31.	**C**	61.	**C**
2.	**B**	32.	**B**	62.	**C**
3.	**D**	33.	**B**	63.	**D**
4.	**C**	34.	**C**	64.	**B**
5.	**D**	35.	**B**	65.	**D**
6.	**D**	36.	**C**	66.	**A**
7.	**B**	37.	**B**	67.	**C**
8.	**C**	38.	**B**	68.	**C**
9.	**D**	39.	**B**	69.	**C**
10.	**A**	40.	**A**	70.	**C**
11.	**C**	41.	**A**	71.	**C**
12.	**D**	42.	**A**	72.	**C**
13.	**B**	43.	**B**	73.	**B**
14.	**A**	44.	**A**	74.	**B**
15.	**D**	45.	**B**	75.	**A**
16.	**A**	46.	**A**	76.	**A**
17.	**C**	47.	**B**	77.	**C**
18.	**D**	48.	**B**	78.	**B**
19.	**B**	49.	**A**	79.	**A**
20.	**C**	50.	**B**	80.	**D**
21.	**A**	51.	**C**	81.	**A**
22.	**D**	52.	**A**	82.	**C**
23.	**B**	53.	**B**	83.	**C**
24.	**C**	54.	**C**	84.	**B**
25.	**D**	55.	**C**	85.	**C**
26.	**C**	56.	**C**	86.	**B**
27.	**A**	57.	**D**	87.	**B**
28.	**C**	58.	**C**	88.	**C**
29.	**C**	59.	**A**	89.	**B**
30.	**D**	60.	**C**	90.	**B**

Physics

PART – I

SECTION – A

1. $\frac{v_1}{v_2} = \frac{27}{8}$

So, $\frac{m_1}{m_2} = \frac{8}{27}$ (from conservation of momentum)

$r \propto A^{1/3}$

$\frac{r_1}{r_2} = \left(\frac{8}{27}\right)^{1/3} = \frac{2}{3}$

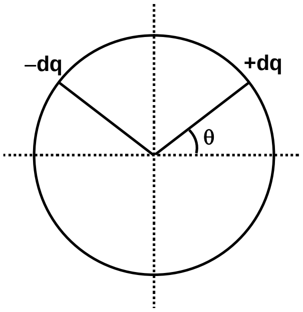
2. $7 \times \frac{D\lambda}{d} = \frac{(\mu_1 - \mu_2)t \cdot D}{d}$

$t = 9.1\ \mu m$

3. $dp = dq\ (2R \cos \theta)$

$= (3R \cos \theta\ d\theta)\ (2R \cos \theta)$

$p = \int dp = 48\ \pi \times 10^{-4}$ Coulomb-meter



4. In absorption spectrum electrons jumps from ground state to higher excited state.

5. $E \propto \frac{1}{n^2}$

$r \propto n^2$

$p \propto \frac{1}{n}$

$L \propto n$

6. u = + 15, $\frac{1}{f} = \left(\frac{4}{3} - 1\right)\left(\frac{1}{\infty} - \frac{1}{10}\right)$

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} - \frac{1}{+15} = \frac{1}{-30}$

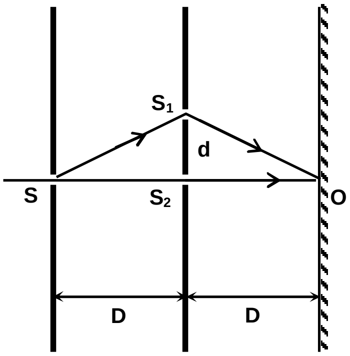
v = 30 cm

7. path difference = $(SS_1 + S_1O) - SO$

$$= 2\sqrt{D^2 + d^2} - 2D = \frac{d^2}{D}$$

$$\frac{d^2}{D} = n\lambda$$

$$d = \sqrt{D\lambda} \quad (n = 1)$$



8. Current through battery = $\frac{40}{5}$ = 8 amp

Current in branch CD = $\frac{1}{2}$ amp

So, $\frac{i_{CD}}{i_{AF}} = \frac{1/2}{8} = \frac{1}{16}$

9. $B_1 = \frac{\mu_0 Nir^2}{2(r^2 + h^2)^{3/2}}$

$B_2 = \frac{\mu_0 Ni}{2r}$

10. Let plank is slight displacement a distance x.

$F_r = \frac{32}{3}kx$

$a = \frac{32k}{3m}x$

$\omega = \sqrt{\frac{32k}{3m}}$

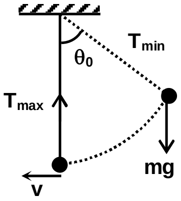
11. $T_{min} = mg\cos\theta_0$ …(i)

$T_{max} - mg = \frac{mv^2}{R}$ …(ii)

$\frac{1}{2}mv^2 = mg(R - R\cos\theta))$ …(iii)

$\frac{T_{max}}{T_{min}} = 4$

$\theta_0 = \cos^{-1}\left(\frac{1}{2}\right)$



12. Process PQ is isochoric
Process QR is isothermal
For process RP;

$V \propto \frac{1}{T}$

VT = constant

13. $$2\left(L\frac{di_1}{dt}\right) = i_2R$$

$$2L\frac{i_0}{\tau_1}e^{-t/\tau_1} = R\cdot\frac{q_0}{\tau_2}e^{-t/\tau_2}$$

$$2e^{-t/\tau_1} = e^{-\frac{t}{\tau_2}}$$

$$t = \frac{\ell n2}{\frac{2R}{L}-\frac{1}{RC}}$$

14. $q = 6e^{-2t}$
$i_C = 12\ e^{-2t}$
$i_L = i_1 + i_2 + i_C$
$i_L = 4 - 2e^{-2t}$

15. $$i = \frac{V}{Z}$$

$$4 = \frac{200\sqrt{2}}{\sqrt{(50)^2 + R^2}}$$

$R = 50\ \Omega$
$V_R = i \times R = 200$ V

16. $$20 = 10\log_{10}\left(\frac{I}{10^{-12}}\right)$$

$I = 10^{-10}$ W/m^2 …(i)

$v = \sqrt{\frac{B}{\rho}} = 200$ m/s …(ii)

$(\Delta P_{max})^2 = 2I\rho v$

$\Delta P_{max} = 2\times10^{-4}$ N/m^2 …(iii)

$K = \frac{\omega}{v} = \frac{5}{2}m^{-1}$ ….(iv)

$\Delta P_{max} = BAK$
$A = 2 \times 10^{-9}$ m ….(v)

17. $$\frac{\alpha_{eq}}{R_{eq}} = \frac{\alpha_1}{R_1}+\frac{\alpha_2}{R_2}$$

$$\frac{\alpha_{eq}}{800/3} = \frac{\alpha}{400}+\frac{4\alpha}{800}$$

$$\alpha_{eq} = 2\alpha$$

18. $$\oint\vec{E}\cdot ds = \frac{q_{in}}{\varepsilon_0} = 0$$

Hence, $q_{in} = 0$
So, charge inside the surface must be zero.

19. from 0 to 4 sec, $e_1 = -\frac{3}{2}$Volt

from 4 to 6 sec, e_2 = +4 Volt

$$e_{av} = \frac{\int edt}{\int dt}$$

$$|e_{av}| = \frac{|-\frac{3}{2} \times 4 + 4 \times 2|}{6} = \frac{1}{3}\text{ Volt}$$

20. $v = LT^{-1}$

$G = M^{-1}L^{3}T^{-2}$

$h = ML^{2}T^{-1}$

So, $\frac{v}{h} = \frac{1}{ML}$

and $\frac{G}{h^2} = \frac{1}{M^3L}$

Hence, $L = G^{1/2}, h^{1/2}, v^{-3/2}$

21. Displacement of point where force is applied

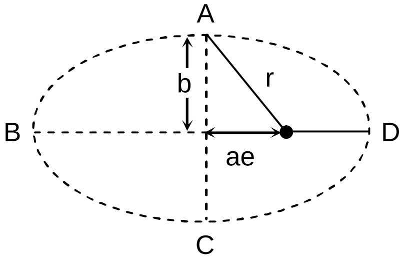
$$= \frac{4}{\sin 30^\circ} - \frac{4}{\sin 45^\circ}$$

$$= 4\left(2-\sqrt{2}\right)\text{meter}$$

So work done = $80\left(2-\sqrt{2}\right)$Joule

22. $r^2 = b^2 + a^2e^2$ …(1)

$b^2 = a^2\left(1-e^2\right)$ …(2)



From equation (1) & (2)

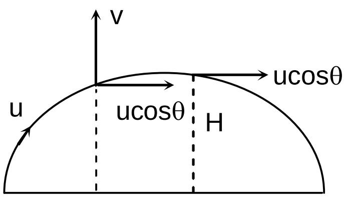
r = a

Now from conservation of energy

$$-\frac{GMm}{2a} = \frac{1}{2}mv^2 - \frac{GMm}{a}$$

$$v = \sqrt{\frac{GM}{a}}$$

23. $$u\cos\theta = \sqrt{\frac{3}{5}}\sqrt{v^2 + \left(u\cos\theta\right)^2}$$



$$\frac{2}{5}u^2\cos^2\theta = \frac{3}{5}v^2 \quad \text{…(1)}$$

$$v^2 = u^2\sin^2\theta - 2g\frac{1}{3}\left(\frac{u^2\sin^2\theta}{2g}\right)$$

$$v^2 = \frac{2}{3}u^2\sin^2\theta \quad \text{…(2)}$$

24. $2(10\cos 60) = (2+2)v_0$

$$v_0 = \frac{5}{2}\text{m/s} \qquad \ldots(1)$$

$$4\times\frac{5}{2} = (4+16)v$$

$$v = \frac{1}{2}\text{ m/s} \qquad \ldots(2)$$

Now from conservation of energy

$$\frac{1}{2}\times 4\left(\frac{5}{2}\right)^2 - \frac{1}{2}(4+16)\left(\frac{1}{2}\right)^2 = 4\times 10\times 1(1-\cos\theta)$$

$$\cos\theta = \frac{3}{4}$$

$$\theta = \cos^{-1}\left(\frac{3}{4}\right)$$

25. $F_0\cos\omega t - kA\cos\omega t = -mA\omega^2\cos\omega t$

$$\Rightarrow\ A = \frac{F_0}{k - m\omega^2}$$

26. Heat produced $\propto r^2$ but change in temperature $\propto r$

27. Gravitation potential due to disc is

$$V = -\frac{2Gm}{R^2}(\sqrt{R^2+\ell^2} - \ell)$$

So, $U_i = -\frac{Gmm}{\ell}$ $(R \ll \ell)$

$$U_f = -\frac{2Gmm}{R}\ (\ell \to 0)$$

$$\Delta U = U_i - U_f = Gmm\left(\frac{2}{R} - \frac{1}{\ell}\right)$$

$$\frac{1}{2}mv^2 + \frac{1}{2}mv^2 = Gmm\left(\frac{2}{R} - \frac{1}{\ell}\right)$$

$$v = \sqrt{Gm\left(\frac{2}{R} - \frac{1}{\ell}\right)}$$

So, relative velocity

$$v_R = 2v = \sqrt{4Gm\left(\frac{2}{R} - \frac{1}{\ell}\right)}$$

28. $\log P = m\log V + C$ …(i)

Where C is constant and m is slope

$$m = \left[\frac{5.38 - 5.10}{3.10 - 3.30}\right] = -1.4$$

So, from (i) $PV^{1.4} = K$ (constant)

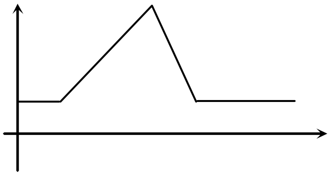
29. $\omega_H - \omega_L = \frac{R}{L}$

$\omega_H \times \omega_L = \omega_0^2$

$\Rightarrow \quad R = 750\,\Omega$

$$\omega_0 = \frac{1}{\sqrt{LC}} \Rightarrow L = \frac{1}{\omega^2 C} = \frac{10^6}{10^4 \times 6} = 16.67H$$

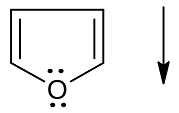
30. Output will be



Chemistry PART – II

SECTION – A

31. The direction of dipole moment in the molecules given in the question is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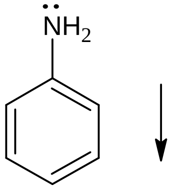
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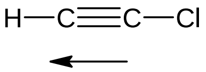


32. Pd belongs to 5th period and 10th group.

33. Highest energy electrons having n = 5 can lie in 5g sub-shell.
$\therefore$ Electronic configuration of element can be
$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10}\ 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 5f^{14}\ 5g^{18}\ 6s^2\ 6p^6\ 6d^{10}\ 7s^2\ 7p^6\ 8s^2$
$\therefore$ Maximum number of electrons can be 138.

34. $\pi = iCST$

$$\frac{74.4}{760} = 2 \times C \times 0.0821 \times 298$$

$$C = \frac{74.4}{760 \times 2 \times 0.0821 \times 298}$$

$$C = \frac{74.4}{37188.016} = 2 \times 10^{-3}\ \text{mol L}^{-1}$$

K_{sp} (MX) = $s^2 = (2 \times 10^{-3})^2 = 4 \times 10^{-6}$

35. (A) If x = 3, y = 0, then complex is $[Fe(Ox)_3]^{-3}$. This complex will show optical isomerism, not geometrical isomerism.
(B) If x = 1, y = 4, then complex is $[Fe(Ox)(H_2O)_4]^{+1}$. This complex neither shows geometrical nor optical.
(C) If x = 2, y = 2, then the complex is $[Fe(Ox)_2(H_2O)_2]^{-1}$. This complex can show geometrical and optical isomerism both.
(D) If x = 3 and y = 0, then complex will be $[Fe(Ox)_3]^{-3}$.

36. Three nucleotides are required to code each amino acid present in the chain. Therefore, chain having 21 amino acids will require 63 nucleotides to code the chain.

38. (i) PF_3 has greater bond angle due to back bonding.
(ii) LiCl has greater solubility in water due to its higher hydration enthalpy.
(iii) F – F is weaker bond due to lone pair – lone pair repulsion.
(iv) $\Delta_{eg}H$ order is : S > Se > O.

39. Xe has highest boiling point among the options given.

40. Correct statements are: a, b, d, f, g

41. Second order rate law for the reaction is
$r = K[A]^1[B]^1$
Since B is in excess, therefore new rate law for pseudo first order reaction becomes

$r = K_1[A]^1 \qquad \left[\text{Here } K_1 = K \times [B]^1\right]$

Now applying integrated equation for pseudo first order reaction

$$K_1 = \frac{2.303}{t}\log_{10}\frac{[A_0]}{[A]}$$

$$5 \times 10^{-3} \times 6 = \frac{2.303}{100}\log_{10}\frac{0.1}{[A]}$$

$$\frac{3 \times 10^{-2} \times 100}{2.303} = \log_{10}\frac{0.1}{[A]}$$

$$1.302 = \log_{10}\frac{0.1}{[A]}$$

Taking antilogarithm

$$20 = \frac{0.1}{[A]}$$

$$[A] = \frac{0.1}{20} = 5 \times 10^{-3}\ \text{M}$$

43. B is correct option.
d_{z^2} will be the highest energy orbital followed by $d_{xy} = d_{yz}$.

44. $B_2H_6 + 6H_2O \longrightarrow 2H_3BO_3 + 3H_2$

$1g\ B_2H_6 = \frac{1}{28}\text{mole} = 0.0357\ \text{mole}\ B_2H_6$

$\therefore$ Moles of H_3BO_3 produced = 0.0714 moles.
H_3BO_3 is a weak monobasic acid.

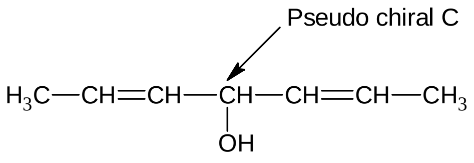
$$[H^+] = \sqrt{K_{a_1} \times C} = \sqrt{\frac{7.3 \times 10^{-10} \times 0.0714}{0.1}}$$

$$= \sqrt{0.521 \times 10^{-9}} = \sqrt{5.21 \times 10^{-10}}$$

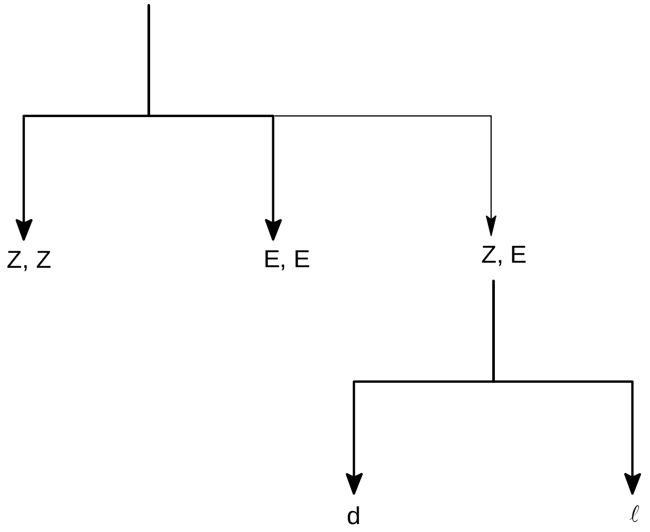
$= 2.28 \times 10^{-5}$
Now pH = $-\log_{10} 228 \times 10^{-7}$
$= 7 - \log_{10} 228$
$= 7 - 2.357$
$= 4.64$

45. MnO_4^-, $Ce^{+4}, Cr_2O_7^{-2}, CrO_4^{-2}, HNO_3, F_2$ are very good oxidizing agents.

46.



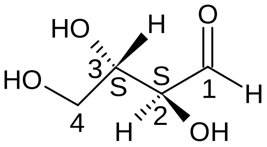
$$H_3C{-}CH{=}CH{-}\underset{\displaystyle OH}{\underset{|}{CH}}{-}CH{=}CH{-}CH_3$$



Thus, four stereoisomers are possible in total.

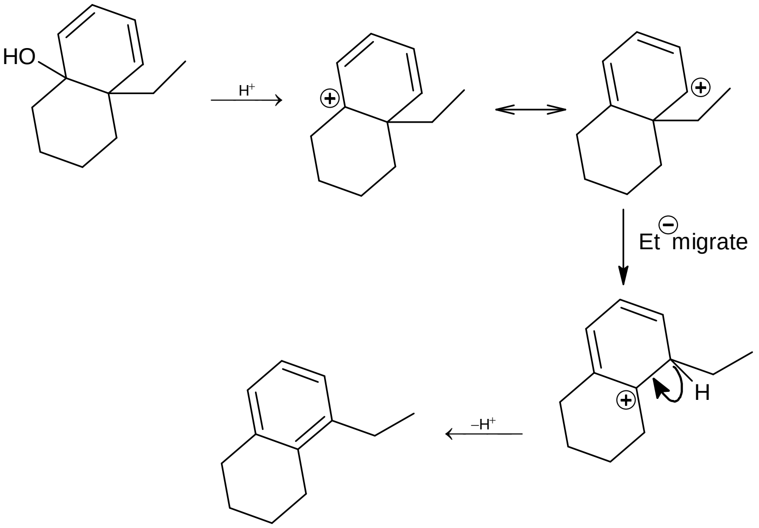
47. (I) is least reactive as C – Br bond acquires partial double bond character due to resonance. (II) is most reactive as it is allylic halide.

48.

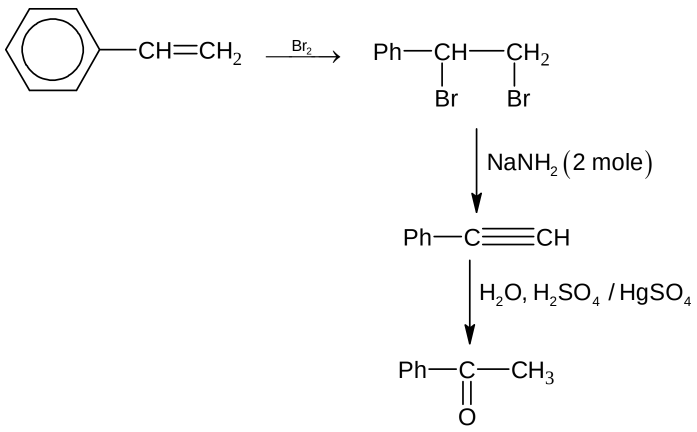


Both the chiral carbon have S, S-configuration. Therefore, correct option is B in which both the chiral carbon also have S, S-configuration.

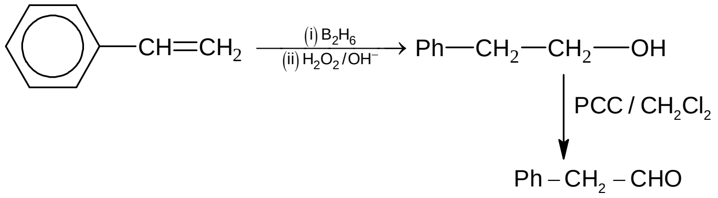
49.



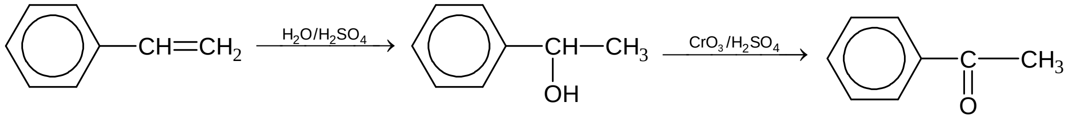
50. (A)


CH=CH2
Br2
Ph—CH—CH2
Br Br
NaNH2 (2 mole)
Ph—C≡CH
H2O, H2SO4 / HgSO4
Ph—C—CH3
O

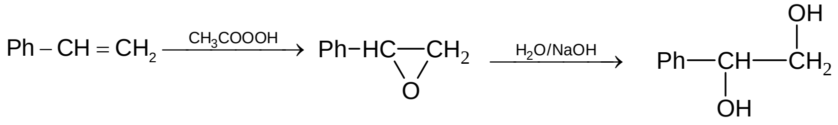
(B)

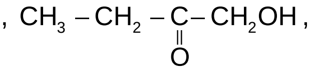

CH=CH2
(i) B2H6
(ii) H2O2/OH⁻
Ph—CH2—CH2—OH
PCC / CH2Cl2
Ph – CH2 – CHO

(C)


CH=CH2
H2O/H2SO4
CH—CH3
OH
CrO3/H2SO4
C—CH3
O

(D)


Ph – CH = CH2
CH3COOOH
Ph–HC—CH2
O
H2O/NaOH
OH
Ph—CH—CH2
OH

51. HCOOH, HCHO,  $CH_3-CH_2-\underset{\overset{\|}{O}}{C}-CH_2OH$, H_3PO_2 give silver mirror test.

$CH_3-C\equiv CH$ reacts with Ammonical silver nitrate but does not give metallic silver.

52. (i) Decolourize bromine in CCl_4] ⇒ Evidence of presence of multiple bond.
(ii) Absorbed hydrogen catalytically] ⇒ Evidence of presence of multiple bond.
(iii) Gives precipitate with ammonical cuprous chloride] ⇒ Evidence of terminal alkyne.
(iv) 448 mL = 1. 49 g

$$22400 \text{ mL} = \frac{1.49}{448}\times 22400 = 74.5 \text{ g} \text{ (molar mass)}$$

∴ Option (A) is correct.

53. (II), (V), (VI), (VIII), (IX) and (X) are antiseptic.

54. Nylon-6 is a condensation homopolymer.
Nylon-6,6 is a condensation heteropolymer.
Bakelite is a condensation heteropolymer.
PMMA is an addition polymer.

55. Diborane shows unsymmetrical Cleavage with NH_3.

56. Ce^{+3} is more stable than Ce^{+4}.

57. $Ni(NO_3)_2$ solution is electrolysed by using Ni electrode. Therefore, no change in molarity of solution after electrolysis.

58. Order of acidic strength of conjugate acid of species given in question

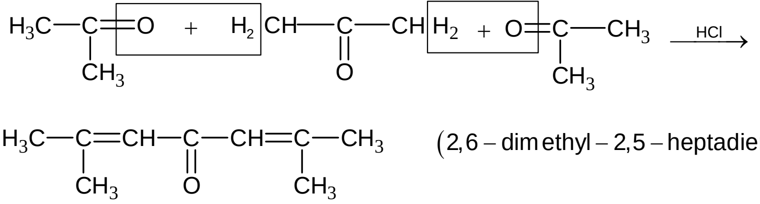
$HI > H_2S > NH_4^+ > R-\overset{+}{N}H_3$

$\therefore$ Proton accepting tendency of conjugate bases will be

$R-NH_2 > NH_3 > \overset{-}{S}H > I^-$

59. - I effect of – OMe group at m-position decreases stability of diazonium ion and hence increases its reactivity.

60. Propanone gives iodoform test, propanal does not.



$$H_3C-\underset{\underset{CH_3}{|}}{C}\boxed{=O \quad + \quad H_2}CH-\underset{\underset{O}{\|}}{C}-CH\boxed{H_2 \quad + \quad O=}\underset{\underset{CH_3}{|}}{C}-CH_3 \xrightarrow{HCl}$$

$$H_3C-\underset{\underset{CH_3}{|}}{C}=CH-\underset{\underset{O}{\|}}{C}-CH=\underset{\underset{CH_3}{|}}{C}-CH_3$$

(2,6 – dimethyl – 2,5 – heptadien – 4 – one)

Mathematics PART – III

SECTION – A

61. $y^n - 1 = (y - 1)(y - \lambda_1)(y - \lambda_2) \ldots\ldots (y - \lambda_{n-1})$

$\Rightarrow \dfrac{y^n - 1}{y - 1} = (y - \lambda_1)(y - \lambda_2)\ldots\ldots(y - \lambda_{n-1})$

$\Rightarrow 1 + y + y^2 + \ldots\ldots + y^{n-1} = (y - \lambda_1)(y - \lambda_2) \ldots\ldots (y - \lambda_{n-1})$

Putting y = 1

$\Rightarrow (1 - \lambda_1)(1 - \lambda_2) \ldots\ldots (1 - \lambda_{n-1}) = n$

62. $\left|\dfrac{z_3 - z_1}{z_3 - z_2}\right| = |i|$

$|z_3 - z_1| = |z_3 - z_2|$

Also $\arg\left(\dfrac{z_3 - z_1}{z_3 - z_2}\right) = \dfrac{\pi}{2}$

$\therefore$ Angle at vertex z_3 is 90º

63. If exactly one negative then the value of expression is 1
If exactly two negative then value of expression is –1
If all three negative then value of expression is –3
If all three positive then value of expression is 3

64. $|P|\,|Q|\,|R| = 3$

$|Q| = \dfrac{3}{4}$

65. $\cos^2\alpha + p + \sin^2\alpha + p = -4$

$p = -\dfrac{5}{2}$

$(\cos^2\alpha + p)(\sin^2\alpha + p) = \dfrac{61}{16}$

$\sin^2\alpha\cos^2\alpha = \dfrac{1}{16}$

$x^2 - (\tan^2\alpha + \cot^2\alpha)x + \tan^2\alpha\cot^2\alpha = 0$

Required equation $x^2 - 14x + 1 = 0$

66. $\alpha + \beta = -p,\ \alpha\beta = +q$

$\because$ α, β are the roots of the equation $x^{2n} + p^nx^n + q^n = 0$

$\Rightarrow \alpha^n, \beta^n$ are the roots of the quadratic equation $y^2 + p^ny + q^n = 0$

$\alpha^n + \beta^n = -p^n,\ \alpha^n\beta^n = q^n$

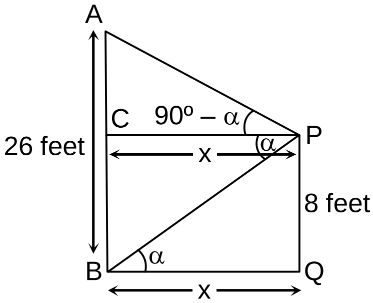
$$f\left(\frac{\alpha}{\beta}\right) = \frac{\left(1 + \frac{\alpha}{\beta}\right)^n}{1 + \frac{\alpha^n}{\beta^n}} = \frac{(\alpha + \beta)^n}{\alpha^n + \beta^n} = \frac{(-p)^n}{-p^n} = -1$$

67. $\tan\alpha = \frac{8}{x}$

$\tan(90^o - \alpha) = \cot\alpha = \frac{18}{x}$

$\frac{x}{8} = \frac{18}{x}$

x = 12



68. $\sin 2\alpha = -\frac{1}{2}$

i.e., α = 105º, 165º, 285º, 345º

69. Let a and b be roots of $x^2 - 7x + 8 = 0$ then a + b = 7 and ab = 8 and ∠C = 60º

$a^2 + b^2 = (a + b)^2 - 2ab = 49 - 16 = 33$

$\cos C = \frac{a^2 + b^2 - c^2}{2ab}$

$\frac{1}{2} = \frac{33 - c^2}{16}$

$c^2 = 33 - 8 = 25 \Rightarrow c = 5$

$r.R = \frac{abc}{2(a+b+c)} = \frac{8\times5}{2\times12} = \frac{5}{3}$

70. AM ≥ G.M.

$\frac{\alpha^8 + \beta^8 + 1+1+1+1+1+1}{8} \geq \left(\alpha^8\beta^8\right)^{1/8}$

$\alpha^8 + \beta^8 + 6 \geq 8\alpha\beta$

Which is possible only if $\alpha^8 = \beta^8 = 1$

$\Rightarrow \alpha = \pm1$ and $\beta = \pm1$

71. $\sum_{i=1}^{4000} \frac{1}{p_i p_{i+1}} = \frac{1}{d}\left[\left(\frac{1}{p_1} - \frac{1}{p_2}\right) + \left(\frac{1}{p_2} - \frac{1}{p_3}\right) + ... + \left(\frac{1}{p_{4000}} - \frac{1}{p_{4001}}\right)\right] = 10$

$\frac{p_{4001} - p_1}{d(p_1 \cdot p_{4001})} = 10 \Rightarrow \frac{4000d}{d(p_1 \cdot p_{4001})} = 10 \Rightarrow p_1\, p_{4001} = 400$ and $p_1 + p_{4001} = 50$

$|p_1 - p_{4001}| = 30$

72. $R(b+c) = a\sqrt{bc} = 2R\sin A\sqrt{bc}$

$\sin A = \frac{b+c}{2\sqrt{bc}}$

Now sin A ≤ 1 $\Rightarrow \frac{b+c}{2\sqrt{bc}} \leq 1$

$\left(\sqrt{b} - \sqrt{c}\right)^2 \leq 0 \Rightarrow b = c$

sin A = 1 $\Rightarrow \angle A = \frac{\pi}{2}$ and b = c

Hence, triangle is right angled isosceles triangle

73. $2\lambda_1 + 2\lambda_2 + 3\lambda_3 - 1 = 0$
$2\lambda_1 + 2\lambda_2 + 3\lambda_3 = 1$
$\therefore \ |2\lambda_1 + 2\lambda_2 + 3\lambda_3| \le \sqrt{4+4+9}\sqrt{\lambda_1^2 + \lambda_2^2 + \lambda_3^2}$
$\lambda_1^2 + \lambda_2^2 + \lambda_3^2 \ge \frac{1}{17}$

74. Any point on the first line is $P(3r_1 + 1, r_1 + 2, 2r_1 + 3)$ and on second line is $Q(r_2 + 3, 2r_2 + 1, 3r_2 + 2)$ P and Q represent the same point if $r_1 = r_2 = 1$ and the point of intersection of the given lines is P(4, 3, 5), the planes given is (A), (B), (C) and (D) all passes through P the plane at greatest distance is one which is at a distance equal to OP from the origin is $\sqrt{4^2 + 3^2 + 5^2} = \sqrt{50}$ which is satisfies by the plane (B)

75. By the change of origin there is no change in the variance but by the change of scale. New variance $|\alpha|^2 \sigma^2$ here $|\alpha| = 2$

76. ${}^7C_4(2)^4(-1)^3$

77. Equation of director circle of $x^2 + y^2 = 25$ is $x^2 + y^2 = 50$
$k \in \left(-5\sqrt{2}, -5\right) \cup \left(5, 5\sqrt{2}\right)$

78. Given below

q	~q	p	~p	~q ∧ p	p ∨ ~p	(~q ∧ p) ∨ (p ∨ ~p)
T	F	T	F	F	T	T
T	F	F	T	F	T	T
F	T	T	F	T	T	T
F	T	F	T	F	T	T

79. Let the number of elements in set P, Q, R, S be p, q, r, s respectively now to find positive integral solutions of $p + q + r + s = 12$, $p, q, r, s > 0$ and $p < q$
$\Rightarrow$ Total ways = 70

80. Equation of tangent to $y^2 = 4x$ at (4, 4) is $x - 2y + 4 = 0$
Let the other point of intersection is $(t^2, 2t)$
$\Rightarrow$ Equation of ellipse is $(2x - y - 4)(2x - (t + 2)y + 4t)) + \lambda(x - 2y + 4)(2x - (t - 1)y - 2t) = 0$
Since axes parallel to coordinate axes
$\Rightarrow$ Coefficient of $xy = 0 \Rightarrow t = -3$

81. $\left(a^2 - 3a - 3\right)^2 \ge \left(a^2 + 7a - 13\right)^2$
$\Rightarrow 20(a^2 + 2a - 8)(a - 1) < 0$
$\Rightarrow (a + 4)(a - 2)(a - 1) < 0$
$\Rightarrow a \in (-\infty, -4) \cup (1, 2)$
Probability = $\frac{1}{11}$

82. As $2q = p + r \Rightarrow$ p and r both are even or both are odd
If p and r both odd then number of ways = $2 \cdot {}^5C_2$
If p and r both even then number of ways = $2 \cdot {}^4C_2 + {}^4C_1$
$\therefore$ Total ways = 36

83. On adding all equation a + b + c = 6.4
Now subtracting one by one all three equation, we get a = 2, b = 1.3, c = 3.1

84. $xf'(x) + 2f(x) = 3x$
I.F. = $e^{2\int \frac{1}{x}dx} = x^2$
$x^2f(x) = c + x^3$
$c = 0$
$f(x) = x$
$f(3) = 3$

85. Let $I_1 = \int_0^1 t^{1004}(1-t)^{1004}\,dt$
$I_2 = \int_0^1 t^{1004}\left(1-t^{2010}\right)^{1004}\,dt$
Put $t^{1005} = u \Rightarrow 1005t^{1004}\,dt = du$
$= \frac{1}{1005}\int_0^1 \left(1-u^2\right)^{1004}\,du$
Using property $\int_0^a f(x)dx = \int_0^a f(a-x)dx$
$= \frac{1}{1005}\int_0^1 u^{1004}(2-u)^{1004}\,du$
Put u = 2v

86. Let $g(x) = ax^2 + bx + c$ then $g(3) = 9$, and $\lim\limits_{x\to 2}\frac{g(x)}{x-2} = 7$

87. $\lim\limits_{t\to\lambda} f(t) = \frac{3}{2}$ and $\lim\limits_{t\to\lambda} g(t) = \frac{1}{2}$; $\lim\limits_{t\to\lambda} f(t)\cdot g(t) = \frac{3}{4}$

88. $\lim\limits_{n\to\infty}\sum_{r=0}^{n}\frac{{}^nC_r}{n^r}\int_0^1 x^{r+2}dx = \int_0^1 x^2\left(\lim\limits_{n\to\infty}\sum_{r=0}^{n}{}^nC_r\left(\frac{x}{n}\right)^r\right)dx$
$= \int_0^1 x^2\left(\lim\limits_{n\to\infty}\left(1+\frac{x}{n}\right)^n\right)dx = \int_0^1 x^2\,e^x dx = e-2$

89. $\frac{1}{1-\sin\left(\cos^{-1}x\right)} = 2$
$\Rightarrow \sin\left(\cos^{-1}x\right) = \frac{1}{2}$
$\Rightarrow x = \frac{\sqrt{3}}{2}$

90. Let P(5 cos θ, 4 sin θ)
PN = 4 sin θ ⇒ AN = 5 – 5 cos θ
⇒ A′N = 5 + 5 cos θ
$\Rightarrow \frac{PN^2}{AN\cdot A'N} = \frac{16\sin^2\theta}{25\left(1-\cos^2\theta\right)} = \frac{16}{25}$

FIITJEE

JEE (Advanced)-2018

ALL INDIA TEST SERIES

FULL TEST – X

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 183**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into Two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01– 07, 19 – 25, 37 - 43)*** *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (08 – 13, 26 – 31, 44 - 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S).*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (14 – 18, 32 – 36, 50 - 54)*** *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

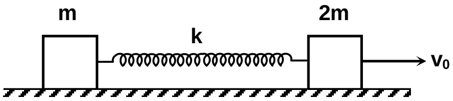
Physics PART – I

SECTION – A

Straight Objective Type

This section contains **7 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

1. Two blocks of mass m and 2m are connected by a spring of spring constant k. The system is placed on a horizontal frictionless surface. Now at t =0, the block 2m is projected horizontally with velocity v_0 towards right. Then



(A) Minimum time when the elongation in spring is maximum is $t = \frac{\pi}{2}\sqrt{\frac{2m}{3k}}$.

(B) The minimum speed of block of mass 2m is $\frac{v_0}{3}$.

(C) The maximum elongation in the spring is $\sqrt{2mv_0^2/3k}$.

(D) The amplitude of oscillation of block of mass 2m with respect the centre of mass frame of the system is $\sqrt{\frac{2mv_0^2}{27k}}$.

2. Gravitational constant G, Bulk modulus B and coefficient of viscosity η are used to form a unit of mass M and length L. Then the correct option(s) is/are

(A) $M \propto \eta^{3/2}$

(B) $M \propto G^{1/2}$

(C) $L \propto \eta^2$

(D) $L \propto B^{-3/2}$

Space for Rough work

3. An object of mass m moving with velocity v, explodes suddenly in two parts of mass ratio 1 : 2. If the direction of motion of two parts makes an angle 60° with each other after explosion and de Broglie wavelength of the lighter part is half of the de-Broglie wavelength of the heavier part, then

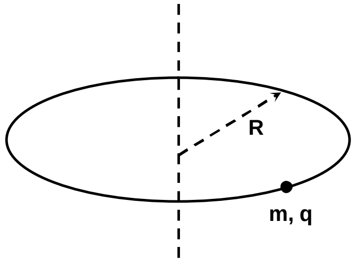
(A) Speed of the smaller part after explosion is $\frac{6v}{\sqrt{7}}$.

(B) Speed of the heavier part after explosion is $\frac{3v}{2\sqrt{7}}$.

(C) Increase in kinetic energy of the system due to explosion is $\frac{4}{7}mv^2$

(D) Ratio of kinetic energy of lighter part to that of heavier part is 4 : 1

4. A small bead of mass m and charge q is threaded on a thin horizontal ring of radius R made of insulating material. The bead can move on the circular track without friction and is initially at rest. A magnetic field that is cylindrically symmetric about the axis of the ring is present and directed along the axis. The magnitude of magnetic field at a distance r from the axis and at time t is given as $B = \frac{K}{r}t$, where K is a constant.



Then

(A) Velocity of the bead at time t is $v = \frac{Kqt}{2m}$

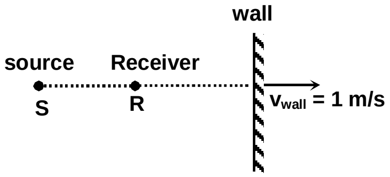
(B) Velocity of the bead at time t is $v = \frac{Kqt}{m}$

(C) Normal force acting on the bead at time t is N = 0

(D) Normal force acting on the bead at time t is $N = \frac{K^2q^2t^2}{mR}$

Space for Rough work

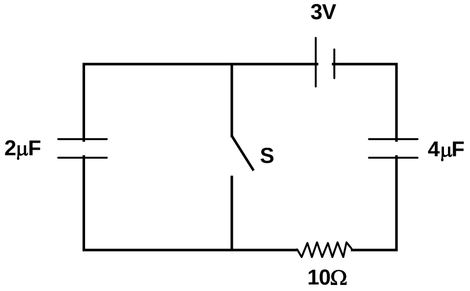
5. A source of sound of frequency f = 1000 Hz and a receiver are located on the same normal to a wall. The wall recedes the receiver with a velocity 1 m/s. Velocity of sound in air is $v = \frac{1000}{3}$ m/s.



(A) The wavelength of sound changes by 0.6% after reflection from the wall.
(B) The wavelength of sound changes by 0.3% after reflection from the wall..
(C) The frequency of echo heard by the receiver is 994 Hz.
(D) The beat frequency detected by the receiver is 6 Hz.

6. A stationary Pb^{206} nucleus emits an α-alpha particle with kinetic energy 5.77 MeV. Then
(A) The recoil speed of the daughter nucleus is approximately equal to $3.4 \times 10^5 \text{ m/s}$.
(B) The total energy released in the decay is approximately equal to 5.88 MeV.
(C) The recoil speed of the daughter nucleus is approximately equal to 6.8×10^5 m/s.
(D) The total energy released is approximately equal to 6.22 MeV.

7. The circuit shown in figure consists of two capacitors of capacitance 2μF and 4μF, a resistor of resistance R = 10 Ω and an ideal battery of emf 3V. Initially the switch S was open for a long time and the capacitors were fully charged. Then after the switch S is closed,



(A) Heat produced in the circuit after the switch is closed is 12 μJ.
(B) Energy supplied by the battery after the switch is closed is 24 μJ
(C) Change in energy stored in the capacitor of capacitance 4 μF after the switch is closed is 16 μJ
(D) Charge flown through the battery after the switch is closed is 12 μC

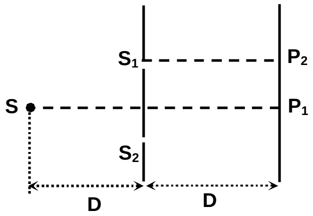
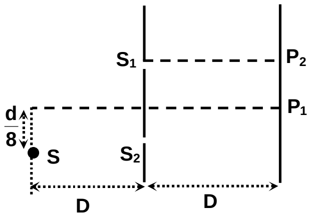
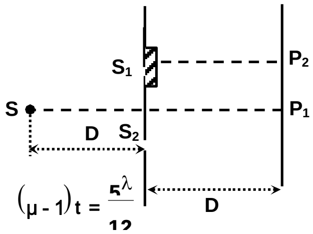
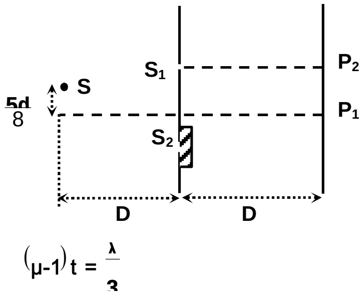
Space for Rough work

Matrix Match Types

Each of 2 tables with 3 Columns and 4 Rows has three questions. Column-1 will be with 4 rows designated (I), (II), (III) and (IV). Column-2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column-3 will be with 4 rows designated (P), (Q), (R) and (S). Each question has four options with only **ONE** correct

Answer questions 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

Column-1 shows four situations of standard Young's double slit arrangement with the screen placed at a distance D = 1.5 m from the slits S_1 and S_2. The distance between the slits is d = 1 mm and wavelength (in air) of light source S used in the experiment is λ = 500 nm. The maximum fringe intensity on the screen is I_m. In column-2 $\delta(P)$ denote the path difference at point P and in column-3 I(P) denote the intensity at point P. A transparent sheet of thickness t and refractive index μ is placed in front of one of the slits in third and fourth cases of column-1 as shown in the figure.

Column 1		**Column 2**		**Column 3**	
(I)		(i)	$\delta(P_2)=\frac{2\lambda}{3}$	(P)	$I(P_2)=\frac{I_m}{2}$
(II)		(ii)	$\delta(P_1)=\frac{\lambda}{6}$	(Q)	$I(P_2)=I_m\cos^2\frac{\pi}{12}$
(III)		(iii)	$\delta(P_2)=\frac{\lambda}{4}$	(R)	$I(P_2)=\frac{I_m}{4}$
(IV)		(iv)	$\delta(P_2)=\frac{11\lambda}{6}$	(S)	$I(P_1)=\frac{3I_m}{4}$

Space for Rough work

8. Which of the following option is the only correct representation of a situation in which $\delta(P_1) = \frac{5\lambda}{12}$

(A) (I) (i) (Q)
(B) (II)(ii) (S)
(C) (III) (iii) (P)
(D) (IV) (iv) (R)

9. Which of the following option is the only correct representation of a situation in which $I(P_2) = 0$.

(A) (I) (i) (S)
(B) (II)(ii) (S)
(C) (III) (iii) (Q)
(D) (IV) (iv) (R)

10. Which of the following option is the only correct representation of a situation in which $\delta(P_1) = 0$.

(A) (I) (i) (S)
(B) (II)(ii) (R)
(C) (I) (i) (R)
(D) (IV) (iv) (Q)

Space for Rough work

Answer questions 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

Column 1		Column 2		Column 3	
(I)	An ideal diatomic gas is compressed such that its pressure $P \propto T^{7/2}$ where T is temperature of the gas	(i)	Heat is rejected by the gas	(P)	Bulk modulus of the gas for the process is $B = \frac{3P}{2}$.
(II)	An ideal monatomic gas is compressed such that $P \propto V^{-3/2}$ where V is volume of the gas	(ii)	Heat supplied to the gas is zero	(Q)	Coefficient of volume expansion of the gas = $\frac{1}{2T}$.
(III)	An ideal diatomic gas expanded such that its internal energy $U \propto \frac{1}{\rho}$ where ρ is density of the gas	(iii)	Pressure of gas remains constant	(R)	The Bulk modulus of the gas for the process is B = 0.
(IV)	An ideal monatomic gas expands such that its pressure $P \propto V$ where V is the volume of the gas	(iv)	Its temperature versus pressure graph is a parabola	(S)	Compressibility of the gas for the process $= \frac{5}{7P}$.

11. Which of the following option is the only correct representation of the process in which $\Delta U = -\int PdV$?

(A) (II) (i) (S)
(B) (III) (ii) (R)
(C) (I) (ii) (P)
(D) (I) (ii) (S)

12. Which of the following option is the only correct representation in which molar heat capacity of the gas is negative?

(A) (II) (iii) (P)
(B) (II) (i) (P)
(C) (IV) (iii) (Q)
(D) (I) (ii) (R)

13. Which of the following options is the correct combination in which $\Delta U = \Delta Q - P\Delta V$?

(A) (IV) (iii) (Q)
(B) (I) (ii) (Q)
(C) (III) (iii) (R)
(D) (I) (i) (Q)

Space for Rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

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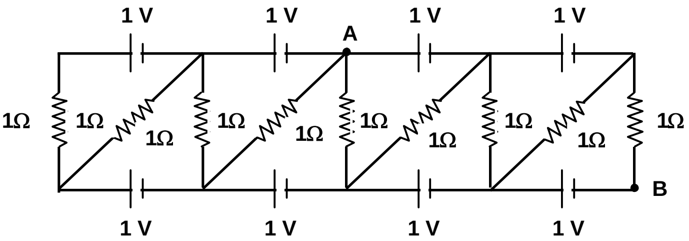
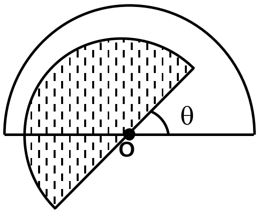
14. If the potential difference $V_A - V_B$ for the given circuit equals $\frac{22}{n}$ volts find the value of n. All the cells are ideal, and emf of each cell is 1 Volt.

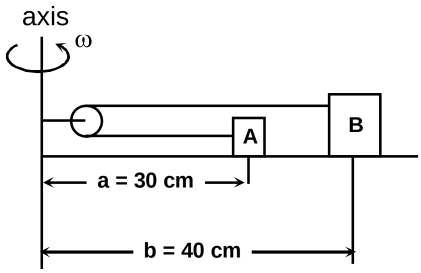


15. A capacitor consists of two fixed semicircular plates of radius R and a movable slab of thickness d and dielectric constant k placed between then. The slab can freely rotate about the axis O and practically fills the entire gap between the fixed plate. A constant voltage V is maintained between the plates. If the torque acting on the dielectric slab when the slab is displaced to an angle θ as shown in the figure, due to electrostatic force is $\tau = \frac{(k-1)\varepsilon_0 R^2 V^2}{nd}$ find the value of n.

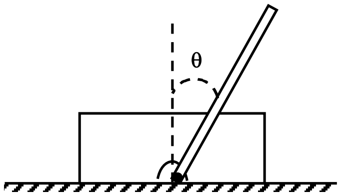


Space for Rough work

16. Block A has a mass $m_A = 15\text{ kg}$ and block B has mass of $m_B = 45\text{kg}$. They are placed on a rotating horizontal surface and are connected to a massless string passing through a frictionless pulley as shown in the figure. The horizontal surface is rotating about a vertical axis with uniform angular velocity ω as shown in the figure. The coefficient of friction between the blocks and the surface is μ = 0.25. If the value of angular speed of the surface at which the blocks will start sliding on the surface is $\omega = \frac{10}{n}$ rad/sec, find the value of n. (given g = 10 m/s^2)



17. A rod of mass m and length $L = \frac{25}{6}\text{m}$ is hinged in a plank of same mass m. The plank is kept on a smooth horizontal surface and rod makes angle θ with the vertical. The system is released from rest from θ = 0°. The velocity (in m/s) of the plank when the angle θ = 180° is (Take g = 10 m/s^2).



18. The nuclei of a radioactive element A decay into nuclei of radioactive element B with decay constant λ. The nuclei of B further decay into stable nuclei of an element with decay constant 2λ. At t = 0 the number of nuclei of A was $N_0 = 2\times10^{21}$ and that of B was zero, if the number of nuclei of B when its activity is maximum is $p\times10^{20}$ then find the value of p

Space for Rough work

Chemistry PART – II

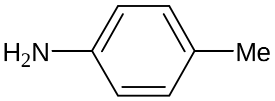
SECTION – A

Straight Objective Type

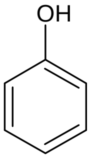
This section contains **7 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

19. p-Toluidine reacts with benzenediazonium chloride to form a compound, which on boiling with H_2SO_4, gives product/s:

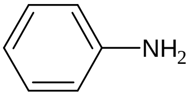
(A)



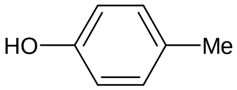
(B)



(C)



(D)



20. Which of the following cation/s do/does not give coloured bead in borax bead test?

(A) Cu^{+2} (B) Co^{+3}
(C) Cd^{+2} (D) Al^{+3}

21. Which of the following are true for Bakelite?

(A) Cross linkage polymer. (B) Condensation polymer.
(C) Thermosetting polymer. (D) Addition polymer.

22. Which of the following species is/are planar and non-polar with lone pair/s, of electrons on the central atom?

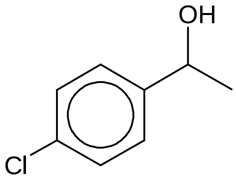
(A) ClF_3 (B) XeF_5^-
(C) PCl_5 (D) BrF_5

Space for Rough work

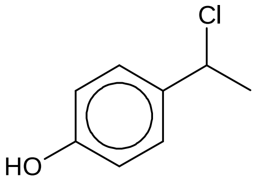
23. Which of the following statement/s, is/are incorrect?
(A) Complex $Na_2[Fe(CN)_5NO].2H_2O$ is formed during brown ring test for nitrate.
(B) The oxidation number of Fe in the above given complex is +3.
(C) Complex $[Fe(H_2O)_5NO]^{+2}$ is brown in colour.
(D) Oxidation number of Fe in sodium nitroprusside complex is +1.

24. Which of the following statement is/are not correct regarding $CuSO_4$?
(A) It reacts with KI to give iodine.
(B) It reacts with KCl to give Cu_2Cl_2.
(C) It reacts with NaOH and glucose to give Cu_2O.
(D) It gives CuO on strong heating in air.

25. Which of the following is/are correct option(s):
(A)



and



can be differented by victor Mayer's test.

(B) Monomer of orlon is acrylonitrile.
(C) Aspartane is a dipeptide of L-aspartic acid and L-phenylalanine.
(D) D-Glucose, D-Fructose and L-Mannose give same osazone with Ph – NH – NH_2.

Space for Rough work

Matrix Match Types

Each of 2 tables with 3 Columns and 4 Rows has three questions. Column-1 will be with 4 rows designated (I), (II), (III) and (IV). Column-2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column-3 will be with 4 rows designated (P), (Q), (R) and (S). Each question has four options with only **ONE** correct

Answer questions 26, 27 and 28 by appropriately matching the information given in the three columns of the following table.

Column 1		Column 2		Column 3	
(I)	Smelting	(i)	Copper glance	(P)	Cu_2S
(II)	Self reduction	(ii)	Malachite	(Q)	Fe_2O_3
(III)	Electrolytic reduction	(iii)	Haematite	(R)	$Al_2O_3.2H_2O$
(IV)	Hydrometallurgy	(iv)	Bauxite	(S)	$CuCO_3.Cu(OH)_2$

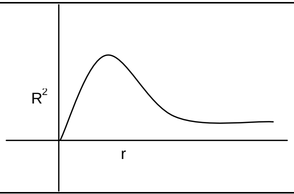
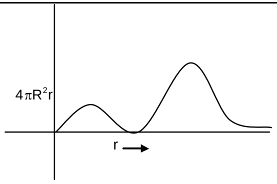
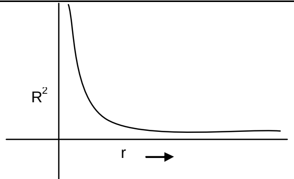
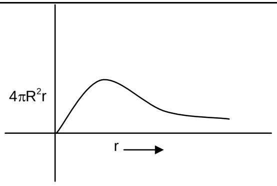
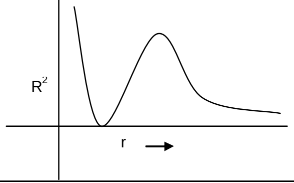
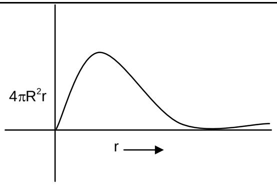
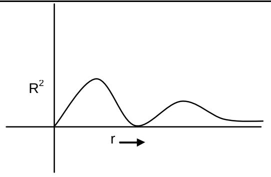
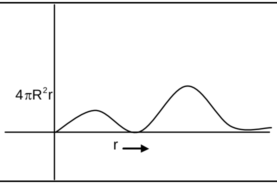
26. Which of the following combination is CORRECT for Copper glance?
(A) (I) (i) (S)
(B) (II)(i) (P)
(C) (III) (i) (S)
(D) (IV) (i) (P)

27. Which of the following combination is CORRECT for malachite?
(A) (I) (ii) (R)
(B) (IV) (ii) (P)
(C) (IV) (ii) (S)
(D) (III) (ii) (S)

28. Which of the following combination is CORRECT for Hematite?
(A) (II) (iii) (Q)
(B) (III) (iii) (R)
(C) (III) (iii) (Q)
(D) (I) (iii) (Q)

Space for Rough work

Answer questions 29, 30 and 31 by appropriately matching the information given in the three columns of the following table.

Column 1		Column 2		Column 3	
(I)	1s orbital	(i)		(P)	
(II)	2s orbital	(ii)		(Q)	
(III)	2p orbital	(iii)		(R)	
(IV)	3p orbital	(iv)		(S)	

29. Which of the following combination is CORRECT for 2s-orbital?
(A) (II) (ii) (R)
(B) (II)(iii) (R)
(C) (II) (iii) (P)
(D) (II) (iv) (S)

30. Which of the following combination is CORRECT for 2p-orbital?
(A) (III) (iii) (P)
(B) (III) (iv) (Q)
(C) (III) (i) (S)
(D) (III) (i) (Q)

31. Which of the following combination is CORRECT for 3p-orbital?
(A) (IV) (iii) (S)
(B) (IV) (iv) (S)
(C) (IV) (ii) (Q)
(D) (IV) (iii) (Q)

Space for Rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

32. Out of NiS, CoS, MnS, ZnS
A = Number of black precipitates
B = Number of sulphides which is/are soluble in HCl.
C = Number of sulphides which is/are soluble in CH_3COOH
D = Number of sulphides which is/are soluble in conc. HNO_3
What will be the value of A + B + C + D?

33. $PhCO_2H + NaHCO_3 \longrightarrow A(gas)$
$PhOH + NaNH_2 \longrightarrow B(gas)$
$CH_3OH + NaH \longrightarrow C(gas)$
$CH_3SH + EtLi \longrightarrow D(gas)$
$PhSO_3H + Na \longrightarrow E(gas)$
If the molecular weight of A, B, C, D, E is x, y, z, w, v. then find the value of (y + z + w + v) – x.

34. How many among the following species contain P – P bond(s):
(i) P (red) (ii) $H_4P_2O_5$ (iii) $H_4P_2O_7$ (iv) $\left(PO_3^-\right)_3$ (v) $\left(PO_3^-\right)_2$ (vi) P_4O_{10}
(vii) P_4S_3 (viii) P_4O_6 (ix) P_4

35. Identify the number of correct statements:
(i) All adiabatic process must be fast.
(ii) All reversible process must be slow.
(iii) For adiabatic process, dq = 0.
(iv) If q = 0, process must be adiabatic.
(v) Absolute value of internal energy can not be determined.
(vi) H = E + PV is applicable only for ideal gases.
(vii) $\Delta H_f^o\left(D_2(g)\right) = 0$, at 298 K.
(viii) $\Delta G_f^o\left(H^+aq\right) = 0$, at 298 K.
(ix) Expansion of an ideal gas not always represent an increase in entropy of system.

36. How many isomeric dienes with a six membered ring are possible of the compound with the molecular formula C_7H_{10}, while two consecutive double bonds are not possible in six membered ring.

Space for Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **7 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

---

37. The integral $\int_{\pi/4}^{\pi/2} (2\cot x)^{2017} dx$ is equal to

(A) $2\int_0^2 \frac{t^{2017}}{t^2+4}dt$

(B) $2\int_2^{2\sqrt{2}} \frac{(t^2-4)^{1008}}{t}dt$

(C) $\frac{2^{2012}}{63} - 4\int_4^8 \frac{(t-4)^{1007}}{t}dt$

(D) $2\int_0^{\ell n(1+\sqrt{2})} \left(\frac{e^t - e^{-t}}{e^t + e^{-t}}\right)^{2017} dt$

38. Sum of series $\frac{1}{\sqrt[3]{1}+\sqrt[3]{2}+\sqrt[3]{4}} + \frac{1}{\sqrt[3]{4}+\sqrt[3]{6}+\sqrt[3]{9}} + \frac{1}{\sqrt[3]{9}+\sqrt[3]{12}+\sqrt[3]{16}} + ...$ to 2196 terms is

(A) a rational number

(B) an irrational number

(C) less than 13

(D) $\sqrt[3]{2196} - 1$

39. Let A = $\tan^{-1}(\cot 65^o + 2\tan 40^o)$; $B = \cos^{-1}\left(\sqrt{3}\sin 80^o - 2\sin 50^o\right)$ then

(A) $\cos(2B - A) > 0$

(B) $\cot(A + B) > -1$

(C) $\sin(2A + 3B) > 0$

(D) $\tan(2A - B) > 1$

Space for rough work

40. Let f be a twice differentiable function on $(0, \infty)$ such that $f(x) > 0$, $f'(x) > 0$ and $f''(x) > 0 \ \forall \ x > 0$. If $\lim\limits_{x\to\infty} \dfrac{f'(x)f'''(x)}{(f''(x))^2} = \dfrac{1}{3}$ then

(A) $\lim\limits_{x\to\infty} f(x) = \infty$

(B) $\lim\limits_{x\to\infty} \dfrac{f'(x)}{xf''(x)} = \dfrac{2}{3}$

(C) $\lim\limits_{x\to\infty} \dfrac{xf'(x)}{f(x)} = \dfrac{3}{2}$

(D) $\lim\limits_{x\to\infty} \dfrac{f(x)f''(x)}{(f'(x))^2} = 1$

41. The tangent to the circle $x^2 + y^2 = 4$ at a point P intersect the parabola $y^2 = 4x$ at points Q and R. Tangents to the parabola at Q and R intersect at S. If Q lies in the first quadrant such that PQ = 1 unit, then

(A) PR = 8 units

(B) $SR = \dfrac{35}{4}$ units

(C) $SQ = \dfrac{7}{2}$ units

(D) area of $\Delta SQR = \dfrac{343}{16}$ sq. units

42. Let $\vec{a}$, $\vec{b}$ and $\vec{c}$ be three non-coplanar vectors and $\vec{d}$ be a non-zero vector perpendicular to $\vec{a}+\vec{b}+\vec{c}$. Now $\vec{d} = (\vec{a}\times\vec{b})\sin x + (\vec{b}\times\vec{c})\cos y + 2(\vec{c}\times\vec{a})$, then

(A) $\dfrac{\vec{d}\cdot(\vec{a}+\vec{c})}{[\vec{a}\ \vec{b}\ \vec{c}]} = 2$

(B) $\dfrac{\vec{d}\cdot(\vec{a}+\vec{c})}{[\vec{a}\ \vec{b}\ \vec{c}]} = -2$

(C) minimum value of $x^2 + y^2 = \dfrac{\pi^2}{4}$

(D) minimum value of $x^2 + y^2 = \dfrac{5\pi^2}{4}$

43. If the two curves $y = ax^3 - 6ax^2 + (12a + 12)x - (8a + 16)$ where $a \in R$ and $y = x^3$ touches each other at some point, then possible value of 'a' are

(A) 0

(B) 1

(C) $\sqrt[3]{2} + \sqrt[3]{3}$

(D) e

Space for rough work

Matrix Match Types

Each of 2 tables with 3 Columns and 4 Rows has three questions. Column-1 will be with 4 rows designated (I), (II), (III) and (IV). Column-2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column-3 will be with 4 rows designated (P), (Q), (R) and (S). Each question has four options with only **ONE** correct

Answer questions 44, 45 and 46 by appropriately matching the information given in the three columns of the following table.

Let S = {A: A = $[a_{ij}]_{2\times 2}$, $a_{ij} \in \{0, \pm1, \pm2\}$}, column-1 and column-2 contain some conditions satisfied by a matrix A $\in$ S. Each entry in column-3 is the number of matrices A in S that satisfy one condition from column-I and one condition from column-II

Column–1	Column–2	Column–3
(I) $A = A^T$	(i) $\lvert A\rvert = 0$	(P) 5
(II) $A = -A^T$	(ii) $\lvert A\rvert \neq 0$	(Q) 8
(III) $A^2 = I$	(iii) Tr(A) = 0	(R) 17
(IV) $AA^T = I$	(iv) Tr(A) $\neq$ 0	(S) 20

Where A^T, |A| and Tr(A) denote the transpose of A, the determinant of A and the trace of A respectively

44. Which of the following is the only correct combination?
(A) (I) (ii) (R)
(B) (II) (iv) (Q)
(C) (III) (iii) (S)
(D) (IV) (iii) (P)

45. Which of the following is the only correct combination?
(A) (III) (i) (R)
(B) (I) (iii) (S)
(C) (II) (ii) (P)
(D) (IV) (ii) (Q)

46. Which of the following is the only correct combination?
(A) (II) (iii) (Q)
(B) (IV) (iv) (P)
(C) (III) (iv) (P)
(D) (I) (i) (R)

Space for rough work

Answer questions 47, 48 and 49 by appropriately matching the information given in the three columns of the following table.

Let $f(x) = \begin{cases} x+a & x<0 \\ |x-1| & x \geq 0 \end{cases}$, $g(x) = \begin{cases} x+1 & x<0 \\ (x-1)^2+b & x \geq 0 \end{cases}$. Where a and b are non negative real numbers

Column-1 contains information about g(f(x)). Column-2 contains information about interval of g(f(x)). Column-3 contains information about continuity and differentiability of g(f(x)) in R match the following Column(s)

Column–1	**Column–2**	**Column–3**
(I) $g(f(x)) = x + a + 1$	(i) $x \geq 1$	(P) g(f(x)) is continuous for all x then $a = 1, b = 1$
(II) $g(f(x)) = x^2 + b$	(ii) $x < -a$	(Q) g(f(x)) is continuous for all x then $a = 1, b = 0$
(III) $g(f(x)) = (x + a - 1)^2 + b$	(iii) $-a \leq x < 0$	(R) g(f(x)) is differentiable at $x = 1$ for $a = 1, b = 0$
(IV) $g(f(x)) = (x - 2)^2 + b$	(iv) $0 \leq x < 1$	(S) g(f(x)) is non-differentiable at $x = -1$ for $a = 1, b = 0$

47. Which of the following is the only correct combination?
(A) (I) (ii) (Q)
(B) (II) (i) (P)
(C) (III) (iv) (R)
(D) (IV) (iii) (S)

48. Which of the following is the only correct combination?
(A) (I) (ii) (P)
(B) (II) (ii) (R)
(C) (III) (iii) (Q)
(D) (IV) (iv) (S)

49. Which of the following is the only correct combination?
(A) (III) (iii) (R)
(B) (II) (ii) (Q)
(C) (III) (ii) (P)
(D) (IV) (i) (S)

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

50. Consider a parabola $4y = x^2$ and point B(0, 1). Let $A_1(x_1, y_1)$, $A_2(x_2, y_2)$, ... $A_n(x_n, y_n)$ are n points on the parabola such that $x_r > 0$ and $\angle OBA_r = \frac{r\pi}{2n}$ (r = 1, 2, 3, ..., n) then $\pi\left(\lim\limits_{x\to\infty}\frac{1}{n}\sum\limits_{r=1}^{n}BA_r\right)$ is equal to _____

51. Let N be the number of function f: A → A where A = {1, 2, 3, 4, 5}, such that f({1, 2, 3}) and f(f({1, 2, 3})) are disjoint. Let M be the sum of all the prime factor of N, then the value of $\sqrt{M}$ is equal to _____

52. The number of solutions of $\log\left(x^{2018}+1\right)+\log\left(1+x+.....+x^{2016}\right)=\log 4034+2017\log x$, is _____

53. If the solution of the differential equation $y\left(2x^4+y\right)\frac{dy}{dx}=\left(1-4xy^2\right)x^2$ is $k(x^2y)^2 + y^3 - x^3 = c$, then k is equal to _____

54. ΔABC is an equilateral triangle with circumcentre (1, 2) and vertex A lying on the line 5x + 2y = 4. A circle with centre I(2, 0) passes through the vertices B and C and intersects the sides AC and AB at D and E respectively. If area of quadrilateral BCDE is Δ, then find the value of $\frac{\Delta}{10\sqrt{3}}$ is _____

Space for rough work

FIITJEE

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FULL TEST – X

PAPER-1

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**A, B, C, D**	19.	**A, B, C, D**	37.	**A, B, C**
2.	**B, C, D**	20.	**C, D**	38.	**A, C**
3.	**A, B**	21.	**A, B, C**	39.	**C, D**
4.	**B, C**	22.	**B**	40.	**A, B**
5.	**A, C, D**	23.	**A, B**	41.	**D**
6.	**A, B**	24.	**B**	42.	**B, D**
7.	**A, B, C**	25.	**B, C**	43.	**A, B, C, D**
8.	**C**	26.	**B**	44.	**C**
9.	**B**	27.	**C**	45.	**D**
10.	**C**	28.	**D**	46.	**D**
11.	**D**	29.	**C**	47.	**A**
12.	**B**	30.	**D**	48.	**C**
13.	**C**	31.	**B**	49.	**D**
14.	**9**	32.	**9**	50.	**4**
15.	**4**	33.	**7**	51.	**7**
16.	**3**	34.	**3**	52.	**1**
17.	**5**	35.	**6**	53.	**3**
18.	**5**	36.	**7**	54.	**9**

Physics

PART – I

SECTION – A

1. Time period of oscillation T = $2\pi\sqrt{\frac{\text{reduced mass}}{k}} = 2\pi\sqrt{\frac{2m}{3k}}$

Required time $t = \frac{T}{4} = \frac{\pi}{2}\sqrt{\frac{(m\times 2m)}{3mk}} = \frac{\pi}{2}\sqrt{\frac{2m}{3k}}$

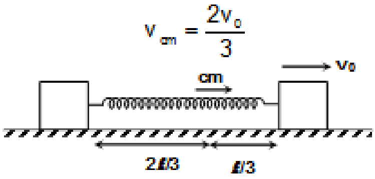
$V_{cm} = \frac{2mv_0}{3m} = \frac{2v_0}{3}$

Initially at mean position the block of mass 2m is moving with velocity $\frac{v_0}{3}$ towards right w.r.t centre of mass. Hence its minimum speed is $\left|\frac{v_0}{3} - \frac{2v_0}{3}\right| = \frac{v_0}{3}$

In centre of mass frame for block of mass 2m,

$\frac{1}{2}(2m)\frac{v_0^2}{9} = \frac{1}{2}(3k)A^2$

$\Rightarrow \quad A = \sqrt{\frac{2mv_0^2}{27k}}$



2. Let $M = G^a\eta^bB^C$

$\Rightarrow \quad M = \left[M^{-1}L^3T^{-2}\right]^a\left[ML^{-1}T^{-1}\right]^b\left[ML^{-1}T^{-2}\right]^c$

$\Rightarrow \quad a = \frac{1}{2}, b = 4, c = -\frac{5}{2}$

Further Let $L = G^a\eta^bB^c$

$= \left[M^{-1}L^3T^{-2}\right]^a\left[ML^{-1}T^{-1}\right]^b\left[ML^{-1}T^{-2}\right]^c$

$\Rightarrow \quad a = \frac{1}{2}, b = 2, c = -\frac{3}{2}$

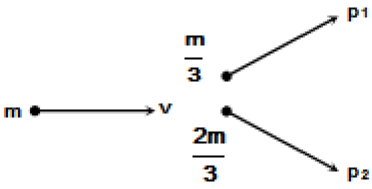
3. $p_1^2 + p_2^2 + 2p_1p_2\cos 60° = p^2$ (where p = mv)

$\Rightarrow \quad p_1^2 + p_2^2 + p_1p_2 = p^2$ …(i)

$\frac{p_1}{p_2} = \frac{\lambda_2}{\lambda_1} = \frac{2}{1} \Rightarrow p_1 = 2p_2$ …(ii)

From equation (I) & (II)

$p_2 = \frac{p}{\sqrt{7}} = \frac{mv}{\sqrt{7}}$ and $p_1 = \frac{2p}{\sqrt{7}} = \frac{2mv}{\sqrt{7}}$



$v_1 = \frac{p_1}{m/3} = \frac{6v}{\sqrt{7}}$ and $v_2 = \frac{p_2}{2m/3} = \frac{3v}{2\sqrt{7}}$

Increase in kinetic energy of the system due to explosion

$$= \frac{1}{2}\frac{m}{3}\left(\frac{6v}{\sqrt{7}}\right)^2 + \frac{1}{2}\left(\frac{2m}{3}\right)\left(\frac{3v}{2\sqrt{7}}\right)^2 - \frac{1}{2}mv^2 = \frac{13}{28}mv^2$$

4. Magnetic flux in a circular loop of radius r

$$= \int_0^r B(2\pi r)\,dr = \int_0^r \frac{Kt}{r} 2\pi r dr = 2\pi K t r$$

$$\oint \vec{E}.\vec{d}r = \frac{-d\phi}{dt}$$

$$\Rightarrow \quad E(2\pi r) = -2\pi K r$$

$$\Rightarrow \quad E = -K$$

Velocity of the bead V = at = $\frac{qE}{m}t = \frac{Kqt}{m}$

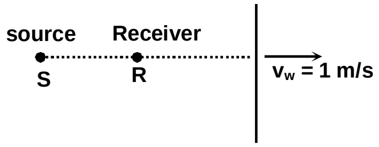
Further

$$qvB + N = \frac{mv^2}{R}$$

$$\Rightarrow \quad \frac{K^2q^2t^2}{mR} + N = \frac{m}{R}\frac{K^2q^2t^2}{m^2}$$

$$\Rightarrow \quad N = 0$$

5.



$$f_w = \frac{v - v_w}{v} f$$

$$f_1 = \frac{v}{v + v_w} f_w = \frac{v}{v + v_w}\left(\frac{v - v_w}{v} f\right)$$

$$f_1 = \frac{v - v_w}{v + v_w} f$$

$$\lambda_1 = \frac{v}{f_1} = \frac{v + v_w}{(v - v_w)}\lambda = \frac{1 + \frac{v_w}{v}}{1 - \frac{v_w}{v}}\lambda$$

$$= \left(1 + \frac{2v_w}{v}\right)\lambda$$

% change in wavelength = $\frac{\lambda_1 - \lambda}{\lambda} \times 100 = \frac{2v_w}{v} \times 100 = \frac{200}{1000/3} \simeq 0.6\%$

Frequency of the echo heard by the observer = $f_1 = \frac{v - v_w}{v + v_w} f \simeq \left(1 - \frac{2v_w}{v}\right) \times 1000$

$$= \left(1 - \frac{2}{1000/3}\right) \times 1000 = 994 \text{ Hz}$$

Beat frequency detected by the receiver = $f - f_1 \simeq 6\text{Hz}$

6. From conservation of momentum

$$\vec{p}_\alpha + \vec{p}_d = 0$$

$$\Rightarrow \quad \vec{p}_d = -\vec{p}_\alpha \Rightarrow p_d = p_\alpha = \sqrt{2m_\alpha k_\alpha}$$

$$v_d = \frac{p_d}{m_d} = \sqrt{\frac{2m_\alpha k_\alpha}{m_d}} = \frac{\sqrt{2 \times 4 \times 1.66 \times 10^{-27} \times 5.77 \times 1.6 \times 10^{-13}}}{202 \times 1.66 \times 10^{-27}} \approx 3.4 \times 10^5 \text{ m/s}$$

Energy released $= \frac{m_p}{m_d} k_\alpha = \frac{206}{202} \times 5.77 = 5.88$ MeV

7. When the switch S was open, charge on the capacitors, $q_1 = C_{eq}v = \frac{4}{3} \times 3 = 4\mu C$. When the switch S is closed then in steady state charge on capacitor of capacitance 2μF will be zero and charge on 4 μF capacitor $q_2 = 4 \times 3 = 12\mu C$. After the switch S was closed.
Energy supplied by the battery = $\varepsilon\Delta q = 3 \times 8 = 24$ μJ
Change in energy stored in capacitors = $\frac{1}{2} 4 \times 9 - \frac{1}{2}\frac{4}{3} \times 9 = 12$ μJ
Hence, Heat produced = 24 – 12 = 12 μJ

8-10. (I) $\delta(P_1) = 0$, $\phi(P_1) = 0$, $I(P_1) = I_m$

$$\delta(P_2) = d\frac{d/2}{D} = \frac{d^2}{2D} = \frac{10^{-6}}{2 \times 1.5} = \frac{10^{-6}}{3} = \frac{2}{3}\lambda$$

$$\phi(P_2) = \frac{2\pi}{\lambda}\frac{2}{3}\lambda = \frac{4\pi}{3},\ I(P_2) = I_m \cos^2\frac{2\pi}{3} = \frac{I_m}{4}$$

⇒ Correct choice for Q. 10 is C

(II) $\delta(P_1) = \frac{d}{D}\frac{d}{8} = \frac{d^2}{8D} = \frac{\lambda}{6},\ \ \phi(p_1) = \frac{2\pi}{\lambda} \times \frac{\lambda}{6} = \frac{\pi}{3}$

$$I(P_1) = I_m \cos^2\frac{\pi}{6} = \frac{3I_m}{4}$$

$$\delta(P_2) = d\frac{d}{2d} - \frac{d}{D}\frac{d}{8} = \frac{2\lambda}{3} - \frac{\lambda}{6} = \frac{3\lambda}{6} = \frac{\lambda}{2}$$

$I(P_2) = 0$

⇒ Correct choice for Q.9. is B

(III) $\delta(P_1) = (\mu - 1)t = \frac{5\lambda}{12}, \phi(P_1) = \frac{2\pi}{\lambda}\frac{5\lambda}{12} = \frac{5\pi}{6}$

$$I(P_1) = I_m \cos^2\frac{5\pi}{12}$$

$$\delta(P_2) = d\frac{d}{2D} - (\mu - 1)t = \frac{2\lambda}{3} - \frac{5\lambda}{12} = \frac{3\lambda}{12} = \frac{\lambda}{4}$$

$$\phi(p_2) = \frac{2\pi}{\lambda} \times \frac{\lambda}{4} = \frac{\pi}{2},\ I(P_2) = I_m \cos^2\frac{\pi}{4} = \frac{I_m}{2}$$

(IV) $\delta(P_1) = d\frac{5d}{8D} + (\mu - 1)t = \frac{5}{4}\frac{2\lambda}{3} + \frac{\lambda}{3} = \frac{5\lambda}{6} + \frac{\lambda}{3} = \frac{7\lambda}{6}$

$$\phi(P_1) = \frac{2\pi}{\lambda}\frac{7\lambda}{6} = \frac{7\pi}{3},\ I(P_1) = I_m \cos^2\frac{7\pi}{6} = \frac{I_m}{4}$$

$$\delta(P_2) = d\frac{5d}{8D} + d\frac{d}{2D} + (\mu - 1)t$$

$$= \frac{5\lambda}{6} + \frac{2\lambda}{3} + \frac{\lambda}{3} = \frac{11\lambda}{6}$$

$$\phi(P_2) = \frac{2\pi}{\lambda}\frac{11\lambda}{6} = \frac{11\pi}{3},\ \ I(P_2) = I_m \cos^2\frac{11\pi}{6} = \frac{I_m}{4}$$

11. $\Delta U = -\int p dv$ is valid when process is adiabatic $P \propto T^{7/2}$ implies process is adiabatic

12. $p \propto V^{-3/2} \Rightarrow pV^{3/2} = \text{constant}$

$$C = C_V + \frac{R}{1-\frac{3}{2}} = \frac{3R}{2} - 2R = -\frac{R}{2}$$

$$p \propto V^{-3/2} \Rightarrow T \propto \frac{1}{\sqrt{V}}$$

Since gas is compressed, its temperature increases

$\Delta Q = nC\Delta T < 0$

13. $\Delta U = \Delta Q - p\Delta V$ is valid for isobaric process

$$U \propto \frac{1}{\rho} \Rightarrow T \propto V \text{ or } \frac{V}{T} = \text{ constant}$$

So, process is isobaric

SECTION – C

14. $i_1 + i_2 = i$

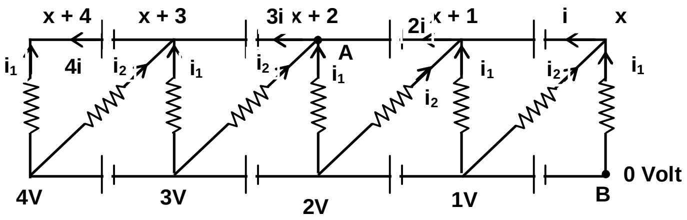
$4i + i_1 = 0$

$\Rightarrow \quad 5i_1 = -4i_2$

$$\Rightarrow \quad \frac{5x}{1} = -4\frac{(x-1)}{1}$$

$$\Rightarrow \quad x = \frac{4}{9}v$$

$$V_A - V_B = x + 2 = \frac{22}{9}V$$



15. $$\tau = -\frac{dU}{d\theta} = -\frac{1}{2}V^2\frac{dc}{d\theta} = -\frac{1}{2}V^2\frac{d}{d\theta}\left\{\frac{\varepsilon_0 R^2\theta}{2d} + \frac{\varepsilon_0 k(\pi-\theta)R^2}{2d}\right\} = \frac{(k-1)\varepsilon_0 R^2 V^2}{4d}$$

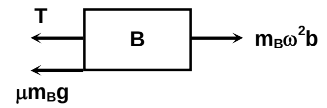
$\therefore \quad n = 4$

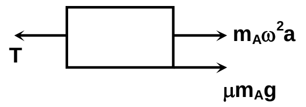
16. $T + \mu m_B g = m_B\omega^2 b$

$T = m_A\omega^2 a + \mu m_A g$

$\Rightarrow \quad m_B\omega^2 b - \mu m_B g = m_A\omega^2 a + \mu m_A g$

$$\Rightarrow \quad \omega = \sqrt{\frac{\mu g(m_A + m_B)}{(m_B b - m_A a)}} = \frac{10}{3}\text{ rad/s}$$





17. $\Sigma F_x = 0$

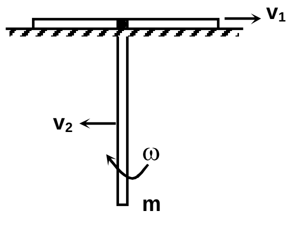
$\Rightarrow \quad mv_1 - mv_2 = 0$

At hinged point

$$v_1 = \frac{L}{2}\omega - v_2$$

From conservation of mechanical energy

$$mgL = \frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2 + \frac{1}{2}\frac{mL^2}{12}\omega^2$$



Solving $v_1 = \sqrt{\frac{3}{5}gL} = 5\,m/s$

18. $-\frac{dN_A}{dt} = \lambda N_A \Rightarrow N_A = N_0 e^{-\lambda t}$

$\frac{dN_B}{dt} = \lambda N_A - 2\lambda N_B$

$\Rightarrow \frac{dN_B}{dt} = \lambda N_0 e^{-\lambda t} - 2\lambda N_B$ …(1)

Solving equation (1)

$N_B = N_0\left(e^{-\lambda t} - e^{-2\lambda t}\right)$

N_B will be maximum, when $\frac{dN_B}{dt} = 0$

$\Rightarrow e^{-\lambda t} = \frac{1}{2}$

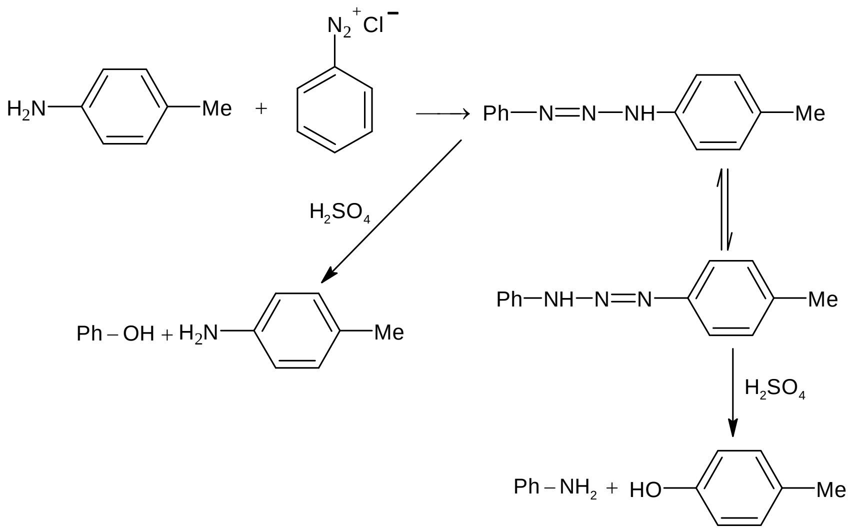
$(N_B)_{max} = N_0\left(\frac{1}{2} - \frac{1}{4}\right) = 5 \times 10^{20}$

Chemistry

PART – II

SECTION – A

19.



20. Cu^{+2} → Green colour
Co^{+3} → Deep blue.

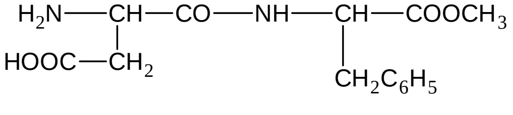
21. Fact

22. ClF_3 → Planar distorted – T- shape and polar
XeF_5^- → Pentagonal planar and non-polar
PCl_5 → Non-planar and non-polar
BrF_5 → Non-planar and polar

23. In brown ring test $[Fe(H_2O)_5NO]^{+2}$ complex is formed. Which is of brown colour.
While $Na_2[Fe(CN)_5NO].2H_2O$ is known as sodium nitroprusside where the oxidation number of iron is +1.

24. $CuSO_4$ reacts with KI to give white ppt. of Cu_2I_2 but $CuSO_4$ does not react with KCl to give $CuCl_2$.

25. Monomer of orlon is acrylonitrile
$\Rightarrow CH_2 = CHCN$
Aspartane is the methyl ester of dipeptide of L-aspartic and L-phenylalanine.



$H_2N—\underset{HOOC—CH_2}{CH}—CO—NH—\underset{CH_2C_6H_5}{CH}—COOCH_3$

26. Fact

27. Fact

28. Fact

29. Fact

30. Fact

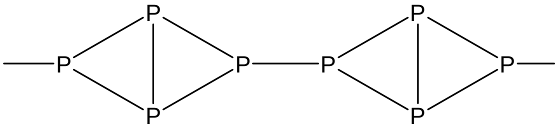
31. Fact

SECTION – C

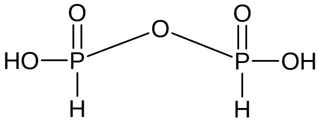
32. NiS and CoS → black in colour.
A = 2
B = 4
C = 0
D = 3

33. $A \rightarrow CO_2$
$B \rightarrow NH_3$
$C \rightarrow H_2$
$D \rightarrow CH_3 - CH_3$
$E \rightarrow H_2$
$(y + z + w + v) - x \Rightarrow (17 + 2 + 30 + 2) - 44$
$= 7$

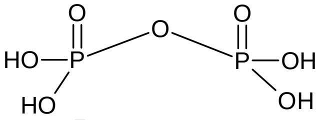
34. (i)



(ii)



(iii)



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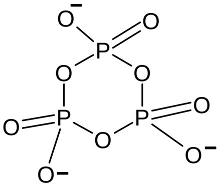
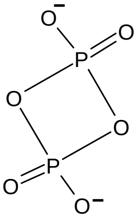


(v)



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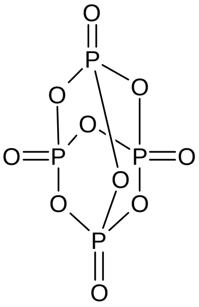

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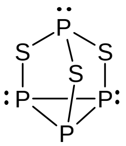
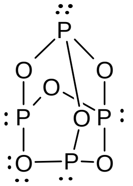
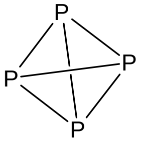


(viii)

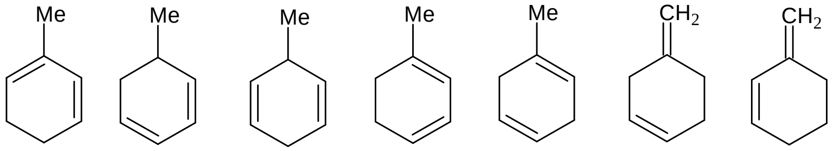


(ix)



35. (ii), (iii), (v), (vii), (viii), (ix) are correct statements.

36.



Mathematics PART – III

SECTION – A

37. (A) Put 2 cot x = t
(B) Put 2 cosec x = t
(C) Put $t^2 = u$ in B
(D) Put cot x + cosec x = e^t

38. $t_n = (n+1)^{1/3} - (n)^{1/3}$
$S_n = \sqrt[3]{2197} - 1 = 12$

39. $\cot 65^\circ + 2\tan 40^\circ = \frac{\sin 25^\circ}{\cos 25^\circ} + \frac{\sin 40^\circ}{\cos 40^\circ} + \tan 40^\circ$
$= \frac{\sin 65^\circ}{\cos 25^\circ \cdot \cos 40^\circ} + \frac{\sin 40^\circ}{\cos 40^\circ} = \frac{1+\sin 40^\circ}{\cos 40^\circ} = \frac{1+\cos 50^\circ}{\sin 50^\circ} = \cot 25^\circ$
and $\sqrt{3}\sin 80^\circ - 2\sin 50^\circ = 2\sin 60^\circ \cdot \sin 80^\circ - 2\sin 50^\circ$
$= \cos 20^\circ - \cos 40^\circ = \sin 10^\circ$

40. $\because$ f is positive, strictly increasing and concave up
$\therefore \lim_{x\to\infty} f(x) = \infty$

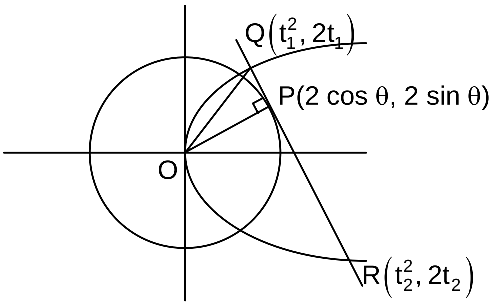
$$\lim_{x\to\infty} \frac{f'(x)}{xf''(x)} = \lim_{x\to\infty} \frac{\frac{f'(x)}{f''(x)}}{x} = \lim_{x\to\infty} \frac{f''(x)f''(x) - f'(x)f'''(x)}{\left(f''(x)\right)^2} \text{ (Applying L' Hospital rule)}$$

$$= \lim_{x\to\infty}\left(1 - \frac{f'(x)f'''(x)}{\left(f''(x)\right)^2}\right) = \frac{2}{3}$$

$$\lim_{x\to\infty} \frac{xf'(x)}{f(x)} = \lim_{x\to\infty} \frac{f'(x) + xf''(x)}{f'(x)} = \lim_{x\to\infty}\left(1 + \frac{xf''(x)}{f'(x)}\right) = \frac{5}{2} \text{ (Applying L' Hospital rule)}$$

$$\lim_{x\to\infty} \frac{f(x)f''(x)}{\left(f'(x)\right)^2} = \lim_{x\to\infty} \frac{f(x)}{xf'(x)} \cdot \lim_{x\to\infty} \frac{xf''(x)}{f'(x)} = \frac{3}{5}$$

41. $OQ^2 = OP^2 + PQ^2$
$\Rightarrow t_1^2 + 4t_1^2 = 5$
$\Rightarrow t_1 = 1$ ($\because t_1 > 0$)
$\Rightarrow Q \equiv (1, 2)$
$PQ = 1 \Rightarrow \cos\theta + 2\sin\theta = 2$
$\Rightarrow \cos\theta = \frac{4}{5}, \ \sin\theta = \frac{3}{5}$
$\Rightarrow p \equiv \left(\frac{8}{5}, \frac{6}{5}\right)$
Now R lies on tangent 4x + 3y = 10
$\Rightarrow t_2 = -\frac{5}{2}$ ($\because t_2 < 0$)
$\Rightarrow R \equiv \left(\frac{25}{4}, -5\right)$ and $S \equiv \left(-\frac{5}{2}, -\frac{3}{2}\right)$



42. $\vec{d}\cdot\vec{a} = \left[\bar{a}\ \bar{b}\ \bar{c}\right]\cos y$

$\Rightarrow -\vec{d}\cdot\left(\vec{b}+\vec{c}\right) = \left[a\ b\ c\right]\cos y$

$\Rightarrow \cos y = -\dfrac{\vec{d}\cdot\left(\vec{b}+\vec{c}\right)}{\left[a\ b\ c\right]}$

Also $\sin x = -\dfrac{\vec{d}\cdot\left(\vec{a}+\vec{b}\right)}{\left[a\ b\ c\right]}$ and $\dfrac{\vec{d}\cdot\left(\vec{a}+\vec{c}\right)}{\left[a\ b\ c\right]} = -2$

$\therefore$ sin x + cos y + 2 = 0

$\Rightarrow$ sin x = –1, cos y = –1

Minimum of $x^2 + y^2 = \dfrac{5\pi^2}{4}$

43. Solving given equations, we get $a(x^3 - 6x^2 + 12x - 8) = x^3 - 12x + 16$

$\Rightarrow a(x-2)^3 = (x-2)^2(x+4)$

$\therefore$ x = 2 is a repeated root and hence the two curves touches each other at x = 2 $\forall$ a $\in$ R

44.-46. (I) $A = A^T$

$\Rightarrow A = \begin{bmatrix} a & b \\ b & c \end{bmatrix}$ where a, b, c $\in$ {0, ±1, ± 2}

$\therefore$ Number of such matrices in A = 5 × 5 × 5 = 125

Now |A| = 0, $\Rightarrow b^2 = ac$

b = 0, 9 matrices

b = ±1, 4 matrices

b = ±2, 4 matrices

Total 17 matrices

|A| ≠ 0, 125 – 17 = 108 matrices

Tr(A) = 0 $\Rightarrow$ a + c = 0 $\Rightarrow$ c = –a, total 5 × 5 = 25 matrices

$\therefore$ For Tr(A) ≠ 0 $\Rightarrow$ 100 matrices

(II) $A = -A^T$

$\therefore A = \begin{bmatrix} 0 & a \\ -a & 0 \end{bmatrix}$ a $\in$ {0, ±1, ± 2}

$\Rightarrow$ 5 matrices

|A| = 0 $\Rightarrow a^2 = 0$, a = 0 $\Rightarrow$ 1 matrix

Here Tr(A) = 0

(III) Let $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \Rightarrow A^2 = I$

$\Rightarrow a^2 + bc = d^2 + bc = 1$

$\Rightarrow$ b(a + d) = c(a + d) = 0

Tr(A) = 0 $\Rightarrow$ a + d = 0, $bc = 1 - a^2$

a = 0, 2 matrices

a = ±1, 18 matrices

a = ±2, not possible $\Rightarrow$ 20 matrices

Tr(A) = a + d ≠ 0 $\Rightarrow$ b = c = 0 and a = d = ±1

$\Rightarrow$ 2 matrices

If $A^2 = I$, then |A| = 1 ≠ 0

(IV) $AA^T = I$

$\Rightarrow$ A is orthogonal matrix

$\Rightarrow$ Rows of A are mutually perpendicular unit vector

$\Rightarrow A = \begin{bmatrix} \pm1 & 0 \\ 0 & \pm1 \end{bmatrix}$ or $\begin{bmatrix} 0 & \pm1 \\ \pm1 & 0 \end{bmatrix}$

Tr(A) = 0 $\Rightarrow$ 6 matrices

Tr(A) $\neq$ 0 $\Rightarrow$ 2 matrices. Here $|A| \neq 0$

47.-49. $g(f(x)) = \begin{cases} x + a + 1 & x < -a \\ (x + a - 1)^2 + b & -a \le x < 0 \\ x^2 + b & 0 \le x < 1 \\ (x - 2)^2 + b & x \ge 1 \end{cases}$

Now for a = 1, b = 0 g(f(x)) is continuous for all $x \in R$

and for a = 1, b = 0 g(f(x)) is non-differentiable at $x = \pm1$

SECTION – C

50. Let $A_r = (2t, t^2)$

$\therefore$ Slope of $BA_r = \frac{t^2 - 1}{2t} = \tan\left(\frac{\pi}{2} + \theta_r\right)$

$\therefore \tan(\theta_r) = \frac{2t}{1 - t^2} = \tan 2\phi$ (Let)

$\Rightarrow \phi = \frac{\theta_r}{2} = \frac{r\pi}{4n}$ where $\tan\phi = t$ and $BA_r = \sqrt{(t^2 - 1)^2 + 4t^2} = t^2 + 1 = \sec^2\phi = \sec^2\left(\frac{r\pi}{4n}\right)$

$\Rightarrow \lim\limits_{n\to\infty} \frac{1}{n}\sum_{r=1}^{n} BA_r = \int_0^1 \sec^2\left(\frac{\pi x}{4}\right)dx = \frac{4}{\pi}$

51. For f({1, 2, 3}) and f(f{1, 2, 3}) to be disjoint, we must have f(1), f(2), f(3) $\notin$ {1, 2, 3}

If f(1) = f(2) = f(3) = 4 or 5, then one of f(4) and f(5) will have 4 and other have 5 choice. Number of possible function = 2 × 4 × 5 = 40

If two of f(1) and f(2) and f(3) are equal and rest is different then f(4), f(5) $\in$ {1, 2, 3}

$\Rightarrow$ Total number of possible function = 3 × 2 × 3 × 3 = 54

$\therefore$ N = 94

52. The given equation is $(x^{2018} + 1)(1 + x + ... + x^{2016}) = 4034.x^{2017}$

$\Rightarrow \left(x + \frac{1}{x^{2017}}\right)\left(1 + x + ... + x^{2016}\right) = 4034$

$\Rightarrow \left(x + \frac{1}{x}\right) + \left(x^2 + \frac{1}{x^2}\right) + ... + \left(x^{2017} + \frac{1}{x^{2017}}\right) = 2.2017$

Here, x > 0 therefore L.H.S $\ge$ 2 × 2017 and for equality each term of L.H.S must be equal to 2

$\Rightarrow$ x = 1

53. Given equation can be written as $2x^2y(x^2\,dy + 2xy\,dx) + y^2\,dy - x^2\,dx = 0$

$\Rightarrow 2x^2y\,d(x^2y) + y^2\,dy - x^2\,dx = 0$

Integrating, we get $3(x^2y)^2 + y^3 - x^3 = c$

54. Equation of OI is, 2x + y = 4

Vertex is point of intersection of 2x + y = 4 and 5x + 2y = 4

$\therefore$ A = (–4, 12), $AO = 5\sqrt{5}$, $AI = 6\sqrt{5}$

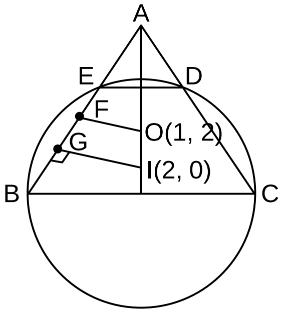
AG = AI cos 30° = $3\sqrt{15}$

$\because AG = \frac{AE + AB}{2}$

$\therefore$ AE = 2AG – AB = $\sqrt{15}$

$\therefore$ Area of quadrilateral BCDE = area of ΔABC – area of ΔADE

$= \frac{\sqrt{3}}{4}\left(AB^2 - AE^2\right) = 90\sqrt{3}$



FIITJEE

JEE (Advanced)-2018

ALL INDIA TEST SERIES

FULL TEST – X

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 231**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-C & Section-D**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01 – 03, 24 – 26, 47 – 49)*** *contains 9 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (04 – 08, 27 – 31, 50 – 54) *contains 15 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (09 – 10, 32 – 33, 55 – 56) *contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer. There is no negative marking.*

2. ***Section-C (11 – 20, 34 – 43, 57 – 66)*** *contains 30 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

3. ***Section-D (21 – 23, 44 – 46, 67 – 69)*** *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

PART – I (Physics), PART – II (Chemistry), PART – III (Mathematics):
(SECTION – D)

For questions **21 to 23, 44 to 46, 67 to 69.**
Numerical answer type questions with answer XXXXX. XX

If answer is 348.4 / 251.37 / 213

Correct Method :

0	0	3	4	8	.	4	0

0	0	2	5	1	.	3	7

0	0	2	1	3	.	0	0

Wrong Method :

	3	4	8		.	4	

3	4	8			.		4

		3	4	8	.		4

	3		4	8	.	4	

	2		5	1	.	3	7

		2	1	3	.		

		2	1	3	.	0	

		2	1	3	.		0

		3	4	8	.	4	0

		2	5	1	.	3	7

		2	1	3	.	0	0

Physics PART – I

SECTION – A

Straight Objective Type

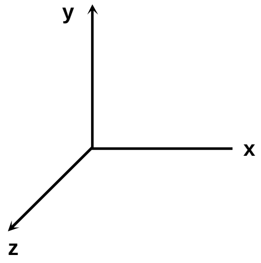
This section contains **3 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

1. The escape velocity at the poles of a planet is v_e. If the effect of rotation of a planet makes the weight of a body at the equator 10% less than the weight at pole, the peripheral velocity of a point on the equator of the planet is (assume the planet to be a uniform solid sphere)

(A) $\frac{v_e}{\sqrt{5}}$ (B) $\frac{v_e}{2\sqrt{5}}$

(C) $\frac{\sqrt{5}v_e}{2}$ (D) $\frac{2v_e}{5}$

2. Current I flowing along edges of one face of a cube as shown in figure-I, produces magnetic field $\vec{B} = B_0\hat{k}$ at the centre of the cube. Consider another identical cube, where current I flows along the path as shown in the figure-II. What magnetic field is produced at the centre of the second cube?



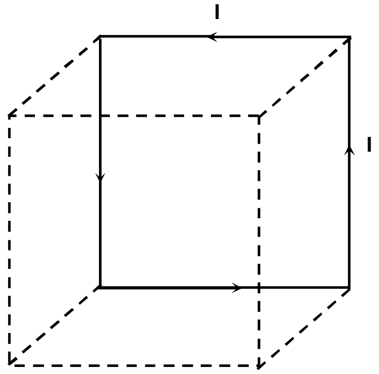


Figure – (i)

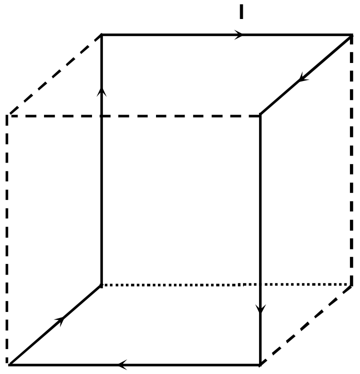


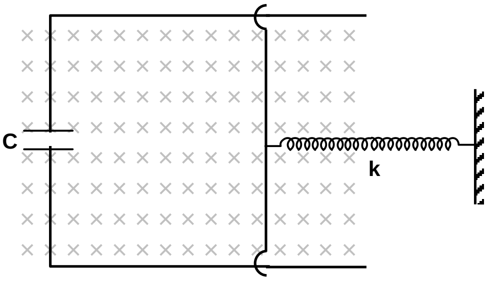
Figure – (ii)

(A) Zero (B) $B_0\left(-\hat{j}+\hat{k}+\hat{i}\right)$

(C) $B_0\left(-\hat{j}-\hat{k}+\hat{i}\right)$ (D) $B_0\left(\hat{j}+\hat{k}-\hat{i}\right)$

Space for Rough work

3. One end of a non-conducting spring of force constant k is connected to the mid-point of a conducting rod of mass m and length ℓ, which can slide freely on a pair of parallel and smooth horizontal conducting rails. The other end of the spring is connected to a rigid wall. There exists a uniform magnetic field B normal to the plane of paper and into it. Electrical resistance of the rails and rod are negligible. The rails are connected to a capacitor of capacitance C. If the wire is pushed towards left and released, the time period of its oscillation will be $\left(\text{Given } m = 2CB^2\ell^2\right)$.



(A) $T = 2\pi\sqrt{\dfrac{m}{k}}$

(B) $T = \pi\left(\sqrt{\dfrac{3m}{2k}} + \sqrt{\dfrac{m}{2k}}\right)$

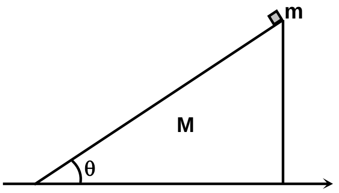
(C) $T = 2\pi\sqrt{\dfrac{3m}{2k}}$

(D) $T = \pi\left(\sqrt{\dfrac{3m}{2k}} + \sqrt{\dfrac{m}{k}}\right)$

Multiple Correct Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

4. In the figure shown, the friction between the wedge and the horizontal surface is sufficient to prevent the wedge from sliding. The mass of the wedge is M and its inclination is θ. A particle of mass m is held motionless on the top of the wedge. Friction coefficient between particle and wedge is μ. Now the particle and the wedge are released from rest. Then



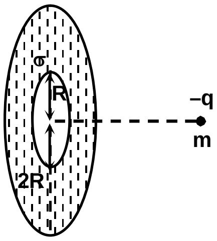
(A) If $\mu > \tan\theta$, wedge will not topple for any value of m.

(B) If $\mu > \tan\theta$, wedge will topple for $m > \dfrac{M}{3\sin\theta(\sin\theta + \mu\cos\theta)}$

(C) If $\mu < \tan\theta$, wedge will topple for $m > \dfrac{M}{3\sin\theta(\sin\theta - \mu\cos\theta)}$

(D) If $\mu < \tan\theta$, wedge will topple for $m > \dfrac{M}{6\sin\theta(\sin\theta - \mu\cos\theta)}$

Space for Rough work



5. A charged fixed annular disc of uniform positive charge density σ has inner and outer radii R and 2R respectively. A negatively charged particle of mass m and charge – q is released on the axis of the disc from a distance x from the centre. Then

(A) The speed of the particle when reaches the centre of ring, $v = \sqrt{\frac{q\sigma}{m\varepsilon_0}\left(R + \sqrt{R^2 + x^2} - \sqrt{4R^2 + x^2}\right)}$

(B) The speed of the particle when it reaches the centre of ring, $v = \sqrt{\frac{q\sigma}{m\varepsilon_0}\left(R + \sqrt{4R^2 + x^2} - \sqrt{R^2 + x^2}\right)}$

(C) Work done by electrostatic force till the particle reaches the centre of ring $= \frac{q\sigma}{2\varepsilon_0}\left(R + \sqrt{R^2 + x^2} - \sqrt{4R^2 + x^2}\right)$

(D) If x << R, the frequency of oscillation of the particle is $f = \frac{1}{2\pi}\sqrt{\frac{q\sigma}{4\varepsilon_0 mR}}$

6. An artificial satellite of mass m revolves in a circular orbit of radius 4R around the centre of the moon (where R is the radius of the moon). Suddenly it starts experiencing a slight resistance due to cosmic dust. The resistance force depends on the speed of satellite as F = kv where k is a constant. If the radius of the moon is R and acceleration due to gravity on the moon's surface is g, then (assume that at every moment the satellite follows a circular path)

(A) The satellite will hit the moon's surface after time $t = \frac{m}{k}\ln 2$

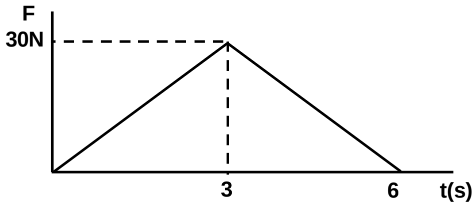
(B) The satellite will hit the moon's surface after time $t = \frac{2m}{k}\ln 2$

(C) The work done by the resistance force on the satellite till it hits the moon surface $= -\frac{3}{8}mgR$.

(D) Work done by gravitational force till the satellite hits the moon's surface = $\frac{3}{4}mgR$.

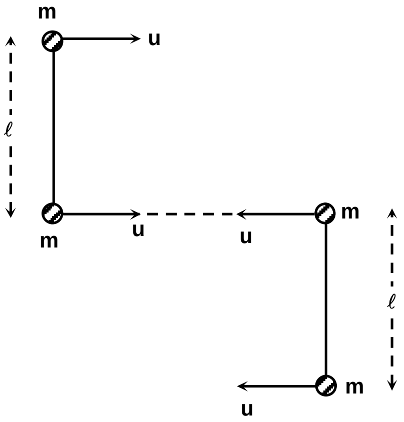
Space for Rough work

7. A block of mass m = 2 kg rests on a rough horizontal surface. The coefficient of friction between block and surface is μ = 0.5. The block is acted upon by a horizontal time varying force as shown. Then



(A) The block starts moving at time t = 1s
(B) The maximum velocity acquired by the block is 25 m/s
(C) The maximum velocity attained by the block is 20 m/s
(D) Velocity of block at t = 6 sec is 12.5 m/s

8. Two identical dumbbells are formed by welding two small identical particles each of mass m at the ends of massless rod each of length ℓ. The dumbbells are moving in free space with equal speed u without rotation towards each other as shown in the figure. Collision between the particles are elastic. Then



(A) Angular velocity of each dumbbell just after first collision is $\frac{u}{\ell}$
(B) Angular velocity of each dumbbell just after first collision is $\frac{2u}{\ell}$
(C) Speed of centre of mass of any one of the dumbbell just after collision is zero.
(D) Speed of centre of mass of any one of the dumbbell just after collision is u.

Space for Rough work

Comprehension Type

This section contains **1 group of questions.** The group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

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Paragraph for Question Nos. 9 and 10

A pendulum is suspended from a fixed point. The mass of the bob of the pendulum is m and the length of string is ℓ. It is initially at rest at its lowest position. A particle of mass $\frac{m}{2}$ moving horizontally along negative x-direction with velocity $\sqrt{2g\ell}$ collides with the bob and comes to rest. When the bob comes to rest, another particle Q of mass m moving horizontally along y-direction collides with the bob and sticks to it. It is observed that the bob now moves along a horizontal circle. There is horizontal floor 2ℓ distance below the point of suspension of the pendulum.

9. Which of the following is possible value of speed of particle Q just before its collision with the bob?

(A) $\sqrt{\frac{7\ell g}{3}}$ (B) $\sqrt{\frac{3\ell g}{4}}$

(C) $\sqrt{\frac{7\ell g}{4}}$ (D) $\sqrt{\frac{4\ell g}{3}}$

10. If string breaks during the circular motion, the bob will hit the floor after a time equal to

(A) $\sqrt{\frac{4\ell}{g}}$ (B) $\sqrt{\frac{4\ell}{2g}}$

(C) $\sqrt{\frac{5\ell}{2g}}$ (D) $\sqrt{\frac{\ell}{2g}}$

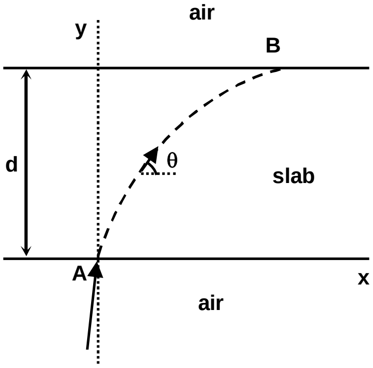
Space for Rough work

SECTION – C

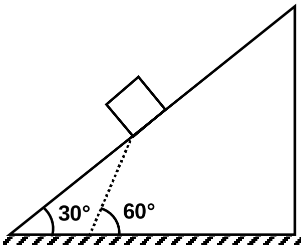
(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

11. A ray of light travelling in air is incident at grazing angle (incident angle ≈ 90°) on a long rectangular slab of a transparent medium of thickness d. The point of incidence is the origin A (0, 0). The medium has a variable index of refraction $\mu = \sqrt{1+e^{x/d}}$. Determine the x coordinate (in meter) of the point B, where the ray meets the upper surface of slab air boundary (Take d = (25/7) m and ln2 = 0.7).



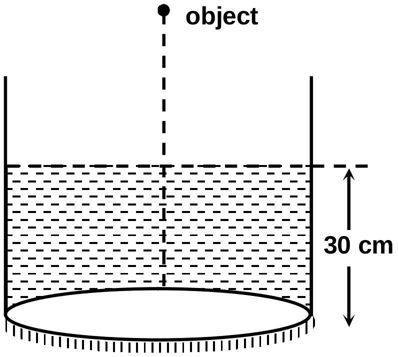
12. A wedge of mass 3 kg is lying at rest on a frictionless horizontal surface. A block of mass m is released from rest on the wedge. If the path of block (with respect to the ground) makes an angle 60° with horizontal after it is released, the mass of block (in kg) is



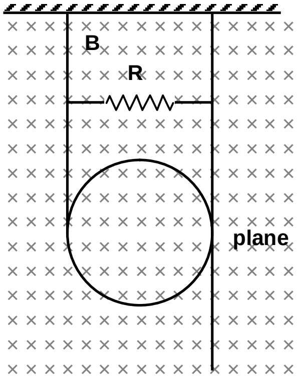
13. A solid object of uniform cross section area and relative density 0.2 is pressed down and held at rest inside water surface so that its upper surface is in level with the water surface. Length of the object is $\ell = 1.2\,\text{m}$. When released the object jumps out of water moving vertically. The velocity of the object (in m/s) when it just comes out completely from the water is (Take g = 10 m /s^2).

Space for Rough work

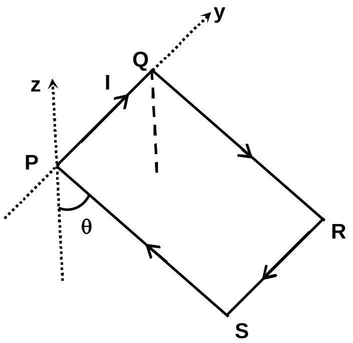
14. The bottom of a container is made of an equi-convex lens. The focal length of the lens in air is 60 cm. Now its lower surface is silvered. The refractive index of the material of the lens is 1.5. Water is filled in the container to a depth 30 cm. When an object is placed at a distance $\frac{27}{n}$ cm above the water surface on the principle axis of lens, the final image of the object coincides with the object. Find the value of n. (given $\mu_{water} = 4/3$)



15. A conducting light string is wound on the rim of a metal ring of radius r and mass m. The free end of the string is fixed to the ceiling. A vertical infinite conducting smooth plane is always tangent to the ring. The ring is released and simultaneously a uniform magnetic field of strength B perpendicular to the plane of the ring is switched on. The string and the plane are connected by a resistance R. The ring is always immersed in the magnetic field. If the terminal velocity of the ring is $\frac{mgR}{nB^2r^2}$, find the value of n.



16. A square current carrying loop of side length ℓ and carrying a current I is hinged about its horizontal side PQ (Parallel to y axis). There is a uniform magnetic field $\vec{B} = B_0(\hat{i} - \hat{k})$ in the region. The linear mass density of loop is λ and acceleration due to gravity is g. The loop remains in equilibrium when it's plane makes an angle θ = 37° with the vertical (z-axis). If the value of B_0 is $\frac{n\lambda g}{7\,I}$, find the value of n. (given sin 37°= 3/5)



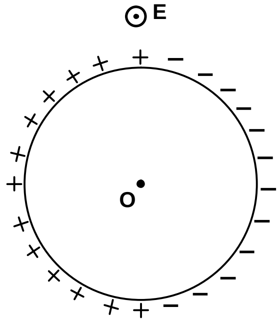
Space for Rough work

17. When the potential difference applied to an x-ray tube is 10 kV the minimum wavelength of continuous x-ray spectrum is λ_0. Further when the potential difference applied is increased from 10 kV to 20 kV the difference of wavelengths of K_α line and minimum wavelength of continuous x-ray increases to twice of its initial value. Atomic number of anode material of x-ray tube is z. If the value of z – 1 equals $\sqrt{\frac{n}{9\lambda_0 R}}$, then find the value of n.

18. The radiation emitted when an electron jumps from n = 4 to n = 3 in a Li^{++} ion (atomic no. z = 3) falls on a metal surface to produce photoelectron. When the photoelectron with maximum kinetic energy are made to move perpendicular to a uniform magnetic field of 2×10^{-4} T, it follows a circular path of radius $\sqrt{\frac{9.1}{1.6}}$ cm. The work function of metal (in eV) to the nearest integer is (given mass of electron $m = 9.1 \times 10^{-31}$ kg and charge on electron $= -1.6 \times 10^{-19}$ C)

19. A car begins to move at time t = 0 and then accelerates along a straight horizontal track with a velocity given by $v = 2t^2$ for $0 \le t \le 2$, where t is time in second. After the end of acceleration, the car continues to move at constant speed. A small block initially at rest on the floor of the car begins to slip at t = 1 sec and stops sliding at t = 3 sec. If the coefficient of static and kinetic friction between the block and the floor are μ_S and μ_K respectively, find the value of $\frac{3\mu_S}{\mu_K}$.

20. A uniform ring of mass m and radius R is placed freely in a gravity free region. Half of the ring is positively charged with uniform linear charge density $+\lambda$ and other half is negatively charged with uniform charged density $-\lambda$. A uniform electric field E is switched on along the normal to the plane of the ring. If the angular speed of the ring when it turns through an angle 90° is $n\left(\sqrt{\frac{\lambda E}{m}}\right)$, find the value of n.



Space for Rough work

SECTION – D

(Numerical Answer Type)

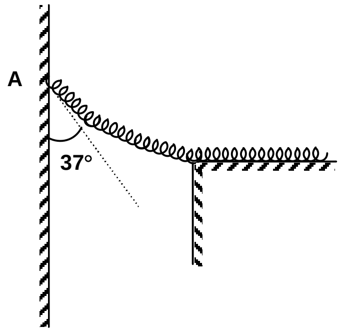
This section contains **3 questions**. Each question, when worked out will result in **numerical answer type** (XXXXX.XX)

21. In a hydrogen like atom, an electron is revolving in an orbit having quantum number n. Its frequency of revolution is found to be 13.2×10^{15} Hz. Energy required to completely remove this electron to infinity from the above orbit of atom is 54.4 eV. In a time interval of 7 nanosecond the electron jumps back to orbit having quantum number n/2. If the average torque acting on the electron during the above process is τ Nm, then find the value of $\tau \times 10^{26}$.

(given $\frac{h}{\pi} = 2.1\times10^{-34}\,\text{J}-\text{s}$, frequency of revolution of electron in the ground state of H-atom = 6.6×10^{15} Hz)

22. A screw gauge with a pitch of 0.5 mm and a circular scale with 50 divisions is used to measure the diameter of a uniform wire. Before starting the measurement, it is found that when the two jaws of the screw gauge are brought in contact, the 47th division of the circular scale coincides with the main scale line and that the zero of the main scale is barely visible. When the diameter of wire is measured by this screw gauge the main scale reads 1.10 cm and the 12th division of the circular scale coincides with the main scale line. Find the diameter (in mm) of the cylinder.

23. A uniform chain of length L has one of its end attached to a vertical wall at point A, while $\frac{3L}{4}$ of the length of the chain is lying on table as shown in figure. Tangent to the chain at A makes an angle 37° with the wall. Find the minimum coefficient of friction between table and chain so that chain remains in equilibrium.



Space for Rough work

Chemistry PART – II

SECTION – A

Straight Objective Type

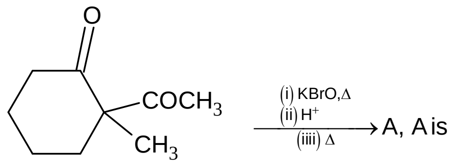
This section contains **3 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

24. KMnO4 in neutral/weakly alkaline medium oxidizes thiosulphate to:

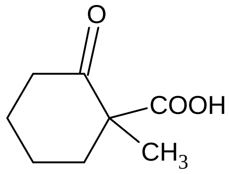
(A) SO_3^{2-} (B) $S_2O_4^{2-}$

(C) SO_4^{2-} (D) $S_4O_6^{2-}$

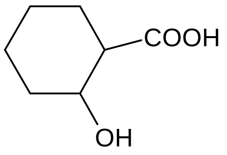
25.



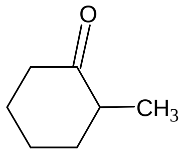
(A)



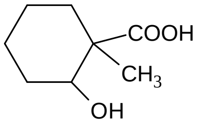
(B)



(C)



(D)



26. A red hot sample of atomic hydrogen in a tube was subjected to electrical discharge. The approximate voltage at which the first indication of current flow was observed:

(A) 13.6 V (B) 10.2 V

(C) 1.51 V (D) 1.89 V

Space for Rough work

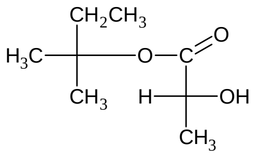
Multiple Correct Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

27. Which of the following pairs of compound could be separated by recrystallization?

(A) meso-tarteric acid and (±)-tartaric acid.

(B)



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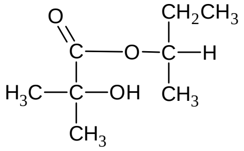
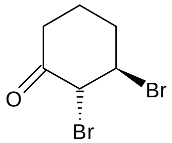


(C)



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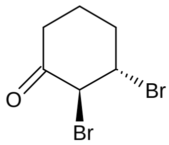
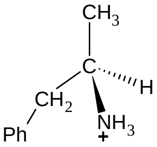
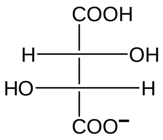


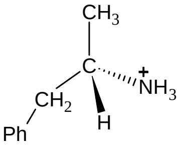
(D)

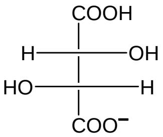


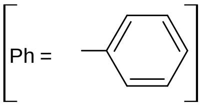


(an acid-base salt)

and







28. Select reaction/s in which anion of main ionic product do not have σ-bond.

(A) Li + O_2 (excess) →

(B) Na (excess) + O_2 →

(C) Ca + F_2 (excess) →

(D) NaOH (cold) + Cl_2 →

Space for Rough work

29. In the following conversion

$$\text{D}-\text{glucopyranose}\xrightarrow[\text{EtONa}]{\text{MeNO}_2}?\xrightarrow{\text{H}_2\text{SO}_4}?\xrightarrow{\text{H}_2/\text{Ni}}\text{Product}(\text{s})$$

Which of the following is/are correct about final product(s)?

(A) optically active (B) optically inactive

(C) optically active as well as optically inactive (D) all are correct

30. Which of the following is **incorrect** statement for an ideal gas?

(A) When temperature increases at constant pressure, collision frequency increases.

(B) Mean free path decreases by increasing temperature at constant pressure.

(C) If all gas molecules are assumed to be rigid sphere of negligible volume, the only possible molecular motion is translation.

(D) Kinetic energy decreases by increasing pressure at constant temperature.

31. There are process which are used to determine some important properties of colloidal solution. By which of the following processes, the nature of electrical charge on colloidal particles can be determined?

(A) ultramicroscopic (B) electrophoresis

(C) dialysis (D) electroosmosis

Space for Rough work

Comprehension Type

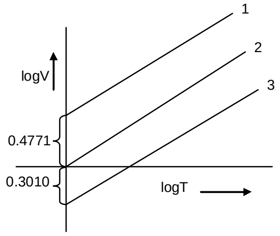
This section contains **1 group of questions.** The group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

---

Paragraph for Question Nos. 32 to 33

When a sample of an ideal gas is changed from an initial state to a final state. Various curves can be plotted for the process like P – V curve, V – T curve, P – T curve etc. For example P – V curve for a fixed amount of an ideal gas at constant temperature is a rectangular, V – T curve for a fixed amount of an ideal gas at constant pressure is straight line and P – T curve for a fixed amount of an ideal gas is again straight line. However, the shapes may vary if the constant parameters are also changed.

32. At constant P of 0.0821 atm, logV v/s log T graph is plotted for 3 samples of ideal gas as shown. Value of number of moles of gas in these three samples is respectively:
[log2 = 0.3010, log3 = 0.4771]



(A) $3,1,\frac{1}{2}$ (B) $\frac{1}{2},1,3$

(C) $1,\frac{1}{2},3$ (D) $\frac{1}{2},3,1$

33. Two moles of an ideal gas is changed from its initial state (16 atm, 6L) to final state (4 atm, 15 L) in such a way that this change can be represented by a straight line in P – V curve. The maximum temperature attained by the gas during the above change is: (take $R = \frac{1}{12} \text{L atm K}^{-1} \text{mol}^{-1}$)

(A) 324 K (B) 648 K

(C) 1296 K (D) 972 K

Space for Rough work

SECTION – C

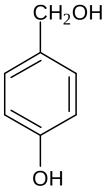
(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

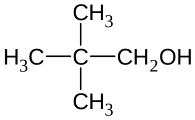
---

34. Compound(x) (C_8H_7N) on treatment with cold $SnCl_2$/dil.HCl (aqueous), produces y(C_8H_8O). y on heating with sodium acetate in acetic anhydride followed by acidification forms (z) ($C_{10}H_{10}O_2$). All these compounds (x, y, z) on oxidation under severe conditions form a diacid which gives only one mononitro isomer in nitrating mixture, how many products will be formed on reductive ozonlysis of (z)?

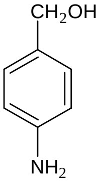
35. How many of the following can give aldehyde by the oxidation with Jones reagent?

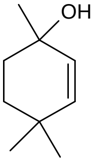
(a)


(b) $CH_2 = CH – CH_2OH$

(c)


$H_3C—C(CH_3)_2—CH_2OH$

(d)


(e)


36. From the following the complex that is expected to show optical isomerism is/are:

(1) $[Ni(en)_3]^{2+}$
(2) $[Fe(ox)Cl_4]^{3-}$
(3) $[Cr(NH_3)_3Cl_2(NO_3)]$
(4) $[Zn(NO_3)_2(NH_3)(CO)]$

37. At 263 K a solid compound $A(H_2O)_8$ show following equilibria (Assume 263 K is sublimation point of H_2O(s) under given condition):

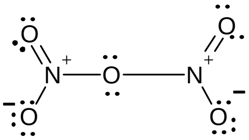
$$A(H_2O)_8(s) \rightleftharpoons A(g) + 8H_2O(g); \qquad K_{p_1}$$

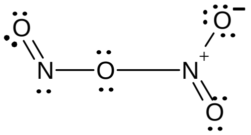
$$A(H_2O)_8(s) \rightleftharpoons A(g) + 8H_2O(s); \qquad K_{p_2}$$

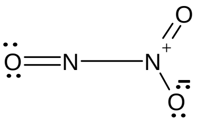
If equilibrium partial pressures of two gases A and H_2O are 0.2 bar and 0.001 bar respectively. And the vapour pressure of ice is 10^{-x} bar. What is value of 'x'?

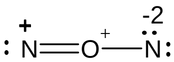
Space for Rough work

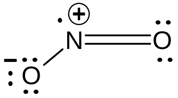
38. How many of the following is/are correct structure(s) for any oxide of nitrogen?

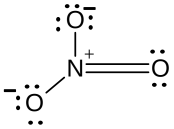
(I)


(II)


(III)


(IV)


(V)


(VI)


39. In 2nd order reaction: $2A \longrightarrow A_2$, the rate of formation of A_2 is 10^{-5} M sec^{-1} at 0.01 M concentration of A, and the rate of disappearance of A is x × 10^{-1}, find out the value of x?

40. How many of the following reaction(s) is/are neither stereospecific nor regiospecific?

(i) $\text{trans}-2-\text{pentene} \xrightarrow{HCl}$

(ii) $1-\text{pentene} \xrightarrow[\text{NaCl(Excess)}]{Br_2}$

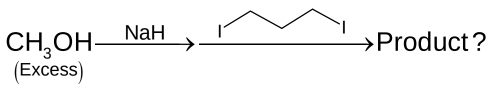
(iii) $\text{Cyclobutene} \xrightarrow[Br_2]{H_2O}$

(iv) $1-\text{ethylcyclopropene} \xrightarrow{D_2/Pt}$

(v) $\text{trans}-2-\text{pentene} \xrightarrow[NaBH_4/H_2O]{Hg(OAc)_2}$

(vi) $\text{trans}-2-\text{pentene} \xrightarrow{H^+/H_2O}$

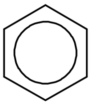
(vii) $\text{trans}-2-\text{pentene} \xrightarrow{Br_2/CCl_4}$,

41.


How many of 'C' atoms are there in one molecule of the product?

Space for Rough work

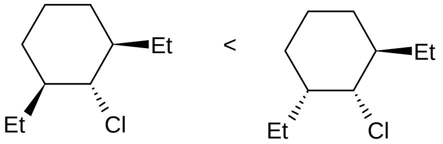
42. How many 'H' atoms are there in the final product of the following reaction sequence?



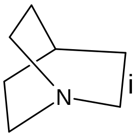
$\xrightarrow{\text{conc. HNO}_3\text{/conc.H}_2\text{SO}_4} A \xrightarrow[\text{Et/AcOH}]{} B \xrightarrow{H^+/\Delta} C$

43. How many of the following option(s) is/are incorrect?

(i) The order of rate of E_2 reaction is

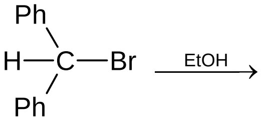


(ii) The poorest leaving group among the – SH, – NH_2, – OAc, – OH is – OH.

(iii) 

is stronger nucleophile as compared to Et_3N.

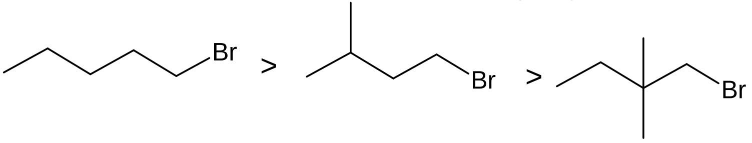
(iv) In the reaction



$\text{H—}\overset{\text{Ph}}{\underset{\text{Ph}}{\text{C}}}\text{—Br} \xrightarrow{\text{EtOH}}$

Rate of reaction is unaffected, if the concentration of Ph_2CHBr is tripled and the concentration of ethanol is doubled.

(v) The order of S_N2 mechanism in the following alkyl halide is:



SECTION – D

(Numerical Answer Type)

This section contains **3 questions**. Each question, when worked out will result in **numerical answer type** (XXXXX.XX)

---

44. There are five solutions

Solution 1 – 0.2 M HCl

Solution 2 – 0.2 M BOH ($K_b = 10^{-2}$M)

Solution 3 – 0.2 M, 1 lit HCl + 0.2 M, 1 lit BOH

Solution 4 – 0.2 M, $K_4[Fe(CN)_6]$

Solution 5 – 0.2 M, Na_3PO_4

What is the correct code of solution numbers in increasing order of their respective freezing points?

45. At 298 K, the emf of the cell

$$\text{Hg}\,|\,\underset{\text{saturated with } Hg_2Cl_2}{0.01\,\text{mol dm}^{-3}\ \text{kcl}}\,|\,1\,\text{mol dm}^{-3}\,\text{KNO}_3\,|\,\underset{\text{saturated with HgO}}{0.01\,\text{mol dm}^{-3}\ \text{KOH}}\,|\,\text{Hg}$$

is found to be 0.1634 v. What is the free energy change of the cell reaction? (Given 1F = 96500 C)

46. The density of a sodium chloride sample is found to be 2.16801 gm/cm^3, instead of 2.18 gm/cm^3. What is the percentage of unoccupied sites in the sample?

Space for Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **3 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

47. A circle C_1 with radius 5 touches x-axis and another circle C_2 with radius 4 touches y-axis. The two circles touches each other externally so that their point of contact lies in the first quadrant, let the locus of their point of contact be the curve S. Two tangents are drawn to the curve S from point P(9, 5) to meet the curve at Q and R. The area of ΔPQR is

(A) $\frac{29}{4}$ (B) $\frac{27}{5}$

(C) $\frac{13}{2}$ (D) $\frac{25}{3}$

48. In a ΔABC, internal angle bisectors AI, BI and CI are produced to meet opposite sides in A', B' and C' respectively, then the maximum value of $\frac{AI\cdot BI\cdot CI}{AA'\cdot BB'\cdot CC'}$ is

(A) $\frac{27}{2}$ (B) $\frac{13}{4}$

(C) $\frac{8}{27}$ (D) $\frac{27}{256}$

49. Point 'O' is the centre of ellipse with major axis AB and minor axis CD. Point F is one focus of ellipse. If OF = 6 and the diameter of the inscribed circle of ΔOCF is 2, then the product AB.CD equals

(A) 65 (B) 72

(C) 78 (D) 92

Space for rough work

Multiple Correct Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

---

50. Vertices A, B and C of a tetrahedron ABCD are (1, 1, 1), (1, 0, 0), (3, 0, 0) respectively. The altitude from vertex D to the opposite face ABC meets the median line through A of the ΔABC at a point E. If the length of side AD is 4 and volume of the tetrahedron is $\frac{2\sqrt{2}}{3}$, then the correct statements is/are

(A) the altitude from vertex D is 2
(B) there is exactly one position for the point E
(C) there can be two position for the point E
(D) vector $\hat{j}-\hat{k}$ is normal to the plane ABC

51. Let $\alpha = e^{\frac{i\pi}{2017}}$, then

(A) $\prod_{r=1}^{2016}\left(\alpha^r + \alpha^{-r}\right) = 2$
(B) $\text{Re}\left(\sum_{r=1}^{2016}\alpha^r\right) = 0$
(C) $\sum_{r=1}^{2016}\left(\alpha^r + \alpha^{-r}\right) = 0$
(D) $\sum_{r=1}^{2016}\left(\alpha^r + \alpha^{-r}\right) = 1$

52. Let $P\left(\alpha, \frac{1}{\alpha}\right)$, ($0 < \alpha < 1$) be any point on the hyperbola xy = 1. Tangent to the hyperbola at P intersect the coordinate axes at Q and R & normal at P intersects the coordinate axes at M and N (Q and M lie on x-axis). If ΔOQR and ΔOMN have equal area, then

(A) area of ΔOMN = 2
(B) $\alpha = \sqrt{2} - 1$
(C) QR = $2^{7/4}$
(D) MN = $2^{7/4}$

53. The roots of equation $x^5 - 40x^4 + \alpha x^3 + \beta x^2 + \gamma x + \delta = 0$ are real and in G.P. If the sum of their reciprocal is 10, then δ can be

(A) –32
(B) $\frac{1}{32}$
(C) $-\frac{1}{32}$
(D) 32

Space for rough work

54. A function y = f(x) satisfying the differential equation $\frac{dy}{dx}\cdot\sin x - y\cos x + \frac{\sin^2 x}{x^2} = 0$ is such that $y \to 0$ as $x \to \infty$, then

(A) $\lim\limits_{x\to 0} f(x) = 1$

(B) $\int_0^{\pi/2} f(x)dx$ is less than $\frac{\pi}{2}$

(C) $\int_0^{\pi/2} f(x)dx$ is greater than unity

(D) f(x) is an odd function

Comprehension Type

This section contains **1 group of questions.** The group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

---

Paragraph for Question Nos. 55 to 56

Read the following write up carefully and answer the following questions:
Consider the following three sets of complex roots of unity. A = {z: $z^{18} = 1$}, B = {ω: $\omega^{48} = 1$} and C = {zω: z ∈ A and ω ∈ B}, then

55. The number of distinct elements in the set C is

(A) 864
(B) 48
(C) 66
(D) 144

56. Let the set C has n distinct elements $C_1, C_2, \ldots, C_n$, then the value of $|C_2 - C_1| + |C_3 - C_1| + \ldots + |C_n - C_1|$ is

(A) $2\cot\left(\frac{5}{8}\right)^{\circ}$
(B) $\cot\left(\frac{5}{4}\right)^{\circ}$
(C) $2\cot\left(\frac{15}{11}\right)^{\circ}$
(D) $\cot\left(\frac{15}{8}\right)^{\circ}$

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

57. f: R → R is a continuous function satisfying $\int_0^1 \left(\frac{f(x)}{x}\right)^2 dx = 2\int_0^1 f(x)dx - \frac{1}{3}$, then $256 f\left(\frac{1}{8}\right)$ is equal to _____

58. There are seven letters L_1, L_2, L_3, L_4, L_5, L_6 and L_7 and six envelopes E_1, E_2, E_3, E_4, E_5, E_6 corresponding to first six letters. The total number of ways if none of the letters goes to its correct envelope, even letters goes to even envelopes. Odd letters goes to envelopes other that E_4 and E_6 and all the envelopes except E_2 contains exactly one letter is, N. If $N = 2\alpha + 4$, where $\alpha \in z$, then α is equal to _____

59. Let A(z_1), B(z_2) and $C\left(z_1 + \frac{z_2 - z_1}{1-i}\right)$ are vertices of a triangle. If $|z_2 + iz_1| = |z_1| + |z_2|$, $|z_1| = \sqrt{7}$ and $|z_2| = 3$, then area of ΔABC is _____

60. Let $A = \frac{1}{\sqrt{2}} + \frac{1}{\sqrt{3}} + ... + \frac{1}{\sqrt{10000}}$, then find $\left[\frac{[A]}{50}\right]$ _____ (where [.] denotes the greatest integer function)

61. The possible number of ordered triplets (m, n, p) where m, n, p ∈ N is (6250)k. Such that $1 \le m \le 100$, $1 \le n \le 50$, $1 \le p \le 25$ and $2^m + 2^n + 2^p$ is divisible by 3, then k is _____

62. Number of integral values of p for which the system of equations $\cos^{-1}x + \left(\sin^{-1}y\right)^2 = \frac{p\pi^2}{4}$ and $\left(\cos^{-1}x\right)\left(\sin^{-1}y\right)^2 = \frac{\pi^4}{16}$ has real solutions is _____

Space for rough work

63. Let f: $R^+ \to R^+$ be a differentiable function satisfying $f(x)\cdot f(yf(x)) = f(x + y)\ \forall\ x, y \in R^+$ and $f'(0) = -1$, and $f(0) = 1$ then area of the region bounded by the curve $y = \frac{f(x)}{x+1}$ and the coordinate axes is _____

64. Let $I = \int\limits_0^{\ln 2} \frac{2e^{3x} + e^{2x} - 1}{e^{3x} + e^{2x} - e^{x} + 1}dx$, then $11e^{-I}$ is equal to _____

65. The number of different hyperbolas, which can be represented by the equation $1 = \sqrt{x^2 + y^2} - {}^{n}C_{r}x$ is _____ (where n and r are integers satisfying $1 \le r \le n \le 5$)

66. Let $A = \begin{bmatrix} 1 & \frac{3}{2} \\ 1 & 2 \end{bmatrix}$, $B = \begin{bmatrix} 4 & -3 \\ -2 & 2 \end{bmatrix}$ and $C_r = \begin{bmatrix} r\cdot 3^r & 2^r \\ 0 & (r-1)3^r \end{bmatrix}$ be given matrices. If $\sum\limits_{r=1}^{50} t_r\left((AB)^r C_r\right) = 3 + a\cdot 3^b$ _____ (where $t_r(A)$ denotes trace of matrix A), then value of $\frac{a+b}{20}$ is (where a, b $\in$ I and a is not divisible by 3)

SECTION – D

(Numerical Answer Type)

This section contains **3 questions**. Each question, when worked out will result in **numerical answer type** (XXXXX.XX)

---

67. The equation $a_8x^8 + a_7x^7 + a_6x^6 + ... + a_0 = 0$ has all roots positive and real and $a_8 = 1$, $a_7 = -4$ and $a_0 = \frac{1}{2^8}$, then the value of $\frac{a_2a_6}{a_4}$ is equal to _____

68. Coordinate of any point P are (4, 5). If A and B are variable points on straight lines y = x and y = 2x respectively. Then find minimum value of $(PA + PB + AB)^2$ _____

69. If the length of the largest interval in which the function $f(x) = \sin^{-1}|\sin \alpha x| + \cos^{-1}(\cos \alpha x)$ is constant is 2π, then the value of α is _____ where ($\alpha > 0$)

Space for rough work

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FULL TEST – X

PAPER-2

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**B**	24.	**C**	47.	**B**
2.	**C**	25.	**C**	48.	**C**
3.	**C**	26.	**C**	49.	**A**
4.	**A, C**	27.	**A, B, D**	50.	**A, C, D**
5.	**A, C, D**	28.	**A, B, C**	51.	**B, C**
6.	**A, C, D**	29.	**A, B, C, D**	52.	**A, C, D**
7.	**A, C**	30.	**A, B, D**	53.	**A, D**
8.	**B, C**	31.	**B, D**	54.	**A, B, C**
9.	**A**	32.	**A**	55.	**D**
10.	**C**	33.	**B**	56.	**A**
11.	**5**	34.	**2**	57.	**4**
12.	**6**	35.	**4**	58.	**9**
13.	**6**	36.	**1**	59.	**4**
14.	**2**	37.	**3**	60.	**3**
15.	**4**	38.	**4**	61.	**5**
16.	**6**	39.	**2**	62.	**1**
17.	**8**	40.	**0**	63.	**1**
18.	**4**	41.	**5**	64.	**4**
19.	**4**	42.	**7**	65.	**6**
20.	**4**	43.	**2**	66.	**5**
21.	**00001.50**	44.	**45123.00**	67.	**00000.70**
22.	**00011.15**	45.	**31536.20**	68.	**00016.40**
23.	**00000.25**	46.	**00000.55**	69.	**00000.50**

Physics

PART – I

SECTION – A

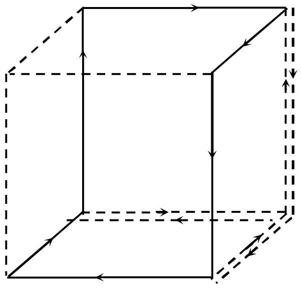
1. $g_{equator} = (0.9)g_{poles}$

$$\Rightarrow \quad g_{pole} - \omega^2 R = (0.9)g_{pole}$$

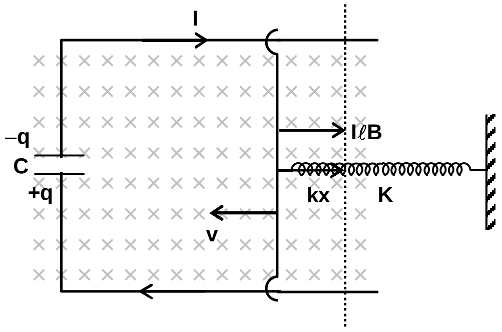
$$\Rightarrow \quad \omega^2 R = \frac{g}{10}$$

Peripheral velocity on equator $v = \omega R = \sqrt{\frac{g}{10R}} \times R = \sqrt{\frac{2gR}{20}} = \frac{v_e}{2\sqrt{5}}$

2. The current distribution is equivalent to three current carrying loops as shown in the figure.



3. When the rod moves towards left with velocity v and has displacement x towards left from mean position



Mean position

$\varepsilon = B\ell v$

$q = C\varepsilon = CB\ell v$

$$I = \frac{dq}{dt} = CB\ell\frac{dv}{dt}$$

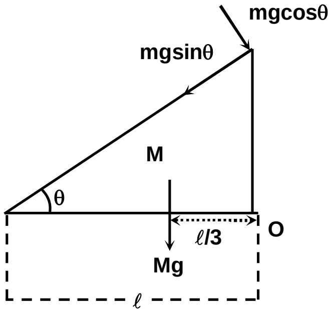
$$-(I\ell B + kx) = m\frac{dv}{dt}$$

$$\Rightarrow \quad -\left(CB^2\ell^2\frac{dv}{dt} + kx\right) = m\frac{dv}{dt}$$

$$\Rightarrow \left(m + CB^2\ell^2\right)\frac{dv}{dt} = -kx$$

$$\Rightarrow \quad \omega = \sqrt{\frac{k}{m + CB^2\ell^2}} = \sqrt{\frac{2k}{3m}}$$

4. When $\mu > \tan\theta$, the particle will remain at rest on the wedge and force exerted by it on the wedge will be equal to mg in the vertically downward direction and wedge will remain at rest. When $\mu < \tan\theta$ the particle will slide down the wedge and force exerted by it on wedge will be as shown.



The wedge will topple if,

$\sum\tau_0 > 0$

$$\Rightarrow \quad mg\cos\theta\,\ell\tan\theta\sin\theta - \mu mg\cos\theta\,\ell\tan\theta\cos\theta$$

$$-Mg\frac{\ell}{3} > 0$$

$$\Rightarrow \quad m > \frac{M}{3\sin\theta(\sin\theta - \mu\cos\theta)}$$

5. From conservation of energy

$$-\frac{\sigma q}{2\varepsilon_0}\left(\sqrt{4R^2+x^2}-\sqrt{R^2+x^2}\right)=\frac{1}{2}mv^2-\frac{q\sigma R}{2\varepsilon_0}$$

$$\Rightarrow \quad v=\sqrt{\frac{q\sigma}{m\varepsilon_0}\left(R+\sqrt{R^2+x^2}-\sqrt{4R^2+x^2}\right)}$$

$$W_{\text{electric force}}=-\Delta U=-q\left(V_f-V_i\right)$$

$$=\frac{q\sigma}{2\varepsilon_0}\left(R+\sqrt{R^2+x^2}-\sqrt{4R^2+x^2}\right)$$

$$a=\frac{-qE}{m}=\frac{-q}{m}\frac{\sigma x}{2\varepsilon_0}\left(\frac{1}{\sqrt{R^2+x^2}}-\frac{1}{\sqrt{4R^2+x^2}}\right)$$

$$\simeq -\frac{q\sigma x}{4\varepsilon_0 mR} \quad \text{(since x << R)}$$

$$\Rightarrow \quad \omega=\sqrt{\frac{q\sigma}{4\varepsilon_0 mR}}$$

$$f=\frac{1}{2\pi}\sqrt{\frac{q\sigma}{4\varepsilon_0 mR}}$$

6. for circular orbit of satellite

$$E=\frac{U}{2}=-K \Rightarrow -dE=dK$$

$$\Rightarrow \quad (kv)vdt=mvdv$$

$$\frac{dv}{dt}=\frac{kv}{m} \Rightarrow \int dt=-\frac{m}{k}\int_{v_i}^{v_f}\frac{dv}{v}$$

$$\Rightarrow \quad t=\frac{m}{k}\ln\left(\frac{v_f}{v_i}\right)=\frac{m}{k}\ln\sqrt{\frac{GM/R}{GM/4R}}=\frac{m}{k}\ln 2$$

$$W_g=U_i-U_f=-\frac{GMm}{4R}-\left(-\frac{GmM}{R}\right)=\frac{3}{4}\frac{gR^2m}{R}=\frac{3}{4}mgR$$

$$W_g+W_r=\frac{1}{2}m\left(v_f^2-v_1^2\right)=\frac{1}{2}m\left(\frac{GM}{R}-\frac{GM}{4R}\right)$$

$$\Rightarrow \quad \frac{3}{4}mgR+W_r=\frac{3}{8}mgR \Rightarrow W_r=\frac{-3}{8}mgR$$

7. The block will start moving

When F > μmg i.e. F > 10 N

$$\Rightarrow \quad t=1\,s$$

The velocity of block is maximum when $F-\mu mg=0$

i.e. at t = 5s

Net impulse = change in momentum

$$\Rightarrow \quad \frac{1}{2}6\times 30-2\frac{1}{2}10\times 1-10\times 4=mv_{max}$$

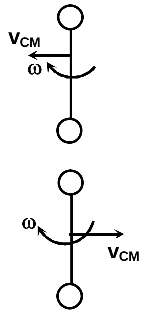
$$\Rightarrow \quad v_{max}=20\,m/s$$

From $t = 1s$ to $t = 6s$

$$\frac{1}{2}\times 30\times 6-5-10\times 5=2v$$

$$\Rightarrow \quad v=\frac{35}{2}m/s$$

8. Let velocity of centre of mass of each dumbbell be V_{CM} and angular velocity ω as shown.



Since $\frac{v_2-v_1}{u_1-u_2}=1 \Rightarrow \frac{\left(V_{CM}+\omega\frac{\ell}{2}\right)+\left(\frac{\omega\ell}{2}+V_{CM}\right)}{u-(-u)}=1$

$$\Rightarrow \quad 2v_{CM}+\omega\ell=2u \qquad \ldots(i)$$

Let the dumbbells exert average impulsive force N on each other during collision.

$$N\Delta t=2m(V_{CM}+u)$$

$$N\Delta t\frac{\ell}{2}=\frac{m\ell^2}{2}\omega$$

$$\Rightarrow \quad \ell=\frac{\omega\ell^2}{2(V_{CM}+u)} \qquad \ldots(ii)$$

From equation (1) & (ii)

$$\omega=\frac{2u}{\ell}$$

9. $\frac{m}{2}\sqrt{2g\ell}=mv_1 \Rightarrow v_1=\sqrt{\frac{g\ell}{2}}$

$mg\ell(1-\cos\theta)=\frac{1}{2}m\frac{g\ell}{2}$ (θ is angular displacement of the bob when it comes to rest)

$$\Rightarrow \cos\theta=\frac{3}{4}$$

When the bob moves in horizontal circle

$$\omega=\sqrt{\frac{g}{\ell\cos\theta}}=\sqrt{\frac{4g}{3\ell}}$$

$$v=\omega r=\omega\ell\sin\theta=\sqrt{\frac{4g}{3\ell}}\frac{\sqrt{7}}{4}\ell=\sqrt{\frac{7g\ell}{12}}$$

$$mv_Q=2m\sqrt{\frac{7g\ell}{12}} \Rightarrow v_Q=\sqrt{\frac{7g\ell}{3}}$$

10. Height of the bob when string slacks

$$h=\ell+\ell(1-\cos\theta)=\ell+\frac{\ell}{4}=\frac{5\ell}{4}$$

Time $t=\sqrt{\frac{2h}{g}}=\sqrt{\frac{5\ell}{2g}}$

SECTION – C

11. $\mu \sin\theta = 1 \times \sin 90°$

$$\sin\theta = \frac{1}{\mu}$$

$$\Rightarrow \quad \tan\theta = \frac{1}{\sqrt{\mu^2 - 1}} = \frac{1}{\sqrt{1 + e^{x/d} - 1}} = e^{-x/2d}$$

$$\frac{dy}{dx} = e^{-x/2d}$$

$$\Rightarrow \quad y = 2d\left(1 - e^{-x/2d}\right)$$

At B, y = d

$$\Rightarrow \quad x = 2d\,\ell n 2 = \frac{50}{7} \times 0.7 = 5\,\text{m}$$

12. For the wedge $N\sin 30° = Ma$ …(i)

The acceleration of block perpendicular to the inclined plane is asin30°

$\Rightarrow \quad mg\sin 60° - N = ma\sin 30°$ …(ii)

The net force on the block perpendicular to its direction of motion w.r.t ground should be zero.

$\Rightarrow \quad N\cos 30° = mg\sin 30°$ …(iii)

$\Rightarrow$ N putting the value of N in equation (i) and (ii)

$(mg\tan 30° = Ma)$

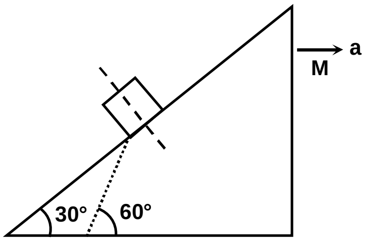
…(iv)

$mg\sin 60° - mg\tan 30° = ma\sin 30°$

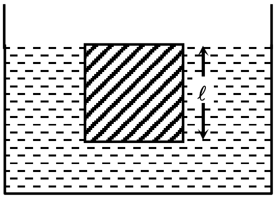
…(v)

Equating the value of a in the equation (iv) and (v)

$$\frac{m}{M} = 2 \Rightarrow m = 6\,\text{kg}$$



13. $$a = \frac{\rho_w A(\ell - x)g - \frac{\rho_w}{5}A\ell g}{\frac{\rho_w}{5}A\ell}$$



$$\int_0^v v\,dv = \int_0^\ell \left(4 - \frac{5x}{\ell}\right) g\,dx$$

$$\Rightarrow \quad v = \sqrt{3\ell g} = \sqrt{3 \times 1.2 \times 10} = 6\ \text{m/s}$$

14. For refraction at first surface of the lens,

$$\frac{1.5}{-60} - \frac{4/3}{u} = \frac{1.5 - \frac{4}{3}}{60}$$

$\Rightarrow$ u = –48 cm

If the object is placed h cm above the water surface, after refraction at the water surface its image will be formed at distance $\frac{4h}{3}$ from the surface

$$\Rightarrow \quad \frac{4h}{3} + 30 = 48 \Rightarrow h = \frac{27}{2}\text{cm}$$

15. Induced current in resistor R

$$I = \frac{2Brv}{R}$$

Magnetic force on the ring $F_m = 2\frac{I}{2}(2r)B$

$$= \frac{4B^2r^2v}{R}$$

When the ring attains terminal velocity

$\sum F = 0$

$$\Rightarrow \quad mg - \frac{4B^2r^2v}{R} = 0$$

$$\Rightarrow \quad v = \frac{mgR}{4B^2r^2}$$

16. Since the loop is in equilibrium $\sum \tau = 0$

$$\Rightarrow \quad \left\{(2\lambda g\ell)\frac{\ell}{2}\sin\theta + \lambda\ell^2 g\sin\theta\right\}\hat{j} + I\ell^2(-\cos\theta\hat{i} - \sin\theta\hat{k})\times B_0(\hat{i}-\hat{k}) = 0$$

$$\Rightarrow \quad B_0 = \frac{6\lambda g}{7\,I}$$

17. $\lambda_{k_\alpha} - \lambda_0' = 2\left(\lambda_{k_\alpha} - \lambda_0\right)$

$$\Rightarrow \quad \lambda_{k_\alpha} = 2\lambda_0 - \lambda_0'$$

$$\frac{\lambda_0'}{\lambda_0} = \frac{10}{20} = \frac{1}{2}$$

$$\Rightarrow \quad \lambda_{k_\alpha} = 2\lambda_0 - \frac{\lambda_0}{2} = \frac{3\lambda_0}{2}$$

$$\Rightarrow \quad \frac{4}{3R(z-1)^2} = \frac{3\lambda_0}{2}$$

$$\Rightarrow \quad z - 1 = \sqrt{\frac{8}{9\lambda_0 R}}$$

18. $r = \frac{mv}{qB} = \frac{\sqrt{2mK_{max}}}{qB}$

$$\Rightarrow K_{max} = \frac{q^2B^2r^2}{2m}$$

Putting the values of q, B, r and m

$K_{max} = 2$ eV

Energy of emitted photon

$$h\nu = 13.6 \times 3^2\left(\frac{1}{9} - \frac{1}{16}\right)\text{eV} = 5.95 \text{ eV}$$

$h\nu = \phi + k_{max}$

$\Rightarrow \phi = 3.95$ eV ≈ 4 eV

19. $a = 4t$

At t = 1 sec, $a = 4 = \mu_s g$

$\Rightarrow \mu_S = 0.4$

$\frac{dv}{dt} = 4t - \mu_k g$ (where v = velocity of block with respect to car)

$\Rightarrow \int_0^{v_2} dv = \left[2t^2 - \mu_k gt\right]_1^2$

$v_2 = 6 - \mu_k g$

From t = 2 s to t = 3s

v = u + at

$0 = (6 - \mu_K g) - \mu_K g \times 1$

$\Rightarrow \mu_K = 0.3$

$\Rightarrow \frac{3\mu_s}{\mu_k} = 4$

20. From conservation of mechanical energy

$$-pE(\cos 90° - \cos 0°) = \frac{1}{2}\frac{mR^2}{2}\omega^2$$

$$(\lambda\pi R)\frac{4R}{\pi}E = \frac{1}{2}\frac{mR^2}{2}\omega^2$$

$$\omega = 4\left(\sqrt{\frac{\lambda E}{m}}\right)$$

SECTION – D

21. $\nu = \nu_0 \frac{z^2}{n^3} \Rightarrow \frac{z^2}{n^3} = 2$ …(i)

$E = E_0 \frac{z^2}{n^2} \Rightarrow \frac{z^2}{n^2} = 4$

Solving (i) and (ii), n = 2 and z = 4

L = mvr = $\frac{nh}{2\pi}$, $\Delta L = \tau\Delta t = \Delta n\frac{h}{2\pi}$

$$\tau = \frac{\Delta n}{\Delta t}\frac{h}{2\pi} = 1.5 \times 10^{-26}\text{ Nm}$$

22. Zero error = $-(50 - 47) \times 0.01$ mm

$= -0.003$ cm

Measured diameter = $1.10 + 0.001 \times 12$

= 1.112 cm

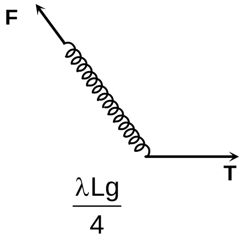
Actual diameter = Measured diameter – Zero Error

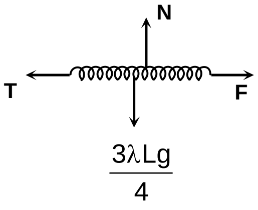
$= 1.112 - (-0.003) = 1.115$ cm = 11.15 mm

23. F cos 37° = $\frac{\lambda L}{4}g$

F sin 37° = T = f ≤ μN $\left(N = \frac{3\lambda Lg}{4}\right)$

$\Rightarrow \mu \geq 1/4, \Rightarrow \mu_{min} = 1/4$





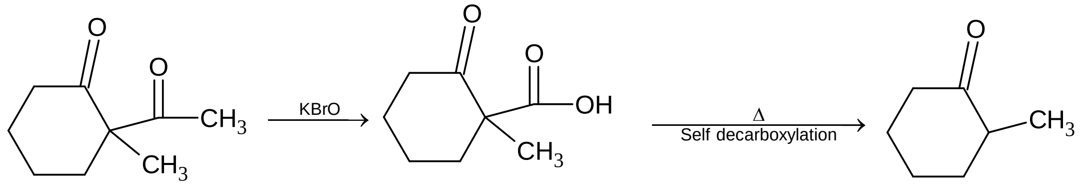
Chemistry

PART – II

SECTION – A

24. $8MnO_4^- + 3S_2O_3^{2-} + H_2O \longrightarrow 8MnO_2 + 6SO_4^{2-} + 2OH^-$

25.


O
O
CH3
CH3
KBrO
O
O
OH
CH3
Δ
Self decarboxylation
O
CH3
Haloform reaction

26. In this condition some atoms of H must be present in n = 3

So, ionization energy from n = 3, is $E = \frac{13.6}{n^2} = \frac{13.6}{9}$

$= 1.51\ V$

27. Diastereomers have different physical properties, so, we can separate them by ordinary means such as recrystalization.

28. $NaOH(cold) + Cl_2 \longrightarrow NaCl + NaOCl + H_2O$

$\downarrow$

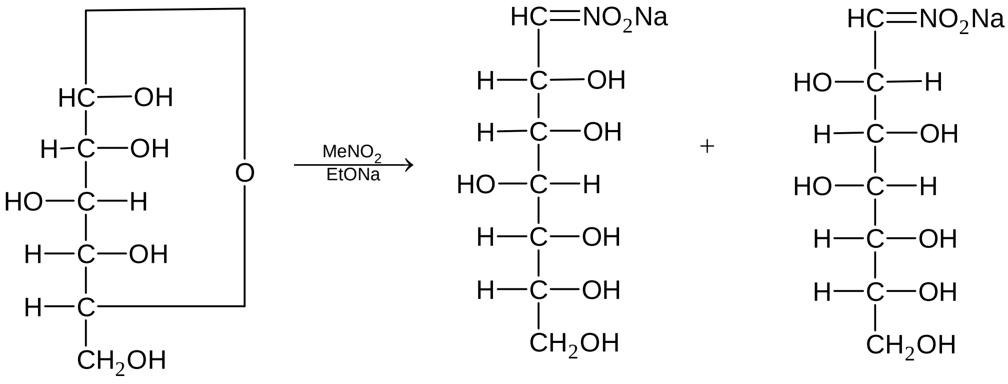
Sodium hypochlorite

$\downarrow$

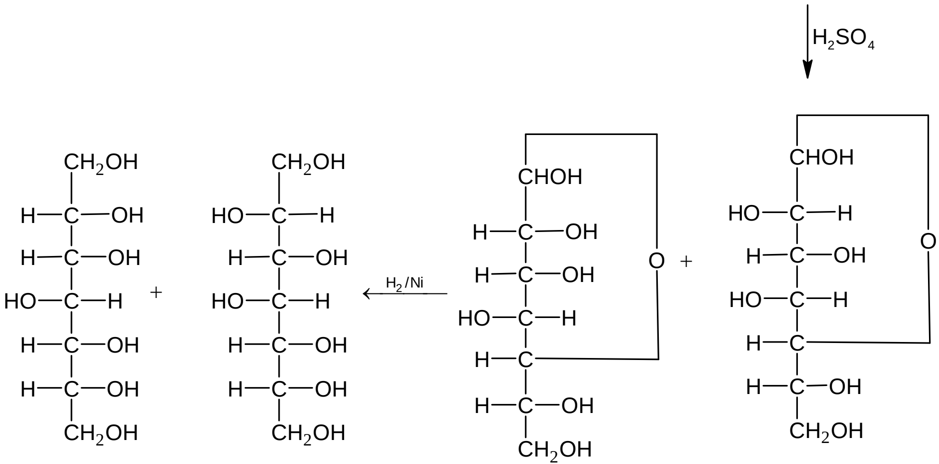
anion $\overset{-}{O}Cl$

contains σ bond

29.


HC—OH
H–C—OH
HO—C—H
H—C—OH
H—C
CH2OH
O
MeNO2
EtONa
HC═NO2Na
H—C—OH
H—C—OH
HO—C—H
H—C—OH
H—C—OH
CH2OH
+
HC═NO2Na
HO—C—H
H—C—OH
HO—C—H
H—C—OH
H—C—OH
CH2OH

D – glucopyranose



(Meso form) (Optically active)

30. If the temperature increases at constant pressure the gas expands, the mean free path increases, and the collision frequency decreases, so, A, B options are wrong.
For ideal gas, the average kinetic energy is dependent only on temperature, for isothermal change in pressure, the average kinetic energy would not change.

31. In electrophoresis and electroosmosis process motion of particles occur under applied charge.

32. $\frac{V}{T} = \text{constant (K)}$

$\log V = \log T + \log K, \text{ where } K = \frac{nR}{P}$

For 2 graph

$\log \frac{nR}{P} = 0 = \log 1$

$\frac{nR}{P} = 1 \ (R = P)$

n = 1 mol

for 1 graph

$\log \frac{nR}{P} = \log 3$

n = 3

log 3 graph

$\log \frac{nR}{P} = -\log 2 \ = \log \frac{1}{2}$

$n = \frac{1}{2} \text{ mol.}$

33. Straight line eqn

$(y - y_1) = \left(\frac{y_2 - y_1}{x_2 - x_1}\right)(x - x_1)$

$$(P-16)=\left(\frac{4-16}{15-6}\right)(V-6)$$

$$3P+4V=72$$

For $T_{max} = \frac{(PV)_{max}}{nR}$

For $(PV)_{max}$

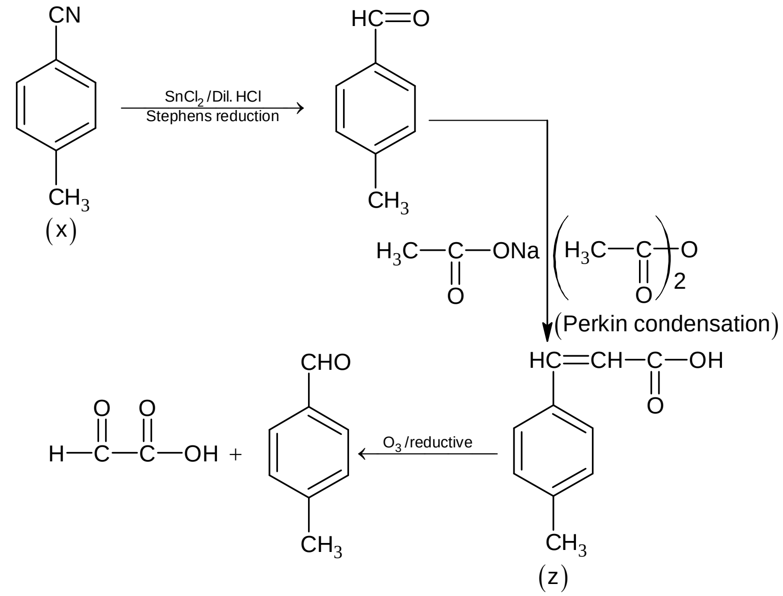
$3P=\frac{72}{2}$, $4V=\frac{72}{2}$

P = 12 V = 9

$$\therefore T_{max}=\frac{12\times 9}{2\times\frac{1}{2}}=648\text{ K}.$$

SECTION – C

34.


CN
CH3
(x)
SnCl2 /Dil. HCl
Stephens reduction
HC=O
CH3
H3C—C(=O)—ONa
(H3C—C(=O))2O
(Perkin condensation)
HC=CH—C(=O)—OH
CH3
(z)
O3 /reductive
CHO
CH3
H—C(=O)—C(=O)—OH +

35. a, b, d because of unstable hydrate 'c' due to steric factor. 'e' gives a ketone.

36. $\left[M(AA)_3\right]\longrightarrow$ show optical isomerism

While in others plane of symmetry is possible.

37. $A(H_2O)_8(s) \rightleftharpoons \underset{(x+y)}{A(g)} + \underset{8x}{8H_2O(g)};$ K_{p_1}

$A(H_2O)_8(s) \rightleftharpoons \underset{(y+x)}{A(g)} + 8H_2O(s);$ K_{p_2}

Given

x + y = 0.2

8x = 0.001

$K_{p_1}=(x+y)(8x)^8$

$=2\times10^{-25}$

$K_{p_2}=y+x$

= 0.2

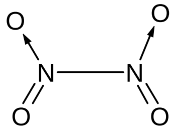
$H_2O(s) \rightleftharpoons H_2O(g)$

Vapour pressure $= \left(\dfrac{K_{p_1}}{K_{p_2}}\right)^{1/8}$

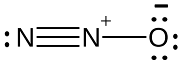
$= \left(\dfrac{2\times10^{-25}}{2\times10^{-1}}\right)^{1/8}$

= 10^{-3} bar.

38. N_2O_4 is a dimer of NO_2.
It's correct structure is



The correct structure of N_2O is:



39. $r_{A_2} = K[A]^2$

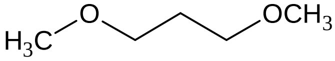
$K = \dfrac{r_{A_2}}{[A]^2} = \dfrac{10^{-5}}{(10^{-2})^2} = 10^{-1}$

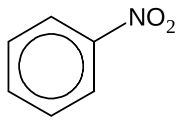
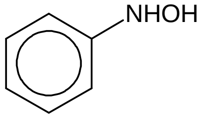
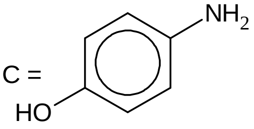
$\dfrac{K_A}{2} = K$

$K_A \Rightarrow 2K$

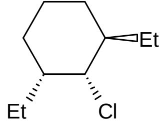
$= 2 \times 10^{-1}$

40. (i), (ii), (vi) → regiospecific reaction
(ii), (iii), (iv), (v), (vii) → stereospecific reaction.

41. Product is 

42. A =  ; B =  ; C =  ;

43. (ii) , (iv) → incorrect
(i), (iii), (v) → correct

(i)  is more reactive

By an E_2 mechanism due to presence of trans diaxial hydrogen. Anti periplannar transition state is possible.

(iii) In triethyl amine, pyramidal inversion is responsible for decreasing its nucleophilicity while in cyclic amine inversion is not possible.

SECTION – D

44. Sol. (1) $\underset{0.2\,M}{HCl} \longrightarrow H^+ + Cl^-$

Effective molarity = 0.4 M

Sol.(2) $BOH \longrightarrow B^+ + OH^-$

$t = 0 \quad 0.2 \quad 0 \quad 0$

$t = t \quad 0.2 - x \quad x \quad x$

$$K_b = \frac{x^2}{(0.2 - x)}$$

$$10^{-2} = \frac{x^2}{0.2 - x}$$

x = 0.04

Effective molarity = 0.2 – x + x + x

= 0.2 + x

= 0.24

Sol.(3) $HCl + BOH \longrightarrow BCl + H_2O$

	0.2	0.2	0	
moles	0	0	0.2	

$\therefore$ Conc. of [BCl] $= \frac{0.2}{2} = 0.1\,M$

Effective molarity = 0.2 M

Sol. (4) effective molarity = 0.2 × 5 = 1.0

Sol. (5) effective molarity = 0.2 × 4 = 0.8

ΔT_f order $= 4 > 5 > 1 > 2 > 3$

And T_f order = 4 < 5 < 1 < 2 < 3

Hence the correct code is 45123.00

45. At anode:

$2Hg(\ell) + 2Cl^-(aq) \longrightarrow Hg_2Cl_2(s) + 2e^-$ … (1)

At cathode:

$HgO(s) + H_2O(\ell) + 2e^- \longrightarrow Hg(\ell) + 2OH^-(aq)$ … (2)

From Eq. (1) and (2)

Cell reaction

$$HgO(s) + H_2O(\ell) + Hg(\ell) + 2Cl^-(aq) \downarrow Hg_2Cl_2(s) + 2OH^-(aq)$$

$\Delta G = -nFE$

$= -2 \times 96500 \times (0.1634\ V)$

= 31536.2 J mol^{-1}.

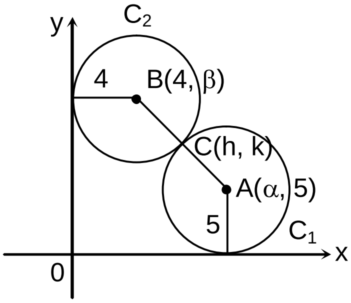
46. % of unoccupied sites $= \frac{2.18 \; - \; 2.16801}{2.18} \times 100$

$$= \frac{0.01199}{2.18} \times 100 = 0.55\%$$

Mathematics PART – III

SECTION – A

47. C(h, k) divides AB into the ratio 5 : 4



$\therefore \ (h, k) = \left(\frac{4\alpha + 20}{9}, \frac{5\beta + 20}{9}\right)$

AB = 9 ⇒ $(\alpha - 4)^2 + (\beta - 5)^2 = 9^2$

$\Rightarrow \frac{(h-4)^2}{4^2} + \frac{(k-5)^4}{5^2} = 1$

Locus of point of contact is $\frac{(x-4)^2}{16} + \frac{(y-5)^2}{25} = 1$

We shift the axes to (4, 5), so that curve become $\frac{x^2}{16} + \frac{y^2}{25} = 1$ and point (9, 5) become (5, 0)

Chord of contact is $x = \frac{16}{5}$

Solving with conic, we get Q and R as $\left(\frac{16}{5}, \pm 3\right)$

$\therefore$ Area of ΔPQR = $\frac{27}{5}$

48. $\frac{AI}{A'I} = \frac{b+c}{a} \Rightarrow \frac{AI}{AA'} = \frac{b+c}{a+b+c}$

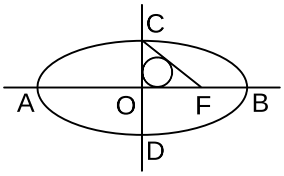
Similarly, $\frac{BI}{BB'} = \frac{a+c}{a+b+c}$ and $\frac{CI}{CI'} = \frac{a+b}{a+b+c}$

$\Rightarrow \frac{AI \cdot BI \cdot CI}{AA' \cdot BB' \cdot CC'} = \frac{(b+c)(a+c)(a+b)}{(a+b+c)^3}$

Now, $\frac{\frac{b+c}{a+b+c} + \frac{c+a}{a+b+c} + \frac{a+b}{a+b+c}}{3} \geq \left(\frac{(a+b)(b+c)(c+a)}{(a+b+c)^3}\right)^{1/3}$

$\Rightarrow \frac{(a+b)(b+c)(c+a)}{(a+b+c)^3} \leq \frac{8}{27}$

49. $a^2e^2 = 36 \Rightarrow a^2 - b^2 = 36$



Using r = (s – a) $\tan\frac{A}{2}$ in ΔOCF

1 = (s – a) (a = CF = OB)

⇒ 2 = 2s – 2a

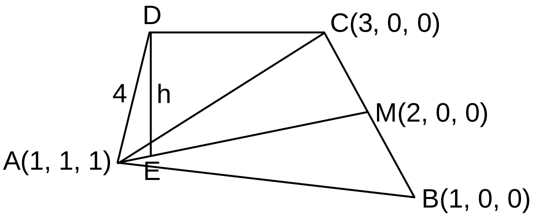
⇒ 2 = 2s – AB

$\Rightarrow 2 = 6 + \frac{AB}{2} + \frac{CD}{2} - AB$

⇒ AB – CD = 8

⇒ a – b = 4 also $a^2 - b^2 = 36$

⇒ 2a = 13; 2b = 5



50. $v = \frac{2\sqrt{2}}{3}$

$\Rightarrow \frac{1}{3}\cdot\frac{1}{2}\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 1 & 1 \\ 2 & -1 & -1 \end{vmatrix} h = \frac{2\sqrt{2}}{3}$

$\Rightarrow h = 2$

Also ΔABC is right angled

Now let E divides AM in the ratio $\lambda : 1$

$E = \left(\frac{2\lambda+1}{\lambda+1}, \frac{1}{\lambda+1}, \frac{1}{\lambda+1}\right)$ and $AE^2 + DE^2 = AD^2$

$\Rightarrow \left(\frac{2\lambda+1}{\lambda+1}-1\right)^2 + \left(1-\frac{1}{\lambda+1}\right)^2 + \left(1-\frac{1}{\lambda+1}\right)^2 + 4 = 16$

$\Rightarrow$ Two values of λ

51. $\text{Re}\sum_{r=1}^{2016} \alpha^r = \sum_{r=1}^{2016} \cos\frac{r\pi}{2017} = 0$

$\sum_{r=1}^{2016}\left(\alpha^r + \alpha^{-r}\right) = 2\sum_{r=1}^{2016}\cos\frac{r\pi}{2017} = 0$

52. Equation of tangent to the hyperbola at P is $x\cdot\frac{1}{\alpha} + y\alpha = 2$

$\therefore$ $Q \equiv (2\alpha, 0)$ and $R \equiv \left(0, \frac{2}{\alpha}\right)$

Equation of normal to the hyperbola at P is $y - \frac{1}{\alpha} = \alpha^2\left(x-\alpha\right)$

$\therefore$ $M \equiv \left(\frac{\alpha^4-1}{\alpha^3}, 0\right)$ and $N \equiv \left(0, \frac{1-\alpha^4}{\alpha}\right)$

Now, area of ΔOQR = area of ΔOMN

$\Rightarrow (1 - \alpha^4)^2 = 4\alpha^4$

$\Rightarrow$ $\alpha^2 = \sqrt{2}-1$

53. Let roots are $\frac{a}{r^2}, \frac{a}{r}, a, ar, ar^2$

Now, $a\left(\frac{1}{r^2}+\frac{1}{r}+1+r+r^2\right) = 40$

$\frac{1}{a}\left(r^2+r+1+\frac{1}{r}+\frac{1}{r^2}\right) = 10$

Dividing both $\Rightarrow a^2 = 4 \Rightarrow a = \pm 2$

As product of roots $= a^5 = -\delta$

$\Rightarrow \delta = 32$ or -32

54. $\frac{\sin x dy - y\cos x dx}{\sin^2 x} = -\frac{1}{x^2}dx$

$\Rightarrow$ $d\left(\frac{y}{\sin x}\right) = -\frac{1}{x^2}dx$

$\Rightarrow$ $y = \frac{\sin x}{x} + c\sin x$

$\because\ y \to 0,\ x \to \infty \Rightarrow c = 0$

$f(x) = \dfrac{\sin x}{x}$

55. Let $z \in A$ and $\omega \in B$ then $z = e^{\frac{i2k_1\pi}{18}}$, $\omega = e^{\frac{i2k_2\pi}{48}}$ $k_1, k_2 \in I$

$\therefore\ z\omega = e^{\frac{i2\pi}{6}\left(\frac{k_1}{3}+\frac{k_2}{8}\right)} = e^{i2\left(\frac{8k_1+3k_2}{144}\right)\pi} = e^{\frac{i2k\pi}{144}}$ where $k = 8k_1 + 3k_2$

$\therefore$ $z\omega$ can have 144 different values

56. Let $C_k = e^{\frac{i(2k-1)\pi}{n}}$, $k = 1, 2, \ldots, n$ then $|C_k - C_1| = |\cos\theta + i\sin\theta - 1|$

where $\theta = \dfrac{(2k-1)\pi}{n}$ = $2\sin\dfrac{\theta}{2}$

$\therefore\ |C_2 - C_1| + |C_3 - C_1| + \ldots\ldots + |C_n - C_1| = 2\left[\sin\dfrac{\pi}{n} + \sin\dfrac{2\pi}{n} + \ldots\ldots + \sin\dfrac{(n-1)\pi}{n}\right]$

$= 2\cot\dfrac{\pi}{2n} = 2\cot\dfrac{180^o}{2\times 144} = 2\cot\left(\dfrac{5}{8}\right)^{o}$

SECTION – C

57. $\displaystyle\int_0^1 \left(\frac{f(x)}{x}\right)^2 dx - 2\int_0^1 f(x)\,dx + \int_0^1 x^2 dx = 0$

$\Rightarrow \displaystyle\int_0^1 \left(\frac{f(x)}{x} - x\right)^2 dx = 0$

$\Rightarrow f(x) = x^2$

58. If even letters goes to even envelopes but none goes to correct envelop, then the number of ways

$= 3!\left(1 - \dfrac{1}{1!} + \dfrac{1}{2!} - \dfrac{1}{3!}\right) = 2$

Now for $L_1\ L_2\ L_5\ L_7$

$E_1\ E_3\ E_5\ E_2$

Total number of without restriction = 4! = 24

Again if L_1, L_3, L_5 goes to their correct envelope number of ways = 1

If any two of them goes to their correct envelope, number of ways = ${}^3C_2 \times 1 = 3$

If any one goes to correct envelope, number of ways = ${}^3C_1 \times 3 = 9$

Total number of required ways for odd letters = 24 – 13 = 11

$\Rightarrow$ Required ways = 11 × 2 = 22 = N

59. $|z_2 + iz_1| = |z_1| + |z_2|$

$\Rightarrow$ z_1 is perpendicular to z_2

Also, let $z_3 = z_1 + \dfrac{z_2 - z_1}{1 - i}$

$\Rightarrow z_2 - z_3 = i(z_1 - z_3)$

$\Rightarrow\ \angle ACB = \dfrac{\pi}{2}$ and $|z_2 - z_3| = |z_1 - z_3|$

$\Rightarrow AC = BC$

$\Rightarrow AB^2 = AC^2 + BC^2$

$\Rightarrow\ AC^2 = \dfrac{AB^2}{2}$

$\Rightarrow$ Area of $\Delta ABC = \frac{1}{2}\cdot\frac{AB^2}{2} = \frac{7+9}{4} = 4$

60. $\frac{1}{\sqrt{k}} = \frac{2}{\sqrt{k}+\sqrt{k}} < \frac{2}{\sqrt{k}+\sqrt{k-1}} = 2\left(\sqrt{k}-\sqrt{k-1}\right)$

Putting k = 2, 3, ..., 10,000 and adding $\frac{1}{\sqrt{2}}+\frac{1}{\sqrt{3}}+.....+\frac{1}{\sqrt{10,000}} < 2\left(\sqrt{10,000}-\sqrt{1}\right)$

$\Rightarrow A < 2 \times 99 \Rightarrow A < 198$

Similarly $\frac{1}{\sqrt{k}} = \frac{2}{\sqrt{k}+\sqrt{k}} > \frac{2}{\sqrt{k+1}+\sqrt{k}} = 2\left(\sqrt{k+1}-\sqrt{k}\right)$

$\Rightarrow\ A > 2\left\{\sqrt{10,000}-\sqrt{2}\right\} > 197$

$\therefore$ [A] = 197

$\therefore\ \left[\frac{[A]}{50}\right] = 3$

61. $2^m + 2^n + 2^p = (3-1)^m + (3-1)^n + (3-1)^p = 3\lambda + (-1)^m + (-1)^n + (-1)^p,\ \lambda \in I$

$\therefore$ Number of possible triplets = 50 × 25 × 12 + 50 × 25 × 13 = 31250

62. Let $\cos^{-1} x = a$, $\sin^{-1} y = b$, $a \in [0, \pi]$, $b \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$

$a + b^2 = \frac{p\pi^2}{4}$, $a\cdot b^2 = \frac{\pi^4}{16}$, $b^2 \in \left[0, \frac{\pi^2}{4}\right]$

$\Rightarrow\ a + b^2 \in \left[0, \pi + \frac{\pi^2}{4}\right]$

$\Rightarrow\ 0 \le \frac{p\pi^2}{4} \le \pi + \frac{\pi^2}{4}\ \Rightarrow O \le p \le \frac{4}{\pi} + 1$

$\therefore$ p = 0, 1 or 2 but if p = 0, a = b = 0, not true

Also, $a\left(\frac{p\pi^2}{4} - a\right) = \frac{\pi^4}{16}$

$\Rightarrow 16a^2 - 4p\pi^2 a + \pi^4 = 0$

$\because\ a \in R, D \ge 0 \Rightarrow 16p^2\pi^4 - 64\pi^4 \ge 0 \Rightarrow p^2 \ge 4 \Rightarrow p \ge 2$

$\therefore$ Possible value of p is 2

63. $f(x)\cdot f(y(f(x)) = f(x + y)$

$\Rightarrow f'(x)\cdot f(yf(x)) + f(x)\cdot f'(yf(x))\cdot yf'(x) = f'(x + y)$

Putting x = 0 and then replacing y by x

$\Rightarrow -f(x) - xf'(x) = f'(x)$ ($\because$ $f(0) = 1, f'(0) = -1$)

$\Rightarrow\ \frac{f'(x)}{f(x)} = -\frac{1}{1+x}$

Integrating $\ln|f(x)| = -\ln|1 + x| + \ln|c|$

$\Rightarrow\ f(x) = \frac{c}{1+x}\ \Rightarrow\ f(x) = \frac{1}{1+x}$ ($\because$ f(0) = 1)

$\therefore$ Required area = $\int_0^\infty \frac{1}{(1+x)^2}dx = 1$

64. Let $e^x = t$

$$\therefore\ I=\int_1^2 \frac{2t^3+t^2-1}{t^3+t^2-t+1}\frac{dt}{t} = \int_1^2 \frac{t\left(3t^2+2t-1\right)-\left(t^3+t^2-t+1\right)}{t\left(t^3+t^2-t+1\right)}dt$$

$$= \int_1^2 \frac{3t^2+2t-1}{t^3+t^2-t+1} - \int_1^2 \frac{dt}{t} = \left[\ln\left|t^3+t^2-t+1\right|\right]_1^2 - \left[\ln|t|\right]_1^2 = \ln\frac{11}{4}$$

65. Eccentricity of the hyperbola in ${}^nC_r$
Possible value of ${}^nC_r$ will be ${}^2C_1$, ${}^3C_1$, ${}^4C_1$, ${}^5C_1$, ${}^4C_2$ and ${}^5C_2$

66. $AB = I$
$(AB)C_1 = C_1$, $(AB)^2C_2 = C_2$ ..... and so on
$t_r(C_r) = r\cdot3^r + (r-1)\cdot3^r = (2r-1)3^r$

$$\sum_{r=1}^{50} t_r\left((AB)^r\ C_r\right) = t_r\left((AB)C_1\right) + t_r\left((AB)^2 C_2\right) + ... + t_r\left((AB)^{50} C_{50}\right)$$

$= t_r(C_1) + t_r(C_2) + ... + t_r(C_{50})$
$= 1\cdot3' + 3\cdot3^2 + 5\cdot3^3 + ... + 99\cdot3^{50}$ (AGP)
$\Rightarrow S = 3 + 49\cdot3^{51}$
$\therefore\ a + b = 100$

SECTION – D

67. Let roots be $\alpha_1, \alpha_2, ..., \alpha_8$

$\alpha_1 + \alpha_2 + ... + \alpha_8 = 4$, $\alpha_1\alpha_2 ..... \alpha_8 = \dfrac{1}{2^8}$

$\therefore$ A.M. and G.M. of $\alpha_1, \alpha_2, ..., \alpha_8$ are equal

$\Rightarrow \alpha_1 = \alpha_2 = ... = \alpha_8 = \dfrac{1}{2}$

$\Rightarrow\ a_2 = {}^8C_6\cdot\left(\dfrac{1}{2}\right)^6$, $a_4 = {}^8C_4\cdot\dfrac{1}{2^4}$, $a_6 = {}^8C_2\cdot\dfrac{1}{2^2}$

68. Reflection of (4, 5) w.r.t lines $y = x$ and $y = 2x$ are (5, 4) and $\left(\dfrac{8}{5}, \dfrac{31}{5}\right)$ respectively minimum value of PA + PB + AB = distance between (5, 4) and $\left(\dfrac{8}{5}, \dfrac{31}{5}\right) = \sqrt{16.4}$

69. Let $g(x) = \sin^{-1}|\sin x| + \cos^{-1}(\cos x) = \begin{cases} 2x & ;\ 0 \le x \le \dfrac{\pi}{2} \\ \pi & ;\ \dfrac{\pi}{2} < x \le \dfrac{3\pi}{2} \\ 4\pi - 2x & ;\ \dfrac{3\pi}{2} < x \le 2\pi \end{cases}$

g(x) is periodic with period 2π and is constant in the interval $\left[2n\pi + \dfrac{\pi}{2}, 2n\pi + \dfrac{3\pi}{2}\right]$, $n \in I$

Now $f(x) = g(\alpha x)$

$\therefore$ f(x) is constant in $\left[\dfrac{2n\pi}{\alpha} + \dfrac{\pi}{2\alpha}, \dfrac{2n\pi}{\alpha} + \dfrac{3\pi}{2\alpha}\right]$

$$\therefore\ 2\pi = \frac{3\pi}{2\alpha} - \frac{\pi}{2\alpha}$$

$$\Rightarrow\ \alpha = \frac{1}{2}$$

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FULL TEST – XI

PAPER-1

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**ABC**	19.	**AC**	37.	**ABD**
2.	**D**	20.	**AB**	38.	**BC**
3.	**ABCD**	21.	**BCD**	39.	**BCD**
4.	**A**	22.	**ACD**	40.	**AB**
5.	**ABC**	23.	**AC**	41.	**D**
6.	**AC**	24.	**BCD**	42.	**BC**
7.	**AD**	25.	**ACD**	43.	**B**
8.	**C**	26.	**B**	44.	**D**
9.	**A**	27.	**B**	45.	**A**
10.	**D**	28.	**C**	46.	**B**
11.	**B**	29.	**B**	47.	**C**
12.	**A**	30.	**C**	48.	**D**
13.	**C**	31.	**D**	49.	**D**
14.	**3**	32.	**2**	50.	**5**
15.	**9**	33.	**5**	51.	**2**
16.	**4**	34.	**4**	52.	**3**
17.	**5**	35.	**4**	53.	**8**
18.	**2**	36.	**6**	54.	**7**

Physics

PART – I

SECTION – A

1. **ABC**

$$u = \frac{kx}{(x^2 + y^2)^{3/2}}$$

$$F_x = -\left(\frac{\partial u}{\partial x}\right)_{(y-CON.)}$$

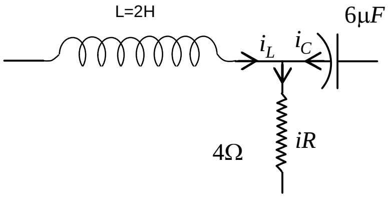
$$F_y = -\left(\frac{\partial u}{\partial y}\right)_{(x-CON.)}$$

After solving find $\bar{a}_t$ and $\bar{a}_r$ *etc*

2. **D**

Use $i_L + i_C = i_R; v_L = \frac{Ldi_L}{dt}$ etc.

$$q = CV = \frac{dq}{dt} = C\left(\frac{dV}{dt}\right) + V\left(\frac{dC}{dt}\right)$$



3. **ABCD**

$$i_1 = \frac{\varepsilon_0}{\sqrt{(R^2 + X_c{}^2)}}\sin(\omega t + 53^o) = 4\sin(\omega t + 53^o)$$

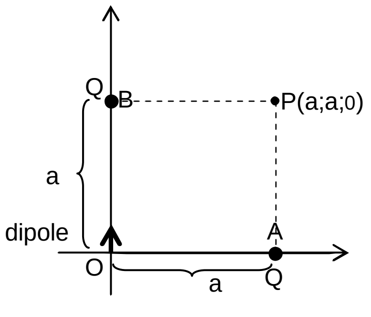
$$i_2 = \frac{\varepsilon_0}{\sqrt{(R^2 + X_L{}^2)}}\sin(\omega t - 37^o) = 4\sin(\omega t - 37^o)$$

Voltmeter & ammeter reads rms value

4. **A**

$$\overrightarrow{E_P} = \overrightarrow{E_A} + \overrightarrow{E_B} + \vec{E}_{dipole}$$

$$Finally\,|\overrightarrow{E_P}| = \frac{Q}{4\pi \in_0 a^2\sqrt{2}}(4^2 + 1^2)^{1/2} = \sqrt{\frac{17}{2}}\frac{Q}{4\pi \in_0 a^2}$$



5. **ABC**

$$A = A_0 e^{-\lambda t_1} \qquad -(i)$$

$$2A/3 = A_0 e^{-\lambda t_2} \qquad -(ii)$$

$$T_{mean} = 1/\lambda = \frac{(t_2 - t_1)}{\ell n_e(3/2)}$$

$$T_{1/2} = \frac{\ell n_e 2}{\lambda}$$

probability of survival of a nucleus = e^{-1}

6. **AC**

$$Y = \frac{stress}{strain} = \frac{T/S}{\Delta L/L} = \frac{TL}{S\Delta L}$$

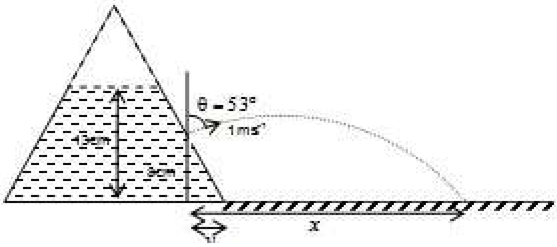
$$T = SY\frac{\Delta L}{L}$$

$$\nu_1 = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$$

$$\nu_1 = 200Hz$$

Hence, the fourth harmonic (or 3rd overtone) has a frequency of 800 Hz.

7. **AD**



$$8/y = \tan 53^o = \frac{4}{3}$$

$v = \sqrt{2g(\Delta n)} = 1ms^{-1}$ to get 't'

$$8/100 = \frac{3t}{5} - 5t^2 \Rightarrow t = (1/5)\sec$$

So $$x = \frac{1\times 1}{5}\times\frac{4}{5}\times 100 = 16\,\text{cm}$$

$$16 - 6 = 10\,cm$$

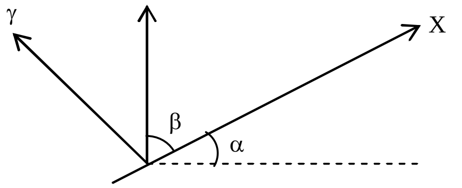
$$F_H = mv\cos 37^o = \rho A v^2 \times \frac{4}{5} = 0.12 \text{ Newton}$$

8. **C**
9. **A**
10. **D**

Sol. **(for 8-10).** After calculating total time of flight $(O \longrightarrow C)$

$$T_0 = \frac{V_0\cos\beta}{q\sin\alpha}$$

$to_A = \dfrac{2V_0\sin\beta}{q\cos\alpha}$; Rebound velocity at $A \longrightarrow (eV_0\sin\beta)$



Calculate t_{AB} & t_{BC}

Using To = $t_{OA} + t_{AB} + t_{BC}$ we get $\beta = \cot^{-1}\left(\frac{13}{4}\tan\alpha\right)$

$$K = \frac{V_0(\cot\beta)}{(q\sin\alpha)} = \frac{(\cot\beta)}{(\sin\alpha)}(V_0 = 10ms^{-1})$$

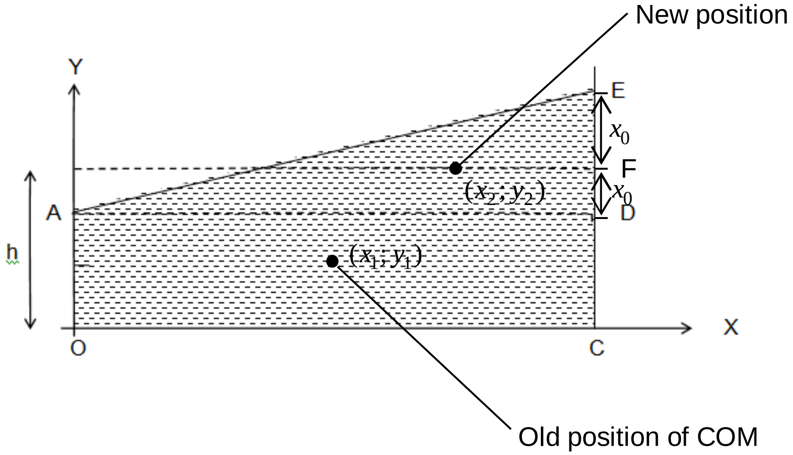
11. **B**
12. **A**
13. **C**

Sol. **(for 11-13).** use Ist law of thermodynamics and apply for different given process.

SECTION – C

14. **3**

The liquid surface after displacing from eq. position



Write down equation of centre of mass

$$(y_2 - y_1) = (y - y_1) = \frac{x_0^2}{6h}$$

$$(x_2 - x_1) = (x - x_1) = \frac{Lx_0}{3h}$$

Hence

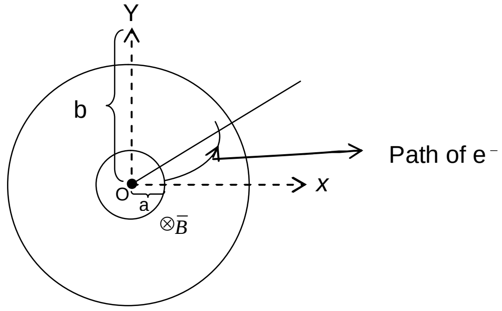
$$y - y_1 = \frac{3h}{2L^2}(x - x_1)^2$$

Restoring force Ma = $-\frac{3}{2}\frac{mgh \times 2X}{L^2}$

$$a = -\frac{3gh \times X}{L^2}$$

Finally $\omega^2 = \frac{3gh}{L^2}$

15. **9**



$$m\left\{r\frac{d^2\theta}{dt^2} + 2\left(\frac{dr}{dt}\right)\left(\frac{d\theta}{dt}\right)\right\} = eB\left(\frac{dr}{dt}\right)$$

$$\Rightarrow \frac{d}{dt}(r^2\dot{\theta}) = \frac{eB}{m} r\dot{r}$$

$$\frac{d}{dt}(r^2\dot{\theta}) = \frac{eB}{2m}\left(\frac{d}{dt}r^2\right)$$

$$\Rightarrow r^2\dot{\theta} = \left(\frac{eB}{2m}\right)(r^2 - a^2) \qquad \left\{\frac{d\theta}{dt} = 0 \text{ for r = a}\right\}$$

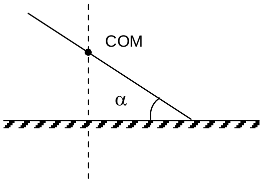
$$\& \quad \dot{\theta} = \frac{eB}{2m}\left(1 - a^2/b^2\right)$$

$$\nu^2 = \frac{2eV}{m} = \left(\frac{e^2B^2}{4m^2}\right)b^2(1 - a^2/b^2)$$

Put the value & get the result.

16. **4**

Sol.



COM remains on this line

17. **5**

$$\Delta E = 3.4eV - \left(-13.6\frac{z^2}{n^2}\right)$$

$$= 17eV$$

$$\frac{hc}{\lambda_1} = 17eV \_\_\_\_\_\_(1)$$

2^{nd} condition $\quad \Delta E' = E_2 - E_1$

$$= \frac{-13.6\times 4}{22}\left(+\frac{13.6\times 4}{1}\right)$$

$$\Delta E' = 40.8eV$$

$$\Delta E' = \frac{hc}{\lambda_2} = 40.8eV$$

$$\lambda_1 / \lambda_2 = 2.4$$

18. **2**

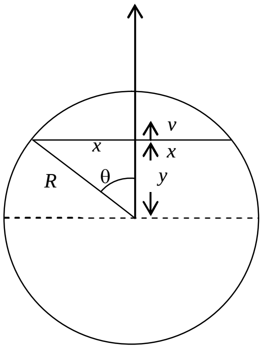
$$F/m = \frac{2ix\mu_0 ni}{m} = \frac{vdv}{dy}$$

Put $\quad x = R\sin\theta;\ y = R\cos\theta$

$$dy = -(R\sin\theta)(d\theta)$$

Rearrange the variables and Int.; on both sides

$$v = 2ms^{-1}$$



Chemistry

PART – II

SECTION – A

19. **AC**

The volume is $\bar{a}\cdot(\bar{b}\times\bar{c})$. Take $\bar{a} = a\cdot i$

Now $\bar{b} = (a\cos\theta)\bar{i} + (a\sin\theta)\bar{j} = \frac{a}{2}\bar{i} + \frac{a\sqrt{3}}{2}\bar{j}$

$$\bar{C} = \frac{a}{2}\bar{i} + \frac{a}{2\sqrt{3}}\bar{j} + \frac{a\sqrt{2}}{3}\bar{k}$$

$$\therefore \bar{a}\cdot(\bar{b}\times\bar{c})$$

$$= \begin{vmatrix} a & 0 & 0 \\ \frac{a}{2} & \frac{a\sqrt{3}}{2} & 0 \\ \frac{a}{2} & \frac{a}{2\sqrt{3}} & \frac{a\sqrt{2}}{\sqrt{3}} \end{vmatrix} = a^3 \times \frac{\sqrt{3}}{2} \times \frac{\sqrt{2}}{\sqrt{3}} = \frac{a^3}{\sqrt{2}}$$

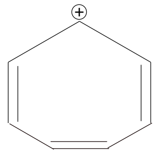
20. **AB**

Due to lanthanide contraction size of $\mathrm{Zr} \simeq \mathrm{Hf}, \mathrm{Nb} \simeq \mathrm{Ta}$

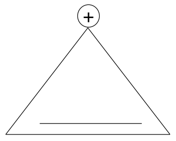
21. **BCD**

(A) Non - aromatic

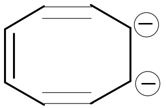
(B)



(C)



(D)



Aromatic

22. **ACD**

23. **AC**

On decreasing pressure concentration decreases so equilibrium shift in forward direction so degree of dissociation increases but in net concentration of all decreases

Molecular wt. of PCl_5 = (1 + α) Molecular wt. of mixture

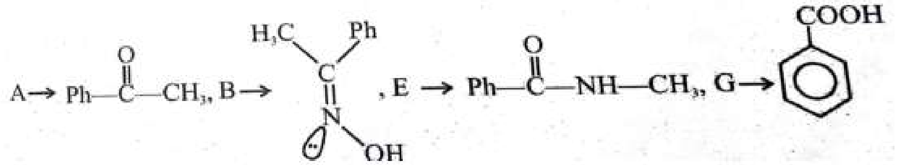
$$M_{PCl_5} = (1+\alpha).2.V.D_{mix.}$$

$$V.D\,\mathrm{mi}\,x. = \frac{M_{PCl_5}}{2(1+\alpha)}$$

$$\alpha\uparrow so, V.D\,\mathrm{mi}\,x\downarrow$$

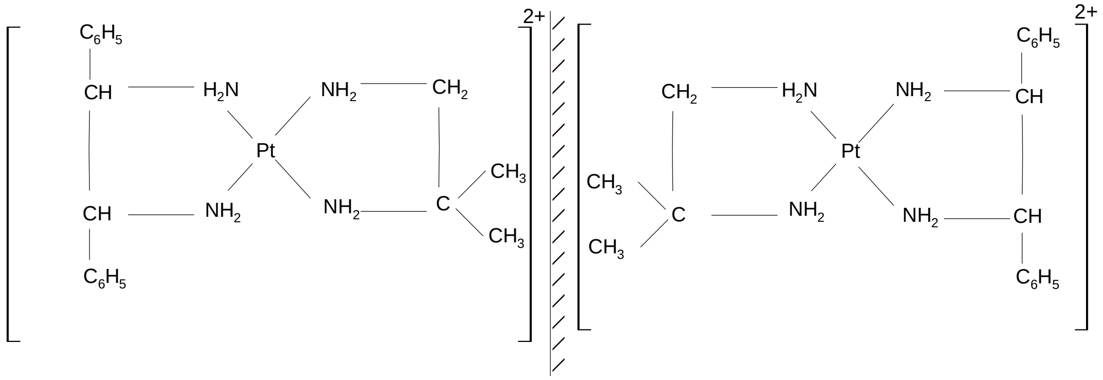
24. **BCD**

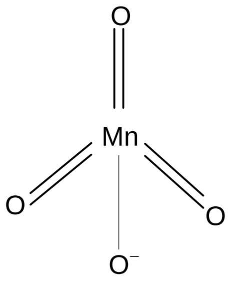
Sol.


A→ Ph—C(=O)—CH3, B→
H3C
Ph
C
N
OH
, E → Ph—C(=O)—NH—CH3, G→
COOH

25. **ACD**

Square planar complex can show enantiomerism.

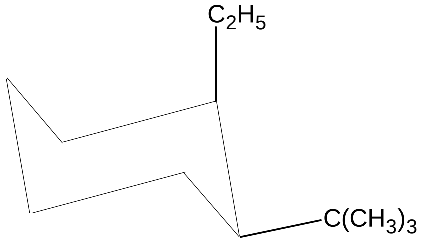

C6H5
CH
H2N
NH2
CH2
Pt
CH3
CH
NH2
NH2
C
CH3
C6H5
2+
CH2
H2N
NH2
C6H5
CH
Pt
CH3
C
NH2
NH2
CH
CH3
C6H5
2+



Tetrahaedral, d^{3}s hybridisation

26. **B**

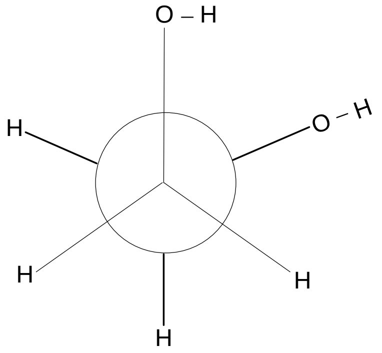
Sol.

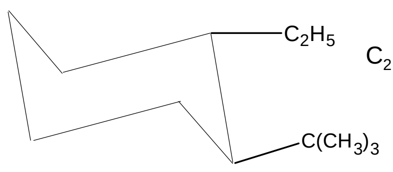


Cis – form

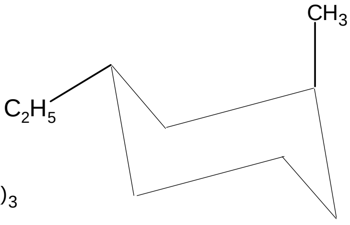
27. **B**

Sol.





Trans – form

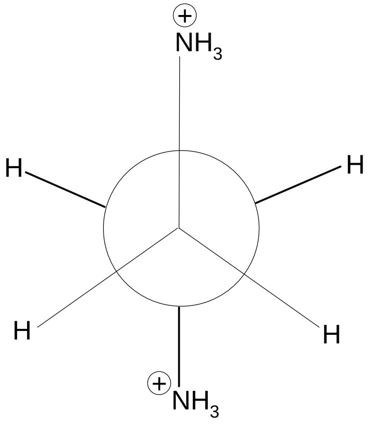


Trans – form

Gauche form stable due to intra molecular H – bonding

28. **C**

In acidic medium pH = 4 in aq. solution


⊕ NH3
H
H
H
H
⊕ NH3

Stable form

29. **B**

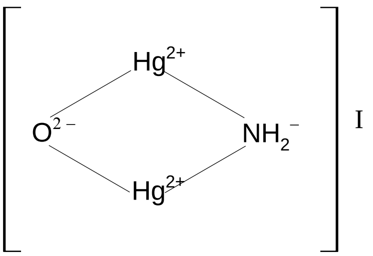
30. **C**

31. **D**

SECTION – C

32. **2**

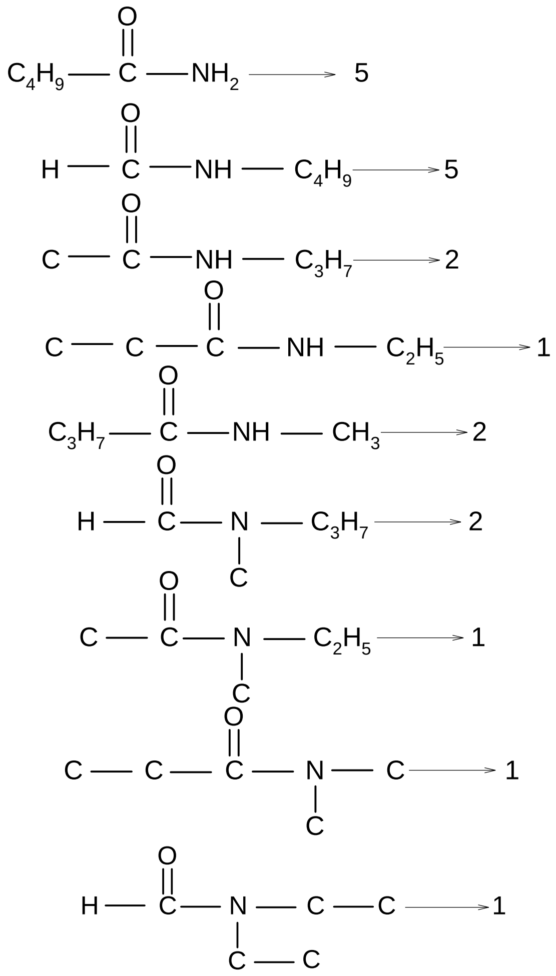
Sol.


Hg2+
O2–
NH2–
Hg2+
I

Iodide of Millen's base.

33. **5**

Sol.



$$C_4H_9-\overset{O}{\overset{\|}{C}}-NH_2 \longrightarrow 5$$

$$H-\overset{O}{\overset{\|}{C}}-NH-C_4H_9 \longrightarrow 5$$

$$C-\overset{O}{\overset{\|}{C}}-NH-C_3H_7 \longrightarrow 2$$

$$C-C-\overset{O}{\overset{\|}{C}}-NH-C_2H_5 \longrightarrow 1$$

$$C_3H_7-\overset{O}{\overset{\|}{C}}-NH-CH_3 \longrightarrow 2$$

$$H-\overset{O}{\overset{\|}{C}}-\underset{\underset{C}{|}}{N}-C_3H_7 \longrightarrow 2$$

$$C-\overset{O}{\overset{\|}{C}}-\underset{\underset{C}{|}}{N}-C_2H_5 \longrightarrow 1$$

$$C-C-\overset{O}{\overset{\|}{C}}-\underset{\underset{C}{|}}{N}-C \longrightarrow 1$$

$$H-\overset{O}{\overset{\|}{C}}-\underset{\underset{C-C}{|}}{N}-C-C \longrightarrow 1$$

Total = 20

$X = 20$

$\frac{X}{4} = 5$

34. **4**

$HA \rightleftharpoons H^{+} + A^{-}$

$C_1(1-\alpha_1)$ $\quad C_1\alpha_1$ $\ C_1\alpha_2$

3.838L volume of water is added so that its conc. will change let C_2. Now new [H^+] = $C_2\alpha_2$

$C_2\alpha_2 = \frac{C_1\alpha_1}{X}$ given

$$Ka = \frac{C_1\alpha_1 . C_1\alpha_1}{C_1(1-\alpha_1)} = \frac{C_1\alpha_1^2}{1-\alpha_1} = \frac{C_2\alpha_2^2}{1-\alpha_2}$$

$1-\alpha_1 \simeq 1$ but $1-\alpha_2 \neq 1$ because on dilution Degree of ionisation increase $\alpha_2 > \alpha_1$

$$C_1\alpha_1^2 = \frac{(C_2\alpha_2)^2}{C_2(1-\alpha_2)}$$

$$C_1\alpha_1^2 = \frac{\left(\frac{C_1\alpha_1}{X}\right)^2}{C_2 - \frac{C_1\alpha_1}{X}}$$

$$C_1\alpha_1^2\cdot\left(C_2-\frac{C_1\alpha_1}{X}\right)=\frac{C_1^{\,2}\alpha_1^2}{X^2}$$

$$C_2=\frac{C_1}{X^2}\left[1+X\alpha_1\right]$$

$$\alpha_1=\sqrt{\frac{K_a}{C_1}}=\sqrt{\frac{1.6\times10^{-4}}{0.1}}=4\times10^{-2}$$

$$C_2=\frac{C_1}{X^2}[1+4X.10^{-2}]$$

On solving we get X = 4

35. **4**

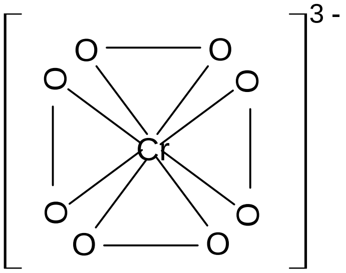
Minimum boiling azeotropes:
Acetone and Benzene
Acetone and carbon disulphide
Acetone and Ethanol
Carbon tetra chloride and Chloroform

36. **6**

$[Fe(H_2O)_5NO]^{2+}$

Oxidation state of Fe = +1 $\Rightarrow$ a

$K_3[CrO_8] \rightarrow 3K^{1+} + CrO_8^{3-}$



Oxidation state of Cr is = + 5 = b

$a+b=6$

Mathematics PART – III

SECTION – A

37. **ABD**

If $\alpha = 0$

$${}^{n-5}C_0({}^{n-5}C_0 + {}^{n-5}C_1 . + ... + {}^{n-5}C_{n-5}) = 2^{n-5}$$

$\alpha = 5$

$${}^{5}C_5 . \left({}^{n-5}C_0 + {}^{n-5}C_1 + ... + {}^{n-5}C_{n-5}\right) = 2^{n-5}$$

$\alpha = 1$

$${}^{5}C_1 . \left({}^{n-5}C_0 + {}^{n-5}C_1 + ... + {}^{n-5}C_{n-5}\right) = 5.2^{n-5}$$

$\alpha = 2$

$${}^{5}C_2(2^{n-5})$$

$\therefore A, B, D$

38. **BC**

$$\int \frac{dx}{x^{1/3}+2} = g(x) + C$$

Put

$x = t^3$

$$g(x) = \frac{3}{2}x^{2/3} - 6x^{1/3} + 12\ln|x^{1/3}+2|$$

$$g(-1) = \frac{15}{2}$$

39. **BCD**

No. ways = $\frac{1}{n+1}\ {}^{2n}C_n$

40. **AB**

$$y = \log_{\frac{1}{3}}(x - 0.\overline{3}) + \log_3\sqrt{(3x-1)^2}$$

$$= -\log_3\left(\frac{3x-1}{3}\right) + \log_3|3x-1|$$

$x > \frac{1}{3}$

$\therefore y = 1$

$x = \pm 2$ -2 Rejected

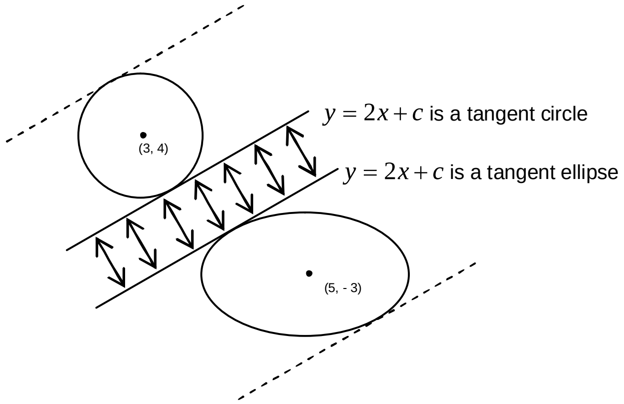
$\therefore x = +2$

$A \equiv (2,1)$ $B \equiv (1,1)$

(A), (B) option satisfy

41. **D**

Sol.


$y = 2x + c$ is a tangent circle
$y = 2x + c$ is a tangent ellipse
(3, 4)
(5, - 3)

42. **BC**

Points of discontinuities will be

$$x = 0,\ x = \frac{1}{2} x = 1, x = 2$$

$$M = \frac{1}{2}\cos 2t + 1\cos t + 2$$

$$= \cos^2 t + \cos t + \frac{3}{2}$$

$$= \left(\cos t + \frac{1}{2}\right)^2 + \frac{5}{4}$$

$(B), (C)$

43. **B**

is incorrect

$\angle A = 90^{\circ}$

44. **D**

45. **A**

46. **B**

Sol. **(for 44-46)**

(I) $f'(x) > 0$ and Range is a subset of codomain

(II) It is not a function

(III) Decreasing function from $[-1, 1]$

(IV) $f'(x) > 0$.

47. **C**

48. **D**

49. **D**

Sol. **(for 47-49)**

(I) Consider $P(x) = ax^4 + bx^3 + cx^2 + dx + e$

$\lim_{x \to 0} \left| \frac{P(-x)}{2x^3} \right|^{\frac{1}{x}}$ must be of the form 1^{∞}

(II) $Q(x) = x - k$ where $k = \int_0^1 f(t)\,dt$

$$f(x) = \frac{x^3}{3} + 1 - x\int_0^x (t-k)\,dt$$

$$= \frac{x^3}{2} + 1 - \frac{x^3}{2} + kx^2$$

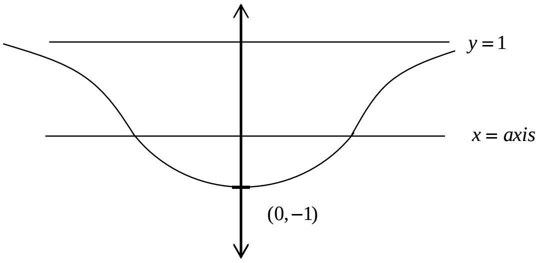
$$= 1 + kx^2$$

$$k = \int_0^1 (1 + kt^2)\,dt = 1 + \frac{k}{3}$$

$$\Rightarrow k = \frac{3}{2}$$

$$\therefore P(x) = 1 + \frac{3}{2}x^2$$

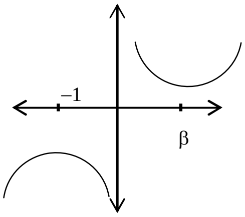
(III)



(IV) $P'(x) = \dfrac{e^{3x}(x+1)(x+e^{-x})(x-e^{-x})}{(xe^x)^2}$

$\therefore x = -1$ Local maxima

$x = \beta$ $\beta \in (0,1)$ local minima



SECTION – C

50. **5**

Perfect squares = x

$1, (2^2, 2^4, 2^6.........2^{14}), \left(3^2, 3^4, ...3^{10}\right), (5^2, ...5^6)$

$1 + 7 + 5 + 3 + 7\times5 + 5\times3 + 3\times7 + 7\times3\times5 = 192$

Perfect cubes

$1, (2^3, 2^6, ...2^{15})\ (3^3, 3^6, 3^9)\ (5^3 5^6)$

$1 + 5 + 3 + 2 + 5\times3 + 3\times2 + 5\times2 + 5\times3\times2 = 72$

Both

$1, (2^6, 2^{12})\ (3^6)\ (5^6)$

$1+2+1+1+2\times1+1\times1+2\times1+2\times1\times1=12$
Required
192 + 72 – 2(12) = 240
$\therefore$ Answer is 5

51. **2**

n^2+3n+6 is a perfect square

$$n^2+3n+6=y^2$$

D must be 0 or square for n to be an integer
Since

$$n=\frac{-3+\sqrt{9-4(6-y^2)}}{2}$$

$$D=4y^2-15=k^2$$

$$4y^2-k^2=15$$

$$(2y+k)\,(2y-k)=15$$

$$1\times15$$

$$3\times5$$

$\therefore y=4; y=2$

$\Rightarrow n^2+3n-10=0 \qquad n^2+3n+2=0$

$$\therefore n=-5,\ n=2,\ n=-1,\ n=-2$$

$$\therefore f(x)=k(x+1)(x+2)(x+5)+x^2$$

Since $f(2)=0$

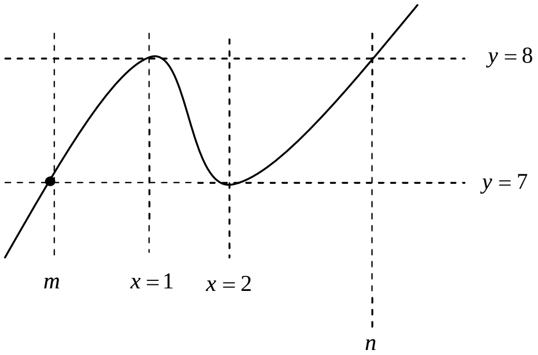
$k=\frac{-1}{21}$

Sum of coefficients = $\frac{-5}{7}$

$\therefore$ Answer = 2

52. **3**

Sol. $(-\infty,m)\cup(n,\infty)$



53. **8**

$$\int_0^1 \frac{dx}{\sqrt{1+x}+\sqrt{1-x}+2}$$

Substitute $x=\cos2\theta$

54. **7**

7 points
6 vertices of regular hexagon and one centre of the circle

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

FULL TEST – XI

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 183**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into Two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01– 07, 19 – 25, 37 - 43)*** *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (08 – 13, 26 – 31, 44 - 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S).*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (14 – 18, 32 – 36, 50 - 54)*** *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Straight Objective Type

This section contains **7 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

1. Potential energy of a particle of mass m in xy plane is expressed by:-

$$U = \frac{(32/\sqrt{2})^2}{(x^2+y^2)^{\frac{3}{2}}}$$

Where x and y are the position coordinates. If at a point defined by position vector $\vec{r} = 2(\hat{i}+\hat{j})$. The particle is observed to be moving perpendicular to $\vec{r}$. Then which of the following is/are correct.

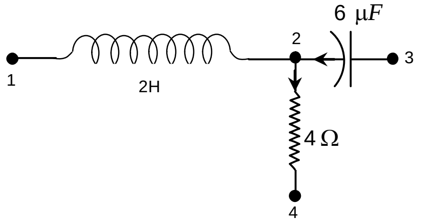
(A) $|\vec{a}_r|$ (Radial Acceleration) of the particle is $\frac{2\sqrt{2}}{m}\ m/s^2$

(B) $|\vec{a}_t|$ (Tangential Acceleration) of the particle is $\frac{\sqrt{2}}{m}\ m/s^2$

(C) Net force on the particle is $(\hat{i}+3\hat{j})N$

(D) Net force on the particle is $(2\hat{i}+3\hat{j})N$

2. The figure given is a part of bigger network. At the shown moment, the capacity of the capacitor is $6\,\mu F$ and decreasing at a constant rate $0.5\,\mu F/s$. The potential difference (V) across the capacitor at this moment is changing as under (Direction of current is shown in figure.)



$$\frac{dV}{dt} = 2(volt/s) \quad ; \qquad \frac{d^2V}{dt^2} = \frac{1}{2}(volt/s^2)$$

The current in the $4\,\Omega$ resistor is decreasing at the rate of $1\,\mu A/s$. The potential difference across the inductor at the moment is:-

(A) $1\,\mu V$ (B) $2\,\mu V$

(C) $3\,\mu V$ (D) $4\,\mu V$

Space for rough work

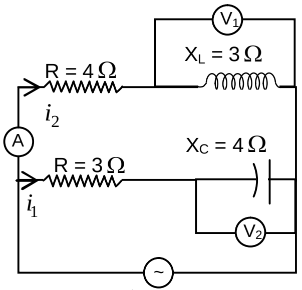
3. Consider the AC circuit shown and mark the correct option/s.

(A) Phase difference between i_1 and i_2 is $\frac{\pi}{2}$

(B) Reading of voltmeter V_1 is $6\sqrt{2}V$

(C) Reading of voltmeter V_2 is $-8\sqrt{2}V$.

(D) Reading of ammeter is $2\sqrt{2}A$.



$\varepsilon = \varepsilon_0 \sin \omega t$

$[\varepsilon_0 = 20]$

4. Two equal charges Q are at opposite corners of a square of side ‘a’ and an electric dipole of moment p is at a third corner, pointing towards one of the charges. If $p = 2\sqrt{2}a\,Q$; The field strength at the fourth corner of the square is:-

(A) $\frac{\sqrt{17/2}}{4\pi \in_0 a^2}Q$

(B) $\frac{\sqrt{17/4}}{4\pi \in_0 a^2}Q$

(C) $\frac{Q}{4\sqrt{2}\pi \in_0 a^2}$

(D) $\frac{\sqrt{3}}{4\pi \in_0 a^2}Q$

5. A radioactive sample is undergoing $\alpha-$decay. At any time t_1 its activity is A and at a later instant t_2 it is $\frac{2A}{3}$. Which of the following is/are correct

(A) Mean life for the sample = $\frac{t_2 - t_1}{\log_e\left(\frac{3}{2}\right)}$

(B) Half life for the sample is $(t_2 - t_1)\left(\frac{\log_e 2}{\log_e \frac{3}{2}}\right)$

(C) Probability of survival of a nucleus after one mean life is 1/e.

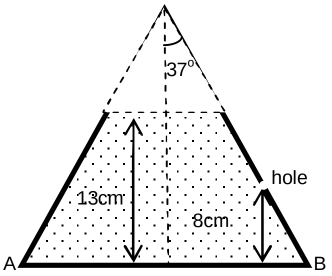
(D) Sum of lives of all nuclei is finite.

Space for rough work

6. A steel wire is stretched between two clamps 100 cm apart with a tension, which produces an extension of 0.608 cm in it. (Density of steel = 7600 kg/m^3; Young's modulus of elasticity = $2\times10^{11} N/m^2$)

(A) The fundamental frequency of its transverse vibration is 200 hz.
(B) The fundamental frequency of its transverse vibration is 400 hz.
(C) The 3rd overtone of the string will correspond to the frequency of 800 Hz.
(D) The 4th overtone of the string will correspond to the frequency of 600 Hz.

7. Curved surface of a vessel has shape of a truncated cone having semi vertex angle 37°. Vessel is full of water (density $\rho = 1000 kg/m^3$) upto a height of 13 cm and is placed on a smooth horizontal plane. Upper surface is opened to atmosphere. A hole of 1.5 cm^2 is made on curved wall at a height of 8 cm from bottom as shown in the figure. Area of water surface in the vessel is large as compared to the area of the hole



(A) Initial velocity of efflux is 1 m/s
(B) Initial horizontal range of water jet from point B is 6.65 cm
(C) Horizontal force required to keep the vessel in static equilibrium is 0.15 N.
(D) Horizontal force required to keep the vessel in static equilibrium is 0.12 N.

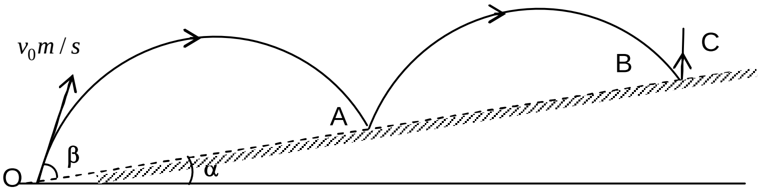
Space for rough work

Matrix Match Types

Each of 2 tables with 3 Columns and 4 Rows has three questions. Column-1 will be with 4 rows designated (I), (II), (III) and (IV). Column-2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column-3 will be with 4 rows designated (P), (Q), (R) and (S). Each question has four options with only **ONE** correct

Answer questions 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

A particle is projected along an inclined plane having inclination $\alpha,$ at angle β with the inclined plane. If coefficient of restitution is $\frac{1}{2}$, and it is given that the initial speed of particle is $v_0 = 10 m/s,$ and that the particle bounces vertically upwards after 2 collisions as shown in figure, then answer the questions accordingly. (T denotes total time of flight and $K = \frac{T}{\sin\beta}$); (All units are in S.I. system)



Column – 1	Column – 2	Column – 3
(I) $\alpha = 45^o$	(i) $\beta = \cot^{-1}\left[\frac{13\sqrt{3}}{4}\right]$	(P) $K = \frac{13}{2\sqrt{2}}s$
(II) $\alpha = 30^o$	(ii) $\beta = \cot^{-1}\left[\frac{13\sqrt{3}}{12}\right]$	(Q) $K = 5.42s$
(III) $\alpha = 60^o$	(iii) $\beta = \cot^{-1}\left[\frac{13}{3}\right]$	(R) $K = \frac{13}{2\sqrt{3}}s$
(IV) $\alpha = 53^o$	(iv) $\beta = \cot^{-1}\left[\frac{13}{4}\right]$	(S) $K = 6.5s$

8. (I) (iv) (R) (II) (iii) (Q) (III) (i) (S) (IV) (iii) (Q)
How many of the above combinations are correct?
(A) 1 (B) 0
(C) 2 (D) 3

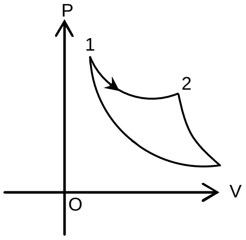
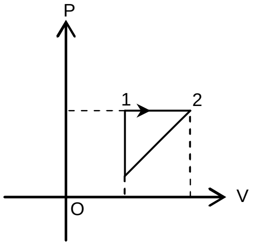
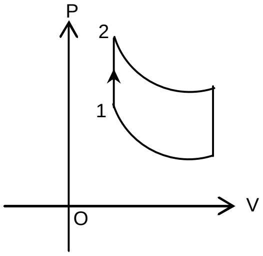
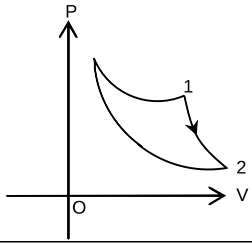
9. For which of the following combination will $T_{AB} = \frac{4\sqrt{2}}{\sqrt{185}}$ where T_{AB} is the time taken for particle to move from A to B.
(A) (I) (iv) (P) (B) (I) (iii) (R)
(C) (II) (iii (Q) (D) (IV) (iii) (Q)

10. In which of the case, will the velocity perpendicular to the plane after second collision be $\frac{7.5}{\sqrt{178}}$
(A) (I) (ii) (S) (B) (II) (i) (R)
(C) (III) (iv) (P) (D) (IV) (iii) (Q)

Space for rough work

Answer questions 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

An ideal monatomic gas (2 moles) undergoing a cyclic thermodynamic process in different ways as shown in corresponding diagrams in columns (3) of table. Consider only path from state 1 to state (2) Q; W; U denotes the correspoing heat exchange, workdone and internal energy for the system. For all shown process $1 \to 2$; pressure & volume is represented by $P_1; V_1$.

Column – 1	Column – 2		Column – 3
(I) $Q_{12} = 0$	(i) Isobaric	(P)	
(II) $\Delta U_{12} = 0$	(ii) Adiabatic	(Q)	
(III) $W_{12} = P_1(V_2 - V_1)$	(iii) Isothermal	(R)	
(IV) $Q_{12} = \dfrac{3(P_1V_1 - P_2V_2)}{2}$	(iv) Isochoric	(S)	

11. Which one of the following options is the correct combination?
(A) (II) (ii) (S)
(B) (I) (ii) (S)
(C) (II) (i) (P)
(D) (IV) (ii) (R)

Space for rough work

12. For which combination $\Delta Q = W$?

(A) (II) (iii) (P) (B) (III) (i) (P)
(C) (II) (i) (R) (D) (I) (i) (P)

13. For which one combination $\Delta Q = (5R)(\Delta T)$?

(A) (I) (iii) (P) (B) (II) (ii) (S)
(C) (III) (i) (Q) (D) (IV) (i) (Q)

SECTION – C

(One Integer Value Correct Type)

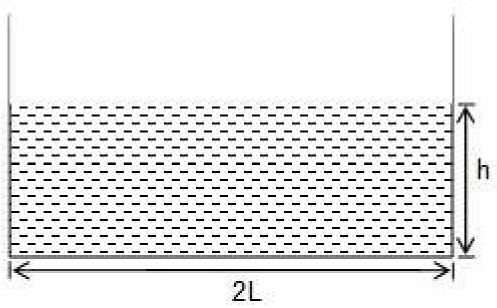
This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

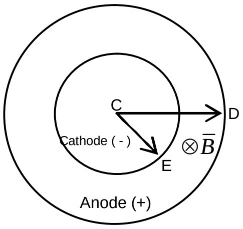
14. A rectangular pan of base (2L) is partly filled with water upto a height h as shown in figure. When the pan is pull a little, the water begins to slosh. Assuming that the water surface remains practically flat during sloshing the time period of the sloshing mode is given by:-

$$T = 2\pi\sqrt{\frac{L^2}{ngh}}$$

Find the value of n.



15. The electrodes of a diode are coaxial cylinders of radii inner 2m and outer 4 m. A potential difference V is maintained between them and their common axis is parallel to a uniform magnetic field $B = 1$ Tesla. The inner cylinder is the cathode, electrons leave it radially with negligible speed. If they will reach the anode at grazing incidence if $v = \frac{ne}{8m}$, then $n = ?$ $(CD = b$ and $CE = a)$

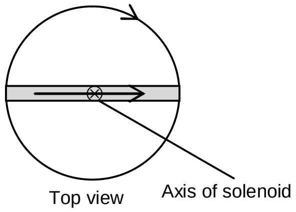


16. A homogeneous rod leans on a frictionless horizontal plane making an angle $\alpha = \pi/3$ with the horizontal. If released from rest it will fall. If the ratio of the length of the rod to the distance covered by the end on the plane at the beginning is given by n. Then n will be?

Space for rough work

17. A free electron with kinetic energy 3.4 eV happens to fall into an orbit around a fixed alpha particle forming a He^+ atom in the first excited state. A photon of wavelength λ_1 is emitted. Then the atom comes to the ground state emitting another photon of wavelength λ_2. If $\frac{\lambda_1}{\lambda_2} = \frac{12}{k}$, then find the value of k.

18. Circular coils are placed very close to each other so that they make up an infinite solenoid. The current in coils is 1A and number of coils/length of solenoid is 4000 turns/m. The diameter of the solenoid is 2 m. A wire of length equal to diameter of circular coil and carrying the same current is kept along the diameter as shown. Its mass is 4g. This wire is near the centre of solenoid. Find the velocity of the wire (in m/s) when it comes out of the solenoid. (Neglect friction and assume that rod is moving in the horizontal plane) (taken $\pi^2 = 10$) Neglect gravity.



Space for rough work

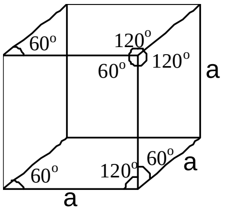
Chemistry PART – II

SECTION – A

Straight Objective Type

This section contains **7 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

19. A rhombohedral unit cell is shown What is its volume? Side length = $a\overset{o}{\mathrm{A}}$



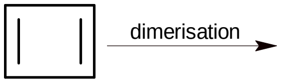
(A) $\frac{\sqrt{2}a^3}{2}$ (B) $\frac{a^3\sqrt{3}}{2}$

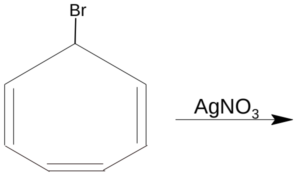
(C) $\frac{a^3}{\sqrt{2}}$ (D) $a^3\sqrt{\frac{3}{2}}$

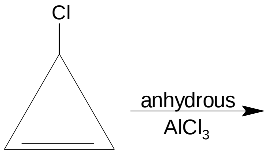
20. Which of the following pair/s have nearly same size?

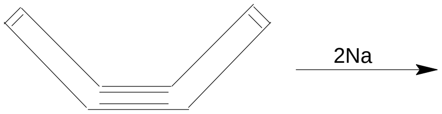
(A) Zr, Hf (B) Nb,Ta
(C) Fe, Zn (D) K, Rb

21. Select the correct combination in which aromatic compound is/are formed in the reaction.

(A)


(B)


(C)


(D)


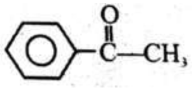
Space for rough work

22. For spontaneity select the correct statement/s
(A) ∂ G < O at constant, temperature and pressure for irreversible process.
(B) ∂ G < O at constant, temperature and volume for irreversible process.
(C) dS > O at constant, internal energy and volume for an isothermal irreversible process.
(D) dU < O at constant, entropy and volume for an isothermal irreversible process.

23. In a chemical reaction:
$PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$
if pressure of the system get decrease then :

(A) Degree of dissociation of PCl_5 increases, net concentration of all decreases
(B) Degree of dissociation of PCl_5 decreases, net concentration of all increases
(C) Vapour density of the mixture decreases
(D) Vapour density of the mixture increases

24. Compound(A)$C_8H_8O \xrightarrow[HCl]{NH_2OH}$ B + C; C $\xrightarrow{H^+}$ D
B $\xrightarrow{H^+}$ E $\xrightarrow[\text{(ii) } H^+/H_2O]{\text{(i)Boil NaOH}}$ G($C_7H_6O_2$)
(white solid)
D $\xrightarrow[\text{(ii) } H^+/H_2O]{\text{(i)KOH}}$ F(C_6H_7N) $\xrightarrow[\text{rapid}]{CH_3COCl}$ D
(Oil)
[B, C, D and E are isomers having molecular formula C_8H_9NO]
Which of the following statement is/are correct regarding above reaction:
(A) Compound(A) is an aldehyde and can give (+ ve) Tollen's test
(B) Compound (B) and (C) can show geometrical isomerism

(C) Compound (A) is an aromatic ketone which having structure 

(D) Compound (G) is more acidic than CH_3COOH

25. Select the correct statement/s:
(A) Square planer complex can show enantiomerism
(B) In $KMnO_4$ central atom is sp^3 hybridised and its geometry is tetrahaedral
(C) $[PtF_6]^{2-}$ is inner orbital complex while $[Co(NH_3)_6]^{2+}$ is outer orbital complex
(D) The order of crystal field splitting energy in tetrahaedral, octahedral and square planar complex are $\Delta_t < \Delta_0 < \Delta_{sp}$ respectively

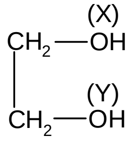
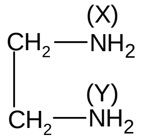
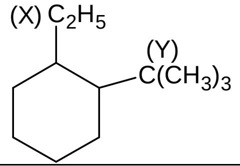
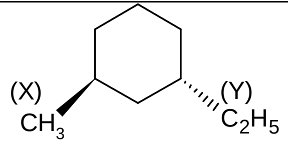
Space for rough work

Matrix Match Types

Each of 2 tables with 3 Columns and 4 Rows has three questions. Column-1 will be with 4 rows designated (I), (II), (III) and (IV). Column-2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column-3 will be with 4 rows designated (P), (Q), (R) and (S). Each question has four options with only **ONE** correct

Answer questions 26, 27 and 28 by appropriately matching the information given in the three columns of the following table.

If two different 3 – D arrangements in space of atom in a molecule are interconvertible merely by free rotation about σ bond is called conformations.

Column – 1		Column – 2	Column – 3
(I)	 $\mathrm{\overset{}{CH_2}\overset{(X)}{—OH}}$ $\mathrm{CH_2\overset{(Y)}{—OH}}$	(i) Gauche conformer most stable	(P) Tortional & Vander Waal's strain is decrease.
(II)	 $\mathrm{CH_2\overset{(X)}{—NH_2}}$ $\mathrm{CH_2\overset{(Y)}{—NH_2}}$ at pH = 4 in aq. solution	(ii) Anti/staggered conformer most stable	(Q) Intramolecular Hydrogen Bonding
(III)		(iii) group (X) is at axial position while group (Y) is at equatorial for stable conformer	(R) Trans form
(IV)		(iv) group (X) & (Y) both are at equatorial position for stable conformer	(S) Cis form

26. Select the correct one:
(A) (IV), (iv), (S)
(B) (III), (iii), (S)
(C) (I), (iv), (Q)
(D) (I), (ii), (P)

Space for rough work

27. Select the incorrect one:
(A) (I), (i), (Q)
(B) (I), (ii), (P)
(C) (III), (iv), (R)
(D) (IV), (iii), (P)

28. The correct one with respect to ethylene diamine.
(A) (II), (i), (P)
(B) (II), (i), (Q)
(C) (II), (ii), (R)
(D) (II), (ii), (Q)

Answer questions 29, 30 and 31 by appropriately matching the information given in the three columns of the following table.

Column – 1	Column – 2	Column – 3
(I) Very dilute HNO_3	(i) reacts with copper	(P) Metal nitrate + NO are formed
(II) Dilute HNO_3	(ii) reacts with Tin	(Q) Metal nitrate + NO_2 are formed
(III) Concentrated HNO_3	(iii) reacts with Zinc	(R) Metal nitrate + N_2O are formed
(IV) Aqua regia	(iv) reacts with Iron	(S) Metal nitrate + NH_4NO_3 are formed

29. From the given columns the correct set is:
(A) (I) (i) (Q)
(B) (II) (i) (P)
(C) (IV) (i) (Q)
(D) (III) (iv) (R)

30. From the given columns the incorrect is:
(A) (I) (ii) (S)
(B) (III) (iii) (Q)
(C) (II) (ii) (P)
(D) (II) (iv) (R)

31. HNO_3 reacts with metal (Tin) will give the correct reaction by the following combination____
(A) (III) (ii) (S)
(B) (III) (ii) (R)
(C) (I) (ii) (P)
(D) (II) (ii) (S)

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

32. The number of Hg – O bond present in chemical formula of iodide of million's base____

33. The total no. of amide/s possible with the molecular formula $C_5H_{11}NO$ is X. Find the value of $\frac{X}{4}$.

34. 3.838L water is added in 300 ml of 0.1M HA so that its $[H^+]$ is decreased by a factor of X Ka for HA = 1.6×10^{-4} Find the approximate value of X.

35. How many of them shows minimum boiling azeotrope;
Acetone and benzene
Acetone and carbon disulphide
Acetone and ethanol
Acetone and aniline
Carbon tetra chloride and silicon tetra chloride
Carbon tetra chloride and chloroform
Benzene and chloroform
Diethyl ether and chloroform
n – butyl chloride and n – butyl bromide

36. Oxidation number of Fe in the complex formed during NO_3^- ring test is 'a' and oxidation number of Cr in K_3CrO_8 is 'b' then 'a + b' is:

Space for rough work

Mathematics

PART – III

SECTION – A

Straight Objective Type

This section contains **7 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

---

37. Let X be a set $\{1, 2, 3, 4, 5, ..., n\}$ and P the subset $\{1, 2, 3, 4, 5\}$. The number of subsets Q of X such that $n(P \cap Q) = \alpha$, is

(A) $2^n - 2^{n-5}$ if $\alpha < 5$
(B) $2^n - 2^{n-5}$ if $\alpha > 0$
(C) ${}^{n-5}C_2 . {}^5C_2$ if $\alpha = 2$
(D) ${}^5C_1 . \sum_{r=0}^{n-5} {}^{n-5}C_r$ if $\alpha = 1$

38. If $\int \frac{dx}{x^{1/3} + 2} = g(x) + c$ where $g(0) = 12 \ln 2$ then $2g(-1)$ is a multiple of

(A) 2
(B) 3
(C) 5
(D) 7

39. There are 2m people, m people wearing red shirts and m people wearing blue. The number of ways in which these 2m people can stand in a queue, such that at any instant a person standing in queue sees more number of red shirt people standing in front of him than the blue shirt people is

(A) 4 if m = 2
(B) 5 if m = 3
(C) 14 if m = 4
(D) 42 if m = 5

40. If A and B be two points on the curve $y = \log_{\frac{1}{3}}(x - 0.\overline{3}) + \log_3 \sqrt{9x^2 - 6x + 1}$ and A is also a point on the ellipse $\frac{x^2}{8} + \frac{y^2}{2} = 1$. B lies inside the ellipse having integral co ordinates. Then

(A) $\overrightarrow{OA} \cdot \overrightarrow{OB} = 3$
(B) $|\overrightarrow{AB}| = 1$
(C) $|\overrightarrow{AB}| = 1$ or $|\overrightarrow{AB}| = 3$
(D) $\Delta_{AOB} = 1$ sq. unit

Space for rough work

41. Consider the curves $C_1 \equiv x^2 + y^2 - 6x - 8y + 24 = 0$ and $C_2 \equiv 4x^2 + 5y^2 - 40x + 30y + 125 = 0$. The set of values of c for which $y = 2x + c$ does not intersect any of the curves and lies between them, is.

(A) $c \in (-\infty, -13 + 2\sqrt{6}) \cup (-2 - \sqrt{5}, \infty)$ (B) $c \in (-2\sqrt{6} - 13, \infty)$

(C) $c \in [2\sqrt{6} - 13, \sqrt{5} - 2]$ (D) $c \in (-13 + 2\sqrt{6}, -2 - \sqrt{5})$

42. Consider f in [0, 2] where

$f(x) = |4x - 5|[x]$ for $x > 1$

$[\cos \pi x]$ for $x \le 1$; where $[\cdot]$ denotes G. I. F.

The points of discontinuities of this function say $(\alpha, \beta, \gamma, \delta)$ in increasing order satisfy $M = \alpha \cos 3t + \beta \cos 2t + \gamma \cos t + \delta \ (t \in R)$. Then

(A) $M_{\max} = \frac{9}{2}$ (B) $M_{\min} = \frac{5}{4}$

(C) $M_{\max} = \frac{7}{2}$ (D) $M_{\min} = \frac{3}{4}$

43. Which of the following is/are incorrect?

(A) The ratio $\frac{\Delta}{\Delta_E}$ is equal to $2\sin\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2}$ (Where Δ_E denotes area of triangle formed by joining the excentres)

(B) The radius of escribed circles of ΔABC are r_1, r_2 and r_3 respectively (opposite to vertices A, B and C) It $r_1 + r_2 = 3R$ and $r_2 + r_3 = 2R$ (Where R is circum radius of ΔABC), then $\angle C = 90^\circ$.

(C) In a right angled triangle, acute angle α, β satisfy $\tan\alpha(1 + \tan\alpha) + \tan\beta(1 + \tan\beta) = 4$. If hypotenuse is of length d, then area of triangle is $\frac{d^2}{4}$

(D) None of these

Space for rough work

Matrix Match Types

Each of 2 tables with 3 Columns and 4 Rows has three questions. Column-1 will be with 4 rows designated (I), (II), (III) and (IV). Column-2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column-3 will be with 4 rows designated (P), (Q), (R) and (S). Each question has four options with only **ONE** correct

Answer questions 44, 45 and 46 by appropriately matching the information given in the three columns of the following table.

Column –1: Contains functions/expressions

Column –2 & 3: Contain properties that these functions/expressions exhibit

Column – 1	Column – 2	Column – 3
(I) Consider $f : R \to R$ $f(x) = 2x + [x] + \sin x \cos x$	(i) One One	(P) Continuous
(II) Consider $f : [4,6] \to R$ $f(x) = \tan\left(2\sqrt{x-4} + \sqrt{6-x}\right)$	(ii) Many One	(Q) Differentiable
(III) Consider $f : [-1,1] \to \left[\frac{13}{36}, \frac{19}{20}\right]$ $f(x) = \frac{1}{\pi}\left(\sin^{-1} x + \cos^{-1} x - \tan^{-1} x\right) + \frac{1}{x^2 + 2x + 6}$	(iii) Into	(R) Not Differentiable at exactly one point
(IV) Let a, b, c be real numbers such that $3b > a^2$. Then the function $f : R \to R$ given by $f(x) = x^3 + ax^2 + bx + c$ is	(iv) Onto	(S) Discontinuous

44. Which of the following is a correct combination?
(A) (I), (iv), (S) (B) (IV), (iii), (Q)
(C) (II), (i), (R) (D) (III), (iv), (Q)

45. Which of the following is a correct combination?
(A) (I), (iii), (S) (B) (II), (i), (R)
(C) (III), (iii),(P) (D) (IV), (ii), (P)

46. Which of the following is a correct combination?
(A) (I), (ii), (P) (B) (I), (i), (S)
(C) (III), (ii), (P) (D) (IV), (ii), (Q)

Space for rough work

Answer questions 47, 48 and 49 by appropriately matching the information given in the three columns of the following table.

Column – 1	Column – 2	Column – 3
(I) Let $P(x)$ be a bi quadratic function of x such that $\lim_{x\to 0}\left[\frac{P(-x)}{2x^3}\right]^{\frac{1}{x}} = \frac{1}{e^3}$	(i) $P(x)$ has maxima but no minima	(P) $P(x)$ is continuous for all x in its domain
(II) Consider the functions $P(x)$ and $Q(x)$ such that $P(x) = \frac{x^3}{2} + 1 - x\int_0^x Q(t)dt.$ and $Q(x) = x - \int_0^1 P(t)dt$ Both $P(x)$ and $Q(x)$ are defined from $R \to R$	(ii) $P(x)$ has minima but no maxima	(Q) $P(x)$ is discontinuous at exactly 2 points
(III) Consider function $P : R \to R$ defined by $P(x) = \frac{x^2 - a}{x^2 + a}; 0 < a < 9$	(iii) $P(x)$ has both local minima and maxima	(R) $P(x)$ is bounded
(IV) consider $P(x) = xe^x + (xe^x)^{-1}$ $\forall x \in R - \{0\}$	(iv) $P(x)$ is decreasing in $(-\infty, 0)$ and increasing in $(0, \infty)$	(S) $P(x)$ attains all values from $(-\infty, \infty)$

47. Which of the following is the correct combination?

(A) (IV), (iv), (R)
(B) (I), (ii), (Q)
(C) (III), (ii), (R)
(D) (II), (i), (P)

Space for rough work

48. Which of the following is the correct combination?
(A) (II), (ii), (R) (B) (I), (i), (R)
(C) (IV), (ii), (P) (D) (III), (iv), (R)

49. Which of the following is the incorrect combination?
(A) (III), (ii), (P) (B) (II), (ii), (P)
(C) (III), (iv), (R) (D) (I), (ii), (P)

SECTION – C

(One Integer Value Correct Type)

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

50. The number of factors of $2^{15}3^{10}5^{6}$ which are either perfect squares or perfect cubes (but not both) are α. Then $\left[\frac{\alpha}{42}\right]$ is equal to______ [where $[\cdot]$ denotes G.I.F]

51. n^2+3n+6 is a perfect square is satisfied by a set of integers $\{a_1, a_2, ..., a_k\}$. Let $P(x)$ be a polynomial of least possible degree such that

$$\left.\begin{matrix} p(a_i)=(a_i)^2 & a_i<0 \\ P(a_i)=0 & a_i \ge 0 \end{matrix}\right\} \forall\ 1 \le i \le k$$

If the sum of coefficients of $P(x)$ can be expressed as $\frac{m}{n}$ in the lowest form, then $|m+n|$ is equal to?

52. Let $f(x)=\frac{(2x^3-9x^2+12x+3)\ (x-\alpha)}{(x-\alpha)}$. If range of $f(x)$ is a proper subset of R , then $\alpha \in (-\infty, m) \cup (n, \infty)$. The value of $m+n$ equals______.

53. If $\int_0^1 \frac{dx}{\sqrt{1+x}+\sqrt{1-x}+2}=\sqrt{a}-\sqrt{b}-\frac{\pi}{\sqrt{c}}$, where $a, b, c \in N$, then value of $\left[\frac{a^2+b^2+c^2}{10}\right]$ is equal to_____. [where $[\cdot]$ denotes G.I.F.]

54. Let $D=\{(x,y) \in R^2 : x^2+y^2 \le 1\}$. Then the maximum number of points in D such that distance between any pair of points is at least 1 will be______.

Space for rough work

FIITJEE **JEE(Advanced)-2018**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

FULL TEST – XI

PAPER-2

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**B**	24.	**A**	47.	**B**
2.	**A**	25.	**B**	48.	**A**
3.	**D**	26.	**A**	49.	**B**
4.	**A,B**	27.	**B,C**	50.	**B**
5.	**B,C**	28.	**B,C**	51.	**C, D**
6.	**B,C**	29.	**A,C,D**	52.	**A,D**
7.	**C,D**	30.	**B,D**	53.	**A,C,D**
8.	**A,C**	31.	**A,D**	54.	**A,B,D**
9.	**C**	32.	**D**	55.	**A**
10.	**C**	33.	**B**	56.	**B**
11.	**4**	34.	**4**	57.	**2**
12.	**2**	35.	**3**	58.	**1**
13.	**2**	36.	**5**	59.	**2**
14.	**5**	37.	**2**	60.	**1**
15.	**2**	38.	**3**	61.	**8**
16.	**1**	39.	**1**	62.	**9**
17.	**2**	40.	**6**	63.	**1**
18.	**4**	41.	**7**	64.	**5**
19.	**5**	42.	**6**	65.	**0**
20.	**4**	43.	**5**	66.	**4**
21.	**00000.15**	44.	**00100.00**	67.	**00002.63**
22.	**00126.00**	45.	**00000.66**	68.	**00000.50**
23.	**00001.32**	46.	**00009.87**	69.	**00121.17**

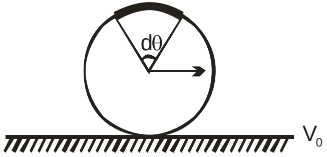
Physics

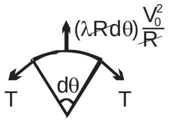
PART – I

SECTION – A

1. **B**

Sol. F.B.D. of small part of ring.





$2T\sin\left(\frac{d\theta}{2}\right) = \lambda d\theta v_0^2$ $\qquad v_{wave} = \sqrt{\frac{T}{\mu}}$

$\lambda \cancel{d\theta} v_0^2 = T\cancel{d\theta}$ $\quad T = \lambda v_0^2 = \sqrt{\frac{\cancel{\lambda} v_0^2}{\cancel{\lambda}}} = v_0$

Time take by hoop in one complete revolution $= \frac{2\pi}{v_0} = \frac{2\pi R}{V_0}$

Distance traveled by wave in this time $= \frac{\cancel{V_0} \times 2\pi R}{\cancel{V_0}}$

$\therefore$ angle rotated $= 2\pi$

2. **A**

Sol. Writing energy equation at any instance we get,

$mg\frac{2R}{\pi}(1-\cos\theta) + \frac{1}{2}I\omega^2 = \text{constant}$ (where I = moment of inertia about bottom most point)

$I_{CM} = mR^2 - m\left(\frac{2R}{\pi}\right)^2$

$I_{\text{Bottom point}} = I_{CM} + m\left(R - \frac{2R}{\pi}\right)^2$

$= mR^2 - \cancel{m\left(\frac{2R}{\pi}\right)^2} + mR^2 + \cancel{m\left(\frac{2R}{\pi}\right)^2} - 2.m.R.\frac{2R}{\pi}$ $\quad I_B = 2mR^2 - 4\frac{mR^2}{\pi}$

$mg\frac{2R}{\pi}(1-\cos\theta) + \frac{1}{\cancel{2}} \times \cancel{2}\left(mR^2 - \frac{2mR^2}{\pi}\right)\omega^2 = \text{constant}$

Differentiating if we get,

$mg\frac{\cancel{2}R}{\pi}\cdot\sin\theta\cdot\frac{\cancel{d\theta}}{\cancel{dt}} + \left(mR^2 - \frac{2mR^2}{\pi}\right)\cdot\cancel{2}\,\cancel{w}\frac{d\theta}{dt} = 0$

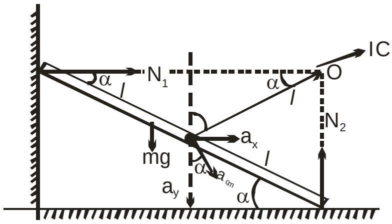
$mg\frac{R}{\pi}\cdot\theta + mR^2\left(1-\frac{2}{\pi}\right)\frac{d^2\theta}{dt^2} = 0$

$\frac{d^2\theta}{dt} + \frac{\cancel{m}g\frac{\cancel{R}}{\pi}}{\cancel{m}R^{\cancel{2}}\left(1-\frac{2}{\pi}\right)}\theta = 0$

$\omega^2 = \frac{g}{R(\pi-2)}$ $\quad \omega = \sqrt{\frac{g}{R(\pi-2)}}$ $\quad$ **Ans.:** $T = 2\pi\sqrt{\frac{R(\pi-2)}{g}}$

3. **D**

Sol. F.B.D when at any instant rod values angle ' α ' with horizontal when rod leaves contact $N_1 = 0$, $a_x = 0$, $v_x = \max$.



Writing energy equation we get,

$$mg\,l(\sin\theta_0 - \sin\theta) = \frac{1}{2} I_0 \omega^2$$

$$\cancel{m} g\,l(\sin\theta_0 - \sin\theta) = \frac{1}{\alpha}\left[\frac{m(2l)^2}{12} + ml^2\right]\omega^2$$

$$= \frac{1}{2}\left[\frac{ml^2}{3} + ml^2\right]\omega^2 \qquad = \frac{1}{2}\left[\frac{4}{3} ml^2 \omega^2\right] \qquad = \frac{1}{\cancel{2}} \times \frac{\overset{2}{\cancel{4}}}{3} \cancel{m} v_0^2$$

$$v_{cm} = \sqrt{\frac{3}{2} gl(\sin\theta_0 - \sin\theta)} \qquad v_x = v_{cm} \sin\theta$$

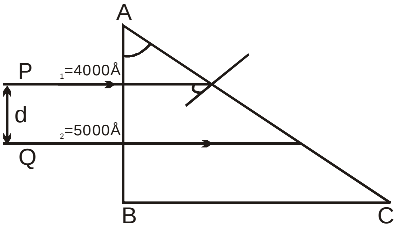
$$v_x = \sqrt{\frac{3}{2} gl}\left(\sqrt{\sin\theta_0 - \sin\theta}\right)\sin\theta \qquad \frac{dv_x}{d\theta} = \sqrt{\sin\theta_0 - \sin\theta} \cdot \cos\theta - \sin\theta \frac{1 - \cos\theta}{2\sqrt{\sin\theta_0 - \sin\theta}} = 0$$

$$\frac{2(\sin\theta_0 - \sin\theta) \cdot \cos\theta - \sin\theta}{2\sqrt{\sin\theta_0 - \sin\theta}} = 0$$

$$3\sin\theta_0 = 2\sin\theta_0$$

Ans.: $\sin\theta = \frac{2}{3}(\sin\theta_0)$

4. **AB**



Sol. $\sin C$ will be smaller for smaller λ.

For $\left(0 < C < \pi/2\right)$ C will be small for smaller λ.

$\therefore$ TIR will occur for 4000 Å and not 5000 Å

$$\mu = 1.20 + \frac{b}{\lambda^2} \qquad 1.25 = 1.20 + \frac{b}{\lambda^2} \qquad \Rightarrow \frac{b}{\lambda^2} = 0.05$$

$$b = 0.05 \times (4000 \times 10^{-10})^2 \qquad b = 8 \times 10^{-15}\, m^2$$

From Snell's law

$$\mu_1 \sin i = 1 \sin r \qquad \mu = \frac{\sin r}{\sin i}$$

$$1.0 + \frac{8 \times 10^{-15}}{(5000 \times 10^{-10})^2} = \frac{\sin r}{0.8} \qquad \Rightarrow \sin r = 0.9856 \qquad \Rightarrow r = 80.3^0$$

$$8 = (r - i) = 80.3^0 - 53.1^0$$

$$\delta = 27.2^0$$

5. **BC**

Sol. No. of photons emitted per second $= \dfrac{3.2 \times 10^{-3}}{\left(\dfrac{hc}{\lambda}\right)}$

$$= \frac{\cancel{3.2}\times 10^{-3}}{5\times\cancel{1.6}\times 10^{-19}}$$

$$= \frac{2}{5}\times 10^{16} = 4\times 10^{15} \text{ photons/sec.}$$

Photons striking the metallic sphere $= \dfrac{\cancel{4}\times 10^{15}}{\cancel{4}\times\cancel{\pi}\times(0.8)^2}\times\cancel{\pi}\times(8\times 10^{-3})^2$

$$= \frac{10^{15}\times 100}{\cancel{8\times 8}}\times\cancel{64}\times 10^{-6}$$

$$= 10^{11} \text{ photon/sec}$$

$\therefore$ No. of electron emitted per second = $\dfrac{10^{11}}{10^{6}} = 10^{5}$ electron/sec.

K.E$_{max}$ of electron = 5 - 3 = 2eV

Potential at which emitted stops = 2 Volt

$\therefore \dfrac{Kq}{r} = 2V \qquad q = \dfrac{2\times 8\times 10^{-3}}{9\times 10^{9}} \quad = \dfrac{16}{9}\times 10^{-12}C$

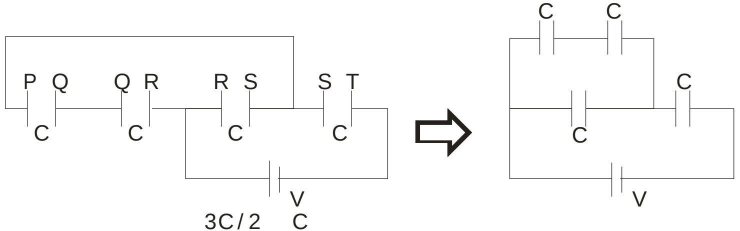
$\therefore$ Time after which sphere acquires this change

$$= \frac{\cancel{16}}{9}\,\frac{\times 10^{-12}\times\cancel{10}}{\cancel{16}\times 10^{-19}\times 10}$$

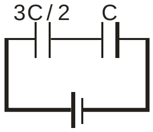
$$t = \frac{10^{3}}{9} = 111.11 \text{ sec.}$$

6. **BC**

Sol. Drawing the capacitor diagram we get



$C = \dfrac{A\varepsilon_0}{d}$



$\dfrac{1}{C_{eq.}} = \dfrac{2}{3C} + C \qquad C_{eq} = \dfrac{3}{5}C$

After charge distribution on plates we get, Charge on plate P = $\dfrac{\varepsilon_0 AV}{5d}$ charge on plate $R = \dfrac{3\varepsilon_0 AV}{5d}$

7. **CD**

Sol. It is clear from theory of electrostatics (C, D)

8. **AC**

Sol. Flux linked with loop due to its own magnetic field,

$\phi = \dfrac{\mu_0 I}{2r}(\pi r^2) = \dfrac{\mu_0 \pi r I}{2}$

emf induced $= -\dfrac{d\phi}{dt} = \varepsilon = -\dfrac{\mu_0\pi r}{2}\dfrac{dI}{dt}$

$I = \dfrac{\varepsilon}{R} = -\dfrac{\mu_0 \pi r}{2R}\dfrac{dI}{dt} \qquad \displaystyle\int_{I_0}^{I}\frac{dI}{I} = -\int_0^t \frac{2R}{\mu_0\pi r}.dt;\, I = I_0 e^{-2Rt/\mu_0\mu r}$

Now, $10^{-3} I_0 = I_0 e^{-\frac{2Rt}{\mu_0 \pi r}}$ which gives $t = \frac{3\pi^2 \ln 10}{10^{10}} s$.

9. **C**

10. **C**

Sol. **(9 - 10)**

P_0, V_0, T_0 A_1	P_0, V_0, T_0 A_2	P_0, V_0, T_0 A_3

Initial condition

P, V_1, T_1 A_1	$P, V, \frac{9T_0}{4}$ A_2	$P, V, \frac{9T_0}{4}$ A_3

final equilibrium

Considering chamber A_2 and A_3,

No. of moles = constant $\frac{P_0 \cancel{2} V_0}{\cancel{2}\, \cancel{R T_0}} = \frac{P \cancel{2} V}{\cancel{2} \frac{9T_0}{4}}$

$$PV = \frac{9}{4} P_0 V_0$$

Apply adiabatic condition

$$P_0 (2V_0)^{\gamma} = P(2V)^{\gamma}$$

$$P_0 (V_0)^{\gamma} \cancel{2^{\gamma}} = P \cancel{2^{\gamma}} v^{\gamma}$$

$$P_0 V_0^{\gamma} = PV^{\gamma}$$

$$V^{\gamma} = \frac{P_0 V_0^{\gamma}}{P}$$

$$V^{\gamma} = \frac{P_0 V_0^{\gamma}}{\frac{9}{4} \frac{P_0 V_0}{V}}$$

$$V^{\gamma - 1} = \frac{4}{9} V_0^{\gamma - 1}$$

$$V^{\cancel{2}/3} = \frac{4}{9} V_0^{2/3}$$

$$V^2 = \left(\frac{4}{9}\right)^3 V_0^2$$

$$V = \frac{4}{9}^{3/2} V_0$$

$$V = \left|\frac{2}{3}\right|^3 V_0$$

$$V = \frac{8}{27} V_0$$

$$V_1 = 3V_0 - 2V = 3V_0 - \frac{16V_0}{27}$$

$$= \frac{81V_0 - 16V_0}{27}$$

$$V_1 = \frac{65V_0}{27}$$

From above volume we can calculate the final pressure.

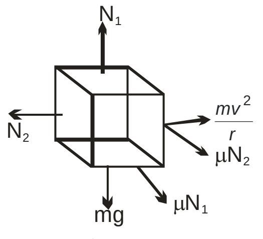
Final pressure $P = \frac{243}{32} P_0$ and

Final temperature $T = \frac{585}{32} T_0$

SECTION – C

11. **4**

Sol. F.B.D of block at any instant



$$\mu(N_1 + N_2) = -m\upsilon \frac{d\upsilon}{dx} \quad \Rightarrow \mu\left(\cancel{m} g + \frac{\cancel{m}\upsilon^2}{r}\right) = -\cancel{m}\upsilon \frac{d\upsilon}{dx} \quad \Rightarrow \mu\left(\frac{rg + \upsilon^2}{r}\right) = -\upsilon \frac{d\upsilon}{dx}$$

$$\int_0^{2\pi}\frac{\mu}{r}dx = \int_0^{2\pi} -\frac{vdv}{(rg+v^2)}dx \qquad \left(rg+v^2 = t,\ 2vdv = dt, vdv = \frac{dt}{2}\right)$$

$$\int \frac{\mu}{r}dx = -\int\frac{dt}{t\cdot 2} \Rightarrow \frac{\mu}{\cancel{r}}\times 2\pi\cancel{r} = -\frac{1}{2}\left[\ln\frac{rg}{rg+v_0^2}\right]$$

$$\mu.4\pi = \ln\left(\frac{rg+v_0^2}{rg}\right) \qquad \Rightarrow rg+v_0^2 = rge^{4\pi\mu} \qquad \Rightarrow v_0=\sqrt{rg(e^{4\pi\mu}-1)}$$

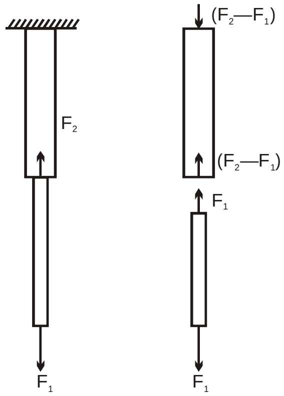
12. **2**

Sol. Deflection of C = 0 $\frac{F_1.L_2}{A_2Y} = \frac{(F_2-F_1)L_1}{A_1Y}$

$$\frac{F_1L_2}{A_2}+\frac{F_1L_1}{A_1}=\frac{F_2L_1}{A_1}$$

$$\frac{F_2}{F_1}=\left|\frac{\frac{L_2}{A_2}+\frac{L_1}{A_1}}{\frac{L_1}{A_1}}\right| = \left(1+\frac{L_2A_1}{A_2L_1}\right)$$

$$\frac{F_2}{F_1}=2$$



13. **2**

Sol. Consider refraction from oil surface.

$$\frac{\mu_2}{v}-\frac{\mu_1}{u}=\frac{\mu_2-\mu_1}{R}$$

$$\frac{7}{\cancel{4}v}+\frac{1}{\underset{6}{\cancel{24}}}=\frac{3}{\cancel{4}\times 6}$$

$$\frac{7}{v}=\frac{3}{6}-\frac{1}{6}$$

$$\frac{7}{v}=\frac{1}{3}$$

$v = 21$ cm

This will act as an object for oil water interface.

$$\frac{\mu_2}{v}-\frac{\mu_1}{u}=\frac{\mu_2-\mu_1}{R}$$

$$\frac{\mu_2}{v}-\frac{\mu_1}{u}=0$$

$$\frac{4}{3v}-\frac{7}{4\times 21}=0$$

$$\frac{4}{\cancel{3}v}-\frac{\cancel{7}}{4\times\underset{3}{\cancel{21}}}=0 \qquad \Rightarrow v=16$$

$\therefore\ x = 18-16 = 2$

14. **5**

Sol. $\frac{1}{Z_{eq}}=\frac{1}{Z_1}+\frac{1}{Z_2}+\frac{1}{Z_3}$ (for parallel circuit)

$$=\frac{1}{4+2i}+\frac{1}{3-4i}+\frac{1}{8+6i}$$

Solving this we will get $Z_{eq.}=\frac{5}{2}+0i$

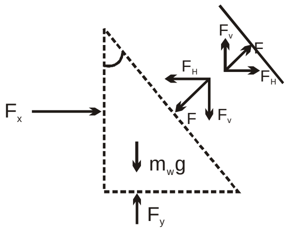
Now, over all impedance of the circuit is $Z=\frac{5}{2}+\frac{5}{2}+5i=5+5i$

Therefore, $|Z|=5\sqrt{2}$

Current supplied by source $=\frac{25\sqrt{2}}{5\sqrt{2}}=5$ **Ans.**

15. **2**

Sol. F.B.D.



$$F_x = \rho g \frac{h}{2} \times h \times b$$

$$F_x = \rho g \frac{h^2}{2} b$$

$$F_y = \rho g h \times h \tan\theta . b$$

$$F_y = \rho g h^2 \tan\theta b$$

$F_H = F_x$ $\qquad$ $F_v = F_y - mg$ $\qquad$ $m_w g = \frac{1}{2} \times h \tan\theta . h \times b \times \rho g$

$F_H = \rho g \frac{h^2}{2} b$ $\qquad$ $= \frac{1}{2} \rho g h^2 \tan\theta b$ $\qquad$ $m_w g = \frac{1}{2} \rho g h^2 \tan\theta u$

Friction force on wedge $= \mu \times F_H = \mu . \rho g \frac{h^2}{2} b$

Max. height of water which can be filled, is the height when wedge starts moving up.

$$F_v = mg + \mu F_H \Rightarrow F_v = mg + \mu \rho g \frac{h^2}{2} b \Rightarrow \frac{1}{\cancel{2}} \rho g^2 \tan\theta b = 2mg + \mu \rho g \frac{h^2}{\cancel{\alpha}} b$$

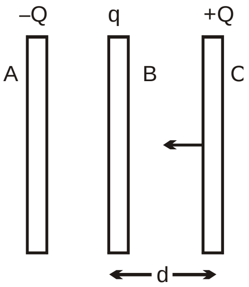
$$\Rightarrow h^2 (\rho g \tan\theta - \mu \rho g b) = 2mg$$

$$h^2 = \frac{2mg}{\rho g \tan\theta b - \mu \rho g b} \quad \Rightarrow h = \sqrt{\frac{2m \cancel{g}}{\cancel{g} \rho b (\tan\theta - \mu)}} \quad \Rightarrow h = \sqrt{\frac{2m}{g b (\tan\theta - \mu)}}$$

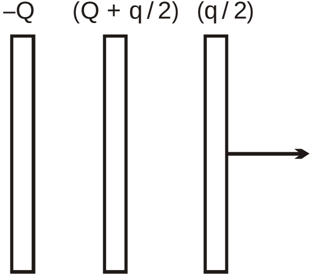
16. 1

Sol. At any instant force on plate $C = \frac{(Q-q)Q}{2S\varepsilon_0}$

word done = $\frac{(Q-q)Qd}{2S\varepsilon_0}$



After the collision charge on plates A, B, C become



Work done $= \frac{(\cancel{Q} + {}^{q}\!/_{2} - \cancel{Q}).{}^{q}\!/_{2}\, d}{2S\varepsilon_0} = \frac{\left[\frac{q}{2}\right]^2 d}{2S\varepsilon_0}$

Total work

$$\text{done} = \frac{(Q-q)Qd}{2S\varepsilon_0} + \frac{\left(\frac{q}{2}\right)^2 d}{2S\varepsilon_0} = \frac{d}{2S\varepsilon_0}\left[Q^2 - qQ + \left(\frac{q}{2}\right)^2\right]$$

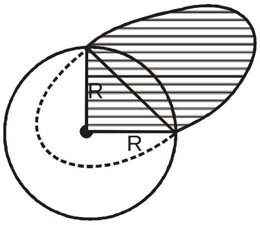
$$= \frac{d}{2S\varepsilon_0}\left[\left(Q - \frac{q}{2}\right)^2\right]$$

Total work done = charge in K.E.

$$\frac{1}{\cancel{2}} m v^2 = \frac{d}{\cancel{2}S\varepsilon_0}\left(Q - {}^{q}\!/_{2}\right)^2 \qquad \Rightarrow v = \sqrt{\frac{d}{ms\varepsilon_0}}\left(Q - \frac{q}{2}\right) \Rightarrow v = \sqrt{\frac{d}{ms\varepsilon_0}} . \left[\frac{3}{2} - \frac{1}{2}\right] = 1$$

17. **2**

Sol. Figure shows the path followed by the rocket



Semi major axis = R Semi minor axis $=\frac{R}{\sqrt{2}}$

Time of flight $\propto$ Area swept

$$\frac{t}{T}=\frac{\left(\frac{\pi R}{2}.\frac{R}{\sqrt{2}}+\frac{R^2}{2}\right)}{\frac{\pi R^2}{\sqrt{2}}} \qquad t=T.\frac{\left(\frac{\pi R^2}{2\sqrt{2}}+\frac{R^2}{2}\right)}{\frac{\pi R^2}{\sqrt{2}}}$$

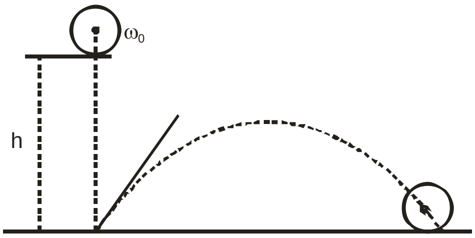
$$\left[T=\frac{2\pi}{\sqrt{GM}}a^{3/2}.\text{ Here } a=R \qquad T=\frac{2\pi}{\sqrt{GM}}R^{3/2}\right]$$

$$t=\frac{\cancel{2\pi}}{\sqrt{GM}}R^{3/2}\frac{\left[\frac{\pi}{\cancel{2}\sqrt{2}}+\frac{1}{\cancel{2}}\right]}{\frac{\cancel{\pi}}{\sqrt{2}}} \qquad t=\frac{R^{3/2}}{R\sqrt{\frac{GM}{R^2}}}\left[\pi+\sqrt{2}\right]$$

$$t=\sqrt{\frac{R}{g}}\left[\pi+\sqrt{2}\right]$$

18. **4**

Sol. v_{cm} just before striking $=\sqrt{2gh}$



v_{cm} just after striking $=e\sqrt{2gh}$

Impulse: $\int N\,dt=m(1+e)\sqrt{2gh}$

Frictional impulse in horizontal direction

$\mu\int N\,dt=\mu.m(1+e)\sqrt{2gh}\ \Rightarrow\ \cancel{m}v_x=\mu\,\cancel{m}(1+e)\sqrt{2gh}$

$\Rightarrow v_x=\mu(1+e)\sqrt{2gh}$

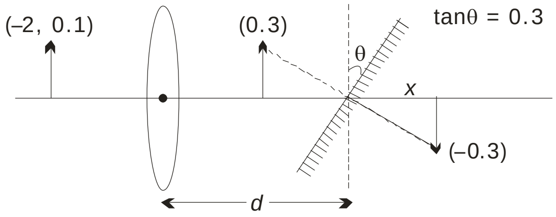
Time of flight $=\frac{2u_y}{g}=2\times e\frac{\sqrt{2gh}}{g}$

Range $=\frac{\mu(1+e)\sqrt{2gh}\times\sqrt{2gh}.e}{g}$

$=2\mu.(1+e).e.2h=4\mu(1+e)eh$

19. **5**

Sol. $\frac{1}{u}-\frac{1}{v}=\frac{1}{f}\qquad\Rightarrow\frac{1}{u}+\frac{1}{2}=\frac{\cancel{10}}{\cancel{15}}\frac{2}{3}$



$\Rightarrow\frac{1}{u}=\frac{2}{3}-\frac{1}{2}=\frac{1}{6}\Rightarrow u=6m$

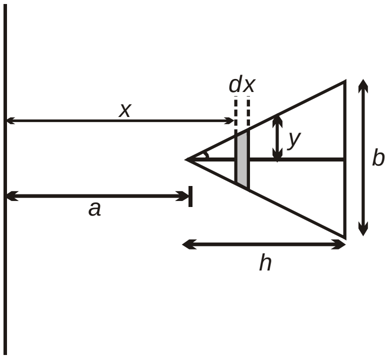
$m=\frac{u}{v}=-3$

$\tan\theta=\frac{0.3}{x}\qquad\Rightarrow 0.3=\frac{0.3}{x}\qquad\Rightarrow x=1$

$x=6-d\qquad\Rightarrow 6-d=1$

Ans.: $d=5m$

20. **4**



Sol. $d\phi = \left(\frac{\mu_0 i}{2\pi x}\right)\cdot\left(\frac{b}{h}(x-a)dx\right)$

$$\int d\phi = \int_a^{a+h} \frac{\mu_{0i}}{2\pi}\left[\frac{b}{h}\left[1-\frac{a}{x}\right]\right] dx$$

$$\phi = \frac{\mu_0 i}{2\pi}\frac{b}{h}[h - a\ln x]_a^{a+h}$$

$$\phi = \frac{\mu_0 i}{2\pi}\frac{b}{h}\left[h - a\ln\left(\frac{a+n}{a}\right)\right] \qquad \phi = \frac{\mu_0 i}{2a}\frac{b}{h}\left[h - a\ln 2\right]$$

$$M = \frac{\phi}{i} \Rightarrow M = \frac{\mu_0}{2\pi}\frac{b}{h}\left[h - a\ln 2\right] = \frac{4\cancel{\pi}\times 10^{-7}}{\cancel{2}\cancel{\pi}}\times\cancel{2}\times\left[1-\ln 2\right]$$

Ans.: $= 4\times 10^{-8}[1-\ln 2]$

SECTION – D

21. **00000.15 m**

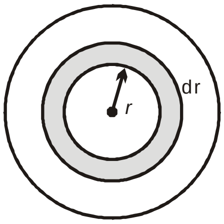
Sol. $\frac{1}{2}mv^2 = \left(\frac{hc}{\lambda}-\phi\right) \Rightarrow v = \sqrt{\frac{2}{m}\left(\frac{hc}{\lambda}-\phi\right)}$

$$r = \frac{mv}{qB} \Rightarrow r = \frac{m\sqrt{\frac{2}{m}\left(\frac{hc}{\lambda}-\phi\right)}}{q\,B}$$

Ans.: r = 0.15 m.

22. **00126.00 °C**

Sol. Heat generated with in element = heat conduct by the element.
Let heat generated per unit volume per unit time be, x



$$x\times\cancel{\pi}r^{\cancel{2}}.\cancel{l} = -k.2\cancel{\pi}\cancel{r}\cancel{l}\frac{dT}{dr} \qquad \int_0^R x\,r\,dr = -\int_{T_C}^{T_S} 2kdT$$

$$x.\frac{R^2}{2} = -2k\left[T_S - T_C\right] \Rightarrow x\frac{R^2}{2} = 2K\left[T_C - T_S\right]$$

$$T_C - T_S = \frac{x}{2k}\frac{R^2}{2}$$

$$\Rightarrow T_C = T_S + \frac{x}{2k}\frac{R^2}{2}$$

$$= T_S + \left(\frac{P}{\pi \cancel{R^2} l}\right)\times\frac{\cancel{R^2}}{2}\frac{1}{2k} = T_S + \frac{P}{4Alk}$$

$$= T_S + \frac{\cancel{2}\times 10^3}{\pi\times\cancel{4}\times 0.5\times 15} \qquad T_C = 105 + 21$$

(the 4 in the denominator cancelled to $\cancel{2}$ beneath it)

Ans.: $T_C = 126^0 C$

23. **00001.32 kg**

Sol. $2\cdot {}_1D^2 \longrightarrow {}_1T^3 + {}_1p^1 + \Delta E$

$\Delta m = [2\times 2.01458 - (3.01605 + 1.00728)]\text{amu}$ $\quad\Delta m = 0.00583\ \text{amu}$

$E = \Delta mc^2 = 8.71\times 10^{-13} J$

$8.71\times 10^{-13} J$ ____ 2 molecules

1 J ____ $\dfrac{2}{8.71\times 10^{-13}}$ molecules

$10^9 J$ ____ $\dfrac{2}{8.71\times 10^{-13}}\times 10^9$ molecules $= 2.2962\times 10^{21}$ molecules

No. of molecules is used in a day $= 2.2962\times 10^{21}$ × 86400 × 2 (efficiency 50%)

$= 396783.36\times 10^{21}$ molecules

Therefore mass used in a day $= 1.32$ kg **Ans.**

Chemistry PART – II

SECTION – A

24. **A**

Sol.

$$FeSO_4 + aq. \longrightarrow FeSO_4 + 110.52$$

$$FeSO_4 \cdot 7H_2O + aq. \longrightarrow FeSO_4 + 7H_2O - 6.62$$

$$- \qquad - \qquad - \qquad -$$

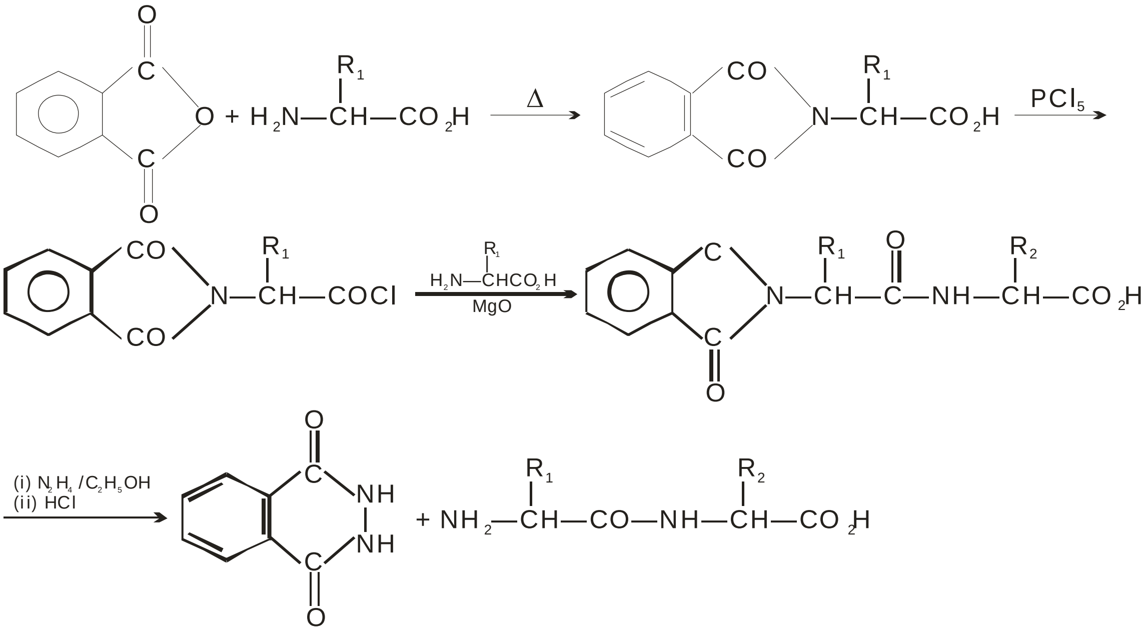
$$FeSO_4 + 7H_2O \longrightarrow FeSO_4 \cdot 7H_2O + 117.14$$

25. **B**

Sol. [Fact]

26. **A**

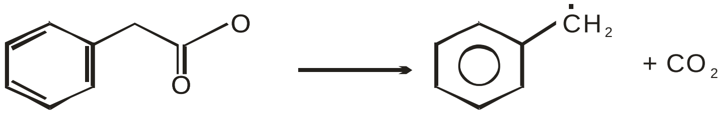
Sol.



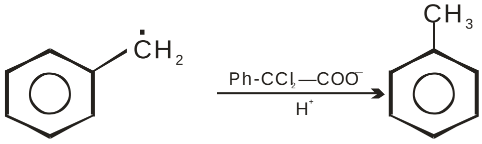
27. **BC**

Sol.

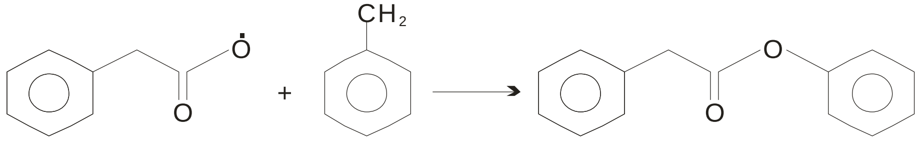
Step-1



Step-2



Step-3



28. **BC**

Sol. $E = \frac{hc}{\lambda} = 2.075\,eV$ $\quad$ $K.E. = (2.075 - 0.4) \times 1.6 \times 10^{-19}$ Joule

$\lambda = \frac{h}{\sqrt{2m}K.E.}$

29. **ACD**

Sol. Fact

30. **BD**

Sol. $AgNO_3 + NH_4Cl \longrightarrow \underset{(X)}{AgCl} + NH_4NO_3$

$AgNO_3 + NH_5 + NaOH \longrightarrow \underset{(Y)}{[Ag(NH_3)_2]^+} + NaNO_3 + H_2O$

31. **AD**

Sol. Fact $O^{2-} =$ weak field ligand

Fe^{2+} :octa $CFSE = -(0.4 + P_0)$ $\quad$ tetra CFSE = $-\left(\frac{3}{5} + P_0\right) = -(0.6 + P_0)$

Fe^{+3} : octa/tetra = 0 CFSE

32. **D**

Sol. Fact (experimental)

33. **B**

Sol. $E_{cell} = E^0_{cell} - \frac{0.059}{2}\log\frac{[Zn^{2+}]}{[H^+]^2}$ $\quad$ $0.701 = 0.76 - \frac{0.059}{2}\log\frac{(0.1)}{[H^+]^2}$

$[H^+] = 0.036$ M

Equivalud of H^+ = equivalued of NaOH = $\frac{w}{E}$

$\therefore\ w_{NaOH} = 0.036 \times 40 = 1.264$ gm

SECTION – C

34. **4**

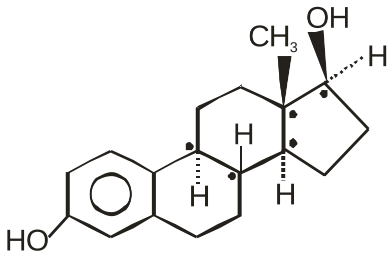
Sol. $(Na - NH_3),\ B_2, \overset{+}{C}O,\ KO_2 =$ para

35. **3**

Sol. $\gamma = \frac{37.2}{28.9} = 1.287 \cong 3$

36. **5**

Sol.

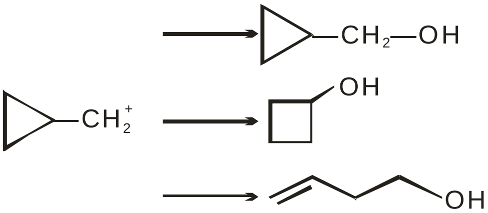


37. **2**

Sol. Fact

38. **3**

Sol.



39. **2**

Sol. Fact M_2 & M_3

40. **6**

Sol. $M_{64\%} = \frac{64\times1.225\times10}{98} = 8$ $\quad M_{20\%} = \frac{20\times0.98\times10}{98} = 2$ $M_1 \longrightarrow M_2 = 6$

41. **7**

Sol. $C_xH_y \longrightarrow x = 3,\ y = 4$ Apply POAC $\quad x + y = 7$

$$\begin{array}{lllll} CH_4 & + & 2O_2 \longrightarrow & CO_2 & + \; 2H_2O \\ 20-x & & 2(20-x) & 20-x & \end{array}$$

$$\begin{array}{lllllll} C_xH_{2y-2} & + & O_2 & \longrightarrow & nCO_2 & + & (n-1)H_2O \\ \left(\frac{3x-1}{2}\right) & & x\left(\frac{3x-1}{2}\right) & & & & \end{array}$$

Total volume of CO_2 $\longrightarrow$ $20 - x + nx = 40$ $\quad x(n-1) = 20 \longrightarrow (i)$

Total volume of O_2 used $\longrightarrow$ 100 - 40 = 60 ml

$$2(20-x) + x\frac{(3x-1)}{2} = 60 \longrightarrow (ii)$$

solve equ. (i) & (ii) find the value of *x*. $\quad x = n \qquad y = 2n-2$

42. **6**

Sol. b, d, f, h, i, j $\longrightarrow$ True

43. **5**

Sol. $K_{sp} = \left[Zn^{+2}\right]\left[S^{-2}\right]$ $S^{2-} = 10^{-15}$ $K_{H_{2s}} = \frac{[H^+]^2[S^{2-}]}{[H_2S]}$

$10^{-2} = \frac{[H^+][10^{-15}]}{10^{-4}}$ $H^+ = 10^{-5}$ $pH = 5$

SECTION – D

44. **00100.00 KJ**

Sol. $E_a = \frac{K_1Ea_1 + K_2Ea_2}{K_1 + K_2}$

45. **00000.66**

Sol. $\pi_1 = \pi_2$ $iC_1 RT = C_2RT$ $i = 7/3$

$MgCl_2 \longrightarrow Mg^{2+} + 2Cl^-$ $i = 1 + 2\alpha$ $\alpha = 0.66$

46. **00009.87**

Sol. $I.P = \frac{10.79 + 8.95}{2} = 9.87$

Mathematics PART – III

SECTION – A

47. **B**

Sol. $2\cos^4 x - 2\cos^3 x + \cos^2 x + \cos x - 1 = 0$

$\cos x = t$

$2t^4 - 2t^3 + t^2 + t - 1 = 0$

$\Rightarrow \quad 2t^4 - 2t^3 + 2t^2 - t^2 + t - 1 = 0$

$\Rightarrow \quad 2t^2(t^2 - t + 1) - 1(t^2 - t + 1) = 0$

$\Rightarrow \quad (\cos^2 x - \cos x + 1)(2\cos^2 x - 1) = 0$

$\Rightarrow \quad \cos^2 x = 1/2 \quad \Rightarrow \quad \sin^2 x = 1/2$

48. **A**

Sol. $$\int \frac{x^2 \sin 2x - \sin 2x(x \tan x - 1)}{(x^2+1)^2}\, dx$$

$$= \int \frac{(x^2+1)\sin 2x - 2x\sin^2 x}{(x^2+1)^2}\, dx$$

$$= \int \frac{d}{dx}\left(\frac{\sin^2 x}{x^2+1}\right) dx$$

$$= \frac{\sin^2 x}{x^2+1}$$

49. **B**

Sol. Put y = ux and solve.

50. **BC**

Sol. Hyperbola if a = 1, parabola if $a = 2(1+\sqrt{2})$

51. **CD**

Sol. $a_n = a_{n-1} + 2a_{n-2}; n > 2$, $a_n = 2^{n-1}$

52. **AD**

53. **ACD**

Sol. $Z\bar{Z} + 2\sqrt{2}\,|Z-1| - 4 = 0 \qquad Z\bar{Z} - \sqrt{2}\bar{Z}i + \sqrt{2}iZ = 0$

$\Rightarrow \quad |Z+1| + |Z-1| = 2\sqrt{2} \qquad \Rightarrow \qquad |Z - \sqrt{2}i| = \sqrt{2}$

$\Rightarrow \quad \dfrac{x^2}{a^2} + \dfrac{y^2}{b^2} = 1 \qquad\qquad x^2 + (y - \sqrt{2})^2 = 2$ ....(2)

$\Rightarrow \quad a = \sqrt{2}$ & $b = 1$ ....(1)

(2) implies $x = \sqrt{2}\cos\theta, \quad y = \sqrt{2}(1+\sin\theta)$

then maximum & minimum value of (1)

$\Rightarrow \quad \dfrac{x^2}{a^2} + \dfrac{y^2}{b^2} - 1$

$= \frac{(\sqrt{2}\cos\theta)^2}{(\sqrt{2})^2} + \left(\frac{\sqrt{2}(1+\sin\theta)}{1}\right)^2 - 1$

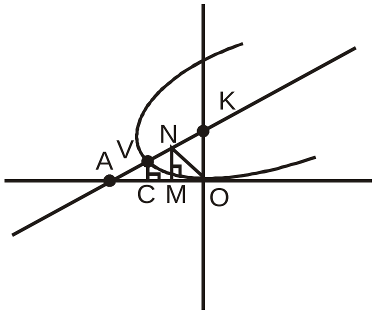
$= \sin^2\theta + 4\sin\theta + 2$

$= (\sin\theta + 2)^2 - 2$

$m_1 = 7$ $m_2 = -1$

54. **ABD**

Sol. $N(-2, 2)$



$\angle NOM = 45^0$

$ON = AN = 2\sqrt{2}$

$OA = 4$

$NK = 2\sqrt{2} = 2a$ (semi L.R.)

$\Rightarrow$ $a = \sqrt{2}$

eqn. of NK : $y = x + 4$

$\therefore$ $A:(-4, 0)$

$V:(-3,1)$ $\{\because (AV = VN)$

55. **A**

Sol. $1 + ie^{i\theta} + \frac{\left(ie^{i\theta}\right)^2}{2!} + ... = e^{ie^{i\theta}} = e^{-\sin\theta}(\cos(\cos\theta) +$
$i\sin(\cos\theta))$

integrate real parts.

56. **B**

Sol. Do as 55.

SECTION – C

57. **2**

Sol. $\frac{x}{\cos 45} = \frac{y}{\sin 45} = r$ (1)

$y = x^2 - x + 1/x$ $\Rightarrow$ $xy = x^3 - x^2 + 1$

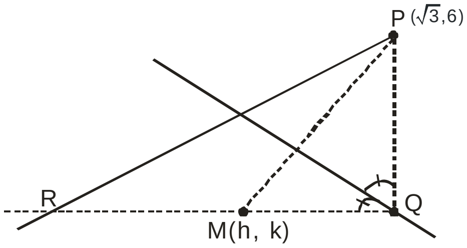
use (1) to find cubic in r.

58. **1**

Sol. Sketch the graph

59. **2**

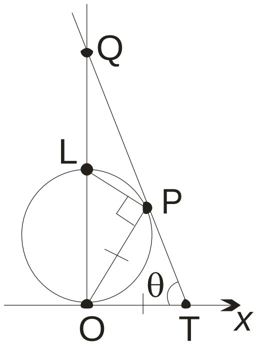
Sol.



M(h, k) is fixed.

60. **1**

61. **8**



Sol. ΔOPQ

$$\frac{OQ}{\sin(\pi-\theta)}=\frac{OP}{\sin\left(\frac{\pi}{2}-\theta\right)}$$

$OQ = OP\tan\theta$ (1)

$\frac{OP}{4}=\sin 2\theta$

$\Rightarrow$ $OP = 4\sin 2\theta$ (2)

From (1), (2)

$OQ = 8\sin^2\theta$;

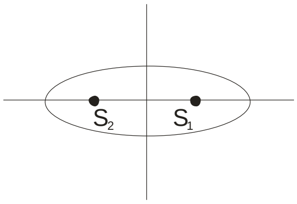
$\lim\limits_{\theta\to\pi/2} OQ = 8$

62. **9**

63. **1**

Sol. $(2x-y-5)+\lambda(x-2y-1)=0$ passes through S_1

& $(3x-y+4)+\mu(x-2y+3)=0$ passes through S_2



64. **5**

65. **0**

Sol. $F'(x)=f(x)\Rightarrow c\,f(x)\ge f'(x)$

$\Rightarrow$ $e^{cx}\frac{d}{dx}\left(e^{-cx}f(x)\right)\le 0$ $\Rightarrow$ $e^{-cx}f(x)$

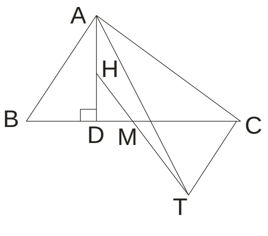
is decreasing in.

$\Rightarrow$ $f(x)$ is decreasing function but $f(0)=0$ & it is non-negative given.

$\Rightarrow$ $f(x)=0$

66. **4**

Sol.



SECTION – D

67. **00002.63**

Sol. $\lambda=\left(\frac{1}{19}-\frac{1}{20}\right)$

$\therefore$ $1000\lambda=\frac{1000}{19\times 20}=2.631$

68. **00000.50**

Sol. $\int \frac{(5x^4 + 3x^2)dx}{x^{10} + 2x^8 + x^6 + 2x^5 + 2x^3 + 2}$

$= \int \frac{5x^4 + 3x^2}{(x^5 + x^3 + 1)^2 + 1} dx$

69. **00121.17**

Sol. $x^3 dy = (3x^2 y + x^2 + x^7)dx$

$\Rightarrow \quad (x^3 dy - 3x^2 y\, dx) \quad = (x^2 + x^7)dx$

$\Rightarrow \quad \frac{x^3 dy - 3x^2 y}{(x^3)^2} \quad = (x + x^{-4})dx$

$\Rightarrow \quad d\left(\frac{y}{x^3}\right) \quad = (x + x^{-4})dx$

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

FULL TEST – XI

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 231**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-C & Section-D**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01 – 03, 24 – 26, 47 – 49)*** *contains 9 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (04 – 08, 27 – 31, 50 – 54) *contains 15 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (09 – 10, 32 – 33, 55 – 56) *contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer. There is no negative marking.*

2. ***Section-C (11 – 20, 34 – 43, 57 – 66)*** *contains 30 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

3. ***Section-D (21 – 23, 44 – 46, 67 – 69)*** *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	g = 10 m/s^2
Planck constant	h = 6.6 $\times 10^{-34}$ J-s
Charge of electron	e = 1.6 $\times$ 10^{-19} C
Mass of electron	m_e = 9.1 $\times$ 10^{-31} kg
Permittivity of free space	ε_0 = 8.85 $\times$ 10^{-12} C^2/N-m^2
Density of water	ρ_{water} = 10^3 kg/m^3
Atmospheric pressure	P_a = 10^5 N/m^2
Gas constant	R = 8.314 J K^{-1} mol^{-1}

CHEMISTRY

Gas Constant	R	=	8.314 J K^{-1} mol^{-1}
		=	0.0821 Lit atm K^{-1} mol^{-1}
		=	1.987 $\approx$ 2 Cal K^{-1} mol^{-1}
Avogadro's Number	N_a	=	6.023 $\times$ 10^{23}
Planck's constant	h	=	6.625 $\times$ 10^{-34} J·s
		=	6.625 $\times$ 10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66 $\times$ 10^{-27} kg
1 eV		=	1.6 $\times$ 10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

PART – I (Physics), PART – II (Chemistry), PART – III (Mathematics):
(SECTION – D)

For questions **21 to 23, 44 to 46, 67 to 69.**
Numerical answer type questions with answer XXXXX. XX

If answer is 348.4 / 251.37 / 213

Correct Method :

0	0	3	4	8	.	4	0
0	0	2	5	1	.	3	7
0	0	2	1	3	.	0	0

Wrong Method :

	3	4	8		.	4	
3	4	8			.		4
		3	4	8	.		4
	3		4	8	.	4	
	2		5	1	.	3	7
		2	1	3	.		
		2	1	3	.	0	
		2	1	3	.		0
		3	4	8	.	4	0
		2	5	1	.	3	7
		2	1	3	.	0	0

Physics PART – I

SECTION – A

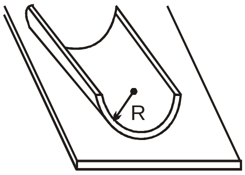
Straight Objective Type

This section contains **3 multiple choice questions**. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** is correct.

1. If a loop of chain is spun at high speed, it will roll like a loop without collapsing. Consider a chain of linear mass density 'μ' that is rolling without slipping at a high speed v_0. The chain rolls over a small bump and a transverse wave pulse is generated in the chain. How far around the loop (in radians) will a transverse wave pulse travel in the time the loop rolls through one complete revolution.

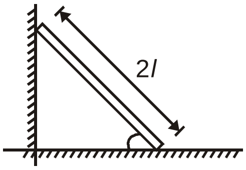
(A) π
(B) 2π
(C) 3π
(D) 4π

2. The semicircular cylindrical shell of radius R with small but uniform wall thickness is set into small oscillation on the horizontal surface. If no slipping occurs, then the expression for the period T of each complete oscillation is:



(A) $T = 2\pi\sqrt{\frac{(\pi-2)R}{g}}$
(B) $T = 2\pi\sqrt{\frac{(\pi-4)R}{g}}$
(C) $T = 2\pi\sqrt{\frac{2R}{g}}$
(D) $T = 2\pi\sqrt{\frac{(\pi-6)R}{g}}$

3. A plank of length 2L leans against a vertical wall. It starts to slip downward without friction. The top of the plank loses contact with the wall when it is at a height of



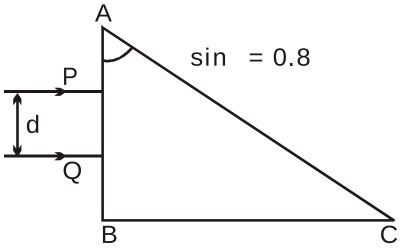
(A) $\frac{3}{4}^{\text{th}}$ of its initial height
(B) half of its initial height
(C) $\frac{1}{4}^{\text{th}}$ of its initial height
(D) $\frac{2}{3}^{\text{rd}}$ of its initial height

Space for rough work

Multiple Correct Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

4. Two parallel beams of light P and Q (separation d) containing radiation of wavelength 4000 Å and 5000 Å are incident normally on a prism as shown in figure. The refractive index of the prism as a function of wavelength is given by $\mu(\lambda) = 1.20 + \frac{b}{\lambda^2}$ where λ (in Å) and b is a positive constant. The value of b is such that the condition for total internal reflection of the face AC is satisfied for one wavelength and not for the other then $[\sin 80.3 = 0.9856]$

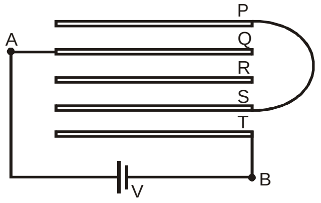


(A) The value of b = 8 × 10^{-15} m^2.
(B) Deviation of beam transmitted through face AC is 27.2^0.
(C) The value of $b = 4 \times 10^{-15} m^2$
(D) Deviation of beam transmitted through face AC is 38.7^0

5. In a photoelectric effect set up, a point source of light of power 3.2 × 10^{-3} W emits monoenergetic photons of energy 5.0 eV. The source is located at a distance of 0.8m from the centre of a stationary metallic sphere of work function 3.0 eV and of radius 8 × 10^{-3}m. The efficiency of photo electrons emission is one for every 10^6 incident photons. Assume sphere is isolated and initially neutral and that photo-electrons are instantly swept away after emission then.

(A) No. of electrons emitted per second is 10^6
(B) Time after which electron emission stops is 111.11 sec
(C) No. of electrons emitted per second is 10^5.
(D) Time after which electron emission stops is 11.11 sec

6. Five plates are arranged as shown in figure and connected across a battery of emf V. The separation between each plate is 'd' and the surface area of each plates is 'A'.



(A) Equivalent capacity between A and B is $\frac{\varepsilon_0 A}{5d}$
(B) Equivalent capacity between A and B is $\frac{3\varepsilon_0 A}{5d}$
(C) Charge on plates P is $\frac{\varepsilon_0 AV}{5d}$
(D) Charge on plate R is $\frac{3\varepsilon_0 AV}{5d}$

Space for rough work

7. Which of the following statement(s) is/are correct:-
   (A) If the electric field due to a point charge varies as $r^{-2.5}$ instead of r^{-2}, then Gauss law will still be valid.
   (B) The Gauss law can be used to calculate the field distribution around an electric dipole
   (C) If the field between the two point charges is zero somewhere, then the sign of charge is same.
   (D) The work done by external force in moving a unit positive charge from point A at potential V_A to point B at potential V_B is $V_B - V_A$.

8. An external magnetic field is decreased to zero, due to which a current is induced in a small circular wire loop of radius 'r' and resistance 'R' placed in the field. This current will not become zero,
   (A) At the instant when external magnetic field stops changing (t = 0), the current in the loop as a function of time for t > 0 is given by $i = i_0\ e^{-2RT/\mu_0\pi r}$
   (B) At the instant B stops changing (t = 0) the current in the loop as a function of time t > 0 is given by $i = \frac{\mu_0 i_0 R}{2r}$
   (C) The time in which current in loop decreases to $10^{-3} I_0$ (from t = 0) for R = 100Ω and r = 5 cm is given by $\frac{3\pi^2 \ln 10}{10^{10}}$ sec.
   (D) The time in which current in loop decreases to $10^{-3} I_0$ (from t = 0) for $R = 100\Omega$ and r = 5 cm is given by $\frac{3\pi^2}{10^6}$ sec.

Space for rough work

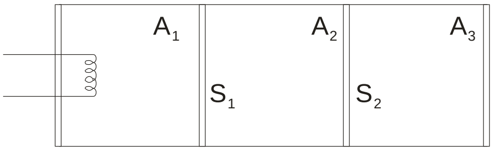
Comprehension Type

This section contains **1 group of questions.** The group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

---

Paragraph for Question Nos. 9 and 10

Consider a closed cylinder whose walls are adiabatic. The cylinder lies in a horizontal position and is divided into three parts A_1, A_2, A_3 by mean of a partition S_1 and S_2 which can move along the length of the cylinder without friction. Piston S_1 is adiabatic while piston S_2 is conducting. Initially each part contains one mole of Helium gas at temperature T_0, pressure P_0, volume v_0 (see figure). Now heat is slowly supplied to the gas in part A_1 till the temperature in part A_3 becomes $T_3 = \frac{9T_0}{4}$.



9. The final equilibrium temperature of A_1 is:

(A) $\frac{9T_0}{4}$ (B) $\frac{585}{24}T_0$

(C) $\frac{585T_0}{32}$ (D) $\frac{585T_0}{36}$

10. The final volume of A_1 is:

(A) $\frac{8V_0}{27}$ (B) $\frac{65V_0}{18}$

(C) $\frac{65V_0}{27}$ (D) $\frac{65V_0}{9}$

Space for rough work

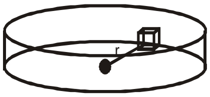
SECTION – C

(One Integer Value Correct Type)

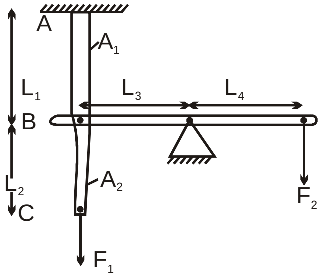
This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

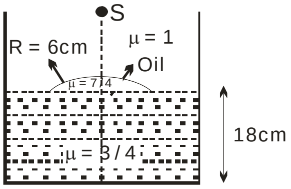
11. A block of mass 'm' slides on a circular track of radius 'r' whose wall and floor both have coefficient of kinetic friction ' μ ' with the block. The size of block is small compared to the radius of the track. The floor lies in horizontal plane and the wall is vertical. The block is in contact with both wall and the floor. The block has initial speed υ_0. For the block to circle the track exactly once before coming to rest, v_0 is given by $\sqrt{gr(e^{K\pi\mu}-1)}$. Find the value of K.



12. The assembly shown in figure is loaded by forces F1 and F2. Assuming that both parts of the vertical bar ABC are made of same material, if net vertical displacement of point C is zero then ratio of $\frac{F_2}{F_1}$ is:
Given: $\left[A_1 = 2A_2,\ L_3 = L_4,\ L_1 = 2L_2\right]$.

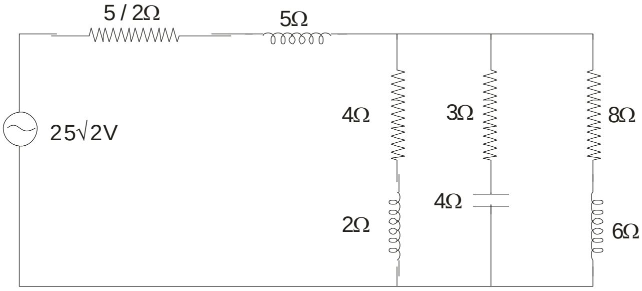


13. Water (with refractive index $\mu = \frac{4}{3}$) in a tank is 18 m deep. Oil of refractive index $\frac{7}{4}$ lies on water making a convex surface of radius of curvature R = 6 cm as shown. Consider oil to act as a thin lens. An object is placed 24 cm above water surface. The location of its image is at *x* cm above the bottom of the tank. Then find value of *x*.



Space for rough work

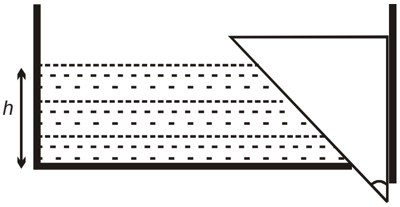
14. Consider a network shown in figure. The current supplied by the AC voltage source is n amperes. What is the value of n.



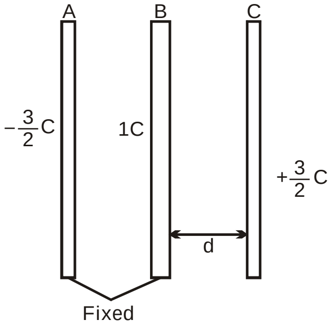
15. A slit is cut along the right bottom edge of a rectangular tank. The slit is closed by a wooden wedge of mass m and apex angle θ as shown in figure. The vertical plane surface of the wedge is in contact with the right vertical wall of the tank. Coefficient of static friction between these surfaces in contact is μ. If the maximum height upto which the water can be filled in the tank without any leakage is:

Given: $\sqrt{\frac{\mathrm{Km}}{\delta\,\mathrm{b}\tan\theta-\mu}}$. Find the value of K.

where → $\delta =$ density of water, b = width of tank.



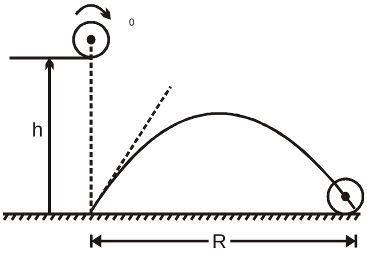
16. Two identical conducting plates A and B with charges $-\mathrm{Q}\left(-\frac{3}{2}\mathrm{C}\right)$ and $+\mathrm{q}(1\mathrm{C})$ respectively are located parallel to each other at a small distance. Another identical plate C with mass m and charge +Q$\left(\frac{3}{2}C\right)$ is situated parallel to the original plates at a distance d from plate B. (see figure). Area of each plates is S. The plate C is released and can move freely, collides elastically with plate B. [Neglect gravity and boundary effects]. Assume that the charge has enough time to redistribute. The velocity v of plate C after the collision at a distance d from the plate B is $\mathrm{K}\sqrt{\frac{\mathrm{d}}{\mathrm{m}\varepsilon_0\mathrm{S}}}$. Find value of K.



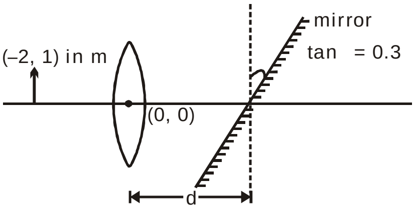
Space for rough work

17. A rocket is launched from a pole of the Earth with velocity V_0, where V_0 is the orbital velocity of rotation near the surface of the Earth, in such a way that it lands at the equator. The rocket's time of flight is T = $\left(\pi + \sqrt{K}\right)\sqrt{\frac{R}{g}}$. Where R → Radius of earth, g → acc. due to gravity at the surface.
Find value of K.

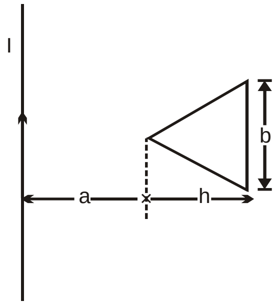
18. Figure shows a solid homogeneous ball of radius R. Before falling, the velocity of centre of mass is zero, but the ball is rotating with angular velocity ω_0 about horizontal axis passing through the centre. The ball is release, it collides with the floor (coefficient of restitution is 'e'). The coefficient of friction between the ball and the floor is μ_k due to which the ball moves in a projectile. Assume that there is slipping throughout the impact and neglect air resistance. The horizontal range of the ball is given by $R = N\mu_k(1+e)eh$. What is the value of N.



19. A convex lens of focal length 1.5 m is placed in a system of co-ordinate axis such that its optical centre is at origin and principle axis coincide with the *x*-axis. An object and a plane mirror are arranged on the principal axis as shown in figure. Find the value of d(in m) so that *y*-co-ordinate of image after refraction and reflection is 0.3 m.



20. A very long straight conductor and an isosceles triangular conductor lie in a plane and are separated from each other as shown in figure. If a = 10 cm, b = 20 cm and h = 10 cm, the coefficient of mutual inductance is given by $N \times 10^{-8}[1 - \ln 2]H.$ Find value of N.



Space for rough work

SECTION – D

(Numerical Answer Type)

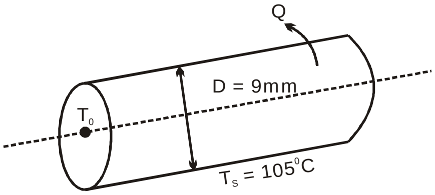
This section contains **3 questions**. Each question, when worked out will result in **numerical answer type** (XXXXX.XX)

---

21. Radiation of wavelength 180 nm ejects photoelectrons from a plate whose work function is 2.0 eV. If a magnetic field of flux density 5.0 × 10^{-5}T is applied parallel to the plate, what would be the radius of path in metres followed by electrons ejected normally from the plate with maximum energy?

$(e = -1.6\times10^{-19}\,C,\ m_e = 9.1\times10^{-31}\,kg, h = 6.6\times10^{-34}\,Js,\ c = 3\times10^{8}\,m/s)$

22. A 2kW resistance heater wire whose thermal conductivity is K = 15 w/m.k. has a diameter of D = 4 mm and a length of L = 0.5 m, and is used to boil water. (see fig). If the outer surface temperature of the resistance wire is T_s = 105 ^{0}C, determine the temperature in ^{0}C at the centre of the wire. [Assume radial heat flow]



23. Consider a following nuclear reaction

$${}^{2}_{1}D + {}^{2}_{1}D \longrightarrow {}^{3}_{1}T + {}^{1}_{1}P + \Delta E$$

Given $m\left({}^{2}_{1}D\right) = 2.01458\,amu,\ m\left({}^{3}_{1}D\right) = 3.01605\,amu,\ m\left({}^{1}_{1}D\right) = 1.00728\,amu$.

Calculate the mass in Kg of deuterium $\left({}^{2}_{1}D\right)$ required per day for a power output of 10^9W.

Assume that the efficiency of powers to be 50%.

Space for rough work

Chemistry

PART – II

SECTION – A

Straight Objective Type

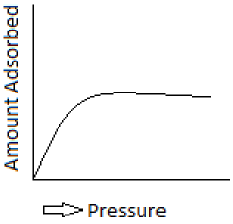
This section contains **3 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

24. 200 gm of anhydrous $FeSO_4$, when dissolved in excess of water produced 84 KJ/mole of heat. Same amount $FeSO_4.7H_2O$, on dissolving in large excess of water absorbs 9.20 KJ/mole. Heat of Hydrogenation of $FeSO_4$ is approx.

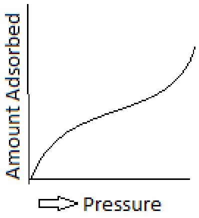
(A) 117 KJ
(B) 104 KJ
(C) 120 KJ
(D) 123.76 KJ

25. Which physical adsorption isotherm graph represents the pressure at which formation of monomolecular layer is complete and that of the multi layer is being started.

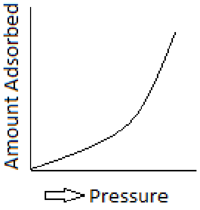
(A)



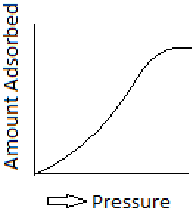
(B)



(C)

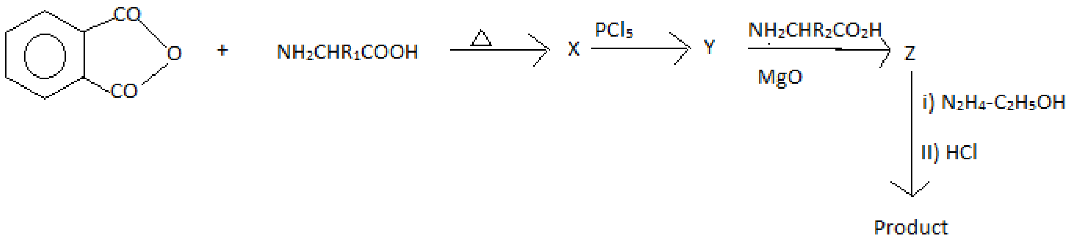


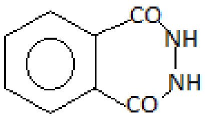
(D)

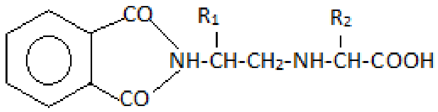


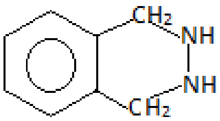
Space for rough work

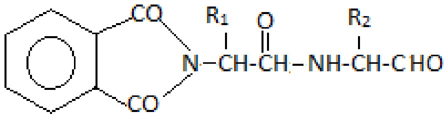
26. Final product for the given reaction below is


CO
O
CO
+
NH₂CHR₁COOH
△
X
PCl₅
Y
NH₂CHR₂CO₂H
MgO
Z
i) N₂H₄-C₂H₅OH
II) HCl
Product

(A)


(B)

CO
R₁
R₂
NH-CH-CH₂-NH-CH-COOH
CO

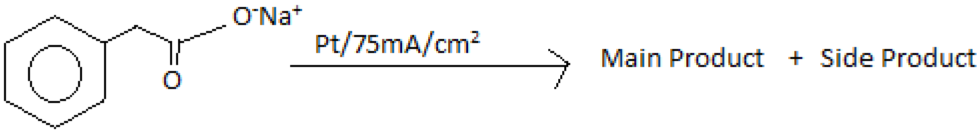
(C)

CH₂
NH
NH
CH₂

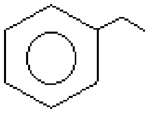
(D)

CO
R₁
O
R₂
N−CH-CH−NH-CH-CHO
CO

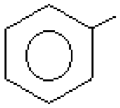
Multiple Correct Choice Type

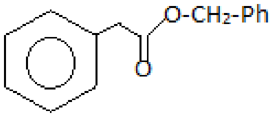
This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

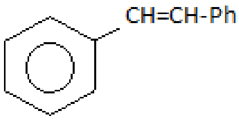
27. Side Product obtained during the electrolysis of given reactant are:


O⁻Na⁺
O
Pt/75mA/cm²
Main Product + Side Product

(A)


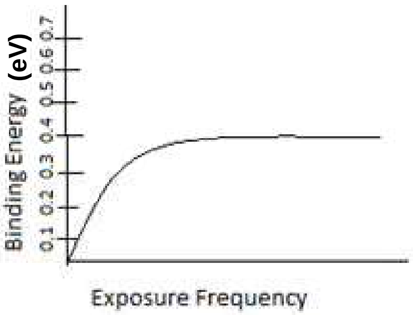
(B)


(C)


(D)


Space for rough work

28. An electron is ejected from Li^{2+} on exposing 600 nm, the stopping potential & Wavelength of ejected electron is:
(A) 1.675eV, 3.83×10^{-10}nm
(B) 1.675eV, 1.23 nm
(C) 2.68×10^{-19}J, 1.23 nm
(D) 6.4×10^{-20}J, 3.83×10^{-10} nm



29. Select the correct option:
(A) $PH_3 > NH_3 > I_3^- > MnO_4^-$ (% p- character)
(B) $PH_3 > NH_3 > I_3^- > MnO_4^-$ (Bond Angle)
(C) $PF_3 > PCl_3 > PBr_3 > PH_3 > PI_3$ (Dipole moment)
(D) $H_2O_2 > H_2O > CH_3COCH_3 > HF$ (Boiling Point)

30. An unknown inorganic salt give white ppt. X with compound Y which form buffer in excess weak base. When heated with weak base in alkaline medium give compound which is the main component to distinguish aldehyde & ketone. Compound X & Y are:
(A) $X = Fe(NO_3)_2$; $Y = Fe(OH)_3$
(B) $X = AgCl$; $Y = [Ag(NH_3)_2]^+$
(C) $X = AgBr$; $Y = [Ag(NH_3)_2]^+$
(D) $X = Ag_2O + NH_4Cl$ $Y = AgNO_3 + NH_3 + OH^-$

31. In Fe_3O_4, Fe^{2+} occupy octahedral site because of
(A) High Δ° CFSE
(B) Low Δ° CFSE
(C) High Δ_t CFSE
(D) Low Δ_t CFSE

Space for rough work

Comprehension Type

This section contains **1 group of questions.** The group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

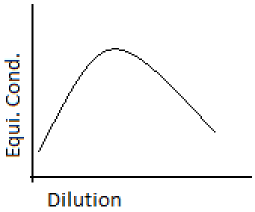
---

Paragraph for Question Nos. 32 and 33

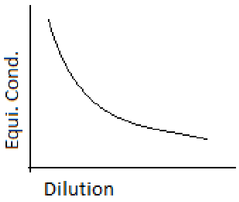
Equivalent point is measured by conductometric titration. We measure the volume of base used to neutralize the acid ions completely in the solution. During the titration, one of the ion is replaced by the other & invariably there two ions differ in the ionic conductivity with the result that conductivity of the solution varies during the course of titration.

32. Which of the following graph represents the correct variation of equivalent conductance with dilution for strong electrolyte?

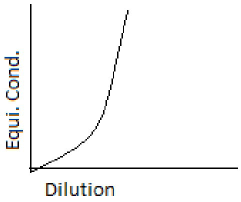
(A)



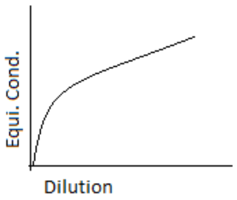
(B)



(C)



(D)



33. The minimum Weight of NaOH required to be added in R.H.S. to consume all the H^+ present in R.H.S. of the cell of e.m.f. 0.701V at 25˚C before it use
$Zn|Zn^{2+}(0.1M) || HCl (1 L) | H_2(1atm.)| Pt$
(A) 2.53 gm (B) 1.26 gm
(C) 0.632 gm (D) None

Space for rough work

SECTION – C

(One Integer Value Correct Type)

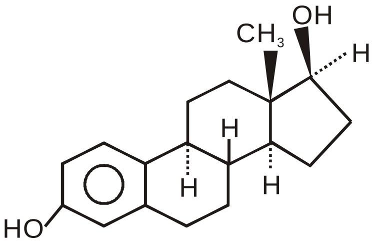
This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

34. Number of Species with paramagnetic nature
B_2, NO^+, CO^+, C_2^{2-}, KO_2, Na-NH_3 (dil.)

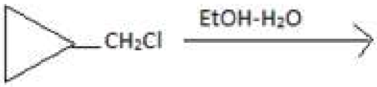
35. Molar mass of gas is 48. If the molar heat of gas at constant volume is 28.9. The atomicity of gas is.

36. No. of stereogenic centre in female sex hormone estradiol is



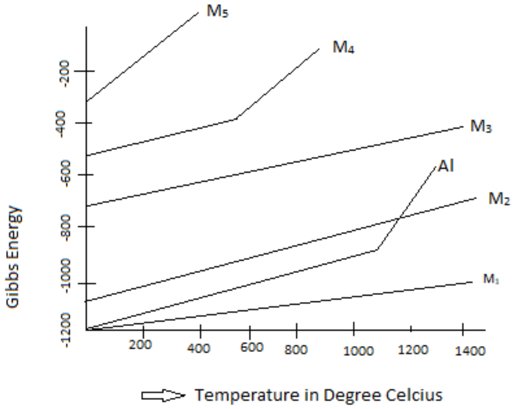
37. In cannizaro reaction, in the presence of 40% base, the order of reaction with respect to aldehyde is

38. Number of possible product in the given reaction below is



Space for rough work

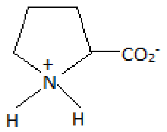
39. In the given Ellingham diagram, the number of species which can be reduced by aluminum above 800 ˚C.

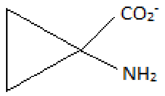


40. During the discharge of lead storage battery, the density of 64% H_2SO_4 (by weight) falls from 1.225 to 0.98 which is 20% (by weight). What is the change in Molarity of H_2SO_4

41. 100 ml of O_2 gas was mixed with 20 ml of a mixture of CH_4 and a gaseous compound of Ethyne & exploded in a eudiometric tube. On cooling at room temperature & pressure, 20 ml volume was observed. After treatment with caustic potash solution, a further contraction of 40 ml was observed. The value of X + Y for the alkyne C_xH_y is

42. Number of correct statements is:
a) Sucrose is a carbohydrate which gives silver mirror test.
b) Starch on complete hydrolysis gives β-D Glucose.
c) Protein gives purple color when treated with ninhydrin
d) Given compounds are α- amino acid





e) Nylon & Polythene are example of step-growth polymer.
f) $TiCl_4 + (CH_3)_3Al$ combination act as catalyst in manufacture of stereo-specific polypropylene.
g) Thermosetting polymer has strongest inter-particle force.
h) Amino glycosides are usually used as antibiotic
i) Parathion is an organic phosphorus compound
j) Butylated Hydroxyanisole (BHA) is used as antioxidant

Space for rough work

43. The minimum pH required to prevent the precipitation of ZnS in a solution that is 0.01M $ZnCl_2$ & saturated with 5 x 10^{-5} M H_2S. (Given: $K_{sp}(ZnS) = 10^{-17}$; $K(H_2S) = 10^{-21}$)

SECTION – D

(Numerical Answer Type)

This section contains **3 questions**. Each question, when worked out will result in **numerical answer type** (XXXXX.XX)

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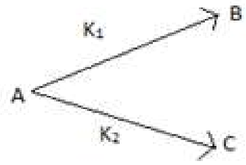
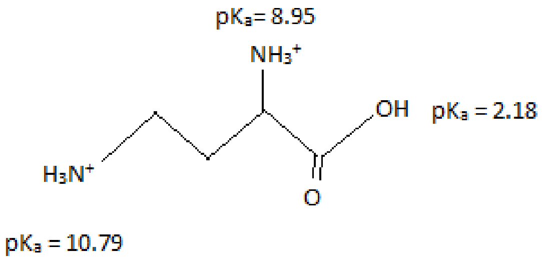
44. Consider the reaction
The rate constant for two parallel reaction were found to be 10^{-2} dm^3/mol/sec for B and 3 x 10^{-2} dm^3/mol/sec for C. If the corresponding energy of activation of the parallel reactions are 70 & 110 KJ respectively. What is the apparent net energy of activation in KJ of given reaction?



45. When dry air is passed through 0.03 M solution of $MgCl_2$ & then through 0.07 M glucose solution, there is no loss in mass of glucose solution. Hence the degree of dissociation of $MgCl_2$ is

46. What is the isoelectric point of the following amino acid?



Space for rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **3 multiple choice questions** numbered. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** is correct.

47. If $2\cos^4 x - 2\cos^3 x + \cos x = \sin^2 x$, then $\sin^2 x =$

(A) 1 (B) $\frac{1}{2}$

(C) $\frac{3}{4}$ (D) $\frac{1}{4}$

48. $p(x) = \int \frac{x^2 \sin 2x - \sin 2x(x\tan x - 1)}{(x^2+1)^2}\,dx$, then $p(1) - p(0) =$

(A) $\frac{1-\cos 2}{4}$ (B) $\frac{-1+\cos 2}{4}$

(C) $1-\frac{\cos 2}{4}$ (D) None of these

49. $\frac{dy}{dx} = \frac{x}{y} + f\left(\frac{x+y}{y}\right)$ where $y = x.\ln kx;\ k > 0,\ x > 0$, then $f(x) =$

(A) $\frac{3x - x^2 + 1}{x-1}$ (B) $\frac{x^2 - 3x + 1}{1-x}$

(C) $\frac{x^2 + 3x - 1}{x-1}$ (D) $\frac{-x^2 + 3x - 1}{1-x}$

Space for rough work

Multiple Correct Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

---

50. Locus of point of intersection of tangents at the ends of a chord subtending an angle of θ, at origin, such that $\tan\theta = a$ for a parabola $y^2 = 4ax$ is:

(A) Parabola if $a = 2$
(B) Hyperbola if $a = 1$
(C) Parabola if $a = 2(1+\sqrt{2})$
(D) Pair of straight line if $a = \frac{1}{2}$

51. If a_n is no. of ways to split positive integer 'n' in all possible ways, then

(A) $a_n = 2^n$
(B) $a_n = a_{n-1} + a_{n-2};\ n > 2$
(C) $a_n = a_{n-1} + 2\cdot a_{n-2};\ n > 2$
(D) $a_n = 2^{n-1}$

52. If Z moves on $\arg\left(\frac{Z-2i}{Z-(1+i)}\right) = \pi/3$, then

(A) $\left(\frac{1}{5}+i\right)$ is interior point
(B) $\left(\frac{1}{5}+2i\right)$ is interior point
(C) $\left(\frac{1}{5}+i\right)$ is exterior point
(D) $\left(\frac{1}{5}+2i\right)$ is exterior point

53. Maximum and minimum value of $\frac{6|Z|^2 - Z^2 - (\bar{Z})^2 - 8}{8}$ are m_1 and m_2 respectively, if Z moves on $Z\bar{Z} - \sqrt{2}\bar{Z}i + \sqrt{2}iZ = 0$, then

(A) $m_1 + m_2 = 6$
(B) $m_1 m_2 = 10$
(C) $\left|\left[\frac{m_1}{m_2}\right]\right| = 7$
(D) $\left[\left|\frac{m_2}{m_1}\right|\right] = 0$

where [.] denotes G.I.F. and |.|is modulus value function.

54. A parabola touches *x*-axis at origin such that foot of perpendicular from origin to axis of parabola is $N(-2, 2)$ then

(A) eqn. of directrix is $x + y + 4 = 0$
(B) Focus of parabola is $(-2,\ 2)$
(C) Length of latus rectum is $2\sqrt{2}$
(D) eqn. of axis of parabola is $y = x + 4$

Space for rough work

Comprehension Type

This section contains **1 group of questions.** The group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

---

Paragraph for Question Nos. 55 and 56

$$e^x = 1 + \frac{x}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + ...\infty$$

55. $\int e^{-\sin\theta} \cos(\cos\theta)\, d\theta =$

(A) $K_1 + \theta + \frac{\cos\theta}{1} - \frac{\sin 2\theta}{2\times 2} - \frac{\cos 3\theta}{3\times 3\times 2} + \frac{\sin 4\theta}{4\times 4\times 6} + ...$

(B) $K_2 - \theta + \frac{\cos\theta}{1} - \frac{\sin 2\theta}{2^2} + \frac{\cos 3\theta}{3^2} + \frac{\sin 4\theta}{4^2} + ...$

(C) $K_3 + \theta - \frac{\cos\theta}{1} + \frac{\sin 2\theta}{2^2} - \frac{\cos 3\theta}{3^2} + \frac{\sin 4\theta}{4^2} + ...$

(D) $K_4 + \theta - \frac{\cos\theta}{1\times 1} - \frac{\sin 2\theta}{2\times 2} - \frac{\cos 3\theta}{3\times 3\times 4} - \frac{\sin 4\theta}{4\times 4\times 4\times 5} + ...$

where K_1, K_2, K_3, K_4 are real constants.

56. $\int e^{\cos\theta}.\sin(\sin\theta)\, d\theta =$

(A) $K_1 - \sin\theta - \frac{\sin 2\theta}{2\times 2!} - \frac{\sin 3\theta}{3\times 3!} - \frac{\sin 4\theta}{4\times 4!} - ....; k_1 \in R$

(B) $K_2 - \cos\theta - \frac{\cos 2\theta}{2\times 2!} - \frac{\cos 3\theta}{3\times 3!} - \frac{\cos 4\theta}{4\times 4!} - ....; k_2 \in R$

(C) $K_3 + \sin\theta + \frac{\sin 2\theta}{2\times 2!} + \frac{\sin 3\theta}{3\times 3!} + \frac{\sin 4\theta}{4\times 4!} + ...; k_3 \in R$

(D) $K_4 + \cos\theta - \frac{\cos 2\theta}{2\times 2!} - \frac{\cos 3\theta}{3\times 3!} + \frac{\cos 4\theta}{4\times 4!} - ....; k_4 \in R$

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

57. If the line $y = x$ intersects the curve $y = x^2 - x + x^{-1}$ at the points P, Q, R and O is the origin then [|OP . OQ . OR |] is _______; where |.| is modulus value function and [.] is G.I.F.

58. $y = \frac{\left[e^x\right]}{x}; x > 0$ has range $[b, \infty]$, then [b] is_____. where [.] is G.I.F.

59. Point P is taken uniquely on lines $x = \sqrt{3}$ and $y = \sqrt{3}(x + \sqrt{3})$ such that angle bisector of $\angle PQR$ in ΔPQR is $y = (\sqrt{3} - 2)x + 2$. If side QR always passes there M (h, k) where PM is not perpendicular to the given angle bisector, then $8h^2 =$

60. If $\cot^4 p + \cot^4 q - 3 = \sin^2(p+q) - 2\tan^2 p \tan^2 q$ where $p, q \in \left(0, \pi/2\right)$ then $[p+q] = ?$

61. On circle $|z - 2i| = 2;$ through origin 'O', a chord OP is drawn. On the tangent at O, a point T is taken so that OT = OP. If TP produced meet normal at O to the circle at Q, then limiting value of OQ as P moves towards origin is.

62. No. of ways to put 10 identical balls in 4 identical boxes, so that none of the boxes are empty.

63. If $2x - y - 5 + \lambda(x - 2y - 1) = 0$ represents incident rays and $(3x - y + 4) + \mu(x - 2y + 3)$ represent reflected rays to an ellipse S = 0; where $\lambda, \mu \in \mathbf{R}$. Point P(2, 4) is a point on S = 0, normal at which meets major axis at N. If N divides line segment joining two focii in the ratio a : b (a, b are co-primes) then $a^2 + b^2 - 15$ is.

Space for rough work

64. A line $3x-4y+K=0$ intersects the circle $x^2+y^2-8x-6y+21=0$ at P and Q. If the tangents at P and Q to the circle intersect at $\pi/3$, then |K| is; where |.| is modulus value function.

65. For $x \geq 0,\ F(x)=\int_0^x f(t)\,dt$ and $f(x)$ is a non-negative continuous function. If for some $c>0,\ (cF(x) \geq f(x))$ then, for $x \geq 0,\ f(2)$ is.

66. ΔABC is an acute angle triangle with $\angle B = 30^0$, H is the orthocenter and M is the mid point of BC. On the line HM a point T is taken such that HM = TM. If AT = 8 cm then length of AC is.

SECTION – D

(Numerical Answer Type)

This section contains **3 questions**. Each question, when worked out will result in **numerical answer type** (XXXXX.XX)

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67. If $\lambda = \lim\limits_{n\to\infty}\left(\frac{1^{18}+2^{18}+3^{18}+.....+n^{18}}{n^{19}}-\frac{1^{19}+2^{19}+3^{19}+....+n^{19}}{n^{20}}\right)$; then 1000λ is

68. If $P(x)=\int\frac{5x^{-1}+3x^{-3}}{(x^5+2x^{-5})+(2x^3+2x^{-2})+x+2}dx$ then $\tan(P(1)-P(0))$ is.

69. If $x^3dy=(3x^2y+x^2+x^7)\,dx$ with $y(0)=0$ then $y(3)$ is.

Space for rough work

FIITJEE **JEE (Advanced)-2018**

PART TEST – I

Paper 1

ALL INDIA TEST SERIES

Time Allotted: 3 Hours **Maximum Marks: 183**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into Two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01– 07, 19 – 25, 37 - 43)*** *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (08 – 13, 26 – 31, 44 - 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S).*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (14 – 18, 32 – 36, 50 - 54)*** *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{\text{water}} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant R = $8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
= 0.0821 Lit atm $\text{K}^{-1}\ \text{mol}^{-1}$
= $1.987 \approx 2$ Cal $\text{K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

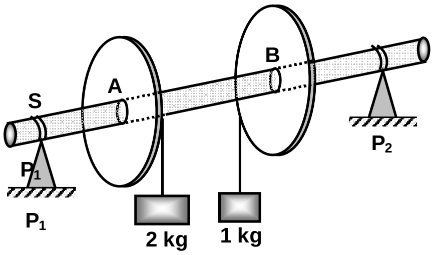
PART – I

SECTION – A

(One or More than one correct type)

This section contains **7** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. Two discs A and B each of mass 2 kg and radius 0.5 m are rigidly fixed to the ends of a thin shaft S, which is supported in horizontal position with the help of two smooth bearings at points P_1 and P_2. Two blocks of masses 2 kg and 1 kg are connected to the light cords wrapped around the discs as shown in the figure. There is no slipping between the cord and the discs. If the system is released from rest from the position shown, then mark the correct statement(s). (Take g = 10 m/s^2)



(A) Power developed by tension in cord connected to 2 kg block is, negative.
(B) Acceleration of each block is 2 m/s^2.
(C) Total work done by tension on the discs is zero during the motion.
(D) Acceleration of each block is 1 m/s^2.

2. A uniform ball of radius R rolls without slipping between the rails such that the horizontal distance is $\sqrt{3}$ R between the two contact points of the rails of the ball. Figure (a) shows the front view of the ball and figure (b) shows the side view of the ball. v_{CM} is the velocity of centre of mass of the ball and ω is the angular velocity of the ball after rolling down a distance 2h along the incline then

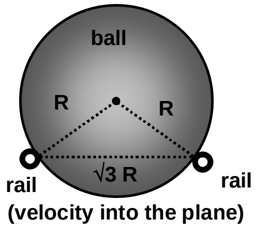


figure (a)

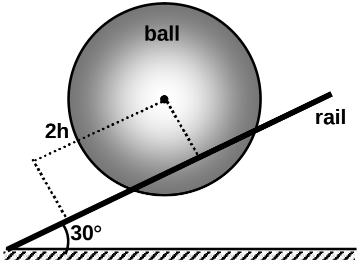


figure (b)

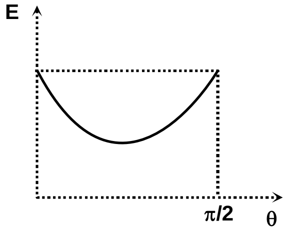
(A) $v_{CM} = \omega R$
(B) $v_{CM} = \omega \frac{R}{2}$
(C) $v_{CM} = \sqrt{\frac{10gh}{13}}$
(D) $v_{CM} = \sqrt{\frac{10gh}{7}}$

Space for Rough work

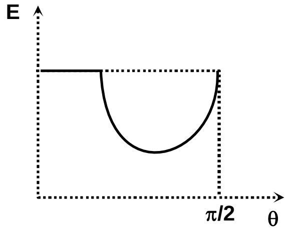
3. A worker wishes to pile up sand on to a circular area of radius R. No sand is to spill on to the surrounding area. If μ_s is the coefficient of static friction between sand particles, then choose the correct statement(s).
(A) The greatest height of sand pile that can be created is $\mu_s R$.
(B) The greatest height of sand pile that can be created is R/μ_s.
(C) Minimum work required to create greatest height sand pile is $\frac{\pi}{12}\mu_s^2 R^4 \rho g$. Where ρ is the density of sand volume.
(D) Sand pile will be in stable equilibrium.

4. A solid spherical ball is released from rest on an incline of inclination angle θ (which can be varied) but through a fixed vertical height h. The coefficient of static and kinetic friction are both equal to μ. If E represents the total kinetic energy of the ball at the bottom of the incline as a function of the angle of inclination θ. W represents the work done by friction for the whole time of motion as a function of the angle of inclination θ. Choose the correct graph(s).

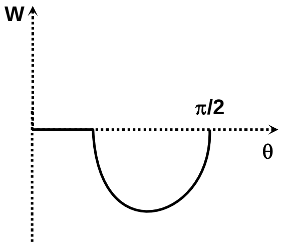
(A)



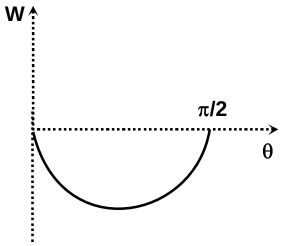
(B)



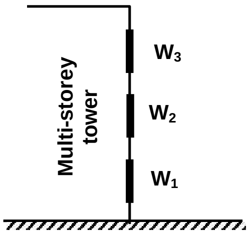
(C)



(D)



Space for Rough work



5. W_1, W_2 and W_3 are the different sizes of windows 1, 2 and 3 respectively placed in a vertical plane. A particle is thrown up in the vertical plane. Let t_1, t_2 and t_3 are the time taken to cross the window W_1, W_2 and W_3 respectively and ΔV_1, ΔV_2 and ΔV_3 are the change in speed after respective window cross.

   (A) Average speed of the particle passing the windows may be equal if $W_1 < W_2 < W_3$

   (B) Average speed of the particle passing the windows may be equal if $W_1 > W_2 > W_3$.

   (C) If $W_1 = W_2 = W_3$, the change in speed of the particle while crossing the windows will satisfy $\Delta V_1 < \Delta V_2 < \Delta V_3$.

   (D) If $W_1 = W_2 = W_3$, the time taken by particle to cross the windows will satisfy $t_1 < t_2 < t_3$.

6. The potential energy function of a particle is given by $U(r) = \frac{A}{2r^2} - \frac{B}{3r}$, where A and B are constants and r is the radial distance from the centre of the force. Choose the correct option(s).

   (A) The equilibrium distance will be $r_0 = \frac{2A}{B}$

   (B) The equilibrium distance will be $r_0 = \frac{3A}{B}$

   (C) If the total energy of the particle is $\frac{B^2}{6A}$, then its radial velocity will vanish at $\frac{r_0}{3}$, where r_0 is the equilibrium distance.

   (D) If the total energy of the particle is $\frac{B^2}{6A}$, then its radial velocity will vanish at $\frac{r_0}{2}$, where r_0 is the equilibrium distance.

7. Velocity of a particle of mass 2 kg changes from $\vec{v}_1 = -2\hat{i} - 2\hat{j}$ m/s to $\vec{v}_2 = (\hat{i} - \hat{j})$ m/s after colliding with a smooth plane surface.

   (A) The angle made by the plane surface with the positive x-axis is 90° + $\tan^{-1}\left(\frac{1}{3}\right)$

   (B) The angle made by the plane surface with the positive x-axis is $\tan^{-1}\left(\frac{1}{3}\right)$

   (C) The direction of change in momentum makes an angle $\tan^{-1}\left(\frac{1}{3}\right)$ with the positive x-axis.

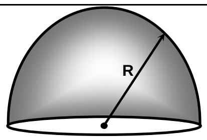
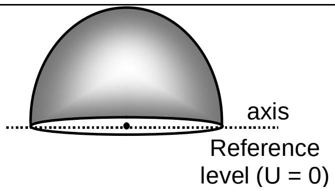
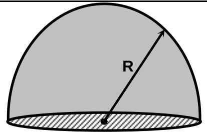
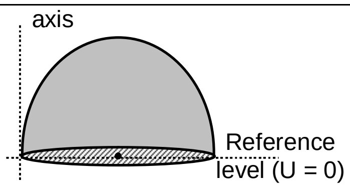
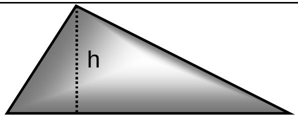
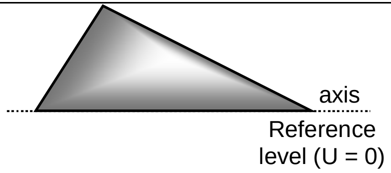
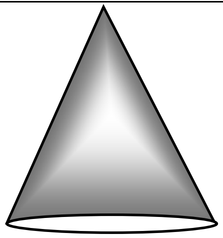
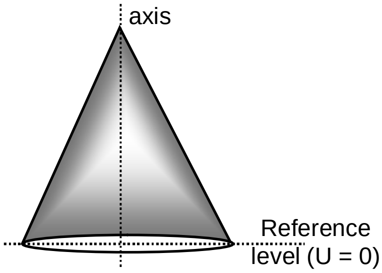
   (D) The direction of charge in momentum makes an angel $90° + \tan^{-1}\left(\frac{1}{3}\right)$ with the plane surface.

Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

Match the following					
Column 1 **(Body)**		**Column 2** **(Axis and reference level)**		**Column 3** **(magnitude of physical quantity in S.I. Unit)**	
(I)	 Uniform hollow hemispherical shell of M = 3 kg and R = 2 m	(i)		(P)	1
(II)	 Uniform solid hemisphere of $M = \frac{5}{7}$ kg and R = 3 m	(ii)		(Q)	2
(III)	 Uniform triangular plate of M = 9 kg and h = 3 m	(iii)		(R)	3
(IV)	 Uniform hollow cone of M = 2 kg, R = 1m and h = 3 m	(iv)		(S)	9

Space for Rough work

8. Distance of centre of mass (in m) of the body (shown in column-1) from the axis (shown in column-2)

(A) (I) (i) (Q)
(B) (II) (ii) (S)
(C) (III) (iii) (P)
(D) (IV) (iv) (R)

9. Moment of inertia of body (in kg-m^2) (shown in column –1) about the axis (shown in column –2)

(A) (I) (i) (S)
(B) (II) (ii) (S)
(C) (III) (iii) (Q)
(D) (IV) (iv) (R)

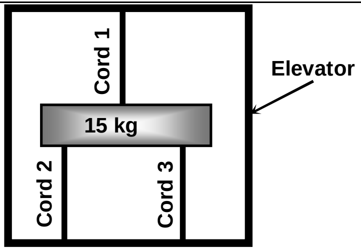
10. $\dfrac{\text{Gravitational potential energy } (U = 0, \text{ at the reference level})}{g}$ (in J-s^2/m) of the body (shown in column-1) with respect to the reference level (shown in column-2), where g is gravitation acceleration.

(A) (I) (i) (S)
(B) (II)(ii) (R)
(C) (III) (iii) (P)
(D) (IV) (iv) (Q)

Space for Rough work

Answer questions 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

A block of mass m = 15 kg is suspended in an elevator with the help of three identical light elastic cords (spring constant k = 100 N/m each) attached vertically. One of them, cord 1 is tied to the ceiling of the elevator and the other two cords 2 and 3 are tied to the elevator floor as shown in the figure. When the elevator is stationary the tension force in each of the lower cords is T = 7.5 N. Take g = 10 m/s^2. Now the elevator starts moving with given four accelerations shown in column I. Column II given the displacement of the block with respect to elevator when it is accelerating. Column III gives tension in the cords when elevator is accelerating.



Column 1 (acceleration of the elevator in different cases)		**Column 2** (displacement of the block with respect to the elevator upto new equilibrium position)		**Column 3** (Tension in the cord)	
(I)	1 m/s^2 upward	(i)	7.5 cm downward	(P)	2.5 N
(II)	1.5 m/s^2 upward	(ii)	2.5 cm downward	(Q)	5 N
(III)	2 m/s^2 upward	(iii)	15 cm downward	(R)	172.5 N
(IV)	33 m/s^2 downward	(iv)	5 cm downward	(S)	0 N

11. Tension in cord-1.
(A) (I) (i) (S)
(B) (II)(i) (R)
(C) (III) (ii) (P)
(D) (IV) (iii) (Q)

12. Tension in cord 2.
(A) (I) (iv) (P)
(B) (II)(i) (Q)
(C) (III) (iii) (R)
(D) (IV) (ii) (S)

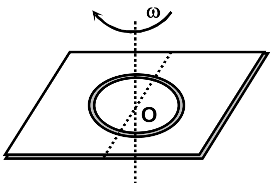
13. Tension in cord 3.
(A) (I) (i) (P)
(B) (II)(ii) (P)
(C) (III) (iii) (S)
(D) (IV) (iii) (R)

Space for Rough work

SECTION – C
(Single digit integer type)

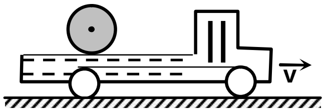
This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

14. A uniform ring of mass m is placed on a rough horizontal fixed surface as shown in the figure. The coefficient of friction between the left part of the ring and left part of the horizontal surface is $\mu_1 = 0.6\pi$ and between right half and the surface is $\mu_2 = 0.2\pi$. At the instant shown, now the ring has been imparted an angular velocity in clockwise sense in the figure shown. At this moment magnitude of acceleration of centre O of the ring (in m/s^2) is (take g = 10 m/s^2)

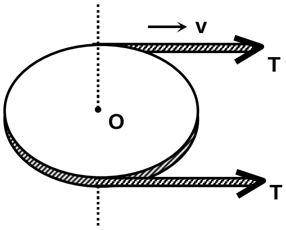


15. A power output from a certain experimental car design to be shaped like a cube is proportional to the mass m of the car. The force of air friction on the car is proportional to Av^2, where v is the speed of the car and A is the cross-sectional area. On a level surface the car has a maximum speed v_{max}. Assume that all versions of this design have the same density. Then v_{max} is proportional to $m^{1/C}$. Find C.

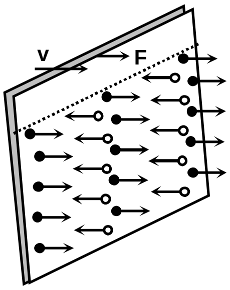
16. A solid cylinder rolls from the back of a large truck travelling at 10 m/s to the right. The cylinder is travelling horizontally at 8 m/s to the left relative to an observer in the truck. The ball lands on the roadway 1.25 m below its starting level. How far behind the truck does it land (in m)?



17. A flexible drive belt runs over a frictionless pulley as shown in figure. The pulley is rotating freely about the vertical axis passing through the centre O of the pulley. The vertical axis is fixed on the horizontal smooth surface. The mass per unit length of the drive belt is 1 kg/m and the tension in the drive belt 8 N. The speed of the drive belt is 2 m/s. Find the net normal force applied by the belt on the pulley in newton.



18. A thin heavy metal plate is being bombarded by a perpendicular beam of gas particles from both sides as shown in the figure. The solid dots are representing the molecules hitting from left side and the faint dots are the molecules hitting from right side. The mass of these gas particles is $m = 10^{-26}$ kg and velocity before hitting is $v_0 = 5$ m/s. Volume density of the gas particles on both sides is $n = 10^{25}$ per m^3. Each beam has an area A = 1 m^2 and the collisions are perfectly elastic. What is the external force F (in newton) required to move the plate with a constant velocity v = 2 m/s.



Space for Rough work

Chemistry PART – II

SECTION – A

(One or More than one correct type)

This section contains **7** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Pure PCl_5(g) was introduced into an evacuated vessel and comes to equilibrium at 247°C and 2 atm pressure. At equilibrium the equilibrium mixture contains 40% by volume of Cl_2(g)

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

Which of the following statement(s) regarding the above equilibrium is/are correct?
(A) K_P for the equilibrium is 1.6 atm.
(B) K_C for the equilibrium is 0.071.
(C) Addition of inert gas to the equilibrium mixture at constant pressure increase the number of moles of PCl_3.
(D) Increase in pressure increases the number of moles of Cl_2.

20. If 0.53 $\overset{o}{A}$ is the Bohr's radius for the 1st orbit of hydrogen atom, the correct statement(s) in the light of wave mechanical model is/are
(A) The product of ψ^2 and $4\pi r^2$ increases till it reaches at the distance of 0.53 $\overset{o}{A}$.
(B) ψ^2 goes on increasing till it reaches at the distance of 0.53 $\overset{o}{A}$.
(C) ψ goes on decreasing till it reaches at the distance of 0.53 $\overset{o}{A}$.
(D) The nodal point for the 1s orbital is at 0.53 $\overset{o}{A}$.

21. The disproportionation reaction(s) among the following reactions is/are
(A) $2NO_2(g) + 2OH^- \longrightarrow NO_2^-(aq) + NO_3^-(aq) + H_2O(\ell)$
(B) $P_4(s) + 3OH^-(aq) + 3H_2O(\ell) \longrightarrow PH_3(g) + 3H_2PO_2^-(aq)$
(C) $Cl_2(g) + 2OH^-(aq) \longrightarrow Cl^-(aq) + ClO^-(aq) + H_2O(\ell)$
(D) $(CN)_2 + 2OH^-(aq) \longrightarrow CN^-(aq) + OCN^-(aq) + H_2O(\ell)$

22. The correct among the following statements is/are
(A) Calcium carbide on hydrolysis produces acetylene
(B) Calcium carbide when heated with N_2 at 1100°C forms calcium cyanamide
(C) Cyanamide ion is isoelectronic with CO_2
(D) Beryllium carbide on hydrolysis forms CH_4

Space for Rough work

23. Two equilibria are simultaneously existing in a vessel at 25°C

$NO(g) + NO_2(g) \rightleftharpoons N_2O_3(g) \quad K_{P_1}$

$2NO_2(g) \rightleftharpoons N_2O_4(g) \quad K_{P_2} = 8\ atm^{-1}$

Initially only NO(g) and NO_2(g) are present in 3 : 5 mole ratio. The total pressure at equilibrium is 5.5 atm and the partial pressure of NO_2 at equilibrium is 0.5 atm.
The incorrect statement(s) regarding the above equilibria is/are
(A) K_{P_1} for the equilibrium is 0.4 atm^{-1}.
(B) Partial pressure of N_2O_4 at equilibrium is 1.6 atm.
(C) Partial pressure of N_2O_3 at equilibrium is 2 atm.
(D) Partial pressure of NO at equilibrium is 2.5 atm.

24. The correct statement among the following is/are
(A) The B – F bond length of BF_3 is smaller than the B – F bond length of BF_4^-.
(B) Diborane on hydrolysis forms H_3BO_3.
(C) Borazine on hydrolysis produces N_3H.
(D) In $T\ell I_3$ oxidation state of $T\ell$ is +3.

25. 60 ml of 0.1 M NH_4OH is mixed with 40 ml of 0.1 M HCl. Which of the following statement(s) is/are INCORRECT about the resulting solution/mixture? (Given $pK_b(NH_4OH) = 4.74$, log2 = 0.3)
(A) The pH of the resulting solution is 5.04.
(B) The resulting solution is a basic buffer.
(C) The pOH of the resulting solution is 9.26.
(D) The resulting solution is acidic due to hydrolysis of NH_4Cl.

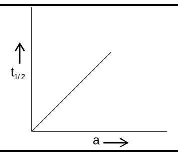
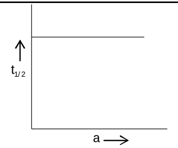
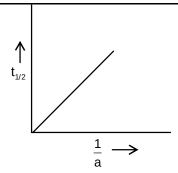
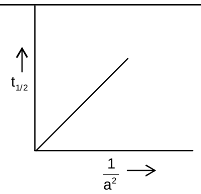
Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 26, 27 and 28 by appropriately matching the information given in the three columns of the following table.

Columns 1 contains integrated rate equation, Column 2 contains half-life and Column 3 contain graph corresponding to different order reactions, 'a' is initial concentration of reactant and a – x is the concentration at time 't'.

Column 1		**Column 2**		**Column 3**	
(I)	$k = \frac{1}{t}\left(\frac{1}{a-x} - \frac{1}{a}\right)$	(i)	$t_{1/2} = \frac{a}{2k}$	(P)	
(II)	$k = \frac{x}{t}$	(ii)	$t_{1/2} = \frac{0.693}{k}$	(Q)	
(III)	$k = \frac{2.303}{t}\log\frac{a}{a-x}$	(iii)	$t_{1/2} = \frac{1}{ka}$	(R)	
(IV)	$k = \frac{1}{2t}\left[\frac{1}{(a-x)^2} - \frac{1}{a^2}\right]$	(iv)	$t_{1/2} = \frac{3}{2ka^2}$	(S)	

26. For the decomposition of HI on the surface of gold the only correct combination is
(A) (III) (ii) (R) (B) (II)(i) (P)
(C) (IV) (i) (P) (D) (I) (iii) (z)

27. For the reaction $N_2O_5 \longrightarrow 2NO_2 + \frac{1}{2}O_2$, the only correct combination is
(A) (III) (ii) (Q) (B) (I)(iii) (P)
(C) (II) (i) (S) (D) (IV) (i) (P)

28. For the reaction $2A \longrightarrow \text{Product}$, the rate equation is
$r = k[A]^2$
Which of the following is the only correct combination for the reaction?
(A) (II) (iii) (P) (B) (II)(iii) (S)
(C) (III) (i) (S) (D) (I) (iii) (R)

Space for Rough work

Answer 29, 30 and 31 by appropriately matching the information given in the three columns of the following table.

Column 1 **Hybridisation of central atom**		**Column 2** **Shape of molecule/ion**		**Column 3** **No of lone pair in the central atom**	
(I)	sp^2	(i)	Linear	(P)	0
(II)	sp^3	(ii)	Square pyramidal	(Q)	1
(III)	sp^3d	(iii)	T-shaped	(R)	2
(IV)	sp^3d^2	(iv)	See-saw	(S)	3

29. For the ion BrF_5 the only correct combination is
(A) (III) (ii) (Q)
(B) (IV)(ii) (Q)
(C) (III) (iv) (P)
(D) (IV) (iv) (R)

30. For the ion $\left[ICl_2\right]^-$, the only correct combination is
(A) (III) (i) (S)
(B) (II)(iii) (Q)
(C) (IV) (iv) (R)
(D) (IV) (i) (R)

31. For the molecule $XeOF_2$, the only correct combination is
(A) (IV) (ii) (Q)
(B) (IV)(iii) (Q)
(C) (III) (iv) (P)
(D) (III) (iii) (R)

Space for Rough work

SECTION – C

(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

32. 4 mol of a mixture containing one mol each of $LiNO_3$, $NaNO_3$, $Ca(NO_3)_2$ and $Mg(NO_3)_2$ is decomposed by strongly heating. The total number of moles of $NO_2(g)$ evolved is (assuming complete decomposition of all the salts)

33. The velocity of an electron in the orbit of hydrogen atom is 5.47×10^5 m/sec. Total number of waves formed by the electron in one complete revolution is

34. How many of the following species are paramagnetic?
$N_2^+, O_2^-, B_2, C_2, CN^-, NO^+, CO, H_2^-, He_2^+$

35. 6 ml of 0.1 M CH_3COOH when mixed with x ml of 0.1 M NaOH, the pH of the resulting buffer solution was found to be 5.04. The value of x is (log2 = 0.3) $pK_{a(CH_3COOH)} = 4.74$.

36. For the reaction
$A(g) \rightleftharpoons B(g) + C(g)$
At 300 K, the average molecular weight of the equilibrium mixture is 83 g/mol. If atomic weight of A, B and C are 100, 60 and 40 gram/mol respectively, then the number of moles of 'C' present at equilibrium in a reaction starting with 10 moles of A is

Space for Rough work

Mathematics PART – III

SECTION – A

(One or More than one correct type)

This section contains **7** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. If α is the root of the equation x – tan x = 3 where $\alpha \in \left(\frac{\pi}{2}, \frac{3\pi}{2}\right)$; then which of the following is/are correct?, (where [.] denotes the greatest integer function and {.} fractional part function)

(A) $\lim\limits_{x \to \alpha^+} \left[\frac{\max(\tan x, \{x\})}{x-3}\right] = 1$

(B) $\lim\limits_{x \to \alpha^+} \left[\frac{\min(\tan x, \{x\})}{x-3}\right] = 1$

(C) $\lim\limits_{x \to \alpha^-} \left[\frac{\min(\tan x, \{x\})}{x-3}\right] = 0$

(D) $\lim\limits_{x \to \alpha^-} \left[\frac{\max(\tan x, \{x\})}{\tan x}\right] = 1$

38. Which of the following is/are incorrect?

(A) let f: R → R, such that $f(x) = 2x + \left[\frac{x(x^2-1)}{4(x^4-x^2+1)} + \frac{1}{8}\right] + [x] + \sin x \cos x$ then (where [.] denotes the greatest integer function) f is one-one onto

(B) let f: R → R, such that $f(x) = \frac{x^3+2x^2}{\sin x + 2}$ then f is one-one onto

(C) let f: R → [1, ∞) such that $f(x) = 2^{|x-1|^{\sqrt{2}}}$ then f(x) is one-one into

(D) let f: R – {0} → R such that f(x) = |x|ln|x| then f(x) is one-one onto

39. Let $S_n = \sum\limits_{r=1}^{n} \left(\frac{r^4 + r^3 n + r^2 n^2 + 2n^4}{n^5}\right)$ and $T_n = \sum\limits_{r=0}^{n-1} \left(\frac{r^4 + r^3 n + r^2 n^2 + 2n^4}{n^5}\right)$, n = 1, 2, 3, ... then

(A) $T_n > \frac{167}{60}$

(B) $T_n < \frac{167}{60}$

(C) $S_n > \frac{167}{60}$

(D) $S_n < \frac{167}{60}$

Space for rough work

40. Which of the following option(s) is/are incorrect?

(A) $\int_0^{\pi/8}\left|\frac{\sin(8nx)+\cos(8nx)}{x}\right|dx < \frac{2\sqrt{2}}{\pi}\left(1+\frac{1}{2}+\frac{1}{3}+.....+\frac{1}{n}\right)$

(B) $\frac{2}{\ln 3} < \int_0^1 3^{x^{1/3}}dx < \int_0^1 4^{x^{1/3}}dx$

(C) $\int_0^{\pi/6}\sqrt{\sin x}\left(8-3\sqrt{\sin x}\right)dx > \frac{8\pi}{9}$

(D) $\frac{1}{4} < \int_{\pi/4}^{\pi/3}\frac{\tan x}{x}dx < \frac{1}{\sqrt{3}}$

41. The most general solution of the differential equation $\dfrac{x+y\dfrac{dy}{dx}}{x-y\dfrac{dx}{dy}} = \dfrac{2y^3}{x^5}\sin^2\left(x^2+y^2\right)$ is

(A) $-\frac{1}{2}\cot\left(x^2+y^2\right)-\frac{2(y/x)^4}{4}+c=0$

(B) $-\frac{1}{2}\cot\left(x^2+y^2\right)-\frac{2(y/x)^4}{4}+e^c=0$

(C) $-\frac{1}{2}\cot\left(x^2+y^2\right)-\frac{2(y/x)^4}{4}+\tan c=0$

(D) $\frac{1}{4}\tan\left(x^2+y^4\right)-\frac{2y^3}{x}+c=0$

42. Let f(x) = $2x^3 - 3x^2 - x + \frac{3}{2}$ then which of the following is/are incorrect?

(A) $\int_{1/8}^{7/8} f(f(x))dx = \frac{3}{4}$

(B) $y = (f(x))^{3/5}$ is not differentiable at exactly 1 point

(C) y = [f(x) + λ], ($\lambda \in$ prime number) is discontinuous at 3 points if x $\in$ [0, 1]

(D) f(f(x)) = 0 has minimum 6 real roots

43. If $\int e^{x\sec^2 x-\tan x}\left(x\tan x-\frac{\sin 2x}{2}\right)dx = e^{f(x)}\cdot g(x)+c$ then which of the following is/are incorrect?

(A) f(0) is equal to = 1

(B) number of solution(s) of the equation $(g(x))^{3/2} = \frac{1}{2\sqrt{2}}x^3$ is 3

(C) number of solution(s) of the equation $(g(x))^{3/2} = \frac{1}{2\sqrt{2}}x^3$ is 1

(D) f(x) is an even function

Space for rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 44, 45 and 46 by appropriately matching the information given in the three columns of the following table.

Column-1: real valued function; Column-2: continuity of the function; Column-3: differentiability of the function; Match the following Column(s)

Column–1	Column–2	Column–3
(I) $f(x) = \lvert\lvert x-6\rvert - \lvert x-8\rvert\rvert - \lvert x^2-4\rvert + 3x - \lvert x-7\rvert^3$	(i) continuous $\forall\ x \in R$	(P) not differentiable at 3 points
(II) $f(x) = (x^2-9)\lvert x^2+11x+24\rvert + \sin\lvert x-7\rvert + \cos\lvert x-4\rvert + (x-1)^{3/5}\sin(x-1)$	(ii) discontinuous at a single point only	(Q) not differentiable at 4 points
(III) $f(x) = \begin{cases} (x+1)^{3/5} - \dfrac{3\pi}{2} & : \ x < -1 \\ \left(x-\dfrac{1}{2}\right)\cos^{-1}(4x^3-3x) & : \ -1 \le x \le 1 \\ (x-1)^{5/3} & : \ 1 < x < 2 \end{cases}$	(iii) discontinuous at 2 points	(R) not differentiable at 2 point
(IV) $f(x) = \{\sin x\}\{\cos x\} + (\sin^3\pi\{x\})([x]),\ x \in [-1, 2\pi]$	(iv) discontinuous at 3 points	(S) not differentiable at 5 points

(Where [.] denotes the greatest integer function and {.} fractional part function)

44. Which of the following combination is correct?
(A) (I) (i) (R) (B) (III) (ii) (R)
(C) (IV) (iv) (P) (D) (I) (i) (Q)

45. Which of the following combination is correct?
(A) (II) (iii) (S) (B) (III) (i) (P)
(C) (II) (iii) (R) (D) (III) (i) (R)

46. Which of the following is correct?
(A) (I) (i) (S) (B) (IV) (i) (S)
(C) (II) (ii) (S) (D) (II) (ii) (P)

Space for rough work

Answer 47, 48 and 49 by appropriately matching the information given in the three columns of the following table.

Column-1: real valued function; Column-2: domain of the function; Column-3: range of the function.
Match the following Column(s) (where [.] denotes the greatest integer function and {.} denotes fractional part function)

Column–1	Column–2	Column–3
(I) $f_1(x)=\left[\log_{\sqrt{2}}\sqrt{\left\|(x-1)^3\right\|+\left\|(x-3)^3\right\|}\right]$	(i) number of integers in the domain of f(x) is 2	(P) set of all non positive integers ∪ {1}
(II) $f_2(x)=\left[\log_{\sqrt{2}}\left(\sin\left(\ln\left(\frac{\sqrt{4-x^2}}{1-x}\right)\right)+\cos\left(\ln\left(\frac{\sqrt{4-x^2}}{1-x}\right)\right)\right)\right]$	(ii) number of integers not in the domain of f(x) is 2	(Q) set of all non negative integers
(III) $f_3(x)=\left\{\frac{\|x+5\|-2}{x^2+10x+21}\right\}$	(iii) number of integers in the domain of f(x) is 3	(R) set of all positive integers
(IV) $f_4(x)=\left[\frac{1}{\sqrt{\ln\left(\cos^{-1}x\right)}}\right]$	(iv) number of integers in the domain of f(x) is infinite	(S) $\left(0,\frac{1}{2}\right]$

47. Which of the following combination is correct?
(A) (I) (iv) (P) (B) (I) (iv) (R)
(C) (II) (ii) (R) (D) (III) (i) (S)

48. Which of the following combination is correct?
(A) (IV) (i) (P) (B) (III) (ii) (S)
(C) (IV) (i) (Q) (D) (II) (iii) (S)

49. Which of the following combination is correct?
(A) (II) (iv) (P) (B) (IV) (i) (P)
(C) (II) (i) (P) (D) (IV) (i) (R)

Space for rough work

SECTION – C

(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

50. If the value of A for which the equation $\cot^3 A + \cot^2 A\,|\cot A + x| + |\cot^2 Ax + 1| = 1$ has not less than 6 different solutions which are integers are $[\cot^{-1}\alpha, \pi) \cup [\cot^{-1}\beta, \cot^{-1}\gamma]$, then $|\alpha + 30(\beta\gamma)^2|$ is equal to _____ (where $A \in (0, \pi)$)

51. Let f(x) be a differentiable and g(x) be a twice differentiable function such that $|f(x) - 1| \le 1$ and $f'(x) = g(x)$. If $f^2(3) + g^2(3) = 20$ then number of value(s) of $c \in (0, 4)$ such that $g(c)g''(c) > 0$ is/are _____

52. Let f(x) be a non-constant thrice differential function defined on $(-\infty, \infty)$ such that $f\left(\frac{x+13}{2}\right) = f\left(\frac{3-x}{2}\right)$ and $f'(0) = f'\left(\frac{1}{2}\right) = f'(2) = f'(3) = f'\left(\frac{9}{2}\right) = 0$ then the minimum number of zeroes of $h(x) = (f''(x))^2 + f'(x)f'''(x)$ in the interval [0, 9] is 2k then k is equal to _____

53. If $\forall\, h \in R - \{0\}$, two distinct tangents can be drawn from the points $(2 + h, 3h - 1)$ to the curve $y = x^3 - 6x^2 - a + bx$ then $\frac{a}{b}$ is equal to _____

54. Let $\lim\limits_{n\to\infty} \sum\limits_{k=1}^{n} \frac{\lambda k^4 + 2k^3 + k^2 + k + 1}{3n^5 + n^2 + n + 5k} = \frac{1}{3}$ then λ is equal to _____

Space for rough work

FIITJEE **JEE(Advanced)-2018**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

PART TEST – I

PAPER-1

ANSWERS KEY

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**A, B**	19.	**A, C**	37.	**A, B, C, D**
2.	**B, C**	20.	**A, C**	38.	**A, B, C, D**
3.	**A, C**	21.	**A, B, C, D**	39.	**B, C**
4.	**B, C**	22.	**A, B, C, D**	40.	**A, C**
5.	**A, C, D**	23.	**B, C**	41.	**A, C**
6.	**B, C**	24.	**A, B**	42.	**A, B, C**
7.	**A, C**	25.	**A, C, D**	43.	**A, B, D**
8.	**C**	26.	**B**	44.	**C**
9.	**B**	27.	**A**	45.	**D**
10.	**D**	28.	**D**	46.	**A**
11.	**B**	29.	**B**	47.	**B**
12.	**A**	30.	**A**	48.	**C**
13.	**C**	31.	**D**	49.	**C**
14.	**4**	32.	**5**	50.	**4**
15.	**9**	33.	**4**	51.	**0**
16.	**4**	34.	**5**	52.	**9**
17.	**8**	35.	**4**	53.	**1**
18.	**8**	36.	**2**	54.	**5**

Physics

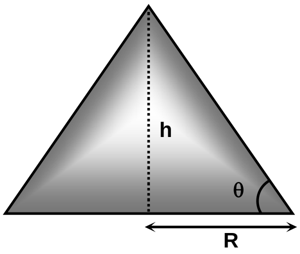
PART – I

SECTION – A

1. $20 - T_1 = 2a$ (for 2 kg block) ….(i)
$T_2 - 10 = 1a$ (for 1 kg block) ….(ii)
$T_1\frac{1}{2} - T_2\frac{1}{2} = (2)\left(\frac{1}{2}\right)^2\frac{1}{2}(2)\frac{a}{1/2}$ (for the shaft + disc system)
So, $T_1 - T_2 = 2a$ ….(iii)
After solving these three equation
$a = 2\ m/s^2$

2. $v_{CM} = \omega\sqrt{R^2 - \frac{3R^2}{4}} = \omega\frac{R}{2}$ (from pure rolling)
$mgh = \frac{1}{2}mv_{cm}^2 + \frac{1}{2}\frac{2}{5}mR^2\omega^2$ (from conservation of energy)
$\therefore\ v_{CM} = \sqrt{\frac{10gh}{13}}$

3. From free body diagram of sand particle
$\tan\theta = \mu_S = h/R$
work required = $\left(\frac{1}{3}\pi R^2 h\rho g\right)\frac{h}{4}$.
The system is in unstable equilibrium.



4. For small angle of inclinations, ball rolls without slipping. So there is no work done by friction. At some critical angle θ_C, the ball starts slipping. For $\theta > \theta_C$, energy would be lost due to work done by kinetic friction. But again for ($\theta = \pi/2$), friction would be zero.

5. As going up, speed of the particle is decreasing and hence the time taken in crossing the windows will be $t_1 < t_2 < t_3$ (If $W_1 = W_2 = W_3$)
Simultaneously $\Delta V \propto t$
$\therefore\ \Delta V_1 < \Delta V_2 < \Delta V_3$
For unequal windows $t_1 = t_2 = t_3$ may be if $W_3 < W_2 < W_1$

6. $F = -\frac{dU}{dr} = \frac{A}{r^3} - \frac{B}{3r^2}$
For equilibrium F = 0, $r = \frac{3A}{B}$
$\frac{B^2}{6A} = \frac{A}{2r_0^2} - \frac{B}{3r_0}$ (for $r_0 = \frac{r}{3}$)

7. $\Delta\vec{P} = 2(\hat{i} - \hat{j}) - 2(-2\hat{i} - 2\hat{j})$
$= 6\hat{i} + 2\hat{j}$ kg-m/s

So, $\Delta\vec{P}$ makes angle $\tan^{-1}\left(\frac{1}{3}\right)$ with positive x-axis which is also the direction of normal force exerted on the ball. So the plane surface makes an angle $\frac{\pi}{2}+\tan^{-1}\left(\frac{1}{3}\right)$ with positive x-axis.

8. Center of mass of a triangular uniform plate from its base is $\frac{h}{3}=1\text{m}$

9. $I_{axis} = \frac{2}{5}MR^2 + MR^2 = \frac{7}{5}MR^2 = \frac{7}{5}\times\frac{5}{7}\times 9 = 9$ kg-m^2

10. $\frac{U}{g} = Mh_{CM} = (2)\left(\frac{3}{3}\right) = 2\,\text{m}$

11. For elevator acceleration 1.5 m/s^2, tension in cord 2 and cord 3 is zero
So, $T_1 - 150 = (15)\ (1.5)$
$\Rightarrow$ Tension in cord 1, $T_1 = 172.5$ N

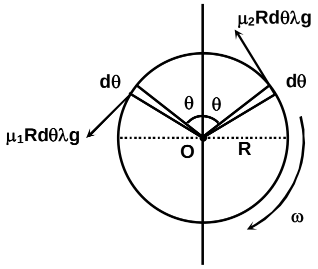
12. For elevator acceleration 1 m/s^2, tension in cord 2 and cord 3 decreases.
So, $165 + \Delta T - 2 \times (7.5 - \Delta T) - 150 = (15)\ (1)$
$\Rightarrow \Delta T = 5$ N
$\Rightarrow$ Tension in cord 2, $T_2 = 2.5$ N

13. For elevator acceleration 2 m/s^2, tension in cord 2 and cord 3 is zero.
So, $T_1 - 150 = (15)\ (2)$
$\Rightarrow$ Tension in cord 1, $T_1 = 180$ N
So, displacement of block = 15 cm downward.

SECTION – C

14. $$2\left[\int_0^{\pi/2}(\mu_1-\mu_2)Rg\lambda\cos\theta d\theta\right] = 2(\mu_1-\mu_2)R\lambda g$$

$$\therefore\ a = \frac{2(\mu_1-\mu_2)R\lambda g}{2\pi R\lambda} = 4$$



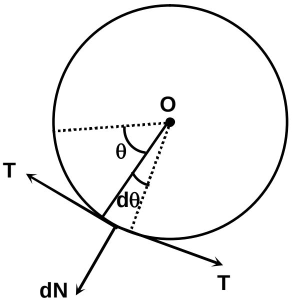
15. At v_{max}

$$Av_{max}^2 = F = \frac{km}{v_{max}}$$ (where k is a proportionalty constant)

$$m^{2/3}v_{max}^2 \propto \frac{m}{v_{max}}$$

$$\therefore\ v_{max} \propto m^{1/9}$$

16. $1.25 = \frac{1}{2}(10)t^2$
$\therefore$ t = 0.5 sec
Distance of the cylinder from the truck = 8 × 0.5 = 4 m



17. $2T\sin\frac{d\theta}{2} - dN = \lambda R d\theta \frac{v^2}{R}$ (λ is linear mass density of belt)

$\therefore$ $T d\theta - dN = \lambda v^2 d\theta$

$\therefore$ so total normal = $\int_{-\frac{\pi}{2}}^{+\frac{\pi}{2}} dN\cos\theta = \int_{-\frac{\pi}{2}}^{+\frac{\pi}{2}} T\cos\theta d\theta - \lambda v^2 \int_{-\frac{\pi}{2}}^{+\frac{\pi}{2}} \cos\theta d\theta$

$\therefore$ N = 8 newton

18. $F = 2m\eta A\left[(v_0 + v)^2 - (v_0 - v)^2\right]$

$= 2(10^{-26})(10^{25})(1)\left[(5+2)^2 - (5-2)^2\right]$

$= 0.2 \times 40 = 8$ N

Chemistry

PART – II

SECTION – A

19. $V \propto n$

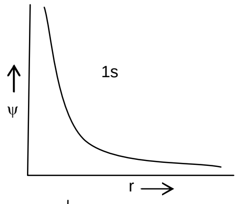
$P_{PCl_3} = P_{Cl_2} = 2 \times \frac{40}{100} = 0.8$ atm

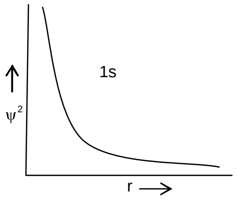
$K_P = \frac{0.8 \times 0.8}{0.40} = 1.6$ atm

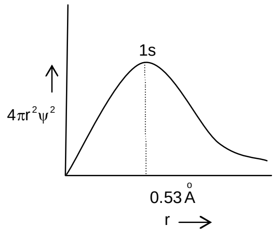
$K_C = \frac{K_P}{(RT)^{\Delta n}} = \frac{1.6}{0.0821 \times 520} = 0.037$

Increase in pressure increases the number of moles $PCl_5(g)$.

20.







21. All the reactions are disproportionation reactions.

22. $CaC_2 + 2H_2O \longrightarrow Ca(OH)_2 + C_2H_2$

$CaC_2 + N_2 \longrightarrow Ca(NCN) + C$

$Be_2C + 4H_2O \longrightarrow 2Be(OH)_2 + CH_4$

Cyanamide ion $[N = C = N]^{2-}$ is isoelectronic with CO_2.

23.

$$\begin{array}{lll} NO(g) + & NO_2(g) & \rightleftharpoons N_2O_3(g) \\ 3P & 5P & \quad 0 \\ 3P - x & 5P - x - 2y & \quad x \end{array}$$

$$\begin{array}{lll} 2NO_2(g) & \rightleftharpoons & N_2O_4(g) \\ 5P - x - 2y & & y \end{array}$$

$$K_{P_2} = \frac{P_{N_2O_4}}{\left(P_{NO_2}\right)^2}, \quad 8 = \frac{P_{N_2O_4}}{(0.5)^2}$$

$P_{N_2O_4} = 2$ atm

$\therefore y = 2$ atm

$P_{total} = P_{NO} + P_{NO_2} + P_{N_2O_3} + P_{N_2O_4}$

$5.5 = 3P - x + 0.5 + x + 2$

3P = 3, P = 1

5P – x – 2y = 0.5

5 × 1 – x – 2 × 2 = 0.5, x = 0.5 atm.

$$K_{P_1} = \frac{P_{N_2O_3}}{\left(P_{NO}\right)\left(P_{NO_2}\right)}$$

$$= \frac{0.5}{2.5 \times 0.5} = 0.4 \text{ atm}$$

$P_{NO} = 2.5$ atm $P_{NO_2} = 0.5$ atm $P_{N_2O_3} = 0.5$ atm, $P_{N_2O_4} = 2$atm

24. B – F bond in BF_3 is smaller due to $P\pi - P\pi$ back bonding.

$B_3N_3H_6 + 9H_2O \longrightarrow 3NH_3 + 3H_3BO_3 + 3H_2$

In $T\ell I_3$ oxidation state of $T\ell$ is +1.

25.

$$\begin{array}{cccc} NH_4OH + & HCl & \longrightarrow & NH_4Cl + H_2O \\ 60\times0.1=6 & 40\times0.1=4 & & 0 \\ 2 & 0 & & 4 \end{array}$$

The resulting solution is a basic buffer.

$$pOH = pK_b + \log\frac{\left[NH_4^+\right]}{\left[NH_4OH\right]}$$

$$pOH = 4.74 + \log\frac{4}{2} = 5.04$$

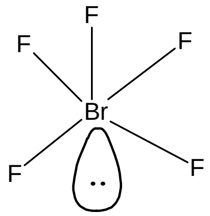
$$pH = 14 - 5.04 = 8.96$$

26. Decomposition of HI on surface of gold is a zero order reaction.

27. For a 1st order reaction $k = \frac{2.303}{t}\log\frac{a}{a-x}$.

28. For 2nd order reaction $k = \frac{1}{t}\left(\frac{1}{a-x} - \frac{1}{a}\right)$.

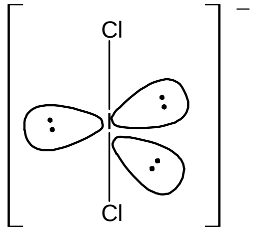
Solution for the Q. No. 29 to 31.



Hybridisation – sp^3d^2

Shape – square pyramidal
Lone pair in central atom = 1

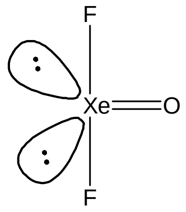
$[ICl_2]^-$



Hybridisation – sp^3d

Shape – Linear
Lone pair in the central atom = 3

$XeOF_2$



Hybridisation – sp^3d

Shape – T-shaped
Lone pair in the central atom = 2

SECTION – C

32. $2LiNO_3 \xrightarrow{\Delta} Li_2O + 2NO_2 + \frac{1}{2}O_2$

1 mol of $LiNO_3$ will produce NO_2 = 1

$2Mg(NO_3)_2 \xrightarrow{\Delta} 2MgO + 4NO_2 + O_2$

1 mol of $Mg(NO_3)_2$ will produce NO_2 = 2

$2Ca(NO_3)_2 \xrightarrow{\Delta} 2CaO + 4NO_2 + O_2$

1 mol of $Ca(NO_3)_2$ will produce NO_2 = 2

$2NaNO_3 \xrightarrow{\Delta} 2NaNO_2 + O_2$

Total number of moles of NO_2 produced = 5

33. $V = 2.188 \times 10^6 \times \frac{Z}{n} m/sec.$

$\therefore n = \frac{2.188 \times 10^6 \times 1}{5.47 \times 10^5} = 4$

$\therefore$ According to de-Broglie, total number of waves made by an electron in one complete revolution = n = 4

34. The following species are paramagnetic.
$N_2^+, O_2^-, B_2, H_2^-, He_2^+$

35. $$\underset{\substack{6\times0.1=0.6\\0.6-0.x}}{CH_3COOH}+\underset{x\times0.1}{NaOH}\longrightarrow\underset{\substack{0\\0.x}}{CH_3COONa}+H_2O$$
The resulting solution is a buffer solution.

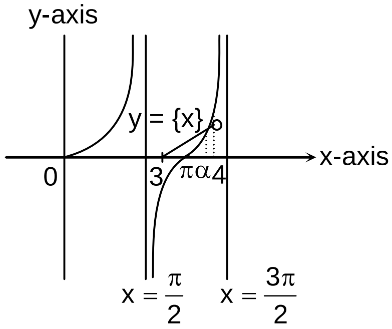
$$pH = pK_a + \log\frac{[CH_3COO^-]}{[CH_3COOH]}$$
$$pH = pK_a + \log\frac{0.x}{0.6-0.x}$$
$$5.04 = 4.74 + \log\frac{0.x}{0.6-0.x}$$
$$0.3 = \log\frac{0.x}{0.6-0.x}$$
$$\log 2 = \log\frac{0.x}{0.6-0.x}$$
$$\frac{0.x}{0.6-0.x} = 2$$
$x = 4$

36. $$\underset{10(1-\alpha)}{A(g)} \rightleftharpoons \underset{10\alpha}{B(g)} + \underset{10\alpha}{C(g)}$$
$$D = \frac{100}{2} = 50, \quad d = \frac{83}{2} = 41.5$$
$$\therefore \alpha = \frac{D-d}{d(n-1)}$$
$$= \frac{50-41.5}{41.5(2-1)} = 0.2$$
$\therefore$ Number of moles of 'C' at equilibrium $= 10\alpha = 10\times0.2 = 2$

Mathematics PART – III

SECTION – A

37. Shown in the figure



38. (A) $$\frac{x-\frac{1}{x}}{4\left(x^2+\frac{1}{x^2}-1\right)} = \frac{x-\frac{1}{x}}{4\left((x-1/x)^2+1\right)}$$

So, $$-\frac{1}{8} \le \frac{x-\frac{1}{x}}{4\left(\left(x-\frac{1}{x}\right)^2+1\right)} \le \frac{1}{8}$$

$$\therefore \left[\frac{x\left(x^2-1\right)}{4\left(x^4-x^2+1\right)}+\frac{1}{8}\right]=0$$

So: $f(x)=2x+[x]+\frac{1}{2}\sin 2x$ injective but not onto

(B) $f'(x) = -x^3 \cos x + x^2 (3 \sin x + 2 \cos x) + 4x(\sin x + 2)$
Many one onto

39. $T_n=\frac{1}{n}\sum_{r=0}^{n-1} f\left(\frac{r}{n}\right)$ where $f(x) = x^4 + x^3 + x^2 + 2$, f(x) is an increasing function for $\forall$ x > 0.

$$T_n=\frac{1}{n}\left[f(0)+f\left(\frac{1}{n}\right).....+f\left(\frac{n-1}{n}\right)\right]$$

$$T_n<\int_0^1\left(x^4+x^3+x^2+2\right)dx=\frac{167}{60}$$

$$S_n=\frac{1}{n}\sum_{r=1}^{n} f\left(\frac{r}{n}\right)>\frac{1}{n}\left[f\left(\frac{1}{n}\right)+.....+f\left(\frac{r}{n}\right)\right]=\frac{167}{60}$$

40. (A) Let $\int_0^{n\pi}\left|\frac{\sin t+\cos t}{t}\right|dt=A_n$

$$A_n>\frac{1}{\pi}\left[\int_0^{\pi}\left|\sin t+\cos t\right|dt+\int_{\pi}^{2\pi}\frac{\left|\sin t+\cos t\right|dt}{2}+.....\right]$$

$$>\frac{1}{\pi}\left(1+\frac{1}{2}+\frac{1}{3}+.....+\frac{1}{n}\right)\left(\int_0^{\pi}\left|\sin t+\cos t\right|dt\right)$$

$$>\frac{2\sqrt{2}}{\pi}\left(1+\frac{1}{2}+\frac{1}{3}+.....+\frac{1}{n}\right)$$

(C) $\frac{3\sqrt{\sin x}+8-3\sqrt{\sin x}}{2}\geq\sqrt{3\sqrt{\sin x}\left(8-3\sqrt{\sin x}\right)}$

(D) $1\leq\tan x\leq\sqrt{3}$ and $\frac{3}{\pi}\leq\frac{1}{x}\leq\frac{4}{\pi}$

So; $\frac{3}{\pi}\leq\frac{\tan x}{x}\leq\frac{4\sqrt{3}}{\pi}$

41. $\frac{1}{2}\operatorname{cosec}^2\left(x^2+y^2\right)d\left(x^2+y^2\right)=2\left(\frac{y}{x}\right)^3 d\left(\frac{y}{x}\right)$

$$\Rightarrow -\frac{1}{2}\cot\left(x^2+y^2\right)-\frac{2(y/x)^4}{4}+c=0$$

42. $I=\int_{1/8}^{7/8} f\left(f(x)\right)dx$ ..... (1)

$I=\int_{1/8}^{7/8} f\left(f(1-x)\right)dx=\int_{1/8}^{7/8} f\left(1-f(x)\right)dx$ ..... (2)

So, $2I=\frac{3}{4}$

43. $\int e^{x\sec^2 x-\tan x}\left(x\tan x-\frac{\sin 2x}{2}\right)dx = \int e^{x\sec^2 x-\tan x}\left(\frac{\cos^2 x}{2}\left(x\sec^2 x-\tan x\right)'+\left(\frac{\cos^2 x}{2}\right)'\right)$

$= e^{x\sec^2 x-\tan x}\cdot\frac{\cos^2 x}{2}+c$

44.-46. (I) $f(x) = ||x-6|-|x-8|| - |x^2-4| + 3x - |x-7|^3$ is continuous $\forall\ x \in R$ and not differentiable at $x = -2, 2, 6, 7$ & 8

(II) $f(x) = (x^2-9)|x^2+11x+24| + \sin|x-7| + \cos|x-4| + (x-1)^{3/5}\sin(x-1)$ is continuous $\forall\ x \in R$ and not differentiable at $x = -8$ & 7

(III) $f(x)=\begin{cases}(x+1)^{3/5}-\frac{3\pi}{2} & : \ x<-1\\ \left(x-\frac{1}{2}\right)\cos^{-1}\left(4x^3-3x\right) & : \ -1\le x\le 1\\ (x-1)^{5/3} & : \ 1<x<2\end{cases}$ is discontinuous at $x = -1$ & 1 not differentiable at $x = -1, -\frac{1}{2}$ & 1

(IV) $f(x) = \{\sin x\}\{\cos x\} + (\sin^3\pi\{x\})([x]),\ x \in [-1, 2\pi]$

Let $g(x)=\underbrace{\left(\sin\pi\{x\}\right)\left([x]\right)}_{\text{cont. at } x\,=\,I}\left(\sin^2\pi\{x\}\right)$

$g'(I^+) = g'(I^-)$ so differentiable at $x = I$ and for $\{\sin x\}\{\cos x\}$

Doubtful points for non differentiability are $x = 0, \frac{\pi}{2}, \pi, \frac{3\pi}{2}$

$\because$ $\{\sin x\}\cdot\{\cos x\}$ is discontinuous at $x = 0, \frac{\pi}{2}, 2\pi$

So not differentiable at $x = 2n\pi, 2n\pi + \frac{\pi}{2}$

47.-49. (I) $\frac{(3-1)^3}{4}\le|x-1|^3+|x-3|^3<\infty$

(II) $u=\sin\left(\ln\left(\frac{\sqrt{4-x^2}}{1-x}\right)\right)+\cos\left(\ln\left(\frac{\sqrt{4-x^2}}{1-x}\right)\right)$

$\because\ 0\le\frac{\sqrt{4-x^2}}{1-x}<\infty$

$-\infty<\ln\left(\frac{\sqrt{4-x^2}}{1-x}\right)<\infty$

So; $-\sqrt{2}\le u\le\sqrt{2}$

(III) Let $|x+5| = t$; $g(t) \in \left(0,\frac{1}{2}\right]-\left\{\frac{1}{4}\right\}$

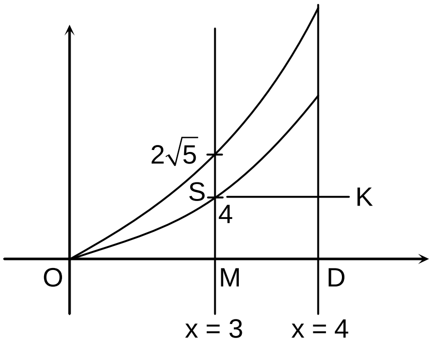
$g(t)=\frac{(t-2)}{(t-2)(t+2)}$

(IV) $\theta \le \cos^{-1} x \le \pi$

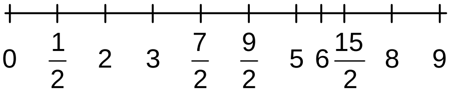
$-\infty < \ln(\cos^{-1} x) \le \ln \pi < 2$

SECTION – C

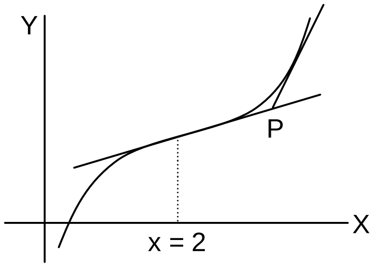
50. Let cot A = a then $a^3 + a^2|a + x| + |a^2x + 1| = 1$
$|a^3 + a^2x| + |a^2x + 1| = (a^2x + 1) - (a^2x + a^3)$
$|\alpha| + |\beta| = \alpha - \beta$
So, $\alpha \geq 0$ and $\beta \leq 0$
Now take cases: $a \leq -1$ and $-1 < a \leq 0$ & $0 < a \leq 1$
Finally we get, $a \in (-\infty, -5] \cup \left[-\frac{1}{\sqrt{5}}, \frac{1}{\sqrt{6}}\right]$



51. $\because\ 0 \leq f(x) \leq 2$
and g(3) $\in \left[-2\sqrt{5}, -4\right] \cup \left[4, 2\sqrt{5}\right]$
Also $\int_0^4 g(x)dx = \int_0^4 f'(x)dx = \left(f(4) - f(0) \in (-2, 2)\right)$
Case-I: Let g(x) > 0 and g″(x) > 0
Clearly $\int_0^4 g(x)dx \geq \text{Area}(MDKS) = 4$
Which is a contradiction
Thus, there is no such C
Similarly **case-II**: Let g(x) < 0 and g″(x) < 0



52. $f\left(\frac{x+13}{2}\right) = f\left(\frac{3-x}{2}\right)$
f(x) = f(8 – x)
f′(x) = –f′(8 – x)
$f'\left(\frac{1}{2}\right) = -f'\left(\frac{15}{2}\right) = 0$
f′(2) = –f′(6) = 0
f′(3) = –f′(5) = 0
$f'\left(\frac{9}{2}\right) = -f'\left(\frac{7}{2}\right) = 0$
f′(0) = –f′(8); $h(x) = \frac{d}{dx}\left(f'(x)f''(x)\right)$
Clearly: h(x) has minimum 18 zeroes



53. $y'' = 0 \Rightarrow x = 2$
Let P be the point of inflection
So; $P \equiv (2, 2b - a - 16)$
Equation of tangent line passing through inflection
Point: y = (b – 12)x – a + 8 .....(1)
Let $Q \equiv (2 + h, 3h - 1)$
Locus of Q: 3x – y = 7 ..... (2)
From equation (1) and (2), we get !
So; a = 15 and b = 15

54. $$\lim_{n\to\infty}\sum_{k=1}^{n}\frac{\frac{\left(\lambda k^4 + 2k^3 + k^2 + k + 1\right)}{n^5}}{\frac{\left(3n^5 + n^2 + n + 5k\right)}{n^5}} = \int_0^1 \frac{\lambda x^4 dx}{3} = \frac{\lambda}{3}\left(\frac{x^5}{5}\right)_0^1 = \frac{\lambda}{15}$$

FIITJEE

JEE (Advanced)-2018

ALL INDIA TEST SERIES

PART TEST – I

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 231**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-C & Section-D**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01 – 03, 24 – 26, 47 – 49)*** *contains 9 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (04 – 08, 27 – 31, 50 – 54) *contains 15 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (09 – 10, 32 – 33, 55 – 56) *contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer. There is no negative marking.*

2. ***Section-C (11 – 20, 34 – 43, 57 – 66)*** *contains 30 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

3. ***Section-D (21 – 23, 44 – 46, 67 – 69)*** *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

PART – I (Physics), PART – II (Chemistry), PART – III (Mathematics):

(SECTION – D)

For questions **21 to 23, 44 to 46, 67 to 69.**
Numerical answer type questions with answer XXXXX. XX

If answer is 348.4 / 251.37 / 213

Correct Method :

		3	4	8	.	4	0

		2	5	1	.	3	7

		2	1	3	.	0	0

Wrong Method :

	3	4	8		.	4	

3	4	8			.		4

		3	4	8	.		4

	3		4	8	.	4	

	2		5	1	.	3	7

		2	1	3	.		

		2	1	3	.	0	

		2	1	3	.		0

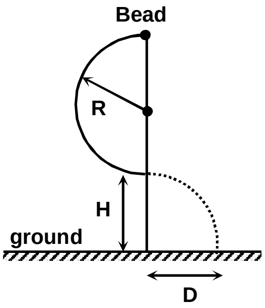
Physics

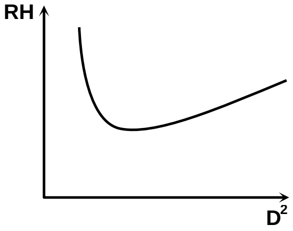
PART – I

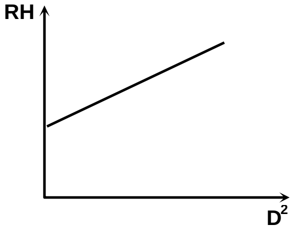
SECTION – A
(One Options Correct Type)

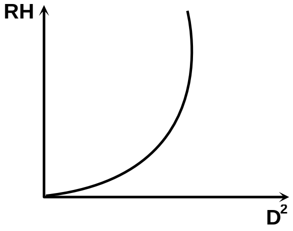
This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

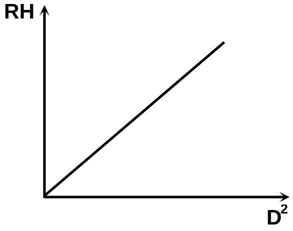
1. A semicircular wire of radius R is oriented vertically. A small bead is released from rest from the top of the wire. It slides without friction under the influence of gravity to the bottom, where it then leaves the wire horizontally and falls distance H to the ground. The bead lands a horizontal distance D away from where it was launched. Which of the following is correct graph of RH versus D^2?



(A)


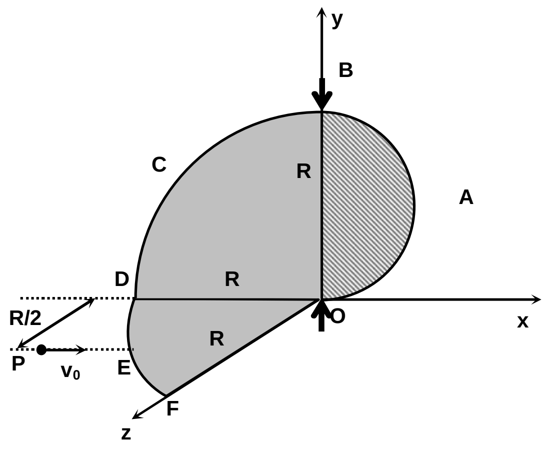
(B)


(C)


(D)


Space for Rough work

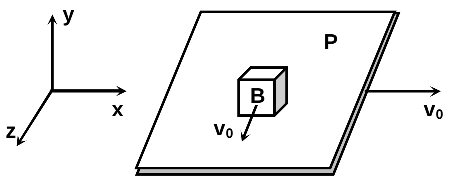
2. A folded plate OABCDEFO made of materials such that part OABO (say part(i)), BCDOB (say part(ii)) and DEFOD (say part(iii)) has mass 4m, m and m respectively. Part (i) is a uniform semicircular plate of radius R/2 and is on the xy plane. Part (ii) and (iii) each is a uniform quarter circular plate of radius R on xy and xz plane respectively. The whole system is free to rotate about y-axis. A particle P of mass m moving with velocity v_0 hits to a point located at the circumference of the part (iii) and sticks to it. The point is at a distance R/2 from x-axis as shown in the figure. Angular velocity of the combined system just after the collision is



(A) $\frac{v_0}{4R}$ (B) $\frac{2v_0}{5R}$

(C) $\frac{3v_0}{5R}$ (D) $\frac{v_0}{2R}$

3. A very large plank P of some unknown mass is being moved with velocity $v_0\hat{i}$ under application of an external force (not shown in figure). Simultaneously a block B of mass m placed on the plank is also moving with velocity $v_0\hat{k}$. All these velocities are with respect to ground frame and at t = 0. Coefficient of friction between the plank and the block is μ. Choose the correct option(s).



(A) Kinetic friction force acting on the block, at t = 0 is $-\mu mg\hat{k}$.

(B) At t = 0, power developed (with respect to ground frame) by kinetic friction force on the block B is $-\frac{\mu mgv_0}{\sqrt{2}}$

(C) At t = 0, power developed (with respect to ground frame) by kinetic friction force on the block B is $-\mu mg\sqrt{2}v_0$

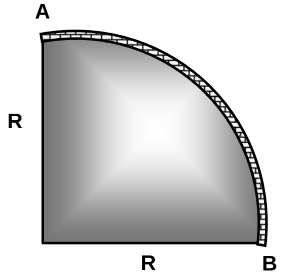
(D) At t = 0, heat dissipation per sec in the system is $2\sqrt{2}\,\mu mgv_0$.

Space for Rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

4. A rope AB of linear mass density λ is placed on a quarter vertical fixed disc of radius R as shown in the figure. The surface between the disc and rope is rough such that the rope is just in equilibrium. Gravitational acceleration is g. Choose the correct option(s).



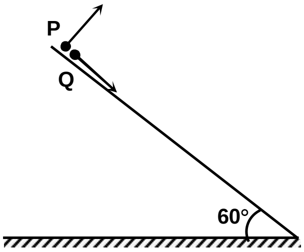
(A) Coefficient of static friction between rope and disc is $\mu = 1$.

(B) Coefficient of static friction between rope and disc is $\mu = \frac{1}{\sqrt{2}}$.

(C) Maximum tension in the rope is at the top most point A of the rope.

(D) Maximum tension in the rope is $\lambda Rg(\sqrt{2}-1)$.

5. A particle P is projected at t = 0 from a point on the surface of a smooth inclined plane as shown in the figure simultaneously another particle Q is released on the smooth inclined plane from the same position. P and Q collide after t = 4 seconds. Then choose the correct Option(s).



(A) Trajectory of particle P in the frame of Q is parabola during the flight of particle P.

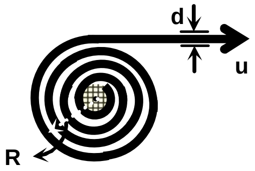
(B) Speed of projection of P is 20 m/s.

(C) Relative velocity of Particle P in the frame of Q changes linearly with time during the flight of P.

(D) Acceleration of particle P in the frame of Q is zero during the flight of P.

Space for Rough work

6. A disc is free to rotate about an axis passing through its centre and perpendicular to its plane. The moment of inertia of the disc about its rotation axis is I. A light ribbon is tightly wrapped over it in multiple layers. The end of the ribbon is pulled out at a constant speed of u. Let the radius of the ribboned disc be R at any time and thickness of the ribbon be d(<<R).



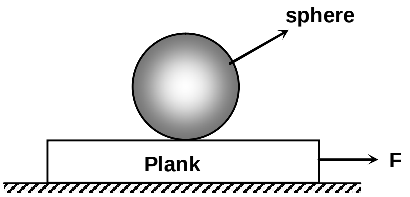
(A) Angular acceleration of the disc at any instant is proportional to $\frac{1}{R^3}$, where R is radius of the ribboned disc.

(B) Angular acceleration of the disc at any instant is proportional to $\frac{1}{R^2}$, where R is the radius of the ribboned disc.

(C) Force required to pull the ribbon at constant speed u is $F = \frac{Iu^2d}{2\pi R^4}$.

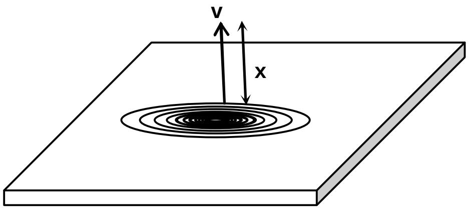
(D) Force required to pull the ribbon at constant speed u is $F = \frac{Iu^2d}{\pi R^4}$.

7. A plank with a uniform sphere placed on it rests on a smooth horizontal plane. The plank is pulled to right by a constant force F. If the sphere does not slip over the plank, then



(A) Both have the same acceleration.
(B) Acceleration of the center of sphere is less than that of the plank.
(C) Work done by friction acting on the sphere is equal to its total kinetic energy.
(D) Total kinetic energy of the system is equal to work done by force F.

8. A uniform rope of liner mass density λ and length ℓ is coiled on a smooth horizontal surface. One end is pulled up by an external agent with constant vertical velocity v. Choose the correct option(s).



(A) Power developed by external agent as a function of x is $P = \lambda xgv$
(B) Power developed by external agent as a function of x is $P = (\lambda v^2 + \lambda xg)v$
(C) Energy lost during the complete lift of the rope is zero.
(D) Energy lost during the complete lift of the rope is $\frac{\lambda\ell v^2}{2}$.

Space for Rough work

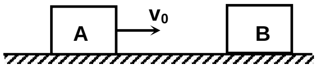
(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 9 and 10

Graphical solution of a two body head on collision

A block A of mass m moving with a uniform velocity v_0 strikes another identical block B kept at rest on a horizontal smooth surface as shown in the figure-(i). We can conserve linear momentum.



Smooth horizontal surface

figure-(i)

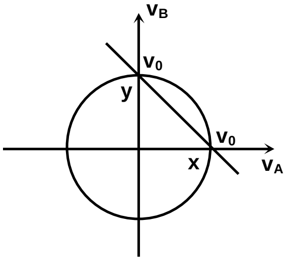


figure-(ii)

So, $mv_0 = mv_A + mv_B$ (v_A and v_B are the velocities of the blocks after collision)

$$\therefore \quad v_0 = v_A + v_B \qquad \ldots(i)$$

If the collision is perfectly elastic

$$\frac{1}{2}mv_0^2 = \frac{1}{2}mv_A^2 + \frac{1}{2}mv_B^2$$

$$\Rightarrow \quad v_0^2 = v_A^2 + v_B^2 \qquad \ldots(ii)$$

Both the above equations (i) and (ii) are plotted on $v_A - v_B$ plane as shown in figure (ii). This plot can be used to find the unknowns v_A and v_B.

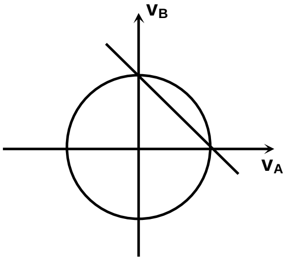
For example, the solution of the situation in figure (i) is $v_A = 0$, $v_B = v_0$ (point y in the plot)

Because $v_A = v_0$, $v_B = 0$ (point x in the plot) is not physically possible.

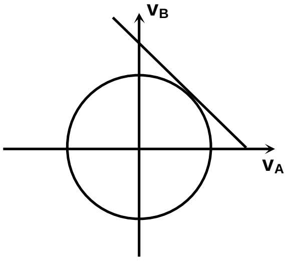
Now answer the following questions based on the above comprehension.

9. If the collision is perfectly inelastic, then the $v_A - v_B$ plot is

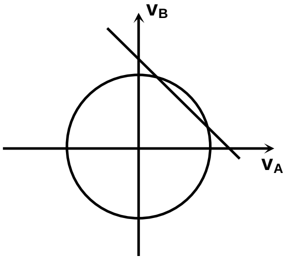
(A)



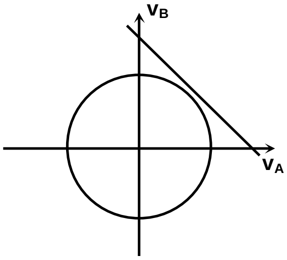
(B)



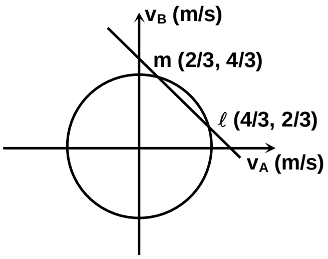
(C)



(D)



Space for Rough work



10. In a situation, block A is moving with velocity 2 m/s and strikes another identical block B kept at rest. The $v_A - v_B$ plot for the situation is shown. m and ℓ are the intersection points whose v_A, v_B coordinates are given in the figure. The coefficient of restitution of the collision is
(A) 1/2
(B) 1/3
(C) 1
(D) Collision not possible

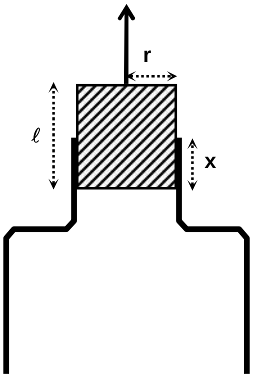
SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

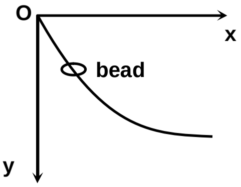
11. A table has a heavy circular top of radius 1 m and mass 2 kg. It has four light legs of length 1 m fixed symmetrically on its circumference. Find the maximum mass (in kg) which may be placed anywhere on this table without toppling it. (take $\sqrt{2} = 1.4$)

12. A cylindrical massless cork of length ℓ = 10 cm and radius r = 3 cm is slowly extracted from the neck of a bottom opened bottle. If the normal pressure between the bottle and un-extracted part of the cork at any instant is constant and equal to $P = \frac{10^5}{\pi}$ N/m^2, find the work done (in Joule) in extracting it completely. The coefficient of friction between the cork and bottle is μ = 0.3.

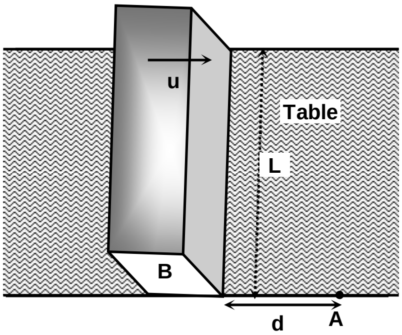


Space for Rough work

13. A bead under the influence of gravity, sides down a frictionless wire whose y coordinate is changing with x co-ordinate as shown in the figure. Assume that at position O the wire is vertical and the bead passes this point with a given speed v_0 downward. If the shape of the wire is such that the vertical component of velocity remains v_0 at all time, find (a + b + c) in the shape function of wire given by $y = \frac{(agv_0x)^{\frac{b}{c}}}{2g}$, where g is gravitational acceleration.



14. A heavy block B is sliding with constant velocity u = 5 m/s on a horizontal table. The width of the block is L = 4 m. There is an insect A at distance d = 3 m from the block as shown in the figure. The insect wants to cross to the opposite side of the table. It begins to crawl at a constant velocity v at the instant shown in the figure. Find the least value of v (in m/s) for which the insect can cross to the other side without getting hit by the block.



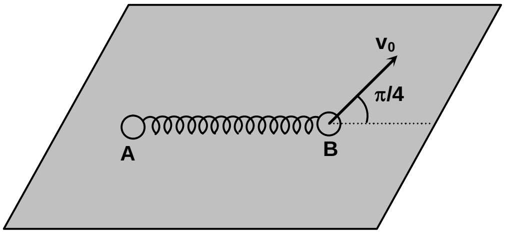
(Top view, slightly skewed)

15. A body is projected vertically upwards with a velocity u = 5 m/s. After time t another body is projected vertically upward from the same point with a velocity v = 3 m/s. If they meet in minimum time duration measured from the projection of first body, then $t = \frac{k}{g}$ sec, find k. (where g is gravitation acceleration)

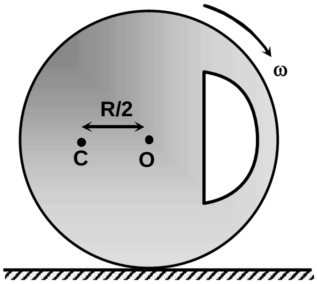
16. A car can pull a trailer of twice its mass up a certain slope at a maximum speed v = 1 m/s. Without the trailer the maximum speed of the car up the same slope is 2v. The resistance to the motion is proportional to mass and square of speed. If the car (without trailer) starts to move down the same slope, with its engine shut off, eventually it will acquire a constant speed v_t, then find v_t^2 (in m^2/s^2).

Space for Rough work

17. A dumbbell consists of two balls A and B each of mass m = 1 kg and connected by a spring. The whole system is placed on a smooth horizontal surface as shown in the figure. Initially the spring is at its natural length, the ball B is imparted a velocity $v_0 = \frac{8}{\sqrt{7}}$ m/s in the direction shown. The spring constant of the spring is adjusted so that the length of the spring at maximum elongation is twice that of the natural length of the spring. Find the maximum potential energy stored (in Joule) in the spring during the motion.

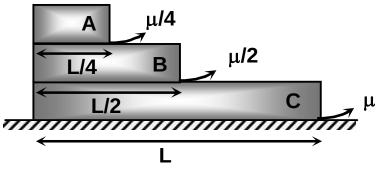


18. A disc shaped body (having a hole as shown in the figure) of mass m = 10 kg and radius R = $\frac{10}{9}$m is performing pure rolling motion on a rough horizontal surface. In the figure point O is geometrical center of the disc and at this instant the centre of mass C of the disc is at same horizontal level with O. The radius of gyration of the disc about an axis passing through C and perpendicular to the plane of the disc is $\frac{R}{2}$ and at the instant shown the angular velocity of the disc is $\omega = \sqrt{\frac{g}{R}}$ rad/sec in clockwise sense. g is gravitation acceleration = 10 m/s^2. Find angular acceleration α(in rad/s^2) of the disc at this instant.



19. A long plank begins to move at t = 0 and accelerates along a straight track with a speed given by $v = 2t^2$ for $0 \le t \le 2$ (where v is in m/s and t is in second). After 2 sec the plank continues to move at the constant speed acquired. A small block initially at rest on the plank begins to slip at t = 1 sec and stops sliding at t = 3 sec. If the coefficient of static friction and kinetic friction between the plank and the block is 0.s and 0.k (where s and k are digits) respectively, find s + k. (take g = 10m/s^2)

20. Three blocks A, B and C of mass m, $\frac{m}{2}$ and m of different densities and dimensions are placed over each other as shown in the figure. The coefficients of friction are shown. Blocks placed in a vertical line are made to move towards right with same velocity at the same instant. Find the time (in sec) taken by the upper block A to topple from the middle block B. Assume that blocks B and C don't stop sliding before A topples from B. (given L = 36 m, μ = 0.4 and g = 10 m/s^2)



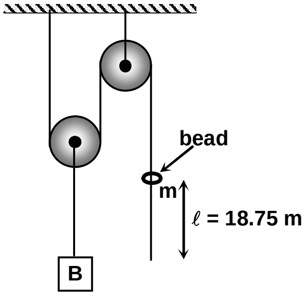
Space for Rough work

SECTION – D

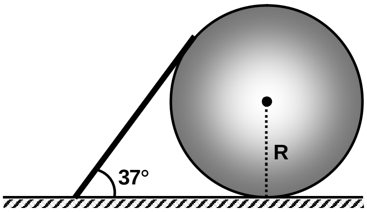
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

21. In the system shown in the figure, a bead of mass m can slide on the string. There is friction between the bead and the string. Block B has mass equal to twice that of the bead. The system is released from rest with length ℓ = 18.75 m of the string hanging below the bead. Assuming the pulley and string to be massless. Find the distance (in meter) moved by the block B before the bead slips out of the thread.



22. A stick of mass density λ = 8 kg/m rests on a disc of radius R = 20 cm as shown in the figure. The stick makes an angle $\theta = 37°$ with the horizontal and is tangent to the disc at its upper end. Friction exists at all points of contact and assume that it is large enough to keep the system at rest. Find the friction force (in Newton) between the ground and the disc. (take g = 10 m/s^2)



23. A bead moves along straight horizontal wire of length L, starting from the left end with a velocity v_0. Its retardation is proportional to the distance from the right end of the wire. Find the initial retardation (in m/s^2) (at left end of the wire) if the bead reaches the right end of the wire with a velocity $\frac{v_0}{2}$. (given v_0 = 5 m/s and L = 1 m)

Space for Rough work

Chemistry

PART – II

SECTION – A

(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

24. 10 ml of $\frac{M}{10}$ NH_4OH is mixed with 4 ml of $\frac{M}{10}$ H_2SO_4 solution. The pH of the resulting solution is (pK_b NH_4OH = 4.76), (log2 = 0.3).

(A) 5.36	(B) 8.64
(C) 9.26	(D) 4.74

25. A catalyst lower the activation energy of a reaction from 200 KJ mol^{-1} to 100 KJ mol^{-1}. The temperature at which the rate of uncatalysed reaction will be same as the rate of catalysed reaction at 25^o C is (assuming Arrheneous constant A to be same in both the cases)

(A) 50^oC	(B) 225^oC
(C) 323^oC	(D) 596^oC

26. Which of the following reaction is incorrect?

(A) $2B_2O_3 + P_4O_{10} \longrightarrow 4BPO_4$	(B) $BCl_3 + 3H_2O \longrightarrow H_3BO_3 + 3HCl$
(C) $2BF_3 + 6NaH \xrightarrow{180^oC} 2B + 6NaF + 3H_2$	(D) $B_3N_3H_6 + 3HCl \longrightarrow B_3N_3H_9Cl_3$

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

27. Which of the following statement is/are correct?
(A) In PCl_3F_2 the P – F bond length is greater than P – Cl bond length.
(B) N – N bond length in N_2H_4 is greater than N – N bond length in N_2F_4.
(C) In PCl_5 the P – Cl axial bond length is greater than P – Cl equatorial bond length.
(D) In SF_6 all S – F bonds have equal bond length.

28. The **incorrect** statement(s) among the following is/are?
(A) In aqueous solution Na has stronger reducing character than Li.
(B) LiH is thermally more stable than NaH.
(C) Li_2CO_3 is thermally more stable than Na_2CO_3.
(D) KO_2 is paramagnetic in nature.

Space for Rough work

29. Which of the following silicates is/are pyrosilicate?
(A) $Sc_2Si_2O_7$
(B) $MgSiO_3$
(C) $Ca_3Si_3O_9$
(D) Zn_2SiO_4

30. Which of the following statement(s) is/are correct?
(A) Borax on strong heating produces a glassy mass of sodium metaborate and boric anhydride.
(B) The formula of borax is $Na_2[B_4O_5(OH)_2].8H_2O$.
(C) Aqueous solution of borax is weakly acidic in nature.
(D) The number of B – O – B bonds in borax is 5.

31. Which of the following statement(s) is/are correct for the following equilibrium?

$$NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$$

(A) Addition of $NH_4HS(s)$ at equilibrium increases the concentration of $NH_3(g)$.
(B) Addition of $NH_3(g)$ at equilibrium decreases the concentration of $H_2S(g)$.
(C) K_P is independent of the amount of $NH_4HS(s)$.
(D) Increase in temperature changes the K_P of this reaction.

Space for Rough work

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 32 to 33

Solid $AgNO_3$ is gradually added to a solution which is 0.01 M in Cl^- and 0.01 M in CO_3^{2-}.
$K_{sp}AgCl = 1.8 \times 10^{-10}$ and $K_{sp}Ag_2CO_3 = 4 \times 10^{-12}$.

32. The minimum concentration of Ag^+ required to start the precipitation of Ag_2CO_3 is
(A) 2×10^{-5} M
(B) 4×10^{-10} M
(C) 4×10^{-5} M
(D) 2×10^{-10} M

33. The concentration of Cl^- when Ag_2CO_3 starts precipitating is
(A) 1.8×10^{-9} M
(B) 1.8×10^{-5} M
(C) 1.2×10^{-4} M
(D) 9×10^{-6} M

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

34. In a hydrogen atom the de-Broglie wavelength of an electron is 1.67 nm. The value of principal quantum number of the electron is

35. For the redox reaction
$$xCr(OH)_3 + yIO_3^- + zOH^- \longrightarrow xCrO_4^{2-} + yI^- + 5H_2O$$
the sum of the stoichiometric coefficient (x + y + z) is equal to

36. The following equilibrium exists in a closed vessel in 1 L capacity
$$A(g) + 3B(g) \rightleftharpoons 4C(g)$$
initial concentration of A(g) is equal to that of B(g). The equilibrium concentration of A(g) and C(g) are equal. K_c for the reaction is

37. A vessel at 1000 K contains CO_2(g) at 2 atm pressure. When graphite is added the following equilibrium is established
$$CO_2(g) + C(s) \rightleftharpoons 2CO(g)$$
the total pressure at equilibrium is 3 atm. The value of K_p is

38. The half-lie period for the decomposition of AB_2(g) at 100 mm pressure is 10 min and at 200 mm pressure is 5 min, the order of reaction is

39. How many of the following compounds have polymeric structure?
Boron Nitride, Boric acid, Borazole, Borax, Beryllium hydride, Gypsum, Graphite.

40. Total number of solutions from the following which has pH < 7 at 25°C.
$$\left(K_a CH_3COOH = 1.8 \times 10^{-5}, K_b NH_4OH = 1.8 \times 10^{-5}\right)$$
(i) 10^{-8} M HCl
(ii) 0.01 M solution of NH_4Cl
(iii) 0.01 M solution of CH_3COONa
(iv) 0.01 M solutin of $B(OH)_3$
(v) 0.01 M solution of CH_3COONH_4

Space for Rough work

41. 200 ml of 1 M CH_3COOH ($K_a = 10^{-6}$) is mixed with 200 ml of 0.1 M HCOOH ($K_a = 10^{-5}$). The pH of the resulting mixture is

42. How many of the following molecules/ion are planar?
$CO_3^{2-}, NO_3^-, XeF_4, XeO_4, SF_4, I_3^-, COCl_2, SO_3, ClO_3^-, I_2Cl_6$ (solid)

43. How many of the following hydroxides are soluble in excess NaOH solution?
$Fe(OH)_3$, $Al(OH)_3$, $Zn(OH)_2$, $Ni(OH)_2$, $Mn(OH)_2$, $Sn(OH)_2$, $Cu(OH)_2$

SECTION – D

(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

44. The shortest wavelength of transition in Paschen series of He^+ ion in nanometer(nm) is $\left(\frac{1}{R_H} = 91.12\,\text{nm}\right)$

45. 4 mole of $S_2Cl_4(g)$ is introduced into a 10 L vessel. The following equilibrium was establised
$S_2Cl_4(g) \rightleftharpoons 2SCl_2(g)$
at equilibrium 0.2 mol of S_2Cl_4 was present in the vessel. The value of equilibrium constant is.

46. A weak base MOH was titrated against a strong acid. The pH at $\frac{1}{4}$th equivalence point was 9.3. What will be the pH at $\frac{3}{4}$th equivalence point in the same titration? (log3 = 0.48)

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

47. If $\int_{-20}^{-10}\left(\frac{x^2-x}{x^3-3x+1}\right)^2 dx+\int_{\frac{1}{21}}^{\frac{1}{11}}\left(\frac{x^2-x}{x^3-3x+1}\right)^2 dx+\int_{\frac{21}{20}}^{\frac{11}{10}}\left(\frac{x^2-x}{x^3-3x+1}\right)^2 dx=\ell$ then $\ell+\frac{420}{7939}$ is equal to

(A) $\frac{110}{939}$
(B) $\frac{110}{969}$
(C) $\frac{110}{739}$
(D) $\frac{120}{759}$

48. Solution of the differential equation $x^2dy - 2xydx = x^3y^3dx + x^4y^2dy$ is

(A) $y = kx^2e^{\frac{x^2y^2}{2}}$
(B) $y = ky^2e^{\frac{x^2y^2}{2}}$
(C) $y = \frac{k}{x^2}e^{\frac{3x^2y^2}{2}}$
(D) $\ln\left(\frac{y}{x^2}\right) = \frac{(xy)^2}{4} + e^{c^2}$

49. If $f(x) = k^3x + k^3 - 2$ cuts the curve $g(x) = \frac{1}{2}\ln x^2$ at exactly one point then 'k' may lie in the interval

(A) $\left(\frac{1}{\sqrt{e}}, e\right)$
(B) $\left(\frac{1}{e}, \frac{1}{\sqrt{e}}\right)$
(C) $\left(\frac{1}{e^2}, \frac{1}{e}\right)$
(D) none of these

Space for rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

50. Let y = f(x) be the solution of the differential equation $y' = \frac{3y^2 + x}{4y^2 + 5}$ where $y\left(\frac{15}{4}\right) = 0$ then which of the following is/are correct?

(A) $y' \geq \frac{3}{4} \ \forall \ x \geq \frac{15}{4}$
(B) $\int_{15/4}^{27/4} f(x)dx \geq \frac{27}{8}$
(C) $\int_{15/4}^{27/4} f(x)dx < \frac{27}{8}$
(D) $f'(x) \geq 0 \ \forall \ x \geq 0$

51. The solution of the differential equation $(x^2 + 4y^2 - 5)xdx = (4x^2 - 3y^2 - 1)ydy$ is

(A) $\frac{2}{\sqrt{3}}\tan^{-1}\left(\sqrt{3}\left(\frac{y^2-1}{x^2-1}\right)\right) - \frac{1}{4}\ln\left(6\left(\frac{y^2-1}{x^2-1}\right)^2 + 2\right) - \ln\sqrt{|x^2-1|} + c = 0$

(B) $\frac{2}{\sqrt{3}}\tan^{-1}\left(\sqrt{3}\left(\frac{y^2-1}{x^2-1}\right)\right) - \frac{1}{4}\ln\left(6\left(\frac{y^2-1}{x^2-1}\right)^2 + 2\right) - \ln\sqrt{|x^2-1|} + \tan c = 0$

(C) $\frac{2}{\sqrt{3}}\tan^{-1}\left(\sqrt{3}\left(\frac{x^2-1}{y^2-1}\right)\right) - \frac{1}{4}\ln\left(6\left(\frac{y^2-1}{x^2-1}\right)^2 + 2\right) - \ln\sqrt{|x^2-1|} + e^c = 0$

(D) $\frac{2}{\sqrt{3}}\tan^{-1}\left(\sqrt{3}\left(\frac{x^2-1}{y^2-1}\right)\right) - \frac{1}{4}\ln\left(6\left(\frac{x^2-1}{y^2-2}\right)^2 + 2\right) - \ln\sqrt{|x^2-1|} + e^c = 0$

52. Let functions are defined from set A to set B where B = {α, β} and α & β are the roots of the equation $t^2 - \sqrt{2}t - \pi = 0$, then the number of functions which are

(A) discontinuous only at each even integers if A = [0, 11] is 682
(B) discontinuous only at each odd integer if A = [0, 11] is 243
(C) discontinuous only at prime numbers if A = [0, 11] is 81
(D) discontinuous only at x = 5k(k $\in I^+$) if A = [0, 11] is 27

53. If f(x) is a twice differentiable function and given that f(1) = 2, f(2) = 5 and f(3) = 10 then

(A) $f''(x) = 2 \ \forall \ x \in (1, 3)$
(B) $f''(x) = f'(x) = 2$ for some $x \in (2, 3)$
(C) $f''(x) = 3 \ \forall \ x \in (2, 3)$
(D) $f''(x) = 2$ for some $x \in (1, 3)$

Space for rough work

54. Let $f(x) = \begin{cases} 0 & ; \text{ x is irrational} \\ \dfrac{2}{2q^3 - q^2 + q + \sin^2 q + 5} & ; \text{ if } x = \dfrac{p}{q} \text{ (rational)} \left(\text{where HCF } (p, q) = 1;\ p, q > 0\right) \end{cases}$ and f(x) is defined $\forall$ x > 0 then which of the following is/are incorrect?
(A) f(x) is continuous at each irrational in $(0, \infty)$
(B) f(x) is continuous at each rational in $(0, \infty)$
(C) f(x) is discontinuous at each rational in $(0, \infty)$
(D) f(x) is discontinuous for all x in $(0, \infty)$

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 55 to 56

Read the following write up carefully and answer the following questions:

Let y = f(x) be the solution of the differential equation $\frac{dy}{dx} + \frac{k}{7} x \tan x = 1 + x \tan x - \sin x$, where f(0) = 1 and let k be the minimum value of g(x) where $g(x) = \max\left|\frac{\sqrt{193} - 1}{2}\cos y + \cos\left(y + \frac{\pi}{3}\right) - x\right|$ where y $\in$ R, then

55. Area bounded by y = f(x) and its inverse between $x = \frac{\pi}{2}$ and $x = \frac{7\pi}{2}$ is

(A) 12	(B) 6
(C) 9	(D) 8

56. Number of solution of the equation f(x) = $2^x - x^2 + x + \cos x$ is equal to

(A) 3	(B) 1
(C) 2	(D) 4

Space for rough work

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

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57. Let $f(x)=\begin{cases}|x-1|+|x-2| & ; \ x\ge 1\\ x & ; \ x<1\end{cases}$ and $g(x)=\begin{cases}\max\{f(t):x-1\le t\le x\} & : \ 0\le x\le 2\\ -x+3 & : \ 2<x\le 3\end{cases}$ then number of points in [0, 3] where g(x) is not differentiable is/are _____

58. Let Q(x) be a function defined for $x \in [e^3, e^6]$ be a real valued differentiable function such that $Q(e^3) = 1$ and $Q'(x) = \dfrac{2}{x+\ln\left(\ln x+\dfrac{3}{\ln x}+e-4\right)}$ then maximum value of Q can't exceed a number ℓ ($\ell \in$ N), then minimum value of ℓ is _____

59. If $\lim\limits_{x\to 1^-}\prod\limits_{n=0}^{\infty}\left(\dfrac{1+x^{n+1}}{1+x^n}\right)^{x^n} = \ell$ then $\left[\dfrac{1}{\ell}\right]$ is equal to _____

60. If the least area bounded by the curves $y = x^2 - 4$ and $y = \lambda x + 12$ is equal to $\dfrac{\alpha}{\beta}$, then $\left[\dfrac{\alpha}{20\beta}\right]$ is equal to _____ (where [.] denotes the greatest integer function)

61. The range of real constant 't' for which $(1 - \tan^2 t)\sin \theta^2 + \tan^2 t\cdot\tan \theta^2 \ge \theta^2$; always holds $\forall\ \theta \in \left(0, \dfrac{\pi}{2}\right)$ is $[\alpha, \beta)$ then $\dfrac{\beta}{\alpha}$ is equal to _____

62. The complete set of non-zero values of 'k' such that the equation $|x^2 - 7x + 6| = kx$ is satisfies by at least one and at most three real value(s) of x is $(-\infty, \ell_1] \cup [\ell_2, \infty)$ then $\dfrac{|\ell_1-\ell_2|}{2}$ is equal to _____

63. Let f be the real valued differentiable function on R such that $e^{-x}f(x)=\dfrac{3}{e^2}+4e^{-x}\displaystyle\int_2^x\sqrt{2t^2+6t+5}\,dt$ $\forall\ x \in$ R and let $g(x) = f^{-1}(x)$ then $[g'(3)] + [|g''(3)|]$ is equal to _____ (where [.] denote the greatest integer function)

Space for rough work

64. Let f(x) = [x] + $\{x\}^3$ then the area of the figure bounded by y = $f^{-1}(x)$, y = 0 between the ordinates x = 2 and $x = \frac{9}{2}$ is α, then $\alpha - \frac{3}{2^{10/3}} + \frac{1}{2}$ is equal to _____ (where [.] denotes the greatest integer function)

65. Total number of distinct x $\in$ [0, 1] for which $\int_0^x \frac{t^8+1}{t^8+t^2+1}dt = 3x - 2$ is _____

66. Let

f(x) = ax^{17} + b sin x·sin 2x·sin3x + cx^2 sgn(sin x) + d $\log\left(x+\sqrt{1+x^2}\right) + x\left(|x+1|-|x-1|\right)\left(\frac{e^x - e^{-x}}{e^x + e^{-x}}\right)$

be defined on the set of real numbers, (a > 0, b, c, d $\in$ R) if f(–7) = 7, f(–5) = –5, f(–2) = 3, then the minimum number of zeroes of the equation f(x) = 0 is equal to _____

SECTION – D

(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

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67. If $I_1 = \int_0^1 \left(1-\left(1-x^3\right)^{\sqrt{2}}\right)^{\sqrt{3}} x^2 dx$ and $I_2 = \int_0^1 \left(1-\left(1-x^3\right)^{\sqrt{2}}\right)^{\sqrt{3}+1} \cdot x^2 dx$, then $\frac{\frac{I_1}{I_2} - \frac{\sqrt{3}-1}{2\sqrt{2}} + 0.2}{10}$ is equal to _____

68. If f(x) = $2x^3 - 3x^2 + 1$ then number of distinct real solution(s) of the equation f(f(x)) = 0 is/(are) k then $\frac{7k}{10^2}$ is equal to _____

69. Number of points of inflexion on the curve f(x) = $(x-1)^7(x+2)^8$ is equal to ℓ then $\frac{5\ell}{10^2}$ is equal to _____

Space for rough work

FIITJEE **JEE(Advanced)-2018**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

PART TEST – I

PAPER-2

ANSWERS KEY

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**D**	24.	**B**	47.	**B**
2.	**A**	25.	**C**	48.	**A**
3.	**B**	26.	**C**	49.	**A**
4.	**A, D**	27.	**B, C, D**	50.	**A, B, D**
5.	**C**	28.	**A, C**	51.	**A, B**
6.	**A, C**	29.	**A**	52.	**B, C**
7.	**B, C, D**	30.	**A, D**	53.	**D**
8.	**B, D**	31.	**B, C, D**	54.	**B, D**
9.	**B**	32.	**A**	55.	**A**
10.	**B**	33.	**D**	56.	**A**
11.	**5**	34.	**5**	57.	**2**
12.	**9**	35.	**7**	58.	**7**
13.	**8**	36.	**8**	59.	**1**
14.	**4**	37.	**4**	60.	**4**
15.	**6**	38.	**2**	61.	**3**
16.	**5**	39.	**4**	62.	**7**
17.	**2**	40.	**3**	63.	**0**
18.	**6**	41.	**3**	64.	**9**
19.	**7**	42.	**7**	65.	**1**
20.	**3**	43.	**3**	66.	**7**
21.	**00006.25**	44.	**205.02**	67.	**00000.12**
22.	**00006.40**	45.	**28.88**	68.	**00000.21**
23.	**00018.75**	46.	**8.34**	69.	**00000.15**

Physics

PART – I

SECTION – A

1. $D = \sqrt{\frac{2H}{g}}\sqrt{2g(2R)}$

2. Moment of inertia of combined system about y-axis

$$= \frac{4m\left(\frac{R}{2}\right)^2}{4} + \frac{mR^2}{4} + \frac{mR^2}{2} + mR^2 = 2mR^2$$

Conservation of angular momentum along y-axis

$$mv_0 \frac{R}{2} = 2mR^2\omega$$

$$\omega = \frac{v_0}{4R}$$

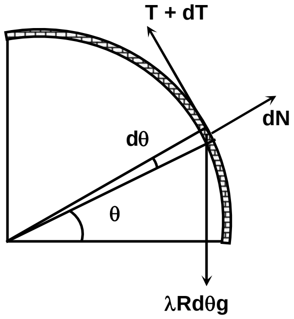
3. $\vec{f}_k$ on the block B = $\mu mg\left(\frac{1}{\sqrt{2}}\hat{i} - \frac{1}{\sqrt{2}}\hat{k}\right)$

$$P_{f_k} = \mu mg\left[\frac{\hat{i}}{\sqrt{2}} - \frac{\hat{k}}{\sqrt{2}}\right]\cdot(v_0\hat{k})$$

$$= -\frac{\mu mgv_0}{\sqrt{2}}$$

$$\frac{dQ}{dt} = \mu mgv_0\frac{2}{\sqrt{2}} = \sqrt{2}\mu mgv_0$$

4. For equilibrium



$$\lambda Rg\int_0^{\frac{\pi}{2}}\cos\theta d\theta = \mu\lambda Rg\int_0^{\frac{\pi}{2}}\sin\theta d\theta$$

$\therefore$ $\mu = 1$

At the position of maximum tension in the rope

$$\lambda Rd\theta g\cos\theta = \mu(\lambda Rd\theta g\sin\theta)$$

$\therefore$ $\theta = 45°$

At any θ,

$$dT = \lambda Rd\theta g\cos\theta - \mu\lambda Rd\theta g\sin\theta$$

$$\int_0^{T_{max}} dT = \lambda Rg\int_0^{\frac{\pi}{4}}(\cos\theta - \sin\theta)d\theta$$

$$T_{max} = \lambda Rg[\sin\theta + \cos\theta]_0^{\frac{\pi}{4}} = \lambda Rg\left[\frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}} - 1\right] = \lambda Rg\left(\sqrt{2} - 1\right)$$

5. Acceleration of particle P and Q along the incline is same.
Acceleration of particle P perpendicular to the incline plane is 10 cos 60° = 5 m/s^2
So, $v_P - 5(2) = 0$
$\therefore$ $v_P = 10$ m/s

6. $\omega R = u = \text{constant}$

$$\omega\frac{dR}{dt} + R\frac{d\omega}{dt} = 0$$

$$\therefore\ \frac{d\omega}{dt} = -\frac{\omega}{R}\frac{dR}{dt}$$

In time dt radius decreases by dR

$-2\pi R dR = uddt$

$$\therefore\ \frac{dR}{dt} = -\frac{ud}{2\pi R}$$

$$\frac{d\omega}{dt} = \alpha = \frac{\omega}{R}\frac{ud}{2\pi R}$$

$$\alpha = \frac{u^2 d}{2\pi R^3}$$

$$\tau = \frac{Iu^2 d}{2\pi R^3}$$

$$\therefore\ F = \frac{Iu^2 d}{2\pi R^4}$$

7. For pure rolling motion, static friction would act in the forward direction on the sphere. Work done by static friction is change in the kinetic energy of the sphere. Work done by static friction on the complete sphere + Plank system is zero.

8. F applied by external agent = Weight + thrust force = $\lambda xg + \lambda v^2$

Energy lost in the complete lift = $W_F - \Delta K.E. - \Delta U = \dfrac{\lambda \ell v^2}{2}$

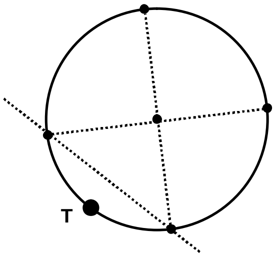
9. For perfectly in elastic collision both blocks have same velocity after collision.

10. $$e = \frac{\frac{4}{3} - \frac{2}{3}}{2} = \frac{1}{3}$$

SECTION – C

11. $$2g\left(R\frac{1}{\sqrt{2}}\right) \ge mg\left(R - \frac{R}{\sqrt{2}}\right)$$

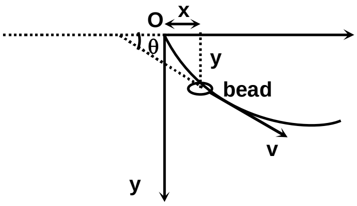
$$m \le \frac{2}{\sqrt{2}-1} = 5\,\text{kg}$$



12. $$W = \int_0^{\ell} \mu 2\pi r x dx P$$

$= \pi\mu r P \ell^2$

$= \pi(0.3)(3 \times 10^{-2})\dfrac{10^5}{\pi} \times 10^{-2} = 9$ J



13. $v = \sqrt{v_0^2 + 2gy}$

and v sin θ = v_0 (as given in question)

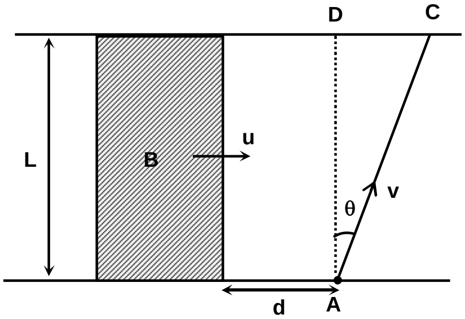
$\therefore \ \sin\theta = \frac{v_0}{\sqrt{v_0^2 + 2gy}}$

$\therefore \ \tan\theta = \frac{v_0}{\sqrt{2gy}}$

$\frac{dy}{dx} = \frac{v_0}{\sqrt{2gy}}$

$\therefore \ y = \frac{(3gv_0x)^{2/3}}{2g}$

$\therefore$ a + b + c = 8



14. Time to cross, t = $\frac{L}{v\cos\theta}$

$\therefore \ ut = d + L\tan\theta = \frac{uL}{v\cos\theta}$

$\therefore \ v = \frac{uL}{d\cos\theta + L\sin\theta}$

$\therefore \ v_{min} = \frac{uL}{\sqrt{d^2 + L^2}} = 4$ m/s

15. If they meet a height h after time T of the projection of the second.

Then, h = u(T) – $\frac{1}{2}g(T)^2 = v(T-t) - \frac{1}{2}g(T-t)^2$ …(i)

$T = \frac{5t^2 + 3t}{10t - 2}$

For minimum T, $\frac{dT}{dt} = 0$

$50t^2 - 20t - 6 = 0$

$\Rightarrow$ t = 0.6 = $\frac{6}{g}$

16. For car + trailer system

$P_{max} = (3mg\sin\theta + 3kmv^2)v$

For car only

$P_{max} = (mg\sin\theta + 4kmv^2)2v$

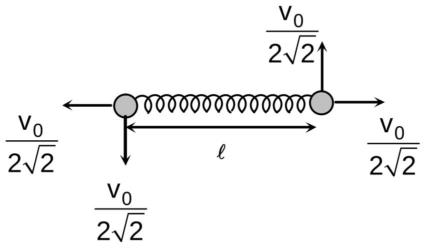
$\therefore$ $(3mg\sin\theta + 3kmv^2)v = (mg\sin\theta + 4kmv^2)2v$

$\therefore \ k = \frac{g\sin\theta}{5v^2}$

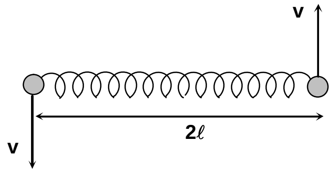
For down the incline $kmv_t^2 = mg\sin\theta$

$\therefore \ v_t^2 = 5v^2$

17. At the starting (with respect to COM frame)



At the instant of maximum elongation (with respect to the COM frame)



Conservation of angular momentum with respect to centre of mass (COM) frame

$$2m\frac{v_0}{2\sqrt{2}}\frac{\ell}{2} = 2mv\ell$$

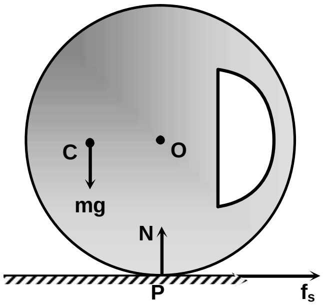
$$\therefore\ v = \frac{v_0}{4\sqrt{2}}$$

From conservation of energy with respect to centre of mass frame

$$2\frac{1}{2}m\left(\frac{v_0^2}{8}+\frac{v_0^2}{8}\right) - 2\frac{1}{2}m\frac{v_0^2}{32} = U_{spring}$$

$$\therefore\ U_{spring} = mv_0^2\left(\frac{1}{4}-\frac{1}{32}\right) = \frac{7mv_0^2}{32} = 2\ \text{Joule}$$

18. considering torque of real and pseudo force in the frame of P,



$$\tau = mg\frac{R}{2} + m\omega^2 R\frac{R}{2}$$

$$= mg\frac{R}{2} + m\frac{g}{R}R\frac{R}{2} = mgR$$

$$I_P = m\left(\frac{R}{2}\right)^2 + m\left(R^2+\frac{R^2}{4}\right) = \frac{3}{2}mR^2$$

$$\therefore\ \alpha = \frac{2mgR}{3mR^2} = \frac{2g}{3R} = 6\ \text{rad/s}^2$$

19. $\mu_s g = \frac{dv}{dt}$ at t = 1 sec

$\therefore\ \mu_s = 0.4$

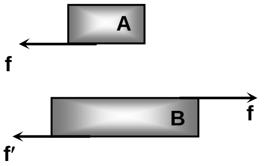
At t = 3 sec velocities of plank and block are equal.

$\therefore\ 2 + \mu_k g(2) = v$ at t = 3 sec = 8

$\therefore\ \mu_k = 0.3$

$\therefore$ s + k = 4 + 3 = 7

20. Since $\frac{\mu}{4} < \frac{\mu}{2} < \mu$, the upper block will move faster than the middle block and hence force of friction on upper block is towards left



$$\therefore\ f = \frac{\mu}{4}mg$$

$$\therefore\ a_A = \frac{\mu g}{4}\ \text{leftward}$$

$$f' = \frac{\mu}{2}\left(m + \frac{m}{2}\right)g = \frac{3}{4}\mu mg$$

$\therefore\ a_B = \mu g$ (leftward)

$\therefore\ a_{A/B} = \frac{3}{4}\mu g$ (rightward)

For sliding down the block B, A has to move a distance $\frac{3L}{8}$ relative to block B.

$$\frac{3L}{8} = \frac{1}{2}\frac{3}{4}\mu g t^2$$

$$\therefore\ t = \sqrt{\frac{L}{\mu g}} = 3\,\text{sec.}$$

SECTION – D

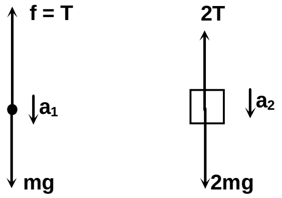
21. mg – T = ma_1

2mg – 2T = $2ma_2$

So, $a_1 = a_2$

Relative acceleration of bead with respect to end = 3a

$\therefore$ displacement of block x = $\frac{1}{2}at^2 = \frac{\ell}{3}$ = 6.25 m



22. $\tau_A = 0$

$$N = \frac{Mg}{2}\cos\theta$$

For disc, N sin θ = f + f cos θ

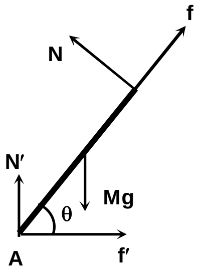
$$\therefore\quad f = \frac{N\sin\theta}{1+\cos\theta} = \frac{Mg\sin\theta\cos\theta}{2(1+\cos\theta)}$$

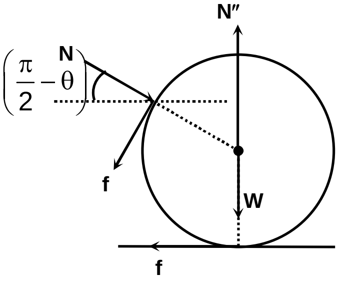
$$M = \lambda L \text{ and } L = \frac{R}{\tan\frac{\theta}{2}}$$

$$f = \frac{1}{2}\lambda g R\cos\theta$$

$$= \frac{1}{2}\times 8\times 10\times\frac{2}{10}\times\frac{4}{5}$$

$$= \frac{32}{5} = 6.40\ \text{N}$$



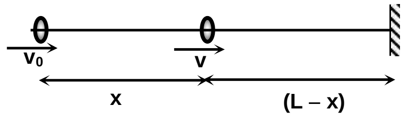


23. $v\frac{dv}{dx} = -k(L-x)$, where k is a constant.

$$\int_{v_0}^{v_0/2} v\,dv = -k\int_0^L (L-x)\,dx$$

$$\Rightarrow \frac{3}{4}v_0^2 = KL^2$$

So initial retardation = KL = $\frac{3}{4}\frac{v_0^2}{L} = \frac{3}{4}\times 25 = 18.75\ \text{m/s}^2$



Chemistry

PART – II

SECTION – A

24.

	$2NH_4OH +$	$H_2SO_4 \longrightarrow$	$(NH_4)_2SO_4 + 2H_2O$
Initial	1 m mol	0.4 m mol	0
	0.2 m mol	0	0.4 m mol

$$\left[NH_4^+\right] = \frac{2\times 0.4}{14}, \left[NH_4OH\right] = \frac{0.2}{14}$$

$$\therefore pOH = pK_b + \log\frac{0.8/14}{0.2/14}$$

= 4.76 + log4 = 4.76 + 0.6

= 5.36

pH = 14 - 5.36 = 8.64

25. $$\frac{E_{a_1}}{T_1} = \frac{E_{a_2}}{T_2}$$

$$\frac{200}{T_1} = \frac{100}{298}$$

T_1 = 596 K = 323^{o}C

26. $2BF_3 + 6NaH \xrightarrow{180^o C} B_2H_6 + 6NaF$

27. P – F bond length is less than P – Cl bond length
P – F 159.6 pm P – Cl 200.5 pm.

28. (i) Li has stronger reducing character than Na in aqueous solution.
(ii) Li_2CO_3 is thermally less stable than Na_2CO_3.

29. Pyrosilicates have general formula $(Si_2O_7)^{6-}$.

30. (i) Formula of borax is $Na_2[B_4O_5(OH)_4].8H_2O$.

(ii) Aqueous solution of borax is weakly alkaline.

31. $K_P = P_{NH_3} \times P_{H_2S}$
Addition of $NH_4HS(s)$ at equilibrium does not change the concentration of $NH_3(g)$.

32. $$\left[Ag^+\right] = \sqrt{\frac{K_{sp}Ag_2CO_3}{\left[CO_3^{2-}\right]}} = \sqrt{\frac{4\times 10^{-12}}{10^{-2}}} = 2\times 10^{-5}\ M$$

33. $$\left[Cl^-\right] = \frac{K_{sp}AgCl}{\left[Ag^+\right]} = \frac{1.8\times 10^{-10}}{2\times 10^{-5}}$$

= 9 × 10^{-6} M.

SECTION – C

34. $$\lambda = \frac{2\pi r_n}{n}$$

$$\lambda = \frac{2\times 3.14\times 0.529\times 10^{-10}\times n^2}{n}$$

$$1.67\times 10^{-9} = 2\times 3.14\times 0.529\times 10^{-10}\times n$$

$$\therefore n = 5$$

35. $2Cr(OH)_3 + IO_3^- + 4OH^- \longrightarrow 2CrO_4^{2-} + I^- + 5H_2O$

x = 2, y = 1, z = 4

$\therefore x + y + z = 2 + 1 + 4 = 7$

36. $A(g) \; + 3B(g) \rightleftharpoons 4C(g)$

$a - x \quad a - 3x \qquad 4x$

$a - x \; = 4x \quad a = 5x$

[A] = a – x = 5x – x = 4x

[B] = a – 3x = 5x – 3x = 2x

[C] = 4x

$$K_c = \frac{[C]^4}{[A]\times[B]^3}$$

$$= \frac{(4x)^4}{4x\times(2x)^3}$$

= 8

37. $CO_2(g) + C(s) \rightleftharpoons 2CO(g)$

$2 - x \qquad 2x$

$\therefore 2 - x + 2x = 3$

x = 1

$P_{CO_2} = 2 - 1 = 1$ atm, $\quad P_{CO} = 2x = 2\times 1 = 2$ atm

$$K_p = \frac{(P_{CO})^2}{P_{CO_2}} = \frac{(2)^2}{1} = 4$$

38. $\frac{(t_{1/2})_1}{(t_{1/2})_2} = \left(\frac{P_2}{P_1}\right)^{n-1}$ $\qquad$ n – 1 = 1

$\frac{10}{5} = \left(\frac{200}{100}\right)^{n-1}$ $\qquad$ n = 2

$2 = 2^{n-1}$

39. Boron Nitride, Boric acid, Beryllium hydride, Graphite.

40. (i) 10^{-8} M HCl

(ii) 0.01 M solution of NH_4Cl

(iii) 0.01 M solutin of $B(OH)_3$

41. $[CH_3COOH] = C_1 = \frac{200\times 1}{400} = 0.5$

$[HCOOH] = C_2 = \frac{200\times 0.1}{400} = 0.05$

$$\left[H^+\right] = \sqrt{K_{a_1}C_1 + K_{a_2}C_2}$$

$$= \sqrt{\left(10^{-6} \times 0.5\right) + \left(10^{-5} \times 0.05\right)}$$

$= 10^{-3}$

pH = - log 10^{-3} = 3

42. The following molecules/ion are planar

$CO_3^{2-}, NO_3^-, XeF_4, I_3^-, COCl_2, SO_3, I_2Cl_6$ (solid)

43.

$$Al\left(OH\right)_3 + NaOH \longrightarrow \underset{(Soluble)}{NaAlO_2} + 2H_2O$$

$$Zn\left(OH\right)_2 + 2NaOH \longrightarrow \underset{(Soluble)}{Na_2ZnO_2} + 2H_2O$$

$$Sn\left(OH\right)_2 + 2NaOH \longrightarrow \underset{(Soluble)}{Na_2SnO_2} + 2H_2O$$

SECTION – D

44. For shortest wavelength $n_2 = \infty$

$$\frac{1}{\lambda_{min}} = 4 \times R_H\left[\frac{1}{3^2} - \frac{1}{\infty^2}\right]$$

$$\frac{1}{\lambda_{min}} = \frac{4}{9}R_H$$

$$\lambda_{min} = \frac{9}{4} \times \frac{1}{R_H}nm$$

= 205.02 nm

45.

	$S_2Cl_4(g) \rightleftharpoons$	$2SCl_2(g)$
Initial	4	0
At equilibrium	0.2	7.6

$$\therefore \left[S_2Cl_4\right] = \frac{0.2}{10} \qquad \left[SCl_2\right] = \frac{7.6}{10}$$

$$K_c = \frac{\left[SCl_2\right]^2}{\left[S_2Cl_4\right]}$$

$$= \frac{\frac{7.6}{10} \times \frac{7.6}{10}}{\frac{0.2}{10}}$$

= 28.88

46. pOH at $\frac{1}{4}$th equivalence point = 14 – 9.3 = 4.7

At $\frac{1}{4}$th equivalence point

$$pOH = pK_b + \log\frac{[Salt]}{[Base]}$$

$$4.7 = pK_b + \log\frac{0.25x}{0.75x}$$

$4.7 = pK_b + \log\frac{1}{3}$

$pK_b = 4.7 + \log 3$

At $\frac{3}{4}$th equivalence point

$pOH = pK_b + \log\frac{[Salt]}{[Base]}$

$pOH = 4.7 + \log 3 + \log\frac{0.75x}{0.25x}$

$pOH = 4.7 + \log 3 + \log 3$

$pOH = 4.7 + 2 \times \log 3$

$pOH = 4.7 + 2 \times 0.48$

$pOH = 5.66$

pH = 14 – 5.66 = 8.34

Mathematics

PART – III

SECTION – A

47. Put $x = \frac{1}{1-t}$ in I_2 and $x = 1 - \frac{1}{t}$ in I_3

We get $\ell = \int_{-20}^{-10}\left(\frac{x^2 - x}{x^3 - 3x + 1}\right)^2\left(1 + \frac{1}{x^2} + \frac{1}{(1-x)^2}\right)dx$

Let $u = \frac{x^3 - 3x + 1}{x(x-1)}$ then $\ell = \int\frac{du}{u^2}$

48. $\frac{x^2dy - 2xydx}{x^4} = \frac{x^3y^2(ydx + xdy)}{x^4}$

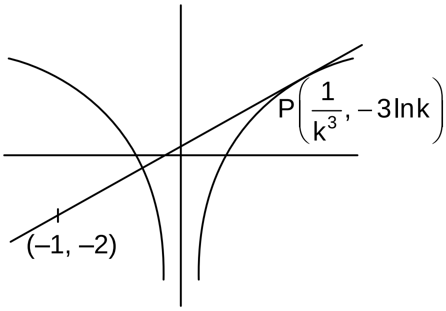
$$\frac{d\left(\frac{y}{x^2}\right)}{\frac{y}{x^2}} = xyd(xy)$$

$$\Rightarrow \ln\left(\frac{y}{x^2}\right) = \frac{(xy)^2}{2} + c$$

49. $\frac{-3\ln k + 2}{\frac{1}{k^3} + 1} = k^3$

So, f(k) = k^3 + 3lnk – 1

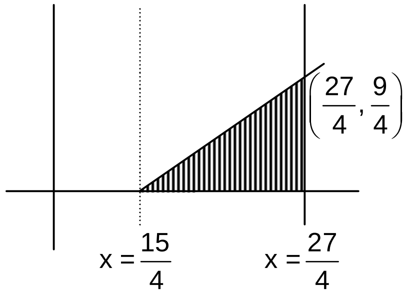
$f\left(\frac{1}{\sqrt{e}}\right)f(e) < 0$



50. $$y' = \frac{3}{4}\left(\frac{4y^2+5+\frac{4x}{3}-5}{4y^2+5}\right) = \frac{3}{4}+\frac{1}{4}\left(\frac{4x-15}{4y^2+5}\right)$$

$y' \geq \frac{3}{4}$ for $4x - 15 \geq 0$

$$\int_{15/4}^{27/4} f(x)\,dx \geq \frac{1}{2}\times\frac{12}{4}\times\frac{9}{4}$$



51. $$\frac{\left(\left(x^2-1\right)+4\left(y^2-1\right)\right)x}{\left(4\left(x^2-1\right)-3\left(y^2-1\right)\right)y} = \frac{dy}{dx}$$

Let $y^2 - 1 = v(x^2 - 1)$

$$\Rightarrow \frac{6v^2+2}{4-3v} = \left(\frac{x^2-1}{x}\right)\frac{dv}{dx}$$

$$\Rightarrow \int\frac{4-3v}{6v^2+2}dv = \int\frac{x}{x^2-1}dx$$

$$\Rightarrow \frac{2}{\sqrt{3}}\tan^{-1}\left(\sqrt{3}\left(\frac{y^2-1}{x^2-1}\right)\right)-\frac{1}{4}\ln\left(6\left(\frac{y^2-1}{x^2-1}\right)^2+2\right)-\ln\sqrt{\left|x^2-1\right|}+c=0$$

52. (A) $2C_1(2\times 2-1)^5$
(B) $(2\times 2-1)^5\times 1$
(C) $(2\times 2-1)^4\times 1$
(D) $(2\times 2-1)^2 = 9$

53. Let $g(x) = f(x) - x^2 - 1$
$g(1) = g(2) = 0$
So; $g'(C_1) = 0$ for at least one $C_1 \in (1, 2)$
Similarly $g'(C_2) = 0$ for at least one $C_2 \in (2, 3)$
Using LMVT on $x \in (C_1, C_2)$

$$g''(C) = \frac{g'(C_2)-g'(C_1)}{C_2-C_1} = 0$$

$f''(C_3) = 2$

54. Let $x = \sqrt{3}$
$f\left(\sqrt{3}\right) = 0$
$\because\ \sqrt{3} = 1.732050807.....$

As the decimal part increases then in the expression $\frac{p}{q}$, q becomes very large

So, $\frac{2}{2q^3-q^2+q+\sin^2 q+5} \to 0$

Hence, $\lim\limits_{x\to\sqrt{3}} f(x) = 0$

Thus, f(x) is continuous at each irrational

55.-56. $-7 \le \frac{\left(\sqrt{193}-1\right)}{2}\cos y + \cos\left(y+\frac{\pi}{3}\right) \le 7$

So; $g(x) = \begin{cases} |x+7| & ; \quad x \ge 0 \\ |x-7| & ; \quad x < 0 \end{cases}$

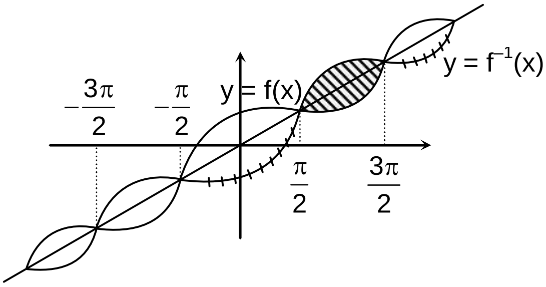
So; $g(x)_{\min} = 7$

So; $f(x) = x + \cos x$

55. $A = 3 \times 2 \int_{\pi/2}^{3\pi/2} \left(x - \left(x + \cos x\right)dx\right)$

$= -3 \times 2\left(\sin x\right)_{\pi/2}^{3\pi/2}$

$= -6(-1 - 1) = 12$



56. $2^x = x^2$ intersect at 3 points

SECTION – C

57. $g(x) = \begin{cases} x & : \quad 0 \le x \le 1 \\ 1 & : \quad 1 \le x \le 2 \\ -x+3 & : \quad x > 2 \end{cases}$

58. Q(x) is an increasing function

So, $\int_{e^3}^{e^6} Q'(x)dx \le \int_{e^3}^{e^6} \frac{2}{x}dx$

$Q(e^6) \le 7$

59. $\frac{1+x^{n+1}}{1+x^n} = 1 + \frac{x^n(x-1)}{1+x^n}$

So, $\ln\left(\prod_{n=0}^{N}\left(1+\frac{x^n(x-1)}{1+x^n}\right)^{x^n}\right) = \sum_{n=0}^{N} x^n \ln\left(1+\frac{x^n(x-1)}{1+x^n}\right)$

So, $(x-1)\left(\frac{1}{1-x^2} - \frac{1}{1-x^3} + ... + \frac{1}{1-x^{2k}}\right) \le \sum_{n=0}^{\infty} x^n \left(\frac{x^n(n-1)}{1+x^n}\right)$

$\le (x-1)\left(\frac{1}{1-x^2} - \frac{1}{1-x^3} + ... - \frac{1}{1-x^{2k+1}}\right)$

So, limit = $\frac{2}{e}$

60. For least area $\lambda = 0$

So; $A_{\min} = 2\int_0^4 \left(12 - \left(x^2 - 4\right)\right)dx = \frac{256}{3}$

61. $\tan^2 t \ge \dfrac{\theta^2 - \sin\theta^2}{\tan\theta^2 - \sin\theta^2} \forall\, \theta \in \left(0, \dfrac{\pi}{2}\right)$

So; $\tan^2 t \ge \left(\dfrac{\theta^2 - \sin\theta^2}{\tan\theta^2 - \sin\theta^2}\right)_{\max} \quad \forall\, \theta \in \left(0, \dfrac{\pi}{2}\right)$

Since; in $\left(0, \dfrac{\pi}{2}\right)$: tan $\theta^2 > \theta^2$ and the same is subtracted from N^{-r} and D^{-r} both

So; maximum value occurs at $\theta \to O^+$

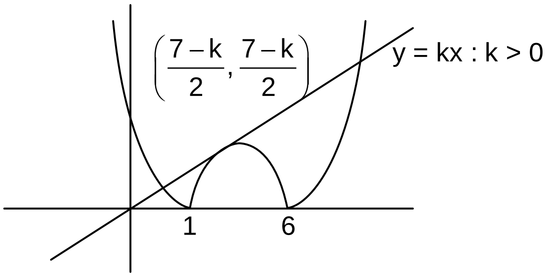
Therefore $\tan^2 t \ge \dfrac{1}{3}$; $t \in \left(\dfrac{\pi}{6}, \dfrac{\pi}{2}\right)$

62. So; $-2x + 7 = k$

$\Rightarrow\ x = \dfrac{7-k}{2}$

Also $-\dfrac{(7-k)^2}{4} + 7\left(\dfrac{7-k}{2}\right) - 6 = k\left(\dfrac{7-k}{2}\right)$

$\Rightarrow\ k = 7 + \sqrt{24}\ ,\ 7 - \sqrt{24}$ (Rejected)



So: $k \in \left[7 - \sqrt{24}, \infty\right)$

Similarly: consider case-II if k < 0 then $k \in \left(-\infty, -\left(7 + \sqrt{24}\right)\right]$

Second Method

Clearly: $m_1 < k < k_2$

For slope of ON

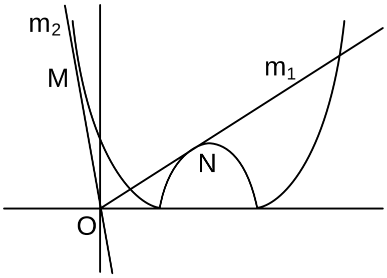
$-(x^2 - 7x + 6) = kx$

Must have equal roots

For slope of OM

$x^2 - 7x + 6 = kx$

Must have equal roots



63. $g(f(x)) = x$

So; $g'(f(x))\cdot f'(x) = 1$

$g''(f(x)) = -\dfrac{f''(x)}{(f'(x))^3}$

So; $g'(3) = \dfrac{1}{23}$ and $g''(3) = \dfrac{-43}{5(23)^3}$

64. $f^{-1}(x) = [x] + \{x\}^{1/3}$

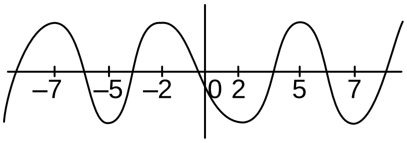
So, $\displaystyle\int_2^{9/2} [x]\,dx + \int_2^{9/2} \{x\}^{1/3}dx = \frac{17}{2} + \frac{3}{2^{10/3}}$

65. Let $f(x) = \displaystyle\int_0^x \frac{t^8 + 1}{t^8 + t^2 + 1}dt - 3x + 2$

f(0) = 2, f(1) = negative

So; f(x) has one root in [0, 1]

66. f is an odd function
So; f(7) = –7, f(5) = 5, f(2) = 3
$x \to -\infty$, $f(x) \to \infty$
$x \to \infty$, $f(x) \to \infty$



SECTION – D

67. Let $1 - x^3 = t$

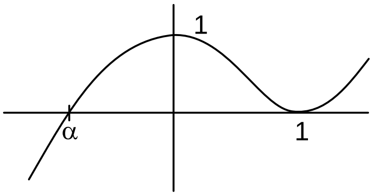
$$3I_1 = \int_0^1 \left(1-t^{\sqrt{2}}\right)^{\sqrt{3}} dt \text{ and } 3I_2 = \int_0^1 \left(1-t^{\sqrt{2}}\right)^{\sqrt{3}+1} \cdot 1 \cdot dt$$

$$= \int_0^1 \left(\sqrt{3}+1\right)\sqrt{2}\left(1-t^{\sqrt{2}}\right)^{\sqrt{3}} \left(1-t^{\sqrt{2}}-1\right) dt \text{ (Using integration by parts)}$$

$$3I_2 = -\left(\sqrt{3}+1\right)\sqrt{2}\cdot 3I_2 + \left(\sqrt{3}+1\right)\sqrt{2}\cdot 3I_1$$

So, $\frac{I_1}{I_2} - \frac{\sqrt{3}-1}{2\sqrt{2}} + 0.2 = 1 + \frac{\sqrt{3}-1}{2\sqrt{2}} - \frac{\sqrt{3}-1}{2\sqrt{2}} + 0.2 = 1.2$

68. Roots of the f(x) = 0 are $\alpha \in (-1, 0)$ and 1
then f(f(x)) = 0 (where f(x) = t)
$f(t) = 0 \Rightarrow t = \alpha, 1$
So; total number of distinct real solutions = 2 + 1 = 3



69. $f''(x) = (x-1)^5(x+2)^6(195x^2 + 153x + 30)$
$f''(x) = 0$ if $x = 1, -2, x_1, x_2$
Clearly: there are 3 inflexion points

FIITJEE **JEE (Main)-2018**

ALL INDIA TEST SERIES

PART TEST – I

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 – 30, 31 – 60, 61 – 90)** *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant R = $8.314\ J\ K^{-1}\ mol^{-1}$
= 0.0821 Lit atm $K^{-1}\ mol^{-1}$
= $1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A point mass performs straight line motion along positive x-axis. At t = 0 point mass is at point $A(x_1, 0)$. It moves such that its velocity is given by $v = \frac{a}{x}$, where a is positive constant and x is the x-coordinate of position vector of point mass at a certain time t. Find the time required to move from A to B $(x_2, 0)$

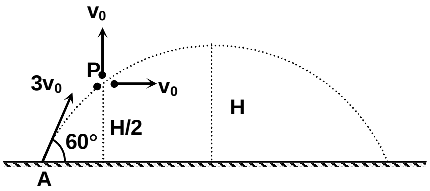
(A) $\frac{x_2^2 - x_1^2}{2a}$

(B) $\frac{x_2^2 - x_1^2}{a}$

(C) $\frac{2x_2^2 - x_1^2}{2a}$

(D) $\frac{2x_2^2 - x_1^2}{a}$

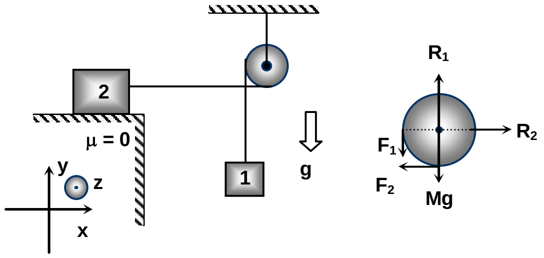
2. A particle of mass 3m is projected from point-A with speed $3v_0$ as shown in figure. When the particle is at point P, it explodes in three identical particles. Choose the INCORRECT statement regarding the physical quantities just before and just after explosion.



(A) The linear momentum of system can be conserved just before and just after explosion.
(B) The centre of mass of the system will trace same path as it will follow without explosion.
(C) The mechanical energy of the system remains conserved just before and just after explosion.
(D) The impulse given by the weight of particle during explosion is negligible as compared to that by the explosive forces.

Space for Rough work

3. The Letters A, B, C and D represent the sign (either + or –, consistent with the co-ordinate system shown in the figure). FBD of the pulley is also shown in the figure. The symbol a_{1y} and a_{2x} represent y and x components of magnitude of acceleration of block-1 and block-2 respectively



For Pulley :

$$\Sigma\vec{\tau}_{CM} = I_{CM}\alpha\hat{k} : [A]\ F_1 r + [B]\ F_2 r = I_{CM}\alpha_z$$

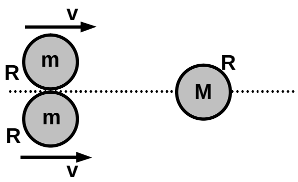
Constraint :

$$a_{1y} = [C]\,a_{2x} = [D]\ \alpha_z r$$

Choose correct option.

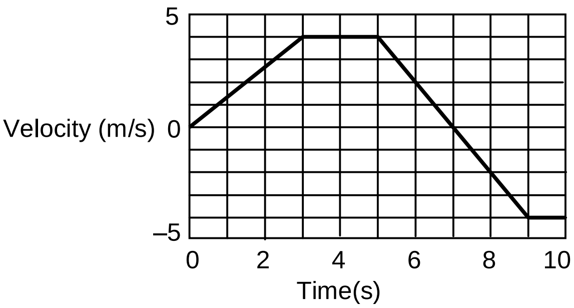
	A	**B**	**C**	**D**
(A)	–	+	–	+
(B)	+	–	–	+
(C)	+	–	–	–
(D)	+	–	+	+

4. Two identical discs of mass m and of radius R touch each other and move with the same velocity perpendicularly to the line segment which joins their centres of mass, along the surface of a horizontal smooth tabletop. There is a third disc of mass M and of radius R at rest, at a point on the perpendicular bisector of the line segment joining the centres of mass of the two moving discs as shown in the figure. The two moving discs collide elastically with the third one, which is at rest. There is no friction between the rims of the discs. What should the ratio of M/m be in order that after the collision the two discs of mass m move perpendicularly to their initial velocity?



(A) 3
(B) 2
(C) $\sqrt{3}$
(D) $\sqrt{2}$

5. An object starts at the origin in a straight line. Its velocity versus time graph is shown in the figure. Which one of the following choices best gives the proper intervals(s) of time for which the object is moving away from the origin?



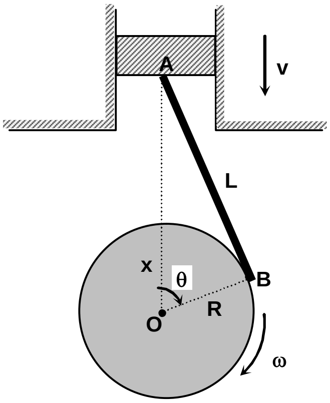
(A) Only for times 0 s < t < 3s

(B) Only for times 0 s < t < 5 s

(C) Only for times 3 s < t < 5s

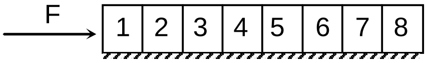
(D) Only for times 0 s < t < 7 s

6. Find velocity of piston A in the given situation if angular velocity of wheel of radius R is ω (constant), in the clockwise sense. (O is fixed point)



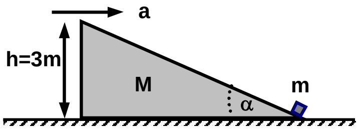
(A) $\frac{xR\omega\sin\theta}{R\cos\theta + x}$
(B) $\frac{x^2\omega\sin\theta}{R\cos\theta - x}$
(C) $\frac{xR\omega\sin\theta}{R\cos\theta - x}$
(D) $\frac{R^2\omega\sin\theta}{R\cos\theta - x}$

7. Ram pushes eight identical blocks on the horizontal frictionless surface with horizontal force F. The force that block-1 exerts at block-2 has magnitude F_{21} and the force that block-7 exerts on the block-8 is F_{87}. Find $\frac{F_{21}}{F_{87}}$



(A) 3
(B) 5
(C) 7
(D) 9

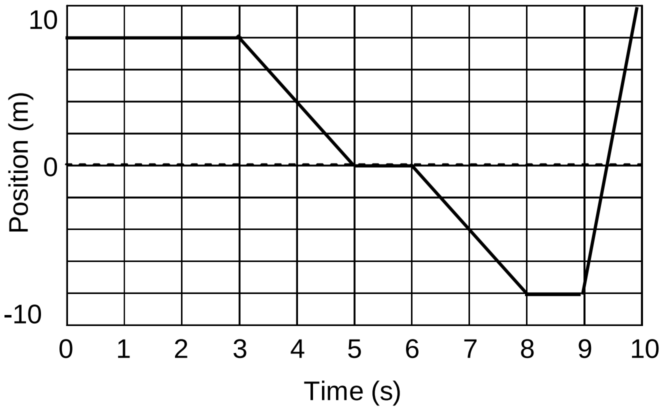
8. A wedge of mass M= 10kg, height h= 3m and angle of inclination α =37^0 is at rest at horizontal surface. There is a small point –like object (mass m =0.5kg) next to the slope as shown in the figure. At what acceleration must wedge be moved in order that the point like object reaches its top in a time t = 5s (Neglect the friction between point like object and wedge)



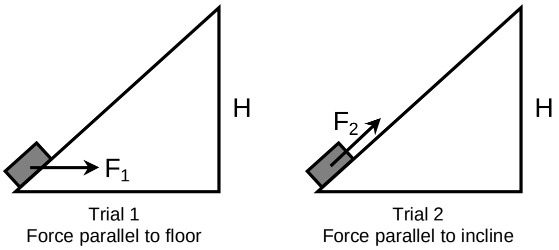
(A) 2m/s^2
(B) 4m/s^2
(C) 8m/s^2
(D) 10 m/s^2

Space for Rough work

9. The position versus time graph of a particle moving along a straight line is shown. What is the total distance travelled by the particle from t = 0 s to t = 10s?
(A) 2m
(B) 18 m
(C) 26m
(D) 34m

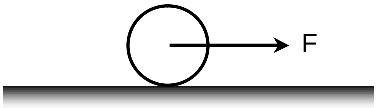


10. An object of mass M starts from rest at the bottom of a fixed incline of height H. A person decides to push the object up the incline in one of two ways with an applied force shown in the diagram. In each of the trials, the object reaches the top of the incline with speed V. How would the work done by the person on the block compare for the two trials? Assume the same constant non-zero coefficient of kinetic friction between the incline and the object for both trials.



(A) More work would be done in Trial 1
(B) More work would be done in Trial 2
(C) It is impossible to determine for which trial there would be more work done without knowing the value of the speed V.
(D) It is impossible to determine for which trial there would be more work done without knowing the value of the coefficient of kinetic friction.

11. A uniform, solid cylinder having mass M and radius R is pulled by a horizontal force F acting through the center as shown. The cylinder rolls to the right without slipping. What is the magnitude of the force of friction between the cylinder and the ground?

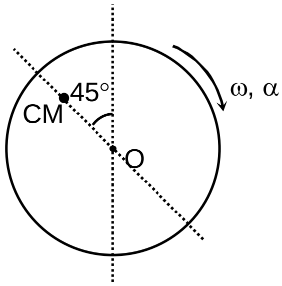


(A) F/4 (B) F/3
(C) F/2 (D) 2F/3

Space for Rough work

12. A particle is moving along straight line such that dot product of its acceleration $\vec{a}$ and velocity $\vec{v}$ is negative. How many times particle can be found at a distance d from the origin?
(A) One (B) Three
(C) Two (D) Can't be determined with given data

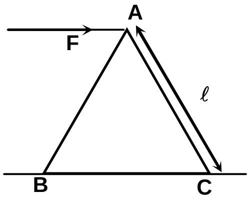
13. A solid sphere of mass m and radius R is rolling without slipping on a rough horizontal surface with angular acceleration α. Centre of mass of sphere lies at a distance $\frac{R}{\sqrt{2}}$ from the centre of sphere. Find the normal force applied by sphere on the surface at an instant when line joining centre of mass of sphere and centre of sphere makes an angle 45° with the vertical and angular velocity of sphere at this instant is ω.



(A) $mg + \frac{mR}{2}\left(\alpha - \omega^2\right)$ (B) $mg - \frac{mR}{2}\left(\alpha + \omega^2\right)$
(C) $mg - \frac{mR}{2}\left(\alpha - \omega^2\right)$ (D) $mg + \frac{mR}{2}\left(\alpha + \omega^2\right)$

14. A block of mass m = 5 kg is being whirled in a horizontal circle with the help of a string of length ℓ = 1m with constant speed v = 5 ms^{-1}. One end of the string is held fixed at a point O above the centre of the horizontal circle. Gravity exists vertically downwards. The force of tension exerted by the string on bob is $\vec{T}$. For this given situation, choose INCORRECT statement:
(A) Total force acting on mass is $m\vec{g} + \vec{T} - \frac{mv^2}{\ell}\hat{T}$
(B) Total force acting on mass is $m\vec{g} + \vec{T}$
(C) Net force on the particle is in the horizontal direction.
(D) Horizontal component of tension provides required centripetal force.

15. A triangular frame consists of three identical rods, each of mass m and length ℓ. It rests upright on a horizontal smooth surface with its lower right corner against a stop about which the frame could pivot. A horizontal force of magnitude F is applied to the upper corner of the frame as shown in the figure. What is the largest value of F may have without causing the frame to pivot upward about the stop?



(A) $\sqrt{3}$ mg (B) 3 mg
(C) $\frac{mg}{\sqrt{3}}$ (D) $\frac{3}{2}$mg

16. A massless spring of stiffness 400 N/m is fastened at left end to a vertical wall as shown in the figure I. Initially block C of mass 2 kg and block D of mass 5 kg rest on horizontal surface with block C in contact with spring (But not compressing it.) and the block D in contact with block C. Block C is moved leftward, compressing spring by a distance of 0.5 m and held in place while block D remains at rest as shown in the figure. Now Block C is released and it accelerates to the right towards block D. The surface is rough and the coefficient of friction between each block and surface is 0.1. The block collide instantaneously stick together and move right. Find the velocity of combined system just after collision.

(A) 2 m/s
(B) 3 m/s
(C) 4 m/s
(D) 6 m/s

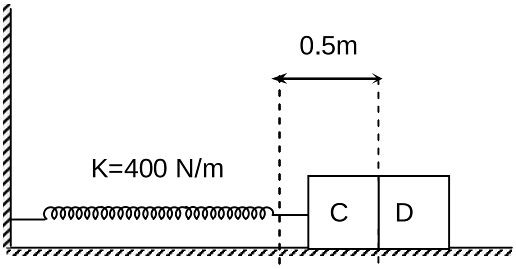


Figure-I

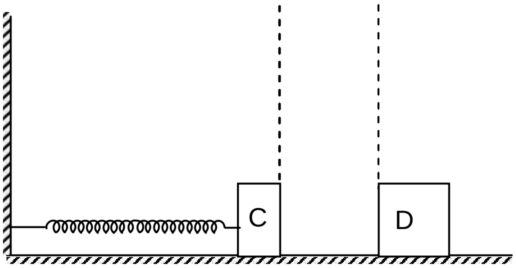
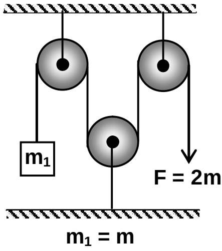
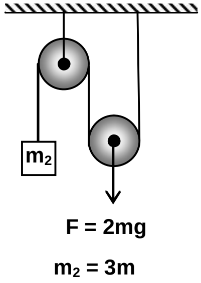
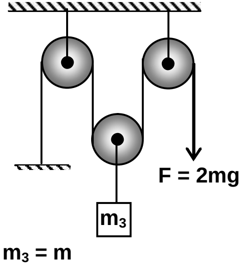


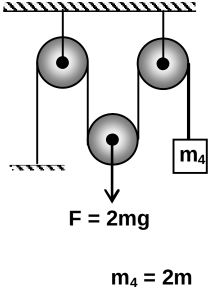
Figure-II

17. All the blocks are attached to an ideal rope which passes over an ideal pulley. If accelerations of blocks m_1, m_2, m_3, and m_4 are a_1, a_2, a_3 and a_4 respectively then choose the correct option.





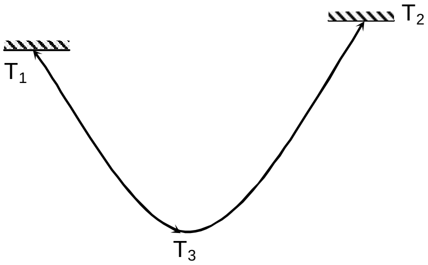




	a_1	a_2	a_3	a_4
(A)	g↑	2g↑	3g↑	g/2↓
(B)	g↑	2g/3↓	3g↑	g/2↓
(C)	2g/3↓	2g↑	3g↑	g↑
(D)	g↓	g/2↓	3g↓	2g/3↓

Space for Rough work

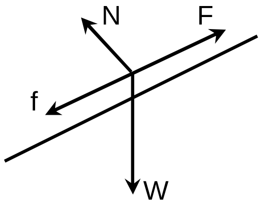
18. A string of mass m (can be non uniform as well) is suspended through two points which are not in same horizontal level. Tension in the string at the end points are T_1 and T_2 and at the lowest point is T_3. Mass of string in terms of T_1, T_2 and T_3 can be represented a {uniform gravity 'g' exists downwards)



(A) $\frac{\sqrt{T_1^2 - T_3^2} + \sqrt{T_2^2 - T_3^2}}{g}$ (B) $\frac{(T_1 + T_2 - 2T_3)}{g}$

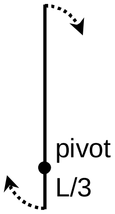
(C) $\frac{\sqrt{T_1^2 + T_2^2}}{g}$ (D) $\frac{\sqrt{T_1^2 + T_3^2} + \sqrt{T_2^2 + T_3^2}}{g}$

19. An object is being pushed at constant speed on an inclined plane. The free body diagram of the object is shown with the gravitational force represented by W, the friction force by f, the applied external push parallel to the incline by F, and the normal force with surface by N. Which one of the following choices represents correct relationships between the forces?



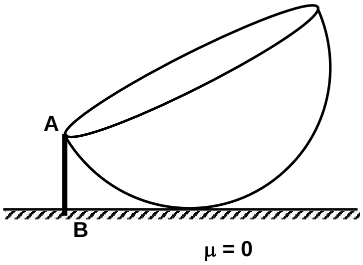
(A) N > W and F < f (B) N < W and F > f
(C) N < W and F < f (D) N = W and F > f

20. A uniform rod of mass M and length L is free to rotate about a frictionless pivot located L/3 from one end. The rod is released from rest incrementally away from being perfectly vertical, resulting in the rod rotating clockwise about the pivot. When the rod is horizontal, what is the magnitude of the tangential acceleration of its center of mass?



(A) g/6 (B) g/2
(C) g/4 (D) 2g/3

21. A uniform solid hemisphere of radius 10 m and mass 64 kg is placed with its curved surface on the smooth horizontal surface and a string AB of length 4m is attached to point A on its rim as shown in the figure. Find the tension in the string if hemisphere is in equilibrium.



(A) 320 N (B) 640 N
(C) 180 N (D) 360 N

Space for Rough work

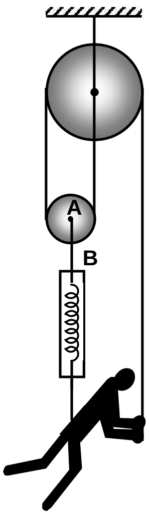
22. A man of mass 60 kg hangs himself from a massless spring balance, which itself suspended from an ideal string-pulley system as shown in the figure. The string AB can bear maximum 900 N. Choose correct statement.

(A) The man is never ever able to read his correct weight in the spring balance.

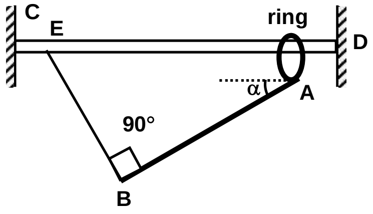
(B) If man is able to manage himself at rest, the spring balance reads his true weight.

(C) The maximum magnitude of acceleration, man can manage is 12.5 m/s^2 while moving upward.

(D) When man moves downward with acceleration 5 m/s^2, the spring balance will read 40 kg.



23. One end of a heavy uniform rod AB can slide along rough horizontal guiding surface CD with the help of massless ring as shown in the figure. The dimension of ring is negligible. BE is the ideal string. If $\angle EBA$ is right angle and α is the angle between rod AB and horizontal when the rod is on the verge of sliding. Find the coefficient of friction between ring and horizontal guiding surface CD.



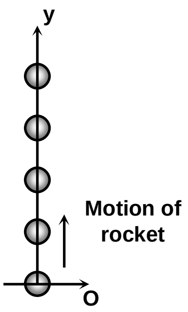
(A) $\dfrac{\tan\alpha}{2+\tan^2\alpha}$

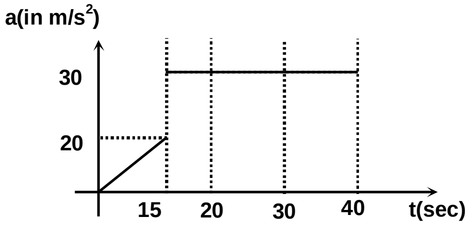
(B) $\dfrac{\tan\alpha}{1+2\tan^2\alpha}$

(C) $\dfrac{\tan\alpha}{2-\tan\alpha}$

(D) $\dfrac{\tan\alpha}{1-\tan^2\alpha}$

24. A two stage rocket is fired vertically upward from rest with acceleration as shown in a-t graphs. After 15 sec, the first stage burns out and second stage ignites. Choose the INCORRECT statement regarding motion of rocket in the time interval $0 \le t \le 40$ s.





(A) At t = 15 sec, the speed of rocket is 15 0 m/s.

(B) At t = 20 sec, the speed of rocket is 300 m/s.

(C) In time interval t = 0 sec to t = 15 sec, the distance travelled by rocket is 750 m.

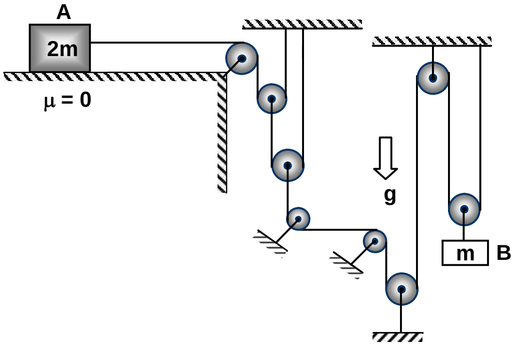
(D) In time interval t = 0 sec to t = 20 sec, the distance travelled by rocket is 1500 m.

Space for Rough work

25. A particle whose velocity is given as $\vec{v} = \hat{i} + 6t\hat{j}$ m/s is moving in x-y plane. At t = 0, particle is at origin. Find the radius of curvature of path at point $\left(\frac{\sqrt{2}}{3}\text{m}, \frac{2}{3}\text{m}\right)$

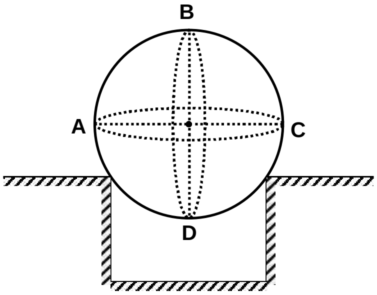
(A) 1.5 m (B) 3.0 m
(C) 4.5 m (D) 6.0 m

26. An ideal string-pulley system is shown in the figure and system is released from rest. Choose correct option.



(A) When mass B moves with speed 4 m/s, the speed of mass A is 1 m/s.
(B) When mass B moves with speed 1 m/s, the speed of mass A is 4 m/s.
(C) In the time interval in which the mass A covers distance 8 m, in the same time interval, mass B travels a distance 1 m.
(D) In the time interval in which the mass A covers distance 1 m, in the same time interval, mass B travels a distance 8 m.

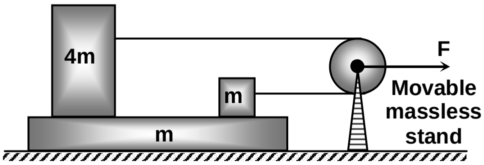
27. A sphere of mass m and radius r rolls without slipping over a tunnel of width $d = \frac{8r}{5}$ as shown in the figure. (in the figure, the sphere rolls perpendicular to the plane of the page). The velocity of centre of mass of sphere is v directed into the plane of the page. The maximum speed of a point on the sphere is



(A) $\frac{4v}{3}$ (B) $\frac{8v}{3}$
(C) $\frac{6v}{3}$ (D) $\frac{3v}{2}$

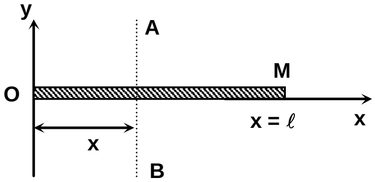
Space for Rough work

28. In the given figure, a long platform of mass m is placed on frictionless surface. Two blocks of masses 4m and m (where m = 10 kg) are placed on the platform. For both blocks, the coefficient of static friction with platform equal to 0.16 and the coefficient of kinetic friction equal to 0.10. The blocks are connected by a light ideal string through a light pulley (mounted at a movable massless stand), which is acted upon by an unknown horizontal force F. If the acceleration of the platform is 2 m/s^2, find the value of unknown force F and acceleration of blocks 4m and m on a_1 and a_2 respectively.



	F(N)	**a_1(m/s^2)**	**a_2(m/s^2)**
(A)	180 N	2 m/s^2	8 m/s^2
(B)	180 N	8 m/s^2	2 m/s^2
(C)	90 N	2 m/s^2	8 m/s^2
(D)	90 N	8 m/s^2	2 m/s^2

29. A non uniform rod OM (of length ℓ m) is kept along x-axis and rotating about an axis AB, which is perpendicular to rod as shown in the figure. The rod has linear mass density that varies with the distance x from left end of the rod according to $\lambda = \lambda_0\left(\frac{x^3}{L^3}\right)$



Where unit of λ_0 is kg/m. What is the value of x so that moment of inertia of rod about axis AB (I_{AB}) is minimum?

(A) $\frac{7\ell}{15}$ (B) $\frac{2\ell}{5}$

(C) $\frac{8\ell}{15}$ (D) $\frac{4\ell}{5}$

30. Identical constant forces push two identical cars A and B continuously from a starting line to a finish line. The cars move on a frictionless horizontal surface. If car A is initially at rest and car-B is initially moving right with speed v_0. Choose the correct statement.

(A) Car-A has the larger change in momentum.
(B) Car-B has the larger change in momentum.
(C) Both cars have the same change in momentum.
(D) Not enough information is given to decide.

Space for Rough work

Chemistry

PART – II

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. For a 3s-orbital

$$\psi(3s) = \frac{1}{a\sqrt{3}}\left(\frac{1}{a_0}\right)^{3/2}\left(6 - 6\sigma + \sigma^2\right) \in^{-\sigma/2},$$

Where $\sigma = \frac{2rZ}{3a_o}$

What is the maximum radial distance of node from nucleus?

(A) $\frac{\left(3+\sqrt{3}\right)a_o}{Z}$ (B) $\frac{a_o}{Z}$

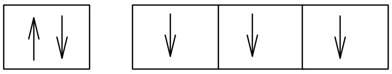
(C) $\frac{3}{2}\frac{\left(3+\sqrt{3}\right)a_o}{Z}$ (D) $\frac{2a_o}{Z}$

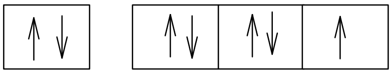
32. Calculate the minimum and maximum number of electrons which may have magnetic quantum number, m = +1 and spin quantum number $s = -\frac{1}{2}$ in chromium(Cr):

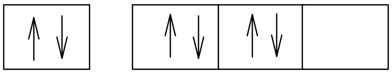
(A) 0, 1 (B) 1, 2

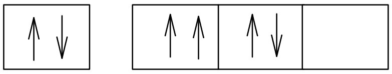
(C) 4, 6 (D) 2, 3

33. The orbital diagram in which both the Pauli's exclusion principle and Hund's rule violated is:

(A) 

(B) 

(C) 

(D) 

Space for Rough work

34. Listed in the table are forward and reverse rate constant for the reaction:
$2NO(g) \rightleftharpoons N_2(g) + O_2(g)$

Temperature (K)	$K_f\left[M^{-1}s^{-1}\right]$	$K_b\left[M^{-1}s^{-1}\right]$
1400	0.29	1.1×10^{-6}
1500	1.3	1.4×10^{-5}

Select the correct statement:
(A) Reaction is exothermic and value of equilibrium constant (K_{eq}) at 1400 K is 3.79×10^{-6}.
(B) Reaction is endothermic and value of equilibrium constant (K_{eq}) at 1400 K is 2.63×10^{5}.
(C) Reaction is exothermic and value of K_{eq} at 1400 K is 2.63×10^{5}.
(D) Reaction is endothermic and value of K_{eq}) at 1500 K is 9.28×10^{4}.

35. For a first order homogeneous gaseous reaction
$A \longrightarrow 2B + C$
If the total pressure after time t was P_t and after long time $(t \to \infty)$ was P_∞ then K in terms of P_t, P_∞ and t is
(A) $K = \frac{2.303}{t}\log\left(\frac{P_\infty}{P_\infty - P_t}\right)$
(B) $K = \frac{2.303}{t}\log\left(\frac{2P_\infty}{P_\infty - P_t}\right)$
(C) $K = \frac{2.303}{t}\log\left(\frac{2P_\infty}{3(P_\infty - P_t)}\right)$
(D) None of these

36. Which of the following is incorrect statement?
(A) Stoichiometry of a reaction tells about the order of the elementary reactions.
(B) For a zero order reaction, rate and the rate constant are identical.
(C) A zero order is controlled by factors other than concentration of reactants.
(D) A zero order reaction is an elementary reaction.

Space for Rough work

37. What will be the effect on the equilibrium constant on increasing temperature, if the reaction neither absorbs heat nor releases heat?
(A) Equilibrium constant will remain constant.
(B) Equilibrium constant will decrease
(C) Equilibrium constant will increase.
(D) Can not be predicted.

38. The conversion of ozone into oxygen is exothermic under what conditions is ozone is most stable?

$$2O_3(g) \rightleftharpoons 3O_2(g)$$

(A) At low pressure and low temperature.
(B) At high pressure and high temperature.
(C) At high pressure and low temperature.
(D) At low pressure and high temperature.

39. Consider the partial decomposition of A as

$$2A(g) \rightleftharpoons 2B(g) + C(g)$$

At equilibrium 700 ml gaseous mixture contains 100 ml of gas C at 10 atm and 300 K. What is the value of K_P for the reaction?
(A) $\frac{40}{7}$
(B) $\frac{1}{28}$
(C) $\frac{10}{28}$
(D) $\frac{28}{10}$

40. The equilibrium constant K_P for the reaction

$N_2O_4(g) \rightleftharpoons 2NO_2(g)$ is 4.5

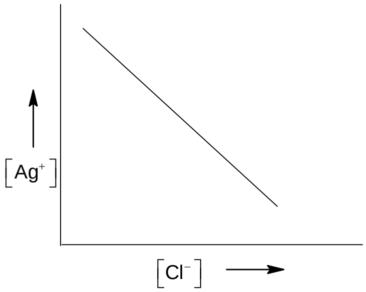
What would be the average molar mass (in g/mol) of an equilibrium mixture of N_2O_4 and NO_2 formed by the dissociation of pure N_2O_4 at a total pressure of 2 atm?
(A) 69
(B) 57.5
(C) 80.5
(D) 85.5

41. What is the hydronium ion concentration of a 0.25 M HA solution ($K_a = 4 \times 10^{-8}$)
(A) 10^{-4}
(B) 10^{-5}
(C) 10^{-7}
(D) 10^{-10}

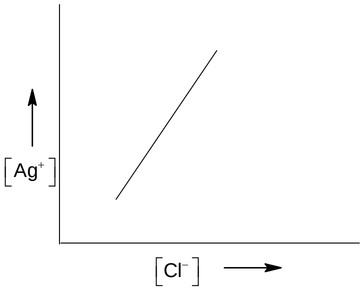
Space for Rough work

42. In a saturated solution of AgCl, NaCl is added gradually. The concentration of Ag^+ is plotted against the concentration of Cl^-, the graph appears as:

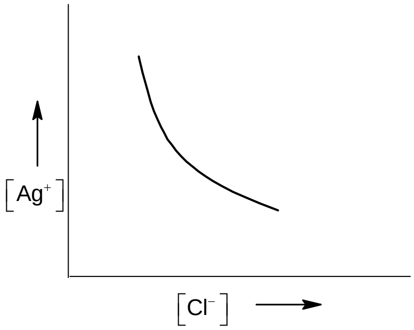
(A)



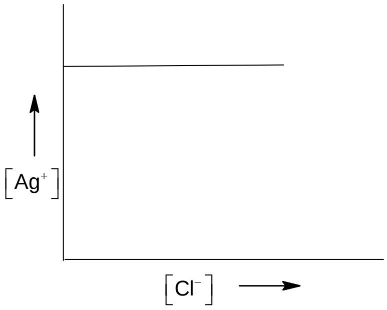
(B)



(C)



(D)



43. A solution is 0.01 M KI and 0.1 M KCl. If solid $AgNO_3$ is added to the solution, what is the $[I^-]$ when AgCl begins to precipitate?

$\left[K_{SP}(AgI) = 1.5\times10^{-16}; K_{SP}(AgCl) = 1.8\times10^{-10}\right]$

(A) 3.5×10^{-7} (B) 6.1×10^{-8}
(C) 2.2×10^{-7} (D) 8.3×10^{-8}

44. Solubility of AgCl in 0.2 M NaCl is x and that in 0.1 M $AgNO_3$ is y. Then which of the following is correct?

(A) x = y (B) x > y
(C) x < y (D) we cannot predict

45. The incorrect order of bond angle

(A) $CO_2 > CO_3^{2-} > CF_2Cl_2$ (B) $NO_2^+ > NO_3^- > NO_2^-$
(C) $XeF_2 > XeF_4 > XeCl_4$ (D) $PH_3 > AsH_3 > SbH_3$

Space for Rough work

46. All fluorine atoms are in same plane in
(A) CHF_3 (B) ClF_3
(C) $XeOF_4$ (D) All of these

47. Consider a P_y orbital of an atom and identify correct statement.
(A) s-orbital of another atom produce π bond when y is the bond formation axis.
(B) P_y - orbital of another produce σ bond when x is the bond formation axis.
(C) P_z - orbital of another atom produce π bond when x is the bond formation axis.
(D) d_{xy} – orbital of another atom produce π bond when x is the bond formation axis.

48. The set of d-orbitals which do not contain any d-orbital which is involved in hybridization of central atom in ICl_4^-
(A) $d_{z^2}, d_{x^2-y^2}$ (B) $d_{x^2-y^2}, d_{xy}, d_{yz}, d_{zx}$
(C) $d_{z^2}, d_{xy}, d_{yz}, d_{zx}$ (D) d_{xy}, d_{zx}, d_{yz}

49. Select the correct order of hydration energy of ions?
(A) $Li^+ > Na^+ > K^+$ (B) $Li^+ > K^+ > Na^+$
(C) $Cs^+ > Rb^+ > K^+$ (D) $Li^+ > Cs^+ > K^+$

50. Decomposition temperature of $CaCO_3(s)$ is approximately 900°C. Which of the following decompose below 900°C?
(A) $BeCO_3$, $MgCO_3$ (B) $SrCO_3$, $BaCO_3$
(C) $BeCO_3$, $BaCO_3$ (D) $MgCO_3$, $SrCO_3$

51. Select the correct order of basic strength?
(A) $KOH > Mg(OH)_2 > Al(OH)_3$ (B) $Al(OH)_3 > Mg(OH)_2 > KOH$
(C) $Mg(OH)_2 > KOH > Al(OH)_3$ (D) $KOH > Al(OH)_3 > Mg(OH)_2$

52. Be and Mg have zero value of electron affinity, because
(A) Be and Mg have $[He]2s^2$ and $[Ne]3s^2$ configuration respectively.
(B) 2s and 3s orbital are filled to their capacity.
(C) Be and Mg are unable to accept electron.
(D) All the above are correct.

Space for Rough work

53. Out of N, O, Ne, Na, Na^+, select the species which have maximum and minimum ionization energy
(A) Na^+, Na (B) NO, Na
(C) Na^+, O (D) Ne, N

54. The correct ionic radii order is
(A) $N^{3-} > O^{2-} > F^- > Na^+$ (B) $N^{3-} > Na^+ > O^{2-} > F^-$
(C) $Na^+ > O^{2-} > N^{3-} > F^-$ (D) $O^{2-} > F^- > Na^+ > N^{3-}$

55. Boron compounds behave as Lewis acid because of
(A) Acidic nature (B) Covalent nature
(C) Ionic nature (D) Vacant orbital

56. H_3BO_3 is
(A) Mono basic and weak Lewis acid
(B) Mono basic and weak Bronsted acid
(C) Mono basic acid and strong Lewis acid
(D) Tri basic acid and weak Bronsted acid

57. Graphite is a soft solid lubricant extremely difficult to smelt. The reason for this anomalous behaviour is that graphite:
(A) Has molecules of variable molecular masses like polymer
(B) Has carbon atom arranged in large plated of rings of strongly bonded carbon atoms with weak interplate bonds
(C) Is a non-crystalline substance
(D) Is an allotropic form of diamond

58. The reaction is balanced if

$$5H_2O_2 + xClO_2 + 2OH^- \longrightarrow xCl^- + yO_2 + 6H_2O$$

(A) x = 5, y = 2 (B) x = 2, y = 5
(C) x = 4, y = 10 (D) x = 5, y = 5

59. Consider the following reaction:

$$xMnO_4^- + yC_2O_4^{2-} + 2H^+ \longrightarrow xMn^{2+} + 2yCO_2 + \frac{z}{2}H_2O$$

The values of x, y, z in the reaction are respectively:
(A) 2, 5 and 16 (B) 5, 2 and 8
(C) 5, 2 and 16 (D) 2, 5 and 8

60. Metal hydrides are ionic, covalent or molecular in nature. Among LiH, NaH, KH, RbH, CsH the correct order of increasing ionic character is
(A) LiH > NaH > CsH > KH > RbH (B) LiH < NaH < KH < RbH < CsH
(C) RbH > CsH > NaH > KH > LiH (D) NaH > CsH > RbH > LiH > KH

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. The solution to the differential equation $\frac{dy}{dx} = \frac{(x+y+1)^2}{xy - y + 2x - 2}$ is

(A) $e^{2y/x} = cx^4 + cx^3y$
(B) $e^{y/x} = cx^3 + cx^4y$
(C) $e^{\frac{2y+2}{x-1}} = cx^4 + cx^2y$
(D) none of these

62. Let a continuous function f(x) on R → R be defined such that it satisfies the relation $f(x) + f(x + 2y) + 3xy = 2f(2y - x) + 2y^2 \ \forall\ x, y \in R$. Then which of the following is true

(A) f(x) is an odd function
(B) f(x) is one-one
(C) f(x) is into
(D) f(x) is invertible

63. $\lim\limits_{n\to\infty}\left[\frac{1\cdot n + 2(n-1) + ... + n\cdot 1}{1^3 + 2^3 + ... + n^3} + 1\right]^n$ is equal to

(A) $\frac{2}{3}$
(B) e^2
(C) $e^{\frac{1}{2}}$
(D) $e^{\frac{2}{3}}$

64. Which of the following statements is NOT true (where [.] denote the greatest integer function and {.} denote fractional part function)

(A) $\{x^2\}$ is continuous as well as differentiable at x = 0
(B) $[x^2]$ is continuous as well as differentiable at x = 0
(C) $\sqrt{\{x\}^2}$ is continuous as well as differentiable at x = 0
(D) none of the above

Space for rough work

65. If $\frac{d^3x}{dy^3}\left(\frac{dy}{dx}\right)^5 = P\left(\frac{d^2y}{dx^2}\right)^2 - \frac{dy}{dx}\frac{d^3y}{dx^3}$ then value of 'P' is equal to

(A) 1 (B) 2
(C) 3 (D) none of these

66. $\int x^9\left(1+x^5\right)^{2/5} dx$ is equal to

(A) $\frac{5}{12}\left(1+x^5\right)^{12/5} + \frac{1}{14}\left(1+x^5\right)^{7/5} + C$ (B) $\frac{1}{12}\left(1+x^5\right)^{12/5} - \frac{1}{7}\left(1+x^5\right)^{7/5} + C$
(C) $\frac{5}{12}\left(1+x^5\right)^{12/5} - \frac{5}{7}\left(1+x^5\right)^{7/5} + C$ (D) none of these

67. If f(x) = x(x – 1)(x – 2)(x – 3)(x – 4)(x – 5) then value of $\int_0^5 \left[\frac{3f(x)-|f(x)|}{3f(x)+|f(x)|}\right]dx$ (where [.] denotes the greatest integer function) is equal to

(A) 10 (B) 15
(C) 6 (D) 9

68. If f(x) = cos($\pi \sin^2 x$) and g(x) = cos($\pi \cos^2 x$) then which of the following statements is true

(A) f(x) is aperiodic
(B) g(x) is aperiodic
(C) f(x) + g(x) is periodic with fundamental period π
(D) none of these

69. Let $S_n = \sum_{k=1}^{n} \frac{\tan^{-1}\left(\frac{k}{n}\right)}{n}$ and $T_n = \sum_{k=0}^{n-1} \frac{\tan^{-1}\left(\frac{k}{n}\right)}{n}$ for n $\in$ N, then which of the following statements is false

(A) $S_n > \frac{\pi - \ln 4}{4}$ (B) $T_n < \frac{\pi - \ln 4}{4}$
(C) $\lim_{n\to\infty} S_n > \lim_{n\to\infty} T_n$ (D) none of these

Space for rough work

70. Let if $f(x)=\sum_{i=0}^{9}a_i x^i$ be a real valued function, $a_i \notin R^-$, where f(x) = 0 has two distinct negative roots. Then minimum number of distinct real roots of f(x) = 0 are

(A) 3 (B) 2

(C) 9 (D) not enough information

71. Area bounded by curve y = 1 and $y=\frac{\sin x+\cos x+|\sin x-\cos x|}{2}$ in $x \in [0, \pi]$ is

(A) $\frac{3\pi}{4}-\frac{1}{\sqrt{2}}-1$ (B) $\frac{3\pi}{4}-\frac{1}{\sqrt{2}}$

(C) $\pi+\sqrt{2}-3$ (D) $\pi-\sqrt{2}-1$

72. Number of points where function $f(x)=(1-\sin x-\cos x)\operatorname{sgn}\left(x^2-\frac{\pi x}{2}\right)$ is discontinuous is

(A) 0 (B) 1

(C) 2 (D) 3

73. If $f(x)=\frac{1}{\sqrt{|x|-x}}$ and $g(x)=\cos\left(\ln\left(\frac{\sqrt{1-x^2}}{e^x}\right)\right)$, then domain of (fog)(x) is

(A) $(-\infty, 0)$ (B) $(-1, 0)$

(C) $(-1, 1)$ (D) $(0, 1)$

74. The curve for which square of sub tangent varies as subnormal is

(A) $(x + 2)^2 = y^3$ (B) $(x - 2)^3 = y^2$

(C) $x^2 = (y - 2)^3$ (D) $x^3 = (y + 2)^2$

75. Let f(x) be a 'n' degree polynomial function having 'n' real and distinct roots.
If g(x) = f′(x) + 100f(x), then minimum number of roots that g(x) must possesses is

(A) n (B) n + 1

(C) n – 1 (D) information is insufficient

76. Which of the following statement is true?

(A) $e^{\pi} < \pi^{e}$ (B) $\pi^3 > 3^{\pi}$

(C) $2^e > e^2$ (D) $\pi^{10} > 10^{\pi}$

Space for rough work

77. $\int_{-2}^{2} x^4 d(\ln x)$ is equal to

(A) $\frac{e^8 - e^{-8}}{4}$ (B) $\frac{64}{5}$

(C) 0 (D) none of these

78. Area bounded by the curve $f(x) = \frac{1}{x^2 + [x]^2 + 2\{x\} + 1 - 2x[x]}$ and x-axis between $x = -\frac{3}{2}$ and $x = \frac{5}{2}$ is equal to (where [.] denote the greatest integer function and {.} denote fractional part function)

(A) $\frac{1}{2}$ (B) 1

(C) 2 (D) 4

79. Area bounded by the curves $C_1 : x^2 + y^2 = 36$; $C_2 : y^2 = 5x$; $C_3 : y^2 = -5x$ is equal to

(A) $4\int_0^4 \left(\sqrt{36 - x^2} - 5x\right)dx$ (B) $2\int_0^4 \left(\sqrt{36 - x^2} - 5x\right)dx$

(C) $4\left(\int_0^{\sqrt{20}} \frac{y^2}{5} dy\right)$ (D) $4\left[9\pi - \left(\int_0^{\sqrt{20}} \left(\sqrt{36 - y^2} - \frac{y^2}{5}\right) dy\right)\right]$

80. $\int \frac{6x^{23} - 9x^8}{\left(x^{15} + x^9 + 1\right)^2} dx$ is equal to

(A) $-\frac{x^9}{x^{15} + x^9 + 1} + c$ (B) $\frac{3x^9}{\left(x^{15} + x^9 + 1\right)^3} - \frac{2x^3}{\left(x^{15} + x^9 + 1\right)^2} + c$

(C) $-\frac{x^{15} + x^6}{x^{15} + x^9 + 1} + c$ (D) none of these

81. Which of the following limits vanish? (i) $\lim_{x \to \infty} \frac{\sin x}{x}$ (ii) $\lim_{x \to \infty} \frac{\int_0^x e^t dt}{e^{x^2}}$ (iii) $\lim_{x \to 0} (\sin x)^{1/x^2}$

(A) (ii), (iii) (B) (i), (ii)

(C) (i), (iii) (D) (i), (ii), (iii)

Space for rough work

82. The statement $(p \vee \sim r) \vee (\sim p \wedge q \wedge r)$ is equivalent to

(A) $\sim(p \wedge q \wedge \sim r)$ (B) $(p \wedge \sim q) \vee r$

(C) $\sim(\sim p \wedge q \wedge \sim r)$ (D) $\sim(\sim p \wedge \sim q \wedge r)$

83. $\int \frac{3x^2+1}{x^6+2x^4+2x^3+x^2+2x+2}$ is equal to

(A) $\frac{x^5-2x^2}{x^3+x+1}+c$ (B) $-\cot^{-1}(x^3 + x + 1) + c$

(C) $\frac{x^3+x}{\left(x^6+2x^4+2x^3+x^2+2x+2\right)^2}$ (D) none of these

84. If $\sqrt{2y+x}+\sqrt{2y-x}$ = constant then $\frac{dy}{dx}$ is equal to

(A) $\frac{x}{4y-\sqrt{4y^2-x^2}}$ (B) $\frac{x}{4y+\sqrt{4y^2-x^2}}$

(C) $\frac{x}{4y+2\sqrt{4y^2-x^2}}$ (D) $\frac{x}{4y-2\sqrt{4y^2-x^2}}$

85. Consider the functions $f(x) = |x|^5$; $g(x) = \{\cos x\}$; $h(x) = [|\sin x|]$ (where [.] denote the greatest integer function and {.} denote fractional part function) then which of these functions is differentiable at x = 0?

(A) f(x) and g(x) (B) g(x) and h(x)

(C) f(x), g(x) and h(x) (D) f(x) and h(x)

86. If the line segment $y = 2x$, $-1 \le x \le 1$ is rotated about y-axis, then which of the following statements hold true for the solid so formed

(A) volume = $\frac{2\pi}{3}$, surface area = $\sqrt{5}\pi$ (B) volume = $\frac{4\pi}{3}$, surface area = $\sqrt{5}\pi+2\pi$

(C) volume = $\frac{2\pi}{3}$, surface area = $\sqrt{5}\pi+\pi$ (D) volume = $\frac{4\pi}{3}$, surface area = $2\sqrt{5}\pi$

Space for rough work

87. Let a relation be defined on a set of functions defined on R → R such that R = {(f, g)|f – g is an even function} then, relation R is
(A) reflexive, symmetric
(B) reflexive, transitive
(C) symmetric, transitive
(D) equivalence relation

88. If area bound by the curves $y = e^{ax^2}$, $y = e^{\frac{1}{8}}$ between x = 0 and x = 1 is minimum, then the value of 'a' is
(A) 1
(B) 2
(C) $\frac{1}{2}$
(D) none of these

89. Order and degree of the differential equation $\sin\left(\frac{dy}{dx}\right) = 2xy - 3\cos\frac{dy}{dx}$ respectively are
(A) order 1, degree 1
(B) order 1, degree not defined
(C) order 2, degree not defined
(D) none of these

90. Let the number of elements in a set A be 'n'. A set 'C' is defined such the
C = {(x, y)| x, y $\in$ P(A) and x $\cap$ y = ϕ}, where P(A) is power set of A, then cardinal number of C is equal to
(A) 2^{2n}
(B) 3^n
(C) 2.3^n
(D) none of these

Space for rough work

FIITJEE

JEE(Main)-2018

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

PART TEST – I
(Main)

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**A**	31.	**C**	61.	**D**
2.	**C**	32.	**D**	62.	**C**
3.	**C**	33.	**D**	63.	**D**
4.	**A**	34.	**C**	64.	**C**
5.	**D**	35.	**C**	65.	**C**
6.	**C**	36.	**D**	66.	**B**
7.	**C**	37.	**A**	67.	**C**
8.	**C**	38.	**B**	68.	**D**
9.	**D**	39.	**C**	69.	**C**
10.	**A**	40.	**B**	70.	**A**
11.	**B**	41.	**A**	71.	**D**
12.	**D**	42.	**C**	72.	**A**
13.	**A**	43.	**D**	73.	**B**
14.	**A**	44.	**C**	74.	**B**
15.	**A**	45.	**C**	75.	**C**
16.	**A**	46.	**D**	76.	**D**
17.	**B**	47.	**D**	77.	**A**
18.	**A**	48.	**D**	78.	**C**
19.	**B**	49.	**A**	79.	**D**
20.	**C**	50.	**A**	80.	**A**
21.	**C**	51.	**A**	81.	**D**
22.	**C**	52.	**D**	82.	**D**
23.	**B**	53.	**A**	83.	**B**
24.	**D**	54.	**A**	84.	**C**
25.	**C**	55.	**D**	85.	**D**
26.	**C**	56.	**A**	86.	**D**
27.	**B**	57.	**B**	87.	**D**
28.	**A**	58.	**B**	88.	**C**
29.	**D**	59.	**A**	89.	**A**
30.	**A**	60.	**B**	90.	**B**

Physics

PART – I

SECTION – A

1. $$v = \frac{dx}{dt}$$

$$\Rightarrow dt = \frac{dx}{v} = \frac{xdx}{a}$$

$$\Rightarrow \int_0^t dt = \frac{1}{a}\int_{x_1}^{x_2} xdx$$

$$\Rightarrow t = \frac{x_2^2 - x_1^2}{2a}$$

2. Weight is non impulsive force during explosion.

3. Basic concept of direction

4. Conservation of momentum for (M +m)

$2mv_0 = Mv_1$ …(i)

Newton's second law :

$v_0 \cos 30° = v_1 \cos 30° + v_2 \cos 60°$

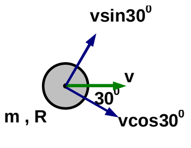
$\sqrt{3}v_0 = \sqrt{3}v_1 + v_2$ …(ii)

For 'm': $v_0 \sin 30° = v_2 \sin 60°$ …(iii)

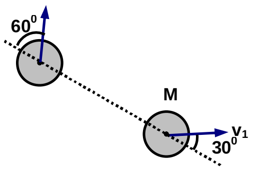
$$\Rightarrow v_2 = \frac{v_0}{\sqrt{3}},\ v_1 = \frac{2}{3}v_0$$

from (i) $\dfrac{2mv_0}{M} = \dfrac{2v_0}{3}$

$$\Rightarrow \left(\frac{m}{M}\right) = \frac{1}{3} \Rightarrow \left(\frac{M}{m}\right) = 3$$



Before collision



After collision

5. Object is moving away from the origin till velocity is positive.

6. $$\cos\theta = \frac{x^2 + R^2 - L^2}{2xR} \Rightarrow 2xR \cos\theta = x^2 + R^2 - L^2$$

$$2R\left\{-x\sin\theta\frac{d\theta}{dt} + \cos\theta\frac{dx}{dt}\right\} = 2x\frac{dx}{dt}$$

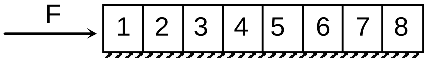
$xv = Rv \cos\theta - Rx\ \omega \sin\theta$

$$\Rightarrow v = \left(\frac{xR\omega\sin\theta}{R\cos\theta - x}\right)$$

7. $F_{81} = ma$

$F_{21} = 7\ ma$

$$\frac{F_{21}}{F_{87}} = 7$$



8. Let Wedge is moving rightward with acceleration a and mass m has an acceleration A with respect to wedge along the surface of the wedge in upward direction, so

$$\frac{h}{\sin\alpha} = \frac{1}{2}At^2 \Rightarrow A = \frac{2h}{t^2 \sin\alpha} \qquad \text{.....(1)}$$

With the help of FBD of mass m in the frame of wedge, we can write

$$A = a\cos\alpha - g\sin\alpha \Rightarrow \frac{2h}{t^2 \sin\alpha} = a\cos\alpha - g\sin\alpha$$

$$\Rightarrow a = g\tan\alpha + \frac{2h}{t^2 \sin\alpha\cos\alpha} = 10 \times \frac{3}{4} + 2 \times 3 \times \frac{5}{3} \times \frac{5}{4} \times \frac{1}{5 \times 5} = 8\text{m}/\text{s}^2$$

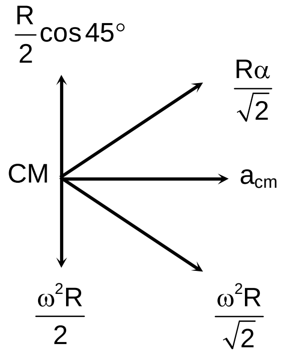
9. Use the concept of graph

10. Using work energy theorem, we get $\Sigma W_1 = \Sigma W_2$
$[W_g + W_{\text{friction}}]_1 = [W_g + W_{\text{friction}}]_2$
Since, $|f_1| > |f_2| \Rightarrow [W_{\text{ext}}]_1 > [W_{\text{ext}}]_2$

11. $F - f = Ma,\ fR = \dfrac{MaR}{2}$
$\Rightarrow\ f = F/3$

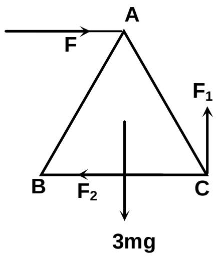
12. Basic concept of kinematics

13. Net acceleration of c.m. in + y direction = $\dfrac{R\alpha}{2} - \dfrac{\omega^2 R}{2}$
$N - mg = ma_{cm,y}$
$N = mg + \dfrac{m}{2}\left(\alpha - \omega^2\right)R$



14. F.B.D. of torque

15. Since system is in rotational equilibrium so net torque on the system about C is zero's
$F_{\max} \times \dfrac{\ell\sqrt{3}}{2} - 3mg\dfrac{\ell}{2} = 0$
$\Rightarrow F_{\max} = \sqrt{3}mg$



16. Using WET, we can write
$\dfrac{1}{2}m_c v_c^2 = \dfrac{-K}{2}\left(x_f^2 - x_i^2\right) - \mu m_0 gd$
$\Rightarrow v_c = \sqrt{\dfrac{kx_i^2 - 2\mu m_c gd}{m_e}}$
$v_{sys} = \dfrac{m_c v_c}{m_e + m_D} = 2\ \text{m}/\text{s}$

17. Case I:

$T_1 = 2mg$

$ma_1 = 2mg - T_1$

$\Rightarrow a_1 = g\uparrow$

Case II:

$T_2 = mg$

$3ma_2 = 3mg - T_2$

$\Rightarrow a_2 = 2g/3 \downarrow$

Case III:

$T_3 = 4mg$

$ma_3 = T_3 - mg$

$\Rightarrow a_3 = 3g\uparrow$

Case IV:

$T_4 = mg$

$2ma_4 = 2mg - T_4$

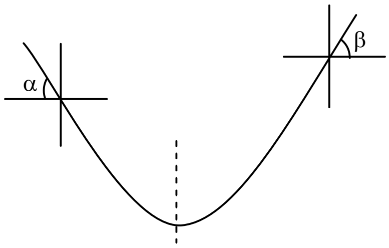
$\Rightarrow a_4 = g/2\downarrow$

18. $T_1 \cos\alpha = T_3 = T_2 \cos\beta$

$T_1 \sin\alpha + T_2 \sin\beta = mg$

$$\Rightarrow \quad mg = T_1\sqrt{1-\left(\frac{T_3}{T_1}\right)^2} + T_2\sqrt{1-\left(\frac{T_3}{T_2}\right)^2}$$

$$\Rightarrow \quad m = \frac{\sqrt{T_1^2 - T_3^2} + \sqrt{T_2^2 - T_3^2}}{g}$$



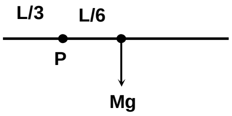
19. Use the concept of F.B.D.

20. Torque about P

$$Mg\frac{\ell}{6} = \frac{M\ell^2}{9}\alpha$$

$$\Rightarrow \alpha = \frac{3}{2}\frac{g}{\ell}$$

$$\Rightarrow a_t = \alpha\frac{\ell}{6} = \frac{g}{4}$$



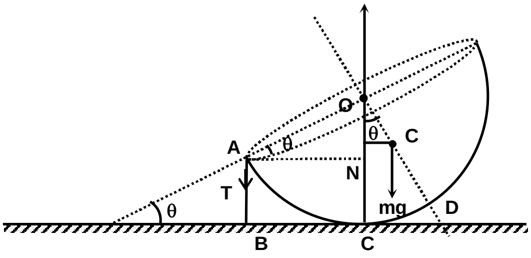
21. According the rotational equilibrium of the hemisphere we can write

$$OC = \frac{3R}{8} \text{ and } ON = R - L = 6 \text{ m}$$

$$AN = \sqrt{R^2 - (R-L)^2} = 8 \text{ m}$$

$$T \times R\cos\theta - mg\frac{3R}{8}\sin\theta = 0$$

$$T = \frac{3mg\tan\theta}{8} = \frac{3 \times 64 \times 10 \times 6}{8 \times 8} = 180 \text{ N}$$



22. 2T – Mg + T = Ma ⇒Mg – 3T = Ma ⇒ 3T = M(g – a) ….(i)

2T = kx

$$T = \frac{M(g+a)}{3}$$

$$\text{Reading of spring balance} = \frac{kx}{g} = \frac{2T}{g} = \begin{cases} \dfrac{2M(g+a)}{3g} & \text{(when moving upward)} \\ \dfrac{2M(g-a)}{3g} & \text{(when moving downward)} \end{cases}$$

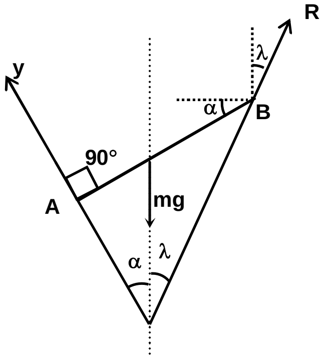
23. Since body is in equilibrium, under the influence of three forces only so they must be concurrent. Using Lami's theorem we can write

$\tan\alpha = \dfrac{L}{2x}$ and $\tan(\alpha+\lambda) = \dfrac{L}{x}$

$\tan(\alpha + \lambda) = 2\tan\alpha \Rightarrow \dfrac{\tan\alpha + \tan\lambda}{1 - \tan\alpha\tan\lambda} = 2\tan\alpha$

$\Rightarrow \tan\alpha + \tan\lambda = 2\tan\alpha - 2\tan^2\alpha\tan\lambda$

$\Rightarrow \tan\lambda = \mu = \dfrac{\tan\alpha}{1 + 2\tan^2\alpha}$



24. $$v = \begin{cases} \dfrac{2t^2}{9} & \text{if } 0 \le t \le 15 \text{ sec} \\ 150 + 30(t-15) & \text{if } 15\text{ s} \le t \le 40\text{ s} \end{cases}$$

at t = 15 sec

$$v = \frac{3 \times 15 \times 15}{3} = 150 \text{ m/s}$$

$$\vec{r} = \begin{cases} \dfrac{2t^3}{3}\hat{j} & \text{if } 0 \le t \le 15 \text{ sec} \\ 150 + 150(t-15) + 15(t-15)^2\hat{j} & \text{if } 15\text{ s} \le t \le 40\text{ s} \end{cases}$$

at t = 15

$$r = \frac{2 \times 15 \times 15 \times 15}{3 \times 3} = 750 \text{ m}$$

25. $v_x = 1 \Rightarrow x = t$ and $v_y = 6t \Rightarrow y = 3t^2 \Rightarrow y = 3x^2$

$$\Rightarrow \frac{dy}{dx} = 6x,\ \frac{d^2y}{dx^2} = 6 \Rightarrow \left.\frac{dy}{dx}\right|_{x=\frac{\sqrt{2}}{3}} = 2\sqrt{2}$$

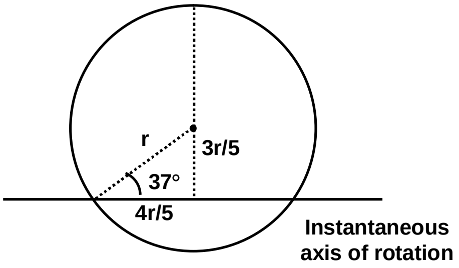
As we know that

$$R = \frac{\left[1 + \left(\dfrac{dy}{dx}\right)^2\right]^{3/2}}{\dfrac{d^2y}{dx^2}} = \frac{(1+8)^{3/2}}{6} = 4.5\text{ m}$$

26. $8x_B = x_A \Rightarrow 8v_B = v_A \Rightarrow 8a_B = a_A$

27. $v = \omega \times \frac{3r}{5} \Rightarrow \omega = \frac{5v}{3r}$

$v_B = \omega \times \frac{8r}{5} = \frac{5v}{3r} \times \frac{8r}{5} = \frac{8v}{3}$

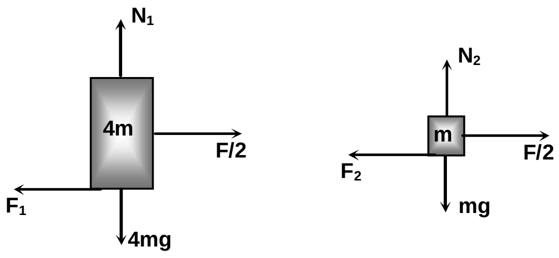


28. Both blocks 4m and m has tendency of motion towards rightwards, so friction forces (F_1 and F_2) will act on both blocks leftward, hence on the platform rightward, so

$a = \frac{F_1 + F_2}{m} = 2\,\text{m/s}$

$F_1 + F_2 = 20$ N

$F_1 \le 64\ N_1\ F_2 \le 16$ N



Case I: Suppose block of mass 4m has a relative motion with respect to platform

So, $F_{1k} = 40$ N

$F_2 = -20$ N (not possible)

Case II: Suppose block of mass m has a relative motion with respect to platform, so

$F_{2k} = 10\text{ N} \Rightarrow F_{1s} = 10$ N (possible)

$\frac{F}{2} - F_{1s} = 4m \times 2 \Rightarrow \frac{F}{2} = 1) + 4 \times 10 \times 2 = 90$

$\Rightarrow F = 180\text{ N} \Rightarrow \frac{F}{2} - F_{2k} = ma \Rightarrow 90 - 10 = 10a \Rightarrow a = 8\text{ m/s}^2$

29. First Method:

$$I_{AB} = \int y^2 dm = \frac{\lambda_0}{\ell^3} \int_{-x}^{\ell - x} (y+x)^3 y^2 dy$$

$$\int (y+x)^3 y^2 dy = y^2 \frac{(y+x)^4}{4} - \frac{1}{2} y(y+x)^4 dy$$

$$= \frac{y^2 (y+x)^2}{4} - \frac{y}{10}(y+x)^5 + \frac{1}{10}(y+x)^5 dy$$

$$= \frac{y^2 (y+x)^2}{4} - \frac{y(x+y)^5}{10} + \frac{(y+x)^2}{60}$$

$$\int_{-x_0}^{(\ell - x)} y^2 (y+x)^3 dx = \frac{(L-x)^2 (\ell)^4}{4} - \frac{(\ell - x)\ell^5}{10} + \frac{\ell^6}{60}$$

$$I_{AB} = \lambda_0 \left[\frac{(\ell - x)^2}{4} \ell - \frac{1}{10}(\ell - x)\ell^2 + \frac{1}{60}\ell^3 \right] = \lambda_0 \ell \left[\frac{(\ell - x)^2}{4} \ell - \frac{1}{10}(\ell - x) + \frac{1}{60}\ell^2 \right]$$

$$\frac{dI_{AB}}{dx} = 0 \Rightarrow -\frac{(\ell - x)}{2} + \frac{\ell}{10} = 0 \Rightarrow 5\ell - 5x = \ell \Rightarrow 5x = 4\ell \Rightarrow x = \frac{4\ell}{5}$$

Second Method:

As we know that moment of inertia is minimum among all set of parallel axis, if axis is passing through centre of mass, so x must be distance of centre of mass.

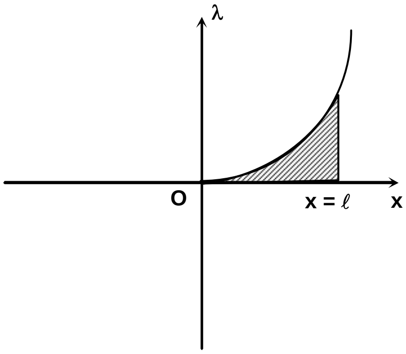
$$x_{CM} = \frac{1}{M}\int_0^L x\,dm \qquad ....(i)$$

$$M = \int dm = \frac{\lambda_0}{\ell^3}\int_0^\ell x^3 dx = \frac{\lambda_0 \ell}{4}, \text{ and } \int_0^\ell x\,dx = \frac{\lambda_0}{\ell^3}\int_0^\ell x^4 dx = \frac{\lambda_0 \ell^2}{5}$$

Putting these values in equation (i) we have $x_{cm} = \frac{4\ell}{5}$

Third Method:

From given function it is clear that centre of mass of system must be at distance grater than $\ell/2$. We have only two option, $\frac{8\ell}{15}$ and $\frac{4\ell}{5}$. For graph it is clear that maximum mass existence is nearer to other end, so it can't be $\frac{8\ell}{15}$, so right answer will be $\frac{4\ell}{5}$.



30. Time taken by Car-A to reach the finish line is greater than that of Car-B, So

$$\int_0^{t_A} F\,dt > \int_0^{t_B} F\,dt \Rightarrow \Delta p_A > \Delta p_B$$

Chemistry

PART – II

SECTION – A

31. $\psi(3s) = 0$

$$6 - 6\sigma + \sigma^2 = 0$$

$$\sigma = -\frac{(-6) \pm \sqrt{36 - (4(1)6)}}{2 \times 1}$$

$$\sigma = \frac{6 \pm \sqrt{12}}{2}$$

$$\sigma = \frac{6 \pm 2\sqrt{3}}{2}$$

$$\sigma = 3 + \sqrt{3} \text{ or } 3 - \sqrt{3}$$

$$\frac{2rZ}{3a_o} = 3 + \sqrt{3}$$

$$r = \frac{3}{2}\left(3 + \sqrt{3}\right)\frac{a_o}{Z}$$

32. $[Cr] = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$

For p $\ell = 1$

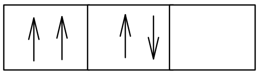
m = +1, 0, -1

For 2p of 3p there are 2e with $s = -\frac{1}{2}$

For d $\ell = 2$

m = +1 may have e with $+\frac{1}{2}$ or $-\frac{1}{2}$

So minimum 2 and maximum 3.

33. 

Same value of spin quantum number.

34. K_{eq} at 1400 K $= \frac{0.29}{1.1 \times 10^{-6}} = 0.26 \times 10^6$

$= 26 \times 10^4$

K_{eq} at 1500 K $= \frac{1.3}{1.4 \times 10^{-5}} = 0.92 \times 10^5$

$= 92 \times 10^3$

Since K_{eq} decreases on increasing temperature. So reaction is exothermic.

35.

$$\begin{array}{llll} & A \longrightarrow & 2B & + \quad C \\ t = 0 & P_A & & \\ t = t & P_A - P' & 2P' & P' \\ t = \infty & 0 & 2P_A & P_A \end{array}$$

$$P_A - P' + 2P' + P' = P_t$$

$$P_A + 2P' = P_t$$
$$2P_A + P_A = P_\infty$$
$$P_A = \frac{P_\infty}{3}$$
$$\frac{P_\infty}{3} + 2P' = P_t$$
$$P' = \left(P_t - \frac{P_\infty}{3}\right)\frac{1}{2}$$
$$Kt = \ell n\frac{P_A}{P_A - P'} = \ell n\frac{P_\infty}{3\left(\frac{P_\infty}{3} - \frac{P_t}{2} + \frac{P_\infty}{6}\right)}$$
$$Kt = \ell n\frac{P_\infty}{3\left(\frac{2P_\infty - 3P_t + P_\infty}{6}\right)}$$
$$Kt = \ell n\frac{2P_\infty}{3P_\infty - 3P_t}$$
$$K = \frac{2.303}{t}\log\frac{2(P_\infty)}{3(P_\infty - P_t)}$$

36. Zero order reaction is always a complex reaction.

37. $\log\frac{K_2}{K_1} = \frac{\Delta H}{R \times 2.303}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$

If $\Delta H = 0$

Then $K_2 = K_1$

Means no effect.

38. For exothermic reaction high temperature favour backward reaction and with increase in pressure reaction goes where number of moles are less.

39.
$$\begin{array}{lll} 2A(g) \rightleftharpoons & 2B(g) + & C(g) \\ v & & \\ v - 2v' & 2v' & v' \end{array}$$
$$v' = 100$$
$$v - 2v' + 2v' + v' = 700$$
$$v = 600$$
$$\begin{array}{lll} 2A(g) \rightleftharpoons & 2B(g) \ + & C(g) \\ 400 & 200 & 100 \\ 10 \times \frac{400}{700} & 10 \times \frac{200}{700} & 10 \times \frac{100}{700} \\ = \frac{40}{7} & \frac{20}{7} & \frac{10}{7} \end{array}$$
$$K_P = \frac{\left(\frac{20}{7}\right)^2 \times \frac{10}{7}}{\left(\frac{40}{7}\right)^2} = \frac{20 \times 20 \times 10}{40 \times 40 \times 7} = \frac{10}{28}$$

40. $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ is 4.5

P

$P - P\alpha \qquad 2P\alpha$

$P - P\alpha + 2P\alpha = 2$

$P + P\alpha = 2$

$$4.5 = \frac{4P^2\alpha^2}{P(1-\alpha)}$$

$$4.5 = \frac{4P\alpha^2}{1-\alpha}$$

$4.5(1-\alpha) = 4P\alpha^2$

$$P = \frac{4.5(1-\alpha)}{4\alpha^2}$$

$P(1+\alpha) = 2$

$$\frac{4.5(1-\alpha)(1+\alpha)}{4\alpha^2} = 2$$

$4.5(1-\alpha^2) = 8\alpha^2$

$4.5 - 4.5\alpha^2 = 8\alpha^2$

$4.5 = 12.5\alpha^2$

$$\alpha = \sqrt{\frac{4.5}{12.5}}$$

$\alpha = 0.6$

$$\alpha = \frac{M - EMM}{EMM(n-1)}$$

$$0.6 = \frac{92 - EMM}{EMM(2-1)}$$

$0.6EMM = 92 - EMM$

$1.6EMM = 92$

$$EMM = \frac{92}{1.6}$$

= 57.5

41. $HA \rightleftharpoons H^+ + A^-$

0.25

$0.25 - x \qquad x \qquad x$

$\simeq 0.25$

$$4 \times 10^{-8} = \frac{x^2}{0.25}$$

$$x^2 = 4 \times \frac{25}{100} \times 10^{-8}$$

$x = 10^{-4}$

$x = \left[H^+\right] = 10^{-4}$

42. Due to common ion effect solubility decreases.

43. When AgCl start precipitating concentration of $[Ag^+]$ in the solution

$$\left[Ag^+\right] = \frac{K_{spAgCl}}{\left[Cl^-\right]} = \frac{1.8\times10^{-10}\times10}{0.1}$$

$$\left[Ag^+\right] = 1.8\times10^{-9}$$

$$K_{spAgI} = \left[Ag^+\right]\left[I^-\right]$$

$$1.5\times10^{-16} = 1.8\times10^{-9}\left[I^-\right]$$

$$\left[I^-\right] = \frac{1.5\times10^{-16}}{1.8\times10^{-9}} = 0.833\times10^{-7}$$

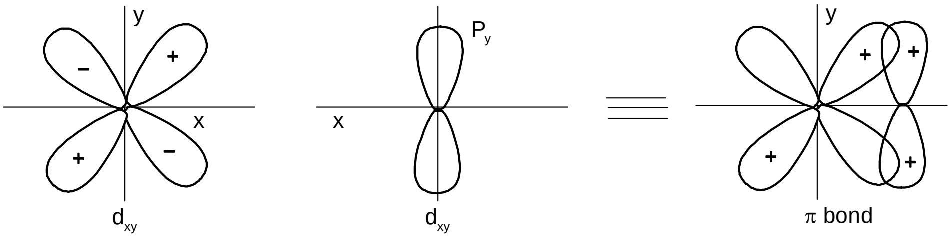
$$= 8.3\times10^{-8}$$

44. More is the concentration of common ion, lesser is the solubility.

45. Bond angle in XeF_4 and $XeCl_4$ is equal.

46. Fact

47.



48. sp^3d^2 orbital involved are d_{z^2} and $d_{x^2-y^2}$

49. Smaller is the size, larger is the hydration energy.

50. More is covalent character, lesser is the thermal stability.

51. More is the ionic character, stronger is the base.

52. Conceptual.

53. Na^+ have maximum ionization energy because of noble gas configuration and Na have lowest ionization energy because electron have to remove from 3rd shell.

54. More is the negative charge, larger is the size.

55. They can accept pair of electron because of vacant orbital.

56. Fact.

57. Because of layer of structure.

58. $5H_2O_2 + 2ClO_2 + 2OH^- \longrightarrow 2Cl^- + 5O_2 + 6H_2O$

59. $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

60. Larger is the size of cation more is the ionic character.

Mathematics PART – III

SECTION – A

61. Use substitution

$x - 1 \rightarrow X$

$y + 2 \rightarrow Y$

To make it homogenous differential equation

$$\frac{dY}{dX} = \frac{(X+Y)^2}{XY}$$

$$\Rightarrow Y = vX$$

$$\Rightarrow X\frac{dv}{dX} = \frac{1+2v}{v}$$

$$\Rightarrow \frac{1}{2}v - \frac{1}{2\cdot 2}\ln|1+2v| = \ln|X| + c$$

62. $x = 0,\ y = \frac{x}{2}$

$$\Rightarrow f(x) + f(0) = 2f(x) + \frac{x^2}{2}$$

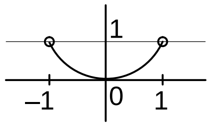
$$\Rightarrow f(0) - \frac{x^2}{2} = f(x)$$

$\Rightarrow$ f(x) is into, many-one, non-invertible

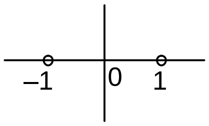
63. $$\lim_{n\to\infty}\left[1+\frac{\sum r(n-r+1)}{n^2(n+1)^2/4}\right]^n = e^{\frac{n\left[n^2(n+1)/2-n(n+1)(2n+1)/6+n(n+1)/2\right]}{n^2(n+1)^2/4}} = e^{\frac{1/2-1/3}{1/4}} = e^{\frac{2}{3}}$$

64. Shown in the figures

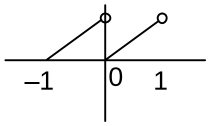
(a) $\{x^2\}$



(b) $[x^2]$



(c) $\sqrt{\{x\}^2}$



65. $$\frac{d^2x}{dy^2} = \frac{d}{dy}\left(\frac{1}{\frac{dy}{dx}}\right) = \frac{dx}{dy}\frac{d}{dx}\left(\frac{dy}{dx}\right)^{-1} = \frac{-\frac{d^2y}{dx^2}}{\left(\frac{dy}{dx}\right)^3}$$

$$\frac{d^3x}{dy^3} = \frac{d}{dy}\left(\frac{d^2x}{dy^2}\right) = \frac{dx}{dy}\frac{d}{dx}\left(-\frac{d^2y}{dx^2}.\left(\frac{dy}{dx}\right)^{-3}\right) = \frac{-d^3y}{dx^3}\left(\frac{dy}{dx}\right)^{-4} + 3\left(\frac{dy}{dx}\right)^{-5}\left(\frac{d^2y}{dx^2}\right)^2$$

$$\Rightarrow \left(\frac{d^3x}{dy^3}\right)\left(\frac{dy}{dx}\right)^5 = 3\left(\frac{d^2y}{dx^2}\right)^2 - \frac{dy}{dx}\frac{d^3y}{dx^3}$$

66. $$\int\left(x^9 + x^4 - x^4\right)\left(1+x^5\right)^{2/5}dx = \int x^4\left(x^5+1\right)^{7/5}dx - \int x^4\left(1+x^5\right)^{2/5}dx$$

$$= \frac{\left(1+x^5\right)^{12/5}}{12} - \frac{\left(1+x^5\right)^{7/5}}{7} + C$$

67. $$\left[\frac{3f(x)-|f(x)|}{3f(x)+|f(x)|}\right] = \begin{cases} 0 & \text{if} \quad f(x) \ge 0 \\ 2 & \text{if} \quad f(x) < 0 \end{cases}$$

$$\Rightarrow \int_0^1 2dx + \int_2^3 2dx + \int_4^5 2dx = 6$$

68. $$f(x+\pi) = \cos\left(\pi \sin^2(x+\pi)\right) = f(x)$$

$$g(x+\pi) = \cos\left(\pi \cos^2(x+\pi)\right) = g(x)$$

$$h(x) = f(x) + g(x) = 2\cos\left(\frac{\pi}{2}\right).\cos\left(\pi\cos\left(2(x+\pi)\right)\right) = 0$$

h(x) periodic without any fundamental period

69. $\tan^{-1}x$ is increasing function

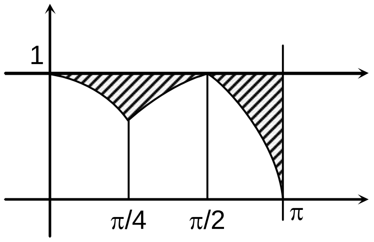
$\Rightarrow T_n < S_n$

$$\lim_{n\to\infty} S_n = \lim_{n\to\infty} T_n = \int_0^1 \tan^{-1} x dx = \frac{\pi - \ln 4}{4}$$

$$S_n > \frac{\pi - \ln 4}{4}, T_n < \frac{\pi - \ln 4}{4}$$

70. Third root will have to be zero

71. $$\frac{\sin x + \cos x + |\sin x - \cos x|}{2} = \begin{cases} \cos x & x \in \left[0, \frac{\pi}{4}\right] \\ \sin x & x \in \left[\frac{\pi}{4}, \pi\right] \end{cases}$$



Required Area = $\displaystyle\int_0^{\pi/4} (1-\cos x)dx + \int_{\pi/4}^{\pi/2} (1-\sin x)dx + \frac{\pi}{2} - 1$

$= \pi - \sqrt{2} - 1$

72. $\text{Sgn}\left(x^2 - \frac{\pi x}{2}\right)$ is discontinuous at x = 0 and x = $\frac{\pi}{2}$ and (1 – sin x – cos x) → 0

As x → 0 and x → $\frac{\pi}{2}$. So f(x) is continuous ∀ x.

73. Domain of f(x) = (–∞, 0)

Range of g(x) = [–1, 1]

⇒ Domain of (fog) (x) = (–1, 0)

74. $$\left|\frac{y}{m}\right|^2 \propto |ym| \Rightarrow \frac{y^2}{m^2} = kym$$

$\Rightarrow y = 0$ or $\frac{y}{k} = m^3$

$$\Rightarrow \frac{dy}{y^{1/3}} = \frac{dx}{k^{1/3}} \Rightarrow \frac{3}{2}y^{2/3} = \frac{x}{k^{1/3}} + C$$

$$\Rightarrow y^2 = \frac{2}{3k^{1/3}}\left(x + Ck^{1/3}\right)^3$$

If $\frac{2}{3k^{1/3}}$ = 1 and $Ck^{1/3} = -2$

$\Rightarrow y^2 = (x-2)^3$

75. Let $C_1(x) = e^{100x}f(x)$

$\Rightarrow C_1^{'}(x) = e^{100x}g(x)$

If $C^{'}_{(x)} = 0 \Rightarrow g(x) = 0$

If f(x) has roots $\alpha_1, \alpha_2, \ldots, \alpha_n$ then applying Rolle's theorem in (α_1, α_2), (α_2, α_3) ..... (α_{n-1}, α_n), we get g(x) has atleast n – 1 roots

76. Let $f(x) = x^{c/x}$ where c is a constant then f(x) has maxima at x = e

(a) use function $f(x) = x^{\frac{e\pi}{x}} \Rightarrow f(e) > f(\pi) \Rightarrow e^{\pi} > \pi^{e}$

(b) $f(x) = x^{\frac{3\pi}{x}}$ $\quad f(3) > f(\pi) \Rightarrow 3^{\pi} > \pi^{3}$

(c) $f(x) = x^{\frac{2e}{x}} \Rightarrow f(e) > f(2) \Rightarrow e^2 > 2^e$

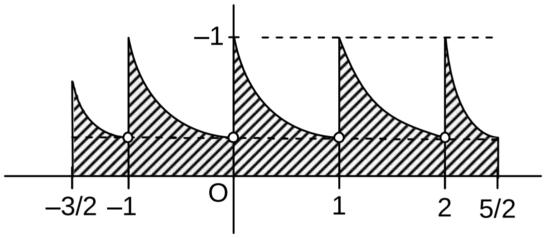
(d) $f(x) = x^{\frac{10\pi}{x}} \Rightarrow f(\pi) > f(10) \Rightarrow \pi^{10} > 10^{\pi}$

77. $\int_{-2}^{2} x^4 d(\ln x)$

Let ln x = t $\Rightarrow$ d (ln x) = dt

$$\int_{-2}^{2} e^{4t}dt \Rightarrow \left|\frac{e^{4t}}{4}\right|_{-2}^{2} = \frac{e^8 - e^{-8}}{4}$$

78. $f(x) = \frac{1}{\left(\{x\}+1\right)^2}$

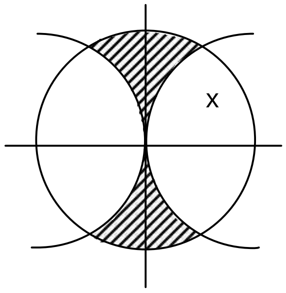


$$\int_{-3/2}^{5/2} f(x)dx = 4\int_0^1 \frac{1}{\left(\{x\}+1\right)^2}\,dx$$

$$= 4\int_0^1 \frac{1}{(1+x)^2}\,dx = 4\left|\frac{-1}{1+x}\right|_0^1 = 2$$

79. Required area can be through of as 4[area of quadrant of circle – x]

Where $x = \int_0^{\sqrt{20}} \left(\sqrt{36-y^2} - \frac{y^2}{5}\right) dy$



80. $$\int \frac{6x^{23} - 9x^8}{\left(x^{15} + x^9 + 1\right)^2}\, dx = \int \frac{6x^5 - 9x^{-10}}{\left(x^6 + 1 + x^{-9}\right)^2}\, dx$$

$$= \frac{-1}{x^6 + x^{-9} + 1} + C = \frac{-x^9}{x^{15} + x^9 + 1} + C$$

81. $$\lim_{x\to\infty} \frac{\sin x}{x} = 0$$

$$\frac{\lim\limits_{x\to\infty} \int_0^x e^t dt = 0}{e^{x^2}} = 0$$

$$\lim_{x\to\infty} \left(\sin x\right)^{1/x^2} = 0$$

82. $(p \vee \sim r) \vee (\sim p \wedge q \wedge r) = (p \vee \sim r) \vee (\sim(p \vee \sim r) \wedge q) = (p \vee \sim r) \vee q = \sim(\sim p \wedge \sim q \wedge r)$

83. $$\int \frac{\left(3x^2 + 1\right)dx}{\left(x^3 + x + 1\right)^2 + 1} = \tan^{-1}\left(x^3 + x + 1\right) + C = -\cot^{-1}(x^3 + x - 1) + C$$

84. $$\sqrt{2y + x} + \sqrt{2y - x} = C$$

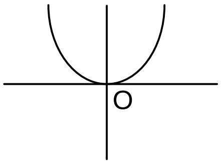
$$\Rightarrow \frac{2y' + 1}{2\sqrt{2y + x}} + \frac{2y' - 1}{\sqrt{2y - x}} = 0$$

Rearrange and rationalize to get

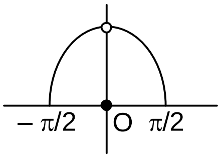
$$y' = \frac{x}{4y + 2\sqrt{4y^2 - x^2}}$$

85. Shown in the figure

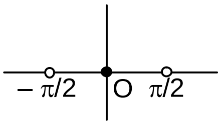
$f(x) = |x|^5$



$f(x) = \{\cos x\}$



$h(x) = [|\sin x|]$

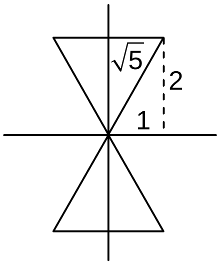


86. $V = 2\ \frac{\pi}{3}\ r^2h$

$= 2.\ \frac{\pi}{3}\ .\ 1.\ 2 = \frac{4\pi}{3}$

$S = 2\ \pi rl$

$= 2\sqrt{5}\ \pi$



87. **Reflexive** $\forall$ f $\in$ R, f – f = 0 $\in$ R

$\Rightarrow$ (f, f) $\in$ R

Symmetric $\forall$ (f, g) $\in$ R

$\Rightarrow$ f – g is even

$\Rightarrow$ g – f is even

$\Rightarrow$ (g, f) $\in$ R

Transitive $\forall$ (f, g) $\in$ R, (g, h) $\in$ R

$\Rightarrow$ f – g is even, g – h is even
$\Rightarrow$ f – h is even
$\Rightarrow$ (f, h) $\in$ R
So, R is equivalence relation

88. For area to be minimum $y = e^{1/8} = e^{a(1/2)^2}$

$\Rightarrow a = \frac{1}{2}$

89. sin(y′) + 3 cosy′ = 2xy

$\Rightarrow \sqrt{10}\sin\left(y' + \phi\right) = 2xy$

$\Rightarrow y' = \sin^{-1}\frac{2xy}{\sqrt{10}} - \phi$

90. Number of possible pairs of (x, y) = ${}^{n}C_{0}2^{n} + {}^{n}C_{1}2^{n-1} + ... + {}^{n}C_{n}2^{n-n}$

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

PART TEST – II

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 186**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into Two sections: **Section-A & Section-C**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01– 05, 19 – 23, 37 - 41)*** *contains 15 multiple choice questions which have* ***one correct*** *answer. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (06 – 13, 24 – 31, 42 - 49) *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.

2. ***Section-C (14 – 18, 32 – 36, 50 – 54)*** *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{\text{water}} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

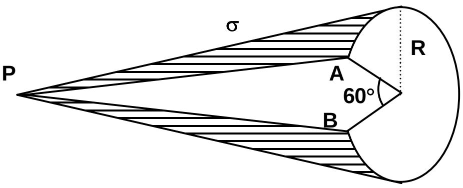
SECTION – A
(One Options Correct Type)

This section contains **5 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. Magnetic field exist in the space and given as $\vec{B} = -\frac{B_0}{\ell^2}x^2\hat{k}$, where B_0 and ℓ are positive constants. A particle having positive charge 'q' and mass 'm' is projected with speed 'v_0' along positive x-axis from the origin. What is the maximum distance of the charged particle from the y-axis before it turns back due to the magnetic field. (Ignore any interaction other than magnetic field)

(A) $\left(\frac{m\ell^2 v_0}{3qB_0}\right)^{1/3}$
(B) $\left(\frac{3m\ell^2 v_0}{2qB_0}\right)^{1/3}$
(C) $\left(\frac{3m\ell^2 v_0}{qB_0}\right)^{1/3}$
(D) $\left(\frac{m\ell^2 v_0}{qB_0}\right)^{1/3}$

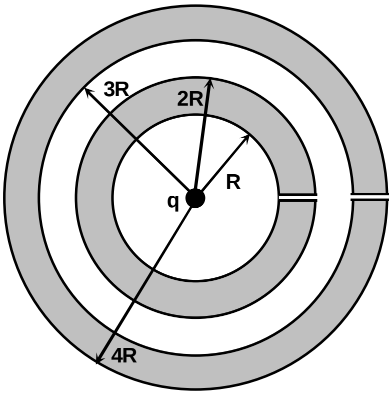
2. A non-conducting hollow cone has charge density σ. A part ABP is cut and removed from the cone. The potential due to the remaining portion of the cone at point 'P' is



(A) $\frac{5}{6}\frac{\sigma R}{\varepsilon_0}$
(B) $\frac{5}{24}\frac{\sigma R}{\varepsilon_0}$
(C) $\frac{5}{3}\frac{\sigma R}{\varepsilon_0}$
(D) $\frac{5}{12}\frac{\sigma R}{\varepsilon_0}$

Space for Rough work

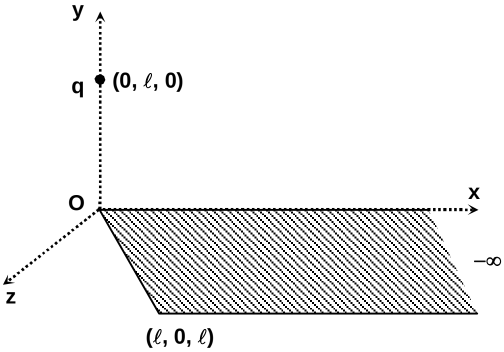
3. A charge particle 'q' lies at the centre of two concentric hollow sphere of inner radii R and 3R and outer radii 2R and 4R respectively. What amount of work has to be performed to slowly transfer the charge 'q' from center through the orifice to infinity.



(A) $\frac{5}{96}\frac{q^2}{\pi\varepsilon_0 R}$ (B) $\frac{q^2}{16\pi\varepsilon_0 R}$

(C) $\frac{7}{96}\frac{q^2}{\pi\varepsilon_0 R}$ (D) $\frac{q^2}{96\pi\varepsilon_0 R}$

4. A point charge 'q' is placed at a distance 'ℓ' (on the y-axis) vertically above the surface which lies in the xz plane as shown in the figure. The flux of electric field passing through the plate is



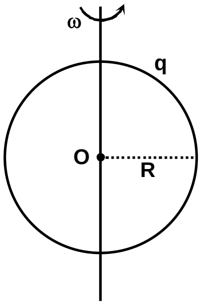
(A) $\frac{q}{6\varepsilon_0}$

(B) $\frac{q}{18\varepsilon_0}$

(C) $\frac{q}{24\varepsilon_0}$

(D) $\frac{q}{48\varepsilon_0}$

5. A hollow non conducting sphere of radius R has a positive charge q uniformly distributed on its surface. The sphere starts rotating with a constant angular velocity 'ω' about an axis passing through center of sphere, as shown in the figure. Then the net magnetic field at center of the sphere is



(A) $\frac{\mu_0 q\omega}{2\pi R}$ (B) $\frac{\mu_0 q\omega}{3\pi R}$

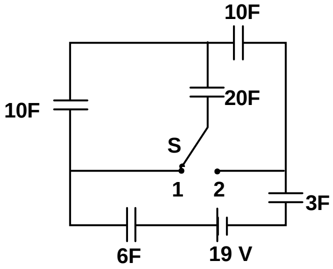
(C) $\frac{\mu_0 q\omega}{6\pi R}$ (D) $\frac{\mu_0 q\omega}{12\pi R}$

Space for Rough work

(One or More than one correct type)

This section contains **EIGHT** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

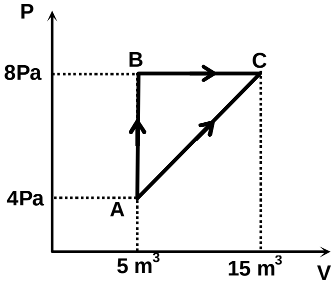
6. When the steady state is reached by keeping switch in position - 1, then switch 'S' is transferred from position 1 to 2. Then



(A) Charge on 3F capacitor is 30 C after S is transferred from position 1 to 2.
(B) Charge on 3F capacitor is $\frac{650}{19}$ C after S is transferred from position 1 to 2.
(C) Work done by the battery is 380 Joule after S is transferred from position 1 and 2.
(D) Work done by the battery is 80 Joule after S is transferred from position 1 and 2.

7. A cubical box of side 5 m contains helium gas at a pressure 320 N/m^2. During an observation time of 1 second, an atom travelling with root mean square speed parallel to one of the sides of the cube was found to make 1000 hits with a particular wall, without any collision with the other atoms. (take $R = \frac{25}{3}$ J/mol-K). Then
(A) The temperature of gas is 16×10^3 K.
(B) The temperature of gas is 8×10^3 K.
(C) The total mass of helium gas in the box is 1.2 gm.
(D) The total mass of helium gas in the box is 2.4 gm.

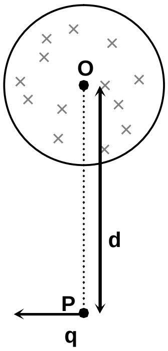
8. In the given graph, an ideal gas can change its state from A to C by two paths ABC or AC. Then



(A) If the internal energy of gas at 'A' is 10 J and the amount of heat supplied in path AC is 200 J, then the internal energy of gas at 'C' is 150 J.
(B) If the internal energy of gas at 'A' is 10 J and the amount of heat supplied in path AC is 200 J, then the internal energy of gas at 'C' is 75 J.
(C) If the internal energy of gas at state B is 20 J. Then the amount of heat supplied to the gas to go from A to B may be 5 Joule.
(D) If the internal energy of gas at state B is 20 J. Then the amount of heat supplied to the gas to go from A to B must be 10 Joule.

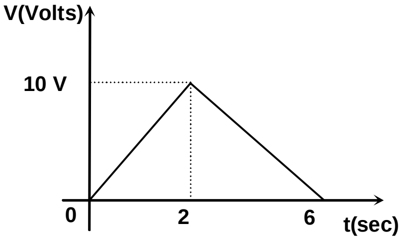
Space for Rough work

9. In the cylindrical region of radius R = 2m, there exists a time varying magnetic field B such that $\frac{dB}{dt} = 2$ Tesla/sec. A charged particle having charge q = 2C is placed at the point P at a distance d from its center O. Now, the particle is moved in the direction perpendicular to line OP by an external agent up to infinity so that there is no gain in kinetic energy of charged particle. Then
(A) work done by external agent is 4π Joule when d = 4m
(B) work done by external agent is 4π Joule when d = 8m
(C) work done by external agent is independent of d.
(D) work done by external agent is positive.



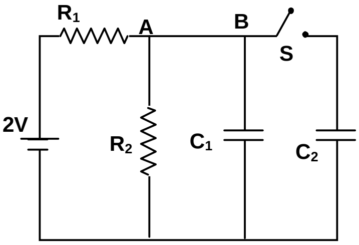
10. A uniform conducting ring of mass m = 2 kg, radius r = 2m and resistance 8 Ω is kept on smooth, horizontal surface. A time varying magnetic field $\vec{B} = (\hat{i} + t^2\hat{j})$ Tesla is present in the region, where t is time in second and take vertical as y-axis. (Take $\pi^2 = 10$). Then
(A) Time when ring starts toppling is 1 sec.
(B) Time when ring starts toppling is 3/4 sec.
(C) Heat generated through the ring till the instant when the ring start toppling is 40/3 Joule.
(D) Heat generated through the ring till the instant when the ring start toppling is 80/3 Joule.

11. The potential difference across a 10 H inductor as a function of time is shown in the figure. At t = 0, current is zero. Then
(A) The current in the inductor at t = 6 sec is 3 amp.
(B) The current in the inductor at t = 1 sec is 1/4 amp.
(C) The current in the inductor at t = 4 sec is 5/2 amp.
(D) The variation of current versus time is parabola.



Space for Rough work

12. Initially the switch ‘S’ is open for a ling time. Now the switch ‘S’ is closed at t = 0 ($R_1 = 2\Omega$, $R_2 = 2\Omega$, C_1 = 1F and C_2 = 1F). Then



(A) The current through the wire AB at t = 2 sec is 1/2e ampere.
(B) The current through the wire AB at t = 2 sec is 1/e ampere.
(C) The charge on the capacitor C_2, which was initially uncharged, at t = 2 sec is $\left(1-\frac{1}{2e}\right)$ coulombs.
(D) The charge on the capacitor C_1 at t = 2 sec is $\left(1-\frac{1}{2e}\right)$ coulombs.

13. An electric kettle has two coils of different power. When one coil is switched on, it takes 30 minutes to boil a certain amount of water and when second coil is switched on, it takes 45 minutes to boil same amount of water. Then
(A) It takes 150 minutes to boil same amount of water when both the coils are used in series combination.
(B) It takes 75 minutes to boil same amount of water when both the coils are used in series combination.
(C) It takes 18 minutes to boil same amount of water when both the coils are used in parallel combination.
(D) It takes 25 minutes to boil same amount of water when both the coils are used in parallel combination.

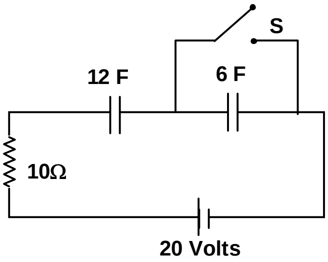
Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

14. A ideal gas whose adiabatic exponent equals γ is expanded so that the amount of heat transferred to the gas is equal to twice of decrease of its internal energy. The equation of the process is $TV^{\frac{\gamma-1}{K}} = $ constant (where T and V are absolute temperature and volume respectively). Then find the value of 'K'.

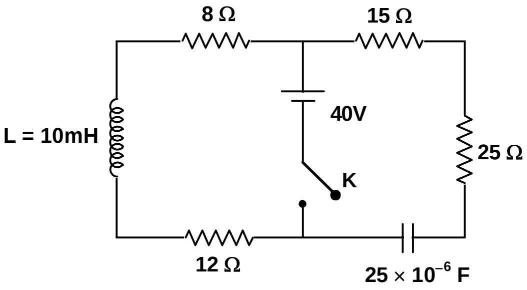
15. When steady state is reached, switch S is opened. Then the amount of heat rejected by the resistor is 800 K Joule. Then find the value of K.



16. A coil of inductance L = 5H and resistance R = 55 Ω is connected in series to the mains alternating voltage of frequency f = 50 Hz in series. What can be the non-zero capacitance of the capacitor (in μF) connected in series with the coil if the power dissipated has to remain unchanged. (take $\pi^2 = 10$)

17. A particle having charge 'q' and mass 'm' is projected with velocity $(4\hat{i} - 6\hat{j} + 3\hat{k})$ m/sec from the origin in a region occupied by electric field 'E' and magnetic field 'B' such that $\vec{B} = B_0\hat{j}$ and $\vec{E} = E_0\hat{j}$ (take $\frac{qE_0}{m} = 2$). Find the time (in sec) when the magnitude of velocity of the charge particle becomes $5\sqrt{5}$ m/sec. (neglect the gravity)

18. In the circuit the key (K) is closed at t = 0. Find the current in ampere through the key(K) at the instant t = $10^{-3}\ell n2$ sec.



Space for Rough work

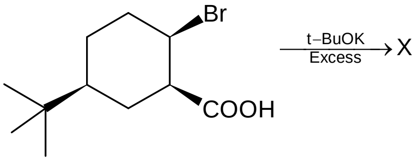
Chemistry

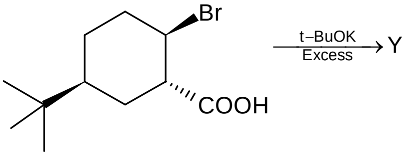
PART – II

SECTION – A
(One Options Correct Type)

This section contains **5 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

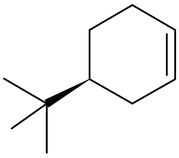
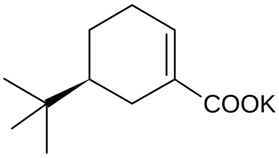
19.


Br
COOH
t–BuOK
Excess
X


Br
COOH
t–BuOK
Excess
Y

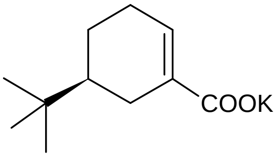
Which of the following option is correct?

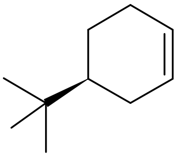
(A)

X is  : Y is 

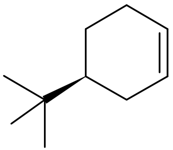
(Major products)

(B)

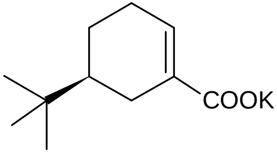
X is 

: Y is  (Major products)

(C)

Both X & Y are  (Only)

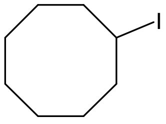
(D)

Both X & Y are 

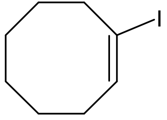
(Only)

Space for Rough work

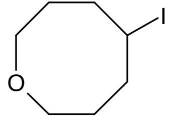
20. The relative rates of solvolysis of following iodides are



(x)



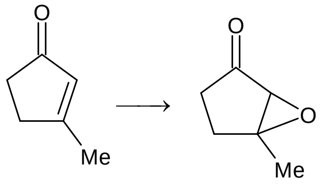
(y)



(z)

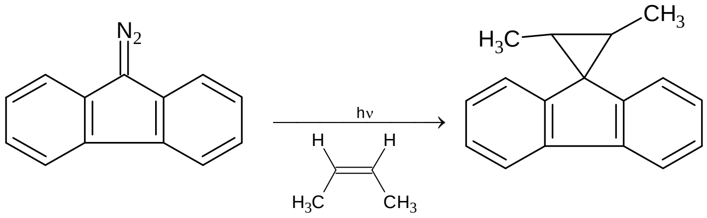
(A) x > y > z
(B) y > x > z
(C) x > z > y
(D) z > x > y

21. The suitable reagent for the following conversion is



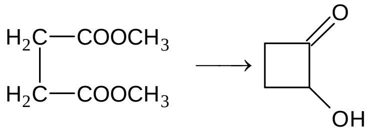
(A) m-CPBA
(B) H_2O_2/AcOH
(C) BuOH/HCl
(D) H_2O_2/NaOH

22. The intermediate in the reaction given below is:



(A) Free radical
(B) Carbocation
(C) Carbanion
(D) Carbene

23. The correct combination of reagents required to effect the following conversion is



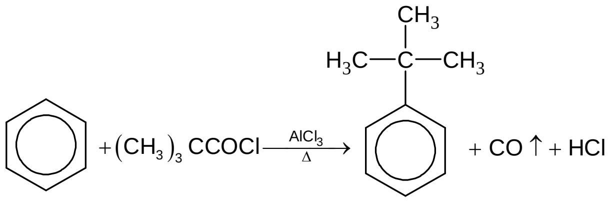
(A) (i) Na, xylene, heat (ii) H_2O_2, NaOH
(B) (i) NaOEt, EtOH (ii) Na, xylene, heat
(C) (i) Na, xylene, Me_3SiCl, heat (ii) H_3O^+
(D) (i) $TiCl_3$, Zn – Cu, $(CH_3)_3SiCl$, heat (ii) H_3O^+

Space for Rough work

(One or More than one correct type)

This section contains **EIGHT** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

24.



+(CH3)3 CCOCl
AlCl3
Δ
CH3
H3C—C—CH3
+ CO↑ + HCl

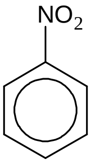
Which of the following statement(s) is/are correct?

(A) ΔS for the rearrangement of $(CH_3)_3C\overset{+}{C}O$ to $(CH_3)_3\overset{+}{C}$ is positive.

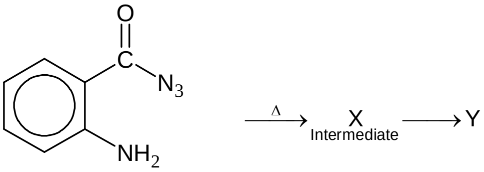
(B) $(CH_3)_3\overset{+}{C}$ is more stable than $(CH_3)_3C\overset{+}{C}O$.

(C) It's an example of homogeneous catalysis.

(D) Solvent used for Friedel Craft acylation is



25.



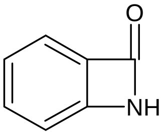
O
C
N3
NH2
Δ
X
Intermediate
Y

X & Y are:

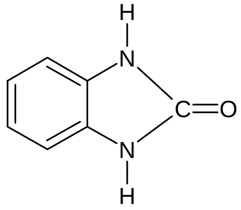
(A) X is acyl cation

(B) X is nitrene

(C) Y is



(D) Y is



Space for Rough work

26. In the reaction,

$$2x + B_2H_6 \longrightarrow \left[BH_2\left(x\right)_2\right]^+\left[BH_4\right]^-$$

The reactant(s) 'x' is (are):

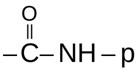
(A) NH_3	(B) CH_3NH_2
(C) $(CH_3)_2NH$	(D) $(CH)_3N$

27. Which of the following are true for Bakelite?

(A) Cross linked polymer	(B) Condensation polymer
(C) Thermosetting polymer	(D) Addition polymer

28. Which of the following statements about the peptide bond is(are) correct?

(A) The C – N bond of the peptide linkage is longer than that of an amide.

(B) The  $-\overset{O}{\overset{\|}{C}}-NH-$ portion of the peptide linkage is planar.

(C) The C – N bond length of peptide is shorter than that of an amine.

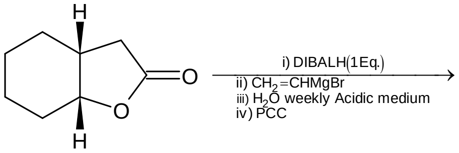
(D) The rotation about CO – N bond of peptide is restricted.

29. In which of the following pairs at least one of the compounds give positive Tollens test?

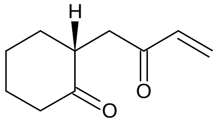
(A) Glucose and sucrose	(B) Glucose and fructose
(C) Fructose and sucrose	(D) Maltose and sucrose

Space for Rough work

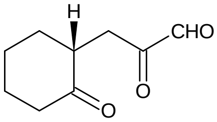
30. Which of the following is/are not the products in the following reaction?


H
O
O
H
i) DIBALH(1Eq.)
ii) CH2=CHMgBr
iii) H2O weekly Acidic medium
iv) PCC

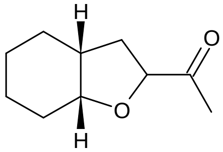
(A)



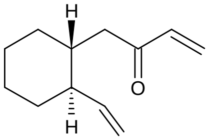
(B)



(C)

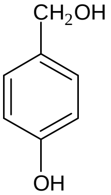


(D)



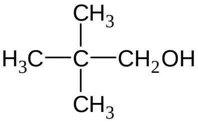
31. Which of the following can give aldehyde by the oxidation with Jones reagent?

(A)



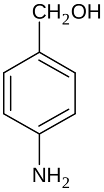
(B) $CH_2 = CH - CH_2OH$

(C)



$H_3C-C(CH_3)_2-CH_2OH$

(D)



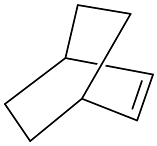
Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

32. Pure (+) 2-chlorobutane gives how many different dichlorbutanes?

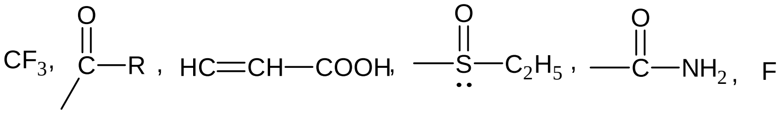
33.



$\xrightarrow[\text{ii) Zn}-\text{H}_2\text{O}]{\text{i)O}_3} \xrightarrow[\Delta]{\overset{-}{:}\text{OH}}$ No. of aldol condensation product.

34. Number of amine isomer of the molecular formula $C_4H_{11}N$ is/are structural isomers

35. Number of following substituents those are deactivating but ortho and para directing.



CF_3, $-\overset{O}{\overset{||}{C}}-R$, $HC{=}CH-COOH$, $-\overset{O}{\overset{||}{\underset{\cdot\cdot}{S}}}-C_2H_5$, $-\overset{O}{\overset{||}{C}}-NH_2$, F

36. Total number of chiral carbons in $\beta-D(+)$ glucose is:

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **5 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. Consider two parabola $y = x^2 - x + 1$ and $y = -x^2 + x + \frac{1}{2}$, the parabola $y = -x^2 + x + \frac{1}{2}$ is fixed and parabola $y = x^2 - x + 1$ rolls without slipping around the fixed parabola, then the locus of the focus of the moving parabola is

(A) $y = \frac{3}{4}$ (B) $y = -\frac{3}{4}$

(C) $y = x^2$ (D) $y = -x^2$

38. Three circles C_1, C_2, C_3 with radii r_1, r_2, r_3 $(r_1 < r_2 < r_3)$ respectively are given as $r_1 = 2$, and $r_3 = 8$ they are placed such that C_2 lies to the right of C_1 and touches it externally, C_3 lies to the right of C_2 and touches it externally. There exist two straight lines each of which is a direct common tangent simultaneously to all the three circles then r_2 is equal to

(A) $r_2 = 4$ (B) $r_2 = 5$

(C) $r_2 = 10$ (D) $r_2 = 16$

39. Let A, B, C and D be four distinct point on a line in that order. The circles with diameters AC is $x^2 + y^2 + ax + c = 0$ and BD is $x^2 + y^2 - by = 0$ intersect at X and Y the line XY meets BC at Z. Let P be a point on XY other than Z, the line CP intersects the circle with diameter AC at C and M, and line BP intersects the circle with diameter BD at B and N and the equation of line AM and DN are $bx + cy + a = 0$ and $cx + ay + b = 0$ respectively, then which of the following is true (where ω is a cube root of unity)

(A) $a + b + c = 1$ (B) $a\omega + b\omega^2 + c = 0$

(C) $a + b\omega^2 + c\omega = 0$ (D) none of these

Space for rough work

40. Let A and B be the ends of the diameter $4x - y - 15 = 0$ of the circle $x^2 + y^2 - 6x + 6y - 16 = 0$. A and B lie on tangents at the end points of the major axis of an ellipse such that line joining A and B is a tangent to the same ellipse at a point P. If the equation of major axis of the ellipse is $y = x$ then the distance between the foci is

(A) $2\sqrt{2}$	(B) $4\sqrt{2}$
(C) 8	(D) $2\sqrt{3}$

41. Two circle with radii r_1 and r_2 respectively touch each other externally. Let r_3 be the radius of a circle that touches these two circles as well as a common tangents to two circles then which of the following relation is true

(A) $\frac{1}{\sqrt{r_3}} = \frac{1}{\sqrt{r_1}} + \frac{1}{\sqrt{r_2}}$	(B) $\frac{1}{\sqrt{r_3}} = \left\lvert \frac{1}{\sqrt{r_1}} - \frac{1}{\sqrt{r_2}} \right\rvert$
(C) $\sqrt{r_3} = \sqrt{r_1} + \sqrt{r_2}$	(D) $\sqrt{r_3} = \left\lvert \sqrt{r_1} - \sqrt{r_2} \right\rvert$

(One or More than one correct type)

This section contains **EIGHT** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

42. A point M divides A and B in the ratio 1 : 2 where A and B diametrically opposite ends of a circle $x^2 + y^2 - 5x - 9y + 22 = 0$ square AMCD and BMEF on the length AM and MB are constructed on the same side of line AB if co-ordinates of A is (1, 3) then find the orthocentre of ΔABE

(A) (1, 6)	(B) (1, 5)
(C) (3, 3)	(D) (4, 6)

43. If largest and smallest value of $\frac{y-4}{x-3}$ is p and q where (x, y) satisfy $x^2 + y^2 - 2x - 6y + 9 = 0$ then which of the following is true

(A) $p + q = \frac{4}{3}$	(B) $q = 1$
(C) $p = \frac{4}{3}$	(D) $pq = \frac{4}{3}$

Space for rough work

44. A particle P moves on the line y = x, x ≥ 0 with constant speed u m/sec. Another particle Q revolves along the circle $\left(x-1\right)^2+y^2=\frac{1}{9}$ with constant speed $\frac{\omega}{3}$ m/sec. in anticlockwise direction, let at t = 0, both P and Q simultaneously started, P from the point (0, 0) and Q from the point $\left(\frac{2}{3}, 0\right)$. Further at any time instant t sec., let the distance of their separation is r(t) m. Also it was observed that at time t_0 sec., both P and Q are at their closest distance of approach, denoted by $r_{minimum}$ m, then choose the correct statements from among the following

(A) $[12\ r_{minimum}] = 4$ (where [.] denotes the greatest integer function)

(B) $t_0 = \frac{7\pi}{4\omega}$ sec

(C) $t_0 = \frac{\pi}{2\omega}$ sec

(D) $2r\left(t\right)\frac{dr\left(t\right)}{dt}\bigg|_{t=\frac{7\pi}{2\omega}\text{sec}} = \frac{16\omega}{3\pi}$ m^2/sec

45. A rectangle HOMF has sides HO = 11 and OM = 5. A triangle ABC has H as the intersection of the altitude, O the centre of the circumscribed circle, M the mid point of BC, and F the foot of the altitude from A, then

(A) perimeter of ΔABC is greater than 70

(B) area of ΔABC in integer

(C) one side of ΔABC in rational

(D) all sides of ΔABC are less than 30

46. All x in the interval $\left(0, \frac{\pi}{2}\right)$ such that $\frac{\sqrt{3}-1}{\sin x}+\frac{\sqrt{3}+1}{\cos x}=4\sqrt{2}$ is

(A) $\frac{\pi}{12}$

(B) $\frac{11\pi}{36}$

(C) $\frac{13\pi}{36}$

(D) $\frac{\pi}{6}$

47. In a triangle ABC, $\frac{a}{b}=2+\sqrt{3}$, and ∠C = 60° then angle A and B is

(A) ∠A = 105°

(B) ∠B = 15°

(C) ∠A = 115°

(D) ∠B = 105°

Space for rough work

48. Let cos A + cos B = x; cos 2A + cos 2B = y; cos 3A + cos 3B = z, then which of the following is true

(A) $\cos^2 A + \cos^2 B = 1+\frac{y}{2}$
(B) $\frac{1}{4}\left(2x^2 - y - 2\right) = \cos A \cos B$
(C) $2x^2 + z = 3x(1 + y)$
(D) $xyz = 0 \ \forall\ A, B \in R$

49. Let A(4, 3), B(–4, 3) and C(0, –5) be the vertices of triangle and P(5, 0) let L, M and N be the feet of the perpendiculars drawn from P onto the sides BC, CA and AB respectively, then

(A) area of ΔLMN is 5 sq. units
(B) the centroid of ΔLMN does not exist
(C) the orthocentre of ΔLMN is the origin
(D) L, M and N are collinear

SECTION – C

(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

50. The number of solution in the interval [0, π] of the equation $\sin^3 x \cdot \cos 3x + \sin 3x \cdot \cos^3 x = 0$ is _____

51. The number of values of θ in the range [0, 2π] satisfying the equation
$\cos^4 2\theta + 2 \sin^2 2\theta = 17(\sin \theta + \cos \theta)^8$ is _____

52. A line divides an equilateral triangle ABC of side 1 unit into two parts with same perimeter and different area S_1 and S_2 sq. units. If maximum value of $\frac{S_1}{S_2} = \frac{m}{n}$ (where m and n are coprime), then |m – n| is _____

53. If the tangent at the point (h, 2) on the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ cuts the circle $x^2 + y^2 = a^2$ at the points $Q(x_1y_1)$ and $R(x_2y_2)$, then the value of $\frac{1}{y_1} + \frac{1}{y_2}$ is _____

54. In a triangle ABC, a = 3, b = 4, c = 5, then the value of $\frac{rr_1r_2r_3}{6}$ is _____

Space for rough work

FIITJEE **JEE(Advanced)-2018**

ALL INDIA TEST SERIES

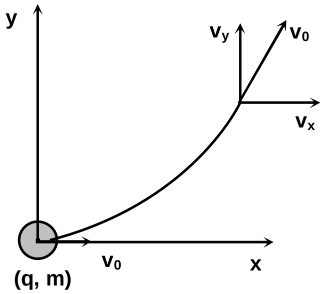
ANSWERS, HINTS & SOLUTIONS
PART TEST – II
PAPER-1

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	C	19.	B	37.	A
2.	D	20.	D	38.	A
3.	C	21.	D	39.	C
4.	C	22.	D	40.	C
5.	C	23.	C	41.	A
6.	B, D	24.	A, D	42.	B, C
7.	A, C	25.	B, D	43.	A, C
8.	A, D	26.	A, B, C	44.	A, B
9.	A, B, C, D	27.	A, B, C	45.	A, B, C, D
10.	A, D	28.	B, C, D	46.	A, B
11.	A, B, C, D	29.	A, B, C, D	47.	A, B
12.	A, C, D	30.	B, C, D	48.	A, B, C
13.	B, C	31.	A, B, C, D	49.	B, D
14.	3	32.	5	50.	5
15.	0	33.	0	51.	4
16.	1	34.	8	52.	2
17.	8	35.	3	53.	1
18.	2	36.	5	54.	6

Physics

PART – I

SECTION – A



1. $\vec{F} = q\vec{v} \times \vec{B}$

$= q(v_x\hat{i} + v_y\hat{j})\vec{B}$

$F_y = q\frac{B_0}{\ell^2}x^2 v_x$

$\int_0^{v_0} dv_y = \frac{qB_0}{m\ell^2}\int_0^{x_{max}} x^2 dx$

$v_0 = \frac{qB_0}{m\ell^2}\frac{x_{max}^3}{3}$

$x_{max} = \left(\frac{3m\ell^2 v_0}{qB_0}\right)^{1/3}$

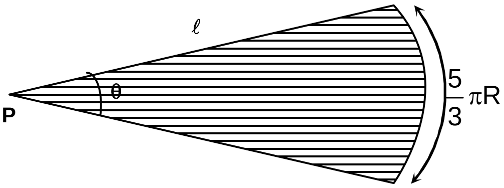
Alternate solution

Impulse momentum theorem along x-axis

$\int_0^{x_{max}} \frac{qB_0x^2}{\ell^2} v_x dt = mv_0$

$\therefore \int_0^{x_{max}} \frac{qB_0x^2}{\ell^2} dx = mv_0$

$\therefore x_{max} = \left(\frac{3m\ell^2 v_0}{qB_0}\right)^{1/3}$



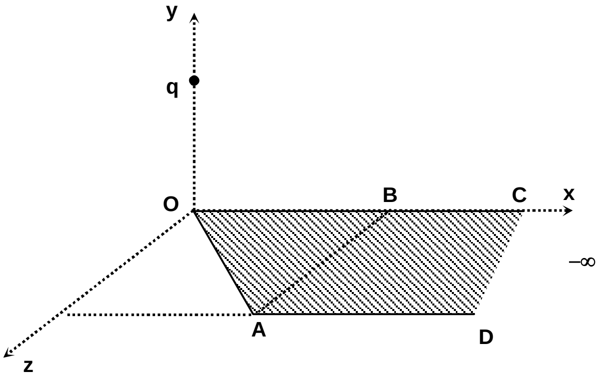
2. Potential due to circular non conducting disc, $V_C = \frac{\sigma r}{2\varepsilon_0}$ (where r is radius of disc)

So, $v_P = \left(\frac{\theta}{2\pi}\right)\left(\frac{\sigma \cdot \ell}{2\varepsilon_0}\right)$

$= \left(\frac{\sigma\ell}{2\varepsilon_0}\right)\left(\frac{5}{3}\frac{\pi R}{(\ell)}\right)\left(\frac{1}{2\pi}\right) = \frac{5\sigma R}{12\varepsilon_0}$

3. Work performed = $\int_R^{2R}\frac{1}{2}\varepsilon_0E^2dV + \int_{3R}^{4R}\frac{1}{2}\varepsilon_0E^2dV = \frac{7}{96}\frac{q^2}{\pi\varepsilon_0 R}$

4. $$\phi = \phi_{OAB} + \phi_{ABCD}$$
$$= \frac{q}{48\varepsilon_0} + \frac{q}{48\varepsilon_0} = \frac{q}{24\varepsilon_0}$$



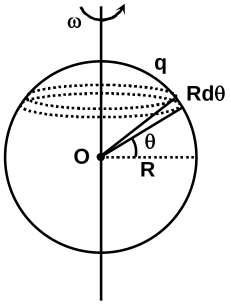
5. Magnetic field due to the ring on its axis is

$$B = \frac{\mu_0 \pi r^2 i}{2\pi(r^2 + x^2)^{3/2}} \text{ (due to ring)}$$

$$B = \int_{-\pi/2}^{+\pi/2} \frac{\mu_0 \pi (R\cos\theta)^2 \left(\frac{2\pi R\cos\theta R d\theta \sigma}{2\pi/\omega}\right)}{2\pi\left[(R\cos\theta)^2 + (R\sin\theta)^2\right]^{3/2}}$$

Where $\sigma = \frac{q}{4\pi R^2}$

$$B = \frac{\mu_0 q\omega}{6\pi R}$$



6. By applying Kirchhoff's law charge transferred by the battery is $\frac{80}{19}$C.

7. Time between two consecutive collision = $\frac{1}{1000}$ sec

So, $\frac{2\ell}{v_{rms}} = \frac{1}{1000}$

$v_{rms} = 2000 \times 5 = 10000$ m/s

$$v_{rms} = \sqrt{\frac{3RT}{M}} = 10000$$

So, T = $\frac{10^8 \times 4 \times 10^{-3}}{3 \times \left(\frac{25}{3}\right)} = 16 \times 10^3 K$

Mass of helium gas ⇒ PV = nRT

PV = $\frac{m}{M}RT$

$$m = \frac{PVM}{RT} = \frac{320 \times 125 \times (4 \times 10^{-3})}{\left(\frac{25}{3}\right) \times 16 \times 10^3} = 1.2\,\text{gm}$$

8. In path A→C

$$dW = 4\times 10 + \frac{1}{2}\times 10\times 4 = 40 + 20 = 60\ \text{J}$$

dQ = dU + dW

$200 = U_C - U_A + 60$

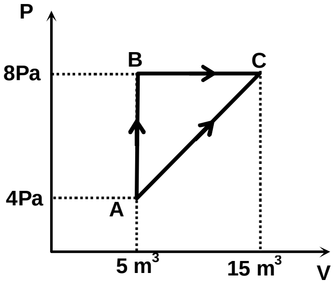
$U_C = 140 + U_A = 140 + 10 = 150$ J

In path A → B

$Q_{AB} = U_B - U_A$

$$= U_B\left(1 - \frac{U_A}{U_B}\right) = U_B\left(1 - \frac{T_A}{T_B}\right)$$

$$= 20\left(1 - \frac{1}{2}\right) = 10\ \text{Joule}$$



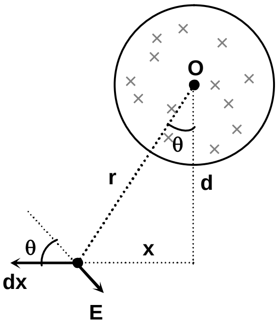
9. $$\oint \vec{E}\cdot d\vec{\ell} = A\cdot\frac{dB}{dt}$$

$E\cdot 2\pi\sqrt{x^2+d^2} = \pi R^2 k$, where $\left(\frac{dB}{dt} = k\right)$

$$E = \frac{R^2 k}{2\sqrt{x^2+d^2}}$$

$$W = \int_0^{\infty} q\vec{E}\cdot d\vec{x}$$

$$= \int_0^{\infty} qE\cos\theta\cdot dx = \int_0^{\infty} \frac{qR^2k}{2\sqrt{x^2+d^2}}\frac{d}{\sqrt{d^2+x^2}}dx = \frac{qR^2k\pi}{4}$$



Alternate solution

By applying Faraday's Law for an imaginary triangular loop having vertex O, P and point at infinity, $q\oint \vec{E}\cdot d\vec{\ell}$ can be found out.

10. $$\phi = BA = (t^2)(\pi r^2)$$

$$\varepsilon = \frac{d\phi}{dt} = 2\pi r^2 t$$

$$i = \frac{\varepsilon}{R} = \frac{2\pi r^2 t}{R}$$

For toppling

$$\tau = |\vec{\mu}\times\vec{B}| \geq mgr$$

$$(i.\pi r^2).1 \geq mgr$$

$$\frac{2\pi r^2 t}{R}\cdot\pi r^2 \geq mgr$$

$$t \geq \frac{mgR}{2\pi^2 r^3} = 1\text{sec}$$

$$\text{Heat} = \int i^2 R dt = \int\left(\frac{2\pi r^2 t}{R}\right)^2 dt.R$$

$$\text{Heat} = \frac{4\pi^2 r^4}{R}\int_0^1 t^2 dt = \frac{80}{3}\text{Joule}$$

11. $V_L = L\dfrac{di}{dt} \Rightarrow Ldi = V_L\,dt$

$$L\int di = \int V_L dt = \frac{1}{2}\cdot 6\cdot 10 = 30$$

$$L(i_f - i_i) = 30 \text{ Amp}$$

$$i_f = \frac{30}{10} = 3 \text{ amp}$$

for $t \le 2$,

$$V_L = \frac{10}{2}t = 5t$$

$$\int_0^i Ldi = \int V_L dt = 5\int_0^1 tdt$$

$$L(i-0) = \frac{5}{2}$$

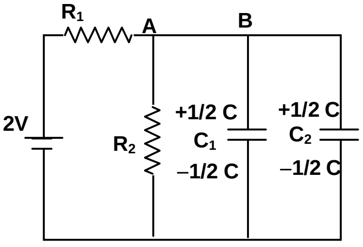
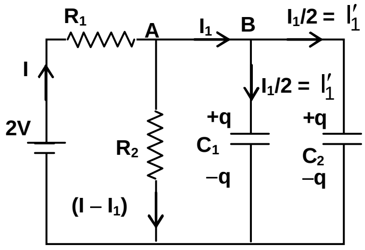
$\Rightarrow i = 1/4$

for $t \ge 2$

$$V_L = \left(15 - \frac{5}{2}t\right)$$

$$\int_1^i Ldi = \int_2^4 \left(15 - \frac{5}{2}t\right)dt$$

$\Rightarrow i = 5/2$ amp

12.	 R₁ A B 2V R₂ +1/2 C C₁ −1/2 C +1/2 C C₂ −1/2 C **(at t = 0)** When the switch is closed then at t = 0 the distribution of the charge is shown in the figure.	 R₁ A I₁ B I₁/2 = I′₁ I I₁/2 = I′₁ 2V R₂ +q C₁ −q +q C₂ −q (I − I₁) By applying Kirchhoff's Law $I_1' = \dfrac{(1-q)}{2}$ $\displaystyle\int_{1/2}^{q}\frac{dq}{1-q} = \int_0^t \frac{dt}{2}$ $q = \left(1 - \dfrac{1}{2}e^{-t/2}\right)$ $I_1' = \dfrac{dq}{dt} = \dfrac{1}{4}e^{-t/2}$

13. $H_1 = \dfrac{V^2}{R_1}(30\times 60)$, $H_2 = \dfrac{V^2}{R_2}(45\times 60)$

$H_1 = H_2 \Rightarrow \dfrac{30}{R_1} = \dfrac{45}{R_2} \Rightarrow 3R_1 = 2R_2$

$$H_{series} = \frac{V^2}{(R_1 + R_2)} t_s = \frac{V^2}{\left(R_1 + \frac{3}{2}R_1\right)} t_s = H_1 = \frac{V^2}{R_1}(30 \times 60)$$

$\Rightarrow t_s = (30 \times 60)\frac{5}{2} = 75$ min

$$H_P = \left(\frac{V^2}{R_1} + \frac{V^2}{R_2}\right) t_P = \left(\frac{V^2}{R_1} + \frac{2V^2}{3R_1}\right) t_P$$

$$\Rightarrow \frac{5V^2}{3R_1} t_P = \frac{V^2}{R_1}(30 \times 60)$$

$$t_P = \frac{3 \times 30 \times 60}{5} = 18 \text{ min}$$

SECTION – C

14. $dQ = dU + dW$

$dQ = -2dU$

$-3dU = dW$

$-3nC_V dT = PdV$

$$\frac{-3nRdT}{\gamma - 1} = \left(\frac{nRT}{V}\right) dV$$

From this $TV^{\frac{\gamma-1}{3}} = \text{constant}$

So, K = 3

15. There is no transfer of charge through the battery

16. $P_{av} = VI\cos\phi = V\left(\frac{V}{z}\right)\left(\frac{R}{z}\right) = \frac{V^2R}{Z^2}$

It means Z has to be same in both cases

$$Z_1 = Z_2 \Rightarrow \sqrt{R^2 + X_L^2} = \sqrt{R^2 + (X_C - X_L)^2}$$

$2X_L = X_C$

$\Rightarrow C = \frac{1}{2\omega^2 L} = 10^{-6} = 1 \times 10^{-6}$

17. $v_y = u_y + a_y t$

$$0 = 6 - \frac{qE_0}{m} t_1$$

$t_1 = 3$ sec

$v_x^2 + v_y^2 + v_z^2 = (5\sqrt{5})^2$

$4^2 + v_y^2 + 3^2 = 125$

$v_y = 10$ m/sec

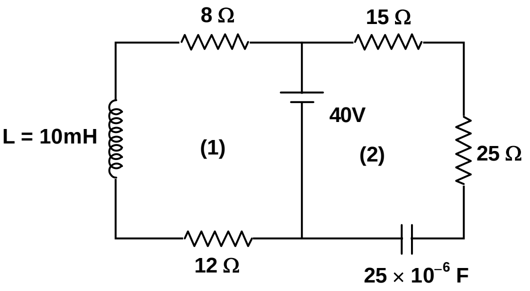
$v_y = u_y + a_y t$

$$10 = 0 + \frac{qE_0}{m} t_2$$

$\Rightarrow t_2 = 5$ sec

So, $t = t_1 + t_2 = 8$ sec

18. i_1 is current in the first loop



$$i_1 = \frac{40}{20}\left(1 - e^{-\frac{t}{5\times10^{-4}}}\right) = \frac{3}{2}\text{ amp}$$

i_2 is current in the second loop

$$i_2 = \frac{40}{40}e^{-\frac{t}{10^{-3}}} = \frac{1}{2}\text{ amp}$$

So, total current through key (K)

$i = i_1 + i_2$

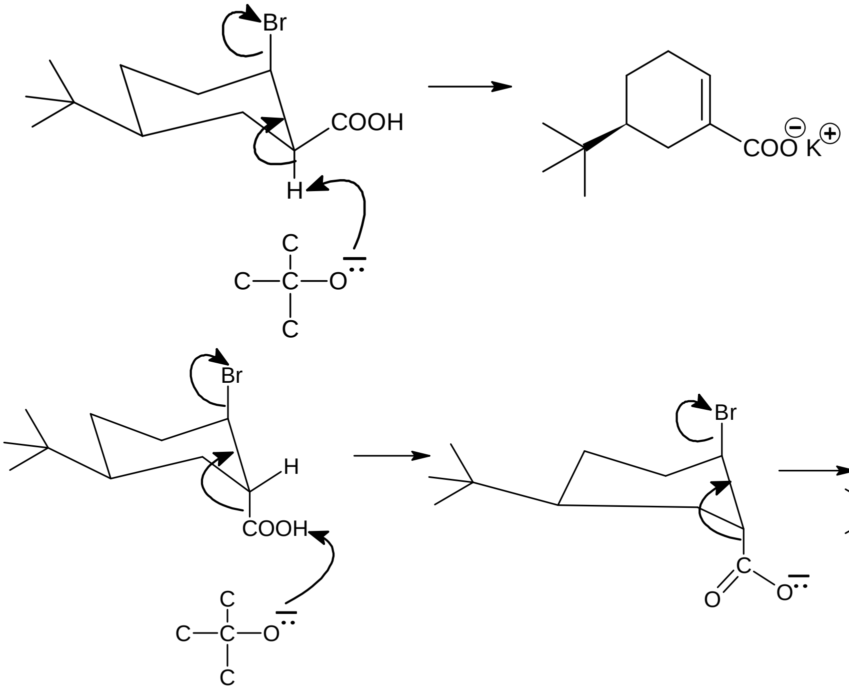
$$= \frac{3}{2} + \frac{1}{2} = 2\text{ amp}$$

Chemistry

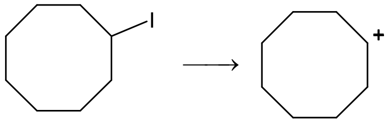
PART – II

SECTION – A

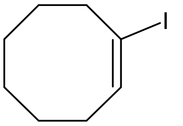
19.


Br
COOH
H
C
C—C—O
C
COO K
Br
H
COOH
C
C—C—O
C
Br
C
O
O

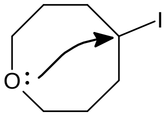
20.



2° cation



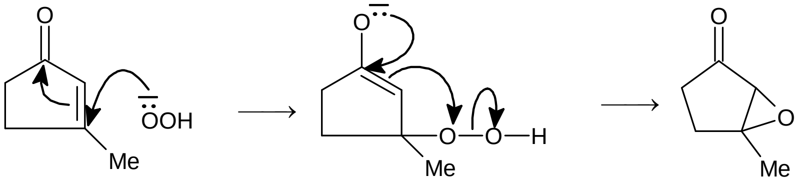
$\longrightarrow$ both S_N2 and S_N1 are slow



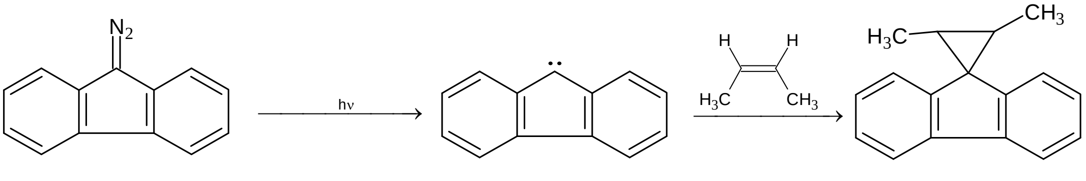
NGP

21.

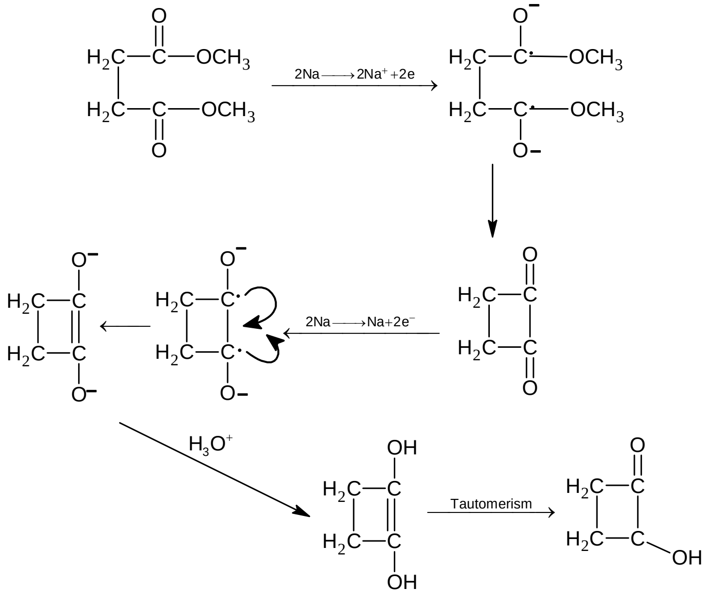
$H_2O_2 + \bar{\ddot{O}}H \longrightarrow H-O-\bar{\ddot{O}} + H_2O$


O
OOH
Me
O
O—O—H
Me
O
O
Me

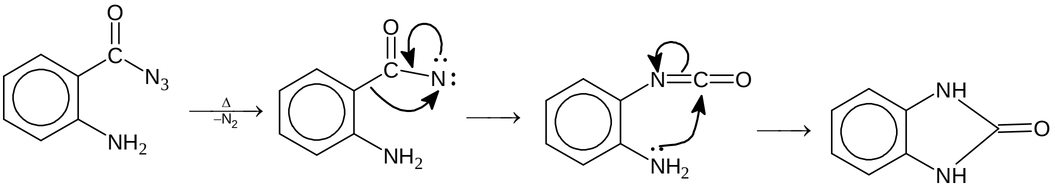
22.


N2
hν
H
H
H3C
CH3
H3C
CH3

23. Acyloin condensation



25.



26. $H_3N: + B_2H_6 \longrightarrow \left[H_3N \longrightarrow BH_2 \longleftarrow NH_3\right]^+ \left[BH_4\right]^-$

$CH_3NH_2: + B_2H_6 \longrightarrow \left[CH_3NH_2 \longrightarrow BH_2 \longleftarrow NH_2CH_3\right]^+ \left[BH_4\right]^-$

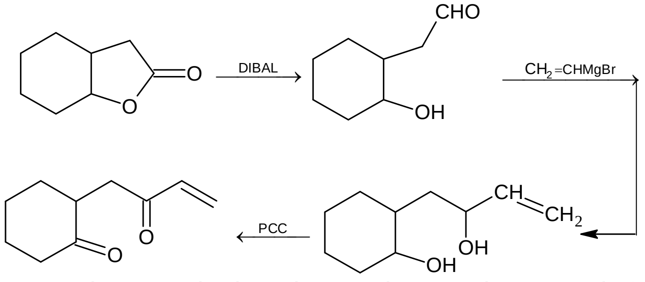
$(CH_3)NH + B_2H_6 \longrightarrow \left[(CH_3)_2NH \longrightarrow BH_2 \longleftarrow NH(CH_3)_2\right]^+ \left[BH_4\right]^-$

27. Facts

28. Facts

29. Glucose, Fructose, Maltose are reducing sugars.

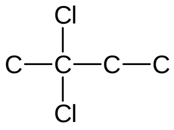
30.



31. A, B, D because hydrate is unstable, 'C' due to steric factor.

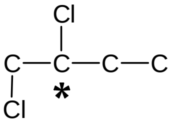
SECTION – C

32.



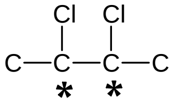
$C-\overset{Cl}{\underset{Cl}{C}}-C-C$

(1)



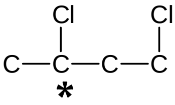
$\underset{Cl}{C}-\overset{Cl}{\underset{*}{C}}-C-C$

(1)



$C-\overset{Cl}{\underset{*}{C}}-\overset{Cl}{\underset{*}{C}}-C$

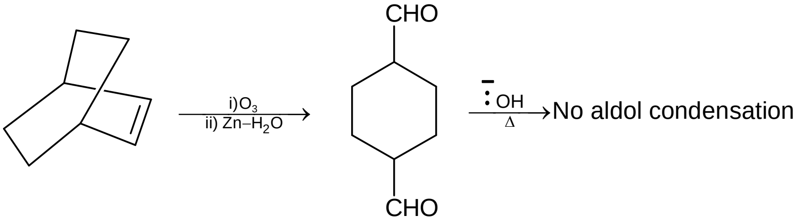
(2)



$C-\overset{Cl}{\underset{*}{C}}-C-\overset{Cl}{C}$

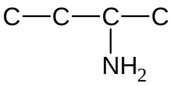
(1)

33.

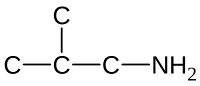


34.

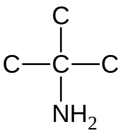
$C-C-C-C-NH_2$



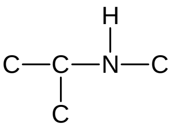
$C-C-\underset{NH_2}{C}-C$



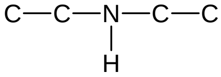
$C-\overset{C}{C}-C-NH_2$



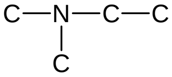
$C-\overset{C}{\underset{NH_2}{C}}-C$



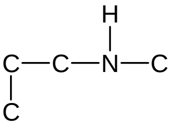
$C-\underset{C}{C}-\overset{H}{N}-C$



$C-C-\underset{H}{N}-C-C$



$C-\underset{C}{N}-C-C$



$\underset{C}{C}-C-\overset{H}{N}-C$

Mathematics

PART – III

SECTION – A

37. Let F be the fixed focus and M be the moving focus and T be the varying points of mutual tangency. The tangent line at T makes equal angle with FT and with a vertical line. This and congruence of the two parabola imply that MT is vertical and FT = MT and must line on directrix of $y = x^2 - x + 1$

So, $y = \frac{3}{4}$

38. $DE = AK = \sqrt{(r_2 + r_1)^2 - (r_2 - r_1)^2} = 2\sqrt{r_1 r_2}$

Similarly $EF = 2\sqrt{r_2 r_3}$

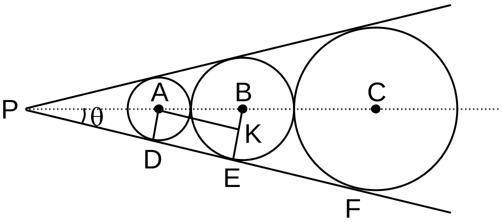
$\angle APD = \theta$ and PD = x then

$$\tan\theta = \frac{AD}{PD} = \frac{BE}{PE} = \frac{CF}{PF} = \frac{r_1}{x}$$

$$= \frac{r_2}{x + 2\sqrt{r_1 r_2}} = \frac{r_3}{x + 2\sqrt{2r_1 r_2} + \sqrt{r_2 r_3}}$$

Hence, $\frac{r_2 - r_1}{2\sqrt{r_1 r_2}} = \frac{r_3 - r_2}{2\sqrt{r_2 r_3}}$

$\Rightarrow r_2 = \sqrt{r_1 r_3} \Rightarrow r_2 = \sqrt{2 \times 8} = 4$



39. Since ln x AM and ND are concurrent $\begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix} = 0$

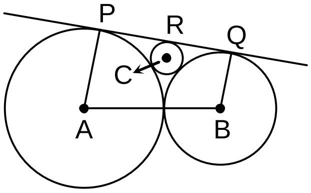
$a(bc - a^2) - b(b^2 - ac) + c(ab - c^2) = 0$
$abc - a^3 - b^3 + abc + abc - c^3$
$3abc - a^3 - b^3 - c^3 = 0$
$a^3 + b^3 + c^3 = 3abc = (a + b + c)(a + b\omega + c\omega^2)(a + b\omega^2 + c\omega) = 0$

40. Solve y = x with circle
Circle must passes through the foci of the ellipse

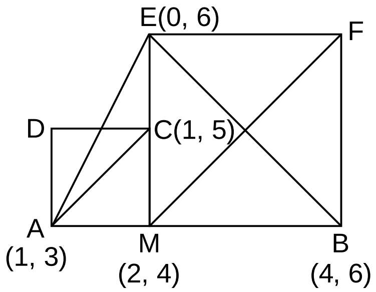
41. Using length of direct common tangent

$$\left.\begin{array}{l} PQ^2 = 4r_1 r_2 \\ QR^2 = 4r_1 r_3 \end{array}\right| = PQ = PR + QR$$

$$\Rightarrow \frac{1}{\sqrt{r_3}} = \frac{1}{\sqrt{r_1}} + \frac{1}{\sqrt{r_2}}$$



42. Shown in the figure since C(1, 5) is the orthocentre of triangle ΔAEB, similarly for the other side the coordinates of C(3, 3)



43. Given circle is $(x-1)^2 + (y-3)^2 = 1$

Let of tangent to circle is $y - 3 = m(x - 1) + 1\sqrt{1+m^2}$

(3, 4) lies on axis

$1 = 2m + \sqrt{1+m^2}$

$(1-2m)^2 = 1 + m^2$

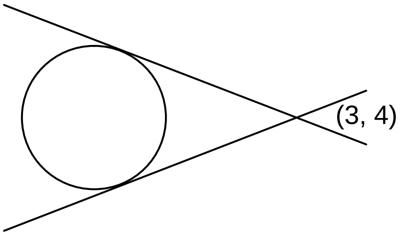
$4m^2 - 2m + 1 = 1 + m^2$

$3m^2 - 4m = 0$

$m = 0, \frac{4}{3}$

$\Rightarrow \frac{y-4}{n-3} = m = 0.0r\frac{4}{3}$

Smallest is 0 and tangent = $\frac{4}{3}$

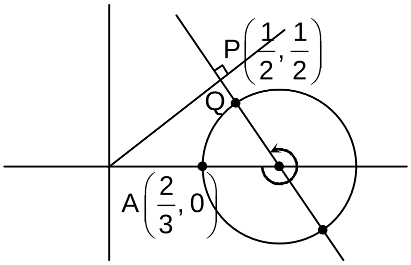


44. Eg. of common normal $y - 0 = -1(x - 1)$

$y = -x + 1 \qquad (x-1)^2 + y^2 = \frac{1}{3}$

$x + y - 1 = 0 \qquad 2y^2 = \frac{1}{9}$

$x - 1 = y \qquad y^2 = \frac{1}{3\sqrt{2}}$


$P\left(\frac{1}{2}, \frac{1}{2}\right)$
Q
$A\left(\frac{2}{3}, 0\right)$

Clearly shortest distance of approach is along common normal whose equation is $x + y - 1 = 0$

So when they are at their closest distance P must be at $\left(\frac{1}{2}, \frac{1}{2}\right)$ and Q must be at

$\left(1 - \frac{1}{3\sqrt{2}}, \frac{1}{3\sqrt{2}}\right)$ covering angle $\frac{7\pi}{4}$ on the circle

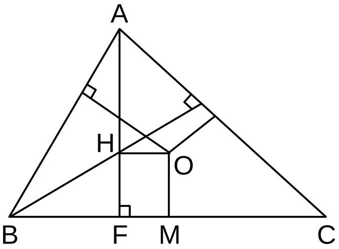
Since P and Q happened to be at these points at same time so we can have

$t_0 = \frac{7\pi}{4w} = \frac{1}{\sqrt{2}u}$ also at this instance

t_0 , $r_{min} = \frac{3-\sqrt{2}}{3\sqrt{2}} \Rightarrow [12r_{min}] = \left[6\sqrt{2} - 4\right] = 4$

Also at any time instant t₁ co-ordinate of P, Q are $\left(\frac{ut}{\sqrt{2}}, \frac{ut}{\sqrt{2}}\right)$ at $Q\left(1 + \frac{\cos(\omega t)}{3}, + \sin\left(\frac{\omega t}{3}\right)\right)$

$$\therefore\ r^2(t) = \left(\frac{ut}{\sqrt{2}} - 1 - \frac{\cos(\omega t)}{3}\right)^2 + \left(\frac{ut}{\sqrt{2}} - \frac{\sin(\omega t)}{3}\right)^2$$



45. Centroid G of triangle is collinear with H and O and G lies two third of way from A to M, therefore H is two third of the way from A to F. So AF = 3 × OM = 15
Since ∠HFB = ∠AFC, ∠HBF = ∠ ACF
So, ΔBFH and ΔAFC are similar

$\frac{BF}{HF}=\frac{AF}{FC}\Rightarrow BF\cdot FC = FA\cdot HF = 75$

Now $BC^2 = (BF + CF)^2 = (BF - CF)^2 + 4BF\cdot FC$
But FC – BF = (FM + MC) – (BM – FM) = 2FM = 22

$BC=\sqrt{22^2+4\times75}=28$

46. $\frac{\frac{\sqrt{3}-1}{2\sqrt{2}}}{\sin x}+\frac{\frac{\sqrt{3}+1}{2\sqrt{2}}}{\cos x}=2$

$\Rightarrow \sin\frac{\pi}{12}\cdot\cos x+\cos\frac{\pi}{12}\sin x=\sin 2x$

$\Rightarrow \sin\left(x+\frac{\pi}{12}\right)=\sin 2x$

$\Rightarrow n=\frac{\pi}{12}$ and $\frac{11\pi}{36}$

47. Since $\frac{\frac{a}{b}-1}{\frac{a}{b}+1}=\tan\frac{A-B}{2}\tan\frac{C}{2}$

$\Rightarrow A - B = 90^o$ and $A + B = 120^o$
$\Rightarrow A = 105^o$ and $B = 15^o$

48. $x^2 = \cos^2 A + \cos^2 B + 2\cos A\cdot\cos B$
$y = 2(\cos^2 A + \cos^2 B) - 2$

$\therefore \cos^2 A + \cos^2 B = 1+\frac{y}{2}$

$\because \cos A\cdot\cos B = \frac{1}{4}\left(2x^2-y-2\right)$ and $z = -2x^3 + 3xy + 3x$

$\therefore 2x^3 + z = 3x(y + 1)$
$xyz = 0\ \forall$ A and B is not true

49. P lies on circumcircle
So, L, M, N are collinear (i.e. Simson's line)

SECTION – C

50. Use $\sin^3 x=\frac{3\sin x-\sin 3x}{4}$ and $\cos^3 x=\frac{3\cos x+\cos 3x}{4}$
Equation becomes sin 4x = 0

$x=\frac{n\pi}{4}$

51. Put $\sin 2\theta = x$ given equation becomes $x^4 + 1 = 17(1 + 2x + x^2)^2$

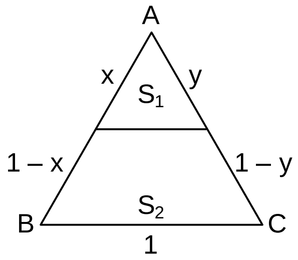
Divide by x^2, we have $x^2 + \frac{1}{x^2} = 17\left(x + \frac{1}{x} + 2\right)$

Now put $y = x + \frac{1}{x} \Rightarrow y = -\frac{7}{4}$ or $-\frac{5}{2}$

Now $y = -\frac{7}{4}$ have no solution and $y = -\frac{5}{2}$, we have $x = -\frac{1}{2}, -2$

So, there are (4) solution in $[0, 2\pi]$

52. $x + y = 1 - x + 1 - y \; 1$



$x + y = \frac{3}{2}$

$S_3 = S_1 + S_2$

$$\frac{S_1}{S_3} = \frac{\frac{1}{2}xy\sin 60^o}{\frac{\sqrt{3}}{4}} = \frac{xy\sqrt{3}}{\left(\frac{\sqrt{3}}{4}\right)} = xy = x\left(\frac{3}{2} - x\right)$$

$\because S_2 = S_3 - S_1$

$$\frac{S_2}{S_3} = 1 - \frac{S_1}{S_3} = 1 - xy = 1 - x\left(\frac{3}{2} - x\right)$$

$$\frac{S_1}{S_3}(\max) = \frac{3}{16} \text{ as } \frac{S_2}{S_3} = \frac{16}{9} - 1 = \left(\frac{7}{9}\right)$$

53. Equation of tangent $\frac{xh}{a^2} - \frac{2y}{b^2} - 1 = 0$; $x = \left(1 + \frac{2y}{b^2}\right)\frac{a^2}{h}$

By solving $\left(\left(1 + \frac{2y}{b^2}\right)\frac{a^2}{h}\right)^2 + y^2 - a^2 = 0$

$$\left(1 + \frac{4y}{b^2} + \frac{4y^2}{b^4}\right)\frac{a^4}{h^2} + y^2 - a^2 = 0$$

$$y^2\left(\frac{4a^4}{b^4h^2} + 1\right) + \frac{4}{b^2} \cdot \frac{a^4}{h^2} \cdot y + \frac{a^4}{h^2} - a^2 = 0$$

$$\Rightarrow \frac{y_1 + y_2}{y_1y_2} = 1$$

54. $\because rr_1r_2r_3 = \Delta^2$

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

PART TEST – II

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 231**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into three sections: **Section-A, Section-C & Section-D**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01 – 03, 24 – 26, 47 – 49)*** *contains 9 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (04 – 08, 27 – 31, 50 – 54) *contains 15 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

   Partial Marks **+1** for each correct option provided no incorrect options is selected.

   Section-A (09 – 10, 32 – 33, 55 – 56) *contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer. There is no negative marking.*

2. ***Section-C (11 – 20, 34 – 43, 57 – 66)*** *contains 30 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

3. ***Section-D (21 – 23, 44 – 46, 67 – 69)*** *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ \text{m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3\ \text{kg/m}^3$
Atmospheric pressure	$P_a = 10^5\ \text{N/m}^2$
Gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
		=	$0.0821\ \text{Lit atm K}^{-1}\ \text{mol}^{-1}$
		=	$1.987 \approx 2\ \text{Cal K}^{-1}\ \text{mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

PART – I (Physics), PART – II (Chemistry), PART – III (Mathematics):

(SECTION – D)

For questions **21 to 23, 44 to 46, 67 to 69.**
Numerical answer type questions with answer XXXXX. XX

If answer is 348.4 / 251.37 / 213

Correct Method :

		3	4	8	.	4	0

		2	5	1	.	3	7

		2	1	3	.	0	0

Wrong Method :

	3	4	8		.	4	

3	4	8			.		4

		3	4	8	.		4

	3		4	8	.	4	

	2		5	1	.	3	7

		2	1	3	.		

		2	1	3	.	0	

		2	1	3	.		0

Physics

PART – I

SECTION – A

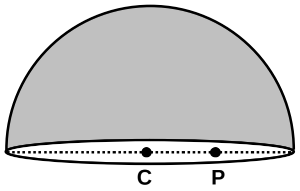
(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE** option is correct.

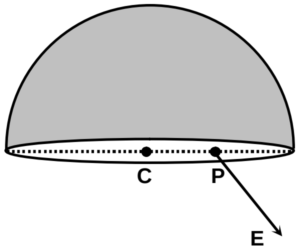
1. A non-uniform magnetic field $\vec{B} = B_0\left(1+\frac{y}{d}\right)(-\hat{k})$ is present in the region of space between y = 0 and y = d. A particle of mass m and positive charge q has velocity $\vec{v} = \frac{3qB_0d}{m}\hat{i}$ at origin O. Find the angle made by velocity of the particle with the positive x-axis when it leaves the field. (Ignore any interaction other than magnetic field)

(A) 90°
(B) 30°
(C) 60°
(D) 45°

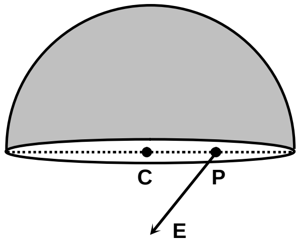
2. A thin non-conducting hemispherical shell contains a positive charge q on it, which is uniformly distributed on the shell. A point P lies on the diameter of shell as shown in figure. Then the direction of electric field at the point 'P' is



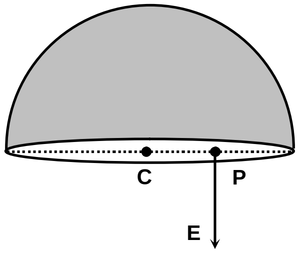
(A)



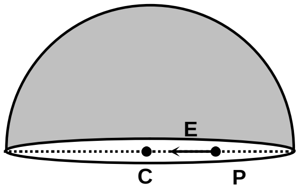
(B)



(C)

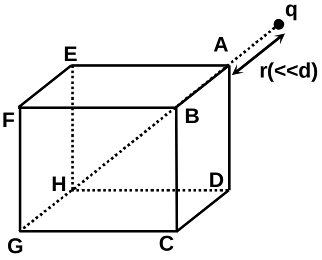


(D)



Space for Rough work

3. A point charge q is placed on the line AH and just outside the cube (of side d) at a distance of 'r' (r << d). Total flux of electric field through the surface ABCD (ϕ_{ABCD}) is



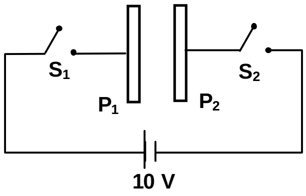
(A) $-\frac{q}{8\varepsilon_0}$ (B) $\frac{q}{16\varepsilon_0}$

(C) $\frac{q}{8\varepsilon_0}$ (D) $-\frac{q}{16\varepsilon_0}$

(One or More than one correct type)

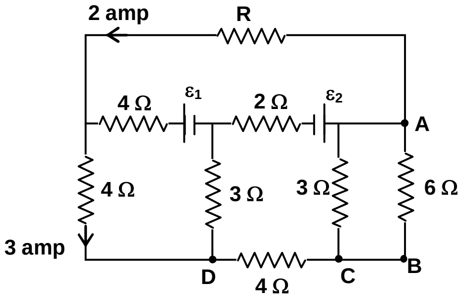
This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

4. Two identical plates P_1 and P_2, of cross sectional area A are separated at a very small distance d, where $\frac{\varepsilon_0 A}{d} = 2$ -SI unit. Initially charge on the plate P_1 is -10 C and charge on the plate P_2 is +30C. Now plate P_1 and P_2 are connected to positive and negative terminals of battery of potential difference 10 Volts with the help of switches S_1 and S_2 respectively. Choose the correct option(s).



(A) The work done by the battery is 200 J.
(B) The net charge on the plate P_2 is -10C.
(C) The charge on the left side of the plate P_1 is 10C.
(D) The charge on the right side of the plate P_2 is 20C.

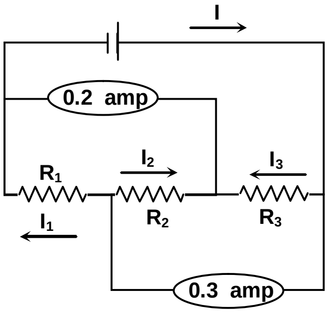
5. In the circuit shown, ε_1 and ε_2 are two ideal sources of unknown emfs. Some currents are shown in some branches of the circuit. Potential difference appearing across resistance 6 Ω is $V_A - V_B = 10$ V. Then
(A) The current in the CD branch is 5 amp.
(B) The unknown emf ε_1 is 40 volts.
(C) The unknown emf ε_2 is 68 volts.
(D) The unknown resistance R is 9 Ω.



Space for Rough work

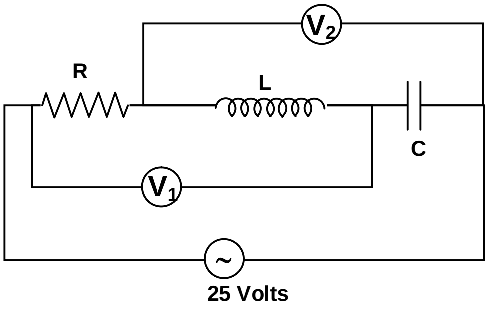
6. A circuit contains an ideal battery, three resistors and two ideal ammeters. The ammeters read 0.2 amp and 0.3 amp. After two of the resistor are switched (interchanged) the readings of ammeter do not change. Then

(A) If $R_2 = R_1$, $I_1 = I_2 = 0.15$ amp and $I_3 = 0.05$ amp.
(B) If $R_2 = R_1$, the battery current is, $I = 0.20$ amp.
(C) If $R_2 = R_3$, $I_2 = I_3 = 0.10$ amp and $I_1 = 0.20$ amp.
(D) If $R_2 = R_3$, the battery current is $I = 0.40$ amp.



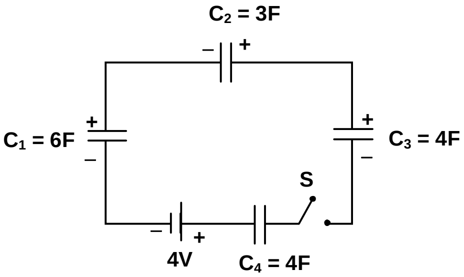
7. In an LCR series circuit, the reading of ideal voltmeters V_1 and V_2 are $20\sqrt{2}$ volt and 15 volts respectively as shown in the figure (the given circuit is inductive in nature). Then

(A) The voltage across resistor is 20 volts.
(B) The voltage across inductor is 20 volts.
(C) The voltage across capacitor is 5 volts.
(D) The power factor of the circuit is $\frac{4}{5}$.



8. Three capacitor $C_1 = 6F$, $C_2 = 3F$ and $C_3 = 4F$ are separately charged with battery such that charge on each capacitor are 36 C, 24 C and 40 C respectively and then disconnected with the battery. After that they are connected in a circuit along with an uncharged capacitor $C_4 = 4F$ and a battery of emf = 4 volts as shown in figure. Now the switch S is closed. Choose the correct option(s).

(A) Final charge on capacitor C_4 = 4C.
(B) Final charge on capacitor C_2 = 24C.
(C) Final charge on capacitor C_3 = 36C.
(D) Amount of charge flow in circuit = zero.



Space for Rough work

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 9 and 10

Two moles of an ideal mono-atomic gas undergoes a thermodynamic process in which the molar heat capacity 'C' of the gas depends on absolute temperature as $C = \frac{RT}{T_0}$, where R is gas constant and T_0 is the initial temperature of the gas. (V_0 is the initial volume of the gas). Then answer the following questions.

9. The equation of process is

(A) $\frac{1}{P} = \frac{V_0 T_0^{3/2}}{4RT^{5/2}} e^{\left(\frac{T-T_0}{T_0}\right)}$ (B) $\frac{1}{P} = \frac{V_0 T_0^{3/2}}{2RT^{5/2}} e^{\left(\frac{T-T_0}{T_0}\right)}$

(C) $\frac{1}{P} = \frac{V_0 T_0^{3/2}}{4RT^{5/2}} e^{\left(\frac{T+T_0}{T_0}\right)}$ (D) $\frac{1}{P} = \frac{V_0 T_0^{3/2}}{3RT^{5/2}} e^{\left(\frac{T-T_0}{T_0}\right)}$

10. The minimum volume of the gas is

(A) $\left(\frac{2}{3}\right)^{3/2} V_0 e^{1/2}$ (B) $\left(\frac{4}{3}\right)^{3/2} V_0 e^{1/2}$

(C) $\left(\frac{5}{3}\right)^{3/2} V_0 e^{1/2}$ (D) $\left(\frac{8}{3}\right)^{3/2} V_0 e^{1/2}$

Space for Rough work

SECTION – C

(Single digit integer type)

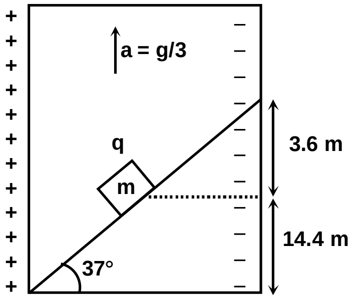
This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

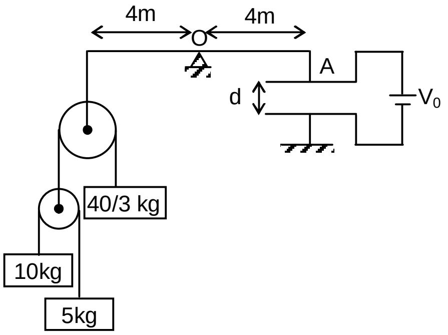
11. The electrostatic potential existing in the space is given as $V = -\left(\frac{x^3}{6\varepsilon_0} + 2\right)$ volts. Find the charge density (in coulomb/m^3) at x = 2m.

12. A hollow cube A of very small thickness at temperature T emits radiation like a black body. The cube A is kept in a room of temperature $T_0(<T)$. The side of cube is doubled without changing the volume of material and its temperature. Find the ratio of rate of cooling of cube A in first case to that of second case.

13. A small block of mass 'm' is kept on the smooth inclined plane of angle 37°, placed in an elevator going upward with acceleration $a = \frac{g}{3}$, as shown in the figure. A horizontal electric field E perpendicular to the left and right vertical wall of the elevator exists. The charge on the block is +q. Find the time (in sec) when the block collide with the vertical wall. (take g = 10 m/s^2 and $\frac{qE}{m} = 25$ m/s^2)

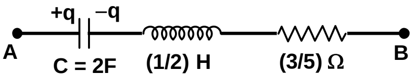


14. A capacitance balance is shown in the figure. The balance has a block pulley system attached on one side and a capacitor that has a variable gap width on the other side. Assume upper plate of the capacitor has negligible mass. When the separation between the plate is $\frac{1}{\sqrt{5}}$ meter, the attractive force between the plates balances the pulley block system. Then find value of V_0 in volts (EMF of battery). (Take area of the plate = $\frac{20}{3\varepsilon_0}$ m^2)

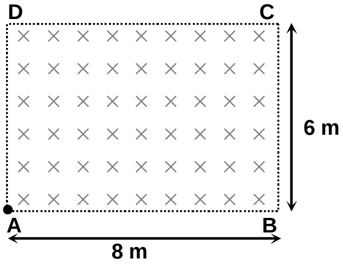


Space for Rough work

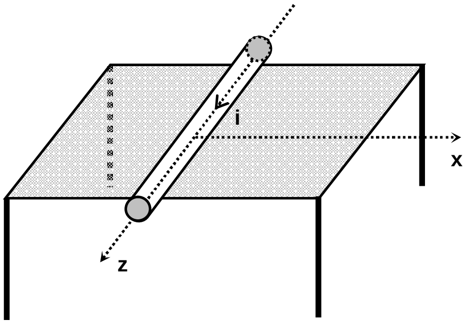
15. In the circuit shown, charge q varies with time 't' as $q = t^3 - t^2 + 4t$, where q is in coulombs and time 't' is in second. Find V_{AB} ($V_A - V_B$) in volts at time t = 1 sec.



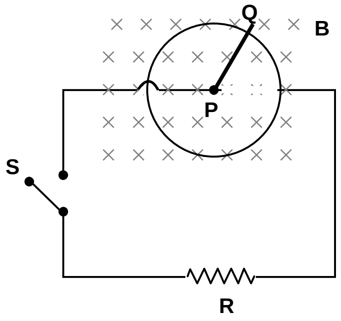
16. A charged particle of mass m = 5 gm and charge q = 12 μC enters along AB at point A in a uniform magnetic field of magnitude B = 100 Tesla existing in a rectangular region of size (8m × 6m) and into the plane of paper as shown in figure. The particle leaves the region at 'C'. The speed of the charge particle (in m/s) as it leaves the region is



17. A conducting rod of length 'ℓ' = $2\sqrt{5}$ meter and mass 'm' = 4 kg lies on the horizontal table. Coefficient of friction between the rod and the table is 'μ' $= \left(\frac{1}{2}\right)$. If the current in the conductor is 2 ampere, then find the minimum magnitude of magnetic field strength (in Tesla) such that conducting rod just starts to translate along x-axis. (take g = 10 m/sec^2) [neglect the radius of rod]

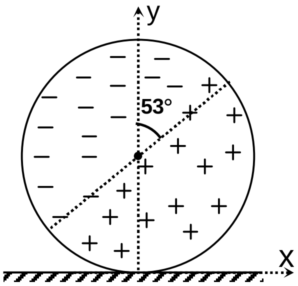


18. A resistance R = 1 kΩ connected to a conducting rod PQ that can slide on a conducting circular ring of radius 2m with center at P. A constant uniform magnetic field 10 Tesla exist as shown in figure. At t = 0, switch 'S' is closed and simultaneously an external torque is applied on the rod so that it rotates with constant angular velocity 20 rad/sec. The magnitude of power delivered by external agent is 20K Watt. Find the value of K. (Neglect the gravity, friction and self inductance of circular loop)

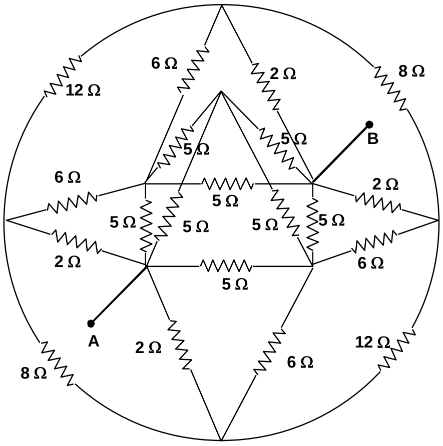


Space for Rough work

19. A non conducting solid sphere of mass m and radius R having uniform charge density $+\rho$ and $-\rho$ as shown in figure. It is then placed on a rough non conducting horizontal plane. At t = 0 a uniform electric field $\vec{E} = E_0\hat{i}$ N/C is switched on and the solid sphere starts rolling without sliding. The magnitude of frictional force at t = 0 is $\frac{2\rho\pi R^3 E_0}{K}$. Find the value of K.



20. Determine the equivalent resistance between point A and B in Ω, considering that connecting wires have no resistance.



Space for Rough work

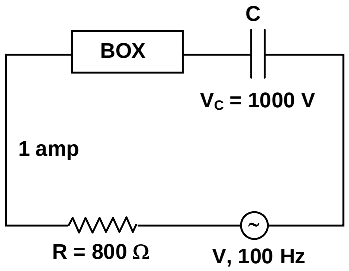
SECTION – D

(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

21. There are two vessels. Each of them contains one mole of a monoatomic ideal gas. Initial volume of the gas in each vessel is 8.3×10^{-3} m^3 at 27°C. Equal amount of heat is supplied to each vessel. In one of the vessel, the volume of the gas is doubled without change in its internal energy, where as the volume of the gas is held constant in the second vessel. The vessels are now connected to allow free mixing of the gas. Find the final temperature of the combined gas in Kelvin. (take $\ell n2 = 0.6931$)

22. A circuit shown in the figure contains a box having either a capacitor or an inductor. The power factor of the circuit is 0.8, while current lags behind the voltage. Then find the inductance/capacitance of the box in S.I. unit. (take $\pi = 3.2$) The circuit draws 1 ampere current.



23. A conductor of mass m = 5 kg and length ℓ = 4m is placed on horizontal surface and a uniform magnetic field B = 2 Tesla exist parallel to horizontal surface but perpendicular to the conductor. Suddenly, a certain amount of charge is passed through it, then it is found to jump to a height h = 5m. Then, find the amount of charge that passes through the conductor in coulomb. (take g = 10 m/s^2)

Space for Rough work

Chemistry

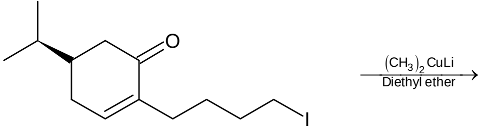
PART – II

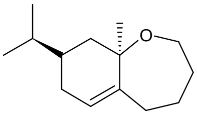
SECTION – A

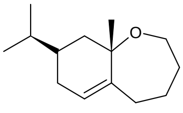
(One Options Correct Type)

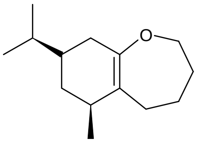
This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE** option is correct.

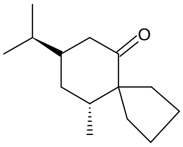
24. Major product formed in the following reaction is:


O
I
$(CH_3)_2CuLi$
Diethyl ether

(A) 

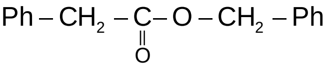
(B) 

(C) 

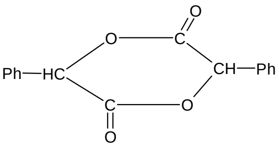
(D) 

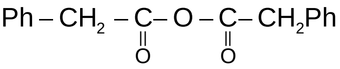
25. Identify the final product in the given reaction:

$$Ph-CH_2COOH \xrightarrow[\text{ii) }\ddot{\overline{O}}H]{\text{i) }P_{red}+Br_2} X \xrightarrow{H^+,\ \Delta} Y$$

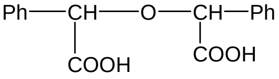
(A) 

$Ph-CH_2-\underset{\underset{O}{\|}}{C}-O-CH_2-Ph$

(B) 
O
O
C
Ph—HC
CH—Ph
C
O
O

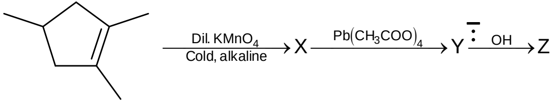
(C) 

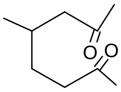
$Ph-CH_2-\underset{\underset{O}{\|}}{C}-O-\underset{\underset{O}{\|}}{C}-CH_2Ph$

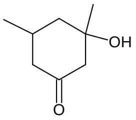
(D) 

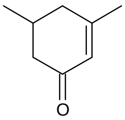
$Ph-\underset{\underset{COOH}{|}}{CH}-O-\underset{\underset{COOH}{|}}{CH}-Ph$

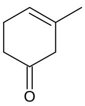
26. Identify the final product in the following reaction:


Dil. $KMnO_4$
Cold, alkaline
X
$Pb(CH_3COO)_4$
Y
$\ddot{\overline{O}}H$
Z

(A) 

(B) 

(C) 

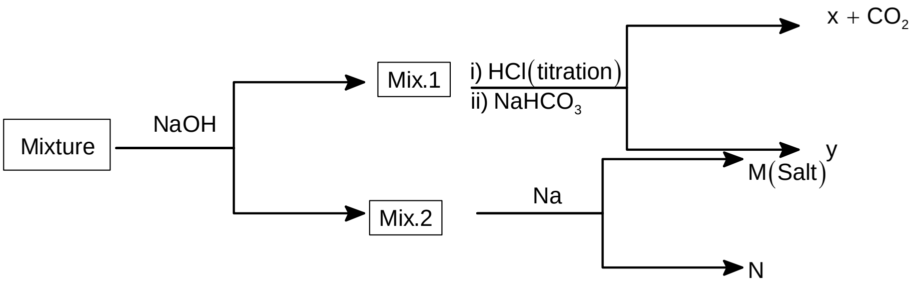
(D) 

Space for Rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

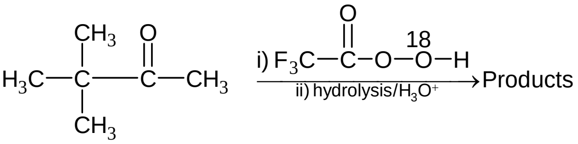
27.


Mixture
NaOH
Mix.1
Mix.2
i) HCl(titration)
ii) NaHCO3
x + CO2
y
Na
M(Salt)
N

Which of the following option is correct for the above reaction?

(A) x = PhCOOH y = C_2H_5OH
(B) M = PhCOONa N = CH_3OCH_3
(C) x = PhOH y = CH_3OCH_3
(D) M = C_2H_5ONa N = CH_3OCH_3

28.

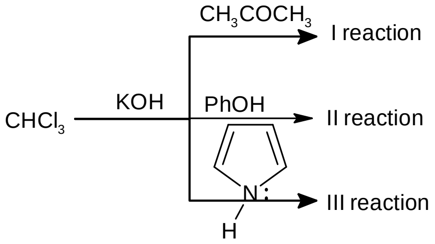


$$H_3C-C(CH_3)_2-\overset{O}{\overset{\|}{C}}-CH_3 \xrightarrow[\text{ii) hydrolysis}/H_3O^+]{\text{i) } F_3C-\overset{O}{\overset{\|}{C}}-O-\overset{18}{O}-H} \text{Products}$$

Which of the following option is/are correct?

(A) $(CH_3)_3C-\overset{18}{O}H$
(B) $CH_3CO\overset{18}{O}H$
(C) $(CH_3)_3COH$
(D) CH_3COOH

29.

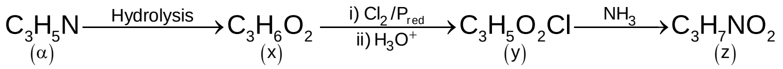

CHCl3
KOH
CH3COCH3
I reaction
PhOH
II reaction
N:
H
III reaction

in which of the following reaction carbene is intermediate

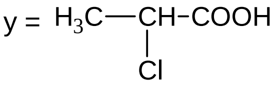
(A) I, II
(B) II, III
(C) III, I
(D) I, II, III

Space for Rough work

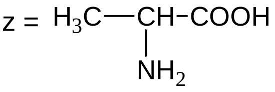
30. Which of the following reagent give same type of reaction with HCHO and PhCHO?
(A) Fehling solution
(B) NH_3
(C) NaOH
(D) Tollen's sol.

31.


$$\underset{(\alpha)}{C_3H_5N} \xrightarrow{\text{Hydrolysis}} \underset{(x)}{C_3H_6O_2} \xrightarrow[\text{ii) } H_3O^+]{\text{i) } Cl_2/P_{red}} \underset{(y)}{C_3H_5O_2Cl} \xrightarrow{NH_3} \underset{(z)}{C_3H_7NO_2}$$

Correct option(s) is/are for the above reaction.
(A) $\alpha = C_2H_5CN$
(B) $x = C_2H_5COOH$
(C) 

$y = H_3C-\underset{\underset{Cl}{|}}{CH}-COOH$

(D) 

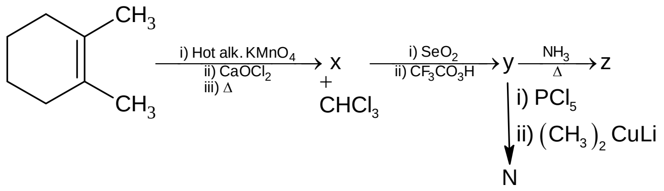
$z = H_3C-\underset{\underset{NH_2}{|}}{CH}-COOH$

Space for Rough work

(Paragraph Type)

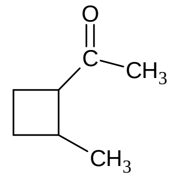
This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 32 and 33

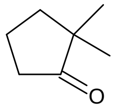

CH3
CH3
i) Hot alk. KMnO4
ii) CaOCl2
iii) Δ
x
+
CHCl3
i) SeO2
ii) CF3CO3H
y
NH3
Δ
z
i) PCl5
ii) (CH3)2 CuLi
N

32. $N \xrightarrow[H_2O]{Mg-Hg} P \xrightarrow[\text{Dil. } H_2SO_4]{\text{hot}} Q$: Q is

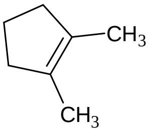
(A)



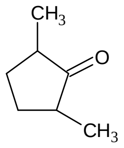
(B)



(C)



(D)



33. $x \xrightarrow[\text{ii) } H_2/Ni]{\text{i) KCN}} R \xrightarrow[\text{ii) } NH_2OH \text{ iii) } PCl_5]{\text{i) } HNO_2} S$

S forms a polymer. Name of polymer is:

(A) Nylon 6, 6
(B) Nylon 6
(C) Nylon 6-12
(D) Nylon 6-10

Space for Rough work

SECTION – C

(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

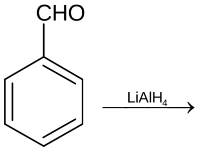
34. $\mathrm{CH_3CH_2CHO \xrightarrow[D_2O]{DCl} Products}$: Number of different enol of products is / are

35. $\mathrm{PhCOOC_2H_5 + C_2H_5 - COOC_2H_5 \xrightarrow{NaNH_2}}$ Number of condensated products (including stereoisomer)

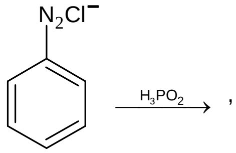
36. Number of reaction which gives Benzene as major products?

(a) $\mathrm{H{-}C{\equiv}CH \xrightarrow[\Delta]{Fe\ tube}}$

(b)

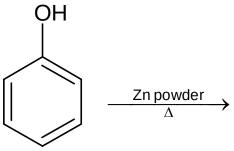


(c)

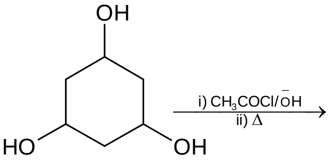


,

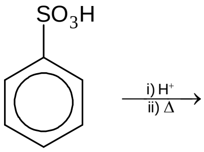
(d)



(e)

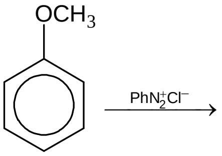


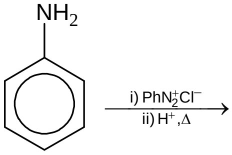
(f)

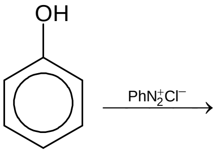


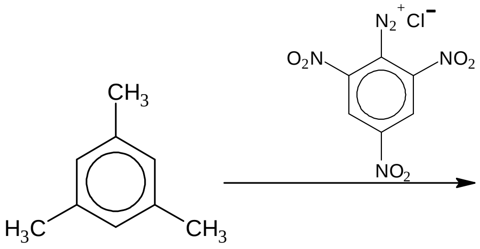
Space for Rough work

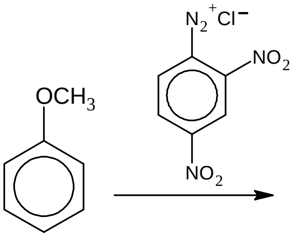
37. How many of these gives coupling reaction:

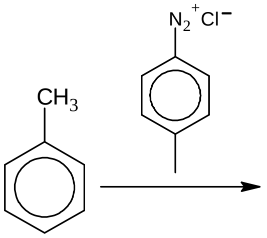

OCH3
PhN2+Cl−


NH2
i) PhN2+Cl−
ii) H+, Δ

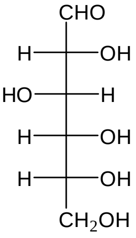
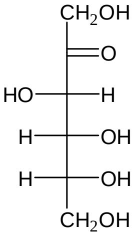
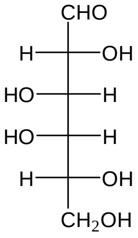
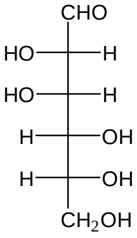
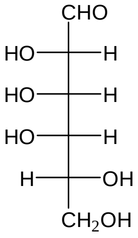
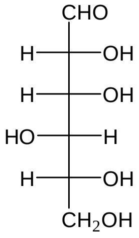



CH3
H3C
CH3
N2+ Cl−
O2N
NO2
NO2


OCH3
N2+ Cl−
NO2
NO2



38. How many of these gives same osazone with PhNHNH2:

39. How many nitrogen atoms are present in melamine monomer?

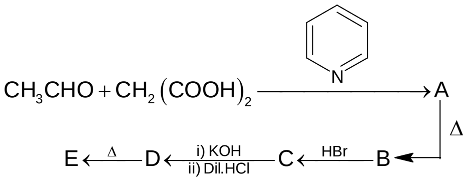
Space for Rough work

40. How many of these are thermoplastic polymers
Polyethylene, Polystyrene, Bakelite, Nylon 6,6, Terylene, Poly(methyl(methacrylate))

41. How much gm of bromine reacts with 3.15 gm of butane-2-ene (Atomic mass of bromine = 80)

42. Total number of isomers of C_4H_9Cl are

43.



Number of isomeric form of E are?

Space for Rough work

SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

44. A sugar exist in two isomeric form $\alpha - D$ & $\beta - D$ with specific rotation of 110° and 30° respectively. When $\alpha - D$ form of the sugar is dissolved in water exhibits mutarotation till the equilibrium value of 90° is attained. The equilibrium constant of mutarotation of $\beta - D$ form [Assuming only α and β form in solution] is equal to:

45. A sample of 1.0 gm of organic compound was treated with NaOH and NH_3 evolved was absorbed in 70 ml 0.5 M H_2SO_4. The residual acid required 65 ml of 0.5 M NaOH solution for neutralization in Kjeldahl's method. What is the percentage of nitrogen in organic compound.

46. When 78.5 gm of CH_3COCl is treated with 29.75 gm of CH_3MgBr then what will be the mass of alcohol produces? (Given: M. wt. of Cl = 35.5, Br = 80, C = 12)

Space for Rough work

Mathematics PART – III

SECTION – A

(One Options Correct Type)

This section contains **3 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D) out of which **ONLY ONE** option is correct.

47. Let ABC be a right angle triangle right angle at $\underline{|A}$, S be its circumcircle. Let S_1 be the circle touching the lines AB and AC and the circle S internally. Let S_2 be the circle touching the lines AB, AC and the circle S externally, if r_1, r_2 be the radii of the circle S_1 and S_2 respectively then area ΔABC is

(A) $\frac{r_1 r_2}{4}$ (B) $\frac{r_1 r_2}{8}$

(C) $\frac{r_1 r_2}{2}$ (D) $r_1 r_2$

48. If tangents are drawn to the parabola $y = x^2 + bx + c$ for b and c fixed real number at the points (i, y_i) for i = 1, 2, ..., 10. Let I_1, I_2, I_3 ..... I_9 be the point of intersection of tangents at (i, y_j) and $(i + 1, y_{i+1})$ then the least polynomial satisfying whose graph passes through all nine points

(A) $y = x^2 + bx + c$ (B) $y = x^2 + bx + c - \frac{1}{2}$

(C) $y = x^2 + bx + c - \frac{1}{4}$ (D) $y = x^2 + bx + c - \frac{1}{8}$

49. If a tangent of slope 4 of the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ is normal to the circle $x^2 + y^2 + 4x + 1 = 0$ then the maximum value of ab is

(A) 4 (B) 5

(C) 6 (D) 8

Space for rough work

(One or More than one correct type)

This section contains **FIVE** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

---

50. A(2, 0) is a point on the circle $(x + 2)^2 + (y - 3)^2 = 25$, A line through A(2, 0) making an angle of 45° with the tangent to the circle at A is drawn. Then the equations of the circles with the centres on these lines which are at a distance of $5\sqrt{2}$ units from point A and of radius 3 are

(A) $(x - 1)^2 + (y - 7)^2 = 9$
(B) $(x - 3)^2 + (y + 7)^2 = 9$
(C) $(x - 9)^2 + (y - 1)^2 = 9$
(D) $(x + 9)^2 + (y + 1)^2 = 9$

51. The normal to a curve at $P(x_1, y_1)$ meets the x-axis at G. If the distance of G from the origin is twice the abscissa of P, then the curve is a

(A) circle
(B) hyperbola
(C) ellipse
(D) parabola

52. The value(s) of x satisfying the equation $\tan^{-1}\left(x+\frac{2}{x}\right)-\tan^{-1}\left(x-\frac{2}{x}\right)-\tan^{-1}\left(\frac{4}{x}\right)=0$ is/are

(A) $\sqrt{3}$
(B) $-\sqrt{3}$
(C) $-\sqrt{2}$
(D) $\sqrt{2}$

53. Solution of the equation $\cos^2 x + \cos^2 2x + \cos^2 3x = 1$ is

(A) $x=(2m+1)\frac{\pi}{2}$ $(m \in I)$
(B) $x=(2n+1)\frac{\pi}{4}$ $(n \in I)$
(C) $x=(2k+1)\frac{\pi}{6}$ $(k \in I)$
(D) $x=(2\ell+1)\frac{\pi}{8}$ $(\ell \in I)$

54. Normals are drawn from the external point (h, k) to the rectangular hyperbola $xy = c^2$. If circles are drawn through the feet of these normals taken three at a time then centre of circle lies on another hyperbola whose centre and eccentricity is

(A) $\left(\frac{h}{2},\frac{k}{2}\right)$
(B) (h, k)
(C) $\sqrt{2}$
(D) $\sqrt{2}+1$

Space for rough work

(Paragraph Type)

This section contains **ONE** paragraph. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 55 and 56

Read the following write up carefully and answer the following questions:
A variable line L intersects the parabola $y = x^2$ at points P and Q whose x-coordinate are α and β respectively with $\alpha < \beta$ the area of the figure enclosed by the segment PQ and the parabola is always equal to $\frac{4}{3}$. The variable segment PQ has its middle point as M

55. Which of the following is/are correct?
(A) $(\beta - \alpha)$ can have more than one real values (B) $(\beta - \alpha)$ can be equal to 2
(C) $(\beta - \alpha)$ can have exactly one real value (D) $\alpha = 2 + \beta$

56. Which of the following is/are correct?
(A) equations of the pair of tangents, drawn to the curve, represented by locus of M from origin are $y = 2x$ and $y = -2x$
(B) equation of pair of tangents to be curve, represented by locus of M from origin are $y = x$ and $y = -x$
(C) area of the region enclosed between the curve, represented by locus of M, and the pair of tangents drawn to it from origin is $\frac{2}{3}$ sq. units
(D) area of the region enclosed between the curve, represented by locus of M, and the pair of tangents drawn to it, from origin is $\frac{1}{3}$ sq. units

SECTION – C
(Single digit integer type)

This section contains **TEN** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

57. Two tangents to an ellipse $x^2 + 2y^2 = 2$ are drawn which intersect at right angles, let ℓ_1 and ℓ_2 be the intercepts on these tangents made by the circle $x^2 + y^2 = 2$, then $\ell_1^2 + \ell_2^2$ is equal to _____

Space for rough work

58. If α, β, γ are the eccentric angles of three points on the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ at which the normals are concurrent, then $\sin(\alpha + \beta) + \sin(\beta + \gamma) + \sin(\gamma + \alpha)$ is equal to _____

59. In a circle are inscribed a trapezoid with one side as diameter and a triangle with sides parallel to the sides of the trapezoid, then the ratio of area of trapezoid to the area and triangle is _____

60. For x, y $\in$ R with $0 < x < \frac{\pi}{2}$ such that $\frac{(\sin x)^{2y}}{(\cos x)^{\frac{y^2}{2}}}+\frac{(\cos x)^{2y}}{(\sin x)^{\frac{y^2}{2}}}=\sin 2x$, then y is _____

61. The value of cos x cos 2x·cos 3x ..... cos 999x where $x=\frac{2\pi}{1999}$ is p then $2^{1000}p$ is equal to _____

62. Normals are drawn to the parabola $y^2 = 4x$ from any point on the line y = 2, then vertices of the triangle formed by corresponding tangents lie on a fixed rectangular hyperbola $xy = -c^2$ then c^2 is _____

63. If $\frac{\tan(A+B-C)}{\tan(A-B+C)}=\frac{\tan C}{\tan B}$ then sin 2A + sin 2B + sin 2C is equal to _____

64. The line through P, perpendicular to the chord of contact of the tangents drawn from the point P to the parabola $y^2 = 16x$ touches the parabola $x^2 = 12y$, then the locus of P is $2ax + 3y + 4a^2 = 0$ then a is _____

65. Find the length of focal chord of the parabola $x^2 = 4y$ which touches the hyperbola $x^2 - 4y^2 = 1$ _____

66. Total number of solution for the equation $x^2-3\left[\sin\left(x-\frac{\pi}{6}\right)\right]=3$ is _____ (where [.] denotes the greatest integer function)

Space for rough work

SECTION – D
(Numerical Based XXXXX.XX answer Type)

This section contains **3 questions**. Each question, when worked out will result in numerical answer Type with answer xxxxx.xx.

67. Quadrilateral ABCD is inscribed in a circle with AD as diameter. If AD = 4, AB = BC =1 then perimeter of quadrilateral ABCD is _____

68. From a point (2, α) tangents are drawn to the same branch of hyperbola $\frac{x^2}{100} - \frac{y^2}{16} = 1$, then the range of $\alpha \in (\ell_1, \ell_2)$, then ℓ_2 is equal to _____

69. Let ΔABC be equilateral on side AB produced, take a point P such that A lies between P and B. Consider 'a' as the length of sides of ΔABC, r_1 as the radius of incircle of ΔPAC, r_2 as the ex-radius of ΔPBC with respect to side BC, then $\frac{r_1 + r_2}{\sqrt{3}\,a}$ is equal to _____

Space for rough work

FIITJEE **JEE(Advanced)-2018**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

PART TEST – II

PAPER-2

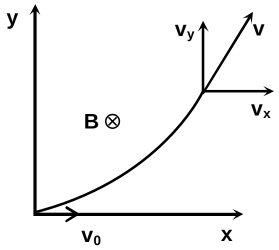
Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	C	24.	D	47.	A
2.	C	25.	B	48.	C
3.	D	26.	C	49.	D
4.	B, C	27.	D	50.	A, B, C, D
5.	A, B, C, D	28.	B, C	51.	B, C
6.	A, C, D	29.	B	52.	C, D
7.	A, B, C, D	30.	C, D	53.	A, B, C
8.	B, D	31.	A, B, C, D	54.	A, C
9.	B	32.	B	55.	B
10.	A	33.	B	56.	C
11.	2	34.	4	57.	4
12.	4	35.	4	58.	0
13.	1	36.	5	59.	1
14.	4	37.	4	60.	2
15.	7	38.	3	61.	2
16.	2	39.	6	62.	2
17.	2	40.	3	63.	0
18.	8	41.	9	64.	4
19.	7	42.	5	65.	9
20.	2	43.	2	66.	2
21.	00369.31	44.	00003.33	67.	00009.50
22.	00002.50	45.	00063.75	68.	00000.80
23.	00006.25	46.	00009.25	69.	00000.50

Physics

PART – I

SECTION – A

1. $\vec{F} = q(v_x\hat{i} + v_y\hat{j}) \times B_0\left(1 + \frac{y}{d}\right)(-\hat{k}) = F_x\hat{i} + F_y\hat{j}$



$|F_x| = qB_0\left(1 + \frac{y}{d}\right)v_y$

$-\int_{v_0}^{v_x} m\,dv_x = q\int_0^d B_0\left(1 + \frac{y}{d}\right)dy \quad \left(\frac{dv_x}{dy} \text{ is negative}\right)$

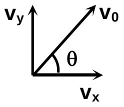
$v_x = v_0 - \frac{qB_0}{m}\left(\frac{3}{2}d\right)$

$v_x = \frac{3qB_0d}{m} - \frac{3}{2}\frac{qB_0d}{m} = \frac{3}{2}\frac{qB_0d}{m} = \frac{v_0}{2}$

$v_x^2 + v_y^2 = v_0^2$

$\frac{v_0^2}{4} + v_y^2 = v_0^2$

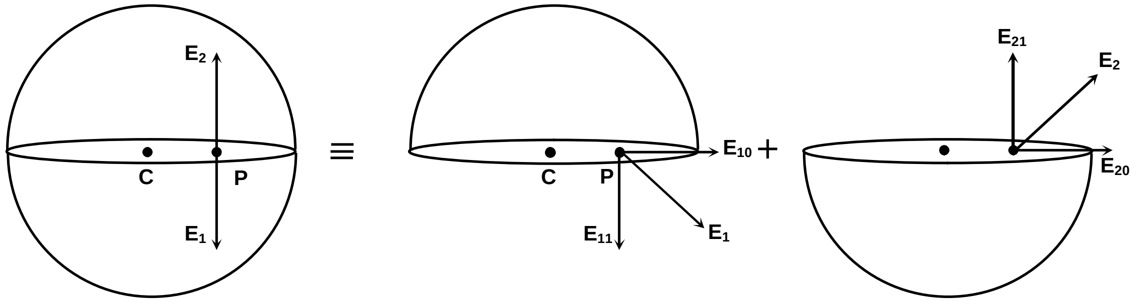
$\Rightarrow \quad v_y = \frac{\sqrt{3}v_0}{2}$



$\tan\theta = \frac{v_y}{v_x} = \sqrt{3}$

$\theta = 60°$

2. E_1 and E_2 are the magnitude of electric field due to upper hemispherical shell and lower spherical shell respectively, whose components along the diameter and its perpendicular direction are shown in the figure. By the combination of two hemispherical shells: At P, $E_{11} = E_{21}$ and $E_{10} = E_{20} = 0$
net electric field must be zero.

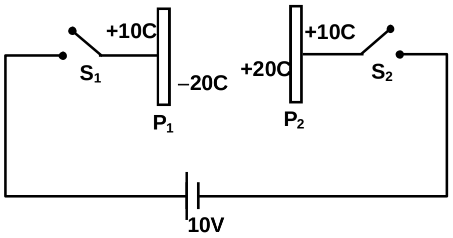


3. $\phi_{BCFG} = \phi_{CDGH} = \phi_{EFGH} = \frac{q}{24\varepsilon_0}$, $\phi_{EHAD} = 0$, $\phi_{ABEF} = \phi_{ABCD} = x$

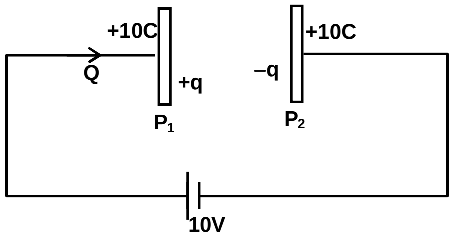
$2 \times x + 0 + \frac{q}{24\varepsilon_0} \times 3 = 0$

$\Rightarrow x = -\frac{q}{16\varepsilon_0}$

4.


+10C
+10C
S₁
−20C
+20C
S₂
P₁
P₂
10V

When switches are not closed


+10C
+10C
Q
+q
−q
P₁
P₂
10V

When switches are closed

$$\frac{q}{A\varepsilon_0 \times d} = 10$$

$$\Rightarrow \; q = 10 \times \frac{A\varepsilon_0}{d} = 20 \text{ C}$$

Q = 20 + 20 = 40 C

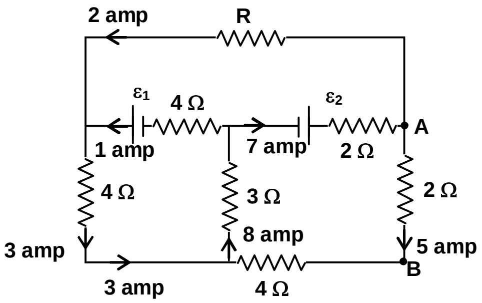
W_B = (20 + 20) 10 = 400 J

5. By applying Kirchhoff's law

ε_1 = 40 V

ε_2 = 68 V

R = 9 Ω and current through 4Ω = 5 amp.


2 amp
R
ε₁
4 Ω
ε₂
A
1 amp
7 amp
2 Ω
4 Ω
3 Ω
2 Ω
8 amp
3 amp
5 amp
B
3 amp
4 Ω

6. As the ammeters are ideal, so

$$R_{eq} = \frac{R_1R_2R_3}{R_1R_2 + R_2R_3 + R_3R_1}$$

The readings of two ammeters are different so resistors R_1 and R_3 are different.

If R_1 and R_3 are interchanged, the reading of ammeters will also change.

If $R_2 = R_1$ (If R_2 and R_1 switched the reading of the ammeter do not vary) similarly if $R_2 = R_3$ (R_2 and R_3 switched the reading of ammeters do not change)

If $R_2 = R_1$, $I_1 = I_2 = 0.15$, $I_3 = 0.05$ and I = 0.35

If $R_2 = R_3$, $I_2 = I_3 = 0.10$, $I_1 = 0.20$ and I = 0.40 amp

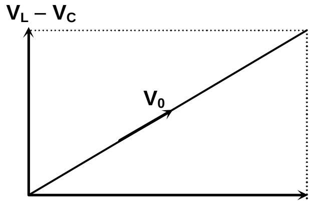
7.

$$V_R^2 + V_L^2 = V_1^2 = (20\sqrt{2})^2 = 800 \qquad \ldots\text{(i)}$$

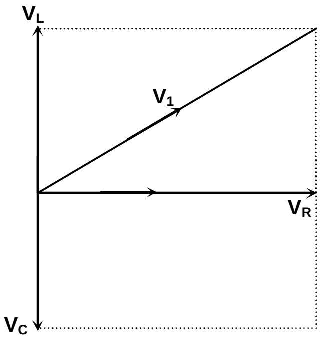
$$V_L - V_C = 15 \qquad \ldots\text{(ii)}$$

$$\sqrt{V_R^2 + (V_L - V_C)^2} = (25)^2$$

$$V_R^2 + 225 = 625$$



V_0 = source voltage



$\Rightarrow V_R = 20$ volts

$V_L = 20$ volts

$V_L - V_C = 15$

$20 - V_C = 15$

$V_C = 5$ volts

Power factor = $\cos\phi = \dfrac{R}{Z} = \dfrac{iR}{iZ} = \dfrac{V_R}{V_Z} = \dfrac{20}{25} = \dfrac{4}{5}$

8. By applying Kirchhoff's Law

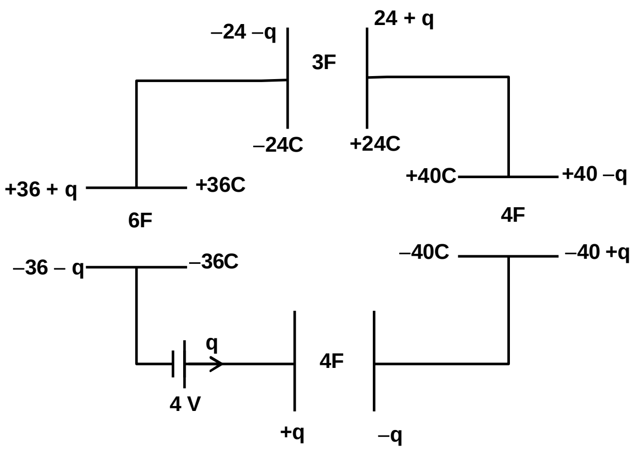
$$-4 + \frac{q}{4} + \frac{-40+q}{4} + \frac{24+q}{3} + \frac{36+q}{6} = 0$$

$$-4 + \frac{q}{4} - 10 + \frac{q}{4} + 8 + \frac{q}{3} + 6 + \frac{q}{6} = 0$$

$$\frac{q}{4} + \frac{q}{4} + \frac{q}{3} + \frac{q}{6} = 0$$

$\Rightarrow q = 0$

Hence, there is no flow of charge.



9-10. dQ = dU + dW

$\Rightarrow$ nCdT = nC_vdT + PdV

$$\Rightarrow \frac{2RT}{T_0} - 3R = \frac{2RT}{V}\cdot\frac{dV}{dT}. \qquad ...(1)$$

From (1) $\displaystyle\int_{T_0}^{T}\left(\frac{1}{T_0} - \frac{3}{2T}\right)dT = \int_{V_0}^{V}\frac{dV}{V}$

On solving, $V = V_0\left(\dfrac{T_0}{T}\right)^{3/2} e^{\left(\frac{T-T_0}{T_0}\right)}$

$$\frac{2RT}{P} = V_0\left(\frac{T_0}{T}\right)^{3/2} e^{\left(\frac{T-T_0}{T_0}\right)}$$

$$\frac{1}{P} = \frac{V_0T_0^{3/2}}{2RT^{5/2}}e^{\left(\frac{T-T_0}{T_0}\right)}$$

For minimum volume, $\dfrac{dv}{dT} = 0$

So, $T = \dfrac{3}{2}T_0$,

$$V_{min} = V_0\left(\frac{T_0}{\frac{3}{2}T_0}\right)^{3/2} e^{\left(\frac{\frac{3}{2}T_0 - T_0}{T_0}\right)}$$

$$V_{min} = \left(\frac{2}{3}\right)^{3/2} V_0e^{1/2}$$

SECTION – C

11. $E = -\frac{\partial V}{\partial x} = \frac{3x^2}{6\varepsilon_0} = \frac{x^2}{2\varepsilon_0}$

$\phi = E.A. = \frac{x^2}{2\varepsilon_0}A$

$\frac{d\phi}{dx} = \frac{(xA)}{\varepsilon_0} \Rightarrow d\phi = \frac{(xAdx)}{\varepsilon_0}$

$\rho(x) = \frac{dq}{Adx} = \frac{(xAdx)}{(Adx)} = x$

$\rho(x = 2) = 2$

Alternating Method

$\nabla\vec{E} = \frac{\rho}{\varepsilon_0} \Rightarrow \frac{x}{\varepsilon_0} = \frac{\rho}{\varepsilon_0} \Rightarrow \rho = x$

If $x = 2 \Rightarrow \rho = 2$

12. The rate of heat loss by cube of thickness Δx, side ℓ and made of density ρ is given by

$-ms\frac{dT}{dt} = \varepsilon\sigma A\left(T^4 - T_0^4\right)$

$-\frac{dT}{dt} = \frac{\varepsilon\sigma A(T^4 - T_0^4)}{ms}$

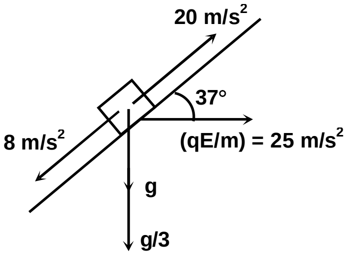
13. F.B.D. of block

$a_{net} = 12$ m/s^2, up the incline plane

$S = ut + \frac{1}{2}gt^2$

$3.6 \times \frac{5}{3} = \frac{1}{2} \times 12 \times t^2$

$\Rightarrow t = 1$ sec



14. Tension in upper rope $= \frac{800}{3}$N.

By balancing Torque about 'O'

$\frac{800}{3} = \frac{V_0^2\varepsilon_0 A}{2d^2} = \frac{V_0^2\varepsilon_0 20}{2\left(\frac{1}{5}\right)3\varepsilon_0}$

$V_0 = 4\,\text{Volts}$

15. $q = t^3 - t^2 + 4t$

$i = \frac{dq}{dt} = 3t^2 - 2t + 4$

$i(t = 1) = 5$ amp

$\frac{di}{dt} = 6t - 2$

$\frac{di}{dt}(t = 1) = 4$

Current is increasing with time

q(t = 1) = 1 – 1 + 4 = 4 coulombs

$V_A - V_B = \frac{4}{2} + \frac{4}{2} + 5 \times \frac{3}{5} = 7$ Volts

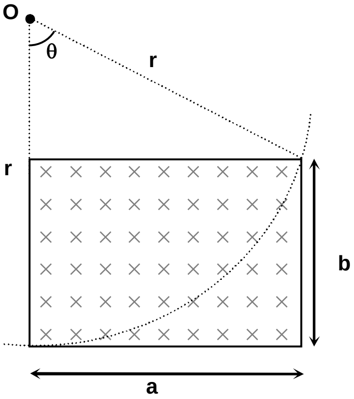
16. $r = \frac{mv}{qB}$

$\sin\theta = \frac{a}{r},\ \cos\theta = \frac{r-b}{r}$

$\left(\frac{a}{r}\right)^2 + \left(\frac{r-b}{r}\right)^2 = 1$

$\Rightarrow r = \frac{(a^2+b^2)}{2b} = \frac{mv}{qB}$

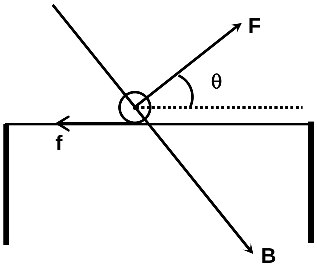
$v = \frac{qB(a^2+b^2)}{2mb} = 2\text{ m/s}$



17. $F_{min} = \frac{\mu mg}{\sqrt{1+\mu^2}}$

$i\ell B_{min} = \frac{\mu mg}{\sqrt{1+\mu^2}}$

$B_{min} = 2$ Tesla



18. Induced emf = $\frac{B\omega\ell^2}{2}$, current $i_0 = \frac{B\omega\ell^2}{2R}$

Torque about P = $\tau = \int (idx)B.x = \frac{iB\ell^2}{2}$

$= \left(\frac{B\omega\ell^2}{2R}\right)\left(\frac{B\ell^2}{2}\right) = 8$

So, power P = $\vec{\tau}\cdot\vec{\omega}$ = 160 Watt

Alternate Solution

Power = Heat loss in resistance = $Ri_1^2 = \frac{B^2\omega^2\ell^4}{4R} = 160\text{ Watt}$

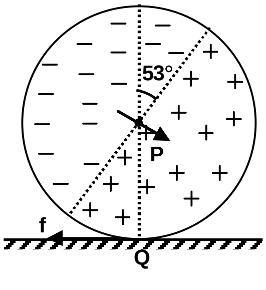
19. $\tau_Q = PE\sin 53°$

$= \left(\rho\frac{2}{3}\pi R^3\right)\left(\frac{3R}{4}\right)E_0\frac{4}{5}$

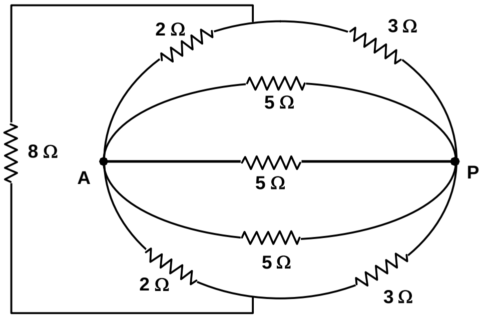
$= \frac{2}{5}\rho\pi R^4 E_0 = \left(\frac{7}{5}mR^2\alpha\right)$

$a_{cm} = R\alpha = \frac{2}{7}\frac{\rho\pi R^3 E_0}{m}$

$f = ma_{cm} = \frac{2}{7}\rho\pi R^3 E_0$



20. $R_{AB} = 1\ \Omega$ so $R_{AB} = 1 + 1 = 2\ \Omega$



SECTION – D

21. For first vessel.

$\Delta U = 0$

$\Delta Q_1 = \Delta W = nRT\ell n\left(\frac{V_f}{V_i}\right) = 1.R.300.\ell n2$

$= (0.6931) \times 300 \times R = 207.93\ R$

For second vessel $\Delta V = 0$

$\Delta Q_2 = \Delta U = nC_V\Delta T = 1 \cdot \frac{3}{2}R\Delta T$

$\Delta Q_1 = \Delta Q_2$

$207.93R = \frac{3}{2}R\Delta T$

$\Rightarrow \Delta T = 138.62$

$T_f = 300 + 138.62 = 438.62$

$U_{mix} = U_1 + U_2$

$(n_1 + n_2)C_{Vmix}T_{mix} = n_1C_{V_1}T_1 + n_2CV_2T_2$

$T_{mix} = \frac{T_1 + T_2}{n_1 + n_2} = 369.31K.$

22 $X_C = \frac{V_C}{I} = \frac{1000}{1} = 1000\Omega$

Current lags behind voltage

So, box has an inductor

Power factor = 0.8 = $\frac{R}{Z} = \frac{800}{\sqrt{(800)^2 + (X_L - 1000)^2}}$

$X_L = 1600\ \Omega$

$\omega L = 1600$

$L = \frac{1600}{2 \times 3.2 \times 100} = 2.5\ H$

23. Impulse, $F\Delta t = m\sqrt{2gh}$

$(i\ell B)\Delta t = m\sqrt{2gh}$ …(i)

$i\Delta t = \Delta q$ …(ii)

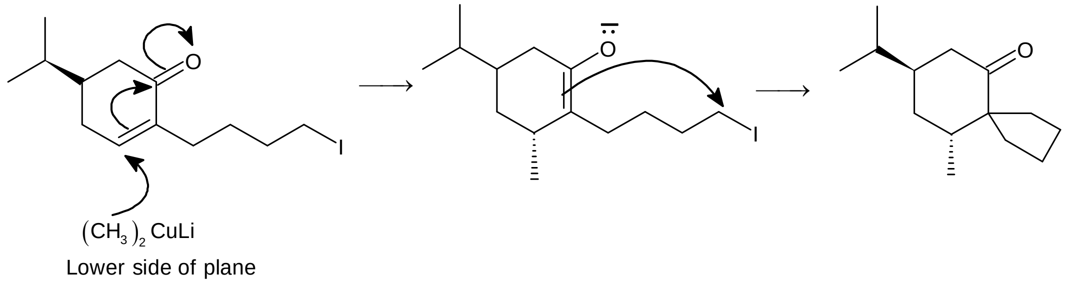
$\Delta q = \frac{m\sqrt{2gh}}{B\ell} = \frac{5\sqrt{2 \times 10 \times 5}}{2 \times 4} = 6.25$ Coulomb

Chemistry

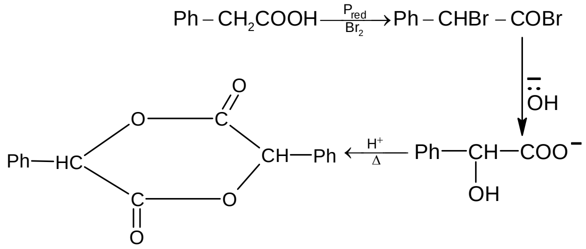
PART – II

SECTION – A

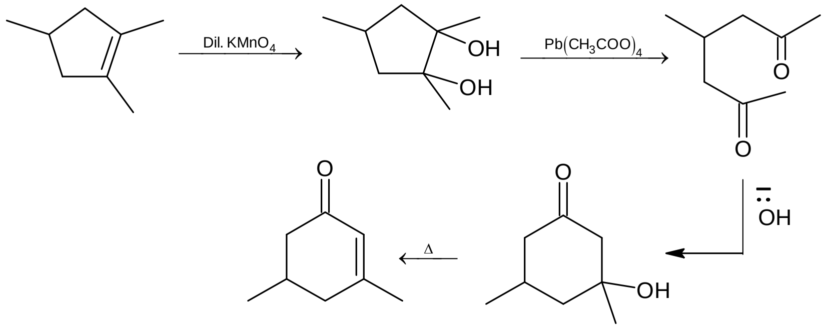
24.


O
I
$(CH_3)_2CuLi$
Lower side of plane
O
I
O

25.

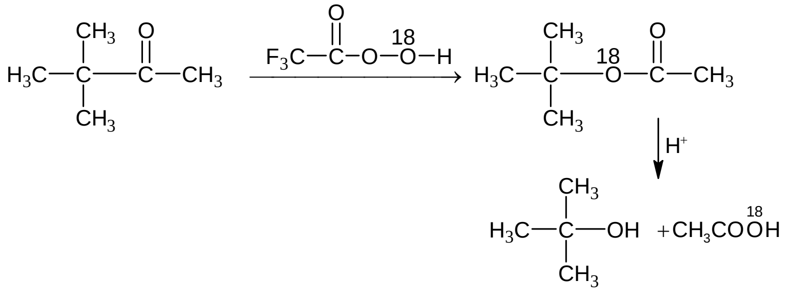

Ph – CH₂COOH
P red
Br₂
Ph – CHBr – COBr
OH
Ph—CH—COO⁻
OH
H⁺
Δ
Ph—HC
O
C
O
CH—Ph
C
O
O

26.

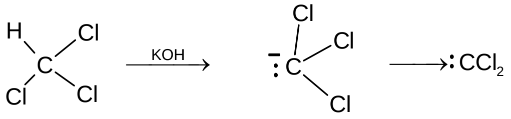

Dil. KMnO₄
OH
OH
Pb(CH₃COO)₄
O
O
OH
O
OH
Δ
O

27. PhCOOH is more acidic than H_2CO_3 while PhOH is less acidic than H_2CO_3.

28.


H₃C—C(CH₃)₂—C(=O)—CH₃
F₃C—C(=O)—O—O—H
18
H₃C—C(CH₃)₂—O—C(=O)—CH₃
18
H⁺
H₃C—C(CH₃)₂—OH
+CH₃COOH
18

29.

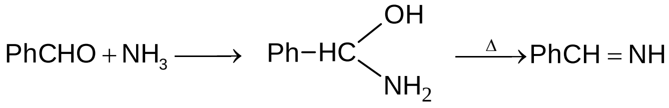

H
Cl
C
Cl
Cl
KOH
Cl
Cl
C
Cl
:CCl₂

30.

$$HCHO \xrightarrow{\text{Fehling solution}} HCOOH$$

$$PhCHO \xrightarrow{\text{Fehling solution}} \text{No reaction}$$

$$HCHO + NH_3 \longrightarrow (CH_2)_6N_4$$



$$PhCHO + NH_3 \longrightarrow Ph{-}HC\begin{smallmatrix}OH\\ NH_2\end{smallmatrix} \xrightarrow{\Delta} PhCH=NH$$

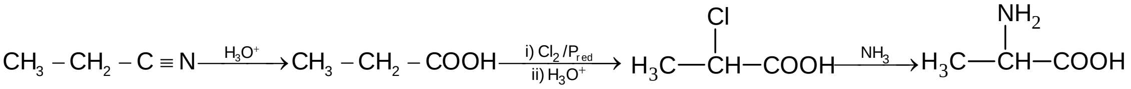
$$HCHO + NaOH \longrightarrow CH_3OH + HCOO^-$$

$$PhCHO + NaOH \longrightarrow PhCH_2OH + PhCOO^-$$

$$HCHO \xrightarrow{\text{Tollens}} HCOO^-$$

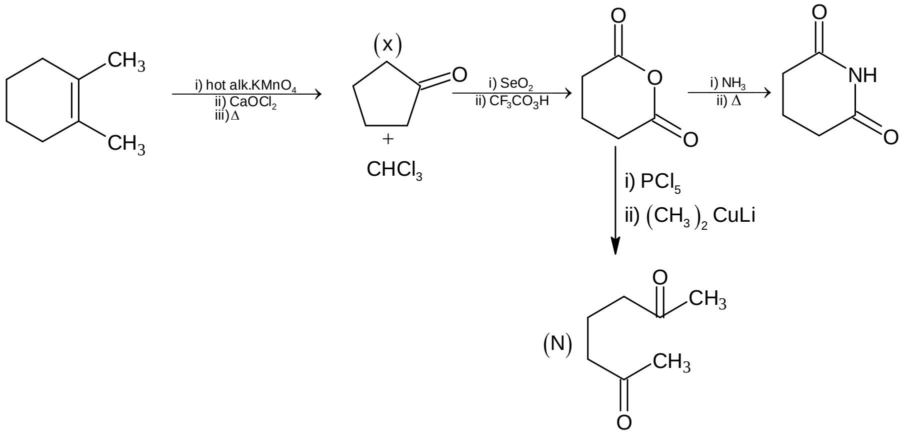
$$PhCHO \xrightarrow{\text{Tollens}} PhCOO^-$$

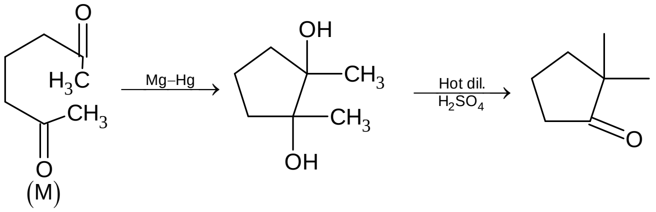
31.

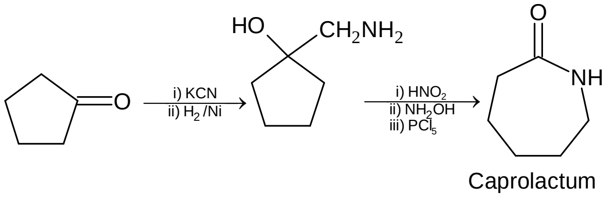


$$CH_3-CH_2-C\equiv N \xrightarrow{H_3O^+} CH_3-CH_2-COOH \xrightarrow[\text{ii) } H_3O^+]{\text{i) } Cl_2/P_{red}} H_3C-\underset{}{\overset{Cl}{\overset{|}{C}}}H-COOH \xrightarrow{NH_3} H_3C-\overset{NH_2}{\overset{|}{C}}H-COOH$$

33.


CH3
CH3
i) hot alk.KMnO4
ii) CaOCl2
iii) Δ
(x)
O
+
CHCl3
i) SeO2
ii) CF3CO3H
O
O
O
i) NH3
ii) Δ
O
NH
O
i) PCl5
ii) (CH3)2 CuLi
(N)
O
CH3
CH3
O

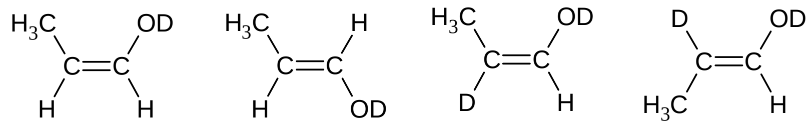

O
H3C
CH3
O
(M)
Mg–Hg
OH
CH3
CH3
OH
Hot dil.
H2SO4
O


O
i) KCN
ii) H2/Ni
HO
CH2NH2
i) HNO2
ii) NH2OH
iii) PCl5
O
NH
Caprolactum

Polymer of caprolactum → Nylon – 6

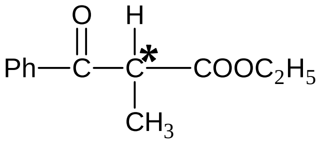
SECTION – C

34.

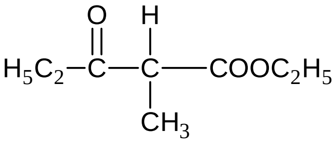


H3C
OD
C=C
H
H
H3C
H
C=C
H
OD
H3C
OD
C=C
D
H
D
OD
C=C
H3C
H

35.

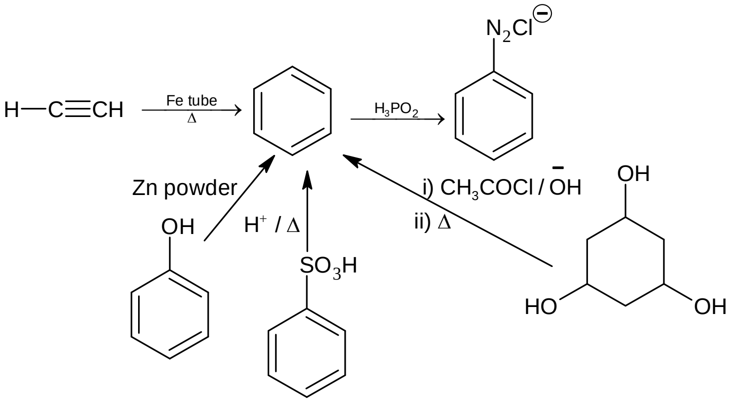


$Ph-\overset{O}{\overset{||}{C}}-\overset{H}{\underset{CH_3}{C^*}}-COOC_2H_5$



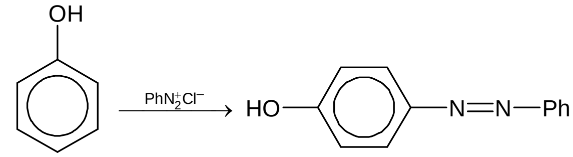
$H_5C_2-\overset{O}{\overset{||}{C}}-\overset{H}{\underset{CH_3}{C}}-COOC_2H_5$

36.

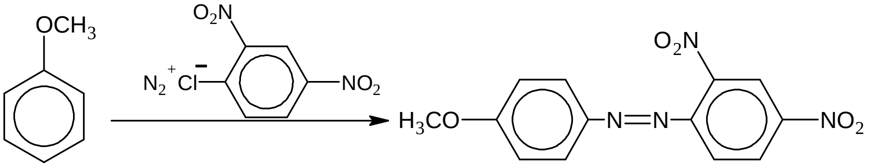


H—C≡CH
Fe tube
Δ
H3PO2
N2Cl⊖
Zn powder
OH
H+ / Δ
SO3H
i) CH3COCl / OH−
ii) Δ
OH
HO
OH

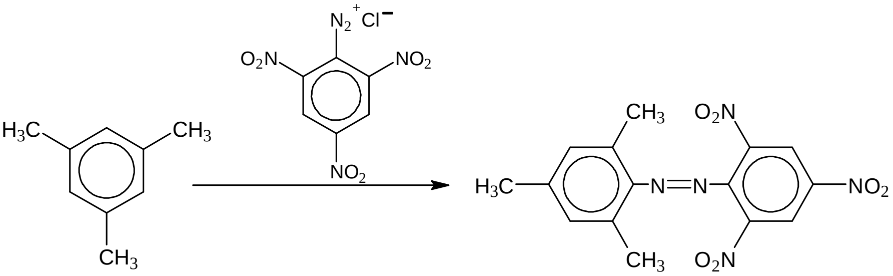
37.



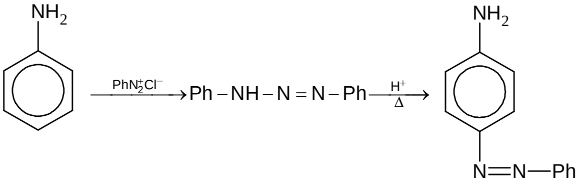
OH
PhN2+Cl−
HO
N=N—Ph



OCH3
O2N
N2+Cl−
NO2
H3CO
N=N
O2N
NO2



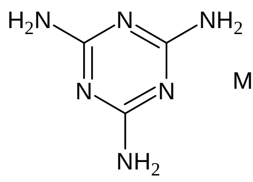
N2+Cl−
O2N
NO2
NO2
H3C
CH3
CH3
CH3
O2N
H3C
N=N
NO2
CH3
O2N



NH2
PhN2+Cl−
Ph – NH – N = N – Ph
H+
Δ
NH2
N=N—Ph

38. Glucose, Fructose and Mannose.

39.

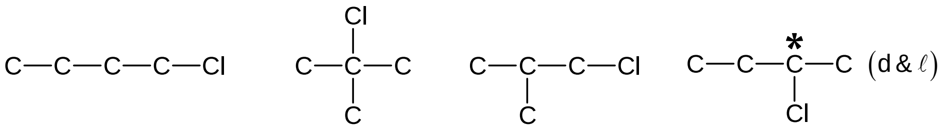

H2N
N
NH2
N
N
NH2

Melamine

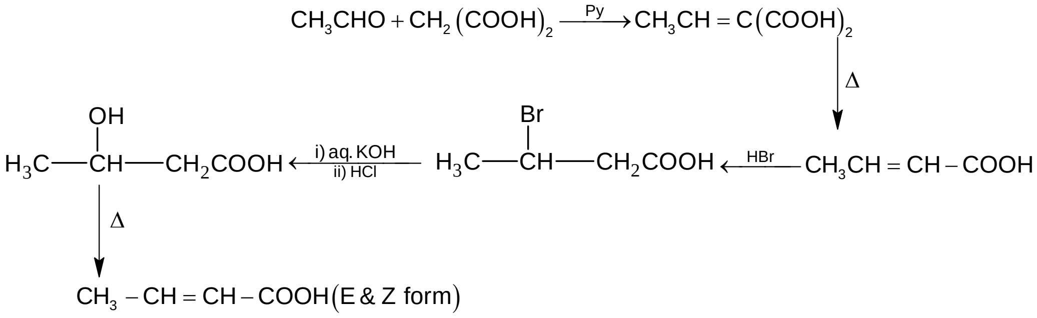
40. Polyethylene, Polystyrene, Poly(methyl(methacrylate)

41. $\frac{160}{56} \times 3.15 = 9$

42.


C—C—C—C—Cl
Cl
C—C—C
C
C—C—C—Cl
C
*
C—C—C—C
Cl
(d & ℓ)

43.


CH3CHO + CH2(COOH)2
Py
CH3CH = C(COOH)2
Δ
CH3CH = CH − COOH
HBr
Br
H3C—CH—CH2COOH
i) aq. KOH
ii) HCl
OH
H3C—CH—CH2COOH
Δ
CH3 − CH = CH − COOH (E & Z form)

SECTION – D

44.

$\alpha - D \longrightarrow x\%$

$\beta - D \longrightarrow (1 - x)$

$90^\circ = (110x - 30x) + 30^\circ$

$x = \frac{60}{80} = \frac{6}{8}$

$\underset{1-x}{\alpha - D} \rightleftharpoons \underset{x}{\beta - D}$

$K_{eq} = \frac{x}{1 - x}$

$\therefore K'_{eq}$ for $\beta - D \rightleftharpoons \alpha - D$ is $\frac{1}{K_{eq}} = \frac{1 - x}{x}$

$\therefore K'_{eq} = \frac{2/8}{6/8} = \frac{2}{6} = \frac{1}{3} = 3.33$

$\therefore 90^\circ = \frac{(x)(110) + (1 - x)30^\circ}{1}$

45. Mili moles of H_2SO_4 initially = 70 × 0.5 = 35
Mili moles of NaOH required = 65 × 0.5 = 32.5
∴ Mili moles of H_2SO_4 consumed = 35 – (32.5/2)
= 18.75

∴ Mili moles NH_3 = 37.5

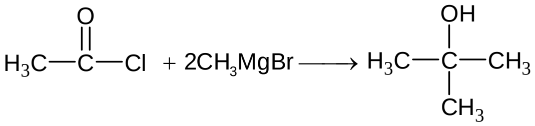
$\therefore W_{NH_3} = \frac{37.5 \times 17}{1000} = 0.6375$ gm

$$\%NH_3 = \frac{0.6375}{1.0} \times 100 = 63.75$$

46. Moles of $CH_3COCl = \frac{78.5}{78.5} = 1.0$ mole

Moles of $CH_3MgBr = \frac{29.75}{119} = 0.25$

$\therefore$ CH_3MgBr is limiting reagent.



$$H_3C-\overset{\overset{O}{\|}}{C}-Cl + 2CH_3MgBr \longrightarrow H_3C-\underset{CH_3}{\overset{OH}{C}}-CH_3$$

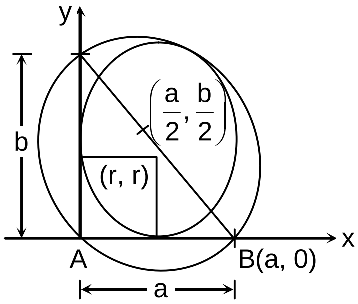
Moles of alcohol = $\frac{0.25}{2}$

Weight of alcohol = $\frac{0.25}{2} \times 74 = 9.25$ gm

Mathematics PART – III

SECTION – A

47. Equation of $S = \left(x-\frac{a}{2}\right)^2 + \left(y-\frac{b}{2}\right)^2 = \frac{a^2+b^2}{4}$



$x^2 + y^2 - ax - by = 0$
And circle with centre (r, r) and radius r
Touches AB and AC its equation is
$(x - r)^2 + (y - r)^2 = r^2$
$x^2 + y^2 - 2xr - 2yr + r^2 = 0$
Both circle touches internally or externally
Using $\sqrt{\left(r-\frac{a}{2}\right)^2 + \left(r-\frac{b}{2}\right)^2} = \sqrt{\left(\frac{a^2}{4}+\frac{b^2}{4}\right)} \pm r$

$\Delta ABC = \frac{r_1 r_2}{4}$

48. Equation of tangent at (i, y_j)
$y = (2i + b)x - i^2 + c$
Also at $(i + 1, y_{i+1})$, $y = (2(i + 1) + b)x - (i + 1)^2 + c$
Point of intersection is $x = \frac{2i+1}{2} \Rightarrow i = \frac{2x-1}{2}$
Put this i in any tangent, we get $y = x^2 + bx + c - \frac{1}{4}$

49. Equation of tangent is $y = 4x \pm \sqrt{16a^2 + b^2}$ this normal passes through (–2, 0)
$\Rightarrow 0 = -8 \pm \sqrt{16a^2+b^2}$; $264 = 16a^2 + b^2$
Giving AM $\geq$ GM
$\frac{16a^2+b^2}{2} \geq \sqrt{16a^2b^2}$
$\frac{64}{2} \geq \sqrt{16a^2b^2}$
$4ab \leq 32$
$ab \leq 8$

50. Equation of tangent at A is $4x - 3y - 8 = 0$
Let $y = m(x - 2)$ a line thro (2, 0) and $m = -7$ or $\frac{1}{7}$
We have $\frac{x-2}{-\frac{1}{\sqrt{50}}} = \frac{y}{\frac{7}{\sqrt{50}}} = 5\sqrt{2}$
$\Rightarrow$ Centre of circle are (1, 7), (3, –7), (9, 1) and (–5, –1)

51. Normal at $P(x_1 y_1)$
$y - y_1 = \frac{-1}{m}(x - k_1)$
Where $y = 0$, $x = x_1 + my_1$
We have $|x_1 + my_1| = 2|x_1|$

$\Rightarrow x_1 + my_1 = \pm 2x_1$

Case-I: $x_1 + my_1 = 2x_1 \Rightarrow m = \frac{x_1}{y_1}$

$\Rightarrow \frac{dy}{dx} = \frac{x}{y} \quad \left(\because m = \left(\frac{dy}{dx}\right)_{\text{at}\,(x_1y_1)}\right)$

$\Rightarrow x\,dx - y\,dy = 0;\ \frac{x^2}{2} - \frac{y^2}{2} = C - a$ hyperbola

Case-II: $x_1 + my_1 = -2x_1;\ m = \frac{-3x_1}{y_1}$

$y\frac{dy}{dx} + 3x = 0$

$\Rightarrow \frac{y^2}{2} + \frac{3x^2}{2} = C$ (Ellipse)

52. Given equation can be written as $\frac{4x}{x^4 + x^2 - 4} - \frac{4}{x} = 0$

$\Rightarrow x = \pm\sqrt{2}$

53. Equation can be written as cos 2x(cos 4x + cos 2x) = 0
$\Rightarrow$ 2 cos x cos 2x cos 3x = 0

54. Equation of normal to hyperbola $xy = c^2$ at $\left(ct, \frac{c}{t}\right)$ which passes through (h, k) is

$ct^4 - ht^3 + kt - c = 0$
Roots of this equation is t_1, t_2, t_3 and t_4
Let equation of circle be $x^2 + y^2 - 2gx - 2fy + p = 0$
If $\left(ct, \frac{c}{t}\right)$ lies on this $c^2t^4 - 2gct^3 + pt^2 - 2fct + c^2 = 0$

Its roots are t_1 t_2 t_3 and t_4'

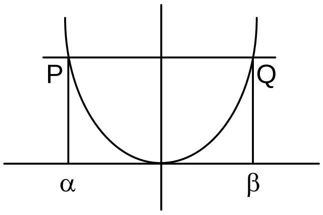
We get $t_4 = -t_4'$ also $\frac{c}{t_4} - \frac{c}{t_4'} = k - 2f$

So locus of centre is $4c^2 = (h - 2g)(k - 2f)$

Centre lies on hyperbola $\left(x - \frac{h}{2}\right)\left(y - \frac{k}{2}\right) = c^2$

$c\left(\frac{h}{2}, \frac{k}{2}\right)$ and $c = \sqrt{2}$

55.-56. Any two point on $y = x^2$ is $P(\alpha, \alpha^2); Q(\beta, \beta^2)$



Equation of PQ, $y - \alpha^2 = (\alpha + \beta)(x - \alpha)$
$y = (\alpha + \beta)x - \alpha\beta$
Required area $\int_{\alpha}^{\beta}\left((\alpha + \beta)x - \alpha\beta - x^2\right)dx$
$\Rightarrow \beta - \alpha = 2$
Pair of tangents from origin are $y = 2x$ and $y = -2x$
Area $\int_{0}^{1}\left(\left(x^2 + 1\right) - 2x\right)dx = \frac{2}{3}$

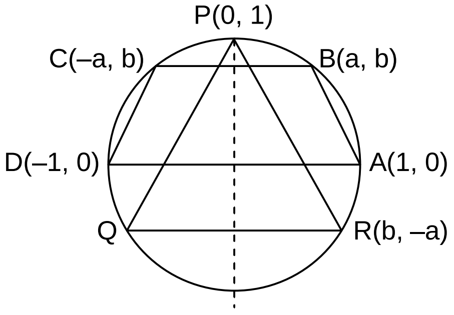
SECTION – C

57. As $\ell_1^2 + \ell_2^2 = (SS_1)^2$ (S, S_1 are focii of ellipse)

58. Suppose normals at α, β and γ are concurrent at (h, k) and let S be the foot of the fourth normals from (h, k), then we have, $\sum \tan\frac{\alpha}{2}\tan\frac{\beta}{2} = 0$ and $\tan\frac{\alpha}{2}\tan\frac{\beta}{2}\tan\frac{\gamma}{2}\tan\frac{\delta}{2} = -1$

Eliminating $\tan\frac{\delta}{2}$ from above, we will get sin(α + β) + sin(β + γ) + sin(γ + α) = 0

59. Let circle is $x^2 + y^2 = 1$



Equation of AB $y = \frac{b}{a-1}x + 1$ and $a^2 + b^2 = 1$

$\Rightarrow b^2 = (1 - a)(1 + a)$ or $\frac{b}{1-a} = \frac{1+a}{b}$

So equation of line $y = \frac{-1(1+a)}{b}x + 1$

So area of Δ = b + ab
So ratio is 1

60. Apply AM ≥ GM

$$\frac{(\sin x)^{2y}}{(\cos x)^{\frac{y^2}{2}}} + \frac{(\cos x)^{2y}}{(\sin x)^{\frac{y^2}{2}}} = 2(\sin x \cdot \cos x)^{y - \frac{y^2}{4}}$$

It follows that sin 2x ≥ $2(\sin x \cdot \cos x)^{y - \frac{y^2}{4}}$

$\because$ sin x·cos x < 1 $\Rightarrow 1 \le y - \frac{y^2}{4}$ or $\left(1 - \frac{y}{2}\right)^2 \le 0$

$\Rightarrow$ y = 2 and sin x = cos x

So there is a unique solution $x - \frac{\pi}{4}$, y = 2

61. Let P = cos x cos 2x·cos 3x ..... cos 999x and Q = sin x sin 2x sin 3x ..... sin 999x
$PQ \cdot 2^{999}$ = sin 2x sin 4x sin 6x ..... sin 1998x
= (sin 2x·sin 4x ..... sin 998x)(–sin(2π – 1000x)(–sin(2π – 1002x) ..... [–sin(2π – 1998x)]
= sin 2x·sin 4x ..... sin 998x·sin999x·sin997x ..... sin x = Q
$P = \frac{1}{2^{999}}$ (Q ≠ 0)

62. Equation of normal at $(t^2, 2t)$ is $y = -xt + 2t + t^3$
Let any point on y = 2 is (h, 2)
If normal passes through (h, 2)
$2 + ht - 2t - t^3 = 0$
$t^3 - t(h - 2) - 2 = 0$
t_1, t_2 and t_3 are points of this equation vertices lies on xy = –2

63. $$\frac{\sin(A+B-C)\cdot\cos(A-B+C)}{\sin(A-B+C)\cos(A+B-C)} = \frac{\sin C\cos B}{\sin B\cos C}$$

$$\Rightarrow \frac{\sin 2A + \sin(2B-2C)}{\sin 2A - \sin(2B-2C)} = \frac{\sin C\cos B}{\cos B\sin C}$$

Use C and D rule will get sin 2A + sin 2B + sin 2C = 0

64. Let P(x_1, y_1) equation of chord of contact $yy_1 = 8(x + x_1)$

Equation of line perpendicular to this and passes through P is $y - y_1 = \frac{-y_1}{8}(x - x_1)$

This touches $x^2 = 12y$
$\Rightarrow$ Locus is $8x + 3y + 64 = 0$

65. Let point $\left(2t_1, t_1^2\right)$ and $\left(2t_2, t_2^2\right)$ be the extremities of focal chord

$\Rightarrow t_1t_2 = -1$

Equation of focal chord $x(t_1 + t_2) - 2y + 2 = 0$ and line $y = mx + \sqrt{m^2 - \frac{1}{4}}$ is tangent to hyperbola passes through (0, a)

$\Rightarrow m = \pm\sqrt{1 + \frac{1}{4}} = t_1 + t_2$

Length of focal chord = 9

66. Given equation can be written as $x^2 - 3 = 3\left[\sin\left(x - \frac{\pi}{6}\right)\right]$

Hence, $x^2 - 3 = -3, 0, 3$
$\Rightarrow x = 0,\ x = \sqrt{3}$ is only solution

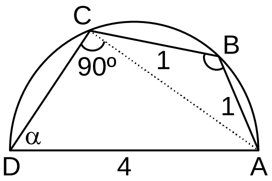
SECTION – D

67. Let $\angle ADC = \alpha$ and AC = x
By Cosine Rule

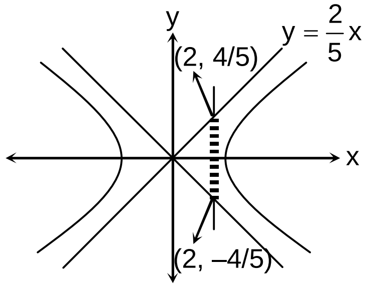
$x^2 = 1 + 1 - 2(1)(1)\cos(180^\circ - \alpha) = 2 + 2\cos\alpha = 2 + 2\cdot\frac{CD}{4}$

$= 2 + \frac{1}{2}\sqrt{16 - x^2} \Rightarrow x = \frac{\sqrt{15}}{2} \Rightarrow CD = \sqrt{16 - x^2} = \frac{7}{2}$

Perimeter = $4 + 2 + \frac{7}{2} = \frac{19}{2} = 9.50$



68. Shown in the figure
$\alpha \in (-4/5, 4/5)$



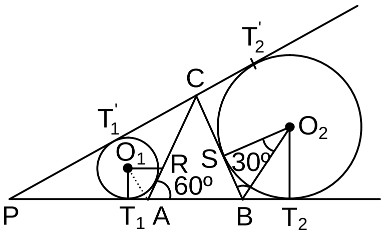
69. $\angle T_1O_1R = 60^\circ$ and $\angle AO_1R = 30^\circ$
Similarly $\angle BO_2S = 30^\circ$
$T_1T_2 = T_1A + AB + BT_1 = RA + RB + SB$

$= r_1 \tan 30^\circ + a + r_2 \tan 30^\circ = \frac{r_1 + r_2}{\sqrt{3}} + a$

and $T_1'T_2' = T_1'C + T_2'C = a - RA + a - BS = 2a - \frac{r_1 + r_2}{\sqrt{3}}$

Since common external tangents are equal $T_1T_2 = T_1'T_2'$

$\Rightarrow r_1 + r_2 = \frac{\sqrt{3}a}{2}$



FIITJEE **JEE (Main)-2018**

ALL INDIA TEST SERIES

PART TEST – II

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 – 30, 31 – 60, 61 – 90)** *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

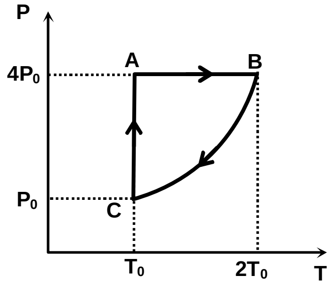
Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics PART – I

SECTION – A
(One Options Correct Type)

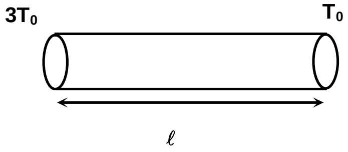
This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. Two moles of an ideal monoatomic gas is taken through a cyclic process as shown in the P-T diagram. In the process BC, PT^{-2} = constant. Then the ratio of heat absorbed and heat released by the gas during the process AB and process BC respectively is



(A) 2 (B) 3
(C) 5 (D) 6

2. Two ends of a rod of uniform cross sectional area are kept at temperatures $3T_0$ and T_0 as shown. Thermal conductivity of rod varies as $k = \alpha T$, (where α is a constant and T is absolute temperature). In steady state, the temperature of the middle section of the rod is



(A) $\sqrt{7}T_0$ (B) $\sqrt{5}T_0$
(C) $2T_0$ (D) $\sqrt{3}T_0$

3. An ideal gas is taken through a process $PT^3 =$ constant. The coefficient of thermal expansion of the gas in the given process is
(A) 1/T (B) 2/T
(C) 3/T (D) 4/T

4. 4 kg of ice at −20°C is mixed with 5 kg of water at 40°C. The water content in the equilibrium mixture is (S_{water} = 1kcal/kg-C, S_{ice} = 0.5 kcal/kg-c, $L_{f(water)}$ = 80 kcal/kg)
(A) 6 kg (B) 7 kg
(C) 8 kg (D) 9 kg

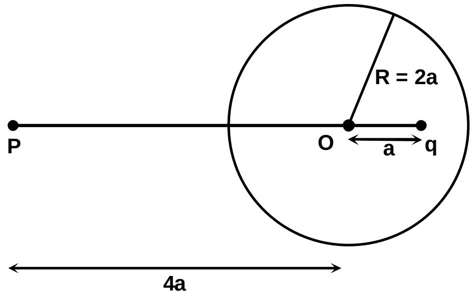
Space for Rough work

5. The molar heat capacity of an ideal gas in a process varies as $C = C_V + \alpha T^2$(where C_V is molar heat capacity at constant volume and α is a constant). Then the equation of the process is

(A) $Ve^{-\left(\frac{\alpha T^2}{2R}\right)} =$ constant (B) $Ve^{-\left(\frac{\alpha T^2}{R}\right)} =$ constant

(C) $Ve^{-\left(\frac{2\alpha T^2}{R}\right)} =$ constant (D) $Ve^{-\left(\frac{3\alpha T^2}{2R}\right)} =$ constant

6. A point charge 'q' is placed at distance 'a' from the centre of an uncharged thin spherical conducting shell of radius R = 2a. A point 'P' is located at a distance '4a' from the centre of the conducting shell as shown. The electric potential due to induced charge on the inner surface of the conducting shell at point 'P' is



(A) $\frac{kq}{5a}$ (B) $-\frac{kq}{5a}$

(C) $\frac{kq}{4a}$ (D) $-\frac{kq}{4a}$

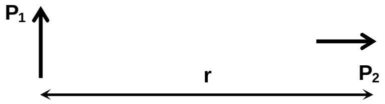
7. A solid sphere of radius 'R' density 'ρ', and specific heat 'S' initially at temperature T_0 Kelvin is suspended in a surrounding at temperature 0K. Then the time required to decrease the temperature of the sphere from T_0 to $\frac{T_0}{2}$ Kelvin is (Assume sphere behaves like a black body)

(A) $\frac{\rho SR}{9\sigma T_0^3}$ (B) $\frac{5\rho SR}{9\sigma T_0^3}$

(C) $\frac{7\rho SR}{9\sigma T_0^3}$ (D) $\frac{8\rho SR}{9\sigma T_0^3}$

Space for Rough work

8. Two point electric dipoles with dipole moments ‘P_1’ and ‘P_2’ are separated by a distance ‘r’ with their dipole axes mutually perpendicular as shown. The force of interaction between the dipoles is $\left(\text{where, } k = \frac{1}{4\pi\varepsilon_0}\right)$



(A) $\frac{2kP_1P_2}{r^4}$ (B) $\frac{3kP_1P_2}{r^4}$

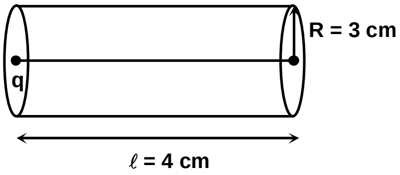
(C) $\frac{4kP_1P_2}{r^4}$ (D) $\frac{6kP_1P_2}{r^4}$

9. 4 moles of an ideal monoatomic gas is heated isobarically so that its absolute temperature increases 2 times. Then the entropy increment of the gas in this process is

(A) 285. J/k (B) 42.5 J/k

(C) 57.5 J/k (D) 76.5 J/k

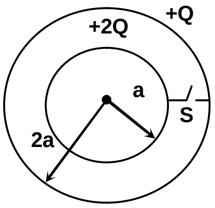
10. A point charge ‘q’ is placed at the centre of left circular end of a cylinder of length ℓ = 4 cm and radius R = 3 cm as shown. Then the electric flux through the curved surface of the cylinder is



(A) $\frac{q}{5\varepsilon_0}$ (B) $\frac{2q}{5\varepsilon_0}$

(C) $\frac{3q}{5\varepsilon_0}$ (D) $\frac{4q}{5\varepsilon_0}$

11. Two concentric spherical conducting shells of radii ‘a’ and ‘2a’ are initially given charges +2Q and +Q respectively as shown. The total heat dissipated after switch ‘S’ has been closed is (where $k = \frac{1}{4\pi\varepsilon_0}$)

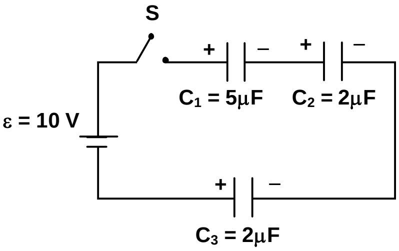


(A) $\frac{5kQ^2}{4a}$ (B) $\frac{kQ^2}{a}$

(C) $\frac{kQ^2}{2a}$ (D) $\frac{kQ^2}{4a}$

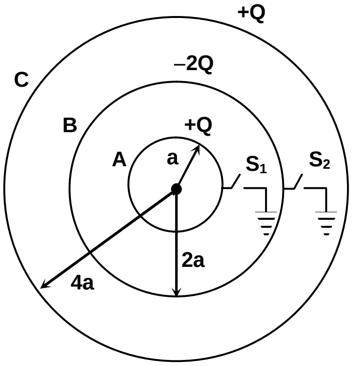
Space for Rough work

12. Three capacitors of capacitances 5 μF, 2μF and 2 μF are charged to 20 V, 30 V and 10 V respectively and then connected in the circuit with polarities as shown. The magnitude of charge flown through the battery after closing the switch 'S' is



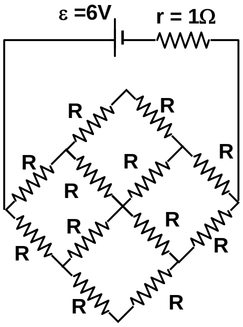
(A) 25 μC
(B) 40 μC
(C) 50 μC
(D) 75 μC

13. Three concentric spherical conducting shells A, B and C of radii a, 2a and 4a are initially given charges +Q, –2Q and +Q respectively. The charge on the middle spherical shell 'B' after switches S_1 and S_2 are simultaneously closed, will be



(A) –Q
(B) $-\frac{Q}{2}$
(C) +Q
(D) $\frac{+3Q}{2}$

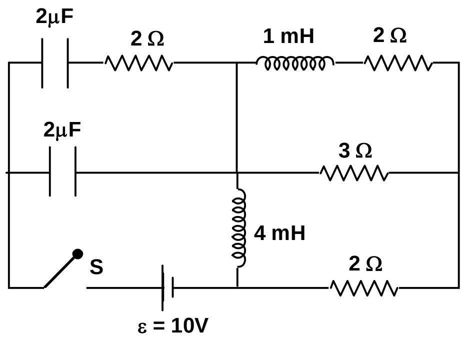
14. In the circuit shown the cell will deliver maximum power to the network if the value of 'R' is



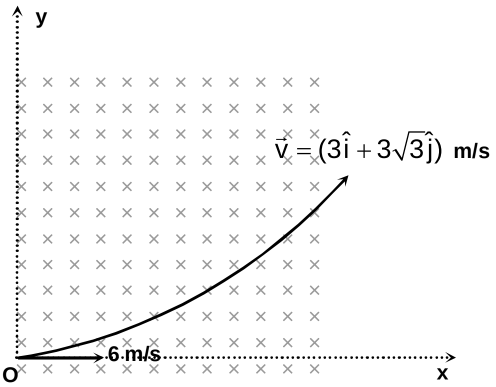
(A) $\frac{2}{3}\Omega$
(B) $\frac{4}{3}\Omega$
(C) $\frac{1}{3}\Omega$
(D) $\frac{5}{3}\Omega$

Space for Rough work

15. In the circuit shown, all the capacitors are initially uncharged. The current through the battery just after closing the switch 'S' is
(A) 2 A
(B) 4 A
(C) 5 A
(D) 10 A

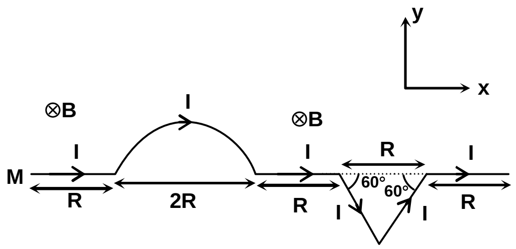


16. A particle of charge 'q' and mass 'm' enters a uniform magnetic field region $\vec{B} = -B\hat{k}$ at origin 'O' with a velocity $\vec{v}_0 = 6\hat{i}$ m/s and after some time it exits the magnetic field region with a velocity $\vec{v} = (3\hat{i} + 3\sqrt{3}\hat{j})$ m/s as shown. The time interval for which the particle has moved in the magnetic field region is



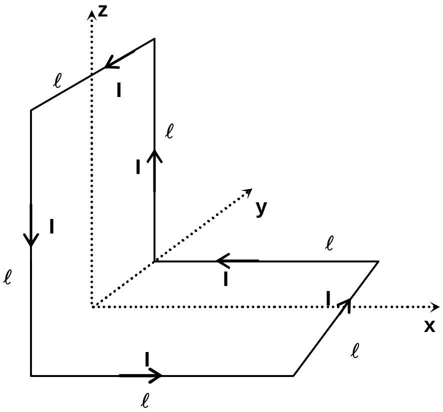
(A) $\frac{\pi m}{qB}$
(B) $\frac{\pi m}{2qB}$
(C) $\frac{\pi m}{3qB}$
(D) $\frac{\pi m}{4qB}$

17. A conducting wire MN carrying a current I is bent into the shape as shown and placed in xy plane. A uniform magnetic field $\vec{B} = -B\hat{k}$ is existing in the region. The net magnetic force experienced by the conducting wire MN is
(A) 2BIR
(B) 3BIR
(C) 4BIR
(D) 6BIR



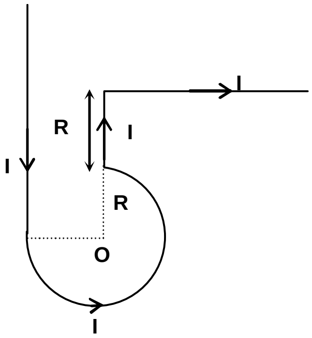
Space for Rough work

18. A conducting loop carrying current 'I' is bent into two halves and placed in mutually perpendicular planes xy and yz planes as shown. A uniform magnetic field $\vec{B} = B\hat{j}$ is existing in the region. The net magnetic torque experienced by the loop is



(A) $BI\ell^2(\hat{k} - \hat{i})$
(B) $BI\ell^2(\hat{i} + \hat{j})$
(C) $BI\ell^2(\hat{j} - \hat{k})$
(D) $BI\ell^2(\hat{i} + \hat{k})$

19. A conducting wire carrying a current I is bent into the shape as shown. The net magnetic field at the centre 'O' of the circular arc of radius 'R' is



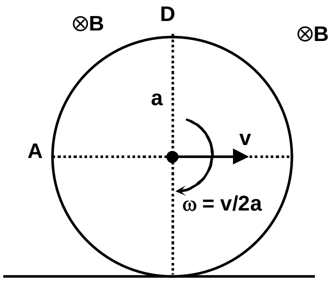
(A) $\frac{\mu_0 I}{2R}\left(\frac{1+3\pi}{\pi}\right)$ (B) $\frac{\mu_0 I}{4R}\left(\frac{1+3\pi}{\pi}\right)$
(C) $\frac{\mu_0 I}{8R}\left(\frac{1+3\pi}{\pi}\right)$ (D) $\frac{\mu_0 I}{8R}\left(\frac{2+3\pi}{\pi}\right)$

20. An infinitely long cylindrical wire of radius 'R' is carrying a current with current density $j = \alpha r^3$ (where α is constant and 'r' is the radial distance from the axis of the wire). If the magnetic field at $r = \frac{R}{2}$ is 'B_1' and at r = 2R is 'B_2' then the ratio $\frac{B_2}{B_1}$ is

(A) 2 (B) 4
(C) 6 (D) 8

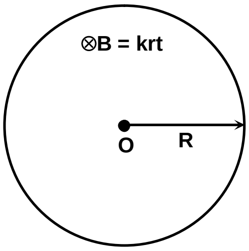
Space for Rough work

21. A circular conducting ring of radius ‘a’ is rolling with slipping on a horizontal surface as shown. A uniform magnetic field ‘B’ is existing perpendicular to the plane of motion of the ring. The emf induced between the points ‘A’ and ‘D’ of the ring is



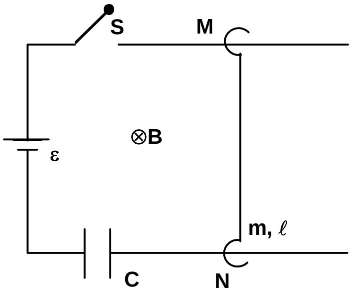
(A) $B\omega a^2$ (B) $2\,B\omega a^2$
(C) $4\,B\omega a^2$ (D) $6\,B\omega a^2$

22. A time varying magnetic field B = krt (where k is a constant, r is the radial distance from centre ‘O’) is existing in a circular region of radius ‘R’ as shown. If induced electric field at $r = \frac{R}{2}$ is E_1 and at r = 2R is E_2 then the ratio $\frac{E_2}{E_1}$ is



(A) 6 (B) 4
(C) 2 (D) 1

23. A conducting rod MN of mass ‘m and length ‘ℓ’ is placed on parallel smooth conducting rails connected to an uncharged capacitor of capacitance ‘C’ and a battery of emf ε as shown. A uniform magnetic field ‘B’ is existing perpendicular to the plane of the rails. The steady state velocity acquired by the conducting rod MN after closing switch S is (neglect the resistance of the parallel rails and the conducting rod)

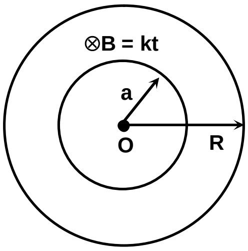


(A) $\frac{2CB\ell\varepsilon}{(m + CB^2\ell^2)}$ (B) $\frac{CB\ell\varepsilon}{(m + CB^2\ell^2)}$

(C) $\frac{CB\ell\varepsilon}{2(m + CB^2\ell^2)}$ (D) $\frac{CB\ell\varepsilon}{4(m + CB^2\ell^2)}$

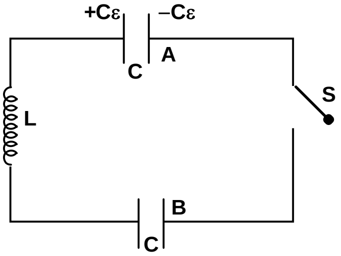
Space for Rough work

24. Charge ‘q’ is uniformly distributed along the length of a non-conducting circular ring of mass ‘m’ and radius ‘a’. The ring is placed concentrically on a rough horizontal circular surface of radius ‘R’. A time varying magnetic field B = kt (where k is constant) is existing perpendicular to the plane of circular region of radius ‘R’ as shown. The minimum coefficient of friction between the ring and the surface required to keep the ring stationary is



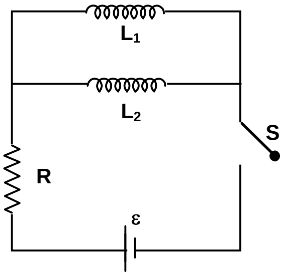
(A) $\frac{2kqa}{mg}$
(B) $\frac{kqa}{mg}$
(C) $\frac{kqa}{2mg}$
(D) $\frac{kqa}{4mg}$

25. Initially capacitor ‘A’ is charged to a potential drop ‘ε’ and capacitor B is uncharged. At t = 0, switch ‘S’ is closed, then the maximum current through the inductor is



(A) $\varepsilon\sqrt{\frac{C}{2L}}$
(B) $\varepsilon\sqrt{\frac{C}{L}}$
(C) $2\varepsilon\sqrt{\frac{C}{L}}$
(D) $\frac{\varepsilon}{2}\sqrt{\frac{C}{L}}$

26. In the circuit shown, switch’s is closed at t = 0. Then the ratio $\frac{U_1}{U_2}$ of potential energy stored in the inductors L_1 and L_2 in steady state is

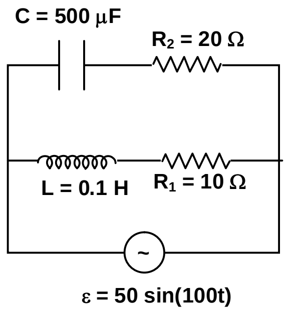


(A) $\frac{L_1}{L_2}$
(B) $\frac{L_2}{L_1}$
(C) $\left(\frac{L_1}{L_2}\right)^2$
(D) $\left(\frac{L_2}{L_1}\right)^2$

Space for Rough work

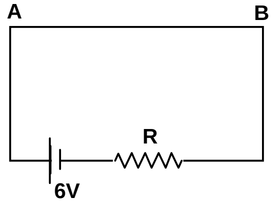
27. In the circuit shown the average power developed in the resistor ‘R_1’ is

(A) 31.25 W (B) 62.50 W
(C) 125 W (D) 250 W



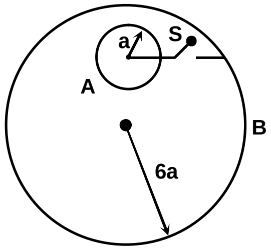
28. A uniform potentiometer wire AB of length 100 cm has a resistance of 5 Ω and it is connected in series with an external resistance ‘R’ and a cell of emf 6V and negligible internal resistance. If a source of potential drop 2V is balanced against a length of 60 cm of the potentiometer wire, the value of resistance ‘R’ is

(A) 1Ω (B) 2Ω
(C) 4Ω (D) 6Ω



29. A small spherical conductor ‘A’ of radius ‘a’ is initially charged to a potential ‘V’ and then placed inside an uncharged spherical conducting shell ‘B’ of radius ‘6a’ as shown. The potential of the spherical conductor ‘A’ after closing the switch ‘S’ is

(A) V (B) $\frac{V}{3}$
(C) $\frac{V}{2}$ (D) $\frac{V}{6}$



30. Two moles of an ideal diatomic gas is taken through a process VT^2 = constant so that its temperature increases by ΔT = 300 K. The ratio $\left(\frac{\Delta U}{\Delta Q}\right)$ of increase in internal energy and heat supplied to the gas during the process is

(A) 2 (B) 3
(C) 4 (D) 5

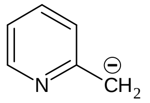
Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

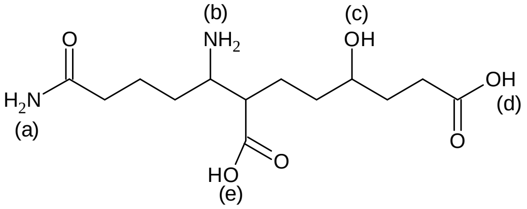
31. The number of resonating structures possible for



are?

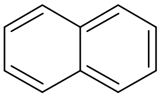
(A) 4 (B) 5
(C) 3 (D) 6

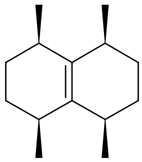
32. The most acidic portion among the following is:

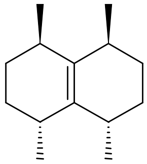


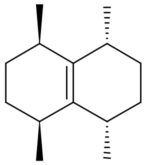
(A) a (B) c
(C) e (D) b

33. Which one of the following does not contain centre of symmetry?

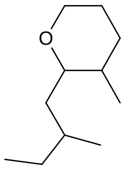
(A)


(B)


(C)


(D)


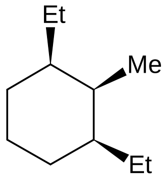
34. The total number of optical isomers possible for this compound are?

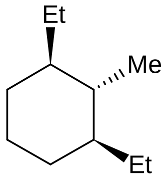


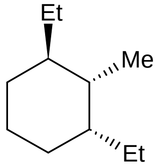
(A) 9 (B) 8
(C) 10 (D) 16

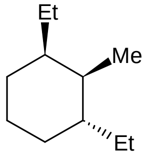
Space for Rough work

35. Which of the following has the least negative heat of combustion?

(A)


(B)


(C)


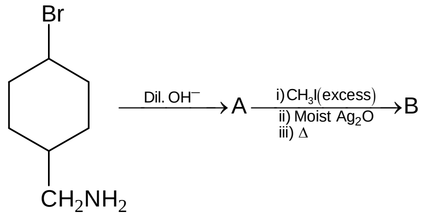
(D)


36. Which of the following agents is responsible for generating chlorine radicals into stratosphere?

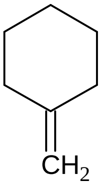
(A) Smog
(B) NO_2
(C) UV radiation
(D) CFC

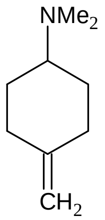
37. Which one is a copolymer?

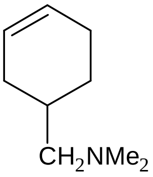
(A) PVC
(B) Polypropene
(C) Polystyrene
(D) Glyptal

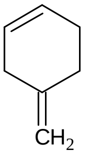
38.

Br
CH2NH2
Dil. OH⁻
A
i) CH3I(excess)
ii) Moist Ag2O
iii) Δ
B

Identify the product in the following sequence of reaction?

(A)


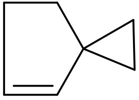
(B)


(C)


(D)


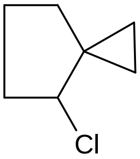
Space for Rough work

39. Major product obtained by the following reaction is

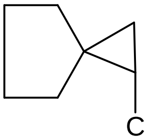


$+ \text{HCl} \longrightarrow$

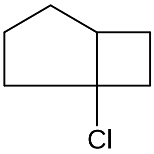
(A)



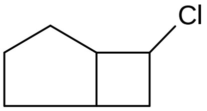
(B)



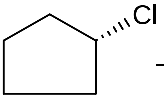
(C)



(D)

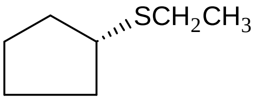


40. What could be the product(s) for the following S_N1 reaction?

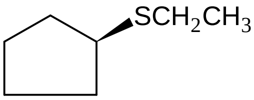


$\xrightarrow[S_N1]{CH_3CH_2S^-} \text{Product(s)} + Cl^-$

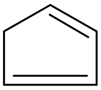
i)



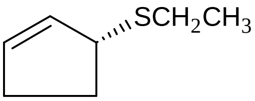
ii)



iii)



iv)

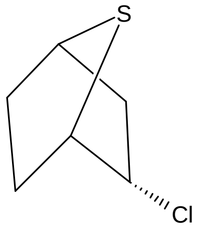


(A) i, ii
(B) i, iii
(C) iii, iv
(D) ii, iii

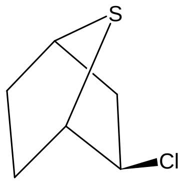
Space for Rough work

41. Identify the correct rate of hydrolysis

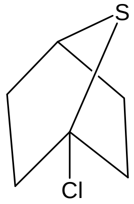
i)



ii)

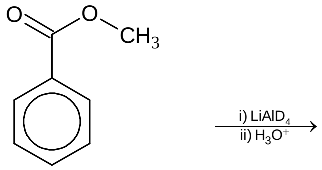


iii)



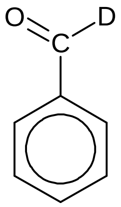
(A) i > ii > iii (B) ii > iii > i
(C) i > iii > ii (D) iii > i > ii

42.

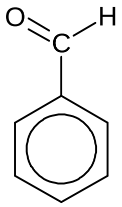

O
O
CH3
i) LiAlD4
ii) H3O+

Choose the major product of the following reaction?

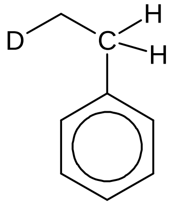
(A)



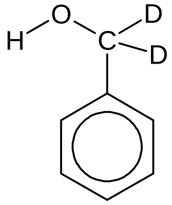
(B)



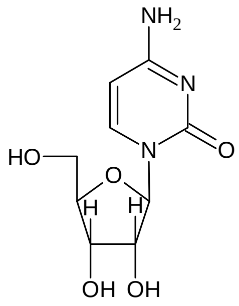
(C)



(D)

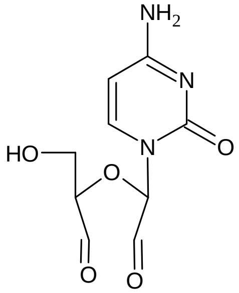


43.

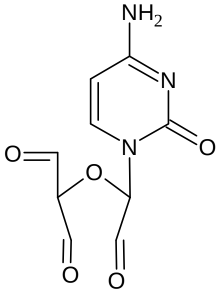


$\xrightarrow{HIO_4}$ Product is

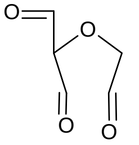
(A)



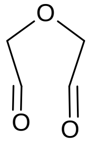
(B)



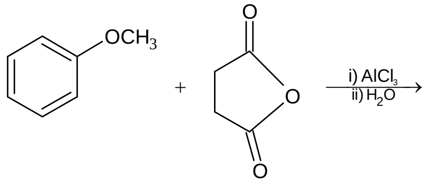
(C)



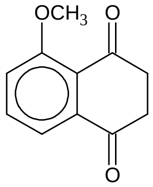
(D)



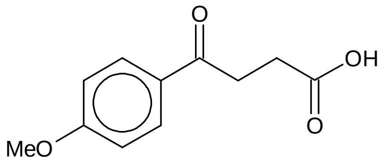
44. What could be the product for the following reaction?



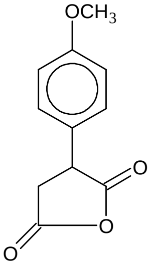
(A)



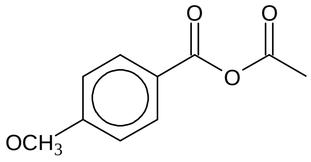
(B)

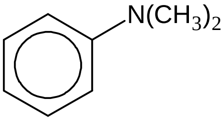


(C)

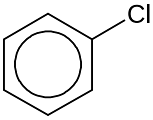


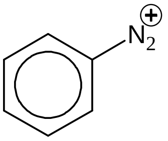
(D)

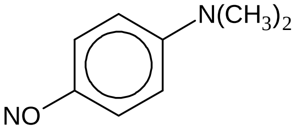


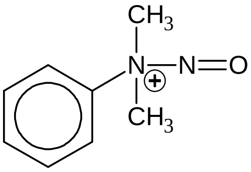
45. 

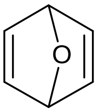
$\xrightarrow[HCl]{NaNO_2}$ Product?

(A) 

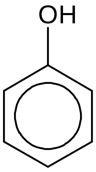
(B) 

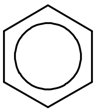
(C) 

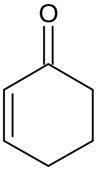
(D) 

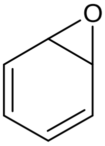
46. 

$\xrightarrow[H_2SO_4/\Delta]{Conc.}$ Identify product?

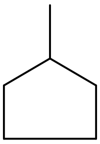
(A) 

(B) 

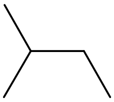
(C) 

(D) 

47. Consider the following reaction:



$\xrightarrow[h\nu]{Cl_2}$ Total number of mono chlorinated product = x



$\xrightarrow[h\nu]{Cl_2}$ Total number of mono chlorinated product = y

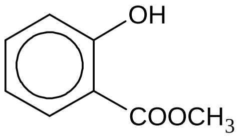
(Excluding stereoisomer)

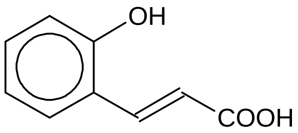
Identify value of x + y?

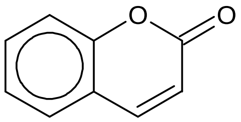
(A) 13
(B) 14
(C) 12
(D) 16

Space for Rough work

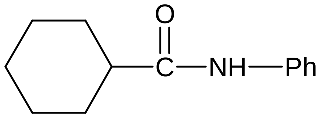
48. When o-hydroxybenzaldehyde is heated with ethanoic anhydride in the presence of sodium ethanoate, compound formed during the reaction is?

(A)


(B)


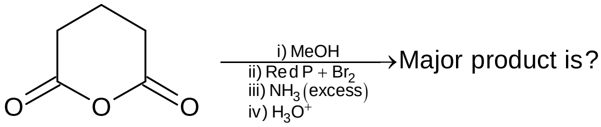
(C)


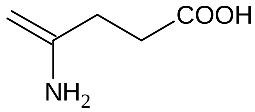
(D) Both B and C

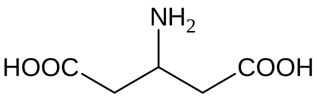
49. The IUPAC name of


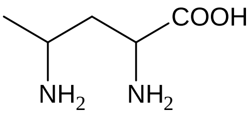
is

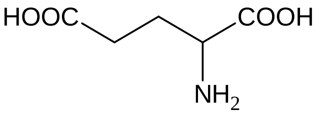
(A) N-cyclohexylbenzene
(B) N-Phenyl-N-cyclohexyl methanamide
(C) N-Phenylcyclohexanecarboxamide
(D) N-cyclohexyl-N-phenyl methyl amide

50.

O
O
O
i) MeOH
ii) Red P + Br2
iii) NH3 (excess)
iv) H3O+
Major product is?

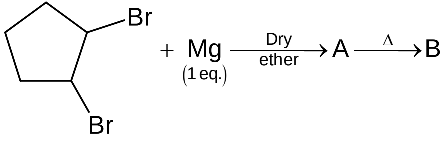
(A)


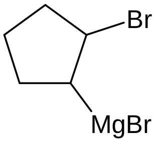
(B)

NH2
HOOC
COOH

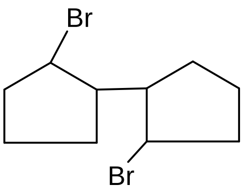
(C)

COOH
NH2
NH2

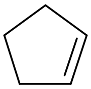
(D)

HOOC
COOH
NH2

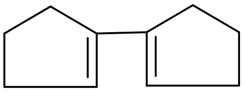
51. In the following reaction, compound (B) is


Br
Br
+ Mg
(1 eq.)
Dry
ether
A
Δ
B

(A)


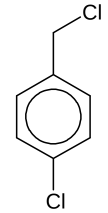
(B)


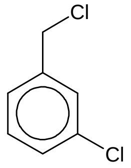
(C)


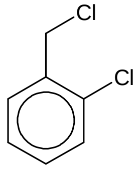
(D)


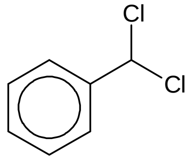
Space for Rough work

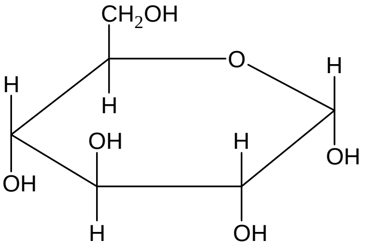
52. An aromatic compound (A), $C_7H_6Cl_2$ gives AgCl on boiling with alcoholic $AgNO_3$ soln. and yields C_7H_7OCl on treatment with NaOH. (A) on oxidation gives a monochlorobenzoic acid which affords only one monoderivative on nitration. The compound (A) is

(A)


(B)


(C)


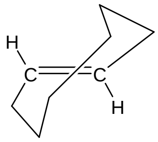
(D)


53.

CH2OH
O
H
H
H
OH
H
OH
OH
H
OH
H

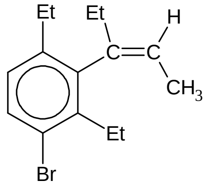
$\xrightarrow[H_2O]{Br_2}(A)$; number of chiral centre in compound (A) is :

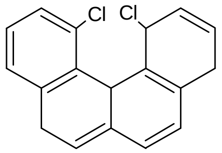
(A) 3
(B) 5
(C) 4
(D) 6

54. Which of the following is an optically inactive compound?

(A)


(B) *Cis*-1,2-dimethylcyclohexane

(C)

Et
Et
H
C
C
CH3
Et
Br

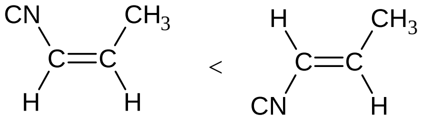
(D)


Space for Rough work

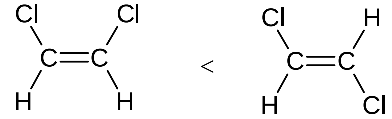
55. Which of the following options is incorrect?

(A) pK_{a_1} cis but-2-ene dioic acid > Trans but-2-ene dioic acid

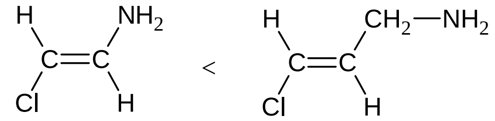
(B) Dipole moment



(C) Stability



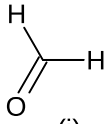
(D) Basicity



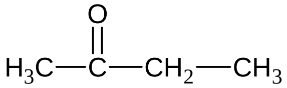
56. An optically active compound (A) has the molecular formula C_6H_{10}. The compound gives a ppt. when treated with $Ag(NH_3)_2OH$. On catalytic hydrogenation, A yields $B(C_6H_{14})$ which is only optically inactive. Identify the total number of αH in product formed by treatment of A with O_3/H_2O_2 then LAH and then $H^{\oplus} / \Delta$.

(A) 7 (B) 6
(C) 8 (D) 9

57. How many compounds will give Cannizzaro reaction?

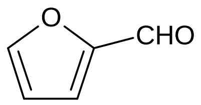


(i)



$H_3C-\overset{\overset{\displaystyle O}{\|}}{C}-CH_2-CH_3$

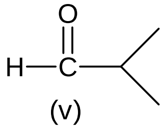
(ii)



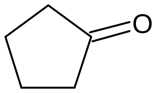
(iii)

OHC—CHO

(iv)



(v)

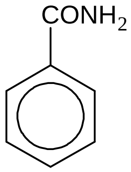


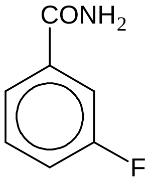
(vi)

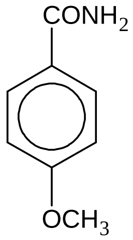
(A) 2 (B) 3
(C) 4 (D) 5

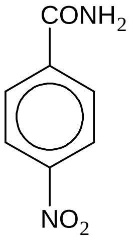
Space for Rough work

58. Which of the following can undergo Hofmann Bromamide reaction most easily?

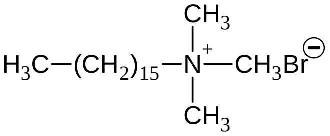
(A)


(B)


(C)


(D)


59. Which of the following is not a surfactant?

(A)


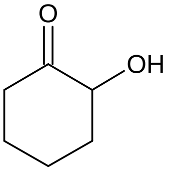
$H_3C-(CH_2)_{15}-\overset{+}{N}(CH_3)_2-CH_3Br^{\ominus}$

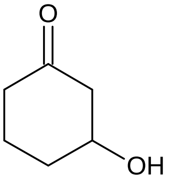
(B) $H_3C-(CH_2)_{14}-NH_2$

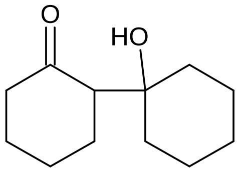
(C) $H_3C-(CH_2)_{16}-CH_2OSO_2^{\ominus}Na^{\oplus}$

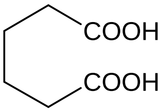
(D) $OHC-(CH_2)_{15}-COO^{\ominus}Na^{\oplus}$

60. When cyclohexanone is treated with Na_2CO_3 soln, we get

(A)


(B)


(C)


(D)


Space for Rough work

Mathematics PART – III

SECTION – A

(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

61. If tan α, tan β are the roots of the equation $x^2 + px + q = 0$, then the value of $\sin^2(\alpha + \beta) + p\sin(\alpha + \beta)\cos(\alpha + \beta) + q\cos^2(\alpha + \beta)$ is
(A) independent of p but dependent on q
(B) independent of q but dependent on p
(C) independent of both p and q
(D) dependent on both p and q

62. If the equation $x^3 - (1 + \cos\theta + \sin\theta)x^2 + (\cos\theta\sin\theta + \cos\theta + \sin\theta)x - \sin\theta\cos\theta = 0$ has roots α, β and γ then $\alpha^2 + \beta^2 + \gamma^2$ is
(A) 2
(B) $\frac{1}{2}$
(C) $\frac{3}{2}$
(D) none of these

63. If $x = \tan(22.5)^o$, then the value of $x^4 + 3x^3 - 3x^2 - 9x + 6$ is
(A) 0
(B) 3
(C) 2
(D) none of these

64. If x and y are non zero real numbers satisfying $xy(x^2 - y^2) = x^2 + y^2$, then the minimum value of $x^2 + y^2$ is
(A) 4
(B) $\frac{1}{4}$
(C) 3
(D) none of these

65. If the roots of $x^2 + ax + b = 0$ are $\sec^2\frac{\pi}{8}$ and $\text{cosec}^2\frac{\pi}{8}$, then which of the following is correct?
(A) $a - b = 0$
(B) $a + b = 0$
(C) $2a = b$
(D) $a = 2b$

Space for rough work

66. In a ΔABC, a semi circle is inscribed, whose diameter lies on the side c. If x is the length of the angle bisector through angle C, then the radius of the semicircle is (where s = semi perimeter and Δ = area of triangle)

(A) $\frac{\Delta}{x}$
(B) $\frac{abc}{2R^2(\sin A + \sin B)}$
(C) $x \sin\frac{C}{2}$
(D) $\frac{2\sqrt{s(s-a)(s-b)(s-c)}}{s}$

67. Let x be the set of all solutions to the equation $\cos x \cdot \sin\left(x + \frac{1}{x}\right) = 0$. Number of real numbers contained by x in the interval ($0 < x < \pi$), is

(A) 0
(B) 1
(C) 2
(D) more than 2

68. Let $f(x) = \frac{\text{cosec}^4 x - 2\,\text{cosec}^2 x + 1}{\text{cosec}\ x(\text{cosec}\ x - \sin x) + \frac{\sin x - \cos x}{\sin x} + \cot x}$. The sum of all the solutions of f(x) = 0 in [0, 100π] is

(A) 2550π
(B) 2500π
(C) 5000π
(D) 5050π

69. In a ΔABC, $a = a_1 = 2$, $b = a_2$, $c = a_3$ such that $a_{p+1} = \frac{5^p}{3^{2-p}} a_p \left(2^{2-p} - \frac{4p-2}{5^p} a_p\right)$, where p = 1, 2 and r_1, r_2, r_3 are ex-radii, then

(A) $r_1 = r_2$
(B) $r_3 = 2r_1$
(C) $r_2 = 2r_1$
(D) $r_2 = 3r_1$

70. The value of $\tan\left(\sum_{r=1}^{\infty} \tan^{-1}\left(\frac{4}{4r^2+3}\right)\right)$ is equal to

(A) 1
(B) 2
(C) 3
(D) 4

71. A triangular park is enclosed on two sides by a fence and on the third side by a straight river bank. The two sides having fence are of same length x. The maximum area enclosed by park is

(A) $\sqrt{\frac{x^3}{8}}$
(B) $\frac{1}{2}x^2$
(C) πx^2
(D) $\frac{3}{2}x^2$

Space for rough work

72. The equation of circle having the lines $x^2 + 2xy + 3x + 6y = 0$ as its normals and having size just sufficient to contain the circle $x^2 + y^2 - 4x - 3y = 0$ is $x^2 + y^2 + 6x - 3y - k = 0$ then k is

(A) 42 (B) 45

(C) $3\sqrt{5}$ (D) 15

73. The acute angle of a rhombus whose side is geometric mean of its diagonals is

(A) 15º (B) 20º

(C) 30º (D) 80º

74. The number of solutions of $\left(\log_{\sqrt{3}} \tan x\right)\left(\sqrt{\log_{\sqrt{3}} 3\sqrt{3} + \log_{\tan x} 3}\right) = -1$ in $[0, \pi]$ is

(A) 0 (B) 1

(C) 2 (D) 4

75. Vertex A of triangle ABC moves in such a way that tan B + tan C = constant then locus of orthocentre of ΔABC (BC is fixed) is a/an

(A) straight line (B) parabola

(C) circle (D) ellipse

76. If a hyperbola is confocal and coaxial with ellipse $\frac{x^2}{4} + y^2 = 1$ and intersect it at $\left(\sqrt{3}, \frac{1}{2}\right)$, then length of transverse axis of hyperbola is

(A) 4 (B) 2

(C) 3 (D) 7

77. The number of rational points on a circle with centre $\left(\sqrt{2}, -\sqrt{2}\right)$ and passing through (1, –1) are

(A) 1 (B) 2

(C) 4 (D) infinite

78. The values of λ for which the curve $\lambda(x^2 + y^2 + 2y + 1) = (x - 2y + 3)^2$ represents a hyperbola is

(A) $\lambda > 5$ (B) $0 < \lambda < 5$

(C) $\lambda < 0$ (D) $\lambda > 6$

79. If in a right angled triangle having integer sides a, b, $c \le 10$ the perimeter of the triangle is equal to the area of the triangle then area of triangle is

(A) 12 (B) 18

(C) 24 (D) 30

Space for rough work

80. The two adjacent sides of a cyclic quadrilateral are 2 and 5 and the angle between them is 60º. If the third side is 3 then the remaining fourth side is

(A) 2 (B) 3
(C) 5 (D) 8

81. Let A, B, C be three points on the ellipse $\frac{x^2}{4}+\frac{y^2}{1}=1$. If equation of AB is y = x then maximum area of ΔABC is

(A) 1 (B) $2\sqrt{2}$
(C) 2 (D) none of these

82. Let P(1, 1) is a point inside the circle $x^2 + y^2 + 2x + 2y - 8 = 0$. The chord AB is drawn passing through the point P. If $\frac{PA}{PB}=\frac{\sqrt{5}-2}{\sqrt{5}+2}$, then equation of chord AB is

(A) y = 2x + 1 (B) y = x
(C) y = –x (D) $y=\sqrt{2}x+1$

83. If AB is a double ordinate of the hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ such that ΔABC is equilateral, C being centre of hyperbola, then eccentricity e of hyperbola satisfies

(A) $e=\frac{2}{\sqrt{3}}$ (B) $e=\frac{\sqrt{3}}{2}$
(C) $1<e<\frac{2}{\sqrt{3}}$ (D) $e>\frac{2}{\sqrt{3}}$

84. Lines are drawn from a point P(–1, 3) to a circle $x^2 + y^2 - 2x + 4y - 8 = 0$ which meets the circle at two points A and B, then the minimum value of PA + PB is

(A) 6 (B) 8
(C) 10 (D) 12

85. A variable line ax + by + c = 0, where a, b, c are in A.P., is normal to a circle $(x - \alpha)^2 + (y - \beta)^2 = \gamma$, which is orthogonal to the circle $x^2 + y^2 - 4x - 4y - 1 = 0$ then the value of $\alpha + \beta + \gamma$ is

(A) 3 (B) 5
(C) 10 (D) 7

Space for rough work

86. Tangent is drawn to the ellipse $\frac{x^2}{27}+y^2=1$ at $\left(3\sqrt{3}\cos\theta, \sin\theta\right)$ (where $\theta \in \left(0, \frac{\pi}{2}\right)$), then the value of θ such that sum of intercepts on the axes made by this tangent is minimum, is

(A) $\frac{\pi}{3}$ (B) $\frac{\pi}{6}$

(C) $\frac{\pi}{8}$ (D) $\frac{\pi}{4}$

87. The locus of orthocentre of the triangle formed by the focal chord of the parabola $y^2 = 4ax$ and the normals drawn at its extremities is

(A) $y^2 = a(x - 3a)$ (B) $y^2 = a(x + 3a)$

(C) $y^2 = a(x - 4a)$ (D) $y^2 = a(x + 4a)$

88. If the ellipse $\frac{x^2}{a^2-3}+\frac{y^2}{a+4}=1$ is inscribed in a square of side length $a\sqrt{2}$ then a is

(A) 4 (B) 2

(C) 1 (D) none of these

89. In the triangle ABC if sin C cos 15º cos A + sin 15º sin A = 1 then sin C + tan A tan B is equal to

(A) 1 (B) 2

(C) $\frac{3}{2}$ (D) $\frac{1}{2}$

90. From origin two perpendicular lines are drawn to intersect $\frac{x^2}{4}+\frac{y^2}{1}=1$ at A and B then $\frac{1}{(OA)^2}+\frac{1}{(OB)^2}$ is equal to

(A) 1 (B) $\frac{1}{4}$

(C) $\frac{5}{4}$ (D) $\frac{3}{4}$

Space for rough work

FIITJEE **JEE(Main)-2018**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

PART TEST – II
(Main)

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	C	31.	B	61.	A
2.	B	32.	C	62.	A
3.	D	33.	B	63.	C
4.	B	34.	B	64.	A
5.	A	35.	B	65.	B
6.	B	36.	D	66.	C
7.	C	37.	D	67.	D
8.	B	38.	C	68.	C
9.	C	39.	C	69.	D
10.	B	40.	A	70.	B
11.	B	41.	A	71.	B
12.	A	42.	D	72.	B
13.	B	43.	A	73.	C
14.	A	44.	B	74.	B
15.	A	45.	C	75.	A
16.	C	46.	A	76.	C
17.	D	47.	B	77.	A
18.	A	48.	D	78.	B
19.	C	49.	C	79.	C
20.	D	50.	D	80.	A
21.	B	51.	C	81.	C
22.	C	52.	A	82.	B
23.	B	53.	C	83.	D
24.	C	54.	B	84.	B
25.	A	55.	C	85.	D
26.	B	56.	D	86.	B
27.	B	57.	C	87.	A
28.	C	58.	C	88.	D
29.	D	59.	B	89.	B
30.	D	60.	C	90.	C

Physics

PART – I

1. $\Delta Q_{AB} = nC_P\Delta T = 2\times\frac{5R}{2}\left(2T_0 - T_0\right) = 5RT_0$

In the process BC, PT^{-2} = constant

$PP^{-2}V^{-2}$ = constant

PV^2 = constant

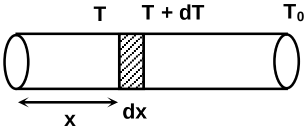
$\therefore$ molar heat capacity, $C = C_V + \frac{R}{1-x} = \frac{3R}{2} + \frac{R}{1-2}$

$C = \frac{R}{2}$

$\therefore \Delta Q_{BC} = nC\Delta T = 2\times\frac{R}{2}(T_0 - 2T_0) = -RT_0$

$\therefore \frac{|\Delta Q_{AB}|}{|\Delta Q_{BC}|} = \frac{5RT_0}{RT_0} = 5$

2. In steady state



$\frac{\Delta Q}{\Delta t} = -kA\frac{dT}{dx}$

$\frac{\Delta Q}{\Delta t} = -\alpha TA\frac{dT}{dx}$

$\frac{\Delta Q}{\Delta t}\int_0^{\ell} dx = -\alpha A\int_{3T_0}^{T_0} TdT$

$\frac{\Delta Q}{\Delta t}\ell = 4\alpha AT_0^2$ …(i)

Similarly,

$\frac{\Delta Q}{\Delta t}\int_0^{\ell/2} dx = -\alpha A\int_{3T_0}^{T} TdT$

$\frac{\Delta Q}{\Delta t}\frac{\ell}{2} = \alpha A\frac{(9T_0^2 - T^2)}{2}$ …(ii)

Dividing (ii) by (i)

$9T_0^2 - T^2 = 4T_0^2$

$T^2 = 5T_0^2$

$T = \sqrt{5}T_0$

3. Given PT^3 = constant

$\frac{T}{V}T^3 = \text{constant}$

$\therefore V = kT^4$

The coefficient of thermal expansion is

$\gamma = \frac{dV}{VdT} = \frac{4kT^3}{kT^4} = \frac{4}{T}$

4. Equilibrium temperature of mixture is 0°C.
Total heat released by water = $m_wS_w\Delta\theta = 5 \times 1 \times 40 = 200$ kcal
Heat taken by ice to increase its temperature from –20°C to 0°C = $4 \times 0.5 \times 20 = 40$ kcal
$\therefore$ mass of ice melted = $\frac{200-40}{80} = \frac{160}{80} = 2\text{ kg}$
$\therefore$ water content in the equilibrium mixture = 5 + 2 = 7 kg

5. Given
$C = C_V + \alpha T^2$

$$C_V + \frac{RT}{V}\frac{dV}{dT} = C_V + \alpha T^2$$

$$\int \frac{\alpha T}{R} dT = \int \frac{dV}{V} + \ell nk$$

$$\frac{\alpha T^2}{2R} = \ell n(kV)$$

$$kV = e^{\frac{\alpha T^2}{2R}}$$

$$\therefore\ Ve^{-\left(\frac{\alpha T^2}{2R}\right)} = \text{constant}$$

6. The net electric potential due to external charge inside the cavity and the induced charge on the surface of the cavity at any point outside the cavity is zero. If 'V' is the electric potential due to induced charge on the surface of cavity at point 'P'.

$$V + \frac{kq}{5a} = 0$$

$$\therefore\ V = -\frac{kq}{5a}$$

7. $$-mS\frac{dT}{dt} = \sigma A T^4$$

$$-\rho\frac{4}{3}\pi R^3 S\frac{dT}{dt} = \sigma 4\pi R^2 T^4$$

$$-\int_{T_0}^{T_0/2} \frac{dT}{T^4} = \frac{3\sigma}{\rho SR}\int_0^t dt$$

$$\left[\frac{1}{3T^3}\right]_{T_0}^{T_0/2} = \frac{3\sigma}{\rho SR}t$$

$$\left(\frac{8}{T_0^3}\right) - \frac{1}{T_0^3} = \left(\frac{9\sigma t}{\rho SR}\right)$$

$$\therefore\ t = \frac{7\rho SR}{9\sigma T_0^3}$$

8. The electric field due to $\vec{P}_1$ at the position of $\vec{P}_2$ is

$$E_1 = \frac{KP_1}{r^3}$$

$\therefore$ force of inter action between the dipoles is

$$F = P_2\left|\frac{dE_1}{dr}\right|$$

$$F = \frac{3kP_1P_2}{r^4}$$

9. $$dS = \frac{dQ}{T}$$

$$\int dS = nc_P\int_{T_0}^{2T_0}\frac{dT}{T}$$

$$\Delta S = 4\times\frac{5R}{2}\ell n2 = 10R\ell n2 = 10\times\frac{25}{3}\times 0.69$$

$$25\times 2.3 = 57.5\ \text{J/k}$$

10. The electric flux through the right end plane surface.

$$\phi_{PS} = \frac{q}{4\pi\varepsilon_0}\times 2\pi(1-\cos\theta) = \frac{q}{2\varepsilon_0}\left(1-\frac{4}{5}\right)$$

$$\phi_{PS} = \frac{q}{10\varepsilon_0}$$

Hence, the electric flux through the curved surface of the cylinder is

$$\phi_{CS} = \frac{q}{2\varepsilon_0} - \phi_{PS}$$

$$= \frac{q}{2\varepsilon_0} - \frac{q}{10\varepsilon_0} = \frac{4q}{10\varepsilon_0}$$

$$\phi_{CS} = \frac{2q}{5\varepsilon_0}$$

11. $$U_i = \frac{k(2Q)^2}{2a} + \frac{kQ^2}{4a} + \frac{k(2Q)Q}{2a}$$

$$= \frac{2kQ^2}{a} + \frac{5kQ^2}{4a}$$

$$U_i = \frac{13kQ^2}{4a}$$

$$U_f = \frac{k(3Q)^2}{4a} = \frac{9kQ^2}{4a}$$

∴ Total heat dissipated, $\Delta H = U_i - U_f$

$$= \frac{13kQ^2}{4a} - \frac{9kQ^2}{4a}$$

$$= \frac{4kQ^2}{4a} = \frac{kQ^2}{a}$$

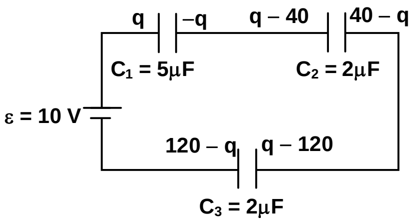
12. $\frac{q}{5}+\left(\frac{q-40}{2}\right)+\left(\frac{q-120}{2}\right)=10$

$\frac{6q}{5}=90$

q = 75 μC

∴ magnitude of charge flown through the battery is

$\Delta q = 100 - 75 = 25\ \mu C$

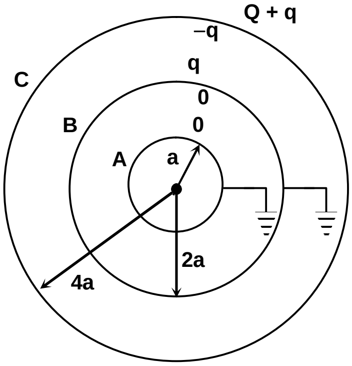


13. The electric potential of shell B is zero

$V_B = 0$

$\frac{kq}{2a}+\frac{kQ}{4a}=0$

$\therefore\ q=-\frac{Q}{2}$



14. The cell will deliver maximum power to the network if $R_{eq} = r$

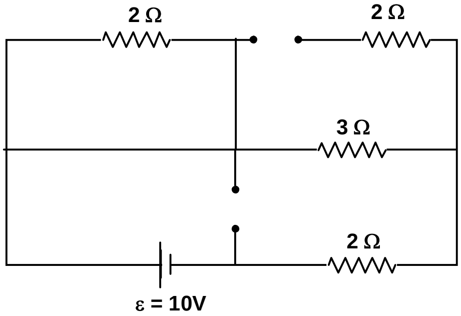
$\Rightarrow\ \frac{3R}{2}=r$

$\therefore\ R=\frac{2r}{3}=\frac{2}{3}\Omega$

15. The equivalent circuit just after closing the switch 'S' is

$R_{eq} = 3 + 2 = 5\ \Omega$

$\therefore\ I_0=\frac{\varepsilon}{R_{eq}}=\frac{10}{5}=2A$



16. Since the particle exists the magnetic field region with a velocity $\vec{v}=(3\hat{i}+3\sqrt{3}\hat{j})$ m/s

$\tan\theta=\frac{3\sqrt{3}}{3}$

$\therefore\ \theta=\frac{\pi}{3}$

The angular displacement of the particle in the magnetic field region is $\theta=\frac{\pi}{3}$

Angular velocity, $\omega=\frac{qB}{m}$

$\therefore\ t=\frac{\theta}{\omega}=\frac{\pi m}{3qB}$

17. Since $\vec{B}$ is constant in the region

The net magnetic force experienced by the conducting wire MN is

$$\vec{F} = I\left(\vec{L}_{eff} \times \vec{B}\right)$$

Where, $\vec{L}_{eff} = 6R\hat{i}$

$$\vec{F} = I\left[6R\hat{i} \times B(-\hat{k})\right]$$

$$F = 6BIR(\hat{j})$$

18. The net magnetic moment of the loop is

$$\vec{M} = I\ell^2(\hat{i} + \hat{k})$$

The net magnetic torque experienced by the loop is

$$\vec{\tau} = \vec{M} \times \vec{B}$$

$$= I\ell^2(\hat{i} + \hat{k}) \times B\hat{j}$$

$$\vec{\tau} = BI\ell^2(\hat{k} - \hat{i})$$

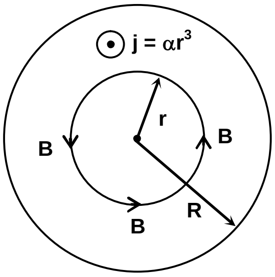
19. The net magnetic field at the centre 'O' of the circular arc is

$$B_0 = \frac{\mu_0 I}{4\pi R} + \frac{3\mu_0 I}{8R} - \frac{\mu_0 I}{8\pi R}$$

$$= \frac{\mu_0 I}{8\pi R} + \frac{3\mu_0 I}{8R}$$

$$B_0 = = \frac{\mu_0 I}{8R}\left(\frac{1+3\pi}{\pi}\right)$$

20. When $r \le R$



$$B2\pi r = \mu_0 \int_0^r j2\pi r dr$$

$$Br = \frac{\mu_0 \alpha r^5}{5}$$

$$B = \frac{\mu_0 \alpha r^4}{5}, \; r \le R$$

when $r > R$

$$B2\pi r = \mu_0 \int_0^R j2\pi r dr$$

$$Br = \mu_0 \int_0^R \alpha r^3 r dr$$

$$Br = \frac{\mu_0 \alpha R^5}{5}$$

$$\therefore \; B = \frac{\mu_0 \alpha R^5}{5r}, \; r > R$$

$$\text{at } r = \frac{R}{2}, \; B_1 = \frac{\mu_0 \alpha R^4}{80}$$

$$\text{at } r = 2R, \; B_2 = \frac{\mu_0 \alpha R^4}{10}$$

$$\therefore \; \frac{B_2}{B_1} = 8$$

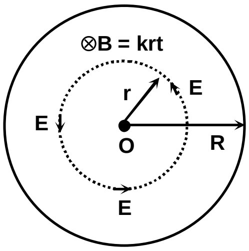
21. The emf induced between the points ‘A’ and ‘D’ is

$$\varepsilon = \vec{B}\cdot(\vec{\ell}_{\text{eff}} \times \vec{v})$$

$$= Ba\sqrt{2}v\sin 45^\circ$$

$$= Ba\sqrt{2}\frac{v}{\sqrt{2}} = Bva = 2B\omega a^2$$

22. When $r \le R$



$$E2\pi r = \frac{d}{dt}\int_0^r B2\pi r dr$$

$$Er = \frac{d}{dt}\left(\frac{ktr^3}{3}\right)$$

$$E = \frac{kr^2}{3}, \text{ when } r \le R$$

When $r > R$

$$E2\pi r = \frac{d}{dt}\left(\int_0^R B2\pi r dr\right)$$

$$Er = \frac{d}{dt}\left(\int_0^R krtrdr\right)$$

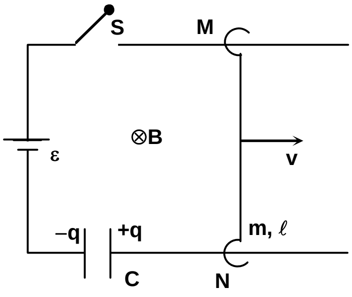
$$E = \frac{kR^3}{3r}, \text{ where } r > R$$

$$\therefore \text{ at } r = \frac{R}{2},\ E_1 = \frac{kR^2}{12}$$

$$\text{at } r = 2R,\ E_2 = \frac{kR^2}{6}$$

$$\therefore \frac{E_2}{E_1} = 2$$

23. $$\frac{q}{C} + Bv\ell = \varepsilon$$



$$q = C(\varepsilon - Bv\ell)$$

$$\text{Now, } m\frac{dv}{dt} = Bi\ell$$

$$mdv = B\ell idt$$

$$m\int_0^v dv = B\ell\int_0^q dq$$

$$mv = B\ell q$$

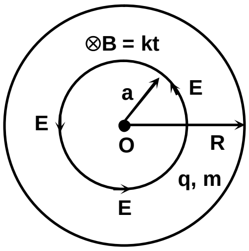
$$\therefore q = \frac{mv}{B\ell} \qquad \ldots\text{(ii)}$$

From (i) and (ii)

$$\frac{mv}{B\ell} = C\varepsilon - CB\ell v$$

$$\Rightarrow v = \frac{CB\ell\varepsilon}{(m + CB^2\ell^2)}$$

24. $E2\pi r = \frac{d}{dt}(kt\pi r^2)$



$E = \frac{kr}{2}$, $r \le R$

at r = a

$E = \frac{ka}{2}$

To keep the ring stationary

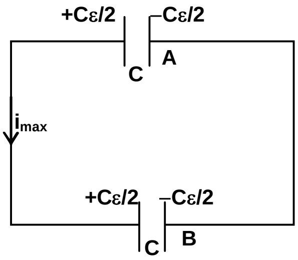
$qEa = \mu mga$

$\frac{qka}{2} = \mu mg$

$\therefore\ \mu = \frac{kqa}{2mg}$

$\mu_{min} = \frac{kqa}{2mg}$

25. When the current through the inductor is maximum



$V_L = L\frac{di}{dt} = 0$

Hence capacitors A and B will be in parallel

Now, using conservation of energy

$\frac{1}{2}C\varepsilon^2 = 2 \times \frac{1}{2}C\frac{\varepsilon^2}{4} + \frac{1}{2}Li_{max}^2$

$\frac{C\varepsilon^2}{4} = \frac{1}{2}Li_{max}^2$

$i_{max} = \varepsilon\sqrt{\frac{C}{2L}}$

26. $L_1\frac{di_1}{dt} = L_2\frac{di_2}{dt}$

$L_1\int_0^{i_1} di_1 = L_2\int_0^{i_2} di_2$

$L_1 i_1 = L_2 i_2$ …(i)

$i_1 + i_2 = i$ …(ii)

$i_1\left(1 + \frac{L_1}{L_2}\right) = i$

$\Rightarrow\ i_1 = \left(\frac{L_2}{L_1 + L_2}\right)i$ and $i_2 = \left(\frac{L_1}{L_1 + L_2}\right)i$

$$\therefore\ \frac{U_1}{U_2} = \frac{\frac{1}{2}L_1 i_1^2}{\frac{1}{2}L_2 i_2^2} = \frac{L_1 L_2^2}{L_2 L_1^2} = \frac{L_2}{L_1}$$

27. Rms current through resistor ‘R_1’ is

$$I_{1(rms)} = \frac{50}{\sqrt{2}\times 10\sqrt{2}} = \frac{5}{2}A$$

$\therefore$ Average power developed in the resistor ‘R_1’ is

$$P_1 = I^2_{1(rms)}R_1 = \left(\frac{5}{2}\right)^2 10 = \frac{250}{4} = 62.50\,W$$

28. Current through the potentiometer wire is

$$I = \frac{6}{R+5}$$

$$\therefore\ V = \frac{6\times 3}{(R+5)}$$

$$2 = \frac{18}{R+5}$$

R + 5 = 9

R = 4 Ω

29. Let the initial charge on the spherical conductor ‘A’ is Q.

$$\therefore\ \frac{kQ}{a} = V$$

$\Rightarrow$ kQ = Va …(i)

When switch ‘S’ is closed, the total charge ‘Q’ will appear on the outer surface of shell B.

$\therefore$ Final potential of the spherical conductor ‘A’ is

$$V' = \frac{kQ}{6a} = \frac{Va}{6a} = \frac{V}{6}$$

30. Given process is

VT^2 = constant

VP^2V^2 = constant

$PV^{3/2}$ = constant

$\therefore$ molar heat capacity

$$C = C_V + \frac{R}{1-x} = \frac{5R}{2} + \frac{R}{1-\frac{3}{2}}$$

$\Rightarrow$ C = R/2

$\therefore$ Heat supplied to the gas is

$\Delta Q = nC\Delta T = 2\times\frac{R}{2}\times 300 = 300\,R$

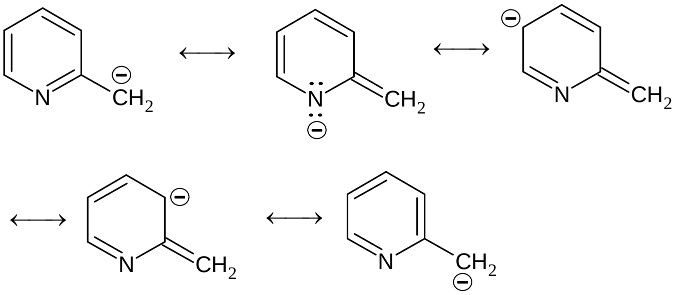
Increase in internal energy of the gas is

$\therefore\ \Delta U = nC_V\Delta T = 2\times\frac{5R}{2}\times 300 = 1500R$

$\therefore$ The ratio $\frac{\Delta U}{\Delta Q} = \frac{1500R}{300R} = 5$

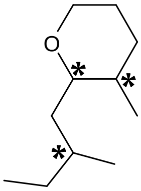
Chemistry PART – II

31.



32. The carboxylic acid group stabilizes the conjugate base and – I of other groups at closest distance.

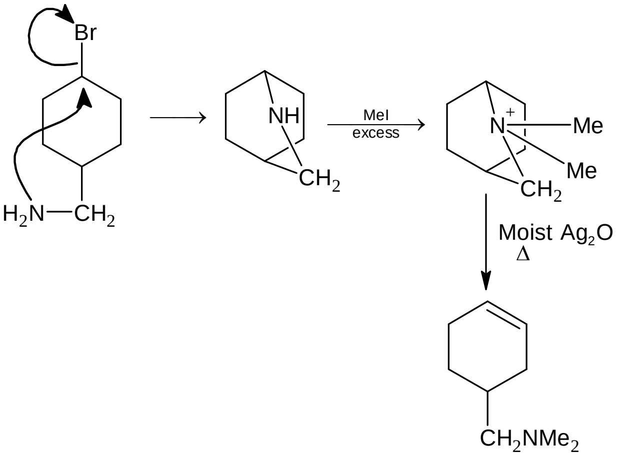
34. Total chiral centres = 3
$2^n = 2^3 = 8$



35. In B all alkyl groups are at equatorial positions so most stable.
Most stable will have least heat of combustion.

37. Glyptal is made from polymerization of ethylene glycol and pthalic acid.

38.



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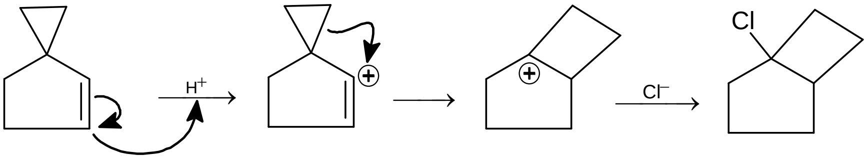

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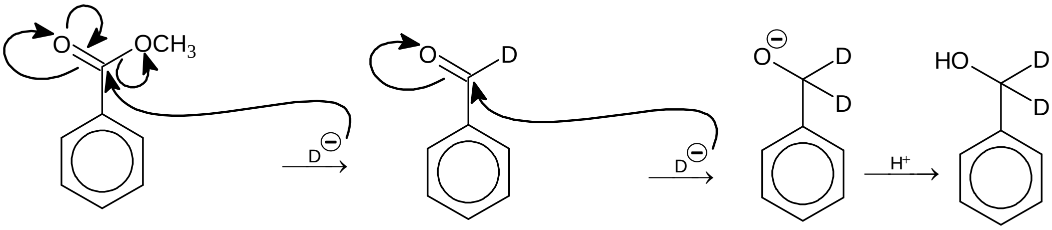
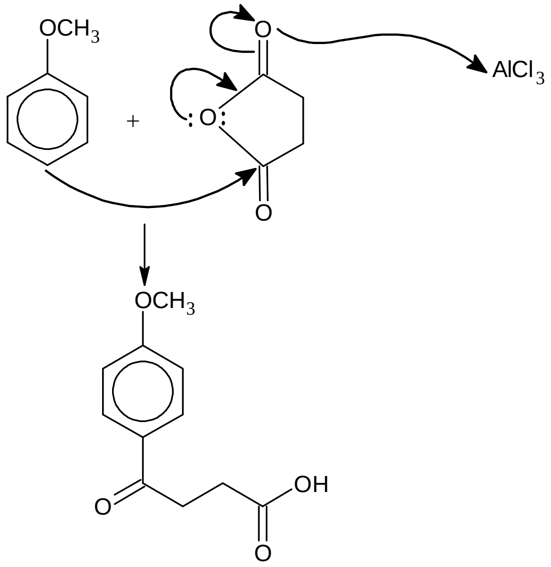
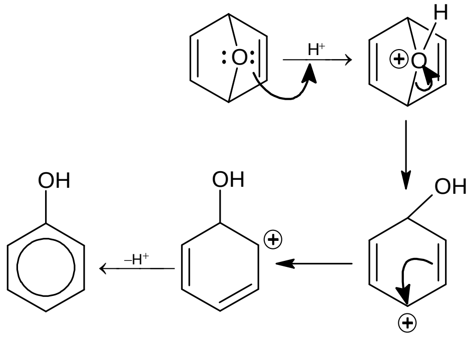

OCH3
O
D⊖
O
D
D⊖
O⊖
D
D
H+
HO
D
D

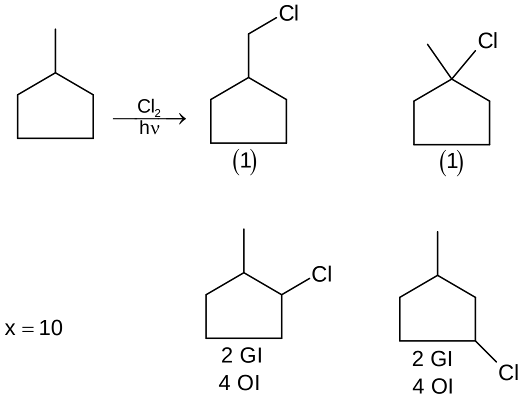
44.


OCH3
+
O
O
O
AlCl3
OCH3
O
OH
O

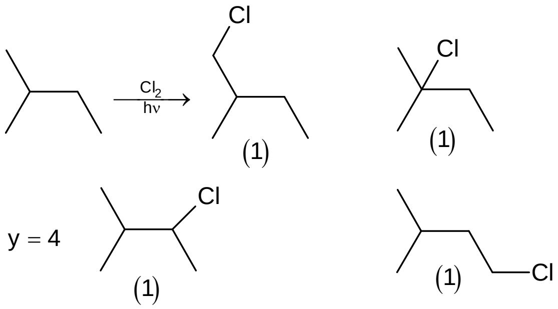
46.


:O:
H+
H
⊕O
OH
⊕
OH
⊕
OH
–H+

47.


Cl2
hν
Cl
(1)
Cl
(1)
Cl
2 GI
4 OI
2 GI
4 OI
Cl

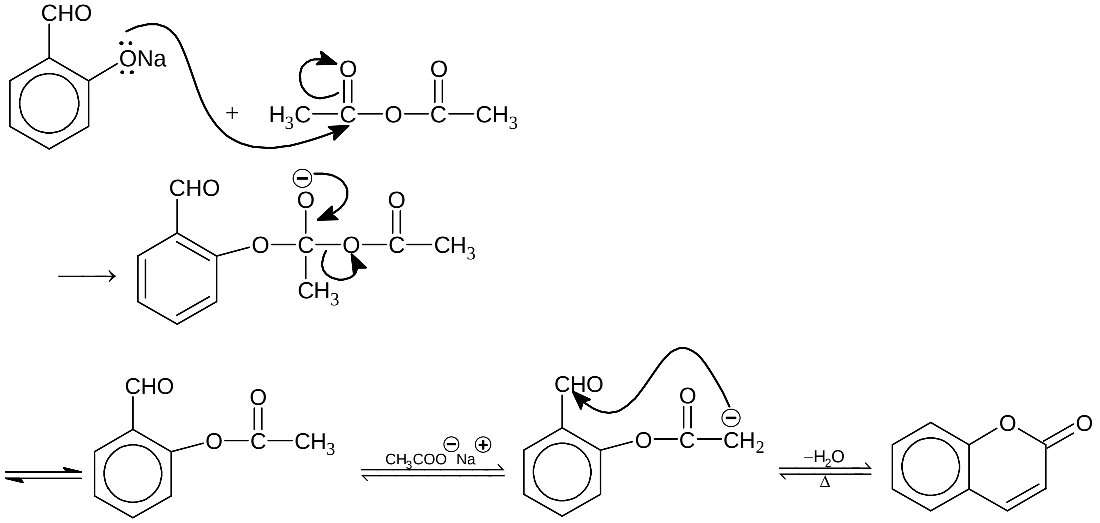
$x = 10$



Cl
Cl₂
hν
(1)
Cl
(1)
Cl
(1)
(1)
Cl

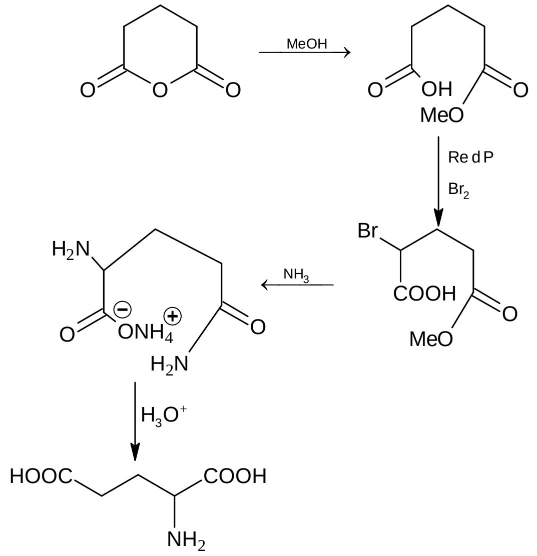
y = 4

48.



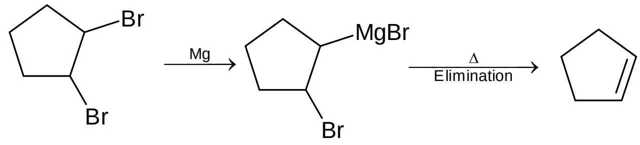
CHO
ONa
+
H₃C—C—O—C—CH₃
O
O
CHO
O—C—O—C—CH₃
CH₃
CHO
O—C—CH₃
CH₃COO⁻ Na⁺
CHO
O—C—CH₂
−H₂O
Δ
O
O

50.



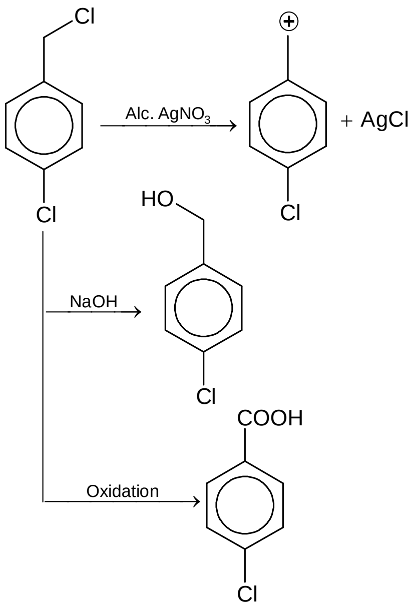
O
O
O
MeOH
O
OH
MeO
O
Red P
Br₂
Br
COOH
MeO
O
NH₃
H₂N
O
ONH₄
O
H₂N
H₃O⁺
HOOC
COOH
NH₂

51.

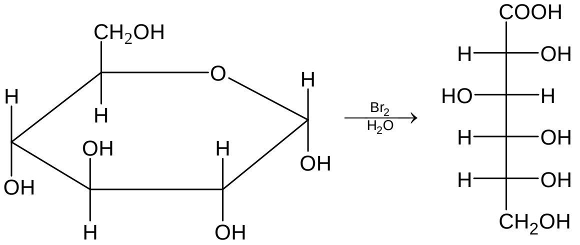


Br
Br
Mg
MgBr
Br
Δ
Elimination

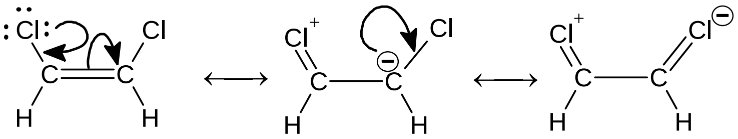
52.


Cl
Cl
Alc. AgNO$_3$
+ AgCl
Cl
HO
NaOH
Cl
COOH
Oxidation
Cl

53.

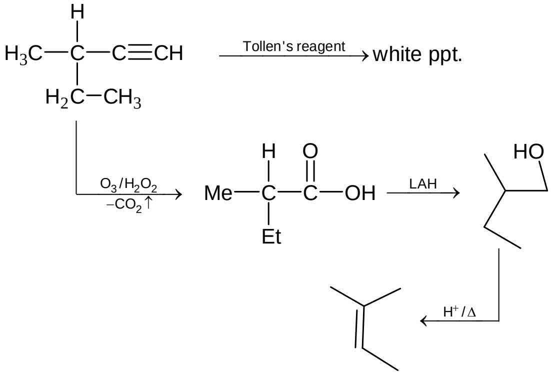

CH$_2$OH
O
H
H
H
OH
H
OH
OH
H
OH
Br$_2$
H$_2$O
COOH
H
OH
HO
H
H
OH
H
OH
CH$_2$OH

55.


Cl
Cl
C
C
H
H
Cl
Cl
C
C
H
H
Cl
Cl
C
C
H
H

In cis form attraction between both chlorine leads to stability.

56.


H
H$_3$C—C—C≡CH
H$_2$C—CH$_3$
Tollen's reagent
white ppt.
O$_3$/H$_2$O$_2$
−CO$_2$↑
H O
Me—C—C—OH
Et
LAH
HO
H$^+$/Δ

57. (ii), (vi) will not give Cannizzaro test.

58. Rate of reaction depends upon migration aptitude.

60. Intermolecular aldol reaction.

Mathematics

PART – III

61. $\tan(\alpha+\beta) = -\frac{p}{1-q} = \frac{p}{q-1}$

$$\frac{1}{1+\tan^2(\alpha+\beta)}\left(\tan^2(\alpha+\beta)+p\tan(\alpha+\beta)+q\right)$$

$$= \frac{1}{1+\frac{p^2}{(q-1)^2}}\left(\frac{p^2}{(q-1)^2}+\frac{p^2}{q-1}+q\right)$$

$$= \frac{1}{p^2+(q-1)^2}\left(p^2+p^2(q-1)+q(q-1)^2\right) = q$$

62. $f(x) = (x-1)(x-\cos\theta)(x-\sin\theta)$

$\alpha^2+\beta^2+\gamma^2 = 1+\sin^2\theta+\cos^2\theta = 2$

63. $x = \sqrt{2}-1 \Rightarrow (x+1)^2 = 2$

$\Rightarrow x^4+3x^3-3x^2-9x+6 = (x^2+x-4)(x^2+2x-1)+2 = 2$

64. $x = r\cos\theta,\ y = r\sin\theta$

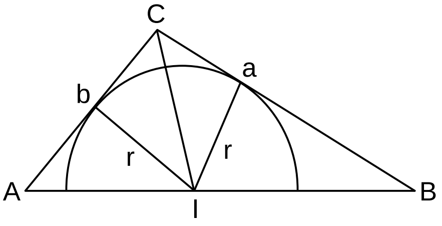
$\Rightarrow r^2\sin\theta\cos\theta\, r^2(\cos^2\theta-\sin^2\theta) = r^2$

$\Rightarrow r^2 = \frac{4}{\sin 4\theta} = 4\operatorname{cosec} 4\theta \geq 4$

65. $\sec^2\frac{\pi}{8}+\operatorname{cosec}^2\frac{\pi}{8} = \sec^2\frac{\pi}{8}\operatorname{cosec}^2\frac{\pi}{8}$

$\Rightarrow -a = b \Rightarrow a+b = 0$

66. $x = \frac{2ab}{a+b}\cos\frac{C}{2}$



$\frac{1}{2}ra+\frac{1}{2}rb = \frac{1}{2}ab\sin C$

$$\Rightarrow r = \frac{2\cdot\frac{1}{2}ab\sin C}{a+b} = \frac{2ab\sin\frac{C}{2}\cos\frac{C}{2}}{a+b} = x\sin\frac{C}{2}$$

$r = \frac{2\Delta}{a+b} \Rightarrow r = \frac{abc}{4R^2(\sin A+\sin B)}$

67. $\cos x = 0$ or $\sin\left(x+\frac{1}{x}\right) = 0$

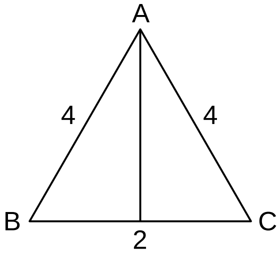
$\Rightarrow x = \frac{\pi}{2}$ or $x+\frac{1}{x} = n\pi \Rightarrow$ infinite solution

68. $f(x) = \frac{\left(\operatorname{cosec}^2 x-1\right)^2}{\left(\operatorname{cosec}^2 x-1\right)+1-\cot x+\cot x} = \frac{\cot^4 x}{1+\cot^2 x} = 0$; $x \in R - n\pi,\ n \in I$

$\Rightarrow\ x = (2n-1)\frac{\pi}{2} = \frac{\pi}{2}, \frac{3\pi}{2}, \frac{5\pi}{2}, ..., \frac{199\pi}{2}$

Sum = $\frac{\pi}{2}(1+3+5+.....+199) = 5000\pi$

69. p = 1, $a_2 = 4 \Rightarrow b = 4$
p = 2, $a_3 = 4 \Rightarrow c = 4$
$\Rightarrow \Delta$ is isosceles
$\Delta = \sqrt{15}$
$r_1 = \frac{\Delta}{s-a} = \frac{\sqrt{15}}{3}$, $r_2 = \frac{\Delta}{s-b} = \sqrt{15} = r_3$
$\Rightarrow r_2 = r_3 = 3r_1$



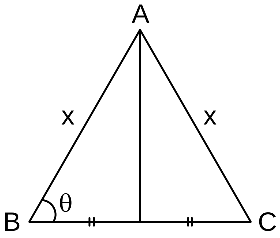
70. $\tan^{-1}\left(\frac{4}{4r^2+3}\right) = \tan^{-1}\left(\frac{1}{r^2+\frac{3}{4}}\right) = \tan^{-1}\left(\frac{1}{1+\left(r+\frac{1}{2}\right)\left(r-\frac{1}{2}\right)}\right) = \tan^{-1}\left(r+\frac{1}{2}\right) - \tan^{-1}\left(r-\frac{1}{2}\right)$

$\sum_{r=1}^{n}\tan^{-1}\left(\frac{4}{4r^2+3}\right) = \tan^{-1}\left(n+\frac{1}{2}\right) - \tan^{-1}\left(\frac{1}{2}\right)$

$\Rightarrow \sum_{r=1}^{\infty}\tan^{-1}\left(\frac{4}{4r^2+3}\right) = \tan^{-1}2$

71. $A = \frac{1}{2}(2x\cos\theta)x\sin\theta = \frac{1}{2}x^2\sin 2\theta$

$\text{Max}(A) = \frac{x^2}{2}$



72. Lines intersect at $\left(-3, \frac{3}{2}\right)$ which is centre of required circle. Given circle $x^2 + y^2 - 4x - 3y = 0$ whose centre is $\left(2, \frac{3}{2}\right)$, $r = \frac{5}{2}$
For just sufficient circle $d = |r_1 - r_2|$
$\Rightarrow \left|\frac{5}{2} - r\right| = 5 \Rightarrow r = \frac{15}{2} \Rightarrow 9 + \frac{9}{4} + k = \frac{225}{4} \Rightarrow k = 45$

73. If acute angle = $\theta \Rightarrow \cos(\pi-\theta) = \frac{a^2+a^2-d_1^2}{2a^2}$

$\Rightarrow 2a^2 - d_1^2 = -2a^2\cos\theta \Rightarrow d_1 = \sqrt{2a^2+2a^2\cos\theta} = 2a\cos\frac{\theta}{2}$

Similarly, $d_2 = \sqrt{2a^2(1-\cos\theta)} = 2a\sin\frac{\theta}{2}$ and $d_1d_2 = a^2$

$\Rightarrow 4\sin\frac{\theta}{2}\cos\frac{\theta}{2} = 1 \Rightarrow \sin\theta = \frac{1}{2}$

74. Let $\log_{\sqrt{3}} \tan x = t \Rightarrow t\sqrt{3+\frac{2}{t}} = -1$, t < 0

$\Rightarrow t^2\left(3+\frac{2}{t}\right) = 1 \Rightarrow 3t^2 + 2t - 1 = 0 \Rightarrow t = -1, \frac{1}{3}$

$\Rightarrow \log_{\sqrt{3}} \tan x = -1 \Rightarrow \tan x = \frac{1}{\sqrt{3}} \Rightarrow x = \frac{\pi}{6}$

75. $\tan B + \tan C = \frac{\sin(B+C)}{\cos B\cos C} = \frac{2R\sin A}{2R\cos B\cos C} = \frac{a}{2R\cos B\cos C} = \lambda$

$\Rightarrow$ 2R cos B cos C = k

$\Rightarrow$ Locus of orthocentre is a line parallel to BC

76. $2 - a = SP = \frac{1}{2} \Rightarrow a = \frac{3}{2} \Rightarrow 2a = 3$

77. (1, –1) lies on y + x = 0. Hence only one rational point

78. $\sqrt{x^2+y^2+2y+1} = \sqrt{x^2+(y+1)^2}$ = distance between (x, y) and (0, –1)

The distance from (x, y) to x – 2y + 3 = 0 is $\frac{|x-2y+3|}{\sqrt{5}}$

$\Rightarrow \sqrt{x^2+(y+1)^2} = \frac{|x-2y+3|}{\sqrt{5}} \cdot \sqrt{\frac{5}{\lambda}}$

$\Rightarrow e = \sqrt{\frac{5}{\lambda}}$ for hyperbola $\sqrt{\frac{5}{\lambda}} > 1$

$\Rightarrow \lambda < 5$

79. $a + b + \sqrt{a^2+b^2} = \frac{ab}{2}$

$\Rightarrow b = \frac{4(a-2)}{a-4}$ for a = 5, a = 6, b = 8

$\Rightarrow \Delta = \frac{1}{2}ab = 24$

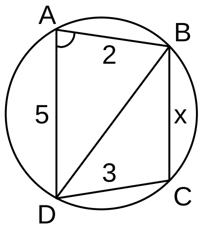
80. $BD^2 = 2^2 + 5^2 - 2\cdot2\cdot5\cdot\frac{1}{2}$

$= 3^2 + x^2 - 2\cdot3\cdot x\left(-\frac{1}{2}\right)$

$\Rightarrow 19 = x^2 + 3x + 9$

$\Rightarrow x^2 + 3x - 10 = 0$

$\Rightarrow x = 2$



81. $\Delta = \frac{1}{2}\cdot 4\sqrt{\frac{2}{5}}\cdot\frac{|2\cos\theta - \sin\theta|}{\sqrt{2}} \le 2$

82. $\frac{PA}{PB} = \frac{\sqrt{10}-2\sqrt{2}}{\sqrt{10}+2\sqrt{2}} \Rightarrow$ AB is a diameter

83. $2b\tan\theta = \sqrt{a^2\sec^2\theta + b^2\tan^2\theta}$

$\Rightarrow\ e^2 > 1 + \dfrac{1}{3}$

84. $\dfrac{PA + PB}{2} \ge \sqrt{PA \cdot PB}$

$\Rightarrow$ PA + PB $\ge$ 2PT

85. $a\left(x + \dfrac{y}{2}\right) + c\left(\dfrac{y}{2} + 1\right) = 0$

$\Rightarrow \alpha = 1, \beta = -2$ and $4(\alpha + \beta) = \alpha^2 + \beta^2 - \gamma - 1$

$\Rightarrow \gamma = 8$

$\alpha + \beta + \gamma = 7$

86. Equation of tangent is $\dfrac{x}{3\sqrt{3}}\cos\theta + y\sin\theta = 1$

$S = \dfrac{3\sqrt{3}}{\cos\theta} + \dfrac{1}{\sin\theta}$. It is minimum at $\theta = \dfrac{\pi}{6}$

87. Orthocentre (h, k) = $\left(2a + a\left(t_1^2 + t_2^2 + t_1t_2\right), -at_1t_2\left(t_1 + t_2\right)\right)$ where $t_2 = -\dfrac{1}{t_1}$

$\Rightarrow k = a(t_1 + t_2)$

$h = 2a + a\left(\left(t_1 + t_2\right)^2 - t_1t_2\right) = 2a + a\left(\dfrac{k^2}{a^2} + 1\right)$

$ah = 3a^2 + k^2$

88. Sides of squares will be perpendicular tangents to the ellipse. So vertices of square will lie on diameter circle

$\Rightarrow$ Diameter of circle = $2\sqrt{a^2 - 3 + a + 4} = \sqrt{2a^2 + 2a^2}$

$\Rightarrow a^2 + a + 1 = a^2$

$\Rightarrow a = -1$

But $a^2 > 3$ and $a > -4$

$\Rightarrow a \in \phi$

89. $\angle C = \dfrac{\pi}{2}$, A = 15°, B = 75°

90. $\dfrac{1}{(OA)^2} + \dfrac{1}{(OB)^2} = \dfrac{1}{a^2} + \dfrac{1}{b^2} = \dfrac{1}{4} + 1 = \dfrac{5}{4}$

FIITJEE **JEE(Advanced)-2018**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

PART TEST – III

PAPER-2

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**A, C, D**	21.	**A, C, D**	41.	**B, C**
2.	**B, D**	22.	**B, C, D**	42.	**A, B, C**
3.	**B, C**	23.	**B, C**	43.	**A, B, C**
4.	**B, C, D**	24.	**A, B, C, D**	44.	**A, B, C**
5.	**B, D**	25.	**A, B**	45.	**A, B**
6.	**A, C**	26.	**C**	46.	**A, C, D**
7.	**B, C**	27.	**A, B, C, D**	47.	**A, C, D**
8.	**A, C**	28.	**C**	48.	**A, B, C**
9.	**C**	29.	**C**	49.	**A**
10.	**B**	30.	**B**	50.	**D**
11.	**D**	31.	**D**	51.	**D**
12.	**B**	32.	**B**	52.	**C**
13.	**3**	33.	**6**	53.	**5**
14.	**5**	34.	**1**	54.	**5**
15.	**5**	35.	**2**	55.	**8**
16.	**2**	36.	**1**	56.	**0**
17.	**4**	37.	**3**	57.	**1**
18.	**6**	38.	**4**	58.	**8**
19.	**5**	39.	**0**	59.	**7**
20.	**8**	40.	**5**	60.	**6**

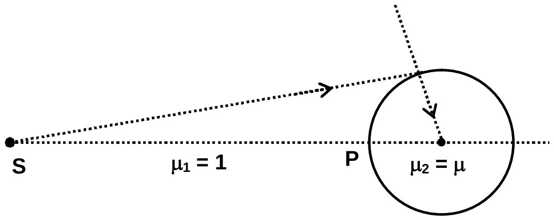
Physics

PART – I

SECTION – A

1. (A) $\frac{\mu}{+R} = \frac{\mu - 1}{+R}$(not possible)

The higher the refractive index of the material of sphere (μ), the closer one could come to fulfilling the objective



(B) $\frac{f_a}{f_w} = \left(\frac{\mu - \mu_w}{\mu - \mu_a}\right)\left(\frac{\mu_a}{\mu_w}\right)$

$$= \left(\frac{\frac{3}{2} - \frac{4}{3}}{\frac{3}{2} - 1}\right)\frac{1}{\left(\frac{4}{3}\right)} = \frac{1}{6} \times 2 \times \frac{3}{4} = \frac{1}{4}$$

(C) basic (NCERT-point to ponder)
(D) basic (NCERT-point to ponder)

2. As we know that,

$\frac{hC}{\lambda} = \phi + K \Rightarrow \frac{12400}{\lambda} = \phi + v_s$, where ϕ is in electron Volt and λ is in Å

When light of wavelength λ = 6000 Å is used

$\frac{12400}{6000} = \phi + 0.3 \Rightarrow \phi = 1.77 \approx 1.8$ eV (approximately)

When light with wavelength λ = 4000 Å is used

$\frac{12400}{4000} = \phi + eV$

$\Rightarrow$ eV = (3.1 – 1.8) e volt = 1.3 eV

$\Rightarrow$ v = 1.3 Volt

3. Condition for maximum intensity due to thin film

$$2\mu d - \frac{\lambda}{2} = n\lambda$$

$\Rightarrow 2\mu d = (2p+1)\frac{\lambda_1}{2} \Rightarrow (2p + 1)\lambda_1 = 4\mu d$

Here λ_1 = 400 nm and n = p $\Rightarrow$ An integer

Let λ' = 1150 nm. Since only two wavelength give maximum intensity, so

$$\frac{4\mu d}{2(p-1)+1} < \lambda' < \frac{4\mu d}{2(p-2)+1}$$

$$\frac{\lambda_1(2p+1)}{2(p-1)+1} < \lambda' < \frac{\lambda_1(2p+1)}{2(p-2)+1}$$

$$\Rightarrow \frac{\lambda_1(2p+1)}{2(p-1)+1} < \lambda' \text{ or } \lambda' < \frac{\lambda_1(2p+1)}{2(p-2)+1}$$

$$\Rightarrow p > \frac{1}{2}\left(\frac{\lambda' + \lambda_1}{\lambda' - \lambda_1}\right) = \frac{1}{2}\left(\frac{1150 + 400}{1150 - 400}\right) = 1\text{......, or}$$

$$p < \frac{1}{2}\left(\frac{3\lambda' + \lambda_1}{\lambda' - \lambda_1}\right) = \frac{1}{2}\left(\frac{3 \times 1150 + 400}{1150 - 400}\right) = 2......$$

The only integer which satisfies both inequalities is 2, so

$$d = \frac{(2 \times 2 + 1)400 \times 10^{-9}}{4 \times 1} = 500 \text{ nm}$$

$$\lambda_2 = \frac{4\mu d}{2(p-1)+1} = \frac{4 \times 1 \times 500 \times 10^{-9}}{2+1} = 666.7 \text{ nm}$$

$$\Delta T = \frac{d}{\alpha h} = \frac{500 \times 10^{-9}}{8 \times 10^{-6} \times 2 \times 10^{-2}} \approx 3.1\,°\text{C}$$

4. k = stiffness of string $= \frac{F}{x_{max}} = \frac{mg}{x_{max}} = \frac{40 \times 10^{-3} \times 9.8}{20 \times 10^{-2}} = 1.96 \text{ N/m}$

When we replace the mass 40 gm by the mass $m_2 = \frac{2205}{32}\text{gm}$, we have

$$T = 2\pi\sqrt{\frac{m}{k}} = \frac{3\pi}{8}\text{ sec}$$

$$\omega = \frac{2\pi}{T} = \sqrt{\frac{k}{m}} = \frac{16}{3}\text{ rad/sec}$$

$x = x_0 \cos \omega t = 0.2 \cos \frac{16}{3}t$

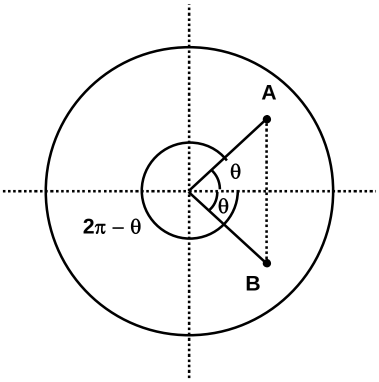
$v = -x_0\omega \sin \omega t = -\frac{16}{15}\sin\frac{16}{3}t$

$a = -x_0\, \omega^2 \cos \omega t = -\frac{256}{45}\cos\frac{16}{3}t$

If x = 10 cm $\Rightarrow \cos\frac{16}{3}t = \frac{1}{2} = \cos\left(\frac{\pi}{3}\right)$

$\Rightarrow \frac{16}{3}t = (2n\pi \pm \frac{\pi}{3})$

$\Rightarrow t = \left(\frac{3n\pi}{8} \pm \frac{\pi}{8}\right)\text{sec}$



5. L.C. = $\frac{1}{20} \times 0.1 = 0.005$ cm

Let 1 V.S.D. = x

$\Rightarrow \frac{1}{20} = 1 - x \Rightarrow x = 0.95$ mm

$(n-4) \times 1 = n \times 0.95$

$\Rightarrow n = 80$

Length of pencil = $8.4 + 0.005 \times \left(\frac{80}{5}\right) = 8.48$ cm

6. $\phi = \frac{2\pi}{\lambda}\delta$

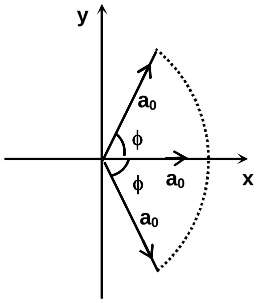
$y_2 = a_0 \sin(\omega t - kx)$

$\Rightarrow y_1 = a_0 \sin(\omega t - kx - \phi)$ and $y_3 = a_0 \sin(\omega t - kx + \phi))$

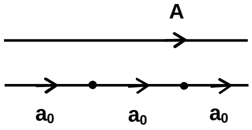
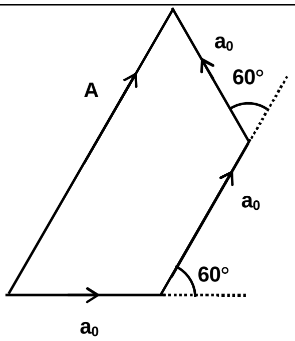
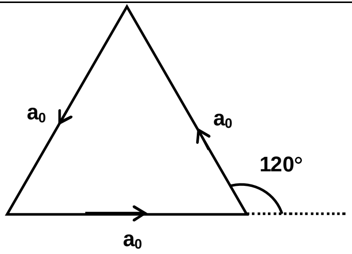
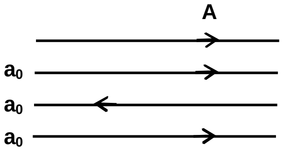
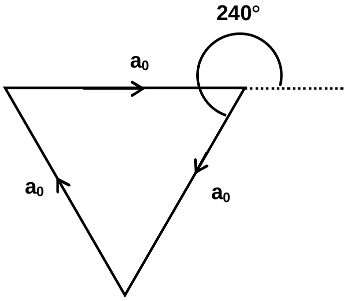
$$A = |a_0 + 2a_0\cos\phi| = a_0\,|(1+2\cos\phi)|$$

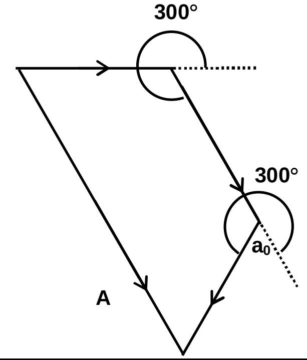
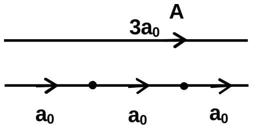
$$\Rightarrow A = a_0\,\left|(1+2\cos\left(\frac{2\pi xd}{\lambda D}\right)\right|$$

$$= a_0\,\left|(1+2\cos\left(\frac{2\pi\delta}{\lambda}\right)\right|$$



Second Method : Suppose ϕ and δ represent the phase difference and path difference between two connective waves so

ϕ	δ	Phasor representation	Resultant amplitude
0	0		A = 3a₀
60°	$\frac{\lambda}{6}$		A = 2a₀
120°	$\frac{\lambda}{3}=\frac{2\lambda}{6}$		A = 0
180°	$\frac{\lambda}{2}=\frac{3\lambda}{6}$		A = a₀
240°	$\frac{2\lambda}{3}=\frac{4\lambda}{6}$		A = 0

300°	$\frac{5\lambda}{6}$		A = 2a₀
360°	$\lambda = \frac{6\lambda}{6}$		A = 3a₀

7. For transverse wave, $v_T = \sqrt{\frac{F}{\mu}} = \sqrt{\frac{F}{\rho \times S}}$

$$V_{Al} = \sqrt{\frac{900}{2.5\times10^3\times10^{-6}}} = \frac{30}{50\times10^{-3}} = 600\ m/s$$

$$V_{Cu} = \sqrt{\frac{900}{8.1\times10^3\times10^{-6}}} = \frac{30}{90\times10^3} = \frac{1000}{3} m/s$$

$$\frac{a_r}{a_i} = \frac{V_{Al}-V_{Cu}}{V_{Al}+V_{Cu}} = \frac{\frac{800}{3}}{\frac{2800}{3}} = \frac{2}{7} \approx 0.3$$

For longitudinal wave $V_\ell = \sqrt{\frac{Y}{\rho}}$

$$V_{Al} = \sqrt{\frac{9\times10^{10}}{2.5\times10^3}} = \frac{3\times10^5}{50} = 6000\ m/s$$

$$V_{Cu} = \sqrt{\frac{16\times10^{10}}{8.1\times10^3}} = \frac{4\times10^5}{9\times10} = \frac{40000}{9}\ m/s$$

$$\frac{a_r}{a_i} = \frac{V_{Al}-V_{Cu}}{V_{Al}+V_{Cu}} = \frac{\frac{1400}{9}}{\frac{94000}{9}} = \frac{7}{47} \approx 0.15$$

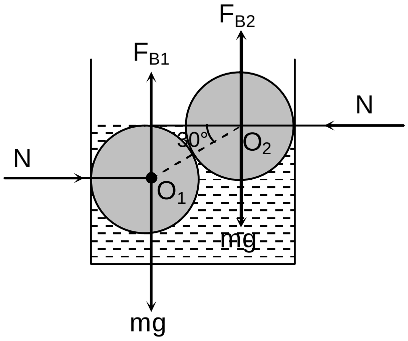
8. $2mg = F_{B1} + F_{B2}$

$\Rightarrow \rho_{wood} = \frac{3}{4}\rho_{water} = 750\,kg/m^3$

Taking torque about O₁

$N \times R = (mg - F_{B2}) \times 2R\cos 30°$

$\Rightarrow\ = 45 \times 10 \times \frac{1}{3} \times 1.732 = 259.8 \approx 260N$



9. During one time period (T_0)

$$W = \frac{T\omega^2 y_0^2}{2v}\left[\int_0^{T_0}\left(1+\cos\left\{2\omega\left(t-\frac{x}{v}\right)\right\}\right)dt\right]$$

Average Power = $\frac{W}{T_0} = \frac{\omega^2 y_0^2 T}{2v}$

10. Since the work done will be same at any place along the string in one cycle so choose x = 0, for convenience. Then work done in a cycle = $\frac{\omega^2 y_0^2 T}{v}\int_0^{2\pi/\omega}\cos^2\omega t\,dt = \frac{\pi\omega y_0^2 T}{v}$

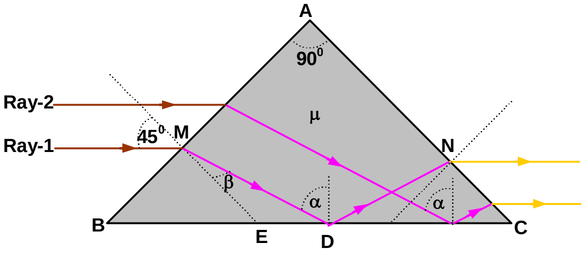
Average power = work done per unit time = $\frac{\text{work done in a cycle}}{\text{Time period}} = \frac{\frac{\pi\omega y_0^2 T}{v}}{\frac{2\pi}{\omega}} = \frac{\omega^2 y_0^2 T}{2v}$

Average power = $2\pi^2 f^2 y_0^2 T\sqrt{\frac{\mu}{T}} = 2\pi^2 f^2 y_0^2\sqrt{\mu T}$

$= 2\times 10\times 200\times 200\times 0.2\times 0.2\times 10^{-4}\sqrt{5\times 10^{-4}\times 5}$ = 160 × 10^{-3} Watt = 0.16 Watt.

11.-12. In figure-I, total internal reflection takes place at face AB.

$\angle EMD + \angle MDE = \angle BEM$



$$\Rightarrow \beta + \left(90^\circ - \alpha\right) = 45^\circ$$

$$\Rightarrow \sin\left(\beta + 45^\circ\right) > \left(\frac{1}{\mu}\right)$$

$$\Rightarrow \sin\beta + \cos\beta > \frac{\sqrt{2}}{\mu} \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

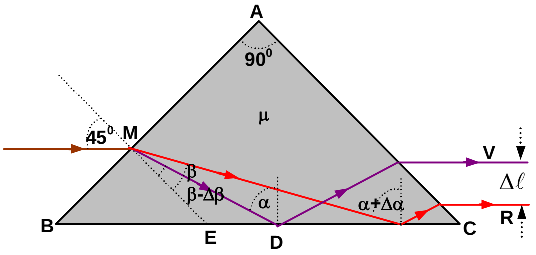
According to law of refraction at point M, we can write

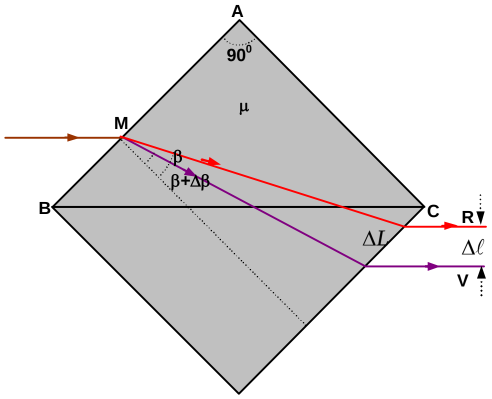
$$1\times\sin\left(45^\circ\right) = \mu\sin\beta \Rightarrow \sin\beta = \frac{1}{\mu\sqrt{2}} \Rightarrow \cos\beta = \sqrt{1-\frac{1}{2\mu^2}}$$

Putting these value in equation (1), we have

$$\frac{1}{\mu\sqrt{2}} + \sqrt{1-\frac{1}{2\mu^2}} > \frac{\sqrt{2}}{\mu} \Rightarrow \sqrt{2\mu^2-1} > 1 \Rightarrow \mu > 1$$

In figure-II: Replace the **Dove Prism,** by glass cube of side as AB.





$\Delta\ell = \frac{\Delta L}{\sqrt{2}}$ ……………..(2)

From geometry, we can write

$\sin\beta = \frac{1}{\mu_R\sqrt{2}}$ and $\sin(\beta - \Delta\beta) = \frac{1}{(\mu_R + \Delta\mu_R)\sqrt{2}}$

$$\Delta L = a\tan\beta - a\tan(\beta - \Delta\beta) = \frac{a}{\sqrt{2\mu_R^2 - 1}} - \frac{a}{\sqrt{2(\mu_R + \Delta\mu)^2 - 1}}$$

$$\Rightarrow \Delta L = \frac{a}{\sqrt{2\mu_R^2 - 1}}\left(1 - \sqrt{\frac{2\mu_R^2 - 1}{2(\mu_R + \Delta\mu)^2 - 1}}\right) = \frac{a}{\sqrt{2\mu_R^2 - 1}}\left(1 - \sqrt{\frac{2\mu_R^2 - 1}{2(\mu_R + \Delta\mu)^2 - 1}}\right)$$

$$\Rightarrow \Delta L = \frac{a}{\sqrt{2\mu_R^2 - 1}}\left(1 - \sqrt{\frac{2\mu_R^2 - 1}{2\mu_R^2 + 4\mu_R\Delta\mu + 2(\Delta\mu)^2 - 1}}\right)$$

Neglecting the value $(\Delta\mu)^2$, we have

$$\Rightarrow \Delta L = \frac{a}{\sqrt{2\mu_R^2 - 1}}\left(1 - \sqrt{\frac{1}{1 + \frac{4\mu_R\Delta\mu}{2\mu_R^2 - 1}}}\right) = \frac{a}{\sqrt{2\mu_R^2 - 1}}\left(1 - \left\{1 + \frac{4\mu_R\Delta\mu}{2\mu_R^2 - 1}\right\}^{-\frac{1}{2}}\right)$$

Expand binomially, we have

$$\Rightarrow \Delta L = \frac{2a\mu_R\Delta\mu}{(2\mu_R^2 - 1)^{\frac{3}{2}}}$$

Putting this value in equation (2), we have

$$\Delta\ell = \frac{\sqrt{2}a\mu_R\Delta\mu}{(2\mu_R^2 - 1)^{\frac{3}{2}}}$$

Second method:

$$\Delta L = \left(\frac{d}{d\beta}(a\tan\beta)\right) \times \Delta\beta$$

$$\Delta L = (a\sec^2\beta) \times \Delta\beta$$

Also $\sin\beta = \frac{1}{\sqrt{2}\mu_R}$

$$\Rightarrow \quad \cos\beta\Delta\beta = \frac{1}{\sqrt{2}\mu_R^2}\Delta\mu$$

$$\Rightarrow \quad \Delta L = \frac{a\sec^2\beta \times \Delta\mu}{\sqrt{2}\mu_R^2\cos\beta}$$

$$\Rightarrow \quad \Delta L = \frac{2a\mu_R\Delta\mu}{(2\mu_R^2 - 1)^{\frac{3}{2}}}$$

Third method:

$\Delta\ell = \frac{\Delta L}{\sqrt{2}}$, $\sin\alpha = \frac{1}{\mu_r\sqrt{2}}$, $\sin\beta = \frac{1}{\mu_v\sqrt{2}}$

$\Delta L = a\tan\alpha - a\tan\beta$

$$= a\left[\frac{1}{\sqrt{2\mu_r^2-1}}-\frac{1}{\sqrt{2\mu_v^2-1}}\right]$$

$$= a\left[\frac{1}{2}-\frac{1}{2\sqrt{1+\mu_r\Delta\mu}}\right]$$

$$= \frac{a}{2}\left[1-\left(1+\mu_r\Delta\mu\right)^{-1/2}\right]$$

$$= \frac{a}{2}\left[1-1+\frac{1}{2}\mu_r\Delta\mu\right]$$

$$= \frac{a}{4}\mu_r\Delta\mu$$

$$\Delta\ell = \frac{\Delta L}{\sqrt{2}} = \frac{a}{4\sqrt{2}}\mu_r\Delta\mu = \frac{4\,\text{cm}}{4\sqrt{2}}\times\frac{\sqrt{5}}{\sqrt{2}}\times\frac{2}{100}$$

$$= \frac{\sqrt{5}}{100}\text{cm} = \sqrt{5}\times10^{-4}\text{ m}$$

$$= 2.25\times10^{-4}\text{ m}$$

Since: $\Delta\ell \geq d$

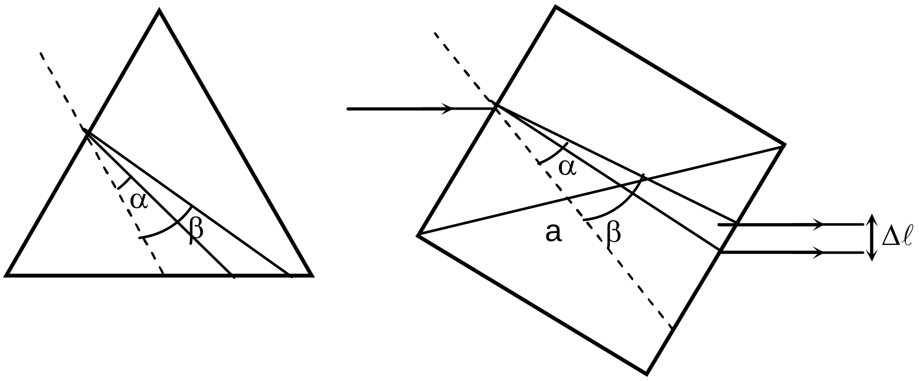
$\Rightarrow \quad d \leq 2.25\times10^{-4}\text{m}$

$$\sqrt{2\mu_v^2-1} = \sqrt{2\left(\mu_r+\Delta\mu\right)^2-1}$$

$$= \sqrt{2\mu_r^2+2\left(\Delta\mu\right)^2+4\mu_r\Delta\mu-1}$$

$$= \sqrt{4+4\mu_r\Delta\mu}\ \left[\left(\Delta\mu\right)^2\approx 0\right]$$

$$= 2\sqrt{1+\mu_r\Delta\mu}$$



SECTION – C

13. $\frac{EB}{\mu} = \frac{B^2C}{\mu}$ = energy density × speed

= Energy per unit volume × speed

= $\frac{\text{Energy}}{\text{volume}}\times\text{speed}$

$$\frac{ML^2T^{-2}}{L^3}\times LT^{-1} = ML^0T^{-3}$$

Here a = 1, b = 0 c = –3 $\Rightarrow \frac{b-c}{a} = \frac{0-(-3)}{1} = 3$

14. μ = mass per unit length = $\frac{m}{\ell} = \frac{0.6\times10^{-3}}{2}$ = 3×10^{-4} kg/m

T = mg = 0.5 × 9.8 = 4.9 N $\Rightarrow$ Tension in the string

v = speed of wave in string = $\sqrt{\frac{T}{\mu}}$

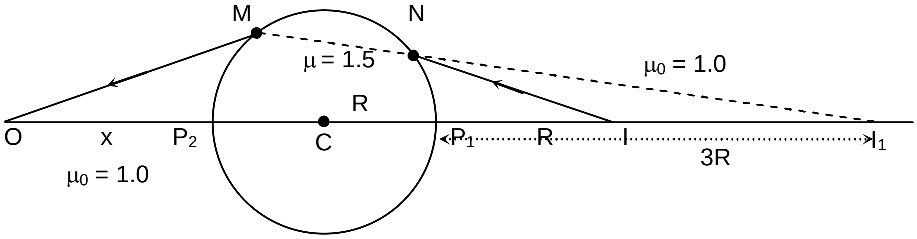
$= \sqrt{\frac{4.9}{3\times10^{-4}}} = 128$ m/s

$\lambda \Rightarrow$ wavelength of the wave = $\frac{v}{f} = \frac{128}{400} = 32\times10^{-2}$ m = $2^5 \times 10^{-2}$ m

$\Rightarrow$ n = 5

15. We can reverse the question. Let I behaves as object and O behaves as image, because retracing the path will not alter the distances.
Consider first refraction at point N

$$\frac{1.5}{v} - \frac{1.0}{-R} = \frac{1.5-1.0}{+R} \Rightarrow \frac{1.5}{v} = \frac{1}{2R} - \frac{1}{R} \Rightarrow v = -3R$$



Consider second refraction at point M, for this I, will behaves as normal object so

$$\frac{1.0}{v} - \frac{1.5}{-5R} = \frac{1.0-1.5}{-R}$$

$$\Rightarrow \frac{1}{v} + \frac{3}{10R} = \frac{1}{2R} = \frac{5}{10R}$$

$$\Rightarrow \frac{1}{v} = \frac{5}{10R} - \frac{3}{10R} = \frac{1}{5R}$$

$\Rightarrow$ v = 5R

$\Rightarrow$ x = 5R $\Rightarrow$ k = 5

16. We have to calculate the partial pressure, generated due the liquid of variable density

$$\rho = \frac{\rho_0}{H}y + \rho_0$$

W = weight of liquid column above the point A

$$\Rightarrow W = \int_y^H S\rho g dy = gS\rho_0 \int_y^H \left(1 + \frac{y}{H}\right) dy$$

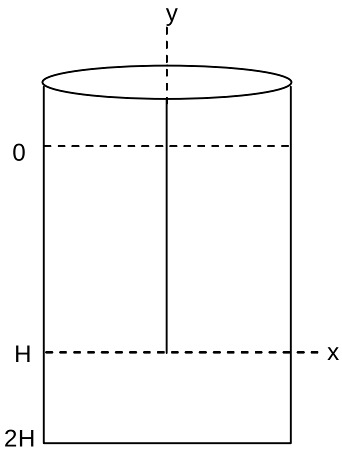
$$= gs\rho_0 \left[(H-y) + \frac{H^2-y^2}{2H}\right] = \frac{S\rho_0 (H-y)(3H-y)g}{2H}$$

P_1 = Partial pressure at interface (y = 0) due to liquid with variable density = $\left.\frac{W}{S}\right|_{y=0}$

$= \frac{3\rho_0 gH}{2}$

P $\Rightarrow$ Pressure at bottom = $P_0 + P_1 + \rho_0 gH = \rho_0 + \frac{5\rho_0 gH}{2}$

$= 10^5 + \frac{5\times10^3\times10\times4}{2} = 2\times10^5 = 2$ atm



17. Use Bernoulli's equation at point-3 and point-4, we can write

$$\frac{P_0+\Delta P}{\rho_{air}} = \frac{P_{BC}}{\rho_{air}} + \frac{1}{2}v^2 \Rightarrow P_{BC} = P_0 + \Delta P - 0.65\,v^2$$

Using Bernoulli's equation at point -1 and point -2, we can write

$$\frac{P_1}{\rho_{liquid}} + \frac{1}{2}v_{liquid}^2 = \frac{P_2}{\rho_{liquid}}$$

$$\Rightarrow \frac{P_{BC}+\rho_{\ell iquid}gh}{\rho_{\ell iquid}} + \frac{1}{2}v_\ell^2 = \frac{P_0}{\rho_\ell}$$

$$\Rightarrow \frac{P_0+\Delta P+\rho_\ell gh-0.65v^2}{\rho_\ell} + \frac{1}{2}v_\ell^2 = \frac{P_0}{\ell}$$

$$\Rightarrow \frac{1}{2}\rho_\ell v_\ell^2 = 0.65v^2 - \Delta P - \rho_\ell gh \ge 0$$

$$\Rightarrow v^2 \ge \frac{\Delta P+\rho_\ell gh}{0.65}$$

$$v_{min} = \sqrt{\frac{\Delta P+\rho_\ell gh}{0.65}} = \frac{100}{5} = 20 \text{ m/s}$$

18. According to Bohr's model

$$\Delta E = E_0\left(1-\frac{1}{n^2}\right) \Rightarrow \Delta E_{min} = \frac{3E_0}{4}$$

During inelastic collision, a part of kinetic energy of colliding particles is converted into internal energy. The internal energy of the system of two hydrogen atoms, considered in the problem cannot be changed less than ΔE_{min}. It means if the change in kinetic energy of system in ground frame is less than ΔE_{min} (or if the kinetic energy of colliding atoms with respect to their centre of mass is less than ΔE_{min}), then collision must be an elastic one. Hence considering the critical case

$$\frac{1}{2}m_H\left(\frac{v_0}{2}\right)^2\times2 = \frac{3E_0}{4} \Rightarrow v_0 = \sqrt{\frac{3E_0}{m_H}}$$

$$\sqrt{\frac{3\times2.18\times10^{-18}}{1.67\times10^{-27}}} = \sqrt{39.1617}\times10^4 = 6.257\times10^4 \text{ m/s} \approx 6.26\times10^4 \text{ m/s}$$

$$\frac{a\times b\times c}{k\times n} = \frac{6\times2\times6}{3\times4} = 6$$

19. $\cos\theta = \frac{r}{R} = \frac{1}{2}$

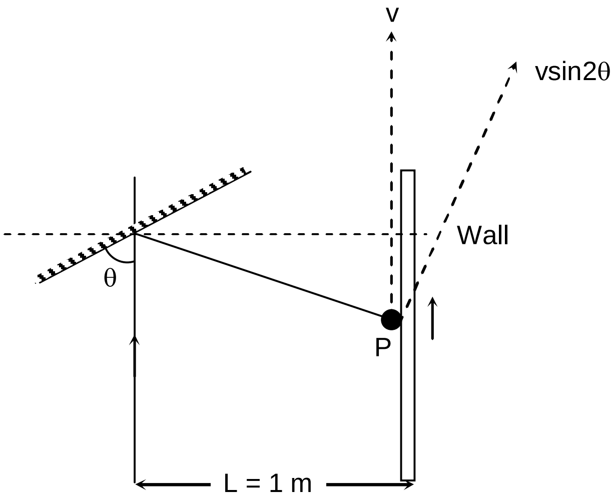
$4\pi r T\cos\theta = \pi r^2 \Delta P$

20. $\tan(2\theta - 90) = \frac{Y}{L}$

$y = -L\cot 2\theta$

$\frac{dy}{dt} = -L \times \left(-\operatorname{cosec}^2 2\theta\right) \times 2\frac{d\theta}{dt}$

$= 2L\left(\operatorname{cosec}^2 2\theta\right)\frac{d\theta}{dt}$



Chemistry PART – II

SECTION – A

21. (A) $2CrI_3 + 27Cl_2 + 64KOH \longrightarrow 2K_2CrO_4 + 54KCl + 6KIO_4 + 32H_2O$

(B) n-Factor of $(NH_4)_2Cr_2O_7$ is 6.

(C) $\left[\overset{+3}{Fe}\left(\overset{+2}{C}\overset{-3}{N}\right)_6\right] \longrightarrow Fe^{3+} + \overset{+4}{C}O_2 + \overset{+5}{N}O_3^-$

n-Factor = 60.

(D) $\underset{n-Factor=\frac{2}{3}}{\overset{+6}{Mn}O_4^{2-}} + H^+ \longrightarrow \overset{+7}{Mn}O_4^- + \overset{+4}{Mn}O_2$

Hence, eq. wt. of $MnO_4^{2-} = \dfrac{119 \times 3}{2} = 178.5$

22. B. $CuCl_2 + H_2S \longrightarrow CuS + 2HCl$

C. $\left[Cd(CN)_4\right]^{2-} + H_2S \longrightarrow CdS + 2H^+ + 4CN^-$

D. $\left[Zn(OH)_4\right]^{2-} + H_2S \longrightarrow ZnS + 2OH^- + 2H_2O$

23.
$$\begin{array}{lcc} & 2A & \rightleftharpoons A_2 \\ \text{moles at } t = 0 & m & 0 \\ \text{moles at } t_{eq} & m - m\alpha & \dfrac{m\alpha}{2} \end{array}$$

Total moles = $m - \dfrac{m\alpha}{2} = m\left(1 - \dfrac{\alpha}{2}\right)$

$$\Delta T_b = iK_b m = K_b m\left(1 - \frac{\alpha}{2}\right)$$

$$1 - \frac{\alpha}{2} = \frac{\Delta T_b}{K_b m}$$

$$\alpha = \frac{2(K_b m - \Delta T_b)}{K_b m}$$

Equilibrium constant K for the dimer formation is

$$K = \frac{[A_2]}{[A]^2} = \frac{m\alpha}{2[m(1-\alpha)]^2}$$

$$K = \frac{\alpha}{2m(1-\alpha)^2}$$

$$K = \frac{2(K_b m - \Delta T_b)}{K_b m} \Big/ 2m\left[1 - \frac{2(K_b m - \Delta T_b)}{K_b m}\right]^2$$

$$K = \frac{K_b(K_b m - \Delta T_b)}{(K_b m - 2K_b m + 2\Delta T_b)^2}$$

$$K = \frac{K_b(K_b m - \Delta T_b)}{(2\Delta T_b - K_b m)^2}$$

24. Cloud seeding is a form of weather modification, a way changing the amount or type of precipitation that falls from clouds by dispersing chemicals into the air.

25. Fe_2O_3, $\phi = \frac{\pi}{3\sqrt{2}}\left\{1+\frac{2}{3}(0.414)^3\right\}$

Diamond, $\phi = 8\times\frac{4\pi r^3}{3\times\left(2\sqrt{2}r\right)^3}$

26. Diaspore is an aluminium oxide hydroxide mineral crystallizing in the orthorhombic system.

28. A represent liquid composition and B represent vapour composition.

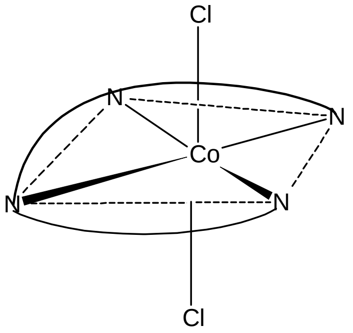
29. Above packing represent two possible arrangements, hexagonal close packing or cubic close packing, hence minimum distance, a or $\frac{a}{\sqrt{2}}$.

30. Above information represent cubic close packing

$$\rho = \frac{197\times 4}{(4.07)^3\times 10^{-24}\times 6.02\times 10^{23}}$$

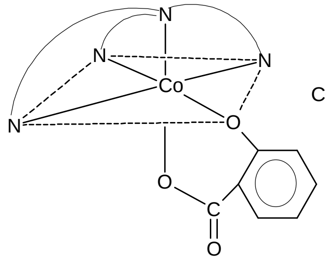
$$\rho = 19.41\ \text{g/cc}$$

31. (A)

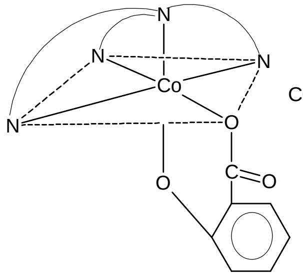


trans form has 3 coplanar ring

(C)



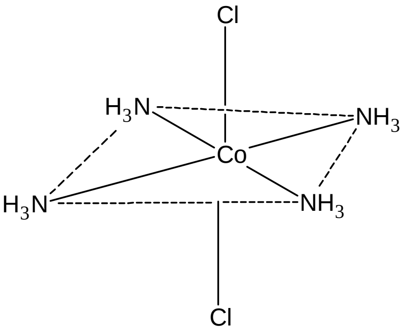
COO⁻ *trans* to tertiary N



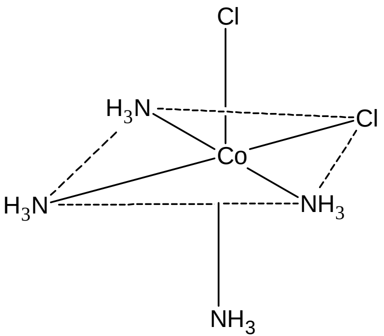
COO⁻ *cis* to tertiary N

$[Pt(NH_3)_2(py)_2Cl_2]^{2+}$ has 4 non chiral isomer.

32.



trans achiral



cis achiral

It has axis of symmetry and plane of symmetry

SECTION – C

33. The energy involved during oxidation of glucose is $= -\dfrac{2880 \times 150}{180} = -2400$ kJ

Energy available for muscular work $= \dfrac{2400}{4} = 600$kJ

Energy required for 1 km walk = 100 kJ

Therefore the distance that a person will be able to walk taking 150 g glucose = 6 km.

34. $14H^+ + Cr_2O_7^{--} + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$

$$E_{Cr_2O_7^{--}/Cr^{3+}} = E^o_{Cr_2O_7^{--}/Cr^{3+}} - \frac{0.059}{6}\log_{10}\frac{\left[Cr^{3+}\right]^2}{\left[Cr_2O_7^{--}\right]\left[H^+\right]^{14}}$$

$$E_{Cr_2O_7^{--}/Cr^{3+}} = 1.33 + \frac{0.059}{6}\log_{10}\frac{\left(\frac{4.5}{1000}\right)\left(10^{-2}\right)^{14}}{\left(\frac{15}{1000}\right)^2}$$

$$= 1.33 + \frac{0.059}{6}\log_{10}\frac{4.5 \times 10^{-31}}{2.25 \times 10^{-4}}$$

$$= 1.33 + \frac{0.059}{6}\log_{10}\left(2 \times 10^{-27}\right)$$

= 1.06

= 1 V

35. Assume organic compound is A and n molecules of A polymerise

$\Delta T_f = iK_f m$

$$i = \frac{\Delta T_f}{K_f m} = \frac{0.93 \times 94 \times 100}{1.86 \times 9.4 \times 1000}$$

$$i = \frac{1}{n} = 0.5$$

n = 2

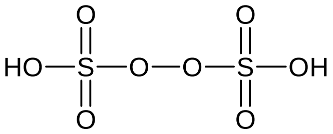
36. Average velocity $= \dfrac{5 \times 5 + 10 \times 3 + 6 \times 6}{21} = 4.33$

rms velocity $= \sqrt{\dfrac{5 \times 25 + 10 \times 9 + 6 \times 36}{21}} = 4.53$

$$\frac{V_{av}}{V_{rms}} = 0.955 = 9.5 \times 10^{-1}$$

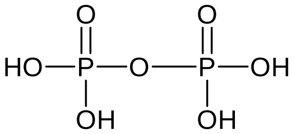
x = 1

37.



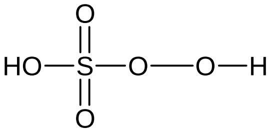
$$\mathrm{HO-\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}-O-O-\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}-OH}$$

Marshall acid a = 0



$$\mathrm{HO-\overset{\overset{O}{\|}}{\underset{\underset{OH}{|}}{P}}-O-\overset{\overset{O}{\|}}{\underset{\underset{OH}{|}}{P}}-OH}$$

Pyrophosphoric acid b = 0



$$\mathrm{HO-\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}-O-O-H}$$

Caro acid c = 1

$O = C = C = C = O$ Carbon suboxide d = 2

38. $\frac{r_c}{r_a} = 0.858$

From above ratio it is clear that cation occupy cubic void in simple cubic unit cell, hence $\sqrt{3}a = 2(r_c + r_a)$

a = 4

40. $\underset{A}{FeCl_3} + 3KCN \longrightarrow \underset{B}{Fe(CN)_3} + 3KCl$

$Fe(CN)_3 + 3KCN \longrightarrow \underset{C}{K_3[Fe(CN)_6]}$

$4FeCl_3 + 3K_4[Fe(CN)_6] \longrightarrow \underset{D}{Fe_4[Fe(CN)_6]_3} + 12KCl$

$Fe_4[Fe(CN)_6]_3 + 12NaOH \longrightarrow 4Fe(OH)_3 + 3Na_4[Fe(CN)_6]$

$FeCl_3 + Na_2HPO_4 \longrightarrow \underset{E}{FePO_4} + 2NaCl + HCl$

Mathematics PART – III

SECTION – A

41. Put i = j = k
$a_{ij} = 0$ and put k = i $\Rightarrow a_{ij} = -a_{ji}$
So, matrix is skew symmetric of odd order

42. $y = (2x+3) + \frac{7}{(x+3)}$
x, y $\in$ I; x + 3 = ±1, ±7
(x, y) → (–2, 6), (–4, –12), (4, 12), (–10, –18)

43. $[a_{n+2} = 2a_{n+1} - 3a_n]$

44. $\frac{x}{(x+i)!} \le \frac{x+i-1}{(x+i)!} = \frac{1}{(x+i-1)!} - \frac{1}{(x+i)!}$

$x\sum_{i=1}^{y}\frac{1}{(x+i)!} \le \frac{1}{x!} - \frac{1}{(x+y)!}$ ..... (1)

$\lim_{y\to\infty}(f(x, y)) \le \frac{1}{xx!} \le \frac{1}{x!}$ ..... (2)

$f(x, x) = \frac{1}{(x+1)!} + \frac{1}{(x+2)!} + ... + \frac{1}{(x+x)!} \le \frac{x}{x!} = \frac{1}{(x-1)!}$

45. A.M. ≥ H.M. for $\frac{1}{a}, \frac{1}{b}, \frac{1}{c}$, we get $\frac{\frac{1}{a}+\frac{1}{b}+\frac{1}{c}}{3} \ge \frac{3}{6}$

$\Rightarrow \frac{1}{a}+\frac{1}{b}+\frac{1}{c} \ge \frac{3}{2}$

Now, $\frac{\left(a+\frac{1}{b}\right)^2 + \left(b+\frac{1}{c}\right)^2 + \left(c+\frac{1}{a}\right)^2}{3} \ge \left(\frac{a+\frac{1}{b}+b+\frac{1}{c}+c+\frac{1}{a}}{3}\right)^2 \ge \left(\frac{6+\frac{3}{2}}{3}\right)^2$

$\left(a+\frac{1}{b}\right)^2 + \left(b+\frac{1}{c}\right)^2 + \left(c+\frac{1}{a}\right)^2 \ge \frac{75}{4}$

46. $P_n = P_{n-1} + P_{n-2}$, $P_1 = 1$, $P_2 = 1$
$P_3 = 1 + 1 = 2$
$P_4 = 2 + 1 = 3$
$P_5 = 5$
$P_6 = 8$
$P_7 = 13$
$P_8 = 21$
$P_9 = 34$
$P_{10} = 55$

47. (A) Intersection point is mid-point of AB and CD
(B) $2\alpha + 6\beta + 15\gamma = 7$

$$\left(2\hat{i}+6\hat{j}+3\hat{k}\right)\cdot\left(\alpha\hat{i}+\beta\hat{j}+5\gamma\hat{k}\right)\le 7\times\sqrt{\alpha^2+\beta^2+25\gamma^2}$$

$$\left(2\alpha+6\beta+15\gamma\right)\le 7\sqrt{\alpha^2+\beta^2+25\gamma^2}$$

$\alpha^2 + \beta^2 + 25\gamma^2 \ge 1$

(C) Triangle is equilateral

(D) Intersection points are (1, 2, 3) and (2, –3, 1)

48. Let N = $x_1x_2x_3$ ..... x_{10} be one of such number

$\sum x_i = 45$, hence N is divisible by 9. Hence N should by divisible by 11111 × 9 = 99999

Now $x_1x_2x_3$ ..... $x_{10} = x_1x_2x_3x_4x_5 \times 10^5 + x_6x_7x_8x_9x_{10}$

$= x_1x_2x_3x_4x_5 \times 99999 + (x_1x_2x_3x_4x_5) + (x_6x_7x_8x_9x_{10})$

Now $x_1x_2x_3x_4x_5 < 99999$

$x_6x_7x_8x_9x_{10} < 99999$

$x_1x_2x_3x_4x_5 + x_6x_7x_8x_9x_{10} < 2 \times 99999$

$x_1x_2x_3x_4x_5 + x_6x_7x_8x_9x_{10} = 99999$

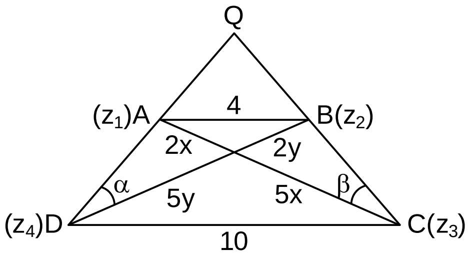
$x_1 + x_6 = x_2 + x_7 = x_3 + x_8 = x_4 + x_9 = x_5 + x_{10} = 9$

So, smallest number 1023489765

Largest number 9876501234

Total number 9 × 8 × 6 × 4 × 2 × 1 × 1 × 1 × 1 × 1 = 3456

49.-50. ΔABP and ΔCDP are similar if AP = 2x, BP = 2y then CP = 5x, DP = 5y



Area of trapezium $ABCD = \frac{49}{2}xy$

$\tan\alpha = \frac{2x}{5y}, \tan\beta = \frac{2y}{5x}$ also $\alpha + \beta = 45^o$

$\Rightarrow\ xy = \frac{10}{21}\left(x^2+y^2\right)$

Also $AB^2 = AP^2 + BP^2 \Rightarrow x^2 + y^2 = 4 \Rightarrow xy = \frac{40}{21}$

Ar(ΔPCD) = 5xy

51. 9 + 8 + 6 + 5 + 4 = 32

Set P(A , B, C, D, E, F, G) = (2, 3, 4, 5, 6, 8, 9)

n(S) = ${}^7C_5 \times 5!$

Total numbers divisible by 5 = ${}^6C_4 \times 4!$

Total numbers divisible by 3 = ${}^3C_1 \times 5! + {}^3C_2 \times 5! = 6!$

Total numbers divisible by 4 = 720

52. 9, 8, 6, 5, 4

(A and B) ..... 9 + 8 + 6 + 5 + 4 = 32

|(9 + 8) – (6 + 5 + 4)| = 2 not divisible by 11

|(9 + 6) – (8 + 5 + 4)| = 3 not divisible by 11

|(9 + 5) – (8 + 6 + 4)| = 4 not divisible by 11

|(9 + 4) – (8 + 6 + 5)| = 6 not divisible by 11

|(8 + 6) – (9 + 5 + 4)| = 4 not divisible by 11

|(8 + 5) – (9 + 6 + 4)| = 6 not divisible by 11

|(8 + 4) – (9 + 6 + 5)| = 8 not divisible by 11

|(6 + 5) – (9 + 8 + 4)| = 10 not divisible by 11

|(6 + 4) – (9 + 8 + 5)| = 12 not divisible by 11

|(5 + 4) – (9 + 8 + 6)| = 14 not divisible by 11

(C) ..... $\underline{4}$ $\underline{8}$

$\underline{5}\ \ \underline{6}$
$\underline{6}\ \ \underline{4}$
$\underline{8}\ \ \underline{4}$
$\underline{9}\ \ \underline{6}$

Probability = $\frac{5\times 3!}{5!}=\frac{1}{4}$

SECTION – C

53. Let a + 2b + c = x, a + b + 2c = y, a + b + 3c = z
a = –x + 5y – 3z, b = z + x – 2y, c = z – y
Apply A.M. ≥ G.M.

$$\frac{a+3c}{a+2b+c}+\frac{4b}{a+b+2c}-\frac{8c}{a+b+3c}\ \geq -17+12\sqrt{2}$$

54. $\alpha+\beta=\frac{a_2}{a_1}$, $\alpha\beta=\frac{a_3}{a_1}$, α, $\beta \in (1, 2)$

$\Rightarrow \alpha - 1, \beta - 1, 2 - \alpha, 2 - \beta \in (0, 1)$

A.M. ≥ G.M. $\Rightarrow \frac{(\alpha-1)+(2-\alpha)}{2}\geq\sqrt{(\alpha-1)(2-\alpha)}$

$\Rightarrow (\alpha-1)(2-\alpha)\leq\frac{1}{4}$ similarly $(\beta - 1)(2 - \beta) \leq \frac{1}{4}$

$0<(\alpha-1)(2-\alpha)(\beta-1)(2-\beta)<\frac{1}{16}$ (Both can't equal to $\frac{1}{4}$ simultaneously $(\alpha \neq \beta)$

$$0<\left(\frac{a_3}{a_1}-\frac{a_2}{a_1}+1\right)\left(4-\frac{2a_2}{a_1}+\frac{a_3}{a_1}\right)<\frac{1}{16}$$

$$0<\frac{(a_1-a_2+a_3)(4a_1-2a_2+a_3)}{a_1^2}<\frac{1}{16}$$

$$\frac{a_1^2}{16}>(a_1-a_2+a_3)(4a_1-2a_2+a_3)$$

$$\frac{a_1^2}{16}>f(1)\cdot f(2)\ \Rightarrow\ \frac{a^2}{16}>1$$

$\Rightarrow$ Least integral value of a is 5

55. Let $\frac{n}{m}$ be the common ratio of G.P., where n and m are coprime integers n > m

$a_5=a_1\cdot\frac{n^4}{m^4}$ so let $a_1 = km^4$ $(k \in I^+)$

G.P. km^4, km^3n, km^2n^2, kmn^3, kn^4

$kn^4 < 100 \Rightarrow$ n can't be greater than or equal to 4

Case-I: n = 3 and m = 2

$\Rightarrow a_5 = kn^4 < 100$

$\Rightarrow k<\frac{100}{81}\ \Rightarrow k = 1$

G.P. (16, 24, 36, 54, 81)

Case-II: n = 3 and m = 1

$\Rightarrow a_5 = 81k < 100 \Rightarrow k = 1$

G.P. (1, 3, 9, 27, 81)

Case-III: n = 2, m = 1

$\Rightarrow k < \frac{100}{16}$

$\Rightarrow$ k = 1, 2, 3, ... 6

G.P.'s (1, 2, 4, 8, 16), (2, 4, 8, 16, 32), (3, 6, 12, 24, 48), (4, 8, 16, 32, 64), (6, 12, 24, 48, 96), (5, 10, 20, 40, 80)

56. Highest power of $x = \frac{n(n+1)}{2} = m$ (let) have to find coefficient of x^{m-9}

$-9 + (-8 \times -1) + (-7 \times -2) + (-6 \times -3) + (-5 \times -4) + (-6 \times -2 \times -1)$
$+ (-5 \times -3 \times -1) + (-4 \times -3 \times -2) = 0$

57. $$\frac{\frac{a^4}{2}+\frac{a^4}{2}+\frac{b^6}{4}+\frac{b^6}{4}+\frac{b^6}{4}+\frac{b^6}{4}+\frac{c^8}{2}+\frac{c^8}{2}}{8} \geq \left(\frac{a^8b^{24}c^{16}}{2^{12}}\right)^{\frac{1}{8}}$$

Equality hold for a = 1, $b = 2^{1/6}$, c = 1

58. $\Sigma|z + \alpha^k z^2|^2 = \Sigma|z|^2 + \Sigma|\alpha^k|\,|z^2|^2 + 0$

59. $AA^T = 4I \Rightarrow |A| = \pm 2$

$A^T = 4A^{-1} = \frac{4\text{Adj}(A)}{|A|}$

$$\Rightarrow \begin{bmatrix} a_{11} & a_{21} & a_{31} \\ a_{12} & a_{22} & a_{32} \\ a_{13} & a_{23} & a_{33} \end{bmatrix} = \frac{4}{|A|}\begin{bmatrix} c_{11} & c_{21} & c_{31} \\ c_{12} & c_{22} & c_{32} \\ c_{13} & c_{23} & c_{33} \end{bmatrix}$$

Now, $a_{ij} = \frac{4}{|A|} c_{ij} = -2c_{ij} \Rightarrow |A| = -2$

Now, $|A + 4I| = |A + AA^T| = |A|\,|I + A^T| = -2|(I + A)^T| = -2|I + A|$ so, $\frac{|A+4I|}{|A+I|} = -2 = -5\lambda$

$\lambda = \frac{2}{5}$

60. $x^3 - x^2 - 1 = 0 \rightarrow \alpha, \beta, \gamma \Rightarrow \alpha^2 + \beta^2 + \gamma^2 = 1$

$\alpha^2 + \beta^3 + \gamma^4 = \alpha^2 + \beta^2 + 1 + \gamma^3 + \gamma = 3 + \gamma$

In given equation $x \rightarrow x - 3 \Rightarrow x^3 - 10x^2 + 33x - 37 = 0$

FIITJEE **JEE(Advanced)-2018**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

PART TEST – III

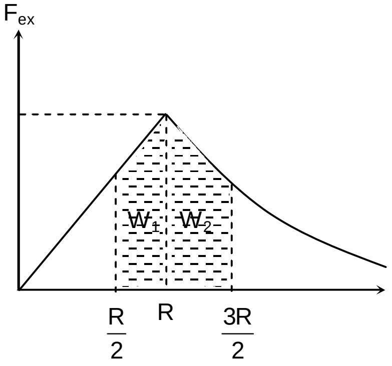
PAPER-1

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**A, C**	21.	**A, B, C, D**	41.	**A, D**
2.	**A, D**	22.	**A, B**	42.	**A, B, D**
3.	**A, B, C**	23.	**A, B, D**	43.	**A, B, D**
4.	**B, C**	24.	**A, C, D**	44.	**A, B, C**
5.	**B, D**	25.	**A, B, C, D**	45.	**A, B, C**
6.	**A, B, C, D**	26.	**A, B, D**	46.	**A, B**
7.	**A, B**	27.	**A, B, C, D**	47.	**A, C, D**
8.	**A, B, C**	28.	**A, D**	48.	**A, C**
9.	**A**	29.	**A, B, C, D**	49.	**A, B, C, D**
10.	**A**	30.	**A, B, C**	50.	**A, B, C**
11.	**(A) → (p, r), (B) → (s), (C) → (q, s), (D) → (p, r)**	31.	**(A) → (t), (B) → (r, s), (C) → (p, q), (D) → (p, q, s)**	51.	**(A) → (q, r, t), (B) → (q, r, t), (C) → (p, q), (D) → (p, r, s, t)**
12.	**(A) → (q, s), (B) → (q, s), (C) → (p, r), (D) → (q, s)**	32.	**(A) → (p, q, r), (B) → (q, s), (C) → (q, r, s, t), (D) → (p, q, r, t)**	52.	**(A) → (p, r, t), (B) → (s, t), (C) → (s), (D) → (p, r, t)**
13.	**4**	33.	**3**	53.	**1**
14.	**8**	34.	**8**	54.	**1**
15.	**2**	35.	**3**	55.	**8**
16.	**5**	36.	**5 m^3**	56.	**1**
17.	**6**	37.	**3**	57.	**1**
18.	**2**	38.	**2**	58.	**1**
19.	**8**	39.	**6**	59.	**4**
20.	**1**	40.	**5**	60.	**9**

Physics

PART – I

SECTION – A



1. $$F_{ex} = \begin{cases} \frac{GMm}{R^3}\vec{r} & \text{if } 0 \le r \le R \\ \frac{GMm}{r^3}\vec{r} & \text{if } R \le r < \infty \end{cases}$$

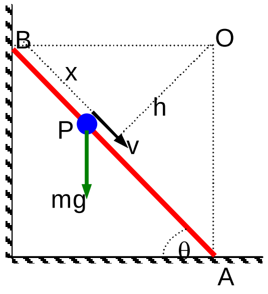
$$\Rightarrow W_1 > W_2$$

$$W_1 = \int_{R/2}^{R} \frac{4}{3}\pi G\rho m x dx = \frac{3GMm}{8R}$$

$$W_2 = \int_{R}^{3R/2} \frac{GMm}{x^2} dx = \frac{GMm}{3R}$$

$$\Rightarrow \frac{W_1}{W_2} = \frac{9}{8} \Rightarrow \left|\frac{W_1+W_2}{W_1-W_2}\right| = 17$$

2. Consider the bug at point P at any time t, moving with speed v along the stick, so $L = mvh = mv\ell\sin\theta\cos\theta \Rightarrow$ Angular momentum of bug about point O



$$\Rightarrow \tau = \frac{dL}{dt} = (m\ell\sin\theta\cos\theta)\frac{dv}{dt}$$

$$\Rightarrow mg(\ell - x)\cos\theta = (m\ell\sin\theta\cos\theta)\frac{dv}{dt}$$

$$\Rightarrow \frac{dv}{dt} = \frac{g}{\sin\theta}\left(1 - \frac{x}{\ell}\right)$$

$$\Rightarrow \frac{dv}{dt} + \frac{g}{\ell\sin\theta}x = \frac{g}{\sin\theta} \Rightarrow \text{Equation of SHM with mean position at point A}$$

$$\Rightarrow T = 2\pi\sqrt{\frac{\ell\sin\theta}{g}}$$

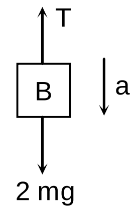
Time required = $\frac{T}{4} = \frac{\pi}{2}\sqrt{\frac{\ell\sin\theta}{g}}$

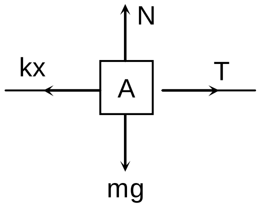
3. Basic concept of Intensity of light

4. Consider the system at any time t when each block is moving with speed v and spring has an extension x.

$\Rightarrow\ 2mg - T = 2ma$ …(1)

$\Rightarrow\ T – kx = ma$ …(2)





From equation (1) & (2), we can write

$$\frac{2g}{3} - \frac{k}{3m}x = a \Rightarrow \frac{d^2x}{dt^2} + \frac{kx}{3m} - \frac{2g}{3} = 0$$

$$\Rightarrow \frac{d^2x}{dt^2} + \frac{k}{3m}\left[x - \frac{2mg}{k}\right] = 0 \Rightarrow \omega = \sqrt{\frac{k}{3m}}$$

For equilibrium $\frac{d^2x}{dt^2} = 0 \Rightarrow x_0 = \frac{2mg}{k}$

Amplitude of motion = $x_0 - 0 = \frac{2mg}{k}$

$$a_{max} = \omega^2 A = \frac{k}{3m} \times \frac{2mg}{k} = \frac{2g}{3}$$

$$v_{max} = \omega A = \frac{2mg}{k}\sqrt{\frac{k}{3m}} = 2g\sqrt{\frac{m}{3k}}$$

Second Method:

Using **COME**, we can write

$$2mgx = \frac{3mv^2}{2} + \frac{kx^2}{2}$$

For extreme position, v = 0 ⇒ x = 0, $\frac{4mg}{k}$

A ⇒ Amplitude of motion = $\frac{2mg}{k}$

For maximum velocity, $\frac{d^2x}{dt^2} = 0 \Rightarrow x = \frac{2mg}{k} \Rightarrow$ Equilibrium position

$$\Rightarrow 2mg \times \frac{2mg}{k} = \frac{3mv_{max}^2}{2} + k\frac{4m^2g^2}{2k}$$

$$\Rightarrow \frac{4m^2g^2}{2k} = \frac{3mv_{max}^2}{2} \Rightarrow v_{max}^2 = 4g^2\left(\frac{m}{3k}\right)$$

$$\Rightarrow v_{max} = 2g\sqrt{\frac{m}{3k}}$$

$$a_{max} = \left|\frac{2g}{3} - \frac{k}{3m} \times \frac{4mg}{k}\right| = \frac{2g}{3}$$

5. The energy released in α-decay is given by

$Q = (M_U - M_{Th} - M_{He})c^2$

Substituting the atomic masses as given in the data, we find

$Q = (238.05079 - 234.04363 - 4.00260)u \times c^2 = (0.00456\ u)c^2 = (0.00456u)c^2$

$= (0.00456u)(931.5\ MeV/u)$ = 4.25 MeV.

If ${}^{238}_{92}U$ spontaneously emits a proton, the decay process would be ${}^{238}_{92}U \rightarrow {}^{237}_{91}Pa + {}^{1}_{1}H$

The Q for this process to happen is

$= (M_U - M_{Pa} - M_H)c^2 = (238.05079 - 237.05121 - 1.00783)u \times c^2 = (-0.00825u)c^2$

$= -(0.00825\ u)(931.5\ MeV/u)$ = – 7.68 MeV

Thus, the Q of the process is negative and therefore it cannot proceed spontaneously. We will have to supply an energy of 7.68 MeV to a ${}^{238}_{92}U$ nucleus to make it emit a proton.

6. $v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{50 \times 1 \times 9.8}{0.1}} = 70\,m/s$.

$\frac{\lambda}{4} = 1 \Rightarrow \lambda = 4m \Rightarrow f = \frac{v}{\lambda} = \frac{70}{4} = 17.5\,Hz$.

$v_{pmax} = \omega A \Rightarrow A = \frac{v_{pmax}}{2\pi f} = \frac{15}{2 \times 3.14 \times 17.5} = 0.136\,m = 13.6 \times 10^{-2}\,m$

7. (C) $\frac{M}{M_0} = \frac{Mc^2}{M_0c^2} = \frac{K + M_0c^2}{M_0c^2} = 1 + \frac{10^{-9}}{1.67 \times 10^{-27} \times 9 \times 10^{20}} \approx 7.68$

(D) $Mc^2 = M_0c^2 + K = 2m_0c^2$

$\Rightarrow$ M = 2 M_0

$\Rightarrow \frac{M_0}{\sqrt{1 - \frac{v^2}{c^2}}} = 2M_0$

$\Rightarrow 1 = 4 - \frac{4v^2}{c^2}$

$\Rightarrow v^2 = \frac{3c^2}{4} \Rightarrow v = \frac{\sqrt{3}}{2}c = 0.866c$

8. $\frac{m\lambda}{2} = 40$

$\left(n + \frac{1}{2}\right)\frac{\lambda}{2} = 30$

$\frac{(2n+1)}{m} = \frac{6}{4} \Rightarrow m = \frac{2(2n+1)}{3}$

n = 1 m = 2 λ = 40 cm
n = 4 m = 6 v = f$\lambda \Rightarrow$ f/40 = f_0
n = 7 m = 10
λ = 8 second overtone
f = v/8 = 5f_0
n = 10 m = 14

$\lambda = \frac{40}{7} \Rightarrow f_3 = \frac{7v}{40}$.

9. Let x be the wave length for K_α-line

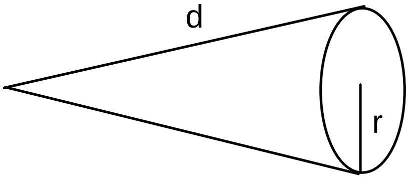
$$\frac{x - \frac{hc}{eV_2}}{x - \frac{hc}{eV_1}} = 3$$

$$x = \frac{4}{3R(Z-1)^2}$$

$\Rightarrow$ Z = 29

10. $\frac{dN}{dt} = \frac{P}{(hc/\lambda)} = 5\times10^{19}\,/\,s$

$\frac{hc}{\lambda} = 2.49\,eV > W_0$: Yes.



SECTION – B

11. Use $K_{max} = h\nu - \phi$

12. Use concept of combination of lenses.

SECTION – C

13. OE = x

$FG = \sqrt{2}a + 2y$

From the property of rhombus, we can write

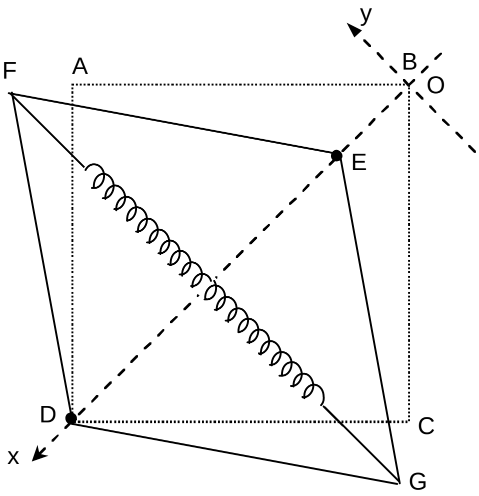
$$\left(\frac{a}{\sqrt{2}} + y\right)^2 + \left(\frac{a}{\sqrt{2}} - \frac{x}{2}\right)^2 = a^2$$

Neglecting x^2 and y^2, we have $y = \frac{x}{2}$

Using COME, we can write

$$\frac{mv^2}{2} + \frac{k}{2}(x)^2 = E = \text{constant}$$

$$\Rightarrow T = \pi\sqrt{\frac{4m}{k}}$$



14. Let in time t, m mass of liquid collides with windshield. So

$$F = \left|\frac{p_f - p_i}{t}\right| = \left|\frac{0 - mv}{t}\right| = \frac{mv}{t}$$

$\lambda \Rightarrow$ density of liquid molecules in air so

$m = Svt \times \lambda = Sv\lambda t$

Where $S \Rightarrow$ surface area of the windshield

$F = Sv^2\lambda \Rightarrow$ Mean pressure = $\frac{F}{S} = \lambda v^2$ …(1)

Now as we assumed that λ is the density of liquid molecules of drops in air so in τ time $u\tau S_0$ volume of liquid will strikes on the surface of earth so mass of liquid strikes on the earth in time interval τ will be

$m_0 = S_0 u\tau\lambda$

$\Rightarrow S_0\rho h = S_0 u\tau\lambda$

$\Rightarrow \lambda = \frac{\rho h}{u\tau}$

Putting this value in equation (1), we have

Mean pressure = $\frac{\rho h v^2}{u\tau} = \frac{48}{5} \Rightarrow$ K = 8

15. $P_2 = \rho g(h-x),\ P_1 = \rho gh$

$V_2 = Ax \quad V_1 = Ax_0$

Using Boyle's low we can write

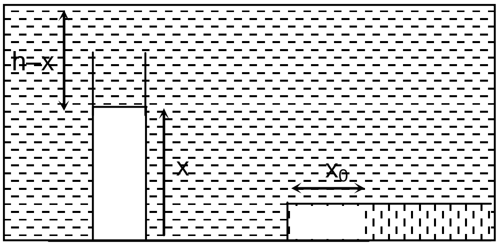
$\rho g(h-x)Ax = \rho gh(Ax_0)$

$\Rightarrow \quad x^2 - hx + hx_0 = 0 \ \Rightarrow \ x = \frac{h}{2} \pm \sqrt{\frac{h^2}{4} - hx_0}$

$\Rightarrow \quad x = 10\text{m}, 90\text{m}$

$x < \ell$ (length of pipe)

So answer will be x = 10 m



16. $$\frac{m\ell^2}{12}\alpha = -\left\{\frac{2k\theta}{12} + \frac{k\theta}{4}\right\}\ell^2 \Rightarrow \alpha = -\left(\frac{5k}{m}\right)\theta$$

17. $$mg = F_B = \left[\pi R^2 h - \int_0^h \pi\left(R^2 - z^2\right)dz\right]\rho g \quad \Rightarrow m = \frac{\pi h^3 \rho}{3}$$

$$\Rightarrow h^3 = \frac{3m}{\pi\rho} = \frac{3\times\pi\times 9}{\pi\times 10^3} \Rightarrow h = \frac{3}{10} = 0.3\,\text{m} = 30\,\text{cm}$$

18. Mass of water striking vanes/sec $= \rho av$

Initial velocity = v

Final velocity of water = u

Change in velocity = v – u

F = force on the vane $= \rho av(v-u)$

Work done $= f \times u = \rho avu(v-u)$ = 5400 watts

$\Rightarrow$ K = 2

19. $\frac{h}{d} = \tan\theta$

using triangle EAB

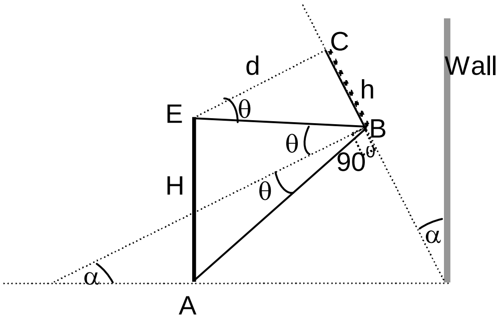
$$\frac{\frac{d}{\cos\theta}}{\sin\{90-(\alpha+\theta)\}} = \frac{H}{\sin 2\theta}$$

$$\Rightarrow \quad \frac{d}{\cos(\alpha+\theta)} = \frac{H}{2\sin\theta}$$

$$\Rightarrow \quad 2d = H[\cos\alpha\cot\theta - \sin\alpha]$$

$$= H\cos\alpha\left(\frac{d}{h}\right) - H\sin\alpha$$

$$\Rightarrow \quad h = \frac{Hd\cos\alpha}{2d + H\sin\alpha} = \frac{\frac{3}{2}\times 3\times\frac{3}{5}}{2\times 3 + \frac{3}{2}\times\frac{4}{5}} = \frac{27}{36\times 2} = \frac{3}{8}.$$



20. $$\varepsilon_0 VB^2 \equiv \frac{\varepsilon_0 E^2}{v^2}V \quad \left[B \equiv \frac{E}{v}\right]$$

$$\equiv \frac{u_e}{2v^2}V \equiv \frac{\text{Energy}}{(\text{speed})^2} \equiv \text{mass, so } a = 1, b = 0, c = 0$$

Chemistry

PART – II

SECTION – A

21. At critical temperature various physical properties of gas and liquid are identical.

22. A. $P = \alpha V$

$PV^{-1} = \alpha$

We know for polytropic process

$PV^{x} = \text{constant}$

$\therefore x = -1$

We know $C = C_v - \frac{R}{x-1}$

$C = C_v + \frac{R}{2}$

$C = \frac{R}{\gamma - 1} + \frac{R}{2}$

$C = \frac{R(\gamma+1)}{2(\gamma-1)}$

B. $dW = -PdV$

$dW = -\alpha V dV$

On integrating above equation.

$$W = -\alpha\left[\frac{(4V_o)^2}{2} - \frac{V_o^2}{2}\right]$$

$$W = -\frac{\alpha}{2}\left[16V_o^2 - V_o^2\right]$$

$$W = -15V_o^2\frac{\alpha}{2}$$

23. $[M(AA'A)_2]$, $[Ma_3b_3]$ and $[M(AB)_3]$ can show fac and mer forms.

24. Say, number of Cu^{2+} ions = x

Number of Cu^{+} ions = 1.8 – x

$\therefore x \times 2 + (1.8 - x) \times 1 = 1 \times 2$

$2x + 1.8 - x = 2$

$x = 2 - 1.8$

$x = 0.2$

% of $Cu^{2+} = \frac{0.2}{1.8} \times 100 = 11.11$

% of Cu^{1+} = 88.89

26. $\Delta G_{mix} = RT(n_A \ell n\chi_A + n_B \ell n\chi_B)$

$= 2 \times 300\left(1\,\ell n\frac{1}{3} + 2\,\ell n\frac{2}{3}\right)$

$\Delta G_{mix} = 600(-1.0986 - 0.8109) = -1145.7$ cal

$\Delta S_{mix} = -\frac{\Delta G_{mix}}{T} = 3.82$ cal k^{-1}

$\Delta H_{mix} = 0$

28. In froth floatation process pine oil used as collectors which enhance non-wettability of mineral particles.

- Cresol is froth stabilizers.
- NaCN used as depressant

29.
$$C + 4HNO_3 \longrightarrow CO_2 + 4NO_2 + 2H_2O$$
$$Cu + 4HNO_3 \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$$
$$Zn + 4HNO_3 \longrightarrow Zn(NO_3)_2 + 2NO_2 + 2H_2O$$
$$Sn + 4HNO_3 \longrightarrow H_2SnO_3 + 4NO_2 + H_2O$$

30. (A) $H_2O + Cl_2 \longrightarrow 2HCl + O$ (B) $H_2S + Cl_2 \longrightarrow 2HCl + S$

(C) $C_{10}H_{16} + 8Cl_2 \longrightarrow 16HCl + 10C$ (D) $8NH_3 + 3Cl_2 \longrightarrow 6NH_4Cl + N_2$

SECTION-B

31. Pb^{2+} :
$$Pb^{2+} + 2KI \longrightarrow \underset{\text{Yellow}}{PbI_2} \downarrow + 2K^+$$
$$Pb^{2+} + K_2CrO_4 \longrightarrow \underset{\text{Yellow}}{PbCrO_4} \downarrow + 2K^+$$

Ag^+ :
$$2Ag^+ + 2NaOH \longrightarrow \underset{\text{Brown}}{Ag_2O} \downarrow + H_2O + 2Na^+$$
$$2Ag^+ + H_2S \longrightarrow \underset{\text{Black}}{Ag_2S} \downarrow + 2H^+$$

Hg_2^{2+} :
$$Hg_2^{2+} + 2NaOH \longrightarrow \underset{\text{Black}}{Hg_2O} \downarrow + H_2O + 2Na^+$$
$$Hg_2^{2+} + H_2S \longrightarrow \underbrace{Hg \downarrow + HgS \downarrow}_{\text{Black}} + 2H^+$$
$$Hg_2^{2+} + 2KI \longrightarrow Hg_2I_2 + 2K^+$$
$$Hg_2I_2 + 2KI \longrightarrow K_2[HgI_4] + \underset{\text{Black}}{Hg} \downarrow$$

32. (A). Process is isobaric

$$C_V = \frac{5R}{2} \qquad C_P = \frac{7R}{2}$$
$$|q_p| = nC_P\Delta T = \frac{7RT_o}{2}$$
$$|\Delta U| = nC_V\Delta T = \frac{5RT_o}{2}$$
$$|W| = RT_o$$

(B). Process is isochoric, $C_V = \frac{3R}{2}$

$$|q_V| = |\Delta U| = \frac{3RT_o}{2}$$
$$|W| = 0$$

(C). $C_V = \frac{R}{\gamma - 1} = \frac{R}{1.5 - 1} = 2R$

$VT = \text{constant}$ $PV^2 = \text{constant}$ $\frac{P}{\rho^2} = \text{constant}$

$V + T\frac{dV}{dT} = 0$ $\frac{dV}{dT} = -\frac{V}{T}$ $\frac{P}{n}\frac{dV}{dT} = -\frac{PV}{nT} = -R$

$|W| = RT_o$ $|\Delta U| = 2RT_o$ $|q| = RT_o$

(D). $\gamma = 1 + \frac{2}{4} = \frac{3}{2}$

$C_V = \frac{R}{\gamma - 1} = 2R$

PT = constant P^2V = constant

$\frac{P^2}{\rho} = \text{constant}$

$|\Delta U| = 2RT_o$

SECTION – C

33. Ionisation isomerism
Linkage isomerism
Geometrical isomerism

34. $$\underset{n_f=2}{3ZnSO_4} + \underset{n_f=3}{2K_4\left[Fe(CN)_6\right]} \longrightarrow K_2Zn_3\left[Fe(CN)_6\right]_2 + 3K_2SO_4$$

Milliequivalents of $ZnSO_4$ = milliequivalents of $K_4[Fe(CN)_6]$

N_1V_1 = N_2V_2

Volume of $K_4[Fe(CN)_6]$ **(V_2)** $= \frac{60 \times 0.01 \times 2}{0.05 \times 3} = 8$ ml

35. $\Delta T_f = K_f m$

$m = \frac{0.93}{1.86} = 0.5$

$\Delta T_b = K_b m$

$K_b = \frac{0.26}{0.5} = 0.52\,\text{K kgmol}^{-1}$

Similarly $\Delta T_b' = K_b m'$

$\Delta T_b' = \frac{K_b \times w \times 1000}{W \times \text{m.wt}}$

$\therefore$ m.wt. of solute $= \frac{K_b \times w \times 1000}{W \times \Delta T_b'}$

$= \frac{0.52 \times 7.87 \times 1000}{100 \times 0.44}$

$31x \simeq 93$

x = 3

36. $2H_2 + O_2 \longrightarrow 2H_2O$

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

$2CO + O_2 \longrightarrow 2CO_2$

$C_2H_2 + \frac{5}{2}O_2 \longrightarrow 2CO_2 + H_2O$

Required oxygen for the combustion of given gas = 1.04 m^3

Hence, volume of air required $= \frac{1.04 \times 100}{20.8} = 5\ m^3$

37. Al, Cr, Fe

38. Telluric acid H_6TeO_6 is quite different from sulphuric and selenic acid. It exists as octahedral $Te(OH)_6$ molecule in the solid. It is a weak dibasic acid and forms two series of salt, $NaTeO(OH)_5$ and $Na_2TeO_2(OH)_4$.

39. $Zn(s) + 2Ag^+(aq) \rightleftharpoons Zn^{2+}(aq) + 2Ag(s)$

$E^o_{cell} = \frac{0.059}{2}\log_{10} K_{eq}$

$0.8 + 0.76 = \frac{0.059}{2}\log_{10} K_{eq}$

$K_{eq} = 7.61 \times 10^{52}$

As K_{eq} is very large the reaction will tend towards completion

Moles of zinc added $\frac{6.53 \times 10^{-2}}{65.3} = 10^{-3}$

Moles of Ag^+ in solution $= \frac{10^{-5} \times 100}{1000} = 10^{-6}$

As Ag^+ is limiting reagent, the moles of Ag precipitated $\simeq 10^{-6}$

Hence x = 6

40. $P_1V_1 = P_2V_2$

P_2 = pressure of H_2 gas $= \frac{60 \times 10}{20}$

P_2 = 30 cm of Hg

Final total pressure over liquid water (P) = 30 + 20 = 50 cm of Hg

$\frac{P}{10} = \frac{50}{10} = 5$

Mathematics

PART – III

SECTION – A

41. D_m will be open finally if m is the perfect square

42. (A) $(1 + x)^n = {}^nC_0 + {}^nC_1x + {}^nC_2x^2 + {}^nC_3x^3 + ... + {}^nC_nx^n$

Put x = ω where $\omega = -\frac{1}{2} + \frac{i\sqrt{3}}{2}$

$$\left({}^nC_0 + {}^nC_3 + {}^nC_6 + ...\right) + ... + \left({}^nC_1 + {}^nC_4 + {}^nC_7 + ...\right)\omega + \left({}^nC_2 + {}^nC_5 + {}^nC_8 + ...\right)\omega^2 = (1+\omega)^n$$

$$\left({}^nC_0 + {}^nC_3 + {}^nC_6 + ...\right) + \left({}^nC_1 + {}^nC_4 + {}^nC_7 + ...\right)\left(-\frac{1}{2} + \frac{i\sqrt{3}}{2}\right) +$$

$$\left({}^nC_2 + {}^nC_5 + {}^nC_8 + ...\right)\left(-\frac{1}{2} - \frac{i\sqrt{3}}{2}\right) = \left(-\omega^2\right)^n$$

$$\left({}^nC_0 + {}^nC_3 + {}^nC_6 + ...\right) - \frac{1}{2}\left({}^nC_1 + {}^nC_2 + {}^nC_4 + {}^nC_5 + ...\right) +$$

$$\frac{i\sqrt{3}}{2}\left({}^nC_1 - {}^nC_2 + {}^nC_4 - {}^nC_5 + ...\right) = \left(-\omega^2\right)^n$$

Take modulus both sides

(B) $a^5b^2 = 4 \Rightarrow 5\log_2(a) + 2\log_2(b) = 2$

$y = 10\log_2 a \cdot 4\log_2 b = 40\log_2 a \cdot \log_2 b$

A.M. ≥ G.M. $\Rightarrow \frac{5\log_2(a) + 2\log_2(b)}{2} \ge \sqrt{10\log_2 a \cdot \log_2 b}$

$\log_2 a \cdot \log_2 b \le \frac{1}{10} \Rightarrow y \le 4$, y = 4 when $5\log_2 a = 2\log_2 b \Rightarrow a^5 = b^2 = 2$

(C) For constant term put x = 0 and get constant term = 4

(D) Coefficient of $x^{24} = 1.25 + 2.24 + 3.23 + ... + 25.1 = 2925$

43. Roots of the equation $y^3 - x_3y^2 - x_2y - x_1 = 0$ are 3, 5 and 7

$x_3 = 15$, $x_2 = -71$, $x_1 = 105$

44. Let R be the common ratio of the G.P. and D be the common difference of A.P.

$a_5 = a_5$, $a_9 = Ra_5$, $a_{16} = a_5R^2$

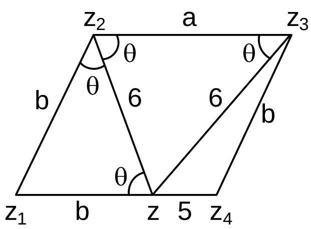
$a_9 - a_5 = 4D \Rightarrow (R - 1)a_5 = 4D$ ..... (1)

$a_{16} - a_9 = 7D \Rightarrow R(R - 1)a_5 = 7D$ ..... (2)

From equation (1)/(2), we get $\frac{1}{R} = \frac{4}{7} \Rightarrow R = \frac{7}{4}$

From equation (2) – (1), we get $(R - 1)^2a_5 = 3D \Rightarrow \frac{9a_5}{16} = 3D$

$$\frac{3}{16}(a_1 + 4D) = D \Rightarrow \frac{3}{16}a_1 = \left(1 - \frac{3}{4}\right)D \Rightarrow a_1 = \frac{4D}{3}$$


z_2
a
z_3
θ
θ
θ
b
6
6
b
θ
z_1
b
z
5
z_4

45. $a = b + 5$

and $\frac{b}{6} = \frac{6}{a}$

$\Rightarrow ab = 36$

$b^2 + 5b - 36 = 0$

$\Rightarrow b = 4$

46. $\left(\frac{n}{3}\right)^n < n!$ put $n = 300 \Rightarrow 100^{300} < 300!$ ..... (1)

$3 < 100 \Rightarrow 3^{150} < 100^{150} \Rightarrow (300)^{150} < 100^{300}$

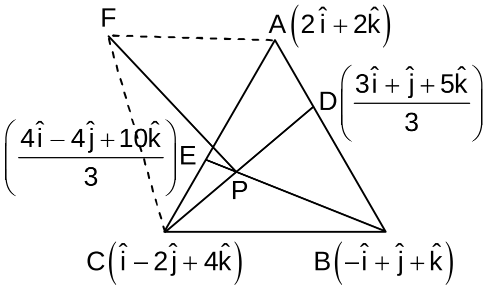
$\sqrt{300^{300}} < 100^{300}$ ..... (2)

From equation (1) and (2), we get $\sqrt{300^{300}} < 300!$

47. (A) $a_{ij} = -a_{ji} \Rightarrow a_{ij} + a_{ji} = 0 \Rightarrow$ A is skew symmetric matrix

(C) $A^2 = 2A \Rightarrow A^3 = 2^2A \Rightarrow A^6 = 2^5A$

(D) A^6B^7 is a skew symmetric matrix of odd order


F
$A\left(2\hat{i} + 2\hat{k}\right)$
$D\left(\frac{3\hat{i} + \hat{j} + 5\hat{k}}{3}\right)$
$\left(\frac{4\hat{i} - 4\hat{j} + 10\hat{k}}{3}\right)E$
P
$C\left(\hat{i} - 2\hat{j} + 4\hat{k}\right)$
$B\left(-\hat{i} + \hat{j} + \hat{k}\right)$

48. CD : $\vec{r} = \left(\hat{i} - 2\hat{j} + 4\hat{k}\right) + \frac{\lambda}{3}\left(7\hat{j} - 7\hat{k}\right)$

BE : $\vec{r} = \left(-\hat{i} + \hat{j} + \hat{k}\right) + \frac{\mu}{3}\left(7\hat{i} - 7\hat{j} + 7\hat{k}\right)$

$P \equiv \left(\hat{i} - \hat{j} + 3\hat{k}\right)$

Area of tetrahedron ABCF

$= \frac{1}{3}(\text{Area of base triangle}) \times \text{height} = \frac{7}{3}$ cubic units

$\overrightarrow{AB} \times \overrightarrow{AC} = 7\hat{j} + 7\hat{k}$, $\left|\overrightarrow{PF}\right| = PF = \sqrt{2}$ units

$\overrightarrow{PF} = \sqrt{2}\left(\frac{7\hat{j} + 7\hat{k}}{\sqrt{49 + 49}}\right) = \hat{j} + \hat{k}$ = P.V. of F – P.V. of P

P.V. of F = $\hat{i} + 4\hat{k}$

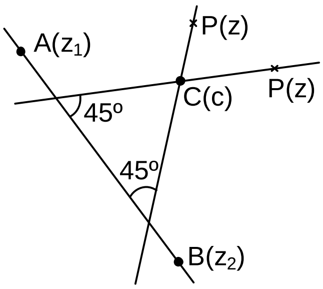
Vector equation of AF is $\vec{r} = 2\left(\hat{i} + \hat{k}\right) + \alpha\left(-\hat{i} + 2\hat{k}\right)$

49. By eliminating n $2\left(\frac{\ell}{m}\right)^2 - \frac{\ell}{m} - 1 = 0$

$\Rightarrow \frac{\ell_1}{m_1} = 1, \frac{\ell_2}{m_2} = -\frac{1}{2}$

On solving, we get $(\ell_1, m_1, n_1) = \left(\frac{1}{\sqrt{6}}, \frac{1}{\sqrt{6}}, -\sqrt{\frac{2}{3}}\right)$ and $(\ell_2, m_2, n_2) = \left(\frac{1}{\sqrt{6}}, -\sqrt{\frac{2}{3}}, \frac{1}{\sqrt{6}}\right)$

50. Let P(z) be any point on the required line.



Then, $\frac{\overrightarrow{CP}}{|\overrightarrow{CP}|}$ i.e. $\frac{z-c}{|z-c|}$ is a unit vector parallel to it

Let A(z_1) and B(z_2) be two points on

$\bar{a}z + a\bar{z} + b = 0$ then $\frac{z_2 - z_1}{|z_2 - z_1|}$ is a unit vector parallel to the line

$a\bar{z} + \bar{a}z + b = 0$

$$\frac{z-c}{|z-c|} = \frac{z_2 - z_1}{|z_2 - z_1|} e^{\pm i\left(\frac{\pi}{4}\right)}$$

$$\frac{(z-c)^2}{(z-c)(\bar{z}-\bar{c})} = \frac{(z_2 - z_1)^2}{(z_2 - z_1)(\bar{z}_2 - \bar{z}_1)} e^{\pm i\frac{\pi}{2}}$$

$$\frac{z-c}{\bar{z}-\bar{c}} = \pm i\left(\frac{z_2 - z_1}{\bar{z}_2 - \bar{z}_1}\right) \qquad \text{..... (1)}$$

∵ A(z_1) and B(z_2) are on the line $a\bar{z} + \bar{a}z + b = 0$ therefore $a\bar{z}_1 + \bar{a}z_1 + b = 0$

$a\bar{z}_2 + \bar{a}z + b = 0$

$$\Rightarrow -\frac{a}{\bar{a}} = \frac{z_2 - z_1}{\bar{z}_2 - \bar{z}_1} \qquad \text{..... (2)}$$

From equation (1) and (2), we get $\frac{z-c}{a} \pm \frac{i(\bar{z}-\bar{c})}{\bar{a}} = 0$

SECTION – B

51. (A) $f(x) = x^3 + ax^2 + bx + c = (x^2 + 1)(x + a) + (b - 1)x + (c - a)$

∵ f(x) is divisible by $x^2 + 1 \Rightarrow b - 1 = 0 \Rightarrow c = a$

(B) $(A + B)(A - B) = (A - B)(A + B) \Rightarrow AB = BA$, $A^T = A$, $B^T = -B$

$(AB)^T = (-1)^{k-1}AB \Rightarrow$ k is an odd number

(C) $10^{100} - 43 = 999 ..... 9957$

Sum of digits = 98(9) + 5 + 7 = 894

(D) $x = 7\cos\theta - \sin\theta$, $y = 7\sin\theta + \cos\theta$, $z = 10$

$$\frac{x^2 + y^2}{z} = 5$$

52. (A) $(x + y^2)(x - y^2) = 17^2$

$x + y^2 = 17^2$ and $x - y^2 = 1$ or $x + y^2 = 17$ and $x - y^2 = 17$

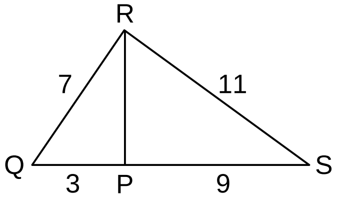
or $x + y^2 = -1$ and $x - y^2 = -17^2$ or $x + y^2 = -17$ and $x - y^2 = -17$

Possible cases: (x, y) → (±145, ±12), (±17, 0)

x + 12y + 4 = 293, 5, 21, –13, 3, –285

(B) $PQ^2 + RS^2 = QR^2 + SP^2 = 130$

$$\frac{\overrightarrow{PS}\cdot\overrightarrow{QR}}{9} = \frac{9 \times 7 \times \frac{3}{7}}{9} = 3$$



(C) x + y + z = 20, number of the solution is ${}^{19}C_2$ they form triangle if $1 \le x, y, z \le 9$

Number of solutions = coefficient of x^{20} in $(x^1 + x^2 + ... + x^9)^3 = {}^{19}C_2 - 3\,{}^{10}C_2$

Required probability $P = \frac{{}^{19}C_2 - 3 \times {}^{10}C_2}{{}^{19}C_2} \Rightarrow P = \frac{4}{19}$

(D) Let the series be 21, 21r, $21r^2$, $21r^3$, ...

Sum = $\frac{21}{1-r} \in N$ and $21r \in N$

$\frac{21\times 21}{21-21r} \in N \Rightarrow 21 - 21r \in N$ and $21r < 21$

$21 - 21r$ may be equal to 1, 3, 7, 9

$21r = 20, 18, 14, 12$

$|k - 15| = 5, 3, 1$

SECTION – C

53. $(x^4 + 2x^3 + bx^2 + cx + d) = (x - \alpha_1)(x - \alpha_2)(x - \alpha_3)(x - \alpha_4) = (x^2 + px + q)(x^2 + px + r)$
$= x^4 + 2px^3 + (q + r + p^2)x^2 + (pr + pq)x + qr$
$(2p)^3 - 4(2p)(q + r + p^2) + 8(pq + pr) = 0$
$2^3 - 4 \times 2 \times b + 8c = 0$
$\Rightarrow b - c = 1$

54. Probability that B wins the match in the 4th game
$= \frac{1}{2}\times\frac{1}{6}\times\frac{1}{3}\times\frac{1}{2}\times 6 + {}^3C_1\times\frac{1}{2}\times\frac{1}{3}\times\frac{1}{3}\times\frac{1}{2} = \frac{6}{72} + \frac{3}{36} = \frac{6+6}{72} = \frac{1}{6}$

55. $x^3 + 3x^2 + k = 0 \rightarrow \alpha, \beta, \gamma$
$\alpha + \beta + \gamma = -3$, $\alpha\beta + \beta\gamma + \gamma\alpha = 0$, $\alpha\beta\gamma = -k$
$\alpha^2 + \beta^2 + \gamma^2 = 9$
$\because\ \alpha, \beta, \gamma \in I \Rightarrow \alpha^2 = 9, \beta^2 = 0, \gamma^2 = 0$
or $\alpha^2 = 4, \beta^2 = 4, \gamma^2 = 1$
$\alpha^2 = 4, \beta^2 = 4, \gamma^2 = 1$
Possible roots: ±3, 0, 0, ±2, ±2, ±1
But $\alpha\beta + \beta\gamma + \gamma\alpha = 0$
So, possible roots are 3, 0, 0; –3, 0, 0; 2, 2, –1; –2, –2, 1
Possible non-zero values of k are –4 and 4

56. $$A_k \cdot A_{k+1} = \begin{bmatrix} a_{k-1} & 0 \\ 0 & a_k \end{bmatrix}\begin{bmatrix} a_k & 0 \\ 0 & a_{k+1} \end{bmatrix}$$
$$A_k \cdot A_{k+1} = \begin{bmatrix} a_{k-1}\cdot a_k & 0 \\ 0 & a_k a_{k+1} \end{bmatrix}$$
$$A_k \cdot A_{k+1} = \begin{bmatrix} {}^nC_{k-1}\ {}^nC_k & 0 \\ 0 & {}^nC_k\ {}^nC_{k+1} \end{bmatrix}$$
$$B = \begin{bmatrix} \sum_{k=1}^{n-1} {}^nC_{k-1}\cdot {}^nC_k & 0 \\ 0 & \sum_{k=1}^{n-1} {}^nC_k \cdot {}^nC_{k+1} \end{bmatrix} = \begin{bmatrix} a & 0 \\ 0 & b \end{bmatrix}$$
$a = b = {}^{2n}C_{n-1} - n$

57. $(r^2 + 2)(r + 1)! + 2r(r + 1)! = (r + 1)(r + 2)! - r(r + 1)!$

58. $a^3 + b^3 + c^3 - 3abc = (a + b + c)(a + \omega b + \omega^2 c)(a + \omega^2 b + \omega c)$
$a + b + c = e^x$, $a + b\omega + c\omega^2 = e^{\omega x}$, $a + b\omega^2 + c\omega = e^{\omega^2 x}$

59. det(A) is twice of area of triangle with vertices (ℓ, p), (m, q), (n, r) with sides 3, 4, 5

$\Delta^2 = s(s - a)(s - b)(s - c)$
$\Rightarrow \Delta^2 = 6 \times 3 \times 2 \times 1$
$\Rightarrow \Delta = 6$
Now det(A) = 12
$\Rightarrow$ det(B) = 144

60. $a + ib = z \Rightarrow |z|^{5015} - |z|^3 = 0$
$|z|^3 (|z|^{5012} - 1) = 0$
$|z| = 0$ or $|z|^{5012} = 1 \Rightarrow |z| = 1 \Rightarrow z\bar{z} = 1$
$z = 0$
$z^{5015} = \bar{z}^3 \Rightarrow z^{5015} = \dfrac{1}{z^3} \Rightarrow z^{5018} = 1$
Number of complex numbers = 5018 + 1 = 5019

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

PART TEST – III

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 240**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-C.**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section–A (01 – 08, 21 – 28, 41 – 48)** contains 24 multiple choice questions which have one or more correct answer. Each question carries **+4 marks** for correct answer and **–2 marks** for wrong answer.

   Section–A (09 – 12, 29 – 32, 49 – 52) contains 12 paragraphs with each having 2 questions with one correct answer. Each question carries **+4 marks** for correct answer and **–2 marks** for wrong answer.

2. **Section–C (13 – 20, 33 – 40, 53 – 60)** contains 24 Numerical based questions with answers as numerical value from 0 to 9 and each question carries +4 marks for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

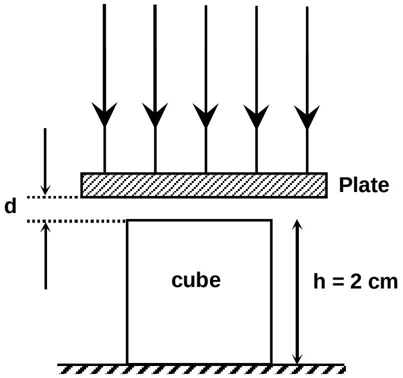
One OR More Than One Choice Type

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

1. Choose the correct statement(s).
   (A) The image of sun (consider point source of light) can never be produced at center of glass sphere, (assuming the space between sphere and sun is filled with air).
   (B) If a lens having $\mu = 1.5$ has focal length 20 cm in air, then its focal length will be 60 cm when it is immersed in water of refractive index $\frac{4}{3}$
   (C) The laws of reflection and refraction are true for all surface and pairs of media at the point of incidence.
   (D) The thick lenses give coloured images due to dispersion of light.

2. When a yellow light of wavelength 6000 Å from a sodium lamp falls on a certain photocell, a negative potential of 0.30 volt is needed to stop all the electrons from reaching the collector. Then choose correct option(s).
   (A) Work function of the given photocell is 2.5 eV approximately.
   (B) Work function of the given photocell is 1.8 eV approximately.
   (C) A negative potential of 0.6 Volt will be needed to stop all the electrons if light of wavelength $\lambda = 4000$ Å is used
   (D) A negative potential of 1.3 Volt will be needed to stop all the electrons if light of wavelength $\lambda = 4000$ Å is used

3. An electromagnetic radiation of wavelength ranging between 400 nm and 1150 nm (for which the plate is penetrable) incident perpendicularly on the plate from above is reflected from both the air surfaces and interferes. In this range only two wavelength give maximum reinforcements, one of them is $\lambda = 400$ nm. (refractive index of air = 1 and the coefficient of linear thermal expansion of cube = 8×10^{-6} °C^{-1}). The distance of bottom of cube from plate does not change during warming up. Choose the correct option(s)

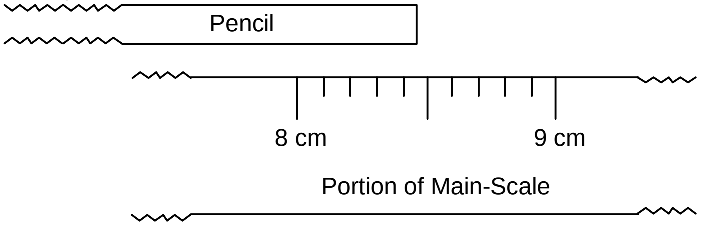


   (A) The change in temperature of cube so that it would touch the plate is 6.2°C
   (B) The change in temperature of cube so that it would touch the plate is 3.1°C
   (C) The second wavelength, which gives maximum reinforcement is $\lambda = \frac{2000}{3}$nm
   (D) The second wavelength, which gives maximum reinforcement is $\lambda = \frac{4000}{3}$nm

Space for Rough work

4. A certain ideal spring stretches 20 cm when m_1 = 40 gm mass is hung from it. If a mass of $m_2 = \frac{2205}{32}$gm gm is hung instead of 40 gm at its end pulled out 20 cm from equilibrium and released at t = 0 sec. Choose the correct option(s). (g = 10 m/s^2)
(A) The magnitude of acceleration of the m_2 mass when it is 2.5 cm from the equilibrium position is $\frac{64}{45}$ m/s^2
(B) The magnitude of acceleration of the m_2 mass when it is 2.5 cm from the equilibrium position is $\frac{32}{45}$ m/s^2
(C) At $t = \frac{\pi}{8}$ sec. m_2 mass is 10 cm from equilibrium position.
(D) At $t = \frac{\pi}{2}$ sec. m_2 mass is 10 cm from equilibrium position.

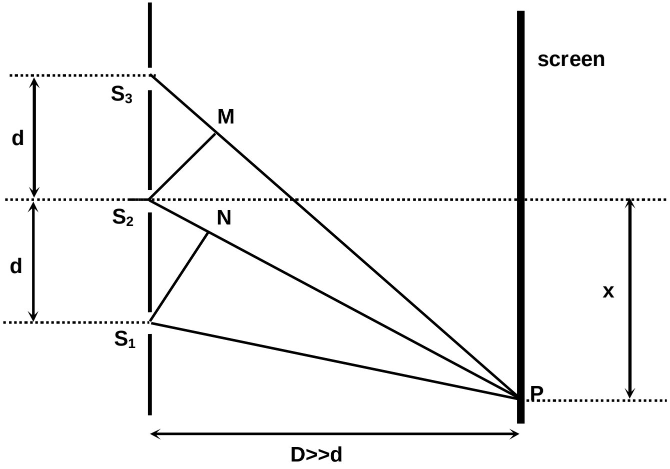
5. I am a Vernier Calliper. I have a task to measure the length of a pencil as shown in the figure. The least count of my Vernier scale is 0.05 times the value of one division of main-scale.



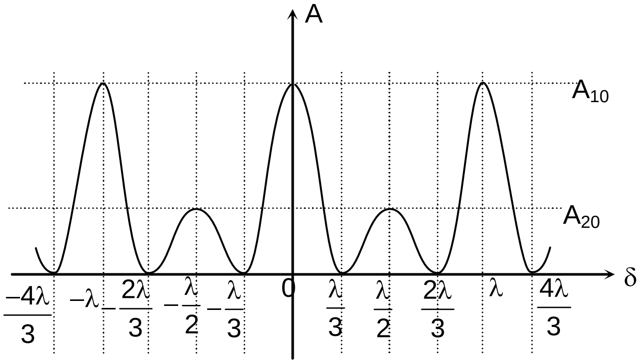
My Vernier Scale has n-divisions and coincides with (n – 4) divisions of main scale. While measuring the length of pencil, the $\frac{n}{5}$th division of Vernier-Scale exactly coincide the main-scale.
Now choose the correct option(s)
(A) The value of n is 40
(B) The least count of Vernier scale is 0.005 cm
(C) The length of Pencil is 8.44 cm
(D) The length of Pencil is 8.48 cm

Space for Rough work

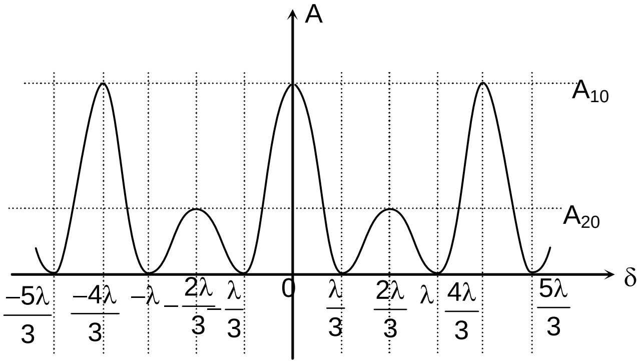
6. A triple slit experiment is performed as shown in the figure with monochromatic light of amplitude a_0. $S_3M \approx S_2N = \delta$. The graph between resultant amplitude (A) versus δ is plotted. Choose the correct option(s).



(A)



(B)



(C) $\frac{A_{10}+A_{20}}{A_{10}-A_{20}} = 2$, where A_{10} and A_{20} are the values shown in option A.

(D) $\frac{A_{10}+A_{20}}{A_{10}-A_{20}} = 5$, where A_{10} and A_{20} are the values shown in option A.

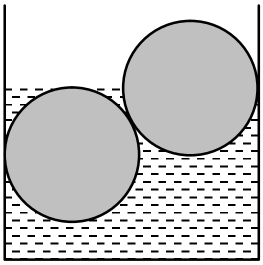
Space for Rough work

7. One end of thin aluminium rod (cross-sectional Area = 10^{-6} m^2) is bult welded to the end of copper rod with same diameter. Both rods are very long and under uniform tension of 900 N. Given that

$Y_{(Cu)} = 1.6 \times 10^{11}$ Nm^{-2} $Y_{(Al)} = 0.9 \times 10^{11}$ N m^{-2}
$\rho_{(Cu)} = 8.1 \times 10^3$ kg m^{-3} $\rho_{(Al)} = 2.5 \times 10^3$ Kg m^{-3}

(A) The value of reflection factor $\frac{A_r}{A_i}$ for longitudinal pulse approaching the junction along copper rod is 0.15
(B) The value of reflection factor $\frac{A_r}{A_i}$ for longitudinal pulse approaching the junction along copper rod is approximately 0.3
(C) The value of reflection factor $\frac{A_r}{A_i}$ for transverse pulse approaching the junction along copper rod is 0.15
(D) The value of reflection factor $\frac{A_r}{A_i}$ for transverse pulse approaching the junction along copper rod is approximately 0.3

8. There are two cylinder-shaped wooden billets, each having a mass of mass 45 kg, in a vertical wall sewage, which contains water in it. The two billets have the same size and the same material; they touch each other and the walls of the sewage. One of them is totally under the water, whilst only half of the other one is immersed into the water. Friction is negligible everywhere. (density of water is 1000 kg/m^3 and g = 10 m/s^2). Choose the correct option(s)



(A) Density of the wood is 750 kg/m^3
(B) Density of the wood is 800 kg/m^3
(C) The forces exerted by the billets on the vertical walls is 260 N approximately
(D) The forces exerted by the billets on the vertical walls is 320 N approximately

Space for Rough work

Comprehension Type

This section contains **2 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

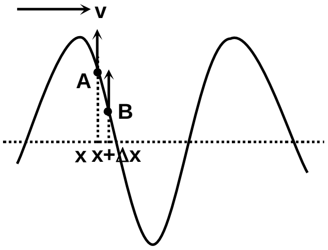
Paragraph for Question Nos. 09 and 10

Consider a wave sent down a string in the positive direction whose equation is given as

$$y = y_0 \sin\left[\omega\left(t - \frac{x}{v}\right)\right]$$

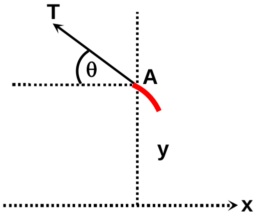
The wave is propagated along because each string segment pulls upward and downward on the segment adjacent to it at a slightly larger value of x and, as a result does work upon the string segment to which wave is travelling.

For example, the portion of string at point A is going upward, and will pull the portion at point B upward as well. In fact, at any point along the string, each segment of the string is pulling on the segment just adjacent and to its right, causing the wave to propagate. It is by this process that the energy is sent along the string.



Now we try to calculate how much energy is propagated down the string per second

$$T_y = T\sin\theta \approx T\tan\theta \Rightarrow T_y = -T\frac{\partial y}{\partial x}$$



(The negative sign appears because as shown in the figure-II, the slope is negative) the force will act through a distance

$$dy = v_y dt = \frac{\partial y}{\partial t}dt$$

Therefore work done by force in time dt is

$$dW = T_y dy = -T\left(\frac{\partial y}{\partial x}\right)\left(\frac{\partial y}{\partial t}\right)dt \Rightarrow dW = \frac{\omega^2 y_0^2 T}{v}\cos^2\left[\omega\left(t - \frac{x}{v}\right)\right]dt \qquad \ldots(A)$$

Now answer the following questions.

9. The average power transmitted down the string (i.e. the average energy transfer or sent down it per second) is

(A) $\frac{2\omega^2 y_0^2 T}{v}$ (B) $\frac{\omega^2 y_0^2 T}{v}$

(C) $\frac{\omega^2 y_0^2 T}{2v}$ (D) $\frac{\omega^2 y_0^2 T}{4v}$

10. How much average power is transmitted dawn a string having density $\mu = 5 \times 10^{-4}$ kg/m and T = 5 N by a 200 Hz vibration of amplitude of 0.20 cm.

(A) 0.08 Watt (B) 0.16 Watt

(C) 0.32 Watt (D) 0.64 Watt

Space for Rough work

Paragraph for Question Nos. 11 and 12

ABC is an isosceles right angled triangular reflecting prism of average refractive index μ . When incident rays on face AB are parallel to face BC , then they emerges from Face AC , which are also parallel to Face BC as shown in figure-I. The prism capable to do so , known as **Dove Prism.** In figure-II, the **Dove Prism** is used for dispersion of incident light containing red colour and violet colour only. The red colour and violet colour lights are separated(displaced) on screen by a distance $\Delta\ell$. In reality , each ray of any colour has some width, which can be designated as d. It is clear that an observer can distinguish the red and violet rays that emerges from prism only if $\Delta\ell \geq d$ .Otherwise the bundles of rays will overlap and mix.

[Given for **Dove Prism** in figure-II: $\mu_R = \sqrt{\frac{5}{2}}$, $\Delta\mu = \mu_V - \mu_R = 0.02$, $\sqrt{5} = 2.25$, EF = 1m and AB =4cm]

Now answer the following questions.

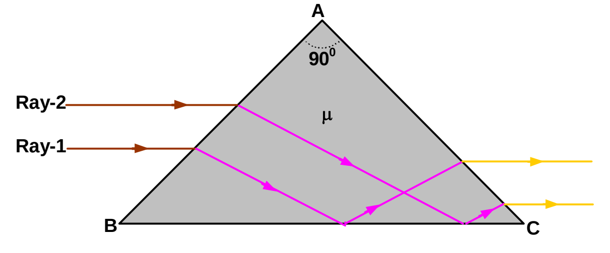


Figure-I

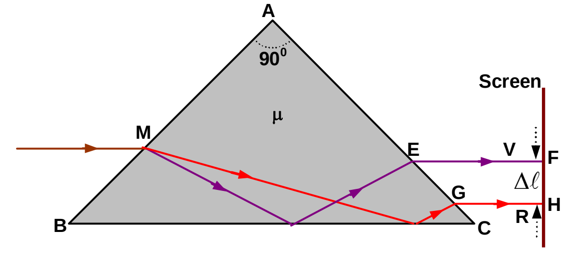


Figure-II

11. Choose the **INCORRECT** option.
    (A) As per figure-I, the average refractive index of **Dove Prism** may be greater than 1.
    (B) As per figure-I, the average refractive index of **Dove Prism** may be greater than $\sqrt{2}$.
    (C) As per figure-II, the displacement $\Delta\ell$ depends upon average refractive index μ and length of AB.
    (D) As per figure-II, the displacement $\Delta\ell$ depends upon average refractive index μ and length of EF.

12. Find the maximum value of width d of bundle of rays that can be resolved at the outlet of **Dove Prism** as shown in the figure-II.
    (A) $2.25\times10^{-3}m$ (B) $2.25\times10^{-4}m$
    (C) $1.125\times10^{-3}m$ (D) $1.125\times10^{-4}m$

Space for Rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive)

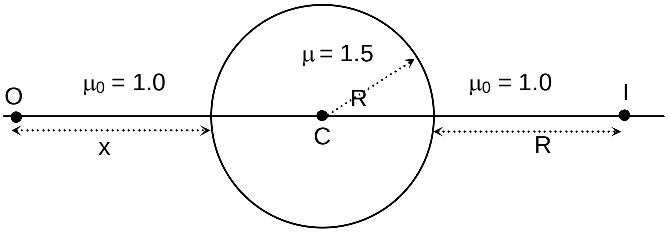
---

13. If the dimension of a physical quantity $\frac{EB}{\mu}$ is $M^aL^bT^c$. Find the value of $\left(\frac{b-c}{a}\right)$. Here

E ⇒ magnitude of electric field
B ⇒ Magnitude of magnetic field
μ ⇒ Permeability of medium

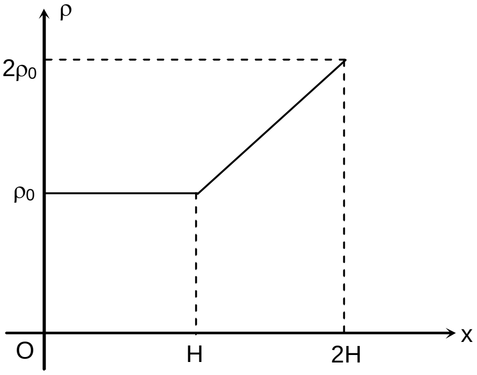
14. A 200 cm length of wire weighs 0.6 gm. If the tension in the wire caused by a 500 gm mass hanged from it. If the approximate wavelength of a wave of frequency 400 Hz sent down by it is $2^n \times 10^{-2}$ m. Find the value fo n. (g = 9.8 m/s^2)

15. A glass sphere of refractive index 1.5 forms the real image of object O at point I as shown in the figure when kept in air of refractive index 1. If the value of x is kR. Find k.

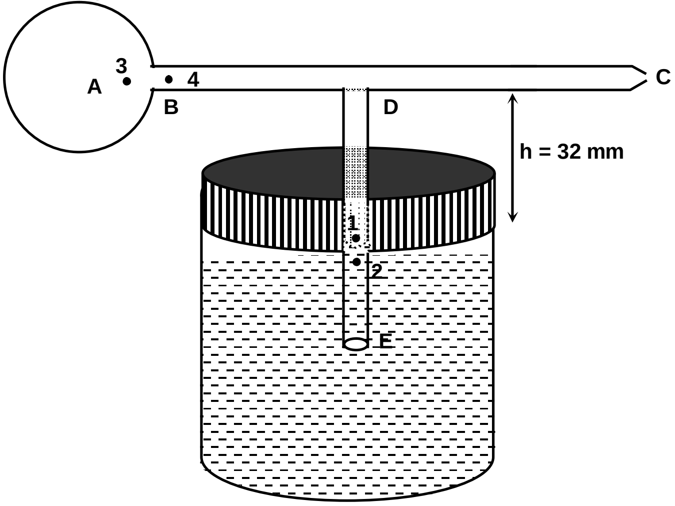


Space for Rough work

16. A large cylindrical container with open top contains a liquid upto height (2H = 8m) and whose density varies as shown in the figure. Atmospheric pressure is 1 atm (= 10^5 N/m^2)
Find the pressure at bottom of cylindrical container in atm.
(given $\rho_0 = 10^3 \text{ Kg/m}^3$, and $g = 10 \text{ m/s}^2$).



17. The figure shows a crude type of perfume atomizer. When bulb at A is compressed, air flows swiftly through the tiny BC with uniform speed v, there by causing a reduced pressure at the position of vertical tube DE. The liquid of density 500 kg/m^3, then rises in the tube, enters tube BC and sprayed out. When bulb is in natural position the air in the bulb and tube are at atmospheric pressure $P_{0} = 10^5$ N/m^2. When bulb A is compressed, it creates an excess pressure $\Delta p = 0.001\ P_0$ inside the bulb A. Density of air is 1.3 kg/m^3. If the magnitude of minimum value of speed v, required to cause the liquid to rise to tube BC is 5k m/s. Find the value of k. (g = 10 m/s^2).



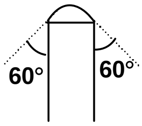
Space for Rough work

18. A hydrogen atom in ground state, moving with speed v collides with another hydrogen atom in ground state at rest. If $v \le v_0 = \sqrt{\frac{kE_0}{m_H}} \approx a \bullet bc \times 10^n \, m/s,$ then the collision is elastic. Here a, b and c are whole number, less then 9. Find the value of $\frac{a \times b \times c}{k \times n}$.

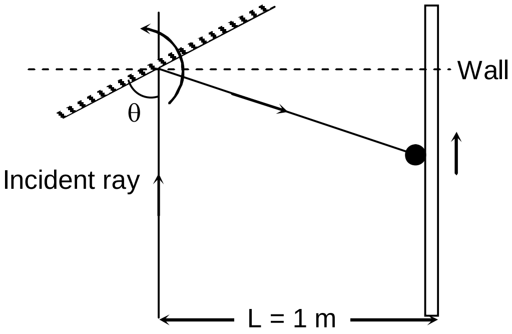
$\frac{me^4}{2\hbar^2} = E_0 = 13.6\,eV/atom = 2.18 \times 10^{-18}$ J/atom $\Rightarrow$ ionisation energy of H-atom

$\Rightarrow$ $m_H = 1.67 \times 10^{-27} kg$ $\Rightarrow$ Mass of hydrogen atom.

19. A soap bubble is being blown on a tube of radius 1 cm. The surface tension of the soap solution is 0.05 N/m and the bubble makes an angle of 60° with the tube in equilibrium state as shown. If the excess of pressure over the atmospheric pressure in the tube in Pascal (Pa) is x, find x



20. A light ray is incident on a rotating mirror, which is rotating with angular speed 3 rad/s as shown in figure. The speed of bright spot on the wall when θ = 30°.



Space for Rough work

Chemistry

PART – II

SECTION – A

One OR More Than One Choice Type

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

21. Which of the following statement is/are correct?
   (A) $CrI_3 + KOH + Cl_2 \longrightarrow K_2CrO_4 + KCl + KIO_4 + H_2O$
   In the balanced chemical reaction, stoichiometric coefficient of KOH is 64.
   (B) $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + Cr_2O_3 + 4H_2O$
   n-Factor of $(NH_4)_2Cr_2O_7$ is 12.
   (C) $\left[Fe(CN)_6\right]^{3-} \longrightarrow Fe^{3+} + CO_2 + NO_3^-$
   n-Factor for $[Fe(CN)_6]^{3-}$ is 60.
   (D) $MnO_4^{2-} \xrightarrow{H^+} MnO_4^- + MnO_2$
   Eq. wt. of MnO_4^{2-} is 178.5.

22. Which of the following on reaction with H_2S will produce metal sulphide?
   (A) $COCl_2$
   (B) $CuCl_2$
   (C) $\left[Cd(CN)_4\right]^{2-}$
   (D) $\left[Zn(OH)_4\right]^{2-}$

23. A dilute solution contains m mol of solute A in 1 kg of a solvent with molal elevation constant K_b. The solute dimerises in solution as
   $2A \rightleftharpoons A_2$
   Select the correct expression of equilibrium constant 'K' for the dimer formation. (assume molarity = molality)
   (A) $K = \dfrac{K_b(K_bm - \Delta T_b)}{(K_bm + 2\Delta T_b)^2}$
   (B) $K = \dfrac{\alpha}{2m(1-\alpha)^2}$
   (C) $K = \dfrac{K_b(K_bm - \Delta T_b)}{(2\Delta T_b - K_bm)^2}$
   (D) $K = \dfrac{2(K_bm - \Delta T_b)}{K_bm}$

24. Select the correct statement for cloud seeding:
   (A) It promotes rainfall.
   (B) It suppress fog.
   (C) Most commonly used chemical for cloud seeding is silver iodide because it has a crystalline structure to that of ice.
   (D) It helps in snow fall.

Space for Rough work

25. Which of the following combination, of compounds/elements and its packing fraction is true? Assume all cations or anions are ideally fitted in the voids without any distortion in lattice.

(A) Na_2O, $\phi = \frac{\pi}{3\sqrt{2}}\left\{1 + 2\times(0.225)^3\right\}$

(B) Cr_2O_3, $\phi = \frac{\pi}{3\sqrt{2}}\left\{1 + \frac{2}{3}\times(0.414)^3\right\}$

(C) Fe_2O_3, $\phi = \frac{\pi}{3\sqrt{2}}\left\{1 + (0.225)^3\right\}$

(D) Diamond, $\phi = \frac{\pi}{3\sqrt{2}}\left\{1 + (0.414)^3\right\}$

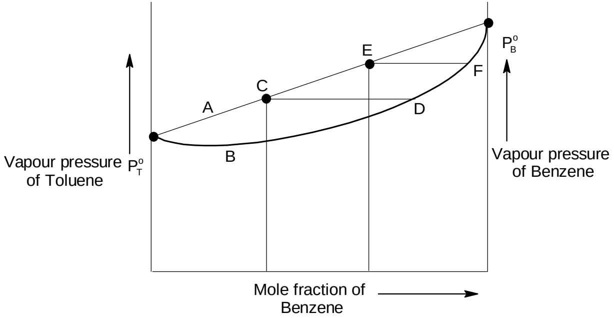
26. In which of the following ores at least one metal is in +3 oxidation state and crystal system is orthorhombic.

(A) Haematite
(B) Copper pyrite
(C) Diaspore
(D) Aragonite

27. Which of the following IUPAC names are correct?

(A) $K_2[OsCl_5N]$: Potassium pentachloridonitridoosmate(VI)
(B) $[Fe(NH_4C_5 - C_5H_4N)_3]Cl_2$: Tris(bipyridine)iron(II) chloride
(C) $[Fe(C_5H_5)_2]$: Bis(η^5-cyclopentadienyl)iron(II)
(D) $[Pt(py)_4][PtCl_4]$: Tetrapyridineplatinum(II) tetrachloridoplatinate(II)

28. Consider the following graph and choose the correct option



(A) A represent vapour composition and B represent liquid composition.
(B) At the state E of the system the vapour phase just start forming and its vapour phase composition will correspond to the point C.
(C) At the state C of the system the vapour phase just start forming and its vapour phase composition will correspond to the point D.
(D) A and B both represent vapour composition.

Space for Rough work

Comprehension Type

This section contains **2 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

Paragraph for Question Nos. 29 to 30

A metal crystallizes in a closed packed structure, the atoms stack together occupying maximum space and leaving minimum vacant space. Each sphere in the first layer is in contact with six neighbours. Now while arranging the second layer on the first layer, spheres are placed in depression of first layer. Spheres of third layer lie in the depression of second layer.
This repeating arrangement of atoms produces a giant lattice.

29. If one of the edge length of unit cell is 'a' what is the shortest distance between two atoms?

(A) $\frac{\sqrt{3}a}{4}$ (B) $\frac{a}{4}$ or $\frac{a}{3}$

(C) a or $\frac{a}{\sqrt{2}}$ (D) $\frac{a}{2}$

30. If spheres of third layer do not lie directly over the atoms of first layer, then density of unit cell is:

(Given: atomic weight of metal is 197u and a = 4.07 $\overset{o}{A}$)

(A) 86.5 g/cc (B) 19.4 g/cc

(C) 56.2 g/cc (D) 40.5 g/cc

Space for Rough work

Paragraph for Question Nos. 31 to 32

Stereoisomerism occurs when the bond connectivity is same but the spatial arrangement of more than one type is possible. Stereoisomerism finds vast use in organic chemistry, mainly biochemistry as all the biomolecules, are generally stereospecific in their actions. Stereoisomerism is limited not only to organic compounds but also to inorganic compounds, mainly in co-ordination complexes. Stereoisomers include *cis* and *trans* isomers, chiral isomers, compound with different conformation of chelate rings and other isomers that differ only in the geometry of attachment to the metal ion.

31. Select the incorrect statement:
    (A) trans form of $[CoCl_2(trien)]^+$ has 3 coplanar chelate ring.
    (B) $[Pt(py)(NH_3)(NO_2)(Cl)(Br)(I)]$ has 15 geometrical isomers.
    (C) Carboxylic group of salicylate ion is *cis* and *trans* to tertiary nitrogen in $[Co(tren)(sal)]^+$.
    (D) $[Pt(NH_3)_2(py)_2Cl_2]^{2+}$ complex has 5 non chiral isomer.

32. Select the correct option for tetraamminedichlorocobalt(III) ion, the *trans* isomer
    (A) does not have any symmetry
    (B) has plane of symmetry
    (C) *trans* form is meso form
    (D) *trans* form exists as a pair of enantiomer

Space for Rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive)

---

33. The enthalpy change involved in oxidation of glucose is - 2880 kJ mol^{-1}, 25% of this energy is available for muscular work. if 100 kJ of muscular work is needed to walk one km, the maximum distance (km) that a person will be able to walk after taking 150 g of glucose is……

34. 1 litre solution containing 4.5 millimoles of $Cr_2O_7^{--}$ and 15 millimoles of Cr^{3+} shows a pH of 2.0. The potential of the reduction half reaction is approximately x V. Then [x] is ……., where [ ] is GIF. $\left(E^o \text{ of } Cr_2O_7^{2-}/Cr^{3+} \text{ is } 1.33\text{ V}\right)$

35. Assuming 100% polymerization of an organic compound in its aqueous solution, the number of moles of organic compound undergoing polymerization containing 9.4 g of organic compound per 100 g of the solvent is…….. Freezing point depression is 0.93 K, K_f of water is 1.86 K kg mol^{-1} and molecular weight of organic compound is 94u.

36. A gas consists of 5 molecules with a velocity of 5 ms^{-1}, 10 molecules with a velocity of 3 ms^{-1} and 6 molecules with a velocity of 6 ms^{-1}. The ratio of average velocity and rms velocity of the molecules is 9.5×10^{-x}. Where x is …..

Space for Rough work

37. Number of S – S linkage in Marshall acid = a
Number of P – P linkage in Pyrophosphoric acid = b
Number of O – O linkage in Caro acid = c
Number of C = C linkage in Carbon suboxide = d
Find out the value of a + b + c + d?

38. In an ionic solid $r_c = 1.6\overset{o}{A}$ and $r_a = 1.864\overset{o}{A}$. Find edge length of cubic unit cell in $\overset{o}{A}$

39. Percentage of silver in german silver…..

40. $A \xrightarrow{\text{KCN added slowly}} \underset{(\text{Reddish brown precipitate})}{B} \xrightarrow{\text{In excess KCN precipitate dissolves}} \underset{(\text{Yellow solution})}{C}$

$A \xrightarrow{K_4Fe(CN)_6} \underset{(\text{Intense blue precipitate})}{D} \xrightarrow{NaOH} (\text{Red precipitate})$

$A \xrightarrow{Na_2HPO_4} \underset{(\text{Yellowish white precipitate})}{E}$

How many products are correctly match?

A = $FeCl_3$
A = $FeCl_2$
A = $CuCl_2$
B = $Fe(CN)_3$

B = $K_3Fe(CN)_6$
C = $K_3Fe(CN)_6$
C = $K_4[Fe(CN)_6]$
D = $Fe_4[Fe(CN)_6]_3$

D = $Fe[Fe(CN)_6]$
E = $FePO_4$

Space for Rough work

Mathematics PART – III

SECTION – A

One OR More Than One Choice Type

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

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41. A is a matrix of order 3 × 3 and a_{ij} is its elements of i^{th} row and j^{th} column. If $a_{ij} + a_{jk} + a_{ki} = 0$ holds for all $1 \le i, j, k \le 3$ then

(A) A is a non-singular matrix
(B) A is a singular matrix
(C) $\sum_{1\le i,\, j\le 3} a_{ij}$ is equal to zero
(D) A is a symmetric matrix

42. If x and y satisfy the equation $xy - 2x^2 - 9x + 3y - 16 = 0$, then

(A) number of ordered pair (x, y) is 4 where $x, y \in Z$
(B) number of ordered pair (x, y) is 1 where $x, y \in N$
(C) if $x \ge y$, $x, y \in N$ then number of ordered pair is zero
(D) if $x \le y$, $x, y \in N$ then number of ordered pairs are two

43. Let p, q be integers and let α, β be the roots of the equation $x^2 - 2x + 3 = 0$ where $\alpha \ne \beta$, if n = 0, 1, 2, 3, ... Let $a_n = p\alpha^n + q\beta^n$ where $n \in \{0, 1, 2, ...\}$ then the value of a_9 is equal to

(A) $3a_8 - 5a_7 + 3a_6$
(B) $a_7 - 6a_6$
(C) $a_7 - 12a_5 + 18a_4$
(D) $2a_8 + 3a_6$

44. For any two positive integers x and y $f(x, y) = \frac{1}{(x+1)!} + \frac{1}{(x+2)!} + \frac{1}{(x+3)!} + ... + \frac{1}{(x+y)!}$, then which of the following options is/are correct

(A) $f(x, y) \le \frac{1}{x}\left(\frac{1}{x!} - \frac{1}{(x+y)!}\right)$
(B) $\lim_{y\to\infty} \left(f(x, y)\right) \le \frac{1}{x!}$
(C) $f(x, x) < \frac{1}{(x-1)!}$
(D) f(2, 2) is equal to $\frac{2}{3}$

Space for rough work

45. Let a > 0, b > 0, c > 0 and a + b + c = 6 then $\frac{(ab+1)^2}{b^2}+\frac{(bc+1)^2}{c^2}+\frac{(ca+1)^2}{a^2}$ may be

(A) $\frac{75}{4}$ (B) 35
(C) 15 (D) 10

46. A and B play a game in which they alternately call out positive integers less than or equal to n, according to the following rules. A goes first and always calls out an odd number, B always calls out an even number and each player must call out a number which is greater than the previous number (except for A′s first turn). The game ends when one player cannot call out a number, then which of the following is/are correct?

(A) For n = 6, number of possible games is 8 (B) For n = 6, number of possible games is 10
(C) For n = 10, number of possible games is 55 (D) For n = 8, number of possible games is 21

47. Which of the following is/are correct?

(A) The point of intersection of $\overrightarrow{AB}$ and $\overrightarrow{CD}$ where A(4, 7, 8), B(–1, –2, 1), C(2, 3, 4) and D(1, 2, 5) is $\left(\frac{3}{2},\frac{5}{2},\frac{9}{2}\right)$
(B) If (α, β, γ) be a point on the plane 2x + 6y + 15z = 7 then the least value of $\alpha^2 + \beta^2 + 25\gamma^2$ is 7
(C) The circumcentre of the triangle formed by the points (3, 2, –5), (–3, 8, –5) and (–3, 2, 1) is the point (–1, 4, –3)
(D) The length of intercept on the line $\frac{x+1}{-1}=\frac{y-12}{5}=\frac{z-7}{2}$ by the surface $11x^2 - 5y^2 + z^2 = 0$ is $\sqrt{30}$ units

48. Consider all 10 digit numbers formed by using all the digits 0, 1, 2, 3, ..., 9 without repetition such that they are divisible by 11111, then

(A) the digit in tens place for smallest number is 6
(B) the digit in tens place for largest number is 3
(C) total numbers of such numbers is 3456
(D) total numbers of such numbers is 4365

Space for rough work

Comprehension Type

This section contains **2 groups of questions.** Each group has 2 multiple choice question based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE** is correct

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Paragraph for Question Nos. 49 to 50

Read the following write up carefully and answer the following questions:
Let A(z_1), B(z_2), C(z_3) and D(z_4) be the vertices of a trapezium in an Argand plane such that AB || CD. Let $|z_1 - z_2| = 4$, $|z_3 - z_4| = 10$ and the diagonals AC and BD intersect at P. It is given that $\text{Arg}\left(\frac{z_4 - z_2}{z_3 - z_1}\right) = \frac{\pi}{2}$ and $\text{Arg}\left(\frac{z_3 - z_2}{z_4 - z_1}\right) = \frac{\pi}{4}$

49. Which of the following option(s) is/are correct?

(A) Area of the trapezium ABCD is equal to $\frac{140}{3}$ sq. units

(B) Area of the trapezium ABCD is equal to $\frac{70}{3}$ sq. units

(C) Area of the triangle BCP is equal to $\frac{100}{21}$ sq. units

(D) Area of the triangle BCP is equal to $\frac{200}{42}$ sq. units

50. Which of the following option(s) is/are incorrect?

(A) value of |CP – DP| is equal to $\frac{10}{\sqrt{21}}$ (B) PB : PD = 2 : 5

(C) PC : AC = 5 : 7 (D) PC : AC = 2 : 3

Space for rough work

Paragraph for Question Nos. 51 to 52

Read the following write up carefully and answer the following questions:
In the equation A + B + C + D + E = FG, where FG is the two digit number whose value is 10F + G and letters A, B, C, D, E, F and G each represents different digits and FG is as large as possible

51. A five digit number is made using digits A, B, C, D, E, F, G (repetition not allowed), then which of the following is incorrect

(A) probability that number made is divisible by 5 is $\frac{1}{7}$

(B) probability that number made is divisible by 3 is $\frac{2}{7}$

(C) probability that number made is divisible by 4 is $\frac{2}{7}$

(D) probability that number made is divisible by 4 is $\frac{1}{7}$

52. If a five digit number is made using the digits A, B, C, D, E without repetition then

(A) the probability that the number is divisible by 11 is $\frac{2}{5}$

(B) the probability that the number is divisible by 11 is $\frac{1}{5}$

(C) the probability that the number is divisible by 4 is $\frac{1}{4}$

(D) the probability that the number is divisible by 4 is $\frac{2}{5}$

SECTION – C

(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive)

---

53. If a, b, c are three positive real numbers then the minimum value of $\frac{a+3c}{a+2b+c}+\frac{4b}{a+b+2c}-\frac{8c}{a+b+3c}$ is $\alpha+\beta\sqrt{2}$ (where a, b $\in$ Z), then $|\alpha + \beta|$ is equal to _____

Space for rough work

54. If the quadratic equation $a_1x^2 - a_2x + a_3 = 0$ where $a_1, a_2, a_3 \in N$ has two distinct real roots belonging to the interval (1, 2), then least value of a_1 is _____

55. Let a_1, a_2, a_3, a_4, a_5 be five terms of an increasing geometric progression such that $a_1, a_2, a_3, a_4, a_5 \in N$, and $a_5 < 100$. Then the number of possible geometric progression (is/are) _____

56. If the coefficient of $x^{\frac{n^2+n-18}{2}}$ in $(x-1)(x^2-2)(x^3-3)(x^4-4) \ldots\ldots (x^n - n)$, where $(n \geq 8)$ is k, then k is equal to _____

57. If a, b, c are three positive numbers then the minimum value of $\dfrac{a^4+b^6+c^8}{\left(ab^3c^2\right)2\sqrt{2}}$ is equal to _____

58. Let α^k when k = 0, 1, 2, 3, 4, ..., 253 are 254th roots of unity then the unit digit of $\sum_{k=0}^{253}\left|z+\alpha^k z^2\right|^2$ is _____ (where $z = e^{i\left(\frac{2\pi}{7}\right)}$)

59. Let $A = [a_{ij}]_{3\times 3}$ be a matrix such that $AA^T = 4I$ and $a_{ij} + 2c_{ij} = 0$ where c_{ij} is the cofactor of a_{ij} $\forall$ i & j, I is the unit matrix of order 3 and A^T is the transpose of the matrix A.
If $\begin{vmatrix} a_{11}+4 & a_{12} & a_{13} \\ a_{21} & a_{22}+4 & a_{23} \\ a_{31} & a_{32} & a_{33}+4 \end{vmatrix} + 5\lambda \begin{vmatrix} a_{11}+1 & a_{12} & a_{13} \\ a_{21} & a_{22}+1 & a_{23} \\ a_{31} & a_{32} & a_{33}+1 \end{vmatrix} = 0$, then $\lambda = \dfrac{a}{b}$ where a and b are coprime positive integers then the value of a + b is _____

60. If $x^3 - ax^2 + bx + c = 0$ has the roots $\alpha^2+\beta^3+\gamma^4$, $\beta^2+\gamma^3+\alpha^4$ and $\gamma^2+\alpha^3+\beta^4$ where α, β, γ are the roots of $x^3 - x^2 - 1 = 0$ then the value of a + b + c is equal to _____

Space for rough work

FIITJEE **JEE (Advanced)-2018**

ALL INDIA TEST SERIES

PART TEST – III

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 264**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into Three sections: **Section-A Section-B & Section-C.**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section–A (01 – 10, 21 – 30, 41 – 50)** contains 30 multiple choice questions which have one or more than one correct answer. Each question carries **+4 marks** for correct answer and **–2 marks** for wrong answer.

2. **Section–B (11 – 12, 31 – 32, 51 – 52)** contains 6 Match the following Type questions. Each question having 4 statements in Column I & 5 statements in Column II with any given statement in Column I having correct matching with 1 or more statement (s) given in Column II. Each statement carries **+2 marks** for correct answer and **–1 mark** for wrong answer.

3. **Section–C (13 – 20, 33 – 40, 53 – 60)** contains 24 Numerical based questions with answers as numerical value from **0 to 9** and each question carries **+4 marks** for correct answer. There is no negative marking.

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity $g = 10\ m/s^2$

Planck constant $h = 6.6 \times 10^{-34}$ J-s

Charge of electron $e = 1.6 \times 10^{-19}$ C

Mass of electron $m_e = 9.1 \times 10^{-31}$ kg

Permittivity of free space $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$

Density of water $\rho_{water} = 10^3\ kg/m^3$

Atmospheric pressure $P_a = 10^5\ N/m^2$

Gas constant $R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant R = $8.314\ J\ K^{-1}\ mol^{-1}$
= 0.0821 Lit atm $K^{-1}\ mol^{-1}$
= $1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

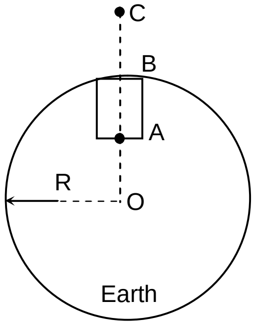
Physics

PART – I

SECTION – A

One OR More Than One Choice Type

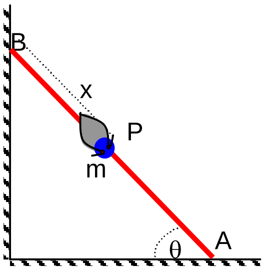
This section contains **10 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct



1. First an object is slowly lifted from the bottom (point – A) of a shaft of depth $h_1 = \frac{R}{2}$ to earth's surface (point-B) and then it is slowly lifted still higher to attain an altitude $h_2 = \frac{R}{2}$ above the earth's surface (Point C). W_1 and W_2 are the work performed in two cases respectively. Choose the correct option(s)

   (A) $W_1 > W_2$ (B) $W_1 < W_2$

   (C) $\left|\frac{W_1 + W_2}{W_1 - W_2}\right| = 17$ (D) $\left|\frac{W_1 + W_2}{W_1 - W_2}\right| = 9$



2. A light stick of length ℓ rests with its one end against the smooth wall and other end against the smooth horizontal floor as shown in the figure. The bug starts at rest from point B and moves such that the stick always remains at rest. a_P is the magnitude of acceleration of bug of mass m, which depends upon its distance of x from the top end of the stick. Choose the correct option(s)

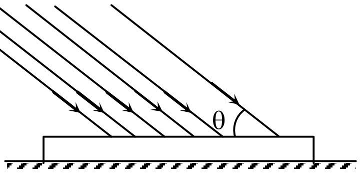
   (A) $a_P = \frac{g}{\sin\theta}\left(1 - \frac{x}{\ell}\right)$

   (B) $a_P = \frac{g}{\cos\theta}\left(1 - \frac{x}{\ell}\right)$

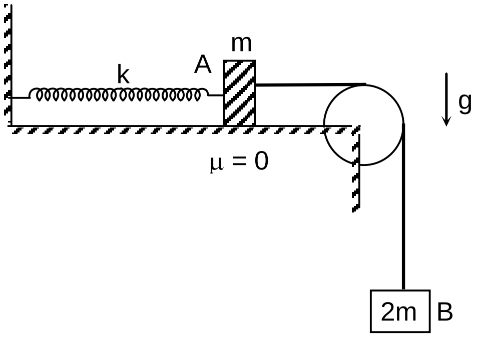
   (C) The time taken by the bug to reach the bottom of the stick having started at the top end from rest is $\frac{\pi}{2}\sqrt{\frac{\ell\sin\theta}{3g}}$

   (D) The time taken by the bug to reach the bottom of the stick having started at the top end from rest is $\frac{\pi}{2}\sqrt{\frac{\ell\sin\theta}{g}}$

Space for Rough work



3. Monochromatic rays of intensity I are falling on a metal plate of surface area A placed on a rough horizontal surface at certain angle θ as shown in figure. Choose correct statement (s) based on above information:
   (A) There is a value of θ for which plate will not move however high the intensity of radiation is
   (B) Plate will not move if plate is perfectly reflecting irrespective of the value of intensity.
   (C) If rays are falling perpendiculars to surface plate will not move
   (D) None of these

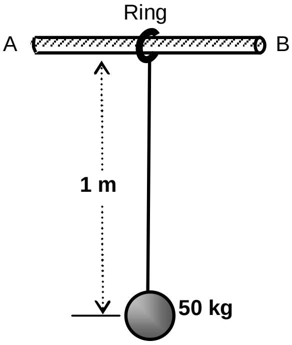


4. All the surfaces are frictionless and system is released from rest when ideal spring of stiffness k is in its relaxed state. Choose the correct statement.
   (A) The magnitude of maximum acceleration of particle B is $\frac{g}{3}$
   (B) The magnitude of maximum acceleration of particle B is $\frac{2g}{3}$
   (C) The maximum speed of particle A is $2g\sqrt{\frac{m}{3k}}$
   (D) The maximum speed of particle A is $g\sqrt{\frac{m}{3k}}$

5. We are given the following atomic masses:
   ${}^{238}_{92}U = 238.05079$ u ${}^{4}_{2}He = 4.00260$ u
   ${}^{234}_{90}Th = 234.04363$ u ${}^{1}_{1}H = 1.00783$ u
   ${}^{237}_{91}Pa = 237.05121$ u
   Here the symbol Pa is for the element protactinium (Z = 91).
   (A) The energy released during the α-decay of ${}^{238}_{92}U$ is 4.75 MeV approximately.
   (B) The energy released during the α-decay of ${}^{238}_{92}U$ is 4.25 MeV approximately.
   (C) The emission of proton from ${}^{238}_{92}U$ can be spontaneous.
   (D) The emission of proton from ${}^{238}_{92}U$ can not be spontaneous.

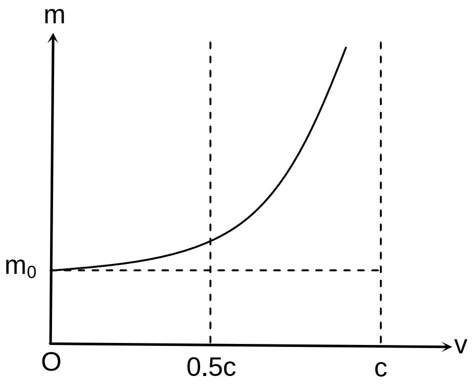
Space for Rough work

6. A 50–kg ball is attached to one end of a 1 m cord that has a mass of 0.10 kg. The other end of the cord is attached to a ring that can slide on a frictionless horizontal shaft AB, as shown in the diagram. A horizontal blow is delivered to the cord and excites the fundamental vibration with a maximum transverse velocity of 15 m/s. Assume that the ball remains essentially stationary as the cord vibrates. [$g = 9.8\ m/s^2$]



(A) The frequency of the fundamental vibration is 17.5 Hz.
(B) The amplitude of the motion is 13.6×10^{-2} m
(C) If the blow is delivered as an impulse to a stationary cord, the wave function for the cord is $y(x, t) = A \sin(\pi x/2L) \sin \omega t$, where the ball is located at x = 0 and positive x-axis is along the string.
(D) The period of the pendulum motion of the hanging ball is 2 sec. approximately.

7. Mass $m = \dfrac{m_0}{\sqrt{1-\dfrac{v^2}{c^2}}}$ as a function of velocity is shown in the graph. m_0 is the rest mass of the system. The kinetic energy of system is given as $K = mc^2 - m_c c^2$
Choose correct option(s)



(A) If a system is moving with speed v = 0.5c, the mass of system is increased by 15.5%
(B) Electrons in Cornell university synchrotron reach a velocity of v = 0.8c. The mass of these electrons are approximately $\left(\dfrac{5}{3}\right)$ time the rest mass of electron.
(C) The Bevatron a proton accelerator generates the accelerated protons with kinetic energy 10^{-9} Joules. The mass of accelerated protons is 8.68 times the actual mass of proton approximately $\left(m_{p_0} = 1.67 \times 10^{-27} kg\right)$
(D) If the kinetic energy of particle is equal to its rest mass energy then speed of particle is 0.75c approximately.

Space for Rough work

8. A rod of length l = 100 cm is fixed at 30 cm from both end. If velocity of transverse wave in rod is v(cms^{-1}), then choose the correct option(s)
(A) Fundamental frequency (in Hz) of transverse wave in rod is v/40
(B) Second overtone in rod will be 5th harmonic
(C) Frequency of third overtone (in Hz) is 7v/40
(D) Third overtone is 5th harmonic.

9. If voltage applied to an X-ray tube increased from V = 10 kV to 20 kV. The wave length interval between K$_\alpha$-line and short wave cut off of continuous X-ray increases by factor of 3 $\frac{Rhc}{e} = 13.6\,V$, where R is Rydberg constant, h is plank's constant, c is speed of light in vacuum and e is charge on electron.
(A) Atomic no. of target metal used is 29
(B) Cut-off wavelength when V = 10 kV is 1.2 Å
(C) Cut off wavelength when V = 10 kV is 2 Å
(D) Atomic no. of target metal used is 26

10. Consider a 20 W bulb emitting light of wavelength 5000 Å and shining on a metal surface kept at a distance 2m. Assume that the metal surface has work function of 2 eV and that each atom on the metal surface can be treated as a circular disk of radius 1.5 Å.
(A) Number of photon emitted by bulb is 5×10^{19} per second
(B) Time required by atomic disk to receive energy equal to work function of metal is 22.4 sec.
(C) Number of photon received by disk to receive 2 eV energy is 4
(D) Number of photons emitted by bulb is 5×10^{17} per sec.

Space for Rough work

SECTION – B

(Matching Type)

This section contains **2 multiple choice questions.** Each question has matching Column(s). The Column(s) have choices (A), (B), (C) and (D) out of which only **ONE OR MORE THAN ONE** is/are correct

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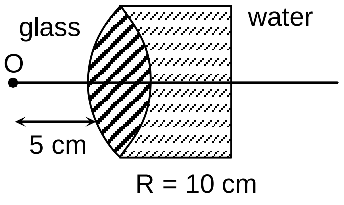
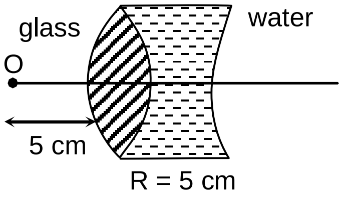
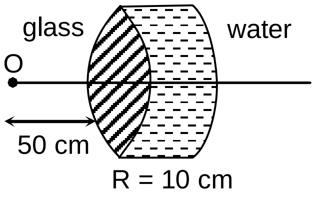
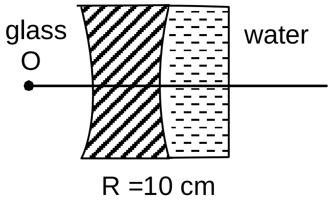
11. In the photoelectric effect experiment, if f is the frequency of radiations incident on the metal surface and I is the intensity of the incident radiations, then match the following columns.

Column -I		**Column -II**	
(A)	If f is increased keeping I and work-function constant	(p)	Stopping potential increases
(B)	If distance between cathode and anode is increased	(q)	Saturation current increases
(C)	If I is increased keeping f and work-function constant	(r)	Maximum kinetic energy of photoelectron increases
(D)	Work-function is decreased keeping f and I constant	(s)	Stopping potential remains same
		(t)	Stopping potential decreases

Space for Rough work

12. Two thin lens made of glass $\left(\mu = \frac{3}{2}\right)$ and water $\left(\mu = \frac{4}{3}\right)$ kept in contact with each other. An object is placed at point O. Assume all curved surfaces have equal radius.
Match the following Columns:

Column – I		Column - II	
(A)	 glass water O 5 cm R = 10 cm	(p)	Image of O will be Real
(B)	 glass water O 5 cm R = 5 cm	(q)	Image of O will be Virtual
(C)	 glass water O 50 cm R = 10 cm	(r)	Focal length = 10 cm
(D)	 glass O water R =10 cm	(s)	Focal length = 15 cm
		(t)	Focal length = 25 cm

Space for Rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

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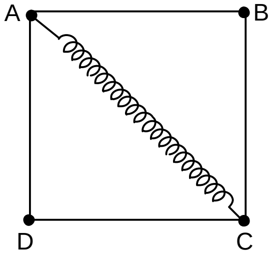
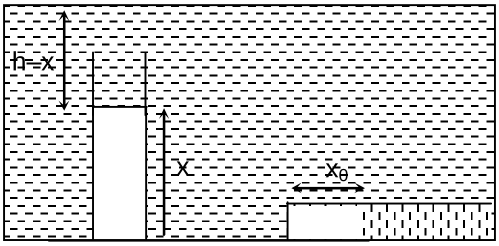
13. A square hinged-structure (ABCD) is formed with four massless rods which lies on the smooth horizontal table. The hinge-D of structure is fixed with table and hinge A, hinge-B and hinge-C are free to move on the table. A point mass m is attached at hinge-B, and an ideal spring of stiffness k is connected between hinge-A and hinge-C as shown in the figure. System is in equilibrium. The mass m is slightly displaced along line BD and released to perform SHM. The time period of SHM is $\pi\sqrt{\frac{nm}{k}}$. Find



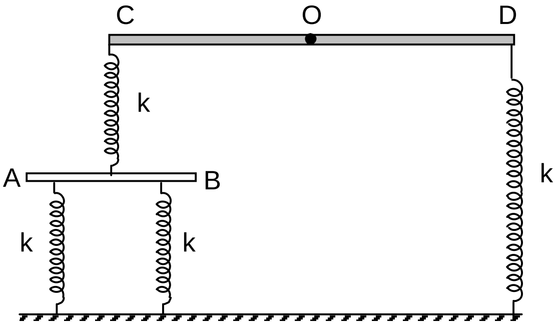
14. The mean pressure is $\frac{6K}{5}$, which rain renders to vertical windshield of automobile, moving with constant velocity of magnitude v = 12 m/s. Consider that raindrops fall vertically with speed u = 5 m/s. The intensity of rainfall deposits h = 2 cm of sediments in time τ = 1 minute. [$\rho = 10^3$ kg/m^3 is the density of liquid] (Assume collisions are inelastic). Calculate K.

15. On the bottom of lake at a depth h = 100m, a horizontal pipe of length 80m with piston is kept as shown in the figure. The piston is light and movable. Between the piston and pipe some air is captured (x_0 = 9m). The pipe is slowly raised to vertical position and open end upward. The length of air column (x) in SI units is 5K. Find value of K. (Disregard the atmospheric pressure & piston and pipe are air tight. Temperature of gas remains constant).

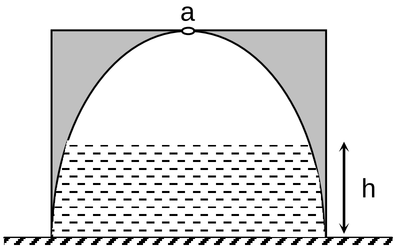


Space for Rough work

16. In the figure shown rod AB is light and rigid while rod CD is also rigid and hinged at midpoint O Rod can rotate without friction about O. The time period of small oscillation of rod CD is $T = 2\pi\sqrt{\frac{m}{nk}}$. Where m is mass of rod CD and k is spring constant of each spring. The value of n is

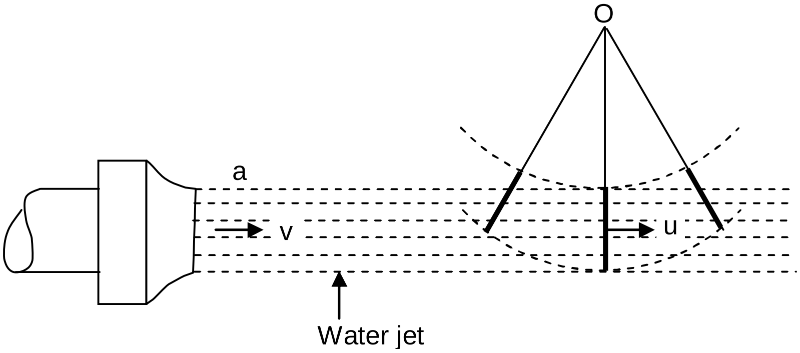


17. Consider a cuboidal vessel (2R × 2R × R) with a hemispherical cavity of radius R, kept at a horizontal smooth surface as shown in the figure. The vessel has very small hole of cross-sectional area **"a"**. Now water of density ρ is poured into space developed due horizontal surface and vessel through hole very slowly. When the height of water level is h, the vessel lifts off the surface and liquid leaks through space generated. (R = 2m, $\rho = 10^3$ kg/m^3, m = 9π kg). If the value of h is 5k cm, find the valve of k. (Atmospheric pressure = 10^5 N/m^2).



Horizontal Surface

18. In an undershot water wheel, the cross-sectional area $a = 0.1\,m^2$ of the stream is striking the series of radial flat vanes of the wheel. The velocity of stream is 6 m/s. The velocity of vanes is 3 m/s. If the power supplied by jet (in watts) is 2700K, find K.



19. A man of height = 3/2 m, wants to see himself in plane mirror from top to bottom. The plane mirror is inclined with vertical wall at angle α = 53º. If the least size of mirror to see him is $\frac{3}{n}m$. the distance of eye from mirror is d = 3m, find the value of n.

20. If ε_0, B, V represent permittivity of free space, magnitude of magnetic field and volume of space respectively, then the dimension of $\varepsilon_0 B^2 V$ is $\left[M^a L^b T^c\right]$. Find a + b + c.

Space for Rough work

Chemistry PART – II

SECTION – A

One OR More Than One Choice Type

This section contains **10 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

21. Select the correct statement
    - (A) Viscosity in gases arises principally from the molecular diffusion that transport momentum between layers of flow. The net effect will be decrease in the relative rate of movement of one layer with respect to the other.
    - (B) Viscosity of ideal gas increases as temperature increases.
    - (C) Viscosity of liquids decreases with the rise in temperature.
    - (D) At critical temperature the surface of separation between liquid and gas disappear and their viscosity is same.

22. An ideal gas whose adiabatic exponent γ is expanded according to the law $P = \alpha V$, where α is a constant. The initial volume of the gas is equal to V_o. As a result of expansion, the volume increases 4 times. Select the correct option for above information.
    - (A) Molar heat capacity of gas in the process is $\frac{R(\gamma+1)}{2(\gamma-1)}$
    - (B) Work done by the gas is $15V_o^2\frac{\alpha}{2}$
    - (C) Change in internal energy of gas is $15V_o^2\frac{\alpha}{2}$
    - (D) Both B and C are correct

23. Which of the following complexes exists in facial and meridional forms?
    - (A) $[Co(dien)_2]^{3+}$
    - (B) $[Co(NH_3)_3Cl_3]$
    - (C) $[Co(en)_3]^{3+}$
    - (D) $[Co(gly)_3]$

24. Select the correct statement, for non stoichiometric cuprous oxide $Cu_{1.8}O$.
    - (A) % of Cu^{2+} in total copper is 11.11%
    - (B) % of Cu^{1+} in total copper is 11.11%
    - (C) It behaves like p-type semiconductor
    - (D) Defect is metal deficiency defect

25. Which of the following are colourless?
    - (A) Ce^{3+}
    - (B) La^{3+}
    - (C) Lu^{3+}
    - (D) Gd^{3+}

Space for Rough work

26. One mole of component P and two moles of component Q are mixed at 27°C to form an ideal binary solution. Select the correct option for given information?

(A) $\Delta S_{mix} = 3.82 \text{ cal k}^{-1}$ (B) $\Delta H_{mix} = 0$

(C) $\Delta S_{mix} = 0$ (D) $\Delta G_{mix} = -1145.7 \text{ cal}$

27. Select the correct statement for lead storage battery:
(A) It is a reversible cell.
(B) Salt bridge is not required for lead storage battery.
(C) It is recharged by using DC source of current.
(D) Specific gravity of sulphuric acid solution decreases during discharging.

28. Which of the following statements are true for froth floatation process (for the concentration of sulphide ores)?
(A) Pine oil used as collectors.
(B) Cresol enhance non wettability of the mineral particles.
(C) NaCN selectively prevents PbS from coming to the froth but allows ZnS to come with the froth.
(D) The mineral particles become wet by oils while the gangue particles by water.

29. Which of the following elements can give NO_2 as a by product on reaction with conc. HNO_3?
(A) C (B) Cu
(C) Zn (D) Sn

30. Chlorine has great affinity for hydrogen. It reacts with compounds containing hydrogen to form HCl. Which of the following reaction/s give/s HCl?

(A) $H_2O + Cl_2 \longrightarrow$ (B) $H_2S + Cl_2 \longrightarrow$

(C) $C_{10}H_{16} + 8Cl_2 \longrightarrow$ (D) $\underset{\text{(excess)}}{NH_3} + 3Cl_2 \longrightarrow$

Space for Rough work

SECTION – B

(Matching Type)

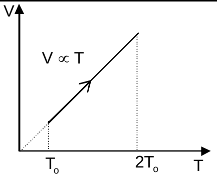
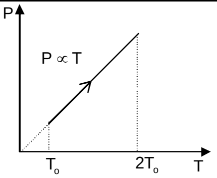
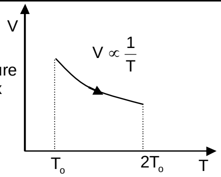
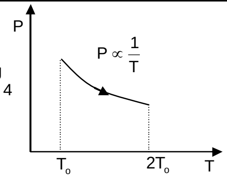
This section contains **2 multiple choice questions.** Each question has matching Column(s). The Column(s) have choices (A), (B), (C) and (D) out of which only **ONE OR MORE THAN ONE** is/are correct

31. Match the following column of precipitate/mass listed in Column I with the reagent (s) listed in Column II:

Column – I (Observations)		**Column – II (Reagents)**	
(A)	Mg^{2+} gives pale pink mass with	(p)	NaOH solution
(B)	Pb^{2+} gives yellow ppt. with	(q)	H_2S gas
(C)	Ag^{+} gives black/brown ppt. with	(r)	K_2CrO_4 solution
(D)	Hg_2^{2+} gives black ppt. with	(s)	KI (not in excess) or KI in excess
		(t)	Cobalt nitrate in charcoal cavity test

Space for Rough work

32. In Column I, certain thermodynamic process are given and in Column II, the value of physical quantities are given. Match the Column I with Column II suitably. (Given : $\rho =$ density of gas)

Column – I		Column – II	
(A)	1 mole of N_2 	(p)	$\|Q\| \geq 2RT_o$
(B)	1 mole of He 	(q)	$\|\Delta U\| \geq \frac{3}{2}RT_o$
(C)	1 mole of gaseous mixture having adiabatic index $\gamma = 1.5$ 	(r)	$\|W\| \geq RT_o$
(D)	1 mole of gas having degree of freedom **f** = 4 	(s)	ρ vs T graph for the process is a straight line
		(t)	P vs ρ graph for the process is a parabola

Space for Rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

33. How many types of isomerism is exhibited by the complex $[Co(NH_3)_4(NO_2)_2]Cl$?

34. How many millilitres of 0.05 M $K_4[Fe(CN)_6]$ solution is required for titration of 60 ml of 0.01 M $ZnSO_4$ solution, when the product of reaction is $K_2Zn_3[Fe(CN)_6]_2$?

35. A molecule A_x dissolve in water and is non volatile. A solution of certain molality showed a depression of 0.93 K in freezing point. The same solution boiled at 100.26°C. When 7.87 g of A_x was dissolved in 100 g of water, the solution boiled at 100.44°C. Given K_f for water = 1.86 K kg mol^{-1}, atomic mass of A = 31 u. Assume no association or dissociation of solute. Calculate the value of x……….

36. What volume of air (in m^3) is needed for the combustion of 1 m^3 of a gas having the following composition in percentage volume : 2% of C_2H_2, 8% of CO, 35% of CH_4, 50% of H_2 and 5% of non-combustible gas. The air contains 20.8% (by volume) of oxygen.

Space for Rough work

37. Find the total number of metals, which makes a thin protective layer of its oxide on treatment with conc. HNO_3.
Zn, Cu, Al, Pt, Cr, Au, Pb, Fe

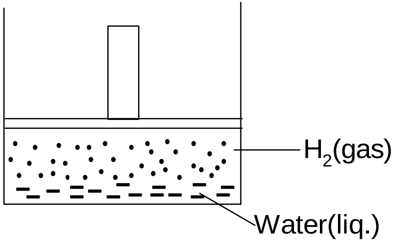
38. The number of salts formed by telluric acid when treated with strong base NaOH is/are….

39. If 6.53×10^{-2} g of metallic zinc is added to 100 ml saturated solution of AgCl, it reacts with Ag^+ of solution as following reaction

$$Zn(s) + 2Ag^{+}(aq) \rightleftharpoons Zn^{2+}(aq) + 2Ag(s)$$

and approximately 10^{-x} moles of Ag will be precipitated. Calculate the value of x……(Given $E^{o}_{Zn^{++}/Zn} = -0.76V$ $E^{o}_{Ag^{+}/Ag} = 0.8\,V$, K_{sp} of AgCl = 10^{-10}, atomic mass of Zn = 65.3u, $10^{52.8813} = 7.61 \times 10^{52}$)

40. Initial volume of H_2 gas saturated with water vapour is confined under a piston in a container is 10 litres as shown in the given figure:



the container also contains some liquid water. The total pressure over liquid water is 80 cm of Hg. If now the piston is removed such that volume of container is doubled, then final total pressure over liquid water in the container is P. The vapour pressure of water is 20 cm of Hg and volume of liquid is negligible. Calculate P/10…….

Space for Rough work

Mathematics

PART – III

SECTION – A

One OR More Than One Choice Type

This section contains **10 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

41. If $D_1, D_2, D_3, \ldots.. D_{1000}$ are 1000 doors and $P_1, P_2, P_3, \ldots.. P_{1000}$ are 1000 persons. Initially all doors are closed. Changing the status of doors means closing the door if it is open or opening it if it is closed. P_1 changes the status of all doors. Then P_2 changes the status of $D_2, D_4, D_6, \ldots.. D_{1000}$ (doors having numbers which are multiples of 2). Then P_3 changes the status of $D_3, D_6, D_9, \ldots.. D_{999}$ (doors having number which are multiples of 3) and this process is continued till P_{1000} changes the status of D_{1000}, then the doors which are finally open is/are

(A) D_{961} (B) D_{269}

(C) D_{413} (D) D_{729}

42. Which of the following options are correct?

(A) $[({}^nC_0 + {}^nC_3 + {}^nC_6 + \ldots..) - \frac{1}{2}({}^nC_1 + {}^nC_2 + {}^nC_4 + {}^nC_5 + \ldots..)]^2 + \frac{3}{4}({}^nC_1 - {}^nC_2 + {}^nC_4 - {}^nC_5 + \ldots..)^2 = 1$

(B) If a and b are two positive numbers such that $a^5b^2 = 4$ then the maximum value of $\log_{2^{1/5}}\left(a^2\right)\cdot\log_{2^{1/2}}\left(b^2\right)$ is equal to 4

(C) Constant term in $((((((x-2)^2-2)^2-2)^2-2)^2-2)^2 \ldots.. 2)^2$ is equal to 2

(D) The coefficient of x^{24} in $\left(\frac{{}^{25}C_1}{{}^{25}C_0}-x\right)\left(x-2^2\frac{{}^{25}C_2}{{}^{25}C_1}\right)\left(x-3^2\frac{{}^{25}C_3}{{}^{25}C_2}\right)\left(x-4^2\frac{{}^{25}C_4}{{}^{25}C_3}\right)\ldots..$ $\left(x-25^2\frac{{}^{25}C_{25}}{{}^{25}C_{24}}\right)$ is equal to 2925

43. x_1, x_2, x_3 are three real numbers satisfying the system of equations
$x_1 + 3x_2 + 9x_3 = 27$, $x_1 + 5x_2 + 25x_3 = 125$ and $x_1 + 7x_2 + 49x_3 = 343$, then which of the following options are correct

(A) number of divisors of $x_1 + x_3$ is 16 (B) $\frac{x_1 + x_2}{2}$ is a prime number

(C) $x_3 - x_2$ is a prime number (D) $x_1 + x_2 + x_3$ is square of an integer

Space for rough work

44. $a_1, a_2, a_3, \ldots$ are distinct terms of an A.P. We call (p, q, r) an increasing triad if a_p, a_q, a_r are in G.P. where $p, q, r \in N$ such that $p < q < r$. If (5, 9, 16) is an increasing triad, then which of the following option is/are correct
(A) if a_1 is a multiple of 4 then every term of the A.P. is an integer
(B) (85, 149, 261) is an increasing triad
(C) if the common difference of the A.P. is $\frac{1}{4}$, then its first term is $\frac{1}{3}$
(D) ratio of the (4k + 1)th term and 4kth term can be 4

45. If z_1, z_2, z_3 z_4 are complex numbers in an Argand plane satisfying $z_1 + z_3 = z_2 + z_4$. A complex number 'z' lies on the line joining z_1 and z_4 such that $\text{Arg}\left(\frac{z - z_2}{z_1 - z_2}\right) = \text{Arg}\left(\frac{z_3 - z_2}{z - z_2}\right)$. It is given that $|z - z_4| = 5$, $|z - z_2| = |z - z_3| = 6$ then
(A) area of the triangle formed by z, z_1, z_2 is $3\sqrt{7}$ sq. units
(B) area of the triangle formed by z, z_3, z_4 is $\frac{15\sqrt{7}}{4}$ sq. units
(C) area of the quadrilateral formed by the points z_1, z_2, z_3, z_4 taken in order is $\frac{27\sqrt{7}}{2}$ sq. units
(D) area of the quadrilateral formed by the points z_1, z_2, z_3, z_4 taken in order is $\frac{27\sqrt{7}}{4}$ sq. units

46. Which of the following is/are true?

(A) $100^{300} < 300!$	(B) $\sqrt{300^{300}} < 300!$
(C) $100^{300} > 300!$	(D) $\sqrt{300^{300}} > 300!$

47. Which of the following is/are correct?
(A) If A is a n × n matrix such that $a_{ij} = \left(i^2 + j^2 - 5ij\right)\cdot(j - i)$ $\forall$ i and j then trace (A) = 0
(B) If A is a n × n matrix such that $a_{ij} = \left(i^2 + j^2 - 5ij\right)\cdot(j - i)$ $\forall$ i and j then trace (A) ≠ 0
(C) If P is a 3 × 3 orthogonal matrix, α, β, γ are the angles made by a straight line with OX, OY, OZ and $A = \begin{bmatrix} \sin^2\alpha & \sin\alpha\cdot\sin\beta & \sin\alpha\cdot\sin\gamma \\ \sin\alpha.\sin\beta & \sin^2\beta & \sin\beta\cdot\sin\gamma \\ \sin\alpha\cdot\sin\gamma & \sin\beta\cdot\sin\gamma & \sin^2\gamma \end{bmatrix}$ and $Q = P^TAP$, then $PQ^6P^T = 32A$
(D) If matrix $A = \left[a_{ij}\right]_{3\times3}$ and matrix $B = \left[b_{ij}\right]_{3\times3}$ where $a_{ij} + a_{ji} = 0$ and $b_{ij} - b_{ji} = 0$ $\forall$ i and j then A^6B^7 is a singular matrix

Space for rough work

48. The vertices of a triangle ABC are A ≡ (2, 0, 2), B(–1, 1, 1) and C ≡ (1, –2, 4). The points D and E divide the sides AB and CA in the ratio 1 : 2 respectively. Another point F is taken in space such that the perpendicular drawn from F to the plane containing ΔABC, meets the plane at the point of intersection of the line segments CD and BE. If the distance of F from the plane of triangle ABC is $\sqrt{2}$ units, then

(A) the volume of the tetrahedron ABCF is $\frac{7}{3}$ cubic units

(B) the volume of the tetrahedron ABCF is $\frac{7}{6}$ cubic units

(C) one of the equation of the line AF is $\vec{r} = \left(2\hat{i} + 2\hat{k}\right) + \lambda\left(2\hat{k} - \hat{i}\right)$ $(\lambda \in R)$

(D) one of the equation of the line AF is $\vec{r} = \left(2\hat{i} + 2\hat{k}\right) + \mu\left(\hat{i} + 7\hat{k}\right)$

49. The direction cosines of two lines are connected by the relations $\ell + m + n = 0$ and $mn = 2\ell(m + n)$, then

(A) $\frac{\ell_1}{\ell_2} + \frac{m_1}{m_2} + \frac{n_1}{n_2}$ is equal to $-\frac{3}{2}$

(B) $\ell_1\ell_2 + m_1m_2 + n_1n_2$ is equal to $-\frac{1}{2}$

(C) $\ell_1m_1n_1 + \ell_2m_2n_2$ is equal to $-\frac{\sqrt{2}}{3\sqrt{3}}$

(D) $(\ell_1 + \ell_2)(m_1 + m_2)(n_1 + n_2)$ is equal to $\frac{1}{3\sqrt{6}}$

50. Let the equation of a straight line L in complex form be $a\bar{z} + \bar{a}z + b = 0$, where a is a complex number and b is a real number, then

(A) the straight line $\frac{z - c}{a} + \frac{i(\bar{z} - \bar{c})}{\bar{a}} = 0$ makes an angle of 45º with L and passes through a point c (where c is a complex number)

(B) the straight line $\frac{z - c}{a} = \frac{i(\bar{z} - \bar{c})}{\bar{a}}$ makes an angle of 45º with L and passes through a point c (where c is a complex number)

(C) the complex slope of the line L is $-\frac{a}{\bar{a}}$

(D) the complex slope of the line L is $\frac{a}{\bar{a}}$

Space for rough work

SECTION – B

(Matching Type)

This section contains **2 multiple choice questions.** Each question has matching Column(s). The Column(s) have choices (A), (B), (C) and (D) out of which only **ONE OR MORE THAN ONE** is/are correct

51. Match the following Column-I with Column-II

Column – I		**Column – II**	
(A)	If the polynomial $x^3 + ax^2 + bx + c$ is divisible by $(x^2 + 1)$, where a, b, c belong to {1, 2, 3, 4, ..., 10} then a + b + c may be equal to	(p)	6
(B)	A and B are 3 × 3 matrices of real numbers, where A is symmetric a matrix and B is a skew symmetric a matrix, and $(A + B)(A – B) = (A – B)(A + B)$. If $(AB)^T = (–1)^k AB$ then k may be equal to	(q)	3
(C)	Sum of the digits of $(100^{50} – 43)$ is divisible by	(r)	9
(D)	Let $\vec{a} = (\cos\theta)\hat{i} - (\sin\theta)\hat{j}$, $\vec{b} = (\sin\theta)\hat{i} + (\cos\theta)\hat{j}$, $\vec{c} = \hat{k}$, $\vec{r} = 7\hat{i} + \hat{j} + 10\hat{k}$, if $\vec{r} = x\vec{a} + y\vec{b} + z\vec{c}$ then the value of $\frac{x^2 + y^2}{z}$ is less than	(s)	10
		(t)	11

52. Match the following Column-I with Column-II

Column – I		**Column – II**	
(A)	If x and y are two integers such that $289 – x^2 + y^4 = 0$ then the possible value(s) of unit digit of x + 12y + 4 is/are	(p)	1
(B)	If P, Q, R, S be four points in space satisfying $\left|\overrightarrow{PQ}\right| = 3$, $\left|\overrightarrow{QR}\right| = 7$, $\left|\overrightarrow{RS}\right| = 11$, $\left|\overrightarrow{SP}\right| = 9$, then the value of $\frac{\overrightarrow{PS} \cdot \overrightarrow{QR}}{9}$ is less than	(q)	2
(C)	The sum of three positive integer is 20. If the probability that they form the sides of a triangle is P then 19P is equal to	(r)	3
(D)	The first term of an infinite geometric series is 21. The second term and the sum of the series are both positive integers. If the value of second term is k then the possible value(s) of |k – 15| is/are	(s)	4
		(t)	5

Space for rough work

SECTION – C

(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

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53. If $\alpha_1, \alpha_2, \alpha_3, \alpha_4$ are the roots of $x^4 + 2x^3 + bx^2 + cx + d = 0$ such that $\alpha_1 - \alpha_3 = \alpha_4 - \alpha_2$, then b – c is equal to _____

54. A chess match between two players A and B is won by whoever first wins a total of two games. Probability of A's winning, drawing and losing any particular game are $\frac{1}{6}$, $\frac{1}{3}$ and $\frac{1}{2}$ respectively. (The games are independent). If the probability that B wins the match in the 4th game is p, then 6p is equal to _____

55. If k_1 and k_2 ($k_1 > k_2$) are two non-zero integral values of k for which the cubic equation $x^3 + 3x^2 + k = 0$ has all integer roots, then the value of $k_1 - k_2$ is equal to _____

56. Let $a_k = {}^nC_k$ for $0 \le k \le n$ and $A_k = \begin{bmatrix} a_{k-1} & 0 \\ 0 & a_k \end{bmatrix}$ & $B = \sum_{k=1}^{n-1} A_k \cdot A_{k+1} = \begin{bmatrix} a & 0 \\ 0 & b \end{bmatrix}$, then $\frac{a}{b}$ is equal to _____

57. If $\sum_{r=0}^{203}\left(\left(r^2+2\right)(r+1)!+2r(r+1)!\right) = a! - 2(b!)$ (where a, b $\in$ N), then a – b is equal to _____

58. If $a = 1 + \frac{x^3}{3!} + \frac{x^6}{6!} + \frac{x^9}{9!} + ...,\ b = x + \frac{x^4}{4!} + \frac{x^7}{7!} + \frac{x^{10}}{10!} + ...$ and $c = \frac{x^2}{2!} + \frac{x^5}{5!} + \frac{x^8}{8!} + \frac{x^{11}}{11!} + ...$ then the value of $a^3 + b^3 + c^3 - 3abc$ is equal to _____

59. Let $A = \begin{bmatrix} \ell & m & n \\ p & q & r \\ 1 & 1 & 1 \end{bmatrix}$ and $B = A^2$. If $(\ell - m)^2 + (p - q)^2 = 9$, $(m - n)^2 + (q - r)^2 = 16$, $(n - \ell)^2 + (r - p)^2 = 25$, then the value of |det(B) – 140| is _____

60. If the number of ordered pairs (a, b) where a, b $\in$ R such that $(a + ib)^{5015} = (a - ib)^3$ is k, then the unit digit of k is equal to _____

Space for rough work

FIITJEE **JEE (Main)-2018**

ALL INDIA TEST SERIES

PART TEST – III

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 – 30, 31 – 60, 61 – 90)** *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10 \text{ m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3 \text{ kg/m}^3$
Atmospheric pressure	$P_a = 10^5 \text{ N/m}^2$
Gas constant	$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
		=	$0.0821 \text{ Lit atm K}^{-1} \text{ mol}^{-1}$
		=	$1.987 \approx 2 \text{ Cal K}^{-1} \text{ mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

Straight Objective Type

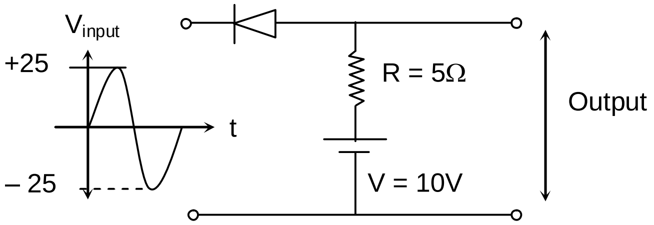
This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A spherical ball of mass m, radius r is connected to string of length $(\ell >> r)$. This string is then connected to fixed point and this arrangement allowed to oscillate in a medium whose density is ρ and viscosity is η. If amplitude of oscillation becomes half of the initial value after n seconds. Then viscosity of liquid is given by (Assume that resistance force on ball follows stoke's law).

(A) $\frac{m}{\pi rn}$ (B) $\frac{m\ell n\left(2^{1/3}\right)}{\pi rn}$

(C) $\frac{m\ell n8}{\pi rn}$ (D) $\frac{m\ell n2}{\pi rn}$

2. An ideal diode is connected in a circuit with resistance R = 5Ω and V = 10 volt as shown in figure maximum and minimum value of output voltage. When no load applied is (assume diode to be ideal)



(A) 10V, – 25V (B) 10V, – 15V

(C) 25V, – 25V (D) 25V, – 15V

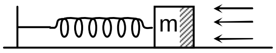
3. A vessel is half filled with a liquid of refractive index μ. The other half of the vessel is filled with an immiscible liquid of refractive index 1.5μ. The apparent depth of the vessel is 50% of the actual depth. Then μ is

(A) 1.4 (B) 1.5

(C) 1.8 (D) 1.67

Space for Rough work

4. A spring block system with mass of block m and spring constant K (all the surfaces of block are perfectly absorbing and smooth) is placed on a smooth horizontal plane as shown in the diagram at rest. A light beam of intensity I is switched on its right side. Find the amplitude of oscillations of the block. (face area of block is A and c is the speed of light in vacuum)



(A) $\frac{I}{Kc}A$ (B) $\frac{2I}{Kc}A$
(C) $\frac{4I}{Kc}A$ (D) Zero

5. What should be the approximate kinetic energy of an electron so that its de-Broglie wavelength is equal to the wavelength of X-ray of maximum energy, produced in an X-ray tube operating at 24800 V? (given that $h = 6.6 \times 10^{-34}$ joule-sec, mass of electron = 9.1×10^{-31} kg)
(A) 600 eV (B) 365 eV
(C) 120 eV (D) 300 eV

6. A 2 kg block moving with 10 m/sec strikes a spring of constant π^2 N/m which is attached to 2 kg block at rest kept on a smooth horizontal floor. The time for which rear moving block remain in contact with spring is
(A) $\sqrt{2}$ sec (B) $\frac{1}{\sqrt{2}}$ sec
(C) 1 sec (D) 1/2 sec

7. Unpolarised light of intensity 32 watt m^{-2} passes through three polarisers such that the transmission axes of the first and second polarises makes an angle 30º with each others the transmission axes of the second and third polarises makes an angle 60º with each other. The intensity of final emerging light will be
(A) 32 watt m^{-2} (B) 3 watt m^{-2}
(C) 8 watt m^{-2} (D) 4 watt m^{-2}.

8. Choose the incorrect statements
(A) An electron beam is used to obtain interference in a simple Young's double-slit experiment. If speed of electron is increased the fringe width decreases.
(B) de-Broglie wavelength of electron is inversely proportional to the speed of electrons.
(C) Two coherent point sources of light having non-zero phase difference are separated by a small distance. On the perpendicular bisector of line segment joining both the point sources, no Constructive interference can be obtained.
(D) For two waves from coherent point sources to interference constructively at a point the magnitude of their phase difference at that point must be $2n\pi$(where n is non-negative integer)

Space for Rough work

9. In radio-receiver, the short wave and medium wave stations transmit signal using same capacitors but ideal coils of different inductors L_s and L_m respectively. Choose the correct option
(A) $L_s > L_m$ (B) $L_s = L_m$
(C) $L_s < L_m$ (D) None.

10. A string of length 2L, obeying Hooke's Law, is stretched so that its extension is L. The speed of the tranverse wave travelling on the string is v. If the string is further stretched so that the extension in the string becomes 4L. The speed of transverse wave travelling on the string will be.
(A) $\sqrt{2}V$ (B) V
(C) $2\sqrt{2}V$ (D) 2V

11. A rigid bar of mass M is supported symmetrically by three wires each of length ℓ. Those at each end are of copper and the middle one is of iron. The ratio of their diameters, if each is to have the same tension, is equal to
(A) $\frac{Y_{copper}}{Y_{iron}}$ (B) $\sqrt{\frac{Y_{iron}}{Y_{copper}}}$
(C) $\frac{Y_{iron}^2}{2Y_{copper}^2}$ (D) $\frac{2}{3}\frac{Y_{iron}}{Y_{copper}}$

12. A close organ pipe of diameter 10 cm has length 42 cm. The air column in pipe vibrates in its second overtone with the maximum amplitude ΔP_o. The pressure amplitude at middle of pipe is
(A) $\frac{\Delta P_o}{2}$ (B) $\frac{\Delta P_o}{\sqrt{2}}$
(C) $\frac{\sqrt{3}\Delta P_o}{2}$ (D) ΔP_o

13. For the same objective, the ratio of the least separation between two points to be distinguished by a microscope using electrons accelerated through 100 V and light of 5500 Å used as the illuminating substance is
(A) 2×10^{-4} (B) 2×10^{-3}
(C) 2×10^{-2} (D) 4×10^{-4}

Space for Rough work

14. M_x and M_y denote the atomic masses of the parent and the daughter nuclei respectively in a radioactive decay. The Q-value for a β-decay is Q_1 and that for a β^+ decay is Q_2. If m_e denotes the mass of an electron, then which of the following statements is correct?
(A) $Q_1 = (M_x - M_y)c^2$ and $Q_2 = (M_x - M_y - 2m_e)c^2$
(B) $Q_1 = (M_x - M_y)c^2$ and $Q_2 = (M_x - M_y)c^2$
(C) $Q_1 = (M_x - M_y - 2m_e)c^2$ and $Q_2 = (M_x - M_y + 2m_e)c^2$
(D) $Q_1 = (M_x - M_y + 2m_e)c^2$ and $Q_2 = (M_x - M_y + 2m_e)c^2$

15. Tritium is an isotope of hydrogen whose nucleus Triton contains 2 neutrons and 1 proton. Free neutrons decay into $p + \overline{e} + \overline{\nu}$ If one of the neutrons in Triton decays, it would transform into a He^3 nucleus. This does not happen because
(A) Triton energy is less than that of a He^3 nucleus.
(B) The electron created in the beta decay process cannot remain in the nucleus.
(C) Both the neutrons in triton have to decay simultaneously resulting in a nucleus with 3 protons, which is not a He^3 nucleus.
(D) Because free neutrons decay due to external perturbations which is absent in a triton nucleus.

16. A tuning fork A is being tested using an accurate oscillator. It is found that they produce 2 beats per second when the oscillator reads 514 Hz and 6 beats per second when it reads 510 Hz. The actual frequency of the fork in Hz is
(A) 512 Hz
(B) 504 Hz
(C) 516 Hz
(D) 510 Hz

17. The objective of telescope has diameter 12 cm. The distance at which two small green object placed 30 cm apart can be barely resolved by telescope, assuming the resolution to be limited by diffraction by objective only ($\lambda = 5.4 \times 10^{-5}$ cm)
(A) 54.6 km
(B) 57.0 km
(C) 546 km
(D) 52.4 km

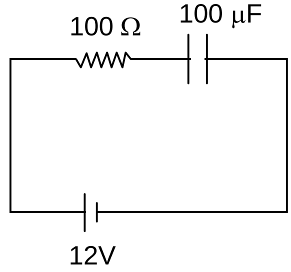
Space for Rough work

18. Two cars A and B are moving towards each other with same speed 25 m/s. Wind is blowing with speed 5 m/s in the direction of motion of car A. The car A blows horn of frequency 300 Hz and the sound is reflected from car B. The wavelength of the reflected sound received by the driver of car A is (velocity of sound in air = 330 m/s)

(A) $\frac{25}{36}$m (B) $\frac{31}{36}$m

(C) $\frac{35}{36}$m (D) $\frac{37}{36}$m

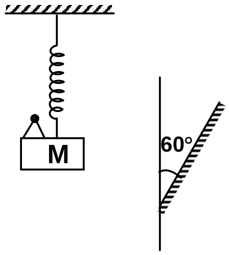
19. The value of displacement current at t = 1 time constant is



(A) $\frac{120}{e}$mA (B) $\frac{120}{e^2}$mA

(C) 120 mA (D) None of these

20. An insect of negligible mass is sitting on a block of mass M, tied with a spring of force constant k. The block performs simple harmonic motion with amplitude A in front of a plane mirror placed as shown in the figure. The maximum speed of insect relative to its image will be



(A) $A\sqrt{\frac{k}{m}}$ (B) $\frac{A\sqrt{3}}{2}\sqrt{\frac{k}{m}}$

(C) $A\sqrt{3}\sqrt{\frac{k}{m}}$ (D) $A\sqrt{\frac{m}{k}}$

21. Mass of a sphere of radius r = 10.00 cm is 30.000 g
If measured values are expressed upto the correct significant figures then maximum fractional error in calculation of density of the sphere is

(A) 3×10^{-5} (B) 3.3×10^{-3}

(C) 3.033×10^{-3} (D) 3.03×10^{-5}

Space for Rough work

22. Maximum pressure difference between inner and outer surface of a thin walled circular tube of radius r and thickness $\Delta r\left(\Delta r << r\right)$, so that tube won't break is (Breaking stress of the material is σ_0)

(A) $\frac{\sigma_0 r}{\Delta r}$ (B) $\frac{\Delta r\sigma_0}{r}$

(C) $\frac{2\sigma_0 r}{\Delta r}$ (D) σ_0

23. $\frac{7}{8}$th of nuclei have been disintegrated in 2 minutes after fresh sample was prepared. The half life of the sample is

(A) 30 seconds (B) 1 minute

(C) 40 seconds (D) 20 seconds

24. An astronomical telescope has angular magnification m = 7 for distant object. Distance between objective and eyepiece is 40 cm. Final image is formed at infinitely. Focal length of objective and eyepiece respectively are:

(A) 35 cm, 5 cm (B) 28 cm, 14 cm

(C) 5 cm, 35 cm (D) 70 cm, 10 cm

25. The length of an elastic chord is ℓ_1 when tension in it is T_1 and ℓ_2 when tension is T_2. The natural length of wire is

(A) $\frac{\ell_1 T_1 + \ell_2 T_2}{T_1 + T_2}$ (B) $\frac{\ell_2 T_1 - \ell_1 T_2}{T_1 - T_2}$

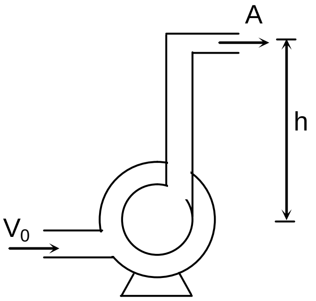
(C) $\frac{\ell_2 T_1 + \ell_1 T_2}{T_1 + T_2}$ (D) $\frac{\ell_1 T_1 - \ell_2 T_2}{T_1 - T_2}$

26. The angular speed of rotation of earth about its axis when the weight of a man standing on equator will become half of its weight at the north pole (assume earth to be a perfect sphere) R-6400 km.

(A) 275 × 10^{-4} rad sec^{-1} (B) 9.75 × 10^{-4} rad sec^{-1}

(C) 8.75 × 10^{-4} rad sec^{-1} (D) 8.0 × 10^{-4} rad sec^{-1}

Space for Rough work

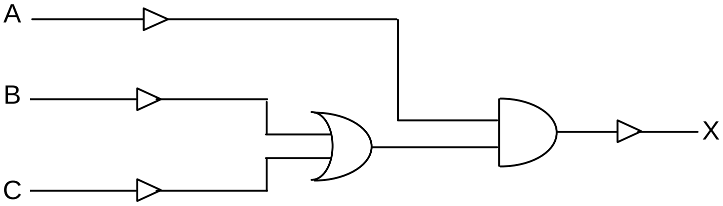


27. In a certain pump whose rated power is P. Ideal fluid of density ρ enters with speed V_0 which lifts water upto height h through a pipe of uniform cross section area without discontinuity. Volumetric flow rate of the liquid is Q. Speed of fluid when it comes out of the pipe at point A is {Assume that pump works at 100% efficiency and flow is streamline}

(A) $\sqrt{\frac{2P}{Q\rho}+V_0^2-2gh}$ (B) $\sqrt{\frac{2P}{Q\rho}+V_0^2}$

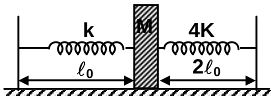
(C) $\sqrt{\frac{2P}{Q\rho}+V_0^2+2gh}$ (D) $\sqrt{\frac{2P}{Q\rho}-V_0^2+2gh}$

28. In above diagram × = ?
(A) A + BC
(B) AB + C
(C) AC + B
(D) None of above



29. An object is floating in water with fraction of its volume submerged in water filled in beaker which is at rest with respect to ground. Now this beaker is accelerated with constant acceleration downwards ($a < g$). Then,
(A) Fraction of volume submerged will not change.
(B) Buoyant force on the block will remain same.
(C) Pressure at any point in the water will be more than earlier.
(D) Fraction of volume submerged will change.

30. A block of mass M is kept in gravity free space and touches the two springs as shown in the figure. Initially springs are in its natural length. Now, the block is shifted ($\ell_0/2$) from the given position in such a way it compresses a spring and released. The time-period of oscillation of mass will be



(A) $\frac{\pi}{2}\sqrt{\frac{M}{K}}$ (B) $2\pi\sqrt{\frac{M}{5K}}$

(C) $\frac{3\pi}{2}\sqrt{\frac{M}{K}}$ (D) $\pi\sqrt{\frac{M}{2K}}$

Space for Rough work

Chemistry

PART – II

SECTION – A

Straight Objective Type

This section contains **30 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

31. The pair of compounds having metals in their highest oxidation state

(A) MnO_2, $FeCl_3$ (B) $[MnO_4]^-, CrO_2Cl_2$

(C) $[Fe(CN)_6]^{3-}, [Co(CN)_3]$ (D) $[NiCl_4]^{2-}, [CoCl_4]^-$

32. The density of solid Ar (Ar = 40 g/mole) is 1.68 g/ml at 40 K. If the argon atom is assumed to be a sphere of radius 1.50×10^{-8} cm, then % of solid Ar is apparently empty space?

(A) 35.64 (B) 64.36

(C) 74 (D) None these

33. Resistance of a decimolar solution between two electrodes is 0.02 meter apart and 0.0004 m^2 in area was found to be 50 ohm. Specific conductance will be

(A) 0.1 Scm^2 (B) 1 Scm^2

(C) 10 Scm^2 (D) 4×10^{-4} Scm^2

34. Poling process is used for

(A) the removal of Cu_2O from Cu (B) the removal of Al_2O_3 from Al

(C) the removal of Fe_2O_3 from Fe (D) All of these

35. A solution of $Na_2S_2O_3$ is standarised idometrically against 0.167 gram of $KBrO_3$. This process requires 50 mL of the $Na_2S_2O_3$ solution. What is the normality of the $Na_2S_2O_3$?

(A) 0.2 N (B) 0.12 N

(C) 0.72 N (D) 0.02 N

36. A 0.10 M solution of a mono protic acid (d = 1.01 g/cm^3) is 5% dissociated. What is the freezing point of the solution. The molar mass of the acid is 300 and $K_f(H_2O) = 1.86^oC/m$

(A) -0.189^oC (B) -0.194^oC

(C) -0.199^oC (D) None

Space for Rough work

37. In a spinel structure of a mixed oxide, oxide ion are arranged in FCC packing whereas $\frac{1}{8}$th of tetrahedral voids are occupied by A^{2+} ion and $\frac{1}{2}$ of octahedral voids are occupied by B^{3+} cations. The general formula of the compound having structure is

(A) $A_2B_2O_4$	(B) AB_2O_4
(C) $A_2B_4O_2$	(D) $A_4B_2O_2$

38. In the purification of impure Ni by Mond's process, metal is purified by

(A) Electrolytic reduction	(B) Vapour phase thermal decomposition
(C) Thermite reduction	(D) Carbon reduction

39. $\underset{(\text{Black})}{X} \xrightarrow{\text{Dil. } H_2SO_4} \underset{(\text{Gas})}{Y} \xrightarrow{\text{Dil. } HNO_3} \text{Colloidal sulphur}$

Identify X?

(A) CuS	(B) FeS
(C) As_2S_3	(D) CdS

40. Fixed mass of an ideal gas collected in a 24.63 litre sealed rigid vessel at 1 atm is heated from – 73°C to 27°C. Calculate change in Gibbs free energy if entropy of gas is a function of temperature as $S = 2 + 10^{-2}\,T$ (J/K) (1 atm = 0.1 kJ)

(A) 1231.5 J	(B) 1281.5 J
(C) 785.1 J	(D) None

41. CsCl has bcc structure with Cs^+ at the centre and Cl^- ion at each corner. If r_{Cs^+} is 1.69 $\overset{o}{A}$ and r_{Cl^-} is 1.81 $\overset{o}{A}$. What is the edge length of the cube?

(A) 3.5 $\overset{o}{A}$	(B) 3.80 $\overset{o}{A}$
(C) 4.04 $\overset{o}{A}$	(D) 4.5 $\overset{o}{A}$

42. The cell $Pt\,|\,H_2(g, 0.1\,\text{bar})\,|\,H^+(aq), pH = x\,||\,Cl^-(1M)\,|\,Hg_2Cl_2\,|\,Hg\,|\,Pt$ has emf of 0.5755 V at 25°C. The SOP of Calomel electrode is – 0.28 V, then pH of the solution will be

(A) 11	(B) 4.5
(C) 5.5	(D) None

Space for Rough work

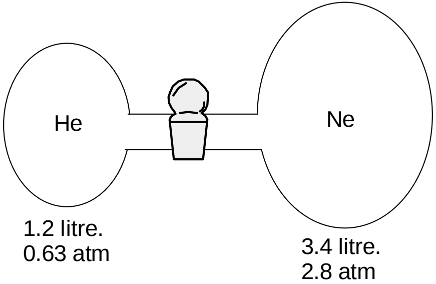
43. For a reversible adiabatic ideal gas expansion $\frac{dp}{p}$ is equal to

(A) $\gamma\frac{dV}{v}$
(B) $-\gamma\frac{dv}{v}$
(C) $\left(\frac{\gamma}{\gamma-1}\right)\frac{dV}{V}$
(D) $\frac{dV}{V}$

44. A freshly prepared $Fe(OH)_3$ precipitate is peptized by adding $FeCl_3$ solution. The charge on the colloidal particle is due to preferential adsorption of

(A) Cl^-
(B) Fe^{3+}
(C) OH^-
(D) None of these

45. Consider the following apparatus. Calculate the partial pressure of He after opening the valve. The temperature is remain constant at 16^oC



(A) 0.164 atm
(B) 1.64 atm
(C) 0.328 atm
(D) 1 atm

46. On adding KI to a metal salt solution, no precipitate was observed but the salt solution gives yellow precipitate with K_2CrO_4 in the presence CH_3COOH. Then the salt is

(A) $Sr(NO_3)_2$
(B) $Pb(CH_3COO)_2$
(C) $AgNO_3$
(D) $BaCl_2$

47. Which of the following is true in respect of chemical adsorption?

(A) $\Delta H < O \ \ \Delta S > O \ \ \Delta G > O$
(B) $\Delta H < O \ \ \Delta S < O \ \ \Delta G < O$
(C) $\Delta H > O \ \ \Delta S > O \ \ \Delta G < O$
(D) $\Delta H > O \ \ \Delta S < O \ \ \Delta G > O$

48. For the reaction $N_2H_4 + IO_3^- + 2H^+ + Cl^- \longrightarrow ICl + N_2 + 3H_2O$

The eq. mass of N_2H_4 and KIO_3 is respectively are

(A) 8 and 53.5
(B) 16 and 53.5
(C) 8 and 35.6
(D) 8 and 87

Space for Rough work

49. Which of the following statement is false?

(A) Optical isomerism is observed in $\left[M_{abcd}\right]^{n\pm}$ tetrahedral complexes.

(B) Geometrical isomerism does not exists while optical isomerism exists in the complex $\left[Fe\left(C_2O_4\right)_3\right]^{3-}$.

(C) Both *cis* and *trans* forms are optically inactive in $\left[PtCl_2\left(NH_3\right)_4\right]^{2+}$ complex ion.

(D) $\left[Pt\left(en\right)_2\right]^{2+}$ shows geometrical isomerism as well as optical.

50. Consider the following reaction:

$$H_2O(\ell) \longrightarrow H_2O(g) \qquad \Delta H_1 = 44 \text{ kJ}$$

$$2CH_3OH(\ell) + 3O_2 \longrightarrow 4H_2O(\ell) + 2CO_2(g) \qquad \Delta H_2 = -1453 \text{ kJ}$$

What is the value of ΔH for second reaction if water vapour instead of liquid water is formed as product?

(A) - 1409 kJ
(B) - 1629 kJ
(C) - 1277 kJ
(D) None of these

51. Smog is essentially caused by the presence of

(A) O_3 and N_2
(B) O_2 and N_2
(C) Oxides of sulphur and N_2
(D) O_2 and O_3

52. Which of the following is not tranquilizer?

(A) Luminal
(B) Seconal
(C) Reserpine
(D) Piperazine

53. Which of the following will not be oxidised by O_3?

(A) KI
(B) $FeSO_4$
(C) $KMnO_4$
(D) K_2MnO_4

54. Which of the following process is used in the extractive metallurgy of Mg?

(A) Fused salt electrolysis
(B) Self – reduction
(C) Aqueous solution electrolysis
(D) Thermite reduction

55. Which of the following compound is not an antacid?

(A) Aluminium hydroxide
(B) Cimetidine
(C) Phenelzine
(D) Ranitidine

56. The gas leaked from a storage tank of the union carbide plat in Bhopal gas tragedy was

(A) Ammonia
(B) Phosgene
(C) Methyl isocynate
(D) Methyl amine

Space for Rough work

57. 36 mL of pure water takes 100 sec to evaporate from a vessel when a heater of 806 watt is used. The $\Delta H_{vaporisation}$ of H_2O is: (density of water = 1 g/cc)

(A) 40.3 kJ/mole (B) 43.2 kJ/mole
(C) 4.03 kJ/mole (D) none

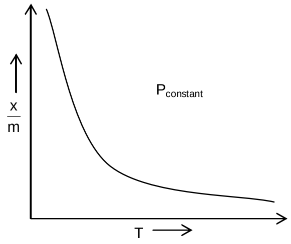
58. 108 g fairly concentrated solution of $AgNO_3$ is electrolysed by using 0.1 F charge. The mass of resulting solution is

(A) 94 g (B) 11.6 g
(C) 96.4 g (D) None

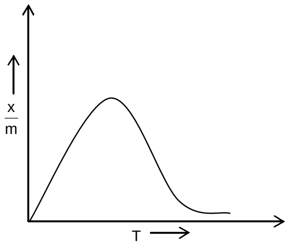
59. The geometry, hybridization and magnetic moment of $[Ni(CO)_4]$ are……..,….and …..respectively

(A) tetrahedral, sp^3, zero (B) square planar, sp^3, $\sqrt{3}$
(C) tetrahedral, sp^3, $2\sqrt{2}$ (D) square planar, dsp^2, zero

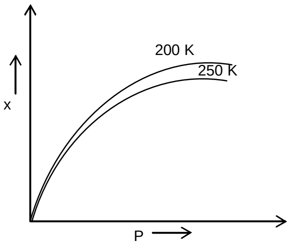
60. X = amount of gas adsorbed
P = Pressure
T = Temperature
L = Physisorption
M = Chemisorption
For the following graphs I, II, III and IV



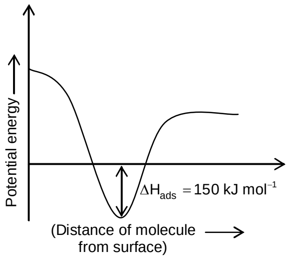
I



II



III



IV

Chose correct combination:

(A) I → L, II → M (B) I → L, III → M
(C) IV → M, II → L (D) IV → M, III → M

Space for Rough work

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **30 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

61. If $\vec{a} = x\hat{i} + y\hat{j} + 2\hat{k}$, $\vec{b} = \hat{i} - \hat{j} + \hat{k}$, $\vec{c} = \hat{i} + 2\hat{j}$, $\left(\vec{a} \wedge \vec{b}\right) = \frac{\pi}{2}$, and $\vec{a} \cdot \vec{c} = 4$, then

(A) $\left[\vec{a}\ \vec{b}\ \vec{c}\right]^2 = |\vec{a}|$ (B) $\left[\vec{a}\ \vec{b}\ \vec{c}\right] = |\vec{a}|$

(C) $\left[\vec{a}\ \vec{b}\ \vec{c}\right] = 0$ (D) $\left[\vec{a}\ \vec{b}\ \vec{c}\right] = |\vec{a}|^2$

62. The value of m for which the straight line 2x – 3y + 4 = 0 = x – 4y + 4z + 5 is parallel to the plane 2x – y + mz – 2 = 0 is

(A) 3 (B) 2

(C) $\frac{-16}{5}$ (D) –4

63. A line L passing through the point P(0, 1, –1), and is perpendicular to both the lines $\frac{x-2}{2} = \frac{y-4}{1} = \frac{z+2}{4}$ and $\frac{x+2}{3} = \frac{y+4}{2} = \frac{z-1}{-2}$. If the position vector of point Q on L is (a, b, c) such that $(PQ)^2 = 357$, then a + 2b + 3c is equal to

(A) 26 (B) 24

(C) –24 (D) 7

64. Let O be the interior point of ΔABC such that $3\overrightarrow{OA} + 4\overrightarrow{OB} + 6\overrightarrow{OC} = 0$, then $\frac{\text{Area of } \Delta ABC}{\text{Area of } \Delta AOB}$ is equal to

(A) $\frac{13}{7}$ (B) $\frac{13}{6}$

(C) $\frac{8}{7}$ (D) $\frac{7}{13}$

Space for Rough work

65. If $\vec{a} = 3\hat{i} + 2\hat{j} + 3\hat{k}$ and $\vec{b} = 2\hat{i} - 3\hat{j} - 3\hat{k}$ then the vector $(\hat{a} \times \hat{b}) \times (\hat{a} + \hat{b})$ is collinear to the vector

(A) $4\hat{i} + \hat{j} + 4\hat{k}$
(B) $\hat{i} + 5\hat{j} + 6\hat{k}$
(C) $5\hat{i} + 4\hat{j} + 5\hat{k}$
(D) $5\hat{i} + 5\hat{k}$

66. If $\vec{a}, \vec{b}$ and $\vec{c}$ are three non-zero non-coplanar vectors and $\vec{x} = \vec{a} + 2\vec{b} - \vec{c}$, $\vec{y} = \vec{a} - 2\vec{b} - 2\vec{c}$ and $\vec{z} = \vec{a} - 4\vec{b} + 2\vec{c}$ are three vectors such that volume of the parallelopiped formed by $\vec{a}, \vec{b}, \vec{c}$ and $\vec{x}, \vec{y}, \vec{z}$ as their coterminous edges are v_1 and v_2 respectively. Then $\frac{v_2}{v_1}$ is

(A) 10
(B) 15
(C) 18
(D) none of these

67. If $\sum_{k=0}^{100}\left(\frac{k}{k+1}\right){}^{100}C_k = \frac{x(2^{100}) + y}{z}$ where x, y, z $\in$ N then least value of xy^2z is equal to

(A) 9999
(B) 1010
(C) 9090
(D) none of these

68. A two digit positive number is selected at random then the probability that its tens digit is at least four more than its unit digit, is

(A) $\frac{1}{6}$
(B) $\frac{7}{30}$
(C) $\frac{14}{45}$
(D) none of these

69. Consider the system of equations $\alpha x - y + z = \alpha$; $x - \alpha y + z = 1$; $x - y + \alpha z = 1$. If L, M, and N denotes the number of integral values of α in interval [–5, 7] for which the system of equation has unique solution, no solution and infinite solution respectively, then the value of $L^2 + M^2 + N^2$ is

(A) 125
(B) 13
(C) 15
(D) 121

70. If α, β, γ be the roots of the equation $3x^3 - 5x^2 + 6x - 2 = 0$ and $A(\alpha, \beta, \gamma)$, $B(\beta, \gamma, \alpha)$, $C(\gamma, \alpha, \beta)$ are the vertices of the triangle, then centroid of ΔABC lies on the line

(A) $x = 2y = 3z$
(B) $x = y = z$
(C) $x = -2y = z$
(D) $-x = y = -z$

Space for Rough work

71. The coefficient of x^{20} in the polynomial $(1 + x)^{22} + x(1 + x)^{21} + x^2(1 + x)^{20} + \ldots.. + x^{20}(1 + x)^2$ is

(A) $^{22}C_{19}$ (B) $^{23}C_3$

(C) $^{22}C_2$ (D) $^{23}C_{19}$

72. Number of complex numbers z such that $|z| < \frac{1}{3}$ and $\sum_{r=1}^{n} a_r z^r = 1$ (where $|a_r| < 2$) is

(A) 1 (B) 2

(C) n (D) 0

73. Let $A_k = \cos\frac{k\pi}{20} + i\sin\frac{k\pi}{20}$ where $\sqrt{-1} = i$, then $\dfrac{\sum_{k=0}^{2018}\left|A_{k+1} - A_k\right|}{\sum_{k=1}^{673}\left|A_{2k+1} - A_{2k+2}\right|}$ is equal to

(A) 3 (B) $\frac{2018}{673}$

(C) $\frac{2019}{674}$ (D) none of these

74. The value of $\begin{vmatrix} (a-p)^{-2} & (a-p)^{-1} & p^{-1} \\ (a-q)^{-2} & (a-q)^{-1} & q^{-1} \\ (a-r)^{-2} & (a-r)^{-1} & r^{-1} \end{vmatrix}$ is

(A) $\frac{a^2\prod(p-q)}{pqr\prod(a-p)^2}$ (B) $\frac{-a^2\prod(p-q)}{prq\prod(a-p)^2}$

(C) $\frac{b^2\prod(p-q)}{pqr\prod(a-p)^2}$ (D) $\frac{c^2\prod(p-q)}{pqr\prod(a-p)^2}$

Space for Rough work

75. If a_r, b_r, c_r (r = 1, 2, 3) are non-negative real numbers and $\sum_{r=1}^{3}\left(a_r + b_r + c_r\right) = A$, then maximum value of $\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}$ is

(A) A^3 (B) $\frac{A^3}{8}$

(C) $\frac{A^3}{27}$ (D) $\frac{A^2}{9}$

76. If a point z_1 satisfying $|z + 8| \le 2$ and z_2 satisfying $|z + 3| + |z - 3| \le 10$ then the range of $|z_1 - z_2|$ is

(A) [10, 15] (B) [1, 15]

(C) [2, 10] (D) none of these

77. Area of the triangle whose vertices are A(–3 – 2i), B(2 – 3i) and C(–1 –5i), is

(A) $\frac{\sqrt{7}}{4}$ (B) $\frac{\sqrt{14}}{2}$

(C) $\frac{\sqrt{13}}{2}$ (D) $2\sqrt{14}$

78. If k_1 is the number of arrangements of the letters of the word "EQUATION" in which all vowels are together and k_2 is the number of arrangements of the letters of the word "EQUATION" in which vowels are in alphabetical order then $\frac{7k_1}{k_2}$ is

(A) 120 (B) 4! × 5!

(C) 60 (D) $\frac{8!}{5!}$

79. 100 identical objects are distributed among 10 persons in which 1st person gets at least one object, 2nd person gets at least 2 objects, 3rd person gets at least 3 objects, ..., 10th person gets at least 10 objects, then total number of ways of distribution is

(A) ${}^{55}C_{10}$ (B) ${}^{55}C_9$

(C) ${}^{54}C_9$ (D) ${}^{54}C_{44}$

Space for Rough work

80. A palindrome is a word, number, phrase or sequence of words that reads the same backwards as forwards e.g. "SOLOS". The number of palindromes that can be formed using the letters AABBBBCCCDDDD are

(A) $\frac{6!}{2!}$ (B) $\frac{6!}{2! \times 2!}$

(C) $\frac{7!}{2! \times 2!}$ (D) none of these

81. Two cards are missing from a pack of 52 playing cards. One card is selected at random then the probability that it is a king, is

(A) $\frac{3}{26}$ (B) $\frac{1}{13}$

(C) $\frac{10}{13}$ (D) $\frac{4}{13}$

82. All the words formed using the letters of the word "ALGEBRA" taken all at a time and one of the word is selected from it, then the probability that the word contains the word "AGE", is

(A) $\frac{{}^{7}C_{2}}{5!}$ (B) $\frac{5!}{7!}$

(C) $\frac{1}{{}^{7}P_{2}}$ (D) $\frac{1}{{}^{7}C_{2}}$

83. If $I_n = \int\limits_0^{\pi/4} \tan^n x dx$ and $\frac{1}{I_2 + I_4}, \frac{1}{I_3 + I_5}, \frac{1}{I_4 + I_6}, \frac{1}{I_5 + I_7}$ form an A.P., then the common difference of the A.P. is

(A) 1 (B) 2

(C) 3 (D) none of these

84. The sum of the series $\frac{8}{5} + \frac{16}{65} + \frac{24}{325} + \frac{32}{1025}$ ..... upto 20 terms is

(A) $\frac{1280}{841}$ (B) $\frac{1680}{841}$

(C) $\frac{1880}{841}$ (D) none of these

Space for Rough work

85. If x^2, A_1, A_2, y^2 are in arithmetic progression, x^2, G_1, G_2, y^2 are in geometric progression and x^2, H_1, H_2, y^2 are in harmonic progression, then the value of
$(G_1G_2)(H_1 + H_2) - H_1H_2(A_1 + A_2)$ is
(A) 0 (B) 1
(C) 2 (D) none of these

86. Let A and B are two events such that P(A) = 0.4, P(B) = 0.6 and $P\left(\frac{B}{A}\right) = 0.5$. Then $P\left(\frac{\bar{A}}{\bar{B}}\right)$ equals to
(A) $\frac{1}{4}$ (B) $\frac{2}{3}$
(C) $\frac{1}{2}$ (D) $\frac{1}{3}$

87. If $f(x) = x^2 + \alpha x + \beta$ (where $\alpha, \beta \in R$) and $f(f(x)) = 0$ has two roots 1 and 2, then f(0) is equal to
(A) 1 (B) –2
(C) $\frac{-3}{2}$ (D) –1

88. A bag contains 5 balls of unknown colours. A ball is drawn at random from it and is found to be white. The probability that bag contains only white balls is
(A) $\frac{3}{5}$ (B) $\frac{1}{5}$
(C) $\frac{2}{3}$ (D) $\frac{1}{3}$

89. The arithmetic mean of a set of observation is $\bar{x}$. If each observation is divided by α and then increased by 10, then mean of the new series is
(A) $\frac{\bar{x}}{\alpha}$ (B) $\frac{\bar{x}+10}{\alpha}$
(C) $\frac{\bar{x}+10\alpha}{\alpha}$ (D) $\alpha\bar{x}+10$

90. The coefficient of x^{203} in the expression $(x - 1)(x^2 - 2)(x^3 - 3) \ldots (x^{20} - 20)$ is
(A) 11 (B) 12
(C) 13 (D) 15

Space for Rough work

FIITJEE

JEE(Main)-2018

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

PART TEST – III
(Main)

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**B**	31.	**B**	61.	**D**
2.	**A**	32.	**B**	62.	**C**
3.	**D**	33.	**B**	63.	**B**
4.	**A**	34.	**A**	64.	**B**
5.	**A**	35.	**B**	65.	**B**
6.	**C**	36.	**C**	66.	**C**
7.	**B**	37.	**B**	67.	**A**
8.	**C**	38.	**B**	68.	**B**
9.	**C**	39.	**B**	69.	**A**
10.	**C**	40.	**C**	70.	**B**
11.	**B**	41.	**C**	71.	**B**
12.	**C**	42.	**C**	72.	**D**
13.	**A**	43.	**B**	73.	**A**
14.	**A**	44.	**B**	74.	**B**
15.	**A**	45.	**A**	75.	**C**
16.	**C**	46.	**D**	76.	**B**
17.	**A**	47.	**B**	77.	**C**
18.	**B**	48.	**A**	78.	**C**
19.	**A**	49.	**D**	79.	**C**
20.	**C**	50.	**C**	80.	**B**
21.	**C**	51.	**C**	81.	**B**
22.	**B**	52.	**D**	82.	**D**
23.	**C**	53.	**C**	83.	**A**
24.	**A**	54.	**A**	84.	**B**
25.	**B**	55.	**C**	85.	**A**
26.	**C**	56.	**C**	86.	**C**
27.	**A**	57.	**A**	87.	**C**
28.	**A**	58.	**C**	88.	**D**
29.	**A**	59.	**A**	89.	**C**
30.	**C**	60.	**A**	90.	**C**

Physics

PART – I

1. $A = A_0 e^{-b/2mt}$ $b = 6\ \pi r\eta$

$$\frac{A_0}{2} = A_0 e^{-b/2m.\Delta t}$$

$$\ell n2 = \frac{6\pi r\eta}{2m}.n$$

$$\eta = \frac{m\ell n2}{3\pi rn}$$

2. Positive half cycle
V_{output} = 10V
For negative half cycle.
potential difference across output = – 25 V

3. The distance by which image appears to be raised is

$$d = t_1\left(1-\frac{1}{\mu_1}\right)+t_2\left(1-\frac{1}{\mu_2}\right)$$

$$\frac{t}{2} = \frac{t}{2}\left(1-\frac{1}{\mu}\right)+\frac{t}{2}\left(1-\frac{2}{3\mu}\right)$$

$$\therefore \quad \mu = \frac{5}{3} = 1.67$$

4 Leftward Force = $\frac{IA}{c} = \frac{\Delta P}{\Delta t}$

5. The wavelength λ_{min} emitted by the X-ray tube operating at a voltage V is given by

$$eV = \frac{hc}{\lambda_{min}}$$

Kinetic energy of the electron = $\frac{1}{2}mv^2 = \frac{1}{2}\left(\frac{m^2v^2}{m}\right) = \frac{h^2}{2m\lambda_1^2}$

Now the wavelength λ of an electron moving with the velocity v is given by

$$\lambda = h/mv \Rightarrow \lambda = \frac{h}{\sqrt{2meV}}$$

$\therefore$ K.E. = 600 eV

6. $T = 2\pi\sqrt{\frac{\mu}{k}}$

$$T = \frac{2\pi}{\pi} \Rightarrow T = 2\,sec$$

Required time $= \frac{T}{4}+\frac{T}{4} = \frac{T}{2} = 1sec$.

7. I_0 is intensity of unpolarized incident light.

$$I = \frac{I_0}{2}\ \cos^2 30^o\ \ \cos^2 60^o = 3\ \text{watt}\ m^{-2}.$$

8. $\lambda = \frac{h}{mv}$

9. $f = \frac{c}{\lambda} \Rightarrow f_m = \frac{c}{\lambda_m}$ & $f_s = \frac{c}{\lambda_s}$

$\because \lambda_m > \lambda_s \Rightarrow f_m < f_s$

$f_m = \frac{1}{2\pi\sqrt{L_m c}}$ & $f_s = \frac{1}{2\pi\sqrt{L_s c}}$

$\Rightarrow L_s < L_m$.

10. $v = \sqrt{\frac{T}{\mu}}$

T can be calculated by using Hooke's Law and on stretching μ also changes.

11. $\frac{T}{A} = \frac{Y\Delta\ell}{\ell}$

12. Here

$5\frac{\lambda}{4} = 42 + 0.3 \times 10 \Rightarrow \lambda = 36\text{cm}$

$\therefore$pressure amplitude at middle of pipe is

$\Delta P = \Delta P_o \left|\sin Kx\right| = \Delta P_o \left|\sin\left(\frac{2\pi}{36} \times 24\right)\right|$

$= \frac{\sqrt{3}\Delta P_o}{2}$

13. $d_{min} = \frac{1.22\lambda}{2\sin\beta}$

Where β is the angle subtended by the objective at the object.
For light of 5500 Å

$d_{min} = \frac{1.22 \times 5.5 \times 10^{-7}}{2\sin\beta}\text{m}$

For electrons accelerated through 100V the deBroglie wavelength is

$\lambda = \frac{h}{p} = \frac{1.227}{\sqrt{100}} = 0.13 \times 10^{-9}\text{m}$

$\therefore \quad d'_{min} = \frac{1.22 \times 1.3 \times 10^{-10}}{2\sin\beta}$

$\therefore \quad d'_{min} = \frac{1.22 \times 1.3 \times 10^{-10}}{2\sin\beta}$

$\frac{d'_{min}}{d_{min}} = \frac{1.3 \times 10^{-10}}{5.5 \times 10^{-7}} \sim 0.2 \times 10^{-3}$

14. $E = \Delta mc^2$

16. For 1st reading of oscillator
$f_A = (514 \pm 2)$Hz
$\Rightarrow$ f_A = 516 Hz or 512 Hz
For 2nd reading of oscillator
$f_A = (510 \pm 6)$ Hz
$\Rightarrow$ f_A = 516 Hz or 504 Hz
$\Rightarrow$ A has a frequency of 516 Hz

17. $$\frac{1.22\lambda}{d} = \theta$$
$$\frac{1.22 \times 5.4 \times 10^{-5}}{12} = \frac{30}{x}$$
$$x = 54.645\,\text{km}$$

18. Frequency received by car B is $f_1 = \left(\frac{v+w+u}{v+w-u}\right)f$
Now the car B will be treated as a source of frequency f_1
$\therefore$ wavelength of reflected sound received by the driver of car A is
$$\lambda' = \frac{(v-w-u)}{f_1} = \frac{(v-w-u)(v+w-u)}{(v+w+u)f}$$
$$\frac{(330-5-25)(330+5-25)}{(330+5+25)300} = \frac{31}{36}m$$

19. For continuity displacement current should be equal to conduction current
$$q = q_0\left(1-e^{-t/RC}\right) \Rightarrow |i| = \frac{q_0}{RC}e^{-t/RC}\ CR = t$$
$$\Rightarrow \frac{1200\,\mu F}{ex1} \Rightarrow i = \frac{0.0012}{e}\ A = \frac{1.2}{e}mA$$

20. $v_{max} = A\omega$

21. $$\rho = \frac{m}{\frac{4}{3}\pi r^3} \Rightarrow \frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} + \frac{3\Delta r}{r}$$
$$\Rightarrow \frac{\Delta\rho}{\rho} = \frac{0.001}{30} + \frac{3 \times 0.01}{10}$$
$$\frac{\Delta\rho}{\rho} = 3.3 \times 10^{-5} + 3 \times 10^{-3}$$
$$\frac{\Delta\rho}{\rho} = 0.033 \times 10^{-3} + 3 \times 10^{-3}$$
$$\frac{\Delta\rho}{\rho} = 3.033 \times 10^{-3}$$

22. $$2T\sin\theta = \Delta P \times \text{Area}$$
$$\left(\frac{T}{A}\right).\theta = \Delta P \Rightarrow \frac{\sigma_0 \Delta r}{r} = \Delta P$$

23. 2 minutes = 3 half life

1 half life = $\frac{120}{3} = 40$ sec

24. $f_0 + f_e = 40$

$7 = \frac{f_0}{f_e} \Rightarrow f_0 = 35\,\text{cm}$

$f_e = 5\,\text{cm}$

25. $T_1 = k(\ell_1 - \ell_0)$

$T_2 = k(\ell_2 - \ell_0)$

$\Rightarrow \quad \ell_0 = \frac{\ell_2 T_1 - \ell_1 T_2}{T_1 - T_2}$

26. $\frac{g}{2} = g - R\omega^2$

$\Rightarrow \quad \omega = \sqrt{\frac{g}{2R}}$

27. $P = \frac{1}{2}Q\rho\left(V^2 - V_0^2\right) + \rho Qgh$

$\sqrt{\frac{2P}{Q\rho} - 2gh + V_0^2} = V$

28. $\overline{A + B} = \overline{A} \cdot \overline{B}$

29. Buoyancy = effective weight of liquid displaced

30. $T = \pi\left[\sqrt{\frac{M}{K}} + \frac{1}{2}\sqrt{\frac{M}{K}}\right] = \frac{3\pi}{2}\sqrt{\frac{M}{K}}$

Chemistry PART – II

31. Oxidation number of Mn in $[MnO_4]^-$ is 7 and Cr in CrO_2Cl_2 +6.

32. Volume of all atoms in 1.68 g of Ar

$$= \frac{1.68}{40} \times 6 \times 10^{23} \times \frac{4}{3} \times \frac{22}{7} \times \left(1.50 \times 10^{-8}\right)^3 = 0.356$$

% of empty space = (1 – 0.3564) × 100 = 64.36

33. $G^* = \frac{\ell}{A} = \frac{0.02}{0.0004} = 50\ m^{-1}$

$$\frac{1}{R} = \frac{1}{50}$$

Specific conductance $= G^* \times \frac{1}{R} = 1\,S\,cm^2$

34. When impure metal has impurity of its own metal oxide, then poling process is used e.g. impure Cu and Sn are purified by this method.

35. Equivalent weight of $KBrO_3$ $\frac{167}{6(n - \text{factor})}$ n-factor = 6

$$N_{Na_2S_2O_3} = \frac{0.167}{167} \times 6 \times \frac{1}{0.05} = 0.12\ N$$

36. Mass of 1 litre of solution = 1010 gram
Mass of solvent = 1010 – 300 × 0.1 = 980 gram

$$m = \frac{0.1}{0.98} = 0.102$$

$$\Delta T_f = iK_f m = (1 + \alpha)K_f.m$$

$$\Rightarrow \Delta T_f = 0.199^oC$$

$$\Rightarrow T_f = 0 - 0.199^oC = -0.199^oC$$

37. Effective number of O^{2-} in a unit cell $= 8 \times \frac{1}{8} + 6 \times \frac{1}{2} = 4$

Effective number of A^{2+} in a unit cell = $8 \times \frac{1}{8} = 1$

Effective number of B^{3+} in a unit cell = $4 \times \frac{1}{2} = 2$

∴ General formula = AB_2O_4

38. $$\underset{\text{Impure}}{Ni} + 4CO \longrightarrow \underset{\text{Volatile compound}}{\left[Ni(CO)_4\right]} \uparrow \xrightarrow[\text{Thermal decomposition}]{200 \text{ to } 300^oC} \underset{\text{Pure}}{Ni} + 4CO \uparrow$$

39. $$\underset{\text{(Black)}}{FeS} \xrightarrow{\text{Dil. } H_2SO_4} H_2S \xrightarrow{\text{Dil. } HNO_3} \underset{\text{Colloidal sulphur}}{S} + NO_2 + 2H_2O$$

40. At constant V $= \frac{P_1}{T_1} = \frac{P_2}{T_2} \Rightarrow P_2 = 1.5$ atm

For single phase $dG = VdP - SdT$

$\Rightarrow \Delta G = v.\Delta P - \int\left(2 + 10^{-2}\,T\right)dT$

= 781.5 J

41. $\sqrt{3}a = 2\left(r^{+} + r^{-}\right)$

$$\Rightarrow a = \frac{2\times\left(1.69 + 1.81\right)}{1.732}$$

$\Rightarrow a = 4.04\,\overset{o}{A}$

42. For normal Calomel electrode $E_{RP} = E^{o}_{RP}$

$$E_{cell} = \left(0.28 - 0\right) - \frac{0.059}{2}\log\frac{\left[H^{+}\right]^{2}}{P_{H_2}} \Rightarrow pH = 5.5$$

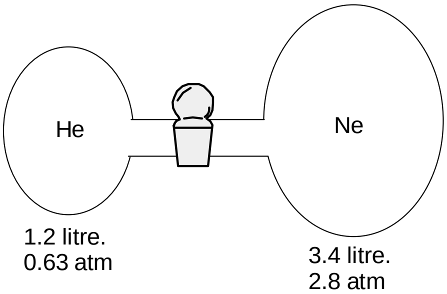
43. As $PV^{\gamma} = \text{constant} \Rightarrow p.\gamma v^{\gamma-1}\times dv + V^{\gamma}.dp = 0$

$$\frac{dP}{P} = -\gamma.\frac{v^{\gamma-1}}{v^{\gamma}}dv$$

$$\Rightarrow \frac{dp}{p} = -\gamma\frac{dV}{V}$$

44. Preferential adsorption of Fe^{3+} takes place so positive charge develop.

45.



$n_{He} = \frac{1.2\times0.63}{0.082\times289}$

= 0.032

$n_{Ne} = \frac{3.4\times2.8}{0.0821\times289}$

= 0.4

$$P_T = \frac{0.432\times0.0821\times289}{4.6} = 2.223$$

$$P_{He} = \frac{0.032}{0.432}\times2.223 = 0.164\text{ atm}$$

46. $BaCl_2 + KI \longrightarrow$ No ppt.

$BaCl_2\left(aq\right) + CrO_4^{2-} \longrightarrow \underset{\text{Yellow ppt.}}{BaCrO_4} \downarrow$

47. $\Delta H, \Delta S$ & ΔG should all be – ve to hold chemical adsorption.

48. Eq. wt. of $N_2H_4 = \dfrac{\text{Molar mass}}{4}$

Eq. wt. of $IO_3^- = \dfrac{\text{Molar mass}}{4}$

49. $\left[M(AA)_2\right]^{n\pm}$ does not show geometrical isomerism and can not show optical.

50. $$2CH_3OH(\ell)+3O_2 \longrightarrow 4H_2O(\ell)+2CO_2(g)+1453$$
$$\underline{4\times 44+4H_2O \longrightarrow 4H_2O}$$

$$2CH_3OH(\ell)+3O_2(g) \longrightarrow 4H_2O(\ell)+2CO_2(g)+1277$$
$$\Delta H=-1277\text{ kJ}$$

51. The word smog is originated from smoke and fog. Hence it is oxide of sulphur and N_2.

52. Piperazine is not a tranquilizer.

53. As in higher oxidation state transition elements show acidic nature.

54. $$\underset{\text{Fused anhydrous}}{MgCl_2} \longrightarrow Mg^{2+}+2e^-$$
At cathode: $Mg^{2+}+2e^- \longrightarrow Mg$

At anode: $2Cl^- - 2e^- \longrightarrow Cl_2 \uparrow$

55. Phenelzine is a tranquilizer. It is not an antacid.

57. 1 watt = 1 J/sec
Total heat for 36 mL H_2O
= 806 × 100
= 80600 J
$$\Delta H_{\text{vaporisation}}=\frac{80600}{36}\times 18$$
= 40300 J or 40.3 kJ/mole

58. At anode,
$$2HgO(\ell) \longrightarrow 4H^+(aq)+O_2(g)+4e^-$$
At cathode
$$Ag^+(aq)+e^- \longrightarrow Ag(s)$$
Ag deposited = 0.1 mole = 10.8 gram

O_2 expelled out = $\dfrac{0.1}{4}=0.8\,\text{gram}$

Total wt. loss of the solution = 11.6 gram
wt. of remaining solution = 108 – 11.6 = 96.4 gram

59. On applying valence bond theory
Ni has electronic configuration [Ar]$3d^8$ $4s^2$ and in presence of CO (strong field ligand), electronic configuration is $3d^{10}$.
Hybridization is sp^3 and all the electrons are paired.

Mathematics

PART – III

61. $x - y + 2 = 0$

$x + 2y = 4$

$x = 0,\ y = 2$

$\vec{a} = 2\hat{j} + 2\hat{k}$ and $|\vec{a}|^2 = 8$

$$\left[\vec{a}\ \vec{b}\ \vec{c}\right] = \begin{vmatrix} 0 & 2 & 2 \\ 1 & -1 & 1 \\ 1 & 2 & 0 \end{vmatrix} = 8 = |\vec{a}|^2$$

62. Vector $\left(2\hat{i} - 3\hat{j}\right) \times \left(\hat{i} - 4\hat{j} + 4\hat{k}\right)$ is perpendicular to $2\hat{i} - \hat{j} + m\hat{k}$

$$\Rightarrow \begin{vmatrix} 2 & -3 & 0 \\ 1 & -4 & 4 \\ 2 & -1 & m \end{vmatrix} = 0 \Rightarrow m = \frac{-16}{5}$$

63. Equation of line L is $\vec{r} = \left(\hat{j} - \hat{k}\right) + \lambda \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 1 & 4 \\ 3 & 2 & -2 \end{vmatrix}$

$\vec{r} = \left(\hat{j} - \hat{k}\right) + \lambda\left(-10\hat{i} + 16\hat{j} + \hat{k}\right)$

Point Q is $(-10\lambda,\ 16\lambda + 1,\ \lambda - 1)$

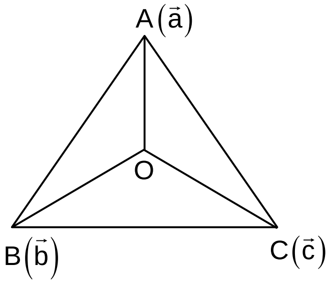
$\left|\overrightarrow{PQ}\right|^2 = 357\lambda^2 = 357$

$\lambda^2 = 1$

$\lambda = \pm 1$

$Q \equiv (-10, 17, 0)$ or $(10, -15, -2)$ then $a + 2b + 3c = 24$ or -26

64. Let $\overrightarrow{OA} = \vec{a}$; $\overrightarrow{OB} = \vec{b}$; $\overrightarrow{OC} = \vec{c}$



Area of $\Delta ABC = \frac{1}{2}\left|\vec{a} \times \vec{b} + \vec{b} \times \vec{c} + \vec{c} \times \vec{a}\right|$

Now, $\vec{r} = 3\vec{a} + 4\vec{b} + 6\vec{c} = 0$

$\vec{a} \times \vec{r} = 4\vec{a} \times \vec{b} + 6\vec{a} \times \vec{c} = 0$

$4\vec{a} \times \vec{b} = 6\vec{c} \times \vec{a} \Rightarrow \vec{c} \times \vec{a} = \frac{2}{3}\left(\vec{a} \times \vec{b}\right)$

$\vec{b} \times \vec{r} = 3\vec{b} \times \vec{a} + 6\vec{b} \times \vec{c} = 0$

$3\vec{a} \times \vec{b} = 6\vec{b} \times \vec{c} \Rightarrow \vec{b} \times \vec{c} = \frac{1}{2}\vec{a} \times \vec{b}$ and Area of Δ AOB is $\frac{1}{2}\left|\vec{a} \times \vec{b}\right|$

$$\text{Now, } \frac{\text{Area of } \Delta ABC}{\text{Area of } \Delta AOB} = \frac{\frac{1}{2}\left|\vec{a} \times \vec{b} + \vec{b} \times \vec{c} + \vec{c} \times \vec{a}\right|}{\frac{1}{2}\left|\vec{a} \times \vec{b}\right|}$$

$$= \frac{\frac{1}{2}\left|\vec{a} \times \vec{b}\right|\left|1 + \frac{1}{2} + \frac{2}{3}\right|}{\frac{1}{2}\left|\vec{a} \times \vec{b}\right|} = \frac{13}{6}$$

65. $\left(\hat{a}\times\hat{b}\right)\times\left(\hat{a}+\hat{b}\right)=\left(1+\hat{a}\cdot\hat{b}\right)\left(\hat{b}-\hat{a}\right)$

66. $v_1=\left[\bar{a}\ \ \bar{b}\ \ \bar{c}\right]$

$v_2=\left[\bar{a}+2\bar{b}-\bar{c}\quad \bar{a}-2\bar{b}\ 2\bar{c}\quad \bar{a}-4\bar{b}+2\bar{c}\right]=18\left[\bar{a}\ \ \bar{b}\ \ \bar{c}\right]$

67. $\sum_{k=0}^{100}\frac{k+1-1}{k+1}\,{}^{100}C_k=\sum_{k=0}^{100}{}^{100}C_k-\sum_{k=0}^{100}\frac{{}^{100}C_k}{k+1} = 2^{100}-\frac{1}{101}\sum_{k=0}^{100}\frac{101}{k+1}\,{}^{100}C_k$

$= \frac{99\cdot 2^{100}+1}{101}$ (x = 99, y = 1 and z = 101) $\Rightarrow xy^2z = 9999$

68.

Tens place (A)	Unit place (B)
1, 2, 3 not possible	
4	0
5	0, 1
6	0, 1, 2
7	0, 1, 2, 3
8	0, 1, 2, 3, 4
9	0, 1, 2, 3, 4, 5

$P=\frac{21}{90}=\frac{7}{30}$

69. $D = -(\alpha + 2)(\alpha - 1)^2$
$D_1 = -(\alpha - 1)^2(\alpha + 2)$
$D_2 = D_3 = 0$
From α = 1, –2 infinite solution
$\alpha \neq 1, -2$ unique solution
So, L = 11; M = 0; N = L; $L^2 + M^2 + N^2 = 125$

70. $\alpha+\beta+\gamma=\frac{5}{3}\ \Rightarrow\ \frac{\alpha+\beta+\gamma}{3}=\frac{5}{9}$

71. ${}^{22}C_2 + {}^{21}C_2 + {}^{20}C_2 + {}^{19}C_2 + \ldots + {}^{3}C_2 + {}^{2}C_2 = {}^{23}C_3$

72. $\sum_{r=1}^{n}a_rz^r=1$

$a_1z + a_2z^2 + \ldots + a_nz^n = 1$
$|a_1z + a2z^2 + \ldots + a_nz^n| = 1$
$1 \le |a_1||z| + |a_2||z|^2 + \ldots + |a_n||z^n| < 2[|z| + |z|^2 + \ldots + |z|^n \ \because\ |a_r| < 2$

$$1\le 2\left[\frac{|z|\left[1-|z|^n\right]}{1-|z|}\right]$$

$1 - |z| < 2|z| - 2|z|^{n+1}$
$2|z|^{n+1} - 3|z| + 1 < 0$

$|z|>\frac{1}{3}+\frac{2}{3}|z|^{n+1}$

$|z|>\frac{1}{3}$ which is contradiction

73. $A_k = e^{i\frac{k\pi}{20}} \Rightarrow \dfrac{\sum\limits_{k=0}^{2018}\left|e^{i\frac{k\pi}{20}}\right|\left|e^{\frac{i\pi}{20}}-1\right|}{\sum\limits_{k=1}^{673}\left|e^{i\frac{k\pi}{20}}\right|\left|1-e^{\frac{i\pi}{20}}\right|} = 3$

74. $$\Delta = \frac{1}{\prod(a-p)^2}\begin{vmatrix} 1 & a-p & \frac{(a-p)^2}{p} \\ 1 & a-q & \frac{(a-q)^2}{q} \\ 1 & a-r & \frac{(a-r)^2}{r} \end{vmatrix}$$

Apply $R_2 \to R_2 - R_1$ and $R_3 \to R_3 - R_1$ and then on explained, we get $\Delta = \dfrac{-a^2\prod(p-q)}{prq\prod(a-p)^2}$

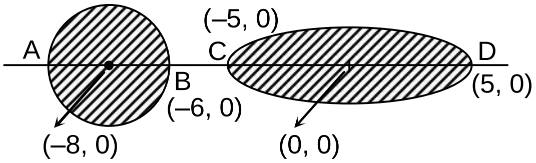
75. $A = \sum(a_r + b_r + c_r) = \sum a_r + \sum b_r + \sum c_r$

$\left(\sum a_r \cdot \sum b_r \cdot \sum c_r\right)^{1/3} \le \dfrac{\sum a_r + \sum b_r + \sum c_r}{3}$

$\sum a_r \cdot \sum b_r \cdot \sum c_r \le \dfrac{A^3}{27}$

$$\Delta = \begin{vmatrix} \sum a_r & a_2 & a_3 \\ \sum b_r & b_2 & b_3 \\ \sum c_r & c_2 & c_3 \end{vmatrix} = \sum a_r \sum b_r \sum c_r \begin{vmatrix} 1 & \frac{a_2}{\sum a_r} & \frac{a_3}{\sum a_r} \\ 1 & \frac{b_2}{\sum b_r} & \frac{b_3}{\sum b_r} \\ 1 & \frac{c_2}{\sum c_r} & \frac{c_3}{\sum c_r} \end{vmatrix} \le \sum a_r \sum b_r \sum c_r \le \frac{A^3}{27}$$

76. AD is maximum distance
BC is minimum distance
Range is [1, 15]



77. Area of the triangle formed by z, iz and z + iz is $\frac{1}{2}|z|^2$

78. $k_1 = 4! \times 5!$

$k_2 = \dfrac{8!}{5!}$

$\dfrac{7k_1}{k_2} = 60$

79. ${}^{(100-55)+(10-1)}C_{10-1} = {}^{54}C_9$

80. Letters C must be in middle of word

Required number are $\frac{6!}{2!\times 2!}$

81. Required probability is $\frac{1}{13}$

82. $\frac{5!\times 2!}{7!} = \frac{1}{{}^{7}C_{2}}$

83. $I_n + I_{n+2} = \frac{1}{n+1}$

Hence, common difference = 1

84. $t_r = \frac{8r}{4r^4+1} = \frac{8r}{\left(2r^2+1+2r\right)\left(2r^2+1-2r\right)}$

$S_n = 2\left[1-\frac{1}{2n^2+1+2n}\right]$ by method of difference

Hence, $S_{20} = \frac{1680}{841}$

85. $\frac{G_1G_2}{H_1H_2} = \frac{A_1+A_2}{H_1+H_2}$ in this case

86. P(A $\cap$ B) = $P(A)\cdot P\left(\frac{B}{A}\right) = (0.4)(0.5) = 0.2$

Now P(A $\cup$ B) = P(A) + P(B) – P(A $\cap$ B) = 0.4 + 0.6 – 0.2 = 0.8

Also, $P\left(\bar{A}/\bar{B}\right) = P\left(\frac{\bar{A}\cap\bar{B}}{P\left(\bar{B}\right)}\right) = \frac{1-P(A\cup B)}{1-P(B)} = \frac{0.2}{0.4} = \frac{1}{2}$

87. Given f(f(–1)) = 0 and f(f(1)) = 0

i.e., f(f(x)) = 0 has of two roots f(1) and f(2)

88. Let ω_i (i = 1, 2, 3, 4, 5) denotes 1, 2, 3, 4, 5 white balls in the bag.

$P\left(\omega/\omega_i\right) = \frac{i}{5}$ (i = 1, 2, 3, 4, 5)

$P(\omega_i) = \frac{1}{5}$ (i = 1, 2, 3, 4, 5)

Now, $P\left(\omega/\omega_5\right) = \frac{P(\omega_5)P\left(\omega/\omega_5\right)}{\sum\limits_{i=1}^{5}P(\omega_i)P\left(\omega/\omega_i\right)}$

$= \frac{\frac{1}{5}\times 1}{\frac{1}{5}\left(\frac{1}{5}+\frac{2}{5}+\frac{3}{5}+\frac{4}{5}+\frac{5}{5}\right)} = \frac{5}{15} = \frac{1}{3}$

89. x_1, x_2 ..... x_n be n observations then, $\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$

Let $y_i = \frac{x_i}{\alpha} + 10$ then $\bar{y} = \frac{1}{n}\sum_{i=1}^{n} y_i = \frac{1}{\alpha}\left(\frac{1}{n}\sum_{i=1}^{n} x_i\right) + \frac{1}{n}(10n)$

$\Rightarrow \bar{y} = \frac{\bar{x}}{\alpha} + 10 = \frac{\bar{x} + 10\alpha}{\alpha}$

90. Expression = $x \cdot x^2 \cdot x^3$ ..... $x^{20} \cdot \left(1 - \frac{1}{x}\right)\left(1 - \frac{2}{x^2}\right)\left(1 - \frac{3}{x^3}\right) \ldots\ldots \left(1 - \frac{20}{x^{20}}\right) = x^{210} \cdot E$

Where $E = \left(1 - \frac{1}{x}\right)\left(1 - \frac{2}{x^2}\right) \ldots\ldots \left(1 - \frac{20}{x^{20}}\right)$

Now, coefficient of x^{203} in original expression = coefficient of x^{-7} in E

But $E = 1 - \left(\frac{1}{x} + \frac{2}{x^2} + \frac{3}{x^3} \ldots\ldots\right) + \left(\frac{1}{x} \cdot \frac{6}{x^6} + \frac{2}{x^2} \cdot \frac{5}{x^5} + \frac{3}{x^3} \cdot \frac{4}{x^4} + \ldots\ldots\right) - \left(\frac{1}{x} \cdot \frac{2}{x^2} \cdot \frac{4}{x^4} + \ldots\ldots\right)$

Coefficient of x^{-7} = –7 + 6 + 10 + 12 – 8 = 13

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – I

JEE (Advanced)-2019

PAPER – 1

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01– 06, 19 – 24, 37 - 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*

   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*

   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*

   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*

   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*

   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 - 46) *contains 12 questions. Based on* this section contains **TWO (02)** paragraphs. Based on each paragraph, there are **TWO (02)** questions.
   *Each question has **only one correct** answer and carries **+3 marks** for correct answer and **–1 mark** for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries **+3 marks** for correct answer. There is no negative marking.*

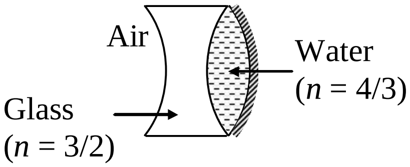
Physics

PART – I

SECTION – A
(One or More than one correct type)

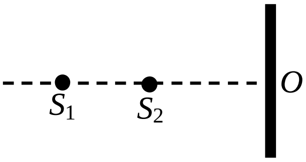
This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. The radius of curvature of the left and right surface of the concave lens are 10 cm and 15 cm respectively. The radius of curvature of the mirror is 15 cm



(A) equivalent focal length of the combination is –18 cm
(B) equivalent focal length of the combination is +36 cm
(C) the system behaves like a concave mirror
(D) the system behaves like a convex mirror

2. Two mohochromatic and coherent point sources of light of wavelength λ are placed on the dotted line in front of an finite screen. The source emit waves in phase with each other. The distance between S_1 and S_2 is d while their distance from the screen is much larger. Then

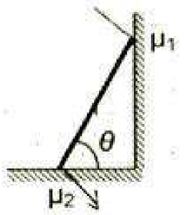


(A) If $d = 7\lambda/2$, O will be a minima
(B) If $d = 4.3\ \lambda$, there will be a total of 8 minima on screen
(C) If $d = 7\ \lambda$, O will be a maxima
(D) If $d = \lambda$, there will be only one maxima on the screen

3. A wave disturbance in a medium is described by
$y(x, t) = 0.02 \cos (50\ \pi t + \pi/2) \cos (10\ \pi x)$,
where 'x' and 'y' are in metre and 't' in seconds.
(A) A node occurs at x = 0.15 m
(B) An antinode occurs at x = 0.3 m
(C) The speed of the component wave is 5.0 m/s
(D) The wavelength is 0.2 m.

Space for Rough work

4. In figure, a ladder of mass m is shown leaning against a wall. It is in static equilibrium making an angle θ with the horizontal floor. The coefficient of friction between the wall and the ladder is μ_1 and that between the floor and the ladder is μ_2. The normal reaction of the wall on the ladder is N_1 and that of the floor is N_2. If the ladder is about to slip, then



(A) $\mu_1 = 0$ $\mu_2 \neq 0$ and $N_2 \tan\theta = \frac{mg}{2}$

(B) $\mu_1 \neq 0$ $\mu_2 = 0$ and $N_1 \tan\theta = \frac{mg}{2}$

(C) $\mu_1 \neq 0$ $\mu_2 \neq 0$ and $N_2 = \frac{mg}{1+\mu_1\mu_2}$

(D) $\mu_1 = 0$ $\mu_2 \neq 0$ and $N_1 \tan\theta = \frac{mg}{2}$

5. In the series L – C – R circuit, the voltage across resistance, capacitance and inductance are 30V each at frequency $f = f_0$.

(A) It the inductor is short-circuited, the voltage across the capacitor will be $30\sqrt{2}$ V.

(B) If the capacitor is short-circuited, the voltage drop across the inductor will be $\frac{30}{\sqrt{2}}$ V.

(C) If the frequency is changed to $2f_0$, the ratio of reactance of the inductor to that of the capacitor is 4 : 1.

(D) If the frequency is changed to $2f_0$, the ratio of the reactance of the inductor to that of the capacitor is 1 : 4.

6. An ammeter has a resistance of 50 Ω and a full scale deflection current of 50 μA. It can be used as a voltmeter or as a higher range ammeter provided that a resistance is added to it. Choose the correct range and resistance combination from the following

(A) 20 V range with approximately 400 kΩ resistance in series

(B) 100 V range with approximately $2 \times 10^6 \Omega$ resistance in series

(C) 1 mA range with 50 Ω resistance in parallel

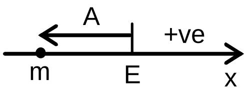
(D) 0.1 mA range with 50 Ω resistance in parallel

Space for Rough work

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 7 and 8



A particle of mass m is constrained to move on x-axis. A fore F acts on the particle. F always points toward the position labeled E. For example, when the particle is to the left of E, F points to the right. The magnitude of F is a constant F except at point E where it is zero
The system is horizontal. F is the net force acing on the particle. The particle is displaced a distance A towards left from the equilibrium position E and released from rest at t = 0.

7. What is the period of the motion?

(A) $4\left(\sqrt{\frac{2Am}{F}}\right)$

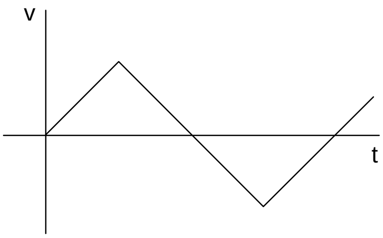
(B) $2\left(\sqrt{\frac{2Am}{F}}\right)$

(C) $\left(\sqrt{\frac{2Am}{F}}\right)$

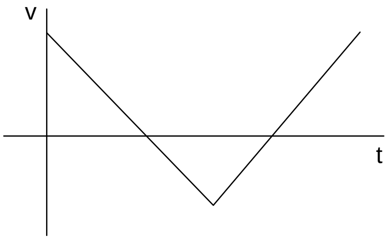
(D) None of these

8. Velocity–time graph of the particle is

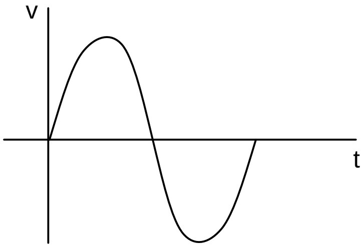
(A)



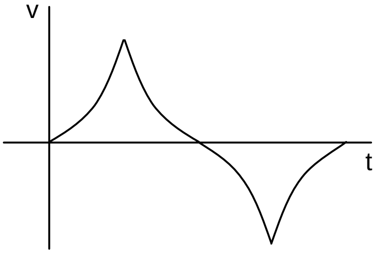
(B)



(C)



(D)



Space for Rough work

Paragraph for Question Nos. 9 and 10

The main scale of a vernier callipers reads in millimetre and its vernier is divided into 10 divisions which coincide with 9 divisions of the main scale. When the two jaws of the instrument touch each other the seventh division of the vernier scale coincide with a scale division and the zero of the vernier lies to the right of the zero of main scale. Furthermore, when a cylinder is tightly placed along its length between the two jaws, the zero of the vernier scale lies slightly to the left of 3.2 cm; and the fourth vernier division coincides with a scale division. Calculate the measured length of the cylinder.

9. The zero error in the apparatus is

(A) –0.07 cm	(B) 0.07 cm
(C) 0.03 cm	(D) –0.03 cm

10. The measured value of the length of the cylinder is

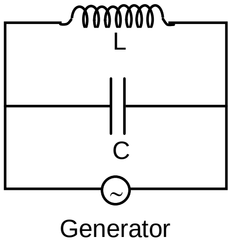
(A) 3.14 cm	(B) 3.24 cm
(C) 3.07 cm	(D) 3.17 cm

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

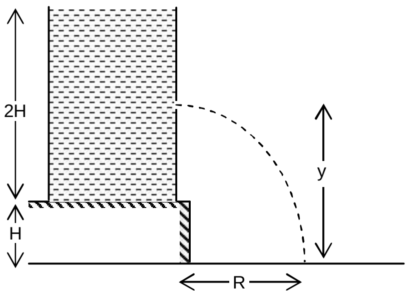
11. A non-viscous liquid of constant density 10^3 kg/m^3 flows in streamline motion along a vertical tube PQ of variable cross-section. Height of P and Q are 2m and 2.5m respectively. Area of tube at Q = 3 time area of tube at P. Find the work done per unit volume (in J/m^3) by pressure as liquid flows from P to Q. Speed of liquid at P is 3 m/s (g = 10 m/s^2).

12. For the circuit shown in the figure, the current through the inductor is 0.6 A, while the current through the capacitor is 0.4 A. Find the current (in A) drawn from the generator



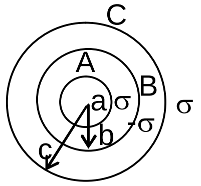
Space for Rough work

13. A tank is filled upto a height 2H with a liquid and is placed on a platform of height H from the ground. The distance y (in m) from the ground where a small hole is made in the tank, to get the maximum horizontal range R is (take H = 1.5 m)



14. A uniform disc of radius R having charge Q distributed uniformly all over its surface is placed on a smooth horizontal surface. A magnetic field, $B = kxt^2$, where k is a constant, x is the distance (in metre) from the centre of the disc and t is the time (in second), is switched on perpendicular to the plane of the disc. Find the torque (in N-m) acting on the disc after 15 sec. (Take 4kQ = 2.50 S.I. unit and R = 1m)

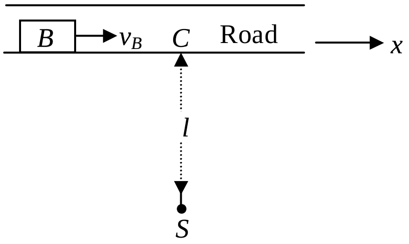
15. The adjacent figure shows charged spherical shells A, B and C having charge densities $\sigma, -\sigma, \sigma$ and radii a, b, c respectively. If $V_A = V_c$ then c is equal to (in m) (assuming a = 0.10 m, b = 0.20 m)



16. A string of length 1 m and mass 10 gm is tightly clamped at its ends. The tension in the string is 4 N. Identical wave pulses are produced at one end at equal intervals of time t. What is the minimum value of t (in sec.) which allows a constructive interference between successive pulses?

17. A cubical body floats in a mercury bath with half of its volume submerged. What fraction of the body will be inside mercury if a layer of water is poured on the mercury covers the body completely? (Sp. gr. of mercury = 13.6)

18. A bus B is moving with a velocity v_B in the positive x-direction along a road as shown in the figure. A shooter 'S ' is at a distance l from the road. He has a detector which can detect signals only of frequency 1500Hz. The bus blows horn of frequency 1000 Hz. When the detector detects a signal the shooter immediately shoots towards the road along SC and the bullet hits the bus. Find the velocity of the bullet if velocity of sound in air is v = 340 m/s and $\frac{v_B}{v} = \frac{2}{3\sqrt{3}}$.

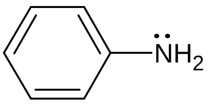


Space for Rough work

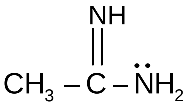
Chemistry PART – II

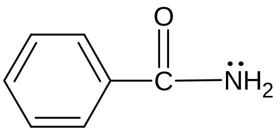
SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Which of the following compounds are more basic than  ?

(A) $CH_3-CH_2-\ddot{N}H_2$

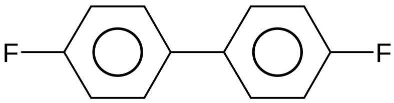
(B) 
$CH_3-\overset{\overset{NH}{||}}{C}-\ddot{N}H_2$

(C) 

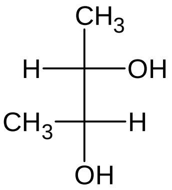
(D) $CH_2=CH-\ddot{N}H_2$

20. Which of the following compounds would be optically inactive?

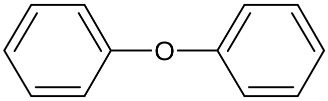
(A) $H_2C=C=CH_2$

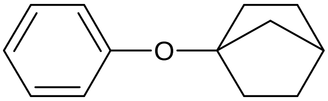
(B) 

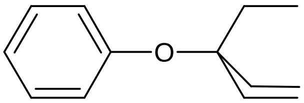
(C) $H_3C-CH=C=CH-CH_3$

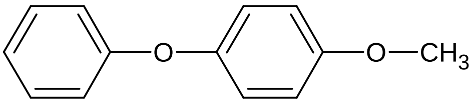
(D) 

21. Which of the following ethers will get hydrolysed by HI?

(A) 

(B) 

(C) 

(D) 

Space for Rough work

22. Ionisation energy order is CORRECT for:
(A) $Sc^{3+} > Sc^{2+} > Sc^{+}$
(B) $Sc^{3+} > Ti^{4+} > V^{5+}$
(C) Sc > Y > La
(D) Sc > Ca > K

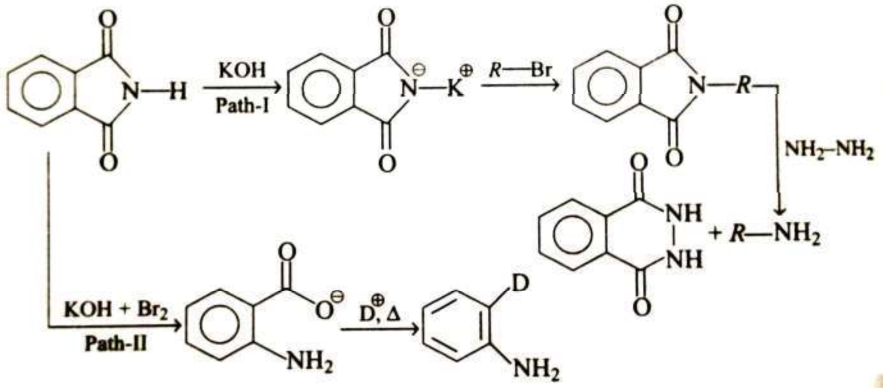
23. In which case EAN value is satisfied?
(A) $\left[Fe\left(\eta^5C_5H_5\right)_2\right]$
(B) $\left[Ni\left(DMG\right)_2\right]$
(C) $\left[Mn_2\left(CO\right)_{10}\right]$
(D) $\left[Mn\left(CO\right)_5\right]^{1-}$

24. NaH produces H_2 gas when:
(A) it reacts with water
(B) it reacts with heavy water
(C) it is electrolysed in fused state
(D) it is heated for decomposition

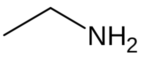
(Paragraph Type)

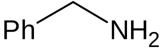
This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

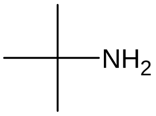
Paragraph for Question Nos. 25 and 26

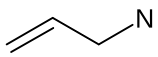


25. Which of the following amines cannot be prepared by path-I?

(A)


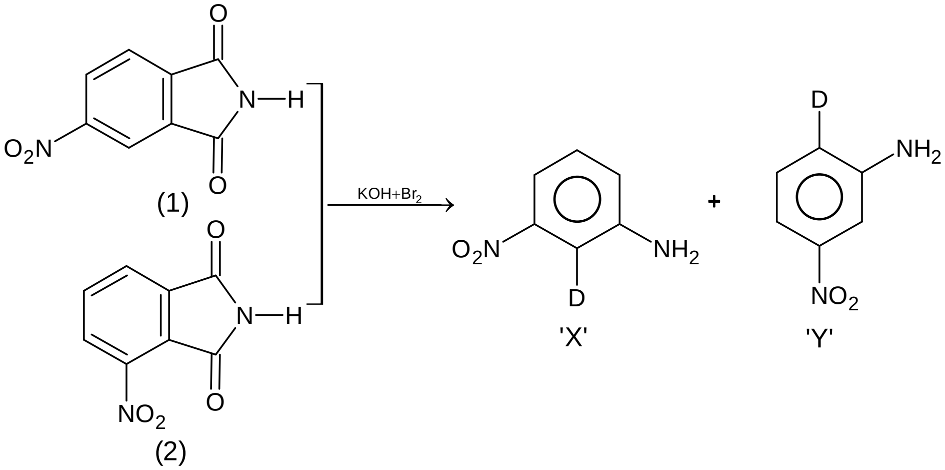
(B)


(C)


(D)


Space for Rough work

26. Consider path II, choose the major product for 1 and 2.



(A) 1 – Y, 2 – X
(B) 1 – X, 2 – Y
(C) 1 – X, 2 – X
(D) 1 – Y, 2 – Y

Paragraph for Question Nos. 27 and 28

Bond length: Internuclear distance between two adjacent atoms in a species is known as bond length. Bond length depends on:

(i) Size of the atom involved in the bond formation
(ii) Size of the orbitals involved in the bond formation
(iii) Lone pair-lone pair repulsion
(iv) Resonance (also backbonding)
(v) s-character of combining orbital

With the increasing size of the atoms and atomic orbitals bond length increase. Lone pair-lone pair repulsion increases bond length (if atoms are small sized) whereas resonance can increase some bond lengths and decrease some other bond length. With increasing s-character bond length decreases, and with increasing multiplicity of bonds, bond length decreases. However, in some cases, bond lengths are also affected by relative position of bonds (between two similar atoms). Usually but not always with increasing bond length, bond strength (and hence bond dissociation energy) decreases.

27. The correct order of B – F bond length follows the sequence:

(A) $BF_3 < BF_2OH < BF_2NH_2 < BF_4^-$
(B) $BF_2NH_2 < BF_2OH < BF_3 < BF_4^-$
(C) $BF_3 < BF_4^- < BF_2OH < BF_2NH_2$
(D) $BF_3 < BF_2NH_2 < BF_2OH < BF_4^-$

Space for Rough work

28. In which of the following all bonds are not equivalent?

(A) N_2O (B) CN_2^{2-}

(C) N_3^- (D) NO_2^-

SECTION – D
(Numerical Answer Type)

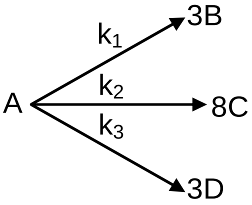
This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

29. If edge fraction unoccupied in ideal FCC structure is x. Calculate the value of 10 x.

30. Calculate depression of freezing point for 0.66 molal aq. Solution of KCl.
(Given : $K_{f(H_2O)} = 1.86\ \text{K kg mol}^{-1}$)

31. If K_C for the reaction $Cu^{2+}(aq) + Sn^{2+}(aq) \longrightarrow Sn^{4+}(aq) + Cu(s)$ at 25°C is represented as a × 10^6 then find the value of a. (Given : $E^o_{Cu^{2+}|Cu} = 0.34\ V;\ E^o_{Sn^{4+}|Sn^{2+}} = 0.15\ V$)

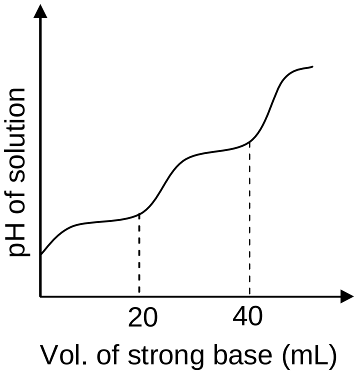
32. 

; At time t = 0, initial mole of A is 1.

Overall half life of the reaction is 15 days. Then calculate the number of mole of B + C + D after 45 days if the ratio of $k_1 : k_2 : k_3$ is 4 : 2 : 1.

Space for Rough work

33. 10 mL of H_2A (weak diprotic acid) solution is titrated against 0.1 M NaOH. pH of the solution is plotted against volume of strong base added and following observation is made.



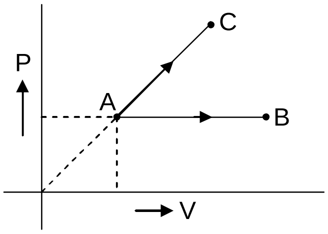
If pH of the solution at first equivalence point is pH_1 and at second equivalence point is pH_2.

Calculate the value of $\frac{pH_2}{pH_1}$ at 25°C

Given : For H_2A, $pK_{a_1} = 4.6$ and $pK_{a_2} = 8$, $\log 25 = 1.4$

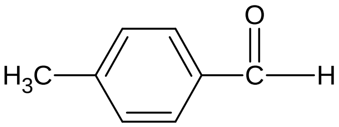
34. One mole ideal monoatomic gas is heated according to path AB and AC.
If temperature of state B and state C are equal.

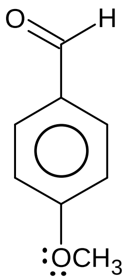
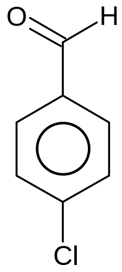
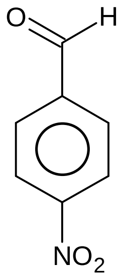
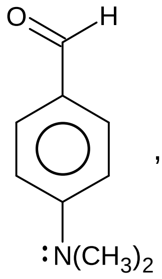
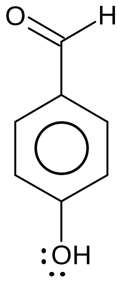
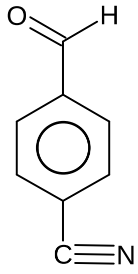
Calculate $\frac{q_{AC}}{q_{AB}}$.



Space for Rough work

35. Examine the structural formulas of following compounds and find out number of compounds which show higher rate of nucleophilic addition than



 ,  ,  ,  ,  , 

36. Total number of substance which contain hexagonal planer rings in their structures (graphite, $(BN)_x$, $B_3N_3H_6$, C_6H_6, B_2H_6, $H_3P_3O_9$):

Space for Rough work

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. Let $S_2 = 0$ be the mirror image of $S_1 : x^2 + y^2 - 4x - 6y + 12 = 0$ w.r.t. the line $L_1 : 10^4 x + \left(10^4 + 10\right)y + \left(10^4 + 20\right) = 0$. Let $L_2 : 2^{11}x + \left(2^{11} + 2^{12}\right)y + \left(2^{11} + 2^{13}\right) = 0$ be a line. The equation of the line passing through the point of intersection of the line $L_2 = 0$ with the radical axis of $S_1 = 0, S_2 = 0$ and making equal intercepts with the coordinate axes, is

(A) $x - y - 3 = 0$
(B) $x + y + 1 = 0$
(C) $2x - 2y + 1 = 0$
(D) $2x + 2y + 3 = 0$

38. A chord of negative slope from the point $P\left(\sqrt{264}, 0\right)$ is drawn to the ellipse $x^2 + 4y^2 = 16$. This chord intersects the ellipse at A and B (O is the origin).

(A) The maximum area of ΔAOB is 4
(B) The maximum area of ΔAOB is 8
(C) If the area of ΔAOB is maximum, then the slope of line AB is $\frac{-1}{2\sqrt{2}}$
(D) If the area of ΔAOB is maximum, then the slope of line AB is $\frac{-1}{8\sqrt{2}}$

39. Equation of plane passing through the line $\frac{x-1}{1} = \frac{y-2}{1} = \frac{z-2}{-2}$ and making an angle of 30° with the plane x + y + z = 5 is.

(A) $(x - y - 1) + \left(2 - \sqrt{2}\right)(2y + z - 6) = 0$
(B) $(x - y + 1) + \left(2 + \sqrt{2}\right)(2y + z - 6) = 0$
(C) $(x - y - 1) + \left(2 + \sqrt{2}\right)(2y + z - 6) = 0$
(D) $(x - y + 1) + \left(2 - \sqrt{2}\right)(2y + z - 6) = 0$

Space for Rough work

40. The volume of the parallelepiped whose coterminous edges are represented by the vectors $2\vec{b}\times\vec{c}$, $3\vec{c}\times\vec{a}$ and $4\vec{a}\times\vec{b}$, where $\vec{a}=(1+\sin\theta)\hat{i}+\cos\theta\hat{j}+\sin 2\theta\hat{k}$,

$\hat{b}=\sin\left(\theta+\frac{2\pi}{3}\right)\hat{i}+\cos\left(\theta+\frac{2\pi}{3}\right)\hat{j}+\sin\left(2\theta+\frac{4\pi}{3}\right)\hat{k}$,

$\vec{c}=\sin\left(\theta-\frac{2\pi}{3}\right)\hat{i}+\cos\left(\theta-\frac{2\pi}{3}\right)\hat{j}+\sin\left(2\theta-\frac{4\pi}{3}\right)\hat{k}$ is 18 cubic units, then the value of θ, in the interval $\left(0,\frac{\pi}{2}\right)$, is are

(A) $\frac{\pi}{9}$ (B) $\frac{2\pi}{9}$

(C) $\frac{\pi}{3}$ (D) $\frac{4\pi}{3}$

41. A player tosses a coin. He sets one point for head and two points for tail. He plays till he gets sum of points equal to n. If p_n be the probability that his score becomes n, then

(A) $p_3=\frac{1}{2}$ (B) $p_n=\frac{1}{2}P_{n-1}+\frac{1}{4}P_{n-2}$

(C) $p_4=\frac{11}{16}$ (D) $p_n=\frac{1}{2}(p_{n-1}+p_{n-2})$

42. If the imaginary part of the complex number $(z-1)(\cos\alpha-i\sin\alpha)+(z-1)^{-1}(\cos\alpha+i\sin\alpha)$ is zero, then

(A) $|z|=1$ (B) $|z-1|=1$

(C) $\arg(z)=\alpha$ (D) $\arg(z-1)=\alpha$

Space for Rough work

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 43 and 44

Consider the function $f(x) = b\log_e x - x$ on the interval $(0, \infty)$, where b is a positive real constant.

43. The set of all values of b for which the equation $b\log x - x = 0$ has exactly one real roots is equal to

(A) $\left(0, \frac{1}{e}\right)$ (B) (0, 1)

(C) $(-\infty, 0)$ (D) none of these

44. If the line $x - y = 0$ is tangent to $f(x) = b\log_e x - x,$ then b lies in the interval

(A) (1, 3) (B) (0, 1)

(C) (4, 6) (D) (5, 7)

Paragraph for Question Nos. 45 and 46

Given a ΔABC in which AD is perpendicular to base BC, Incircle with radii r_1 and r_2 are drawn in ΔABD and ΔACD respectively. They touch the altitude AD at point M and N respectively. Assume sides and angles have usual meaning.

45. If ΔABC is an isosceles triangle and the angle between the equal sides AB and AC is $\frac{2\pi}{3}$, then $r_1 : r_2$ is

(A) $\sqrt{3} + 1 : \sqrt{3} - 1$ (B) $3 + \sqrt{3} : 2 - \sqrt{3}$

(C) $3 - \sqrt{3} : 3$ (D) none of these

Space for Rough work

46. If R be the circum radius of ΔABC then MN will be

(A) $\left|2R\sin\frac{B-C}{2}.\cos\frac{B}{2}\cos\frac{C}{2}\right|$ (B) $\left|4R\sin\left(\frac{C-A}{2}\right)\cos\frac{B}{2}\sin\frac{C}{2}\right|$

(C) $\left|4R\sin\left(\frac{B-C}{2}\right)\sin\frac{B}{2}\sin\frac{C}{2}\right|$ (D) None of these

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

47. Let $f(x) = x^3 + 3x + 2$ and $g(x)$ be its inverse. If the area bounded by $g(x)$, x – axis and the ordinates x = – 2 and x = 6 is $\frac{p}{q}$ (where p& q are coprime), find value of $p+q-1$

48. If the maximum value of $\left|\sqrt{x^4 - 7x^2 - 4x + 20} - \sqrt{x^4 + 9x^2 + 16}\right|$ is P, find the value of $[P]$ (where [.] denotes GIF)

49. If $\int_0^{\pi} x f\left(\cos^2 x + \tan^4 x\right)dx = \pi k\int_0^{\pi/2} f\left(\cos^2 x + \tan^4 x\right)dx,$ then the value of k is

50. If $a, b, c \in R^+$ and $a^2bc + 4abc + 4bc = 81$. Find the value of $a+b+c$ such that $2a+b+c+4$ assumes its least value _______

51. Let $A = \begin{bmatrix} 2 & 0 \\ 0 & -3 \end{bmatrix}, B = \begin{bmatrix} 0 & 1 \\ 3 & 0 \end{bmatrix}$ and $x = \begin{bmatrix} \cos x & -\sin x \\ \sin x & \cos x \end{bmatrix}$. If $P = AXB,\ Q = BX^TA$ and $Tr.\left((PQ)^{10}\right) = a^{10} + b^{10}$, where $a < b$, then find the value of $b - 2a$ ______
(Tr (M) denotes trace of Matrix M and M^T denotes transpose of matrix M)

Space for Rough work

52. Let $1+\sum_{r=1}^{10}\left(3^r.\,{}^{10}C_r + r.\,{}^{10}C_r\right) = 2^{10}\left(\alpha.4^5 + \beta\right)$ where $\alpha, \beta \in N$ and $f(x) = x^2 - 2x - k^2 + 1$.

If α, β lies between the roots of $f(x) = 0$, then find the smallest positive integral value of k.

53. If the straight line $x = 1 + s,\ y = 3 - \lambda s,\ z = 1 + \lambda s$ and $x = \frac{t}{2},\ y = 1 + t,\ z = 2 - t$ with parameters s and t respectively, are coplanar, then the value of $|\lambda|$ is ___________

54. If the sum of the first 3n terms is equal to the next n terms of an A.P. whose common difference is non – zero, then the reciprocal of the ratio of the sum of the first 2n terms to the next 2n terms is _______

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – I

JEE (Advanced)-2019

PAPER – 1

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. AC

Sol. $$-\frac{1}{F} = P = 2P_{l_1} + 2P_{l_2} + P_m \qquad \ldots(1)$$

$$P_{l_1} = \frac{1}{f_1} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

$$P_{l_1} = [(1.5 - 1]\left[-\frac{1}{10} - \frac{1}{15}\right] = -\frac{1}{12} \qquad \ldots(2)$$

$$P_{l_2} = \frac{1}{f_2} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

$$P_{l_2} = \left(\frac{4}{3} - 1\right)\left[\frac{2}{15}\right] = \frac{2}{45} \qquad \ldots(3)$$

$$P_m = -\frac{1}{f} = +\frac{2}{15} \qquad \ldots(4)$$

$$-\frac{1}{F} = P = 2\left[-\frac{1}{12} + \frac{2}{45}\right] + \frac{2}{15} = -\frac{1}{6} + \frac{4}{45} + \frac{2}{15} = \frac{1}{18}$$

$F = -18\,\text{cm}$. Focus is negative means system will behave as concave mirror.

2. ABCD

Sol. For maxima path difference = $n\,\lambda$

If d = path difference between waves reaching point O = 7 λ

O will be maxima.
For $d = \lambda$ only one maxima at *O* is possible, the screen being finite.

3. ABCD

Sol. $y = 2a\cos(\omega t + \phi)\cos(Kx)$ comparison with given equation gives

$K = \frac{2\pi}{\lambda} = 10\pi \Rightarrow \lambda = \frac{1}{5}\text{m}$

$\omega = 2\pi f = 50\pi \Rightarrow f = 25$ Hz

$\therefore$ $v = 5\ \text{ms}^{-1}$

at x = 0.15 m

$\cos(10\pi \times 0.15) = \cos(1.5\pi) = 0$ for all t

at x = 0.3

$\cos(10\pi \times 0.3) = \cos 3\pi = -1$ for all t

4. CD

Sol. If $\mu_1 = 0$, $\mu_2 \neq 0$

$t_1 = 0$, balancing torques about A

$N_1\ell\sin\theta = mg\frac{\cos\theta}{2}$; $N_1\tan\theta = \frac{mg}{2}$

If $\mu_1 \neq 0$, $\mu_2 \neq 0$

$T_2 = 0$, equilibrium cannot be attained.

If $\mu_1 \neq 0$, $\mu_2 \neq 0$

$N_1 = t_2 = \mu_2 N_2$; $N_2 + t_1 = mg$

$N_2 + \mu_1 N_1 = mg$; $N_2 + \mu_1(\mu_2 N_2) = mg$; $N_2 = \frac{mg}{1+\mu_1\mu_2}$

5. BC

Sol. $v_L = v_C = v_R$;

$\Rightarrow x_L = x_C = R$

when inductor is short circuited

$Z = \sqrt{R^2 + x_C^2} = \sqrt{2}R$

$\therefore I = \frac{30}{Z} = \frac{30}{\sqrt{2}R}$

$\therefore V_L = ix_L = \frac{30}{\sqrt{2}R} \times R = \frac{30}{\sqrt{2}}$

$\therefore$ (A) is incorrect and with similar calculations (B) will be correct.

Here f_0 is the resonance frequency as $v_L = v_C$

$\Rightarrow f_0 = \frac{1}{2\pi\sqrt{LC}}$

and $\omega_0 = 2\pi f_0 = \frac{1}{\sqrt{LC}}$

$\frac{x_L}{x_C} = \frac{\omega L}{1/\omega C} = \omega^2 LC$

Given $f = 2f_0$

$\Rightarrow \omega = 2\omega_0$

$\therefore \frac{X_L}{X_C} = 4$

$\therefore$ (C) is also correct.

6. ABD

Sol. For ammeter,

$$i = \frac{i_{max}(R_s + R_A)}{(R_s)}$$

$\Rightarrow$ $i = 0.1\text{mA}$ for $R_s = 50\,\Omega$ [as $R_A = 50\,\Omega$ and $i_{max} = 50\,\mu\text{A}$]

For voltmeter,

$$V = i_{max}(R_A + R_V)$$

$\Rightarrow$ $V \approx 10\text{V}$ for $R_v = 200\,\text{k}\Omega$

7. A

Sol. Time taken to move from mean to extreme (t) = $\sqrt{\frac{2A}{(F/m)}} = \sqrt{\frac{2Am}{F}}$

$\therefore$ Time period = $4t = 4\sqrt{\frac{2Am}{F}}$

8. A

Sol. Acceleration = constant $\Rightarrow$ velocity time curve should be straight line.

9. B

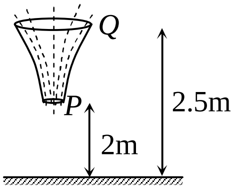
Sol. LC = $\frac{1}{10}$mm = 0.11 mm and zero error is 7 × LC

10. C

Sol. Measured value 3.10 + 4 × LC – 7 × LC = 3.10 + 0.04 – 0.07 = 3.07 cm.

SECTION – D

11. 01000.00



Sol. $P_1 - P_2 = \frac{1}{2}\rho\left(v_2^2 - v_1^2\right) + \rho g\left(h_2 - h_1\right)$

$= \frac{1}{2} \times 10^3(1^2 - 3^2) + 10^3 \times 10(0.5)$

$= -4 \times 10^3 + 5 \times 10^3$ = 1000 J/m^3

12. 00000.20

Sol. I_L and I_C will be in opposite phases.

$I_{net} = I_L - I_C$

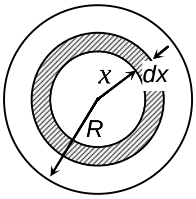
= 0.6 – 0.4 = 0.2 A

13. 00002.25

Sol. R to be maximum.

$$Y = \frac{3H}{2} = \frac{\text{Total height}}{2}.$$

14. 00002.50



Sol. $d\phi = (2\pi x dx)kxt^2$

$$\phi = \frac{2}{3}kt^2\pi x^3$$

$$\frac{d\phi}{dt} = \frac{4k\pi tx^3}{3}$$

$$E2\pi x = \frac{4\pi ktx^3}{3}\ ; \quad E = \frac{2}{3}ktx^2\ ; \quad d\tau = \left(\frac{2}{3}ktx^2\right)\frac{Q}{\pi R^2}(2\pi x dx)x$$

$$\int d\tau = \frac{4}{3}\frac{ktQ}{R^2}\int_0^R x^4 dx \qquad \Rightarrow \quad \tau = \frac{4}{3}\frac{ktQ}{R^2}\frac{R^5}{5}$$

At *t* = 15sec, τ = 2.50 Nm

15. 00000.30

Sol. $V_A = V_C$
c = a + b

16. 00000.10

Sol. $v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{4\times 1}{10\times 10^{-3}}} = 20 \quad m/s$

$$t = \frac{2\ell}{v} = 0.1\text{sec}$$

17. 00000.46

Sol. $W = \frac{V}{2}\rho_{Hg}g$ …(i)

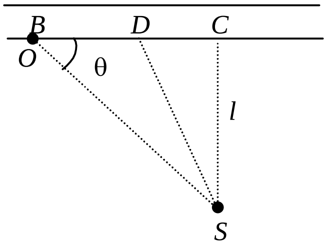
$W = xV\rho_{Hg}g + (1-x)V\rho_w g$ …(ii)

From (i) and (ii)

$$\frac{V}{2}\rho_{Hg}g = xV\rho_{Hg}g + (1-x)V\rho_w g$$

Solving we get x = 0.46

18. 00136.00



Sol. Let the bus be at O when it sends a signal that is detected by the detector as of frequency = 1500 Hz

$$\therefore \quad f' = \left(\frac{v}{v - v_B\cos\theta}\right)\times 1000 = 1500$$

$$\therefore \quad \cos\theta = \frac{\sqrt{3}}{2} \quad \Rightarrow \quad \theta = 30°$$

By the time signal reaches at S the bus reaches at D.
Let this time be t_0

$$\therefore \quad t_0 = \frac{OS}{v} = \frac{l\,\text{cosec}\,\theta}{v} \qquad \dots (1)$$

Now man fires and the bullet reaches C in time t_1 (say). In the same time bus moves from D to C

$\therefore$ $t_1 = \frac{l}{u}$; where u = speed of bullet

Also, OD + DC = $l\cot\theta$

$v_B t_0 + v_B t_1 = l\cot\theta$

$v_B \left(\frac{l\operatorname{cosec}\theta}{v}\right) + v_B (l/u) = l\cot\theta$

$\frac{2}{3\sqrt{3}} \times 2 + \frac{2}{3\sqrt{3}}\frac{v}{u} = \sqrt{3}$

$\therefore$ $\frac{v}{u} = \frac{5}{2}$

$\therefore$ $u = \frac{2}{5}v = \frac{2}{5} \times 340$ = 00136.00 m/s

Chemistry PART – II

SECTION – A

19. ABD

Sol. In ABD the lone pair is less dispersed as compared to aniline.

20. ABD

Sol. Only (C) is asymmetric in nature, so active.

21. CD

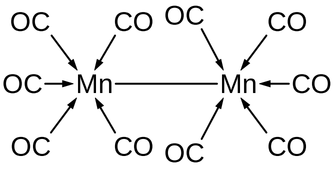
Sol. Ethers having – O – R group can be hydrolysed.

22. ACD

Sol. (A) z* increases from Sc^+ to Sc^{3+} so I.E. increases.
(C) Down the group I.E. decreases
(D) Along the period I.E. increases

23. ACD

Sol. EAN of metal in A, C and D is equal to next inert gas.



24. AC

Sol. $\mathrm{NaH} + \mathrm{H_2O} \longrightarrow \mathrm{NaOH} + \mathrm{H_2}$

$$\underset{\text{(Molted)}}{\mathrm{NaH}} \xrightarrow{\text{Electrolysis}} \underset{\text{(at cathode)}}{\mathrm{Na}} + \underset{\text{(at anode)}}{\frac{1}{2}\mathrm{H_2}}$$

25. C

Sol. In this case elimination reaction is dominating.

26. A

Sol. Position of E.W.G. (NO_2) decides the rearrangement step to form R – N = C = O.

27. A

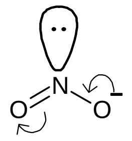
Sol. Extent of back bonding in B – F bond is decreased if – NH_2 or –OH groups are bonded with boron.

28. A

Sol. $\mathrm{O} = \overset{+}{\mathrm{N}} = \overset{-}{\mathrm{N}}$ (Two types of bond)

$\overset{-}{\mathrm{N}} = \mathrm{C} = \overset{-}{\mathrm{N}}$ (Both bonds are identical)

$\overset{-}{\mathrm{N}} = \overset{+}{\mathrm{N}} = \overset{-}{\mathrm{N}}$ (Both bonds are identical)



(Both bonds are identical)

SECTION – D

29. 00002.93

Sol. Fraction of edge unoccupied $= \dfrac{a-2R}{a}$

$$a = 2\sqrt{2}R \qquad X = \frac{2\left(\sqrt{2}-1\right)}{2\sqrt{2}}$$

$$X = \frac{0.414}{1.414} = 0.293 \qquad \Rightarrow 10X = 2.93$$

30. 00002.45

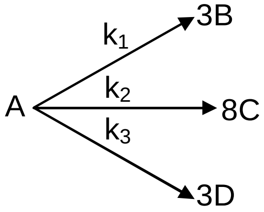
Sol. $\Delta T_f = iK_f m = 2\times 1.86\times 0.66$

31. 00002.60

Sol. $K_C = 10^{\frac{2(0.34-0.15)}{0.0591}} = 2.6\times 10^{6}$

32. 00003.87

Sol.



$k_1 : k_2 : k_3 = 4 : 2 : 1$

mole of A remain after 45 days

$$= \frac{N_0}{2^n} = \frac{N_0}{2^{\frac{T}{t_{1/2}}}} = \frac{1}{2^{45/15}} = \frac{1}{2^3} = \frac{1}{8}$$

moles of [A] convert into product $= \dfrac{7}{8}$ mol

moles of $\left[B\right] = \dfrac{k_1}{k_1+k_2+k_3}\times\dfrac{7}{8}\times 3 = \dfrac{3}{2}$

moles of $\left[C\right] = \dfrac{k_2}{k_1+k_2+k_3}\times\dfrac{7}{8}\times\dfrac{8}{1} = 2$

and moles of $\left[D\right] = \dfrac{1}{7}\times\dfrac{7}{8}\times 3 = \dfrac{3}{8}$

33. 00001.63

Sol. $H_2CO_3 + NaOH \longrightarrow NaHCO_3 + H_2O$

$$pH_1 = \frac{1}{2}\left(pK_{a_1} + pK_{a_2}\right) = \frac{1}{2}\left(4.6+8\right) = 6.3$$

$$N_1V_1 = N_2V_2$$

$$N_1\times 10 = 0.1\times 20$$

$$N_1 = 0.2$$

$$\text{NaHCO}_3 + \text{NaOH} \longrightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O}$$

$$c = \frac{2\text{m mole}}{50\text{ mL}} = \frac{1}{25}\text{M}$$

$$\Rightarrow \text{pH} = \frac{[14 + 8 - 1.4]}{2} = 10.3$$

$$\frac{\text{pH}_2}{\text{pH}_1} = \frac{10.3}{6.3} = 1.63$$

34. 00000.80

Sol. Process AC = polytropic process

Molar Heat capacity $c_m = c_v + R/2 = 2R$

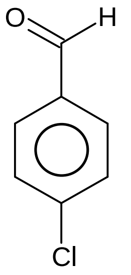
Process AB = Isobaric

$c_m = c_p = 5R/2$

$$\frac{q_{AC}}{q_{AB}} = \frac{\int_{T_A}^{T_C} nC_m \cdot dT}{\int_{T_A}^{T_B} n \cdot C_{p,m} \cdot dT} = \frac{2R}{\frac{5}{2}R} = 0.8$$

35. 00003.00

Sol.



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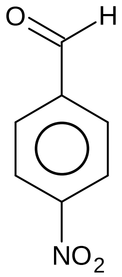

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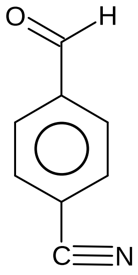


36. 00004.00

Sol. Graphite, $(BN)_x$, $B_3N_3H_6$, C_6H_6

Mathematics

PART – III

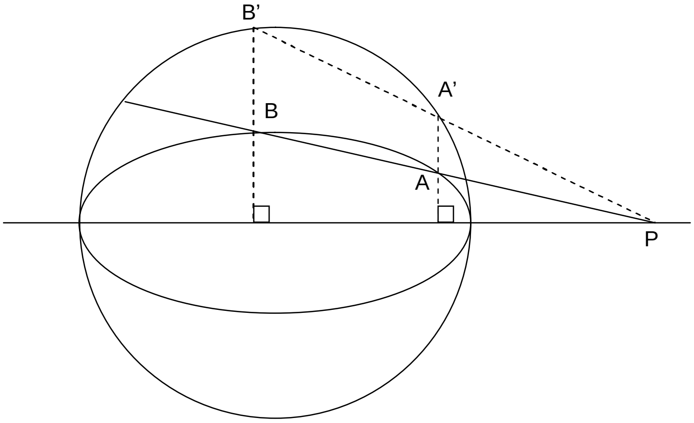
SECTION – A

37. AB

Sol. Radical axis of $S_1 = 0$ and $S_2 = 0$ is the line $L_1 = 0$, the point of concurrency of family of lines $ax + by + c = 0$ if a,b,c are in A.P. is (1,-2)

38. AD

Sol. Take $A(\theta_1)$ and $B(\theta_2)$



39. BD

Sol. Equation of required plane is

$$(x - y + 1) + \lambda(2y + z - 6) = 0$$

$$x + (2\lambda - 1)y + \lambda z + 1 - 6\lambda = 0$$

Since it makes an angle of 30^o with x + y + z = 5

$$\Rightarrow \frac{|1 + (2\lambda - 1) + \lambda|}{\sqrt{3} \cdot \sqrt{1 + \lambda^2 + (2\lambda - 1)^2}} = \frac{\sqrt{3}}{2}$$

$$\Rightarrow |6\lambda| = 3\sqrt{5\lambda^2 - 4\lambda + 2}$$

$$\Rightarrow 4\lambda^2 = 5\lambda^2 - 4\lambda + 2 \Rightarrow \lambda = \left(2 \pm \sqrt{2}\right)$$

40. ABD

Sol. Volume $= \left|\left[2\vec{b} \times \vec{c} \quad 3\vec{c} \times \vec{a} \quad 4\vec{a} \times \vec{b}\right]\right| = 18$

$$\Rightarrow \qquad 24\left[\vec{a} \quad \vec{b} \quad \vec{c}\right]^2 = 18$$

$$\Rightarrow \qquad \left|\left[\vec{a} \quad \vec{b} \quad \vec{c}\right]\right| = \frac{\sqrt{3}}{2}$$

$$\text{Now, } \left[\vec{a} \quad \vec{b} \quad \vec{c}\right] = \begin{vmatrix} (1 + \sin\theta) & \cos\theta & \sin 2\theta \\ \sin\left(\theta + \frac{2\pi}{3}\right) & \cos\left(\theta + \frac{2\pi}{3}\right) & \sin\left(2\theta + \frac{4\pi}{3}\right) \\ \sin\left(\theta - \frac{2\pi}{3}\right) & \cos\left(\theta - \frac{2\pi}{3}\right) & \sin\left(2\theta - \frac{4\pi}{3}\right) \end{vmatrix}$$

Applying $R_1 \to R_1 + R_2 + R_3$ and expanding

$$\left|\left[\vec{a} \quad \vec{b} \quad \vec{c}\right]\right| = \sqrt{3}\left|\cos 3\theta\right| = \frac{\sqrt{3}}{2}$$

$$\Rightarrow \cos 3\theta = \pm\frac{1}{2} \Rightarrow 3\theta = \frac{\pi}{3}, \frac{2\pi}{3}, \frac{4\pi}{3} \Rightarrow \theta = \frac{\pi}{9}, \frac{2\pi}{9}, \frac{4\pi}{9}$$

41. CD

Sol. Clearly $p_1 = \frac{1}{2}$.

$$p_2 = p(HH) + p(T) = \frac{3}{4}$$

Now, the score n can be obtained in two distinct ways.
I. By throwing head when the score is n – 1
II. By throwing tail when the score is n – 2

$$\Rightarrow p_n = \left(p_{n-1}\right)\frac{1}{2} + \left(p_{n-2}\right)\frac{1}{2} = \frac{1}{2}\left(p_{n-1} + p_{n-2}\right)$$

Also, from this $P_4 = \frac{11}{16}$.

42. B

Sol. $$\left(\frac{1}{(z-1)}\left(\cos\alpha + i\sin\alpha\right)\right)^{-1} = (z-1)\left(\cos\alpha - i\sin\alpha\right)$$

$$\therefore\ E = z_1 + \frac{1}{z_1} \text{ hence } I_m(E) = 0 \Rightarrow |z-1| = 1$$

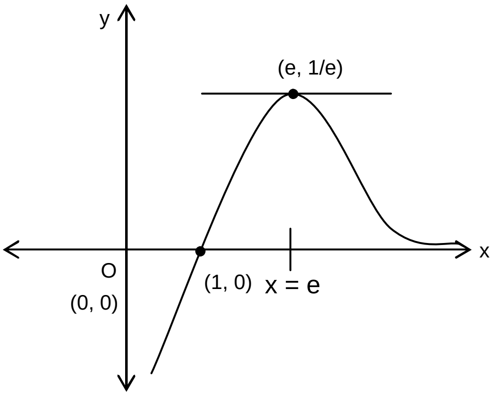
43. D

Sol. We have $b\log_e x - x = 0$

$$\Rightarrow \frac{\log_e x}{x} = \frac{1}{b} \qquad \text{..... (1)}$$

Let $y_1 = \frac{\log_e x}{x}$ and $y_2 = \frac{1}{b}$

Clearly, the equation $\frac{\log_e x}{x} = \frac{1}{b}$ has exactly one real root for positive real value of b = e.



44. D

Sol. Let $A(x_1, y_1)$ be the point of tangency.

Then $x_1 = b\log_e x_1 - x_1$ …….. (1)

Also, $1 = \frac{b}{x_1} - 1$ …….. (2)

$\therefore$ On solving (1) and (2), we get

$b = b\ln x_1 \Rightarrow b(\ln x_1 - 1) = 0$

$\therefore$ $x_1 = e$ (As b > 0) (given)

So, $b = 2x_1 = 2e$

Also, point of contact is (e, e)

45. D

Sol. In the ΔABC, $AD \perp BC$ and $\angle BAC = \frac{2\pi}{3}$

$\Rightarrow \underline{|BAD} = \underline{|DAC} = \frac{\pi}{3}$

$\Rightarrow$ ΔBAD and ΔDAC are congruent Δle's

s$\Rightarrow r_1;r_2 = 1:1$

46. C

Sol. Let b > c

In ΔADC, $AD^2 + (a - x)^2 = b^2$ ....(1)

$\Delta ADC, AD^2 + x^2 = C^2$ ...(2)

Solving (1) and (2), $x = c\cos B$ and $AD = c\sin B$

From ΔADC

$$MD = S_1 - AC = \frac{a + b + c(\sin B - \cos B)}{2} - b$$

$$\Rightarrow MD = \frac{a - b + c(\sin B - \cos B)}{2}$$

From ΔADB

$$ND = S_2 - AB = \frac{c + c\cos B + c\sin B}{2} - c \Rightarrow ND = \frac{-c + c\cos B + c\sin B}{2}$$

$$\therefore\ MN = ME - ND = \frac{a - b + c - 2c\cos B}{2}$$

$$= R[\sin A - \sin B + \sin C - 2\cos B\sin C] = R[\sin(B + C) - \sin B + \sin C - 2\cos B\sin C]$$

$$= \left|4R\sin\left(\frac{B - C}{2}\right)\sin\frac{B}{2}\sin\frac{C}{2}\right|$$

SECTION – D

47. 00008.00

Sol. Area $= \int_0^1 (6 - f(x))dx + \int_{-1}^0 (f(x) - (-2))dx = \frac{5}{4}$

48. 00008.00

Sol. $x^4 - 7x^2 - 4x + 20 = (x^2 - 4)^2 + (x - 2)^2$

$x^4 + 9x^2 + 16 = (x^2 + 4)^2 + x^2$

Take the curve $y = x^2$. Both square roots can be interpreted as distances.

49. 00001.00

Sol. $I = \int_0^{\pi} x\,f\left(\cos^2 x + \tan^4 x\right)dx$

$= \int_0^{\pi} (\pi - x) f\left(\cos^2(\pi - x) + \tan^4(\pi - x)\right)dx$

$= \int_0^{\pi} \pi f\left(\cos^2 x + \tan^4 x\right)dx - \int_0^{\pi} x\,f\left(\cos^2 x + \tan^4 x\right)dx$

$\Rightarrow \quad I = \frac{\pi}{2}\int_0^{\pi} f\left(\cos^2 x + \tan^4 x\right)dx$

$= \frac{\pi}{2}.2\int_0^{\pi/2} f\left(\cos^2 x + \tan^2 x\right)dx$

Hence $k = 1$

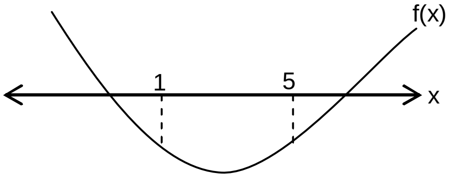
50. 00007.00

Sol. $\frac{(a+2)+(a+2)+b+c}{4} \ge \left((a+b)^2 + bc\right)^{1/4} \ge (81)^{1/4}$

51. 00003.00

Sol. $XX^T = I$; Find PQ then $(PQ)^{10}$

52. 00005.00



Sol. We have $1 + \sum_{r=1}^{10}\left(3^r.\,^{10}C_r + r.\,^{10}C_r\right)$

$= 1 + \sum_{r=1}^{10} 3^r.\,^{10}C_r + 10\sum_{r=1}^{10} {}^9C_{r-1}$

$= 1 + 4^{10} - 1 + 10.2^9$

$= 4^{10} + 5.2^{10} = 2^{10}\left(4^5 + 5\right) = 2^{10}\left(\alpha.4^5 + \beta\right)$, so $\alpha = 1$

and $\beta = 5$

Now $f(1) < 0$ and $f(5) < 0$

So, $f(1) < 0 \quad \Rightarrow \quad -k^2 < 0$

$\Rightarrow \quad k \ne 0$

and $f(5) < 0 \quad \Rightarrow \quad 16 - k^2 < 0$

$\Rightarrow \quad k^2 - 16 > 0$

$\Rightarrow \quad k \in (-\infty, 4) \cup (4, \infty)$

Hence smallest positive integral value of k = 5

53. 00002.00

Sol. The given lines are $\frac{x-1}{1} = \frac{y-3}{-\lambda} = \frac{z-1}{\lambda}$ (=s)

and $\frac{x-0}{1/2} = \frac{y-1}{1} = \frac{z-2}{-1} (= t)$

are coplanar if $\begin{vmatrix} 0-1 & 1-3 & 2-1 \\ 1 & -\lambda & \lambda \\ \frac{1}{2} & 1 & -1 \end{vmatrix} = 0$

$\Rightarrow \begin{vmatrix} -1 & -2 & 1 \\ 1 & -\lambda & \lambda \\ \frac{1}{2} & 1 & -1 \end{vmatrix} = 0$

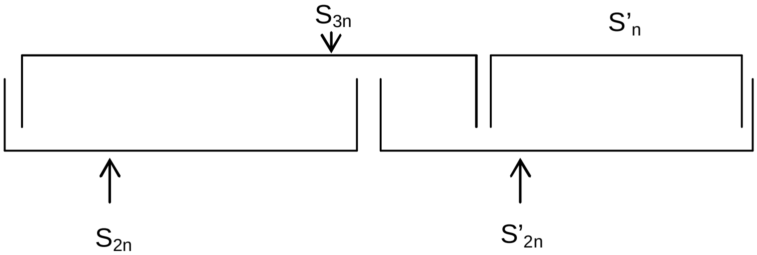
$\Rightarrow 1(\lambda-\lambda)+2\left(-1-\frac{\lambda}{2}\right)+1\left(1+\frac{\lambda}{2}\right)=0$

$\Rightarrow \lambda = -2$

54. 00005.00

Sol. Given $S_{3n} = S'_n = S_{4n} - S_{3n}$

$\Rightarrow 2S_{3n} = S_{4n}$



$\Rightarrow 2\times\frac{3n}{2}\left[2a+(3n-1)d\right) = \frac{4n}{2}\left[2a+(4n-1)d\right]\Big] =$

$\Rightarrow 12a+(18n-6)d = 8a+(16n-4)d$

$\Rightarrow 4a = (-2n+2)d$ ……….(i)

$\Rightarrow 2a = (1-n)d$

Now, we have to find $\frac{S_{2n}}{S_{2n}'}$

$\frac{S_{2n}}{S_{2n}'} = \frac{S_{2n}}{S_{4n}-S_{2n}}$

$= \frac{\frac{2n}{2}\left[2a+(2n-1)d\right]}{\frac{4n}{2}\left[2a+(4n-1)d\right]-\frac{2n}{2}\left[2a+(2n-1)d\right]}$

$= \frac{2\left[(1-n)d+(2n-1)d\right]}{4\left[(1-n)d+(4n-1)d\right]-2\left[(1-n)d+(2n-1)d\right]} = \frac{2^{nd}}{10^{nd}} = \frac{1}{5}$

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – I

JEE (Advanced)-2019

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01 – 06, 19 – 24, 37 – 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 – 46) *contains 12 questions. Each question has* ***TWO (02)*** *matching lists:* ***LIST-I*** *and* ***LIST-II***. ***FOUR*** *options are given representing matching of elements from* ***LIST-I*** *and* ***LIST-II***. ***ONLY ONE*** *of these four options corresponds to a correct matching.*
   For each question, choose the option corresponding to the correct matching.
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

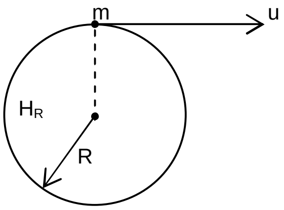
Physics

PART – I

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A small particle is thrown parallel to the earth's surface with initial velocity μ wrt earth assuming there is no other planet and that the velocity of the earth is zero, then which of the following will be correct



(A) For the particle to move in circular orbit around the earth minimum value of 'μ' must be $\sqrt{\dfrac{GM}{R}}$

(B) For the particle to escape, minimum μ should be equal to $\sqrt{\dfrac{2GM}{R}}$

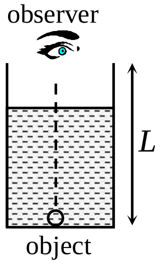
(C) For particle to escape, minimum μ should be more than $\sqrt{\dfrac{2GM}{R}}$

(D) The total mechanical energy of the particle and the earth system remain conserved

2. Let I_A and I_B be moments of inertia of a body about two axes *A* and *B* respectively. The axis *A* passes through the centre of mass of the body but *B* does not, then

(A) I_A may be greater than I_B
(B) I_B may be greater than I_A
(C) I_A may be equal to I_B
(D) I_A must be smaller than I_B

3. A cylinder is filled with a liquid of refractive index μ. The radius of the cylinder is decreasing at a constant rate *K*. The volume of the liquid inside the container remains constant at *V*. The observer and the object *O* are in a state of rest and at a distance *L* from each other. The apparent velocity of the object as seen by the observer, (when radius of cylinder is *r*)



(A) $\dfrac{(1-\mu)2KV}{(\pi\mu r^3)}$
(B) $\dfrac{(1-\mu)2KV}{(\pi\mu L r^2)}$
(C) $\dfrac{(1-\mu)2K}{\mu}$
(D) $\dfrac{(1-\mu)K}{2\mu}$

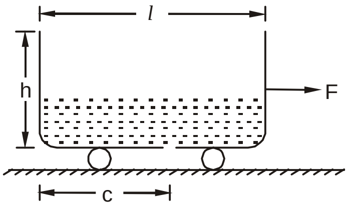
Space for Rough work

4. Nucleus *A* decays to *B* with decay constant λ_1 and *B* decays to *C* with decay constant λ_2. Initially at $t = 0$, number of nuclei of *A* and *B* are $2N_0$ and N_0 respectively. At $t = t_0$, number of nuclei of *B* stop changing. If at this instant number of nuclei of *B* are $\frac{3N_0}{2}$.

(A) the value of t_0 is $\frac{1}{\lambda_1}\ln\frac{4}{3}\frac{\lambda_1}{\lambda_2}$ (B) the value of t_0 is $\frac{1}{\lambda_2}\ln\frac{4}{3}\frac{\lambda_1}{\lambda_2}$

(C) the value of N_A at t_0 is $\frac{3N_0}{2}\frac{\lambda_2}{\lambda_1}$ (D) the value of N_A at t_0 is $\frac{2N_0}{3}\frac{\lambda_2}{\lambda_1}$

5. A rectangular vessel of dimension ($l \times b \times h$) and mass M contains a liquid of density ρ. The vessel has a orifice at its bottom at a distance *c* from the rear wall as shown in fig.



(A) The maximum volume of the water that can be stored when the vessel is accelerated is $\frac{hcb}{2}$.

(B) The maximum volume of the water that can be stored the when the vessel is accelerated is $\frac{hlb}{2}$

(C) Force F that must be applied when maximum water is stored is $\left[M + \frac{hcb\rho}{2}\right]\frac{hg}{c}$

(D) Force F that must be applied when maximum water is stored is $\left[M + \frac{hcb\rho}{2}\right]\frac{lg}{c}$

6. A closed vessel contains a mixture of two diatomic gases A and B. Molar mass of A is 16 times that of B and mass of gas A contained in the vessel is 2 times that of B. Which of the following statements are correct?

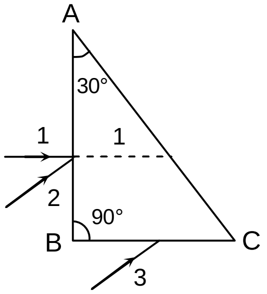
(A) Average kinetic energy per molecule of A is equal to that of B
(B) Root-mean-square value of translational velocity of B is four times that of A
(C) Pressure exerted by B is eight times of that exerted by A
(D) Number of molecules of B, in the cylinder, is eight times that of A

Space for Rough work

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST–I** and **LIST–II**. **FOUR** options are given representing matching of elements from **LIST–I** and **LIST–II**. **ONLY ONE** of these four options corresponds to a correct matching.

7. ABC is a right-angled prism kept in air. A ray (1) is incident on the face AB along the normal. Refractive index of the material of prism is the minimum value that will be required so that ray (1) undergoes total internal reflection at the face AC. Another ray (2) is incident on the face AB such that it emerges from face AC along the normal to AC. A third ray (3) falls on the face BC and emerges from face AC such that its angle of emergence is the same as that of incidence. Assuming light (1), (2) and (3) have the same wavelength, then match the following.

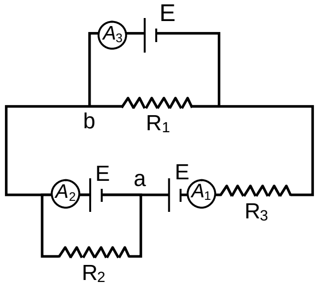


List–I		List–II	
(P)	Refractive index of the material of prism is	(1)	120
(Q)	Angle of incidence in degree of ray (2) is	(2)	90
(R)	Deviation in degree suffered by ray (2) is	(3)	2
(S)	Deviation in degree suffered by ray (3) is	(4)	60
		(5)	1.5

Codes:

(A) P–3, Q–2, R–1, S–2
(B) P–3, Q–2, R–4, S–1
(C) P–4, Q–1, R–2, S–3
(D) P–3, Q–1, R–4, S–2

8. In the circuit shown in figure, $R_1 = R_2 = R_3 = 3\Omega$ and e.m.f. of each cell is E = 4V and negligible internal resistance. All ammeters are ideal. Match the following:



List–I		List–II	
(P)	Reading of ammeter A_1 in ampere is	(1)	4/3
(Q)	Reading of ammeter A_2 in ampere is	(2)	8/3
(R)	Reading of ammeter A_3 in ampere is	(3)	4
(S)	Potential difference between point a and point b in volt is	(4)	zero
		(5)	2

Codes:

(A) P–1, Q–2, R–3, S–4
(B) P–2, Q–1, R–4, S–5
(C) P–1, Q–3, R–2, S–3
(D) P–1, Q–2, R–4, S–3

Space for Rough work

9. List-I contains units/dimensions and List-II some combination of quantities. Match the List-I to List-II.

List–I		List–II	
(P)	Henry	(1)	$\sqrt{LC}$ where L is inductance and C is capacitance
(Q)	Second	(2)	$\frac{M\ell^2}{Q^2}$, ℓ is length, M-mass and Q is charge
(R)	$(\text{Second})^3$	(3)	RC, R is resistance & C is capacitance.
(S)	Dimensionless	(4)	C^2LR, C-capacitance, L = Inductance, R is resistance
		(5)	$\frac{Pc}{Q}$ where Q is radiation energy striking unit area pr second. c is speed of light and P is radiation pressure.

Codes:

(A) P–2; Q–1,3; R–4; S–5
(B) P–5; Q–1, 3; R–2; S–4
(C) P–5; Q–3; R–1, 4; S–2
(D) P–2; Q–1; R–4; S–3, 4

10. Velocity of sound in air is V and the length of organ pipe is L. P_o is the mean pressure and ΔP_0 is amplitude of pressure variations.

List – I		List – II	
(P)	If the pipe is closed at one end, the frequency of first overtone is	(1)	3V/4L
(Q)	If the pipe is open at both ends the frequency of fourth harmonic is	(2)	2V/L
(R)	If the pipe is closed at one end the pressure at open end is	(3)	0
(S)	The pressure at closed end is	(4)	$[P_o - \Delta P_o, \quad P_o + \Delta P_o]$
		(5)	P_o

Codes:

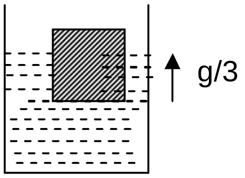
(A) P–1, Q–2, R–4, S–5
(B) P–1, Q–2, R–5, S–4
(C) P–2, Q–1, R–5, S–4
(D) P–3, Q–2, R–5, S–4

Space for Rough work

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

11. A cubical block is floating in a liquid with half of its volume immersed in the liquid. When the whole system accelerates upwards with a net acceleration of g/3. Find the fraction of volume immersed in the liquid

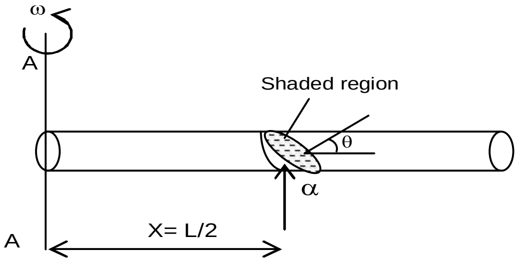


12. A projectile is thrown with a velocity of 18 m/s at an angle of 60° with horizontal. The interval between the moments when speed of the projectile is 15 m/s is ($g = 10\ m/s^2$)

13. A source of sound emitting a note of frequency 200Hz moves towards an observer with a velocity v equal to the velocity of sound. If the observer also moves away from the source with the same velocity v, the apparent frequency heard by the observer is

14. If 10% of the current passes through a moving coil galvanometer of resistance 99 ohm, then the shunt resistance will be:

15. A thin uniform metallic rod of mass m, length L, Young modulus of elasticity Y and cross–sectional area A is rotated by angular velocity ω about extreme end AA'. Consider a section on the rod at midpoint of rod. What will be the normal stress in N/m^2 on the shaded region? (Take the value of $\frac{M\omega^2 L^2 \cos^2\theta}{A} = 10\ N/m^2$)

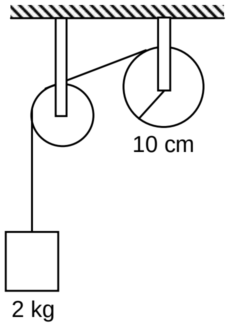


Space for Rough work

16. An object is cooled from 75^0C to 65^0C in 2 minutes in a room at 30^0C. The time taken to cool another identical object from 55^0C to 45^0C in the same room in minutes is

17. The thickness of a glass plate is measured to be 2.17 mm, 2.17 mm and 2.18 mm at three different places. Find the average thickness of the plate from this data. (in mm)

18. A string is wrapped on a wheel of moment of inertia 0.20 kg m^2 and radius 10 cm and goes through a light pulley to support a block of mass 2.0 kg as shown in figure. Find the acceleration of the block. (in m/s^2)



Space for Rough work

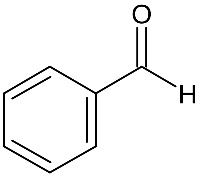
Chemistry

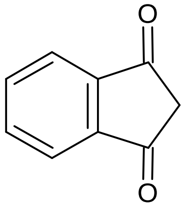
PART – II

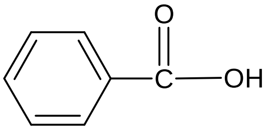
SECTION – A
(One or More than one correct type)

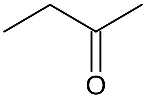
This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Which of the following compounds exhibit acid base reaction with NaOH?

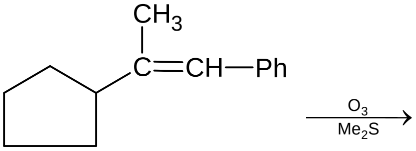
(A)


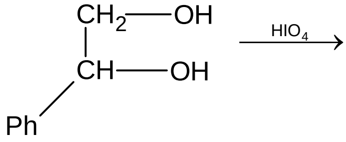
(B)


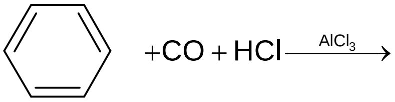
(C)


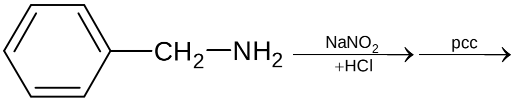
(D)


20. Which of the following reactions can produce benzaldehyde as major product?

(A)

CH3
C=CH—Ph
O3
Me2S

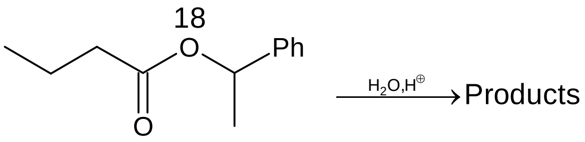
(B)

CH2—OH
CH—OH
Ph
HIO4

(C)

+CO + HCl
AlCl3

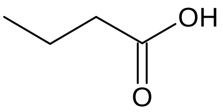
(D)

CH2—NH2
NaNO2
+HCl
pcc

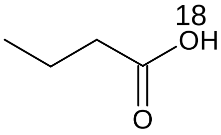
Space for Rough work

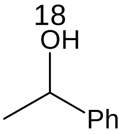
21.

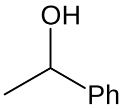

18
O
Ph
O
H2O,H⊕
Products

Products are:

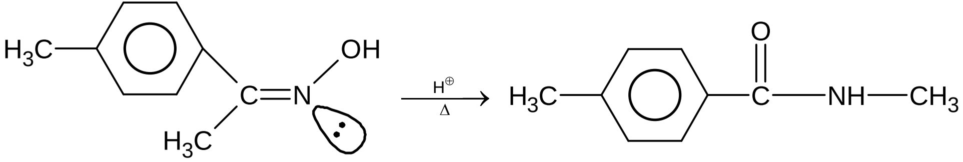
(A)


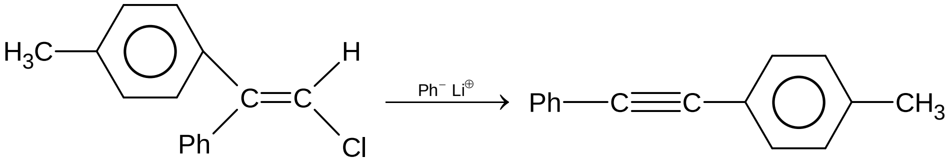
(B)


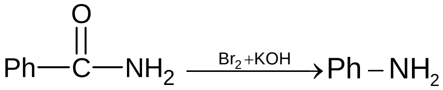
(C)


(D)


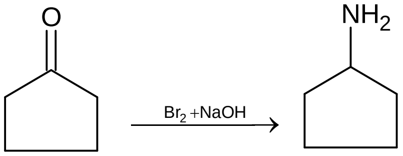
22. Which of the following reactions represent major products?

(A)

H3C
OH
C=N
H3C
H⊕
Δ
H3C
O
C
NH
CH3

(B)

H3C
H
C=C
Ph
Cl
Ph⁻ Li⊕
Ph
C
C
CH3

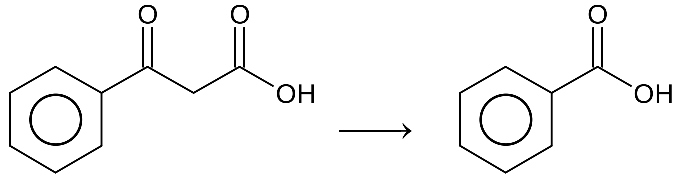
(C)


$$Ph-\overset{O}{\overset{\|}{C}}-NH_2 \xrightarrow{Br_2+KOH} Ph-NH_2$$

(D)

O
Br2 +NaOH
NH2

Space for Rough work

23. The following conversion reaction can be carried out by using reaction sequences:



(A) $\xrightarrow{Zn-Hg/HCl}\xrightarrow{Br_2,hv}\xrightarrow{KCN}\xrightarrow{H_3^{\oplus}O,\Delta}$ (B) $\xrightarrow{NaBH_4}\xrightarrow{Al_2O_3,\Delta}\xrightarrow{O_3/H_2O(Oxidation)}$

(C) $\xrightarrow{\Delta}\xrightarrow{I_2+NaOH}\xrightarrow{H^{\oplus}}$ (D) $KMnO_4$ / $\overset{-}{O}H$/ Δ

24. Which of the following statements are correct?

(A) Hydrolysis of sucrose with dilute acid yields an equimolar mixture of D-Glucose and D-Fructose.

(B) Acidic hydrolysis of sucrose is accompanied by a change in optical reaction.

(C) In sucrose, the glycosidic linkage is between C – 1 of glucose and C – 2 of fructose.

(D) Aqueous solution of sucrose exhibits mutarotation.

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST–I** and **LIST–II**. **FOUR** options are given representing matching of elements from **LIST–I** and **LIST–II**. **ONLY ONE** of these four options corresponds to a correct matching.

---

25. Match List-I with List-II and select correct code for your answer.

List – I (Molecules)		**List – II (M = Central atom)**	
(P)	H_2O	(1)	largest M – H length
(Q)	H_2S	(2)	largest $H\hat{M}H$ bond angle
(R)	H_2Se	(3)	lowest boiling point
(S)	H_2Te	(4)	4p – 1s overlapping

Code:

	P	**Q**	**R**	**S**
(A)	3	2	4	1
(B)	2	3	4	1
(C)	3	1	4	2
(D)	1	3	4	2

Space for Rough work

26. List-I contains some cations and List-II contains some anion which produce white ppt with corresponding cation. Match List-I with List-II and select correct code for your answer.

List – I		List – II	
(P)	Ag^+	(1)	Cl^-
(Q)	Zn^{2+}	(2)	S^{2-}
(R)	Mg^{2+}	(3)	CO_3^{2-}
(S)	Ba^{2+}	(4)	SO_4^{2-}

Code:

	P	**Q**	**R**	**S**
(A)	2	3	1	4
(B)	4	3	2	1
(C)	1	4	3	2
(D)	1	2	3	4

27. The unbalanced chemical reactions given in List-I show missing reagent or condition (?) which are provided in List-II. Match List-I with List-II and select the correct answer using the code given below the lists:

List – I		List – II	
(P)	$PbO_2 + H_2SO_4 \xrightarrow{?} PbSO_4 + O_2 + \text{other product}$	(1)	NO
(Q)	$Na_2S_2O_3 + H_2O \xrightarrow{?} NaHSO_4 + \text{other product}$	(2)	I_2
(R)	$N_2H_4 \xrightarrow{?} N_2 + \text{other product}$	(3)	Warm
(S)	$XeF_2 \xrightarrow{?} Xe + \text{other product}$	(4)	Cl_2

Code:

	P	**Q**	**R**	**S**
(A)	4	2	3	1
(B)	3	2	1	4
(C)	1	4	2	3
(D)	3	4	2	1

Space for Rough work

28. Match List-I with List-II.

List – I (Metal)		List – II (Outer electronic configuration of either metal or its M^{2+} ion)	
(P)	Cu	(1)	ns^2, np^6, nd^{10}
(Q)	Cd	(2)	ns^2, np^6, nd^9
(R)	Fe	(3)	$(n-1)d^5, ns^2$
(S)	Mn	(4)	ns^2, np^6, nd^6

Code:

	P	**Q**	**R**	**S**
(A)	1	2	3	4
(B)	2	1	4	3
(C)	2	1	3	4
(D)	1	2	4	3

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

29. For soaps critical micelle concentration (CMC) is 10^{-x} (min.) to 10^{-y} (max.) mol/L. What is the value of x?

30. The average life of a radioactive element is 7.2 min. Calculate the time required (in min.) for the stage of 33.33% decay ($\log 3/2 = 0.1761$)

31. 0.16 g N_2H_4($K_b = 4 \times 10^{-6}$) are dissolved in water and the total volume made up to 500 mL. Calculate the mole fraction of N_2H_4 that has reacted with water in this solution.

Space for Rough work

32. At 273 K and 1 atm, 10 litre of N_2O_4 decomposes to NO_2 according to equation

$$N_2O_2(g) \rightleftharpoons 2NO_2(g)$$

What is degree of dissociation (α) when the original volume is 25% less than that of existing volume?

33. What will be the pH of an aqueous solution of 1.0 M ammonium formate?
Given : $pK_a = 3.8$ and $pK_b = 4.8$

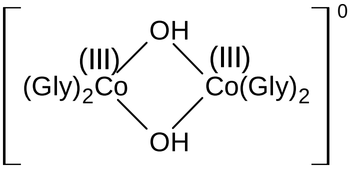
34. For the reaction; $FeCO_3(s) \longrightarrow FeO(s) + CO_2(g); \Delta H = 82.8\ kJ$ at 25°C, what is (ΔE or ΔU) at 25°C?

35. Calculate $|\Delta_f H°|$ (in kJ/mol) for Cr_2O_3 from the $\Delta_r G°$ and the S° values provided at 27°C

$$4Cr(s) + 3O_2(s) \longrightarrow 2Cr_2O_3(s); \qquad \Delta_r G° = -2093.4\ kJ/mol$$

$$S°(J/K\ mol): S°(Cr,s) = 24;\ S°(O_2,g) = 205; \qquad S°(Cr_2O_3,s) = 81$$

36. Total number of Co – N (cobalt-nitrogen) linkages in



(Gly^{-1} = Glycinate)

Space for Rough work

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. If $z_1 = a + ib$ and $z_2 = c + id$ are two complex numbers such that $|z_1| = |z_2| = 1$ and $\text{Re}\left(z_1\bar{z}_2\right) = 0,$ then the pair of complex numbers, $w_1 = a + ic$ and $w_2 = b + id$ satisfying

(A) $|w_1| = 1$
(B) $|w_2| = 1$
(C) $|w_1\bar{w}_1| = 1$
(D) $\text{Re}\left(\bar{w}_1 w_2\right) = 0$

38. If p, q, r, s are positive real numbers and the equation $x^4 - px^3 + qx^2 - rx + s = 0$ has four positive real roots, then

(A) $p^4 \geq 256s$
(B) $r^4 \geq 256s^3$
(C) $pr \geq 16s$
(D) $q^2 \geq 36s$

39. In a ΔABC with fixed base BC, the vertex A moves such than $\cos B + \cos C = 4\sin^2\left(\frac{A}{2}\right).$ If a, b and c denote the length of the sides of the triangle opposite to the angle A, B and C respectively, then

(A) $b + c = 4a$
(B) $b + c = 2a$
(C) locus of point A is an ellipse
(D) locus of point A is a pair of straight lines.

40. Let $f(x) = \begin{cases} x^3 + x^2 - 10x & -1 \leq x < 0 \\ \sin x & 0 \leq x < \frac{\pi}{2} \\ 1 + \cos x & \frac{\pi}{2} \leq x \leq \pi \end{cases}$ then $f(x)$ has

(A) local maxima at $x = \frac{\pi}{2}$
(B) local minima at $x = \frac{\pi}{2}$
(C) absolute maxima at $x = 0$
(D) absolute maxima at $x = \frac{\pi}{2}$

Space for Rough work

41. If $I_n = \int_{-\pi}^{\pi} \frac{\sin nx}{(1+\pi^x)\sin x} dx, = 0,1,2$ then

(A) $I_n = I_{n+2}$

(B) $\sum_{m=1}^{10} I_{2m+1} = 10\pi$

(C) $\sum_{m=1}^{10} I_{2m} = 0$

(D) $I_n = I_{n+1}$

42. If $f(x) = \begin{cases} \int_0^x (1+|1-t|)dt, x > 2 \\ 5x+1, x \le 2 \end{cases}$, then

(A) f(x) is not continuous at x = 2
(B) f (x) is continuous but not differentiable at x = 2
(C) f (x) is differentiable everywhere
(D) the right derivative of $f(x)$ at x = 2 does not exist

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST–I** and **LIST–II**. **FOUR** options are given representing matching of elements from **LIST–I** and **LIST–II**. **ONLY ONE** of these four options corresponds to a correct matching.

---

43. Match the sequence $a_1, a_2, a_3, ...$ whose nth term is given on the left with properties of the sequence on the right

LIST - I		LIST – II	
(P)	$a_n = \int_0^{\pi/2} \frac{1-\cos 2nx}{1-\cos 2x} dx$	(1)	a_1, a_2, a_3 … are in A.P.
(Q)	$I_n = \int_0^{\pi/4} \tan^n x\, dx \quad a_n = \frac{1}{I_{n+1} + I_{n+3}}$	(2)	$a_1, a_2, a_3, ...$ are in G.P.
(R)	$I_n = \int_0^{\pi/4} \frac{\sin^2 nx}{\sin x} dx \,\forall n \ge 0$ and $a_n = I_n - I_{n-1} \forall n \ge 1$	(3)	$a_1, a_2, a_3, ...$ are in H.P.
(S)	$b_n = \int_0^{\pi/2} \frac{\sin^2 nx}{\sin^2 x} dx \quad a_n = b_n - b_{n-1} \,\forall n \ge 1$	(4)	$a_1, a_2, a_3, ...$ is a constant sequence.
		(5)	$a_1, a_2, a_3, ...$ are in A.G.P.
		(6)	$a_1, a_2, a_3, ...$ are neither in A.P. nor G. P nor H.P.

The correct option is
(A) P → 1; Q → 1; R → 3; S → 1,2, 3, 4
(B) P → 5; Q → 2; R → 6; S → 1
(C) P → 1; Q → 1; R → 3; S → 6
(D) P → 1; Q → 1; R → 5; S → 1, 2, 3, 4

Space for Rough work

44. Let A be a set containing n elements. P and Q are two subsets of A. The number of ways of choosing P and Q so that

	LIST - I		LIST – II
(P)	$P \cup Q = A$	(1)	2^{n-1}
(Q)	$P \cup Q \neq \phi$	(2)	3^n
(R)	$P \sim Q$ is a singleton	(3)	$2^n + 1$
(S)	$P \cap Q = \phi$	(4)	$3^n - 1$
		(5)	$n.3^{n-1}$
		(6)	$4^n - 3^n$

The correct option is
(A) P → 2; Q → 6; R → 1; S → 5
(B) P → 1; Q → 2; R → 3; S → 4
(C) P → 2; Q → 6; R → 5; S → 2
(D) P → 1; Q → 2; R → 5; S → 6

45. Match the statement given in List I with List II

	LIST – I		LIST – II
(P)	The set $\left\{\text{Re}\left(\frac{2iz}{1-z^2}\right) : z \text{ is a complex number}, \lvert z\rvert = 1, z \neq \pm 1\right\}$	(1)	$(-\infty, -1) \cup (1, \infty)$
(Q)	The domain of the function $f(x) = \sin^{-1}\left(\frac{8(3)^{x-2}}{1-3^{2(x-1)}}\right)$ is	(2)	$(-\infty, 0) \cup (0, \infty)$
(R)	If $f(\theta) = \begin{vmatrix} 1 & \tan\theta & 1 \\ -\tan\theta & 1 & \tan\theta \\ -1 & -\tan\theta & 1 \end{vmatrix}$, then the set $\left\{f(\theta) : 0 \leq \theta < \frac{\pi}{2}\right\}$ is	(3)	$[2, \infty)$
(S)	If $f(x) = x^{3/2}(3x - 10)$, $x \geq 0$, then $f(x)$ is increasing in	(4)	$(-\infty, -1] \cup [1, \infty)$
		(5)	$(-\infty, 0] \cup [2, \infty)$
		(6)	$(-\infty, -2] \cup [-1, \infty)$

The correct option is
(A) P → 4; Q → 5; R → 3; S → 3
(B) P → 3; Q → 3; R → 4; S → 5
(C) P → 4; Q → 3; R → 3; S → 5
(D) P → 4; Q → 3; R → 2; S → 1

Space for Rough work

46. Suppose a. b, c are three distinct real numbers and p (x) is a real quadratic polynomial such that $\begin{bmatrix} 4a^2 & 4a & 1 \\ 4b^2 & 4b & 1 \\ 4c^2 & 4c & 1 \end{bmatrix}\begin{bmatrix} p(-1) \\ p(1) \\ p(1) \end{bmatrix} = \begin{bmatrix} 3a^2+3a \\ 3b^2+3b \\ 3c^2+3c \end{bmatrix}$

LIST - I		LIST – II	
(P)	x – coordinates (s) of the point of intersection of $y = f(x)$ with the x – axis	(1)	4
(Q)	Area bounded by $y = \frac{3}{2}f(x)$ and the x – axis	(2)	2
(R)	Maximum value of $f(x)$	(3)	1
(S)	Length of the intercept made by $y = f(x)$ on the x – axis	(4)	–2
		(5)	0
		(6)	3

The correct option is
(A) P → 2, 4; Q → 1; R → 3; S → 1
(B) P → 1, 2; Q → 2; R → 3; S → 4
(C) P → 5; Q → 6; R → 3; S → 1
(D) P → 5, 6; Q → 1; R → 3; S → 1

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

47. If $x_n = 1^2 + (2)(2^2) + 3^2 + (2)(4^2) + ... = n\frac{(n+1)^2}{2}$ if n is even, find x_{51}

48. Find the number of three digit numbers of the form xyz with x, z < y, $x \neq 0$.

Space for Rough work

49. Let $a_r = r^2 \frac{^{50}C_r}{^{50}C_{r-1}}$ a and b denote the coefficient of x^{49} in $(x-a_1)(x-a_2)..(x-a_{50})$, find $\left(-\frac{1}{17}\right)b$.

50. Let ABC and ABC' be tow non – congruent triangles with sides AB = 4, AC = AC' = $2\sqrt{2}$ and angle B = 30^o. The absolute value of the difference between the areas of these triangles is

51. In a triangle ABC; A = $\frac{\pi}{3}$, b = 50, c = 30, AD is a median through A, then AD^2 is equal to

52. The tangent at three points A, B, C on the parabola $y^2 = 4x$, taken in pairs intersect at the point P, Q and R. If Δ, Δ' be the areas of the triangles ABC and PQR respectively, then $\frac{\Delta}{\Delta'} =$

53. If the position vector of the point of intersection of the line $r = (i+2j+3k) + \lambda(2i+j+2k)$ and the plane $r.(2i-6j+3k)+5=0$ is $a\hat{i}+b\hat{j}+c\hat{k}$ then value of $(50a+60b+75c)^2$ is equal to

54. If $f(x) = \frac{\sin^{-1}(1-\{x\}).\cos^{-1}(1-\{x\})}{\sqrt{2\{x\}}.(1-\{x\})}$, then the value of $\left(\frac{18\sqrt{2}}{\pi}\lim_{x\to 0^-} f(x)\right)$ is (where {x} denotes the fractional part of x)

Space for Rough work

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PAPER – 2

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

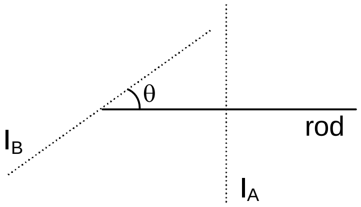
SECTION – A

1. ACD

Sol. For the angular momentum to remain conserved, the final velocity of the particle must not be zero.

2. ABC

Sol. $I_B = \frac{m\ell^2}{3}\sin^2\theta,\ I_A = \frac{m\ell^2}{12}$



3. A

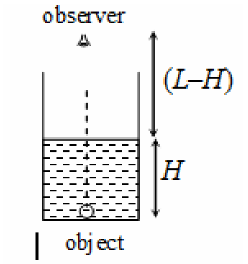
Sol. $X_{app} = L - H + \frac{H}{\mu}$

$$\frac{dX_{app}}{dt} = \frac{dH}{dt}\left(\frac{1-\mu}{\mu}\right)$$

$$\pi r^2 H = V$$

$$\therefore \frac{dH}{dt} = -\frac{2H}{r}\frac{dr}{dt} = \frac{2KH}{r}$$

$$\therefore \frac{dX_{app}}{dt} = \frac{2KV}{\pi r^3}\left(\frac{(1-\mu)}{\mu}\right)$$



4. AC

Sol. $\frac{dN_B}{dt} = \lambda_1 N_A - \lambda_2 N_B$

at, $t = t_0$, $\frac{dN_B}{dt} = 0$, $N_B = \frac{3N_0}{2}$

$\Rightarrow 2N_0\lambda_1 e^{-\lambda_1 t_0} - \lambda_0 \frac{3N_0}{2} = 0$

$t_0 = \frac{1}{\lambda_1} \ln \frac{4}{3} \frac{\lambda_1}{\lambda_2}$

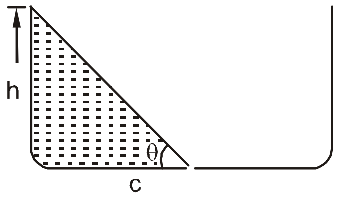
5. AC

Sol. The maximum amount of water that can be retained is shown in the fig. If θ is the angle made by the water surface with the horizontal then.

$\tan\theta = \frac{h}{c} = \frac{a}{g} \quad \Rightarrow a = \frac{hg}{c}$

So the maximum volume that can be retained is $\frac{1}{2} \times h \times c \times b$.

And $F = \left[M + \frac{hcb\rho}{2}\right]\frac{hg}{c}$



6. ABCD

Sol. Since both the gases are contained in the same vessel, temperature of both the gases is same.

Average KE per molecule of a diatomic gas is 5/2 KT. Hence, average KE permolecule of both the gases is same. Therefore, option (a) is correct.

$\nu_{rms} = \sqrt{\frac{3RT}{M}}$

Hence, $\frac{(\nu_{rms})_2}{(\nu_{rms})_1} = \sqrt{\frac{M_1}{M_2}} = \sqrt{16} = 4$

Hence, option(b) is correct.

Let molar mass of B be M, then that of A will be equal to 16 M.

Let mass of gas B in the vessel be m, then that of A will be 2m. The number of moles of a gas, in the vessel will be n = m/M. hence, number of moles of gases A and B will be

$n_1 = \frac{2m}{16M}$ and $n_2 = \frac{m}{M}$

Hence, $\frac{n_1}{n_2} = \frac{1}{8}$

Hence, option(d) is correct.

Partial pressure exerted by a gas is

$P = \frac{nRT}{V}$

Hence, $\frac{P_2}{P_1} = \frac{n_2}{n_1} = 8$

Therefore, option(c) is also correct.

7. B

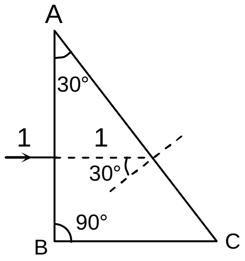
Sol. (P) Refractive index of the prism is the minimum value required for ray (1) to undergo total internal reflection at face AC. Ray (1) falls on face AC at an angle of incidence 30°

$\therefore$ $30° > i_C$

$\sin 30° > \sin i_C$

$\therefore$ $\mu > 2$

Minimum value of μ can be taken as 2.



(Q) For ray 2, refractive angle of prism is 30°. Apply Snell's law for refraction at face AB.

$1 \sin i = \mu \sin r$

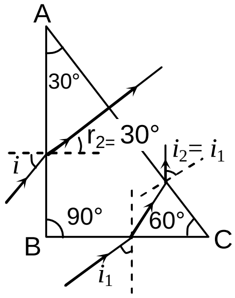
$i = 90°$

(R) Using the relation $i_1 + i_2 = A + \delta$ for ray 2.

$90° + 0° = 30° + \delta$

$\delta = 60°$

(S) $$\mu = \frac{\sin\left(\frac{A + \delta m}{2}\right)}{\sin\frac{A}{2}} \Rightarrow \delta m = 120°$$



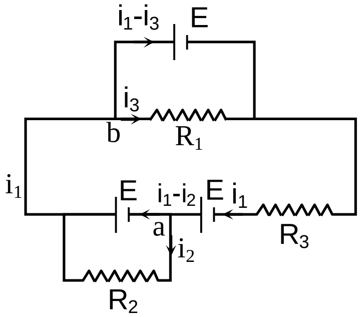
8. D

Sol. On solving by KVL we get, $i_1 = \frac{E}{R}$, $i_2 = -\frac{E}{R}$, $i_3 = \frac{E}{R}$

$\Rightarrow$ $i_1 - i_2 = \frac{2E}{R}$ and $i_1 - i_3 = 0$

So reading of ammeter A_1 is $E/R = 4/3$

A_2 is $2E/R = 8/3$, A_3 is zero and $\Delta V_{ab} = 4V$



9. A

Sol. RC is time constant $\sqrt{LC}$ is inverse of frequency and $\frac{Pc}{Q}$ is dimensionless.

10. B

Sol. For closed pipe, $\nu = \frac{(2n+1)v}{4L}$ and for first overtone, n = 1

For open pipe, $\nu = \frac{nv}{2L}$ and for fourth harmonic, n = 4.

SECTION – D

11. 00000.50

Sol. The apparent weight of block and apparent weight of fluid are changed by same amount.

12. 00002.40

Sol. $V_x = 18 \cos 60° = 9$ m/s.

$V_{1y} = \sqrt{15^2 - 9^2} = 12$ m/s $V_{2y} = -12$ m/s

$\therefore\ \Delta t = \frac{-12-(12)}{-10} = \frac{12}{5}$ sec.

13. 00200.00

Sol. No relative motion between source and observers.

14. 00011.00

Sol. $I_1 = \left(\frac{s}{s+99}\right) \times I$

$\frac{I_1}{I} = \frac{s}{99+s} = 0.1$

$s = 11\Omega$

15. 00003.75

Sol. $T = \frac{3}{8} M\,\omega^2 L^2$

Stress = $\frac{F_\perp}{(A/\cos\theta)} = \frac{3}{8}\frac{M\omega^2 L^2 \cos^2\theta}{A}$

16. 00004.00

Sol. Newton's law for cooling.

Rate of decrease of temperature $\propto$ temperature difference between object and surrounding.

$\frac{75-65}{2}$ = Ab (70 – 30)

$\frac{55-45}{t}$ = Ab (50 – 30)

$\therefore$ t = 4 min.

17. 00002.17

Sol. $\frac{2.17+2.17+2.18}{3}$ = 2.1733 ….. ≈ 2.17 mm upto 3 significant figure.

18. 00000.89

Sol. $2g - T = 2a$ …(i)

$TR = I\alpha$ …(ii)

$a = R\alpha$ …(iii)

From (ii) and (iii) $T = \frac{Ia}{R^2}$

$\therefore\ 2g = a\left(2 + \frac{I}{R^2}\right)$

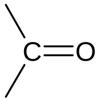
$$\Rightarrow\ a = \frac{2g}{\left(2+\frac{I}{R^2}\right)} = \frac{2\times 9.8}{2+\frac{0.2}{0.01}} = \frac{9.8}{11} \approx 0.89 \text{ m/s}^2$$

Chemistry

PART – II

SECTION – A

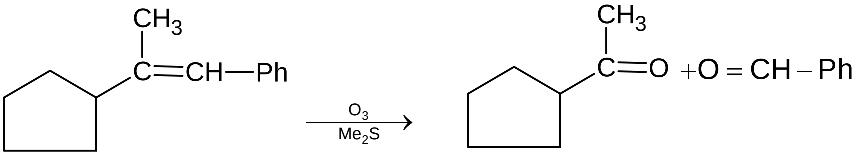
19. BCD

Sol. C is acid and B and D contain α - H w.r.t.  group.

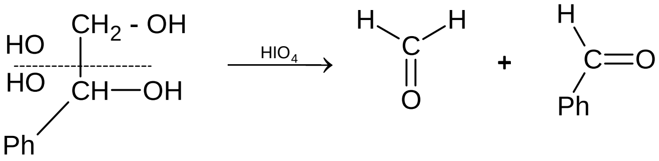
20. ABCD

Sol.

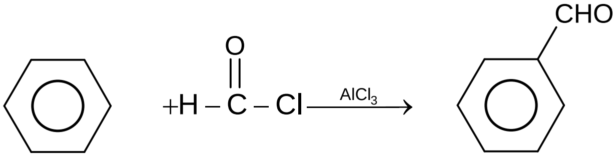
(A)


CH$_3$
C=CH—Ph
O$_3$
Me$_2$S
CH$_3$
C=O +O = CH – Ph

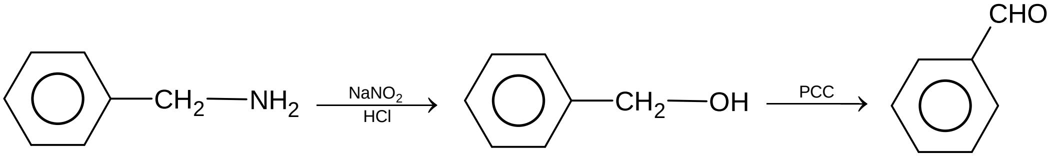
(B)


HO
HO
CH$_2$ - OH
CH—OH
Ph
HIO$_4$
H
H
C
O
+
H
C=O
Ph

(C)

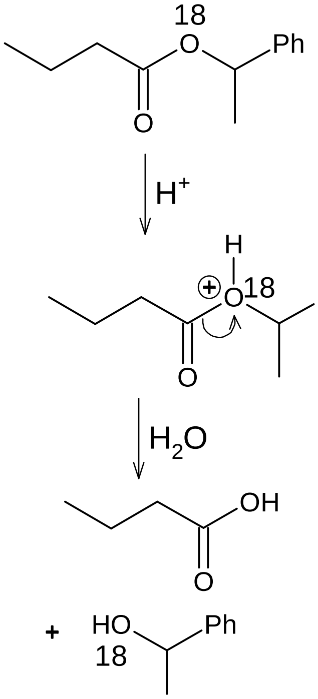

O
+H – C – Cl
AlCl$_3$
CHO

(D)


CH$_2$—NH$_2$
NaNO$_2$
HCl
CH$_2$—OH
PCC
CHO

21. AC

Sol.


18
O
Ph
O
H$^+$
H
⊕O
18
Ph
O
H$_2$O
OH
O
+
HO
18
Ph

22. ABC
Sol. Self explanatory reactions.

23. BCD
Sol. All the reagents in B, C and D are suitable.

24. ABC

25. B
Sol. M – H length = $H_2Te > H_2Se > H_2S > H_2O$
HMH B.A. = $H_2O > H_2S > H_2Se > H_2Te$
B.P. = $H_2O > H_2Te > H_2Se > H_2S$
(due to hydrogen bonding in H_2O)
All have two L.P. on central atom.

26. D
Sol.

	Ag^+	Zn^{2+}	Mg^{2+}	Ba^{2+}
Cl^-	White ppt.	No ppt.	No ppt.	No ppt.
S^{2-}	Black ppt.	White ppt.	No ppt.	No ppt.
CO_3^{2-}	Pale yellow ppt.	White ppt.	White ppt.	White ppt.
SO_4^{2-}	White ppt. which is sparingly soluble	No ppt.	No ppt.	White ppt.

In code (D) all are given with correct observation.

27. D
Sol.
$$\overset{IV}{Pb}O_2 + H_2SO_4 \xrightarrow{\Delta} \overset{II}{Pb}SO_4 + O_2 + 2H_2O$$
$$Na_2S_2O_3 + 5H_2O + 4Cl_2 \longrightarrow 2NaHSO_4 + 8HCl$$
$$N_2H_4 + 2I_2 \longrightarrow N_2(g) + 4HI$$
$$XeF_2 + 2NO \longrightarrow Xe(g) + 2NOF$$

28. B
Sol. $Cu^{2+} = 1s^22s^22p^63s^23p^63d^9$
$Cd^{2+} = 1s^22s^22p^63s^23p^63d^{10}4s^24p^64d^{10}$
$Fe^{2+} = 1s^22s^22p^63s^23p^63d^6$
$Mn = 1s^22s^22p^63s^23p^63d^54s^2$

SECTION – D

29. 00004.00
Sol. CMC of soap
10^{-4} M to 10^{-3} M
x = 4

30. 00002.92
Sol.
$$\lambda = \frac{1}{t_{avg}} = \frac{1}{t}\ln\frac{[A_0]}{[A_t]}; \frac{1}{7.2} = \frac{1}{t}\ln\frac{100}{100-\frac{100}{3}}$$
$$t = 2.303 \times 7.2 \times 0.1761$$

31. 00000.02

Sol. $C = \frac{0.16/32}{500/1000} M$

$\alpha = \sqrt{K_b / c} = 2 \times 10^{-2}$

32. 00000.33

Sol. For ideal gas mole % = volume %

$$\begin{array}{lcc} & N_2O_2(g) \rightleftharpoons & 2NO_2(g) \\ \text{initial moles} & a & 0 \\ \text{at eqm} & a(1-\alpha) & 2a\alpha \end{array}$$

As per given, original volume

$= \frac{75}{100} \times$ Volume at equilibrium at constant T and P $(V \propto n)$

$\therefore$ $a = 0.75 \times a(1 + \alpha)$

$\Rightarrow$ $\alpha = 0.33$

33. 00006.50

Sol. $pH = \frac{1}{2}(pK_w + pK_a - pK_b) = 6.5$

34. 00080.32

Sol. $\Delta H = \Delta E + \Delta n_g RT$

$\Rightarrow$ $82.8 = \Delta U + \frac{1 \times 8.314 \times 298}{1000}$

$\Rightarrow$ $\Delta U = 80.32$

35. 01129.05

Sol. $\Delta_r G° = \Delta_r H° - T \times \Delta_r S°$

$\Delta_r S° = 2 \times 81 - 4 \times 24 - 3 \times 205$ J/mol

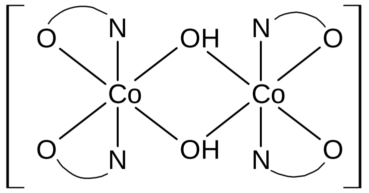
$\therefore$ $\Delta_r H° = -2258.1$ kJ/mol

$\Delta_r H° = 2 \times \Delta_f H° (Cr_2O_3, s)$

$\therefore$ $\Delta_f H°(Cr_2O_3, s) = -\frac{2258.1}{2} = -1129.05$ kJ / mol

36. 00004.00

Sol.



$\left(Gly^{-1} = NH_2 - CH_2 - COO^-\right)$

$= (\ddot{N} - \bar{O})$

Mathematics

PART – III

SECTION – A

37. ABCD

Sol. Let $z_1 = \cos\theta + i\sin\theta$ and $z_2 = \cos\phi + i\sin\phi$

$a = \cos\theta, b = \sin\theta$

$c = \cos\phi,\ d = \sin\phi$

$z_1\bar{z}_2 = \cos(\theta-\phi) + i\sin(\theta-\phi)$

$\text{Re}(z_1\bar{z}_2) = 0 \Rightarrow \cos(\theta-\phi) = 0$

$\Rightarrow \quad \theta - \phi = \frac{\pi}{2}$

$\therefore \quad z_1 = -\sin\phi + i\cos\phi$

$\Rightarrow \quad a = -\sin\phi = -d,$

$b = \cos\phi = c$

Now, $w_1 = a + ic = -\sin\phi + i\cos\phi$

$w_2 = b + id = \cos\phi + i\sin\phi$

$|w_1| = |w_2| = 1 \Rightarrow |w_1w_2| = 1$

Also, $\text{Re}(\bar{w}_1 w_2) = 0$

38. ABCD

Sol. $\alpha + \beta + \gamma + \delta = p$ and $\alpha\beta\gamma\delta = s$

By using $A.M \geq G.M.$ inequality

$\therefore \frac{p}{4} \geq \sqrt[4]{s}$

$\therefore\ p^4 \geq 256s$

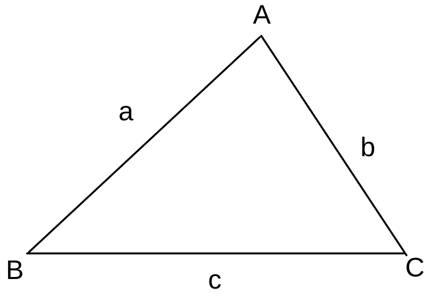
Similarly we can evaluate other options by same inequality

39. BC

Sol. $\cos B + \cos C = 4\sin^2\left(\frac{A}{2}\right)$

$\Rightarrow \quad 2\cos\frac{B+C}{2}\cos\frac{B-C}{2} = 4\sin^2\frac{A}{2}$

$\Rightarrow \quad 2\cos\left(\frac{\pi}{2} - \frac{A}{2}\right)\cos\frac{B-C}{2} = 4\sin\frac{A}{2}\sin\left(\frac{\pi}{2} - \frac{B+C}{2}\right)$



$$\Rightarrow \quad \frac{\cos\frac{B-C}{2}}{\cos\frac{B+C}{2}} = 2 \quad \Rightarrow \quad \frac{\cos\frac{B}{2}\cos\frac{C}{2} + \sin\frac{B}{2}\sin\frac{C}{2}}{\cos\frac{B}{2}\cos\frac{C}{2} - \sin\frac{B}{2}\sin\frac{C}{2}} = 2$$

$$\Rightarrow \quad \tan\frac{B}{2}\tan\frac{C}{2} = \frac{1}{3} \quad \Rightarrow \quad \frac{\Delta}{s(s-b)}\frac{\Delta}{s(s-c)} = \frac{1}{3}$$

$$\Rightarrow \quad 3s(s-a)(s-b)(s-c) = s^2(s-b)(s-c)$$

$$\Rightarrow \quad 3(s-a) = s \Rightarrow 2s = 3a$$

$$\Rightarrow \quad a+b+c = 3a \qquad \Rightarrow b+c = 2a$$

$$\Rightarrow \quad AB + AC = 2a$$

Also $AB + AC > BC = a$

So locus of A is an ellipse with foci at B and C and the length of the major major axis in 2a.

40. AC

Sol. The function f is no differentiable at x = 0, $x = \frac{\pi}{2}$ as

$$f'(0-) = -10,\ f'(0+) = 1;\ f'\left(\frac{\pi}{2}-\right) = 1,\ f'\left(\frac{\pi}{2}+\right) = -1$$

The function $f'(x)$ is given by $f'(x) = \begin{cases} 3x^2+2x-10 & -1 \le x < 0 \\ \cos x & 0 < x < \frac{\pi}{2} \\ -\sin x & \frac{\pi}{2} < x \le \pi \end{cases}$

The critical points of f are given by $f'(x) = 0$ or $x = 0, \frac{\pi}{2}$, Thus critical points are $x = \frac{\pi}{2}$, x = 0. Since $f'(x) > 0$, for $0 < x < \frac{\pi}{2}$ and $f'(x) < 0$, for $\frac{\pi}{2} < x < \pi$ so f has local maxima at $x = \frac{\pi}{2}$. Also $f'(x) < 0$ for $-1 \le x < 0$ and $f'(x) > 0$ for $0 < x < \frac{\pi}{2}$ so f has local minima at x = 0. Since $f(-1) = -9$, $f\left(\frac{\pi}{2}\right) = 1$, $f(0) = 0$ and $f(\pi) = 0$. Thus f has absolute minimum at $x = -1$ and absolute maximum at x = 0.

41. ABC

Sol. $I_n = \int\limits_{-\pi}^{\pi} \frac{\sin nx}{(1+\pi^x)\sin x}dx$

$$= \int\limits_0^{\pi}\left(\frac{\sin nx}{(1+\pi^x)\sin x} + \frac{\pi^x \sin nx}{(1+\pi^x)\sin x}\right)dx = \int\limits_0^{\pi}\frac{\sin nx}{\sin x}dx$$

Now, $I_{n+2} - I_n = \int\limits_0^{\pi}\frac{\sin(n+2)x - \sin nx}{\sin x}dx$

$$=\int_0^{\pi}\frac{2\cos(n+1)x.\sin x}{\sin x}dx=0$$

$$\Rightarrow I_1=\pi,\ I_2=\int_0^{\pi}2\cos x\,dx=0$$

42. AD

Sol. $f(x)=\int_0^x(1+|1-t|)dt,\ x>2$

$$=\int_0^1(2-t)dt+\int_1^x t\,dt=\frac{1}{2}x^2+1$$

We have, $f(x)=\begin{cases}\frac{1}{2}x^2+1, & x>2\\ 5x+1, & x\le 2\end{cases}$

$\therefore \lim\limits_{x\to 2^+}f(x)=3$ and $\lim\limits_{x\to 2^-}f(x)=11$

Hence, f(x) is not continuous at x = 2.

$$Rf'(2)=\lim_{h\to 0}\frac{f(2+h)-f(2)}{h}$$

$$=\lim_{h\to 0}\frac{\frac{1}{2}(2+h)^2+1-11}{h}$$

$$=\lim_{h\to 0}\frac{(2+h)^2-20}{2h}\to\pm\infty$$

43. A

Sol. (P) $a_1=\int_0^{\pi/2}dx=\frac{\pi}{2},\ a_2=\pi$

Also, $a_{n+2}+a_n-2a_{n+1}$

$$=\int_0^{\pi/2}\frac{2\cos(2n+2)x-\cos(2n+4)x-\cos(2nx)}{1-\cos 2x}dx$$

$$=\int_0^{\pi/2}\frac{2\cos(2n+2)x-2\cos(2n+2)x\cos 2x}{1-\cos 2x}dx\ =\int_0^{\pi/2}2\cos(2n+2)x\,dx$$

$$=\frac{2}{2n+2}\left(\sin(2n+2)x\right)_0^{\pi/2}=0$$

$\therefore\ a_1, a_2, a_3, \ldots.$ are in A.P.

(Q) $I_{n+1}+I_{n+3}$

$$=\int_0^{\pi/4}\tan^{n+1}x\sec^2 x\,dx$$

$$=\frac{1}{n+2}\tan^{n+2}x\Big]_0^{\pi/4}=\frac{1}{n+2}$$

$\therefore a_n=n+2$

$\Rightarrow a_1, a_2, \ldots..$ are in A.P.

(R) $I_n - I_{n-1} = \int_0^{\pi/2} \frac{\sin^2(nx) - \sin^2(n-1)x}{\sin x} dx$

$= \int_0^{\pi/2} \frac{\sin(2n-1)x \sin x}{\sin x} dx$

$= -\frac{1}{2n-1}\cos(2n-1)x\Big]_0^{\pi/2} = \frac{1}{2n-1}$

$\Rightarrow a_1, a_2, a_3, ...$ are in H.P.

(S) $b_n = \int_0^{\pi/2} \frac{1-\cos 2nx}{1-\cos 2x} dx = \frac{n\pi}{2}$ (see (a))

$a_n = \frac{\pi}{2} \forall n$

$\therefore$ $a_1, a_2, a_3, ...$ are in A.P., G.P. and H.P.

Also $a_1, a_2, a_3, ...$ is a constant sequence.

44. C

Sol. Let $A = \{a_1, a_2, ...a_n\}$. For each $a_i \in A$, we have following four choices

(1) $a_i \in P$, $a_i \in Q$

(2) $a_i \in P$, $a_i \notin Q$

(3) $a_i \notin P$, $a_i \in Q$

(4) $a_i \notin P$, $a_i \notin Q$

For $P \cup Q = A$ or $P \cap Q = \varphi$ the number of choice is 3^n. The singleton can be chose in ${}^nC_1$ ways, rest of the elements in 3^{n-1} ways. $P \cup Q = \varphi$ in just one way.

45. A

Sol. (P) $z = e^{i\theta}$

$= \text{Re}\left(\frac{2ie^{i\theta}}{1-e^{i2\theta}}\right)$

$= \text{Re}\left(\frac{2ie^{i\theta}}{2\sin^2\theta - i2\sin\theta\cos\theta}\right) = \text{Re}\left(-\frac{1}{\sin\theta}\right) = (-\infty, -1] \cup [1, \infty)$

(Q) $3^x = t$

$-1 \le \frac{8t}{9-t^2} \le 1$

$0 \le \frac{t^2 - 8t - 9}{t^2 - 9}$

$t < 3 \cup 9 \le t$

$x < 1 \cup 2 \le x$ ……..(i)

where $\frac{8t}{9-t^2} \le 1$

$\frac{(t+9)(t-1)}{(3-t)(3+t)} \le 0$

$t \le 1 \cup 3 < t$

$x \le 0 \cup 1 < x$ …….(ii)

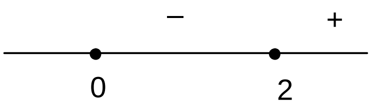
from (i) and (ii)

$x \le 0 \cup 2 \le x$

(R) $f(\theta) = 2\sec^2\theta \ge 2$

(S) $f'(x) = x^{3/2} \times 3 + (3x - 10)\dfrac{3}{2}x^{1/2}$

$= 3\sqrt{x}\left(x + \dfrac{3x-10}{2}\right)$



$x \ge 2$

46. A

Sol. a, b, c are three roots of the quadratic equation

$\left((4f(-1) - 3)x^2 + (4f(1) - 3)\right)x + f(2) = 0$

$\Rightarrow 4f(-1) = 3, 4f(1) = 3$ and $f(2) = 0$

Let $f(x) = (x-2)(Ax + B)$

Now, $3 = 4f(-1) = 4(-3)(-A + B) \Rightarrow A - B = \dfrac{1}{4}$

$3 = 4f(-1) = 4(-1)(A + B) \Rightarrow A + B = \dfrac{-3}{4}$

$\therefore\ A = \dfrac{-1}{4}, B = \dfrac{-2}{4}$

Thus, $f(x) = \dfrac{1}{4}(4 - x^2)$.

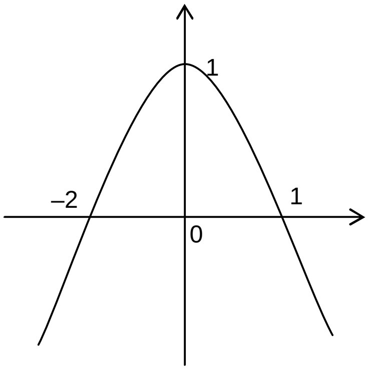
The graph of $y = f(x)$ is given in Figure.

(A) x coordinates of points of intersection of $y = f(x)$ when the x – axis are ± 2.

(B) Area $= \dfrac{3}{2}\displaystyle\int_{-2}^{2}\dfrac{1}{4}(4 - x^2)dx = \dfrac{3}{8}(2)\left(4x - \dfrac{x^2}{3}\right)\Bigg]_0^2 = 4$

(C) Maximum value of f(x) is 1

(D) Length of intercept on the x – axis is 4.



SECTION – D

47. 67676.00

Sol. $x_{51} = x_{50} + 51^2$

$= \frac{1}{2}(50)(51)^2 + 51^2 = 67626$

48. 00240.00

Sol. We must have $x \geq 1$ and $y \geq 2$, since x is less than y. That is, y = j with $2 \leq j \leq 9$, then x can take the j – 1 values from 1 to j – 1, and z can take the j values from 0 to j – 1. For each value y = j, therefore, xyz can take j (j – 1) values. We can now get the answer by summing over all values of y:

$$\sum_{j=2}^{9} j(j-1) = \sum_{j=1}^{9} j(j-1) = \sum_{j=1}^{9} j^2 - \sum_{j=1}^{9} j$$

$= 285 - 45 = 240$

49. 01300.00

Sol. $b = \sum_{r=1}^{50} a_r$

But $a_r = r^2 \frac{(50-r+1)}{r} = \sum r(51-r)$

50. 00004.00

Sol. $\cos\beta = \frac{a^2 + 16 - 8}{2 \times a \times 4}$

$\Rightarrow a^2 - 4\sqrt{3}a + 8 = 0$

$\Rightarrow a_1 + a_2 = 4\sqrt{3},\ a_1 a_2 = 8$

$\Rightarrow |a_1 - a_2| = 4$

$\Rightarrow |\Delta_1 - \Delta_2| = \frac{1}{2} \times 4 \sin 30^o \times 4 = 4$

51. 01225.00

Sol. $\cos A = \frac{b^2 + c^2 - a^2}{2bc}$

$\Rightarrow \quad \frac{1}{2} = \cos\frac{\pi}{3} = \frac{b^2 + c^2 - a^2}{2bc}$

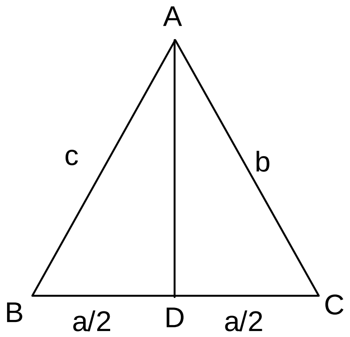
$\Rightarrow \quad b^2 + c^2 - a^2 = bc \qquad (1)$

In triangle ABD.

$AD^2 = c^2 + \frac{a^2}{4} - 2c \times \frac{a}{2}\cos B$

$\Rightarrow \quad 4AD^2 = 4c^2 + a^2 - 4ca\frac{(c^2 + a^2 - b^2)}{2ca}$

$= 2c^2 + 2b^2 - a^2$



$$= 2c^2 + 2b^2 - \left(b^2 + c^2 - bc\right) \text{ [Using (1)]}$$
$$= b^2 + c^2 + bc$$
$$= 2500 + 900 + 1500 = 4900 \Rightarrow \ AD^2 = 1225$$

52. 00002.00

Sol. Let the coordinate of A, B, C be $\left(t_i^2,\ 2t_i\right)$

$i = 1, 2, 3$ respectively. The tangent at A and B are $t_1 y = x + t_1^2$ and $t_2 y = x + t_2^2$ which intersect at $x = t_1 t_2, y = t_1 + t_2$

So the vertices are $P\left(t_1t_2, t_1 + t_2\right)$, $Q\left(t_2t_3,\ t_2 + t_3\right)$ and $R\left(t_1t_3,\ t_1 + t_3\right)$

$$\Delta = \left|\left(t_1 - t_2\right)\left(t_2 - t_3\right)\left(t_3 - t_1\right)\right|$$

$$\Delta' = \left|\frac{1}{2}\begin{vmatrix} t_1t_2 & t_1 + t_2 & 1 \\ t_2t_3 & t_2 + t_3 & 1 \\ t_3\,t_1 & t_3 + t_1 & 1 \end{vmatrix}\right|$$

$$= \left|\frac{1}{2}\begin{vmatrix} \left(t_1 - t_3\right)t_2 & t_1 - t_3 & 0 \\ \left(t_2 - t_1\right)t_3 & t_2 - t_1 & 0 \\ t_3\,t_1 & t_3 + t_1 & 1 \end{vmatrix}\right|$$

$$= \left|\frac{1}{2}\left(t_1 - t_3\right)\left(t_2 - t_1\right)\left(t_2 - t_3\right)\right| \Rightarrow \Delta = 2\Delta'$$

53. 07225.00

Sol. Any point on the line is $r = \left(2\lambda + 1\right)i + \left(\lambda + 2\right)j + \left(2\lambda + 3\right)k$ which lies on the plane if $2\left(2\lambda + 1\right) - 6\left(\lambda + 2\right) + 3\left(2\lambda + 3\right) + 5 = 0 \Rightarrow \lambda = -1$ and the position vector of the point of intersection is $-i + j + k = ai + bj + ck$ $a = -1,\ b = 1,\ c = 1$

$$\therefore \left(50a + 60b + 75c\right)^2 = \left(85\right)^2 = 7225$$

54. 00009.00

Sol. $\lim\limits_{x \to 0^-} f\left(x\right) = \lim\limits_{h \to 0} f\left(0 - h\right)$

$$= \lim_{h \to 0} \frac{\sin^{-1}\left(1 - \left\{0 - h\right\}\right).\cos^{-1}\left(1 - \left\{0 - h\right\}\right)}{\sqrt{2\left\{0 - h\right\}}.\left(1 - \left\{0 - h\right\}\right)}$$

$$= \lim_{h \to 0} \frac{\sin^{-1}\left(1 - \left(1 - h\right)\right).\cos^{-1}\left(1 - \left(1 - h\right)\right)}{\sqrt{2\left(1 - h\right)}.\left(1 - \left(1 - h\right)\right)}$$

$$= \lim_{h \to 0} \frac{\sin^{-1}h.\cos^{-1}h}{\sqrt{2\left(1 - h\right)}.h} = \frac{\pi}{2\sqrt{2}}$$

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – I

JEE (Main)-2019

Time Allotted: 3 Hours **Maximum Marks: 360**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only one section: **Section-A**.

Section-A (01 – 30, 31 – 60, 61 – 90) *contains 90 multiple choice questions which have **only one correct answer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.*

Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A boat which has a speed of 6 km/h in still water crosses a river of width 1 km along the shortest possible path in 20 min. The velocity of the river water in km/h is
(A) 1
(B) 3
(C) 4
(D) $3\sqrt{3}$

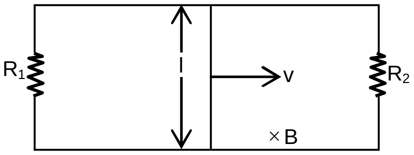
2. A mirror (μ = 3/2) is 10 cm thick. An object is placed 15 cm in front of it. The position of image from the front surface is
(A) 15 cm
(B) 21.67 cm
(C) 28.34 cm
(D) 35 cm

3. A thin prism P_1 with angle 4^o and made from glass (μ = 1.54) is combined with another prism P_2 made of another glass of μ = 1.72 to produce dispersion without deviation. The angle of prism P_2 is
(A) 53.3^o
(B) 4^o
(C) 3^o
(D) 2.6^o

4. A particle starts its motion from rest and moves with constant acceleration for time t_1 and then it retards with constant rate for time t_2 until it comes to rest. Then the ratio of maximum speed and average speed during the complete motion will be
(A) 2 : 1
(B) 1 : 2
(C) $t_1 : t_2$
(D) $t_2 : t_1$

Space for Rough work

5. A rectangular loop with a slide wire of length l is kept in a uniform magnetic field as shown in figure. The resistance of slider is R. neglecting self inductance of the loop find the current in the connector during its motion with a velocity v.



(A) $\frac{Blv}{R_1 + R_2 + R}$ (B) $\frac{Blv(R_1 + R_2)}{R + (R_1 + R_2)}$

(C) $\frac{Blv(R_1 + R_2)}{RR_1 + RR_2 + R_1R_2}$ (D) $Blv\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$

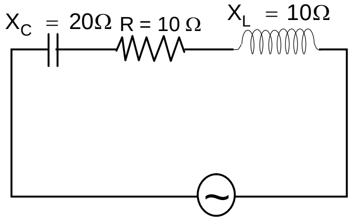
6. A uniform solid brass sphere is rotating with angular speed ω_0 about a diameter. If its temperature is now increased by 100^0C. What will be its new angular speed (Given $\alpha_{brass} = 2.0 \times 10^{-5} per^0C$)

(A) 1.1 ω_0 (B) 1.01 ω_0

(C) 0.996 ω_0 (D) 0.824 ω_0

7. When a positively charged conductor is connected to earth,
(A) electrons flow from the earth to the conductor
(B) protons flow from the conductor to the earth
(C) electrons flow from the conductor to the earth
(D) any of A or C may happen

8. In LCR circuit shown in figure, then choose incorrect option
(A) Current will lead the voltage
(B) rms value of current is 20 A
(C) Power factor of the circuit is $\frac{1}{\sqrt{2}}$
(D) Voltage drop across resistance = voltage drop across inductor



Space for Rough work

9. A charged particle of unit mass and unit charge moves with velocity of $\vec{v} = \left(8\hat{i} + 6\hat{j}\right) m/s$ in a magnetic field of $\vec{B} = 2\hat{k}T$. Choose the correct alternative

(A) The path of the particle may be $x^2 + y^2 - 4x - 21 = 0$

(B) The path of the particle may be $x^2 + y^2 - 4x - 5 = 0$

(C) The path of the particle may be $x^2 + y^2 + 2x - 8 = 0$

(D) The path of the particle may be $x^2 + y^2 - 2x - 15 = 0$

10. Three charge +q, +q and –q are situated in x-y plane at the point (0 , a) (0 , 0) (0 , –a). Then, the electric potential at a point in first quadrant whose position vector makes an angle θ with y axis and at a distance r(r>>a) from the origin is

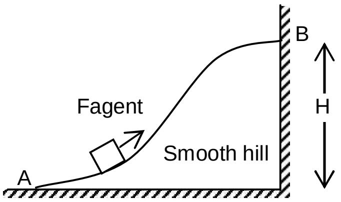
(A) $\frac{qa\cos\theta}{2\pi \in_0 r^2}$

(B) $\frac{q}{4\pi \in_0 r}\left(1 + \frac{2a\cos\theta}{r}\right)$

(C) $\frac{q}{4\pi \in_0 r}$

(D) $\frac{q}{4\pi \in_0 r}\left(1 - \frac{2a\cos\theta}{r}\right)$

11. A external agent moves the block m slowly from A to B, along a smooth hill such that every time he applies the force tangentially. Find the work done by agent in this interval.



(A) $\frac{m^2g^2H^2}{L}$

(B) $\frac{mgH^2}{L}$

(C) mg(H+L)

(D) mgH

12. A tank has a hole made at its bottom. The time needed to empty the tank from level h_1 to h_2 will be proportional to

(A) $h_1 + h_2$

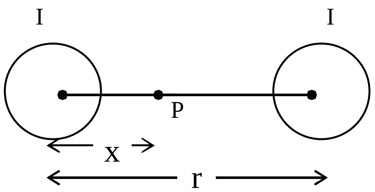
(B) $\sqrt{h_1} + \sqrt{h_2}$

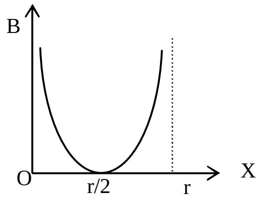
(C) $h_1 - h_2$

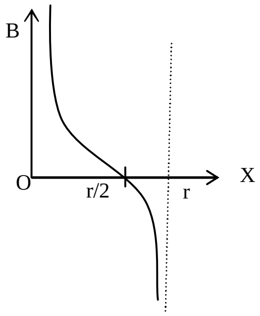
(D) $\sqrt{h_1} - \sqrt{h_2}$

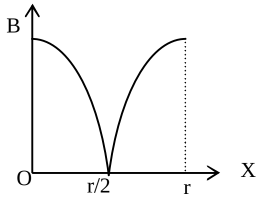
Space for Rough work

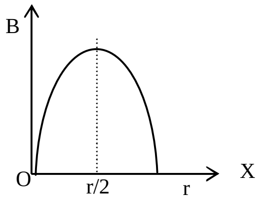
13. Two thin long straight wires are parallel to each other at a separation r apart and they carry current I each along the same directions as shown then induction of magnetic field B, between the wires, varies with x according to



(A)


(B)


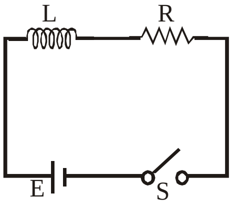
(C)


(D)


14. One half mole of a monoatomic ideal gas absorbs 1200 J of heat energy while performing 2196 J of work. The temperature of the gas changes by

(A) 160^0C
(B) 80^0C
(C) 40^0C
(D) -160^0C

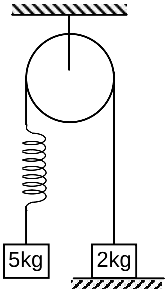
15. In the LR circuit as shown in figure, the switch is closed at t = 0. Mark the incorrect statement of the following:



(A)The current increases with time
(B)The current increases with a decreasing rate
(C)The voltage drop across the inductor increases
(D)The voltage drop across the resistor increases

Space for Rough work

16. System shown in figure is released from rest pulley and spring is massless and friction is absent everywhere. The speed of 5 kg block when 2 kg block leaves the contact with ground is (K = 40 N/m & g = 10 m/s^2)

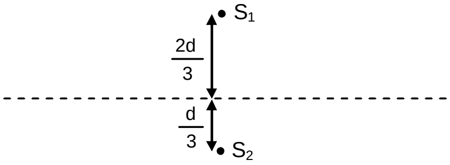


(A) $\sqrt{2}$ m / s
(B) $2\sqrt{2}$ m / s
(C) 2 m/s
(D) $4\sqrt{2}$ m / s

17. There is a 90^0 bend in a pipe line in which water is flowing at speed v. The cross sectional area of pipe is A. The force exerted by pipe walls on water at bend is
(A) $\sqrt{3}\, A v^2\rho$
(B) $\sqrt{2}\, Av^2\rho$
(C) $Av^2\rho$
(D) $\sqrt{5}\, Av\rho$

18. A uniform solid hemisphere of radius r is joined to uniform solid right circular cone of base of radius r. Both have same density. The centre of mass of the composite solid lies on the common face. The height (h) of the cone is
(A) 2r
(B) $\sqrt{3}\, r$
(C) 3r
(D) $r\sqrt{6}$

19. Two coherent point sources of frequency $\left(f = \frac{10v}{d}\right.$ where v is speed of light) are placed at a distance d apart as shown in figure. The receiver is free to move along the dotted line shown in the figure. Find total number of maxima observed by receiver.



(A) 6
(B) 7
(C) 5
(D) 8

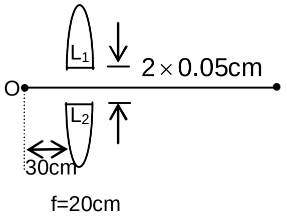
Space for Rough work

20. A hydrogen atom and a Li^{++} ions are both in the second excited state. If ℓ_H and ℓ_{Li} are their respective electronic angular momenta, and E_H and E_{Li} their respective energies, then

(A) $\ell_H > \ell_{Li}$ and $|E_H| > |E_{Li}|$ (B) $\ell_H = \ell_{Li}$ and $|E_H| < |E_{Li}|$

(C) $\ell_H = \ell_{Li}$ and $|E_H| > |E_{Li}|$ (D) $\ell_H < \ell_{Li}$ and $|E_H| < |E_{Li}|$

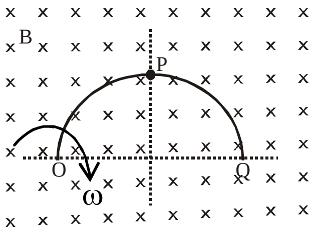
21. A point object O is placed at a distance of 0.3 m from a convex lens (focal length 0.2 m) cut into two halves each of which is displaced by 0.0005 m as shown in figure. Find the distance between the images (in mm)



(A) 1 (B) 2

(C) 3 (D) 4

22. The figure shows a semi-circular conducting ring of radius a, which is rotated with constant angular velocity ω about an axis passing through O and parallel to field B as shown. Identify the correct value of potential difference



(A) $V_P - V_Q = \frac{1}{2}B\omega a^2$

(B) $V_Q - V_O = 2B\omega a^2$

(C) $V_P - V_O = \frac{1}{4}B\omega a^2$

(D) The maximum value of $|V_P - V_O| = \frac{\pi a^2 \omega B}{2}$

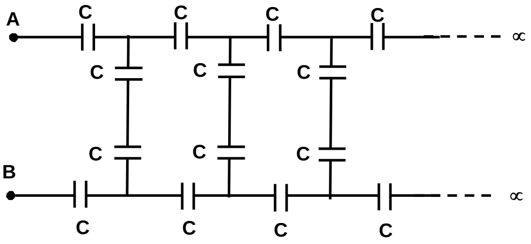
23. A train of mass M is moving on a circular track of radius R with constant speed v. The length of train is half the perimeter of track. The linear momentum of the train will be

(A) 0 (B) $2Mv/\pi$

(C) MvR (D) Mv

Space for Rough work

24. The equivalent capacitance of the shown infinite network across A and B, if each capacitor has a capacitance of C, is



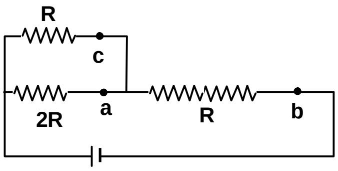
(A) $\left(\frac{\sqrt{3}-1}{4}\right)C$

(B) $\left(\frac{\sqrt{3}+1}{4}\right)C$

(C) $\left(\frac{\sqrt{5}-1}{4}\right)C$

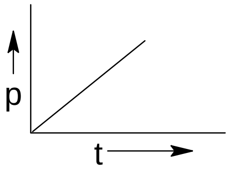
(D) None of these

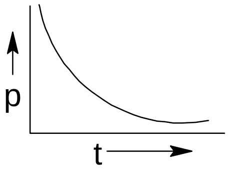
25. Referring to the shown circuit, the current will be minimum in

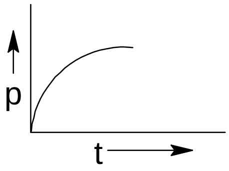


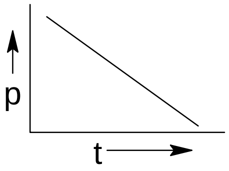
(A) a
(B) b
(C) c
(D) same in all the branches

26. A soap bubble is blown slowly at the end of a tube by a pump supplying air at a constant rate. Which one of the following graphs represents the correct variation of the excess of pressure inside the bubble with time?

(A)


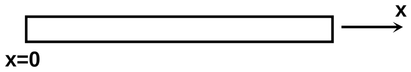
(B)


(C)


(D)


Space for Rough work

27. If along a uniform rod of length ℓ carrying current I, the voltage V changes with position x along the length of the rod such that dV/dx = – k, where k is a positive number, then the resistance of the rod is

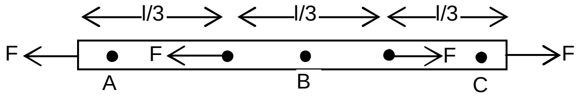


(A) $k\ell/2I$ (B) $k\ell/I$
(C) $I/k\ell$ (D) $k\ell I$

28. A cylindrical hall has a horizontal smooth floor. A ball is projected along the floor from A point on the wall in a direction making an angle θ with the radius through the point the ball returns back to the initial point after two impacts with the wall. If the coefficient of restitution is e then $\tan^2\theta$ will be

(A) $\frac{1+e+e^2}{e^3}$ (B) $\frac{1+e}{e^2}$
(C) $\frac{e^2}{1+e}$ (D) $\frac{e^3}{1+e+e^2}$

29. Four persons are holding a rope of length ℓ at position as shown in figure. All of them are applying equal force F in the direction as shown in figure. Then the tension



Statement 1 – at point A will be F
Statement 2 – at point B will be 2F
Statement 3 – at point C will be F

(A) only statement 1 & 2 is true (B) only statement 2 is true
(C) all the three statements are true (D) none of the statements are true

30. The mass of a body is measured as 10.1 kg. The possible percentage error in the measurement is

(A) ± 1% (B) ± 0.1%
(C) ± 10% (D) ± 0.01%

Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. Among the following oxoacids, the correct decreasing order of acid strength is:
(A) $HClO_4 > HClO_3 > HClO_2 > HOCl$ (B) $HClO_2 > HClO_4 > HClO_3 > HOCl$
(C) $HOCl > HClO_2 > HClO_3 > HClO_4$ (D) $HClO_4 > HOCl > HClO_2 > HClO_3$

32. In which of the following species $p\pi$-$d\pi$ bond is present but $p\pi$-$p\pi$ bond is absent?
(A) SiH_4 (B) CS_2
(C) SO_2 (D) SO_2Cl_2

33. Nodal plane of all the π-bonds is in same plane:
(A) C_6H_6 (B) CO_2
(C) $H_2C = C = CH_2$ (D) N_2

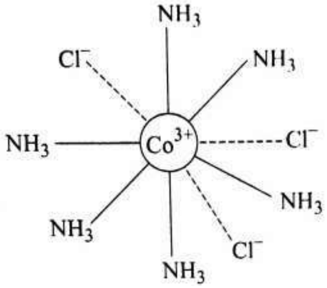
34. In which of the following pairs both are monobasic, proton donor acid when dissolve in water?
(A) H_3PO_2, H_3PO_3 (B) H_3BO_3, H_3PO_2
(C) $HClO_3$, H_3BO_3 (D) H_3PO_2, $HClO_4$

35. Which of the following paramagnetic complex of metal in its +2 oxidation state shows geometrical isomerism?
(A) $\left[Ni(en)_3\right]Cl_2$ (B) $\left[Co(H_2O)_5NO_2\right]Cl$
(C) $\left[Pt(NH_3)_2Cl_2\right]$ (D) $\left[Co(NH_3)_4(H_2O)_2\right]Cl_2$

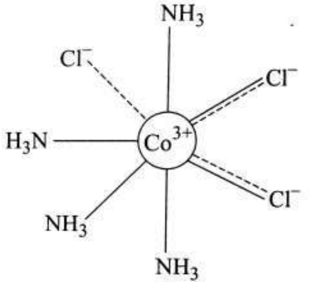
Space for Rough work

36. Which of the following complexes (Werner presentation) have minimum electrical conductance in aqueous solution?

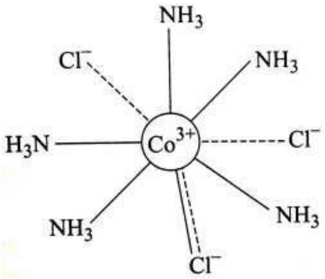
(A)


NH₃
Cl⁻
NH₃
NH₃
Co³⁺
Cl⁻
NH₃
NH₃
Cl⁻
NH₃

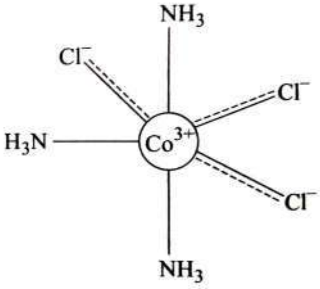
(B)


NH₃
Cl⁻
Cl⁻
H₃N
Co³⁺
Cl⁻
NH₃
NH₃

(C)


NH₃
Cl⁻
NH₃
H₃N
Co³⁺
Cl⁻
NH₃
NH₃
Cl⁻

(D)


NH₃
Cl⁻
Cl⁻
H₃N
Co³⁺
Cl⁻
NH₃

37. Sulphide ores are common for the metals:
(A) Ag, Cu and Pb
(B) Ag, Cu and Sn
(C) Ag, Mg and Pb
(D) Al, Cu and Pb

38. Which of the following bicarbonates does not exist in solid state?
(A) $LiHCO_3$
(B) $NaHCO_3$
(C) $KHCO_3$
(D) $RbHCO_3$

39. Which of the following does not give gaseous product on treatment with concentrated HNO_3?
(A) $BaCO_3$
(B) $NaNO_2$
(C) $Ca_3(PO_4)_2$
(D) $CaBr_2$

40. Hard water does not contain:
(A) Ca^{2+} with HCO_3^-
(B) Mg^{2+} with SO_4^{2-}
(C) Mg^{2+} with Cl^-
(D) Ca^{2+} with CO_3^{2-}

Space for Rough work

41. 100 mL of H_2SO_4 solution having molarity 1 M and density 1.5 g/mL is mixed with 400 mL of water. Calculate final molarity of H_2SO_4 solution, if final density is 1.25 g/mL:
(A) 4.4 M
(B) 0.145 M
(C) 0.52 M
(D) 0.227 M

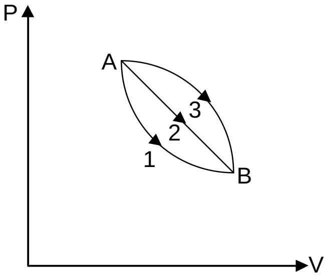
42. When $K_2Cr_2O_7$ is converted to K_2CrO_4, the change in the oxidation state of chromium is:
(A) 0
(B) 6
(C) 4
(D) 3

43. The mass of an electron is m, charge is e and it is accelerated from rest through a potential difference of V volts. The velocity acquired by electron will be:
(A) $\sqrt{\frac{V}{m}}$
(B) $\sqrt{\frac{eV}{m}}$
(C) $\sqrt{\frac{2eV}{m}}$
(D) zero

44. Wavelength for high energy EMR transition in H-atom is 91 nm. What energy is needed for this transition?
(A) 1.36 eV
(B) 1240 eV
(C) 13 eV
(D) 13.6 eV

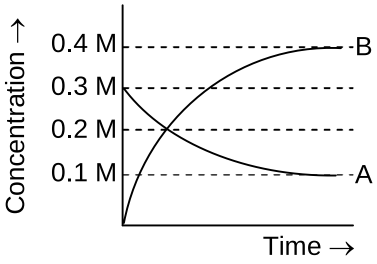
45. An ideal gaseous mixture of ethane (C_2H_6) and ethene (C_2H_4) occupies 28 litre at 1 atm and 273 K. the mixture reacts completely with 128 gm O_2 to produce CO_2 and H_2O. Mole fraction at C_2H_4 in the mixture is:
(A) 0.6
(B) 0.4
(C) 0.5
(D) 0.8

46. A given mass of gas expands reversibly from the state A to the state B by three paths 1, 2 and 3 as shown in the figure. If w_1, w_2 and w_3 respectively be the work done by the gas along three paths then:
(A) $w_1 > w_2 > w_3$
(B) $w_1 < w_2 < w_3$
(C) $w_1 = w_2 = w_3$
(D) $w_2 > w_3 > w_1$



Space for Rough work

47. The figure shows the change in concentration of species A and B as a function of time. The equilibrium constant K_c for the reaction $A(g) \rightleftharpoons 2B(g)$ is:



(A) $K_c > 1$
(B) $K < 1$
(C) $K = 1$
(D) data insufficient

48. What concentration of $HCOO^-$ is present in a solution of 0.01 M HCOOH ($K_a = 1.8 \times 10^{-4}$) and 0.01 M HCl?

(A) 1.8×10^{-3}
(B) 10^{-2}
(C) 1.8×10^{-4}
(D) 10^{-4}

49. In the following reaction, how is the rate of appearance of the underlined product related to the rate of disappearance of the underlined reactant

$$\underline{BrO_3^-(aq)} + 5Br^-(aq) + 6H^+(aq) \longrightarrow \underline{3Br_2(\ell)} + 3H_2O(aq)$$

(A) $-\frac{d[BrO_3^-]}{dt} = \frac{d[Br_2]}{dt}$

(B) $-\frac{1}{3}\frac{d[BrO_3^-]}{dt} = \frac{d[Br_2]}{dt}$

(C) $\frac{-d[BrO_3^-]}{dt} = \frac{1}{3}\frac{d[Br_2]}{dt}$

(D) None of these

50. The cell reaction $Hg_2Cl_2(s) + Cu(s) \longrightarrow Cu^{2+}(aq) + 2Cl^-(aq) + 2Hg(\ell)$, is best represented by:

(A) $Cu(s) | Cu^{2+}(aq) || Hg_2Cl_2(s) | Hg(\ell)$
(B) $Cu(s) | Cu^{2+}(aq) || Hg(\ell) | HgCl_2(s)$
(C) $Cu(s) | Cu^{2+}(aq) || Cl^-(aq) | Hg_2Cl_2(s) | Hg(\ell) | Pt(s)$
(D) $Hg_2Cl_2(s) | Cl^-(aq) || Cu^{2+}(aq) | Cu(s)$

Space for Rough work

51. The degree of dissociation of an electrolyte is α and its van't Hoff factor is i. The number of ions obtained by complete dissociation of 1 molecule of the electrolyte is:

(A) $\frac{i+\alpha-1}{\alpha}$ (B) $i-\alpha-1$

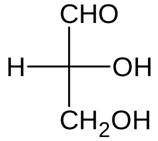
(C) $\frac{i-1}{\alpha}$ (D) $\frac{i+1+\alpha}{1-\alpha}$

52. The co-ordination number of a metal crystallising in a hexagonal close-packed structure is:

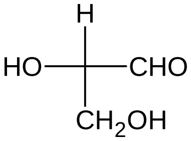
(A) 12 (B) 4

(C) 8 (D) 6

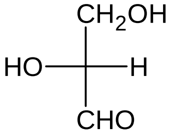
53. Which is the correct structure of D-glyceraldehyde?

(A)


$$\begin{array}{c} CHO \\ H - \!\!\!-\!\!\!+\!\!\!-\!\!\!- OH \\ CH_2OH \end{array}$$

(B)


$$\begin{array}{c} H \\ HO - \!\!\!-\!\!\!+\!\!\!-\!\!\!- CHO \\ CH_2OH \end{array}$$

(C)


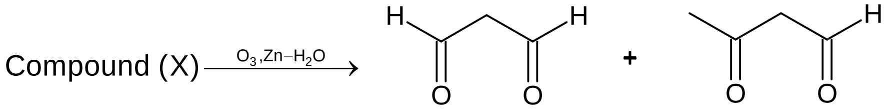
$$\begin{array}{c} CH_2OH \\ HO - \!\!\!-\!\!\!+\!\!\!-\!\!\!- H \\ CHO \end{array}$$

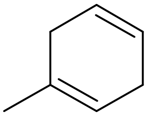
(D) All

54. Which alkene on oxidation with acidic $KMnO_4$ gives only acetic acid?

(A) $CH_3 = CH - CH_3$ (B) $CH_3 - CH = CH - CH_3$

(C) Ethylene (D) Pentene – 2

55.


(A)


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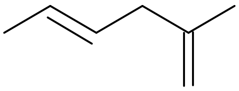
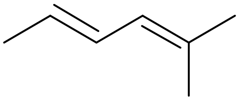
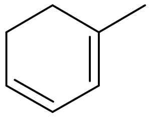
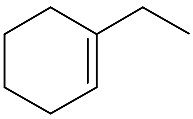


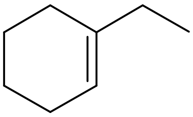
(C)


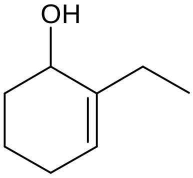
(D)


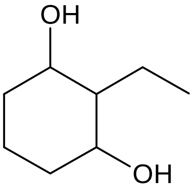
Space for Rough work

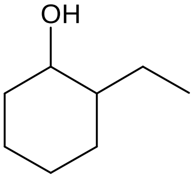
56. Vinylic halides are unreactive towards nucleophilic substitution because of the following except:
(A) C-halogen bond is strong
(B) The halogen is bonded to sp^2 carbon
(C) A double bond character is developed in the carbon-halogen bond by resonance
(D) Halide ions are not good leaving groups

57.  $\xrightarrow{SeO_2}$ A, A is:

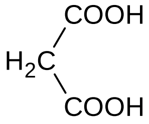
(A) 

(B) 

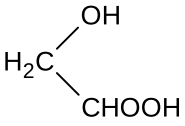
(C) 

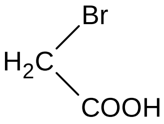
(D) 

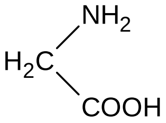
58. Which will give silver mirror test with Tollen's reagent?
(A) C_6H_5CHO
(B) $CH_3 – CHO$
(C) HCOOH
(D) All of these

59. In the reaction A $\xrightarrow{KCN}$ B $\xrightarrow[\text{reflux}]{H_3O^{\oplus}}$  $H_2C(COOH)_2$

Identify A:

(A)  $H_2C(OH)(CHOOH)$

(B)  $H_2C(Br)(COOH)$

(C)  $H_2C(NH_2)(COOH)$

(D) All of these

60. PhCOOH and Ph – CH_3 can be separated by:
(A) $NaHCO_3$
(B) aq. $NaHCO_3$ + n-Hexane
(C) H_2O
(D) n-Hexane

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. Let $f(x) = [9^x - 3^x + 1] \forall x \in (-\infty, 1)$, then range of f(x) is ([·] denotes the greatest integer function)
(A) {0, 1, 2, 3, 4, 5, 6} (B) {0, 1, 2, 3, 4, 5, 6, 7}
(C) {1, 2, 3, 4, 5, 6} (D) {1, 2, 3, 4, 5, 6, 7}

62. If α and β are the roots of the equation $ax^2 + bx + c = 0$ such that $\beta < \alpha < 0$, then the quadratic equation whose roots are $|\alpha|, |\beta|$ is given by :
(A) $|a|x^2 + |b|x + |c| = 0$ (B) $ax^2 - b|x| + c = 0$
(C) $|a|x^2 - |b|x + |c| = 0$ (D) $a|x|^2 + b|x| + c = 0$

63. if $\alpha_0, \alpha_1, \alpha_2, \ldots, \alpha_{n-1}$, be the n, n^th^ roots of the unity, then the value of $\sum_{i=0}^{n-1} \frac{\alpha_i}{(3-\alpha_i)}$ is equal to :
(A) $\frac{n}{3^n - 1}$ (B) $\frac{n-1}{3^n - 1}$
(C) $\frac{n+1}{3^n - 1}$ (D) $\frac{n+2}{3^n - 1}$

64. If the ratio of A.M. between two positive real numbers a and b to their H.M. is m : n; then a : b is equal to :
(A) $\frac{\sqrt{(m-n)} + \sqrt{n}}{\sqrt{(m-n)} - \sqrt{n}}$ (B) $\frac{\sqrt{n} + \sqrt{(m-n)}}{\sqrt{n} - \sqrt{(m-n)}}$
(C) $\frac{\sqrt{m} + \sqrt{(m-n)}}{\sqrt{m} - \sqrt{(m-n)}}$ (D) $\frac{\sqrt{(m-n)} + \sqrt{m}}{\sqrt{(m-n)} - \sqrt{m}}$

Space for Rough work

65. Given that $(1+\sqrt{(1+x)}\tan y = 1+(\sqrt{1-x})$, then sin 4y is equal to:

(A) 4x
(B) 2x
(C) x
(D) none of these

66. Number of solutions of the equations $y = \frac{1}{3}[\sin x + [\sin x + [\sin x]]]$ and $[y + [y]] = 2\cos x,$ where $[\cdot]$ denotes the greatest integer function is :

(A) 0
(B) 1
(C) 2
(D) infinite

67. Let f(x + y) = f(x) · f(y) for all x and y and f(1) = 2. If in a triangle ABC, a = f(3), b = f(1) + f(3), c = f(2) + f(3) , then 2A is equal to :

(A) C
(B) 2C
(C) 3C
(D) 5C

68. If $-\frac{\pi}{2} \le x \le \frac{\pi}{2},$ then the two curves y = cos x and y = sin 3x intersect at

(A) $\left(\frac{\pi}{4},\frac{1}{\sqrt{2}}\right)$ and $\left(\frac{\pi}{8},\cos\frac{\pi}{8}\right)$
(B) $\left(-\frac{\pi}{4},\frac{1}{\sqrt{2}}\right)$ and $\left(-\frac{\pi}{8},\cos\frac{\pi}{8}\right)$
(C) $\left(\frac{\pi}{4},-\frac{1}{\sqrt{2}}\right)$ and $\left(\frac{\pi}{8},-\cos\frac{\pi}{8}\right)$
(D) $\left(-\frac{\pi}{4},\frac{1}{\sqrt{2}}\right)$

69. The number of ways in which 9 identical balls can be placed in three identical boxes is :

(A) 55
(B) $\frac{9!}{(3!)^4}$
(C) $\frac{9!}{(3!)^3}$
(D) 12

Space for Rough work

70. If C_r stands for ${}^nC_r$, then the coefficient of $\lambda^n\mu^n$ in the expansion of $[(1+\lambda)(1+\mu)(\lambda+\mu)]^n$ is :

(A) $\sum_{r=0}^{n} C_r^2$ (B) $\sum_{r=0}^{n} C_{r+2}^2$

(C) $\sum_{r=0}^{n} C_{r+3}^2$ (D) $\sum_{r=0}^{n} C_r^3$

71. A piece of wire of length 4L is bent at random, to form a rectangle. The probability that its area is at most $\frac{L^2}{4}$ is :

(A) 1/4 (B) $\frac{\sqrt{3}}{2}$

(C) $\frac{2-\sqrt{3}}{2}$ (D) $4-\sqrt{3}$

72. The number of distinct values of a 2 × 2 determinant whose entries are from the set {–1, 0, 1} is:

(A) 3 (B) 4

(C) 5 (D) 6

73. If A is non-singular matrix, then $\det\cdot(A^{-1})$ is equal to :

(A) $\det\cdot\left(\frac{1}{A^2}\right)$ (B) $\frac{1}{\det\cdot(A^2)}$

(C) $\det\cdot\left(\frac{1}{A}\right)$ (D) $\frac{1}{\det\cdot(A)}$

74. The four sides of a quadrilateral are given by the equation $xy(x-2)(y-3)=0$. The equation of the line parallel to $x-4y=0$ that divides the quadrilateral in two equal areas is :

(A) $x-4y-5=0$ (B) $x-4y+5=0$

(C) $x-4y-1=0$ (D) $x-4y+1=0$

Space for Rough work

75. The equation of image of pair of lines $y = |x-1|$ in y-axis is :

(A) $x^2 + y^2 + 2x + 1 = 0$ (B) $x^2 - y^2 + 2x - 1 = 0$

(C) $x^2 - y^2 + 2x + 1 = 0$ (D) none of these

76. The equation of the image of the circle $(x - 3)^2 + (y - 2)^2 = 1$ by the mirror x + y = 19 is :

(A) $(x - 14)^2 + (y - 13)^2 = 1$ (B) $(x - 15)^2 + (y - 14)^2 = 1$

(C) $(x - 16)^2 + (y - 15)^2 = 1$ (D) $(x - 17)^2 + (y - 16)^2 = 1$

77. The point ([P + 1], [P]), (where [·] denotes the greatest integer function) lying inside the region bounded by the circle $x^2 + y^2 - 2x - 15 = 0$ and $x^2 + y^2 - 2x - 7 = 0$, then :

(A) $P \in [-1, 0) \cup [0, 1) \cup [1, 2)$ (B) $P \in [-1, 2) - \{0, 1\}$

(C) $P \in (-1, 2)$ (D) none of the above

78. Let α be the angle which a tangent to the parabola $y^2 = 4ax$ makes with its axis, the distance between the tangent and a parallel normal will be :

(A) $a \sin^2 \alpha \cos^2 \alpha$ (B) $a \operatorname{cosec} \alpha \sec^2 \alpha$

(C) $a \tan^2 \alpha$ (D) $a \cos^2 \alpha$

79. The point, at shortest distance from the line x + y =7 and lying on an ellipse $x^2 + 2y^2 = 6$, has co-ordinates :

(A) $(\sqrt{2}, \sqrt{2})$ (B) $(0, \sqrt{3})$

(C) (2,1) (D) $\left(\sqrt{5}, \frac{1}{\sqrt{2}}\right)$

80. The normal at P to a hyperbola of eccentricity e, intersects its transverse and conjugate axes at L and M respectively. If locus of the mid-point of LM is hyperbola, then eccentricity of the hyperbola is :

(A) $\left(\frac{e+1}{e-1}\right)$ (B) $\frac{e}{\sqrt{(e^2 - 1)}}$

(C) e (D) none of these

Space for Rough work

81. If x is a real number in [0, 1] then the value of $f(x)=\lim\limits_{m\to\infty}\lim\limits_{n\to\infty}\{1+\cos^{2m}(n!\pi x)\}$ is given by :

(A) 2 or 1 according as x is rational or irrational
(B) 1 or 2 according as x is rational or irrational
(C) 1 for all x
(D) 2 or 1 for all x

82. If $\sqrt{(x+y)}+\sqrt{(y-x)}=a$, then $\frac{d^2y}{dx^2}$ equals :

(A) 2 / a
(B) –2 / a^2
(C) 2 / a^2
(D) none of these

83. The angle of intersection of curves $Y=\left[|\sin x|+|\cos x|\right]$ and $x^2+y^2=5$, where [·] denotes the greatest integer function, is :

(A) $\tan^{-1}2$
(B) $\tan^{-1}\left(\frac{1}{2}\right)$
(C) $\tan^{-1}(\sqrt{2})$
(D) $\tan^{-1}\left(\frac{1}{\sqrt{2}}\right)$

84. $\int x^{-2/3}(1+x^{1/2})^{-5/3}\,dx$ is equal to :

(A) $3(1+x^{-1/2})^{-1/3}+C$
(B) $3(1+x^{-1/2})^{-2/3}+C$
(C) $3(1+x^{1/2})^{-2/3}+C$
(D) none of these

85. If [x] denotes the greatest integer less than or equal to x then $\int_0^\infty\left[\frac{2}{e^x}\right]dx$ is equal to :

(A) $\log_e 2$
(B) e^2
(C) 0
(D) $\frac{2}{e}$

Space for Rough work

86. Value of $\int_{2}^{3}\frac{dx}{\sqrt{(1+x^3)}}$ is :

(A) less than 1 (B) greater than 2
(C) lies between 3 and 4 (D) none of these

87. The slope of the tangent to a curve y = f(x) at (x, f(x)) is 2x + 1. If the curve passes through the point (1, 2), then the area of the region bounded by the curve, the x-axis and the line x = 1 is:

(A) $\frac{5}{6}$ sq. units (B) $\frac{6}{5}$ sq. units
(C) $\frac{1}{6}$ sq. units (D) 6 sq. units

88. The curve for which sum of the reciprocals of the radius vector and the polar subtangent is k, is equal to :

(A) $kr = c\,r\,e^{\theta} + 1$ (B) $k\,r^2 = c\,e^{\theta} + 1$
(C) $r = k\,r\,e^{\theta} + c$ (D) $k^2\,r^2 = k\,e^{\theta} + c$

89. The three planes 4y + 6z = 5; 2x + 3y + 5z = 5 6x + 5y + 9z = 10 :

(A) meet in a point (B) have a line in common
(C) form a triangular prism (D) none of these

90. The condition for the lines $x = az + b$, $y = cz + d$ and $x = a_1z + b_1$, $y = c_1z + d_1$ to be perpendicular is :

(A) $ac_1 + a_1c = 1$ (B) $aa_1 + cc_1 + 1 = 0$
(C) $bc_1 + b_1c + 1 = 0$ (D) none of the above

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – I

JEE (Main)-2019

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. D

Sol. $t = 20 \text{ min} = \frac{1}{3}\text{hr}$

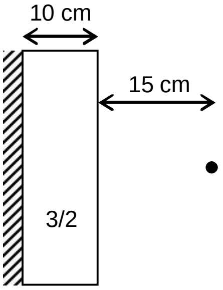
$1 \text{ km} = \sqrt{(6)^2 - V^2} \times \left(\frac{1}{3}\text{hr}\right)$

$V = 3\sqrt{3}$ km/hr

2. C

Sol. $X_{app} = \frac{10}{3/2} + \frac{10}{3/2} + \frac{15}{1}$

$= \frac{40}{3} + 15 = 28.33$



3. C

Sol. For no deviation

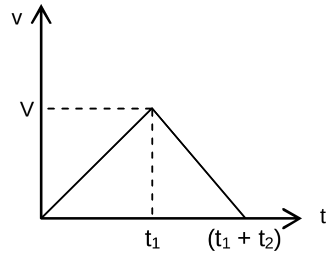
$(\mu_1 - 1)A_1 = (\mu_2 - 1)A_2$

$4^o(1.54 - 1) = (1.72 - 1)A_2$

$A_2 = \frac{4 \times 0.54}{0.72} = 3°$.

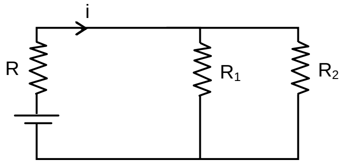
4. A

Sol. Required ratio = $\frac{V}{\text{Area}/(t_1+t_2)} = \frac{2}{1}$



5. C

Sol. Inductor behaves like a cell of emf, ε' = Blv and equivalent ckt is



Blv = ε'

Hence, i = $\frac{Blv}{R+\frac{R_1R_2}{R_1+R_2}}$

$= \frac{Blv(R_1+R_2)}{RR_1+RR_2+R_1R_2}$

6. C

Sol. Variation of moment of inertia with temperature

$I = I_o\,(1 + 2\alpha\,\Delta T)$

C.O.A.M:

$I_i\omega_i = I_f\,\omega_f$

7. D

Sol. Upon earthing, final potential of conductor becomes zero. Final charge may or may not be zero.

8. B

Sol. tan θ = $\frac{X_c - X_L}{X_R}$ and cosθ = power factor.

9. A

Sol. $r = \frac{mv}{qB} = \frac{1\times 10}{1\times 2} = 5\text{m}$ And motion of particle will be in x – y plane.

10. B

Sol. $\frac{q}{4\pi\epsilon_0 r} + \frac{1}{4\pi\varepsilon_o}\frac{(2a\,q)\cos\theta}{r^2}s$

11. D

Sol. $W_{agent} - mgH = 0$

$W_{agent} = mgH$

12. D

Sol. $A_1V_1 = A_2V_2 \Rightarrow a\sqrt{2gh} = A\left(-\frac{dh}{dt}\right) \Rightarrow \frac{a}{A}\int_0^t dt = -A\int_{h_1}^{h_2}\frac{dh}{\sqrt{2gh}}$

13. B

Sol. If we consider a point very close to one wire than magnetic field due to this wire will dominate.

14. D

Sol. $\Delta q = \Delta u + \Delta w$

$\Rightarrow \quad \Delta U = -996\ J = \frac{nR}{\gamma - 1}\Delta T$

$\gamma = \frac{5}{3}$ for mono-atomic gas.

15. C

Sol. $i = \frac{E}{R}\left(1 - e^{-\frac{tR}{L}}\right)$

16. B

Sol. Kx = 2 × g = 20, $\quad x = \frac{1}{2}m$

$5\ gx - \frac{1}{2}Kx^2 = \frac{1}{2}5V^2$

$V = 2\sqrt{2}$ m/s

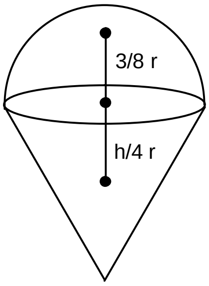
17. B

Sol. $F = \frac{dp}{dt} = \left(\sqrt{2}\,V\right)\frac{dm}{dt} = \left(\sqrt{2}\,V\rho\right)\frac{d(volume)}{dt} = \left(\sqrt{2}\,V\rho\right)(AV)$

18. B

Sol. $\frac{3}{8}r\cdot\rho\frac{2}{3}\pi r^3 = \frac{h}{4}\cdot\rho\frac{1}{3}\pi r^2 h$

$\Rightarrow \quad h = \sqrt{3}\,r$



19. A

Sol. $f\lambda = v = \frac{10\lambda v}{d} \Rightarrow \lambda = \frac{d}{10}.$

Maximum path diff. can be $\frac{d}{3}$. Hence, number of maximum will be 6.

20. B

Sol. According to Bohr's atomic model.

21. C

Sol. V = 0.6 m

$\Rightarrow \quad \frac{h_I}{h_o} = \frac{h_I}{0.05} = 2 \;\Rightarrow\; h_I = 0.1$ cm.

$\Rightarrow$ Distance between them = 0.3 cm = 3 mm.

22. B

Sol. $V_Q - V_O = \frac{1}{2}B(\omega)(r^2) = \frac{B\omega}{2}(2a)^2 = 2B\omega a^2$.

23. B

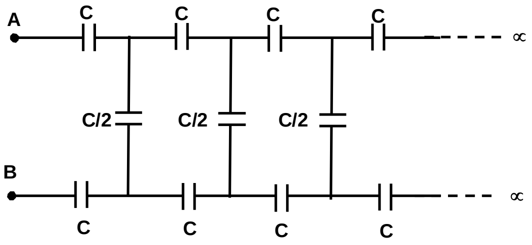
Sol. Total momentum = $\int\limits_{\theta=-90}^{+90} (dm)v\cos\theta$

dm = $\frac{M}{\pi R} \times R d\theta$

Total momentum = $\int \frac{M}{\pi R} vRd\theta \cos\theta = \frac{2Mv}{\pi}$

24. C

Sol. The Equivalent circuit is as follows



25. A

Sol. $I_a = \frac{3V}{15R}, \; I_b = \frac{3V}{5R}$

$I_c = \frac{6V}{15R}$.

26. C

Sol. At first the pressure will increase rapidly and then it will become constant.

27. B

Sol. $dV = -IdR = = -I\rho\frac{dx}{A}$

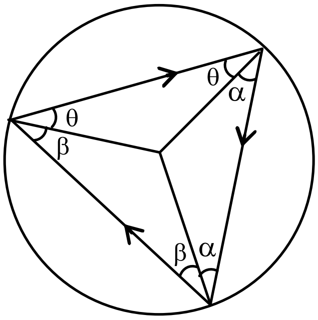
$\frac{dV}{dx} = -I\frac{\rho}{A} = -k$

$\Rightarrow R = k\ell/I$

II Method:

$$V_2 - V_1 = \int \left(\frac{dV}{d\ell}\right) d\ell = kL = IR$$

28. D



Sol. $\tan\alpha = \frac{u\sin\theta}{eu\cos\theta} = \frac{\tan\theta}{e}$

$\therefore\ \tan\alpha = \frac{1}{e}\tan\theta$

$\therefore\ \tan\beta = \frac{1}{e}\tan\theta$

$2\theta + 2\alpha + 2\beta = 180°$

$\alpha + \beta = (90 - \theta)$

$\tan(\alpha + \beta) = \cot\theta$

$$\Rightarrow \frac{\tan\alpha + \tan\beta}{1 - \tan\alpha\tan\beta} = \frac{1}{\tan\theta}$$

$$\Rightarrow \frac{\frac{1}{e}\tan\theta + \frac{1}{e^2}\tan\theta}{1 - \frac{1}{e^3}\tan^2\theta} = \frac{1}{\tan\theta}$$

$$\Rightarrow \tan^2\theta\left(\frac{1}{e} + \frac{1}{e^2}\right) = 1 - \frac{1}{e^3}\tan^2\theta$$

$$\Rightarrow \tan^2\theta\left(\frac{1}{e} + \frac{1}{e^2} + \frac{1}{e^3}\right) = 1$$

$$\tan^2\theta\left(\frac{1}{\frac{1}{e} + \frac{1}{e^2} + \frac{1}{e^3}}\right) = \frac{e^3}{1 + e + e^2}$$

29. C

Sol. $\because$ acceleration = 0. Net force towards left = Net force towards right.

30. A

Sol. $\Delta m = 0.1$ kg ; $\frac{\Delta m}{m} = \frac{0.1}{10}$

$\therefore$ Error $= \pm\frac{\Delta m}{m} \times 100 = \pm 1\%$.

Chemistry PART – II

SECTION – A

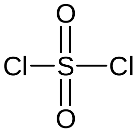
31. A

Sol. Stability of anion $= ClO_4^- > ClO_3^- > ClO_2^- > ClO^-$

Oxidation number of $Cl = H\overset{+7}{Cl}O_4 > H\overset{+5}{Cl}O_3 > H\overset{+3}{Cl}O_2 > HO\overset{+1}{Cl}$

32. D

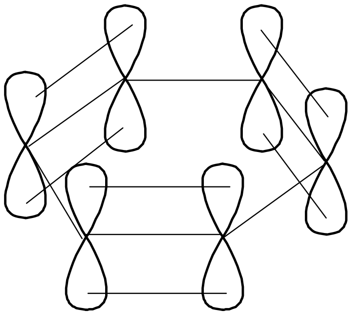
Sol.



$Cl-S(=O)_2-Cl$

33. A

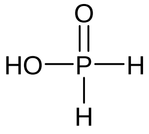
Sol.



Molecular plane is the nodal plane of all the π-bonds.

34. D

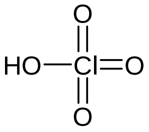
Sol.



$HO-P(=O)(H)-H$

(H_3PO_2)

monobasic nature and replaceable hydrogen is one



$HO-Cl(=O)_2=O$

monobasic nature and replaceable hydrogen is one

35. D

Sol. $\left[Co(NH_3)_4(H_2O)_2\right]Cl_2$ has two geometrical isomers and Co^{2+} has $3d^7$ configuration (paramagnetic).

36. D

Sol. (A) $\left[Co(NH_3)_6\right]Cl_3$

(B) $\left[Co(NH_3)_4Cl_2\right]Cl$

(C) $\left[Co(NH_3)_5Cl\right]Cl_2$

(D) $\left[Co(NH_3)_3Cl_3\right]$

37. A

Sol. $\left.\begin{array}{l}\bullet\ Ag_2S\\ \ \ Cu_2S\\ \ \ PbS\end{array}\right\}$ are the main sulphide ore of Ag, Cu and Pb respectively

- Sn exists as SnO_2
- Al exists as Al_2O_3
- Mg exists as $MgSO_4 \cdot 7H_2O$, $MgCO_3$, etc.

38. A

Sol. Only five HCO_3^- salt exist in solid form $NaHCO_3$, $KHCO_3$, $RbHCO_3$, $CsHCO_3$, NH_4HCO_3.

39. C

Sol. $Ca_3(PO_4)_2$ does not give volatile product

$$CO_3^{2-} \xrightarrow{HNO_3} CO_2$$

$$NO_2^- \xrightarrow{HNO_3} NO\uparrow \xrightarrow{O_2} NO_2\uparrow$$

$$Br^- \xrightarrow{HNO_3} Br_2\uparrow$$

40. D

Sol. Hard water contains soluble salt of Ca^{2+} and Mg^{2+}.

$CaCO_3$ = Insoluble salt.

41. D

Sol. Total moles of H_2SO_4 = 0.1 mole and total mass taken 100 × 1.5 = 150 g

Final volume $= \frac{150+400}{1.25} = \frac{550}{1.25} = 440$

$\therefore \quad M = \frac{0.1}{440} \times 1000 = \frac{1}{4.4} = 0.227\ M$

42. A

Sol. $\overset{+6}{Cr_2}O_7^{2-} \longrightarrow \overset{+6}{Cr}O_4^{2-}$

43. C

Sol. When an electron of charge e and mass m is accelerated with a potential difference of V volts K.E. = eV

$\Rightarrow \quad \frac{1}{2}mv^2 = eV \quad$ or $\quad v^2 = \frac{2\ eV}{m}$

$\Rightarrow v = \sqrt{\frac{2\ eV}{m}}$

44. D

Sol. $E = \frac{1240}{\lambda_{nm}} = \frac{1240}{91} = 13.6\ eV$

45. A

Sol. Moles of C_2H_6 and C_2H_4 are a and b respectively.

$$a+b=\frac{28}{22.4}=1.25$$

$$\underset{a}{C_2H_6(g)}+3.5\underset{3.5a}{O_2(g)}\longrightarrow 2CO_2(g)+3H_2O(\ell)$$

$$\underset{b}{C_2H_4(g)}+3\underset{3b}{O_2(g)}\longrightarrow 2CO_2(g)+2H_2O(\ell)$$

Moles of O_2 = 3.5 a + 3b = 4

a + b = 1.25

a = 0.5

b = 0.75

46. B

Sol. w = – Area of P – V curve

47. A

Sol. From graph, $[A]_{eq}$ = 0.1 M, $[B]_{eq}$ = 0.4 M

$$K_c=\frac{[B]^2}{[A]^1}=1.6$$

48. C

Sol. $\underset{C-x}{HCOOH}\rightleftharpoons\underset{x+0.01}{H^+}+\underset{x}{HCOO^-}$

$$K_a=\frac{(x+0.01)x}{0.01-x}$$

neglect x w.r.t. 0.01 due to common ion effect.

K_a = x

$\therefore x\simeq\left[HCOO^-\right]=1.8\times10^{-4}$

49. C

Sol. $\text{Rate of reaction}=\dfrac{\text{Rate of disappearance / appearance}}{\text{Stoichiometric coefficient}}$

50. C

Sol. $Cu(s)\,|\,Cu^{2+}(aq)\,||\,Cl^-(aq)\,|\,Hg_2Cl_2(s)\,|\,Hg(\ell)\,|\,Pt(s)$,

Anode : Cu | Cu^{2+}

Cathode : Cl^- | Hg_2Cl_2 | Hg

51. A

Sol. $i=1+(n-1)\alpha$ so $n=\dfrac{i+\alpha-1}{\alpha}$

52. A

Sol. The co-ordination number of a metal crystallising in a hexagonal close-packed structure is 12.

53. D

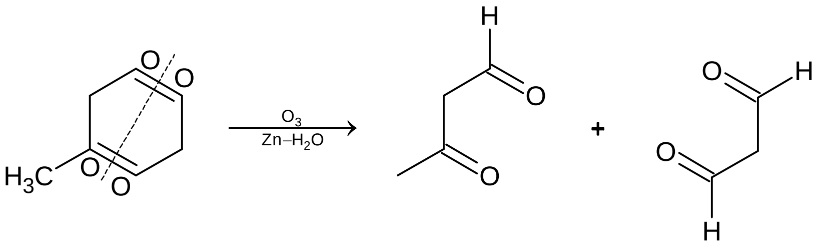
Sol. All the above options are correct.

54. B

Sol. $CH_3-CH\vdots\!=\!CH-CH_3 \xrightarrow[H^+]{KMnO_4} CH_3COOH + HOOC-CH_3$

55. A

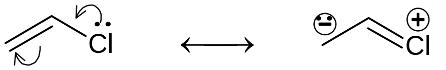
Sol.



O
O
H3C
O
O
O3
Zn–H2O
H
O
O
+
O
H
O
H

56. D

Sol.

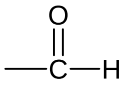


57. B

Sol. SeO_2 is a selective oxidising agent.

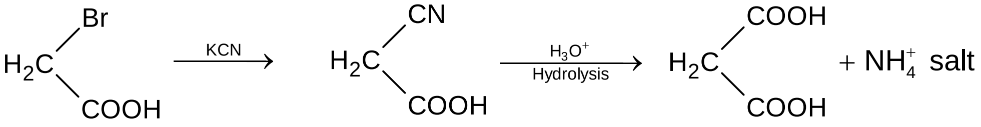
58. D

Sol.

It is given by  $-\overset{\displaystyle O}{\overset{\|}{C}}-H$ group

59. B

Sol.



Br
H2C
COOH
KCN
CN
H2C
COOH
H3O+
Hydrolysis
COOH
H2C
COOH
+ NH4+ salt

60. A

Sol. $PhCOOH + NaHCO_3 \longrightarrow PhCOONa(\text{Solution}) + CO_2\uparrow + H_2O$

Mathematics PART – III

SECTION – A

61. A

Sol. $\because 9^x - 3^x + 1 = \left(3^x - \frac{1}{2}\right)^2 - \frac{1}{4} + 1 = \left(3^x - \frac{1}{2}\right)^2 + \frac{3}{4} \ge \frac{3}{4}$

$\therefore$ For $x \in (-\infty, 1)$

$\Rightarrow \frac{3}{4} \le 9^x - 3^x + 1 < \frac{28}{4}$

Now, $f(x) = [9^x - 3^x + 1]$ = {0, 1, 2, 3, 4, 5, 6}

$\therefore$ R_f = {0, 1, 2, 3, 4, 5, 6} .

62. C

Sol. Sum of roots $= |\alpha| + |\beta| = -\alpha - \beta (\because \alpha < 0 \text{ and } \beta < 0)$

$= -(\alpha + \beta) = -\left(-\frac{b}{a}\right) = \frac{b}{a}$

$= \left|\frac{b}{a}\right| (\because |\alpha| + |\beta| > 0)$

and product of roots $= |\alpha||\beta| = |\alpha\beta| = \left|\frac{c}{a}\right|$

Hence, required equation is

$x^2 - \left|\frac{b}{a}\right| x + \left|\frac{c}{a}\right| = 0$ or $|a| x^2 - |b| x + |c| = 0$

63. A

Sol. Let P $= \sum_{i=0}^{n-1} \frac{\alpha_i}{(3-\alpha_i)} = -\sum_{i=0}^{n-1} \frac{(3-\alpha_i) - 3}{(3-\alpha_i)}$

$= 3\sum_{i=0}^{n-1} \frac{1}{(3-\alpha_i)} - \sum_{i=0}^{n-1} 1$ … (i)

$\because z^n - 1 = \prod_{i=0}^{n-1} (z - \alpha_i)$

$\because \ln(z^n - 1) = \sum_{i=0}^{n-1} \ln(z - \alpha_i)$

Differentiating both sides w.r.to z, we get

$\frac{nz^{n-1}}{(z^n - 1)} = \sum_{i=0}^{n-1} \frac{1}{(z - \alpha_i)}$ … (ii)

and put z = 3, then

$\frac{n \cdot 3^{n-1}}{(3^n - 1)} = \sum_{i=0}^{n-1} \frac{1}{(3 - \alpha_i)}$

From eq. (i), $3\left(\frac{n \cdot 3^{n-1}}{3^n - 1}\right) - n = \frac{n \cdot 3^n}{3^n - 1} - n = \frac{n}{(3^n - 1)}$.

64. C

Sol. Let A = mλ, H = nλ

$\therefore$ $G^2 = AH = mn\lambda^2$

$\because$ a, b are the roots of $t^2 - (a + b)t + ab = 0$

or $t^2 - 2m\lambda t + mn\lambda^2 = 0$

$$\therefore t = \frac{2m\lambda \pm \sqrt{(4m^2\lambda^2 - 4mn\lambda^2)}}{2}$$

$$= \lambda\sqrt{m}\{\sqrt{m} \pm \sqrt{(m-n)}\}$$

$$a : b = \sqrt{m} + \sqrt{(m-n)} : \sqrt{m} - \sqrt{(m-n)}$$

or $\sqrt{m} - \sqrt{m-n} : \sqrt{m} + \sqrt{m-n}$

65. C

Sol. $\because$ $$\tan y = \frac{1+\sqrt{(1-x)}}{1+\sqrt{(1+x)}}$$

In R.H.S. put x = cosθ, then

$$\tan y = \frac{1+\sqrt{2}\sin(\theta/2)}{1+\sqrt{2}\cos(\theta/2)} = \frac{\frac{1}{\sqrt{2}} + \sin(\theta/2)}{\frac{1}{\sqrt{2}} + \cos(\theta/2)}$$

$$= \frac{\sin\left(\frac{\pi}{4}\right) + \sin\left(\frac{\theta}{2}\right)}{\cos\left(\frac{\pi}{4}\right) + \cos\left(\frac{\theta}{2}\right)} = \frac{2\sin\left(\frac{\pi}{8} + \frac{\theta}{4}\right)\cos\left(\frac{\pi}{8} - \frac{\theta}{4}\right)}{2\cos\left(\frac{\pi}{8} + \frac{\theta}{4}\right)\cos\left(\frac{\pi}{8} - \frac{\theta}{4}\right)} = \tan\left(\frac{\pi}{8} + \frac{\theta}{4}\right)$$

$\therefore$ $$y = n\pi + \frac{\pi}{8} + \frac{\theta}{4}$$

$\Rightarrow$ $$4y = 4n\pi + \frac{\pi}{2} + \theta$$

$\therefore$ $\sin 4y = \cos\theta = x$

$\Rightarrow$ $\sin x = 1$ (impossible)

Case III : $\sin x = 1$

$\therefore$ $y = 1$

i.e., $\cos x = 1$

$\Rightarrow$ $\sin x = 0$ (impossible)

Hence, no solution

i.e. no. of solutions is zero.

66. A

Sol. $$\because y = \frac{1}{3} = [\sin x + [\sin x + [\sin x]]]$$

$$= \frac{1}{3}([\sin x] + [\sin x] + [\sin x])$$

$$= [\sin x]$$

and $[y + [y]] = 2\cos x$

$\Rightarrow$ $2[y] = (2\cos x)$

$\Rightarrow \quad [y] = \cos x$

Case I : When $-1 \le \sin x < 0$

$\Rightarrow \quad [\sin x] = -1$

Then, $y = -1$

i.e., $[-1] = \cos x$

$\Rightarrow \quad \cos x = -1$

$\Rightarrow \quad \sin x = 0$ (impossible)

Case II : When $0 \le \sin x < 1$

$\therefore \quad [\sin x] = 0$

then, $y = 0$

i.e., $0 = \cos x$

67. A

Sol. $\therefore f(x+y) = f(x) \cdot f(y)$

for $x = y = 1$

$f(2) = 2^2$

for $x = 1, y = 2$

$f(3) = f(1)f(2) = 2^3$

$\therefore \quad f(n) = 2^n$

$\therefore \quad a = f(3) = 2^3 = 8,$

$b = f(1) + f(3) = 2 + 8 = 10$

and $c = f(2) + f(3) = 2^2 + 2^3 = 12$

$\cos A = \frac{3}{4}$ and $\cos C = \frac{1}{8}$

$\cos 2A = 2\cos^2 A - 1 = 2 \times \frac{9}{16} - 1 = \frac{1}{8} = \cos C$

$\therefore 2A = C$

68. A

Sol. $y = \cos x$

$y = \sin 3x$

$\therefore \sin 3x = \cos x = \sin\left(\frac{\pi}{2} - x\right)$

$\Rightarrow \quad 3x = n\pi + (-1)^n \left(\frac{\pi}{2} - x\right)$

Case I: when n is even, then

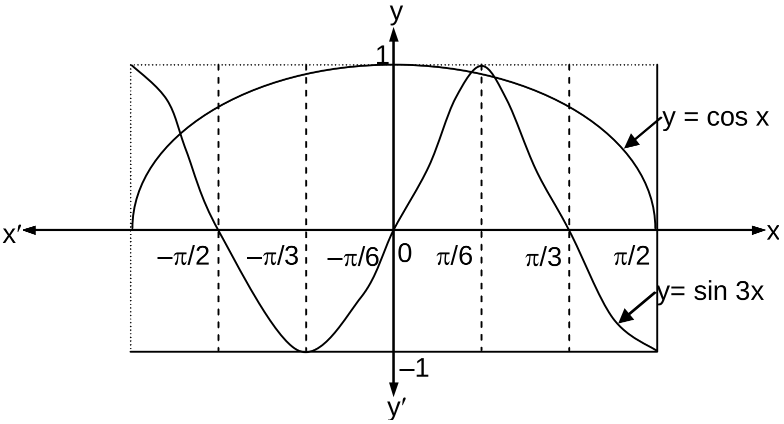
$3x = n\pi + \frac{\pi}{2} - x$

$\Rightarrow \quad x = \frac{n\pi}{4} + \frac{\pi}{8}$

$\therefore \quad x = \frac{\pi}{8}$, at $n = 0$

Then, $y = \cos\frac{\pi}{8}$

$\Rightarrow \left(\frac{\pi}{8}, \cos\frac{\pi}{8}\right)$



Case II : when n is odd, then

$3x = n\pi - \frac{\pi}{2} + x$

or $x = \frac{n\pi}{2} - \frac{\pi}{4}$

$= \frac{\pi}{4}(\text{for } n = 1)$

Then, $y = \cos\frac{\pi}{4} = \frac{1}{\sqrt{2}}$

$\Rightarrow \left(\frac{\pi}{4}, \frac{1}{\sqrt{2}}\right)$

Hence, point of intersection is

$\left(\frac{\pi}{4}, \frac{1}{\sqrt{2}}\right)$ and $\left(\frac{\pi}{8}, \cos\frac{\pi}{8}\right)$

69. D

Sol. Required ways $= ({}^3C_1 \times {}^2C_1 \times {}^1C_1) \times 2 = 12$

70. D

Sol. $(1+\lambda)^n (\mu+1)^n (\lambda+\mu)^n = \sum_{r=0}^{n} C_r \lambda^r \sum_{s=0}^{n} C_s \mu^{n-s} \sum_{t=0}^{n} C_t \lambda^{n-1} \mu^t$

Since, C_0^3 is the coefficient of $\lambda^0 \mu^{n-0} \lambda^{n-0} \mu^0$

i.e., $\lambda^n \mu^n (r = s = t = 0)$

Now, C_1^3 is the coefficient of $\lambda^1 \mu^{n-1} \lambda^{n-1} \mu^1$

i.e., $\lambda^n \mu^n (r = s = t = 1)$ etc.

and C_k^3 is the coefficient of $\lambda^k \mu^{n-k} \lambda^{n-k} \mu^k$

i.e., $\lambda^n \mu^n (r = s = t = k)$

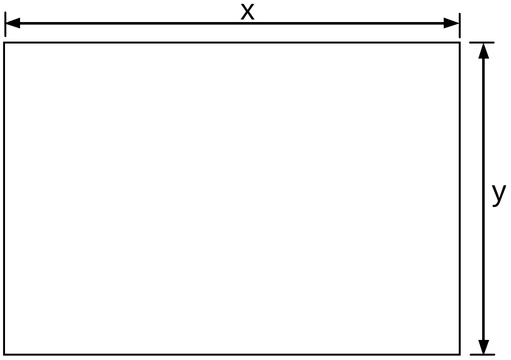
Hence, the coefficient of $\lambda^n\mu^n$ in

$$(1+\lambda)^n(\mu+1)^n(\lambda+\mu)^n = C_0^3 + C_1^3 + C_2^3 + \ldots + C_n^3 = \sum_{r=0}^{n} C_r^3$$

71. C

Sol. $\because 2x + 2y = 4L$

$\Rightarrow x + y = 2L$



$\therefore$ The are of the rectangle = xy

$= x(2L - x)$

But given, $x(2L - x) \le \frac{L^2}{4}$

$$\Rightarrow \quad x^2 - 2Lx + \frac{L^2}{4} \ge 0$$

$$\Rightarrow \quad (x - L)^2 - L^2 + \frac{L^2}{4} \ge 0$$

$$\Rightarrow \quad (x - L)^2 - \left(\frac{L\sqrt{3}}{2}\right)^2 \ge 0$$

$$\left(x - L + \frac{L\sqrt{3}}{2}\right)\left(x - L - \frac{L\sqrt{3}}{2}\right) \ge 0$$

$$\left\{x - \left(\frac{2-\sqrt{3}}{2}\right)L\right\}\left\{x - \left(\frac{2+\sqrt{3}}{2}\right)L\right\} \ge 0$$

$$\therefore x \in \left[0\left(,\frac{2-\sqrt{3}}{2}\right)L\right] \cup \left[\left(\frac{2+\sqrt{3}}{2}\right)L, 2L\right]$$

Now, x takes values in the interval [0, 2L]

$\therefore$ Required probability

$$= \frac{\int_0^{\left(\frac{2-\sqrt{3}}{2}\right)L} dx + \int_{\left(\frac{2+\sqrt{3}}{2}\right)L}^{2L} dx}{\int_0^{2L} dx} = \frac{\left(\frac{2-\sqrt{3}}{2}\right)L + 2L - \left(\frac{2+\sqrt{3}}{2}\right)L}{2L - 0} = \frac{2L - \sqrt{3}L}{2L} = \left(\frac{2-\sqrt{3}}{2}\right)$$

72. C

Sol. Possible values are –2, –1, 0, 1, 2 i.e., $\begin{vmatrix} 1 & 0 \\ -1 & 1 \end{vmatrix} = 1, \begin{vmatrix} 1 & -1 \\ 0 & 0 \end{vmatrix} = 0, \begin{vmatrix} 0 & 1 \\ 1 & -1 \end{vmatrix} = -1$

$\begin{vmatrix} 1 & -1 \\ 1 & 1 \end{vmatrix} = 2, \begin{vmatrix} -1 & 1 \\ 1 & 1 \end{vmatrix} = -2$

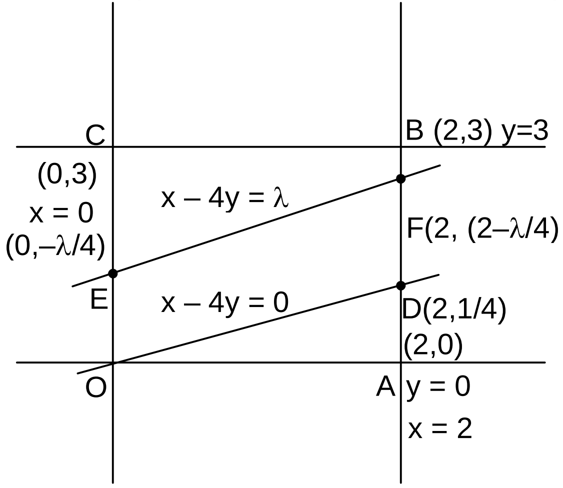
73. D

Sol. $\det(AA^{-1}) = \det(I)$

$\Rightarrow \det(A)\det(A^{-1}) = 1 \Rightarrow \det(A^{-1}) = \dfrac{1}{\det(A)}$

74. B

Sol. ∴ Area of quadrilateral OABC = 2 × 3 =6 sq. units



∴ Area of OAFEO = $\frac{1}{2}$ Area of quadrilateral OABC

$\Rightarrow \quad \frac{1}{2} \times \left(\frac{2-\lambda}{4} - \frac{\lambda}{4} \right) \times 2 = 3 \;\; \Rightarrow \;\; \frac{1}{2} - \frac{\lambda}{2} = 3$

or $\quad -\frac{\lambda}{2} = \frac{5}{2}$

∴ $\quad = -5$

∴ Required equation is x – 4y + 5 =0

75. C

Sol. ∵ $\quad y = |x-1|$

$\Rightarrow \quad y^2 = (x-1)^2$

Change x by –x, then required image is

$y^2 = (-x-1)^2$

$\Rightarrow \quad y^2 = x^2 + 1 + 2x$

or $\quad x^2 - y^2 + 2x + 1 = 0$

76. D

Sol. The image of the circle has same radius but centre different. If centre is (α, β), then

$$\frac{\alpha-3}{1}=\frac{\beta-2}{1}=\frac{-2(3+2-19)}{1^2+1^2}$$

$\Rightarrow \quad \alpha-3=\beta-2=14$

$\therefore \quad \alpha=17$

$\beta=16$

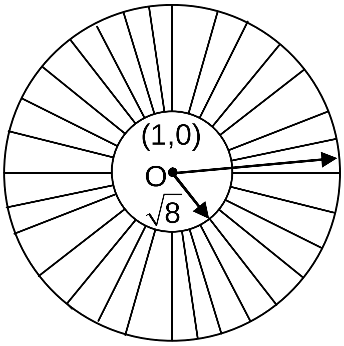
$\therefore$ Required circle is $(x-17)^2+(y-16)^2=1$

77. D

Sol. $\because$ The point ([P + 1], [P]) lies inside the circle

$x^2+y^2-2x-15=0$, then

$[P+1]^2+[P]^2-2[P+1]-15<0$



$\Rightarrow \quad ([P]+1)^2+[P]^2-2([P]+1)-15<0$

$\Rightarrow \quad 2[P]^2-16<0$

$\Rightarrow \quad [P]^2<8$ … (i)

$\because$ Circles are concentric

$\therefore$ Point ([P + 1], [P]) lies out side the circle

$x^2+y^2-2x-7=0$

$\therefore \quad ([P+1])^2+[P]^2-2[P+1]-7>0$

$\Rightarrow \quad ([P+1])^2+[P]^2-2[P]-2-7)=0$

$[P]^2+2[P]+1+[P]^2-2[P]-9=0$

$\therefore \quad 2[P]^2-8>0$

$[P]^2>4$ … (ii)

From eqs. (i) and (ii), we get

$4<[P]^2<8$ which is impossible

$\therefore$ For no value of ‘P’, the point will be within the region.

78. B

Sol. Tangent of parabola $y^2=4ax$ is

$y=mx+\frac{a}{m}$ … (i)

Where $m=\tan\alpha$

And equation of normal parallel to eq. (i) is

$y=mx-2am-am^3$ … (ii)

Distance between eqs. (i) and (ii) is $\frac{\left|\frac{a}{m}+2am+am^3\right|}{\sqrt{(1+m^2)}}$

$$=\frac{a(1+m^2)^2}{m\sqrt{(1+m^2)}}=\frac{a(1+m^2)^{3/2}}{m}=\frac{a(1+\tan^2\alpha)^{3/2}}{\tan\alpha}=\frac{a\sec^3\alpha}{\tan\alpha}=a\sec^2\alpha\cdot\operatorname{cosec}\alpha$$

79. C

Sol. The tangent at the point of shortest distance from the line x + y = 7 parallel to the given line.

Any point on the given ellipse is $(\sqrt{6}\cos\theta,\sqrt{3}\sin\theta)$.

Equation of the tangent is

$$\frac{x\cos\theta}{\sqrt{6}}+\frac{y\sin\theta}{\sqrt{3}}=1$$

It is parallel to x + y = 7

$$\Rightarrow \quad \frac{\cos\theta}{\sqrt{6}}=\frac{\sin\theta}{\sqrt{3}} \Rightarrow \quad \frac{\cos\theta}{\sqrt{2}}=\frac{\sin\theta}{1}=\frac{1}{\sqrt{3}}$$

The required point is (2, 1).

80. B

Sol. Equation of normal at $P(a\sec\phi,b\tan\phi)$ is

Hence, co-ordinates of L and M are

$$L\equiv\left(\frac{a^2+b^2}{a}\cdot\sec\phi,0\right)$$

and $M=\left(0,\frac{a^2+b^2}{b}\tan\phi\right)$ respectively.

Let mid-point of ML is Q (h, k)

Then $h=\frac{(a^2+b^2)}{2a}\sec\phi$

$$\therefore \quad \sec\phi=\frac{2ah}{(a^2+b^2)} \qquad \ldots \text{(i)}$$

and $k=\frac{(a^2+b^2)}{2b}\tan\phi$

$$\therefore \quad \tan\phi=\frac{2bk}{(a^2+b^2)} \qquad \ldots \text{(ii)}$$

From eqns. (i) and (ii)

$$\sec^2\phi-\tan^2\phi=\frac{4a^2h^2}{(a^2+b^2)^2}-\frac{4b^2k^2}{(a^2+b^2)^2}$$

Hence, locus

$$\frac{x^2}{\left(\frac{a^2+b^2}{2a}\right)^2}-\frac{y^2}{\left(\frac{a^2+b^2}{2b}\right)}=1$$

Let eccentricity is e_1

$\therefore \left(\frac{a^2+b^2}{2b}\right) = \left(\frac{a^2+b^2}{2a}\right)(e_1^2-1)$

$\Rightarrow \quad a^2 = b^2(e_1^2-1)$

$\Rightarrow \quad a^2 = a^2(e^2-1)(e_1^2-1)$

$(\because b^2 = a^2(e^2-1))$

$\Rightarrow \quad e^2e_1^2 - e^2 - e_1^2 + 1 = 1$

$\Rightarrow \quad e_1^2(e^2-1) = e^2$

$\therefore \quad e_1 = \frac{e}{\sqrt{(e^2-1)}}$

81. A

Sol. $\because 0 < \cos^2(n!\pi x) \le 1$

If $-0 < \cos^2(n!\pi x) < 1$

Then, $f(x) = \lim\limits_{m\to\infty}\lim\limits_{n\to\infty}\{1+(\cos^2(n!\pi x))^m\}$

= 1 + 0 = 1, when x is irrational

and if $\cos^2(n!\pi x) = 1$

$\Rightarrow \quad n!\pi x = r\pi$

$\Rightarrow x = \frac{r}{n!} = \text{rational}$

Then, $f(x) = \lim\limits_{m\to\infty}\lim\limits_{n\to\infty}\{1+(\cos^2(n!\pi x))^m\}$ = 1 + 1 = 2

Hence, f(x) = $\begin{cases} 2, \text{x is rational} \\ 1, \text{x is irrational} \end{cases}$

82. C

Sol. Given, $\sqrt{(x+y)} + \sqrt{(y-x)} = a$ ... (i)

$\therefore \quad \sqrt{x+y} - \sqrt{y-x} = \frac{2x}{a}$ … (ii)

Adding eqns. (i) and (ii), then

$2\sqrt{x+y} = a + \frac{2x}{a}$

Squaring, $4x + 4y = a^2 + \frac{4x^2}{a^2} + 4x$

$\therefore \quad 4 + 4\frac{dy}{dx} = 0 + \frac{8x}{a^2} + 4$

$\therefore \quad 0 + 4\frac{d^2y}{dx^2} = \frac{8}{a^2}$

$\therefore \quad \frac{d^2y}{dx^2} = \frac{2}{a^2}$

83. A

Sol. $\because \quad 1 \le |\sin x| + |\cos x| \le \sqrt{2}$

$\therefore \quad y = \left[|\sin x| + |\cos x|\right] = 1$

Let P and Q be the points of intersection of given curves.
Now, solving y = 1 and $x^2 + y^2 = 5$

$\therefore \quad x^2 + 1 = 5$

$\Rightarrow \quad x = \pm 2$

$\therefore \quad P \equiv (-2,1)$ and $Q \equiv (2,1)$

Clearly, the slope of line y = 1 is zero.

$\because \quad x^2 + y^2 = 5$

$\therefore \quad 2x + 2y\dfrac{dy}{dx} = 0 \Rightarrow \quad \dfrac{dy}{dx} = -\dfrac{x}{y}$

$\left(\dfrac{dy}{dx}\right)_{(-2,1)} = 2$ and

$\left(\dfrac{dy}{dx}\right)_{(2,1)} = -2$

84. B

Sol. $\int x^{-2/3} \cdot \{(x^{1/2})(x^{-1/2} + 1)\}^{-5/3} dx$

$= \int x^{-2/3} \cdot x^{-5/6} \cdot (x^{-1/2} + 1)^{-5/3} dx$

$= \int x^{-3/2} \cdot (x^{-1/2} + 1)^{-5/3} dx$

Put $x^{-1/2} + 1 = t$

$\therefore -\dfrac{1}{2}x^{-3/2}dx = dt$

Then, $-2\int t^{-5/3}dt = -2 \cdot \dfrac{t^{-2/3}}{-2/3} + C = 3(x^{-1/2} + 1)^{-2/3} + C$

85. A

Sol. $\left[\dfrac{2}{e^x}\right] = \begin{Bmatrix} 1, \text{ if } x \le \log_e 2 \\ 0, \text{ if } x > \log_e 2 \end{Bmatrix}$

$\therefore I = \int_0^{\log_e 2}\left[\dfrac{2}{e^x}\right]dx + \int_{\log_e 2}^{\infty}\left[\dfrac{2}{e^x}\right]dx$

$I = \int_0^{\log_e 2} 1 dx + 0 = \log_e 2$

86. A

Sol. Let I = $\int\limits_2^3 \dfrac{dx}{\sqrt{(1+x^3)}}$

Since, $1 + x^3 > (1 + x)^2$ in $x \in (2, 3)$

$\Rightarrow \sqrt{(1+x^3)} > (1+x)$

$\int_2^3 \dfrac{1}{\sqrt{(1+x^3)}}dx < \int_2^3 \dfrac{1}{(1+x)}dx$

$\Rightarrow I < [\log_e(1+x)]_2^3 \ \Rightarrow I < \log_e(4/3)$

$\therefore$ I < 1

87. A

Sol. We have, $\frac{dy}{dx} = 2x+1$

$\Rightarrow y = x^2 + x + c,$ it passes through (1, 2)

$\therefore$ c = 0

Then , $y = x^2 + x$

$\therefore$ Required area $= \int_0^1 (x^2+x)dx = \frac{5}{6}$ sq. units

88. A

Sol. The reciprocal of polar subtangent is $\frac{1}{r^2}\frac{dr}{d\theta}$.

According to the given condition,

$\frac{1}{r} + \frac{1}{r^2}\frac{dr}{d\theta} = k \Rightarrow d\theta = \frac{dr}{r(kr-1)} \Rightarrow kr - 1 = cre^{\theta}$

89. B

Sol. If DC's of line of intersection of planes4y + 6z = 5 and 2x + 3y + 5z = 5 are l, m, n

$\therefore \quad 0 + 4m + 6n = 0$

$2l + 3m + 5n = 0$

$\Rightarrow \quad \frac{l}{1} = \frac{m}{6} = \frac{n}{-4} = \frac{1}{\sqrt{53}}$

$\Rightarrow \quad l = \frac{1}{\sqrt{53}}, m = \frac{6}{\sqrt{53}}, n = -\frac{4}{\sqrt{53}}$

Also, $6\left(\frac{1}{\sqrt{53}}\right) + 5\left(\frac{6}{\sqrt{53}}\right) + 9\left(-\frac{4}{\sqrt{53}}\right) = 0$

i.e. line of intersection of perpendicular to normal of third plane. Hence, three planes have a line in common.

90. B

Sol. Lines are x = az + b, y = cz + d

$\Rightarrow \quad \frac{x-b}{a} = \frac{y-d}{c} = \frac{z}{1}$ … (i)

and $x = a_1 z + b_1,\ y = c_1 z + d_1$ … (ii)

$\frac{x-b_1}{a_1} = \frac{y-d_1}{c_1} = \frac{z}{1}$

$\therefore$ Lines (i) and (ii) are perpendicular, then

$aa_1 + cc_1 + 1 = 0$

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – II

JEE (Advanced)-2019

PAPER – 1

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01– 06, 19 – 24, 37 - 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*

   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 - 46) *contains 12 questions. Based on this section contains* ***TWO (02)*** *paragraphs. Based on each paragraph, there are* ***TWO (02)*** *questions.*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics PART – I

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. Two particles A and B, each carrying a charge Q, are held fixed with a separation d between them. A particle C having a mass m and charge –q, in kept at the middle point of line AB.
It displaced through a distance x perpendicular to AB. Assume x << d. Then:
(A) Force experienced by C is proportional to x
(B) Force experienced by C is proportional to d
(C) Particle C may execute SHM with time period $\left(\frac{m\pi^3\varepsilon_0 d^3}{qQ}\right)^{1/2}$
(D) Particle C may executes SHM with time period $\left(\frac{m\pi^2\varepsilon_0 d^2}{qQ}\right)^{1/2}$

2. If the potential difference of Coolidge tube producing X-ray is increased, then choose the correct option(s).
(A) the interval between $\lambda_{k\alpha}$ and $\lambda_{k\beta}$ increases
(B) the interval between $\lambda_{k\alpha}$ and λ_0 increases
(C) the interval between $\lambda_{k\beta}$ and λ_0 increases
(D) λ_0 does not change
Here λ_0 is cut off wavelength and $\lambda_{k\alpha}$ and λ_{kB} are wavelength of k_α and k_B characteristic X-rays.

3. For a single material
(A) its absorptive power and emissivity, have equal magnitude
(B) molar specific heat capacity is proportional to its specific heat capacity.
(C) mass is proportional to number of moles.
(D) density is proportional to volume of material.

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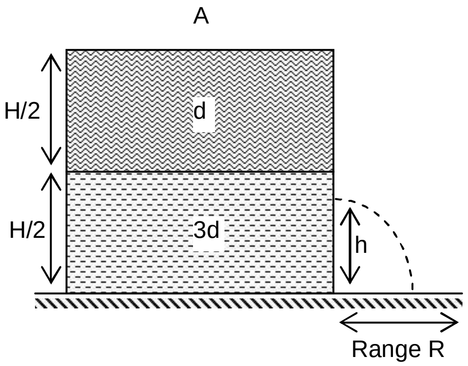


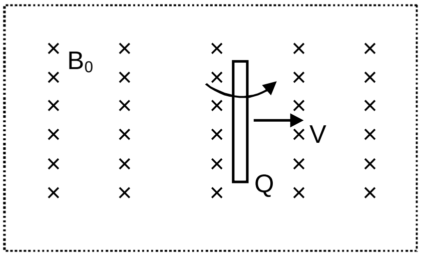
4. A container of large uniform cross sectional area A resting on a horizontal surface holds two immiscible non viscous and incompressible liquids of density d and 3d, each of height H/2. The lower density liquid is open to the atmosphere having pressure P_0. A tiny hole of area a(a<<A) is punched to the vertical side of lower container at a height h (0<h<H/2) for which range is maximum.

(A) h = H /3

(B) Range $R = \dfrac{2H}{3}$

(C) Range $R = \dfrac{3H}{2}$

(D) Velocity of efflux $v = \sqrt{\dfrac{2}{3}gH}$



5. A uniform thin rod PQ of length 'L' is moving in a uniform magnetic field B_0 such that velocity of its centre of mass is v and angular velocity is $\omega = \dfrac{4v}{L}$. Then

(A) e.m.f. between end P and end Q of the rod is $B_0 l v$

(B) end P of the rod is at higher potential than end Q of the rod

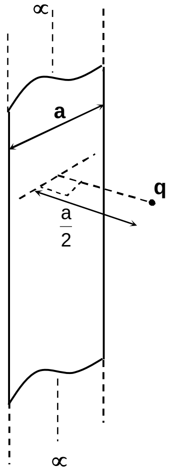
(C) end Q of the rod is at higher potential than end P of the rod

(D) the electrostatic field induced in the rod has same direction at all points along the length of rod.

Space for Rough work

6. There is an infinite long straight surface having width 'a'. A point charge q is placed at a perpendicular distance $\frac{a}{2}$ from the surface symmetrically as shown in the figure. If the flux linked with this infinitely long surface due to charge q is $\frac{q}{k\varepsilon_0}$. Then find the value of k is

(A) 6 (B) 4
(C) 2 (D) 12

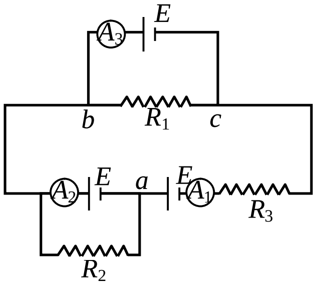


(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 7 and 8

In the circuit shown in figure, $R_1 = R_2 = R_3 = 3\Omega$ and e.m.f. of each cell is E = 4V and negligible internal resistance. All ammeters are ideal. Match the following:



7. Reading of ammeter A_1 in ampere is

(A) 2/3 (B) 4/3
(C) 1 (D) 4

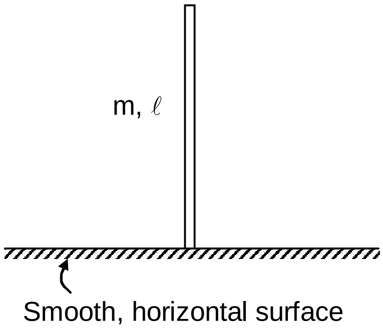
Space for Rough work

8. Reading of ammeter A_2 in ampere is

(A) 8/3　(B) 1/3

(C) 1　(D) 2

Paragraph for Question Nos. 9 and 10



9. The thin rod is released from the vertical position as shown, and falls by itself, then angular speed of the rod just before it falls flat, will be

(A) $\sqrt{\frac{g}{\ell}}$　(B) $\sqrt{\frac{3g}{\ell}}$

(C) $\sqrt{\frac{4g}{\ell}}$　(D) $\sqrt{\frac{6g}{\ell}}$

10. KE of the rod, just before it falls flat, will be

(A) $mg\ell$　(B) $mg\frac{\ell}{2}$

(C) $mg\frac{\ell}{4}$　(D) $mg\frac{\ell}{6}$

Space for Rough work

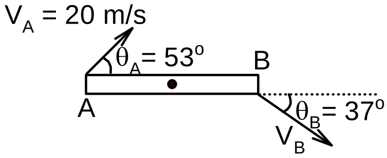
SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

11. A 10 kg mass rests on a horizontal frictionless table. How much energy (in Joule) is needed to accelerate the mass from rest to a speed of 5 m/s?

12. A block of mass 2kg is gently placed over a massive plank moving horizontally over a smooth surface with velocity 6 m/s. The coefficient of friction between the block and plank is 0.2. The distance travelled by the block till it slides on the plank is (g=10 m/s^2)

13. The two ends A and B of a uniform rod of length ℓ = 1m are moving with velocities V_A and V_B as shown. The velocity V_B (m/s) is

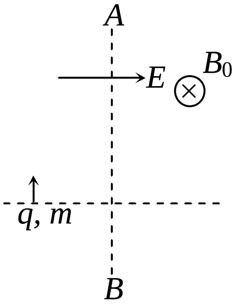


14. A hollow sphere and a solid sphere have equal mass and equal moment of inertia about the respective diameter. Find the ratio of their square of radii is given by

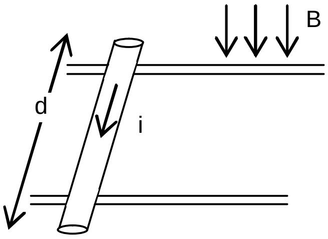
15. A steel wire of cross-sectional area 2mm^2 and Young's modulus 2×10^{11}N / m^2 is stretched longitudinally by a force of 200 N. The elastic potential energy stored per unit volume in the string is n × 10^4. Find the value of 'n'.

Space for Rough work

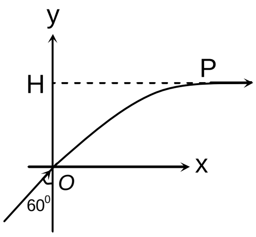
16. A uniform electric field E is present horizontally along the paper throughout region but uniform magnetic field B_0 is present horizontally (perpendicular to plane of paper in inward direction) right to the line AB as shown. A charge particle having charge q and mass m is projected vertically upward and crosses the line AB after time t_0. The speed of projection if particle moves after t_0 with constant velocity. (given $qE = mg$) is nt_o. Find the value of 'n'. ($g = 9.8\ m/s^2$)



17. A cylindrical uniform rod of mass 0.72 kg and radius 6 cm rests on two parallel rails, that are d = 50 cm apart. The rod caries a current I = 48A (In the direction shown) and rolls along the rails without slipping. If it starts from rest, uniform magnetic field of magnitudes 0.25 T is directed perpendicular to the rod and the rail, then find the friction force(In N) between rod and rails



18. A system of coordinates is drawn in a medium whose refractive index varies as $\mu = \frac{2}{1+y^2}$, where $0 \le y \le 1$. A ray of light is incident at origin at an angle 60^0 with y –axis as shown in the figure. At point P ray becomes parallel to x-axis. Find the value of 'H'.



Space for Rough work

Chemistry PART – II

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Choose correct statement(s) regarding PCl_5 molecule.
(A) Phosphorus uses 3d orbital in hybridization
(B) Three different bond angles are observed in the molecule
(C) In solid state it contains ion-pairs
(D) All P – Cl bonds are of equal length

20. Which of the following solution(s) form buffer if they are taken in 2 : 1 molar ratio?
(A) CH_3COOH and CH_3COONa
(B) NH_4OH and NaCl
(C) NH_4OH and NH_4Cl
(D) $NaHCO_3$ and Na_2CO_3

21. Which of the following compound(s) on catalytic hydrolysis forms carbonyl compound(s)?
(A) $CH_3CH = CH_2$
(B) $CH_3C \equiv CH$
(C) $CH_3C \equiv CCH_3$
(D) $HC \equiv CH$

22. Which of the following compound(s) contain(s) hydrogen atoms?
(A) Silicate anions
(B) Silicones
(C) Silanes
(D) Selenes

23. Which of the following complex(es) is/are insoluble in water?
(A) $Na_2[Zn(CN)_4]$
(B) $[Co(NH_3)_3Cl_3]$
(C) $[Cr(H_2O)_6]Br_3$
(D) $H_2[SiF_6]$

24. $FeCl_3 + K_4\left[Fe\left(CN\right)_6\right] \longrightarrow \text{Precipitate} \downarrow$
The correct statement(s) regarding the precipitate in above reaction is/are
(A) it is blue in colour
(B) one mole of the precipitate can consume 12 moles of NaOH
(C) the maximum van't Hoff factor of the ppt. can be seven
(D) the ppt. becomes soluble in hot water

Space for Rough work

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 25 and 26

For dissociation reactions, like $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$, the degree of dissociation of SO_3 can be determined by vapour density measurement of the reacting species through the following relation.

$$\alpha = \frac{D-d}{(n-1)d}$$

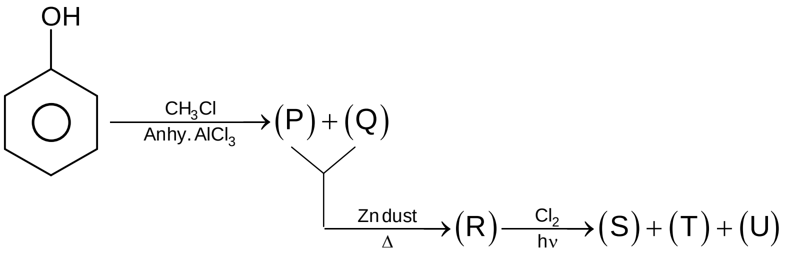
The molecular mass of the reaction mixture at equilibrium is 60. Initially only SO_3 was taken for the reaction.
Answer the following questions on the basis of above write up.

25. What is the value of 'D' in the reaction?
(A) 60 (B) 30
(C) 40 (D) 80

26. What is the value of 'α' for the reaction?
(A) 0.2 (B) 0.4
(C) 0.6 (D) 0.8

Space for Rough work

Paragraph for Question Nos. 27 and 28



(S) → Monosubstituted product
(T) → Disubstituted product
(U) → Trisubstituted product
Answer the following questions on the basis of above write up.

27. The unknown compounds S, T, U are
    (A) position isomers (B) functional isomers
    (C) metamers (D) different compounds

28. The most deactivating unknown compound towards EAS reaction is:
    (A) R (B) U
    (C) T (D) S

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

29. The energy of the first orbit of hydrogen atom is -13.6 eV. If the fourth ionization enthalpy of beryllium atom is expressed as $Y \times 10^{-19}$ J, what is the value of 'Y'?

30. How much heat is absorbed in calorie unit by heating 5 moles of a gas at constant pressure from 900 K to 1727.21 K?
    [$C_P = 4R$, R = 2 Cal]

Space for Rough work

31. What is the kinetic energy of one mole of helium gas at 10000 K in kJ mol^{-1} unit?

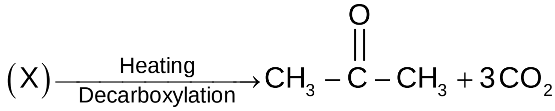
32. Optically active chloride $(P) \xrightarrow{KOH} (Q)$

$$(Q) \xrightarrow[\text{Heat}]{\text{Conc.}H_2SO_4} \underset{\text{Major}}{(R)} + \underset{\text{Minor}}{(S)}$$

$$(R) \xrightarrow{\text{Ozonolysis}} (T) + (U)$$

'Q' forms a hydrocarbon when treated with C_2H_5MgBr. 'U' is the simple aliphatic aldehdye that give aldol condensation. (T) is acetophenone. What is the molar mass of (P) in gram unit?

33.



$$(X) \xrightarrow[\text{Decarboxylation}]{\text{Heating}} CH_3 - \overset{\overset{\displaystyle O}{||}}{C} - CH_3 + 3CO_2$$

One mole of (X) on heating produces one mole of acetone and three moles of CO_2. The tri-sodium salt of the keto acid (X) reacts with CH_3COCl in presence of pyridine to form acid anhydride. How much CH_3COCl in gram can be completely consumed by one mole of the tri-sodium salt of (X)?

34.

$$\underset{\text{metal chloride}}{(P)} \xrightarrow{NaOH} \underset{\text{green ppt.}}{(Q)\downarrow} \xrightarrow{\text{Excess NaOH}} \underset{\text{green solution}}{(R)}$$

$$\underset{\text{Soln}}{(R)} \xrightarrow{H_2O_2} \underset{\text{yellow soln}}{(S)} \xrightarrow[BaCl_2]{CH_3COOH} \underset{\text{yellow ppt.}}{(T)\downarrow}$$

What is the molar mass of (P) in gram unit?

35. Electrolysis of molten $CuSO_4$ is carried out in an electrolytic cell, using inert electrodes. How many gram of copper will be deposited at cathode by passing 14 F of electricity through the cell?

36. How many gram of magnesium carbonate ($MgCO_3$) can be completely dissolved in 3.26 litre of 5 M HCl solution according to the following reaction?

$$MgCO_3 + 2HCl \longrightarrow MgCl_2 + CO_2 + H_2O$$

Space for Rough work

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. If $f(x) = 2x - \sin x$ and $g(x) = \sqrt[3]{x}$, then

(A) range of gof is R
(B) gof is one – one
(C) both f and g are one – one
(D) both f and g are onto

38. $\lim\limits_{x\to\infty} \sqrt{x}\left(\sqrt{x+1} - \sqrt{x}\right)$ equals

(A) $\lim\limits_{x\to 0} \frac{\ln(1+x) - x}{x^2}$
(B) $\lim\limits_{x\to 0} \frac{1-\cos x}{x^2}$
(C) $\lim\limits_{x\to 0} \frac{\sqrt{1+x} - 1}{x}$
(D) $\lim\limits_{x\to 0} \frac{\sqrt{x}}{\sqrt{x + \sqrt{x^2 + 2x}}}$

39. If $f(x) = \begin{cases} \int_0^x \left(1 + |1-t|\right)dt, & x > 2 \\ 5x + 1, & x \le 2 \end{cases}$, then

(A) f(x) is not continuous at x = 2
(B) f (x) is continuous but not differentiable at x = 2
(C) f (x) is differentiable everywhere
(D) the right derivative of $f(x)$ at x = 2 does not exist

40. If $f(x) = \begin{vmatrix} n & n+1 & n+2 \\ {}^{n}P_{n} & {}^{n+1}P_{n+1} & {}^{n+2}P_{n+2} \\ {}^{n}C_{n} & {}^{n+1}C_{n+1} & {}^{n+2}C_{n+2} \end{vmatrix}$, where the symbols have their usual meanings, then $f(x)$ is divisible by

(A) $n^2 + n + 1$
(B) $(n+1)!$
(C) $n!$
(D) $n^2 + 3n + 1$

Space for Rough work

41. The solution/s of the equation $9\cos^{12}x + \cos^2 2x + 1 = 6\cos^6 x\cos 2x + 6\cos^6 x - 2\cos 2x$ is/are

(A) $x = n\pi + \frac{\pi}{2}, n \in I$
(B) $x = n\pi \pm \cos^{-1}\sqrt[4]{\frac{2}{3}}, n \in I$
(C) $x = n\pi \pm \cos^{-1}\sqrt{\frac{2}{3}}, n \in I$
(D) $x = n\pi, n \in I$

42. If a straight line through a point $P(\alpha, 2), \alpha \neq 0$, meets the ellipse $\frac{x^2}{9} + \frac{y^2}{4} = 1$ at A and D and x – and y–axes at B and C respectively such that $PA \times PD = PB \times PC$, then '$\alpha$' can lie in the interval

(A) $[7, \infty)$
(B) $(-12, -8)$
(C) $(-5, 0)$
(D) $(10, \infty)$

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 43 and 44

Let $a_1, a_2, a_3, \ldots$ be a harmonic progression such that $a_1 = 5$ and $a_{20} = 25$.

43. The value of n for which a_n is maximum is

(A) 22
(B) 23
(C) 24
(D) 25

44. The least value of n for which $a_n < 0$ is

(A) 22
(B) 23
(C) 24
(D) 25

Space for Rough work

Paragraph for Question Nos. 45 and 46

Let $A(4,-2)$ and $B(0,1)$ be two points on a parabola, the normals at which intersect at the point $P(2,2)$.

45. The equation of the directrix of the parabola is

(A) $x+y+1=0$ (B) $x=2$

(C) $y=-3$ (D) $2x+y-1=0$

46. The focus of the parabola is

(A) $\left(\frac{6}{5},-\frac{6}{5}\right)$ (B) $\left(\frac{16}{5},-\frac{7}{5}\right)$

(C) $\left(\frac{12}{5},\frac{6}{5}\right)$ (D) $\left(-\frac{6}{5},\frac{6}{5}\right)$

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

47. If $2 < x^2 < 3$, then the positive root of $\left\{x^2\right\} = \left\{\frac{1}{x}\right\}$, (where {x} denotes the fractional part of x) is equal to

48. Let $L = \lim_{x\to 0}\left(\left[\frac{100x}{\sin x}\right]+\left[\frac{99\sin x}{x}\right]\right)$, where [.] denotes the greatest integer function. The number of divisors of L is equal to

Space for Rough work

49. If $f(x)+f(y)=f\left(\dfrac{x+y}{1-xy}\right)$ for all $x, y \in R$, $xy \neq 1$ and $\lim\limits_{x\to 0}\dfrac{f(x)}{x}=2$, then the value of $\dfrac{f\left(\sqrt{3}\right)}{f'(-2)}$ is

50. The number of solutions of the equation $\sin\left(\dfrac{x}{2}\right)+2\pi x=x^2+\pi^2+1$ is

51. The minimum value of $(\tan A-\cos B)^2+(\cot A-\sin B)^2$, where A and B are independent variables, is of the form $a-b\sqrt{c}$, where a, b, c are natural numbers. The value of $a+b+c$ is equal to

52. The smallest value of 'a' for which the inequality $(a-1)x^2-(a+1)x+(a-1)\geq 0$ holds for all $x \geq 2$, is equal to

53. Three distinct dice are thrown and the sum of the numbers appearing on the top faces is 12. If n is the number of ways in which this is possible, the sum of the digits of n is equal to

54. The papers of 4 students can be checked by any one of the 7 teachers. If the probability that all the 4 papers are checked by exactly 2 teachers is A, then the value of 50A is equal to

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – II

JEE (Advanced)-2019

PAPER – 1

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. AC

Sol. $F = \frac{16kQqx}{d^3} = \frac{4Qqx}{\pi\varepsilon_o d^3}$

$a = -\frac{F}{m} = -\frac{4Qqx}{\pi\varepsilon_p md^3}$; $T = 2\pi\sqrt{\frac{\pi\varepsilon_o md^3}{4Qq}}$

2. BC

Sol. As $\lambda_0 = \frac{hc}{eV}$ and as V increases. λ_0 decreases but characteristic wavelengths do not change so interval between $\lambda_{k\alpha} \,\&\, \lambda_0$ increases and the same for the interval between $\lambda_{k\beta} \,\&\, \lambda_0$

3. ABC

Sol. e = a

And $\rho = \frac{m}{v}$

4. ABD

Sol. Bernoulli's theorem for an orifice at depth 'x' in liquid '3d'.

$P_o + \left(dg\frac{H}{2} + 3dg.x\right) = P_o + \frac{1}{2} \times 3d \times v^z$ …(1)

$$\frac{H}{2} - x = \frac{1}{2}gt^2 \qquad \ldots(2)$$

$$R = Vt \qquad \ldots(3)$$

Solve for R and apply maxima/minima.

5. ABCD

Sol. Due to rotation no potential difference will be across the end.

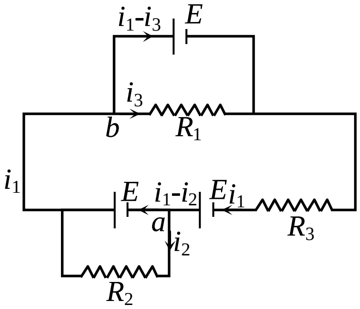
6. B

Sol. Consider three more identical surfaces, such that a square shaped cylinder is formed with point charge at the centre. Flux will be equally divided between these surfaces.

7. B

8. A

Sol. (for Q. 7 & Q. 8)



On solving by KVL we get, $i_1 = \frac{E}{R}$, $i_2 = -\frac{E}{R}$

$i_3 = \frac{E}{R}$

$\Rightarrow\ i_1 - i_2 = \frac{2E}{R}$ and $i_1 - i_3 = 0$

So reading of ammeter A_1 is $E/R = 4/3$

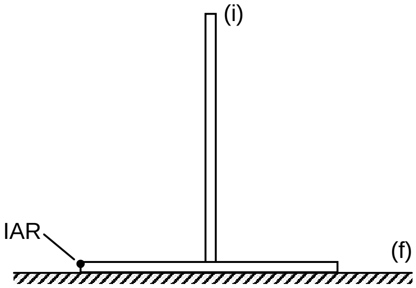
A_2 is $2E/R = 8/3$, A_3 is zero and $\Delta V_{ab} = 4V$

9. B

Sol. $K_f = mg\frac{\ell}{2}$

and $\frac{1}{2}\ m\frac{\ell^2}{3}\omega^2 = mg\frac{\ell}{2}$

$\Rightarrow\ \omega = \sqrt{\frac{3g}{\ell}}$



10. B

Sol. $K_f = mg\frac{\ell}{2}$

SECTION – D

11. 00125.00

Sol. Energy required = $\frac{1}{2}mv^2 = \frac{1}{2} \times 10 \times 5 \times 5$ = 125 J.

12. 00009.00

Sol. $a = \mu g$

$6^2 = 0^2 + 2 \times \mu g S$

13. 00015.00

Sol. $V_B \cos\theta_B = V_A \cos\theta_A \Rightarrow V_B = 15\,m/s$

14. 00000.60

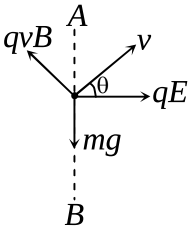
Sol. $\frac{2}{3}MR_1^2 = \frac{2}{5}MR_2^2$

15. 00002.50

Sol. EPE per unit volume = $\frac{1}{2} \times \text{stress} \times \text{strain}$

16. 00019.60

Sol. When crosses *AB*



$qvB_0 \cos\theta = mg$

$qvB_0 \sin\theta = qE$

$\tan\theta = \frac{qE}{mg} = 1$

$\theta = \frac{\pi}{4}$

along horizontal $v\cos\theta = \frac{qE}{m}t_0$

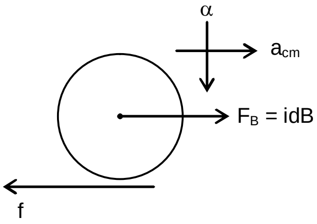
$u - gt_0 = v\sin\theta$

$u = \left(g + \frac{qE}{m}\right)t_0 = 2gt_0$

17. 00002.00

Sol. $f = \frac{F}{3} = \frac{idB}{3}$

$\Rightarrow \frac{48 \times 0.5 \times 0.25}{3} = 2.00$



18. 00000.39

Sol. Applying Snell's law between the points *O* and *P*, we have

$2 \times \sin 60^0 = \left(\sin 90^0\right) \times \frac{2}{\left(1 + H^2\right)}$, $2 \times \frac{\sqrt{3}}{2} = 1 \times \frac{2}{\left(1 + H^2\right)}$

$\left(1 + H^2\right) = \frac{2}{\sqrt{3}}$, $H = \sqrt{\left(\frac{2}{\sqrt{3}} - 1\right)}$

Chemistry

PART – II

SECTION – A

19. ABC

Sol. PCl_5 has trigonal pyramidal structure.

20. ACD

Sol. The ratio of [salt] to [acid] or [base] should be 1 : 10 or 10 : 1 for buffer solution.

21. BCD

Sol. $CH_3CH = CH_2$ will form alcohol upon hydrolysis.

22. BCD

Sol. Silicones contain carbon, silicone and oxygen. Silanes and selenes contain silicone and hydrogen.

23. B

Sol. It contains no complex ions.

24. ABC

Sol. The precipitate is $Fe_4[Fe(CN)_6]_3$.

25. C

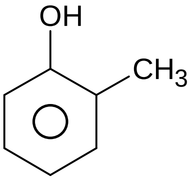
Sol. $D = \frac{\text{mol.mass of } SO_3}{2} = \frac{80}{2} = 40$

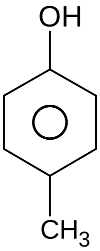
26. C

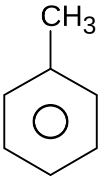
Sol. $\alpha = \frac{40 - 30}{(1.5 - 1)30} = \frac{10}{15} = 0.66$

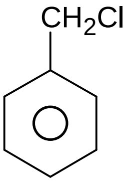
27. D

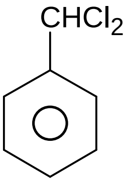
Sol.

P =


Q =


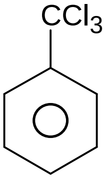
R =


S =


T =


28. B

Sol.

U =


SECTION – D

29. 00348.16

Sol. $I.E_4 \text{ of Be} = \left(\frac{Z^2}{n^2} \times 13.6 \times 1.6 \times 10^{-19}\right) J$

$= 16 \times 13.6 \times 1.6 \times 10^{-19} = 348.16 \times 10^{-19}$

$= Y \times 10^{-19}$ J

$\therefore$ Y = 348.16

30. 33088.40

Sol. $\Delta H = nC_P\Delta T = 5 \times 4R \times (1727.21 - 900)$

$= 5 \times 4 \times 2 \times 827.21 = 33088.40$ Cal

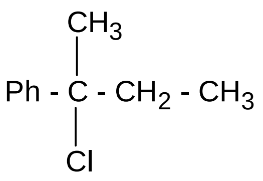
31. 00124.71

Sol. $K.E = \frac{3}{2}nRT = \frac{3}{2} \times 1 \times 8.314 \times 10^{-3} \times 10000 = 124.71$ kJ

32. 00168.50

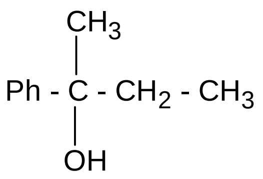
Sol.

P =



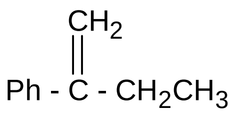
$Ph-\overset{\displaystyle CH_3}{\underset{\displaystyle Cl}{C}}-CH_2-CH_3$

Q =



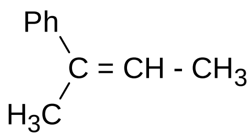
$Ph-\overset{\displaystyle CH_3}{\underset{\displaystyle OH}{C}}-CH_2-CH_3$

S =



$Ph-\overset{\displaystyle CH_2}{\overset{\|}{C}}-CH_2CH_3$

R =

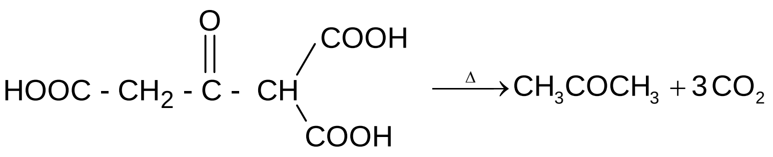


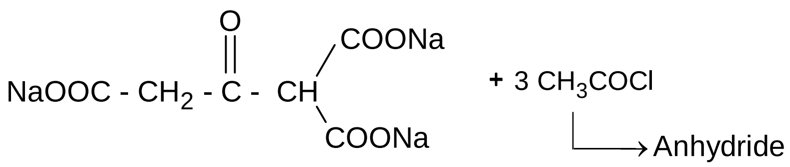
T = $PhCOCH_3$, U = CH_3CHO

33. 00235.50

Sol.

X is





E.g. $RCOONa + CH_3COCl \xrightarrow{Py} RCOOCOCH_3 + HCl$

34. 00158.50

Sol. P = $CrCl_3$

Q = $Cr(OH)_3$

R = $[Cr(OH)_4]^-$

S = Na_2CrO_4

T = $BaCrO_4$

35. 00444.50

Sol. $Cu^{2+} + 2e^{-} \longrightarrow Cu$

2F deposits one mole

14 F will deposit 7 mole

Mass of Cu = 7 × 63.5 = 444.5 g

36. 00684.60

Sol. Moles of HCl = $\frac{M \times V}{1000} = \frac{5 \times 3.26 \times 1000}{1000} = 16.3$

Moles of $MgCO_3$ = $\frac{16.3}{2} = 8.15$

Mass of $MgCO_3$ = 8.15 × 84 = 684.6 g

Mathematics PART – III

SECTION – A

37. ABCD

Sol. $(gof)(x) = (2x - \sin x)^{1/3}$

Range of (gof) (x) is R.

38. BC

Sol. $\lim\limits_{x\to\infty} \sqrt{x}\left(\sqrt{x+1} - \sqrt{x}\right)$

$$= \lim_{x\to\infty} \frac{\sqrt{x}}{\sqrt{x+1}+\sqrt{x}} = \lim_{x\to\infty} \frac{1}{\sqrt{1+\frac{1}{x}}+1} = \frac{1}{2}$$

Option (A): $\lim\limits_{x\to 0} \dfrac{\ln(1+x)-x}{x^2} = \lim\limits_{x\to 0} \dfrac{\left(x - \frac{x^2}{2} + \frac{x^3}{3} - ...\right) - x}{x^2} = -\dfrac{1}{2}$

Option (B): $\lim\limits_{x\to 0} \dfrac{1-\cos x}{x^2} = \lim\limits_{x\to 0} \dfrac{2\sin^2 \frac{x}{2}}{4\times\left(\frac{x}{2}\right)^2} = \dfrac{1}{2}$

Option (C): $\lim\limits_{x\to 0} \dfrac{\sqrt{1+x}-1}{x} = \lim\limits_{x\to 0} \dfrac{(1+x)^{1/2} - (1)^{1/2}}{(1+x)-1} = \dfrac{1}{2}$

Option (D): $\lim\limits_{x\to 0} \dfrac{\sqrt{x}}{\sqrt{x+\sqrt{x^2+2x}}} = \lim\limits_{x\to 0} \dfrac{1}{\sqrt{1+\sqrt{1+\frac{2}{x}}}} = \dfrac{1}{\sqrt{2}}$

39. AD

Sol. $f(x) = \int_0^x (1+|1-t|)\,dt,\ x > 2$

$$= \int_0^1 (2-t)\,dt + \int_1^x t\,dt = \frac{1}{2}x^2 + 1$$

We have, $f(x) = \begin{cases} \frac{1}{2}x^2 + 1, & x > 2 \\ 5x + 1, & x \le 2 \end{cases}$

$\therefore \lim\limits_{x\to 2^+} f(x) = 3$ and $\lim\limits_{x\to 2^-} f(x) = 11$

Hence, f(x) is not continuous at x = 2.

$$Rf'(2) = \lim_{h\to 0} \frac{f(2+h) - f(2)}{h}$$

$$= \lim_{h\to 0} \frac{\frac{1}{2}(2+h)^2 + 1 - 11}{h}$$

$$=\lim_{h\to 0}\frac{(2+h)^2-20}{2h}\to\pm\infty$$

40. AC

Sol. $f(x)=\begin{vmatrix} n & n+1 & n+2 \\ {}^nP_n & {}^{n+1}P_{n+1} & {}^{n+2}P_{n+2} \\ {}^nC_n & {}^{n+1}C_{n+1} & {}^{n+2}C_{n+2}\end{vmatrix}=\begin{vmatrix} n & n+1 & n+2 \\ n! & (n+1)! & (n+2)! \\ 1 & 1 & 1\end{vmatrix}$

Applying $C_2\to C_2-C_1$ and $C_3\to C_3-C_1$, we get

$$f(x)=\begin{vmatrix} n & 1 & 2 \\ n! & n.n! & (n^2+3n+1).n! \\ 1 & 0 & 0\end{vmatrix}=n!(n^2+n+1)$$

41. AB

Sol. $9\cos^{12}x+\cos^2 2x+1-6\cos^6 x\cos 2x-6\cos^6 x+2\cos 2x=0$

$\Rightarrow\quad (3\cos^6 x-1-\cos 2x)^2=0$

$\Rightarrow\quad \cos^2 x(3\cos^4 x-2)=0$

$\Rightarrow\quad \cos x=0$

$x=n\pi+\frac{\pi}{2},\ n\in I$

or $\quad \cos^4 x=\frac{2}{3}$

$\cos x=\pm\sqrt[4]{\frac{2}{3}}$

$x=m\pi\pm\cos^{-1}\sqrt[4]{\frac{2}{3}},\ m\in I$

42. ABD

Sol. Let any point on the line through P be $x=\alpha+r\cos\theta,\ y=2+r\sin\theta$.

Put this in $\frac{x^2}{9}+\frac{y^2}{4}=1$ and $xy=0$.

$PA\times PD=PB\times PC$

$\Rightarrow\ 2\alpha\sin 2\theta+5\cos 2\theta=13$

$\Rightarrow\ 13\le\sqrt{4\alpha^2+25}$

43. C

44. D

Sol. (for Q. 43 & Q. 44)

Let $b_k=\frac{1}{a_k}$.

$b_1, b_2, b_3, \ldots$ are in A.P. with $b_1=\frac{1}{5},\ b_{20}=\frac{1}{25}$

If d is the common difference of this A.P. then $19d == \frac{1}{25} - \frac{1}{5} = -\frac{4}{25}$

$d = -\frac{4}{475}$

$b_n = b_1 + (n-1)d = \frac{1}{5} - \frac{4(n-1)}{475} = \frac{99-4n}{475}$

$\Rightarrow \ a_n = \frac{475}{99-4n}$

Note that a_n is maximum if $99-4n > 0$ and $99-4n$ is least

$\Rightarrow \ n < \frac{99}{4} \Rightarrow n \le 24$

Thus, a_n is maximum for $n = 24$.

Also, $a_n < 0$ if $99 - 4n < 0$

$\Rightarrow \ n > \frac{99}{4} \Rightarrow n \ge 25$

Thus, least value of n for which $a_n < 0$ is 25.

45. C

46. B

Sol. (for Q 45 & Q. 46)

The normals at A and B are perpendicular. Hence, AB is a focal chord. Use

(1) The directrix is perpendicular to the line joining the mid-point of a focal chord and the point of intersection of tangents or normals at the ends of the focal chord.

(2) The focus is the foot of the perpendicular from the point of intersection of tangents to the focal chord.

SECTION – D

47. 00001.62

Sol. $2 < x^2 < 3 \ \Rightarrow \ \{x^2\} = x^2 - [x^2] = x^2 - 2$

Also, $\sqrt{2} < x < \sqrt{3}$

or $\frac{1}{\sqrt{3}} < \frac{1}{x} < \frac{1}{\sqrt{2}}$

$\therefore$ $\left\{\frac{1}{x}\right\} = \frac{1}{x}$

Hence, $x^2 - 2 = \frac{1}{x}$

or $x^3 - 2x - 1 = 0$

or $(x+1)(x^2 - x - 1) = 0$

$\therefore$ $x = \frac{1+\sqrt{5}}{2}$ $(\because x > 0)$

48. 00008.00

Sol. For $x > 0$, $\sin x < x$

$\Rightarrow \quad \frac{\sin x}{x} < 1$

For $x < 0$, $\sin x > x$

$\Rightarrow \quad \frac{\sin x}{x} < 1$

Hence, $\lim\limits_{x\to 0}\left(\left[\frac{100x}{\sin x}\right]+\left[\frac{99\sin x}{x}\right]\right)=100+98=198$

49. 00005.24

Sol. Given, $f(x)+f(y)=f\left(\frac{x+y}{1-xy}\right)$

Putting x = 0, y = 0, we get f (0) = 0 ………………..(i)

and putting y = –x, we get

$f(x)+f(-x)=f(0)=0$

$\therefore \quad f(x)=-f(-x)$ ……………….(ii)

Now, $f'(x)=\lim\limits_{h\to 0}\frac{f(x+h)-f(x)}{h}$

$=\lim\limits_{h\to 0}\frac{f(x+h)+f(-x)}{h}$ [from Eq. (ii)]

$=\lim\limits_{h\to 0}\frac{f\left(\frac{x+h-x}{1+(x+h)x}\right)}{h} \quad =\lim\limits_{h\to 0}\frac{f\left(\frac{h}{1+x^2+xh}\right)}{\left(\frac{h}{1+x^2+xh}\right).\left(1+x^2+xh\right)}$

$\Rightarrow \quad f'(x)=\frac{2}{1+x^2} \qquad \left(\because \lim\limits_{x\to 0}\frac{f(x)}{x}=2\right)$

$\therefore f'(-2)=\frac{2}{1+4}=\frac{2}{5}$

and $\quad f(x)=2\tan^{-1}x+c$

$f(0)=0+c=0$

$\therefore \quad$ c = 0

$\therefore \quad f(x)=2\tan^{-1}x$

$\Rightarrow \quad f\left(\sqrt{3}\right)=2\tan^{-1}\sqrt{3}=\frac{2\pi}{3}$

50. 00001.00

Sol. $\sin\left(\frac{x}{2}\right)-1=x^2-2\pi x+\pi^2$

$\Rightarrow \sin\left(\frac{x}{2}\right)-1=(x-\pi)^2$

LHS ≤ 0 and RHS ≥ 0.

Then solution is obtained if LHS = RHS = 0 and $x=\pi$ satisfies both.

51. 00007.00

Sol. The given expression can be interpreted as the square of the distance between the points $(\tan A, \cot A)$ and $(\cos B, \sin B)$.

The minimum value of this distance is the minimum distance between the curves $xy = 1$ and $x^2 + y^2 = 1$.

52. 00002.33

Sol. $a(x^2 - x + 1) - (x^2 + x + 1) \geq 0$

$$\Rightarrow a \geq \frac{x^2 + x + 1}{x^2 - x + 1} \text{ or } a \geq \frac{(x^2 - x + 1) + 2x}{x^2 - x + 1}$$

$$\Rightarrow a \geq 1 + \frac{2x}{x^2 - x + 1} \text{ or } a \geq 1 + \frac{2}{\left(x + \frac{1}{x}\right) - 1}$$

Now, for $x \geq 2$, the minimum value of $x + \frac{1}{x}$ is $\frac{5}{2}$.

$$\Rightarrow a \geq \frac{7}{3}$$

53. 00007.00

Sol. $x_1 + x_2 + x_3 = 12$

$t_1 + t_2 + t_3 = 9$ Total solutions $(t_i = x_i - 1)$

$y_1 + t_2 + t_3 = 3$ Extra solutions $(y_1 = t_1 - 6)$

54. 00006.12

Sol. Total number of ways in which papers of 4 students can be checked by seven teachers $= 7^4$

Now, number of ways of choosing 2 teachers out of 7 is $^7C_2 = 21$

Number of ways in which 4 papers can be checked by exactly two teachers $= 2^4 - 2 = 14$

$\therefore$ Favourable ways $= (21)(14)$

$\therefore$ Required probability $= \frac{(21)(14)}{7^4} = \frac{6}{49}$.

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – II

JEE (Advanced)-2019

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01 – 06, 19 – 24, 37 – 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 – 46) *contains 12 questions. Each question has* ***TWO (02)*** *matching lists:* ***LIST-I*** *and* ***LIST-II***. ***FOUR*** *options are given representing matching of elements from* ***LIST-I*** *and* ***LIST-II***. ***ONLY ONE*** *of these four options corresponds to a correct matching.*
   For each question, choose the option corresponding to the correct matching.
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

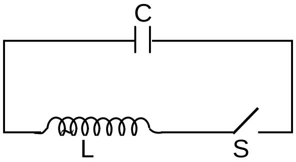
Physics

PART – I

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. In the given circuit, initially the charge on capacitor is Q_0. At t = 0 switch S is closed. Which of the following statement(s) is/are correct?



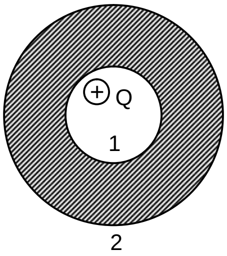
(A) Maximum current through the inductor is $\frac{Q_0}{\sqrt{LC}}$

(B) Charge on the capacitor is zero at $t = \frac{\pi}{2}\sqrt{LC}$

(C) Current through the inductor is maximum at $t = \frac{\pi}{2}\sqrt{LC}$

(D) Maximum magnetic energy can be stored in the inductor is $\frac{Q_0^2}{2C}$

2. The positive charge Q is placed in the cavity of the spherical conductor.

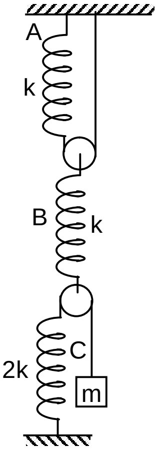


(A) the induced charge at the surface 1 is –Q and on the surface 2 is +Q
(B) the surface charge density at inner surface is uniform
(C) the surface charge density at the outer surface is uniform
(D) the charge Q does not experience electric force if it is placed at the centre of the spherical cavity.

3. In case of earth:
(A) Potential is minimum at the centre of earth
(B) Potential is same, both at centre and infinity but not zero
(C) Potential is zero, both at centre and infinity
(D) Field is zero, both at centre and infinity

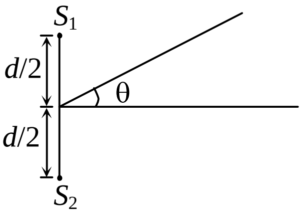
Space for Rough work

4. In the given figure, the block is attached with a system of three ideal springs A, B, C. The block is displaced by a small distance x from its equilibrium position vertically downwards and released. T represents the time period of small vertical oscillations of the block. Then (pulleys are ideal)



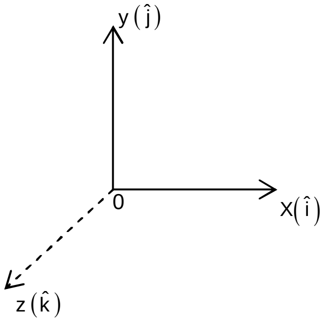
(A) $T = 2\pi\sqrt{\frac{11m}{2k}}$
(B) the deformation of the spring A is (2/11) times the displacement of the block.
(C) the deformation of the spring C is (1/11) times the displacement of the block.
(D) the deformation of the spring B is (4/11) times the displacement of the block.

5. In an interference arrangement, similar to Young's double slit experiment, the slits S_1 and S_2 are illuminated with coherent microwave sources, each of frequency 10^6 Hz. The sources are synchronized to have zero phase difference. The slits are separated by distance d = 150.0 m. The intensity $I_{(\theta)}$ is measured as a function of θ, where θ is defined as shown in the figure. If I_0 is maximum intensity, then $I_{(\theta)}$ for $0 \le \theta \le 90$ is given by



(A) $I_{(\theta)} = I_0$ for $\theta = 0°$
(B) $I_{(\theta)} = (I_0 / 2)$ for $\theta = 30°$
(C) $I_{(\theta)} = (I_0 / 4)$ for $\theta = 90°$
(D) $I_{(\theta)}$ is constant for all values of θ

6. A particle is projected from origin with velocity $\vec{u} = \left(\hat{i} + \hat{j} + \sqrt{2}\hat{k}\right)$ m/s. Horizontal surface lies in X – Y plane, then (take g = 10 m/sec^2)



(A) Time of flight = $\frac{\sqrt{2}}{5}$ sec
(B) horizontal range = $\frac{2}{5}$ m
(C) Maximum height $\frac{1}{10}$ m
(D) Maximum height = $\frac{1}{5}$ m

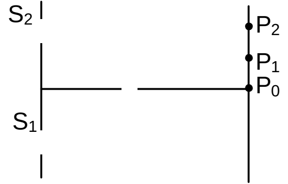
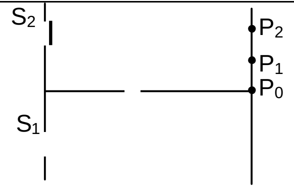
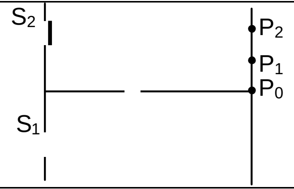
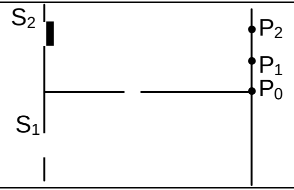
Space for Rough work

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

---

7. List-I shows four situations of standard young's double slit arrangement with screen placed far away from the slits S_1 and S_2. In each of these cases $S_1P_0 = S_2P_0$, $S_1P_1 - S_2P_1 = \lambda/4$ and $S_1P_2 - S_2P_2 = \lambda/3$, where λ is the wavelength of the light used. In the cases B, C and D, a transparent sheet of refractive index μ and thickness t is pasted on slit S_2. The thickness of the sheets are different in different cases. The phase difference between the light waves reaching a point P on the screen from the two slits is denoted by $\delta(p)$ and the intensity by I(p). Match each situation given in List-I with the statement(s) in List-II

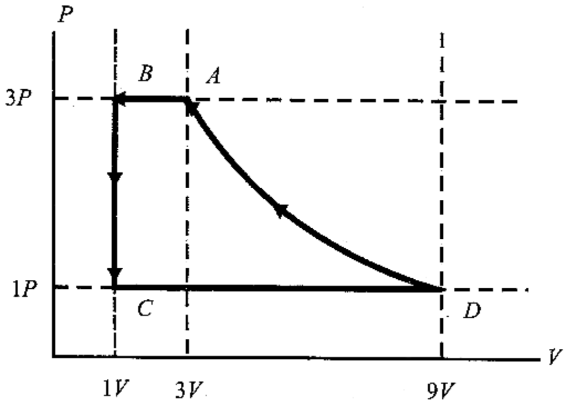
List - I			List - II	
(P)			(1)	$\delta(P_0) = 0$
(Q)	$(\mu - 1)t = \lambda / 4$		(2)	$\delta(P_1) = 0$
(R)	$(\mu - 1)t = \lambda / 2$		(3)	$I(P_1) = 0$
(S)	$(\mu - 1)t = 3\lambda / 4$		(4)	$I(P_0) > I(P_1)$
			(5)	$I(P_2) > I(P_1)$

The correct option is:

(A) P→1,4 ; Q→3 ; R→5 ; S→3,5
(B) P→1,3 ; Q→4 ; R→5 ; S→3,4,5
(C) P→1,4 ; Q→2 ; R→3 ; S→3,4,5
(D) P→1,2 ; Q→5 ; R→4 ; S→1,5

Space for Rough work

8. One mole of a monatomic ideal gas is taken through a cycle ABCDA as shown in the P-V diagram. Column II gives the characteristics involved in the cycle. Match them with each of the processes given in Column I.



List – I		List – II	
(P)	Process A → B	(1)	Internal energy decreases
(Q)	Process B → C	(2)	Internal energy increases
(R)	Process C → D	(3)	Heat is lost
(S)	Process D → A	(4)	Heat is gained
		(5)	Work is done on the gas

The correct option is:

(A) P→1,3,5 ; Q→1,3 ; R→2,4 ; S→3,5 (B) P→1,2,5 ; Q→1,2 ; R→4 ; S→3,5
(C) P→1,5 ; Q→1,3 ; R→2,4 ; S→4,5 (D) P→3,5 ; Q→1,4 ; R→2,3 ; S→2,4

9. Average speed of a bus measured by six different students is given as follows:

Student number	1st	2nd	3rd	4th	5th	6th
Speed (m/s)	12.5 m/s	12.3 m/s	11.8 m/s	12.4 m/s	12.2 m/s	12.6 m/s

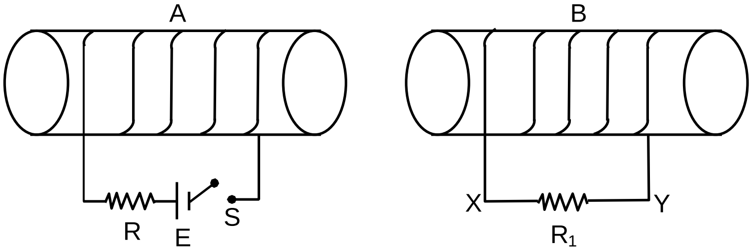
List -I		List -II	
(P)	Mean absolute error	(1)	± 0.2
(Q)	Mean value	(2)	12.3 m/s
(R)	Relative error	(3)	± 0.0163
(S)	Percentage error	(4)	± 1.63 %

The correct option is:

(A) P→3 ; Q→1 ; R→2 ; S→4 (B) P→1 ; Q→2 ; R→3 ; S→4
(C) P→1 ; Q→3 ; R→4 ; S→2 (D) P→1 ; Q→4 ; R→3 ; S→2

Space for Rough work

10. In the circuit shown in figure two coils are arranged as shown. In List-I, some operation which is carried out in circuit I is mentioned and in List-II about its effect. Match the entries of List – I with the entries of List–II.



List – I		List – II	
(P)	Switch S is closed (exclude small switching time)	(1)	Current in R_1 is form X to Y.
(Q)	Switch S is closed for long time then it opened for this transition time.	(2)	Current in R_1 is form Y to X
(R)	If coil A is move, perpendicular to B, switch S is closed.	(3)	No current is flowing through R_1.
(S)	The battery of constant emf is replaced by a varying emf and switch S is closed.	(4)	Current in R_1 can be from X to Y or form Y to X.
		(5)	Coil B will attract coil A

The correct option is:

(A) P→2 ; Q→1, 3 ; R→5 ; S→4
(B) P→3 ; Q→2 ; R→2, 5 ; S→3,4
(C) P→3 ; Q→4 ; R→1, 2 ; S→4
(D) P→1 ; Q→2, 5 ; R→2, 5 ; S→4

SECTION – D

(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

11. Two blocks of masses 2kg and 5kg are connected by a light string passing over a frictionless pulley. Find the tension (in Newton) in the cord connecting the masses. (G = 9.8 M/S^2)

12. A bullet losses 19% of its kinetic energy when passes through an obstacle. Find the fractional change in its speed

Space for Rough work

13. A 10 m wide spacecraft moves through the interstellar space at a speed 3×10^6 m/s. A magnetic field $B = 3 \times 10^{-9}$ T exists in the space in a direction perpendicular to the plane of motion. Treating the spacecraft as a conductor, calculate the emf induced across its width. (in volt)

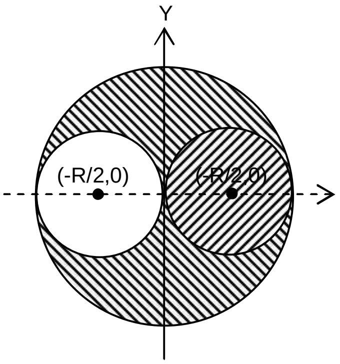
14. The refractive index for water w.r.t. air for a sound wave if the velocities of sound in water and air are 1440 ms^{-1} and 340ms^{-1}, is approximately,

15. Two glass plates are separated by water. If surface tension of water is 75 dynes per cm and area of each plate wetted by water is 8 cm^2 and the distance between the plates is 0.12 mm, then the force (in newton) applied to separate the two plates is

16. An organ pipe P_1 closed at one end vibrating in its first overtone and another pipe P_2 open at the both ends vibrating in its third overtone are in resonance with a given tuning fork. The ratio of the length of P_1 to that of P_2 is $\frac{3}{n}$ then n = ?

17. Gravitational filed in a region is given by $\vec{E} = \left(3\hat{i} - 4\hat{j}\right)$ N/kg. Find out the work done (in J) in displacing a particle of mass 1 unit by 1m along the line 4y = 3x + 9?

18. Figure shows a uniform disc of radius R from which a hole of radius R/2 has been cut out from left of the centre and is placed on right of the centre of disc. The centre of mass of resulting disc is at a distance R/n from centre of uniform disc. Find the value of n



Space for Rough work

Chemistry PART – II

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. The paramagnetic species out of the following is/are

(A) O_2^+ (B) N_2^+

(C) O_2^{2-} (D) N_2^{2-}

20. The following data are given for the reaction

$X(g) + Y(g) \longrightarrow \text{Product}$

No. of expt.	Initial concentration of 'X' in 'M'	Initial concentration of 'Y' in 'M'	Rate of reaction in M s^{-1} unit
1.	0.1	0.1	2×10^{-8}
2.	0.2	0.2	4×10^{-8}
3.	0.4	0.2	8×10^{-8}

Choose the correct statement(s) from the following

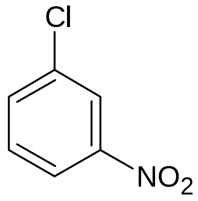
(A) The order of reaction w.r.t X is one

(B) The overall order of reaction is one

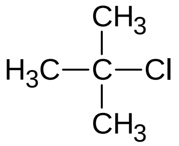
(C) The rate constant of the reaction is 2×10^{-7} s^{-1}

(D) The half-life of 'Y' does not depend on its concentration

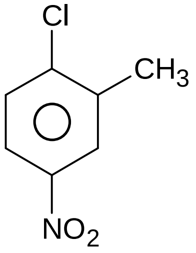
21. In which of the following compound(s) the C – Cl bond is shorter than that in C_2H_5Cl?

(A) 

(B) $CH_2 = CH – Cl$

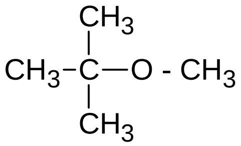
(C) 

$H_3C-C(CH_3)_2-Cl$

(D) 

Space for Rough work

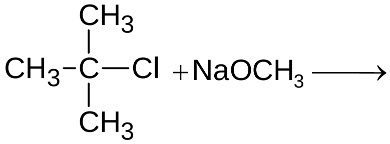
22.



$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-O-CH_3$

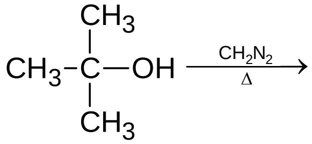
Which of the following reaction(s) form the above compound?

(A)



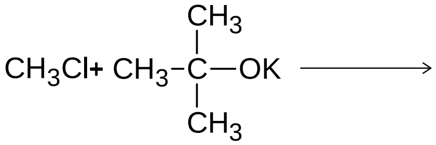
$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-Cl + NaOCH_3 \longrightarrow$

(B)



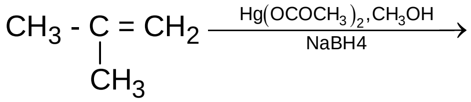
$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-OH \xrightarrow[\Delta]{CH_2N_2}$

(C)



$CH_3Cl + CH_3-\underset{CH_3}{\overset{CH_3}{C}}-OK \longrightarrow$

(D)



$CH_3-\underset{CH_3}{C}=CH_2 \xrightarrow[NaBH4]{Hg(OCOCH_3)_2, CH_3OH}$

23. Which of the following statements is/are true about an azeotropic mixture?
(A) An azeotropic mixture boils at constant temperature
(B) The composition of an azeotropic mixture changes on distillation
(C) An azeotropic solution of two liquids has a boiling point lower than that of either of them when it shows positive deviation from the Raoult's law
(D) An azeotropic solution of two liquids has a boiling point higher than that of either of them if it shows positive deviation from Raoult's law

24. Which of the following statements is / are correct
(A) The coordination number of each type of ion in CsCl crystal is 8
(B) A metal that crystallizes in bcc structure has a coordination number of 12
(C) A unit cell of an ionic crystal shares some of its ions with other unit cells
(D) Length of the unit cell in NaCl is 552 pm ($r_{Na^+} = 95pm; r_{Cl^-} = 181pm$)

Space for Rough work

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

---

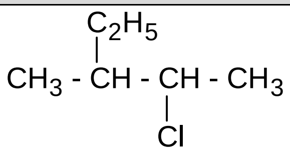
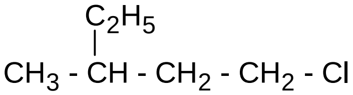
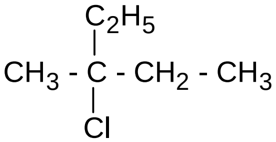
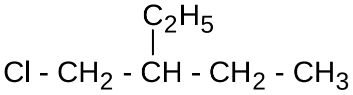
25. Match the bases mentioned in List - I with their properties mentioned in List - II.

List – I		**List – II**	
(P)	LiOH	(1)	Undergoes dehydration on heating to produce normal oxide
(Q)	NaOH	(2)	Used as an antacid
(R)	KOH	(3)	Used to prepare soft soaps
(S)	$Mg(OH)_2$	(4)	Absorbs CO_2 to form a compound which hydrated form is called washing soda

The correct option is

(A) P → 3; Q → 4; R → 1; S → 2
(B) P → 1; Q → 3,4; R → 3; S → 1, 2
(C) P → 2,3; Q → 1; R → 3; S → 4
(D) P → 1; Q → 3,4; R → 2; S → 2,4

26. Match the alkyl chlorides mentioned in List-I with the nature of their elimination reaction products mentioned in List- II.

List – I		**List – II**	
(P)	 $CH_3-CH(C_2H_5)-CH(Cl)-CH_3$	(1)	One product shows geometrical isomerism if formed through E_2 mechanism
(Q)	 $CH_3-CH(C_2H_5)-CH_2-CH_2-Cl$	(2)	One product shows geometrical isomerism if formed through E_1 mechanism
(R)	 $CH_3-C(C_2H_5)(Cl)-CH_2-CH_3$	(3)	One product shows optical isomerism if formed through E_2 mechanism
(S)	 $Cl-CH_2-CH(C_2H_5)-CH_2-CH_3$	(4)	One product shows optical isomerism if produced through E_1 mechanism

The correct option is

(A) P → 3; Q → 4; R → 1; S → 2, 3, 4
(B) P → 2,3; Q → 1,4; R → 3; S → 1, 2
(C) P → 1,2,3,4; Q → 2,3,4; R → 1,2; S → 2
(D) P → 1; Q → 3,4; R → 2; S → 2,4

Space for Rough work

27. Match the compounds mentioned in List -I with their characteristics mentioned in List-II

List – I		List – II	
(P)	CH_3COCl	(1)	Forms CH_3COOH as only or one of the products on hydrolysis
(Q)	$CH_3COOC_2H_5$	(2)	Forms two organic compounds on hydrolysis
(R)	$(CH_3CO)_2O$	(3)	Hydrolysis is irreversible in both acidic and basic medium
(S)	CH_3CONH_2	(4)	Undergoes the easiest nucleophilic substitution reaction among the four compounds

The correct option is

(A) P → 3; Q → 4; R → 1; S → 2
(B) P → 2,3; Q → 3,4; R → 3; S → 1, 2
(C) P → 1,3,; Q → 1,,4; R → 1,2; S → 2
(D) P → 1, 4; Q → 1,2; R → 1; S → 1,3

28. Match the precipitates of the compounds listed in List -I with the solvent(s) listed in List-II.

List – I		List – II	
(P)	$Zn(OH)_2$ precipitate dissolves in	(1)	Potassium cyanide
(Q)	$Cr(OH)_3$ precipitate dissolves in	(2)	Ammonia solution
(R)	AgCl precipitate dissolves in	(3)	Sodium hydroxide
(S)	CuS precipitate dissolves in	(4)	Hydrochloric acid

The correct option is

(A) P → 1, 2, 3, 4; Q → 2, 3, 4; R → 1, 2; S → 1
(B) P → 2,3; Q → 1, 2; R → 3; S → 1, 2
(C) P → 1,3,; Q → 1,,4; R → 1,2; S → 2
(D) P → 2, 3, 4; Q → 3; R → 1; S → 4

Space for Rough work

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

29. The following two reactions attain equilibrium in a container by taking in initially only $FeSO_4$, and O_2 gas is passed then

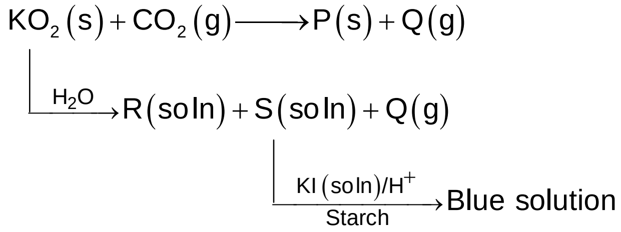
$$2FeSO_4(s) \rightleftharpoons Fe_2O_3(s) + SO_2(g) + SO_3(g); K_{P_1} = 900\,cm^2 \text{ of Hg}$$

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g); K_{P_2} = 25\times10^{-4}\,cm^{-1} \text{ of Hg}$$

What is the equilibrium partial pressure of $O_2(g)$ in cm of Hg unit?

30. The molar mass of the salt MX_2 is 208.3 g. The solubility product of MX_2 is 4×10^{-3}. How many gram of the salt should be dissolved in water to form 10 litre saturated solution?

31.



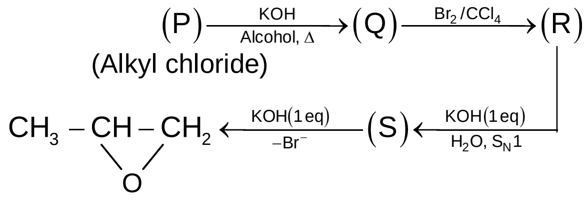
$$KO_2(s) + CO_2(g) \longrightarrow P(s) + Q(g)$$

$$KO_2(s) \xrightarrow{H_2O} R(soln) + S(soln) + Q(g)$$

$$S(soln) \xrightarrow[\text{Starch}]{KI\,(soln)/H^+} \text{Blue solution}$$

What is the molar mass in g of the heaviest unknown product (out of P, Q, R and S) in above reactions?

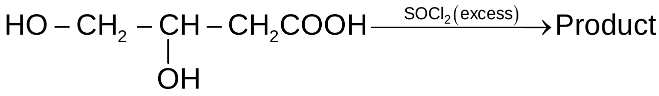
32.



$$\underset{\text{(Alkyl chloride)}}{(P)} \xrightarrow[\text{Alcohol, }\Delta]{KOH} (Q) \xrightarrow{Br_2/CCl_4} (R) \xrightarrow[H_2O,\,S_N1]{KOH(1\,eq)} (S) \xrightarrow[-Br^-]{KOH(1\,eq)} CH_3-\underset{\diagdown O \diagup}{CH-CH_2}$$

How many grams of (P) is required to form one mole of 2, 3-dimethylbutane upon treatment with sodium metal in dry ether?

Space for Rough work

33. 

$$HO-CH_2-\underset{\underset{OH}{|}}{CH}-CH_2COOH\xrightarrow{SOCl_2(excess)}Product$$

What will be the molar mass in gram of the organic product of above reaction?

34. Cr(III) forms an octahedral complex with NH_3 and Cl ligands. The van't Hoff factor of the complex is 2 when it is 100% ionized in water. The complex ion shows geometrical isomerism. What is the molar mass of the complex in gram unit?

35. Calculate the reversible work done at 5000 K in joule unit by compressing one mole of an ideal gas to one-tenth $\left(\frac{1}{10}\right)$ of its original volume in an isothermal process?

36. The molar conductance at infinite dilution of $CaCl_2$, $Ca(CH_3COO)_2$ and HCl are respectively 271.6, 200.8 and 425.95 S cm^2 mol^{-1}. What will be the molar conductance of CH_3COOH in S cm^2 mol^{-1} unit?

Space for Rough work

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. The value of the expression $\tan\frac{\pi}{7}+2\tan\frac{2\pi}{7}+4\tan\frac{4\pi}{7}+8\cot\frac{8\pi}{7}$ is equal to:

(A) $\operatorname{cosec}\frac{2\pi}{7}+\cot\frac{2\pi}{7}$

(B) $\tan\frac{\pi}{14}-\cot\frac{\pi}{14}$

(C) $\dfrac{\sin\frac{2\pi}{7}}{1-\cos\frac{2\pi}{7}}$

(D) $\dfrac{1+\cos\frac{\pi}{7}+\cos\frac{2\pi}{7}}{\sin\frac{\pi}{7}+\sin\frac{2\pi}{7}}$

38. Which of the following pair(s) of function have same graphs?

(A) $f(x)=\frac{\sec x}{\cos x}-\frac{\tan x}{\cot x},g(x)=\frac{\cos x}{\sec x}+\frac{\sin x}{\operatorname{cosec} x}$

(B) $f(x)=\operatorname{sgn}\left(x^2-4x+5\right)$, $g(x)=\operatorname{sgn}\left(\cos^2 x+\sin^2\left(x+\frac{\pi}{3}\right)\right)$ where sgn denotes signum function.

(C) $f(x)=e^{\ln\left(x^2+3x+3\right)},g(x)=x^2+3x+3$

(D) $f(x)=\frac{\sin x}{\sec x}+\frac{\cos x}{\operatorname{cosec} x},g(x)=\frac{2\cos^2 x}{\cot x}$

39. Let $f(x)=\cos^{-1}\left(2x^2-1\right)$ then:

(A) $f(x)$ is continuous in $[-1, 1]$

(B) $f(x)$ is derivable in (–1, 1)

(C) range of $f(x)$ is $[0, \pi]$

(D) derivative of $f(x)$ w.r.t. $\sin^{-1}x$ at $x=\frac{1}{2}$ is 2

Space for Rough work

40. Suppose $I_1 = \int_0^{\pi/2} \cos\left(\pi \sin^2 x\right)dx; I_2 = \int_0^{\pi/2} \cos\left(2\pi \sin^2 x\right)dx$ and $I_3 = \int_0^{\pi/2} \cos\left(\pi \sin x\right)dx$, then

(A) $I_1 = 0$
(B) $I_2 + I_3 = 0$
(C) $I_1 + I_2 + I_3 = 0$
(D) $I_2 = I_3$

41. Consider the function $f(x) = \left[\cos\left(\tan^{-1}\left(\sin\left(\cot^{-1} x\right)\right)\right)\right]^2$. Which of the following is correct?
(A) Range of f is (0, 1)
(B) f is even
(C) $f'(0) = 0$
(D) The line y = 1 is asymptotes to the graph $y = f(x)$

42. A function $y = f(x)$ satisfying the differential equation $\frac{dy}{dx}(\sin x) - y\cos x + \frac{\sin^2 x}{x^2} = 0$ is such that, $y \to 0$ as $x \to \infty$ then the statement which is correct is:

(A) $\lim_{x\to 0} f(x) = 1$
(B) $\int_0^{\pi/2} f(x)dx$ is less than $\frac{\pi}{2}$
(C) $\int_0^{\pi/2} f(x)dx$ is greater than unity
(D) $f(x)$ is an odd function

Space for Rough work

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

---

43. Match the following

List-I		List-II	
(P)	If m and n are positive integers satisfying $1+\cos 2\theta+\cos 4\theta+\cos 6\theta+\cos 8\theta+\cos 10\theta$ $=\dfrac{\cos m\theta.\sin n\theta}{\sin\theta}$, then $(m+n)$ is equal to	(1)	9
(Q)	The minimum value of the expression $\dfrac{9x^2+\sin^2 x+4}{x\sin x}$ for $x\in(0,\pi)$ is	(2)	10
(R)	Let $f(x)=11-8\sin x-2\cos^2 x$. If the maximum and minimum value of $f(x)$ are denoted by M and m respectively, then $\dfrac{M+8}{m}$ has the value equal to	(3)	11
(S)	If $\tan 9\theta=\dfrac{3}{4}$ (where $0<\theta<\dfrac{\pi}{18}$), then the value of $(3\operatorname{cosec} 3\theta-4\sec 3\theta)$ is equal to	(4)	12
		(5)	13
		(6)	10

The correct option is

(A) P → 3; Q → 4; R → 1; S → 2
(B) P → 1; Q →4; R →3; S → 4
(C) P → 1; Q → 1; R → 3; S → 6
(D) P → 1; Q → 1; R → 5; S → 4

Space for Rough work

44. Match the following

	List-I		**List-II**
(P)	Let f be a real valued differentiable function on f such that $f'(1)=6$ and $f'(2)=2$. Then $\lim\limits_{h\to 0}\frac{f(3\cosh h+4\sin h-2)-f(1)}{f(3e^h-5\sec h+4)-f(2)}$ is equal to	(1)	4
(Q)	For $a>0$, let $f:[-4a, 4a]\to R$ be an even function such that $f(x)=f(4a-x)\forall x\in[2a, 4a]$ and $\lim\limits_{h\to 0}\frac{f(2a+h)-f(2a)}{h}=4$ then $\lim\limits_{h\to 0}\frac{f(h-2a)-f(-2a)}{2h}$ is equal to	(2)	5
(R)	Suppose f is a differentiable function on R. Let $F(x)=f(e^x)$ and $G(x)=e^{f(x)}$. If $f'(1)=e^3$ and $f(0)=f'(0)=3,$ then $\frac{G'(0)}{F'(0)}$ is equal to	(3)	3
(S)	Let $f(x)=\text{Max.}(\cos x, x, 2x-1)$ where $x\ge 0$. Then number of points of non – differentiability	(4)	2
		(5)	1
		(6)	0

The correct option is

(A) P → 1; Q → 1; R → 3; S → 6
(B) P → 1; Q →4; R →3; S → 4
(C) P → 1; Q → 1; R → 3; S → 6
(D) P → 1; Q → 1; R → 6; S → 2

Space for Rough work

45. Consider $f(x) = \left|\ln|x|\right| - kx^2,\ x \neq 0$. Match the column – I with the value of k in column – II

List-I		List-II	
(P)	$f(x) = 0$ has two distinct solutions	(1)	k = 0
(Q)	$f(x) = 0$ has four distinct solutions	(2)	$k = \frac{1}{2e}$
(R)	$f(x) = 0$ has six distinct solutions	(3)	$k \in \left(\frac{1}{2e}, \infty\right)$
(S)	$f(x) =$ has no solution	(4)	$k \in (-\infty, 0)$
		(5)	$k \in \left(0, \frac{1}{2e}\right)$
		(6)	$k = \frac{1}{e}$

The correct option is

(A) P → 2; Q → 3; R → 5; S → 4 (B) P → 3; Q →5; R →4; S → 5

(C) P → 1; Q → 2; R → 5; S → 4 (D) P → 1; Q → 1; R → 5; S → 2

46. Match the following

List-I		List-II	
(P)	Let $f: R \to R$ defined as $f(x) = e^{\text{sgn}(x)} + e^{x^2}$, where sgn x denotes signum function of x, then $f(x)$ is	(1)	Odd
(Q)	Let $f: (-1, 1) \to R$ defined as $f(x) = x\left[x^4\right] + \frac{1}{\sqrt{1-x^2}}$ where [x] denotes greatest integer less than or equal to x, then $f(x)$ is	(2)	Even
(R)	Let $f: R \to R$ defined as $f(x) = \frac{x(x+1)(x^4+1) + 2x^4 + x^2 + 2}{x^2 + x + 1}$, then $f(x)$ is	(3)	Neither odd nor even
(S)	Let $f: R \to R$ defined as $f(x) = x + 3x^3 + 5x^5 + ... + 101x^{101}$ then $f(x)$ is	(4)	One – One
		(5)	Many – one
		(6)	Constant

The correct option is

(A) P → 2, 3; Q → 3,4; R → 5,1; S → 4, 2 (B) P → 3, 2; Q →5. 4; R →3, 4; S →5, 6

(C) P → 1, 2; Q → 2, 6; R → 5, 4; S → 2, 4 (D) P → 3, 5; Q → 2, 5; R → 3, 5; S → 1, 4

Space for Rough work

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

47. If solution of $\left(x\cos y - y\sin y\right)dy + \left(x\sin y + y\cos y\right)dx = 0$ is $\ell n\left(x\sin y + y\cos y - \sin y\right) = -4kx + c$ then k is

48. Given sequence of numbers $x_1, x_2, x_3, ...x_{2005}$ which satisfy, $\frac{x_1}{x_1+1} = \frac{x_2}{x_2+3} = \frac{x_3}{x_3+5}........\frac{x_{2005}}{x_{2005}+2009}$ where $x_1 + x_2 + ...x_{1005} = 2010$ then $\frac{1005}{164}x_{21}$ is

49. If roots of $x^3 + ax^2 + bx - \frac{1}{9} = 0$ are in A.P. the $\frac{121}{64}\left(2a^3 - 9ab + 1\right)$ is _______.

50. A bag contain N marbles (N < 200) of 4 colours: Red, White and Green. Following events are equally likely
(i) Selection of 4 Red marbles
(ii) Selection of 1 White and 3 Red marbles
(iii) Selection of 1 White, 1 Blue and 2 Red marbles
(iv) Selection of 1 marble of each color
If S is sum of digits of maximum possible value of N then $\frac{7S}{500}$ is

51. Let A and B be two non singular matrices of order 2 such that $9A^2B - 6AB + B = 9\left\{B - \begin{bmatrix} 2 & -3 \\ 2 & 1 \end{bmatrix}\right\}$. If $B = \begin{bmatrix} 3 & 0 \\ 1 & 1 \end{bmatrix}$ and Trace (A) $\left(A\right) = \frac{10}{3}$ then $\frac{|A|}{4}$ is

Space for Rough work

52. If $\sum_{k=0}^{100}\left(\frac{k}{k+1}\right)^{100}C_k = \frac{a\left(2^{100}\right)+b}{c}$ where $a, b, c \in N$, then find the least value of $\frac{(a+b+c)}{670}$.

53. If the sum of an infinite geometric series, whose first term is the limit of the function $f(x) = \left(\frac{9}{1-x^9} - \frac{7}{1-x^7}\right)$ as $x \to 1$ and the common ratio is the limit of function $g(x) = \frac{\tan x - \sin x}{\ln^3(1+x)}$ as $x \to 0$, is S then $\frac{7S}{100}$ is

54. If $f: R \to R$ be an injective mapping and p, q, r are non – zero distinct real quantities satisfying $f\left(\frac{p}{r}\right) = f\left(\frac{p-q}{q-r}\right)$ and $f\left(\frac{q}{r}\right) = f\left(\frac{r}{p}\right)$

If the graph of $g(x) = px^2 + qx + r$ passes through M (1, 6) then find the value of $\frac{q}{32}$.

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – II

JEE (Advanced)-2019

PAPER – 2

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. ABCD

Sol. Charge on capacitor at time t is

$q = Q_0 \cos \omega t$

Where $\omega = \frac{1}{\sqrt{LC}}$

At $\omega t = \frac{\pi}{2}, q = 0$

$\Rightarrow \ t = \frac{\pi}{2}\sqrt{LC}$

By conservation of energy

$\frac{Q_0^2}{2C} = \frac{1}{2}Li_{max}^2$

$\Rightarrow \ i_{max} = \frac{Q_0}{\sqrt{LC}}$

2. ACD

Sol. Apply Gauss law and property of conductor.

3. AD

Sol. $V = \frac{-GM}{2R^3}[3R^2 - r^2]$, inside the earth.

4. ABCD

Sol. Let elongation in spring A, B and C be x_1, x_2 and x_3 respectively.
Considering spring forces and constraint relations

$x_2 = 4x_3$ …(i)

$x_2 = 2x_1$ …(ii)

and $x_1 + 2x_2 + x_3 = x$ …(iii)

$$\Rightarrow \; x_1 = \left(\frac{2}{11}\right)x \quad ; \quad x_2 = \left(\frac{4}{11}\right)x \quad ; \quad x_3 = \left(\frac{1}{11}\right)x$$

Also, $F = 2K\left(\frac{x}{11}\right)$

$$\Rightarrow \; T = 2\pi\sqrt{\frac{11m}{2k}}$$

5. AB

Sol. For microwaves,

$$\lambda = \frac{c}{f} = \frac{3\times10^8}{10^6} = 300 \text{ m.}$$

$\Delta x = d \sin\theta$

$$\phi = \frac{2\pi}{\lambda} d\sin\theta = \frac{2\pi}{300}(150\sin\theta) = \pi \sin\theta$$

$$I_\theta = I_0 \cos^2\left(\frac{\pi\sin\theta}{2}\right)$$

6. ABC

Sol. $T = \frac{2\sqrt{2}}{10} = \frac{\sqrt{2}}{5}$; $R = \sqrt{(1)^2 + (1)^2}$ $T = \frac{2}{5}$

$$H = \frac{\left(\sqrt{2}\right)^2}{2g} = \frac{1}{10}$$

7. C

Sol. Optical path difference at any point P on the screen, $\delta(P) = S_2P - S_1P - (\mu - 1)t$ and the intensity on the screen, at point P = $4I_o \times \cos^2 \frac{\pi}{\lambda} \times \delta P$.

8. A

Sol. (A) $A \to B$: V ↓, P constant → T↓, U↓ and ΔW is –ve, $\Delta Q < 0$, $\Delta U < 0$

(B) $B \to C$: V is same, P ↓ T ↓, U↓, $\Delta Q < 0$, $\Delta U < 0$

No work is done.

(C) $C \to D$: V ↑ ⇒ T↑, $\Delta U > 0$, $\Delta Q > 0$, $\Delta W > 0$

(D) $D \to A$: V decrease so $\Delta W < 0$

$\therefore T_D = T_A$ $\therefore \Delta U = 0$

and then $\Delta Q < 0$

9. B

Sol. Mean value $= \frac{12.5+12.3+11.8+12.4+12.2+12.6}{6}$ = 12.3

Mean absolute error = $\frac{|\Delta x_1| + ... + |\Delta x_6|}{6}$

Relative error = $\frac{\text{Mean absolute error}}{\text{Mean value}}$

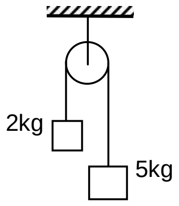
10. D

Sol. According to Lenz's law induced current flows in such a way that it is opposing the change in magnetic flux.

SECTION – D

11. 00028.00

Sol. T = $\frac{2m_1m_2g}{m_1+m_2} = \frac{2\times2\times5\times9.8}{7}$ = 28 N



12. 00000.10

Sol. Given, $\frac{1}{2}mv^2 = \frac{1}{2}mu^2(1-0.19) = \frac{1}{2}mu^2(0.81)$

$\therefore$ v = 0.9 u

$\therefore \frac{\Delta v}{u} = 0.10$

13. 00000.09

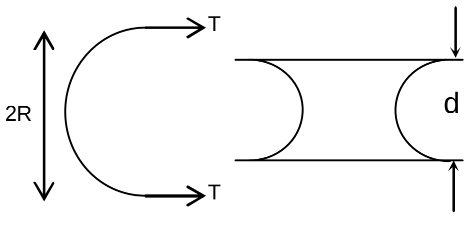
Sol. $\varepsilon = vB\ell = 3 \times 10^6 \times 10 \times 3 \times 10^{-9} = 9 \times 10^{-2} \approx 0.09$ V

14. 00000.23

Sol. $\mu = \frac{\text{velocity in air}}{\text{velocity in medium}}$

15. 00001.00

Sol. The shape of water layer between the two plates is shown in the figure.



Thickness *d* of the film = 0.12 mm = 0.012 cm.

Radius *R* of cylindrical face $= \frac{d}{2}$.

F = T(2l) = $P(l \times 2R)$

$P = \frac{T}{R}$

Pressure difference across the cylindrical surface $= \frac{T}{R} = \frac{2T}{d}$.

Area of each plate wetted by water = *A*.
Force *F* required to separate the two plates is given by
F = pressure difference × area $= \frac{2T}{d}A = \frac{2\times 75\times 8}{0.012} = 1\text{N}$

16. 00008.00

Sol. $\frac{4\ell_1}{3} = \frac{2\ell_2}{4}$

17. 00000.00

Sol. $dw = \vec{E}.d\vec{r} = 0$

18. 00004.00

Sol. $X_{cm} = \dfrac{\sigma\pi R^2(O) + \sigma\pi\left(\frac{R}{2}\right)^2\frac{R}{2} + (-\sigma)\pi\left(\frac{R}{2}\right)^2\left(-\frac{R}{2}\right)}{\sigma\pi R^2 + \sigma\pi\left(\frac{R}{2}\right)^2 + (-\sigma)\pi\left(\frac{R}{2}\right)^2}$

Chemistry PART – II

SECTION – A

19. ABD

Sol. O_2^+ contains unpaired electron in π-antibonding M.O and N_2^+ in σ_{2p} orbital N_2^{2-} contains unpaired electron in π-antibonding M.OS.

20. ABC

Sol. Rate = $k[X][Y]^0 \Rightarrow 2 \times 10^{-8} = k[0.1]\,[0.1]^0 \Rightarrow k = 2 \times 10^{-7} s^{-1}$.

21. ABD

Sol. When Cl is directly attached to benzene, +R effect of chlorine is observed. Which increases the bond order of C – Cl bond.

22. BCD

Sol. Elimination takes place in option(A).

23. AC

Sol. Azeotropic mixture has fixed composition.

24. ACD

Sol. $a = 2\left(r_{Na^+} + r_{Cl^-}\right) = 2(95 + 181) = 552\,\text{pm}$

25. B

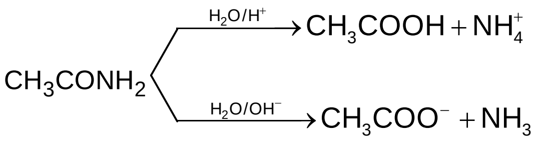
Sol. $2LiOH \xrightarrow{\Delta} Li_2O + H_2O$

26. C

Sol. In E_2 mechanism, loss of Hydrogen takes place from that carbon atoms which are adjacent to the carbon atoms that hold chlorine. Carbocations are formed in E_1 mechanism.

27. D

Sol.



$$CH_3CONH_2 \xrightarrow{H_2O/H^+} CH_3COOH + NH_4^+$$

$$CH_3CONH_2 \xrightarrow{H_2O/OH^-} CH_3COO^- + NH_3$$

$$(CH_3CO)_2O \xrightarrow{H_2O} 2CH_3COOH$$

28. A

Sol. Fact based

SECTION – D

29. 00400.00

Sol. $K_{P_1} = p_{SO_2} \times p_{SO_3} = 900$

$$\therefore p_{SO_2} = p_{SO_3} = 30\,\text{cm of Hg}$$

$$K_{P_2} = \frac{p^2_{SO_3}}{p^2_{SO_2} \times p_{O_2}} = \frac{30}{30 \times p_{O_2}} = 25 \times 10^{-4}$$

$$\therefore p_{O_2} = \frac{1}{25 \times 10^{-4}} = 400\text{ cm of Hg}$$

30. 00208.30

Sol. $K_{sp} = 4s^3 = 4 \times 10^{-3}$

$\therefore$ s = 10^{-1} = 0.1 mol L^{-1}

In 10 L → 1 mole dissolves

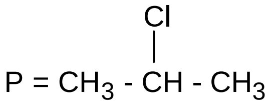
Mass of 1 mole = 208.3 g

31. 00138.00

Sol. P = K_2CO_3, Q = O_2, R = KOH, S = H_2O_2. Heaviest product is K_2CO_3.

32. 00157.00

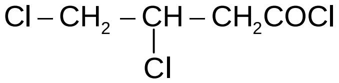
Sol.



$P = CH_3 - \underset{}{\overset{Cl}{\overset{|}{C}}}H - CH_3$

33. 00175.50

Sol. The product is



$Cl - CH_2 - \underset{\underset{Cl}{|}}{C}H - CH_2COCl$

34. 00226.50

Sol. The complex is $[Cr(NH_3)_4Cl_2]Cl$.

35. 95735.71

Sol. W = -2.303nRT log $\frac{V_2}{V_1}$ = -2.303 × 1 × 8.314 × 5000 × $\log\frac{1/10}{1}$ = 95735.71

36. 00390.55

Sol. $$\Lambda^0_m CH_3COOH = \frac{\left(\Lambda^0_m Ca\left(CH_3COO\right)_2 + 2\Lambda^0_m HCl - \Lambda^0_m CaCl_2\right)}{2}$$

$$= \frac{200.8 + 2\left(425.95\right) - 271.6}{2} = 390.55$$

Mathematics PART – III

SECTION – A

37. ACD

Sol. $\tan\frac{\pi}{7}+2\tan\frac{2\pi}{7}+4\tan\frac{4\pi}{7}+8\cot\frac{8\pi}{7}=\cot\frac{\pi}{7}\tan$

$\tan\theta+2\tan 2\theta+4\tan 4\theta+8\cot 8\theta=\cot\theta$ [when $\theta=\frac{\pi}{7}$]

(a) $\operatorname{cosec}2\theta+\cot 2\theta=\frac{1+\cos 2\theta}{\sin 2\theta}=\cot\theta=\cot\frac{\pi}{7}$ (where $\theta=\frac{\pi}{7}$)

(b) $\tan\frac{\pi}{14}-\cot\frac{\pi}{14}=-2\cot\frac{\pi}{7}$

(c) $\frac{\sin\frac{2\pi}{7}}{1-\cos\frac{2\pi}{7}}=\frac{2\sin\frac{\pi}{7}\cos\frac{\pi}{7}}{2\sin^2\frac{\pi}{7}}=\cot\frac{\pi}{7}$

(d) $\frac{\left(1+\cos\frac{2\pi}{7}\right)+\cos\frac{\pi}{7}}{2\sin\frac{\pi}{7}\cos\frac{\pi}{7}+\sin\frac{\pi}{7}}=\frac{2\cos^2\frac{\pi}{7}+\cos\frac{\pi}{7}}{2\sin\frac{\pi}{7}\left(\cos\frac{\pi}{7}+1\right)}=\cot\frac{\pi}{7}$

38. ABCD

Sol. (a) We have $f(x)=\frac{\sec x}{\cos x}-\frac{\tan x}{\cot x}$, $g(x)=\frac{\cos x}{\sec x}+\frac{\sin x}{\operatorname{cosec}x}$

Clearly both $f(x)$ and $g(x)$ are identical functions as $x\neq\frac{k\pi}{2}\,\forall k\in I$.

(b) As $x^2-4x+5=(x-2)^2+1>0$

Hence $f(x)=1\,\forall\, x\in R$.

Also $\cos^2 x+\sin^2\left(x+\frac{\pi}{2}\right)>0$

Hence $g(x)=1\,\forall\, x\in R$ g.

$\Rightarrow f(x)$ and $g(x)$ are identical.

(c) $f(x)=e^{\ln\left(x^2+3x+3\right)}$

As $x^2+3x+3=\left(x+\frac{3}{2}\right)^2+\frac{3}{4}>0\,\forall\, x\in R$.

Hence $f(x)=x^2+3x+3\,\forall\, x\in R$

$\Rightarrow f(x)$k is identical to $g(x)$

(d) We have $f(x)=\frac{\sin x}{\sec x}+\frac{\cos x}{\operatorname{cosec}x}$, $g(x)=\frac{2\cos^2 x}{\cot x}$

Clearly both $f(x)$ and $g(x)$ are identical functions as $x\neq\frac{k\pi}{2}\,\forall k\in I$.

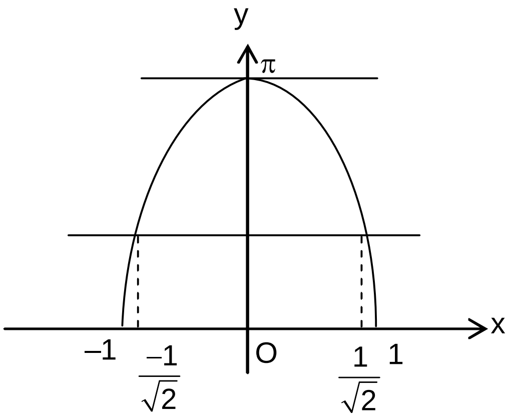
39. AC

Sol. Differential coefficient of $f(x)$ w.r.t.

$\sin^{-1}x = -2\dfrac{x}{|x|}$ at $x = \dfrac{1}{2}$ it is –2

$f(0^+) = -2; f'(0^-) = 2$

$\Rightarrow$ f is not derivable at x = 0



40. ABC

Sol. $I_1 = \int_0^{\pi/2} \cos(\pi \sin^2 x)\,dx$

$\int_a^b f(x)\,dx = \int_a^b f(a+b-x)\,dx$

$I_1 = \int_0^{\pi/2} \cos(\pi \cos^2 x)\,dx$

On adding

$2I_1 = \int_0^{\pi/2} \cos(\pi \sin^2 x) + \cos(\pi\cos^2 x)\,dx$

$= \int_0^{\pi/2} 2\cos\left(\frac{\pi}{2}\right).\cos\left(\frac{\pi}{2}\cos 2x\right)dx = 0$

$I_1 = 0$ ……..(i)

$I_2 = \int_0^{\pi/2} \cos\left(\pi(1-\cos 2x)\,dx = -\int_0^{\pi/2} \cos(\pi\cos 2x)\,dx\right)$

$= -\frac{1}{2}\int_0^{\pi} \cos(\pi\cos t)\,dt$ [Put $2x = t$]

$= -\frac{2}{2}\int_0^{\pi/2} \cos(\pi \cos t)\,dt = -I_3$

$\therefore I_2 + I_3 = 0$ …….(ii)

Hence, $I_1 + I_2 + I_3 = 0$

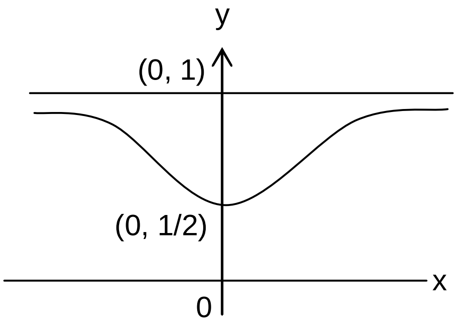
41. BCD

Sol. Domain is $x \in R$

Also $f(x) = \left[\cos\left(\tan^{-1}(\sin\theta)\right)\right]^2$

where $\cot\theta = x$

$= \left[\cos\left(\tan^{-1}\left(\frac{1}{\sqrt{1+x^2}}\right)\right)\right]^2$



$=(\cos\phi)^2$ where $\tan\phi=\frac{1}{\sqrt{1+x^2}}=\left(\frac{\sqrt{1+x^2}}{\sqrt{2+x^2}}\right)^2$

$g(x)=\frac{1+x^2}{2+x^2}=1-\frac{1}{2+x^2}$

Range is $\left[\frac{1}{2},1\right);f'(x)=\frac{2x}{\left(2+x^2\right)^2}$

Hence $f'(0)=0$

Also $\lim\limits_{x\to\infty}f(x)=1$

Hence (B), (C), (D)

42. ABC

Sol. $f(x)=\frac{\sin x}{x}$

43. A

Sol. (P) Let $S=\cos\theta+\cos2\theta+\cos4\theta+.....+\cos10\theta$

$2\sin\theta.S=2\sin\theta[\cos\theta+\cos2\theta+.....+\cos10\theta]$

$S=\frac{2\sin6\theta\cos5\theta}{2\sin\theta}\quad=\frac{\sin n\theta\cos m\theta}{\sin\theta}$

$\Rightarrow n=6$ and $m=5$

(Q) $E=9x\sin x+\frac{4}{x\sin x}$

[Note that $x\sin x>0$ in $(0,\pi)$]

$E=\left(3\sqrt{x\sin x}-\frac{2}{\sqrt{x\sin x}}\right)^2+12$

$\therefore E_{\min}=12$ which occurs when $3x\sin x=2$

$\Rightarrow x\sin x=\frac{2}{3}$

[Note that $x\sin x$ is continuous at x = 0 and attains the value $\frac{\pi}{2}$ which is greater than $\frac{2}{3}$ at $x=\frac{\pi}{2}$, hence it must take the $\frac{2}{3}$ in $(0,\pi)$]

(R) $f(x)=2\left((\sin x-2)^2+\frac{1}{2}\right)$

$\therefore M=19$ and $m=3$

Hence $\frac{M+8}{m}=\frac{19+8}{3}=9$

(S) $\tan 9\theta = \dfrac{3}{4}$

$\sin 9\theta = \dfrac{3}{5};\ \cos 9\theta = \dfrac{4}{5}$

Now given $\dfrac{3}{\sin 3\theta} - \dfrac{4}{\cos 3\theta}$

$$= 2\frac{\left(3\cos 3\theta - 4\sin 3\theta\right)}{2\sin 3\theta \cos 3\theta}$$

$$= \frac{10\left[\frac{3}{5}\cos\theta - \frac{4}{5}\sin 3\theta\right]}{\sin 6\theta}$$

$$= 10\left[\frac{\sin 9\theta 3\theta - \cos 9\theta \sin 3\theta}{\sin 6\theta}\right] = 10\frac{\sin\left(9\theta - 3\theta\right)}{\sin 6\theta} = 10$$

44. B

Sol. (P) $\displaystyle\lim_{h\to 0}\frac{f\left(3\cosh + 4\sinh - 2\right) - f\left(1\right)}{f\left(3e^{h} - 5\sec h + 4\right) - f\left(2\right)}\left(\frac{0}{0}\text{form}\right)$

$$= \lim_{h\to 0}\frac{\left(-3\sinh + 4\cosh\right)f'\left(3\cosh + 4\sinh - 2\right)}{\left(3e^{h} - 5\sec h\tan h\right)f'\left(3e^{h} - 5\sec h + 4\right)} = \frac{4}{3}\times\frac{f'\left(1\right)}{f'\left(2\right)} = \frac{4\times 6}{3\times 2} = 4$$

(Q) $f'\left(2a^{+}\right) = \displaystyle\lim_{h\to 0}\frac{f\left(2a + h\right) - f\left(2a\right)}{h} = 4$ (Given)

Now $f'\left(-2a^{+}\right) = \displaystyle\lim_{h\to 0}\frac{f\left(-2a + h\right) - f\left(-2a\right)}{h}$

$= \displaystyle\lim_{h\to 0}\frac{f\left(2a - h\right) - f\left(2a\right)}{h}$ ($\because$ f is even function)

$= \displaystyle\lim_{h\to 0}\frac{f\left(2a + h\right) - f\left(2a\right)}{h} = f'\left(2a^{+}\right) = 4$

$\because \quad f\left(x\right) = f\left(4a - x\right)\forall x \in \left[2a,\ 4a\right]$

Put $x = 2a + h$, we get $f\left(2a + h\right) = f\left(2a - h\right)$

(R) We have $F\left(x\right) = f\left(e^{x}\right)$

$\Rightarrow\ F'\left(x\right) = e^{x} f'\left(e^{x}\right)$

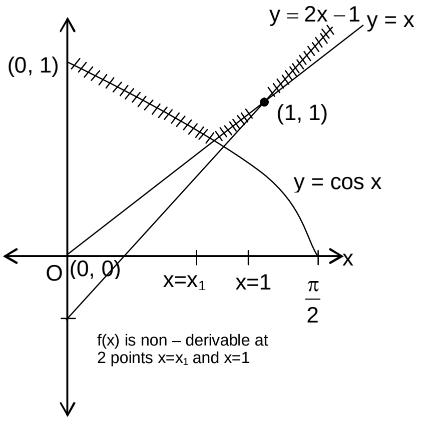
And $G\left(x\right) = e^{f(x)}$

$\Rightarrow\ G'\left(x\right) = e^{f(x)}f'\left(x\right)$

$\therefore\ \dfrac{G'\left(0\right)}{F'\left(0\right)} = \dfrac{f'\left(0\right)e^{f(0)}}{e^{0}f'\left(e^{0}\right)}$

$= \dfrac{f'\left(0\right)e^{f(0)}}{f'\left(1\right)} = \dfrac{3e^{3}}{e^{3}} = 3$

(S) $\therefore$ Number of points of non – differentiability =2

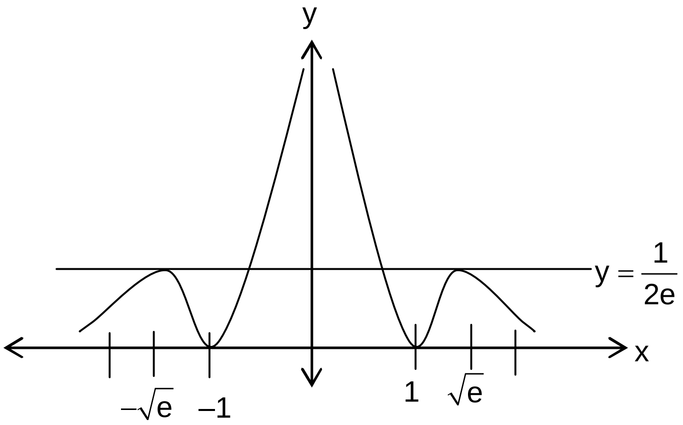

y = 2x − 1
y = x
(0, 1)
(1, 1)
y = cos x
O
(0, 0)
x=x₁
x=1
π/2
x
f(x) is non – derivable at
2 points x=x₁ and x=1

45. C

Sol. $f(x) = |\ln|x|| - kx^2 = 0$

$$\Rightarrow k = \frac{|\ln|x||}{x^2}$$

Consider $g(x) = \frac{|\ell n|x||}{x^2}$ as shown



46. D

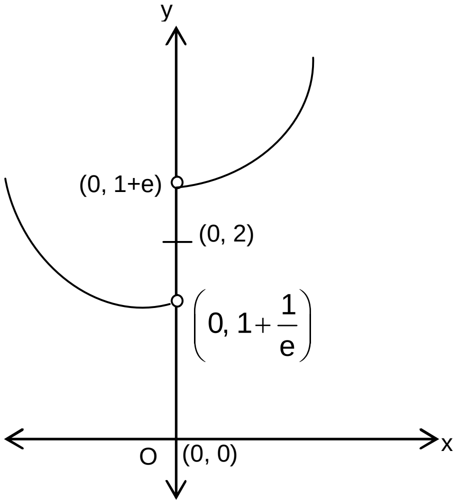
Sol. (P) $f(x) = e^{\text{sgn}\,x} + e^{x^2}$

When $x = 0$ $f(0) = 2$

When $x > 0$ $f(x) = e + e^{x^2}$

When $x < 0$ $f(x) = \frac{1}{e} + e^{x^2}$

Hence, $f(x)$ is many – one and neither odd nor even.



(Q) $D_f : 1 - x^2 > 0$

$x^2 - 1 < 0 \Rightarrow x \in (-1, 1)$

$\left[x^4\right]$ when $x \in (-1,1)$ is equal to 0.

$\therefore f(x) = \frac{1}{\sqrt{1-x^2}}$

Hence, $f(x)$f is even and many – one.

(R) $f(x) = x^4 + 1 + \left(\frac{x^4 + x^2 + 1}{x^2 + x + 1}\right)$

$= x^4 + 1 + x^2 - x + 1$

$= x^4 + x^2 - x + 2 = x\left(x^3 + x - 1\right) + 2$

Hence, $f(x)$ is many – one and neither odd nor even.

(S) $f(x) = x + 3x^3 + 5x^5 + ... + 101x^{101}$

Clearly $f(x)$ is an odd function.

Now, $f'(x) > 0 \,\forall\, x \in R$

$\Rightarrow f'(x) > 0 \,\forall\, x \in R$

Hence, $f(x)$f is one – one function

SECTION – D

47. 00000.25

Sol. Put $x \sin y + y \cos y = t$ and after rearrangement put $\sin y = z$

48. 00000.50

Sol. Above sequence is in A.P.

$$\frac{x_1 + 1}{x_1} = \frac{x_2 + 3}{x_2} = ...\frac{x_{1005} + 2009}{x_{1005}} = k$$

$$\therefore k = \frac{(x_1 + 1) + (x_2 + 3) + ...(x_{1005} + 2009)}{x_1 + x_2.............x_{1005}}$$

$$k = 1 + \frac{(1005)^2}{2010} = \frac{x_{21} + 41}{x_{21}}$$

$$\Rightarrow x_{21} = \frac{82}{1005}$$

49. 00007.56

Sol. Let $\alpha - d, \alpha, \alpha + d$ are roots

$\therefore 3\alpha = -a$ (1)

$3\alpha^2 - d^2 = b$ (2)

$\alpha\left(\alpha^2 - d^2\right) = \frac{1}{9}$ (3)

From (1) and (2), $d^2 = \frac{a^2}{3} - b$

Put d^2 in (3) to get

$2a^3 - 9ab + 1 = 4$

50. 00000.22

Sol. Let number of marbles are

Red = a, White = b, Blue = c, Green = d

$\therefore \frac{{}^{a}C_4}{T} = \frac{b\left({}^{a}C_3\right)}{T} = \frac{(b)(c)\left({}^{a}C_4\right)}{T} = \frac{abcd}{T}$

where $T = {}^{a+b+c+d}C_4$

solving, $b = \frac{a-3}{4}, c = \frac{a-2}{3}, d = \frac{a-1}{2}$

N is max when a = 95

$\therefore N_{max} = 196$

51. 00000.50

Sol. $9A^2 - 6A + I = \begin{bmatrix} 6 & 27 \\ -10 & -1 \end{bmatrix} B^{-1}$

$\Rightarrow (3A - I)^2 = 81$

$\Rightarrow |3A - I| = \pm 9$ (1)

Let $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$

$\therefore g(ad - bc) = 18$ or 0 (using equation 1)

Since $|A| \neq 0$

$\therefore ad - bc = 2 \Rightarrow |A| = 2$

52. 00000.30

Sol. Let $S = \sum_{k=0}^{100} \left(\frac{k}{k+1}\right) {}^{100}C_k$

$= \sum_{k=0}^{100} \frac{((k+1)-1)}{(k+1)} {}^{100}C_k = \left(\sum_{k=0}^{100} {}^{100}C_k\right) - \sum_{k=0}^{100} \frac{{}^{100}C_k}{k+1}$

$= 2^{100} - \frac{1}{101} \sum_{k=0}^{100} \left(\frac{101}{k+1} {}^{100}C_k\right)$

$= 2^{100} - \frac{1}{101} \sum_{k=0}^{100} {}^{101}C_{k+1}$

$2^{100} - \left(\frac{2^{101} - 1}{101}\right) = \frac{(101)2^{100} - 2^{101} + 1}{101} = \frac{99\left(2^{100}\right) + 1}{101}$

$= \frac{a\left(2^{100}\right) + b}{c}$ (Given)

So, $a = 99, b = 1, c = 101$

Hence, $(a + b + c)_{\text{least}} = 99 + 1 + 101 = 201.$

53. 00000.14

Sol. Let $I = \lim\limits_{x \to 1}\left(\dfrac{9}{1 - x^9} - \dfrac{7}{1 - x^7}\right)$ ……(i)

Put $x = \dfrac{1}{y}$, we get $I = \lim\limits_{x \to 1}\left(\dfrac{-9x^9}{1 - x^9} + \dfrac{7x^7}{1 - x^7}\right)$ ………(ii)

$\therefore$ On adding equation (i) and (ii), we get

$2I = 9 - 7 = 2$

$\Rightarrow I = 1$

Common ratio $= \lim\limits_{x \to 0} \dfrac{\tan x - \sin x}{\ln^3(1 + x)}$

$$= \lim_{x \to 0} \frac{\tan x - \sin x}{x^3 \left(\dfrac{\ln(1 + x)}{x}\right)^3}$$

$$= \lim_{x \to 0} \frac{\tan x(1 - \cos x)}{x^2} = \frac{1}{2}$$

54. 00000.25

Sol. Since f is injective Sp $\dfrac{p}{r} = \dfrac{p - q}{q - r}$

$\Rightarrow \quad pq - pr = rp - rq$

$\Rightarrow \quad 2pr = q(p + r)$ ……….(i)

Also, $\dfrac{q}{r} = \dfrac{r}{p} \Rightarrow p, r, q$ are in G.P.

So, let $r = pa, q = pa^2$, where a is the common ratio of G.P.

Therefore from equation (i), we get

$2.p.pa = pa^2(p + pa)$

$\Rightarrow \quad 2 = a^2 + a$

$\Rightarrow \quad a^2 + a - 2 = 0$

$\Rightarrow (a + 2)(a - 1) = 0$

$\Rightarrow \quad a = -2, 1$

So, $(p, -2p, 4p)$ and (p, p, p)

(But common ratio = a= 1, is not possible as p, q, r are non – zero distinct quantities.)

Also, $p + q + r = 6$ [As $g(x) = px^2 + qx + r$ passes through M (1, 6)]

$\Rightarrow \quad p + 4p - 2p = 6$

$\Rightarrow \quad p = 2$

Hence $q = 4p = 4(2) = 8$

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – II

JEE (Main)-2019

Time Allotted: 3 Hours **Maximum Marks: 360**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only one section: **Section-A**.

Section-A (01 – 30, 31 – 60, 61 – 90) *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

PART – I

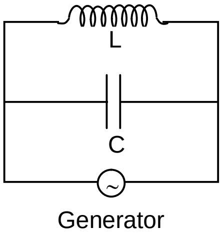
SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. The rms value of the electric field of the light coming from the sun is 720 N/C. The average total energy density of the electromagnetic wave is

(A) 4.58×10^{-6} J/m^3	(B) 6.37×10^{-9} J/m^3
(C) 81.35×10^{-12} J/m^3	(D) 3.3×10^{-3} J/m^3

2. For the circuit shown in the figure, the current through the inductor is 0.6 A, while the current through the capacitor is 0.4 A. The current drawn from the generator is

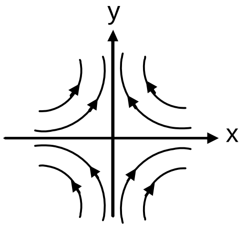


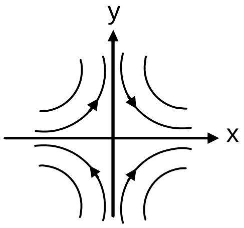
(A) 1.0 A	(B) 0.4 A
(C) 0.6 A	(D) 0.2 A

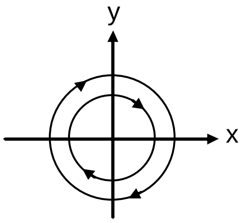
3. In forced oscillation of a particle, the amplitude is maximum for a frequency ω_1 of the force, while the energy is maximum for a frequency ω_2 of the force, then
(A) $\omega_1 = \omega_2$
(B) $\omega_1 > \omega_2$
(C) $\omega_1 < \omega_2$ when damping is small and $\omega_1 > \omega_2$ when damping is large.
(D) $\omega_1 < \omega_2$

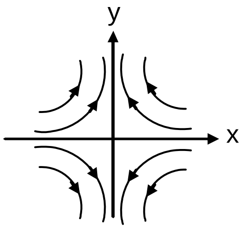
Space for Rough work

4. Electric potential is varying with x and y as V = $2\left(x^2 - y^2\right)$. The corresponding field pattern is:

(A)


(B)


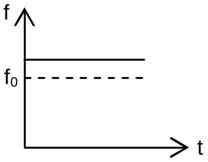
(C)


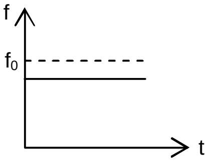
(D)


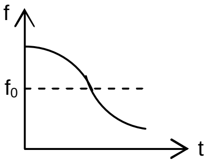
5. Two point white dots are 1 mm apart on a black paper. They are viewed by eye of pupil diameter 3 mm. Approximately, what is the maximum distance at which these dots can be resolved by the eye? (Take wavelength of light = 500 nm)

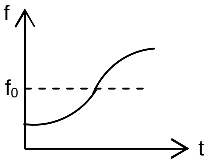
(A) 5 m
(B) 1 m
(C) 6 m
(D) 3 m

6. Source and observer both start moving simultaneously from origin one along x-axis and the other along y-axis with speed of source = 2 (speed of observer). The graph between the apparent frequency observed by observer (f) and time (t) would be (dotted lines represent frequency of source f_0)

(A)


(B)


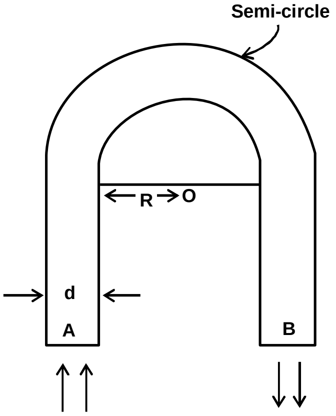
(C)


(D)


Space for Rough work

7. Curie temperature is the temperature above which:
(A) a ferromagnetic material becomes paramagnetic.
(B) a paramagnetic material becomes diamagnetic.
(C) a ferromagnetic material becomes diamagnetic.
(D) a paramagnetic material becomes ferromagnetic.

8. A glass rod (μ = 1.5) of square cross-section is bent into the shape shown in the figure. A parallel beam of light falls perpendicularly on the plane flat surface A. Referring to the diagram, d is the width of a side and R is the radius of inner semi-circle. The maximum value of ratio (d/R) so that all light entering the glass through surface A emerge from the glass through surface B is
(A) 1/2 (B) 2/3
(C) 3/2 (D) 2/1

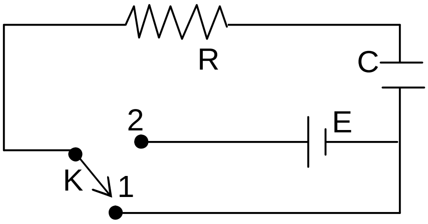


9. A train of mass M is moving on a circular track of radius R with constant speed v. The length of train is half the perimeter of track. The linear momentum of the train will be
(A) 0 (B) $2Mv/\pi$
(C) MvR (D) Mv

10. A cube of side a is placed on an inclined plane of inclination θ. What is the maximum value of θ for which cube will not topple?
(A) 15^0 (B) 30^0
(C) 45^0 (D) 60^0

Space for Rough work

11. In the shown circuit involving a resistor of resistance R Ω, capacitor of capacitance C farad and an ideal cell of emf E volt, the capacitor is initially uncharged and the key is in position 1. At t = 0 second the key is pushed to position 2 for t_0 = RC seconds and then key is pushed bank to position 1 for t_0 = RC seconds. This process is repeated again and again. Assume the time taken to push key from position 1 to 2 and vice versa to be negligible.
The charge on capacitor at t = 2RC second is

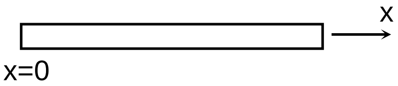


(A) CE
(B) $CE\left(1-\frac{1}{e}\right)$
(C) $CE\left(\frac{1}{e}-\frac{1}{e^2}\right)$
(D) $CE\left(1-\frac{1}{e}+\frac{1}{e^2}\right)$

12. Two polaroids are placed in the path of unpolarized beam of intensity I_0 such that no light is emitted from the second polaroid. If a third Polaroid whose polarization axis makes an angle θ with the polarization axis of first Polaroid, is placed between these polaroids then the intensity of light emerging from the last polaroid will be

(A) $\left(\frac{I_0}{8}\right)\sin^2 2\theta$
(B) $\left(\frac{I_0}{4}\right)\sin^2 2\theta$
(C) $\left(\frac{I_0}{2}\right)\cos^4 \theta$
(D) $I_0 \cos^4 \theta$

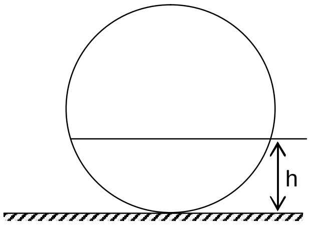
13. If along a uniform rod of length ℓ carrying current I, the voltage V changes with position x along the length of the rod such that dV/dx = – k, where k is a positive number, then the resistance of the rod is



(A) $k\ell/2I$
(B) $k\ell/I$
(C) $I/k\ell$
(D) $k\ell I$

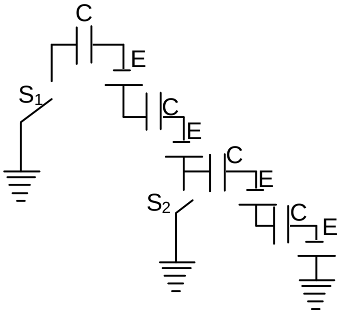
Space for Rough work

14. A liquid is filled in a spherical container of radius R till a height h. At this positions the liquid surface at the edges is also horizontal. The contact angle is



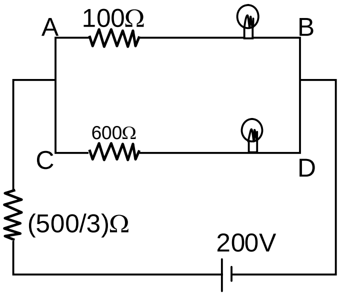
(A) 0
(B) $\cos^{-1}\left(\frac{R-h}{R}\right)$
(C) $\cos^{-1}\left(\frac{h-R}{R}\right)$
(D) $\sin^{-1}\left(\frac{R-h}{R}\right)$

15. In the given circuit, all the capacitors are initially uncharged. After closing the switch S_1 for a long time suddenly S_2 is also closed and kept closed for a long time. Total heat produced after closing S_2 will be :



(A) $4C\varepsilon^2$
(B) $\frac{1}{2}C\varepsilon^2$
(C) $2C\varepsilon^2$
(D) 0

16. Two bulbs 25W, 100V (upper bulb in figure) and 100W, 200V (lower bulb in figure) are connected in the circuit as shown in figure. Choose the correct answer.



(A) Heat lost per second in the circuit will be 80J
(B) Ratio of heat produced per second in bulbs will be 1: 1
(C) Ratio of heat produced in branch AB to branch CD will be 1:2
(D) Current drawn from the cell is 0.2 A

17. A uniform sphere of radius r rolls without slipping down the top of a sphere of radius R. The initial velocity of the sphere is negligible. The angular velocity of the fixed sphere at the moment when it breaks off from the other sphere is

(A) $\sqrt{\frac{10g(R+r)}{17r^2}}$
(B) $\sqrt{\frac{17g(R+r)}{10r^2}}$
(C) $\sqrt{\frac{5g(R+r)}{10r^2}}$
(D) $\sqrt{\frac{5g(R+r)}{11r^2}}$

Space for Rough work

18. The first overtone of an open organ pipe beats with the first overtone of a closed organ pipe with a beat frequency of 2.2 Hz. The fundamental frequency of the closed organ pipe is 110 Hz. The lengths of the pipes are

(A) 1.1 m, 0.9 m (B) 1.2 m, 0.8 m
(C) 1.0067 m, 0.9937 m (D) 2.0067 m, 0.9937 m

19. A particle starts from rest and travels a distance s with uniform acceleration, then it travels a distance 2s with uniform speed finally it travels a distance 3s with uniform retardation and comes to rest. If the complete motion of the particle is a straight line then the ratio of its average velocity to maximum velocity is

(A) 6/7 (B) 4/5
(C) 3/5 (D) 2/5

20. The velocity of a particle varies with time as $\vec{v} = 3\hat{i} + (4-5t)\hat{j}$ m/s. Find the average velocity of the particle for a time interval between t = 0 and a time when the speed of the particle becomes minimum.

(A) $(3\hat{i} + 2\hat{j})$ m/s (B) $(6\hat{i} + 5\hat{j})$ m / s
(C) $(4\hat{i} + \hat{j})$ m / s (D) $(3\hat{i} - 5\hat{j})$ m / s

21. The resistivity of pure silicon is 2300 Ω-m and the mobilities of electrons and holes in it are 0.135 and 0.048 m^2/V-s respectively. The resistivity of a specimen of silicon doped with
10^{19} atoms of phosphorus per meter will be

(A) 4.6 Ω m (B) 4 Ω m
(C) 4.4 Ω m (D) 0 Ωm

22. A perfectly absorbing surface intercepts a parallel beam of monochromatic light of power 10 W (λ = 500 nm) incident on it normally the force exerted by light beam on the surface is

(A) $\frac{1}{4} \times 10^{-7}$N (B) $\frac{1}{3} \times 10^{-7}$N
(C) $\frac{1}{2} \times 10^{-7}$N (D) 1×10^{-7} N

Space for Rough work

23. A mixture of two gases X and Y is enclosed at constant temperature. The relative molecular mass of X, which is diatomic, is 8 times that of Y which is monoatomic. What is the ratio of the rms speed of molecules of Y to that of molecules of X?

(A) 2
(B) $2\sqrt{2}$
(C) 4
(D) 8

24. In a photodiode the conductivity increases when light of wavelength less than 620 nm is incident. The band gap is

(A) 1.12 eV
(B) 1.8 eV
(C) 2.0 eV
(D) 1.62 Ev

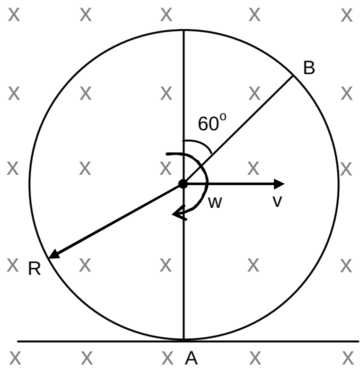
25. Two narrow cylindrical pipes A and B have the same length. Pipe A is open at both ends and is filled with a monatomic gas of molar mass M_A. Pipe B is open at one end and closed at the other end, and is filled with a diatomic gas of molar mass M_B. Both gases are at the same temperature. If the frequency of the second harmonic in pipe A is equal to the frequency of the third harmonic in pipe B, what is the value of M_A/M_B?

(A) $\frac{100}{189}$
(B) $\frac{200}{189}$
(C) $\frac{400}{189}$
(D) $\frac{500}{189}$

26. The efficiency of a Carnot cycle is 1/6. If on reducing the temperature of the sink by 65^0C, the efficiency becomes 1/3, the initial temperatures between which the cycle is working are

(A) 390 K, 325 K
(B) 780 K, 325 K
(C) 390 K, 162 K
(D) 300 K, 100 K

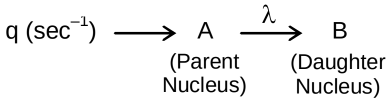
27. A conducting wheel is rolling on the ground in a uniform magnetic field B_o then the emf induced between points A and B; $V_A - V_B$ will be



(A) $B_o w^2(\sqrt{3}R)$
(B) $-\frac{\sqrt{3}}{2}Bw^2R$
(C) $B_o w^2\sqrt{2}R$
(D) $-B_o w^2\left(\frac{\sqrt{5}}{2}\right)R$

Space for Rough work

28. In a radioactive reaction an unstable nucleus A dis-integrates into a stable nucleus B. But A is generated at a constant rate of q nucleus per second. Then at steady state number of nucleus of A will be



$$q\,(\text{sec}^{-1}) \longrightarrow \underset{\text{(Parent Nucleus)}}{A} \xrightarrow{\lambda} \underset{\text{(Daughter Nucleus)}}{B}$$

(A) $q\lambda$ (B) $\frac{q}{\lambda}$

(C) $q - \lambda$ (D) $\frac{\lambda}{q}$

29. A 200 W and a 100 W bulb, both meant for operation at 220 V are connected to a 220 V supply.
(A) Total power consumed by them will be 150 W, if they are in series
(B) Total power consumed by them will be (200/3) W, if they are in series
(C) Total power consumed by them will be 150 W, if they are in parallel
(D) Total power consumed by them will be (200/3) W, if they are in parallel

30. At a place the angle of dip is 30°. If the horizontal component of the earth's magnetic field is H, then the total field intensity will be given by

(A) H/2 (B) $2H/\sqrt{3}$

(C) $H\sqrt{2}$ (D) $H\sqrt{3}$

Space for Rough work

Chemistry

PART – II

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. The energy of the first orbit of hydrogen atom is -13.6 eV. How much minimum amount of energy is required to ionize a gaseous hydrogen atom to a gaseous H^+ ion?
(A) Greater than 13.6 eV
(B) Less than 13.6 eV
(C) Equal to 13.6 eV
(D) Greater than 13.6 eV & less than 17 eV

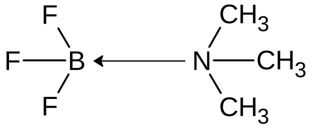
32. For which of the following reversible reaction, pressure has not effect on the state of equilibrium?
(A) $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$
(B) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
(C) $S(s) + O_2(g) \rightleftharpoons SO_2(g)$
(D) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

33. $(P) \xrightarrow{\text{Radioactive disintegration}} {}_{2}^{3}He + \beta\text{-ray}$
The element or compound (P) in the above reaction is:
(A) protium
(B) deuterium
(C) tritium
(D) helium

34. Drugs that reduce body temperature are called
(A) analgesics
(B) antipyretics
(C) antibiotics
(D) hipnotics

Space for Rough work

35. Choose the correct statement regarding the following molecule



(A) $\angle$FBF bond angle is 120°

(B) Nitrogen undergoes sp^2 hybridization

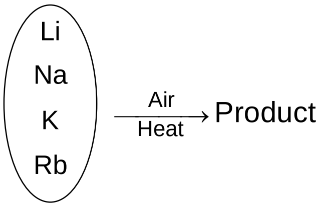
(C) $p\pi$ - $p\pi$ back bond between B & F in the molecule is more dominant than that in isolated BF_3 molecule

(D) All central atoms have the same type of hybridization

36. The pH of 0.01 M NaCl is identical to that of

(A) 0.01 M Na_2CO_3
(B) 0.01 M NaOH
(C) 0.01 M KNO_3
(D) 0.01 M $KHCO_3$

37.



Which product is not formed in the above reaction?

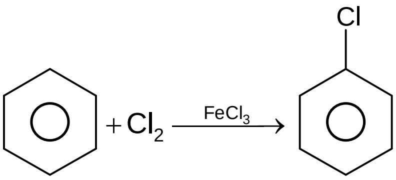
(A) Na_2O_2
(B) Li_3N
(C) KH
(D) RbO_2

38. In a reaction, the time taken for 75% completion of the reaction is two times of that taken for 50% completion of the reaction. What is the order of reaction?

(A) Zero
(B) First
(C) Second
(D) Third

Space for Rough work

39.



The species that attacks the benzene ring in the above reaction is:

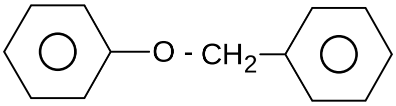
(A) Cl^- (B) Cl^+

(C) $\dot{\text{Cl}}$ (D) $\ddot{\text{Cl}}$

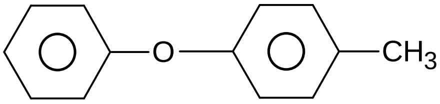
40. Which ether forms the maximum no. of product(s) with HI?

(A) $CH_3OCH_2CH_3$ (B) $CH_3CH_2OCH_2CH_3$

(C)



(D)



41. Which halide of boron has the highest thermal stability?

(A) BF_3 (B) BCl_3

(C) BBr_3 (D) BI_3

42. Which of the following compounds(s) containing asymmetric carbon atoms can rotate plane polarized light?

(I) Dexotro rotatory (II) Racemic mixture

(III) Diastereomers (IV) Meso compounds

Choose the correct code

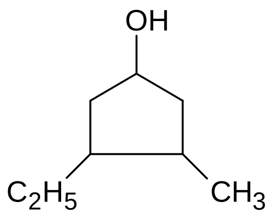
(A) I, II (B) II, IV

(C) I, III (D) I, IV

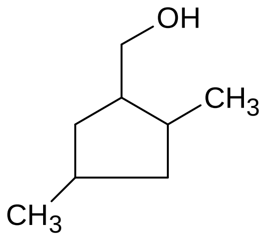
Space for Rough work

43. Which alcohol forms a derivative of cyclohexene upon dehydration reaction?

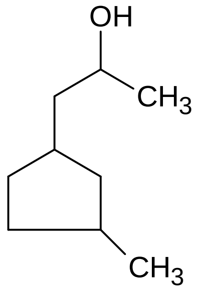
(A)



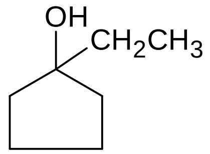
(B)



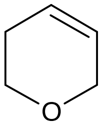
(C)



(D)



44.



does not form cyclic product when reacts with

(A) Cl_2/CCl_4 (B) HCl
(C) H_2/Ni (D) Br_2/CS_2

45. Which of the following forms a primary alcohol when reacts with Grignard's reagent?
(A) CH_3CHO (B) HCHO
(C) CH_3COCH_3 (D) CH_3COOH

46. The incorrect statement regarding glycine is
(A) it is the simplest α-amino acid (B) it contains two functional groups
(C) it contains a chiral carbon atom (D) it can exist as zwitter ion

47. Which reagent is used to check phenolic functional group?
(A) Lucas reagent (B) $FeCl_3$
(C) 2, 4-DNP (D) NH_4OH

Space for Rough work

48. How many element(s) is/are present in Teflon?
(A) 4 (B) 2
(C) 3 (D) 6

49. $NH_4NO_2 \longrightarrow N_2 + 2H_2O$
The equivalent mass of NH_4NO_2 (molar mass = M) in the above reaction is:
(A) $\frac{M}{2}$ (B) M
(C) $\frac{M}{3}$ (D) $\frac{M}{4}$

50. The velocity possessed by maximum number of gas molecules in a layer of an ideal gas is represented by
(A) $\sqrt{\frac{3RT}{M}}$ (B) $\sqrt{\frac{2RT}{M}}$
(C) $\sqrt{\frac{8RT}{\pi M}}$ (D) $\sqrt{\frac{8RT}{M}}$

51. The most basic hydride of gr-15 elements is:
(A) NH_3 (B) PH_3
(C) AsH_3 (D) BiH_3

52. The gases evolved when carbon reacts with conc.H_2SO_4 is/are
(A) CO_2 and SO_2 (B) CO, CO_2 and SO_3
(C) CO_2 and SO_3 (D) CO_2, SO_2 and H_2S

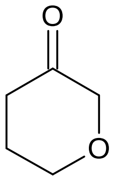
53. The most acidic oxide of chlorine is
(A) Cl_2O (B) ClO_2
(C) Cl_2O_3 (D) Cl_2O_7

54. What is the hybridization of xenon in XeO_4?
(A) sp^3 (B) sp^3d
(C) sp^3d^2 (D) sp^3d^3

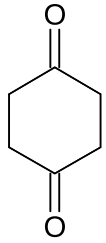
Space for Rough work

55. Which of the following compound does not react with $NaBH_4$?

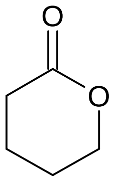
(A)



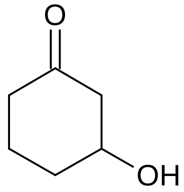
(B)



(C)



(D)

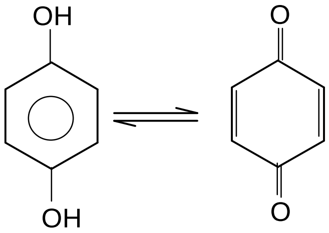


56. The CHO group of D-glucose will be only converted to COOH group when it reacts with
(A) conc.HI/red P
(B) Br_2/H_2O
(C) $PhNHNH_2$
(D) conc.H_2SO_4

57. An aqueous solution of a gas X change the colour of an acidified $K_2Cr_2O_7$ solution. On passing H_2S gas through the solution of X, a white turbidity is obtained . The gas X is
(A) NH_3
(B) SO_2
(C) CO_2
(D) SO_3

58. Which of the following substance has zero standard enthalpy of formation at room temperature?
(A) liquid H_2
(B) liquid N_2
(C) liquid Br_2
(D) liquid Cl_2

59. The cell reaction involving quinhydrone electrode is



+ 2H$^+$ +2e$^-$, E^0 = 1.30V

What will be the electrode potential at pH =3
(A) 1.48 V
(B) 1.20 V
(C) 1.10 V
(D) 1.30 V

60. The number of tetrahedral and octahedral voids in hexagonal primitive unit cell are:
(A) 8, 4
(B) 2, 1
(C) 12, 6
(D) 6, 12

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. If combined equation of two sides AB and AC of a triangle is $x^2 - xy - 2y^2 + x + y = 0$ and (1, 1) is orthocenter, then circum – radius of ΔABC is

(A) $\frac{5\sqrt{2}}{3}$ (B) $\frac{10\sqrt{2}}{3}$

(C) $\frac{3\sqrt{2}}{5}$ (D) $\frac{3}{10\sqrt{2}}$

62. Two variable chords AB and BC of a circle $x^2 + y^2 = a^2$ are such that AB = BC = a, then locus of point of intersection of tangents at A and C is a circle of radius

(A) $a\sqrt{2}$ (B) 2a

(C) 4a (D) none of these

63. Suppose x and y are real numbers and that $x^2 + 9y^2 - 4x + 6y + 4 = 0$ then the minimum value of $(4x - 9y)$ is

(A) 1 (B) 4

(C) 5 (D) 6

64. A hyperbola has focus at origin, its eccentricity is $\sqrt{2}$ and corresponding directrix is $x + y + 1 = 0$. The equation of one of its asymptotes is

(A) $x + 1 = 0$ (B) $x - 2 = 0$

(C) $y - 1 = 0$ (D) $y - 2 = 0$

Space for Rough work

65. The latus rectum of conic is 6 and its eccentricity is $\frac{1}{2}$. Then the length of focal chord making an angle 45^{o} with the major axis is

(A) less than 6 (B) greater than 6
(C) less than 7 (D) greater than 8

66. A normal to the hyperbola $\frac{x^2}{4}-\frac{y^2}{1}=1$, has equal intercepts on positive x and y – axes. If this normal touches the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$, then find $\frac{9}{25}\left(a^2+b^2\right)$.

(A) 1 (B) 2
(C) 3 (D) 4

67. If $c \in R$ and the negative for one of the solutions of $x^2-3x+c=0$ is a solution of $x^2+3x-c=0$, then the smallest solution of $x^2-3x+c=0$ is

(A) -1 (B) 1
(C) 0 (D) 3

68. If 1 + 2 + 3 + ……. + 49 = x, then $1^3 + 2^3 + 3^3 + \ldots\ldots + 49^3$ is given by

(A) x^3 (B) x^2
(C) $x^2 + x$ (D) x^3+x^2

69. Number of solutions of $z \in C$ with $|z|=1$ and $\left|\frac{z}{\bar{z}}+\frac{\bar{z}}{z}\right|=1$ is

(A) 2 (B) 4
(C) 6 (D) 8

70. The coefficient of x^{32} in the expansion of $\left((1+x)(2+x)(3+x)\right)^{10}(2+x)(3+x)^2$ is

(A) 60 (B) 64
(C) 68 (D) none of these

Space for Rough work

71. Let $\vec{a} = \hat{i} + \hat{j} + \hat{k}$, $\vec{b} = x_1\hat{i} + x_2\hat{j} + x_3\hat{k}$, where x_1, x_2, $x_3 \in \{-3, -2, -1, 0, 1, 2\}$. Number of possible vectors $\vec{b}$ such that $\vec{a}$ and $\vec{b}$ are mutually perpendicular, is

(A) 25 (B) 28
(C) 22 (D) None of these

72. Let f(θ) = cos θ cos 2θ cos 3θ cos 4θ cos 5θ cos 6θ and $f\left(\frac{2\pi}{13}\right) = P$. Find value of $2^8|P|$

(A) 2 (B) 4
(C) 6 (D) 8

73. In a triangle ABC, $b + c = 2a$ and $\angle A = 60^o$. Let O be an interior point and its distance from three sides 3,4,5 units , then circum radius of triangle ABC is

(A) 2 (B) 4
(C) 8 (D) 16

74. If $\sum_{k=1}^{n} \tan^{-1}\frac{2k}{2 + k^2 + k^4} = \tan^{-1}\left(\frac{6}{7}\right)$, then the value of 2n is equal to

(A) 2 (B) 4
(C) 6 (D) 8

75. The number of pairs of integer (x, y) that satisfy the following two equations

$$\begin{cases} \cos(xy) = x \\ \tan(xy) = y \end{cases} \text{ is}$$

(A) 1 (B) 2
(C) 4 (D) 6

Space for Rough work

76. Consider the function $f(x)$ satisfying the identity $f(x)+f\left(\frac{x-1}{x}\right)=1+x,\ \forall x \in R-\{0,1\}$ and $g(x)=2f(x)-x+1$.Then the domain of $y=\sqrt{g(x)}$ is

(A) $\left(-\infty, \frac{1-\sqrt{5}}{2}\right] \cup \left[1, \frac{1+\sqrt{5}}{2}\right]$
(B) $\left(-\infty, \frac{1-\sqrt{5}}{2}\right] \cup (0,1) \cup \left[\frac{1+\sqrt{5}}{2}, \infty\right)$
(C) $\left[\frac{-1-\sqrt{5}}{2}, 0\right] \cup \left[\frac{-1+\sqrt{5}}{2}, 1\right]$
(D) $\left[\frac{1-\sqrt{5}}{2}, 0\right) \cup \left[1, \frac{1+\sqrt{5}}{2}\right]$

77. If $y=\frac{2x+5}{3x+10}$ and $2\left(\frac{dy}{dx}\right)\left(\frac{d^3y}{dx^3}\right)=k\left(\frac{d^2y}{dx^2}\right)^2$ then k =

(A) 1
(B) 2
(C) 3
(D) 4

78. If $f(x)$ is continuous such that

$f(x)=f(3x-4y)+f(4y-2x)-(3x-4y)(4y-2x)\forall x,y \in R$ and $\lim_{h\to 0}\frac{f(h)}{h}=4$, then $f'(2)$ is

(A) 1
(B) 2
(C) 3
(D) 4

79. The angle at which curve $y=ke^{kx}$ intersects the y axis is

(A) $\tan^{-1}(k^2)$
(B) $\cot^{-1}(k^2)$
(C) $\sin^{-1}\frac{1}{k^2}$
(D) none of these

80. If $Y=\tan^{-1}\frac{1}{1+x+x^2}+\tan^{-1}\frac{1}{3+3x+x^2}+\tan^{-1}\frac{1}{7+5x+x^2}$ + ……..upto n terms then Y'(0) is equal to :

(A) $\frac{-1}{1+n^2}$
(B) $\frac{-n^2}{1+n^2}$
(C) $\frac{n}{1+n^2}$
(D) None of these

Space for Rough work

81. The side of a triangle are in the ratio 3:5 and the third side is 16, if the largest possible area of the triangle is

(A) 120 (B) 230

(C) 130 (D) 240

82. Let $f:[0,1]\rightarrow[0,\infty)$ be a real valued continuous function such that

$(f(t))^2 \le 1+2\int_0^t f(u)du \,\forall\, t\in[0,1]$, then which of the following is (are) correct?

(A) $f\left(\frac{1}{2}\right)\le\frac{5}{2}$ (B) $f\left(\frac{3}{4}\right)\ge\frac{7}{4}$

(C) $\int_0^{3/4} f(u)du > \frac{33}{32}$ (D) $\int_0^{1/2} f(u) \le \frac{5}{8}$

83. $\int e^x\left(\frac{2\tan x}{1+\tan x}+\cot^2\left(x+\frac{\pi}{4}\right)\right)dx$ is equal to

(A) $e^x\tan\left(\frac{\pi}{4}-x\right)+c$ (B) $e^x\tan\left(x-\frac{\pi}{4}\right)+c$

(C) $e^x\tan\left(\frac{3\pi}{4}-x\right)+c$ (D) none of these

84. If y = f(x) satisfies the condition f(x) = f(4 – x) ∀ x □ (0, 4), f(x) = f(14 – x) ∀ x □ [4, 10],

$$f(x)=\begin{cases}[x^2-2x+5], & x\in(0,1]\\ 3+\sqrt{2x-x^2}, & x\in(1,2]\\ \frac{20-2x}{3}, & x\in[4,7]\end{cases}$$

Then the area bounded by y = f(x), x = 0, x = 10 and the x-axis is

(A) $\frac{\pi}{2}+16$ (B) $\frac{\pi}{2}+20$

(C) $\frac{\pi}{2}+32$ (D) None of these

Space for Rough work

85. A six faced die is so biased that it is twice as likely to show on even number as an odd number when thrown. It is thrown twice then probability that the sum of the two numbers thrown is even is

(A) 1/3 (B) 5/9

(C) 7/9 (D) none of these

86. If $bx^2 + ax + c = 0$, $ax^2 + bx + c = 0$ and $ax^2 + cx + b = 0$, each equation has equal roots, then $\begin{vmatrix} 3 & a & bc \\ 3 & b & ac \\ 3 & c & ab \end{vmatrix}$ is equal to

(A) $3(a - b)(b - c)(c - a)$ (B) $\frac{3}{4}(a-b)(b-c)(c-a)$

(C) 3 abc (D) abc

87. If A is a skew symmetric matrix of order 2 & B, C are matrices $\begin{bmatrix} 1 & 4 \\ 2 & 9 \end{bmatrix}, \begin{bmatrix} 9 & -4 \\ -2 & 1 \end{bmatrix}$,then $A^3BC + A^5(B^2C^2) + A^7(B^3C^3) + ...A^{2017}(B^{1009}C^{1009})$ is

(A) a symmetric matrix (B) an identity matrix

(C) a skew symmetric matrix (D) None of these

88. If $\vec{a}, \vec{b}, \vec{c}$ are unit vectors, then the maximum value of $|\vec{a} - 2\vec{b}|^2 + |\vec{b} - 2\vec{c}|^2 + |\vec{c} - 2\vec{a}|^2$ is

(A) 21 (B) 22

(C) 23 (D) 24

89. The volume of the parallelepiped whose coterminous edges are represented by the vectors $4\vec{b} \times \vec{c}$, $3\vec{c} \times \vec{a}$ and $8\vec{a} \times \vec{b}$, where $\vec{a} = (1 + \sin\theta)\vec{i} + \cos\theta\vec{j} + \sin 2\theta\vec{k}$,

$\vec{b} = \sin\left(\theta + \frac{2\pi}{3}\right)\vec{i} + \cos\left(\theta + \frac{2\pi}{3}\right)\vec{j} + \sin\left(2\theta + \frac{4\pi}{3}\right)\vec{k}$ and

$\vec{c} = \sin\left(\theta - \frac{2\pi}{3}\right)\vec{i} + \cos\left(\theta - \frac{2\pi}{3}\right)\vec{j} + \sin\left(2\theta - \frac{4\pi}{3}\right)\vec{k}$, is 18 cubic units, then $|\cos 3\theta| =$

(A) $\frac{\sqrt{3}}{2}$ (B) $\frac{1}{2}$

(C) 1 (D) none

90. The negation of $\sim s \vee (\sim r \wedge s)$ is equivalent to :

(A) $s \wedge (r \wedge \sim s)$ (B) $s \vee (r \vee \sim s)$

(C) $s \wedge r$ (D) $s \wedge \sim r$

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – II

JEE (Main)-2019

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. A

Sol. Energy density = $\frac{1}{2}\varepsilon_o E_o^2$ and $E_o = (E_{rms})\sqrt{2}$

2. D

Sol. I_L and I_C will be in opposite phases.
$I_{net} = I_L - I_C$
$= 0.6 - 0.4 = 0.2$ A

3. A

Sol. Amplitude and energy both are maximum at resonant frequency.

4. D

Sol. $V = 2(x^2 - y^2)$
Equipotential surfaces will be hyperbolic and $\vec{E}$ everywhere will be $\perp$ to them.

5. A

Sol. $\frac{1.22\,\lambda}{d} = \frac{\Delta r}{x}$

$\Rightarrow \quad x = \frac{(\Delta)\,(d)}{1.22\lambda} = \frac{1mm \times 3mm}{1.22 \times 500 \times 10^{-9} m}$ = 5 m

6. B

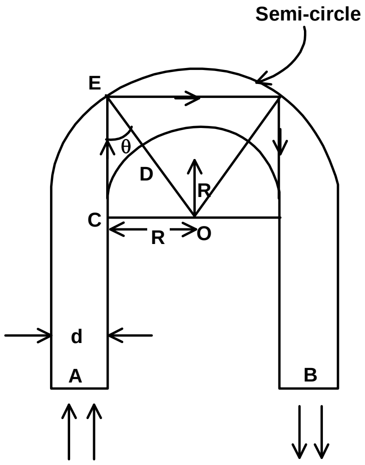
Sol. Source and observer are receding with a constant relative velocity.

7. A

Sol. Above curie temperature ferromagnetic substance become paramagnetic.

8. A

Sol. As shown in the figure, angle of incidence will be minimum for the ray travelling along the inner edge. So the whole incident light entering the glass through surface A will emerge from the glass through surface B.



$\theta > I_C$

$\sin\theta > \sin I_C$

But as, $\sin I_C = \frac{1}{\mu} = \frac{2}{3}$

And from the geometry of the figure,

$$\sin\theta = \frac{OC}{OE} = \frac{R}{OD+DE} = \frac{R}{R+d}$$

so, $\frac{R}{R+d} > \frac{2}{3}$, i.e. $R > 2d$

i.e., $\frac{d}{R} < \frac{1}{2}$ so $\left(\frac{d}{R}\right) = \frac{1}{2}$

9. B

Sol. Total momentum = $\int_{\theta=-90}^{+90} (dm)v\cos\theta$

$dm = \frac{M}{\pi R} \times Rd\theta$

Total momentum = $\int \frac{M}{\pi R} vRd\theta \cos\theta = \frac{2Mv}{\pi}$

10. C

Sol. When centre of cube is directly above the edge of cube.

$\Rightarrow \theta = 45°$.

11. C

Sol. For charging $q = CE(1 - e^{-t/RC})$

Charge at t = RC $\Rightarrow q_o = CE(1 - e^{-1})$

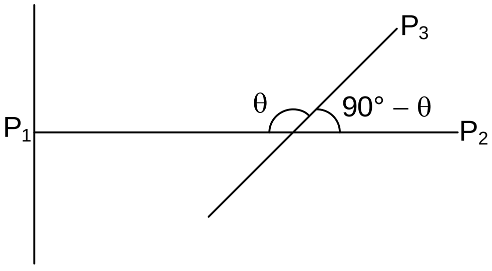
At t = RC discharging starts

$\Rightarrow q = q_o(e^{-t/RC}) = CE(1 - e^{-1}) \times \frac{1}{e} = CE\left(\frac{1}{e} - \frac{1}{e^2}\right)$

12. A

Sol. No light is emitted from the second polaroid, so P_1 and P_2 are perpendicular to each other

Let the initial intensity of light is I_0. So Intensity of light after transmission from first polaroid $= \frac{I_0}{2}$.



Intensity of light emitted from P_3

$$I_1 = \frac{I_0}{2}\cos^2\theta$$

Intensity of light transmitted from polaroid i.e., from

$$P_2 = I_1\cos^2\left(90^\circ - \theta\right) = \frac{I_0}{2}\cos^2\theta\sin^2\theta$$

$$P_2 = \frac{I_0}{8}\left(2\sin\theta\cos\theta\right)^2 = \frac{I_0}{8}\sin^2 2\theta$$

13. B

Sol. $dV = -\,IdR = = -I\rho\dfrac{dx}{A}$

$$\frac{dV}{dx} = -I\frac{\rho}{A} = -k$$

$\Rightarrow R = k\ell/I$

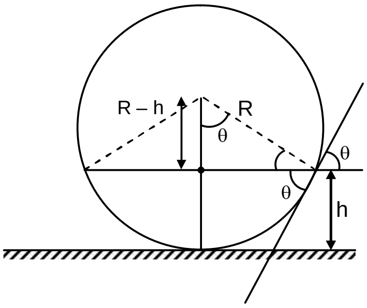
II Method:

$$V_2 - V_1 = \int\left(\frac{dV}{d\ell}\right)d\ell = kL = IR$$

14. B

Sol. $\cos\theta = \dfrac{R-h}{R}$

$\Rightarrow\ \cos^{-1}(\theta) = \dfrac{R-h}{R}$



15. D

Sol. No heat will be produced as no charge flows through S_2 when it is closed.

16. A

Sol. Total resistance = $\dfrac{500}{3} + \dfrac{\left(100 + \dfrac{100^2}{25}\right)\left(600 + \dfrac{200^2}{100}\right)}{100 + \dfrac{100^2}{25} + 600 + \dfrac{200^2}{100}} = 500$

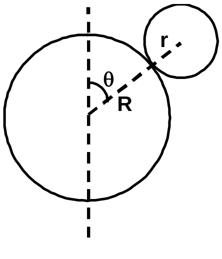
Required heat = $\dfrac{200^2}{500}$ = 80 J.

17. A

Sol. When the line joining the centers of the two spheres makes an angle θ with the vertical, then

$mg\cos\theta - N = \dfrac{mv^2}{R+r}$

When the contact breaks off, N= 0



$$mg\cos\theta = \frac{mv^2}{R+r} = \frac{m\omega^2r^2}{R+r} \qquad \ldots (1)\ [\because v = \omega r]$$

From COE principle

$$mg(R + r) = mg\,(R+r)\cos\theta + \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

$$mg(R + r) = (R+r)\frac{m\omega^2r^2}{R+r} + \frac{m\omega^2r^2}{2} + \frac{1}{2}.\ \frac{2}{5}mr^2\omega^2$$

$$\text{or } g(R + r) = \frac{17}{10}\omega^2r^2$$

$$\therefore\ \omega = \sqrt{\frac{10g(R+r)}{17r^2}}$$

18. C

Sol. For closed organ pipe $f_C = (2n-1)\dfrac{v}{4L_C}$ with n = 1, 2, …

While for open organ pipe $f_O = n\dfrac{v}{2L_O}$ with n = 1, 2, …

According to given problem

$$f_C = \frac{v}{4L_C} = 110 \qquad \text{i.e.,} \qquad L_C = \frac{330}{4\times110} = 0.75\ \text{ m}$$

Furthermore

$$\frac{3v}{4L_C} \sim \frac{2v}{2L_O} = 2.2 \qquad \text{or} \qquad \frac{330}{L_O} = 330 \mp 2.2 \qquad \left(\text{as } \frac{3v}{4L_C} = 3f_C = 330\right)$$

$$\text{i.e.,} \qquad L_O = \frac{330}{330\mp2.2} \Rightarrow L_O = 1.00067\ \text{ m} \qquad \text{or} \qquad 0.9937\text{ m}$$

19. C

Sol. Maximum velocity $v_{max} = \sqrt{2as}$

$$v_{avg} = \frac{6s}{T} \qquad T = t_1 + t_2 + t_3$$

$$t_1 = \sqrt{\frac{2s}{a}}, \qquad t_2 = \frac{2s}{v_{max}} = \sqrt{\frac{2s}{a}}$$

Retardation $\Rightarrow$ B

$$\beta = \frac{v_{max}^2}{6s}$$

$$\beta = \frac{2a\times s}{6\times s} = \frac{a}{3}$$

$$t_3 = \frac{v_{max}}{\beta} = 3\sqrt{\frac{2a\times s}{a}} = 3\sqrt{\frac{2s}{a}}$$

$$T = 5\sqrt{\frac{2s}{a}}$$

$$v_{avg} = \frac{6}{5}\frac{5}{\sqrt{\frac{2s}{a}}}$$

$$v_{avg} = \frac{6}{5}\sqrt{\frac{a\,s}{2}}$$

$$\frac{v_{avg}}{v_{max}} = \frac{6}{5}\sqrt{\frac{as}{2}} \times \frac{1}{\sqrt{2as}} = \frac{3}{5}$$

20. A

Sol. $\vec{v}_{avg} = \dfrac{\int_0^{4/5} \vec{v}dt}{\int_0^{4/5} dt}$

21. A

Sol. The resistivity of pure silicon is 2300 Ω m
and $\mu_e = 0.135\ m^2/v\text{-}s$, $\mu_h = 0.048\ m^2/v\text{-}s$.
Using
$\sigma = 1/\rho = (n_I\,\mu_e + n_I\,\mu_h)e$
$(2300)^{-1} = n_I\ (0.135 + 0.048) \times 1.6 \times 10^{-19}$
$n_I = 1.5 \times 10^{16}\ /m^3$.
Is the intrinsic electron & hole concentration. The resistivity of a specimen doped with 10^{19} P-atoms/m^3 can be found from :
σ (conductivity) = $n_e\, e.\mu_e$ $(\because n_e = 10^{19}/m^3 >> n_I)$
$= 10^{19} \times 1.6 \times 10^{-19} \times 0.135 = 0.216$ mho / m.
$\rho = \dfrac{1}{\sigma} = 4.6\ \Omega$ -m

22. B

Sol. Power = 10W
$\Rightarrow$ Force = $\dfrac{P}{C}$ (for perfectly absorbing surface)
$F = \dfrac{10}{3 \times 10^8 m/s} = \dfrac{1}{3} \times 10^{-7}$

23. B

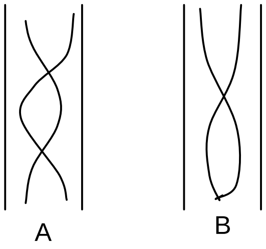
Sol. $v_{rms} = \sqrt{\dfrac{3RT}{M}}$

24. C

Sol. $E_g\left(eV\right) = \dfrac{1242}{\lambda\left(nm\right)} = \dfrac{1242}{620} = 2eV$

25. C

Sol. (a) $2\dfrac{V_A}{2L_A} = 3\dfrac{V_B}{4L_B}$



$$\Rightarrow \frac{V_A}{V_B} = \frac{3}{4} \qquad [\because L_A = L_B]$$

$$V_A = \sqrt{\frac{\gamma_A RT}{M_A}}, \qquad V_B = \sqrt{\frac{\gamma_B RT}{M_B}}$$

$$\Rightarrow \sqrt{\frac{\gamma_A}{\gamma_B}\frac{M_B}{M_A}} = \frac{3}{4}, \qquad \gamma_A = \frac{5}{3}, \qquad \gamma_B = \frac{7}{5}$$

$$\Rightarrow \frac{M_A}{M_B} = \frac{400}{189}$$

26. A

Sol. Given $\eta_1 = \frac{1}{6}$, $\eta_2 = \frac{1}{3}$

If the temperatures of the source and the sink between which the cycle is working are T_1 and T_2, then the efficiency in the first case will be

$$\eta_1 = 1 - \frac{T_2}{T_1} = \frac{1}{6}$$

In the second case $\eta_2 = 1 - \frac{T_2 - 65}{T_1} = \frac{1}{3}$

Solving $T_1 = 390$ K and $T_2 = 325$ K.

27. B

Sol. $\Delta V = \frac{B\omega^2(\ell)}{2} = \frac{B\omega^2(\sqrt{3}\,R)}{2} = V_B - V_A$.

28. B

Sol. At steady state.

Rate of generation of A = Rate of decay of A.

$q = \lambda N_A$

$$\Rightarrow N_A = \frac{q}{\lambda}$$

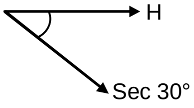
29. B

Sol. For series combination $R = 220^2\left(\frac{1}{200} + \frac{1}{100}\right) = 220^2 \times \frac{3}{200}$

$$\therefore \text{ Power} = \frac{220^2}{R} = \frac{200}{3}\text{W}$$

30. B

Sol.



$\therefore$ H sec 30° = $2H/\sqrt{3}$

Chemistry PART – II

SECTION – A

31. C

Sol. I.E = -E_1 = - (-13.6) = 13.6 eV.

32. C

Sol. $\Delta n = n_P - n_R = 1 - 1 = 0$

$\therefore$ Pressure has no effect.

33. C

Sol. ${}^{3}_{1}T \longrightarrow {}^{3}_{2}He + {}^{0}_{-1}e$

34. B

Sol. Antipyretics reduce body temperature.

35. D

Sol. Hybridization of boron changes to sp^3.

36. C

Sol. Both NaCl and KNO_3 are neutral salt.

37. C

Sol. KH is not formed as there is not H_2 in the atmosphere.

38. B

Sol. For first order reaction, $t_{1/2} = \frac{0.693}{k}$

39. B

Sol. Electrophilic substitution reaction takes place.

40. A

Sol. The products are CH_3OH, CH_3I, C_2H_5OH and C_2H_5I.

41. A

Sol. Due to strong B – F bond energy.

42. C

Sol. d- or ℓ- and diastereomers rotate plane polarized light.

43. B

Sol. Expansion of ring takes place in (B). In(C) the initially formed carbocation does not undergo rearrangement to initiate ring expansion.

44. B

Sol. Cleavage for expoxy ring takes place in acidic medium.

45. B

Sol. $HCHO + CH_3MgBr \xrightarrow{H_2O/H^+} CH_3CH_2OH$

46. C

Sol. It contains no chiral atom, $H_2N - CH_2 - COOH$.

47. B

Sol. Phenol forms complex with $FeCl_3$ and changes its colour.

48. B

Sol. It is a polymer of $CF_2 = CF_2$.

49. C

Sol. n-factor of NH_4NO_2 is 3.

50. B

Sol. Maximum number of molecules of a gas moves with most probable velocity.

51. A

Sol. On moving down the group, the s-character of the orbital that holds the lone pair increases. Hence basicity decreases.

52. A

Sol. $C + 2H_2SO_4 \longrightarrow CO_2 + 2SO_2 + 2H_2O$

53. D

Sol. In Cl_2O_7, it's oxidation number is maximum.

54. A

Sol. Oxygen forms both sigma and pi bonds with xenon.

55. C

Sol. Esters are not reduced by $NaBH4_4$.

56. B

Sol. Br_2/H_2O is a mild oxidizing agent.

57. B

Sol. $SO_2 + 2H_2S \longrightarrow 3S + 2H_2O$

58. C

Sol. Br_2 exists as a liquid at room temperature.

59. A

Sol. $E = E^0 - \frac{0.0591}{2}\log\left[H^+\right]^2, \left[H^+\right] = 10^{-3}, E^0 = 1.30\,V$

60. C

Sol. No. of tetrahedral voids = 12

No. of octahedral voids = 6

Mathematics PART – III

SECTION – A

61. A

Sol. Clearly two sides are $x - 2y + 1 = 0$ and $x + y = 0$

As orthocenter lies on $x - 2y + 1 = 0$ is right angled (let at B)

Third side passes through (1, 1) and is perpendicular to $x - 2y + 1 = 0$

$\Rightarrow$ Third side is $2x + y - 3 = 0$

$\therefore$ Circum – radius $= \frac{1}{2}AC = \frac{5\sqrt{2}}{3}$

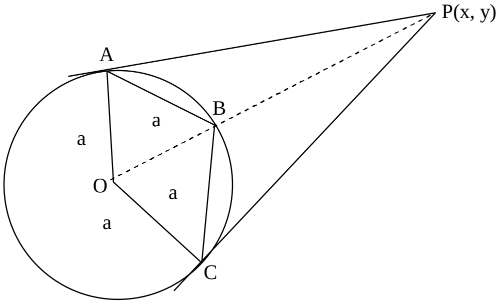
62. B

Sol. $AB = AO = BO = a \Rightarrow \angle AOB = 60^\circ$

$\Rightarrow \frac{PA}{r} = \sqrt{3}$

$\Rightarrow x^2 + y^2 - a^2 = 3a^2$

$\Rightarrow x^2 + y^2 = 4a^2$



63. D

Sol. $x^2 + 9y^2 - 4x + 6y + 4 = 0$

$$\Rightarrow \quad (x-2)^2 + 9\left(y^2 + \frac{2}{3}y + \frac{1}{9}\right) = 1$$

$$\Rightarrow \quad \frac{(x-2)^2}{1} + \frac{\left(y + \frac{1}{3}\right)^2}{\left(\frac{1}{9}\right)} = 1$$

Its parametric equation is

$x = 2 + \cos\theta, y = -\frac{1}{3} + \frac{1}{3}\sin\theta$

Hence $4x - 9y = 8 + 4\cos\theta + 3 - 3\sin\theta$

$\Rightarrow$ minimum value of $4x-9y$ is 6

64. A

Sol. Equation of hyperbola $x^2 + y^2 = (x + y + 1)^2$

$2xy + 2x + 2y + 1 = 0$

$\therefore$ Equation of Asymptotes $2xy + 2x + 2y + 1 + \lambda = 0$. For a pair of straight lines $\lambda = 1$

$\therefore$ Asymptoes : $(y+1)(x+1) = 0$ or $y = -1$ and $x = -1$

65. B

Sol. Length $= \frac{2ab}{a^2m^2+b^2}\sqrt{\left(1+m^2\right)\left(a^2m^2+b^2+c^2\right)}$ where $m=1, c^2=\left(ae\right)^2$

$$= \frac{2\left(\frac{2b^2}{a}\right)}{1+\frac{b^2}{a^2}} = \frac{2\left(\frac{2b^2}{a}\right)}{1+1-e^2} = 6.\frac{6}{7}$$

66. C

Sol. Equation of normal at $\left(2\sec\theta, \tan\theta\right)$ is $\frac{2x}{\sec\theta}+\frac{y}{\tan\theta}=5$

Slope $=-1 \Rightarrow -\frac{2\tan\theta}{\sec\theta}=-1$

$\Rightarrow \quad \theta=\frac{\pi}{6}$

$\therefore$ normal becomes $y=-x+\frac{5}{\sqrt{3}}$

$\because$ It is tangent to ellipse $\Rightarrow a^2+b^2=\frac{25}{3} \Rightarrow \frac{9}{25}\left(a^2+b^2\right)=3$

67. C

Sol Let α be a root of equation $x^2-3x+c=0$ then -α is a root of equation
$x^2+3x-c=0 \Rightarrow c=0$
$\Rightarrow$ the smallest of $x^2-3x=0$ are 0 and 3

68. B

Sol. $x=1+2+3+.....49$

$$=\sum_{n=1}^{49} n$$

$=\frac{n\left(n+1\right)}{2}$, where $n=49$ (i)

Let $1^3+2^3+3^3+.......+49^3=y$

$y=\sum_{n=1}^{49} n^3 = \left(\frac{n\left(n+1\right)}{2}\right)^2$, where n = 49 (ii)

Hence $y=x^2$ by comparing (i) & (ii)

69. D

Sol. Let $z=e^{ix}$ $x\in\left[0, 2\pi\right)$

$$\left|\frac{z}{\overline{z}}+\frac{\overline{z}}{z}\right|=1 \Rightarrow \left|z^2+\overline{z}^2\right|=1$$

$$\left|\cos 2x+i\sin 2x+\cos 2x-i\sin 2x\right|=1$$

$$\Rightarrow \cos 2x = \pm\frac{1}{2}$$

$$x = \frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{11\pi}{6}\left(\cos x = \frac{1}{2}\right)$$

$$x = \frac{\pi}{3}, \frac{2\pi}{3}, \frac{4\pi}{3}, \frac{5\pi}{3}\left(\cos x = \frac{-1}{2}\right)$$

70. C

Sol. $(1+x)^{10}(2+x)^{11}(3+x)^{12}$

$= \left(x^{10} + {}^{10}C_1x^9 + ...\right)\left(x^{11} + {}^{11}C_1x^{10}(2) + ...\right)\left(x^{12} + {}^{12}C_1x^{11}(3) + ...\right)$

coefficient of $x^{32} = (12)(3) + (11)(2) = (10) = 68$

71. A

Sol. $\vec{a}.\vec{b} = 0 \Rightarrow x_1 + x_2 + x_3 = 0$

Thus we have to obtain the number of integral solution of this equation.

Coefficient of $x^\circ \mid (x^{-3} + x^{-2} + x^{-1} + x^0 + x + x^2)^3$

$= x^\circ \left|\left(\frac{1+x+x^2+x^3+x^4+x^5}{x^3}\right)^3\right.$

$= x^9 \mid (1 - x^6)^3 (1 - x)^{-3} = {}^{11}C_9 - 3.{}^5C_3 = 25$.

72. B

Sol. $\cos 5\theta = \cos 8\theta$

$\cos 3\theta = \cos 16\theta$

$\therefore \cos\theta \cos 2\theta \cos 4\theta \cos 8\theta \cos 16\theta \cos 32\theta$

$= \frac{\sin 64\theta}{2^6 \sin\theta} = -\frac{\sin\theta}{2^6\sin\theta} = \frac{-1}{2^6} = P$

$2^8|P| = 2^8 \times \frac{1}{2^6} = 4$

73. C

Sol. $\cos 60^\circ = \frac{b^2c^2 - a^2}{2bc} \Rightarrow bc = a^2$

$b + c = 2a \Rightarrow b - c = 0$

$\therefore$ Triangle is equation

$A\ \frac{\sqrt{3}}{4}a^2 = \frac{1}{2}(3+4+5)a$

$a = \frac{24}{\sqrt{3}}$

$R = \frac{abc}{4} = \frac{a}{\sqrt{3}}$

74. C

Sol. $T_n = \tan^{-1}\left(\frac{(k^2+k+1)-(k^2-k+1)}{1+(k^2+k+1)(k^2-k+1)}\right)$

$= \tan^{-1}(k^2+k+1) - \tan^{-1}(k^2-k+1)$

$S_n = \tan^{-1}(n^2+n+1) - \tan^{-1}(1)$

$= \tan^{-1}\left(\frac{n^2+n+1-1}{1+n^2+n+1}\right) = \tan^{-1}\left(\frac{n^2+n}{2+n+n^2}\right) = \tan^{-1}\left(\frac{6}{7}\right) \Rightarrow n = 3$

$\therefore 2n = 6$

75. A

Sol. $\frac{\sin(xy)}{\cos(xy)} = y$

$\Rightarrow \sin(xy) = xy$

$\Rightarrow xy = 0$

$\Rightarrow x = 0$ or $y = 0$

But x = 0 is not possible

$\therefore$ y = 0 and x = 1, i.e. (1, 0)

76. B

Sol. $g(x) = \frac{x^3-x^2-1}{x(x-1)} - x + 1 = \frac{-2+2x^2-2x}{2x(x-1)} = \frac{x^2-x-1}{x(x-1)}$

Now for $y = \sqrt{g(x)}$, we must have $\frac{x^2-x-1}{x(x-1)} \ge 0$ or $\frac{\left(x-\frac{1-\sqrt{5}}{2}\right)\left(x-\frac{1+\sqrt{5}}{2}\right)}{x(x-1)} \ge 0$

$\Rightarrow x \in \left(x \in -\infty, \frac{1-\sqrt{5}}{2}\right] \cup (0, 1) \cup \left[\frac{1+\sqrt{5}}{2}, \infty\right)$

77. C

Sol. $\Rightarrow 3xy + 10y = 2x + 5$

$y_1 = \frac{2-3y}{3x+10}, y_2 = \frac{-6(2-3y)}{(3x+10)^2}$

$y_3 = \frac{54(2-3y)}{(3x+10)^3}$

$\frac{y_1 y_3}{54} = \frac{{y_2}^2}{36}$

78. B

Sol. $f(x) = f(3x-4y+4y-2x) = f(3x-4y) + f(4y-2x) - (3x-4y)(4y-2x)$

$f(x+y)=f(x)+f(y)-xy$

$f'(2)=\underset{h\to 0}{\text{Lt}}\dfrac{f(2+h)-f(2)}{h}=f'(0)$

79. B

Sol. $y=ke^{kx}$ cuts the y-axis at x = 0

$\frac{dy}{dx}=k^2e^{kx}$

at x = 0

$\frac{dy}{dx}=k^2$

$\alpha=\tan^{-1}(k^2)$ this is angle made by x-axis, angle made by y-axis $\frac{\pi}{2}-\tan^{-1}(k^2)$

or $\cot^{-1}(k^2)$

80. B

Sol. $T_1=\tan^{-1}\left(\frac{1}{1+x(1+x)}\right)=\tan^{-1}\left(\frac{1+x-x}{1+x(1+x)}\right)$

$=\tan^{-1}(1+x)-\tan^{-1}(x)$

$T_2=\tan^{-1}(2+x)-\tan^{-1}(1+x)$, etc

81. A

Sol. $S=\frac{16+3x+5x}{2}=8+4x$

Now $3x+5x>16\Rightarrow x>2$

$3x+16>5x\Rightarrow x<8\Rightarrow x\in(2,8)$

$5x+16>3x\Rightarrow x>-8$

Now $A^2(x)=(8+4x)(4x-18)(x+8)(8-x)=(16x^2-64)(64-x^2)$

Let $x^2=t\Rightarrow t\in(4,64), f(t)=16(t-4)(64-t)=16(64t-t^2-256+4t)$

$\therefore f(t)=-16(t^2-68t+256), f'(t)=2t-68=0\Rightarrow t=34$

$f''(t)=-32<0$

Maxima occurs at t=34

F(34)=16(30)(30)

$\therefore$ largest possible area = 120

82. D

Sol. Let $\int_0^t f(u)du=F(t)\Rightarrow F'(t)=f(t)$ and $F(0)=0$

Also $f(t)\geq 0\ \Rightarrow\int_0^t f(u)du\geq 0\ \forall t\in[0,1]$

$$\Rightarrow \left|f(t)\right| \le \sqrt{1+2\int_0^t f(u)\,du}$$

$$\Rightarrow F'(t) \le \sqrt{1+2F(t)} \Rightarrow \frac{F'(t)}{\sqrt{1+2F(t)}} \le 1 \text{ as } f(t) \ge 0$$

$$\int_0^t \frac{F'(t)\,dt}{\sqrt{1+2F(t)}} \le \int_0^t dt\ \forall\, t \in [0, 1]$$

$$\Rightarrow \sqrt{1+2F(t)} \le t+1$$

$$\Rightarrow f(t) \le t+1 \text{Also } 1+2F(t) \le (t+1)^2 \Rightarrow 2F(t) \le t^2+2t \ \Rightarrow F(t) \le \frac{t^2}{2}+t \Rightarrow \int_0^t f(u)\,du \le \frac{t^2}{2}+t$$

83. B

Sol. $\int e^x\left(\frac{2\tan x}{1+\tan x}+\tan^2\left(x-\frac{\pi}{4}\right)\right)dx$

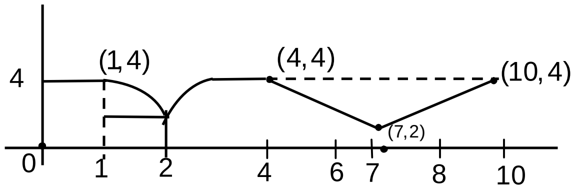
$=\int e^x\left(\tan\left(x-\frac{\pi}{4}\right)+\sec^2\left(x-\frac{\pi}{4}\right)\right)dx \ = e^x\tan\left(x-\frac{\pi}{4}\right)+c$.

84. C

Sol. Required area =

$2\left(4+\frac{\pi}{4}+3\right)+\left[(6\times4)-\frac{1}{2}\times2\times6\right]$

$= 32+\frac{\pi}{2}$ sq. units



85. B

Sol. Probability of getting an odd number= $\frac{1}{9}$

Probability that getting an even number = $\frac{2}{9}$

Let 'A' denote the sum of the numbers thrown is even. $P(A)=9\left(\frac{1}{81}\right)+9\left(\frac{4}{81}\right)=\frac{5}{9}$.

86. B

Sol. $\begin{vmatrix}3 & a & bc\\ 3 & b & ac\\ 3 & c & ab\end{vmatrix}=\begin{vmatrix}1 & a & 3bc\\ 1 & b & 3ac\\ 1 & c & 3ab\end{vmatrix}$

now $a^2-4bc=0,\ b^2-4ac=0,\ c^2-4ab=0$

$\Rightarrow a^2-bc=3bc,\ b^2-ac=3ac,\ c^2-ab=3ab$

$$\Rightarrow \begin{vmatrix}1 & a & a^2-bc\\ 1 & b & b^2-ac\\ 1 & c & c^2-ab\end{vmatrix}=0$$

$$\text{also}\begin{vmatrix}1 & a & \frac{3}{4}a^2\\ 1 & b & \frac{3}{4}b^2\\ 1 & c & \frac{3}{4}c^2\end{vmatrix}=\frac{3}{4}[a-b)(b-c)(c-a)$$

87. C

Sol Here $BC=\begin{bmatrix}1 & 4\\ 2 & 9\end{bmatrix}\begin{bmatrix}9 & -4\\ -2 & 1\end{bmatrix}=\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}=I$

The given matrix reduce to $A^3+A^5+A^7+.....+A^{2017}$ which is skew symmetric as A is skew symmetric

88. A

Sol. $\left|\vec{a}-2\vec{b}\right|^2+\left|\vec{b}-2\vec{c}\right|^2+\left|\vec{c}-2\vec{a}\right|^2=5a^2+5b^2+5c^2-4\left(\vec{a}\cdot\vec{b}+\vec{b}\cdot\vec{c}+\vec{c}\cdot\vec{a}\right)$

$$=15-4\left(\vec{a}\cdot\vec{b}+\vec{b}\cdot\vec{c}+\vec{c}\cdot\vec{a}\right)\le 15-4\left(\frac{-3}{2}\right)=21$$

89. B

Sol. $\left|\left[\vec{a}\ \vec{b}\ \vec{c}\right]\right|=\frac{\sqrt{3}}{4}$

$$\left[\vec{a}\ \vec{b}\ \vec{c}\right]=\begin{vmatrix}1+\sin\theta & \cos\theta & \sin 2\theta\\ \sin\left(\theta+\frac{2\pi}{3}\right) & \cos\left(\theta+\frac{2\pi}{3}\right) & \sin\left(2\theta+\frac{4\pi}{3}\right)\\ \sin\left(\theta-\frac{2\pi}{3}\right) & \cos\left(\theta-\frac{2\pi}{3}\right) & \sin\left(2\theta-\frac{4\pi}{3}\right)\end{vmatrix}$$

Apply $R_1\to R_1+R_2+R_3$.

$$\left|\left[\vec{a}\ \vec{b}\ \vec{c}\right]\right|=\frac{\sqrt{3}}{2}\left|\cos 3\theta\right|=\frac{\sqrt{3}}{4}$$

90. C

Sol.

s	r	~r	$\sim r\wedge s$	$\sim s$	$\sim s\vee(\sim r\wedge s)$	$\sim(\sim s\vee(\sim r\wedge s))$
T	T	F	F	F	F	T
T	F	T	T	F	T	F
F	T	F	F	T	T	F
F	F	T	F	T	T	F

Which is the same as $s\wedge r$.

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – III

JEE (Advanced)-2019

PAPER – 1

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

Section-A (01– 07, 19 – 25, 37 - 43) *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 mark*** *for wrong answer*
Partial Marks **+1** for each correct option provided no incorrect options is selected.

Section-A (08 – 13, 26 – 31, 44 - 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S).*
Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-C (14 – 18, 32 – 36, 50 - 54) *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

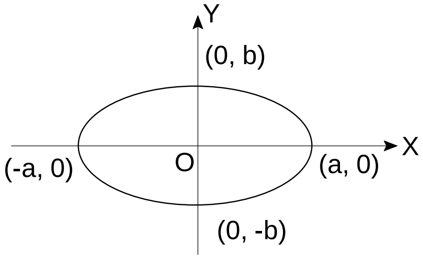
Physics

PART – I

SECTION – A
(More Than One Correct Type)

This section contains **7 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

1. Consider an elliptic disc having uniform distribution of mass M as shown in figure.
The moment of inertia (M.I.) about the major and minor axis are $\frac{1}{4}mb^2$ *and* $\frac{1}{4}ma^2$ respectively. Then



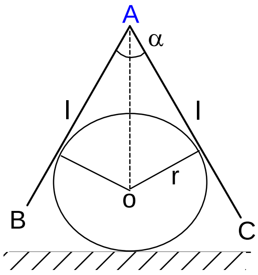
(A) The M.I. about a line, in its plane, passing through its centre and inclined at an angle θ to the major axis is $\frac{1}{4}m\left(b^2\cos^2\theta + a^2\sin^2\theta\right)$

(B) The M.I. about a chord of length 2r passing through O and lying in plane of elliptic disc is $\frac{1}{4}\frac{Ma^2b^2}{r^2}$

(C) The M.I. about a line perpendicular to the plane of elliptic disc and passing through the centre O is $\frac{1}{4}M\left(a^2+b^2\right)$

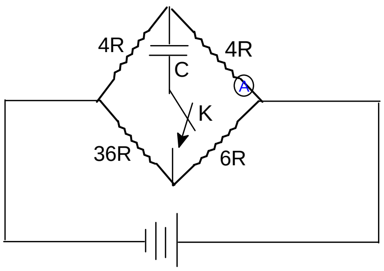
(D) The M.I. about a line, in its plane, passing through its centre and inclined at an angle θ to the minor axis is $\frac{1}{4}m\left(b^2\sin^2\theta + a^2\cos^2\theta\right)$

2. Two equal uniform rods of length l are joined at one end so that the angle between them is α and they rest in a vertical plane on a smooth sphere of radius r which is fixed to the ground.
(A) The rods are in stable equilibrium if $l > 4r\,\mathrm{cosec}\,\alpha$
(B) The rods are in stable equilibrium if $l < 4r\,\mathrm{cosec}\,\alpha$
(C) The rods are in unstable equilibrium if $l > 4r\,\mathrm{cosec}\,\alpha$
(D) The rods are in unstable equilibrium if $l < 4r\,\mathrm{cosec}\,\alpha$



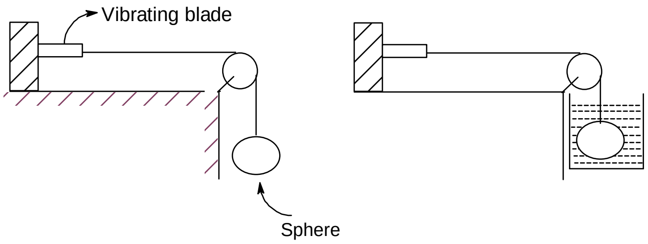
Space for Rough work

3. In the circuit shown below, the capacitor is initially uncharged. Immediately after the key K is closed, the reading of the ammeter is I.
(A) The Emf of battery is 8 IR
(B) The Emf of battery is 10 IR
(C) The steady state charge on capacitor is $\frac{25}{7}CIR$
(D) The steady state current through 6 R is $\frac{4}{21}I$



4. Which of the following is correct for Fission Nuclear Reactor?
(A) Slower neutrons are more effective in causing fission than faster neutrons in case of ^{235}U.
(B) Cadmium rod increase the reactor power when they are inserted and decrease when they are pulled back
(C) The kinetic energy of fast neutrons decreases when passed through heavy water
(D) Cadmium is a very good neutron absorber

5. A string is tied at one end to a vibrating blade, and the other end is passes over a fixed pulley as shown in figure. A sphere of mass m hangs on the other end of the string. The string is vibrating in its n_1 harmonic. A container of water is raised under the sphere so that the sphere is completely submerged. In this configuration, the string vibrates in its n_2 harmonic.



(A) The magnitude of buoyant force is $mg\left[1-\left(\frac{n_1}{n_2}\right)^2\right]$

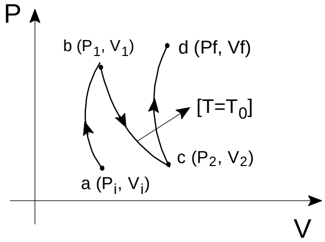
(B) The magnitude of buoyant force is $mg\left[1-\left(\frac{n_2}{n_1}\right)^2\right]$

(C) The radius of the sphere is $\left\{\frac{3m}{4\pi\rho_{water}}\left[1-\left(\frac{n_1}{n_2}\right)^2\right]\right\}^{1/3}$

(D) The radius of the sphere is $\left\{\frac{3m}{4\pi\rho_{water}}\left[1-\left(\frac{n_2}{n_1}\right)^2\right]\right\}^{1/3}$

Space for Rough work

6. One mole of an ideal monochromatic gas in an initial state a with pressure P_i and Volume V_i is to be taken to a final state d with $P_f = B^2 P_i$ *and* $V_f = V_i / B$ through the path $a \to b \to c \to d$ as shown in figure below for a particular values of $B(>1)$. Here $a \to b$ *and* $c \to d$ are adiabatic paths while $b \to c$ is an isothermal with temperature T_0. States b and c correspond to (P_1, V_1) *and* (P_2, V_2) respectively.



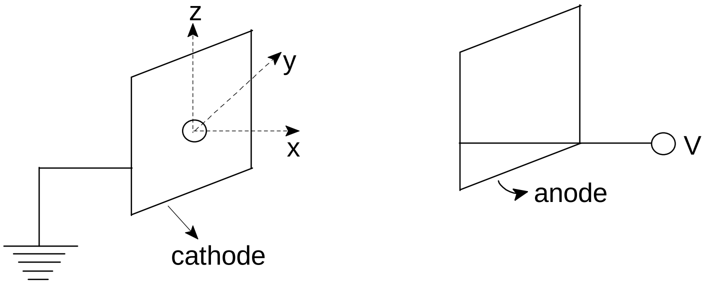
(A) The ratio of $\frac{V_2}{V_1}$ *is* $\sqrt{B}$

(B) The ratio of $\frac{V_2}{V_1}$ *is* $\sqrt{B^3}$

(C) Work done by the gas $\frac{RT_0}{2}\ln B + \frac{3}{2}P_i V_i (1-B)$

(D) Work done by the gas $\frac{RT_0}{2}\ln B + \frac{3}{2}(RT_0 - BP_i V_i)$

7. An electron initially at rest at point O (lying on the cathode) is acted upon by a magnetic field $\vec{B} = B_0\hat{k}$ and electric field $\vec{E} = E_0\hat{i}$. This electric field results due to the potential difference V between the cathode and anode separated by a distance d as shown in figure. Dimension of anode & cathode plates are very large compared to 'd'.



(A) The electron will not reach the anode if $B_0 = \frac{\pi}{2}\sqrt{\frac{mE_0}{2qd}}$

(B) The electron will not reach the anode if $B_0 = \frac{\pi}{2}\sqrt{\frac{mE_0}{qd}}$

(C) The electron will just reach the anode in time $t = \frac{m\pi}{2qB}$

(D) The electron will just reach the anode in time $t = \sqrt{\frac{2md}{qE}}$

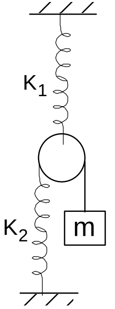
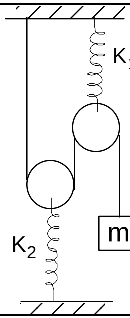
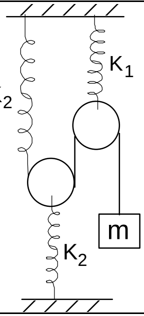
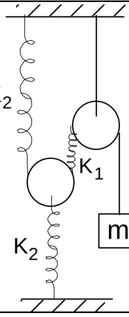
Space for Rough work

(Matching Type)
(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

The Time period of spring-mass system executing SHM is given by $T = 2\pi\sqrt{\frac{M}{K_{eff}}}$. Column–1 shows the spring mass system executing SHM. Column–2 shows the force constant (spring constant) of combination while column–3 represents the time period of the oscillation.

Column–1		**Column–2**		**Column–3**	
(I)		(i)	$\frac{1}{K} = \frac{4}{K_1} + \frac{4}{K_2}$	(P)	$T = 2\pi\sqrt{4M\left(\frac{1}{K_1} + \frac{1}{K_2}\right)}$
(II)		(ii)	$\frac{1}{K} = \frac{4}{K_1} + \frac{1}{K_2}$	(Q)	$T = 2\pi\sqrt{M\left(\frac{4}{K_1} + \frac{1}{K_2}\right)}$
(III)		(iii)	$\frac{1}{K} = \frac{1}{K_1} + \frac{5}{K_2}$	(R)	$T = 2\pi\sqrt{M\left(\frac{4}{K_1} + \frac{5}{K_2}\right)}$
(IV)		(iv)	$\frac{1}{K} = \frac{4}{K_1} + \frac{5}{K_2}$	(S)	$T = 2\pi\sqrt{M\left(\frac{1}{K_1} + \frac{5}{K_2}\right)}$

8. If the time period of the combination of spring mass-system shown in column I (III) $\left[if\ k_1 = k_2 = K\right]$ *is* $2\pi\sqrt{\frac{6M}{K}}$] The correct matching for the system is

(A) (III) (iii) (S) (B) (IV) (iii) (S)
(C) (I) (iii) (S) (D) (II) (iii) (S)

9. If spring constant for the combination shown in the column I (II) becomes twice if K_1 & K_2 becomes twice. Then correct matching shown for the spring-mass system is

(A) (I) (i) (P) (B) (II) (i) (P)
(C) (II) (i) (Q) (D) (I) (ii) (Q)

10. Which of the following is correct matching?

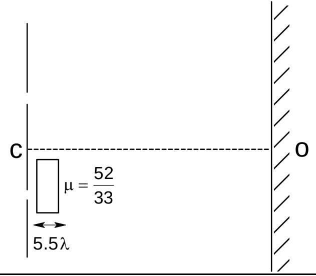
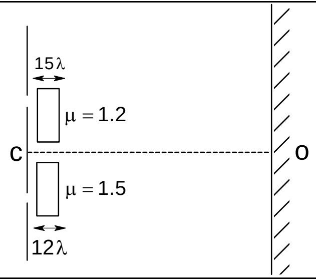
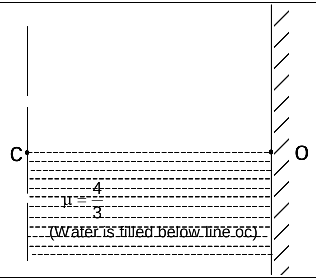
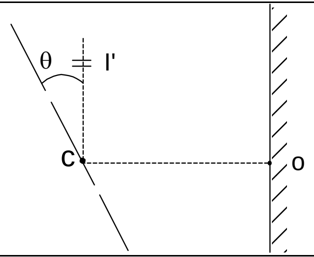
(A) (I) (i) (P) (B) (II) (ii) (Q)
(C) (III) (iv) (R) (D) (III) (iii) (S)

Space for Rough work

Answer 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

Every figure in column 1 shows a YDSE Apparatus with two slits of equal width emitting coherent light of equal intensity I and wavelength 'λ' in phase. Distance between midpoint of slits and midpoint of screen (which are in same horizontal line) is $D = 10^7 \lambda$. The distance between slits is $d = \frac{8.82}{\pi} \times 10^4 \lambda$. The plane containing slits and the plane of screen are vertical except for figure in column 1, Row 4 where, the plane of slits is tilted at an angle of $1'\left(= \frac{1}{60}^\circ\right)$ with the vertical but the plane of screen is here also vertical.

Column 2 represents the intensity of light.
Column 3 depicts [n] where [.] is a greatest integer function and 'n' represents number of fringes shifted through 'O' when the apparatus are formed with a standard YDSE apparatus. A standard YDSE apparatus is the one shown in column 1, row 4, with plane of slits vertical or $\theta = 0^\circ$ as shown in figure.

Column–1		Column–2			Column–3
(I)		(i)	0	(P)	0
(II)		(ii)	I	(Q)	3
(III)	 c o $\mu = \frac{4}{3}$ (Water is filled below line oc)	(iii)	3I	(R)	8
(IV)		(iv)	4I	(S)	33, 33, 333

11. For setup in Column 1, Row 4, which of the following options from Column 2 & 3 are correct match?
(A) (IV) (ii) (Q)
(B) (IV) (iii) (Q)
(C) (IV) (iii) (R)
(D) (IV) (ii) (R)

12. Which of the following is a correct match?
(A) (I) (ii) (R)
(B) (III) (ii) (S)
(C) (III) (iii) (P)
(D) (I) (iii) (R)

13. For setup in Column 1, Row 2, which of the following options from Column 2 & 3 are correct match
(A) (II) (i) (Q)
(B) (II) (iv) (P)
(C) (II) (i) (P)
(D) (II) (iv) (Q)

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

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14. If we model the electron as a uniform sphere of radius r_e spinning uniformly about an axis passing through its centre with angular momentum $L_e = 2\hbar$ and demand that the velocity of rotation at the equator cannot exceed the velocity c of light in vacuum. Then the minimum value of r_e *is* $\frac{n\hbar}{mc}$. Find n?

15. At normal incidence, a beam of light propagating in vacuum reflects off an interface with a medium of refractive index n=2.0. The fraction of energy reflected R is given by $R = \left(\frac{n-1}{n+1}\right)^2$ If the fractional error in the value of n is 3%, the fractional error in the estimation of R is.

16. A light beam from a laser pointer, on normal incidence creates a circular spot of diameter $2\times10^{-3}\,m$ on a perfectly reflecting surface. If the radiation pressure P on the surface due to totally reflected beam is $\frac{2}{3}\times10^{-5}\,N/\text{m}^2$, the time averaged power of laser beam (in mW) is nπ. Find n?

17. The electric field due to unknown charge distribution is given by $\vec{E} = \frac{k}{r^2}\exp(-4r)\hat{r}$, where k is a constant. The total charge in overall space is equal to

18. A spherical planet of radius R has a uniform density ρ and does not rotate. If the planet is made up of some liquid, the pressure at any point r from the centre is $\frac{2n\pi g\rho^2}{9}\left(R^2 - r^2\right)$. Find n?

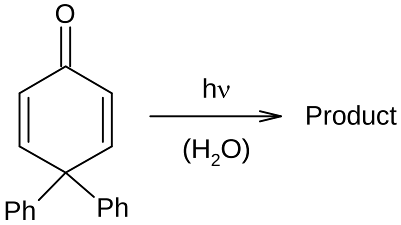
Space for Rough work

Chemistry

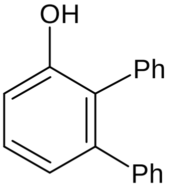
PART – II

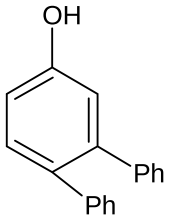
SECTION – A
(More Than One Correct Type)

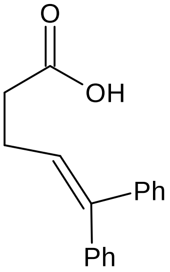
This section contains **7 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

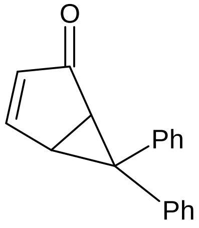
19.


The product is/are

(A)


(B)


(C)


(D)


20. Which of the following is/are optically active?

(A) $\left[Co(en)_3\right]^{3+}$

(B) $\left[Co(ox)_3\right]^{3-}$

(C) cis $-\left[CoCl_2(en)_2\right]^{+}$

(D) trans $-\left[CoCl_2(en)_2\right]^{+}$

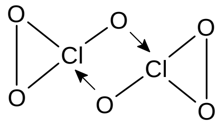
Space for Rough work

21. Which is/are true about the N – N bond length among the following speices?
1. $H_2N - NH_2$ 2. N_2 3. $HN^+ - NH_2$ 4. N_2O
(A) N – N bond length is shortest in 2
(B) N – N bond length in 1 is shorter than that in 3
(C) N – N bond length in 3 is shorter than that in 1
(D) N – N bond length in 4 is intermediate between 1 and 3

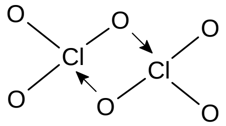
22. By which of the following structure may Cl_2O_6 be represented?

(A) $ClO_2^+ClO_4^-$

(B)



(C)



(D) $ClO_3^-ClO_3^+$

23. Consider the following statements. Pick the correct one.
(A) All mono saccharides are reducing sugar
(B) Sucrose is a disaccharide and is a non – reducing sugar
(C) A solution consisting of equimolar glucose and fructose is dextrorotatory
(D) A solution consisting of equimolar sucrose and glucose in water dextrorotatory

24. Which of the following statements is/are correct?
(A) First dissociation constant of maleic acid is higher than that of first dissociation constant of fumaric acid
(B) Second dissociation constant of fumaric acid is higher than that of second dissociation constant of maleic acid
(C) pK_a value of salicylic acid is higher than that of benzoic acid
(D) pK_b of aniline is lower than that of o - toluidine

25. The $Al(OH)_3$ is involved in the following two equilibria,

$$Al(OH)_3(s) \rightleftharpoons Al^{3+}(aq.) + 3OH^-(aq.);K_{sp}$$

$$Al(OH)_3(s) + OH^-(aq.) \rightleftharpoons Al(OH)_4^-(aq);K_c$$

Which of the following relationship is correct at which solubility is minimum?

(A) $\left[OH^-\right] = \left(\frac{K_{sp}}{K_c}\right)^{\frac{1}{3}}$

(B) $\left[OH^-\right] = \left(\frac{K_c}{K_{sp}}\right)^{\frac{1}{4}}$

(C) $\left[OH^-\right] = \sqrt{\left(\frac{K_{sp}}{K_c}\right)^{\frac{1}{4}}}$

(D) None of these

Space for Rough work

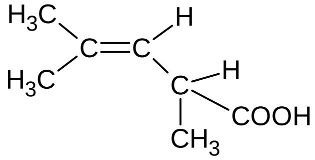
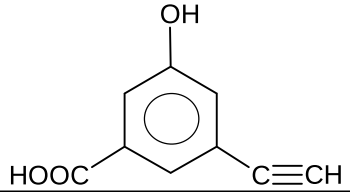
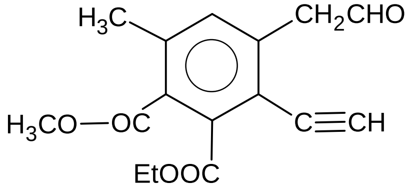
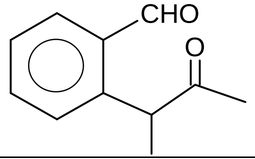
(Matching Type)

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer 26, 27 and 28 by appropriately matching the information given in the three columns of the following table.

Match the following

Column – 1		Column – 2		Column – 3	
(I)		(i)	Compound show optical activity	(P)	1 mol CH_3MgX is consumed
(II)		(ii)	CO_2 liberated with $NaHCO_3$	(Q)	2 mols CH_3MgX is consumed
(III)		(iii)	Pink colour of $KMnO_4$ is decolorized	(R)	3 mols CH_3MgX is consumed
(IV)		(iv)	Given precipitate with Tollen's reagent	(S)	5 mols CH_3MgX is consumed

26. Correct combination is

(A) (II) (iii)(Q) (B) (I)(iv)(P)

(C) (III)(iv)(S) (D) (IV)(i)(R)

27. Incorrect combination is

(A) (I)(i)(P) (B) (II)(iv)(R)

(C) (III)(ii)(Q) (D) (III)(iv)(P)

Space for Rough work

28. Correct combination is

(A) (I)(iii)(Q) (B) (II)(ii)(S)

(C) (IV)(iv)(P) (D) (I)(ii)(P)

Answer 29, 30 and 31 by appropriately matching the information given in the three columns of the following table.

Match the following

Column – 1		Column – 2		Column – 3	
(I)	$\underset{(1\,\text{mol})}{P_4(s)} + NaOH + H_2O \longrightarrow$	(i)	Disproportionation reaction	(P)	An atom in the product is in the highest oxidation no.
(II)	$\underset{(1\,\text{mol})}{FeS_2(s)} + O_2 \xrightarrow{\Delta}$	(ii)	$\frac{3}{5}$ mol of gas is formed in the product	(Q)	An atom in the product is in the lowest oxidation no.
(III)	$\underset{(1\,\text{mol})}{H_3PO_3} \xrightarrow{\Delta}$	(iii)	2 mol of gas is formed in the product	(R)	An atom in the product has zero oxidation no.
(IV)	$ClO_3^- + \underset{(1\,\text{mol})}{Cl^-} + H^+ \longrightarrow$	(iv)	1 mol of gas is formed in the product	(S)	One of the product in water behaves as an acid

29. Which of the following is the only correct combination?

(A) (I) (iv)(R) (B) (II)(i)(S)

(C) (IV)(ii)(R) (D) (III)(iii)(P)

30. Which of the following is the only INCORRECT combination?

(A) (III)(i)(P) (B) (III)(iv)(Q)

(C) (II)(iii)(S) (D) (I)(iv)(Q)

31. Which of the following is the correct combinations?

(A) (I)(i)(Q) (B) (II)(iv)(P)

(C) (III)(ii)(R) (D) (IV)(iii)(S)

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

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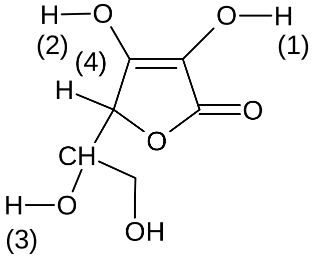
32. 1 gm of complex $\left[Cr\left(H_2O\right)_5 Cl\right]Cl_2.H_2O\left(Mol.Wt. = 266.5\right)$ was passed through a cation exchanger to produce HCl. The acid liberated was diluted to 1 litre. The normality of acid solution is $7.5 \times 10^{-x}N$. The value of x is

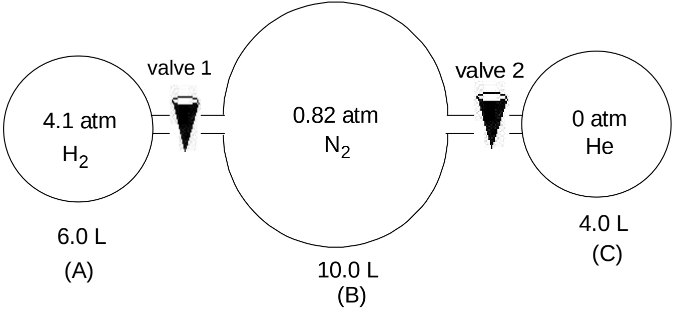
33. The density of steam at 27^0C and 8.314×10^4 pascal is 0.8 kg/m^3. The compressibility factor would be $\frac{a}{b}$. The value of a + b = ?

34. 

Identify the most acidic H in ascorbic acid (vitamin C)

35. Dark gray material (A) when it is heated at high temperature in air gives gas (B). Gas (B) is colourless and odourless which can not decolourize acidified $K_2Cr_2O_7$ solution. One of the allotropic forms of (A) is (A'), however (A) is the thermodynamically more stable than (A'). (A) on oxidation by hot concentration HNO_3 gives an acid (C), whereas (A) is unaffected by concentrated acids.
How many COOH groups are present in one molecules of acid (C)?

36. The figure given below shows three glass chambers that are connected by valves of negligible volume. At the outset of an experiment, the valves are closed and the chambers contain the gases as detailed in the diagram. All the chambers are at the temperature of 30 K and external pressure of 1.0 atm. What will be the work done by N_2 gas when valve -2 is opened and valve -1 remaining closed? What will be the work done by N_2 gas when valve – 2 is opened and valve -1 remaining closed?



Space for Rough work

Mathematics

PART – III

SECTION – A

(More Than One Correct Type)

This section contains **7 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

37. Let $f(x)=\dfrac{x^2-x+1}{x^2+x+1}$ and $g(x)=2f^3(x)-9f^2(x)+12f(x)+5$. In which of the following interval(s) is g(x) increasing?

(A) $(-2,-1)$ (B) $\left(-1,-\dfrac{1}{2}\right)$

(C) $\left(-\dfrac{2}{5},0\right)$ (D) $(1,\infty)$

38. Let $f(x)=\int\limits_0^{\sin^2 x}\sin^{-1}\sqrt{t}\,dt+\int\limits_0^{\cos^2 x}\cos^{-1}\sqrt{t}\,dt,\ x\in\left(0,\dfrac{\pi}{2}\right)$. Then the value of f(0) equals:-

(A) $f(1)$ (B) $2f\left(\dfrac{1}{2}\right)$

(C) $f\left(\dfrac{1}{2}\right)$ (D) $2f(1)$

39. Let S be set of all value (s) of 'a' which the inequality $x^2+|x-a|-3<0$ is satisfied by at least one negative 'x'. Which of the following can be subset of S?

(A) $(-3,2)$ (B) $(0,3)$

(C) $(-4,1)$ (D) $(-2,3)$

40. The vector $\vec{a}=-\hat{i}+2\hat{j}+\hat{k}$ is rotated through right angle such that $\vec{a}$ crosses through the Y- axis, while undergoing rotation. In the new position $\vec{a}$ is given by:-

(A) $\sqrt{2}\left(\hat{i}+\hat{j}-\hat{k}\right)$ (B) $\sqrt{2}\left(-\hat{i}-\hat{j}+\hat{k}\right)$

(C) $\sqrt{3}\left(\hat{i}+\hat{k}\right)$ (D) $\sqrt{3}\left(-\hat{i}-\hat{k}\right)$

Space for Rough work

41. Consider the lines $L_1 : x = y = z \; and \; L_2 : 2x + y + z - 1 = 0 = 3x + y + 2z - 2.$ Which of the following is (are) correct?
(A) The shortest distance between $L_1 \; and \; L_2 \; is \; \sqrt{2}$
(B) The shortest distance between $L_1 \; and \; L_2 \; is \; 1/\sqrt{2}$
(C) The plane containing L_2 and parallel to $L_1 \, is \; y - z + 2 = 0$
(D) The plane containing L_2 and parallel to $L_1 \, is \; x - y + 1 = 0$

42. Let P(A) and P(B) be the probabilities of occurrence of two events A and B respectively. If $P(A) = \frac{3}{5} \; and \; P(B) = \frac{2}{3}$ then which of the following is (are) correct?
(A) $P\left(A \cap \overline{B}\right) \le \frac{1}{3}$
(B) $P(A \cup B) \ge \frac{2}{3}$
(C) $\frac{4}{15} \le P(A \cap B) \le \frac{3}{5}$
(D) $P\left(\frac{\overline{A}}{B}\right) \le \frac{3}{5}$

43. If $z_1 = a + ib \; and \; z_2 = c + id$ are two complex numbers such that $|z_1| = |z_2| = 1 \, and \; \mathrm{Re}\left(z_1 \overline{z_2}\right) = 0, \left(a, b, c, d \in R\right).$ Then for the pair of complex numbers $\omega_1 = a + ic \; and \; \omega_2 = b + id,$ which of the following is (are) correct?
(A) $|\omega_1| = 1$
(B) $\mathrm{Re}\left(\omega_1, \overline{\omega_2}\right) = 0$
(C) $\mathrm{Re}\left(\overline{\omega_1}, \omega_2\right) = 1$
(D) $\mathrm{Re}\left(\omega_1, \overline{\omega_2}\right) = 1$

Space for Rough work

(Matching Type)

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer 44, 45 and 46 by appropriately matching the information given in the three columns of the following table.

Answer Questions 8 -10 by appropriate matching the information given in the three columns of the following table.

Column 1, 2, 3 contains equations of hyperbola, co-ordinates of a point & value of ‘a’					
Column – 1		**Column – 2**		**Column – 3**	
(I)	$x^2 - y^2 = 4$	(i)	$(a-1, a-2)$	(P)	$\frac{5}{2}$
(II)	xy = 4	(ii)	$(1-a, a)$	(Q)	$\frac{1}{6}$
(III)	$\frac{x^2}{4} - y^2 = 1$	(iii)	$(2a, a-1)$	(R)	2
(IV)	$x^2 - \frac{y^2}{4} = 1$	(iv)	(4a, a)	(S)	0

44. The tangents to suitable hyperbola (column I) from the point (column II) are on both branches for the value of a (column III). Which of the following options is the only correct combination.
(A) (I) (ii) (S) (B) (I) (iii) (S)
(C) (II) (iv) (R) (D) (IV) (i) (R)

45. Suitable point (column II) lies on director circle of hyperbola (column I) for the value of ‘a’. Which of the following options is the only correct combination.
(A) (I) (ii) (P) (B) (II) (i) (R)
(C) (II) (iv) (S) (D) (IV) (iii) (Q)

46. Suitable point (column II) lies on hyperbola (column I) for the value of ‘a’ (column III). Which of the following options is the only correct combination
(A) (III) (i) (R) (B) (II) (iv) (P)
(C) (I) (iii) (Q) (D) (IV) (i) (R)

Space for Rough work

Answer 47, 48 and 49 by appropriately matching the information given in the three columns of the following table.

Column 1, 2, 3 contain Trigonometric Function, Maximum Value and Minimum Value respectively					
Column – 1		**Column – 2**		**Column – 3**	
(I)	$f(x)=\dfrac{7+6\tan x-\tan^2 x}{1+\tan^2 x},\ x\in\left(-\dfrac{\pi}{2},\dfrac{\pi}{2}\right)$	(i)	$\dfrac{1}{4}$	(P)	1
(II)	$f(x) = 4\cos x + 3\cos\left(x+\dfrac{\pi}{2}\right) + 3,\ x\in R$	(ii)	1	(Q)	-2
(III)	$f(x) = \sin^6 x + \cos^6 x,\ x\in R$	(iii)	8	(R)	$-\dfrac{1}{4}$
(IV)	$f(x) = \cos x.\cos\left(x+\dfrac{\pi}{3}\right).\cos\left(x-\dfrac{\pi}{3}\right),\ x\in R$	(iv)	2	(S)	$\dfrac{1}{4}$

47. Which of the following option is the only CORRECT combination?
(A) (I) (iii) (Q)
(B) (II) (iii) (P)
(C) (III) (ii) (P)
(D) (IV) (ii) (R)

48. Which of the following option is the only CORRECT combination?
(A) (I) (iii) (P)
(B) (II) (iii) (Q)
(C) (III) (iv) (P)
(D) (IV) (i) (Q)

49. Which of the following option is the only CORRECT combination?
(A) (I) (iii) (S)
(B) (II) (iii) (R)
(C) (III) (iv) (S)
(D) (IV) (i) (R)

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

50. Consider two circles $C_1 : x^2 + y^2 + 4x + 4y - 1 = 0$ *and* $C_2 : x^2 + y^2 + 6x + 2y - 7 = 0$. The line $L_1 : x + 2y + 3 = 0$ intersects C_1 at points A and B and the line $L_2 : 2x + 3y + \lambda = 0$ intersects C_2 at point C and D. The value of $(2\lambda - 1)$ such that points A, B, C and D are concyclic, is:

51. If M is a 3×3 matrix, such that $\det(M) = 2$ *and* $M^T M = I$, (M^T is the transpose of matrix M). Then, the value of $\det(M - I)$ is:

52. The coefficient of x^{70} in the product $(x-1)(x^2-2)(x^3-3)..........(x^{12}-12)$ is:

53. If 'z' is a complex number satisfying the equation $11z^{10} + 10iz^9 + 10iz - 11 = 0$, then the value of $3|z|$ is:

54. The largest integer value of 'k' for which the equation $e^x - 1 - k\tan^{-1}x = 0$, possess only one real root, is:

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – III

JEE (Advanced)-2019

PAPER – 1

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. ABC

Sol. We know that

$$I_{PQ} = I_x \cos^2\theta + I_y \sin^2\theta - I_{xy}\sin 2\theta$$

$$I_{PQ} = \frac{1}{4}\text{mb}^2\cos^2\theta + \frac{1}{4}\text{m}a^2\sin^2\theta \quad \left[\because I_{xy} = 0\right]$$

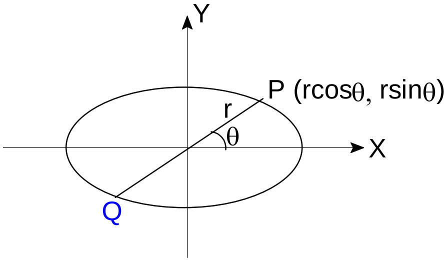
The equation of ellipse is

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

$$\frac{r^2}{a^2}\cos^2\theta + \frac{r^2}{b^2}\sin^2\theta = 1$$

$$a^2\sin^2\theta + b^2\cos^2\theta = \frac{a^2b^2}{r^2}$$

$$\therefore I_{PQ} = \frac{1}{4}\text{m}\left(\text{b}^2\cos^2\theta + a^2\sin^2\theta\right) = \frac{1}{4}\text{m}\frac{a^2b^2}{r^2}$$



2. AD

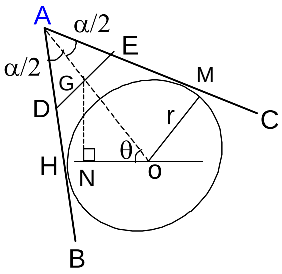
Sol.
$$AB = AC = l$$

$$z = GN = OG\sin\theta$$

$$= (AO - AG)\sin\theta$$

$$= \left(r\,\text{cosec}\frac{\alpha}{2} - \frac{l}{2}\cos\frac{\alpha}{2}\right)\sin\theta$$

$$\frac{d\theta}{dt} = 0 \Rightarrow \cos\theta = 0 \ i.e;\ \theta = \frac{\pi}{2}$$



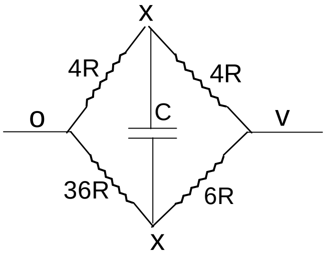
$$\frac{d^2z}{d\theta^2} = -r\,\text{cosec}\frac{\alpha}{2} + \frac{l}{2}\cos\frac{\alpha}{2}\ \textit{for}\ \theta = \frac{\pi}{2}$$

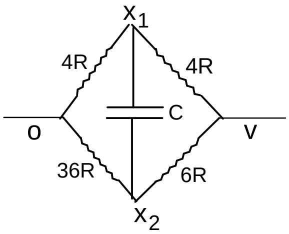
$$\textit{Stable equilibrium}: \frac{d^2z}{d\theta^2} > 0 \Rightarrow l > 4r\,\text{cosec}\alpha$$

$$\textit{Unstable equilibrium}: \frac{d^2z}{d\theta^2} < 0 \Rightarrow l < 4r\,\text{cosec}\alpha$$

3. BC

Sol. Applying KCL, we get





$$\frac{x-v}{4R} + \frac{x}{4R} + \frac{x}{36R} + \frac{x-v}{6R} = 0$$

$$x = \frac{3}{5}v$$

$$\therefore 4IR = \frac{2}{5}v$$

$$v = \frac{4\times 5IR}{2} = 10IR$$

In steady state:

$$\frac{x_1-v}{4R} + \frac{x_1}{4R} = 0 \Rightarrow x_1 = \frac{v}{2}$$

$$\frac{x_2-v}{6R} + \frac{x_2}{36R} = 0 \Rightarrow x_2 = \frac{6v}{7}$$

$$\textit{change on capacities} = \frac{25}{7}CIR$$

4. ACD

5. AC

Sol. $T_1 = mg \qquad -(1)$

$T_2 = mg - B \qquad -(1)$

$$\text{f} = \frac{n_1}{2l}\sqrt{\frac{T_1}{\mu}} = \frac{n_1}{2l}\sqrt{\frac{T_2}{\mu}}$$

$$T_2 = \left(\frac{n_1}{n_2}\right)^2 T_1 = \left(\frac{n_1}{n_2}\right)^2 mg$$

$$B = mg - \left(\frac{n_1}{n_2}\right)^2 mg = mg\left[1 - \left(\frac{n_1}{n_2}\right)^2\right]$$

$$r = \left(\frac{3B}{4\pi\rho_\omega g}\right)^{1/3}$$

6. AC

Sol. $ab: \quad p_i v_i^{\gamma} = p_1 v_1^{\gamma} \quad -(i)$

$cd: \quad p_f v_f^{\gamma} = p_2 v_2^{\gamma} \quad -(ii)$

$bc: \quad p_1 v_1 = p_2 v_2 \quad -(iii)$

Dividing (2) by (1), we get

$$\frac{v_2}{v_2} = B^{\frac{2-\gamma}{\gamma-1}} = \sqrt{B}\left[\gamma = \frac{5}{3}\right]$$

work done by the gas

$$W = W_{ab} + W_{bc} + W_{cd}$$

$$= \frac{RT_0}{2}\ln B + \frac{3}{2}p_i v_i\left(1-B\right)$$

7. ACD

Sol. $\omega = \frac{qB}{m}$

The electron will not reach the anode only when it turns by $\frac{\pi}{2}$ by the time it comes near anode.

Let time taken be t.

$\theta = \omega t$

$$\frac{\pi}{2} = \frac{qB}{m}t \Rightarrow t = \frac{m\pi}{2qB}$$

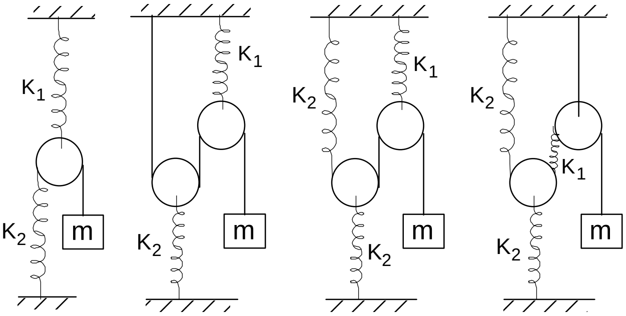
Acceleration due to electronic field $a = \frac{qE}{m}$

Horizontal distance curved in time t=d

$$\frac{1}{2}at^2 = d \Rightarrow \qquad B = \frac{\pi}{2}\sqrt{\frac{mE}{2qd}}$$

8. B

Sol.



$$\frac{1}{K_{eq}} = \frac{1}{K_2} + \frac{4}{K_1}$$

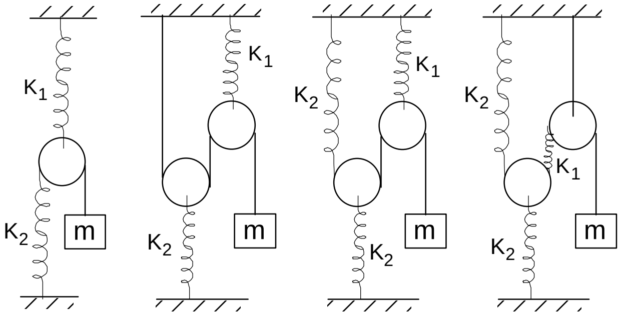
$$\frac{1}{K_{eq}} = \frac{4}{K_1} + \frac{4}{K_2}$$

$$\frac{1}{K_{eq}} = \frac{4}{K_1} + \frac{5}{K_2}$$

$$\frac{1}{K_{eq}} = \frac{1}{K_1} + \frac{5}{K_2}$$

9. B

Sol.



$$\frac{1}{K_{eq}} = \frac{1}{K_2} + \frac{4}{K_1}$$

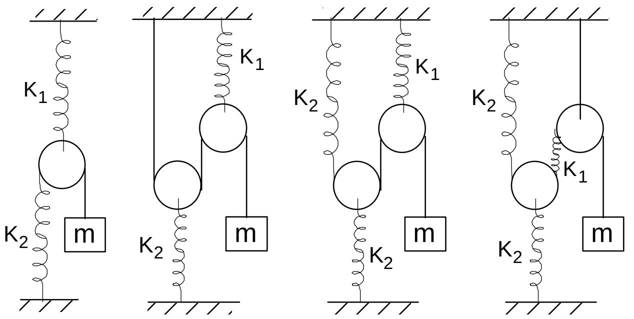
$$\frac{1}{K_{eq}} = \frac{4}{K_1} + \frac{4}{K_2}$$

$$\frac{1}{K_{eq}} = \frac{4}{K_1} + \frac{5}{K_2}$$

$$\frac{1}{K_{eq}} = \frac{1}{K_1} + \frac{5}{K_2}$$

10. C

Sol.



$$\frac{1}{K_{eq}}=\frac{1}{K_2}+\frac{4}{K_1}$$

$$\frac{1}{K_{eq}}=\frac{4}{K_1}+\frac{4}{K_2}$$

$$\frac{1}{K_{eq}}=\frac{4}{K_1}+\frac{5}{K_2}$$

$$\frac{1}{K_{eq}}=\frac{1}{K_1}+\frac{5}{K_2}$$

11. C

Sol. For figure Column 1, Row1,

$$(\Delta x)_{at\ 0}=(\mu-1)\times 5.5\lambda=\left(\frac{52}{33}-1\right)5.5\lambda$$

Path difference $=\frac{19}{33}\times 5.5\lambda=\frac{19}{6}\lambda$

$$Hence,\ [n]=\left[\frac{19\lambda}{6}\times\frac{1}{\lambda}\right]=\frac{19}{6}=3$$

$$\delta=\frac{2\pi}{\lambda}(\Delta x)=\frac{19\pi}{3}$$

$$\therefore Intensity\ at\ 0=4\text{I}\cos^2\left(\frac{8}{2}\right)=3\text{I}$$

For figure Column 1, Row2,

$$(\Delta x)_{at\ 0}=\left[(1.5-1)12\lambda\right]-\left[(1.2-1)15\lambda\right]=3\lambda$$

$$Hence,\ [n]=\left[3\lambda\times\frac{1}{\lambda}\right]=3$$

$$\delta=\frac{2\pi}{\lambda}(\Delta x)=6\pi$$

Hence, *Intensity at* $0=4\text{I}$

For figure Column 1, Row3,

$$(\Delta x)_{at\ 0}=(\mu-1)D=\left(\frac{4}{3}-1\right)\times 10^7\lambda=\frac{10^7}{3}\lambda$$

$$Hence,\ [n]=\left[\frac{10^7}{3}\right]=33{,}33{,}333$$

$$\delta=\frac{2\pi}{\lambda}(\Delta x)=\frac{2\pi\times 10^7}{3}$$

Hence, *Intensity at* $0=\text{I}$

For figure Column 1, Row4,

$$(\Delta x)_{at\ 0}=d\sin\theta\approx d\theta=\frac{8.82}{\pi}\times 10^4\lambda\times\left(\frac{1}{60}\times\frac{\pi}{180}\right)$$

$$=\frac{882}{108}\lambda=\frac{49}{6}\lambda$$

$$[n]=\left[\frac{49}{6}\right]=8,\quad \delta=\frac{2\pi}{\lambda}(\Delta x)=\frac{49\pi}{3}$$

Hence, *Intensity at* $0=3\text{I}$

12. B

Sol. For figure Column 1, Row1,

$$(\Delta x)_{at\ 0} = (\mu - 1)\times 5.5\lambda = \left(\frac{52}{33} - 1\right) 5.5\lambda$$

Path difference $= \frac{19}{33}\times 5.5\lambda = \frac{19}{6}\lambda$

$$Hence, [n] = \left[\frac{19\lambda}{6}\times\frac{1}{\lambda}\right] = \frac{19}{6} = 3$$

$$\delta = \frac{2\pi}{\lambda}(\Delta x) = \frac{19\pi}{3}$$

$$\therefore Intensity\ at\ 0 = 4\mathrm{I}\cos^2\left(\frac{8}{2}\right) = 3\mathrm{I}$$

For figure Column 1, Row2,

$$(\Delta x)_{at\ 0} = \left[(1.5-1)12\lambda\right] - \left[(1.2-1)15\lambda\right] = 3\lambda$$

$$Hence, [n] = \left[3\lambda\times\frac{1}{\lambda}\right] = 3$$

$$\delta = \frac{2\pi}{\lambda}(\Delta x) = 6\pi$$

$$Hence, Intensity\ at\ 0 = 4\mathrm{I}$$

For figure Column 1, Row3,

$$(\Delta x)_{at\ 0} = (\mu - 1)D = \left(\frac{4}{3} - 1\right)\times 10^7\lambda = \frac{10^7}{3}\lambda$$

$$Hence, [n] = \left[\frac{10^7}{3}\right] = 33{,}33{,}333$$

$$\delta = \frac{2\pi}{\lambda}(\Delta x) = \frac{2\pi\times 10^7}{3}$$

$$Hence, Intensity\ at\ 0 = \mathrm{I}$$

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$$(\Delta x)_{at\ 0} = d\sin\theta \approx d\theta = \frac{8.82}{\pi}\times 10^4\lambda\times\left(\frac{1}{60}\times\frac{\pi}{180}\right)$$

$$= \frac{882}{108}\lambda = \frac{49}{6}\lambda$$

$$[n] = \left[\frac{49}{6}\right] = 8$$

$$\delta = \frac{2\pi}{\lambda}(\Delta x) = \frac{49\pi}{3}$$

$$Hence, Intensity\ at\ 0 = 3\mathrm{I}$$

13. D

Sol. For figure Column 1, Row1,

$$(\Delta x)_{at\ 0} = (\mu - 1)\times 5.5\lambda = \left(\frac{52}{33} - 1\right) 5.5\lambda$$

Path difference $= \frac{19}{33}\times 5.5\lambda = \frac{19}{6}\lambda$

$$Hence, [n] = \left[\frac{19\lambda}{6} \times \frac{1}{\lambda}\right] = \frac{19}{6} = 3$$

$$\delta = \frac{2\pi}{\lambda}(\Delta x) = \frac{19\pi}{3}$$

$$\therefore Intensity\ at\ 0 = 4\mathrm{I}\cos^2\left(\frac{8}{2}\right) = 3\mathrm{I}$$

For figure Column 1, Row2,

$$(\Delta x)_{at\ 0} = \left[(1.5-1)12\lambda\right] - \left[(1.2-1)15\lambda\right] = 3\lambda$$

$$Hence, [n] = \left[3\lambda \times \frac{1}{\lambda}\right] = 3$$

$$\delta = \frac{2\pi}{\lambda}(\Delta x) = 6\pi$$

$$Hence, Intensity\ at\ 0 = 4\mathrm{I}$$

For figure Column 1, Row3,

$$(\Delta x)_{at\ 0} = (\mu-1)D = \left(\frac{4}{3}-1\right)\times 10^7\lambda = \frac{10^7}{3}\lambda$$

$$Hence, [n] = \left[\frac{10^7}{3}\right] = 33{,}33{,}333$$

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$$Hence, Intensity\ at\ 0 = \mathrm{I}$$

For figure Column 1, Row4,

$$(\Delta x)_{at\ 0} = d\sin\theta \approx d\theta = \frac{8.82}{\pi}\times 10^4\lambda \times \left(\frac{1}{60}\times\frac{\pi}{180}\right)$$

$$= \frac{882}{108}\lambda = \frac{49}{6}\lambda$$

$$[n] = \left[\frac{49}{6}\right] = 8$$

$$\delta = \frac{2\pi}{\lambda}(\Delta x) = \frac{49\pi}{3}$$

$$Hence, Intensity\ at\ 0 = 3\mathrm{I}$$

SECTION – C

14. 5

Sol. $L_e = 2\hbar$

$$\frac{2}{5}mR^2\omega = 2\hbar$$

$$\frac{2}{5}mRv = 2\hbar$$

$$R = \frac{5\hbar}{mv}$$

$$R_{\min} = \frac{5\hbar}{mv_{\max}} = \frac{5\hbar}{mc} \qquad [n = 5]$$

15. 8

Sol. $R = \left(\frac{n-1}{n+1}\right)^2$

$\log R = 2\log(n-1) - 2\log(n+1)$

Differentiating

$$\frac{dR}{R} = \frac{2dn}{n-1} - \frac{2dn}{n+1}$$

$$\frac{DR}{R} = 2\left[\frac{1}{n-1} - \frac{1}{n+1}\right]\Delta n = \left(\frac{4n}{n^2-1}\right)\frac{\Delta n}{n}$$

$$= \frac{8}{3} \times 3\% = 8\%$$

16. 1

Sol. $\text{Radiation pressure } P = \frac{2E}{cA}$

$$E = \frac{1}{2}PCA$$

$$= \pi m\omega \quad [n = 1]$$

17. 0

Sol. $\phi = \oint \vec{E} \cdot \hat{n}\, ds = 4\pi q e^{-4r}$

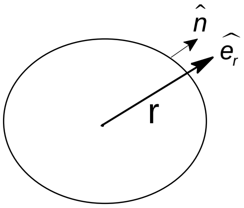
Change enclosed

$$Q = \in_0 \oint \vec{E} \cdot \hat{n}\, ds$$

$$= 4\pi \in_0 q e^{-4r}$$

Total change over all space $(r \to \infty)$

$$Q = \lim_{r\to\infty} 4\pi \in_0 q e^{-4r} = 0$$



18. 3

Sol. $\int_0^P dP = -\int_R^r \frac{4\pi G\rho^2}{3} r\,dr$

$$= \frac{2\pi G\rho^2}{3}\left(R^2 - r^2\right) \qquad [n = 3]$$

Chemistry

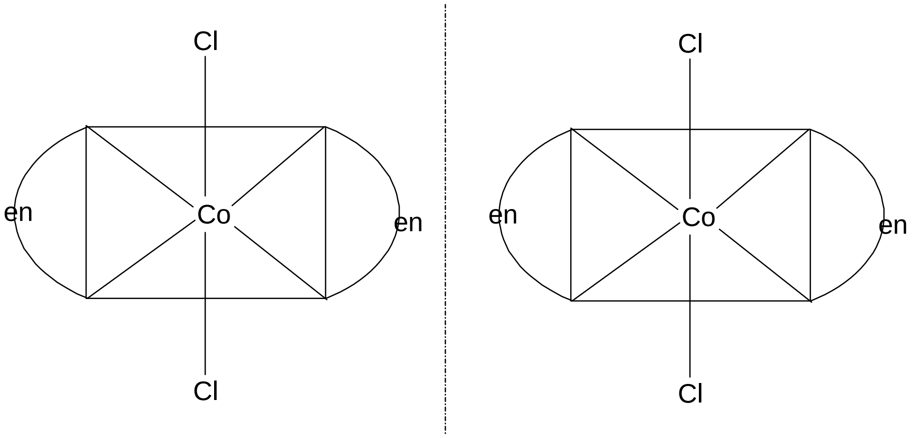
PART – II

SECTION – A

19. ABCD

20. ABC

Sol.



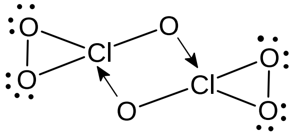
Superimposable mirror images
Optically inactive

21. ACD

22. AB

Sol. Cl_2O_6 in solid state $ClO_2^+ClO_4^-$

In the gaseous



23. ABD

Sol. Fact

24. ABD

Sol. Salicylic acid is more acidic than benzoic acid due to o-effect.
o-toluidine is less basic than aniline due to SIP.

25. D

Sol. Dissolved $Al(OH)_3$ present in solution as Al^{3+}(aq.) as well as $\left[Al(OH)_4\right]^-$ (aq.)

$$\therefore S = \left[Al^{3+}(aq.)\right] + \left[Al(OH)_4^-(aq.)\right]$$

$$S = \frac{K_{sp}}{\left[OH^-\right]^3} + K_c\left[OH^-\right]$$

For minimum solubility

$$\frac{dS}{d\left(OH^-\right)} = 0$$

$$\text{or } -\frac{K_{sp} \times 3}{\left[OH^-\right]^4} + K_c = 0$$

$$\left[OH^-\right] = \left(\frac{3K_{sp}}{K_c}\right)^{\frac{1}{4}}$$

26. C
27. C
28. D

29. C
30. B
31. A
Sol. (for Q. 29 to Q. 31)

$$P_4 + 3NaOH + 3H_2O \longrightarrow PH_3\left(g\right) + 3NaH_2PO_2$$

$$4Fes_2 + 11O_2 \longrightarrow 2Fe_2O_3 + 8SO_2\left(g\right)$$

$$4H_3PO_3 \xrightarrow{\Delta} 3H_3PO_4 + PH_3\left(g\right)$$

$$ClO_3^- + 5Cl^- + 6H^+ \longrightarrow 3Cl_2\left(g\right) + 3H_2O$$

SECTION – C

32. 3
Sol. Mole of complex = $\frac{1}{266.5}$

1 mole of complex produce 2 mole of HCl

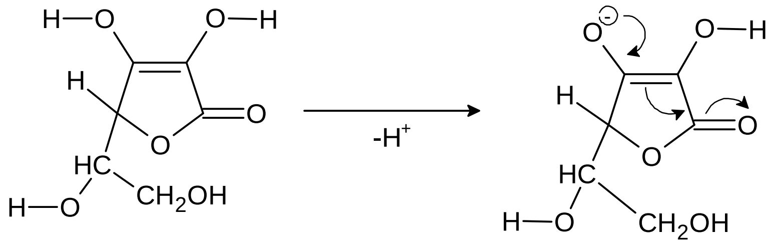
$$\left[Cr\left(H_2O\right)_5 Cl\right]Cl_2 \longrightarrow \left[Cr\left(H_2O\right)_5 Cl\right]^{+2} + 2Cl^-$$

Mole of HCl = $\frac{1}{266.5}\times 2$

$$N_{HCl} = \frac{2}{266.5\times 1} = 7.5\times 10^{-3}$$

33. 7
Sol. $Z = \frac{PV}{nRT} = \frac{PM}{dRT} = \frac{8.314\times 10^4\times 18\times 10^{-3}}{0.8\times 8.314\times 300} = \frac{18\times 10}{300\times 0.8} = \frac{3}{4} = 0.75$

34. 2
Sol.



35. 6
Sol. $C_6\left(COOH\right)_6$ mellitic acid is produced

36. 0
Sol. $P_{ext} = 0$

$\therefore$ Total work done $= P_{ext}\left(\Delta V\right)$

$\therefore P_{ext} = 0$

$\therefore$ Work done $= 0$

Mathematics PART – III

SECTION – A

37. ACD

Sol. $f(x)=\dfrac{x^2-x+1}{x^2+x+1}$ and $g'(x)=6f'(x)\left(f(x)-1\right)\left(f(x)-2\right)$

Draw graph of f(x) and analyse.

38. AC

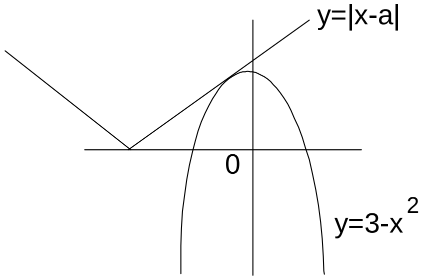
Sol. $f'(x)=\sin^{-1}(\sin x)\cdot 2\sin x\cos x+\cos^{-1}(\cos x)(-2\sin x\cos x)=0$

Hence, f(x) is a constant function.

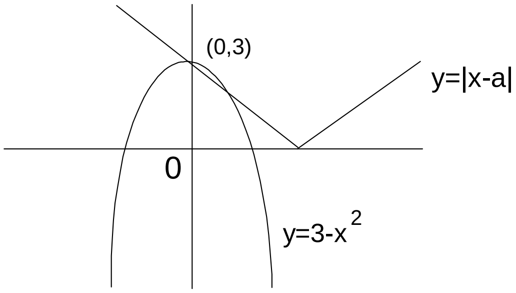
39. ABD

Sol. $x^2+|x-a|-3<0$

or $|x-a|<3-x^2$



Hence, $a=-\dfrac{13}{4}$



Hence, $a=3$

40. AB

Sol. $\vec{a}=-\hat{i}+2\hat{j}+\hat{k}$

Let $\vec{a}$ in new position be $\vec{b}=x\hat{i}+y\hat{j}+z\hat{k}$

$|\vec{a}|=|\vec{b}|\Rightarrow x^2+y^2+z^2=6$

$\vec{a}\cdot\vec{b}=0\Rightarrow -x+2y+z=0$

And $\vec{a},\vec{b}$ and $\hat{j}$ are coplanar

$$\Rightarrow\begin{vmatrix}-1 & 2 & 1\\ x & y & z\\ 0 & 1 & 0\end{vmatrix}=0 \qquad \therefore \vec{b}=\pm\sqrt{2}\left(\hat{i}+\hat{j}-\hat{k}\right)$$

41. B

Sol. $L_1: x=y=z$

$L_2: \dfrac{x-1}{1}=\dfrac{y+1}{-1}=\dfrac{z}{-1}$

Shortest distance=$1/\sqrt{2}$

Equation of plane containing L_2 and parallel to L_1 is $y-z+1=0$

42. ABCD

Sol. $Max\,P(A\cap B)=P(A)=\dfrac{3}{5}$

$$Min\,P(A\cap B)=P(A)+P(B)-1=\frac{4}{15}$$

$$P(A\cup B)=P(A)+P(B)-P(A\cap B)=\frac{19}{15}-P(A\cap B)$$

$$P\left(A\cap\overline{B}\right)=P(A)-P(A\cap B)=\frac{3}{5}-P(A\cap B)$$

$$P\left(\frac{\overline{A}}{B}\right)=\frac{P\left(\overline{A}\cap B\right)}{P(B)}=\frac{P(B)-P(A\cap B)}{P(B)}=1-\frac{3}{2}P(A\cap B)$$

43. AB

Sol. $z_1=a+ib=\cos\theta+i\sin\theta$

$z_2=c+id=\cos\phi+i\sin\phi$

$\operatorname{Re}\left(z_1\overline{z}_2\right)=0\Rightarrow\cos(\theta-\phi)=0\Rightarrow\theta-\phi=\pm\frac{\pi}{2}$

$|\omega_1|=\cos^2\theta+\cos^2\phi=1$

Similarly, $|\omega_2|=1$

$\operatorname{Re}\left(\omega_1\overline{\omega}_2\right)=\cos\theta\sin\theta+\cos\phi\sin\phi$

$=\frac{1}{2}(\sin 2\theta+\sin 2\phi)$

$=\sin(\theta+\phi)\,\cos(\theta-\phi)=0$

Similarly, $\operatorname{Re}\left(\overline{\omega}_1\,\omega_2\right)=0$

44. B
45. C
46. D

Sol. (for Q. 44 to Q. 46)
In each of these questions, check options one by one.

47. A
48. B
49. D

Sol. (for Q. 47 to Q. 49)

$f(x)=\frac{7+6\tan x-\tan^2 x}{1+\tan^2 x};x\in\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$

or $y=\frac{7+6t-t^2}{1+t^2};t\in(-\infty,\infty)$

Hence, $y\in[-2,8]$

$f(x)=4\cos x+3\cos\left(x+\frac{\pi}{2}\right)+3;\ x\in R$

$=4\cos x-3\sin x+3$

Hence, $f(x)\in[-2,8]$

$f(x)=\sin^6 x+\cos^6 x;\ x\in R$

$=\left(\sin^2 x\right)^3+\left(\cos^2 x\right)^3$

$=1-\frac{3}{4}(\sin 2x)$

$$Hence,\ f(x) \in \left[\frac{1}{4}, 1\right]$$

$$f(x) = \cos x \cdot \cos\left(x + \frac{\pi}{3}\right) \cdot \cos\left(x - \frac{\pi}{3}\right);\ x \in R$$

$$= \frac{\cos 3x}{4}$$

$$Hence,\ f(x) \in \left[-\frac{1}{4}, \frac{1}{4}\right]$$

SECTION – C

50. 7

Sol. Let C_0 be the circle passing through points A, B, C and D.

Radical axis of C_0 *and* $C_1 : x + 2y + 3 = 0$

Radical axis of C_0 *and* $C_2 : 2x + 3y + \lambda = 0$

Radical axis of C_1 *and* $C_2 : x - y - 3 = 0$

$$\begin{vmatrix} 1 & 2 & 3 \\ 2 & 3 & \lambda \\ 1 & -1 & -3 \end{vmatrix} = 0 \Rightarrow \lambda = 4$$

51. 0

Sol. $(M - I)^T = M^T - I$

$$\Rightarrow (M - I)^T M = M^T M - M$$

$$\Rightarrow (M - I)^T M = I - M = -(M - I)$$

$$\Rightarrow \left|(M - I)^T M\right| = \left|-(M - I)\right|$$

$$\Rightarrow \left|(M - I)^T\right| |M| = -|M - I|$$

$$\Rightarrow |M - I| \times 2 = -|M - I|$$

$$\Rightarrow |M - I| = 0$$

52. 4

Sol. Coefficient of x^{70}

$$= \left[(-8) + (-1 \times -7) + (-2 \times -6) + (-3 \times -5) + (-1 \times -2 \times -5) + (-1 \times -3 \times -4)\right]$$

$$= (-8 + 7 + 12 + 15 - 10 - 12) = 4$$

53. 3

Sol. $z^9 = \dfrac{11 - 10iz}{11z + 10i}$ $\quad$ *Let* $z = a + ib\ (a, b \in R) : |z|^2 = a^2 + b^2$

$$|z|^9 = \sqrt{\frac{11^2 + 220b + 10^2\left(a^2 + b^2\right)}{11^2\left(a^2 + b^2\right) + 220b + 10^2}}$$

Clearly, $|z|^2 = a^2 + b^2 > 1$ *or* < 1 *is not possible.*

Hence $|z| = 1$

54. 1

Sol. $e^x - 1 - k\tan^{-1} x = 0$

or, $e^x - 1 = k\tan^{-1} x$

$y_1 = e^x - 1$ *and* $y_2 = k\tan^{-1} x$

Draw graphs and analyse.

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – III

JEE (Advanced)-2019

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 231**

General Instructions:

- The test consists of total 69 questions.
- Each subject (PCM) has 23 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Three Sections**: **Section-A, Section-C & Section-D.**

Section-A (01 – 03, 24 – 26, 47 – 49) *contains 9 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-A (04 – 08, 27 – 31, 50 – 54) *contains 15 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 mark*** *for wrong answer.*
Partial Marks **+1** for each correct option provided no incorrect options is selected.

Section-A (09 – 10, 32 – 33, 55 – 56) *contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Section-C (11 – 20, 34 – 43, 57 – 66) *contains 30 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Section-D (21 – 23, 44 – 46, 67 – 69) *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

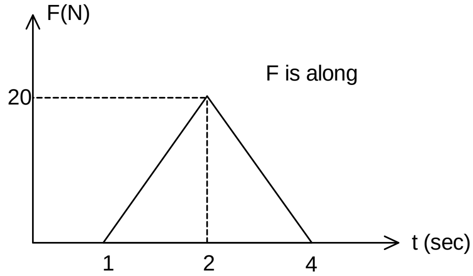
Physics

PART – I

SECTION – A
(Single Correct Choice Type)

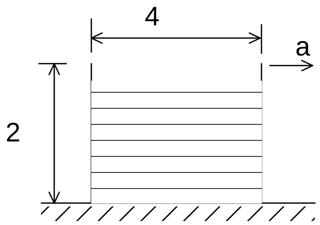
This section contains **3 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. A particle of mass 2 kg is moving along x-axis with a velocity of 5 m/s. It crosses the origin at t = 0. A time varying force whose variation is as shown starts acting on a particle at t = 1 sec. For this situation, mark out the correct statement.



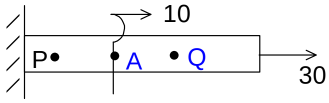
(A) the particle will come to rest instantaneously at t = 6.8 sec
(B) the final velocity of the particle will be 18 m/s.
(C) work done by the force F on the particle is 375 J.
(D) all of the above

2. A liquid is filled in a rectangular vessel of dimension 4 m × 3 m × 2 m. Now the container starts to move with uniform acceleration 1.25 m/s^2 at t = 0. The volume of liquid in vessel is 18m^3. The speed of liquid coming out from a very small orifice made at bottom of right side wall at t = 4s is



(A) zero (B) $\sqrt{30}$ m / s
(C) 5 m/s (D) 10 m/s

3. One end of a rope is bound to a vertical wall. The other end is pulled with a horizontal force of 30 N. An additional force of 10 N is applied to the right at the point A in the middle of the rope. Which of the following is true about tensions at points P and Q



(A) $T_P = T_Q = 40N$ (B) $T_P = T_Q = 20N$
(C) $T_P - T_Q = 10N$ (D) $T_Q = 20N, T_P = 40N$

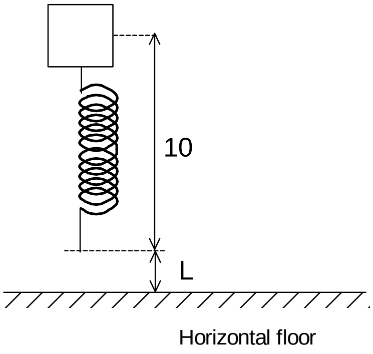
Space for Rough work

(One or More than one correct type)

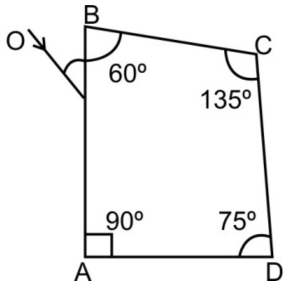
This section contains **5 questions**. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

4. With regard to sound waves, mark out the correct statement(s).
   (A) the phase difference between incident & reflected displacement waves from the fixed end is zero.
   (B) the phase difference between incident & reflected pressure waves from the fixed end is zero.
   (C) the phase difference between incident & reflected pressure waves from the fixed end is π.
   (D) the phase difference between incident & reflected pressure waves from the free end is π.

5. A small block mass m is fixed at upper end of a massless vertical spring of spring constant $K = \frac{4mg}{L}$ and natural length 10 L. The lower end of spring is free and is at a height L from fixed horizontal floor as shown. The spring is initially unstretched and the spring block system is released from rest in the shown position.
   (A) When the speed of block is maximum the magnitude of force exerted by spring on the block is mg.
   (B) The maximum speed attained by the block is $\frac{3}{2}\sqrt{gL}$.
   (C) The maximum compression of the spring is L/8.
   (D) The time taken by the mass to move from the equilibrium position to the maximum compressed position of the spring is $\frac{\pi}{4}\sqrt{\frac{L}{g}}$

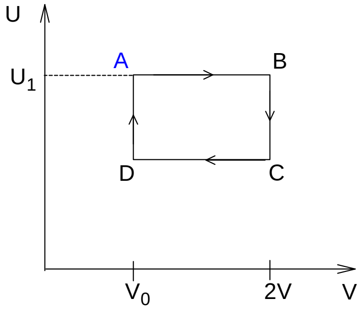


6. A ray OP of monochromatic light is incident on the face AB of prism ABCD near vertex B at an incident angle of 60º as shown in figure. If the refractive index of the material of the prism is $\sqrt{3}$, which of the following is(are) correct ?
   (A) The ray gets totally internally reflected at face CD.
   (B) The ray comes out through face AD.
   (C) The angle between the incident ray and the emergent ray is 90º
   (D) The angle between the incident ray and the emergent ray is 120º

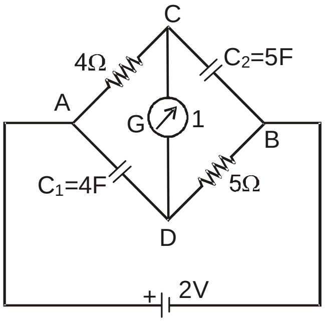


Space for Rough work

7. One mole of an ideal gas has an internal energy given by $U = U_o + 2\ PV$, where P is the pressure and V the volume of the gas, U_o is a constant. this gas undergoes the quasi-static cyclic process ABCD as shown the U-V diagram. choose the correct statement (s) :
(A) The work done by the ideal gas in the process AB is $\frac{U_1 - U_0}{2}\ln 2$.
(B) The gas must be monoatomic
(C) The gas must be diatomic.
(D) The molar heat capacity of the gas at constant pressure is 3 R



8. In the circuit shown in Fig. the cell is ideal, with e.m.f. = 2V. The resistance of the coil of the galvanometer G is 1Ω. Then
(A) No current flows in G
(B) 0.2 A current flows in G
(C) Potential difference across C_1 is 1V
(D) Potential difference across C_2 is 1.2 V

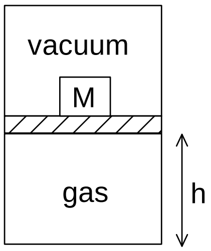


Paragraph type (One Option Correct)

This section contains **1 paragraph** each describing theory, experiment, data etc. **Two questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Questions 9 & 10

One mole of an ideal diatomic gas is contained in the lower part of the cylinder beneath a piston of area 50 cm^2 as shown in the figure. The piston has negligible mass but a block of mass M = 100 kg is kept on the piston. Initially the gas is maintained at a temperature of 300 K and piston is at a height h from the bottom of the cylinder. The gas is now heated to raise the weight by 10 cm. [Take g = 10 m/s^2, atmospheric pressure = 10^5 N/m^2]



9. The thermal energy supplied to the gas in the process is

(A) 249 J	(B) 348.6 J
(C) 99.6 J	(D) 100 J

Space for Rough work

10. If a small hole has been created in the upper part of the cylinder, then the value of h before heating the gas is
(A) 1.66 m (B) 2.49 m
(C) 1.40 m (D) none of these

SECTION – C
(Single digit integer type)

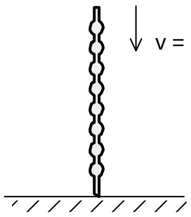
This section contains **10 questions**. The answer to each question is a **Single Digit Integer** ranging from 0 to 9, both inclusive.

11. A container filled with air under pressure P_0 contains a soap bubble of radius R. When the air pressure is reduced to half isothermally, the bubble radius becomes (5R/4). If the surface tension of the soap water solution is S, then find $\left(\frac{RP_o}{12S}\right)$.

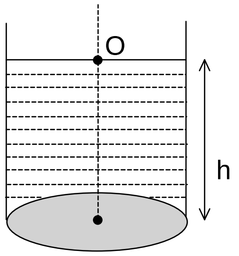
12. A glass tube of 1.0 m length is filled with water. The water is drained out very slowly from the tube through a hole in the bottom while a vibrating 500 HZ tuning fork is held near the open upper end of the tube. If the speed of sound is 320 ms^{-1}, find the number of resonance that can be obtained.

13. A 50 Ω resistor is connected in series with a coil and a sinusoidal ac–source of effective voltage 50 V. If the effective voltage drop across the resistor is 20 V and across the coil is 40 V, Find the power developed in coil in watt?

14. The upper end of the uniform chain of linear mass density 2 kg/m is lowered with a speed 1 m/s as shown in diagram. The normal reaction offered by the ground after the chain fall through a distance 5 cm is given by k newton. Find the value of k.

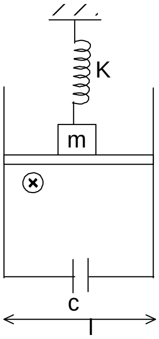


15. Bottom of glass beaker is made of a thin equi-convex lens having bottom side silver polished as shown in the figure. Now the water is filled in the beaker upto a height of h = 4 m. The image of point object floating at middle point of beaker at the surface of water coincides with it. The value of radius of curvature of lens is $\left(\mu_g = \frac{3}{2}, \mu_w = \frac{4}{3}\right)$

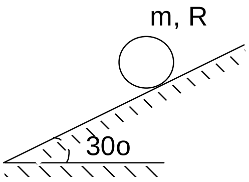


Space for Rough work

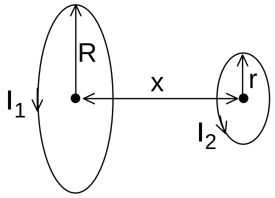
16. A block is attached to the ceiling by a spring that has a force constant K = 200 N/m. A conducting rod is rigidly attached to the block. The combined mass of the block and the rod is m = 0.3 kg. The rod can slide without friction along the two vertical parallel rails, which are a distance $\ell = 1$ m apart. A capacitor of known capacitance C = 500 μF is attached to the rails by the wires. The entire system is placed in a uniform magnetic field B = 20 T directed inwards as shown. Neglect the self inductance and electrical resistance of the rod and all wires. The angular frequency (in rad/s) of the vertical oscillations of the block is 4ω. Find the value of ω?



17. A uniform spherical shell of mass m and radius R starts from rest with pure rolling on a long inclined plane as shown in the figure. If angular momentum of shell about point of contact after 1 sec of its starting is KmR, find K [Take g = 10 m/s^2] ....

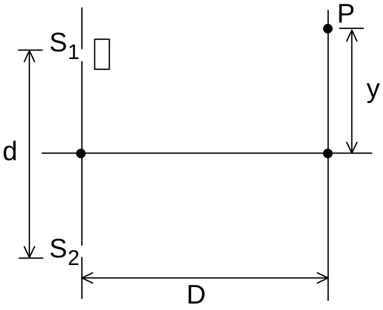


18. The force of interaction between two co-axial current loops having radii R & r (r<<R), separated by a distance x carrying currents I_1 & I_2 respectively is given by the expression, $F = \frac{N\mu_o \pi R^2 r^2 I_1 I_2 x}{2\left(R^2 + x^2\right)^{\frac{5}{2}}}$. Find 'N'



19. The minimum deviation suffered by a ray emerging through a prism $\left(\mu = \frac{2}{\sqrt{3}}\right)$ is equal to half the refracting angle of the prism. Find the value of C if the refracting angle of the prism is $(2\pi / C)$.

20. Young's double slit experiment is conducted with white light (4000A^o –7000A^o). As shown in the diagram, the slit separation $d = \left(\frac{1}{2}\right)$mm, and the screen slit distance, D = 1 m. The upper slit is covered with a film of thickness, t = 1 μm having a refractive index, $\mu = \frac{3}{2}$. Find the number of wavelengths which will form a maxima at y = 3mm



Space for Rough work

SECTION – D
(Numerical Answer Type)

This section contains **3 questions**. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded - off to the **second decimal place**; e.g. xxxxx.xx).

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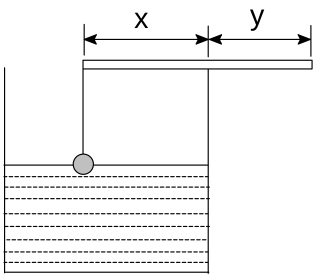
21. A homogeneous aluminium ball of radius r = 0.5 cm is suspended on a weightless thread from an end of a homogeneous rod of mass M = 4.4 g. The rod is placed on the edge of a conditioner with water so that half of the ball is submerged in water when the system is in equilibrium as shown. The densities ρ_{al} and ρ_w of aluminium an water are 2.7×10^3 kg/m^3 and 1×10^3 kg/m^3 respectively. Determine the ratio y/x of the parts of the rod to the brim, neglecting the surface tension on the boundaries between the ball and water.



22. A parachutist jumps from the top of a very high tower with a siren of frequency 800 Hz on his back. Assume his initial velocity to be zero. After falling freely for 12s, he observes that the frequency of sound heard by him reflected from level ground below him is differing by 700 Hz w.r.t. the original frequency. What was the height of tower. Velocity of sound in air is 330 m/s, and g = 10 m/s^2.

23. A radionuclide with disintegration constant λ is produced in a reactor at a constant rate $\alpha\left(=2\lambda\right)$ nuclei per second. At t = 0, there are no nuclei present in the reactor. During each decay energy E_0 is released. 20% of this energy is utilized in increasing the temperature of water. Find the increase in temperature of m mass of water in time t = $T_{1/2}$ if specific heat of water is s. Assume that there is no loss of energy through water surface. (Given E_0 = 100 times the energy required to raise the temperature of mass m of water from 0^0 to 100^0C).

Space for Rough work

Chemistry PART – II

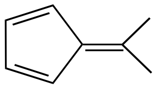
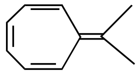
SECTION – A
(Single Correct Choice Type)

This section contains **3 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

24. Number of S–S bond in $H_2S_nO_6$

(A) n	(B) (n–1)
(C) (n–2)	(D) (n + 1)

25. Which one of the following statements is True:

(1) 
(2) 

(A) PhLi adds to both compound with equal ease
(B) PhLi does not add to either of the compound
(C) PhLi react readily with 1 but does not add to 2.
(D) PhLi react readily with 2 but does not add to 1.

26. One mole of Argon is heated using $PV^{5/2}$ = constant. By what amount heat is absorbed during the process, when temperature changes by $\Delta T = 26$ K.

(A) 100 J	(B) 200 J
(C) 180 J	(D) 208 J

(One or More than one correct type)

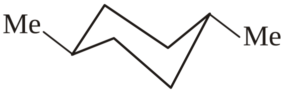
This section contains **5 questions**. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

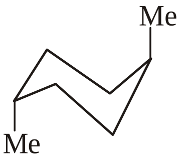
27. Select the correct statement(s).
(A) For equilibrium, pressure is constant.
(B) For equilibrium, temperature is constant.
(C) For equilibrium, concentration is constant.
(D) For equilibrium, pressure & temperature is variable.

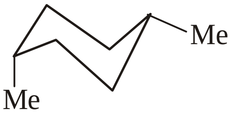
Space for Rough work

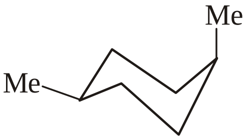
28. A_2O_n is oxidised to AO_3^- by MnO_4^- in acid medium. If 1.5×10^{-3} mole of A_2O_n requires 60 ml of 0.03 M-$KMnO_4$ solution for complete oxidation, which of the following statement(s) is/are correct?
(A) The value of n = 2
(B) Empirical formula of oxide is AO.
(C) 0.15 mole of A_2O_n would require 0.15 mole of acidified $K_2Cr_2O_7$ solution
(D) 'A" may be a metal from second group of periodic table.

29. Select the correct statement for the following species.

(I)


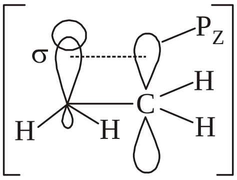
(II)


(III)


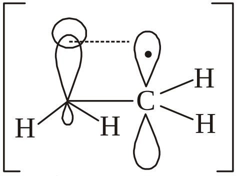
(IV)


(A) I and III are Geometrical isomers.
(B) I and II are Conformational pairs
(C) III and IV are Conformational pairs
(D) II and IV are Geometrical isomers

30. Among the following orbital interactions which represents hyper-conjugation interaction?

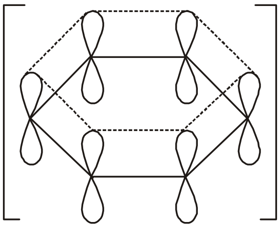
(A)


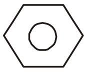
$CH_3–CH_2^{\oplus}$

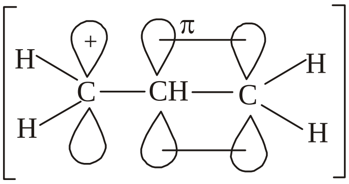
(B)


free radical

$(CH_3–\dot{C}H_2)$

(C)




(D)


$(H_2\overset{\oplus}{C} – CH = CH_2)$

Space for Rough work

31. Which of the following statements is/are false

(A) In $[PtCl_2(NH_3)_4]^{2+}$ complex ion, the cis-form is optically active, while trans-form is optically inactive

(B) In $[Fe(C_2O_4)_3]^{3-}$, geometrical isomerism does not exist, while optical isomerism exists

(C) $[Mabcd]^{n\pm}$ square planar complexes exhibit both optical as well as geometrical isomerism

(D) In $[Mabcd]^{n\pm}$ tetrahedral complexes, optical isomerism cannot be observed

Paragraph type (One Option Correct)

This section contains **1 paragraph** each describing theory, experiment, data etc. **Two questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Questions 32 & 33

Complex compounds which have same molecular formula but have different structural arrangements of ligands around central metal atom or ion are called structural isomers and phenomenon is named as structural isomerism.

32. Which of the following compounds is/are polymerisation isomer of $[Fe(NO_2)_3(NH_3)_3]$.

(I) $[Fe(NO7)(NH_3)_5]$ $[Fe(NO_2)_5(NH_3)]$
(II) $[Fe(NO_2)_2(NH_3)_4]_2$ $[Fe(NO_2)_5(NH_3)]$
(III) $[Fe(NO_2)(NH_3)_5]$ $[Fe(NO_2)_4(NH_3)_2]_2$
(IV) $[Fe(NO_2)_2(NH_3)_4]$ $[Fe(NO_2)_4(NH_3)_2]$

Choose the correct code :

(A) II, III
(B) II, III, IV
(C) I, IV
(D) I, II, III, IV

33. Select incorrect match

(A) $[Co(NO_2)(H_2O)(en)_2)]Cl_2$, $[CoCl(NO_2)(en)_2]$ Cl . H_2O – Hydrate isomerism

(B) $[Cu(NH_3)_4][PtCl_4]$, $[CuCl_2(NH_3)_2]$ $[PtCl_2(NH_3)_2]$ – Coordination isomerism

(C) $[Ni(CN)(H_2O)(NH_3)_4]Cl$, $[NiCl(H_2O)(NH_3)_4]CN$ – Ionization isomerism

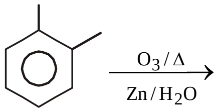
(D) $[Cr(NCS)(NH_3)_5]$ $[ZnCl_4]$, $[Cr(SCN)(NH_3)_5]$ $[ZnCl_4]$ – Linkage isomerism

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **10 questions**. The answer to each question is a **Single Digit Integer** ranging from 0 to 9, both inclusive.

34. How many more coordination isomers are possible of the following complex compound.
$[PtCl_2(NH_3)_4][Pt(SCN)_4]$

35. 

How many different species are formed?

36. $\underset{(X)}{C_6H_4} \xrightarrow[\text{(ii) Zn/H}_2\text{O}]{\text{(i) O}_3} C_3H_2O_3$
no of pi-bond present in X is

37. Number of possible spectral lines which may be emitted in bracket series in H atom, if electrons present in 9th excited level returns to ground level, are

38. 15 g of a solute in 100 g water makes a solution freeze at –1°C. 30 g of a solute in 100 g of water will give a depression in freezing point equal to

39. The enthalpies of neutralization of a weak acid HA & a weak acid HB by NaOH are - 6900 Cal/equivalent & - 2900 Cal/equivalent respectively. When one equivalent of NaOH is added to a solution containing one equivalent of HA & one equivalent of HB, the enthalpy change was - 3900 Calories. If base distributed between HA & HB in X : Y then find value of X+Y.

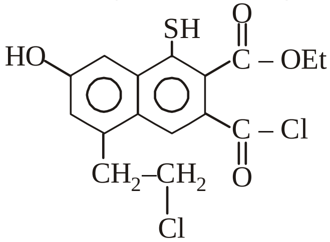
40. 50 mL of 0.1M $CuSO_4$ solution is electrolyzed with a current of 0.965 A for a period of 200 sec. The reactions at electrodes are:
Cathode : $Cu^{2+} + 2e^- \rightarrow Cu(s)$ Anode : $2H_2O \rightarrow O_2 + 4H^+ + 4e$.
Assuming no change in volume during electrolysis, calculate the decimolar concentration of SO_4^{2-} at the end of electrolysis.

41. If the radius of Mg^{2+} ion, Cs^+ ion, O^{2-} ion, S^{2-} ion and Cl^- ion are 0.65 Å , 1.69 Å, 1.40 Å, 1.84 Å, and 1.81 Å respectively. Calculate the average of co-ordination numbers of the cations in the crystals of MgS, MgO and CsCl.

Space for Rough work

42. Which of the following statements is (are) true about resonance.
(a) Resonance is an intramolecular process.
(b) Resonance involves delocalization of both s and p electrons.
(c) Resonance involves delocalization of p electrons only.
(d) Resonance decreases potential energy of a molecule.
(e) Resonance has no effect on the potential energy of a molecule.
(f) Resonance is the only way to increase molecular stability.
(g) Resonance is not the only way to increase molecular stability.
(h) Any resonating molecule is always more stable than any nonresonating molecule.
(i) The canonical structure explains all features of a molecule.
(j) The resonance hybrid explains all features of a molecule.
(k) Resonating structures are real and resonance hybrid is imaginary.
(l) Resonance hybrid is real and resonating structures are imaginary.
(m) Resonance hybrid is always more stable than all canonical structures.

43. How many moles of Grignard reagent will be required by one mole of given compound?



Space for Rough work

SECTION – D
(Numerical Answer Type)

This section contains **3 questions**. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded - off to the **second decimal place**; e.g. xxxxx.xx).

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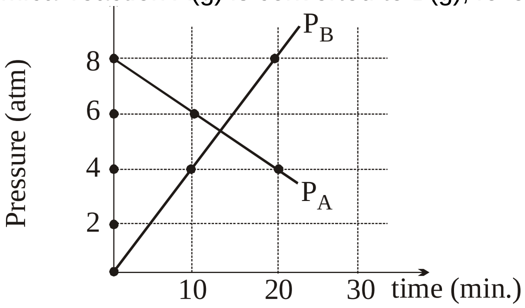
44. KF has NaCl structure. What is the distance between K^+ and F^- in KF in angstrom if density of KF is 2.48 gm/cm^3.

45. In a chemical reaction A(g) is converted to B(g), following observation is made.



Time of completion for the reaction (in min) is

46. A current of 0.5 A is passed through molten $AlCl_3$ for 40 min. Calculate the mass of aluminium in gram deposited at cathode.

Space for Rough work

Mathematics PART – III

SECTION – A
(Single Correct Choice Type)

This section contains **3 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

47. Let f(x) be defined on [0, 1] such that f(x) = min $\left|x-\frac{1}{2^n}\right|$; n = 0, 1, 2……..then area under f(x) is

(A) $\frac{1}{12}$ (B) $\frac{1}{24}$

(C) $\frac{1}{6}$ (D) $\frac{1}{36}$

48. Consider the region R defined as

$$R=\left\{(x,y)\left|\begin{matrix} x^2+y^2\le & 100 \\ \sin(x+y)\ge & 0\end{matrix}\right.\right\}$$

What is the area of R;

(A) 25π (B) 40π

(C) 50π (D) 32π

49. The $\lim\limits_{x\to1}\frac{\left(\log(1+x)-\log2\right)\left(3.4^{x-1}-3x\right)}{\left((7+x)^{\frac{1}{3}}-(1+3x)^{\frac{1}{2}}\right)\sin\pi x}$ is

(A) $\frac{2}{3\pi}\left(\log4-\frac{1}{2}\right)$ (B) $\frac{4}{3\pi}\left(\log4-\frac{2}{3}\right)$

(C) $\frac{9}{4\pi}\left(\log4-1\right)$ (D) $\frac{4}{3\pi}\left(\log2-\frac{2}{3}\right)$

Space for Rough work

(One or More than one correct type)

This section contains **5 questions**. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

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50. Let $\vec{a} = 2\hat{i} + \hat{k}, \vec{b} = \hat{i} + \hat{j} + \hat{k}$ and $\vec{c} = 4\hat{i} - 3\hat{j} + 7\hat{k}$. Let $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$ be a vector such that $\vec{r} \times \vec{b} = \vec{c} \times \vec{b}$ and $\vec{r}.\vec{a} = 0$. The magnitude of x + y + z is

(A) 3
(B) 5
(C) 7
(D) 9

51. If ω is one of the angle between normal to the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ at the point whose eccentric angle θ & $\frac{\pi}{2} + \theta$. then $\frac{2\cot\omega}{\sin 2\theta}$ is

(A) $-\frac{e^2}{\sqrt{1-e^2}}$
(B) $\frac{e^2}{\sqrt{1+e^2}}$
(C) $\frac{e^2}{\sqrt{1-e^2}}$
(D) $\frac{e^2}{1+e^2}$

52. If the point p on the parabola $y^2 = 4ax$ for which $|PR - PQ|$ is maximum. Where $R \equiv (-a, 0)$, $Q(0, a)$ is represented as (k_1a, k_2a) then find the value of (k_1 + k_2).

(A) 3
(B) 2
(C) 4
(D) 6

53. Let two tangents $3x - 4y + 20 = 0$ & $x - y - 3 = 0$ of a parabola intersect the tangents at point P(0, 5) and Q(3, 0) respectively, then

(A) length of latus rectum is $24/\sqrt{34}$
(B) Equation of axis is $3x - 5y - 33 = 0$
(C) focus is (6, -3)
(D) Equation of tangent at vertex 5x + 3y = 15

54. If $f(x) = e^{[\cot x]}$, where [y] denotes the greatest integer less than or equal to y, then

(A) $\lim_{x \to \frac{\pi}{2}^+} f(x) = 1$
(B) $\lim_{x \to \frac{\pi}{2}^+} f(x) = \frac{1}{e}$
(C) $\lim_{x \to \frac{\pi}{2}^-} f(x) = \frac{1}{e}$
(D) $\lim_{x \to \frac{\pi}{2}^-} f(x) = 1$

Space for Rough work

Paragraph type (One Option Correct)

This section contains **1 paragraph** each describing theory, experiment, data etc. **Two questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Questions 55 & 56

In a ΔABC, suppose that $\tan\frac{A}{2}$, $\tan\frac{B}{2}$, $\tan\frac{C}{2}$ are in harmonic progression.

55. What is the minimum possible value of $\cot\frac{B}{2}$?

(A) 1
(B) $\sqrt{2}$
(C) $\sqrt{3}$
(D) 2

56. What is the maximum possible value of angle B?

(A) $\frac{\pi}{6}$
(B) $\frac{\pi}{4}$
(C) $\frac{\pi}{3}$
(D) $\frac{\pi}{2}$

SECTION – C
(Single digit integer type)

This section contains **10 questions**. The answer to each question is a **Single Digit Integer** ranging from 0 to 9, both inclusive.

---

57. The no of values of z satisfying $|z-2i|=2$ and $|z-1-3i|+|z+1-3i|=2\sqrt{2}$ is

58. The minimum value of $|f(x)|$ where

$$f(x)=\frac{\left(x+\frac{1}{x}\right)^6-\left(x^6+\frac{1}{x^6}\right)-2}{\left(x+\frac{1}{x}\right)^3+\left(x^3+\frac{1}{x^3}\right)}$$

Space for Rough work

59. If A is 3 × 4 matrix and B is 4 × 3 matrix and det(AB) = 3, then find det(BA)

60. A variable circle S of radius r cuts a rectangular hyperbola H in four distinct point A, B, C and D. If O is the centre of H then the value of
$\lambda = \dfrac{OA^2 + OB^2 + OC^2 + OD^2}{r^2}$ is

61. Let S be the sum of all x in the internal $\left[0, 2\pi\right]$ such that $3\cot^2 x + 8\cot x + 3 = 0$. Then the value of $\dfrac{S}{\pi}$ is

62. Let A be n × n matrix with $|A| = 4.$ B is the adjoint of the matrix 2A such that $|B| = 1024.$ What is the value of n.

63. The graph xy = 1 is reflected in y = 2x to give the graph $12x^2 + r.xy + sy^2 + t = 0$ $\left(r + s + t\right)$ is

64. If the straight line joining origin to the point of intersection of straight lines 4x + 3y = 24 and the curve $(x- 3)^2 + (y – 4)^2 = c^2$ are at right angle then find the value of $|c|$.

65. The value of $\int_0^2 \left[x + \left[x + \left[x\right]\right]\right] dx$ where [.] is greatest integer function.

66. If f is real valued differentiable function satisfying $\left|f(x) - f(y)\right| \le (x - y)^2$, x, y $\in R$ and f(0) = 0 then f(1) is equal to

SECTION – D
(Numerical Answer Type)

This section contains **3 questions**. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded ‑ off to the **second decimal place**; e.g. xxxxx.xx).

---

67. If $\sum_{r=1}^{n} T_r = \dfrac{n(n+1)(n+2)}{3}$ then $\lim_{n\to\infty} \sum_{r=1}^{n} \dfrac{2008}{T_r}$ is

68. Word of length 10 are formed using the letters A, B, C, D, E, F, G, H, I, J. Let X be the number of such word where no letter is repeated and y see the number of such word where exactly are letters is repeated twice and no other letter is repeated then y/9x =

69. Find the minimum value of the sum of real no. $a^{-5}, a^{-4}, 3a^{-3}, 1, a^8$ and $a^{10}\left(a > 0\right)$.

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – III

JEE (Advanced)-2019

PAPER – 2

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. C

Sol. Use $\int_0^4 F dt = mv - m(5)$

$\text{work}_F = \frac{1}{2}mv^2 - \frac{1}{2}m(5)^2$

2. D

Sol. $\tan\theta = \frac{a}{g} = \frac{y_1 - y_2}{4}$

$\therefore y_1 - y_2 = 0.5$ ....(i)

Volume of water is

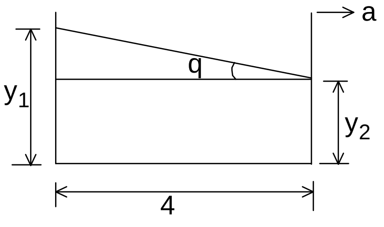
$\frac{4(y_1 + y_2)}{2} \times 3 = 18$

$\therefore y_1 + y_2 = 3$ ....(ii)

$\therefore y_2 = \frac{2.5}{2}$

$\therefore$ speed of liquid coming from orifice is

$= at + \sqrt{2gy_2} = 10 m/s$



3. C

Sol. $T_P = 40$ N

$T_Q = 30 N$

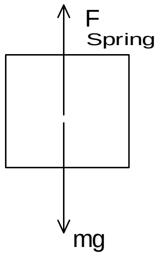
$T_P - T_Q = 10$ N

4. BD

Sol. When a displacement wave strikes a fixed end, it gets inverted after reflection and when a pressure wave strikes a fixed end, compression pulse gets reflected as compression pulse.

5. ABD

Sol. Speed will be maximum when the block passes through the equilibrium position.



$F_{\text{spring}} = mg$

$\therefore$ A is correct

(B) From conservation of energy

$$mg(\ell + x) = \frac{1}{2}Kx^2 + \frac{1}{2}mv_{\max}^2 \qquad (1)$$

Where $x = \frac{mg}{K} = \frac{mg}{4mg}\ell = \frac{\ell}{4}$

putting $x = \frac{\ell}{4}$ in equation (1)

$$V_{\max} = \frac{3}{2}\sqrt{gl}$$

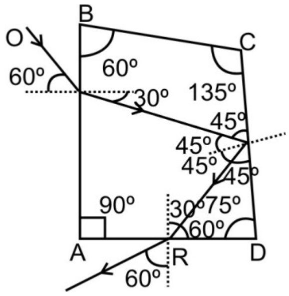
(C) is incorrect as in equilibrium compression is $\ell/4$ which is more than $\frac{\ell}{8}$

(D) Time taken is $\frac{T}{4} = \frac{1}{4}2\pi\sqrt{\frac{m}{K}}$

$\therefore$ D is correct

6. ABC

Sol. Applying Snell's law at face AB, we get



$1 \times \sin 60^\circ = \sqrt{3} \times \sin r$

$\frac{\sqrt{3}}{2} = \sqrt{3}\sin r$ or $\sin r = \frac{1}{2}$

$r = \sin^{-1}\left(\frac{1}{2}\right) = 30^\circ$

$\sin\theta_c = \frac{1}{\sqrt{3}}$

(where, θ_c is the critical angle)

$\theta_c = \sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$ or $\theta_c \approx 35^\circ$

From geometry, angle of incidence at Q is 45°. At face CD angle of incidence is greater than θ_c. Therefore, the rays gets totally internally reflected at face CD. Hence, option (a) is correct. From geometry, angle of incidence at R is 30°. At face AD angle of incidence is less than θ_c

So, the ray comes through face AD. Hence option (b) is correct.

Applying Snell's law at face AD, we get

$$e = \sin^{-1}\left(\frac{\sqrt{3}}{2}\right) = 60^\circ$$

The angle between the incident ray and the emergent ray is 90°.

Hence, option (c) is correct and option (d) is incorrect.

7. AD

Sol. $W_{A\to B} = nRT_1 \ln 2$

$$W_{A\to B} = \frac{U_1 - U_0}{2}\ln 2$$

$$\frac{dv}{dT} = 2R$$

$$dv = 2RdT$$

$$C_V = 2R$$

$$C_P = 3R$$

8. BCD

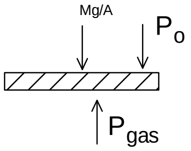
Sol. Current through resistances remains constant.

9. B

Sol. $Q = nC_P\Delta T = C_P\left(\frac{P\Delta V}{R}\right)$

10. A

Sol.



SECTION – C

11. 8

Sol. $\left(P_o + \frac{4S}{R}\right)R^3 = \left(0.5P_o + 0.8\times\frac{4S}{R}\right)\left(\frac{5R}{4}\right)^3$

$$P = \frac{96S}{R}$$

12. 4

Sol. $L_{min} = \frac{C}{4f} = 16 \text{ cm}$

so resonance for length 16 cm, 48 cm, 80 cm i.e 3 cases.

13. 5

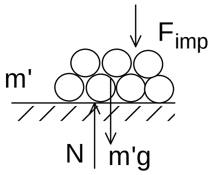
Sol. $V_S^2 = V_R^2 + V_C^2 + 2V_RV_C\cos\phi$

$$i = \frac{V_R}{R}$$

$$P_C = i\,V_C\cos\phi$$

14. 3

Sol. each falling link collides with the fallen links with a relative velocity



$$\vec{v}_{imp} = -vj$$

$$\vec{f}_{imp} = \vec{v}_{rel}\,\frac{dm^1}{dt}$$

$$\vec{f}_{imp} = -\mu v^2 j$$

from equation on heap

$$N - m'g + f_{imp} = 0$$
$$N = \mu\left(v^2 + gy\right)$$
$$= 2\left(1^2 + 10 \times 0.05\right)$$
$$= 2\left(1 + 0.5\right)$$
$$= 3N$$

15. 5

Sol. $P_M' = 2P_2 + P_M$

$$P_2 = \frac{1}{f_2} = \frac{1}{4R}$$
$$-\frac{1}{f_m'} = 2 \times \frac{1}{4R} + \frac{2}{R} = \frac{5}{2R}$$
$$f_m' = -\frac{2}{5}R$$
$$|h| = 2|f_m'|$$
$$h = 2 \times \frac{2R}{5} = 4$$
$$R = 5m$$

16. 5

Sol. $E = \frac{1}{2}mv^2 + \frac{1}{2}kx^2 + \frac{q^2}{2c}$

$$e = Bv\ell = \frac{q}{c}$$
$$E = \frac{1}{2}\left(m + B^2\ell^2c\right)v^2 + \frac{1}{2}kx^2$$

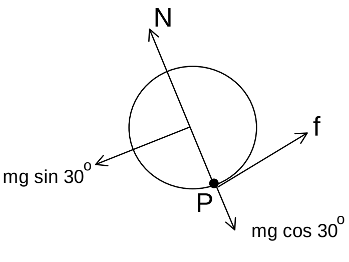
as E = constant

$$\frac{dE}{dt} = 0$$
$$\frac{dv}{dt} = -\left(\frac{k}{m + B^2\ell^2c}\right)x$$

ω = 20 rad/sec

17. 5

Sol. Angular momentum about P = $\tau\Delta t$ = $\left(mg\sin 30^o\right)R(1)$



18. 3

Sol. $\because$ P.E., $U = -\vec{\mu}.\vec{B} = (-)\frac{\left(I_2\pi r^2\right)\mu_o I_1 R^2}{2\left(R^2 + x^2\right)^{\frac{3}{2}}}$

$$F = (-)\frac{du}{dx} = \frac{3\mu_o \pi R^2 r^2 I_1 I_2 x}{2\left(R^2 + x^2\right)^{\frac{5}{2}}}, \therefore N = 3$$

19. 3

Sol. $\because \mu = \dfrac{\sin\left(\dfrac{A+\delta_m}{2}\right)}{\sin\left(\dfrac{A}{2}\right)} \Rightarrow \dfrac{2}{\sqrt{3}} = \dfrac{\sin\left(\dfrac{A+\dfrac{A}{2}}{2}\right)}{\sin\left(\dfrac{A}{2}\right)}$

$\Rightarrow \dfrac{2}{\sqrt{3}} = \dfrac{\sin\left(\dfrac{3A}{4}\right)}{\sin\left(\dfrac{A}{2}\right)}$, Let $\dfrac{A}{4} = \theta$

$\Rightarrow \dfrac{2}{\sqrt{3}} = \dfrac{\sin 3\theta}{\sin 2\theta} = \dfrac{3\sin\theta - 4\sin^3\theta}{2\sin\theta.\cos\theta} = \dfrac{3-4\sin^2\theta}{2\cos\theta}$

$\Rightarrow 4\sqrt{3}\cos^2\theta - 4\cos\theta - \sqrt{3} = 0$

$\Rightarrow \cos\theta = \dfrac{1 \pm 2}{2\sqrt{3}} = \dfrac{\sqrt{3}}{2}, \left(-\dfrac{1}{2\sqrt{3}}\right)$

$\Rightarrow \theta = 30^o \Rightarrow \dfrac{A}{4} = 30^o = \dfrac{\pi}{6}$

$\Rightarrow A = \dfrac{2\pi}{3}, \therefore C = 3$

20. 1

Sol. For maxima at P, path Diff. = $n\lambda$, n = integer

$\Rightarrow (s_2P - s_1P) - (\mu - 1)t = n\lambda \Rightarrow y\dfrac{d}{D} - (\mu-1)t = n\lambda$

$\Rightarrow n\lambda = 10^{-6}m \Rightarrow n = \dfrac{10^{-6}}{\lambda}$

$n^{max} = \dfrac{10^{-6}}{4000 \times 10^{-10}} = 2.5 \,\&\, n^{min} = \dfrac{10^{-6}}{7000 \times 10^{-10}} = 1.42$

$\therefore n = 2, \therefore$ only one wavelength will give maxima at P for $n = 2$

SECTION – D

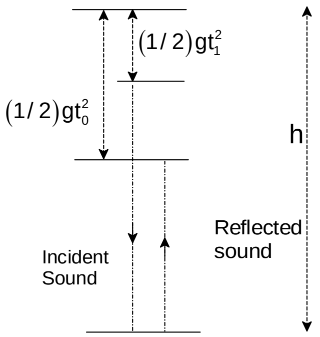
21. 00001.53

Sol. The centre of mass of the rod is at distance $\dfrac{(y-x)}{2}$ from the brim.

$\left(\rho_{al} gV - \rho_w g\dfrac{V}{2}\right)x = mg\dfrac{(y-x)}{2}$

$\Rightarrow \dfrac{4}{x} = 1.53$

22. 01057.50



Sol. Let the sound observed by the parachutist at t_0 = 12s be produced at t_1s. Velocity of source at the instant of emitting sound = gt_1 and velocity of observer at the instant of observing same sound = gt_0. Hence the relation between apparent frequency f' and original frequency f will be

$$f' = f\left(\frac{v + gt_0}{v - gt_1}\right)$$

Here f = 800 Hz, g = 10 m/s^2, v = 330 m/s

T_0 = 12s and f' = 800 + 700 = 1500 Hz

Putting these, we get

T_1 = 9s

Now the distance traveled by sound in ($t_0 - t_1$) sec

is $v(t_0 - t_1) = \left(h - \frac{1}{2}gt_0^2\right) + \left(h - \frac{1}{2}gt_1^2\right)$

Putting the values, we get

H = 1057.5 m

23. 00772.00

Sol. Rate of formation of nuclei at time t is

$\frac{dN}{dt} = \alpha - \lambda N,$ where N = number of nuclei at that time

$$N = \frac{\alpha}{\lambda}\left(1 - e^{-\lambda t}\right)$$

Number of nuclei disintegrated in time t, N_d = $\alpha t - \frac{\alpha}{\lambda}\left(1 - e^{\lambda t}\right)$

$\therefore$ Energy released till time t, E = E_0N_d = $E_0\left[\alpha t - \frac{\alpha}{\lambda}\left(1 - e^{-\lambda t}\right)\right]$

20% of this energy is used for heating water,

$$0.2E_0\left[\alpha t - \frac{\alpha}{\lambda}\left(1 - e^{-\lambda t}\right)\right] = ms\Delta\theta$$

$$\Delta\theta = \frac{0.2E_0\left[\alpha t - \frac{\alpha}{\lambda}\left(1 - e^{-\lambda t}\right)\right]}{ms}$$

At t = $T_{1/2}$

$$\Delta\theta = \frac{0.2E_0\left[2\alpha T_{\frac{1}{2}} - \frac{2\alpha}{\lambda}\left(1 - \frac{1}{2}\right)\right]}{ms}$$

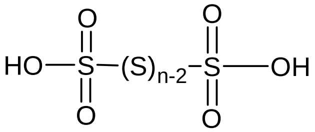
$$\Delta\theta = \frac{0.2E_0\left[0.386\right]}{ms}772K$$

Chemistry PART – II

SECTION – A

24. B

Sol.

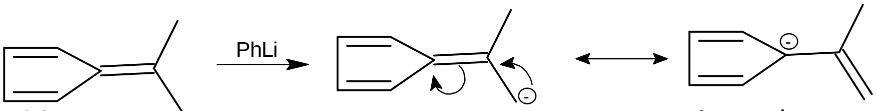


$$HO-\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}-(S)_{n-2}-\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}-OH$$

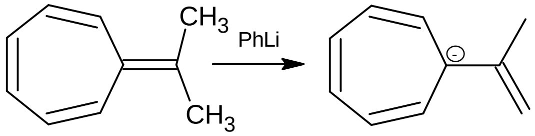
No. of S-S bond = (n-1)

25. C

Sol.



(1) Aromatic



(2) Anti Aromatic

26. C

Sol. $pv^{5/2} = const;\quad n = 5/2$ (Polytropic process)

$\text{no. of moles} = 1$

$$\text{Cv of Ar} = \frac{3}{2}R$$

$$q = nC \cdot \Delta T$$

$$= n\left(Cv + \frac{R}{1-n}\right)\Delta T$$

$$= 1\left(\frac{3}{2}R + \frac{R}{1-5/2}\right) \times 26$$

$$= \frac{5}{6}R \times 26$$

$$= \frac{5}{6} \times 8.314 \times 26 = 180J$$

27. ABC

Sol. (a) Mechanical equilibrium

(b) Thermal equilibrium

(c) Chemical equilibrium

28. ABC

Sol. $A_2O_n + MnO_4^- \xrightarrow{H^+} AO_3^- + Mn^{+2}$

$Eq.\ of\ A_2O_n = Eq.\ of\ MnO_4^-$

$1.5 \times 10^{-3} \times (10 - 2n) = 60 \times 0.03 \times 10^{-3} \times 5$

$no.\ of\ moles \times (n - factor)$

$\therefore n = 2$

$formula = A_2O_2$

$Empirical\ formula = AO$

29. ABCD

Sol. ABCD

I=Trans form but both methyl on equational position

IV=III=cis form one methyl on axial position and one on equational position

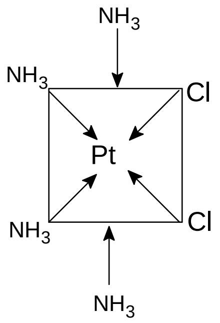
II=Trans form but both methyl on axial position

30. AB

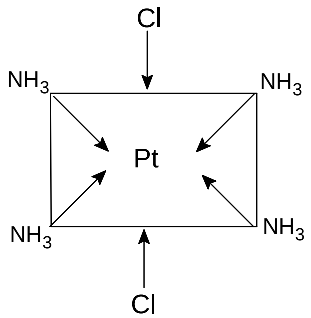
Sol. In hyper conjugation σ electron interact with vacant orbital.

31. ACD

Sol. (A)



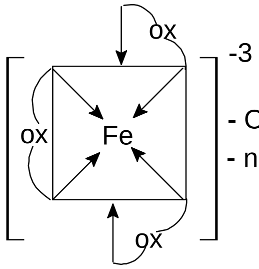
cis



trans

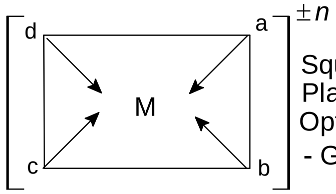
Plane of symmetry optically in active Plane of symmetry optically in active

(B)



- Optically active
- no geometrical isomerism

(C)



Square planer

Plane of symmetry

Optically inactive

- GI occurs

(D) If ligand is optically active then complex is optically active.

32. D

Sol. In polymerisation isomerism; ratio of metal and different ligand should be same.

33. B

SECTION – C

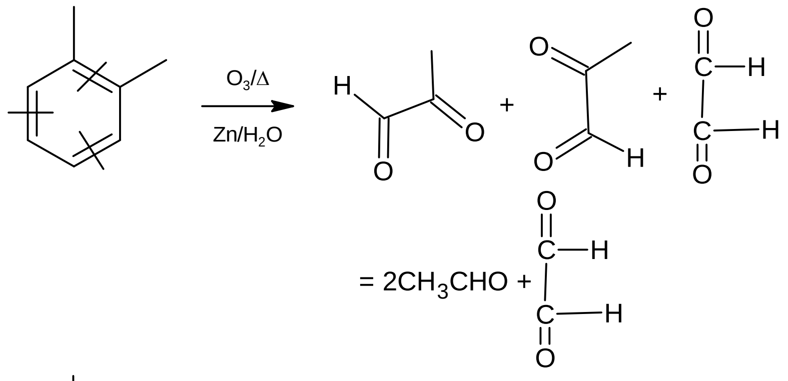
34. 8

Sol. $[PtCl_2(NH_3)_4][PtCl_2(SCN)_4]$ c

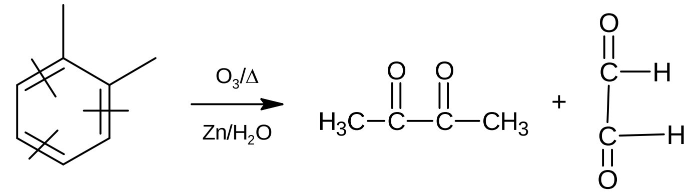
$$\begin{array}{l}\left[PtCl\left(SCN\right)\left(NH_3\right)\right]\left[PtCl\left(SCN\right)_3\right]\\ \qquad\quad\downarrow\\ \qquad\quad ambidentate\ ligand\\ \qquad\quad so\ two\ isomer\ possible\\ Total\ \left(SCN^-\right) ligand = 4\\ Total\ isomer = 4\times 2 = 8\end{array}$$

35. 3

Sol.

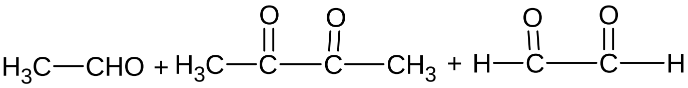


O$_3$/Δ
Zn/H$_2$O
H
O
O
+
O
O
H
+
O
C—H
C—H
O
= 2CH$_3$CHO +
O
C—H
C—H
O



O$_3$/Δ
Zn/H$_2$O
O O
H$_3$C–C—C—CH$_3$
+
O
C—H
C—H
O

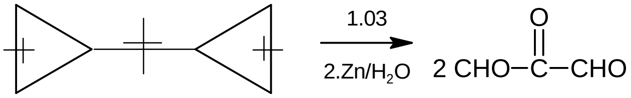
So, no. of different pdt are



$$H_3C—CHO + H_3C—\overset{\overset{\displaystyle O}{\|}}{C}—\overset{\overset{\displaystyle O}{\|}}{C}—CH_3 + H—\overset{\overset{\displaystyle O}{\|}}{C}—\overset{\overset{\displaystyle O}{\|}}{C}—H$$

36. 3

Sol.



1.03
2.Zn/H$_2$O
2 CHO–C–CHO
O

(X)

No. of π bond = 3

37. 6

Sol.

$$\left.\begin{array}{ccc}10 & \to & 4\\ 9 & \to & 4\\ 8 & \to & 4\\ 7 & \to & 4\\ 6 & \to & 4\\ 5 & \to & 4\end{array}\right\} Total\ 6\ spectral\ lines$$

38. 2

Sol. $\Delta T_f = K_f m = k_f \times \dfrac{15/m}{100} \times 1000$

$1 = k_f \times \frac{15}{m} \times 10 \quad ---(1)$

$if\ mass\ of\ solute = 30g$

$\Delta T_f = K_f \times \frac{30/m}{100} \times 1000$

$= 2 \times k_f \times \frac{15}{m} \times 100$

$= 2 \times 1 = 2$

39. 4

Sol. $HA + NaOH \rightarrow NaA + H_2O;\ \Delta H = -6900\,cal/eg$

$HB + NaOH \rightarrow NaB + H_2O;\ \Delta H = -2900\,cal/eg$

Let x eq of NaOH react with HA and y eg NaOH react with HB

$x + y = 1$

$-6900x(x) - 2900 \times y = -3900$

$\therefore x = 1/4$

$y = 3/4$

$x : y = 1 : 3$

$x + y = 1 + 3 = 4$

40. 1

Sol. SO_4^{-2} ion is present in solution; no electrolysis of SO_4^{-2}

[SO_4^{-2}]=0.1 M

Decimolar concentration of $SO_4^{-2} = 1$

41. 6

Sol. $\frac{r_{Mg^{+2}}}{r_{S^{-2}}} = \frac{0.65}{1.84} = 0.35$

Co-ordination no.=4

$\frac{r_{Mg^{+2}}}{r_{O^{-2}}} = \frac{0.65}{1.4} = 0.464$

Co-ordination no.=6

$\frac{r_{Cs^{+}}}{r_{Cs^{-}}} = \frac{1.69}{1.81} = 0.933$

Co-ordination no.=8

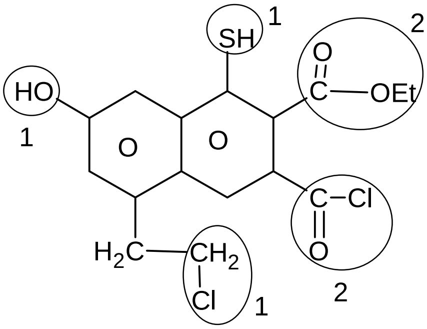
	$Co-ordination\ no.$
$0.225 < \frac{r+}{r-} < 0.414$	4
$0.414 < \frac{r+}{r-} < 0.732$	6
$0.732 < \frac{r+}{r-} < 1$	8

42. 7

Sol. a, c, d, g, j, l, m

43. 7

Sol.



SECTION – D

44. 00002.68

Sol. $Density = \dfrac{Z \times M}{N_A \times a^3}$

$a^3 = \dfrac{Z \times M}{N_A \times d}$

$Dis\tan ce\, between\ K^+\ and\ F^- = \dfrac{a}{2}$

45. 00040.00

Sol. Rate after 10 minutes = $\dfrac{-(6-8)}{10} = \dfrac{2}{8}$

Rate after 20 minutes = $\dfrac{-(4-6)}{10} = \dfrac{2}{8}$

Reaction of 1st order

$A_t = A_o - kt$

$0 = 8 - k \times t$

t = $\dfrac{8}{k}$

$6 = 8 - k \times 10$

$\therefore\ k = \dfrac{2}{10}$

t = $\dfrac{8}{k}$ = $\dfrac{8}{\frac{2}{10}} = 40$ min

46. 00000.11

Sol. no of equivalent of Al = $\dfrac{0.5 \times 40 \times 60}{96500}$

No of moles of Al = $\dfrac{0.5 \times 40 \times 60}{96500} \times \dfrac{1}{3}$

Mass of Al deposited = $\dfrac{0.5 \times 40 \times 60}{96500} \times \dfrac{27}{3} = 0.11\,g$

Mathematics PART – III

SECTION – A

47. A

Sol. $A = \frac{1}{16}\left(1 + \frac{1}{4} + \frac{1}{4^2} + ...\right) = \frac{\frac{1}{16}}{1 - \frac{1}{4}} = \frac{1}{12}$ sq. unit

48. C

Sol. Area of required region is half of the area of circle.

49. C

Sol. $x = 1 + h, \qquad h \to 0$

$$\lim_{h\to 0} \frac{\left(\log(2+h) - \log 2\right)\left(3.4^h - 3 - 3h\right)}{\left((8+h)^{\frac{1}{3}} - (4+3h)^{\frac{1}{2}}\right)(-\sin \pi h)}$$

$$\lim_{h\to 0} \frac{3\left(\frac{\frac{1}{2}\log\left(1 + \frac{h}{2}\right)}{\frac{4}{2}}\right)\left(\frac{4^h - 1}{h} - 1\right)}{\left\{\frac{(8+h)^{\frac{1}{3}} - 8^{\frac{1}{3}}}{h} - \frac{3(4+3h)^{\frac{1}{2}} - 4^{\frac{1}{2}}}{3h}\right\}\left\{-\pi \frac{\sin \pi h}{\pi h}\right\}}$$

$$= \frac{3 \times \frac{1}{2} \times (\log 4 - 1)}{\left(\frac{1}{3}.\frac{1}{4} - 3 \times \frac{1}{2} \times \frac{1}{2}\right)(-\pi)} = \frac{\frac{3}{2}(\log 4 - 1)}{4\frac{\pi}{3}}$$

$$= \frac{9}{4\pi}(\log 4 - 1)$$

50. C

Sol. $\vec{r} - \vec{c} \parallel \vec{b} \Rightarrow \vec{r} = \vec{c} + \lambda\vec{b}$

$\vec{r}.\vec{a} = 0 \Rightarrow \lambda = -\frac{\vec{a}.\vec{c}}{\vec{a}.\vec{b}} = \frac{-(8+7)}{2+0+1} = -5$

$\vec{r} = \vec{c} + \lambda\vec{b} = \left(4\hat{i} - 3\hat{j} + 7\hat{k}\right) - 5\left(\hat{i} + \hat{j} + \hat{k}\right)$

$\vec{r} = -\hat{i} - 8\hat{j} + 2\hat{k}$

$\therefore x + y + z = -7$

51. C

Sol. $\tan\omega = \pm\left|\frac{m_1 - m_2}{1 + m_1 m_2}\right| = \pm\left|\frac{a}{b}\frac{\left(\tan\theta + \frac{1}{\tan\theta}\right)}{1 - \frac{a^2}{b^2}}\right|$

$$\cot\theta = \pm\frac{\left(a^2 - b^2\right)\sin\theta.\cos\theta}{a.b}$$

$$\therefore \frac{2\cot\theta}{\sin 2\theta} = \pm\frac{\left(a^2 - b^2\right)}{a^2}\left(\frac{a}{b}\right) = \pm\frac{e^2}{\sqrt{1-e^2}}$$

52. A

Sol. The line x – y + a = 0 tangent at P. then $\left|PR - PQ\right|$ will be maximum $\left(= RQ\right)$

53. ACD

Sol. focus $\left(6, -3\right)$ and equation of tangent at vertex is $5x + 3y = 15$.

$$\therefore \text{Length of latus rectum} = 4\frac{\left|30-9-15\right|}{\sqrt{34}} = \frac{24}{\sqrt{34}}$$

54. BD

Sol. As $x \to \frac{\pi}{2}^{-}$, $\left(\cot x \text{ is positive } \left(\text{being in I quadrant}\right)\right)$

thus $\left[\cot x\right] = 0$ $\lim\limits_{x\to\frac{\pi}{2}^{-}} f\left(x\right) = e^0 = 1$

$f\left(x\right) = e^{\left[\cot x\right]}$as $\cot x$ is negative in 2nd quadrant

and $\cot\frac{\pi}{2} = 0 \Rightarrow \left[\cot x\right] = -1$

$$\lim_{x\to\frac{\pi}{2}^{+}} f\left(x\right) = \frac{1}{e}$$

55. C

Sol. $A \ge G \Rightarrow \dfrac{\cot\frac{A}{2} + \cot\frac{C}{2}}{2} = \cot\frac{B}{2} \ge \sqrt{3}$

$\cot\frac{B}{2} \ge \sqrt{3}$

56. C

Sol. $\tan\frac{B}{2} \le \frac{1}{\sqrt{3}} \Rightarrow B \le \frac{\pi}{3}$

SECTION – C

57. 1

Sol. Ellipse in internally tangent to the circle at point of intersection.

58. 6

Sol. Let $\left(x + \frac{1}{x}\right)^3 = a$ and $x^3 + \frac{1}{x^3} = b$

$$f\left(x\right) = \left|\frac{a^2 - b^2}{a + b}\right| = \left|a - b\right| = \left|\left(x + \frac{1}{x}\right)^3 - x^3 - \frac{1}{x^3}\right|$$

$$= 3\left|x + \frac{1}{x}\right| \ge 6.$$

59. 0

Sol. use property

60. 4

Sol. $H = xy = c^2, S \equiv (x-\lambda)^2 + (y-\beta)^2 = r^2$ let $P\left(ct, \frac{c}{t}\right)$

$$S_1 = t_1^2 + t_2^2 + t_3^2 + t_4^2 = 2\frac{(\alpha^2 - \beta^2 + \gamma^2)}{c^2}$$

$$S_2 = \frac{1}{t_1^2} + \frac{1}{t_2^2} + \frac{1}{t_3^2} + \frac{1}{t_4^2} = 2\frac{(\beta^2 - \alpha^2 + \gamma^2)}{c^2}$$

$$\lambda = \frac{c^2}{r^2}(S_1 + S_2) = \frac{c^2}{r^2} \times \frac{4r^2}{c^2}$$

61. 5

Sol. Let y = cotx; $3y^2 + 8y + 3 = 0$, y_1, y_2 be roots

$$y_1 + y_2 = -\frac{8}{3}, y_1y_2 = 1$$

$y = \cot x$ is a bijection on $(0, \pi) \to R$

and also $(\pi, 2\pi) \to R$

$\cot x < 0$ when $x \in \left(\frac{\pi}{2}, \pi\right) \cup \left(\frac{3\pi}{2}, 2\pi\right)$

$$\therefore x_1, x_2 \in \left(\frac{\pi}{2}, \pi\right) \& (x_3, x_4) \in \left(\frac{3\pi}{2}, 2\pi\right)$$

$$y_1 = \cot x_1 = \cot x_3, y_2 = \cot x_2 = \cot x_4$$

$$y_1y_2 = 1 \Rightarrow \cot x_1 \cot x_2 = \cot x_3 . \cot x_4 = 1$$

$$\therefore x_1 + x_2 + x_3 + x_4 = 5\pi$$

62. 3

Sol. $B = \text{adj}(2A) \Rightarrow |B| = |2A|^{n-1}$

$$1024 = 4^{n-1} \times 2^{n(n-1)}$$

$$2^{10} = 2^{n^2+n-2}$$

$$n = 3$$

63. 6

Sol. Let (h, k) lies on hyperbola

$$\frac{h - x_1}{2} = \frac{k - y_1}{-1} = \frac{2(2h-k)}{5} \Rightarrow hk = 1$$

$$12x^2 - 7xy - 12y^2 + 25 = 0.$$

64. 5

Sol. Use Homogenization.

65. 3

Sol. Properties of G.I.F.

66. 0
Sol. Use L.M.V.T

SECTION – D

67. 02008.00

Sol. $t_n = \sum t_n - \sum t_{n-1}$

68. 01008.00
Sol. Use fundamental principle of counting.

69. 01210.00
Sol. (AM > GM)

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – III

JEE (Main)-2019

Time Allotted: 3 Hours **Maximum Marks: 360**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only one section: **Section-A**.

  Section-A (01 – 30, 31 – 60, 61 – 90) *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics PART – I

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A cyclist is moving with a speed of 6 ms^{-1}. As he approaches a circular turn on the road of radius 120 m, he applies brakes and reduces his speed at a constant rate of 0.4 ms^{-2}. The magnitude of the net acceleration of the cyclist on the circular turn just after brakes is
(A) 0.5 ms^{-2} (B) 1.0 ms^{-2}
(C) 2.0 ms^{-2} (D) 4.0 ms^{-2}

2. A force $\vec{F} = (3\hat{i} + 4\hat{j})$ Newton acts on a particle moving along a line 4y + kx = 3. The work done by the force is zero if the value of k is
(A) 1 (B) 2
(C) 3 (D) 4

3. Moment of inertia of uniform horizontal solid cylinder of mass M about an axis passing through its edge and perpendicular to the axis of the cylinder when its length is 6 times its radius R is
(A) $\frac{39MR^2}{4}$ (B) $\frac{39MR}{4}$
(C) $\frac{49MR}{4}$ (D) $\frac{49MR^2}{4}$

4. How many significant figures should be written in the sum 4.56g+9.032g+580.0078g+540.439g ?
(A) 3 (B) 4
(C) 5 (D) 6

5. A ball is thrown into the air and follows a parabolic trajectory. At the highest point in the trajectory
(A) the velocity is zero, but the acceleration is not zero
(B) both the velocity and the acceleration are zero
(C) the acceleration is zero, but the velocity is not zero
(D) neither the acceleration nor the velocity are zero

Space for Rough work

6. A thin string that can support a weight of 35.0 N, but breaks under any larger weight, is attached to the ceiling of an elevator. How large a mass can be attached to the string if the initial acceleration as the elevator starts to ascend is 3.20 m/s^2 ?

(A) 3.57 kg (B) 2.69 kg
(C) 2.96 kg (D) 5.30 kg

7. The potential energy (in joule) of a body of mass 2 kg moving in the x-y plane is given by U = 6x + 8y where the position coordinates x and y are measured in metre. If the body is at rest at point (6 m, 4m) at time t = 0, it will cross the y-axis at time t equal to

(A) 1 s (B) 2 s
(C) 3 s (D) 4 s

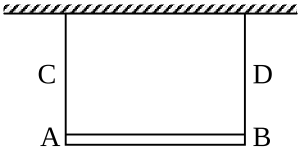
8. A shell is fired from a fixed cannon with a velocity 'v' at an angle θ with the horizontal direction. At the highest point on its path, it explodes into two pieces of equal mass. One of the pieces retraces its path to the cannon. The speed of the other piece immediately after the explosion is

(A) 3 v cos θ (B) 2 v cos θ
(C) $\frac{3}{2}$ v cos θ (D) $\sqrt{\frac{3}{2}}$ v cos θ

9. A body of mass *m* is projected with a velocity *u* at an angle of 60º with the horizontal. The magnitude of the angular momentum about the point of projection when the body is at the highest point of its trajectory is

(A) $\frac{mu^3}{2g}$ (B) $\frac{2mu^3}{5g}$
(C) $\frac{3mu^3}{16g}$ (D) $\frac{mu^3}{4g}$

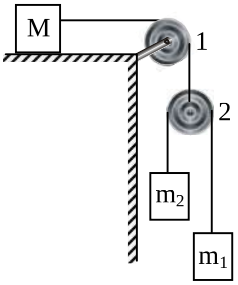
10. A uniform rod AB of mass m and length L is suspended by two strings C and D of negligible mass as shown in the figure. When string D is cut, the tension in string C will be



(A) $\frac{mg}{4}$ (B) mg
(C) 2 mg (D) 4 mg

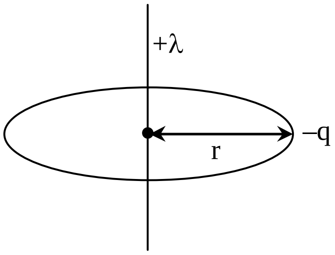
Space for Rough work

11. In the arrangements shown in figure m_1 = 1kg, m_2 = 2 kg. Pulleys are massless and strings are light. For what value of M the mass m_1 moves with constant velocity (neglect friction)



(A) 6 kg (B) 4 kg
(C) 8 kg (D) 10 kg

12. A particle of charge –q and mass m moves in a circle of radius *r* around an infinitely long line charge of linear charge density +λ. Then time period will be – (where $k = \frac{1}{4\pi \in_0}$)



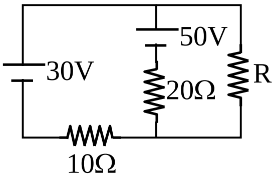
(A) $T = 2\pi r\sqrt{\frac{m}{2k\lambda q}}$

(B) $T^2 = \frac{4\pi^2 m}{2k\lambda q} r^3$

(C) $T = \frac{1}{2\pi r}\sqrt{\frac{2k\lambda q}{m}}$

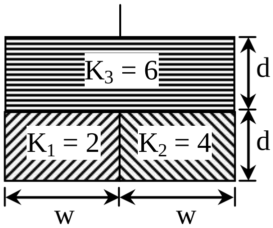
(D) $T = \frac{1}{2\pi r}\sqrt{\frac{m}{2k\lambda q}}$

13. In the circuit shown, the value of R in ohm that will result in no current through the 30 V battery, is



(A) 10Ω (B) 25Ω
(C) 30Ω (D) 40Ω

14. A parallel plate capacitor of capacitance C (without dielectrics) is filled by dielectric slabs as shown in figure. Then the new capacitance of the capacitor is



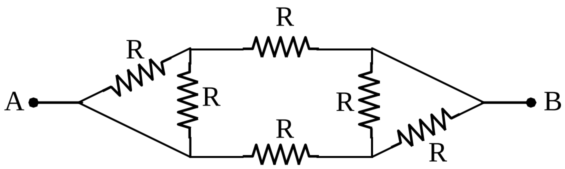
(A) 3.9 C (B) 4 C
(C) 2 C (D) 3 C

Space for Rough work

15. An LCR series circuit with 100Ω resistance is connected to an AC source of 200 V and angular frequency 300 radians per second. When only the capacitance is removed, the current lags behind the voltage by 60º. When only the inductance is removed, the current leads the voltage by 60º. Then the current and power dissipated in LCR circuit are respectively
(A) 1A, 200 watt (B) 1A, 400 watt
(C) 2A, 200 watt (D) 2A, 400 watt

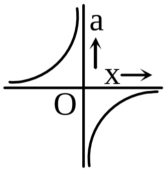
16. A wire of length λ is bent in the form of a circular coil of some turns. A current 'i' flow through the coil. The coil is placed in a uniform magnetic field B. The maximum torque on the coil can be
(A) $\frac{iB\ell^2}{4\pi}$ (B) $\frac{iB\ell^2}{\pi}$
(C) $\frac{iB\ell^2}{2\pi}$ (D) $\frac{2iB\ell^2}{\pi}$

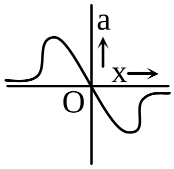
17. Equivalent resistance between A and B is

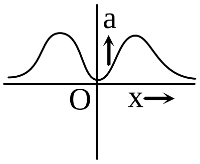


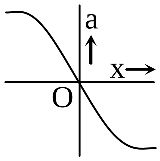
(A) $\frac{3}{4}$R
(B) $\frac{5}{3}$R
(C) $\frac{7}{5}$R
(D) R

18. Two identical positive charges are fixed on the y-axis, at equal distances from the origin O. A particle with a negative charge starts on the negative x-axis at a large distance from O, moves along the x-axis, passed through O and moves far away from O. Its acceleration *a* is taken as positive along its direction of motion. The particle's acceleration *a* is plotted against its x-co-ordinate. Which of the following best represents the plot ?

(A)


(B)


(C)


(D)


Space for Rough work

19. A charged particle is projected with velocity v_0 along positive x-axis. The magnetic field B is directed along negative z-axis between x = 0 and x = L. The particle emerges out (at x = L) at an angle of 60° with the direction of projection. Find the velocity with which the same particle were projected (at x = 0) along positive x-axis so that when it emerges out (at x = L), the angle made by it is 30° with the direction of projection

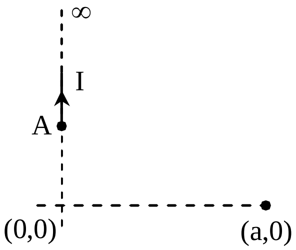
(A) $2v_0$

(B) $\frac{v_0}{2}$

(C) $\frac{v_0}{\sqrt{3}}$

(D) $v_0\sqrt{3}$

20. An infinitely long wire carrying current I is along Y-axis such that its one end is at point A(0, b) while the wire extends upto +∞. The magnitude of magnetic field strength at point (a, 0)



(A) $\frac{\mu_0 I}{4\pi a}\left(1+\frac{b}{\sqrt{a^2+b^2}}\right)$

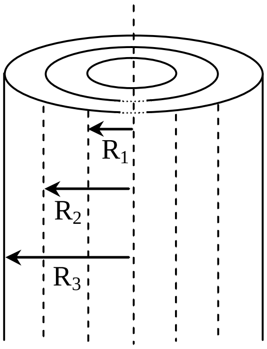
(B) $\frac{\mu_0 I}{4\pi a}\left(1-\frac{b}{\sqrt{a^2+b^2}}\right)$

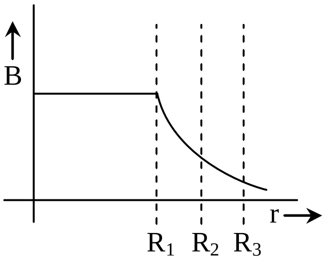
(C) $\frac{\mu_0 I}{4\pi a}\left(\frac{b}{\sqrt{a^2+b^2}}\right)$

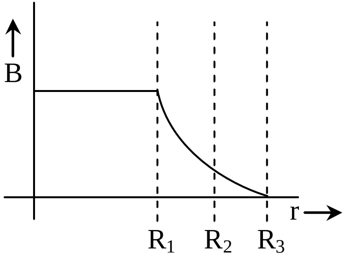
(D) None of these

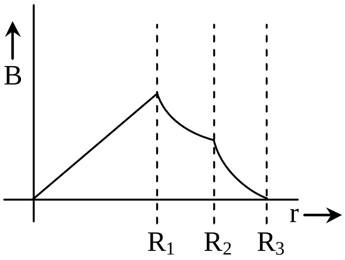
Space for Rough work

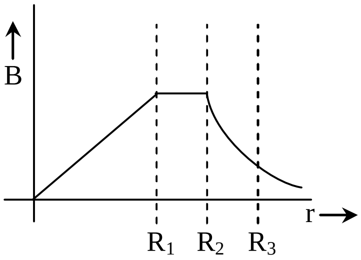
21. A coaxial cable is made up of two conductors. The inner conductor is solid and is of radius R_1 and the outer conductor is hollow of inner radius R_2 and outer radius R_3. The space between the conductors is filled with air. The inner and outer conductors are carrying currents of equal magnitudes and in opposite directions. Then the variation of magnetic field with distance from the axis is best plotted as



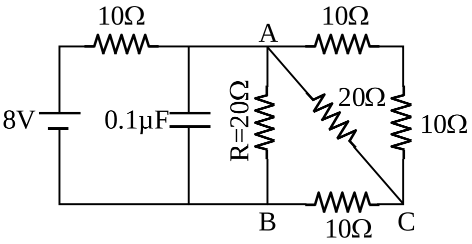
(A)


(B)


(C)


(D)


22. A capacitor of capacitance 0.1 µF is connected to a battery of emf 8V as shown in the figure. Under steady state condition



(A) Charge on the capacitor is 0.4 µC
(B) Charge on the capacitor is 0.2 µC
(C) Current in the resistor (R) between points A and B is 0.1 A
(D) Current in the resistor (R) between points A and B is 0.4 A

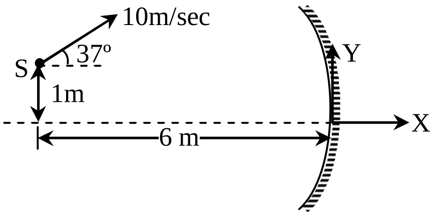
Space for Rough work

23. In a sample of a radioactive substance what fraction of the initial number of nuclei will remain undecayed after time t=$\frac{T}{2}$, where T = half-life of radioactive substance

(A) $\frac{1}{\sqrt{2}}$ (B) $\frac{1}{2\sqrt{2}}$

(C) $\frac{1}{4}$ (D) $\frac{1}{\sqrt{2}-1}$

24. A point source S is moving with a speed of 10 m/sec in x-y plane as shown. The radius of curvature of concave mirror is 4m. What will be velocity vector of image formed by paraxial rays



(A) $-2\hat{i}-6\hat{j}$

(B) $-2\hat{i}-4\hat{j}$

(C) $-2\hat{i}-8\hat{j}$

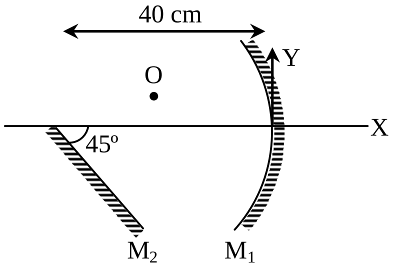
(D) $2\hat{i}-4\hat{j}$

25. Magnetic field at the centre (at Nucleus) of the hydrogen like atoms (atomic No. Z) due to motion of electron in nth orbit is proportional to

(A) $\frac{n^3}{Z^5}$ (B) $\frac{n^4}{Z}$

(C) $\frac{Z^2}{n^3}$ (D) $\frac{Z^3}{n^5}$

26. As shown in figure an object "O" is at the position (–10, 2) with respect to origin "P". The concave mirror M$_1$ has radius of curvature 30 cm. A place mirror M$_2$ is kept at a distance of 40 cm in front of concave mirror. Considering first reflection at concave mirror M$_1$ and second through plane mirror M$_2$. Find the co-ordinates of second image w.r.t. origin P

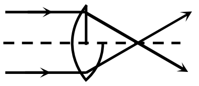


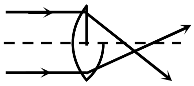
(A) –40, –70 (B) –52, –70

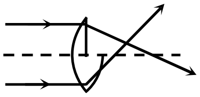
(C) – 46, –70 (D) –52, – 60

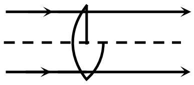
Space for Rough work

27. Choose the correct ray diagram of a thin equi-convex lens which is cut as shown in the figure.

(A) 

(B) 

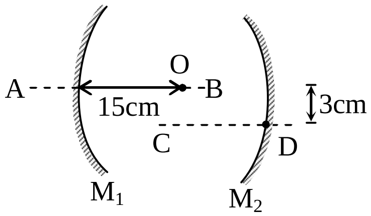
(C) 

(D) 

28. A radioactive isotope is being produced at a constant rate X. Half life of the radioactive substance is Y. After some time the number of radioactive nuclei constant. The value of the constant is

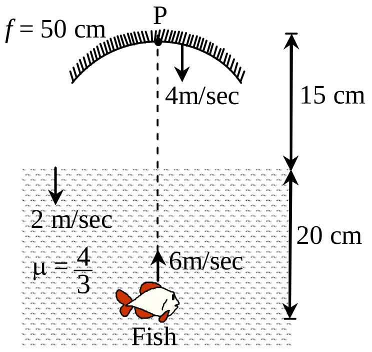
(A) $\frac{XY}{\ell n(2)}$
(B) XY
(C) XY ℓ n(2)
(D) $\frac{X}{Y}$

29. In the shown figure M_1 and M_2 are two concave mirrors of same focal length 10 cm. AB and CD are their principal axis respectively. A point object O is kept on the line AB at a distance 15 cm from M_1. The distance between the mirrors is 20 cm. Considering two successive reflections first on M_1 and then on M_2. The distance of final image from the line AB is



(A) 3 cm
(B) 1.5 cm
(C) 4.5 cm
(D) 1 cm

30. In the figure shown a concave mirror of focal length 50 cm is made to move downward with constant velocity of 4 m/sec. The level of water having μ = $\frac{4}{3}$ in also falling downward at speed of 2 m/sec. Inside the water the fish is moving upward with speed of 6 m/sec and is lying along principal axis of concave mirror. Find out the speed of image of fish which is formed after reflection through concave mirror at the instant shown



(A) 36 m/sec downward
(B) 54 m/sec downward
(C) 18 m/sec downward
(D) none of these

Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. A definite amount of solid NH_4HS is placed in a flask already containing ammonia gas at a certain temperature and 0.50 atm pressure. NH_4HS decomposes to give NH_3 and H_2S and at equilibrium total pressure in flask is 0.84 atm. The equilibrium constant for the reaction is :
(A) 0.30 (B) 0.18
(C) 0.17 (D) 0.11

32. $Mg_2C_3 + H_2O \longrightarrow X$ (organic compound). Compound X is
(A) C_2H_2 (B) CH_4
(C) propyne (D) ethene

33. $BeCl_2 + LiAlH_4 \longrightarrow X + LiCl + AlCl_3$
(A) X is LiH (B) X is BeH_2
(C) X is $BeCl_2 \cdot 2H_2O$ (D) None

34. 1 cc of 0.1 N HCl is added to 99 cc solution of NaCl. The pH of the resulting solution will be
(A) 7 (B) 3
(C) 4 (D) 1

35. 10 ml of $\frac{M}{200}$ H_2SO_4 is mixed with 40 ml of $\frac{M}{200}$ H_2SO_4. The pH of the resulting solution is
(A) 1 (B) 2
(C) 2.3 (D) none of these

36. The incorrect statement(s) is/are
(A) Mg cannot form complexes
(B) Be can form complexes due to a very small atomic size
(C) the first ionisation potential of Be is higher than that of Mg
(D) Mg forms an alkaline hydroxide while Be forms amphoteric oxides

Space for Rough work

37. $MgBr_2$ and MgI_2 are soluble in acetone because of
(A) Their ionic nature (B) Their coordinate nature
(C) Their metallic nature (D) Their covalent nature

38. aq. NaOH + P_4 (white) $\longrightarrow PH_3$ + X; compound X is
(A) NaH_2PO_2 (B) $NaHPO_4$
(C) Na_2CO_3 (D) $NaHCO_3$

39. $H_3BO_3 \xrightarrow{T_1} X \xrightarrow{T_2} Y \xrightarrow{\text{red hot}} B_2O_3$ if $T_1 < T_2$ then X and Y respectively are
(A) X = Metaboric acid and Y = Tetraboric acid
(B) X = Tetraboric acid and Y = Metaboric acid
(C) X = Borax and Y = Metaboric acid
(D) X = Tetraboric acid and Y = Borax

40. $RCl \xrightarrow[Si]{cu-powder} R_2SiCl_2 \xrightarrow{H_2O} R_2Si(OH)_2 \xrightarrow{\text{condensation}} A$
Compound (A) is
(A) a linear silicone (B) a chlorosilane
(C) a linear silane (D) a network silane

41. The initial rate of zero order reaction of the gaseous reaction A(g) $\longrightarrow$ 2B(g) is 10^{-2} M min^{-1}. If the initial concentration of A is 0.1 M, what would be the concentration of B after 60 sec.?
(A) 0.09 M (B) 0.01 M
(C) 0.02 M (D) 0.002 M

42. The vapour density of N_2O_4 at a certain temperature is 30. What is the % dissociation of N_2O_4 at this temperature?
(A) 53.3% (B) 106.6%
(C) 26.7% (D) None

43. For the reaction : 2HI(g) $\rightleftharpoons$ H_2(g) + I_2(g), the degree of dissociated (a) of HI(g) is related to equilibrium constant K_p by the expression
(A) $\frac{1+2\sqrt{K_p}}{2}$ (B) $\sqrt{\frac{1+2K_p}{2}}$
(C) $\sqrt{\frac{2K_p}{1+2K_p}}$ (D) $\frac{2\sqrt{K_p}}{1+2\sqrt{K_p}}$

Space for Rough work

44. Solution of sodium metal in liquid ammonia is a strong reducing agent due to presence of
(A) solvated sodium ions
(B) solvated hydrogen ions
(C) sodium atoms or sodium hydroxide
(D) solvated electrons

45. The solubility of anhydrous $AlCl_3$ and hydrous $AlCl_3$ in diethyl ether are S_1 and S_2 respectively. Then
(A) $S_1 = S_2$
(B) $S_1 > S_2$
(C) $S_1 < S_2$
(D) $S_1 < S_1$ but not $S_1 = S_2$

46. For the reaction $A + B \longrightarrow C$; starting with different initial concentration of A and B, initial rate of reaction were determined graphically in four experiments.

S.No.	$[A]_0$/M (Initial conc.)	$[B]_0$/M (Initial conc.)	rate/(M sec^{-1})
1	1.6×10^{-3}	5×10^{-2}	10^{-3}
2	3.2×10^{-3}	5×10^{-2}	4×10^{-3}
3	1.6×10^{-3}	10^{-1}	2×10^{-3}
4	3.2×10^{-3}	10^{-1}	8×10^{-3}

Rate law for reaction from above data is
(A) $r = k[A]^2 [B]^2$
(B) $r = k[A]^2 [B]$
(C) $r = k[A] [B]^2$
(D) $r = k[A] [B]$

47. The compound which contains ionic as well as covalent bonds is
(A) $C_2H_4Cl_2$
(B) CH_3I
(C) KCN
(D) H_2O_2

48. The hybridisation and shape of BrF_3 molecule are :
(A) sp^3d and bent T shape
(B) sp^2d^2 and tetragonal
(C) sp^3d and bent
(D) none of these

49. The correct order of decreasing bond angle is :
(A) $H_2O > Cl_2O > F_2O$
(B) $Cl_2O > H_2O > F_2O$
(C) $F_2O > Cl_2O > H_2O$
(D) $F_2O > H_2O > Cl_2O$

50. The electron affinity of the members of oxygen family of the periodic table, follows the sequence
(A) O > S > Se
(B) S > O < Se
(C) O < S > Se
(D) Se > O > S

Space for Rough work

51. The correct order of atomic / ionic size

(A) N < Li < B
(B) Cl < Mg < Ca
(C) $Ca^{+2} < S^{-2} < Cl^{-}$
(D) $Na^{+} < Mg^{+2} < Cl^{-}$

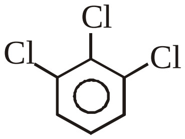
52. If radius of second stationary orbit (in Bohr's atom) is R. Then radius of third orbit will be

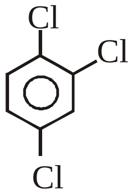
(A) R/3
(B) 9R
(C) R/9
(D) 2.25R

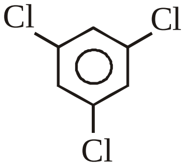
53. The shortest wavelength of He^{+} ion in Balmer series is x, then longest wavelength in the Paschen series of Li^{+2} is

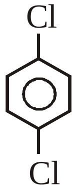
(A) $\frac{36x}{5}$
(B) $\frac{16x}{7}$
(C) $\frac{9x}{5}$
(D) $\frac{5x}{9}$

54. Which has maximum dipole moment.

(A) 

(B) 

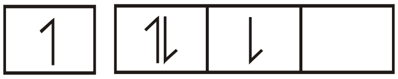
(C) 

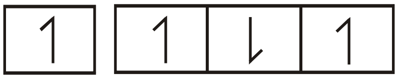
(D) 

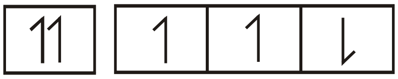
55. The correct order in which the O—O bond length increases in the following :

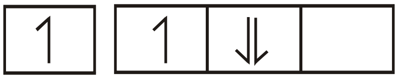
(A) $H_2O_2 < O_2 < O_3$
(B) $O_3 < H_2O_2 < O_2$
(C) $O_2 < H_2O_2 < O_3$
(D) $O_2 < O_3 < H_2O_2$

56. Which among the following orbital diagram violates Pauli's exclusion principle, Hund's rule as well as Aufbau's rule :

(A) 

(B) 

(C) 

(D) 

Space for Rough work

57. The increasing order of acidic nature of Li_2O, BeO, B_2O_3

(A) Li_2O > BeO < B_2O_3
(B) Li_2O < BeO < B_2O_3
(C) Li_2O < BeO > B_2O_3
(D) Li_2O > BeO > B_2O_3

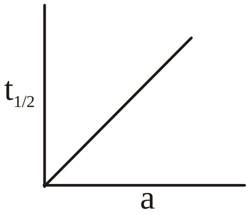
58. Order of hydration energy

(A) $Na^+ = Mg^{2+} = Al^{3+}$
(B) $Na^+ > Mg^{2+} > Al^{3+}$
(C) $Al^{+3} > Mg^{2+} > Na^+$
(D) $Al^{+3} > Mg^{2+} < Na^+$

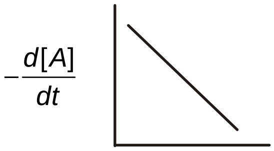
59. For the reaction : CO(g) + $\frac{1}{2}$ O_2(g) l CO_2(g), K_p/K_c is :

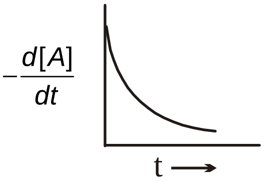
(A) RT
(B) $(RT)^{-1}$
(C) $(RT)^{-1/2}$
(D) $(RT)^{1/2}$

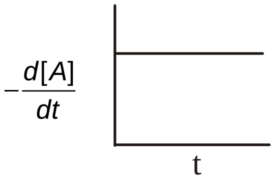
60. Consider the reaction A $\longrightarrow$ B, graph between half life ($t_{1/2}$) and initial concentration (a) of the reactant is

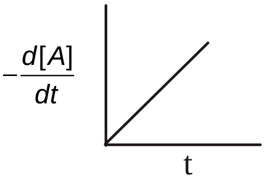


Hence graph between $-\frac{d[A]}{dt}$ and time will be

(A)


(B)


(C)


(D)


Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

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61. Let $f(x) = (x-1)^{100}.(x-2)^{2(99)}.(x-3)^{3(98)}......(x-100)^{100}$. The value of $\frac{f'(101)}{f(101)}$ will be

(A) 5051 (B) 5050
(C) 5049 (D) 0

62. Let F(x) be a polynomial function of degree 2018 and leading coefficient unity such that F(0) = 2017, F(a) = 2016, F(b) = 2015, ...F(2017) = 0. The value of F(2018) is of the form n! – a, where n, a $\in$ N and a is least possible value, then n + a is equal to

(A) 2016 (B) 2017
(C) 2019 (D) 2021

63. If ω is a complex cube root of unity and
$f(n) = 2(1+\omega)(1+\omega^2) + 3(2+\omega)(2+\omega^2) + ...(n+1)(n+\omega)(n+\omega^2)$, then the value of $f(19)$ is

(A) 36150 (B) 36100
(C) 36101 (D) 36119

64. Let z $\in$ C satisfy the equation $\left|z^2\right| + 2\left(z+\bar{z}\right) - 5 = 0$, then the complex number z + 3 + 2i will lie on

(A) circle with center 1 – 2i and radius 3 (B) circle with center 3 – 2i and radius 4
(C) circle with center 1 + 2i and radius 3 (D) circle with center 3 + 2i and radius 4

65. Let $f(x)$ be a derivable function defined over the set of real numbers such that $f(f(x)) = \lambda(x^7 + 2x)$, $\lambda \neq 0$, then $\forall$ x $\in$ R, $f(x)$ is always

(A) Increasing (B) Decreasing
(C) Non monotonic (D) Either increasing or decreasing

66. Consider 12 face diagonals of a cubical block. How many pairs of them are skew lines?

(A) 30 (B) 15
(C) 45 (D) 60

Space for Rough work

67. Logical equivalent of $p \rightarrow (p \vee q)$ is

(A) $\sim p \wedge \sim q$ (B) $\sim p \rightarrow (p \wedge q)$

(C) $q \rightarrow (p \rightarrow q)$ (D) $p \rightarrow \sim q$

68. For 200 observations of a specific set of data, the mean was found to be 48 and the standard deviation is 3. Sum of squares of these 200 observations will be

(A) 462000 (B) 462600

(C) 482600 (D) 462800

69. Number of values of x for which $\cos^{-1}x + \cot^{-1}2x = -\pi/2$ is

(A) 4 (B) 2

(C) 1 (D) 0

70. If $A = \begin{bmatrix} x & y & z \\ y & z & x \\ z & x & y \end{bmatrix}$; $AA^T = I$, xyz = 1 and tr.(A) > 0, then the value of $x^3 + y^3 + z^3$ is

(where A^T, tr.(A) denotes transpose of square matrix A and sum of elements of principal diagonal of matrix A, and I is identity matrix of order 3)

(A) 3xyz (B) x + y + z

(C) 0 (D) 4

71. Least positive integral value of x for which $x^2 - 4x > \cot^{-1}x$ is

(A) 1 (B) 2

(C) 5 (D) 6

72. If x + y = k is a tangent to the hyperbola $x^2 - 2y^2 = 18$, then sum of squares of possible values of k is

(A) 3 (B) 9

(C) 12 (D) 18

73. Consider $f(x) = \sin x \ \forall\, x \in \left[0, \frac{\pi}{2}\right]$; $f(x) + f(\pi - x) = 2 \ \forall\, x \in \left(\frac{\pi}{2}, \pi\right]$ and $f(x) = f(2\pi - x) \ \forall\, x \in (\pi, 2\pi)$. If n, m denotes number of points where $f(x)$ is discontinuous and non derivable respectively in $[0, 2\pi)$, then value of n + m is

(A) 0 (B) 1

(C) 2 (D) 4

Space for Rough work

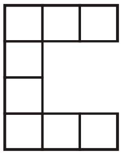
74. Let $f : R \rightarrow R$ and $g : R \rightarrow R$ be two functions such that $f(x) + f''(x) = -x.g(x).f'(x)$ and $g(x) > 0$, $f'(x) > 0 \ \forall x \in R$, then for $h(x) = f^2(x) + (f'(x))^2$
(A) x = 0 is point of maxima
(B) x = 0 is point of minima
(C) h(x) is monotonic increasing at x = 0
(D) h(x) is monotonic decreasing at x = 0

75. If $\alpha + \sin\beta = 2018$; $\alpha + 2018\cos\beta = 2017$, $\beta \in \left(0, \frac{\pi}{2}\right]$, then value of $[\alpha + \beta]$ is
(where [.] denotes greatest integer function)
(A) 2016
(B) 2017
(C) 2018
(D) 2020

76. Common tangents of $9x^2 - 9y^2 = 8$ and $y^2 = 32x$ passes through (a,0), then a is
(A) $\frac{8}{9}$
(B) $-\frac{8}{9}$
(C) $\frac{9}{8}$
(D) $-\frac{9}{8}$

77. For different values of λ, the circle $x^2 + y^2 + (8 + \lambda)x + (8 + \lambda)y + 16 + 12\lambda = 0$ passes through two fixed points A and B. Value of λ for which tangents at A and B to the circle intersect at origin, is
(A) –8
(B) $\frac{8}{3}$
(C) –16
(D) $\frac{16}{3}$

78. Six different letters are arranged in boxes shown in figure. Each box can hold exactly one letter. Number of ways in which letters can be arranged so that none of the rows remain empty, is
(A) 7200
(B) 9600
(C) 10000
(D) 10800



79. A and B alternately throw a pair of die until one of them wins. A is considered winner if he gets a total 7 and B is considered winner, if he gets a total of 5. If A starts the game, then probability that one of the die shows face 3 on the last throw is
(A) $\frac{11}{28}$
(B) $\frac{9}{28}$
(C) $\frac{5}{28}$
(D) $\frac{3}{28}$

Space for Rough work

80. If $n \in N$ and $(1 - 2x + 5x^2 + 10x^3)(1 + x)^n = a_0 + a_1x + a_2x^2 + ...$, and $a_1^2 = 2a_2$, then value of $a_0 + n$ is
(A) 1 (B) 5
(C) 6 (D) 7

81. Let be three non zero, non coplanar vectors and be three vectors given by $\vec{\alpha} = \vec{a} - 4\vec{b} - 2\vec{c}$, $\vec{\beta} = \vec{a} + \vec{b} - 2\vec{c}$, $\vec{\gamma} = 3\vec{a} + 2\vec{b} + \vec{c}$. If V_1 is volume of parallelopiped with coterminous edges and V_2 is volume of tetrahedron with coterminous edges $\vec{a}, \vec{b}, \vec{c}$, then $\frac{V_1}{V_2}$ is
(A) 1 (B) 6
(C) 35 (D) 210

82. Angles of elevation of top of a tower when observed from ground floor and roof of a building of height h are α and β respectively, then height of tower will be
(A) $\frac{h\cos\beta}{\cot\beta - \cot\alpha}$ (B) $\frac{h\cot\beta}{\cot\beta - \cot\alpha}$
(C) $\frac{h\cot\alpha}{\cot\beta - \cot\alpha}$ (D) $\frac{h\cos\alpha}{\cot\beta - \cot\alpha}$

83. If the lines $\frac{x-1}{2} = \frac{y-2}{3} = \frac{z-3}{4}$ and $\frac{x-4}{1} = \frac{y-6}{2} = \frac{z+\lambda}{2}$ intersect, then value of λ is
(A) –9 (B) 9
(C) 8 (D) –8

84. Solution of differential equation given by $\frac{dy}{dx} = \frac{x^2 + y + 1}{x(1 - x\sin y)}$, where $y(1) = 0$, is
(A) $y + x\cos y = x^2 + x - 1$ (B) $y + x\cos y = x^2 - x + 1$
(C) $y + x\cos y = -x^2 + x + 1$ (D) $y + x\cos y = x^2 + x + 1$

85. If roots of equation $(k^2 - 4k + 5)x^2 + (2k - 1)x - 3k = 0$ lie on either sides of unity then number of integral values of k is
(A) 1 (B) 2
(C) 3 (D) 4

Space for Rough work

86. Value of $\lim\limits_{x\to 1} x^{\frac{1}{\ell nx}}$, is

(A) $\frac{1}{e}$ (B) e^2

(C) e (D) does not exist

87. If cot(θ + α), 3cotθ, cot(θ – α) are in AP, then value of $\frac{\sin^2\theta}{\sin^2\alpha}$, wherever defined, is

(A) $\frac{3}{2}$ (B) 3

(C) $\frac{2}{3}$ (D) 2

88. For an ellipse, the locus of mid points of chords which are drawn through an end of minor axis will be

(A) a parabola (B) an ellipse

(C) a hyperbola (D) a pair of lines

89. Value of $I = \int_{-\pi/2}^{\pi/2} \frac{e^x dx}{\left(1+e^x\right)\left(1+\tan^2 x\right)}$ is

(A) $\frac{\pi}{2e}$ (B) $\frac{\pi}{2}$

(C) $\frac{\pi}{4e}$ (D) $\frac{\pi}{4}$

90. Area enclosed between the curves given by $y = x^4$ and $y = x^2 + 12$ will be (in sq. units)

(A) $\frac{304}{15}$ (B) $\frac{594}{15}$

(C) $\frac{608}{15}$ (D) cannot be determined

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – III

JEE (Main)-2019

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. A
Sol. $a_t = 0.4 \text{ m/s}^2$

$a_c = \frac{F}{m}$

$a_c = \frac{mv^2}{mr}$

$a_c = \frac{v^2}{r} \Rightarrow \frac{6^2}{120} \Rightarrow 0.3 \text{ m/s}^2$

$a_{net} = \sqrt{a_c^2 + a_t^2} = \sqrt{(0.3)^2 + (0.4)^2} = 0.5$

2. C
Sol. $4y + kx = 3$

$4y = 3 - kx$

$y = -\frac{k}{4}x + \frac{3}{4}$

slope $m_1 = \frac{k}{4}$

$F \Rightarrow 3\hat{i} + 4\hat{j}$

slope $m_2 \Rightarrow \frac{4}{3}$

for perpendicular $m_1 \times m_2 = -1$

$-\frac{k}{4} \times \frac{4}{3} = -1$

$k = 3$

3. D

Sol. By parallel axis theorem

$$I = M\left(\frac{R^2}{4}+\frac{\ell^2}{3}\right)$$

$$= M\left[\frac{R^2}{4}+\frac{(6R)^2}{3}\right]$$

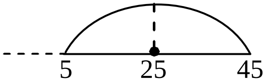
$$I = \frac{49}{4}MR^2$$

4. D

Sol. 1134.04g

5. D

Sol. At highest point, speed is not zero and acceleration is g downward.



6. B

Sol. T-Mg = ma

7. B

Sol. $f_x = \frac{dU}{dx} = \frac{d}{dx}(6x + 8y) = 6$

$f_y = \frac{dU}{dy} = 8$

$a_x = \frac{6}{2} = 3,\ a_y = \frac{8}{2} = 4$

after time (t) $x = x_0 - \frac{1}{2}a_x t^2 = 6 - \frac{1}{2}\times 3 \times t^2$

$y = y_0 - \frac{1}{2}a_y t^2 = 4 - 2t^2$

body crosses y axis at x = 0

$6 - \frac{3}{2}t^2 = 0,\ t = 2$ sec

8. A

Sol. $mv\cos\theta = \frac{m}{2}(-v\cos\theta) + \frac{m}{2}v'$

$v' = 3v\cos\theta$

9. C

Sol. At highest point

$v = u\cos 60^\circ = \frac{u}{2}$

Hence at maximum height perpendicular distance from line of projection

$= \frac{u^2\sin^2\theta}{2g} = \frac{3u^2}{8g}$

$L = mvr = m(u\cos 60^\circ) \times \frac{3u^2}{8g} = \frac{3mu^3}{16g}$

10. A

Sol. mg – T = ma

$\tau = mg.\frac{\ell}{2}$

$\alpha = \frac{\tau}{I} = \frac{3g}{2\ell}$

$a = \frac{L\alpha}{2}$

$mg - T = \frac{3mg}{4}$

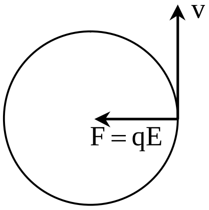
$T = \frac{mg}{4}$

11. C

Sol. Draw free body diagram & apply equation of motion.

12. A

Sol. Here electric force on the particle provide required centripetal force.



$F = qE = \frac{mv^2}{r}$

$$\frac{q\lambda}{2\pi\varepsilon_0 r} = \frac{mv^2}{r}$$

or $v = \sqrt{\frac{\lambda q}{2\pi\varepsilon_0 m}}$

$T = \frac{2\pi r}{v}$

$T = 2\pi r\sqrt{\frac{2\pi\varepsilon_0 m}{\lambda q}}$

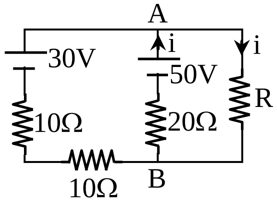
13. C

Sol. As there is no current through 30 V cell

Hence, V_{AB} = 30 V = iR

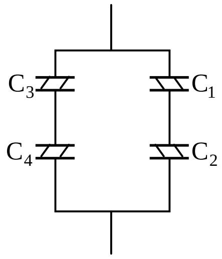
and $i = \frac{50-30}{20}$ = 1A

Hence, R = 30 Ω



14. A

Sol. $C = \frac{\epsilon_0 W}{d}$



$C_1 = \frac{6\in_0 W}{d}$; $C_2 = \frac{4\in_0 W}{d}$

$C_3 = \frac{6\in_0 W}{d}$; $C_4 = \frac{2\in_0 W}{d}$

$C_{eq} = \frac{C_1C_2}{C_1+C_2}+\frac{C_3C_4}{C_3+C_4}$

15. D

Sol. When only capacitor is removed, the circuit will be RL circuit and tan $\phi_1 = \frac{X_L}{R}=\sqrt{3}$

or $X_L = 100\sqrt{3}\ \Omega$

When only inductor is removed then

tan $\phi_2 = \frac{X_C}{R}=\sqrt{3}$

or $X_C = 100\sqrt{3}$

In LRC circuit

$Z = \sqrt{R^2+(X_L-X_C)^2} = 100\ \Omega$

$i = \frac{V}{Z} = 2A$

$P = i^2R = 400W$

16. A

Sol. Let these are N turns

hence $(2\pi r)N = \ell$

$r = \frac{\ell}{2\pi N}$

τ = iAB sin θ

$\tau = \frac{i\ell^2B}{4\pi N^2}\sin\theta$

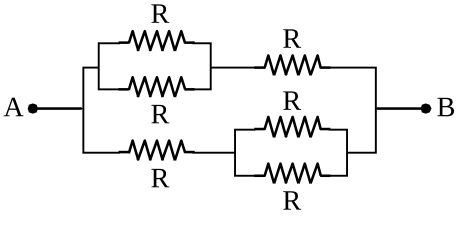
for τ_{max},θ = 90° and N = 1

i.e., $\tau_{max} = \frac{i\ell^2B}{4\pi}$

17. A

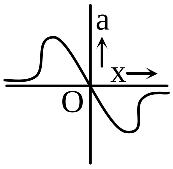
Sol. The given circuit can be simplified as

$R_{eq} = \frac{3}{4}R$



18. B

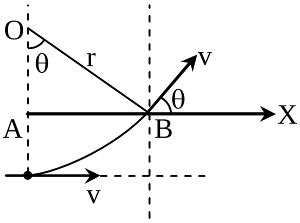
Sol. $F \propto \frac{x}{(x^2+a^2)^{3/2}}$; a = $\frac{F}{m}$



19. D

Sol. In ΔOAB

AB = L = constant



OB = r = $\frac{mv}{qB}$

sin θ = $\frac{L}{r}$ ⇒ L = r sin θ = constant

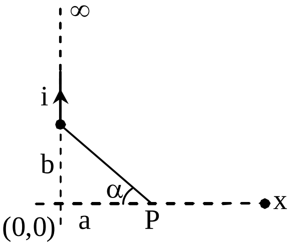
or v sin θ = constant

$v_0 \sin 60^\circ = v' \sin 30^\circ$

$v' = \sqrt{3}v_0$

20. B

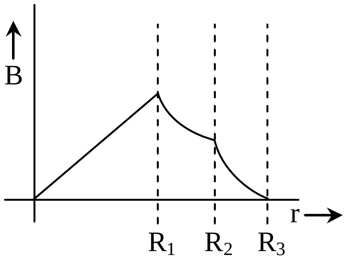
Sol. B = $\frac{\mu_0}{4\pi}\frac{i}{a}(1 - \sin\alpha)$



$$B = \frac{\mu_0}{4\pi}\frac{i}{a}\left(1-\frac{b}{\sqrt{a^2+b^2}}\right)$$

21. C

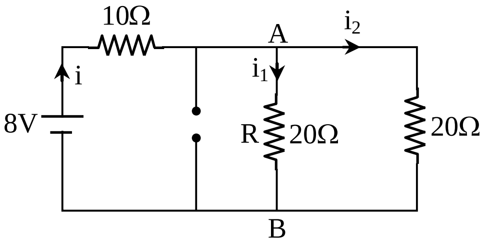
Sol. From ampere's law the field at the axis is zero. From x = zero to R_1, the field increases linearly as the charge enclosed increases. From x = R_1 to R_2 and from x = R_2 to R_3, the field decreases hyperbolically but with different slopes as the media are different. Hence the required graph is.



$$B = \begin{cases} \dfrac{\mu_0}{2\pi}\dfrac{ir}{R_1^2} & \text{for} \quad r \le R_1 \\ \dfrac{\mu_0}{2\pi}\dfrac{i}{r} & \text{for} \quad R_1 \le 2r \le R_2 \\ 0 & \text{for} \quad r > R_3 \end{cases}$$

22. A

Sol. The given circuit can be simplified as



at steady state

R_{eq} = 20Ω

i = $\frac{8}{20}$ = 0.4 A

i_1 = 0.2A

V_{AB} = 4V

charge on capacitor q = CV = 0.1 × 4
= 0.4 μC

23. A

Sol. We have

N = $N_0 \left(\frac{1}{2}\right)^n$

Where n is no. of half lives i.e., $\frac{1}{2}$

Hence N = $\frac{N_0}{\sqrt{2}}$ or $\frac{N}{N_0} = \frac{1}{\sqrt{2}}$

24. B

Sol. Reducible in exact form

25. D

Sol. $B_n = \frac{\mu_0 I_n}{2r_n}$

or $B_n \propto \frac{I_n}{r_n} \propto \frac{f_n}{r_n} \propto \frac{v_n}{r_n^2}$

$\Rightarrow B_n \propto \frac{z/n}{(n^2/z)^2} \propto \frac{z^3}{n^5}$

26. C

Sol. For M_1 : u = – 10 cm
f = – 15 cm
n_0 = 2

Using mirror formula v = 30 cm
and n_I = 6 cm
The image formed by plane mirror is at 70 cm below the principle axis and 70 + 6 – 30 = 46 cm from concave mirror.
So, coordinates of second image w.r.t.
P = (– 46, – 70)

27. C
Sol. For upper segment,

$$\frac{1}{f} = \frac{\mu - 1}{R}$$

For lower segment,

$$\frac{1}{f} = \frac{2(\mu - 1)}{R}$$

28. A
Sol. $N = \frac{X}{\lambda} = \frac{X}{\frac{\ell n(2)}{Y}} = \frac{XY}{\ell n(2)}$

29. B
Sol. For reflection through M_1
u = –15 cm
f = –10 cm

$\frac{1}{v} = -\frac{1}{10} + \frac{1}{15} \Rightarrow$ v = –30 cm

For reflection through M_2
u = 10 cm
f = –10 cm
$\Rightarrow$ v = – cm (from mirror formula)

Now magnification, m = $-\frac{v}{u} = \frac{5}{10} = \frac{1}{2}$

So, finally formed image will be at the distance of $\frac{3}{2}$ cm from the line AB.

30. B
Sol. For any outside stationary observer (Paraxial rays approx) the fish will be appeared at 15 cm from surface and moving with speed of 4 cm/sec in upward direction

Now, use $\vec{v}_{1m} = -m^2 v_{OM}$

where m = $\frac{-50}{-50 + 30} = \frac{5}{2}$

$\Rightarrow v_I - (-4) = -\frac{25}{4}\,[4 - (-4)]$

$\Rightarrow v_I + 4 = -50$

$\Rightarrow v_I = -54$ m/sec

(–ve sign showing downward direction)

Chemistry

PART – II

SECTION – A

31. D

Sol.
$$NH_4SH(s) \rightleftharpoons NH_3(g) + H_2S(g)$$

$t = 0$	0	0.5 atm	
$t = teq$	0	$0.5 + P$	P

Total Pressure=0.5+P+P=0.84

P=0.17 atm

$$K_P = P_{NH_3} \cdot P_{H_2S} = (0.5 + 0.17) \times (0.17) = 0.1139\,atm$$

32. C

Sol.
$$\underset{\text{Propyne}}{Mg_2C_3 + H_2O \to Mg(OH)_2 + C_3H_4}$$

33. B

Sol. $2BeCl_2 + LiAlH_4 \to 2BeH_2 + LiCl + AlCl_3$

34. B

Sol.
$$m \cdot moles\ of\ HCl = 1 \times 0.1 = 0.1$$
$$now\ Vol\ of\ solution = 1 + 99 = 100\,cc$$
$$Molarity\ of\ HCl = \frac{0.1}{100} = 10^{-3}$$
$$pH = -\log[H^+] = -\log(10^{-3}) = 3$$

35. B

Sol.
$$M_1V_1 + M_2V_2 = M(V_1 + V_2)$$
$$\frac{1}{200} \times 10 + \frac{1}{200} \times 40 = M(10 + 40)$$
$$M = \frac{1}{200}$$
$$H_2SO_4 \to 2H^+ + SO_4^{-2}$$
$$[H^+] = 2 \times \frac{1}{200} = 10^{-2}$$
$$pH = -\log[H^+] = -\log(10^{-2}) = 2$$

36. A

Sol. Mg can form Complex (Mg-EDTA Complex)

37. D

Sol. Due to their covalent character

38. A

Sol. $P_4 + 3NaOH + 3H_2O \to 3NaH_2PO_2 + PH_3$

39. A

Sol.
$$H_3BO_3 \xrightarrow{T_1>170^\circ} \underset{\text{meta boric acid}}{HBO_2} + H_2O$$
$$4HBO_2 \xrightarrow{T_2>300^\circ C} H_2O + \underset{\text{Tetra boric acid}}{H_2B_4O_7}$$
$$H_2B_4O_7 \xrightarrow{\text{red hot}} 2B_2O_3 + H_2O$$

40. A

Sol. Information base

41. C

Sol.
$$R = K[A]^o$$
$$10^{-2} = K \times (0.1)^o$$
$$K = 10^{-2}$$
$$A_t = A_o - Kt$$
$$= 0.1 - 10^{-2} \times \frac{60}{60}$$
$$A_t = 0.1 - 0.01$$
$$[B] = 2 \times 0.01 = 0.02$$

42. A

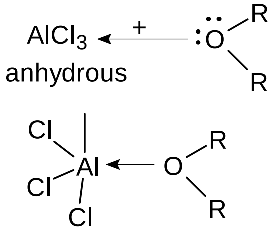
Sol.
$$\begin{array}{lll} & N_2O_4 \rightleftharpoons & 2NO_2 \\ t=0 & 1 & 0 \\ t=teq & 1-\alpha & 2\alpha \end{array}$$
$$M_{eq} = \frac{1 \times M_{N_2O_4}}{1-\alpha+2\alpha} = \frac{92}{1+\alpha}$$
$$2 \times VD = \frac{92}{1+\alpha}$$
$$\alpha = 0.533$$

43. D

Sol.
$$\begin{array}{llll} & 2HI \rightleftharpoons & H_2 + & I_2 \\ t=0 & 1 & 0 & 0 \\ t=teq & 1-\alpha & \frac{\alpha}{2} & \frac{\alpha}{2} \end{array}$$
$$K_P = \frac{P_{H_2} \cdot P_{I_2}}{(P_{HI})^2} = \frac{\left(\frac{\alpha}{2(1+\alpha)}P\right)\left(\frac{\alpha}{2(1+\alpha)}P\right)}{\left(\frac{1-\alpha}{1+\alpha}P\right)^2}$$
$$K_P = \frac{\alpha^2}{4(1-\alpha)^2}$$
$$\alpha = \frac{2\sqrt{K_P}}{1+2\sqrt{K_P}}$$

44. D
Sol. It is due to solvated electron.

45. B
Sol.



46. B

Sol. $R = K[A]^m[B]^n$

$$10^{-3} = K\left(1.6\times10^{-3}\right)^m\left(5\times10^{-2}\right)^n$$

$$3.2\times10^{-3} = K\left(3.2\times10^{-3}\right)^m\left(5\times10^{-2}\right)^n$$

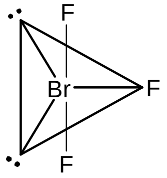
$$1.6\times10^{-3} = K\left(10^{-1}\right)^m\left(2\times10^{-3}\right)^n$$

$$3.2\times10^{-3} = K\left(10^{-1}\right)^m\left(8\times10^{-3}\right)^n$$

Solving $R = K[A]^2[B]$

47. C
Sol. $\mathrm{KCN} \longrightarrow \mathrm{K}^+ + {}^-\mathrm{C} \equiv \mathrm{N}$

48. A
Sol.



SP^{3}d hybridisation
T-shaped

49. B
Sol. $Cl_2O > H_2O > F_2O$ (bond angle)

50. C
Sol. Electron affinity S>Se>O

51. D
Sol. $Cl < Mg < Ca$

52. D

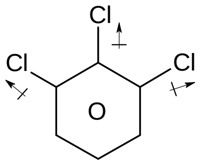
Sol. $r_n = \dfrac{n^2}{z} r_o$

53. B

Sol. $\dfrac{1}{\lambda} = RZ^2\left(\dfrac{1}{n_1^2} - \dfrac{1}{n_2^2}\right)$

54. A

Sol.



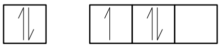
55. D

Sol. Bond order $H_2O_2 < O_3 < O_2$

Bond length $H_2O_2 > O_3 > O_2$

56. D

Sol.



57. B

Sol. Non metal oxide are acidic metal oxide are basic

58. C

Sol. $Hyd \propto \frac{q_1 q_2}{r}$

59. C

Sol. $K_P = K_c \cdot (RT)^{\Delta ng}$

60. C

Sol. $t_{1/2} \propto (a)^{1-n}$

$hence\ n = 0$

$t_{1/2} \propto a;\ '0'\ order\ reaction$

$Rate = -\frac{d[n]}{dt} = K[A]^o = const$

Mathematics PART – III

SECTION – A

61. B

Sol. Take log both sides, then differentiate

62. C

63. D

Sol. $f(n)=\sum(n+1)(n+\omega)(n+\omega^2)=\sum(n+1)(n^2-n+1)=\sum(n^3+1)$

64. C

Sol. $\left|z^2\right|+2\left(z+\bar{z}\right)-5=0: centre=(-2,0)\, radius=\sqrt{4+5}=3$

$\therefore\ \ z=-2+3e^{i\theta}\Rightarrow z+3+2i=L+2i+3e^{i\theta}$

65. D

Sol. $f\left(f(x)\right)=\lambda\left(x^7+2x\right),\lambda\neq 0\quad f^{'}\left(f(x)\right)\times f^{'}(x)=\lambda\left(7x^6+2\right)$

66. A

Sol. For any one diagonal, there are 7 lines skew diagonal

$\therefore No=\frac{12\times 5}{2}=30$

67. C

Sol. Using truthtable

68. B

Sol. $\sum x_i=48\times 200;\sum(x-\mu)^2=200\times 9$

$\Rightarrow\sum x^2-n\mu^2=200\times 9\Rightarrow\sum x^2=462600$

69. D

Sol. $\cot^{-1}x>0\ \&\ \cos^{-1}x>0$

$\therefore$ No solution

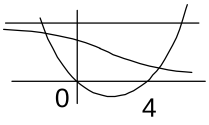
70. D

Sol. $A=A^T\Rightarrow x^2+y^2+z^2=1;xy+yz+zx=0\Rightarrow x+y+z=1$

$\therefore x^3+y^3+z^3=4$

71. C

Sol.



72. D

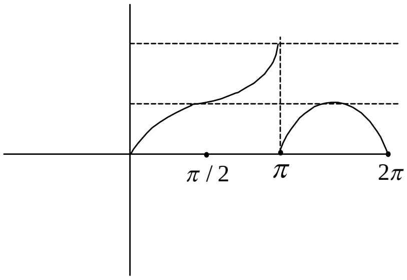
Sol. $\frac{x^2}{18}-\frac{y^2}{9}=1$

Equation of Tangent : y = -x + k

$$\therefore\ K^2 = 18(-1)^2 - 9$$

$$K = \pm 3$$

73. B



Sol. $$f(x) = \begin{cases} \sin x & 0 \le x \le \pi/2 \\ 2 - \sin x & \frac{\pi}{2} < x \le \pi \\ -\sin x & \pi < x < 2\pi \end{cases}$$

Points of discontinuity x = π (n = 1)
Points of non-dertvability x = π (m = 1)n + m = 2

74. A

Sol. $$h(x) = f^2(x) + (f'(x))^2$$

$$h'(x) = 2f(x)f'(x) + 2f'(x).f''(x)$$

$$= 2f'(x)(f(x) + f''(x))$$

$$= -2xg(x)(f'(x))^2$$

h'(x) changes from positive to negative about x = 0 so x = 0 is a point of maxima

75. C

Sol. $$\alpha + \sin\beta = 2018$$

$$\alpha + 2018\cos\beta = 2017$$

satisfies

$$if\,\alpha = 2017\,and\,\beta = \frac{\pi}{2}$$

$$[\alpha+\beta] = \left[2017 + \frac{\pi}{2}\right] = 2018$$

76. B

Sol. $$\frac{x^2}{8/9} - \frac{y^2}{8/9} = 1$$

$$\textit{Equation of Tangent}: y = mx \pm \sqrt{\frac{8}{9}(m^2-1)} ----(\text{i})$$

$$\text{y}^2 = 32x$$

$$\textit{Equation of Tangent}: y = mx + \frac{8}{m} ------(\text{ii})$$

on comparing equation (i) and (ii)

$$\text{m} = \pm 3$$

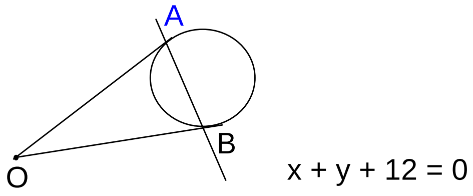
$putting\ \ m\ \ in\ equation(\text{ii})$

$y = 3x + 8/3\ or\ y = -3x - 8/3$

$a = \dfrac{-8}{9}$

77. D

Sol. $\left(x^2 + y^2 + 8x + 8y + 16\right) + \lambda\left(x + y + 12\right) = 0$



Equation of line AB = x + y + 12 = 0 -----------------(i)
Equation of chord of contact:

$(8+\lambda)x + (8+\lambda)y + 2(16+12\lambda) = 0 - - - - (\text{ii})$

On comparing equation (i) and (ii)

$\lambda = \dfrac{16}{3}$

78. D

Sol.

$$\begin{array}{|c|}\hline 2\\ \hline 1\\ \hline 1\\ \hline 2\\ \hline\end{array} = \left(3c_2.1.1.3c_2\right)6!$$

Total = 10800

$$\begin{array}{|c|}\hline 1\\ \hline 1\\ \hline 1\\ \hline 3\\ \hline\end{array} = \left(3c_1.1.1.1\right)6!$$

$$\begin{array}{|c|}\hline 3\\ \hline 1\\ \hline 1\\ \hline 1\\ \hline\end{array} = \left(1.1.1.3c_1\right)6!$$

79. B

80. D

Sol. On comparing coefficients

$a_0 = 1\ \ - - - - - (\text{i})$ (constant term)

$\text{n} - 2 = \text{a}_1 - - - - - (ii)(\text{coeff .of x})$

$5 + {}^n c_2 - 2n = a_2 - - - - (\text{iii})\left(coeff .of\ x^2\right)$

$On\,solving\,(\text{ii})\,\text{and}(\text{iii})$

n = 6

$\therefore a_0 + n = 7$

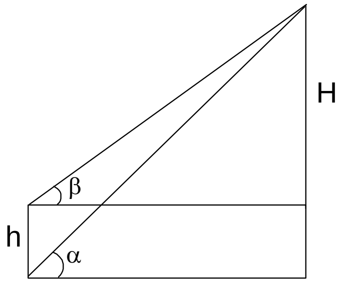
81. D

Sol. $V_1 = \left[\vec{\alpha}\ \ \vec{\beta}\ \ \vec{\gamma}\right]$

$V_2 = \left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right]$

82. B

Sol.



83. A

Sol. $\frac{x-1}{2}=\frac{y-2}{3}=\frac{z-3}{4}=\alpha$

Point P on line

$P(2\alpha+1,3\alpha+2,4\alpha+3)$

$\frac{x-4}{1}=\frac{y-6}{2}=\frac{z+\lambda}{2}=\beta$

Any point Q

$Q(4+\beta,6+2\beta,2\beta-\lambda)$

For certain value of α & β P & Q represents same points

$2\alpha+1=4+\beta------(\text{i})$

$3\alpha+2=6+2\beta----(\text{ii})$

$4\alpha+3=2\beta-\lambda----(\text{iii})$

From (i) & (ii)

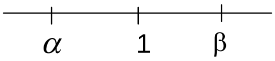
α=2 & β = 1 now from (iii)

$\lambda=-9$

84. A

85. B

Sol.



$(k^2-4k+5)(k^2-4k+5+(2k-1)-3k)<0$

86. C

Sol. 1^{∞} form

87. A

Sol. $x\Rightarrow a+b-x$

88. B

89. D

90. C

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – IV

JEE (Advanced)-2019

PAPER – 1

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

Section-A (01– 07, 19 – 25, 37 - 43) *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 mark*** *for wrong answer*

Partial Marks **+1** for each correct option provided no incorrect options is selected.

Section-A (08 – 13, 26 – 31, 44 - 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S).*

Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-C (14 – 18, 32 – 36, 50 - 54) *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

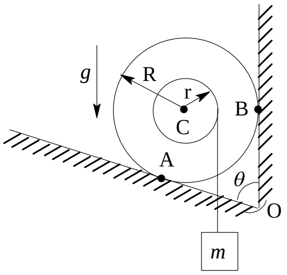
Physics

PART – I

SECTION – A
(More Than One Correct Type)

This section contains **7 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

1. A massless spool of inner radius r, outer radius R is placed against a vertical wall and a tilted split floor as shown. A light inextensible thread is tightly wound around the spool through which a mass m is hanging. There exists no friction at point A, while the coefficient of friction between the spool and point B is μ. The angle between the two surfaces is ρ.



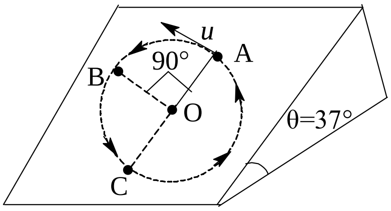
(A) The magnitude of the force on the spool at B in order to maintain equilibrium is $\text{mg}\sqrt{(\text{r/R})^2+(1\text{-r/R})^2\ 1/\tan^2\theta}$

(B) The magnitude of the force on the spool at B in order to maintain equilibrium is $\text{mg}(1\text{-r/R})1/\tan\theta$

(C) The minimum value of μ for the system to remain in equilibrium is $\cot\theta/(\text{R/r})\text{-}1$

(D) The minimum value of μ for the system to remain in equilibrium is $\tan\theta/(\text{R/r})\text{-}1$

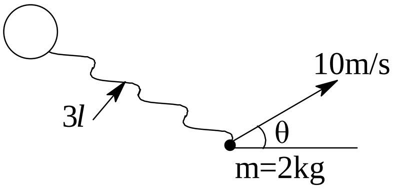
2. A small sphere of mass m is connected by a string to a nail at O and moves in a circle of radius r on the smooth plane inclined at an angle θ with the horizontal. If the sphere has a velocity u at the top position A. Mark the correct options.



(A) Minimum velocity at A so that the string does not get slack instantaneously is $\sqrt{3/5\text{gr}}$
(B) Tension at B is 9mg/5 if the sphere has the required velocity as in option (A).
(C) Tension at C is 18mg/5 in situation of option (B)
(D) None of these

Space for Rough work

3. A string of length $3l$ is connected to a fixed cylinder whose top view is shown in figure. The string is initially slack. The other end of the string (connected to a marble) is moving at a constant velocity of 10 m/s as shown. The string will get stretched at some instant and impulsive tension occurs in the string. If hinge is exerting a force of 40000 N for 0.25 ms on the cylinder to bear up the impact of impulsive tension, then mark the correct statements. (Take string to be light, breaking tension of the string is $2\times10^5\text{N}$)



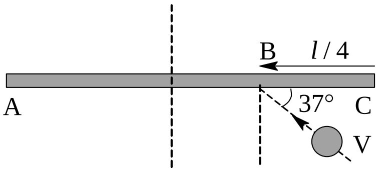
(A) The angle made by the velocity of marble with the length of string when it is just stretched is 60°

(B) The marble will move in a circular path of varying radius with constant speed of $5\sqrt{3}$ m/s, after the string is taut

(C) To answer above two options, the value of θ must be given

(D) The string will break is impulse duration is less than 0.05 min

4. A rod AC of length l and mass m is kept on a horizontal smooth plane. It is free to rotate and move. A particle of same mass m moving on the plane with velocity v strikes the rod at point B making angle 37° with the rod. The collision is elastic. After collision.



(A) The angular velocity of the rod will be 72/55 v/l

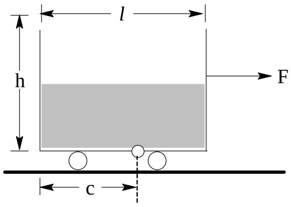
(B) The centre of the rod will travel a distance $\pi l/3$ in the time in which it makes half rotation

(C) Impulse of the impact force is $24\text{m v}/55$

(D) None of these

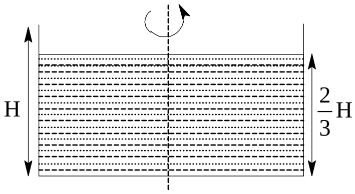
Space for Rough work

5. A rectangular vessel of dimension $(l \times b \times h)$ and mass M contains a liquid of density ρ. The vessel has an orifice at its bottom at a distance c from the rear wall as shown in the figure.



(A) The maximum volume of the water that can be stored when the vessel is accelerated is $hcb/2$
(B) The maximum volume of the water that can be stored when the vessel is accelerated is $hlb/2$
(C) Force F that must be applied when maximum water stored is $[M + hcb\rho/2]hg/c$
(D) Force F that must be applied when maximum water stored is $[M + hcb\rho/2]lg/c$

6. A circular cylinder of radius R and height H is filled with water to a height $\left(\frac{2}{3}\right)\mathrm{H}$. It starts rotating about its axis with constantly increasing angular speed. Choose the correct alternatives.

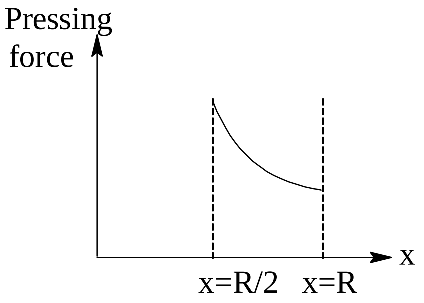


(A) At all speeds, shapes of the free surface is parabolloid
(B) The free surface touches first the brim of the cylinder and then the base of the cylinder.
(C) The free surface cannot touch the base without spilling water.
(D) The free surface touches the brim as well as the base at the same instant.

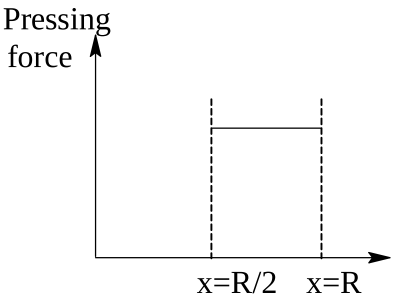
Space for Rough work

7. A tunnel is dug along a chord of the earth at a perpendicular distance R/2 from the earth's centre. The wall of the tunnel may be assumed to be frictionless. A particle is released from one end of the tunnel. The pressing force by the particle on the wall, and the acceleration of the particle vary with x (distance of the particle from the centre) according to:

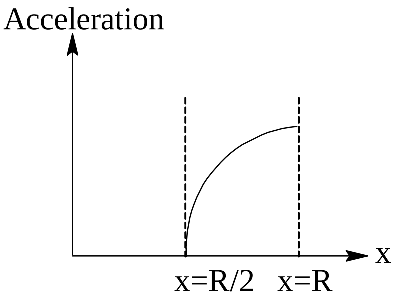
(A)



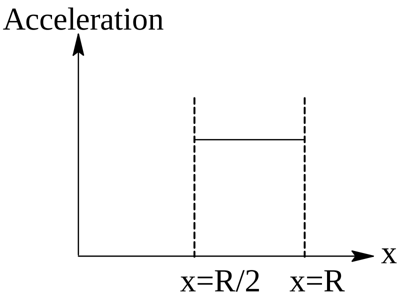
(B)



(C)



(D)



Space for Rough work

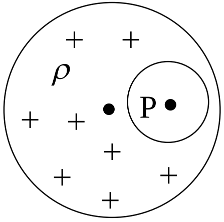
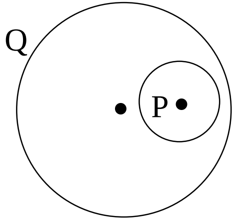
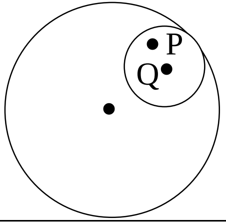
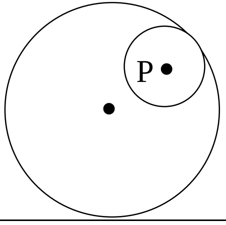
(Matching Type)

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

Column – 1 gives the continuous charge arrangement, Column – 2 gives the electric field at any arbitary point P inside the cavity and Column – 3 gives the potential at the same arbitary point P:

	Column –1		**Column –2**		**Column –3**
(I)	Uniformly charged non-conducting sphere having a cavity  charge density ρ	(i)	$\vec{E}$ in non-uniform	(P)	Potential is constant at every point
(II)	A charged conductor having cavity  Charge conducting sphere	(ii)	E is uniform and non zero	(Q)	Potential is zero at every point
(III)	A uncharged conductor with a V cavity having spherical Q at its centre. 	(iii)	$\vec{E}$ is unidirectional at every point with varying magnitude	(R)	Potential is varying at every point
(IV)	A conducting sphere having charge Q 	(iv)	$\vec{E}$ is zero	(S)	Potential cannot be defined

8. Which of the following is correct combination if the given matrix?

(A) $(\text{I})\ (\text{ii})\ (\text{R})$ (B) $(\text{I})\ (\text{ii})\ (\text{P})$

(C) $(\text{I})\ (\text{iv})\ (\text{P})$ (D) $(\text{II})\ (\text{iii})\ (\text{P})$

9. Which of the following is correct combination if the given matrix?

(A) $(\text{I})\ (\text{ii})\ (\text{P})$ (B) $(\text{II})\ (\text{iv})\ (\text{P})$

(C) $(\text{I})\ (\text{iv})\ (\text{P})$ (D) $(\text{II})\ (\text{iii})\ (\text{P})$

10. Which of the following is correct combination if the given matrix?

(A) $(\text{I})\ (\text{ii})\ (\text{P})$ (B) $(\text{I})\ (\text{iii})\ (\text{P})$

(C) $(\text{III})\ (\text{i})\ (\text{R})$ (D) $(\text{II})\ (\text{iii})\ (\text{P})$

Answer 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

For one mole of a monoatomic gas match the following:

	Column –1 [Thermodynamics Process]		**Column –2 [Bulk modulus]**		**Column –3 [Slope of P-V graph]**
(I)	Isothermal	(i)	Infinity	(P)	$-\frac{RT}{V^2}$
(II)	Adiabatic	(ii)	$\frac{5RT}{3V}$	(Q)	Zero
(III)	Isobaric	(iii)	$\frac{RT}{V}$	(R)	Infinity
(IV)	Isochoric	(iv)	Zero	(S)	$-\frac{5RT}{3V^2}$

11. Pick correct combination for the given matrix:

(A) $(\text{I})\ (\text{ii})\ (\text{P})$ (B) $(\text{I})\ (\text{iii})\ (\text{P})$

(C) $(\text{I})\ (\text{iv})\ (\text{P})$ (D) $(\text{II})\ (\text{iii})\ (\text{P})$

Space for Rough work

12. Pick correct combination for the given matrix:

(A) $(\text{II})\ (\text{ii})\ (\text{S})$ (B) $(\text{II})\ (\text{i})\ (\text{S})$

(C) $(\text{II})\ (\text{ii})\ (\text{P})$ (D) $(\text{III})\ (\text{ii})\ (\text{S})$

13. Pick correct combination for the given matrix:

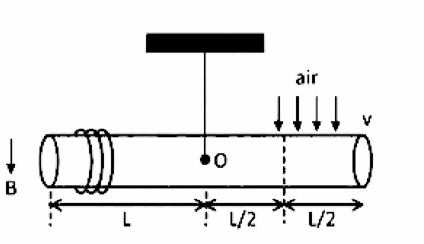
(A) $(\text{IV})\ (\text{ii})(\text{R})$ (B) $(\text{IV})\ (\text{iii})(\text{R})$

(C) $(\text{IV})\ (\text{i})(\text{R})$ (D) $(\text{IV})\ (\text{iv})(\text{R})$

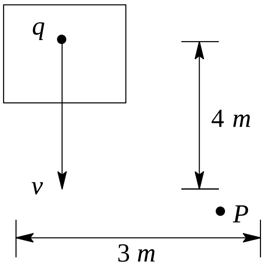
SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

14. A non-conducting non-magnetic rod having circular cross section of radius R is suspended from a rigid support as shown in figure. A light and small coil of 300 turns is wrapped tightly at the left end of the rod where uniform magnetic field B exists in vertically downward direction. Air of density ρ hits the half of the right part of the rod with velocity V as shown in the figure. What should be current in clockwise direction (as seen from O) in the coil so that rod remains horizontal? Give answer in mA. Given $\frac{2}{\text{LV}}\sqrt{\frac{\pi PB}{\rho}} = \frac{1}{\sqrt{5}}\text{A}^{-1/2}$ [Assume air stops after collision]



15. An elevator carrying a charge of $0.5C$ is moving down with a velocity of $5\times10^{3}ms^{-1}$. The elevator is $4m$ from the bottom and $3m$ horizontally from P as shown in fit.2.202. What magnetic field (in μT) does it produce at point P?

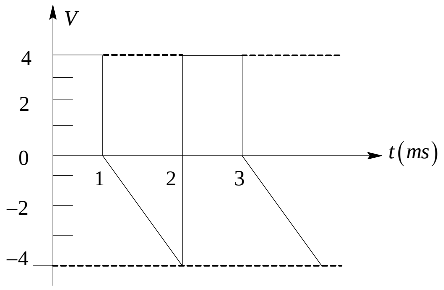


Space for Rough work

16. A long coaxial cable consists of two thin-walled conducing cylinders with inner radius $2\,cm$ and outer radius $8\,cm$. The inner cylinder carries a steady current $0.1A,$ and the outer cylinder provides the return path for that current. The current produces a magnetic field between the two cylinders. Find the energy stored in the magnetic field for length $5\,m$ of the cable. Express answer in nJ (use $\ln 2 = 0.7$).

17. A capacitor of capacity $2\mu F$ is charged to a potential difference of $12V$. It is then connected across an inductor of inductance $6\mu H$. What is the current (in A) in the circuit at a time when the potential difference across the capacitor is $6.0V$?

18. Variation of voltage with time is shown in Figure. The rms voltage is found to be $N\sqrt{\frac{2}{3}}V$. Find N.



Space for Rough work

Chemistry

PART – II

SECTION – A
(More Than One Correct Type)

This section contains **7 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

19. Which of the following process is/are associated with change of hybridization of underlined compounds?

(A) $\underline{Al}(OH)_3$ ppt. dissolved in NaOH

(B) $\underline{B}_2H_6$ is dissolved in THF

(C) $\underline{Si}F_4$ vapours is passed though liquid HF

(D) Solidification of $\underline{P}Cl_5$ vapour.

20. Which of the following statement is/are true? (lp – lone pair and Bp-bond pair)

(A) At $102°$ bond angle in H_2O , $\ell p\text{-}\ell p<\ell p\text{-}Bp<Bp\text{-}Bp\ (\text{Repulsion})$

(B) At $104.5°$ bond angle in H_2O , $\ell p\text{-}\ell p=\ell p\text{-}Bp=Bp\text{-}Bp\ (\text{Repulsion})$

(C) At $106°$ bond angle in water, $\ell p\text{-}\ell p>\ell p\text{-}Bp>Bp\text{-}Bp\ (\text{Repulsion})$

(D) Maximum number of hydrogen bonds H_2O molecule can form are 3.

21. 40 mL 0.05 M solution of sodium sesquicarbonate dihydrate $(Na_2CO_3.NaHCO_3.2H_2O)$ is titrated against $0.05M\ HCl$ solution, $x\,mL$ of acid is required to reach the phenolphthalein end point while $y\,mL$ of same acid were required when methyl orange indicator was used in a separate titration. Which of the following is/are correct statement?

(A) $y\text{-}x=80\,mL$

(B) $y+x=160\,mL$

(C) If titration is started with phenol phthalein indicator and methyl orange is added at the end point, $2x$ mL of HCl would be required further to reach the end point.

(D) If same volume of same solution is titrated against 0.10 M NaOH, $x/2$ mL of base would be required.

Space for Rough work

22. The incorrect statements are?
(A) The molar volume of every gas at STP is 22.4L
(B) At critical point, compression factor is unity
(C) A gas with large 'b' has high critical pressure.
(D) For real gas, $\lim_{p\to 0}\left(\frac{\text{PV}}{\text{RT}}\right)=1$ where symbols have their usual meaning.

23. When $0.5\,\text{mL}$ of a $1.0\,\text{M}\,\text{HCl}$ solution is mixed with $5.0\,\text{mL}$ of a $0.1\text{M}\,\text{NaOH}$ solution, temperature of solution increases by $2°\text{C}$. Which of the following(s) can be predicated accurately from this observation?
(A) If 10mL of same HCl is mixed with $10\,\text{mL}$ of same NaOH, temperature rise will be $4°\text{C}$
(B) If 10mL of 0.05 M HCl is mixed with $10\,\text{mL}$ of $0.5\,\text{M}$ NaCl, the temperature rise will be $2°\text{C}$
(C) If 5mL of 0.1 M HCl is mixed with 5 mL 0.1 M NH_3 solution, the temperature rise will be less than $2°\text{C}$
(D) If 5 mL of 0.1 M CH_3COOH is mixed with 5 mL 0.1 M NaOH, the temperature rise will be less than $2°\text{C}$

24. At a certain temperature (T_1), some hydrazine (N_2H_4) gas is placed in a sealed flask where the following equilibrium is established.

$$3\text{N}_2H_4(g) \xrightleftharpoons{K_1} 4NH_3(g)+N_2(g) \qquad \Delta H° > 0$$

If the temperature is increased to T_2, some ammonia gas also decomposes as

$$2NH_3(g) \xrightleftharpoons{k_2} N_2(g)+3H_2(g) \qquad \Delta H° > 0$$

What would be observed as temperature is increased from T_1 to T_2?
(A) Some more hydrazine would decompose.
(B) If $\text{K}_1<\text{K}_2$, concentration of NH_3 would decrease.
(C) Partial pressure of N_2 would be doubled.
(D) All of these would be observed.

25. The yellow precipitate is obtained when:
(A) Lead acetate solution is treated with K_2CrO_4
(B) $\text{Pb}(\text{NO}_3)_2$ solution is treated with K_2CrO_4
(C) AgNO_3 solution is treated with KI
(D) H_2S is passed through a solution of CdSO_4

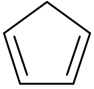
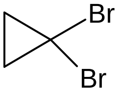
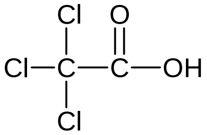
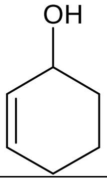
Space for Rough work

(Matching Type)

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer 26, 27 and 28 by appropriately matching the information given in the three columns of the following table.

	Column –1 (Reaction)		Column –2 (Intermediate)		Column –3 (Double bond equivalent in product)
(I)	 + $\xrightarrow[\Delta]{CHCl_3,\ KOH}$	(i)	Carbocation	(P)	0
(II)	 $\xrightarrow[\Delta]{Ph-Li}$	(ii)	Carbonion	(Q)	1
(III)	 $Cl-\overset{Cl}{\underset{Cl}{C}}-\overset{O}{\overset{\parallel}{C}}-OH$ $\xrightarrow[\Delta]{Na}$	(iii)	Free Radical	(R)	2
(IV)	 $\xrightarrow[\Delta]{H^+}$	(iv)	Carbene	(S)	3

26. Which of the following is correct combination if the given matrix?

(A) (II) (iv) (R)
(B) (I) (ii)(iv) (R)
(C) (II) (ii)(iv) (R)
(D) (III) (iii) (P)

27. Which of the following is correct combination if the given matrix?

(A) (IV)(i) (R)
(B) (I) (iv) (R)
(C) (III) (iv) (P)
(D) (I) (ii)(iv) (S)

28. Which of the following is used for extraction of copper?

(A) (IV)(i) (R)
(B) (IV) (i) (Q)
(C) (III) (ii)(iv) (P)
(D) (III) (iv) (Q)

Space for Rough work

Answer 29, 30 and 31 by appropriately matching the information given in the three columns of the following table.

	Column –1		Column –2		Column –3
(I)	$2NH_3(g) \rightleftharpoons N_2(g)+3H_2(g)$	(i)	Introduction of H_2(g) at constant volume shift equilibrium back.	(P)	$Kp=K_C(RT)$
(II)	$PCl_5(g) \rightleftharpoons PCl_3(g)+Cl_2(g)$	(ii)	α increases on increasing temperature	(Q)	$Kp=K_C(RT)^2$
(III)	$2HI(g) \rightleftharpoons H_2(g)+I_2(g)$	(iii)	On increasing the pressure, concentration of all the reactants increases	(R)	$Kp=K_C(RT)^{-2}$
(IV)	$NH_4HS(s) \rightleftharpoons NH_3(g)+H_2S(g)$	(iv)	α is independent of equilibrium pressure	(S)	$Kp=K_C$

29. Which of the following is correct combination?

(A) (III) (i)(iii)(iv) (S)
(B) (III) (i)(ii)(iv) (S)
(C) (IV) (ii)(iii) (Q)
(D) (IV) (ii)(iv) (Q)

30. Which of the following is correct combination?

(A) (I) (i)(ii)(iii)(iv) (Q)
(B) (III) (i)(ii)(iii)(iv) (S)
(C) (III) (i)(ii)(iii) (S)
(D) (I) (ii)(iii)(iv) (Q)

31. Which of the following is correct combination?

(A) (I) (i)(ii)(iii) (Q)
(B) (II) (ii)(iii)(iv) (P)
(C) (II) (i)(ii)(iii) (P)
(D) (I) (iii)(iv) (Q)

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

32. The solubility product constant of a metal carbonate MCO_3 is 2×10^{-12} at 25°C. A solution is 0.1 M in $M(NO_3)_2$ and it is saturated with 0.01M CO_2. Also the ionization constant of CO_2 are $Ka_1 = 4\times10^{-7}$ and $Ka_2 = 5\times10^{-11}$ at 25°C. The minimum pH that must be maintained to start any precipitation is?

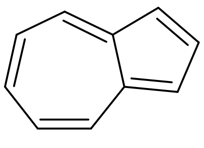
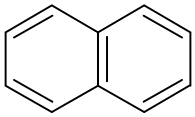
33. 2.0 moles of an ideal gas of unknown heat capacity are in a piston fitted cylinder at 300K. The piston has a mass on the top of it that supplies a constant pressure. The piston is then brought into contact with a thermostal. Heat flow into the system causing the gas to both expand and change temperature. After the temperature has equilibrated, the work done by the gas on surrounding was found to be 3.32 kJ. Also 14.94 kJ of heat flows into the system. What is the atomicity of the gas. Assume $R = 8.3\ jK^{-1}\ mol^{-1}$.

34. The standard reduction potential of silver chloride electrode (metal – sparingly soluble salt electrode) is 0.209 V and for silver electrode is 0.80 V. If the moles of AgCl that can dissolve in 10 L of a 0.01 M NaCl solution is represented as 10^{-y}, then find the value of y?

35. Consider the following reversible system:

$$A(g)+2B(g) \rightleftharpoons AB_2(g) \qquad K_C=\frac{1}{4}$$

The above equilibrium is established in a 1.0 L flask and at equilibrium 2 moles of each A and B are present. If 2 moles of B is added further, how many moles of AB_2 should be added so that moles of A does not change?

36. Which of these statements are correct?
(i) 1, 3, 5-cycloheptatriene is not acidic while 1, 3-cyclopentadiene is acidic in nature.
(ii) p-chlorophenol is less acidic than p-fluorophenol
(iii) $-N=O$ shows both $+M$ and $-M$ effect.
(iv) singlet halo-carbene are more stable than triplet halo-carbene
(v) conjugated acid of pyridine remains aromatic but pyrrole does not remain aromatic.
(vi) Dipole moment of  is greate than 
(vii) energy needed for homolytic bond fission is less than that required for the heterolytic bond fission.

Space for Rough work

Mathematics PART – III

SECTION – A
(More Than One Correct Type)

This section contains **7 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

37. Let $x, y \in [0, 2\pi]$ and satisfying the equation $\sin^3 x + \cos^3 y + 6\sin x \cos y = 8$. If $\ell = x + y$ and $m = x - y$, then:

(A) least value of ℓ is $\frac{\pi}{2}$ (B) largest value of ℓ is $\frac{5\pi}{2}$

(C) least value of m is $\frac{\pi}{2}$ (D) largest value of m is $\frac{\pi}{2}$

38. If $\sin^{-1}\left(\tan\left(\frac{\pi}{2}\sin\theta\right)\right) + \cos^{-1}\left(\cot\left(\frac{\pi}{2}\cos\theta\right)\right) = \frac{\pi}{2}$, then value of $\sin\frac{\theta}{3}$ can be:

(A) 0 (B) $\frac{1}{2}$

(C) $\frac{1}{\sqrt{2}}$ (D) $\frac{\sqrt{3}}{2}$

39. Let $\alpha, \beta\ and\ \gamma$ be three real numbers. Suppose that $\cos\alpha + \cos\beta + \cos\gamma = 1$ and $\sin\alpha + \sin\beta + \sin\gamma = 1$, then smallest possible value of $\cos\alpha = \frac{-p - \sqrt{q}}{r}$

(where p, q, r $\in \mathbb{Z}^+$)

(A) $p + q + r = 12$ (B) $p + q + r = 10$

(C) $|p + q - r| = 4$ (D) $|p - q + r| = 2$

Space for Rough work

40. Consider an equation $8x^4 - 16x^3 + 16x^2 - 8x + a = 0$ then the sum of all the non-real roots of the equation can be $[a \in \mathbb{R}]$

(A) 1 (B) 2

(C) $\frac{1}{2}$ (D) None of these

41. The vector(s) which is/are coplanar with vectors $\hat{i} + \hat{j} + 2\hat{k}, \hat{i} + 2\hat{j} + \hat{k}$ and perpendicular to the $\vec{c}$, where $\vec{c}$ is unit vector perpendicular to the plane of vectors of vectors $\hat{i} + \hat{j} + \hat{k}$ and $\hat{i} + 2\hat{j} + 3\hat{k}$ is/are:

(A) $3\hat{i} + 4\hat{j} + 5\hat{k}$ (B) $\frac{3}{\sqrt{2}}\hat{i} + 2\sqrt{2}\hat{j} + \frac{5}{\sqrt{2}}\hat{k}$

(C) $-\left(\hat{i} + \frac{4}{3}\hat{j} + \frac{5}{3}\hat{k}\right)$ (D) $\sqrt{3}\hat{i} + \frac{4}{\sqrt{3}}\hat{j} + 5\sqrt{3}\hat{k}$

42. On xy-plane, the path defined by the equation $\frac{1}{x^m} + \frac{1}{y^m} + \frac{k}{(x+y)^n} = 0$ is

(A) a parabola if $m = \frac{-1}{2}, k = -1, n = 0$ (B) a hyperbola if $m = 1, k = -1, n = 0$

(C) a pair of lines if $m = k = n = 1$ (D) a pair of lines if $m = k = -1, n = 1$

43. Let $A = \begin{bmatrix} 2 & 1 \\ 0 & 3 \end{bmatrix}$ be a matrix if $A^{10} = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$, then

(A) $a + d$ is a multiple of 13 (B) b is an even integer

(C) Number of factors of $d - b$ is 11 (D) Number of factors of $a + b + c + d$ is 22

Space for Rough work

(Matching Type)

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer 44, 45 and 46 by appropriately matching the information given in the three columns of the following table.

Column – 1: Real valued function
Column – 2: Domain of the function
Column – 3: Range of the function
Match the following column(s) (where [.] denotes greatest integer function and {.} denotes fractional part function)

	Column –1		Column –2		Column –3
(I)	$f_1(x)=\left[\log_{\sqrt{2}}\sqrt{\left\|(x-1)^3\right\|+\left\|(x-3)^3\right\|}\right]$	(i)	Number of integers in the domain of f(x) is 2	(P)	Set of all non positive integers $\cup\{1\}$
(II)	$f_2(x)=\left[\log_{\sqrt{2}}\left(\sin\left(\ln\left(\frac{\sqrt{4-x^2}}{1-x}\right)\right)+\cos\left(\ln\left(\frac{\sqrt{4-x^2}}{1-x}\right)\right)\right)\right]$	(ii)	Number of integers not in the domain of f(x) is 2	(Q)	Set of all non-negative integers
(III)	$f_3(x)=\left\{\frac{\|x+5\|-2}{x^2+10x+21}\right\}$	(iii)	Number of integers in the domain of f(x) is 3	(R)	Set of all positive integers
(IV)	$f_4(x)=\left[\frac{1}{\sqrt{\ln\left(\cos^{-1}x\right)}}\right]$	(iv)	Number of integers in the domain of f(x) is infinite	(S)	$\left(0,\frac{1}{2}\right]$

44. Which of the following combination is correct?
(A) (I) (iv) (P)
(B) (I) (iv) (R)
(C) (II) (ii) (R)
(D) (III) (i) (S)

45. Which of the following combination is correct?
(A) (IV)(i) (P)
(B) (III) (ii) (S)
(C) (IV) (i) (Q)
(D) (II) (iii) (S)

46. Which of the following combination is correct?
(A) (II)(iv) (P)
(B) (IV) (i) (P)
(C) (II) (i) (P)
(D) (IV) (i) (R)

Space for Rough work

Answer 47, 48 and 49 by appropriately matching the information given in the three columns of the following table.

If three planes are given

$P_1 : 2x + 3y + 4z = 9$

$P_2 : 4x + 5y + 6z = 15$

$P_3 : y + az = b$

And two lines are given

$L_1 : \vec{r} = \left(\hat{i} + a_1\hat{j} + \hat{k}\right) + \lambda\left(b_1\hat{i} + b_2\hat{j} + \hat{k}\right)$

$L_2 : \vec{r} = \mu\left(\hat{i} + \hat{j} + \hat{k}\right)$

Where line L_1 is contained in $\mathrm{P}_1, \mathrm{P}_2$ and P_3:

Then,

	Column –1		Column –2		Column –3
(I)	$b_1 - b_2$ is -3	(i)	Acute angle between P_1 & P_3 is $\cos^{-1}\left(\frac{11}{\sqrt{145}}\right)$	(P)	Image of point $(0, 0, 0)$ w.r.t. P_3 is $\left(0, \frac{6}{\sqrt{5}}, \frac{12}{\sqrt{5}}\right)$
(II)	$a_1 + a$ is 3	(ii)	Acute angle between L_2 & P_3 is $\cos^{-1}\left(\sqrt{\frac{3}{5}}\right)$	(Q)	Image of point $(0, 0, 0)$ w.r.t. line L_1 is $(1, 1, 1)$
(III)	$b + b_1 + b_2$ is 2	(iii)	Distance between L_1 and L_2 is zero	(R)	Distance of point $(0, 0, 0)$ from P_1 measured parallel to L_2 is $\frac{9}{\sqrt{29}}$
(IV)	$\int_{b_2}^{b_1} \{x\}\, dx$ is $\frac{1}{2}$ (where {.} represents fractional part function)	(iv)	Acute angle between L_2 & P_1 is $\sin^{-1}\left(\frac{3\sqrt{3}}{\sqrt{29}}\right)$	(S)	Distance of a point $(1, 0, 0)$ from P_3 measured parallel to L_2 is $\sqrt{3}$

47. Which of the following is correct?

(A) $(\mathrm{I})\ (\mathrm{iii})\ (\mathrm{Q})$

(B) $(\mathrm{II})\ (\mathrm{iii})\ (\mathrm{P})$

(C) $(\mathrm{III})\ (\mathrm{ii})\ (\mathrm{S})$

(D) $(\mathrm{IV})\ (\mathrm{iv})\ (\mathrm{R})$

Space for Rough work

48. Which of the following is correct?

(A) (III) (iv) (S)

(B) (III) (ii) (P)

(C) (IV) (i) (P)

(D) (II) (iii) (R)

49. Which of the following is incorrect?

(A) (II) (i) (P)

(B) (III) (iii) (S)

(C) (III) (iv) (R)

(D) (III) (iii) (P)

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

50. A special deck of cards contains 49 cards, each labeled with a number from 1 to 7 and coloured with one of seven colours. Each number – colour combination appears on exactly one card. Mokshika will select a set of eight cards from the deck at random. Given that she gets atleast one card of each colour and atleast one card with each number, the probability that Mokshika can discard one of her cards and still have atleast one card of each colour and atleast one card with each number is $\frac{p}{q}$, where p and q are relatively prime positive integers. Find $|p-q|$:

51. If $f(y)=\lim\limits_{n\to\infty}\sum\limits_{n=1}^{n}\frac{e^{n+y}(e-1)}{(e^n-1)(e^{n+1}-1)}$ then the value of $\int_0^1 f(x)dx$ is:

52. Let $y=f(x)\,(f:\mathbb{R}\to\mathbb{R})$ be an explicit function defined by the implicit equation $x^3+y^3+3(x^2+y^2)+3(x+y)=14$ and g be the inverse of f. If $\frac{d}{dx}\left(f(x+g(x)).g(x+f(x))\right)$ at $x=-1+\sqrt[3]{15}$ is equal to $\lambda(15)^{2/3}$, where $\lambda\in\mathbb{Z}$, then find the value of $|\lambda|$.

53. The remainder when $2^{\frac{1.2}{2}}+2^{\frac{2.3}{2}}+2^{\frac{3.4}{2}}+.......+2^{\frac{2011.2012}{2}}$ Is divided by 7 is_______

54. Evaluate: $\left[x^2\left(\frac{\cos\left(\cot^{-1}x\right)+\frac{1}{x}\left(\sin\left(\cot^{-1}x\right)\right)}{\cot\left(\cos ec^{-1}x\right)+\tan\left(\cos ec^{-1}x\right)}\right)+\frac{1}{x^4}\right]^{\frac{1}{2}}=$

Space for Rough work

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CONCEPT RECAPITULATION TEST – IV

JEE (Advanced)-2019

PAPER – 1

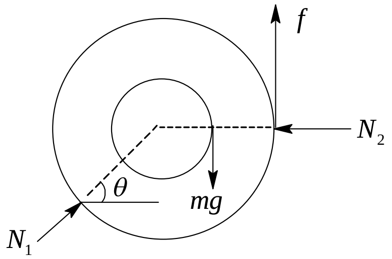
ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. AD

Sol.



$mgr = fR \ --(i)$

$N_1 \sin\theta + f = mg --(ii)$

$N_1 \cos\theta = N_2 ---(iii)$

Solve $(i),(ii)\&(iii)$ to get N_2 and f

So, force at $B = \sqrt{f^2 + N_2^2}$

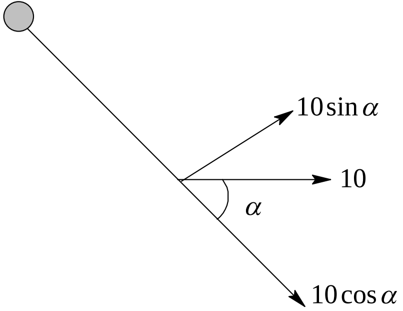
For minimum value of N, use $f \le \mu N_2$

2. ABC

Sol. Use $g_{eff} = g\sin 37 = \frac{3g}{5}$ instead of g in all standard vertical circle cases

3. ABD

Sol. The impulse exerted by the string on the cylinder is equal and opposite to the impulse exerted by the cylinder on the string.



$\vec{J} = 40000 \times 0.25 \times 10^{-3} = 10\,ms$ along the string

For marble,

$J = 0 - \left(-2 \times 10\cos\alpha\right)$

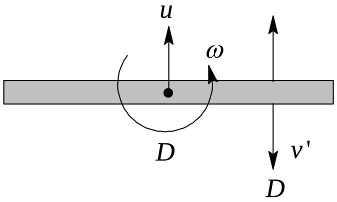
$\because$ final velocity along the string is zero.

Putting $J = 10ms,$ we get $\alpha = 60°$

4. ABC

Sol. The ball has v' component of its velocity perpendicular to the length of rod immediately after collision u is the velocity of CM of the rod and ω is the angular velocity of the rod just after collision.

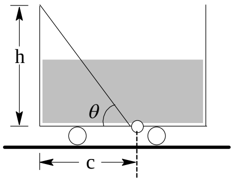
Write velocity of separation = velocity of approach for the point of collision.



Use, conservation of linear momentum perpendicular to the rod and conserve angular momentum about point D

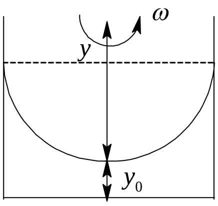
5. AC

Sol. $\tan\theta = \dfrac{h}{c} = \dfrac{a}{g}$

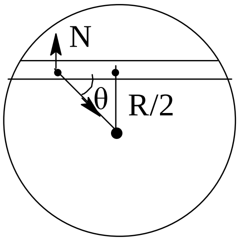


6. ABC

Sol. The equation of free surface is $y = \dfrac{\omega^2 r^2}{2g} + y_0$



7. BC



Sol. Net force towards the centre of the earth $= mg' = mg\frac{x}{R}$ and

$$N = mg'\sin\theta = \frac{mg}{2}$$

8. A
9. B
10. C
11. B
12. A
13. C

SECTION – C

14. 2

Sol. Balancing torque about point O, $NI\left(\pi R^2\right)B = \rho LRV^2\frac{3L}{4}$

[$\because$ force exerted by air on rod $=\left(\rho\frac{L}{2}2R\right)\pi^2 = \rho L_0 RV^2$]

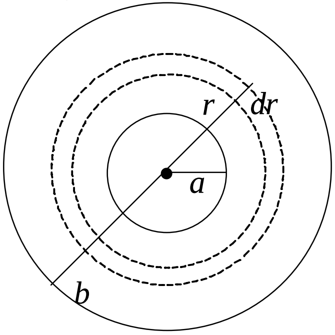
15. 6

Sol. Use Biot-Savart Law:-

$$B = \frac{\mu_0\, qV\sin\theta}{4\pi\ r^2}$$

16. 7

Sol. At any distance r from the axis



$$B = \frac{\mu_0 i}{2\pi r}$$

$$\therefore 4B = \frac{B^2}{2\mu_0} = \frac{\mu_0 i^2}{8\pi^2 r^2}$$

[Magnetic energy density]

$$\int du_B = \int_a^b u_B dv$$

17. 8

Sol. Using energy conservation $\frac{1}{2}Cv_0^2 = \frac{1}{2}Cv^2 + \frac{1}{2}L_0I^2$

Putting all given values

I=6A

18. 4

Sol. Make two separate equations, one f $V(t)$ from 0 to 1 ms and the other from 1 to 2 ms

$V_1 = 4,\ for\ 0-1ms$

And $V_2 = -4t + 4,$ for $t \Rightarrow 1 \rightarrow 2ms$

Chemistry PART – II

SECTION – A

19. ACD

Sol.

$$\mathrm{Al}(OH)_3 + NaOH \longrightarrow Na\left[Al(OH)_4\right]$$

$$sp^2 \qquad\qquad sp^3$$

$$SiF_4 + 2HF \longrightarrow H_2SiF_6$$

$$sp^3 \qquad\qquad sp^3d^2$$

$$2PCl_5 \longrightarrow PCl_4^+ + PCl_6^-$$

$$sp^3d \qquad sp^3 \qquad sp^3d^2$$

20. ABC

Sol. At $104.5°$ angle, $\ell p - \ell p = \ell p - Bp = Bp - Bp$

At $102°$ angle, i.e. bond angle is decreased so, $Bp - Bp > Bp - \ell p > \ell p - Bp$ similarly at 106 angle, is bond angle is increased, $\ell p - \ell p > \ell p - Bp > Bp > Bp - Bp$

Water can form maximum of 4 hydrogen bonds.

21. ABCD

Sol. Salt has equal moles of Na_2CO_3 and $NaHCO_3$ when phenol phthalein indicator is used, only reaction occur till end point is

$$Na_2CO_3 + HCl \longrightarrow NaHCO_3 + NaCl$$

$$40\,mL \qquad 40\,mL$$

$$0.05M \qquad 0.05M$$

$$\because x = 40\,mL$$

When methyl orange is used in an independent titration, 2x mL of HCl would be required for Na_2CO_3 and x mL for original $NaHCO_3$.

$$\because y = 3x = 3 \times 40 = 120\,mL$$

Hence $y - x = 80 \quad and \quad y + x = 160$

If methyl orange is added subsequently at phenol phthalein end point, x mL of HCl would be required for $NaHCO_3$ produced from Na_2CO_3 and x mL for original $NaHCO_3$ i.e. a total of 2x mL of HCl would be required further.

$$NaOH + NaHCO_3 \longrightarrow Na_2CO_3 + H_2O$$

$$2m\,mol \qquad 2m\,mol$$

Volume of $NaOH$ required $= \dfrac{2}{0.10} = 20\,mL = \dfrac{x}{2}mL$

22. ABC

Sol. (A) Molar volume of ideal gas at STP is 22.4 L

(B) AT critical point, z = 3/8

(C) $P_c = a/27b^2$, hence large ‘b’ implies low critical pressure.

(D) As p → 0, gas approaches ideal behaviour hence PV=const. and PV/RT = 1 .

23. CD

Sol. Weak acid and weak base gives less heat in neutralisation hence smaller temperature rise than in cane of strong acids and bases if all other conditions are same.

24. AB

Sol. (A) As some ammonia is removed by 2nd reaction, some N_2H_4 would decompose to restore 1st equilibrium.

(B) As $K_1 < K_2$, less ammonia will be formed than it is decomposed.

(C) Partial pressure of N_2 will increase but it cannot be predicated with guarantee that it would be doubled.

25. ABCD

Sol.

$$Pb(CH_3COO)_2 + K_2CrO_4 \longrightarrow \underset{(Yellow)}{PbCrO_4} + K\,CH_3COO$$

$$Pb(NO_3)_2 + K_2CrO_4 \longrightarrow \underset{(Yellow)}{PbCrO_4} + KNO_3$$

$$AgNO_3 + KI \longrightarrow \underset{(Yellow)}{AgI} + KNO_3$$

$$H_2S + CdSO_4 \longrightarrow \underset{(Yellow)}{CdS} + H_2SO_4$$

26. C
27. D
28. C
29. C
30. B
31. A

SECTION – C

32. 4

Sol.

$$H_2CO_3 \rightleftharpoons H^+ + HCO_3^- \qquad Ka_1 = 4.0 \times 10^{-7}$$

$$HCO_3^- \rightleftharpoons H^+ + CO_3^{2-} \qquad Ka_2 = 5 \times 10^{-11}$$

On adding above two equilibria

$$H_2CO_3 \rightleftharpoons 2H^+ + CO_3^{2-} \quad Ka = 2.0 \times 10^{-17} \; ---(1)$$

$$K_{sp} = [M^{+2}][CO_3^{2-}]$$

$$[CO_3]^{2-}_{minimum} = \frac{K_{sp}}{[M^{+2}]} = \frac{2 \times 10^{-12}}{0.1} = 2 \times 10^{-11} M$$

For equation (1)

$$K_a = \frac{[H^+]^2 [CO_3^{2-}]}{[H_2CO_3]}$$

$$\because 2 \times 10^{-17} = \frac{[H^+]^2 \times 2 \times 10^{-11}}{0.01}$$

$$\because [H^+] = 10^{-4}$$

$$pH = 4$$

33. 3

Sol. $-w = 3320 = p_0 \Delta V = nR\Delta T$

$$\Rightarrow \Delta T = \frac{3320}{2 \times 8.3} = 200$$

$$\Rightarrow q = 14.94\, kJ = nC_p \Delta T$$

And $C_p = \frac{19.94 \times 1000}{2 \times 200} = 37.35\ jK^{-1}\, mol^{-1}$

Also $C_p = \left(\frac{3}{2} + x\right)R,$ where x = atomicity.

$$\Rightarrow x = \frac{C_p}{R} - \frac{3}{2} = \frac{37.35}{8.3} = 1.5 = 3$$

34. 7

Sol.

$$E^{\circ}_{Cl^-/AgCl/Ag} = E^{\circ}_{Ag^+/Ag} + \frac{0.0591}{1} 10g\ K_{sp}$$

$$0.209 = 0.80 + \frac{0.0591}{1} 10g\, K_{sp}$$

$$\because K_{sp} = 10^{-10}$$

Let solubility of AgCl in 0.01 M

$$AgCl \rightleftharpoons \left[Ag^+\right]\left[Cl^-\right]$$

$$10^{-10} = x\left(x + 0.01\right)$$

$$x = 10^{-8}$$

Moles of AgCl dissolved in 10 L = $10^{-8} \times 10 = 10^{-7}$

$$\because y = 7$$

35. 6

Sol. $K_C = \frac{[AB_2]}{[A][B]^2} \Rightarrow \frac{1}{4} = \frac{x}{2 \times (2)^2} \Rightarrow \frac{1}{4} = \frac{x}{2 \times 4} \because x = 2$

$$[AB]_2 = 2$$

Now let y moles of AB_2 is added

$$\because K_C = \frac{(2+y)}{2(2+2)^2} = \frac{1}{4}$$

$$\because \frac{2+y}{2 \times (4)^2} = \frac{1}{4}$$

$$\because \frac{2+y}{8} 1$$

$$y = 8 - 2$$

$$y = 6$$

36. 6

Mathematics

PART – III

SECTION – A

37. ABD

Sol. $\sin^3 x+\cos^3 y+(-2)^3=3.\sin x\cos y(-2)$

$\Rightarrow \sin x+\cos y-2=0$

$\Rightarrow \sin x+\cos y=2$

$\sin x=1$ & $\cos y=1$

$x=\frac{\pi}{2}$ *and* $y=0,2\pi$

38. AD

Sol. $\tan\left(\frac{\pi}{2}\sin\theta\right)=\cot\left(\frac{\pi}{2}\cos\theta\right)$

$\tan\left(\frac{\pi}{2}\sin\theta\right)=\tan\left(\frac{\pi}{2}-\frac{\pi}{2}\cos\theta\right)$

$\Rightarrow \frac{\pi}{2}\sin\theta=n\pi+\frac{\pi}{2}-\frac{\pi}{2}\cos\theta$

$\Rightarrow \sin\theta+\cos\theta=2n+1$

$\Rightarrow \sin\theta+\cos\theta=1,-1$

$\Rightarrow \sin\left(\theta+\frac{\pi}{4}\right)=\pm\frac{1}{\sqrt{2}}$

$\therefore \theta+\frac{\pi}{4}=n\pi+(-1)^n\frac{\pi}{4}$

$\theta=0,\frac{\pi}{2},\pi,\frac{3\pi}{2},2\pi$

But $\theta=\frac{\pi}{2}\&\frac{3\pi}{2}$ are not in domain

$\therefore \sin\frac{\theta}{3}=0,\frac{\sqrt{3}}{2}$

39. ACD

Sol. $a=\cos\alpha+i\sin\alpha$

$b=\cos\beta+i\sin\beta$

$c=\cos\gamma+i\sin\gamma$

then $a+b+c=1+i$

Where a,b,c are complex numbers on the unit circle. Now to minimise $\cos\alpha$, consider a triangle with vertices $a,1+i$ and the origin. We want a as far away from $1+i$ as possible while maintaining a nonnegative imaginary part. This is achieved when $b\,and\,c$ have the same argument, so $|b+c|=|1+i-a|=2$.

Now a,O and $1+i$ form a triangle having side lengths $1,2,\sqrt{2}$

$$\therefore \cos\delta = \frac{1^2 + \left(\sqrt{2}\right)^2 - 2^2}{2\cdot 1\cdot\sqrt{2}}$$

$$= \frac{-1}{2\sqrt{2}}$$

$$and\ \cos\alpha = \cos\left(\frac{\pi}{4} + \delta\right)$$

$$= \cos\frac{\pi}{4}\cos\delta - \sin\frac{\pi}{4}\sin\delta$$

$$= \frac{-1-\sqrt{7}}{4}$$

40. AB

Sol. Substituting $x = y + \frac{1}{2}$

$$8\left(y+\frac{1}{2}\right)^4 - 16\left(y+\frac{1}{2}\right)^3 + 16\left(y+\frac{1}{2}\right)^2 - 8\left(y+\frac{1}{2}\right) + a = 0$$

$$\Rightarrow 8y^4 + 4y^2 + \left(a - \frac{3}{2}\right) = 0$$

Let $y^2 = z$

$$\therefore 8z^2 + 4z + \left(a - \frac{3}{2}\right) = 0$$

Case I:

If $a > \frac{3}{2}$

All roots are non-real

$sum = 2$

Case II

If $a = \frac{3}{2}$

$$8z^2 + 4z = 0$$

$$\Rightarrow 2z^2 + z = 0$$

$$\Rightarrow z = 0; z = -\frac{1}{2}$$

$$\Rightarrow y^2 = 0; y^2 = -\frac{1}{2}$$

$$\Rightarrow \left(x - \frac{1}{2}\right)^2 = 0; \left(x - \frac{1}{2}\right)^2 = \frac{-1}{2}$$

$$\Rightarrow x = \frac{1}{2}, \frac{1}{2}; 2\, non\, real\, roots$$

$sum = 2 = \frac{1}{2} + \frac{1}{2} + \alpha + \beta$

$\therefore \alpha + \beta = 1$

Case III

$a < \frac{3}{2}$

Let $z = k_1 \,\&\, -k_2$

$\therefore y^2 = k_1 \Rightarrow y = \pm\sqrt{k_1}$

$x = y + \frac{1}{2} = \pm\sqrt{k_1} + \frac{1}{2}$

$x = +\frac{1}{2} \pm \sqrt{k_1}$

$\therefore sum = 2 = \left(\frac{1}{2} + \sqrt{k_1}\right) + \left(\frac{1}{2} - \sqrt{k_1}\right) + \alpha + \beta$

$\Rightarrow \alpha + \beta = 1$

41. ABC

Sol. $\vec{c} = \pm\frac{\left(-\hat{i} + 2\hat{j} - \hat{k}\right)}{\sqrt{6}}$

Let $\vec{a} = \hat{i} + \hat{j} + 2\hat{k}$ and $\vec{b} = \hat{i} + 2\hat{j} + \hat{k}$

$\therefore$ A vector coplanar to $\vec{a}\, and\, \vec{b}$ and perpendicular to $\vec{c}$

$\Rightarrow \lambda\left(\left(\vec{a} \times \vec{b}\right) \times \vec{c}\right) = \lambda\left\{\left(\vec{a} \cdot \vec{c}\right)\vec{b} - \left(\vec{b} \cdot \vec{c}\right)\vec{a}\right\}$

$= \pm\frac{\lambda}{\sqrt{6}}\left\{\left(-1 + 2 - 2\right)\left(i + 2\hat{j} + \hat{k}\right) - \left(-1 + 4 - 1\right)\left(\hat{i} + \hat{j} + 2\hat{k}\right)\right\}$

$= \pm\frac{\lambda}{\sqrt{6}}\left(3\hat{i} + 4\hat{j} + 5\hat{k}\right)$

For $\lambda = -\sqrt{6}, \lambda = -\sqrt{3}\, and\, \lambda = \frac{\sqrt{6}}{3}$

42. ABCD

Sol. (A) $\sqrt{x} + \sqrt{y} = 1$

$\Rightarrow x + y + 2\sqrt{xy} = 1$

$\Rightarrow x^2 - 2xy + y^2 - 2x - 2y + 1 = 0$ is a parabola

(B) $\frac{1}{x} + \frac{1}{y} = 1 \Rightarrow xy - x - y = 0$ is a hyperbola

(C) $\frac{1}{x} + \frac{1}{y} + \frac{1}{x + y} = 0 \Rightarrow x^2 + 3xy + y^2 = 0$ pair of straight lines

(D) $x + y - \frac{1}{x + y} = 0 \Rightarrow \left(x + y\right)^2 - 1 = 0$ pair of straight lines

43. ACD

Sol. As $A^n = \begin{bmatrix} 2^n & 3^n - 2^n \\ 0 & 3^n \end{bmatrix}$

$a + d = 2^{10} + 3^{10} = 4^5 + 9^5$ multiple of 13

Also $d - b = 2^{10}, a + b + c + d = 2 \times 3^{10}$

44. B
45. C
46. C

Sol. **(for Q. 44 to Q. 46)**

(I) $\frac{(3-1)^3}{4} \le |x-1|^3 + |x-3|^3 < \infty$

(II) $u = \sin\left(\ln\left(\frac{\sqrt{4-x^2}}{1-x}\right)\right) + \cos\left(\ln\left(\frac{\sqrt{4-x^2}}{1-x}\right)\right)$

$\because 0 \le \frac{\sqrt{4-x^2}}{1-x} < \infty$

$-\infty < \ln\left(\frac{\sqrt{4-x^2}}{1-x}\right) < \infty$

So, $-\sqrt{2} \le u \le \sqrt{2}$

(III) Let $|x+5| = t;$ $\quad g(t) \in \left(0, \frac{1}{2}\right] - \left\{\frac{1}{4}\right\}$

$g(t) = \frac{t-2}{(t-2)(t+2)}$

(IV) $0 \le \cos^{-1} x \le \pi$

$-\infty < \ln\left(\cos^{-1} x\right) \le \ln \pi < 2$

47. B
48. A
49. C

Sol. **(for Q. 47 to Q. 49)**

Point $(1, a_1, 1)$ lies on P_1 and P_2

$2 + 3a_1 + 4 = 9 \Rightarrow a_1 = 1$

$(b_1, b_2, 1)$ is $\perp$ to normal of planes $P_1, P_2 \,\&\, P_3$

$2b_1 + 3b_2 + 4 = 0$

$4b_1 + 5b_2 + 6 = 0$

$\Rightarrow b_1 = 1, \; b_2 = \ldots \quad a = 2, b = 3$

SECTION – C

50. 5

Sol. First note that out of the 8 selected cards, one pair of cards have to share the same number and another pair of cards have to share the same colour. Now, these 2 pairs of cards cannot be the same or else there will be 2 cards which are completely same.

Then WLOG let the numbers be $1,1,2,3,4,5,6$ and 7 and the colours be

a,a,b,c,d,e,f and g. We therefore obtain only 2 cases:

Case I: $1a1b\,2a,3c,4d,5e,6f,7g$. In this case, we can discard $1a$

There are $2\times 6=12$ situation in this case

Case II: $1b,1c,2a,3a,4d,5e,6f$ and $7g$. In this case, we cannot discard. There are

${}^6C_2=15$ situations in this case.

Probability $=\dfrac{12}{12+15}=\dfrac{4}{9}\therefore|p-q|=5$

51. 1

Sol.
$$f(y)=e^y\lim_{n\to\infty}\sum_{n=1}^{n}\left(\frac{(e^{n+1}-1)-(e^n-1)}{(e^n-1)(e^{n+1}-1)}\right)$$
$$=e^y\lim_{n\to\infty}\sum_{n=1}^{n}\left(\frac{1}{e^n}-\frac{1}{e^{n+1}-1}\right)$$
$$=\frac{e^y}{e-1}$$
$$\therefore\int_0^1 f(x)dx=\frac{1}{e-1}\int_0^1 e^x dx=1$$

52. 0

Sol.
$$(x+1)^3+(y+1)^3=16$$
$$y=-1+\left(16-(x+1)^3\right)^{1/3}=f(x)$$
$$x=-1+\left(16-(y+1)^3\right)^{1/3}$$
$$\therefore f^{-1}(x)=-1+\left(16-(x+1)^3\right)^{1/3}=g(x)$$
$$\Rightarrow f(x)=g(x)$$
$$f\left(-1+\sqrt[3]{15}\right)=g\left(-1+\sqrt[3]{15}\right)=0$$
$$\therefore f\left(x+g(x)\right).g\left(x+f(x)\right)=\left(f\left(x+f(x)\right)\right)^2$$
$$\therefore\frac{d}{dx}\left(f\left(x+f(x)\right)\right)^2=2f\left(x+f(x)\right).f'\left(x+f(x)\right).\left(1+f'(x)\right)$$
$$\frac{d}{dx}\left(f\left(x+f(x)\right)\right)^2 \text{ at } x=-1+\sqrt[3]{15}=0$$

53. 1

Sol. $Since\ 2^3 \equiv 1(\bmod 7)$

Let $S \equiv 2^{\frac{1.2}{2}} + 2^{\frac{2.3}{2}} + 2^{\frac{3.4}{2}} + ... + 2^{\frac{2011.2012}{2}}$

$$\equiv \left(2^1 + 2^0 + 2^0 + 2^1 + ... + 2^0 + 2^1\right)(\bmod 7)$$

$$\equiv \left(\frac{2010}{3}\left(2^1 + 2^0 + 2^0\right) + 2^1\right)(\bmod 7)$$

$$\equiv \left(670 \times 4 + 2\right)(\bmod 7)$$

$$\equiv 1(\bmod 7)$$

54. 1

Sol. $$\left[x^2\left(\frac{\frac{x}{\sqrt{1+x^2}} + \frac{1}{x}\left(\frac{1}{\sqrt{1+x^2}}\right)}{\sqrt{x^2-1} + \frac{1}{\sqrt{x^2-1}}}\right) + \frac{1}{x^4}\right]^{\frac{1}{2}}$$

$$= \left[x^2\left(\frac{\sqrt{x^4-1}}{x^3}\right)^2 + \frac{1}{x^4}\right]^{\frac{1}{2}}$$

$$= \left[\frac{x^4}{x^4}\right]^{\frac{1}{2}}$$

$$= 1$$

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – IV

JEE (Advanced)-2019

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 231**

General Instructions:

- The test consists of total 69 questions.
- Each subject (PCM) has 23 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Three Sections**: **Section-A, Section-C & Section-D.**

__Section-A (01 – 03, 24 – 26, 47 – 49)__ contains 9 multiple choice questions which have __only one correct answer__. Each question carries __+3 marks__ for correct answer and __–1 mark__ for wrong answer.

__Section-A (04 – 08, 27 – 31, 50 – 54)__ contains 15 multiple choice questions which have __one or more than one correct__ answer. Each question carries __+4 marks__ for correct answer and __–2 mark__ for wrong answer.

Partial Marks **+1** for each correct option provided no incorrect options is selected.

__Section-A (09 – 10, 32 – 33, 55 – 56)__ contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has __only one correct__ answer and carries __+3 marks__ for correct answer. There is no negative marking.

__Section-C (11 – 20, 34 – 43, 57 – 66)__ contains 30 Numerical based questions with answer as numerical value from __0 to 9__ and each question carries __+3 marks__ for correct answer. There is no negative marking.

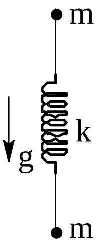
__Section-D (21 – 23, 44 – 46, 67 – 69)__ contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries __+4 marks__ for correct answer and __–1 mark__ for wrong answer.

Physics PART – I

SECTION – A
(Single Correct Choice Type)

This section contains **3 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

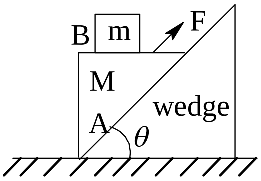
1. A mass m is hung on an ideal massless spring. Another equal mass is connected to the other end of the spring. The whole system is at rest. At t = 0, m is released and the system falls freely under gravity. Assume that natural length of the spring is L_0, its initial stretched length is L and the acceleration due to gravity is g. What is distance between masses as function of time?



(A) $L_0+(L-L_0)\cos\sqrt{\frac{2k}{m}}t$ (B) $L_0+(L-L_0)\cos\sqrt{\frac{k}{m}}t$

(C) $L_0-2(L+2L_0)\cos\sqrt{\frac{2k}{m}}t$ (D) $L_0+(L-L_0)\sin\sqrt{\frac{2k}{m}}t$

2. Wedge is fixed on horizontal surface. Triangular block A of mass M is pulled upward by applying a constant force F parallel to incline of the wedge as shown in the figure and there is no friction between the wedge and the block A, while coefficient of friction between A and block B of mass m is μ. If there is no relative motion between A and B then frictional force developed between A and B is



(A) $\left[\frac{F+(m+M)g\sin\theta}{(m+M)}\right]m\cos\theta$ (B) μmg

(C) $\left[\frac{F-(m+M)g\sin\theta}{(m+M)}\right]m\cos\theta$ (D) $\mu mg/2$

Space for Rough work

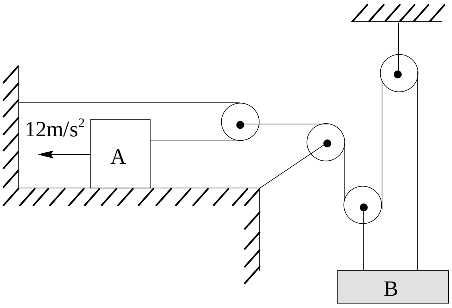
3. Assuming only translational motion of blocks A and B. Find the acceleration of B.

(A) 6m/s^2

(B) 2m/s^2

(C) 4m/s^2

(D) None of these



(One or More than one correct type)

This section contains **5 questions**. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

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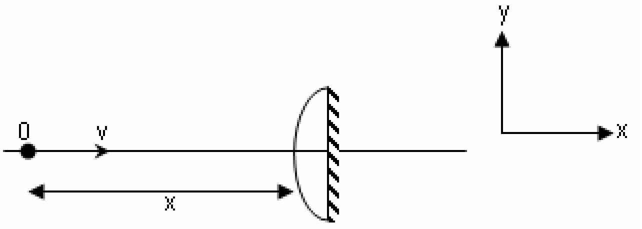
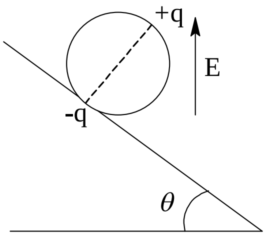
4. When object 'O' moves towards a fixed lens mirror combination, select correct choice/choices:



(A) Image moves towards negative x-axis
(B) Speed of image and object may be same
(C) Image may move faster than object
(D) Image may come closer to arrangement

5. Two point charges $+q$ and $-q$ are fixed on diametrically opposite point on the uniform ring, such that $-q$ is at bottom and is in contact with a perfect insulator incline plane. Total mass is equal to m. It remains in equilibrium on the rough inclined plane in the presence of uniform vertical electric field $\vec{E}$. Then



(A) The value of friction force is $mg\sin\theta$

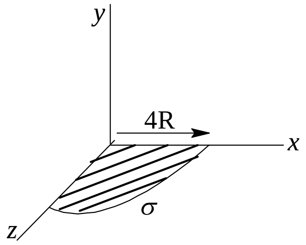
(B) The value of friction force is less than $mg\sin\theta$

(C) The value of electric field is $\frac{mg}{2q}$

(D) The value of electric field is $\frac{mg\tan\theta}{2q}$

Space for Rough work

6. Quarter non–conducting disc of radius 4R having uniform surface charge density σ is placed in xz-plane then which of the following is the correct:



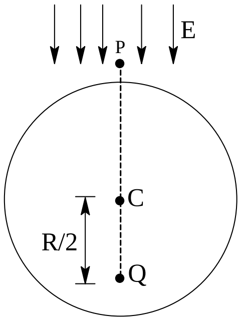
(A) Electric potential at (0, 3R, 0) is $\frac{\sigma R}{4\varepsilon_0}$

(B) Electric potential at (0,0,0) is $\frac{\sigma R}{2\varepsilon_0}$

(C) Electric field at (0, 3E, 0) is symmetric with x and z axis

(D) Electric field intensity at (-4R, 0, -4R) is equally inclined with x and z axis

7. A positive charge q is placed inside a neutral hollow conducting sphere of radius R, as shown in figure. Whole system is placed in uniform external vertical electric field pointing downward (line PCQ is also vertical) then select the correct statement(s) about electric field at point P. Point P is a point of the material inside the conductor.



(A) Electric field due to outer surface of sphere at point P is zero

(B) Magnitude of electric field due to inner surface of sphere at point P is $q/9\pi\varepsilon_0 R^2$

(C) Magnitude of electric field at point P, due to hollow sphere is less than E

(D) Direction of resultant electric field at point P due to charge q and hollow sphere is vertically upward

8. The particle displacement of a travelling longitudinal wave is represented by S = f (x, t). The midpoints of a compression zone and an adjacent rarefaction zone are represented by the letter 'C' and 'R'. Which of the following is true?

(A) $\left|\frac{\partial S}{\partial x}\right|_{C} = \left|\frac{\partial S}{\partial x}\right|_{R}$

(B) $\left|\frac{\partial S}{\partial t}\right|_{C} = \left|\frac{\partial S}{\partial t}\right|_{R} = 0$

(C) $(\text{pressure})_C - (\text{pressure})_R = 2\left|\frac{\partial S}{\partial x}\right|_{C} .(\text{bulk modulus of air})$

(D) Particles of air are stationary mid-way between 'C' and 'R'.

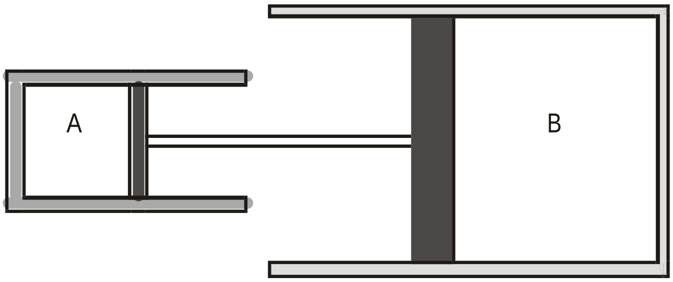
Space for Rough work

Paragraph type (One Option Correct)

This section contains **1 paragraph** each describing theory, experiment, data etc. **Two questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Questions 9 & 10

Two fixed and horizontal cylinders A and B having pistons (both massless) of cross sectional area 100 cm^2 and 200 cm^2 respectively, are connected by massless rod. The piston can move freely without friction. The cylinder A contains 100 gms of an ideal gas (γ = 1.5) at pressure 10^{5}N/m^2 and temperature T$_0$. The cylinder B contains identical gas at same temperature T$_0$ but has different mass. The piston are held at the state such that volume of gas in cylinder A and cylinder B are same and is equal to 10^{-2}m^3. The walls and piston of cylinder A are thermally insulated where as gas in cylinder B is maintained at constant temperature T$_0$. The whole system is in vacuum. Now the pistons are slowly released and they move towards left and mechanical equilibrium is reached at the state when the volume of gas in cylinder A becomes $25\times10^{-4}\ \text{m}^3$.



9. The mass of gas in cylinder B is
(A) 200 gms (B) 600 gms
(C) 500 gms (D) 1 kg

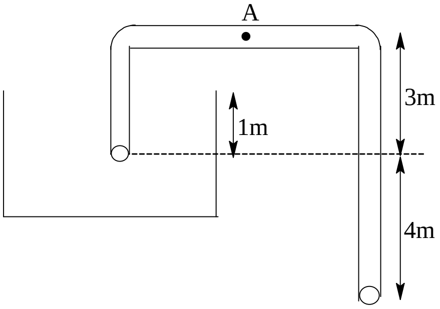
10. The change in internal energy of gas in cylinder A is :
(A) 2000 J (B) 1000 J
(C) 500 J (D) 3000 J

Space for Rough work

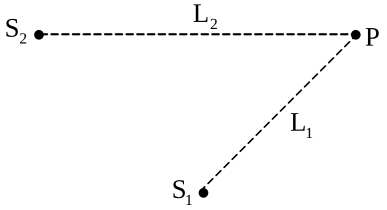
SECTION – C
(Single digit integer type)

This section contains **10 questions**. The answer to each question is a **Single Digit Integer** ranging from 0 to 9, both inclusive.

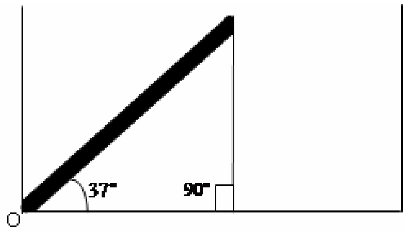
11. A liquid of specific gravity 0.5 is filled in a large container shown in figure. Area of cross section of tube is negligible as compare to the area of cross section of container then the magnitude of gauge pressure at point A is given by $\frac{x}{20}\text{atm}$ then x is :



12. Two sound sources shown in the figure vibrate in phase. By moving S_1 along PS_1 consecutive minima are heard when $L_1\text{-}L_2$ has values, 20cm, 60cm and 100 cm. If the frequency of sound source is $\frac{1700}{n}\text{Hz}$. Then find the value of n: [Speed of sound is 340 m/s]

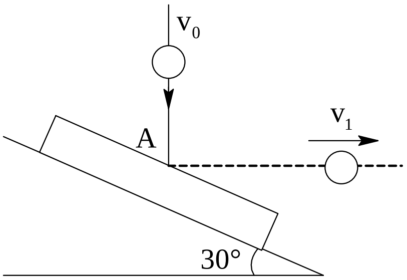


13. A cylindrical rod of uniform cross section, is attached at O in a water tank. The linear mass density of rod is $\lambda_0 x$, where x is distance of the element of the rod, from end O as shown in figure. If the tension in string is given by $\frac{10^4}{P}\text{N}$ then P is (Length of rod 1m, radius of area of cross section is $\frac{1}{\sqrt{\pi}}\text{m}, \rho_{\text{water}} = 1000\text{kg m}^{-3},\ \text{g}=10\text{ms}^{-2}, \lambda_0 = 10^3$ in S.I. unit)

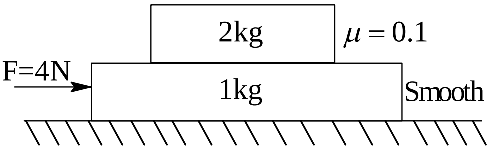


Space for Rough work

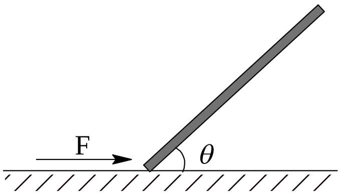
14. A steel ball falling vertically strikes a fixed rigid plate A with velocity v_0 and rebounds horizontally as shown. Assuming surface to be same and the effect of gravity on motion of ball to be neglected. If the coefficient of the restitution for the ball is 'e' then the value of $\frac{1}{e}$ is:



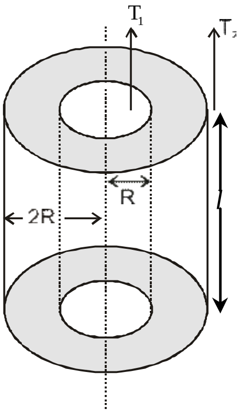
15. 2 kg block is kept on 1 kg block as shown. Both blocks are initially at rest. The friction between 1 kg block and fixed surface is absent and the coefficient of friction between 2kg block and 1 kg block is μ = 0.1. A constant horizontal force F=4 N is applied on 1 kg block. If the work done by the friction on 1 kg block in 2s is – XJ, then find the value of X.



16. A force F is applied to a uniform, thin rod of mass 4 kg and length $\ell = 50\ \text{cm}$. The rod has pure translational motion in the vertical plane along a smooth, horizontal surface as shown. If F = 60 N, the angle θ for translation of rod in the given orientation comes to be $\theta = \tan^{-1}\left(\frac{2}{X}\right)$. Find X.



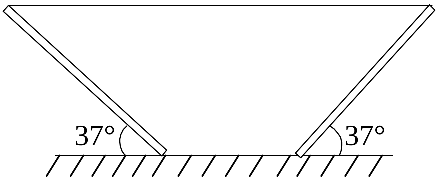
17. Inner surface of a cylindrical shell of length ℓ and of material of thermal conductivity k is kept at constant temperature T_1 and outer surface of the cylinder is kept at constant temperature T_2 such that $(T_1 > T_2)$ as shown in figure. Heat flows from inner surface to outer surface radially outward. Inner and outer radii of the shell are R and 2R respectively. Due to lack of space this cylinder has to be replaced by a smaller cylinder of length $\frac{\ell}{2}$ inner and outer radii $\frac{R}{4}$ and R respectively and thermal conductivity of material nk. If rate of radially outward heat flow remains same for same temperatures of inner and outer surface i.e. T_1 and T_2, then find the value of n.



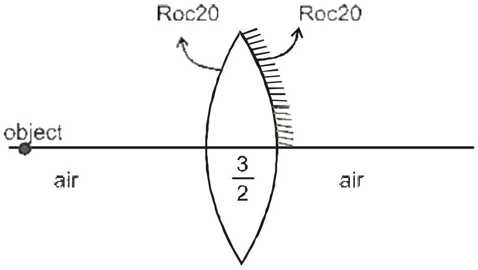
Space for Rough work

18. In a certain hypothetical radioactive decay process, species A decays into species B and species B decays
in to species C according to the given reactions.
A→2B + particles + energy
B→3C + particles + energy
The decay constant for species A is $\lambda_1 = 1\ \sec^{-1}$ and that for species B is $\lambda_2 = 100\ \sec^{-1}$. Initially 10^4 moles of species of A were present, while there were none of B and C. It was found that species B reaches its maximum number at a time t_0 = 2 ln (10) sec. Calculate the value of maximum number of moles of B.

19. Two uniform identical rods of same mass are tied together with the help of a string and balanced as shown in the figure. The minimum coefficient of friction for which the system will remain in equilibrium in the position is $\frac{2}{x}$. The value of 'x' is



20. Distance between two images formed by upper and lower part of the point object placed at 30 cm from given lens is (60 + x) cm, then the value of x is:



Space for Rough work

SECTION – D
(Numerical Answer Type)

This section contains **3 questions**. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded - off to the **second decimal place**; e.g. xxxxx.xx).

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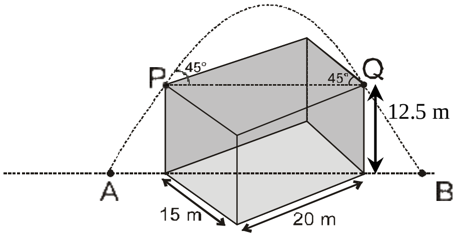
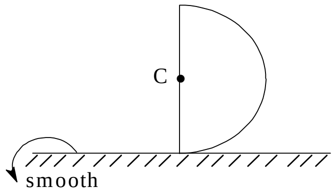
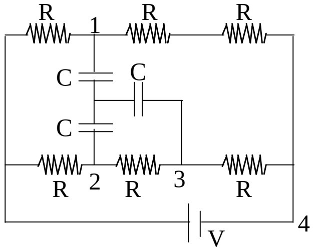
21. A commander fires a shell at certain angle of projection from 'A' which clears the building (cuboid) of dimensions 20 × 15 × 12.5 m^3 in its diagonal plane. Shell just clears the roof diagonally at points P and Q and falls on the other side of the building at B, and makes 45° angle with horizontal at P and Q as shown in the figure. If the range AB of the shell is $N\times\sqrt{3}$ metre then find N. (g = 10 m/s^2)



22. If angular acceleration of the uniform disc just after release from rest position shown in figure is $\frac{8\pi g}{NR}$, then calculate N. (C is centre of semi-circular disc.) ($\pi^2 = 10$)



23. In the show circuit, all three capacitor are identical and have capacitance $C\mu F$ each. Each resistor has resistance of $R\Omega$. An ideal cell of emf V volts is connected as shown. If the magnitude of potential difference across capacitor C_3 in steady state is $\frac{a}{b}$V then value of $a \times b$ is:



Space for Rough work

Chemistry PART – II

SECTION – A
(Single Correct Choice Type)

This section contains **3 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

24. $\left[Ni\left(H_2O\right)_6\right]^{+2}$ complex typically absorbs at 600 nm. It is allowed to react with ammonia where a new complex $\left[Ni\left(NH_3\right)_6\right]^{+2}$ is formed, this complex should have absorption nearly at:

(A) 800 nm (B) 550 nm
(C) 650 nm (D) 600 nm

25. Which of the following statements is correct about behaviour of radicals?
(A) All radicals are very selective in their attack on other species.
(B) Radical reaction occur only in gas phase
(C) Radical may be produced by polar molecules like R – X in gas phase but not in aqueous phase.
(D) Radical can only be generated by non-polar molecules like alkanes

26. An amount of 1 mole each of A and D is introduced in 1L container, simultaneously the following two equilibria are established:

$$A \rightleftharpoons B + C \quad K_C = 10^6 M^2 \ \& B + D \rightleftharpoons A \quad K_C = 10^{-6} M^{-1}$$

The equilibrium concentration of A will be:

(A) 10^{-6}M (B) 10^{-3}M
(C) 10^{-12}M (D) 10^{-4}M

Space for Rough work

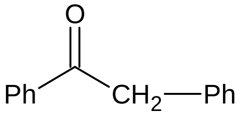
(One or More than one correct type)

This section contains **5 questions**. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

27. $N \equiv C\text{-}CH_2 - OCMe_3 \xrightarrow[(ii)\ H_2O,\ HI]{(i)\ PhMgBr}$

The major product(s) of above reaction ore:

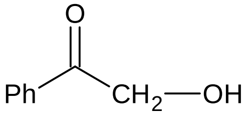
(A)



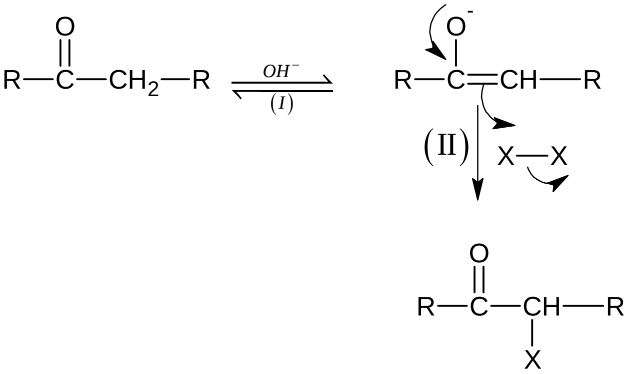
(B) CH_3OH

(C) CMe_3I

(D)



28. The correct statement(s) regarding the iodination of ketones is (are):

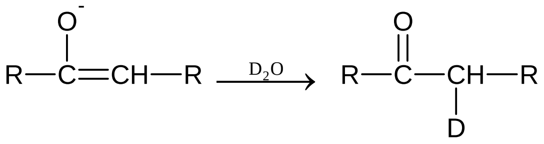


(A) Step (I) is slow and rate determining

(B) The reaction exhibit kinetic isotopic effect i.e. $k_H > k_D$

(C) Step (II) is slow and rate determining

(D)



this occurs at similar rate as step (II)

Space for Rough work

29. Two moles of an ideal gas $\left(\gamma = 5/3\right)$ is subjected to following changes in state:

$$A\left(500k, 5bar\right) \xrightarrow[\text{Isothermal expansion}]{\text{reversible}} B \xrightarrow[\text{cooling}]{\text{Isochoric}} C\left(250k, 1bar\right) \xrightarrow[\text{adiabatic compresion}]{\text{Single stage}} D\left(3bar\right)$$

The correct statement(s) is (are):

(A) The pressure at B is 2.0 bar

(B) The temperature at D is 450 bar

(C) $\Delta \mathrm{H}_{\mathrm{CD}} = 1000\mathrm{R}$ & $\Delta H_{AB} = \Delta U_{AB}$

(D) $\Delta U_{BC} = 375R \,\&\, \Delta H_{ABCD} \neq 0$

30. A concentrated solution of H_2SO_4 is added to saturated solution of sodium dichromate as:

$$Na_2Cr_2O_7 + H_2SO_4 \longrightarrow {}'A' + Na_2SO_4 + H_2O$$

Which of the following statement(s) regarding $'A'$ is/are correct?

(A) $'A'$ is an orange solid and is an acidic oxide

(B) $'A'$ is a green solid and is an amphoteric oxide

(C) $'A'$ dissolves in alkalies forming a yellow coloured solution

(D) On heating $'A'$ loses oxygen & forms a green coloured compound.

31. Which of the following property(ies) are identical for body centered & face centered cubic crystal with same unit cell edge length.

(A) Distance between the nearest neighbours in BCC and distance between a tetrahedral void and octahedral void in FCC

(B) Coordination number of corner atom in FCC (if all tetrahedral voids are filled) and BCC

(C) Number of octahedral voids in FCC and number of tetrahedral voids in BCC

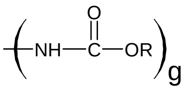
(D) Distance between second nearest neighbour in FCC & BCC

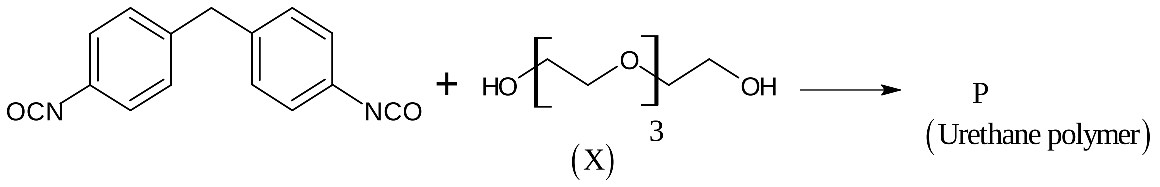
Space for Rough work

Paragraph type (One Option Correct)

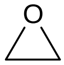
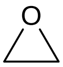
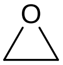
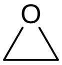
This section contains **1 paragraph** each describing theory, experiment, data etc. **Two questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Questions 32 & 33

Isocyanates can undergo polymerisation with alcohols to form polymers containing  $\left(-NH-\overset{O}{\overset{\|}{C}}-OR\right)$ group and are called urethanes – hybrids between carbonates and urea i.e. half esters & half amides of carbonic acid. Consider the following polymerisation between diaryl diisocyanate with long chain aliphatic diol is:



32. Which of the following is incorrect about the polymerisation reaction?
    (A) It involves nucleophilic addition of alcohol on isocyanate.
    (B) It involves nucleophilic addition elimination.
    (C) On adding an amine RNH_2 to the polymer, the new functional group is urea rather than urethane.
    (D) The amine added attack terminal isocyanate of the polymer.

33. The diol (X) can be synthesized by which of the reaction?
    (A) 4  $\xrightarrow[\text{excess}]{H_2O}$
    (B) 4  $\xrightarrow{CH_3CH_2OH}$
    (C) 4  $\xrightarrow[\text{limited}]{H_2O}$
    (D) 4  $\xrightarrow[HCl]{H_2O}$

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **10 questions**. The answer to each question is a **Single Digit Integer** ranging from 0 to 9, both inclusive.

34. The total energy of an electron in H-atom is given by

$E_n = \frac{-e^2}{8\pi \in_0 a_0 n^2}$ where n – shell number , a_0 – Bohr radius, $\in_0$ – Permittivity of the medium

An electron in a shell in H-atom has total energy $E = \frac{-e^2}{72\pi \in_0 a_0}$.

One of the subshell of this shell is described by radial part of wave function as

$\psi(r) = \frac{1}{81\sqrt{2\pi}}\left(\frac{1}{a_0}\right)^{3/2} \frac{r^2}{a_0^2} e^{-r/3a_0}$. The degeneracy of this subshell is:

35. How many of the following species contain one or more lone pair(s) on central atom, that is present in an orbital having contribution from d-orbital.

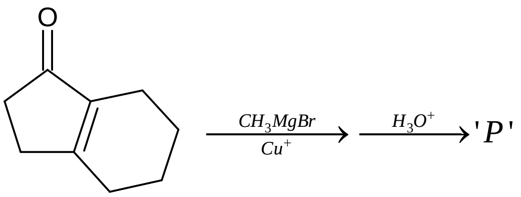
SOF_4 $SeOCl_2$ SeF_3^+

XeF_5^+ BrF_6^- TeF_5^- ICl_4^-

36. The enthalpies of combustion of formaldehyde & paraformaldehyde (a cyclic polymer of formaldehyde) are -112 and -356 k cal/mol, respectively. The enthalpy of polymerisation of paraformaldehyde is $-92\,\text{k cal}$ per mole. If the molecular formula of paraformaldehyde is represented as $(\text{CH}_2\text{O})_\text{n}$ then the value of n is:

Space for Rough work

37.



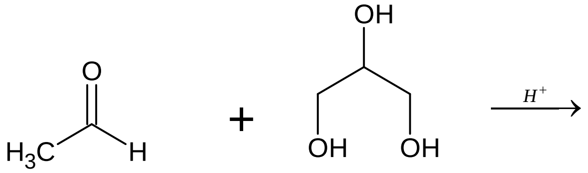
Number of $-OH$ groups in P is(are)?

38. Total number of molecules that can be hydrolysed at room temperature are:

XeF_4 NCl_3 NF_3 CCl_4 PCl_3 SF_6 TeF_6 $SeBr_4$

39. Dibromoacetic acid $(CHBr_2\,COOH)$ is oxidised to CO_2, H_2O & Br_2 by 12 equivalents of an oxidising agent. Same amount of acid can be neutralised by $'y'$ moles of NaOH. The value of 'y' is:

40. Number of optically active isomers formed by the given reaction is(are):



41. Number of sugars that give same osazone as given by D-glucose.

D-Mannose, D-Fructose, $D-$galactose, Starch, $D-$aldopentose

42. In a certain polluted atmosphere containing O_3 at a steady state concentration of 2×10^{-8}M, the hourly production of O_3 by all sources was estimated as 7.2×10^{-15}M. If only mechanism for the destruction of O_3 is of second order, the rate constant (in ml mol^{-1} s^{-1}) for the destruction reaction is:

43. Among the following, number of sols containing negatively charged colloidal particles is/are:

Soap solution of sodium stearate, sol of AgCl obtained by adding excess $AgNO_3$ to KCl solution, gold sol, $Fe(OH)_3$ sol, silcic acid sol, Basic dye, metal sulphide sol, acidic dye.

Space for Rough work

SECTION – D
(Numerical Answer Type)

This section contains **3 questions**. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded - off to the **second decimal place**; e.g. xxxxx.xx).

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44. Fumaric acid $C_4H_4O_4$ present in 1g sample of mushroom was titrated using phenolphalein as indicator against OH^- ions which were obtained by electrolysis of water. As soon as OH^- ions are produced, they react with fumaric acid & at complete neutralisation immediately a pink colour is obtained. If electrolysis was done for 8685 seconds using 50mA current to reach end point, what was percentage of fumaric acid in mushroom.

45. The acid ionisation of hydrated alluminium ion is:

$$\left[Al\left(H_2O\right)_6\right]^{+3}(aq.)+H_2O(\ell)\rightleftharpoons\left[Al\left(H_2O\right)_5OH\right]^{+2}(aq.)+H_3O^+(aq.)$$

$$K_a=1.0\times10^{-5}$$

How many milligrams of $AlCl_3$ should be dissolved in sufficient water to get 400 ml of solution of pH, 3.0.

46. Two weak acids HA_1 & HA_2 each with same concentration & having pK_a values 3 & 5 are placed in contact with hydrogen electrode (1 atm 25°C) & are interconnected through a salt bridge. Emf of the cell in volt is: [Take $\frac{RT}{F}(2.303)=0.06$]

Space for Rough work

Mathematics PART – III

SECTION – A
(Single Correct Choice Type)

This section contains **3 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

47. If $P(\theta)$ and $Q\left(\frac{\pi}{2}+\theta\right)$ are two points on the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1,$ locus of the mid-point of PQ is:

(A) $\frac{x^2}{a^2}+\frac{y^2}{b^2}=\frac{1}{2}$ (B) $\frac{x^2}{a^2}+\frac{y^2}{b^2}=4$

(C) $\frac{x^2}{a^2}+\frac{y^2}{b^2}=2$ (D) None of these

48. If A,B,C are acute positive angles, then $(\sin A+\sin B)(\sin A+\sin C)\frac{(\sin B+\sin C)}{\sin A\sin B\sin C}$ is:

(A) <8 (B) ≥ 8

(C) $=2$ (D) None of these

49. If $k>0,|z|=|\omega|=k,$ and $\alpha=\frac{z-\overline{\omega}}{\mathrm{k}^2+z\overline{\omega}},$ then $\mathrm{Re}(\alpha)$ is equal to:

(A) $2k$ (B) $k/2$

(C) k (D) 0

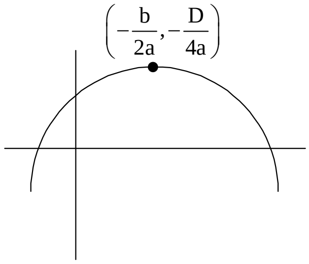
Space for Rough work

(One or More than one correct type)

This section contains **5 questions**. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

50. L_1 and L_2 are two lines whose vector equations are
$L_1 : \vec{r} = \lambda((\cos\theta + \sqrt{3})\hat{i} + (\sqrt{2}\sin\theta)\hat{j} + (\cos\theta - \sqrt{3})\hat{k})$
$L_2 : \vec{r} = \mu\left(a\hat{i} + b\hat{j} + c\hat{k}\right)$, where λ and μ are the scalars and α is the acute angle between L_1 and L_2. If the angle α is independent of θ, then the value of α is
(A) $\frac{\pi}{6}$ (B) $\frac{\pi}{4}$
(C) $\frac{\pi}{3}$ (D) $\frac{\pi}{2}$

51. The graph of $f(x) = ax^2 + bx + c$ is
(A) $ac < 0$ (B) $bc > 0$
(C) $ab > 0$ (D) $abc < 0$



52. If P and Q are represented by the complex number z_1 and z_2 such that $|1/z_2 + 1/z_1| = |1/z_2 - 1/z_1|$ then
(A) ΔOPQ (Where O is the origin) is equilateral
(B) ΔOPQ is right angled
(C) The circumcenter of ΔOPQ is $\frac{1}{2}(z_1 + z_2)$
(D) The circumcenter of ΔOPQ is $\frac{1}{3}(z_1 + z_2)$

53. Let $\left(1+x^2\right)^2 \left(1+x\right)^n = \sum_{k=0}^{n+4} a_k x^k$. If a_1, a_2 and a_3 are in arithmetic progression, then the possible value/values of n is/are
(A) 5 (B) 4
(C) 3 (D) 2

Space for Rough work

54. Consider the ellipse $\frac{x^2}{f\left(k^2+2k+5\right)}+\frac{y^2}{f\left(k+11\right)}=1$. If $f\left(x\right)$ is a positive decreasing function then

(A) The set of values of k for which the major axis is the $x-axis$ is (-3,2)

(B) The set of values of k for which the major $axis$ is the $y-axis$ is $\left(-\infty,2\right)$

(C) The set of values of k for which the major $axis$ is the $y-axis$ is $\left(-\infty,-3\right)\cup\left(2,\infty\right)$

(D) The set of values of k for which the major $axis$ is the $y-axis$ is $\left(-3,\infty\right)$

Paragraph type (One Option Correct)

This section contains **1 paragraph** each describing theory, experiment, data etc. **Two questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Questions 55 & 56

A box has 10 coins. Five have heads on both sides. Three have tails on both sides; two are fair. A coin is chosen at random and tossed.

55. Probability that head appears is

(A) $\frac{4}{5}$ (B) $\frac{2}{5}$

(C) $\frac{3}{5}$ (D) $\frac{1}{5}$

56. Probability that the coin is fair given that head has appeared is

(A) $\frac{5}{6}$ (B) $\frac{1}{6}$

(C) $\frac{3}{8}$ (D) $\frac{5}{8}$

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **10 questions**. The answer to each question is a **Single Digit Integer** ranging from 0 to 9, both inclusive.

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57. In equilateral triangle ABC of side p, a square is inscribed in its incircle. If area of the square is p^2/k then value of *k* is

58. *f* is a function such that $f(x)+2f(1-x)=x^2+1$. Value of $f(3)$ is

59. Degree of differential equation of family of ellipses of same size having minor axis along a given line is

60. Coefficient of x^6 in the expansion of $(1+x+x^2+x^3)^{-3}$ is

61. If the line $3x+4y=12$ intersects the hyperbola at *P* & P' and its asymptotes at *Q* and *Q* then value of $\dfrac{PQ}{P'Q'}+\dfrac{PQ'}{P'Q}$ is

62. Let $A=\begin{bmatrix}3 & -4\\ 1 & -1\end{bmatrix}$, if let $(A+A^2+A^3+A^4+\ldots+A^n)=64,$ then value of *n* is

63. If the number of the positive integral solution of equation $\left[\dfrac{x}{9}\right]=\left[\dfrac{x}{11}\right]$ is *n*, then $\dfrac{n}{3}$ is$\left([\cdot]\,\text{denotes}\,\text{GIF}\right)$.

64. $\text{f(x)}=\max|2\sin y-x|$ Where $y\in R$ then minimum value of f(x) is

65. If $\text{f(n)}=\dfrac{1}{\pi}\displaystyle\int_0^{\pi/2}\dfrac{\sin^2 n\theta}{\sin^2\theta}d\theta,\ (n\in N)$, then the value of $\dfrac{\text{f(15)}+\text{f(3)}}{\text{f(15)}-\text{f(9)}}$ is

66. The sum to infinity of the series $\dfrac{5}{3^2.2}+\dfrac{7}{3^4.2}+\dfrac{1}{3^3.4}+\dfrac{11}{3^5.20}+.....$ is K/9 then K is

Space for Rough work

SECTION – D
(Numerical Answer Type)

This section contains **3 questions**. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded ‑ off to the **second decimal place**; e.g. xxxxx.xx).

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67. The points of discontinuity of $y = g\left(u\right) = \dfrac{1}{u^2 + u - 2}$, where $u = \dfrac{1}{x-1}$ are x_1, x_2, x_3 find the value of $x_1 + x_2 + x_3 = ?$

68. If $\int_0^1 \dfrac{x^b - 1}{\ln x} dx = \ln\left(12.4\right)$, where $\left(b \geq 0\right)$ then value of $'b'$

69. Three students appear in three examinations. The number of possible ways in which we can have result such that any students fails in all examinations nor neither these is a examination which is not cleared by any student is

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Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – IV

JEE (Advanced)-2019

PAPER – 2

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. A

Sol. In CM frame both the mass execute SHM with

$$\omega = \sqrt{\frac{k}{\mu}} = \sqrt{\frac{2k}{m}} SHM$$

Initially particles are at extreme

Distance = $L_0 + (L - L_0)\cos\sqrt{\frac{2k}{m}}t$

2. C

Sol. $$\mathrm{a}=\left[\frac{\mathrm{F\text{-}(m+M)g\sin\theta}}{\mathrm{(m+M)}}\right]$$

So, $\mathrm{f=ma}\cos\theta$

$$\mathrm{a}=\left[\frac{\mathrm{F\text{-}(m+M)g\sin\theta}}{\mathrm{(m+M)}}\right] m\cos\theta$$

3. B

Sol. $\mathrm{a_B=2m/s^2}\ (\uparrow)$

$$(\ell - x_3) + (x_2 - x_3) = k_1$$

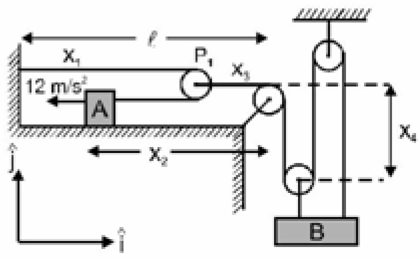
& $x_3 + 3x_4 = k_2$

$$a_2 - 2a_3 = 0 \Rightarrow a_3 = \frac{a_2}{2} = \frac{12}{2} = 6m/s^2$$

[$a_3 \Rightarrow$ acceleration of P_1 pulley]

$$-a_3+3a_4=0 \quad \Rightarrow a_4=\frac{a_3}{3}=\frac{6}{3}=2m/s^2$$

[$a_4 \Rightarrow$ acceleration of block B]



4. ABCD

Sol. The above lens mirror combination is an equivalent converging mirror.

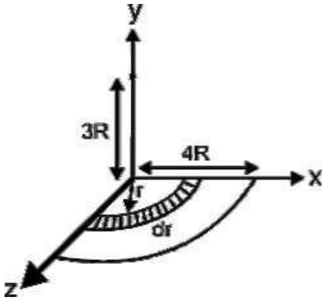
5. AC

Sol. $\text{f=mg}\sin\theta$ and $\text{PE}\sin\theta\text{=mg}\sin\theta\text{.R}$

$\text{q 2 R E}\sin\theta\text{=mg}\sin\theta\text{ R}$

$$\text{E}=\frac{\text{mg}}{\text{2q}}$$

6. ABCD



Sol. (A) $$\text{v}=\int_0^{4r}\frac{K\frac{\pi}{2}rdr\sigma}{\sqrt{r^2+(3R)^2}}=\frac{\sigma R}{4\varepsilon_0}$$

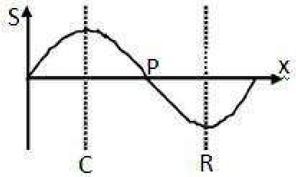
(B) $$\text{v}=\int_0^{4r}\frac{K\frac{\pi}{2}rdr\sigma}{r}=\frac{\sigma R}{2\varepsilon_0}$$

7. BD

Sol. External electric field and induced charge on outer surface of the sphere will produce a net zero field inside it. Net field at P must be vertically upward.

8. ACD

Sol. $\text{P}_\text{C}\text{-P}_\text{R}\text{=2BAK} \qquad \text{S=A sin(kx-}\omega\text{t)}$



9. D

10. A

Sol. (for Q. 9 to Q.10)

Let the initial temperature, pressure and volume of gas in 'A' be $\text{T}_0, \text{P}_0, \text{V}_0$ and the area of the position A and B be a, 2a. Now gas in chamber 'A' undergoes adiabatic compression whereas gas in chamber 'B' undergoes isothermal expansion.

Now solving for gas in 'A'

$$\text{P}_{1A}\text{V}_{1A}^{\gamma}=\text{P}_{2A}\text{V}_{2A}^{\gamma}\Rightarrow \text{P}_0\text{V}_0^{\gamma}\text{=P}_{2A}(0.25\text{V}_0)\Rightarrow \text{P}_{2A}\text{=8P}_0$$

Solving for gas in 'B'

$$\text{P}_{1B}\text{V}_{1B}\text{=P}_{2B}\text{V}_{2B}\Rightarrow \text{P}_{1B}\text{V}_0\text{=P}_{2B}\times 2.5\text{V}_0\Rightarrow \text{P}_{2B}\text{=0.4P}_{1B}$$

Also $(\text{P}_{2A}\times\text{a})=(\text{P}_{2B}\times\text{2a})\text{ for gas is chambers 'B'}$

$\Rightarrow 8P_0 a = P_2 \times 2a \Rightarrow P_2 = 4P_0$

$\Rightarrow 0.4\,P_1 = 4P_0 \Rightarrow P_1 = 10P_0$

Now comparing the moles of gas in A and B

$$n_A = \frac{P_0 V_0}{RT_0}$$

$$n_B = \frac{10P_0V_0}{RT_0} = 10n_A$$

$$m_B = 10m_A = 10\times 100\text{gm} = 1\text{kg}$$

Again for gas is $A, \Delta Q = \Delta U + \Delta W$

$\Rightarrow 0 = \Delta U + \Delta W$

$$\Rightarrow 0 = \Delta U + \left\{\frac{P_0V_0 - 8P_0 \times \frac{V_0}{4}}{(\gamma - 1)}\right\}$$

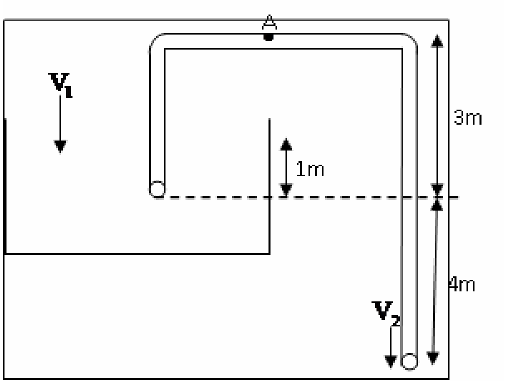
$$\Rightarrow \Delta U = 2P_0V_0 = 2\times 10^5 \times 10^{-2} = 2000\text{J}$$

$$F = 8P_0 a = 8\times 10^5 \times 10^{-2} = 8000\text{N}$$

SECTION – C

11. 7

Sol. $P_0 + \frac{\rho v_1^2}{2} + 0 = P_A + \rho g h + \frac{\rho v_2^2}{2}$



$\left(\because V_2 = \sqrt{2g\times 5} = 10 >> V_1\right)$

$$\left(\frac{\rho v_1^2}{2} - \frac{\rho v_2^2}{2}\right) - \rho g h = \left(P_A - P_0\right)$$

$$\left(P_A - P_0\right) = -\rho g h - \frac{\rho v_2^2}{2}$$

$$= -\frac{10^3}{2}\times 10\times 2 - \frac{10^3}{2}\times\frac{10\times 10}{1} = -\frac{7}{2}\times 10^4$$

$$= -\frac{7}{20}\times 10^5\,\text{N/m}^2 = -\frac{7}{20}\,atm$$

12. 2

Sol. The minima will be heard at P when a crest from S_1 and a trough from S_2 reach there at the same time. This will happen if $L_1 - L_2$ is $\lambda/2$ or $\lambda + (\lambda/2)$ or $2\lambda + (\lambda/2)$ and so on. Hence, the increase in L_1 between consecutive minima is λ_1 and from the data we see that $\lambda = 0.40\text{m}$.

Then $\lambda = v/f \Rightarrow f = 340/0.40 = 850\text{Hz}$.

13. 6

Sol. $$X_{CM} = \frac{\int dm.x}{\int dm} = \frac{2L}{3}$$

Mass of rod;

$$M = \int_0^L \lambda_0 x\, dx = \frac{10^3}{2}$$

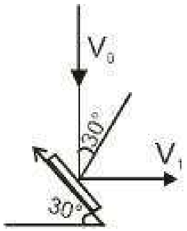
Torque about 'O';

$$F_B \frac{L}{2}\cos37^o - Mg\frac{2L}{3}\ \cos 37^o = TL\cos 37^o$$

$$10^3\pi\left(\frac{1}{\pi}\right)\times 10\frac{1}{2} - \frac{10^4}{2}\times\frac{2}{3} = T$$

$$T = \frac{10^4}{6}N$$

14. 1



Sol. $$V_0\sin30^o = V_1\cos30^o \qquad (i)$$

$$eV_0\cos 30^o = V_1\sin 30^o \qquad (ii)$$

Dividing (i) & (ii)

$$\frac{1}{e}\tan30^o = \frac{1}{\tan30^o} \qquad \frac{1}{e} = 3$$

15. 8

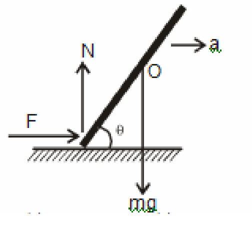
Sol. $f=2N$

$a_1Kg = 2m/s^2$

$$S = \frac{1}{2}\times2\times4 = 4m$$

$$W_{friction} = -2\times4 = -8J$$

16. 4



Sol. Since the rod is in translation so $\alpha = 0$

$\therefore$ about O,

$$F\frac{\ell}{2}\sin\theta - N\frac{\ell}{2}\cos\theta = 0$$

$$\Rightarrow F\sin\theta = N\cos\theta$$

$$\Rightarrow \tan\theta = \frac{N}{F} ------(1)$$

$$Also, \quad N = Mg ---(2)$$

$$So, \Rightarrow \tan\theta = \frac{Mg}{F} = \frac{40}{60} = \frac{2}{3}$$

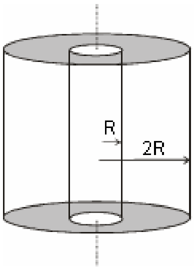
$$\therefore \theta = \tan^{-1}\left(\frac{2}{3}\right)$$

$$X = 3$$

17. 4

Sol. $H = -K.2\pi r \,/\, \dfrac{dT}{dr}$

$$\int_{R_1}^{R_2} \frac{Hdr}{2\pi rl} = -K\int_{T_1}^{T_2} dT \Rightarrow H = \frac{2\pi lk\left(T_1 - T_2\right)}{\ln\dfrac{R_2}{R_1}} H_i = H_f$$



18. 2

Sol. $\dfrac{dN_A}{dt} = -\lambda_1 N_A, \dfrac{dN_B}{dt} = 2\lambda_1 N_A - \lambda_2 N_B$

$$N_B = \text{maximum} \Rightarrow \frac{dN_B}{dt} = 0$$

$$\Rightarrow 2\lambda_1 N_A = \lambda_2 N_{B_{\max}} \quad \Rightarrow N_{B_{\max}} = \frac{2\lambda_1}{\lambda_2} N_A$$

$$\Rightarrow N_{B_{\max}} = \frac{2\lambda_1}{\lambda_2} N_0 e^{-\lambda_1 t} = 2$$

19. 3

Sol. T the FBD of any one rod is

$$T = \mu N - - - - - - - - (1)$$

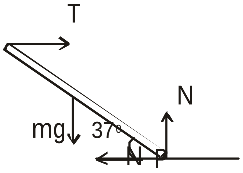
$$mg = N - - - - - - - - (2)$$

Taking torque of any one rod is

$$\text{mg}\frac{\text{L}}{\text{g}}\cos 37^{\text{o}} = \text{TL}\sin 37^{\text{o}}$$

$$\text{T} = \frac{\text{mg}}{2}\frac{4}{3} = \frac{2\text{mg}}{3}$$

$$\frac{2\text{mg}}{3} = \mu\text{mg} \Rightarrow \mu = \frac{2}{3}$$



20. 6

Sol. $\dfrac{1}{\text{f}_\text{L}} = \left(\dfrac{3}{2} - 1\right)\left(\dfrac{1}{20} - \dfrac{1}{20}\right)$

$$\Rightarrow \text{F}_L = 20cm$$

$$\frac{1}{\text{f}} = \frac{1}{-10} - \frac{2}{20} = -\frac{1}{5}$$

$$\frac{1}{v} + \frac{1}{-30} = \frac{1}{-5} \Rightarrow \frac{1}{v} = \frac{1}{30} - \frac{1}{5}$$

For lens $\dfrac{1}{v} - \dfrac{1}{-30} = \dfrac{1}{20}$

SECTION – D

21. 00025.00

Sol. $\overline{PQ} = \sqrt{15^2 + 20^2} = 25m$

$$25 = \frac{V_P^2 \sin 2(45)}{g} \text{Þ} V_P = 5\sqrt{10} \text{m/s}$$

$$\therefore V_A^2 \sin^2\theta - 2\times10\times12.5 = \left(5\sqrt{5}\right)^2 \Rightarrow V_A \sin\theta = 5\sqrt{15} \text{m/s}$$

$$V_A \cos\theta = V_P \cos 45^o = 5\sqrt{5} \text{m/s and } \theta = 60^o$$

$$\therefore \overline{AB} = \frac{V_A^2 \sin 2\theta}{g} = 25\sqrt{3}$$

22. 00030.00

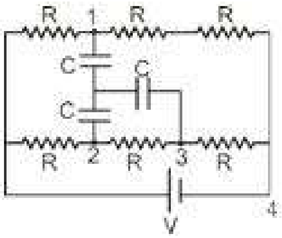
Sol. Consider equation of torque about C

$$\left[mg\frac{4R}{3\pi}\right] = \frac{mR^2}{2}\alpha$$

$$\alpha = \frac{8g}{3\pi R} = \frac{8\pi g}{3\pi^2 R} = \frac{8\pi g}{30R}$$

23. 00018.00

Sol. No current passes through capacitors in steady state. Assume potential at point '4' to be zero.

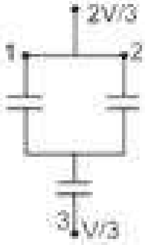


Then points '1' and '2' are at same potential $\frac{2V}{3}$

Hence $C_1$and C_2 can be taken in parallel

The potential at point 3 is $\frac{V}{3}$

$\therefore$ Equivalent circuit of all three capacitors is shown Hence potential difference across capacitor C_3 is



$$= \frac{2C}{2C+C} \times \left(\frac{2V}{3} - \frac{V}{3}\right) = \frac{2V}{9}$$

Chemistry

PART – II

SECTION – A

24. B

Sol. NH_3 is a stronger field ligand than H_2O & causes greater crystal field splitting.

25. C

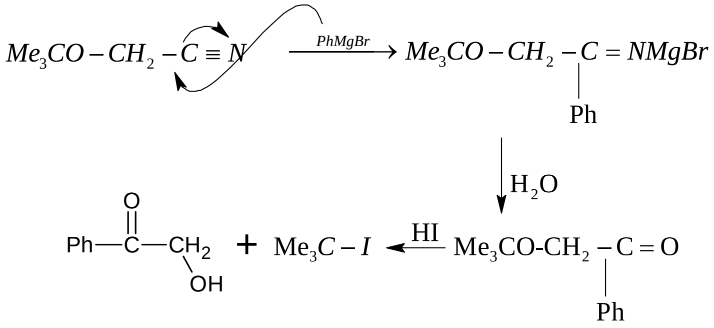
Sol. Radical are generally non-selective in their attack & readily combine with any species having unpaired electron & these can be produced by polar species like R – X in gas phase or in non polar solutions.

26. A

Sol.
$$\mathrm{A} \rightleftharpoons B + C \qquad K_C = 10^6$$
$$1-x \qquad x \qquad x$$
$$\approx 0 \qquad \approx 1M \qquad \approx 1M$$
$$B + \quad D \quad \rightleftharpoons A \qquad K_C = 10^{-6}$$
$$1-x \; 1-x \qquad x$$
$$\approx 1 \;\; \approx 1 \qquad \frac{x}{(1)(1)} = 10^{-6} \Rightarrow x = 10^{-6}$$

27. CD

Sol.



28. ABD

Sol. First step involving formation of carbanion is slow & second is fast. Once the carbanion is formed, it undergoes rapid attack by an electrophile

29. ABC

Sol.
$$\Delta U_{BC} = nC_V\left(T_2 - T_1\right) = -750R,\ \Delta H_{CD} = nC_p\left(T_2 - T_1\right)$$
$$B \to C$$
$$\frac{P_B}{T_B} = \frac{P_C}{T_C} \Rightarrow P_B = 2\,bar$$
$$C \to D$$
$$nC_V\left(T_2 - T_1\right) = -P_{ex}\left(V_2 - V_1\right)$$

$\Delta H_{ABCD} \neq 0$ as the whole process is not cyclic

$$\Delta H_{AB} = \Delta U_{AB} = 0 \because \Delta T = 0$$

30. ACD

Sol. $'A'\,is\,CrO_3$

$$CrO_3 + NaOH \longrightarrow \underset{yellow\,solution}{Na_2CrO_4} + H_2O$$

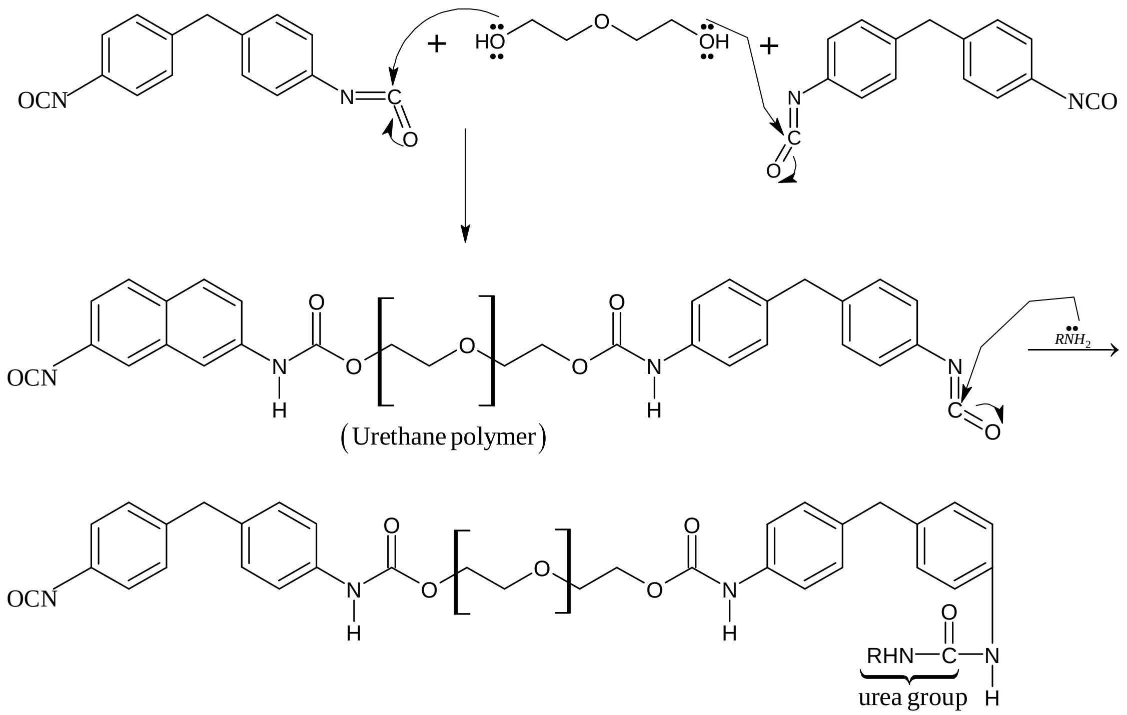
$$CrO_3 \xrightarrow{heat} Cr_2O_3 + O_2$$

31. ABD

Sol. Distance between nearest neighbours in BCC = Distance between test & octahedral void in FCC $= \sqrt{3}a/4$ and distance between second nearest neighbours in both is a

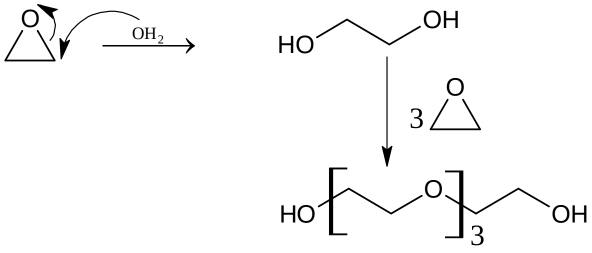
32. B

Sol.


OCN
N=C
O
+
HO
O
OH
+
N
C
O
NCO
OCN
O
N
H
O
O
O
O
N
H
N
C
O
RNH2
(Urethane polymer)
OCN
O
N
H
O
O
O
O
N
H
O
RHN—C—N
H
urea group

33. C

Sol.


O
OH2
HO
OH
3
O
HO
O
3
OH

SECTION – C

34. 5

Sol. n=3

The subshell of this shell contains no radial node as described by wave function

So it is 3d.

35. 3

Sol. SOF_4 is sp^3d hybrid but contains no lone pair.

SeF_3^+ & $SeOCl_2$ contains lone pairs in sp^3 orbitals (no d - character)

XeF_3^+ is pentagonal bipyramidal with one lone pair.

BrF_6^- is perfectly octahedral containing lone pair in pure s-orbital

TeF_5 & ICl_4^- are sp^3d^2 hybrid with one & two lone pairs respectively.

36. 4

Sol.

$$CH_2O + O_2 \longrightarrow CO_2 + H_2O \;\; \Delta H_1 = -112 ----(1)$$

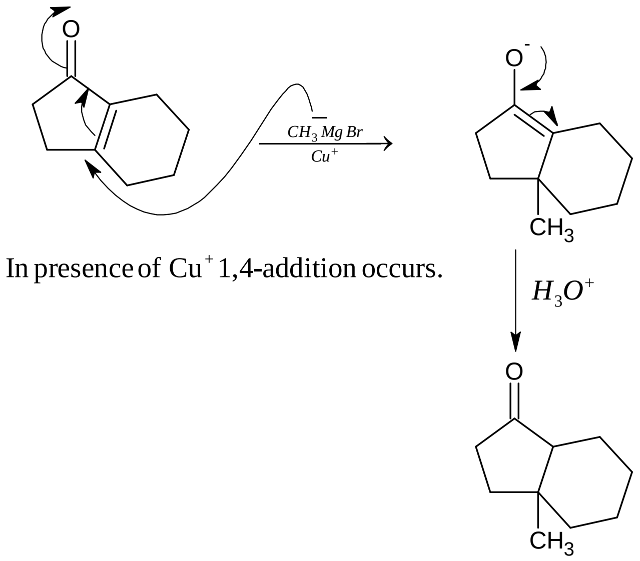
$$nCH_2O + nO_2 \longrightarrow nCO_2 + nH_2O \;\; \Delta H_2 = -356 ---(2)$$

$$nCH_2O \longrightarrow (CH_2O)_n \;\; \Delta H_3 = -92\,k\,Cal ----(3)$$

Equation (1)× n – equation (2) = equation (3)

37. 0

Sol.



In presence of Cu^+ 1,4-addition occurs.

38. 5

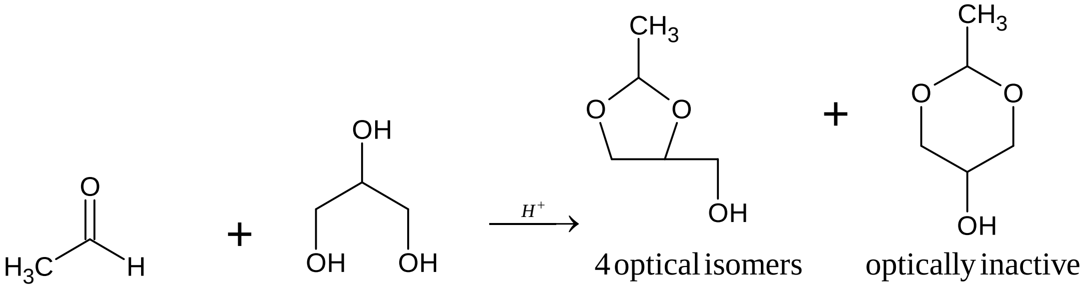
Sol. $XeF_4, NCl_3, PCl_3, TeF_6, SeBr_4$ are hydrolysed at room temperature but NF_3, CCl_4 & SF_6 are either not hydrolysed or require drastic conditions for hydrolysis.

39. 2

Sol. $(n_f)_{reaction} = 6$

40. 4

Sol.



41. 2

Sol. Sugars differing around C_1 & C_2 only give same osazone.

42. 5

Sol.
$$\text{r=k}\left[O_3\right]^2$$
$$-\frac{d\left[O_3\right]}{dt}=k\left[O_3\right]^2$$
$$=k\left(2\times10^{-8}\right)^2$$

43. 5

Sol. Soap solution, acidic sols, sulfide sols, metal sols & acidic dyes are negatively charged.

SECTION – D

44. 00026.10

Sol.
$$2H_2O+2e\xrightarrow{electrolysis}H_2+2OH^-$$
$$\text{millimoles}\,of\ OH^-\ \ produced=\frac{50\times8685}{96500}=4.5$$

Milimoles of acid present $=2.25$

Mass present $=0.261g$

Percentage $=26.100$

45. 05340.00

Sol. $\left[H_3O^+\right]=\sqrt{CK_a}$

Milligram of $AlCl_3=C\times0.4\times M_{AlCl_3}\times10^3$

46. 00000.06

Sol.
$$H^+\left(HA_1\right)\longrightarrow H^+\left(HA_2\right)\&\qquad H^+=\sqrt{Ka.C}$$
$$E_{cell}=0-\frac{0.06}{1}\log\frac{\sqrt{10^{-5}.C}}{\sqrt{10^{-3}.C}}$$

Mathematics PART – III

SECTION – A

47. A

Sol. $\because P \equiv \left(a\cos\theta, b\sin\theta\right)$

And $Q \equiv \left(a\cos\left(\frac{\pi}{2}+\theta\right), b\sin\left(\frac{\pi}{2}+\theta\right)\right)$

$Q \equiv \left(-a\sin\theta, b\cos\theta\right)$

Let midpoint of PQ is (x, y), then

$$\frac{2x}{a} = \left(\cos\theta - \sin\theta\right)$$

$$\frac{2y}{b} = \left(\sin\theta + \cos\theta\right)$$

Squaring and adding equation (iii) and equation (iv), we get

$$\Rightarrow \frac{x^2}{a^2} + \frac{y^2}{b^2} = \frac{1}{2}$$

48. B

Sol. Since $A.M. \geq G.M.$

$\therefore \sin A + \sin B \geq 2\sqrt{\sin A.\sin B}$

Similarly, $\sin B + \sin C \geq 2\sqrt{\sin B.\sin C}$

And $\sin C + \sin A \geq 2\sqrt{\sin C.\sin A}$

$$\Rightarrow \left(\sin A + \sin B\right)\left(\sin B + \sin C\right)$$
$$\left(\sin C + \sin A\right) \geq 8\sin A.\sin B.\sin C$$

49. D

Sol. $\overline{\alpha} = \dfrac{\overline{z} - \omega}{k^2 + \overline{z}\omega}$

But $z\overline{z} = \omega\overline{\omega} = k^2, thus$

$$\overline{\alpha} = \frac{\frac{k^2}{z} - \frac{k^2}{\overline{\omega}}}{k^2 + \frac{k^2}{z}\frac{k^2}{\overline{\omega}}} = \frac{\overline{\omega} - z}{z\overline{\omega} + k^2} = -\alpha$$

$$\Rightarrow \alpha + \overline{\alpha} = 0$$

$$\Rightarrow \operatorname{Re}\left(\alpha\right) = 0$$

50. A

Sol. Both the lines passes through the origin. Line L_1 is parallel to the vector $\vec{V}_1$.

$\vec{V}_1 = \left(\cos\theta + \sqrt{3}\right)\hat{i} + \left(\sqrt{2}\sin\theta\right)\hat{j}\left(\cos\theta - \sqrt{3}\right)\hat{k}$

And L_2 is parallel to the vector $\vec{V}_2$.

$$\therefore\ \cos\alpha = \frac{\vec{V}_1.\vec{V}_2}{\left|\vec{V}_1\right|\left|\vec{V}_2\right|} = \frac{a\left(\cos\theta+\sqrt{3}\right)+\left(b+\sqrt{2}\right)\sin\theta+c\left(\cos\theta-\sqrt{3}\right)}{\sqrt{a^2+b^2+c^2}\sqrt{(\cos\theta+\sqrt{3})^2+2\sin^2\theta(\cos\theta+\sqrt{3})}}$$

$$= \frac{(a+c)\cos\theta+b\sqrt{2}\sin\theta+(a-c)\sqrt{3}}{\sqrt{a^2+b^2+c^2}\sqrt{2+6}}$$

For cosα to be independent of θ, we get
a + c = 0 and b = 0

$$\therefore\ \cos\alpha = \frac{2a\sqrt{3}}{a\sqrt{2}.2\sqrt{2}} = \frac{\sqrt{3}}{2} \text{ or } \alpha = \frac{\pi}{6}$$

51. ABD

Sol. From the graph it is clear that a < 0 and c > 0.

Now since vertex is in first quadrant $-\frac{b}{2a} > 0$.

$-b < 0 \Rightarrow b > 0$

52. BC

Sol. $\left|\frac{1}{z_2}+\frac{1}{z_1}\right| = \left|\frac{1}{z_2}-\frac{1}{z_1}\right| \Rightarrow |z_1+z_2| = |z_1-z_2|$

$\Rightarrow \cos(\theta_1 - \theta_2) = 0$ where θ_1 and θ_2 are arguments of z_1 and z_2.

53. BCD

Sol. Equating coefficients of x, x^2 and x^3 both sides we get,

$a_1 = n$, $a_2 = \frac{n(n-1)}{2}+2$, $a_3 = \frac{n(n-1)(n-2)}{6}+2n$.

Now $2a_2 = a_1 + a_3$ gives $n^3 - 9n^2 + 26n - 24 = 0$

54. AC

Sol. f(x) is a decreasing function and for the major axis to be the x-axis.
$f(k^2 + 2k + 5) > f(k + 11)$
or $k^2 + 2k + 5 < k + 11$
or k (–3, 2)
Then for the remaining values of k, i.e., $k \in (-\infty, -3) \cup (2, \infty)$ k, the major axis is the y-axis.

55. C

Sol. $$\frac{{}^5C_1+\frac{1}{2}\times{}^2C_1}{10} = \frac{3}{5}$$

56. B

Sol. $$p(F/H) = \frac{P(F)P(H/F)}{\sum P(Hi)\times P(Hi/F)}$$

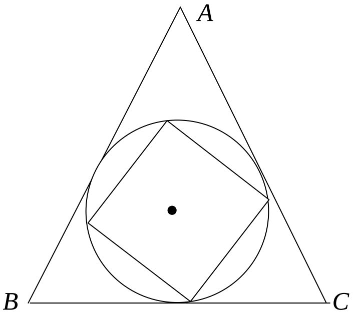
$F \rightarrow$ fair coin
$H \rightarrow$ head appears

$$P(H/F) = \frac{\frac{1}{5}\times\frac{1}{2}}{\frac{1}{5}\times\frac{1}{2}+\frac{4}{5}\times\frac{5}{8}} = \frac{1}{6}$$

SECTION – C

57. 6

Sol.



$$R = \frac{a}{2\sin A} = \frac{P}{\sqrt{3}}$$

$$r = 4R\sin\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2} = \frac{R}{2}$$

$$\Rightarrow r = \frac{P}{2\sqrt{3}}$$

$\Rightarrow$ side of $= r\sqrt{2} = \frac{P}{\sqrt{6}}$

Area = $\frac{P^2}{6} \Rightarrow K = 6$

58. 0

Sol. $f(x) + 2f(1-x) = x^2 + 1 \quad .....(1)$

Replace x by (1-x)

$f(1-x) + 2f(x) \neq (1-x)^2 + 1 \quad ....(2)$

(2) – (1)

$3f(x) = 2(1-x)^2 + 2 - x^2 - 1$

$f(3) = 0$

59. 1

Sol. Let equation of line along minor axis is

$lx + my + n = 0$

$$\frac{(x-\alpha)^2}{a^2} + \frac{(y-\beta)^2}{b^2} = 1$$

$l\alpha + m\beta + n = 0$

$\Rightarrow$ only one arbitary constant will be left (size is same)

$\Rightarrow$ degree of differential equation will be ‘1’

60. 9

Sol. $(1 + x + x^2 + x^3)^{-3}$

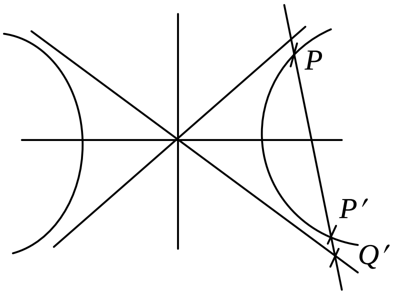
$$=\left(\frac{1-x^4}{1-x}\right)^{-3}=\left(1-x^4\right)^{-3}\left(1-x\right)^{-1}$$

Coefficient of x^r in expansion of $\left(1-x\right)^{-n}$ is ${}^{n+r-1}C_r$

61. 2

Sol. For any line in case of hyperbola we know that $PQ = P'Q'$

$$\frac{PQ}{P'Q'}+\frac{PQ'}{P'Q}=1+\frac{PP'+P'Q'}{PP'+PQ}=2$$



62. 8

Sol. $=\begin{bmatrix}3 & -4\\1 & -1\end{bmatrix}^k=\left(\begin{bmatrix}1 & 0\\0 & 1\end{bmatrix}+\begin{bmatrix}2 & -4\\1 & -2\end{bmatrix}\right)^k$

$=\begin{bmatrix}1 & 0\\0 & 1\end{bmatrix}+k\begin{bmatrix}2 & -4\\1 & -2\end{bmatrix}\left(\text{as}\begin{bmatrix}2 & -4\\1 & -2\end{bmatrix}^2=0\right)$

$=\begin{bmatrix}1+2k & -4k\\k & 1-2k\end{bmatrix}$

$\Rightarrow \sum_{k=1}^{n}A^k=\begin{bmatrix}n+n(n+1) & -2n(n+1)\\ \frac{n(n+1)}{2} & n-n(n+1)\end{bmatrix}$

$\Rightarrow$ Let $\left(\sum_{k=1}^{n}A^k\right)=n^2=64$

$\Rightarrow n=8$

63. 8

Sol. $[\mathrm{x}/9]=[\mathrm{x}/11]=\mathrm{I}$

$\Rightarrow I\le x/9<I+1,\ I\le x/11<I+1,$ Solution is possible only when $11\mathrm{I}<9\mathrm{I}+9$

$\Rightarrow 0\le I<\frac{9}{2}$

Total number of solution $\sum_{I=0}^{4}(9\text{-}2\mathrm{I})\text{-}1=24$

64. 2

Sol. $f(x)=2-x \qquad x\le 0$

$2+x \qquad x>0$

Hence minimum value of $f(x)=2$

65. 3

Sol. $$f(n+1)-f(n)=\frac{1}{\pi}\int_0^{\pi/2}\left(\frac{\sin^2(n+1)\theta-\sin^2 n\theta}{\sin^2\theta}\right)d\theta$$

$$=\frac{1}{\pi}\int_0^{\pi/2}\frac{\sin(2n+1)\theta}{\sin\theta}d\theta=\frac{1}{\pi}\left(\int_0^{\pi/2}\frac{\sin 2n\theta\cos\theta d\theta}{\sin\theta}+\int_0^{\pi/2}\cos 2n\theta\, d\theta\right)$$

$$=\frac{1}{\pi}\int_0^{\pi/2}\frac{\sin 2n\theta\cos\theta d\theta}{\sin\theta}=\frac{1}{\pi}2\int_0^{\pi/2}(\cos\theta+\cos 3\theta+\ldots\cos(2n-1)\theta)\cos\theta d\theta$$

$$=\frac{1}{\pi}\int_0^{\pi/2}(1+\cos 2\theta)+(\cos 2\theta+\cos 4\theta)+\ldots+(\cos(2n-2)\theta+\cos 2n\theta)d\theta$$

$$=\frac{1}{\pi}\int_0^{\pi/2}d\theta=\frac{1}{2}$$

$$\Rightarrow f(n+1)-f(n)=\frac{1}{2}$$

$$\Rightarrow f(n)=\frac{n}{2}\ \text{(as f(1)=}\frac{1}{2}\text{)}$$

Hence, $\dfrac{f(15+f(3)}{f(15)-f(9)}$ = 3

66. 3

Sol. General term $T_r=\dfrac{2r+3}{3^{r+1}.r(r+1)}$

$$\Rightarrow T_r=\frac{1}{3^r.r}-\frac{1}{3^{r+1}.(r+1)}$$

$$\Rightarrow T_1=\frac{1}{3\times 1}-\frac{1}{3^2\times 2}$$

$$\Rightarrow T_2=\frac{1}{3^2\times 2}-\frac{1}{3^3\times 3}$$

$$\Rightarrow T_n=\frac{1}{3^n\times n}-\frac{1}{3^{n+1}\times(n+1)}$$

Let $S_n = T_1 + T_2 + \ldots\ldots\ldots\ldots + T_n = \dfrac{1}{3\times 1}-\dfrac{1}{3^{n+1}\times(n+1)}$

$$\lim_{x\to\infty}S_n=\frac{1}{3}-0 \qquad \Rightarrow \frac{k}{9}=\frac{1}{3} \qquad \Rightarrow k=3$$

SECTION – D

67. 00003.50

Sol. The function $u=\mathrm{f}(\mathrm{x})=\dfrac{1}{x-1}$ is discontinuous at the point $x=1$. The function

$y=g(u)=\dfrac{1}{u^2+u-2}=\dfrac{1}{(u+2)(u-1)}$ is discontinuous at $u=-2$ and $u=1$

When $u=-2, \frac{1}{x-1}=u=-2 \Rightarrow x=\frac{1}{2}$

When $u=1, \frac{1}{x-1}=1 \Rightarrow x=2$. Hence, the composite function $y=g\left(f\left(x\right)\right)$ is discontinuous at three points $x=1/2,1,2$.

68. 00011.40

Sol. Let $\mathrm{I}\left(b\right)=\int_0^1 \frac{x^b-1}{\ln x}dx \Rightarrow \mathrm{I}'\left(b\right)=\int_0^1 \frac{x^b \ln x}{\ln x}dx=\int_0^1 x^b dx$

Or $\mathrm{I}'\left(b\right)=\left[\frac{x^{b+1}}{b+1}\right]_0^1=\frac{1}{b+1} \Rightarrow \mathrm{I}\left(b\right)=\int \frac{db}{b+1}=\ln\left(b+1\right)+c$

If $b=0,$ then $I\left(b\right)=0 \Rightarrow c=0.$ Hence, $\mathrm{I}\left(\mathrm{b}\right)=\ln\left(b+1\right)$

69. 00265.00

Sol. The number of ways when number student falled in any examination $=(2^3-1)^3$

The number of ways when out of above cases atleast are subject was not cleaned by any students $=3C_1(3)^3$

The number of ways when out of above cases atleast any two subjects were not cleaned by any student $=3C_2(1)^3$

So required cases $=(2^3-1)^3-3C_1 3^3+3C_2$ = 265

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – IV

JEE (Main)-2019

Time Allotted: 3 Hours **Maximum Marks: 360**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only one section: **Section-A**.

Section-A (01 – 30, 31 – 60, 61 – 90) *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

---

1. If A × B = C, then which of the following statements is wrong -

(A) C $\perp$ A (B) C $\perp$ B
(C) C $\perp$ (A + B) (D) C $\perp$ (A × B)

2. The dimensional formula of a physical quantity x is $\left[M^{-1}L^{3}T^{-2}\right]$. The error in measuring the quantities M, L, and T are 2%, 3% and 4%. The maximum percentage of error that occurs in measuring, the quantity x is:

(A) 9 (B) 10
(C) 14 (D) 19

3. A rocket is fired vertically up from the ground with a resultant vertical acceleration of $10\,m/s^2$. The fuel is finished in 1 minute and it continues to move up.
(A) The maximum height reached.
(B) After how much time from then will the maximum height be reached (Take g = 10 m/s^2)

(A) 36km, 1 min (B) 6km, 1 min
(C) 36km, 1 sec (D) 36 km, 1 sec

4. An object of 6 kg is in the state of limiting equilibrium on an inclined plane having angle of inclination $30°$. Now if the angle of inclination is increased to $60°$, then the extra force along the plane to be applied on the object, to keep it in equilibrium will be (take g = 10 m/s^2)

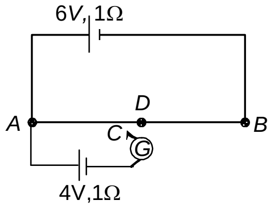
(A) 3 kg wt (B) $2\sqrt{3}$ kg wt
(C) $\sqrt{3}$ kg wt (D) $3\sqrt{3}$ kg wt

5. A particle moving in a straight line is acted by a force, which works at a constant power and changes its velocity from u to v in passing over a distance x. The time taken will be:

(A) x $\left(\frac{v-u}{v^2+u^2}\right)$ (B) x$\left(\frac{v+u}{v^2+u^2}\right)$
(C) $\frac{3}{2}$ x$\left(\frac{v^2-u^2}{v^3-u^3}\right)$ (D) x$\left(\frac{v}{u}\right)$

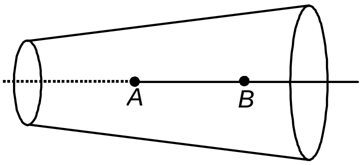
Space for Rough work

6. A 6 volt battery of internal resistance 1Ω is connected across a uniform wire AB of length 100 cm. The positive terminal of another battery of emf 4V and internal resistance 1Ω is joined to the point A as shown. Find the distance of point D from A if there is no current through galvanometer. (resistance of $AB = 5\Omega$)



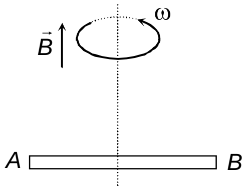
(A) 80 cm (B) 60 cm
(C) 75 cm (D) 40 cm

7. A resistance of frustum shape is shown in figure. If a current *i* passes through the resistance, the electric field at *A* and *B* are related as



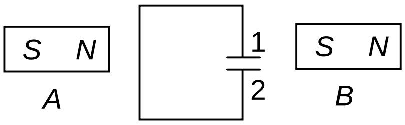
(A) $E_A > E_B$
(B) $E_B > E_A$
(C) $E_A = E_B$
(D) there is no relation

8. A conducting rod of length 2*l* is rotating with constant angular speed ω about its perpendicular bisector. A uniform magnetic field $\vec{B}$ exists parallel to the axis of rotation. The emf induced between two ends of the rod is



(A) $B\omega l^2$ (B) $\frac{1}{2}B\omega l^2$
(C) $\frac{1}{8}B\omega l^2$ (D) zero

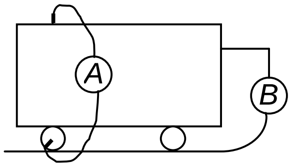
9. Two bar magnet moving with same speed in the given figure. Choose correct statement.



(A) Plate (1) will be +ve relative to (2) if *A* moving *B* moving towards left.
(B) Plate (1) will be +ve relative to (2) if *A* moving towards left and *B* moving towards right.
(C) Charge on capacitor increase if *A* and *B* are at rest.
(D) None of these

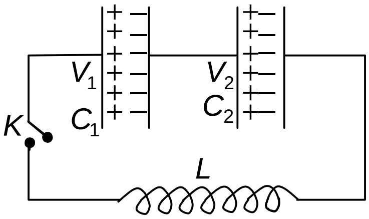
Space for Rough work

10. A flat, rail road car with a wooden base moves left with some velocity. A millivoltmeter A is connected across the axle of the car and is in the car. Another voltmeter B is connected across the rails of the car. Then



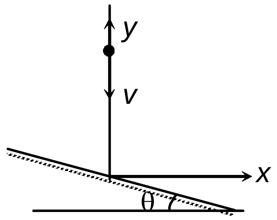
(A) Reading of A and B = zero
(B) Reading of A = zero and B is non zero.
(C) Reading of B = zero and A and is no zero.
(D) Reading of A and B are non zero.

11. Two capacitors of capacitance C_1 and C_2 are charged to a potential difference of V_1 and V_2 respectively and are connected to an inductor of inductance L as shown in the figure. Initially key k is open. Now key k is closed and current in the circuit starts increasing. When current in the circuit is maximum



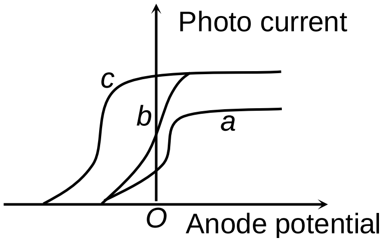
(A) charge on both the capacitors is same
(B) induced emf in the inductor is zero
(C) potential difference across both the capacitors is half of the induced emf
(D) electrostatic potential energy stored in both the capacitors is same

12. An object is moving towards a mirror with a velocity v as shown in figure. If the collision between the mirror and the object is perfectly elastic, then the velocity of the image after collision with mirror in vector form is



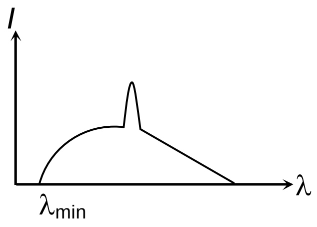
(A) $-v\hat{j}$
(B) $-v\cos 2\theta\hat{j} + v\sin 2\theta\hat{i}$
(C) $-v\hat{i}$
(D) $-v\cos 2\theta\,\hat{j} - v\sin 2\theta\hat{i}$

13. The figure shows the variation of photo current with anode potential for a photo-sensitive surface for three different radiations. Let I_a, I_b and I_c be the intensities and f_a, f_b and f_c be the frequencies for the curves a, b and c respectively;



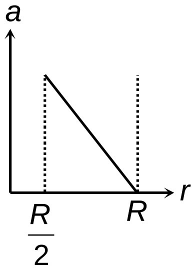
(A) $f_a = f_b$ and $I_a \neq I_b$
(B) $f_a = f_c$ and $I_a = I_C$
(C) $f_a = f_b$ and $I_a = I_b$
(D) $f_b = f_c$ and $I_b = I_c$

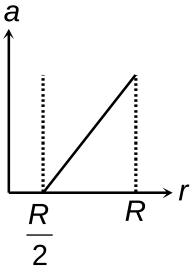
Space for Rough work

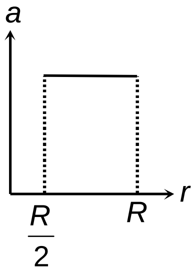


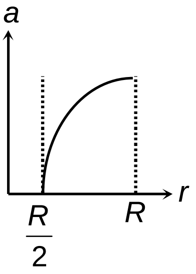
14. An X-ray tube has three main controls.
(i) the target material (its atomic number Z)
(ii) the filament current (I_f) and
(iii) the accelerating voltage (V)
Figure shows a typical intensity distribution against wavelength.
Which of the following is incorrect?
(A) The limit λ_{min} is proportional to V^{-1}
(B) The sharp peak shifts to the right as Z is increased
(C) The penetrating power of X ray increases if V is increased
(D) The intensity everywhere increases if filament current I_f is increased

15. A frictionless tunnel is dug along a chord of the earth at a perpendicular distance $\frac{R}{2}$ from the centre of earth (where R is radius of earth). An object is released from one end of the tunnel. The correct graph, showing the variation of acceleration of particle with its distance r from centre of earth is

(A)


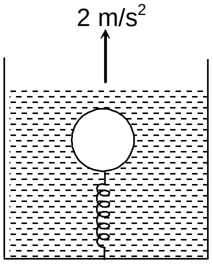
(B)


(C)


(D)


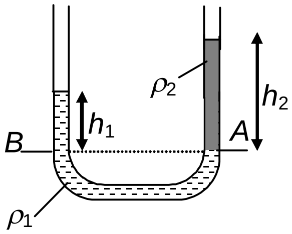
Space for Rough work

16. A ball of mass 10 kg and density 1 gm/cm^3 is attached to the base of a container having a liquid of density 1.1 gm/cm^3, with the help of a spring as shown in the figure. The container is going up with an acceleration 2 m/s^2. If the spring constant of the spring is 200 N/m, the elongation in the spring is



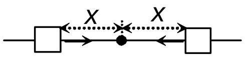
(A) 2 cm
(B) 4 cm
(C) 6 cm
(D) 8 cm

17. Two immiscible liquids are poured in a *U*-tube having densities ρ_1 and ρ_2. The ratio of height of the liquids above their interface (h_1/h_2) is



(A) directly proportional to their densities
(B) inversely proportional to their densities
(C) directly proportional to square of their densities
(D) equal

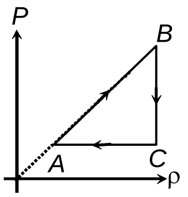
18. Two particles are performing simple harmonic motion with same amplitude and same frequency. When they are at same distance from mean position on opposite sides, their speeds are one fourth of maximum speed. Also at these positions their direction of velocities are opposite, the phase difference between the two simple harmonic motions is

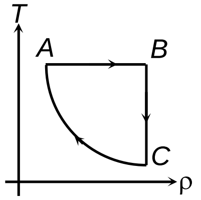


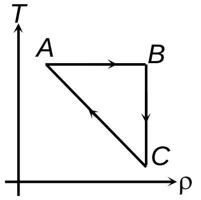
(A) $\frac{\pi}{2}$
(B) π
(C) $\frac{3\pi}{2}$
(D) $\frac{5\pi}{4}$

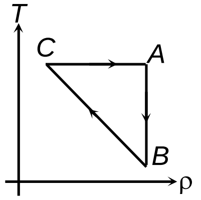
Space for Rough work

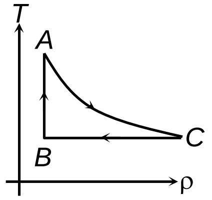
19. Pressure versus density of an ideal gas is shown in the graph. Then the correct temperature versus density of gas graph is



(A)


(B)


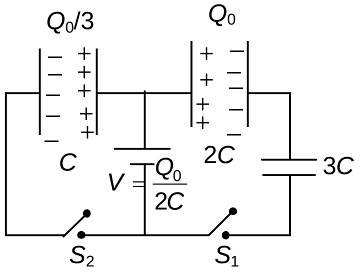
(C)


(D)


20. P-V diagram of a diatomic gas is straight line parallel to P-axis. The molar heat capacity of the gas in the process will be

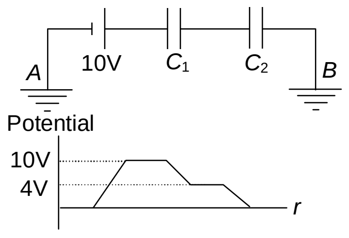
(A) $4R$ (B) $2.5\ R$
(C) $3R$ (D) $4R/3$

21. In the given circuit, the initial charges on the capacitors are shown in the figure. The charge flown through the switches S_1 and S_2 respectively after closing the switches are



(A) zero, $\frac{Q_0}{6}$ (B) $\frac{Q_0}{5}, \frac{Q_0}{2}$
(C) zero, $\frac{Q_0}{2}$ (D) $\frac{3}{5}Q_0, \frac{Q_0}{6}$

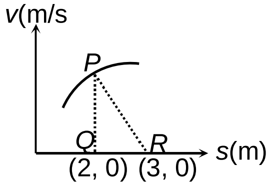
22. Figures shows two capacitors C_1 and C_2 connected with 10 V battery and terminal A and B are earthed. The graph shows the variation of potential as one moves from left to right. Then the ratio of C_1/C_2 is



(A) 5/2 (B) 2/3
(C) 2/5 (D) 4/3

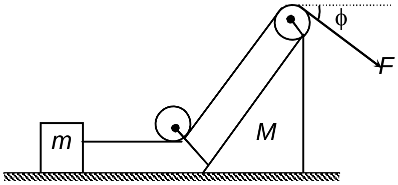
Space for Rough work

23. Velocity versus displacement curve of a particle moving in straight line is shown in the figure. From a point *P*, a line is drawn perpendicular to displacement axis and line *PR* is drawn normal to the curve at *P*. The instantaneous acceleration of the particle at point *P* is



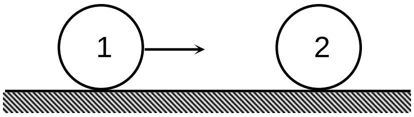
(A) 1 m/s^2 (B) 2 m/s^2
(C) 3 m/s^2 (D) 2.5 m/s^2

24. In the given arrangement pulleys and string are massless and frictionless and all surfaces are smooth. Find the magnitude of acceleration of wedge of mass *M*.



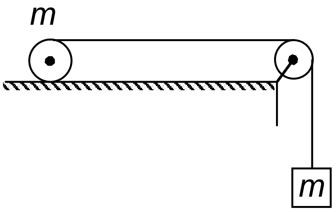
(A) $\frac{F\cos\phi}{M}$
(B) $\frac{F(1-\cos\phi)}{M}$
(C) $\frac{F}{m+M}$
(D) $\frac{F\cos\phi}{m+M}$

25. Ball 1 collides with an another identical ball 2 at rest as shown in figure. For what value of coefficient of restitution *e*, the velocity of second ball becomes two times that of 1 after collision?



(A) 1/3 (B) 1/2
(C) 1/4 (D) 1/6

26. In the given figure a ring of mass *m* is kept on a horizontal surface while a body of equal mass '*m*' attached through a string, which is wounded on the ring. When the system is released the ring rolls without slipping. Consider the following statements and choose the correct option.



(i) acceleration of the centre of mass of ring is $2g/3$
(ii) acceleration of the hanging particle is $4g/3$
(iii) frictional force (on the ring) acts along forward direction
(iv) frictional force (on the ring) acts along backward direction
(A) statement (i) and (ii) only (B) statement (ii) and (iii) only
(C) statement (iii) and (iv) only (D) none of these

Space for Rough work

27 A brass scale is graduated at 10ºC. What is the true length of a zinc rod which measures 60.00 cm on this scale at 30ºC. Coefficient of linear expansion of brass = 18×10^{-6} K^{-1}.

(A) 60.02 cm (B) 50.02 cm
(C) 65.04 cm (D) 55.05 cm

28. A uniform rope of length 12 metre & mass 6 kg, is swinging vertically from rigid base. From its free end, one 2 kg mass is attached. At its bottom end one transverse wave is produced of wavelength 0.06 metre. At upper end of rope, wavelength will be-

(A) 1.2 m (B) 0.12 m
(C) 0.12 cm (D) 0.12 mm

29. A very small sphere of mass 80 g having a charge q is held at a height 9 m vertically above the centre of a fixed non conducting sphere of radius 1 m, carrying an equal charge q. When released it falls until it is repelled just before it comes in contact with the sphere. Calculate the charge q.

[$g = 9.8$ m/s^2]

(A) $28\mu C$ (B) $26\mu C$
(C) $27\mu C$ (D) $25\mu C$

30 In a two slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance from the plane of slits. If the screen is moved by 5×10^{-2} m towards the slits, the change in fringe width is 3×10^{-5} cm. If the distance between the slits is 10^{-3} m, calculate the wavelength of the light used.

(A) $7000Å$ (B) $5000Å$
(C) $6000Å$ (D) $4000Å$

Space for Rough work

Chemistry

PART – II

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. Which of the following statement is **INCORRECT** about the homogeneous reaction?
$aA+bB \rightarrow cC+dD$.

(A) The relation $-\frac{1}{a}\frac{dn_A}{dt}=\frac{1}{c}\frac{dn_C}{dt}$ need not hold if the reaction has more than one step and concentration of reaction intermediates are not small.

(B) The rate of reaction $=k[A]^a[B]^b$ if the above reaction is elementary reaction.

(C) The rate of reaction = $-\frac{1}{a}\frac{d[A]}{dt}=-\frac{1}{b}\frac{d[B]}{dt}=+\frac{1}{c}\frac{d[C]}{dt}=+\frac{1}{d}\frac{d[D]}{dt}$.

(D) If concentration of A reduces to half in time x seconds than concentration of B reduces to half in time $\frac{b}{a}x$ seconds regardless of initial concentrations of A & B and order of reaction w.r.t. A & B

32. Which species is linear at the central atom?

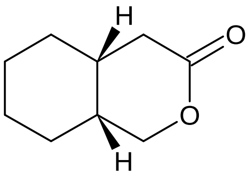
(A) CO_3^{2-}

(B) $\left[S_3\,Sn\,S\,Sn\,S_3\right]^{6-}$

(C) $Me_3SiOSiMe_3$

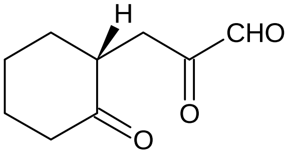
(D) SC_3S

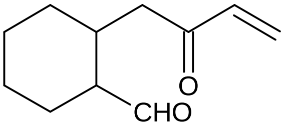
Space for Rough work

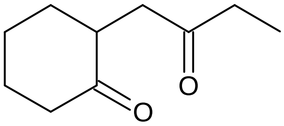
33. 

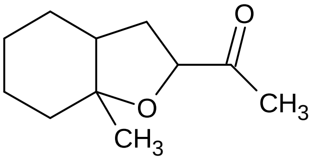
$\xrightarrow[\substack{\text{(2) } CH_2=CH\,MgBr \\ \text{(3) } H_2O, \text{(weakly acidic medium)} \\ \text{(4) PCC}}]{\text{(1) DIBAL-H (1 equivalent)}} \text{product (A)}$

Which of the following is correct structure of 'A'?

(A) 

(B) 

(C) 

(D) 

34. Which of the following statement is correct about various periodic properties?
(A) The electron affinity of an atom under consideration is equal to the negative of the electron gain enthalpy at any temperature.
(B) The electronegativity of any given element is not constant; it varies depending on the element to which it is bound.
(C) The first ionization enthalpy values of group 13 elements varies as $\mathrm{B} > Al > \mathrm{Ga} > \mathrm{In} > Tl$.
(D) An element with ground state electronic configuration $[Xe]4f^{14}5d^{1}6s^{2}$ belongs to d-block in the modern periodic table.

35. Which of the following statement is correct about various properties?
(A) At 1 atm pressure boiling temperature is called standard boiling point while at 1 bar pressure boiling point is called normal boiling point.
(B) Standard boiling point of the liquid is slightly greater than the normal boiling point.
(C) Boiling does not occur when liquid is heated in a closed vessel.
(D) Vapour pressure of various compounds at 300K is in order, diethyl ether > $\mathrm{CCl_4 > H_2O > ethyl\ alchol}$

Space for Rough work

36. Calculate bond enthalpy (in kJ/mol) of C-Cl in $CCl_4(g)$ from the following

Data:

$$\Delta_{vap.}H^\circ_{CCl_4} = 30.5\,kJ/mol \quad \Delta_f H^\circ_{(CCl_4,l)} = -135.5\,kJ/mole$$

$$\Delta_a H^\circ(C) = 715\,kJ/mol \ \ (i.e.\ enthalpy\ of\ atomisation)$$

$$\Delta_a H^\circ_{(Cl_2)} = 242\,kJ/mole$$

(A) 326 (B) 333.625
(C) 356.5 (D) 447

37. For a system (such as an atom or a molecule whose energy does not change with time) the Schrodinger equation is written as $\hat{H}\psi = E\psi$. Which of the following is **INCORRECT** about the Schrodinger equation?

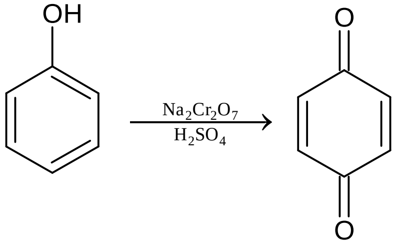
(A) $\hat{H}$ is a mathematical operator called Hamiltonian.
(B) The solution of this equation gives E and ψ.
(C) Schrodinger gave a recipe of constructing $\hat{H}$ operator from the expression for the total energy of the system.
(D) The total energy of the system takes into account the kinetic energies of all the sub-atomic particles, attractive potential between the electrons and nuclei but excludes repulsive potential among the electrons and nuclei individually.

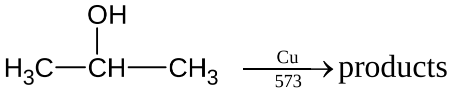
38. Aqueous solution of boric acid is treated with salicylic acid. Which of the following statement is correct for the product formed in the above reaction?

(A) No product will be formed because both the acid
(B) Product is 4-coordinated complex and optically resolvable
(C) Product is 6-coordinated complex and optically non-resolvable
(D) There are two ring only which are five membered

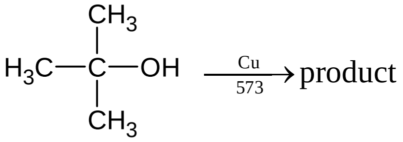
Space for Rough work

39. Which of the following reaction **INCORRECTLY** matched?

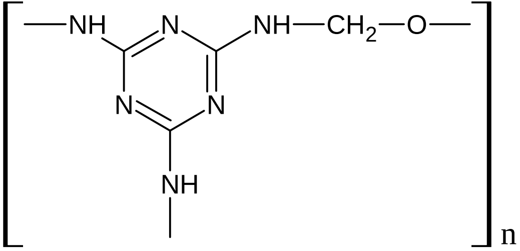
(A)

(oxidation)

(B)

$H_3C-CH(OH)-CH_3 \xrightarrow[573]{Cu} \text{products}$ (oxidation)

(C) $CH_3-CH=CH-CH_2-OH \xrightarrow{PCC} CH_3-CH=CH-CHO$ (dehydrogenation)

(D)

$H_3C-C(CH_3)_2-OH \xrightarrow[573]{Cu} \text{product}$ (oxidation)

40. Which of the following is correct about,


polymer?

(A) Polymer is formed by addition polymerisation of melamine and formaldehyde.
(B) It is used in manufacturing of unbreakable crockery.
(C) It is a thermoplastic polymer i.e. capable of repeatedly softening on heating and hardening on cooling.
(D) It is a linear polymer.

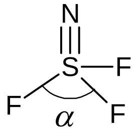
Space for Rough work

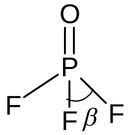
41. Which of the following statement is correct about antimicrobials?
(A) Ampicillin and amoxycillin are narrow spectrum antibiotics.
(B) Antibiotics have both cidal (killing) effect and static (inhibitory) effect on microbes.
(C) A substance cannot act as an antiseptic as well as disinfectant by varying the concentration.
(D) A mixture of chloroxylenol and terpineol, tincture of iodine, iodoform, boric acid etc are used as antiseptics.

42. Which of the following Vitamin is not matched with its correct scientific name?
(A) Vitamin B_1=Threonin
(B) Vitamin B_2=Riboflavin
(C) Vitamin B_6=Pyridoxine
(D) Vitamin C=Ascorbic acid

43. Which of the following properties about bond angle and bond lengths is correct for the given compound?

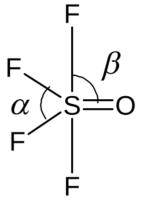
(A)





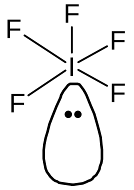
$\alpha > \beta$

(B)



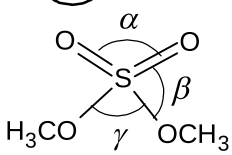
$\alpha = 120°$ *and* $\beta > 90°$

(C)



all I-F bonds are of equal length because Iodine is sp^{3}d hybridized.

(D)



$\alpha > \beta > \gamma$

Space for Rough work

44. Calculate the molar solubility of $\mathrm{Ni(OH)_2}$ in 0.1 M NaOH. The solubility product of $\mathrm{Ni(OH)_2}$ is 2×10^{-15}. (Given: $\sqrt[3]{0.5}=0.79$)

(A) $2\times10^{-13}\mathrm{M}$
(B) $2\times10^{-14}\mathrm{M}$
(C) $7.9\times10^{-6}\mathrm{M}$
(D) $7.9\times10^{-4}\mathrm{M}$

45. Calculate ΔG for the following reaction

$$\underset{(2atm,373K)}{H_2O(l)} \longrightarrow \underset{(2\,atm,373K)}{H_2O(g)}$$

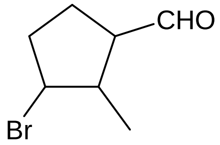
(Given: $0.0821\times373\times\ln 2=21.23\,\text{atm-ltr}$, molar volume of water at 2 atm , 373 K=18ml)

(A) $\Delta G=0$
(B) $\Delta G>0$
(C) $\Delta G<0$
(D) None of these

46. Which of the following is not a magnesium ore?

(A) Carnalite
(B) Dolomite
(C) Magnesite
(D) Malachite

47. Which of the following is the correct IUPAC name of the compound?



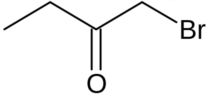
(A) 2-methyl-3-bromocyclopentane carbaldehyde
(B) 1-formyl-2-methyl-3-bromocyclopentane
(C) 3-bromo-2-methyl cyclopentane carbaldehyde
(D) 1-bromo-2-methyl cyclopentane-3-carbaldehyde

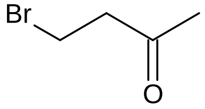
48. Which of the following is correct about defects in solid crystals?

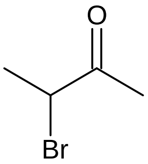
(A) Vacancy defects and interstitial defects are two main types of non-stoichiometric defects.
(B) If molten NaCl containing a little amount of $\mathrm{MCl_3}$(ionic) is crystallised, the cationic vacancies thus produced are equal to twice the number of $\mathrm{M^{3+}}$ ions.
(C) Zinc oxide is white in colour at room temperature, on heating it turns green and its formula becomes $\mathrm{Zn_{1\text{-}x}O}$
(D) Frenkel defect is shown by ionic substance in which the cation and anion are of almost similar sizes.

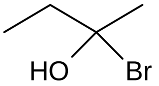
Space for Rough work

49. Which of the following is the major product in the acid catalysed bromination of butan-2-one?

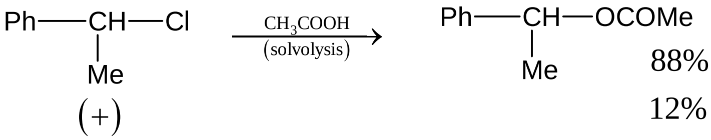
(A) 

(B) 

(C) 

(D) 

50. Adding the much more powerful nucleophile CH_3COO^- (as CH_3COONa) to the reactant mixture was found to result in:



$$\underset{(+)}{\underset{\displaystyle Me}{Ph-\overset{}{CH}-Cl}} \xrightarrow[(solvolysis)]{CH_3COOH} \underset{\displaystyle Me}{Ph-CH-OCOMe}$$

88% racernisation

12% net inversion

(A) No increase in the overall reaction rate
(B) Increase in the proportion of net inversion.
(C) The inversion that is observed does stem from part of the overall reaction proceeding via an SN^2 path
(D) A mixed $S_{N^1}+S_{N^2}$ pathway is operating in the above reaction.

51. Which of the following is correct about conductivity?
(A) $0.1M\,HCl > 0.01M\,CH_3COOH > pure\,water > 0.1M\,CH_3COOH$ (Conductivity order of aqueous solution)
(B) $Copper > Glass > Si > Fe$ (Conductivity order)
(C) The conductivity of ionic solution depends on size of ions produced, concentration of electrolyte, nature of solvent & its viscosity, nature of electrolyte.
(D) Molar conductivity of weak electrolytic solution increase on increasing the concentration of electrolyte.

Space for Rough work

52. When colloidal solution is viewed under a powerful ultra microscope, the colloidal particles appear to be in a state of continuous zigzag motion. Which of the following is correct about the zigzag motion i.e. Brownian motion?
(A) It depends on the nature of the colloid
(B) It depends on the size of the particles and viscosity of the solution
(C) It is independent of the mass of the particles.
(D) Lesser the viscosity slower in the Brownian motion

53. The correct sequence of CO bond length in the given compound is:
(I) $Fe(CO)_5$ (II) CO
(III) $H_3B \leftarrow CO$ (IV) $[Mn(CO)_5]^-$
(A) II>IV>III>I (B) II>III>I>IV
(C) III>I>IV>II (D) IV>I>II>III

54. Which of the following complex is optically active?
(A) trans-$[Co(NH_3)_4Cl_2]^+$ (B) Cis-$[Co(NH_3)_2(en)_2]^{3+}$
(C) trans-$[Co(NH_3)_2(en)_2]^{3+}$ (D) Cis-$[CoCl_3(NH_3)_3]$

55. Which of the following salt will not give positive brown ring test?
(A) $Cu(NO_3)_2$ (B) $Pb(NO_3)_2$
(C) $Zn(NO_3)_2$ (D) $Mg(NO_3)_2$

56. Which of the following is not a correct transformation?
(A) $2PCl_5(s) \longrightarrow [PCl_4]^+[PCl_6]^-$
(B) $[Al(H_2O)_6]^{3+} + H_2O \longrightarrow [Al(H_2O)_5(OH)]^{2+} + H_3O^+$
(C) $BiF_3 + H_2O \longrightarrow H_3BiO_3 + 3HF$
(D) $XeF_6 + NaF \longrightarrow Na[XeF_7]$

57. PH_3 can be obtained by:
(A) Heating phosphorous acid
(B) Reacting white P_4 with hot concentration NaOH
(C) Hydrolysis of calcium phosphide
(D) All of the above

Space for Rough work

58. Prussian blue is a deep blue pigment containing Fe^{2+}, Fe^{3+} and CN^- ions. It has the formula $Fe_7(CN)_{18}$. How many Fe^{2+} and Fe^{3+} ions are there per formula unit?

(A) $3Fe^{2+}$ and $4Fe^{3+}$ (B) $4Fe^{2+}$ and $3Fe^{3+}$

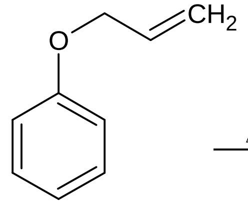
(C) $5Fe^{2+}$ and $2Fe^{3+}$ (D) $6Fe^{2+}$ and $1Fe^{3+}$

59. A small piece of Na metal is placed in an ignition tube and small quantity of the compound is added and tube is heated strongly. The red hot tube is plunged into 10 ml distilled water contained in a mortar is crushed and solution is filtered. The filtrate is called sodium extract. To small quantity of extract few crystals of Mohr's salt are added and boiled on adding dilute H_2SO_4 to it, an intense blue is observed. The element present in the compound is?

(A) S (B) halogen

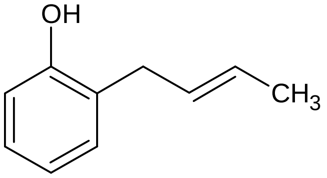
(C) nitrogen (D) phosphorus

60. The product 'C' in the given reaction sequence is:

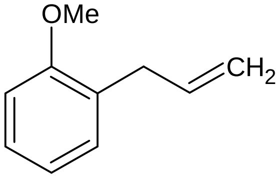


$\xrightarrow{\Delta}$ 'A' $\xrightarrow{\text{NaOH}}$ 'B' $\xrightarrow{CH_3I}$ 'C'

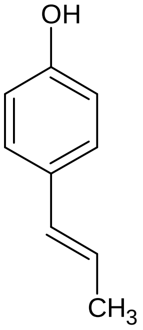
(A)



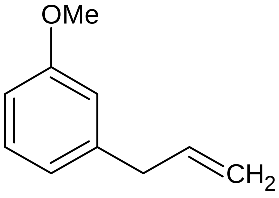
(B)



(C)



(D)



Space for Rough work

Mathematics

PART – III

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. Which of the following function is surjective but not injective?

(A) $f:R\to R,\ f(x)=x^4+2x^3-x^2+1$

(B) $f:R\to R,\ f(x)=x^3+x+1$

(C) $f:R\to R^+,\ f(x)=\sqrt{1+x^2}$

(D) $f:R\to R,\ f(x)=x^3+2x^2-x+1$

62. If [*x*] denotes the integral part of *x* and in (0, π), we define

$$f(x)=\begin{cases}\left[\dfrac{2(\sin x-\sin^n x)+|\sin x-\sin^n x|}{2(\sin x-\sin^n x)-|\sin x-\sin^n x|}\right], & x\neq\dfrac{\pi}{2}\\ 3, & x=\dfrac{\pi}{2}\end{cases}$$

Then for *n* > 1,

(A) *f* (*x*) is continuous but not differentiable at $x=\frac{\pi}{2}$

(B) both continuous and differentiable at $x=\frac{\pi}{2}$

(C) neither continuous nor differentiable at $x=\frac{\pi}{2}$

(D) $\lim\limits_{x\to\frac{\pi}{2}} f(x)$ exists but $\lim\limits_{x\to\frac{\pi}{2}} f(x)\neq f\left(\frac{\pi}{2}\right)$

63. Let *f* be a function defined on *R* by $f(x)=[x]+\sqrt{x-[x]}$, then

(A) *f* is not continuous at every $x\in I$

(B) *f* is not continuous at every $x\in R\sim I$

(C) *f* is a continuous function

(D) none of these

Space for Rough work

64. The maximum value of area of rectangle *OABC*, where *O* is origin, *A* lies on positive *y*-axis and *B* lies on the curve $y=\frac{\ln x}{x^2}$, is

(A) e^{-1} (B) $e^{-1/2}$

(C) 1 (D) $e^{1/2}$

65. Let $f(x)=\int \frac{x^2dx}{(1+x^2)(1+\sqrt{1+x^2})}$ and $f(0)=0$. Then *f* (1) is

(A) $\log(1+\sqrt{2})$ (B) $\log(1+\sqrt{2})-\frac{\pi}{4}$

(C) $\log(1+\sqrt{2})+\frac{\pi}{4}$ (D) none of these

66. For $x>-1$, let $f(x)=\int_0^{\pi/4}\log_e(1+x\tan z)dz$. Then value of $f\left(\frac{1}{2}\right)-f\left(\frac{1}{3}\right)$ equals

(A) $\frac{\pi}{4}\log_e\left(\frac{9}{8}\right)$ (B) $\frac{\pi}{8}\log_e\left(\frac{9}{8}\right)$

(C) $\frac{\pi}{9}\log_e\left(\frac{8}{9}\right)$ (D) $\frac{\pi}{8}\log_e\left(\frac{3}{2}\right)$

67. Area bounded by $y = \tan^{-1}x$, $y = \cot^{-1}x$ and *y*-axis is equal to

(A) $\ln\sqrt{2}$ sq. units (B) ln 4 sq. units

(C) ln 8 sq. units (D) ln 2 sq. units

68. Solution of $\sec^2 y\frac{dy}{dx}+x\tan y=x^3$ is

(A) $\tan y=x^2+ce^{-x^2}$ (B) $\tan y=x^2-2+ce^{-x^2}$

(C) $\tan y=x^2-2+ce^{-x^2/2}$ (D) none of these

Space for Rough work

69. If $y = \dfrac{\cos 6x + 6\cos 4x + 15\cos 2x + 10}{\cos 5x + 5\cos 3x + 10\cos x}$, then $\dfrac{dy}{dx}$ is equal to

(A) $2\sin x + \cos x$ (B) $-2\sin x$

(C) $\cos 2x$ (D) $\sin 2x$

70. The tangents at $z_1,\ z_2$ on the circle $\left| z - z_0 \right| = a$, meet at z_3. Then $\left(\dfrac{z_3 - z_1}{z_0 - z_1}\right)\left(\dfrac{z_0 - z_2}{z_3 - z_2}\right)$ is equal to

(A) 0 (B) 1

(C) –1 (D) 2

71. The number of permutations of letters of word HINDUSTAN such that neither the pattern 'HIN' nor 'DUS' nor 'TAN' appears are

(A) 12246 (B) 169194

(C) 166680 (D) 181434

72. *A* is a 3 × 3 matrix with entries from the set {–1, 0, 1}. Then the probability that *A* is neither symmetric nor skew-symmetric is

(A) $\dfrac{3^9 - 3^6 - 3^3 + 1}{3^9}$ (B) $\dfrac{3^9 + 3^6 - 3^3 + 1}{3^9}$

(C) $\dfrac{3^9 - 3^6 + 3^3 + 1}{3^9}$ (D) none of these

73. Number of value(s) of *x* satisfying the equation $3x^2 - 2x^3 = \log_2\left(x^2 + 1\right) - \log_2 x$ is

(A) 1 (B) 2

(C) 3 (D) none of these

74. If $(1 + x + x^2)^n = \sum_{r=0}^{2n} a_r x^r$, then the value of $\sum_{k=0}^{3r} (-1)^k a_k\ {}^nC_{3r-k}$ (where $3r \le n$) equals

(A) $(-1)^r.\,{}^nC_r$ (B) ${}^nC_{3r}$

(C) $(-1)^{3r}.\,{}^nC_{3r}$ (D) ${}^nC_r$

Space for Rough work

75. If $x \in R$ and $n \in I$, then the determinant $\Delta = \begin{vmatrix} \sin(n\pi) & \sin x - \cos x & \log\tan x \\ \cos x - \sin x & \cos\left[(2n+1)\frac{\pi}{2}\right] & \log\cot x \\ \log\cot x & \log\tan x & \tan(n\pi) \end{vmatrix}$ equals

(A) 0 (B) $\log\tan x - \log\cot x$

(C) $\tan\left(\frac{\pi}{4} - x\right)$ (D) none of these

76. If $A = \begin{bmatrix} 2 & 3 & 0 \\ 1 & \sin^2 x & -\cos^2 x \\ \cos^2 x & \cos^4 x & \sin^4 x \end{bmatrix}$ and $\mathrm{A\,(Adj\,A) = K} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$, then the value of K is

(A) 0 (B) –1

(C) 1 (D) None of these

77. If *m* is the root of the equation $(1-ab)x^2 - (a^2+b^2)x - (1+ab) = 0$ and *m* harmonic means are inserted between *a* and *b*, then the difference between the last and the first of the means equals

(A) $ab(a+b)$ (B) $a(b-a)$

(C) $ab(b-a)$ (D) $b-a$

78. Let S_n denote the sum to *n* terms of an arithmetic progression. If the common difference is equal to $S_n - kS_{n-1} + S_{n-2}$, then *k* =

(A) 1 (B) 2

(C) 3 (D) none of these

79. If the equal sides *AB* and *AC* along positive *x* and *y* axes (each equal to *a*) of a right angled isosceles triangle *ABC* be produced to *P* and *Q* respectively so that *B*P. *CQ* = AB^2, then the line *PQ* always passes through a fixed point

(A) (*a*, 0) (B) (0, *a*)

(C) (*a*, *a*) (D) none of these

Space for Rough work

80. The equation of the circle, which is touched by the line $y = x$, has its centre on the positive direction of the x-axis and cut off a chord of length 2 units on the line $\sqrt{3}\ \ y = x,$ is

(A) $x^2 + y^2 - 4x + 2 = 0$ (B) $x^2 + y^2 - 4x + 1 = 0$

(C) $x^2 + y^2 - 8x + 8 = 0$ (D) $x^2 + y^2 - 4y + 2 = 0$

81. If the tangents at two points (1, 2) and (3, 6) on a parabola intersect at the point (1, 6), then equation of directrix is

(A) $2x + y - 8 = 0$ (B) $x - 2y + 11 = 0$

(C) $x + 2y - 13 = 0$ (D) $2x - y + 4 = 0$

82. If tangent and normal at point P (in first quadrant) to ellipse $\frac{x^2}{25} + \frac{y^2}{16} = 1$ intersect major axis at T and N respectively in such a way that ratio of area of ΔPTN and $\Delta PSS'$ is $\frac{91}{60}$, then area of $\Delta PSS'$ is (S and S' are foci)

(A) $6\sqrt{3}$ sq. units (B) $12\sqrt{3}$ sq. units

(C) $4\sqrt{3}$ sq. units (D) $3\sqrt{3}$ sq. units

83. If a hyperbola whose foci are $S \equiv (2, 4)$ and $S' \equiv (8, -2)$ touches x-axis, then equation of hyperbola is

(A) $\frac{(x+y-6)^2}{10} - \frac{(x-y-4)^2}{8} = 1$ (B) $\frac{(x-y-4)^2}{10} - \frac{(x+y-6)^2}{8} = 1$

(C) $\frac{(x-y-4)^2}{20} - \frac{(x+y-6)^2}{16} = 1$ (D) $\frac{(x+y-6)^2}{20} - \frac{(x-y-4)^2}{16} = 1$

Space for Rough work

84. If $\sin A = x,\ \cos B = y,\ A + B + C = 0,$ then $x^2 + 2xy\sin C + y^2$ is equal to

(A) $\sin^2 C$ (B) $\cos^2 C$

(C) $1 + \sin^2 C$ (D) $1 + \cos^2 C$

85. The values of $x \in \left(0, \frac{\pi}{2}\right)$ satisfying the equation $\frac{\sqrt{3}-1}{\sin x} + \frac{\sqrt{3}+1}{\cos x} = 4\sqrt{2}$ are

(A) $\frac{\pi}{36}, \frac{\pi}{12}$ (B) $\frac{\pi}{12}, \frac{11\pi}{36}$

(C) $\frac{12\pi}{36}, \frac{11\pi}{36}$ (D) $\frac{11\pi}{36}, \frac{\pi}{36}$

86. If in ΔABC, $\sin B\cos C = \frac{\sqrt{3}-1}{\sqrt{3}}$ and $\cos B\sin C = \frac{1}{\sqrt{3}}$, then the triangle is

(A) isosceles (B) equilateral

(C) right angled (D) right angled isosceles

87. If for $x < -1, \cos^{-1}\left(\frac{x^2-1}{x^2+1}\right) + \sin^{-1}\left(\frac{2x}{1+x^2}\right) - \tan^{-1}\left(\frac{2x}{x^2-1}\right) = \frac{\pi}{3},$ then x is equal to

(A) $-\sqrt{3}$ (B) $-\sqrt{2}$

(C) –2 (D) none of these

88. The vector equation of the plane through the point $2\hat{i} - \hat{j} - 4\hat{k}$ and parallel to the plane $\vec{r}\,.\,(4\hat{i} - 12\hat{j} - 3\hat{k}) - 7 = 0$ is

(A) $\vec{r}\,.\,(4\hat{i} - 12\hat{j} - 3\hat{k}) = 0$ (B) $\vec{r}\,.\,(4\hat{i} - 12\hat{j} - 3\hat{k}) = 32$

(C) $\vec{r}\,.\,(4\hat{i} - 12\hat{j} - 3\hat{k}) = 12$ (D) none of these

89. If statement $(p \to q) \to (q \to r)$ is false, then truth values of statement p,q,r respectively, can be-

(A) FTF (B) TTT

(C) FFF (D) FTT

90. Standard Deviation of a data is 7, when each observation is decreased by 7 then standard deviation of new data is

(A) 0 (B) 14

(C) 7 (D) 49

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – IV

JEE (Main)-2019

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. D

Sol. From the property of vector product, we notice that **C** must be perpendicular to the plane formed by vector **A** and **B**. Thus **C** must be perpendicular to **A** and to **B**. Thus the statements (1) and (2) are correct. Now **A** + **B** vector also must lie in the plane formed by vector **A** and **B**. Thus **C** must be perpendicular to **A** + **B** also the cross product (**A** × **B**) gives a vector **C** which cannot be perpendicular to itself. Thus the statement (4) is wrong.

2. D

3. A

Sol. The distance travelled by the rocket during burning interval (1 minute = 60 s) in which resultant acceleration is vertically upwards and is 10 m/s^2 will be

$h_1 = 0 \times 60 + (1/2) \times 10 \times 60^2 = 18000$ m ...(1)

And velocity acquired by it will be

$v = 0 + 10 \times 60 = 600$ m/s ...(2)

Now after 1 minute the rocket moves vertically up with initial velocity of 600 m/s and acceleration due to gravity oppose its motion.

So, it will go to a height h_2 till its velocity becomes zero such that

$0 = (600)^2 - 2gh_2$

$\Rightarrow h_2 = 18000$ m [as g = 10m/s^2] ..(3)

So from eq. (1) and (3) the maximum height reached by the rocket from the ground.

$H = h_1 + h_2 = 18 + 18 = 36$ km (B) As after burning of fuel the initial velocity from Eq. (2) is 600 m/s and gravity opposes the motion of rocket, so from 1st equation of motion time taken by it to reach the maximum height (for which v = 0)

$0 = 600 - gt$, i.e.t = 60 s

after finishing of fuel, the rocket goes up for 60 sec i.e., 1 minute more.

Hence correct answer is (A)

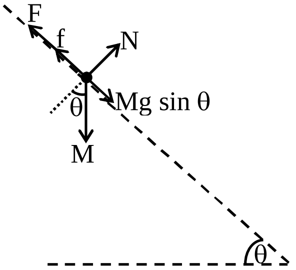
4. B

Sol. First data implies from

$$\tan\theta = \mu_S$$

that $\mu_S = \tan 30^o = \frac{1}{\sqrt{3}}$ ....(1)

For the second situation, the force, acting on the object are shown in fig. For equilibrium



$F + f_S = Mg\sin\theta$ ....(2)

$N = mg\cos\theta$

with $f_S = \mu_S\, Mg\cos\theta$ ....(3)

Using (1) and (3) in (2) with $\theta = 60^o$, we get

$$F = Mg\ \sin\theta - \mu_S M\cos\theta\ g$$

$$= 60\sin 60^o - \frac{1}{\sqrt{3}}(60)\cos 60^o$$

$$= 30\sqrt{3} - \frac{30}{\sqrt{3}} = \frac{30\times 2}{\sqrt{3}} \text{ newton}$$

or $F = \frac{30\times 2}{\sqrt{3}\times g}$ kg wt = $2\sqrt{3}$ kg wt

5. C

Sol. The force acting on the particle = $\frac{mdv}{dt}$

Power of the force = $\left(\frac{mdv}{dt}\right)$ v = k (constant)

$m\frac{v^2}{2} = kt + c$ ...(1)

at $t = 0, v = u$ $\therefore$ $c = \frac{mu^2}{2}$

Now from (1),

$$m\frac{v^2}{2} = kt + \frac{mu^2}{2}$$

$\frac{1}{2}m(v^2 - u^2) = kt$ ...(2)

Again $\frac{mdv}{dt}v = k$

$$m.v\frac{dv}{dx}v = k$$

$$\int_u^v mv^2 dv = \int_0^x k\,dx$$

Intergrating, $\frac{1}{3}$m (v^3 – u^3) = kx ...(3)

From eqn (2) and (3),

$$t = \frac{3}{2}\left(\frac{v^2 - u^2}{v^3 - u^3}\right) x$$

6. A

Sol. Distance $AD = \frac{4}{5} \times 100 = 80\, cm$

7. A

Sol. From ohm's law

Electric field α current density

8. D

Sol. $e = \int_{-\ell/2}^{\ell/2} B\omega r dr = 0$

9. A

10. B

11. B

Sol. When current is maximum $= \frac{di}{dt} = 0$

12. D

13. A

Sol. Saturation for A and B are different hence intensities are different. Stopping potentials for A and B are equal hence frequencies are equal.

14. B

Sol. Characteristic wavelengths shift of left if z is increased hence B is incorrect

15. D

16. C

17. B

Sol. $\rho_1 g h_1^2 = \rho_2 g h_2$

$\frac{h_1}{h_2} = \frac{\rho_2}{\rho_1}$

18. B

19. A

Sol. Process A $\rightarrow$ B is isothermal

Process B $\rightarrow$ C isochoric

Process C $\rightarrow$ A is isobaric

20. C

Sol. The process described is isochoric

Therefore molar heat capacity $= C_v = 2.5R$

21. A

22. B

Sol. Capacitors are in series therefore

$$\frac{C_1}{C_2}=\frac{V_2}{V_1}=\frac{2}{3}$$

23. A

Sol. Use $a=\frac{dV}{ds}$ and find $\frac{dV}{ds}$ using the slope of normal

24. B

25. A

Sol. $mu=3mv$

$V=u/3$

$e=-\frac{2u/3-u/3}{-u}\Rightarrow e=1/3$

26. D

Sol. Friction will be absent

$T=ma$

$mg-T=2ma$

Acceleration of $a=g/3$

Acceleration of block $=2g/3$

27. A

Sol. Since the scale is graduated at 10ºC,

1 cm of the scale at 10ºC = exactly 1 cm

∴ 1 cm of the scale at 30ºC

= exactly $(1 + 18 \times 10^{-6} \times 20)$cm

∴ 60 cm of the scale at 30ºC

= exactly $60.00\,(1 + 36 \times 10^{-5})$

= 60.02 cm

28. B

Sol. Tension at bottom end of rope = $T_1 = 2\times9.8$ N

Θ weight of rope acts on gravity centre,

Therefore, tension at upper end of rope,

$T_2 = (6 + 2) \times 9.8 = 8 \times 9.8$ N

Thus, $T_2 = 4T_1$

if v_1 & v_2 are respective velocity at bottom & upper end, then $v_1 = \sqrt{\frac{T_1}{m}}$ & $v_2 = \sqrt{\frac{T_2}{m}}$

∴ $v_2 = 2v_1$ (Θ $T_2 = 4T_1$)

Frequency n does not depend on medium,

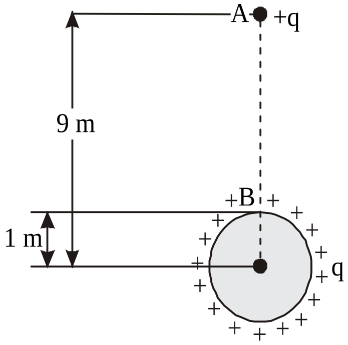
therefore $v \propto \lambda$

if λ_1 & λ_2 are respective wavelength at bottom & upper end

$\lambda_2 = 2\lambda_1 = 2 \times 0.06 = 0.12$ m

29. A

Sol. Keeping in mind that here both electric and gravitational potential energy are changing and for external point a charged sphere behaves as whole of its charge were concentrated at its centre, applying conservation of energy between initial and final position, we have



$$\frac{1}{4\pi\varepsilon_0}\frac{qq}{9} + mg \times 9 = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{1} + mg \times 1$$

or $q^2 = \frac{80\times10^{-3}\times9.8}{10^9}$

or $q = 28\ \mu C$

30. C

Sol. The fringe–width β is given by

$$\beta = \frac{\lambda D}{2d} \text{ and } \beta' = \frac{\lambda D'}{2d}$$

where λ is the wavelength of light used, D is the distance of the screen from the two slits and 2 d is the separation between two slits.

Now $\beta - \beta' = \frac{\lambda(D - D')}{2d}$

$\Rightarrow$ $\lambda = \frac{(\beta - \beta')2d}{D - D'}$

$\lambda = \frac{(3\times10^{-5})(10^{-3})}{5\times10^{-2}}$

$= 0.6 \times 10^{-6}$ m = 6000 Å

Chemistry

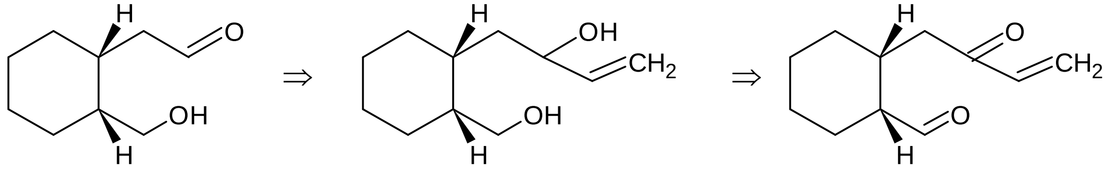
PART – II

SECTION – A

31. D
Sol. Theoretical

32. D
Sol. $S = C = C = C = S$

33. B
Sol.



34. B
Sol. Theoretical

35. C
Sol. Theoretical

36. A
Sol.

$$C(s) + 2Cl_2(g) \longrightarrow CCl_4(\ell) \qquad \Delta H = -135.5\,KJ/mole$$

$$CCl_4(\ell) \longrightarrow CCl_4(g) \qquad \Delta H = 30.5\,KJ/mole$$

$$C(s) + 2Cl_2(g) \longrightarrow CCl_4(g) \qquad \Delta H = -105\,KJ/mole$$

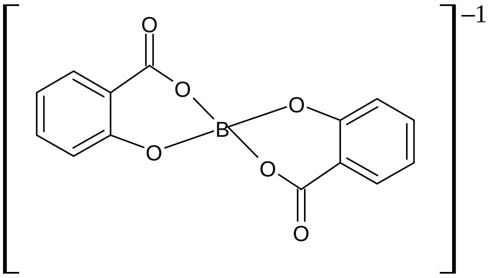
$$715 + 2\times 242 - 4\times x = -105$$

$$x = 326\,KJ/mole \qquad i.e.\,x = B.E.\,of\ C-Cl\ in\,CCl_4(g)$$

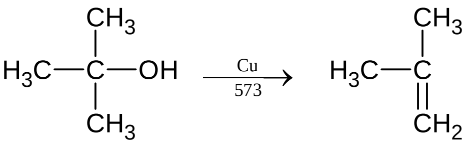
37. D
Sol. The total energy of the system takes into account the kinetic energies of all the sub-atomic particles, attractive potential between the electrons and nuclei also **include** repulsive potential among the electrons and nuclei individually.

38. B
Sol.

the product is



39. D
Sol.



$$H_3C-\overset{CH_3}{\underset{CH_3}{C}}-OH \xrightarrow[573]{Cu} H_3C-\overset{CH_3}{\underset{CH_2}{C}}$$

i.e. dehydration

40. B

Sol. Polymer is prepared by condensation reaction and cross link polymer.

41. D
Sol. Theoretical

42. A
Sol. Theoretical

43. D
Sol. VSEPR theory

44. A
Sol.

$$Ni\left(OH\right)_2\left(s\right) \rightleftharpoons Ni^{2+} + 2OH^-$$

$$s \qquad 2s+0.1$$

$$s\left(2s+0.1\right)^2 = 2\times10^{-15} \qquad 2s+0.1 \approx 0.1$$

$$s = 2\times10^{-13}$$

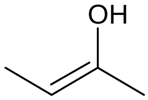
45. B
Sol. The process is non- spontaneous at given condition so $\Delta G > 0$

46. D
Sol. Malachite is $CuCO_3.Cu\left(OH\right)_2$

47. C
Sol. Theoretical

48. B
Sol. One M^{3+} ion can replace three Na^{+1} ion so the cationic vacancies produced are equal to twice the number of M^{3+} ions.

49. C
Sol.



this enole form is more stable

50. A
Sol. Reaction goes by $S_N{}^1$ mechanism so effect of increase in concentration of CH_3COO^- does not increase rate of reaction.

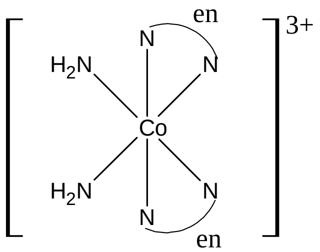
51. C
Sol. Theoretical

52. B
Sol. Theoretical

53. D
Sol. As the oxidation state of metal decrease the extant of back bonding by CO increases.

54. B

Sol.



55. B

Sol. Because Pb^{2+} ion will interfere due to formation of $PbSO_4$.

56. C

Sol. Bismuth(III) compounds hydrolysed to give oxymetalic $[BiO]^{+1}$ ion.

57. D

Sol. Theoretical

58. A

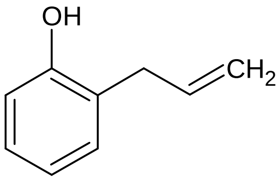
Sol. Prussian blue is a deep blue pigment is $Fe_4\left[Fe(CN)_6\right]_3$.

59. C

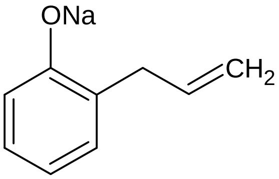
Sol. Theoretical

60. B

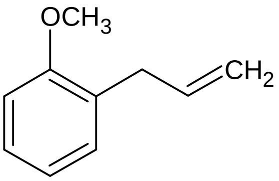
Sol.



A



B



C

Mathematics PART – III

SECTION – A

61. D

Sol. $f(x) = x^4 + 2x^3 - x^2 + 1$ is polynomial of even degree hence its range can't be *R*.
Hence not surjective.
$f(x) = x^3 + x + 1,\ f'(x) = 3x^2 + 1 \Rightarrow$ monotonic hence bijective.
$f(x) = \sqrt{1 + x^2}$, neither surjective not injective.
$f(x) = x^3 + 2x^2 - x + 1,\ f'(x) = 3x^2 + 4x - 1 \Rightarrow$ $D = 16 + 12 > 0$.
Hence $f(x)$ is non-monotonic cubic polynomial hence surjective but not injective.

62. B

Sol. For $0 < x < \frac{\pi}{2}$ or $\frac{\pi}{2} < x < \pi$, $0 < \sin x < 1$.

$\therefore$ for $n > 1$, $\sin x > \sin^n x$

$\therefore$ $f(x) = \left[\frac{3(\sin x - \sin^n x)}{\sin x - \sin^n x}\right] = 3$, $x \neq \frac{\pi}{2}$ and $f(x) = 3$, $x = \frac{\pi}{2}$

Thus in $(0, \pi)$, $f(x) = 3$.

Hence $f(x)$ is continuous and differentiable at $x = \frac{\pi}{2}$.

63. C

Sol. If $x_0 = K \in I$, then $\lim\limits_{x \to K+} f(x) = \lim\limits_{x \to K} K + \sqrt{x - K} = K$

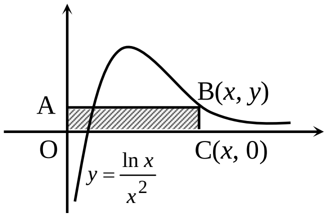
and $\lim\limits_{x \to K-} f(x) = \lim\limits_{x \to K-} (K - 1) + \sqrt{x - (K - 1)}$

$= \lim\limits_{x \to K} (K - 1) + \sqrt{x - K + 1} = K - 1 + 1 = K$

Hence *f* is continuous at every $x_0 = K \in I$. If $x_0 \in R \sim I$, then $[x]$ is continuous at x_0 which is turn gives that *f* is continuous at every $x_0 \in R \sim I$

64. A

Sol. Area = *A* = *xy*



$A = \frac{\ln x}{x} \Rightarrow \frac{dA}{dx} = \frac{1 - \ln x}{x^2}$

$\frac{dA}{dx} = 0 \Rightarrow x = e$

$\frac{dA}{dx} < 0,\ \forall x > e$ and $\frac{dA}{dx} > 0,\ \forall x < e$.

Hence $x = e$ is point of maxima. $A_{\max} = e.\frac{1}{e^2} = \frac{1}{e}$

65. B

Sol. $f(x) = \int \frac{x^2(\sqrt{1 + x^2} - 1)}{(1 + x^2)(1 + x^2 - 1)}dx = \int \frac{\sqrt{1 + x^2} - 1}{1 + x^2}dx = \int \frac{dx}{\sqrt{1 + x^2}} - \int \frac{dx}{1 + x^2}$

$= \log(x + \sqrt{1 + x^2}) - \tan^{-1} x + k$

$$\therefore\ f(0) = \log 1 - \tan^{-1} 0 + k = k = 0$$

$$\therefore\ f(x) = \log(x + \sqrt{1+x^2}) - \tan^{-1} x$$

$$\therefore\ f(1) = \log(1+\sqrt{2}) - \frac{\pi}{4}$$

66. B

Sol. Let $I = f\left(\frac{1}{2}\right) - f\left(\frac{1}{3}\right) = \int\limits_0^{\pi/4} \log_e \left(\frac{1+\frac{1}{2}\tan z}{1+\frac{1}{3}\tan z}\right) dz = \int\limits_0^{\pi/4} \log_e \left(\frac{3}{2}.\frac{2+\tan z}{3+\tan z}\right) dz$

$$= \int\limits_0^{\pi/8} \left(\log_e\left(\frac{3}{2}.\frac{2+\tan z}{3+\tan z}\right) + \log_e\left(\frac{3}{2}.\frac{2+\tan\left(\frac{\pi}{4}-z\right)}{3+\tan\left(\frac{\pi}{4}-z\right)}\right)\right) dz = \frac{\pi}{8}\log_e\left(\frac{9}{8}\right)$$

$$\Rightarrow\ I = \frac{\pi}{8}\log_e\left(\frac{9}{8}\right)$$

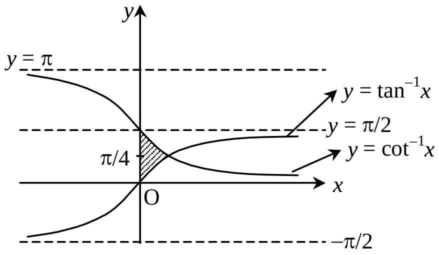
67. D

Sol. Required area,

$$\Delta = \int\limits_0^{\pi/4} \tan y\ dy + \int\limits_{\pi/4}^{\pi/2} \cot y\ dy$$

$$= \ln \sec y\Big|_0^{\pi/4} + \ln \sin y\Big|_{5\pi/4}^{\pi/2}$$

$$= \ln\sqrt{2} - \ln\frac{1}{\sqrt{2}} = \ln 2\,.$$



68. C

Sol. Put $\tan y = z \quad \therefore\ \sec^2 y \frac{dy}{dx} = \frac{dz}{dx} \quad \therefore\ \frac{dz}{dx} + xz = x^3$

which is a linear differential equation, on solving we get

$$\tan y = x^2 - 2 + ce^{-x^2/2}$$

69. B

Sol. Numerator = $\cos 6x + \cos 4x + 5(\cos 4x + \cos 2x) + 10(\cos 2x + 1)$

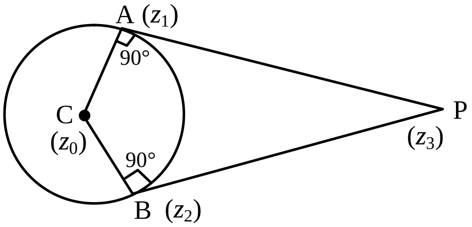
= $2\cos x\{\cos 5x + 5\cos 3x + 10\cos x\}$

$$\therefore\ y = \frac{\text{Nr}}{\text{Dr}} = 2\cos x,\ \frac{dy}{dx} = -2\sin x$$

70. C

Sol. Let $z_1,\ z_2$ are represented by *A, B* whereas

z_0 is represented by *C*.



Let P represent z_3

$$\frac{z_3 - z_1}{z_0 - z_1} = \frac{PA}{AC} e^{\frac{i\pi}{2}} \ ; \ \frac{z_0 - z_2}{z_3 - z_2} = \frac{BC}{PB} e^{\frac{i\pi}{2}}$$

$$\frac{z_3 - z_1}{z_0 - z_1} \cdot \frac{z_0 - z_2}{z_3 - z_2}$$

$$= \frac{PA}{radius} \cdot \frac{radius}{PB} e^{i\pi} = -1 \ (\because \ PA = PB)$$

71. B

Sol. Let A_1 be the property that HIN appears

Let A_2 be the property that DUS appears

Let A_3 be the property that TAN appears

$$n(A_1) = 7! = 5040$$

$$n(A_2) = \frac{7!}{2!} = 2520$$

$$n(A_3) = 7! = 5040$$

$$n(A_1 \cap A_2) = n(A_2 \cap A_3) = n(A_3 \cap A_1) = 5! = 120$$

$$n(A_1 \cap A_2 \cap A_3) = 3! = 6$$

$$n(A_1 \cup A_2 \cup A_3) = \sum n(A_i) - \sum_{i \neq j} n(A_i \cap A_j) + n(A_1 \cap A_2 \cap A_3) = 12246$$

Total number of ways to arrange the letters of the word HINDUSTAN $= \frac{9!}{2!} = 181440$

$\therefore$ Number of ways in which neither the pattern HIN or DUS and TAN appears
= 181440 – 12246 = 169194

72. A

Sol. Total number of matrices = 3^9
Number of symmetric matrices = 3^6
Number of skew symmetric matrices = 3^3
The zero matrix is both symmetric and skew-symmetric the required probability is

$$= \frac{3^9 - 3^6 - 3^3 + 1}{3^9}$$

73. A

Sol. LHS achieves its maximum value at $x = 1$ (in the domain of the equation i.e., $x > 0$)
Maximum value of LHS =1 at $x = 1$
RHS achieves it minimum value at $x = 1$ (in the domain of equation i.e., $x > 0$)
Minimum value of RHS = 1 at $x = 1$
Hence only possible value of x satisfying the given equation is 1.

74. D

Sol. $(1 - x + x^2)^n = a_0 - a_1 x + a_2 x^2 - .... + a_{2n} x^{2n}$

$$(1 + x)^n = {}^nC_0 + {}^nC_1 x + {}^nC_2 x^2 + {}^nC_3 x^3 + ... + {}^nC_n x^n$$

On multiplying and collecting coefficient of x^{3r}, we get $\sum_{k=0}^{3r} (-1)^k a_k \ {}^nC_{3r-k} = {}^nC_r$

75. A

Sol. We can write Δ as

$$\Delta = \begin{vmatrix} 0 & \sin x - \cos x & \log\tan x \\ -(\sin x - \cos x) & 0 & -\log\tan x \\ -\log\tan x & \log\tan x & 0 \end{vmatrix}$$

Which is determinant of a skew symmetric matrix of odd order, hence value will be zero

76. B

Sol. $\mathrm{A\,(Adj\,A)} = |\mathrm{A}|\,\mathrm{I}_3$

$\mathrm{K} = |\mathrm{A}| = 2(\sin^6 x + \cos^6 x) - 3(\sin^4 x + \cos^4 x)$

$= 2(1 - 3\sin^2 x.\cos^2 x) - 3\,(1 - 2\sin^2 x\cos^2 x) = -1$

77. C

Sol. By the given condition $(1-ab)m^2 - (a^2+b^2)m - (1+ab) = 0$

$\Rightarrow m(a^2+b^2) + (m^2+1)ab = m^2 - 1$ …(i)

Now H_1 = First H.M. between *a* and *b* = $\dfrac{(m+1)ab}{a+mb}$ and $H_m = \dfrac{(m+1)ab}{b+ma}$

$\therefore\ H_m - H_1 = (m+1)ab\left[\dfrac{1}{b+ma} - \dfrac{1}{a+mb}\right] = (m+1)ab\dfrac{[(m-1)(b-a)]}{(b+ma)(a+mb)}$

=

$\dfrac{(m^2-1)ab(b-a)}{m(a^2+b^2)+(m^2+1)ab} = \dfrac{(m^2-1)ab(b-a)}{m^2-1}$ [From (i)]

= $ab(b-a)$.

78. B

Sol. We have, $a_n = S_n - S_{n-1}$ …(i)

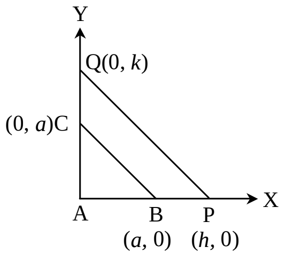
and $a_{n-1} = S_{n-1} - S_{n-2}$ …(ii)

$\therefore d = a_n - a_{n-1} = (S_n - S_{n-1}) - (S_{n-1} - S_{n-2})$ [From (i) and (ii)]

= $S_n - 2S_{n-1} + S_{n-2}$

79. C

Sol. We take *A* as the origin and *AB* and *AC* as *x*-axis and *y*-axis respectively. Let *AP* = *h*, *AQ* = *k* Equation of the line *PQ* is



$\dfrac{x}{h} + \dfrac{y}{k} = 1$ …(i)

Given, *BP* . *CQ* = AB^2

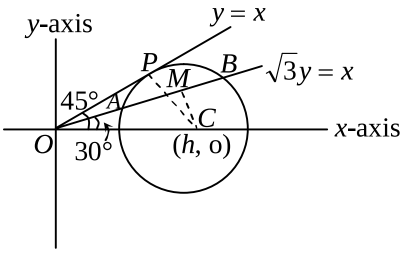
$\Rightarrow (h-a)(k-a) = a^2$

$\Rightarrow hk - ak - ah + a^2 = a^2$ or $ak + ha = hk$

Or $\dfrac{a}{h} + \dfrac{a}{k} = 1$ ….(ii)

From (ii), it follows that line (i) i.e. PQ always passes through a fixed point (*a*, *a*).

80. A



Sol. $OP = CP = \frac{h}{\sqrt{2}} = AC$

$CM = h \sin 30° = \frac{h}{2}$

From Δ *ACM*

$AC^2 = AM^2 + CM^2$

$\frac{h^2}{2} = 1 + \frac{h^2}{4} \Rightarrow \frac{h^2}{4} = 1 \quad \Rightarrow h = 2$

radius $= \sqrt{2}$

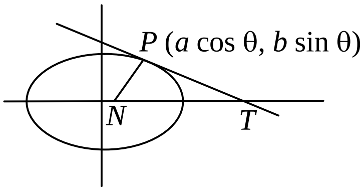
$(x-2)^2 + y^2 = 2\,;\, x^2 + y^2 - 4x + 2 = 0$

81. B

Sol. Mid-point of (1, 2) and (3, 6) is (2, 4), line passing through (1, 6) and (2, 4) is parallel to axis of the parabola (property). So, slope of its axis is –2 or slope of its directrix is 1/2, also in this case tangents are perpendicular. So, (1, 6) must lie on directrix,

$\therefore\ y - 6 = \frac{1}{2}(x-1) \quad \Rightarrow \quad x - 2y + 11 = 0$

82. A



Sol. $e = \sqrt{1 - \frac{b^2}{a^2}} = \frac{3}{5}$

$T \equiv \left(\frac{a}{\cos\theta}, 0\right),\ N \equiv \left(\frac{a^2 - b^2}{a\sec\theta}, 0\right)$

On solving we get, $\cos\theta = \frac{1}{2},\ \sin\theta = \frac{\sqrt{3}}{2}$

$\therefore$ Area of $\Delta PSS' = 6\sqrt{3}$ sq. units

83. C

Sol. $b^2 = d_1 d_2$, where d_1 and d_2 are perpendicular distances of any tangent from focii of the hyperbola $b^2 = 4 \times 2 = 8 \Rightarrow b = 2\sqrt{2}$

$2ae = \sqrt{72} = 6\sqrt{2}$

So $a^2 = 10$

Centre is (5, 1)

Equation of conjugate axis $x - y = 4$ and equation of transverse *axis* is $x + y = 6$

$\therefore$ Equation of hyperbola is $\frac{(x-y-4)^2}{20} - \frac{(x+y-6)^2}{16} = 1$

84. B

Sol. The expression = $\sin^2 A + 2\sin A\cos B\sin C + \cos^2 B$

$= \sin^2 A + 1 - \sin^2 B + 2\sin A\cos B\sin C$

$= \sin(A+B)\sin(A-B) + 1 + 2\sin A\cos B\sin C$

$= -\sin C\sin(A-B) + 2\sin A\cos B\sin C + 1$

$= \sin C[2\sin A\cos B - \sin(A-B)] + 1$

$= \sin C\sin(A+B) + 1$

$$= \sin C\left(-\sin C\right)+1=\cos^2 C$$

85. B

Sol. $\dfrac{\sin \pi/12}{\sin x}+\dfrac{\cos\pi/12}{\cos x}=2 \;\Rightarrow\; \sin\dfrac{\pi}{12}\cos x+\cos\dfrac{\pi}{12}\sin x = 2\sin x\cos x$

$\sin\left(\dfrac{\pi}{12}+x\right)=\sin 2x$

$\dfrac{\pi}{12}+x=2x$ and $\dfrac{\pi}{12}+x=\pi-2x$

$\Rightarrow x=\dfrac{\pi}{12}$ and $x=\dfrac{11\pi}{36}$

86. C

Sol. Adding the given two

$\sin\left(B+C\right)=1 \;\Rightarrow\; B+C=90°$

Subtracting, $\sin\left(B-C\right)=\dfrac{\sqrt{3}-2}{\sqrt{3}}\neq 0$

$\therefore B\neq C$

$\therefore$Triangle is right-angled.

87. A

Sol. Put $\tan^{-1}x=\theta$ $\tan^{-1}x=\theta \Rightarrow \theta\in\left(-\pi/2,-\pi/4\right)\Rightarrow 2\theta\in\left(-\pi,-\pi/2\right)$

$\therefore \text{equation becomes}\,\pi\text{-}\cos^{-1}\left(\cos 2\theta\right)+\sin^{-1}\left(\sin 2\theta\right)+\tan^{-1}\left(\tan 2\theta\right)=\pi/3$

On solving we get $\theta=-\pi/3 \Rightarrow x=-\sqrt{3}$

88. B

Sol. The equation of a plane parallel to the plane $\vec{r}\,.\,(4\hat{i}-12\hat{j}-3\hat{k})-7=0$ is

$\vec{r}\,.\,(4\hat{i}-12\hat{j}-3\hat{k})+\lambda=0$. This passes through $2\hat{i}-\hat{j}-4\hat{k}$. Therefore

$(2\hat{i}-\hat{j}-4\hat{k})\,.\,(4\hat{i}-12\hat{j}-3\hat{k})+\lambda=0$

$\Rightarrow 8 + 12 + 12 + \lambda = 0 \quad \Rightarrow \quad \lambda = -32$

So, the required plane is $\vec{r}\,.\,(4\hat{i}-12\hat{j}-3\hat{k})-32=0$

89. A

Sol. $p\rightarrow q$ must be true & q→r must be false

$\therefore$ q must be true, r must be false but p can be true or false.

90. C

Sol. Deviation does not changes by changing a data

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – I

JEE (Advanced)-2019

PAPER –1

Time Allotted: 3 Hours **Maximum Marks: 264**

General Instructions:

- The test consists of total 60 questions.
- Each subject (PCM) has 20 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Three Sections**: **Section-A, Section-B & Section-C.**

  Section–A (01 – 10, 21 – 30, 41 – 50) *contains 30 multiple choice questions which have one or more than one correct answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

  Section–B (11 – 12, 31 – 32, 51 – 52) *contains 6 Match the following Type questions. Each question having 4 statements in Column I & 5 statements in Column II with any given statement in Column I having correct matching with one or more statement (s) given in Column II. Each statement carries* ***+2 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

  Section–C (13 – 20, 33 – 40, 53 – 60) *contains 24 Numerical based questions with answers as numerical value from* ***0 to 9*** *and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

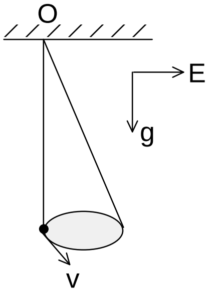
Physics

PART – I

SECTION – A
(One OR More Than One Choice Type)

This section contains **10 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **one or more than one** is/are correct

1. A positive charged particle of charge q and mass m is suspended from a point O by a string of length λ. In the space a uniform horizontal electric field E exists. The particle is drawn aside so that the string becomes vertical and then it is projected horizontally with velocity v such that the particle starts to move along a circle with same constant speed v.



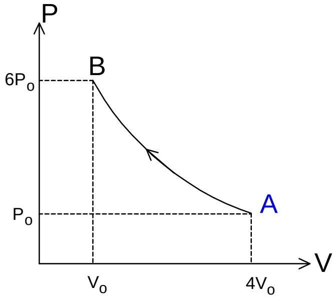
(A) tension in string is $\sqrt{(mg)^2+(qE)^2}$

(B) tension in string is mg $\left[1+\left(\frac{qE}{mg}\right)^2\right]$

(C) kinetic energy of mass is $\frac{q^2E^2\ell}{2mg}$

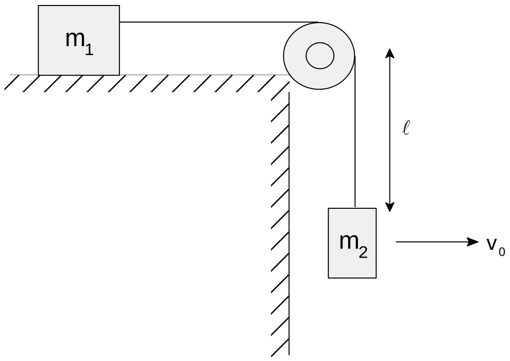
(D) kinetic energy of mass is $\frac{5}{2}m\ell\sqrt{g^2+\frac{q^2E^2}{m^2}}$

2. One mole of a diatomic gas is taken through a process A → B as shown in the figure. The gas obeys the relation
$Q_{A\to B}+W_{A\to B}=O$
(A) the molar heat capacity for process AB is 5R/4
(B) the heat supplied in the process is (5/2) P_oV_o
(C) for A to B, temperature initially decreases and then increases
(D) the temperature goes on increasing from A to B



Space for Rough work

3. In the arrangement shown in the figure, initially the block of mass m, is in limiting equilibrium. The coefficient of friction between the block of mass m_1 and floor is μ. Now the particle of mass m_2 is given a horizontal velocity v_0. The initial distance of the block of mass m_2 from the pulley is ℓ. The masses of pulley and threads are negligible. Choose the correct option(s):



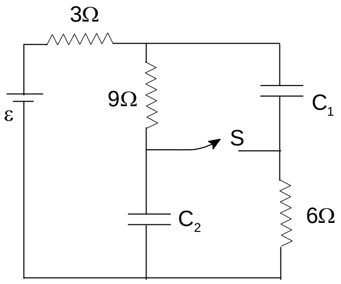
(A) Acceleration of m_1 just after the velocity given is $\left(\frac{\mu}{1+\mu}\right)\frac{v_0^2}{\ell}$

(B) Acceleration of m_1 just after the velocity given is $\left(\frac{\mu}{1+\mu}\right)\frac{v_0^2}{2\ell}$

(C) Radius of curvature of path of m_2 just after the velocity given is $\ell(1+\mu)$

(D) Radius of curvature of path of m_2 just after the velocity given is $2\ell(1+\mu)$

4. In the circuit shown there is steady state with the switch closed. The switch is opened at t = 0. Choose the correct option(s).
$(\text{Given}: \varepsilon = 24\text{V}, C_1 = 3\text{F and } C_2 = 2\text{F})$

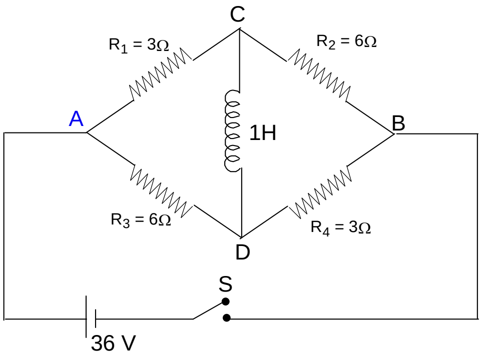


(A) The voltage across C_1 before the switch is open, is 12V
(B) The voltage across C_1 after a long time after the switch is open, is 12V
(C) The voltage across C_2 after a long time after the switch is open, is 24V
(D) The voltage across C_2 before the switch is open, is 8V

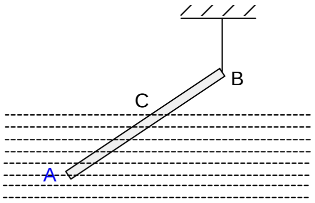
5. Energy liberated in the de – excitation of hydrogen atom from 3rd level to 1st level falls on a photo-cathode. Later when the same photo – cathode is exposed to a spectrum of some unknown hydrogen like gas, excited to 2nd energy level, it is found that the de – Broglie wavelength of the fastest photoelectrons, now ejected has decreased by a factor of 3. For this new gas, difference of energies of 2nd Lyman line and 1st Balmer line found to be 3 times the ionization potential of the hydrogen atom. Select the correct statement(s):
(A) The gas is lithium
(B) The gas is helium
(C) The work function of photo – cathode is 8.5 eV
(D) The work function of photo – cathode is 5.5 eV

Space for Rough work

6. The switch S is closed at t = 0 as shown in the figure.
   (A) the current as function of time in the inductor is $3(1 - e^{-4t})$A.
   (B) the current through R_1 just after closing of switch is 8A
   (C) the power supply by the battery as function of time is $36(9 - e^{-4t})$
   (D) the current through R_2 after long time closing of switch is 3A



7. A uniform thin rod AB, 12 m long weighing 24 kg, is supported at end B by a flexible light string and a lead weight (of very small size) of 12 kg is attached at end A. The rod floats in a river with one-half of its length submerged. For this situation, mark out the correct statement. [Take g = 10 m/s^2, density of water = 1000 kg/m^3]
   (A) the tension in the string is 36 g
   (B) the tension in the string is 4 g
   (C) the volume of the rod is 60000 m^3
   (D) the point of application of the buoyancy force is passing through C (centre of mass of the rod).



8. Mark the correct statement(s).
   (A) when a sound wave strikes a wall, the compression pulse is reflected as compression pulse.
   (B) when a sound wave strikes a wall, the compression pulse is reflected as rarefaction pulse.
   (C) when a sound wave is coming out after passing through a narrow pipe, then reflection would be there at open end.
   (D) when a sound wave is coming out after passing through a narrow pipe, then compression pulse is reflected as rare fraction pulse.

9. A t = 0, two particles B & C are located at the origin of the coordinate system. Then they start moving simultaneously. B moves under a constant acceleration of $2\hat{k}\,m/s^2$ with an initial velocity of $8\hat{j}\,m/s$. Particle C moves with constant velocity $\vec{V}_o$ in such a way that B & C collides at t = 4 sec. Then mark the incorrect statement(s).
   (A) $\vec{v}_o = 8\hat{j} + 4\hat{k}\,m/s$
   (B) position vector of location where two particles collide is $16\hat{i} + 32\hat{k}$ m.
   (C) both (A) & (B) are correct
   (D) It is not possible that B & C collide with each other for any value of $\vec{V}_o$

Space for Rough work

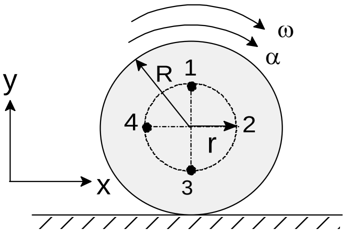
10. A transverse wave travelling on a taut string is represented by:
$y = 0.01\ \sin 2\pi(10t - x) \rightarrow$ y and x are in meters and t in seconds. Then
(A) The speed of the wave is 10 m/s
(B) Closest points on the string which differ in phase by 60^0 are (1/6) m apart
(C) Maximum particles velocity is $\pi/4$ m/s
(D) The phase of a certain point on the string changes by 120^0 in (1/20) seconds

SECTION – B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.**

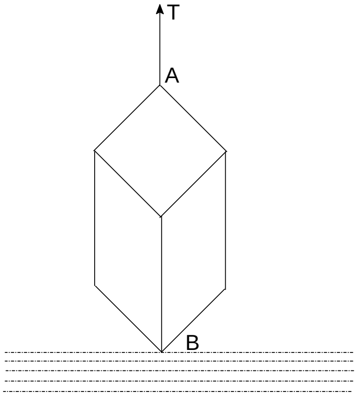
11. A disc of radius R is rolling without slipping with an angular acceleration α, on a horizontal plane. Four points are marked at the end of horizontal and vertical diameter of a circle of radius r (<R) on the disc. If horizontal and vertical direction are chosen as x and y axis as shown in the figure, then acceleration of points 1, 2, 3 and 4 are $\vec{a}_1, \vec{a}_2, \vec{a}_3$ and $\vec{a}_4$ respectively, at the moment when angular velocity of the disc is ω. Match the following



Column – I		Column - II	
(A)	$\vec{a}_1$	(p)	$(R\alpha - r\alpha)\hat{i} + (r\omega^2)\hat{j}$
(B)	$\vec{a}_2$	(q)	$(R\alpha + r\alpha)\hat{i} - (r\omega^2)\hat{j}$
(C)	$\vec{a}_3$	(r)	$(R\alpha - r\omega^2)\hat{i} - (r\alpha)\hat{j}$
(D)	$\vec{a}_4$	(s)	$(R\alpha + r\omega^2)\hat{i} + (r\alpha)\hat{j}$
		(t)	None of these

Space for Rough work

12. A cube of volume 1 m^3 and specific gravity 2 is very slowly being lowered in to a lake with help of a massless string tied to one of its vertices as shown.
Initially the vertex B is just touching the surface of water and finally, vertex A is just beneath the surface of water. For the process of immersion, match the columns: (Ignore change in KE of water). ($g = 10\ ms^{-2}$).

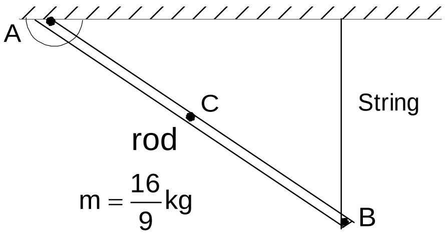


Column – I		Column - II	
(A)	Work done by gravity on water + cube system	(p)	$\frac{3\sqrt{3}}{2}\times 10^4$ Joule
(B)	Work done by tension on the cube	(q)	$\frac{-3\sqrt{3}}{2}\times 10^4$ Joule
(C)	Work done by gravity on water	(r)	$\frac{\sqrt{3}}{2}\times 10^4$ Joule
(D)	Work done by gravity on the cube	(s)	$2\sqrt{3}\times 10^4$ Joule
		(t)	$40\sqrt{3}\times 10^4$ Joule

SECTION – C
(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

13. A rod is kept at an angle of 60^0 with the horizontal by the help of a string in vertical plane. The string is now cut at t = 0. Find the force (in N) applied by upper half section of the rod AC on the lower half section of the rod BC just after t = 0. (Take mass of the rod = $= \frac{16}{9}$kg and g = 10 m/s^2)



Space for Rough work

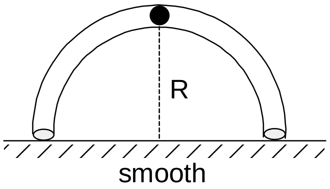
14. A man crosses a river of width d. Current flow speed is v. Speed of swimmer relative to water is v. Man always heads towards the point exactly opposite to the starting point at the another bank (relative to water). If radius of curvature of the path followed by the swimmer just after he start swimming is $n\sqrt{2}d$, then the value of n is.

15. The following measurement are obtained on a single phase load V = 220 V $\pm 1\%$. I = 5.0 A $\pm 1\%$ and W = 555 W $\pm 2\%$. If the power factor is calculated using these measurements, the worst case error in the calculated power factor in percent is______________. (Give answer up to one decimal place.)

16. A small ball of density $4\rho_o$ is left from the surface of liquid. The density of liquid varies as $\rho = \rho_o(1 + ay)$, where y is height of liquid from the surface and ρ_o, a are constants. The time-period of oscillation of ball is found to be $\frac{2\pi}{\sqrt{K}}$ sec. Find K [a = 2 m^{-1}, g = 10 ms^{-2}]. Neglect viscosity]

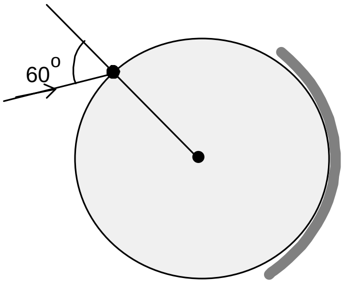
17. The volume of glass vessel is 1000 cc at 20^0C. What volume of mercury should be poured into it at this temperature so that the volume of the remaining space does not change with temperature is 10 n cc. Coefficient of cubical expansion of mercury and glass are $1.8 \times 10^{-4}\,/\,^0C$ and $9.0 \times 10^{-6}\,/\,^0C$ respectively. Find the value of n?

18. A smooth narrow semicircular tube (in vertical plane) contains a small ball of mass m at its top as shown. System is initially at rest and now ball is slightly pushed to its right such that system starts moving. If the acceleration of the tube just before the ball hits the floor is $\frac{4g}{\eta}$, find η. (Take mass of tube = 2 m and neglect the break-off of the tube from floor)



19. A gas containing hydrogen like ions with atomic number z, emits photons in transition (n + 2) → n, where n = z. These photons fall on a metallic plate and eject electrons having minimum de-broglie wavelength λ of 5 Å. Find the value of 'z' if the work function of metal is 4.2 eV. [Take h = 6.625×10^{-34} J-s, mass of electron = 9.1×10^{-31} kg]

20. A ray is incident on a glass sphere as shown. The opposite surface of the sphere is partially silvered. The net deviation of the ray transmitted at the partially silvered surface is 1/3rd of the net deviation suffered by the ray reflected at the partially silvered surface (after emerging out of the sphere). The refractive index of the sphere is $\sqrt{n}$. Find n.



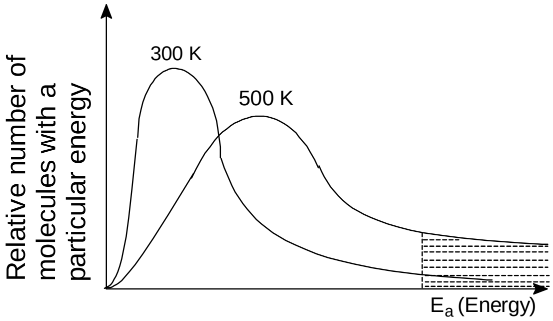
Space for Rough work

Chemistry PART – II

SECTION – A
(One OR More Than One Choice Type)

This section contains **10 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **one or more than one** is/are correct

21. The distribution of molecular kinetic energy at two temperature is as shown in the following graph.



Which of the following conclusions are correct ?
(A) The number of molecules with energy E_a or greater is proportional to the shaded area for each temperature.
(B) The number of molecules with energy E_a or less is proportional to the shaded area for each temperature.
(C) The number of molecules with energy E_a is the mean of all temperatures.
(D) The graph follows the Maxwell – Boltzmann energy distribution law.

22. How much charge must be supplied to a cell for the electrolytic production of 245 gram $NaClO_4$ from $NaClO_3$? Because of the side reaction, the anode efficiency for the desired reaction is 60 %.
(A) $6.43\times10^{5}C$ (B) 6.67 F
(C) $6.43\times10^{6}C$ (D) 66.7 F

23. In which of the following pairs of solutions will the values of the van't Hoff factor be the same ?
(A) 0.05 M $K_4\left[Fe(CN)_6\right]$ and 0.10 M $FeSO_4$
(B) 0.10 M $K_4\left[Fe(CN)_6\right]$ and 0.05 M $FeSO_4\left(NH_4\right)_2SO_4.6H_2O$
(C) 0.20 M NaCl and 0.10 M $BaCl_2$
(D) 0.05 M $FeSO_4\left(NH_4\right)_2SO_4.6H_2O$ and 0.02 M KCl. $MgCl_2.6H_2O$

Space for Rough work

24. Which of the following crystals have 8 : 8 coordination ?
(A) NH_4Cl
(B) AlFe
(C) MnO
(D) NH_4Br

25. On treatment of hard water with zeolite, sodium ions get exchanged with
(A) Ca^{2+} ions
(B) H^{+} ions
(C) Mg^{2+} ions
(D) OH^{-} ions

26. Which of the following statement/s is/are correct?
(A) Boric acid is a hydrogen – bonded molecule.
(B) Boric acid combines with CuO to give metaborate in the borax bead test.
(C) Al_2O_3 is more acidic than B_2O_3.
(D) Al_2O_3 is amphoteric and B_2O_3 is acidic.

27. Nitrous oxide is prepared by
(A) Heating a mixture of NH_4Cl and $NaNO_3$
(B) Heating a mixture of NH_4Cl and $NaNO_2$
(C) The hydrolysis of Mg_3N_2
(D) Heating a mixture of nitric oxide and sulphur dioxide

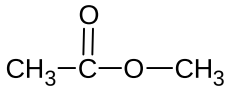
28.

$$CH\equiv CH + 2CH_3COOH \xrightarrow[\text{2. } \Delta\ (300 - 400^0C)]{\text{1. } Hg^{2+}} \text{Products}$$

(A) $CH_3-CH(OCOCH_3)_2$

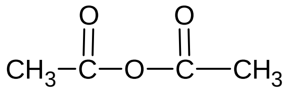
(B) CH_3CHO

(C)



$CH_3-\overset{\overset{\displaystyle O}{||}}{C}-O-CH_3$

(D)

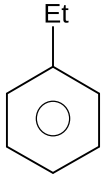


$CH_3-\overset{\overset{\displaystyle O}{||}}{C}-O-\overset{\overset{\displaystyle O}{||}}{C}-CH_3$

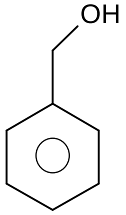
Space for Rough work

29. Benzoic acid may be prepared by the oxidation of

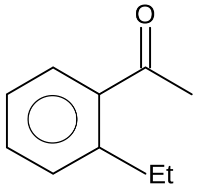
(A)



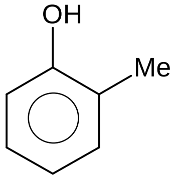
(B)



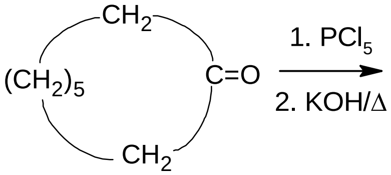
(C)



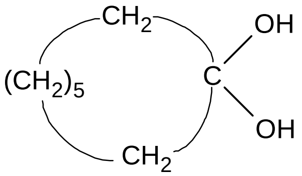
(D)



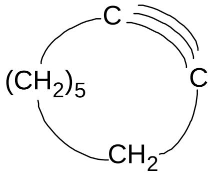
30. The final product of the reaction is


CH2
(CH2)5
C=O
CH2
1. PCl5
2. KOH/Δ

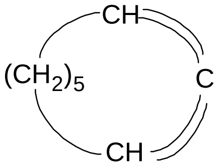
(A)


CH2
OH
(CH2)5
C
OH
CH2

(B)



(C)



(D) The starting compound is recovered

Space for Rough work

SECTION – B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.**

---

31. Match the Column – I with Column – II.

	Column I		**Column II**
(A)	Molten $PbCl_2$ using inert electrode	(p)	Metal of salt will reduced
(B)	NaCl solution using inert electrode	(q)	$2H_2O+2e^- \longrightarrow H_2(g)+2OH^-$
(C)	Silver nitrate solution using Ag electrode	(r)	Solution becomes basic after electrolysis
(D)	Sodium nitrate solution using inert electrode	(s)	Solution becomes acidic after electrolysis
		(t)	Solution becomes neutral after electrolysis

32. Match the Column – I with Column – II.

	Column I		**Column II**
(A)	$\left[Cr(CN)_3(NO_2)_3\right]^{4-}$	(p)	Outer orbital complex
(B)	$\left[Co(C_2O_4)_3\right]^{3-}$	(q)	Inner orbital complex
(C)	$\left[Fe(EDTA)\right]^{-}$	(r)	$\mu = 2.83BM$
(D)	$\left[Ni(en)_3\right](NO_3)_2$	(s)	Shows optical activity
		(t)	$\mu = 0$

Space for Rough work

SECTION – C
(One Integer Value Correct Type)

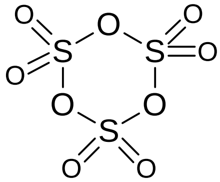
This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

33. Find number of basic radicals among the following cations, which can form soluble complex on adding excess of NH_3 solution.

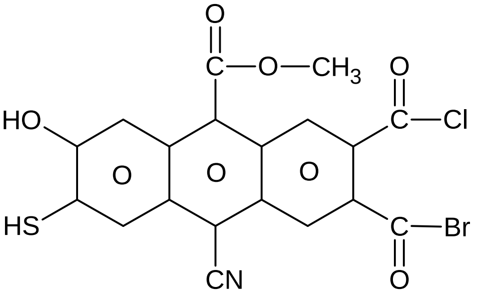
$$Pb^{2+}_{(aq)}, Cd^{2+}_{(aq)}, Mn^{2+}_{(aq)}, Ni^{2+}_{(aq)}, Fe^{3+}_{(aq)}, Zn^{2+}_{(aq)}, Ag^{+}_{(aq)}$$

34. In the following molecule



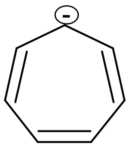
If x is the total number of dπ – pπ bonds and y is the total number of sp^3 hybridized atoms. Find the value of $\frac{x}{y}$?

35. How many moles of CH_3MgBr will consume when it reacts with following compound



Space for Rough work

36. Calculate total number of aromatic species in following



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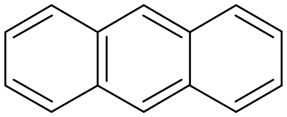

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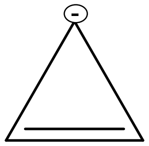

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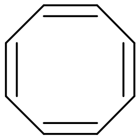

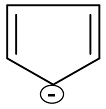

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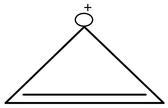
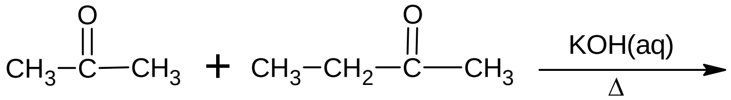


37.



$$CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3 + CH_3-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3 \xrightarrow[\Delta]{KOH(aq)}$$

Calculate total number of aldol condensation product (s) including stereoisomers.

38. The total number of α & β particles emitted in the nuclear reaction ${}^{238}_{92}U \longrightarrow {}^{214}_{82}Pb$

39. In 1 litre saturated solution of $AgCl\left[K_{SP}\left(AgCl\right)=1.6\times10^{-10}\right]$, 0.1 mol of CuCl [$K_{sp}$(CuCl) = 1.0×10^{-6}] is added. The resultant concentration of Ag^+ in the solution is 1.6×10^{-x}. The value of "x" is.

40. A gas diffuse $\frac{1}{5}$ times as fast as hydrogen. If its molecular mass is 10 y. What is the value of y.

Space for Rough work

Mathematics PART – III

SECTION – A
(One OR More Than One Choice Type)

This section contains **10 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **one or more than one** is/are correct

41. A square matrix 'A' of order 3, satisfies the relation $A^3 - 6A^2 + 7I = 0$, where I is unit matrix of order 3. Which of the following are correct
(A) trace of the matrix A is 6
(B) det(A) = 6
(C) trace of the matrix A is – 7
(D) det(A) = –7

42. From a variable point P, normal are drawn to the hyperbola xy = 16. If sum of slopes of normal is equal to the sum of ordinates & abscissas of feet of normal, then the locus of point P is the curve 'C'. Which of the following are correct.
(A) 'C' is a parabola of length of latus rectum 16
(B) 'C' is an ellipse of length of latus rectum 16
(C) 'C' is a hyperbola of length of latus rectum 16
(D) focus of 'C' is at (8, 0)

43. Five fair dice are tossed. Which of the following are true
(A) mean of no. of dice showing even nos. is 2.5
(B) varience of no. of disc showing even nos. is 1.25
(C) probability that same nos. appeared on all the 5 dice is $\frac{1}{6^4}$
(D) probability that atleast two dice show even number, if atleast one die show even number is $\frac{26}{31}$

44. Solution of the differential equation $x\left[y\ln x - y\ln y - x - y\right]dy = y\left[x\ln y - x\ln x - y - x\right]dx$; y(1)=e is $ay\ln\left(\frac{x}{y}\right) = bx\ln\left(\frac{y}{x}\right) - ce + d$ where a, b, c & d are integers. Which of the following are correct
(A) a + b = 2
(B) ab + c + d = 1
(C) ab + bc + cd + ad + bd + ac = 0
(D) a + b + c + d = 2

Space for Rough work

45. If $g(x)=\lim_{n\to\infty} n\left[x^{\frac{2018}{n}}-x^{\frac{2019}{n}}\right]; x>0$ then choose the correct option(s)

(A) the number of solution(s) of the equation $g(|x|)=e^{-2019x^2}$ is 2

(B) the number of solution(s) of the equation $g(|x|)=e^{-2019x^2}$ is 2

(C) the number of solution(s) of the equation $g(x)=e^{2018}$ is 1

(D) the number of solution(s) of the equation $g(x)=e^{-2018}$ is 1

46. For fixed positive λ the locus of the point z satisfying the equation $|3z - i| = \lambda|z + 2|$ can be
(A) a straight line
(B) a circle
(C) a rectangular hyperbola
(D) an ellipse

47. If $g(x,y)=2x^2-(\lambda+1)xy-\lambda y^2$ be an orthogonal pair if straight lines and a point (h, k) (h, k $\in$ z) lies on the curve g(x, y) = 7, then
(A) value of λ is – 2
(B) value of λ is 2
(C) possible value of h + k is – 4
(D) possible value of h + k is 4

48. N is the number of ways in which 8 different books can be distributed among 3 students, if each student receives at least 2 books. Then N is divisible by
(A) 2
(B) 3
(C) 4
(D) 5

49. Six people $(P_1P_2P_3P_4P_5P_6)$ are going to sit in a row on a bench. $P_1 \& P_2$ are adjacent. P_3 doesn't want to sit adjacent to P_4. P_5 *and* P_6 can sit anywhere. Number of ways in which these six people can be seated, is less or equal to
(A) 200
(B) 144
(C) 120
(D) 56

50. Plane $'\pi'$ meets the co-ordinate axes (X, Y & Z axes respectively) at A, B & C. If areas of $\Delta OAB, \Delta OBC \& \Delta OCA$ are 3, 6 & 4 units respectively. Now which of the following are correct.

(A) Area of $\Delta ABC=\sqrt{61}$ Square unit

(B) Equation of plane $'\pi'$ may be $6x-4y+3z=12$

(C) Equation of plane $'\pi'$ may be $6x+4y-3z=12$

(D) Volume of tetrahedron OABC is 2 unit

Space for Rough work

SECTION – B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.**

---

51. Match the following:-

Column – I		Column – II	
(A)	Let $\vec{P} = 2\hat{i} + \hat{j} - \hat{k}$ and $\vec{q} = \hat{i} + 3\hat{k}$. If $\vec{r}$ is an unit vector and μ is the maximum value of $\left[\vec{p}\ \vec{q}\ \vec{r}\right]$. Then the value of $\mu^2 - 57$ is	(p)	1
(B)	The value of t $\in$ R for which the vectors $\vec{a} = (1,-2,3)$, $\vec{b} = (-2,3,-4)$, $\vec{c} = (1,-1;\ t)$ form a linearly dependent system	(q)	2
(C)	If the area of the parallelogram whose diagonals are $3\hat{i} + \hat{j} - 2\hat{k}$ and $\hat{i} - 3\hat{j} + 4\hat{k}$ is $\mu\sqrt{3}$ sq. unit, then the value of μ is	(r)	3
(D)	Let $\vec{p} = \hat{i} + \hat{j}; \vec{q} = \hat{i} - \hat{j}$ and $\vec{r} = \hat{i} + 2\hat{j} + 3\hat{k}$ if $\vec{x}$ is an unit vector such that $\vec{p}.\vec{x} = 0$ and $\vec{q}.\vec{x} = 0$ then $\left|\vec{r}.\vec{x}\right|$ is equal to	(s)	4
		(t)	5

52. Match the following:-

Column – I		Column – II	
(A)	If $I = \int_0^{\frac{\pi}{4}} \sin^3 x.\cos^3 x\,dx$, then I^{-1} is divisible by	(p)	1
(B)	If $I = \int_0^{2\pi} \left[2\sin x\right] dx$, then |[I]| is divisible by ([.] is GIF)	(q)	2
(C)	If $I = \int_{-2}^{2} \text{sgn}(x-1)\,dx$, then I + N can be equal to (N be a natural no., sgn(.) is signum function)	(r)	4
(D)	$I = \int_0^1 \frac{x^3-1}{x+1} dx$; then $\left|\left[-2I - \ln 16\right]\right|$ is divisible by ([.] is GIF)	(s)	8
		(t)	16

Space for Rough work

SECTION – C
(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

53. A variable point 'p' moving inside a square whose co-ordinates of vertices are (1, 1), (-1, 1), (-1, -1) & (1, -1) in such a way that 'p' is closer to the diagonals of square compare to the co-ordinate axes. If A is the area of the region transversed by p the [A] is ([·] is GIF)

54. If $\int_1^e \frac{x^3 \ln x + 2}{x^3 \ln x + x} dx = \frac{e^2 + a}{b} - \ln\left(e^2 + 1\right)$ where a & b are positive integers. Then value of a + b is

55. The number of real roots of $(6-x)^4 + (8-x)^4 = 16$ is

56. Number of points on the ellipse $\frac{x^2}{2} + \frac{y^2}{10} = 1$ from which perpendicular tangents can be drawn to the hyperbola $\frac{x^2}{6} - \frac{y^2}{2} = 1$ is

57. Number of principal solution(s) of the equation $\sin x + \cos x + \sin 2x + \cos 2x + \sin 3x = -1$ is

58. 'K' is a three digit number which is no. of ways of distributing 10 identical balls in 5 different boxes such that no. two adjacent boxes remain empty. 'P' is prime number by which sum of digits of 'K' is divisible. The value $\left(P_{\max} - P_{\min}\right)$ is

59. The sum of the coefficients of all the even powers of x in the expansion of $(2x^2 - 3x + 1)^{11}$ is $P_1^m P_2^n$ where P_1 & P_2 are prime numbers, $P_1 < P_2$ and m & n are positive integers. The value of $\frac{P_1 + P_2}{n - m}$ is

60. I(α, r) is the intercept made by the circle $|z|^2 + \overleftarrow{\alpha} z + \alpha \bar{z} + r = 0$ on the real axis on complex plane, where r is a real number and α may be real. The value of $I\left(\frac{5}{2} + i, 4\right)$ is

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – I

JEE (Advanced)-2019

PAPER –1

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. BD

Sol. $T\cos\theta = mg_{eff}\,.....(i)$

$$T\sin\theta = \frac{m\nu^2}{\ell\sin\theta}\,...........(ii)$$

By (i)

$$T = \frac{mg_{eff}\cos\theta}{\cos^2\theta} = \frac{mg}{\frac{g^2}{\left[g^2+\left(\frac{qE}{m}\right)^2\right]}} = mg\left[1+\left(\frac{qE}{mg}\right)^2\right]$$

By (i) & (ii)

$$\frac{mg_{eff}}{\cos\theta}\sin\theta = \frac{m\nu^2}{\ell\sin\theta} \Rightarrow \nu = \sqrt{\left(g_{eff}\sin\theta\right)\ell\tan\theta} = \frac{qE}{m}\sqrt{\frac{\ell}{g}}$$

$$\therefore K.E = \frac{1}{2}m\left(\frac{qE}{m}\right)^2\frac{\ell}{g} = \frac{q^2E^2\ell}{2mg}$$

2. ABD

Sol. By first low of thermodynamics

$Q = W + \Delta U$

$\Rightarrow 2Q = \Delta U$ ……………. (i)

$$\Rightarrow 2\cancel{n}C\left(\cancel{T_B - T_A}\right) = \cancel{n}\frac{5R}{2}\left(\cancel{T_B - T_A}\right)$$

$$\therefore C = \frac{5R}{4}$$

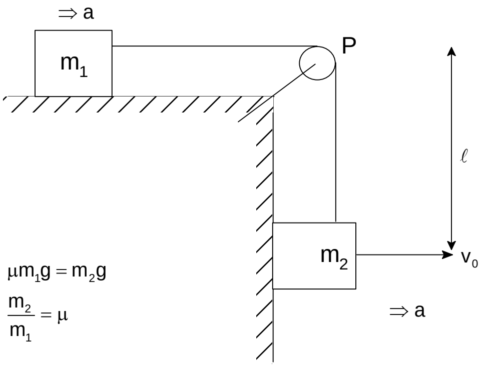
By (i)

$$Q = \frac{1}{2}\Delta U = \frac{1}{2}\left[\frac{5}{2}\left(6P_oV_o - 4P_oV_o\right)\right] = \frac{5}{2}P_oV_o$$

sinceΔU = -2W, therefore temperature goes on increasing from A to B

3. AC

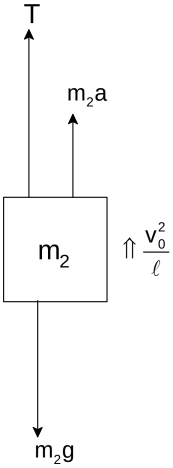
Sol.



$\mu m_1 g = m_2 g$

$\frac{m_2}{m_1} = \mu$

Lets observe the motion of m₂ from an observer fixed at P (point on string)



$$T + m_2a - m_2g = \frac{m_2v_0^2}{\ell} \qquad ....(1)$$

for m_1

$$T - \mu m_1 g = m_1 a \qquad ....(2)$$

$$\text{from}(1) \text{ and } m_1a + \mu m_1 g - m_2 a - m_2 g = \frac{m_2 v_0^2}{\ell}$$

$$a = \frac{m_2\frac{v_0^2}{\ell}}{(m_1 + m_2)} = \left(\frac{\mu}{1+\mu}\right)\frac{v_0^2}{\ell}$$

ROC of m_2

$$T - m_2 g = \mu m_{1g} + \left(\frac{\mu m_1}{1+\mu}\right)\frac{v_0^2}{\ell} - m_2 g$$

$$= \left(\frac{\mu m_1}{1+\mu}\right)\frac{v_0^2}{\ell} = m_2\frac{v_0^2}{R}$$

$$R = \left(\frac{m_2}{\mu m_1}\right)(1+\mu)\ell = \ell(1+\mu)$$

4. BD

Sol. $i = \frac{24}{3+9+6} = \frac{4}{3}A$

$V_1 = \frac{4}{3}\times 9 = 12V$

$V_2 = \frac{4}{3}\times 6 = 8V$

at $t = \infty$

$V_2 = V_1 = 24$

5. BC

Sol. $E_0 z^2\left(1-\frac{1}{9}\right) - E_0 z^2\left(\frac{1}{4}-\frac{1}{9}\right) = 3E_0$

$z = 2$

$\lambda_1 / \lambda_2 = 3$

$KE_1 = E_0\left(1-\frac{1}{9}\right) - \phi$

$KE_2 = E_0 z^2\left(1-\frac{1}{4}\right) - \phi$

$KE \propto \frac{1}{\lambda^2} = 8.5\,eV$

6. ACD

Sol. using Kirchhoff's loop law

$-3i - 1\frac{di}{dt} - 3i + 36 = 0$

$\therefore \frac{di}{dt} = 36 - 6i$ ....(i)

$-3i - 6(i - i_1) + 36 = 0$

$\Rightarrow 3i - 2i_1 = 12$ ....(ii)

by (i) and (ii) $\frac{di_1}{dt} = 12 - 4i_1$

on solving

$i_1 = 3\left(1 - e^{-4t}\right)$

from (ii) $i = 2\left(1 - e^{-4t}\right) + 4$

$\therefore$power supply by battery = $36(2i - i_1) = 36(9 - e^{-4t})$

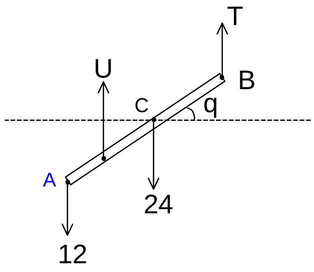
7. C

Sol. U = up thrust = $A\left(\frac{\ell}{2}\right)P_w g$

T + U = 12 g + 24 g

Taking torque about B,

$U\left(\frac{\ell}{2}+\frac{\ell}{4}\right)\cos\theta = 12g\left(\ell\cos\theta\right) + 24g\left(\frac{\ell}{2}\cos\theta\right)$



8. BC

Sol. Use $\Delta x = n\lambda$ (for maxima)

& $\Delta x = \left(n + \frac{1}{2}\right)\lambda$ (for minima

9. BCD

Sol. $\overrightarrow{v_B} = 8\hat{j} + 2t\hat{k}$

$\overrightarrow{v_C} = \overrightarrow{v_o} = v_x\hat{i} + v_y\hat{j} + v_z\hat{k}$

$\overrightarrow{r_B} = 8t\hat{j} + t^2\hat{k}$

$\overrightarrow{r_C} = v_x t\hat{i} + v_y t\hat{j} + v_z t\hat{k}$

At 4 sec, $\overrightarrow{r_B} = \overrightarrow{r_C} \Rightarrow v_x = 0, v_y = 8 m/s$ & $v_z = 4 m/s$

$\therefore \overrightarrow{v_o} = \left(8\hat{j} + 4\hat{k}\right) m/s$

10. AB

Sol. $\Delta\phi = \frac{2\pi}{\lambda}(\Delta x)$ and

$\Delta\phi = \frac{2\pi}{\omega}(\Delta t)$

SECTION – B

11. $(A) \to q; (B) \to r; (C) \to p; (D) \to s.$

Sol. For (B): $\vec{a}_2 = -r\alpha\hat{j} - \omega^2 r\hat{i} + R\alpha\hat{i} = \left(R\alpha - \omega^2 r\right)\hat{i} - r\alpha\hat{j}$

For (C): $\vec{a}_3 = -r\alpha\hat{i} + \omega^2 r\hat{j} + R\alpha\hat{i} = \left(R\alpha - r\alpha\right)\hat{i} + \omega^2 r\hat{j}$

For (D): $\vec{a}_4 = r\alpha\hat{j} + \omega^2 r\hat{i} + R\alpha\hat{i} = \left(R\alpha + \omega^2 r\right)\hat{i} + r\alpha\hat{j}$

12. $(A) \to p; (B) \to q; (C) \to r; (D) \to s.$

Sol. C.M. of the cube comes down through a height of $\sqrt{3}$ m while C. M. Of displaced water goes up by a height of $\frac{\sqrt{3}}{2}$m.

$\Rightarrow$ Loss in PE of cube = $2000 \times 10 \times \sqrt{3}$ Joule.

$= 2\sqrt{3} \times 10^4$ Joule.

Gain in PE of water = $1000 \times 10 \times \frac{\sqrt{3}}{2} = \frac{\sqrt{3}}{2} \times 10^4$ Joule

Using work energy theorem:

$W_r + W_{Gravity} = 0$

SECTION – C

13. 5

Sol. $mg\frac{\ell}{4} = \frac{m\ell^2}{3}\alpha$

$\alpha = \frac{3g}{4\ell}$

$F = \frac{m}{2}.\frac{3\ell}{4}.\frac{3g}{4\ell}$

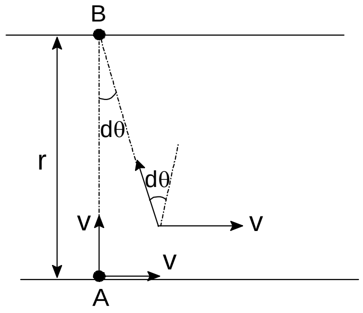
$F = \frac{9mg}{32} = 5N$

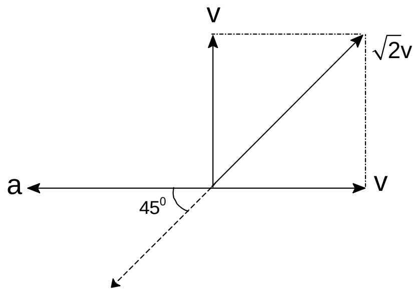
14. 2

Sol. $\frac{dr}{dt} = -v$

$\frac{rd\theta}{dt} = v$

$dv = vd\theta \Rightarrow a = \frac{dv}{dt} = \frac{vd\theta}{dt} = v\omega = v\left(\frac{v}{d}\right) = \frac{v^2}{d}$





$a_r = a\sin 45 = \frac{a}{\sqrt{2}} = \frac{v^2}{\sqrt{2}d} = \frac{\left(\sqrt{2}v\right)^2}{\rho} = \rho = 2\sqrt{2}d$

15. 4

Sol. $V = 220 \pm 1\%$

$I = 5 \pm 1\%$

$W = 555 \pm 2\%$

$W = VI.\cos(\phi)$

$\Rightarrow p.f = \cos(\phi) = \frac{W}{V.I}$

$p.f = \cos(\phi) = \frac{555 \pm 2\%}{(220 \pm 1\%)(5 \pm 1\%)} = \frac{555}{220 \times 5} \pm 4\%$

$p.f = \cos(\phi) = 0.5 \pm 4\%$

16. 5

Sol. $F_{net} = mg - B \Rightarrow m\frac{dv}{dt} = mg - v\rho g$

$\Rightarrow \frac{dv}{dt} = (-)\frac{ga}{4}\left(y - \frac{3}{a}\right) \therefore \text{SHM, } T = \frac{2\pi}{\sqrt{\frac{ga}{4}}} = \frac{2\pi}{\sqrt{5}}\text{sec}$

$\therefore K = 5$

17. 5

Sol. Let volume of glass vessel at 20^0C is V_g and volume of mercury at 20^0C is V_m

So volume of remaining space is = V_g - V_m

It is given constant so that

$$V_g - V_m = V_g^{'} - V_m^{'}$$

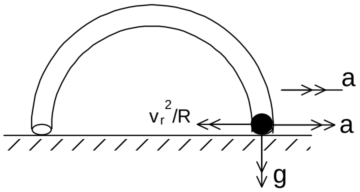
Where $V_0^{'}$ and $V_m^{'}$ are final volumes.

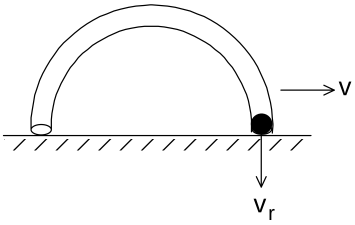
$$V_g - V_m = V_g\left\{1+\gamma_g\Delta\theta\right\} - V_m\left\{1+\gamma_{Hg}\Delta\theta\right\} \Rightarrow V_g\gamma_g = V_m\gamma_{Hg}$$

$$\Rightarrow V_m = \frac{100\times 9\times 10^{-6}}{1.8\times 10^{-4}} \Rightarrow V_m = 50 \text{ cc.}$$

18. 6

Sol.





a = acceleration of tube just before the ball hits the floor

v_r = velocity of ball w.r.t. tube

v = velocity of tube w.r.t. ground

as floor is smooth, acceleration of CM of the system in horizontal direction is zero

$$\Rightarrow m\left(a-\frac{v_r^2}{R}\right)+2m\,a=0$$

using ME conservation for the system in ground frame, $mgR=\frac{1}{2}m\left(v_r^2+v^2\right)+\frac{1}{2}(2m)v^2$

on solving, $a=\frac{4g}{6}$

19. 2

Sol. $\because E=(-)13.6\left[\frac{1}{(n+2)^2}-\frac{1}{n^2}\right]z^2eV$

$$\Rightarrow E=(-)13.6\left[\frac{z^2}{(z+2)^2}-1\right]=\frac{4(z+1)\times 13.6}{(z+2)^2}eV$$

$\therefore$ energy of electron,

$$K=\frac{h^2}{2\lambda^2m}=6eV\left[\because \lambda=\frac{h}{\sqrt{2mK}}\right]$$

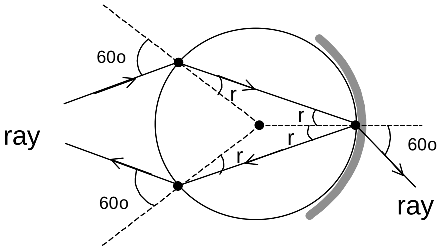
$$\Rightarrow \text{Energy } E=(6+4.2)eV$$

$$\Rightarrow \frac{4\times 13.6(z+1)}{(z+2)^2}=10.2\Rightarrow \frac{z+1}{(z+2)^2}=\frac{3}{16}\Rightarrow z=2,(-)\frac{2}{3}$$

$$\therefore z=2$$

20. 3

Sol. 1st ray



$\delta_1 = \left(60^o - r\right) + \left(60^o - r\right) = 2\left(60^o - r\right)$

2nd ray

$\delta_2 = \left(60^o - r\right) + \left(\pi - 2r\right) + \left(60^o - r\right) = \pi + 2\left(60^o - 2r\right)$

$\because \delta_2 = 3\delta_1 \quad \Rightarrow r = 30^o$

$$\Rightarrow \mu = \frac{\sin i}{\sin r} = \frac{\sin 60^o}{\sin 30^o} = \sqrt{3}$$

$\therefore n = 3$

Chemistry PART – II

SECTION – A

21. AD
Sol. Facts

22. AB
Sol. $ClO_4^- + 2H^+ + 2e^- \longrightarrow ClO_3^- + H_2O$

Eq. mass of $NaClO_4 = \dfrac{23+35.5+64}{2} = 61.25$

No. of equivalents of $NaClO_4 = \dfrac{245}{61.25} = 4 = 4.0F$

The anode efficiency = 60 %

No. of $faradays = \dfrac{4.0}{60} \times 100 = 6.67F$

23. BD
Sol. Both pairs in (b) and (d) produce the same total number of ions after dissociation.

24. ABD
Sol. Such coordination is exhibited by compounds which have BCC Lattice structure.

25. AC
Sol. Fact based.

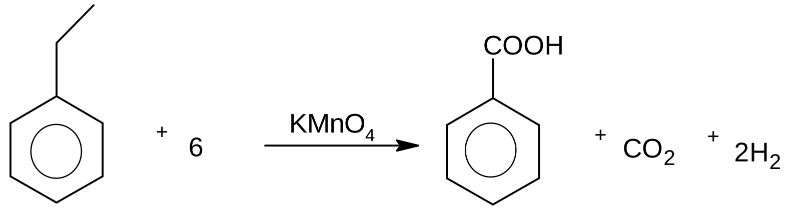
26. ABD
Sol. Facts

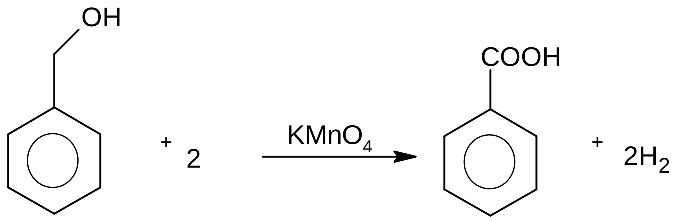
27. AD
Sol. Facts

28. BD
Sol.

$$CH\equiv CH \;+\; 2CH_3 \xrightarrow[2.\ 80°C]{1\ \ Hg^{2+}} CH_3CH(OOCH_3)_2 \xrightarrow{300°C} CH_3COOCOCH_3 + CH_3CHO$$

29. AB
Sol.





30. BC

Sol. The gem – dihalide is obtained initially.

SECTION – B

31. (A) → (p,t); (B) → (q, r); (C) → (p,t); (D) → (q, t)

Sol. (A) Cathode : $Pb^{2+} + 2e^- \longrightarrow Pb(s)$

Anode : $2Cl^- \longrightarrow Cl_2(g) + 2e^-$

(B) Cathode : $H_2O + 2e^- \longrightarrow H_2(g) + 2OH^-$

Anode : $2Cl^- \longrightarrow Cl_2(g) + 2e^-$

(C) Cathode : $Ag^+ + e^- \longrightarrow Ag(s)$

Anode : $Ag(s) \longrightarrow Ag^+(aq) + e^-$

(D) Cathode : $2H_2O + 2e^- \longrightarrow H_2(g) + 2OH^-$

Anode : $2H_2O \longrightarrow O_2 + 4H^+ + 4e^-$

32. (A) → (q,r); (B) → (q,s,t); (C) → (q,s); (D) → (p,r,s)

Sol. Fact based

SECTION – C

33. 4

Sol. $Cd^{2+}_{(aq)}, \mathrm{Zn}^{2+}_{(aq)}, Ag^{+}_{(aq)}, Ni^{2+}_{(aq)}$

34. 1

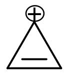
Sol. x = 6, y = 6

35. 9

Sol. CH_3MgBr acts as both base and nucleophile.

36. 3

Sol.



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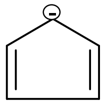

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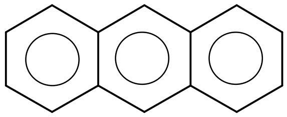
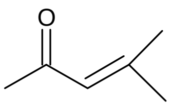


37. 9

Sol.



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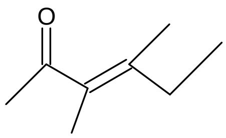

(E & Z)

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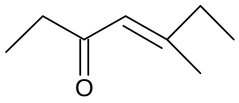
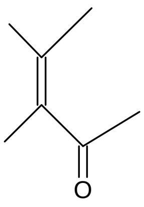
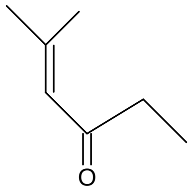
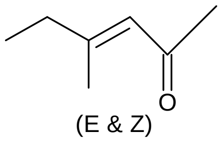


(E & Z)







(E & Z)

38. 8

Sol. Facts

39. 7

Sol. Solubility of CuCl is higher than AgCl

$\therefore \left[Cl^-\right] = \left[Cl^-\right]_{CuCl} = \sqrt{K_{sp} \text{ of CuCl}} = 10^{-3} M$

$\because K_{sp} \text{ of AgCl} = \left[Ag^+\right]\left[Cl^-\right]$

$1.6 \times 10^{-10} = \left[Ag^+\right] \times 10^{-3}$

$\left[Ag^+\right] = 1.6 \times 10^{-7} M$

$\therefore x = 7$

40. 5

Sol. $r_g = \frac{1}{5}.r_{H_2}$

$$\frac{M_g}{M_{H_2}} = \left(\frac{r_{H_2}}{r_g}\right)^2 = (5)^2 = 25$$

$M_g = 2 \times 25 = 50$

$10y = 50$

$\therefore y = 5$

Mathematics

PART – III

SECTION – A

41. AD

Sol. $T_r(A)$ = sum of the roots
det(A) = product of the roots

42. AD

Sol. Let $P \equiv (\alpha, \beta)$ & foot of normal $\equiv \left(4t, \frac{4}{t}\right)$ so, $\frac{\beta - \frac{4}{t}}{\alpha - 4t} = t^2$

$\Rightarrow 4t^4 - \alpha t^3 + t\beta - 4 = 0$

Let t_1, t_2, t_3 & t_4 are roots

then $\sum 4t_1 + \sum \frac{4}{t_1} = \sum t_1^2$

$$\alpha + \beta = \frac{\alpha^2}{16}$$

Locus of P is $x^2 = 16(x + y)$

43. ABCD

Sol.

X = no of dice showing even no.	P = probability
0	$\left(\frac{3}{6}\right)^5 = \left(\frac{1}{2}\right)^5$
1	${}^5C_1 \cdot \left(\frac{1}{2}\right) \cdot \left(\frac{1}{2}\right)^4 = \frac{5}{2^5}$
2	${}^5C_2 \cdot \left(\frac{1}{2}\right)^5 = \frac{10}{2^5}$
3	${}^5C_3 \cdot \left(\frac{1}{2}\right)^5 = \frac{10}{2^5}$
4	${}^5C_4 \cdot \left(\frac{1}{2}\right)^5 = \frac{5}{2^5}$
5	$\left(\frac{1}{2}\right)^5 = \left(\frac{1}{2}\right)^5$

$$\mu = 1.\frac{5}{2^5} + 2.\frac{10}{2^5} + 3.\frac{10}{2^5} + 4.\frac{5}{2^5} + 5.\left(\frac{1}{2}\right)^5$$

$$= \frac{1}{2^5}[5 + 20 + 30 + 20 + 5] = \frac{80}{32} = \frac{5}{2} = 2.5$$

$$\sigma^2 = \frac{1}{25}[5 + 40 + 90 + 80 + 25] - \frac{25}{4}$$

$$= \frac{240}{32} - \frac{25}{4} = \frac{240 - 200}{32} = \frac{40}{32} = \frac{5}{4}$$

$$\frac{1-\left(\frac{1}{2}\right)^5-\frac{5}{2^5}}{1-\left(\frac{1}{2}\right)^5}=\frac{32-1-5}{32-1}=\frac{26}{31}$$

44. ABCD

Sol. $\left[\ln x-\ln y-\frac{x}{y}-1\right]dy=\left[\ln y-\ln x-\frac{y}{x}-1\right](dx)$

$\ln\left(\frac{x}{y}\right)dy+\frac{y}{x}dx-dy=\ln\left(\frac{y}{x}\right)dx+\frac{x}{y}dy-dx$

$d\left(y\ln\left(\frac{x}{y}\right)\right)=d\left(x\ln\frac{y}{x}\right)$

So, a = 1, b = 1, c = 1, d = -1

45. CD

Sol. $g(x)=\lim\limits_{n\to\infty}n\left(x^{\frac{2018}{n}}-x^{\frac{2019}{n}}\right)\ (\infty.0)$

Let $n=\frac{1}{t}$ as $n\to\infty, t\to 0$

$g(x)=\lim\limits_{t\to 0}\frac{x^{2018t}-x^{2019t}}{t}\ \left(\frac{0}{0}\right)$

Apply L' hospital Rule
g(x) = -ln(x)

46. AB

Sol. $3\left|z-\frac{i}{3}\right|=\lambda|z+2|$

For λ = 3, it's a straight line, else circle

47. BCD
Sol. orthogonal straight lines ⇒ 2 - λ = 0, λ = 2

$2h^2-3hk-2k^2=7$

$(2h+k)(h-2k)=7$

48. ABCD
Sol. *Groups* $(2, 2, 4)$ *or* $(2, 2, 3)$

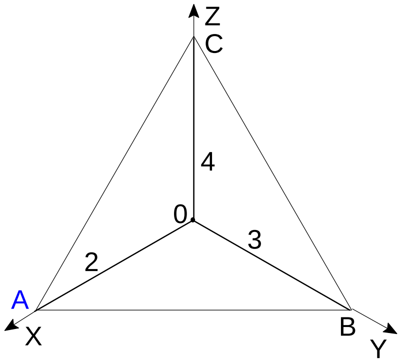
$\left(\frac{8!}{2!2!4!2!}+\frac{8!}{2!3!3!2!}\right)3!$

49. AB
Sol. Total ways

$3!\cdot 2!\cdot {}^4C_2\cdot 2!=144$

50. ABCD

Sol. $\left[ar(\Delta ABC)\right]^2=\left[ar(\Delta OAB)\right]^2+\left[ar(\Delta OBC)\right]^2+\left[ar(\Delta OCA)\right]^2$



If A & C are on positive axes & B is on negative axis then equation plane is $\frac{x}{2}+\frac{y}{-3}+\frac{z}{4}=1$

If A & B are on positive axes & C is on negative axis then equation of plane is $\frac{x}{2}+\frac{y}{3}+\frac{z}{-4}=1$

SECTION – B

51. $(A)\to(q), (B)\to(p), (C)\to(t), (D)\to(r)$

Sol. (A).

$Let\ \vec{r}=a\hat{i}+b\hat{j}+c\hat{k}$

$\left|\vec{r}\right|=1\Rightarrow a^2+b^2+c^2=1$

$\lambda=\left[\vec{p}\,\vec{q}\,\vec{r}\right]=3a-7b-c$

$\lambda^2\ge\frac{59}{10}$

$\mu=\lambda_{\max}$

(D). $\vec{X}=\lambda\left(\vec{p}\times\vec{q}\right)$ & $\left|\vec{X}\right|=1$

52. $(A)\to(p,q,r,s), (B)\to(p,q,r), (C)\to(p,q,r,s,t), (D)\to(p,q)$

Sol. (A). $I=\int_0^{\frac{\pi}{4}}\sin^3 x\cdot\cos^3 xdx=\frac{1}{16}\int_0^{\frac{\pi}{3}}\sin^3 xdx=\frac{1}{24}$

(B). $I=\int_0^{\frac{\pi}{6}}0dx+\int_{\frac{\pi}{6}}^{\frac{5\pi}{6}}1dx+\int_{\frac{5\pi}{6}}^{\pi}0dx+\int_{\pi}^{\frac{7\pi}{6}}-1dx+\int_{\frac{7\pi}{6}}^{\frac{11\pi}{6}}-2dx+\int_{\frac{11\pi}{6}}^{4\pi}-1dx$

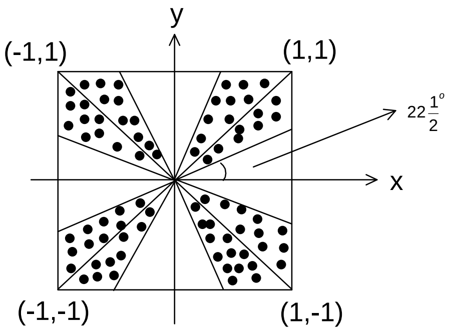
(C). $I=\int_{-3}^{1}\sin xdx=-2$

(D). $I=\int_0^1\frac{x^3+1-2}{x+1}dx=\int_0^1\left(x^2-x+1-\frac{2}{x+1}\right)dx$

SECTION – C

53. 2

Sol. A required area is the shaded region = $4\sqrt{2}\left(\sqrt{2}-1\right)$



54. 5

Sol. $\int_1^e \frac{x^3 \ln x + x^2 - x^2 + 2}{x^3 \ln x + x} dx = \int_1^e x dx - \int_1^e \frac{x^2 - 2}{x^3 \ln x + x} dx$

$\int_1^e x dx - \int_1^e \frac{\frac{1}{x} - \frac{2}{x^3}}{\ln x + \frac{1}{x^2}} dx$

55. 2

Sol. put 7 – x = t

then given equation becomes

$t^4 + 6t^2 - 7 = 0 \Rightarrow t = \pm 1$

$\Rightarrow 7 - x = \pm 1$

So x = 6 or 8

56. 4

Sol. Solve director circle of hyperbola with ellipse

57. 6

Sol. $\cos x + \sin x + \sin 2x + \cos 2x + \sin 3x = -1$

$\Rightarrow (\sin x + \sin 3x) + (\cos x + \sin 2x) = -(1 + \cos 2x)$

$\Rightarrow 4\sin x + 4\sin^3 x + \cos x(1 + 2\sin x) = -2\cos^2 x$

$\Rightarrow 4\sin x(1 - \sin^2 x) + 2\cos^2 x + \cos x(1 + 2\sin x) = 0$

$\Rightarrow (2\cos^2 x + \cos x)(1 + 2\sin x) = 0$

$So, cosx = 0, -\frac{1}{2}, \sin x = -\frac{1}{2}$

58. 2

Sol. K = 771

$P_{max} = 5$, $P_{min} = 3$

59. 5

Sol. Sum = $\frac{(2\times 1^2 - 3\times 1 + 1)^{11} + (2(-1)^2 - 3(-1) + 1)^{11}}{2}$

= $3 \times 6^{10} = 2^{10}.3^{11}$

60. 3

Sol. $I(\alpha, r) = \sqrt{(\alpha + \bar{\alpha})^2 - 4r}$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – I

JEE (Advanced)-2018-19

PAPER –2

Time Allotted: 3 Hours **Maximum Marks: 240**

General Instructions:

- The test consists of total 60 questions.
- Each subject (PCM) has 20 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

  Section–A (01 – 08, 21 – 28, 41 – 48) *contains 24 multiple choice questions which have one or more correct answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

  Section–A (09 – 12, 29 – 32, 49 – 52) *contains 12 paragraphs with each having 2 questions with one or more than one correct answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer.*

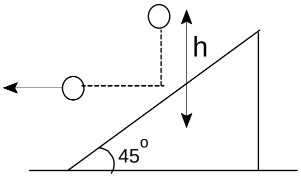
  Section–C (13 – 20, 33 – 40, 53 – 60) *contains 24 Numerical based questions with answers as numerical value from 0 to 9 and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

Physics PART – I

SECTION – A
(One OR More Than One Choice Type)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **one or more than one** is/are correct

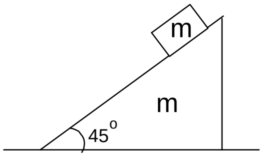
1. A body dropped over a fixed rough inclined plane of inclination 45° from height h. If after collision velocity of body becomes horizontal then co-efficient of restitution if co-efficient of friction is 1/2.



(A) $\frac{1}{2}$ (B) $\frac{1}{3}$
(C) $\frac{1}{4}$ (D) 1

2. A body is moving along straight line such that it velocity represented through x and velocity gradient is represented through y then relation between x and y for movement under constant acceleration may be
(A) xy=const (B) $x^2 - y^2 = const$
(C) $x^2 + y^2 = const$ (D) $y^2 = 4ax$

3. A block having mass m is placed over a inclined plane of same mass and inclination 45° if co-efficient of friction between all surface is same and it is μ. Now system set free to move then

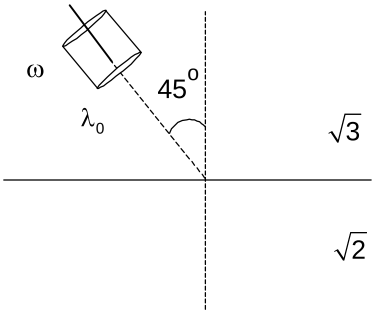


(A) For $\mu > 1$ block over incline will move but wedge don't
(B) For $0.2 < \mu < 1$ block will move but wedge will not
(C) For $\mu = 0.15$ both will move
(D) It is not possible to move wedge without moving block over wedge

4. Let 1.0 kg of super cooled water at temp $-10^\circ C$ kept in a container and crushed ice at temp $\theta = -20^\circ C$ kept in another container. How much ice have to add the water so that whole water freezes. Specific heat of water $S_w = 4.2\times10^3\, J/kg-k$. Specific heat of ice $S_i = 2.1\times10^3\, J/kg-k$. Latent heat of meeting ice $L = 336\, kJ\, kg^{-1}$ meeting point $\theta = 0^\circ C$. Neglecting Heat capacity of vessel and surrounding.
(A) 14 kg (B) 7 kg
(C) 5 kg (D) can't find

Space for Rough work

5. A Beam of light having wavelength λ_0 and wattage ω falls over a surface separating two medium of refractive index $\sqrt{3}$ *and* $\sqrt{2}$ respectively as shown in figure. Force exerted by beam of light over and along surface are $F_{\perp}$ *and* f_{II}



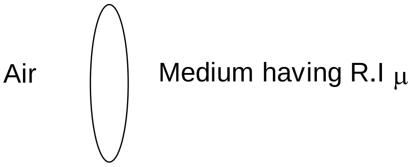
(A) $\frac{(\sqrt{3}-1)}{\sqrt{6}} - \frac{\omega}{C} = F_{\perp}$

(B) $F_{II} = 2\sqrt{3}\,\frac{\omega}{C}$

(C) $\frac{(\sqrt{3}+1)}{\sqrt{6}} - \frac{\omega}{C} = F_{\perp r}$

(D) $F_{II} = 0$

6. An equiconvex lens of focal length 20 cm having a glass of refractive index 3/2 is used in a medium air on left side and another medium having refractive index μ on a right side of lens as shown in figure.



(A) Character of lens will be diversing for $\mu > 2$

(B) Focal length of lens will be 40 cm for $\mu = 4$ and character will be diversing

(C) Object distance and image distance with respect to lens will be same for $\mu = 2$

(D) Character of lens can't be explained

7. A solid metal cylinder rotates with angular speed ω about its axis of symmetry. The cylinder is in a region having uniform magnetic field B along its axis then

(A) Electric field inside cylinder will be proportional to $\perp r$ distance from axis of rotation if $\omega \neq \frac{eB}{m}$

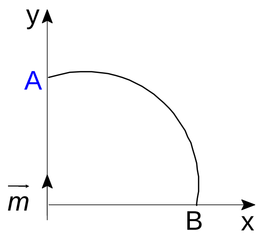
(B) Electric field, inside cylinder is radially away from axis of rotation of $\omega > \frac{eB}{m}$

(C) Charge density inside the cylinder may be positive, negative or zero accordingly ω and direction of magnetic field

(D) For $\omega = \frac{eB}{m}$ and $\vec{B} \parallel \vec{\omega}$ charge density inside cylinder is zero.

Space for Rough work

8. A quarter circular conducting ring of large radius R with centre at origin where a magnetic dipole of moment $\vec{m}$ is placed as shown in figure. When the ring rotates at angular velocity ω about the y axis electromotive force induced between its end is



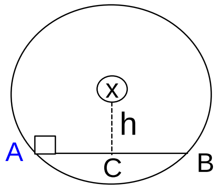
(A) Zero
(B) $\frac{\mu_0 m\omega}{2\pi r}$
(C) $\frac{\mu_0 m\omega}{4\pi r}$
(D) $\frac{\mu_0 m\omega}{8\pi r}$

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions of each paragraph. Each question has **FOUR** options (A), (B), (C) and (D). **One OR More than One** of these four options is/are correct.

Paragraph for Questions 09 & 10

A small insect having mass m is in rest at one end of a horizontal platform placed inside a circular cage as shown in figure. Circular cage is pivot about its centre and cage inner surface is smooth. Now insect start its motion on platform such that platform and cage is in rest. Radius of cage is R.



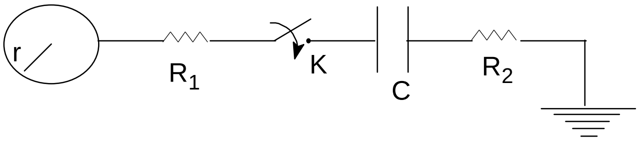
9. Time taken by insect to move from A to B on platform
(A) $\pi\sqrt{\frac{h}{g}}$
(B) $2\pi\sqrt{\frac{h}{g}}$
(C) $\left\{\frac{\sqrt{R^2-h^2}}{g}\right\}^{\frac{1}{2}}$
(D) can't find

10. Speed of insect when it passes is
(A) $\sqrt{\frac{gh}{2}}$
(B) $\sqrt{2gh}$
(C) $h\sqrt{\frac{g}{h}}$
(D) $\sqrt{R^2-h^2}\sqrt{\frac{g}{h}}$

Space for Rough work

Paragraph for Questions 11 & 12

A charged spherical shell of radius r is connected to a capacitor of capacity C through two resistances $R_1\, and\, R_2$ as shown in figure. Initially charged on sphere is Q_0.



11. Charge on capacitor C after long time as switch k gets closed.
(A) zero
(B) Q_0
(C) $\dfrac{cQ_0}{c+4\pi\in_0 r}$
(D) can't find

12. Heat energy developed across resistor R_1 after long time interval as switch gets closed.
(A) $\dfrac{Q_0^2 c}{8\pi\in_0 r\left(c+4\pi\in_0 r\right)}\left(\dfrac{R_1}{R_1+R_2}\right)$
(B) $\dfrac{R_1 Q_0^2 4\pi\in_0 r}{c\left(R_1+R_2\right)\left(c+4\pi\in_0 r\right)}$
(C) $\dfrac{Q_0^2}{2c}$
(D) $\dfrac{Q_0^2 R_1 c}{4\pi\in_0 r\left(c+4\pi\in_0 r\right)\left(R_1+R_2\right)}$

SECTION – C
(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

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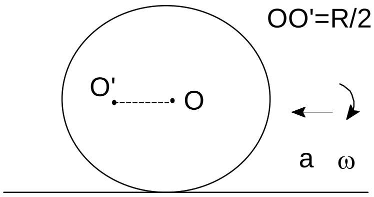
13. If a tap above empty rectangular basin able to fill it in time t_1=3 min and small hole at bottom able to make it completely empty from filled stage in time t_2=2 min. Now both tap and hole are opened simultaneously (At initial stage basin is completely empty). The maximum height up to which liquid may filled in basin is $\frac{H_0}{n}$ find $n\left\{H_0 = Height\ of\ basin\right\}$

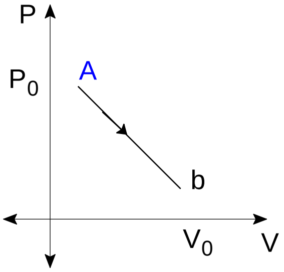
Space for Rough work

14. A non uniform sphere of radius R=50 cm accelerating over a rough horizontal surface with $a = 10\, ms^{-2}$ and angular velocity $\omega = 5\sqrt{2}\, rad\, s^{-1}$ such that it rolls without slipping over surface. If minimum coefficient of friction for given motion is $\mu = \frac{1}{k}$. Then k (position of C.O.M is given in figure) is



O=Geometric centre
O'=C.O.M

15. One mole of monoatomic gas undergoes a linear process A→B shown in P-V diagram. Volume of gas from where process turn from an endothermic to an exothermic is $\frac{n}{(2n-2)} V_0$ find n.



16. A small positively charged ball of mass m is suspended by insulator thread of negligible mass. Another similar positively charged small ball moved very slowly from large distance until it is in original position of first ball. As a result first ball rises by height h. Work done in this process is nmgh then n is

17. An observer moving with uniform velocity towards a stationary sound source observes frequency f=170 Hz over a distance of x=80 m. If frequency of sound is f_0=160 Hz and sound travel with speed $c = 340\, ms^{-1}$. Then duration of beep emitted by source is n. Find n.

Space for Rough work

18. Water drop is stuck between two plates of glass. Distance between plates of glass is d where diameter of water drop disc D>>d. If surface tension of water is T and angle of contact is 0°. Force between plates is $\left\{T\frac{\pi D^2}{d}\right\}x\frac{1}{K}$. Find K.

19. One night a person of height h=1.8 m is standing on the bank of a straight canal. There is no wind and no ripples on water surface. On the opposite bank a lamp is installed at height H=5.4 m on a lamppost. Light emanated from the lamp, appears as a bright spot after reflection from the water surface. When a person starts walking along the bank the spot appears to him moving at constant speed u_0 relative to ground. Speed of person is $\frac{(n+1)}{n}u_0$. Find n.

20. Let current I uniformly distributed uniformly over circumference of hollow cylinder of L and radius R. If L>>R then force enerted by one half of cylinder on other is $\frac{\mu_0 I^2}{K\pi^2 R}\cdot L$. Find K.

Space for Rough work

Chemistry

PART – II

SECTION – A
(One OR More Than One Choice Type)

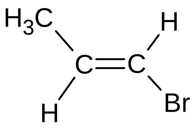
This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **one or more than one** is/are correct

21. Select the correct matches.

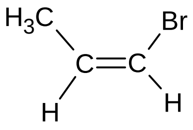
(Ions)		**(Reagents)**		**(Colour/Precipitate obtained)**	
(A)	Cu^{2+}	(I)	$Na_2S_2O_3$	(X)	Violet colour which disappear slowly
(B)	Fe^{3+}	(II)	$K_4\left[Fe(CN)_6\right]$	(Y)	Blue
(C)	Fe^{2+}	(III)	$K_3\left[Fe(CN)_6\right]$	(Z)	Chocolate brown

(A) A – (I)- Y, B-(II)-Z, C-(III)-Y
(B) A –(III)-Z, B-(I)-X, C-(III)-Y
(C) A-(II)-Z, B-(II)-Y, C-(III)-Y
(D) A-(III)-Y, B-(III)-Y, C-(II)-Y

22. Consider the molecules



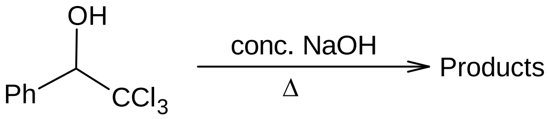
(I)

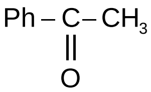


(II)

Which of the following is/are true regarding (I) and (II).
(A) Dipole moment: I > II
(B) Melting point: I > II
(C) Solubility is H_2O: I > II
(D) Stability: I > II

23. The possible product formed is/are



(A) PhCOONa
(B) $PhCH_2OH$
(C) HCOONa
(D) 
$Ph-\underset{\underset{O}{\|}}{C}-CH_3$

Space for Rough work

24. $^{14}CH_2 = CH - CH_2OH \xrightarrow{SOCl_2}$ Major product is

(A) $^{14}CH_2 = CH - CH_2 - Cl$
(B) $CH_2 = CH -^{14} CH_2 - Cl$
(C) (A) and (B) are in equal ratio
(D) $^{14}CH_3 - \underset{\displaystyle Cl}{\underset{|}{CH}} - CH_3$

25. A $\xrightarrow{\text{High T \& P}}$ 3B is a first order reaction. If A is a strong monoprotic acid and B is strong diprotic acid and reaction kinetic is studied by using a standard solution of NaOH required to neutralise reaction mixture at different instant of time, when initially we had taken some concentration of A. Now, it was observed that volume required after 970 sec was double that required initially, then half life of reaction is

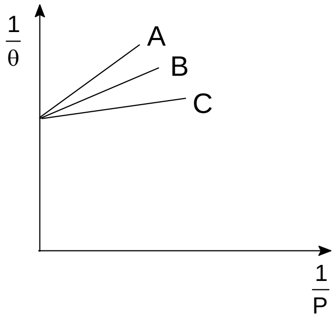
(A) 485 sec
(B) 1942 sec
(C) 3010 sec
(D) 971 sec

26. Which of the following is/are true about the salt bridge?
(A) doesn't participate chemically in the cell reaction
(B) ensures mixing of the two electrolytic solution
(C) the ionic mobility of cation and anion of salt in salt bridge must be same
(D) in IUPAC cell notation, it is not written if the electrolyte is same in both half cell having equal concentration

27. Which of the following overlapping can be of two types either (σ, π) or (π, δ) or (σ, δ) with appropriate internuclear axis as per the requirement of overlapping?

(A) $d_{x^2-y^2} + d_{x^2-y^2}$
(B) $s + p_x$
(C) $d_{xy} + d_{xy}$
(D) $p_z + p_z$

28. Adsorption isotherms of three gases A, B and C are shown in the following figure, where θ is the percentage of surface area of adsorbent (powdered charcoal) covered by the gas and P is the partial pressure of the gas over the adsorbent, then which of the following statement(s) is/are correct? (Consider only monolayer formation)



(A) At any finite value of pressure, A shows the highest extent of adsorption
(B) At any finite value of pressure, C shows the highest extent of adsorption
(C) Gas A has the highest critical temperature
(D) Gas C has the highest critical temperature

Space for Rough work

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions of each paragraph. Each question has **FOUR** options (A), (B), (C) and (D). **One OR More than One** of these four options is/are correct.

Paragraph for Questions 29 & 30

All the boron trihalides except BI_3 may be prepared by direct reaction between the elements. Boron thrihalides consist of trigonal – planar BX_3 molecules. Unlike the halides of the other elements in the group they are monomeric in the gas, liquid and solid states, BF_3 and BCl_3 are gases, BBr_3 is a volatile liquid and BI_3 is a solid. Boron trihalides are Lewis acids because they form Lewis complexes with suitable bases.

$$BF_{3(g)} + :NH_{3(g)} \longrightarrow F_3B-NH_{3(g)}$$

However, boron chlorides, bromides and iodides are susceptible (sensitive) to protolysis by mild proton sources such as water, alcohols and even amines for example BCl_3 undergoes rapid hydrolysis.

$$BCl_{3(g)} + 3H_2O_{(\ell)} \longrightarrow B(OH)_{3(aq.)} + 3HCl_{(aq.)}$$

It is supposed that the first step in the above reaction is the formation of the complex $Cl_3B \longleftarrow OH_2$ which then eliminates HCl and reacts further with water.

29. Which is correct about the hydrolysis of BX_3?
(A) All BX_3 undergo hydrolysis to produce $B(OH)_{3(aq.)}$ and $HX_{(aq.)}$
(B) BF_3 does not undergo complete hydrolysis due to formation of $H^+[BF_3OH]^-$
(C) BBr_3 does not undergo hydrolysis at all because it can not form H-bonds with water
(D) All of the above are correct

30. Which of the following is correct?
(A) $B(OCH_3)_3$ is much weaker Lewis acid than BBr_3
(B) $B(OH)_{3(aq.)}$ behaves as a triprotic acid
(C) $[H_2BO_3]^-_{(aq.)}$ is a conjugate base of $H_3BO_{3(aq.)}$
(D) BF_3 does not react with ethers

Space for Rough work

Paragraph for Questions 31 & 32

The structure of unit cell of perovskite - a salt of lanthanum (La), manganese (Mn) and oxygen (O), has Mn^{+2} at each corner, oxide on every edge centre and lanthanum ion at the body centre.

31. What are the coordination numbers of Mn, La and O respectively?
(A) 6, 2, 8
(B) 6, 4, 12
(C) 8, 4, 8
(D) 6, 12, 2

32. Considering the closed packed arrangement of ions, which of the following statement regarding the ionic radius is the most appropriate?
(A) $r_{La^{+4}} > r_{O^{-2}}$
(B) $r_{La^{+4}} > r_{Mn^{+2}}$
(C) edge length of unit cell = $r_{Mn^{+2}} + r_{O^{-2}}$
(D) None of these

SECTION – C
(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

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33. Consider the following list of reagents:
Acidified $K_2Cr_2O_7$, alkaline $KMnO_4$, $CuSO_4$, H_2O_2, Cl_2, O_3, $FeCl_3$, HNO_3 and $Na_2S_2O_3$. The total number of reagents that can oxidise aqueous iodide to iodine is:

34. Assuming covalent radii to be additive property. What is the iodine – iodine distance in p-di-iodo benzene. Given the C – C bond length in C_6H_6 are 1.40 $\overset{0}{A}$ and covalent radius of iodine and carbon atom are 1.33 $\overset{0}{A}$ and 0.77 $\overset{0}{A}$.

35. Consider the statements:-
(a) Inversion temperature (T_i) = x × Boyle's temp (T_b)
(b) Boyle's temp is determined by Virial equation when the value of 2nd viral coefficient = y
(c) The value of compressibility factor (Z) at critical condition = $\frac{z}{w}$
Find the value of z + w – x – y.

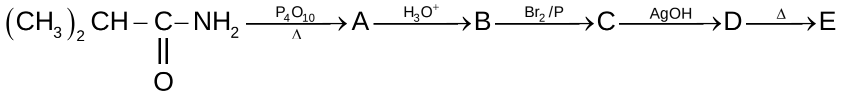
Space for Rough work

36. 2 mols of an ideal gas of unknown heat capacity are in a piston fitted cylinder at 300K. The piston has a mass on the top of it that supplies a constant pressure. The piston is then brought into contact with a thermostat. Heat flows into the system causing the gas to both expand and change temperature. After the temperature has equilibriated, the work done by the gas on the surrounding was found to be 3.32 kJ. Also 14.94 kJ of heat flows into the system. What is the atomicity of the gas. Take R = 8.3 J K^{-1} mol^{-1}

37. At 25^0C, ksp of AgCN is 4×10^{-16} while k_a of HCN is 4×10^{-10}. The value of molar solubility of AgCN in 0.01 M HNO_3 is 10^{-x}. The value of x is..........

38. A certain hydrocarbon effuses $\sqrt{2}$ times slower as compared to N_2 gas under identical conditions. The number of carbon atoms in one molecule of hydrocarbon is 'p' and index of hydrogen deficiency is 'q'. Find the value of $'p\times q'$.

39. Consider the following sequence of reaction:



$$(CH_3)_2CH-\underset{\underset{O}{\|}}{C}-NH_2 \xrightarrow[\Delta]{P_4O_{10}} A \xrightarrow{H_3O^+} B \xrightarrow{Br_2/P} C \xrightarrow{AgOH} D \xrightarrow{\Delta} E$$

The no. of O-atoms in final product 'E' = x
The no. of geometrical isomer of final product E = y
Find the value of x + y.

40. If n is the total number of pentasachharides of D – glucose obtained by C_1 – C_4 glycosidic linkage between successive pyranose from of D – glucose, then the value of n divided by 4 is equal to ....

Space for Rough work

Mathematics PART – III

SECTION – A
(One OR More Than One Choice Type)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **one or more than one** is/are correct

41. The value of $f(x) = \tan\left[\frac{1}{2}\sin^{-1}\left(\frac{2x}{1+x^2}\right) + \frac{1}{2}\cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)\right]$ is

(A) $f(x) = \frac{2x}{1-x^2}$, If $x \in [0, 1)$
(B) $f(x) = \frac{2x}{1-x^2}$, If $x \in (-\infty, 1)$
(C) Not finite, if x > 1
(D) $f(x) = \frac{2x}{1-x^2}$, If x > 1

42. Which of the following statement(s) is./are true?

(A) If $\frac{z^2}{z+1} \in R$ then z either lies on a circle $x^2 + y^2 + 2x = 0$ or on real axis excluding the point (-1, 0)
(where z = x + iy)
(B) If $|z| = 4\sqrt{5}$, then the points representing the complex number $3 + \sqrt{5}z$ will lie on a circle of radius 20
(C) If $z = (2+a) + i\sqrt{3-a^2}$, where $a \in R$ & $a^2 < 3$, then locus of z for different value of a is a semi-circle with centre (2, 0)
(D) If $z(1+a) = b + ic$ & $a^2 + b^2 + c^2 = 1$, then $\frac{1+iz}{1-iz} = \frac{a+ib}{1+c}$, where a, b, c $\in R$ & z = x + iy

43. If $\vec{a}, \vec{b}$ & $\vec{c}$ are three vectors such that

$\vec{a}.\vec{a} = \vec{b}.\vec{b} = \vec{c}.\vec{c} = 3$ & $\left|\vec{a}-\vec{b}\right|^2 + \left|\vec{b}-\vec{c}\right|^2 + \left|\vec{c}-\vec{a}\right|^2 = 27$ then,

(A) $\vec{a}, \vec{b}$ & $\vec{c}$ are necessarily coplanar
(B) $\vec{a}, \vec{b}$ & $\vec{c}$ represent sides of triangle
(C) $\vec{a}.\vec{b} + \vec{b}.\vec{c} + \vec{c}.\vec{a}$ has the least value $-\frac{9}{2}$
(D) $\vec{a}, \vec{b}$ & $\vec{c}$ represent orthogonal triad of vectors

Space for Rough work

44. If $\left(f(x)-1\right)\left(x^2+x+1\right)^2-\left(f(x)+1\right)\left(x^4+x^2+1\right)=0$ is true for all $x \in R-\{0\}$, then which of the following statement(s) is/are true?

(A) $\left|f(x)\right| \geq 2, \forall x \in R-\{0\}$

(B) f(x) has local maxima at x = -1

(C) f(x) has local minima at x = 1

(D) The value of definite integral $\int_{-\pi}^{\pi}(\cos x) f(x) dx = 0$

45. Let a, b, c, d be non – zero distinct digits. The number of 4 digit numbers 'abcd' such that ab + cd is even is divisible by

(A) 3
(B) 4
(C) 7
(D) 11

46. In a triangle ABC, if tan A = 2sin2C & 3cosA = 2sinB. sinC then possible value of C is/are

(A) $\frac{\pi}{8}$
(B) $\frac{\pi}{6}$
(C) $\frac{\pi}{4}$
(D) $\frac{\pi}{3}$

47. Let the function f(x) be trice differentiable and satisfies $f\left(f(x)\right)=1-x \ \forall \ x \in [0, 1]$

If $J=\int_0^1 f(x) dx$ and $f''\left(\frac{4}{5}\right)=0$

Then which of the following is(are) trure?

(A) $f\left(\frac{1}{3}\right)+f\left(\frac{2}{3}\right)=1$

(B) $J=\frac{1}{2}$

(C) $f''(x)=0$ has at least one root in $x \in \left(\frac{1}{4}, \frac{3}{4}\right)$

(D) $f''(x)=0$ at least one root in $x \in \left(\frac{1}{2}, \frac{4}{5}\right)$

Space for Rough work

48. If P is any point on the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$, whose foci are S_1 & S_2. Let $\angle PS_1S_2=\alpha$ & $\angle PS_2S_1=\beta$ then,

(A) $PS_1+PS_2=2a$, if a > b

(B) $PS_1+PS_2=2b$, if a < b

(C) $\tan\frac{\alpha}{2}.\tan\frac{\beta}{2}=\frac{1-e}{1+e}$

(D) $\tan\frac{\alpha}{2}.\tan\frac{\beta}{2}=\frac{\sqrt{a^2-b^2}}{b^2}\left[a-\sqrt{a^2-b^2}\right]$

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions of each paragraph. Each question has **FOUR** options (A), (B), (C) and (D). **One OR More than One** of these four options is/are correct.

Paragraph for Questions 49 & 50

Let $g(x)=x^C.e^{Cx}$ & $f(x)=\int_0^x te^{2t}\left(1+3t^2\right)^{\frac{1}{2}}dt$

If $L=\lim_{x\to\infty}\frac{f'(x)}{g'(x)}$ is non – zero finite number.

49. The value of C is

(A) 7

(B) $\frac{3}{2}$

(C) 2

(D) 3

50. The value of L is,.

(A) $\frac{2}{7}$

(B) $\frac{1}{2}$

(C) $\frac{\sqrt{3}}{4}$

(D) $=\frac{\sqrt{3}}{2}$

Space for Rough work

Paragraph for Questions 51 & 52

$y = f(x)$ is parabola of the form $f(x) = x^2 + bx + 1$, b is a constant. The tangent line is drawn at the point where f(x) cuts y – axis, also touches $x^2 + y^2 = r$. It is also given that at least one tangent can be drawn from point P to y = f(x), where D is a point at which $y = |x - \alpha|$ is non – differentiable $\forall \alpha \in R$.

51. For maximum value of b, the area of circle is

(A) $\frac{\pi}{10}$ (B) $\frac{\pi}{5}$

(C) π (D) 5π

52. The value of L is,.

(A) $y = 1 - x^2 \ \forall x \in [-1, 1], y \in [-1, 0]$ (B) $y = 1 - x^2 \ \forall x \in [-2, 2], y \in [0, 1]$

(C) $y = 1 - x^2 \ \forall x \in [-2, 2], y \in [-3, 1]$ (D) $y = 1 - x^2 \ \forall x \in [-1, 1], y \in [0, 1]$

SECTION – C
(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

53. Let $y = f(t)$ be a solution to the differential equation $\frac{dy}{dt} + 2ty = t^2$, then $16\lim_{t\to\infty}\frac{y}{t}$ is

54. If $\alpha + \frac{1}{\alpha}$ & $2 - \beta - \frac{1}{\beta}(\alpha, \beta > 0)$ are the roots of the quadratic equation $x^2 - 2(a+1)x + a - 3 = 0$, then the sum of integral value of 'a'.

55. If A & B are points on the parabola $y^2 = 4ax$ with vertex O such that OA is perpendicular to OB and having length r_1 & r_2 respectively, then find the value of $\frac{r_1^{\frac{4}{3}}r_2^{\frac{4}{3}}}{2\left(r_1^{\frac{2}{3}} + r_2^{\frac{2}{3}}\right)a^2}$

Space for Rough work

56. Let P(a, b, c) be any point on the plane $3x+2y+z=7$ then find the least value of $2\left(a^2+b^2+c^2\right)$.

57. If f(x) is continuous function and

$$F(x)=\int_0^x\left((2t+3).\int_t^2 f(x)dx\right)dt,$$

Then $\left|F^{II}(2)/f(2)\right|$ is.............

58. Let A and B be two 3×3 invertible matrices such that A is an idempotent matrix and

$$\det(\text{adj }B)=\det(A)^{12}+\det\left(A-A^T\right)^{13}+\det(\text{adj}A-I)^{14}+L$$

$$\text{where } L=\lim_{x\to\infty}\frac{\int_0^{\sin^2 x}\ln\left(1+t^3\right)dt}{\int_0^x\left(e^t-1-t\right)(\tan t-t)(1-\cos t)dt}$$

Then the value of det(B)

59. Let r be the positive real zero of $P(x)=9x^5+7x^2-9$. If the sum $S=r^4+2r^9+3r^{14}+4r^{19}..........\infty$ can be expressed as the rational number $\left(\frac{a}{b}\right)$ in the lowest term, then the sum of digits in (a + b)

60. T_1, T_2 & T_3 are three different taxies, each having 3 duly numbered seats for the passenger. Seven passenger are to accommodated in these taxies. If probability that taxies T_1 & T_2 are used to their full capacity is $\frac{m}{n}$, m, n $\in$ N, then the least value of $(n-4m)$ is...........

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – I

JEE (Advanced)-2018-19

PAPER –2

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

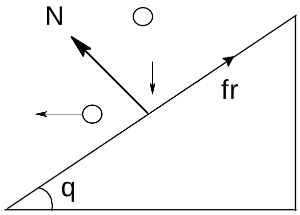
1. B

Sol. $\int N dt = mv_0(1+e)Cos\theta$ (1)

$-\mu\int N dt = m(V_x - V_0\sin\theta)$ (2)

$V_x = V_0\sin\theta - \mu V_0(1+e)Cos\theta$

$\tan\theta = \frac{eV_0\cos\theta}{V_x} \Rightarrow \mu = \frac{1-e}{1+e}$

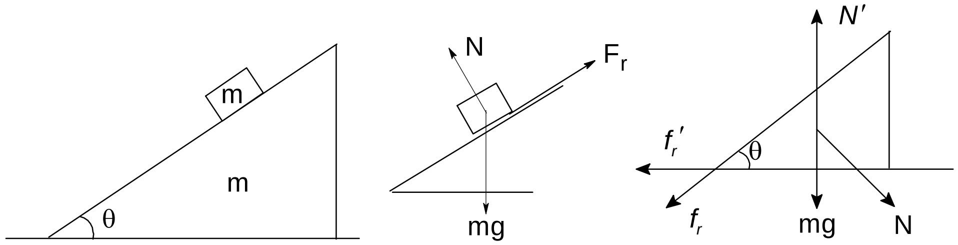


2. AB

Sol. Graph must be hyperbolic.

3. BCD

Sol.



$N' = mg + N\cos\theta + \perp\sin\theta$

$N\sin\theta = \perp' + fr\cos\theta$

(for inclined plane to move over horizontal surface)

4. B

Sol. Heat taken from water to freeze

$m_{\omega} L_f - m_{\omega} S_i \left(0-\left(-10^{\circ} c\right)\right) =$ Heat taken by crushed ice $= m_i s_i \left(0-\left(-20^{\circ} c\right)\right)$

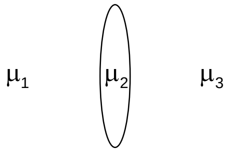
5. AD

Sol. $f \perp = n\left(\frac{hc}{\lambda_2}\cos 60^{\circ} - \frac{hc}{\lambda_1}\cos 45^{\circ}\right)$

$f_{11} = 0$

6. ABC

Sol.



$$\frac{\mu_3}{V} - \frac{\mu_1}{U} = \frac{\mu_3 - \mu_2}{R_2} + \frac{\mu_2 - \mu_1}{R_1}$$

7. ABCD

Sol. $eVB = eE$

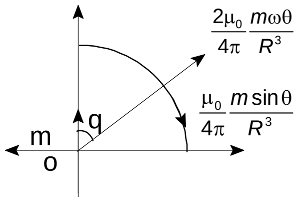
$ex\omega B = eE$

$E = \omega Bx$

$\Rightarrow E \propto x$

8. C

Sol. $E.m.f() = \int_0^{\pi/2} \frac{2\mu_0}{4\pi} m \frac{m\omega\theta}{R^3} \cdot Rd\theta$

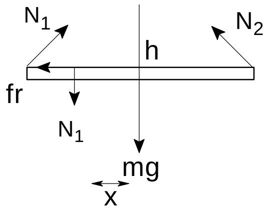

$\frac{2\mu_0}{4\pi}\frac{m\omega\theta}{R^3}$
$\frac{\mu_0}{4\pi}\frac{m\sin\theta}{R^3}$
q
m
o

9. A

Sol. Motion of insect will be S.H.M as Plank is always horizontal

$f_r h = N'x$ (1)

$f_r = ma$ (2)

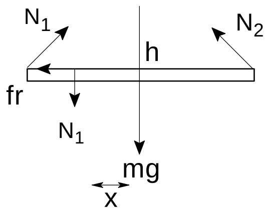

N_1
N_2
h
fr
N_1
mg
x

10. D

Sol. Motion of insect will be S.H.M as Plank is always horizontal

$f_r h = N'x$ (1)

$f_r = ma$ (2)


N_1
N_2
h
fr
N_1
mg
x

11. C

Sol. R.C circuit

12. A

Sol. R.C circuit

SECTION – C

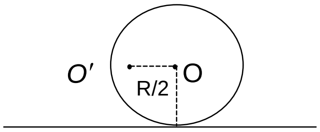
13. 9

Sol. $$\left\{\frac{dx}{dt}\right\}_{in} = \frac{1}{T_1}\left\{\frac{dx}{dt}\right\}_{out} = -k\sqrt{x}$$

$$\left\{\frac{dx}{dt}\right\}_{net} = \left\{\frac{dx}{dt}\right\}_{in} + \left\{\frac{dx}{dt}\right\}_{out}$$

14. 6

Sol.



For pure Rolling $\Rightarrow a = Rh$

Vertical line equation Lo sphere

$$N - mg = ma_{cmy} \left\{a_{cmy} = \frac{Rh}{2} = \frac{a}{2}\right\}$$

$$N = mg + \frac{ma}{2}$$

for not sliping

$$m\omega^2 \frac{R}{2} \le \mu\left(mg + m\frac{a}{2}\right)$$

15. 5

Sol. Process will turn from endothermic to exothermic at point where slope of P-V graph satisfy the slope of adiabatic curve for same gas.

i.e. $\frac{YP}{V} = \frac{P_0}{V_0}$ *and* $P = -\frac{P_0}{V_0} \cdot V + P_0$

16. 3

Sol. $\omega_{Total} = \omega_g + \omega_{Electro} + \omega_{External} = \Delta K \cdot E$

{Final state is also in equilibrium}

17. 4

Sol. $$f_{ab} = \left(\frac{v + v_{ob}}{v}\right) f_o$$

$$1 + \frac{v_{ob}}{v} = \frac{f_{ob}}{f_o}$$

$$v_{ob} = \left(\frac{f_{ob} - f_o}{f_o}\right) v$$

$$\Delta\tau = \tau_o - \tau_{ob} = \frac{L}{f_o} - \frac{L}{f_{ob}}$$

$$\Delta\tau = \frac{f_{ob} - f_o}{f_o \cdot f_{ob}}$$

Difference in time interval of beep observed and produced is no. of oscillation multiplied by $\Delta\tau$.

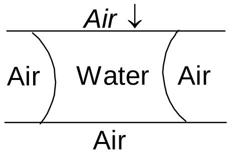
$$t' = \frac{\Delta t}{\tau_{ob}} \cdot \Delta\tau$$

Hence beep produced for interval

$$\Delta t + t' = 4\,\text{sec}$$

18. 2

Sol.



$$P_o - P_w = \frac{2T}{R}$$

$$P_w = \left(P_o - \frac{2T}{R}\right)$$

$$F_{net} = P_oA - \left(P_o - \frac{2T}{R}\right)A$$

19. 3

Sol. $BD = l_2$

$CD = l_1$

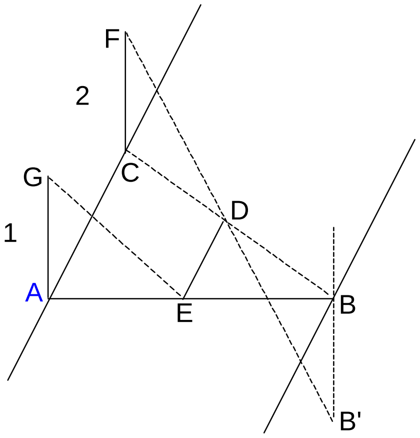
ΔCDF and $\Delta BB'D$ are similar

$$\frac{BB'}{CF} = \frac{BD}{CD}$$

$$\Rightarrow \frac{l_2}{l_1} = \frac{h_1}{h}$$

ΔACB and ΔBDE are similar

$$\frac{AC}{l_1 + l_2} = \frac{DE}{l_2}$$

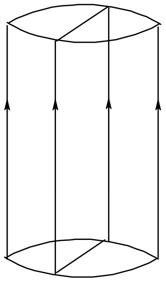


20. 4

Sol. $$\frac{\mu_0\lambda^2}{2} = \text{Magnetic Pressure}$$

$$\text{Force} = \frac{\mu_0\lambda^2}{2} \times \text{Prosection area}$$

$$\lambda = \frac{I}{2\pi R}$$



Chemistry PART – II

SECTION – A

21. BC

Sol.

$$Fe^{2+} + \left[Fe(CN)_6\right]^{3-} \longrightarrow Fe^{3+} + \left[Fe(CN)_6\right]^{4-} \longrightarrow Fe_4\left[Fe(CN)_6\right]_3 \text{ Blue precipitate}$$

$$Fe^{3+} + \left[Fe(CN)_6\right]^{4-} \longrightarrow Fe_4\left[Fe(CN)_6\right]_3 \text{ Blue precipitate}$$

$$Fe^{2+} + \left[Fe(CN)_6\right]^{4-} \longrightarrow Fe_2\left[Fe(CN)_6\right] \text{ White precipitate}$$

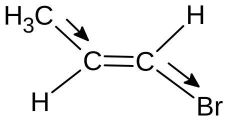
$$Fe^{3+} + \left[Fe(CN)_6\right]^{3-} \longrightarrow Fe\left[Fe(CN)_6\right] \text{ Brown colour}$$

$$Cu^{2+} + \left[Fe(CN)_6\right]^{4-} \longrightarrow Cu_2\left[Fe(CN)_6\right] \text{ Brown colour}$$

$$Fe^{3+} + S_2O_3^{2-} \longrightarrow \underset{\text{violet colour}}{\left[Fe(S_2O_3)\right]^{-1}} \longrightarrow Fe^{2+} + S_4O_6^{2-}$$

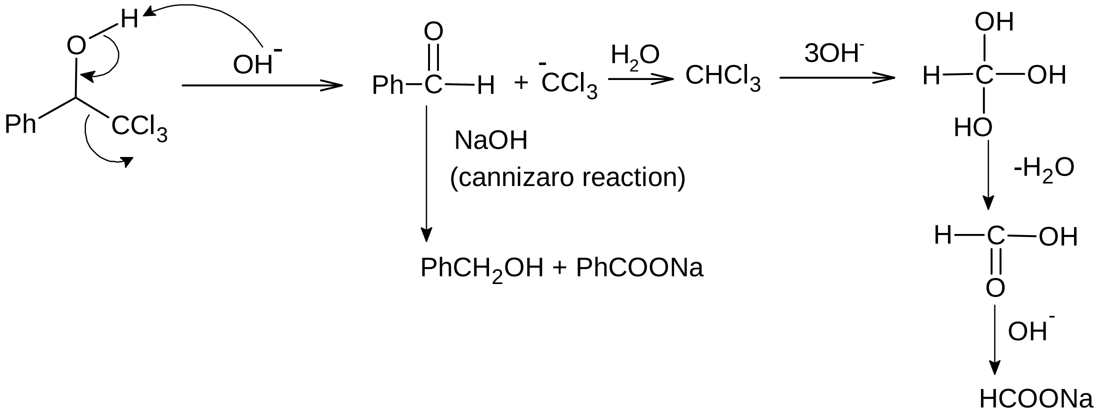
22. ABCD

Sol. (I) has higher dipole moment than (II).



23. ABC

Sol.


H
O
Ph
CCl3
OH-
O
Ph–C–H + CCl3-
H2O
CHCl3
3OH-
OH
H–C–OH
HO
-H2O
H–C–OH
O
OH-
HCOONa
NaOH
(cannizaro reaction)
PhCH2OH + PhCOONa

24. B

Sol. (B) is major due to 6-membered cyclic transition state.

25. C

Sol.

$$A \longrightarrow 3B$$

$a \quad 0 \quad$ initially

$a - x \quad 3x \quad$ time't'

$v_0 \propto a$ and $v_t \propto a + 5x$

$$k = \frac{2.303}{t}\log\left(\frac{5v_0}{6v_0 - v_t}\right)$$

Putting $v_t = 2v_0$ and at $t = 970\,\text{sec}$

$$k = \frac{2.303}{970}\log\left(\frac{5}{4}\right) = \frac{2.303}{970}\times 0.0971 = 2.303\times 10^{-4}$$

$$\therefore t_{\frac{1}{2}} = \frac{0.693}{2.303\times 10^{-4}} = 3010\,\text{sec}$$

26. ACD

Sol. Fact

27. ACD

Sol. (A) $d_{x^2-y^2} + d_{x^2-y^2}$ can do σ or δ overlap

(B) s + p_x can do σ overlap

(C) $d_{xy} + d_{xy}$ can do π or δ overlap

(D) $p_z + p_z$ can do σ or π overlap

28. BD

Sol. Gas having higher critical temperature, shows higher extent of adsorption.

29. B

Sol. BF_3 forms addition product with water

$$BF_3 + H_2O \longrightarrow H^+\left[BF_3OH\right]^- \xrightarrow{H_2O} H_3O^+\left[BF_3OH\right]^-$$

30. A

Sol. H_3BO_3 is monobasic and $\left[B\left(OH_4\right)\right]^-$ is conjugate base of H_3BO_3. Also BF_3 (electron deficient) reacts with ether as:

$$R_2O + BF_3 \longrightarrow \left[R_2O \rightarrow BF_3\right]$$

31. D

Sol. In the nearest neighbour of Mn^{2+}(0), there are six oxides (x) at the adjacent six edge centre, hence CN of Mn^{2+} = 6.

The nearest neighbour points to the body centre is the 12 edge centres where oxide ions (x) are present, hence CN of Ln^{4+} = 12.

In the nearest neighbour of O^{2-}(x) there are only two Mn^{2+} on the adjacent corners, hence CN of x = 2.

32. B

Sol. $$r\left(O^{2-}\right) + r\left(Mn^{2+}\right) = \frac{a}{2} \qquad \text{(i)}$$

$$r\left(O^{2-}\right) + r\left(Ln^{4+}\right) = \frac{a}{\sqrt{2}} \qquad \text{(ii)}$$

From (i) and (ii),

$$r\left(O^{2-}\right) + r\left(Ln^{4+}\right) > r\left(O^{2-}\right) + r\left(mn^{2+}\right)$$

$$r\left(Ln^{4+}\right) > r\left(Mn^{2+}\right)$$

SECTION – C

33. 7

Sol. $K_2Cr_2O_7, CuSO_4, H_2O_2, Cl_2, O_3, FeCl_3, HNO_3$

$$K_2Cr_2O_7 + 7H_2SO_4 + 6KI \longrightarrow 4K_2SO_4 + Cr_2\left(SO_4\right)_3 + 3I_2 + 7H_2O$$

$$2CuSO_4 + 4KI \longrightarrow Cu_2I_2 + I_2 + 2K_2SO_4$$

$$H_2O_2 + 2KI \longrightarrow I_2 + 2KOH$$

$$Cl_2 + 2KI \longrightarrow 2KCl + I_2$$

$$O_3 + 2KI + H_2O \longrightarrow 2KOH + I_2 + O_2$$

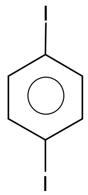
$$2FeCl_3 + 2KI \longrightarrow 2FeCl_2 + I_2 + 2KCl$$

$$8HNO_3 + 6KI \longrightarrow 6KNO_3 + 2NO + 4H_2O + 3I_2$$

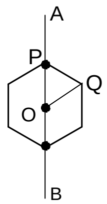
$$2KMnO_4 + KI + H_2O \longrightarrow KIO_3 + 2MnO_2 + 2KOH$$

34. 7

Sol.



or



$$AB = OA + OB = 2OA = 2\left(OP + PA\right)$$

$$= 2\left(PQ + PA\right) \qquad \left(\because OP = PQ;\ \Delta OPQ \text{ is equilateral}\right)$$

$$= 2\left(PQ + \text{covalent radius of C} + \text{covalet radius of I}\right)$$

$$= 2\left(1.40 + 0.77 + 1.33\right) = 7.0\,\overset{0}{A}$$

35. 9

Sol. x = 2, y = 0, z = 3, w = 8.

36. 7

Sol. $-w = 3320 = P_{ext}\Delta V = nR\Delta t$

$$\Rightarrow \Delta T = \frac{3320}{2 \times 8.3} = 200$$

$$\Rightarrow Q = 14.94\,kJ = nC_p\Delta T$$

$$\Rightarrow C_p = \frac{14.94 \times 1000}{2 \times 200} = 37.35\ Jk^{-1}mol^{-1}$$

$$\text{Also, } C_p = \left(\frac{3}{2} + x\right)R \ \text{ where } x = \text{atomicity}$$

$$\Rightarrow x = \frac{C_p}{R} - \frac{3}{2} = \frac{37.35}{8.3} - 1.5 = 3$$

37. 3

Sol.

$$\begin{array}{lllll} AgCN & + & H^+ \rightleftharpoons & Ag^+ & + HCN;\ k_{eq} = \dfrac{k_{sp}}{k_a} \\ 0.01 - x & & & x & \ \ x \end{array}$$

$$k_{eq} = \frac{k_{sp}}{k_a} = 10^{-6} = \frac{x^2}{0.01 - x}$$

$\because$ k_{eq} is sufficiently small, $0.01 - x \approx 0.01$

$\Rightarrow x = 10^{-4} M$

38. 4

Sol. Hydrocarbon is C_4H_8

$$\frac{r_{HC}}{r_{N_2}} = \frac{1}{\sqrt{2}} = \sqrt{\frac{M_{N_2}}{M_{HC}}}$$

$$M_{HC} = 28 \times 2 = 56$$

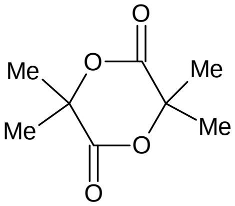
$$\text{DBE / DU} = \frac{2 \times 4 + 2 - 8}{2} = 1$$

39. 4

Sol.

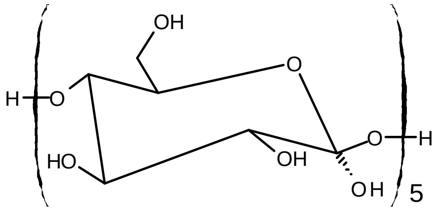
Final product E is

x = 4 and y = 0



40. 8

Sol.



pentasachharides derived from D - glucose

Each of the five monosachharides may be either α-D-glucose or β- D – glucose, thus total pentasachharides possible = n = 2^5 = 32

Answer is $\frac{32}{4} = 8$

Mathematics PART – III

SECTION – A

41. AC

Sol. Use formula of $2\tan^{-1}x$

42. ABCD

Sol. (A) $\frac{z^2}{z+1}=\frac{\bar{z}^2}{z+1}\Rightarrow z\bar{z}+z+\bar{z}=0$ or $z=\bar{z}$

(B) $|z|=4\sqrt{5}$ let $\omega=3+\sqrt{5}z$

$|\omega-3|=\sqrt{5}\times4\sqrt{5}=20$

(C) $z=(2+a)+i\sqrt{3-a^2}=x+iy$

$x=2+a$ & $y=\sqrt{3-a^2}$

$\Rightarrow(x-2)^2+y^2=3$

(D) $z(1+a)=b+ic$ & $a^2+b^2+c^2=1$

$\Rightarrow\frac{1+iz}{1-iz}=\frac{a+ib}{1+c}$

43. ABC

Sol. $\left|\vec{a}+\vec{b}+\vec{c}\right|^2=\left|\vec{a}\right|^2+\left|\vec{b}\right|^2+\left|\vec{c}\right|^2+2\sum\vec{a}.\vec{b}\ge0$

$9+9+9+2\sum\vec{a}.\vec{b}\ge0\Rightarrow\sum\vec{a}.\vec{b}\ge-\frac{27}{2}$

$2\sum\left|\vec{a}\right|^2-2\sum\left(\vec{a}.\vec{b}\right)=27$

$\sum\left(\vec{a}.\vec{b}\right)=\frac{27}{2}$

44. ABCD

Sol. $f(x)=\frac{x^2+1}{x}=x+\frac{1}{x},\ x\ne0$

45. ABD

Sol. $(\text{Four odd})+(\text{Four even})+(\text{Three even}+\text{Three odd})+(\text{Two even}+\text{Two odd})$

$={}^5C_4.4!+{}^4C_4.4!+{}^4C_3.{}^5C_1.4!+{}^4C_2.{}^5C_2\times4\times4$

$=1584$

46. CD

Sol. $3\cos A=\text{coa}(B-C)-\cos(B+C)=\cos(B-C)+\cos A$

$2\cos A=\cos(B-C)=-\cos(A+2C)$

$2=(\tan A.\sin2C-\cos2C)$

47. ABCD

Sol. $f\left(f\left(x\right)\right)=\left(1-x\right)\Rightarrow f\left(t\right)=1-f^{-1}\left(t\right)$

$f\left(t\right)+f^{-1}\left(t\right)=1$

$\Rightarrow f\left(x\right)+f\left(1-x\right)=1$

48. ABC
Sol. Facts

49. C
50. D
Sol. **(for Q. 49-50)**

$$L=\lim_{x\to\infty}\frac{xe^{2x}\left(1+3x^2\right)^{\frac{1}{2}}}{C\left(xe^x\right)^{C-1}\left(e^x+xe^x\right)}$$

51. B
52. D
Sol **(for Q. 51-52)**

$b_{max}=2,\ r=\dfrac{1}{\sqrt{1+b^2}}$

SECTION – C

53. 8
Sol. 1st order linear DE

54. 5
Sol. $f\left(x\right)=x^2-2\left(a+1\right)x+\left(a-3\right)$

$f\left(0\right)\le 0$ & $f\left(2\right)\le 0.$

55. 8
Sol. $$\frac{r_1^{\frac{4}{3}}r_2^{\frac{4}{3}}}{\left(r_1^{\frac{2}{3}}+r_2^{\frac{2}{3}}\right)a^2}=16$$

56. 7
Sol. $\left(3\hat{i}+2\hat{j}+\hat{k}\right).\left(a\hat{i}+b\hat{j}+c\hat{k}\right)\le\sqrt{a^2+b^2+c^2}\sqrt{9+4+1}$

57. 7
Sol. $F'\left(x\right)=\left(2x+3\right)\int_x^2 f\left(x\right)\,dx$

58. 5
Sol. Newton Leibnitz's Rule

59. 4
Sol. Sum of AGP

60. 8
Sol. Facts

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – I

JEE (Main)-2019

TEST DATE: 16-12-2018

Time Allotted: 3 Hours **Maximum Marks: 360**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only one section: **Section-A**.

  Section-A (01 – 30, 31 – 60, 61 – 90) *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

PART – I

SECTION – A

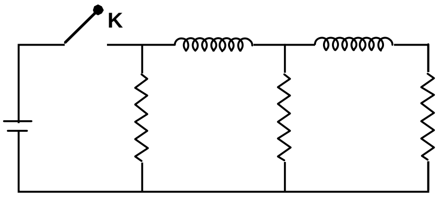
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. Two identical blocks of metal are at 20°C and 80°C respectively. The specific heat of the material of the two blocks increases with temperature. Which of the following is true about the final temperature T_f when the two blocks are brought into contact? (assuming that no heat is lost to the surroundings)
   (A) T_f will be 50°C
   (B) T_f will be more than 50°C
   (C) T_f will be less than 50°C
   (D) T_f can be either more than or less than 50°C depending on the precise variation of the specific heat with temperature.

2. An electron in an electron microscope with initial velocity $v_0\hat{i}$ enters a region of a transverse electric field $E_0\hat{j}$. The time taken for the change in its de-Broglie wavelength from the initial value of λ to $\lambda/3$ is proportional to
   (A) E_0
   (B) $1/E_0$
   (C) $\frac{1}{\sqrt{E_0}}$
   (D) $\sqrt{E_0}$

3. In the circuit shown below, all the inductors (assumed ideal) and resistors are identical. The current through the resistance on the right is I after the key K has been switched on for along time. The currents through the three resistors (in order, from left to right) immediately after the key is switched off are



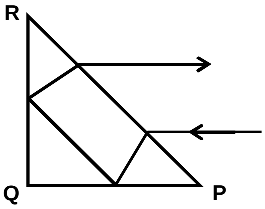
   (A) 2I upwards, I downwards and I downwards
   (B) 2I downwards, I downwards and I downwards
   (C) I upwards, I downwards and I downwards
   (D) 0, I downwards and I downwards

4. The moments of inertia (in kg-m^2) of a non-uniform circular disc of mass 1 kg and radius 25 cm about four mutually perpendicular tangents AB, BC, CD and DA are 2, 4, 6, 7 respectively (the square ABCD circumscribes the disc). The distance of the centre of mass (in m) of the disc from its geometrical centre is
   (A) 5
   (B) 4
   (C) 3
   (D) 2

5. A small box resting on one edge of the table is struck in such a way that it slides off the other edge, 1 m away, after 2 seconds. The coefficient of kinetic friction between the box and the table-
   (A) must be less than 0.05
   (B) must be exactly zero
   (C) must be more than 0.05

(D) must be exactly 0.05

6. A ray of light incident parallel to the base PQ of an isosceles right angled triangular prism PQR suffers two successive total internal reflections at the face PQ and QR before emerging reversed in direction as shown. If the refractive index of the material of the prism is μ, then

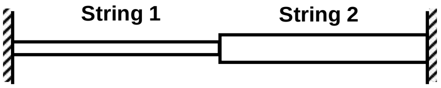


(A) $\mu > \sqrt{5}$
(B) $\sqrt{3} < \mu < \sqrt{5}$
(C) $\sqrt{2} < \mu < \sqrt{3}$
(D) $\mu > \sqrt{2}$

7. A rigid body in the shape of a "V" has two equal rams made of uniform rods with an angle θ between them. When the body is suspended from one end, the other arm is horizontal. The value of θ is

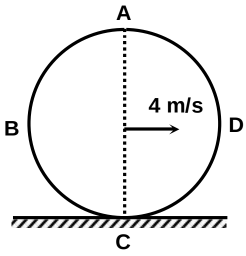
(A) $\cos^{-1}\left(\frac{1}{3}\right)$
(B) $\cos^{-1}\left(\frac{1}{2}\right)$
(C) $\cos^{-1}\left(\frac{1}{4}\right)$
(D) $\cos^{-1}\left(\frac{1}{6}\right)$

8. A composite string is formed by joining two string of equal length but different mass per unit length and stretched between two rigid supports. The string 2 has mass per unit length 4 times the mass per unit length of string 1. A progressive wave, travelling in string 1 to the right, is incident on the boundary what fraction of incident energy goes in string 2?



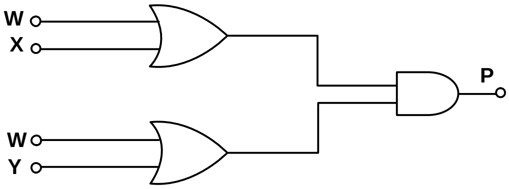
(A) 1/8
(B) 4/9
(C) 2/3
(D) 8/9

9. A sphere of mass 1 kg and radius 1 m rolls on a horizontal surface with a speed 4 m/s. The force by one half of the sphere ABC (line AC is vertical) on the other ADC is (in N)



(A) 1
(B) 2
(C) 3
(D) 4

10. The diagram of a logic circuit is given. The output of the circuit is represented by



(A) W.(X+Y)
(B) W.(X.Y)
(C) W+(X.Y)
(D) W+(X+Y)

11. The minimum speed of flow of water through a long cylindrical pipe of diameter 2 cm so that the flow becomes turbulent is (density of water = 1×10^3 kg/m^3, viscosity of water = 1×10^{-3} N-s/m^2, Reynold's number for critical velocity = 3000)
(A) 1.5 m/s
(B) 0.15 m/s
(C) 2 m/s
(D) 1 m/s

12. Two identical metallic sheets of area $\frac{10^3}{17 \times 27}$ m^2 are arranged parallel with some separation between them in vacuum. Thermal energy at a constant rate 'P' is generated in one of the sheets by passing current through it. In steady state, the temperature of the other sheet is found to be 300 K. The value of P (in kW) is $\left(\sigma = \frac{17}{3} \times 10^{-8} \frac{\text{W}}{\text{m}^2\text{K}^4}\right)$
(A) 1
(B) 2
(C) 3
(D) 4

13. The lower end of uniform string whose upper end is attached to ceiling, is oscillated simple harmonically with a frequency f and amplitude A. The relation between A and f, if the maximum acceleration of the particle is equal to the acceleration of wave is (g = acceleration due to gravity)
(A) $\pi^2 f^2 A = g$
(B) $2\pi^2 f^2 A = g$
(C) $4\pi^2 f^2 A = g$
(D) $8\pi^2 f^2 A = g$

14. An eye can distinguish between two points on an object placed 25 cm from the eye if they are separated by more than 0.22 mm. A compound microscope of 20 D objective and 10 D eyepiece separated by 20 cm is used to view this object. The final image is formed at a distance of 25 cm from the eye. The minimum separation between two points which can now be distinguished (in mm) is nearly.
(A) 0.01
(B) 0.02
(C) 0.04
(D) 0.05

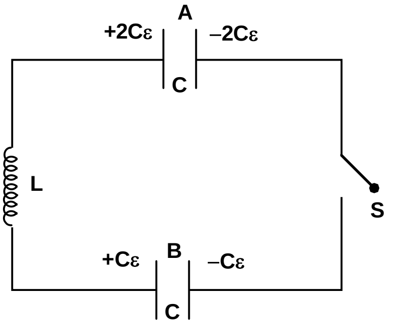
15. A sonometer wire of length 1.5 m is made of steel. The tension in it produces an elastic strain of 1%. If density and Young's modulus of steel are 7.7×10^3 kg/m^3 and 2.2×10^{11} N/m^2, the fundamental frequency of the wire (in Hz) is nearly
(A) 178
(B) 200
(C) 700
(D) 188

16. It is observed that output power from a (non-ideal) cell is same when the current through it is either 2A or 8A. The output power will be maximum for a current (in A) of
(A) 3
(B) 4
(C) 5
(D) 6

17. A gas enclosed in a vessel at an initial pressure of 144 cm of Hg, is being pumped out of the vessel by means of a piston-pump. The pressure reduces to 36 cm of Hg after two strokes. After another two strokes, the pressure (in cm of Hg) is

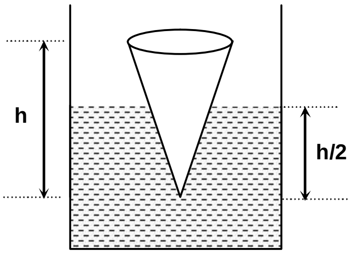
(A) 8
(B) 16
(C) 12
(D) 9

18. In the adjacent circuit, initially capacitors A and B are charged by voltage 2ε and ε respectively. Initial current through the inductor is zero and switch 'S' is closed at t = 0. The maximum current through the inductor is



(A) $\varepsilon\sqrt{\frac{C}{L}}$
(B) $\varepsilon\sqrt{\frac{C}{2L}}$
(C) $\varepsilon\sqrt{\frac{2C}{L}}$
(D) $\varepsilon\sqrt{\frac{C}{3L}}$

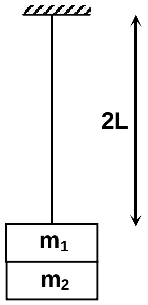
19. A solid cone of height h with heavy mass attached to it floats upside down in water, as shown in the figure. In equilibrium, water reaches a height h/2. When displaced downward slightly and released, it performs simple harmonic motion. The frequency of these oscillations is



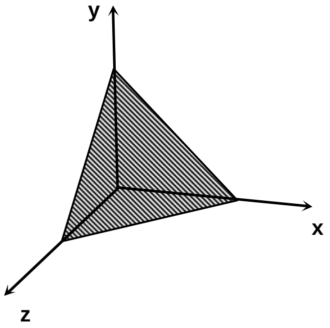
(A) $\frac{1}{2\pi}\sqrt{\frac{6g}{h}}$
(B) $\frac{1}{2\pi}\sqrt{\frac{g}{h}}$
(C) $\frac{1}{2\pi}\sqrt{\frac{3g}{h}}$
(D) $\frac{1}{2\pi}\sqrt{\frac{8g}{h}}$

20. From a fixed support O, hangs an elastic string of negligible mass and natural length L. Masses m_1 and m_2 attached at the lower end, elongate the string to 2L. When m_2 is removed gently, m_1 is able to bounce back to O. The ratio m_2/m_1 is (assume that the string does not obstruct the motion of m_1)

(A) 1
(B) 2
(C) 3
(D) 4

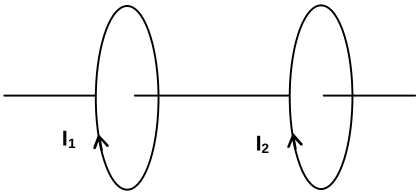


21. A point charge Q is placed at $\left(0, \frac{a}{\sqrt{2}}, 0\right)$. Consider a triangular surface having vertices at (a, 0, 0), (0, a, 0) and (0, 0, a). The flux of the electric field through this surface is



(A) $\frac{Q}{6\varepsilon_0}$
(B) $\frac{7}{21}\frac{Q}{\varepsilon_0}$
(C) $\frac{3}{25}\frac{Q}{\varepsilon_0}$
(D) $\frac{5}{24}\frac{Q}{\varepsilon_0}$

22. A system consists of two coaxial circular current carrying rings as shown in the figure. Their self inductances are L_1 and L_2 respectively and M is the coefficient of mutual induction. They carry current in the indicated directions. The magnetic energy of the system is



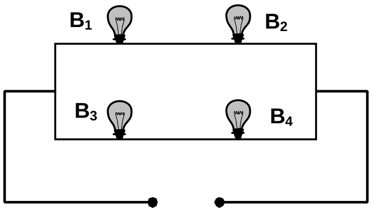
(A) $\frac{1}{2}L_1i_1^2 + \frac{1}{2}L_2i_2^2 - Mi_1i_2$
(B) $\frac{1}{2}L_1i_1^2 + \frac{1}{2}L_2i_2^2 + Mi_1i_2$
(C) $\frac{1}{2}L_1i_1^2 + \frac{1}{2}L_2i_2^2 - \frac{1}{2}Mi_1i_2$
(D) $\frac{1}{2}L_1i_1^2 + \frac{1}{2}L_2i_2^2 + \frac{1}{2}Mi_1i_2$

23. The main scale of vernier callipers reads in mm and its vernier scale is divided into 8 divisions which coincide with 5 divisions of the main scale. When the two jaws touch each other, the zero of the vernier coincides with the zero of main scale. When a rod is tightly placed along its length between the jaws, it is observed that the zero of vernier scale lies just left to 36th division of main scale and fourth division of vernier scale coinides with one main scale division. The measured value is (in cm)
(A) 3.66
(B) 3.55
(C) 3.65
(D) 3.56

24. The number n of β particles emitted with energy E is given by $n \propto (E_{max} - E)^2 \times \sqrt{E}$, where E_{max} is the maximum energy released in β decay. The maximum number of antineutrinos would come out with energy approximately equal to
(A) $\frac{E_{max}}{5}$
(B) $\frac{4E_{max}}{5}$
(C) E_{max}
(D) zero

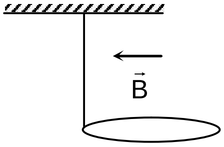
25. Four bulb are connected as shown in the figure. Their ratings are:

Bulb	Rating
1	24 W, 6 Ω
2	48 W, 3 Ω
3	72 W, 2 Ω
4	72 W, 2 Ω

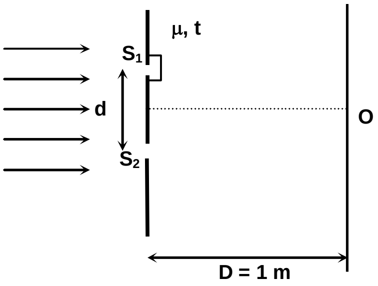


The maximum power produced by the combination is
(A) 216 W
(B) 208 W
(C) 307 W
(D) 117 W

26. A circular ring of radius 1 m and mass π kg suspended from the ceiling with the help of an ideal string, carries a current I. In the presence of a uniform horizontal magnetic field of 1 T, the ring remains in equilibrium with its plane horizontal. The current I is
(A) 10 A is ACW direction when viewed from above.
(B) 10 A is CW direction when viewed from above.
(C) 5 A is CW direction when viewed from above.
(D) 5 A is ACW direction when viewed from above.



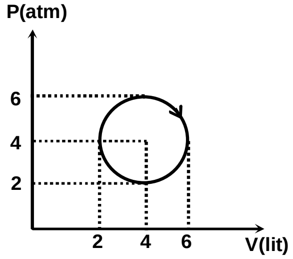
27. A coherent parallel beam of light of wavelength λ is incident normally on the plane of slits. Slit S_1 is covered by a thin slab of refractive index $\mu = 1.5$ and thickness $t = 1 \times 10^{-5}$ m. The separation between the slits is d = 1 mm. The distance of the central maxima from point O is
(A) 0.5 cm
(B) 1 cm
(C) 1.5 cm
(D) 2 cm



28. The maximum and minimum amplitudes of an AM wave are 10 V and 3V respectively. The modulation index is
(A) 0.3
(B) 10/3
(C) 13/30
(D) 7/13

29. The dominant mechanisms for motion of charge carriers in forward and reverse biased silicon p-n junctions are
(A) drift in forward biased, diffusion in reverse biased.
(B) diffusion in forward biased, drift in reverse biased.
(C) diffusion in both forward and reverse biased.
(D) drift in both forward and reverse biased.

30. One mole of an ideal gas undergoes a circular cycle centered at 4 atm, 4 lit as shown in the diagram. The maximum temperature attained in this process is close to
(A) 30/R
(B) 36/R
(C) 24/R
(D) 16/R



Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. In ccp structure of mixed oxides, the lattice is made up of oxide ions. Tetrahedral voids are occupied by divalent X^{2+} ions and octahedral voids are occupied by trivalent Y^{3+} ions. If only 12.5% of tetrahedral voids are occupied, then the fraction of octahedral voids occupied is:
(A) 0.75
(B) 0.50
(C) 0.40
(D) 0.25

32. $\text{Cyclopentane} \xrightarrow[\text{(1 eqv.)}]{Cl_2, h\nu} [X] \xrightarrow[C_2H_5OH, \Delta]{KOH} [Y] \xrightarrow[CS_2]{O_3/Zn} [Z]$
Here [Z] is
(A) Pentanal
(B) Pentan-2-one
(C) Pentane-3-one
(D) Pentane 1, 5, dial

33. Which of the statement is correct?
(A) Li, when burnt in air, gives monoxide, peroxide and superoxide
(B) On heating Li_2CO_3, Li_2O and CO_2 are formed
(C) Among alkali metals, Li metal has high I.E. and impart no colour to flame
(D) Li_2SO_4 forms alum

34. In which of the following reaction XeF_4 is not reduced to Xe?
(A) $XeF_4 + O_2F_2$
(B) $XeF_4 + H_2$
(C) $XeF_4 + KI$
(D) $XeF_4 + SF_4$

35. Which of the following is incorrectly matched?
(A) $\left[Al(OH)_4\right]^-(aq) + NH_4^+(aq) \xrightarrow{\text{Slightly heat}} \text{white precipitate} + \text{liberation of } NH_3$
(B) $Pb^{2+}(aq) + 2Br^-(aq) \longrightarrow \text{Red precipitate}$
(C) $BiI_3(\text{black precipitate}) + H_2O(\ell) \xrightarrow{\Delta} \text{orange precipitate}$
(D) $S^{2-} + Na_2\left[Fe(CN)_5 NO\right] \longrightarrow \text{Purple colouration}$

36. pH range of a basic indicator (InOH) is 3.3 – 4.7. What is the minimum value of $\left[In^+\right]/\left[InOH\right]$ above which the solution assumes only the colour of In^+ ion?
(A) 4
(B) 5
(C) 6
(D) 7

37. 200 cm^3 of 0.50 M $H_2C_2O_4$ solution was shaken with 9.0 g of activated charcoal for some time. 10 cm^3 of filtrate required 32 cm^3 of 0.25 M NaOH for just neutralization. The amount of adsorption of acid per gram of adsorbent is.
(A) 2 g
(B) 0.2 g
(C) 7.2 g
(D) 1.8 g

38. The reduction potential at 25^{o}C for Fe^{3+}/Fe^{2+} electrode is 0.718 V. If $E^o_{Fe^{2+}/Fe} = -0.44$ V and $E^o_{Fe^{3+}/Fe} = -0.04$ V the ratio of molar concentration of Fe^{2+} ion to that of Fe^{3+} ion in solution is $\left[\frac{2.303RT}{F} = 0.06, \log 5 = 0.7\right]$
(A) 5
(B) 0.5
(C) 0.005
(D) 0.05

39. In Kjeldahl's method the gas evolved from 1.731 g sample of a fertilizer is passed into 50 ml of 0.20 N of H_2SO_4. 25 ml of 0.19 N NaOH are required for the titration of unused acid. The percentage of nitrogen by mass in fertilizer is:
(A) 4.2
(B) 5.25
(C) 4.75
(D) 6.8

40. What volume of NH_3 gas at NTP will be required to be passed into 30 ml of 1 N H_2SO_4 to bring down the acid normality to 0.2 N.
(A) 408 mL
(B) 53.76 mL
(C) 537.6 mL
(D) 40.8 mL

41. 24.0 g of diborane is treated with excess of ammonia at low temperature. The addition product so obtained is heated to 200^{o}C and then cooled to room temperature. The colourless liquid so obtained weighs…..(Consider atomic mass of Boron = 11)
(A) 81 g
(B) 69.43 g
(C) 8. 5 g
(D) 46.29 g

42. Tetrahedral and colourless complexes among the following are:
(A) $K_2[Ni(CN)_4]$
(B) $Na_2[NiCl_4]$
(C) $K_2[Zn(CN)_4]$
(D) $Ni(CO)_4$

43. For the coagulation of a particular colloidal solution, the order of coagulation values of some electrolytes is in the order : $AlCl_3 > Na_2SO_4 > Na_3PO_4$
Which of the following conclusions is incorrect for such a colloidal solution?

(A) Counter ions in the electrical double layer around the colloidal particles are negatively charged.
(B) It may be basic dye sol such as methylene blue.
(C) In electrophoresis, the sol particles move towards the anode.
(D) In electrosmosis, the dispersion medium moves towards the anode.

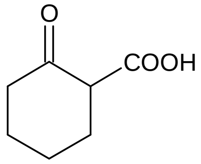
44. Consider the following reactions:
(i) $NH_4NO_3 \xrightarrow{\Delta} \text{Products}$
(ii) $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} \text{Products}$
(iii) $Hg(NO_3)_2 \xrightarrow{\Delta} \text{Products}$
(iv) $Na(NH_4)HPO_4,4H_2O \xrightarrow{\Delta} \text{Products}$

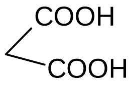
What is the sum of the oxidation states of nitrogen 'N' in the compounds (product) formed in the above reactions?
(A) 2
(B) 6
(C) 5
(D) 3

45. If 10^{-x} is the factor by which solubility of AgBr(s) [$K_{sp} = 10^{-10}$] changes with respect to initial solubility, when it is dissolved in 0.01 M NaBr (aq) solution. The value of 'X' is:
(A) 2
(B) 3
(C) 4
(D) 5

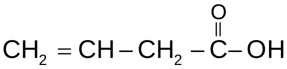
46. 'X' is one of substance formed when SO_2 and PCl_5 react together. It is a fuming liquid which dissolves in water to give a pungent smelling aqueous solution which turns blue litmus red. The "fuming liquid" is
(A) SO_2Cl_2
(B) HCl
(C) $SOCl_2$
(D) SO_2

47. Which of the following is not addition Homopolymer?
(A) Polystyrene
(B) Teflon
(C) Melamine
(D) Polyacrylonitrile

48. Which of the following compounds does not decarboxylate on heating?
(A)


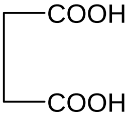
(B)


(C)



$CH_2=CH-CH_2-\overset{\overset{O}{||}}{C}-OH$

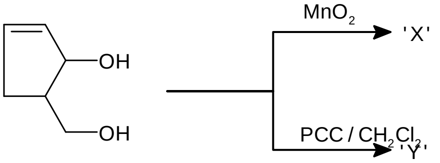
(D)



49. Which of the following statement is correct?
(A) Anglesite is a sulphate ore with +4 oxidation state of the metal
(B) Corundum is a sulphide ore with +3 oxidation state of the metal
(C) Argentite is an oxide ore with +1 oxidation state of the metal
(D) Siderite is a carbonate ore with +2 oxidation state of the metal

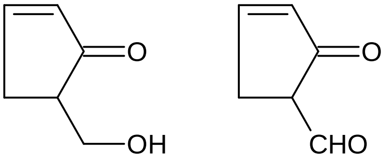
50. Which of the following statements is correct?
(A) Vitamin C and D are water soluble
(B) Vitamin B_6 is known as pyridoxine
(C) Morphine is used as antipyretic
(D) Vitamin E is also known as cyanocobalamin

51.

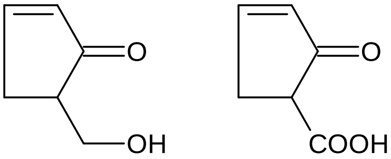


The compounds 'X' and 'Y' respectively are

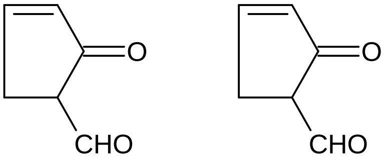
(A)



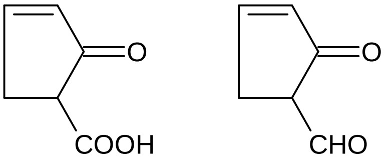
(B)



(C)

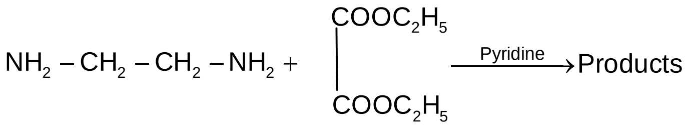


(D)



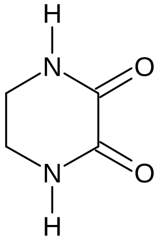
52. For H-atom, as the orbit number increases, the distance between two successive orbits (r_1 = radius of first orbit)
   - (A) Increases by $2r_1$
   - (B) increases by $(2n + 1)r_1$, where n is higher orbit
   - (C) increases by $(2n + 1)r_1$, where n is lower orbit
   - (D) remains constant

53. The major product of the following reaction is:

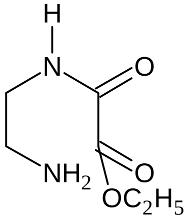


$$NH_2-CH_2-CH_2-NH_2 + \begin{matrix} COOC_2H_5 \\ | \\ COOC_2H_5 \end{matrix} \xrightarrow{\text{Pyridine}} \text{Products}$$

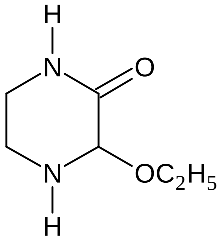
(A)



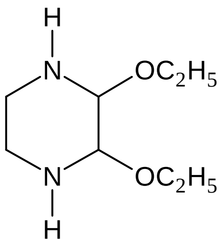
(B)



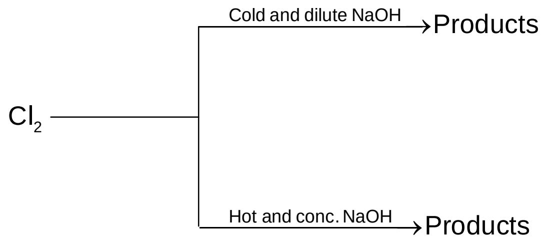
(C)



(D)



54.



The product which is not common in (i.e. present in one but not in the other) both the reactions is:
(A) NaOCl
(B) NaCl
(C) H_2O
(D) $NaClO_2$

55. For a first order reaction in gaseous phase, $A \longrightarrow B + C + D,$ starting with initial pressure 400 mm. If the total pressure after 2 hours is 800 mm, the value of rate constant is:
(A) 4.63 hr^{-1}
(B) 0.346 hr^{-1}
(C) 0.463 hr^{-1}
(D) 3.46 hr^{-1}

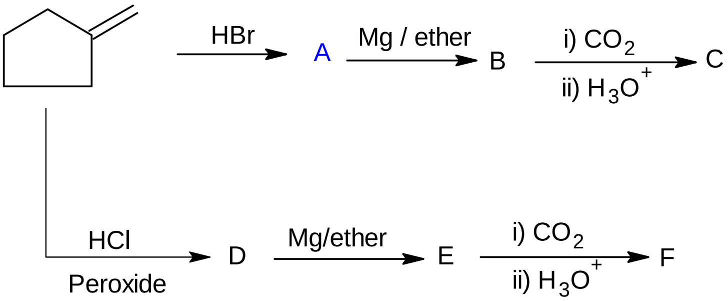
56. Which of the following statements is correct?
(A) D-Glucose and D-Fructose do not reduce Fehling's solution.
(B) Glycogen and dextrin are reducing sugars.
(C) α-D(+) glucopyranose is an example of hemiketal.
(D) Reduction with Na-Hg/H_2O, D-Glucose gives D-Sorbitol.

57. Glycerol can be oxidized to the lowest carbohydrate by using:
(A) $Bi(NO_3)_3$
(B) dil. HNO_3
(C) conc. HNO_3
(D) Fenton's reagent

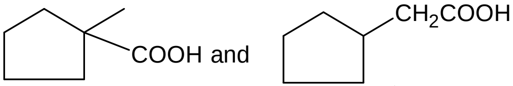
58. 5 moles of an ideal mono atomic gas are heated from 300 K to 600 K at constant volume. The entropy change during the process is:
(A) 6.30 cal/K
(B) 10.39 cal/K
(C) 0.63 cal/K
(D) 3.46 cal/K

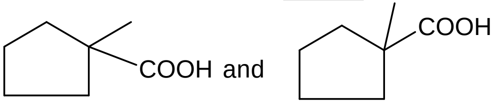
59. Which of the following alloys does not contain copper?
(A) German silver
(B) Magnelium
(C) Gun metal
(D) Bronze

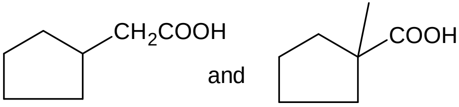
60. In the following reaction sequence:

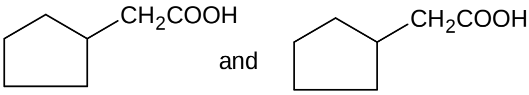

HBr
A
Mg / ether
B
i) CO$_2$
ii) H$_3$O$^+$
C
HCl
Peroxide
D
Mg/ether
E
i) CO$_2$
ii) H$_3$O$^+$
F

C and F respectively are

(A)

COOH and
CH$_2$COOH

(B)

COOH and
COOH

(C)

CH$_2$COOH
and
COOH

(D)

CH$_2$COOH
and
CH$_2$COOH

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. Number of six digit numbers whose sum of the digits is 49 are
(A) $^{12}C_5$
(B) 6
(C) $^{10}C_5$
(D) 1200

62. A square matrix A satisfies the relation $A^2 = 2I - A$, where I is the identity matrix, $A^5 = KI + PA$, then P + K is equal to (where $P, K \in R$)
(A) 6
(B) –6
(C) –1
(D) 1

63. $\int \frac{1-\cos x - x\sin x}{x^2+1-2x\sin x}dx = \tan^{-1}(f(x)) + c$, then f(n) is
(A) continuous at x = 0
(B) an odd function
(C) an even function
(D) $f\left(\frac{\pi}{2}\right) = 1$

64. If f(x) = ||sin(|x| – 2)| – 3|, then
(A) f(x) is continuous but not differentiable at x = 4
(B) f(x) is discontinuous at x = 4
(C) f(x) is differentiable at x = 4 and f′(4) = cos 2
(D) f(x) is differentiable at x = 4 and f′(4) = –cos 2

65. $\frac{\sin\theta}{\cos\theta} + \frac{\sin 2\theta}{\cos^2\theta} + \frac{\sin 3\theta}{\cos^2\theta} + ... + \frac{\sin 6\theta}{\cos^6\theta}$ is equal to
(A) $\cot\theta + \frac{\cos 7\theta}{\sin\theta\cos^6\theta}$
(B) $\cot\theta - \frac{\cos 7\theta}{\sin\theta\cos^6\theta}$
(C) $\frac{\cos 7\theta}{\sin\theta\cos^6\theta} - \cot\theta$
(D) 21 tan θ

66. $f'(x) = f(x) + \int_0^1 f(x)dx$ and f(0) = 1, then $\int f(x)dx$ is equal to
(A) $\frac{2}{3-e}e^x + \left(\frac{3-e}{1-e}\right)x + c$
(B) $\frac{2}{3-e}e^x + \left(\frac{1-e}{3-e}\right)x + c$

(C) $\frac{2}{2-e}e^{x}+\left(\frac{e}{e-2}\right)x+c$

(D) $\frac{3}{2-e}e^{x}+\left(\frac{1-e}{2-e}\right)x+c$

67. In ΔABC, the sides a, b, c are the roots of the equation $x^3 - 12x^2 + 47x - 60 = 0$. Then $\frac{\cos A}{a}+\frac{\cos B}{b}+\frac{\cos C}{c}$ is equal to

(A) $\frac{7}{15}$

(B) $\frac{8}{15}$

(C) $\frac{12}{5}$

(D) $\frac{5}{12}$

68. If the radii of the circles $x^2 + y^2 - 4x - 6y - 12 = 0$ and $x^2 + y^2 + 8x + 10y + 32 = 0$ are increasing uniformly with respect to time as 0.2 unit/sec and 0.3 unit/sec respectively. If t_1 and t_2 are the time when they touch each other, then $|t_1 - t_2|$ is equal to

(A) 116 seconds
(B) 76 seconds
(C) 68 seconds
(D) 108 seconds

69. If $4^{\cos^2 x+\cos^4 x+\cos^6 x+.....+\infty}$ satisfies the equation $t^2 - 20t + 64 = 0$, then number of $(x \neq n\pi)$ values of x in $\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$ are

(A) 2
(B) 4
(C) 6
(D) 18

70. The vertex A of an equilateral triangle ABC is (5, 4) and the sides AB and BC are the members of the family of lines $\ell x+my+n=0$. If ℓ, m, n are in A.P., then area of triangle ABC is

(A) $\frac{\sqrt{39}}{2}$

(B) $10\sqrt{3}$

(C) $4\sqrt{3}$

(D) $13\sqrt{3}$

71. Domain and range of the function $f(x)=\sqrt{\sin^{-1}(3x)+\frac{\pi}{3}}$ is $\left[\frac{a}{\sqrt{3}},\frac{b}{3}\right]$ and $\left[c, d\sqrt{5\pi}\right]$ respectively, then 2a + b + c + 6d is equal to

(A) 1
(B) $2\sqrt{3}$
(C) $\sqrt{6}$
(D) none of these

72. Let $f_k(\theta) = \sum_{k=0}^{n} \frac{1}{4^k} \sin^4\left(2^k \theta\right)$. Then which of the following is correct?
(A) $f_4\left(\frac{3\pi}{2}\right) = 2$
(B) $f_4\left(\frac{3\pi}{2}\right) = 1$
(C) $f_5(\pi) = 1$
(D) $f_5\left(\frac{\pi}{8}\right) = \frac{1}{\sqrt{2}}$

73. Let A = {x: |x – 1| < 3} and B = {x : $x^2 - 2ax + a^2 - 4 \geq 0$} be two sets.
If A ∩ B = {x : –2 < x ≤ 1}, then the possible integral value of a is
(A) 7
(B) 8
(C) 3
(D) 1

74. Let t_n be nth term of a geometric progression with common ratio r. If r < 0, $\frac{t_6}{t_8} = \frac{1}{4}$ and $t_3 + t_7 = 100$ and $t_1 = \frac{a}{b}$, then the value of a + b is (a and b are coprime numbers)
(A) 37
(B) 83
(C) 50
(D) 42

75. Consider a triangle PQR and p, q, r denote the length of the sides opposite to vertices P, Q and R respectively. If p, q, r are in A.P. and $x^2 + 3x + 5 = 0$ and $3x^2 + px + r = 0$ have a common root. Then the sum of inradius and circumradius of triangle PQR is
(A) 7
(B) $\frac{15}{2}$
(C) $\frac{21}{2}$
(D) $\frac{17}{2}$

76. Let $f(n) = \sum_{k=-n}^{n} \left(\cot^{-1}\left(\frac{1}{k}\right) - \tan^{-1} k\right)$, k ≠ 0. If the value of $\sum_{n=2}^{20} \left(f(n) + f(n-1)\pi\right)$ is mπ, then the vale of m is
(A) 100
(B) 98
(C) 99
(D) 117

77. If $\sum_{r=0}^{n} \left(\frac{r+2}{r+1}\right) {}^nC_r = \frac{2^{17}-1}{14}$, then the value of n is equal to
(A) 14
(B) 13
(C) 10
(D) none of these

78. Let $L = \prod_{n=3}^{\infty}\left(1-\frac{4}{n^2}\right)$; $M = \prod_{n=2}^{\infty}\left(\frac{n^3-1}{n^3+1}\right)$; $N = \prod_{n=1}^{\infty}\frac{\left(1+n^{-1}\right)^2}{1+2n^{-1}}$, then the value of $L^{-1} + M^{-1} + N^{-1}$ is
(A) 0
(B) 1
(C) 8
(D) 10

79. Given that z_1, z_2 and z_3 are complex numbers with $|z_1| = |z_2| = |z_3| = 1$, $z_1 + z_2 + z_3 = 1$ and $z_1z_2z_3 = 1$, then $|(z_1 + 2)(z_2 + 2)(z_3 + 2)|$ is equal to
(A) 14
(B) 15
(C) 20
(D) 9

80. A restaurant has 5 menu items. If the first 4 customers each choose one menu item at random, the probability that the 4th customer order a previously unordered item is $\frac{m}{n}$, where m and n are relatively prime positive integers. Then m + n is equal to
(A) 179
(B) 189
(C) 207
(D) none of these

81. Let circles C_1 and C_2 on Argand plane be given $|z + 2| = 4$ and $|z - 1| = 10$ respectively. If a variable circle $|z - z_0| = r$ be inside circle C_2 such that it touches C_1 externally and C_2 internally, then locus of z_0 is a conic whose eccentricity is
(A) $\frac{1}{2}$
(B) $\frac{3}{10}$
(C) $\frac{3}{8}$
(D) $\frac{3}{14}$

82. Let f: R → R be a differentiable function such that $f(1) = 1$, $f(2) = 20$, $f(-4)$, $f'(0) = 0$ and
$f(x + y) = f(x) + f(y) + 3xy(x + y) + bxy + c(x + y) + 4 \ \forall\ x, y \in R$ where b, c are constants, then number of solutions of the equation $f(x) = x^3 + 4e^x$ is equal to
(A) 0
(B) 1
(C) 2
(D) 3

83. Consider a tetrahedron ABCD with AB = 12, CD = 6. The shortest distance between the skew lines AB and CD is 8 and the angle between them is $\frac{\pi}{6}$. If the volume of tetrahedron is v, then $\frac{v}{12}$ is
(A) 5
(B) 8
(C) 4
(D) 2

84. Let f be a differentiable function on R and satisfying $f(x) = -(x^2 - x + 1)e^x + \int_0^x e^{x-y} f'(y)\,dy$. If f(1) + f′(1) = ke, where k ∈ N, then k is equal to
(A) 0
(B) 3
(C) 6
(D) 4

85. The radius of the circle passing through the vertices of the triangle formed by a pair of straight lines $23x^2 + 26xy + 5y^2 = 0$ and $3x + y - 1 = 0$ is
(A) 5
(B) $\sqrt{13}$
(C) $\sqrt{29}$
(D) $2\sqrt{13}$

86. The number of integral values of a for which three distinct chords of the ellipse $\frac{x^2}{2a^2} + \frac{y^2}{a^2} = 1$ passing through the point $\left(20a, -\frac{a^2}{2}\right)$ are bisected by the parabola $y^2 = 4ax$ is
(A) 14
(B) 8
(C) 6
(D) 20

87. Let f(x) be a continuous function which takes positive values for x ≥ 0 and satisfy $\int_0^x f(t)\,dt = x\sqrt{f(x)}$ with $f(1) = \frac{1}{4}$. Then the numbers of values of x in [0, 4π] for which f(x) = cosec x is
(A) 4
(B) 3
(C) 1
(D) 0

88. The director circle of an ellipse is $x^2 + y^2 - 16x = 0$. One end of the major axis is (3, 5), then one of its focus is
(A) $\left(8 + 3\sqrt{3}, \sqrt{2}\right)$
(B) $\left(8 - 3\sqrt{2}, 3\sqrt{2}\right)$
(C) $\left(\frac{37}{5}, \frac{3}{5}\right)$
(D) $\left(\frac{37}{5}, \frac{-3}{5}\right)$

89. If $\theta_1, \theta_2, \theta_3 \in [0, 3\pi]$, then the number of ordered triplets $(\theta_1, \theta_2, \theta_3)$ which satisfy $(1 + \text{cosec}^4\,\theta_1)(2 + \cot^4\theta_2)(4 + \sin 4\theta_3) \le 12 \sin^2\theta_1$ are
(A) 18
(B) 36
(C) 72
(D) 48

90. If $I_1 = \int_{-2017}^{2019} \frac{dx}{\left(5+2x-x^2\right)\left(1+e^{3x-3}\right)}$ and $I_2 = \int_{-2017}^{2019} \frac{dx}{\left(5+2x-x^2\right)}$, then $\frac{I_1}{I_2}$ is equal to

(A) $\frac{1}{2}$
(B) 2
(C) 0
(D) none of these

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – I

JEE (Main)-2019

TEST DATE: 16-12-2018

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

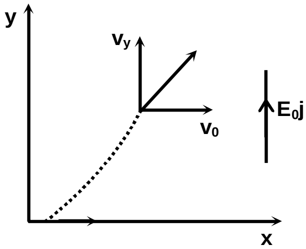
SECTION – A

1. B

Sol. At higher temperatures, specific heat is also higher. Therefore, block with higher initial temperature will suffer less change in temperature.

2. B

Sol.



$$\lambda = \frac{h}{mv} \Rightarrow \lambda \propto 1/v$$

$$v = \sqrt{v_y^2 + v_0^2}$$

$$v_y = u_y + a_y t$$

$$v_y = 0 + \frac{qE_0}{m}t$$

$$(3v_0) = \sqrt{v_y^2 + v_0^2}$$

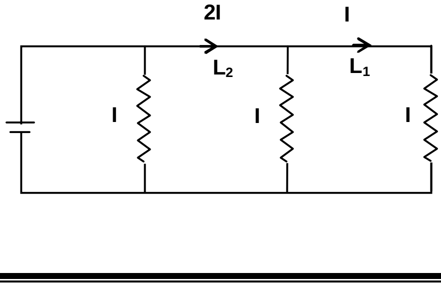
$$\Rightarrow v_y^2 = 8v_0^2 \quad \Rightarrow \frac{qE_0}{m}t = 2\sqrt{2}v_0$$

$$t = \frac{2\sqrt{2}m}{qE_0}v_0 \Rightarrow t \propto 1/E_0$$

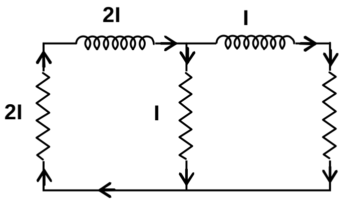
3. A

Sol. When switch is closed

Initially circuit is in steady state current through each resistor as all are identical and are in parallel combination. When switch is off current through L_1 and L_2 just after unchanged. So flow of current remain same.



In right and middle wire current is I downward and in left wire current is 2I upward



4. A

Sol. $I_{cm} + m(R + y)^2 = I_3$ …(i)

$I_{cm} + m(R - y)^2 = I_1$ …(ii)

from (i) and (ii)

$I_1 - I_3 = m[(R - y)^2 - (R + y)^2]$

$I_1 - I_3 = m(2R)(-2y)$ …(iii)

$I'_{cm} + m(R + x)^2 = I_4$ …(iv)

$I'_{cm} + m(R - x)^2 = I_2$ …(v)

From (iv) and (v)

$(I_2 - I_4) = m[(R - x)^2 - (R + x)^2]$

$(I_2 - I_4) = m[(2R)(-2x)]$ …(vi)

from (iii) and (vi)

distance from CM from O

$= \sqrt{x^2 + y^2}$

$= \frac{1}{4MR}\sqrt{(I_1 - I_3)^2 + (I_2 - I_4)^2}$, putting values d = 5 m

5. A

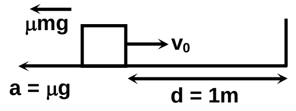
Sol. Velocity after time t, $v = v_0 - \mu g t$

$\Rightarrow v_0 > 2\mu g$ …(i)

Displacement in time ‘t’

$S = v_0 t - \frac{1}{2}\mu g t^2$

$1 = 2v_0 - \frac{1}{2}\mu g(2)^2 \quad \Rightarrow v_0 = \left(\frac{1}{2} + \mu g\right)$ …(ii)



From (i) and (ii)

$\frac{1}{2} + \mu g > 2\mu g$

$\Rightarrow \quad \mu < 1/2g$

$\Rightarrow \quad \mu < 0.05$

6. A

Sol. $45 + r > \theta_C$ …(i)

$45 - r > \theta_C$ …(ii)

$90° > 2\theta_C$

$45° > \theta_C$

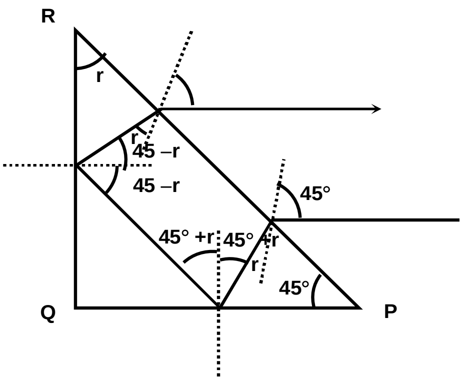
$\sin 45° > \sin \theta_C$

$\frac{1}{\sqrt{2}} > \frac{1}{\mu}$

$\mu > \sqrt{2}$

taking equation 2 only

$45 - \theta_C > r$, $\sin(45 - \theta_C) > \sin r$

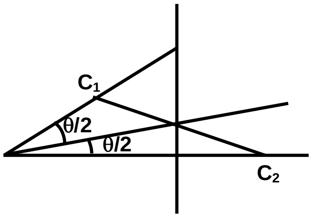


$$\frac{1}{\sqrt{2}}\cos\theta_C - \frac{1}{\sqrt{2}}\sin\theta_C > \frac{\sin 45^\circ}{\mu}$$
$$\frac{\sqrt{\mu^2-1}}{\mu} - \frac{1}{\mu} > \frac{1}{\mu} \Rightarrow \sqrt{\mu^2-1} > 2 \Rightarrow \mu > \sqrt{5}$$

7. A

Sol. $\ell\cos\theta = \frac{\ell}{2}\cos^2\frac{\theta}{2}$

$\cos\theta = 1/3$



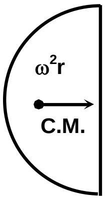
8. D

Sol. $v = \sqrt{\frac{T}{\mu}}$ and $A_t = \left(\frac{2v_2}{v_2+v_1}\right)A_i$ and $A_r = \left(\frac{v_2-v_1}{v_2+v_1}\right)A_i$

9. C

Sol. r = 3R/8

$$F = \frac{m}{2}\cdot\left(\frac{v}{R}\right)^2\frac{3R}{8} = \frac{3mv^2}{16R} = 3N$$



10. C

Sol. Associative Law

(W + X) · (W + Y) = W + (X · Y)

11. B

Sol. Use, $N = \frac{\rho v d}{\eta}$

12. C

Sol. In steady state,

$\sigma AT^4 = 2\,\sigma A(300)^4$

and $P + \sigma A(300)^4 = 2\,\sigma AT^4$

$\therefore\ P = 3\sigma A(300)^4 = 3$ kW

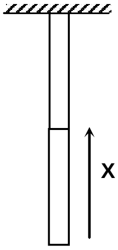
13. D

Sol. Wave speed $v = \sqrt{gx}$

$$\frac{dv}{dt} = \sqrt{g}\cdot\frac{1}{2\sqrt{x}}\cdot\sqrt{gx} = \frac{g}{2}$$

$\therefore\ A(2\pi f)^2 = \frac{g}{2}$

i.e., $8\pi^2 f^2 A = g$



14. C

Sol. $|M| = \frac{v_0}{u_0}\left(1+\frac{D}{f_e}\right) = \frac{11}{2}$

$\therefore\ S_{min} = \frac{0.22}{11/2} = 0.04 \text{ mm}$

15. A

Sol. $f = \frac{1}{2\ell}\sqrt{\frac{T}{\mu}} = \frac{1}{2\ell}\sqrt{\frac{\sigma}{\rho}} = \frac{1}{2\ell}\sqrt{\frac{Y\varepsilon}{\rho}}$

16. C

Sol. $P = Ei - i^2r$

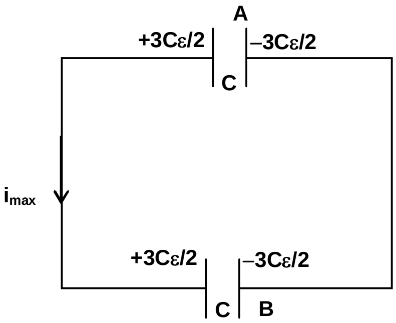
and $i = \frac{E}{2r}$ for P_{max}

17. D

Sol. $\frac{P_n}{P_0} \propto C^n$, n : no of strokes

18. B

Sol. Using conservation of energy



$$\frac{1}{2}C(2\varepsilon)^2 + \frac{1}{2}C\varepsilon^2 = \frac{1}{2}(C+C)\left(\frac{3\varepsilon}{2}\right)^2 + \frac{1}{2}Li_{max}^2$$

$$2C\varepsilon^2 + \frac{C\varepsilon^2}{2} = \frac{9C\varepsilon^2}{4} + \frac{1}{2}Li_{max}^2$$

$$\frac{5C\varepsilon^2}{2} - \frac{9C\varepsilon^2}{4} = \frac{1}{2}Li_{max}^2$$

$$\frac{C\varepsilon^2}{4} = \frac{1}{2}Li_{max}^2$$

$$i_{max} = \varepsilon\sqrt{\frac{C}{2L}}$$

19. A

Sol. In equilibrium (m + m′) = $\frac{1}{3}\pi\left(\frac{h}{2}\right)^3 \tan^2\alpha\rho g$ (α : semi-vertical angle of the cone)

When displaced slightly by y

$$f_r = (m+m')g - \frac{1}{3}\pi\left(\frac{h}{2}+y\right)^3 \tan^2\alpha\rho g$$

$$\therefore\ a = -\frac{6gy}{h}$$

$$\therefore\ f = \frac{1}{2\pi}\sqrt{\frac{6g}{h}}$$

20. C

Sol. $(m_1+m_2)g = KL$

$$\frac{1}{2}KL^2 = m_1g\cdot 2L$$

21. D

Sol. Consider a pyramid of square base of side $\sqrt{2}a$.

22. B

Sol. $\int L_1 di_1 i_1 + \int L_2 di_2 i_2 + \int (M di_1 i_2 + M di_2 i_1)$

$= \int L_1 di_1 i_1 + \int L_2 di_2 i_2 + \int M d(i_1 i_2) = \frac{1}{2}L_1 i_1^2 + \frac{1}{2}L_2 i_2^2 + M i_1 i_2$

23. B

Sol. M.S. reading 35 mm

X + 4V = nM

$X = nM - 4\left(\frac{5}{8}M\right)$

X < 1 mm for n = 3 only

So, $X = 3 - \frac{5}{2} = \frac{1}{2}$mm

∴ reading = 35 + 0.5 mm

= 3.55 cm

24. B

Sol. Maximum number of β particles will be emitted when dn/dE = 0

i.e. at $E = \frac{E_{max}}{5}$

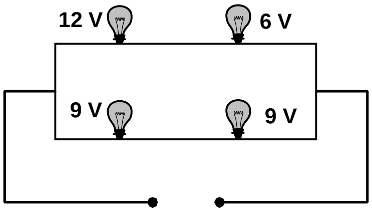
Thus, maximum number of neutrinos would come out energy $\frac{4}{5}E_{max}$.

25. D

Sol. Maximum p.d. can be 18 V

$R_{eq} = \frac{9 \times 4}{9 + 4} = \frac{36}{13}\Omega$

∴ P_{max} = 117 W



26. A

Sol. In equilibrium T = mg and RT = $\pi R^2 BI$

27. A

Sol. For central maxima

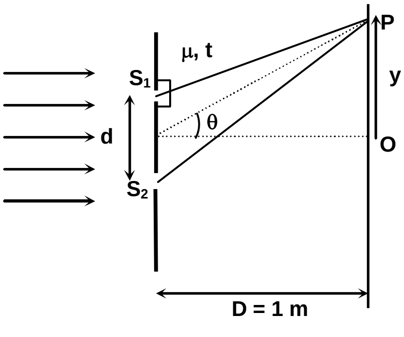
$(\mu - 1)t = d\sin\theta$

$\sin\theta = \frac{(\mu-1)t}{d} = \frac{(1.5-1)1\times10^{-5}}{1\times10^{-3}} = \frac{1}{200}$

⇒ for small θ

$\tan\theta = \frac{1}{200}$, $\frac{y}{D} = \frac{1}{200}$

∴ y = 0.5 cm



28. D

Sol. Modulation index $\mu = \frac{A_{max} - A_{min}}{A_{max} + A_{min}}$

29. B

Sol. Basic Concept

30. A

Sol. $T = \frac{PV}{R}$

T will be maximum when PV is maximum

$T = \frac{PV}{R} = \frac{(4+2\sin\theta)(4+2\cos\theta)}{R}$

As sin θ and cosθ both can not be equal to 1 for same value of θ

$\therefore$ T can not be 36/R

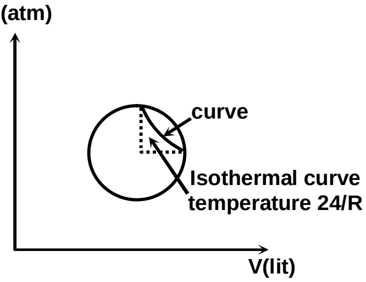
T_{max} should be less than 36R

Curve is above isothermal curve

$\therefore$ temperature is more than 24/R on the given process

So T_{max} lie between 24/R and 36/R

Only one option is present.



Chemistry

PART – II

SECTION – A

31. B

Sol. In ccp number of O^{2-} ions per unit cell = 4

Total negative charge per unit cell = 4 × 2 = 8

Number of tetrahedral voids = 4 × 2 = 8

Number of octahedral voids = 4 × 1 = 4

Number of tetrahedral voids occupied $= 8 \times \frac{12.5}{100} = 1$

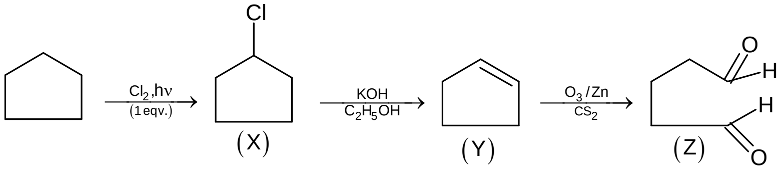
Number of negative charges left unneutralized = 8 – 2 = 6

Number of Y^{3+} ions required to occupy octahedral voids $= \frac{6}{3} = 2$

Fraction of octahedral voids occupied $= \frac{2}{4} = 0.5$

32. D

Sol.



33. B

Sol. (A) Li when burnt in air only forms monoxide.

(B) $Li_2CO_3 \xrightarrow{\Delta} Li_2O + CO_2$

(C) Lithium has high I.E. as compared to other alkali metals and imparts crimson red colour to flame.

(D) Li_2SO_4 is the only alkali metal sulphate which does not form double salts.

34. A

Sol. (A) $XeF_4 + O_2F_2 \longrightarrow XeF_6 + O_2$

(B) $XeF_4 + H_2 \longrightarrow Xe + HF$

(C) $XeF_4 + KI \longrightarrow KF + Xe + I_2$

(D) $XeF_4 + SF_4 \longrightarrow SF_6 + Xe$

35. B

Sol. (A) $\left[Al(OH)_4\right]^-(aq) + NH_4^+(aq) \longrightarrow \underset{(White)}{Al(OH)_3} \downarrow + NH_3 \uparrow + H_2O$

(B) $Pb^{2+}(aq) + 2Br^-(aq) \longrightarrow PbBr_2 \downarrow (White)$

(C) $BiI_3 \downarrow (\text{black precipitate}) + H_2O \xrightarrow{\Delta} BiOI(\text{orange})$

(D) $S^{2-} + Na_2\left[Fe(CN)_5NO\right] \longrightarrow \underset{(\text{Purple colouration})}{Na_4\left[Fe(CN)_5NOS\right]}$

36. B

Sol. $InOH \rightleftharpoons In^+ + OH^-$

$$K_b = \frac{[In^+][OH^-]}{[InOH]}$$

Also $pOH = pK_b + \log\frac{[In^+]}{[InOH]}$

At pH = 3.3, pOH = 14 – 3.3 = 10.7, the indicator will be sufficiently ionized to give the colour solely due to In^+ ion.
Hence,

$$10.7 = pK_b + \log\frac{[In^+]}{[InOH]}$$

$$= (14 - pk_a) + \log\frac{[In^+]}{[InOH]}$$

$$= \left[14 - \frac{(3.3 + 4.7)}{2}\right] + \log\frac{[In^+]}{[InOH]}$$

$$\Rightarrow \log\frac{[In^+]}{[InOH]} = 0.7 = \log 5$$

$$\Rightarrow \frac{[In^+]}{[InOH]} = 5$$

37. B

Sol. Amount of $H_2C_2O_4$ in 200 cm^3 of original solution $= \frac{200}{1000} \times 0.5 \times 90 = 9.0$ g

Molarity of filterate $= \frac{32 \times 0.25}{2 \times 10} = 0.4$ M

Amount of the acid left out after adsorption = 0.4 × 0.2 × 90 = 7.2 g
Amount of the acid adsorbed = 9.0 – 7.2 = 1.8 g

Amount of the acid adsorbed (x/m) per gram $= \frac{1.8}{9} = 0.2$

38. A

Sol. $E^o_{Fe^{3+}/Fe^{2+}} = 3E^o_{Fe^{3+}/Fe} - 2E^o_{Fe^{2+}/Fe}$
= 3 × (- 0.04) – 2 × (- 0.44) V
= 0.76 V
$Fe^{3+} + e^- \longrightarrow Fe^{2+}$

$$E_{Fe^{3+}/Fe^{2+}} = E^o_{Fe^{3+}/Fe^{2+}} - \frac{2.303RT}{F}\log\frac{[Fe^{2+}]}{[Fe^{3+}]}$$

$$0.718 = 0.76 - 0.06\log\frac{[Fe^{2+}]}{[Fe^{3+}]}$$

$$\Rightarrow \log\frac{[Fe^{2+}]}{[Fe^{3+}]} = \frac{0.042}{0.06} = 0.7 = \log 5 \quad \Rightarrow \frac{[Fe^{2+}]}{[Fe^{3+}]} = 5$$

39. A

Sol. Meq. of H_2SO_4 taken to absorb NH_3 = 50 × 0.2 = 10

Meq. of H_2SO_4 left after NH_3 absorption = Meq. of NaOH used for H_2SO_4 = 25 × 0.19 = 4.75

$\therefore$ Meq. of H_2SO_4 used for NH_3 = 10 – 4.75 = 5.25

$$\therefore \%N = \frac{1.4 \times NV}{\text{wt. of Fertilizer}} = \frac{1.4 \times 5.25}{1.731} = 4.2\%$$

40. C

Sol. Meq. of H_2SO_4 (original) = 30 × 1 = 30 meq.

Meq. of H_2SO_4 after passing NH_3 = 30 × 0.2 = 6

Meq. of H_2SO_4 reacted = Meq. of NH_3 = 30 – 6 = 24

$$\therefore \frac{W_{NH_3}}{17} \times 1000 = 24 \Rightarrow W_{NH_3} = 0.408 \text{ g}$$

$$\therefore \text{Volume of } NH_3 \text{ at STP } = \frac{0.408}{17} \times 22.4 = 0.5376 \text{lit}$$

= 537.6 ml.

41. D

Sol. Diborane forms adduct at low temperature

$$B_2H_6 + 2NH_3 \longrightarrow B_2H_6.2NH_3$$

$B_2H_6.2NH_3$ on heating to 200°C gives borazole

$$3B_2H_6.2NH_3 \xrightarrow{200^o C} 2B_3N_3H_6 + 12H_2 \uparrow$$

$$\text{Moles of addition product = moles of diborane } = \frac{24}{28}$$

$$\text{Moles of borazole } = \frac{2}{3} \times \frac{24}{28}$$

$$\text{Weight of borazole } = \frac{2}{3} \times \frac{24}{28} \times 81 = 46.29 \text{ g}$$

42. C

Sol. $[Ni(CN)_4]^{2-}$ is square planar and coloured.

$[NiCl_4]^{2-}$ is tetrahedral and contains Ni(II) which is coloured.

$K_2[Zn(CN)_4]$ is tetrahedral and colourless.

43. C

Sol. The colloidal solution has positively charged particles.

44. A

Sol. $$NH_4NO_3 \xrightarrow{\Delta} \overset{(+1)}{N}{}_2O \uparrow + 2H_2O$$

$$(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} \overset{(0)}{N_2} \uparrow + 4H_2O + Cr_2O_3$$

$$Hg(NO_3)_2 \xrightarrow{\Delta} Hg + 2\overset{(+4)}{N}O_2 + O_2$$

$$Na(NH_4)HPO_4.4H_2O \xrightarrow{\Delta} NaPO_3 + \overset{(-3)}{N}H_3 + 5H_2O$$

+1 + 0 + 4 – 3 = (+ 2)

45. B

Sol. $\mathrm{NaBr}(aq) \longrightarrow \underset{(0.01)}{\mathrm{Na}^+(aq)} + \underset{(\alpha+0.01)}{\mathrm{Br}^-(aq)}$

$\mathrm{AgBr}(s) \underset{}{\overset{K_{sp}}{\rightleftharpoons}} \underset{\alpha}{\mathrm{Ag}^+(aq)} + \underset{(\alpha+0.01)}{\mathrm{Br}^-(aq)}$

$K_{sp} = [\mathrm{Ag}^+][\mathrm{Br}^-]$

$K_{sp} = (\alpha)(\alpha + 0.01) \Rightarrow (\alpha + 0.01 \approx 0.01)$

$\therefore 10^{-10} = \alpha \times 0.01 \Rightarrow \alpha = 10^{-8}$

Solubility in pure water is $\sqrt{K_{sp}} = 10^{-5}$ M

Factor by which solubility changes = $\frac{10^{-8}}{10^{-5}} = 10^{-3}$

$\therefore x = 3$

46. C

Sol. $SO_2 + PCl_5 \longrightarrow \underset{(X)}{SOCl_2} + POCl_3$

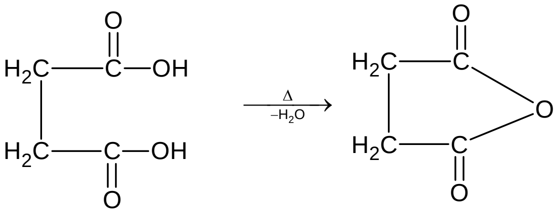
$SOCl_2 + H_2O \longrightarrow SO_2 + \underset{\text{(Pungent smell)}}{2HCl}$

47. C

Sol. Polystyrene, Teflon and Polyacrylonitrile are addition homopolymer, whereas melamine is copolymer.

48. D

Sol. β-Ketoacid, β- γ - unsaturated acid and 1-3 diacid decarboxylates on heating, where as 1-4 diacid dehydrates on heating.



49. D

Sol. Siderite → $FeCO_3$
Anglesite → $PbSO_4$

50. B

Sol. Vitamin C is water soluble, but Vitamin D is fat soluble.
Morphine is used as analgesic.
Vitamin E is known as lactoflavin.

51. A

Sol. MnO_2, is a selective and specific oxidizing agent which oxidizes allylic or benzylic hydroxyl group to carbonyl group (C = O) where as PCC is a mild oxidant which oxidizes 1^o and 2^o ROH to aldehyde and ketones respectively.

52. C

Sol. Radius (x_1) of n^{th} orbit for H-atom = $r_1 \times n^2$

If n is lower orbit, the next orbit = n + 1

and $x_2 = r_1 (n + 1)^2 = r_1(n^2 + 2n + 1)$

$x_2 - x_1 = r_1 (2n + 1)$

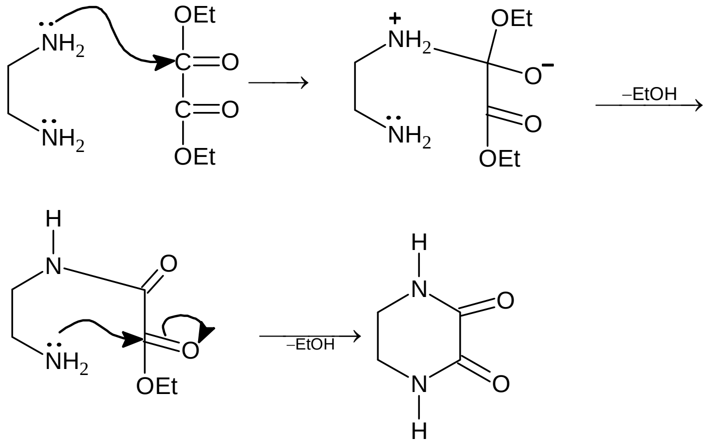
If n is higher orbit, then consecutive lower orbit = n – 1

and $x_2' = r_1(n-1)^2 = r_1(n^2 - 2n + 1)$

$x_1 - x_2' = r_1 \times n^2 - r_1(n^2 - 2n + 1) = r_1 \times (2n - 1)$

53. A

Sol.



54. A

Sol. $Cl_2 + 2NaOH \longrightarrow NaCl + NaOCl + H_2O$

$3Cl_2 + 6NaOH \longrightarrow 5NaCl + NaClO_3 + 3H_2O$

55. B

	A	$\longrightarrow$ B	+ C	+ D
Sol. At $t = 0$	400 mm			
After 2 hrs	$400 - x$	x	x	x

As per question 400 – x + x + x + x = 800

$\Rightarrow$ x = 200

$$k = \frac{2.303}{2}\log\frac{P_A^o}{P_A}$$

$$= \frac{2.303}{2}\log\frac{400}{200}$$

= 0.346 hr^{-1}

56. D

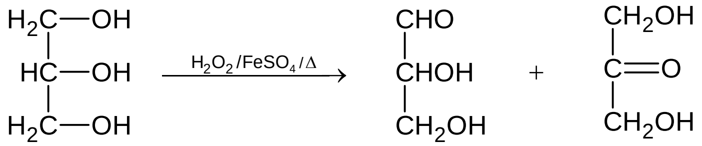
Sol. D-Glucose and D-Fructose are reducing sugar.

Glycogen and dextrin are non-reducing sugars.

α-D-(+) glucopyranose is an example of hemiacetal.

57. D

Sol.



$$\begin{matrix}H_2C-OH\\ |\\ HC-OH\\ |\\ H_2C-OH\end{matrix} \xrightarrow{H_2O_2/FeSO_4/\Delta} \begin{matrix}CHO\\ |\\ CHOH\\ |\\ CH_2OH\end{matrix} + \begin{matrix}CH_2OH\\ |\\ C=O\\ |\\ CH_2OH\end{matrix}$$

Conc. HNO_3 gives mainly glyceric acid.

Dil. HNO_3 oxidizes glycerol to glyceric acid and tartonic acid.

$Bi(NO_3)_3$ gives mainly mesoxalic acid.

58. B

Sol. $\Delta S = nC_V \ell n\frac{T_2}{T_1} + nR\ell n\frac{V_2}{V_1}$

$= 2.303 \times 5 \times 3 \times \log\frac{600}{300}$

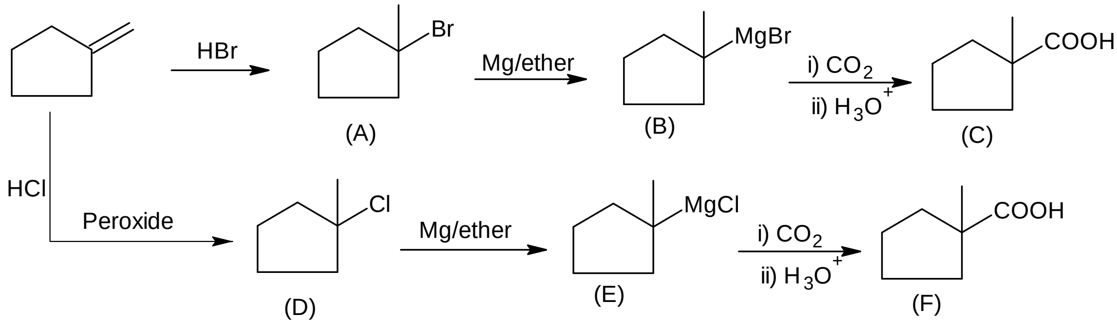
$= 10.39$ cal/K

59. B

Sol. German silver, Gun-metal and Bronze are alloys of copper but magnelium is alloy of aluminium and magnesium.

60. B

Sol.


HBr
Br
(A)
Mg/ether
MgBr
(B)
i) CO2
ii) H3O+
COOH
(C)
HCl
Peroxide
Cl
(D)
Mg/ether
MgCl
(E)
i) CO2
ii) H3O+
COOH
(F)

Mathematics PART – III

SECTION – A

61. C

Sol. $(9 - x_1) + (9 - x_2) + (9 - x_3) + (9 - x_4) + (9 - x_5) + (9 - x_6) = 49$

$x_1 + x_2 + x_3 + x_4 + x_5 + x_6 = 5$

Number of solution is ${}^{5+6-1}C_{6-1} = {}^{10}C_5$

62. D

Sol. $A^3 = A^2 \cdot A = (2I - A)A = 2A - A^2 = 2A - (2I - A) = 3A - 2I$

$A^4 = A^3 \cdot A = (3A - 2I)A = 3A^2 - 2A = 3(2I - A) - 2A = 6I - 5A$

$A^5 = (6I - 5A)A = 6A - 5A^2 = 6A - 5(2I - A) = 11A - 10I$

$\Rightarrow$ P = 11 and K = –10

63. B

Sol. $$\int \frac{1 - \cos x - x\sin x}{(x - \sin x)^2 + \cos^2 x}dx = \int \frac{1}{1 + \left(\frac{\cos x}{x - \sin x}\right)^2} \times \frac{1 - \cos x - x\sin x}{(x - \sin x)^2}dx$$

Let $\frac{\cos x}{x - \sin x} = t \Rightarrow \int \frac{1}{1 + t^2}dt = \tan^{-1} t + c = \tan^{-1}\left(\frac{\cos x}{x - \sin x}\right) + c$

64. D

Sol. Around x = 4 $\Rightarrow$ f(x) = 3 – sin(x – 2)

$\therefore$ It continuous and differentiable f′(x) = –cos(x – 2)

65. B

Sol. $$\cot\theta - \frac{\sin\theta}{\cos\theta} = \frac{\cos 2\theta}{\sin\theta\cos\theta} \Rightarrow \frac{\cos 2\theta}{\sin\theta\cos\theta} - \frac{\sin 2\theta}{\cos^2\theta} = \frac{\cos 3\theta}{\cos^2\theta\sin\theta}$$

Similarly, $\frac{\cos 6\theta}{\cos^5\theta\sin\theta} - \frac{\sin 6\theta}{\cos^6\theta} = \frac{\cos 7\theta}{\cos^6\theta\sin\theta}$

66. B

Sol. $\frac{dy}{dx} = y + k$ (where $k = \int_0^1 f(x)dx$)

$y = ce^x - k$ if $f(0) = 1 \Rightarrow c - k = 1$

$$k = \int_0^1 f(x)dx \Rightarrow k = \int_0^1 (ce^x - k)dx \Rightarrow 2k = c(e - 1) \Rightarrow k = c\left(\frac{e-1}{2}\right) \Rightarrow c = \frac{2}{3-e} \text{ and } k = \frac{e-1}{3-e}$$

67. D

Sol. $$\frac{\cos A}{a} + \frac{\cos B}{b} + \frac{\cos C}{c} = \frac{a^2 + b^2 + c^2}{2abc} = \frac{(a+b+c)^2 - 2(ab+bc+ca)}{2abc} = \frac{144-94}{120} = \frac{5}{12}$$

68. A

Sol. $C_1C_2 = |r_1 + r_2|$ or $C_1C_2 = |r_1 - r_2|$

$10 = |(5 + 0.2t) + (3 + 0.3t)|$ or $10 = |5 + 0.2t - 3 - 0.3t|$

$\Rightarrow$ t = 4 sec or t = 120 sec

69. B

Sol. $4^{\cot^2 x} = 4$ or $4^{\cot^2 x} = 16$

$\cot^2 x = 1$ or $\cot^2 x = 2$

Number of solution 2 + 2 = 4

70. D

Sol. B is fixed $\ell x + my + n = 0$ passes and we know $\ell - 2m + n = 0$ point B is (1, –2)

$\therefore$ Side length = $\sqrt{52}$

Area of equilateral triangle = $\frac{\sqrt{3}}{4} \times a^2 = \frac{\sqrt{3}}{4} \times 52 = 13\sqrt{3}$

71. C

Sol. Domain $\left[-\frac{1}{2\sqrt{3}}, \frac{1}{3}\right]$ $\therefore$ a = $-\frac{1}{2}$ and b = 1

Range $\left[0, \sqrt{\frac{5\pi}{6}}\right]$ $\therefore$ c = 0 and d = $\frac{1}{\sqrt{6}}$

72. B

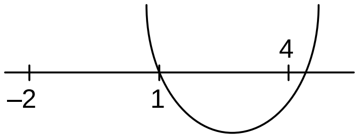
Sol. $f_k(\theta) = \sum_{k=0}^{n} \frac{1}{4^k} \sin^2\left(2^k \theta\right)\left(1 - \cos^2\left(2^k \theta\right)\right) = \sum_{k=0}^{n} \frac{1}{4^k}\left[\sin^2\left(2^k \theta\right) - \frac{1}{4}\sin^2\left(2^{k+1}\theta\right)\right]$

$= \sum_{k=0}^{n}\left[\frac{1}{4^k}\sin^2\left(2^k\theta\right) - \frac{1}{4^{k+1}}\sin^2\left(2^{k+1}+1\right)\right] = \sin^2\theta - \frac{1}{4^{n+1}}\sin^2\left(2^{n+1}\theta\right)$

$f_4\left(\frac{3\pi}{2}\right) = \sin^2\frac{3\pi}{2} - \frac{1}{1024}\sin^2\left(32 \times \frac{3\pi}{2}\right) = 1$ $\therefore$ $f_5(\pi) = 0$

73. C

Sol. Let $f(x) = x^2 - 2ax + a^2 - 4$



$\because$ $A \cap B = \{x : -2 < x \le 1\}$

$\therefore$ graph of f(x) must be i.e. $\frac{-b}{2a} > 1$ and $f(4) \le 0$

$\Rightarrow \frac{a}{2} > 1$ and $16 - 8a + a^2 - 4 \le 0$

$\Rightarrow$ a > 2 and a $\in$ a is 3 $\therefore$ Least value of a is 3

74. D

Sol. $\frac{(a/b)r^5}{(a/b)r^7} = \frac{1}{4} \Rightarrow r = -2$

75. C

Sol. As $x^2 + 3x + 5 + 0$ has non-real roots so the equations $x^2 + 3x + 5 = 0$ and $3x^2 + px + r = 0$ have both roots common i.e., $\frac{3}{1} = \frac{p}{3} = \frac{r}{5} \Rightarrow p = 9$ and r = 15

$\because$ $q = \frac{p+r}{2} \Rightarrow q = 12$

ΔPQR is right angled triangle therefore circumradius is half of length of hypotenuse

$\therefore$ Circumradius = $\frac{15}{2}$ and $\Delta = rs \Rightarrow r = \frac{\Delta}{s} = \frac{54}{18} = 3$

76. C

Sol. $f(n) = \sum_{k=-n}^{-1}\left(\cot^{-1}\frac{1}{k} - \tan^{-1}k\right) + \sum_{k=1}^{n}\left(\cot^{-1}\frac{1}{k} - \tan^{-1}k\right) = \sum_{k=-n}^{-1}\left(\tan^{-1}k + \pi - \tan^{-1}k\right) + 0 = n\pi$

$\therefore \sum_{n=2}^{10} n\pi + (n-1)\pi = \sum_{n=2}^{10}(2n-1)\pi = 99\pi$

77. B

Sol. $\sum_{r=0}^{n}\left(\frac{r+2}{r+1}\right){}^nC_r = \sum_{r=0}^{n}\left(\frac{r+1+1}{r+1}\right){}^nC_r = \sum_{r=0}^{n}{}^nC_r + \sum_{r=0}^{n}\frac{{}^nC_r}{r+1} = 2^n + \sum_{r=0}^{n}\frac{1}{n+1}\,{}^{n+1}C_{r+1} = 2^n + \frac{2^{n+1}}{n+1}$

$= \frac{2^n(n+3)-1}{n+1}$ $\therefore$ n = 13

78. C

Sol. $L = \prod_{n=3}^{\infty}\left(1 - \frac{4}{n^2}\right) = \prod_{n=3}^{\infty}\left(\frac{n^2-4}{n^2}\right) = \prod_{n=3}^{\infty}\frac{n-2}{n} \times \prod_{n=3}^{\infty}\frac{n+2}{n}$

$\Rightarrow L = \left(\frac{1}{3}\times\frac{2}{4}\times\frac{3}{5}\times.....\times\frac{n-2}{n}\right)\times\left(\frac{5}{3}\times\frac{6}{4}\times\frac{7}{5}\times.....\times\frac{n+1}{n-1}\times\frac{n+2}{n}\right)$

$\Rightarrow L = \frac{1\cdot 2}{n(n-1)}\times\frac{(n+1)(n+2)}{3\times 4}$; $\lim_{n\to\infty}\frac{2(n^2+3n+2)}{12(n^2-n)} = \frac{1}{6}$

$M = \prod_{n=2}^{\infty}\frac{n-1}{n+1}\times\frac{n^2+n+1}{n^2-n+1} = \left(\frac{1}{3}\times\frac{2}{4}\times\frac{3}{5}\times\frac{4}{6}\times.....\times\frac{n-2}{n}\times\frac{n-1}{n+1}\right)\times\left(\frac{7}{3}\times\frac{13}{7}\times\frac{21}{3}\times.....\times\frac{n^2-n+1}{n^2+n+1}\right)$

$= n^2 + \frac{2}{n(n+1)}\times\frac{n^2\times n+1}{3} = \frac{2}{3}$ $\therefore M = \frac{2}{3}$

$N = \prod_{n=1}^{\infty}\frac{(n+1)^2}{n(n+2)} = \prod_{n=1}^{\infty}\frac{n+1}{n+2}\times\prod_{n=1}^{\infty}\frac{n+1}{n} = \frac{2(n+1)}{n+2} = 2$ $\therefore$ N = 2

$L^{-1} + M^{-1} + N^{1-} = 6 + \frac{3}{2} + \frac{1}{2} = 8$

79. B

Sol. $(z_1 + 2)(z_2 + 2)(z_3 + 2) = z_1z_2z_3 + 2(z_1z_2 + z_2z_3 = z_3z_1) + 4(z_1 + z_2 + z_3) + 8$

$= 1 + 2(z_1z_2 + z_2z_3 + z_3z_1) + 4 + 8 = 13 + 2(z_1z_2 + z_2z_3 + z_3z_1)$

Now $z_1z_2 + z_2z_3 + z_3z_1 = z_1z_2z_3\left(\frac{1}{z_1}+\frac{1}{z_2}+\frac{1}{z_3}\right) = \frac{1}{z_1}+\frac{1}{z_2}+\frac{1}{z_3}$

$= \frac{\bar{z}_1}{|z_1|^2}+\frac{\bar{z}_2}{|z_2|^2}+\frac{\bar{z}_3}{|z_3|^2} = \bar{z}_1+\bar{z}_2+\bar{z}_3 = z_1 + z_2 + z_3 = 1$

80. B

Sol. Total ways in which 4 customers can order is $5^4 = 625$

Now for the 4th person, number of ways is ${}^5C_1 = 5$ and for the other three persons, number of ways = 4 × 4 × 4

$\therefore$ Total number of ways 4th person orders unordered item = 5×4^3

$\therefore$ Probability that 4th person orders an unordered item = $\frac{5\times 4^3}{5\times 5^4} = \frac{64}{125}$

81. D

Sol. $C_1: (x + 2)^2 + y^2 = 16$

$C_2 : (x - 1)^2 + y^2 = 100$

$CC_1 = r + r_1$ and $CC_2 = r_2 - r \therefore CC_1 + CC_2 = r_1 + R_2 = 14$

$\therefore$ Locus of C is an ellipse whose focus is at C_1 and C_2 and length of major axis = 14

$\therefore$ 2a = 14 and 2ae = 3 $\therefore$ $e = \frac{3}{14}$

82. B

Sol. Put x = 0, y = 0, we get f(0) = –4

$$f'(x) = \lim_{h\to 0} \frac{f(x+h) - f(x)}{h} = \lim_{h\to 0} \frac{f(x) + f(h) + 3xh(x+h) + 8xh + 4 - f(x)}{h}$$

$$= \lim_{h\to 0} \frac{f(h) + 3xh(x+h) + 8xh - f(0)}{h} \text{ (as } f(0) = -4)$$

$= f'(0) + 3x^2 + 8x = 3x^2 + 8x \therefore f(x) = x^3 + 4x^2 + c$

as f(1) = 1 $\therefore$ c = –4

$\therefore f(x) = x^3 + 4x^2 - 4 \therefore f(x) = x^3 + 4e^x \Rightarrow x^2 - 1 = e^x$ which has one solution

83. C

Sol. Given $\left|\vec{b} - \vec{a}\right| = 12$; $\left|\vec{c}\right| = 6$

Equation of CD is $\vec{r} = \lambda\vec{c}$

Equation of AB is $\vec{r} = \vec{a} + \mu\left(\vec{b} - \vec{a}\right)$

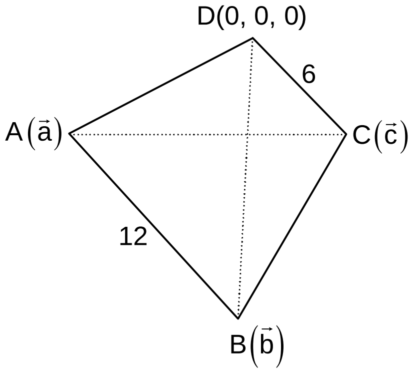
Shortest distance between AB and CD

$$= \left|\frac{\vec{a}\cdot\left(\vec{c}\times\left(\vec{b}-\vec{a}\right)\right)}{\vec{c}\times\left(\vec{b}-\vec{a}\right)}\right| = 8 \Rightarrow \left|\frac{[a\ c\ b]}{\left|\vec{c}\times\left(\vec{b}-\vec{a}\right)\right|}\right| = 8$$

$$\left[\vec{a}\ \ \vec{c}\ \ \vec{b}\right] = 8\left|\vec{c}\times\left(\vec{b}-\vec{a}\right)\right|$$

$\Rightarrow 6 \times$ volume of tetrahedron = $8 \times \left|\vec{c}\right| \times \left|\vec{b} - \vec{a}\right| \times \frac{1}{2}$

$\Rightarrow$ v = 48



84. D

Sol. $f'(x) = -((x^2 - x + 1)e^x + e^x(2x - 1)) + e^x \cdot e^{-x} \cdot f'(x) + e^x \int_0^x e^{-y} f'(y)\,dy$

$$f'(x) = f'(x) + \int_0^x e^{x-y} f'(y)\,dy - e^x\left(x^2 + x\right)$$

$0 = f(x) + (x^2 - x + 1)e^x - e^x(x^2 + x)$

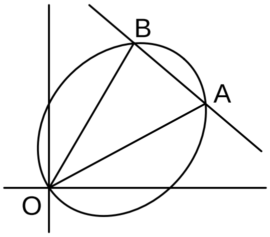
$f(x) = e^x(x^2 + x - x^2 + x - 1)$

$f(x) = e^x(2x - 1)$

$f'(x) = e^x 2 + (2x - 1)e^x$

$\therefore f(1) = e; f'(1) = 3e$

85. A



Sol. Equation of circle $x^2 + y^2 + 2gx + 2fy = 0$
Homogenizing the equation of circle with the help of the line
$3x + y – 1 = 0$, we get equation of pair of straight lines OA and OB
$x^2 + y^2 + 2gx(3x + y) + 2fy(3x + y) = 0$
$= x^2(1 + 6g) + y^2(1 + 2f) + xy(2g + 6f) = 0$
Comparing it with $23x^2 + 5y^2 + 26xy = 0$
we get $\frac{1+6g}{23}=\frac{1+2f}{5}=\frac{2g+6f}{26}$
$f = –3$ and $g = –4$
$\therefore$ Equation of circle is $x^2 + y^2 – 8x – 6y = 0$
$\therefore$ Radius = 5

86. A

Sol. Any point on the parabola $y^2 = 4ax$ is $(at^2, 2at)$
Equation of the chord of the ellipse $\frac{x^2}{2a^2}+\frac{y^2}{a^2}=1$
Whose mid-point is $(at^2, 2at)$ is $T = S_1$
$\Rightarrow x\frac{at^2}{2a^2}+y\frac{2at}{a^2}=\frac{a^2t^4}{2a^2}+\frac{4a^2t^2}{a^2}$ $\Rightarrow tx + 4y + at^3 + 8at$
As it passes through $\left(20a,-\frac{a^2}{2}\right)\Rightarrow 20at+4\left(-\frac{a^2}{2}\right)=at^3+8at$
$\Rightarrow at^3 – 12at + 2a^2 = 0 \Rightarrow t^3 – 12t + 2a = 0$ $(a \neq 0)$
Now three should be 3 distinct values of t for three distinct chords
Let $f(t) = t^3 – 12t + 2a$; $f'(t) = 3t^2 – 12 = 0 \Rightarrow t = \pm2$
So $f(2)\, f(–2) < 0 \Rightarrow (a + 8)(a – 8) < 0$
$\therefore$ 14 values of a are possible $(a \neq 0)$

87. D

Sol. $\int_0^x f(t)dt = x\sqrt{f(x)}$. Differentiating w.r.t. to x, we get $f(x)=\frac{xf'(x)}{2\sqrt{f(x)}}+\sqrt{f(x)}$

$2f(x)^{3/2} = xf'(x) + 2f(x)$; $f'(x)+\frac{2}{x}f(x)=\frac{2}{x}(f(x))^{3/2}$; $\frac{1}{(f(x))^{3/2}}f'(x)+\frac{2}{x}(f(x))^{-1/2}=\frac{2}{x}$

Let $f(x)^{-1/2}=t \Rightarrow \frac{dt}{dx}=-\frac{1}{2}f(x)^{-3/2}f'(x) \Rightarrow -2\frac{dt}{dx}+\frac{2t}{x}=\frac{2}{x} \Rightarrow \frac{dt}{dx}\frac{-1}{x}t=\frac{-1}{x}$

Solving, we get $t = 1 + cx$; i.e., $\frac{1}{\sqrt{f(x)}}=1+cx$

$f(1)=\frac{1}{4} \Rightarrow c = 1 \therefore \sqrt{f(x)}=\frac{1}{1+x} \Rightarrow f(x)=\frac{1}{(1+x)^2}$

Now $f(x) = \text{cosec } x \Rightarrow \frac{1}{(1+x)^2}=\frac{1}{\sin x} \Rightarrow (1 + x)^2 = \sin x$; No solutions

88. B

Sol. Radius of director circle $=\sqrt{a^2+b^2}=8 \Rightarrow a^2 + b^2 = 64$

$\therefore 50 + b^2 = 64 \Rightarrow b^2 = 14$; $b^2 = a^2(1 – e^2) \Rightarrow 14 = 50(1 – e^2) \Rightarrow e^2=\frac{36}{50} \Rightarrow e=\frac{3\sqrt{2}}{5}$

Slope of line joining centre and vertex = $\frac{5-0}{8-3} = -1$ foci lies on this line

$\therefore$ Foci (x, y) can be (x, y) = $\left(8+5\sqrt{2}\times\frac{3\sqrt{2}}{5}\times\frac{-1}{\sqrt{2}},\ 0+5\sqrt{2}\times\frac{3\sqrt{2}}{5}\times\frac{1}{\sqrt{2}}\right) = \left(8-3\sqrt{2}, 3\sqrt{2}\right)$

or (x, y) = $\left(8-5\sqrt{2}\times\frac{3\sqrt{2}}{5}\times\frac{-1}{\sqrt{2}},\ 0-5\sqrt{2}\times\frac{3\sqrt{2}}{5}\times\frac{1}{\sqrt{2}}\right)$

89. B

Sol. 1 + cosec$^4\,\theta_1 \geq 2$

2 + cot$^4\,\theta_2 \geq 2$ and 4 + sin $4\theta_3 \geq 3$

$\therefore$ L.H.S. $\geq$ 12

$\therefore$ Only possibility is sin$^2\,\theta_1$ = 1, cot$^4\,\theta_2$ = 0 and sin $4\theta_3$ = –1

$\theta_1 = \frac{\pi}{2}, \frac{3\pi}{2}, \frac{5\pi}{2};\ \theta_2 = \frac{\pi}{2}, \frac{3\pi}{2}, \frac{5\pi}{2};\ \theta_3 = \frac{3\pi}{8}, \frac{7\pi}{8}, \frac{11\pi}{8}, \frac{18\pi}{8}$

$\therefore$ Number of triplets are 3 × 3 × 4 = 36

90. A

Sol. $I_1 = \int_{-2017}^{2019} \frac{dx}{\left(5+2x-x^2\right)\left(1+e^{3x-3}\right)}$ ..... (1)

Using the property $\int_a^b f(x)dx = \int_a^b f(a+b-x)dx$, we get

$I_1 = \int_{-2017}^{2019} \frac{dx}{\left(5+2x-x^2\right)\left(1+e^{3-3x}\right)}$ ..... (2)

Adding equation (1) and (2), we get $2I_1 = \int_{-2017}^{2019} \frac{dx}{\left(5+2x-x^2\right)}$

$2I_1 = I_2 \Rightarrow \frac{I_1}{I_2} = \frac{1}{2}$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – X

JEE (Advanced)-2019

PAPER – 1

TEST DATE: 05-05-2019

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. B, D

Sol. $\left(\vec{A}\times\vec{B}\right)\vec{C}-\left(\vec{A}\times\vec{C}\right)\times B=0$

$\left(\vec{C}.\vec{B}\right)\vec{A}-\left(\vec{C}\vec{A}\right)\vec{B}-\left(\vec{B}.\vec{C}\right)\vec{A}+\left(\vec{B}.\vec{A}\right)=0$

$\left(\vec{B}.\vec{A}\right)\vec{C}-\left(\vec{C}\vec{A}\right)\vec{B}=0$

$\vec{A}\times\left(\vec{B}\times\vec{C}\right)=0$

2. A, D

Sol. $U_y=V_0\sin\alpha$

$U_x=V_0+V_0\cos\alpha$

$\frac{U_y}{U_x}=\tan\frac{\alpha}{2}$

When throwing point and two stones are collinear

$\frac{y_1}{x_1}=\frac{y_2}{x_2}\Rightarrow t=\frac{2V_0}{g}\tan\frac{\alpha}{2}$ (where top point of pole is origin and x_1, x_2, y_1, y_2 are measured from there)

and $h<\frac{1}{2}gt^2$

3. A, C

Sol. $\tau = (kx)R = kR^2\theta$

$I\alpha = kR^2\theta$

$\left(\frac{MR^2}{2} + mR^2\right)\alpha = kR^2\theta$

$T = 2\pi\sqrt{\frac{\frac{M}{2}+m}{k}}$

4. A, D

Sol. Basic concept of charging and discharging.

5. B

Sol. Shape of conductor does not make any difference.

6. A, B, D

Sol. Theory of wave optics

7. B

8. B

Sol. for (7-8)

$v = \frac{660}{31}$m/s

If duration of beep is t
then

$\left(\frac{330t}{v+330}\right) = \frac{100}{v}$

9. B

10. D

Sol. for (9 – 10)

Total charge in an element = $Rd\theta \times \lambda_0 \sin\theta$

On revolving this ring we get a sphere of charge density = $\frac{Rd\theta\lambda_0 \sin\theta}{2\pi R \sin\theta Rd\theta}$ which is a constant.

Basic concept of potential

$V_A - V_B = E.R$

SECTION – D

11. 00060.00

Sol. $\sqrt{a^2 + a^2 + 2a^2\cos(180-\alpha)} = a$

$\alpha = 60°$

12. 00012.50

Sol. For equilibrium centre of mass should be on the wire.

13. 00025.02

Sol. $\frac{dh}{dt} = \frac{\sqrt{2g(h-76)}}{\sqrt{n^2-1}}$

$$\int_{0.96}^{0.76} \frac{dh}{\sqrt{h-76}} = \int_{0}^{5} \frac{\sqrt{2g}\ dt}{\sqrt{n^2-1}}$$

14. 00015.00

Sol. Calculate by potential method.

15. 00004.00

Sol. $f_{Beat} = f_1 - f_2$

$= f\left(\frac{c}{c-v}\right) - f\left(\frac{c}{c+v}\right)$

$f_{beat} = \frac{2fv}{c}$

16. 00017.50

Sol. Object must be at 2f distance of combination

$$\frac{1}{f_{net}} = \frac{-2}{f_L} + \frac{1}{f_M}$$

17. 00001.00

Sol. $F = \frac{-edV}{dr} = -\frac{eV_0r_0}{r}$

$\frac{mv^2}{r} = \frac{eV_0r_0}{r}$

v = constant

$mvr = \frac{nh}{2\pi}$

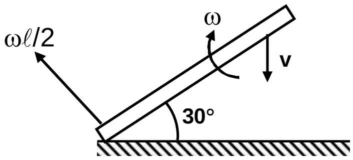
$r \propto n$

$M = \frac{evr}{2} \Rightarrow M \propto n$

18. 00001.50

Sol. Constraint at contract point

$$\frac{\omega\ell}{2}\cos 30° = v$$



energy conservation

$$mg\frac{\ell}{4} = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

$$v = \sqrt{\frac{g}{26}g\ell}$$

Chemistry

PART – II

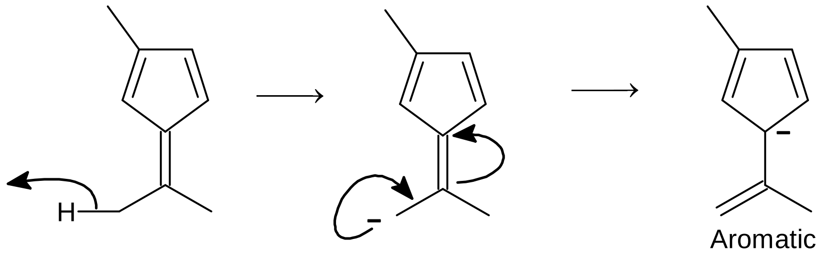
SECTION – A

19. C, D

Sol. As per Usanovich concept, in the first reaction As_2S_3 will behave as a acid and $(NH_4)_2S$ will behave as a base. Similarly in second reaction $Fe(CN)_2$ is acid and KCN is base.

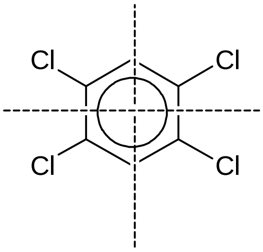
20. B

Sol.



21. A

Sol.



xy plane
yz plane
zx plane

22. C

Sol. Equilibrium constant for the formation of a hydrate $\propto$ electron deficient nature of the carbon of carbonyl group (C = O). In the fourth compound the carbon of carbonyl group will be more electron deficient.

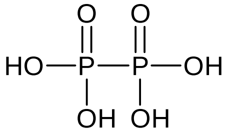
23. A, B, C, D

Sol. Properties of orthoboric acid.

$$H_3BO_3 \xrightarrow{\Delta} B_2O_3$$

24. A, C

Sol.



$$HO-\overset{\overset{O}{||}}{\underset{\underset{OH}{|}}{P}}-\overset{\overset{O}{||}}{\underset{\underset{OH}{|}}{P}}-OH$$

Hypophosphoric acid

It is tetrabasic
No P–O–P linkage
P atoms show maximum covalency
O. S. of P is 4

25. C

26. A

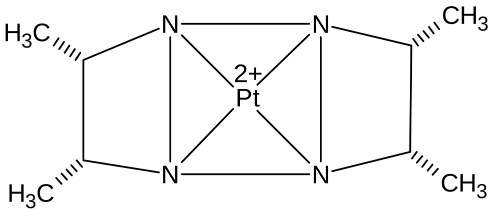
Sol. $FeCl_3 \rightarrow$ Yellow solution and does not react with dil H_2SO_4

$$2Fe^{3+} + H_2S \xrightarrow{H^+} 2\underset{U}{Fe}^{2+} + S$$

$$Fe^{3+} + \underset{\text{(excess)}}{3NaOH} \longrightarrow \underset{\text{Brown ppt (V)}}{\left(Fe\left(OH\right)_3\right)} \downarrow + 3Na^{+}$$

27. B
28. D

Sol.



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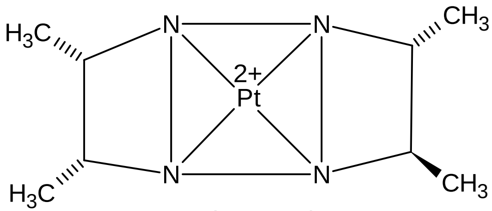

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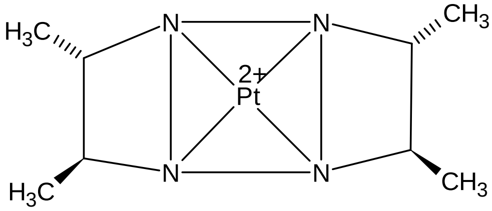

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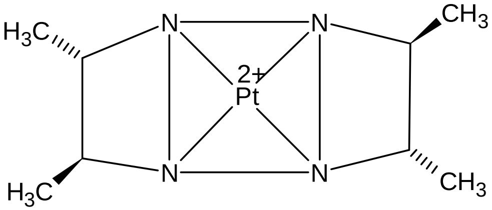

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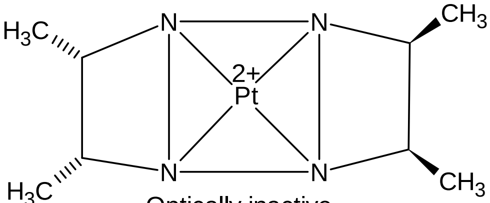


Optically inactive

SECTION – D

29. 00002.22

Sol. $N_2 \rightleftharpoons 2N$

$\frac{2.8}{28}$ $\quad$ 0

$\frac{2.8}{28} \times \frac{50}{100}$ $\qquad$ $\frac{2.8}{28} \times 2 \times \frac{50}{100}$

Total moles = $\frac{3}{20}$

PV = nRT

$P \times 10 = \frac{3}{20} \times 0.082 \times 1805$

P = 2.22

30. 00036.36

Sol. $Fe + Fe_2(SO_4)_3 \rightarrow 3FeSO_4$

1.25 gm ferric alum produces 0.5913 gm $FeSO_4$

Meq of $FeSO_4$ = Meq of $KMnO_4$

$$\frac{0.5913}{152}\times 1000 = 0.107\times V$$

V = 36.36 ml

31. 00001.25

Sol. There are four co-ordination isomers are possible for the given complex. These are

$$\left[Cu\left(NH_3\right)_4\right]\left[PtCl_4\right],\left[Cu\left(NH_3\right)_3 Cl\right]\left[PtCl_3NH_3\right],$$

$$\left[Cu\left(NH_3\right)Cl_3\right]\left[Pt\left(NH_3\right)_3 Cl\right],\left[CuCl_4\right]\left[Pt\left(NH_3\right)_4\right]$$

32. 00009.50

Sol. $HA \rightleftharpoons H^+ + A^-$

$$\left[H^+\right] = \sqrt{CK_a}$$

$$Ka = 10^{-8}$$

$$BOH \rightleftharpoons B^+ + OH^-$$

$$\left[OH^-\right] = \sqrt{CK_b}\left(K_a = K_b\right)$$

$$= \sqrt{10^{-9}}$$

$$\left[H^+\right] = \frac{10^{-14}}{10^{-\frac{9}{2}}}$$

= pH = 9.50

33. 00001.25

Sol. As we know,

$$t_{1/2} \propto a_0^{1-n}$$

$$\Rightarrow t_{1/2} = c.\left(a_0\right)^{1-n}\left[c = \text{constant}\right]$$

$$\log t_{1/2} = \log c + (1-n)\log a_0$$

$$\therefore [1-n] = \tan 45^o \Rightarrow 1-n = 1 \Rightarrow n = 0$$

Now, for K,

As we know for zero order reaction,

$$t_{1/2} = \frac{a_0}{2K}$$

$$\Rightarrow \log t_{1/2} = \log\left(\frac{a_0}{2K}\right) = \log a_0 + \log\frac{1}{2K} \qquad \ldots (1)$$

From graph,

$$\log\frac{1}{2K} = 2$$

$$K = \frac{1}{200}\,\text{mol}\,l^{-1}\,\text{sec}^{-1}$$

$$\therefore 250\ K = 250\times\frac{1}{200} = 1.25\ \text{mol / l / sec}$$

34. 00155.88

Sol. $\frac{a\sqrt{3}}{4} = 2r$

2r = 155.88 pm

35. 00003.63

Sol. For a polyprotic process:

$PV^x = K$ $[x \notin \{1, \gamma\}]$

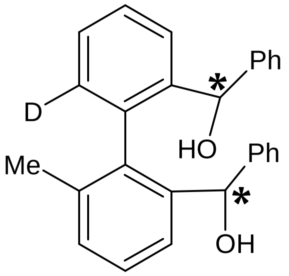
$$C = C_{V,m} + \frac{R}{1-x}$$

$$C = \frac{3}{2}R + \frac{R}{3}$$

$$= \frac{11R}{6} = \frac{11 \times 1.98}{6} = 3.63$$

36. 00001.60

Sol. P is:



Total number of stereo isomers in P is 8.

$$\therefore \frac{x}{5} = \frac{8}{5} = 1.60$$

Mathematics PART – III

SECTION – A

37. C, D

Sol. $L=\lim\limits_{x\to 0}\dfrac{ae^x+b\ln(1+x)+5}{x^2} \Rightarrow L=\lim\limits_{x\to 0}\dfrac{a\left(1+\dfrac{x}{1!}+\dfrac{x^2}{2!}+.....\right)+b\left(x-\dfrac{x^2}{2}+\dfrac{x^3}{3}.....\right)+5}{x^2}$

$\Rightarrow$ a = –5, b = 5, L = –5

38. A, B, C

Sol. Let $\lim\limits_{n\to\infty}\prod\limits_{k=3}^{n}\left(1-\tan^4\dfrac{\pi}{2^k}\right)=L \Rightarrow L=\lim\limits_{n\to\infty}\cos\dfrac{\pi}{4}\prod\limits_{k=3}^{n}\left(\cos\left(\dfrac{\pi}{2^k}\right)\right)^{-3}$

As $\dfrac{\sin x}{x}=\prod\limits_{k=1}^{\infty}\cos\left(\dfrac{x}{2^k}\right) \Rightarrow \dfrac{\sin x}{x\cos\left(\dfrac{x}{2}\right)\cos\left(\dfrac{x}{4}\right)}=\prod\limits_{k=3}^{\infty}\cos\left(\dfrac{x}{2^k}\right)$

$\Rightarrow \lim\limits_{x\to\pi}\dfrac{\sin x}{x\cos\left(\dfrac{x}{2}\right)\cos\left(\dfrac{x}{4}\right)}=\lim\limits_{x\to\pi}\prod\limits_{k=3}^{\infty}\cos\left(\dfrac{x}{2^k}\right) \Rightarrow \prod\limits_{k=3}^{\infty}\cos\left(\dfrac{x}{2^k}\right)=\dfrac{2\sqrt{2}}{\pi} \Rightarrow L=\dfrac{1}{\sqrt{2}}\left(\dfrac{\pi}{2\sqrt{2}}\right)^3=\dfrac{\pi^3}{32}$

39. A, B

Sol. Let a_1 = a and $b_2 – a_1$ = d $\Rightarrow$ $(a + 4d)^2 = (a + 2d)(a + 7d)$ $\Rightarrow$ a = 2d

Also, a_9 = 40 $\Rightarrow$ a + 8d = 40 $\Rightarrow$ a = 8, b = 4 $\Rightarrow$ $\sum\limits_{i=1}^{9}a_i^2=6144$

Also, b_1 = 54, $\dfrac{b_2}{b_1}=\dfrac{3}{2} \Rightarrow \sum\limits_{i=1}^{\infty}\dfrac{1}{b_i}=\dfrac{1}{18}$

40. B, D

Sol. A = Coefficient of x^{m-2} in $(1+x)^m(x+1)^m - {}^mC_0\cdot{}^mC_2 \Rightarrow A={}^{2m}C_{m-2}-{}^mC_2$

41. A, B, C, D

Sol. Exponent of ‘2’ is same in 15!, 14!·1!, 13!·2!, ...

$\Rightarrow$ Number of values of ‘r’ = 16 $\Rightarrow$ k = 16

42. A, C, D

Sol. $\text{Arg}\left(\dfrac{z+z_1}{z_2-z_3}\right)=0$ or π

43. D

Sol. $\int\limits_0^x\left(a_0+a_1x+a_2x^2+.....+a_{125}x^{125}\right)dx=\int\limits_0^x\left(x^3+x^5\right)\left(2x^6+3x^4-1\right)^{20}dx$

$\Rightarrow a_0x+a_1\dfrac{x^2}{2}+a_2\dfrac{x^3}{3}+a_3\dfrac{x^4}{4}+.....+a_{125}\dfrac{x^{126}}{126}=\dfrac{\left(2x^6+3x^4-1\right)^{21}+1}{252}$

In the expansion of $\dfrac{\left(2x^6+3x^4-1\right)^{21}+1}{252}$, we have only even powers of ‘x’

$\Rightarrow$ $a_0 = a_2 = a_4 = ... = a_{124} = 0$

44. D

Sol. $a_0 = a_2 = a_4 = ... = a_{124} = 0$
Also, $a_1 = 0$ and $a_{125} = 2^{20}$

45. C
46. B

Sol. (for Q.45.-46)

$$I\left(\frac{1}{\ln 2}\right) = I(\log_2 e) \Rightarrow I(\log_2 e) = \int_0^{2\pi} \frac{2^{\log_2 e}}{2^{\log_2 e} + 2^{-\log_2 e}} dx \Rightarrow I(\log_2 e) = \int_0^{2\pi} \frac{e}{e + \frac{1}{e}} dx$$

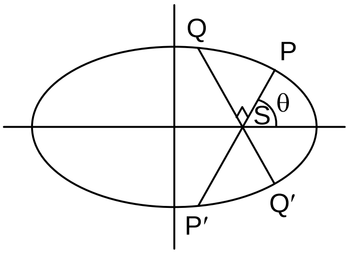
$$\Rightarrow I(\log_2 e) = \frac{2\pi e^2}{e^2 + 1} \Rightarrow I(\sin x) = \int_0^{2\pi} \frac{2^{\sin x}}{2^{\sin x} + 2^{-\sin x}} dx \Rightarrow I(\sin x) = \int_0^{2\pi} \frac{2^{-\sin x}}{2^{-\sin x} + 2^{\sin x}} dx$$

Adding both
$\Rightarrow 2I(\sin x) = 2\pi \Rightarrow I(\sin x) = \pi$

SECTION – D

47. 00004.00

Sol. $P \equiv (ae + r\cos\theta, r\sin\theta)$



$$\frac{\left(\sqrt{10}e + r\cos\theta\right)^2}{10} + \frac{(r\sin\theta)^2}{6} = 1$$

$$r^2\underbrace{\left(\frac{\cos^2\theta}{10} + \frac{\sin^2\theta}{6}\right)}_{r_1 \quad r_2} + \frac{10e^2 - 10}{10} + \frac{2\sqrt{10}er\cos\theta}{10} = 0$$

$$r_1r_2 = \frac{(10e^2 - 10)60}{10\cdot(6\cos^2\theta + 10\sin^2\theta)}$$

$$|SP\cdot SP'| = \frac{(1 - e^2)60}{6\cos^2\theta + 10\sin^2\theta} \Rightarrow \frac{1 - e^2}{SP\cdot SP'} = \frac{6\cos^2\theta + 10\sin^2\theta}{60}$$

Similarly for Q coordinate replace θ by 90º – θ

It gives $\frac{10\cos^2\theta + 6\sin^2\theta}{60} = \frac{1 - e^2}{SQ\cdot SQ'}$

$$\therefore \frac{1 - e^2}{SQ\cdot SQ'} + \frac{1 - e^2}{SQ\cdot SQ'} = \frac{6\cos^2\theta + 10\sin^2\theta}{60} + \frac{10\cos^2\theta + 6\sin^2\theta}{60} = \frac{16}{60} = \frac{4}{15} = \frac{N}{15}$$

$\therefore N = 4$

48. 00005.00

Sol. $$P = \prod_{k=1}^{n} \frac{4(2k - 1)^4 + 1}{4(2k^4) + 1}$$

$4a^4 + b^4 = ((a + b)^2 + a^2)((a - b)^2 + a^2)$

$$P = \prod_{k=1}^{n} \frac{\left(4k^2 + (2k - 1)^2\right)\cdot\left((2k - 2)^2 + (2k - 1)^2\right)}{\left((2k)^2 + (2k + 1)^2\right)\cdot\left(4k^2 + (2k - 1)^2\right)}$$

$$P = \prod_{k=1}^{n} \frac{(2k - 2)^2 + (2k - 1)^2}{(2k)^2 + (2k + 1)^2}$$

$$P = \frac{0^2 + 1^2}{2^2 + 3^2}\cdot\frac{2^2 + 3^2}{4^2 + 5^2}\cdot\frac{4^2 + 5^2}{6^2 + 7^2}.....\frac{(2n - 2)^2 + (2n - 1)^2}{(2n)^2 + (2n + 1)^2}$$

$$P = \frac{1}{4n^2 + (2n + 1)^2} = \frac{1}{8n^2 + 4n + 1} \Rightarrow k_1 = 8, k_2 = 4, k_3 = 1$$

$\therefore k_1 + k_3 - k_2 = 5$

49. 00001.00

Sol. $(56x+33y)i=\frac{-iy}{x^2+y^2},\ 33x-56y=\frac{x}{x^2+y^2}$ (z = x + iy)

$$56iz+33z=\frac{x-iy}{x^2+y^2}$$

$$56iz+33z=\frac{1}{z}\ \Rightarrow\ z^2=\frac{1}{33+56i}\ \Rightarrow\ z=\pm\frac{1}{7+4i}=\pm\frac{7-4i}{65}$$

$$|x|+|y|=\frac{11}{65}=\frac{p}{q}\Rightarrow 6p-q=66-65=1$$

50. 00041.00

Sol. $\Rightarrow\ x^2+\frac{1}{x^2}+b+a\left(x+\frac{1}{x}\right)=0\ \Rightarrow\ x+\frac{1}{x}=t$

$t^2+at+b-2=0\Rightarrow at+b+t^2-2=0,\ t^2\in[4,\infty)$

This represents equation of line in a-b plane and a^2+b^2 represent square of distance of a point on this line from O (origin)

$$d=\frac{t^2-2}{\sqrt{1+t^2}}\Rightarrow t^2\in[4,\infty),\ d_{min}=\frac{2}{\sqrt5}\text{ at }t^2=4$$

$$d^2_{min}=\frac{4}{5}=\frac{p}{q}\Rightarrow p^2+q^2=41$$

51. 00010.00

Sol. P(tail) = $\frac{n}{2n+1}\cdot1+\frac{n+1}{2n+1}\cdot\frac{1}{2}=\frac{31}{42}\Rightarrow n=10$

52. 00008.00

Sol. Let $\vec a=a_1\hat i+a_2\hat j+a_3\hat k$

$\vec b=b_1\hat i+b_2\hat j+b_3\hat k$

$\vec c=c_1\hat i+c_2\hat j+c_3\hat k$

$\vec a\times\vec b=D_1\hat i+D_2\hat j+D_3\hat k$

$|\vec a\times\vec b|=\sqrt{D_1^2+D_2^2+D_3^2}=4$

$|c|=\sqrt{c_1^2+c_2^2+c_3^2}=2$

Maximum value of $\left[\vec a\ \ \vec b\ \ \vec c\right]=|\vec a\times\vec b|\,|\vec c|=4\times2=8$

53. 00001.00

Sol. $\int_1^{\sqrt2}\left((x^4-2x^2+1)^{\frac13}-1\right)dx+\int_{-1}^{0}\sqrt{(x+1)^{\frac32}+1}dx=1$

$$\Rightarrow\int_1^{\sqrt2}(x^4-2x^2+1)^{\frac13}dx+\int_{-1}^{0}\sqrt{(x+1)^{\frac32}+1}dx=1+\sqrt2-1\Rightarrow I=\sqrt2$$

54. 00004.00

Sol. Put $e^x=t\Rightarrow e^x\,dx=dt$

$$\Rightarrow\int\frac{2e^{5x}+e^{4x}-4e^{3x}+4e^{2x}+2e^x}{(e^{2x}+4)(e^{2x}-1)^2}dx=\tan^{-1}\left(\frac{e^x}{2}\right)-\frac{1}{2(e^{2x}-1)}+c$$

$\Rightarrow a+b=4$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – X

JEE (Advanced)-2019

PAPER – 1

TEST DATE: 05-05-2019

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01– 06, 19 – 24, 37 - 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*

   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 - 46) *contains 12 questions. Based on this section contains* ***TWO (02)*** *paragraphs. Based on each paragraph, there are* ***TWO (02)*** *questions.*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. Three vectors $\vec{A}$, $\vec{B}$ & $\vec{C}$ are such that

$$\left(\vec{A}\times\vec{B}\right)\times\vec{C}-\left(\vec{A}\times\vec{C}\right)\times\vec{B}=\vec{0}$$

Then which of the following may be correct.

(A) $\vec{A}\,||\,\vec{B}$

(B) $\vec{B}\,||\,\vec{C}$

(C) $\vec{C}\,||\,\vec{A}$

(D) Either $\vec{A}$ or $\vec{B}$ or $\vec{C}$ is null vector.

2. Two small stones are thrown simultaneously with the same projection speed v_0 from the top of a pole of height h. One of the stone is thrown towards right horizontally and other stone is thrown at an angle α above horizontally towards left. After time t two stones and top point of pole are lying on same line & x component & y component of relative velocity of first stone w.r.t. second stone are u_x & u_y. It is given that $t = \left[\frac{u_y}{u_x}\right]T$; here T is having the dimensions of time

Pick the correct options:

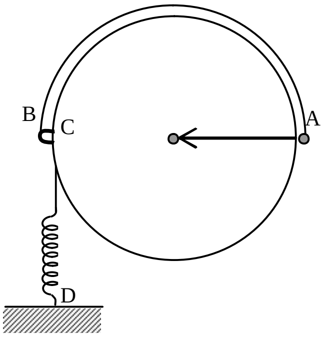
(A) T is independent of α

(B) T is independent of v_0

(C) $\left(\frac{u_y}{u_x}\right)^2\frac{v_0^2}{g} < h < \left(\frac{u_y}{u_x}\right)^2\frac{2v_0^2}{g}$

(D) $\left(\frac{u_y}{u_x}\right)^2\frac{2v_0^2}{g} < h$

3. A cylinder of mass M is placed in such a way that it is free to rotate about its axis. A ball of mass m is attached in one end A of the string and second end of the string is fixed in diametrically opposite end B of the cylinder. A spring of spring constant k is attached at point C (nearest to B) in cylinder whose other end D is fixed on ground. If m < M then pick the correct options. (Initially system is in equilibrium and T is time period)



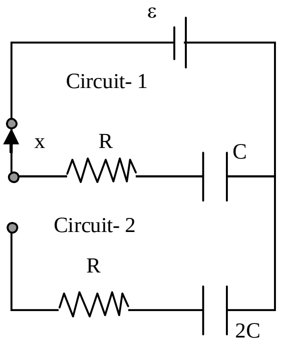
(A) $T < 2\pi\sqrt{\frac{3M}{2k}}$

(B) $T > 2\pi\sqrt{\frac{3M}{2k}}$

(C) $T > 2\pi\sqrt{\frac{3m}{2k}}$

(D) $T < 2\pi\sqrt{\frac{3m}{2k}}$

4. A circuit 1 is shown in which a capacitor of capacitance C, a resistor of resistance R and a battery of emf ε are connected together. Switch x can be shifted to position y for changing the connections. After one time constant of circuit 1, key x is shifted to position y at this time, charge on C is Q_1. After one time constant of circuit 2 from this moment charge in capacitor 2C is Q_2. Pick the correct options:



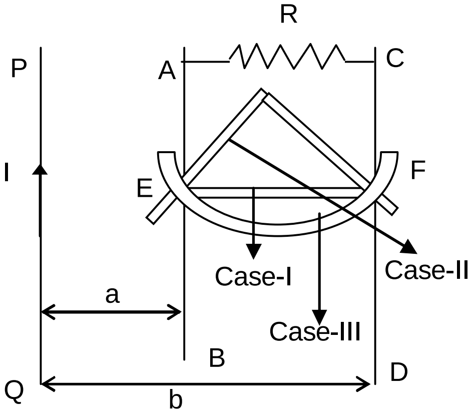
(A) $Q_1 = C\varepsilon\,[1 - e^{-1}]$

(B) $Q_1 = \dfrac{2C\varepsilon[1-e^{-1}]}{3}$

(C) $Q_2 = \dfrac{2}{3}C\varepsilon[1-e^{-1}]$

(D) $Q_2 = \dfrac{2}{3}C\varepsilon[1-e^{-1}]^2$

5. PQ is an infinitely long current carrying conductor AB & CD are smooth conducting rods on which a conductor EF which is a rod in case I an angle in case II& an arc in case III moves with a constant velocity V away from resistance R. Pick the correct options



(A) Maximum force is needed to maintain constant velocity of EF in case III

(B) Force needed to maintain constant velocity of EF is same in all cases.

(C) In case II force needed maintain constant velocity of EF is less than the force needed in case I.

(D) Force needed to maintain constant velocity of EF in case I is given by F = $\dfrac{\mu_0^2 I^2 v}{4R\pi^2}\ln\left(\dfrac{b}{a}\right)$.

6. Pick the correct options:

(A) In Young's double slit experiment, if the width of the source slit is increased, the fringe pattern becomes indistinct.

(B) On refraction energy carried by refracted light is reduced.

(C) Young's double slit experiment can be performed using a source of white light.

(D) In 3D movies 2 projectors are used to project 2 images on screen.

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 7 and 8

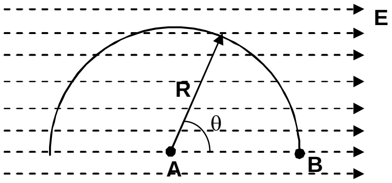
A listener moving with uniform velocity towards a stationary sound source hears a beep of sound of frequency 165 Hz over a distance of 100 m. The actual frequency emitted by the source is 155 Hz and the speed of sound is 330 m/s.

7. Duration of beep emitted by source is
   (A) 4s
   (B) 5s
   (C) 6s
   (D) 7s

8. If listener would move perpendicular to the line joining the listener and stationary source then duration of beep emitted by source would be
   (A) definitely less than time taken in first - case
   (B) definitely more than time taken in first - case
   (C) definitely equal to time taken in first – case exactly
   (D) may be less than or more than time taken in first case.

Paragraph for Question Nos. 9 and 10

A non conducting semi circular ring of radius r having charge distributed over its circumference according to the formula $\lambda = \lambda_0 \sin\theta$ is placed in a uniform electric field E in such a way that plane of the semi circular ring is parallel to electric field E as shown in figure. Consider that polarizability of the semi circular ring is equal to zero.



Answer the following questions.

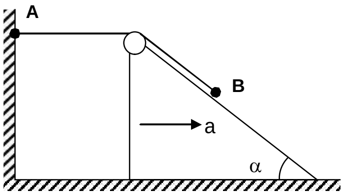
9. Potential at the midpoint of line AB in the absence of electric field E (consider that potential at infinite is zero).
   (A) $\frac{\lambda_0}{\pi\varepsilon_0}$
   (B) $\frac{\lambda_0}{2\pi\varepsilon_0}$
   (C) $\frac{2\lambda_0}{\pi\varepsilon_0}$
   (D) $\frac{\lambda_0}{4\pi\varepsilon_0}$

10. Potential difference between point A and point B
   (A) $\frac{\lambda_0}{2\pi\varepsilon_0} + E.R$
   (B) $\frac{\lambda}{\pi\varepsilon_0} + E.R$
   (C) $\frac{\lambda}{2\pi\varepsilon_0}$
   (D) E.R

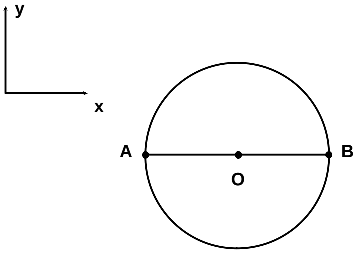
SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

11. A weightless inextensible rope rests on a stationary wedge forming an angle α with the horizontal. One end of the rope is fixed to the wall at point A. A small load is attached to the rope at point B. Wedge start moving to the right with a constant acceleration a and same is the magnitude of acceleration of load. α (in degree) is

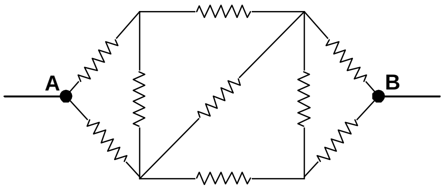


12. A disc of radius 10 cm is placed on a wire parallel to y axis in such a way that it is in equilibrium. AB is the diameter of the disc. Density of the disc linearly increases from A to B starting from zero density at A. Distance of the wire from end A is (in cm)



13. A container of height 96 cm is filled with mercury up to the brim. The container is sealed airtight and a hole of small area n^{th} part of the area of container is punched in its bottom. Time taken upto which mercury come out from the bottom hole is 5 sec. Atmospheric pressure is equal to 76 cm of mercury. n is

14. 9 resistors of resistance 11 Ω are connected in the network shown below. Equivalent resistance between A and B is



15. One train is approaching an observer at rest and another train is receding from him with the same speed 2 m/s. Both trains blow whistles of same frequency 332 Hz. The speed of sound in air is 332 m/s. Beat frequency in Hz as heard by the observer is

16. A biconvex thin lens is prepared from glass of refractive index 3/2. The two bounding surfaces have equal radii of 35 cm each. One of the surfaces is silvered to make it reflecting. An object is placed infront of his lens in such a way that the image coincides with the object. Distance of object from lens is (in cm)

17. The electric potential between a proton and an electron is given by $V = V_0 \ell n\left[\frac{r}{r_0}\right]$, where r_0 is a constant. Assuming Bohr's model to be applicable, the magnetic dipole moment of the electron is proportional to n^x, n is principle quantum number. x is equal to

18. A uniform thin rod of mass 1 kg and length 65 cm is standing on a smooth horizontal table. It slips on the smooth surface and rod starts falling. Velocity of the centre of mass of rod in (m/s) at the instant when it makes an angle 30° with horizontal

Chemistry PART – II

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

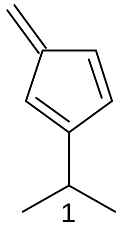
19. (1) $As_2S_3 + 3(NH_4)_2S \longrightarrow 2(NH_4)_3AsS_4$

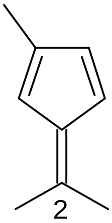
(2) $Fe(CN)_2 + 4KCN \longrightarrow K_4Fe(CN)_6$

Which of the following option(s) is/are correct?

(A) Acids → As_2S_3 KCN
(B) Base → $(NH_4)_2S$, $Fe(CN)_2$
(C) Acids → As_2S_3, $Fe(CN)_2$
(D) Base → $(NH_4)_2S$, KCN

20. Which of the given compound is strongest acid?


1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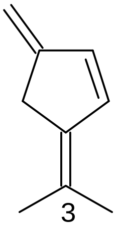
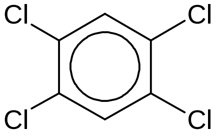

3

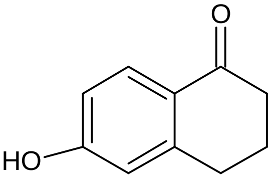
(A) 1
(B) 2
(C) 3
(D) 2 and 3

21. Total number of plane of symmetry present in the given compound is

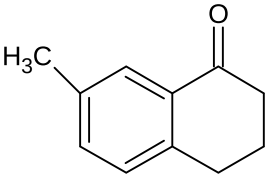


(A) 3
(B) 4
(C) 5
(D) 6

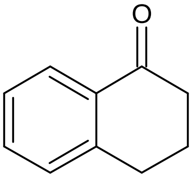
22. Increasing order of equilibrium constants for the formation of a hydrate:



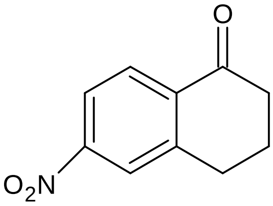
(i)



(ii)



(iii)



(iv)

(A) iv < iii < ii < i
(B) iv < iii < i < ii
(C) i < ii < iii < iv
(D) ii < iii < i < iv

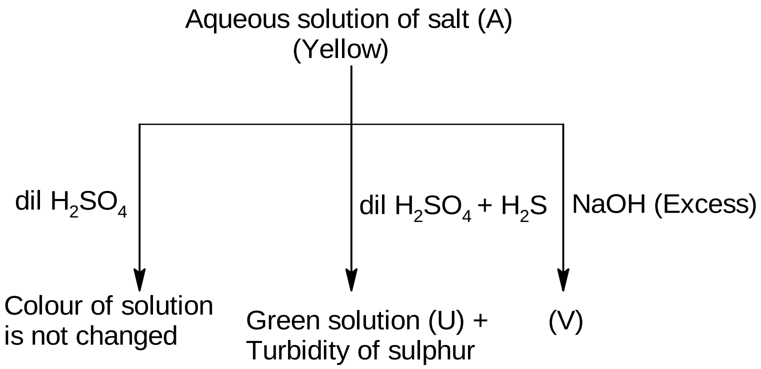
23. Choose the correct options regarding orthoboric acid?
    (A) Orthoboric acid is white crystalline solid with soapy touch.
    (B) Orthoboric acid on strong heating gives B_2O_3.
    (C) It can be prepared by hydrolysis of borax.
    (D) It is monobasic Lewis acid.

24. Select correct statement(s) about the oxoacid $H_4P_2O_6$:
    (A) It is tetrabasic acid
    (B) It has 1 P–O–P linkage
    (C) P atoms show their maximum covalency
    (D) P atoms are in highest oxidation state

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 25 and 26


Aqueous solution of salt (A)
(Yellow)
dil H_2SO_4
dil H_2SO_4 + H_2S
NaOH (Excess)
Colour of solution is not changed
Green solution (U) + Turbidity of sulphur
(V)

25. Inorganic salt (A) is
    (A) $CrCl_3$
    (B) K_2CrO_4
    (C) $FeCl_3$
    (D) $AlCl_3$

26. Which observation is correct regarding (V)?
    (A) Brown ppt
    (B) Yellow ppt
    (C) Brown solution
    (D) Yellow solution

Paragraph for Question Nos. 27 and 28

Stereoisomeric complexes have same molecular formula, same constitution they differ only with respect to the spatial orientation of ligand in space around the metal ion.

27. How many geometrical isomers are possible for the complex $[Pt(bn)_2]^{2+}$ [where bn is $H_3C—CH(NH_2)—CH(NH_2)—CH_3$]
    (A) 4
    (B) 5
    (C) 6
    (D) 7

28. How many total stereoisomers are possible for the same complex $[Pt(bn)_2]^{2+}$?
   (A) 4
   (B) 5
   (C) 6
   (D) 7

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

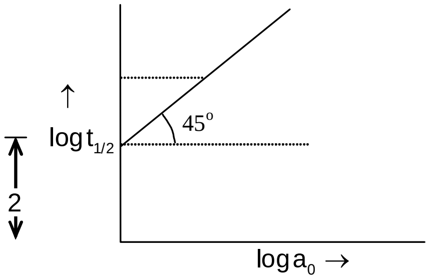
29. A vessel of volume 10 lit. contains 2.8 g of nitrogen gas at a temperature of 1805 K. Find the pressure of the gas (if 50% of its molecules are dissociated into atom at this temperature, [Given: R = 0.082 atm-litre/mol K)

30. 25 ml of a solution of ferric alum $Fe_2(SO_4)_3.(NH_4)_2SO_4.24H_2O$ containing 1.25 gm of the salt was boiled with iron when the reaction $Fe + Fe_2(SO_4)_3 \rightarrow 3FeSO_4$ occurred. The unreacted iron was filtered off and solution treated with 0.107 N $KMnO_4$ in acidic medium. What is volume of $KMnO_4$ solution used?

31. The total number of possible co-ordination isomers of the complex $[Cu^{II}(NH_3)_4]\ [Pt^{II}Cl_4]$ is *x* then value of $\left(\frac{x}{3.2}\right)$ is:

32. The dissociation constant of Acid HA and base BOH at 25°C in aqueous solution is same. The pH of 0.01 M solution of HA is 5. The pH of 0.1 M solution of BOH is

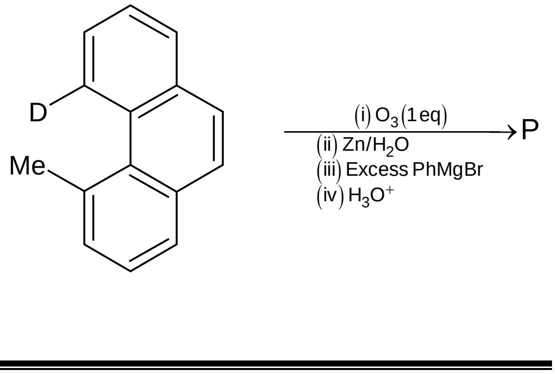
33. In given curve $\left(t_{1/2} \text{ vs } \log a_0\right)$
(where $t_{1/2}$ is half-life and a_0 is initial concentration.)
The value of rate constant is K unit (where unit of K is according as order of reaction). The value of 250 K is:



34. Carbon atoms occupy fcc lattice points as well as alternate tetrahedral voids in diamond. If edge length of the unit cell is 360 pm then the diameter of carbon atom in pm is:

35. A monoatomic gas follow the relation $\frac{P}{V^2} = K$ then molar heat capacity of gas is x, [Assuming there is no vibrational degree of freedom]. What is the value of x in calorie [Given : R = 1.98 cal./mol K]

36. The total number of stereoisomers obtained in the product of the following reaction is *x*. The value of $\frac{x}{5}$ is.



Mathematics PART – III

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. If $\lim\limits_{x\to 0}\dfrac{ae^x + b\ln(1+x)+5}{x^2}$ = L(finite), then

(A) $a = 5$
(B) $b = -5$
(C) $a + b = 0$
(D) $b + L - 2a = 10$

38. Let $\lim\limits_{n\to\infty}\prod\limits_{k=3}^{n}\left(1-\tan^4\dfrac{\pi}{2^k}\right)=\dfrac{\pi^3}{m}$, then 'm' is greater than

(A) 8
(B) 16
(C) 28
(D) 36

39. Let $a_1, a_2, a_3, \ldots, a_n$ are in A.P., and $a_3, a_5, a_8, b_1, b_2, b_3, \ldots b_n$ are in G.P. and $a_9 = 40$, then

(A) $\sum\limits_{i=1}^{9} a_i^2 = 6144$
(B) $\sum\limits_{i=1}^{\infty}\dfrac{1}{b_i}=\dfrac{1}{18}$
(C) $\sum\limits_{i=1}^{9} a_i^2 = 6278$
(D) $\sum\limits_{i=1}^{\infty}\dfrac{1}{b_i}=\dfrac{1}{28}$

40. Let $A = C_1C_3 + C_2C_4 + C_3C_5 + C_4C_6 + \ldots + C_{m-2}C_m$, (where $C_r = {}^mC_r$), then

(A) $A \geq {}^{2m}C_{m-2}$
(B) $A < {}^{2m}C_{m-2}$
(C) $A > \sum\limits_{r=0}^{m} C_r^2$
(D) $A < \sum\limits_{r=0}^{m} C_r^2$

41. Let number of values of 'r' for which ${}^{15}C_r$ is an odd integer, be 'k', then k is greater than

(A) 7
(B) 11
(C) 9
(D) 5

42. Let $A(z_1)$, $B(z_2)$, $C(z_3)$ lies on a circle $|z| = r$ and forms an acute angled triangle, and $\omega = \frac{z + z_1}{z_2 - z_3}$, where P(z) is the point where altitude from A to BC meets the circumcircle, then
    (A) ω is purely real
    (B) ω is purely imaginary
    (C) $\text{Arg}(\omega) = 0$
    (D) $\text{Arg}(\omega) = \pi$

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 43 and 44

Let $(x^3 + x^5)(2x^6 + 3x^4 - 1)^{20} = a_0 + a_1x + a_2x^2 + ... + a_{125}x^{125}$

43. The $a_0 - \frac{a_2}{3} + \frac{a_4}{5} - \frac{a_6}{7} ..... + \frac{a_{124}}{125}$ is equal to
    (A) 2^{41}
    (B) $\frac{2^{40}}{63}$
    (C) $\frac{-1}{256}$
    (D) none of these

44. Which of the following is incorrect?
    (A) $a_0 = a_2 = a_4 ..... = a_{124}$
    (B) $a_{125} = 2^{20}$
    (C) $a_0 + a_1 + a_2 = 0$
    (D) $a_1 + a_2 + a_3 = 0$

Paragraph for Question Nos. 45 and 46

Let $I(f(x)) = \int_0^{2\pi} \frac{2^{f(x)}}{2^{f(x)} + 2^{-f(x)}} dx$, where f(x) is real valued function

45. The value of $I\left(\frac{1}{\ln 2}\right)$ is equal to
    (A) $\frac{2\pi 2^{2e}}{2^{2e} + 1}$
    (B) $\frac{\pi \cdot 2^{2e}}{2^{2e} + 1}$
    (C) $\frac{2\pi e^2}{e^2 + 1}$
    (D) $\frac{\pi e^2}{e^2 + 1}$

46. The value of I(sin x) is equal to

(A) $\frac{\pi}{2}$
(B) π
(C) 2π
(D) 4π

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

47. In an ellipse $\frac{x^2}{10}+\frac{y^2}{6}=1$. If focal chord PSP′ and QSQ′ are at right angles to each other, then $\frac{1-e^2}{(SP)(SP')}+\frac{1-e^2}{(SQ)(SQ')}=\frac{N}{15}$, then value of [N] (where [.] denotes the greatest integer function)

48. If $\frac{\left(1^4+\frac{1}{4}\right)\left(3^4+\frac{1}{4}\right).....\left((2n-1)^4+\frac{1}{4}\right)}{\left(2^4+\frac{1}{4}\right)\left(4^4+\frac{1}{4}\right).....\left((2n)^4+\frac{1}{4}\right)}=\frac{1}{k_1n^2+k_2n+k_3}$, then $k_1 - k_2 + k_3$ equal to

49. Let (x, y) be a pair of real numbers satisfying $56x+33y=\frac{-y}{x^2+y^2}$ and $33x-56y=\frac{x}{x^2+y^2}$. If $|x|+|y|=\frac{p}{q}$ (where p and q are relatively prime), then (6p – q) is

50. The equation $x^4 + ax^3 + bx^2 + ax + 1 = 0$ has atleast one real root and if the minimum value of $E(a, b) = a^2 + b^2$ can be expressed as $\frac{p}{q}$ (p and q are relatively prime), then $(p^2 + q^2)$ is

51. A bag contains (2n + 1) coins. It is known that ‘n’ of these coins have tail on both sides, whereas the remaining (n + 1) coins are fair. A coin is randomly drawn from bag and tossed. If the probability of that the toss results in a tail is $\frac{31}{42}$, then value of n is

52. Let $\Delta=\begin{vmatrix}a_1 & a_2 & a_3\\ b_1 & b_2 & b_3\\ c_1 & c_2 & c_3\end{vmatrix}$, where D_1, D_2, D_3 are cofactors of c_1, c_2 and c_3 respectively such that $D_1^2+D_2^2+D_3^2=16$ and $c_1^2+c_2^2+c_3^2=4$, then maximum value of Δ is

53. Let the value of $\int_1^{\sqrt{2}}(x^4-2x^2+1)^{\frac{1}{3}}dx+\int_{-1}^{0}\sqrt{(x+1)^{\frac{3}{2}}+1}\,dx$ be I, then [I] is equal to (where [.] denotes the greatest integer function)

54. Let $\int\frac{2e^{5x}+e^{4x}-4e^{3x}+4e^{2x}+2e^x}{(e^{2x}+4)(e^{2x}-1)^2}dx=\tan^{-1}\left(\frac{e^x}{a}\right)-\frac{1}{b(e^{2x}-1)}+c$ (where a, b, c are constants), then the value of a + b is equal to

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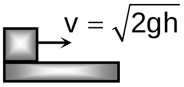
ANSWERS, HINTS & SOLUTIONS

Physics PART – I

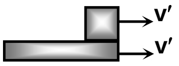
SECTION – A

1. C, D

Sol. From initial to final instant
Conservation of momentum gives :
mv = 2mv′



(i)



(f)

$$\Rightarrow v' = \frac{\sqrt{2gh}}{2}$$

Work energy theorem on block + Plank:

$$W_f = \frac{1}{2}(2m)\left(\frac{2gh}{4}\right) - \frac{1}{2}m(2gh) = -\frac{mgh}{2}$$

Work energy theorem on block:

$$W_f = \frac{1}{2}(2m)\left(\frac{2gh}{4}\right) - \frac{1}{2}m(2gh) = -\frac{3}{4}mgh$$

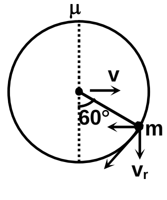
$$\therefore\ \left(W_f\right)_{\text{plank}} = -\frac{mgh}{2} - \left(-\frac{3}{4}mgh\right) = +\frac{mgh}{4}$$

2. C

Sol. Conservation of momentum give:

$$Mv = m(v_r\cos 60° - v)$$

$$\frac{mv_r\cos 60°}{(m+M)} = v \qquad \ldots(i)$$



Energy conservation

$$\frac{3}{2}mgR = \frac{1}{2}Mv^2 + \frac{1}{2}m\left[(v_r\cos 60^\circ - v)^2 + (v_r\sin 60^\circ)^2\right] \quad \ldots(ii)$$

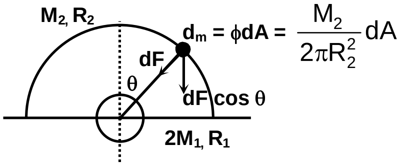
Solve (i) and (ii) for v

3. B, C, D

Sol. Based on blackbody radiation.

4. A, B, C

Sol. $F_N = \int dF\cos\theta = \frac{G(2M_1)}{R_2^2}\frac{M_2}{2\pi R_2^2}\int dA\cos\theta = \frac{GM_1M_2}{R_2^2}$


M_2, R_2
$d_m = \phi dA = \frac{M_2}{2\pi R_2^2}dA$
dF
θ
dF cos θ
$2M_1, R_1$

$\therefore$ The force extended by half shell (M_1, R_1) will be $\frac{GM_1M_2}{2R_2^2}$

So, A, B, C are Correct.

5. A, B, D

Sol. Based on magnetism

6. B, C, D

Sol. From the concept of power in A.C. circuit.

7. C

Sol. Equations are :

$f_1 - f_2 = Ma_C$ …(i)

$(f_1 + f_2)R = \frac{MR^2}{2}\alpha$ …(ii)

$2F - f_1 = Ma_1$ …(iii)

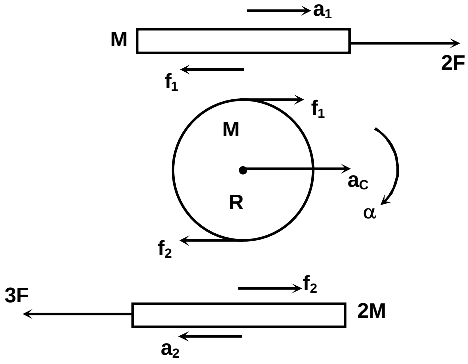
$3F - f_2 = 2Ma_2$ …(iv)

Constraints are

Lower point: $\alpha R - a_C = a_2$ …(v)

Upper point : $\alpha R + a_C = a_1$ …(vi)

Solve for required quantities.


a_1
M
2F
f_1
f_1
M
a_C
R
α
f_2
3F
f_2
2M
a_2

8. B

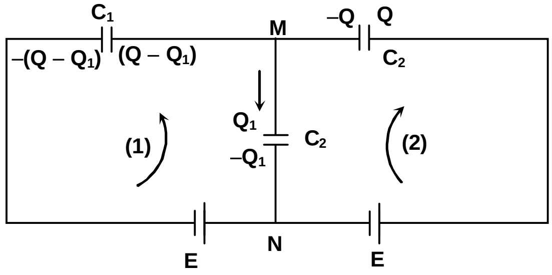
Sol. KVL in L_1 and L_2 gives

$$E = \left(\frac{Q - Q_1}{C_1}\right) - \frac{Q_1}{C_2} \quad \ldots(i)$$

$$E = \frac{Q}{C_2} - \frac{Q_1}{C_2} \quad \ldots(ii)$$

Solving above

$$V_{MN} = \left|E\left(\frac{C_2 - C_1}{2C_2 + C_1}\right)\right|$$

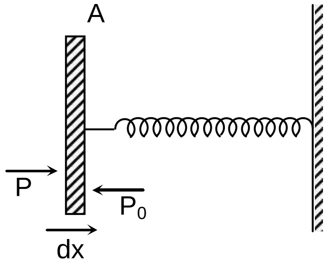

C_1
M
–Q
Q
–(Q – Q₁)
(Q – Q₁)
C_2
Q_1
C_2
$-Q_1$
(1)
(2)
E
N
E

9. C

Sol. Draw FBD and use LOM to solve

10. D

Sol. From Work energy theorem,



$$W_{gas} - \int P_0 A dx - \int kx dx = 0$$

$$\therefore\ W_{gas} = P_0 \Delta V + \frac{1}{2}kx^2 = 90\,J$$, where x = 0.1 m

Using $\Delta Q = \Delta U + W_{gas}$

$= nC_v \Delta T + W_{gas}$

$= \frac{3}{2}\left[PV - P_0V_0\right] + W_{gas}$

$= \frac{3}{2}\left[PV - P_0V_0\right] + W_{gas} = 2010 + 90 = 2100J$

Calculate the other values similarly

SECTION – D

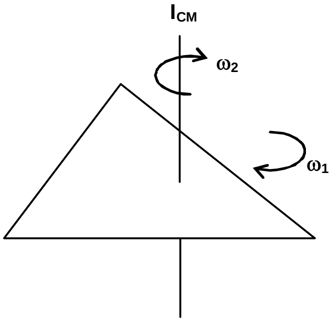
11. 00001.00

Sol. Use constraint that length of thread is constant always.

12. 00000.01

Sol. $\omega_1 \rightarrow$ angular velocity of lamina about I_{CM}.

$\omega_2 \rightarrow$ angular velocity of axis I_{CM}.



$$\therefore\ \frac{\overrightarrow{dL}}{dt} = \vec{\omega}_2 \times \vec{L}$$

$$\Rightarrow \left|\frac{\overrightarrow{dL}}{dt}\right| = \omega_1\omega_2 I_{CM}$$

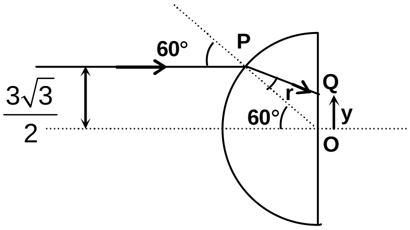
13. 00000.50

Sol. Using $\Delta\ell = \ell\,\alpha\Delta T$

For no displacement, compare the stress on both side of section.

14. 00000.02

Sol. At P, $\sin r = \frac{\sqrt{3}}{2\mu}$



$$\Rightarrow dr = \frac{-\sqrt{3}}{2\mu^2}\frac{du}{\cos r}$$

In ΔOPQ,

$$\frac{y}{\sin r} = \frac{3}{\sin(150 - r)} \qquad \ldots(i)$$

Differentiate (i) and put r = 30° for $\mu = \sqrt{3}$

$\therefore |dy| = \frac{2}{3}d\mu = 0.2133$

15. 00001.33

Sol. For K_α; $\sqrt{\nu} = \sqrt{\frac{3R}{4}}(z - b)$

$$K_\beta;\ \sqrt{\nu} = \sqrt{\frac{8R}{9}}(z-b)$$

$$\frac{K_\beta}{K_\alpha} = \frac{\sqrt{\frac{8}{9}}}{\sqrt{\frac{3}{4}}} = \left(\frac{4}{3}\right)^{3/2}\frac{1}{\sqrt{2}} \Rightarrow n = 1.33$$

16. 00016.67

Sol. $\vec{F} = q(\vec{v}\times\vec{B})$

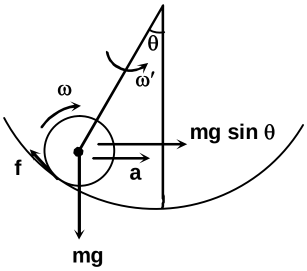
$$(3\hat{i}+4\hat{j})\times 10^{-10} = 2\times 10^{-9}(x\hat{i}+y\hat{j})\times 3\times 10^{-3}\hat{k}$$

Solve: $x = -\frac{400}{6};\ y = \frac{300}{6} \Rightarrow |x + y| = \frac{100}{6} = 16.67$

17. 00001.76

Sol. $mg\sin\theta - f = ma$ …(i)

$f_r = \frac{2}{5}mr^2\alpha$ …(ii)



$$\Rightarrow a = \frac{5}{7}g\sin\theta$$

For small θ; $a = \frac{5}{7}g\theta = \left(\frac{5g}{7(R-r)}\right)x$

$$\Rightarrow T = 2\pi\sqrt{\frac{7(R-r)}{5g}}$$

18. 00312.50

Sol. $B = \frac{dP}{dV/V} \Rightarrow \frac{dV}{V} = \frac{dP}{B} \Rightarrow dR = \frac{R}{3}\left(\frac{dP}{B}\right)$

$$dR = \frac{3}{100\times 3}\times\frac{50}{8\times 10^{-3}}\times\frac{1}{2\times 10^{9}} \simeq 312.5\,\text{Å}$$

Chemistry PART – II

SECTION – A

19. B

Sol. $pH = \frac{PKa_1 + PKa_2}{2}$

$= \frac{2.4 + (14 - 4.6)}{2}$

= 5.9

20. A, B, D

21. A, B, C, D

Sol. Properties of Baryllium.

22. A, B, D

Sol.
$$\underset{(\text{White})}{P_4} + 3NaOH + 3H_2O \longrightarrow PH_3 + 2NaH_2PO_2$$

23. A

24. B, C

Sol. $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + 4H_2O + Cr_2O_3$

$2CrO_3 \xrightarrow{\Delta} Cr_2O_3 + \frac{3}{2}O_2$

$2K_2Cr_2O_7 \xrightarrow{\Delta} 2K_2CrO_4 + Cr_2O_3 + \frac{3}{2}O_2$

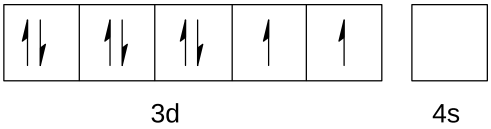
$Al_2O_3 + Cr \longrightarrow$ No reaction

25. B

Sol. (P) $[Ni(CN)_4]^{2-}$

O. S of Ni is +2

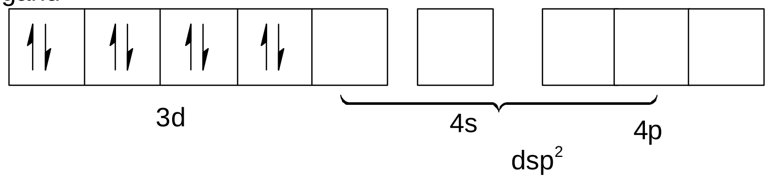
$Ni^{+2} \Rightarrow 3d^8 \Rightarrow$



Paramagnetic

In presence of ligand

$Ni^{+2} \Rightarrow 3d^8 \Rightarrow$

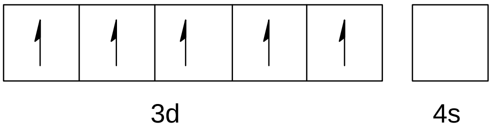


Diamagnetic

(Q) $K_3[Fe(CN)_6]$

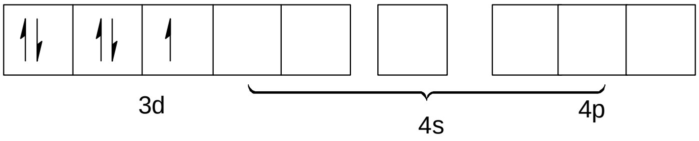
Oxidation state of Fe = +3

$Fe^{+3} \Rightarrow 3d^5 4s^0 \Rightarrow$



Paramagnetic

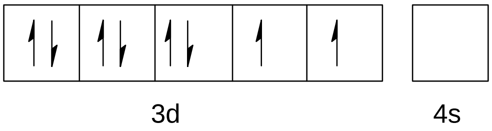
In presence of ligand



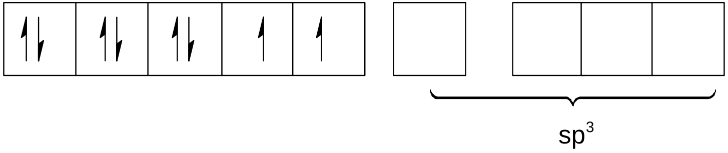
Paramagnetic low spin

d^2sp^3

(R) $Ni^{2+} \Rightarrow$



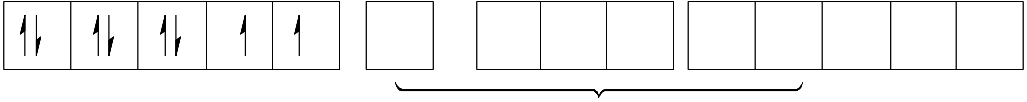
In presence of ligand



Paramagnetic

(S) $[Ni(NH_3)_6]SO_4$

In presence of ligand



sp^3d^2 paramagnetic

26. A

Sol. Ag^+ - $Ag_2S\downarrow$
- $AgI\downarrow$ yellow
- 1st group

Zn^{2+} - 4th group
- $ZnS\downarrow$
- Soluble in KI
- form Amphoteric Oxide

Pb^{2+} - Pbs $\downarrow$
- $PbI_2\downarrow$ yellow
- 1st and 2nd group
- form Amphoteric oxides

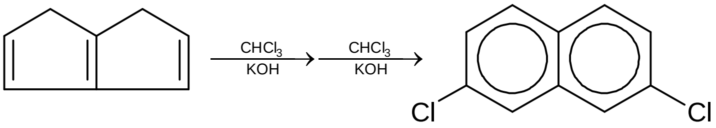
Bi^{3+} - $Bi_2S_3\downarrow$
- $BiI_3\downarrow$ Black
- BiO^+X^- (white ppt on dilution with water)
- 2nd group

27. D

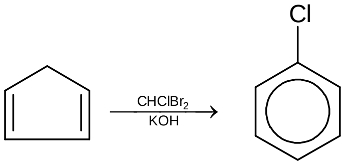
Sol. P – Chiral, G. I., 2 chiral centers
Q – Chiral, G.I., 2 chiral centers
R – Chiral, G. I., 3 chiral centers
S – Achiral, G. I., plane of symmetry

28. A

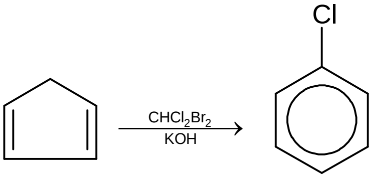
Sol. (P)



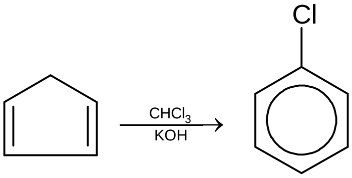
(Q)



(R)



(S)



SECTION – D

29. 00042.22

Sol. For n mole

$$\left(P+\frac{n^2a}{V^2}\right)(V-nb)=nRT \text{ for negligible volume } b\approx 0$$

$PV^2 - nRTV + n^2a = 0$

Quadratic in V thus,

$$V=\frac{nRT\pm\sqrt{n^2R^2T^2-4an^2P}}{2}$$

V has one value at given pressure and temperature thus discriminant = 0

$n^2R^2T^2 = 4a\,n^2P$

P = 42.22 atm.

30. 00046.06

Sol. Meq of H_2SO_4 = Meq of NaOH

N of H_2SO_4 = $\frac{84.6}{5}$

Weight of H_2SO_4 in 1 lit = $\frac{84.6}{5}\times 49$

Weight of H_2SO_4 in 1 ml = $\frac{84.6\times 49}{5\times 1000}$

Purity = $\frac{84.6\times 49\times 100}{5\times 1.8\times 1000}=46.06\%$

31. 00008.50

Sol. $u=\frac{h}{m\lambda}=\frac{6.6\times 10^{-34}}{1.6\times 10^{-27}\times 0.01\times 10^{-9}}=4.125\times 10^{4}\,m/s$

QV = 1/2 mu^2

Putting all values we get V

V = 8.50 volt.

32. 00003.82

Sol. Equivalent of oxygen = Equivalent of metal

$\frac{20}{8}=\frac{80}{E}$

E = 32

N.f = $\frac{64}{32}=2$

2F charge is required for 64 gm metal

1F charge is required for 32 gm metal

$\frac{60\times60\times3.2}{96500}$ Coulomb charge is required for $\frac{32\times60\times60\times3.2}{96500}$ gm metal

= 3.82 gm

33. 00062.10

Sol.

$$\begin{array}{llll} & A(g)\longrightarrow & B(g)+ & C(g) \\ \text{At time } t=0 & p & 0 & 0 \\ \text{At time } t=20\text{ min} & p-x & x & x \\ \text{At time } t=\infty & 0 & p & p \end{array}$$

p + x = 300

2p = 500

p = 250

x = 50

$K=\frac{2.303}{20}\log1.25$

$t_{1/2}=\frac{0.693}{K}=62.10\text{ min}$

34. 00001.43

Sol. $HCl + NH_4OH \rightarrow NH_4Cl + H_2O \quad \Delta H = -12.27$

$H^+ + Cl^- + NH_4OH \rightarrow NH_4^+ + Cl^- + H_2O \quad \Delta H = -12.27$ …1

$NH_4OH \rightarrow NH_4^+ + OH^- \quad \Delta H = x$ … 2

From equation (1) and (2)

$H^+ + OH^- \rightarrow H_2O \quad \Delta H = -12.27 - x$

We know that

$-12.27 - x = -13.7$

X = 1.43 Kcal

35. 00073.75

Sol.

$$\begin{array}{lll} PCl_5 \rightleftharpoons & PCl_5 + & Cl_2 \\ 1 & 0 & 0 \\ 1-\alpha & \alpha & \alpha \end{array}$$

$\frac{M_{eq}}{M_{initial}}=\frac{1}{1+\alpha}$

$\frac{208.5}{120}=1+\alpha$

$\alpha = 0.7375$

Or 73.75%

36. 00344.80

Sol. Work is done against constant pressure and thus irreversible.

$\Delta V = 4$ lit

P = 1 atm

w = –1 × 4 lit-atm = - 1 × 4 × 101.3 = - 405.2 Joule

$\Rightarrow \Delta E = a + w$

$\therefore \Delta E = 750 - 405.2$

$\Delta E = +344.80 \text{ J}$

Mathematics PART – III

SECTION – A

37. A, D

Sol. $f'(x) = 3(x - 1)(x + 1)$
$\Rightarrow$ f is strictly non-decreasing in $(-\infty, -1]$ and $[1, \infty)$ and non-increasing in $[-1, 1]$
$f(-1) = 3$, $f(1) = -1$, $f(2) = 3$
$f(x) = 0$ has three distinct roots x_1, x_2, x_3 i.e. $-2 < x_1 < -1 < x_2 < 1 < x_3 < 2$
So $f(x) = x_1$ has one solution
$f(x) = x_2$ = has 3 solution
$f(x) = x_3$ has 3 solution

38. A, C

Sol. $\Delta = 0$

$$\Rightarrow \begin{vmatrix} \cos\theta & \sin\theta & \cos\theta \\ \sin\theta & \cos\theta & \sin\theta \\ \cos\theta & \sin\theta & -\cos\theta \end{vmatrix} = 0$$

$\Rightarrow \cos\theta \cdot \cos 2\theta = 0$

$\therefore\ \theta = \frac{\pi}{4}, \frac{\pi}{2}, \frac{3\pi}{4}, \frac{5\pi}{4}, \frac{3\pi}{2}, \frac{7\pi}{4}$

But $\theta = \frac{\pi}{4}, \frac{3\pi}{4}, \frac{5\pi}{4}, \frac{7\pi}{4}$ (rejected)

Because line are parallel, so system is inconsistent

39. A, C

Sol. (i) We have $u = \frac{4}{4 - x^2} + \frac{9x^2}{9x^2 - 1} = 1 + \frac{35x^2}{-9x^4 + 37x^2 - 4} = 1 + \frac{35}{37 - \left(\left(3x - \frac{2}{x}\right)^2 + 12\right)}$

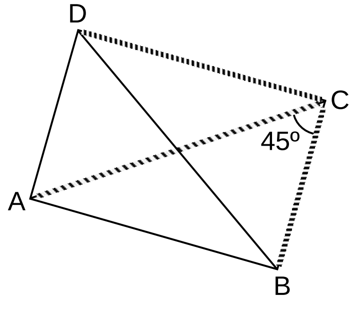
Since $x \in \left(-2, -\frac{1}{2}\right) \cup \left(\frac{1}{2}, 2\right)$. So u reaches minimum value $\frac{12}{5}$, when $x = \pm\sqrt{\frac{2}{3}}$

(ii) Using A.M. and G.M.

$$u \ge 2\sqrt{\frac{4}{4 - x^2} \cdot \frac{9}{9 - y^2}}$$

$$\Rightarrow \frac{12}{\sqrt{36 - 9x^2 - 4y^2 + (xy)^2}} = \frac{12}{\sqrt{37 - 9x^2 - 4y^2}} \ge \frac{12}{\sqrt{37 - 2\sqrt{36(xy)^2}}} = \frac{12}{5}$$

40. A, B



Sol. $\frac{1}{3}AD\left(\frac{1}{2}BC \cdot AC \cdot \sin 45^o\right) \ge V_{ABCD} = \frac{1}{6}$

So, $AD \cdot BC \cdot \frac{AC}{\sqrt{2}} \ge 1$

$$3 = AD + BC + \frac{AC}{\sqrt{2}} \ge 3\sqrt{AD \cdot BC \cdot \frac{AC}{\sqrt{2}}} \ge 3$$

Equality holds if and only if AD = BC = $\frac{AC}{\sqrt{2}} = 1$

So AD is perpendicular to the face ABC. $DC = \sqrt{AD^2 + AC^2} = \sqrt{3}$

41. A, B, C, D

Sol. $(2x + 1)^2 = 1996(1997)^n + 1997$ for n = 1, we get $(2x + 1)^2 = 1997^2$

So $2x + 1 = \pm 1997 \Rightarrow x = 998, -999$

42. A, B

Sol. $T_r = \sum_{r=1}^{n} \cot^{-1}\left(r^2 + \frac{3}{4}\right)$

$$T_r = \tan^{-1}\left(\frac{4}{4r^2+3}\right) = \tan^{-1}\left(\frac{1}{r^2 + \frac{3}{4}}\right)$$

$$T_r = \tan^{-1}\left(\frac{1}{1+\left(r^2 - \frac{1}{4}\right)}\right)$$

$$T_r = \tan^{-1}\left(r + \frac{1}{2}\right) - \tan^{-1}\left(r - \frac{1}{2}\right)$$

$$S_n = \tan^{-1}\left(n + \frac{1}{2}\right) - \tan^{-1}\left(\frac{1}{2}\right)$$

$$\lim_{n\to\infty} S_n = \tan^{-1}\infty - \tan^{-1}\left(\frac{1}{2}\right) = \frac{\pi}{2} - \tan^{-1}\frac{1}{2} = \tan^{-1} 2$$

43. C

Sol. $e^{-x} + e^{-x^3} = x$

Let $f(x) = e^{-x} + e^{-x^3} \Rightarrow f'(x) = -e^{-x} - 3x^2 \cdot e^{-x^3} < 0$

$f(-\infty) = \infty$, $f(\infty) = 0 \Rightarrow f(x) = x$ has one solution

$\sin^5 x \le \sin^2 x$; $\cos^3 x \le \cos^2 x$

$\Rightarrow \sin^5 x + \cos^3 x \le \sin^2 x + \cos^2 x \Rightarrow \sin^5 x + \cos^3 x \le 1$

Equality holds if $\sin^5 x = \sin^2 x$ and $\cos^3 x = \cos^2 x$

$\Rightarrow \sin x = 0, \cos x = 1$ or $\sin x = 1, \cos x = 0$

$\Rightarrow x = \frac{\pi}{2}, 2\pi$

44. A

Sol. $f(x) = \frac{1-\sqrt{17}}{2x} \Rightarrow f'(x) = \frac{\sqrt{17}-1}{2x^2}$

45. B

Sol. Length of common chord = $2\sqrt{9 - \frac{9}{4}} = 3\sqrt{3}$

Angle between circles = $\pi - \cos^{-1}\left(\frac{9+9-9}{2\cdot 3\cdot 3}\right) = \frac{2\pi}{3}$

46. B

Sol. Let $I_n = \int\limits_0^{\pi/2} \sin^n x dx \Rightarrow I_n = \frac{n-1}{n} \cdot I_{n-2}$

Let $P_n = \int\limits_0^{\pi/4} \tan^n x dx \Rightarrow P_n + P_{n-2} = \frac{1}{n-1}$

Let $I_n = \int\limits_0^1 x(1-x)^n dx \Rightarrow I_n = \frac{1}{n+1} - \frac{1}{n+2}$

SECTION – D

47. 00002.00

Sol. $g(\alpha) = g'(\alpha) = g''(\alpha) = 0 \Rightarrow g(x) = a(x-\alpha)^3(x-\beta)$ and $\lim\limits_{x\to\alpha} \frac{f(x)}{g(x)} = 0$

$\Rightarrow f(x) = b(x-\alpha)^4$

$h(x) = f(x)g'(x) + g(x)f'(x) = \frac{d}{dx}\left(f(x)g(x)\right)$

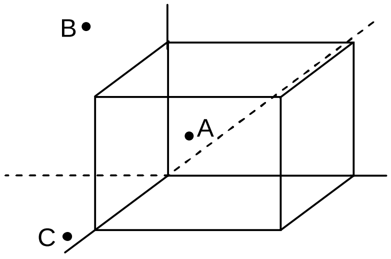
$= \frac{d}{dx}\left(ab(x-\alpha)^7(x-\beta)\right) = ab((x-\alpha)^7 + 7(x-\beta)(x-\alpha)^6)$

$= ab(x-\alpha)^6(x-\alpha+7x-7\beta) = ab(x-\alpha)^6(8x-\alpha-7\beta)$

$\therefore$ h(x) has two different real solutions

48. 00002.00

Sol. A(3, 1, 0) inside cube
B(1, 1, 1) outside cube
C(2, 1, 3) outside cube
Number of intersection point is 2



49. 00006.00

Sol. $|A| = -18$

$A\,\text{adj}(A) = -18\,I$

$$\Rightarrow \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{bmatrix} 5 & -1 & -7 \\ -1 & -7 & 5 \\ -7 & 5 & -1 \end{bmatrix} \begin{bmatrix} -18 & 0 & 0 \\ 0 & 18 & 0 \\ 0 & 0 & -18 \end{bmatrix}$$

$\Rightarrow -3\sum a_{ij} = -3(18) \Rightarrow \frac{1}{3}\sum a_{ij} = 6$

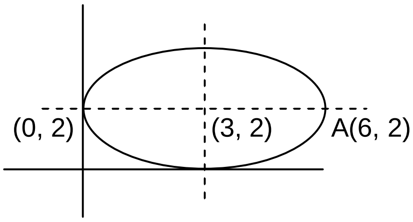
50. 00007.00

Sol. $\frac{\sin 1^o \sin 2^o \sin 3^o \ldots\ldots \sin 179^o}{\sin 2^o \sin 4^o \ldots\ldots \sin 178^o} = \sin 1^o \sin 3^o \sin 5^o \ldots\ldots \sin 179^o$

$$\frac{\left(\frac{1}{2^{44}} \times \frac{1}{\sqrt{2}} \sin 2^o \sin 4^o \ldots\ldots \sin 88^o\right)^2}{(\sin 2^o \sin 4^o \ldots\ldots \sin 88^o)^2} = \frac{1}{2^{89}} \Rightarrow \lambda = 89$$

51. 00036.00

Sol. $C_1 : \frac{(x-3)^2}{9} + \frac{(y-2)^2}{4} = 1$



∴ $A_1 = (6, 2), A_2 = (0, 2)$

∴ $|PA_1 - PA_2| = 3\sqrt{2}$

Clearly locus of P is hyperbola for which

$A_1A_2 = 2ae = 6$ and $2a = 3\sqrt{2} \Rightarrow e = \sqrt{2}$

∴ Locus of P is rectangular hyperbola

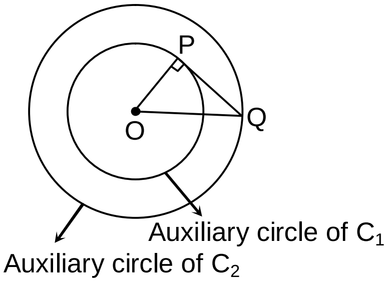
Equation of conic $C_2 : (x-3)^2 - (y-2)^2 = \frac{9}{2}$

Now $D_1 = 2ae = 6$

$D_2 = b^2 = \frac{9}{2}$

$D_3 : L = \sqrt{9 - \frac{9}{2}} = \frac{3}{\sqrt{2}}$

∴ $\left(\frac{D_1D_2}{D_3^2}\right)^2 = 36$



52. 00002.00

Sol. $\left(y + \frac{2}{3}\right)^2 = 2\left(x - \frac{10}{9}\right)$

Clearly for three distinct normal x-coordinate > 2a

$\Rightarrow x - \frac{10}{9} > 2 \cdot \frac{1}{2} \Rightarrow h > \frac{19}{9} \Rightarrow [h]_{\text{least}} = 2$

53. 00003.00

Sol. $x = 6q + r$ where $0 \le r \le 5$

∴ $\left[\frac{x}{2}\right] - \left[\frac{x}{3}\right] = \frac{x}{7} \Rightarrow \left[\frac{r}{2}\right] - \left[\frac{r}{3}\right] = \frac{-9}{7} + \frac{r}{7}$

for r = 0, we get q = 0 $\Rightarrow$ x = 0

for r = 1, we get q = 1 $\Rightarrow$ x = 7

for r = 2, we get q = –5 $\Rightarrow$ x = –28

for r = 3, we get q = 3 $\Rightarrow$ x = 21

for r = 4, we get q = –3 $\Rightarrow$ x = –14

for x = 5, we get q = –2 $\Rightarrow$ x = –7

∴ N = sum of all value = –21 $\Rightarrow \left|\frac{N}{7}\right| = 3$

or Put x = 7k where $k \in I$

54. 00005.00

Sol. $f(x) = \frac{\sin x}{x}$ for $x \in \left(0, \frac{\pi}{2}\right)$; $f'(x) = \frac{x\cos x - \sin x}{x^2} = \cos x\left(\frac{x - \tan x}{x^2}\right) = -\text{ve}$ for $x \in \left(0, \frac{\pi}{2}\right)$

$\Rightarrow$ f(x) is decreasing function for $x \in \left(0, \frac{\pi}{2}\right)$

$f''(x) = \left(\frac{-x^2\sin x - 2x\cos x + 2\sin x}{x^3}\right)$

Let $h(x) = -x^2 \sin x - 2x \cos x + 2 \sin x$

$h'(x) = -x^2 \cos x = -\text{ve for } x \in \left(0, \frac{\pi}{2}\right)$

$\Rightarrow h(x)$ is decreasing function for $x \in \left(0, \frac{\pi}{2}\right)$; $h(x) < h(0)$ for $x \in \left(0, \frac{\pi}{2}\right)$

$\Rightarrow -x^2 \sin x - 2x \cos x + 2 \sin x < 0 \ \forall \ x \in \left(0, \frac{\pi}{2}\right)$

$\Rightarrow f''(x) < 0 \ \forall \ x \in \left(0, \frac{\pi}{2}\right) \Rightarrow f(x)$ is concave down on $\left(0, \frac{\pi}{2}\right)$

$\therefore$ for any $x_1, x_2, x_3 \in \left(0, \frac{\pi}{2}\right)$

We can write $f\left(\frac{x_1 + x_2 + x_3}{3}\right) \ge \frac{f(x_1) + f(x_2) + f(x_3)}{3}$

$x_1 = A.\ x_2 = B,\ x_3 = C$

$$\frac{\sin\left(\frac{A+B+C}{3}\right)}{\frac{A+B+C}{3}} \ge \frac{\frac{\sin A}{A} + \frac{\sin B}{B} + \frac{\sin C}{C}}{3}$$

$$\frac{9}{\pi}\sin\frac{\pi}{3} \ge \frac{\sin A}{A} + \frac{\sin B}{B} + \frac{\sin C}{C}, \quad M = \frac{9\sqrt{3}}{2\pi} \Rightarrow \left[\frac{2M\pi}{3}\right] = \left[3\sqrt{3}\right] = 5$$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – X

JEE (Advanced)-2019

PAPER – 2

TEST DATE: 05-05-2019

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01 – 06, 19 – 24, 37 – 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 – 46) *contains 12 questions. Each question has* ***TWO (02)*** *matching lists:* ***LIST-I*** *and* ***LIST-II***. ***FOUR*** *options are given representing matching of elements from* ***LIST-I*** *and* ***LIST-II***. ***ONLY ONE*** *of these four options corresponds to a correct matching.*
   For each question, choose the option corresponding to the correct matching.
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

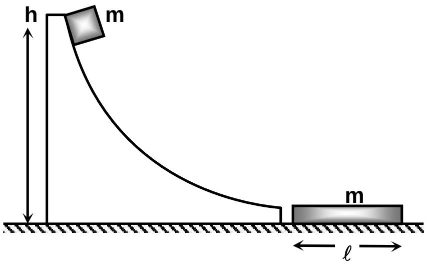
2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics PART – I

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.



1. A block of mass m is released from height h from a fixed smooth inclined plane. At the foot plank of mass m is kept on smooth surface. Friction coefficient between plank and block is μ and block just fails to leave the plank of length ℓ. Pick the correct options for the work done by friction on the block and the plank.

(A) $-\frac{mgh}{4}$

(B) $+\frac{mgh}{2}$

(C) $-\frac{3mgh}{4}$

(D) $+\frac{mgh}{4}$

2. A thin hoop of mass 5 kg and radius 10 cm is placed on a horizontal plane. At the initial instant, the hoop is at rest. A small washer of mass 4 kg with zero initial velocity slides from the upper point of the hoop along a smooth groove in the inner surface of the hoop. Speed of the centre of the hoop at the moment when the washer is at a certain point of the hoop, whose radius vector forms an angle 60° with the vertical downward direction is (The friction between the hoop and the plane should be neglected)

(A) $2\sqrt{\frac{1}{3(5+2\sqrt{3})}}$ m/s

(B) $2\cdot\sqrt{\frac{5-2\sqrt{3}}{21}}$ m/s

(C) $\frac{1}{\sqrt{6}}$ m/s

(D) $\sqrt{6}$ m/s

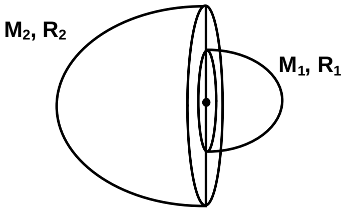
3. Which of the following is correct about a black body?

(A) A black body in thermal equilibrium must emit radiation at a rate lower than as it absorbs.

(B) Objects around room temperature radiate mainly in the infrared region of spectrum.

(C) At very high temperature (10000 K or more); an iron object is seen blue.

(D) At temperature 2898 K, the wavelength of maximum intensity is 1 μm.



4. Two hemispherical shells having uniform mass distribution are kept as shown in figure. Force exerted by one hemisphere on the other is 6.67×10^{-11} Newton. Pick the correct options:

(A) Masses and radii are 2 kg, 4 kg and $\sqrt{2}$ m, 2 m respectively.

(B) Masses and radii are 1 kg, 2 kg and $\frac{1}{2}$ m, 1 m respectively.

(C) Masses and radii are 2 kg, 2 kg and 1 m, $\sqrt{2}$ m respectively.

(D) Masses and radii are 1 kg, 1 kg and $\frac{1}{2}$ m, 1 m respectively.

5. Pick the correct options out of the following.

(A) Coercivity is measure of the reverse field needed to drive the magnetization to zero after being saturated.

(B) Remanence is measure of the remaining magnetization when the driving field is dropped to zero.

(C) For ferromagnetic materials, relative permeability is very close to 1.

(D) Earth has a magnetic field very much like that of a bar magnetic, directed from the geographic south pole to geographic north pole.

6. A ring of thin wire with active resistance R and inductance L rotates with constant angular velocity ω in the external uniform magnetic field perpendicular to the rotation axis. In this process the flux of magnetic induction of external field across the ring varies with time as $\phi = \phi_0 \cos \omega t$. Pick the correct option(s).

(A) Power developed in the circuit due to rotation is given by $\frac{\phi_0^2\omega^2}{\sqrt{(\omega L)^2+R^2}}\sin^2 \omega t$.

(B) The mean mechanical power developed by external forces to maintain rotation is equal to $P = \frac{1}{2}\frac{\omega^2\phi_0^2 R}{(R^2+\omega^2L^2)}$

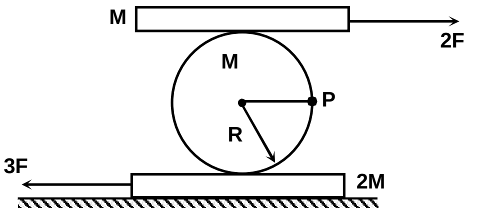
(C) The mean power developed in the circuit is equal to P = $\frac{1}{2}e_0 I_0 \cos\phi$, where $\tan\phi = \frac{\omega L}{R}$ and I_0 is peak current.

(D) The mean mechanical power developed by external forces to maintain rotation is equal to $\frac{1}{2}I_0^2 R$, where I_0 is peak current.

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

7. A cylinder is sandwiched between two planks shown in the figure. Two constant horizontal forces 2F and 3F are applied on the planks at t = 0 as shown. There is no slipping at the top and bottom of cylinder. Surface below the plank is smooth.

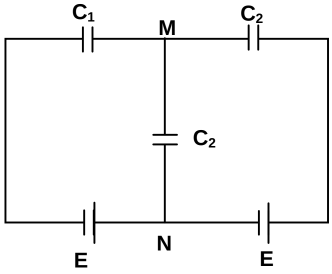


LIST–I		LIST–II	
P.	Acceleration of Centre of mass of cylinder at t = 0	1.	$\frac{20F}{13M} < a < \frac{21F}{13M}$
Q.	Acceleration of top plank at t = 0	2.	$\frac{19F}{13M} < a < \frac{20F}{13M}$
R.	Acceleration of bottom plank at t = 0	3.	$\frac{F}{13M} < a < \frac{2F}{13M}$

S.	Acceleration of point P of cylinder at t = 0	4.	$\frac{17F}{13M} < a < \frac{18F}{13M}$

(A) P → 3; Q → 2; R → 4; S → 1
(B) P → 2; Q → 4; R → 3; S → 1
(C) P → 3; Q → 1; R → 4; S → 2
(D) P → 2; Q → 4; R → 1; S → 3

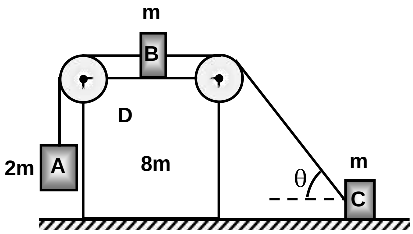
8. In the given circuit two batteries of emf E and E and 3 capacitors of capacitance C_1, C_2 and C_2 are connected. Below is a List – II for the different set of values of potential difference between M and N and value of E with $\frac{C_1}{C_2}$ are given in List-I.



LIST–I		LIST–II	
P.	$\frac{C_1}{C_2} = 2$; E = 100 Volt	1.	0 Volt
Q.	$\frac{C_1}{C_2} = 1$; E = 200 Volt	2.	100 Volt
R.	$\frac{C_1}{C_2} = 3$; E = 100 Volt	3.	25 Volt
S.	$\frac{C_1}{C_2} = 4$; E = 200 Volt	4.	40 Volt

(A) P → 3; Q → 2; R → 4; S → 1
(B) P → 3; Q → 1; R → 4; S → 2
(C) P → 4; Q → 3; R → 2; S → 1
(D) P → 4; Q → 1; R → 2; S → 3

9. A block A of mass 2m is hanging by the pulley fixed on a block D of mass 8m. Another block B of mass m is placed on D whereas a third block C of mass m is on the ground passing by a pulley fixed on the block D. Given that m = 1 kg and angle θ shown in the figure is 60°. The system (maintained in equilibrium) is made free at time t = 0. Answer the following questions in MKS.

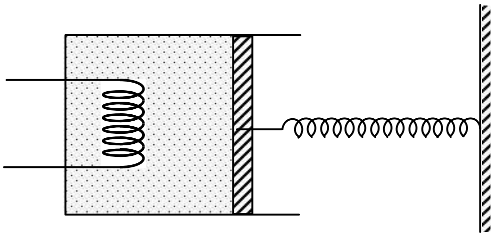


LIST–I		LIST–II	
P.	Acceleration of block D at t = 0 is	1.	$\frac{200}{61}$

Q.	Tension in the slant string attached to C is	2.	$\frac{680}{61}$
R.	Tension in the string joining A and B	3.	$\frac{820}{61}$
S.	Acceleration of block A at t = 0	4.	$\frac{60}{61}$

(A) P → 3; Q → 2; R → 4; S → 1
(B) P → 3; Q → 1; R → 4; S → 2
(C) P → 4; Q → 2; R → 3; S → 1
(D) P → 4; Q → 1; R → 2; S → 3

10. An ideal mono atomic gas is confined by a spring loaded massless piston of cross section 4.0×10^{-3} m^2. Initially the gas is at 400 K and occupies a volume of 4.8×10^{-3} m^3 and the spring is in its relaxed state. The gas is heated by an electric heater until the piston moves out slowly without friction by 0.1 m. Force constant of the spring is 10000 N/m and atmospheric pressure is 1.0×10^5 N/m^2. The cylinder and the piston are thermally insulated.



LIST–I		LIST–II	
P.	Heat supplied by the heater is	1.	2100 J
Q.	Additional amount of heat required to compress the spring by additional 0.1 m is	2.	2010 J
R.	Internal energy change of the gas when piston moves 0.1 m from start	3.	2500 J
S.	Internal energy change of the gas when pistons moves 0.2 m from start.	4.	4320 J

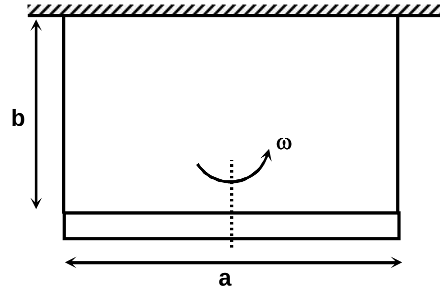
(A) P → 4; Q → 1; R → 2; S → 3
(B) P → 2; Q → 3; R → 1; S → 4
(C) P → 3; Q → 2; R → 4; S → 1
(D) P → 1; Q → 3; R → 2; S → 4

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

11. A rod of mass 1 kg and length 2 m is suspended from the ceiling with the help of two light inextensible cords each of length 1 m so that the rod is horizontal. The rod is given an angular velocity 2 rad/sec about its center vertical axis. Tension in a string immediately after the rod is given angular velocity is 7K Newton. K is



12. An equilateral triangular lamina of mass 1 kg and side length 10 cm is rotating with constant angular velocity 4 rad/sec about an axis passing through centroid O of the triangle and perpendicular to the plane of lamina. The axis is rotating with constant angular velocity 3 rad/sec. Rate of charge of angular momentum of triangular lamina is

13. A rod of length 1 meter has variable coefficient of thermal expansion $\alpha = (1.67 + 1.67x - 1.67x^2) \times 10^{-4}$ (in MKS). The rod is uniform throughout and its Young's modulus is same throughout the rod. Rod is rigidly fixed between two vertical walls. Find the distance x (in MKS) of the point of the rod from corner x = 0 which is not displaced from its position on heating the rod by 1°C. (Given that x is neither 0 nor 1)

14. A light beam of diameter $3\sqrt{3}$ cm in the shape of a hollow cylinder is incident symmetrically around the radius of symmetry on a glass hemisphere of radius 3 cm and refractive indices $\sqrt{3}$ and 1.7 for violet and red colours. Distance between the red and violet colour of light in flat face of hemisphere is (in cm)

15. According to Moseley's Law, the ratio of the slope of graph between $\sqrt{\nu}$ and z (here ν and z are frequency of radiation and atomic number respectively) for K_β and K_α is given by $\frac{n^{\frac{3}{2}}}{\sqrt{2}}$. n is equal to

16. A magnetic field of 3.0×10^{-3} T along z-axis exerts a force $(3\hat{i} + 4\hat{j}) \times 10^{-10}$ N on a particle having a charge 2×10^{-9} C and moving in x-y plane. Here $\hat{i}$ and $\hat{j}$ are unit vectors for x-axis and y-axis respectively. Velocity of particle is given by $(x\hat{i} + y\hat{j})$ m/s. $|(x + y)|$ is equals to

17. A solid sphere of radius 14 cm rolls without slipping in a cylindrical curve of radius 70 cm. The time period of small oscillations is equal to (in sec) (given that g = 10 m/s^2)

18. A solid sphere of radius 3 cm made of material of bulk modulus 2×10^9 N/m^2 is surrounded by a liquid in a cylindrical container. A massless piston of area 8×10^{-3} m^2 (area of the container is also same) floats on the surface of liquid. A mass of 5 kg is placed on the piston to compress the liquid, change in radius of sphere (in Å) is

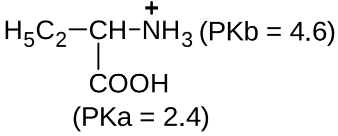
Chemistry PART – II

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

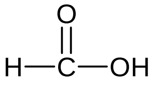
19. What is the pI (iso-electric point) of the following amino acid:



$$\underset{\underset{(PKa = 2.4)}{COOH}}{H_5C_2-\overset{|}{C}H-\overset{+}{N}H_3}\ (PKb = 4.6)$$

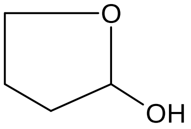
(A) 3.5
(B) 5.9
(C) 2.3
(D) 4.6

20. Which of the following compounds give positive test with Tollen's reagent:

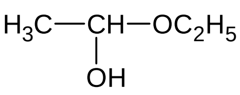


$H-\overset{\overset{O}{||}}{C}-OH$

(1)

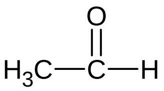


(2)



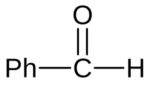
$H_3C-\underset{\underset{OH}{|}}{CH}-OC_2H_5$

(3)



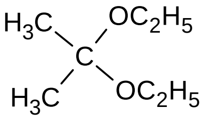
$H_3C-\overset{\overset{O}{||}}{C}-H$

(4)

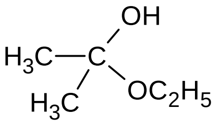


$Ph-\overset{\overset{O}{||}}{C}-H$

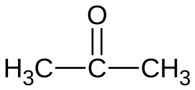
(5)



(6)



(7)



$H_3C-\overset{\overset{O}{||}}{C}-CH_3$

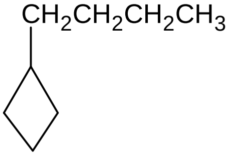
(8)

(A) 1, 2, 3
(B) 3, 4, 5
(C) 6, 7, 8
(D) 1,3, 5

21. Which of these properties is/are correct for Beryllium?
(A) Exhibiting amphoteric nature in their oxides
(B) Forming polymeric chloride by forming (3c, $4e^-$) bond
(C) Forming polymeric hydride by forming (3c, $2e^-$) bond
(D) Forming co-valent halides

22. $P_4 + NaOH(aq) \rightarrow ? + ?$
Select correct statement(s) about the reaction:
(A) One of the product is PH_3
(B) It is disproportionation reaction
(C) One of the product is NaH_2PO_3
(D) This reaction is not given by red phosphorous

23. What is the IUPAC name of the following compound:



(A) Butylcyclobutane
(B) Cyclobutylbutane
(C) Butanecyclobutane
(D) Cyclobutanebutane

24. Which of the following reaction(s) produce(s) Cr_2O_3 along with O_2?
(A) Heating $(NH_4)_2Cr_2O_7$
(B) Heating CrO_3
(C) Heating $K_2Cr_2O_7$
(D) Reaction of Al_2O_3 with Cr

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

---

25. Match the following List – I with List - II:

	List – I		List – II
P.	$[Ni(CN)_4]^{2-}$	1.	Paramagnetic and number of unpaired electrons(s) is/are same as the free metal ion
Q.	$K_3[Fe(CN)_6]$	2.	Paramagnetic but number of unpaired electron(s) is/are less than the free metal ion
R.	$[NiCl_4]^{2-}$	3.	Free metal ion is paramagnetic but complex is diamagnetic
S.	$[Ni(NH_3)_6]SO_4$	4.	d-orbital(s) is/are involved in hybridization
		5.	Metal in +2 oxidation state
		6.	Metal in +3 oxidation state.

The correct option is
(A) P → 2, 4, 5, Q → 3, 4, 6, R → 1, 4, 5, S → 1, 5
(B) P → 3, 4, 5, Q → 2, 4, 6, R → 1,5, S → 1, 4, 5
(C) P → 1, 5, Q → 3, 4, 6, R → 2, 4, 5, S → 1, 5
(D) P → 2, 4, 5, Q → 1, 4, 6, R → 3, 4, 5, S → 1, 5

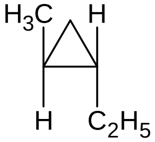
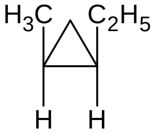
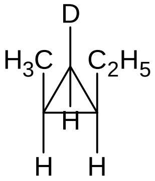
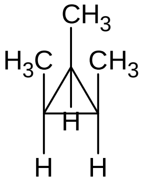
26. Match the following List – I with List - II:

	List – I		List – II
P.	Zn^{2+}	1.	1st group cation
Q.	Ag^{+}	2.	Precipitated by Na_2S
R.	Pb^{2+}	3.	Yellow precipitate with KI
S.	Bi^{3+}	4.	Produce precipitate on dilution with water
		5.	Produce amphoteric hydroxide

The correct option is
(A) P → 2, 5, Q → 1, 2, 3, R → 1, 2, 3, 5, S → 2, 4
(B) P → 3, 4, Q → 1, 4, 5, R → 1, 2, 3, 4, 5, S → 3, 5

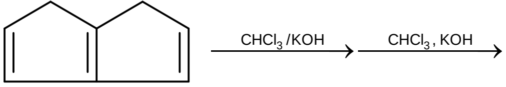
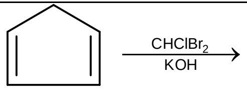
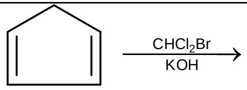
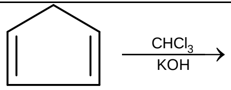
(C) P → 2, 5, Q → 1, 4, 5, R → 1, 2, 3, 5, S → 3, 5
(D) P → 3, 4, Q → 1, 2, 3, R → 1, 2, 3, 4, 5, S → 2, 4

27. Match the list:

List – I		List – II	
P.		1.	Chiral
Q.		2.	Achiral
R.	 D H3C C2H5 H H H	3.	Geometrical isomerism
S.	 CH3 H3C CH3 H H H	4.	Containing plane of symmetry
		5.	Compound containing even number of chiral centers

The correct option is
(A) P → 2, 3, 4, Q → 1, 3, 5, R → 2, 3, 4 S → 1, 3
(B) P → 1, 3, 5, Q → 2, 3, 4, R → 1, 3, S → 2, 3, 4
(C) P → 1, 3, 5, Q → 1, 3, 5, R → 2, 3, 4, S → 1, 3
(D) P → 1, 3, 5, Q → 1, 3, 5, R → 1, 3, S → 2, 3, 4

28. Match the following List – I with List - II:

List – I		List – II	
P.	 CHCl3 /KOH CHCl3 , KOH	1.	Dichloro aromatic compound
Q.	 CHClBr2 KOH	2.	Monochloro aromatic compounds
R.	 CHCl2Br KOH	3.	Monobromo aromatic compound
S.		4.	Carbine formation
		5.	Ring expansion takes place

The correct option is
(A) P → 1, 4, 5, Q → 2, 4, 5, R → 2, 4, 5, S → 2, 4, 5
(B) P → 2, 4, 5, Q → 3, 4, 5, R → 3, 4, 5, S → 2, 4, 5
(C) P → 2, 4, 5, Q → 3, 4, 5, R → 3, 4, 5, S → 1, 4, 5
(D) P → 1, 4, 5, Q → 3, 4, 5, R → 3, 4, 5, S → 1, 4, 5

SECTION – D

(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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29. Calculate the pressure exerted (in atm) by 2 mole of CO_2 gas at 300 K, if volume occupied by CO_2 molecules is negligible. a = 3.592 atm $lit^2 mol^{-2}$.

30. What is the percentage purity of concentrated H_2SO_4 solution (Specific gravity 1.8 g/ml) if 5 ml of this solution is neutralized by 84.6 ml of 1 N NaOH.

31. Calculate the accelerating potential (in volts) that must be imparted to a proton beam to give it an effective wavelength of 0.01 nm.
Given : mass of proton = 1.6×10^{-27} kg
Charge on proton = 1.6×10^{-19} Coulomb
Plank's constant h = 6.6×10^{-34} J/sec

32. An oxide of metal m (at wt = 64) contains 20% oxygen by weight. The oxide was converted into chloride by treatment with HCl and electrolysed. Calculate the amount of metal (in gm) that would be deposited at cathode if a current of 1 ampere was passed for a period of 3.2 hr.

33. The following reaction follows 1st order kinetics at 150°C:
$A(g) \rightarrow B(g) + C(g)$
On starting with pure A, at the end of 20 min, the total pressure was found to be 300 mm of Hg. After a long time the total pressure of the system was 500 mm of Hg. Calculate the half-life period of the reaction in minutes. (log 1.25 = 0.09691)

34. Calculate the heat of dissociation (in Kcal) for NH_4OH if
$HCl + NH_4OH \rightarrow NH_4Cl + H_2O \quad \Delta H = -12.27$ Kcal
$H^+ + OH^- \rightarrow H_2O \quad \Delta H = -13.7$ Kcal

35. At 470 K partially dissociated vapours of PCl_5 are 60 times as heavy as H_2. Calculate the % dissociation of PCl_5.

36. A gas present in a cylinder fitted with a frictionless piston expands against a constant pressure of 1 atm from a volume of 3 lit. to a volume of 7 lit. In doing so, it absorbs 750 J heat from surroundings. Determine increase in internal energy of the gas. [Take 1 L atm = 101.3 J]

Mathematics PART – III

SECTION – A

(One or More than one correct type)

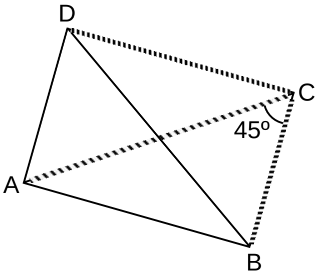
This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. Let $f(x) = x^3 - 3x + 1$, then
    (A) $f(f(x)) = 0$ has 7 solutions
    (B) $f(f(x)) = 0$ has 4 solutions
    (C) $f(f(x)) = -1$ has 7 solutions
    (D) $f(f(x)) = -1$ has 4 solutions

38. If the system of linear equations $(\cos\theta)x + (\sin\theta)y + \cos\theta = 0$, $(\sin\theta)x + (\cos\theta)y + \sin\theta = 0$, $(\cos\theta)x + (\sin\theta)y - \cos\theta = 0$ is consistent, then the possible values of $\theta \in [0, 2\pi]$ is/are
    (A) $\frac{\pi}{2}$
    (B) $\frac{3\pi}{4}$
    (C) $\frac{3\pi}{2}$
    (D) $\frac{7\pi}{4}$

39. Suppose $x, y \in (-2, 2)$ and $xy = -1$ then the least value of $u = \frac{4}{4-x^2} + \frac{9}{9-y^2}$ is $\frac{a}{b}$ (where a and b are coprime), then
    (A) $a + b = 17$
    (B) $a + b = 19$
    (C) $a - b = 7$
    (D) $a - b = 5$

40. As shown in the diagram, the volume of tetrahedron DABC is $\frac{1}{6}$.



also $\angle ACB = 45^o$ and $AD + BC + \frac{AC}{\sqrt{2}} = 3$, then
    (A) $CD = \sqrt{3}$
    (B) $AD = 1$
    (C) $BC = 2$
    (D) $AC = 2$

41. The number of natural numbers n such that there exists an integers number x for which $499(1997^n + 1) = x^2 + x$, is/are less than
    (A) 2
    (B) 3
    (C) 4
    (D) 5

42. If $\cot^{-1}\left(1^2+\frac{3}{4}\right)+\cot^{-1}\left(2^2+\frac{3}{4}\right)+\cot^{-1}\left(3^2+\frac{3}{4}\right)+..........\infty$ is equal to $\tan^{-1}$ k, then k is
(A) prime
(B) even
(C) multiple of three
(D) odd

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

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43. Match the following List-I with List-II

	LIST – I (Number of solution of)		LIST - II
P.	$\lvert\sin x\rvert = \frac{\lvert x\rvert}{2}$ is	1.	1
Q.	$e^{-x}+e^{-x^3}=x$ is	2.	2
R.	$\sin^5 x + \cos^3 x = 1$ in $(0, 2\pi]$ is	3.	4
S.	$\lvert\cos x\rvert = 2\lvert\lvert x\rvert-1\rvert$ in $\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$ is	4.	3

The correct option is:
(A) P → 4; Q → 1; R → 3; S → 2
(B) P → 4; Q → 3; R → 1; S → 2
(C) P → 4; Q → 1; R → 2; S → 3
(D) P → 3; Q → 1; R → 4; S → 2

44. Let f: $R^+ \to R$ be an increasing function such that xf(x) + 2 > 0 and $f(x)\cdot f\left(\frac{xf(x)+4}{x}\right)=1$. Match the following List-I with List-II

	LIST - I		LIST - II
P.	The value of [f′(1)] is (where [.] denotes the greatest integer function)	1.	2
Q.	Number of points of inflection of f(x) are	2.	1
R.	The value of [1 – f(1)] is (where [.] denotes the greatest integer function)	3.	0
S.	Number of solutions of sin x = f(8) in the interval [–π, 2π] are	4.	4

The correct option is:
(A) P → 2; Q → 3; R → 1; S → 4
(B) P → 4; Q → 3; R → 1; S → 2
(C) P → 2; Q → 3; R → 4; S → 1
(D) P → 2; Q → 1; R → 3; S → 4

45. Consider two circles $S_1 \equiv (x-3)^2 + (y-1)^2 = 9$ and $S_2 = x^2 + (y-1)^2 = 9$.
Match the following List-I with List-II

LIST – I		LIST - II	
P.	Length of common tangent to $S_1 = 0$ and $S_2 = 0$ is	1.	9
Q.	Length of common chord to $S_1 = 0$ and $S_2 = 0$ is	2.	$3\sqrt{3}$
R.	Maximum distance between two points, one on $S_1 = 0$ and other on $S_2 = 0$, is	3.	6
S.	Angle between $S_1 = 0$ and $S_2 = 0$ is $\lambda\pi$, then 9λ is	4.	3

The correct option is:
(A) P → 2; Q → 4; R → 3; S → 1
(B) P → 4; Q → 2; R → 1; S → 3
(C) P → 4; Q → 3; R → 2; S → 1
(D) P → 4; Q → 3; R → 1; S → 2

46. Match the following List-I with List-II

LIST - I		LIST - II	
P.	$\int_0^{\pi/2} \sin^5 x dx$ is	1.	$\frac{3\pi - 8}{12}$
Q.	$\int_0^{\pi/4} \tan^4 x dx$ is	2.	$\frac{8}{15}$
R.	$\int_0^1 x(1-x)^5 dx$ is	3.	$\frac{1}{120}$
S.	$\int_0^{\pi/2} \sin^7 x \cos^5 x dx$ is	4.	$\frac{1}{56}$

The correct option is:
(A) P → 1; Q → 2; R → 3; S → 4
(B) P → 2; Q → 1; R → 4; S → 3
(C) P → 4; Q → 3; R → 2; S → 1
(D) P → 3; Q → 4; R → 1; S → 2

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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47. Let f(x) and g(x) are polynomial of degree 4 such that $g(\alpha) = g'(\alpha) = g''(\alpha) = 0$. If $\lim_{x\to\alpha} \frac{f(x)}{g(x)} = 0$, then number of different real solutions of equation $f(x)g'(x) + g(x)f'(x) = 0$ is equal to

48. Consider a cube whose faces are given by $x + y + z = 3\sqrt{3}$, $x + y + z = 2\sqrt{3}$, $4x - 5y + z = \sqrt{42}$, $4x - 5y + z = 2\sqrt{42}$, $2x + y - 3z = \sqrt{14}$ and $2x + y - 3z = 2\sqrt{14}$ & a triangle whose vertices are (2, 1, 3), (1, 1, 1), (3, 1, 0), then the number of point of intersection of cube and triangle is

49. Let $A = \left[a_{ij}\right]_{3\times3}$ is a square matrix of order 3 such that $\text{adj}\,A = \begin{bmatrix} 5 & -1 & -7 \\ -1 & -7 & 5 \\ -7 & 5 & -1 \end{bmatrix}$ and det(A) < 0, then $\frac{1}{3}\sum_{i=1}^{3}\sum_{j=1}^{3} a_{ij}$ is equal to

50. If the value of sin 1º sin 3º sin 5º ..... sin 179º = $\frac{1}{2^{\lambda}}$, then $(\lambda - 82)$ is equal to

51. A_1 and A_2 are the vertices of the conic C_1 : $4(x - 3)^2 + 9(y - 2)^2 - 36 = 0$ and point P is moving in the plane such that $\left|PA_1 - PA_2\right| = 3\sqrt{2}$, then the locus of P is another conic C_2. If D_1 denotes the distance between foci of conic C_2. D_2 denotes the product of perpendicular distances from the points A_1, A_2 upon any tangent drawn to the conic C_2 and D_3 denotes length of tangent drawn from any point on auxiliary circle of conic C_1 to the auxiliary circle of the conic C_2, then $\left(\frac{D_1D_2}{D_3^2}\right)^2$ is equal to

52. If (h, k) be a point on the axis of parabola $3y^2 + 4y - 6x + 8 = 0$ from which three distinct real normals could be drawn to the parabola, then $[h]_{\text{least}}$ is equal to (where [.] denotes the greatest integer function)

53. If N denotes the sum of all values of x satisfying equation $\left[\frac{x}{2}\right] - \left[\frac{x}{3}\right] = \frac{x}{7}$, then $\left|\frac{N}{7}\right|$ is equal to (where [.] denotes the greatest integer function)

54. For any acute angle ΔABC, let M denotes the maximum value of $\frac{\sin A}{A} + \frac{\sin B}{B} + \frac{\sin C}{C}$, then $\left[\frac{2\pi M}{3}\right]$ is equal to (where [.] denotes the greatest integer function)

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – XI

JEE (Advanced)-2019

PAPER – 1

TEST DATE: 13-05-2019

ANSWERS, HINTS & SOLUTIONS

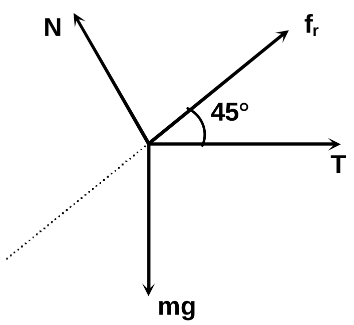
Physics PART – I

SECTION – A

1. A, B, C, D
Sol. Total displacement is zero.
Total distance travelled = $\left(\frac{1}{2}\times 10\times 20\right)\times 2 = 200\text{m}$

2. B
Sol. Equation of motion perpendicular to inclination
10 sin 30° – g cos 30° t = 0
$t = \frac{10}{10\sqrt{3}} \Rightarrow \left(t = \frac{1}{\sqrt{3}}\right)$
Time of flight T = 2t = $\frac{2}{\sqrt{3}}$ sec

3. A, B
Sol. Torque about centre must be zero
$\Rightarrow T = f_r$
T cos 45° + f_r = mg sin 45°
$$T\frac{\left(\sqrt{2}+1\right)}{\sqrt{2}} = \frac{100}{\sqrt{2}}$$
$$T = \frac{100}{\left(\sqrt{2}+1\right)}$$



4. A, B, D

Sol. $F = -\frac{dU}{dx}$

5. A, D

Sol. The maximum energy of photon depends on the energy of electrons incident.

6. A, B

Sol. Optical path difference = $\left(n_1L_1 - n_2\lambda_2\right)$

$$\Delta\phi = \frac{2\pi}{\lambda}\Delta x$$

7. A

8. A

Sol. (for Q.7-8)

$$\Delta\phi = \pi R^2\left(3B_0 - 2B_0\right) = B_0\pi R^2$$

$$\omega t = \frac{\pi}{2} \Rightarrow t = \frac{\pi}{2\omega}$$

$$\frac{\Delta\phi}{\Delta t} = \frac{2\beta_0\pi R^2\omega}{\pi}$$

$$\vec{\tau} = \vec{\mu}\times\vec{B}$$

9. A

10. A

Sol. (for Q.9-10)

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$= \frac{1}{30} + \frac{1}{60}$$

$$\Rightarrow \frac{1}{f} = \frac{1}{20} \Rightarrow f = 20\text{cm}$$

Focal length of convex mirror

$$f = \frac{1}{2}\left(30 - 10\right) = 10\text{cm}$$

SECTION – D

11. 01200.00

Sol. $$V_1 = \frac{1}{4\pi\in_0}\times\frac{q}{\sqrt{x^2 + R^2}}$$

$$V_1 = \frac{9\times10^{+9}\times10\times10^{-9}}{3\times10^{-2}} = 3000$$

$$V_2 = \frac{9\times10^{9}\times10^{-9}\times10}{5\times10^{-2}} = 1800$$

$$\Delta V = 1200\text{ V}$$

12. 00781.25

Sol. $E_1 = \frac{r}{2}\frac{dB}{dt}$

$E_2 = \frac{R^2}{2r}.\frac{dB}{dt}$

$= \frac{3}{2} \times 5 \times 10^{-2} \times \frac{25}{2 \times 6} \times 5 \times 10^{-2}$

$= \frac{25 \times 25 \times 3 \times 10^{-4}}{4 \times 6}$ = $78.125 \times 10^{-4} = 781.25 \times 10^{-5}$

13. 00002.88

Sol. $P = \frac{V^2}{4R} \Rightarrow R = \frac{V^2}{4P} = \frac{48 \times 48}{4 \times 200} = 2.88\Omega$

14. 00093.75

Sol. $I = \frac{m\ell^2}{12} = 20 \times \frac{3}{4} \times \frac{3}{4} \times \frac{1}{12} = \frac{180}{192}$

15. 00010.20

Sol. Excess pressure

$\Delta P = \frac{2T}{R} = \frac{2 \times 7 \times 10^{-2}}{0.2 \times 10^{-3}} = 700\ \text{N/m}^2$

Pressure inside bubble = $1.013 \times 10^5 + 700$

$= 10.13 \times 10^4 + 0.07 \times 10^4 = 10.20 \times 10^4\ \text{N/m}^2$

16. 00026.68

Sol. $E = \frac{GM}{2R^2} = \frac{6.67 \times 10^{-11} \times 2}{2 \times \left(\frac{1}{2}\right)^2} = 6.67 \times 4 \times 10^{-11} = 26.68 \times 10^{-11}\ \text{N/kg}$

17. 00000.60

Sol. $A_t = A_i \frac{2v_2}{(v_1 + v_2)} = \frac{2 \times 2 \times 0.9}{6} = 2 \times 0.3 = 0.6$

18. 00014.00

Sol. Slope $\frac{dP}{dV} = -\frac{\gamma P}{V}$

$\frac{7}{5} \times 10^5 = V$

$V = \frac{70}{5} \times 10^4\ \text{m}^3 = 14 \times 10^4\ \text{m}^3$

Chemistry PART – II

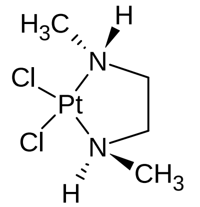
SECTION – A

19. A, C

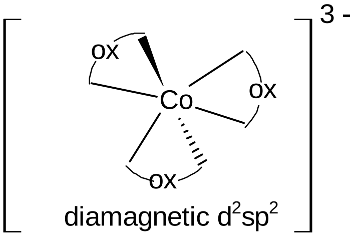
Sol. Be also reacts directly with fluorine Except Be and Mg, other alkaline earth metals give flame test.

20. A, B

Sol.



diamagnetic dsp^2



diamagnetic d^2sp^2

$K\left[Cr(H_2O)_2(C_2O_4)_2\right]$

paramagnetic

$\left[Ni(en)_2Cl_2\right]$

paramagnetic

21. B, C

Sol. $F_2 + H_2O \longrightarrow HF + O_2$

$I_2 + H_2O \longrightarrow$ No reaction

$Cl_2 + H_2O \longrightarrow HCl + HClO$

$Br_2 + H_2O \longrightarrow HBr + HBrO$

22. B, C, D

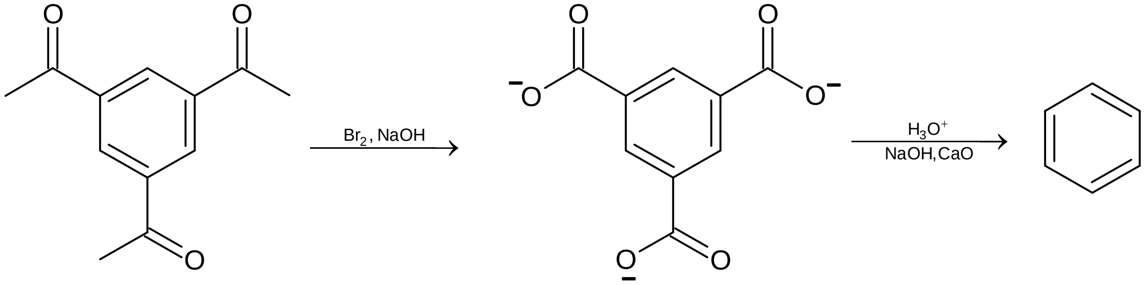
Sol. Peptization is the process of forming colloidal sol by freshly prepared precipitate in the presence of small amount of electrolyte.

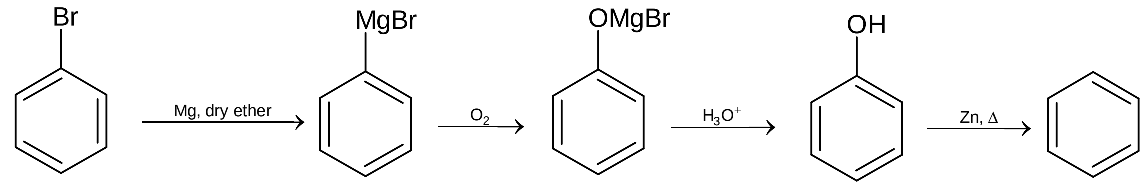
23. B, C

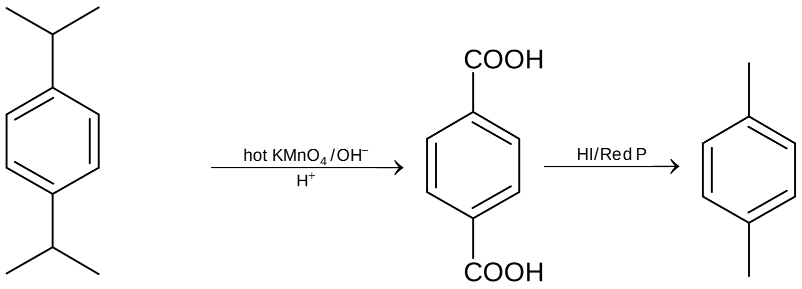
Sol. As temperature decreases or molar mass decreases
H increases
L decreases
w decreases

24. A, C, D

Sol.



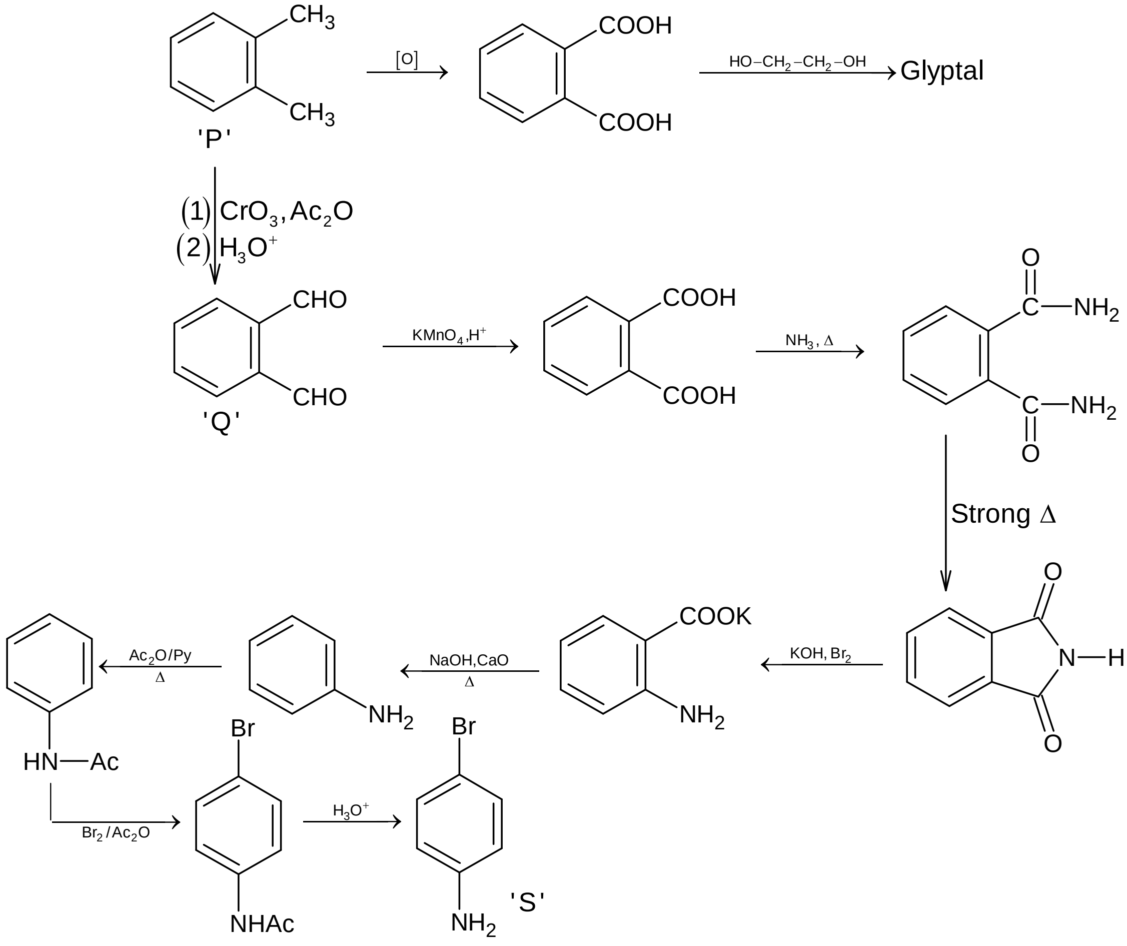

Br
Mg, dry ether
MgBr
O_2
OMgBr
H_3O^+
OH
Zn, Δ

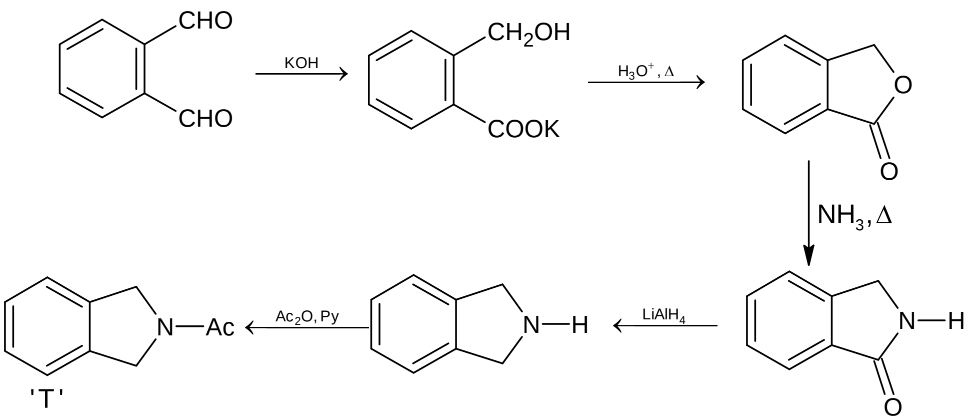

hot $KMnO_4/OH^-$
H^+
COOH
COOH
HI/Red P

25. C

26. B

Sol.

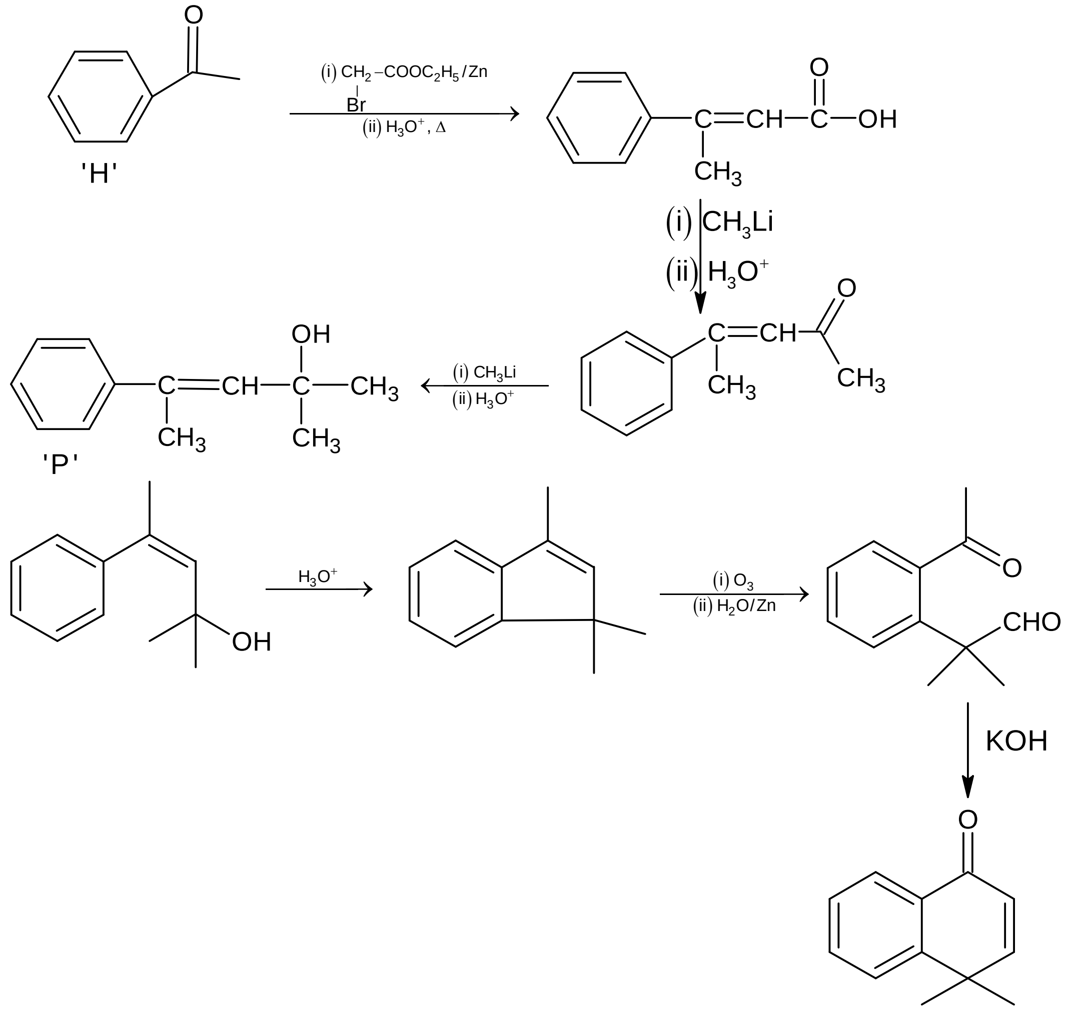

CH_3
CH_3
'P'
[O]
COOH
COOH
$HO-CH_2-CH_2-OH$
Glyptal
(1) CrO_3, Ac_2O
(2) H_3O^+
CHO
CHO
'Q'
$KMnO_4, H^+$
COOH
COOH
NH_3, Δ
O
C—NH_2
C—NH_2
O
Strong Δ
O
N—H
O
KOH, Br_2
COOK
NH_2
NaOH,CaO
Δ
NH_2
Ac_2O/Py
Δ
HN—Ac
Br_2/Ac_2O
Br
NHAc
H_3O^+
Br
NH_2
'S'


CHO
CHO
KOH
CH2OH
COOK
H3O+, Δ
O
O
NH3, Δ
N—H
O
LiAlH4
N—H
Ac2O, Py
N—Ac
'T'

27. C

28. B

Sol.


O
'H'
(i) CH2–COOC2H5/Zn
Br
(ii) H3O+, Δ
C=CH—C—OH
O
CH3
(i) CH3Li
(ii) H3O+
O
C=CH
CH3
CH3
(i) CH3Li
(ii) H3O+
OH
C=CH—C—CH3
CH3
CH3
'P'
OH
H3O+
(i) O3
(ii) H2O/Zn
O
CHO
KOH
O

SECTION – D

29. 00010.00

Sol. $d = \dfrac{Z \times m}{N_A \times a^3}$

$90 \times 10^{-3} = \dfrac{4 \times 108}{6 \times 10^{23} a^3}$

$a^3 = \dfrac{4 \times 108}{6 \times 9 \times 10^{21}}$

$a^3 = 8 \times 10^{-21}$

$a = 2 \times 10^{-7}$ cm

$a = 2 \times 10^{-9}$ m

$a = 20 \times 10^{-10}$ m

Distance between X & Y $= \dfrac{20 \times 10^{-10}}{2}$

$= 10 \times 10^{-10}$ m

30. 00051.20

Sol. $Q_P = \dfrac{(200)^2}{(2)^3 \times 50} = 100$

$\Delta G = \Delta G^o + RT\ell nQ$

$= -31.06 + \dfrac{2500}{1000} \times 4.6$

$= -31.06 + 2.5 \times 4.6$

$= -31.06 + 11.5$

$= -19.56$

$\Delta G = \Delta H - T\Delta S$

$-19.56 = -4.2 - T\Delta S$

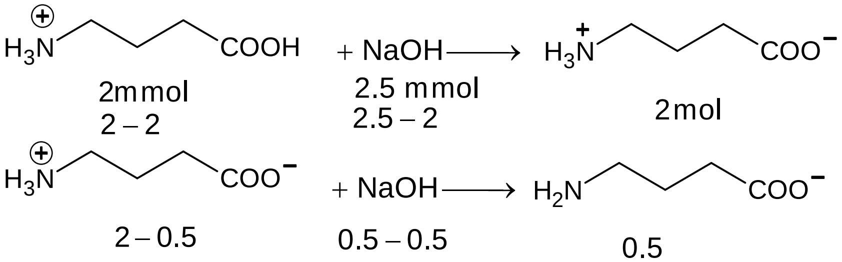
$-15.36 = -T\Delta S$

$\Delta S = \dfrac{15.36}{300} \times 1000\ JK^{-1}$

$= 51.2\ JK^{-1}$

31. 00010.22

Sol.



$pH = pK_{a_2} + \log\dfrac{[C.B]}{[Acid]}$

$= 10.7 + \log\dfrac{0.5 / V}{15 / V}$

$$pH = 10.7 + \log\frac{1}{3}$$

$= 10.7 - 0.48$

$= 10.22$

32. 00001.25

Sol. $\Lambda^{\infty} = 2x + 4xx_2 - 3xx_2 = 4x$

$$\left|\frac{k_1}{k_2} = \frac{G_1}{G_2} = \frac{R_2}{R_1}\right. \qquad k_1 \text{ for } Ba(OH)_2 \qquad k_2 \text{ for KCl}$$

$$\frac{k_1}{k_2} = \frac{1}{4000} \Rightarrow k_1 = \frac{k_2}{4000} = \frac{0.002x}{4000}$$

$$\Lambda_m^c = \frac{k_1 \times 1000}{M} = \frac{0.002x \times 1000}{4000 \times 10^{-2}} = \frac{0.2x}{4} = \frac{2x}{40} = \frac{x}{20}$$

$$\alpha = \frac{\Lambda_m^c}{\Lambda_M^{\infty}} = \frac{x}{20 \times 4x} = \frac{1}{8} \times 10^{-1} = 0.125 \times 10^{-1}$$

$$= 1.25 \times 10^{-2}$$

33. 00013.20

Sol.

$$\begin{array}{llll} & A(g) \longrightarrow & 2B(g) + C(s) + & D(g) \\ & P_o & & \\ 10\text{ min} & P_o - P & 2P & P \\ & P_o - P_o & 2P_o & P_o \end{array}$$

$3P_o = 27$

$P_o = 9\,\text{bar}$

$P_T = P_o - P + 2P + P$

$P_T = P_o + 2P$

$21 = 9 + 2P$

$2P = 12$

$P = 6\text{atm}$

$$k = \frac{1 \times 60}{10} \ln\frac{9}{9-6}$$

$= 6\ell n3$

$= 6 \times 1.1$

$= 6.6\ \text{min}^{-1}$

$r = k \times [A]$

$= 6.6 \times 2$

=13.2 mole/litre min^{-1}

34. 00000.82

Sol.

$$\begin{array}{ll} AgBr(s) \rightleftharpoons Ag^+ + Br^- & \Delta G_1^o = -RT\ell nK_{SP} \\ Ag^+ + e^- \rightleftharpoons Ag & \Delta G_2^o = -nFE_1^o \\ \hline AgBr + e^- \rightleftharpoons Ag + Br^- & \Delta G_3^o = -nFE_2^o \end{array}$$

$$\Delta G_3^o = \Delta G_1^o + \Delta G_2^o$$

$$-1FE_2^o = -1FE_1^o - RT\ell nK_{SP}$$

$$E_2^o = E_1^o + \frac{RT}{F}\ell nK_{SP}$$

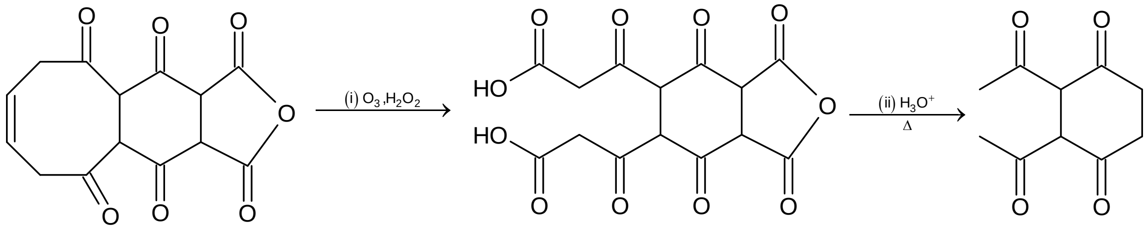
$$0.0725 = E_1^o + 0.025(-29.9)$$

$$0.0725 = E_1^o - 0.7475$$

$$E_1^o = 0.0725 + 0.7475$$
$$= 0.82$$

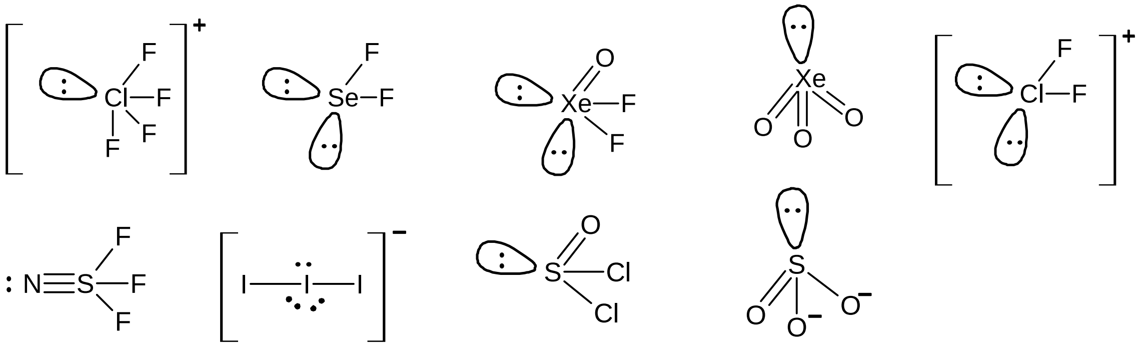
35. 00000.80

Sol.


O
HO
HO
(i) O_3,H_2O_2
(ii) H_3O^+
Δ

36. 00001.50

Sol.


$[ClF_4]^+$
Cl
F
Se
Xe
O
S
N
I
Cl
+
−

Mathematics PART – III

SECTION – A

37. B, C, D

Sol. Consider $\Delta A'B'C'$, where $\angle A' = \frac{2\pi}{3} - \angle A$, $\angle B' = \frac{2\pi}{3} - \angle B$, $\angle C' = \frac{2\pi}{3} - \angle C$

Now apply triangle inequality to get $S > -\frac{1}{\sqrt{3}}$

38. A, B, C

Sol. Take base as the x – y plane with one vertex as origin. A, B be vertices along the x, y-axes respectively

$\overrightarrow{OA} = 2\hat{i}$, $\overrightarrow{OB} = 2\hat{j}$, $\overrightarrow{OC} = \hat{i} + \hat{j} + 2\hat{k}$, where C is the apex

$\therefore$ $\overrightarrow{OA} \times \overrightarrow{OB} = 4\hat{k}$; $\overrightarrow{OA} \times \overrightarrow{OC} = 2\hat{k} - 4\hat{j}$; $\overrightarrow{OB} \times \overrightarrow{OC} = -2\hat{k} + 4\hat{i}$

Volume is $\frac{1}{3} \times$ parallelopiped = $\frac{8}{3}$

Tetrahedron with half of pyramid's base and the pyramid's apex has volume = $\frac{4}{3}$

39. C, D

Sol. $F(x) = \int_1^n \frac{x^u}{u} du$; $u \in [1, n] \Rightarrow \frac{x^u}{u}$ is strictly monotonic in x

$\Rightarrow$ F(x) is strictly monotonic

$x\int_1^n \frac{du}{u} \le \int_1^n \frac{x^u}{u} du \le x^n \int_1^n \frac{du}{u}$ as $x \to 1^+$ and $x\int_1^n \frac{du}{u} \ge \int_1^n \frac{x^u}{u} du \ge x^n \int_1^n \frac{du}{u}$ as $x \to 1^-$

$\Rightarrow \lim_{x \to 1} F(x) = \ln n$

40. A, B

Sol. $\int_0^{n+1} f(x)dx - \int_0^n f(x)dx = \int_n^{n+1} n^{x-n} dx = \frac{1}{n^n}\left[\frac{n^x}{\ln n}\right]_n^{n+1} = \frac{n-1}{\ln n}$

$\int_0^{n+1} g(x)dx - \int_0^n g(x)dx = \int_n^{n+1} (x-n)^n dx = \left.\frac{(x-n)^{n+1}}{n+1}\right]_n^{n+1} = \frac{1}{n+1}$

$t \in (0, 1) \Rightarrow \int_0^t f(x)dx = 0$, $t \in \left[1, \frac{\pi}{2}\right) \Rightarrow \int_0^t f(x)dx < \frac{\pi}{2} - 1$

$t = 1 \Rightarrow \int_0^t g(x)dx = 1$

$\lim_{n\to\infty} \int_0^n g(x)dx = \lim_{n\to\infty} \sum_{i=0}^{n} \frac{1}{i+1} \to$ Divergent series

41. A, B, D

Sol. For $x \in \left(0, \frac{\pi}{2}\right)$, f(x) = 0

For $x \in \left(\frac{\pi}{2}, \pi\right)$, $f(x) = \pi - x - x = \pi - 2x < 0$

For $x \in \left(\pi, \frac{3\pi}{2}\right)$, $f(x) = \pi - x - (2\pi - x) = -\pi < 0$

for $x \in \left(-\pi, \frac{-\pi}{2}\right)$, $f(x) = -(\pi + x) - (-x) = -\pi < 0$

42. D

Sol. Incident ray, if extended, passes through one focus (2, 0). So reflected ray will follow the path to pass through the other focus (–2, 0)

43. A

Sol. Area = $2 \cdot \frac{1}{2}\int_0^{\frac{\pi}{4}} \frac{9\cos^2\theta\sin^2\theta}{\left(\cos^3\theta + \sin^3\theta\right)^2} d\theta = \frac{3}{2}$

44. C

Sol. Length = $\int_0^1 \sqrt{r^2 + \left(\frac{dr}{d\theta}\right)^2} d\theta = \int_0^1 \sqrt{\theta^2 + 1} d\theta = \left[\frac{\theta}{2}\sqrt{1+\theta^2} + \frac{1}{2}\ln\left|\theta + \sqrt{1+\theta^2}\right|\right]_0^1$ = $\frac{1}{2}\ln\left(1+\sqrt{2}\right) + \frac{1}{\sqrt{2}}$

45. A

46. C

Sol. (for Q.45.-46)

Let A(h, k), C(x_0, y_0), B(x_1, y_1)

$h + x_0 = 9(k + y_0)$ and $h^2 + k^2 = x_0^2 + y_0^2 \Rightarrow x_0 = \frac{1}{41}(40h + 9k)$, $y_0 = \frac{1}{41}(9h - 40k)$

$h + x_1 = -(k + y_1)$ and $h^2 + k^2 = x_1^2 + y_1^2 \Rightarrow x_1 = -k, y_1 = -h$

$\frac{5 - y_1}{4 - x_1} = \frac{5 - y_0}{4 - x_0} \Rightarrow 4h^2 + 4k^2 + 41k = 0$

SECTION – D

47. 00001.00

Sol. Two bishops attack each other if they are in squares along the same diagonal. The number of ways of choosing two squares along the same diagonal on a 8 × 8 chessboard is

$2\times\left(2\left({}^2C_2 + {}^3C_2 + \ldots.. + {}^7C_2\right) + {}^8C_2\right) = 2\left({}^8C_3 + {}^9C_3\right)$

$\therefore\ P = 1 - \frac{2\left({}^8C_3 + {}^9C_3\right)}{{}^{64}C_2} = 1 - \frac{280\times 2}{64\times 63} \Rightarrow \left[\frac{1}{P}\right] = 1$

48. 00000.20

Sol. $\begin{vmatrix} x & x^2 & 1-yz \\ y & y^2 & 1-zx \\ z & z^2 & 1-xy \end{vmatrix} = (x-y)(y-z)(z-x)(1-xy-yz-zx)$

49. 00002.00

Sol. $|\text{adj } \lambda A| = |\lambda A|^2 = \lambda^6|A|^2 = \lambda^6$ (as A is orthogonal)

$|\text{Adj}(\text{adj } \lambda A)| = |\text{adj } \lambda A|^2 = \lambda^{12}$

$$\therefore \frac{\lambda^{12}}{\lambda^6} = \lambda^6 = 16 \Rightarrow [\lambda^2] = \left[\sqrt[3]{16}\right] = 2$$

50. 00003.00

Sol. $$\int_0^1 \lim_{n\to\infty} \sum_{k=0}^{n} \frac{x^{k+1}3^k}{k!}dx = \int_0^1 x \lim_{n\to\infty}\sum_{k=0}^{n} \frac{x^k 3^k}{k!}dx = \int_0^1 xe^{3x}dx = \left.\frac{xe^{3x}}{3}\right|_0^1 - \left.\frac{e^{3x}}{9}\right|_0^1 = \frac{2e^3+1}{9}$$

51. 00000.60

Sol. Probability that (i) Dice shows 2 and A reports it correctly, $\frac{1}{6}\times\frac{1}{3}=\frac{1}{18}$

(ii) Dice did not show 2 and A reported it as 2, $\frac{5}{6}\times\frac{2}{3}\times\frac{1}{5}=\frac{1}{9}$

(iii) Dice showed 4 or 6 and A reported it as 2, $\frac{2}{6}\times\frac{2}{3}\times\frac{1}{5}=\frac{2}{45}$

$$P = \frac{\frac{1}{18}+\frac{2}{45}}{\frac{1}{18}+\frac{1}{9}} = \frac{3}{5}$$

52. 00000.50

Sol. $$\frac{1}{{}^nC_0}+\frac{1}{{}^nC_n} \le a_n \le \left(\frac{1}{{}^nC_0}+\frac{1}{{}^nC_n}\right)+\left(\frac{1}{{}^nC_1}+\frac{1}{{}^nC_{n-1}}\right)+\sum_{i=2}^{n-2}\frac{1}{{}^nC_2}$$

53. 00000.02

Sol. $$T_k = \frac{51!}{50}\left[\frac{1}{(k+1).....(k+50)} - \frac{1}{(k+2)(k+3).....(k+51)}\right]$$

$$S = \frac{1}{50}$$

54. 00000.05

Sol. Other 2 vertices lie on the director circle

$L = 2\sqrt{5}$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – XI

JEE (Advanced)-2019

PAPER – 1

TEST DATE: 13-05-2019

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01– 06, 19 – 24, 37 - 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*

   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*

   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 - 46) *contains 12 questions. Based on this section contains* ***TWO (02)*** *paragraphs. Based on each paragraph, there are* ***TWO (02)*** *questions.*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

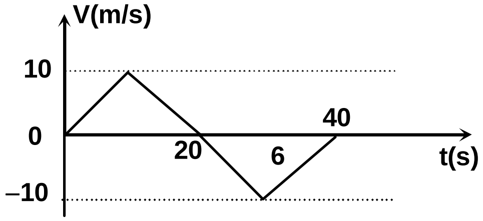
2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics PART – I

SECTION – A
(One or More than one correct type)

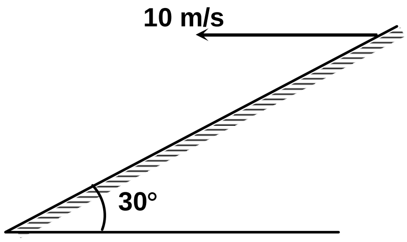
This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. Velocity time graph of a particle moving along straight line is shown in figure. Choose correct option(s).



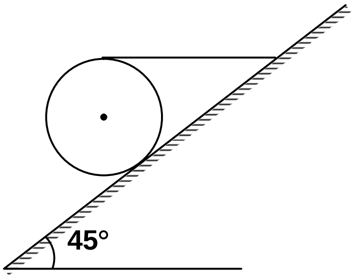
(A) Average velocity of the particle through out motion is zero.
(B) Average speed of the particle is 5 m/s.
(C) Distance travelled by the particle in 40 sec is 200 m.
(D) Displacement of the particle during first 20 sec is 100 m.

2. A particle is projected horizontally from an inclined plane with speed 10 m/s as shown in figure. ($g = 10 ms^{-2}$) choose correct option(s)



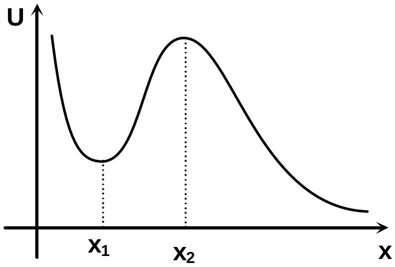
(A) Range along inclination is 10 m
(B) Time of flight is $\frac{2}{\sqrt{3}}$ sec
(C) Speed of particle when it strikes inclined plane is 15 m/s
(D) Time of flight is $\sqrt{3}$ sec.

3. A sphere of mass 10 kg is kept stationary on a rough inclined plane as shown in figure. String is massless and inextensible. At equilibrium string remains horizontal. Choose correct statement(s) : ($g = 10 ms^{-2}$)



(A) Tension in string is $\frac{100}{(\sqrt{2}+1)}$N
(B) Friction force acting on sphere is $\left(\frac{100}{\sqrt{2}+1}\right)$N
(C) Minimum value of coefficient of friction for equilibrium is 1
(D) Normal reaction between sphere and inclination is $50\sqrt{2}$ N.

4. The given plot shows the variation of potential energy of interaction between two particles with distance between them. (Particles are placed in isolated space).



(A) Mutual force acting on the particles is zero when distance between then is x_1
(B) Mutual force acting on the particles is zero when distance between then is x_2
(C) Mutual force between the particles is repulsive when distance between them is more than x_1 but less than x_2.
(D) Equilibrium is stable at x_1.

5. Electrons having de-Broglie wave length λ are incident on target in X-ray tube. Minimum wavelength of X-rays generated is λ_1. Then choose INCORRECT statement(s).
(A) If λ is increased the value of λ_1 decreases.
(B) If λ is increased the value of λ_1 increases.
(C) The value of λ_1 will not change if target metal is changed.
(D) The value of λ_1 does not depend on λ.

6. Two waves having same wavelength λ in vacuum are in phase initially. First wave travels a path length L_1 in medium of refractive index n_1 and second wave travels path length L_2 in medium of refractive index n_2. They are now combined in vacuum. Based on above information choose correct option(s).
(A) Phase difference between waves after combination is $\frac{2\pi}{\lambda}(n_1L_1 - n_2L_2)$.
(B) Frequency of both waves remains unchanged when they travel through different medium.
(C) Phase difference between waves after combination is $\frac{2\pi}{\lambda}\left(\frac{L_1}{n_1} - \frac{L_2}{n_2}\right)$
(D) Frequency of wave in medium with more refractive index will be more.

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 7 and 8

A circular loop of radius R is kept in x–y plane with centre at origin. Magnetic field in region is given by $\vec{B} = B_0\hat{i} + 2B_0\hat{j} + 3B_0\hat{k}$. Based on above information, answer the following questions.

7. If loop starts rotating with angular velocity ω about x–axis. Then value of average induced emf during the time loop changes its plane from x-y plane to x–z plane for the first time is
(A) $2B_0R^2\omega$
(B) $\frac{2B_0\omega R^2}{\pi}$
(C) $B_0\omega R^2$
(D) $\frac{B_0\omega R^2}{\pi}$

8. If a current i is flowing in loop when it was in x–y plane and at rest. The direction of current is such that when an observer situated at positive z-axis looks at loop he finds direction of current clockwise. The value of net torque about centre of loop is

(A) $2i\pi R^2 B_0\left(\hat{i}-\frac{\hat{j}}{2}\right)$

(B) $i\pi R^2 B_0\left(\hat{i}-2\hat{j}\right)$

(C) $2i\pi R^2 B_0\left(\hat{i}+\frac{\hat{j}}{2}+\hat{k}\right)$

(D) $i\pi R^2 B_0\left(\hat{i}+2\hat{j}+\hat{k}\right)$

Paragraph for Question Nos. 9 and 10

An experiment is performed to calculate the focal length of a convex mirror using convex lens. The setup consists of two pins, optical bench, one convex lens and one convex mirror.
When only convex lens is placed at a distance 60 cm from pin (object) its image is formed at a distance 30 cm from the lens as shown in figure (i) Now. Convex mirror is also kept right to the lens without changing distance between pin (object) and lens. The mirror is kept at a distance 10 cm from lens such that position of image of object pin and position of object pin coincides as shown in figure (ii)

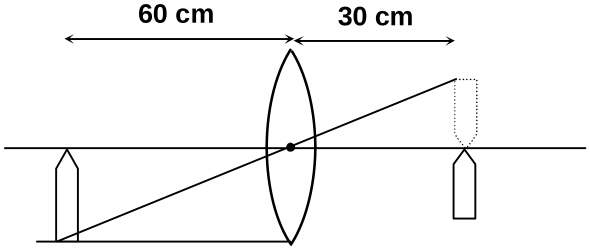


Figure (i)

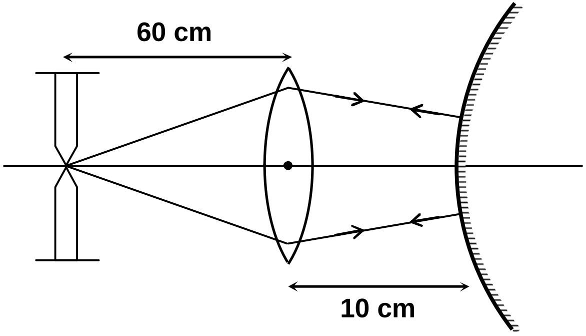


Figure (ii)

Now answer the following questions.

9. Focal length of convex lens used is
(A) 20 cm
(B) 40 cm
(C) 60 cm
(D) 30 cm

10. Focal length of convex mirror is
(A) 10 cm
(B) 30 cm
(C) 20 cm
(D) 60 cm

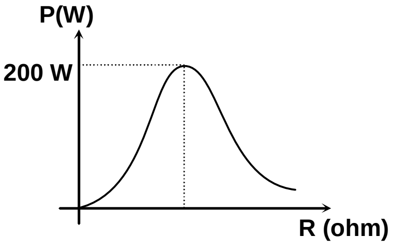
SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

11. A uniformly charged ring is placed in x – y plane with its centre at origin. Total charge on ring is (10 nC) and radius of ring is 1 cm. The magnitude of potential difference between points having co–ordinate (0, 0, $2\sqrt{2}$ cm) and (0, 0 $-2\sqrt{6}$ cm) is (in volts)

12. The magnetic field in a certain cylindrical region of radius 5 cm is varying with time according to law given by B = ($4t^2$ – 3t) where B is in Tesla and t is in second. The value of induced electric field at 3 cm from centre is E_1 and at 6 cm from centre is E_2. The value of product of magnitude of E_1 and E_2 (at t = 1 sec) is k × 10^{-5} V^2/m^2. The value of k is

13. A battery of emf 48 V unknown internal resistance is connected to a rheostat whose resistance can be varied in a long range. A graph is plotted between power developed across rheostat and resistance of rheostat which is shown in figure. The internal resistance of the battery in Ω is



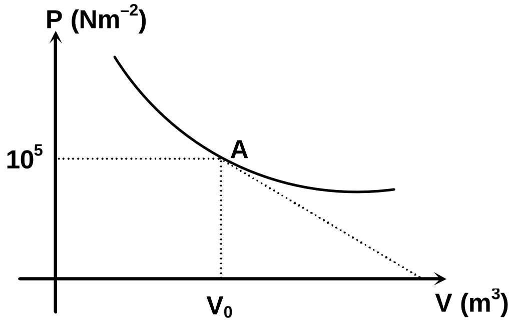
14. Moment of inertia of a uniform equilateral triangular lamina of mass 20 kg and side length 75 cm about an axis perpendicular to plane and passing through centroid (in kg–m^2) is I. The value of 100 I is

15. If pressure inside a spherical bubble of radius 0.2 mm just below the surface of water is k × 10^4 N/m^2 then the value of k is ……... (Given surface tension of water = 7 × 10^{-2} N/m and atmospheric pressure 1.013 × 10^5 N/m^2)

16. Gravitational field intensity at the centre of the base of a uniform hollow hemisphere of mass 2 kg and radius 50 cm is E × 10^{-11} N/kg. The value of E is

17. A harmonic pulse given by $y(\text{in cm}) = (0.9\text{ cm})\sin\left(t - \frac{x}{4}\right)$. x in meter and t in second is travelling in a uniform tight string. Same pulse is transmitted onto another string where speed of wave becomes 2 m/s. The amplitude of transmitted wave in (cm) is

18. P-V graph of an ideal di-atomic gas undergoing adiabatic process is shown in figure. At certain point A, tangent is drawn slope of tangent is –1 (N/m^5). The volume of the gas at point A is V × 10^4 m^3. The value of V is



Chemistry PART – II

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

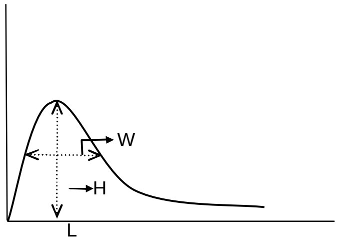
19. Which of the following statement(s) regarding alkaline earth metals is/are correct?
    (A) Only BeF_2 behaves as a Lewis acid while other fluorides of alkaline earth metals don't act as Lewis acid.
    (B) Be doesn't react directly with fluorine hence BeF_2 is prepared by heating $(NH_4)_2BeF_4$.
    (C) In solid state the geometry of $BeCl_2$ is tetrahedral.
    (D) All metals of alkaline earth metals show characteristic colour in flame test.

20. Which of the following complex(es) is/are diamagnetic as well as show(s) optical isomerism
    (A) $[PtCl_2\,(MeNH-CH_2-CH_2-NHMe)]$
    (B) $\left[Co\left(C_2O_4\right)_3\right]^{3-}$
    (C) $K\left[Cr\left(H_2O\right)_2\left(C_2O_4\right)_2\right]$
    (D) $\left[Ni\left(en\right)_2Cl_2\right]$

21. Which of the following halogen react(s) with water at room temperature to give hypohalous acid (HOX)
    (A) F_2
    (B) Cl_2
    (C) Br_2
    (D) I_2

22. The correct statement(s) pertaining to colloids is/are
    (A) The process of converting freshly prepared precipitate into colloidal sol by shaking it with dispersion medium in the presence of excess amount of electrolyte is called peptization.
    (B) Lyophilic colloids are also called as reversible sols.
    (C) Sulphur sol is an example of multimolecular colloid.
    (D) Sols are those colloids in which dispersion medium is liquid phase while dispersed phase is solid phase.

23. The Maxwell-Boltzmann distribution for molecular speeds of a gas is shown in the figure at given temperature T



In the figure H is the height of the peak, L is the location of the maximum and W is the width at half height. Which of the following statement(s) is/are correct regarding this graph:
    (A) For a given gas, as the temperature decreases, H decreases, L increases and W increases.
    (B) At a given temperature as the molar mass decreases H increases, L decreases and W decreases.

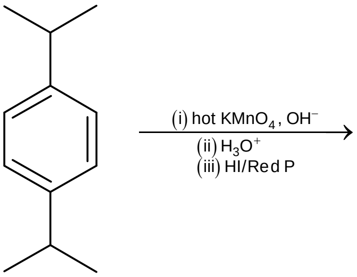
(C) For a given gas, as the temperature decreases, H increases, L decreases and W decreases.

(D) At a given temperature as the molar mass decreases H decreases, L increases and W increases.

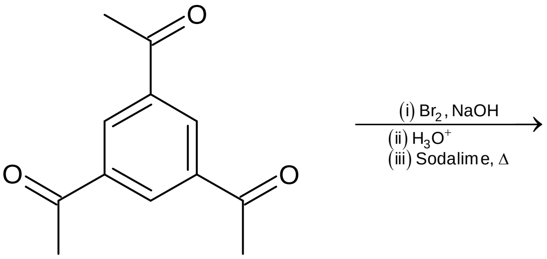
24. The reaction(s) leading to the formation of Benzene is/are

(A) $\text{n} - \text{hexane} \xrightarrow[773\text{ K}, 10-20\text{ atm}]{Cr_2O_3 \text{ or } V_2O_5}$

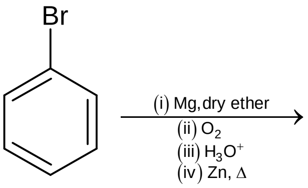
(B)



(C)



(D)



(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

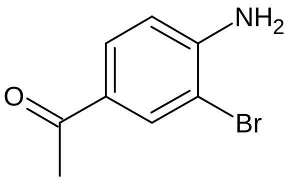
Paragraph for Question Nos. 25 and 26

A hydrocarbon 'P' (C_8H_{10}) on oxidation gives a dicarboxylic acid which reacts with ethylene glycol produce a polymer Glyptal. The compound 'P' on reaction with CrO_3/Ac_2O followed by acidic hydrolysis give a compound Q. Q undergoes the following sequences to furnish S via R. The compound Q also undergoes another set of reaction to produce T.

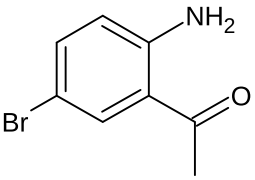
$$T \xleftarrow[\substack{3.\ NH_3,\ \Delta \\ 4.\ LiAlH_4 \\ 5.\ Ac_2O,\ Py}]{\substack{1.\ KOH \\ 2.\ H_3O^+,\ \Delta}} Q \xrightarrow[\substack{3.\ \text{Strong heating} \\ 4.\ KOH,\ Br_2}]{\substack{1.\ KMnO_4,\ H^+ \\ 2.\ NH_3,\ \Delta}} R \xrightarrow[\substack{3.\ Br_2/Ac_2O \\ 4.\ H_3O^+}]{\substack{1.\ NaOH,\ CaO \\ 2.\ Ac_2O/Py}} S$$

25. The compound S is

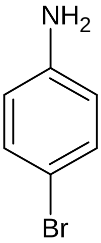
(A)



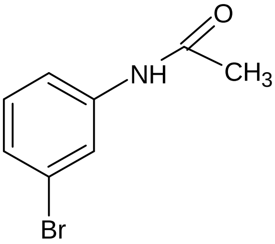
(B)



(C)

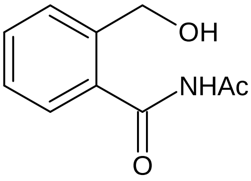


(D)

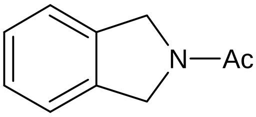


26. The compound T is:

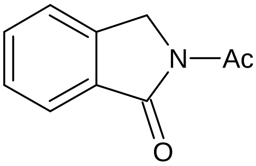
(A)



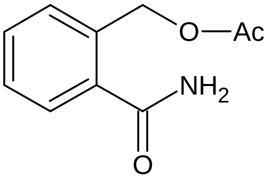
(B)



(C)



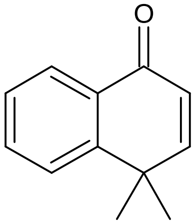
(D)



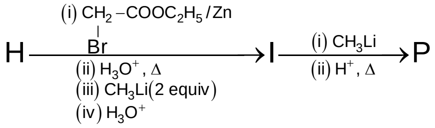
Paragraph for Question Nos. 27 and 28

A 3^o alcohol P upon acid catalysed dehydration gives a product Q. Ozonolysis of Q leads to only compound R which upon heating with KOH gives a compound S.

S =



3^o alcohol 'P' is synthesized by the following route:

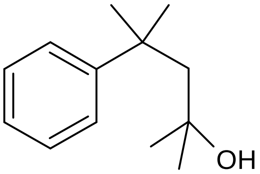


$$H \xrightarrow[\text{(ii) } H_3O^+,\ \Delta \ \text{(iii) } CH_3Li(2\text{ equiv}) \ \text{(iv) } H_3O^+]{\text{(i) } \underset{Br}{CH_2}-COOC_2H_5/Zn} I \xrightarrow[\text{(ii) } H^+,\ \Delta]{\text{(i) } CH_3Li} P$$

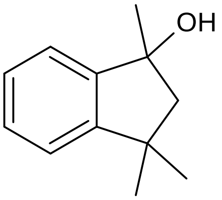
Molecular formula of H is C_8H_8O and it gives positive iodoform test.

27. The compound 'P' is:

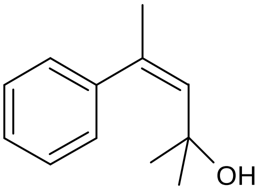
(A)



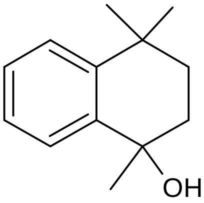
(B)



(C)

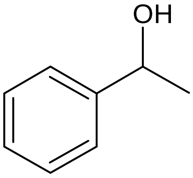


(D)

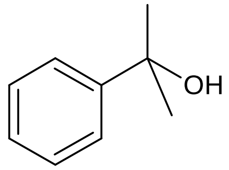


28. The compound 'H' on reaction with CH_3MgBr followed by hydrolysis gives:

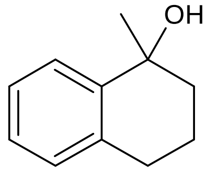
(A)



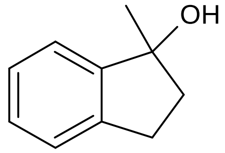
(B)



(C)



(D)



SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

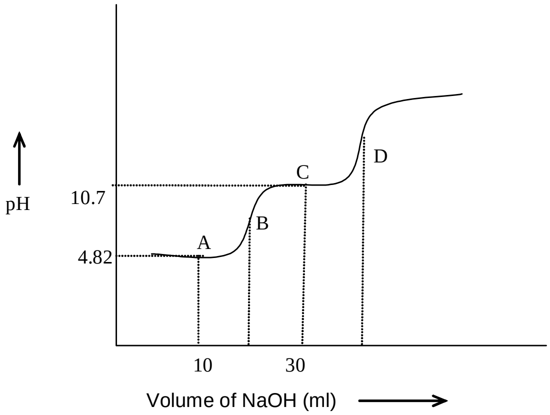
29. The density of solid XY having Rock salt type structure is 90 mg/cm^3. If the distance between X and Y is $n \times 10^{-10}$ meter. The n is (given atomic mass of X and Y are 42 and 66 gm mol^{-1} respectively and $N_A = 6 \times 10^{23}$)

30. The equilibrium of the reaction

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

is set up at 300 K by mixing $N_2(g)$ and $H_2(g)$. If the standard free energy of formation of $NH_3(g)$ is – 15.53 kJ/mol. If after one hour of mixing the partial pressure of N_2, H_2 and NH_3 are 50, 2 and 200 bar respectively and the enthalpy change of reaction is – 4.2 kJ, what is the entropy change of the reaction. (in J K^{-1}) [Given: $\ell n100 = 4.6, RT = 2500\ JK^{-1}$]

31. 4-amino butanoic acid is an important neurotransmitter. The plot given below shows the titration curve for 20 ml of 0.1 M of 4-aminobutanoic acid hydrochloride against 0.1 M of NaOH



The pH of the solution when 20 ml of 0.1 M of 4-aminobutonoic acid hydrochloride is titrated with 25 ml of 0.1 M NaOH solution is [Given: $\log_{10}3 = 0.48$]

32. The resistance of $Ba(OH)_2$ is 4000 times greater than KCl if measured in the same conductivity cell. The molar conductivity of $BaCl_2$, NaOH and NaCl at infinite dilution are 2x, 4x and 3x Scm^2 mol^{-1} respectively. If the degree of dissociation of 10^{-2} M $Ba(OH)_2$ is a × 10^{-2}. The value of 'a' is: [Given: specific conductivity of KCl is 0.002x Scm^{-1}]

33. The rate expression for the following reaction

$$A(g) \longrightarrow 2B(g) + C(s) + D(g)$$

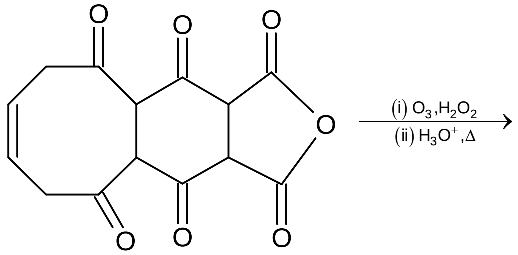
is $r = k[A]$ at 500 K and at constant volume.

The pressure of system after 10 second and after a very long time was found to be 21 and 27 bar respectively. If the conc. of A after 20 second was 2 mol/litre, then rate of reaction (in mol. $Litre^{-1}$ $minute^{-1}$) after 20 minute is [Given $\ell n3 = 1.1$]

34. The solubility product of AgBr is 1×10^{-13} at 298 K. If standard reduction potential of half cell, $E^o_{Ag/AgBr(s)/Br^-}$ is 0.0725 V, the standard reduction potential, $E^o_{Ag^+/Ag}$ (in volt) is:

$$\left[\text{Given}: \frac{RT}{F} = 0.025,\ \ell n10 = 2.3\right]$$

35. Number of carbonyl groups present in the final product of the following reaction sequence is P then $\frac{P}{5}$ is:



36. Total number of compounds in which central atom have only two lone pair is x then $\frac{x}{2}$ is:

$ClF_4^+, SeF_2, XeOF_2, XeO_3, ClF_2^+, SNF_3, I_3^-, SOCl_2, SO_3^{2-}$

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. In a ΔABC, if all angles are less than $\frac{2\pi}{3}$ and $S = \frac{\cos A + \cos B - \cos C}{\sin A + \sin B - \sin C}$, then which of the following values of S is/are possible

(A) $-\frac{1}{\sqrt{3}}$

(B) $-\frac{1}{2}$

(C) $\frac{1}{\sqrt{3}}$

(D) $\frac{1}{2}$

38. Consider a pyramid built on a square base of side 2 such that the lengths of the line segments joining its apex to the 4 corners of the base are equal and the height of the structure is equal to the length of a side of its base. Then which of the following statements is/are true

(A) volume of the pyramid is $\frac{8}{3}$

(B) the angle between the base and any other face is $\sin^{-1}\frac{2}{\sqrt{5}}$

(C) the angle between two faces with common edge which passes through the apex is $\cos^{-1}\frac{1}{5}$

(D) volume of the largest tetrahedron that can be inscribed in the pyramid is 1

39. Consider the function $F(x) = \int_1^n \frac{x^u}{u} du$ (n > 1), then which of the following statements is/are true

(A) F(x) has a local maxima at x = 2

(B) $\lim_{x \to 1^+} F(x) = 0$

(C) $\lim_{x \to 1} F(x) = \ln n$

(D) $\lim_{x \to 1^+} F(x) = \ln n$

40. Two functions f(x) and g(x) are defined as $f(x) = \begin{cases} [x]^{\{x\}} & , \ x \neq 0 \\ 0 & , \ x = 0 \end{cases}$ and $g(x) = \begin{cases} \{x\}^{[x]} & , \ x \neq 0 \\ 0 & , \ x = 0 \end{cases}$, (where [.] and {.} refer to the greatest integer function and the fractional part function respectively). Then which of the following statements is/are true (where $n \in N$)

(A) $\int_0^{n+1} f(x)dx - \int_0^n f(x)dx = \frac{n-1}{\ln n}$

(B) $\int_0^{n+1} g(x)dx - \int_0^{n} g(x)dx = \frac{1}{n+1}$

(C) $\int_0^{t} f(x)dx = \int_0^{t} g(x)dx$ has at least one solution in $t \in \left(0, \frac{\pi}{2}\right)$

(D) $e < \lim\limits_{n\to\infty} \int_0^{n} g(x)dx < e^2$

41. Consider f(x) = $\sin^{-1}(\sin x) - \cos^{-1}(\cos x)$, then which of the following statements is/are true

(A) f(x) = 0 for $x \in \left(0, \frac{\pi}{4}\right)$

(B) f(x) < 0 for $x \in \left(\frac{\pi}{2}, \frac{3\pi}{4}\right)$

(C) f(x) > 0 for $x \in \left(\pi, \frac{5\pi}{4}\right)$

(D) f(x) < 0 for $x \in \left(-\pi, \frac{-3\pi}{4}\right)$

42. Consider a mirror made out of hyperbola $x^2 - y^2 = 2$ such that its exterior surface is reflecting. A ray of light passes along x – y = 2 from the exterior of the hyperbola, then the reflected ray travels along which of the below lines.

(A) 3y – x + 3 = 0
(B) 3y + x = 0
(C) y + 7x + 2 = 0
(D) 7y + x + 2 = 0

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 43 and 44

Finding the area or the length of boundary of the shape enclosed by a set of curves requires the use of definite integration between limits defined by their points of intersection. Quite often it is easier to do the integration using polar coordinates

43. The area enclosed by the curve $x^3 + y^3 = 3xy$ is

(A) $\frac{3}{2}$

(B) $\frac{1}{2}$

(C) $\frac{\pi}{2}$

(D) $\frac{3\pi}{2}$

44. The length of the curve defined by $r = \theta$, where $0 \le \theta \le 1$, is

(A) $\frac{1}{\sqrt{2}}$

(B) $\frac{\pi}{\sqrt{2}}$

(C) $\frac{1}{\sqrt{2}}+\ln\sqrt{1+\sqrt{2}}$

(D) $\frac{\pi}{\sqrt{2}}+\ln\left(1+\sqrt{2}\right)$

Paragraph for Question Nos. 45 and 46

Let ABC be a triangle such that origin is its circumcentre & its base, BC, always passes through the point (4, 5). If the lateral sides (AB and AC) have x + y = 0 and x – 9y = 0 as their perpendicular bisectors, then the locus of A is a circle Γ.

45. Γ passes through which of the below points
(A) (0, 0)
(B) (1, 41)
(C) $\left(\frac{4}{5},\frac{3}{5}\right)$
(D) (–1, –2)

46. The centre of Γ lies on the line
(A) x + 5y = 7
(B) x – y = 0
(C) x = 0
(D) y = 0

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

47. If P is the probability of choosing two squares on a 8 × 8 standard chess-board such that two bishops on these squares cannot attack each other in one move, then $\left[\frac{1}{P}\right]$ is (where [.] denotes the greatest integer function).

48. Let x, y, z be three distinct complex numbers such that xyz = 5 and $\begin{vmatrix} x & x^2 & 1-yz \\ y & y^2 & 1-zx \\ z & z^2 & 1-xy \end{vmatrix}=0$, then $\frac{1}{x}+\frac{1}{y}+\frac{1}{z}$ is equal to

49. Let A be a 3 × 3 orthogonal matrix and λ be a non-zero, real number such that $|\text{adj}(\text{adj }\lambda A)| = 16|\text{adj }\lambda A|$, then $[\lambda^2]$ is equal to (where [.] denotes the greatest integer function)

50. Let $L=\int_0^1 \lim_{n\to\infty}\sum_{k=0}^{n}\frac{x^{k+1}3^k}{k!}dx$, then $\left[\ln\frac{9}{2}L\right]$ is equal to (where [.] denotes the greatest integer function)

51. An unbiased dice with numbers {1, 2, 3, 4, 5, 6} on its faces is rolled once. An observer, A, sees the number shown on the dice and reports it. The probability that A speaks the truth is $\frac{1}{3}$ and the probability that he lies is $\frac{2}{3}$. Assume that the number he reports is always from the set {1, 2, 3, 4, 5, 6}. If p is the probability that the actual number on the dice is even given that A reports that the number was 2, then p is equal to

52. If $a_n = \sum_{r=0}^{n} \frac{1}{{}^{n}C_r}$ and $L = \lim_{n\to\infty} \frac{1}{a_n}$, then L is equal to

53. If $S = \sum_{k=1}^{\infty} \frac{1}{{}^{k+51}C_k}$, then S is equal to

54. A parallelogram is drawn to circumscribe the curve $x^2 + 4y^2 = 4$ such that two of its vertices are $\left(\sqrt{3}, \sqrt{2}\right)$ and $\left(-\sqrt{3}, -\sqrt{2}\right)$. If L is the sum of distances of the other two vertices from the centre of the curve then $\frac{1}{L^2}$ is equal to

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – XI

JEE (Advanced)-2019

PAPER – 2

TEST DATE: 13-05-2019

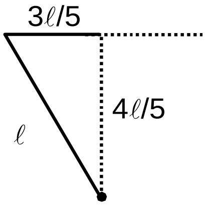
ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. A, B, D

Sol. There will be no normal reaction between rod and ring, because rod is massless. The motion of ring will be free fall under gravity.



Velocity of ring when it leaves contact with rod

$$= \sqrt{2\times g\times\frac{4\ell}{5}} = \sqrt{\frac{8g\ell}{5}}$$

Angular momentum

$$= m\frac{3\ell}{5}\sqrt{\frac{8g\ell}{5}} = m\sqrt{\frac{72g\ell^3}{125}}$$

2. C, D

Sol. $P_0A + kx_0 = P_iA$

$P_0A + k(x_0 + x) = PA$

$$P = P_0 + \frac{k}{A}(x_0 + x)$$

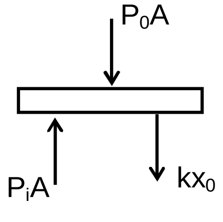
Volume = $v_0 + (x + x_0)A$

$$P = P_0 + \frac{k}{A^2}(V - V_0)$$

$$P = \frac{kV}{A^2} + \left(P_0 - \frac{kV_0}{A^2}\right)$$

$P = mV + C$

$nRT = mV^2 + CV$



$P_0A + kx_0 = P_iA$

3. A, D

Sol. $f = \frac{330}{(330-10)} \times 640$

$= \frac{330}{320} \times 640 = 660\text{ Hz}$

4. A, B, C

Sol. $q = q_0 \sin\left(\omega t + \frac{\pi}{6}\right)$

$i = q_0 \omega \cos\frac{\pi}{6}$

$\sigma = \frac{q_0}{2}\frac{\sqrt{3}}{2} \Rightarrow q_0 = \frac{24}{\sqrt{3}} = 8\sqrt{3}$

Alternatively

$\frac{q_0^2}{2C} = \frac{1}{2}\frac{(4\sqrt{3})^2}{2} + \frac{1}{2} \times 2 \times (6)^2$

$q_0 = 8\sqrt{3}$

$\frac{1}{2}Li_0^2 = \frac{q_0^2}{2C} \Rightarrow i_0 = 4\sqrt{3}$

5. A, D

Sol. $Td\theta = dm\omega^2 R$

$Td\theta = \rho\omega^2 R^2$

K.E. = $\frac{1}{2}(\rho.2\pi R)R^2\omega^2$

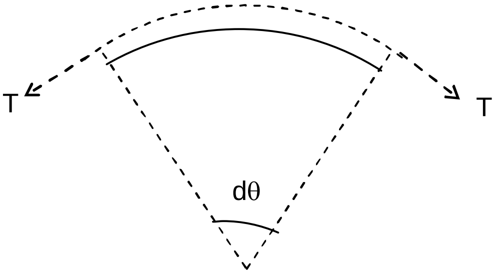
$= \pi\ \rho R^3\omega^2$

Elastic potential energy

$= \frac{1}{2} \times \frac{(\text{stress})^2}{Y} \times \text{volume}$

$= \frac{1}{2}\frac{\rho\omega^2 R^2 \times \rho\omega^2 R^2}{YA^2}.A \times 2\pi R$

$= \frac{\pi\rho^2\omega^4 R^5}{yA}$



6. A, D

Sol. $d\phi = \frac{\mu_0 i}{2\pi r}adr$

$\phi = \frac{\mu_0 ia}{2\pi}\ln 2$

7. D

Sol. $\frac{V}{2}3\rho g = V\rho g + T$

$T = \frac{V\rho g}{2}$

8. B

Sol. Magnetic field due to long wire is given by $\vec{B}=\frac{\mu_0 i}{2\pi r}\hat{n}$, where $\hat{n}$ is determined by right hand thumb rule.

9. D

Sol. $V=-x^2y+5$

$V(5, 2\ 1) = -45$ V
$V(1, 1, 1) = +4$ V
$V(2, 1, 1) = 1$ V
$V(1, 2, 1) = 3$ V

10. B

Sol. $(\mu - 1)t = \Delta x$

$\frac{t}{2} = \Delta x$

$\Delta\phi = \frac{2\pi}{\lambda}\Delta x$

$\Delta\phi = \frac{\pi}{600}\times t$

SECTION – D

11. 00000.11

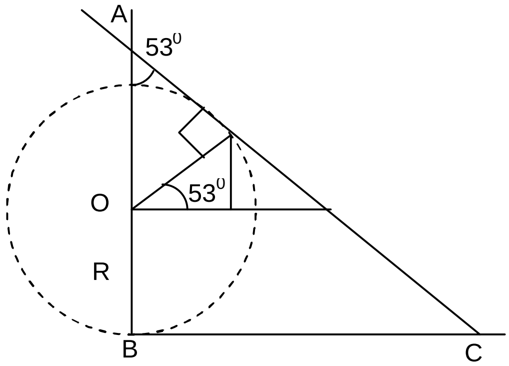
Sol. $kx = mg + m_0g - \rho Av^2$

$k.\frac{dx}{dt}=\frac{dm}{dt}.g-\rho A.2v.\frac{dv}{dt}$

$\frac{500\times(5-1)}{30\times 60}\times\frac{1}{10}=\frac{dm}{dt}$

$=\frac{2000}{30\times 60\times 10} = \frac{1}{9}=0.11.$

12. 00060.00



Sol. $\sin 53° = \frac{R}{OA}$

$OA = \frac{5R}{4}$

$AB = \frac{9R}{4}$

$\tan 53 = \frac{BC}{AB}$

$\Rightarrow \quad BC = \frac{9R}{4}\times\frac{4}{3}$

$\Rightarrow \quad BC = 3R = 60$ cm

13. 01000.00

Sol. Potential difference across resistor = iR = 10 × 100 = 1000 V
Which is equal to potential difference across capacitor.

14. 00001.50

Sol. $\frac{4\lambda}{2} = \ell$

$\Delta P = \Delta P \sin \pi/3 = \frac{\sqrt{3}\Delta P_0}{2}$

$\left|\frac{\Delta v}{v}\right| = \frac{\sqrt{3}\Delta p}{2B} = \frac{\sqrt{3}\times\sqrt{3}}{2\times 100}\times 10^{-3}$

$\frac{3}{2}\times 10^{-5} = 1.5 \times 10^{-5}$.

15. 08000.00

Sol. $\vec{a}_{cm} = -(2\hat{i} + 4\hat{j})$

$F_1 = m\,\vec{a}_{cm}$

$F_1^2 = 20 \times 400$

$= 8000$

16. 00005.00

Sol. $A = A_0 (1 - 0.19)$

$A = A_0 e^{-\lambda t}$

$0.81 = e^{-\lambda t}$

$\lambda = -\ln(0.81)$

$= 2\times 0.10 = 0.20$

$\frac{1}{\lambda} = \frac{1}{0.20} = 5\,\text{hours}$

17. 02528.00

Sol. $\frac{u^2}{g} = 4 \Rightarrow u^2 = 4g$

$v_c^2 = \frac{2GM}{R^2}$

$V_e^2 = 24\rho_1.\frac{4\pi}{3}R$

$u^2 = 4.\frac{GM}{R^2} = 4.G\rho\frac{4}{3}\pi R_3$

$\Rightarrow R^2 = R_e$

18. 00006.00

Sol. Velocity of image : $8 \times \frac{2}{4/3}\times\frac{1}{2} = 6\text{cm/s}$

Chemistry PART – II

SECTION – A

19. B, D

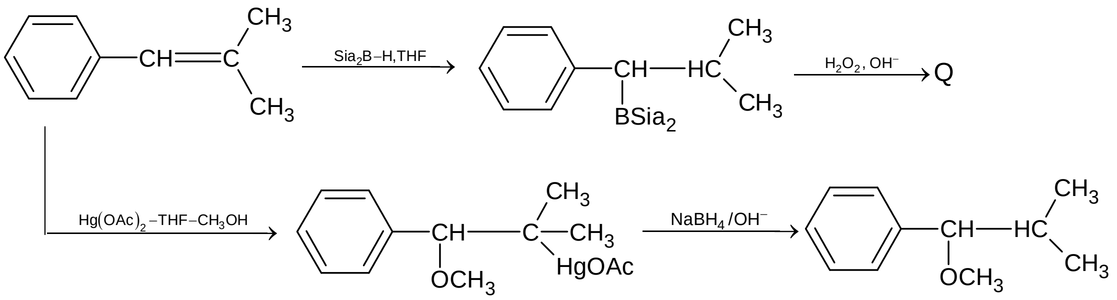
Sol. $Cu^{2+} + 4NH_3 \longrightarrow \left[Cu(NH_3)_4\right]^{2+}$

$Cd^{2+} + 4NH_3 \longrightarrow \left[Cd(NH_3)_4\right]^{2+}$

CdS and CuS both are insoluble in yellow ammonium sulphide.

20. A, C, D

Sol.



CH₃
CH═C
CH₃
Sia₂B–H,THF
CH—HC
BSia₂
CH₃
CH₃
H₂O₂, OH⁻
Q
Hg(OAc)₂–THF–CH₃OH
CH₃
CH—C—CH₃
OCH₃
HgOAc
NaBH₄/OH⁻
CH—HC
OCH₃
CH₃
CH₃

21. A, C, D

22. B, C

Sol. Since intermolecular forces are zero hence potential energy increases with decreasing distance, while Z increases by increasing pressure.

23. B, C, D

Sol. α-hydroxy ketones and aldehydes give +ve Tollen's test hence are reducing sugar.

24. A, C

Sol. S_NNGP path hence retention of configuration.

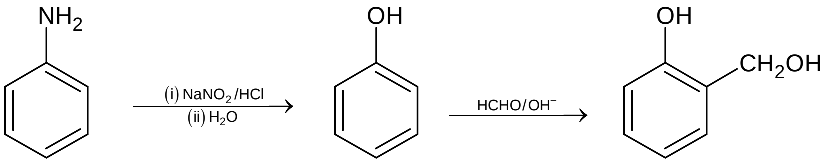
25. B

Sol. $[Co(NH_3)_4(H_2O)Cl]Br$ → shows cis-trans isomerism, paramagnetic.
sp^3d^2 hybridization, shows ionization isomerism.
$K_3[Cr(Ox)_2Cl_2]$ → shows cis-trans isomerism, paramagnetic,
shows optical isomerism d^2sp^3 hybridization
$[Ni(H_2O)_6]Cl_2$ → sp^3d^2 hydridization, paramagnetic
$[Pt(NH_3)_2Cl_2]$ → Geometrical isomerism, dsp^2 hybridization, diamagnetic

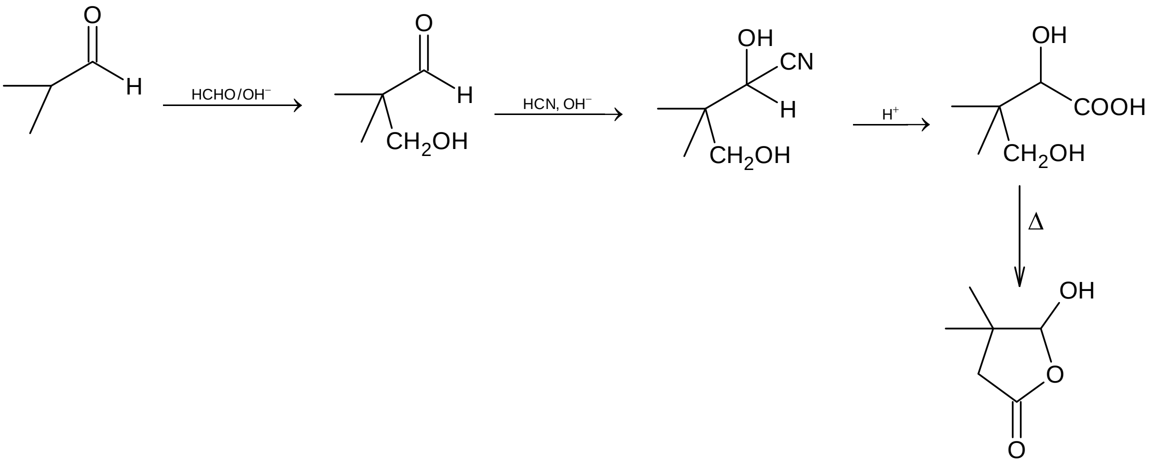
26. C

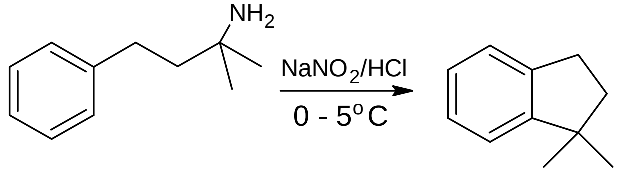
27. B

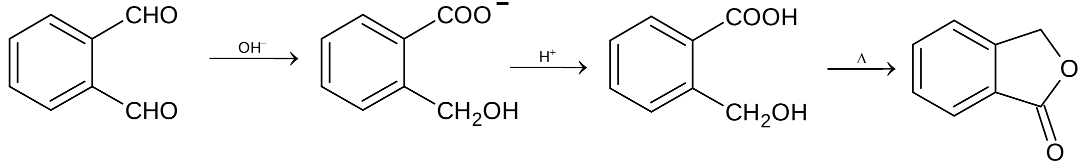
Sol.



NH₂
(i) NaNO₂/HCl
(ii) H₂O
OH
HCHO/OH⁻
OH
CH₂OH







28. B

SECTION – D

29. 00003.50

Sol. $\left[\mathrm{Ni}\left(\mathrm{NH_3}\right)_6\right]^{2+}, \mathrm{O_2}, \left[\mathrm{Ti}\left(\mathrm{H_2O}\right)_5\mathrm{Cl}\right]\mathrm{NO_3}, \mathrm{S_2}, \mathrm{Se}, \left[\mathrm{Mn}\left(\mathrm{H_2O}\right)_6\right]^{2+}, \mathrm{S}$

30. 00000.80

Sol. Leucine form N-terminal then possible combination

Leu – Ala – Phe – gly	Leu – Phen – Ala – gly
Leu – Ala – Gly – Phe	Leu – Phen – Gly – Ala

31. 00001.50

Sol.

$$2\mathrm{A(s)} \longrightarrow 2\mathrm{A}^{n+} + 2n\mathrm{e}^-$$

$$\underline{\mathrm{B}^{2n+} + 2n\mathrm{e}^- \longrightarrow \mathrm{B}}$$

$$2\mathrm{A(s)} + \mathrm{B}^{2n+}_{(aq)} \longrightarrow 2\mathrm{A}^{n+}_{(aq)} + \mathrm{B(s)}$$

$$\Delta G^o = -nFE^o$$

$$E^o = \frac{9.5}{2nF}$$

$$E = E^o - \frac{RT}{nF}\ell n\frac{\left[\mathrm{A}^{n+}\right]^2}{\left[\mathrm{B}^{2n+}\right]}$$

$$\frac{10^3}{F} = \frac{9.5\times10^3}{2nF} - \frac{2500}{2nF}\times2\times0.7$$

$$2n = 6,\quad n = 3$$

32. 08250.00

Sol. $A_3B_6(g) \rightleftharpoons 3AB_2(g)$

1

1 - α 3α

$n_T = 1 + 2\alpha$

$$\frac{VD_1}{VD_2} = \frac{n_2}{n_1}$$

$2 = 1 + 2\alpha$

α = 1/2

$$P_{AB_2} = \frac{3 \times \frac{1}{2}}{2} \times 4 = 3\,\text{atm}$$

$$P_{A_3B_6} = \frac{\frac{1}{2} \times 4}{2} = 1\,\text{atm}$$

$$K_P = \frac{(3)^3}{1} = (3)^3$$

$\Delta_r G^o = -RT\ell n(3)^3$

= - 2500 × 3 × 1.1 = - 8250 J.

33. 00020.00

Sol. PV = nRT

8.21 × 3 = n × 0.0821 × 300

n = 1

$2KI + O_3 + H_2O \longrightarrow 2KOH + I_2 + O_2$

$I_2 + 2Na_2S_2O_3 \longrightarrow 2NaI + Na_2S_4O_6$

Moles of $O_3 = \frac{1}{2}$ moles of hypo solution

$$= \frac{1}{2} \times \frac{200 \times 2}{1000} = 0.2$$

Mole % $= \frac{0.2}{1} \times 100 = 20$

34. 00140.00

Sol. $W_{ABC} = -PV\ell n\frac{P_1}{P_2}$

$= -2\ell n4$

= -2 × 2 × 0.7 = - 2.8 atm L

$W_{CDBEA} = W_{DB} + W_{EA}$

= 1.2 × 2.5 + 0.3 × 4

= 4.2 L atm

W_{net} = -2.8 + 4.2 = 1.4 L atm

= 140 J

$\Delta U = q + W$

W = - q

q = - 140 J.

35. 00050.40

Sol.
$$H_2O_2(\ell) \longrightarrow H_2O(\ell) + \frac{1}{2}O_2(g)$$

a

$a - x \qquad x \qquad x/2$

$$K = \frac{2.303}{t}\log\frac{a}{a-x}$$

$$\frac{0.693}{180} = \frac{2.303}{360}\log\frac{a}{a-x}$$

$$\frac{a}{a-x} = 4$$

3a = 4x

$$x = \frac{3}{4}a = \frac{3}{4}\times 6 = \frac{9}{2} = 4.5$$

Volume of O_2 at S.T.P. = 4.5 × 11.2 L = 50.4 litre.

36. 00001.60

Sol. Mohr's salt, Oxalic acid, Ferrous oxalate, Sodium nitrite, Sodium thiosulphate, Ethyl alcohol, Hydrogen sulphide, Stannous chloride.

Mathematics

PART – III

SECTION – A

37. D

Sol. $\left(\sum_{r=1}^{n} r\sqrt{{}^{n}C_r}\right)^2 \le \left(\sum_{r=1}^{n} r^2\right)\left(\sum_{r=1}^{n} {}^{n}C_r\right)$

38. A, B

Sol. $S \le (a_1 + a_3 + ...)(a_2 + a_4 + ...) \le \left(\frac{\sum a_i}{2}\right)^2 = \frac{1}{4}$

39. A, B, C

Sol. Let the foot of the perpendicular from origin to the line be P(2λ + 3, 3λ + 2, λ + 2)

$2(2\lambda + 3) + 3(3\lambda + 2) + (\lambda + 2) = 14\lambda + 14 = 0$

$\Rightarrow \lambda = -1$

$\Rightarrow P(1, -1, 1)$

∴ length of perpendicular is $\sqrt{3}$

$\Rightarrow$ side (a) $= \sqrt{3} \cdot \frac{2}{\sqrt{3}} = 2$

Area $= \frac{\sqrt{3}}{4}a^2 = \sqrt{3}$

Circum radius $= \frac{2}{3} \cdot \sqrt{3} = \frac{2}{\sqrt{3}}$, inradius $= \frac{1}{3} \cdot \sqrt{3} = \frac{1}{\sqrt{3}}$, Centroid is $\left(\frac{2}{3}, \frac{-2}{3}, \frac{2}{3}\right)$

40. A, B, D

Sol. $\cos C = \frac{2b}{a} = \frac{a^2 + b^2 - c^2}{2ab} \Rightarrow 3b^2 = a^2 - c^2$

41. B, D

Sol. $f(x) = \frac{1}{3}x\tan 3(x - 1)$

42. A, C

Sol. $I_n = \int_0^\infty \frac{dx}{\left(x + \sqrt{1 + x^2}\right)^n} = \int_1^\infty \frac{1}{t^n}\frac{t + \frac{1}{t}}{2t}dt$ (Put $t = x + \sqrt{1 + x^2}$)

$= \frac{1}{2}\int_1^\infty \frac{t^2 + 1}{t^{n+2}}dt = \frac{1}{2}\left[\frac{t^{-n+1}}{-n+1} + \frac{t^{-n-1}}{-n-1}\right]_1^\infty = \frac{n}{n^2 - 1}$

43. C

Sol. $f_1(x) = \tan^{-1}x + \frac{x}{1 + x^2}\begin{cases} > 0 & \text{if} \quad x > 0 \\ = 0 & \text{if} \quad x = 0 \\ < 0 & \text{if} \quad x < 0 \end{cases}$

$f_2(x)$ is not continuous at x = 1

$$f_3(x)=\begin{cases}(x+1) & ;\ \text{if } x\in[-2,0)\\ 0 & ;\ \text{if } x=0\\ (x+1)e^{-\frac{2}{x}} & ;\ \text{if } x\in(0,2]\end{cases}$$

$$\lim_{x\to\frac{\pi}{4}} f_4(x)=1$$

44. D

Sol. C_1 reduces to $(z-\bar{z})^2=(z+\bar{z}) \Rightarrow -4y^2 = 2x$
C_2 reduces to $(3x - 2y + 3) + i(-y + 1) = 0 \Rightarrow$ point where $3x - 2y + 3 = 0$ and $-y + 1 = 0$ intersect
C_3 is simply $\sqrt{2}\times$ distance from fixed line = distance from fixed point
C_4 is similar interpretation as above however fixed point lies on the fixed line

45. A
Sol. Use slope form

46. A

Sol. $\tan\frac{x}{2}=\cot\frac{x}{2}-2\cot x$

$$\cot^{-1}\left(k^2+\frac{3}{4}\right)=\cot^{-1}\left(\frac{2k-1}{2}\right)-\cot^{-1}\left(\frac{2k+1}{2}\right)$$

$$\sum_{k=1}^{\infty}\frac{1}{(2k-1)2k(2k+1)}=\frac{1}{2}\sum_{k=1}^{\infty}\left(\frac{1}{2k-1}+\frac{1}{2k+1}-\frac{2}{2k}\right)$$

$$\sum_{k=1}^{\infty}\frac{1}{(4k-1)(4k+1)}=\frac{1}{2}\sum_{k=1}^{\infty}\left(\frac{1}{4k-1}-\frac{1}{4k+1}\right)=\frac{1}{2}\sum_{k=1}^{\infty}\int_0^1\left(x^{4k-2}-x^{4k}\right)dx = \frac{1}{2}\int_0^1\left(1-x^2\right)\sum_{k=1}^{\infty}x^{4k-2}dx$$

SECTION – D

47. 00000.00

Sol. Distance of directrix from $\left(4\sqrt{3},2\right)$ is $\sqrt{3}$ and from (2, 0) is 1

$$d^2=\left(4\sqrt{3}-2\right)^2+2^2>\left(\sqrt{3}+1\right)^2$$

48. 00002.00
Sol. f(n, m) = n + 2m, each chord defines one segment, with each point of intersection creating 2 additional segments

49. 00008.00
Sol. The curve is symmetric in all 4 quadrants. Confining to first quadrant, curve is $r^2 = 4\cos\theta$

$$A=4\int_0^{\pi/2}\frac{1}{2}r^2d\theta=8\int_0^{\pi/2}\cos\theta d\theta=8$$

50. 00007.50

Sol. Use series expansion, $L=\frac{2}{5}-2\times\frac{2}{15}=\frac{2}{15}$

51. 00008.00

Sol. $|z|_{\max}=\sqrt{3}+1$ and $|z|_{\min}=\sqrt{3}-1$

52. 00004.00

Sol. $I_{n+1} = \int_0^{\pi/2} \cos^n x\left[\cos nx - \sin(n+1)x\sin x\right]dx$

$= I_n + \frac{\cos^{n+1}x}{n+1}\sin(n+1)x\Big|_0^{\pi/2} - \int_0^{\pi/2} \cos^{n+1}x\cos(n+1)xdx$

$\Rightarrow 2I_{n+1} = I_n$

53. 00004.00

Sol. Curve is one arm of hyperbola with foci (2, 4) and (2, –4)

54. 00000.08

Sol. Non-adjacent numbers with 0 = ${}^6C_3 \cdot 3 \cdot 3!$

Non-adjacent numbers without 0 = ${}^6C_4 4!$

$P = \frac{3 \cdot 3!\ {}^6C_3 + 4!\ {}^6C_4}{9000} = \frac{2}{25}$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – XI

JEE (Advanced)-2019

PAPER – 2

TEST DATE: 13-05-2019

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01 – 06, 19 – 24, 37 – 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 – 46) *contains 12 questions. Each question has* ***TWO (02)*** *matching lists:* ***LIST-I*** *and* ***LIST-II***. ***FOUR*** *options are given representing matching of elements from* ***LIST-I*** *and* ***LIST-II***. ***ONLY ONE*** *of these four options corresponds to a correct matching.*
   For each question, choose the option corresponding to the correct matching.
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics PART – I

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A light rod of length ℓ is free to rotate about one of its end in vertical plane. A ring of mass m can slide freely without friction on the rod. Initially rod is kept horizontal and ring is situated at a distance $3\ell/5$ from fixed end. Now, rod is released choose correct statement(s).

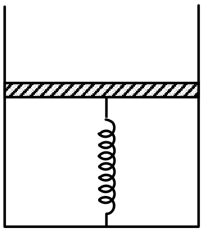
(A) Velocity of ring when it leaves contact with rod is $\sqrt{\frac{8g\ell}{5}}$.

(B) Angular momentum of the ring about point of suspension of rod when it looses contact with rod is $m\sqrt{\frac{72g\ell^3}{125}}$.

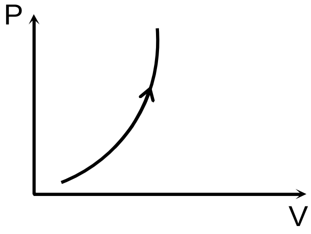
(C) Angular velocity of the rod remains constant through out the motion.

(D) Acceleration of the ring is uniform.

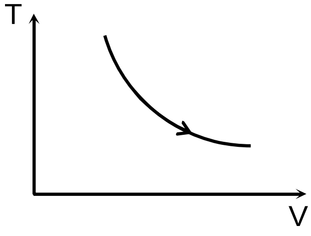
2. A piston of negligible mass is fitted with a cylinder and connected to spring of spring constant k as shown in figure. An ideal mono-atomic gas is filled in cylinder and piston is in equilibrium. Now gas in heated slowly. Which of the following graph(s) can be correct representation of process? (Initial pressure of gas is greater than atmospheric pressure).



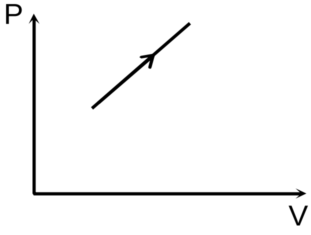
(A)

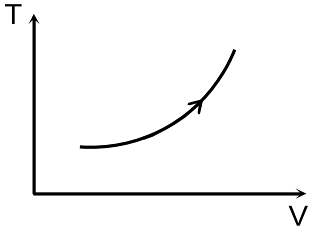


(B)

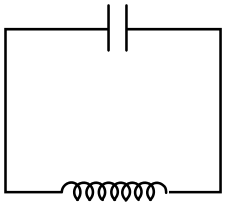


(C)



(D) 

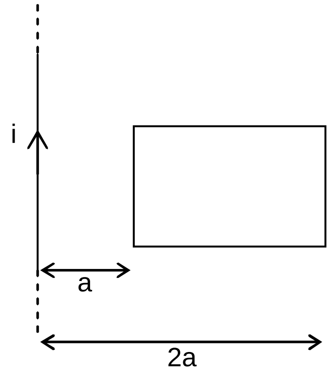
3. A car is moving towards a stationary observer with speed 10 m/s. The car blows a horn of frequency 640 Hz for 10 seconds. If speed of sound in air is 330 m/s, then
   (A) Frequency of horn heard by stationary observer is 660 Hz
   (B) The time duration during which observer hears the horn is 12 s.
   (C) Frequency of horn heard by driver of car is 640 Hz
   (D) The time duration during which observer hears the horn is 10 s.



4. In an LC circuit shown in figure C = 2F and L = 2H. At t = 0 charge on capacitor is $4\sqrt{3}\ \mu C$ and at same instant is increasing at a rate of 6 μC/s. Choose the correct statement(s):
   (A) Maximum charge on capacitor $8\sqrt{3}\ \mu C$.
   (B) Maximum current through inductor is $4\sqrt{3}\ \mu A$.
   (C) Total energy stored in circuit 48 μJ.
   (D) Total energy stored in circuit is 24 μJ.

5. A ring of radius R is made up of thin wire of linear mass density ρ having cross section area A and Young's modulus Y is made to rotate about its axis with angular velocity ω then,
   (A) Tension in ring $\rho\omega^2R^2$
   (B) Elastic potential energy stored in ring is $\frac{2\pi\rho^2\omega^4R^5}{YA}$
   (C) Tension in ring is $\frac{\rho}{2}\omega^2R^2$
   (D) Kinetic energy of the ring is $\pi\rho R^3\omega^2$

6. An infinitely long straight wire is carrying a constant current i. There is a square closed loop made of conducting wire which is placed near the wire as shown in figure. Choose correct statement(s) for above situation.



   (A) If loop is taken away from wire the current in the loop will be clockwise.
   (B) Mutual inductance of the system for the situation shown in figure will be $\frac{\mu_0 a}{4\pi}\ln 2$
   (C) If loop is taken away from the wire the current in the loop will be anticlockwise.
   (D) Mutual inductance of the system for the situation shown in figure will be $\frac{\mu_0 a \ln 2}{2\pi}$

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

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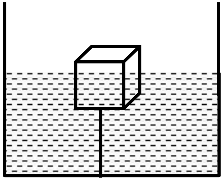
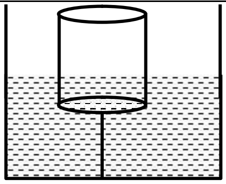
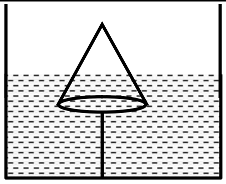
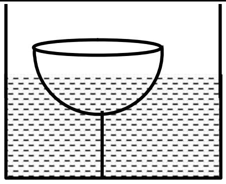
7. Different geometrical constructions of density ρ are tied to string such that they are floating in a liquid of density 3ρ with half of their volume outside liquid as shown in List –I and the value of tension in the string is given in List-II.

LIST–I		**LIST–II**	
P.	 **A cube of side 2a**	1.	$\pi a^3 \rho g$
Q.	 **A cylinder of height 2a and radius a**	2.	$4 a^3 \rho g$
R.	 **A cone of height 3a and base radius a**	3.	$9 \pi a^3 \rho g$
S.	 **A solid hemisphere of radius 3a**	4.	$\dfrac{\pi a^3 \rho g}{2}$

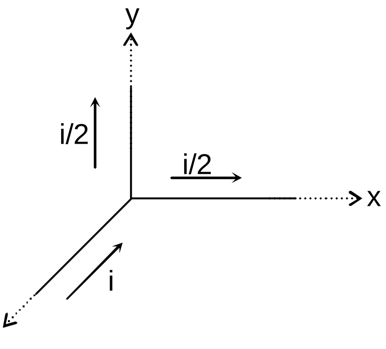
(A) P → 4; Q → 1; R → 3; S → 2

(B) P → 2; Q → 1; R → 4; S → 2

(C) P → 3; Q → 4; R → 1; S → 2

(D) P → 2; Q → 1; R → 4; S → 3

8. Three long wire carrying current are placed along axis. The magnitude and directions of current are also shown in figure. List- I contains the coordinates of certain points and List-II contains magnetic field at points listed in List-I, not necessarily in same order.



LIST–I		LIST–II	
P.	(–2a, 0, 0)	1.	$\frac{\mu_0 i}{8\pi a}(-\hat{i})+\frac{\mu_0 i}{16\pi a}(-\hat{k})$
Q.	(0, –a, 0)	2.	$\frac{\mu_0 i}{4\pi a}(-\hat{i})+\frac{\mu_0 i}{8\pi a}(-\hat{k})$
R.	(0, 0, –4a)	3.	$\frac{\mu_0 i}{16\pi a}(\hat{k})+\frac{\mu_0 i}{8\pi a}(\hat{j})$
S.	(0, –2a, 0)	4.	$\frac{\mu_0 i}{32\pi a}(-\hat{i})+\frac{\mu_0 i}{32\pi a}(\hat{j})$

(A) P → 4; Q → 1; R → 3; S → 2
(B) P → 3; Q → 2; R → 4; S → 1
(C) P → 3; Q → 4; R → 1; S → 2
(D) P → 4; Q → 1; R → 2; S → 3

9. Electric field in a region is given by $\vec{E}=\left[(2xy)\hat{i}+(x^2)\hat{j}\right]$ V/m. Electric potential at origin is 5V. Match the following two columns.

LIST–I		LIST–II	
P.	Potential at point (5 m, 2m, 1m)	1.	4 V
Q.	Potential at point (1m, 1m, 1m)	2.	1 V
R.	Potential at point (2m, 1m, 1m)	3.	3 V
S.	Potential at point (1m, 2m, 1m)	4.	–45 V

(A) P → 4; Q → 1; R → 3; S → 2
(B) P → 3; Q → 1; R → 4; S → 2
(C) P → 3; Q → 4; R → 1; S → 2
(D) P → 4; Q → 1; R → 2; S → 3

10. In a YDSE setup a transparent film of refractive index 1.5 is placed on one of the slit. Different values of t are given in column I. Column II contains the ratio of intensity at central line on screen after inserting the slab and before inserting the slab. Wavelength of light used in experiment is 600 nm. Then

LIST–I		LIST–II	
P.	400 nm	1.	3/4
Q.	200 nm	2.	1/4
R.	300 nm	3.	1/2
S.	600 nm	4.	0

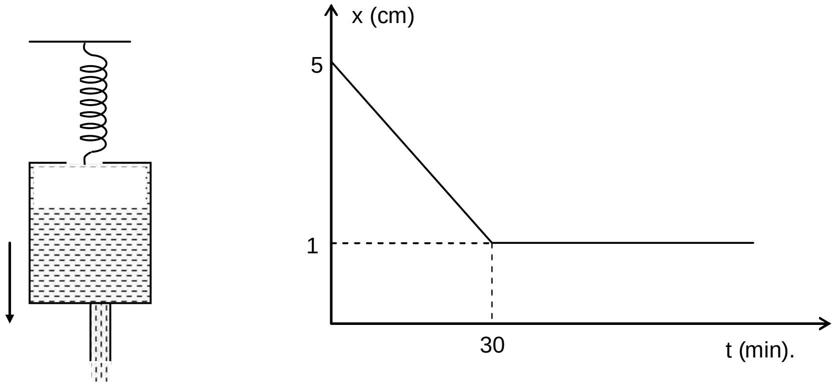
(A) P → 4; Q → 1; R → 3; S → 2

(B) P → 2; Q → 1; R → 3; S → 4
(C) P → 3; Q → 4; R → 1; S → 2
(D) P → 2; Q → 1; R → 2; S → 3

SECTION – D
(Numerical Answer Type)

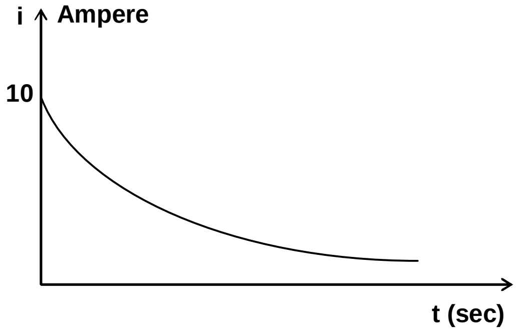
This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

11. A container filled with water is suspended with the help of a spring of spring constant 500 N/cm. A small orifice is made in container and water starts flowing out. The variation of elongation in spring with time is shown in graph calculate the flow rate of water in cm^3/sec. [Neglect any oscillations]



12. A circular plane mirror is kept on a horizontal surface, an opaque sphere of radius R = 20 cm is placed symmetrically on the circular plane mirror. An insect lies on the sphere at a vertical height of 36 cm from the circular mirror. Find the minimum radius of mirror so that image is formed by the mirror.

13. An R-C series circuit having resistance R = 100 Ω is switched on at t = 0. The graph of current v/s time is shown in figure. The value of initial potential difference across capacitor is (in Volts)



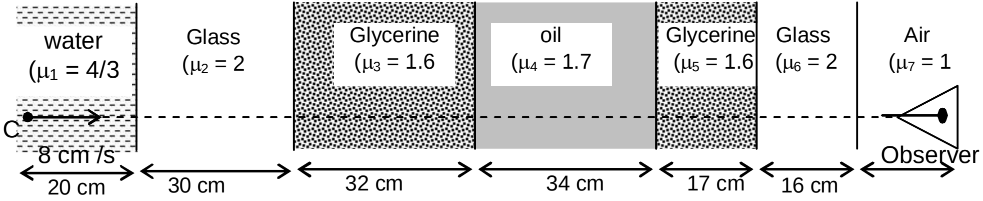
14. An open organ pipe is vibrating in air and it is vibrating in 3rd overtone with maximum pressure amplitude $\sqrt{3}$ N/m^{-2} the value of maximum volumetric strain at a distance (1/12)m from any end is k × 10^{-5}. The value of k is (Adiabatic Bulk modulus of air = 100 kN/m^2, length of organ pipe = 1m)

15. Total mass of a system of particles is 20 kg. To apply Newton's law from the centre of mass frame on a particle of mass 5 kg one has to apply pseudo force $\vec{F} = (10\hat{i} + 20\hat{j})$N on it. The magnitude of net force acting on system of particle in Newton is F_1. The value of F_1^2 is

16. What will be mean life (in hours) of a radioactive sample, if it is known that its activity decrease at the rate of 19 % per hour? [Given ln(0.9) = –0.10].

17. A man can jump over 4 m wide trench on earth. Mean density of an imaginary planet is twice that of earth, calculate maximum possible radius of that planet (in m) so that same man can escape from planet by jumping. (Radius of earth = 6400 km, use $\sqrt{10}$ = 3.16)

18. Find the velocity (in cm/s) of the car C as appeared by the observer shown in the figure. There are several parallel slabs of different medium placed between the car and the observer.


water
(μ_1 = 4/3
Glass
(μ_2 = 2
Glycerine
(μ_3 = 1.6
oil
(μ_4 = 1.7
Glycerine
(μ_5 = 1.6
Glass
(μ_6 = 2
Air
(μ_7 = 1
C
8 cm /s
Observer
20 cm
30 cm
32 cm
34 cm
17 cm
16 cm

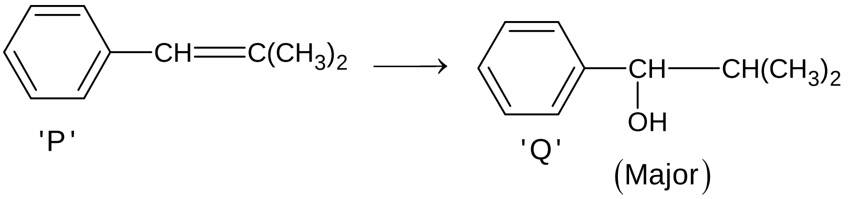
Chemistry PART – II

SECTION – A
(One or More than one correct type)

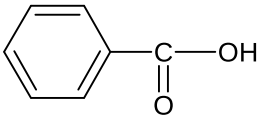
This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

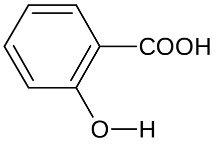
19. Which of the following statement(s) is/are correct regarding Cu^{2+} ion and Cd^{2+} ion (M = Cu or Cd)
    - (A) Only CdS is soluble in yellow ammonium sulphide.
    - (B) Only Cu^{2+} ion form $K_3[M(CN)_4]$ complex when treated with excess of KCN.
    - (C) Only Cd^{2+} ion form $[M(NH_3)_4]^{2+}$ complex when treated with excess of NH_3.
    - (D) Cu^{2+} ion gives back ppt. of CuS with H_2S gas in presence of HCl.

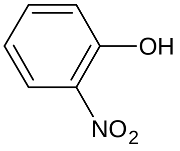
20. Which of the following reagent(s) is/are correct regarding the following conversion of (P) into (Q)

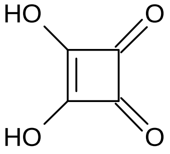


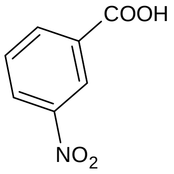
- (A) (i) $Sia_2B – H$, THF
  (ii) H_2O_2 - OH^-
- (B) (i) $Hg(OAc)_2 – THF – CH_3OH$
  (ii) $NaBH_4/OH^-$
- (C) (i) Conc. H_2SO_4
  (ii) H_2O
- (D) (i) HBr, peroxide
  (ii) Aq. KOH

21. Which of the following is/are stronger acid than 

(A)


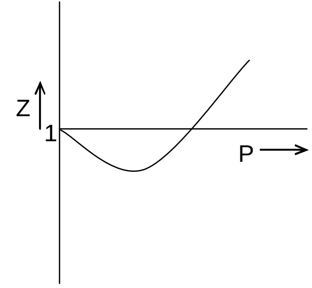
(B)


(C)


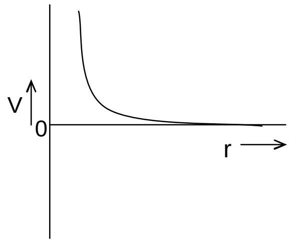
(D)


22. If intermolecular force of attraction between the atoms of a real gas is zero, which of the following graphs is/are correct regarding that gas (Z = compressibility factor, V = Potential energy, r = intermolecular distance between gas particle)

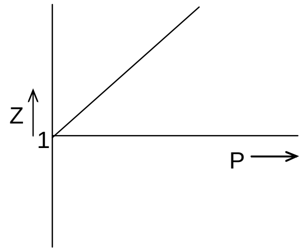
(A)



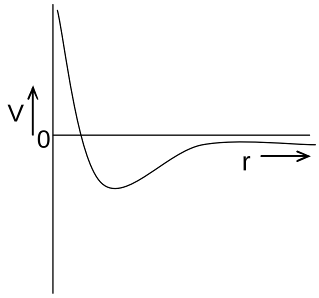
(B)



(C)

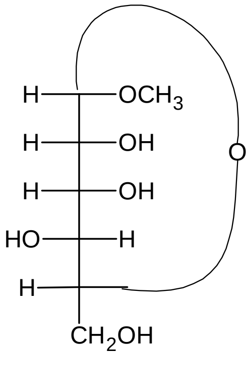


(D)

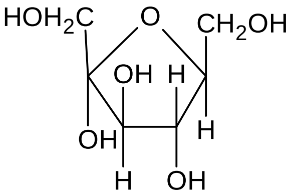


23. Which of the following is/are reducing sugar?

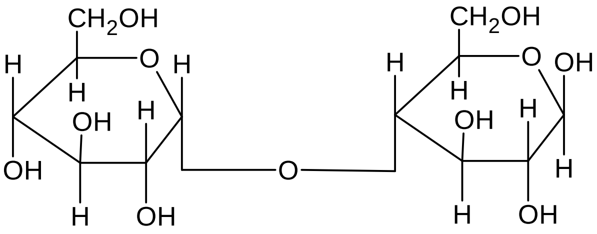
(A)



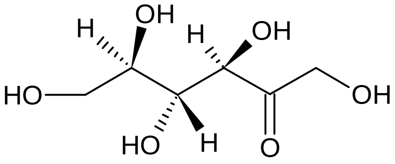
(B)



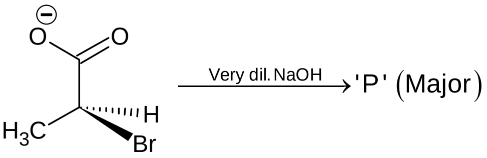
(C)



(D)

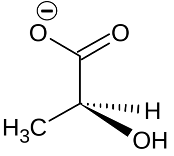


24.

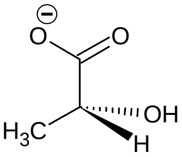


The configuration of product 'P' is/are:

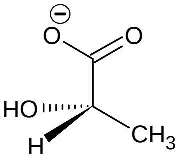
(A)



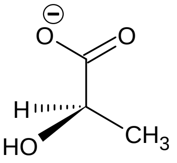
(B)



(C)



(D)



(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

---

25. Match each coordination compound in **List – I** with an appropriate pair of characteristics from **List – II** and select the correct answer using the code given below the list [Atomic number Co = 27, Cr = 24, Ni = 28, Pt = 78, Ox = oxalate ion]:

	List – I		List – II
P.	$[Co(NH_3)_4(H_2O)Cl]Br$	1.	sp^3d^2 hybridization
Q.	$K_3[Cr(Ox)_2Cl_2]$	2.	Geometrical isomerism
R.	$[Ni(H_2O)_6]Cl_2$	3.	Optical isomerism
S.	$[Pt(NH_3)_2Cl_2]$	4.	Ionization isomerism
		5.	Diamagnetic
		6.	dsp^2

The correct option is

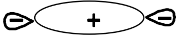
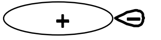
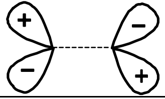
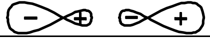
(A) P → 1, 2; Q → 2, 5; R → 1, 4; S → 2, 6

(B) P → 1, 2, 4; Q → 2, 3; R → 1; S → 2, 5, 6

(C) P → 2; Q → 2, 3, 4; R → 4, 5; S → 2, 3

(D) P → 4, 5, Q → 1, 5; R → 4; S → 2, 5

26. Atomic orbitals of two elements combine to form molecular orbitals. The axis which connect the nucleus of two elements is y axis then match each sets of atomic orbitals of **List – I** with **List – II** showing shape of molecular orbital.

	List – I		List – II
P.	$p_z + p_z$	1.	Form σ bond and shape of bonding molecular orbirtal is 
Q.	$p_y + p_y$	2.	Form σ bond and shape of bonding molecular orbital is 
R.	$p_x + p_y$	3.	Form π bond and shape of antibonding molecular orbital is 
S.	$s + p_y$	4.	Don't form any molecular orbital
		5.	Form σ bond and shape of antibonding molecular orbital is 

The correct option is

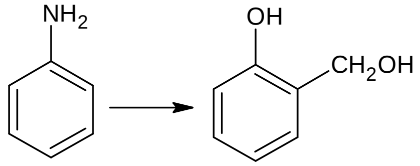
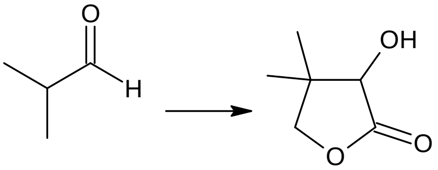
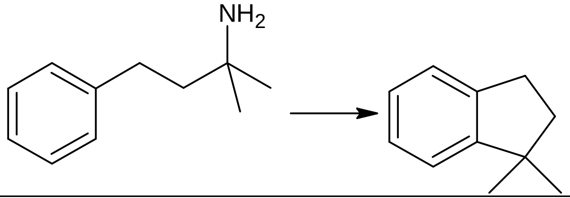
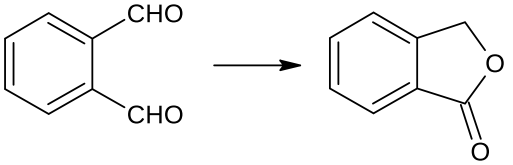
(A) P → 1, 5; Q → 3; R → 2, 5; S → 4

(B) P → 5; Q → 1, 2; R → 4; S → 5

(C) P → 3; Q → 1, 5; R → 4; S → 2

(D) P → 2, 5, Q → 3; R → 1, 2; S → 4

27. Match the chemical conversions in **List – I** with appropriate reagent(s) which is/are required for conversion in **List-II** and select the correct answer using the code given below:

List – I		**List – II (Reagents)**	
P.		1.	(i) Oleum (ii) NaOH fused (iii) H^+
Q.		2.	$HCHO / OH^-$
R.		3.	(i) HCN / OH^- (ii) H^+, Δ
S.		4.	(i) OH^- (ii) H^+, Δ
		5.	(i) $NaNO_2$|HCl (0 – 5°C) (ii) H_2O

The correct option is

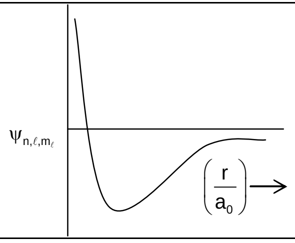
(A) P → 1, 3; Q → 4, 5; R → 1; S → 3

(B) P → 2, 5; Q → 2, 3; R → 5; S → 4

(C) P → 2; Q → 3, 4; R → 4; S → 1, 3

(D) P → 2, 5; Q → 3; R → 1, 2; S → 4, 5

28. Match each set of orbitals from **List-I** with their properties given in **List-II** (ψ_{n,ℓ,m_ℓ} is wave function depends upon spherical polar coordinate (r, θ, ϕ) of electron, z = atomic number, a_0 = Bohr's radius)

List – I		**List – II**	
P.	$3p_z$	1.	One nodal surface
Q.	$3d_{z^2}$	2.	Probability density is maximum at nucleus.
R.	2s	3.	$\psi_{n,\ell,m_\ell} \propto \left(\frac{Z}{a_0}\right)^{3/2} r^2 e^{-\left(\frac{Zr}{3a_0}\right)} \left(3\cos^2\theta - 1\right)$
S.	1s	4.	
		5.	$\psi_{n,\ell,m_\ell} \propto \left(\frac{Z}{a_0}\right)^{3/2} e^{-\frac{Zr}{3a_0}}$

The correct option is

(A) $P \to 3$; $Q \to 2, 3$; $R \to 4$; $S \to 2, 5$

(B) $P \to 1$; $Q \to 3$; $R \to 1, 2, 4$; $S \to 2, 5$

(C) $P \to 5$; $Q \to 1, 3$; $R \to 1, 5$; $S \to 2, 3$

(D) $P \to 1, 3$, $Q \to 3$; $R \to 1, 4, 5$; $S \to 2, 5$

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

29. The total number of species which having at least two unpaired electrons is X, then $\frac{X}{2}$ is:

$$\left[Ni(NH_3)_6\right]^{2+}, \left[Ni(CN)_4\right]^{2-}, \left[PtCl_4\right]^{2-}, O_2, S, NO, C_2, \left[Co(NH_3)_4(NO_3)_2\right]NO_3$$

$$\left[Ti(H_2O)_5\,Cl\right]NO_3,\ S_2\,(\text{vapour phase}), \left[Mn(H_2O)_6\right]^{2+}, Se$$

(Atomic number Ti = 22, Co = 27, S = 16, Ni = 28, Pt = 78, O = 8, N = 7, Se = 34 and Mn = 25)

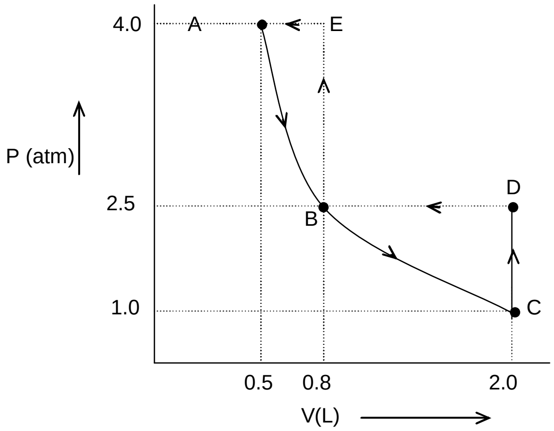
30. A tetrapeptide made up of natural amino acid has Leucine as the N-terminal residue which is coupled to a chiral amino acid upon complete hydrolysis, the tetrapeptide gives alanine, phenylalanine, glycine and leucine. The number of possible sequences of the tetrapeptide is P, $\frac{P}{5}$ is:

31. Consider an electrochemical cell $A(s) \mid A^{n+}(aq,\,2M) \parallel B^{2n+}(aq,\,1\,M) \mid B(s)$.
The value of standard free energy change of the reaction is – 9.5 kJ per mole of formation of B at 300 K and the EMF of the cell is $\frac{10^3}{F}$ volt. The value of n/2 is:
(Given RT = 2500 J/mol, $\ell n2 = 0.7$, F is Faraday charge)

32. For the reaction, at 4 atm and 300 K equilibrium established.
$A_3B_6(g) \rightleftharpoons 3AB_2(g)$
The vapour density of equilibrium mixture is half of the vapour density of A_3B_6. If the $\Delta_r G^o$ of the system is – x Joule per mole of the dissociation of A_3B_6. what is x. [Given RT = 2500 J mol^{-1}, $\ell n3 = 1.1$]

33. 3L of a mixture of O_2 and O_3 having pressure 8.21 atm at 27^{o}C is treated with 800 ml of 2M KI solution buffered with a borate buffer of pH 9.2, the iodine so liberated is titrated with 200 ml of 2M hypo solution. The mole % of ozone in the mixture (Assuming ideal behaviour of gaseous mixure and there is no reaction between oxygen and hypo solution) [Given: R = 0.0821 L atm mol^{-1} K^{-1}]

34. One mole of an ideal gas is taken reversibly from state A to C through path ABC as shown below. If the gas return back to state A through the path CDBEA as shown in the figure, the net heat given by the gas (in Joule) in complete cycle is (Only magnitude of heat change) [Given: 1 L atm = 100 J, $\ell n2 = 0.7$]



35. At 300 K the half life for first order decomposition of H_2O_2 is 180 minutes. If 6 moles of H_2O_2 is left for 360 minute at 300 K, what will be the volume of O_2 at S.T.P. (in litre) produced?

36. The total number of compounds given below can discharge the pink colour of acidic solution of $KMnO_4$ is x, then $\frac{x}{5}$.

Mohr's salt, Glauber's salt, Oxalic acid, Ferrous oxalate, Sodium nitrite, Sodium thiosulphate, Ethyl alcohol, Sodium sulphates, Hydrogen sulphide, Stannous chloride.

Mathematics PART – III

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

---

37. Consider $S = \sum_{r=1}^{n} r\sqrt{^{n}C_{r}}$, where n and r are natural numbers, then which of the following statements is/are always true

(A) $S \geq 2^{n/2} n$

(B) $S \geq \sqrt{2^{n-1} n^3}$

(C) $S \leq 2^{n/2} n$

(D) $S \leq \sqrt{2^{n-1} n^3}$

38. Let $a_1, a_2, \ldots, a_n$ represent real numbers such that $\sum_{i=1}^{n} a_i = 1$ and $a_i \geq 0 \ \forall \ i \in \{1, 2, \ldots, n\}$.

If $S = \sum_{i=1}^{n-1} a_i a_{i+1}$, then S can take which of the following values

(A) 0

(B) $\frac{1}{4}$

(C) $\frac{2}{3}$

(D) 1

39. An equilateral triangle is constructed such that the origin is one of its vertices while the other two vertices lie on the line $\frac{x-3}{2} = \frac{y-2}{3} = z-2$, then which of the following statements is/are correct

(A) area of the equilateral triangle is $\sqrt{3}$

(B) inradius of the equilateral triangle is $\frac{1}{\sqrt{3}}$

(C) circumradius of the equilateral triangle is $\frac{2}{\sqrt{3}}$

(D) centroid of the equilateral triangle is $\left(\frac{2}{\sqrt{3}}, \frac{-2}{\sqrt{3}}, \frac{2}{\sqrt{3}}\right)$

40. In ΔABC, if AD is a median and AD is perpendicular to AC, then which of the following statements is/are correct

(A) $\cos A \cos C = \frac{2(c^2 - a^2)}{3ac}$

(B) $\cos A \cos C = \frac{b^2 + c^2 - a^2}{ac}$

(C) tan A + 2 tan B = 0

(D) tan A + 2 tan C = 0

41. If f(x) satisfies the differential equation $xf'(x) = f(x) + x^2 + 9(f(x))^2$ and f(1) = 0, then which of the following statements is/are true

(A) $\lim\limits_{x \to 1^+} \frac{f(x)}{x-1} = 0$

(B) $\lim\limits_{x \to 1^-} \frac{f(x)}{x-1} = 1$

(C) $\lim\limits_{x \to 0^+} \frac{f(1+x)+f(1-x)}{x^2} = 0$

(D) $\lim\limits_{x \to 0^-} \frac{f(1+x)+f(1-x)}{x^2} = 2$

42. Consider $I_n = \int_0^{\infty} \frac{dx}{\left(x+\sqrt{1+x^2}\right)^n}$ where n > 1, then which of the following statements is/are true

(A) $I_2 = \frac{2}{3}$

(B) $I_2 = \frac{2}{5}$

(C) $I_{10} < I_5$

(D) $I_{10} > I_5$

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

---

43. Let $f_1(x) = x\tan^{-1}x$, $f_2(x) = \begin{cases} \frac{x}{\ln 2} & ; \text{ if } x \neq 1 \\ 1 & ; \text{ if } x = 1 \end{cases}$, $f_3(x) = \begin{cases} (x+1)e^{-\left(\frac{1}{|x|}+\frac{1}{x}\right)} & ; \text{ if } x \neq 0 \\ 0 & ; \text{ if } x = 0 \end{cases}$ and

$f_4(x) = \frac{2\tan\left(\frac{\pi}{4}-x\right)}{\cot 2x}$ if $x \neq \frac{\pi}{4}$

	LIST - I		LIST - II
P.	Number of critical points for $f_1(x)$ over its domain is	1.	–1
Q.	Derivative of $f_2(x)$ at x = 1 is	2.	0
R.	Number of points of discontinuity for $f_3(x)$ in the interval [–2, 2] is	3.	1
S.	Value of $f_4\left(\frac{\pi}{4}\right)$ such that the function is continuous everywhere on interval $\left[\frac{\pi}{6}, \frac{5\pi}{6}\right]$ is	4.	2
		5.	3
		6.	none of these

The correct option is:
(A) P → 4; Q → 6; R → 2; S → 2
(B) P → 3; Q → 6; R → 5; S → 3
(C) P → 3; Q → 6; R → 3; S → 3
(D) P → 2; Q → 1; R → 4; S → 1

44. Let four curves C_1, C_2, C_3 and C_4 in the Argand plane be defined as below

C_1 is $z^2+\overline{z}^2-z-\overline{z}=2|z|^2$; C_2 is $(1+i)z+(2-i)\overline{z}+(3+i)=0$;
C_3 is $|(1+i)z+(1-i)\overline{z}+5|=2|z-5-2i|$; C_4 is $|(3+4i)z+(3-4i)\overline{z}+6|=20|z-3-3i|$

LIST - I		**LIST - II**	
P.	Shape defined by C_1 is	1.	point circle
Q.	Shape defined by C_2 is	2.	circle
R.	Shape defined by C_3 is	3.	ellipse
S.	Shape defined by C_4 is	4.	hyperbola
		5.	parabola
		6.	pair of straight lines

The correct option is:
(A) P → 2; Q → 1; R → 5; S → 3
(B) P → 2; Q → 6; R → 4; S → 6
(C) P → 5; Q → 6; R → 5; S → 3
(D) P → 5; Q → 1; R → 4; S → 6

45. Consider four conics defined as follows

$C_1:\frac{x^2}{10}-\frac{y^2}{4}=1;\ C_2:\frac{x^2}{3}+\frac{y^2}{4}=1;\ C_3:\frac{y^2}{2}-x^2=1;\ C_4:x^2=16y$

LIST - I		**LIST - II**	
P.	One of the tangents to C_1 is	1.	$y = 2x + 9$
Q.	One of the tangents to C_2 is	2.	$y = 2x + 7$
R.	One of the normals to C_3 is	3.	$y = 2x + 4$
S.	One of the normals to C_4 is	4.	$y=2x+\frac{3}{\sqrt{5}}$
		5.	$y = 2x + 6$
		6.	$y=2x+\frac{6}{\sqrt{7}}$

The correct option is:
(A) P → 5; Q → 3; R → 6; S → 1
(B) P → 2; Q → 4; R → 1; S → 3
(C) P → 5; Q → 3; R → 4; S → 1
(D) P → 5; Q → 1; R → 6; S → 3

46. Match the following List-I with List-II

LIST - I		LIST - II	
P.	$\sum_{k=1}^{\infty}\frac{1}{2^k}\tan\frac{\pi}{2^{k+2}}$	1.	$\ln 2-\frac{1}{2}$
Q.	$\sum_{k=1}^{\infty}\cot^{-1}\left(k^2+\frac{3}{4}\right)$	2.	$\tan^{-1}\frac{1}{2}$
R.	$\sum_{k=1}^{\infty}\frac{1}{(2k-1)2k(2k+1)}$	3.	$\frac{\pi}{2}$
S.	$\sum_{k=1}^{\infty}\frac{1}{(4k+1)(4k-1)}$	4.	$\frac{1}{2}-\frac{\pi}{8}$
		5.	$\frac{4}{\pi}-1$
		6.	$\tan^{-1}2$

The correct option is:
(A) P → 5; Q → 6; R → 1; S → 4
(B) P → 5; Q → 3; R → 3; S → 4
(C) P → 4; Q → 6; R → 1; S → 5
(D) P → 4; Q → 2; R → 6; S → 1

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

47. The number of parabola(s) that can be drawn, with $x=\sqrt{3}y$ as directrix and passing through both the points $\left(4\sqrt{3}, 2\right)$ and (2, 0), is equal to

48. In a given circle if n chords are drawn, where n ≥ 2, such that no three chords are concurrent inside the circle and m is the number of points of intersection of the chords inside the circle, then the number of line segments obtained by dividing the chords through these m points of intersection is f(n, m). Then $\left[\frac{f(8,8)}{f(6,3)}\right]$ is equal to (where [.] denotes the greatest integer function)

49. The area enclosed by the curve $(x^2+y^2)^3=16x^2$ is equal to

50. If $L=\lim_{x\to 0}\frac{1}{x^5}\left(\ln\left(\frac{1+x}{1-x}\right)-2\tan x\right)$, then $\frac{1}{L}$ is equal to

51. Let C be the curve $\left|z+\frac{2}{z}\right|=2$ on the Argand plane. If a and b represent the maximum and minimum modulus of the complex numbers on C, then a^2+b^2 is equal to

52. If $I_n = \int_0^{\pi/2} \cos^n x \cos nx dx$, then $\sqrt{\frac{I_4}{I_8}}$ is equal to

53. The minimum distance of the curve |z – (2 + 4i)| – |z – (2 – 4i)| = 6 from the point 2 + i in the Argand plane is equal to

54. Let $a_1a_2a_3a_4$ be the decimal representation of a 4-digit number. This number is said to be "non-adjacent" if for any pair (i, j), where $1 \leq i, j \leq 4$ and $i \neq j$, $|a_i - a_j| > 1$. Let P be the probability that a 4-digit number chosen randomly is "non-adjacent", then P is equal to _____

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PAPER –1

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. BCD

Sol. $f_{\max} = \mu Mg\left(friction = f\right)$

$$\alpha_{\max} = \frac{f_{\max}R}{I_{\omega}} = \frac{2\mu g}{R}$$

At the five of slipping

$$\alpha_{\max}R = a = \frac{F = 3f_{\max}}{3M}$$

2. BC

Sol. For the bubble, $\mathrm{PV=const.}$

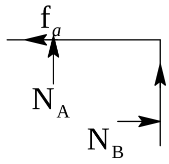
$$\therefore \frac{\mathrm{dV}}{V} = \frac{-dP}{P}$$

$$\frac{dV}{V} = \frac{3dr}{r}, dP \approx -\frac{4T}{R},\ P \approx P_0\left(\text{according to the question}\right)$$

$$\therefore\ dr = \frac{4Tr}{3P_0R}$$

3. AC

Sol. $A_A + f_B = 2mg$



$$f_B \downarrow 2mg$$

$N_B = f_A$

$mgR - f_A R - f_B R = 0$

$\Rightarrow mg = f_A + f_B$

Solve to get the ans.

4. BCD

Sol. Taking torque about R.H. side of loop

$$\mathrm{mg}\frac{\ell}{2}\text{-}\mathrm{T}_1\ell - \mathrm{ibB}=0$$

$$= -\pi \mathrm{nir}^2\mathrm{B}\hat{\mathrm{k}}$$

5. AD

Sol. $Y = \dfrac{T/A}{x/\ell}$ where $T = M\left(\ell + x\right)\omega^2 \Rightarrow x = \dfrac{\ell}{\left(\dfrac{YA}{M\ell\omega^2} - 1\right)}$

And $ms\Delta\theta = \Delta U$

$$\Delta\theta = \frac{YA\ell}{2ms}\left(\frac{1}{\dfrac{YA}{M\ell\omega^2} - 1}\right)^2$$

6. AB

Sol. As the prism are identical so deviation will be zero for even number of prism and δ for odd number of prism.

7. AC

Sol. Equivalent diagram is as shown in P is moved 2 cm right them R_1=12, R_3=3

$\dfrac{\mathrm{R}_1}{\mathrm{R}_2} = \dfrac{\mathrm{R}_2}{\mathrm{R}_4}$(Hence wheat stone will be balanced)

If s is moved left $\dfrac{5}{3}cm$ then $R_4 = \dfrac{20}{3}$ hence $\dfrac{R_1}{R_3} = \dfrac{R_2}{R_4}$ (hence wheat stone will be balanced)

8. A
9. C
10. D
11. B
12. C
13. A

Sol. **(for Q. 11 to 13)**

Take effective value of $g :\rightarrow$

For entry (II) $g_{eff} = \sqrt{3}g$

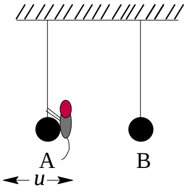
For entry (IV) of column (I)

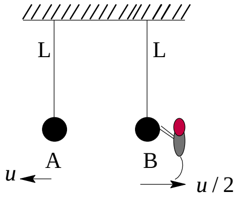
$g_{eff} = g\sin 30° = g/2$

SECTION – C

14. 8

Sol. $\frac{u}{2} = \sqrt{2g\ell} = 8m/s$

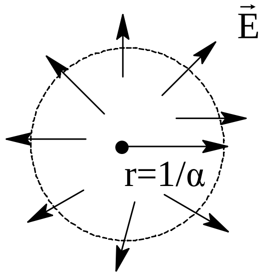




15. 1

Sol. As the electric field is radial, by applying gauss law, we can write

$$\int \vec{E}.d\vec{s} = \frac{Q}{\varepsilon_0}$$



For $r = \frac{1}{\alpha}$, $\vec{E} = C\left(1 - e^{-\alpha \times 1/\alpha}\right)\frac{\hat{r}}{\left(1/\alpha\right)^2}$

$$\therefore \oint \vec{E}.d\vec{s} = C\left(1 - e^{-1}\right)\alpha^2 \times 4\pi\left(1/\alpha\right)^2$$

$$\Rightarrow \frac{Q}{\varepsilon_0} = 4\pi C\left(1 - e^{-1}\right) \Rightarrow Q = \left(1 - e^{-1}\right) \Rightarrow \therefore N = 1$$

16. 2

Sol. $\mathrm{mr}^2\beta = \int_0^{\theta} \frac{2q}{2\pi} d\alpha\, vBr\cos\alpha$

$$\beta = \frac{dw}{dt} = \frac{qUB\sin\theta}{\pi\ mr} ----(1)$$

$$-ma = \int_0^{\theta} 2\frac{q}{2\pi} d\alpha\, rwB\cos\alpha$$

$$a = \frac{dv}{dt} = \frac{qrwB\sin\theta}{\pi\ m} ----(2)$$

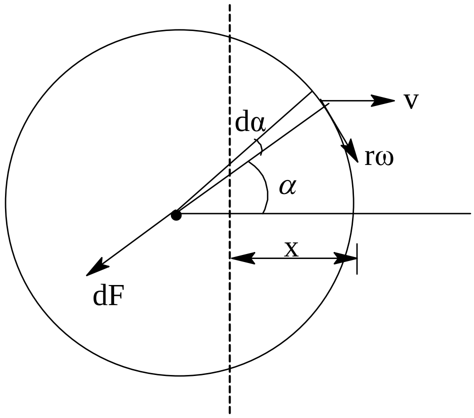
$$= \frac{dw}{dv} = \frac{v}{r^2 w} \Rightarrow r^2\int_0^{w} wdw = -\int_{v_0}^{v} v\,dv$$

$$\Rightarrow v = \frac{v_0}{\sqrt{2}}$$

$$\frac{vdv}{dx} = \frac{qrwB\sin\theta}{\pi m}$$

$$\int_{v_0}^{v_0/\sqrt{2}} \frac{vdv}{\sqrt{v_0^2 - v^2}} = \frac{qrB}{m\pi}\int_0^{\pi} \sin^2\theta d\theta$$

$$\Rightarrow q = \frac{\sqrt{2}mv_0}{Br}$$



x=r-rcosθ

dx=rsinθdθ

17. 6

Sol. Consider the object as two portion ‘A uniform rod’ and ‘A frustum’ with thermal resistance R_1 and R_2 respectively then

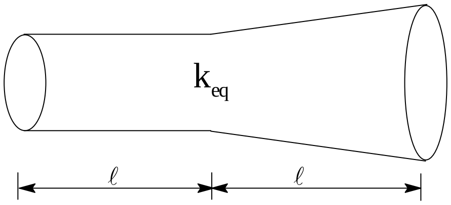
$$\mathrm{R}_1 = \frac{\ell_1}{k_1 A_1} = \frac{\ell}{k\pi r^2}$$

And $R_2 = \frac{\ell_2}{k_2 A_2} = \frac{\ell}{(2k)(\pi r_1 r_2)} = \frac{\ell}{4k\pi r^2}$

$\therefore$ Equivalent thermal resistance $R_{eq} = R_1 + R_2$

$$\Rightarrow R_{eq} = \frac{5\ell}{4k\pi r^2}......................(1)$$

Now if we consider the same lamina with equivalent thermal conductivity K_{eq}, then



$$R_{eq} = R_1 + R_2 = \frac{\ell}{k_{eq}\pi r^2} + \frac{\ell}{k_{eq}\left(2\pi r^2\right)} = \frac{3\ell}{2k_{eq}\pi r^2}........(2)$$

By equating the terms of R_{eq} from eqn. (1) & (2), we get

$$\frac{5\ell}{4k\pi r^2} = \frac{3\ell}{2k_{eq}\pi r^2}$$

$$k_{eq} = \frac{6k}{5}$$

$$\therefore N = 6$$

18. 2

Sol. t1 = RC; t2 = R/L

→LC = t1t2 = 0.1 sec -> T = 2pie $\sqrt{\frac{1}{LC}}$

T = 2 sec.

Chemistry PART – I

SECTION – A

19. ABCD

Sol. $E^0_{Cr^{3+}/Cr^{2+}} < E^0_{Fe^{3+}/Fe^{2+}} < E^0_{Co^{3+}/Co^{2+}}$

20. BC

Sol. Hydrolysis requires a $\beta-$galactosidase, showing that galactose and mannose are linked by a $\beta-$galactosidic linkage. For sugar to be reducing, one of the hexoses must have free hemiacetal form.

The methylation /hydrolysis procedure shows the point of attachment of the glycosidic bond to mannose. C_1 is anomeric carbon on mannose ring and both $\alpha-\beta$ forms satisfy the above conditions.

21. AC

Sol. Octanol and water are insoluble.

22. CD

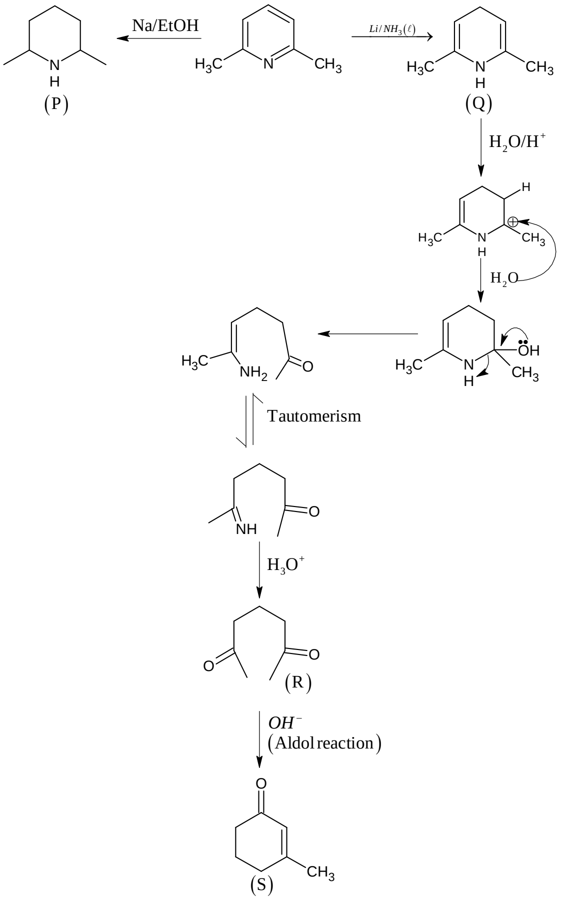
Sol. ΔG is the thermodynamical concept

23. AB

Sol. β-Keto acid on heating shows de-carboxylation on heating, through enol form

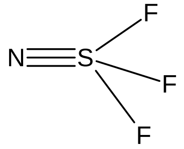
24. ABC

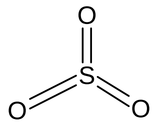
Sol.

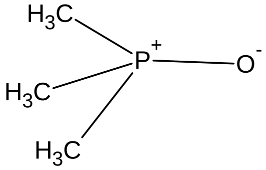


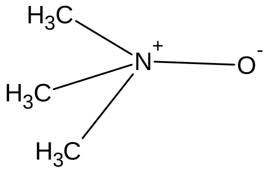
25. ABC

Sol.

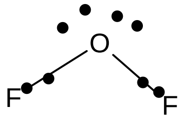


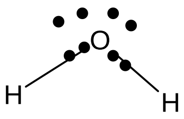






(pπ-dπ back bonding is possible)





(Less space is available for lone pairs)

26. B
27. C
28. C
29. A
30. C
31. C

Sol. **(for Q. 29 to 31)**
Increasing in polarity of the solvent will increase the rate if T.S. has more charge density in comparison to reactant**.**

SECTION – C

32. 4

Sol. $\mathrm{Ag_2C_2O_4 \longrightarrow 2Ag^+ + C_2O_4^{-2}}$

$\mathrm{C_2O_4^{-2} + H_2O \longrightarrow OH^- + HC_2O_4^{-1}}$

$\mathrm{HC_2O_4^{-1} + H_2O \longrightarrow OH^- + H_2C_2O_4}$

$$\left[C_2O_4^{2-}\right]_0 = \frac{\left[Ag^+\right]}{2} = \left[C_2O_4^{2-}\right] + \left[H_2C_2O_4^-\right] + \left[H_2C_2O_4\right]$$

$$= \left[C_2O_4^{2-}\right] + \frac{\left[H^+\right]\left[C_2O_4^{2-}\right]}{Ka_2} + \frac{\left[C_2O_4^{-2}\right]\left[H^+\right]^2}{Ka_1Ka_2}$$

$$= \left[C_2O_4^{2-}\right]\left[1 + \frac{10^{-5}}{5\times10^{-5}} + \frac{10^{-10}}{25\times10^{-7}}\right]$$

$$\frac{[\mathrm{Ag^+}]}{2} = \frac{\mathrm{K_{sp}}}{[\mathrm{Ag^+}]^2}\left[1.20004\right]$$

$$[Ag^+]^3 = 2\times K_{sp}\times\left[1.20004\right]$$

$$[Ag^+]^3 = 2\times5\times10^{-11}\times\left[1.20004\right]$$

$$[Ag^+]^3 = 10^{-10}\times\left[1.20004\right]$$

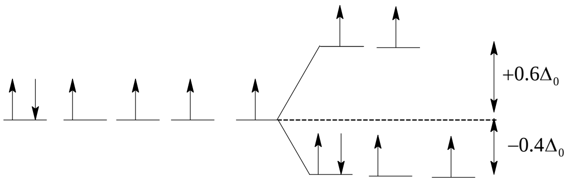
$$[Ag^+]^3 = 10^{-12}\times\left[120.004\right]$$

$$[Ag^+] = 10^{-4}\times\left[4.932\right]$$

$$\text{solubility} = \frac{[Ag^+]}{2} = 10^{-4}\times\frac{4.932}{2} = 10^{-4}\times2.46$$

33. 3

Sol. $\text{CFSE} = E_{\text{ligand field}} - E_{\text{isotopic field}}$



$$=\left[4\times\left(\frac{-2}{5}\Delta_0\right)+\left(2\times\frac{3}{5}\Delta_0\right)+P\right]-P$$

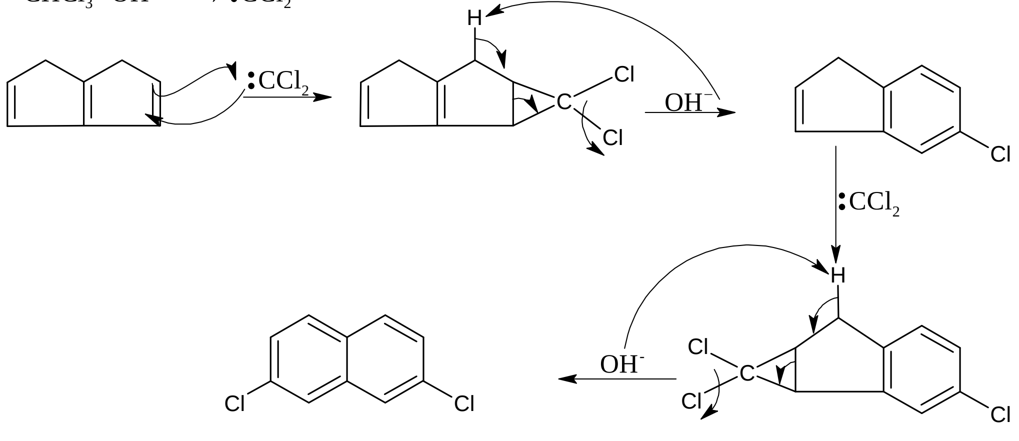
$$=\frac{-2}{5}\Delta_0$$

$$=\frac{-2}{5}\times75 \Rightarrow x=-30$$

$$\Rightarrow\left|\frac{x}{10}\right|=3$$

34. 2

Sol. $CHCl_3 + OH^- \longrightarrow :CCl_2$



It has two plane of symmetry

35. 4

Sol. Volume of unit cell$=\frac{\sqrt{3}}{2}\times(4.53)^2\times7.41\times10^{-24}\text{cm}^3$

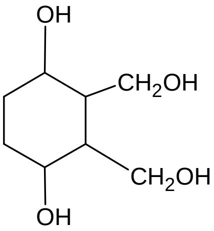
so mass$=1.211\times10^{-22}$g

molecules of $H_2O=\frac{1.211\times10^{-22}}{18}\times6.023\times10^{23}=4$

number of H atom=4

36. 4

Sol.



(A)

Mathematics PART – III

SECTION – A

37. BCD

Sol. $I = \int_{-1}^{1} \left(e^{x^3} + e^{-x^3} \right) dx > 2$

Graph is concave upwards

$\Rightarrow I < f(0) + f(1)$

38. ACD

Sol. $f'(x) = e^{-\frac{1}{x^2}} . \frac{2}{x^3} + \frac{\pi}{2}\sqrt{1 + \sin\frac{\pi x}{2}}$

And $\lim\limits_{x \to 0^+} \frac{e^{-\frac{1}{x^2}}}{x^3} = 0$

Also $\lim\limits_{x \to \infty} f(x) = \infty$

f''(x) does not exist for x=3, 7, 11….

39. AD

Sol. $\frac{2x^4 + 2y^4 + 4z^4 + 1}{4} \geq 2xyz$

And $x^4 y + xy^4 + \frac{4}{x^2 y^3} + \frac{1}{x^3 y^2} + 8 \geq 5 - 2$

$\Rightarrow \ell_2 > 10$ (equality cannot hold)

40. AB

Sol. (Put $x = y + \frac{1}{2}$)

41. AB

Sol. $\left(\frac{1}{x-1} + 1 \right) - \left(\frac{4}{x-4} + 1 \right) - \left(\frac{5}{x-5} + 1 \right) + \left(\frac{8}{x-8} + 1 \right) = \frac{6x^2 - 27x}{40}$

$\Rightarrow x = 0$

Also $\frac{2x-9}{(x-1)(x-8)} - \frac{2x-9}{(x-4)(x-5)} = \frac{3}{40}(2x-9)$

And x=9

42. ABD

Sol. Condition is satisfied for (a, b+c-2a)

$\Rightarrow b + c = 2003$

43. AD

Sol. Let

x: Total No of ways of selecting even number of red balls
even number of red balls
y: Total No of ways of selecting
odd numbers of red balls
(2-1)(4-1)(6-1)(8-1)(10-1)=x-y (2+1)(4+1)(6+1)(8+1)(10+1)=x+y

44. D
45. A
46. C

Sol. **(for Q. 44 to 46)**

(I) $\left(2+\frac{1}{2}+\frac{1}{2^3}+.......\right)+\left(\frac{1}{2^2}+\frac{1}{2^4}+....\right)$

(II) $f(t)=f^{-1}(t)$ $(t=\sin x)$

(t=1)

(III) $x=2n\pi+\frac{\pi}{4}$

(IV) $\alpha+\beta=a-1+\frac{4}{a-1}+1\geq 5$

(i) $\sum_{n=0}^{\infty}\tan^{-1}\sqrt{n+2}-\tan^{-1}\sqrt{n}$

(ii) $a^2+b^2+c^2<2(ab+bc+ca)$

(iii) $(ab+bc+ca)(a-b)=0$

$\Rightarrow ab+bc+ca=0$

(iv) $P^2+Q^2+R^2+S^2=1$

47. D
48. A
49. C

Sol. **(for Q. 47 to 49)**

(I) $|x|+|2y|=2$ and points are $\left(\pm\frac{2}{5},\pm\frac{4}{5}\right)$

(II) $(x-3)^2+(y-4)^2=4$ required minimum and maximum slopes of target from origin

(III) $3[(x-1)^2+(y-2)^2+10]$

(IV) Points are on

$|Z|=\frac{2}{\sqrt{3}}$

$AP^2+BP^2+CP^2=3|Z|^2+|Z_1|^2+|Z_2|^2+|Z_3|^2$

$-Z(\bar{Z}_1+\bar{Z}_2+\bar{Z}_3)-Z(Z_1+Z_2+Z_3)$

$=1+3\times\frac{4}{3}=5$

(i) Minimum distance

$\sqrt{4+(\tan\alpha-\cot\alpha)^2}-\sqrt{3}=2-\sqrt{3}$

(ii) $n_2=1-\frac{1}{1+n_1}$

(0 ,0) and (-2, 2)

(iii) $T_n\frac{\sqrt{n^2+(n-1)^2}-\sqrt{n^2-(n-1)^2}}{4}$

(iv) $(x+y-5)(3x+2y)(3x-2y)=0$

SECTION – C

50. 8

Sol. E_1: Dot removed from odd face.

$P(E_1)=\frac{9}{21}$

E_2: Dot removed from even face.

$P(E_2) = \frac{12}{21}$ E: Die shows odd numbers of dots.

$P(E) = P(E \cap E_1) + P(E \cap E_2) = \frac{11}{21}$

51. 9

Sol. $\left|Z\left(a+bi\right) - Z\right| = \left|(a+bi)Z\right|$

$\Rightarrow a = \frac{1}{2}$

$a^2 + b^2 = 64$

52. 2

Sol. $\begin{bmatrix} 1 & 2n & na+8\sum_{k=0}^{n-1} k \\ 0 & 1 & 4n \\ 0 & 0 & 1 \end{bmatrix}$

53. 9

Sol. A.M.=G.M.

$\frac{r_1}{2} = \frac{r_2}{4} = \frac{r_3}{5} = \frac{r_4}{8} = k$

54. 8

Sol. $t_1 + t_2 = 2$

$\frac{2-m_2}{1+2m_2} = \sqrt{3}$

and $\frac{m_3-2}{1+2m_3} = \sqrt{3}$

$t_1 + t_2 + t_3 = \frac{p}{q} = \frac{3}{11}$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – II

JEE (Advanced)-2019

PAPER –1

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

Section-A (01– 07, 19 – 25, 37 - 43) *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 mark*** *for wrong answer*

Partial Marks **+1** for each correct option provided no incorrect options is selected.

Section-A (08 – 13, 26 – 31, 44 - 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S).*

Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

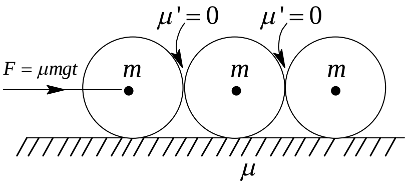
Section-C (14 – 18, 32 – 36, 50 - 54) *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics PART – I

SECTION – A
(More Than One Correct Type)

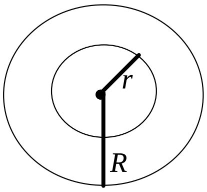
This section contains **7 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

1. Three identical cylinders each of mass M and radius R are in contact and kept on a rough horizontal surface, coefficient of friction between any cylinder and surface is μ. A force $F = \mu Mgt$ acts on the first cylinder. Mark the correct statement:



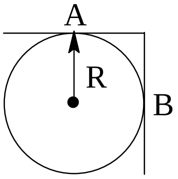
(A) The cylinders will start pure rolling and keep on rolling without sliding
(B) At t = 9 second slipping will start
(C) Velocity of centre of mass of each sphere will keep on increasing
(D) After a certain value of F angular velocity of each sphere will become constant

2. A soap bubble of radius r is formed inside another soap bubble of radius R(>r). The atmosphere pressure is P_0 and surface tension of the soap solution is T. Now the bigger bubble bursts. Assume that the excess pressure inside a bubble is small compared to P_0. For the smaller bubble choose the correct options:



(A) The bubble shrinks
(B) The bubble expands
(C) Change in its radius is $\frac{4Tr}{3P_0R}$
(D) Change in its radius is $\frac{3Tr}{4P_0R}$

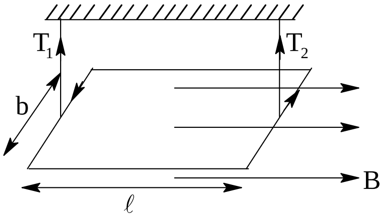
3. A rod bent at right angel along its centre line, is placed on a rough horizontal fixed cylinder of radius R as shown in figure. Mass of rod is 2m and rod is in equilibrium. Assume that friction force on rod at A and B are equal in magnitude. Then:



(A) Normal force applied by cylinder on rod at A is 3mg/2
(B) Normal force applied by cylinder on rod at B must be zero
(C) Friction force acting on rod at B is upward
(D) Normal force applied by cylinder on rod at A is mg

Space for Rough work

4. A uniform conducting rectangular loop of sides ℓ, b and mass m carrying current i is hanging horizontally with the help of two vertical strings. There exists a uniform horizontal magnetic field B which is parallel to the longer side of loop. Choose the **CORRECT** option(s)



(A) The value of $T_1=T_2=\frac{mg}{2}$

(B) The value of $T_1=\frac{mg-2ibB}{2}$

(C) The value of $T_2=\frac{mg+2ibB}{2}$

(D) The value of $T_1<\text{value of } T_2$

5. A bob of mass M is rotating on smooth horizontal table with constant angular speed ω on a circular path with the help of an elastic wire of mass m $(m<<M)$, length ℓ, specific heat s, area of cross-section A and young's modulus Y. Then:

(A) The increase in length of wire $\frac{\ell}{\left(\frac{YA}{M\ell\omega^2}-1\right)}$

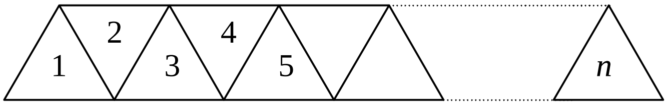
(B) The increase in length of wire $\frac{\ell}{\left(\frac{YA}{2M\ell\omega^2}-1\right)}$

(C) If the bob snaps then the rise in temperature of wire is $\frac{YA\ell}{2ms}\left(\frac{1}{\frac{YA}{2M\ell\omega^2}-1}\right)^2$ (ignore radiation loses)

(D) If the bob snaps then the rise in temperature of wire is $\frac{YA\ell}{2ms}\left(\frac{1}{\frac{YA}{M\ell\omega^2}-1}\right)^2$ (ignore radiation loses)

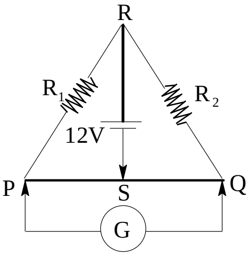
Space for Rough work

6. *n* number of identical equilateral prisms are kept in contact as shown in figure. If deviation through a single prism is δ. Then (*n*, *m* are integers)



(A) if $n = 2m$, deviation through *n* prism is zero.
(B) if $n = 2m + 1$, deviation through system of *n* prisms is δ.
(C) if $n = 2m$, deviation through system of *n* prism is δ
(D) if $n = 2m + 1$ deviation through system of *n* prisms is zero

7. In the circuit shown $R_1 - R_2 = 10\Omega$ and resistance per unit length of wire $PQ = 1\Omega / cm$ and length $PQ = 10cm$. If R_2 is made 20Ω the to get zero deflection in galvanometer. S is midpoint of wire PQ?



(A) The jockey at P can be moved towards right 2 cm.
(B) The jockey at Q can be moved towards right 2 cm.
(C) The jockey at S can be moved towards left a distance 5/3 cm.
(D) The jockey at all positions fixed and R_1 should be made 20

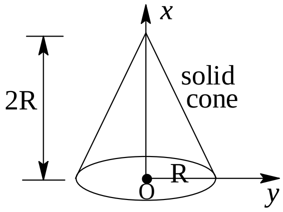
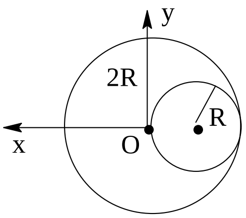
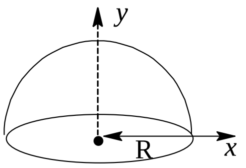
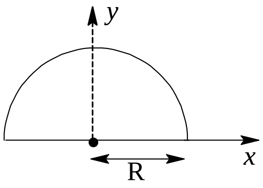
Space for Rough work

(Matching Type)
(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

In the column – I below, we have four bodies of uniform mass densities. Mass of each body is M. Column II gives their centre of mass distance from origin. Column three gives moment of inertia of respective bodies about an axis passing through the centre of mass and either along x-axis or parallel to x-axis:

	Column I		Column II		Column III
(I)		(i)	$\frac{R}{2}$	(P)	$\frac{2}{3}MR^2$
(II)	 A disc of radius 2R from which a smaller disc of R has been cut.	(ii)	$\frac{4R}{3\pi}$	(Q)	$\frac{3}{10}MR^2$
(III)	 Hemispherical shell	(iii)	$\frac{2R}{3}$	(R)	$\left(\frac{9\pi^2-64}{36\pi^2}\right)MR^2$
(IV)	 Semi circular disc	(iv)	$\frac{R}{3}$	(S)	$\frac{15MR^2}{12}$

8. Which of the following cases is true for the solid cone?

(A) (I) (iii) (Q)
(B) (I) (i) (Q)
(C) (I) (iii) (P)
(D) (I) (ii) (R)

Space for Rough work

9. Which of the following options hold true for the semicircular disc?

(A) (IV) (ii) (P) (B) (IV) (iii) (P)

(C) (IV) (ii) (R) (D) (IV) (iv) (Q)

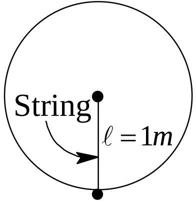
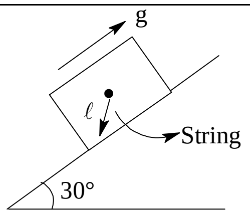
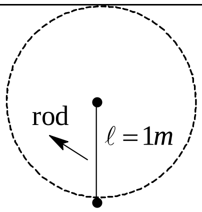
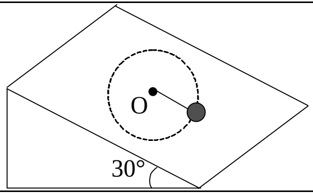
10. Which one of the following combinations is true for the disc from which a circular disc has been cut off:

(A) (II) (i) (P) (B) (II) (iii) (S)

(C) (II) (ii) (P) (D) (II) (iv) (S)

Answer 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

The table below gives different situations of vertical circular motion. Select the appropriate combination. Column I gives the situation of motion. Column II gives the minimum velocity required at the equilibrium position to complete the loop. Column III gives the velocity at the point which is diametrically opposite to the equilibrium position:

	Column I		Column II (m/s)		Column III
(I)		(i)	$\sqrt{50}$	(P)	Zero
(II)	 Cabin accelerating upward the plane with g & $\ell=\sqrt{3}m$	(ii)	$\sqrt{40}$	(Q)	$\sqrt{10}$
(III)		(iii)	$\sqrt{150}$	(R)	$\sqrt{5}$
(IV)		(iv)	$\sqrt{25}$	(S)	$\sqrt{30}$

Space for Rough work

11. Which of the following combinations is true for entry (II) of column (I)

(A) $(\text{II})\ (\text{i})\ (\text{P})$ (B) $(\text{II})\ (\text{iii})\ (\text{S})$

(C) $(\text{II})\ (\text{ii})\ (\text{Q})$ (D) $(\text{II})\ (\text{iii})\ (\text{Q})$

12. Which one is true for entry (III) of column (I)

(A) $(\text{III})\ (\text{ii})\ (\text{Q})$ (B) $(\text{III})\ (\text{iii})\ (\text{S})$

(C) $(\text{III})\ (\text{i})\ (\text{P})$ (D) $(\text{III})\ (\text{i})\ (\text{Q})$

13. The combination which is true for entry four of column (I)

(A) $(\text{IV})\ (\text{iv})\ (\text{R})$ (B) $(\text{IV})\ (\text{iii})\ (\text{Q})$

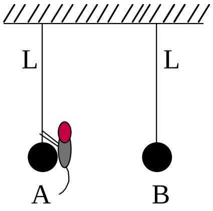
(C) $(\text{IV})\ (\text{iv})\ (\text{P})$ (D) $(\text{IV})\ (\text{ii})\ (\text{Q})$

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

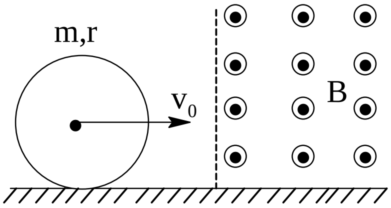
14. An insect jumps from ball A onto ball B, which are suspended from inextensible light strings each of length L = 8 cm. The mass of each ball and insect is same. What should be the minimum relative velocity (in ms^{-1}) of jump of insect w.r.t ball A, if both the balls manage to complete the full circle?



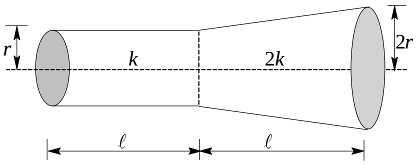
15. An electric charge distribution produces an electric field $\vec{E}=C\left(1-e^{-\alpha r}\right)\frac{\hat{r}}{r^2}$ where $C=\frac{1}{4\pi\varepsilon_0}$ & α are constant. If the net charge within the radius $r=\frac{1}{\alpha}$ is $\left(1\text{-}e^{-N}\right)$, then find the value of 'N' ?

Space for Rough work

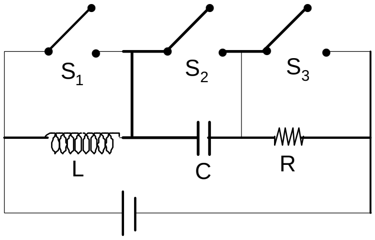
16. A ring of mass m and radius r and made of an insulating material carries uniformly distributed charge. Initially it rests on a frictionless horizontal tabletop with its plane vertical. The charge on the ring so that it starts rolling on entering completely into the region of the magnetic field is $\frac{\sqrt{N}mv_0}{rB}$,then find the value of $'N'$



17. A composite object is formed by combining a uniform rod of circular cross-section with thermal conductivity k and a frustum of same length with thermal conductivity $2k$ as shown in the figure. The equivalent thermal conductivity of the object is given as $\frac{Nk}{5}$, find $'N'$.



18. Consider the circuit shown in figure. With switch S1 closed and the other two switches open, the circuit has a time constant 0.05 sec. With switch S2 closed and the other two switches open, the circuit has a time constant 2 sec. With switch S3 closed and the other two switches open, the circuit oscillates with a period T. Find T (in sec). (Take pie2 = 10)



Space for Rough work

Chemistry

PART – II

SECTION – A
(More Than One Correct Type)

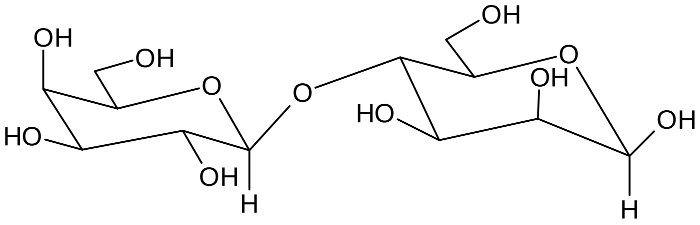
This section contains **7 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

19. The correct statements about some of the ions of 3d-series in aqueous solution
(A) Cr^{2+} is better reducing agent than Fe^{2+}
(B) Co^{3+} is better oxidising agent than Fe^{3+}.
(C) When Fe^{3+} is used as oxidising agent, it attains $3d^6$ electronic configuration
(D) Cu is the only metal in 3d series, which is not having ability to displace hydrogen as H_2 from acid (consider thermodynamic aspect).

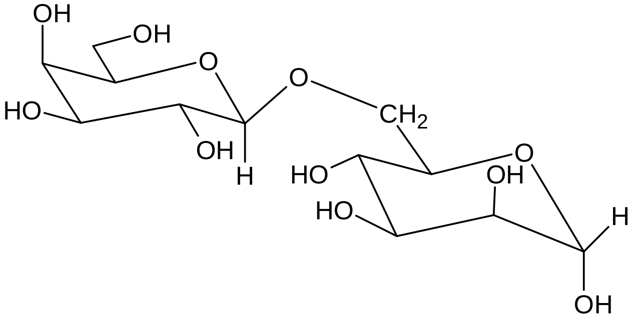
Space for Rough work

20. An unknown carbohydrate, formula $C_{12}H_{22}O_{11}$ reacts with Tollen's reagent to form a silver mirror. An α-glycosidase has no effect on the carbohydrate but a β-galactosidase hydrolyzes it to D-galactose (C_4 – epimers of D-glucose) and D-mannose (C_2 – epimers of D-glucose). When the carbohydrate is methylated (using methyl iodide and silver oxide) and then hydrolyzed with dilute HCl, the products are 2,3,4,6-tetra-O-methyl galactose and 2,3,4 tri-O-methyl mannose. Which of the following is correct structure of unknown carbohydrate?

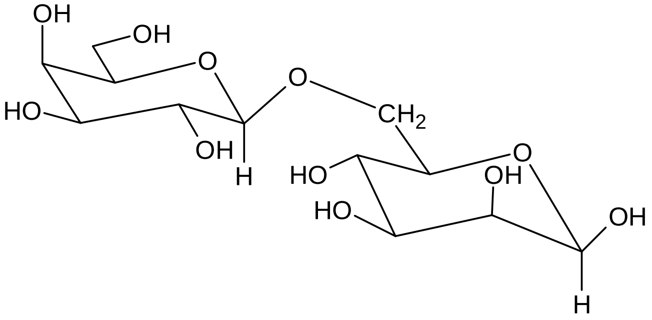
(A)


OH
OH
O
HO
OH
H
O
OH
O
OH
HO
OH
H

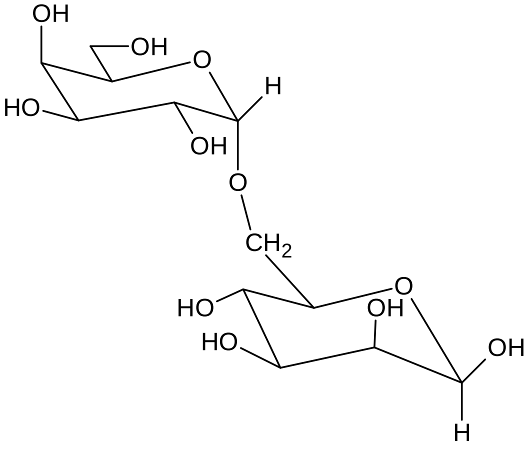
(B)


OH
OH
O
HO
OH
H
O
CH2
O
HO
OH
HO
H
OH

(C)


OH
OH
O
HO
OH
H
O
CH2
O
HO
OH
HO
OH
H

(D)


OH
OH
O
H
HO
OH
O
CH2
O
HO
OH
HO
OH
H

Space for Rough work

21. Which of the following solution will show negative deviation from ideal behaviour (Raoult's law)

(A) HNO_3+H_2O (B) Benzene+toluene

(C) Acetone+chloroform (D) Octanol+water

22. The standard electrode potentials of some of the alkali metals are

(i) $Li^+/Li = -3.05\,V$

$Na^+/Na = -2.71\,V$

$K^+/K = -2.93\,V$

(ii) Alkali metals react with water according to the following reaction. (M = alkali metal)

$2M + H_2O \rightarrow 2MOH + H_2$ It is found Li reacts gently with water whereas potassium reacts violently with water.

Which of the following statement (s) is/ are correct about the above experimental facts?

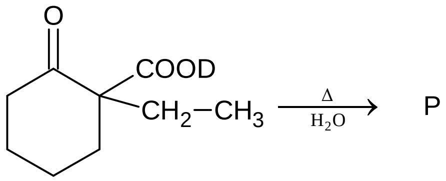
(A) ΔG values related with the kinetics of a reaction

(B) The metal having large standard oxidation potential will have lesser reactivity.

(C) K has a low melting point, and the heat of reaction is sufficient to make it melt or even vaporize. This leads to exponential increase in its surface area thus it reacts violently.

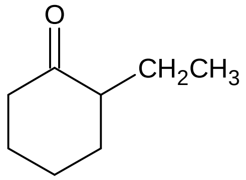
(D) Lithium is the best reducing agent due to its high hydration enthalpy.

23.

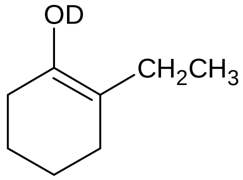


Which is possible for P is

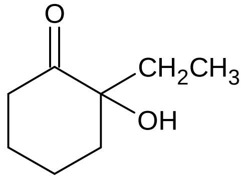
(A)



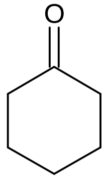
(B)



(C)

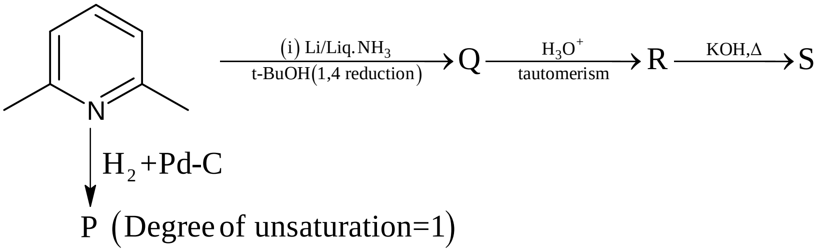


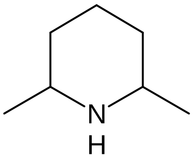
(D)

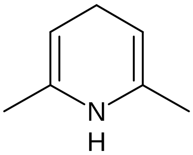


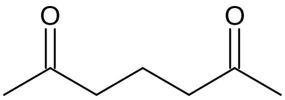
Space for Rough work

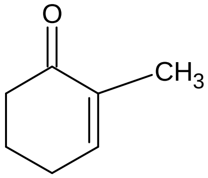
24. Which of the following are the correct statement(s) about the reaction given?


N
(i) Li/Liq.NH3
t-BuOH(1,4 reduction)
Q
H3O+
tautomerism
R
KOH,Δ
S
H2+Pd-C
P (Degree of unsaturation=1)

(A) 'P' is


(B) 'Q' is


(C) 'R' is


(D) 'S' is


25. Which of the following is correct?

(A) SO_3 and NSF_3 has $p\pi$-$d\pi$ bonding

(B) $(CH_3)_3NO$ has higher dipole moment than $(CH_3)_3PO$

(C) The bond angle in F_2O is smaller than H_2O

(D) The Cl-P-Cl bond angle is smaller in $POCl_3$ than PCl_3.

Space for Rough work

(Matching Type)
(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer 26, 27 and 28 by appropriately matching the information given in the three columns of the following table.

	Column I (Ores)		Column II (Type of Ore)		Column III (Process involved in extraction/refining)
(I)	Dolomite	(i)	Chloride	(P)	Self reduction
(II)	Cassiterite	(ii)	Carbonate	(Q)	Carbon reduction
(III)	Chalcopyrite	(iii)	Sulphide	(R)	Fused electrolysis
(IV)	Cuprite	(iv)	Oxide	(S)	Poling

26. Which of the following is suitable for calcium?

(A) $(\text{I})\ (\text{ii})\ (\text{P})$
(B) $(\text{I})\ (\text{ii})\ (\text{R})$
(C) $(\text{I})\ (\text{ii})\ (\text{S})$
(D) $(\text{III})\ (\text{ii})\ (\text{R})$

27. Which is correct for tin:

(A) $(\text{II})\ (\text{iii})\ (\text{P})$
(B) $(\text{II})\ (\text{iv})\ (\text{R})$
(C) $(\text{II})\ (\text{iv})\ (\text{Q})$
(D) $(\text{IV})\ (\text{ii})\ (\text{Q})$

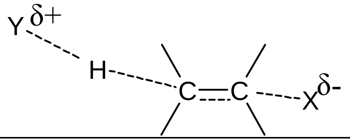
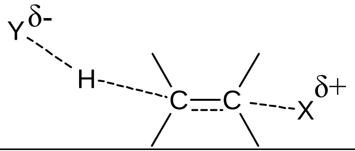
28. Which of the following is used for extraction of copper?

(A) $(\text{III})\ (\text{iii})\ (\text{R})$
(B) $(\text{IV})\ (\text{iii})\ (\text{Q})$
(C) $(\text{III})\ (\text{iii})\ (\text{P})$
(D) $(\text{II})\ (\text{iv})\ (\text{Q})$

Space for Rough work

Answer 29, 30 and 31 by appropriately matching the information given in the three columns of the following table.

Consider X as leaving group and Y as a nucleophile or base :

	Column I (Activated complex of initial substrate)		**Column II (Mechanism)**		**Column III (Effect)**
(I)	$Y^{\delta+}$-----R-----$X^{\delta+}$	(i)	SN^2	(P)	Large decrease
(II)	$Y^{\delta-}$-----R-----$X^{\delta+}$	(ii)	E_2	(Q)	Large increase
(III)		(iii)	SN^1	(R)	Small decrease
(IV)		(iv)	E_1	(S)	Small increase

29. A neutral nucleophile attacks on a substrate containing neutral leaving group. Which of the following represent the correct combination of effect of increased solvent polarity on reaction rate?

(A) (I) (i) (R) (B) (II) (i) (P)

(C) (I) (iii) (Q) (D) (II) (iii) (S)

30. A negatively charged nucleophile attacks on a substrate containing neutral leaving group. Which of the following represent the correct combination of effect of decreased solvent polarity on reaction rate?

(A) (I) (iii) (R) (B) (II) (i) (P)

(C) (II) (i) (Q) (D) (I) (iii) (S)

31. A neutral base attacks on a substrate containing an anion as leaving group. Which of the following represent the correct combination of effect of increased solvent polarity on reaction rate?

(A) (IV) (iv) (P) (B) (III) (iv) (Q)

(C) (III) (ii) (S) (D) (III) (ii) (R)

Space for Rough work

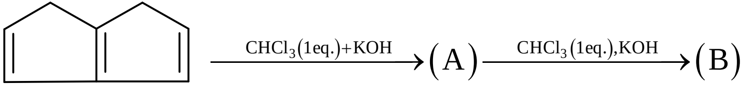
SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

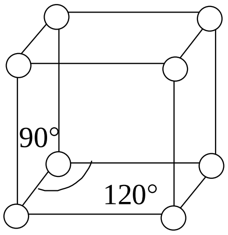
32. The solubility of $Ag_2C_2O_4$ in acidified water of $pH=5$ is 2.46×10^{-x}. The value of 'x'
$(Ka_1=5\times10^{-2}, K_{a_2}=5\times10^{-5}, K_{sp}=5\times10^{-11}, (120.004)^{1/3}=4.93)$

33. The CFSE $\left(E_{\text{in octahedral field}}-E_{\text{symmetric field}}\right)$ for octahedral complex for d^6 electronic configuration is 'x' kJ/mol, the value of $\left|\frac{x}{10}\right|$
$[\Delta_0=75\,\text{kJ/mole, Pairing energy}=90\,\text{kJ/mole}]$

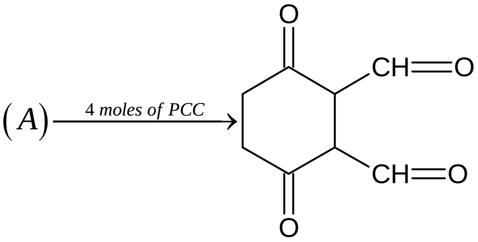
34. Number of plane (s) of symmetry in the product B is/are



35. Ice crystallizes is an hexagonal lattice. At the low temperatures at which the structure was determined, the lattice constants were $a=4.53\mathring{A}$ and $b=7.41\mathring{A}$ as shown in the figure. How many H_2O molecules are contained in a unit cell? (Given that density of ice $=0.92\,g/cm^3$)?



36.



Maximum number of moles of Ac_2O consumed by reactant (A) is?

Space for Rough work

Mathematics PART – III

SECTION – A
(More Than One Correct Type)

This section contains **7 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

37. $\int_{-1}^{1}\left(e^{x^3}+e^{-x^3}\right)dx$ is less than

(A) 2 (B) $2e+\frac{2}{e}$

(C) $\mathrm{e}+\frac{1}{\mathrm{e}}+2$ (D) 2e

38. Let $\mathrm{f(x)}=\mathrm{e}^{-\frac{1}{x^2}}+\int\limits_{0}^{\frac{\pi x}{2}}\sqrt{1+\sin t}\,dt\,\forall x\in(0,\infty)$ then-

(A) f' exists and is continuous $\forall x\in(0,\infty)$

(B) f'' exists $\forall x\in(0,\infty)$

(C) f' is bounded

(D) There exists $\alpha>0$ such that $\left|f(x)\right|>\left|\mathrm{f}'(\mathrm{x})\right|\forall x\in(\alpha,\infty)$

39. Let x, y, z are positive real numbers and ℓ_1 is the least value of $2x^4+2y^4+4z^4-8xyz$ and ℓ_2 is the least value of $x^4y+xy^4+\frac{4}{x^2y^3}+\frac{1}{x^3y^2}+8$, then-

(A) $\ell_1=-1$ (B) $\ell_2>-1$

(C) $\ell_2=10$ (D) $\ell_2>10$

40. Consider the equation in x, $8x^4-16x^3+16x^2-8x+a=0$, then sum of all the non-real roots of equation can be $(a\in R)$

(A) 1 (B) 2

(C) $\frac{1}{2}$ (D) None of these

Space for Rough work

41. For the equation $\frac{40}{x-1}-\frac{160}{x-4}-\frac{200}{x-5}+\frac{320}{x-8}=6x^2-27x$

(A) Number of real solution of above equation is 3
(B) If E denotes the product of non-zero or complex roots of equation, then sum of divisors of E is 2904
(C) It S denotes the set of all real roots of equation then, sum of elements of S taken two at a time is 81
(D) If $\alpha_1, \alpha_2 \in R$ be two roots of equation such that $\log_{\alpha_2}(2\alpha_1)$ is defined it must be 1.

42. Let a, b, c be the positive integers such that a<b<c. If the two curves $y=|x-a|+|x-b|+|x-c| \, and \, 2x+y=2003$ have exactly one point in common, then-

(A) least possible value of c is 1002
(B) greatest possible value of b is 1001
(C) least possible value of b is 1002
(D) greatest possible of a is 1000

43. Three are 5 boxes numbered from 1 to 5. There is 1 Red and 2k black balls in k^{th} box, $k=1,2,3,4,5$. From each box either one red ball is taken or one or more than one black balls are taken. But from each box both coloured balls are never taken (ball of same coloure are all alike). Now which of the following holds good?

(A) Total number of ways selecting odd number of red balls is 4725
(B) Total number of ways of selecting even number of red balls is 5670
(C) Total number of ways selecting odd number of red balls is 5670
(D) Total number of ways of selecting even number of red balls is 4725

Space for Rough work

(Matching Type)
(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer 44, 45 and 46 by appropriately matching the information given in the three columns of the following table.

	Column I		**Column II**		**Col. III**
(I)	The value of $\sum_{n=0}^{\infty} 2^{-n+(-1)^n}$ is	(i)	The value of $\left[\sum_{n=0}^{\infty} \tan^{-1}\left(\frac{2}{\sqrt{n+2}+\sqrt{n}+(n+2)\sqrt{n}+n\left(\sqrt{n+2}\right)}\right)\right]$ (where [.] denotes greatest integer function) is	(P)	2
(II)	Number of solutions of equation $16\sin^3 x = 14 + \sqrt[3]{\sin x + 7}$ in $[0, 4\pi]$ is	(ii)	If a, b, c are sides of a triangle, then $\frac{2\left(a^2+b^2+c^2\right)}{ab+bc+ca}$ is always less than	(Q)	3
(III)	Number of solutions of equation $\tan^{-1}(2\sin x) = \cot^{-1}(\cos x)$ in $[0, 10\pi]$ is	(iii)	If a, b, c are distinct real numbers such that $a^2(b+c) = b^2(a+c) = 2$, then the value of $c^2(a+b)$ is	(R)	4
(IV)	If the sum of roots of the quadratic equation $(-a+1)x^2 + (a^2-a+4)x - 2a + 3 = 0$ is minimum, then the value of a(a>1) is	(iv)	If $\mathrm{P} = \sin A \sin B, \mathrm{Q} = \sin C \cos A,$ $\mathrm{R} = \sin A \cos B$ $\mathrm{S} = \cos A \cos C$, then the value of $5\left(\mathrm{P}^2+\mathrm{Q}^2+\mathrm{R}^2+\mathrm{S}^2\right)$ is	(S)	5

44. Which of the following options is the only **CORRECT** combination?

(A) $(\mathrm{I})\ (\mathrm{ii})\ (\mathrm{R})$
(B) $(\mathrm{II})\ (\mathrm{iv})\ (\mathrm{S})$
(C) $(\mathrm{III})\ (\mathrm{i})\ (\mathrm{Q})$
(D) $(\mathrm{IV})\ (\mathrm{iv})\ (\mathrm{S})$

45. Which of the following options is the only **CORRECT** combination?

(A) $(\mathrm{II})\ (\mathrm{i})\ (\mathrm{P})$
(B) $(\mathrm{I})\ (\mathrm{iii})\ (\mathrm{R})$
(C) $(\mathrm{II})\ (\mathrm{ii})\ (\mathrm{P})$
(D) $(\mathrm{IV})\ (\mathrm{iii})\ (\mathrm{Q})$

46. Which of the following options is the only **CORRECT** combination?

(A) $(\mathrm{IV})\ (\mathrm{i})\ (\mathrm{P})$
(B) $(\mathrm{III})\ (\mathrm{iii})\ (\mathrm{R})$
(C) $(\mathrm{II})\ (\mathrm{iii})\ (\mathrm{P})$
(D) $(\mathrm{I})\ (\mathrm{iii})\ (\mathrm{Q})$

Space for Rough work

Answer 47, 48 and 49 by appropriately matching the information given in the three columns of the following table.

	Column I		**Column II**		**Col. III**
(I)	If $S=\{Z: \lvert Z+\bar{Z}\rvert + 2\lvert Z-\bar{Z}\rvert = 4$ and $\lvert Z\rvert$ is minimum$\}$ then $\frac{25}{8}A$ is (where A is area of polygon formed of all points in S taking as vertices)	(i)	If the Point $(\sec\alpha, \operatorname{cosec}\alpha)$ moves in the plane of circle $x^2+y^2=3$ and the minimum distance of this point from circle is $a-\sqrt{b}\,(a,b\in N)$ then $a+b$	(P)	2
(II)	Let $S=\left\{Z \left\lvert Z\bar{Z}-(3-4i)Z-(3+4i)\bar{Z}+21=0\right\rvert\right\}$ If M and m be maximum value and minimum value of $\frac{Z-\bar{Z}}{i(Z+\bar{Z})}$ then $\frac{1}{M}+\frac{1}{m}$ is	(ii)	Two circles $x^2+y^2+2n_1x+2y+\frac{1}{2}=0$ and $x^2+y^2+n_2x+n_2y+n_1=\frac{1}{2}$ intersect each other orthogonally where n_1, n_2 are integers then the number of possible ordered pairs (n_1, n_2) is	(Q)	3
(III)	Let x is the minimum value of $\lvert Z\rvert^2+\lvert Z-3\rvert^2+\lvert Z-6i\rvert^2$ then $\frac{x}{10}$ is	(iii)	If $a_n=\sqrt{1+\left(1+\frac{1}{n}\right)^2}+\sqrt{1+\left(1-\frac{1}{n}\right)^2}$, then the value of $\left(\sum_{n=1}^{20}\frac{1}{a_n}\right)-3$ is	(R)	4
(IV)	Consider a triangle formed by the points $A\left(\frac{2}{\sqrt{3}}e^{i(\pi/2)}\right), B\left(\frac{2}{\sqrt{3}}e^{-i\left(\frac{\pi}{6}\right)}\right), C\left(\frac{2}{\sqrt{3}}e^{-i\left(\frac{5\pi}{6}\right)}\right)$ Let P(Z) is any point on it's in-circle, then $AP^2+BP^2+CP^2$ is	(iv)	The ea^n $9x^3+9x^2y-45x^2=4y^3+4xy^2-20y^2$ represents 3 straight lines two of which pass through origin then $\frac{1}{10}$(Area of triangle formed by these lines)	(S)	5

47. Which of the following options is the only **CORRECT** combination?

(A) (I) (ii) (R)
(B) (II) (iv) (S)
(C) (III) (i) (Q)
(D) (IV) (iv) (S)

Space for Rough work

48. Which of the following options is the only **CORRECT** combination?

(A) $(\text{II})\ (\text{i})\ (\text{P})$ (B) $(\text{I})\ (\text{iii})\ (\text{R})$

(C) $(\text{II})\ (\text{ii})\ (\text{P})$ (D) $(\text{IV})\ (\text{iii})\ (\text{Q})$

49. Which of the following options is the only **INCORRECT** combination?

(A) $(\text{IV})\ (\text{i})\ (\text{P})$ (B) $(\text{III})\ (\text{iii})\ (\text{R})$

(C) $(\text{II})\ (\text{iii})\ (\text{P})$ (D) $(\text{I})\ (\text{iii})\ (\text{Q})$

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

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50. On a normal standard die one of the 21 dots from any one of the six faces is removed at random with each dot equally likely to be chosen. The die is then rolled. If the probability that the top face has an odd number of dots is $\frac{p}{q}$ where p and q are in their lowest form, find $\frac{(\text{p}+\text{q})}{4}$

51. A function f is defined on the complex number by $f(z)=(a+bi)z$, where 'a' and 'b' are positive numbers. This function has the property that the image of each point in the complex plane is equidistant from that point and the origin. Given that $|a+bi|=8$ and that $b^2=\frac{u}{v}$ where u and v are coprimes. Find the value of (u + v)-250.

Space for Rough work

52. If $\begin{bmatrix} 1 & 2 & a \\ 0 & 1 & 4 \\ 0 & 0 & 1 \end{bmatrix}^n = \begin{bmatrix} 1 & 18 & 2007 \\ 0 & 1 & 36 \\ 0 & 0 & 1 \end{bmatrix}$ then find the value of $\frac{(n+a)}{100}$.

53. If the polynomial $f(x) = 4x^4 - ax^3 + bx^2 - cx + 5$ where $a, b, c \in R$ has four positive real roots say r_1, r_2, r_3 and r_4, such that $\frac{r_1}{2} + \frac{r_2}{4} + \frac{r_3}{5} + \frac{r_4}{8} = 1$. Find the value of (a-10).

54. All the three vertices of an equilateral triangle lie on the parabola $y = x^2$, and one of its sides has a slope of 2. The x-coordinates of the three vertices have a sum equal to $\frac{p}{q}$ where p and q are relatively prime positive integers. Find the value of (q-p)

Space for Rough work

FIITJEE

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JEE (Advanced)-2019

PAPER – 2

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. B

Sol. F_1 should be greater than F_2 therefore friction is towards right.
To balance torque about centre of mass normal shifted towards the right wall.

2. B

Sol. Tension in the string T = mg
Torque on the cylinder about the point of contact = 0

$$Mgr\sin\theta = mgr\left(1-\sin\theta\right)$$

$$m = \frac{M\sin\theta}{1-\sin\theta}$$

3. C

Sol. Work done by force = change in gravitational potential energy

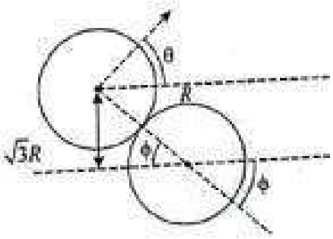
$W = m_0 \times \Delta V$

$$W = GMm_0\left[\frac{1}{\sqrt{2}} - \frac{1}{\sqrt{5}}\right]$$

4. AC

5. AD

Sol.



For elastic collision $\theta + \phi = 90°$ and form figure we use

$\sin\theta = \sqrt{3}/2 \Rightarrow \theta = 60°\,\text{hence}\,\phi = 30°$

6. ABCD

Sol. $a_t = \dfrac{dv}{dt} \Rightarrow a_r = v^2/R$ & $\vec{a}_{net} = \sqrt{a_t^2 + a_r^2}$

7. BC

Sol. $\text{e=B}_0 v_0 (2y) = 4B_0 v_0^{3/2}\sqrt{t}$

$$i = \frac{e}{\lambda(2y)} = \frac{Bv_0}{\lambda} \qquad where \Rightarrow y = \sqrt{4v_0 t}$$

$$F = \left(\frac{B_0 v_0}{\lambda}\right)(2y)B_0 = \frac{2B_0^2 v_0 y}{\lambda} = \frac{4B_0^2 v_0^{3/2}}{\lambda}\sqrt{t}$$

$$p = \vec{F}.\vec{v} = \frac{2B_0^2 v_0^2 y}{\lambda} = \frac{4B_0^2 v_0^{5/2}}{\lambda}\sqrt{t}$$

8. CD

Sol. Take torque of tension about IAOR it will first clockwise and then anticlockwise torque so it will come to rest after covering certain distance. When spool at rest at extreme right block will also be remain at rest but at same initial position (according to energy conservation)

9. A

Sol. $dQ = -dU$

$dQ = -nC_v dt$

$$\frac{dQ}{n \times dt} = -C_v = -5/2R$$

10. B

Sol. $dQ = dU + dW$

$-dU = dU + dW$

$-2dU = dW$

$$-2n \times \frac{5}{2}RdT = pdV$$

$-5nRdT = pdV$

$nRT = pV$

Dividing these equation we get $\int \dfrac{dV}{V} = \int -5\dfrac{dT}{T}$

Solving we get $TV^{1/5} = \text{constant}$

SECTION – C

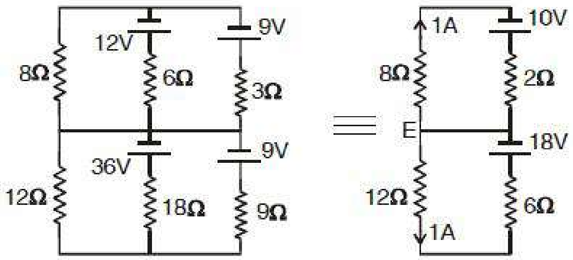
11. 1

Sol. $W_{NA}+W_{NG}+W_G=\frac{1}{2}m_BV^2-0$

$W_{NA}+0+0=\frac{1}{2}(2)(1)^2-0=1$

12. 1

Sol. Since A and B are same potential we can redraw the circuit as



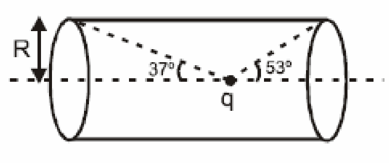
Hence current through 8Ω is 1A and

$V_B-V_D=\left(V_B-V_E\right)+\left(V_E-V_D\right)=-8+12=4V$

$x+y=1+0=1$

13. 7

Sol.



$$\phi=\frac{q}{\in_0}\left(\frac{2\pi\left(1-\cos 37^o\right)}{4\pi}\right)-\frac{q}{\in_0}\left(\frac{2\pi\left(1-\cos 53^o\right)}{4\pi}\right)$$

$$\phi=\frac{q}{\in_0}\left[1-\frac{1}{2}\left(1-\frac{4}{5}\right)-\frac{1}{2}\left(1-\frac{3}{5}\right)\right]$$

$$\phi=\frac{q}{\in_0}\left(1-\frac{1}{10}-\frac{2}{10}\right)=\frac{7q}{10\in_0}$$

14. 6

Sol. $X_{BF}=\mu\ell_1+\ell_2$

$$\frac{dx_{BF}}{dt}=\frac{\mu d\ell_1}{dt}+\frac{d\ell_2}{dt}$$

$$V_{BF}=\frac{4}{3}(-8+2)+(4-2)$$

$$=\frac{4}{3}\times(-6)+2=-8+2=-6ms^{-1}$$

15. 5

Sol. The plate is free to rotate about vertical axis yy'.

Let $\text{v}, \text{v}_{cm}\ and\ \omega$ be the velocity of particle, velocity of centre of mass of plate and angular velocity of plate just after collision.

$\therefore$ From conservation of angular momentum about vertical axis passing through O is

$$mu\frac{a}{2}+\frac{ma^2}{3}\omega------(1)$$

Since the collision is elastic, the equation of coefficient of restitution is

$$e=\frac{v_{cm}-v}{u}=1-------(2)$$

But $v_{cm}=\frac{a\omega}{2}-----(3)$

Solving, equation (1), (2) and (3) we get

$$\omega=\frac{12}{7}\frac{\text{u}}{\text{a}}=5\,\text{rad/s}$$

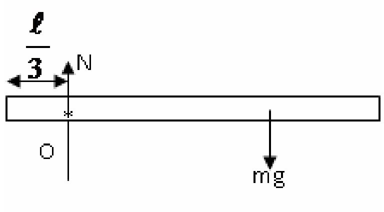
16. 4

Sol. $\text{F}=\frac{\sigma^2}{2\in_0}\times(\text{Projected area})$

$$F=\frac{\sigma^2}{2\in_0}\times\pi\left(\frac{R}{\sqrt{2}}\right)^2\Rightarrow\frac{\pi\sigma^2R^2}{4\in_0}$$

17. 3

Sol.



Taking torques about 'O'

$$\text{Mg}\times\frac{\ell}{6}=\left[\frac{1}{12}ml^2+\frac{Ml^2}{36}\right]\alpha$$

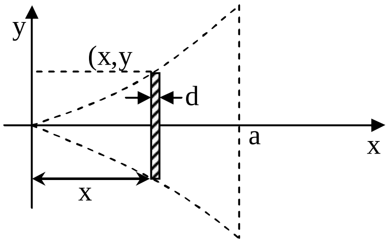
$$g=\left(\frac{1}{2}+\frac{1}{6}\right)l.\alpha\Rightarrow\alpha.l\Rightarrow\frac{3}{2}g$$

$$a_{cm}\Rightarrow\alpha\times\frac{\ell}{6}\Rightarrow\frac{g}{4}$$

$$\therefore N=mg-\frac{mg}{4}\Rightarrow\frac{3mg}{4},x=3$$

18. 2

Sol.



$$dI=\frac{1}{12}dm\times(2y)^2$$

$$dI=\frac{1}{12}(2y)^3\,dx\rho$$

$$I=\frac{1}{12}\times 8\rho\times\int_0^a x^6dx \Rightarrow I=\frac{2}{3}\times\frac{a^7\rho}{7}=\frac{2a^7\rho}{21}, N=2$$

19. 4

Sol. $\frac{M}{L}=\frac{q}{2m}$

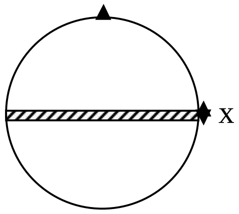
$\therefore M \Rightarrow \frac{e.L}{2m} \& L=\frac{nh}{2\pi}$

$\therefore M \Rightarrow \frac{nhe}{4\pi m}, k=4$

20. 3

Sol. $F \Rightarrow \pi R^2 x.\rho g$

$\therefore \frac{d^2x}{dt^2}=-\frac{\pi R^2 x\rho g}{m}$



$m=\frac{2}{3}\pi R^3\rho$

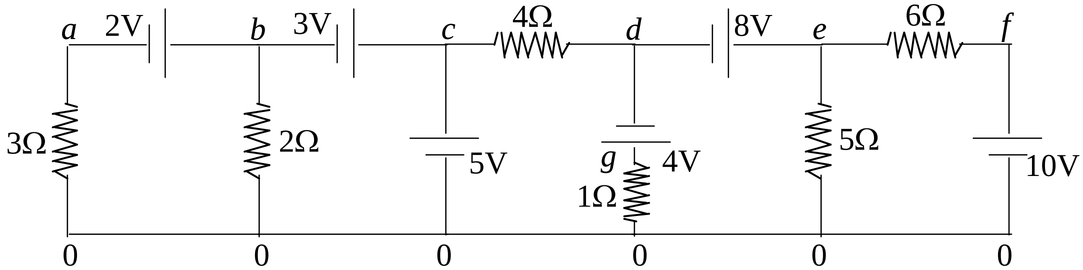
$\therefore \frac{d^2x}{dt^2} \Rightarrow \frac{-\pi R^2 x\rho}{2\pi R^3\rho}\times 3g \Rightarrow \frac{-3xg}{2R}$

$\therefore x=\frac{1}{2\pi}\sqrt{\frac{3g}{2R}} \qquad , N=3$

SECTION – D

21. 00001.52

Sol. Assuming the potential of different junctions as shown in figure



Using junction rule:

$$\frac{x-5}{4}+\frac{4+x}{1}+i=0---(1)$$

$$i-\frac{(8+x)}{5}+\frac{(2-x)}{6}=0---(2)$$

From (1) and (2)

$$x = \frac{-482}{194}$$

So current through $1\Omega = 4 - \frac{482}{194} = 1.52\,\text{ampere}$

22. 00001.12

Sol. $\mathrm{k_{eq}} = \frac{16k}{5} \Rightarrow T = 2\pi\sqrt{\frac{m}{k_{eq}}} = 1.12\,\text{seconds}$

23. 00019.20

Sol. $v + u = 120 - - - (1)$

$$\frac{v^2}{u^2} = \frac{1}{16} \Rightarrow \frac{v}{u} = \frac{1}{4} - - - (2)$$

$$\Rightarrow v = 24 \; and \; u = 96$$

$$\Rightarrow \frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{24} + \frac{1}{96}$$

$$\Rightarrow f = 19.2\,\text{cm}$$

Chemistry PART – II

SECTION – A

24. A

Sol. In option (A) all methyl groups are equatorial

25. A

Sol. Due to back bonding (A) is a weaker base.

26. B

Sol. $Fe(CO)_x$

$26 - 0 + 2x = 36(EAN)$

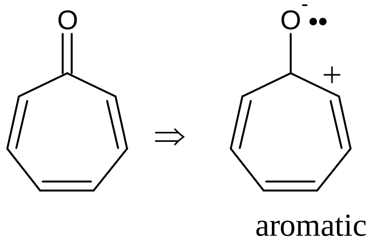
$x = 5$

27. BC

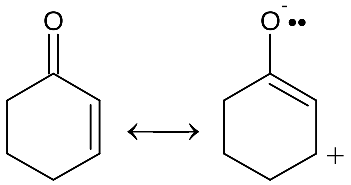
Sol.

(A)

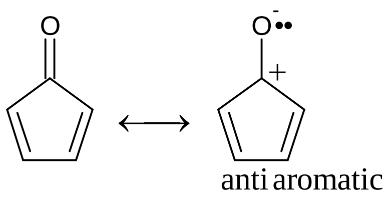
(B)


O
O⁻
+
⇒
aromatic

(C)



(D)

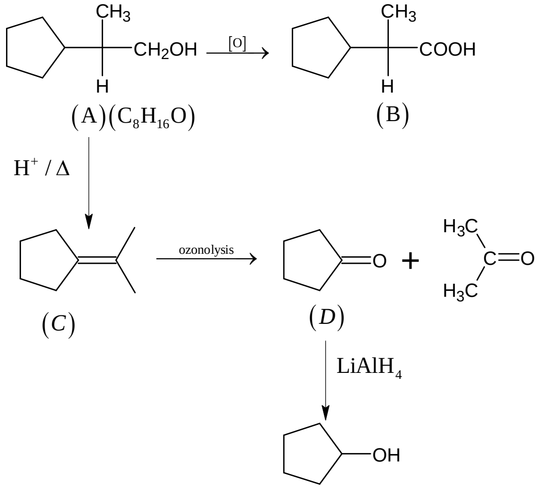

O
O⁻
+
⟷
anti aromatic

28. ABCD

29. ABC

30. ABCD

Sol.


CH3
CH2OH
H
[O]
CH3
COOH
H
(A)(C8H16O)
(B)
H+ / Δ
ozonolysis
O
+
H3C
C=O
H3C
(C)
(D)
LiAlH4
OH

31. AD

Sol. Chiral molecules do not have plane of symmetry

32. B

Sol. $P_4(s) \longrightarrow P_4(g)$ $\Delta H = 59 KJ$ b

$P_4(s) \longrightarrow 4P(g)$ $\Delta H = 1265 KJ$

$P_4(g) \longrightarrow 4P(g)$ $\Delta H = 1206 KJ$

Average P-P bond enthalpy $= \frac{1206}{6} = 201 KJ$

33. C

Sol. On an average, one $P-P$ bond of tetrahedral is broken and one new $P-P$ bond joining the two tetrahedral units is formed.

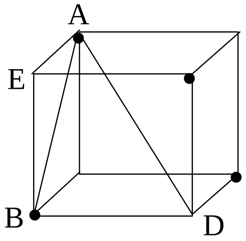
$201 - x = -104$

$\therefore x = 305 KJ\, mol^{-1}$

SECTION – C

34. 6

Sol.



Face diagonal of cube $(AB) = 2R$

Edge length of cube $(BE) = \frac{2R}{\sqrt{2}}$

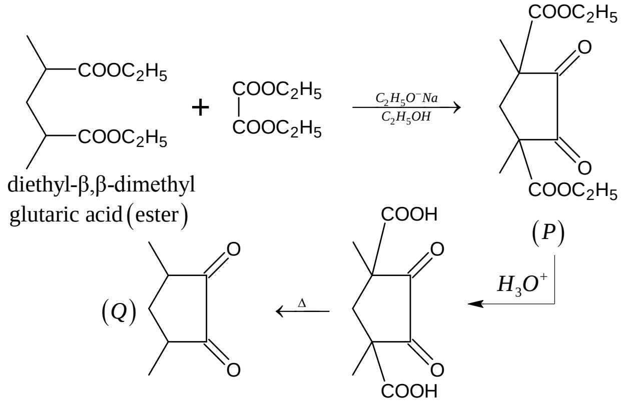
Body diagonal of cube $(AD) = \sqrt{3} \times \frac{2R}{\sqrt{2}} \Rightarrow \sqrt{6} \times R$

35. 7

Sol. It will be neutral solution.

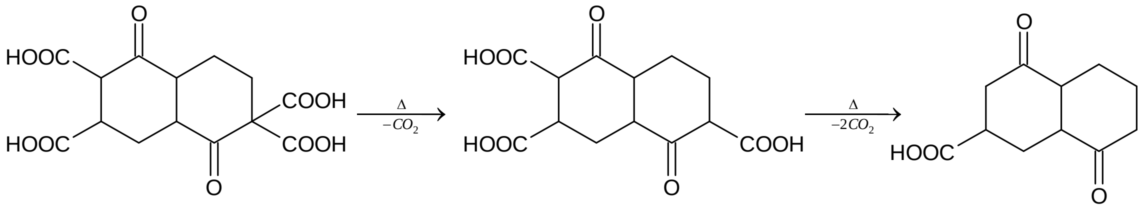
36. 6

Sol.


COOC2H5
COOC2H5
diethyl-β,β-dimethyl
glutaric acid (ester)
+
COOC2H5
COOC2H5
C2H5O⁻Na
C2H5OH
COOC2H5
O
O
COOC2H5
(P)
H3O+
COOH
O
O
COOH
Δ
O
O
(Q)

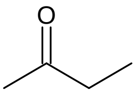
37. 3

Sol.



38. 6

Sol. These compounds will give iodoform test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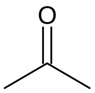
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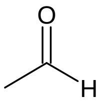
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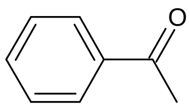
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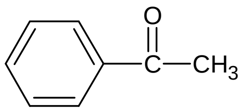

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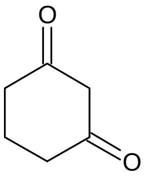
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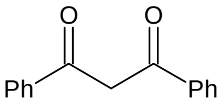


39. 5

Sol. $\mathrm{Mg}^{2+}+2e^{-}\longrightarrow Mg\left(E_{Mg}=\frac{24}{2}=12g\right)$

Charge required for the deposition of $12\text{g Mg}=1\text{F}$

Charge required for the deposition of $1\text{g Mg}=\frac{1}{12}\text{F}$

$\therefore$ cost for $\frac{F}{12}\text{charge}=\text{Rs}.5$

$\mathrm{Al}^{3+}+3\mathrm{e}^{-}\longrightarrow \mathrm{Al}\left(\mathrm{E}_{\mathrm{Al}}=\frac{27}{3}=9\mathrm{g}\right)$

Charge required for $9g=1F$

Charge required for $30g=\frac{30}{9}F=\frac{10F}{3}$

Cost for $\frac{10F}{3}\text{charge}=5\times12\times\frac{10F}{3}\Rightarrow Rs.200$

40. 8

Sol. $(\mathrm{CO})_{x/2}\,\mathrm{Co\text{-}Co}(\mathrm{CO})_{x/2}$

$\mathrm{EAN}(=36)=27+1+2\times\frac{x}{2}$

$\Rightarrow 28+x=36\Rightarrow x=8$

41. 1

Sol. The unit cell which is formed in this arrangement will be SCC.

42. 7

Sol. $64g$ $\mathrm{CaC_2}$ gives 28g polythene

43. 3

Sol. Balanced equation is

$$3M^{x+} + Cr_2O_7^{2-} \longrightarrow 3MO_3^{-} + 2Cr^{3+} + 4H^{+} \Rightarrow x = 3$$

SECTION – D

44. 00004.90

Sol. $$2K_2Cr_2O_7 + 6H_2C_2O_4 \longrightarrow 4Cr^{3+} + 12CO_2$$

$n = 6$ $n = 2$ $\downarrow$

$n_{K_2Cr_2O_7} = 0.1/6$ $n_{CO_2} = 4.4/44 = 0.1\,\text{mole}$

$$mass\,of\;K_2Cr_2O_7 = \frac{1}{60} \times 294 \Rightarrow 4.9g$$

45. 00000.60

46. 00000.50

Sol. $$d = \frac{1 \times 1000}{2 \times 10^{24} \times \left(a \times 10^{-8}\right)^3} = 4$$

$$\left(a \times 10^{-8}\right)^3 = \frac{10^{-21}}{8}$$

$$a \times 10^{-8} = \frac{10^{-7}}{2} \Rightarrow a = 5\mathring{A}$$

Mathematics PART – III

SECTION – A

47. A

Sol. $\frac{3f''(x)}{f'(x)} = \frac{f'''(x)}{f''(x)}$

$\Rightarrow 3\ln f'(x) = \ln f''(x) + k$

$\Rightarrow \frac{d^2x}{dy^2} = c$

48. D

Sol. Let $I=\int_0^3 \frac{f(x)dx}{(x^2-3x+1)}$.............(1)

$I=\int_0^3 \frac{f(3-x)}{(x^2-3x+1)}$.............(2)

$(1)+(2) \Rightarrow 2I=3$

$I=\frac{3}{2}$

49. C

Sol. $V_n=2a_{n+2}+S_n$

$=2[-4+(n+1)]+\frac{n}{2}[-8+(n-1)]$

$=\frac{n^2-5n-12}{2}$

V_n is minimum at n=2 or n=3

$\Rightarrow$ Minimum value of V_n is -9

50. BD

51. D

52. BCD

Sol. $p(n) =$ Probability that child stops after drawing exactly n marbles

$p(n) = \frac{1}{2}.\frac{2}{3}.\frac{3}{4}.......\left(\frac{n-1}{n}\right)\left(\frac{1}{n+1}\right) = \frac{1}{n(n+1)}$

53. ABCD

Sol. $x^3 + 2x^2 - 3x + 1 = 0 \begin{cases} \alpha \\ \beta \\ \gamma \end{cases}$

$$x^3 - 3x^2 - 2x + 1 = 0\begin{cases}1/\alpha\\1/\beta\\1/\gamma\end{cases}$$

Given expression $\dfrac{1}{3-\dfrac{1}{\alpha}}+\dfrac{1}{3-\dfrac{1}{\beta}}+\dfrac{1}{3-\dfrac{1}{\gamma}}$

$$=\frac{\sum\left(3-\frac{1}{\alpha}\right)\left(3-\frac{1}{\beta}\right)}{\left(3-\frac{1}{\alpha}\right)\left(3-\frac{1}{\beta}\right)\left(3-\frac{1}{\gamma}\right)}=\frac{27-6\sum\left[\frac{1}{\alpha}+\frac{1}{\beta}+\frac{1}{\gamma}\right]+\frac{1}{\alpha\beta}+\frac{1}{\beta\gamma}+\frac{1}{\gamma\alpha}}{\left(3-\frac{1}{\alpha}\right)\left(3-\frac{1}{\beta}\right)\left(3-\frac{1}{\gamma}\right)}=\frac{11}{7}$$

54. ABC

Sol. $3x^2\dfrac{dx}{dy}=\dfrac{x^3}{x^3-y}$ $x^3=t$

$\Rightarrow \dfrac{dt}{dy}=\dfrac{t}{t-y}$ $\Rightarrow (t-y)dt = t\,dy$

$\Rightarrow t\,dt = y\,dt + t\,dt \Rightarrow \dfrac{t^2}{2}=t.y+\dfrac{c}{2}$

$\Rightarrow x^6 = 2x^3y + c$

55. A

Sol. For $\lambda = 10 \Rightarrow t_1 = 2,\ t_2 > 2$ and if $x + 1/x = 2 \Rightarrow x = 1$ and $x + 1/x = t_2$ so there will be two distinct values of x

56. B

Sol. Since domain of $f(t) = 2t^3 - 9t^2 + 30,\ t = x + 1/x,\ |t| \ge 2\ f(-2) = -22,\ f(2) = 10,$ critical points at $t = 0 \,\&\, 3;\ f(3) = 3$

SECTION – C

57. 2
58. 0
59. 6
60. 3
61. 4
62. 8

Sol. The triangle has circumcentre at origin and its orthocentre laying on the circumcircle.

63. 5

Sol. $\lim\limits_{y\to 1}\dfrac{100y^{100}}{y^{100}-1}-\dfrac{50.y^{50}}{y^{50}-1}$

$$\lim_{y\to 1} 100-50-\left(\frac{100}{1-y^{100}}-\frac{50}{1-y^{50}}\right)$$

$$\text{L=50-L} \therefore \text{L=}\frac{50}{2}=25$$

64. 1

Sol. $T_n=\frac{H_{n+1}\text{-}H_n}{H_n H_{n+1}}$

As $H_{n+1}\text{-}H_n=\frac{1}{n+1}$

$\Rightarrow T_n=\frac{1}{H_n}-\frac{1}{H_{n+1}}$

$\Rightarrow T_1=\frac{1}{H_1}-\frac{1}{H_2}$

$T_2=\frac{1}{H_2}-\frac{1}{H_3}$

$\vdots \quad \vdots \quad \vdots$

$T_n=\frac{1}{H_n}\text{-}\frac{1}{H_{n+1}}$

$T_1+T_2+...+T_n=\frac{1}{H_1}\text{-}\frac{1}{H_{n+1}}$

$\text{As } n\to\infty,\quad T_1+T_2+...+0=1$

65. 7

Sol. Clearly a team of 4 with two batsman and two bowler can be formed as

Case-I: 2 bowler+2batsman

Number of ways=${}^4C_2\times{}^4C_2=36$

Case-II: 2 bowler+1 batsman +1 all-rounder

${}^4C_2\times{}^4C_1\times{}^1C_1=24$

Case-III: 1bowler +2 batsman +1 all-rounder

${}^4C_1\times{}^4C_2\times{}^1C_1=24$

$\therefore$ Probability that all-rounder is selected=$\frac{24+24}{36+24+24}=\frac{4}{7}$

$\therefore \qquad p=7$

66. 5

SECTION – D

67. 00000.32

68. 00031.00

Sol. $$\frac{(x-3)^{\frac{-|x|}{x}}\sqrt{(x-4)^2}\,(17-x)}{\sqrt{-x}\left(-x^2+x-1\right)\left(|x|-32\right)}<0$$

For $\sqrt{-x}$ to be defined $x<0$

$\Rightarrow \frac{-|x|}{x}=1$

Since $\sqrt{(x-4)^2}, \sqrt{-x}$ are positive & $-x^2+x-1$ is always negative

$\frac{(x-3)(x-17)}{x+32}>0$

$x<0$

$\Rightarrow \frac{1}{x+32}>0 \Rightarrow x=31$

69. 00833.33

Sol. $\because \int_a^x e^{f(t)}dt=\int_0^x g(x-t)dt+2x+3$

$\Rightarrow \int_a^x e^{f(t)}dt=\int_0^x g(t)dt+2x+3$ (Using King Property)

Differential both sides, we get

$e^{f(x)}=g(x)+2$

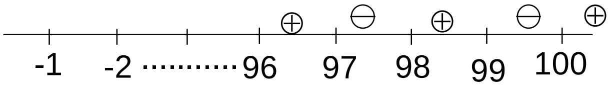
$\Rightarrow g(x)=e^{f(x)}-2$

$\Rightarrow g'(x)=e^{f(x)}.f'(x)$

$\because e^{f(x)}$ is always greater than zero.

$\therefore$ sign of g'(x) is same as sign of $f'(x)$.

$\therefore$ sign of g'(x)



Clearly, local extremum (maximum or minimum) will occur at x=99,97,95,….,3,1

$\therefore$ Sum of all the values=1+3+5+…+99=$\frac{50}{2}[2\times1+(50-1)\times2]=2500$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – II

JEE (Advanced)-2019

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 231**

General Instructions:

- The test consists of total 69 questions.
- Each subject (PCM) has 23 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Three Sections**: **Section-A, Section-C & Section-D.**

Section-A (01 – 03, 24 – 26, 47 – 49) *contains 9 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-A (04 – 08, 27 – 31, 50 – 54) *contains 15 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 mark*** *for wrong answer.*
Partial Marks **+1** for each correct option provided no incorrect options is selected.

Section-A (09 – 10, 32 – 33, 55 – 56) *contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Section-C (11 – 20, 34 – 43, 57 – 66) *contains 30 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

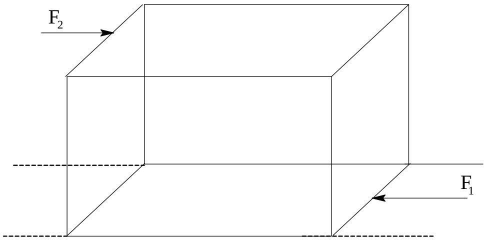
Section-D (21 – 23, 44 – 46, 67 – 69) *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics PART – I

SECTION – A
(Single Correct Choice Type)

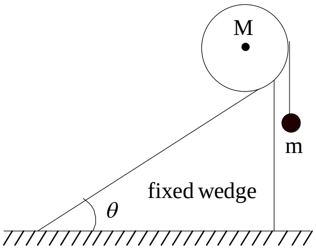
This section contains **3 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. A cubical container has 2 fixed vertical walls and two vertical walls can freely rotate about one of the horizontal edges. The right wall can rotated about upper edge the bottom wall about the bottom edge. Water is filled upto the top and forces F_1 and F_2 (perpendicular to the walls) are applied to keep the walls at from opening as shown in figure. Given that the cube is at rest on a rough horizontal surface. (Ignore atmospheric pressure)



(A) Friction from the surfaces is to the left
(B) Friction from the surfaces is to the right
(C) Normal reaction is shifted towards left wall
(D) Normal reaction is passes through the center

2. A uniform cylinder of mass M lies on a fixed plane inclined at an angle θ with the horizontal. A light string is tied to the cylinder at the right most point, and a mass m hangs from the string, as shown. Assume that the coefficient of friction between cylinder and the surface to be large enough to prevent slipping. For cylinder to remains static, the value of m is:

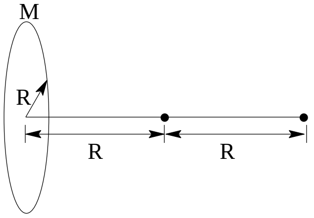


(A) $\dfrac{M\cos\theta}{1+\sin\theta}$ (B) $\dfrac{M\sin\theta}{1-\sin\theta}$

(C) $\dfrac{M\cos\theta}{1-\sin\theta}$ (D) $\dfrac{M\sin\theta}{1+\sin\theta}$

Space for Rough work

3. A ring having non-uniform distribution of mass M and radius R is being considered. A point mass m_0 is taken slowly away from the ring from A to B. In doing so, work done by the external force is:



(A) $\frac{GMm_0}{\sqrt{2}}$

(B) $\frac{G}{\sqrt{2}} \frac{Mm_0}{+\sqrt{5}}$

(C) $GMm_0\left[\frac{1}{\sqrt{2}} - \frac{1}{\sqrt{5}}\right]$

(D) It cannot be determined, because the nature of distribution of mass is not known.

(One or More than one correct type)

This section contains **5 questions**. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

4. A string of wood of mass M and length l is placed on a smooth horizontal surface. An insect of mass m starts at one end of the strip and walks to the other end in time t, moving with a constant speed:

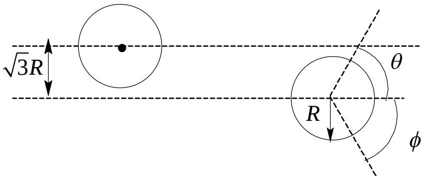
(A) The speed of the insect as seen from the ground is $< l/t$

(B) The speed of the strip as seen from the ground is $l/t\left(M/M+m\right)$

(C) The speed of the strip as seen from the ground is $l/t\left(m/M+m\right)$

(D) The total kinetic energy of the system is $1/2\ \left(m+M\right)\left(l/t\right)^2$

5. A disk moving on a frictionless horizontal table collides elastically with another identical disk as shown. The directions of motion of the two disks make angle θ and ϕ with the initial line of motion as shown. Then:



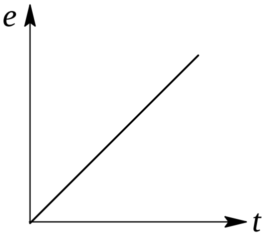
(A) $\theta = 30°$
(B) $\theta = 60°$
(C) $\phi = 30°$
(D) $\phi = 60°$

Space for Rough work

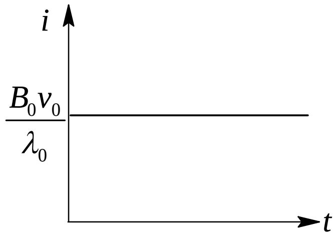
6. A particle moves in a circle of radius 20 cm. Its linear speed is given by v = 2t where t is in seconds and v in ms^{-1}. Then:
(A) The radial acceleration at t= 2s is $80\ \mathrm{ms}^{-2}$
(B) Tangential acceleration at t = 2s is $2\ \mathrm{ms}^{-2}$
(C) Net acceleration at t =2s is greater than $80\ \mathrm{ms}^{-2}$
(D) Tangential acceleration remains constant in magnitude

7. A long straight slider is moved with constant velocity $\vec{v} = v_0\hat{i}$ parallel to earth surface in the x-y plane in a uniform magnetic field $\vec{B} = B_0\hat{k}$ on a resistanceless rails in the form of curve $y^2=4x$. Here emf induced in the loop, current, power, resistance of slider per unit length and time are represented by e, i, p, λ_0 and t respectively. If at t = 0 slider starts from x = 0. Then which of the following option(s) is/are correct.

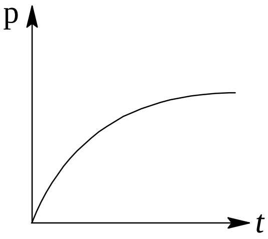
(A)



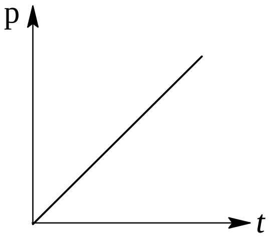
(B)



(C)



(D)



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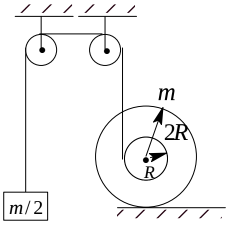


8. System shown in the figure is released form rest and spool does not slip at any point of its motion. Thread and pulley are ideal thread is of sufficient in length. Which of following are correct statements after of spool and block are released:
(A) Spool will keep moving toward right
(B) Spool will leave contact with table after covering certain distance
(C) Block will be at rest when spool will have maximum velocity.
(D) Block and spool will both execute oscillatory motion and their ratio of time period will be 2 : 1

Paragraph type (One Option Correct)

This section contains **1 paragraph** each describing theory, experiment, data etc. **Two questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Questions 9 & 10

An ideal diatomic gas is expanded so that the amount of heat transferred to the gas is equal to the decrease in its internal energy.

9. The molar specific heat of the gas in this process is given by C whose value is:

(A) $-\frac{5R}{2}$
(B) $-\frac{3R}{2}$
(C) $2R$
(D) $\frac{5R}{2}$

10. The process can be represented by the equation $\mathrm{TV^n} =$ constant, where the value of n is:

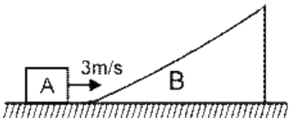
(A) $n=\frac{7}{5}$
(B) $n=\frac{1}{5}$
(C) $n=\frac{3}{2}$
(D) $n=\frac{3}{5}$

Space for Rough work

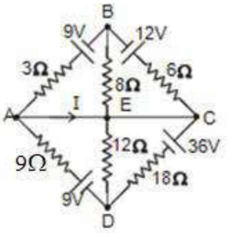
SECTION – C
(Single digit integer type)

This section contains **10 questions**. The answer to each question is a **Single Digit Integer** ranging from 0 to 9, both inclusive.

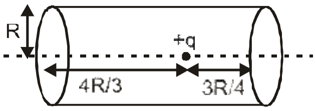
11. In the figure shown A is of mass 1 kg and B of mass 2 kg. A moves with velocity 3 m/s and rises on B which is initially at rest. All the surfaces are smooth. By the time A reaches the highest point on B, find the work done by A on B in joule



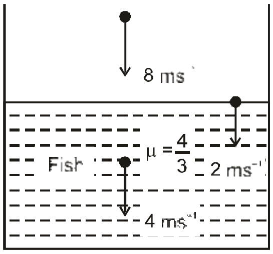
12. In the show circuit all cells are ideal. If current in branch BE is x ampere and current in branch AE is y ampere then value of x + y (in ampere) is



13. A point charge +q is placed on the axis of a closed cylinder of radius R and height $25R/12$ as shown. If electric flux coming out from the curved surface of cylinder is $\frac{xq}{10\in_0}$,then calculate x.

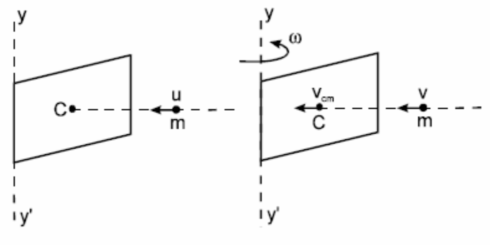


14. Speed of bird with respect to fish in ms^{-1} at given instant, if water surface is moving downward 2 m/sec at this time:

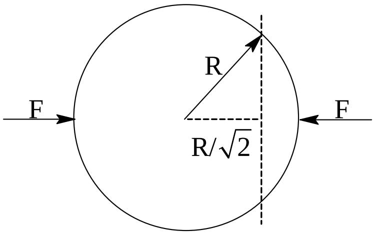


Space for Rough work

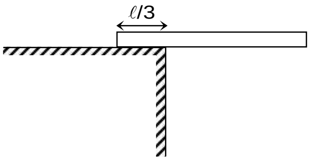
15. A uniform square plate of mass m = 100 gm and side a = 24 cm can rotate about a smooth vertical axis passing through one edge. It is initially at rest. A particle of mass m = 100 gm is moving horizontally and perpendicular to the plane of the plate with velocity u = 70 cm/s. It collides with the plate elastically at the centre of the plate. Find the angular velocity (in rad/s) of the plate just after collision?



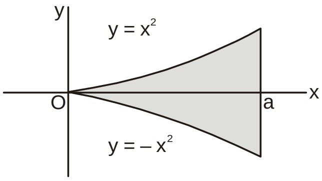
16. A thin spherical shell of radius 'R' carries a uniform surface change density σ. It is cut into two parts by a plane at a distance $R/\sqrt{2}$ from the centre as shown. To hold two parts together force F from both sides has to be applied. The minimum force F is $\frac{\pi\sigma^2R^2}{n\in_0}$k, then the value of 'n' is,



17. A uniform rod is placed at the table such that 1/3rd of the part is on the table initially. Rod is initially at rest. If normal reaction at that instant is $N = k\frac{mg}{4}$, then k =?



18. The moment of inertia about x-axis of uniform thin plate of density ρ kg/m^2 as shown in the figure is $\frac{N\rho a^7}{21}$, then find the value of N?



19. Expression for the magnetic dipole moment induction at the centre of a Bohr's hypothetical hydrogen atom in the nth orbit of the electron in terms of universal constants is $M = \frac{neh}{k\pi m}$, then the value of k…

20. A solid sphere of radius R is half immersed in a liquid of density ρ. The frequency of oscillation of the sphere for small displacement is $f = \frac{1}{2\pi}\sqrt{\frac{Ng}{2R}}$. Find N.

Space for Rough work

SECTION – D
(Numerical Answer Type)

This section contains **3 questions**. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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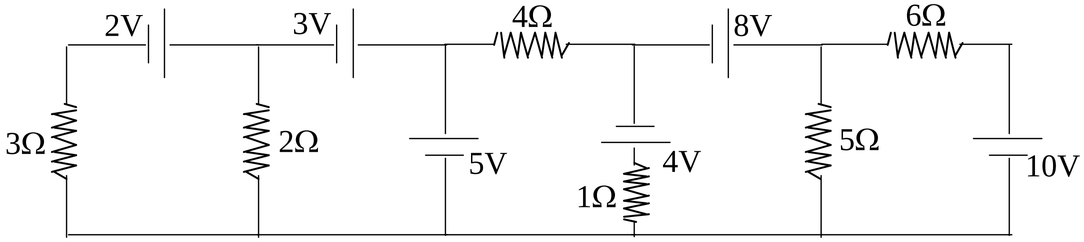
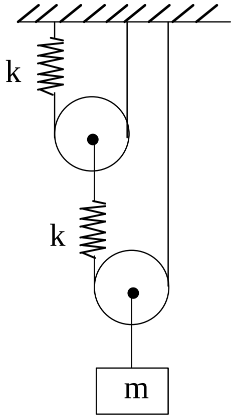
21. For the circuit shown in the figure, find the current passing through the resistor of resistance 1Ω in ampere.



22. A block of mass m hangs in equilibrium with the help of two springs as shown in the figure. Find the time period of vertical oscillation of the block, take m = 1kg and $k = \pi^2 \text{N/m}$.



23. In an experiment for calculation of focal length of a convex lens the distance between a screen and an object is 120 cm. A convex lens is placed closed to the object and is moved along the line joining object and screen, towards the screen. Two sharp images of the object are found on the screen. If the ratio of magnification of two real images is $1:16$ then find the focal length of the convex lens.

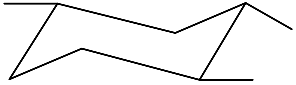
Space for Rough work

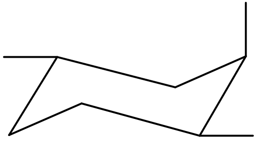
Chemistry PART – II

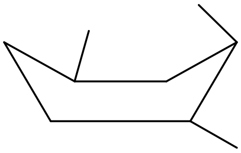
SECTION – A
(Single Correct Choice Type)

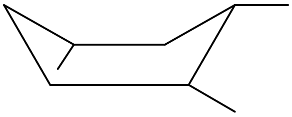
This section contains **3 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

24. Which of the following compound has lowest potential energy?

(A)


(B)


(C)


(D)


25. Which of the following is weaker base?

(A) $N(SiH_3)_3$
(B) $N(CH_3)_3$
(C) $NH(CH_3)_3$
(D) All are equally basic

26. Suppose that metal carbonyls follow the EAN rule, find the value of x in the $Fe(CO)_x$:

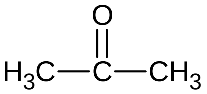
(A) 4
(B) 5
(C) 6
(D) 3

Space for Rough work

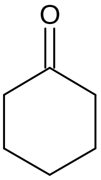
(One or More than one correct type)

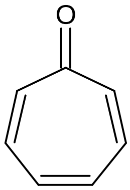
This section contains **5 questions**. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

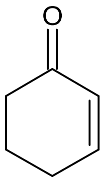
27. Which of the following compound have larger $C-O$ bond length than $C-O$ bond length of

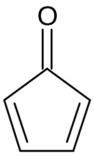


$H_3C-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$?

(A) 

(B) 

(C) 

(D) 

28. The correct statement/statements is/are:

(A) The distance between two octahedral voids of a cubic close packing of atoms with radius r is 2r

(B) The distance between two tetrahedral voids of a cubic close packing of atoms with radius r is $\sqrt{6}\times r$ at the body diagonal axes

(C) The distance between tetrahedral and octahedral void is $\sqrt{\frac{3}{2}}\times r$, where is the radius of atom forming the close packing

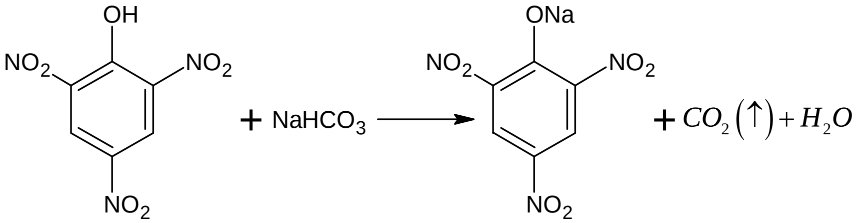
(D) The distance between the surfaces of atoms fcc arrangement along an edge is $2\left(\sqrt{2}-1\right)r$

Space for Rough work

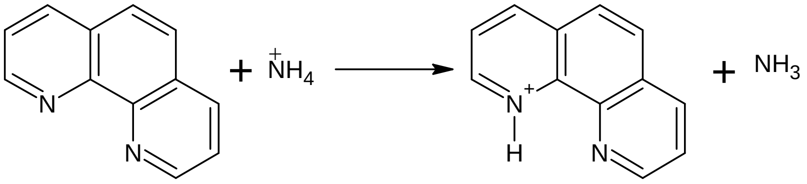
29. Which one of the following reactions is/are correct?

(A) $CH_3COOK + CF_3COOH \longrightarrow CH_3COOH + CF_3COOK$

(B)

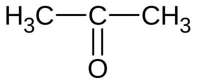

OH
NO2
NO2
NO2
+ NaHCO3
ONa
NO2
NO2
NO2
+ CO2(↑) + H2O

(C)

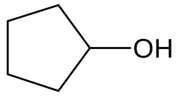

N
N
+ NH4+
N+
H
N
+ NH3

(D) $CH_3CH_2OH + NaHCO_3 \longrightarrow CH_3CH_3ONa + H_2O + CO_2(\uparrow)$

30. An optically active alcohol $A(C_8H_{16}O)$ on oxidation gives B. A on acidic heating gives $C(C_8H_{14})$ as major product. C on ozonolysis produces $D(C_5H_8O)$ and

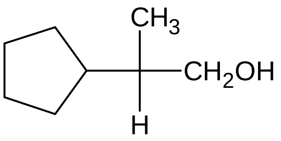


$H_3C-\underset{\underset{O}{\|}}{C}-CH_3$. D on reduction with $LiAlH_4$ gave

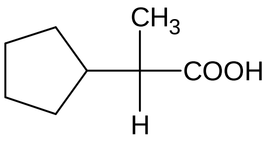


Identify correct answer:

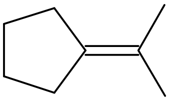
(A) A is



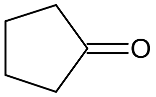
(B) B is



(C) C is



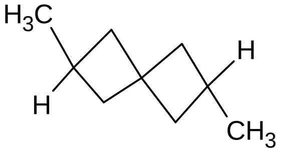
(D) D is



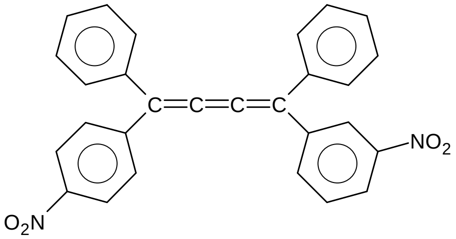
Space for Rough work

31. Identify the chiral molecule/molecules:

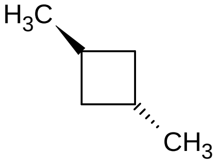
(A)



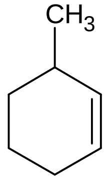
(B)



(C)



(D)

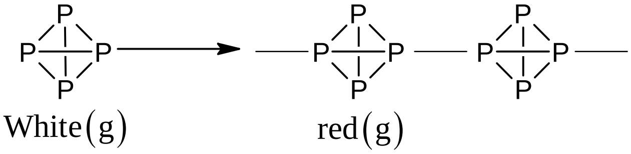


Paragraph type (One Option Correct)

This section contains **1 paragraph** each describing theory, experiment, data etc. **Two questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Questions 32 & 33

White phosphorus is a tetra atomic solid $\left[P_4(s)\right]$ at room temperature and on strong heating in absence of oxygen, it polymerizes into red phosphorus as:



$\Delta H = -104 \text{KJ/mol of } P_4$

The enthalpy of sublimation $\left[P_4(s) \longrightarrow P_4(g)\right]$ white is 59 KJ/mol and enthalpy of atomization is 316.25 KJ/mol of $P(g)$.

Now give the answers of following questions:

32. The average $P-P$ bond enthalpy in P_4 molecule is:

(A) $102\,KJ$
(B) $201\,KJ$
(C) $104\,KJ$
(D) $120\,KJ$

Space for Rough work

33. The $\mathrm{P-P}$ bond enthalpy in red phosphorus joining the two tetrahedral is:
(A) $201KJ$ (B) $104KJ$
(C) $305KJ$ (D) $80KJ$

SECTION – C
(Single digit integer type)

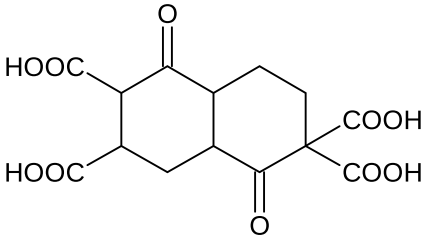
This section contains **10 questions**. The answer to each question is a **Single Digit Integer** ranging from 0 to 9, both inclusive.

34. If four atoms of same radius are placed at the alternate corner of a cube touching each other, than the length of body diagonal of the cube is equal to $\sqrt{x} \times R$, where R is the radius of atom. Find the value of x?

35. What will be the pH of the resulting solution obtained by mixing 20 mL of 0.1 N HCl and 20 mL of 0.1 N KOH solution?

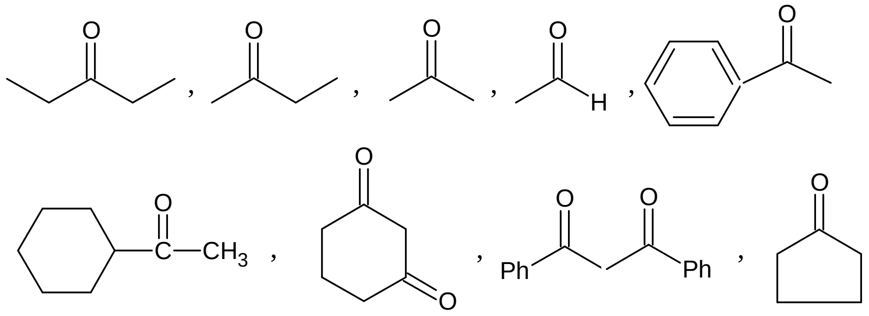
36. Diethyl$-\beta$, $\beta-$dimethylglutaric acid (ester) is condensed with diethyl oxalate in presence of sodium ethoxide and ethanol to form a major product(P), which on acidic hydrolysis followed by heating gives another product(Q). Calculate total number of C=O bonds in (P) and (Q) compounds?

37. How many moles of CO_2 will released when following compound is heated



Space for Rough work

38. Examine the structural formulas of compounds given below and identify number of compounds which show positive iodoform test.



39. The cost of electricity required to deposit 1 g Mg is Rs. 5.00. The cost of 30 g of Al to be deposited is Rs. X. Find the value of $\frac{x}{40}$?

40. Co forms dinuclear complex with a sigma bond within two Co atoms. Consider that metal carbonyls follows EAN rule. The complex can be written as $\mathrm{Co_2(CO)_x}$. Find the value of x?

41. In a cube of arrangement of atoms, atoms of an element are present at the corners, face centres, edge centres & the body centre of the cube. The number of atoms per unit cell, which is formed in this arrangement, is equal to.

42. Polythene can be prepared from calcium carbide by following reactions

$$\mathrm{CaC_2 + 2H_2O \longrightarrow Ca(OH)_2 + C_2H_2}$$

$$\mathrm{C_2H_2 + H_2 \longrightarrow C_2H_4}$$

$$\mathrm{nC_2H_4 \longrightarrow polythene}$$

Calculate the amount of polythene formed from 16 kg CaC_2 in kg…………..

43. Consider the following reaction $\mathrm{M^{x+} + Cr_2O_7^{2-} \longrightarrow MO_3^- + Cr^{3+}}$. If one mole of $\mathrm{Cr_2O_7^{2-}}$ oxides 3 mole of $\mathrm{M^{3+}}$ to $\mathrm{MO_3^-}$. Find the value of x …………..

Space for Rough work

SECTION – D
(Numerical Answer Type)

This section contains **3 questions**. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

44. Calculate the amount of $K_2Cr_2O_7$ required to produce 4.4 L CO_2 at STP when treated with excess of oxalic acid. (Molar mass of $K_2Cr_2O_7$ is 294)

45. A mixture of ethane and ethene occupies 40 L at 1 atm and at 400K. The mixture reacts completely with 128g of O_2 to produce CO_2 and H_2O. Assuming ideal behaviour, calculate the mole fraction of C_2H_4 in the mixture (gas constant R = 0.08 atm mol^{-1}, molar wt of O_2 = 32)

46. There are 2×10^{24} unit cells in 1 kg of metal for which the density is $4\ \text{g/cc}$. Calculate the side length of the cubic simple unit cell of the lattice of metal in Å.

Space for Rough work

Mathematics PART – III

SECTION – A
Single Correct Choice Type

This section contains **3 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

---

47. Solution of differential equation $f'(x)f'''(x)=3\left(f''(x)\right)^2,\left(y=f(x)\right)$ is:

(A) $x=k_1y^2+k_2y+k_3$ (B) $y=k_1x^2+k_2+k_3$

(C) $x=\sin y$ (D) None of these

48. Let $f(x)$ is an even function such that $f(x)+f(x-3)=x(x-3)+1$, then $\int_0^3 \frac{f(x)dx}{(x^2-3x+1)}$ is

(A) $-\frac{2}{3}$ (B) $-\frac{3}{2}$

(C) $\frac{2}{3}$ (D) $\frac{3}{2}$

49. Let S_n denotes the sum of first n term of an arithmetic progression whose first term is -4 and common difference is 1. If $V_n=2S_{n+2}-2S_{n+1}+S_n(n\in N)$, then

(A) $V_n=\frac{-9n^2+5n-12}{2},(n\in N)$ (B) $V_n=\frac{n^2+5n+12}{2},(n\in N)$

(C) Minimum value of V_n is -9 (D) Minimum value of V_n is $-\frac{73}{8}$

Space for Rough work

(One or More than one correct type)

This section contains **5 questions**. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

50. If in a ΔABC, a, b, c are in A.P. and P_1, P_2, P_3 are the altitudes from the vertices A, B and C respectively, then

(A) P_1, P_2, P_3 are in A.P.
(B) P_1, P_2, P_3 are in H.P.
(C) $P_1 + P_2 + P_3 \le \frac{3R}{\Delta}$
(D) $\frac{1}{P_1} + \frac{1}{P_2} + \frac{1}{P_3} \le \frac{3R}{\Delta}$

51. Given three non – zero, non – coplanar vectors, and $\vec{a}, \vec{b}$ and $\vec{c}$ and $\vec{r}_1 = p\vec{a} + q\vec{b} + \vec{c}$ and $\vec{r}_2 = \vec{a} + p\vec{b} + q\vec{c}$ if the vectors $\vec{r}_1 + 2\vec{r}_2$ and $2\vec{r}_1 + \vec{r}_2$ are collinear then (p, q) is

(A) (0, 0)
(B) (1, –1)
(C) (–1, 1)
(D*) (1, 1)

52. Each of 2010 boxes in a line contains one red marble and for $1 \le k \le 2010,$ the box is the k^{th} position also contain k white marbles. A child begins at the fist box and successively drawn a single marble at random from each box in order. The stops when be fist draws a red marble. Let $p(n)$ be the probability that he stops after drawing exactly n marbles. The possible value(s) of n for which $p(n) < \frac{1}{2010}$ is:

(A) 44
(B) 45
(C) 46
(D) 47

53. If α, β, γ are roots of $x^3 + 2x^2 - 3x + 1 = 0$, then value of $\frac{\alpha\beta}{\alpha+\beta} + \frac{\alpha\gamma}{\alpha+\gamma} + \frac{\beta\gamma}{\beta+\gamma}$ is less than

(A) 2
(B) 3
(C) 4
(D) 5

54. The solution of differential equation $3\frac{dx}{dy} = \frac{x}{x^3 - y}$ is $x^{\ell} = mx^n y + c$, then which of the following is/are **CORRECT**?{c is any arbitrary constant}

(A) $\ell + m + n = 11$
(B) $\ell + n = 9$
(C) $\ell + 2m = 10$
(D) m+n=4

Space for Rough work

Paragraph type (One Option Correct)

This section contains **1 paragraph** each describing theory, experiment, data etc. **Two questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Questions 55 & 56

Let t be a real number satisfying $2t^3 - 9t^2 + 30 - \lambda = 0$ where $t = x + \frac{1}{x}$ and $\lambda \in R$ then

55. If the cubic equation has three real and distinct solution for x then λ

(A) Is greater than 9
(B) Is greater than 11
(C) Is less than 8
(D) Is not equal to 10

56. If the cubic equation has exactly two real and distinct roots of x then exhaustive set of values of λ is

(A) $\lambda \in (-\infty, 3) \cup (30, \infty)$
(B) $\lambda \in (-\infty, -22) \cup (10, \infty) \cup \{3\}$
(C) $\lambda \in \{3, 30\}$
(D) None of these

SECTION – C
(Single digit integer type)

This section contains **10 questions**. The answer to each question is a **Single Digit Integer** ranging from 0 to 9, both inclusive.

57. $f(x) = \max|2\sin y - x|$ where $y \in R$ then minimum value of $f(x)$ is:

58. Let $f(x)(x > 1)$ be a differentiable function satisfying $f(x) = (\ln x)^2 - \int_1^e \frac{f(t)}{t} dt$. Then if Area bounded by tangent line of $y = f(x)$ at $(e, f(e))$, then curve $y = f(x)$ and $x = 1$ is A then $[A]$ is ($[.]$ is G. I. F)

Space for Rough work

59. If the equation on reflection of $\frac{(x-4)^2}{16}+\frac{(y-3)^2}{9}=1$ about the line $x-y-2=0$ is $16x^2+9y^2+k_1x-36y+k_2=0$ then $\frac{k_1+k_2}{22}$ is

60. A and B are two square matrices such that $A^2B=BA$ and if $(AB)^{10}=A^kB^{10}$ then the value of $k-1020$ is….

61. If two points P and Q on $9x^2-5y^2=1$ (whose centre is C) be such that CP is perpendicular to CQ then value of $\frac{1}{\text{CP}^2}+\frac{1}{\text{CQ}^2}$ is…..

62. Let z_1, z_2 and z_3 be complex numbers such that $|z_1|=|z_2|=|z_3|=|z_1+z_2+z_3|=2$. If $|z_1-z_2|=|z_1-z_3|$ *and* $z_2\neq z_3$. Then find the value of $|z_1+z_2||z_1+z_3|$.

63. If $\lim\limits_{x\to1}\frac{100}{1-x^{100}}-\frac{50}{1-x^{50}}=5\text{A}$; find the value of A.

64. Let $\text{H}_n=1+\frac{1}{2}+\frac{1}{3}+...+\frac{1}{n}$ and $\text{T}_n=\frac{1}{(n+1)\text{H}_n\text{H}_{n+1}}$, then the value of $(\text{T}_1+\text{T}_2+\text{T}_3+...+\infty)$ is:

65. There are 4 bowlers, 4 batsman and 1 all-rounder (who is bowler as well as batsman). Randomly a team of 4 players consisting of at least two bowlers and at least two batsman is formed. If the probability that all-rounder has been selected in team is $\frac{4}{p}$, then p is equal to:

66. Suppose $\int\frac{1-7\cos^2 x}{\sin^7 x\cos^2 x}dx=\frac{g(x)}{\sin^7 x}+C$, where C is an arbitrary constant of integration. Then the value of $g'(0)+g''\left(\frac{\pi}{4}\right)$.

Space for Rough work

SECTION – D
(Numerical Answer Type)

This section contains **3 questions**. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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67. Mr. A lists all the positive divisors of the number $N(2010)^2$ and selects two divisors from the list then the probability that exactly one of the selected divisors is perfect squares is:

68. If $\frac{(x-3)^{\frac{-|x|}{x}}\sqrt{(x-4)^2}\,(17-x)}{\sqrt{-x}\left(-x^2+x-1\right)\left(|x|-32\right)}<0$ then no. of integers x satisfying the inequality is:

69. Let f be real function defined on R (the set of real numbers) such that $f'(x)=100\ (x-1)(x-2)^2(x-3)^3.......(x-100)^{100}$, for all $x\in R$. If g is a function defined on R such that $\int_a^x e^{f(t)}dt=\int_0^x g(x-t)dt+2x+3$, If some of the all the values of x for which g(x) has a local extremum be λ then find $\frac{\lambda}{3}$

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – III

JEE (Advanced)-2019

PAPER –1

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01– 06, 19 – 24, 37 - 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*

   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 - 46) *contains 12 questions. Based on this section contains* ***TWO (02)*** *paragraphs. Based on each paragraph, there are* ***TWO (02)*** *questions.*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A

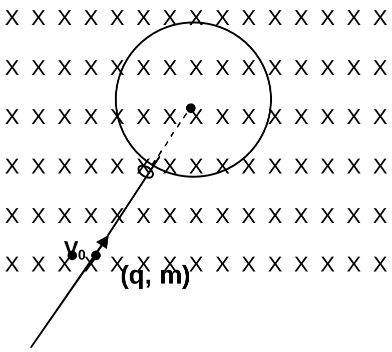
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. If λ_{min} is minimum wavelength produced in $X-$ray tube and $\lambda_{K\alpha}$ is the wavelength of K_α line. As the operating voltage is increased

(A) $\lambda_{K\alpha}$ increases
(B) $\lambda_{K\alpha}$ decreases
(C) $(\lambda_{K\alpha}-\lambda_{min})$ increases
(D) $(\lambda_{K\alpha}-\lambda_{min})$ decreases

2. A non-conducting cylindrical shell of radius R is placed in uniform magnetic field. The axis of the cylinder is parallel to the direction of magnetic field. A hole is drilled in cylinder and a particle having charge q and mass m is projected with velocity v_0 perpendicular to magnetic field and directed towards the axis of cylinder as shown in diagram. The particle collides elastically with inner wall of the cylinder and rebounds.



(A) The minimum no. of collisions after which it will emerge is two.

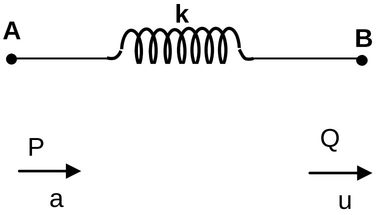
(B) The maximum speed v_0 for which it can come out is $v_0=\left(\frac{qBR}{m}\right)\sqrt{3}$.

(C) The minimum time in which it can come out will be $\left(\frac{\pi m}{qB}\right)$

(D) If the particle is projected with a velocity $v_0/3\left\{\text{where } v_0=\left(\frac{qBR}{m}\right)\sqrt{3}\right\}$ it will come out after five collisions.

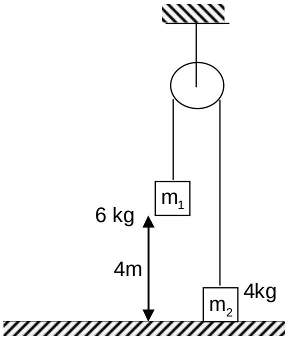
Space for Rough work

3. A massless spring of spring constant k has two ends P and Q as shown in the figure. End Q is being pulled by person B with constant speed u towards right. End P is being pushed by person A with constant acceleration a towards right starting from rest. Both starts simultaneously. Choose the correct option at the instant when B appears to be at rest with respect to A



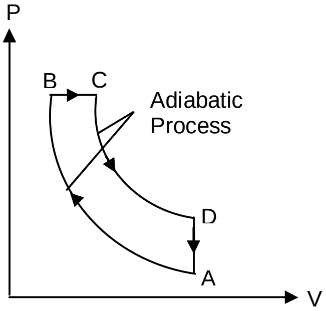
(A) work done by $B = ku^4 / 3a^2$
(B) work done by $A = -5ku^4 / 24a^2$
(C) work done by $A = +5ku^4 / 24a^2$
(D) elastic potential energy stored in spring $= ku^4 / 8a^2$

4. Two objects are connected by a light string passing over a light frictionless pulley as shown. The object of mass 6 kg is released from rest. (g = 10 m/s^2)



(A) Time taken by object of mass 6 kg to strike the surface is 2sec.
(B) Maximum height attained by block of mass 4 kg is 4.8 m.
(C) Duration after which 6 kg block will leave the surface for the first time is 2.8 sec.
(D) None of the above

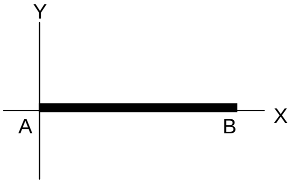
5. An idealized diesel engine operates in a cycle known as air standard diesel cycle as shown. Fuel is sprayed into the cylinder at the point of maximum compression, B. Combustion occurs during expansion BC.



(A) Heat is absorbed during process BC
(B) Heat is released during process DA
(C) Heat is absorbed during process CD
(D) Efficiency of the cycle is $\left[1-\frac{1}{\gamma}\left(\frac{T_D - T_A}{T_C - T_B}\right)\right]$

Space for Rough work

6. A wire of mass M and length L is placed along x-axis with end A at origin. The linear mass density λ (of the rod) varies as $\lambda = \lambda_0 x$, where x is distance from end A, λ_0 is a constant.



(A) The value of λ_0 is $\frac{2M}{L^2}$

(B) Moment of Inertia of the rod about an axis passing through A and parallel to y-axis is $\frac{1}{2}ML^2$

(C) Moment of inertia of the rod about an axis passing through COM of the rod and parallel to y-axis is $\frac{ML^2}{18}$.

(D) Moment of inertia of the rod about an axis passing through B and parallel to y-axis is $\frac{1}{6}ML^2$.

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 7 and 8

A ring of radius R is made of a thin wire of material of density p, having cross-section area a and Young's Modulus y. The ring rotates about an axis perpendicular to its plane and through its centre. Angular frequency of rotation is ω.

7. The tension in the ring will be

(A) $\frac{apR^2\omega^2}{2}$ (B) $apR^2\omega^2$

(C) $2apR^2\omega^2$ (D) $\frac{apR^2\omega^2}{4}$

8. The ratio of kinetic energy to potential energy is

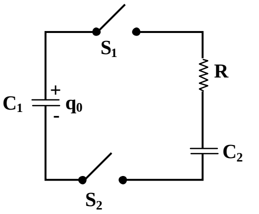
(A) $\frac{y}{pR^2\omega^2}$ (B) $\frac{2y}{pR^2\omega^2}$

(C) $\frac{y}{2pR^2\omega^2}$ (D) $\frac{y}{4pR^2\omega^2}$

Space for Rough work

Paragraph for Question Nos. 9 and 10

The capacitor C_1 in the figure shown initially carries a charge q_0. When the switches S_1 and S_2 are closed, capacitor C_1 is connected in series to a resistor R and a second capacitor C_2, which is initially uncharged. Where $C = \frac{C_1C_2}{C_1 + C_2}$.



9. The charge flown through wire as a function of time t is

(A) $q_0e^{-t/RC} + \frac{C}{C_2}q_0$
(B) $\frac{q_0C}{C_1} \times \left[1 - e^{-t/RC}\right]$
(C) $q_0\frac{C}{C_1}e^{-t/CR}$
(D) $q_0e^{-t/CR}$

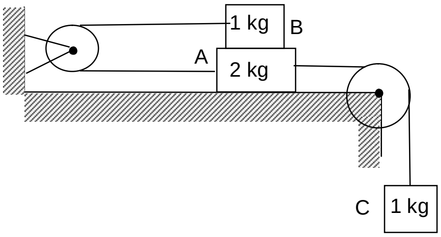
10. The total heat dissipated in the circuit during the discharging process of C_1 is

(A) $\frac{q_0^2}{2C_1^2} \times C$
(B) $\frac{q_0^2}{2C}$
(C) $\frac{q_0^2C_2}{2C_1^2}$
(D) $\frac{q_0^2}{2C_1C_2}$

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

11. Friction coefficient between any two surfaces in contact is 0.5. Pulleys and strings are frictionless. Find the friction between blocks A and B (in Newton)

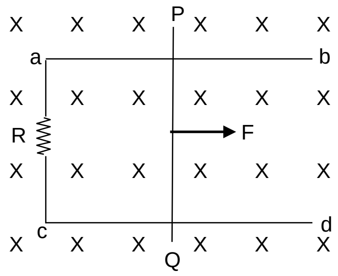


Space for Rough work

12. When a tangential force of 0.02 N is applied on a large wooden plate of area $10\,m^2$ floating on the surface of river, plate moves with the speed 2 m/s on the river surface. The river is 1 m deep and the water in contact with the bed is stationary. Assuming constant speed gradient, coefficient of viscosity of water is 10^{-N} poise. Find the value of N

13. A car is moving towards an approaching bike. Bike is moving with velocity 30 m/s. Frequency of horn sounded by car is 100 Hz while it is observed by bike rider as 120 Hz. The actual duration of horn is 6 sec. Find the time the bike rider hears it, in seconds. Take velocity of sound in air as 330 m/s.

14. In the figure ab and cd are two long conducting wires kept parallel to each other at a separation l in a uniform time varying magnetic field. The ends a and c are connected together by a resistor of resistance R. The magnetic induction B perpendicular to the plane of the wires varies with time according to the relation $B = B_0 t$, where B_0 is a positive constant with proper unit and t is the time in second. A conducting wire PQ placed on the wires ab and cd and dragged on the wire with constant speed v along the length of the wires by applying a constant force F. At $t = 0$, PQ is very close to ac. Ignore any resistance (electrical as well as mechanical) other than R. Find the value of $\frac{FR(250)}{B_0^2 l^2 v t^2}$.

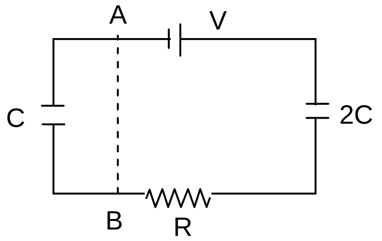


15. A choke coil is needed to operate an arc lamp at 250 V (rms) and 50 Hz. The lamp has an effective resistance of 15Ω when running at 10 A (rms). The inductance of the choke coil is $\frac{N}{125\pi}$H. Find the value of N

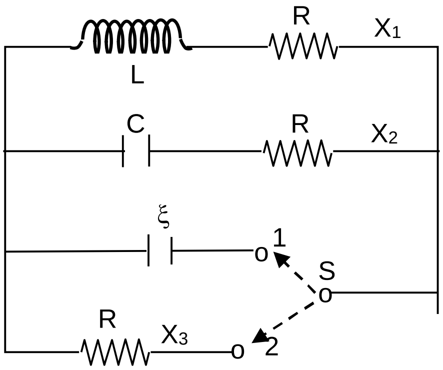
16. A conducting rod of length 1 m aligned along the unit vector $\left(\frac{3}{5}\hat{j} + \frac{4}{5}\hat{k}\right)$, is moving with a velocity $\vec{v} = (2\,\hat{i})\,m/s$. The motion take place in a uniform magnetic field $\vec{B} = (\hat{j} - 2\hat{k})$ tesla. Find the magnitude of induced emf in across the rod in volt.

Space for Rough work

17. If the heat dissipated in the circuit after a zero resistance wire is connected across the pairs A & B, is $\frac{2CV^2}{n}$, the value of 150n is



18. Figure shows a circuit containing three resistor $X_1, X_2 \& X_3$ having resistance R each, an inductor, capacitor and an emf source having inductance 'L', capacitance C & emf ξ respectively (Given $R = \sqrt{\frac{L}{C}}$). The switch is first connected to position-1. When charge on capacitor becomes half of it maximum possible value then switch S is connected to position-2. Current in resistance X_3 just after shifting the switch from position-1 to position -2, is (given L = 5mH, C = $2\mu F, R = 10\Omega, \xi = 5V$)



Space for Rough work

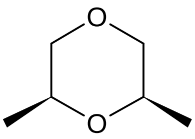
Chemistry PART – II

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Identify which of the structures below are not meso structures?

1


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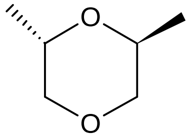

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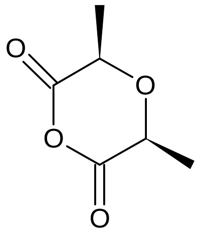

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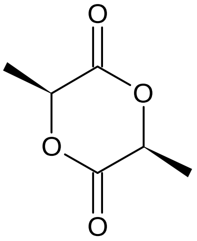
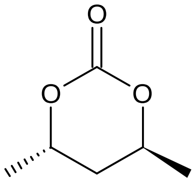
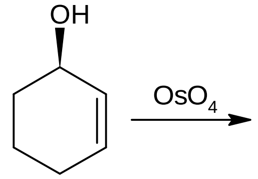


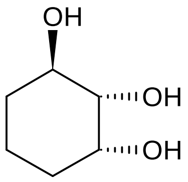
5


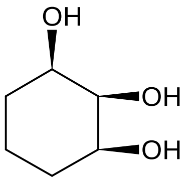
(A) 1 and 3
(B) 1, 3 and 5
(C) 1, 3 and 4
(D) 2 and 5

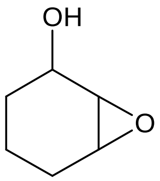
20.


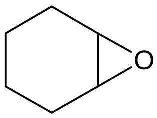
X + Y
12 : 1 The product which is not X

Prodcut (X) will be :

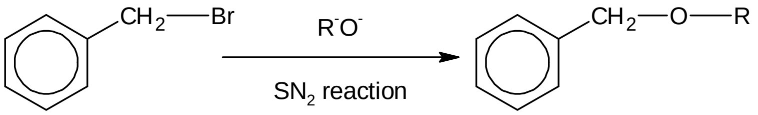
(A)


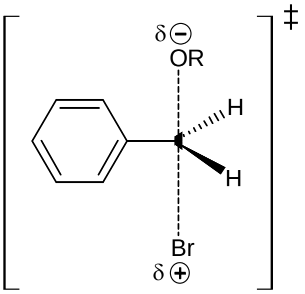
(B)


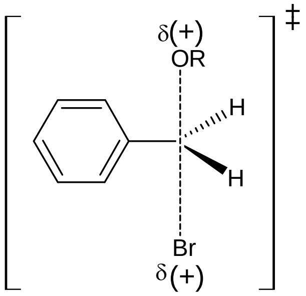
(C)


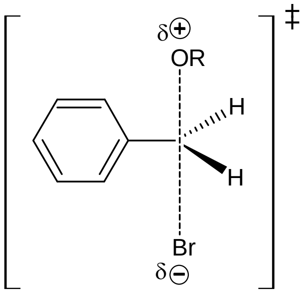
(D)


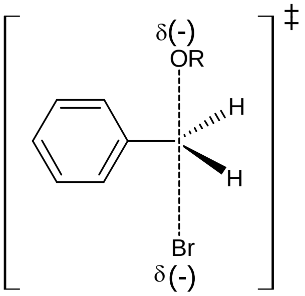
21. Which transition state is not for SN^2?


CH2—Br
R⁻O⁻
SN2 reaction
CH2—O—R

(A)


(B)


(C)


(D)


22. The correct statement(s) among the following is (are):

(A) All d-orbitals except d_{z^2} have two angular nodes

(B) $d_{x^2-y^2}$ and d_{z^2} orbitals lie on the axis or axes

(C) The degeneracy of p-orbital remains unaffected in a homogeneous external magnetic field

(D) The angle between the Z – component of orbital angular momentum of P_z – electron and Z-axis is 90^o

Space for Rough work

23. The standard redox potential E^o of the following systems are

	System	E^o (volts)
(i)	$MnO_4^- + 8H^+ + 5e - \longrightarrow Mn^{2+} + 4H_2O$	1.51
(ii)	$Sn^{2+} \longrightarrow Sn^{4+} + 2e^-$	–0.15
(iii)	$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^3 + +7H_2O$	1.33
(iv)	$Ce^{3+} \longrightarrow Ce^{4+} + e^-$	–1.61

The oxidizing power of the various species are related as

(A) $Cr_2O_7^{2-} > MnO_4^-$
(B) $Ce^{4+} > Sn^{4+}$
(C) $Ce^{4+} > MnO_4^-$
(D) $MnO_4^- > Sn^{4+}$

24. Which of the following condition are correct for a binary solution, in which the solute as well as the solvent are liquid?

(A) C_6H_6 and $C_6H_5CH_3 \Delta H_{solution} > 0$; $\Delta V_{solution} = 0$
(B) CH_3COCH_3 and $CHCl_3 \Delta H_{solution} < 0$; $\Delta V_{solution} < 0$
(C) H_2O and $HCl \Delta H_{solution} > 0$; $\Delta V_{solution} < 0$
(D) H_2O and C_2H_5OH $\Delta H_{solution} > 0$; $\Delta V_{solution} > 0$.

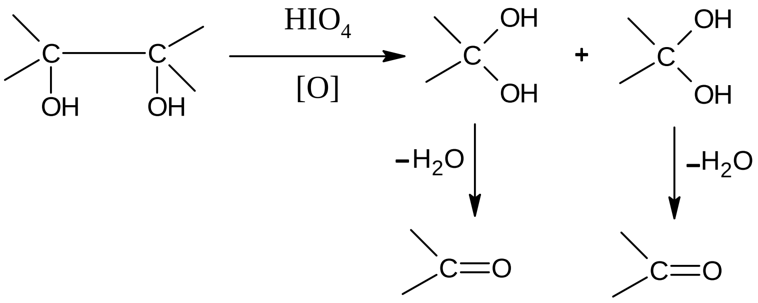
Space for Rough work

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

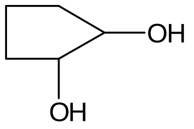
Paragraph for Question Nos. 25 and 26

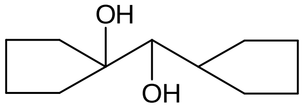
Vicinal diol on periodic acid oxidation gives a mixture of two carbonyl compounds which may be same of different.

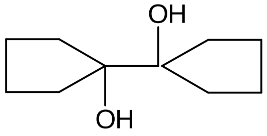


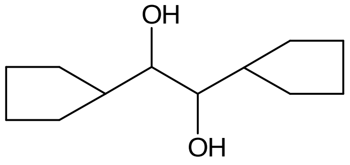
If diol is not vicinal then it is not oxidised by HIO_4. Cyclic diol on oxidation gives dicarbonyl compounds. By knowing the structures of carbonyl compounds formed we can get the structures of diols also.

25. 2 moles of cyclopentanone is obtained on HIO_4 oxidation of

(A)


(B)


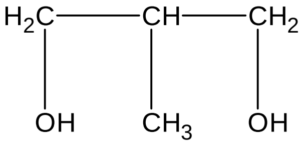
(C)


(D)


Space for Rough work

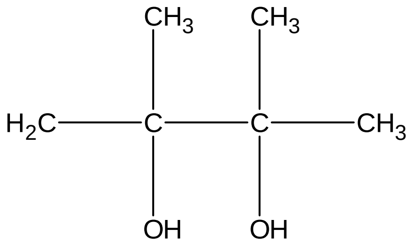
26. Which one of the following will be oxidised by periodic acid?

(A)



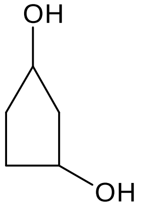
$\underset{OH}{H_2C}-\underset{CH_3}{CH}-\underset{OH}{CH_2}$

(B)

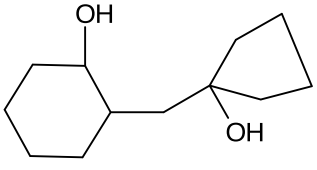


$H_2C-\overset{CH_3}{\underset{OH}{C}}-\overset{CH_3}{\underset{OH}{C}}-CH_3$

(C)



(D)



Paragraph for Question Nos. 27 and 28

Given

$E^{o}_{Ni^{2+}/Ni} = -0.26\ V$

$E^{o}_{Sn^{2+}/Sn} = -0.12\ V$

A solution containing $SnSO_4$(1M) and $NiSO_4$(1 M) is electrolyzed. (assume neutral aqueous solution)

27. Which of the ions will be deposited preferentially at cathode? (Given pH of pure water = 7) $\left(P_{H_2} = 1\ \text{atm}\right)$

(A) Ni^{2+} (B) Sn^{2+}

(C) H^{+} (D) OH^{-}

28. The concentration of Sn^{2+} when both Ni^{2+} and Sn^{2+} starts depositing at cathode. $\left(\text{assume } \frac{2.303RT}{F} = 0.06\right)$

(A) 1 M (B) 10^{-4}M

(C) 10^{-3}M (D) 10^{-8}M

Space for Rough work

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

29. Find the quantum number ‘n’ corresponding to the excited state of He^+ ion. If on transition to the ground state that ion emits two photons in succession with wavelengths 108.5 and 30.4 nm.

30. How many isomers of $C_4H_{10}O$ reacts with CH_3MgBr to evolve CH_4 gas? (Excluding stereoisomer)

31. Write the sum of geometrical isomers in $\left[Pt\left(H_2N-CH\left(CH_3\right)-CO\overset{\ominus}{O}\right)_2\right]$ complex and stereomers of $\left[Pt\left(gly\right)_3\right]^{\oplus}$ complex.

32. 2.47 g of an element A_x when dissolved in 50 g of benzene, lowered the freezing point of benzene to 0.4 K. K_f for benzene is 5.12 K kg mol^{-1}. The value of x, for atomic weight of A being 79, is

33. What is the time in hours for collecting 18 g of magnesium from molten $MgCl_2$ using a current of 10 amperes?

34. What $[H_3O^+]$ must be maintained in a saturated H_2S solution to precipitate Pb^{2+}, but not Zn^{2+} from a solution in which each ion is present at a concentration of 0.01 M?
$(K_{sp}\text{ of }H_2S = 8\times10^{-22}\,;\,K_{sp}\text{ of }ZnS = 1.0\times10^{-24})$

35. A thermally isolated vessel contains 100 g of water at $0\ ^oC$. When air above the water is pumped out, some of the water freezes and some evaporates at $0\ ^oC$ itself. Calculate the mass of the ice formed such that no water is left in the vessel. (Latent heat of vaporization of water at $0\ ^oC = 2.10\times10^6\ J/Kg$ and latent heat of fusion of ice $= 3.36\times10^5\ J/Kg$.)

36. A mineral having formula $Mg_xAl_yO_z$ is found in the spinel structure in which O^{2-} ions constitute ccp lattice, Mg^{2+} ions occupy 1/8th of the tetrahedral voids and Al^{3+} ions occupy ½ of the octahedral voids. Find the total positive charge contained in one unit cell.

Space for Rough work

Mathematics PART – III

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. $\int \frac{x^{2018}}{1+x+\frac{x^2}{2!}+......+\frac{x^{2018}}{2018!}}\,dx = m!\,x - m!\log P(x) + c$, then

(A) $m = 2019$

(B) $m = 2018$

(C) $P(x) = 1 = x + \frac{x^2}{2!} + ... + \frac{x^{2018}}{2018!}$

(D) $P(x) = x + \frac{x^2}{2!} + ... + \frac{x^{m+1}}{(m+1)!}$

38. For $|x| > 1$, $\lim_{n\to\infty}\prod_{K=0}^{n}\left(1+\frac{2}{x^{2^K}+x^{-2^K}}\right) = f(x)$, then

(A) $\int_2^5 f(x)\,dx = 3 + \ln 16$

(B) $\lim_{x\to\infty} f(x) = 1$

(C) $f(x) = 0$ has one solution

(D) $f(x)$ is decreasing function

39. If $f : R \to R$ be a differentiable function such that $(f(x))^7 = x - f(x)$, then

(A) The value of $\int_0^{\sqrt{2}} f^{-1}(x)\,dx$ is 3

(B) $f(x)$ is increasing for $\forall\ x \in R$

(C) The area bounded by by curve $y = f(x)$, between the ordinates $x = 0, x = \sqrt{3}$ & x axis is $\frac{f(\sqrt{3})}{8}\left[8\sqrt{3} - \left(f\sqrt{3})\right)^7 - 4\,f\left(\sqrt{3}\right)\right]$

(D) The area bounded by curve $y = f(x)$ between the ordinates, $x = 0, x = \sqrt{3}$ & $x -$ axis is $f\left(\sqrt{3}\right)\left[\sqrt{3} + \left(f(\sqrt{3}\right)^4 + 4\,f\left(\sqrt{3}\right)\right]$

Space for Rough work

40. Let C_1 & C_2 be centres of two circles whose radii are 2 & 4 respectively. Also $C_1C_2 = 10$ & direct common tangents of these circles touch them at P, Q, R, S. Another circle of radius 'λ' is drawn passing through P, Q, R, S. Then

(A) Midpoint of $C_1 C_2$ is centre of the circle passing through P, Q, R, S.

(B) Centre of the circle passing through P, Q, R, S divides $C_1 C_2$ in the ration 1 : 2

(C) $\lambda^2 = 33$

(D) $\lambda^2 = 35$

41. Let $S(n+1) = \sum_{r=0}^{n} \frac{(-1)^{n-r} r}{r+1} \cdot \frac{(n+1)!}{r!(n+1-r)!}$ then

(A) $S(8) = 1$ (B) $S(7) = \frac{3}{4}$

(C) $S(9) = \frac{4}{5}$ (D) $S(11) = \frac{5}{6}$

42. Let $A(t) = [aij]$ is a matrix of order 3×3 given by $aij = \begin{cases} 2\cos t, \text{ if } i = j \\ 1 \quad \text{if } |i-j| = 1 \\ 0, \quad \text{otherwise} \end{cases}$

Where $|A(t)|$ is determinant value of matrix A(t), then which of the following are correct?

(A) $\lim_{t \to 0} |A(t)|\,|A(4t)|$ is equal to 16 (B) Maximum value of $|A(t)|\,|A(3t)|$ is equal to 16

(C) $\int_0^{\pi} |A(t)|\,|A(4t)|\,dt$ is equal to 0 (D) $\left|A\left(\frac{\pi}{17}\right)\right| \left|A\left(\frac{4\pi}{17}\right)\right|$ is equal to 1

Space for Rough work

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 43 and 44

Let $f(x)$ satisfy the functional equation $\left(f(x)\right)^2 = 1 + x\,f(x+1)$ & the inequality $\frac{x+1}{2} \le f(x) \le 2(x+1)\ \forall\ x \ge 1$, then answer the following questions.

43. The function $f(x)$ defined from $[1, \infty) \to R$ is

(A) Into (B) Onto

(C) Many one (D) None of these

44. The domain the function $y = \cos^{-1}[f(x)]$ is

(A) ϕ (B) $[-1, 1]$

(C) $[-2, 1]$ (D) None of these

Paragraph for Question Nos. 45 and 46

Let $< a_n >$ & $< b_n >$ be the arithmetic sequences each with common difference 2 such that $a_1 < b_1$ & let $c_n = \sum_{k=1}^{n} a_n$, $d_n = \sum_{k=1}^{n} b_k$. Suppose that the point $A_n(a_n, c_n)$, $B_n(b_n, d_n)$ are all lying on the parabola C: $y = px^2 + qx + r$ where p, q, r constants.

45. The value of p equals

(A) $\frac{1}{4}$ (B) $\frac{1}{3}$

(C) $\frac{1}{2}$ (D) 2

46. If $r = 0$, then the value of a_1 & b_1 are

(A) $\frac{1}{2}$ & 1 (B) 1 & $\frac{3}{2}$

(C) 0 & 2 (D) $\frac{1}{2}$ & 2

Space for Rough work

SECTION – D

(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

47. Let $f(x) = 30 - 2x - x^3$ then the number of positive integral values of x which satisfies $f\left(f\left(f(x)\right)\right) > f\left(f\left(-x\right)\right)$ is

48. Let ABCD be a tetrahedron such that the edges AB, AC & AD are mutually perpendicular let the area of triangles ABC, ACD & ADB be given by 1, 3 & $\sqrt{90}$ sq. units respectively, then the area of ΔBCD is ___ sq. units.

49. Let p & q are real numbers such that
$(\tan p - 1)^3 + 2019\,(\tan p - 1) = -1$ & $(1 - \cot q)^3 + 2019\,(1 - \cot q) = -1$
$\tan p \neq \cot q$, then number of possible values of r which satisfy the equation
$\tan p + \cot q + \sin r + \cos r = 3$ in $x \in [-2\pi, 2\pi]$ is

50. Two circles are passing through point A of the Δ ABC & one of the circle touches the side BC at B & other circle touches the side BC at C. If $BC = 5$ & $\angle A = 30^o$ & the product of radii of two circles is

51. The area of region in xy plane consisting of all points (p, q) such that quadratic equation $px^2 + 2(p + q - 7)x + 2q = 0$ has less than 2 real solutions is ………….., where (π = 3.14).

52. If $\bar{p}, \bar{q}, \bar{r}$ are three vectors such that $|\bar{p}| = |\bar{q}| = 1$ & $\bar{r} = \bar{p} \times \bar{q}$, then maximum value of $\left|(\bar{p} + 2\bar{q} + 3\bar{r}).[(2\bar{p} + 3\bar{q} + \bar{r}) \times (3\bar{p} + \bar{q} + 2\bar{r})\right|$ is equal to

53. Four distinct integer are picked at random from $\{0, 1, 2, 3, 4, 5, 6\}$. If the probability that among those selected the second smallest is 3 is P, then 35 P is equal to …………

54. Given $M = \left[\frac{1}{1^{2/3}} + \frac{1}{2^{2/3}} + ... + \frac{1}{1000^{2/3}}\right]$, where [.] denotes G.I.F., then (M –20) is equal to

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – III

JEE (Advanced)-2019

PAPER –1

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. C

Sol. As V increases, E increases, λ_{min} decreases, $\lambda_{K\alpha}$ remains constant SO $(\lambda_{K\alpha} - \lambda_{min})$ increases

2. A, B, C, D

3. A, B, D

Sol. Work done by B $= \int_0^{u/a} k\left(ut - \frac{1}{2}at^2\right)udt = \frac{ku^4}{3a^2}$

Work done by $A = -\int_0^{u/a} k\left(ut - \frac{1}{2}at^2\right)atdt = -\frac{5ku^4}{24a^2}$

Energy stored in spring $= \frac{1}{2}k\left(\frac{u^2}{2a}\right)^2 = \frac{ku^4}{8a^2}$

4. A, B, C

Sol. (A) $a = \frac{m_1 = m_2}{m_1 + m_2}g \Rightarrow \frac{g}{5} = 2m/s^2$

$h = \frac{1}{2}at^2 \Rightarrow t = 2\,sec.$

(B) $H = 4 + \frac{U^2}{2g}$ where $U = at$

$= 4.8$ m.

(C) 6 kg block will be lifted after time $2 + \frac{2U}{g} = 2.8\,sec.$

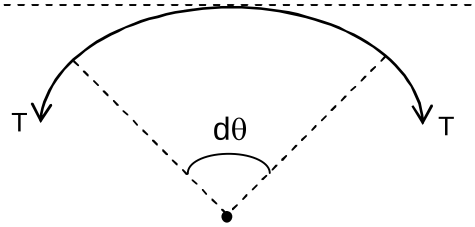
5. A, B, D

6. A, B, C, D

7. B

Sol. $2T\sin\frac{d\theta}{2} = Rd\theta a p\omega^2 R\left[\sin\frac{d\theta}{2} \approx \frac{d\theta}{2}\right]$

$T = apR^2\omega^2$.



8. A

Sol. $KE = \frac{1}{2}m\omega^2R^2 = \pi R^3 a p\omega^2$.

Stress in ring $= \frac{T}{a} = pR^2\omega^2$

$PE = \frac{1}{2}\frac{(\text{stress})^2}{Y} \times \text{volume}$

$PE = \frac{\pi p^2R^5 a\omega^4}{y}$

9. B

Sol. Finally, the capacitors are in parallel and total charge (= q_0) distributes between them in direct ratio of capacity.

$\therefore \quad q_{C_2} = \left(\frac{C_2}{C_1 + C_2}\right)q_0 \rightarrow$ in steady state.

But this charge increases exponentially.
Hence, charge on C_2 at any time t is

$q_{C_2} = \left(\frac{C_2\, q_0}{C_1 + C_2}\right)\left(1 - e^{-t/\tau_C}\right)$

Initially,C_2 is uncharged so, whatever is the charge on C_2 it is charge flown through switches

10. A

Sol. Common potential in steady state when they finally come in parallel is

$V = \frac{\text{Total charge}}{\text{Total capacity}} = \frac{q_0}{C_1 + C_2}$

Total heat dissipated $U_i - U_f$

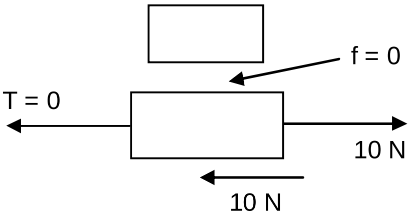
$= \frac{q_0^2}{2C_1} - \frac{1}{2}(C_1 + C_2)\left(\frac{q_0}{C_1 + C_2}\right)^2$

$= \left(\frac{q_0^2}{2C_1}\right)\left(\frac{C_1C_2}{C_1 + C_2}\right)^2$

SECTION – D

11. 00000.00

Sol. Since force which try to move the system is less than max friction hence system does not move. Hence $T = 0, f = 0$



12. 00002.00

Sol. $$n = \frac{\left(\frac{F}{A}\right)}{\left(\frac{dv}{dx}\right)} = \frac{\frac{0.02}{10}}{\frac{2}{1}} = 10^{-3} \text{kg/ms} = 10^{-2} \text{poise}$$

13. 00005.00

Sol. Velocity of bike $V_b = 30 \text{ m/s}$

Let velocity of car be V_c

$$f_{obs} = f_{actual} \times \frac{V_{so} + V_b}{V_{so} - V_c}$$

$$120 \text{ Hz} = 100 \text{ Hz} \times \frac{330 + 30}{330 - V_c}$$

$\Rightarrow \quad V_C = 30 \text{ m/s}$

Distance between initial and final pulse of horn

$= V_{so} \times \Delta t - V_C \, \Delta t \qquad \{\Delta t \text{ is duration of emission of sound}\}$

$= (330 - 30) \times 6 = 1800 \text{ m}$

This wave train travels with 330 m/s and cross bike rider moving with velocity of 30 m/s towards it.

$$\text{time taken} = \frac{\text{length of wave train}}{V_{so} + V_b} = \frac{1800}{330 + 30} = \frac{180}{36} = 5 \text{sec}$$

14. 00500.00

Sol. EMF, ε_1 (due to varying B) $= B_0 l \, vt$

ε_2 (due to motion of PQ) $= B_0 l \, vt$.

$\varepsilon = \varepsilon_1 + \varepsilon_2 = 2B_0 \, l \, vt$

$$\because \quad F = ilB = \frac{2B_0 lvt}{R} lB_0 t = \frac{2B_0^2 l^2 vt^2}{R}$$

15. 00025.00

Sol. $(V_{rms})_R = i_{rms} R = 150 \text{ V}$

$(V_{rms})_L = \sqrt{V_{rms}^2 - (V_{rms})_R^2} = 200 \text{ V}$

$(V_{rms})_L = i_{rms} X_L = i_{rms} 2\pi f L$

$$L = \frac{200}{10 \times 2\pi \times 50} = \frac{1}{5\pi} \text{H}$$

16. 00004.00

Sol. $|\varepsilon| = |\vec{v}.(\vec{B}\times\vec{l})|$

$$= (2\hat{i})\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 1 & -2 \\ 0 & 3/5 & 4/5 \end{vmatrix} = 4$$

17. 00450.00

Sol. $V_1 = \frac{(2C)V}{3C} = \frac{2}{3}V$

$U_1 = \frac{1}{2}C\frac{4}{9}V^2 = \frac{2CV^2}{9}$

$V_2 = \frac{V}{3}$

$U_2 = \frac{1}{2}(2C)\frac{V^2}{9} = C\frac{V^2}{9} = \frac{CV^2}{9}$

Initial total energy $= \frac{CV^2}{3}$

Final total energy $= \frac{1}{2}(2C)V^2 = CV^2$

Charge flow through the battery $= 2CV - \frac{2}{3}CV = \frac{4}{3}CV$

$\Rightarrow W_{\text{battery}} = \frac{4}{3}CV^2$

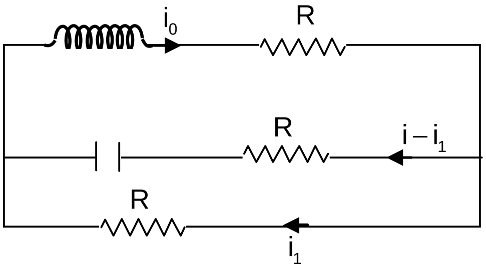
$\Rightarrow$ Heat dissipated $= \frac{4CV^2}{3} - \frac{2CV^2}{3} = \frac{2}{3}CV^2$

18. 00000.00

Sol. $R = \sqrt{\frac{L}{C}} \Rightarrow RC = L/R$ i.e. time constants of RC & LR circuit are same.

After switching from 1 to 2

$i_0 = \frac{\xi}{2R}$



From loop rule,

$$-(i_0 - i_1)R + \varepsilon/2 + i_1 R = 0$$

$\Rightarrow i_1 = \frac{2i_0R - \xi}{4R} = 0$

Chemistry PART – II

SECTION – A

19. B, C, D

20. B, C, D

21. A, B, C

22. A, B, C, D

23. B, C, D
Sol. The SRP should be high for a species to be a good oxidizing agent.

24. B, D
Sol. Factual

25. C
Sol. Boric acid (mild antiseptic), chloramphenicol (antibiotic) and aspirin (antipyretic as well as Analgesic) are all medicinal compounds.

26. B
Sol. $N_2 : KK\ \sigma_{2s}^2\sigma_{2s}^{*2}\ \pi_{2p_x}^2\ \pi_{2p_y}^2\sigma_{2p_z}^2$ (B.O = 3, Diamagnetic)

$N_2^+ : KK\ \sigma_{2s}^2\sigma_{2s}^{*2}\pi_{2p_x}^2\pi_{2p_y}^2\sigma_{2pz}^1$ (B.O = 2.5, Paramagnetic)

$C_2 : KK\sigma_{2s}^2\sigma_{2s}^{*2}\ \pi_{2p_x}^2\pi_{2p_y}^1$ (B.O = 2, Diamagnetic)

$C_2^+ : KK\ \sigma_{2s}^2\sigma_{2s}^{*2}\pi_{2p_x}^2\pi_{2p_y}^1$ (B.O = 1.5, Paramagnetic)

$NO : KK\ \sigma_{2s}^2\sigma_{2s}^{*2}\sigma_{2p_z}^2\pi_{2p_x}^2\pi_{2p_y}^2\pi_{2p_z}^{*1}$ (B.O. = 2.5, Paramagnetic)

$NO^+ : KK\ \sigma_{2s}^2\sigma_{2s}^{*2}\sigma_{2p_z}^2\pi_{2p_x}^2\pi_{2p_y}^2$ (B.O. = 3, Diamagnetic)

$O_2 : KK\ \sigma_{2s}^2\sigma_{2s}^{*2}\sigma_{2p_z}^2\pi_{2p_x}^2\pi_{2p_y}^2\pi_{2p_x}^{*2}\pi_{2p_y}^{*1}$ (B.O. = 2., Paramagnetic)

$O_2^+ : KK\ \sigma_{2s}^2\sigma_{2s}^{*2}\sigma_{2p_z}^2\pi_{2p_x}^2\pi_{2p_y}^2\pi_{2p_x}^{*1}$ (B.O. = 2.5, Paramagnetic)

27. B

28. B

SECTION – D

29. 00005.00
Sol. Given, $D_2 = 30.4 \times 10^{-7}$ cm

$D_1 = 108.5 \times 10^{-7}$ cm

Let excited state of He^+ be n_2. It comes from n_2 to n_1 and then n_1 to 1 to emit two successive photon

$$\frac{1}{D_2} = R_H.Z^2\left[\frac{1}{1^2} - \frac{1}{n_1^2}\right]$$

$$\frac{1}{30.4\times10^{-7}} = 109678\times4\left[\frac{1}{1^2} - \frac{1}{n_1^2}\right]$$

$\therefore n_1 = 2$

Now for $D_1 : n_1 = 2$ and $n_2 : ?$

$$\frac{1}{D_1} = R_H Z^2\left[\frac{1}{2^2} - \frac{1}{n_2^2}\right]$$

$$\frac{1}{108.5\times10^{-7}} = 109678\times4\left[\frac{1}{2^2} - \frac{1}{n_2^2}\right]$$

$\therefore n_2 = 5$

Thus, excited state for He is 5th orbit.

30. 00004.00

31. 00008.00

Sol. Total number of geometrical isomers in $\left[Pt\left(H_2N-CH(CH_3)-CO\overset{\ominus}{O}\right)_2\right]$ Total number of stereoisomer in $\left[Pt(gly)_3\right]^{\oplus}$ some of geometrical isomers and stereoisomers of given complexes = 8.

32. 00008.00

Sol. $\Delta T_f = \dfrac{1000\ K_f\ W_B}{M_B\ W_A}, M_B = 79x$

$$79x = \frac{1000\times5.12\times2.47}{0.4\times50} = 632.32 \Rightarrow x = \frac{632.32}{79} = 8$$

33. 00004.02

Sol.
$$Mg^{2+} + \underset{2\ F}{2e^-} \longrightarrow \underset{24\ g}{Mg}$$

24 g Mg need change $= 2F = 2\times96500$ C

18 g Mg needs charge $= (2\times96500)\times\dfrac{18}{24}$

It $= Q \Rightarrow t = \dfrac{2\times96500}{10}\times\dfrac{18}{24}$ seconds

$$= \frac{3474000}{240}\text{ seconds } = 14475\text{ seconds}$$

$$= \frac{14475}{3600}\text{hr} = 4.02\text{ hours}$$

34. 00002.82

35. 00086.20

Sol. Total mass of the water $= M = 100$ g Latent heat of vaporization of water at $0\ ^{o}C = L_1 = 21.0 \times 10^5\ J/Kg$

Latent heat of fusion of ice $= L_2 = 3.36 \times 10^5\ J/Kg$

Suppose, the mass of the ice formed $= m$

Then, the mass of water evaporated $= M - m$

Heat lost by the water in freezing $=$ Heat taken by the water in evaporation

Thus, $mL_2 = (M - m)L_1$ or $m = 86.2$ g

36. 00008.00

Sol. In $Mg_xAl_yO_z$, O^{2-} ions are in ccp arrangement. Number of atoms in a unit cell of ccp $= 4$. Hence, there are 4 octahedral voids and 8 tetrahedra voids.

Total positive charge $=$ charge on Mg^{2+} $+$ charge on Al^{3+} $= \frac{1}{8} \times 8 \times 2 + \frac{1}{2} \times 4 \times 3 = 8$

Mathematics

PART – III

SECTION – A

37. B, C

Sol. Let $P(x) = 1 + x + \frac{x^2}{2!} + \ldots.. + \frac{x^{2018}}{2018!}$

$$P'(x) = 1 + \frac{x}{1!} + \ldots. + \frac{x^{2017}}{2017!}$$

$$\therefore \int (2018)! \frac{(P(x) - P'(x))}{P(x)} dx$$

$$= 2018! \int \left(1 - \frac{P'(x)}{P(x)}\right) dx$$

$$= 2018!\left(x - \ln P(x)\right) + C$$

38. A, B, D

Sol. $a_n = \prod_{K=0}^{n} \left(1 + \frac{2}{x^{2^K} + x^{-2^K}}\right), |x| > 1$

$$= \frac{x+1}{x-1} \cdot \frac{x^{2^{n+1}} - 1}{x^{2^{n+1}} + 1}$$

$$\lim_{n \to \infty} a_n = \left(\frac{x+1}{x-1}\right)\left(\frac{1-0}{1+0}\right) = \frac{x+1}{x-1}$$

$$\therefore \ f(x) = \frac{x+1}{x-1}$$

39. A, B, C

Sol. $f(x)\left[f(x))^6 + 1\right] = x$

$$f(0)\left[f(0)^6 + 1\right] = 0 \Rightarrow f(0) = 0$$

$$\& \ 7\left(f(x)\right)^6 f'(x) = 1 - f'(x)$$

$$f'(x)\left[7\left(f(x)\right)^6 + 1\right] = 1$$

$$\Rightarrow \ f'(x) > 0 \forall x \in R$$

$\Rightarrow$ $f(x)$ is increasing function $\forall x \in R$

$$\Rightarrow \ x^7 + x = f^{-1}(x)$$

$$\Rightarrow \ \int_0^{\sqrt{2}} (x^7 + x)\, dx = 3$$

$$\& \ \int_0^a f(x)dx + \int_0^{f(a)} f^{-1}(x)dx = af(a)$$

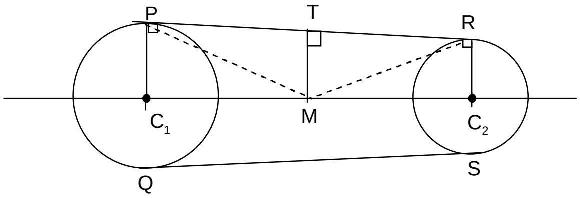
$$\Rightarrow \ \int_0^{\sqrt{3}} f(x)dx = \frac{f(\sqrt{3})}{8}\left[8\sqrt{3} - \left(f(\sqrt{3})\right)^7 - 4f(\sqrt{3})\right]$$

40. A, C

Sol. Let T be the midpoint of PR, perpendicular from T to PR meets $C_1 C_2$.

Also $MP^2 = MR^2 = MQ^2 = MS^2 = MT^2 + TR^2$

Hence M is centre of required circle



$$PR = \sqrt{(C_1\,C_2)^2 - (r_1 - r_2)^2}$$

$$= \sqrt{100-4} \quad = \sqrt{96}$$

$$\lambda^2 = MT^2 + TR^2$$

$$= \left(\frac{2+4}{2}\right)^2 + TR^2 = 9 + \frac{96}{4}$$

$$= 9 + 24 = 33$$

41. A, B, C, D

Sol. $S(n+1) = \sum_{r=0}^{n} (-1)^{n-r} \left\{1 - \frac{1}{r+1}\right\} \frac{(n+1)!}{r!(n+1-r)!}$

$$= \sum_{r=0}^{n} (-1)^{n-r}\ {}^{n+1}C_r - \sum_{r=0}^{n} (-1)^{n-r} \frac{(n+1)!\ \ n+2}{(r+1)!\,(n+1-r)!} \cdot \frac{1}{n+2}$$

$$= 1 - \frac{1}{n+2} \sum_{r=0}^{n} (-1)^{n-r}\ {}^{n+2}C_{n+1-r}$$

$$= 1 - \frac{1+(-1)^n}{n+2}$$

42. A, B, C, D

Sol. $|A(t)| = \frac{\sin 4t}{\sin t}$

$$|A(4t)| = \frac{\sin 16t}{\sin 4t}.$$

43. A

44. A

Sol. $(f(x))^2 = 1 + x\,f(x+1)........(1)$

$$\frac{x+1}{2} \le f(x) \le 2\,(x+1).......(2)$$

Replacing x by $x+1$in eqn (2)

$$\frac{x+2}{2} \le f(x+1) \le 2(x+2)........(3)$$

From (1) we have

$$\frac{1}{2} + x\,f(x+1) < (f(x))^2 < 2 + x\,f(x+1)$$

From (2) & (3)

$$\frac{1+x(x+2)}{2} < (f(x))^2 < 2\,[1 + x(x+2)]$$

Taking square root

$$2^{-1/2}(1+x) < f(x) < 2^{1/2}\,(1+x)$$

On continuing the process, k times we get

$$2^{-1/2^k}\,(1+x) < f(x) < 2^{1/2^k}(1+x)$$

Let $k \to \infty$ gives $1 + x \le f(x) \le 1 + x)$

$$\to\ f(x) = x+1$$

45. A

46. C

Sol. $C_n = a_1 + a_2 + ... + a_n$

$a_1, a_2, ...a_n$ are in A.P with common difference = 2

$d_n = b_1 + b_2 + ... + b_n$ are in A.P with common difference = 2

(a_n, c_n) lies on $y = px^2 + qx + r$

$c_n = p\,a_n^2 + q\,a_n + r$

$c_{n-1} = p(a_{n-1}^2 + qa_{n-1} + r$

$c_n - c_{n-1} = p(a_n^2 - a_{n-1}^2) + q(a_n - a_{n-1})$

$\Rightarrow a_n = p(a_n + a_{n-1})(a_n - a_{n-1}) + q(a_n - a_{n-1})$

$a_n = (a_n - a_{n-1})\,[p(a_n + a_{n-1}) + q]$

let $n = 2$ & 3

$a_2 = d\,[p(a_2 + a_4) + q].....(1)$

$a_3 = d\,[p(a_3 + a_2) + q].....(2)$

Subtracting above 2 eqns (1) & (2)

$a_3 - a_2 = d\,[p(a_3 - a_1)]$

$4p = 1 \Rightarrow p = \frac{1}{4}$.

Adding (1) & (2)

$q = \frac{1}{2}$

SECTION – D

47. 00002.00

Sol. $f'(x) = -2 - 3x^2 < 0 \Rightarrow f(x)$ is decreasing

$\therefore\ f\big(f(x)\big) < f(-x) \Rightarrow f(x) > -x$

$\Rightarrow 30 - x - x^3 > 0 \Rightarrow x^3 + x - 30 < 0$

$\Rightarrow\ (x-3)(x^2 + 3x + 10) < 0$

$\Rightarrow\ x < 3$

No. of values = 2

48. 00010.00

Sol. Area of Δ ABC $\Rightarrow \frac{1}{2}ab = 1$

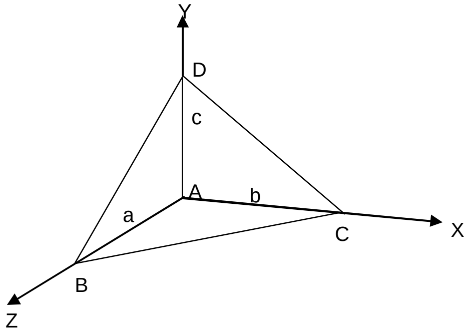
Area of Δ ACD $= \frac{1}{2}bc = 3$

Area of Δ ADB $= \frac{1}{2}ac = \sqrt{90}$

Area of ΔBCD

$= \frac{1}{2}\sqrt{a^2b^2 + b^2c^2 + c^2a^2}$

$= \frac{1}{2} \times 2\sqrt{1 + 9 + 90} = 10$



49. 00005.00

Sol. On subtracting given equation

$\left[(\tan p - 1)^3 - (1 - \cot q)^3\right] + 2019\left[(\tan p - 1) - (1 - \cot q)\right] = 0$

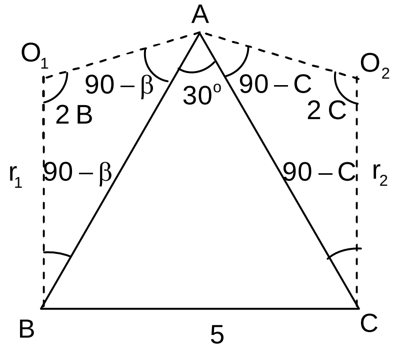
$\Rightarrow\ [\tan p + \cot q - 2]\,[(\tan p - 1)^2 + (1 - \cot q)^2 + (\tan p - 1)(1 - \cot q) + 2019] = 0$

This is possible if $\tan p + \cot q = 2$

$\therefore \sin r + \cos r = 1$

$\Rightarrow \; r = -2\pi, -\dfrac{3\pi}{2}, 0, \dfrac{\pi}{2}, 2\pi$

50. 00025.00



Sol. In $\Delta AO_1B \; \dfrac{AB}{\sin 2B} = \dfrac{r_1}{\cos B}$......(1)

In $\Delta \; AO_2 \; B \; \dfrac{AC}{\sin 2C} = \dfrac{r_2}{\cos C}$.......(2)

From above (2) equations

$$\frac{AB \, . \, AC}{\sin 2B \, . \, \sin 2C} = \frac{r_1 \, r_2}{\cos B \cos C}$$

$$\frac{2\,R \,\sin C \, . \, 2R\, \sin B}{2\sin B \; 2\sin C} = r_1 \, r_2$$

$$r_1 \, r_2 = R^2 = \left(\frac{5}{2\sin 30^o}\right)^2 = 25 \, .$$

51. 00153.86

Sol. $D \le 0$

$4(p+q-7)^2 - 8pq \le 0$

$\Rightarrow \; (p-7)^2 + (q-7)^2 \le 7^2$ interior & circumference of this represents an circle with centre (7, 7) & radius 7

$\therefore$ Area $= 49\pi$.

52. 00018.00

Sol. $\begin{vmatrix} 1 & 2 & 3 \\ 2 & 3 & 1 \\ 3 & 1 & 2 \end{vmatrix} [\bar{p} \; \bar{q} \; \bar{r}]$

$= -18(\bar{p} \times \bar{q}) \, . \, \bar{r} = -18 \, \bar{r}^{\;2}$

So maximum value of $\left|-18\bar{r}^{\;2}\right|$ is 18.

$\left(\because \left|\bar{r}\right| \le \left|\bar{p}\right| \left|\bar{q}\right|\right)$

53. 00009.00

Sol. Required Probability $= \dfrac{{}^3C_1 . {}^3C_2}{{}^7C_4} = \dfrac{9}{35}$

54. 00007.00

Sol. $\displaystyle\sum_{n=1}^{1000} n^{-2/3} > \int_1^{1000} x^{-2/3} dx = 3(x^{1/3})^{1000} = 27$......(1)

& $\displaystyle\sum_{n=1}^{1000} n^{-2/3} < \int_1^{1000} x^{-2/3} \; dx + \left\{\left(1^{-2/3} - 2^{-2/3}\right) + \left(2^{-2/3} - 3^{-2/3}\right) + \right.$

$\left.(3^{-2/3} - 4^{-2/3}) + ... + (999^{-2/3} - 1000^{-2/3})\right\} + \left(1000\right)^{-2/3} = 28$ …… (2)

$\therefore$ From (1) & (2)

$$M = \left[\sum_{n=1}^{1000} n^{-2/3}\right] = 27$$

$\Rightarrow M - 20 = 7$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – III

JEE (Advanced)-2019

PAPER –2

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01 – 06, 19 – 24, 37 – 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 – 46) *contains 12 questions. Each question has* ***TWO (02)*** *matching lists:* ***LIST-I*** *and* ***LIST-II***. ***FOUR*** *options are given representing matching of elements from* ***LIST-I*** *and* ***LIST-II***. ***ONLY ONE*** *of these four options corresponds to a correct matching.*
   For each question, choose the option corresponding to the correct matching.
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

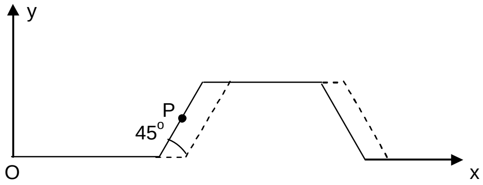
PART – I

SECTION – A

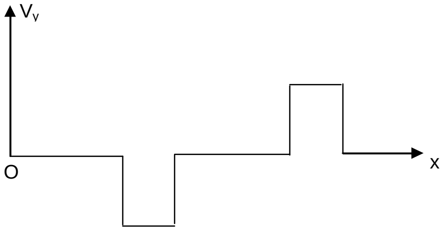
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. The figure shows a taut string, initially aligned with the x-axis, which carries a waveform travelling towards the right without any change its shape. The bold line and the dotted line indicate the displacement of the string (i.e., shape of the waveform) at time = t second and at time = (t + dt) second, respectively. The speed of particle at point P at t = 2 sec is 1 cm/s. Choose the correct statement(s) from the following (assume that dt is positive).

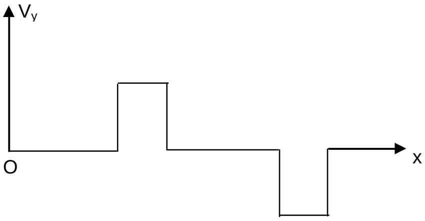


(A)



Particle velocity as a function of position

(B)

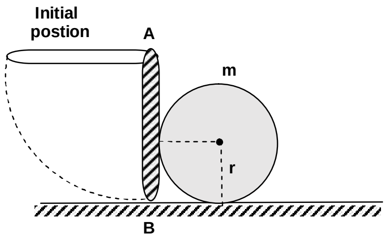


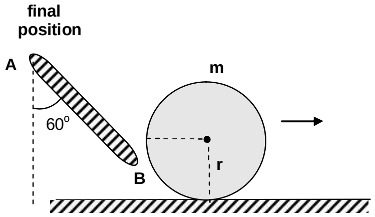
Particle velocity as a function of position

(C) Speed of waveform is 1 cm/s and it is moving along positive x-axis
(D) Speed of waveform is 1 cm/s and it is moving along negative x-axis

Space for Rough work

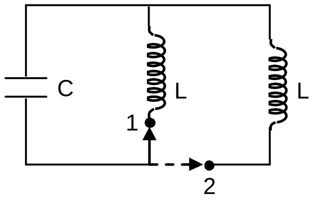
2. A uniform rod AB of mass M is attached to a hinge at one end A, and released from rest from the horizontal position. The rod rotates about A, and when it reaches the vertical position the rod strikes a sphere of mass m and radius r initially at rest on the smooth horizontal surface as shown in the adjacent figure. The impact is along the horizontal direction and perfectly elastic. If at the moment of impact, the lowest end of the rod is very close to the smooth horizontal surface. After the impact, the sphere moves along the horizontal and the rod, subsequently rises to a maximum of 60^o with the vertical. Choose the correct statement(s) form the following, taking into account the information given above. The length of the rod equals $\sqrt{2}r$. ($r = \frac{6\sqrt{2}}{10}$ m)





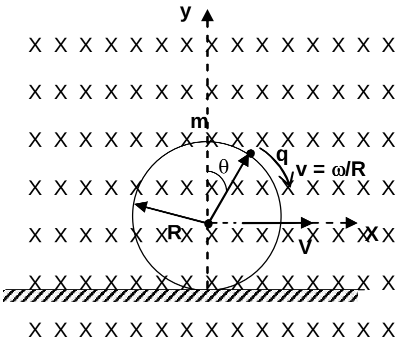
(A) The ratio M/m is 3/2
(B) The ratio m/M is 2/3
(C) The speed of the sphere just after collision is 6 m/s
(D) The speed of the sphere just after collision is 3 m/s

3. A capacitor with charge Q on it is connected to an inductor L as shown in diagram at t = 0. When the switch is flipped from position 1 to 2, the current in the circuit is observed to be at half of its maximum value. Then

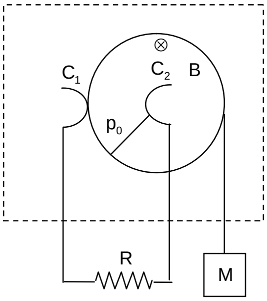


(A) Charge on capacitor at the time was Q/2
(B) Charge on capacitor at that time was $\frac{Q\sqrt{3}}{2}$
(C) Total energy lost is $\frac{Q^2}{4C}$
(D) Total energy lost is $\frac{Q^2}{8C}$

Space for Rough work



4. A ring of mass m and radius R is set into pure rolling on horizontal rough surface, in a uniform magnetic field of strength B – as shown in the figure. A point charge q of negligible mass is attached to rolling ring. Friction is sufficient so that it does not slip at any point of its motion. (θ is measured in clockwise from positive y-axis)
(A) Ring will continue to move with constant velocity.
(B) The value of friction acting on ring is Bqv cos θ.
(C) The value of friction acting on ring is Bqv sin θ.
(D) Ring will lose contact with ground if v is greater than $\left(\frac{mg}{2qB}\right)$.



5. Consider a perfectly conducting disc of radius r_o in a constant magnetic field B perpendicular to the plane of the disk sliding contacts are provided at the edge of the disc (C_1) and its axle (C_2). After long time angular velocity will become constant and becomes equal to ω & current in resistance is i, then
(A) $i = \frac{B\omega r_o^2}{R}$ (B) $i = \frac{B\omega r_o^2}{2R}$
(C) $\omega = \frac{4MgR}{B^2 r_o^3}$ (D) $\omega = \frac{2MgR}{B^2 r_o^3}$

6. Some successive frequencies of an ideal organ pipe are measured as 150 Hz, 250 Hz, 350 Hz. Velocity of sound is 340 m/s.
(A) it must be an open organ pipe of length 3.4 m
(B) it must be an open organ pipe of length 6.8 m
(C) it must be an closed organ pipe of length 1.7 m
(D) it must be an closed organ pipe of length 3.4 m

Space for Rough work

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

---

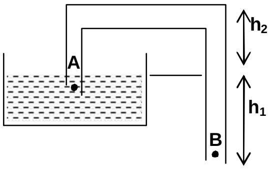
7. In closed organ pipe,

List –I		**List –II**	
(P)	Third overtone frequency is times fundamental frequency then n is	(1)	3
(Q)	Number of nodes in second overtone	(2)	4
(R)	Number of antinodes in second overtone	(3)	5
(S)	n^{th} harmonic does not exist whose n is	(4)	7

Codes:

	P	Q	R	S
(A)	4	1	2	3
(B)	4	1	1	2
(C)	3	1	2	2
(D)	3	4	1	2

8. A siphon transfers liquid from high level to low lend as shown. If P is density of fig. P_o is atmospheric pressure. V_a in redo. At pt. A and V_B at B then.



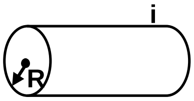
List –I		**List –II**	
(P)	$(h_1+h_2)-\frac{P_o}{P_g}$	(1)	= 1
(Q)	$V_A - V_B$	(2)	< 0
(R)	h_1	(3)	> 0
(S)	P_A-P_B	(4)	= 0

Codes:

	P	Q	R	S
(A)	2	1	4	1
(B)	2	4	1	2
(C)	2	1	3	4
(D)	1	2	3	4

Space for Rough work

9. A long straight conductor of radius R carries a current I as shown. The current density j varies as a function of radius according to j = br where b is a constant. Match the quantities in List – I with those in List – II.



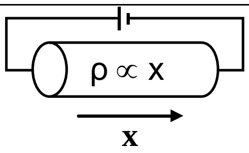
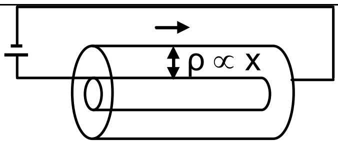
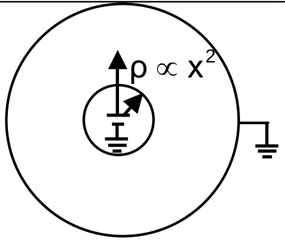
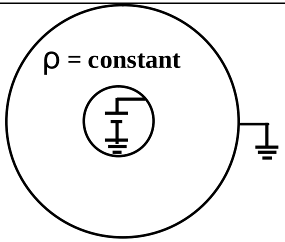
List –I		List –II	
(P)	B_{inside}	(1)	Maximum
(Q)	$B_{surface}$	(2)	$\frac{\mu_0 br^2}{3}$
(R)	$B_{outside}$	(3)	$\frac{2\pi br^3}{3}$
(S)	I_{inside}	(4)	$\frac{\mu_0 bR^3}{3r}$
		(5)	Continuous

Codes:

	P	Q	R	S
(A)	1	2	4,5	3
(B)	2	1,5	4	3
(C)	3	5	2	3,5
(D)	4,5	1	4	3

Space for Rough work

10. List – I has some conductor across which battery is connected as shown. Variation of resistivity ρ is also indicated. Which of the quantities in List – II remains constant throughout the volume of conductor.

List –I		**List –II**	
(P)		(1)	Magnitude of electric field
(Q)		(2)	Magnitude of current density
(R)		(3)	Power dissipated per unit volume
(S)		(4)	Drift speed of free electron
		(5)	Electric current

Codes:

	P	Q	R	S
(A)	2,4	4	5	2,5
(B)	4	1,3	1	4,5
(C)	1,4,5	2,4	2,4,5	3,5
(D)	2,4,5	2,4,5	1,5	5

Space for Rough work

SECTION – D

(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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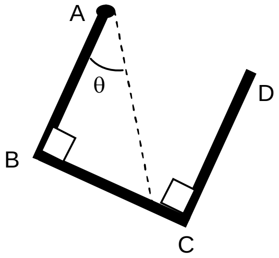
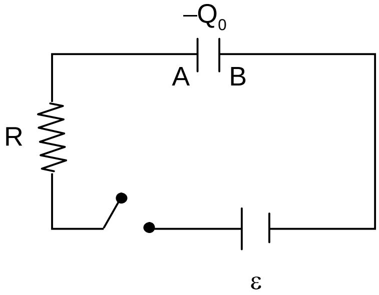
11. Three identical rods are hinged at point A as shown.
The angle made by rod AB with vertical is θ. Find the value of $5 \times \sin\theta$

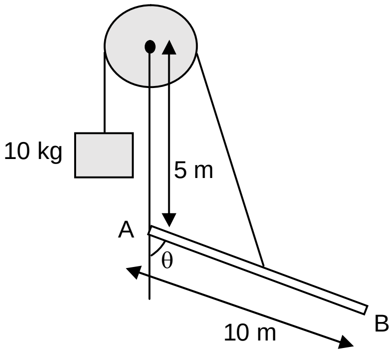


12. The figure shows a RC circuit with a parallel plate capacitor. Before switching on the circuit, plate A of the capacitor was given a charge $-Q_0$ while plate B had no net charge. Now, at t = 0, the circuit is switched on. Time (in seconds) will elapse before the net charge on plate A becomes zero is K. Value of 125K is

Take $C = 1\,\mu F, Q_0 = 1\,mC, \varepsilon = 1000$ V and $R = \dfrac{2 \times 10^6}{\ln(3)}\Omega$

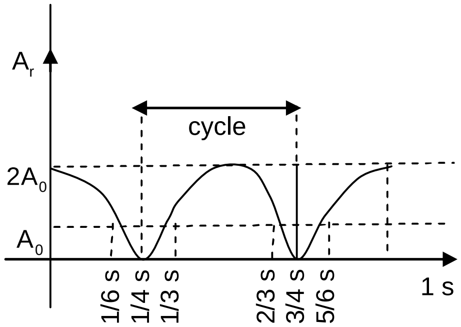


13. A uniform rod AB of mass 5 kg and length 10m is hinged at A. A block of mass 10 kg is hanging with a string and other end of the string is attached to a middle point of the rod passes over a smooth pulley as shown in the figure. Find the value of $365\left(\cos\frac{\theta}{2}\right)$.

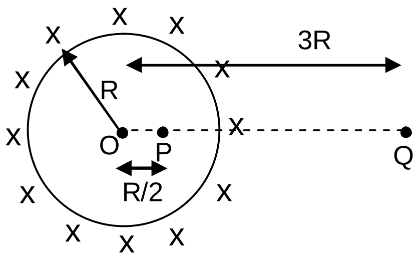


Space for Rough work

14. Two sound waves of frequencies 100 Hz and 102 Hz and having same amplitude 'A' are interfering. A stationary detector, which can detect waves of amplitude greater than or equal to A, in a given time interval of 12 seconds, find the total duration in which detector is active.



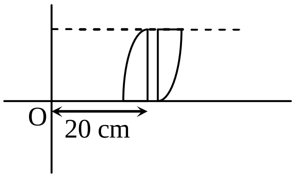
15. Conducting shell of radius R carrying charge Q, another charge Q is placed at 3R distance from centre of shell. If the potential at point P due to charge on shell is $\frac{11}{3n}\frac{KQ}{R}$, Then the value of 20n is



16. A liquid is kept in a cylindrical vessel. When the vessel is rotated about its axis, the liquid rises at its sides. If the radius of the vessel is 0.05 m and the speed of rotation is 2 revolutions per second, the difference in the heights (in cm) of the liquid at the centre and at the sides of the vessel is (take $g = 10\ ms^{-2}$ and $\pi^2 = 10$)

17. If two spherical bubbles of same radius 2 m. and same liquid coalesece to form a common plane surface, then find the gap between the centres of the bubbles is n. Then the value of 393n is

18. A biconvex thin lens of focal length 30 cm and aperture diameter 10 cm is broken into four identical pieces. Two of the pieces are placed in a coordinate system as shown in the diagram. Find the magnitude of the y coordinate of the image if an object is placed at origin.



Space for Rough work

Chemistry

PART – II

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. The solubility of $CH_3COOAg\left(K_{sp} = X\right)$ in a buffer solution of $pH = Y\left(Y < 7\right)$

(A) increases as the value of Y decreases
(B) decreases as the value of Y decreases
(C) will be greater if the K_a value of the CH_3COOH is greater
(D) will be smaller if the K_a value of the CH_3COOH is greater

20. For the gas phase reaction,

$$C_2H_4 + H_2 \rightleftharpoons C_2H_6;\ \Delta H = -137 \text{ kJ mol}^{-1}$$

Carried out in a closed vessel, the equilibrium concentration of C_2H_4 can be increased by

(A) Increasing the temperature
(B) Decreasing the pressure
(C) Removing some C_2H_6
(D) Adding some H_2

21. A vessel at 1000 K contains CO_2 with a pressure of 0.5 atm. Some of the CO_2 is converted into CO on adding graphite. The total pressure at equilibrium was found to be 0.8 atm.

(A) The equilibrium is achieved as soon as $Q = K, K$ value = 0.18 atm^2
(B) The equilibrium is achieved as soon as Q = K, K value = 0.18 atm
(C) The $p_{CO_2} = 0.2$ atm at equilibrium
(D) The $p_{CO} = 0.6$ atm at equilibrium

22. Potassium chromate solution is added to aqueous solutions of metal nitrate. The yellow precipitate thus obtained are insoluble in acetic acid. These are subjected to flame test, flame colour of individual ppt. is/are

(A) Lilac
(B) Apple green
(C) Crimson red
(D) Blue

Space for Rough work

23. Synergic bonding in metal carbonyl complexes [M = Metal]:
(A) decreases C – O bond strength
(B) increases M – C bond length
(C) increases bond order for M – C bond
(D) increases paramagnetic of complex

24. $\left[M(NH_3)_2(py)_2(NO_2)_2\right]\xrightarrow[-NO_2]{+NH_3}\left[M(NH_3)_3(py)_2(NO_2)\right]$ Difference between the possible geometrical isomers of reactant and product is:

(A) 3	(B) 4
(C) 2	(D) 0

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

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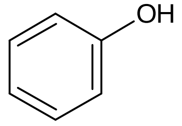
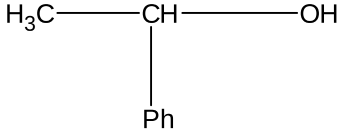
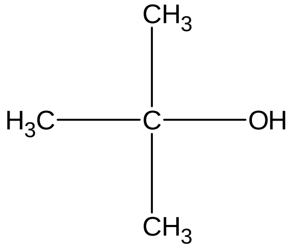
25. Match List I with List II and choose the correct answer using the codes given below:

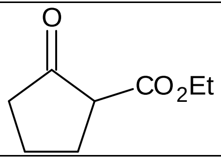
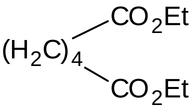
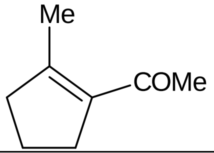
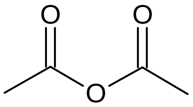
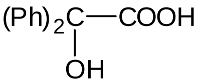
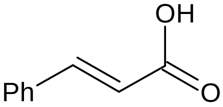
List –I		**List –II**	
(P)		(1)	White turbidity with $HCl / ZnCl_2$
(Q)	CH_3CH_2OH	(2)	Violet colour with $FeCl_3$
(R)	 $H_3C-CH(Ph)-OH$	(3)	Colour change with $Na_2Cr_2O_7, H^+$
(S)	 $H_3C-C(CH_3)_2-OH$	(4)	I_2 / OH^-, gives bright yellow ppt

Codes:

	P	Q	R	S
(A)	1,2	3,4	1,4	2
(B)	1,2,3	1	3,4	1,2,3
(C)	2	3,4	1,3,4	1
(D)	2	1,3,4	3,4	2

Space for Rough work

26. Match List I (reaction) with List II (product) and then select the correct answer from the codes given below the lists:

List –I (Reactions)		**List –II (Product)**	
(P)	$MeCO(CH_2)_4COMe \xrightarrow[(ii)\ \Delta]{(i)\ OH^-}$	(1)	
(Q)	 $(H_2C)_4(CO_2Et)_2 \xrightarrow{OEt^-}$	(2)	
(R)	PhCHO +  $\xrightarrow{CH_3COO^-}$	(3)	 $(Ph)_2C(OH)—COOH$
(S)	$PhCOPh \xrightarrow[H_3O^+]{HCN}$	(4)	

Codes:

	P	Q	R	S
(A)	1	2	3	4
(B)	1	2	4	3
(C)	2	1	3	4
(D)	2	1	4	3

27. Match List I with List II and then select the correct answer from the codes given below the lists:

List –I (Reactants)		**List –II (Product)**	
(P)	Benzaldehyde + $NaBH_4$	(1)	Benzoic acid
(Q)	Benzoyl chloride + H_2 + Pd + $BaSO_4$ + Δ	(2)	Benzyl amine
(R)	Benzyl alcohol + H_2CrO_4	(3)	Benzyl alcohol
(S)	Benzamide + $LiAlH_4$	(4)	Benzaldehyde

Codes:

	P	Q	R	S
(A)	3	4	1	2
(B)	2	3	1	4
(C)	3	4	2	1
(D)	3	1	4	2

Space for Rough work

28. Match List –I (Group when attached to phenyl ring) with List –II (Effect shown) and select the correct answer using the code given below lists:

List –I		**List –II**	
(P)	$-Cl$	(1)	+m and +I
(Q)	$-O^-$	(2)	+m and –I
(R)	$-CH_2-CH_3$	(3)	Only –I
(S)	$-\overset{\oplus}{N}H_3$	(4)	+I and Hyperconjugation

Codes:

	P	Q	R	S
(A)	1	3	2	4
(B)	3	4	2	1
(C)	4	2	3	1
(D)	2	1	4	3

SECTION – D

(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

29. The angular momentum of an electron in a Bohr's orbit of H atom is 4.2178×10^{-34} Kg m^2 / sec. The wavelength of spectral line emitted when electron falls from this level to next lower level is $x\times10^{-4}$ cm. Find the value of x.

30. $\left[(C_2H_5)_x Al\right]$ and $TiCl_4$ form the basis of Zeigler-Natta type heterogeneous catalyst. What is x?

31. In the structure of XeF_2. $2SbF_5$ in solid state how many types of Xe-F bond lengths are present?

32. How many of the following are pseudohalogens?
Azidocarbon disulphide, Isocyanide ions, Fluminate ion, Tellurocynante ion, Oxyeyanogen. Selerocyanogen.

33. When $K_2Cr_2O_7$ reacts with HCl, in how many products chlorine exits as chloride ion?

34. What is the oxidation number of Cl_2 in final product formed due to oxidation in it when Cl_2 reacts with hot NaOH?

35. How many of the following oxides are neutral oxides?
$Cl_2O_7, SO_3, SrO, H_2O, CO, N_2O_5, N_2O, P_2O_5$ and No

36. Number of lone pair-bond pair repulsion at 90° are (P) in I_3^-

Space for Rough work

Mathematics PART – III

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. Let $f : [0, 1] \to [0, \infty)$ be a differentiable with decreasing first derivative & $f(0) = 0$, then $\int_0^1 \frac{dx}{f^2(x)+1}$ is

(A) $< \frac{\tan^{-1} f(1)}{f'(1)}$

(B) $< \frac{f(1)}{f'(1)}$

(C) $> \frac{\tan^{-1} f'(1)}{f'(1)}$

(D) $\le \frac{f(1)}{f'(1)}$

38. Let $f : R \to (0, \infty)$ be such that $f(x) + \frac{e^{x+x^2}}{f(x)} \le e^x + e^{x^2}$ $\forall$ $x > 0$, then $\lim_{x\to1} f(x)$ is equal to

(A) y where $y = \sqrt{\lim_{n\to\infty} n^{-n^2}\left[(n+1)\left(n+\frac{1}{2}\right)\left(n+\frac{1}{2^2}\right)........\left(n+\frac{1}{2^{n-1}}\right)\right]}$

(B) p^3 where $p^2 = \lim_{x\to0}\left(\frac{1+5x^2}{1+3x^2}\right)^{\frac{1}{x^2}}$

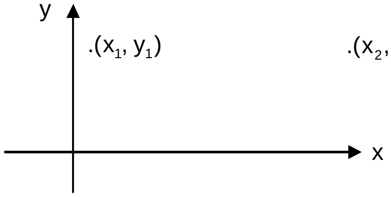
(C) t where $\frac{1}{t} = \lim_{x\to0}\frac{\tan^{-1}x - \sin^{-1}x}{\sin^3 x}$

(D) r where $r = \frac{3}{5_e}\lim_{n\to\infty}\sum_{K=1}^{n}\frac{K^5 + 6K^2 + 11K + 5}{(K+3)!}$

Space for Rough work

39. If $P(x, y)$ means to make the point (x, y) on $x - y$ plane dark.

$P(x_1, y_1) + P(x_2, y_2)$ means to make both the points (x_1, y_1) & (x_2, y_2) as dark on $x - y$ plane.



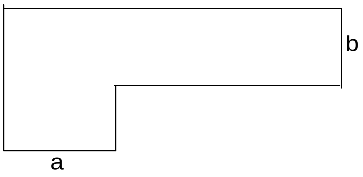
(A) $\lim\limits_{n\to\infty} \sum\limits_{r=1}^{2n} P\left(1, \frac{r}{n}\right)$ represents a line segment

(B) $\lim\limits_{n\to\infty} \sum\limits_{r=1}^{2n} P\left(\frac{r}{n}, \left(\frac{r}{n}\right)^2\right)$ represents a parabolic segment

(C) $\lim\limits_{n\to\infty} \sum\limits_{r=1}^{2n} P\left(1, \frac{r}{n}\right)$ represents a circle

(D) $\lim\limits_{n\to\infty} \sum\limits_{r=1}^{m} P\left(\frac{r}{n}, \left(\frac{r}{n}\right)^2\right)$ represents an ellipse

40. A corridor housing the shape as shown below is 'a' unit wide in one of its wings & b units wide in the other stick is moved from one of the wings to the other (It is assumed that the thickness of the stick is negligible & during the motion the stick stays horizontal)



(A) The length of longest stick that can move is $(a^{2/3} + b^{2/3})^{3/2}$

(B) The length of longest stick that can move is $(a^{3/2} + b^{3/2})^{2/3}$

(C) The longest stick makes L α with one of its walls & is tangent to vertex 0 of the inside might angle of the corridor then $\tan\alpha = (b/a)^{1/3}$.

(D) None of these

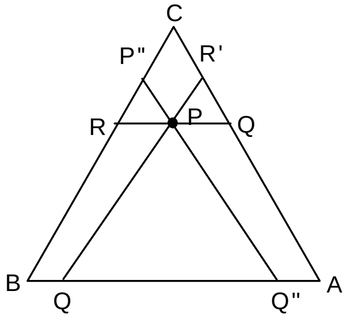
Space for Rough work

41. Let A, B, C, D be non-singular real matrices such that
$A^T = BCD, B^T = CDA, C^T = DAB$ & $D^T = ABC$ for the matrix $M = ABCD$, then find M^{2018}.

(A) M
(B) M^2
(C) M^3
(D) M^4

42. In a Δ ABC, $AB = 85, BC = 90$ & $AC = 102$. P is an interior pt & line segments are drawn through P parallel to the sides of the triangle. If these three line segments (as shown in the diagram by $RQ, R'Q', R''Q''$) are of equal length d, then $\frac{5d}{34}$ is equal to

(A) 9
(B) 6
(C) 3
(D) 12



(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

43. Let f(x) and g(x) be two distinct functions such that $f^{-1}\left(\frac{f(x)+f(y)}{2}\right) = g^{-1}\left(\frac{g(x)+g(y)}{2}\right)$, then:

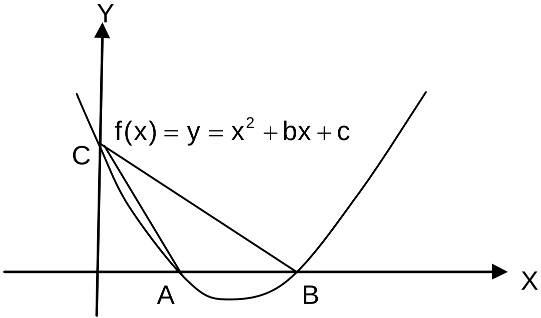
List –I		**List –II**	
(P)	If $f(x) = x^{10}\ \forall x \ge 0$ & $g(1) = 2, g(0) = 1$, then	(1)	No. of solutions of $g(x) = 0$ is 0
(Q)	If $f(x) = x^5$ & $g(1) = 7$ & $g(0) = 2$	(2)	No. of solutions of $g(x) = 0$ is infinite
(R)	If $f(x) = \tan x$ & $g(0) = 1$ & $g(\pi/4) = \sqrt{3}$	(3)	No. of solutions of $g(x) = 0$ is 1
(S)	If $f(x) = x^3$ & $g(0) = 5$ & $g(1) = 2$	(4)	No. of solutions of $g(x) = 0$ is 2

Codes:

	P	Q	R	S
(A)	2	3	2	1
(B)	1	3	2	3
(C)	4	1	3	2
(D)	1	2	4	3

Space for Rough work

44. In the given figure ΔOBC is an isosceles right triangle in which AC is median:



List –I		List –II	
(P)	The equation whose roots are $(\alpha+\beta)$ & $(\alpha-\beta)$, where α, β $(\alpha > \beta)$ are roots of $x^2 + bx + c = 0$ is $x^2 - px + 3 = 0$, then p is	(1)	8
(Q)	Minimum value of quadratic expression corresponding to quadratic eqn obtained in above question occurs at x =	(2)	2
(R)	The sum of fifth power of roots of equation $f(x) = -x^3 + x^2 + 1$ is given by K then $\left\lvert\frac{K}{5}\right\rvert$ is equal to	(3)	4
(S)	The no. of solutions of $f(\lvert x\rvert) = 0$ is	(4)	3

Codes:

	P	Q	R	S
(A)	1	2	4	3
(B)	4	2	3	1
(C)	2	3	4	1
(D)	3	2	4	3

Space for Rough work

45. Let $b_1 = 50$ & $b_1, b_2, ...b_n$ be a sequence of numbers satisfying the rule $n(b_n - b_{n+1}) = n^3 + n^2 - b_n$. Then, match List (I) to List (II):

List –I		**List –II**	
(P)	$\frac{b_{16}}{16}$	(1)	–16
(Q)	b_{11}	(2)	50
(R)	b_{10}	(3)	–55
(S)	$\frac{b_{12}}{12}$	(4)	–70

Codes:

	P	Q	R	S
(A)	4	2	3	1
(B)	1	4	2	4
(C)	4	3	2	1
(D)	1	3	2	4

46. Let P be the plane parallel to y-axis & containing the points (1, 0, 1) & (3, 2, –1). Also $A \equiv (4,0,0)$ & $B \equiv (6, 0, -2)$ are 2 pts & $P(x_0, y_0, z_0)$ is a variable point on the plane $P = 0$

List –I		**List –II**	
(P)	If the equation of plane P = 0 is $x + ay + by = c$ then $\lvert a+b+c\rvert$ is	(1)	16
(Q)	If $PA + PB$ is minimum, then $\lvert 4x_0 + y_0 + 2z_0\rvert$ is	(2)	12
(R)	If $\lvert PA - PB\rvert \in [0, \sqrt{N})$, then N is	(3)	3
(S)	If the reflection of the line AB in the plane P = 0 is $\frac{x-2}{1} = \frac{y-\alpha}{0} = \frac{Z+\beta}{-1}$, then $\alpha^4 + \beta^4$ is	(4)	8

Codes:

	P	Q	R	S
(A)	3	2	4	1
(B)	2	4	3	1
(C)	3	1	4	2
(D)	2	3	1	4

Space for Rough work

SECTION – D

(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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47. A game is played with fair cubic die which has one red side, two blue sides & three green sides. The result is the color of the top side after the dice is rolled. If the die is rolled repeatedly. The probability that second blue result occurs on or before the tenth roll can be expressed in the form of $\frac{3^p - 2^q}{3^r}$ where p, q, r are positive integers then the value of $p + r - q$ is ______

48. If area of triangle formed by the points $(2\alpha, \beta), (\alpha+\beta, 2\beta+\alpha)$ & $(2\beta, 2\alpha)$ is 8 sq. unit then area of triangle whose vertex are $(\alpha+\beta, \alpha-\beta), (3\beta-\alpha, \beta+3\alpha)$ & $(3\alpha-\beta, 3\beta-\alpha)$ is ______

49. Let z_1, z_2, z_3 be complex numbers such that $|z_1| = |z_2| = |z_3| = 10$ & $z_2 \neq z_3$ then $\frac{\min\limits_{a\in R} |az_2 + (1-a)z_3 - z_1|}{|z_1 - z_2|\,|z_1 - z_3|}$ is equal to

50. Given circles C_1 & C_2 intersect at X & Y. Let l_1 be a line through the centre of C_1 & intersecting C_2 at points P & Q and let l_2 be the line through centre of C_2 intersecting C_1 at pts R & S. Let $C_1 : x^2 + y^2 - 2x - 2y + 1 = 0$ & $C_2 : x^2 + y^2 - 4x - 4y + 4 = 0$. If P, Q, R, S are concyclic with centre of circle passing through them is (α, β), then $\tan^{-1}(\alpha+\beta) + \tan^{-1}(\alpha+\beta-1)$ is equal to $\tan^{-1}\left(\frac{10}{K}\right)$, then K is

51. Functions $P(x), Q(x), R(x)$ are differentiate on some open interval around O & satisfy the equations & initial conditions

$$P'(x) = 2P^2(x).\,Q(x).\,R(x) + \frac{1}{Q(x).R(x)},\ P(0) = 1$$

$$Q'(x) = P(x)\,Q^2(x)\,R(x) + \frac{4}{P(x)\,R(x)},\ Q(0) = 1$$

$$R'(x) = 3P(x)\,Q(x)\,R^2(x) + \frac{1}{P(x)\,.Q(x)},\ R(0) = 1$$

Then $P(x)\,Q(x)\,R(x) = \tan\left(nx + \frac{\pi}{4}\right)$, then n is equal to ___

Space for Rough work

52. If area of the region in the complex plane that consists of all points z such that $\frac{z}{40}$ and $\frac{40}{z}$ have real & imaginary parts lifting in the interval [0, 1] is A then $\frac{A}{100}$ is (take π = 3.14)

53. Suppose f is a function on the interval [1, 3] such that $-1 \le f(x) \le 1 \,\forall x$ & $\int_1^3 f(x)dx = 0$. If maximum value of $\int_1^x \frac{f(x)}{x} dx$ is $C_n\left(\frac{a}{b}\right)$ (where a, b are coprime numbers, then $a + b$ is equal to ______.

54. Let $y = g(x)$ is solution of differential equation $g'(x) + g(x) = \frac{2xe^{-x}}{1 + g(x)e^{x}}$ such that $g(0) = 1$, then $\left[\frac{f(-1)}{e}\right]$ is equal to [where [.] denotes GIF]

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – III

JEE (Advanced)-2019

PAPER –2

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. A, C

2. B, D

3. B, D

Sol. $\frac{q^2}{2C} = \frac{3}{4}\left(\frac{Q^2}{2C}\right) = H \Rightarrow q = Q\frac{\sqrt{3}}{2}$

$\therefore$ Energy in inductor $= \frac{1}{2}L\left(\frac{i_{max}}{2}\right)^2 = \frac{1}{4}\left(\frac{1}{2}Li_{max}^2\right) = \frac{1}{4}\frac{Q^2}{2C}$

4. A, C, D

Sol. $F = qv'B\sin\frac{\theta}{2} = q\left\{2v\cos\left(\frac{\theta}{2}\right)\right\}B\sin\frac{\theta}{2} = Bqv\sin\theta$

$N = mg - 2Bqv$

$\Rightarrow$ To loose the contact, $N = 0$

$\Rightarrow v = \frac{mg}{2qB}$

5. B, C

Sol. $i = \frac{\varepsilon}{R} = \frac{B\omega r_o^2}{2R}$

Then $P = i^2R = \frac{B^2\omega^2 r_o^4}{4R}$

KE of disk, $K = I\omega^2 / 2$

For energy conservation

dK/dt + P = $Mgr_o\omega$

and for constant angular velocity $\omega = \omega_f$

$$\Rightarrow \omega_f = \frac{4MgR}{B^2 r_o^3} \text{ and } i = \frac{B\omega_f r_o^2}{2R}$$

6. C

Sol. Frequencies are in odd ratio hence it is a closed organ pipe.

$$\text{freq} = (2n+1)\frac{v}{4L}$$

$$\Delta(\text{frequency}) = \frac{2v}{4L} = 100\text{Hz} \Rightarrow L = 1.7 \text{ m.}$$

7. B

Sol. Hint: Odd harmonics.

8. C

Sol. Hint: Bernoulli's equation and continuity equation.

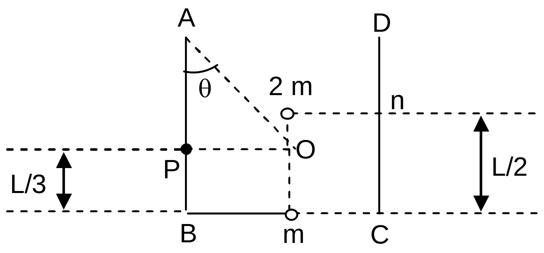
9. B

10. D

SECTION – D

11. 00003.00

Sol. Vertical line from hinge A must pass through C.M. of rod system.



$$\tan\theta = \frac{OP}{AP} = \frac{L/2}{L - L/3}$$

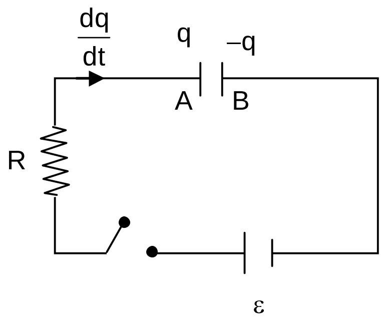
$$\tan\theta = \frac{3}{4}$$

$$\Rightarrow \quad \sin\theta = \frac{3}{5}$$

12. 00250.00

Sol. $-\frac{q}{C} + \varepsilon - \frac{dq}{dt}R = 0$

$$\Rightarrow \int_{-Q_0/2}^{Q_0/2} \frac{dq}{q - C\varepsilon} = \int_0^t -\frac{dt}{RC}$$



13. 00365.00

Sol. $10g\sin\frac{\theta}{2} = 5g\sin\theta$

$10\sin\frac{\theta}{2} = 5\ (2\sin\theta/2\cos\theta/2)$

$\cos 0/2 = 1$

14. 00008.00

Sol. $y_1 = A\sin\omega_1 t$

$y_2 = A\sin\omega_2 t$

$y_r = 2A\cos\left\{\frac{(\omega_2-\omega_1)}{2}t\right\}\left\{\sin\frac{(\omega_2+\omega_1)}{2}t\right\}$

Resultant amplitude $A_r = 2A\left|\cos(\Delta\omega)t/2\right|$

$(\Delta\omega)\frac{t}{2} = \frac{\pi}{2} \Rightarrow t = \frac{1}{4}s$

$(\Delta\omega)\frac{t}{2} = \frac{\pi}{3} \Rightarrow t = \frac{1}{6}s$

In one cycle of intensity of 1/2s, the detector remain idle for

$2\left(\frac{1}{4}-\frac{1}{6}\right)s = \frac{1}{6}\text{sec}$

$\therefore$ In $\frac{1}{2}$ sec cycle, active time is $\left(\frac{1}{2}-\frac{1}{6}\right) = 1/3$ sec

$\therefore$ In 12 sec interval, active time is 12 x $\frac{(1/3)}{(1/2)} = 8\,\text{sec}$

15. 00100.00

Sol. $V_O = V_P$

$\frac{KQ}{R} + \frac{KQ}{3R} = V_{shell} + \frac{2Kq}{5R}$

$V_{shell} = \frac{KQ}{R}\left[1+\frac{1}{3}-\frac{2}{5}\right]$

$= \frac{KQ}{R}\left[\frac{4}{3}-\frac{2}{5}\right]$

$= \frac{KQ}{R}\left[\frac{20-9}{15}\right] = \frac{11}{15}\frac{KQ}{R}$

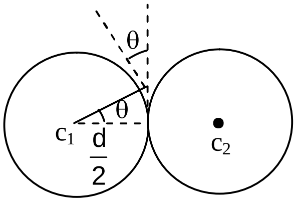
16. 00002.00

Sol. Using Bernouli's theorem

$\frac{1}{2}pv^2 = p = pgh$ or $h = \frac{v^2}{2gh}$ ….. (1)

Put : $V = r\omega = r\ (2\pi v)$ in (1)

17. 00786.00



Sol. 4T.cos θ.dl = 2T.dl

$\cos\theta = \frac{1}{2}$

$\theta = 60^o$

So, $\frac{d}{2} = R\cos 60 = \frac{R}{2}$

c_1c_2 = d = R = 2 m

18. 00005.00

Sol. $\frac{1}{f} + \frac{1}{f} = 30$ f = 60

$\frac{1}{v_1} - \frac{1}{-20} = \frac{1}{60}$ $\Rightarrow$ $v_1 = -30$ $\frac{1}{v} - \frac{1}{-30} = \frac{1}{60}$

$\frac{I}{0} = m = \frac{v}{v_1} = \frac{-60}{-30} = 2$

$\Rightarrow$ $\frac{I}{-5} = 2$ $\Rightarrow$ $I = -10$

y coordinate = –5

Chemistry PART – II

SECTION – A

19. A, D

Sol. $CH_3COOAg \rightleftharpoons CH_3COO^- + Ag^+ ....K_{sp}$

$CH_3COO^- + H^+ \rightleftharpoons CH_3COOH ....\frac{1}{K_a}$

$(S-a) \approx 10^{pH}$ (buffer solution)

$K_{sp} = (S-a)(s)$ 1

$\frac{1}{K_a} = \frac{(a)(10^{-pH})}{(10^{-pH})(S-a)}$ 2

Solving 1 and 2 we get

$$S=\sqrt{K_{sp}\left(1\alpha\frac{10^{-pH}}{K_a}\right)}$$

20. A, B

21. B, C, D

Sol. $CO_2(g) + C(s) \rightleftharpoons 2CO(g)$

Initial pressure	0.5 atm	0
At eqilibrium	$0.5-x$	2x

$\Rightarrow P_{Total} = p_{CO_2} + p_{CO}$

$P_{Total} = 0.5 - x + 2x = 0.5 + x$

$\Rightarrow 0.8 = 0.5 + x$

$\Rightarrow x = 0.3$ atm

$p_{CO_2} = 0.5 - 0.3 = 0.2$ atm, choice (c) is correct

$p_{CO} = 2x = 0.3 \times 2 = 0.6$ atm, choice (d) is correct

$Q = K$ at equilibrium = $\frac{p_{CO}^2}{p_{CO_2}} = \frac{0.6 \times 0.6}{0.2}$

$\Rightarrow Q = K = 1.8$ atm

22. B, D

Sol. Pb^{2+} and Ba^{2+} both from yellow ppt. with CrO_4^{2-} ion which is not soluble in CH_3COOH.

Flame test of Ba^{2+} = Apple green

Pb^{2+} = Blue

23. A, C

Sol. $M \longleftarrow :C \equiv C$

$M = C = O$

24. C

Sol. $[Ma_2b_2c_2] \longrightarrow [Ma_3b_2c]$

G.I. = 5 G. I. =3

25. C

Sol. The stability decreases in the order:
cyclohexane (I)>cyclopentane (II)>cyclobutene.
Further, trans-1, 2-dimethylclobutane (IV) is more stable than cis-1, 2-dimethylcyclobutane (III). Thus, stability decreases in the order: I > II > IV > III.
Therefore, their heat of combustion decreases in the reverse order: III > IV > II > I.

26. D

27. A

28. D

SECTION – D

29. 00001.90

Sol. According to Bohr' law, $mvr = \frac{nh}{2\pi}$

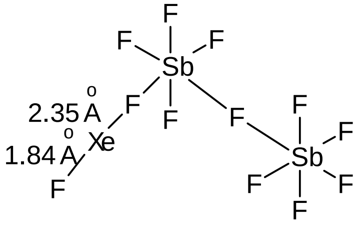
$\therefore \frac{nh}{2\pi} = 4.2178 \times 10^{-34}$

30. 00003.00

Sol. Triethyl aluminium $\left[(C_2H_5)_x Al\right]$ and $TiCl_4$ is used as a catalyst for the low temperature polymerization of alkenes.

31. 00002.00

Sol.



32. 00003.00

Sol. Azidocarbon disulphide $(SCSN_3)_2$, Oxyeyanogen $(OCN)_2$ and Selenocyanogen $(SeCN)_2$

33. 00002.00

Sol. $K_2Cr_2O_7 + 14HCl \longrightarrow 2KCl + 2CrCl_3 + 7H_2O + 3Cl_2$

34. 00005.00

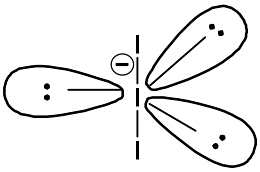
Sol. $3Cl_2 + 6NaOH \xrightarrow{hot} 5NaCl + NaClO_3 + 3H_2O$

35. 00004.00

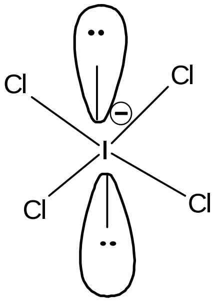
Sol. Neutral oxides: H_2O, CO, N_2O and NO

36. 00002.00

Sol.



(P = 6)



(Q = 8)

Mathematics PART – III

SECTION – A

37. A, B

Sol. $f'(x) \ge f'(1) \;\forall\; x \in [0, 1]$

$$\therefore \; \frac{f'(1)}{f^2(x)+1} \le \frac{f'(x)}{f^2(x)+1}$$

On Integrating

$$f'(1)\int_0^1 \frac{dx}{f^2(x)+1} \le \tan^{-1}\left(f(1)\right) - \tan^{-1}\left(f(0)\right)$$

$$\text{i.e.} \int_0^1 \frac{dx}{f^2(x)+1} \le \frac{\tan^{-1} f(1)}{f'(1)} \le \frac{f(1)}{f'(1)} \qquad [\because \; \tan^{-1} x \le x \;\forall\; x \ge 0]$$

For equality to hold $\tan^{-1} f(1) = f(1)$

$\therefore$ $f(1) = 0$, then $\int_0^1 \frac{dx}{f^2(x)+1} = 0$

Which is not possible as this is strictly positive function

Hence $\int_0^1 \frac{dx}{f^2(x)+1} < \frac{f(1)}{f'(1)}$

38. A, D

Sol. $\left(f(x) - e^x\right)\left(f(x) - e^{x^2}\right) \le 0$

$\Rightarrow$ $e^{x^2} \le f(x) \le e^x$ when $x \in (0, 1)$

$\Rightarrow$ $e^x \le f(x) \le e^{x^2}$ when $x > 1$

$\therefore$ $\lim\limits_{x \to 1} f(x) = e$.

$$\& \lim_{n \to \infty} \sum_{K=1}^{n} \frac{K^3 + 6K^2 + 11K + 5}{(K+3)!}$$

$$= \lim_{n \to \infty} \sum_{K=1}^{n} \left(\frac{1}{K!} - \frac{1}{K+3!}\right)$$

$$= \frac{5}{3}$$

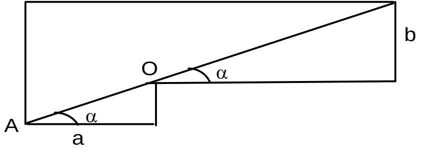
39. A, B

Sol. (A) $x = 1 \Rightarrow$ line segment

(B) $y = x^2 \Rightarrow$ parabolic segment.

40. A, C

Sol. Let AB be a line segment in the corner of the corridor that is tangent to vertex O of the inside right angle of the corridor & makes angle α with one of its walls



Then $f(\alpha) = AB = AO + OB = \frac{a}{\cos\alpha} + \frac{b}{\sin\alpha}$

A stick of length l could be moved from one wing to the other if $l \le f(\alpha) \;\forall\; \alpha \in (0, 90^o)$

$\therefore$ The maximum length l of the stick will be minimum of the function $f(\alpha)$ over $(0, 90^o)$ if it exists

$f'(\alpha) = \frac{a\sin\alpha}{\cos^2\alpha} - \frac{b\cos\alpha}{\sin^2\alpha} = \frac{a\cos\alpha}{\sin^2\alpha}\left(\tan^2\alpha - \frac{b}{a}\right)$

$\because$ $\tan^3\alpha$ increases strictly from 0 to ∞

$\therefore$ f a unique $\alpha_o \in (0, 90^o)$ such that

$\tan^3\alpha_0 = \frac{b}{a}$, then $f'(\alpha_o) = 0$

Also $f'(\alpha) < 0 \ \forall\ \alpha \in (0, \alpha_o)$

$f'(\alpha) > 0 \ \forall\ \alpha \in (\alpha_o, 90^o)$

$\therefore$ $f(\alpha)$ has minimum at α_o

$\tan\alpha_o = \left(\frac{b}{a}\right)^{1/3}$

$\therefore$ $f(\alpha) = \left(a^{2/3} + b^{2/3}\right)^{3/2}$.

41. B, D

Sol. $M^2 = ABCD\ ABCD$

$= ABC\ C^TCD$

$= D^TC^TCD$

Now $\left(A^T\right)^T = D^TC^TB^T$

$A = D^TC^T\ CDA$

$A(I - D^TC^TCD) = 0$.

$\Rightarrow$ $D^TC^TCD = I$

$\Rightarrow$ $M^2 = I$

42. A

Sol. $\frac{R'Q}{CA} = \frac{PQ}{AB} \Rightarrow PQ = \frac{102-d}{102}.85$

$\frac{R''R}{BC} = \frac{PR}{AB} \Rightarrow PR = \frac{90-d}{90}.85$

$QR = d = \frac{102-d}{102}.85 + \frac{90-d}{90}.85$

$QR = d = \frac{102-d}{102}.85 + \frac{90-d}{90}.85$

$\Rightarrow d\left(1 + \frac{85}{102} + \frac{85}{70}\right) = 85 + 85$

$\Rightarrow d\left(1 + \frac{5}{6} + \frac{17}{18}\right) = 170$

$\Rightarrow d = \frac{170.18}{50}$

$\Rightarrow \frac{5d}{34} = 9$

43. B

Sol. Let $u = f(x)$ & $v = f(y)$. The eqn becomes

$$gf^{-1}\left(\frac{u+v}{2}\right) = \frac{\left(gf^{-1}\right)(u) + \left(gf^{-1}\right)(v)}{2}$$

$\therefore$ Let $h(x) = gf^{-1}(x)$

$\therefore\ h\left(\frac{u+v}{2}\right) = \frac{h(u)+h(u)}{2}$

$\Rightarrow\ g(x) = a\ f(x) + b$. Where a & b are real constant

44. D

Sol. $A(\alpha, 0), B(2\alpha, 0)$ & $C(0, 2\alpha)$

$y = x^2 + bx + c$ passes through $(0, 2\alpha)$

$\therefore$ Thus given eqn of curve reduces to $y = x^2 + bx + c$

Now it passes through A & B

$\therefore\ 0 = \alpha^2 + b\lambda + 2\alpha$

$\Rightarrow 0 = \alpha + b + 2$

& $0 = 4\alpha^2 + 2\alpha b + 2\alpha$

$0 = 2\alpha + b + 1$

$\therefore$ On solving we get $\alpha = 1, b = -3$

$\therefore$ The curve is $y = x^2 - 3x + 2$

45. C

Sol. $b_n(n+1) - n\,b_{n+1} = n^2\ (n+1)$

$\frac{b_n}{n} - \frac{b_{n+1}}{n+1} = n$

$\Rightarrow b_1 - \frac{b_{n+1}}{n+1} = \frac{n\ (n+1)}{2}$

$\Rightarrow 50 - n\left(\frac{n+1}{2}\right) = \frac{a_{n+1}}{n+1}$

46. A

Sol. Let the plane be $\alpha x + \beta z + 1 = 0$.

Passes through (1, 0, 1) & (3, 2, –1)

$\therefore\ \alpha = -\frac{1}{2}, \beta = -\frac{1}{2}$

$\therefore$ (P) $x + z = 2$

(Q) Both A & B are same side of P Reflection of A in plane is $A'(2, 0, -2)$ equation of line $A'B : \bar{r} = 6\hat{i} - 2\hat{K} + \lambda(4\hat{i})$ for P : $6 + 4\lambda + 0 - 2 = Z \Rightarrow \lambda = \gamma_2$

(R) $|PA - PB|_{min} = 0 \Rightarrow |PA - PB|_{min}$ will approach AB

$AB = \sqrt{4+0+4} = \sqrt{8}$

$|PA - PB| \in [0, \sqrt{8})$

(S) Also, A' will lie on $\frac{x-2}{1} = \frac{y-\alpha}{0} = \frac{z+B}{-1}$

$\Rightarrow\ \frac{2-2}{1} = \frac{0-\alpha}{0} = \frac{-2+\beta}{-1}$

$\Rightarrow \alpha = 0, \beta = 2$

$\alpha^4 + \beta^4 = 16$

SECTION – D

47. 00007.00

Sol. 2^{nd} blue result occur on or before 10^{th} roll is equivalent to the occurrence of blue face at least twice in 10 rolls

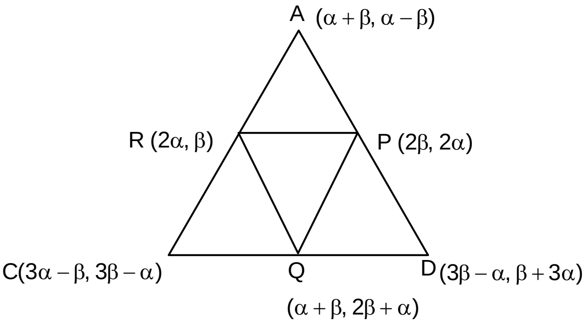
$$n = 10, p = \frac{1}{3}, q = \frac{2}{3}$$

$$P(m \ge 2) = 1 - \left(P(0) + P(1)\right) = \frac{3^9 - 2^{11}}{3^9}$$

48. 00032.00

Sol. Area of $\Delta ABC = 4(\Delta PQR)$

$$= 4 \times 8$$
$$= 32$$

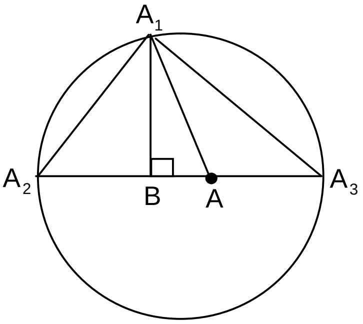

A $(\alpha+\beta, \alpha-\beta)$
R $(2\alpha, \beta)$
P $(2\beta, 2\alpha)$
C$(3\alpha-\beta, 3\beta-\alpha)$
Q
$(\alpha+\beta, 2\beta+\alpha)$
D$(3\beta-\alpha, \beta+3\alpha)$

49. 00000.05

Sol. Let $z = a\,z_2 + (1-a)z_3)$

Let $A_1(z_1), A_2(z_2), A_3(z_3)$ & $A(z)$ respectively.

Circumcentre of $\Delta\ A_1\ A_2\ A_3$ is origin Pt A lies on line $A_2\ A_3$, so, $A_1\ A = |z - z_1|$ is greater than or equal to the altitude $A_1\ B$ of the $\Delta\ A_1\ A_2\ A_3$.



$$A_1\ B = \frac{2 \text{ area of } \Delta\ A_1\ A_2\ A_3}{A_2\ A_3}$$

$$= \frac{2(A_1A_2)(A_2\ A_3)(A_3\ A_1)}{4 \times 10\ .\ A_2\ A_3}$$

$$= \frac{(A,\ A_2)(A_3\ A_1)}{2 \times 10}$$

$$= \frac{|z_2 - z_1|\,|z_3 - z_1|}{20}$$

50. 00001.25

51. 00006.00

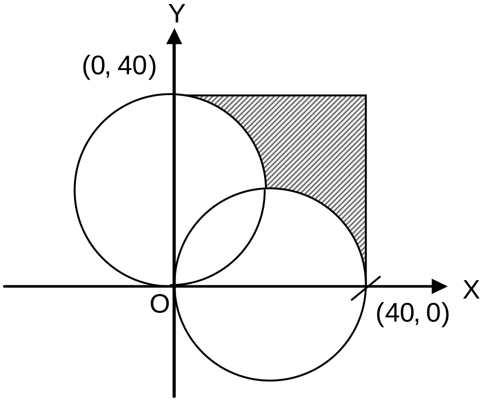
Sol. Multiply $Q(x)\,R(x)$ in (1) $P(x)\,R(x)$ in (2) & $P(x)\,Q(x)$ in (3) & add

$$\left(P(x)\,Q(x)\,R(x)\right) = 6\left(P(x)\,Q(x)\,R(x)\right)^2 + 6$$

$$\Rightarrow \frac{dt}{t^2+1} = 6dx \Rightarrow \tan^{-1} t = 6x + C$$

$$x = 0 \Rightarrow C = \pi/4$$

52. 00005.72



Sol. Let $z = x + i\,y$

$\Rightarrow \frac{x}{40}, \frac{y}{40} \in [0, 1]$

$\Rightarrow x, y \in [0, 40]$

Also $\frac{40}{\bar{z}} = \frac{40z}{|z|^2}$

$\frac{40\,x}{x^2+y^2}, \frac{40y}{x^2+y^2} \in [0, 1]$

$\Rightarrow 40x \le x^2 + y^2$ & $40y \le x^2 + y^2$

$\Rightarrow (x-20)^2 + y^2 \ge 20^2$ & $x^2 + (y-20)^2 \ge 20^2$

$A = 40^2 - \frac{1}{4}(40)^2 - \frac{1}{2}\pi\,(20)^2$

$\frac{A}{100} = 2(6-\pi)$

53. 00007.00

Sol. $\left|\int_1^3 \frac{f(x)}{x}dx\right| = \left|\int_1^3 \frac{f(x)}{x}dx - \int_1^3 \frac{f(x)}{2}dx\right|$

$= 1\left|\int_1^3 f(x)\left(\frac{1}{x}-\frac{1}{2}\right)dx\right|$

$\le \int_1^3 |f(x)|\left|-\frac{1}{x}-\frac{1}{2}\right|dx$

$\le \int_1^3 \left|\frac{1}{x}-\frac{1}{2}\right|dx.$

$= \int_1^2 \left(\frac{1}{x}-\frac{1}{2}\right)dx + \int_2^3 \left(\frac{1}{2}-\frac{1}{x}\right)dx$

$= \ln 2 - \frac{1}{2} + \frac{1}{2} - \ln\frac{3}{2}$

$= \ln\left(\frac{4}{3}\right)$

54. 00001.00

Sol. $(1+ye^x)\,(e^x dy + ye^x dx) = 2\,xdx$

$\Rightarrow \frac{(1+ye^x)^2}{2} = x^2 + c$

$\Rightarrow\ ye^x + 1 = \sqrt{2x^2+4}$

$\therefore\ f(-1) = \left(\sqrt{6}-1\right)e$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – III

JEE (Main)-2019

TEST DATE: 30-12-2018

Time Allotted: 3 Hours **Maximum Marks: 360**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only one section: **Section-A**.

  Section-A (01 – 30, 31 – 60, 61 – 90) *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

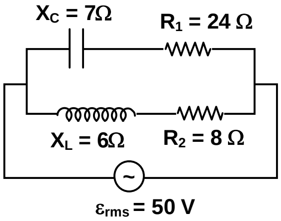
Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. What amount of I_{rms} is flowing through the a.c. source in the circuit shown in figure. (given $X_C = 7\Omega$, $X_L = 6\ \Omega$, $R_1 = 24\ \Omega$ and $R_2 = 8\ \Omega$)



(A) $\sqrt{82}$A
(B) $\frac{1125}{217}$A
(C) $\sqrt{41}$A
(D) $\sqrt{\frac{41}{2}}$A

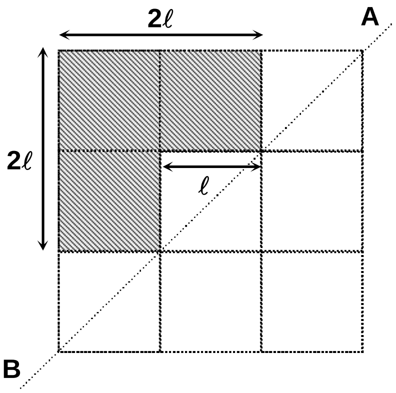
2. The main scale of vernier calipers reads in millimeter and its one division is equal to one millimeter. Its vernier is divided into 10 divisions, which coincide with 7 divisions of main scale. Further more when a cylinder is tightly placed along its length between two jaws, it is observed that the zero vernier scale lies just right to 37th division of main scale and seventh division of vernier scale coincide with the main scale. Then the measured value is
(A) 3.71 cm
(B) 3.77 cm
(C) 3.91 cm
(D) 3.67 cm

3. A transistor is used in a common emitter mode in an amplifier circuit. When a voltage of 20 mV is added to the base emitter voltage, the base current changes by 20 μA and collector current changes by 2mA. The load resistor is 5 kΩ. The input resistance is
(A) 1 kΩ
(B) 2 kΩ
(C) 4 kΩ
(D) 1/2 kΩ

4. In a YDSE, slits are separated by 1 mm, and the screen is place 150 cm away. A beam of light consisting of two wavelengths 560 nm and 980 nm is used to obtain interference fringes on the screen. Then the distance from the common central maxima to the point where bright fringe due to both the wavelength coincide is
(A) 11.70 mm
(B) 5.08 mm
(C) 17.64 mm
(D) 23.02 mm

5. Assume that an electric field $\vec{E} = 40x^3\hat{i}$ N/C exists in space. The charge density at x = 2m is
(A) $360\varepsilon_0$ Coulmb/m^3
(B) $120\varepsilon_0$ Coulmb/m^3
(C) $240\varepsilon_0$ Coulmb/m^3
(D) $480\varepsilon_0$ Coulmb/m^3

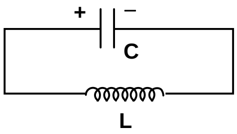
6. The moment of inertia of a square plate of side 'ℓ' about an axis passing through its centre of mass and perpendicular to the plane of plate is I_0. Then find the moment of inertia of the shaded portion of the given lamina about AB as shown in figure. (mass per unit area of square plate and lamina is same)



(A) $39I_0$
(B) $\frac{39}{2}I_0$
(C) $\frac{81}{2}I_0$
(D) $\frac{75}{2}I_0$

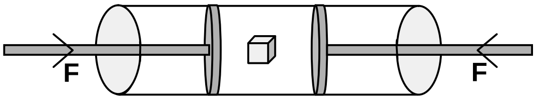
7. When 0.98 meter long metallic wire is stressed, an extension of 0.02 meter is produced. An organ pipe 0.5 meter long and open at both ends, when sounded with this stressed metallic wire produces 8 beats in their fundamental mode. By decreasing the stress in the wire, the numbers of beats are found to decrease. The young's modulus of the wire is (The density of wire is 10^4 kg/m^3 and sound velocity in air is 292 m/sec).
(A) 26.46×10^{10} N/m^2
(B) 8.82×10^{10} N/m^2
(C) 4.41×10^{10} N/m^2
(D) 17.64×10^{10} N/m^2

8. In an LC circuit shown in figure, C = 2F and L = 2H. At time t = 0, charge on the capacitor is 3 coulomb and it is decreasing with rate of $\sqrt{4}$ coulomb/sec. Then choose the correct statement.



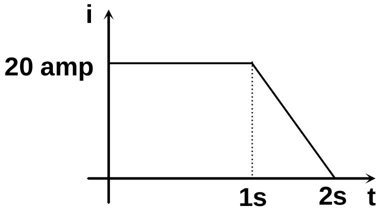
(A) maximum charge on the capacitor can be 6C.
(B) maximum charge on the capacitor can be 4C.
(C) charge on the capacitor will be maximum after time $\frac{127\pi}{90}$sec
(D) charge on the capacitor will be maximum after time $\frac{153\pi}{90}$sec

9. A solid cube of side 'ℓ' made of a soft material of bulk modulus 'K' is surrounded by liquid and piston in a cylindrical container and kept in gravity free space as shown in the figure. Both piston of area 'A' covers entire cross section of the cylindrical container. When a force 'F' is applied from the both side of the piston to compress the liquid, the fractional decrement in side of the cube $\left(\frac{d\ell}{\ell}\right)$, is:



(A) $\frac{2F}{3KA}$
(B) $\frac{2}{3}\frac{F}{K\ell^2}$
(C) $\frac{F}{3KA}$

(D) $\frac{F}{3K\ell^2}$



10. In a coil of resistance 200 Ω, a current is induced by changing the magnitude of magnetic flux through it, is shown in figure. The magnitude of average induced emf in the coil is
(A) 4000 V
(B) 3000 V
(C) 6000 V
(D) 2000 V

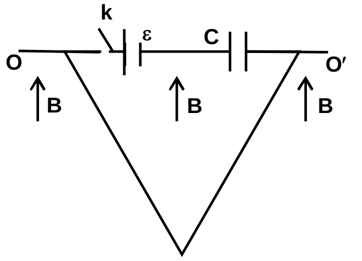
11. A piece of metal weighs 40 gm in air. When it is immersed in the liquid of specific gravity 2.0 at 28°C it weighs 32 gm, when the temperature of liquid is raised to 32°C the metal piece weighs 28 gm. If the specific gravity of the liquid at 32°C is 1.5, then the linear expansion of the metal will be
(A) $\frac{1}{48}$ / °C
(B) $\frac{1}{12}$ / °C
(C) $\frac{1}{32}$ / °C
(D) $\frac{1}{16}$ / °C

12. An optical fiber communication system work on a wavelength 1.5 μm. The number of subscribers it can feed if a channel requires 25 kHz are
(A) 8×10^9
(B) 8×10^7
(C) 8×10^{10}
(D) 4×10^9

13. A time dependent force $F = 3t^2 + 6t$ acts on a particle of mass 18 kg. If particle starts from rest, the work done by the force during the first 3 second, will be:
(A) 40.5 Joule
(B) 324 Joule
(C) 81 Joule
(D) 262 Joule

14. In YDSE double slit experiment, one of the slit wider than other, so that the amplitude of the light from one slit is thrice of that from the other slit. If I_0 be the maximum intensity. Then find the resultant intensity I when the interference at a phase difference 120°.
(A) $\frac{13}{16}I_0$
(B) $\frac{7}{8}I_0$
(C) $\frac{13}{8}I_0$
(D) $\frac{7}{16}I_0$

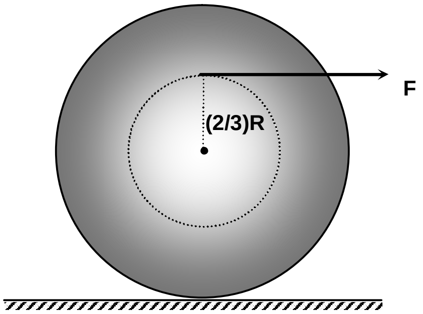
15. A triangular loop which is free to rotate about the axis OO′ is suspended in space in which a vertical magnetic field B is present as shown in the figure. The mass and length of each side of the wire are m and ℓ, respectively. A cell of emf ε and an uncharged capacitor C are connected in the wire frame. The angular velocity of the wire loop just after closing the key K is



(A) $\frac{\sqrt{3}BC\varepsilon}{m}$
(B) $\frac{\sqrt{3}BC\varepsilon}{4m}$
(C) $\frac{\sqrt{3}BC\varepsilon}{2m}$
(D) $\frac{2\sqrt{3}BC\varepsilon}{m}$

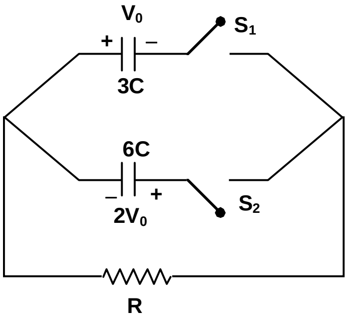
16. In a collinear collision, a block of mass 4 kg moving with initial speed 4 m/sec strikes a stationary particle of the same mass. If the final kinetic energy is 50% of the initial kinetic energy, then the coefficient of restitution is
(A) 1/2
(B) 1/3
(C) 1/4
(D) zero

17. A force F = 12 μmg acts tangentially at the given point of the disc which is at a distance of $\frac{2}{3}$R from centre of disc as shown in figure. Disc is kept on a rough horizontal plane of coefficient of friction μ. The angular acceleration of the disc is (mass of the disc is m and its radius is R)



(A) $\frac{40\mu g}{3R}$
(B) $\frac{18\mu g}{R}$
(C) $\frac{20\mu g}{3R}$
(D) $\frac{14\mu g}{R}$

18. Two capacitor of capacitance 3C and 6C are charged to potential V_0 and $2V_0$ respectively and connected to a resistor of resistance R as shown in fig. Now the both switch S_1 and S_2 are closed. Find the charge flown in the resistor as a function of time 't'
(A) $CV_0(1-e^{-t/9RC})$
(B) $9CV_0\,e^{-t/2RC}$
(C) $9CV_0\,e^{-t/9RC}$
(D) $9CV_0(1-e^{-t/9RC})$



19. When photons of wavelength λ are incident on an isolated sphere suspended by an isolated thread, the corresponding stopping potential is found to be V. When photons of wavelength $\lambda/2$ are used the corresponding stopping potential was thrice the above value. If the light of wavelength $\lambda/3$ is used, then calculate the stopping potential for this case.

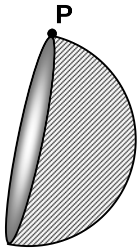
(A) $\frac{5}{4}\frac{hC}{\lambda}$

(B) $\frac{5}{4}\frac{hC}{e\lambda}$

(C) $\frac{5}{2}\frac{hC}{e\lambda}$

(D) $\frac{hC}{2e\lambda}$

20. A uniform hollow hemisphere having mass m is closed with a circular disc of same mass and radius R is hanging at one of its ends freely as shown in figure. the system is slightly disturbed so that it oscillates perpendicular to the plane of the disc. The time period of oscillation is



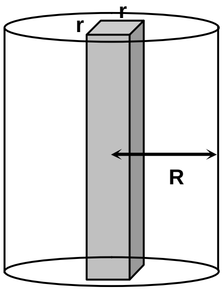
(A) $2\pi\sqrt{\frac{35R}{6\sqrt{17}g}}$

(B) $2\pi\sqrt{\frac{35R}{12\sqrt{5}g}}$

(C) $2\pi\sqrt{\frac{35R}{3\sqrt{17}g}}$

(D) $2\pi\sqrt{\frac{35R}{6\sqrt{5}g}}$

21. A glass rod of side 'r' is inserted into a vertical capillary tube of radius 'R' such that their lower ends are at the same level as shown in figure. The arrangement is now dipped in water. The height to which water will rise into the tube, will be (T = surface tension of water, ρ = density of water and the contact angle between the glass and water is 0°)



(A) $\frac{T(\pi R+2r)}{(\pi R^2-r^2)\rho g}$

(B) $\frac{2T(\pi R+2r)}{(\pi R^2-r^2)\rho g}$

(C) $\frac{T(\pi R+2r)}{2(\pi R^2-r^2)\rho g}$

(D) $\frac{2T(\pi R+2r)}{3(\pi R^2-r^2)\rho g}$

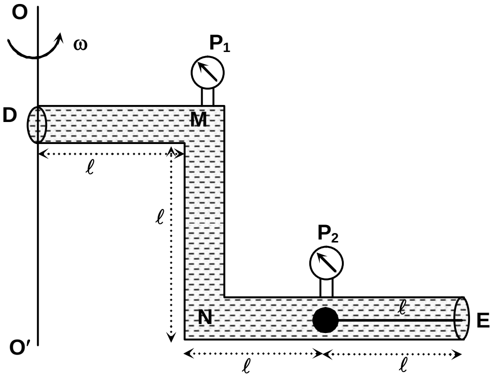
22. An unknown magnitude of charged particle is placed at some distance along the axis of a uniformly charged disc of surface charge density σ. The flux due to the charge particle through the disc is ϕ. The electric force exerted by the disc on the charged particle is

(A) $\frac{\sigma\phi}{\pi}$

(B) $\sigma\phi$

(C) $\frac{\sigma\phi}{2\pi}$
(D) $\frac{\sigma\phi}{2}$

23. A tube filled with water (density ρ) and closed at both ends uniformly rotates in a horizontal plane about a vertical axis OO′-axis and tube MN is parallel to OO′. The manometers fixed in the tube wall at distance ℓ and 2ℓ from the rotational axis indicate pressure P_1 and P_2 respectively as shown in the figure. A spherical ball of mass m and density $\rho/2$ is tied with a massless string which is joined to the end E of the tube and the diameter of sphere is just less than the diameter of tube. The tension in the string is [take $(P_2 - P_1) = 2\rho\ell g$].

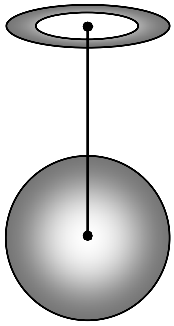


(A) (2/3)mg
(B) (4/3)mg
(C) (8/3)mg
(D) zero

24. A non-conducting disc of radius 6m is rotated about its axis of symmetry perpendicular to the plane of the disc with uniform angular speed 10 rad/sec. The disc carries a charge whose charge density is given as $\sigma = (Ar - Br^2)$, where A and B are positive constant and r is distance from the centre of the disc. The value of A/B for which magnetic field at the centre of the disc will be zero, is
(A) 4
(B) 3
(C) 2
(D) 1

25. Wire has a mass (0.3 ± 0.003) gram radius (0.5 ± 0.005) millimeter and length (0.6 ± 0.006) centimeter. The maximum percentage error in the measurement of its density is
(A) 2
(B) 4
(C) 6
(D) 8

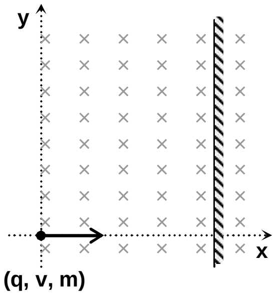
26. Uniform annular disc of inner radius 3R and outer radius $4\sqrt{3}R$ and mass m, is placed directly above a uniform hollow sphere of same mass and radius 2R. The centre of disc directly above the centre of the hollow sphere at a distance 4R as shown in figure. The gravitational force exerted by the hollow sphere on the disc will be



(A) $\frac{2Gmm}{65R^2}$
(B) $\frac{3Gmm}{65R^2}$
(C) $\frac{Gmm}{65R^2}$
(D) $\frac{Gmm}{130R^2}$

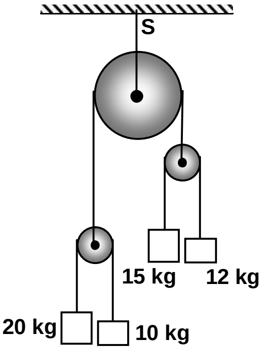
27. Two waves of wavelength λ and (λ + Δλ) produce 5 beats per second. If $\frac{\Delta\lambda}{\lambda} = \frac{\lambda + \Delta\lambda}{65}$, find the speed of sound waves in gas in which these waves produced beats.
(A) 325 m/s
(B) 324 m/s
(C) 334 m/s
(D) 335 m/s

28. A charged particle 'q' moving with a speed v along x-axis. At y = 0, enters a region of uniform magnetic field $\vec{B} = -B_0\hat{k}$ which exist to the right of y-axis. There is a vertical wall which is parallel to y-z plane as shown in figure at a distance $\frac{4mv}{5qB_0}$ from the y-axis. The charged particle may collide with the wall and collision is perfectly elastic and come back. The charged particle exit from the magnetic region after some time, then the y-coordinate from which charged particle exit the magnetic region, is



(A) $\frac{2mv}{qB_0}$
(B) $\frac{4mv}{5qB_0}$
(C) $\frac{2mv}{5qB_0}$
(D) $\frac{mv}{5qB_0}$

29. The three pulley arrangement shown in the figure are identical and four blocks are attached with the rope. The mass of rope is negligible. At t = 0, all the blocks are released from rest. The tension in the string 'S' is



(A) $\frac{800}{3}$N
(B) $\frac{400}{3}$N
(C) $\frac{1600}{3}$N
(D) 700 N

30. A particle moves in the xy plane. The position vector of the particle at any time 't' is $\vec{r} = (2t^2\hat{i} + 3t^3\hat{j})$ m. The rate of change of θ at time t = 4 sec. (where θ is the angle which its velocity vector makes with positive x-axis) is
(A) $\frac{9}{656}$ rad/s
(B) $\frac{9}{164}$ rad/s
(C) $\frac{9}{328}$ rad/s
(D) $\frac{9}{82}$ rad/s

Chemistry

PART – II

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. What is the oxidation state of iodine when it is oxidized in the form of I^- in neutral medium by permanganate ion
(A) +5
(B) +7
(C) +3
(D) +1

32. Which of the following statement is correct?
(A) Diborane hydrolyses to give metaboric acid
(B) SnO_2 is acidic in nature
(C) Ionisation enthalpy of Al > Ga
(D) Borax has 5 B – O – B linkage in it's structure

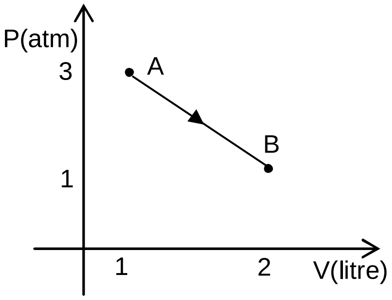
33. Which one is not a synthetic rubber?
(A) Buna – S
(B) Homopolymers of 1, 3-butadiene derivative
(C) PVC
(D) Copolymer of 1,3-butadiene

34. Which of the following is only known example of a non-transition element using three d-orbitals for bonding?
(A) XeF_4
(B) IF_7
(C) SF_6
(D) $XeOF_4$

35. 8 gm of H_2 and 32 gm of SO_2 are present in a gaseous mixture at NTP. The partial pressure of H_2 is
(A) Equal to that of SO_2
(B) Four times to that of SO_2
(C) Eight times to that of SO_2
(D) Two times to that of SO_2

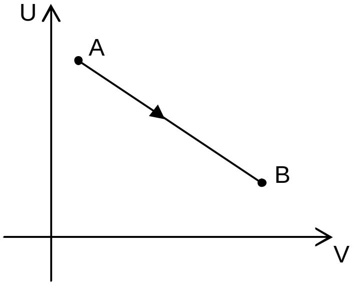
36. What kind of glycosidic linkage is present in maltose?
(A) C1 of glucose (I) and C4 of glucose (II)
(B) C2 of glucose (I) and C1 of glucose (II)
(C) C2 of glucose (I) and C2 of glucose (II)
(D) C1 of glucose (I) and C2 of glucose (II)

37. A diatomic ideal gas changes its state from A to B as shown in the figure.

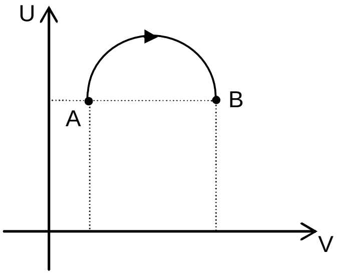


Choose the correct U versus V graph: (where U is internal energy of the gas)

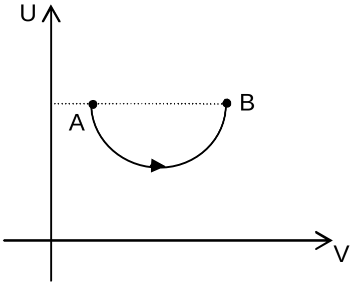
(A)



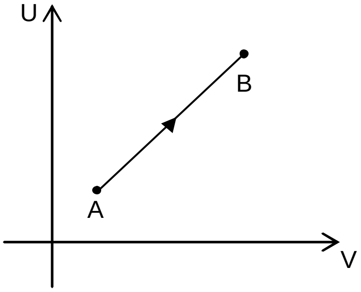
(B)



(C)



(D)



38. Which one of the following shows dπ - dπ bond?
(A) XeO_4
(B) $P(C_2H_5)_3$ with transition metals acting as ligand
(C) $N(SiH)_3$
(D) $R_3P = 0$

39. H_3A is a weak tripotic acid

$\left(K_{a_1} = 10^{-6};\ K_{a_2} = 10^{-10};\ K_{a_3} = 10^{-14}\right)$

Calculate the value of (pY – pX) of 1 M H_3A (aq) solution where $X = \frac{[HA^{2-}]}{[H_2A^-]}$ $\quad Y = \frac{[A^{3-}]}{[HA^{2-}]}$

(A) 10
(B) 3
(C) 7
(D) 4

40. What is the ppm range of chlorine in aqueous solution which will act as disinfectanct?
(A) 0.2 – 0.4 ppm
(B) 2 – 4 ppm
(C) 0.4 – 0.8 ppm
(D) 4 – 8 ppm

41. In a sample of H atom all electrons are present in 4th excited state. If e^- deexcite then a radiation is observed. How many minimum number atoms are required to observe all spectral lines except lines of Balmer series?
(A) 3
(B) 2
(C) 1
(D) 4

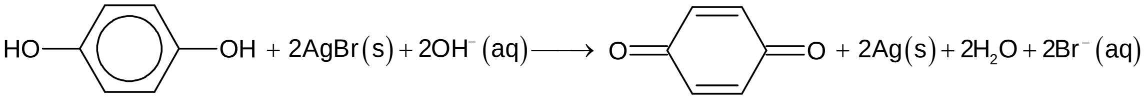
42. Which of the following is correct order regarding ionic size?
(A) $H^- > I^- > Br^- > Cl^- > F^-$
(B) $I^- > Br^- > Cl^- > F^- > H^-$
(C) $I^- > H^- > Br^- > Cl^- > F^-$
(D) $I^- > Br^- > Cl^- > H^- > F^-$

43. How many d-orbitals are used in hybridization of the following molecules in total?

$[Ni(CN)_4]^{2-}, [NiCl_4]^{2-}, [Fe(CO)_5], [Ag(NH_3)_2]^+, [Co(H_2O)_6]^{3+}, CrO_4^{2-}$

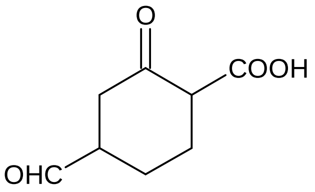
(A) 6
(B) 4
(C) 7
(D) 5

44.



What is the number of moles of electrons exchanged in this balanced redox reaction?
(A) 1
(B) 4
(C) 3
(D) 2

45. The correct IUPAC name of the compound is:

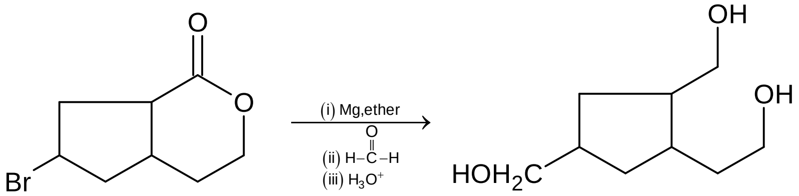


(A) 5-carboxy-3-oxocyclohexane carbaldehyde
(B) 2-carboxy – 5-formyl cyclohexanone
(C) 4-formyl-2-oxocyclohexane carboxylic acid
(D) 4-carboxy-3-oxocyclohexane

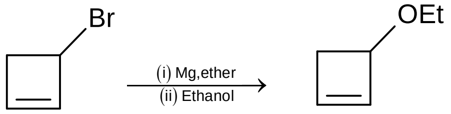
46. Which of the following will give Lassaignes test for nitrogen?
(A) NH_3
(B) $NH_2 – CH_2 – COOH$
(C) $Ph – N_2Cl$
(D) NH_2OH

47. Which of the following is a correct conversion?

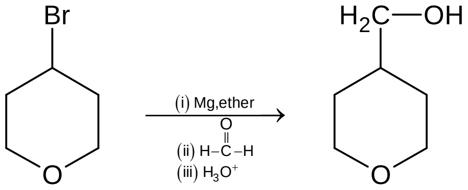
(A)


O
O
Br
(i) Mg,ether
O
(ii) H–C–H
(iii) H3O+
OH
OH
HOH2C

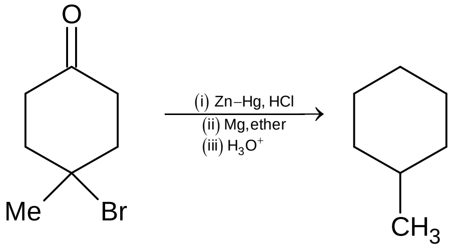
(B)


Br
(i) Mg,ether
(ii) Ethanol
OEt

(C)


Br
O
(i) Mg,ether
O
(ii) H–C–H
(iii) H3O+
H2C—OH
O

(D)


O
Me
Br
(i) Zn–Hg, HCl
(ii) Mg,ether
(iii) H3O+
CH3

48. 3-methylpentane is subjected to chlorination in presence of sunlight. What is the maximum number of monochloro derivatives possible?
(A) 4 only
(B) 5 only
(C) 6 only
(D) 8 only

49. A water heater, operating on a hydrocarbon fuel heats water flowing at the rate of 5 kg per minute, from $27^{o}C$ to $77^{o}C$. If the heat of combustion of hydrocarbon is 20,000 J/g, how much fuel in g is consumed per minute? (Specific heat of water is 4200 J/Kg – K)
(A) 52

(B) 52.7
(C) 53
(D) 52.5

50. Select the correct option if it is known that K_{sp} (AgCl) > K_{sp} (AgBr) > K_{sp} (AgI)
(A) $E^o_{I^-/AgI/Ag} > E^o_{Br^-/AgBr/Ag} > E^o_{Cl^-/AgCl/Ag}$
(B) $E^o_{I^-/AgI/Ag} < E^o_{Br^-/AgBr/Ag} < E^o_{Cl^-/AgCl/Ag}$
(C) $E^o_{I^-/AgI/Ag} < E^o_{Cl^-/AgCl/Ag} < E^o_{Br^-/AgBr/Ag}$
(D) $E^o_{I^-/AgI/Ag} = E^o_{Br^-/AgBr/Ag} = E^o_{Cl^-/AgCl/Ag}$

51. An excited H atom emits a photon of wavelength λ in returning to the ground state. If R is the Rydberg constant, then the quantum number n of the excited state is
(A) $\sqrt{\lambda R - 1}$
(B) $\sqrt{\lambda R}$
(C) $\sqrt{\dfrac{\lambda R}{\lambda R - 1}}$
(D) $\sqrt{\lambda R(\lambda R - 1)}$

52. Graph between log(x/m) vs log P is a straight line at an angle 30^o with intercept on y – axis, 0.477. The amount (in g) of the gas adsorbed per g of the adsorbent when pressure is 1 atm, is
(A) 1
(B) 2
(C) 3
(D) 4

53. If the values of enthalpies of reactants and products are p and q J/mol respectively. If the activation energy for the backward reaction is r J/mol, then the activation energy for forward reaction will be in (J/mol) (take only magnitudes)
(A) p – q - r
(B) p – q + r
(C) q – p – r
(D) q – p + r

54. Which element is present as an impurity, in principal ores of aluminium and iron, obtained from blast furnace?
(A) P
(B) Mn
(C) C
(D) Si

55. What is the correct order of SN^1 reactivity of the following alkyl halide?
$\underset{(1)}{C_6H_5CH_2Br}$, $\underset{(2)}{C_6H_5CH(C_6H_5)Br}$, $\underset{(3)}{C_6H_5CH(CH_3)Br}$, $\underset{(4)}{C_6H_5C(CH_3)(C_6H_5)Br}$
(A) 4 > 2 > 3 > 1
(B) 4 > 3 > 2 > 1
(C) 4 > 2 > 1 > 3
(D) 2 > 3 > 4 > 1

56. Which one of the following statements is correct regarding s-block element?
(A) Superoxides of alkali metals are black in colour.
(B) CsI (Cesium iodide) is less soluble in water due to high covalent character.

(C) On heating $LiNO_3$ gives a brown gas.
(D) Oxide and hydroxide of Be are acidic in nature.

57. α form of S exists in FCC and β form exists in BCC structure. Assuming that distance between the nearest neighbours is the same in the two forms, the ratio of the density of α form to that of β form is?

(A) $4\sqrt{2} : 3\sqrt{3}$
(B) $4\sqrt{3} : 3\sqrt{2}$
(C) $\sqrt{2} : \sqrt{3}$
(D) $2\sqrt{2} : 3\sqrt{3}$

58. The correct order of acidity of following carboxylic acids is

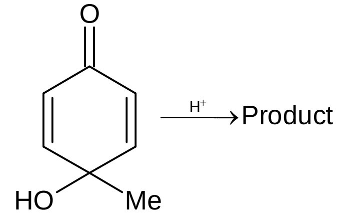
$\underset{(P)}{CCl_3COOH}$ $\underset{(Q)}{NC-CH_2COOH}$ $\underset{(R)}{HCOOH}$ $\underset{(S)}{Ph-COOH}$

(A) Q > P > R > S
(B) P > R > S > Q
(C) S > R > P > Q
(D) P > Q > R > S

59. Which of the following statement is incorrect?

(A) Ammonia reacts with diborane gives $B_2H_6.2NH_3$ and it is formulated as $\left[BH_2\left(NH_3\right)_2\right]^+\left[BH_4\right]^-$
(B) The hybridization of $\left[Sn\left(OH\right)_6\right]^{2-}$ contain two d-orbitals.
(C) H_2CO_3/HCO_3^- buffer system helps to maintain pH of blood below 7.
(D) SiO_2 reacts with HF to form a compound containing 4 mole F atoms per mole of compound.

60. The number of hydroxyl groups present in the product of the following reactions is:



(A) 1
(B) 2
(C) 3
(D) 4

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. If M is the number of words that can be formed using letters of word "EXCELLENCE" and N is the number of such words in which no two vowels are together, then $\frac{M}{N}$ is equal to

(A) $\frac{1}{4}$
(B) 6
(C) 4
(D) none of these

62. The value of $\int \frac{x\left(x^4-1\right)}{\left(x^8+3x^4+1\right)\tan^{-1}\left(x^2+\frac{1}{x^2}\right)}dx$ is equal to

(A) $\ln\tan^{-1}\left(x^2+\frac{1}{x^2}\right)+c$
(B) $\frac{1}{2}\ln\tan^{-1}\left(x^2+\frac{1}{x^2}\right)+c$
(C) $2\ln\tan^{-1}\left(x^2+\frac{1}{x^2}\right)+c$
(D) none of these

63. Let image of point A(3, 1) about line x + y + 7 = 0 be B(α, β) and image of B(α, β) about line x – 2y + 4 = 0 be C(γ, δ), then circumcentre of ΔABC is
(A) (–6, 2)
(B) (–6, –1)
(C) (6, –1)
(D) (6, 1)

64. The value of $\int_0^1 \frac{\log_e(x+1)}{1+x^2}dx = \frac{\pi \ln a}{b}$, then $a^2 + b^2$ equal to
(A) 20
(B) 68
(C) 40
(D) none of these

65. The equation of line through (1, 2, –1) and perpendicular to the lines $\vec{r} = \left(\hat{i}+\hat{j}\right)+\lambda\left(\hat{i}-\hat{j}+\hat{k}\right)$ and $\vec{r} = \left(-\hat{i}+2\hat{j}\right)+\mu\left(\hat{j}-3\hat{k}\right)$ is

(A) $\vec{r} = \left(\hat{i}+2\hat{j}-k\right)+\lambda\left(2\hat{i}+3\hat{j}+\hat{k}\right)$
(B) $\vec{r} = \left(\hat{i}+2\hat{j}-k\right)+\lambda\left(\hat{i}-\hat{j}+\hat{k}\right)$
(C) $\vec{r} = \left(\hat{i}+2\hat{j}-k\right)+\lambda\left(\hat{j}-3\hat{k}\right)$
(D) none of these

66. Number of ways to seat 8 men and 8 women around a round table where one particular man and one particular woman always sit together, and men and women alternate is equal to

(A) $2 \times (7!)^2$
(B) $2(6!)^2$
(C) $16! - 2! \times 14!$
(D) none of these

67. If $\alpha_1, \alpha_2, \alpha_3, \ldots\ldots, \alpha_n$ are n real roots of equation f(x) = 0 and f(x) satisfies the condition f(k – x) = f(x + k), then the value of $\sum_{i=1}^{n} \alpha_i$ is equal to

(A) 2nk, $\forall\ n \in N$
(B) nk, $\forall\ n \in N$
(C) nk, if n is odd
(D) nk, if n is even

68. The number of skew-symmetric matrices of order 4 × 4, whose entries belong to the set {±4, ±3, ±2, ±1, 0} is

(A) 9^6
(B) 6^9
(C) 9^9
(D) 8^6

69. For $f(x) = \tan\frac{\pi x}{2}$ and $g(x) = \frac{e^x - e^{-x}}{e^x + e^{-x}}$, which of the following is not correct?

(A) f(g(x)) is one-one
(B) f(g(x)) is onto
(C) f(g(x)) is not differentiable
(D) none of these

70. Number of solution(s) of $\frac{3\cos 2x + \cos^3 2x}{\cos^6 x - \sin^6 x} = x^2 + 3$ in [0, 4π] is

(A) 0
(B) 1
(C) 2
(D) infinite

71. If $a = \left({}^{100}C_0 + {}^{100}C_3 + {}^{100}C_6 + \ldots\ldots + {}^{100}C_{99}\right)$, $b = \left({}^{100}C_1 + {}^{100}C_2 + {}^{100}C_3 + \ldots\ldots\right)$ and $c = \left({}^{100}C_1 - {}^{100}C_2 + {}^{100}C_4 - {}^{100}C_5 + \ldots\ldots\right)$, then value of $\left(a - \frac{b}{2}\right)^2 + \frac{3}{4}c^2$ is equal to

(A) 4
(B) 7
(C) 1
(D) 2

72. $\text{Min}\left[(x_1 - x_2)^2 + \left(7 + \sqrt{4 - (x_1 + 4)^2} - \sqrt{4x_2}\right)^2\right]$, $\forall\ x_1x_2 \in R$ is

(A) $5\sqrt{2} - 2$
(B) 5
(C) $5\sqrt{3} - 2$
(D) 10

73. If the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ is inscribed in a rectangle whose length to breadth ratio is 3 : 2, then the area of rectangle is

(A) $\frac{2}{13}\left(a^2+b^2\right)$

(B) $\frac{24}{13}\left(a^2+b^2\right)$

(C) $\frac{9}{13}\left(a^2+b^2\right)$

(D) $\frac{8}{9}\left(a^2+b^2\right)$

74. $\sim(p \leftrightarrow q) \wedge p$ is equal to

(A) p

(B) q

(C) $p \wedge \sim p$

(D) $\sim P \wedge q$

75. x_1, x_2, ..., x_{10} are ten observations x such that $\Sigma x_i = 50$ and $\Sigma x_i x_j = 1100 \ \forall\ i \neq j$, then standard deviation of x_1, x_2, ..., x_{10} is equal to

(A) 5

(B) 10

(C) $\sqrt{5}$

(D) $\sqrt{10}$

76. The combined equation of the pair of asymptotes of the hyperbola
$5x^2 + 23xy - 10y^2 + 33x + 3y = 0$ is

(A) $5x^2 + 23xy - 10y^2 + 33x + 3y + 7 = 0$

(B) $5x^2 + 23xy - 10y^2 + 33x + 3y + 18 = 0$

(C) $5x^2 - 23xy + 7x^2 + 33x + 18 = 0$

(D) none of these

77. Let $\vec{a}, \vec{b}, \vec{c}$ be 3 mutually perpendicular unit vectors. If an unknown vector $\vec{x}$ satisfies the equation $\vec{a}\times\left(\left(\vec{x}-\vec{b}\right)\times\vec{a}\right)+\vec{b}\times\left(\left(\vec{x}-\vec{c}\right)\times\vec{b}\right)+\vec{c}\times\left(\left(\vec{x}-\vec{a}\right)\times\vec{c}\right)=0$, then $\vec{x}$ is equal to

(A) $\vec{a}+\vec{b}+\vec{c}$

(B) $\frac{\vec{a}+\vec{b}+\vec{c}}{2}$

(C) $\frac{\vec{a}+\vec{b}+\vec{c}}{3}$

(D) $\frac{\vec{a}+\vec{b}+\vec{c}}{4}$

78. A plane passes through (1, 2, –2) and is perpendicular to two planes $x - 2y + 3z + 4 = 0$ and $2x - y - z + 7 = 0$. The distance of this plane from the point (1, 1, 3) is equal to

(A) $\frac{8}{83}$

(B) $\frac{16}{83}$

(C) $\frac{64}{\sqrt{83}}$

(D) $\frac{8}{\sqrt{83}}$

79. From all the functions that can be defined from the set A to set B, where A = {1, 2, 3, 4, 5, 6}; and B = {7, 8, 9, 10, 11, 12, 13, 14}, a mapping is randomly selected. The chance that the selected mapping is strictly monotonic is

(A) $\frac{7}{2^{14}}$

(B) $\frac{7}{2^{16}}$

(C) $\frac{7}{8^5}$

(D) none of these

80. The locus of centre of circles which bisect the circumference of circles $x^2 + y^2 = 9$ and $x^2 + y^2 - 2x - 4y + 2 = 0$ is

(A) $2x - 2y + 3 = 0$
(B) $2x + 2y - 1 = 0$
(C) $2x - 2y + 1 = 0$
(D) $2x + 2y + 3 = 0$

81. If $\lim_{x\to\infty}\left(\sqrt{x^2+x+2}-ax-b\right)=2$, then equation of circle whose centre is (a, 2b) and radius 1 units is

(A) $x^2 + y^2 + 2x + 6y + 9 = 0$
(B) $x^2 + y^2 - 2x + 6y + 1 = 0$
(C) $x^2 + y^2 - 2x + 6y + 9 = 0$
(D) none of these

82. The point on curve $x^2 + 4y^2 = 4$ nearest to the line $x + 2y + 12 = 0$ is

(A) $\left(-\sqrt{2}, \frac{1}{\sqrt{2}}\right)$

(B) (–2, 0)
(C) (0, –1)

(D) $\left(-\sqrt{2}, \frac{-1}{\sqrt{2}}\right)$

83. The equation of normal to the curve $y = 2x^3 + 6x + 5$, which is parallel to $x + 12y + 15 = 0$ is

(A) $x + 12y + 107 = 0$
(B) $x + 12y - 157 = 0$
(C) $x + 12y - 108 = 0$
(D) $x + 12y + 13 = 0$

84. Remainder when $\sum_{r=0}^{n}\left((r!)^3+(r!)^2+(r!)\right)$ is divided by 36 $(n \geq 4)$ is equal to

(A) 2
(B) 8
(C) 26
(D) none of these

85. If $I_1 = \int_{-5}^{6}\frac{dx}{\left(6+2x-2x^2\right)\left(1+e^{3-6x}\right)}$ and $I_2 = \int_{-5}^{6}\frac{dx}{6+2x-2x^2}$, then $\frac{I_1}{I_2}$ is equal to

(A) 1

(B) $\frac{1}{2}$
(C) 2
(D) none of these

86. Number of real root(s) of equation $x^2 \tan x = 1$ between $-\frac{3\pi}{2}$ and $\frac{3\pi}{2}$ is
(A) 1
(B) 2
(C) 3
(D) 4

87. Let $f(x) = \begin{cases} 1+|x-2| & x \neq 2 \\ 2 & x = 2 \end{cases}$ then at x = 2, f(x) has
(A) a local minimum
(B) a local maximum
(C) no extremities
(D) none of these

88. The area of the region of plane bounded by max(|x|, |y|) ≤ 2 and xy = 1 is equal to
(A) 3 – 2 ln 2
(B) 3 + 2 l n 2
(C) 6 – 4 ln 2
(D) 6 + 4 ln 2

89. A function y = f(x) satisfies the differential equation

$f(x)\sin 2x + \sin x - (1 + \cos^2 x)f'(x) = 0$ with initial condition y(0) = 0, then the value of $f\left(\frac{\pi}{4}\right)$ is equal to
(A) $\frac{\sqrt{2}\left(\sqrt{3}-1\right)}{3}$
(B) $\frac{\sqrt{2}\left(\sqrt{3}-\sqrt{2}\right)}{3}$
(C) $\frac{\sqrt{2}\left(\sqrt{2}-1\right)}{3}$
(D) $\frac{\sqrt{3}\left(\sqrt{2}+1\right)}{3}$

90. Let f(x) be a polynomial, with positive leading coefficient, satisfying f(0) = 0 and

$f\left(f(x)\right) = x\int_0^x f(t)\,dt \ \ \forall\, x \in R$. Then f(2) is equal to
(A) $\frac{2}{\sqrt{3}}$
(B) $\frac{1}{\sqrt{6}}$
(C) $\sqrt{\frac{2}{3}}$
(D) $\frac{4}{\sqrt{3}}$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – III

JEE (Main)-2019

TEST DATE: 30-12-2018

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. C

Sol. $I_1 = \dfrac{50}{\sqrt{7^2 + (24)^2}} = 2\text{ A}$

$I_2 = \dfrac{50}{\sqrt{6^2 + 8^2}} = 5\text{ A}$

$\tan\theta_2 = \dfrac{6}{8} = \dfrac{3}{4} \Rightarrow \theta_2 = 37°$

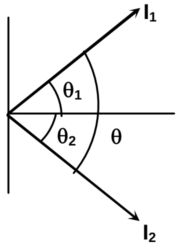
$\tan\theta_1 = \dfrac{7}{24}$

$\tan\theta = \tan(\theta_1 + \theta_2) = \dfrac{4}{3}$

$\theta = 53°$

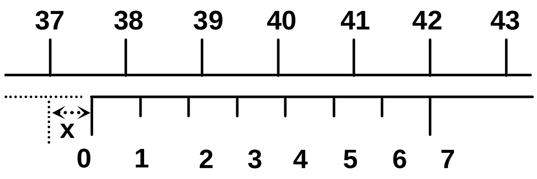
$I = \sqrt{I_1^2 + I_2^2 + 2I_1I_2\cos\theta}$

$\sqrt{4 + 25 + 2\cdot 2\cdot 5\cdot \cos 53°} = \sqrt{41}$



2. A

Sol. 10 V = 7S
V = 0.7 S
So, 7V = 4.9 S
X + 7V = 5S
X = 5S – 4.9 S
= 0.01 cm
So, measured value = 3.7 + 0.01 = 3.71 cm



3. A

Sol. $\beta = \dfrac{\Delta I_c}{\Delta I_B} = \dfrac{2\text{mA}}{20\mu\text{A}} = 100$

$$\text{Voltage gain} = \frac{2\text{mA} \times 5\text{k}\Omega}{20\ \text{mV}} = 500$$

$$\text{Resistance gain} = \frac{\text{Voltage gain}}{\text{Current gain}} = \frac{500}{100} = 5$$

$$\text{So, Input resistance} = \frac{\text{Output resistance}}{5} = \frac{5\ \text{k}\Omega}{5} = 1\,\text{k}\Omega$$

4. C

Sol. $y_1 = \dfrac{n_1\lambda_1 D}{d} = y_2 = \dfrac{n_2 y_2 D}{d}$

$$\frac{n_1}{n_2} = \frac{\lambda_2}{\lambda_1} = \frac{980}{560} = \frac{7}{4}$$

$$y_1 = \frac{7 \times 560 \times 10^{-9} \times 1.5}{1 \times 10^{-3}} = 5.88\ \text{mm}$$

$$n = \frac{17.64}{5.88} = 3$$

5. D

Sol. $\phi = EA$

$\phi = 40\ x^3A$

$d\phi = (120\ x^2)Adx$

$dq = (d\phi)\varepsilon_0 = (120\ \varepsilon_0 x^2)(Adx)$

$$\rho(x) = \frac{dq}{dv} = \frac{120\varepsilon_0 x^2}{(Adx)}(Adx)$$

$\rho(x) = 120\ \varepsilon_0 x^2$

$\rho(x = 2) = 480\ \varepsilon_0$

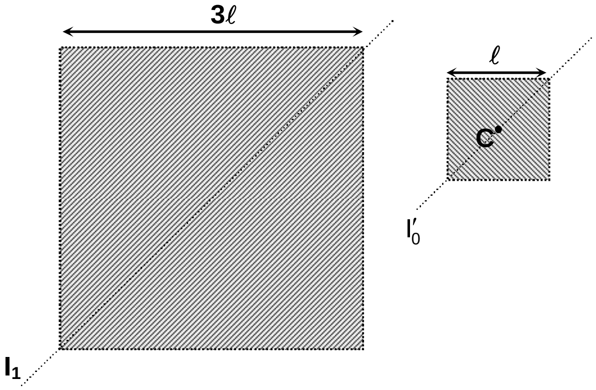
6. B

Sol. $I_C = I_0$

$$I'_0 = \frac{I_0}{2} = K\ell^4$$

$$I_1 = k_0(3\ell)^4 = 81\left(k_0\ell^4\right) = \frac{81}{2}I_0$$

$$I_{AB} = \frac{\left(\frac{81}{2}I_0 - \frac{3}{2}I_0\right)}{2} = \frac{39}{2}I_0$$



7. D

Sol. Fundamental frequency of open pipe is

$$f_1 = \frac{v}{2\ell} = \frac{292}{2 \times (0.5)} = 292\ \text{Hz}$$

$$\ell_f = \ell_i + \Delta\ell = (0.98 + 0.02) = 1.0\ \text{m}$$

Fundamental frequency of stressed wire

$$f_2 = \frac{1}{2\ell_f}\sqrt{\frac{T}{\pi r^2 \rho}} \quad \ldots(i)$$

$f_2 = f_1 \pm 8 \Rightarrow f_2 = 300$ Hz or 284 Hz

As the number of beats decreases on decreasing the stress so $f_2 = 300$ Hz

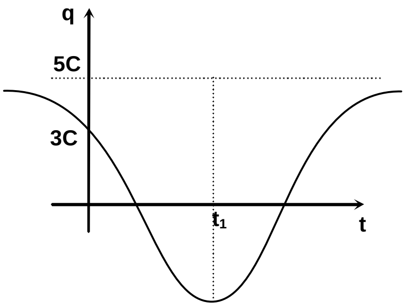
So from (i) $\frac{T}{\pi r^2} = 4f_2^2\ell_f^2\rho$

$$y = \frac{(T/\pi r^2)}{(\Delta\ell/\ell_i)} = \frac{4f_2^2\ell_f^2\rho}{(\Delta\ell/\ell_i)} = \frac{4(300)^2(1)^2\times 10^4}{(0.02)/(0.98)}$$

$= 17.64 \times 10^{10}$ N/m^2

8. C

Sol. $i = \sqrt{4}$ amp



$$\frac{q_m^2}{2C} - \frac{q^2}{2C} + \frac{1}{2}LC^2$$

$q_m^2 = 9 + 4(\sqrt{4})^2$

$q_m = 5C$.

$q = Q\cos(\omega t + \delta)$

at $t = 0$

$3 = 5\cos\delta \Rightarrow \delta = 53°$

Let at $t = t_1$, charge on capacitor is maximum

$\omega t_1 + \delta = \pi$

$$t_1 = \left(\frac{\pi-\delta}{\omega}\right) = (\sqrt{LC})(\pi-\delta) = \frac{2(180-53°)\pi}{180} = \left(\frac{127\pi}{90}\right)\text{sec}$$

9. C

Sol. $\text{Bulk modulus} = \frac{\text{Volumetric stress}}{\text{Volumetric strain}}$

$$K = \frac{F/A}{dV/V} \Rightarrow \frac{F/A}{K} = \frac{dV}{V}$$

$V = \ell^3$, $dV = 3\ell^2 D\ell$

$$\frac{dV}{V} = \frac{3d\ell}{\ell}$$

$$\frac{3d\ell}{\ell} = \frac{F}{KA} \Rightarrow \frac{d\ell}{\ell} = \left(\frac{F}{3KA}\right)$$

10. B

Sol. $q = \frac{\Delta\phi}{R}$

$\Delta\phi = Rq = R\int i\,dt$

$= (200)\left(20\times 1 + \frac{20\times 1}{2}\right) = 6000\text{Wb}$

$$\varepsilon_{av} = \frac{\Delta\phi}{\Delta t} = \frac{6000}{2} = 3000\text{ V}$$

11. B

Sol. Loss of weight at 28°C = $(40 - 32) \times 10^{-3}g = v_1 \cdot 2\rho_\ell g$ …(i)

Loss of weight at 32°C = $(40 - 28) \times 10^{-3}g = v_2 \cdot (1.5\rho_\ell)g$ …(ii)

From (i) and (ii)

$$\frac{V_1}{V_2} = \frac{1}{2} \quad \text{…(iii)}$$

$V_2 = V_1(1 + 3\alpha\Delta T)$

$\alpha = (1/12)/°C$

12. A

Sol. Optical source frequency $f = \frac{c}{\lambda} = \frac{3 \times 10^8}{1.5 \times 10^{-6}} = 2 \times 10^{14}$

Number of channels or subscribers $= \frac{2 \times 10^{14}}{25 \times 10^3} = \frac{200 \times 10^{12}}{25 \times 10^3} = 8 \times 10^9$

13. C

Sol. Charge in momentum

$$\Delta P = \int F dt$$

$$\Delta P = \int_0^3 (3t^2 + 6t)dt = 54$$

$$\Delta K = \frac{P^2}{2m} = \frac{54 \times 54}{2 \times 18} = 81 \text{Joule}$$

14. D

Sol. Let $A_1 = A_0$, $A_2 = 3A_0$

Then $A_{max}^2 = A_0^2 + 9A_0^2 + 2A_0 \cdot 3A_0 = 16A_0^2$

$A_{max} = 4A_0$ …(i)

For $\phi = 120$

$A^2 = A_0^2 + 9A_0^2 + 2A_0 \cdot 3A_0 \cos 120° = 10A_0^2 - 3A_0^2 = 7A_0^2$

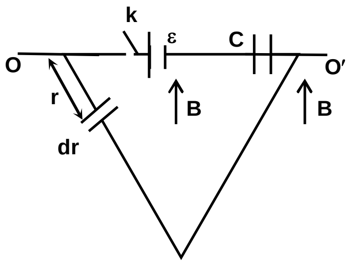
$A = \sqrt{7}A_0$ …(ii)

$$\frac{I}{I_{max}} = \frac{I}{I_0} = \frac{7A_0^2}{16A_0^2}$$

$$I = \frac{7}{16}I_0$$

15. C

Sol. Torque about OO′ $\tau = (idr\cos 60°)Br\sin 60°$



$$= \frac{\sqrt{3}}{4} iB\int_0^\ell rdr = \frac{\sqrt{3}}{4} iB\ell^2$$

Angular impulse, $\int \tau dt = I\omega$

$$\int \frac{\sqrt{3}}{4} iB\ell^2 dt = \frac{m\ell^2}{2}\omega$$

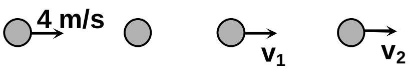
$$\frac{\sqrt{3}}{4} B\ell^2 \int idt = \frac{m\ell^2}{2}\omega$$

$$\frac{\sqrt{3}}{4}B\ell^2C\varepsilon = \frac{m\ell^2}{2}\omega$$

$$\omega = \frac{\sqrt{3}BC\varepsilon}{2m}$$

16. D

Sol. $\frac{1}{2}4v_1^2 + \frac{1}{2}4v_2^2 = \frac{1}{2}\left(\frac{1}{2}4\cdot 4^2\right)$



$v_1^2 + v_2^2 = 8$ …(i)

$4v_1 + 4v_2 = 4 \times 4$

$v_1 + v_2 = 4$ …(ii)

from (i) and (ii)

$v_1 = v_2 = 2$ m/s

Hence $e = \frac{v_2 - v_1}{4} = 0$

17. D

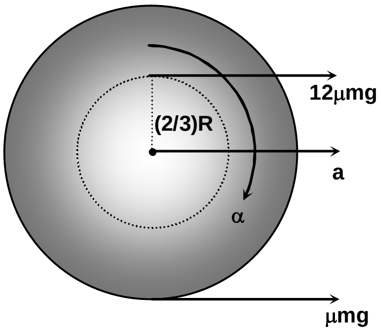
Sol. $r = \frac{I_{cm}}{mR} = \frac{\frac{mR^2}{2}}{mR} = \frac{R}{2}$

But force acts above to it so friction on the disc acts along the applied force.

Torque about centre of mass

$$\frac{mR^2\alpha}{2} = 12\mu mg\left(\frac{2}{3}R\right) - \mu mgR = 7\mu mgR$$

$$\alpha = \frac{14\mu g}{R}$$



18. D

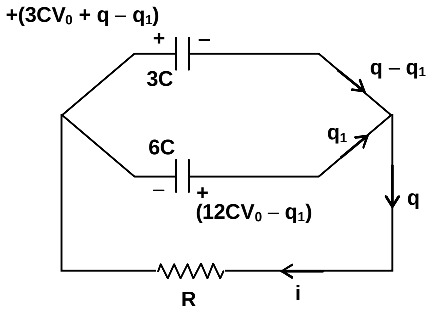
Sol. Applying Kirchhoff' law

$$-\frac{3CV_0 + q - q_1}{3C} - iR = 0 \quad \text{…(i)}$$

$$\frac{12CV_0 - q_1}{6C} - iR = 0 \quad \text{…(ii)}$$

From (i) and (ii)

$q = 9CV_0\,(1–e^{–t/(9RC)})$



19. C

Sol. $K_1 = \frac{hC}{\lambda} - \phi = eV$ …(i)

$K_2 = \frac{2hC}{\lambda} - \phi = e3V$ …(ii)

From (i) and (ii)

$$\left(\frac{hC}{\lambda} - \phi\right)3 = \left(\frac{2hC}{\lambda} - \phi\right)$$

$$\frac{3hC}{\lambda} - 3\phi = \frac{2hC}{\lambda} - \phi$$

$$\frac{hC}{\lambda} = 2\phi \Rightarrow \phi = \frac{hC}{2\lambda} \qquad \ldots\text{(iii)}$$

$$\frac{hC}{\lambda/3} - \phi = eV_0$$

$$\frac{hC}{\lambda/3} - \frac{hC}{2\lambda} = eV_0$$

$$\frac{hC}{\lambda}\left(3 - \frac{1}{2}\right) = eV_0 \Rightarrow V_0 = \left(\frac{5hC}{2e\lambda}\right)$$

20. A

Sol. $T = 2\pi\sqrt{\frac{I}{mgd}}$

$$= 2\pi\sqrt{\frac{\left(\frac{5}{3}mR^2 + \frac{mR^2}{4} + mR^2\right)}{(2m)(g)\left(\sqrt{R^2 + \frac{R^2}{16}}\right)}}$$

$$= \left(2\pi\sqrt{\frac{35R}{6\sqrt{17}g}}\right)$$

21. B

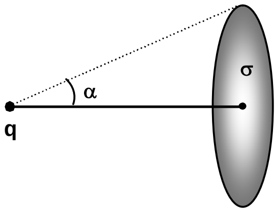
Sol. Total upward force due to surface tension = weight of the liquid column of height h.

$$T \cdot 2\pi R + T \cdot 4r = \rho\left(\pi R^2 - r^2\right)gh$$

$$h = \frac{2T(\pi R + 2r)}{(\pi R^2 - r^2)\rho g}$$

22. B

Sol. Electric field due to disc is



$$E = \frac{\sigma}{2\epsilon_0}(1 - \cos\alpha) \qquad \ldots\text{(i)}$$

Flux through the disc is

$$\phi = \frac{q}{2\epsilon_0}(1 - \cos\alpha) \qquad \ldots\text{(ii)}$$

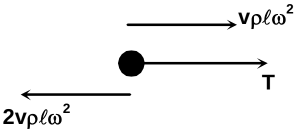
Force due to disc on q

F = qE

$$= \frac{\phi . 2\epsilon_0}{(1 - \cos\alpha)} . \frac{\sigma}{2\epsilon_0}(1 - \cos\alpha)$$

$$= \sigma\phi$$

23. B



Sol. $P_1 = P_D + \frac{\rho\omega^2\ell^2}{2}$

$$P_2 = P_D + \rho\frac{\omega^2\ell^2}{2} + \rho\ell g + \frac{3}{2}\rho\omega^2\ell^2$$

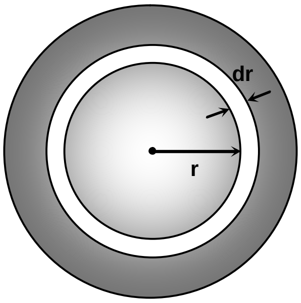
$P_2 - P_1 = 2\rho\ell g$

$\therefore \qquad \omega = \sqrt{\dfrac{2g}{3\ell}}$

So, $T = 2v\rho\ell\omega^2 - v\rho\ell\omega^2 = (4/3)mg$

24. A

Sol. $di = \dfrac{dq}{2\pi/\omega} = \dfrac{\omega}{2\pi}(\sigma, 2\pi r.dr)$



$$B = \int_0^6 \frac{\mu_0}{2}\frac{\left(\frac{\omega}{2\pi}.2\pi r\left(Ar - Br^2\right)dr\right)}{r} = 0$$

$$\int_0^6 \left(Ar - Br^2\right)dr = 0$$

$$\left(\frac{Ar^2}{2} - \frac{Br^3}{3}\right) = 0$$

$$\frac{A}{B} = \frac{2}{3}r = \frac{2}{3}.6 = 4$$

25. B

Sol. $\rho = \dfrac{M}{V} = \dfrac{M}{\pi r^2 \ell}$

$$\frac{\Delta\rho}{\rho} = \frac{\Delta M}{M} + 2\left(\frac{\Delta r}{r}\right) + \frac{\Delta\ell}{\ell}$$

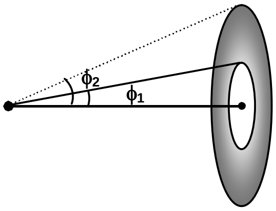
$$= \frac{0.003}{0.3} + 2\times\left(\frac{0.005}{0.5}\right) + \left(\frac{0.006}{0.6}\right) = 0.04$$

Percentage error = $\dfrac{\Delta\rho}{\rho}\times 100 = 4\%$

26. C

Sol. $F = \left[2\pi G\sigma\left(\cos\phi_1 - \cos\phi_2\right)m\right]$

$$= \frac{Gmm}{65R^2}$$



27. A

Sol. $\dfrac{\Delta\lambda}{\lambda} = \dfrac{\lambda + \Delta\lambda}{65}$

$$\frac{\Delta\lambda}{\lambda(\lambda+\Delta\lambda)} = \frac{(\lambda+\Delta\lambda)-\lambda}{\lambda(\lambda+\Delta\lambda)} = \frac{1}{\lambda} - \frac{1}{\lambda+\Delta\lambda} = \frac{1}{65}$$

$f_1 - f_2 = 5$

$$\frac{v}{\lambda} - \frac{v}{\lambda+\Delta\lambda} = 5$$

From (i) and (ii)

$$\frac{5}{v} = \frac{1}{65}$$

v = 325 m/s

28. B

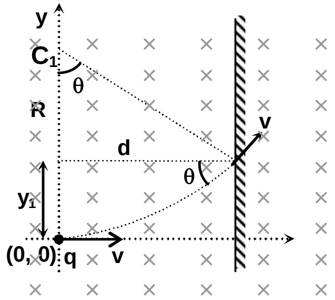
Sol. $y_1 = (R - R\cos\theta)$

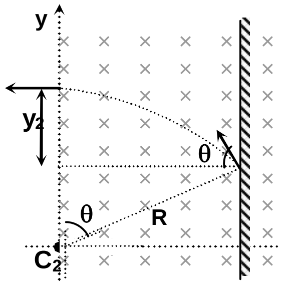
$y_2 = R - R\cos\theta$

So, y-coordinate

$y_0 = y_1 + y_2$

$= 2R - 2R\cos\theta$ ($\sin\theta = d/R = 4/5 \Rightarrow \theta = 53°$)





$= 2R - 2R\left(\frac{3}{5}\right)$s

$= \frac{4R}{5} = \frac{4mv}{5qB_0}$

29. C

Sol. Assume both moving pullies are in rest

$a_{20kg} = \frac{200-100}{30} = \frac{10}{3}$ m/s^2

So, Tension $T_1 = 200 - 20 \times\frac{10}{3} = \frac{400}{3}$N

$a_{15\,kg} = \frac{150-120}{27} = \frac{30}{27} = \frac{10}{9}$ m/s^2

So, tension $T_2 = 150 - \frac{150}{9} = \frac{400}{3}$N

$T_1 = T_2$

So, both pulley remains in rest.

So, $T_s = 2T_1 + 2T_2$

$= 4\left(\frac{400}{3}\right) = \frac{1600}{3}$N

30. C

Sol. $x = 2t^2$, $y = 3t^2$

$v_x = 4t$, $v_y = 9t^2$

$\tan\theta = \frac{v_y}{v_x} = \frac{9}{4}t$

$\sec^2\theta\left(\frac{d\theta}{dt}\right) = \frac{9}{4}$

$\frac{d\theta}{dt} = \frac{9/4}{1+\tan^2\theta} = \frac{9/4}{1+\frac{81}{16}t^2}$

at t = 4, $\frac{d\theta}{dt} = \frac{9}{4}\times\frac{1}{82} = \frac{9}{328}$

Chemistry

PART – II

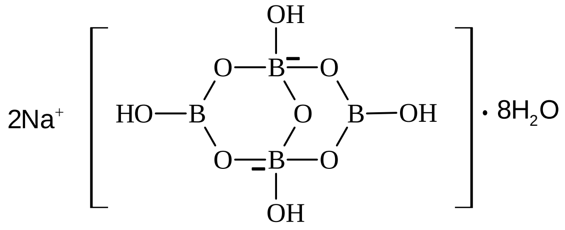
SECTION – A

31. A

Sol. $2MnO_4^- + H_2O + I^- \longrightarrow 2MnO_2 + 2OH^- + IO_3^-$

32. D

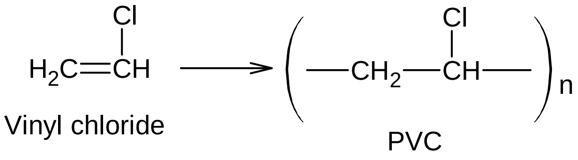
Sol.



$B_2H_6 + 6H_2O \longrightarrow 2H_3BO_3 + 6H_2\uparrow$

33. C

Sol.



$$H_2C{=}CH(Cl) \longrightarrow \left(-CH_2-CH(Cl)-\right)_n$$

PVC is a plastic.

34. B

Sol. IF_7 has sp^3d^3 hybridisation.

35. C

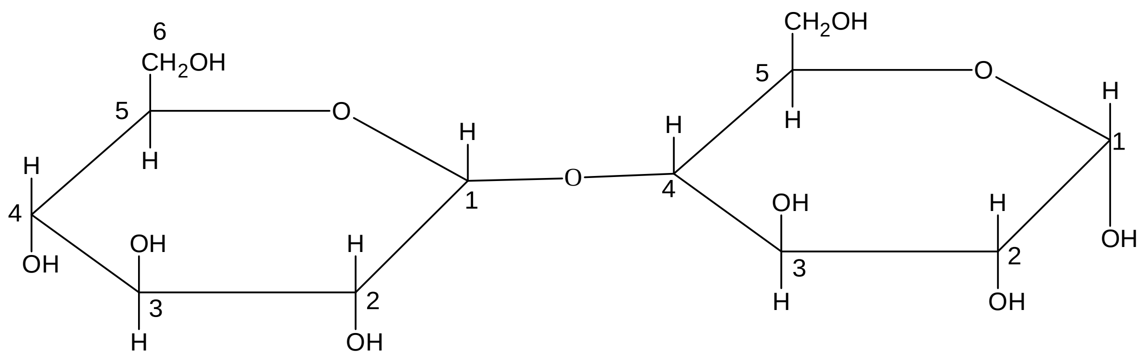
Sol. $nH_2 = 8/2 = 4$

$$nSO_2 = \frac{32}{64} = \frac{1}{2}$$

$$\frac{P_{H_2}}{P_{SO_2}} = \frac{nH_2}{nSO_2} = 8$$

36. A

Sol.



37. B

Sol. In the given process temperature, first increases then decreases.

38. B

Sol. P can form $d\pi$ - $d\pi$ bond with transition metals.

39. D

Sol. $\left[H^+\right] = 10^{-3}$

$$K_{a_2} = \frac{\left[H^+\right]\left[HA^{2-}\right]}{\left[H_2A^-\right]} \qquad K_{a_3} = \frac{\left[H^+\right]\left[A^{3-}\right]}{\left[HA^{2-}\right]}$$

40. A

41. D

Sol. Accepted transitions

1. $5 \rightarrow 1$
2. $5 \rightarrow 4 \rightarrow 1$
3. $5 \rightarrow 3 \rightarrow 1$
4. $5 \rightarrow 4 \rightarrow 3 \rightarrow 1$

42. C

43. C

Sol. $\left[Ni(CN)_4\right]^{2-} \longrightarrow dsp^2$

$\left[NiCl_4\right]^{2-} \longrightarrow sp^3$

$\left[Fe(Co)_5\right] \longrightarrow dsp^3$

$\left[Ag(NH_3)_2\right]^{+} \longrightarrow sp$

$\left[Co(H_2O)_6\right]^{3+} \longrightarrow d^2sp^3$

$CrO_4^{2-} \longrightarrow d^3s$

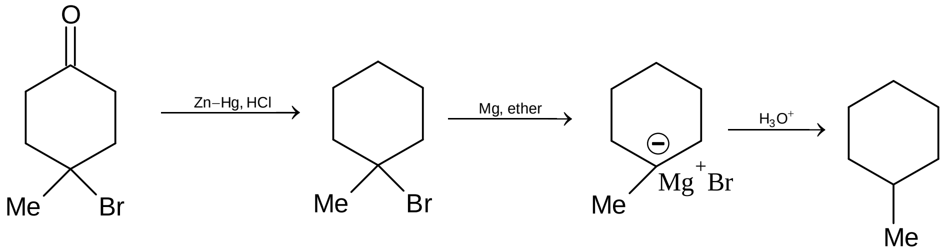
44. D

45. C

46. B

47. D

Sol.



48. D

49. D

Sol. $mc\ \Delta T = 20000 \times \text{Mass of HC}$

$$\text{Mass of HC} = \frac{5 \times 50 \times 4200}{20000}$$

= 52.5 g

50. B

Sol. All salts are of form PQ

$$\underset{}{PQ(s)} \rightleftharpoons \underset{S}{P^+(aq)} + \underset{S}{Q^-(aq)}$$

$K_{sp} = S.\ S = S^2$

$$e^- + PQ(s) \rightleftharpoons P(s) + Q^-(aq.)$$

$$E = E^o - \frac{0.059}{1}\log\left[Q^-\right]$$

E = 0

$$E^o = \frac{0.059}{2}\log K_{sp}$$

51. C

Sol. $R\left(\frac{1}{1^2} - \frac{1}{n^2}\right) = \frac{1}{\lambda}$

$$n = \sqrt{\frac{\lambda R}{\lambda R - 1}}$$

52. C

Sol. $\frac{x}{m} \propto P^{1/n}$

$$\log\frac{x}{m} = \log K + \frac{1}{n}\log P$$

$$\frac{1}{n} = \tan 30^o \qquad P = 1\,\text{atm}$$

$$\log\frac{x}{m} = \log K$$

As log K = 0.477

$\frac{x}{m} = 3g$ per 1 g of adsorbent

53. D

Sol. $\Delta H_{reaction} = Ea_{(f)} - Ea_{(b)}$

$$q - p = Ea_{(f)} - r$$

54. D

Sol. SiO_2 in bauxite

Si in pig iron

55. A

Sol. SN^1 reactivity depends upon stability of carbocation.

56. C

Sol. $4LiNO_3 \xrightarrow{\Delta} 2Li_2O + 4NO_2 + O_2$

57. A

Sol. a_α = edge length of α form

a_β = edge length of β form

$$\frac{a_\alpha}{a_\beta} = \frac{\sqrt{3}}{\sqrt{2}}$$

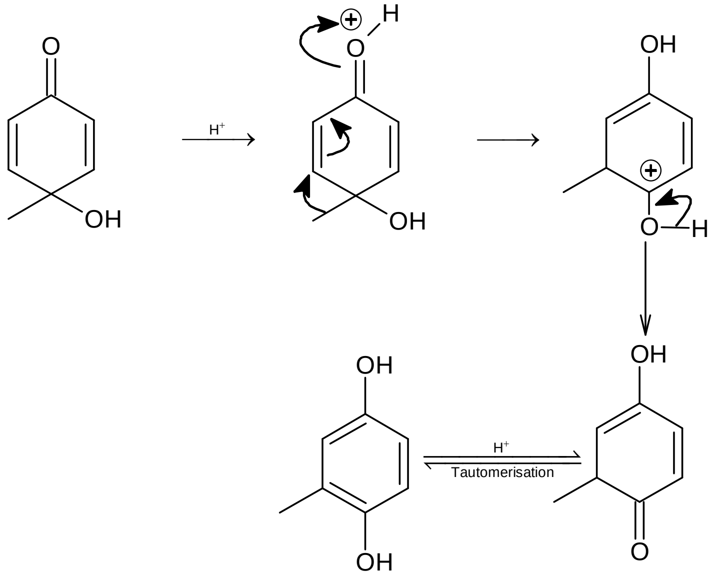
58. D

59. C

Sol. $SiO_2 + 4HF \longrightarrow SiF_4 + 2H_2O$

60. B

Sol.


O
OH
H⁺
H
O
OH
OH
O
H
OH
OH
OH
H⁺
Tautomerisation
OH
O

Mathematics

PART – III

SECTION – A

61. B

Sol. $M = \frac{10!}{4!(2!)^2}$; $N = \frac{6!}{(2!)^2} \times {}^7C_4$; $\frac{M}{N} = \frac{10!}{4!(2!)^2} \times \frac{(2!)^2\, 4! \times 3!}{6! \times 7!} = \frac{10 \times 9 \times 8}{5!} = 6$

62. B

Sol. Put $\tan^{-1}\left(x^2 + \frac{1}{x^2}\right) = t$

63. B

Sol. Circumcentre is point of intersection of perpendicular bisector of sides and perpendicular bisector an
$x + y + 7 = 0$
$x – 2y + 4 = 0$
Circumcentre is (–6, –1)

64. B

Sol. Let $x = \frac{1-u}{1+u}$

$$I = \int_0^1 \frac{\ln 2 - \ln(1+u)}{1+u^2}$$

$$2I = \ln 2\left[\tan^{-1} u\right]_0^1$$

$$I = \frac{\pi \ln 2}{8}$$

65. A

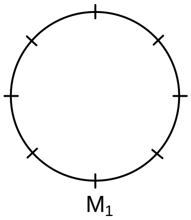
Sol. Vector perpendicular given lines $\begin{vmatrix} i & j & k \\ 1 & -1 & 1 \\ 0 & 1 & -3 \end{vmatrix}$

$$\hat{i}(3-1) - \hat{j}(-3) + \hat{k}(1-0) = 2\hat{i} + 3\hat{j} + \hat{k}$$

Required line is $\vec{r} = \left(\hat{i} + 2\hat{j} - k\right) + \lambda\left(2\hat{i} + 3\hat{j} + \hat{k}\right)$

66. A

Sol. Let m_1 and w_1 always sit together
Number of ways to sit 8 men on normal table = 7!
w_1 can be sited in 2 ways and rows 7 women can sited in 7! ways
Hence, Rearranged number = 7! × 2 × 7! = 2 × $(7!)^2$



67. B

Sol. As f(k – x) = f(k + x)
Hence, f(x) is symmetric about x = k
If $\alpha_1 = p – \lambda_1$ then $\alpha_2 = p + \lambda_2$

$\alpha_3 = p - \alpha_1$ then $\alpha_4 = p + \lambda_4$

$\vdots$

$\vdots$

$\alpha_1 + \alpha_2 + \alpha_3 + ... + \alpha_n = nk \ \forall \ n \in N$

68. A

Sol. For skew-symmetric matrix

$a_{ij} = -a_{ji}$

Only six positions are to be filled using {±4, ±3, ±2, ±1, 0}

Number of ways = 9^6

69. C

Sol. $-1 < g(x) < 1$

f(g(x)) is Bijective in $\forall \ x \in R$ and also f(g(x)) is differentiable

70. B

Sol. $\frac{3\cos 2x + \cos^3 2x}{\cos^6 x - \sin^6 x} = \frac{\cos^2 2x + 3}{1 - \frac{(\sin 2x)^2}{4}} = 4$

Now, $x^2 + 3 = 4$; $x = \pm 1$

71. C

Sol. $(1+\omega)^{100} = {}^{100}C_0 + {}^{100}C_1\omega + {}^{100}C_2\omega^2 + {}^{100}C_3\omega^3.....$

$$\left(-\omega^2\right)^{100} = \left({}^{100}C_1 + {}^{100}C_3 + ...\right) - \frac{1}{2}\left({}^{100}C_1 + {}^{100}C_2 + ...\right) + \frac{i\sqrt{3}}{2}\left({}^{100}C_1 - {}^{100}C_2 - .....\right)$$

$$\left|\left(-\omega^2\right)^{100}\right| = 1 = \left(a - \frac{b}{2}\right)^2 + \frac{3}{4}c^2$$

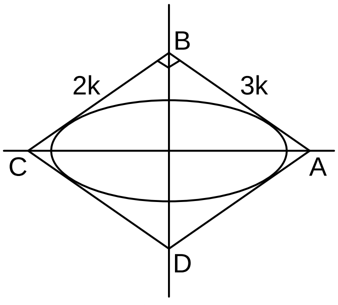
72. A

Sol. $\min\left[\left(x_1 - x_2\right)^2 + \left(7 + \sqrt{4 - \left(x_1 + 4\right)^2} - \sqrt{4x_2}\right)^2\right]$ = shortest distance between the curve

$(x + 4)^2 + (y - 7)^2 = 4$ and $y^2 = 4x$

73. B

Sol. Vertices of rectangle lies on director circle of $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$



Equation of director circle $x^2 + y^2 = a^2 + b^2$

$AC = 2\sqrt{a^2 + b^2}$

$AC^2 = AD^2 + CD^2 = AB^2 + BC^2$

$2\sqrt{a^2 + b^2} = \sqrt{(2k)^2 + (3k)^2}$

$\Rightarrow 4(a^2 + b^2) = 13k^2$; $k^2 = \frac{4\left(a^2 + b^2\right)}{13}$; Area of rectangle = 3k × 2k = $6k^2 = \frac{24\left(a^2 + b^2\right)}{13}$

74. C

Sol. $-(p \leftrightarrow q) \wedge p$

p	**q**	**$p \leftrightarrow q$**	**$-(p\leftrightarrow q)$**	**q**	**$p \wedge -q$**
T	T	T	F	F	F
T	F	F	T	T	T
F	T	F	T	F	F
F	F	T	F	F	F

75. C

Sol. $\Sigma x_i^2 = (\Sigma x_i)^2 - 2\Sigma x_i x_j = 300$; $\dfrac{\Sigma x_i^2}{10} = 30$

$$\sigma = \sqrt{\frac{\Sigma x_i^2}{10} - \left(\frac{\Sigma x_i}{10}\right)^2}\ ;\ \sigma = \sqrt{30 - 25} = \sqrt{5}$$

76. B

Sol. Center of hyperbola is (–1, –1) equation of pair of asymptotes is
$5x^2 + 23xy - 10y^2 + 33x + 3y + \lambda = 0$ where passing through (–1, –1)
$\therefore\ \lambda = 18$

77. B

Sol. $\vec a \cdot \vec b = \vec b \cdot \vec c = \vec c \cdot \vec a = 0$

$|\vec a| = |\vec b| = |\vec c| = 1$

$\vec a \times ((\vec x - \vec b) \times \vec a) = (\vec a \cdot \vec a)\vec x - (\vec a \cdot \vec a)\vec b - (\vec a \cdot \vec x)\vec a$

Similarly $\vec b \times ((\vec x - \vec c) \times \vec b) = (\vec b \cdot \vec b)\vec x - (\vec b \cdot \vec b)\vec c - (\vec b \cdot \vec x)\vec b$

$\vec c \times ((\vec x - \vec a) \times \vec c) = (\vec c \cdot \vec c)\vec x - (\vec c \cdot \vec c)\vec a - (\vec c \cdot \vec x)\vec c$

Now, $\vec a \times ((\vec x - \vec b) \times \vec a) + \vec b((\vec x - \vec b) \times \vec b) + \vec c \times ((\vec x - \vec c)\vec c) = 0$

$\Rightarrow\ 3\vec x - (\vec a + \vec b + \vec c) - ((\vec a \cdot \vec x)\vec a + (\vec b \cdot \vec x)\vec b + (\vec c \cdot \vec x)\vec c) = 0$ as $\vec a, \vec b, \vec c$ are non coplanar vector

$\therefore\ \vec x = x_1\vec a + x_2\vec b + x_3\vec c$

$\vec a \cdot \vec x = x_1;\ \vec b \cdot \vec x = x_2;\ \vec c \cdot \vec x = x_3$

$\vec x = (\vec a \cdot \vec x)\vec a + (\vec b \cdot \vec x)\vec b + (\vec c \cdot \vec x)\vec c$

$3\vec x - (\vec a + \vec b + \vec c) - \vec x = 0$

$$\vec x = \frac{\vec a + \vec b + \vec c}{2}$$

78. D

Sol. Normal vector is $\begin{vmatrix} i & j & k \\ 1 & -2 & 3 \\ 2 & -1 & -1 \end{vmatrix} = i(2+3) - j(-1-6) + k(-1+4)$ = 5i + 7j + 3k

Required plane is $(\vec r - \vec a) \cdot \vec n = 0$

$(\vec r - (i + 2j - 2k)) \cdot (5i + 7i + 3k) = 0$

$\Rightarrow$ 5x + 7y + 3z = 5 + 14 – 6; 5x + 7y + 3z = 13

Distance of plane form (1, 1, 3) is $\left|\dfrac{5+7+9-13}{\sqrt{5^2+7^2+3^2}}\right| = \dfrac{8}{\sqrt{83}}$

79. C

Sol. $\frac{2!\left({}^{8}C_{6}\right)}{8^{6}}$

80. B

Sol. Let S = $x^2 + y^2 + 2gx + 2fy + c = 0$
$S_1 : x^2 + y^2 - 9 = 0$
$S_2 : x^2 + y^2 - 2x + 4y + 2 = 0$
Common chord of S and S_1 passing through (0, 0)
Common chord of S and S_2 passing through (1, 2)
$S - S_1 = 0$
$2gx + 2fy + c = 9 = 0 \Rightarrow c = -9$
$S - S_2 = 0$
$2gx + 2x + 2fy + 4y + c - 2 = 0$
This line passing through (1, 2)
$(2g + 2) \times 1 + (2f + 4) \times 2 + (-9) - 2 = 0$
$2g + 2f + 10 - 11 = 0$
$2g + 2f - 1 = 0$
Locus of centre $2x + 2y - 1 = 0$

81. C

Sol. $\lim\limits_{x\to\infty}\left(\sqrt{x^2+x+2}-ax-b\right)=2$

a = 1; b = $\frac{-3}{2}$ required equation is $(x - 1)^2 + (y + 3)^2 = 1$

82. D

Sol. Any point on curve $x^2 + 4y^2 = 4$ is P(2 cos θ, sin θ)
$PA = \left|\frac{2\cos\theta+2\sin\theta+12}{\sqrt{5}}\right|$; PA is minimum if $\theta = \frac{5\pi}{4}$; $P\left(-\sqrt{2}, -\frac{1}{\sqrt{2}}\right)$

83. B

Sol. $\frac{dy}{dx} = 6x^2 + 6 = 12$; x = ± 1
Points on curve are (1, 13), (–1, –3)
Equation of line are x + 12y – 157 = 0; x + 12y + 37 = 0

84. C

Sol. $\frac{\left(1^3+1^3+2^3+(3!)^3.....\right)+\left(1^2+1^2+2^2+(3!)^2.....\right)+(1+1+2+6+24+120).....}{36}$

$\frac{k\times 36+26}{36}$

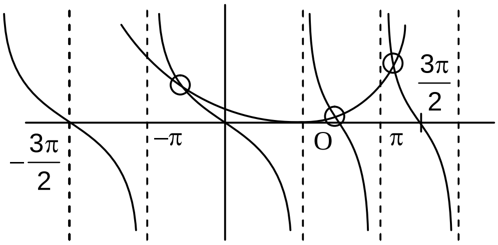
85. B

Sol. $I_1 = \int\limits_{-5}^{6}\frac{dx}{\left(6+2x-2x^2\right)\left(1+e^{3-6x}\right)}$; $I_1 = \int\limits_{-5}^{6}\frac{\left(e^{3-6x}\right)dx}{\left(6+2x-2x^2\right)\left(1+e^{3-6x}\right)}$ f(x) = f(a + b – x)

$2I_1 = I_2$; $\frac{I_1}{I_2} = \frac{1}{2}$

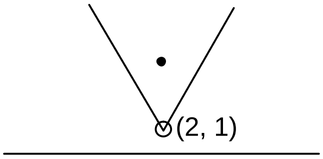
86. C

Sol. Shown in the figure



87. B

Sol. $f(2^-) < f(2)$
$f(2^+) < f(2)$



88. C

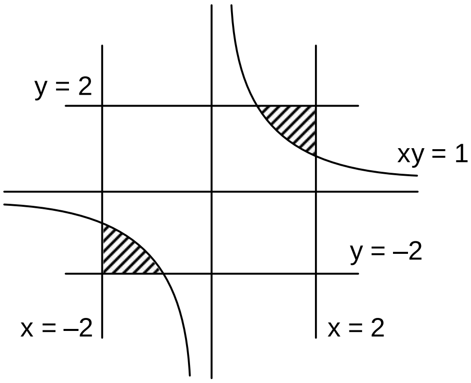
Sol. $\max(|x|, |y|) \le 2$
$\Rightarrow |x| \le 2$ and $|y| \le 2$
Required area is

$$2\int_{1/2}^{2}\left(2-\frac{1}{x}\right)dx = \left[2(2x-\ln x)\right]_{1/2}^{2}$$

$$(4 \times 2 - 2\ln 2) - \left(4\times\frac{1}{2} - 2\ln\left(\frac{1}{2}\right)\right)$$

$$8 - 2\ln 2 - 2 + 2(\ln 1 - \ln 2)$$

$$6 - 4\ln 2$$



89. C

Sol. $y = f(x)$

$f(x)\sin 2x + \sin x - (1 + \cos^2 x)f'(x) = 0$

$$\frac{dy}{dx} - y\frac{\sin 2x}{1+\cos^2 x} = \frac{\sin x}{1+\cos^2 x}$$

$$\text{I.f} = e^{-\int \frac{\sin 2x}{1+\cos^2 x}dx} = 1+\cos^2 x$$

$$y\left(1+\cos^2 x\right) = \int \frac{\sin x\left(1+\cos^2 x\right)}{1+\cos^2 x}dx = -\cos x + c$$

$$y = \frac{-\cos x + c}{1+\cos^2 x}$$

As $y(0) = 0$; $c = 1$

$$y = \frac{1-\cos x}{1+\cos^2 x}$$

90. D

Sol. f(x) is polynomial of define n, then f(f(x)) is polynomial of degree 2n and

$x\int_0^x f(t)dt$ is polynomial of degree n + 2

As $f(f(x)) = x\int_0^x f(t)dt$ ..... (1)

$2n = n + 2$
$n = 2$
f(x) is polynomial of degree 2
$f(x) = ax^2 + bx$ as $f(0) = 0$
Differential (1) w.r.t. x

$$f'\left(f\left(x\right)\right)\cdot f'\left(x\right)=\int_0^x f\left(t\right)dt + x f(x)$$

$f'(0) = 0$
Hence, $f(x) = ax^2$

Now, $f\left(f\left(x\right)\right)=x\int_0^x f\left(t\right)dt$

$$a\left(ax^2\right)^2 = x\int_0^x at^2dt = \frac{ax^4}{3}$$

$$a^3 = \frac{a}{3} \Rightarrow a = 0, \pm \frac{1}{\sqrt{3}}$$

$$f\left(x\right)=\frac{x^2}{\sqrt{3}}$$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – IV

JEE (Advanced)-2019

PAPER –1

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

Section-A (01– 07, 19 – 25, 37 - 43) *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 mark*** *for wrong answer*
Partial Marks **+1** for each correct option provided no incorrect options is selected.

Section-A (08 – 13, 26 – 31, 44 - 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S).*
Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

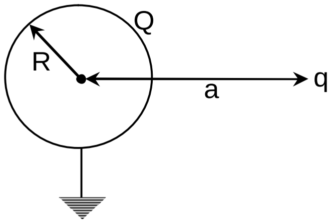
Section-C (14 – 18, 32 – 36, 50 - 54) *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A
(More Than One Correct Type)

This section contains **7 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

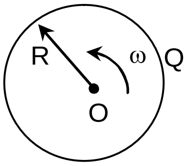


1. In the given figure radius of the conducting sphere is increasing according to the relation R = vt. A point charge q is fixed at distance ‘a’ from centre of conducting sphere. The current flowing in the earthen conductor at the instant when R < a is

(A) $\frac{qv}{a}$ away from sphere
(B) $\frac{qv}{a}$ towards the sphere
(C) due to the reason that potential of sphere is always zero
(D) due to the reason that field inside sphere is changing with time

2. A fixed point charge Q is at origin. At t = 0, a charge q with mass m is at x = a with leftward velocity v_0 which satisfies $\frac{kQq}{a} = 3mv_0^2$. The particle turns around and starts to move rightward at the position b < a.

(A) the ratio b/a is 6/7
(B) the ratio b/a is 3/7
(C) the velocity of the particle at a large distance from the origin is $\sqrt{7}v_0$
(D) the velocity of the particle at a large distance from the origin is zero

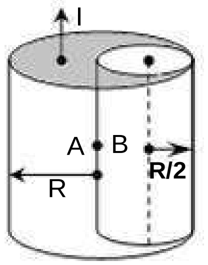


3. A non – conducting disc having uniform positive charge Q, is rotating about its axis with uniform angular velocity ω. The magnetic field at the center of the disc is.

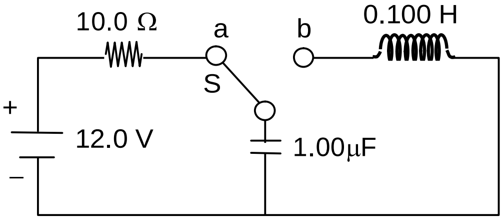
(A) directed outward
(B) having magnitude $\frac{\mu_0 Q\omega}{4\pi R}$
(C) directed inward
(D) having magnitude $\frac{\mu_0 Q\omega}{2\pi R}$

Space for Rough work

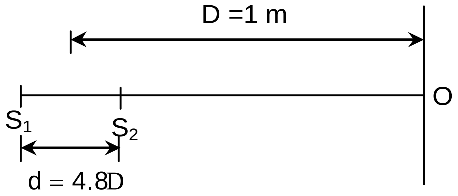
4. From a cylinder of radius R, a cylinder of radius R/2 is removed, as shown. Current flowing in the remaining cylinder is I. Magnetic field strength is
(A) zero at point A
(B) zero at point B
(C) $\frac{\mu_0 I}{3\pi R}$ at point A
(D) $\frac{\mu_0 I}{3\pi R}$ at point B



5. The switch in figure is connected to position a for a long time interval. At t = 0 the switch is thrown to position b. After this time
(A) the frequency of oscillation of the LC circuit is 200 Hz
(B) the maximum charge that appears on the capacitor is 12 μC
(C) the maximum current in the inductor is 38 mA (approx.)
(D) the total energy the circuit possesses at t = 3.00 s is 72 μJ

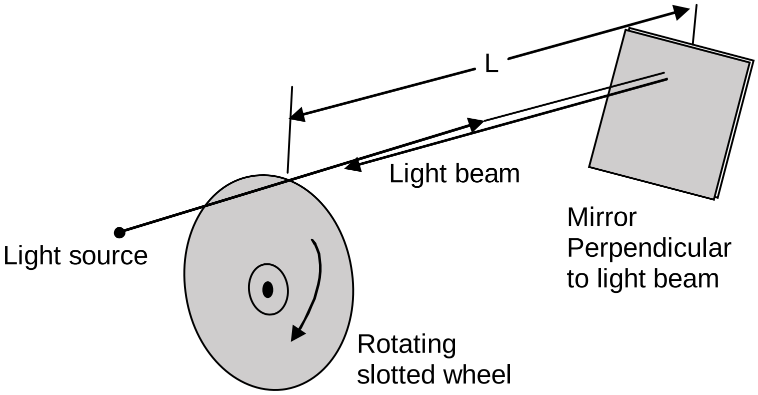


6. Two point coherent source of light of wavelength D, each placed as shown in the figure. The initial phase difference between the sources is zero (D>>d).
(A) The shape of fringes on screen is circular
(B) First minima on screen is at distance from point O is 10 cm
(C) Total minima on screen is 10
(D) Point O is a point of neither minima nor maxima



Space for Rough work

7. Figure shows an early method of measuring the speed of light that makes use of a rotating slotted wheel which rotates with constant angular velocity. A beam of light passes through one of the slots at the outside edge of the wheel, travels to a distant mirror, and returns to the wheel just in time to pass through the next slot in the wheel. One such slotted wheel has a radius of 5.0 cm and 500 slots around its edge. Measurements taken when the mirror is $L = 500\text{ m}$ from the wheel indicate a speed of light of $3.0 \times 10^5\text{ Km/s}$. Which of the following statements are true regarding this experiment?



(A) The angular speed of the wheel should be $1200\pi\text{rad/s}$
(B) The angular speed of the wheel should be $1800\pi\text{rad/s}$
(C) The linear speed of a point on the edge of the wheel should be $30\pi\text{rad/s}$
(D) The linear speed of a point on the edge of the wheel should be $60\pi\text{rad/s}$

Space for Rough work

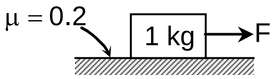
(Matching Type)

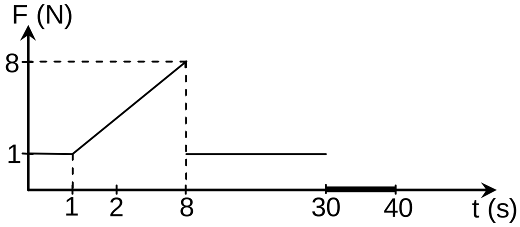
(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

A block of mass 1 kg is placed on a rough horizontal surface of coefficient of friction $\mu = 0.2$. A force is applied on the block horizontally whose variation with time is shown in the figure.





Column –I		Column –II		Column –III	
(I)	Velocity of particle	(i)	t = 1 sec	(P)	Non zero
(II)	Acceleration of particle	(ii)	t = 4 sec	(Q)	Zero
(III)	Friction force	(iii)	t = 35 sec	(R)	Greater than 1 N
(IV)	Friction force	(iv)	t = 1.5 sec	(S)	1 N

8. If we consider the velocity of the block,
   (A) (I) – (i) – (Q) (B) (I) – (ii) – (Q)
   (C) (I) – (iii) – (P) (D) (I) – (ii) – (P)

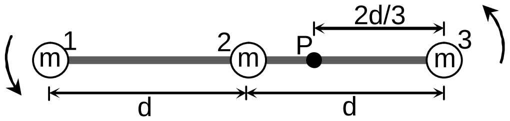
9. If we consider the acceleration of the block,
   (A) (II) – (i) – (P) (B) (II) – (ii) – (P)
   (C) (II) – (iv) – (P) (D) (II) – (iv) – (Q)

10. If we consider the friction force acting on the block,
   (A) (III) – (ii) – (R) (B) (III) – (i) – (R)
   (C) (III) – (i) – (S) (D) (III) – (iv) – (S)

Space for Rough work

Answer 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

A rigid, massless rod has three particles with equal masses attached to it as shown in figure. The rod is free to rotate in a vertical plane about a frictionless axle perpendicular to the rod through the point P and is released from rest in the horizontal position at t = 0. Assume m = 1 kg and d = 1 m.



Column –I		Column –II		Column –III	
(I)	The angular acceleration of the system (in rad/s^2)	(i)	10	(P)	Maximum
(II)	The kinetic energy of the system (in joules)	(ii)	$2\sqrt{\frac{5}{21}}$	(Q)	At t = 0
(III)	The angular momentum of the system (in kgm^2/s)	(iii)	$\frac{30}{7}$	(R)	Minimum
(IV)	The speed reached by the particle labelled 2 (in m/s)	(iv)	$2\sqrt{\frac{35}{3}}$	(S)	Zero

11. Angular acceleration of the system
(A) (I) – (ii) – (Q) (B) (I) – (i) – (Q)
(C) (I) – (iv) – (Q) (D) (I) – (iii) – (Q)

12. Kinetic energy of the system
(A) (II) – (ii) – (R) (B) (II) – (i) – (P)
(C) (II) – (iii) – (S) (D) (II) – (iv) – (P)

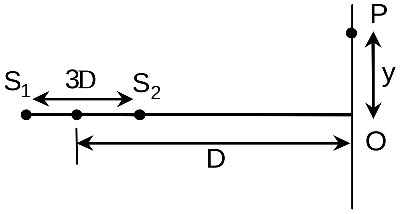
13. Angular momentum of the system
(A) (III) – (iv) – (P) (B) (III) – (ii) – (R)
(C) (III) – (i) – (R) (D) (III) – (iii) – (P)

Space for Rough work

SECTION – C
(Single digit integer type)

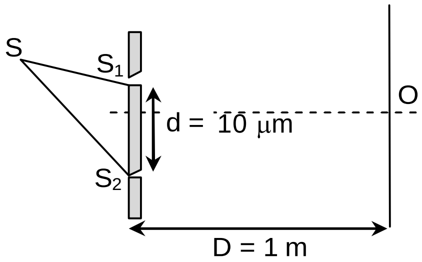
This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

14. Figure shows two coherent microwave source S_1 and S_2 emitting waves of wavelength D and separated by a distance $3D$. For $D << D$ and $y \neq 0$, the minimum value of y for point P to be an intensity maximum is $\frac{\sqrt{m}\ D}{n}$. Determine the value of $m+n$, if m and n are coprime numbers.



15. In a Young's double slit experiment, the two slits are illuminated by a monochromatic light source S of wavelength 400 nm.

If $SS_1 = 10\ \mu m$ and SS_2 is 50 μm, find the number of maxima formed on screen.



16. A hydrogen-like atom of atomic number Z is in an excited state of quantum number 2n. It can emit a maximum energy photon of 204 eV. If the makes a transition to quantum state n, a photon of energy 40.8 eV is emitted. Find the value of n.

17. Find the ratio between total acceleration of the electron in singly ionized helium atom and hydrogen atom (both in ground state).

18. Nuclei of radioactive element A are produced at rate 't^2' at any time t. The element A has decay constant D. Let N be the number of nuclei of element A at any time t. At time $t = t_0, \frac{dN}{dt}$, is minimum. Then the number of nuclei of element A at time t = t_0 is found to be $\frac{Nt_0 - D\,t_0^2}{D^2}$. Find the value of N.

Space for Rough work

Chemistry PART – II

SECTION – A
(More Than One Correct Type)

This section contains **7 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

19. Which of the following is/are ore of Cu?
(A) Chalcopyrites (B) Chalcocite
(C) Cuprite (D) Bornite

20. Which of the following is/are true statement(s)?
(A) $BCl_3 > AlCl_3 > InCl_3$ (lewis acidic strength) (B) $BF_3 < BCl_3 < BBr_3$ (Lewis acidic strength)
(C) $NH_3 < PH_3 < AsH_3$ (Reducing power) (D) $(C_2H_5)_2O > NH_3 > H_2O > PH_3$ (Bond angle)

21. Which of the following on reaction with water will produce polyprotic acid?
(A) B_2O_3 (B) N_2O_5
(C) P_4O_{10} (D) Maleic anhydride

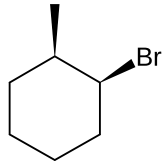
22. Which of the following reactions is/are exothermic?
(A) $SO_2 + O_2 \longrightarrow SO_3$ (B) $H_2S_2O_7 + H_2O \longrightarrow 2H_2SO_4$
(C) $CO + \frac{1}{2}O_2 \longrightarrow CO_2$ (D) $B_2H_6 + O_2 \longrightarrow B_2O_3 + H_2O$

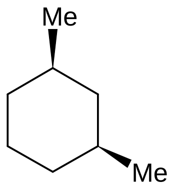
23. Xanthoproteic test is given by
(A) Tyrosine (B) Tryptophan
(C) Phenylalanine (D) Glycine

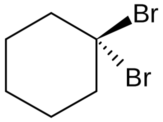
24. Lassaigne's Test for the detection of nitrogen will not fail in the case of:
(A) NH_2CONH_2 (B) $NH_2CONHNH_2$. HCl
(C) NH_2NH_2. HCl (D) $PhNHNH_2$. 2 HCl

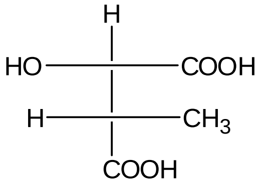
Space for Rough work

25. Which of the following can have meso form?

(A)


(B)


(C)


(D)


(Matching Type)

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer 26, 27 and 28 by appropriately matching the information given in the three columns of the following table.

Column –I		**Column –II**		**Column –III**	
(I)	Dil. NaCl solution	(i)	After electrolysis solution becomes alkaline	(P)	One of the product is Cl_2 during electrolysis
(II)	Aq. $CuSO_4$ solution	(ii)	After electoolysis solution becomes acidic	(Q)	One of the product is H_2 during electrolysis
(III)	Pure water	(iii)	No effect on pH of solution due to electrolysis	(R)	H_2 and O_2 are the product of electrolysis
(IV)	Aq. $AgNO_3$	(iv)	Solution is acidic before electrolysis	(S)	Metal deposition at cathode and O_2 evolved at anode during electrolysis.

26. Which of the following option is correct?

(A) (IV) – (ii) – (S)
(B) (IV) – (iii) – (R)
(C) (I) – (ii) – (R)
(D) (II) – (i) – (S)

Space for Rough work

27. Which of the following option is correct?
(A) (II) – (iv) – (R)
(B) (I) – (ii) – (R)
(C) (I) – (i) – (P)
(D) (IV) – (iv) – (P)

28. Which of the following option is correct?
(A) (III) – (iii) – (R)
(B) (IV) – (i) – (P)
(C) (I) – (ii) – (R)
(D) (II) – (iv) – (S)

Answer 29, 30 and 31 by appropriately matching the information given in the three columns of the following table.

Column –I		**Column –II**		**Column –III**	
(I)	Boron $+H_2O \xrightarrow{25^o C}$ 'X'	(i)	No reaction	(P)	Boron
(II)	$B_2H_6 + H_2O \xrightarrow{100^o C} y$	(ii)	Vigorous reaction	(Q)	B_2O_3 is the product
(III)	$I_4O_9 + H_2O \longrightarrow P + Q$	(iii)	Acid/s are the product	(R)	'P' or 'Q' + ethylene glycol → formaldehyde
(IV)	$Cl_2O_7 + H_2O \longrightarrow R$	(iv)	Base/s are the product	(S)	R + Benzaldehyde → benzoic acid

29. Which of the following option is correct?
(A) (I) – (ii) – (P)
(B) (II) – (ii) – (Q)
(C) (III) – (iii) – (R)
(D) (IV) – (iii) – (S)

30. Which of the following option is correct?
(A) (I) – (i) – (P)
(B) (II) – (ii) – (R)
(C) (III) – (iii) – (P)
(D) (III) – (iv) – (Q)

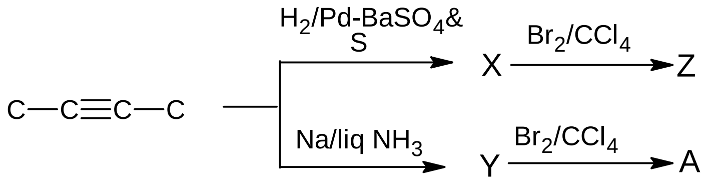
31. Which of the following option is correct?
(A) (III) – (iii) – (R)
(B) (II) – (iv) – (P)
(C) (I) – (i) – (P)
(D) (I) – (ii) – (Q)

Space for Rough work

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

32. Calculate Z + A.



33. For the reaction $2NO + H_2 \rightarrow N_2O + H_2O$ at 900 K, following data are observed.

Initial Pressure of NO	Initial pressure of H_2	Rate
0.15	0.40	0.02
0.075	0.40	0.005
0.150	0.02	0.10

The order of reaction is

34. The pyrolysis of an ester follows a first order process and its rate constant can be expressed as $In\,k = 78.09 - \frac{42075}{T}$. where k is given in the min^{-1}. The time required for 25% reaction to complete at 227^0 C will be _____ hr.

35. From the given compounds number of compounds that will give positive carbylamine test will be____.
N, N dimethyl Aniline
2, 4 Dimethyl Aniline
N- methyl – o – methyl Aniline
O – methyl benzyl Aniline

36. Number of ambident nucleophlie from the following are______
—ONO , —OCH_3 , —CN, —CNO.

Space for Rough work

Mathematics PART – III

SECTION – A
(More Than One Correct Type)

This section contains **7 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

37. $\lim\limits_{n\to\infty}\sum\limits_{K=0}^{K=n}\frac{{}^{n}C_k}{n^K\left(K+3\right)}=a+be$ Where $a,b\in I$ and "e". Natural base lies between 2 & 3. Then, correct option is

(A) $|a|+|b|=a^{|a|}+1$
(B) $|a+b|=1$
(C) $|a|+|b|=3$
(D) $|a-b|=|b|^a+|a|$

38. If $f\left(x\right)=x^2e^{-x}+\int\limits_0^x e^{-\pm}f\left(x-t\right)dt$ and $g\left(x\right)=\left(\frac{2-f\left(x\right)}{2}\right)$ then

(A) $\frac{2-f\left(\ln 5\right)}{1+\ln 5}=2/5$
(B) $\frac{2-f\left(\ln 5\right)}{1+\ln 5}=5/2$
(C) $g\left(x\right)\le 1$
(D) $g\left(x\right)\ge -1$

39. If $f\left(x\right)=\frac{1+x^2}{1+x}$ for $x\ge 0$ the least value of f(x) is β at x = α, then

(A) $\beta=2\alpha$
(B) $\beta=2\alpha+1$
(C) $\alpha^2+\beta=1$
(D) $\left|\alpha^2-\beta\right|=1$

40. If $5x\left(1+\frac{1}{x^2+y^2}\right)=12$ and $5y\left(1-\frac{1}{x^2+y^2}\right)=4\ \ \forall x,y\in R$, then correct option is/are

(A) $\left|x\right|+\left|y\right|=3$
(B) $x+y=\frac{1}{5}$
(C) $\left|x\right|+\left|y\right|=\frac{3}{5}$
(D) $x^2+y^2=5$

Space for Rough work

41. If $f(x) = \dfrac{\cos^{-1}\left(1-\{x\}\right).\sin^{-1}\left(1-\{x\}\right)}{\sqrt{2\{x\}}.\left(1-\{x\}\right)}$ here {.} denotes fractional part of x then;

(A) $\underset{x\to 0^+}{\text{Lt}} f(x) = \sqrt{2} \underset{x\to 0^-}{\text{Lt}} f(x)$

(B) $\underset{x\to 0^-}{\text{Lt}} f(x) = \sqrt{2} \underset{x\to 0^+}{\text{Lt}} f(x)$

(C) $\underset{x\to 0^-}{\text{Lt}} f(x) = \dfrac{\pi}{2\sqrt{2}}$

(D) $\underset{x\to 0^-}{\text{Lt}} f(x) = \pi\sqrt{2}$

42. If $\int_a^b |\sin x| dx = 8$ & $\int_0^{a+b} |\cos x| dx = 9$ then;

(A) $a + b = 9\pi$

(B) $b - a = 4\pi$

(C) $\int_a^b x \sin x dx = 2\sqrt{2}\pi$

(D) $\int_a^b x \sin x dx = -2\sqrt{2}\pi$

43. If $\Delta(x) = \begin{vmatrix} \cos x + 1 & \cos^2 x & 1+\sin^2 x \\ -\sin x & -\sin 2x & \sin 2x \\ \sin x & 2^2 \sin 2x & -2^2 \cos 2x \end{vmatrix}$, then

(A) $\int_0^{\pi/2} \Delta(x) dx = 4$

(B) $\int_0^{\pi/2} \Delta(x) dx = -4$

(C) $\int_{\pi/2}^{\pi} \Delta(x) dx = 4$

(D) $\int_{\pi/2}^{\pi} \Delta(x) dx = -4$

Space for Rough work

(Matching Type)

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer 44, 45 and 46 by appropriately matching the information given in the three columns of the following table.

Consider four distinct positive real numbers a, b, c and d.

Column –I		**Column –II**		**Column –III**	
(I)	a, b, c, d are in A.P.	(i)	$ab + cd > 2bc$	(P)	$ac < bd$
(II)	a, b, c, d are in G.P.	(ii)	$bc > ad$	(Q)	$ab + cd > 2ad$
(III)	ab, bc, cd are in G.P.	(iii)	$ab + bc < ad$	(R)	$ab + bc + cd > 3ad$
(IV)	ab, bc, cd are in H.P.	(iv)	$a + d > b + c$	(S)	$a + c < b + d$

44. Which of the following options is correct?
(A) (I) – (iii) – (Q)
(B) (I) – (ii) – (R)
(C) (IV) – (iii) – (P)
(D) (III) – (ii) – (R)

45. Which of the following options is correct?
(A) (II) – (iv) – (R)
(B) (I) – (iii) – (P)
(C) (III) – (ii) – (R)
(D) (IV) – (iii) – (Q)

46. Which of the following options is correct?
(A) (I) – (ii) – (S)
(B) (II) – (iv) – (P)
(C) (III) – (i) – (Q)
(D) (III) – (ii) – (R)

Space for Rough work

Answer 47, 48 and 49 by appropriately matching the information given in the three columns of the following table.

Column –I		**Column –II**		**Column –III**	
(I)	If $\lim\limits_{x\to\infty}\left(\frac{x^2+1}{x+1}-ax-b\right)=0$, then	(i)	$a = 2$	(P)	$b \in R$
(II)	$\lim\limits_{x\to 0}\left(1+ax+bx^2\right)^{\frac{2}{x}}=e^3$, then	(ii)	$a=\frac{3}{2}$	(Q)	$b = 2$
(III)	$\lim\limits_{x\to 0}\left(\frac{ae^x-b}{x}\right)=2$	(iii)	$a = 1$	(R)	$b = -1$
(IV)	$\lim\limits_{x\to -\infty}\left\{\sqrt{\left(x^2-x+1\right)}-ax-b\right\}=0$	(iv)	$a = -1$	(S)	$b = \frac{1}{2}$

47. Which of the following is correct?
(A) (I) – (ii) – (R)
(B) (I) – (iii) – (R)
(C) (I) – (iii) – (S)
(D) (I) – (iv) – (P)

48. Which of the following is correct?
(A) (II) – (ii) – (P)
(B) (II) – (ii) – (R)
(C) (II) – (iii) – (Q)
(D) (II) – (iv) – (S)

49. Which of the following is correct?
(A) (III) – (ii) – (R)
(B) (III) – (iv) – (R)
(C) (III) – (i) – (Q)
(D) (III) – (ii) – (S)

Space for Rough work

SECTION – C

(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

50. If $x+y=3$ is tangent at (2, 1) on hyperbola, intersects asymptotes at A and B such that $AB=8\sqrt{2}$. If centre of hyperbola is (–1, –1), then least possible value of sum of semi-transverse axis and semi-conjugate axis is $p\sqrt{q}$, where HCF (p, q) = 1 and $\sqrt{q}$ is irrational number. Then, $(p+q)$ is equal to

51. If θ is acute angle of intersect between two curves $x^2+5y^2=6$ and $y^2=x$, then $\cot\theta$ is equal to

52. If 8 harmonic means are inserted between two numbers a and b (a < b) such that arithmetic mean of a and b is $\frac{5}{4}$ times equal to geometric mean of a and b, then $\left(\frac{H_8-a}{b-H_8}\right)$ is equal to

53. If y = 2 is directrix and (0, 1) be the vertex of parabola $x^2+\lambda y+\mu=0$ then; $(\lambda-\mu)=?$

54. The minimum number of real roots of $\left(x^2+3x+a\right)\left(x^2+ax+1\right)=0$ equals

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – IV

JEE (Advanced)-2019

PAPER –1

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. A, C

Sol. Potential of sphere

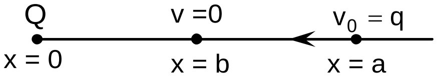
$$= \frac{kQ}{R} + \frac{kq}{a} = 0 \Rightarrow Q = \frac{q}{a}R$$

Current flowing to the sphere $I = \frac{dQ}{dt} = \frac{-q}{a}\frac{dR}{dt} = -\frac{qv}{a}$

So current flowing away from sphere $= -I = \frac{qv}{a}$

2. A, C

Sol.



Applying conservation of energy:

$$\frac{1}{2}mv_0^2 + \frac{kQq}{a} = \frac{kQq}{b}$$

solve to get $\frac{b}{a} = \frac{6}{7}$

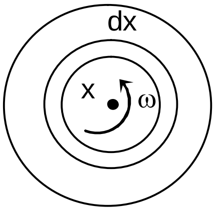
Again apply conservation of energy between x = a and $x = \infty$.

$$\frac{1}{2}mv_0^2 + \frac{kQq}{a} = \frac{1}{2}mv^2$$

Solve to get $v = \sqrt{7}v_0$

3. A, D

Sol. Consider a ring of radius x and thickness dx.



Equivalent current in this ring $= \frac{\omega}{2\pi}\times \text{charge on ring}$

$$= \frac{\omega}{2\pi}\times\left(2\pi\times dx\right)\frac{Q}{\pi R^2}$$

dB (due to this ring) $= \frac{\mu_0}{2x}\left(\frac{\omega}{2\pi}\frac{2xQ}{R^2}dx\right)$

$$\therefore B = \int_0^R \frac{\mu_0\omega}{2\pi}\frac{Q}{R^2}dx. = \frac{\mu_0\omega Q}{2\pi R^2}.R = \frac{\mu_0\omega Q}{2\pi R}$$

4. C, D

Sol. For cylinder;

$$B = \frac{\mu_0 ir}{2\pi R^2}; r < a$$

$$= \frac{\mu_0 i}{2\pi r}; r \ge a$$

We can consider the given cylinder as a combination to two cylinders. One of radius R carrying current I in one direction and other of radius R/2 carrying I/3 in both directions.

At point A:

$$B = \frac{\mu_0\left(I/3\right)}{2\pi\left(R/2\right)} + 0\frac{\mu_0 I}{3\pi R}$$

At point B:

$$B = \frac{\mu_0}{2}\left(\frac{4I/3}{\pi R^2}\right)\left(\frac{R}{2}\right) + 0 = \frac{\mu_0 I}{3\pi R}$$

5. B, C, D

Sol. (A) The frequency of oscillation of the circuit is $f = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{\sqrt{\left(0.100\text{ H}\right)\left(1.00\times10^{-6}\text{F}\right)}} = 503\text{ Hz}$

(B) The maximum charge on the capacitor is $Q = C\varepsilon = \left(1.00\times10^{-6}\text{F}\right)\left(12.0\text{ V}\right) = 12.0\ \mu\text{C}$

To find the maximum current I, we equate $\frac{1}{2}C\varepsilon^2 = \frac{1}{2}LI^2$,

Then solve for I, to obtain

$$I_i = \varepsilon\sqrt{\frac{C}{L}} = 12.0\text{ C}\sqrt{\frac{1.00\times10^{-6}\text{F}}{0.100\text{H}}} = 37.9\text{ mA}$$

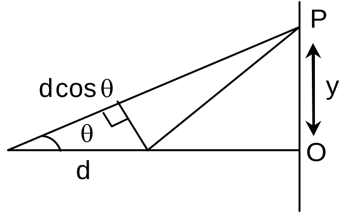
(D) The total energy the circuit possesses at t = 3.00 s and at all

$$U = \frac{1}{2}C\varepsilon^2 = \frac{1}{2}\left(1.00\times10^{-6}\text{F}\right)\left(12.0\text{ V}\right)^2 = 72.0\mu\text{J}$$

6. A, B, C, D

Sol. (A) The line joining point source S_1 and S_2 is perpendicular to screen. Hence, shape of fringe is circular.

(B) The path difference at point P is



$\Delta x = d\cos\theta$

For the minima. $\Delta x = \frac{D}{2}$

$\therefore d\cos\theta = \frac{D}{2}$ or $\cos\theta = \frac{D}{2d}$

or $\frac{y}{\sqrt{D^2+y^2}} = \frac{D}{2d}$ or $\frac{y^2}{D^2+y^2} = \frac{D^2}{4d^2} = \frac{1}{4\times 4.8^2}$

or $92.16y^3 = 1 + y^2$ or $91.16y^2 = 1$

$\therefore y = 0.1\text{ m} = 10\text{ cm}$

(C) $\Delta x = d\cos\theta = (2m-1)\frac{D}{2}$ $\therefore m = -4,-3,-2,-1,0,1,2,3,4,5$

Thus total number of minima is 10.

(D) The path difference at point O is $\Delta x = d = 4.8D$. Hence, it is neither a point of maxima nor a point of minima.

7. A, D

Sol. In the time light takes to go from the wheel to the mirror and back again, the wheel turns through an angle of

$$\theta = \frac{2\pi}{500} = \frac{\pi}{250}\text{ rad}$$

That time is $t = \frac{2l}{C} = \frac{2(500m)}{3\times10^8\text{ m/s}} = \frac{10}{3}\times10^{-6}\text{ s} = \frac{10}{3}\mu\text{s}$

So the angular velocity of the wheel is

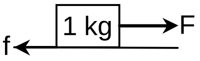
$$\omega = \frac{\theta}{t} = \frac{\frac{\pi}{250}\text{ rad}}{(10/3)\times10^{-6}\text{ s}} = 1200\pi\text{ rad/s}$$

If r is the radius of the wheel, the linear speed of a point on its rim is

$$v = \omega r = (1200\pi\text{ rad/s})\,(0.050\text{ m}) = 60\pi\text{ m/s}.$$

8. A

Sol.



$F = f_{max}$ at equilibrium

$= \mu N = \mu mg$

9. B

Sol. $F - f = MA$

$A = \frac{F-f}{M}$

10. C

11. D

Sol. $\tau = I\alpha \Rightarrow \alpha = \frac{\tau}{I}$

I = moment of inertia

12. B

Sol. $K_{system} = K_1 + K_2 + K_3$

When $V_{max} \Rightarrow KE_{max}$

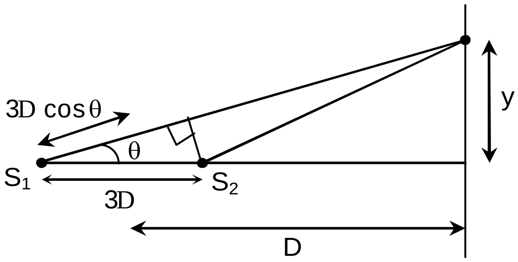
13. A

Sol. Angular momentum $= I\omega$

SECTION – C

14. 7

Sol.



Path difference = $3D\cos\theta = 2D \Rightarrow \cos\theta = 2/3$

$y = D\tan\theta = \frac{D\sqrt{5}}{2} \Rightarrow m + n = 5 + 2 = 7$

15. 5

Sol. Here, $\Delta x = d\sin\theta - (SS_2 - SS_1)$

$= d\sin\theta - 40\ \mu m = m\lambda$

or d $\sin\theta = m\lambda + 40\ \mu m$

$\because -1 < \sin\theta < 1$

or $-1 < \frac{m \times 100 \times 10^{-9}}{10 \times 10^{-6}} + 40 \times 10^{-6} < 1$

or $-2500 < 1000m + 1 < 2500$

or $-2.5 < m < 2.5$

or $\therefore m = -2, -1, 0, 1, 2$

16. 2

Sol. Let ground state energy (in eV) be E_1

Then from the given condition

$E_{2n} - E_1 = 204$ eV or $\frac{E_1}{4n^2} - E_1 = 204$ eV

$\Rightarrow E_1\left(\frac{1}{4n^2} - 1\right) = 204$ eV ....(i)

and $E_{2n} - E_n = 40.8$ eV

$\Rightarrow \frac{E_1}{4n^2} - \frac{E_1}{n^2} = E_1\left(-\frac{3}{4n^2}\right) = 40.8$ eV ....(ii)

From euqation (i) and (ii), $\dfrac{1-\dfrac{1}{4n^2}}{\dfrac{3}{4n^2}} = 5 \Rightarrow n = 2$

17. 8

Sol. Acceleration $a \propto \dfrac{v^2}{r}$

where $v \propto \dfrac{Z}{n}$ and $r \propto \dfrac{n^2}{Z} \Rightarrow a \propto \dfrac{Z^3}{n^4}$

Since both are in ground state i.e., n = 1

so $a \propto Z^3 \Rightarrow \dfrac{a_{He^+}}{a_H} = \left(\dfrac{Z_{He^+}}{Z_H}\right)^3 = \left(\dfrac{2}{1}\right)^3 = \dfrac{8}{1}$

18. 2

Sol. $\dfrac{dN}{dt} = t^2 - \lambda N$

For $\dfrac{dN}{dt}$ to be minimum; $\dfrac{d^2N}{dt^2} = 0$

$\Rightarrow \dfrac{d^2N}{dt^2} = 2t - \lambda\dfrac{dN}{dt} = 2t - \lambda\left(t^2 - \lambda N\right) = 0$

or $N = \dfrac{2t_0 - \lambda t_0^2}{\lambda^2}$

Chemistry PART – II

SECTION – A

19. A, B, C, D
Sol. a is $CuFeS_2$, b is Cu_2S, c is Cu_2O, d is Cu_3FeS_3

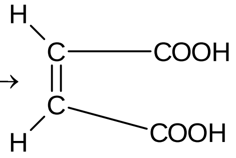
20. A, B, C, D
Sol. (a) In BCl_3. 2P orbital of B will overlap with lone pair of Lewis base while in $AlCl_3$ it is 3 P orbital of Al.
(b) back bonding is reason
(c) bond strength decreases so reducing power increases
(d) bond angle in PH_2 : 93.5^o
Bond angle in NH_3 : 107^o
Bond angle in H_2O : 104.5^o
Bond angle in $(C_2H_5)_2$ O is greater than $109^o.28$

21. C, D
Sol. $B_2O_3 + H_2O \longrightarrow H_3BO_3$

$N_2O_5 + H_2O \longrightarrow HNO_3$

$P_4O_{10} + H_2O \longrightarrow H_3PO_4$

Maleic anhydride + $H_2O \longrightarrow$



Maleic acids

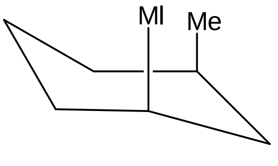
H_3PO_4 & maleic acid are polyprotic acids.

22. A, B, C, D
Sol. All are exothermic reactions.

23. A, B, C
Sol. Xanthoproteic test is given by such amino acids which contains aromatic groups that derivatives of benzene.

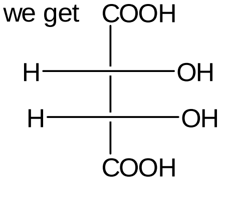
24. A, B, C

25. B, D
Sol. (B)



2 chiral carbon but has POS

(D) Do even no of exchanges at top chiral carbon we get has POS with 2 chiral carbons.



26. A
27. C
28. A

29. D
Sol. P → no reaction y ⇒ H_3PO_3
P + Q ⇒ HIO_2 and HIO_3
R ⇒ $HClO_4$
Reaction q is vigorous

30. A
31. A

SECTION – C

32. 3
Sol. (Z+A) =
X = Cis – But – 2 ene
Y = Trans But – 2 ene
Z = Racemic mixture
A = Meso compound

33. 3
Sol. Let the rate law es Rate = $k\left[P_{NO_2}\right]^x\left[P_{H_2}\right]^y$ By putting the different values and soling
And soling we will get

$$Rate = k\left[P_{NO_2}\right]^2\left[\mathrm{P}_{H_2}\right]^1$$

Order = 2 + 1 = 3

34. 2
Sol. $In\ k = 78.09 - \frac{42075}{500} = -6.06$

$\log k = 2.344\times10^{-3}\ \text{min}^{-1}$

$t_{1/4} = \frac{2.303}{2.344\times10^{-3}}\ by 1.333$

$= 123.06\ \text{min} = 2\ hrc$

35. 2
Sol. Only primary amine will give carbylamines test.

36. 3
Sol. $-OCH_3$ is not ambident nucleophlice

Mathematics

PART – III

SECTION – A

37. B, C, D

Sol. $\because \lim\limits_{n\to\infty}\sum\limits_{K=0}^{k=n}\frac{{}^{n}C_{K}}{n^{K}\left(K+3\right)}=\int\limits_{0}^{1}\underset{I}{x^{2}}\,\underset{II}{e^{x}}\,d_{k}$

$=x^{2}e^{x}\left.\right|_{0}^{1}-\int\limits_{0}^{1}\underset{I}{2x}.\underset{II}{e^{x}}\,dx$

$=e-2\left[xe^{x}\right]_{0}^{1}-\int\limits_{0}^{1}e^{x}dx$

$=e-2\left(e-\left(e-1\right)\right)=e-2 \quad \therefore \begin{cases}a= & -2\\ b= & 1\end{cases}$

38. A, C

Sol. $\because f'\left(x\right)=2xe^{-x}$

$\Rightarrow f\left(x\right)=-2e^{-x}\left(x+1\right)+c$

$f\left(0\right)=-2+c\Rightarrow c=2$

$f\left(x\right)=2-2.e^{-x}\left(x+1\right)$

$e^{x}f\left(x\right)=2e^{x}-2x-2$

$\Rightarrow e^{x}\left(f\left(x\right)-2\right)=-2\left(x+1\right)$

$\Rightarrow\left(2-f\left(x\right)\right)e^{x}=2\left(1+x\right)$

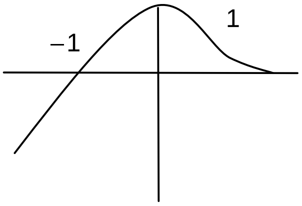
$x=\ln 5$

$\Rightarrow\left(2-f\left(\ln 5\right)\right)5=2x\left(1+\ln 5\right)$

$g\left(x\right)=\left(1+x\right)e^{-x}$

$g'\left(x\right)\left(1+x\right)\left(-e^{-x}\right)+1\times\left(e^{-x}\right)$

$=e^{-x}\left(1-\times-x\right)=-xe^{-x}$



39. A, C

Sol. $\because \alpha=\sqrt{2}-1=\alpha^{2}=3-2\sqrt{2}$

$\&\ \beta=2\sqrt{2}-2 \quad \therefore \alpha^{2}+\beta=1$

$\beta=2\alpha$

40. A, B, C, D

Sol. $x=\frac{12}{15}\times\frac{1}{\left(1+\frac{1}{x^{2}+y^{2}}\right)}$ ………. (i)

and $y=\frac{4}{5}\times\left(\frac{1}{1-\frac{1}{x^{2}+y^{2}}}\right)$ ……. (ii)

Put $x^2 + y^2 = \frac{1}{u}$ and add (i)^2 and (ii)^2

$$\Rightarrow \frac{1}{u} = \left(\frac{4}{5}\right)^2 \left(\frac{9}{(1+4)^2} + \frac{1}{(1-4)^2}\right)$$

$$\Rightarrow 25\left(u^2 - 2 + \frac{1}{u^2}\right) = 32\left\{5\left(4 + \frac{1}{4}\right) - 8\right\}$$

Put $u + \frac{1}{u} = v \Rightarrow v = \frac{6}{5}$ or $\frac{26}{5}$

$$\Rightarrow 4 = 5 \text{ or } \frac{1}{5}$$

$$\Rightarrow (x,\ y) = (2,\ 1) \text{ or } \left(\frac{2}{5},\ \frac{-1}{5}\right)$$

41. A, C

Sol. $\because$ $x \to 0^- \Rightarrow \{x\} = 1 + x$

$$\therefore \quad \lim_{x\to 0^-} f(x) = \lim_{x\to 0} \frac{\sin^{-1}(-x)\cos^{-1}(-x)}{\sqrt{2(1+x)}.(-x)} = \frac{\pi}{2\sqrt{2}}$$

& for $x \to 0^+ \Rightarrow \{x\} = x$

$$\lim_{x\to 0^+} f(x) = \lim_{x\to 0} \frac{\sin^{-1}(1-x)\cos^{-1}(1-x)}{\sqrt{2x}(1-x)} = \frac{\pi}{2}$$

42. B, D

Sol. $\because$ $\int_0^{\pi} \sin x dx = 2$

$\Rightarrow$ $b - a = 4\pi$

$\int_0^{a+b} \cos x dx = 9$

$\Rightarrow$ $a + b = \frac{9\pi}{2}$

$\therefore$ $a = \frac{\pi}{4}$ & $b = \frac{7\pi}{4}$

43. B, D

Sol. $\Delta(x) = \begin{vmatrix} f & g & h \\ f' & g' & h' \\ f'' & g'' & h'' \end{vmatrix}$

$$\Rightarrow \Delta'(x) = \begin{vmatrix} f & g & h \\ f' & g' & h' \\ f''' & g''' & h''' \end{vmatrix}$$

44. B

Sol. $\because b > \sqrt{ac}$ and $c > \sqrt{bd}$ $(\because \text{A.M.} > \text{G.M.})$

$\Rightarrow bc > \sqrt{abcd} \Rightarrow bc > ad$

$\because b > \frac{2ac}{a+c}$ and $c > \frac{2bd}{b+d}$ $(\because \text{A.M.} > \text{H.M.})$

$\Rightarrow bc > \frac{4abcd}{(a+c)(b+d)}$

$\Rightarrow (a+c)(b+d) > 4ad$

$\Rightarrow ab+bc+cd > 3ad$

45. A

Sol. $\because \frac{a+c}{2} > b$ and $\frac{b+d}{2} > c$ $(\because \text{A.M.} > \text{G.M.})$

$\Rightarrow a+c > 2b$ and $b+d > 2c$

$\Rightarrow (a+c)+(b+d) > 2(b+c)$

$\Rightarrow a+d > b+c$

$\because b > \frac{2ac}{a+c}$ and $c > \frac{2bd}{b+d}$ $(\because \text{G.M.} > \text{H.M.})$

$\Rightarrow ab+bc+cd > 3ad$

46. C

Sol. $\because \frac{ab+cd}{2} > bc$ $(\because \text{A.M.} > \text{G.M.})$

$\Rightarrow (ab+cd) > 2bc$

$\because bc > \frac{2(ab)(cd)}{(ab+cd)}$ $(\because \text{G.M.} > \text{H.M.})$

$\Rightarrow (ab+cd) > 2ad$

47. B
48. A
49. C

SECTION – C

50. 9

Sol. $\frac{x-2}{-\frac{1}{\sqrt{2}}} = \frac{y-1}{\frac{1}{\sqrt{2}}} = 4\sqrt{2}$ or $-4\sqrt{2}$

$\therefore A(-2,\ 5)$ & $B(6,\ -3)$

$\therefore$ area of $\Delta CAB = 20$

$\Rightarrow \text{sum} = 2\sqrt{20} = 4\sqrt{5}$

51. 3

Sol. $\because x^2+5x-6=0$

$\Rightarrow (x-1)(x+6)=0 \Rightarrow x=1$

$\therefore x+5y=6$ .... (i) tangents

& $y=\frac{1}{2}(x+1)$ .... (ii)

$$\therefore \tan\theta = \left|\frac{-\frac{1}{5}+\frac{1}{2}}{1-\frac{1}{10}}\right| = \frac{3}{9} = \frac{1}{3}$$

52. 2

Sol. $\frac{a+b}{2} = \frac{5}{4}\sqrt{ab}$

$\Rightarrow \frac{a}{b} = \frac{1}{4}$

$\frac{H_8 - a}{a - H_8} = 8 \times \frac{a}{b} = 8 \times \frac{1}{4} = 2$

53. 8

Sol. $\because$ $x^2 = -4(y-1)$ has directrix

$y - 1 + 1$

$y = 2$

$\therefore$ $\lambda = 4$

$\mu = -4$

$\lambda - \mu = 8$

54. 2

Sol. $\Delta_1 = 9 - 4a \quad \Rightarrow \quad \Delta_1 + \Delta_2 = a^2 - 4a + 5$

$\Delta_2 = a^2 - 4 \qquad\qquad = (a-2)^2 + 1 > 0$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – IV

JEE (Advanced)-2019

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 231**

General Instructions:

- The test consists of total 69 questions.
- Each subject (PCM) has 23 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Three Sections**: **Section-A, Section-C & Section-D.**

Section-A (01 – 03, 24 – 26, 47 – 49) *contains 9 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-A (04 – 08, 27 – 31, 50 – 54) *contains 15 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 mark*** *for wrong answer.*
Partial Marks **+1** for each correct option provided no incorrect options is selected.

Section-A (09 – 10, 32 – 33, 55 – 56) *contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Section-C (11 – 20, 34 – 43, 57 – 66) *contains 30 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

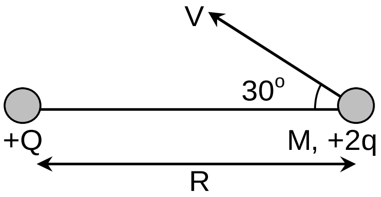
Section-D (21 – 23, 44 – 46, 67 – 69) *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics PART – I

SECTION – A
(Single Correct Choice Type)

This section contains **3 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

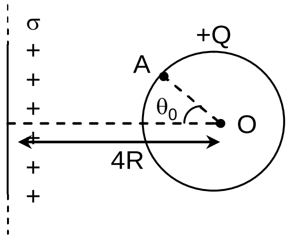
1. In the diagram shown, the charge +Q is fixed. Another charge + 2q, is projected from a distance R from the fixed charge. The minimum separation between the two charges when the velocity becomes $\frac{1}{\sqrt{3}}$ times of the projected velocity, is (Assume gravity to be absent)



(A) $\frac{\sqrt{3}}{2}R$ (B) $\sqrt{3}$ R

(C) $\frac{1}{2}R$ (D) 4 R

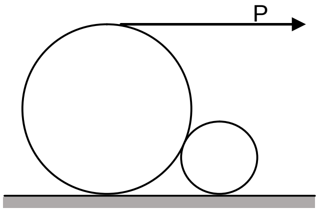
2. A conducting sphere of radius R and charge Q is placed near a uniformly charged non-conducting infinitely large thin plate having surface charge density σ. Then find the potential at point A (on the surface of sphere) due to charge on sphere $\left(\text{here } K = \frac{1}{4\pi \epsilon_o}, \theta_o = \frac{\pi}{3}\right)$



(A) $K\frac{Q}{R} - \frac{\sigma}{4 \epsilon_0}R$ (B) $K\frac{Q}{R} - \frac{\sigma}{2 \epsilon_0}$

(C) $K\frac{Q}{R}$ (D) None of these

3. Two heavy right circular rollers of radii R and r respectively rest on a rough horizontal plane as shown in figure. The larger roller has a string wound around it to which a horizontal force P can be applied as shown. Assuming that the coefficient of friction μ has the same value for all surfaces of contact and the smaller cylinder should neither roll nor slide. The minimum coefficient of friction so that the larger roller can be pulled over the smaller one is



(A) $\frac{r}{R}$ (B) $\left(\frac{r}{R}\right)^2$

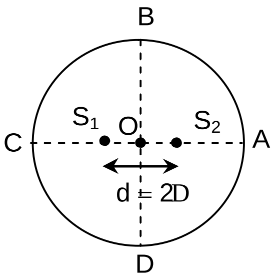
(C) $3\sqrt{\frac{r}{R}}$ (D) $\sqrt{\frac{r}{R}}$

Space for Rough work

(One or More than one correct type)

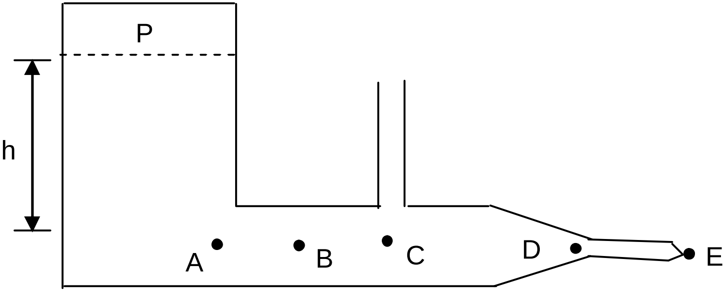
This section contains **5 questions**. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

4. Two point coherent sources separated by d = 2D emits light of wavelength D in phase. A circular wire of radius $R(R >> D)$ has its centre at point O.



(A) Points A, B C and D are points of maxima
(B) Total number of maxima on screen is eight
(C) Total number of minima on screen is eight
(D) None of the above

5. As shown in the figure a liquid of density ρ is standing in a sealed container to a height h. The container contains compressed air at a gauge pressure of P. The horizontal outlet pipe has a cross-sectional area is A/2 at E. Find the correct options.



(A) The velocity of liquid at C will be $\left[\frac{(P+\rho gh)}{4\rho}\right]^{1/2}$

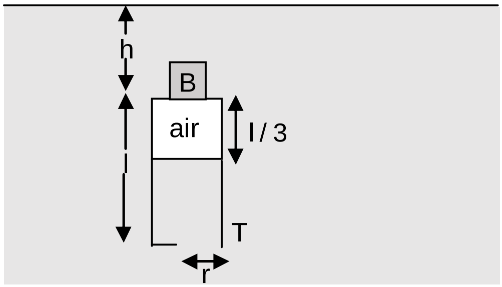
(B) The velocity of liquid at C will be $\left[\frac{2(P+\rho gh)}{\rho}\right]^{1/2}$

(C) The discharge rate is given by $\frac{A}{2\rho}(P+\rho gh)^{1/2}$

(D) The discharge rate is given by $\frac{A}{2\sqrt{\rho}}(P+\rho gh)^{1/2}$

Space for Rough work

6. A light cylindrical tube 'T' of length λ and radius $'r'$ containing air is inverted in water (density d). One end of the tube is open and the other is closed. A block 'B' of density 2d is kept on the tube as shown in the figure. The tube stays in equilibrium in the position shown. (Assume the atmospheric pressure is to be P_0.). Pick up the correct statement(s).



(A) the volume of block B is $\frac{\pi r^2 l}{3}$

(B) the volume of block B is $\frac{2\pi r^2 l}{3}$

(C) the pressure of air trapped in the tube is $P_0 + dg\left(h + \frac{l}{3}\right)$

(D) the pressure of air trapped in the tube is $P_0 + dg\left(h + \frac{2l}{3}\right)$

7. A rod of copper, uniform along its length l and of a rectangular cross section of sides of length a and width b(<a) has one end maintained at $100^\circ C$ and the other end at $0^\circ C$. The rod is insulated so that no heat is lost from the sides. Let Q_1 be the amount of heat per second that is transmitted along its length, Q_a the heat/s transmitted parallel to a and Q_b the heat/s transmitted parallel to b across any section after the steady state conditions are reached. Then,

(A) $Q_1 = \text{constant}, Q_a > Q_b \neq 0$
(B) $Q_1 = 0, Q_a = Q_b \neq 0$
(C) $Q_1 \neq 0, Q_a = Q_b = 0$
(D) $Q_1 = \text{constant}$

Space for Rough work

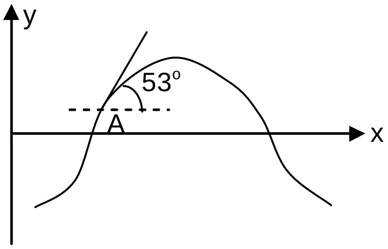
8. The y-x curve at an instant for a wave travelling along x axis on a string is shown. Slope at the point A on the curve, as shown, is 53^o. Which of the following is/are correct?

(A) Transverse velocity of the particle at point A is positive if the wave is travelling along positive x axis.

(B) Transverse velocity of the particle at point A is positive if the wave is travelling along negative x axis of the particle at point A.

(C) Magnitude of transverse velocity of the particle at point A is greater than wave speed.

(D) Magnitude of transverse velocity of the particle at point A is lesser than wave speed.

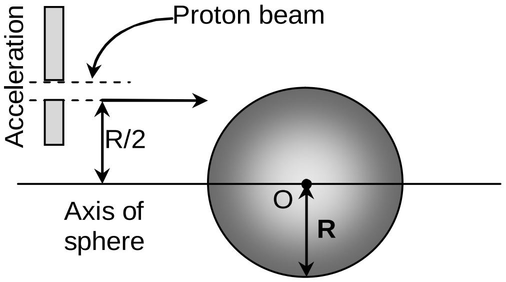


Paragraph type (One Option Correct)

This section contains **1 paragraph** each describing theory, experiment, data etc. **Two questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Questions 9 & 10

An accelerator produces a narrow beam of protons, each having an initial speed of v_o. The beam is directed towards an initially uncharged distant metal sphere of radius R and centered at point O, The initial path of the beam is parallel to the axis of the sphere at a distance of (R/2) from the axis, as indicated in the diagram.



The protons in the beam that collide with the sphere will cause it to become charged. The subsequent potential field at the accelerator due to the sphere can be neglected. The angular momentum of a particle is defined in a similar way to the moment of a force. It is defined as the moment of its linear momentum; linear momentum replacing the force. We may assume the conserved, Assume the mass of the proton as m_p and the charged on it as e. Given that the potential of the sphere increases with time and eventually reaches a constant value.

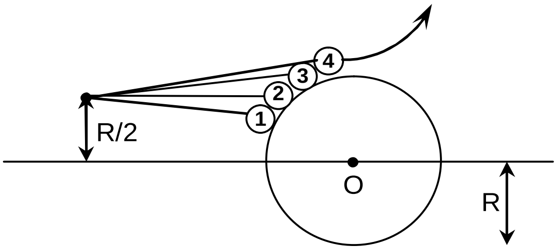
9. The total energy (E) of a proton in the beam travelling with speed v at a distance of $r(r \geq R)$ from point O. Assuming that the sphere has acquired an electrostatic charge Q is

(A) $\frac{eQ}{4\pi\varepsilon_0 r}$ (B) less than $\frac{eQ}{4\pi\varepsilon_0 r}$

(C) greater than $\frac{eQ}{4\pi\varepsilon_0 r}$ (D) zero

Space for Rough work

10. After a long time, when the potential of the sphere reaches a constant value, the trajectory of proton is correctly sketched as
(A) 1
(B) 2
(C) 3
(D) 4



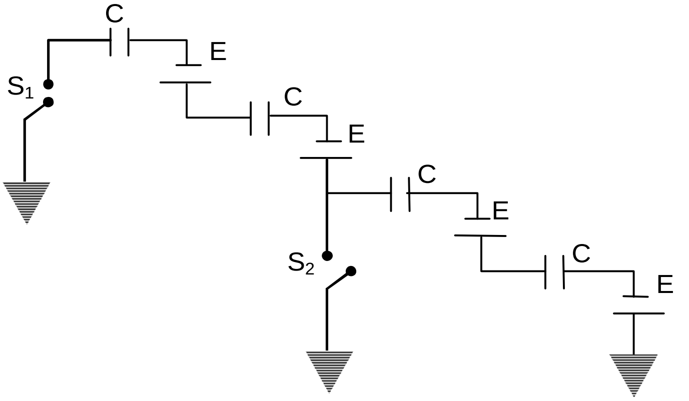
SECTION – C

(Single digit integer type)

This section contains **10 questions**. The answer to each question is a **Single Digit Integer** ranging from 0 to 9, both inclusive.

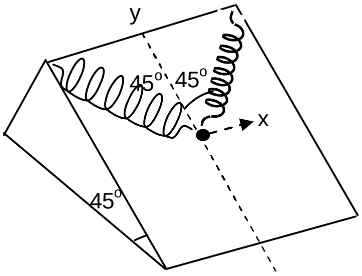
11. Binding energy per nucleon of a fixed nucleus X^A is 6 MeV. It absorbs a neutron moving with KE= 2 MeV, and converts into Y, emitting a photon of energy 1 MeV. If the Binding Energy per nucleon of Y (in MeV) is found to be $\frac{(xA-1)}{(A+1)}$. Find the value of x.

12. In the given circuit, all the capacitors are initially uncharged. After closing the switch S_1 for a long time suddenly S_2 is also closed and kept closed for a long time. Find the total heat produced after closing S_2 (in joules).

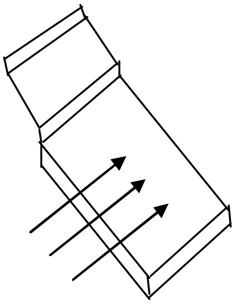


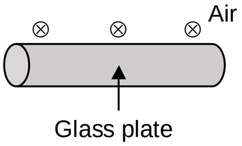
Space for Rough work

13. Figure shows a ball of mass m connected with two ideal springs of force constant k, kept in equilibrium on a smooth incline, suddenly right spring is cut. What is magnitude of instantaneous acceleration (in m/s^2) of ball?

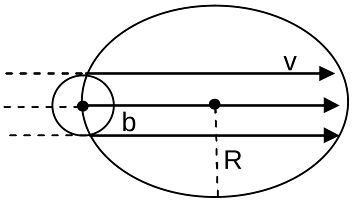


14. A thin glass plate of area A and mass m is hinged along one of its sides. The speed with which the air should be blown parallel to its upper surface to hold the plate horizontal is $\gamma\sqrt{\frac{mg}{18pA}}$. Find the value of γ. The density of air is p.

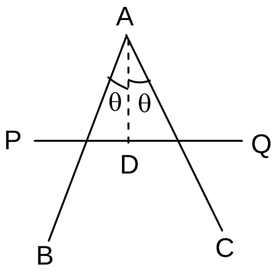




15. A soap film is made by dropping a circular frame of radius b in soap solution. A bubble is formed by blowing air with speed v in the form of a cylinder. Air stops after striking surface of soap bubble. Density of air is ρ. The radius of the bubble is R > b. The radius R of the bubble when the soap bubble separates from the ring is $\frac{\beta T}{\rho v^2}$. Find the value of β (where surface tension of liquid is T).

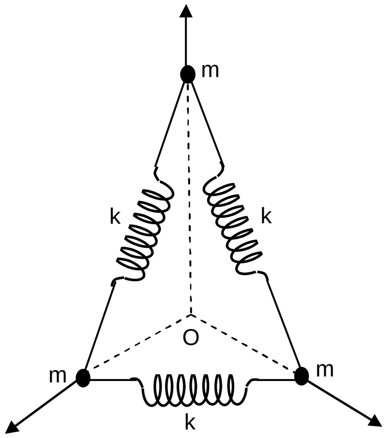


16. In the figure shown AB, BC and PQ are thin, smooth, rigid wires. AB and AC are joined at A and fixed in vertical plane. $\angle BAC = 2\theta = 9^{\circ}$ and line AD is angle bisector of angle BAC. A liquid of surface tension $T = 0.205\,N/m$ forms a thin film in the triangle formed by intersection of the vires AB, AC and PQ. In the figure shown the uniform wire PQ of mass 1 gm is horizontal and in equilibrium under the action of surface tension and gravitational force. Find the time period of SHM of PQ in vertical plane for small displacement from its mean position, in the form $\frac{\pi}{X}$s and fill value of X.



Space for Rough work

17. Three identical ideal springs, each of force constant k are joined to three identical balls (each of mass m) as shown in the figure. O is centroid of the triangle. Initially, each of the springs is in its natural length. Now all the three balls are simultaneously given small displacements of equal magnitude along the directions shown in the figure. The oscillation frequency of balls is $\frac{1}{2\pi}\sqrt{\frac{\beta k}{2m}}$. Find the value of β.



18. An ant with mass m is standing peacefully on top of a horizontal, stretched rope. The rope has mass per unit length μ and is under tension F. Without warning, a student starts a sinusoidal transverse wave of wavelength λ propagating along the rope. What minimum wave amplitude (in mm) will make the ant feel weightless momentarily? Assume that m is very small and that the presence of the ant has no effect on the propagation of the wave. (Given: $\lambda = 0.5\text{m}, \mu = 0.1\,\text{kgm}^{-1}, F = 3.125\text{N}, g = \pi^2$).

19. In a car race sound signals emitted by the two cars are detected by the detector on the straight track at the end point of the race. Frequency observed are 330 Hz and 360 Hz and the original frequency is 300 Hz of both cars. Race ends with the separation of 100 m between the cars. Assume both cars move with constant velocity and velocity of sound is 330 m/s. Find the time (in sec) taken by winning car.

20. Two identical wires are stretched by the same tension of 100 N and each emits a note of frequency 200 Hz. The tension in one wire is increased by 1 N. Calculate the number of beats heard per second when the wires are plucked.

Space for Rough work

SECTION – D
(Numerical Answer Type)

This section contains **3 questions**. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded - off to the **second decimal place**; e.g. xxxxx.xx).

21. A glass beaker of mass 400 g floats in water with the open end just touching the surface of water and half of the beaker filled with water. The inner volume of the beakers is 500 cm^3. What is the density (in g cm^{-3}) of the material of beaker?

22. The equation for the vibration of a string fixed at both ends vibrating in its third harmonic is given by y = 2 cm sin $\left[\left(0.6\ cm^{-1}\right)x\right]\cos\left[\left(500\pi\ s^{-1}\right)t\right]$ The length of the string is:

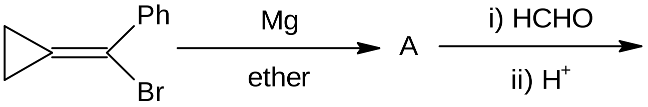
23. An open organ pipe containing air resonates in fundamental mode due to a tuning fork. The measured values of length $l\ (\text{in cm})$ of the pipe and radius r (in cm) of the pipe are $l = 94 \pm 0.1$ $r = 5 \pm 0.05$. The velocity of the sound in air is accurately known. The maximum percentage error in the measurement of the frequency of that tuning fork by this experiment, will be

Space for Rough work

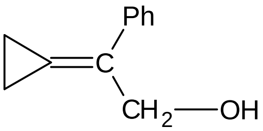
Chemistry PART – II

SECTION – A
(Single Correct Choice Type)

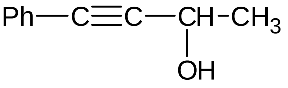
This section contains **3 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

24. 

B; Prodcut B is

(A) 

(B) $Ph—C\equiv C—CH_2—CH_2—CH_2OH$

(C) 
$Ph—C\equiv C—CH(OH)—CH_3$

(D) $Ph—CH_2C\equiv C—CH_2—CH_2—OH$

25. In a unit cell of AB if all the atoms along one of the tetrad axis of symmetry and one of the diad axis of symmetry are removed, then the resultant formulae of the unit cell will be (Atoms 'A' occupy all T.V. and atoms 'B' form fcc)

(A) A_5B_6	(B) A_5B_{11}
(C) A_2B_3	(D) No change in formula.

26. Consider the following reactions

(I) $Na_2S_2O_3 + \text{dil HCl} \xrightarrow{\Delta}$	(II) $Na_2S_2O_3 + Cl_2 + H_2O \xrightarrow{\Delta}$
(III) $SO_2 + H_2S \xrightarrow{\Delta}$	(IV) $H_2S + H_2O_2 \xrightarrow{\Delta}$

The reactions which give yellow turbidity are

(A) II, III & IV	(B) III & IV
(C) I, III & IV	(D) I, II, III & IV

Space for Rough work

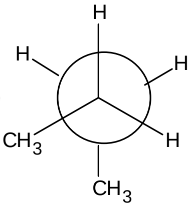
(One or More than one correct type)

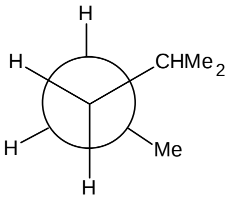
This section contains **5 questions**. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

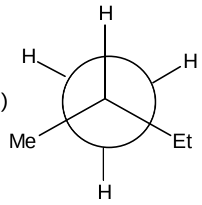
27. For aq. solution of potash alum, which is/true are
(A) One gm eq of potash alum will give 1 gm eq of K^+
(B) One gm eq of potash alum will give 1 gm eq of Al^{3+}
(C) One gm eq of potash alum will give 2 gm eq of SO_4^{2-}
(D) $\frac{1}{8}$ mole of potash alum will give 1 gm eq of SO_4^{2-}

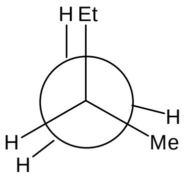
28. If a coordination complex $M(CO)_6$ is colored due to d – d transition & its CFSE corresponds to that wavelength which an electron emits on de – excitation from 4th orbit to 3rd orbit in Li^{2+} ion. Find the value of CFSE for the given complex. $\left(\text{take } R_\infty = 10^7 m^{-1}\right) Ch = 6.62\times10^{-34}$
(A) 9.53×10^{-19} J
(B) 1.36×10^{-18} J
(C) 1.97×10^{-20} J
(D) 2.59×10^{-17} J

29. Which of the following Newmann projection is correct for 2 – methyl butane?

(A)


(B)


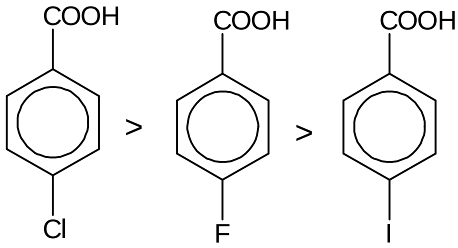
(C)


(D)


Space for Rough work

30. Which of the following is correct order as per the mention property?

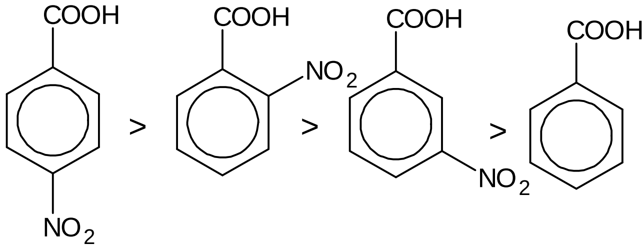
(A)



COOH
Cl
>
COOH
F
>
COOH
I

(acidic strength)

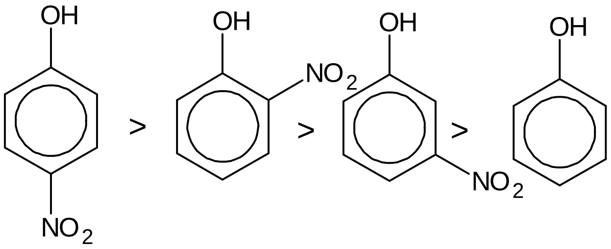
(B)



COOH
NO2
>
COOH
NO2
>
COOH
NO2
>
COOH

(acidic strength)

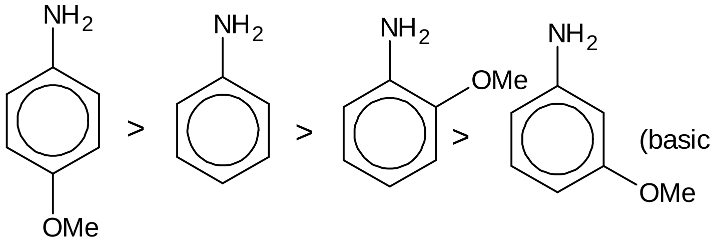
(C)



OH
NO2
>
OH
NO2
>
OH
NO2
>
OH

(acidic strength)

(D)

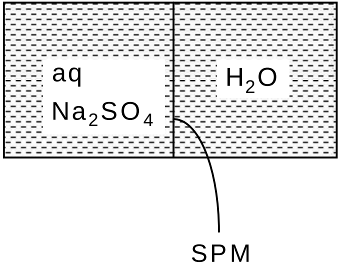


NH2
OMe
>
NH2
>
NH2
OMe
>
NH2
OMe

(basic strength)

Space for Rough work

31. If at 25°C an aq solution of 0.4 M Na_2SO_4 and water are separated by SPM as mentioned below



If a pressure of 2 atm is applied on solution, find what will happen.
(A) Reverse osmosis takes place
(B) Osmosis takes place
(C) Na_2SO_4 will move from solution to solvent side
(D) Nothing will happen

Paragraph type (One Option Correct)

This section contains **1 paragraph** each describing theory, experiment, data etc. **Two questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Questions 32 & 33

$$\underset{(\text{alkali Metal})}{M} + N_2 \longrightarrow A$$

$$A + H_2O \longrightarrow B + C\uparrow$$

$$C + CaOCl_2 \longrightarrow D\uparrow + E + F$$

$$D + CaC_2 \xrightarrow{1100^o C} C + H$$

$$H + O_2 \xrightarrow{\text{burn}} \text{One compound (gas) is proudced}$$

$$C + H_2O \longrightarrow I + \underset{\text{lower mol.wt as compare to C}}{J}$$

32. Which is true for ‘J’?
(A) H is metal oxide
(B) H gives Nesseler’s test
(C) Salt of H with strong base undergoes anionic hydrolysis to give alkaline solution
(D) H can be obtained by treating D with H_2O

Space for Rough work

33. Which of the following statements is correct?
(A) M is Na Metal
(B) C can be obtained by strong heating of $\left(NH_4\right)_2 Cr_2O_7$
(C) The gas produced by combustion of H is also produced by heating compound 'I'
(D) Gas D can not be obtained by heating NH_4NO_3

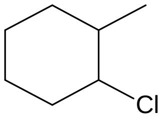
SECTION – C

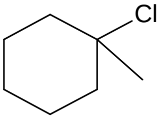
(Single digit integer type)

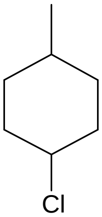
This section contains **10 questions**. The answer to each question is a **Single Digit Integer** ranging from 0 to 9, both inclusive.

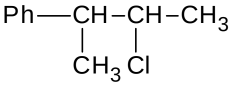
34. Compound (A) gives positive Lucas test in 5 min. when 6.0 gm of (A) is reacted with Na metal, 1120 mL of H_2 is evolved at STP. Assuming A to contain one oxygen per molecule, the number of carbon atom per molecule in (A) will be_____.

35. How many of following will give same SN^1 & SN^2 products $(excluding\ stereo\ isomers)$?









$$Ph-\underset{CH_3}{\underset{|}{CH}}-\underset{Cl}{\underset{|}{CH}}-CH_3$$

36. Calculate the pH at which an acid indicator with $ka = 1\times10^{-5}$ changes color when indicator concentration is $1\times10^{-3}\ M$.

37. 100 mL of hydrocarbon is mixed with excess of oxygen and exploded. Our cooling the mixture was reported to have contraction of 250 mL the remaining gas when passed through a solution of eq. KOH, The mixture shows a further contraction of 300 mL. Find the number of carbon atoms per molecule of hydrocarbon.

38. The critical temperature and pressure CO_2 gas are 304.2 k and 72.9 atm respectively. If the radius of CO_2 molecules is 1.62×10^{-x}cm. Assuming it to behave as Vander Waal's gas find x.

39. 30 mL of a solution containing 9.15 gm/lt of an oxalate $K_xH_y(C_2O_4)_z.nH_2O$ are required for titrating 27 mL of 0.12 N NaOH and 36 ml of 0.12 M $KMnO_4$ separately x + y + z is______.

Space for Rough work

40. A 2.18 gm sample contain a mixture of XO and X_2O_3. If reacts with 0.015 moles of $K_2Cr_2O_7$ to oxidize the sample completely to form XO_4^- and Cr^{+3}. If 0.0187 moles of XO_4^- is formed; the atomic mass of x was found to by approx. $a \times 10^2$. Calculate a.

41. If Ma_3b_3 has x pairs of enantiomers,
$M(AA)_3$ has y pairs of enantiomers &
$Ma_2b_2c_2$ has z pairs of enantiomers
Find the value of x + y + z.
(a,b & c are monodentate & AA is symmetrical bidentate ligand)

42. In how many of the following reactions black ppt is produced?

(i)	$Ag + O_2 + H_2S \longrightarrow$	(v)	$\underset{aq}{CuSO_4} + H_2S \longrightarrow$
(ii)	$Ag + H_2S \longrightarrow$	(vi)	$\underset{aq}{CdSO_4} + H_2S \longrightarrow$
(iii)	$\underset{aq}{Hg^{2+}} + H_2S \longrightarrow$	(vii)	$AgNO_3 + \text{dil. } HCl \longrightarrow$
(iv)	$\underset{aq}{PbCl_2} + H_2S \longrightarrow$	(viii)	$Fe^{3+} + NH_4Cl + NH_4OH \longrightarrow$

43. Which of the following species can be oxidized by O_3?
$HF, HCl, PbS, As(\text{in water}), I_2, K_2MnO_4, Hg, SO_2, KI, K_2SO_4$

Space for Rough work

SECTION – D

(Numerical Answer Type)

This section contains **3 questions**. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded - off to the **second decimal place**; e.g. xxxxx.xx).

44. If a sample of 2 – bromopentane shows specific rotation of + 30^o & specific rotation of optically pure 2 – bromobentane in the 40^o, find % of (d) 2 – bromopentane in the given sample.

45. If Cu atoms form fcc (ABC ABC…………..) and nearest distance between two 'A' layer is $8\sqrt{6}$ nm then find the radius of atoms (in nm) that exactly fits into the octahedral void (do not round off)

46. How many of the following reactions will release a gas as any product (at 25^{o}C)?

(i)	$NH_4^+ + \overline{O}H \longrightarrow$	(vi)	$PH_3 + NO_2 \xrightarrow{\text{electric spark}}$
(ii)	$Al + NaOH + H_2O \longrightarrow$	(vii)	$NH_3 + CaOCl_2 \longrightarrow$
(iii)	$Al(OH)_3 + NaOH \longrightarrow$	(viii)	$SOCl_2 + H_2O \longrightarrow$
(iv)	$Ba + \text{cold water} \longrightarrow$	(ix)	$SnCl_2 + HCl + O_3 \longrightarrow$
(v)	$(NH_4)_2Cr_2O_7 \xrightarrow{\Delta}$		

Space for Rough work

Mathematics PART – III

SECTION – A
(Single Correct Choice Type)

This section contains **3 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

47. Let $a_1 = 1$; and $a_n = n\left(a_{n-1} + 1\right)$ for n = 2, 3,.......... define $P_n = \left(1 + \frac{1}{a_1}\right)\left(1 + \frac{1}{a_2}\right)..........\left(1 + \frac{1}{a_n}\right)$

Then $\lim\limits_{n\to\infty} P_n$ is

(A) 1 + e (B) e
(C) 1 (D) ∞

48. If the roots of the equation $x^4 + ax^3 + bx^2 + cx + d = 0$ are in geometric progression, then

(A) $b^2 = ac$ (B) $a^2 = b$
(C) $a^2b^2 = c^2$ (D) $c^2 = a^2d$

49. $f'(x) = \frac{3^{1/x}}{1 + 3^{1/x}}$ then $\int_{-1}^{1} f'(x)dx = \alpha$ and $\int_{-1}^{1} xf''(x)dx = \beta$

(A) $\alpha = 1, \beta = 1/2$ (B) $\alpha = 1/2, \beta = 0$
(C) $\alpha = -\frac{1}{2}, \beta = 1$ (D) $\alpha = 1/2, \beta = -1$

(One or More than one correct type)

This section contains **5 questions**. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

50. If a tangent on ellipse at A (1, 1) intersect its directrix at B (7, –6) and S be the focus of ellipse and C (α, β) is the centre of ΔSAB, then

(A) $\alpha + \beta = 1$ (B) $\alpha - \beta = 7$
(C) $SC^2 = 20.5$ (D) $SC^2 = 21.25$

Space for Rough work

51. If curve $A \equiv \{z : |z-3| + |z+3| = 8\}$ & $B \equiv \{z : |z-3| = K\}$, $K \in R^+$ touches the curve 'A' internally, and given another curve $C \equiv \{z : \| z-3| - |z+3\| = 4\}$, then;
(A) A & C intersect orthogonally & k = 1
(B) K = 1
(C) K = 3/2
(D) B touches also C internally

52. If $f^3(x) - 3x^2 f(x) + x^3 = 0$, then $\int \frac{f(x)}{x} dx$ is equal to
(A) $f(x)+c$ (B) $-f(x)+c$
(C) $2f(x)+c$ (D) $xf'(x)+c$

53. If $A = \begin{pmatrix} \alpha & 0 \\ 2 & \alpha \end{pmatrix}$ and $\det(2A^2 - 2A) = 144$, then possible correct statement is (for real part)
(A) $\operatorname{tr}(A) = 6$ (B) $\det(A) = 9$
(C) $\det(A) = 4$ (D) $\operatorname{tr}(A) = 1$

54. If $\vec{u}(x) = x\hat{i} + (\sin x)\hat{j} + (1+\sin x)\hat{k}$, $\vec{v}(x) = \hat{i} + \cos x(\hat{j} + \hat{k})$ and $\vec{w}(x) = \sin x(\hat{j} + \hat{k})$, all are linearly dependent vectors for $x = \alpha$, then $\left(\frac{2\alpha}{\pi}\right)$ can be equal to
(A) 101 (B) 1001
(C) 2012 (D) 2011

Space for Rough work

Paragraph type (One Option Correct)

This section contains **1 paragraph** each describing theory, experiment, data etc. **Two questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Questions 55 & 56

If f(x) & g (x) are two real valued functions such that

$$f(\sin x)+f(\cos x)=2x-\frac{\pi}{2} \text{ and } F(x)=\begin{cases}\dfrac{8}{3f'(x)} & \text{for } x^2\neq 1\\ 0 & \text{for } x^2=1\end{cases} \ \& \ g(x)=\frac{3}{4}F(x).$$

55. The range of $f(x)$ is

(A) $\left[-\pi, \frac{3\pi}{2}\right]$ (B) $\left[-\frac{3\pi}{2}, \pi\right]$

(C) $\left[-\frac{3\pi}{2}, \frac{\pi}{2}\right]$ (D) none of these

56. The only one solution of $f(x)=\sin\left(\frac{x}{2}+\frac{\pi}{4}\right)$ for $-\frac{3\pi}{2}\le x\le\frac{\pi}{2}$ is β. Then

(A) $1>\beta>\alpha$ (B) $-1<\beta<\alpha$

(C) $\beta>1$ (D) $\beta=1$

SECTION – C
(Single digit integer type)

This section contains **10 questions**. The answer to each question is a **Single Digit Integer** ranging from 0 to 9, both inclusive.

57. If $x^2+y^2=16$ is director circle of locus of centre of a moving ellipse touches both the axes in first quadrant, then if major axis and minor axis are not fixed, then maximum value of product of semi-major and semi-minor axis is

Space for Rough work

58. If $f(x)=\sum_{i=1}^{\infty}\frac{x}{\{(i-1)x+1\}(ix+1)}$, then $f(2017)+f\left(\frac{1}{2017}\right)$ is equal to

59. If $\cos^{-1}(2-x^2)+\sin^{-1}(2-x^2)+\tan^{-1}x\ge\frac{2\pi}{3}$ have no solution if $x<\alpha$ or $x>\beta$ $(\text{for } \alpha<\beta)$, then $\left\{\frac{1}{\max(\alpha)}+(\min(\beta))^2\right\}=$ ....

60. If $I=\int_1^2\frac{x^3-3x^2}{\ln(x-1)}dx$ and $J=\int_2^3\frac{(3x-5)}{\ln(x-2)}dx$, then e^{I+J} equals ....

61. Position vector of a point A is $\left(a\hat{i}+b\hat{j}+c\hat{k}\right)$ and $a^2+b^2+c^2=4$; and position vector of another point B is $\left(p\hat{i}+q\hat{j}+r\hat{k}\right)$ and $p^2+q^2+r^2=9$. Given $\angle AOB=2\cos^{-1}\frac{1}{5}$, where O is origin. If AQ is perpendicular to angle bisector of $\angle AOB$ i.e. line OQD where D lies on AB, then value of $25|QD|$ = ?

62. If $\frac{3x^2+1}{\sqrt{x^4+x^2}}\ge f(x)$, where $f(x)$ is a constant function in $0<x\le\sqrt{2}$, then minimum value of $\int_0^{\sqrt{2}}\frac{(3x^2+1)dx}{\sqrt{x^4+x^2}}$ is ....

63. If $AB=BA=I$ such that $A=\left[a_{ij}\right]_{2\times2}$, $B=\left[b_{ij}\right]_{2\times2}$, $a_{ii}=b_{ii}$, $a_{12}=-b_{12}$, $a_{21}=-b_{21}$ and a_{ij} are co prime natural numbers, then $|a_{21}-a_{12}|=$ ....

Space for Rough work

64. If $f'(x) > 0 \ \forall \ x \in R^+$ where $f : R^+ \to R$ and $f(x) + \frac{1}{x} = f^{-1}\left(\frac{1}{f(x)}\right)$ and $f^{-1}\left(\frac{1}{f(x)}\right) > 0$ then $\frac{\pi}{\sin^{-1}(f(2))}$ is equal to

65. If S_r is sum of infinite G.P. $(r \geq 3)$, where first term is $\frac{(r-2)}{(r-1)!}$ and common ratio $\frac{1}{(r-1)}$, then $1 + \frac{2011}{(2009)!} + \sum_{r=3}^{r=2011} \left|(r^2 - 4r + 2) \times S_r\right|$ is equal to ………..

66. If $\lim_{x \to 0} \frac{a\tan x - b\sin x + cx^2 - x}{x^3} = \frac{3}{2}$ then, $[a+b+c]$ is equal to ________ . (where [.] denotes greatest integer part)

SECTION – D
(Numerical Answer Type)

This section contains **3 questions**. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded - off to the **second decimal place**; e.g. xxxxx.xx).

---

67. The length of focal chord AB of ellipse $\frac{x^2}{4} + \frac{y^2}{3} = 1$ is: $\left(\text{Given } A = \left(\frac{8}{5}, \frac{3\sqrt{3}}{5}\right)\right)$

68. How many matrices X with entries {0, 1, 2} are there for which sum of diagonal entries of $X.X^T$ is 7?

69. If $\log_{(3x+4)}\left(4x^2 + x + 1\right) + \log_{(2x+1)}\left(6x^2 + 11x + 4\right)$ then x is ________.

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – IV

JEE (Advanced)-2019

PAPER –2

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. A

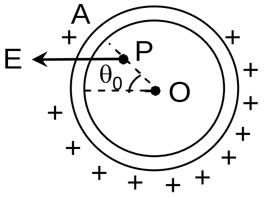
Sol. Using conservation of angular momentum about fixed charged.

$$MV \sin 30R = Mv'.r \Rightarrow \frac{V}{2}R = \frac{V}{\sqrt{3}}r$$

$$r = \frac{\sqrt{3}}{2}R$$

2. A

Sol. Charge on sphere will redistribute due to electric filed produced by thin plate. Electric field at any point (say P) due to charges on sphere is



$E = \frac{\phi}{2\varepsilon_{o0}}$ (so that field at P may become zero combinedly due to thin plate and sphere) Now due to sphere: $V_0 - V_A = \left(E\cos\theta_0\right)R$

$$V_A = V_0 - E_r \cos\theta_0$$

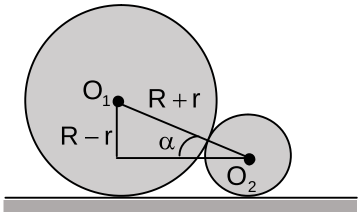
$$= \frac{kQ}{R} - \frac{\sigma}{2\varepsilon_0}R\cos\left(\frac{\pi}{3}\right)$$

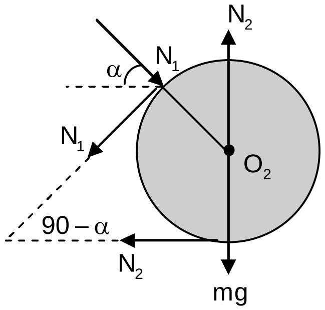
$$= \frac{kQ}{R} - \frac{\sigma R}{4\varepsilon_0}$$

[Here all the calculations are done only for the charges on spheres].

3. D

Sol. Figure shows the forces action on the smaller cylinder. N_1 is reaction between the two cylinders and N_2 the normal reaction between the smaller cylinder and the horizontal surface.





The conditions of equilibrium are

$$\sum F_x = N_1\cos\alpha - \mu N_2 - \mu N_1\cos(90-\alpha) = 0 \qquad \text{....(i)}$$

Taking torque about O_2, centre of smaller sphere,

$$\sum \tau = \mu N_1 r - \mu N_2 r = 0$$

$$N_1 = N_2 \qquad \text{....(ii)}$$

On substituting equations (ii) in (i), we obtain

$$\mu N_1 + \mu N_1 \sin\alpha = N_1\cos\alpha$$

$$\mu(1+\sin\alpha) = \cos\alpha \qquad \text{....(iii)}$$

From figure (b), $\sin\alpha = \sqrt{\frac{R-r}{R+r}, \cos\alpha = \frac{2\sqrt{Rr}}{R+r}}$

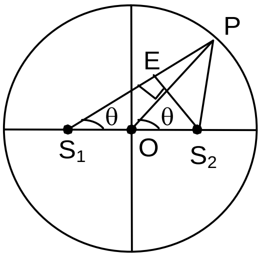
Now equations (iii) becomes; $\mu\left(1+\frac{R-r}{R+r}\right) = \frac{2\sqrt{Rr}}{R+r}\mu = \sqrt{\frac{r}{R}}$

Hence the required condition is $\mu \geq \sqrt{\frac{r}{R}}$.

4. A, B, C

Sol. The path different at point P is

$\Delta x = S_1E = 2D\cos\theta$



For maxima, $2D\cos\theta = mD$

$\therefore \cos\theta = \frac{m}{2}$

The possible value of m in first quadrant is 0, 1, 2.

Thus number of maxima in all four quadrants is eight.

For minima, $\Delta x = (2m-1)\frac{D}{2}$

$\cos\theta = \frac{(2m-1)}{4}$

Thus possible value of m in first quadrant is 1, 2
Thus, total number of minima in all four quadrant is eight.

5. A, D

Sol. $P_A = P + P_0 + \rho gh$ ....(i)

Apply Bernoulli's theorem at A and C and E

$$(P + P_0) + \rho gh = P_c + \rho\frac{V_c^2}{2}$$

$$= P_0 + \rho\frac{V_E^2}{2} \quad ....(ii)$$

$$P_c = P_0 + \rho gh_1 \quad ....(iii)$$

$$A_cV_c = A_EV_E$$

$$A_cV_c = \left(\frac{A_c}{2}\right)V_E \quad ....(iv)$$

From eq. (i),

$$(P_0 + \rho gh_1) + \rho\frac{V_c^2}{2} = P_0 + \rho(2V_c)^2$$

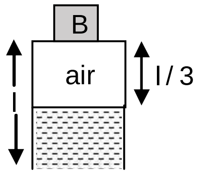
$$P + \rho gh = \rho g\left(\frac{7V_c^2}{2}\right)$$

$$v_c^2 = \frac{(P + \rho gh)}{4\rho}$$

Discharge rate $= A_cV_c = A\left(\frac{(P + \rho gh)}{4\rho}\right)^{1/2}$

6. A, C

Sol. The free body diagram of block + tube inclusive of water is as shown below



Since the block + tube system shown in figure is in equilibrium

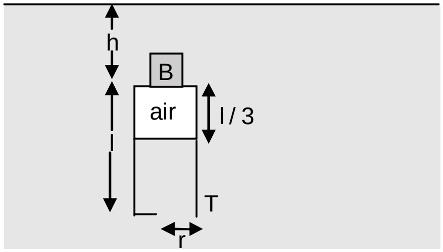
∴ Net weight of system = buoyant force

$$2d\,Vg + \pi r^2\frac{2l}{3}dg = (V + \pi r^2 l)dg$$

Where V is the volume of block B

$$(2d - d)V = \frac{\pi r^2 ld}{3} \text{ or } V = \frac{\pi r^2 l}{3}$$

The pressure of the air trapped inside the tube is same as pressure at point A in the water as shown in figure.



$P = P_0 + \left(h + \frac{l}{3}\right)dg \quad P_a = P_0 + dg\left(h + \frac{l}{3}\right)$

7. C, D

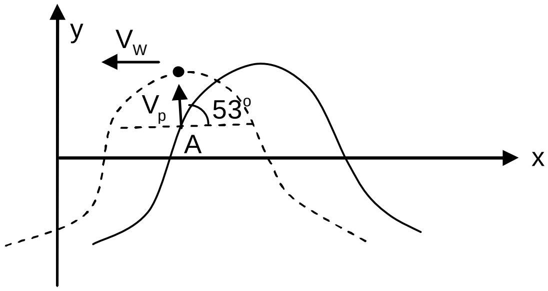
Sol. The temperature gradient (which causes the heat to flow) is only along the length. The temperature at any point of a given cross-section is the same and

so $Q_a = Q_b = 0$.

In the steady state, Q_1 is constant $\neq 0$

8. B, C

Sol. As shown in the curve, if wave is moving alogn $-x$ axis, V_P is positive.



$$\frac{V_p}{V_w} = -\tan\theta$$

$\left|-\tan\theta\right] > 1 \qquad \therefore \quad V_P > V_W$.

9. C

10. D

SECTION – C

11. 6

Sol. BE of X = 6A

Be of Y = 6A - 2 + 1 = 6A - 1

[Because absorption of energy decreases BE and release of energy increases BE] In Y nucleus there are A + 1 nucleus.

$$\therefore \frac{BE}{nuclon} = \frac{6A-1}{A+1}$$

12. 0

Sol. When switch S_2 is closed, due to symmetry no charge will flow through S_2.

13. 5

Sol. Let initial extension in spring is x_0, then

$2kx_0 \cos 45^o = mg \sin 45^o \Rightarrow 2kx_0 = mg$

Let after cutting right spring, acc. of ball is a_1 along the inclined plane and a_2 perpendicular to a_1

$$\Rightarrow \quad \frac{mg}{\sqrt{2}} - \frac{mg}{2}\frac{1}{\sqrt{2}} = ma_1 \Rightarrow a_1 = \frac{g}{2\sqrt{2}}$$

Then $mg\sin 45^o \Rightarrow kx_0 \cos 45^o = ma_1$

$$kx_0 \sin 45^o = ma_2 \Rightarrow a_2 = \frac{g}{2\sqrt{2}}$$

Net acceleration $a = \sqrt{a_1^2 + a_2^2} = \frac{g}{2} = 5\ m/s^2$

14. 6

Sol. Applying Bernoulli's theorem for above the plate (2) and below the plate (1), we have

$$p_1 = p_2 + \frac{1}{2}pv^2$$

$$\Rightarrow \quad p_1 - p_2 = \frac{1}{2}pv^2$$

Upward force is $(p_1 - p_2)A = \frac{1}{2}pv^2A$

$$\therefore \quad \frac{1}{2}pv^2A = mg$$

$$\Rightarrow \quad v = \sqrt{\frac{2mg}{pA}} = 6\sqrt{\frac{mg}{18pA}}$$

$$\Rightarrow \quad \gamma = 6$$

15. 4

Sol. Mass of air entering in 1 s is $m = \pi b^2 vp$

Change in momentum in 1 s $= mv - 0 = \pi b^2 pv^2$

Thus, $F = \pi b^2 pv^2$

Pressure due to this force is $\Delta p = \frac{F}{A} = \frac{\pi b^2 pv^2}{\pi b^2} = pv^2$

When this excess pressure equals to $\frac{4T}{R}$, the bubble gets separated.

$$\therefore \quad pv^2 = \frac{4T}{R} \Rightarrow R = \frac{4T}{pv^2}$$

So, $\beta = 4$

16. 5

Sol. The F.B.D. of wire PQ is the force due to surface tension $= F_{ST} = 2T \times 2AD\tan\theta$

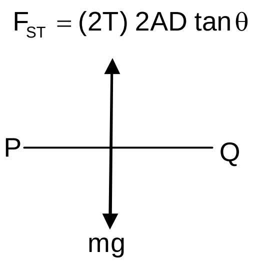


Figure (a)

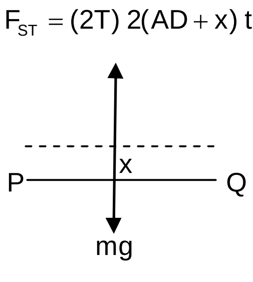


Figure (b)

For wire to be in equilibrium (Figure (a))

$4T\ AD\tan\theta = mg$

If the wire PQ is at a distance x below the mean position, the restoring force on the wire is (Figure (b))

$-ma = 4T\ \tan\theta(AD + x) - mg - 4T\ \tan\theta\ x$

Hence, the wire PQ executes SHM

$$a = \frac{4T}{m}\tan\theta\ X$$

Comparing with $a = -\omega^2 x$, we get

$$\omega^2 = \frac{4T}{m}\tan\theta$$

or $$T = 2\pi\sqrt{\frac{m}{4T\tan\theta}} = 2\pi\sqrt{\frac{1\times10^{-3}}{4\times25\times10^{-3}}} = \frac{\pi}{5}s$$

17. 6

Sol. In the figure, $\theta = 30^o$.

When displacement is each ball x, the extension in each spring is

$$x' = x\cos\theta = x\frac{\sqrt{3}}{2}$$

Each spring is connected to two balls.

So, net extension of each spring $= 2x' = \sqrt{3}x$

Force along the direction of displacement on each ball is

$$F = k\sqrt{3}x\cos30^o + k\sqrt{3}x\cos30^o = 3kx$$

$F = -3$ kx [negative because restoring in nature]

$$\Rightarrow \quad a = \frac{F}{m} = -\frac{3k}{m}x \Rightarrow \omega = \sqrt{\frac{3k}{m}}$$

$$\Rightarrow \quad f = \frac{2}{2\pi}\sqrt{\frac{3k}{m}} = \frac{1}{2\pi}\sqrt{\frac{6k}{2m}} \Rightarrow \beta = 6$$

18. 2

Sol. $a_{max} = \omega^2 A = g$

$$\omega = \frac{2\pi v}{\lambda}, v = \sqrt{\frac{F}{\mu}}$$

$$\therefore \quad \omega^2 = \frac{4\pi^2 F}{\lambda^2}\times\frac{F}{\mu}$$

$$\therefore \quad a_{max} = \frac{4\pi^2 F}{\lambda^2\mu}.A_{min} = g$$

$$A_{min} = \frac{g\lambda^2\mu}{4\pi^2 F} = \frac{\lambda^2\mu}{4F} \qquad (\because \quad \pi^2 = g)$$

$$A_{min} = \frac{(0.5)^2(0.1)}{4(3.125)}$$

$$= 2\times10^{-3}\ m = 2\ mm$$

19. 4

Sol. Let the velocities of car 1 and car 2 be V_1 m / s and V_2 m / s

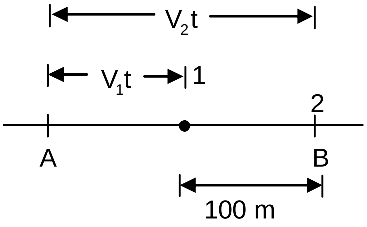
$\therefore$ Apparent frequencies of sound emitted by car 1 and car 2 as detected at end point are

$$f_1 = f_0\frac{V}{V - V_1}, f_2 = f_0\frac{V}{V - V_2}$$

$$\Rightarrow \quad 330 = 300\frac{330}{330 - V_1}, 360 = 300\frac{330}{330 - V_2}$$

$$\Rightarrow \quad V_1 = 20\ m/s \text{ and } V_2 = 100\ m/s.$$

The distance between both the cars just when the 2nd car reach and point B (as shown in figure is)



$100\text{ m} = V_2t - V_1t \Rightarrow t = 4\text{ sec}.$

20. 1

Sol. $f = \frac{1}{2L}\sqrt{\frac{F}{\mu}}$

$f = c\sqrt{F}$

where constant $c = \frac{1}{2L\sqrt{\mu}}$

$$\frac{df}{dF} = c.\frac{1}{2\sqrt{F}}$$

or $$\frac{df}{dF} = \frac{1}{2L\sqrt{\mu}}.\frac{1}{2\sqrt{F}} = \frac{1}{2L\sqrt{\mu}}\frac{\sqrt{F}}{2F}$$

$$\frac{df}{dF} = \frac{1}{2L}\sqrt{\frac{F}{\mu}}.\frac{1}{2F} = \frac{f}{2F}$$

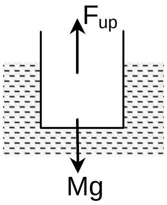
$$df = \frac{fdF}{2F} = \frac{(200)(1)}{2(100)} = 1\,s^{-1}$$

$\therefore$ Beat frequency = $1\,s^{-1}$

SECTION – D

21. 00002.67

Sol.



At equilibrium, $F_{up} = Mg$

22. 00015.70

Sol. $y = 2(\sin kx)(\cos \omega t)$

Now, we can compare with given equation.

23. 00000.16

Sol. $\ell = \ell_0 + \Delta\ell$, $r = r_0 + \Delta r$

By using formula for fundamental frequency.

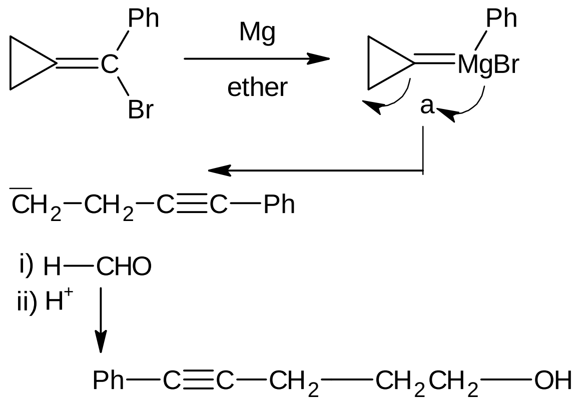
Chemistry

PART – II

SECTION – A

24. B

Sol.



Ph
C
Br
Mg
ether
Ph
MgBr
a
$\overline{C}H_2-CH_2-C\equiv C-Ph$
i) H—CHO
ii) H$^+$
Ph—C≡C—CH$_2$—CH$_2$CH$_2$—OH

(B)

25. A

Sol. Tetrad AOS is C_4 & diad is C_2

26. D

Sol. Yellow turbidity of Sulphur is obtained in all the cases.

27. D

Sol.

$$K_2SO_4.Al_2(SO_4)_3.24H_2O \longrightarrow 2K^+ + 2Al^{3+} + 4SO_4^{2-}$$

n factor = 8	1 mole	2 mol	2 mol	4 mole
	8 gm eq	2 gm eq	6 gm eq	8 gm eq
	1 gm eq	1 gm eq cations		1 gm eq

28. A

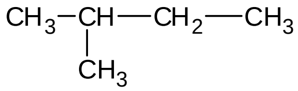
Sol.

$$E_4 - E_3 = -\frac{2.18\times10^{-18}\times9}{16}+\frac{2.18\times10^{-18}\times9}{9}$$

$$= 2.18\times10^{-18}\times\frac{7}{16} = 9.53\times10^{-19}$$

29. A, C, D

Sol.



$$CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-CH_3$$

In (b) one carbon is extra.

30. A, C, D

Sol. O – nitrobenzoic acid is stronger than m, p nitro derivatives as well as benzoic acid o – nitrophenol is weaker acid than P – nitrophenol due to intramolecular H – bonding.

31. B

Sol.

$\pi = iCRT$

$\pi = 3\times0.4\times0.0821\times298$

$= 29.358$ atm

As osmotic pressure is more than applied pressure so osmosis will occur.

32. B

Sol. $\underset{M}{Li} + N_2 \longrightarrow \underset{A}{Li_3N}$

$Li_3N + H_2O \longrightarrow \underset{B}{LiOH} + \underset{C}{NH_3} \uparrow$

$NH_3 + CaOCl_2 \longrightarrow \underset{(D)}{N_2} + \underset{E}{CaCl_2} + \underset{F}{H_2O}$

$\underset{D}{N_2} + CaC_2 \xrightarrow{1100^oC} \underset{G}{CaCN_2} + \underset{H}{C}$

$\underset{H}{C} + O_2 \longrightarrow CO_2$

$\underset{G}{CaCN_2} + H_2O \underset{C}{\longrightarrow} \underset{I}{CaCO_3} + \underset{J}{NH_4OH}$

33. C

Sol. $NH_4NO_3 \xrightarrow{\Delta} N_2 + O_2 + H_2O$

$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

SECTION – C

34. 3

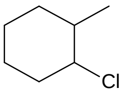
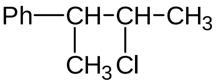
Sol. (A) *is* 2^0 *Alcohol*

mol, wt of $A = 60.$

$\therefore$ *formula* $= C_3H_8o$

35. 2

Sol.

In  &  rearrangement will give different products.

$\underset{CH_3}{Ph—CH}-\underset{Cl}{CH}-CH_3$

36. 5

Sol. $HI_n \rightleftharpoons H^+ + In$

Color A *Colour B*

$$k_{In} = \frac{[H^+][In^-]}{[HI_n]}$$

The midpoint of the colour change of an indicator HI_n is the point at which

$[I_n^-] = [HI_n]$

$\therefore ph = 5$

37. 6

Sol. $C_xH_y + O_2 \to Co_2 + H_2o$

$x = 100 \qquad = 300$

$x = 3$

38. 8

Sol. $T_c = 3.4.2k$

$= \frac{8a}{27Rb}$

$\frac{T_c}{P_c} = \frac{8b}{R}$

$b = 4N_A \times \frac{4}{3}\pi r^3$

$\therefore r = 1.62 \times 10^{-8}$ cm

$P_c = 72.9$ atm

$= \frac{a}{27b^2}$

39. 6

Sol. Let mol. wt of salt is M
(i) n-factor in acid – base titration = y
(ii) n – factor in redox titration = 2xz
Max of acid in 30 mL = Max of NaOH

$30 \times \frac{9.15}{M} \times y = 27 \times 0.12$ ....(i)

$30 \times \frac{9.15}{M} \times (27) = 36 \times 0.12$ ....(ii)

$\therefore \quad \frac{y}{z} = \frac{3}{2}$ ....(iii)

Total cationic charge = Total ammonic chare x + y = 2z
$\therefore$ x : y : z = 1 : 3 : 2

40. 1

Sol. $\frac{x}{x+16} + \frac{2x(2.18-x)}{2x+48} = 0.0187$

$x = 99 \simeq 100$

41. 2

Sol. Ma_3b_3 has two geometrical isomers i.e. fac & mer & both are optically inactive so x = 0

$M(AA)_3$ has one pair of enantiomers

$y = 1$

& Z = 1

so x + y + z = 2

42. 5

Sol. $Ag + O_2 + H_2S \longrightarrow Ag_2S + H_2O$

$Ag + H_2S \longrightarrow Ag_2S + H_2$

HgS, PbS & CuS are black

cds is yellow.

43. 8

Sol. $HCl + O_3 \longrightarrow Cl_2 + H_2O + O_2$

$PbS + O_3 \longrightarrow PbSO_4 + O_2$

$As + O_3 + H_2O \longrightarrow H_3AsO_4 + O_2$

$I_2 + O_3 \longrightarrow I_4O_9 + O_2$

$O_3 + K_2MnO_4 + H_2O \longrightarrow KMnO_4 + O_2 + KOH$

$Hg + O_3 \longrightarrow Hg_2O + O_2$

$O_3 + SO_2 \longrightarrow SO_3$

$O_3 + KI \longrightarrow I_2 + O_2 + KOH$

SECTION – D

44. 00087.50

Sol. % Enantomomeric excess = $\frac{30}{40} \times 100 = 75$

So % of d = $75 + \frac{25}{2} = 87.5$

45. 00001.66

Sol. Nearest distance between two 'A' layers = $\sqrt{3}a$

$\sqrt{3}a = 8\sqrt{6} \Rightarrow a = 8\sqrt{2}$ nm

$a = 8\sqrt{2}$ r $\Rightarrow$ r = $\frac{8\sqrt{2}}{2\sqrt{2}} = 4$

$\frac{r_{v.}}{r} = 0.414$

$r_{o.v} = 0.414 \times 4$

$= 1.656$ nm

46. 00007.00

Mathematics PART – III

SECTION – A

47. B

Sol.
$$P_n = \frac{1+a_1}{a_1}\times\frac{1+a_2}{a_2}\times.........\frac{1+a_n}{a_n}$$
$$= \frac{a_2}{2\times a_1}\times\frac{a_3}{3\times a_2}\times........\times\frac{a_n}{n\times a_{n-1}}\times\frac{a_{n+1}}{(n+1)a_n}$$
$$P_n = \frac{a_{n+1}}{\underline{|n+1}} = \frac{(n+1)(a_n+1)}{(n+1)\underline{|n}}$$
$$= \frac{1}{\underline{|n}}+\frac{a_n}{\underline{|n}} = \frac{1}{\underline{|n}}+\frac{n(1+a_{n-1})}{n\underline{|n-1}}$$
$$= \frac{1}{\underline{|n}}+\frac{1}{\underline{|n-1}}+...................+\frac{(1+a_1)}{\underline{|1}}$$
$$= 1+\frac{1}{\underline{|1}}+\frac{1}{\underline{|2}}+...........+\frac{1}{\underline{|n}}$$
$$\lim_{n\to\infty} P_n = e$$

48. D

Sol. $\frac{\alpha}{r^3}, \frac{\alpha}{r}, \alpha r, \alpha r^3$ are terms

Equation – 1 $\frac{\alpha}{r^3}+\frac{\alpha}{r}+\alpha r+\alpha r^3 = -a$

$\alpha\left(r+\frac{1}{r}+r^3+\frac{1}{r^3}\right) = a$ ....(A)

Equation – 2 $\alpha^4 = d$ ....(B)

Equation – 3 $\frac{\alpha^2}{r^4}+\frac{\alpha^2}{r^2}+\alpha^2+\alpha^2+\alpha^2r^2+\alpha^2r^4 = b$

Equation – 4 $\frac{\alpha^3}{r^2}+\alpha^3 r+\alpha^3 r^3+\frac{\alpha^3}{r} = -C$ ....(C)

(A)(C)

$$\frac{1}{\alpha^2} = \frac{-a}{c} \Rightarrow = \frac{c^2}{a^2}$$

$d = c^2/a^2$

$c^2 = da^c$

49. C

Sol.
$$\alpha = f(x)\Big|_{-1}^{0} + f(x)\Big|_{0}^{1}$$
$$= 0-\frac{1/3}{1+\frac{1}{3}}+\frac{3}{1+3}-\frac{1}{1+0}$$

$$= -\frac{1}{4} + \frac{3}{4} - 1 = \frac{2}{4} - 1 = \frac{1}{2} - 1 = -1/2$$

$$\beta = \int_{-1}^{1} x - f(x).dx = xf'(x)\int_{-1}^{1} - \int_{-1}^{1} f'(x)$$

$$= 1 \times f'(1) - 0 + 0 - \frac{1}{4} + 1/2$$

$$= \frac{1}{2} + 1/2 = 1$$

50. A, B, D

Sol. $\because \Delta SAB$ is right angle at S

Centre C is $\left(\frac{1+7}{2}, \frac{1-6}{2}\right) = (4, -3)$

$\therefore \alpha = 4$ and $\beta = -3$

$\therefore \alpha + \beta = 1$ and $\alpha - \beta = 7$

SC is radius and AB is diameter

$\therefore SC = \frac{1}{2}\sqrt{36+49} = \frac{1}{2}\sqrt{85} = \sqrt{\frac{85}{4}} = \sqrt{21.25}$

51. A, B, D

Sol. Confocalconics always intersect orthogonally & circle touches at vertex of ellipse.

$\therefore k = 1$

52. A, D

Sol. $y^3 - 3x^2y + x^3 = 0$

$$\Rightarrow \frac{dy}{dx} = \frac{-\left(-6xy + 3x^2\right)}{\left(3y^2 - 3x^2\right)} = \frac{-3\left(-2xy + x^2\right)}{3\left(y^2 - x^2\right)} = \frac{y}{x}$$

$$\Rightarrow \int\left(\frac{dy}{dx}\right)dx \text{ i.e., } \int \frac{y}{x}dx = y + c$$

$$= f(x) + c \text{ or } xf'(x) + c$$

53. A, B, C, D

Sol. $\left|2A^2 - 2A\right| = 144$

$2^2|A||A - I| = 144$

$\Rightarrow \alpha^2(\alpha - 1)^2 = 36$

$\alpha(\alpha - 1) = 6 \text{ or } -6$

$\alpha^2 - \alpha - 6 = 0 \text{ or } \alpha^2 - \alpha + 6 = 0$

$(\alpha - 3)(\alpha + 2) = 0$ or $\alpha = \frac{1 \pm \sqrt{1-24}}{2\times1}$

$\alpha = 3 \text{ or } -2$ $\quad = \frac{1}{2} \pm i\frac{\sqrt{23}}{2}$

$\therefore \text{tr}(A) = 2\alpha$

= 6 or –4 or 1 (Real part)

$|A| = \alpha^2 = 9$ or 4

54. A, B, D

Sol. $\because \begin{vmatrix} x & \sin x & 1+\sin x \\ 1 & \cos x & \cos x \\ 0 & \sin x & \sin x \end{vmatrix} = 0$

$\Rightarrow x = (2n+1)\frac{\pi}{2}$

55. C

Sol. $\because f(x) = \frac{4}{3}\sqrt{1-x^2} - \frac{\pi}{12}$

$\therefore$ range is $\left[-\frac{\pi}{12}, \frac{4}{3}, -\frac{\pi}{12}\right]$

56. A

SECTION – C

57. 4

Sol. $\sqrt{2(a^2+b^2)} = 4 \Rightarrow a^2+b^2 = 8$

$\therefore \frac{a^2+b^2}{2} \ge ab$

$\Rightarrow ab \le 4$

58. 2

Sol. $\because f(x) = \sum_{i=1}^{\infty}\left[\frac{1}{(i-1)x+1} - \frac{1}{ix+1}\right]$

$\Rightarrow f(x) = \lim_{n\to\infty}\left[1 - \frac{1}{nx+1}\right]$

$\Rightarrow f(x) = 1$

$\therefore f\left(\frac{1}{x}\right) = 1$

$\Rightarrow f(x) + f\left(\frac{1}{x}\right) = 2$

59. 4

Sol. $\because \tan^{-1}x \ge \frac{2\pi}{3} - \frac{\pi}{2}$ for $-1 \le 2 - x^2 \le 1$

$\Rightarrow \tan^{-1}x \ge \frac{\pi}{6}$ $\qquad -3 \le -x^2 \le -1$

$x \ge \frac{1}{\sqrt{3}}$ $\qquad 1 \le |x| \le \sqrt{3}$

$\therefore 1 \le x \le \sqrt{3}$

$\therefore$ have no solution for x < 1 or $x > \sqrt{3}$

So, $\alpha_{\max} = 1$ and $\beta_{\min} = \sqrt{3}$

60. 4

Sol. $I = \int\limits_1^2 \frac{x^3 - 3x^2}{\ln(x-1)}$ and $J = \int\limits_2^3 \frac{3x-5}{\ln(x-2)}$

$$\Rightarrow J = \int\limits_1^2 \frac{3x-2}{\ln(x-1)}$$

$$J + I = \int\limits_1^2 \frac{x^3 - 3x^2 + 3x - 2}{\ln(x-1)} = \int\limits_1^2 \frac{(x-1)^3 - 1}{\ln(x-1)} dx$$

$$= \int\limits_1^2 \frac{(x-1)^3 - 1}{\ln(x-1)} dx = \int\limits_0^1 \frac{x^3 - 1}{\ln x} dx = \ln 4$$

$\therefore e^{\ln 4} = 4$

61. 2

Sol. $\overrightarrow{OA} = a\hat{i} + b\hat{j} + c\hat{k}$ and $a^2 + b^2 + c^2 = 4$

$$\Rightarrow AB = \left(25 - 24\cos^2\frac{\theta}{2}\right)$$

$$\therefore |QD| = \frac{2}{5}\cos\frac{\theta}{2}$$

$$\Rightarrow 25|QD| = 2$$

62. 4

Sol. $\frac{3x^2 + 1}{\sqrt{x^4 + x^2}} = \frac{3x^2 + 1}{x\sqrt{x^2 + 1}} = \frac{x^2 + 1 + 2x^2}{x\sqrt{x^2 + 1}}$

$$= \frac{\sqrt{x^2 + 1}}{x} + \frac{2x}{\sqrt{x^2 + 1}} \geq 2\sqrt{2}$$

$$f(x) = 2\sqrt{2}$$

$$\therefore x^2 + 1 = 2x^2$$

$$x^2 = 1$$

$x = \pm 1$ $\quad$ $x = 1$

$$\int\limits_0^{\sqrt{2}} \frac{(3x^2 + 1)dx}{\sqrt{x^4 + x^2}} \geq 2\sqrt{2} \times \sqrt{2} = 4$$

63. 2

Sol. Given $a_{11} = b_{11}$, $a_{22} = b_{22}$, $a_{12} = -b_{12}$, $a_{21} = -b_{21}$

and $AB = BA = I$

$$\Rightarrow A = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{11} \end{pmatrix} \text{ and } |A| = 1$$

$$\therefore a_{11}^2 - a_{12}a_{21} = 1$$

$$a_{12}a_{21} = a_{11}^2 - 1$$

$$\Rightarrow a_{12} \text{ or } a_{21} = (a_{11} - 1) \text{ or } (a_{11} + 1)$$

$$\Rightarrow |a_{12} - a_{21}| = 2$$

64. 5

Sol. $f(x) = \frac{(\sqrt{5}-1)}{2x} \Rightarrow f(2) = \frac{\sqrt{5}-1}{4} = \sin\frac{\pi}{10}$

$\Rightarrow \sin^{-1}(f(2)) = \frac{\pi}{10}$

65. 5

Sol. $\because (r^2 - 4r + 2)S_r$

$\therefore \sum_{r=3}^{r=2011} \left|(r^2 - 4r + 2)S_r\right| = \frac{r-1}{\underline{|r-3}} - \frac{r}{\underline{|r-2}}$

66. 5

Sol. $\lim_{x\to 0} \frac{a\tan x - b\sin x + cx^2 - x}{x^3} = \frac{3}{2}$

Then, $\frac{0}{0}$ form $\Rightarrow \lim_{x\to 0} \frac{a\sec^2 x - b\cos x + 2cx - 1}{3x^2}$

Now, $\frac{0}{0}$ form means $a - b - 1 = 0$ ………….. (1)

Again L'Hospital rule,

$\lim_{x\to 0} \frac{2a\sec^2 x\tan x + b\sin x + 2c}{6x}$

$\frac{0}{0}$ form means c = 0

$\lim_{x\to 0} \frac{2a\sec^2 x + 6a\tan^2 x\sec^2 x + b\cos x}{6}$

$\frac{0}{0}$ form means $\frac{2a+b}{6} = \frac{3}{2} \Rightarrow 2a + b = 9$ ……….. (2)

$\therefore 3a = 10$ and $b = \frac{10}{3} - 1$

$a = \frac{10}{3}$ and $b = \frac{7}{3}$

$\therefore a + b + c = \frac{17}{3} = 5.66...... \Rightarrow [a + b + c] = 5$

SECTION – D

67. 00003.20

Sol. $\because 2\cos\theta_1 = \frac{8}{5} \Rightarrow \cos\theta_1 = \frac{4}{5} \Rightarrow \tan\frac{\theta_1}{2} = \sqrt{\frac{1-\frac{4}{5}}{1+\frac{4}{5}}} = \frac{1}{3}$ and $e = \frac{1}{2}$

$$\therefore \tan\frac{\theta_2}{2} \times \frac{1}{3} = \frac{-\frac{1}{2}}{\frac{3}{2}}$$

$$\frac{\theta_2}{2} = \frac{3\pi}{4} \Rightarrow \theta_2 = \frac{3\pi}{2}$$

$$\therefore B = \left(0,\ -\sqrt{3}\right) \Rightarrow AB = 2+2-\frac{1}{2}\times\frac{8}{5} = 4-\frac{4}{5} = \frac{16}{5}$$

68. 00540.00

Sol. $\because a_1^2+b_1^2+c_1^2+a_2^2+b_2^2+c_2^2+a_3^2+b_3^2+c_3^2 = 7$, where $\langle a_i,\ b_i,\ c_i\rangle$ are elements of i^{th} row.

$\therefore$ Case I: All seven entries are 1 and rest of all zero

${}^9C_7 = {}^9C_2 = 36$

Case II: Only one entry is 2 & three entries are 1 and rest of all 0's.

${}^9C_4 \times {}^4C_1 = 504$

$\therefore$ Total = 540

69. 00000.75

Sol. Let $t = \log_{(3x+4)}(2x+1)$

$\Rightarrow \quad 2t + \frac{1}{t} = 3 \quad \Rightarrow \quad t = 1$ or $\frac{1}{2}$

$\log_{(3x+4)}(2x+1) = \frac{1}{2} \Rightarrow x = -1$ or $\frac{3}{4}$

$\therefore$ only solution is $x = \frac{3}{4}$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – IV

JEE (Main)-2019

Time Allotted: 3 Hours **Maximum Marks: 360**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only one section: **Section-A**.

Section-A (01 – 30, 31 – 60, 61 – 90) *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

PART – I

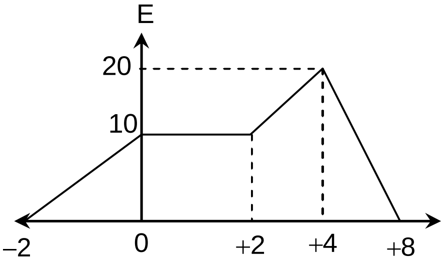
SECTION – A

(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

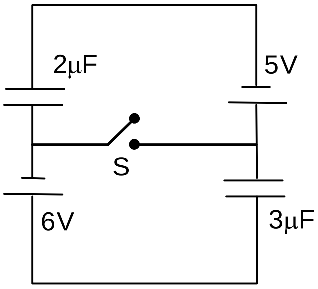
1. If Electric field directed parallel to axis is represented by graph, and potential at origin is taken as zero. Find potential at x = 8 m

(A) 90 V
(B) 100 V
(C) 80 V
(D) None



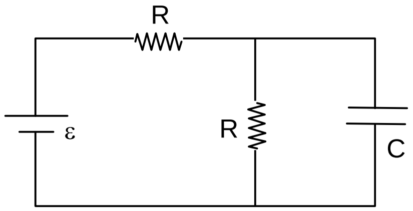
2. In the circuit shown switch S is kept open for long time. Switch is closed at t = 0, find total heat produced after closing the switch.

(A) $40\mu J$
(B) 89μJ
(C) 302.5μJ
(D) None

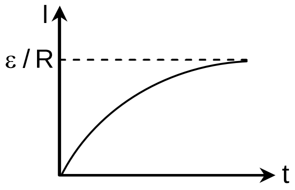


Space for Rough work

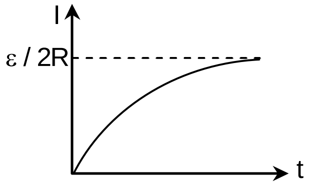
3. Consider the circuit shown in figure. If the switch is closed at t = 0. Then graph of current provided by battery as function of time is best represented by



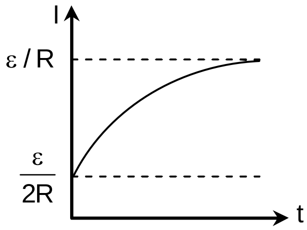
(A)



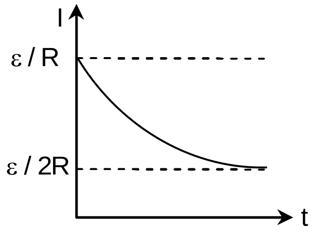
(B)



(C)

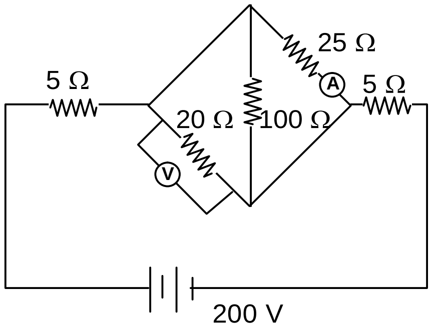


(D)



4. In the figure shown voltmeter and Ammeter are ideal. Reading of voltmeter and Ammeter respectively are

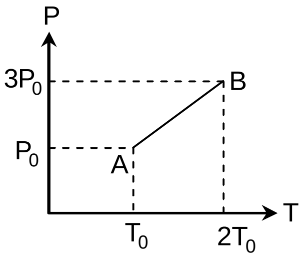
(A) 125 V, 3 A
(B) 120 V, 4 A
(C) 100 V, 4 A
(D) None



5. Pressure versus temperature graph of an ideal gas is shown in figure. If density of gas at point A is ρ_0, what is density at point B?

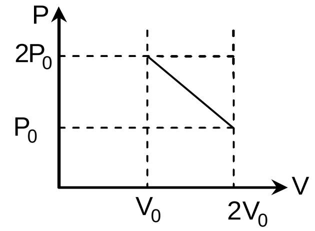
(A) $\frac{3}{4}\rho_0$ (B) $\frac{3}{2}\rho_0$

(C) $\frac{4}{3}\rho_0$ (D) $2\rho_0$



Space for Rough work

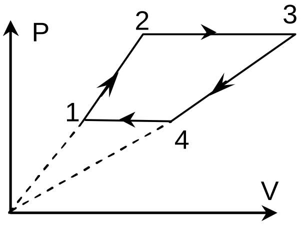
6. n moles of an ideal gas undergoes a thermodynamic process, in which pressure of gas varies linearly with volume as shown in figure. Find the maximum temperature of the gas during the process



(A) $\frac{P_0V_0}{nR}$ (B) $\frac{4P_0V_0}{nR}$

(C) $\frac{2P_0V_0}{nR}$ (D) $\frac{9P_0V_0}{4nR}$

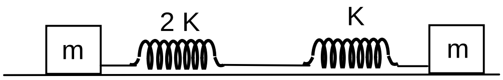
7. Three moles of an ideal monoatomic gas perform a cyclic process as shown in figure. The gas temperature in different states are $T_1 = 400$ K, $T_2 = 800$ K, $T_3 = 2400$ K and $T_4 = 1200$ K. Find the work done during the cycle



(A) 12000 R (B) 2400 R

(C) 1200 R (D) 7200 R

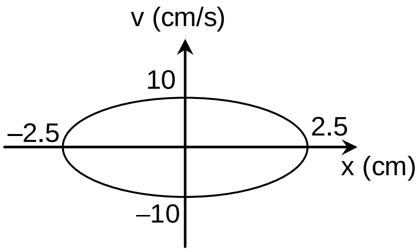
8. Time period of small oscillations of the two blocks shown in figure is



(A) $2\pi\sqrt{\frac{3m}{8k}}$ (B) $2\pi\sqrt{\frac{3m}{4k}}$

(C) $2\pi\sqrt{\frac{3m}{2k}}$ (D) None

9. If graph between velocity and displacement of a particle performing SHM is shown. Find the acceleration when the particle is at half of maximum displacement from mean position.



(A) 10 cm/s^2

(B) 20 cm/s^2

(C) 30 cm/s^2

(D) 40 cm/s^2

Space for Rough work

10. A wire of length 98 cm is stretched between two ends and extends by 2 cm. A organ pipe 50 cm long and open at both ends, when sounded with this stressed wire produces 8 beats in its fundamental mode. By decreasing stress beat frequency decreases. If density of wire is 10^4 Kg/m^3 and speed of sound in air is 292 m/s find young's modulus.

(A) $8.8\times10^{10}\,\text{N/m}^2$ (B) $4.4\times10^{10}\ \text{N/m}^2$
(C) $17.64\times10^{10}\ \text{N/m}^2$ (D) None

11. In order to detect the speed of an approaching aeroplane microwaves of wavelength 0.1 m are sent towards approaching plane and it is found that reflected waves produce 990 beats per second. The speed of the aeroplane is close to

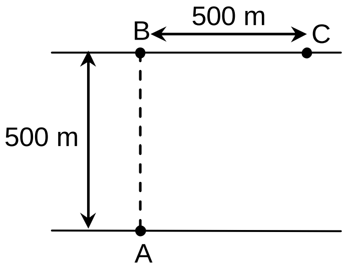
(A) 20 m/s (B) 50 m/s
(C) 35 m/s (D) None

12. From the point on the ground at a distance 30 m from the foot of a pole a ball is thrown at an angle of 45^o, which just touches the top of the pole and lands further 60 m from the foot of the pole on other side, height of the pole is

(A) 30 m (B) 45 m
(C) 22.5 m (D) 20 m

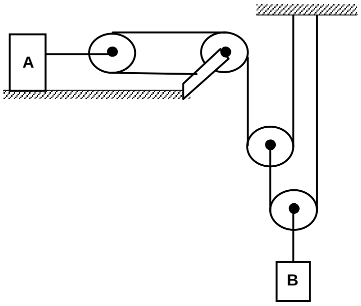
13. A river is flowing with a speed of 1 m/s. A swimmer wants to go to point C directly from point A. If he swims with a speed of 5 m/s at an angle θ with respect to water flow find θ.

(A) 37^o (B) 60^o
(C) 53^o (D) 45^o

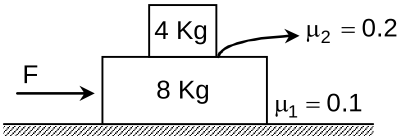


14. In the figure shown if mass of each block is m. Find the acceleration of block A.

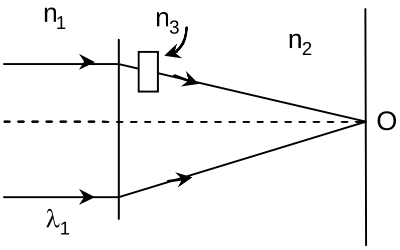
(A) 2 m/s^2 (B) 4 m/s^2
(C) 1 m/s^2 (D) None



Space for Rough work



15. What is the minimum force at which any part of the system starts sliding
(A) 6 N (B) 9 N
(C) 12 N (D) None



16. In YDSE a parallel beam of light is incident on the slit from a medium of refractive index n_1. A transparent slab having thickness t is introduced in the path of one of the interfering beam. Retractive index of slab is n_3 and medium between slits and screen is of refractive index n_2. If wavelength of light in medium of refractive index n_1 is λ_1. Find phase difference at 'O'.
(A) $\frac{2\pi}{n_2\lambda}(n_3 - n_2)t$
(B) $\frac{2\pi}{n_1\lambda}(n_3 - n_1)t$
(C) $\frac{2\pi}{n_1\lambda}(n_3 - n_2)t$
(D) None

17. An unpolarized beam of intensity I_o is incident on a pair of polaroid making an angle 60^o with each other. The intensity of light emerging from the pair is
(A) $I_o / 2$ (B) $I_o / 4$
(C) $I_o / 8$ (D) $\frac{3I_o}{4}$

18. The wavelength of K_α line from an element of atomic number 51 is λ. From another element the wavelength of K_α line is 4λ. What is the atomic number of second element?
(A) 25 (B) 26
(C) 100 (D) 99

Space for Rough work

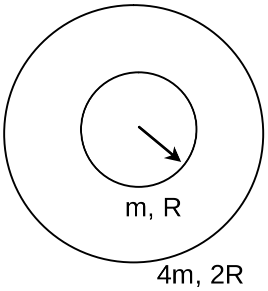
19. On illuminating the surface of a certain metal by two light of wavelengths $\lambda_1 = 350\text{ nm}$ and $\lambda_2 = 540\text{ nm}$ alternately, it is found that the ratio of maximum speeds in two cases comes out to be 2. Work function of metal is
(A) 3.22 eV (B) 5.65 eV
(C) 1.88 eV (D) None

20. Which of the following are known as universal gates?
(A) AND & OR (B) NAND & NOR
(C) NAND only (D) None

21. When the modulation percentage is 75% an AM transmitter radiates 10 KW power. How much of these is carries power?
(A) 7.8 KW (B) 7.5 KW
(C) 5 KW (D) None

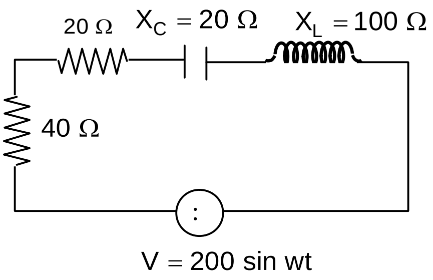
22. A rod of mass 3 kg and length 1 m is lying along the Y axis such that one of its end is at the origin. An Impulse is given to the rod due to which its end at origin acquire a velocity of 4 i and other end acquires a velocity 8 i. What is magnitude of angular momentum of rod about origin.
(A) $8\text{ kmg}^2/\text{s}$ (B) $18\text{ kgm}^2/\text{s}$
(C) $10\text{ kgm}^2/\text{s}$ (D) None

23. What is gravitational potential energy of system consisting of two concentric spherical shells of mass, m, and 4 m and radii R and 2 R.
(A) $\frac{-2Gm^2}{R}$ (B) $\frac{-9Gm^2}{2R}$
(C) $-\frac{5Gm^2}{2R}$ (D) $-\frac{13Gm^2}{2R}$

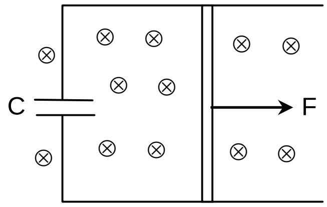


Space for Rough work

24. In figure shown the expression for potential difference across inductor is given by
(A) 200 sin wt
(B) 200 cos wt
(C) 200 sin (wt + 37^o)
(D) 200 sin (wt + 53^o)

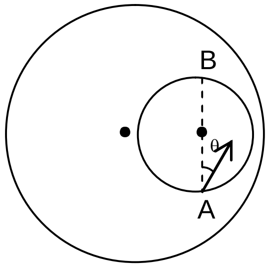


25. A uniform wire of mass m and length l slides freely along parallel rails on application of force F which starts acting at t = 0. Resistance of circuit is zero system is placed in uniform magnetic field B, perpendicular to plane of figure. What is current through capacitor at any time t. (Ignore any inductance)



(A) $\frac{BlCF}{m + B^2 l^2 C}$
(B) $\frac{BlCF}{m}t$
(C) $\frac{BlCFt^2}{m}$
(D) $\frac{BlCFt^2}{m + B^2 l^2 C}$

26. A long thick solid conductor has a cylindrical cavity of radius 1 m parallel to its axis at a distance of 2 m cylinder with cavity has a surface current density $\vec{J} = \frac{10^6}{\pi} A/m^2\ \hat{j}$. A charged particle of mass 0.1 kg and charge π coulomb is projected with velocity v at an angle of 60^o as shown in figure. For what maximum v, particle is able to strike point B?



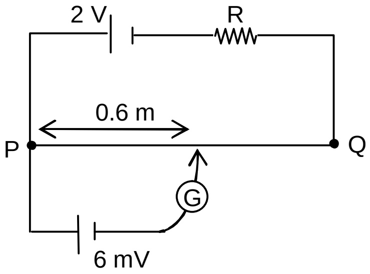
(A) 8 m/s
(B) 6 m/s
(C) 4 m/s
(D) None

Space for Rough work

27. In the shown potentiometer arrangement the wire PQ has a resistance of $5\ \Omega$ and the driver cell has an emf of 2V. If a balance point is obtained at 0.6 m along PQ, what is the value of resistance R? (Length PQ = 1 m)

(A) 495 (B) $995\ \Omega$

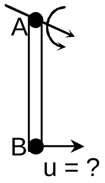
(C) $1495\ \Omega$ (D) $1995\ \Omega$



28. A particle of mass m is attached at the end B of uniform rod of same mass m and length ℓ. If the rod is whirled in vertical circle about end A, what is minimum speed of particle at end B, required to move it in vertical circle?

(A) $\sqrt{4gL}$ (B) $\sqrt{5gL}$

(C) $\sqrt{6gL}$ (D) None



29. A physical quantity a depends on two other physical quantities X and Y as $A = X^4Y^{1/4.}$ If percentage error in the measurement of A and Y are 2% and 4% respectively. Then percentage error in the measurement of X is

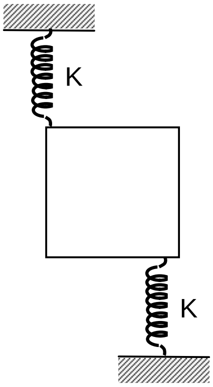
(A) less than 1% (B) more than 1% but less than 2%

(C) between 2% and 4% (D) more than 4%

30. A square plate of mass m and side length is a kept as shown in figure. In equilibrium two of its side are horizontal and too vertical. What is its angular acceleration just after lower spring is cut.

(A) g/a (B) 2g/a

(C) 3g/2a (D) 4g/a



Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. The radial probability distribution curve of an orbital of H has 4 local maxima. If orbital has 3 angular node then orbital will be

(A) 7 f
(B) 8 f
(C) 7 d
(D) 8 d

32. NX is produced by the following step of reaction

$M + X_2 \rightarrow MX_2$

$3MX_2 + X_2 \rightarrow M_3X_8$

$M_3X_8 + N_2CO_3 \rightarrow NX + CO_2 + M_3O_4$

How much M(Metal) is consumed to produce 206 g of NX? (take at. wt. of M = 56, N = 23; X= 80)

(A) 42 gm
(B) 56 gm
(C) $\frac{14}{3}$ gm
(D) $\frac{7}{4}$ gm

33. On heating vapours of S_8 (g) decomposes to S_2 (g). Due to this, the Vander Waal's constant 'b' for the resulting gas;

(A) Increases
(B) Decreases
(C) remains same
(D) changes unpredictably

34. Given wave function represents which orbital of hydrogen $\psi = \frac{1}{4}\frac{1}{\sqrt{2\pi}}\left(\frac{1}{a_o}\right)^{5/2} re^{-r/2a_o \cos\theta}$ (where $\theta =$ angle from z-axis)

(A) $2P_y$
(B) $2P_z$
(C) $3P_y$
(D) $3P_z$

Space for Rough work

35. Two solid compounds X and Y dissociate at a certain temperature in a closed container as followed:

$$X(s) \rightleftharpoons A(g) + 2B(g); k_{p_1} = 9 \times 10^{-3} atm^3$$

$$Y(s) \rightleftharpoons 2B(g) + C(g); k_{p_2} = 4.5 \times 10^{-3} atm^3$$

The total pressure of gases over a mixture of X and Y at equilibrium is

(A) 4.5 atm (B) 0.45 atm
(C) 0.6 atm (D) None of these

36. Calculate resonance enthalpy of $CO_2(g)$ from the following data:

$$\Delta H_C^o C(\text{graphite}) = -390 \text{ kJ/mol}$$

$$\Delta H_S^o C(\text{graphite}) = 715 \text{ kJ/mol}$$

$$\Delta H_{BE}^o [O = O] = 500 \text{ kJ/mol}$$

$$\Delta H_{BE}^o [C = O] = 875 \text{ kJ/mol}$$

(A) –40 kJ/mol (B) –145 kJ/mol
(C) –72.5 kJ/mol (D) –290 kJ/mol

37. A sample containing 1 mol $KHC_2O_4.H_2C_2O_4$ is titrated with different reagent. Select correct statement.

(A) $\frac{1}{3}$ mol of KOH are used

(B) 3 / 2 mol of $Ba(OH)_2$ are used

(D) $\frac{4}{5}$mol of $KMnO_4$ are used in alkaline medium

(D) $\frac{1}{3}$mol of $K_2Cr_2O_7$ are used in acidic medium

Space for Rough work

38. 1 mole of NH_3 gas at 27^oC is expanded under reversible adiabatic conditions to make volume 8 times $(\gamma = 1.33)$. Final temperature and work done respectively are

(A) 150 K, 900 cal (B) 150 K, 400 cal
(C) 250 K, 1000 cal (D) 200 K, 800 cal

39. In a compound, oxide ions are arranged in cubic close packing arrangement. Cations A occupy 1/6 of the tetrahedral voids and cations B occupy 1/3 of the octahedral voids. The formula of the compound is

(A) A_2BO_3 (B) AB_2O_3
(C) $A_2B_2O_2$ (D) ABO_3

40. Two substances $A(t_{1/2} = 5\,\text{min})$ and $B(t_{1/2} = 15\,\text{min})$ are taken in such a way that initially $[A] = 4[B]$. The time after which both the concentration will be equal is : (Assume that reaction is first order)

(A) 15 min (B) 5 min
(C) 20 min (D) concentration can never be equal

41. The reaction takes place in three steps with activation energy $E_{a_1} = 180\text{kJ/mol}$, $E_{a_2} = 80\text{kJ/mol}$, $E_{a_3} = 50\text{kJ/mol}$ respectively. Over all rate constant of the reaction is $k = \left[\dfrac{k_1k_2}{k_3}\right]^{2/3}$ $(k_1, k_2$ and k_3 are rate constant of first, second and third step). The overall activation energy will be

(A) 140 kJ/mol (B) 150 kJ/mol
(C) 43.44 kJ/mol (D) 100 kJ/mol

42. Bombardment of aluminum by $\alpha-$particle leads to its artificial disintegration in two ways (i) and (ii) as shown. Products x, y and z respectively are

$$\begin{tikzcd}
{}^{27}_{13}Al \arrow[r, "(ii)"] \arrow[d, "(i)"] & {}^{30}_{15}P + Y \arrow[d] \\
{}^{30}_{14}Si + X & {}^{30}_{14}Si + Z
\end{tikzcd}$$

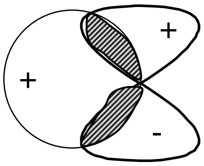
(A) proton, neutron, positron (B) neutron, positron, proton
(C) proton, positron, neutron (D) positron, proton, neutron

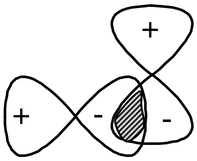
Space for Rough work

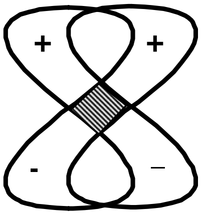
43. One mole of a compound $Co(NH_3)_5Cl_2Br$ gives 2 moles of curdy white ppt. when treated with excess of $AgNO_3$ solution. Which of the following is incorrect about the compound?
(A) The compound may be represented as $\left[Co(NH_3)_5Br\right]Cl_2$
(B) The Vant Hoff factor (i) is 3, when $\alpha = 1$
(C) The B.P of 1 M aq. Solution of $Co(NH_3)_5Cl_2Br$ should be triple of its value, when it were non electrolyte.
(D) The osmotic pressure of 1 M aq. Solution of $\left[CO(NH_3)_5Br\right]Cl_2$ should be triple of its value when it were electrolyte.

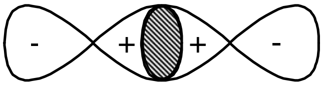
44. At 40^oC, vapour pressure in torr of methanol and ethanol solution is $P = 119X + 135$: where X is the mole fraction of methanol. Hence
(A) Vapour pressure of pure methanol is 119 torr.
(B) Vapour pressure of pure ethanol is 135 torr
(C) Vapour pressure of equimolar mixture of each is 127 torr.
(D) Mixture is completely immiscible.

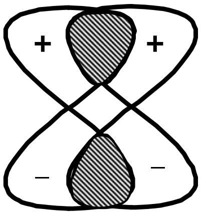
45. Which of the following atomic orbital overlapping are not allowed?

(P)


(Q)


(R)


(S)


(T)


(A) All of these
(B) (P) (Q) (R)
(C) (P) (R) (T)
(D) (Q) only

Space for Rough work

46. The order of $p\pi - d\pi$ interaction in the compounds containing bond between Si/P/S/Cl and oxygen is in the order:

(A) $P > Si > Cl > S$ (B) $SI < P < S < Cl$

(C) $S < Cl < P < Si$ (D) $Si > P > S > Cl$

47. Select the **incorrect** statement.

(A) Br_2 and ICl have the same number of electrons and thus, both have nearly the same boiling points.

(B) N_2H_4 is pyramidal about each N-atom.

(C) In P_4S_3 molecule, there are six P–S bonds, three P–P bonds are then lone pairs of electrons (on all atoms).

(D) In ClO_4^-, all $Cl - O$ bonds are identical and there is strong $p\pi - d\pi$ bonding between chlorine and oxygen atoms.

48. The diamagnetic complex which has two geometrical and 4 optically active isomers is

(A) $\left[Co(gly)_3\right]$ (B) $\left[Pt(en)_2 Cl_2\right]^{2+}$

(C) $\left[Co(en)_3\right]^{3+}$ (D) $\left[Fe(Ox)_3\right]^{3-}$

49. Among the following metal carbonyl carbonyls, the C–O bond is strongest in

(A) $\left[Mn(CO)_6\right]^{+}$ (B) $\left[Cr(CO)_6\right]$

(C) $\left[V(CO)_6\right]^{-}$ (D) $\left[Ti(CO)_6\right]^{2-}$

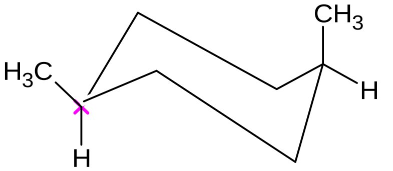
50. Which **does not** represent **correct** method?

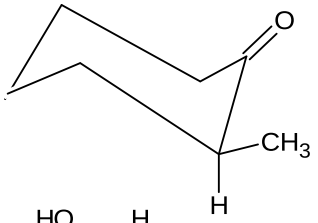
(A) $TiCl_2 + 2Mg \rightarrow Ti + 2MgCl_2$: Kroll (B) $Ni(CO)_4 \rightarrow Ni + 4CO$ Mond

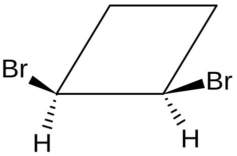
(C) $Ag_2CO_3 \rightarrow 2Ag + CO_2 + O_2$: Van Arkel (D) $ZrI_4 \rightarrow Zr + 2I_2$: Van Arkel

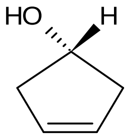
Space for Rough work

51. Which of the following molecules is chiral?

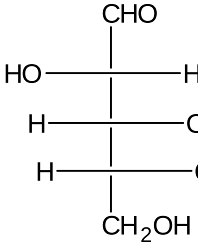
(A)


(B)


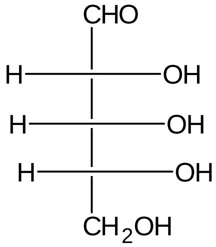
(C)


(D)


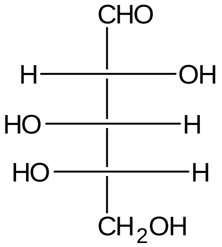
52. The correct statement about the compounds I, II and III:


CHO
HO
H
H
OH
H
OH
CH2OH

I


CHO
H
OH
H
OH
H
OH
CH2OH

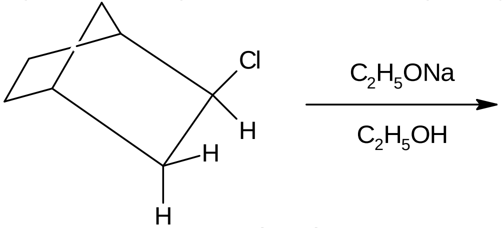
II

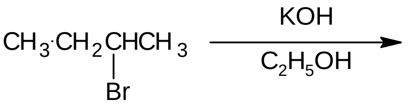

CHO
H
OH
HO
H
HO
H
CH2OH

III

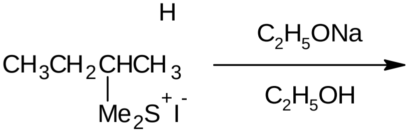
(A) II and III are epimers
(B) I and II are epimers
(C) I and III are diastereomers
(D) I and III are identical

53. Among the following, the one that undergoes syn-E2 reaction almost exclusively is

(A)

Cl
H
H
H
C2H5ONa
C2H5OH

(B)


$CH_3\cdot CH_2\underset{\overset{|}{Br}}{C}HCH_3 \xrightarrow[C_2H_5OH]{KOH}$

(C)


$CH_3CH_2\underset{\overset{|}{Me_2\overset{+}{S}\,I^-}}{C}HCH_3 \xrightarrow[C_2H_5OH]{C_2H_5ONa}$

(D) $(CH_3)_3CBr \xrightarrow[C_2H_5OH]{C_2H_5ONa}$

Space for Rough work

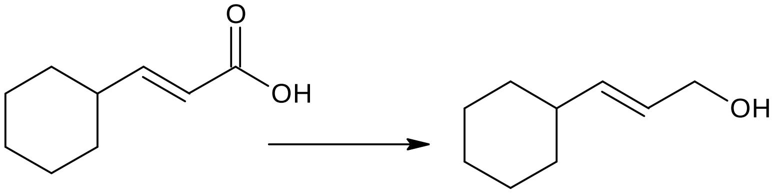
54. Consider the reaction

$CH_3CH = CH_2 \xrightarrow[2.\ CH_3COOH]{1.\ B_2D_6}$ The final product formed is

(A) CH_3CHDCH_3 (B) $CH_3CH_2CH_2D$

(C) CH_3CHDCH_2D (D) $CH_3CHDCH_2OCOCH_3$

55. In order to achieve the conversion

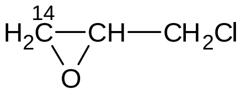


Which of following reducing agents should be employed?

(A) $NaBH_4$ (B) H_2, Ni

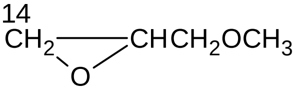
(C) $LiAlH_4$ (D) $\left[(CH_3)_2CHO\right]_3Al, (CH_3)_2CHOH$

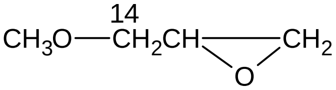
56. For the reaction:

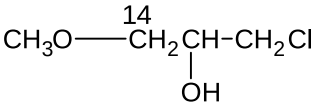


$+ CH_3O^- \xrightarrow{CH_3OH}$ (A) major product.

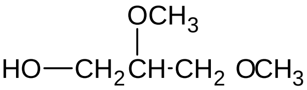
(A) is

(A) 

(B) 

(C) 

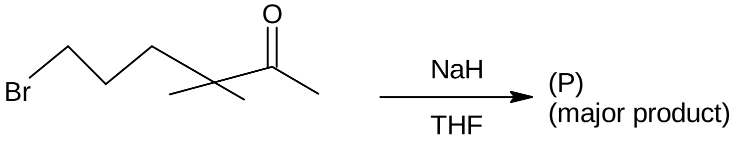
$CH_3O—\overset{14}{C}H_2\underset{\substack{|\\OH}}{CH}-CH_2Cl$

(D) 

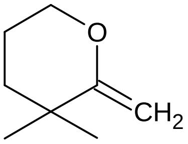
$HO—CH_2\overset{\substack{OCH_3\\|}}{CH}\cdot CH_2\ OCH_3$

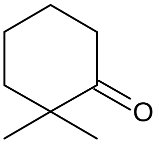
Space for Rough work

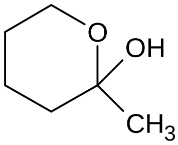
57. For the reaction

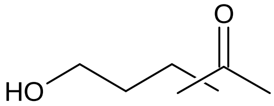

Br
O
NaH
THF
(P)
(major product)

the major product (P) is

(A)


(B)


(C)


(D)


58. Which of the following carboxylic acids undergoes decarboxylation most readily on heating?

(A) $C_6H_5CH(NH_2)COOH$

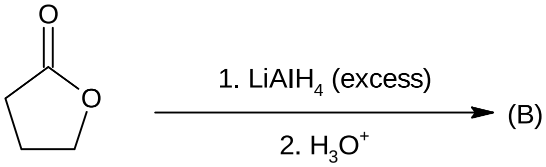
(B) $C_6H_5CH(OH)COOH$

(C) $C_6H_5COCOOH$

(D) $C_6H_5COCH_2COOH$

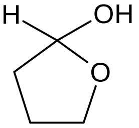
Space for Rough work

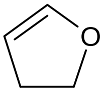
59. γ – Butyrolactone, (A), is reduced with $LiAlH_4$;


O
O
1. $LiAlH_4$ (excess)
2. H_3O^+
(B)

(A)

The product (B) is

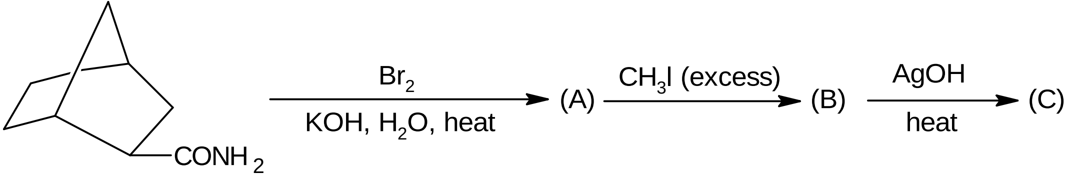
(A)


(B)


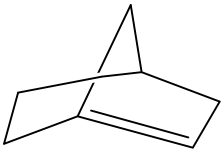
(C) $HOCH_2CH_2CH_2OH$

(D) $CH_3CH_2CH_2CH_2OH$

60. Consider the following sequence of reactions.


CONH 2
Br_2
KOH, H_2O, heat
(A)
CH_3I (excess)
(B)
AgOH
heat
(C)

The end product (C) is

(A)


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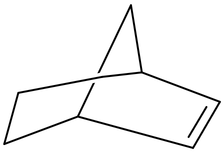
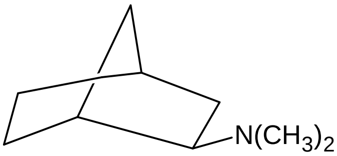
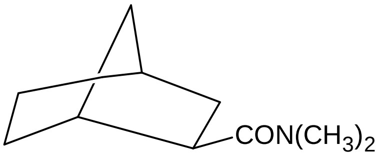


(C)


(D)


Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. If equation of hyperbola touching x-axis and lines $x-2y=0$, $x+y+1=0$ as its asymptotes is $\alpha(x-2y)(x+y+1)+\beta=0$ $(\alpha, \beta \in N$ and their H.C.F is $1)$, then value of $\alpha-\beta$ is
(A) 1 (B) 2
(C) 3 (D) 4

62. Let $f(y)=\int_0^1 e^{x-y^2}\left(x^3-2xy+3x^2-2y\right)dx$, then $\int_0^1 e^y f(y)dy$ is equal to
(A) 1 (B) $e-1$
(C) 0 (D) e^2-2e

63. If $x^2-2x+2\sin\alpha=0$ has unique root in $(-1,1)$, then length of largest continuous interval of α in $[0, 2\pi]$ is
(A) $\frac{\pi}{6}$ (B) $\frac{\pi}{3}$
(C) $\frac{5\pi}{6}$ (D) $\frac{7\pi}{6}$

64. Difference of maximum and minimum value of $f(x)=\sqrt{\cos^{-1}[x-2]}$ is $([.]$ is G.I.F$)$
(A) $\sqrt{\pi}$ (B) $\frac{\sqrt{\pi}}{2}$
(C) $\sqrt{\pi}\left(\frac{\sqrt{2}-1}{\sqrt{2}}\right)$ (D) π

Space for Rough work

65. Let K is number of outcomes by throwing 5 identical dice then maximum values of λ for which 2^{λ} divides K is
(A) 2 (B) 3
(C) 4 (D) 6

66. Tangent to parabola $y^2 = 4p(x+1)$ cuts hyperbola $xy = 2$ in A and B, then locus of mid points of AB is
(A) $\frac{x}{y} + (2x-1) = 0$ (B) $\frac{x^2}{y^2} + 2x - 1 = 0$
(C) $\frac{x}{y} + (2x-1)^2 = 0$ (D) $\frac{x^2}{y^2} + (2x+1) = 0$

67. Let $|z+i| - z + i = \theta$, then arrangements of z can't be
(A) $-\frac{\pi}{2}$ (B) $-\frac{\pi}{4}$
(C) $-\frac{\pi}{6}$ (D) $-\frac{3\pi}{4}$

68. There are two bags, bag 1 contains 3 white and 2 red balls and bag 2 contains 4 white and 5 red balls. A ball is drawn randomly from bag 1 and put in bag 2. Now 2 balls are drawn from bag 2 and found to be red. Then the probability that white ball was drawn from bag 1 to bag 2 is
(A) $< \frac{1}{2}$ (B) $< \frac{1}{4}$
(C) $> \frac{3}{4}$ (D) $> \frac{1}{4}$

69. Value of $\frac{5}{(2+4)^2} + \frac{7}{(2+4+6)^2} + \frac{9}{(2+4+6+8)^2} + ...\infty$ is
(A) $\frac{1}{9}$ (B) $\frac{1}{8}$
(C) $\frac{1}{4}$ (D) $\frac{1}{2}$

Space for Rough work

70. Let $f: R \to R$ such that $f(x+2y) = f(x) + f(2y) + 4xy$, $x, y \in R$ and $f'(0) = 0$.
If $I_1 = \int_0^1 f(x)dx, I_2 = \int_{-1}^0 f(x)dx, I_3 = \int_{1/2}^2 f(x)dx$, then
(A) $I_1 = I_2 > I_3$
(B) $I_1 > I_2 > I_3$
(C) $I_1 = I_2 < I_3$
(D) $I_1 < I_2 < I_3$

71. Value of $\lim_{n\to\infty} \sum_1^{4n} \frac{\sqrt{n}}{\sqrt{r}\left(3\sqrt{r} + 4\sqrt{n}\right)^2}$ is equal to
(A) $\frac{1}{35}$
(B) $\frac{1}{14}$
(C) $\frac{1}{10}$
(D) $\frac{1}{5}$

72. Normal to a curve at a point P (x, y) meets the x-axis at G. If distance of G from the origin is twice the abscissa of P, then the curve is
(A) Parabola
(B) Circle
(C) Ellipse
(D) Hyperbola

73. The area inside parabola $5x^2 - y = 0$ but outside the parabola $2x^2 - y + 9 = 0$ is
(A) $12\sqrt{3}$ sq. unit
(B) $6\sqrt{3}$ sq. unit
(C) $8\sqrt{3}$ sq. unit
(D) $4\sqrt{3}$ sq. unit

74. Minimum value of $n\sin\alpha + \frac{1}{n}\cos\alpha$, where $n > 0$ and α is fixed in (0, 1), is
(A) $\sqrt{n^2 + n^{-2}}$
(B) $\sqrt{\sin 2\alpha}$
(C) 0
(D) $\sqrt{2\sin 2\alpha}$

75. Let A and B are two events. If $P(A) = 0.4, P(B/A) = 0.9, P(\bar{B}/\bar{A}) = 0.6$, then which is not correct?
(A) $P(A \cup B) = .64$
(B) $P(A \cap B) = .36$
(C) $P(A/B) = 0.6$
(D) $P(A/\bar{B}) = 0.2$

Space for Rough work

76. If $y = mx$ bisect two chords of $y^2 = 4x$ from $(4, 4)$, then m can't be

(A) $m = \frac{3}{4}$ (B) $m = \frac{1}{2}$

(C) $m = \frac{5}{6}$ (D) $m = -\frac{1}{2}$

77. Number of circular arrangement of 11 identical green balls, 1 red, 1 white and 1 blue ball is

(A) ${}^{13}P_2$ (B) ${}^{13}P_{11}$

(C) ${}^{14}C_2$ (D) ${}^{14}P_{11}$

78. If $f(x)$ be differentiable function and curve $y = f(x)$ passes through (1, 1) and satisfies the relation $2f(x+y) + f(x-y) + 3y^2 = 3f(x) + 2xy$, then $\lim_{x\to1} \frac{f(x)-1}{x-1}$ is equal to

(A) 3 (B) 0

(C) 2 (D) 1

79. Given two real sets $A = \{a, a_2, a_3 \cdots a_{2n}\}$ and $B\{b_1, b_2, \cdots b_n\}$. If $f : A \to B$ is a function such that every element of B has an inverse image and $f(a_1) \le f(a_2) \le f(a_3) \le f(a_4) \cdots \le f(a_{2n})$, then the number of such mappings are

(A) ${}^{2n}C_n$ (B) ${}^{2n}C_{n-1}$

(C) ${}^{2n-1}C_{n-1}$ (D) ${}^{2n+1}C_n$

80. If A = 30^o and area of triangle ABC is $\frac{\sqrt{3}}{4}a^2$, then the triangle ABC is

(A) Right angled (B) Acute angled

(C) Obtuse angled (D) None of these

81. If α, β are roots of equation $ax^2 + bx + c = 0$, then the system of equation

$x + y\cos(\beta - \alpha) + z\cos\alpha = 0$

$x\cos(\alpha - \beta) + y + z\cos\beta = 0$

and $x\cos\alpha + y\cos\beta + z = 0$ has

(A) only trivial solution (B) has non trivial solution

(C) unique solution (D) exactly 3 solution

Space for Rough work

82. If A, B, C are angles of a triangle such that $\lim_{x\to\infty}\left[\frac{\sin\left(Ax^2+Bx+C\right)}{\sin\left(Cx^2+Bx+A\right)}+\frac{\cos\left(Ax^2+Cx+B\right)}{\cos\left(Cx^2+Ax+B\right)}\right]=\frac{2}{\sqrt{3}}$, $\angle B = 30^\circ$ and perimeter of triangle is $4+2\sqrt{3}$ then area of triangle is

(A) $\sqrt{3}$ sq. unit
(B) 2 sq. unit
(C) $\frac{1}{2}$ sq. unit
(D) $3\sqrt{3}$ sq. unit

83. Consider the polynomial $f(x)=2x^4-ax^3+2bx^2+cx-d$, where $a,b,c,d\in R$ and $f(i)=f(3+i)=0$, then the value of b + d is

(A) –5
(B) –9
(C) 11
(D) 7

84. If z is a complex number such that $\arg z(1+\bar{z})+\arg\left(\frac{|z|^2}{z-|z^2|}\right)=0$, then

(A) $\arg\bar{z}=-\frac{\pi}{2}$
(B) $\arg z=\frac{\pi}{4}$
(C) $|\bar{z}|<1$
(D) $\ln\left(\frac{1}{|z|}\right)\in(-\infty,\ \infty)$

85. If $\sum_{n=1}^{k}\left[\frac{1}{3}+\frac{n}{90}\right]=21$, where [x] denotes the integral part of x, then k is equal to

(A) 84
(B) 80
(C) 85
(D) 86

86. A hat contains a number of cards with 30% white on both sides, 50% black on one side and white on the other side, 20% black on both sides. The cards are mixed up, and a single card is drawn at random and placed on the table. Its upper side shows up black. The probability that its other side is also black is

(A) 2/9
(B) 4/9
(C) 2/3
(D) 2/7

Space for Rough work

87. A man is moving away from a tower 41.6 m high at a rate of 2 m/s. If the eye level of the man is 1.6 m above the ground, then the rate at which the angle of elevation of the top of the tower changes, when he is at a distance of 30 m from the foot of the tower, is

(A) $-\frac{4}{125}$ radian/s	(B) $-\frac{2}{25}$ radian/s
(C) $-\frac{1}{625}$ radian/s	(D) None of these

88. The value of the expression $2(1+\omega)(1+\omega^2)+3(2\omega+1)(2\omega^2+1)+4(3\omega+1)(3\omega^2+1)+..........$ $..........+(n+1)(n\omega+1)(n\omega^2+1)$ is (ω is a complex cube root of unity)

(A) $\frac{n^2(n+1)^2}{4}$	(B) $\left(\frac{n(n+1)}{2}\right)^2+n$
(C) $\left(\frac{n(n+1)}{2}\right)^2-n$	(D) $\frac{n^2(n+1)^2}{2}$

89. The number of solutions of $\sec^2\theta\operatorname{cosec}^2\theta+2\operatorname{cosec}^2\theta=8,\ 0\le\theta\le\pi/2$ is

(A) 4	(B) 3
(C) 0	(D) 2

90. $\sum_{m=1}^{n}\tan^{-1}\left(\frac{2m}{m^4+m^2+2}\right)$ is equal to

(A) $\tan^{-1}\left(\frac{n^2+n}{n^2+n+2}\right)$	(B) $\tan^{-1}\left(\frac{n^2-n}{n^2-n+2}\right)$
(C) $\tan^{-1}\left(\frac{n^2+n+2}{n^2+n}\right)$	(D) None of these

Space for Rough work

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ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. A

Sol. Use relation $\Delta V = -\int \vec{E}.d\vec{r}$

2. A

Sol. Heat produced = work done by battery – energy change in capacitor

3. D

Sol. Initial current is $\frac{\varepsilon}{R}$ and final steady current is $\frac{\varepsilon}{2R}$.

4. C

Sol. Basic concept: Kirchoff's law

5. B

Sol. Using $P = \frac{\rho RT}{M}$

6. D

Sol. Maximum temperature is at midpoint of straight line.

7. C

Sol. Area under PV cycle gives work done.

8. B

Sol. $k_{eff} = \frac{2k}{3}$

$m_{eff} = \frac{m}{2}$

9. B

Sol. Speed $v = \omega\sqrt{A^2 - x^2}$ and $|\vec{a}| = \omega^2 |\vec{x}|$

10. C

Sol. Using $T = \frac{YA}{\ell}.\Delta\ell,\ f = \frac{1}{2\ell}\sqrt{\frac{T}{\mu}}$

11. B

Sol. Basic concept of Doppler's effect.

12. D

Sol. Using $y = x\tan\theta\left(1 - \frac{x}{R}\right)$

13. C

Sol. Resultant $\vec{v}$ should be along $\overrightarrow{AC}$.

14. B

Sol. Using constraint: $a_A = 2a_B$ and writing equation of motion & solving we get the answer.

15. C

Sol. There is no friction between blocks until 8 kg block moves.

16. C

Sol. Basic concept.

17. C

Sol. After 1st polarizer intensity becomes $\frac{I_0}{2}$ and after that changes by $\cos^2\theta$ times.

18. B

Sol. Using Moseley's aw.

19. C

Sol. Basic concept: $h\nu - \phi = KE$

20. B

Sol. Basic concept.

21. A

Sol. $P_{total} = \left(1 + \frac{m^2}{2}\right)P_{carrier}$

22. C

Sol. $\vec{L} = m\vec{r}_{cm} \times \vec{v}_{cm} + I_{cm}\vec{\omega}$

23. D

Sol. Total energy equals sum of self energy of two shells and their mutual energy.

24. C

Sol. Current in inductor lags voltage by $\frac{\pi}{2}$.

25. A

Sol. Using $\frac{q}{C} = vB\ell$ and $F - i\ell B = m\frac{dv}{dt}$

26. A

Sol. Magnetic field inside cavity is uniform, so particle goes in helical path.

27. B

Sol. Basic concept of potentiometer.

28. D

Sol. $\frac{1}{2}I_A\left(\frac{u}{L}\right)^2 = 2mg\left(\frac{3L}{2}\right)$

29. A

Sol. $X = A^{\frac{1}{4}}.Y^{\frac{1}{16}}$

$$\frac{\delta X}{X} = \frac{1}{4}\frac{\delta A}{A} + \frac{1}{16}\frac{\delta Y}{Y}$$

30. C

Sol. Torque about CM = $I_{cm}.\alpha$

Chemistry PART – II

SECTION – A

31. A

Sol. $n - l = 4$

$l = 3$

i.e $n = 7$

$\therefore 7f$

32. A

Sol. $M + X_2 \rightarrow MX_2;\ 3MX_2 + X_2 \rightarrow M_3X_8$

$M_3X_8 + 4N_2CO_3 \rightarrow 8NX + 4CO_2 + M_2O_4$

$\frac{206}{103} \times \frac{1}{8} \times 3 \times 56 = 42$ gm

33. B

Sol. When S_8 decomposes to S_2; size $\downarrow$;b $\downarrow$

34. B

Sol. $R(r) = kr^l\ Le^{-r/na_o}$

$\therefore l = 1$

$n = 2$

$2P_z\left[\text{for } P_z,\ \text{xy plane is nodal plane; } \cos 90^o = 0\right]$

35. B

Sol. $X(s) \rightleftharpoons A(g) + 2B(g)$

$\qquad\qquad P_1 \qquad 2P_1 + 2P_2$

$Y(s) \rightleftharpoons 2B(g) \quad + \quad C(g)$

$\qquad\qquad 2P_1 + 2P_2 \quad P_2$

Total pressure = $P_1 + P_2 + 2P_1 + 2P_2 = 3(P_1 + P_2)$

$k_{p_1} = 4P_1(P_1 + P_2)^2; k_{p_2} = 4P_2(P_1 + P_2)^2$

$k_{p_1} + k_{p_2} = 4(P_1 + P_2)^3; P_1 + P_2 = 1.5 \times 10^{-1}$

36. B

Sol. $C(s) + O_2(g) \rightarrow CO_2(g)$

$715 + 500 - 1750 - \text{R. E.} = -390$

$\text{R.E} = -145$ kJ/mol

37. B

Sol. $\because$ 1 mol of $KHC_2O_4.H_2C_2O_4$ will have basicity = 3

$\therefore$ moles of $Ba(OH)_2$ required = 3/2

38. A

Sol. $T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$

$$T_2 = \frac{300}{8^{0.33}} = 150K$$

$$W = \frac{nR\Delta T}{\gamma-1} = \frac{-1\times 2\times 150}{0.33} = -900 \text{ cal}$$

39. D

Sol. since O^{-2} ions occupy ccp; $\therefore O^{-2} = 4$

Number of A = $8\times\frac{1}{6} = 4/3$

Number of B = $4\times\frac{1}{3} = 4/3$

$\therefore$ Formula $A_{\frac{4}{3}}B_{\frac{4}{3}}O_4 = ABO_3$

40. A

Sol. After 15 min. concentration of B = B/2 and that of A = B/2.

41. A

Sol. $E_a\left(\text{over all}\right) = \frac{2}{3}\left(Ea_1 + Ea_2 - Ea_3\right)$

$= \frac{2}{3}\left(180 + 80 - 50\right)$

$= 140$ kJ/mol

42. A

Sol. ${}^{27}_{13}Al + {}^{4}_{2}He \xrightarrow{(i)} {}^{30}_{14}Si + {}^{1}_{1}H\left(X\right)$

$$\begin{array}{l} {}^{27}_{13}Al + {}^{4}_{2}He \xrightarrow{(ii)} {}^{30}_{15}P + {}^{1}_{0}n\left(Y\right) \\ \qquad\qquad\qquad\quad\ \downarrow \\ \qquad\qquad\qquad\ {}^{30}_{14}Si + {}^{0}_{+1}e\left(Z\right) \end{array}$$

43. C

Sol. If it will not dissociate then will not show abnormal value.

44. B

Sol. For pure ethanol $X_{\text{methanol}} = 0$

$\therefore P = 135$

45. B

Sol. Fact.

46. B

Sol. From Si to Cl in 3rd period, decreasing size increases strength of $p\pi - d\pi$ bond with oxygen.

47. A

Sol. ICl is polar and has stronger I.M.F.

48. A
Sol. Fact.

49. A
Sol. As charge on C.A. ↓, C – O bond strength ↑, or C – O bond order ↑, or C – O bond length ↓.

50. C
Sol. Fact.

51. B
Sol. Does not contain any element of symmetry.

52. B
Sol. Epimers are the compounds having different orientation of groups about a particular carbon.

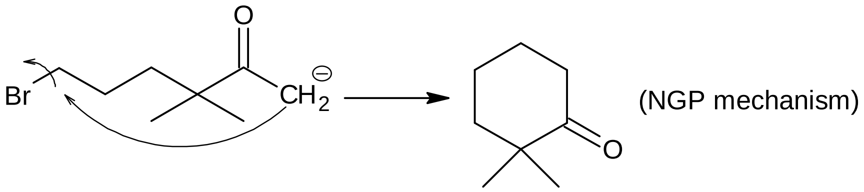
53. A
Sol. In cyclic compounds only the groups existing in same plane can undergo elimination.

54. A
Sol. Hydroboration – oxidation reaction.

55. C
Sol. LAH does not reduce C=C.

56. B
Sol. NGP mechanism.

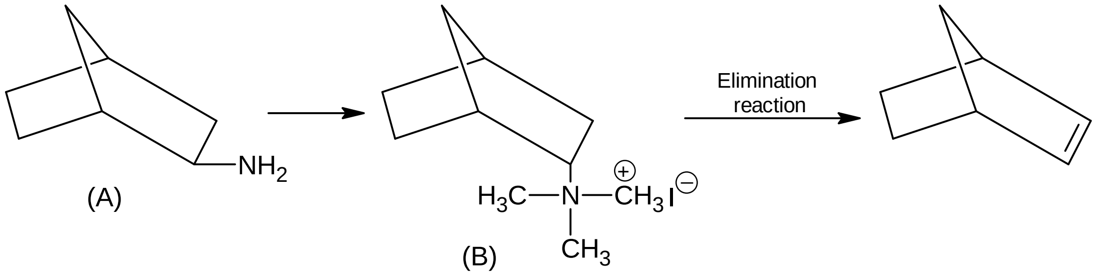
57. B
Sol.


O
Br
$CH_2^{\ominus}$
O
(NGP mechanism)

58. D
Sol. β-keto carboxylic acid undergo elimination most easily.

59. C
Sol. Fact.

60. B
Sol.


NH2
(A)
$H_3C-\overset{\oplus}{N}-CH_3\,I^{\ominus}$
CH3
(B)
Elimination reaction

Mathematics PART – III

SECTION – A

61. C

Sol. Let hyperbola is $(x-2y)(x+y+1)-\lambda=0$

since it touches x-axis $(y=0)$

$$x(x+1)-\lambda=0$$

$D=0\Rightarrow\lambda=-\frac{1}{4}$ so $\alpha=4,\beta=1$

62. C

Sol. $f(y)=e^{-y^2}\int_0^1 e^x\left(x^3-2xy+3x^2-2y\right)dx$

$=e^{-y^2}\left[e^x\left(x^3-2xy\right)\right]_0^1=e^{-y^2}\left(e\left(1-2y\right)-0\right)=e^{\left(1-y^2\right)}\left(1-2y\right)$

$\therefore\int_0^1 e^y f(y)dy=\int_0^1 e^{y+1-y^2}\left(1-2y\right)dy$

$=\int_1^1 e^t dt=0$.

63. D

Sol. $f(x)=x^2-2x+2\sin\alpha$

$f(-1)f(1)<0$

$(2\sin\alpha-1)(3+2\sin\alpha)<0\Rightarrow\sin\alpha<\frac{1}{2}<\frac{5\pi}{6}<\alpha<2\pi$

So length is . $2\pi-\frac{5\pi}{6}=\frac{7\pi}{6}$.

64. A

Sol. Range is $\left\{0,\sqrt{\pi},\sqrt{\frac{\pi}{2}}\right\}$.

65. A

Sol. $K={}^{10}C_5$ and exponent of 2 in ${}^{10}C_5$ is 2.

66. D

Sol. Let mid point is (α,β). So equation of AB is $T=S_1\Rightarrow\frac{x\beta+y\alpha}{2}-2=\alpha\beta-2$

$x=\frac{2\alpha\beta-y\alpha}{\beta}$.

$y^2-4\left(2\alpha-y\frac{\alpha}{\beta}+1\right)=0$

$y^2+y\frac{4\alpha}{\beta}-4(2\alpha+1)=0$

$D=0\Rightarrow 16\frac{\alpha^2}{\beta^2}+16(2\alpha+1)=0$

$\frac{x^2}{y^2}+(2x+1)=0$

67. D

Sol. Let $z = x + iy$

$$\sqrt{x^2 + (y+1)^2} - x - i(y-1) = 0$$

$$\Rightarrow y = -1 \text{ and } x = \lambda, \lambda \ge 0$$

$$z = \lambda - i$$

68. D

Sol. A_1 : – white ball is drawn from bag 1

A_2 : – Red ball is drawn from bag 1

B : – 2 balls are drawn from bag 2 and found to be red.

$$P(B) = P(A_1).P(B/A_1) + P(A_2)P(B/A_2)$$

$$\Rightarrow P(A_1/B) = \frac{\frac{3}{5}.\frac{{}^5C_2}{{}^{10}C_2}}{\frac{3}{5}.\frac{{}^5C_2}{{}^{10}C_2} + \frac{2}{5}.\frac{{}^6C_2}{{}^{10}C_2}} = \frac{1}{2}$$

69. C

Sol. $$a_n = \frac{2n+3}{4.(1+2+..n+1)^2} = \frac{2n+3}{\frac{4(n+1)^2\ (n+2)^2}{4}}$$

$$= \frac{(n+2)^2 - (n+1)^2}{(n+1)^2\ (n+2)^2} = \frac{1}{(n+2)^2} - \frac{1}{(n+1)^2}$$

$$S_n = -\left(\frac{1}{(n+2)^2} - \frac{1}{2^2}\right) \Rightarrow S_\infty = \frac{1}{4}.$$

70. C

Sol. $$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h} = f'(0) + 2x$$

$$\Rightarrow f(x) = x^2 \Rightarrow I_1 = I_2 < I_3$$

71. C

Sol. $$S = \lim_{n \to \infty} \frac{1}{n} \sum \frac{1}{\left(3\sqrt{\frac{r}{n}} + 4\right)^2 \sqrt{\frac{r}{n}}}$$

$$= \int_0^4 \frac{dx}{\sqrt{x}(3\sqrt{x} + 4)^2} = \frac{1}{10}$$

72. D

Sol. G is $\left(x + y\frac{dy}{dx}, 0\right)$

$OG = 2x \Rightarrow y\,dy = x\,dx \Rightarrow y^2 - x^2 = C$ which is rectangle hyperbola.

73. A

Sol. Required area $= 2\int_0^{\sqrt{3}} \left(2x^2 + 9 - 5x^2\right)dx = 12\sqrt{3}$ sq. unit .

74. D

Sol. $\text{AM} \geq \text{GM} \Rightarrow \dfrac{n\sin\alpha + \frac{1}{n}\cos\alpha}{2} \geq \sqrt{\sin\alpha\cos\alpha}$

75. D

Sol. $P(\bar{B}/\bar{A}) = \dfrac{P(\bar{B}\cap\bar{A})}{P(\bar{A})} = \dfrac{1-P(A\cup B)}{0.6} \Rightarrow P(A\cup B) = .64,\ P(B/A) = \dfrac{P(B\cap A)}{P(A)} \Rightarrow P(A\cap B) = 0.36$

$\Rightarrow P(B) = 0.6,\ P(A/B) = \dfrac{P(A\cap B)}{P(B)} = .6$

$P(A/\bar{B}) = \dfrac{P(A\cap\bar{B})}{P(\bar{B})} = 0.1$

76. D

Sol. Any point on $y = mx$ is (t, mt)

Equation of chord under middle point (t, mt)

$T = S_1 \Rightarrow m^2t^2 - 2(2m+1)\,t + 8 = 0$

For two chords,

$D > 0 \Rightarrow 4\,m^2 - 4m - 1 < 0$

77. A

Sol. $x_1 + x_2 + x_3 = 11........(1)$

$x_1 = 0, 1, . . ,,$

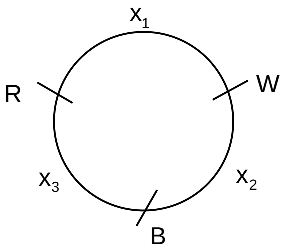
$x_2 = 0, 1... , ,$

$x_3 = 0, 1, ... , ,$

So require number of arrangements

$= \dfrac{3!}{3} \times$ Number of solution of (1)

$= 2! \times {}^{13}C_{11}$



78. C

Sol. Put x = 1, y = h in the relation

$2\left(\dfrac{f(1+h) - f(1)}{h}\right) - \dfrac{(f(1-h) - f(1))}{-h} + 3h = 2$

take limit $h \to 0$

$2f'(1) - f'(1) = 2 \qquad \Rightarrow f'(1) = 2$

79. C

Sol. There is no loss of generality in considering the order of bi's as $b_1 < b_2 < b_3 \cdots < b_n$ also given that $f(a_1) \leq f(a_2)\cdot f(a_{2n})$. Now suppose number of preimages of every b_i are x_i in numbers.

Therefore $x_1 + x_2 + \cdots + x_n = 2n$ where $1 \leq x_i \leq n+1 \to (1)$

Number of solutions of (1) is ${}^{2n-1}C_{n-1}$ or ${}^{2n-1}C_n$

80. C

Sol. $\angle B + \angle C = 150^{\circ}$

$\cos(B+C) = \frac{-\sqrt{3}}{2} \Rightarrow \cos B\cos C - \sin B\sin C = \frac{-\sqrt{3}}{2}$

Also $\frac{1}{2}ab\sin C = \frac{\sqrt{3}}{4}a^2 \Rightarrow \sin B\sin C = \frac{\sqrt{3}}{4}$

$\Rightarrow \tan B\tan C = -1$

$\Rightarrow B = 90^o + C$

Therefore $\angle B = 120^o,\ \angle C = 30^o$

81. B

Sol. $\alpha+\beta = -b/a,\ \alpha\beta = \frac{c}{a}$

Determinants

$$D = \begin{vmatrix} 1 & \cos(\beta-\alpha) & \cos\alpha \\ \cos(\alpha-\beta) & 1 & \cos\beta \\ \cos\alpha & \cos\beta & 1 \end{vmatrix} = \begin{vmatrix} \cos\alpha & \sin\alpha & 0 \\ \cos\beta & \sin\beta & 0 \\ 1 & 0 & 0 \end{vmatrix}\begin{vmatrix} \cos\alpha & \sin\alpha & 0 \\ \cos\beta & \sin\alpha & 0 \\ 1 & 0 & 0 \end{vmatrix} = 0$$

hence will have non trivial solution.

82. A

Sol. $\frac{\sin A}{\sin C} + \frac{\cos A}{\cos C} = \frac{2}{\sqrt{3}}$ & $A + C = 150^o$

$\Rightarrow C = 30^\circ,\ A = 120^\circ$

$a : b : c = \sin A : \sin B : \sin C = \sqrt{3} : 1 : 1$

$K\left(2+\sqrt{3}\right) = 4 + 2\sqrt{3} = K = 2$

$\Delta = \frac{1}{2}\cdot 2\cdot 2\frac{\sqrt{3}}{2} = \sqrt{3}$ sq. unit

83. B

Sol. $f(x) = 2(x-i)(x+i)(x-3+i)(x-3-i)$

$f(1) = 2.(1+1)(4+1) = 2 - a + 2b + c - d$

$\Rightarrow\ \ 2b + c = 18 + a + d$

$f(0) = 2(1)(i-3)(-i-3)$

$-d = 20 \qquad \Rightarrow \quad d = -20$

$f(-1) = 2(-1-i)(-1+i)(-4+i)(-4-i) \qquad = 2 + a + 2b - c - d$

$\Rightarrow\ \ a + 2b - c = 46$ and $2b + c - a = -2$

$\Rightarrow\ b = 11$

therefore, b + d = –9

84. C

Sol. $\arg\left(z\left(1+\bar{z}\right)\right) + \arg\left(\frac{z\bar{z}}{z\left(1-\bar{z}\right)}\right) = 0$

$\Rightarrow\ \ \arg z + \arg\left(1+\bar{z}\right) + \arg\bar{z} - \arg\left(1-\bar{z}\right) = 0$

$\Rightarrow\ \ \arg\left(\frac{1+\bar{z}}{1-\bar{z}}\right) = 0 \qquad \Rightarrow\ \frac{1+\bar{z}}{1-\bar{z}} = k > 0 \qquad \Rightarrow\ \bar{z} = \frac{k-1}{k+1} \qquad \Rightarrow\ \left|\bar{z}\right| < 1$

85. B

Sol. If $\left[\frac{1}{3}+\frac{n}{90}\right]=0 \quad \Rightarrow \quad 0 \le \frac{1}{3}+\frac{n}{90} < 1$

$\Rightarrow \quad 0 \le \frac{(30+n)}{90} < 1 \quad \Rightarrow \quad 0 \le (n+30) < 90$

$\Rightarrow \quad 1 \le n < 60$

and If $\left[\frac{1}{3}+\frac{n}{90}\right]=1 \quad \Rightarrow \quad 1 \le \frac{1}{3}+\frac{n}{90} < 2$

$\Rightarrow \quad 90 \le (n+30) < 180 \quad \Rightarrow \quad 60 \le n < 150$

$\therefore \quad \sum_{n=1}^{59}\left[\frac{1}{3}+\frac{n}{90}\right]+\sum_{n=60}^{k}\left[\frac{1}{3}+\frac{n}{90}\right]=21$

$\Rightarrow \quad 0+\sum_{n=60}^{k}\left[\frac{1}{3}+\frac{n}{90}\right]=21 \quad \Rightarrow \quad \sum_{n=60}^{k}\left[\frac{1}{3}+\frac{n}{90}\right]=21$

which is possible only when k = 80. $\left[\because \left[\frac{1}{3}+\frac{n}{90}\right]=1\right]$

86. B

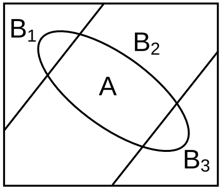
Sol. Let us consider the following events.

A: card shows up black

B_1: card with both sides black

B_2: card with both sides white

B_3: card with one side white and one black



$P(B_1)=\frac{2}{10},\ P(B_2)=\frac{3}{10},\ P(B_3)=\frac{5}{10}$

$P(A/B_1)=1,\ P(A/B_2)=0,\ P(A/B_3)=\frac{1}{2}$

$$P(B_1/A)=\frac{\frac{2}{10}\times 1}{\frac{2}{10}\times 1+\frac{3}{10}\times(0)+\frac{5}{10}\times\frac{1}{2}}=\frac{4}{4+5}=\frac{4}{9}$$

87. A

Sol. Let CD be the position of man at any time t. Let BD = x, then EC = x. Let $\angle ACE=\theta$

Given, AB = 41.6 m, CD = 1.6 m and $\frac{dx}{dt}=2$ m/s.

$AE = AB - EB = AB - CD = 41.6 - 1.6 = 40$ m

We have to find $\frac{d\theta}{dt}$ when x = 30 m

From ΔAEC, $\tan\theta=\frac{AE}{EC}=\frac{40}{x}$ (1)

Differentiating w.r.t. to t, $\sec^2\theta\frac{d\theta}{dt}=\frac{-40}{x^2}\frac{dx}{dt}$

$$\Rightarrow \sec^2\theta\frac{d\theta}{dt} = \frac{-40}{x^2}\times 2$$

$$\Rightarrow \frac{d\theta}{dt} = \frac{-80}{x^2}\cos^2\theta = -\frac{80}{x^2}\frac{x^2}{x^2+40^2} \qquad \left[\because \cos\theta = \frac{x}{\sqrt{x^2+40^2}}\right]$$

$$\Rightarrow \frac{d\theta}{dt} = -\frac{80}{x^2+40^2}$$

when x = 30, $\frac{d\theta}{dt} = -\frac{80}{30^2+40^2} = -\frac{4}{125}$ radian/s.

88. B

Sol. $T_n = (n+1)(n\omega+1)(n\omega^2+1)$

$= (n+1)(n^2-n+1)$

$= n^3+1$

$\therefore \quad S_n = \sum T_n = \sum n^3 + \sum 1$

$$= \left(\frac{n(n+1)}{2}\right)^2 + n$$

89. D

Sol. We have $\frac{1}{\sin^2\theta\cos^2\theta} + \frac{2}{\sin^2\theta} = 8,\ \sin\theta \ne 0,\ \cos\theta \ne 0$

$\Rightarrow \quad 1+2\cos^2\theta = 8\sin^2\theta\cos^2\theta = 8\cos^2\theta(1-\cos^2\theta)$

$\Rightarrow \quad 8\cos^4\theta - 6\cos^2\theta + 1 = 0$

$\Rightarrow \quad (4\cos^2\theta-1)(2\cos^2\theta-1) = 0$

$\Rightarrow \quad \cos^2\theta = 1/4 = \cos^2(\pi/3)$ or $\cos^2\theta = 1/2 = \cos^2(\pi/4)$

$\Rightarrow \quad \theta = n\pi \pm (\pi/3)$ or $\theta = n\pi \pm (\pi/4),\ n \in Z$

Hence, for $0 \le \theta \le \pi/2$, $\theta = \pi/3,\ \theta = \pi/4$

90. A

Sol. We have $\sum_{m=1}^{n}\tan^{-1}\left(\frac{2m}{m^4+m^2+2}\right) = \sum_{m=1}^{n}\tan^{-1}\left(\frac{2m}{1+(m^2+m+1)(m^2-m+1)}\right)$

$$= \sum_{m=1}^{n}\tan^{-1}\left(\frac{(m^2+m+1)-(m^2-m+1)}{1+(m^2+m+1)-(m^2-m+1)}\right)$$

$$= \sum_{m=1}^{n}\left[\tan^{-1}(m^2+m+1) - \tan^{-1}(m^2-m+1)\right]$$

$$= (\tan^{-1}3 - \tan^{-1}1) + (\tan^{-1}7 - \tan^{-1}3) + (\tan^{-1}13 - \tan^{-1}7) + \ldots + \left[\tan^{-1}(n^2+n+1) - \tan^{-1}(n^2-n+1)\right]$$

$$= \tan^{-1}(n^2+n+1) - \tan^{-1}1 = \tan^{-1}\left(\frac{n^2+n}{2+n^2+n}\right)$$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – V

JEE (Advanced)-2019

PAPER – 1

TEST DATE: 27-01-2019

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01– 06, 19 – 24, 37 - 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*

   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 - 46) *contains 12 questions. Based on this section contains* ***TWO (02)*** *paragraphs. Based on each paragraph, there are* ***TWO (02)*** *questions.*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

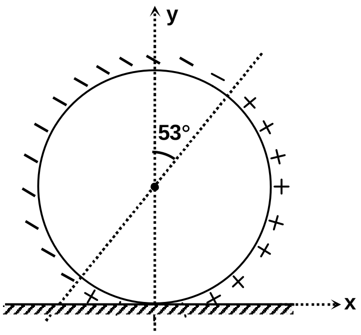
Physics

PART – I

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A non conducting uniform thin shell of mass m and radius R is having uniform charge density $+\sigma$ on one half and $-\sigma$ on another half as shown in figure. It is placed on a rough non conducting horizontal plane. At t = 0 a uniform electric field $\vec{E} = -E_0\hat{j}$ N/C is switched on and the solid sphere starts rolling without slipping. Then which of the following is/are correct.



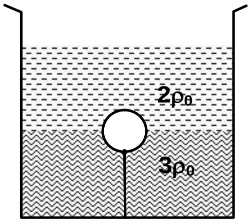
(A) The acceleration of the topmost point of the hollow sphere at t = 0, is $\frac{36}{25}\frac{\pi\sigma E_0R^2}{m}$.

(B) The magnitude of frictional force at t = 0 is $\frac{18}{25}\pi\sigma E_0R^2$.

(C) The acceleration of centre of mass of the hollow sphere at t = 0, is $\frac{12}{25}\frac{\pi\sigma E_0R^2}{m}$.

(D) The magnitude of frictional force at t = 0 is $\frac{9}{25}\pi\sigma E_0R^2$.

2. A large cubical vessel contains two immiscible liquid of density $2\rho_0$ and $3\rho_0$. A solid sphere of volume V_0, radius H/10 and density ρ_0 is tied to one end of a string of length $\left(\frac{9H}{10}\right)$ and other end tied to the bottom of the vessel at centre of the base of the container as shown in the figure. The sphere is immersed with half of its volume in the liquid of higher density and remaining in the liquid of lower density. The entire system starts accelerating toward right side with an acceleration $\frac{4}{3}$g. Then which of the following is/are correct.

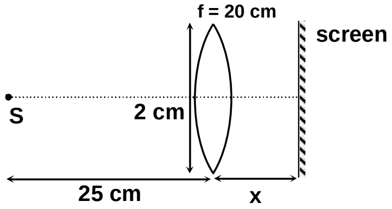


(A) The angle made by the string with the horizontal is 37°.
(B) The solid sphere moves towards right with respect to the vessel.
(C) The tension in the string in the equilibrium is $\frac{5}{2}V_0\rho_0g$
(D) The tension in the string in the equilibrium is $\frac{5}{3}V_0\rho_0g$

3. One mole of an ideal gas undergoes through the process $T = T_0 + V^3$ where T_0 is a positive constant and V is molar volume. Then which of the following is/are correct.
(A) The volume for which pressure will be minimum is $(T_0/2)^{1/3}$.
(B) The volume for which pressure will be minimum is $(T_0/2)^{2/3}$.
(C) The minimum pressure attainable is $\frac{3}{2}2^{1/3}RT_0^{2/3}$.

(D) The minimum pressure attainable is $\frac{3}{2^{2/3}}RT_0^{2/3}$.

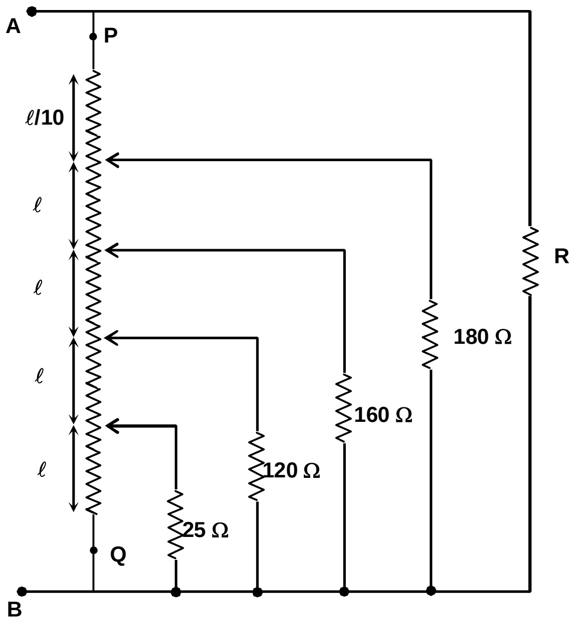
4. A point source of light S is placed on the axis of the lens of focal length 20 cm as shown in the figure. A screen is placed normal to the axis of the lens at a distance x from it. Treat all rays as paraxial. Then which of the following is/are correct regarding the intensity of the image produced on the screen of the point source.



(A) As x is increased from zero, intensity continuously decreases.
(B) As x is increased from zero, intensity first increases then decreases.
(C) Intensity at centre of screen for x = 90 cm and x = 110 cm is same.
(D) Radius of bright circle obtained on screen is equal to 2 cm for x = 300 cm.

5. In a photoelectric effect experiment. If f is the frequency of radiations incident on the metal surface and I is the intensity of incident radiations, then which of the following is/are correct.
(A) If ‘f’ is increased keeping ‘I’ and work function constant, stopping potential and maximum kinetic energy of photoelectron increases.
(B) If distance between cathode and anode is increased, stopping potential remains same.
(C) If ‘I’ is increased keeping ‘f’ and work function constant, saturation current increases and stopping potential remains same.
(D) If the work function is decreased keeping ‘f’ and ‘I’ constant then stopping potential will increase and maximum kinetic energy of photoelectrons also increases.

6. The resistance of wire PQ is 410 Ω, which is tapped with the external wire as shown in the figure. The value of R is not known. If the potential difference between AB is 400 volts and the net current through the source battery is 6 ampere, then which of the following is/are correct.



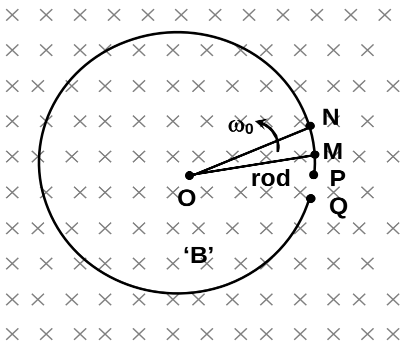
(A) The resistance of unknown resistor R is 200 Ω.
(B) the equivalent resistance across AB is $\frac{200}{3}\Omega$
(C) The current in 25 Ω resistor is $\frac{2}{5}$ ampere.
(D) The potential drop across 120 Ω resistor is 60 volts.

(Paragraph Type)

This section contains **TWO** paragraphs. Based on each paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 7 and 8

Two conducting rod OM and ON each of mass m and length ℓ can rotates about centre of the ring O, with its other end sliding smoothly on a circular conducting ring, as shown in the figure. A constant and uniform magnetic field 'B' acts into the plane of the ring. At t = 0 rod ON is given an angular velocity ω_0 as shown in figure. Assume that the space is gravity free and that there is electrical contact between the ring and the rod. The resistance of the ring is negligible and each rod is having resistance R. There is a small gap in the ring between P and Q, so that the current flows along a unique path (assume that time to rotate one complete revolution is infinite). Then,



7. Find the angular velocity of rod OM as a function of time 't'

(A) $\frac{\omega_0}{2}\left(1-e^{-\frac{3B^2\ell^2}{4mR}t}\right)$

(B) $\omega_0\left(1-e^{-\frac{3B^2\ell^2}{4mR}t}\right)$

(C) $\frac{\omega_0}{2}\left(1+e^{-\frac{3B^2\ell^2}{4mR}t}\right)$

(D) $\frac{\omega_0}{4}\left(1-e^{-\frac{3B^2\ell^2}{4mR}t}\right)$

8. The total heat produced in the system is

(A) $\frac{1}{6}m\ell^2\omega_0^2$

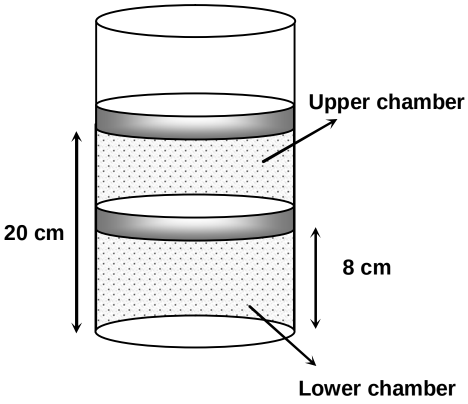
(B) $\frac{1}{12}m\ell^2\omega_0^2$

(C) $\frac{1}{24}m\ell^2\omega_0^2$

(D) $\frac{1}{48}m\ell^2\omega_0^2$

Paragraph for Question Nos. 9 and 10

In a cylindrical container of sufficiently large height, two movable piston enclose certain amount of same ideal gas in two chambers as shown in the figure. The upper piston is at a height 20 cm from bottom and lower piston is at a height 8 cm from the bottom. The mass of each piston is m kg and cross-sectional area of each piston is A m^2, where $\frac{mg}{A} = P_0$ and P$_0$ is the atmospheric pressure = 1 × 10^5 N/m^2. The cylindrical container and piston are made of conducting material. Initially the temperature of gas is 27°C and whole system is in equilibrium. Now if the upper piston is slowly lifted by 16 cm and held in that position with the help of some external force. Then



9. The lower piston will rise by
   (A) 2 cm
   (B) 4 cm
   (C) 8 cm
   (D) 6 cm

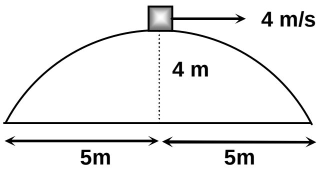
10. The ratio of volume of gas in upper chamber to that of in lower chamber in final state.
   (A) 2 : 1
   (B) 1 : 2
   (C) 4 : 2
   (D) 1 : 4

SECTION – D

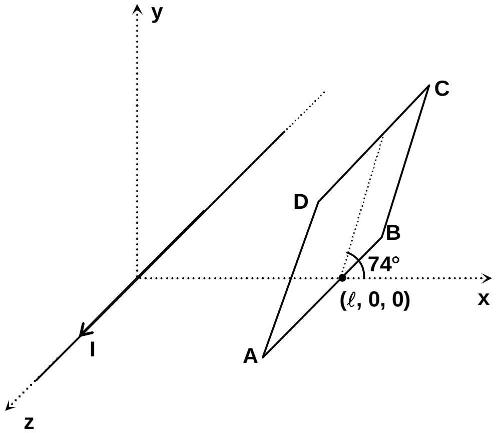
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

11. There is a parabolic shaped bridge across the river of width 10 meter. The highest point of the bridge is 4 meter above the level of bank. A car of mass 952 kg is crossing the bridge at a constant speed of 4 m/s. Find the force (in Newton) exerted on the bridge by car when it is at the highest point 'P' of the bridge. (take g = 10 m/s^2)



12. A wire of infinite length carrying current 'I' lies along the z-axis. A square loop of side 'ℓ' is placed such that the plane of the loop makes an angle 74° with the positive x-axis at (ℓ, 0, 0) and side AB touches the x-axis and parallel to z-axis as shown in the figure. The magnetic flux passing through the loop is $\frac{k\mu_0\ell}{\pi}$. Find the value of k. [take I = 10 amp, ℓn(1.6) = 0.47 and tan 37° = 3/4]

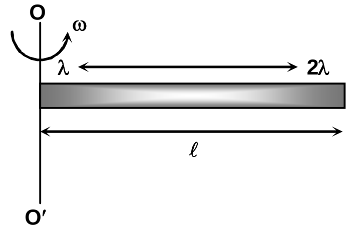


13. When an inductor coil is connected to an ideal battery of emf 15 volts, a constant current 2.5 amp flows if it is left connected for a long time. When the same inductor coil is connected to an AC source of 20 volts and 25 Hz then the current is 2 ampere. The inductance of the inductor is $\frac{k}{\pi}$ Henry. Find the value of k.

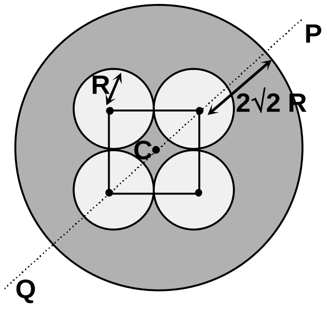
14. The excitation energy of a hydrogen like ion to its first excited state is 43.8 eV. Find the magnitude of energy (in electron volts) needed to remove the electron from the ion in the ground state.

15. One end of copper rod of uniform cross section and length 13.5 m is kept in contact with ice and other end with water at 100°C. At what distance 'x' (in meter) from 100°C water along its length should a temperature of 400°C be maintained so that in steady state, the mass of ice melting be equal to that of the steam produced in same time interval of time? Assume that whole system is insulated from surrounding. Latent heat of fusion of ice and vaporization of water are 80 cal/gm and 540 cal/gm, respectively.

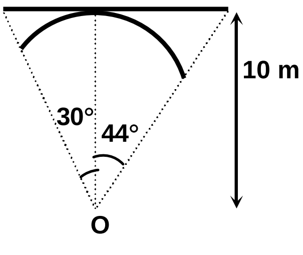
16. A rod of length 'ℓ' can rotate freely in a horizontal plane about vertical axis OO′ passing through one of its ends with angular velocity ω. The mass per unit length linearly increases from λ to 2 λ from the axis of rotation to other end as shown in the figure. Find the tension (in Newton) in the rod at the middle point. (take ω = 2 rad/sec, λ = 4 kg/m, ℓ = 3.6 meter and neglect the gravity)



17. The moment of inertia of a circular disc of radius R about its diameter is 2×10^{-2} kg-m^2. Then find the moment of inertia (in kg-m^2) of given lamina made up from same material and same thickness as that of above mentioned disc about line PQ which passes through C and parallel to plane of lamina as shown in figure.



18. A uniform thin rod and circular arc of radius 10 meter are situated as shown in the figure. The mass of the circular arc is 37π kg and mass per unit length of the rod and the circular arc is same. The net gravitational intensity at the centre O is KG newton/kilogram where G is gravitational constant. Find the magnitude of K. (take tan 37° = 3/4)



Chemistry

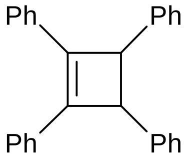
PART – II

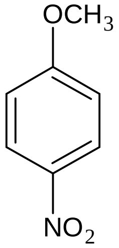
SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

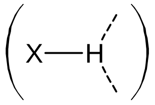
19. When CO_2 is passed into aqueous
    - (A) Na_2CrO_4 solution, its yellow colour changes to green
    - (B) K_2MnO_4 solution, it disproportionates to $KMnO_4$ and MnO_2
    - (C) $Na_2Cr_2O_7$ solution, its orange colour changes to green
    - (D) $KMnO_4$ solution, its pink colour changes to colourless solution

20. Which of the following compound(s) is/are capable of producing H_2 on addition of active metal like (Na/K)?
    - (A) $HC\equiv CH$
    - (B) 

    - (C) 

    - (D) CH_3CH_2SH

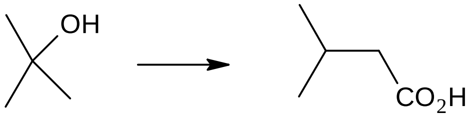
21. Which of the following statements is/are correct provided solutes are not to suffer dissociation or association?
    - (A) The magnitude of osmotic pressure is not dependent on the nature of the membrane provided it is perfectly semipermeable.
    - (B) Equimolecular quantities of different solutes dissolved in the same volume of a solvent exert equal osmotic pressure at the same temperature.
    - (C) Equal volumes of different solutions which are at the same temperature and exert same osmotic pressure contain an equal number of solute molecules.
    - (D) The osmotic pressure of a substance in a dilute solution is the same as it would exert if it exists as a gas in the same volume as that occupied by the solution at the same temperature.

22. Which of the following is/are correct related to hydrogen bonding?
    - (A) The H-bond in the X – H ---Y may be linear or bent.
    - (B) Bifurcated  hydrogen bonds are not possible.

    - (C) Symmetrical hydrogen bonding is present in HF_2^-. i.e. the H-atom is midway.

(D) Hydrogen bond is an extreme of dipole – dipole attraction and therefore the force is inversely related to the cube of distance between the dipoles.

23.



Correct set of reagents required for above conversion is/are

(A) Conc. HI; KCN; H_3O^+

(B) Conc. H_3PO_4; HBr in presence of peroxide, Mg-dryether; CO_2, H_3O^+.

(C) Anhydrous $ZnCl_2$/HCl, Mg. dry ether, CO_2, H_3O^+.

(D) Conc. H_2SO_4, HCl in presence of peroxide, KCN, H_3O^+.

24. Consider the reaction

$$2CO(g)+O_2(g) \rightleftharpoons 2CO_2(g)+\text{heat}$$

Under what conditions shift is undeterminable or no change

(A) Addition of O_2 and decrease in volume

(B) Addition of Ar at constant pressure

(C) Addition of CO and increase in temperature at constant volume

(D) Increase in temperature and decrease in volume

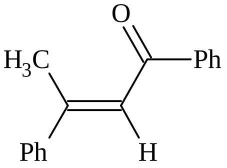
(Paragraph Type)

This section contains **TWO** paragraphs. Based on each paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 25 and 26

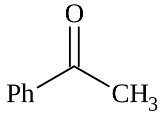
A tertiary alcohol H upon acid catalyzed dehydration gives a product I. Ozonolysis of I leads to compounds J and K. Compound J upon reaction with KOH gives benzyl alcohol and a salt of carboxylic acid, L. Whereas K on reaction with KOH gives only M.

M =



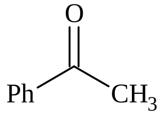
25. Compound H is formed by the reaction of

(A)



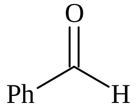
+ PhMgBr

(B)



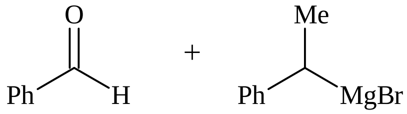
+ $PhCH_2MgBr$

(C)

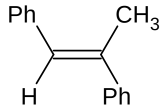


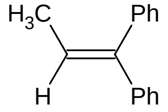
+ $PhCH_2MgBr$

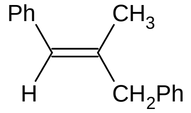
(D)

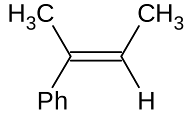


26. The structure of compound I is:

(A)


(B)


(C)


(D)


Paragraph for Question Nos. 27 and 28

$$AgClO_3 \xrightarrow[90^oC]{Cl_2} AgCl + O_2 + X$$

$$X \xrightarrow{\text{Excess } O_3} Y + O_2$$

27. Y on dissolving NaOH produces
    (A) Chlorite and chlorate salts
    (B) Chlorate and perchlorate salts
    (C) Only perchlorate salts
    (D) Hypochlorite and perchlorite salts

28. Which is **wrong** statement related to X and Y?
    (A) Both X and Y are mixed anhydride i.e. on treatment with water producing two acids
    (B) Y is a dark red liquid at room temperature
    (C) X is a paramagnetic
    (D) Y can be obtained by dehydrating perchloric acid with P_4O_{10}

SECTION – D

(Numerical Answer Type)

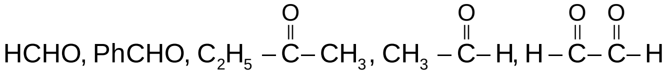
This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

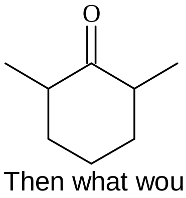
29. The pH of a solution formed by mixing 10 ml 0.1 M NaH_2PO_4 and 20 ml 0.1 M Na_2HPO_4 would be (Given $pK_1 = 2.2$, $pK_2 = 7.2$, log2 = 0.3)

30. Among the following compounds
    (i) the compounds that will not form enamine with R_2NH is ‘a’.

    (ii) the compounds which can involve in Cannizzaro reaction (including intramolecular) is ‘b’.



$$HCHO, PhCHO, C_2H_5-\overset{\overset{\displaystyle O}{||}}{C}-CH_3, CH_3-\overset{\overset{\displaystyle O}{||}}{C}-H, H-\overset{\overset{\displaystyle O}{||}}{C}-\overset{\overset{\displaystyle O}{||}}{C}-H$$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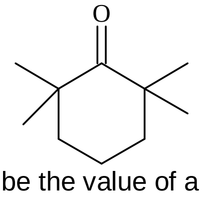
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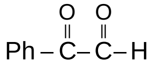

$$Ph-\overset{\overset{\displaystyle O}{||}}{C}-\overset{\overset{\displaystyle O}{||}}{C}-H$$

Then what would be the value of a + b?

31. $X = C_4H_{10}O$

(A) Isomers of compound X give positive iodoform test (excluding stereoisomer) = a

(B) Isomers of compound X do not give H_2 on treatment with Na metal (excluding stereoisomers) = b

(C) Isomers of compound X give red colour in Victor Mayer test = c

Then $\frac{a+b+c}{2}$ would be?

32. If time required when a current of 9.65 amp is passed through 80 ml of 0.1 M NaCl solution in order to make its pH = 12 is x sec. and time required when a current of 965 amp is passed through an aqueous solution of $CuSO_4$ to produce 0.28 litres of oxygen gas at STP is y sec. then the value of $\frac{x}{y}$ would be

33. 6 mol of a mixture containing same number of moles of $NaNO_3$, NH_4NO_3, $LiNO_3$, $Ca(NO_3)_2$, $Pb(NO_3)_2$ and $AgNO_3$, was heated strongly. Total number of moles of $O_2(g)$ evolved is:

34. Among the following acids, if number of acids stronger than H_3PO_4 is x and number of monobasic acids is y. then x/y would be?

H_2CO_3, H_3PO_3, CH_3CO_2H, H_2SO_4, H_3PO_2, $H_4P_2O_7$, $HClO_4$, H_3BO_3, HNO_3.

35. The overall formation constant of $\left[Co(NH_3)_6\right]^{2+}$ in aqueous solution is 10^5 and the standard potential for reduction of Co^{3+} (aq) and $\left[Co(NH_3)_6\right]^{3+}(aq)$ are as follows

$$Co^{3+}(aq) + e \rightleftharpoons Co^{2+}(aq) \quad E^o = 1.90$$

$$\left[Co(NH_3)_6\right]^{3+}(aq) + e \rightleftharpoons \left[Co(NH_3)_6\right]^{2+}(aq) \quad E^o = +0.1\text{ V}$$

If the nearest overall formation constant of the $\left[Co(NH_3)_6\right]^{3+}$ ion is 10^x. Then the value of x would be (Given : $E_{cell} = E^o_{cell} - 0.06\log Q$]

36. The activation energy for a reaction is 30.8 × 298 × 4.606 cal/mol. If the increase in the rate constant when its temperature is increased from 298 K to 308 K is x % then ‘x’ would be

Mathematics

PART – III

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. The number of codes of 20 digits which can be formed using digits 0, 1, 2, 3, 4 such that difference of consecutive digit is one is N, then
    (A) total number of positive integers which divides N is 40
    (B) N is divisible by 3^8
    (C) N is divisible by 7
    (D) the number of ordered pair (a, b) such that $a \times b = N$ and $a, b \in I^+$ and gcd (a, b) = 1 is 4

38. Person A randomly selects 4 distinct numbers from the set {1, 2, 3, 4, 5, 6, 7, 8, 9} and arrange them in descending order to form a 4 digit number and person B randomly selects 4 distinct numbers from set {1, 2, 3, 4, 5, 6, 7, 8} and also arranges them in descending order to form a 4 digit number. Then which of the following is/are correct?
    (A) probability that person A's 4 digit number is greater than person B's number is
    $$\frac{{}^8C_3}{{}^9C_4} + \frac{1}{2}\left(1 - \frac{1}{{}^9C_4}\right)$$
    (B) probability that person A and B have same 4 digit number is $\frac{1}{{}^9C_4}$
    (C) probability that person A's 4 digit number is greater than person B's number is
    $$\frac{2\cdot{}^8C_3 + {}^8C_4 - 1}{2\cdot{}^9C_4}$$
    (D) probability that person A and B have same 4 digit number is $\frac{{}^8C_4}{{}^9C_4}$

39. A rabbit begins at the origin and runs up the positive y-axis with speed 5 m/s. At the same time, a dog runs at speed 10 m/s from the point (20, 0) in pursuit of rabbit. Which of the following is/are correct?
    (A) the dog meet rabbit at the point $\left(0, \frac{40}{3}\right)$
    (B) the dog meet rabbit at the point (0, 10)
    (C) the equation of the path followed by dog $2y(x) = \frac{2}{3\sqrt{20}}\cdot x^{\frac{3}{2}} - 2\sqrt{20}\cdot\sqrt{x} + \frac{80}{3}$
    (D) the dog will pass the point $\left(4, \sqrt{20}\right)$ during his run

40. Let f : R → (0, 1) be a continuous function, then which of the following function has/have the value zero at some point in the internal (0, 1)?
    (A) $f(x) + \int\limits_0^{\pi/2} f(t)\tan t\,dt$
    (B) $x^{11} - f(x)$
    (C) $e^x - \int\limits_0^x f^2(t)\,dt$
    (D) $e^x + \int\limits_0^x f(t)\,dt$

41. The normal at a variable point P on ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$, (a > b) meets axes of the ellipse in Q and R. Then which of the following is/are correct statement(s)
   (A) the locus of mid-point of QR is ellipse
   (B) the locus of mid-point of QR is conic whose eccentricity is same as of given ellipse
   (C) The locus of mid-point of QR is hyperbola
   (D) The locus of mid-point of QR is conic with its eccentricity half of the eccentricity of given ellipse

42. Two fixed points P and Q are 4 units apart and are on same side of a variable line L. Let PM and QN are perpendicular distance of P and Q from line L satisfy equation PM + 3QN = 4, then line L always touches a circle C
   (A) the centre of circle C lies on line PQ
   (B) the radius of circle is 1
   (C) the radius of circle is 2
   (D) the centre of the circle C lies on perpendicular bisector of PQ

(Paragraph Type)

This section contains **TWO** paragraphs. Based on each paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 43 and 44

Let L be a straight line passing through (1, 1, 1) which is parallel to x + y + z = 1 and intersect the line x + 2y + z = 1, x + y + 2z = 3

43. The line L is parallel to the line
   (A) $\frac{x-1}{4}=\frac{y-1}{-3}=\frac{z-1}{1}$
   (B) $\frac{x}{4}=\frac{y}{-3}=\frac{z}{2}$
   (C) $\frac{x}{4}=\frac{y}{-7}=\frac{z}{2}$
   (D) $\frac{x}{4}=\frac{y}{-3}=\frac{z}{-1}$

44. The equation of line which intersect the line L and $\frac{x}{1}=\frac{y}{9}=\frac{z}{17}$ & parallel to $\frac{x}{1}=\frac{y}{2}=\frac{z}{3}$ is
   (A) $\frac{x-1}{1}=\frac{y-1}{2}=\frac{z-2}{3}$
   (B) $\frac{x-1}{2}=\frac{y-2}{4}=\frac{z-2}{3}$
   (C) $\frac{x}{7}=\frac{y}{14}=\frac{z}{21}$
   (D) $\frac{x-1}{1}=\frac{y-1}{2}=\frac{z-1}{3}$

Paragraph for Question Nos. 45 and 46

Let $f(x) = x + \frac{2}{1.3}x^3 + \frac{2.4}{1.3.5}x^5 + \frac{2.4.6}{1.3.5.7}x^7 + ...\ \forall\ x \in (0, 1)$

45. The value of $f\left(\frac{1}{\sqrt{2}}\right)$ is

(A) $\frac{\pi}{\sqrt{2}}$

(B) $\frac{\pi}{3\sqrt{2}}$

(C) $\frac{\pi}{2\sqrt{2}}$

(D) $\frac{\pi}{4\sqrt{2}}$

46. Let $g(x) = \sqrt{1-x^2}\ f(x)$ for $\forall\ x \in (0, 1)$. The range of g(x) is

(A) (0, 1)

(B) $\left(\frac{1}{2}, 1\right)$

(C) $\left(0, \frac{1}{2}\right)$

(D) $\left(0, \frac{\pi}{2}\right)$

SECTION – D

(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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47. If $\lim\limits_{n\to\infty}\sum\limits_{r=1}^{n}\frac{(\cos 2\theta)^{2r-1}}{2r-1}$ is ℓ for $\theta \in (\cot^{-1} 2, \cot^{-1} 1)$, then the value of $[\ell]$ is equal to _____ (where [.] denotes the greatest integer function)

48. If the value of $\frac{{}^nC_1(n-1)^3 + {}^nC_3(n-3)^3 + ...}{n^2(n+3)\cdot 2^n}$, where n = 10, is ℓ, then 16ℓ is equal to _____

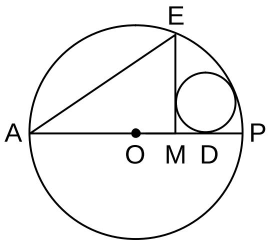
49. In ΔABC let the value of $a^3 \cos 3B + 3a^2b\cos(A-2B) + 3ab^2\cos(2A-B) + b^3\cos 3A$ is ℓ, then the value of $\frac{\ell}{c^3}$ is equal to _____

50. The value of $\frac{1}{\pi^2}\int_0^{\infty}\frac{(\ell nx)^2}{\sqrt{x}(1-x)^2}dx$ is equal to _____

51. Let $a_n = 8 + (n-1)d$, $n \in N$. If $\lim\limits_{n\to\infty}\prod\limits_{r=1}^{n}\left(1-\frac{d^2}{a_r^2}\right) = \frac{1}{4}$, then the value of d is equal to _____

52. Let P(x) be a polynomial whose coefficient are integer satisfies P(1) = 5 and P(2) = 7. The smallest possible positive value of P(10) is equal to _____

53. Let 'O' be centre of circle as shown in figure and AE be a chord from A the diameter AP is drawn and M is foot of perpendicular drawn from E on AP. A circle is drawn such that it touches EM, AP at D and circle whose diameter is AP, then the value of $\frac{AE}{AD}$ is _____



54. Let f : A → A where A = {1, 2, 3, 4, 5, 6, 7}, then number of functions f such that f(f(f(x))) = x, $\forall x \in A$ is _____

FIITJEE

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FULL TEST – V

JEE (Advanced)-2019

PAPER – 1

TEST DATE: 27-01-2019

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

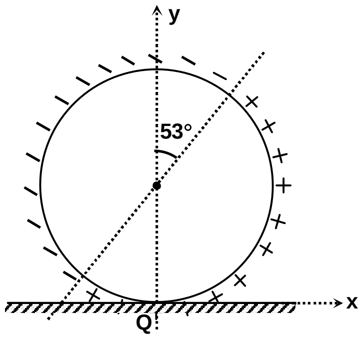
1. A, B

Sol. $\tau_Q = PE\sin 37°$

$= \left(\sigma 2\pi R^2\right)(R)E_0\dfrac{3}{5}$

$= \dfrac{6}{5}\sigma\pi R^3 E_0 = \left(\dfrac{5}{3}mR^2\alpha\right)$

$\alpha = \dfrac{18}{25}\dfrac{\sigma\pi RE_0}{m}$

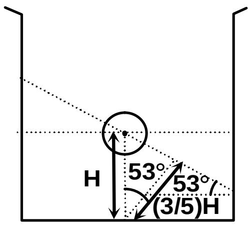


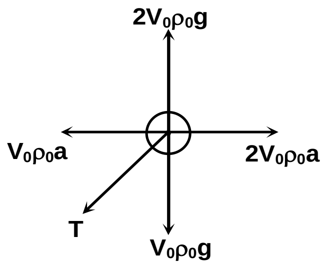
2. A, B, D

Sol. When the vessel starts accelerating then the sphere gets completely immersed in the liquid of density $2\rho_0$.

So,

$T = V_0\left(2\rho_0 - \rho_0\right)\sqrt{a^2+g^2} = \dfrac{5}{3}V_0\rho_0 g$.





3. A, C, D

Sol. PV = nRT

$$P = \frac{nRT}{V} = \frac{nR(T_0 + V^3)}{V}$$

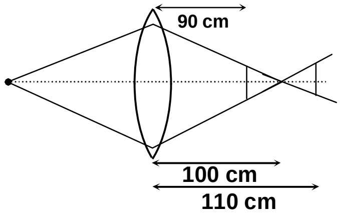
$$\frac{dP}{dV} = 0,\ V = \left(\frac{T_0}{2}\right)^{1/3}$$

$$P_{min} = \frac{R(T_0 + T_0/2)}{\left(\frac{T_0}{2}\right)^{1/3}} = \frac{3}{2}RT_0^{2/3}2^{1/3}.$$

4. B, C, D

Sol. $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

v = 100 cm



5. A, B, C, D

Sol. On increasing frequency stopping potential and maximum kinetic energy of photoelectrons increases.

$K_{max} = hf - \phi = eV_0$

If ϕ is decreased, K_{max} and V_0 both will increases.

With increases in distance between cathode and anode 'f' remains unchanged.

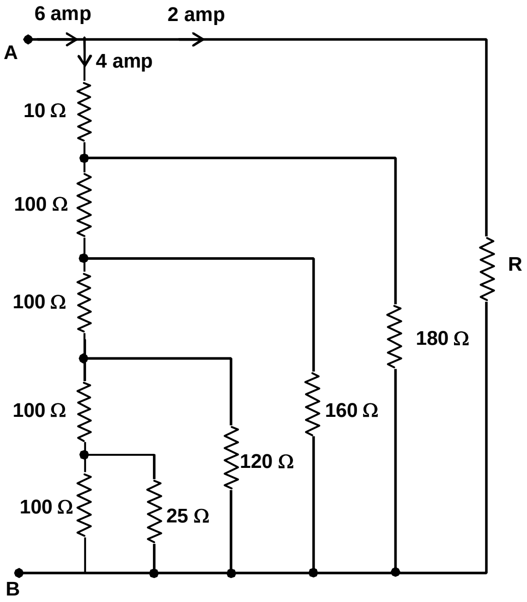
6. A, B, C, D

Sol. Equivalent resistance between P and Q = 100 Ω

So current towards P = $\frac{400}{100} = 4$ ampere

Current through R = 6 – 4 = 2 ampere

So, R = $\frac{400}{2} = 200\ \Omega$



7. A

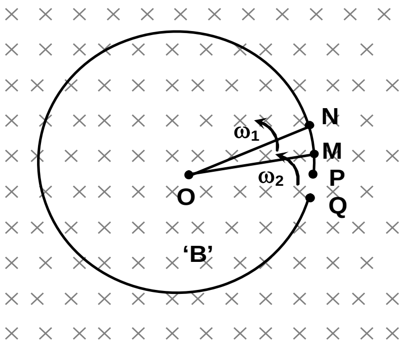
8. B

Sol. (for Q. 7 to Q. 8)

By the conservation of angular momentum about 'O'

$I\omega_1 + I\omega_2 = I\omega_0$

Induced emf in the loop



$$\varepsilon = \frac{1}{2}B(\omega_1 - \omega_2)\ell^2$$

Torque on the rod OM about 'O'

$$\tau = \int_0^{\ell}\left[\left(\frac{B\ell^2(\omega_1-\omega_2)}{4R}\right)dr \cdot B\right]r = = \frac{B^2\ell^4}{8R}(\omega_0 - 2\omega_2)$$

$$I\alpha = \frac{B^2\ell^4}{4R}\left(\frac{\omega_0}{2} - \omega_2\right)$$

$$= \int_0^{\omega_2}\frac{d\omega_2}{\left(\frac{\omega_0}{2}-\omega_2\right)} = \frac{3B^2\ell^2}{4mR}\int_0^t dt \Rightarrow \omega_2 = \frac{\omega_0}{2}\left(1 - e^{-\frac{3B^2\ell^2}{4mR}t}\right)$$

Heat produced = $\frac{1}{2}I\omega_0^2 - \frac{1}{4}I\omega_0^2 = \frac{1}{12}m\ell^2\omega_0^2$

9. B

10. A

Sol. (for Q. 9 to Q. 10)

Let P_2 is the initial pressure in upper chamber

$$P_2 = P_0 + \frac{mg}{A} = 2P_0$$

$V_2 = A \times 12 \times 10^{-2}\ m^3$

Let P_2' and V_2' are final pressure and volume of upper chamber and lower piston moved by ℓ cm.

$$V_2' = A(28-\ell)10^{-2}\ m^3$$

$$P_2V_2 = P_2'V_2'$$

$$\Rightarrow P_2' = \left(\frac{24P_0}{28-\ell}\right)$$

Let P_1 is initial pressure in lower chamber

$$P_1 = P_0 + \frac{2mg}{A} = 3P_0$$

$$V_1 = A \times 8 \times 10^{-2}\ m^3$$

Let lower piston moved by 'ℓ' cm and P_1' and V_1' are final pressure and volume of lower chamber

$$P_1' = P_2' + \frac{mg}{A} = \frac{24P_0}{28-\ell} + P_0 = \left(\frac{52-\ell}{28-\ell}\right)P_0$$

$$V_1' = A(8+\ell)10^{-2}\ m^3$$

$$P_1V_1 = P_1'V_1'$$

$$3P_0A \times 8 \times 10^{-2} = P_0\left(\frac{52-\ell}{28-\ell}\right)A(8+\ell)10^{-2}$$

Solving this ℓ = 4 cm

$$P_1' = \left(\frac{52-4}{28-4}\right)P_0 = 2P_0 = 2 \times 10^5\ N/m^2$$

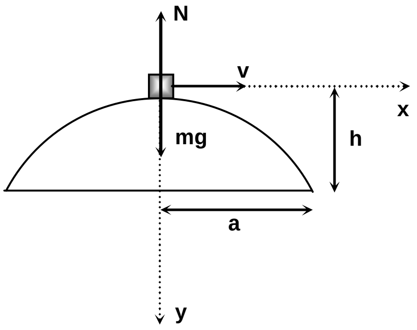
$$P_2' = \frac{24P_0}{28-\ell} = P_0$$

$$\frac{V_2'}{V_1'} = \frac{28-\ell}{8+\ell} = \frac{24}{12} = 2$$

SECTION – D

11. 04645.76

Sol. equation of parabola



$y = kx^2$

$y = h = ka^2$

$$k = \left(\frac{h}{a^2}\right)$$

$$y = \left(\frac{h}{a^2}\right)x^2$$

$$R = \frac{\left[1+\left(\frac{dy}{dx}\right)^2\right]^{3/2}}{\frac{d^2y}{dx^2}}$$

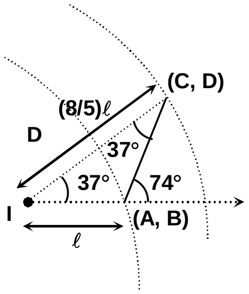
$$R(x = 0) = \left(\frac{1}{2k}\right)$$

$$mg - N = \frac{mv^2}{R}$$

$$N = mg - \frac{mv^2}{R} = m(g - v^2 \cdot 2k) = 4645.76 \text{ N}$$

12. 00002.35

Sol. Flux passing through the loop ABCD



$$\phi = \int_{\ell}^{(8/5)\ell} \frac{\mu_0}{2\pi}\frac{I}{r}\ell dr = \frac{\mu_0 I\ell}{2\pi}\ell n\left(\frac{8}{5}\right)$$

$$\phi = \left(\frac{\mu_0\ell}{\pi}\right)\left(\frac{0.47\times10}{2}\right) = 2.35\left(\frac{\mu_0\ell}{\pi}\right)$$

13. 00000.16

Sol. When DC source is connected resistance of inductor

$$R = \frac{15}{2.5} = 6\Omega$$

When AC source connected

$$Z = \frac{20}{2} = 10\Omega$$

$$Z^2 = R^2 + X_L^2$$

$$X_L = 8\,\Omega$$

$2\pi fL = 8$

$$L = \frac{8}{2\pi\times25} = \frac{0.16}{\pi}$$

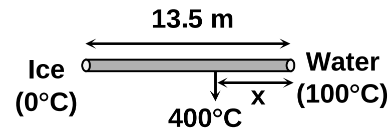
14. 00058.40

Sol. $E_2 - E_1 = 43.8$

$$\frac{E_1}{(2)^2} - E_1 = 43.8$$

$$E_1 = \frac{-43.8 \times 4}{3} = 58.40\text{ eV}$$

15. 00001.35



Sol. $Q_{ice} = KA\left(\frac{400-0}{13.5-x}\right)t$

So ice melt, $m_{ice} = \frac{Q_{ice}}{L_F} = \frac{KA(400-0)t}{80(13.5-x)}$ …(i)

$Q_{water} = KA\frac{(400-100)}{x}t$

$m_{steam} = \frac{Q_{water}}{L_v} = \frac{KA(400-100)}{540x}t$ …(ii)

$m_{ice} = m_{steam}$

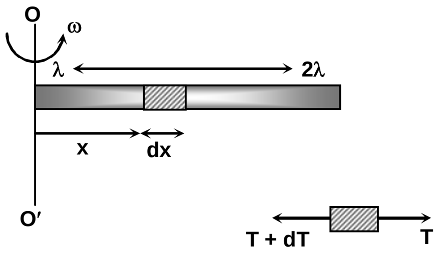
$\frac{400}{80(13.5-x)} = \frac{300}{540x}$

$6(13.5-x) = 54x$

$6 \times 13.5 = (54x + 6x)$

$x = \frac{6 \times 13.5}{60} = 1.35\text{ m}$

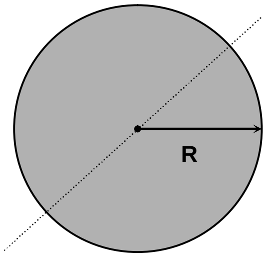
16. 00138.24



Sol. $-\int_0^T dT = \int_{\ell}^{\ell/2}\left[\lambda\left(1+\frac{x}{\ell}\right)dx\right]x\omega^2$

$T = \frac{2}{3}\lambda\omega^2\ell^2 = \frac{2}{3} \times 4 \times (3.6)^2 \times (2)^2 = 138.24$

17. 00006.08



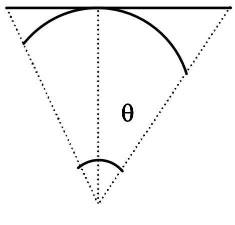
Sol. $I_{disc} = I_0 = \frac{mR^2}{4} = kR^4$

$I_0 = \frac{mR^2}{4}$

$I_{PQ} = k\left[(3\sqrt{2})R\right]^4 - \left[I_0 + I_0 + 2\left\{I_0 + m(\sqrt{2}R)^2\right\}\right]$

$= 320 - 4mR^2 == 320I_0 - 16I_0 = 304I_0$

18. 00002.16



Sol. $I = 2\left[\frac{2G\lambda}{R}\sin\left(\frac{\theta}{2}\right)\right]$

Putting all values
I = 2.16 G newton/kilogram

Chemistry

PART – II

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

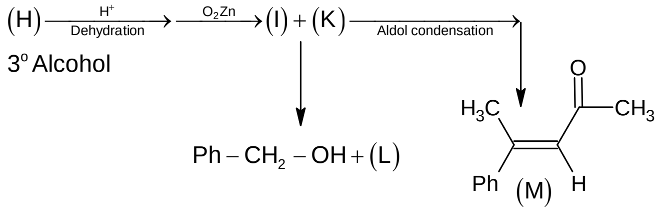
19. B

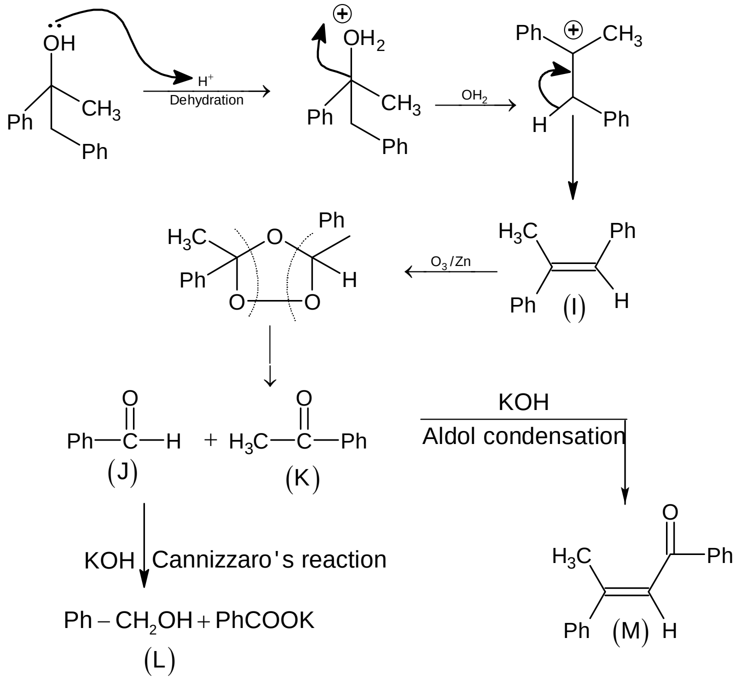
Sol. $$2Na_2CrO_4 + H_2O + 2CO_2 \longrightarrow Na_2Cr_2O_7 + 2NaHCO_3$$
$$3K_2MnO_4 + 2H_2O + 4CO_2 \longrightarrow 2KMnO_4 + MnO_2 + 4KHCO_3$$

20. A, B, D
21. A, B, C, D
22. A, B, C, D
23. B
24. C, D
25. B

26. A

Sol. (for Q. 25 to Q. 26)


(H)
H⁺
Dehydration
O₂Zn
(I) + (K)
Aldol condensation
3° Alcohol
O
H₃C
CH₃
Ph – CH₂ – OH + (L)
Ph
(M)
H


OH
Ph
CH₃
Ph
H⁺
Dehydration
OH₂
CH₃
Ph
Ph
OH₂
Ph
CH₃
H
Ph
H₃C
Ph
Ph
(I)
H
O₃/Zn
H₃C
O
Ph
Ph
H
O
O
O
Ph—C—H
(J)
+ H₃C—C—Ph
(K)
KOH
Aldol condensation
KOH
Cannizzaro's reaction
Ph – CH₂OH + PhCOOK
(L)
O
H₃C
Ph
Ph
(M)
H

27. B

28. D

Sol. $2AgClO_3 + Cl_2 \xrightarrow[90^oC]{} 2AgCl + \underset{(x)}{2ClO_2} + O_2$

$2ClO_2 + 2O_3 \longrightarrow \underset{(y)}{Cl_2O_6} + 2O_2$

$Cl_2O_6 + 2NaOH \longrightarrow NaClO_3 + NaClO_4 + H_2O$

$4HClO_4 + P_4O_{10} \xrightarrow{\Delta} 2Cl_2O_7 + 4HPO_3$

SECTION – D

29. 00007.50

Sol. This is a buffer solution where $H_2PO_4^-$ acts as the acid and NaH_2PO_4 is the salt.

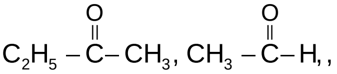
$$\therefore pH = pK_2 + \log\frac{\left[HPO_4^-\right]}{\left[H_2PO_4^-\right]}$$

$\Rightarrow$ 7.2 + log 2

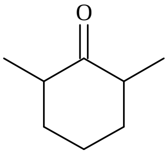
$\Rightarrow$ 7.50

30. 00009.00

Sol. (a) 5



(Except $C_2H_5-\overset{\overset{O}{\parallel}}{C}-CH_3$, $CH_3-\overset{\overset{O}{\parallel}}{C}-H$, ,



(b) 4

31. 00003.50

Sol. a = 1; butan-2-ol

b = 3 (ethers)

c = 3 (1^o alcohols)

32. 00001.60

Sol. pH = 12, pOH = 2

$\left[OH^-\right] = 10^{-2}$

Equivalents of $\left[OH^-\right] = 10^{-2} \times 80 \times 10^{-3}$

$= 8 \times 10^{-4}$

$8 \times 10^{-4} = \dfrac{9.65 \times x}{96500}$

x = 8 sec

Equivalents of oxygen $= \dfrac{0.28}{5.6} = 0.05$

$0.05 = \dfrac{965 \times y}{96500}$

y = 5

33. 00002.25

Sol. 6 compounds has 1 mole each

NH_4NO_3 do not give O_2

$$\underset{(1\,\text{mole})}{2LiNO_3} \longrightarrow Li_2O + 2NO_2 + \frac{1}{2}\underset{(0.25\text{ mole})}{O_2}$$

$$\underset{(1\,\text{mole})}{2Ca(NO_3)_2} \longrightarrow 2CaO + 4NO_2 + \underset{(0.5\text{ mole})}{O_2}$$

$$\underset{(1\,\text{mole})}{2Pb(NO_3)_2} \longrightarrow 2PbO + 4NO_2 + \underset{(0.5\text{ mole})}{O_2}$$

$$\underset{(1\,\text{mole})}{2AgNO_3} \longrightarrow 2Ag + 2NO_2 + \underset{(0.5\text{ mole})}{O_2}$$

$$\underset{(1\,\text{mole})}{2NaNO_3} \longrightarrow Na_2O + \underset{(0.5\text{ mole})}{O_2} + NO + NO_2$$

Total number of moles of O_2 evolved = 2.25

34. 00001.20

Sol. x = 6; (except H_2CO_3; CH_3CO_2H; H_3BO_3)
y = 5

35. 00035.00

Sol.

$$Co^{2+} + 6NH_3 \rightleftharpoons [Co(NH_3)_6]^{2+} \qquad K_1 = 10^5$$

$$Co^{3+} + 6NH_3 \rightleftharpoons [Co(NH_3)_6]^{3+} \qquad K_2 = 10^x$$

$$Co^{3+} + e \longrightarrow Co^{2+} \qquad E^o = 1.9\text{ V}$$

$$[Co(NH_3)_6]^{2+} \longrightarrow [Co(NH_3)_6]^{3+} + e \qquad E^o = -0.1\text{ V}$$

$$Co^{3+} + [Co(NH_3)_6]^{2+} \rightleftharpoons Co^{2+} + [Co(NH_3)_6]^{3+} \qquad E^o = 1.8\text{ V}$$

$$E^o = \frac{0.06}{1}\log\frac{K_2}{K_1} \text{ (at equilibrium)}$$

$$1.8 = 0.06\log\frac{K_2}{10^5}$$

$$30 = \log\frac{K_2}{10^5}$$

$$K_2 = 10^{35}$$

36. 00900.00

Sol.

$$\log\frac{k_2}{k_1} = \frac{30.8\times298\times4.606}{2.303\times2}\times\left[\frac{308-208}{308\times298}\right]$$

$$\log\frac{k_2}{k_1} = 1$$

$$\frac{k_2}{k_1} = 10$$

$$k_2 = 10k_1$$

% increased (x) $= \frac{10k_1 - k_1}{k_1}\times100$
= 900.00

Mathematics PART – III

SECTION – A

37. A, B, D

Sol. Let A_n denotes number of codes which ends with 0 or 4, B_n denotes number of codes which ends with 1 or 3 and C_n denotes number of codes which ends with 2
$A_{n+1} = B_n = C_{n+1}$, $B_{n+1} = A_n + 2C_n$, $N = 2^3 \cdot 3^9$

38. B, C

Sol. For same number probability is $\frac{{}^8C_4}{{}^9C_4} \times \frac{1}{{}^8C_4}$

39. A, C

Sol. Let (x, y) be the point on the path followed by dog, then $\frac{dy}{dx} = \frac{y-5t}{x}$

$xy' - y = -5t$ ..... (1)
On differentiating equation (1), w.r.t. x

$xy'' = -5\frac{dt}{dx} = \frac{\sqrt{1+y'^2}}{2}$

40. B

Sol. Use IVT
Let $h(x) = x^{11} - f(x)$
$h(0) < 0$ and $h(1) > 0$

41. A, B

Sol. Locus of the mid-point is $\frac{x^2}{\left(\frac{a^4e^4}{4a^2}\right)} + \frac{y^2}{\left(\frac{a^4e^4}{4b^2}\right)} = 1$

42. A, B

Sol. Let P, Q be (2, 0) and (6, 0) respectively

43. D

Sol. Equation of L is $\frac{x-1}{4} = \frac{y-1}{-3} = \frac{z-1}{-1}$

44. D

Sol. Required line passes through (1, 1, 1) and parallel to $\frac{x}{1} = \frac{y}{2} = \frac{z}{3}$

45. C

Sol. $f(x) = \int_0^{\pi/2}\left(x\sin t + (x\sin t)^3 + ...\right)dt = \frac{\sin^{-1}x}{\sqrt{1-x^2}}$

46. D

Sol. $f(x) = \int_0^{\pi/2}\left(x\sin t + (x\sin t)^3 + ...\right)dt = \frac{\sin^{-1}x}{\sqrt{1-x^2}}$

SECTION – D

47. 00000.00

Sol. $\lim\limits_{n\to\infty}\sum\limits_{r=1}^{n}\frac{(\cos 2\theta)^{2r-1}}{2r-1} = \ell n\cot\theta$

48. 00001.00

Sol. Expanding $(e^x + 1)^n - (e^x - 1)^n$ in two ways

49. 00001.00

Sol. $(ae^{-iB} + be^{iA})^3 = (c + i(b\sin A - a\sin B))^3 = c^3$

50. 00002.00

Sol. Use integration by parts, then use expansion

51. 00006.00

Sol. $\lim\limits_{n\to\infty}\prod\limits_{r=1}^{n}\left(1-\frac{d^2}{a_r^2}\right) = \lim\limits_{n\to\infty}\frac{(8-d)\cdot(8+nd)}{8\cdot(8+(n-1)d)} = \frac{8-d}{8}$

52. 00023.00

Sol. $P(x) = Q(x)(x-1)(x-2) + 2x + 3$
$P(10) = 72n + 23$

53. 00001.00

Sol. From similar ΔAEM and ΔAPE
$\frac{AE}{AP} = \frac{AM}{AE}$
$\Rightarrow AE^2 = AM\cdot AP = (AD - r)AP$ ..... (1)
AB both circles touches each other $(R - r)^2 = r^2 + OD^2 = r^2 + (AD - R)^2$
AE = AD

54. 00351.00

Sol. ${}^7C_7 + {}^7C_1[10\times2\times2] + {}^7C_4\times2$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – V

JEE (Advanced)-2019

PAPER – 2

TEST DATE: 27-01-2019

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01 – 06, 19 – 24, 37 – 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 – 46) *contains 12 questions. Each question has* ***TWO (02)*** *matching lists:* ***LIST-I*** *and* ***LIST-II***. ***FOUR*** *options are given representing matching of elements from* ***LIST-I*** *and* ***LIST-II***. ***ONLY ONE*** *of these four options corresponds to a correct matching.*
   For each question, choose the option corresponding to the correct matching.
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

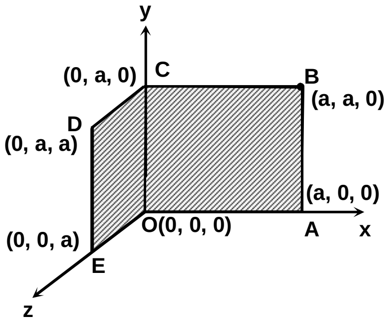
SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

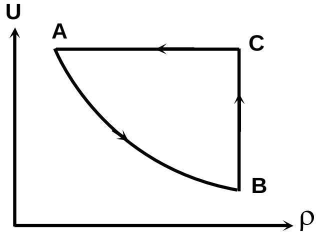
1. The length of sonometer wire between two fixed ends is 100 cm. Three bridges be placed so as to divide the wire into four segments whose fundamental frequencies are in the ratio of 1 : 2 : 3 : 4 from the left end. Then which of the following is/are correct.
   (A) The position of the first bridge from the left fixed end is 48 cm
   (B) The position of the 2nd bridge from the right fixed end is 28 cm
   (C) The position of the 3rd bridge from the left fixed end is 88 cm
   (D) The separation between the first bridge and the 3rd bridge is 40 cm

2. Two surface OABC and OCDE lies in the plane of xy and yz as shown in the figure. A charged particle 'q' lies in the space at a point P, if

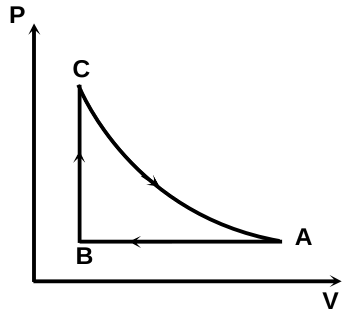


   (A) coordinates of 'P' is ($a - \Delta r$, $a - \Delta r$, Δr) and a >> Δr, then flux passing through surface OABC is $\frac{7q}{24\varepsilon_0}$.
   (B) coordinates of 'P' is ($a - \Delta r$, $a - \Delta r$, Δr) and a >> Δr, then flux passing through surface OCDE is $\frac{q}{24\varepsilon_0}$.
   (C) coordinates of 'P' is ($a + \Delta r$, $a + \Delta r$, $-\Delta r$) and a >> Δr, then flux passing through surface OABC is $\frac{q}{24\varepsilon_0}$.
   (D) coordinates of 'P' is ($a + \Delta r$, $a + \Delta r$, $-\Delta r$) and a >> Δr, then flux passing through surface OCDE is $\frac{q}{24\varepsilon_0}$.

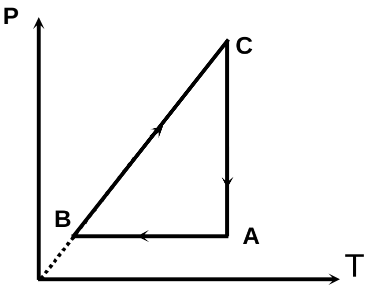
3. U-ρ (U → internal energy of the gas and ρ → density of the gas) plot of an ideal mono-atomic gas undergoing a cyclic process is shown in the figure. A → B is part of a rectangular hyperbola. Then which of the following graphs in options below crosspond to the process given in adjacent diagram?



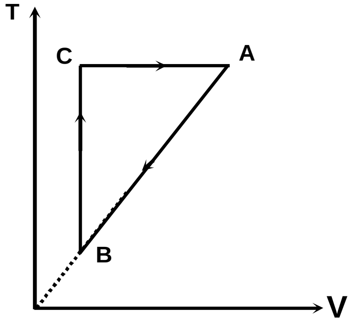
(A)



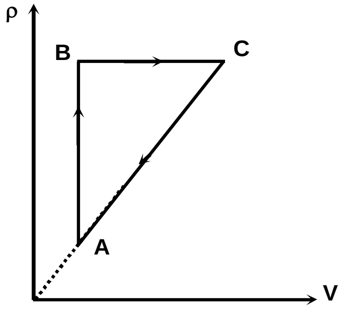
(B)



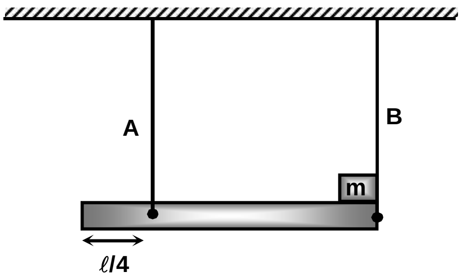
(C)



(D)



4. A uniform rod of mass 'm' and length 'ℓ' is held horizontally by two vertical strings 'A' and 'B' of negligible mass and a small block of mass 'm' is also placed on the top of the rod as shown in the figure. Then which of the following is/are correct.



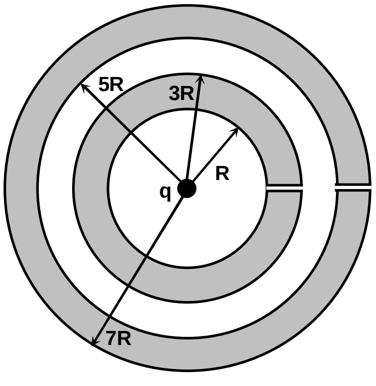
(A) The tension in the string 'A' immediately after the string 'B' is cut, is $\frac{4}{7}mg$.

(B) The tension in the string 'A' immediately after the string 'B' is cut, is $\frac{2}{7}mg$.

(C) The acceleration of centre of mass of the rod immediately after the string 'B' is cut, is $\frac{3}{7}g$.

(D) The acceleration of centre of mass of the rod and the block immediately after the string 'B' is cut, is $\frac{5}{7}g$.

5. A small charged particle 'q' lies at the centre of two concentric conducting hollow spheres of inner radii R and 5R and outer radii 3R and 7R respectively. Then which of the following is/are correct.



(A) The energy stored in the space between 3R to 5R (cavity) is $\frac{kq^2}{15R}$.

(B) The energy stored in the space between 3R to 5R (cavity) is $\frac{kq^2}{30R}$.

(C) The amount of work has to be performed to slowly transfer the charge ‘q’ from center through the orifice to infinity is $\frac{29}{210}\frac{kq^2}{R}$.

(D) The amount of work has to be performed to slowly transfer the charge ‘q’ from center through the orifice to infinity is $\frac{38}{105}\frac{kq^2}{R}$.

6. A source ‘S’ of sound wave of fixed frequency ‘f’ and an observer ‘O’ are located in air initially at the space point A and B, a fixed distance apart. State in which of the following cases, the observer will not see any Doppler effect and will receive the same frequency ‘f’ as produced by the source

(A) Both the source ‘S’ and observer ‘O’ remains stationary but wind blows with constant speed in arbitrary direction.

(B) The observer ‘O’ remains stationary but the source ‘S’ moves parallel to and in the same direction and with the same speed as wind.

(C) The source ‘S’ remains stationary but the observer ‘O’ and the wind have same speed away from the source.

(D) The source ‘S’ and the observer ‘O’ move directly against the wind but both with the same speed.

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

7. A tank of mass 20m (including shells) fires shells of mass 2m, 4m and 8m with velocity v_0 relative to the tank after firing, in the horizontal direction. The tank is placed over a smooth horizontal surface. Randomly any shell is fired from the tank and all the shells are fired. Then match the following.

LIST–I		**LIST–II**	
P.	The magnitude of velocity of tank with respect to ground after firing all shell, may be equal to	1.	$\frac{29}{30}v_0$
Q.	The magnitude of velocity of tank with respect to ground after firing all shell, may be equal to	2.	$\frac{4}{5}v_0$
R.	The magnitude of velocity of shell of mass 4m with respect to ground may be equal to	3.	$\frac{59}{60}v_0$
S.	The magnitude of velocity of shell of mass 2m with respect to ground may be equal to	4.	v_0
		5.	$\frac{9v_0}{10}$

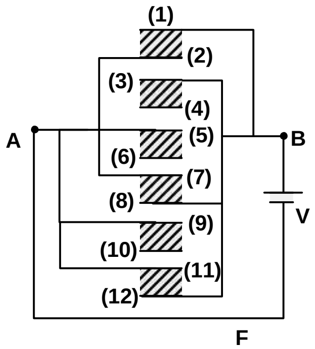
(A) P → 4; Q → 3; R → 1; S → 2

(B) P → 3; Q → 1; R → 2; S → 5

(C) P → 3; Q → 5; R → 4; S → 2

(D) P → 4; Q → 3; R → 5; S → 1

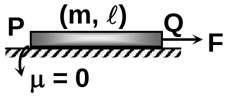
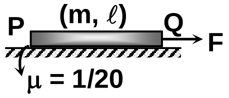
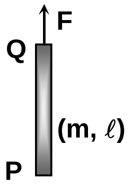
8. All identical capacitor plates each of area A are arranged such that adjacent plates are at d distance apart. Plates are connected to a source of emf V volts as shown in figure. Match the quantities in List –I with their respective answer in List-II. (dielectric constant in each shaded region is k = 2)

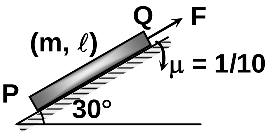


LIST–I		LIST–II	
P.	Charge on plate 3 (multiple of $\frac{\varepsilon_0 AV}{d}$)	1.	4/3
Q.	The heat rejected by the system (multiple of $\frac{13\varepsilon_0 AV^2}{d}$)	2.	1
R.	Equivalent capacitance between AB (multiple of $\frac{13A\varepsilon_0}{d}$)	3.	1/3
S.	Potential difference between the plates 4 and 7 (multiple of V/2)	4.	2/3
		5.	5/3

(A) P → 4; Q → 3; R → 1; S → 5
(B) P → 5; Q → 2; R → 4; S → 3
(C) P → 4; Q → 5; R → 1; S → 2
(D) P → 5; Q → 3; R → 4; S → 1

9. In **List –I** a constant force F is applied on the rod of mass m and length ‘ℓ’ such that in each case rod moves. A transverse pulse is created at the end point P in each case. The time to move the pulse from P to Q is given in **List –II**. Then match the following.

LIST–I		LIST–II	
P.	 (m = 4 kg, ℓ = 20 m, F = 5 N)	1.	12 sec
Q.	 (m = 9 kg, ℓ = 32 m, F = 8 N)	2.	20 sec
R.	 (m = 7 kg, ℓ = 14 m, F = 2 N)	3.	8 sec

S.	 (m = 10 kg, ℓ = 20 m, F = 2 N)	4.	14 sec
		5.	18 sec

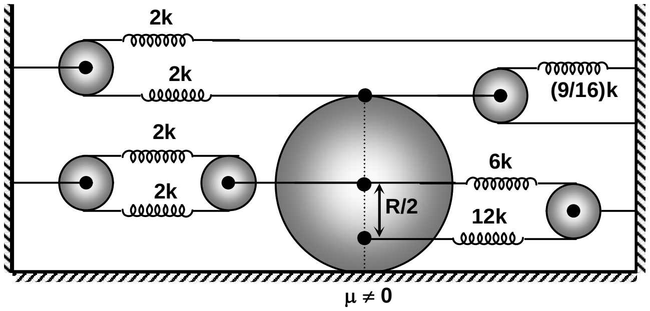
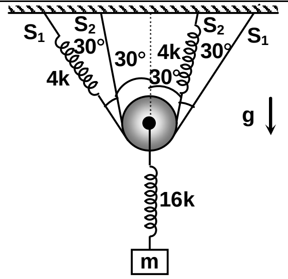
(A) P → 4; Q → 3; R → 1; S → 2

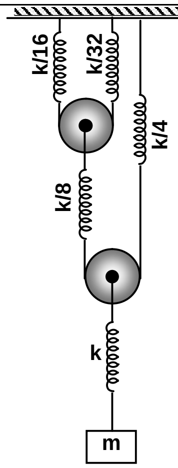
(B) P → 5; Q → 3; R → 1; S → 4

(C) P → 3; Q → 1; R → 4; S → 2

(D) P → 5; Q → 3; R → 4; S → 1

10. Some rigid body or block connected with springs are shown in List – I. All the rigid body or block shown are in equilibrium and their time periods of oscillation are given in List – II.

List – I		List – II	
(P)	 2k 2k 2k 2k (9/16)k 6k 12k R/2 μ ≠ 0 There is sufficient friction between the disc and horizontal surface such that pure rolling exist. All the springs and pulleys are ideal and massless. If the disc is displaced (rotated anticlockwise) towards left and then released, then the time period of oscillation of the disc is (mass of the disc and its radius is m and R respectively, springs constant of each springs are shown in figure) (In the shown position all the springs are at their natural length)	(1)	$\frac{3\pi}{2}\sqrt{\frac{m}{5k}}$
(Q)	 S₁ S₂ 30° 4k 30° 4k 30° S₂ 30° S₁ g 16k m All the springs and pulleys are ideal and massless. If the block is slightly pulled vertically downward from its equilibrium position, then the time period of oscillation of the block is (assume strings are taught all the time)	(2)	$2\pi\sqrt{\frac{7m}{k}}$

<table>
<tr>
<td>(R)</td>
<td>

All the pulleys and strings are massless and frictionless. Find the time period of oscillation of the block as shown in the figure. (Springs and strings are also massless)</td>
<td>(3)</td>
<td>$\pi\sqrt{\frac{m}{2k}}$</td>
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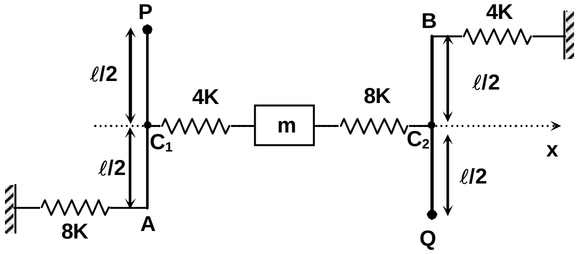
<tr>
<td>(S)</td>
<td>

In the figure shown arrangement is placed on horizontal frictionless plane. The mass of rod PA and QB are negligible and they are free to rotate about hinge point P and Q respectively in the horizontal plane. The block of mass ‘m’ is attached to springs. Springs are light and their stiffness are shown in the figure. The block is slightly displaced along x–axis then released. Then the time period of oscillation of the block is</td>
<td>(4)</td>
<td>$\frac{5\pi}{12}\sqrt{\frac{3m}{k}}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(5)</td>
<td>$2\pi\sqrt{\frac{m}{2k}}$</td>
</tr>
</table>

(A) P → 3; Q → 4; R → 1; S → 2
(B) P → 4; Q → 3; R → 1; S → 5
(C) P → 4; Q → 3; R → 2; S → 1
(D) P → 5; Q → 3; R → 4; S → 1

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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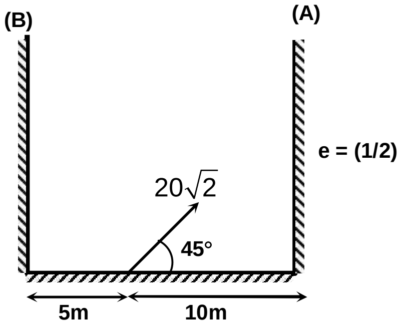
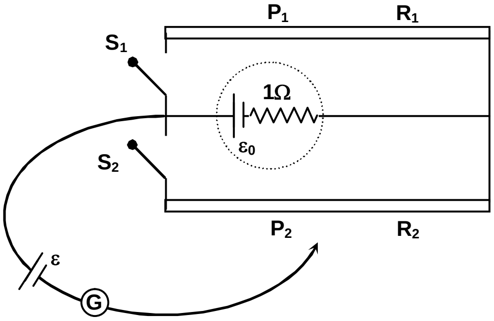
11. A ball is projected with speed $20\sqrt{2}$ m/s at an angle of 45° with horizontal it collide with the wall and after two successive collision it comes at the projection point. Then find the coefficient of restitution between ball and wall B.

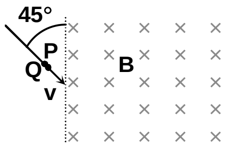


12. A wire is made by attaching two segments together end to end. One segment is made of aluminium and other is steel. The effective linear expansion of two segment is 17×10^{-6}/°C. The fraction length of aluminium is (linear coefficients of thermal expansion of aluminium and steel are 23×10^{-6}/°C and 11×10^{-6}/°C respectively).

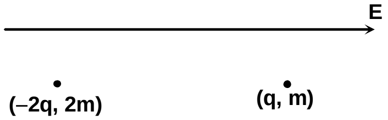
13. Two identical potentiometer P_1 and P_2 of equal length ℓ, resistance R_1, R_2 are connected with a battery of emf ε_0 and internal resistance 1Ω, through two switches S_1 and S_2. A battery of emf ε is balanced on these potentiometer wires one by one. If resistance of wire R_1 is 3.68 Ω and balancing length is $\frac{\ell}{2}$ on it, when S_1 is closed and S_2 is open. On closing S_2 and opening S_1 the balancing length on P_2 is found to be $\frac{2\ell}{3}$, then the resistance of wire R_2 is $k \times 10^{-2}$ Ω. Find the value of k.



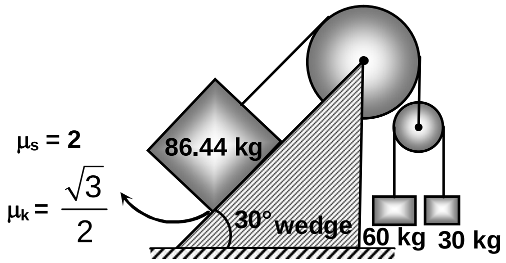
14. Two charged particles P and Q of same mass 'm' having charge q and –q are projected with same magnitude of velocity v into magnetic field B as shown in the figure. Find the maximum separation (in meter) between the charged particles when they are inside the magnetic field. Ignore electric and magnetic effect due to charges on themselves. [take (mv/qB) = 3.14]



15. Two charged particles (m, q) and (2m, –2q) are placed in a gravity free space where a uniform electric field E exists as shown in figure. After the particles are released they stay at a constant distance from each other. What is the distance between them in meter? (Neglected the gravitational interaction). (K is electrostatic constant and take $\frac{kq}{E} = \frac{27}{8}$)

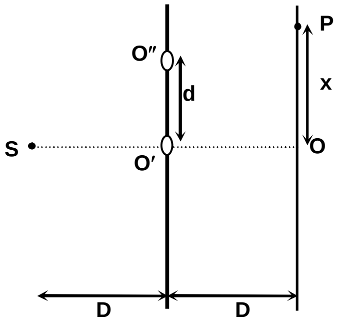


16. All the pulleys and strings are ideal and massless. At t = 0 system is released from rest on the fixed wedge. Find the frictional force acting between the block of mass 86.44 kg and the wedge in Newton. (take $g = 10\ m/s^2$)



17. The main scale of vernier calipers reads in millimeter and its one division is equal to one millimeter. Its vernier is divided into 6 divisions, which coincide with 15 divisions of main scale. Further more when a cylinder is tightly placed along its length between two jaws, it is observed that the zero vernier scale lies just right to 25th division of main scale and fifth division of vernier scale coincide with the main scale. Then find the measured value in millimeter.

18. The minimum value of 'd' so that there is a dark fringe at O is d_{min}. For the value of d_{min}, the distance at which the first bright fringe is formed is 'x' and if the value of 'x' is $k \times 10^{-3}$ meter. Then find the value of k. (Given D = 1 m and λ = 1800 Å)



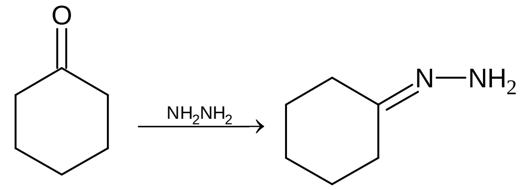
Chemistry PART – II

SECTION – A

(One or More than one correct type)

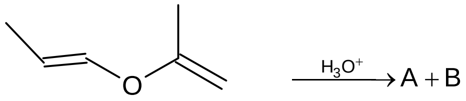
This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19.



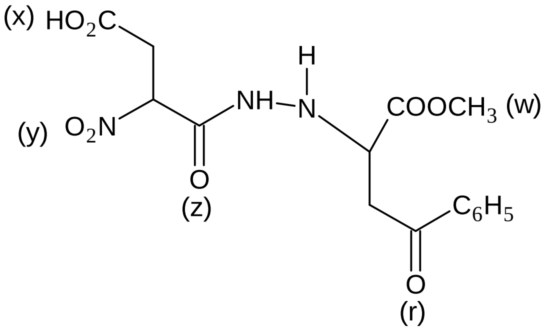
The correct statements regarding this conversion is
(A) The rate of the reaction is very low at pH = 1
(B) Elimination of water become rds when pH of the reaction mixture is approximately 7
(C) Addition of nucleophile become rds when pH of the reaction is < 4.5
(D) Hydrazine is more nucleophilic than a regular amine in nucleophilic addition reaction of carbonyl compounds

20.



A and B can be distinguished by
(A) Acidified $K_2Cr_2O_7$ solution
(B) NaOI
(C) Benedict's solution
(D) Brady's reagent

21. Identify the correct statement(s) given for the reduction of the following compounds:



(A) $LiAlH_4$ reduces x, y, z, w, r
(B) $NaBH_4$ reduces 'r' only
(C) Na/C_2H_5OH reduces x, r and w only
(D) $(CH_3)_2CHOH + [(CH_3)_2CHO^{-}]_3Al$, Δ reduces only 'r'

22. In the Froth Floatation process, ZnS and PbS can be separated by
(A) using xanthates
(B) adjusting the proportion of oil to water
(C) using NaCN
(D) using cresols

23. The correct statement (s) about SO_2 is/are
(A) It contains discrete bent molecules in both gaseous and solid state
(B) It can act both as a Lewis acid and as well as Lewis base
(C) It can be prepared by the reaction of dilute H_2SO_4 with metal sulphides
(D) It acts as bleaching agent in moist conditions

24. Which of the following statement(s) is/are correct?
(A) Each sp^3 hybrid orbital has two lobes of unequal size, making the electron density greater on one side of the nucleus than the other
(B) Extent of overlapping in hybrid orbitals is more than that of atomic orbitals
(C) A molecule adopts a particular shape not because of hybridization but to have the lowest possible energy
(D) Hybridization of s and p orbitals to form effective sp^2 hybrids requires that they have comparable radial extent

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

---

25. Match the following List – I with the List - II

LIST–I		LIST–II	
P.	Bleaching powder	1.	Molecules have two different oxidation states of same element
Q.	Sodium thiosulphate	2.	Fertilizer
R.	Carbon sub oxide	3.	Oxidizing agent
S.	Ammonium nitrate	4.	Anhydride of malonic anhydride
		5.	Antidote to cyanide poisoning

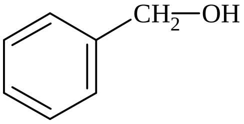
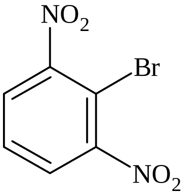
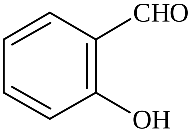
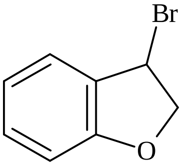
(A) P → 1, 2; Q → 1, 5; R → 1, 4; S → 1, 2
(B) P → 1, 3; Q → 1, 4; R → 1, 5; S → 1, 2, 3
(C) P → 1, 3; Q → 1, 5; R → 1, 4; S → 1, 2, 3
(D) P → 1, 2; Q → 1, 4; R → 1, 5; S → 1, 2

26. Match the following List – I with the List - II

LIST–I		LIST–II	
P.	DMG	1.	O is donor atom
Q.	Dien	2.	Bidentate ligand
R.	Acetylacetonate	3.	Ambidentate ligand
S.	Glycinate	4.	N is donor atom
		5.	Tridentate ligand

(A) P → 2, 4; Q → 3, 4, 5; R → 2, 1; S → 1, 2
(B) P → 2, 3, 4; Q → 4, 5; R → 2, 1; S → 1, 2, 4
(C) P → 2, 3; Q → 3, 4, 5; R → 2, 1; S → 1, 2
(D) P → 2, 4; Q → 4, 5; R → 2, 1; S → 1, 2, 4

27. Match the following List – I with the List - II

LIST–I		LIST–II	
P.		1.	Nucleophilic substitution
Q.		2.	Nucleophilic addition
R.		3.	Esterification with $(CH_3CO)_2O$
S.		4.	Dehydrogenation on treatment with Cu at 300°C
		5.	Dehydrohalogenation

(A) P → 1, 3, 4; Q → 1; R → 2, 3; S → 1, 5
(B) P → 1, 3; Q → 1, 4; R → 2, 3; S → 2, 5
(C) P → 1, 4; Q → 1; R → 2; S → 1, 2
(D) P → 1, 2, 4; Q → 1, 3; R → 2, 3; S → 1, 2

28. Match the following List – I with the List - II

LIST–I		LIST–II	
P.	PTFE	1.	Used in preparing gaskets
Q.	Neoprene	2.	Biodegradable
R.	PHBV	3.	Thermoplastic
S.	PVC	4.	Produced by free radical polymerization
		5.	Vulcanisation improve physical properties
		6.	Polyster

(A) P → 3, 4; Q → 1, 5; R → 2, 5, 6; S → 3, 4
(B) P → 1, 3, 4; Q → 1, 4, 5; R → 2, 3, 6; S → 3, 4
(C) P → 3, 4, 5; Q → 1, 4; R → 2, 6; S → 1, 3, 5
(D) P → 1, 3; Q → 1, 4, 5; R → 2, 5, 6; S → 1, 3, 4

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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29. Chandreyi went to beauty parlour to bleach her hair by H_2O_2 solution. Requirement of oxygen for a good bleach is 10% by mass of hair. Knowing mass of her hair to be 520 g, what concentration of H_2O_2 (in M); she should be looking at the beauty parlour (if each bottle contains 500 ml of H_2O_2 and fully consumed during the bleach)?

30. Wave length of first line of Balmer series of He^+ ion is x times of that of its last line. Then the value of x would be:

31. Among the following if number of linear molecules are x and number of angular molecules are y. then value of x/y would be?

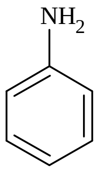
O_3, N_2O, NO_2, SO_2, CO_2, $SnCl_2$, Cl_2O, HCN, $\overset{+}{N}O_2$

32. If number of electrons present in 1990 mg of perchlorate ion is a $\times 10^{23}$. Then the value of a would be? ($N_A = 6.02 \times 10^{23}$)

33. In a crystalline solid, atoms of X forms FCC packing and the atoms of Y occupy all octahedral voids. If all the atoms along one body diagonal are removed, then the simplest formula of the crystalline solid will be X_aY_b, the value of (a/b) is:

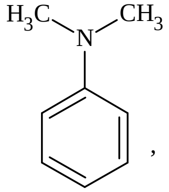
34. The number of following amines, which are relatively more basic than benzyl amine is/are a and the amines which can be easily prepared by Gabriel's phthalimide synthesis is/are b then the value of a/b would be:

$H_3C—NH_2$,



,

$(C_2H_5)_2NH$,



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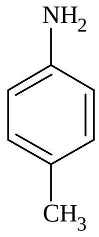

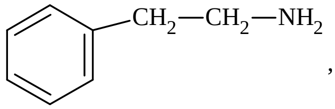

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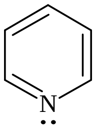

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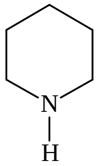

,

$(CH_3)_3N$

35. A chain silicone polymer containing 7 Si atoms is prepared by hydrolysis of $(CH_3)_2SiCl_2$ and $(CH_3)_3SiCl$. The ratio of $(CH_3)_2SiCl_2$ units to $(CH_3)_3SiCl$ units required to prepare that polymer that cannot take part in further condensation reaction, would be?

36. A solution contains 0.6 g urea and 18 g glucose in 100 cc water at 27°C. If the osmotic pressure of the solution is p bars; then find the value of p. (R = 0.083 L bar mol^{-1} K^{-1})

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. $I = \int_0^1 \int_{f(y)}^1 \left(e^{g(x)}dx\right)dy$, then which of the following is/are correct statement(s)?

(A) for f(y) = y and g(x) = x^2 the value of I = $\frac{e-1}{2}$

(B) for f(y) = y and g(x) = x^3 the value of I < $\frac{e-1}{2}$

(C) for f(y) = y^2 and g(x) = $\sqrt{x}$ the value of I < $\frac{2e}{3}$

(D) for f(y) = y^2 and g(x) = $\sqrt{x}$ the value of I > $\frac{2e}{3}$

38. Let p be $\prod_{r=1}^{50} \frac{2r-1}{2r}$, then which of the following is/are correct

(A) $p > \frac{1}{15}$

(B) $p < \frac{1}{10}$

(C) $p < \frac{1}{\sqrt{151}}$

(D) $p > \frac{1}{2}$

39. Let the complex number z be root of the equation $11z^{10} + 10iz^9 + 10iz - 11 = 0$, then which of the following statement(s) is/are correct?
(A) $|z|^2 + |z| + 1 = 3$
(B) $|z|^2 - |z| + 1 = 1$
(C) $|z|^2 + |z| + 1 = 7$
(D) $|z|^2 + |z| + 1 = 8$

40. The number of positive integers of n digits chosen from set {2, 3, 7, 9} which are divisible by 3 is
(A) 22 for n = 3
(B) 23 for n = 3
(C) 86 for n = 4
(D) 342 for n = 5

41. Let f : [0, 1] → R be a function with continuous second derivative and $f'(x) \in (0, 1)\ \forall x \in [0, 1]$. Let $\int_0^x f^2(t)dt = g(x)$, g(0) = f(0), $\int_0^x f^3(t)dt = h(x)$, then for $x \in [0, 1]$
(A) $h(x) \ge g(x)$
(B) $h(x) \le g(x)$
(C) $f(x) \le x + \tan^{-1} x$
(D) $f(x) \ge x + \tan^{-1} x$

42. Let ABCD be a rectangle with A(0, 0), B(4, 0), C(4, 4) and D(0, 4). Rectangle is folded in such a way that corner B always lies on line AD, then which of the following statement(s) is/are correct?
(A) As the point B moves on AD the crease thus formed will touch a fixed parabola whose focus is at (4, 0)
(B) As the point B moves on AD the crease thus formed will touch a fixed parabola whose focus is at $\left(\frac{3}{2}, 0\right)$
(C) As the point B moves on AD the crease thus formed will touch a fixed parabola whose equation is $y^2 = 8(x - 2)$
(D) As the point B moves on AD the crease thus formed will touch a fixed parabola whose equation of directrix is y = 2x

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

---

43. Match the following List-I with List-II

	LIST–I		LIST–II
P.	$\lvert A_{4\times3} B_{3\times4} \rvert$ is equal to	1.	1
Q.	If A and B are non-zero square matrices of same order such that AB = 0, then the value of $\lvert A\rvert + \lvert B\rvert + 5$ is equal to	2.	$\frac{1}{9}$
R.	Let A be an 3 × 3 orthogonal matrix such that AB = BA, then $\lvert AB^T - B^TA + 2I\rvert$ is equal to	3.	0
S.	Let A and B be square matrices of order 3 × 3 such that $\lvert A\rvert = 1$ and $\lvert B\rvert = 3$, then the value of $\lvert 2A^2B^{-3}\rvert$ is equal to	4.	2^3
		5.	5
		6.	$\frac{8}{27}$

The correct option is:
(A) P → 4; Q → 6; R → 2; S → 1
(B) P → 3; Q → 4; R → 5; S → 6
(C) P → 4; Q → 6; R → 5; S → 2
(D) P → 3; Q → 5; R → 4; S → 6

44. Match the following List-I with List-II

	LIST–I		LIST–II
P.	Any chord of conic $x^2 + y^2 + xy = 1$ passing through origin is bisected at point (p, q), then p + q is equal to	1.	1
Q.	The base BC of ABC passes through the point P(1, 1) and its sides are bisected at right angles by x + y = 0 and x + 2y = 0. The locus of the vertex A is circle with radius equal to r, then $\frac{\sqrt{5}}{r}$ is	2.	5
R.	The circle $x^2 + y^2 - 4x - 4y + 4 = 0$ is inscribed in a triangle which has two of its sides along the coordinate axes. If the locus of circumcentre of triangle is $x + y - xy + \lambda\sqrt{x^2 + y^2} = 0$, then λ is equal to	3.	3

S.	Let P be a point in xy plane, then minimum value of PA + BP + CP + DP is equal to ℓ, then $\frac{\ell}{3}$ is equal to (where A(0, 0), B(4, 3), C(3, 4) and D(–2, 11)	4.	0
		5.	7
		6.	$\sqrt{8}$

The correct option is:

(A) P → 4; Q → 6; R → 2; S → 1
(B) P → 1; Q → 4; R → 2; S → 3
(C) P → 4; Q → 3; R → 1; S → 2
(D) P → 6; Q → 5; R → 6; S → 6

45. Let C be curve represented by equation $5x^2 + 5y^2 - 8xy - 9 = 0$, match the following List-I with List-II

LIST–I		LIST–II	
P.	Area enclosed by curve C is equal to _____ square unit	1.	1
Q.	Let a tangent drawn at point P (other then vertex) on ellipse. If a line AP intersect the line passing through B perpendicular to above tangent at Q, then AQ is equal to (where A(–2, –2), B(2, 2))	2.	3π
R.	If normal drawn at P(lying on C) cuts major axis at G and perpendicular from origin cuts normal at F, then PG·PF is equal to	3.	6
S.	Let the line $y - x = \sqrt{2}$ touches C at P(α, β), then $8(\alpha^2 + \beta^2)$ is equal to	4.	5
		5.	4π
		6.	8

The correct option is:

(A) P → 4; Q → 6; R → 2; S → 1
(B) P → 2; Q → 1; R → 3; S → 6
(C) P → 4; Q → 6; R → 5; S → 2
(D) P → 2; Q → 3; R → 1; S → 6

46. Let the vertices of tetrahedron ABCD be $A\left(\hat{i} + \hat{j} + \hat{k}\right)$, $B\left(\hat{i}\right)$, $C\left(2\hat{i} + \hat{j}\right)$ and $D\left(\hat{i} + \hat{j}\right)$ respectively, match the following List-I with List-II

LIST–I		LIST–II	
P.	The position vector of the foot of perpendicular drawn from A to the plane BCD is	1.	$\left(\frac{1}{2}\right)\left(3\hat{i} + \hat{j} + \hat{k}\right)$
Q.	Volume of tetrahedron ABCD is	2.	$\frac{1}{\sqrt{2}}$
R.	The position vector of circumcentre of circum sphere of tetrahedron ABCD is	3.	$\hat{i} + \hat{j}$
S.	Shortest distance between the lines AB and CD is	4.	$\left(\frac{1}{2}\right)\left(\hat{i} + 2\hat{j} + \hat{k}\right)$
		5.	$\frac{1}{6}$
		6.	$\hat{i} + 2\hat{j}$

The correct option is:
(A) P → 4; Q → 6; R → 2; S → 1
(B) P → 3; Q → 5; R → 1; S → 2
(C) P → 4; Q → 6; R → 5; S → 2
(D) P → 3; Q → 5; R → 2; S → 1

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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47. Let $f(x)=\lim\limits_{n\to\infty}\dfrac{3^n\sin x+\left(\sqrt{2}\cos x+2\right)^n+2^n\cos x}{3^n+\cos x\left(\sqrt{2}\cos x+2\right)^n}$, then the value of $\left(\lim\limits_{x\to\frac{\pi}{4}^-} f(x)\right)^4$ is equal to ____

48. $\sum\limits_{m=1}^{\infty}\sum\limits_{n=1}^{\infty}\dfrac{m^2n}{4^m\left(n\cdot4^m+m\cdot4^n\right)}$ is k, then $\left[\dfrac{1}{k}\right]$ is equal to _____ (where [.] denotes the greatest integer function)

49. For each positive integer K, let the point P with abscissa K on curve $y^2 - x^2 = 1$ such that d_K represents shortest distance between P and line y = x, then $4\left(\lim\limits_{K\to\infty} Kd_K\right)^2$ is equal to _____

50. The value of $\prod\limits_{k=0}^{6}\cos\left(\dfrac{\pi}{21}+\dfrac{k\pi}{7}\right)$ is $-\ell$, then the value of 1024ℓ is equal to _____

51. In ΔABC let a = 6, b = 3 and tan(A – B) = $\dfrac{3}{4}$, if the value of $\dfrac{ab-r_1r_2}{r_3}=\ell$, then the value of $\dfrac{\left(3+\sqrt{5}\right)\ell}{6}$ is equal to ______ (where r_1, r_2 and r_3 are ex-radii of ΔABC)

52. If the area enclosed by the curve $x^4 + y^4 = 2xy$ is equal to A square unit, then the value of $\dfrac{100A}{\pi}$ is equal to _____

53. The largest positive integer n such that $\dfrac{1}{(a+b+c)}\left\{\dfrac{a^2}{\frac{b}{11}+\frac{c}{13}}+\dfrac{b^2}{\frac{c}{11}+\frac{a}{13}}+\dfrac{c^2}{\frac{a}{11}+\frac{b}{13}}\right\}\ge n$ holds for all positive real numbers a, b, c is _____

54. Let α be smallest positive root satisfying $\cos^3 3x + \cos^3 5x = 8\cos^3 4x\cdot\cos^3 x$, then cos α is equal to _____

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – V

JEE (Advanced)-2019

PAPER – 2

TEST DATE: 27-01-2019

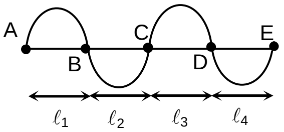
ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. A, B, C, D



Sol. $\ell_1+\ell_2+\ell_3+\ell_4=100$ cm

Let n_1, n_2, n_3 and n_4 are fundamental frequencies of these segments respectively.

$$\frac{n_1}{n_2}=\frac{1}{2},\ \frac{n_2}{n_3}=\frac{2}{3},\ \frac{n_3}{n_4}=\frac{3}{4},\ \frac{n_2}{n_4}=\frac{2}{4}=\frac{1}{2}$$

$$n=\frac{1}{2\ell}\sqrt{\frac{T}{\mu}}\Rightarrow n\ell=\text{constant}$$

$$n_1\ell_1=n_2\ell_2=n_3\ell_3=n_4\ell_4$$

$$\ell_1=\frac{n_2}{n_1}\ell_2,\ \ell_3=\frac{n_2}{n_3}\ell_2,\ \ell_4=\frac{n_2}{n_4}\ell_2$$

$\ell_1+\ell_2+\ell_3+\ell_4=100$ cm

$$2\ell_2+\ell_2+\frac{2}{3}\ell_2+\frac{\ell_2}{2}=100$$

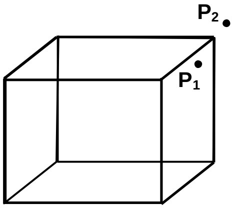
$\ell_2 = 24$ cm

So, $\ell_1 = 48$ cm

$\ell_3 = 16$ cm

$\ell_4 = 12$ cm

2. A, B, C, D



Sol. Using symmetry if charged particle lies at P_1 then $\phi_{OCDE} = \frac{q}{24\varepsilon_0}$

and $\phi_{OABC} = \frac{\left(\frac{q}{\varepsilon_0} - \frac{q}{8\varepsilon_0}\right)}{3} = \frac{7q}{24\varepsilon_0}$

If the charge particle lies at P_2 then

$\phi_{OCDE} = \frac{q}{24\varepsilon_0}$

and $\phi_{OABC} = \frac{q}{24\varepsilon_0}$

3. A, B, C

Sol. AB $\rightarrow$ $U\rho$ = constant

$nC_vT\frac{PM}{RT} = \text{constant}$

P = constant

Isobaric process

BC $\rightarrow$ ρ = constant

$\frac{PM}{RT} = \text{constant}$

$P \propto T$

Isochoric process

CA $\rightarrow$ U = constant

$U = nC_vT$ = constant

T = constant

Isothermal process

4. A, C, D

Sol. Just after cutting the string B, block looses the contact with the rod.

taking torque about P

$mg\frac{\ell}{4} = \left(\frac{m\ell^2}{12} + \frac{m\ell^2}{16}\right)\alpha$

$\alpha = \frac{12}{7}\frac{g}{\ell},\ a_{cm} = \frac{\ell}{4}\alpha = \frac{3}{7}g$

$mg - T = ma_{cm}$

$T = \frac{4}{7}mg$

5. A, D

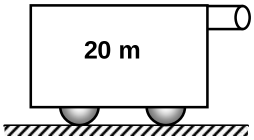
Sol. Work performed = $\int_{R}^{3R}\frac{1}{2}\varepsilon_0E^2dV + \int_{5R}^{7R}\frac{1}{2}\varepsilon_0E^2dV = \frac{kq^2}{3R} + \frac{kq^2}{35R}$

6. A, D

Sol. In both case (A) and (D) the source and observer are relatively at rest. Thus there is no change in the frequency.

7. B

Sol. If first 8m, then 4m, then 2m fired, then velocity of tank



$$v = \left(\frac{8}{20} + \frac{4}{12} + \frac{2}{8}\right)v_0 = \frac{59}{60}v_0$$

If first 8m, then 2m, then 4m fired, then velocity of tank

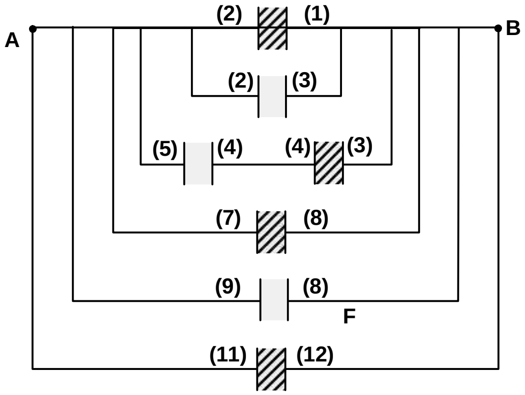
$$v = \left(\frac{8}{20} + \frac{2}{12} + \frac{4}{10}\right)v_0 = \frac{29}{30}v_0$$

If only shell 4m is fired first velocity of shell = $v_0 - \frac{4v_0}{20} = \frac{4}{5}v_0$

If only shell 2m is fired first velocity of shell = $v_0 - \frac{2v_0}{20} = \frac{9v_0}{10}$

8. D

Sol. Apply Kirchoff's Law on the equivalent circuit shown in the diagram.


A
B
(2)
(1)
(2)
(3)
(5)
(4)
(4)
(3)
(7)
(8)
(9)
(8)
F
(11)
(12)

9. C

Sol. In each case

$$T = \frac{F}{\ell}x$$

$$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{F}{\ell}\frac{x}{m/\ell}} = \sqrt{\frac{Fx}{m}}$$

$$\frac{dx}{dt} = \sqrt{\frac{Fx}{m}}$$

$$\int_0^{\ell}\frac{dx}{\sqrt{x}} = \sqrt{\frac{F}{m}}\int_0^{t}dt, \quad t = 2\sqrt{\frac{m\ell}{F}}$$

10. C

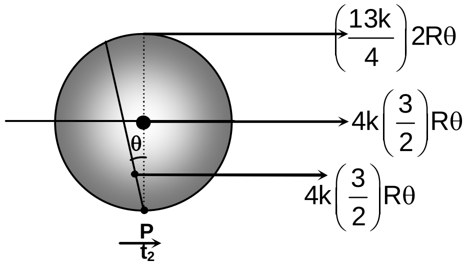
Sol. (P) Case (i)

Torque about 'P'

$$\frac{3}{2}mR^2\alpha = -18kR^2\theta$$

$$\alpha = -\left(\frac{36k}{3m}\right)\theta$$

$$t_1 = \frac{\pi}{6}\sqrt{\frac{3m}{k}}$$


$\left(\frac{13k}{4}\right)2R\theta$
$4k\left(\frac{3}{2}\right)R\theta$
$4k\left(\frac{3}{2}\right)R\theta$
θ
P
t_2

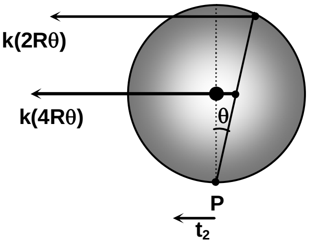
Case (ii)

$$\frac{3}{2}mR^2\alpha = -8kR^2\theta$$

$$\alpha = -\left(\frac{16k}{3m}\right)\theta$$

$$t_2 = \frac{\pi}{4}\sqrt{\frac{3m}{k}}$$

$$T = t_1 + t_2 = \frac{5\pi}{12}\sqrt{\frac{3m}{k}}$$


k(2Rθ)
k(4Rθ)
θ
P
t₂

(Q) $K_{eq_1} = 2(8k\cos^2 30°) + 2(8k\cos^2 60°) = 12k + 4k = 16k$

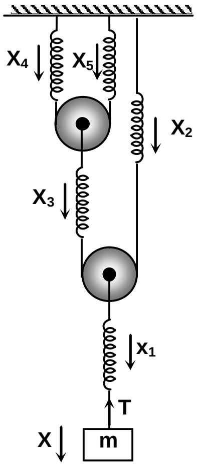
$$\text{So, } K_{eq} = \frac{(16.16)}{32}k = 8k$$

(R) $x = x_1 + \frac{x_2 + x_3}{2} + \frac{x_4 + x_5}{4}$

$$\frac{T}{k_{eq}} = \frac{T}{k} + \frac{T}{k} + \frac{2T}{k} + \frac{T}{k} + \frac{2T}{k}$$

$$k_{eq} = \frac{k}{7}$$

$$T = 2\pi\sqrt{\frac{7m}{k}}$$


X₄
X₅
X₂
X₃
X₁
T
X
m

(S) Block is displaced by 'x' along x–axis.

Torque about P

$$8k(2x_1)\ell = 4k(x - x_1)\frac{\ell}{2}$$

$$x_1 = \frac{x}{9}$$

Torque about Q

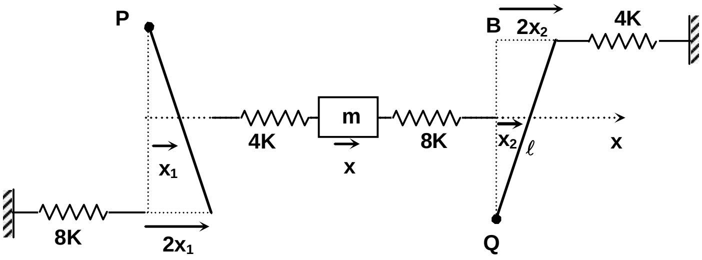
$$4k.2x_2.\ell = 8k(x - x_2)\frac{\ell}{2}$$

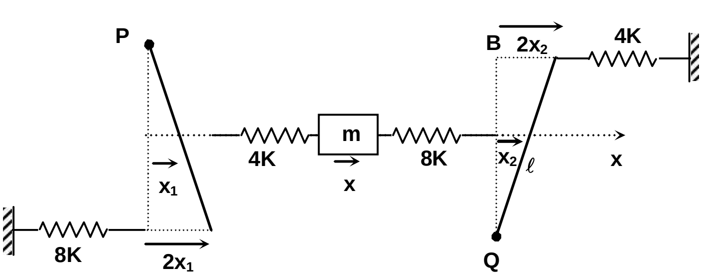
$$x_2 = \frac{x}{3}$$

$$ma = -\frac{80}{9}kx$$

$$a = -\left(\frac{80k}{9m}\right)x$$

$$T = 2\pi\sqrt{\frac{9m}{80k}} = \frac{3\pi}{2}\sqrt{\frac{m}{5k}}$$


P
B
2x₂
4K
m
4K
8K
x
x₁
x₂
ℓ
x
8K
2x₁
Q


P
B
2x₂
4K
m
4K
8K
x
x₁
x₂
ℓ
x
8K
2x₁
Q

SECTION – D

11. 00000.25

Sol. $T = \frac{2u\sin\theta}{g} = 4\,\text{sec}$

When the ball collide with the wall B, time elapsed

$= \frac{10}{20} + \frac{15}{10} = 2\,\text{sec}$

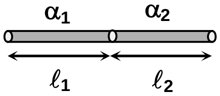
So remaining time = 2 sec

Velocity of the ball after the collision with ball = $\frac{5}{2} = 2.5\,\text{m/s}$

$e = \frac{2.5}{10} = 0.25$

12. 00000.50

Sol. $\Delta\ell_1 + \Delta\ell_2 = \Delta\ell$



$\ell_1\alpha_1\Delta T + \ell_2\alpha_2\Delta T = (\ell_1 + \ell_2)\alpha\Delta T$

$$\frac{\ell_1}{\ell_1+\ell_2} = \frac{\alpha - \left(\frac{\ell_2}{\ell_1+\ell_2}\right)\alpha_2}{\alpha_1} \qquad \ldots\text{(i)}$$

Let $\frac{\ell_1}{\ell_1+\ell_2} = x$, so $\frac{\ell_2}{\ell_1+\ell_2} = 1 - x$ $\qquad \ldots$(ii)

$x = \frac{\alpha - (1-x)\alpha_2}{\alpha_1}$

$\alpha_1 x = \alpha - \alpha_2 + \alpha_2 x$

$x = \left(\frac{\alpha - \alpha_2}{\alpha_1 - \alpha_2}\right) = \frac{17\times10^{-6} - 11\times10^{6}}{23\times10^{-6} - 11\times10^{-6}} = \frac{6}{12} = 0.50$

13. 00143.75

Sol. When S_1 is closed and S_2 is open

Current through R_1

$I_1 = \frac{\varepsilon_0}{1+3.68} = \frac{\varepsilon_0}{4.68}$

Potential difference across $\frac{\ell}{2}$ length = $\left(\frac{\varepsilon_0}{4.68}\right)\times1.84 = \varepsilon$

Similarly in the second case

$I_2 = \frac{\varepsilon_0}{R_2+1} = \frac{468\varepsilon}{184(R_2+1)}$

Potential difference across $\frac{2\ell}{3}$ length of $R_2 = \frac{2}{3}R_2.I_2 = \frac{2}{3}\times\frac{468\varepsilon R_2}{184(R_2+1)}$

$\frac{2}{3}\times\frac{468\varepsilon R_2}{184(R_2+1)} = \varepsilon$

64 R_2 = 92

$\Rightarrow R_2 = 1.4375\ \Omega$

14. 00006.28

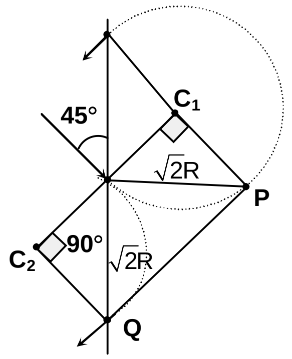
Sol. Negatively charged particle exit from magnetic field first and at the time separation is maximum

$$t_Q = \left(\frac{2\pi m}{qB}\right)\frac{\pi/2}{2\pi} = \frac{\pi m}{2qB}$$

Angle rotated by positively charged particle in the same time = π/2

So, separation between A and B= 2R

= 2 × 3.14 = 6.28



15. 00002.25

Sol. On releasing the particles, if their acceleration is same, they will stay at a constant distance

Acceleration of charged particle

$$a = \frac{F - 2qE}{2m} \text{ and } a = \frac{qE - F}{m}$$

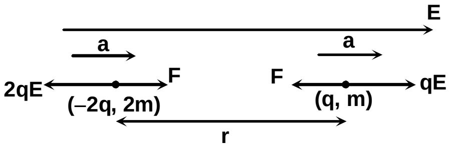
So, F – 2qE = 2qE – 2F

3F = 4qE

$$F = \frac{4qE}{3}$$

When they stay at a constant distance from each other

$$\frac{k.q.2q}{r^2} = \frac{4qE}{3} \Rightarrow r = \sqrt{\frac{3kq}{2E}}$$



16. 00367.80

Sol. Block on the wedge remains in rest

$$a_{60} = a_{30} = \frac{600 - 300}{90} = \frac{10}{3}\ \text{m/s}^2$$

So tension in the rope which is connected with 86.44 kg

T = 800 N

f = 800 – 864.4 sin 30° = 367.80

17. 00025.50

Sol. 6 V = 15S

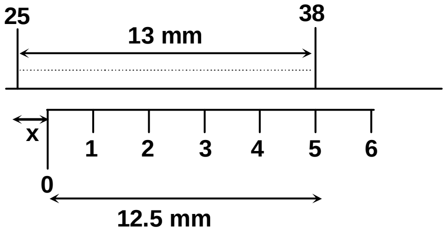
V = 2.5 mm

So, 5V = 12.5 mm

X = 13 mm – 12.5 mm

= 0.50 mm

So, measured value = 25.50 mm



18. 00000.60

Sol. If at O there is dark fringe, then

$$\Delta x = SO''O - SO'O = 2\sqrt{D^2+d^2} - 2D = \frac{d^2}{D}$$

$$\frac{d^2}{D} = \frac{\lambda}{2} \text{ for } d_{min}.$$

$$d_{min} = \sqrt{\frac{D\lambda}{2}} \qquad \ldots(i)$$

The bright fringe is formed at P. So,

$$\Delta x = SO'P - SO''P$$

$$= D + \sqrt{D^2+x^2} - \sqrt{D^2+d^2} - \sqrt{D^2+(x-d)^2} = \lambda$$

$$\Rightarrow x = \frac{D\lambda}{d}$$

x for d_{min}

$$x = \frac{D\lambda}{d_{min}} = \frac{D\lambda}{\sqrt{\frac{D\lambda}{2}}} = \sqrt{2D\lambda} = 0.6 \times 10^{-3}.$$

Chemistry

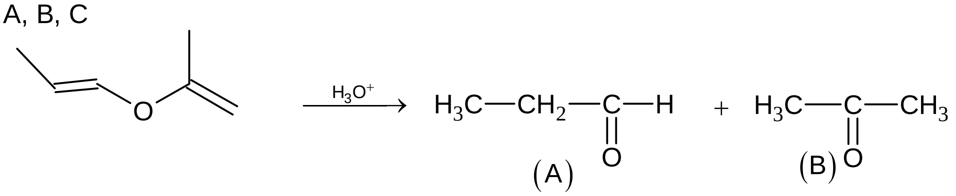
PART – II

SECTION – A

19. A, B, C, D

20. A, B, C

Sol.



21. A, B, D

Sol. Na/C_2H_5OH can not reduce acid.

22. B, C

23. A, B, D

24. A, B, C, D

25. C

26. D

27. A

28. B

SECTION – D

29. 00006.50

Sol. $2H_2O_2 \longrightarrow 2H_2O + O_2$

32 g O_2 is obtained from 68 g H_2O_2

52 g O_2 is obtained from $\frac{68}{32} \times 52g$

$$\frac{M \times 34}{2} = \frac{68}{32} \times 52$$

$$M = \frac{68 \times 52 \times 2}{32 \times 34} = 6.50$$

30. 00001.80

31. 00000.80

Sol. N_2O, CO_2, HCN and $\overset{+}{N}O_2$ are linear.

32. 00006.02

Sol. $ClO_4^- \Rightarrow 35.5 + 16 \times 4$

= 99.5 g

Number of moles $= \frac{1990 \times 10^{-3}}{99.5}$

$= 20 \times 10^{-3}$

Number of moles of electron $= 20 \times 10^{-3} \times 50 = 1$

33. 00001.25

Sol. Number of atoms of X in FCC packing (at corners and face centres of cubic unit cell)

$= 8\times\frac{1}{8}+6\times\frac{1}{2}=4$

Number of atoms of Y at octahedral voids = 4

Along one body diagonal there are two X atoms and one Y-atom.

No. of effective atoms of X after removal $=4-2\times\frac{1}{8}=\frac{15}{4}$

No. of atoms of Y after removal = 4 – 1 = 3

$x : y = \frac{15}{4} : 3$

= 5 : 4

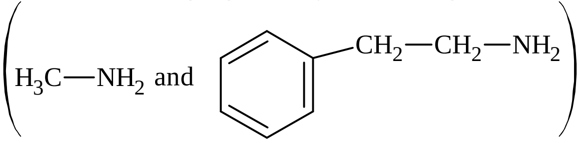
Simplest formula = X_5Y_4

a = 5, b = 4, a/b = 1.25

34. 00002.50

Sol. Stronger base than benzyl amine (a) = 5.

Amines can be prepared by Gabriel's phthalimide method (b) = 2.



35. 00002.50

36. 00004.98

Sol. Concentration per litre $=\frac{6}{60}+\frac{18}{180}=0.2$

$\pi = 0.2\times 0.083\times 300$

= 4.98 bar

Mathematics PART – III

SECTION – A

37. A, B, C
Sol. Using integration by part

38. A, B, C
Sol. $\prod_{r=1}^{n} \frac{2r-1}{2r} \le \frac{1}{\sqrt{3n+1}}$

39. A, B
Sol. $|z| = 1$

40. A, C, D
Sol. Such n digit number will be sum of coefficient of x^{3k} in $(x^2 + x^3 + x^7 + x^9)^n = \frac{4^n + 2}{3}$

41. B, C
Sol. $P(x) = \int_0^x f^3(t)dt - \int_0^x f^2(t)dt$

$P'(x) = f^3(x) - f(x)^2 = f^2(x)\cdot(f(x) - 1) < 0$

42. A, C
Sol. B(4, 0) is focus and x = 0 is directrix of parabola

43. D
Sol. $|2A^2B^{-3}| = 8 \times 1^2 \times \frac{1}{27}$

(P) $|A_{4\times3} B_{3\times4}|$ is 0
(Q) $|A| = 0$ and $|B| = 0$
(R) $AB^T = B^TA$

44. C
Sol. Equation of circle $3x^2 + 3y^2 + 2x + 4y = 0$ and minimum value of PA + BP + CP + DP = 15

45. D
Sol. $\frac{(x+y)^2}{18} + \frac{(x-y)^2}{2} = 1$

46. B
Sol. Volume of tetrahedron = $\frac{1}{2} \times \text{base area} \times \text{height}$

SECTION – D

47. 00004.00

Sol. When x is $\frac{\pi}{4}^{-}$ then $\sqrt{2}\cos x + 2 > 3$

48. 00010.00

Sol. Inter change m and n

49. 00000.50

Sol. $\lim\limits_{K\to\infty} Kd_K = \lim\limits_{K\to\infty} \frac{K\left(\sqrt{1+K^2} - K\right)}{\sqrt{2}}$

50. 00008.00

Sol. $\prod\limits_{k=0}^{n-1} \cos\left(\theta + \frac{k\pi}{n}\right) = \frac{\cos n\theta}{(-1)^{\frac{n-1}{2}} \cdot 2^{n-1}}$ if n odd

51. 00001.00

Sol. $\frac{ab - r_1 r_2}{r_3} = \frac{\Delta}{s}$ and $\angle C = \frac{\pi}{2}$

52. 00050.00

Sol. Put x = r cos θ and y = r sin θ will give area = $\frac{\pi}{4}$

53. 00005.00

Sol. $\vec{p} \cdot \vec{q} \le |\vec{p}||\vec{q}|$

54. 00000.95

Sol. $\cos^3 3x + \cos^3 5x = (\cos 5x + \cos 3x)^3$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – V

JEE (Main)-2019

Time Allotted: 3 Hours **Maximum Marks: 360**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only one section: **Section-A**.

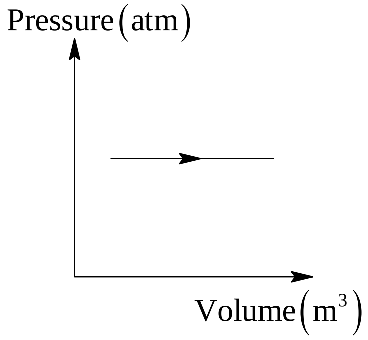
  Section-A (01 – 30, 31 – 60, 61 – 90) *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

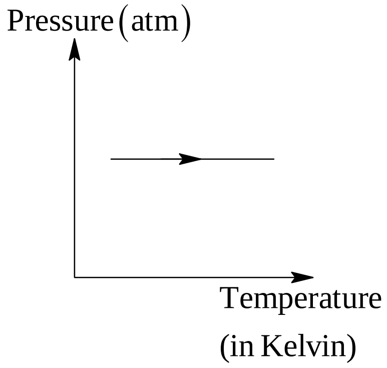
Physics PART – I

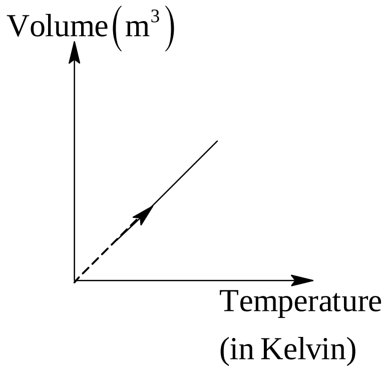
SECTION – A
(One Options Correct Type)

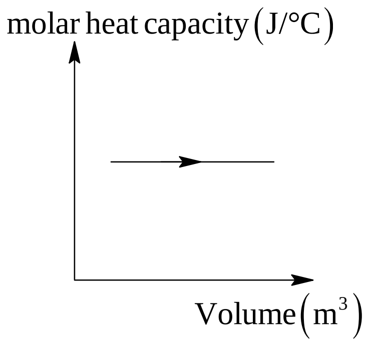
This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. All the graph shown are intended to represent the same thermodynamic process. One of them does it incorrectly. Pick it up:

(A)


(B)


(C)


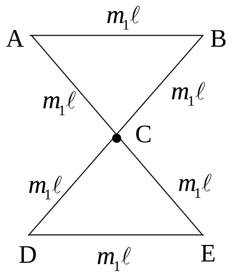
(D)


2. A string of length 1 meter, mass per unit length 0.01 kg/m and under tension of 100 newton is oscillating in first overtone. The frequency of oscillation is:

(A) $20\,\text{Hz}$
(B) $50\,\text{Hz}$
(C) $100\,\text{Hz}$
(D) $200\,\text{Hz}$

Space for Rough work

3. An arrangement of rods each of mass m and length l are welded (whereeever required) to form a shape as shown. The moment of inertia about an axis passing through point C and perpendicular to the plane of figure is:



(A) ml^2 (B) $\frac{3}{2}ml^2$

(C) $3ml^2$ (D) $\frac{9}{2}ml^2$

4. Two particle performs simple harmonic motion with time period of 6 second and 7 second respectively. At t = 0 both were in their mean position and moving in the same direction. After what minimum non zero time they will be in phase again.

(A) 21 second (B) 42 second

(C) 63 second (D) 84 second

5. Two balls are projected with speed 10 m/s at an angle of 37° with the horizontal from the surface of two planets having ratio of mass $2:1$ and ratio of radii $1:2$. The ratio of time of flight is:

(A) $4:1$ (B) $1:1$

(C) $2:1$ (D) $1:8$

6. Three identical spheres A, B and C of radius r and each carrying charge q are placed on the vertices of an equilateral triangle of side $\ell\left(\ell >> r\right)$. The resultant force on B is F. Now an uncharged sphere is first touched with A and then with B and then removed. Now the resultant force on B is:

(A) F (B) $\frac{3\sqrt{7}}{8}F$

(C) $\frac{3}{4}\sqrt{7}F$ (D) $\frac{2\sqrt{7}}{4}F$

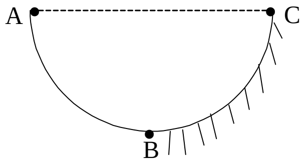
Space for Rough work

7. If in place of two slits in young double slit experiment four identical slits were used with equal spacing. Assuming coherent waves form these slits. The number of minima between two consecutive maximas will be:
(A) 1 (B) 2
(C) 3 (D) 4

8. In an Air conditioner compartment of a train if a material of thermal conductivity K and thickness 10 cm is required to fullfill the purpose. To do so there is a need of two glass each of thickness 1 cm with air gap of 8 cm between them. If thermal conductivity of glass and air are 1 W/mk and 0.01 W/mk then the value of K is:
(A) $0.0125W/mk$ (B) $0.05W/mk$
(C) $0.255W/mk$ (D) $0.33W/mk$

9. The end correction of a resonance column is 0.5 cm. If the shortest length resonating with the tuning fork is $\frac{21}{2}\text{cm}$, find the maximum lengths for resonance, if length of pipe is 100 cm.
(A) 59.1cm (B) 78.5cm
(C) 88.5cm (D) 98.5cm

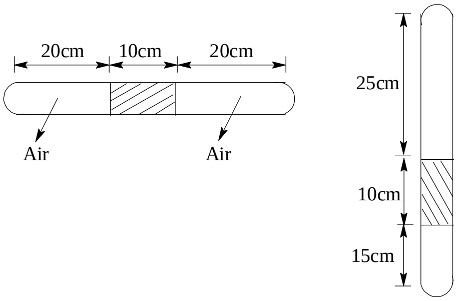
10. A ball is released from the top of a semi cylindrical surface of which part AB is sufficiently rough and BC is smooth. Then:
(A) The maximum angular velocity of the ball will be at point B only
(B) The maximum speed of centre of the ball will not be at point B
(C) Ball will never reach point C
(D) Ball may reach point C if friction is not sufficient to provide pure rolling.



11. A light ray falls perpendicular on one face of an equilateral prism, having refractive index $\sqrt{3}$. The angle of deviation is:
(A) $30°$ (B) $60°$
(C) $90°$ (D) $120°$

Space for Rough work

12. A horizontal tube contains mercury column of length 10 cm and rest is air on both sides of it. When the tube is vertical the length of air column changes as shown in the figure. The pressure when the tube is horizontal is (Assume temperature of air remains constant)



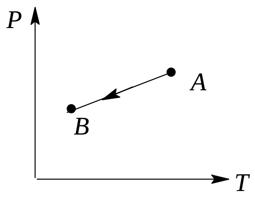
(A) $10^5\ \text{N/m}^2$

(B) $2.5\times10^3\ \text{N/m}^2$

(C) $0.255\times10^3\ \text{N/m}^2$

(D) $25.5\times10^3\ \text{N/m}^2$

13. An ideal gas undergoes a process $A\to B$ as shown on the pressure- temperature graph. The gas undergoes.



(A) Compression
(B) Expansion
(C) No change in volume
(D) Data insufficient

14. An object moves with velocity $\vec{v}_0 = 10\hat{i} + \hat{j} - 2\hat{k}$ in front of a plane mirror moving with velocity $\vec{V}_M = -5\hat{j}$. The velocity image is:

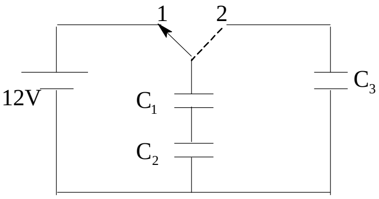
(A) $5\hat{i} + \hat{j} - 2\hat{k}$ (B) $10\hat{i} + \hat{j} + 2\hat{k}$
(C) $15\hat{i} + \hat{j} - 2\hat{k}$ (D) $10\hat{i} + \hat{j} - 2\hat{k}$

15. In the experiment of simple pendulum the percentage errors in length and time period in the measurement of acceleration due to gravity is 2% and 1% respectively. The maximum percentage error in acceleration due to gravity is:

(A) 1% (B) 2%
(C) 3% (D) 4%

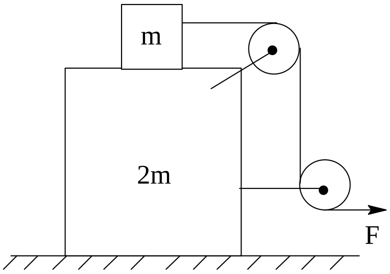
Space for Rough work

16. A capacitor $C_1 = 1\mu f$ and $C_2 = 2\mu f$ are charged with switch in position (1). Now switch is shifted to position (2). Capacitor $C_3 = 3\mu f$ is initially uncharged. The ratio of potential difference on C_1 and C_3 is:



(A) $\frac{1}{3}$ (B) $\frac{2}{3}$
(C) 1 (D) 2

17. A small block is placed on a bigger block as shown in the figure. All surfaces are frictionless and string and pulley are ideal. The acceleration of block of mass m is:



(A) F/2m (B) F/m
(C) F/3m (D) 2F/m

18. A current of 1 ampere is flowing on the sides of a square shaped wire frame of side $16\sqrt{2}cm$. The magnetic field at the centre of the square will be:

(A) $5\times10^{-6} Wb/m^2$ (B) $5\times10^{-5} Wb/m^2$
(C) $2.5\times10^{-5} Wb/m^2$ (D) $2.5\times10^{-6} Wb/m^2$

19. Hysteresis loop represent energy loss per cycle. Then energy loss is:

(A) More for steel than soft iron (B) More for soft iron than steel
(C) Equal for both (D) None of the above

Space for Rough work

20. STATEMENT-1: The temperature above which ferromagnetic material becomes paramagnetic is called curie temperature.

because

STATEMENT-2: Hysteresis is exhibited by ferromagnetic substance only.

(A) Statement-1 is True, Statement-2 is True; Statement -2 **is** a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement -2 **is NOT** a correct explanation for Statement-1.
(C) Statement -1 is True, Statement-2 is False.
(D) Statement -1 is False, Statement-2 is True.

21. An astronomical telescope having focal length of objective 300 cm and of eyepiece 5 cm. It is focused to see an object 20 km from the objective. If final image is formed at infinity, then:

(A) Length of tube is 310 cm
(B) Length of tube is 295 cm
(C) Angular magnification is 60
(D) Angular magnification is 100

22. A screw gauge with a pitch of 0.3 mm and a circular scale with 100 divisions is used to measure the thickness of a thin sheet of steel. What is the thickness of the sheet if main scale reading is 1mm and the 30th division coincides with the main scale line. (There is no zero error)?

(A) $1.9mm$
(B) $1.09mm$
(C) $1.1mm$
(D) $1.99mm$

23. Radiation of certain wavelength is incident on a metal plate of work function 5eV. The stopping potential is 2eV. Now if the wavelength is reduced 2 times, the new stopping potential will be:

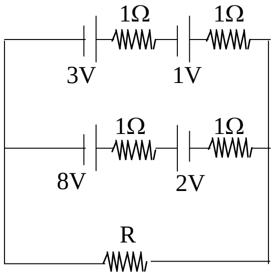
(A) 6 Volt
(B) 9 Volt
(C) 10 Volt
(D) 12 Volt

24. A close loop is placed in an uniform magnetic field. The current will not be induced in the loop if the loop:

(A) Rotate
(B) Translate
(C) Remain stationary
(D) Rolls

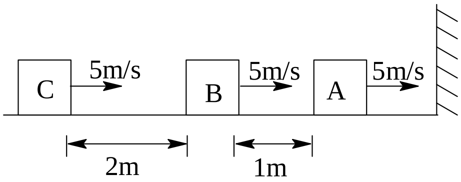
25. The circuit shown in the figure contains unidentical batteries and a bulb of unknown resistance R. For the bulb to have maximum brightness

(A) Its resistance should be 1Ω
(B) Its resistance should be 2Ω
(C) Current through bulb should be 6 Ampere
(D) Current through bulb should be 9 Ampere



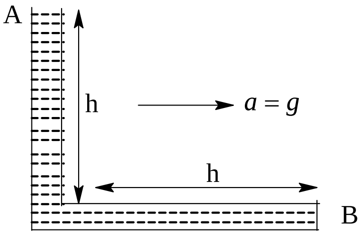
Space for Rough work

26. Three identical small blocks are moving towards a wall with spacing between them and velocities as shown in the figure. Assuming all collision to be elastic. The spacing between block B and C after all possible collisions is:



(A) 1m (B) 2m
(C) 3m (D) 4m

27. A L shaped tube containing liquid of density ρ is accelerated horizontally with acceleration as shown in the figure. The end of tube B is closed while end A is open. If the atmospheric pressure is P_0. Then the pressure at B is:



(A) $\frac{P_0}{2}$ (B) P_0
(C) $\frac{2}{3}P_0$ (D) $2P_0$

28. A TV tower has a height of 80 m. What is the maximum distance and area upto which this TV transmission can be received? Take radius of the earth as $6.4\times10^6 m$:
(A) $2816\,\text{km}^2$ (B) $2580\,\text{km}^2$
(C) $3215\,\text{km}^2$ (D) $3815\,\text{km}^2$

29. A transistor has a current amplification factor of 100. In a CE-amplifier circuit, the collector resistance is chosen as $10k\Omega$ and the input resistance is $1k\Omega$. The output voltage if input voltage is 0.01:
(A) 5 Volt (B) 10 Volt
(C) 15 Volt (D) 20 Volt

30. An elastic wire of length ℓ, area of cross-section A and Young's modulus Y having left end fixed and the other end is pulled by a constant force F, and the point of application of force is displaced by $\Delta\ell$. Then:
(A) Work done by force is $\frac{F\Delta\ell}{2}$
(B) Elastic potential energy stored in the wire $F\Delta\ell$
(C) Elastic potential energy stored in the wire $\frac{1}{3}F\Delta\ell$
(D) Work done by force is $F\Delta\ell$

Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. Considering Ellingham diagram, which of the following metals can be used to reduce alumina?
(A) Mg (B) Zn
(C) Fe (D) Cu

32. Regarding cross-linked or network polymers, which of the following statements is ***incorrect***?
(A) Examples are Bakelite and melamine
(B) They are formed from bi-and tri-functional monomers.
(C) They contain covalent bonds between various linear polymer chains.
(D) They contain strong ionic bonds in their polymer chains.

33. Which is correct about amylose and amylopectin is
(A) Amylopectin have $1 \rightarrow 4\ \alpha -$linkage and $1 \rightarrow 6\ \beta -$linkage
(B) Amylose have $1 \rightarrow 4\ \alpha -$linkage and $1 \rightarrow 6\ \beta -$linkage
(C) Amylopectin have $1 \rightarrow 4\ \alpha -$linkage and $1 \rightarrow 6\ \alpha -$linkage
(D) Amylose is made up of glucose and galactose

34. A mixture of 2.3 g formic acid and 4.5 g oxalic acid (anhyd.) is treated with conc. H_2SO_4. The evolved gaseous mixture is passed through KOH pellets. Weight (in g)of the remaining gaseous product at STP will be
(A) $2 \cdot 8$ (B) $3 \cdot 0$
(C) $1 \cdot 4$ (D) $4 \cdot 4$

35. Which oxide of nitrogen is not a common pollutant introduced into the atmosphere both due to natural and human activity?
(A) N_2O (B) NO_2
(C) N_2O_5 (D) NO

Space for Rough work

36. The compound C_7H_8 undergoes the following reactions:

$$C_7H_8 \xrightarrow{3Cl_2/\Delta} A \xrightarrow{Br_2/Fe} B \xrightarrow{Zn/HCl} C$$

The product $'C'$ is

(A) 3-bromo-2, 4, 6-trichlorotoluene (B) o-bromotoluene
(C) m- bromotoluene (D) p- bromotoluene

37. Which one of the following ions exhibits d-d transition and paramagnetism as well?

(A) MnO_4^- (B) $Cr_2O_7^{2-}$
(C) CrO_4^{2-} (D) MnO_4^{2-}

38. For an ideal gas $\left(\frac{\mathrm{dU}}{\mathrm{dT}}\right)_\mathrm{p}$ equals to:

(A) $\mathrm{C_V}$ (B) $\Delta\mathrm{S}$
(C) $\Delta\mathrm{G}$ (D) $\Delta\mathrm{H}$

39. Iron exhibits BCC structure at room temperature. At $900°C$ and above, it transforms to FCC structure. The ratio of density of iron at room temperature to that at $900°C$ (assuming molar mass and atomic radii of iron remains constant with temperature) is.

(A) $\frac{3\sqrt{3}}{4\sqrt{2}}$ (B) $\frac{4\sqrt{3}}{3\sqrt{2}}$
(C) $\frac{\sqrt{3}}{\sqrt{2}}$ (D) $\frac{1}{2}$

40. For an isothermal process for an ideal gas, $\Delta\mathrm{U}$ is equal to:

(A) Adiabatic work (B) Isothermal work
(C) Isochoric work (D) Isobaric work

41. For the Tyndal effect which is incorrect:

(A) The diameter of the dispersed particle is not much smaller than the wave length of light used.
(B) The refractive indices of the dispersed phase and dispersion medium differ in great magnitude
(C) Information about the size of colloidal particle can't be obtained by ultra microscope.
(D) None of the above

Space for Rough work

42. $4\text{P}\ (\text{s,white}) + 3O_2(g) \longrightarrow P_4O_6(s) \quad \Delta H^\circ = x$

$4\text{P}\ (\text{s,red}) + 3O_2(g) \longrightarrow P_4O_6(s) \quad \Delta H^\circ = y$

$\text{P}_4\text{O}_6(\text{s}) + 2\text{O}_2(g) \longrightarrow \text{P}_4\text{O}_{10}(\text{s}) \quad \Delta\text{H}^\circ = \text{z}$

The standard enthalpy of formation of $\text{P}_4\text{O}_{10(\text{s})}$ at 298 K will be:

(A) x+z (B) y+z
(C) x+y-z (D) x-y+z

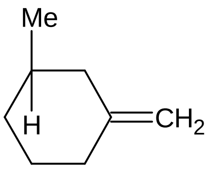
43. Which of the following statements about LDP is false?
(A) Its synthesis requires high pressure
(B) It is poor conductor of electricity
(C) Its synthesis requires dioxygen or a peroxide initiator as catalyst
(D) Its used in the manufacture of buckets dustbin etc.

44. Distillation technique is most suitable for separating glycerol from spent lye in soap industry is:
(A) Simple distillation (B) Fractional distillation
(C) Steam distillation (D) Distillation under reduced pressure.

45. The phosphorous in +3 oxidation state is:
(A) Orthophosphorous acid and Pyrophosphorous acid
(B) Pyrophosphorous acid and Hypophosphorous acid
(C) Orthophosphorous acid and Hypophosphoric acid
(D) Pyrophosphorous acid and Pyrophosphoric acid

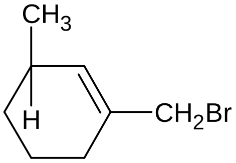
46. Dilute solution of KOH reacts with I_2 and forms:
(I) KI (II) KI_3
(III) KIO
(A) II, II (B) I, III
(C) I (D) I, II, III

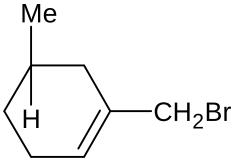
Space for Rough work

47. 

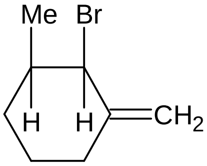
$+$ NBS $\longrightarrow$ six procucts:

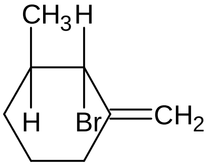
Which of the following statements is incorrect about products?

(A) 

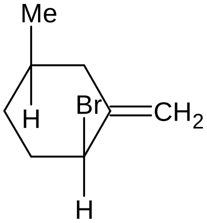
, 

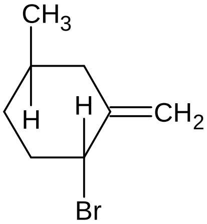
are two possible products.

(B) 

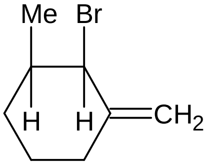
, 
CH3
H
H
Br
CH2

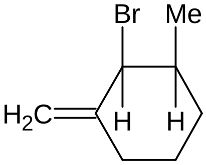
are other two possible products

(C) 

, 
CH3
H
H
CH2
Br

are other two possible products.

(D) 

, 

are other two possible products

Space for Rough work

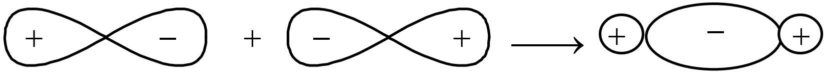
48. $0.32g$ of $\mathrm{CaC_2}$ reacts with water produces gas X. The gas X combination with O_2 produce CO_2. The volume of CO_2 at STP:

(A) $112\,mL$ (B) $484\,mL$

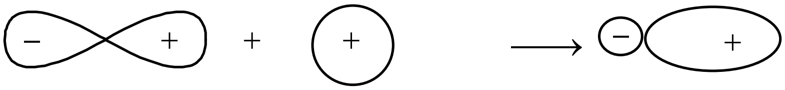
(C) $224\,mL$ (D) $448\,mL$

49. Which of the following combination of atomic orbitals result into non-bonding?

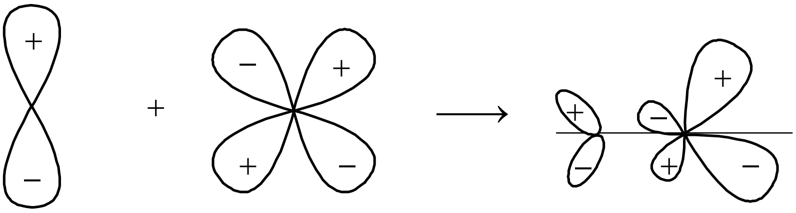
(A)



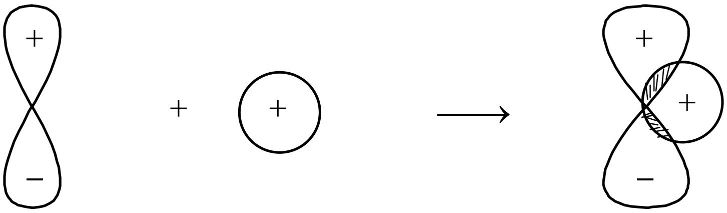
(B)



(C)



(D)



Space for Rough work

50. Consider the Vander Waal's equation of state $\left(p+\frac{a}{V^2}\right)(V-b)=RT$ correct statements is:

(A) Value of $'a'$ of N_2 is larger than that of NH_3 due to higher molecular weight of N_2

(B) Gas $'A'$ has Vander Wall's constants $'a'$ $\left(L^2\, atm/mol^2\right)$ and $'b'(L/mol)$ as 7 and 4.98×10^{-2}, this gas cannot be liquid at temperature $200°C$ however high pressure may be applied.

(C) At high pressure above equation reduces to $Z=1-\frac{b}{RTV}$

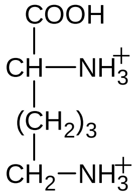
(D) If $Z<1$, attractive forces are dominating among the gaseous molecules

51. While testing BO_3^{3-}, there is green-edges flame on heating the salt with conc. H_2SO_4 and CH_3OH. Green colour is of

(A) $(CH_3)_3B$ (B) $(CH_3O)_3B$

(C) B_2O_3 (D) H_3BO_3

52.



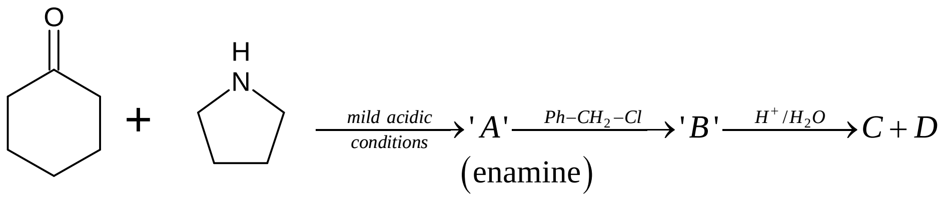
Lysine has $pK_{a,1}, pK_{a,2}, pK_{a,3}$ values 2, 9 and 11 respectively. Then value of its isoelectric point $\left(pH_{\text{ isoelectric}}\right)$ is:

(A) 7.22 (B) 5.565

(C) 6.355 (D) 10

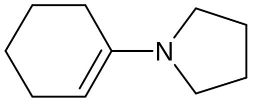
Space for Rough work

53.

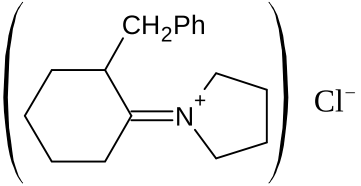


The incorrect statement about various organic products in above sequence is:

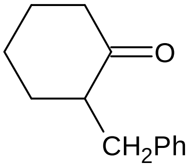
(A) A is



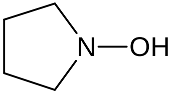
(B) B is



(C) C is



(D) D is



54. An orange coloured compound (A) when treated with $NaCl$ & conc. H_2SO_4 gives red brown vapour (B). This vapour when passed through $NaOH$ gives yellow coloured solution (C). On addition of CH_3COOH and $(CH_3COO)_2Pb$ to this yellow solution, yellow colored ppt (D) is obtained. Which of the following compound is not resemble with above information:

(A) 'A' is $K_2Cr_2O_7$

(B) 'B' is CrO_2Cl_2

(C) 'C' is Na_2CrO_4

(D) 'D' is $PbCl_2$

55. A current of 0.55 Amp deposits 0.55 gm of a metal in 100 minutes. Calculate atomic mass of the metal if equivalent weight $= \frac{\text{M.W.}}{2}$?

(A) 100

(B) 45

(C) 32.35

(D) 144.75

Space for Rough work

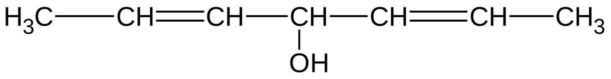
56. Consider following transformation

$$\left[\mathrm{Co}\left(\mathrm{H_2O}\right)_x\right]^{2+} \text{ (Pink complex) } \xrightarrow[\text{HCl}]{\text{Excess}} \left[\mathrm{CoCl}_y\right]^{n-} \text{ (Blue complex)}$$

Find the value of expression $\dfrac{x+y}{n}$.

(A) 5 (B) 8
(C) 10 (D) 7

57. Total number of stereoisomers of the compounds



$H_3C{-}CH{=}CH{-}\underset{\displaystyle OH}{\underset{|}{C}H}{-}CH{=}CH{-}CH_3$ is:

(A) 2 (B) 3
(C) 4 (D) 8

58. $\mathrm{AgNO_3} \xrightarrow{\Delta} (\mathrm{W}) + (\mathrm{X}) + O_2$

$(\mathrm{X}) + \mathrm{H_2O} \longrightarrow \mathrm{HNO_2} + \mathrm{HNO_3}$

$(\mathrm{W}) + \mathrm{HNO_3} \longrightarrow \mathrm{Y{+}NO{+}H_2O}$

$(\mathrm{Y}) + \mathrm{Na_2S_2O_3}\,(excess) \longrightarrow (Z) + \mathrm{NaNO_3}$

Identify (W) to (Z).

(A) $W = Ag \quad X = N_2O \quad Y = AgNO_3 \quad Z = Na_2\left[\mathrm{Ag}\left(\mathrm{S_2O_3}\right)_2\right]$

(B) $W = AgO_2 \quad X = NO \quad Y = AgNO_3 \quad Z = Na_2\left[\mathrm{Ag}\left(\mathrm{S_2O_3}\right)_2\right]$

(C) $W = Ag \quad X = NO_2 \quad Y = AgNO_3 \quad Z = Na_3\left[\mathrm{Ag}\left(\mathrm{S_2O_3}\right)_2\right]$

(D) $W = Ag_2O \quad X = N_2 \quad Y = AgNO_3 \quad Z = Na_2\left[\mathrm{Ag}\left(\mathrm{S_2O_3}\right)_2\right]$

Space for Rough work

59. Which of the following statements is/are correct?
(i) Sulphur solution is an example of macro molecular colloid.
(ii) Adsorbent used in gas masks is activated charcoal
(iii) AgI is used for producing artificial rain by seeding because AgI has crystal structure similar to ice.
(iv) Alums purify muddy water by coagulation of colloidal sized clay & sand.
(v) Physisorption occurs because of van der Waals forces.
(vi) More easily liquefiable gases are adsorbed readily. (For physisorption)
(vii) Under high pressure it results into multimolecular layer on adsorbent surface. (For physisorption)
(viii) Enthalpy of physisorption adsorption ($\Delta H_{\text{adsorption}}$) is low and positive.

(A) 6
(B) 7
(D) 8
(D) 5

60. When a liquid that is immiscible with water was steam distilled at 95.2°C at a total pressure of 748 torr, the distillate contained 1.25 g of the liquid per gram of water. The vapour pressure of water is 648 torr at 95.2°C, what is the molar mass of liquid?

(A) $8\,\text{g/mol}$
(B) $166\,\text{g/mol}$
(C) $146\,\text{g/mol}$
(D) None of these

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. If $f(x) = \sin^4 x + \cos^4 x - \frac{1}{2}\sin 2x$, then the range of f(x) is

(A) $\left[0, \frac{3}{2}\right]$
(B) $\left[-\frac{1}{2}, \frac{7}{2}\right]$
(C) $\left[0, \frac{9}{8}\right]$
(D) $\left[\frac{3}{4}, \frac{7}{8}\right]$

62. The value of $\prod_{r=1}^{7} \cos\frac{\pi r}{15}$ is

(A) $\frac{1}{64}$
(B) $\frac{1}{128}$
(C) $\frac{1}{32}$
(D) $\frac{1}{4}$

63. The exhaustive intervals of real values of x such that $\sqrt{12-4x} > 1 + \sqrt{4x+4}$ is

(A) $\left[1-\frac{\sqrt{31}}{8}, 1+\frac{\sqrt{31}}{8}\right)$
(B) $\left[-1, 1+\frac{\sqrt{31}}{8}\right)$
(C) $[-1, 3]$
(D) $\left[-1, 1-\frac{\sqrt{31}}{8}\right)$

64. If $P = \int_{-1}^{2}\left(\frac{\sqrt{x^2+1}+x-1}{\sqrt{x^2+1}+x+1}\right)dx$ and $Q = \int_{1}^{2}\left(\frac{x}{\sqrt{x^2+1}+1}\right)dx$ then $\frac{P}{Q}$ is equal to

(A) $\ln\frac{2}{5}$
(B) $\frac{2}{3}$
(C) $\frac{1}{2}$
(D) 1

Space for Rough work

65. $\int \frac{e^x(x-2)}{x(x^2+e^x)}$ $\forall$ x > 0 is equal to

(A) $\ln\left(1+\frac{e^x}{x^2}\right)+c$
(B) $\ln\left(-\frac{1}{2}+\frac{e^x}{x^2}\right)+c$
(C) $\ln\left(2+\frac{e^x}{x^2}\right)+c$
(D) $\ln\left(x+\frac{e^x}{x^2}\right)+c$

66. The number of positive 6 digit integers such that the sum of their digits is 9 and four of its digits are 1, 0, 0, 5 is

(A) 60
(B) 120
(C) 180
(D) 210

67. Consider the parabola $x^2 + 4x - 2y + 6 = 0$. If its chord AB $2mx - 2y + (4m + 3) = 0$ intersect its axis at K and directrix at M, then AM, KM and BM are in

(A) A.P
(B) G.P
(C) H.P
(D) none of these

68. $\lim_{x\to\infty}\left(\frac{x^{2013}}{e^{3x}}+\left(\cos\frac{2}{x}\right)^{x^2}\right)$ is

(A) 0
(B) e^3
(C) e^2
(D) e^{-2}

69. If a, b, c denotes the sides of a ΔABC and $a + b - c = 2$ and $2ab - c^2 = 4$, then

(A) $\sin A + \sin B + \sin C < \frac{3\sqrt{3}}{2}$
(B) $\cos A + \cos B + \cos C = 1$
(C) $\frac{a}{b}+\frac{b}{c}+\frac{c}{a} > 3\sqrt{3}$
(D) $a^2 + b^2 + c^2 = 12$

70. If $\cos^{-1}x + \cos^{-1}y + \cos^{-1}z = \pi$, then the value of $\frac{xy\sqrt{1-z^2}+yz\sqrt{1-x^2}+zx\sqrt{1-y^2}}{\sqrt{(1-x^2)(1-y^2)(1-z^2)}}$ is equal to

(A) 0
(B) 1
(C) 2
(D) 3

Space for Rough work

71. If α, $\beta(\alpha < \beta)$ are the roots of the equation $g(x) = ax^2 + bx + c = 0$ and $f(x)$ be an even function, then $\int_{\alpha}^{\beta} \frac{e^{f\left(\frac{g(x)}{x-\alpha}\right)}}{e^{f\left(\frac{g(x)}{x-\alpha}\right)} + e^{f\left(\frac{g(x)}{x-\beta}\right)}} dx$ is equal to

(A) $\frac{1}{2}(\beta - \alpha)$ (B) $\frac{1}{2}(\beta^2 - \alpha^2)$

(C) $\frac{1}{2}(\beta + \alpha)$ (D) 0

72. The equation $x^2 + (1 - 2^{2013})x + 2^{2012}(2^{2012} - 1) - 2 = 0$ have roots α and β then the value of $(\alpha - \beta)^{2014}$ is

(A) $(2^{2012} - 1)1007$ (B) $(3)^{4018}$

(C) 3^{2014} (D) $(2)^{1007}$

73. The value of ${}^nC_1 + 3^2\ {}^nC_3 + 5^2\ {}^nC_5 + \ldots\ldots.$ is

(A) $(n - 1)2^{n-1}$ (B) $n(n + 1)2^{n-3}$

(C) $n(n + 2)2^{n-2}$ (D) $n(n + 1)(n + 2)2^{n-4}$

74. If (1 + 3 + 5 + ….. + p) + (1 + 3 + 5 + …. + q) = (1 + 3 + 5 + ….. r) where each set contains the sum of consecutive odd integers then the smallest possible value of p + q + r is

(A) 23 (B) 21

(C) 29 (D) 31

75. Let $A = \{(x\ y) : x + y = p\}$, $B = \{(x, y) : x^3 + y^3 < p\}$ be two sets such that $A \cap B = \phi$ for any real number p, then the exhaustive intervals of p is

(A) $[-2, 2]$ (B) $\{0\} \cup [2, \infty)$

(C) $(-\infty, -2] \cup \{0\}$ (D) $\{x!\ x \in N \wedge x \leq 3\}$

76. Let C be incircle of ΔABC, if tangents are drawn parallel to the sides of the Δ such that t_1, t_2, t_3 be the lengths of tangents which lie inside the given triangle parallel to sides a, b, c respectively the $\frac{t_1}{a} + \frac{t_2}{b} + \frac{t_3}{c}$ is equal to

(A) 0 (B) 1

(C) 2 (D) 3

Space for Rough work

77. The value of ${}^{n}C_0 + {}^{n}C_1 + 5\,{}^{n}C_2 + 11\,{}^{n}C_3 + 17\,{}^{n}C_4$..........$(n+1)$ terms

(A) $(3n+5)\cdot 2^n + n + 7$
(B) $(3n-7)\cdot 2^n + 2n + 8$
(C) $(2n+3)\cdot 2^n - 11$
(D) $(2^n + 3)\cdot 5^n + 7$

78. Let x + y - z – 4 = 0 be the equation of plane and A be a point (1, 2, –3). If line L passes through (1, 2, 3) with direction ratios 3 : –1 : 4. If distance of A from line measured parallel to the plane is d_1 and if distance of the plane measured parallel to line is d_2 then $\left(\sqrt{d_1^2 - d_2^2}\right)$ is

(A) 1
(B) 5
(C) 3
(D) 10

79. If $a_1x^3 + b_1x^2 + c_1x + d_1 = 0$ and $a_2x^3 + b_2x^2 + c_2x + d_2 = 0$ have a pair of common positive repeated roots. If the value of $\begin{vmatrix} 3a_1 & 2b_1 & c_1 \\ 3a_2 & 2b_2 & c_2 \\ a_2b_1 - a_1b_2 & c_1a_2 - c_2a_1 & d_1a_2 - a_2d_2 \end{vmatrix}$ is

(A) 3
(B) 2
(C) 1
(D) 0

80. A random variable X has the following probability distribution values of X

X:	0	1	2	3	4	5	6	7
P(X):	0	k	2k	2k	3k	k^2	$2k^2$	$7k^2 + k$

then which is true

(A) $\dfrac{k+1}{P(x<6)} = \dfrac{10}{81}$
(B) $\dfrac{P(0<x<5)}{P(x\geq 6)} = \dfrac{81}{19}$
(C) $\dfrac{k-1}{P(x\geq 6)} = \dfrac{2}{23}$
(D) $\dfrac{P(0<x<4)}{P(x<6)} = \dfrac{4}{493}$

81. If $f(x) = \int_0^x \left(e^t + 3\right)dt$, then which of the following is always true $\forall\ x \in R$

(A) f(x – 3) – f(x – 1) ≤ 11
(B) f(x + 1) – f(x – 1) < 4
(C) f(x + 3) – f(x – 5) > 24
(D) f(x) + f(x + 1) < –21

Space for Rough work

82. Consider $f : R^+ \to R$ such that $f(3) = 1$ for $a \in R^+$ and $f(x).f(y) + f\left(\frac{3}{x}\right)f\left(\frac{3}{y}\right) = 2f(xy)\ \forall\ x, y \in R^+$, then f(97) can be

(A) 1
(B) –1
(C) 2
(D) 97

83. If $\alpha, \beta, \gamma, \delta$ be first 4 positive solutions of $\sin x = \frac{1}{4}$ with $\alpha < \beta < \gamma < \delta$, then value of $\sin\frac{\delta}{2} + 2\sin\frac{\gamma}{2} + 3\sin\frac{\beta}{2} + 4\sin\frac{\alpha}{2}$ is

(A) $\sqrt{5}$
(B) $2\sqrt{5}$
(C) $\frac{3}{4}$
(D) $\frac{5}{4}$

84. If e_1 and e_2 are the roots of the equation $x^2 - ax + 2 = 0$ where e_1, e_2 are the eccentricities of an ellipse and hyperbola respectively then the value of a belongs to

(A) $(3, \infty)$
(B) $(2, \infty)$
(C) $(1, \infty)$
(D) $(-\infty, 1) \cup (1, 2)$

85. If domain of f(x) is [1, 3], then find the domain of $f(\log_2 (x^2 + 3x - 2))$

(A) $[-5, -4] \cup [1, 2]$
(B) $[-13, -2] \cup \left[\frac{3}{2}, 5\right]$
(C) $[-4, 1] \cup [2, 7]$
(D) $[-3, 2]$

86. ΔABC is inscribed in a unit circle such that three internal angle bisectors of ΔABC are extended to intersect circumcircle at P, Q, R respectively then maximum value of $AP\cos\frac{A}{2} + BQ\frac{B}{2} + CR\cos\frac{C}{2}$ is equal to

(A) $\sqrt{3}$
(B) $3\sqrt{3}$
(C) $\frac{\sqrt{3}}{2}$
(D) 1

Space for Rough work

87. If f : R → R such that $f(x) = \dfrac{5}{lx^3 + x^2 + x + m}$ then (l, m) can be

(A) (1, 2) (B) (0, 1)

(C) (0, –3) (D) $\left(-3, \dfrac{3}{2}\right)$

88. For any complex number z in the argand plane, the minimum value of $|z| + |z - e^{i\alpha}| + |z - 5e^{i\alpha}| + |z - 7e^{i\alpha}| + |z - 32e^{i\alpha}|$ is

(A) 22 (B) 32

(C) 38 (D) 42

89. Let A = {1, 2, 3}, then the relation R = {(1, 1), (1, 2), (2, 1)} on A is

(A) reflexive (B) transitive

(C) symmetric (D) none of these

90. A flag staff of 5 m height stands on a building 25 m high. At an observer at a height of 30 m, the flag staff and the building subtend equal angles. The distance of the observer from the top of flag staff is

(A) $\dfrac{5\sqrt{3}}{2}$ (B) $5\sqrt{\dfrac{3}{2}}$

(C) $\dfrac{2}{3}$ (D) $\dfrac{5}{3}$

Space for Rough work

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JEE (Main)-2019

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. C

Sol. Graph is for Isobaric process where pressure and molar heat capacity remains constant V-T graph will be straight line but temperature cannot be zero Kelvin.

2. C

Sol. $f=\frac{nv}{2l}\left(n=2 \; for \; first \, overtone\right)$

So, $f=\frac{v}{l}=\frac{\sqrt{T/\mu}}{l}=100\text{Hz}$

3. C

Sol. $I=\frac{4ml^2}{3}+2\left[\frac{ml^2}{12}+\frac{3ml^2}{4}\right]=3ml^2$

4. B

Sol. $w_1t-w_2t=n\left(2\pi\right)$

For minimum t, $n=1$

$t=\frac{T_1T_2}{T_2-T_1}=42\,s$

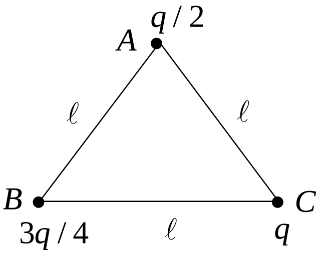
5. D

Sol. Time of flight $=\frac{2u\sin\theta}{g} and \; g=\frac{GM}{R^2}$

So, $\frac{T_1}{T_2}=\frac{g_1}{g_1}=\left(\frac{M_2}{M_1}\right)\left(\frac{R_1}{R_2}\right)^2=\left(\frac{9}{2}\right)\left(\frac{1}{2}\right)^2=\frac{1}{8}$

6. B

Sol. Charges on the sphere after removal of sphere



$$F = \sqrt{3}\frac{Kq^2}{\ell^2} --- (1)$$

$$F' = \frac{Kq^2}{\ell^2}\sqrt{\left(\frac{3}{8}\right)^2 + \left(\frac{3}{4}\right)^2 + \left(\frac{3}{8}\right)\left(\frac{3}{4}\right)}$$

$$F' = \frac{3\sqrt{7}}{8}F$$

7. C

Sol. There will be (N-1) minima's between two maximas if there were N slits equally spaced.

8. A

Sol. $\frac{10}{\text{KA}} = 2\times\frac{1}{\text{A}} + \frac{8}{0.01\text{A}} \Rightarrow K = 0.0125$

9. D

Sol. $\frac{\lambda}{4} = 0.6r + \ell_1 --- (1)$

$$(n+1)\frac{\lambda}{4} = 0.6r + \ell_2 ---- (2)$$

$$(2n+1) = \frac{0.6r + \ell_2}{0.6r + \ell_1}$$

$$(2n+1) = \frac{\frac{1}{2} + \ell_2}{\frac{1}{2} + \frac{21}{2}}$$

$$\Rightarrow \ell_2 = (2n+1)11 - \frac{1}{2}$$

$$\ell_2 < 100cm \Rightarrow n = 4$$

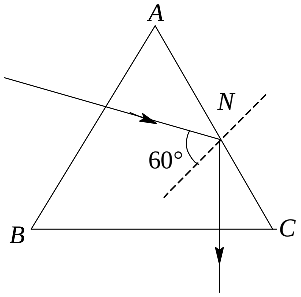
$$\ell_2 = 98.5\,cm$$

10. C

Sol. As the initiall potential energy will convert into rotational and translational kinetic energy so it cannot reach point C.

11. B

Sol.



At point N ray will go through total internal reflection.

12. D

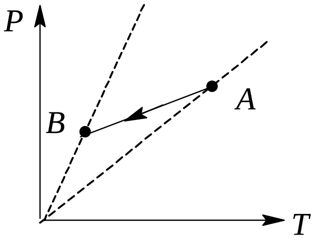
Sol. $\mathrm{P}_1 + h\rho g = P_2 --(1)$

$P_1Al_1 = P_0Al_0 ---(2) \& P_2Al_2 = P_0Al_0 ---(3)$

$h = 25.5\times10^3 N/m^2$

13. A

Sol.



$as\ V \propto \frac{T}{P}$

$so\ V_B < V_A$

14. D

Sol. $\vec{V}_{IM} = \vec{V}_I - \vec{V}_M \Rightarrow \vec{V}_I = 10\hat{i} + \hat{j} - 2\hat{k}$

15. D

Sol. Use $\frac{\Delta g}{g} = \frac{\ell}{\Delta\ell} + \frac{2\Delta T}{T}$

16. B

Sol. $\frac{8-q}{2} + 8 - q - \frac{q}{3} = 0 \Rightarrow q = 72/11$

$\frac{V_1}{V_3} = \frac{16/11}{72/33} = \frac{2}{3}$

17. B

Sol. Nett force on block 2m is zero. So smaller block will only move.

18. A

Sol. $B=\frac{4\mu_0 I}{4\pi R}\left[\sin 45^\circ+\sin 45^\circ\right]=\frac{1}{2}\times 10^{-5}=5\times 10^{-6} Wb/m^2$

19. A
20. B

21. C

Sol. $\mathrm{m}=\frac{f_0}{f_E}$ and length $\ell = f_0 + f_E$

22. B

Sol. Least count = $\frac{pitch}{no.of\ division\ on\ circular\ scale}=\frac{0.3mm}{100}=0.003mm$

Measured value $=1mm+30\times 0.003=1.09\,mm$

23. B

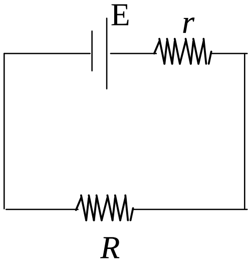
Sol. $E=\phi+eV_s --(1)$

$2E=\phi+eV_s^1 ---(2)$

$V_s^1=9Volts$

24. C
Sol. Use Faraday Law

25. A
Sol. Equivalent circuit diagram



$where\,E=6V$

$r=1\Omega$

$\mathrm{E}=\frac{E_1/r_1+E_2/r_2}{\frac{1}{r_1}+\frac{1}{r_2}}$

For maximum brightness of bulb $\mathrm{R=r}\Rightarrow \mathrm{R}=1\Omega$

26. A
Sol. Use conservation of momentum and Newton's experimental law.

27. B

Sol. $P_A+h\rho g-h\rho a=P_B \Leftrightarrow P_B=P_A=P_0$

28. C

Sol. $\mathrm{d}=\sqrt{2rh}=3.2\times 10^4 meter=32km$

Area covered $=\pi d^2=3215\,km^2$

29. B

Sol. $A_r=\frac{U_0}{V_1}=\beta\frac{h_C}{R_B}\Rightarrow V_0=\beta\frac{R_C V_1}{R_B}=\frac{100\times 10\times 10^3\times 0.01}{1\times 10^3}$

$\Rightarrow V_0=10\,\mathrm{Volt}$

30. D

Chemistry PART – II

SECTION – A

31. A

Sol. Mg is more reactive metal.

32. D

Sol. Chains are linked by covalent bonds.

33. C

Sol. No $\beta-$ linkage in amylose and amylopectin, amylose does not have galactose also.

34. A

Sol. $HCOOH \longrightarrow H_2O(l)+CO(g)$

$2.3\,gm\left(\frac{1}{20}mole\right)$

$H_2C_2O_4 \longrightarrow H_2O(l)+CO(g)+CO_2(g)$

$\frac{1}{20}mole$

$\left(\frac{1}{20}+\frac{1}{20}\right)mole\,CO,\quad \frac{1}{20}mole\,CO_2$

CO_2 is absorbed by KOH.

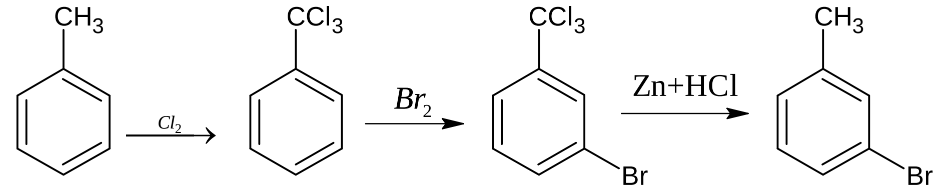
So, $\frac{1}{10}$ mole of CO is left = $2.8\,\text{gm of CO}$

35. C

Sol. Facts

36. C

Sol.



37. D

Sol. MnO_4^{-2}

$Mn(VI) \longrightarrow 3d^1$

38. A

Sol. $dU = C_V dT$

$\left(\frac{dU}{dT}\right)_p = C_V$

39. A

Sol. $$\frac{d_{25^\circ C}}{d_{900^\circ C}} = \frac{\left(\dfrac{Z\times M}{N_A a^3}\right)_{BCC}}{\left(\dfrac{Z\times M}{N_A b^3}\right)_{FCC}} = \frac{\dfrac{2\times M}{N_A\times\left(\dfrac{4r}{\sqrt{3}}\right)^3}}{\dfrac{4\times M}{N_A\times\left(\dfrac{4r}{\sqrt{2}}\right)^3}} = \frac{3}{4}\sqrt{\frac{3}{2}}$$

40. A

Sol. $\Delta U = q + w$

$\Delta U = w\left(\text{for adiabatic process}\right)$

41. C

42. A

Sol. Standard state of phosphorous is P $_{\text{white,solid}}$

$P_{\text{solid ,white}} + 5O_2 \longrightarrow P_4O_{10}$ ΔH^0 is calculated by adding 2 and 3 eqn..

43. D

Sol. LDP is branched chain structure and relatively tough but flexible

44. D

Sol. Distillation under reduced pressure to decrease the boiling point.

45. A

Sol. Pyrophosphorous acid $H_4P^{III}{}_2O_5$, *p*yrophosphoric acid $H_4P^{V}{}_2O_7$

orthophosphorous acid $H_3P^{III}O_3$, Hypophosphoric acid $H_4P_2{}^{IV}O_6$

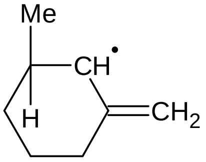
Hypophosphorous acid $H_3P^{I}O_2$

46. B

Sol. $I_2 + dil.OH^- \longrightarrow I^- + IO^- + H_2O$

47. D

Sol.



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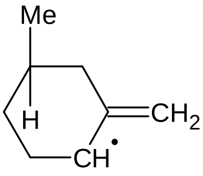
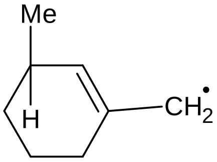
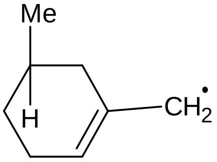






48. C

Sol. $CaC_2 + 2H_2O \longrightarrow Ca\left(OH\right)_2 + C_2H_2$

$$\frac{0.32}{64} = 0.005mole = 5\,m\,moleCaC_2\ or\ C_2H_2$$

$$= 10\,m\,mole\ CO_2$$

$$= 224\,ml\,of\ CO_2$$

49. D

Sol. $a \equiv bonding \qquad C \equiv anti\,bording$

$b \equiv bonding \qquad D \equiv non-bonding$

50. D

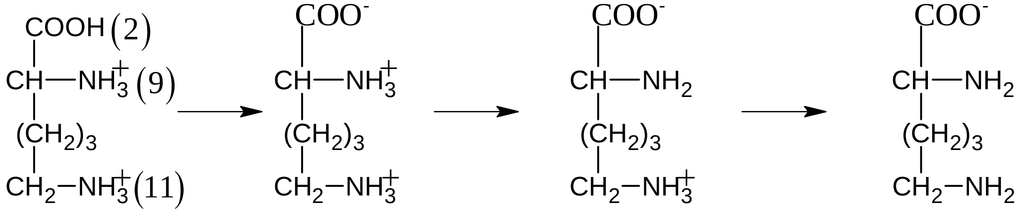
Sol. $\mathrm{T_c = \frac{8a}{27Rb} = 507K = 234^0C}$ is more than $200°C$ .Option D is correct.

51. B

Sol. $BO_3^{3-} + CH_3OH \xrightarrow{H^+} B(OMe)_3$

52. D

Sol.

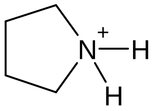


(zwitter ion)

$$\mathrm{pK_{isoelectric} = \frac{11+9}{2} = 10}$$

53. D

Sol.

D is  $\mathrm{OH^-}$

54. D

Sol. $\mathrm{A\ is\ K_2Cr_2O_7,\ B\,is\ CrO_2Cl_2,\ C\,is\ Na_2CrO_4,\ D\,is\ PbCrO_4}$

55. C

Sol. $\mathrm{Charge = 0.55 \times 60 \times 100\ C}$

$\mathrm{= 3300\,C}$

$\mathrm{= 0.0342\ mole\ of\ e^-}$

$\mathrm{= 0.0171\ mole\ of\ M^{2+}}$

$\mathrm{0.017 = \frac{0.55}{MW}, MW = 32.35}$

56. A

Sol. $x = 6, y = 4, n = 2$

57. C

Sol. Cis - -Cis, trans - -trans, Cis- R -trans, tans –S - Cis:

58. C

Sol. $\mathrm{AgNO_3 \xrightarrow{\Delta} Ag + NO_2} + O_2$

$$(X)+H_2O\longrightarrow HNO_2+HNO_3$$
$$Ag+HNO_3\longrightarrow AgNO_3+NO+H_2O$$
$$AgNO_3+Na_2S_2O_3\,(excess)\longrightarrow Na_3\left[Ag\left(S_2O_3\right)_2\right]+NaNO_3$$

59. A

Sol. ii, iii, iv, v, vi, vii

60. C

Sol. $P^*_{H_2O}+P^*_{org.}=748$

$$648+P^*_{org.}=748,\Rightarrow P^*_{org.}=648$$

$$\chi_{org.}=\frac{P^*_{org.}}{P^*_{H_2O}+P^*_{org.}}=\frac{648}{748}=0.1336$$

$$\frac{P^*_{H_2O}+P^*_{org.}}{P^*_{org.}}=\frac{1}{0.1336}=7.48$$

$$1+\frac{P^*_{H_2O}}{P^*_{org.}}=7.48$$

$$\frac{P^*_{H_2O}}{P^*_{org.}}=6.48$$

$$\frac{n_{H_2O}}{n_{org.}}=6.48$$

$$\frac{1/18}{1.25/M}=6.48$$

$$M=146$$

Mathematics PART – III

SECTION – A

61. C

Sol. Let f(x) = $\sin^4 x - \sin x \cos x + \cos^4 x$

$f(x) = 1 - \frac{1}{2}\sin 2x - \frac{1}{2}\sin^2 2x$

$\Rightarrow f(x) = g(t) = 1 - \frac{1}{2}t - \frac{1}{2}t^2 \quad t \in [-1, 1]$

Hence $f(x) \in \left[0, \frac{9}{8}\right]$.

62. B

Sol. $\cos\frac{\pi}{15}\cos\frac{2\pi}{15}\cos\frac{4\pi}{15}\cos\frac{7\pi}{15} = \frac{1}{16}$

$\cos\frac{3\pi}{15}\cos\frac{6\pi}{15} = \frac{1}{4}$

$\cos\frac{5\pi}{15} = \frac{1}{2}$

$\Rightarrow$ required value is $\frac{1}{128}$

63. D

Sol. $f(x) = \sqrt{3-x} - \sqrt{x+1}$ is well defined for $x \in [-1, 3]$

$f'(x) = -\frac{1}{2\sqrt{3-x}} - \frac{1}{2\sqrt{x+1}} < 0 \quad \forall x \in R$

f(–1) = 2 and $\sqrt{12-4x} = 1 + \sqrt{4x+4}$ gives $x = 1 - \frac{\sqrt{31}}{8}$

Hence $x \in \left[-1, 1 - \frac{\sqrt{31}}{8}\right)$.

64. D

Sol. Let $f(x) = \frac{\sqrt{x^2+1} + x - 1}{\sqrt{x^2+1} + x + 1}$

$\Rightarrow f(x) = \frac{x^2 + 1 - (x-1)^2}{\left(\sqrt{x^2+1} + x + 1\right)\left(\sqrt{x^2+1} - x + 1\right)}$

$f(x) = \frac{x}{\sqrt{x^2+1} + 1}$

$\Rightarrow \int_1^2 \frac{xdx}{\sqrt{x^2+1} + 1}$.

65. A

Sol. $\int \frac{e^x(x-2)}{x(x^2+e^x)} = \int \frac{3x^2+e^x+xe^x-3x^2-3e^x}{x(x^2+e^x)}dx = \int \frac{d(x^3+xe^x)}{x^3+xe^x} - 3\int \frac{dx}{x}$ = ln(x^3 + xe^x) – 3lnx + c

$= \ln\left(\frac{x^2+e^x}{x^2}\right)+c \Rightarrow \ln\left(1+\frac{e^x}{x^2}\right)+c.$

66. C

Sol. The pair of missing numbers must be (1, 2) or (0, 3)
case 1 : (1, 2)
⇒ when 1 is first digit the remaining digits (1, 2, 0, 0, 5) can be arranged in 60 ways, when 5 or 2 is first digit then in 30 ways each.
case 2 : (0, 3) will have 3 × 20 = 60 ways
so in all we have 60 + 2.30 + 3.20 = 180 numbers.

67. C

Sol. It can be seen that K is focus of given parabola and a focal chord is divided harmonically at the focus and the point where it meets the directrix.

68. D

Sol. $\lim\limits_{x\to\infty} \frac{x^{2013}}{e^{3x}} = 0$

$\lim\limits_{x\to\infty}\left(\cos\frac{2}{x}\right)^{x^2} = \lim\limits_{t\to 0} e^{-4\left(\frac{1-\cos t}{t^2}\right)} = e^{-2}$ where $t = \frac{2}{x}$

69. D

Sol. c = a + b – 2 and c^2 = 2ab – 4
⇒ $a^2 + b^2 - 4a - 4b + 8 = 0$
⇒ $(a-2)^2 + (b-2)^2 = 0$
⇒ a = b = c = 2.

70. B

Sol. Use sin(A + B + C) = 0 and $\cos^{-1}x = A$, $\cos^{-1}y = B$, $\cos^{-1}z = C$.

71. A

Sol. $I = \int_\alpha^\beta \frac{e^{f(a(\alpha-x))}}{e^{f(a(\alpha-x))}+e^{f(a(\beta-x))}}dx$ …(1)

$I = \int_\alpha^\beta \frac{e^{f(a(x-\beta))}}{e^{f(a(\alpha-x))}+e^{f(a(\beta-x))}}dx$ …(2)

From (1) and (2), we get

$\Rightarrow I = \frac{1}{2}(\beta-\alpha)$

72. C

Sol. The above equation reduces to $(x - 2^{2012})^2 + (x - 2^{2012}) - 2 = 0$
⇒ $\alpha, \beta = 2^{2012} - 2, 2^{2012} + 1$
⇒ $(\alpha - \beta)^{2014} = 3^{2014}$.

73. B

Sol. $nx(x + 1)^{n-1} = {}^nC_1x + 2\,{}^nC_2x^2 + \ldots\ldots + n\,{}^nC_nx^n$ …(1)
$nx(x - 1)^{n-1} = n\,{}^nC_nx^n - (n-1)\,{}^nC_{n-1}x^{n-1} + \ldots\ldots + (-1)^{n-1}\,{}^nC_1x$ …(2)
Again differentiating with respect to x both (1) and (2) and subtracting, we get the required result.

74. B

Sol. $\left(\frac{p+1}{2}\right)^2 + \left(\frac{q+1}{2}\right)^2 = \left(\frac{r+1}{2}\right)^2$

$\Rightarrow (p + 1)^2 + (q + 1)^2 = (r + 1)^2$

$p + 1 = 8$, $q + 1 = 6$, $r + 1 = 10$

hence minimum $(p + q + r) = 21$.

75. B

Sol. Let us consider $x^3 + (p - x)^3 \geq p \; \forall \; x \in R$

$\Rightarrow p^3 - 3p^2x + 3px^2 \geq p$

$\Rightarrow 3p\left[\left(x - \frac{p}{2}\right)^2 + \frac{p^2 - 4}{12}\right] \geq 0$

$\Rightarrow$ for $p < 0 \;\rightarrow$ no solution

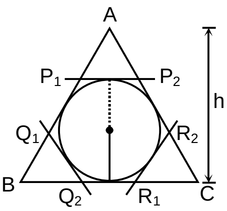
for $p = 0 \rightarrow$ solution exist

for $p > 0 \rightarrow \frac{p^2 - 4}{12} \geq 0$

$\Rightarrow p \in [2, \infty) \cup \{0\}$.

76. B

Sol. $\Delta AP_1P_2 \sim \Delta ABC$



$\Rightarrow \frac{t_1}{a} = \frac{h - 2r}{h} = 1 - \frac{2r}{h} \Rightarrow$ Hence $\frac{t_1}{a} = 1 - \frac{2\Delta}{sh}$

where $\Delta \equiv ar(\Delta ABC)$

$\frac{t_1}{a} = 1 - \frac{a}{s} \Rightarrow \frac{t_2}{b} = 1 - \frac{b}{s} \Rightarrow \frac{t_3}{b} = 1 - \frac{c}{s}$

$\Rightarrow \frac{t_1}{a} + \frac{t_2}{b} + \frac{t_3}{c} = 3 - \frac{(a + b + c)}{s} = 3 - 2 = 1$

77. B

78. D

Sol. $d_1 = \sqrt{126}$, $d_2 = \sqrt{26}$

79. D

80. B

81. C

Sol. $f'(x) = e^x + 3$

$f'(x) > 3$

$\frac{f(x+3) - f(x-5)}{8} = f'(c) > 3$

$\Rightarrow f(x + 3) - f(x - 5) > 24$.

82. A

Sol. Put $x = y = 1$

$f^2(1) + f^2(3) = 2f(1)$

$\Rightarrow (f(1) - 1)^2 = 0 \Rightarrow f(1) = 1$

$f(x)\, f(1) + f\left(\frac{3}{x}\right) f(3) = 2f(x)$

$\Rightarrow f(x) = f\left(\frac{3}{x}\right) \quad \forall\, x > 0$ …(1)

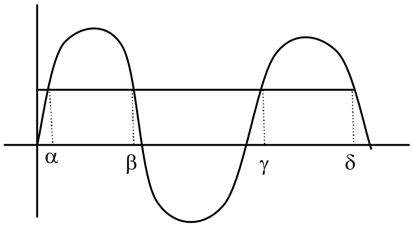
$\Rightarrow f(x)f\left(\frac{3}{x}\right) + f\left(\frac{3}{x}\right)f(x) = 2f(3)$

$\Rightarrow f(x)f\left(\frac{3}{x}\right) = 1$ …(2)

$\Rightarrow$ from (1) and (2)
$f^2(x) = 1 \quad \forall\, x > 0$
Put $x = y = \sqrt{t}$
$f^2\left(\sqrt{t}\right) + f^2\left(\frac{3}{\sqrt{t}}\right) = 2f(t)$ or $f(t) > 0$
$\Rightarrow f(x) = 1 \ \ \forall\, x > 0$.

83. A

Sol. $\beta = \pi - \alpha$, $\gamma = 2\pi + \alpha$, $\delta = 3\pi - \alpha$
given expression is equal to



$\sin\left(\frac{3\pi}{2} - \frac{\alpha}{2}\right) + 2\sin\left(\pi + \frac{\alpha}{2}\right) + 3\sin\left(\frac{\pi}{2} - \frac{\alpha}{2}\right) + 4\sin\frac{\alpha}{2}$

$= -\cos\frac{\alpha}{2} - 2\sin\frac{\alpha}{2} + 3\cos\frac{\alpha}{2} + 4\sin\frac{\alpha}{2}$

$= 2\left[\sin\frac{\alpha}{2} + \cos\frac{\alpha}{2}\right) = 2\sqrt{1 + \sin\alpha} = \sqrt{5}$

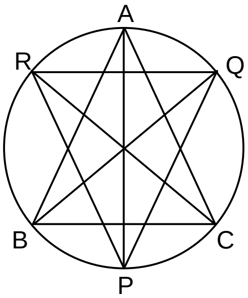
84. A

Sol. We must have
$e_1 < 1 < e_2 \Rightarrow f(1) < 0 \Rightarrow a > 3$

85. A

Sol. $1 \le \log_2 (x^2 + 3x - 2) \le 3 \Rightarrow 2 \le (x^2 + 3x - 2) \le 8$
On solving them, we get $-5 \le x \le -4$ and $1 \le x \le 2$

86. B



Sol. AP = $2\sin\left(B + \frac{A}{2}\right) \Rightarrow$ BQ = $2\sin\left(C + \frac{B}{2}\right)$

CR = $2\sin\left(A + \frac{C}{2}\right)$

$\Rightarrow AP\cos\frac{A}{2} + BQ\frac{B}{2} + CR\cos\frac{C}{2} = 2(\sin A + \sin B + \sin C)$

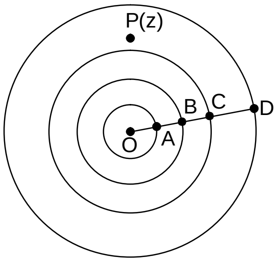
Maximum value of $AP\cos\frac{A}{2} + BQ\frac{B}{2} + CR\cos\frac{C}{2} = 3\sqrt{3}$

87. B

Clearly $m > \frac{1}{4}$ and l = 0

88. C

Sol. The minimum value of above expression will exist for $z = 5e^{i\alpha}$.
For minimum of OP + PA + PB + PC + PD
P must coincide with B.
Hence the value of the given expression is 38 units



89. C

Sol. R is not reflexive as $(2, 2) \notin R$, $(3, 3) \notin R$
Also, R is not transitive as $(2, 1) \in R$
and $(1, 2) \in R$ but $(2, 2) \notin R$.
However R is symmetric.

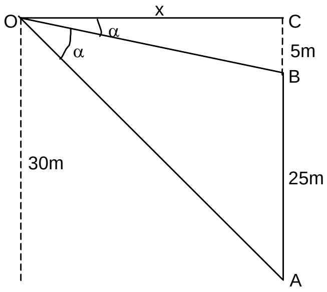
90. B

Sol. We have $\tan\alpha = \frac{5}{x}$ and $\tan 2\alpha = \frac{30}{x}$

$\Rightarrow \tan 2\alpha = \frac{30}{5\cot\alpha}$

$\Rightarrow \tan 2\alpha = 6\tan\alpha \Rightarrow 3 - 3\tan^2\alpha = 1$

$\Rightarrow \tan\alpha = \sqrt{\frac{2}{3}} \Rightarrow x = 5\cot\alpha = 5\sqrt{\frac{3}{2}}$



FIITJEE

ALL INDIA TEST SERIES

OPEN TEST

JEE (Advanced)-2019

PAPER – 1

TEST DATE: 03-02-2019

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01– 06, 19 – 24, 37 - 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*

   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 - 46) *contains 12 questions. Based on this section contains* ***TWO (02)*** *paragraphs. Based on each paragraph, there are* ***TWO (02)*** *questions.*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

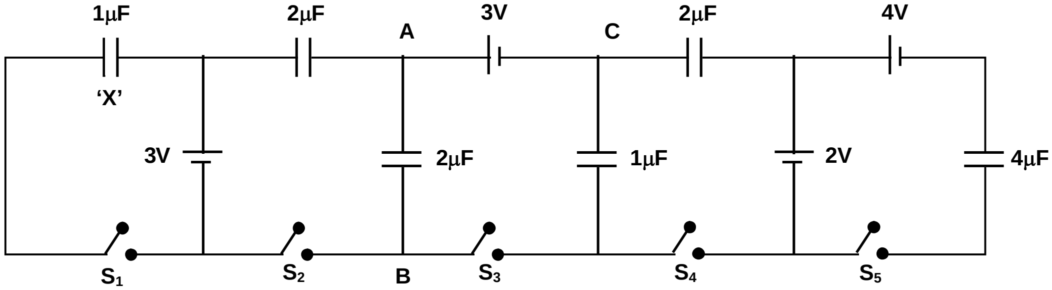
PART – I

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A gas of hydrogen like atoms can absorb radiations of 68 eV. Consequently, the atoms emit radiations of only three different wavelength. All the wave lengths are equal or smaller than that of the absorbed photon. Then choose the correct statement(s) (hc = 12400 eV-Å)
   (A) The Ionization energy of the atoms is 489.6 eV.
   (B) The atomic number of atoms is 6.
   (C) The minimum wavelength of emitted radiation is 28.49 Å
   (D) Initially the atom was in first excited state.

2. Six capacitors and four ideal batteries are connected in a circuit as shown in the figure. Initially all capacitors are uncharged and all switches were open. Now, all switches are closed simultaneously. Which of the following statement(s) is/are correct for the circuit shown in figure?



   (A) Work done by 4V battery is 8μJ.
   (B) The potential difference between point A and B is $\frac{19}{7}$V.
   (C) Charge flow by 3V battery from 'C' to 'A' is $\frac{32}{7}$ μC.
   (D) Charge stored in capacitor 'X' is 3 μC.

3. A concave mirror forms real image of a point object 'O' lying on the optical axis at a distance of 60 cm from the pole of mirror. The focal length of mirror is 30 cm. Now, the mirror is cut into two halves symmetrically. In figure-1 both halves are shifted at a distance of 2 mm apart in a direction perpendicular to the optical axis. In figure-2 both halves are rotated (before being separated) about 'O' with reference to original position. Let I_1 and I_2 are the image formed by both halves in both figure. Charge the correct statement(s).

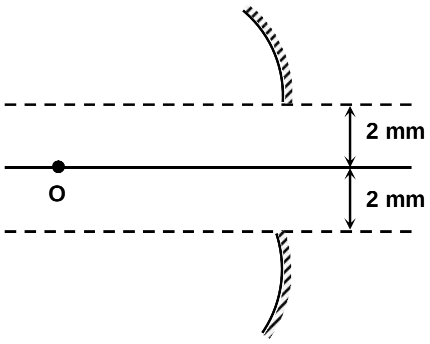


Figure 1

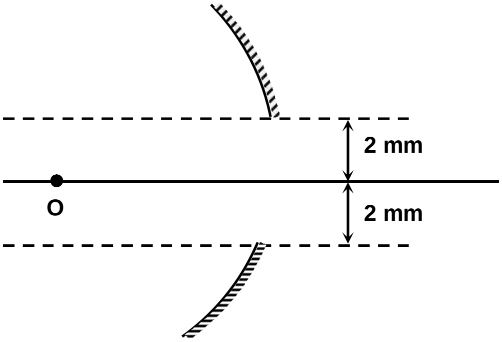
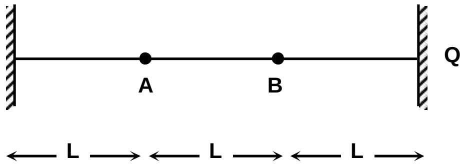


Figure 2

(A) In figure-2 I_1 and I_2 are coincide.
(B) In figure-1 I_1 and I_2 are separated.
(C) In figure-1, the distance between I_1 and I_2 is 8 mm.
(D) In figure-2 the distance between I_1 and I_2 is 4 mm.

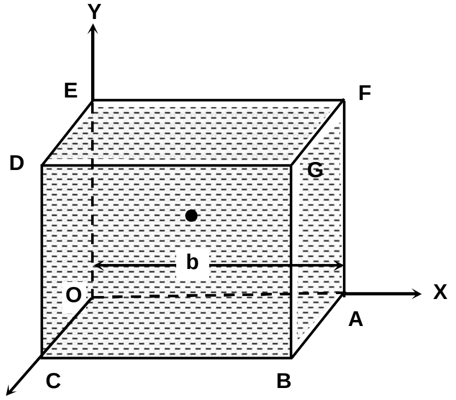
4. A particle is moving in space. Let $\vec{r}$, $\vec{v}$ and $\vec{a}$ are the position vector, velocity vector and acceleration vector of a particle at a given instant. Then
(A) If $\vec{v}\cdot\vec{a} > 0$ then magnitude of velocity must be increasing
(B) If $\vec{r}\cdot\vec{v} > 0$ then magnitude of position vector must be increasing
(C) If $\vec{r}\cdot\vec{a} > 0$ then magnitude of velocity must be increasing
(D) If $\vec{r}\cdot\vec{a} > 0$ then magnitude of velocity must be decreasing

5. A string PQ of length 3L is fixed at its both ends. A standing wave is formed in the string with the help of a tuning fork of frequency f_0. The points A and B are node. Regarding the standing wave formed in the string, pick the correct statement(s).



(A) The positions of antinode from the end P are $\frac{L}{2}, \frac{3L}{2}$ and $\frac{5L}{2}$.
(B) The phase difference between two points on the string is either zero or π at a instant $\frac{T}{3}$, where 'T' is the time period of particle.
(C) When particles reach at their extreme positions, then potential energy of the particles is maximum which are near the end A and B.
(D) When particles cross their mean position then kinetic energy of the particles at antinode is maximum.

6. A liquid of density 'ρ' is filled in a cubical container OABCDEFG. The point 'O' is assumed to be origin. A small ball of density ρ_0 is kept at $\left(\frac{b}{2}, \frac{b}{2}, \frac{b}{2}\right)$ as shown in figure and an acceleration $2g\hat{i} + g\hat{j}$ is given to container. Uniform gravity exists along negative y-axis. Now, choose the correct option(s).

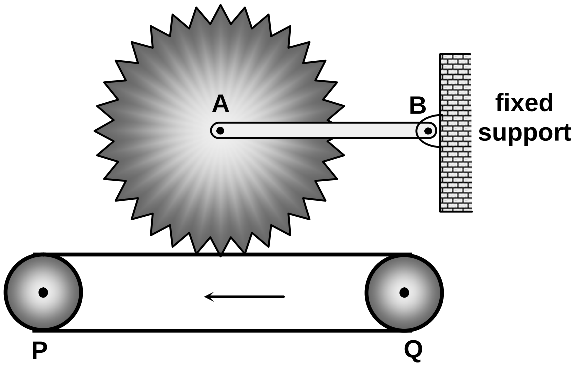


(A) If $\rho = \rho_0$ then acceleration of small ball is $\sqrt{5}g$.
(B) If $\rho = 2\rho_0$ then small ball will hit the mid of edge GF.
(C) If $\rho = 3\rho_0$ then small ball will hit the mid of edge GF.
(D) If $\rho = \rho_0$ then net force on the small ball is zero.

(Paragraph Type)

This section contains **TWO** paragraphs. Based on each paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 7 and 8



A toothed wheel of mass 2 kg and radius $\frac{7}{44}$m is connected with fixed support via a massless rod AB. The total number of teeth on the circumference of wheel is 1000, and they are closely packed. A conveyor belt is kept just below the toothed wheel. Conveyor belt is moving with a constant velocity $\frac{1}{2}$ m/s. P and Q are fixed support for the conveyor belt. The coefficient of friction between teeth of wheel and conveyor belt is 0.4. The moment of inertia of toothed wheel about an axis passing through A and perpendicular to the plane is $\frac{98}{121}$kg-m^2. Toothed wheel is free to rotate about A and rod AB is also free to rotate about B. Assume normal force acts between teeth and conveyor belt is perpendicular to the surface of conveyor belt. At t = 0, toothed wheel is at rest and brought in contact with the conveyor belt. Now answer the following questions.

7. Total number of teeth that are touched with conveyor belt till the time toothed wheel attain maximum angular velocity is
   (A) 1000
   (B) 1500
   (C) 500
   (D) 250

8. Let ‘x’ be the distance moved by a particular tooth to attain maximum angular velocity of toothed wheel and ‘y’ be the distance moved by a fixed point on the conveyor belt for same time then $\frac{y}{x}$ is given by
   (A) 1/4
   (B) 1
   (C) 2
   (D) 1/2

Paragraph for Question Nos. 9 and 10

In a motor cycle engine, when combustion occurs then there is an alternate compression and expansion of the gas product inside the engine of cylinder. In the expansion stroke, the mixture of gaseous product in the cylinder undergoes an adiabatic expansion. Assuming that the gauge pressure immediately after combustion is 20.0 atm in the cylinder, initially volume is 50 cm^3 and the volume of mixture after expansion is 400 cm^3. Assume that adiabatic exponent of gas involved in the cylinder is 4/3.

9. Pressure of the engine chamber after expansion is
   (A) 1.2500 atm
   (B) 0.65625 atm
   (C) 1.3125 atm
   (D) 0.62500 atm

10. Work done by the gas during expansion is
    (A) 142.5 Joule
    (B) 157.5 Joule
    (C) 47.50 Joule
    (D) 95.0 Joule

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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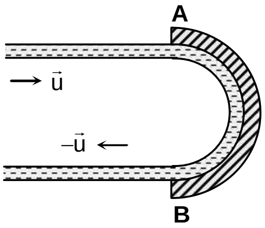
11. AB is stationary curved surface blade. A stream line water impinges on the curved surface. The speed of stream line water is 'u', both before and after it strikes the curved surface of the blade. The mass flow rate of water per unit time is 'μ'. Find the force exerted by water on the blade in Newton (Given u = 2.2 m/s, μ = 200 gm/sec)

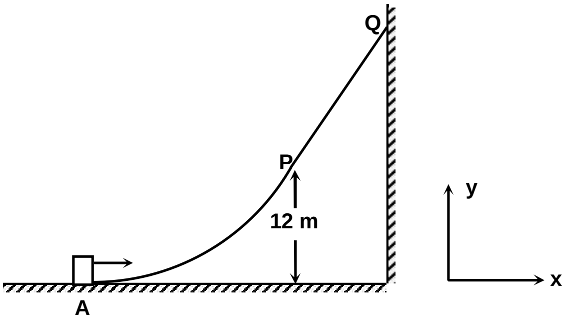


12. A planet is revolving around the sun in elliptical orbit with a semi-major axis of 4×10^8 km. Find the speed of the planet , in km/sec, when it is at a distance of 2×10^8 km from the sun. Given that mass of sun is 2×10^{30} kg and universal gravitational constant is $6.67 \times 10^{-11}\ \frac{\text{N.m}^2}{\text{kg}^2}$.

13. A vernier calipers is used to measure the diameter of a cylinder. When jaws of vernier are brought close to each other then zero of vernier scale is slightly left to the zero of main scale, and 6th division of vernier scale is exactly coincide with the one of the mark of main scale. Total number of division on vernier scale is 10 which is equivalent to 9 mm. When cylinder is fixed between the jaws then it is found that zero of the vernier scale lies between 6 mm and 7 mm of the main scale and 7th division of vernier scale exactly coincide with one of the main scale division. Find the diameter (in mm) of cylinder.

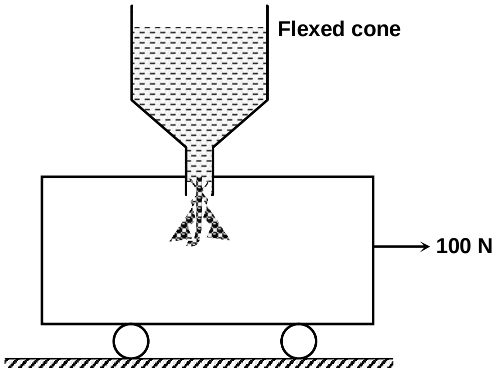
14. A non-conducting solid sphere has a charge density given by $\rho = \rho_0 r^n$, where ρ_0, n are constant and 'r' is the distance from the centre of sphere. If the magnitude of electric field at half of the radius is $\frac{1}{16}$ times that of the surface of non-conductor then find the value of n.

15. APQ is a rough surface. The portion AP is parabolic given by equation $x^2 = 16y$. The point 'A' assumed to be origin. The portion PQ is a straight line of length $20\sqrt{3}$ m. the coefficient of friction between block and surface (APQ) is $\frac{1}{\sqrt{3}}$. A block of mass 3 kg is moved on surface APQ by applying a force on it. The direction of force is always tangential to the surface APQ. The line PQ is tangent on the curve AP at P. If the block moves very slowly on the surface then find the work done by applying force in joule.

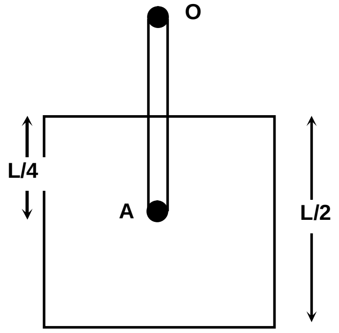


16. A hydrogen like atoms are kept in a closed container. All atoms are at same excited state initially. A photons of energy 3.4 eV are incident on the container then atoms get excited at some higher excited state. During de-excitation of atoms, they emits maximum six types of wavelength of photons, some of them have energy 3.4 eV, some of them have more than 3.4 eV and some less than 3.4 eV. It is assumed that electrons remain in orbit for a finite time during de-excitation. Let a_1 is the maximum acceleration in a given orbit during de-excitation and a_2 is the minimum acceleration in a given orbit. Assuming Bohr's theory is applicable, find ratio of a_1/a_2.

17. A container of mass 200 Kg is moving towards right by applying a constant horizontal force 100 N. Initial velocity of container is zero. Sand is falling in container with a constant rate of 1 kg/sec with the help of a fixed cone as shown in the figure. Find the velocity of the container (in m/s) at t = 100 sec.



18. A rod OA of uniform linear mass density and length 'L' is hinged at O in a vertical plane. Another square plate of same mass is attached with a point A of the rod as shown in the figure. In case (i) square plate is free to rotate about point A and in case (ii) square plate is fixed at point A. Now, system is allowed to oscillate in vertical plane such that axis of rotation is horizontal and passing through point O. Let T_1 and T_2 are the time periods in case (i) and case (ii) respectively. If T_1/T_2 is $m\sqrt{\frac{6}{11}}$. Find the value of m.



Chemistry

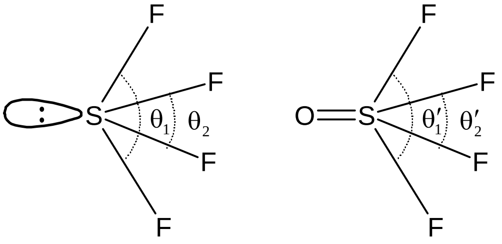
PART – II

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. For the following geometry, which of the inequality is/are correct?



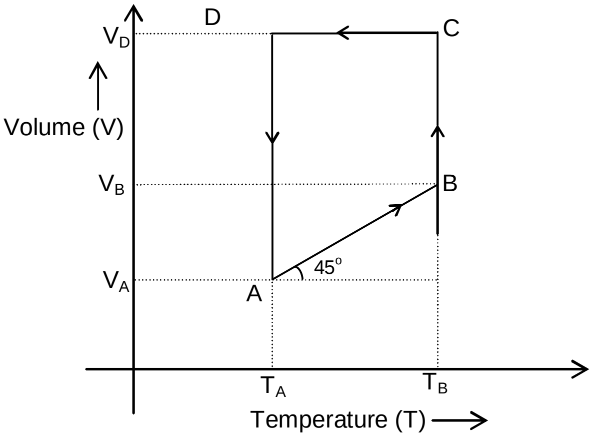
(A) $\theta_1' < \theta_1$

(B) $\theta_2 < \theta_2'$

(C) $\theta_1 < \theta_1'$

(D) $\theta_2 > \theta_2'$

20. Two moles of a monoatomic ideal gas is taken through a reversible cyclic process starting from “A” as shown in figure.



The volume ratio $\frac{V_B}{V_A} = 2$ and $\frac{V_D}{V_A} = 4$. If temperature T_A at ‘A’ is 27°C, then choose the correct option(s)

(A) Temperature of the gas at point ‘B’ is 600 K.

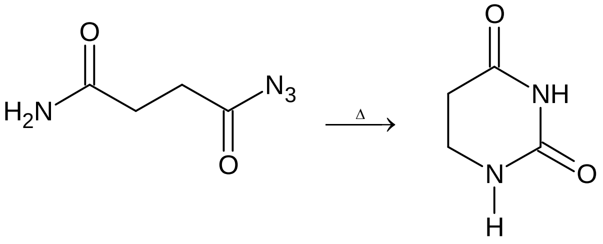
(B) Work done in cyclic process (ABCDA) is -1200 cal.

(C) Work done in the process (C → B) is – 1663.68 cal.

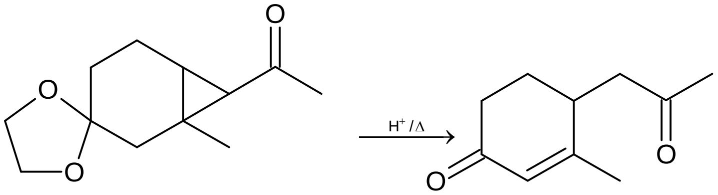
(D) Work done in the process (A → D) is – 1663.68 cal.

21. Choose the reaction(s) with correct major products:

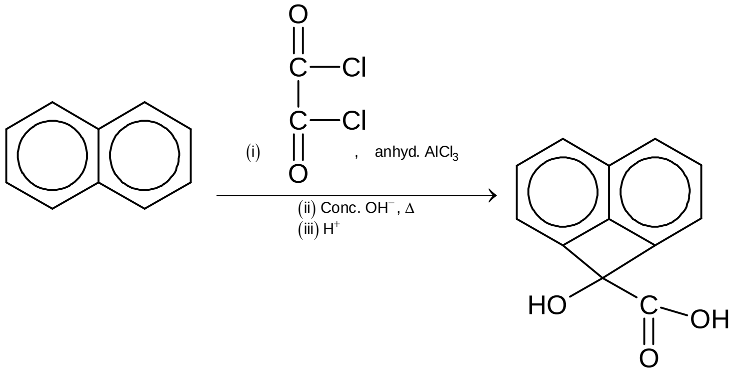
(A)


O
H_2N
N_3
O
Δ
O
NH
N
H
O

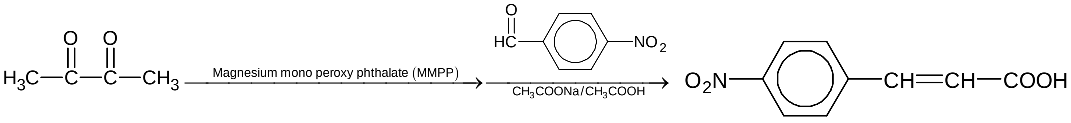
(B)


O
O
O
H^+/Δ
O
O

(C)

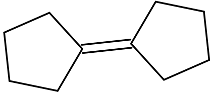

(i)
C—Cl
C—Cl
, anhyd. $AlCl_3$
(ii) Conc. OH^-, Δ
(iii) H^+
HO
C
OH
O

(D)

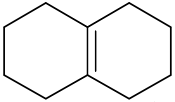

H_3C—C—C—CH_3
Magnesium mono peroxy phthalate (MMPP)
HC
NO_2
CH_3COONa/CH_3COOH
O_2N
CH═CH—COOH

22. Identify the substrate (s) which on acidic hydrolysis produces the same major product?

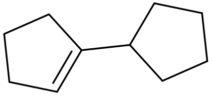
(A)



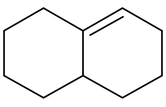
(B)



(C)



(D)



23. Choose the only **incorrect** statement(s) among the following

(A) All boron halides are ionic halides.

(B) Anhydrous aluminium chloride is an ionic compound.

(C) Coordination number of Al in $AlCl_3$(s) is 4.

(D) BI_3 is the least acidic among all boron halides.

24. For which of the following complexes, IUPAC names is/are correctly matched?
    (A) $Na\left[Pt(NH_3)BrCl(NO_2)\right]$-Sodiumamminebromidochloridonitrito-N-platinate (II)
    (B) $\left[CuCl_2\{O=C(NH_2)_2\}_2\right]$ – Dichloridobis(dicarboxidotetraamine)copper(II)
    (C) $\left[PtCl_3(\eta^2-C_2H_4)\right]^-$-Trichlorido$(\eta^2-\text{ethene})$platinate(II) ion.
    (D) $\left[FeCl(CN)_4(O_2)\right]^{4-}$-Chloridotetracyanosuperoxoferrate(II) ion

(Paragraph Type)

This section contains **TWO** paragraphs. Based on each paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 25 and 26

The periodic system of the elements in our three dimensional world is based on the four quantum numbers n = 1, 2, 3,……………;

$\ell = 0, 1,$ ……….n -1; $m_\ell = 0, \pm1, \pm2........\pm\ell$; and $m_s = \pm\frac{1}{2}$

Let us move to flatlandia. It is a two dimensional world where the periodic system of elements is based on three quantum numbers.

n = 1, 2, 3………..; m = 0, $\pm1, \pm2, \pm3, ...\pm(n-1)$; and $m_s = \pm\frac{1}{2}$. 'm' plays the combined role of ℓ and m_ℓ of the three dimensional world (for example s, p, d….level are related to 'm'). Some tasks and basic principles, related to this two dimensional flatlandia where the chemical and physical experience obtained from our common three dimensional world, is applicable. Assume Auf-Bau rule, Hund's rule of maximum multiplicity and Pauli's exclusion principle which are obeyed in three dimensional world, are also obeyed in 2-dimensional world as such. Energy order of various orbitals for filling up the electrons in multi electron atoms in flatlandia is governed by (n + |m|) rule which is analogous to the (n + l) rule in three dimensional world.
Now, answer the following questions:

25. Total number of elements in the first four periods of flatlandia periodic table in two dimensional world will be:
    (A) 36
    (B) 27
    (C) 24
    (D) 18

26. Identify the only **incorrect** statement among the following: ('n' represents valence shell and 'z' represents atomic number)
    (A) In flatlandia, the maximum covalency of an element with atomic number 5 is 3.
    (B) sextet rule corresponds to the octet rule in flatlandia.
    (C) Total number of lone pair of electrons in all the simple binary compounds of the elements (n = 2) with the lightest element (z = 1) are four.
    (D) In flatlandia, if elements with atomic number 1 and 5 are denoted by H and C respectively then the number of π-bonds in C_2H_2 molecule is 1.

Paragraph for Question Nos. 27 and 28

A white crystalline solid (X) exhibits the following observations:
(i) The flame of bunsen burner is intensely yellow coloured.
(ii) An aqueous solution is neutral; dropwise addition of sulphurous acid (an SO_2 solution) leads to a deep brown solution which is decolourised in the presence of excess of sulphurous acid.

(iii) If $AgNO_3$ solution is added to the discoloured solution in (ii) and acidified with HNO_3, a yellow precipitate that is insoluble on addition of NH_3, but that can be readily dissolved by adding CN^- or $S_2O_3^{2-}$, is obtained.

(iv) If an aqueous solution of the solid (X) is treated with KI and dilute H_2SO_4, a deep brown solution is formed that can be decolourised by addition of sulphurous acid or $Na_2S_2O_3$ solution.

(v) An amount of 0.1000 g of the solid (X) is dissolved in water, 0.5g KI and a few mL of dilute H_2SO_4 are added. The deep brown solution formed is titrated with a 0.1000 M $Na_2S_2O_3$ solution until the solution is completely decolourised; the consumption, 37.40 mL. (Atomic mass : Na = 23, K = 39, Cl = 35.5, I = 127, O = 16)
Based on the above paragraph, now answer the following questions:

27. % by mass of 'Cl' in the solid (X) is
(A) 59.34%
(B) 29%
(C) 40.27%
(D) 0 %

28. On the basis of the observations given in the above paragraph, solid (X) can be:
(A) NaI_3
(B) $NaClO_3$
(C) $NaIO_4$
(D) $NaClO_4$

SECTION – D

(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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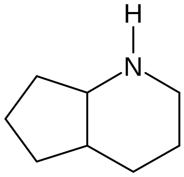
29. When light of suitable frequency is incident on a mixture of gaseous chlorine and hydrogen, hydrogen chloride is formed. The mixture is irradiated with a mercury UV-lamp (λ = 253.6 nm). The lamp has a power input of 10 watt. An amount of 2% of the energy supplied is absorbed by the gas mixture (in a 10 litre vessel). Within 2.5 seconds of irradiation, 65 millimoles of HCl is formed. If the quantum efficiency of this reaction is found to be $x \times 10^4$, then find th value of 'x'.
(Quantum efficiency is defined as the number of product molecules formed per absorbed photon)
(Take Avogadro's number = $6.02 \times 10^{23,}$ Plank's constant = 6.6×10^{-34} Js)

30. An organic compound (P) has molecular formula, $C_8H_{11}NO$ and it can be resolved into enantiomers. (P) does not decolourise bromine water solution. 'P' on refluxing with dilute H_2SO_4 yields another resolvable compound Q ($C_8H_{12}O_3$) which give effervescence with $NaHCO_3$. 'Q' on treatment with $NaBH_4$ yields R($C_8H_{14}O_3$) which on heating with conc. H_2SO_4 yields S($C_8H_{12}O_2$). Compound (P) on reduction with $LiAlH_4$, followed by treatment of H_2SO_4 yields the compound which is given below



Let the sum of degree of unsaturation in P, Q, R and S be 'x'; the sum of the number of rings in P, Q, R and S be 'y' and the sum of distinct functional groups in P, Q, R and S be 'z' (if the same functional group appears in two or more compounds count it once only).

Then find, the value of $\frac{x+y+z}{y+z}$.

31. For an ideal gas, temperature varies as:
$T = K + \beta V^2$
Where K and β are positive constants and 'V' is the molar volume of the gas, if the minimum pressure (P_{min}) of one mole of an ideal gas is expressed as:
$P_{min} = nR^a\beta^bK^c$
Then find the value of $\frac{n+a+b}{n-a+b-c}$

32. If 'θ' is the angle between two bonds on the same central atom, then fraction of s-character of the bond can be calculated as:
$\cos\theta = \frac{s}{s-1}$ (where $90^o < \theta < 180^o$)
Let fraction of s-character of each orbital having lone pair in water be 'x' and fraction of s-character of the lone pair in NH_3 be 'y', then find the value of (x + y).
($\cos 104.5^o = - 0.25$ and $\cos 107^o = - 0.30$)

33. Some aqueous solutions are given below. If 'x' be the number of solution(s) whose pH does not change appreciably by adding small amount of H_2SO_4 and 'y' be the number of solution(s) whose pH changes rapidly by adding H_2SO_4, then find the value of $\frac{y}{x}$.

(a) 0.1 M NH_4CN

(b) 0.1 M NH_4OH + 0.1 M NH_4Cl

(c) 100 mL, 0.1 M HCl + 100 mL, 0.5 M $Ca(OH)_2$

(d) 100 mL, 0.1 M HCl + 100 mL, 0.2 M NaCN

(e) 100 mL, 0.1 M $Ca(OH)_2$ + 100 mL, 0.4 M H_2S

(f) 100 mL, 0.1 M NaOH + 100 mL, 0.2 M HCl

(g) 100 mL, 0.1 M NaOH + 100 mL, 0.2 M K_2SO_4

(h) 100 mL, 0.5 M CH_3COOH + 100 mL, 0.1 M $Ba(OH)_2$

(i) 100 mL, 0.5 M $Ca(OH)_2$ + 100 mL, 0.1 M HCl

34. Consider the following ions:
$S_2O_2^{2-}; S_2O_3^{2-}; S_2O_4^{2-}; S_2O_5^{2-}; S_2O_6^{2-}; S_2O_7^{2-}; S_2O_8^{2-};$
If the number of ions having S – S or S = S linkage be 'x' and the number of ions having S – O – S linkage be 'y', the number of ions having peroxy linkage b ' z',. Find the value of $\left(\frac{x}{y+z}\right)$.

35. o-aminobenzaldehyde is heated with acetone in dilute NaOH solution to produce the major organic product (A), which on treatment with catalytic amount of H_2SO_4, produces another major organic product (B).
Let, the degree of unsaturation of (A) be 'x'; the degree of unsaturation of (B) be 'y'; the number of rings in (A) be 'z' and the number of rings in (B) be 'p', then, find the value of $\left(\frac{y+p}{x-z}\right)$.

36. How many milliliters of 2.0 M NaOH solution must be added to 100 mL of 0.1 M H_3PO_4 solution in order to obtain a buffer solution with pH about 7.2?
(The pK_a values of H_3PO_4 are $pK_{a_1} = 2.1$; $pK_{a_2} = 7.2$ and $pK_{a_3} = 12.0$)
Assume the temperature of reaction mixture to be 298 K.

Mathematics PART – III

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. Let (x, y) be the ordered pair satisfying the inequalities $\sin\frac{\pi x}{2} + \cos \pi y \geq 2$ and $x > 1$, where x, $y \in$ **N**. Choose the **correct** statement(s).
(A) if $x^y - y^x$ is divisible by 8 remainder can be 1.
(B) if $x^y + y^x$ is divided by 8 remainder can be 1.
(C) if $x^y + y^x$ is divided by 8 remainder can be 3.
(D) if $x^y - y^x$ is divided by 8 remainder can be 5.

38. $f : \mathbf{R} \to \mathbf{R}$, be a twice differentiable function such that $f(x)f''(x) \neq 0$, $\forall\, x \in \mathbf{R}$. Choose the **correct** option(s).
(A) $y = f(x)f'(x)$ is a strictly increasing function.
(B) if $f'(x) = 0$ for some $x \in \mathbf{R}$, then it is always point of inflection.
(C) $f(x)f''(x) > 0\ \forall\, x \in \mathbf{R}$
(D) if $f'(x_0) = 0$ and $f(x_0) < 0$ then it is point of local maxima.

39. The roots of the equation $az^4 + bz^2 + cz + d = 0$ are vertices of a convex quadrilateral in argand plane ($a, b, c, d \in C$). Choose the **correct** option(s).
(A) The intersection point of diagonals is necessarily origin.
(B) If the quadrilateral is a parallelogram then point of intersection of diagonals is origin.
(C) If the quadrilateral is a rhombus then it is necessarily a square.
(D) If the quadrilateral is rhombus then its area is $2\sqrt{\left|\frac{d}{a}\right|}$.

40. Let $\mathbf{N} \cup \{0\} \to \mathbf{N} \cup \{0\}$, $f_k(x)$ be a function such that $f_k(x)$ is equal to remainder when x^k is divided by 10. ($k \in N$) choose the **incorrect** option(s).
(A) $y = f_k(x)$ is periodic function with period 3.
(B) $f_{2019}(f_{2017}(x) - x) = f_{2019}(f_{2013}(x) - x)$ has infinitely many solutions.
(C) $f_{2019}(f_{2018}(f_{2017}(\ldots.. f_1(x)))\quad)) = x$ is only true when x has 0, 1, 5 at unit place.
(D) $y = f_k(x)$ is non periodic function.

41. Let $f(x) = e^{x+1} - 1$, $g(x) = p|f(x)| - \sum_{k=1}^{n}\left|f\left(x^k\right)\right|$, ($n \in \mathbf{N}$). It is given that g(x) is differentiable function over the real numbers. Choose the **correct** option(s).
(A) p can assume the value 99.
(B) if p is 100 then n can have two different values.
(C) if p is 100 then sum of possible values of m is 39.
(D) p can assume the value 36.

42. The line $y = t$ intersects $y = x^3 - 3x + 2$ at three points $(f_1(t), t)(f_2(t), t)(f_3(t), t)$ such that $f_3(t) > f_2(t) > f_1(t)$. Define a function $g(t) = t(f_3(t) - f_1(t))$. Choose the **correct** option(s).
(A) $g(2) = 4\sqrt{3}$
(B) $g(2) = \frac{2}{3}$
(C) $g'(2) = 2\sqrt{3}$
(D) $g'(2) = -\frac{2}{3}$

(Paragraph Type)

This section contains **TWO** paragraphs. Based on each paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 43 and 44

Let P be a point in X-Y plane and P′ is a point such that $OP \cdot OP' = r^2$, where O, P and P′ are collinear and O divides P and P′ externally. (O is the origin)

43. If point P lies on the circle $(x - 1)^2 + (y - 5)^2 = 4$ and P′ also satisfy the same circle, then value of r^2 is

(A) 30

(B) 22

(C) 4

(D) none of these

44. If the point P lies on the line $x + y = 1$, then P′ traces

(A) A straight line of slope $\frac{1}{r}$

(B) A circle of radius $\frac{r}{\sqrt{2}}$

(C) A circle of radius $\frac{r^2}{\sqrt{2}}$

(D) A circle of radius $\frac{r^2}{2}$

Paragraph for Question Nos. 45 and 46

Let $y = f(x)$ be an odd cubic polynomial function such that $f(x) = f(\alpha)$ has all the roots real and $y = |f(x) - f(\alpha)|$ is non differentiable at $x = \alpha$ only. Let $y = g(x)$ be another cubic polynomial such that $y = f(x) - g(x)$ is quadratic expression and $|g(x)| \le M$, $\forall\ |x| \le \alpha$, then minimum value of M is $f(\alpha)$.

45. If $f'''(0) = 6$, and $\alpha = 2$, then f(x) is equal to

(A) $x^3 + 2x$

(B) $x^3 - 2x$

(C) $x^3 + 3x$

(D) $x^3 - 3x$

46. If $|4x^3 + ax^2 + bx + c| \le M$ for $\forall\ |x| \le 1$, then minimum value of 4M is

(A) 4

(B) 1

(C) 2

(D) 3

SECTION – D

(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

47. Find the minimum value of $\displaystyle\sum_{k=0}^{4}\sum_{r=0}^{2019}\left|z - \frac{e^{i\left(\frac{k}{3}+\frac{r}{2}\right)\pi}}{1010}\right|$.

48. ABCD is a regular tetrahedron with side length $\left(\sqrt{2}+1\right)$ units. A point P is taken on the edge AB such that $\frac{AP}{BP}=\sqrt{2}-1$. Q is the point in the plane of triangle BCD such that PQ ⊥ AB. If d is perpendicular distance of P from plane BCD and d_1 is minimum distance between P and Q, then find the value of $\left(\frac{d_1}{d}\right)^4$.

49. f : R → R is a differentiable function satisfying $2(f(x))^2f'(x) = (f(2x + 1))^2f'(2x + 1)$, $f\left(-\frac{1}{8}\right)=1$, f(6) = 2 find the value of $\frac{2}{\left(f\left(-1\right)\right)^3}$.

50. y = f(x) is a parabola having $\left(0, \frac{3}{2}\right)$ and (0, 0) as vertex and focus respectively, find the number of roots of the equation $\frac{1}{2f\left(x\right)-3}-\frac{1}{2f\left(x\right)+3}+\frac{6}{x^2}=0$.

51. Out of 10 tokens, numbered from {1, 2, ..., 10}, first person X chooses a token then person Y chooses the token (without replacement in both cases). A person is winner if he gets a prime number and in the next draw other person get a non prime. If both gets prime in successive draw, game is a draw. Game continuous till some one wins or game is drawn. If P(x) is probability of X winning, P(y) is probability of Y wining and P(d) is probability of draw, then the value of 21P(x) + 126P(y) – 7P(d) is _____

52. A point $P\left(\frac{e^t+e^{-t}}{2}, \frac{e^t-e^{-t}}{2}\right)$ traces a locus S = 0 in X–Y plane (t being a non negative parameter). A fixed point P_0, having parameter t_0, lies on the curve S = 0. The area bounded by the curve, line OP_0 and x-axis in 240 sq. units (O being the origin), find the value of t_0.

53. Given that $\cos\alpha\cos\beta + \sin^2\alpha\sin\beta - \cos^2\gamma\sin\alpha = 1$, $0 < \alpha, \beta, \gamma < \pi$.
Find the value of $\sin(\alpha + \beta - \gamma) + \sin(\beta + \gamma - \alpha) + \sin(\alpha + \gamma - \beta)$.

54. Ten points are given in a plane such that no three points are collinear and no four of them form a trapezium. From every point, all the possible lines are drawn which are parallel to lines formed by taking any two points out of remaining points. Find the total number of points of intersection of these lines. (excluding the given ten points)

FIITJEE

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OPEN TEST

JEE (Advanced)-2019

PAPER – 1

TEST DATE: 03-02-2019

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. A, B, C, D

Sol. $^{n}C_2 = 3, n = 3$

So initially atoms was in n = 2.

$E_3 - E_2 = 68$ eV

Hence Z = 6

$\lambda_{min} = \frac{12400}{E_3 - E_1} = 28.49$ Å

2. A, B, C, D

Sol. Let potential of point A is x and potential of point B is zero. Consider charge flown through 3V battery is q_0.

$2(3-x) + q_0 + (0-x)2 = 0$ …(1)

$-q_0 - (x-3)\times 1 + (2-x+3)2 = 0$ …(2)

3. A, B, C

Sol. In figure-1

$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} + \frac{1}{-60} = \frac{1}{-30}$

V = – 60

Hence $m = -\frac{v}{v} = -1$

In figure-2, images will not separated.

4. A, B

Sol. If $\vec{v}\cdot\vec{a} > 0$, then there must be a component of $\vec{a}$ along $\vec{v}$

If $\vec{r}\cdot\vec{v} > 0$, then there must be a component of $\vec{v}$ along $\vec{r}$

5. B, C, D

Sol. Phase difference between two particles in standing wave is either zero or π at any instant of time. Potential energy depends upon strain. Particle near to nodes will experience more strain.

6. A, B, C

Sol. $\vec{a}_0 = (2g\hat{i} + g\hat{j})$

$\vec{F}_B = \rho V(\vec{a}_0 - \vec{g}) = 2\rho Vg(\hat{i} + \hat{j})$

$\vec{F}_{net} = \vec{F}_B + m\vec{g} = 2\rho Vg(\hat{i} + \hat{j}) - \rho_0 Vg\hat{j}$

$\vec{a}_{net} = \frac{2\rho}{\rho_0}g(\hat{i} + \hat{j}) - g\hat{j}$

$\vec{a}_{relative} = \vec{a}_{net} - \vec{a}_0$

7. C

8. C

Sol. (for Q. 7 to Q. 8)

$f_t = \mu mg = 8N$ …(i)

$f_f = I\alpha$

$\alpha = \frac{11}{7}$ rad/s^2 …(ii)

$\omega = \frac{v}{R} = \frac{22}{7}$ ad/sec …(iii)

$\omega^2 = \omega_0^2 + 2\alpha\theta$

$\theta = \pi$ rad …(iv)

$\omega = \omega_0 + \alpha t$

t = 2 sec …(v)

$y = \frac{1}{2}\times 2 = 1m$ …(vi)

$x = \theta\cdot R = \frac{1}{2}m$ …(vii)

9. C

10. B

Sol. (for Q. 9 to Q. 10)

$P_1(V_1)^\gamma = P_2(V_2)^\gamma$

$P_2 = P_1\left(\frac{V_1}{V_2}\right)^\gamma = 21\left(\frac{50}{400}\right)^{4/3}$

$= 21\times\frac{1}{16}$

= 1.3125 atm

Work done = $\frac{P_1V_1 - P_2V_2}{\gamma - 1} = \frac{(21\times 50 - 1.3125\times 400)10^5\times 10^{-6}}{\frac{4}{3} - 1}$ = 157.5 Joule

SECTION – D

11. 00000.88

Sol. $F = \frac{dp}{dt} = \frac{\Delta P}{\Delta t} = \Delta u.\left(\frac{m}{t}\right)$

$= (2 \times 2.2) \times \frac{200}{1000}$

= 0.88 Newton

12. 00031.63

Sol. $\frac{1}{2}\ mv^2 - \frac{GmM}{r}\ = -\frac{GmM}{2a}$

$v^2 = GM\left(\frac{2}{r} - \frac{1}{a}\right)$

$= 6.67 \times 10^{-11} \times 2 \times 10^{30}\ \left(\frac{2}{2} - \frac{1}{4}\right) \times 10^{-11} = 10.005 \times 10^{8}$

v = 31.63 km/sec

13. 00007.10

Sol. 1 MSD = 1 mm
1 VSD = 0.9 mm
L.C. = 0.1 mm
–ve error = 4 × 0.1 mm = 0.4 mm
Reading = 6 mm + 7 × 0.1 mm = 6.7 mm
Diameter = 6.7 + 0.4 = 7.1 mm

14. 00003.00

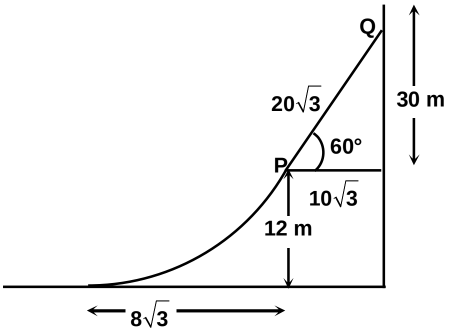
Sol. $q_0 = \int \rho dv = \int_0^R \rho_0 r^n 4\pi r^2 dr$

$q = \int \rho dv = \int_0^{R/2} \rho_0 r^n . 4\pi r^2 dr$

$\frac{kq_0}{R^2} = 16.\frac{kq}{\left(\frac{R}{2}\right)^2}$

So n = 3

15. 01800.00



Sol. $x^2 = 16y$

$2x = \frac{16dy}{dx}$

$\frac{dy}{dx} = \frac{x}{8} = \sqrt{3}$

$\theta = 60°$

$W = \Delta K$

$W_F + W_{ff} + W_g + W_N = 0$

$W_F = -W_{ff} - W_g$

$= \mu mg\left(8\sqrt{3} + 10\sqrt{3}\right) + mg(42)$

= 1800 J

16. 00256.00

Sol. $a \propto \frac{1}{n^4}$

where, a is acceleration of electron and 'n' is no. orbits.

17. 00033.33

Sol. Acceleration of container $a = \frac{100-v}{200+t}$

$$\int_0^v \frac{dv}{100-v} = \int_0^{100} \frac{dt}{200+t}$$

$$v = \frac{100}{3}\,m/s.$$

18. 00001.33

Sol. $T_1 = 2\pi\sqrt{\frac{I_1}{mgd}}, I_1 = \frac{mL^2}{3} + mL^2$

$$T_2 = 2\pi\sqrt{\frac{I_2}{mgd}}, I_2 = \frac{mL^2}{3} + \left[\frac{m(L/2)^2}{6} + mL^2\right]$$

$$\frac{T_1}{T_2} = \sqrt{\frac{I_1}{I_2}} = \frac{4}{3}\sqrt{\frac{6}{11}},$$

Chemistry

PART – II

SECTION – A

19. A, B

Sol. In first molecule, lone pair of electrons lie in equatorial position, hence decreases θ_2 more rapidly the θ_2'. In second molecule, π-electron cloud lie closer to axial bonds and pushes them more, so $\theta_1' < \theta_1$.

20. A, B, D

Sol. Since AB is an isobaric process, so

$$\frac{V_B}{V_A} = \frac{T_B}{T_A} \Rightarrow 2 = \frac{T_B}{300} \Rightarrow T_B = 600\text{K}$$

$$W_{ABCDA} = W_{AB} + W_{BC} + W_{CD} + W_{DA}$$

$$W_{AB} = -nR\Delta T = -1200 \text{ cal}$$

$$W_{BC} = -2.303nRT_B \log\frac{V_C}{V_B} = 2.303nRT_B \log\frac{V_B}{V_D} \quad (\text{as } V_C = V_D)$$

$$W_{BC} = 2.303 \times 2 \times 2 \times 600 \times \log\frac{V_B}{V_A} \times \frac{V_A}{V_D}$$

= 2.303 × 2 × 2 × 600 × log 2/4

= - 1663.68 cal.

$$W_{C\to D} = 0$$

$$W_{D\to A} = 2.303nRT_A \times \log\frac{V_D}{V_A}$$

= 2.303 × 2 × 2 × 300 × log4

= 1663.68 cal.

$$W_{A\to B\to C\to D\to A} = -1200 - 1663.68 + 0 + 1663.68$$

= - 1200 cal

21. A, B, C, D

Sol. A → Curtius degradation type reaction

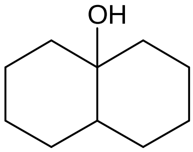
B → Hydration + deprotonation + tautomerisation

C → Friedel-Crafts reaction followed by benzylic acid rearrangement

D → Baeyer-Villiger + Perkin condensation reaction.

22. A, B, C, D

Sol. All substrates give the same major product which is given below



23. A, B, C, D

Sol. Coordination number of Al in $AlCl_3$(s) is 6.

Anhydrous $AlCl_3$ is covalent but becomes ionic when dissolved in water.

BI_3 is the strongest Lewis acid among all boron halides.

All BX_3 are covalent in nature.

24. A, C, D

Sol. $\left[\text{CuCl}_2\left\{\text{O}=\text{C}\left(\text{NH}_2\right)_2\right\}_2\right]-\text{Dichloridodicarbamidocopper}(\text{II})$

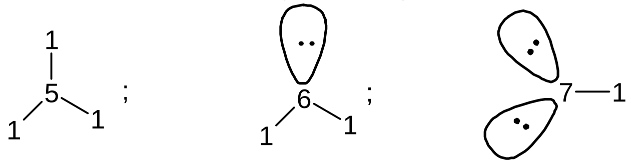
25. C

Sol.

1 $1s^1$									2 $1s^2$
3 [ ] $2s^1$	4 [ ] $2s^2$					5 $2s^22p^1$	6 $2s^22p^2$	7 $2s^22p^3$	8 $2s^22p^4$
9 [ ] $3s^1$	10 [ ] $3s^2$					11 $3s^23p^1$	12 $3s^23p^2$	13 $3s^23p^3$	14 $3s^23p^4$
15 [ ] $4s^1$	16 [ ] $4s^2$	17 $4s^2\ 3d^1$	18 $4s^2, 3d^2$	19 $4s^2, 3d^3$	20 $4s^2, 3d^4$	21 $4s^23d^44p^1$	22 $4s^23d^44p^2$	23 $4s^23d^44p^3$	24 $4s^23d^44p^4$

26. C

Sol. Lewis structures 3 – 1; 1 – 4 – 1;



27. D

28. C

Sol. (for Q. 27 to Q. 28)

(i) The solid must contain Na and I. The yellow colouration of the flame indicates the presence of Na^+ ion; a yellow silver salt that is dissolved only by strong complexing agent such as CN^- or $S_2O_3^{2-}$ must be AgI.

(ii) Reaction (i) to (iv) indicates a sodium salt of an oxygen containing acid containing iodine. Both SO_2 and I^- are oxidized, while in the first case I^- is formed with an intermediate of I_2 or I_3^- (brown solution) and in the second I_2 or (I_3^-) is formed. As the solution is neutral $NaIO_3$ or $NaIO_4$ come into consideration.

(iii) Conditions given in observation(v) proves that solid (x) is $NaIO_4$.

1 mole of $NaIO_4$ = 213.90 g $NaIO_4$ = 8 moles of $S_2O_3^{2-}$.

$$\therefore 0.1000 \text{ g NaIO}_4 = \frac{0.1000\times 8}{213.90} = 3.740\times 10^{-3} \text{ mol of } S_2O_3^{2-}$$

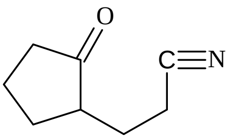
$$\left(IO_4^- + 7I^- + 8H^+ \longrightarrow 4I_2 + 4H_2O\right)$$

SECTION – D

29. 00006.11

30. 00002.20

Sol.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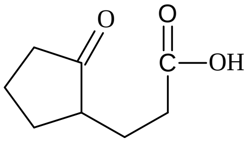
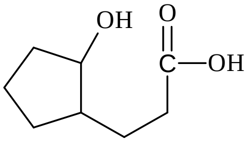
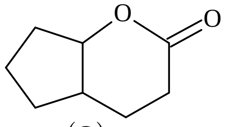

(Q)


(R)


(S)

31. 00003.50

Sol. PV = RT (for 1 mole of ideal gas)

$PV = R(K + \beta V^2)$

$$P = \frac{RK}{V} + \beta RV$$

For minimum pressure

$$\frac{dP}{dV} = 0 \text{ and} \frac{d^2P}{dV^2} = +ve$$

So, $P_{min} = 2R\sqrt{\beta K}$

32. 00000.61

Sol. H_2O

$$\cos 104.5^o = \frac{s}{s-1} \Rightarrow s = 0.20$$

So, fraction of s-character of lone pair in H_2O = 0.30

Similarly, fraction of s-character of lone pair in NH_3 = 0.31

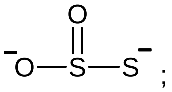
33. 00001.25

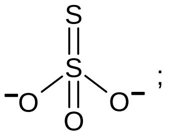
Sol. x = 5 and y = 4

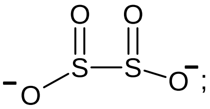
Only a, b, d, e and h will form buffer.

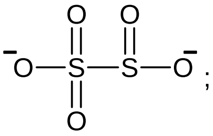
34. 00002.50

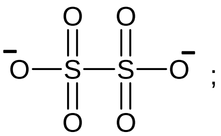
Sol.

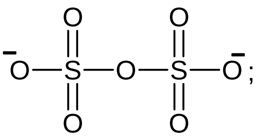


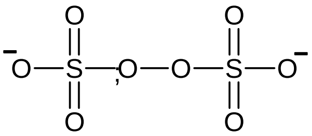








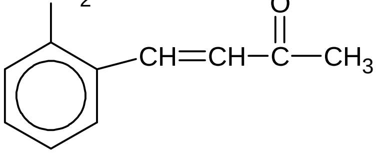


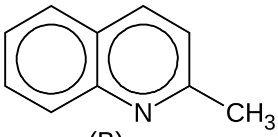


x = 5, y = z = 1

35. 00001.80

Sol.


(A)


(B)

36. 00007.50

Sol. Let, x ml of 2.0 M NaOH solution be added, then

	H_3PO_4	$+$	NaOH	$\longrightarrow$	NaH_2PO_4	$+H_2O$
millimoles	10		2x		0	0
	0		$(2x-10)$			

NaH_2PO_4	$+$	NaOH	$\longrightarrow$	$Na_2HPO_4+H_2O$
10		$(2x-10)$		0
$10-(2x-10)$		0		$2x-10$

= 20 – 2x

So, $7.2 = 7.2 + \log\dfrac{2x-10}{20-2x}$, on solving x = 7.5

Mathematics

PART – III

SECTION – A

37. A, B

Sol. $x = 4k + 1$, $y = 2m$ ($k_1m \in N$)
$y^x = (2m)^{4n+1}$ (it is divisible by 8)
$x^y = (4n + 1)^{2m}$ (it leave remainder 1)

38. A, C, D

Sol. As $f(x)f''(x) > 0 \ \forall\ x \in R$
For $y = f(x)f'(x)$; $y' = (f'(x))^2 + f(x)f''(x) > 0$
If $f(x)_0 < 0$ then $f''(x_0) < 0$

39. B, D

Sol. If it is parallelogram $z_1 + z_3 = z_2 + z_4 = 0$ (in some order)
$\Rightarrow$ If it is rhombus then area is $2|z_1||z_2|$ where $|z_1|^2|z_2|^2 = \left|\frac{d}{a}\right|$

40. A, C, D

Sol. $y = f_k(x)$ is periodic with period 10 and $f_k(f_{4k+1}(x) - x) = 0$

41. B, C, D

Sol. R.H.D. at $x = -1$ is $(p - m^2)$ where $n = 2m$ or $2m - 1$
L.H.D. at $x = -1$ is $(m^2 - p)$ for differentiability $m^2 = p$

42. A, C

Sol. $x^3 - 3x + 2 = 2$; $x = 0, \pm\sqrt{3}$
$3(f^2(t) - 1)f'(t) = 1$

43. B

Sol. $x^2 + y^2 = r^2$ and $(x - 1)^2 + (y - 5)^2 = 4$ must be orthogonal

44. C

Sol. $OP \cdot OP' = r^2$
Using $P(r_1 \cos\theta, r_1 \sin\theta)$
Locus of P' is

$$x^2 + y^2 + \frac{mr^2}{c}x - \frac{r^2}{c}y = 0$$

45. D

46. A

Sol. (for Q. 45 to Q. 46)
$ax^3 + bx = 8a + 2b \Rightarrow (x - 2)(ax^2 + 2ax + 4a + b) = 0$
$D = 0 \Rightarrow 3a + b = 0$ as $a = 1 \Rightarrow f(x) = x^3 - 3x$
Similarly for $g(x) = 4x^3 + ax^2 + bx + c$, $f(x) = (4x^3 - 3x)$ and $f(1) = 1$

SECTION – D

47. 00010.00

Sol. Minimum will occur at $z = 0$

$$\sum_{k=0}^{4}\sum_{r=0}^{2019}\frac{1}{1010}=10$$

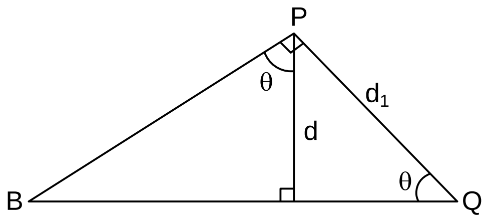
48. 00009.00

Sol. Let ABCD have coordinates

O, λ(i + j), λ(j + k), λ(i + k) respectively

$\frac{d_1}{d}=\operatorname{cosec}\theta=\sqrt{3}$

Where θ is angle between AB and normal of BCD



49. 00002.25

Sol. $4f^3(x) = f^3(2x + 1) + c$

By taking $x=-\frac{1}{8},\frac{3}{4},\frac{5}{2}$ and 6, we get

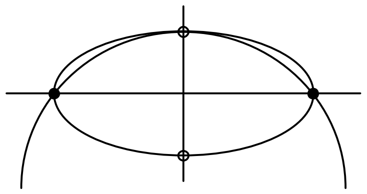
$f^3\left(\frac{3}{4}\right)+c=4$, $f^3\left(\frac{5}{2}\right)+c=4f^3\left(\frac{3}{4}\right)$, $4f^3\left(\frac{5}{2}\right)=f^3(6)+c$

So, we $c=\frac{8}{3}$ i.e., $4f^3(x) = f^3(2x + 1) + \frac{8}{3}$

50. 00002.00

Sol. The given equation reduces to $4f^2(x) + x^2 = 9$, an ellipse.

As in the figure it has two solutions



51. 00035.32

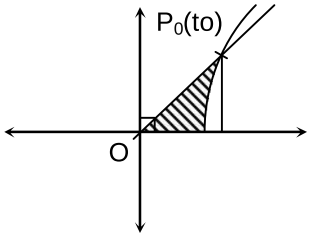
Sol. $P(x)=\sum_{k=1}^{4}\frac{{}^kC_1\,{}^4C_2\cdot 2!\,{}^6C_{2k-2}\;2k-2!\,10-2k!}{10!}=\frac{8}{21}$ and P(d) = 0.4

52. 00480.00

Sol. $\frac{1}{2}\left(\frac{e^{to}+e^{-to}}{2}\right)\left(\frac{e^{to}-e^{-to}}{2}\right)-\int_{0}^{to}ydx$

$\frac{1}{8}\cdot e^{2to}-e^{-2to}-\int_{0}^{to}\frac{\left(e^{t}-e^{-t}\right)^2}{4}dt=\frac{to}{2}=240$

to = 480



53. 00003.00

Sol. $I = \cos\alpha\cos\beta + \sin^2\alpha\sin\beta - \cos^2\gamma\sin\alpha \le \cos\alpha\cos\beta + \sin\alpha\sin\beta = \cos(\alpha-\beta)$

$\Rightarrow \alpha-\beta = 0$ & $\cos\gamma = 0$, $\sin\alpha = 1$

$\Rightarrow \alpha=\beta=\gamma=\frac{\pi}{2}$

54. 57060.00

Sol. For point of intersection we take say two points A and B, from each we can draw ${}^9C_2$ lines cut of which ${}^8C_2$ are parallel. So total number of intersection points are

${}^{10}C_2\left((36)^2-28\right)=57060$

FIITJEE

ALL INDIA TEST SERIES

OPEN TEST

JEE (Advanced)-2019

PAPER – 2

TEST DATE: 03-02-2019

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01 – 06, 19 – 24, 37 – 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 – 46) *contains 12 questions. Each question has* ***TWO (02)*** *matching lists:* ***LIST-I*** *and* ***LIST-II***. ***FOUR*** *options are given representing matching of elements from* ***LIST-I*** *and* ***LIST-II***. ***ONLY ONE*** *of these four options corresponds to a correct matching.*
   For each question, choose the option corresponding to the correct matching.
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

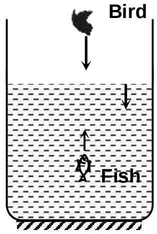
PART – I

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A bird is flying downward with constant velocity 6 cm/s towards a fixed container filled with a liquid of refractive index 4/3. A fish is moving upward with constant speed 4 cm/s towards the surface of liquid. Surface of liquid is also moving downward with constant velocity 2 cm/s as shown in the figure. The bottom of container is silvered. Then

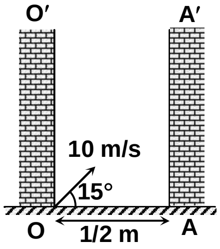


(A) Speed of fish as seen by bird only after refraction is 9 cm/sec
(B) Speed of fish as seen by bird only after refraction is 8.5 cm/sec
(C) Speed of fish as seen by bird after reflection and then refraction is 3 cm/sec
(D) Speed of fish as seen by bird after reflection and then refraction is 2.5 cm/sec

2. Two ideal gases A and B are kept in a closed container at room temperature. Consider collisions takes place between the molecules of A and B. Let K'_A and K'_B are the kinetic energies of molecule A and B respectively after collision and K_A and K_B are the kinetic energies of molecule A and B respectively before collision. Then choose the possible option(s)

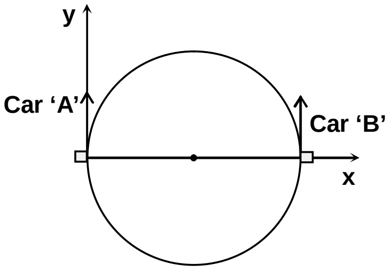
(A) $K_A > K_A', K_B > K_B'$
(B) $K_A < K_A', K_B < K_B'$
(C) $K_A > K_A', K_B < K_B'$
(D) $K_A < K_A', K_B > K_B'$

3. OO′ and AA′ are two vertical walls. A particle is projected from O with speed 10 m/s at an angle 15° from the horizontal. All collisions with each walls are perfectly elastic. Then choose the correct statement(s).



(A) The horizontal component of velocity will change after each collision.
(B) Particle will land on the ground between points O and A.
(C) The total number of collisions with walls is 9 till particle reaches ground again for the first time after projection.
(D) Time taken by particle to reach the ground is 2 sin 15° seconds.

4. Two cars 'A' and 'B' are moving along y-axis and in a circle of radius 30 m respectively. Initial co-ordinate of cars 'A' and 'B' are (0, 0) and (60, 0) respectively. Car 'A' starts from rest and moves with constant acceleration 20/3 m/s^2 and Car 'B' moves with constant speed. Time taken by car 'B' to complete the circle is 12 sec. Choose the correct option(s).



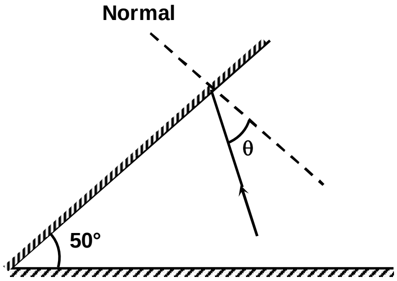
(A) The magnitude of average velocity of car 'A' with respect to car 'B' is 10 m/s in time interval 0 to 3 sec.

(B) The magnitude of average velocity of car 'A' with respect to car 'B' is 10 m/s in time interval 0 to 6 sec.

(C) The magnitude of average acceleration of car 'A' with respect to car 'B' is $\frac{5\pi+20}{3}$ m/s^2 in time interval 0 to 6 sec.

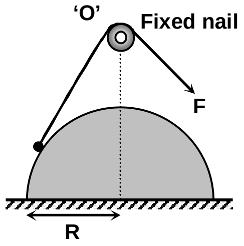
(D) The magnitude of average acceleration of car 'A' with respect to car 'B' is $\frac{5\pi}{3}$ m/s^2 in time interval 0 to 6 sec.

5. Two plane mirrors are placed in such a way that they make an angle 50° as shown in figure. A ray of light falls on one mirror and it reflects from each mirror once. For the given situation mark the correct statement(s).



(A) The value of θ must be less than 40°.
(B) θ can have any value ranging from 0° to 90°.
(C) Total deviation produced in light ray is independent of value 'θ'.
(D) Laws of reflection are valid for only plane and spherical mirrors.

6. A hemisphere of radius 'R' is kept fixed on a horizontal surface. A nail is also fixed at 'O' exactly above the centre of hemisphere at some height. A small ball of mass 'm' is slowly pulled by an external force F on the surface of hemisphere. String is massless and friction force between ball and hemisphere is negligible. Then



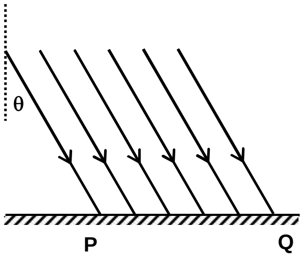
(A) As ball moves up tension in the string decreases.
(B) As ball moves up tension in the string increases.
(C) As ball moves up normal between ball and sphere decrease.
(D) As ball moves up normal between ball and sphere increase.

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

---

7. A parallel beam of light is incident on a fixed surface PQ at an angle 'θ' with the vertical as shown in the figure. The intensity of light is I and area of surface PQ is A. In List –I nature of reflection are given and in List-II force and generated radiation pressure are given. Then match List-I with suitable option List-II. (Given that I = 500 W/m^2, A = 1.5 m^2, θ = 37°)



LIST–I		LIST–II	
P.	If all the incident energy is absorbed by surface PQ then force on the surface and radiation pressure generated are respectively.	1.	3.2×10^{-6} N, 2.13×10^{-6} N/m^2

Q.	If all the incident energy is reflected by surface PQ then force on the surface and radiation pressure generated are respectively.	2.	2.24×10^{-6} N, 1.38×10^{-6} N/m^2
R.	If 30% incident energy is reflected by the surface then force on the surface and pressure generated are respectively.	3.	2.74×10^{-6} N, 1.81×10^{-6} N/m^2
S.	If 70% incident energy is reflected back then force on the surface and radiation pressure are respectively.	4.	2×10^{-6} N, 1.06×10^{-6} N/m^2
		5.	4.2×10^{-6} N, 3.13×10^{-6} N/m^2

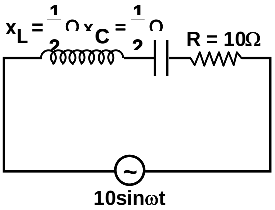
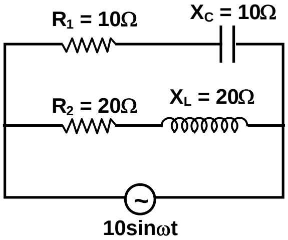
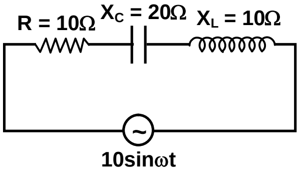
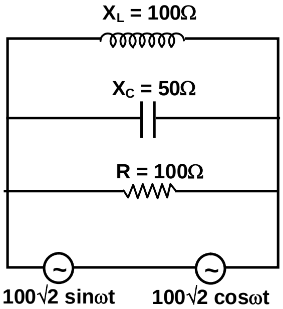
(A) P → 4; Q → 1; R → 3; S → 2

(B) P → 3; Q → 2; R → 1; S → 4

(C) P → 3; Q → 5; R → 4; S → 2

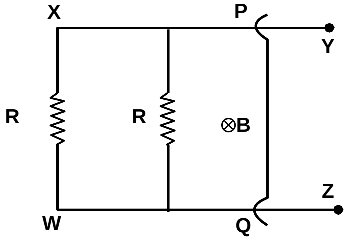
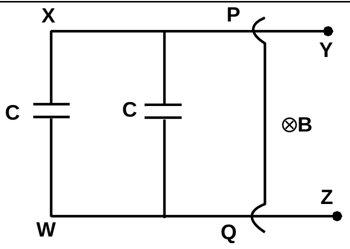
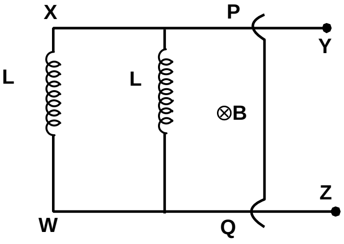
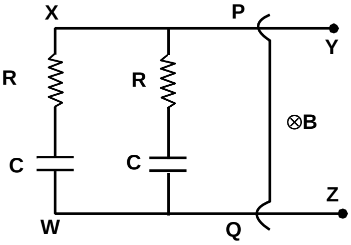
(D) P → 4; Q → 1; R → 2; S → 3

8. Some electric circuits with an A.C. source is given in List-I. In List-II instantaneous current and average power delivered by A.C. source are given. Then Match List-I with List-II.

LIST–I		LIST–II	
P.	 $X_L = \frac{1}{2}\Omega$ $X_C = \frac{1}{2}\Omega$ R = 10Ω 10sinωt	1.	$I = \frac{\sqrt{10}}{4}\sin\left[\omega t + \frac{\pi}{4} - \tan^{-1}\left(\frac{1}{2}\right)\right]$, $P = \frac{15}{4}$ watt
Q.	 R_1 = 10Ω X_C = 10Ω R_2 = 20Ω X_L = 20Ω 10sinωt	2.	$I = 2\sqrt{2}\cos\omega t$, P = 200 watt
R.	 R = 10Ω X_C = 20Ω X_L = 10Ω 10sinωt	3.	I = sin ωt, P = 5 watt
S.	 X_L = 100Ω X_C = 50Ω R = 100Ω 100√2 sinωt 100√2 cosωt	4.	$I = \frac{1}{\sqrt{2}}\sin\left(\omega t + \frac{\pi}{4}\right)$, $P = \frac{5}{2}$ watt
		5.	$I = \frac{\sqrt{10}}{4}\sin\left(\omega t + \frac{\pi}{4} - \tan^{-1}(2)\right)$, $P = \frac{7}{2}$ watt

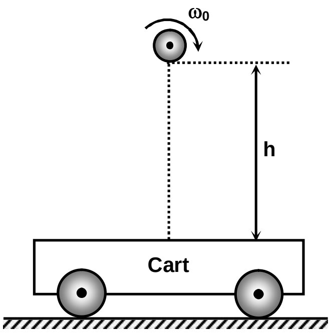
(A) P → 4; Q → 4; R → 1; S → 4
(B) P → 3; Q → 3; R → 1; S → 3
(C) P → 3; Q → 1; R → 4; S → 2
(D) P → 4; Q → 3; R → 4; S → 1

9. In List -I electrical circuits are given. In each circuit perpendicular inward magnetic field (B) exist and an initial velocity v_0 is imparted to the rod (PQ towards right. Rod is conducting and has negligible resistance. 'm' is the mass of rod and ℓ is the length of rod. Both rails xy and wz are frictionless and has negligible resistance also. In List -2, velocity of rod and current in the circuit are given. Match the circuit in List – I to the velocity and current in List – II.

LIST–I		LIST–II	
P.	 Two resistors 'R' in parallel	1.	Minimum magnitude of velocity of rod PQ is $\dfrac{mv_0}{m+2B^2\ell^2C}$.
Q.	 Two capacitor 'C' in parallel	2.	Maximum magnitude of velocity of rod is v_0.
R.	 Two inductors 'L' in parallel	3.	Velocity of rod oscillates with maximum magnitude of velocity v_0.
S.		4.	Minimum magnitude of velocity of rod is zero.
		5.	Current oscillates in the circuit.

(A) P → 2, 4; Q → 1, 2; R → 2, 3, 4, 5; S → 1, 2
(B) P → 2, 3; Q → 1, 2; R → 2, 3, 4, 5; S → 1, 3
(C) P → 2, 4; Q → 1, 2; R → 1, 2, 3, 5; S → 2, 4
(D) P → 2, 1; Q → 1, 2; R → 2, 3, 4, 5; S → 2, 5

10. A solid sphere of mass m = 80 kg and radius r = 0.2 m is released from height h = 5/4 meter. Sphere is initially rotating about horizontal axis passing through its centre of mass. It hits with a stationary cart of mass M = 200 kg exactly at the centre of cart. The cart can move smoothly on the horizontal surface. The collision between sphere and cart occurs in such a way that sphere reaches at same vertical displacement after collision and falls back onto it again. It is found that sphere starts pure rolling at the end of first collision. The coefficient of friction between sphere and cart is $\mu = 0.1$. Match the statement given in **List-I** to the values given in **List-II**.



LIST–I		LIST–II	
P.	The minimum length (in meter) of cart to occur second collision with the sphere	1.	172
Q.	Initial angular velocity ‘ω_0’ (in rad/sec) of sphere for minimum length of cart.	2.	2.8
R.	Magnitude of work done (in Joule) by sphere on the cart during the process.	3.	156
S.	Magnitude of work done (in Joule) by cart on the sphere during the process	4.	19.5
		5.	16

(A) P → 2; Q → 4; R → 5; S → 1
(B) P → 1; Q → 3; R → 1; S → 3
(C) P → 3; Q → 5; R → 4; S → 2
(D) P → 4; Q → 3; R → 4; S → 1

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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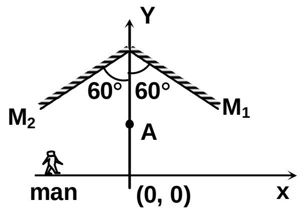
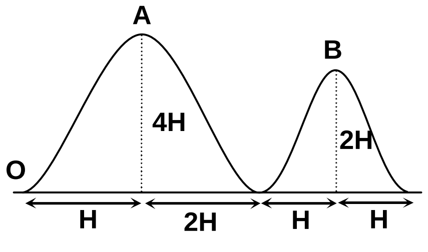
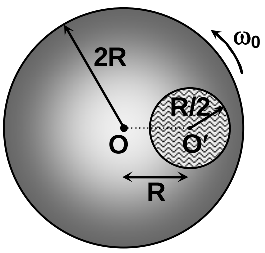
11. Two large plane mirrors M_1 and M_2 are kept at an angle of 120° as shown in figure. The co-ordinate of intersection of plane mirror is (0, 2 meter). A man moves along x-axis. Find the length (in meter) on x-axis for which man can see both the images of point A formed by mirrors simultaneously. (take $\sqrt{3} = 1.73$ and height of man is negligible)



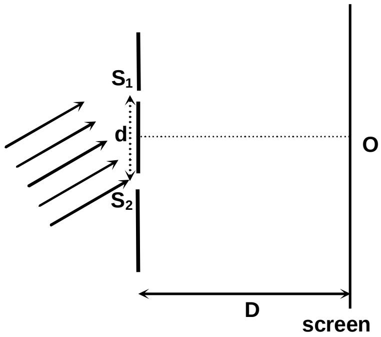
12. A small block of mass m = 200gm is projected from point ‘O’ on a rough curved surface. The coefficient of friction between particle and surface is 0.4. Assume particle is always in contact with the surface. A and B are local peaks of curved surface. Find the minimum kinetic energy (in Joule) given to the small block to reach at B. (Given H = 4 meter)



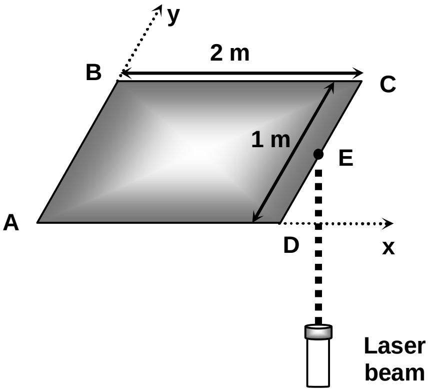
13. A disc of mass m and radius 2R has another disc of mass 2m and radius R/2 kept on it at O′. The system is given an angular velocity ω_0 about a vertical axis passing through O′. The friction between discs is negligible and smaller disc is free to rotate about O′. Find the angular momentum (in M.K.S unit) of system at t = $\frac{\pi}{\omega_0}$ about a vertical axis passing through O.
(Given that m = 300 gm, ω_0 = 8 rad/s and R = 1/2 m)



14. A monochromatic light of wavelength λ_0 and intensity I_0 is incident on YDSE experiment. The distance between slits S_1S_2 is 'd' (d<<D). The angle made by parallel beam light with the normal to the plane of slits is $\text{Sin}^{-1}\left(\frac{3\lambda}{2d}\right)$. Now, if a transparent glass slab of thickness $\frac{3\lambda}{2(\mu-1)}$ is kept infront of one of the slits, where 'μ' is refractive index of glass slab. Find the intensity (in W/m^2) at the geometrical centre 'O' of the screen. (Given, d = 1 mm, D = 2 m, μ = 4/3, λ = 4000Å and I_0 = 4.16 W/m^2)

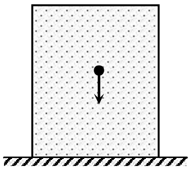


15. A perfectly reflecting rectangular plate ABCD is kept in horizontal (x–y) plane. The dimension of rectangular plane is (2 × 1)m^2 as shown. Rectangular plate can rotate about y–axis and gravity due to earth is along negative Z direction. An impulsive laser is kept below the point E which emits the pulses periodically. A laser beam of diameter 0.2 microns is directly incident at E. The time interval between two pulse is 0.01 ms, and has a total energy of 20 Jules. If the metallic plate ABCD remain in equilibrium then find the mass of plate in gram.

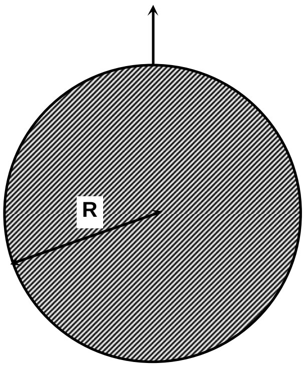


16. A screw gauge is used to measure the thickness of a thin sheet of copper. The pitch of screw gauge is 0.2 mm and total number of division on circular scale is 200. When two jaws are brought in contact then 160th division of circular scale is exactly coincide with the main scale line, and that the zero of main scale is barely visible. When thickness of sheet is measured with screw gauge then main scale reading is 0.6 mm and 100th division coincide with the main scale line. Find the thickness of copper sheet in mm.

17. A dense liquid is completely filled in a closed large container and kept at rest on a horizontal surface. A steel ball is moving downward with a constant speed of 0.5 cm/sec. Find the momentum of dense liquid in C.G.S unit, if its density is 3 gm/cm^3. Given that volume is steel ball of 1.5 cm^3.



18. A small body of mass ‘m’ is projected from the surface of a given planet as shown in the figure. If small body has velocity which is just sufficient to get out from the gravity of planet then time taken by small body to reach at height of 3R from the surface of planet is $K\sqrt{\frac{2R^3}{GM}}$. Find the value of K.



Planet of mass M and radius R

Chemistry

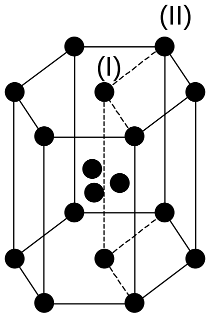
PART – II

SECTION – A

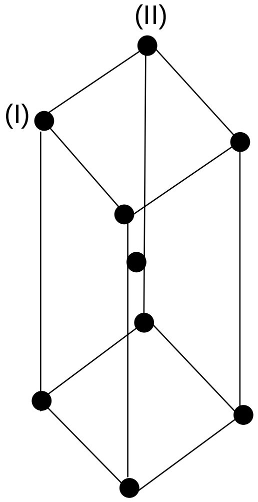
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Consider a hexagonal unit cell as shown in figure (A). It can be considered to consist of three identical unit cells with a rhombus base as shown in figure (B).



(A)



(B)

Now, identify the correct statement(s) regarding (B):

(A) contribution of lattice point (I) per unit cell is $\frac{1}{6}$.

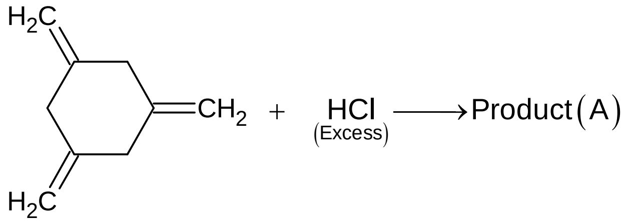
(B) contribution of lattice point (I) per unit cell is $\frac{1}{3}$.

(C) contribution of lattice point (II) per unit cell is $\frac{1}{12}$.

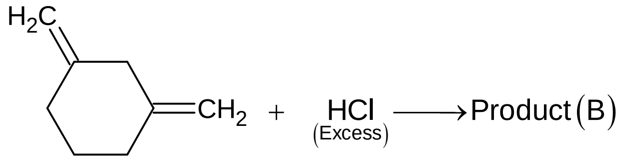
(D) contribution of lattice point (II) per unit cell is $\frac{1}{4}$.

20. Identify the correct statement(s) about the product "A and B" formed in the following reactions: (Assume carbocations do not rearrange)

(i)



(ii)

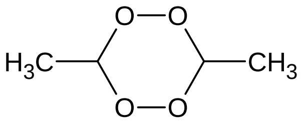


(A) In reaction (i), two geometrical isomers of (A) are possible.
(B) In reaction (i), two optical isomers of (A) are possible.
(C) In reaction (ii), two geometrical isomers of (B) are possible.
(D) In reaction (ii), three stereoisomers of (B) are possible.

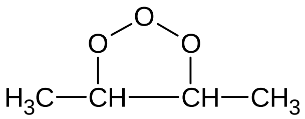
21. Hoope's process of purification of aluminium involves formation of layers during electrolysis. It involves:
(A) The 3 layers have same densities but different materials.
(B) The 3 layers have different densities.
(C) The upper layer is of pure aluminium which acts as cathode.
(D) The bottom layer is of impure aluminium which acts as an anode and middle layer consist of cryolite and fluorspar.

22. Suppose your weight is 80 kg and you want to fly in the sky with the help of balloons each containing 50 moles of H_2 gas at 0.5 atm and 27^oC. How many balloons do you need to attach with yourself to fly. Given density of air = 1.25 g/L and it remains constant throughout (Neglect the weight of balloon).
(A) 25
(B) 27
(C) 30
(D) 20

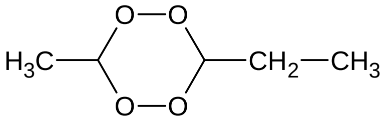
23. Identify the correct statement(s) regarding the reductive ozonolysis of 2-pentene.
(A) A maximum of 10 ozonides can be formed.
(B) One of the intermediate that can be formed is



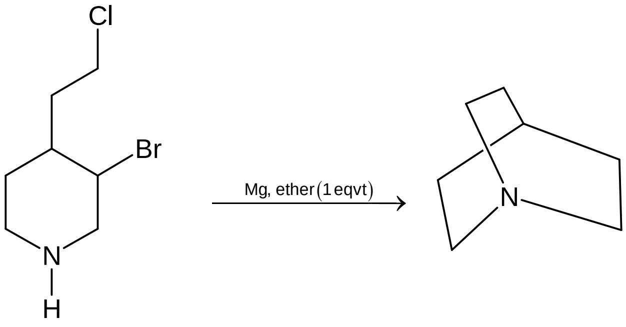
(C) One of the intermediate that can be formed is



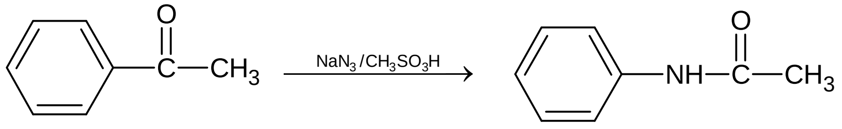
(D) One of the intermediate that can be formed is



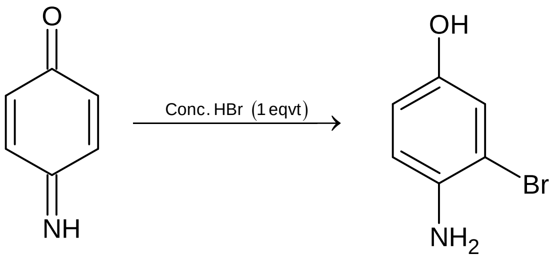
24. Identify the reaction(s) with correct major product?
(A)



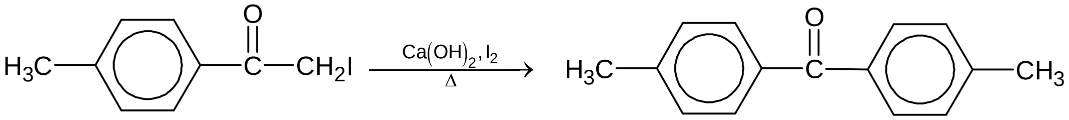
(B)



(C)



(D)



(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

---

25. Match the polymers in List-I with their characteristic in List-II and choose the correct option from the codes given below:

List-I		**List-II**	
(P)	Bakelite	(1)	Natural polymer
(Q)	Natural rubber	(2)	Addition polymer
(R)	Buna-N	(3)	Linear polymer
(S)	Cellulose	(4)	Co-polymer
		(5)	Thermosetting plastic

Codes:

(A) P → 4, 5; Q → 1, 2, 3; R → 2, 3, 4; S → 1, 3
(B) P → 1, 2, 3; Q → 4,5; R → 2, 3, 4; S → 1, 3
(C) P → 4, 5; Q → 2, 3, 4; R → 1, 2, 3; S → 2, 4
(D) P → 1, 4; Q → 1, 2; R → 2, 3, S → 3, 4

26. Match the solids in List-I with their corresponding characteristics in List-II and choose the correct option from the codes given below: (where 'a' is the edge length of unit cell)

List-I		**List-II**	
(P)	NaCl type solid	(1)	Distance of an atom/ion from 6th nearest neighbour is 1.22a
(Q)	CsCl type solid	(2)	Distance of an atom or ion from 4th nearest neighbour is 1.65a
(R)	FCC type of metallic solid	(3)	4th nearest neighbour of an atom or ion is 24
(S)	BCC type of metallic solid	(4)	6th nearest neighbour of an atom or ion is 24
		(5)	2nd nearest neighbours of an atom or ion are 6
		(6)	3rd nearest distance between the neighbour is 1.22a

Codes:

(A) P → 1, 4, 5, Q → 2, 3, 4; R → 5, 6; S → 2, 3, 5
(B) P → 4, 5; Q → 2, 3; R → 4, 6; S → 2, 4, 5
(C) P → 1, 4; Q → 2, 3, 5; R → 5, 6; S → 2, 3, 5
(D) P → 1, 4; Q → 2, 3, 5; R → 4, 5; S → 2, 3, 5

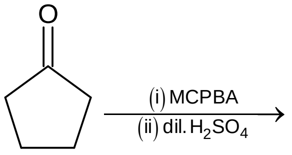
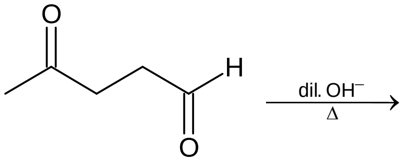
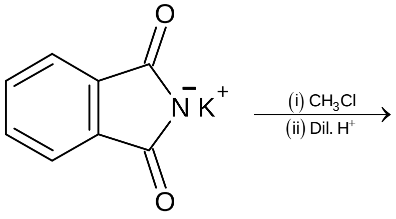
27. Match the inequality given in List-I with corresponding property in List-II and choose the correct option from the codes given below:

List-I		List-II	
(P)	C > N	(1)	Order of first electron affinity
(Q)	O > F	(2)	Order of first ionisation energy
(R)	Mg > Na	(3)	Order of atomic radii
(S)	F > Cl	(4)	Order of second ionisation energy
		(5)	Order of number of valence electrons

Codes:

(A) P → 2, 3; Q → 3; R → 2, 5; S → 4
(B) P → 1; Q → 3; R → 4; S → 5
(C) P → 1, 3; Q → 3, 4; R → 2, 5; S → 2, 4
(D) P → 1, 3; Q → 3, 4; R → 4; S → 1, 4

28. Match the reaction product(s) in List-I with corresponding test which they give positively in List-II and choose the correct option from the codes given below:

List-I		List-II	
(P)	 (where MCPBA is m-chloroperoxy benzoic acid)	(1)	Carbylamine test
(Q)		(2)	$NaHCO_3$ test
(R)		(3)	Product with Hinsberg's reagent is insoluble in aq. KOH solution
(S)	$CH_3NC \xrightarrow{Na/C_2H_5OH}$	(4)	Bromine water test
		(5)	Gives ceric ammonium nitrate test
		(6)	Gives a yellow liquid with CS_2 which do not give a black colour with $HgCl_2$.

Codes:

(A) P → 2, 5; Q → 4; R → 1, 2; S → 3, 6
(B) P → 1, 5; Q → 2, 4; R → 1, 2; S → 3, 6
(C) P → 2, 5; Q → 4; R → 1, 2; S → 2, 6
(D) P → 1, 4; Q → 2, 5; R → 1, 3; S → 3, 6

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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29. If volume occupied by CO_2 molecules is negligible and 'P' is the pressure exerted by one mole of CO_2 gas at 300 K, then find the value of $\frac{P}{16}$ in atm.
(R = 0.08 ℓ atm mol^{-1} K^{-1}, a = 3.6 atm ℓ^2 mol^{-2})

30. If the wave function $'\psi'$ is studied in one dimension that is along X-axis only then $'\psi'$ can be written as $\psi_{(x)} = A\sin\left(\frac{2\pi x}{\lambda}\right)$, here 'A' and '$\lambda$' are constants. If the following equation can be written as Schrodinger's wave equation for the above mentioned wave function (ψ):
$\frac{d^n\psi_{(x)}}{dx^n} - \frac{m\pi^p}{\lambda^q}\psi_{(x)} = 0,$ where n, m, p and q are some constants. (Where n cannot have its value greater than 2). Find the value of $\frac{n+m+p+q}{m+4p}$

31. Sum of the spin only magnetic moment (in the units of B.M.) of the following complexes:
$\left[Cu\left(NH_3\right)_4\right]^{2+}; \left[Fe\left(CN\right)_6\right]^{3-}; [NiCl_4]^{2-}; [CoF_6]^{3-}; \left[Fe\left(H_2O\right)_5\left(NO\right)\right]SO_4$
[Given $\sqrt{2} = 1.41, \sqrt{3} = 1.73; \sqrt{5} = 2.24; \sqrt{7} = 2.64; \sqrt{15} = 3.87; \sqrt{24} = 4.90$

32. Let's assume some statements:
    (i) The rate constants of two parallel reactions are 10^{-2} sec^{-1} and 3 × 10^{-2} sec^{-1}. If their respective activation energy (Ea) values are 15 and 25 kJ mol^{-1}, then let the Ea of the overall reaction be 'x' kJ mol^{-1}.

    (ii) Rate constant of a first order reaction is 0.0693 min^{-1}. If initial concentration of the reactant is 20 M, then in y minutes, its concentration is reduced to 2.5 M.

    (iii) Half-lives of a first order and zero order reactions are same. Assuming initial concentration to be same in both. Let 'z' times of 0.693 be the ratio of their initial rates (initial rate of 1st order to that of zero order).
    Now, calculate the value of (x + y + z).

33. Both gold and silver are extracted by cyanide process. Gold in nature is frequently alloyed with silver, which is also oxidized by aerated NaCN solution, similar to gold. 500 L of a solution of 0.002 M $[Au(CN)]^-$ and 0.003 M $[Ag(CN)_2]^-$ was evaporated to half of the original volume and treated with 78 g zinc (atomic mass = 65).
Assume that elevation from standard conditions is unimportant and that the redox reactions go to completion. Given:

$$\left[Zn\left(CN\right)_4\right]^{2-} + 2e^- \longrightarrow Zn(s) + 4CN^-; \qquad E^o = -1.26\ V$$

$$\left[Au\left(CN\right)_2\right]^{-} + e^- \longrightarrow Au(s) + 2CN^-; \qquad E^o = -0.60\ V$$

$$\left[Ag(CN)_2\right]^- + e^- \longrightarrow Ag(s) + 2CN^-; \qquad E^o = -0.31\ V$$

If the concentration of $[Au(CN)_2]^-$ in the solution after addition of zinc in it, be x mole l^{-1}, and let, the concentration of cyanide ion solution to keep 90% mole of the gold in solution in the form of cyanide complex be 'y' mol/litre? (Given: formation constant K_f of $[Au(CN)_2]^- = 4 \times 10^{28}$)

So, if $\frac{x}{y} = A \times 10^{-11}$, then find the value of 'A':

34. Pure oxygen is manufactured by the following sequential reactions, where MnO_2 is acting as a catalyst. The yield in each step of reaction is 50%.
(i) $MnO_2(s) + 2KClO_3(s) \longrightarrow K_2MnO_4(s) + Cl_2(g) + 2O_2(g)$;
(ii) $K_2MnO_4(s) + Cl_2(g) \longrightarrow 2KCl(s) + MnO_2(s) + O_2(g)$;
How much mass of $KClO_3$ in gms is required to liberate 60 g of O_2 gas at STP?
(Atomic mass : K = 39, Cl = 35.5, O = 16)

35. A 0.001 molal solution of $Pt(NH_3)_4Cl_4$ in water had a freezing point depression of 0.00558^oC. If 'x' be the number of moles of ionisable Cl^- ions per mole of the complex, then find the value of $\frac{2x}{5}$. (Given : K_f of water = 1.86 K kg $mol^{-1,}$ and complex is assumed to be 100% ionized).

36. If the total number of geometrical isomers formed by the square planar complex $[M_{abcd}]$ are 'x', the total number of geometrical isomers formed by the complex $[M_{abcdef}]$ are 'y' and the total number of isomers of $K_4[Fe(CN)_6]$ are 'z', then find the value of $\left(\frac{xy}{z}\right)$

Mathematics PART – III

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. A and B are two n × n matrices such that det(A) ≠ 0, A + B = $(AB)^2$ and BAB = A + I. Choose the **correct** option(s).
(A) $A^{-1} = (A^4 - I)$
(B) $B^5 - A^5 = A + B$
(C) $A^9 = A^4 + A + I$
(D) $A^2B^2 = BA^2B$

38. Let f(x) be a differentiable function such that f′(x) > 0, $\int_0^1 f(x)dx = 2$, $\int_0^1 |f(x)|dx = 4$. Choose the **correct** option(s).
(A) f(x) = 0 has exactly one root in (0, 1).
(B) f(x) = 0 has no root in (0, 1).
(C) $\int_0^1 f(x).\left(\int_0^x |f(t)|dt\right)dx = 1$
(D) $\int_0^1 f(x).\left(\int_0^x |f(t)|dt\right)dx = 7$

39. Points A and B lie on the auxiliary circle of ellipse $\frac{x^2}{4} + y^2 = 1$. P and Q are the corresponding points on the ellipse for the points A and B respectively (O is the origin). Choose the **correct** option(s).
(A) The maximum value of angle AOP is $\tan^{-1} 2\sqrt{2}$.
(B) The maximum value of angle AOP is $\tan^{-1} \frac{1}{2\sqrt{2}}$.
(C) If OA ⊥ OB and Q′ is reflection of Q in origin, then minimum value of angle POQ′ is $\tan^{-1}\frac{4}{3}$.
(D) If OA ⊥ OB and Q′ is reflection of Q in origin, then minimum value of angle POQ′ is $\tan^{-1}\left(\frac{3}{4}\right)$.

40. From the set of n number {1, 3, 5, ..., 2n–1} five consecutive numbers are removed and the mean of remaining numbers is $\frac{393}{5}$. Choose the **correct** option(s).
(A) The value of n is 80.
(B) The value of n is 75.
(C) The mean of removed number is 101.
(D) The mean of removed number is 99.

41. If $\lim\limits_{x\to 0}\dfrac{\sqrt{1+x^2}\tan\sin\tan^{-1}x+2\sqrt{1-x^2}\sin\tan\sin^{-1}x-3x}{x^p}$ exists finitely, then choose the **correct** option(s).
(A) The value of p is 3
(B) The value of p is 5
(C) The value of limit is $\dfrac{-31}{60}$
(D) The value of limit is $\dfrac{-8}{15}$

42. A is 3 × 3 matrix whose every entry is 1 or –1. Choose the **correct** option(s).
(A) The maximum value of determinant of A is 4.
(B) Total number of different values of determinant of A can take is 3.
(C) Total number of different values of determinant of A can take is 5.
(D) Total number of different matrices A, such that determinant of A is positive, is 96.

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

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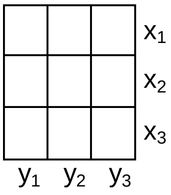
43. Let A and B are points on the line L_1, L_2 respectively such that d = OA + OB + AB is minimum (O being the origin), match the following List-I with List-II

	LIST - I		**LIST - II**
P.	$L_1: x-1=y-1=\dfrac{z+1}{0}$, $L_2: x+2=4-y=\dfrac{z+1}{0}$	1.	$d=4\sqrt{2}$
Q.	$L_1: \dfrac{x-1}{2}=1-y=1-z$, $L_2: x-2=y-2=\dfrac{2-z}{2}$	2.	$d=2\sqrt{3}$
R.	$L_1: x=y=z-\sqrt{2}$, $L_2: x=y=z+\sqrt{2}$	3.	$d=6\sqrt{2}$
S.	$L_1: 2x-3=6-y=\dfrac{z}{0}$, $L_2: x+3=2y=\dfrac{z}{0}$	4.	$d=4\sqrt{3}$

The correct option is:
(A) P → 1; Q → 4; R → 2; S → 3
(B) P → 2; Q → 4; R → 1; S → 3
(C) P → 2; Q → 4; R → 3; S → 1
(D) P → 4; Q → 1; R → 2; S → 3

44. Let every cell of adjoining 3 × 3 array is filled by natural number such that $x_1x_2x_3 = y_1y_2y_3 = 2^3 3^4 5^7$ where x_i, y_j are product of numbers filled in three cells of i^{th} row and j^{th} column respectively i, j ∈ {1, 2, 3}, match the following List-I with List-II



	LIST – I **(Condition on x_i, y_i)**		**LIST – II** **(Number of filling the array)**
P.	If x_i as well as y_j are divisible by 2 for every i, j ∈ {1, 2, 3}	1.	$3\cdot{}^{11}C_3({}^{9}C_2\cdot{}^{9}C_5+{}^{12}C_5\cdot{}^{6}C_2-2\cdot{}^{9}C_2\cdot{}^{6}C_2)$

Q.	If none of y_i (i = 1, 2, 3) is divisible by 27	2.	$(3! \cdot {}^{12}C_4 \cdot {}^{15}C_8)$
R.	If none of x_i (i = 1, 2, 3) is divisible by 15	3.	$2{\cdot}3^5{\cdot}{}^{11}C_3 \cdot {}^{15}C_7$
S.	If exactly two cells are assigned the value 1 and all other cells have number divisible by 5	4.	$({}^9C_6 \cdot {}^{10}C_6){}^9C_2$

The correct option is:
(A) P → 2; Q → 1; R → 3; S → 4
(B) P → 4; Q → 3; R → 1; S → 2
(C) P → 3; Q → 1; R → 4; S → 2
(D) P → 2; Q → 3; R → 1; S → 4

45. The equation $x^2 - a = \sqrt{x+a}$ has real or imaginary roots depending on values of a. List-I represents the nature of root and List-II represents the corresponding exhaustive values of a, match the following List-I with List-II

LIST–I		LIST–II	
P.	No real root	1.	$(0,1) \cup \left\{-\frac{1}{4}\right\}$
Q.	One real root	2.	$\left(-\infty, -\frac{1}{4}\right)$
R.	Exactly two real roots	3.	$\left(-\frac{1}{4}, 0\right] \cup [1, \infty)$
S.	Atleast two real roots	4.	$\left(0, \frac{3}{4}\right) \cup \left\{-\frac{1}{4}\right\}$
		5.	$\left(-\frac{1}{4}, 0\right] \cup \left[\frac{3}{4}, \infty\right)$

The correct option is:
(A) P → 2; Q → 1; R → 3; S → 3
(B) P → 2; Q → 1; R → 5; S → 4
(C) P → 1; Q → 4; R → 5; S → 5
(D) P → 2; Q → 4; R → 5; S → 5

46. For a given n sided regular polygon, its r vertices are chosen randomly. In List-I: the value of n and r as well as event E is defined. In List-II: P(E), probability of event (E), is given. Match the following List-I with List-II

LIST–I		LIST–II	
P.	n = 10; r = 3, circumcentre lies on the side of triangle itself	1.	P(E) = 1
Q.	n = 9; r = 3, orthocentre of triangle so formed lies inside it	2.	$P(E) = \frac{5}{14}$
R.	n = 10; r = 4, quadrilateral thus formed is regular	3.	P(E) = 0
S.	n = 9; r = 4, out of four selected points, feet of perpendiculars from one of the point to sides of triangle formed by remaining three points is collinear	4.	$P(E) = \frac{1}{3}$

The correct option is:
(A) P → 4; Q → 2; R → 3; S → 1
(B) P → 2; Q → 4; R → 3; S → 3
(C) P → 4; Q → 2; R → 3; S → 3
(D) P → 2; Q → 4; R → 1; S → 3

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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47. Given that $\begin{vmatrix} a & d & 1 \\ b & e & 1 \\ c & f & 1 \end{vmatrix} = -5$, $\begin{vmatrix} a & b & c \\ 1 & 2 & 3 \\ d & e & f \end{vmatrix} = -3$ find the value of $\begin{vmatrix} c & 3 & f \\ b & 1 & e \\ a & -1 & d \end{vmatrix}$.

48. Let $a_{n+1} \cdot a_n = a_n + 2a_{n+1}$, $n \in \mathbf{N}$. For $a_1 = a$ $(a \neq 0)$, sequence is periodic and when $a_1 = b$, a_n is undefined for every n such that $n \geq m$, $m \in \mathbf{N}$. Let maximum value of b is c and minimum value of b is d and $e = \lim\limits_{n \to \infty} a_n$ (for the case when sequence is non-periodic and defined for all values of $n \in N$). Find the value of (a + c + d + e).

49. $f(x) = x^6 - 2x^3 - 8$ and $g(x) = x^2 + 2x + 4$. Let $\alpha_1, \alpha_2, \ldots, \alpha_6$ are the roots of equation f(x) = 0, find $g(\alpha_1) \cdot g(\alpha_2) \ldots g(\alpha_6)$.

50. Find the remainder when $\sum\limits_{r=0}^{2014} \sum\limits_{k=0}^{r} (-1)^k (k+1)(k+2)\ {}^{2019}C_{r-k}$ is divided by 64.

51. The curve f(x, y) = 0 passing through (0, 2) satisfy the differential equation $\frac{dy}{dx} = \frac{y^3}{e^x + y^2}$. If the line x = ln 5 intersect it at points $y = \alpha$ and $y = \beta$, then find the value of $\alpha^2 + \beta^2 + \alpha\beta$.

52. P is a point on parabola $y^2 = 4x$ such that PS = 4 (S is the focus). Tangent is drawn at P to parabola which intersects tangent at vertex at T. A point R is taken on axis of parabola such that SR = 4 and R lies inside the parabola. The area of quadrilateral PRST is q. Find the value of $\sqrt{3}\,q$.

53. Find the maximum value of $\int\limits_0^y \sqrt{x^4 + (y(3-y))^2}\,dx$, where $0 \leq y \leq 3$.

54. In a triangle ABC given that a = 7, b = 3, c = 5. The value of

$$\frac{ab}{\left(\tan\frac{B}{2} + \tan\frac{C}{2}\right)\left(\tan\frac{A}{2} + \tan\frac{C}{2}\right)} + \frac{bc}{\left(\tan\frac{A}{2} + \tan\frac{C}{2}\right)\left(\tan\frac{A}{2} + \tan\frac{B}{2}\right)} + \frac{ac}{\left(\tan\frac{B}{2} + \tan\frac{C}{2}\right)\left(\tan\frac{A}{2} + \tan\frac{B}{2}\right)}$$

is _____

FIITJEE

ALL INDIA TEST SERIES

OPEN TEST

JEE (Advanced)-2019

PAPER – 2

TEST DATE: 03-02-2019

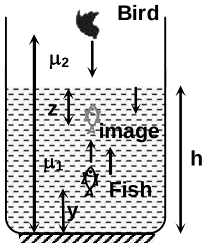
ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. B, D

Sol. Distance of image of fish as seen by bird only after refraction is



$$Z = (x-h) + (h-y)\frac{\mu_2}{\mu_1}$$

$$Z = (x-h) + (h-y)\frac{1}{4/3}$$

Differentiate w.r.t. time

$$\frac{dZ}{dt} = (-6+2) + (-2-4)\frac{3}{4} = -\frac{17}{2}\text{ cm/sec}$$

Similarly we can calculate for 2nd case.

2. C, D

Sol. Collision takes place in ideal gases are elastic hence total kinetic energy will be conserved.

3. A, C, D

Sol. $T = \frac{2u\sin\theta}{g} = 2\sin 15°$

Horizontal component of velocity will reverse in each collision.

$$R = \frac{u^2\sin 2\theta}{g} = 5\text{ m}$$

4. A, C

Sol. In time interval (0 to 3) sec, $S = ut + \frac{1}{2}at^2$ = 30 m

$$\vec{v}_{average} = \frac{30}{3} = 10 \text{ m/s}$$

In time interval (0 to 6) sec

$$v = u + at = 40 \text{ m/s}$$

$$\left|\vec{a}_{average}\right| = \frac{\left|\vec{v}_f - \vec{v}_i\right|}{t} = \frac{(5\pi + 40) + 5\pi}{6} = \frac{5\pi + 20}{3} \text{ m/s}^2$$

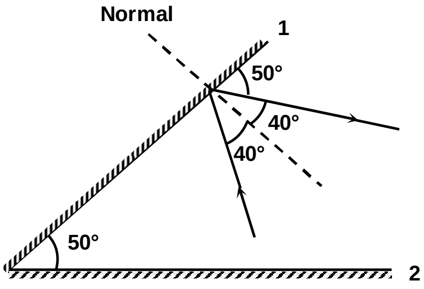
5. A, C

Sol. Deviation

$\delta_1 = \pi - 2\theta$ (Clockwise)

$\delta_2 = \pi - 2(50 + \theta)$ (Anti-clockwise)

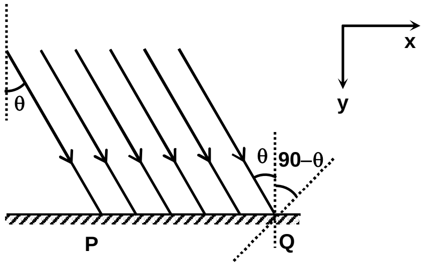
$\delta = \delta_1 - \delta_2$



6. A

Sol. Ball moves very slowly hence it is in equilibrium at each instant.

7. D



Sol. Intensity is given by $I = \dfrac{N\left(\dfrac{hC}{\lambda}\right)}{(A\cos\theta)\Delta t}$, where

N → total number of photons and λ → wavelength of photons

(A) $F_x = \dfrac{\Delta P_x}{\Delta t} = \dfrac{IA\cos\theta \cdot \sin\theta}{C}$

$$F_y = \frac{\Delta P_y}{\Delta t} = \frac{IA\cos\theta\cos\theta}{C}$$

$$p_r = \frac{F_y}{A} = \frac{I\cos^2\theta}{C}$$

(B) $F_x = 0$

$$F_y = \frac{2IA\cos^2\theta}{C}$$

$$p_r = \frac{2I\cos^2\theta}{C}$$

(C) and (D)

$$F_x = \frac{IA\cos\theta\sin\theta}{C}(1 - r)$$

$$F_y = \frac{IA\cos^2\theta}{C}(1 + r)$$

$$p_r = \frac{I\cos^2\theta}{C}(1 + r)$$

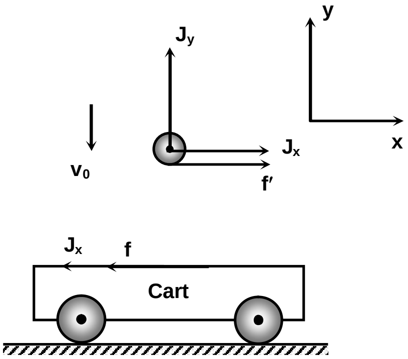
8. C

Sol. Circuit can be solved by using Phasor diagram.

9. A

Sol. By using concept of motional emf induced in the circuit.

10. A



Sol. $\Rightarrow$ $v_0 = \sqrt{2gh} = 5$ m/s …(i)

$\Rightarrow$ $J_y = \Delta P_y = 2 \times 80 \times 5 = 800$ N-s …(ii)

$\Rightarrow$ $J_x = \Delta P_x$

$\mu J_y = mv_x$

$v_x = 1$ m/s …(iii)

$\Rightarrow$ $Mv_C = J_x$

$v_C = 0.4$ m/s …(iv)

$\Rightarrow$ $t_0 = \frac{2 \times 5}{10} = 1$ sec …(v)

$\Rightarrow$ $L_{min} = 2(1 + 0.4)\ \ 1 = 2.8$ m …(vi)

$\Rightarrow$ At the time of second collision

$R\omega' - 1 = 0.4$

$\omega' = 7$ rad/s …(vii)

$\Rightarrow$ $\vec{J}' = \Delta\vec{L}$

$-J_xR = I(\omega' - \omega_0)$

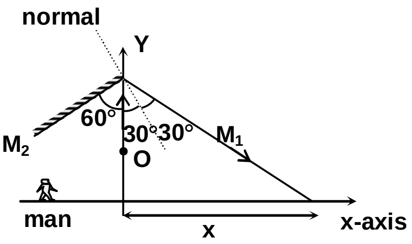
$\omega_0 = 19.5$ rad/sec …(viii)

$\Rightarrow$ $W_{m\to M} = \frac{1}{2}Mv_C^2 = 16J$ …(ix)

$\Rightarrow$ $W_{M\to m} = \frac{1}{2}I(\omega')^2 + \frac{1}{2}mv_x^2 - \frac{1}{2}I\omega_0^2 = -172$ J

SECTION – D

11. 00006.92



Sol. $\tan 60° = \frac{x}{2}$

$x = 2\sqrt{3}$ m

Hence total length = $4\sqrt{3}$ m.

12. 00035.20

Sol. To reach at 'B' it should crosses the point 'A'. Now from work energy theorem

$W = \Delta K$

$W_g + W_f = K_f - K_i$

$-mg(4H) - (0.4)mgH = 0 - k_i$

$K_i = 44$ mH = 35.20

13. 00002.40

Sol. $\vec{L} = I_{cm}\vec{\omega} + (\vec{r} \times \vec{p}_{cm})$

$\left|\vec{L}\right| = \frac{m(2R)^2}{2}\omega_0 + R(2m)(R\omega_0)$

$\left|\vec{L}\right| = 4mR^2\omega_0 = 2.40$

14. 00016.64

Sol. $d\sin\theta \pm (\mu-1)t = \Delta x$

$$d\left(\frac{3\lambda}{2d}\right) \pm \frac{3\lambda}{2} = \Delta x$$

$\Delta x = 3\lambda$

Hence maximum intensity will occur at 'O'.

$I = 4I_0 = 16.64$ W/m^2

15. 00002.67

Sol. $(Mg) \times 1 = \frac{2E_0}{tc} \times 2$

$$M = \frac{2\times 20\times 2}{10\times 0.01\times 10^{-3}\times 3\times 10^{8}} = \frac{8}{3}\times 10^{-3}\text{kg}$$

16. 00000.74

Sol. pitch = 0.2 mm

Total division = 200

Least count = 0.001 mm

–ve zero error = 40 × L.C. = 0.04 mm

Reading = 0.6 mm + 100 × L.C. = 0.7 mm

Thickness = 0.7 mm + 0.04 mm = 0.74 mm

17. 00002.25

Sol. In time dt shift in centre of mass of system (ball + liquid)

$$dS_{CM} = \frac{m_1 ds_1 + m_2 ds_2}{M} = \frac{(\rho_b V)vdt - (\rho_\ell V)vdt}{M} \quad \text{...(i)}$$

$$\text{Momentum of system} = M.\frac{dS_{cm}}{dt} \quad \text{...(ii)}$$

$= (\rho_b V)\, v - (V\, \rho_\ell)\, v$

Therefore momentum of liquid = $(V\, \rho_\ell)v$

= 2.25 gm/cm^3.

18. 00002.33

Sol. Speed of projection $(v_0) = \sqrt{\frac{2GM}{R}}$ ...(1)

$$\frac{1}{2}mv^2 - \frac{GMm}{R} = \frac{1}{2}mv^2 - \frac{GMm}{r} \quad \text{...(2)}$$

$$v = \sqrt{\frac{2GM}{r}}$$

$$\int_R^{4R} \sqrt{r}\,dr = \sqrt{2GM}\int_0^t dt$$

$$t = \frac{7}{3}\sqrt{\frac{2R^3}{GM}}.$$

Chemistry

PART – II

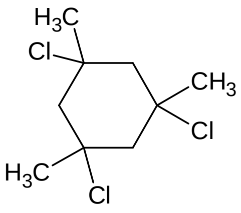
SECTION – A

19. A, C

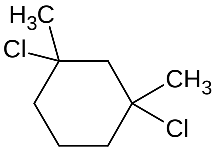
Sol. Main hexagonal unit cell (figure A) consists of three identical smaller unit cells (B).

20. A, C, D

Sol.


H$_3$C
Cl
CH$_3$
Cl
H$_3$C
Cl

(A)


H$_3$C
Cl
CH$_3$
Cl

(B)

21. B, C, D

22. B, C

Sol. Weight of pay load = 80 × 10^3 g

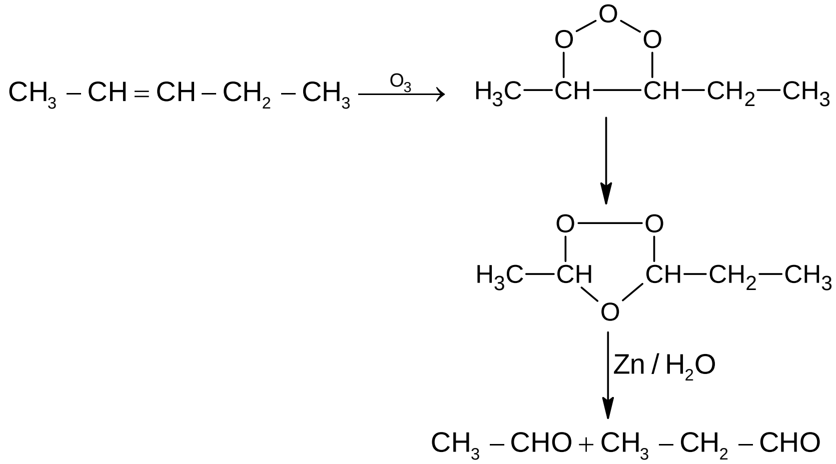
Let, the number of balloons required be x.

$$80\times10^{3}+0+100x=\frac{nRT}{P}x\times1.25$$

x = 26.8

23. A, B, D

Sol.



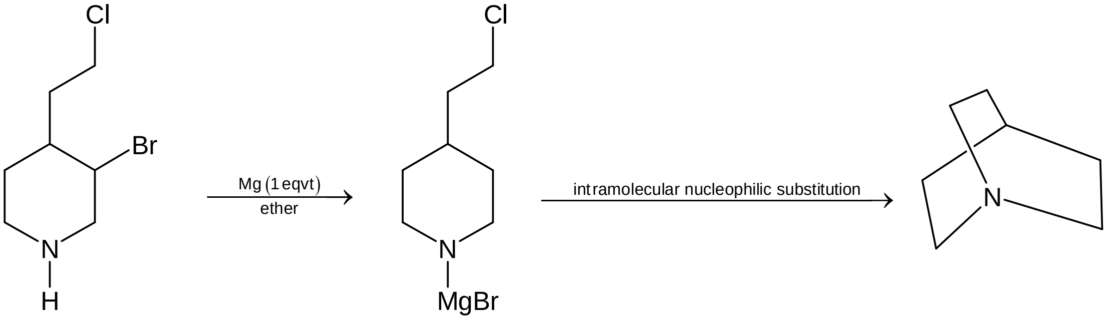
$$CH_3-CH=CH-CH_2-CH_3\xrightarrow{O_3}$$

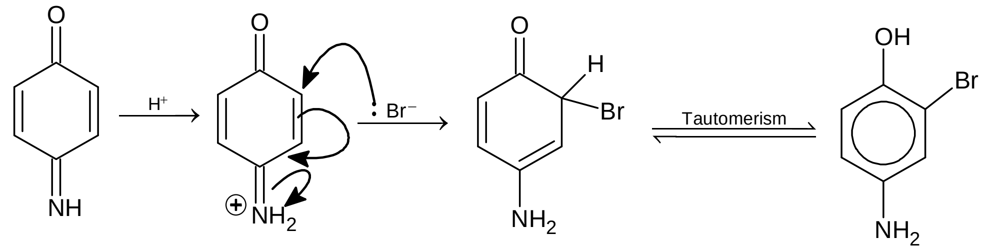
O
O
O
H$_3$C—CH——CH—CH$_2$—CH$_3$
O
O
H$_3$C—CH
CH—CH$_2$—CH$_3$
O
Zn / H$_2$O

$$CH_3-CHO+CH_3-CH_2-CHO$$

24. A, B, D

Sol.


Cl
Br
N
H
Mg (1 eqvt)
ether
Cl
N
MgBr
intramolecular nucleophilic substitution
N


O
NH
H+
O
⊕NH2
Br−
O
H
Br
NH2
Tautomerism
OH
Br
NH2

25. A

26. C

Sol.

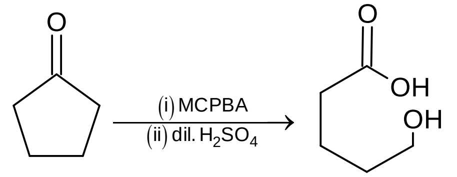
	NaCl type solid	CsCl type solid
1st nearest distance	$\frac{a}{2}$	$\frac{\sqrt{3}a}{2}$
2nd nearest distance	$\frac{a}{\sqrt{2}}$	a
3rd nearest distance	$\frac{\sqrt{3}a}{2}$	$\sqrt{2}a$
4th nearest distance	a	$\frac{\sqrt{11}a}{2}$
5th nearest distance	$\frac{\sqrt{5}a}{2}$	$\sqrt{3}a$
6th nearest distance	$\frac{\sqrt{3}a}{\sqrt{2}}$	2a

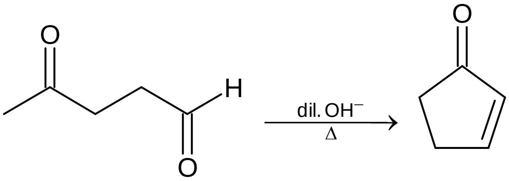
27. C

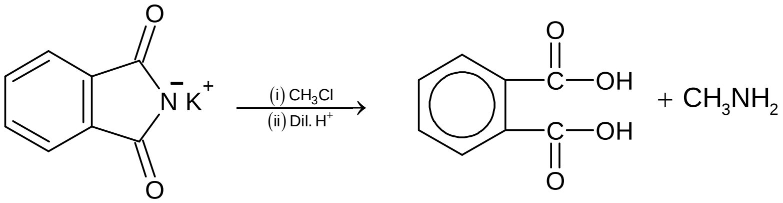
Sol. General property trends.

28. A

Sol.


O
(i) MCPBA
(ii) dil. H2SO4
O
OH
OH


O
H
O
dil. OH−
Δ
O


O
N̄ K+
O
(i) CH3Cl
(ii) Dil. H+
O
C—OH
C—OH
O
+ CH3NH2

$CH_3NC \xrightarrow{Na/C_2H_5OH} CH_3-NH-CH_3$

SECTION – D

29. 00002.50

Sol. $\left(P+\frac{n^2a}{V^2}\right)\left(V-nb\right)=nRT$

n = 1

$\left(P+\frac{a}{V^2}\right)\left(V-b\right)=RT$

If ‘b’ is negligible, then

$\left(P+\frac{a}{V^2}\right)V=RT$, $P=\frac{RT}{V}-\frac{a}{V^2}$

The equation is quadratic in ‘V’, thus

$$V=\frac{+RT\pm\sqrt{R^2T^2-4aP}}{2P}$$

‘V’ has one value at a given P and T, thus numerical value of discriminant = 0

So, $R^2T^2=4aP$

$$P=\frac{R^2T^2}{4a}=\frac{\left(0.08\right)^2\times\left(300\right)^2}{4\times3.6}=40$$

30. 00000.50

Sol. $\psi_{(x)}=A\sin\left(\frac{2\pi x}{\lambda}\right)$

$$\frac{d\psi_{(x)}}{dx}=\frac{2\pi}{\lambda}A\cos\left(\frac{2\pi x}{\lambda}\right)$$

$$\frac{d^2\psi_{(x)}}{dx^2}=-\left(\frac{2\pi}{\lambda}\right)^2A\sin\left(\frac{2\pi x}{\lambda}\right)$$ So, n = 2, m = -4, p = 2, q = 2

$$\frac{d^2\psi_{(x)}}{dx^2}=-\frac{4\pi^2\psi_{(x)}}{\lambda^2}$$

31. 00015.05

Sol.

Complex	Magnetic moment
$\left[Cu\left(NH_3\right)_4\right]^{2+}$	$\sqrt{3}=1.73$ B.M.
$\left[Fe\left(CN\right)_6\right]^{3-}$	$\sqrt{3}=1.73$ B.M.
$\left[NiCl_4\right]^{2-}$	$2\sqrt{2}=2.82$ B.M.
$\left[CoF_6\right]^{3-}$	$\sqrt{24}=4.90$ B.M.
$\left[Fe\left(H_2O\right)_5\left(NO\right)\right]SO_4$	$\sqrt{15}=3.87$ B.M.

32. 00054.50

Sol. x = 22.5; y = 30; z = 2

In parallel reactions the activation energy of the overall path is given by

$$\left(Ea\right)_{net}=\frac{k_1Ea_1+k_2Ea_2}{k_1+k_2}$$

33. 00007.50

Sol. $2\left[Au(CN)_2\right]^- + Zn \longrightarrow 2Au + \left[Zn(CN)_4\right]^{2-}$

$E^o = -0.60 - (-1.26) = 0.66\ V$

Since E^0 value for the reduction of complexed Ag^+ ion to Ag is higher than that of complexed Au^+ ion into Au. So, Ag^+ ion will be reduced first.

Moles of Zn added $= \frac{78}{65} = 1.2$

Moles of $[Ag(CN)_2]^-$ = 0.003 × 500 = 1.5
Moles of $[Au(CN)_2]^-$ = 0.002 × 500 = 1.0
Moles of Zn used to reduce 1.5 moles of $[Ag(CN)_2]^-$ = 0.75
Moles of $[Au(CN)_2]^-$ reduced by remaining 0.45 moles of Zn = 0.90
Moles of $[Au(CN)_2]^-$ left in the solution = 0.10

Concentration of $[Au(CN)_2]^-$ left in the solution $= \frac{0.10}{500} = 2\times10^{-4}\ M = x$

Also, $Au^+ + 2CN^- \rightleftharpoons \left[Au(CN)_2\right]^-$, $K_f = 4\times10^{28}$

$$K_f = \frac{\left[Au(CN)_2\right]^-}{\left[Au^+\right]\left[CN^-\right]^2} = \frac{90\left[Au^+\right]}{10\left[Au^+\right]\left[CN^-\right]^2} = 4\times10^{28}$$

$\left[CN^-\right] = 1.5\times10^{-14}\ M = y$

So, $\frac{y}{x} = \frac{1.5\times10^{-14}}{2\times10^{-4}} = 7.50\times10^{-11}$

So, A = 7. 50

34. 00367.50

Sol. Let, the moles of $KClO_3$ required to be 'x'. Assuming 50% yield in each step.

Moles of O_2 formed in step (i) $= \frac{x}{2}$.

Moles of each of K_2MnO_4 and Cl_2 formed in (i) $= \frac{x}{4}$

Moles of O_2 formed in step (ii) = $\frac{x}{8}$

Total moles of O_2 formed $\frac{x}{2} + \frac{x}{8} = \frac{5x}{8}$

$\frac{5x}{8} = \frac{60}{32}$

x = 3

35. 00000.80

Sol. $\Delta T_f = i\times K_f \times m$

0.00558 = i × 1.86 × 0.001 $\therefore i = 3$

$i = 1 + (y-1)\times1 = 3 \quad \therefore y = 3$

So, formula of the complex $\left[Pt(NH_3)_4Cl_2\right]Cl_2$

36. 00004.50

Sol. x = 3, y = 15, z = 10

Mathematics PART – III

SECTION – A

37. A, B, C, D

Sol. $A + B = ABAB = A^2 + A$

$\Rightarrow B = A^2$

$BAB = A^5 = A + I \Rightarrow A(A^4 - I) = I$

$B^5 - A^5 = (A^5)^2 - A^5 = (A + I)^2 - (A + I) = A^2 + A = A + B$

38. A, D

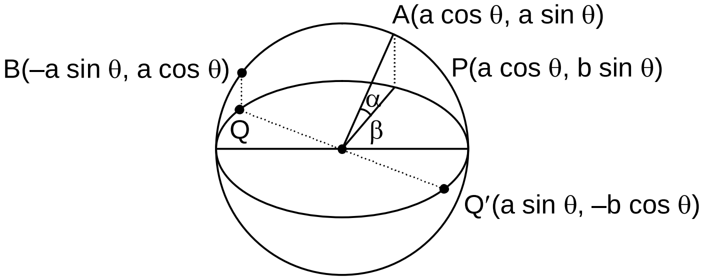
Sol. Let f(a) = 0 and $F(x) = \int_0^x |f(t)|dt$

$F'(x) = -f(x)\ 0 \le x < a$, $F'(x) = f(x)\ a \le x \le 1$

$$\Rightarrow \int_0^1 f(x)\left(\int_0^x |f(t)|dt\right)dx = \frac{(F(1))^2}{2} - (F(a))^2 = \frac{(S_1 + S_2)^2}{2} - (S_2)^2 = 7$$

39. B, C

Sol. $$\tan\alpha = \frac{\tan\theta - \frac{b}{a}\tan\theta}{1 + \frac{b}{a}\tan^2\theta} = \frac{1 - \frac{b}{a}}{\cot\theta + \frac{b}{a}\tan\theta} \le \frac{1 - \frac{b}{a}}{2\sqrt{\frac{b}{a}}} = \frac{a - b}{2\sqrt{ab}}$$



$$\tan\beta = \frac{\frac{b}{a}\tan\theta + \frac{b}{a}\cot\theta}{1 - \frac{b^2}{a^2}} \ge \frac{\frac{2b}{a}}{1 - \frac{b^2}{a^2}} = \left(\frac{2ab}{a^2 - b^2}\right)$$

40. A, C

Sol. $$n^2 - 5(2n - 5) \le \frac{393(n - 5)}{5} \le n^2 - 25$$

$\Rightarrow 73.6 \le n \le 83.6$, n = 80 is only possible value

41. B, C

Sol. $$\lim_{x \to 0} \frac{\sqrt{1 + x^2}\tan\left(\frac{x}{\sqrt{1 + x^2}}\right) + 2\sqrt{1 - x^2}\sin\frac{x}{\sqrt{1 - x^2}} - 3x}{x^p}$$

Using expansion

$$\lim_{x\to 0}\frac{\sqrt{1+x^2}\left(\frac{x}{\sqrt{1+x^2}}+\frac{x^3}{3\left(1+x^2\right)^{\frac{3}{2}}}+\frac{2}{15}\frac{x^5}{\left(1+x^2\right)^{\frac{5}{2}}}.....\right)+2\sqrt{1-x^2}\left(\frac{x}{\sqrt{1-x^2}}-\frac{x^3}{3!\left(1-x^2\right)^{\frac{3}{2}}}+\frac{x^5}{5!\left(1-x^2\right)^{\frac{5}{2}}}.....\right)-3x}{x^p}$$

$$\lim_{x\to 0}\frac{\left(-\frac{2}{3}+\frac{2}{15}\frac{1}{\left(1+x^2\right)^2}+\frac{2}{5!\left(1-x^2\right)^2}\right)x^5}{x^p}$$

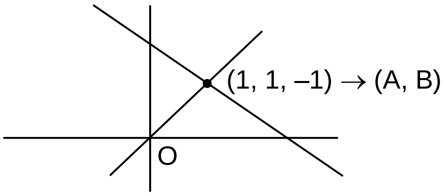
$\Rightarrow$ p = 5 and limit = $-\frac{2}{3}+\frac{2}{15}+\frac{2}{5!}=\frac{-31}{60}$

42. A, B, D

Sol. All the values of |A| = ±4, 0 and determinant is 0 when two rows/columns are proportional

43. B

Sol. (P) $d = 2\sqrt{3}$
(Q) These lines are skew and O lies on shortest distance
(R) Lines are parallel and O lies mid way between them
(S) Lines are coplanar and perpendicular

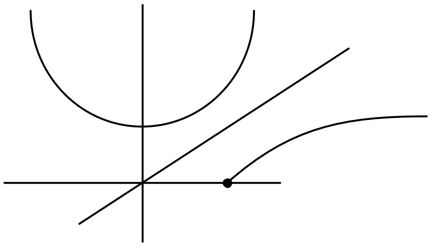


44. D

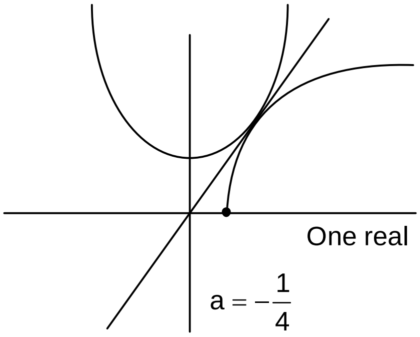
Sol. We can consider 9 cells as 9 different boxes and we have to fill these boxes by 3 identical balls (2 written on them), 4 identical balls (3 written on them) and 7 identical balls (5 written on them) as per given conditions

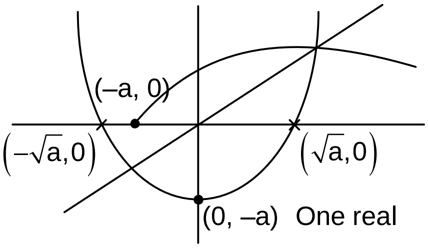
45. A

Sol. (P) $x^2 - a = x$
$x^2 - x - a = 0$
$D < 0$
$1 + 4a < 0$
$a < -\frac{1}{4}$



(Q) $-\sqrt{a} < -a$
$\sqrt{a} > a$
$a > a^2$
$a^2 - a < 0$
$a(a - 1) < 0$
$0 < a < 1$





(R) $x^2 - x - a = 0$

$1 + 4a > 0, -a > 0$

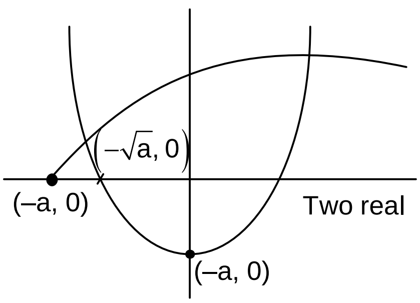
$a > -\frac{1}{4}, a < 0$

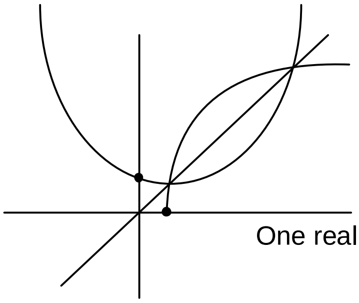
$-\frac{1}{4} < a \le 0$

$-a < -\sqrt{a}$

$a > \sqrt{a}, a^2 > a$

$a(a-1) > 0, a \ge 1$





46. A

Sol. For regular quadrilateral n must be multiple of 4. Perpendiculars dropped from a plane circumcentre to side is always collinear. For one of the side to be diameter $P(E) = \frac{{}^5C_1\,{}^8C_1}{{}^{10}C_3}$ and orthocentre is inside for acute angled triangle $P(E) = 1 - \frac{{}^9C_1\,{}^4C_2}{{}^9C_3} = \frac{5}{14}$

SECTION – D

47. 00021.00

Sol. $\begin{vmatrix} a & d & 1 \\ b & e & 1 \\ c & f & 1 \end{vmatrix} = -5 \begin{vmatrix} a & d & 1 \\ b & e & 2 \\ c & f & 3 \end{vmatrix} = 3$

$$2\begin{vmatrix} a & d & 1 \\ b & e & 2 \\ c & f & 3 \end{vmatrix} - 3\begin{vmatrix} a & d & 1 \\ b & e & 1 \\ c & f & 1 \end{vmatrix} = 21$$

$$\begin{vmatrix} a & d & -1 \\ b & e & 1 \\ c & f & 3 \end{vmatrix} = 21$$

48. 00009.00

Sol. Take $a_n = \frac{1}{(-2)^n t_n}$, on solving, we get $a_n = \frac{a_1}{a_1\left(\frac{2+(-2)^n}{6}\right) + (-2)^{n-1}}$,

for periodicity $a_1\left(\frac{2+(-2)^n}{6}\right) + (-2)^{n-1} = 1$,

for undefined $a_1\left(\frac{2+(-2)^n}{6}\right) + (-2)^{n-1} = 0$,

$\lim_{n\to\infty} a_n = 0$

49. 01600.00

Sol. $x^6 - 2x^3 - 8 = (x - \alpha_1)(x - \alpha_2) \ldots\ldots (x - \alpha_6)$

$(2\omega)^6 - 2(2\omega)^3 - 8 = (2\omega - \alpha_1)(2\omega - \alpha_1) \ldots\ldots (2\omega - \alpha_6)$

$((2\omega^2)^6 - 2(2\omega^2)^3 - 8) = (2\omega^2 - \alpha_1) \ldots\ldots (2\omega - \alpha_6)$

On multiplying $(40)^2 = g(\alpha_1)g(\alpha_2) \ldots\ldots g(\alpha_6)$

50. 00062.00

Sol. $\sum_{r=0}^{2014}\sum_{k=0}^{r}(-1)^k(k+1)(k+2)\ {}^{2019}C_{r-k} = \sum_{r=0}^{2014} 2\ {}^{2016}C_r = 2^{2017} - 4034$

51. 00061.25

Sol. $\frac{dx}{dy}e^{-x} - \frac{1}{y}e^{-x} = \frac{1}{y^3}$

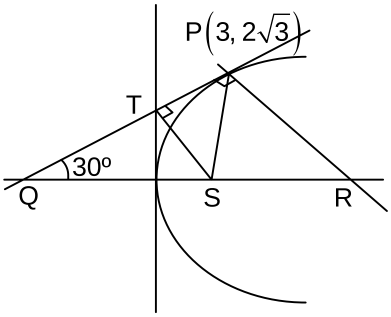
$\frac{d}{dy}\left(e^{-x}y\right) = -\frac{1}{y^2},\ e^{-x}y = \frac{1}{y} + c$

52. 00018.00

Sol. Area PRST = ΔPQR – ΔQST

= $\frac{1}{2}8\times 2\sqrt{3} - \frac{1}{2}\left(\frac{1}{2}\times 4\times 4\sin 150^{o}\right)$

= $8\sqrt{3} - 2\sqrt{3} = 6\sqrt{3}$



53. 00009.00

Sol. $\int_0^y \sqrt{x^4 + (y(3-y))^2}\,dx \le \int_0^y \left(x^2 + y(3-y)\right)dx \le \frac{y^3}{3} + y^2(3-y)$

$f(y) = \frac{y^3}{3} + y^2(3-y)$

$f'(y) = y^2 + 6y - 3y^2 = 2y(3-y) > 0$ for $0 \le y \le 3$ so maximum occurs at $y = 3$

54. 00056.25

Sol. Given expression is $r_1r_2 + r_2r_3 + r_1r_3 = s^2 = (7.5)^2$

FIITJEE

ALL INDIA TEST SERIES

OPEN TEST

JEE (Main)-2019

TEST DATE: 10-02-2019

Time Allotted: 3 Hours **Maximum Marks: 360**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only one section: **Section-A**.

  Section-A (01 – 30, 31 – 60, 61 – 90) *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

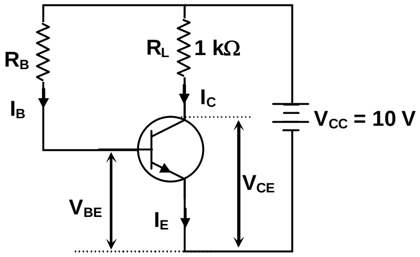
PART – I

SECTION – A

(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. In the circuit shown in the figure the current gain, $\beta = 100$ for the transistor. Find the bias resistance R_B so that $V_{CE} = 6$ V.
(Neglect V_{BE})

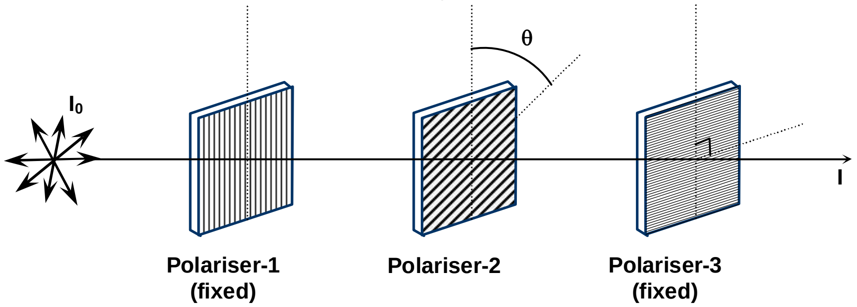


(A) $8 \times 10^5\ \Omega$
(B) $4 \times 10^5\ \Omega$
(C) $6 \times 10^5\ \Omega$
(D) $2.5 \times 10^5\ \Omega$

2. In a nuclear reactor, moderators slow down the neutrons which come out in a fission process. The moderators used have light nuclei. Heavy nuclei will not solve the purpose because
(A) The net weight of the reactor would be unbearably high.
(B) Heavy nuclei will break generating unwanted smaller nuclei.
(C) Elastic collision of neutrons with heavy nuclei will not slow them down.
(D) Substances with heavy nuclei do not occur in liquid or gaseous state at room temperature.

3. Identify the INCORRECT reasoning about why an audio signal of 10 KHz frequency cannot be transmitted over long distances without modulation.
(A) The minimum size of antenna required is at least 7.5 km and this is not convenient.
(B) Effective power transmitted would be very low if the size of antenna is less than 7.5 km.
(C) Audio signals cannot be transmitted through sky waves.
(D) Audio signals can be transmitted only to a small distance by space wave.

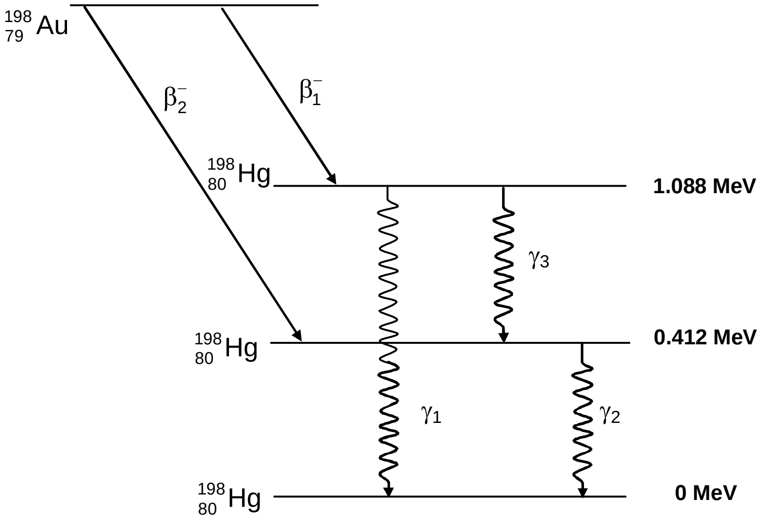
4. A student writes down four conclusions that he observes while performing a polarization experiment with 3 polarisers as shown in the figure. The leftmost and the rightmost polariser are fixed and crossed and the middle one can be rotated. The intensity of the unpolarised light is I_0. Identity the INCORRECT conclusion noted by him.



(A) If $\theta = 0°$ then $I = 0$
(B) If $\theta = 90°$ then $I = 0$
(C) If $\theta = 45°$ then $I = \frac{I_0}{8}$
(D) If $\theta = 30°$ then $I = \frac{3I_0}{16}$

5. The focal lengths of the objective and eyepiece of an astronomical telescope are 4 m and 2 cm respectively. The diameter of the objective is 50 cm. The telescope is directed to view two distant stars (almost point sources of light). The sources are roughly at the same distance ($\approx 10^5$ light year) along the line of sight but are separated transverse to the line of sight by 10^{11} m. Now answer the correct statement when these stars are observed through this telescope.
   (A) The images of these stars will become clear if the diameter of the objective lens is increased.
   (B) The image of these stars will become clear if the diameter of the eyepiece is increased.
   (C) Limit of resolution of this telescope is $\approx 10^{-10}$ rad.
   (D) Two stars cannot be resolved by this telescope.

6. In the decay process of a nucleus given below, identify the correct statement.
   [given: m(Au^{198}) = 197.968233 u, m(Hg^{198}) = 197.966760 u]

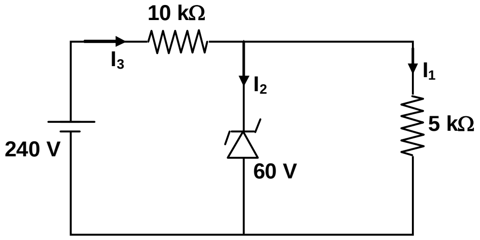


   (A) Maximum K.E. of $\beta_1^- = 0.960$ MeV
   (B) Maximum K.E. of $\beta_2^- = 0.284$ MeV
   (C) Energy associated with γ_1 is 0.412 MeV
   (D) Energy associated with γ_3 is 0.676 MeV

7. The simple Bohr model cannot be directly applied to calculate the energy levels of an atoms with many electrons. This because
   (A) of screening effects
   (B) the force between the nucleus and an electron will no longer be given by Coulomb's law.
   (C) of the electrons not being subject to central force
   (D) of the electrons colliding with each other.

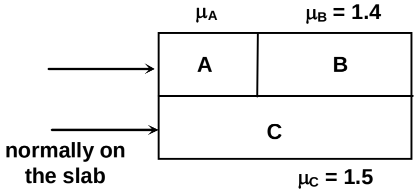
8. The main scale division and pitch of a screw gauge is 0.05 cm. Number of circular scale division in the circular scale is 100. When no object is placed between the studs then the '0' of main scale is not visible and 5th division of circular scale coincides with the main scale. When a wire is placed in between the studs then the reading on main scale is 4.6 mm and 52nd division on circular scale matches with reference line on main scale. The actual diameter of wire is
   (A) 4.385 mm
   (B) 4.885 mm
   (C) 5.335 mm
   (D) 4.835 mm

9. Find the correct value of current (i_1, i_2 and i_3) in the circuit shown in the figure.
(A) I_1 = 16 mA, I_2 = 8 mA, I_3 = 8 mA
(B) I_1 = 16 mA, I_2 = 0 mA, I_3 = 16 mA
(C) I_1 = 12 mA, I_2 = 6 mA, I_3 = 18 mA
(D) I_1 = 12 mA, I_2 = 4 mA, I_3 = 16 Ma



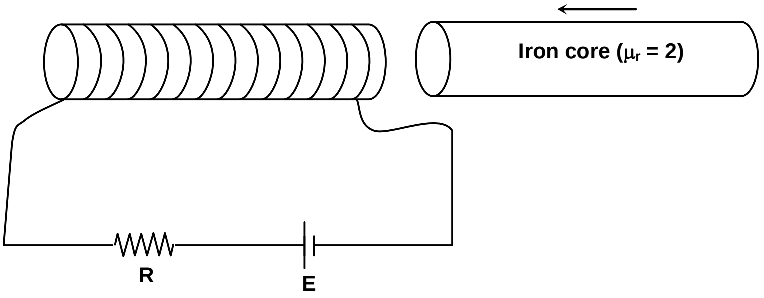
10. In a series LCR circuit the voltage across the resistance, capacitor and inductor is 20 V each. If the inductor is short circuited then, the voltage across the capacitor is
(A) 20 V
(B) $10\sqrt{2}$ V
(C) $20\sqrt{2}$ V
(D) $20(\sqrt{2}-1)$V

11. A composite slab is made of three transparent materials as shown in the figure. Monochromatic parallel beam of light is incident normally on the slabs A and C. Thickness of B is twice that the thickness of A. The number of waves in C is equal to the number of waves in the combination of A and B. If the refractive index of material of B is μ_B = 1.4 and that of C is μ_C = 1.5. Then,
(A) The refractive index of A is 1.6
(B) The refractive index of A is 1.7
(C) The refractive index of A is 1.55
(D) Frequency of light in A is 2 times the frequency of light in B



12. A monochromatic beam of light of wavelength λ = 4500 Å is incident normally on the slits of young's double slit set up. The separation between the slits is 9 μm and the slit width is 2 μm for both the slits. The distance between the slits and the screen is 1 m. Identify the correct option assuming that intensity of the incident light is sufficiently high.
(A) 8 interference fringes will be formed in the central diffraction fringe.
(B) 9 diffraction fringes will be formed in the central interference fringe.
(C) 9th interference maximum will not be formed.
(D) The 2nd diffraction maximum will not be formed.

13. A metallic core made of paramagnetic substance (μ_r =2) and of same size as that of the air core solenoid (self induction L) is inserted suddenly (t = 0) within the space of the core solenoid as shown in the figure. (ignore resistance of the solenoid as well as the end effects) and assume solenoid is of infinite length. Identify the correct option. Assume that charge flowing to the circuit is negligible.



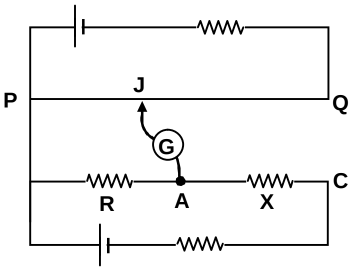
(A) Current just after introduction of the metallic cone is E/R.

(B) Current just before inserting the metallic cone and long time after the introduction of metallic core are not same.

(C) Current at time t after inserting the iron core is $\frac{E}{R}\left(1-2e^{-\frac{Rt}{L}}\right)$

(D) Current at time t after inserting the iron cone is $\frac{E}{2R}\left(2-e^{-\frac{Rt}{2L}}\right)$

14. The circuit for measurement of resistance by potentiometer is as shown in the figure. The galvanometer is first connected at point A and zero deflection is observed at length PJ = 20 cm. In second case galvanometer is connected to the point C and the zero deflection is observed at a length 50 cm from P. Then the unknown resistance X is



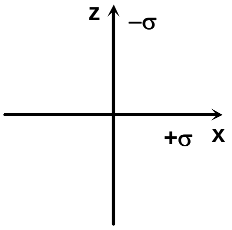
(A) $\frac{5R}{2}$

(B) 2R

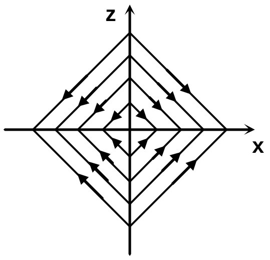
(C) $\frac{2R}{5}$

(D) $\frac{3R}{2}$

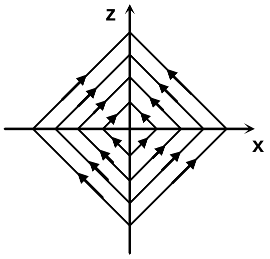
15. Two infinitely large charged non-conducting planes having uniform surface charge density +σ and −σ are placed along x-y and y-z plane respectively as shown in the figure. Then the nature of the electric lines of forces in x-z plane is best represented by



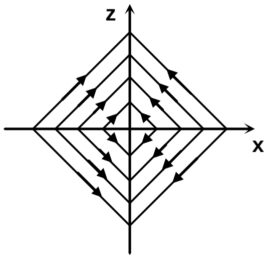
(A)



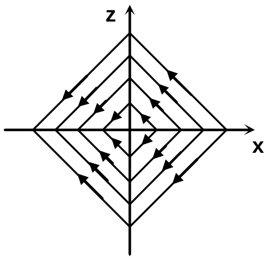
(B)



(C)

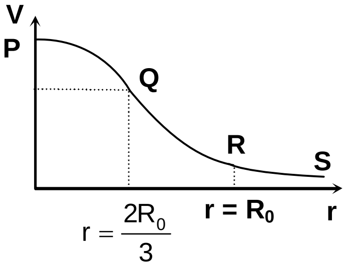


(D)



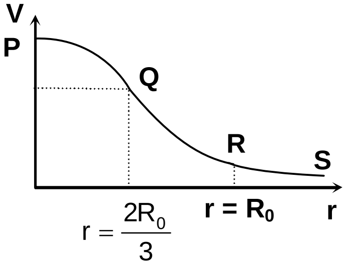
16. A non-conducting solid sphere has a volumetric charge density $\rho = \rho_0\left(1 - \frac{r}{R_0}\right)$, where ρ_0 is constant, R_0 is the radius of sphere and 'r' is the distance from the centre of sphere. The graph between potential and distance from the centre of sphere is best represented by

(A)



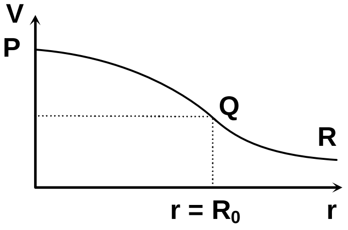
PQ curve is parabolic
QR curve is parabolic
RS curve is rectangular hyperbola

(B)



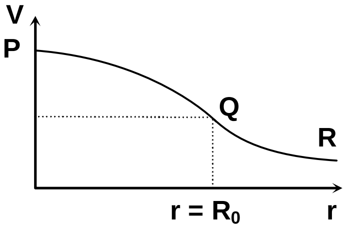
PQ curve is cubic
QR curve is cubic
RS curve is rectangular hyperbola

(C)



PQ curve is cubic
QR curve is rectangular hyperbola

(D)



PQ curve is parabola
QR curve is rectangular hyperbola

17. A particle is moving in x-y plane with $\vec{v} = v_x\hat{i} + v_y\hat{j}$ and acceleration $\vec{a} = a_x\hat{i} + a_y\hat{j}$. If the magnitude of velocity of the particle is constant then choose the correct option.

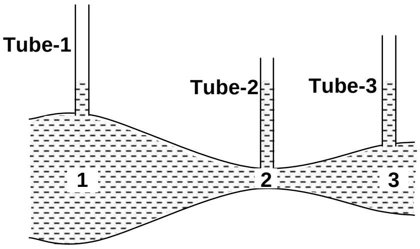
(A) $a_xv_x + a_yv_y = 0$

(B) $a_xv_x - a_yv_y = 0$

(C) $\frac{a_x}{v_x}+\frac{a_y}{v_y}=0$

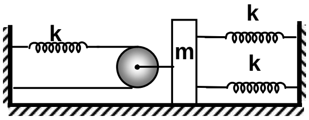
(D) $\frac{a_x}{v_x}-\frac{a_y}{v_y}=0$

18. An ideal liquid is flowing in a tube of small variable cross-section. Tube –1, tube- 2, and tube –3 is connected at point 1, 2 and 3 respectively as shown. Let h_1, h_2 and h_3 are the final heights of liquid in tube 1, 2 and 3 respectively and v_1, v_2 and v_3 are the velocity of liquid at cross-section 1, 2 and 3 respectively.



(A) $h_1 > h_3$ and $v_1 > v_3$
(B) $h_2 < h_3$ and $v_2 < v_3$
(C) $h_1 < h_3$ and $v_1 > v_3$
(D) $h_1 > h_3$ and $v_1 < v_3$

19. A block of mass m is connected with three massless springs and a massless pulley, springs were in natural length initially. Surface is smooth and block is slightly shifted towards right and released then its time period is



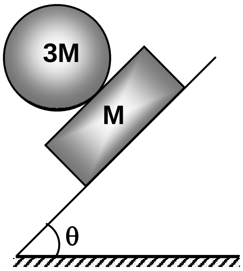
(A) $2\pi\sqrt{\frac{m}{6k}}+2\pi\sqrt{\frac{m}{2k}}$

(B) $2\pi\sqrt{\frac{m}{6k}}+\pi\sqrt{\frac{m}{2k}}$

(C) $\pi\sqrt{\frac{m}{6k}}+\pi\sqrt{\frac{m}{2k}}$

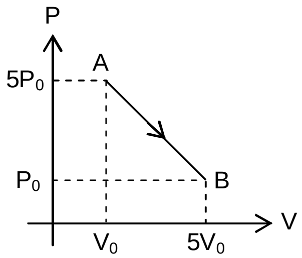
(D) $\pi\sqrt{\frac{m}{6k}}+2\pi\sqrt{\frac{m}{2k}}$

20. A plank of mass M and sphere of mass 3 M are kept on a smooth inclined plane as shown in the figure. The coefficient of friction between sphere and plank is 'μ'. If system is released from rest then choose the correct alternative at t = 0.



(A) Friction force between sphere and plank is $\mu Mg\cos\theta$.
(B) Acceleration of plank with respect to sphere is non zero.
(C) Friction force between sphere and plank is zero.
(D) Friction force between sphere and plank is $3\mu mg\cos\theta$.

21. One mole of an ideal diatomic gas undergoes a process AB as shown. Pressure at A and B are $5P_0$ and P_0 while volumes are V_0 and 5 V_0 respectively. During the process from A → B, pressure and volume of the gas, where the direction of flow of heat is reversed, is



(A) $\frac{5}{2}P_0, \frac{7}{2}V_0$

(B) $P_0, 5V_0$

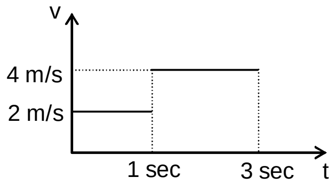
(C) $4P_0, 2V_0$

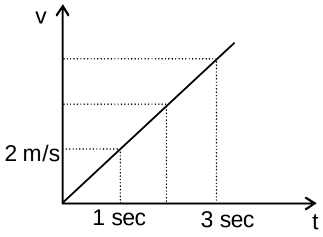
(D) $\frac{9}{2}P_0, \frac{3}{2}V_0$

22. A disc of radius R = 2m starts rolling in vertical plane on a rough horizontal surface. It is observed that the magnitude of acceleration of a point inside the sphere at a distance $\sqrt{2}$ m from the centre is zero. Then find the vertical height of point from the ground.
(A) $\frac{1}{4}$ m
(B) $\frac{3}{2}$ m
(C) $\frac{3}{4}$ m
(D) 1 m

23. A equation is given by $C = \frac{Q^2 \cdot \Delta\theta}{m \cdot \gamma}$, where C is specific heat, $\Delta\theta$ is difference in temperature, Q is heat given to the system and m is mass of system. Then the dimension of γ is given by
(A) $ML^2T^{-2}\theta^2$
(B) $ML^2T^{-2}\theta^{-2}$
(C) $M^2L^2T^2\theta^2$
(D) $ML^2T^{-1}\theta^{-1}$

24. Two particles P and Q starts from the origin along x-axis. Velocity time graph of both particles are shown in the figure. During the given time interval, the maximum separation between the particles is

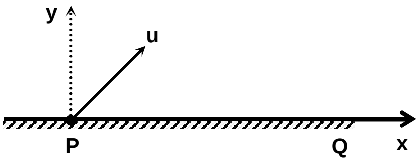




(A) 4 m
(B) 1 m
(C) 2 m
(D) 3 m

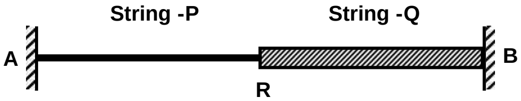
25. A lamp post is fixed at point (0, 0, 5m). A man is moving with constant velocity 6 m/s along a line $y = \sqrt{3}x$. Height of man is 2m and initially the man is at origin. The velocity of edge of his shadow along the line of motion of man is
(A) $8\hat{i} + 6\hat{j}$
(B) $6\hat{i} + 8\hat{j}$
(C) $5\sqrt{3}\,\hat{i} + 5\hat{j}$
(D) $5\hat{i} + 5\sqrt{3}\hat{j}$

26. A small particle is projected from point 'P' in a vertical plane with an initial speed u. It hits the ground at Q. Assume that its collision with the ground which occurs at Q is perfectly inelastic. If area covered between the trajectory and x-axis by particle from P to Q is maximum, then the angle of projection of the particle is
(A) 60°



(B) 45°
(C) 30°
(D) 75°

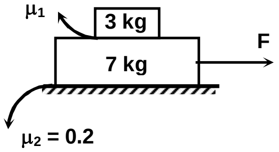
27. Two strings 'P' and 'Q' of length 1 meter and 1/2 meter respectively are connected at 'A' and 'B'. 'R' is the junction of both strings. The mass per unit length of strings P and Q are 0.16 kg/m and 0.25 kg/m respectively. A tension of 100 N is maintained in both strings. A pulse of amplitude 2 mm is given at point 'A' it partly reflected and partially transmitted at R. Then the amplitude of reflected and transmitted wave is



(A) $\frac{16}{9}$ mm and $\frac{1}{9}$ mm
(B) $\frac{8}{9}$ mm and $\frac{2}{9}$ mm
(C) $\frac{2}{9}$ mm and $\frac{16}{9}$ mm
(D) $\frac{2}{9}$ mm and $\frac{8}{9}$ mm

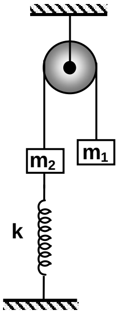
28. Over a certain region of space. The gravitational potential is given by $v = 3x^2y - 2yz + x^3z$. The magnitude of gravitational field at (0, 1, –1) is
(A) 4
(B) 2
(C) $2\sqrt{2}$
(D) 1

29. Two blocks of mass 3 kg and 7 kg are kept on a rough horizontal surface. A force F is applied on lower block of mass 7 kg. Coefficient of friction between 3 kg and 7 kg is 'μ_1' and between 7 kg and surface it is $\mu_2 = 0.2$. Choose the correct option.



(A) If applied force is 15 N then slipping will occur between 3 kg and 7 kg.
(B) If $\mu_1 = 0$ and applied force is 30 N then both block have same acceleration of magnitude 3 m/s^2.
(C) Slipping will start between 7 kg and surface for minimum value of F = 20 N and it is independent of μ_1.
(D) For F = 10 N, slipping can be possible between 7 kg and 3 kg it will depend on μ_1.

30. Two blocks of mass $m_1 = 3$ kg and $m_2 = 1$ kg are connected through a spring of spring constant K = 100 N/m in a vertical plane. Pulley is massless and frictionless. Initially the spring is at its natural length. Now, if system is released in vertical plane then maximum elongation in the spring is



(A) 1/5 m
(B) 3/5 m
(C) 2/5 m
(D) 6/5 m

Chemistry PART – II

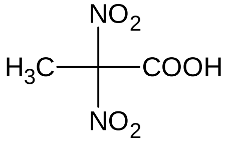
SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

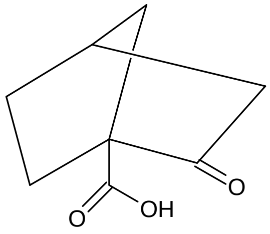
31. If x is number of σ bonds, y be the number of π bonds and z be the number of bonding electrons respectively in C_2 molecule, then the value of $\frac{z-x}{y}$ is:

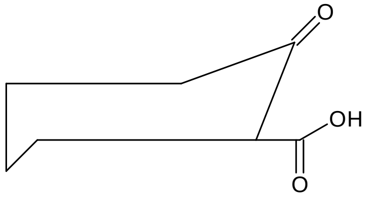
(A) 7
(B) ∞
(C) 4
(D) 0

32. Which of the following acid is least likely to decarboxylate simply on heating?

(A)

$H_3C-C(NO_2)_2-COOH$

(B) $H_2C{=}CH{-}COOH$

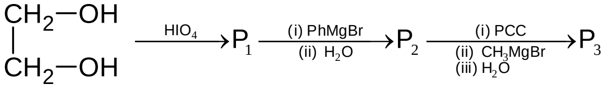
(C)


(D)


33. The species having the strongest gas phase proton affinity amongst the following is:

(A) N^{3-}
(B) NF_3
(C) NH_3
(D) $N(CH_3)_3$

34. Which of the following is **incorrect** for the final product of the given sequence.


$$\begin{matrix}CH_2-OH\\ |\\ CH_2-OH\end{matrix} \xrightarrow{HIO_4} P_1 \xrightarrow[\text{(ii) } H_2O]{\text{(i) PhMgBr}} P_2 \xrightarrow[\substack{\text{(ii) } CH_3MgBr\\ \text{(iii) } H_2O}]{\text{(i) PCC}} P_3$$

(A) Compound P_3 on oxidation with (CrO_3 + H_2SO_4) gives a compound which gives 2, 4 DNP Test.
(B) Compound P_3 on reaction with I_2 + NaOH gives yellow precipitate .
(C) Compound P_3 on reaction with ceric ammonium nitrate gives red colouration
(D) Compound P_3 on reaction with MnO_2 gives carboxylic acid

35. What is the magnetic moment of iron in Brown coloured ring complex formed in nitrate test?
(A) Zero
(B) $\sqrt{15}$
(C) $\sqrt{2}$
(D) $\sqrt{35}$

36. Calculate the value of E_{cell} for the given cell:

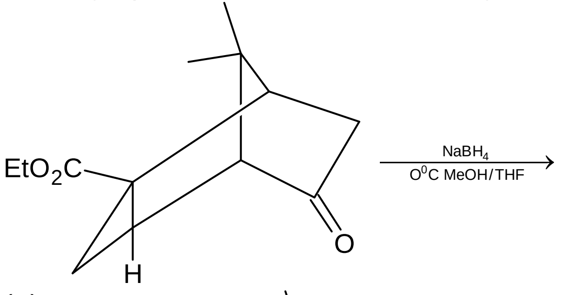
$$Pt\,|\,H_2(g)\,|\,\underset{(0.1M)}{CH_3COOH}+\underset{(0.1M)}{CH_3COONa}\,||\,\underset{(Ksp=4\times10^{-12})}{Ag_2S}\,|\,Ag(s)$$

$$\frac{2.303RT}{nF}=0.059,\ Ka(CH_3COOH)=10^{-5},\ E^0_{Ag^+/Ag}=0.8V,\ \log 5=0.698$$

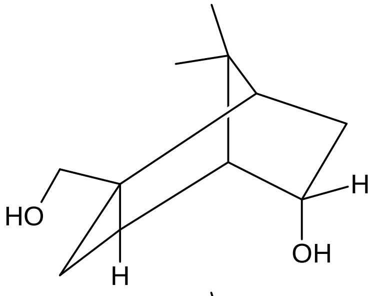
(A) 0.8590 V
(B) 0.6230 V
(C) 0.8767 V
(D) 0.6407 V

37. For a reaction 2A + B → 3Z, if the rate of consumption of A is 2×10^{-4} mol/dm^3/s, the rate of formation of Z (in mole^{-1}s^{-1}):
(A) 3×10^{-4}
(B) 2×10^{-4}
(C) $\frac{4}{3}\times10^{-4}$
(D) 4×10^{-4}

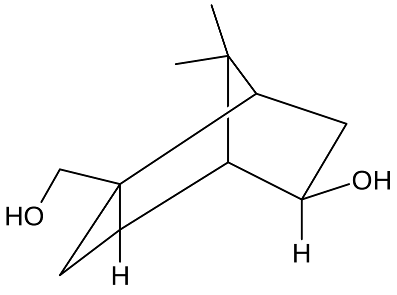
38. The major product formed in the following reaction is:



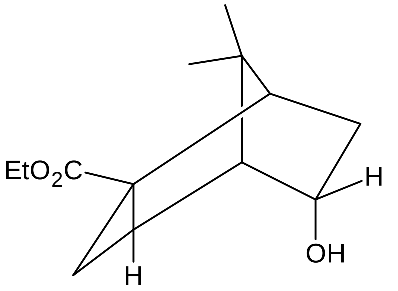
(A)



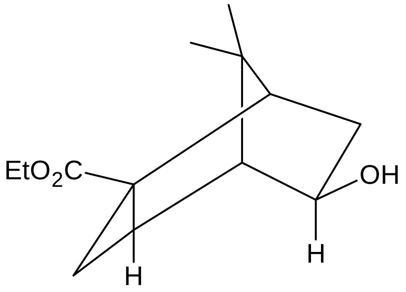
(B)



(C)



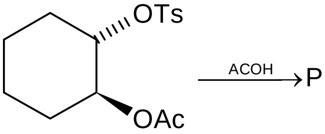
(D)



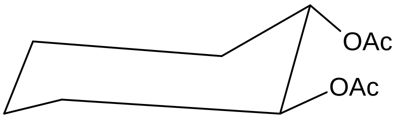
39. Which is not the property of diamond?
    - (A) each carbon atom is sp^3 hybridized
    - (B) it is an isomer of graphite
    - (C) it is purest form of carbon
    - (D) It has abnormally high m.p.

40. For a homogeneous reaction $A \rightarrow 3B$, if the pressure after time 't' was P_T and after completion it was P_∞, then choose the correct relationship:
    - (A) $K = \frac{1}{t}\ln\left(\frac{P_\infty}{3P_\infty - 3P_T}\right)$
    - (B) $K = \frac{1}{t}\ln\left(\frac{2P_\infty}{P_\infty - P_T}\right)$
    - (C) $K = \frac{1}{t}\ln\left(\frac{3P_\infty}{2P_\infty - P_T}\right)$
    - (D) $K = \frac{1}{t}\ln\left(\frac{2P_\infty}{3P_\infty - 3P_T}\right)$

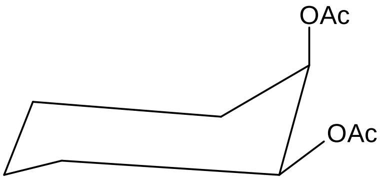
41. Major product of the following reaction in its most stable form is



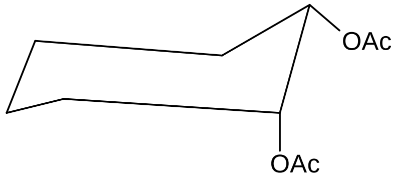
(A)



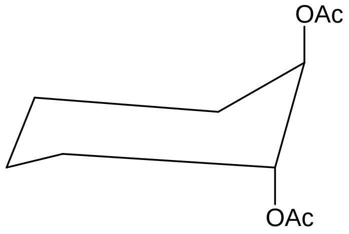
(B)



(C)

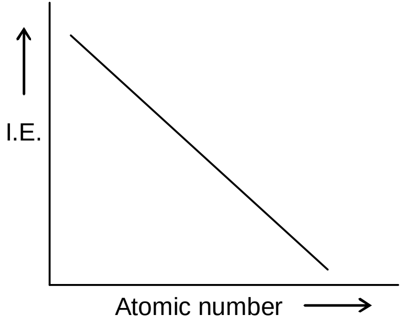


(D)

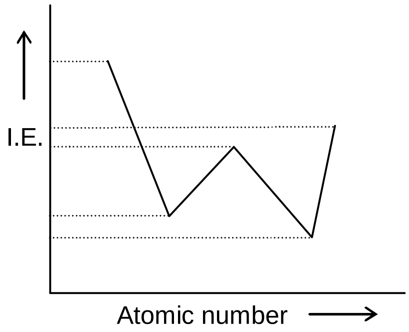


42. Hydrogen gap is found in which block of the periodic table?
    (A) s-block
    (B) p-block
    (C) d-block
    (D) f-block

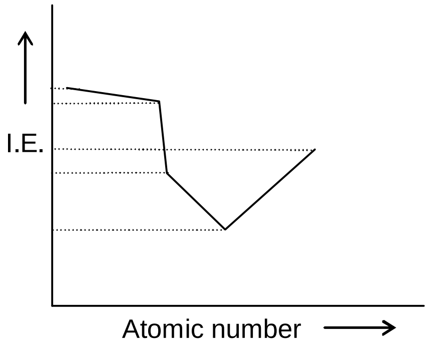
43. The correct curve representing first ionization energy of group 13 elements is:
    (A)



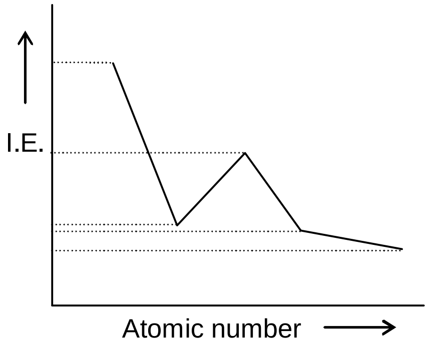
(B)



(C)



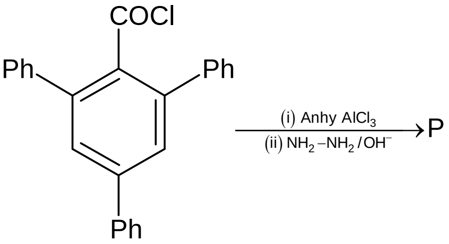
(D)



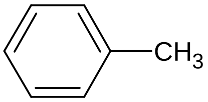
44. Among the following complexes (1) $[Co(ox)_3]^{-3}$, (2) trans-$[CoCl_2(en)_2]^+$, (3) $[Cr(EDTA)]^-$, the chiral one(s) is/are:
(A) 1 and 2
(B) 3 and 2
(C) 3 only
(D) 1 and 3

45. Which statement(s) concerning Bohr's model is **incorrect**?
(A) Predicts the probability of electron near nucleus is more
(B) Angular momentum of electron in H-atom = $\frac{nh}{2\pi}$
(C) Introduces the idea of stationary states.
(D) Explain line spectrum of hydrogen atom.

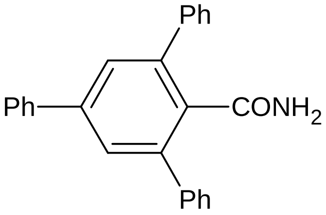
46. The final product in the given sequence is:



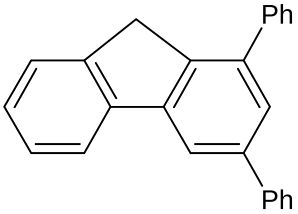
(A)

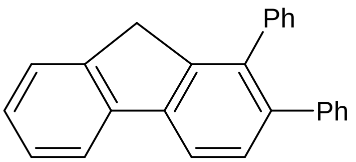


(B)

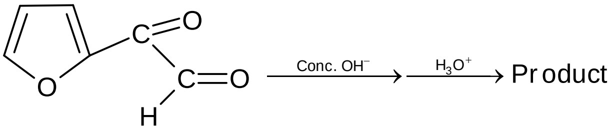


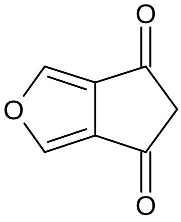
(C)

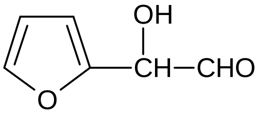


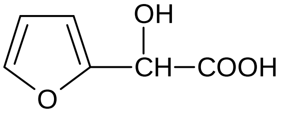
(D) 

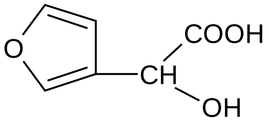
47. The final product of the following sequence is:


C=O
C=O
O
H
Conc. OH⁻
H₃O⁺
Product

(A) 

(B) 

(C) 

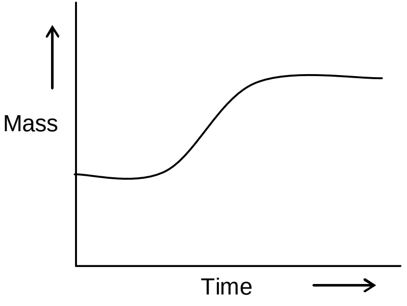
(D) 

48. What is the number of chloride in the given list which dissolves in excess of NaOH solution?
$SnCl_2$, $CrCl_3$, $AlCl_3$, $FeCl_3$, $ZnCl_3$, $BeCl_2$, AgCl
(A) 7
(B) 5
(C) 3
(D) 4

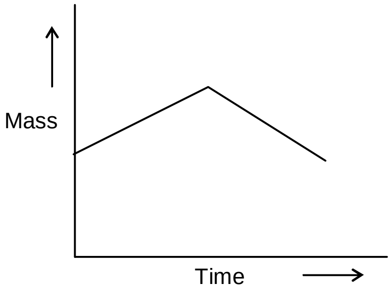
49. Potassium chlorate, $KClO_3$ is heated in test tube and following reaction occurs at 25°C.

$$KClO_3 \xrightarrow{\Delta} KCl + \frac{3}{2}O_2$$

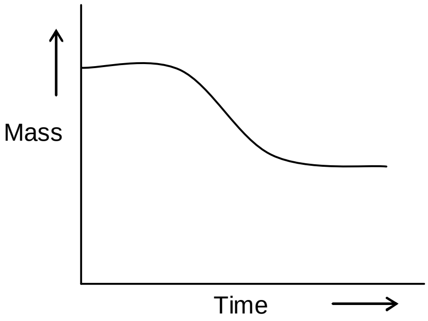
Which graph shows the change in mass of test tube and its content?

(A) 

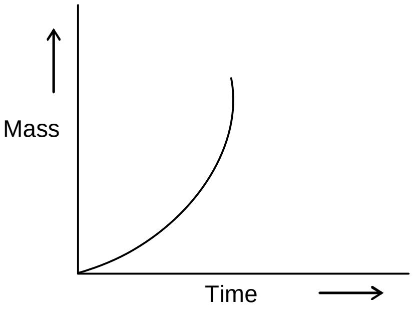
(B)



(C)



(D)



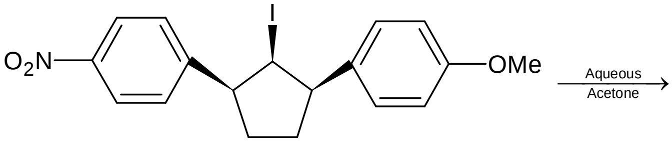
50. Graph between $\log\frac{x}{m}$ vs log P is straight line inclined at an angle of 45°. When the pressure is 0.5 atm and log K is 0.699, the amount of solution adsorbed per g of adsorbent will be:
(A) 2.5 g/g adsorbent
(B) 0.25 g/g adsorbent
(C) 1 g/g adsorbent
(D) 1.5 g/g adsorbent

51. An organic compound is reacted with HNO_2 at 0°C and then the resulting solution is added to a solution of β-napthol whereby a brilliant red dye is produced. This indicates the presence of:
(A) $-NO_2$ group
(B) $-CONH_2$ group
(C) Aromatic NH_2 group
(D) Aliphatic NH_2 group

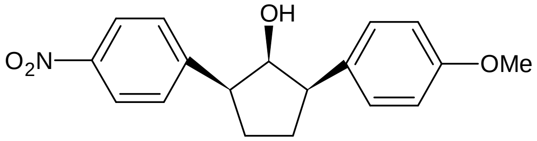
52. 'Matte' in the extraction of Cu has the composition:
(A) Cu_2O, Cu_2S, FeS
(B) Cu_2O, FeO, Cu_2S
(C) Cu_2O, FeO
(D) Cu_2S, FeO, FeS

53. Select an **incorrect** statement out of the following:
- (A) Instead of Radical substitution, cyclopropane undergoes electrophilic addition reactions in sun light.
- (B) In general, bromination is more selective than chlorination
- (C) The 2,4,6-tri-tert butylphenoxy radical is resistant to dimerization
- (D) The boiling point and dipole moment of R – X (R = CH_3) is greater when X = F than when X = Cl.

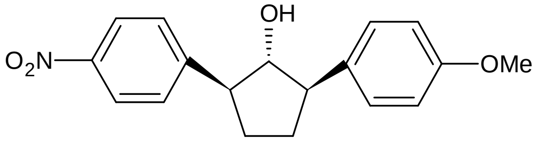
54. Identify the major product for the following reaction:



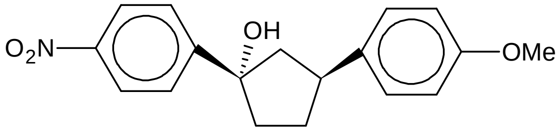
(A)



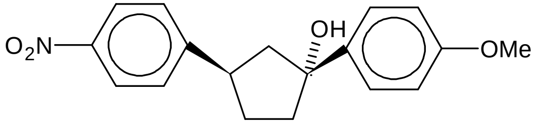
(B)



(C)



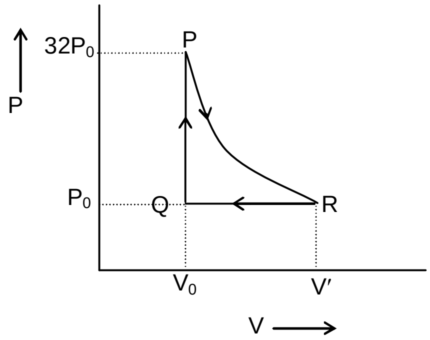
(D)



55. The pair that yields the same gaseous product on reaction with water is:
- (A) Ca and CaH_2
- (B) Ba and BaO_2
- (C) KH and KO_2
- (D) Na and Na_2O_2

56. A crystal is constituted of X and Y particles. Y form ccp arrangement where as X occupies all octahedral voids. If all the particles along one body diagonal are removed and Z atom are introduced in the available voids of that body diagonal (lying inside the cube completely), the formula of this solid becomes $X_aY_bZ_c$. The value of a, b and c respectively are:
- (A) 3, 4, 3
- (B) 4, 5, 4
- (C) 16, 15, 12
- (D) 3, 15, 4

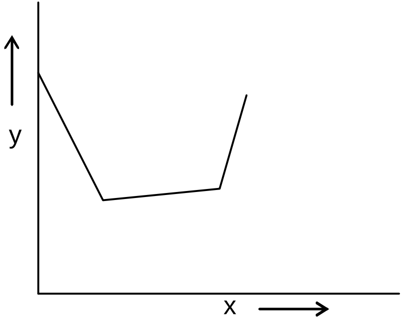
57. One mole of a monoatomic ideal gas is taken along the given path as shown in the P–V diagram. $Q \rightarrow P \rightarrow R \rightarrow Q$



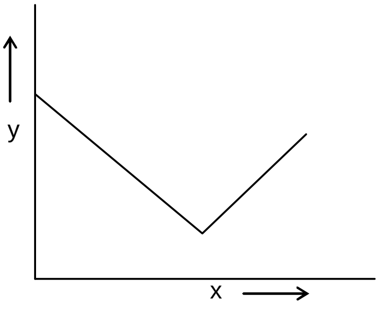
The process $P \rightarrow R$ is purely isothermal, then calculate the work done for the process $R \rightarrow Q$.
(A) $24P_oV_o$
(B) $36P_oV_o$
(C) $31P_oV_o$
(D) P_oV_o

58. If N and S both are present in an organic compound during Lassaigne's test, both will change into
(A) Na_2S and NaCN
(B) NaSCN
(C) Na_2SO_3 and NaCN
(D) Na_2S and NaCNO

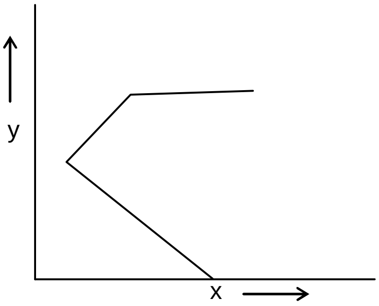
59. On titrating a NaOH solution conductometrically with a mixture of HCl and CH_3COOH solution, plot of the volume of mixed acid in Y–axis (Y) against conductance in X-axis (X) will look like:
(A)



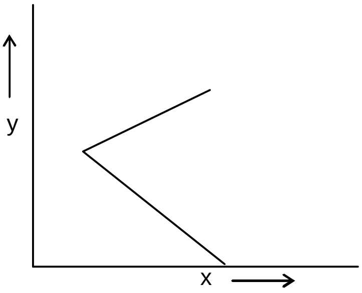
(B)



(C)



(D)



60. How many isomeric disubstituted borazine are possible?
(A) 6
(B) 3
(C) 5
(D) 4

Mathematics

PART – III

SECTION – A

(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. An equilateral triangle is inscribed in ellipse whose equation is $x^2 + 4y^2 = 4$, one vertex of triangle is (0, 1) and one altitude is contained in y-axis and length of each side is $\sqrt{\frac{m}{n}}$ (where m and n are relatively prime), then m + n is
(A) 937
(B) 973
(C) 793
(D) 739

62. If $\sum_{r=1}^{\infty} \tan^{-1}\left(\frac{4}{r^2 + r + 16}\right) = \tan^{-1}\left(\frac{\alpha}{10}\right)$, then α is
(A) 80
(B) 40
(C) 20
(D) 30

63. The radius of the circle touching the parabola $y^2 = 4x$ at an end of latus rectum and passing through focus is
(A) $\sqrt{5}$
(B) $\sqrt{2}$
(C) $\sqrt{3}$
(D) $\sqrt{7}$

64. If $9 + f''(x) + f'(x) = x^2 + f^2(x)$, f(x) is a twice differentiable function such that $f''(x) \neq 0 \ \forall \ x \in R$ and let P be the point of maxima of f(x), then number of tangents which can be drawn from P to circle $x^2 + y^2 = 9$
(A) 0
(B) 2
(C) 1
(D) nothing can be said

65. The number of five digit numbers that can be formed using all the digits 0, 1, 3, 6, 8 greater than 30,000 that are divisible by 11 is
(A) 10
(B) 8
(C) 12
(D) 16

66. The vertices of a triangle are 3 + 4i, 4 + 3i and $2\sqrt{6} + i$, then distance between orthocentre and circumcentre of the triangle is equal to
(A) $\sqrt{137 - 28\sqrt{6}}$
(B) $\sqrt{137 + 28\sqrt{6}}$

(C) $\frac{1}{2}\sqrt{137+28\sqrt{6}}$

(D) $\frac{1}{3}\sqrt{137+28\sqrt{6}}$

67. If $\int \frac{1-7\cos^2 x}{\sin^7 x \cdot \cos^2 x} dx = \frac{g(x)}{\sin^7 x} + c$, then $g'(0)+g''\left(\frac{\pi}{4}\right)$ is
(A) 1
(B) 17
(C) 9
(D) 5

68. The value of $\int_0^2 \left(\sqrt{x^3+1}\right)dx + \int_0^2 \sqrt[3]{x^2+2x}\, dx$ is
(A) 6
(B) 4
(C) 8
(D) 2

69. Three distinct numbers are chosen one by one without replacement from set {1, 2, 3, ..., 9}. If it is known that sum of first two chosen numbers is even, then the probability that sum of all three numbers is even is
(A) $\frac{15}{28}$
(B) $\frac{11}{28}$
(C) $\frac{13}{28}$
(D) $\frac{17}{28}$

70. If curve $y = k\cos\frac{x}{2}$ divides the area bounded by y = sin x, x-axis in between x = 0 and x = π in two equal parts, then k is
(A) $2-\sqrt{2}$
(B) $2+\sqrt{2}$
(C) $3-\sqrt{2}$
(D) $3+\sqrt{2}$

71. If A and B are non-singular square matrices of even order such that $A^T = A, B^T = -B$ and AB + BA = O (where O is a null matrix), then
(A) (AB) is skew symmetric matrix
(B) A^{-1} and B^{-1} commute each other
(C) $(A^{-1}B)$ is symmetric matrix
(D) B and A^{-1} commute each other

72. If x and y are independent variables and $f(x) = 1 + \int_0^1 (x^2y^2 + x) f(y)\,dy$ be a continuous and differentiable function, then f′(0) is

(A) $\frac{164}{57}$

(B) $\frac{25}{19}$

(C) $\frac{38}{73}$

(D) $\frac{91}{103}$

73. If $\vec{a}, \vec{b}, \vec{c}$ are three mutually perpendicular unit vectors and $\vec{d}$ is a unit vector which makes equal angle $\alpha \in \left(0, \frac{\pi}{2}\right)$ with each of $\vec{a}$, $\vec{b}$ and $\vec{c}$, then $\left[\left|\vec{a} + \vec{b} + \vec{c} + \vec{d}\right|^2\right]$ is equal to (where [.] denotes the greatest integer function)

(A) 5
(B) 6
(C) 7
(D) 8

74. Let g : [1, 6] → [0, ∞) be a real values differentiable function satisfying $g'(x) = \frac{2}{x + g(x)}$ and g(1) = 0, then the maximum value of g cannot exceed

(A) $\ell n 2$

(B) $\ell n 6$

(C) $3 \ell n 2$

(D) $2 \ell n 6$

75. Number of solutions of the equation $\frac{\sqrt{6} - \sqrt{2}}{\sin x} + \frac{\sqrt{2} + \sqrt{6}}{\cos x} = 8$ in $\left(0, \frac{\pi}{2}\right)$ is/are

(A) 1
(B) 0
(C) 2
(D) 4

76. Let $T = \int_0^{\ell n 2} \frac{2e^{3x} + e^{2x} - 1}{e^{3x} + e^{2x} - e^x + 1} dx$, then e^T is

(A) $\frac{7}{4}$

(B) $\frac{11}{8}$

(C) $\frac{11}{2}$

(D) $\frac{11}{4}$

77. Let F(x) be a non-negative continuous function defined on R such that $F(x)+F\left(x+\frac{1}{2}\right)=3$, then $\int_{0}^{1500} F(x)dx$ is equal to

(A) 2250
(B) 1500
(C) 750
(D) 0

78. The value of $\lim_{n\to\infty}\left(\frac{1}{2n+1}+\frac{1}{2n+3}+\frac{1}{2n+5}+.....+\frac{1}{4n-1}\right)$ (where n ∈ N) is

(A) $\ell n\ 2$
(B) $\ell n\sqrt{2}$
(C) $2\ \ell n\ 2$
(D) $3\ \ell n\sqrt{2}$

79. A particle starts to travel from a point P on the curve C_1: |z – 3 – 4i| = 5 where |z| is maximum. From P, the particle moves through an angle $\tan^{-1}\frac{3}{4}$ in anticlockwise direction on |z – 3 – 4i| = 5 about the centre and reaches at point Q. From Q, it comes down parallel to imaginary axis by 2 units and reaches at point R. Complex number corresponding to point R in the Argand plane is

(A) (3 + 5i)
(B) (3 + 7i)
(C) (3 + 8i)
(D) (3 + 9i)

80. The parabola $x = y^2 + ay + b$ intersect the parabola $x^2 = y$ at (1, 1) at right angle, then the area enclosed by the parabola $x = y^2 + ay + b$ and its latus rectum is

(A) $\frac{1}{2}$
(B) $\frac{1}{3}$
(C) $\frac{1}{4}$
(D) $\frac{1}{6}$

81. A plane P is perpendicular to the vector $\vec{A}=2\hat{i}+3\hat{j}+6\hat{k}$ and contains the terminal point of the vector $\vec{B}=\hat{i}+5\hat{j}+3\hat{k}$. The perpendicular distance from the origin to the plane P is equal to

(A) 2 units
(B) 5 units
(C) 6 units
(D) 7 units

82. Find the number of all 6 digit numbers such that all the digits of each number are from the set {1, 2, 3, 4, 5} and any digit that appears in the number appears at least twice, is

(A) 1205
(B) 1305
(C) 1405
(D) 1505

83. There are two set of observation with term $\{x_r, f_r\}$ and $\{y_r, f_r\}$ (where x_r and y_r are observation with their respective frequency f_r). Now if $x_r = 2^r$ and $y_r = 2^r - 2$ and $f_r = {}^nC_r$. If the sets are having their variance V_A and V_B respectively, then $\frac{V_A + V_B}{V_B}$ is equal to

(A) 3
(B) 2
(C) –2
(D) 1

84. The preposition $[\sim(p \to q) \to (q \to p)] \Leftrightarrow [\sim\{(p \to q) \wedge (\sim q \wedge p)\}]$ is a
(A) Tautology
(B) Fallacy
(C) Contingency
(D) none of these

85. If $\int_0^1 \ell nx \cdot \ell n(1-x)dx = p - \frac{\pi^q}{r}$, p, q, r $\in$ N, then p + q + r is equal to $\left[\text{Use } \lim_{n\to\infty}\sum_{r=1}^{n}\frac{1}{r^2} = \frac{\pi^2}{6}\right]$
(A) 10
(B) 9
(C) 5
(D) 8

86. Two flagstaffs stand on a horizontal plane. A and B are two points on the line joining their feet and between them. The angles of elevation of the tops of the flagstaffs as seen from A are 30º and 60º and as seen from B are 60º and 45º. If AB is 30 m, the distance between the flagstaffs in metres is
(A) $30+15\sqrt{3}$
(B) $45+15\sqrt{3}$
(C) $60-15\sqrt{3}$
(D) $60+15\sqrt{3}$

87. The line x + y + 2 = 0 is a tangent at point A, intersect the directrix at B and tangent at vertex at C respectively. If the focus of parabola is S(2, 0), then value of AC·BC is
(A) 8
(B) 16
(C) 4
(D) 10

88. Two variable chords AB and BC of a circle $x^2 + y^2 = r^2$ are such that AB = BC = r. The locus of the point of intersection of tangents at A and C is
(A) $x^2 + y^2 + 3r^2$
(B) $x^2 + y^2 = 4r^2$
(C) $x^2 + y^2 = 5r^2$
(D) $x^2 + y^2 = 6r^2$

89. If $\frac{\left(1^4+\frac{1}{4}\right)\left(3^4+\frac{1}{4}\right).....\left((2n-1)^4+\frac{1}{4}\right)}{\left(2^4+\frac{1}{4}\right)\left(4^4+\frac{1}{4}\right).....\left((2n)^4+\frac{1}{4}\right)} = \frac{1}{k_1n^2+k_2n+k_3}$, then $k_1 - k_2 + k_3$ is equal to

(A) 8
(B) 5
(C) 3
(D) 1

90. If the value of $\lim_{n\to\infty} n\tan(4\pi en!) = L$, then fundamental period of f(x) = |sin x| + |cos x| is

(A) $\frac{L}{12}$
(B) $\frac{L}{8}$
(C) $\frac{L}{4}$
(D) $\frac{L}{6}$

FIITJEE

ALL INDIA TEST SERIES

OPEN TEST

JEE (Main)-2019

TEST DATE: 10-02-2019

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. D

Sol. $\beta = \frac{I_C}{I_B}$ or $I_B = \frac{I_c}{\beta} = \frac{I_C}{100}$

Also, $V_{CE} = V_{CC} - I_C R_L$

$6 = 10 - I_C \times 1000$

$\Rightarrow I_C = \frac{4}{1000} = 4 \times 10^{-3}\,A$

$\therefore\ I_B = \frac{I_C}{100} = 4 \times 10^{-5}\,A$

So, $R_B = \frac{V_{CC} - V_{BE}}{I_B} \approx \frac{V_{CC}}{I_B} = \frac{10}{4 \times 10^{-5}} = 2.5 \times 10^5\,\Omega$

2. C

Sol. During elastic collision between two particles, the maximum kinetic energy is transferred from one particle to the other when they have the same mass. Consequently, a neutron loses all its kinetic energy when it collides head on with a proton. For this reason materials which are abundant in hydrogen such as paraffin and water, are good moderates for neutrons.

3. D

Sol. Option, A, B, C are correct and D is the only incorrect option as:

(A) $\lambda = \frac{c}{\nu} = \frac{3 \times 10^8}{10 \times 10^3} = 30$ km

So, minimum length of antenna required ≈ $\lambda/4$ = 7.5 km

(B) $P \propto \left(\frac{\ell}{\lambda}\right)^2$

(C) SKY wave communication is used for short wave communication (3MHz – 30 MHz).

(D) Space wave is used to transfer very high frequency (~ 3GHz)

4. D

Sol. Intensity of light after passing through polariser 1 is $I_0/2$.

Intensity of light after passing through polariser 2 is $\frac{I_0}{2}\cos^2\theta$.

Intensity of light after passing through polariser 3 is

$$I = \frac{I_0}{2}\cos^2\theta\cos^2(90-\theta) = \frac{I_0}{2}\sin^2\theta\cos^2\theta$$

So, for $\theta = 0$ or $90°$, $I = 0$

for $\theta = 45°$, $I = I_0/8$

for $\theta = 30°$, $I = \frac{I_0}{2}\times\left(\frac{1}{2}\right)^2\left(\frac{\sqrt{3}}{2}\right)^2 = \frac{3I_0}{32}$

$\therefore$ d is incorrect.

5. D

Sol. Let a = diameter of the telescope = 50 cm = 0.5 m

d = separation stars = 10^{11} m.

D = distance of stars from earth = 10^5 l_y = $10^5 \times 9.47 \times 10^{15}$ m = 9.47×10^{20} m.

If $\Delta\theta$ is the angle subtended by the line joining the stars with the telescope Then,

$$\Delta\theta = \frac{d}{D} = \frac{10^{11}\text{m}}{9.47\times10^{20}\text{m}} \approx 10^{-10}\text{rad}$$

Limit of resolution of the telescope

$$\Delta\theta' = 1.22\frac{\lambda}{a} = 1.22\times\frac{600\times10^{-9}}{0.5} = 1.46\times10^{-6}\text{rad}$$

Since, $\Delta\theta << \Delta\theta'$ so the stars cannot be resolved by this telescope or alternately separate images will not be seen.

Note: Information on focal length is not required.

6. D

Sol. Maximum Kinetic energy of β_1^- should be less than maximum kinetic energy of β_2^-. So, option (A) and (B) are incorrect.

Energy associated with γ_1 is 1.088 MeV. So option (C) is incorrect.

From the nuclear energy level diagram of ${}^{198}_{80}\text{Hg}$ it is clear that energy released during emission of γ_3 is (1.088 – 0.412) MeV = 0.676 MeV.

7. C

Sol. Each electron will not only interact with positively charged nucleus (which provides the central force) but also with the other electrons (i.e. we have to take electron-electron interaction). and hence electron's are not subject to central force.

8. C

Sol. Least count = $\frac{0.05}{100}\text{cm} = 0.005$ mm

Zero error = (100 – 5) × 0.005 = – 0.475 mm

Reading = MSR + CSR × L.C.

= 4.6 + 52 × 0.005

= 4.6 + 0.26 = 4.86 mm
Actual diameter = 4.86 + 0.475 = 5.335 mm

9. C

Sol. $5 \times 10^3\ I_1 = 60 \Rightarrow I_1 = \frac{60}{5 \times 10^3} = 12$ mA
Potential difference across 10 kΩ = 240 – 60 = 180 V
So, $I_3 \times 10 \times 10^3 = 180 \Rightarrow I_3 = 18$ mA
$I_2 = I_3 - I_1 = 6$ mA

10. B

Sol. Total voltage across the circuit $V = I\left[R^2 + (x_L - x_C)^2\right]^{1/2} = IR = 20$ V
When inductor is short circuited

$$I = \frac{20}{\sqrt{R^2 + X_C^2}} = \frac{20}{\sqrt{2}R}$$

$$\therefore\ V_C = IX_C = \frac{20}{\sqrt{2}R} \times R = 10\sqrt{2}\ \text{V}$$

11. B

Sol. $\mu = \frac{C_{air}}{C_{median}} = \frac{C}{f\lambda}$ or $\lambda = \frac{C}{f\mu} = \frac{A}{\mu}$ where A is same for the 3 media.

For A : $\lambda_A = \frac{A}{\mu_A}$, for B : $\lambda_B = \frac{A}{1.4}$, for C: $\lambda_C = \frac{A}{1.5}$

So, No. of waves in A = $\frac{t/3}{\lambda_A} = \frac{t\mu_A}{3A}$

No. of waves in B = $\frac{2t/3}{\lambda_B} = \frac{2t}{3A} \times 1.4$

No. of waves in C = $\frac{t}{\lambda_C} = \frac{t \times 1.5}{A}$

Since, the no of waves in C is equal to the sum of no. of waves in A and B, so

$$\frac{1.5t}{A} = \frac{\mu_A t}{3A} + \frac{2.8t}{3A}$$

$$\Rightarrow 1.5 = \frac{\mu_A}{3} + \frac{2.8}{3}$$

$$\mu_A = 1.7$$

12. C

Sol. First diffraction minima is formed at $\frac{\lambda D}{a} = \frac{4500 \times 10^{10} \times 1}{2 \times 10^{-6}} = 2.25$ mm
(where λ = 4500Å, a = 2 μm, D = 1 m)

Second diffraction minima is formed at $\frac{2\lambda D}{a} = 4.5$ mm

The interference fringe width is $\frac{\lambda D}{d} = \frac{4500 \times 10^{-10} \times 1}{9 \times 10^{-6}} = 0.5$ mm

So the 9th interference maxima falls on the 2nd diffraction minima. So this will be missing.

13. D

Sol. Flux remains unchanged for sudden change

$\therefore\ L_iI_i = L_fI_f$

$\therefore\ I_f = \frac{I_i}{2} = \frac{E}{2R}$

$L_i == \frac{\mu_0 N^2 A}{L},\ L_f == \frac{\mu_0\mu_r N^2 A}{L} = 2L_i$

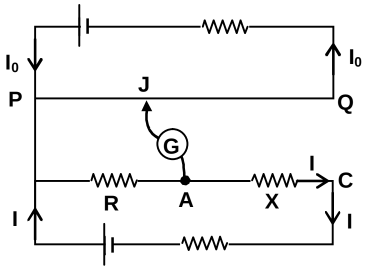
$\therefore$ If just after introducing iron cone is $\frac{I_i}{2} = \frac{E}{2R}$

(As $I_i = \frac{E}{R}$)

$\therefore\ I = \frac{E}{2R}e^{-\frac{Rt}{2L}} + \frac{E}{R}\left(1 - e^{-\frac{Rt}{2L}}\right) = \frac{E}{2R}\left(2 - e^{-\frac{Rt}{2L}}\right)$

14. D

Sol. In potentiometer wire potential difference is directly proportional to the length. Let potential drop per unit length of the potentiometer wire be K. For zero deflection in the galvanometer the current will flow independently in 2 loops.



So, IR = K × 20 …(i)

Also I(R + x) = K × 50 ….(ii)

Subtracting equation (ii) from equation (i)

IX = K × 30 …(iii)

Dividing equation (i) by equation (iii)

$\frac{R}{x} = \frac{20}{30} = \frac{2}{3} \Rightarrow X = \frac{3R}{2}$

15. C

Sol. The electric field intensity due to each uniformly charged infinite plane is uniform. The electric field intensity at point A, B, C and D due to plane 1, plane 2 and both planes are given by E_1, E_2 and E as shown in the figure-A. Hence the electric lines of forces are as given in figure –B.

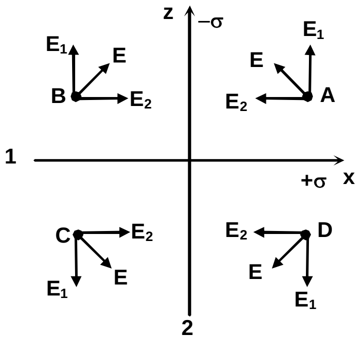


Figure –(A)

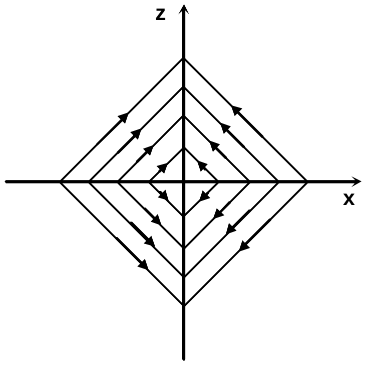


Figure –(B)

Alternate: electric lines of forces originate from positively charged plane and terminate at negatively charged plane. Hence, the correct representation of ELOF is as shown in figure –B.

16. B

Sol. $V_{outside} = \frac{KQ}{r}$ …(i)

For E_{in} use gauss law

$$E_{in} = \frac{\rho_0}{\varepsilon_0}\left(\frac{r}{3} - \frac{r^2}{4R_0}\right)$$

Now, $\int_{V_s}^{V_{in}} dV_{in} = \int_{r-R}^{r} \vec{E}_{in} \cdot dr$

$$V_{in} = \frac{\rho_0}{12R_0\varepsilon_0}(r^3 + 2R^3 - 2r^2R)$$

17. A

Sol. The magnitude of velocity can be written as

$v^2 = v_x^2 + v_y^2$

Differentiate

$$2v\frac{dv}{dt} = 2v_x\frac{dv_x}{dt} + 2v_y\frac{dv_y}{dt}$$

$0 = 2\,v_x a_x + 2v_y a_y$

So, $v_x a_x + v_y a_y = 0$

18. D

Sol. Apply continuity equation and Bernoulli's equation. At the same horizontal level pressure is less where velocity is more.

19. C

Sol. When block is slightly displaced towards right then

$F_r = -(2kx + 4kx)$

When block is slightly displaced towards left then

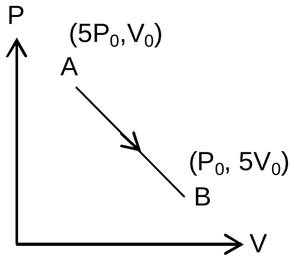
$F_r = -(2kx)$

20. C

Sol. System is released then acceleration of 3M and M must be equal. Hence friction force between sphere and plank is zero.

21. A

Sol. Equation of process



$$P = -\frac{P_0}{V_0}V + 6P_0 \qquad \text{...(1)}$$

Heat reverses its direction when slope of line is equal to

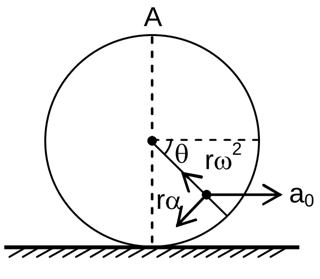
$$\frac{\gamma P}{V} = \frac{P_0}{V_0} \qquad \text{...(2)}$$

From equation (1) and (2)

$$V = \frac{7}{2}V_0, \quad P = \frac{5}{2}P_0$$

22. D

Sol. From lami's



$$\frac{a_0}{\sin 90^\circ} = \frac{r\alpha}{\sin(\pi - \theta)} = \frac{r\omega^2}{\sin\left(\frac{\pi}{2} + \theta\right)} \qquad \text{...(i)}$$

$a_0 = R\alpha$ ...(ii)

from above equations

$\sin\theta = r/R$

$\theta = 45^\circ$

23. A

Sol. $C = \frac{Q^2\Delta\theta}{m\cdot\gamma}$

$$\gamma = \frac{Q^2\cdot\Delta\theta}{m\cdot C} = \frac{[ML^2T^{-2}]^2\theta}{[M]\left[\frac{ML^2T^{-2}}{M\theta}\right]} = [ML^2T^{-2}\theta^2]$$

24. C

Sol. Till 1 sec

$x_A = 2t$

$x_B = t^2$

$x = x_A - x_B = 2t - t^2$

$\frac{dx}{dt} = 0$, t = 1 sec, x = 1 m

Now from 1 sec – 5 sec

$x_A = 2 + 4(t - 1)$

$x_B = t^2$

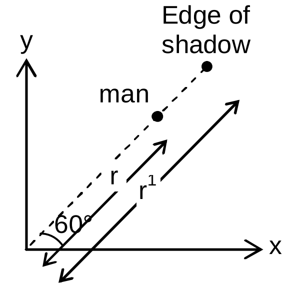
$x = x_A - x_B = 4t - 2 - t^2$

$\frac{dx}{dt} = 0$, t = 2 sec

x = 2 m

25. D

Sol. Let at any instant position of man is at r and its edge of shadow is r’ then



$$\frac{2}{r^1 - r} = \frac{5}{r^1}$$

$$3r^1 = 5r$$

$$\frac{3\cdot dr^1}{dt} = \frac{5\cdot dr}{dt}$$

$$3.V_s = 5\times 6$$

$$V_s = 10\ \text{m/s}$$

$$\vec{V}_s = 5\hat{i} + 5\sqrt{3}\hat{j}$$

26. A

Sol. $A = \int y\,dx$

$$= \int_0^R \left(x\tan\theta - \frac{1}{2}\frac{gx^2}{u^2\cos^2\theta}\right)dx$$

$$= \frac{2u^4}{3g^2}\sin^3\theta\cdot\cos\theta$$

Now, $\frac{dA}{d\theta} = 0$

$\theta = 60°$

27. C

Sol. $v_P = \sqrt{\frac{T}{\mu_P}} = 25\ \text{m/s}$

$$v_Q = \sqrt{\frac{T}{\mu_Q}} = 20\ \text{m/s}$$

$$A_r = \frac{|v_Q - v_P|}{v_Q + v_P} Ai = \frac{2}{9}\,\text{mm}$$

$$A_t = \frac{2v_Q}{v_Q + v_P} Ai = \frac{16}{9}\,\text{mm}$$

28. C

Sol. $E_x = -\frac{\partial V}{\partial x} = -(6yx + 3x^2z) = 0$

$E_y = -\frac{\partial V}{\partial y} = -(3x^2 - 2z) = -2$

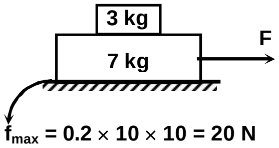
$E_z = -\frac{\partial V}{\partial z} = -(2y + x^3) = -2$

$|\vec{E}| = \sqrt{E_x^2 + E_y^2 + E_z^2} = 2\sqrt{2}$

29. C

Sol. $a_{\text{common}} = \frac{F - 20}{10} > 0$

F > 20 newton



30. C

Sol. W = ΔK

$W_g + W_{spring} = 0$

$m_1gx - m_2gx - \frac{1}{2}kx^2 = 0$

$m_1g - m_2g = \frac{kx}{2}$

$x = \frac{2(m_1 - m_2)g}{k}$ = 2/5 m.

Chemistry PART – II

SECTION – A

31. C

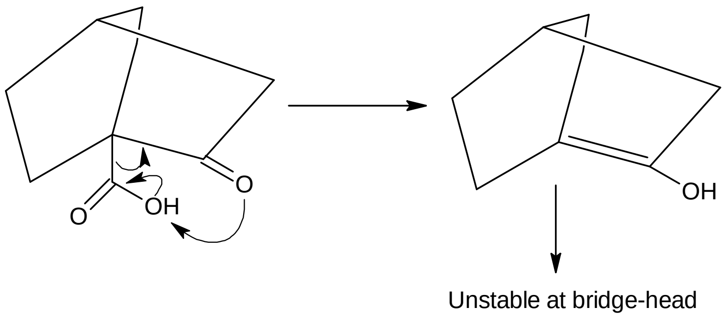
Sol. C_2 (12) = $\sigma 1s^2\ \sigma^*1s^2\ \sigma 2s^2\ \sigma^*2s^2\ \pi p_x^2\ \pi p_y^2$

x = 0, y = 2, z = 8

$$\therefore\ \frac{z-x}{y} = \frac{8-0}{2} = 4$$

32. C

Sol.

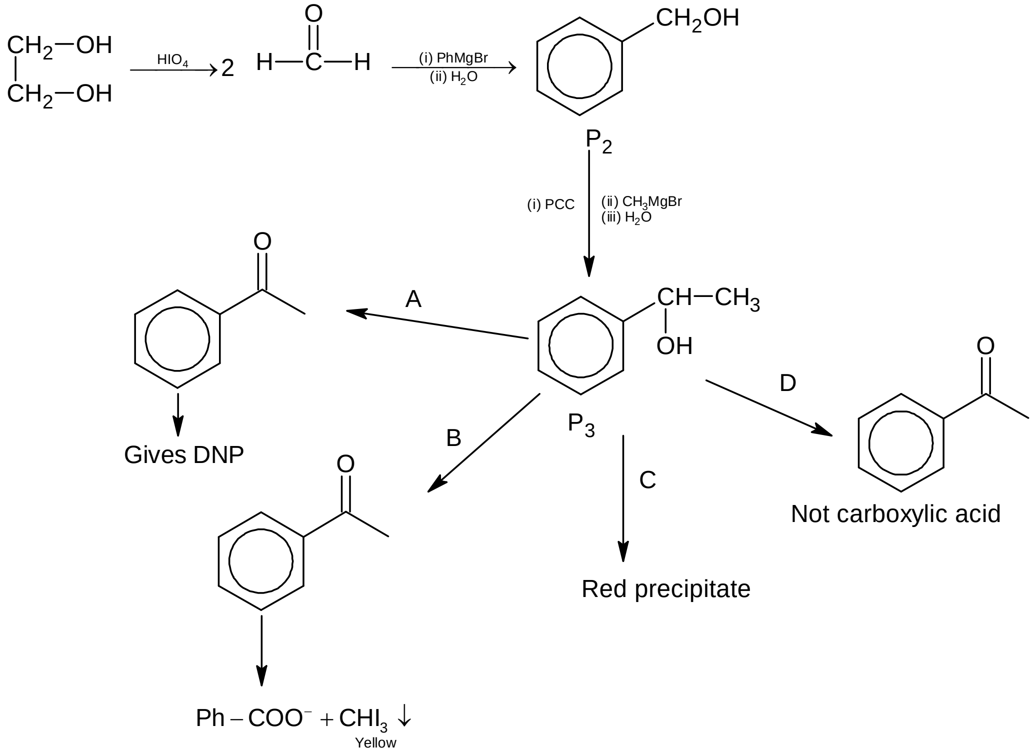

O
OH
O
OH
Unstable at bridge-head

33. A

Sol. N^{3-} is the strongest base amongst the following.

34. D

Sol.


CH2—OH
CH2—OH
HIO4
2 H—C(=O)—H
(i) PhMgBr
(ii) H2O
CH2OH
P2
(i) PCC
(ii) CH3MgBr
(iii) H2O
CH—CH3
OH
P3
A
B
C
D
O
Gives DNP
Red precipitate
Not carboxylic acid
Ph – COO⁻ + CHI3 ↓
Yellow

35. B

Sol. $\left[Fe(H_2O)_5NO\right]^{+2}$

Fe is in +1 state

n = 3 (unpaired e^-)

$\therefore \mu_s = \sqrt{n(n+2)} = \sqrt{15}$

36. C

Sol.

$$\text{Anode}: \frac{1}{2}H_2 \longrightarrow H^+ + e^-$$

$$\text{Cathode}: Ag^+ + e^- \longrightarrow Ag(s)$$

$$\frac{1}{2}H_2(g) + Ag^+(aq) \longrightarrow H^+(aq) + Ag(s)$$

$$E_{cell} = E^0_{Cell} - \frac{0.059}{1}\log\frac{\left[H^+\right]}{\left[Ag^+\right]}$$

$$Ag_2S \longrightarrow 2Ag^+ + S^{-2}$$

$$Ksp = 4\times10^{-12} = \left[Ag^+\right]^2\left[S^{2-}\right]$$

$$\left[Ag^+\right] = 2\times10^{-4}M$$

$$pH = pKa + \log\left(\frac{salt}{acid}\right)$$

$$= 5 + \log\left(\frac{0.1}{0.1}\right)$$

$$= 5$$

$$E_{cell} = 0.8 - \frac{0.059}{1}\log\left(\frac{10^{-5}}{2\times10^{-4}}\right)$$

= 0.8767 V

37. A

Sol. $$\frac{1}{2}\left(-\frac{dA}{dt}\right) = \frac{1}{3}\left(+\frac{dZ}{dt}\right)$$

$$\frac{dZ}{dt} = \frac{3}{2}\times 2\times10^{-4} = 3\times10^{-4}$$

38. D

Sol. $NaBH_4$ reduces aldehydes and ketones not esters.

39. B

Sol. M. P. of diamond ≈ 3930°C.

40. D

Sol.

$$\begin{array}{ll} A \longrightarrow & 3B \\ P_o & - \\ P_o - P & 3P \\ - & 3P_o \end{array}$$

$$P_\infty = 3P_o \Rightarrow P_o = \frac{P_\infty}{3}$$

$$P_T = P_o + 2P$$

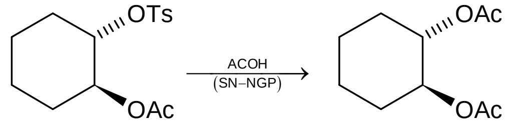
$$P = \frac{P_T - P_o}{2}$$

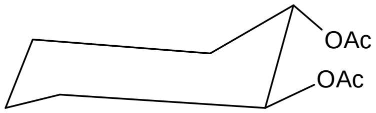
$$K = \frac{1}{t}\ln\left(\frac{P_o}{P_t}\right) \qquad P_t = P_o - P$$

$$= \frac{1}{t}\ln\left\{\frac{P_\infty/3}{\frac{P_\infty}{3} - \left(\frac{P_T - P_o}{2}\right)}\right\} = \frac{1}{t}\ln\left(\frac{2P_\infty}{3P_\infty - 3P_T}\right)$$

41. A

Sol.


OTs
OAc
ACOH
(SN–NGP)
OAc
OAc



Major product and most stable conformation

42. C

Sol. The elements in middle of the d-block do not form hydrides this is known as hydrogen-gap.

43. B

Sol. I. E_1 = B – 801 in (KJ mol^{-1})

Al – 577

Ga – 579

In – 558

Tl – 589

44. D

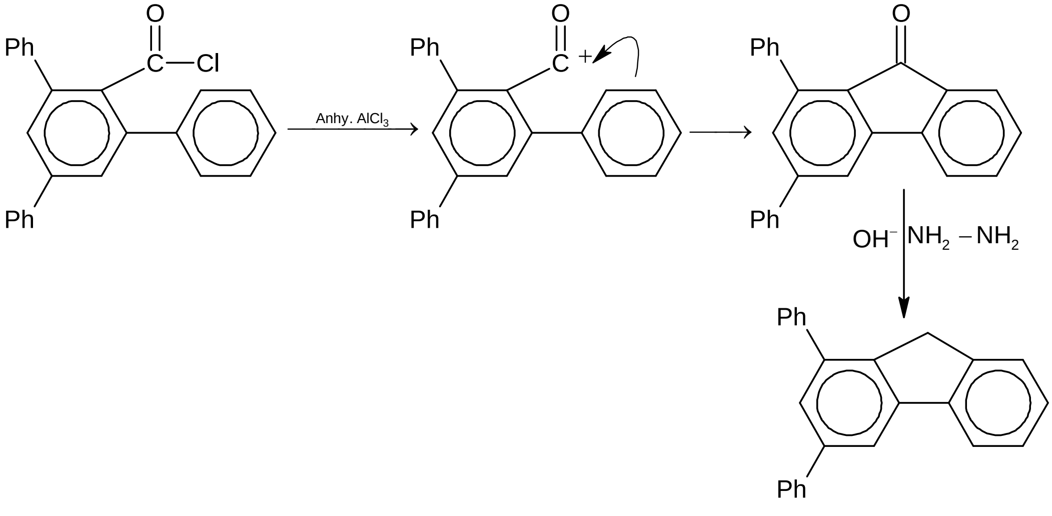
Sol. Trans-$[CoCl_2(en)_2]^+$ contains plane of symmetry.

45. A

Sol. Probability is explained by Quantum theory and not by Bohr Model.

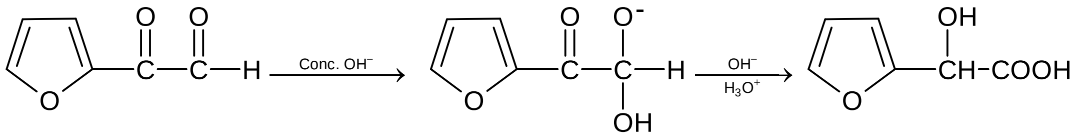
46. C

Sol.


O
Ph
C—Cl
Ph
Anhy. AlCl3
O
Ph
C +
Ph
O
Ph
Ph
OH⁻ NH2 – NH2
Ph
Ph

47. C

Sol.


O
O
C
C
H
O
Conc. OH$^-$
O
O$^-$
C
C
H
OH
O
OH$^-$
H$_3$O$^+$
OH
CH–COOH
O

48. B

Sol. $SnCl_2$ – $Na[Sn(OH)_3]$
$CrCl_3$ + NaOH – $Na_3[Cr(OH)_6]$
$ZnCl_2$ – $Na_2[Zn(OH)_4]$
$BeCl_2$ – $Na_2[Be(OH)_9]$
$AlCl_3$ – $Na[Al(OH)_4]$
All soluble

49. C

Sol. $KClO_3 \longrightarrow KCl + \frac{3}{2}O_2 \uparrow$

$KClO_3$ decomposes (with higher mass) and KCl is formed (lower mass),
$\therefore$ decrease in mass w.r.t. initial stage.

50. A

Sol. $\log\frac{x}{m} = \log k + \frac{1}{n}\log P$

Log k = 0.699
$\therefore$ k = 5

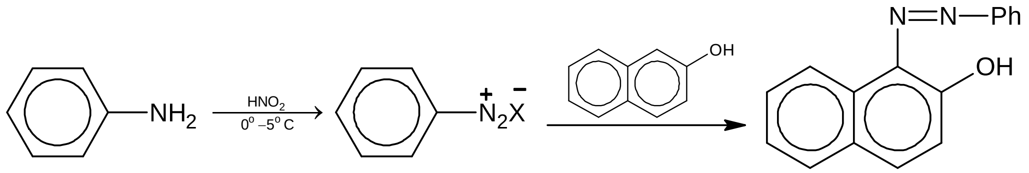
Slope = tanθ = tan 45° = 1 = $\frac{1}{n}$

$\therefore\ \frac{x}{m} = k.p^{\frac{1}{n}}$

= $5 \times (0.5)^{1/1}$
= 2.5 g/g adsorbent.

51. C

Sol.


NH$_2$
HNO$_2$
0^o–5^o C
$\overset{+}{N}_2\overset{-}{X}$
OH
N=N—Ph
OH

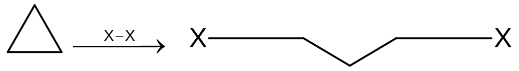
Red dye

52. A

Sol. Copper matte has Cu_2S and FeS along with Cu_2O.

53. D

Sol. (A)

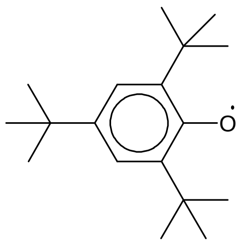


Preffered addition

(B) Reactivity : Chlorination > Bromination.

Reactivity $\propto \frac{1}{\text{selectivity}}$

(C)

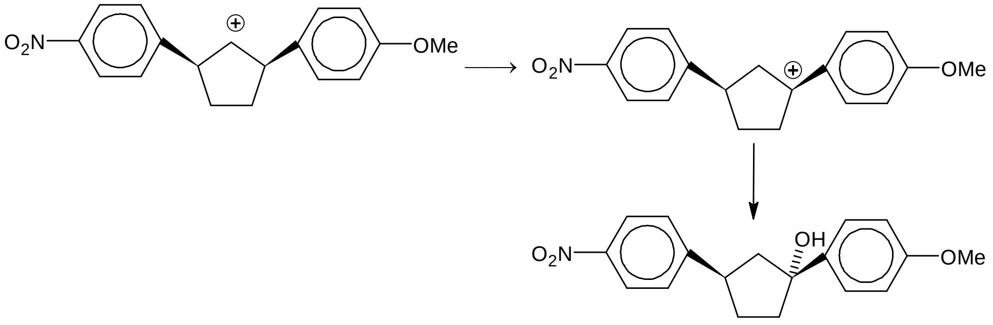


Sterically hindered so cannot give
dimerisation reaction.

(D) Boling point = RCl > RF (R = CH_3)
Dipole moment = $CH_3 - F = 1.847$
$CH_3 - Cl = 1.860$

54. D

Sol.



55. A

Sol. $Ca + 2H_2O \longrightarrow H_2\uparrow + Ca(OH)_2$

$CaH_2 + H_2O \longrightarrow Ca(OH)_2 + 2H_2\uparrow$

56. B

Sol. $Y_{(CCP)} = 4$ $X_{(Oct.\ void)} = 4$

Atoms along one B. D removed $\therefore$ $Y = \frac{15}{4}$, X = 3

Z → introduced in available voids = 2 Td. Voids + 1 oct. void = 3

$X_3Y_{\frac{15}{4}}Z_3 \Rightarrow X_4Y_5Z_4$

57. C

Sol. For isothermal process,
$P_1V_1 = P_2V_2$
$32\ P_oV_o = P_oV'$
$V' = 32V_o$
For process R → Q
$W = -P\Delta V = -P_o[V_o - V']$
$= -P_o[V_o - 32V_o]$
$W = 31\ P_oV_o$

58. B

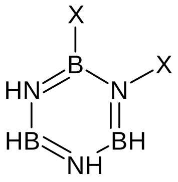
Sol. Na + S + C + N $\xrightarrow{\Delta}$ NaSCN (Sodium extract)

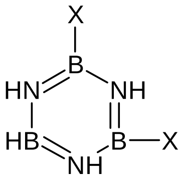
59. D

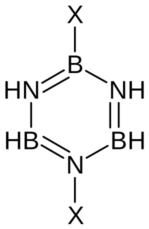
Sol. NaOH → High conductance.
On adding mixture, conductance ↓, after end point HCl + CH_3COOH mixture will have H^+ from HCl, ∴ conductance ↑ again.

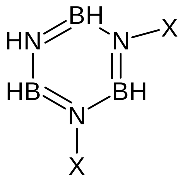
60. D

Sol.


X
B
HN
N
X
BH
HB
NH


X
B
HN
NH
HB
B
X
NH


X
B
HN
NH
HB
BH
N
X


BH
HN
N
X
HB
BH
N
X

Mathematics

PART – III

SECTION – A

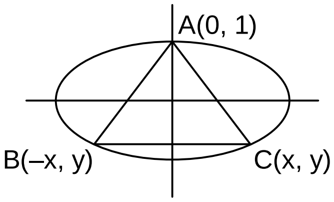
61. A

Sol. Equation of AB

$\Rightarrow \left(y = \sqrt{3}x + 1\right)$

Solve with ellipse

$BC = \dfrac{16\sqrt{3}}{13}$



62. B

Sol. $\tan^{-1}\left(\dfrac{4}{r^2 + r + 16}\right) = \tan^{-1}\left(\dfrac{r+1}{4}\right) - \tan^{-1}\left(\dfrac{r}{4}\right)$

63. B

Sol. $(x - 1)^2 + (y - 2)^2 + \lambda(x - y + 1) = 0$

Satisfy (1, 0), get λ

64. A

Sol. $x_1^2 + f^2(x_1) - 9 < 0$

65. C

Sol. If (1, 8, 0) occupy odd places $\rightarrow$ 4

If (3, 6, 0) occupy odd places $\rightarrow$ 8

Total : 12

66. B

Sol. $|z_1| = |z_2| = |z_3| = 5$

67. D

Sol. Differentiate both sides, g(x) = tan x

68. A

Sol. $f(x) = \left(\sqrt{x^3 + 1} - 1\right)$ then $f^{-1}(x) = \sqrt[3]{x^2 + 2x}$

69. C

Sol. $\dfrac{P(e_1e_2e_3) + P(o_1o_2e_1)}{P(e_1e_2e_3) + P(o_1e_1o_2) + P(e_1o_1o_2) + P(o_1o_2e_1)} = \dfrac{13}{28}$

70. A

Sol. $\sin\alpha = k\cos\dfrac{\alpha}{2} \Rightarrow \sin\dfrac{\alpha}{2} = \dfrac{k}{2}$

$\int_{\alpha}^{\pi}\left(\sin x - k\cos\dfrac{x}{2}\right)dx = 1 \Rightarrow k = 2 \pm \sqrt{2}$

$-1 \le \sin\dfrac{\alpha}{2} \le 1,\ k = 2 - \sqrt{2}$

71. C

Sol. $AB = -BA \Rightarrow A^{-1}AB = -A^{-1}BA \Rightarrow B = -A^{-1}BA \Rightarrow BA^{-1} = -A^{-1}B$

$(A^{-1}B)^T = B^T(A^T)^{-1} = -BA^{-1} = A^{-1}B$

72. A

Sol. $f(x) = 1 + x^2\int_0^1 y^2 f(y)dy + x\int_0^1 f(y)dy$

f(x) = 1 + ax^2 + bx, put in the equation and solve, we get $b = f'(0) = \frac{164}{57}$

73. C

Sol. $|a + b + c + d|^2 = \sum|a|^2 + 2\sum\vec{a}\cdot\vec{b} = 4 + 2\vec{d}\cdot\left(\vec{a}+\vec{b}+\vec{c}\right)$

Let $d = \lambda\vec{a} + \mu\vec{b} + \nu\vec{c}$

$\lambda = \mu = \nu = \cos\alpha \Rightarrow \cos\alpha = \frac{1}{\sqrt{3}}$ as $\alpha \in \left(0, \frac{\pi}{2}\right) \Rightarrow |a + b + c + d|^2 = 4 + 2\sqrt{3}$

74. D

Sol. g(x) is increasing $\int_1^6 g'(x)dx \le \int_1^6 \frac{2}{x}dx \Rightarrow g(6) - g(1) \le 2\ell n 6$

75. C

Sol. $\sin\left(\frac{\pi}{12}\right) = \frac{\sqrt{6}-\sqrt{2}}{4}$, $\cos\frac{\pi}{12} = \frac{\sqrt{6}+\sqrt{2}}{4}$

$\sin\left(x + \frac{\pi}{12}\right) = \sin 2x$

$x = \frac{\pi}{12}, \frac{11\pi}{36}$

76. D

Sol. $T = \int_0^{\ell n 2} \frac{\left(2e^{2x} + e^x - e^{-x}\right)}{\left(e^{2x} + e^x - 1 + e^{-x}\right)}dx$

$T \Rightarrow \ell n\frac{11}{4} \Rightarrow T = \frac{11}{4}$

77. A

Sol. F(x) = F(x + 1)

$\int_0^{1500} F(x)dx = 1500\left(\int_0^{1/2} F(x)dx + \int_{1/2}^1 F(x)dx\right)$

Now put $x = y + \frac{1}{2}$ in 2nd integral

78. B

Sol. $\lim_{n\to\infty}\left(\frac{1}{2n+1} + \frac{1}{2n+2} + \frac{1}{2n+3} + ... + \frac{1}{4n}\right) - \lim_{n\to\infty}\left(\frac{1}{2n+2} + \frac{1}{2n+4} + ... + \frac{1}{4n}\right)$

$\Rightarrow \int_0^2 \frac{dx}{2+x} - \int_0^1 \frac{dx}{2+2x}dx = \frac{1}{2}\ell n 2$

79. B

Sol. P ≡ (6 + 8i), apply rotation, R = (3 + 7i)

80. D

Sol. a + b = 0 ⇒ a = –4, b = 4

$$\text{Area} = 2\int_0^{1/4}\sqrt{x}\,dx = \frac{1}{6}$$

81. B

Sol. Plane is 2x + 3y + 6z = 35

82. C

Sol. All alike + (2 alike, 2 alike, 2 alike) + (2 alike + 4 alike) + (3 alike + 3 alike) = 1405

83. B

Sol. Variance is independent of shifting of origin

84. A

Sol. $\sim(p \to q) \to (q \to p) \equiv T$

and $\sim\{(p \to q) \wedge (\sim q \wedge p)\} \equiv \sim\{(p \to q) \wedge (\sim(p \to q))\} \equiv T$

85. A

Sol. Let $I = \int_0^1 \ell nx \cdot \ell n(1-x)\,dx = -\int_0^1 \ell nx \sum_{n=1}^{\infty}\frac{x^n}{n}\,dx$

$$\Rightarrow -\sum_{n=1}^{\infty}\frac{1}{n}\int_0^1 x^n \ell nx\,dx$$

Use integration by parts, then

$$I = \sum_{n=1}^{\infty}\left(\frac{1}{n}-\frac{1}{n+1}\right)-\sum_{n=1}^{\infty}\frac{1}{(n+1)^2}$$

$\Rightarrow I = 2 - \frac{\pi^2}{6}$, p + q + r = 10

86. D

Sol. AP = x cot 60°

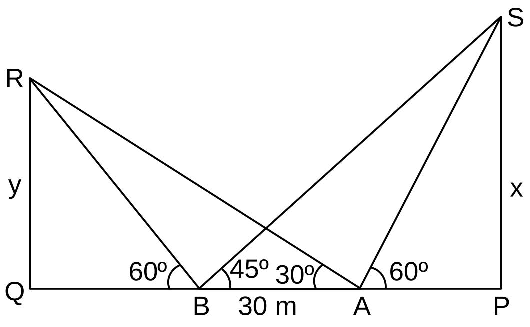
BP = x cot 45°

⇒ PB – AP = AB

$30\sqrt{3} = \left(\sqrt{3}-1\right)x$

Similarly, $y = 15\sqrt{3}$

⇒ PQ = $\left(60+15\sqrt{3}\right)$m



87. A

Sol. $AC\cdot BC = SC^2 = \left(\frac{4}{\sqrt{2}}\right)^2$

88. B

Sol. AOCB is a rhombus $h^2 + k^2 = 4r^2$

89. B

Sol. Given expression is $\prod_{r=1}^{n}\left(\frac{8r^2-12r+5}{8r^2+4r+1}\right)=\frac{1}{8n^2+4n+1}$

$k_1 = 8$, $k_2 = 4$, $k_3 = 1$

90. B

Sol. $\lim_{n\to\infty} n\tan\left(4\pi n!\left(1+\frac{1}{1!}+\frac{1}{2!}+.....+\frac{1}{n!}+\frac{1}{(n+1)!}+.....\infty\right)\right)$

$$= \lim_{n\to\infty}\frac{n\tan\left(4\pi\left(\frac{n!}{(n+1)!}+\frac{n!}{(n+2)!}+.....\infty\right)\right)}{4\pi\left(\frac{n!}{(n+1)!}+.....\infty\right)}\times 4\pi\left(\frac{n!}{(n+1)!}+.....\infty\right) = 4\pi = L$$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VII

JEE (Main)-2019

TEST DATE: 24-03-2019

Time Allotted: 3 Hours **Maximum Marks: 360**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only one section: **Section-A**.

  Section-A (01 – 30, 31 – 60, 61 – 90) *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

PART – I

SECTION – A

(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. At t = 0, an object is projected from ground with an initial velocity of 50 m/s directed at angle 53° above the horizontal. After some time it explodes in air into two parts with the mass ratio 1 : 2. Take the point of projection as origin and horizontal and vertical directions as x and y axes respectively. The motion of object is confined to the xy plane. At t = 5 sec, the coordinates of the lighter part is (100m, 50m). The coordinates of the heavier part at this moment (i.e. t = 5 sec) will be (Given g = 10 m/s^2, $\cos 53^\circ = \frac{3}{5}$)

(A) (125 m, 175 m)

(B) ($\frac{175}{2}$m , 175 m)

(C) (175m, 175 m)

(D) (175 m, $\frac{175}{2}$m)

2. A particle of mass m is thrown vertically upwards in air with initial velocity v_0. During the motion air exerts a resistive force of magnitude F = kv^2 opposite to its motion where v is the instantaneous velocity of the particle and k is a constant. The maximum height attained by the particle from the point of the projection is

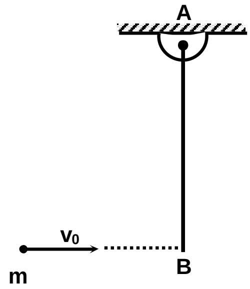
(A) $\frac{m}{k}\ell n\left(\frac{g+\frac{kv_0^2}{m}}{g}\right)$

(B) $\frac{m}{2k}\ell n\left(\frac{g+\frac{kv_0^2}{m}}{g}\right)$

(C) $\frac{2m}{k}\ell n\left(\frac{g+\frac{kv_0^2}{m}}{g}\right)$

(D) $\frac{m}{k}\ell n\left(\frac{g+\frac{kv_0^2}{m}}{2g}\right)$

3. A thin uniform rod of length ℓ and mass m suspended vertically is free to rotate about a smooth horizontal axis which passes through its end A. A point mass m moving horizontally with velocity v_0 hits the lower end B of the rod and sticks to it. After collision the rod just reaches the horizontal position. Which of the following statements is **WRONG**?



(A) The value of v_0 is $\sqrt{4g\ell}$

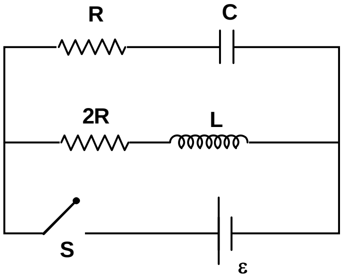
(B) The angular acceleration of the rod when it reaches the horizontal position is $\frac{9g}{8\ell}$

(C) The magnitude of reaction force by the hinge on the rod in horizontal position is $\frac{5mg}{8\ell}$

(D) The magnitude of acceleration of centre of mass of the system (rod + point mass) when the rod is in horizontal position is $\frac{27g}{32}$.

4. In the circuit shown in the figure switch S is closed at t = 0. Then which of the following statements is **WRONG**.

(Given : $R = \sqrt{\frac{L}{2C}}$)



(A) Initial current through the battery is ε/R.

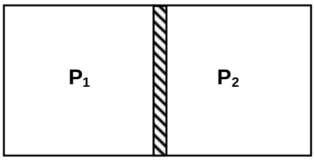
(B) After a long time current through battery is $\frac{\varepsilon}{2R}$.

(C) The current in the battery is $\frac{5}{8}$ times its initial value at t = RCℓn2.

(D) The currents in the inductor and the capacitors are equal at t = RCℓn3.

5. A pipe P open at one end but closed at the other end is filled with hydrogen gas at temperature 27°C. An another pipe Q is open at both ends and having length equal to twice the length of pipe P is filled with Helium gas at temperature 77°C. The pipe P is vibrating in its first overtone and pipe Q is vibrating in its second overtone. The ratio of their frequencies of vibration is
(A) 5/3
(B) 6/5
(C) 3/10
(D) 1/4

6. Figure shows an adiabatic cylindrical container of volume $2V_0$ divided in two parts by a frictionless movable adiabatic piston. Initially the piston is in middle and the two parts of container contain an ideal monatomic gas at pressures P_1 and P_2 respectively. The piston is now released and allowed to move slowly until mechanical equilibrium is attained. The gas pressure now is



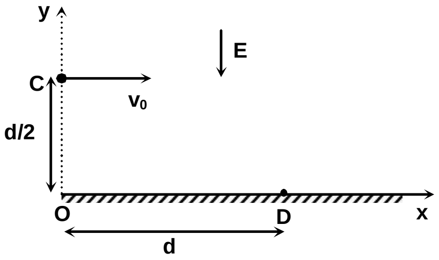
(A) $\frac{P_1 + P_2}{2}$

(B) $\frac{\left(P_1^{3/5} + P_2^{3/5}\right)}{2}$

(C) $\dfrac{\left(P_1^{3/5}+P_2^{3/5}\right)^{5/3}}{2^{5/3}}$

(D) $\dfrac{\left(P_1^{3/2}+P_2^{3/2}\right)^{2/3}}{2^{2/3}}$

7. A particle of mass m and charge q moving in gravity free space with velocity v_0 parallel to x-axis enters a region of uniform electric field $-E\hat{j}$ at point C. At the moment particle collides elastically with a smooth surface at D the electric field E is switched off and a magnetic field $\vec{B}=-B_0\hat{k}$ is switched on. If the particle hit the surface at point O after rebounding from point D, then B_0 is equal to



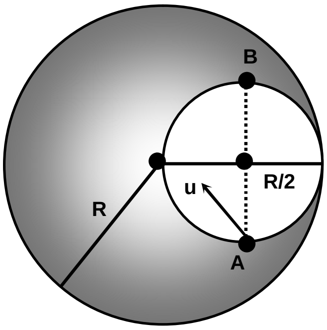
(A) $\sqrt{\dfrac{2mE}{qd}}$

(B) $2\sqrt{\dfrac{mE}{qd}}$

(C) $\sqrt{\dfrac{mE}{2qd}}$

(D) $\dfrac{1}{2}\sqrt{\dfrac{mE}{qd}}$

8. An infinite long cylinder of radius R has a cylindrical cavity of radius R/2 just touching its surface. The region inside the cylinder is filled with uniform charge density ρ except in the cavity. A charge particle of charge q and mass m is thrown from point A in the cavity. Find the minimum velocity u required at A for it to reach point B. AB is perpendicular to the diameter of the cavity passing through the axis of the cylinder.



(A) $\sqrt{\dfrac{q\rho R^2}{4\varepsilon_0 m}}$

(B) $\sqrt{\dfrac{q\rho R^2}{2\varepsilon_0 m}}$

(C) $\sqrt{\dfrac{2q\rho R^2}{\varepsilon_0 m}}$

(D) $\sqrt{\dfrac{4q\rho R^2}{\varepsilon_0 m}}$

9. A car moving toward a wall with a speed $\dfrac{v}{10}$ and wind is blowing in the direction from wall towards the car with same speed $\dfrac{v}{10}$, where v is the speed of sound with respect to air. The driver of the car sounds a whistle with a frequency f. The frequency of the echo as heard by the driver of the car is equal to

(A) $\frac{9f}{8}$

(B) $\frac{27f}{22}$

(C) $\frac{12f}{11}$

(D) $\frac{32f}{33}$

10. The mean time between successive collision between the molecules of an ideal gas is τ. If the gas is isobarically heated to twice its initial volume. As a result the mean time between successive collision between the molecule becomes.

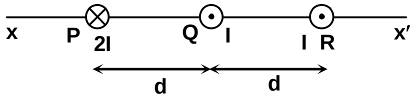
(A) $\sqrt{2}\tau$

(B) $\frac{\tau}{\sqrt{2}}$

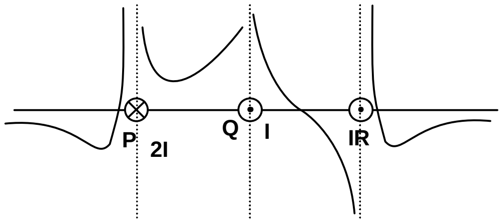
(C) $\frac{\tau}{2}$

(D) 2τ

11. Three long parallel current carrying wires are placed with their lengths normal to the plane of paper. The magnitude and direction of current are shown in the figure. The currents in wire P is 2I into the plane of paper. The current in each of wires Q and R is I and directed out of the plane of the paper. The variation of magnetic field along the line xx′ given by



(A)



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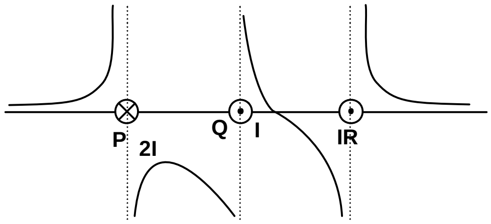

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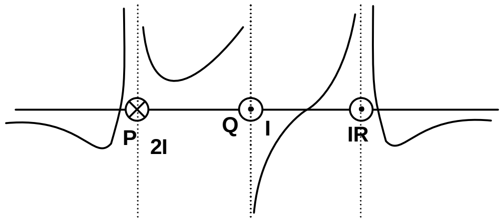

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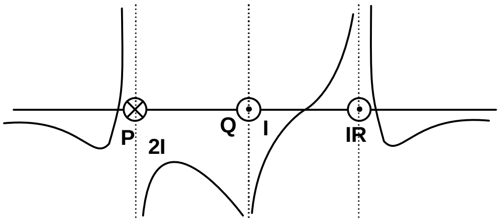
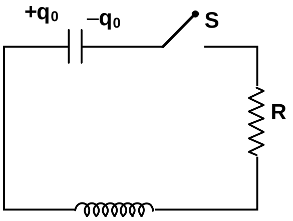


12. The distance moved by the screw of a screw gauge is 2 mm in four rotations and there are 50 divisions on its circular scale. Before starting the measurement, it is found that when the two jaws of the screw gauge are brought in contact 48th division of circular scale coincides with main scale line with zero of the main scale is barely visible. When a plate is placed between the jaws, main scale reads 1 mm and 6th division of the circular scale coincides with the main scale line. Thickness of the plate is
(A) 1.06 mm
(B) 1.04 mm
(C) 1.08 mm
(D) 1.12 mm

13. Which of the following equations is dimensionally correct? (k = Boltzmann constant, T = temperature, C = Capacitance, V = Potential difference, L = Inductance, h = Planck's constant, I = current, R = Resistance, ε_0 = permittivity of free space and ℓ = length)
(A) $\frac{k}{V} = \frac{C}{T}$
(B) $\frac{L}{h} = I\,RC$
(C) $\frac{I^2}{h^2} = RC^2$
(D) $\frac{\varepsilon_0 E^2}{I^2} = \frac{L}{\ell^3}$

14. In the given circuit initially the switch S is open and the capacitor has charge q_0. The switch is closed at time t = 0. Find the time when the amplitude of charge on capacitor will be $\frac{q_0}{2}$. (Assume that resistance R is quite small and damped oscillations are setup in the circuit)



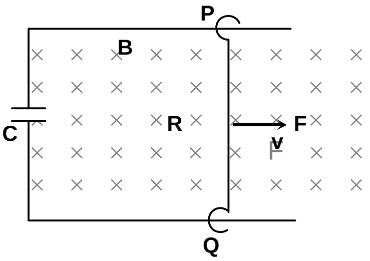
(A) $\frac{L}{R}\ell n2$
(B) $\frac{2L}{R}\ell n2$
(C) $RC\ell n2$
(D) $2RC\ell n2$

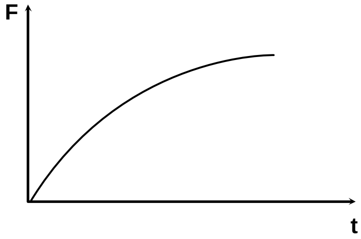
15. A point source of heat of power P is placed at the centre of a spherical shell of mean radius R. The material of shell has thermal conductivity k. If the temperature difference between the outer and inner shell is not to exceed T, then thickness of the shell should not be more than
(A) $\frac{2\pi R^2 kT}{P}$

(B) $\frac{4\pi R^2 kT}{P}$
(C) $\frac{\pi R^2 kT}{P}$
(D) $\frac{\pi R^2 kT}{4P}$

16. A stationary nucleus disintegrates suddenly in two nuclei X and Y. The ratio of the kinetic energy of the two nuclei X and Y after the disintegration is 1 : 2, the ratio of the radii of the nuclei X and Y will be
(A) 2
(B) $2^{2/3}$
(C) $\frac{1}{2^{1/3}}$
(D) $2^{1/3}$

17. In the given circuit two conducting parallel wires are connected by a connector PQ of resistance R. The end of the wires are connected by a capacitor of capacitance C. There is a uniform magnetic field B in the entire region directed into the plane of the paper. The connector is given an initial velocity v with the capacitor initially uncharged, simultaneously a variable force F(t) is applied to maintain the velocity v constant. The magnitude of force F varies with time as



(A)


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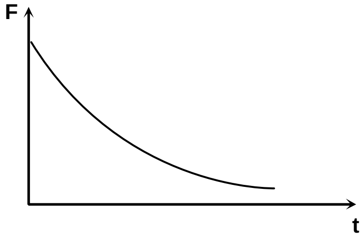

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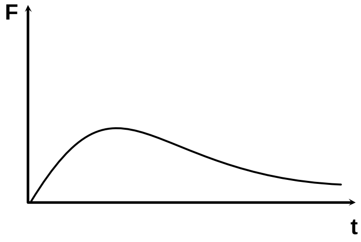
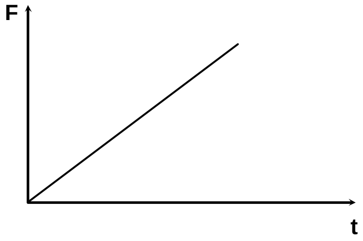


(D)



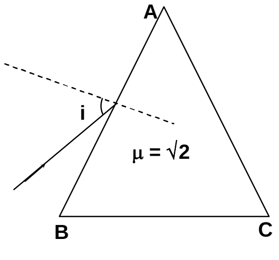
18. The peak value of magnetic field at a distance 6 m from a bulb is 2×10^{-8} T. Assuming that 10% of power consumed by the bulb is converted into light energy, the power consumed by the bulb is
(A) 432 W
(B) 216 W
(C) 1080 W
(D) 108 W

19. Two Polaroids are placed in the path of unpolarised beam of intensity I_0 such that no light is emitted from the second polaroid. If a third polaroid whose transmission axis makes an angle θ with transmission axis of the first polaroid is placed between these polaroid then the intensity of light emerging from last polaroid will be
(A) $\left(\frac{I_0}{8}\right)\sin^2 2\theta$
(B) $\left(\frac{I_0}{4}\right)\sin^2 \theta$
(C) $\left(\frac{I_0}{24}\right)\cos^2 \theta$
(D) $I_0 \cos^4 \theta$

20. A magnet is suspended in such a way that it executes simple harmonic motion in horizontal plane. It makes 20 oscillations per minute at a place where dip angle is 30° and 15 oscillations per minute at place where dip angle is 60°. The ratio of earth's magnetic field at two places is
(A) $2\sqrt{2} : 3$
(B) $4 : 9$
(C) $16 : 9\sqrt{3}$
(D) $3\sqrt{3} : 8$

21. A point object is placed at a distance of 25 cm from a convex lens of focal length 24 cm. If a glass slab of thickness t and refractive index 1.5 is inserted between the lens and the object the final image is formed at infinity. The thickness t is
(A) 1 cm
(B) 3 cm
(C) 2 cm
(D) 4 cm

22. A ray of light is incident on surface AB of an equilateral prism of refractive index $\sqrt{2}$. What should be the maximum angle of incidence i so that the ray could not emerge in air from surface AC
(A) 30°
(B) 45°
(C) $\sin^{-1}(0.366)$
(D) $\sin^{-1}(0.677)$



23. A stationary hydrogen atom of mass M emits a photon corresponding to the first line of Lyman series. If R is the Rydberg's constant, the speed of recoil of the atom after the emission of the photon is

(A) $\frac{3Rh}{4M}$

(B) $\frac{Rh}{4M}$

(C) $\frac{Rh}{2M}$

(D) $\frac{Rh}{M}$

24. The kinetic energy of most energetic electrons emitted from a metallic surface is doubled when the wavelength of the incident radiation is changed from 400 nm to 310 nm. The work function of the metal is (given hc = 1240 eV-nm)

(A) 0.9 eV
(B) 3.1 eV
(C) 1.7 eV
(D) 2.2 eV

25. A sphere and a cube of same material, same volume and heated to the same temperature are allowed to cool in the same surroundings. The ratio of their initial rate of cooling is

(A) $(6\pi)^{1/3}$

(B) $\left(\frac{\pi}{6}\right)^{1/3}$

(C) $\left(\frac{\pi}{3}\right)^{1/3}$

(D) $\left(\frac{2\pi}{3}\right)^{1/3}$

26. n identical liquid drop each of radius r combined to form a bigger drop. Assuming that energy released in the process is converted into kinetic energy of the bigger drop, the speed of the bigger drop is (given surface tension of the liquid = T and density of the liquid = ρ)

(A) $\sqrt{\frac{3T}{r\rho}\left(1-\frac{1}{n^{1/3}}\right)}$

(B) $\sqrt{\frac{6T}{r\rho}\left(1-\frac{1}{n^{1/3}}\right)}$

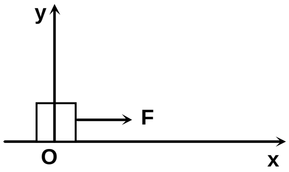
(C) $\sqrt{\frac{6T}{r\rho}\left(1-\frac{1}{n^{2/3}}\right)}$

(D) $\sqrt{\frac{3T}{r\rho}\left(1-\frac{1}{n^{2/3}}\right)}$

27. A satellite is revolving in geostationary orbit of radius r around the Earth. If the angular velocity of rotation of the Earth becomes half of its present value, the new radius of geostationary orbit for satellite will be
(A) $4^{1/3}r$
(B) $2^{1/3}r$
(C) $4^{2/3}r$
(D) r

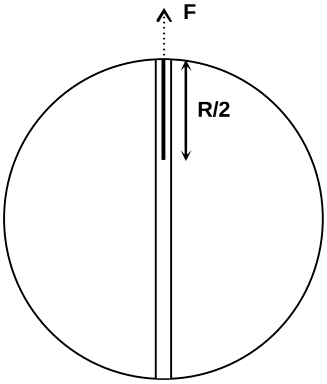
28. A message signal of frequency 60 kHz and peak voltage 8V is used modulate a carrier of frequency 2 MHz and peak voltage of 20 V. Then
(A) The frequencies of the side bands are 2050 Hz and 1940 Hz
(B) The frequencies of the side bands are 2040 Hz and 1940 Hz
(C) The modulation index is 0.8
(D) The modulation index is 0.4

29. A block of mass m is placed on a rough horizontal surface at x = 0. The coefficient of friction between the block and the surface varies as $\mu = kx$ where k is a constant. A constant horizontal force F is applied on the block. Then the maximum velocity of block will be



(A) $\sqrt{\dfrac{F^2}{km^2g}}$
(B) $\sqrt{\dfrac{F^2}{2km^2g}}$
(C) $\sqrt{\dfrac{2F^2}{km^2g}}$
(D) $\sqrt{\dfrac{F^2}{4km^2g}}$

30. Suppose a frictionless tunnel is made inside the earth along a diameter. A string of mass m and length R/2 is suspended in the tunnel with one end of the string at the surface of the earth. A force F is applied to pull the string slowly to the surface to the earth. Find the work done by the force F to pull the string completely on the surface of the earth. (Given acceleration due to gravity on the surface of the earth = g, radius of the earth = R)



(A) $\dfrac{mgR}{2}$
(B) $\dfrac{3mgR}{4}$
(C) $\dfrac{5mgR}{12}$
(D) $\dfrac{5mgR}{24}$

Chemistry

PART – II

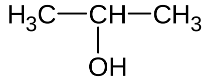
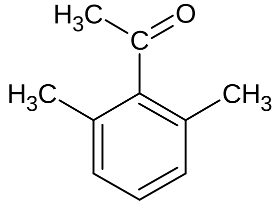
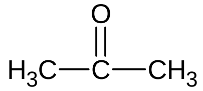
SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

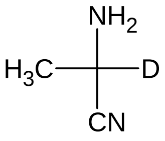
31. Which of the following orders is correct with respect to the given property?
    - (A) $SiF_4 > SiCl_4$ Dipole moment order
    - (B) $MgCO_3 > SrCO_3 > BaCO_3$
      P_{CO_2} order when kept at a fixed temperature in a closed container.
    - (C) $XeF_2 > XeF_4$ Dipole moment order
    - (D) LiBr > LiCl > LiF Lattice energy order

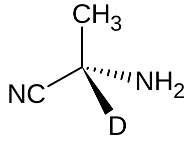
32. pH of a saturated solution of $Ba(OH)_2$ is 12. Hence, K_{sp} of $Ba(OH)_2$
    - (A) 5×10^{-7}
    - (B) 5×10^{-4}
    - (C) 10^{-6}
    - (D) 4×10^{-5}

33. Which of the following option is correct?
    - (A) Borazine is a polar molecule
    - (B) All B – H bond lengths in diborane are equal
    - (C) B_2O_3 reacts as a basic oxide with P_2O_5
    - (D) The order of Lewis acidity
      $BF_3 > BCl_3 > BBr_3$

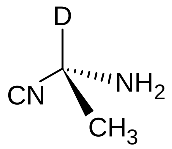
34. Which of the following molecules does not undergo Iodoform reaction
    - (A) 
      $H_3C-\underset{OH}{\underset{|}{CH}}-CH_3$
    - (B) $CH_3 - CH_2 - OH$
    - (C) 
    - (D) 
      $H_3C-\overset{\overset{O}{||}}{C}-CH_3$

35. Which of the following configuration is identical with given configuration?

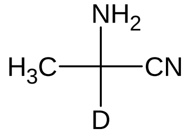


    - (A) 

(B)



(C)



(D) None of these

36. The migration of colloidal particles under the influence of the electric field is called.
    (A) electro osmosis
    (B) endosmosis
    (C) electrophoresis
    (D) electrolysis

37. In the following reaction sequences, compounds B and C are respectively:

$$Na_2S_2O_3 \xrightarrow{\text{dil.}H_2SO_4} Na_2SO_4 + S\downarrow + B(\text{gas})$$

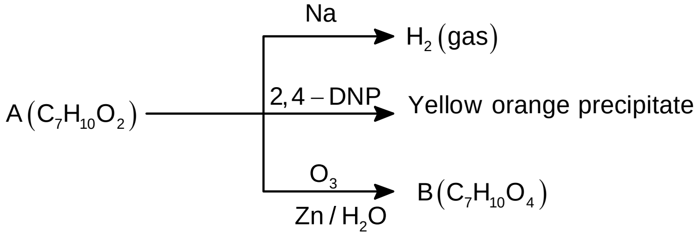
$$\begin{tikzcd} B + Ba(OH)_2 \arrow[r] & C\downarrow(\text{white ppt}) + H_2O \arrow[d, "B"] \\ & \text{Clear solution} \end{tikzcd}$$

(A) H_2S and $BaSO_3$
(B) SO_2 and $BaSO_3$
(C) H_2S and $Ba(HSO_3)_2$
(D) CO_2 and $Ba(HSO_3)_2$

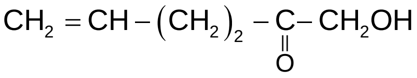
38. What is the increasing order of the energies of electrons which are identified by the quantum numbers n & ℓ.
    I. $n = 4$, $\ell = 1$
    II. $n = 4$, $\ell = 0$
    III. $n = 3$, $\ell = 2$
    IV. $n = 3$, $\ell = 1$
    (A) III < IV < II < I
    (B) IV < II < III < I
    (C) II < IV < I < III
    (D) I < III < II < IV

39. Chlorine can be liquefied easily as compared to ethane because:
    (A) a and b for Cl_2 > a and b for C_2H_6
    (B) a and b for Cl_2 < a and b for C_2H_6
    (C) a for Cl_2 > a for C_2H_6 and b for Cl_2 > b for C_2H_6
    (D) a for Cl_2 > a for C_2H_6 and b for Cl_2 < b for C_2H_6

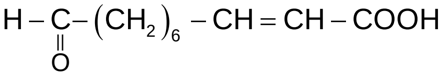
40. The compound A gives the following reactions



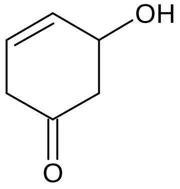
The structure of A can be:

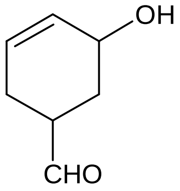
(A) 

$CH_2=CH-(CH_2)_2-\underset{\underset{O}{\|}}{C}-CH_2OH$

(B) 

$H-\underset{\underset{O}{\|}}{C}-(CH_2)_6-CH=CH-COOH$

(C) 

(D) 

41. A metal M can give the following observable change in a sequence of reactions.

$M\xrightarrow[HNO_3]{\text{diluted}}\text{colourless solution}\xrightarrow[NaOH]{\text{aq.}}\text{white ppt.}\xrightarrow[NaOH]{\text{excess}}\text{colourless solution}\xrightarrow{H_2S}\text{white ppt.}$

The metal M is:

(A) Mg
(B) Pb
(C) Zn
(D) Sn

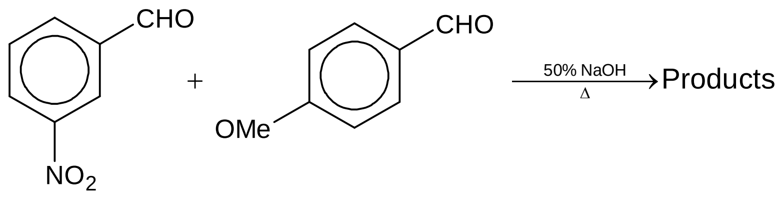
42. For the given concentration cell M|M^{2+} (saturated solution of MX$_2$)||M^{2+} (0.001 molar) | M. (MX$_2$ is a sparingly soluble salt) the EMF is 0.059 volt at the temperature 298 K.

What is the solubility product of MX$_2$ at 298 K? (Consider $\frac{2.303R\times 298}{F}=0.059\ V$)

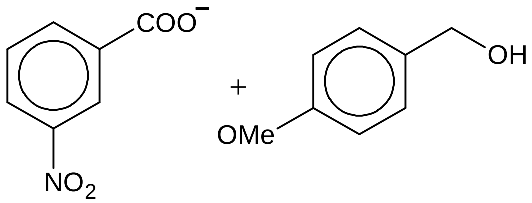
(A) 10^{-15}
(B) 4×10^{-15}
(C) 10^{-12}
(D) 4×10^{-12}

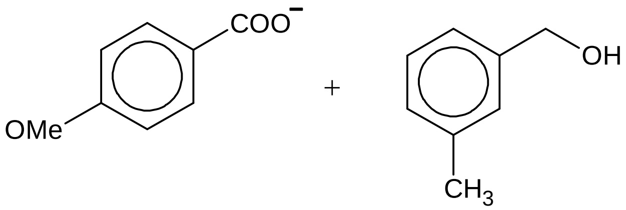
43. 0.518 gm sample of lime was dissolved in HCl and then calcium is precipitated as CaC_2O_4. After filtration and washing, the precipitate required 40 ml of 0.25 N $KMnO_4$ solution in acidic medium for complete reaction. Find out the percentage of CaO in lime sample

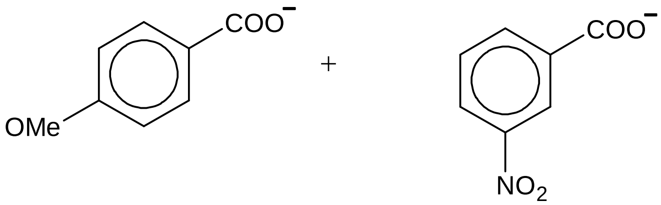
(A) 54%
(B) 27%
(C) 42%
(D) 84%

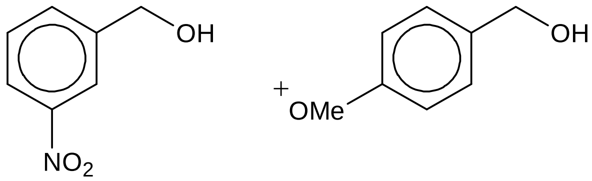
44. 

Identify the products obtained:

(A) 

(B) 

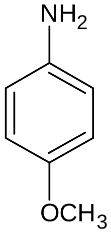
(C) 

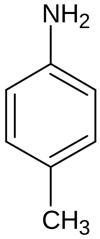
(D) 

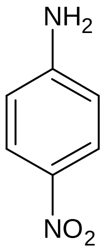
45. The V – C bond distances in $V(CO)_6$ and $\left[V(CO)_6\right]^-$ are respectively (in pm)

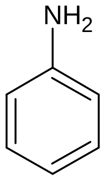
(A) 200, 200
(B) 193, 200
(C) 200, 193
(D) 193, 193

46. Which of the following compounds responds in the carbyl amine test in the fastest rate?

(A) 

(B) 

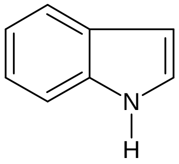
(C) 

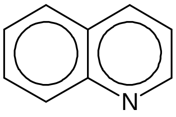
(D) 

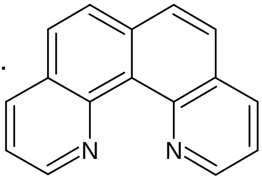
47. A doctor by mistake administrated a $Ba(NO_3)_2$ solution to a patient for radiography investigation. Which of the following should be given as best to prevent the absorption of soluble barium?
(A) NaCl
(B) Na_2SO_4
(C) $NaClO_4$
(D) NH_4Cl

48. Ba^{2+}, CN^-, And Co^{2+} form an ionic compound. If the complex is supposed to 75% ionized in water with van't Hoff factor =4, what is the coordination number of Co^{2+} in the complex?
(A) 6
(B) 5
(C) 4
(D) 8

49. Which of the following is the correct order of basic nature?

P. 

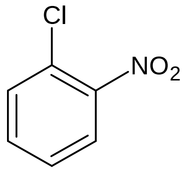
Q. 

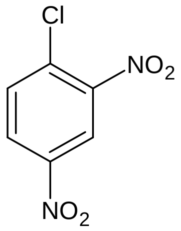
R. 

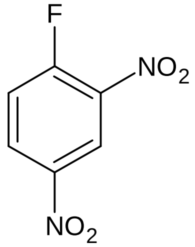
(A) Q > R > P
(B) R > Q > P
(C) R > P > Q
(D) Q > P > R

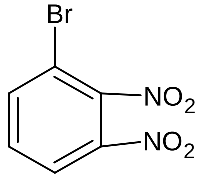
50. Which of the following two are isostructural?
(A) XeF_4, PCl_5^+
(B) ICl_2^-, CO_2
(C) CO_3^{2-} & SO_3^{2-}
(D) PCl_5, BrF_5

51. Which of the following is most readily hydrolysed by aqueous alkali?

(A) 

(B) 

(C) 

(D) 

52. At moderate pressure, the compressibility factor for a gas is given by

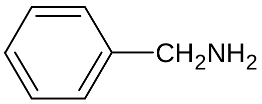
$Z = 1 + 0.34P - \frac{160P}{T}$ (P in bar & Tin Kelvin)

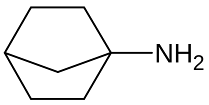
What is the Boyle temperature of gas?

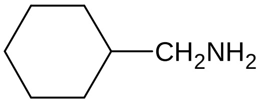
(A) 298 K
(B) 340 K
(C) 470 K
(D) 680 K

53. Which of the following amines can not be synthesized by Gabriel's phthalimide method?

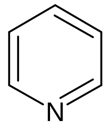
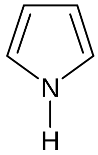
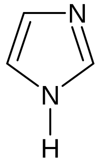
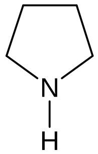
(A) $CH_3CH_2NH_2$

(B) 

(C) 

(D) 

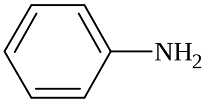
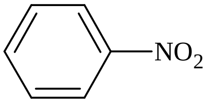
54. Cu^{2+} on reaction with $K_4[Fe(CN)_6]$ gives reddish brown precipitate. The formula of reddish brown precipitate is
(A) $Cu_4[Fe(CN)_6]$
(B) $Cu_2[Fe(CN)_6]$
(C) $Cu_3[Fe(CN)_6]$
(D) $Cu_3[Fe(CN)_6]_2$

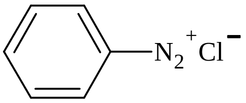
55. Which of the following compounds is most basic?
(A)

(B)

(C)

(D)


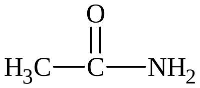
56. Which of the following statement is INCORRECT?
(A) A process may take place in single step and can be isothermal simultaneously.
(B) The internal energy of real gas does not change during isothermal process.
(C) All the spontaneous process are irreversible.
(D) Adsorption is an exothermic process.

57. For a reaction
$A \longrightarrow P$
Half life measured for two different values of initial concentrations 5×10^{-3} M and 25×10^{-4} M are 1 and 8 hrs respectively. If initial concentration is adjusted to 1.25×10^{-3} M, what is the half-life?
(A) 16 hr
(B) 32 hr
(C) 64 hr
(D) 256 hr

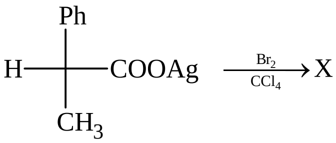
58. Which of the following compounds does not perform Lassaigne Test?

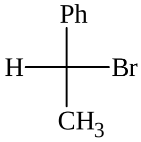
(A)

(B)


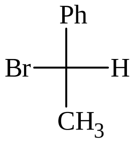
(C) 

(D) 

$H_3C-\overset{\overset{\large O}{||}}{C}-NH_2$

59. 

(A)  Only

(B)  Only

(C) Racemic mixture

(D) Diastereomeric mixture

60. Which of the sulphides can not be oxidized by concentrated HNO_3?
(A) CuS
(B) CdS
(C) Bi_2S_3
(D) HgS

Mathematics PART – III

SECTION – A

(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. Let P and Q are two points which lies on the line 3x + y = 41 where $x \geq 0$, $y \geq 0$, if P, Q have integral coordinates, then find number of triangles ΔOPQ such that area of ΔOPQ is integral where O is origin
(A) 41
(B) 42
(C) 43
(D) 44

62. There are two circles C_1 and C_2 whose radii are r_1 and r_2 respectively. If distance between there centre is $3r_1 - r_2$ and length of direct common tangent is twice of the length of transverse common tangent. Then $r_1 : r_2$ is
(A) 5 : 4
(B) 6 : 5
(C) 7 : 6
(D) 8 : 7

63. Let $x^2 = 3ax + 2ay + 3$ is a family of parabola where a is parameter. Then the locus of the vertex of the parabola is
(A) $3x^2 + 4xy + 9 = 0$
(B) $4x^2 + 3xy + 9 = 0$
(C) $4x^2 + 9xy + 3 = 0$
(D) none of these

64. A tangent at any point P on the ellipse $\frac{x^2}{16}+\frac{y^2}{8}=1$ intersect the major axis at point R and M, M′ are foot of perpendiculars drawn from the focus S and S′ of the ellipse if RS : RS′ = 2 : 3. Then SM is equal to
(A) $\frac{11}{\sqrt{3}}$
(B) $\frac{7}{\sqrt{3}}$
(C) $\frac{5}{\sqrt{3}}$
(D) $\frac{4}{\sqrt{3}}$

65. Tangent at any point P on the hyperbola $\frac{x^2}{9}-\frac{y^2}{4}=1$ intersects the asymptotes at points A and B, if C is the centre of the hyperbola, then area of ΔABC is
(A) 4 sq. units
(B) 6 sq. units
(C) 8 sq. units
(D) none of these

66. The value of $\sum_{r=1}^{50} \frac{1^3+3^3+5^3+.....+(2r-1)^3}{1+3+5+.....+(2r-1)}$

(A) 85800
(B) 85700
(C) 85600
(D) 85500

67. If all the equations $x^2 + (2a + 3b)x + 60 = 0$, $x^2 + ax + 10 = 0$ and $x^2 + bx + 8 = 0$ where $a, b \in R$, have a common root, then value of $|a – b|$ is

(A) 0
(B) 1
(C) 2
(D) none of these

68. The complex number z satisfying $z + |z| = 1 + 7i$, then the value of $\sqrt{|z+\bar{z}|^2 + |z-\bar{z}|^2}$ is

(A) 30
(B) 40
(C) 50
(D) none of these

69. The sum of value of r for which ${}^{18}C_{r-2} + 2\cdot{}^{18}C_{r-1} + {}^{18}C_r \geq {}^{20}C_{13}$

(A) 40
(B) 50
(C) 60
(D) 70

70. There are 7A & 6B and they are to be arranged linearly, then number of palindromes are

(A) 30
(B) 40
(C) 50
(D) none of these

71. Probability of n heads in 2n tosses of a fair coin be given by

(A) $\prod_{r=1}^{n}\left(\frac{2r-1}{2r}\right)$
(B) $\prod_{r=1}^{n}\left(\frac{n+r}{2r}\right)$
(C) $\sum_{r=0}^{n}\frac{{}^nC_r}{2^{2n}}$
(D) $\frac{\sum_{r=0}^{n}\left({}^nC_r\right)^2}{\left(\sum_{r=0}^{n}{}^nC_r\right)^2}$

72. Let p and q be two statements, then $\sim(\sim p \wedge q) \wedge (p \vee q)$ is logically equivalent to

(A) q
(B) $p \wedge q$
(C) p
(D) $p \vee \sim q$

73. The variance of first 100 odd natural numbers is
(A) 2222
(B) 3333
(C) 4444
(D) 5555

74. If $A_n = \sin n\theta \cdot \sec^n \theta$, $B_n = \cos n\theta \cdot \sec^n \theta$, then $\frac{B_n - B_{n-1}}{A_{n-1}} + \frac{1}{n} \cdot \frac{A_n}{B_n}$ is equal to
(A) 0
(B) $\tan\theta$
(C) $-\tan\theta + \frac{\tan(n\theta)}{n}$
(D) $\tan\theta + \frac{\tan(n\theta)}{n}$

75. The value of x in $\left(0, \frac{\pi}{2}\right)$ satisfying equation $\frac{\sqrt{5}-1}{\sin x} + \frac{\sqrt{10+2\sqrt{5}}}{\cos x} = 8$ is
(A) $\frac{\pi}{8}$
(B) $\frac{\pi}{9}$
(C) $\frac{\pi}{10}$
(D) none of these

76. Suppose $3\sin^{-1}(\log_2 x) + \cos^{-1}(\log_2 y) = \frac{\pi}{2}$ and $\sin^{-1}(\log_2 x) + 2\cos^{-1}(\log_2 y) = \frac{11\pi}{6}$, then the value of $\frac{1}{x^2} + \frac{1}{y^2}$ is
(A) 2
(B) 4
(C) 6
(D) 8

77. If ℓ is the length of median from the vertex A to the side BC of ΔABC, then
(A) $4\ell^2 = 2b^2 + 2c^2 - a^2$
(B) $4\ell^2 = 2b^2 + c^2 + 2bc\cos A$
(C) $4\ell^2 = 2a^2 + 4bc\cos A$
(D) $4\ell^2 - (2s-a)^2 = bc\sin^2\frac{A}{2}$

78. Each side of an equilateral triangle subtends an angle of 60º at the top a tower h meter high located at the centre of the triangle. If a is the length of each side of the triangle, then
(A) $3a^2 = 2h^2$
(B) $2a^2 = 3h^2$
(C) $a^2 = 3h^2$
(D) $3a^2 = h^2$

79. If the system of equations $a = \frac{x}{y-z}$, $b = \frac{y}{z-x}$ and $c = \frac{z}{x-y}$ is consistent, then ab + bc + ca is equal to

(A) 0
(B) 1
(C) 2
(D) none of these

80. Let $A = \begin{bmatrix} x^2 & 6 & 9 \\ 3 & y^2 & 9 \\ 4 & 5 & z^2 \end{bmatrix}$, $B = \begin{bmatrix} 2x & 3 & 5 \\ 2 & 2y & 6 \\ 1 & 4 & 2z-3 \end{bmatrix}$ if trace A = trace B, then x + y + z is equal to

(A) 1
(B) 2
(C) 3
(D) none of these

81. If the plane ax – by + cz = 0 contains the line $\frac{x-a}{a} = \frac{y-2d}{b} = \frac{z-c}{c}$, (b ≠ 0) then $\frac{b}{d}$ is equal to

(A) 1
(B) 2
(C) 0
(D) –3

82. Given $|\vec{a}| = |\vec{b}| = 1$ and $|\vec{a}+\vec{b}| = \sqrt{3}$, if $\vec{c}$ be a vector such that $\vec{c} - \vec{a} - 2\vec{b} = 3\left(\vec{a}\times\vec{b}\right)$, then $\vec{c}\cdot\vec{b}$ is equal to

(A) $-\frac{1}{2}$
(B) $\frac{1}{2}$
(C) $\frac{3}{2}$
(D) $\frac{5}{2}$

83. Let n(A) = 4 and n(B) = 6, then number of one-one functions from A to B is
(A) 120
(B) 360
(C) 24
(D) none of these

84. Let $g(x) = \begin{cases} \dfrac{ax^2 + bx + c(\cot x)^n}{4 + (\cot x)^n}, & x \in \left(0, \dfrac{\pi}{4}\right) \\ 1, & \text{at } x = \dfrac{\pi}{4} \\ \dfrac{\sin x + \cos x + (\tan x)^n}{1 + c(\tan x)^n}, & x \in \left(\dfrac{\pi}{4}, \dfrac{\pi}{2}\right) \end{cases}$, where a, b, c are real constants and $f(x) = \lim\limits_{n\to\infty} g(x)$. If $\lim\limits_{x\to\frac{\pi}{4}} f(x)$ exists, then c may be equal to

(A) 2
(B) $\frac{1}{2}$
(C) 3
(D) –1

85. If $y = e^{3x}$, then $\left(\frac{d^2y}{dx^2}\right)\left(\frac{d^2x}{dy^2}\right)$ is

(A) 1

(B) e^{-3x}

(C) $3e^{-3x}$

(D) $-3e^{-3x}$

86. The minimum distance of the curve $y^2 = 2x^3 + 9 - 3x^2$ from point Q(1, 0) is

(A) 2

(B) $2\sqrt{2}$

(C) $4\sqrt{2}$

(D) 8

87. If $\int x^3 \sin 3x(3x\cos 3x + 2\sin 3x)dx = \frac{x^a(\sin 3x)^b}{d} + c$, then a + b + d is

(A) 4

(B) 6

(C) 8

(D) none of these

88. If $\int_0^x f(t)dt = x + \int_x^1 t^2 f(t)dt$, then the value of the integral $\int_{-1}^1 f(x)dx$ is equal to

(A) 0

(B) $\frac{\pi}{4}$

(C) $\frac{\pi}{2}$

(D) π

89. The area enclosed by the ellipse $\frac{x^2}{9} + \frac{y^2}{4} = 1$, $\frac{(x-7)^2}{16} + \frac{y^2}{4} = 1$ and y = 2 is

(A) $\frac{28-\pi}{2}$ sq. units

(B) $\frac{28-3\pi}{2}$ sq. units

(C) $\frac{28-5\pi}{2}$ sq. units

(D) $\frac{28-7\pi}{2}$ sq. units

90. If y(t) satisfies the differential equation $y'(t) + 2y(t) = 2e^{-2t}$, y(0) = 2, then y(1) equals

(A) $\frac{3}{e}$

(B) $\frac{3}{e^2}$

(C) $\frac{4}{e}$

(D) $\frac{4}{e^2}$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VII

JEE (Main)-2019

TEST DATE: 24-03-2019

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. D

Sol. At t = 5 sec

$$x_{cm} = 50\cos 53^\circ \times 5 = 150 \text{ m}$$

$$y_{cm} = 50 \sin 53^\circ \times 5 - \frac{1}{2}\times 10\times 5^2 = 75 \text{ m}$$

$$x_{cm} = \frac{m\times 100 + 2m\times x_2}{3\text{ m}} \Rightarrow x_2 = 175 \text{ m}$$

$$y_{cm} = \frac{m\times 50 + 2m\times y_2}{3m} \Rightarrow y_2 = \frac{175}{2}\text{ m}$$

2. B

Sol. $ma = -mg - kv^2$

$$\Rightarrow v\frac{dv}{dy} = -\left(g + \frac{kv^2}{m}\right)$$

$$\int_0^{y_{max}} dy = -\int_{v_0}^{0} \frac{vdv}{g + \left(\frac{kv^2}{m}\right)}$$

$$y_{max} = \frac{m}{2k}\ell n\left(\frac{g + \frac{kv_0^2}{m}}{g}\right)$$

3. C

Sol. $mv_0\ell = \frac{4}{3}m\ell^2\omega \Rightarrow \omega = \frac{3v_0}{4\ell}$

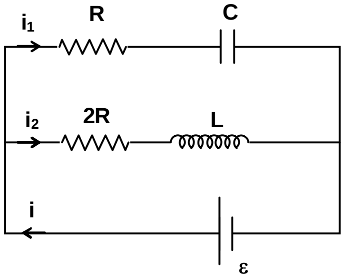
$\frac{1}{2}\frac{4}{3}m\ell^2\left(\frac{3v_0}{4\ell}\right)^2 = 3mg\frac{\ell}{2} \Rightarrow v_0 = \sqrt{4g\ell}$

$3mg\frac{\ell}{2} = \frac{4}{3}m\ell^2\alpha \Rightarrow \alpha = \frac{9g}{8\ell}$

$a_{cm} = \alpha r = \frac{9g}{8\ell}\times\frac{3\ell}{4} = \frac{27g}{32}$

$2mg - F = 2m\times\frac{27g}{32} \Rightarrow F = \frac{5mg}{16}$

4. C



Sol. Since $RC = \frac{L}{2R}$

$\Rightarrow$ time constants for both branches are equal.

$i_1 = \frac{\varepsilon}{R}e^{-t/RC}$

$i_2 = \frac{\varepsilon}{2R}\left(1 - e^{-t/RC}\right)$

$i = i_1 + i_2 = \frac{\varepsilon}{2R} + \frac{\varepsilon}{2R}e^{-t/RC}$

$i_{max} = \frac{\varepsilon}{R}$

When, $i = \frac{5\varepsilon}{8R} = \frac{\varepsilon}{2R} + \frac{\varepsilon}{2R}e^{-t/RC}$

$\Rightarrow t = RC\ell n4 = 2RC\ell n2$

$i_1 = i_2$

$\Rightarrow \frac{\varepsilon}{R}e^{-t/RC} = \frac{\varepsilon}{2R}\left(1 - e^{-t/RC}\right)$

$\Rightarrow t = RC\ell n3$

5. B

Sol. $f_P = \frac{3}{4\ell_1}\sqrt{\frac{\gamma_1 RT_1}{M_1}}$, $f_Q = \frac{3}{2\ell_2}\sqrt{\frac{\gamma_2 RT_2}{M_2}}$

$\frac{f_P}{f_Q} = \frac{\ell_2}{2\ell_1}\sqrt{\frac{\gamma_1}{\gamma_2}\times\frac{T_1}{T_2}\times\frac{M_2}{M_1}} = \sqrt{\frac{7}{5}\times\frac{3}{5}\times\frac{300}{350}\times\frac{4}{2}} = \frac{6}{5}$

6. C

Sol. Let final pressure in both parts of the gas be P.

For left part $P_1V_0^{5/3} = PV_1^{5/3} \Rightarrow V_1 = \left(\frac{P_1}{P}V_0^{5/3}\right)^{3/5}$

For right part $P_2V_0^{5/3} = PV_2^{5/3} \Rightarrow V_2 = \left(\frac{P_2}{P}V_0^{5/3}\right)^{3/5}$

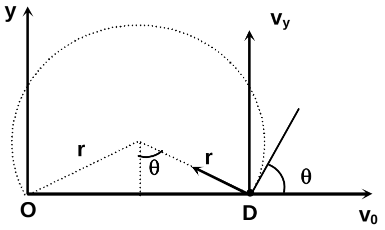
$V_1 + V_2 = 2V_0$

$$\Rightarrow \frac{\left(P_1^{3/5}+P_2^{3/5}\right)V_0}{P^{3/5}} = 2V_0$$

$$\Rightarrow P = \frac{\left(P_1^{3/5}+P_2^{3/5}\right)^{5/3}}{2^{5/3}}$$

7. B

Sol. When the particle strike at D



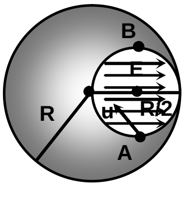
$$v_y = \sqrt{2\frac{qE}{m}\frac{d}{2}} = \sqrt{\frac{qEd}{m}}$$

$$d = 2r\sin\theta = 2\frac{mv}{qB}\sin\theta = \frac{2m}{qB}\sqrt{\frac{qEd}{m}}$$

$$\Rightarrow B = 2\sqrt{\frac{mE}{qd}}$$

8. A

Sol. Electric field inside the cavity is uniform and its magnitude



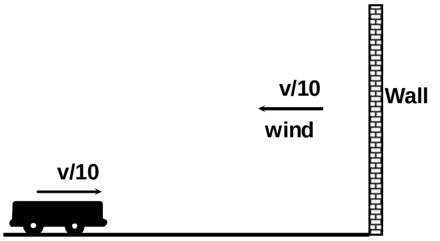
$$E = = \frac{\rho r}{2\varepsilon_0} = \frac{\rho\frac{R}{2}}{2\varepsilon_0} = \frac{\rho R}{4\varepsilon_0}.$$

The direction of the field is as shown in the figure.
If the particle hits at B

$$R = \frac{u^2}{\frac{qE}{m}} = \frac{mu^2}{\frac{q\rho R}{4\varepsilon_0}} \quad \Rightarrow u = \sqrt{\frac{q\rho R^2}{4\varepsilon_0 m}}$$

9. B

Sol. Frequency of sound reaching to the wall



$$f_w = \frac{v_{eff}}{v_{eff}-v_s}f = \frac{\frac{9v}{10}}{\frac{9v}{10}-\frac{v}{10}}f = \frac{9f}{8}$$

Frequency of echo heard by the driver

$$f' = \frac{f_{eff}+v_0}{v_{eff}}f_w = \frac{\frac{11}{10}v+\frac{v}{10}}{\frac{11v}{10}}\times\frac{9f}{8} = \frac{27}{22}f$$

10. A

Sol. The mean time between successive collision of an ideal gas

$$\tau = \frac{1}{(\sqrt{2}n\pi d^2)v_{rms}} \propto \frac{V}{\sqrt{T}}$$

In isobaric process $\frac{V}{T} = \text{constant}$

$$\Rightarrow \tau' = \sqrt{2}\tau$$

11. B

Sol. $B = \frac{\mu_0 I}{2\pi r}$, the net magnetic field at any point on the line xx′ will be the vector sum of magnetic fields due to the three current carrying wires.

12. C

Sol. Least count = $\frac{0.5}{50} = 0.01\,\text{mm}$

Zero error = –(50 – 48) × 0.01 mm = – 0.02 mm
Measured thickness = 1 mm + 6 × 0.01 mm = 1.06 mm
Actual thickness = 1.06 mm – (–0.02 mm) = 1.08 mm

13. D

Sol. $\frac{1}{2}\varepsilon_0 E^2 \times \ell^3 =$ energy density in electric field × volume

$\frac{1}{2}LI^2 =$ energy stored in inductor

14. B

Sol. Comparing with damped SHM the amplitude of charge q_m on the capacitor as a function of time t will be

$q_m = q_0 e^{-Rt/2L}$

When $q_m = \frac{q_0}{2} \Rightarrow t = \frac{2L}{R}\ell n2$

15. B

Sol. $P = \frac{4\pi R^2 T}{t}$

16. D

Sol. $\frac{k_x}{k_y} = \frac{p_x^2 / 2m_x}{p_y^2 / 2m_y} = \frac{m_y}{m_x} = \frac{1}{2}$

$\frac{r_x}{r_y} = \left(\frac{A_x}{A_y}\right)^{1/3} = \left(\frac{m_x}{m_y}\right)^{1/3} = 2^{1/3}$

17. B

Sol. $F = I\ell B = \frac{B\ell v}{R}\left(e^{-t/RC}\right)\ell B = \frac{B^2\ell^2 v}{R}e^{-t/RC}$

18. B

Sol. $\frac{0.1 \times P}{4\pi r^2} = \frac{B_0^2}{2\mu_0} \times c$, where c is speed of light.

$\Rightarrow P = \frac{4\pi r^2 B_0^2 C}{0.1 \times 8\pi \times 10^{-7}} = \frac{r^2 B_0^2 C}{0.1 \times 2 \times 10^{-7}} = 216\text{ W}$

19. A

Sol. Use Malus' Law

20. C

Sol. $T = 2\pi\sqrt{\frac{I}{MB_H}} = 2\pi\sqrt{\frac{I}{MB\cos\theta}}$

$\Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{B_2\cos\theta_2}{B_1\cos\theta_1}}$

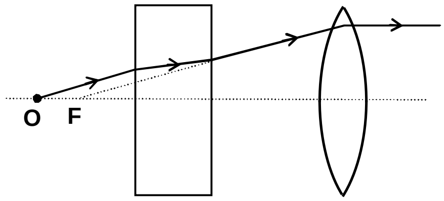
$\Rightarrow \frac{3}{4} = \sqrt{\frac{B_2\cos 60°}{B_1\cos 30°}}$

$\frac{B_1}{B_2} = \frac{16}{9\sqrt{3}}$

21. B

Sol. $25 - t\left(1 - \frac{1}{\mu}\right) = 24$

$\Rightarrow$ t = 3 cm



22. C

Sol. For total internal reflection on surface AC

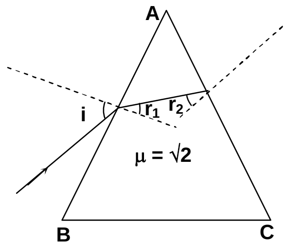
$r_2 > \theta_C$

$\Rightarrow 60° - r_1 > \theta_C$

$\Rightarrow \sin r_1 < \sin\left(60° - \sin^{-1}\frac{1}{\sqrt{2}}\right)$

$\Rightarrow \frac{\sin i}{\sqrt{2}} < \sin 15°$

$\Rightarrow i < \sin^{-1}(0.366)$



23. A

Sol. From conservation of momentum

$\vec{p}_H + \vec{p}_{photon} = 0$

$|\vec{p}_H| = |\vec{p}_{photon}| = \frac{h}{\lambda} = hR\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = \frac{3Rh}{4}$

$v_H = \frac{3Rh}{4M}$

24. D

Sol. Energy of photon of 400 nm wavelength = $\frac{1240}{400} = 3.1\,\text{eV}$

Energy of photon of 310 nm wavelength = $\frac{1240}{310} = 4\,\text{eV}$

$h\nu = \phi + k_{max} \Rightarrow 3.1 = \phi + k_{max}$

$4 = \phi + 2k_{max}$

$\Rightarrow \phi = 2.2$ eV

25. B

Sol. $-\frac{dT}{dt} = \frac{e\sigma A}{ms}\left(T^4 - T_0^4\right)$, Also $\frac{4}{3}\pi r^3 = a^3$

$$\frac{-dT_1 / dt}{-dT_2 / dt} = \frac{A_1}{A_2} = \frac{4\pi r^2}{6a^2} = \left(\frac{\pi}{6}\right)^{1/3}$$

26. B

Sol. $\frac{4}{3}\pi R^3 = n \times \frac{4}{3}\pi r^3 \Rightarrow R = n^{1/3}r$ (R = radius of bigger drop)

$$n \times 4\pi r^2 T - 4\pi R^2 T = \frac{1}{2}mv^2$$

$$\Rightarrow n \times 4\pi r^2 T - 4\pi n^{2/3} r^2 T = \frac{1}{2} n \times \frac{4}{3}\pi r^3 \rho v^2 \quad \Rightarrow v = \sqrt{\frac{6T}{r\rho}\left(1 - \frac{1}{n^{1/3}}\right)}$$

27. A

Sol. $T^2 \propto r^3$

$$\frac{T^{12}}{T^2} = \frac{r'^3}{r^3} \Rightarrow \left(\frac{2T}{T}\right)^2 = \frac{r'^3}{r^3} \Rightarrow r = 4^{1/3} r$$

28. D

Sol. Side band frequencies are $f_C + f_m$ and $f_C - f_m$
i.e., 2060 Hz and 1940 Hz

The modulation index = $\frac{A_m}{A_c} = \frac{8}{20} = 0.4$

29. A

Sol. When v = maximum
a = 0

$$\Rightarrow F - kxmg = 0 \Rightarrow x = \frac{F}{kmg}$$

$$W_F - W_f = \frac{1}{2}mv^2$$

$$\Rightarrow Fx - kmg\frac{x^2}{2} = \frac{1}{2}mv^2$$

$$\Rightarrow F\frac{F}{kmg} - kmg\frac{F^2}{2k^2m^2g^2} = \frac{1}{2}mv_{max}^2 \quad \Rightarrow v_{max} = \sqrt{\frac{F^2}{km^2g}}$$

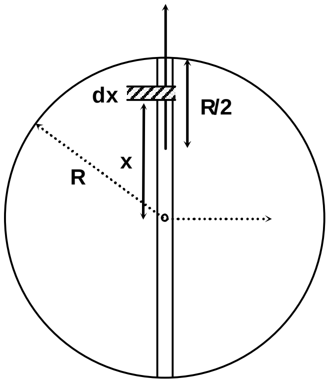
30. D

Sol. $U_i = \int (dm)v = \int_{R/2}^{R} -\frac{m}{R/2}dx\frac{GM}{2R}\left(3 - \frac{x^2}{R^2}\right)$

$$= \frac{29GMm}{24R} = \frac{29gR^2m}{24} = \frac{29mgR}{24}$$

$$U_f = -\frac{GMm}{R} = -\frac{gR^2m}{R} = -mgR$$

$$W = \Delta U = U_f - U_i = \frac{5mgR}{24}$$



Chemistry

PART – II

SECTION – A

31. B

Sol. Smaller be the size of the cation, lattice energy of the ionic carbonates decreases, and then thermal stability decreases.

32. A

Sol. $Ba(OH)_2(s) \rightleftharpoons Ba^{2+}(aq) + 2\overset{-}{O}H(aq)$

pH = 12

pOH = 2

$\therefore \left[\overset{-}{O}H\right] = 10^{-2}$

$\left[Ba^{2+}\right] = \frac{10^{-2}}{2} = 5\times10^{-3}$

$K_{sp} = \left[Ba^{2+}\right]\left[\overset{-}{O}H\right]^2 = 5\times10^{-3}\times\left(10^{-2}\right)^2$

$= 5\times10^{-7}$

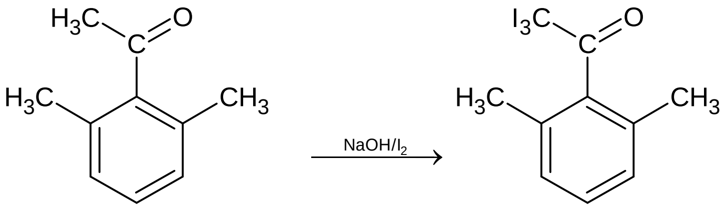
33. C

Sol. Borazine is non polar due to symmetrical distribution of charge.

$B_2O_3 + P_2O_5 \rightarrow 2BPO_4$

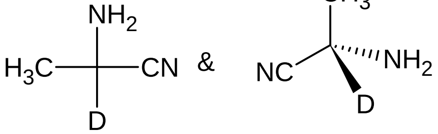
34. C

Sol.



35. A

Sol. Both have ‘S’ configuration.



36. C

Sol. Factual

37. B

38. B

Sol. I. n + ℓ = 4 + 1 = 5

II. n + ℓ = 4 + 0 = 4

III. n + ℓ = 3 + 2 = 5

IV. n + ℓ = 3 + 1 = 4

I is having greater n value as compared to III, II is having greater n value as compared to IV.

39. D

Sol. Since there is stronger intermolecular force of attraction present in Cl_2, it is easily liquifiable.

40. D

Sol. The compound must be cyclic and contains a – OH and – CHO group. It must contain seven carbon atoms.

41. C

Sol. $$Zn \xrightarrow[HNO_3]{\text{diluted}} Zn(NO_3)_2 \xrightarrow[NaOH]{\text{aq.}} \underset{\text{White precipitate}}{Zn(OH)_2} \xrightarrow[NaOH]{\text{excess}} Na_2[Zn(OH)_4] \xrightarrow{H_2S} \underset{\text{(white ppt.)}}{ZnS}\downarrow$$

42. B

Sol. $$E_{cell} = -\frac{0.059}{2}\log\frac{[M^{2+}]}{[0.001]}$$

$$[M^{2+}] = 10^{-5}$$

$$MX_2(s) \rightleftharpoons M^{2+} + 2X^-$$

$$[X^-] = 2\times10^{-5}$$

$$K_{sp} == [M^{2+}][X^-]^2$$

$$= 10^{-5}\times(2\times10^{-5})^2$$

$$= 4\times10^{-15}$$

43. A

Sol. $M_{eqv.}$ of CaO = $M_{eqv.}$ of CaC_2O_4 = $M_{eqv.}$ Of $KMnO_4$

Let in line mass of CaO = w

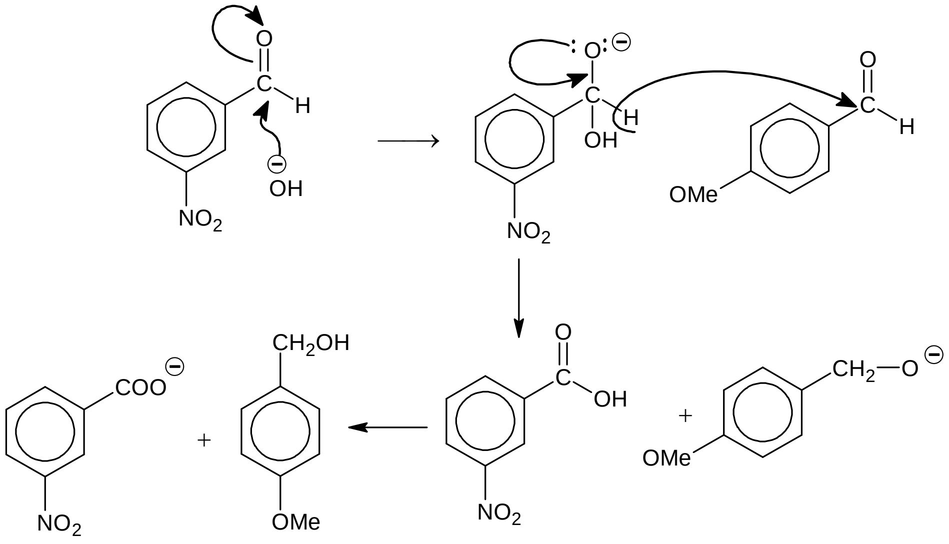
$$\frac{w}{56/2}\times1000 = 40\times0.25$$

w = 0.28

$$\%\text{ of CaO} = \frac{0.28\times100}{0.518} = 54\%$$

44. A

Sol. - NO_2 has – I but – OMe shows +R effect.



45. C

Sol. In $\left[V(CO)_6\right]^-$, tendency of back donation of electron to π^* orbital of CO is greater, thus, V – C bond length decreases.

46. A

Sol. +R effect of – OCH_3 group.

47. B

Sol. $Ba(NO_3)_2 + Na_2SO_4 \longrightarrow 2NaNO_3 + BaSO_4 \downarrow$

48. B

Sol. Formula of the complex Ba(x – 2) $[Co(CN)_x]_2$.

$$\underset{1-0.75}{Ba_{(x-2)}\left[Co(CN)_x\right]_2} \rightleftharpoons \underset{0.75(x-2)}{(x-2)Ba^{2+}} + \underset{0.75\times 2}{2\left[Co(CN)_x\right]^{(x-2)-}}$$

i = 4

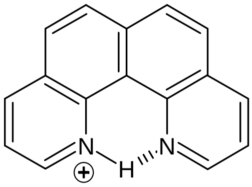
0.25 + 0.75 (x – 2) + 1.5 = 4

i.e. x = 5.

49. B

Sol. (i) Lone pair of N on P is in conjugation.

Conjugate acid of R can be stablised through intramoleuclar H-bonding.



50. B

Sol. ICl_2^- & CO_2 both are linear.

51. C

Sol. Two – NO_2 groups are at ortho and para position with respect to – F. Due to – I effect of F, the intermediate is more stabilized.

52. C

Sol. At Boyle temperature, Z = 1

Thus, $0.34\,P - \dfrac{160P}{T_B} = 0$

$$T_B = \frac{160}{0.34} = 470.58\,K.$$

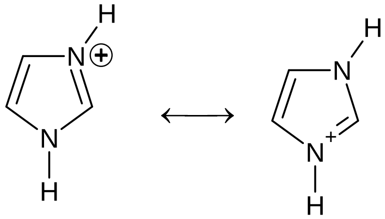
53. C

Sol. Gabriel's phthalimide synthesis takes place through S_N2 pathway which is not possible in bridgehead position.

54. B

55. C

Sol.



Conjugate acid is stabilized by equivalent resonating structure.

56. B

Sol. $$dV = \left(\frac{\partial U}{\partial T}\right)_v dT + \left(\frac{\partial U}{\partial V}\right)_T dV$$

For isothermal process, dT = 0

$$dV = \left(\frac{\partial U}{\partial T}\right)_T dV$$

For real gas, $\left(\frac{\partial U}{\partial T}\right)_T \neq 0.$

57. C

Sol. For a ‘n’ the order reaction,

$t_{1/2} \propto \frac{1}{a^{n-1}}$ where a = initial conc.

$$\left(\frac{5\times10^{-3}}{25\times10^{-4}}\right)^{n-1} = \frac{8}{1}$$

$$\Rightarrow n = 4$$

$$\frac{t_{1/2}}{1} = \left(\frac{5\times10^{-3}}{1.25\times10^{-3}}\right)^{n-1}$$

$$t_{1/2} = 64 \text{ hr}$$

58. C

Sol. Factual

59. C

Sol. The reaction takes place through the formation of free radical.

60. D

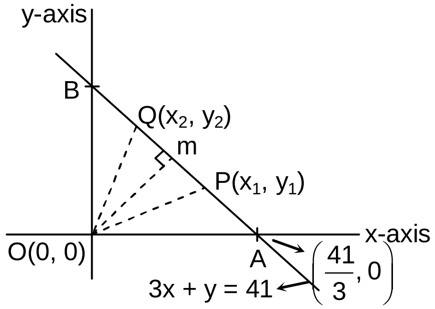
Sol. It is highly insoluble ($K_{sp} \approx 10^{-52}$)

Mathematics PART – III

SECTION – A

61. B

Sol. $OM = \left|\frac{3.0+0-41}{\sqrt{9+1}}\right| = \frac{41}{\sqrt{10}}$



$PQ = \sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$

$\because$ P, Q lies on 3x + y = 41

So, $3x_2 + y_2 = 41$

$3x_1 + y_1 = 41$

$3(x_2 - x_1) + (y_2 - y_1) = 0$

$\Rightarrow (y_2 - y_1) = -3(x_2 - x_1)$

So, $PQ = \sqrt{(x_2-x_1)^2+9(x_2-x_1)^2} = \sqrt{10}|x_2-x_1|$

Area of $\Delta OPQ = \frac{1}{2}\times PQ\times OM = \frac{1}{2}\times\sqrt{10}|x_2-x_1|\times\frac{41}{\sqrt{10}} = \frac{41}{2}|x_2-x_1|$

Since x_1, x_2 are integer

So, $|x_2 - x_1|$ must be even integer

Possible number of x_1 and x_2 are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

So, there are 7 even and 7 odd numbers

So, $|x_2 - x_1|$ will be even if both are even or odd

So, number of ways of solution = ${}^7C_2 + {}^7C_2 = 2\,{}^7C_2 = 2 \times 21 = 42$

62. C

Sol. Length of direct common tangent = $\sqrt{d^2-(r_1-r_2)^2}$

Length of transverse common tangent = $\sqrt{d^2-(r_1+r_2)^2}$

Where d is distance between their centers

Then $\left(\sqrt{d^2-(r_1-r_2)^2}\right) = 2\left(\sqrt{d^2-(r_1+r_2)^2}\right)$

$d^2 = \left(r_1^2+r_2^2+\frac{10}{3}r_1r_2\right)$, where $d = 3r_1 - r_2$

$(3r_1 - r_2)^2 = r_1^2+r_2^2+\frac{10}{3}r_1r_2$

$r_1 : r_2 = 7 : 6$

63. A

Sol. Given equation of parabola $x^2 = 3ax + 2ay + 3$ where a is variable on solving

$\left(x-\frac{3a}{2}\right)^2 = 2a\left(y+\frac{12+9a^2}{8a}\right)$, vertex $v\left(\frac{3a}{2}, -\frac{(12+9a^2)}{8a}\right)$

Let v(h, k)

$h = \frac{3a}{2}$, $k = -\frac{(12+9a^2)}{8a}$

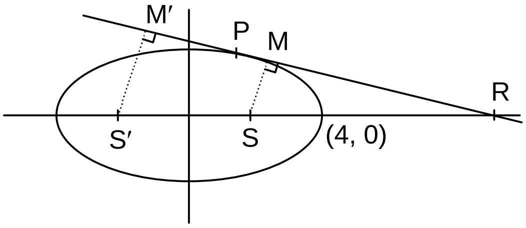
$3h^2 + 4hk + 9 = 0$

So, locus is $3x^2 + 4xy + 9 = 0$

64. D

Sol. We know that $SM \cdot S'M' = b^2$ ..... (1)

and $\Delta RMS \sim \Delta RM'S'$



So, $\frac{RS}{RS'} = \frac{MS}{M'S'} = \frac{2}{3}$

$MS = \frac{2}{3}M'S'$

$\frac{2}{3}(M'S')^2 = 8$

$(M'S')^2 = \frac{8 \times 3}{2} = 4 \times 3$

$M'S' = 2\sqrt{3}$

$MS = \frac{2}{3} \times 2\sqrt{3} = \frac{4}{\sqrt{3}}$

65. B

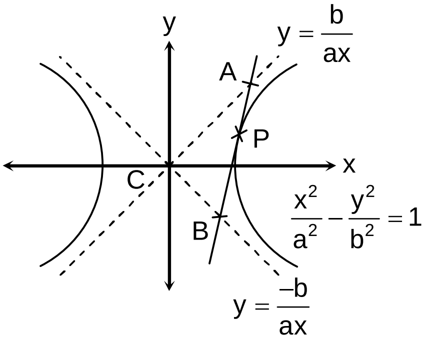
Sol. Area of $\Delta ABC = ab$

Where a = 3

b = 2

= 3 × 2

= 6 sq. units



66. A

Sol. $= \sum_{r=1}^{n} \frac{\left(1^3 + 2^3 + 3^3 + 4^3 + 5^3 + ... + (2r)^3\right) - \left(2^3 + 4^3 + 6^3 + 8^3 + ... + (2r)^3\right)}{1 + 3 + 5 + ... + (2r - 1)}$

$= \sum_{r=1}^{n} \frac{\frac{4r^2(2r+1)^2}{4} - 8\left(\frac{r^2(r+1)^2}{4}\right)}{r^2}$

$= \sum_{r=1}^{n} (2r+1)^2 - 2(r+1)^2$

$= \sum_{r=1}^{n} \left(4r^2 + 1 + 4r - 2r^2 - 2 - 4r\right)$

$= \sum_{r=1}^{n} \left(2r^2 - 1\right) = 2\sum_{r=1}^{n} r^2 - \sum_{r=1}^{n} 1$

$= \frac{2n(n+1)(2n+1)}{6} - n$ where n = 60

$= \frac{50 \times 51 \times 101}{3} - 50 = 50 \times 17 \times 101 - 50$

= 50(17 17 – 1) = 50 × 17 16

= 85800

67. B

Sol. $x^2 + ax + 10 = 0 \Rightarrow 2x^2 + 2ax + 20 = 0$ ..... (1)

$x^2 + bx + 8 = 0 \Rightarrow 3x^2 + 3bx + 24 = 0$ ..... (2)

Adding equation (1) and (2), we get

$5x^2 + (2a + 3b)x + 44 = 0$ ..... (3)

$x^2 + (2a + 3b)x + 60 = 0$ ..... (4)

Subtracting equation (4) from (3), we get

$4x^2 = 16$, $x = \pm 2$, $a = 7$, $b = 6$ or $a = -7$, $b = -6$

So, $|a - b| = 1$

68. C

Sol. Let $z = x + iy$

$$x + iy + \sqrt{x^2 + y^2} = 1 + 7i$$

$$x + \sqrt{x^2 + y^2} = 1 \text{ and } y = 7$$

$$\Rightarrow \sqrt{x^2 + y^2} = 1 - x \Rightarrow x^2 + y^2 = 1 + x^2 - 2x$$

$y^2 = 1 - 2x$

$49 - 1 = -2x$

$x = -24$

$|z|^2 = x^2 + y^2 = 576 + 49 = 625$

$|z| = 25$

$$\sqrt{|z + \bar{z}|^2 + |z - \bar{z}|^2} = \sqrt{(1^2 + 1^2)(|z|^2 + |\bar{z}|^2)} = \sqrt{2 \times 2 \times 625} = \sqrt{4 \times 625} = 2 \times 25 = 50$$

$$\sqrt{|z + \bar{z}|^2 + |z - \bar{z}|^2} = 50$$

69. D

Sol. Using formula ${}^nC_r + {}^nC_{r-1} = {}^{n+1}C_r$

$${}^{18}C_{r-2} + {}^{18}C_{r-1} + {}^{18}C_{r-1} + {}^{18}C_r \geq {}^{20}C_{13}$$

$${}^{19}C_{r-1} + {}^{19}C_r \geq {}^{20}C_{13}$$

$${}^{20}C_r \geq {}^{20}C_{13} \text{ or } {}^{20}C_{20-r} \geq {}^{20}C_{13}$$

r = 7, 8, 9, 10, 11, 12, 13

Sum of all values of r = 70

70. D

Sol.

A – 3 numbers	A – 3 numbers, B – 3 numbers
B – 3 numbers	A

– –

Number of palindromes are $\frac{6!}{3!3!} = \frac{6 \times 5 \times 4 \times 3!}{6 \times 3!} = 20$

Palindrome has same sequence from starting and from ending

71. A

Sol. There will be n heads and n tails in 2n throws

Probability = $\frac{2n!}{n!n!}\left(\frac{1}{2}\right)^n\left(\frac{1}{2}\right)^n = \frac{{}^{2n}C_n}{2^{2n}}$

Option (A) = $\prod_{r=1}^{n}\left(\frac{2r-1}{2r}\right) = \frac{1}{2} \cdot \frac{3}{4} \cdot \frac{5}{6} \cdot \frac{7}{8} \ldots\ldots \frac{2n-1}{2n} = \frac{(2n)!}{2^{2n}(n!)^2} = \frac{{}^{2n}C_n}{2^{2n}}$

72. C

Sol. $\sim(\sim p \wedge q) \wedge (p \vee q)$

$\equiv [\sim(\sim p) \vee (\sim p)] \wedge (p \vee q)$

$\equiv [p \vee \sim q] \wedge (p \vee q)$

$\equiv p \vee (\sim q \wedge q)$

$\equiv p \vee f$

$\equiv p$

73. B

Sol. Variance = $\dfrac{1^2+3^2+5^2+.....+(199)^2}{100} - \left(\dfrac{1+3+5+.....+199}{100}\right)^2$

Sum = $\sum\limits_{n=1}^{n}(2n-1)^2$ = $4\Sigma n^2 - 4\Sigma n + n$ = $\dfrac{4n(n+1)(2n+1)}{6} - \dfrac{4n(n+1)}{2} + n$

Put n = 100

= $\dfrac{4\times100\times101\times201}{6} - 2\times100\times101+100$

= $100\left(\dfrac{2\times101\times201}{3} - 2\times101+1\right)$ = $100(2 \times 6767 - 202 + 1)$

= $100(13534 - 201) = 100 \times 13333 = 1333300$

Variance = $\dfrac{1333300}{100} - (100)^2 = 13333 - 10000 = 3333$

74. C

Sol. $\dfrac{\cos n\theta\cdot(\sec\theta)^n - \cos(n-1)\theta\cdot\sec^{n-1}\theta}{\sin(n-1)\theta\cdot\sec^{n-1}\theta} + \dfrac{1}{n}\tan(n\theta)$

= $\dfrac{\dfrac{\cos n\theta}{\cos\theta} - \cos(n-1)\theta}{\sin(n-1)\theta} + \dfrac{1}{n}\tan(n\theta)$

= $\dfrac{\cos n\theta - \cos\theta(\cos(n-1)\theta)}{\cos\theta\cdot\sin(n-1)\theta} + \dfrac{1}{n}\tan(n\theta)$

= $\dfrac{\cos(n-1+1)\theta - \cos\theta\cdot\cos(n-1)\theta}{\cos\theta\cdot\sin(n-1)\theta} + \dfrac{1}{n}\tan(n\theta)$

= $\dfrac{\cos(n-1)\theta\cos\theta - \sin(n-1)\theta\sin\theta - \cos\theta\cos(n-1)\theta}{\cos\theta\cdot\sin((n-1)\theta)} + \dfrac{1}{n}\tan(n\theta)$

= $-\tan\theta + \dfrac{1}{n}\tan(n\theta)$

75. C

Sol. $\dfrac{\sqrt{5}-1}{4}\times\dfrac{1}{\sin x} + \dfrac{\sqrt{10+2\sqrt{5}}}{4}\times\dfrac{1}{\cos x} = 2$

$\dfrac{\sin\frac{\pi}{10}}{\sin x} + \dfrac{\cos\frac{\pi}{10}}{\cos x} = 2$

$\sin x\cdot\cos\dfrac{\pi}{10} + \cos x\cdot\sin\dfrac{\pi}{10} = 2\sin x\cos x$

$$\sin\left(x+\frac{\pi}{10}\right)=\sin 2x$$

$$x+\frac{\pi}{10}=2x \Rightarrow x=\frac{\pi}{10}$$

$$\text{or } x+\frac{\pi}{10}=\pi-2x$$

$$3x=\frac{9\pi}{10}$$

$$x=\frac{3\pi}{10}$$

76. C

Sol. Let $\sin^{-1}(\log_2 x)=p$, $\cos^{-1}(\log_2 y)=q$

So, $3p+q=\frac{\pi}{2}$ ..... (1)

$p+2q=\frac{11\pi}{6}$ ..... (2)

$$p=\frac{11\pi}{6}-2q$$

$$3\left(\frac{11\pi}{6}-2q\right)+q=\frac{\pi}{2}$$

$$\frac{11\pi}{2}-6q+q=\frac{\pi}{2}$$

$$\frac{11\pi}{2}-\frac{\pi}{2}=5q$$

$$5q=\frac{10\pi}{2}$$

$$q=\pi$$

$$p=\frac{11\pi}{6}-2\pi=-\frac{\pi}{6}$$

$$\sin^{-1}(\log_2 x)=-\frac{\pi}{6}$$

$$\log_2 x=-\sin\frac{\pi}{6}=-\frac{1}{2}$$

$$x=2^{-\frac{1}{2}} \Rightarrow \frac{1}{x}=2^{\frac{1}{2}} \Rightarrow \frac{1}{x^2}=2$$

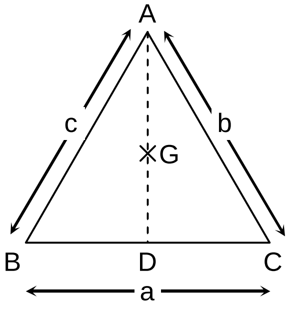
$$\cos^{-1}(\log_2 y)=\pi$$

$\log_2 y = \cos \pi = -1$, $y=\frac{1}{2}$, $\frac{1}{y}=2$

$$\frac{1}{x^2}+\frac{1}{y^2}=2+4 \Rightarrow \frac{1}{x^2}+\frac{1}{y^2}=6$$

77. A

Sol. $AB^2 + AC^2 = 2(BD^2 + AD^2)$



$$c^2 + b^2 = 2\left(\frac{a^2}{4} + AD^2\right)$$

$$b^2 + c^2 - \frac{a^2}{2} = 2AD^2$$

$$b^2 + c^2 - \frac{a^2}{2} = 2AD^2$$

$$2AD^2 = \frac{2b^2 + 2c^2 - a^2}{2}$$

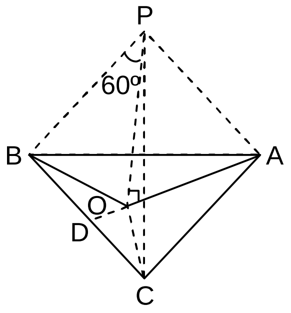
$$AD^2 = \frac{2b^2 + 2c^2 - a^2}{4}$$

$$\ell = AD = \frac{\sqrt{2b^2 + 2c^2 - a^2}}{2}$$

$$4\ell^2 = 2b^2 + 2c^2 - a^2$$

78. B

Sol. $OP = h$



ΔPOA

$\angle POA = 90^o$

$AP^2 = OP^2 + OA^2$

$PA = PB = PC = a$

$$a^2 = h^2 + \frac{a^2}{3}$$

$$h^2 = \frac{2a^2}{3},\ 3h^2 = 2a^2$$

$$AD^2 = BA^2 - BD^2 = a^2 - \frac{a^2}{4} = \frac{3a^2}{4}$$

$$AD = \frac{a\sqrt{3}}{2};\ OA = \frac{2}{3}AD = \frac{2}{3}\times\frac{a\sqrt{3}}{2}$$

$$OA = \frac{a}{\sqrt{3}}$$

79. D

Sol. $x - ay + az = 0$ ..... (1)

$bz - bx - y = 0$ ..... (2)

$cx - cy - z = 0$ ..... (3)

Since equation are consistent

$$\text{So, } \begin{vmatrix} 1 & -a & a \\ -b & -1 & b \\ c & -c & -1 \end{vmatrix} = 0$$

$1 + bc + a(b - bc) + a(bc + c) = 0$

$1 + bc + ab - abc + abc + ac = 0$

$ab + bc + ca = -1$

80. C

Sol. Trace $A = x^2 + y^2 + z^2$

Trace $B = 2x + 2y + 2z - 3$

$x^2 + y^2 + z^2 = 2x + 2y + 2z - 3$
$x^2 + y^2 + z^2 - 2x - 2y - 2z + 3 = 0$
$(x - 1)^2 + (y - 1)^2 + (z - 1)^2 = 0$
It is true if $x = 1$, $y = 1$, $z = 1$
So, $x + y + z = 3$

81. B

Sol. Since plane $ax - by + cz = 0$ contains the line $\frac{x-a}{a} = \frac{y-2d}{b} = \frac{z-c}{c}$
So, point (a, 2d, c) will satisfy the plane and normal of plane will 90º with line
So, $a \cdot a - b \cdot 2d + c^2 = 0$
$c^2 + a^2 = 2bd$ ..... (1)
and $a^2 - b^2 + c^2 = 0$ since angle between normal of plane and line is 90º
$b^2 = a^2 + c^2$ ..... (2)
From equation (1) and (2), we get
$b^2 = 2bd$
$b = 2d$
$\frac{b}{d} = 2$

82. D

Sol. $|\vec{a}| = |\vec{b}| = 1$

$|\vec{a} + \vec{b}| = \sqrt{3} \Rightarrow |\vec{a}|^2 + |\vec{b}| + 2\vec{a} \cdot \vec{b} = 3$

$1 + 1 + 2\vec{a} \cdot \vec{b} = 3$

$2\vec{a} \cdot \vec{b} = 1$

$\vec{a} \cdot \vec{b} = \frac{1}{2}$

Given $3\left(\vec{a} \times \vec{b}\right) = \vec{c} - \vec{a} - 2\vec{b}$

$3\left(\vec{a} \times \vec{b}\right) \cdot \vec{b} = \vec{c} \cdot \vec{a} - \vec{a} \cdot \vec{b} - 2\vec{b} \cdot \vec{b}$

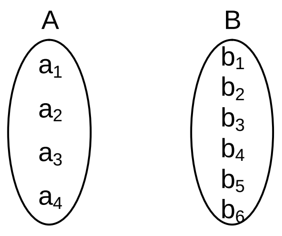
$O = \vec{c} \cdot \vec{b} - \frac{1}{2} - 2 \cdot 1$

$\vec{c} \cdot \vec{b} = 2 + \frac{1}{2} = \frac{5}{2}$

$\vec{c} \cdot \vec{b} = \frac{5}{2}$

83. B

Sol. Number of one-one functions
$= 6 \times 5 \times 4 \times 3$
$= 30 \times 12$
$= 360$



84. D

Sol. $$g(x)=\begin{cases}\dfrac{\dfrac{ax^2+bx}{(\cot x)^n}+c}{1+\dfrac{4}{(\cot x)^n}}=c & \text{if} \quad x<\dfrac{\pi}{4}\\[2ex] \dfrac{\dfrac{\sin x+\cos x}{(\tan x)^n}+1}{\dfrac{1}{(\tan x)^n}+c}=\dfrac{1}{c} & \text{if} \quad x>\dfrac{\pi}{4}\end{cases}$$

Limit to exist $c=\frac{1}{c} \Rightarrow c^2 = 1$, $c = \pm 1$

85. D

Sol. $y=e^{3x}$

$\frac{dy}{dx}=3e^{3x}$

$\frac{d^2y}{dx^2}=9e^{3x}$ ..... (1)

$e^{3x} = y$

$3x = \log_e y$

$3\frac{dx}{dy}=\frac{1}{y}$

$3\frac{d^2x}{dy^2}=-\frac{1}{y^2}$, $\frac{d^2x}{dy^2}=-\frac{1}{3y^2}$ ..... (2)

$\left(\frac{d^2y}{dx^2}\right)\left(\frac{d^2x}{dy^2}\right)=9e^{3x}\times-\frac{1}{3\cdot e^{6x}}=-3e^{-3x}$

86. B

Sol. P(x, y), Q(1, 0)

$PQ=\sqrt{(x-1)^2+y^2}$

$PQ^2 = x^2 + 1 - 2x + y^2$

$PQ^2 = x^2 - 2x + 1 + 2x^3 - 3x^2 + 9$

$PQ^2 = 2x^3 - 2x^2 - 2x + 10$

$\frac{d(PQ^2)}{dx}=6x^2-4x-2=0$

$6x^2 - 4x - 2 = 0$

$3x^2 - 2x - 1 = 0$

$3x^2 - 3x + x - 1 = 0$

$3x(x - 1) + (x - 1) = 0$

$(x - 1)(3x + 1) = 0$

$x = 1$, $x=-\frac{1}{3}$

$\frac{d^2(PQ^2)}{dx^2}=12x-4$

So, PQ^2 is minimum at $x = 1$

$y^2 = 2 + 9 - 3 = 8$

$(PQ)_{\text{minimum}}=\sqrt{0+8}=2\sqrt{2}$

87. C

Sol. $\int x^2 \sin 3x \cdot d\left(x^2 \sin 3x\right)$

$= \dfrac{\left(x^2 \sin 3x\right)^2}{2} + c$

$= \dfrac{x^4 \sin^2 3x}{2} + c$

a = 4, b = 2, d = 2

a + b + d = 8

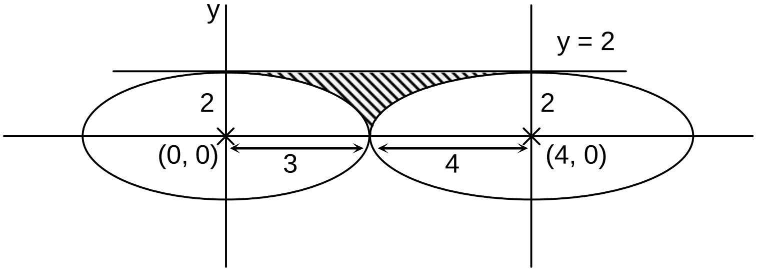
88. C

Sol. $1 \cdot f(x) = 1 + 0 - 1 \cdot x^2 f(x)$

$f(x)(1 + x^2) = 1,\ f(x) = \dfrac{1}{1+x^2} = \int_{-1}^{1} \dfrac{dx}{1+x^2} = 2\int_{0}^{1} \dfrac{dx}{1+x^2} = 2\left|\tan^{-1} x\right|_0^1 = 2 \times \left(\dfrac{\pi}{4} - 0\right) = \dfrac{\pi}{2}$

89. D

Sol. Area of an ellipse = πab



So, area of shaded region = $7 \times 2 - \dfrac{\pi}{4} \cdot 2 \times 3 - \dfrac{\pi}{4} \cdot 4 \cdot 2 = 14 - \dfrac{14\pi}{4} = 14 - \dfrac{7\pi}{2} = \dfrac{28 - 7\pi}{2}$

90. D

Sol. Let y(t) = z

$\dfrac{dz}{dt} + 2z = 2e^{-2t}$

$I \cdot F = e^{\int 2dt} = e^{2t}$

$z \cdot (IF) = \int 2(IF)dt + c$

$z\, e^{2t} = 2t + c$

$y(t)\, e^{2t} = 2t + c$

Put t = 0

$y(0)\, e^{0} = c$

2 = c

$y(t)\, e^{2t} = 2t + 2$

$y(t) = \dfrac{2t+2}{e^{2t}}$

$y(1) = \dfrac{2+2}{e^2} = \dfrac{4}{e^2}$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VII

JEE (Advanced)-2019

PAPER – 1

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01– 06, 19 – 24, 37 - 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 - 46) *contains 12 questions. Based on this section contains* ***TWO (02)*** *paragraphs. Based on each paragraph, there are* ***TWO (02)*** *questions.*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

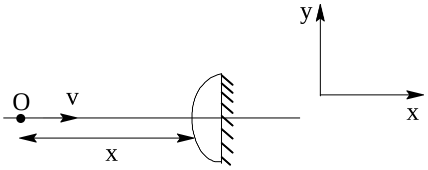
PART – I

SECTION – A

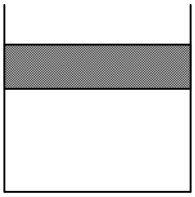
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. When object 'O' moves towards a fixed lens mirror combination, select correct choice/choices:
(A) Image moves towards negative x-axis
(B) Speed of image and object may be same
(C) Image may move faster than object
(D) Image may come closer to arrangement

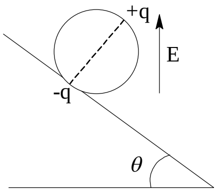


2. An ideal gas has molar heat capacity at constant pressure $C_p = 5R/2$. The gas is kept in a cylindrical vessel fitted with a piston which is free to move. Mass of the frictionless piston is 9 kg. Initial volume of the gas is $0.0027\ m^3$ and cross-section area of the piston is $0.09\ m^2$. The initial temperature of the gas is 300 K. Atmospheric pressure $P_0 = 1.05 \times 10^5 N/m^2$. An amount of $2.5 \times 10^4 J$ of heat energy is supplied to the gas such that piston move without acceleration, then:
(A) Initial pressure of the gas is $1.06 \times 10^5\ N/m^2$
(B) Final temperature of the gas is 1000 K
(C) Final pressure of the gas is $1.06 \times 10^5\ N/m^2$
(D) Work done by gas is 9.94×10^3 J



Space for Rough work

3. Two point charges $+q$ and $-q$ are fixed on diametrically opposite point on the uniform ring, such that $-q$ is at bottom and is in contact with a perfect insulator incline plane. Total mass is equal to m. It remains in equilibrium on the rough inclined plane in the presence of uniform vertical electric field $\vec{E}$. Then



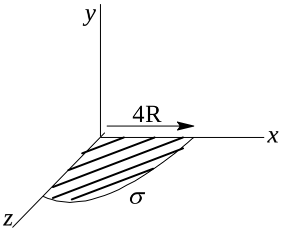
(A) The value of friction force is $mg\sin\theta$

(B) The value of friction force is less than $mg\sin\theta$

(C) The value of electric field is $\frac{mg}{2q}$

(D) The value of electric field is $\frac{mg\tan\theta}{2q}$

4. Quarter non–conducting disc of radius 4R having uniform surface charge density σ is placed in xz-plane then which of the following is the correct:



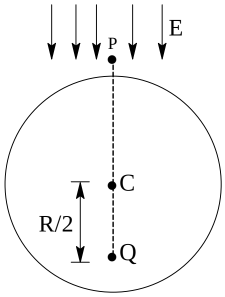
(A) Electric potential at (0, 3R, 0) is $\frac{\sigma R}{4\varepsilon_0}$

(B) Electric potential at (0,0,0) is $\frac{\sigma R}{2\varepsilon_0}$

(C) Electric field at (0, 3E, 0) is symmetric with x and z axis

(D) Electric field intensity at (-4R, 0, -4R) is equally inclined with x and z axis

5. A positive charge q is placed inside a neutral hollow conducting sphere of radius R, as shown in figure. Whole system is placed in uniform external vertical electric field pointing downward (line PCQ is also vertical) then select the correct statement(s) about electric field at point P. Point P is a point of the material inside the conductor.



(A) Electric field due to outer surface of sphere at point P is zero

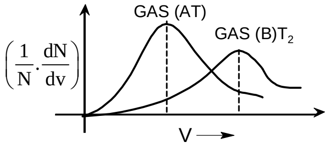
(B) Magnitude of electric field due to inner surface of sphere at point P is $q/9\pi\varepsilon_0 R^2$

(C) Magnitude of electric field at point P, due to hollow sphere is less than E

(D) Direction of resultant electric field at point P due to charge q and hollow sphere is vertically upward

Space for Rough work

6. According to Maxwell's distribution of molecular speeds, for the below graph drawn for two different samples of gases A and B at temperature T_1 and T_2 respectively, which of the following statements is/are INCORRECT :



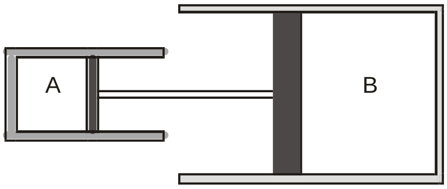
(A) If $T_1 = T_2$, then molecular mass of gas B (M_B) is greater than molecular mass of gas A (M_A).
(B) If molecular mass of gas A (M_A) is equal to molecular mass of gas B(M_B), then $T_1 > T_2$.
(C) If $T_1 < T_2$, then molecular mass of gas B(M_B) is necessarily less than molecular mass of gas A (M_A).
(D) If gas A is O_2 and gas B is N_2, then considering them to be ideal gases, T_1 is necessarily less than T_2.

(Paragraph Type)

This section contains **TWO** paragraphs. Based on each paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 7 and 8

Two fixed and horizontal cylinders A and B having pistons (both massless) of cross sectional area 100 cm^2 and 200 cm^2 respectively, are connected by massless rod. The piston can move freely without friction. The cylinder A contains 100 gms of an ideal gas (γ = 1.5) at pressure 10^5N/m^2 and temperature T_0. The cylinder B contains identical gas at same temperature T_0 but has different mass. The pistons are held at the state such that volume of gas in cylinder A and cylinder B are same and is equal to 10^{-2}m^3. The walls and piston of cylinder A are thermally insulated where as gas in cylinder B is maintained at constant temperature T_0. The whole system is in vacuum. Now the pistons are slowly released and they move towards left and mechanical equilibrium is reached at the state when the volume of gas in cylinder A becomes $25\times10^{-4}\ \text{m}^3$.



7. The mass of gas in cylinder B is

(A) 200 gms	(B) 600 gms
(C) 500 gms	(D) 1 kg

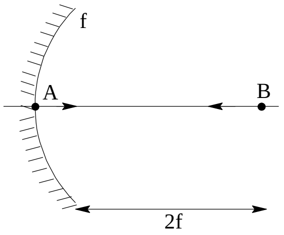
8. The change in internal energy of gas in cylinder A is :

(A) 2000 J	(B) 1000 J
(C) 500 J	(D) 3000 J

Space for Rough work

Paragraph for Question Nos. 9 and 10

At time t = 0, two point objects A and B respectively are at pole and centre of curvature of a fixed concave mirror of focal length f. The velocity vectors of A and B are $\vec{v}_A = u\hat{i}$ and $\vec{v}_B = -u\hat{i}$ respectively, where $\hat{i}$ is unit vector along principal axis directed from pole towards focus and u is a positive constant.



9. The distance between images of A and B will be 4f at time t =

(A) $\frac{f}{\sqrt{2}u}$ (B) $\frac{\sqrt{2}f}{u}$

(C) $\frac{f}{2u}$ (D) $\sqrt{2}u$

10. The magnitude of relative velocity of image of A and image of B at t = 0 is:

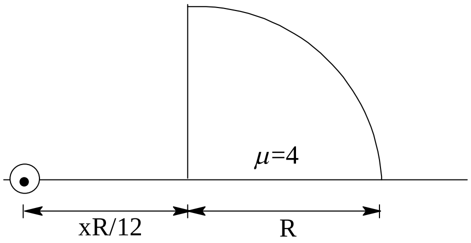
(A) u (B) 2u

(C) $\frac{u}{2}$ (D) $\sqrt{2}u$

SECTION – D
(Numerical Answer Type)

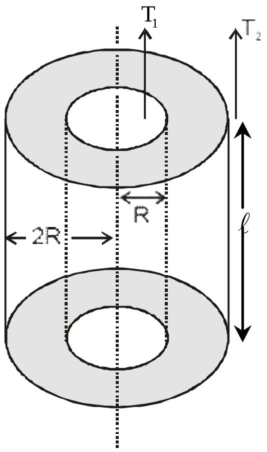
This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

11. Find the value of x so that image of object formed at infinite from a quarter cylinder of refractive index $\mu = 4$.



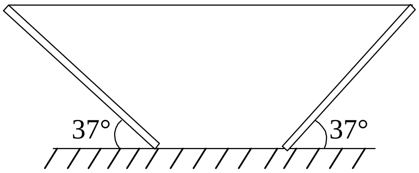
Space for Rough work

12. Inner surface of a cylindrical shell of length ℓ and of material of thermal conductivity k is kept at constant temperature T_1 and outer surface of the cylinder is kept at constant temperature T_2 such that $\left(T_1 > T_2\right)$ as shown in figure. Heat flows from inner surface to outer surface radially outward. Inner and outer radii of the shell are R and 2R respectively. Due to lack of space this cylinder has to be replaced by a smaller cylinder of length $\frac{\ell}{2}$ inner and outer radii $\frac{R}{4}$ and R respectively and thermal conductivity of material nk. If rate of radially outward heat flow remains same for same temperatures of inner and outer surface i.e. T_1 and T_2, then find the value of n.

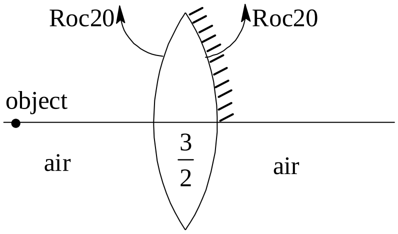


13. In a certain hypothetical radioactive decay process, species A decays into species B and species B decays
into species C according to the given reactions.
$A \rightarrow 2B$ + particles + energy
$B \rightarrow 3C$ + particles + energy
The decay constant for species A is $\lambda_1 = 1\ \text{sec}^{-1}$ and that for species B is $\lambda_2 = 100\ \text{sec}^{-1}$. Initially 10^4 moles of species of A were present, while there were none of B and C. It was found that species B reaches its maximum number at a time t_0 = 2 ln (10) sec. Calculate the value of maximum number of moles of B.

14. Two uniform identical rods of same mass are tied together with the help of a string and balanced as shown in the figure. The minimum coefficient of friction for which the system will remain in equilibrium in the position is $\frac{2}{x}$. The value of 'x' is

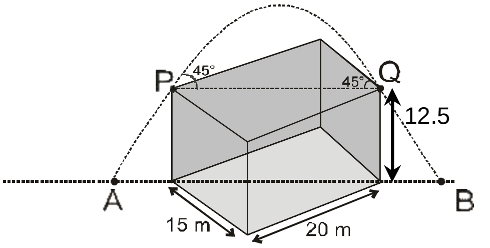


15. Distance between two images formed by upper and lower part of the point object placed at 30 cm from given lens is (60 + x) cm, then the value of x is:

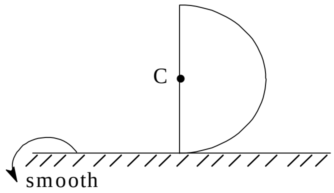


Space for Rough work

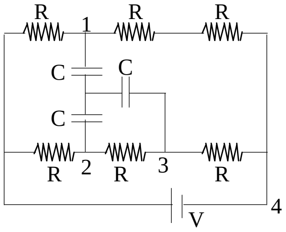
16. A commander fires a shell at certain angle of projection from ‘A’ which clears the building (cuboid) of dimensions 20 × 15 × 12.5 m^3 in its diagonal plane. Shell just clears the roof diagonally at points P and Q and falls on the other side of the building at B, and makes 45° angle with horizontal at P and Q as shown in the figure. If the range AB of the shell is $N\times\sqrt{3}$ metre then find N. ($g = 10\ m/s^2$)



17. If angular acceleration of the uniform disc just after release from rest position shown in figure is $\frac{8\pi g}{NR}$, then calculate N. (C is centre of semi-circular disc.) ($\pi^2 = 10$)



18. In the show circuit, all three capacitor are identical and have capacitance $C\mu F$ each. Each resistor has resistance of $R\Omega$. An ideal cell of emf V volts is connected as shown. If the magnitude of potential difference across capacitor C_3 in steady state is $\frac{a}{b}$V then value of $a\times b$ is:



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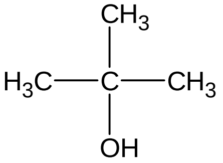
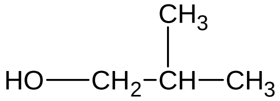
Chemistry PART – II

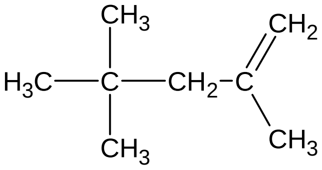
SECTION – A
(One or More than one correct type)

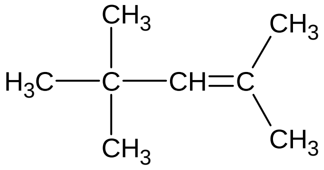
This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. The reaction of isobutene with conc.H_2SO_4 at 70^oC gives

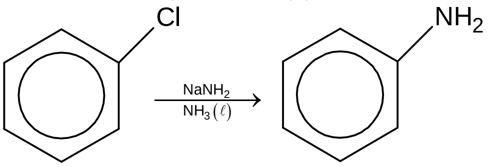
(A) 
$H_3C-\underset{OH}{\overset{CH_3}{C}}-CH_3$

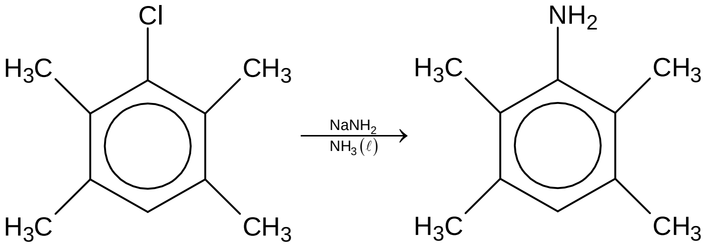
(B) 
$HO-CH_2-\overset{CH_3}{CH}-CH_3$

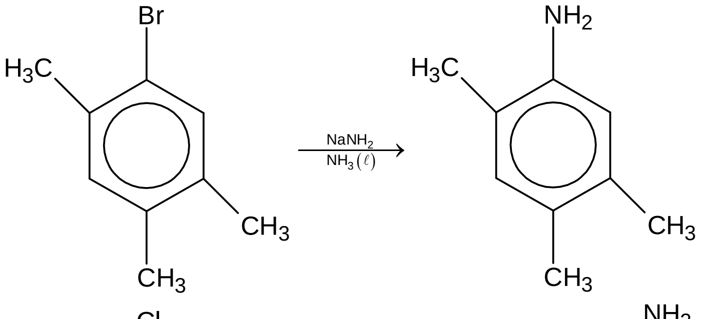
(C) 

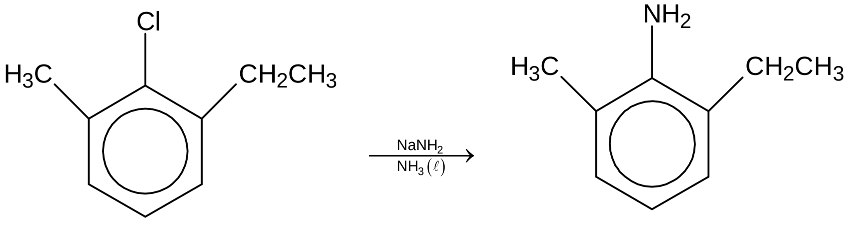
(D) 

20. Which of the following reaction(s) is/are not feasible?

(A) 

(B) 

(C) 

(D) 

21. Example of step growth polymer is/are
(A) nylon-6 (B) nylon-6, 6
(C) polybutadiene (D) none of these

22. Which of the folloiwng alloys contain (s) Cu and Zn?
(A) Bronze (B) Brass
(C) Gun metal (D) Type metal

23. Which of the following statement is correct about the compound of Xe?
(A) $XePtF_6$ was first real compound of any of the noble gases
(B) with SbF_5, XeF_2 act as an Lewis acid but XeF_4 acts as a Lewis base
(C) with SbF_5 both XeF_2 and XeF_4 act as Lewis acid
(D) with SbF_5 both XeF_2 and XeF_4 act as Lewis base

24. Which of the following statements is false for $t_{1/2}$ (half life)?
(A) $t_{1/2}$ increases with increase in temperature
(B) $t_{1/2}$ decreases with increase in temperature
(C) $t_{1/2}$ is independent of temperature
(D) $t_{1/2}$ is the time taken when half the actual time is taken for the chemical reaction to complete

(Paragraph Type)

This section contains **TWO** paragraphs. Based on each paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 25 and 26

In a fuel cell, chemical enegy of fuel is used for producing electricity. H_2 is used as a fuel and oxygen is used as oxidiser. The standard enthalpy of combustion of hydrogen is -241 kcalmol^{-1}. The $E^{\circ}_{cell} = 1.23$ V

25. The equilibrium constant of the reaction is
(A) 4.7×10^{41}
(B) 3.7×10^{41}
(C) 4.210×10^{41}
(D) 4.169×10^{40}

Space for Rough work

26. The thermodynamic efficiency $\frac{\Delta G^o}{\Delta H^o}$*100 of above cell is

(A) 95%	(B) 70%
(C) 98.4%	(D) 100%

Paragraph for Question Nos. 27 and 28

$t_{1/2}$ for nth order reaction. If a reaction $nA \rightarrow$ Products

then $rate = \frac{-d[A]}{dt} = k_n[A]^n \Rightarrow \frac{-d[A]}{[A]^n} = k_n dt$

Integrating both sides and doing further reaction we get $t_{1/2} = \frac{2^{n-1}-1}{k_n(n-1)a_0^{n-1}}$

Where a_0 = initial conc. of A. Hence $t_{1/2} \propto \frac{1}{a_0^{n-1}}$.

27. For a reaction of nth order the ratio of $\frac{t_{1/2}}{t_{3/4}}$ is a function of

(A) a_0	(B) k_n
(C) n	(D) t

28. The following data was obtained for a chemical reaction

a_0 (mol/dm^3)	0.5	1.1	2.48
$t_{1/2}$(s)	4280	885	174

The order of the reaction is

(A) 1	(B) 2
(C) 3	(D) 4

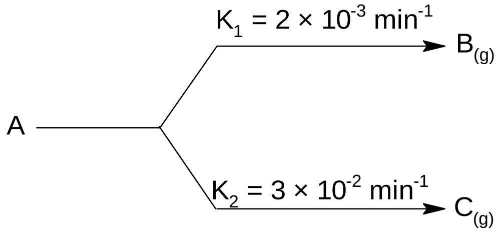
Space for Rough work

SECTION – D

(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

29. A gaseous reactant A decomposes to produce gaseous products B and C in parallel reaction both by first order, as follows


$K_1 = 2 \times 10^{-3}\ min^{-1}$
$B_{(g)}$
A
$K_2 = 3 \times 10^{-2}\ min^{-1}$
$C_{(g)}$

If decomposition is carried out in a sealed flask, partial pressure of $B_{(g)}$ at the end of reaction was found to be 40 mm of Hg. Determine partial pressure of C after 1.0 hour.
(Given that antilog 0.8336 = 6.818)

30. The hydrogen atom in the ground state is excited by mass of monochromatic radiations of wavelength λ Å. The resulting spectrum consists of maximum 15 different lines. What is the value of λ in Å? $R_H = 109737\ cm^{-1}$

31. A metal is known to form fluoride MF_2. When 10 ampere electricity is passed through a molten salt for 330 sec, 1.95 g metal is deposited. Find out the atomic weight of metal. What will be the quantity of charge required to deposit the same mass of Cu from $CuSO_4$(aq) in kilo Coulomb. (At. wt. of Cu = 63.6)

32. If boiling point of an aqueous solution is 100.1°C. What is its freezing point? Given latent heat of fusion and vaporization of water are 80 cal g^{-1} and 540 cal g^{-1} respectively. [Write the answer in the modulus form in °C]

33. What is resistance (in a cell with constant 0.206 cm^{-1}) of an 0.04 M solution of acetic acid at 25°C? Given, $K_a = 1.8 \times 10^{-5}$, $\Lambda_m^o(CH_3COOH) = 390.5\ ohm^{-1}\,cm^2\,mol^{-1}$
[Write the answer in ohm]

Space for Rough work

34. Decomposition of phosgene gas

$COCl_2 \rightleftharpoons CO + Cl_2$ follows first order kinetics with and long

$\log K_f = 13.48 - \frac{52400}{4.5} \times \frac{1}{T}$ … (i)

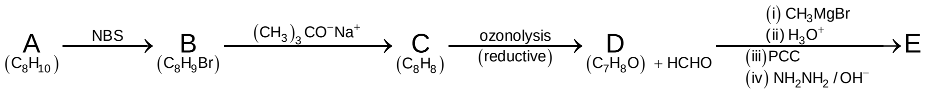
$\log K_b = 8.023 - \frac{26300}{4.5} \times \frac{1}{T}$ … (ii)

Determine ΔS^0

[Write the answer in J-K^{-1}]

35. An ideal gas has a specific heat at constant pressure $C_p = \frac{5}{2}R.$ The gas is kept in a closed vessel of volume 0.0083 m^3, at a temperature of 300 K and pressure 1.6 × 10^6 N/m^2. An amount of 2.49 × 10^4 J of energy is supplied to the gas. Calculate the final temperature of the gas in Kelvin.

36. In following organic reaction



$$\underset{(C_8H_{10})}{A} \xrightarrow{NBS} \underset{(C_8H_9Br)}{B} \xrightarrow{(CH_3)_3CO^-Na^+} \underset{(C_8H_8)}{C} \xrightarrow[\text{(reductive)}]{\text{ozonolysis}} \underset{(C_7H_8O)}{D} + HCHO \xrightarrow[\substack{\text{(iii) PCC} \\ \text{(iv) } NH_2NH_2/OH^-}]{\substack{\text{(i) } CH_3MgBr \\ \text{(ii) } H_3O^+}} E$$

If the number of geometrical isomers of compound C is x and molecular weight of compound E is y then find the value of (x + y).

Space for Rough work

Mathematics PART – III

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. Let g(x) = f(tanx) + f(cotx) $\forall$ x $\in \left(\frac{\pi}{2}, \pi\right)$. If f″(x) < 0 $\forall$ x $\in \left(\frac{\pi}{2}, \pi\right)$ then

(A) g(x) is increasing in $\left(\frac{\pi}{2}, \frac{3\pi}{4}\right)$

(B) g(x) is increasing in $\left(\frac{3\pi}{4}, \pi\right)$

(C) g(x) is decreasing in $\left(\frac{3\pi}{4}, \pi\right)$

(D) g(x) has local maximum at x = $\frac{3\pi}{4}$

38. The value of $\lim\limits_{x\to -4}\frac{\tan \pi x}{x+4}+\lim\limits_{x\to\infty}\left(1+\frac{1}{x^2}\right)^x$ is

(A) greater than 3 (B) greater than 4

(C) greater than 5 (D) less than 6

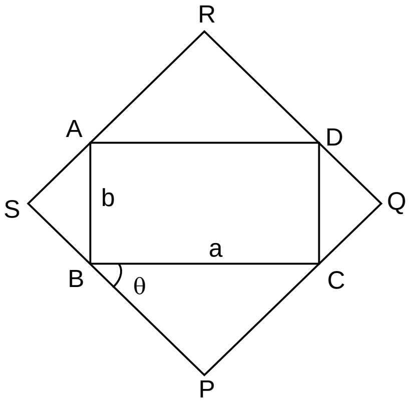
39. Let ABCD is a rectangle whose sides given are a and b. A rectangle PQRS whose area is A is shown in figure, then

(A) area A is maximum when $\theta = \frac{\pi}{3}$

(B) area A is maximum when $\theta = \frac{\pi}{4}$

(C) maximum value of area A = $\frac{1}{4}(a+b)^2$

(D) maximum value of area A = $\frac{1}{2}(a+b)^2$



Space for Rough work

40. The set S of all real x for which $(x^2 - x + 1)^{x-1} < 1$ contains
(A) (– 5, –1) (B) (– 1, 1)
(C) (– 1, 0) (D) (– 3, 1)

41. Let z be a complex number satisfying equation $z^n = \bar{z}^m$, where n, m $\in$ N, then
(A) if n = m, then number of solution of equation will be finite
(B) if n = m, then number of solution of equation will be infinite
(C) if n $\neq$ m, then number of solution of equation will be n + m
(D) if n $\neq$ m, then number of solution of equation will be n + m + 1

42. If u, v, w are real numbers such that $|ux + vy + wz| + |vx + wy + uz| + |wx + uy + vz| = |x + y + z|$ $\forall$ x, y, z $\in$ R then
(A) u, v, w are equal (B) u, v, w are all of same sign
(C) u + v + w can take two values (D) |u| + |v| + |w| = 1

(Paragraph Type)

This section contains **TWO** paragraphs. Based on each paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 43 and 44

There is a point inside an equilateral triangle ABC of side d whose distance from the vertices is 3, 4, 5. Rotate the triangle and P through 60^o about C. Let A go to A' and P to P'.

43. The area of triangle PA P' is
(A) 8 (B) 12
(C) 6 (D) none of these

44. The value of d^2 is
(A) $25 + 12\sqrt{3}$ (B) $25 - 12\sqrt{3}$
(C) $5 + 12\sqrt{3}$ (D) $25 + 24\sqrt{3}$

Space for Rough work

Paragraph for Question Nos. 45 and 46

Let P, Q are two points on the curve y = $\log_{1/2}(x-0.5)+\log_2\sqrt{4x^2-4x+1}$ and P is also on the circle $x^2 + y^2 = 10$, Q lies inside the given circle such that its abscissa is an integer.

45. The co–ordinates of P are given by

(A) (1, 2) (B) (2, 4)
(C) (3, 1) (D) (3, 5)

46. $\overrightarrow{OP}\cdot\overrightarrow{OQ}$, 'O' being the origin is

(A) 4 or 7 (B) 4 or 2
(C) 2 or 3 (D) 7 or 8

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

47. If the normal to the curve x = t – 1, y = $3t^2 - 6$ at the point (1, 6) make intercepts a and b on x and y-axes respectively, then the value of $\frac{a+12b}{10}$ is ____

48. In a triangle ABC, side AB = 20, AC = 11, BC = 13, then the radius of the semicircle inscribed in triangle ABC, whose diameter lies on AB and is touching AC and BC is ___

49. g: R → R, if g(x) = $x^2+x^2\int_{-1}^{1}tg(t)dt+x^3\int_{-1}^{1}g(t)dt$, then $11\int_{-1}^{1}\left(g(x)-g(-x)\right)dx$ is _____

50. The figures 4, 5, 6, 7, 8 are written in every possible order. The number of numbers greater than 56000 is __

Space for Rough work

51. In the expansion of $(a^{1/3} + b^{1/9})^{6561}$, where a, b are distinct prime numbers, If the number of irrational terms are N then the value of $\frac{N}{100}$ is.

52. Let N = aaaaaa be a 6 digit number (all digit repeated) and N is divisible by 924 and let a, β be the roots of the equation $x^2 - 11x + \lambda = 0$, then product of all possible values of λ is ____

53. Let $2(1 + x^3)^{100} = \sum_{i=0}^{100}\left\{a_i x^i - \cos\frac{\pi}{2}(x+i)\right\}$, if $\sum_{i=0}^{50} a_{2i} = 2^k$, then the value of k is ___________

54. Let f: [k, k + 1,…, 2007] → [1, 2, 3, …, n] be defined by $f(x) = \left[\frac{2007}{x}\right]$ (where [.] denotes the greatest integer function). The maximum value of k such that it is not possible to make f an onto function for any vale of n is.

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VII

JEE (Advanced)-2019

PAPER – 1

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. ABCD

Sol. The above lens mirror combination is an equivalent converging mirror.

2. ACD

Sol. PV= nRT --------------------- (1)

Mass of piston is 9kg & area of piston is 0.09m^2

So

$$P=P_0+\frac{9g}{0.09}$$

$$P=1.06\times10^5 N/m^2$$

As mass of piston is not changed & Piston is frictionless so process is isobaric

$$P_f=P_i=1.06\times10^5 N/m^2$$

$$P_f=P_i=1.06\times10^5 N/m^2$$

$$dQ=n\,Cp\,dT\text{------------}(2)$$

$$\text{or } P_2V_2\text{-}P_1V_1=nR\,dT\text{-------}(3)$$

$$(3)\div(2) \qquad \frac{P\left(V_2\text{-}V_1\right)}{dQ}=\frac{2}{5}$$

$$\Rightarrow P\left(V_2\text{-}V_1\right)=\frac{2}{5}\times2.5\times10^4$$

$$W=P\Delta V=10^4 J \quad \&\text{ by equation (1)}$$

$$n=\frac{1.06\times10^{5}\times0.0027}{R\times300}$$

$$n=\frac{1.06\times270}{2500}=0.11448$$

$$\text{or by } dQ=n\,Cp\,dT$$

$$\therefore T_2-T_1=\frac{2.5\times10^{4}}{0.11448\times\frac{5R}{2}}$$

$$\text{on solving } T_2=1.0782.18K$$

3. AC

Sol. $f=mg\sin\theta$ and $PE\sin\theta=mg\sin\theta.R$

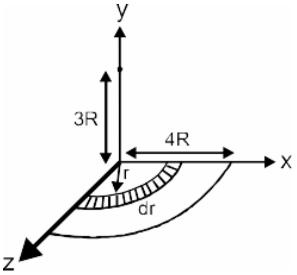
$$q\,2\,R\,E\sin\theta=mg\sin\theta\,R$$

$$E=\frac{mg}{2q}$$

4. ABCD

Sol. (A) $v=\int_0^{4r}\frac{K\frac{\pi}{2}rdr\sigma}{\sqrt{r^2+(3R)^2}}=\frac{\sigma R}{4\varepsilon_0}$

(B) $v=\int_0^{4r}\frac{K\frac{\pi}{2}rdr\sigma}{r}=\frac{\sigma R}{2\varepsilon_0}$



5. BD

Sol. External electric field and induced charge on outer surface of the sphere will produce a net zero field inside it. Net field at P must be vertically upward.

6. ABCD

Sol. At constant temperature, decrease in molecular mass causes flattening of the graph. For same molecular mass of gas, increase in temperature causes flattening of the graph.

$$\left(V_{mp}\right)_{T_1}<\left(V_{mp}\right)_{T_2}$$

$$\therefore \frac{T_1}{M_A}<\frac{T_2}{M_B} \qquad \therefore \frac{T_2}{T_1}>\frac{M_B}{M_A}$$

But, $\frac{M_B}{M_A}$ can be less than or greater than 1

Similarly, $\frac{M_A}{M_B}>\frac{T_1}{T_2}$

If gas A is O_2 and gas B is N_2, then $M_A>M_B$.

$$\left(V_{mp}\right)_{T_1}<\left(V_{mp}\right)_{T_2}$$

$\therefore \frac{T_1}{M_A} < \frac{T_2}{M_B}$ $\therefore \frac{T_2}{T_1} > \frac{M_B}{M_A}$

7. D
8. A

Sol. **(Sol. for Q. 7 and Q.8)**

Let the initial temperature, pressure and volume of gas in 'A' be T_0, P_0, V_0 and the area of the position A and B be a, 2a. Now gas in chamber 'A' undergoes adiabatic compression whereas gas in chamber 'B' undergoes isothermal expansion.

Now solving for gas in 'A'

$P_{1A}V_{1A}^{\gamma} = P_{2A}V_{2A}^{\gamma} \Rightarrow P_0V_0^{\gamma} = P_{2A}(0.25V_0) \Rightarrow P_{2A} = 8P_0$

Solving for gas in 'B'

$P_{1B}V_{1B} = P_{2B}V_{2B} \Rightarrow P_{1B}V_0 = P_{2B} \times 2.5V_0 \Rightarrow P_{2B} = 0.4P_{1B}$

Also $(P_{2A} \times a) = (P_{2B} \times 2a)$ for gas is chambers 'B'

$\Rightarrow 8P_0 a = P_2 \times 2a \Rightarrow P_2 = 4P_0$

$\Rightarrow 0.4\,P_1 = 4P_0 \Rightarrow P_1 = 10P_0$

Now comparing the moles of gas in A and B

$$n_A = \frac{P_0V_0}{RT_0}$$

$$n_B = \frac{10P_0V_0}{RT_0} = 10n_A$$

$$m_B = 10m_A = 10 \times 100\text{gm} = 1\text{kg}$$

Again for gas is $A, \Delta Q = \Delta U + \Delta W$

$$\Rightarrow 0 = \Delta U + \Delta W$$

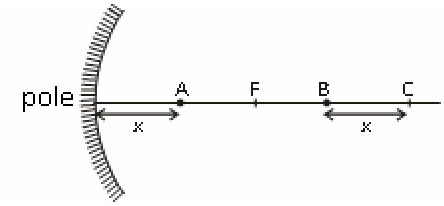
$$\Rightarrow 0 = \Delta U + \left\{\frac{P_0V_0 - 8P_0 \times \frac{V_0}{4}}{(\gamma - 1)}\right\}$$

$$\Rightarrow \Delta U = 2P_0V_0 = 2 \times 10^5 \times 10^{-2} = 2000\text{J}$$

$$F = 8P_0 a = 8 \times 10^5 \times 10^{-2} = 8000\text{N}$$

9. C

Sol. The image distance of A is



$$V_A = -\frac{(f-x)}{xf}\ (\because x<t)$$

The image of B is $V_B = -\frac{[(2f-x)-f]}{(2f-x)-x}$

Solving $|V_A| + |V_B| = 4f$ we get $x = \frac{f}{2}$

$\therefore$ required time $t = \frac{x}{u} = \frac{f}{2u}$

10. B

SECTION – D

11. 00001.00

Sol: at plane surface image of object is $= -\frac{xR}{12} \times 4$ distance at current surface

$$u = -\left[\frac{xR}{12}4 + R\right]$$

$$v = \infty \quad ROC = -R$$

$$\frac{\mu_r - \mu_i}{R} = \frac{\mu_r}{v} - \frac{\mu_i}{u}$$

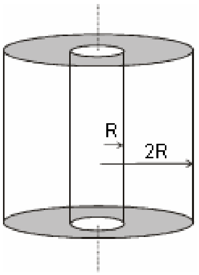
$$\frac{1-4}{-R} = \frac{-4}{\left[\frac{xR4}{12} + R\right]}$$

$$\Rightarrow x = 1$$

12. 00004.00

Sol. $H = -K.2\pi r / \frac{dT}{dr}$

$$\int_{R_1}^{R_2} \frac{Hdr}{2\pi rl} = -K\int_{T_1}^{T_2} dT \Rightarrow H = \frac{2\pi lk\left(T_1 - T_2\right)}{\ln\frac{R_2}{R_1}} \quad H_i = H_f$$



13. 00002.00

Sol. $\frac{dN_A}{dt} = -\lambda_1 N_A, \frac{dN_B}{dt} = 2\lambda_1 N_A - \lambda_2 N_B$

$$N_B = \text{maximum} \Rightarrow \frac{dN_B}{dt} = 0$$

$$\Rightarrow 2\lambda_1 N_A = \lambda_2 N_{B_{\max}} \quad \Rightarrow N_{B_{\max}} = \frac{2\lambda_1}{\lambda_2} N_A \quad \Rightarrow N_{B_{\max}} = \frac{2\lambda_1}{\lambda_2} N_0 e^{-\lambda_1 t} = 2$$

14. 00003.00

Sol. T the FBD of any one rod is

$$T = \mu N - - - - - - - - (1)$$

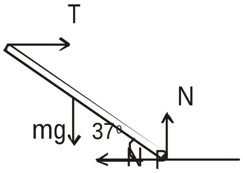
$$mg = N - - - - - - - - (2)$$

Taking torque of any one rod is

$$mg\frac{L}{g}\cos37^o = TL\sin37^o$$

$$T = \frac{mg}{2}\frac{4}{3} = \frac{2mg}{3}$$

$$\frac{2mg}{3} = \mu mg \Rightarrow \mu = \frac{2}{3}$$



15. 00006.00

Sol. $$\frac{1}{f_L}=\left(\frac{3}{2}-1\right)\left(\frac{1}{20}-\frac{1}{20}\right)$$

$$\Rightarrow F_L = 20cm$$

$$\frac{1}{f}=\frac{1}{-10}-\frac{2}{20}=-\frac{1}{5}$$

$$\frac{1}{v}+\frac{1}{-30}=\frac{1}{-5}\Rightarrow\frac{1}{v}=\frac{1}{30}-\frac{1}{5}$$

For lens $\frac{1}{v}-\frac{1}{-30}=\frac{1}{20}$

16. 00025.00

Sol. $$\overline{PQ}=\sqrt{15^2+20^2}=25m$$

$$25=\frac{V_P^2\sin 2(45)}{g}\Rightarrow V_P=5\sqrt{10}\text{m/s}$$

$$\therefore V_A^2\sin^2\theta-2\times10\times12.5=\left(5\sqrt{5}\right)^2\Rightarrow V_A\sin\theta=5\sqrt{15}\text{m/s}$$

$$V_A\cos\theta=V_P\cos45^o=5\sqrt{5}\text{m/s and }\theta=60^o$$

$$\therefore\overline{AB}=\frac{V_A^2\sin2\theta}{g}=25\sqrt{3}$$

17. 00030.00

Sol. Consider equation of torque about C

$$\left[mg\frac{4R}{3\pi}\right]=\frac{mR^2}{2}\alpha$$

$$\alpha=\frac{8g}{3\pi R}=\frac{8\pi g}{3\pi^2R}=\frac{8\pi g}{30R}$$

18. 00018.00

Sol. No current passes through capacitors in steady state. Assume potential at point '4' to be zero.

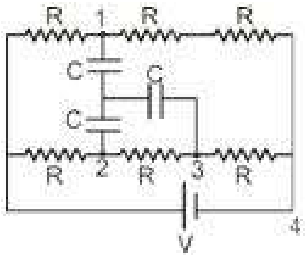
Then points '1' and '2' are at same potential $\frac{2V}{3}$

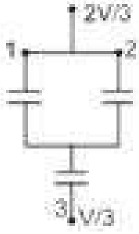
Hence $C_1$and C_2 can be taken in parallel

The potential at point 3 is $\frac{V}{3}$

$\therefore$ Equivalent circuit of all three capacitors is shown Hence potential difference across capacitor C_3 is

$$=\frac{2C}{2C+C}\times\left(\frac{2V}{3}-\frac{V}{3}\right)=\frac{2V}{9}$$





Chemistry PART – II

SECTION – A

19. CD

Sol. It is polymerisation reaction. The chain termination occurs after only isobutylene molecule has been added. This is due to the high concentration of water, the intermediate carbocation loses a proton to water it can react with another alkene molecules.
Hence (C, D) is correct.

20. BD

Sol. The above reaction represent the case of $\mathrm{Ar_{SN}}$ (aromatic nucleophilic substitution) which occurs through the formation of benzyne. For the formation of benzyne intermediate, it is essential that an H should be available in on ortho position to the halogen.
Hence (B, D) is correct.

21. AB

Sol. These copolymers are formed in steps and hence step growth polymer

22. AB

Sol. Bronze contains Cu = 80%, Zn = 10%, Sn = 10% whereas brass contains Cu = 80%, Zn = 20%.
Gun metal and type metal do not contain Zn.
Hence, (A) and (B) are the correct answers.

23. AD

Sol.
$$\underset{\text{Lewis base}}{XeF_2} + \underset{\text{Lewis acid}}{2SbF_5} \rightarrow XeF_2 \cdot 2SbF_5$$
$$XeF_4 + SbF_5 \rightarrow [XeF_3]^+[SbF_6]^-$$
$XePtF_6$ was first real compound of Xe.

24. ACD

Sol. On increasing the temperature k value increases hence rate of reaction increases thus $t_{1/2}$ decreases.
Hence choice (B) is correct while all others are incorrect.

25. C

Sol.
$$\log K = \frac{nE^\circ}{0.0591} = \frac{2 \times 1.23\ V}{0.0591} = 41.62$$
$\therefore$ K = 4.210×10^{41}

26. C

Sol.
$$\text{Efficiency} = \frac{\Delta G}{\Delta H} = \frac{-237.39}{-241.00} = 98.5\%$$

27. C

Sol. For n^th order reaction
$$k_n t = \frac{1}{(n-1)}\left[\frac{1}{a^{n-1}} - \frac{1}{a_0^{n-1}}\right] \qquad \ldots(i)$$
Hence
$$k_n t_{1/2} = \frac{1}{n-1}\left[\left(\frac{2}{a_0}\right)^{n-1} - \left(\frac{1}{a_0}\right)^{n-1}\right] \qquad \ldots(ii)$$

as $a = \frac{a_0}{2}$

At $t_{3/4}$

$$k_n t_{3/4} = \frac{1}{n-1}\left[\left(\frac{4}{3a_0}\right)^{n-1} - \left(\frac{1}{a_0}\right)^{n-1}\right] \qquad \ldots\text{(iii)}$$

$a = \frac{3a_0}{4}$ at $t_{3/4}$

From equations (ii) and (iii)

$$\frac{t_{1/2}}{t_{3/4}} = \frac{2^{n-1}-1}{\left(\frac{4}{3}\right)^{n-1}-1}$$

Hence $\frac{t_{1/2}}{t_{3/4}}$ is a function of n.

28. C

Sol. $t_{1/2} \propto \frac{1}{a_0^{n-1}}$

$$\frac{t_{1/2(1)}}{t_{1/2(2)}} = \frac{\left(a_{o(2)}\right)^{n-1}}{\left(a_{0(1)}\right)^{n-1}}$$

$$\left(\frac{4280}{885}\right) = \left(\frac{1.1}{0.5}\right)^{n-1} = \left(\frac{11}{5}\right)^{n-1}$$

Solving we get n = 3

Hence order = 3

SECTION – D

29. 00512.035

Sol: 32. $\frac{P_B}{P_C} = \frac{2\times10^{-3}}{3\times10^{-2}} = \frac{1}{15}$

$\Rightarrow P_C = 15P_B$

$P_0 = 40 + 15 \times 40 = 640$

$(K_1 + K_2) = \frac{2.303}{60}\log\frac{640}{640-p}$

$\therefore P = 546.17 = P_B^0 + P_C = 16P_B$

$\therefore P_B = 34.135$

$P_C = 546.17 - 34.135$

$= 512.035$ mm of Hg.

30. 00937.30

Sol. Let the electron be boosted to n^th level, then

Number of spectral lines = $\sum \Delta n = \sum n - 1 = 15$. Given,

Or $\frac{1}{2}[n-1]\times n = 15$

$\therefore$ n = 6

Thus electron is boosted upto 6th energy level from ground state. Therefore

$$\frac{1}{\lambda} = R_H\left[\frac{1}{n^2} - \frac{1}{1^2}\right] = 109737 \times \frac{35}{36}$$

$\lambda = 9.373 \times 10^{-6}$ cm = 937.3 Å

31. 00005.92

Sol. Eq. of metal $= \dfrac{i.t}{96500}$ (i = 10 ampere, t = 330 sec)

$$\frac{1.95}{E} = \frac{10 \times 330}{96500}$$

$E_{metal} = 57.0$

At. wt. of metal = 57.0 × 2 (metal is bivalent as salt is MF_2)
= 114.0

Also, if $w_{cu} = 1.95$ g, then

Eq. of Cu $= \dfrac{i.t}{96500}$

or $\dfrac{1.95}{63.6/2} = \dfrac{i.t}{96500}$

$\therefore$ i.t = Q = 5917.45 coulomb = 5.92 kC

32. 00000.37

Sol. For a given aqueous solution

$\Delta T_b = K_b^{'} \times \text{molality}$

$\Delta T_f = K_f^{'} \times \text{molality}$

$$\therefore \quad \frac{\Delta T_b}{\Delta T_f} = \frac{K_b^{'}}{K_f^{'}} = \frac{RT_b^2}{1000\ell_v} \times \frac{1000\ell_f}{RT_f^2}$$

$$\frac{\Delta T_b}{\Delta T_f} = \frac{T_b^2 \times \ell_f}{T_r^2 \times \ell_v}$$

$\because$ $T_b = 100 + 273 = 373$ K

$T_f = 0 + 273 = 273$ K

$\ell_f = 80$ cal g^{-1};

$\ell_v = 540$ cal g^{-1}

$$\therefore \quad \frac{0.1}{\Delta T_f} = \frac{373 \times 373 \times 80}{273 \times 273 \times 540}$$

$\therefore$ $\Delta T_f = 0.362$

$\therefore$ $T_f = 0.0 - 0.362 = -0.362^oC$

$|T_f| = 0.362^oC$

33. 00622.40

Sol. Degree of dissociation $(\alpha) = \dfrac{\wedge_m}{\wedge_m^o}$

$$\Rightarrow \wedge_m = \wedge_m^o \times \alpha$$

$$= \wedge_m^o \times \sqrt{\frac{K_a}{C}} \text{ (by Ostwald dilution law)}$$

$$= 390.5 \times \sqrt{\frac{1.8 \times 10^{-5}}{0.04}} = 8.82 \text{ ohm}^{-1}\text{ cm}^2\text{ mol}^{-1}$$

$$\text{Conductivity} = \frac{\text{molarity} \times \wedge_m}{1000}$$
$$= 3.31 \times 10^{-4}\ \text{ohm}^{-1}\ \text{cm}^{-1}$$

$$\text{Also conductivity} = \text{Cell constant} \times \frac{1}{\text{Resistance}}$$

$$\Rightarrow\ \text{Resistance} = \frac{\text{Cell constant}}{\text{Conductivity}}$$

$$= \frac{0.206}{3.31 \times 10^{-2}} = 622.36\ \text{ohm} = 622.4\ \Omega$$

34. 00104.50

Sol. $-\Delta G^0 = 2.303\ RT\ \log_{10}K$

$\Delta G^0 = \Delta H^0 - T\Delta S^0$

$$\therefore \log K = -\frac{\Delta H^0}{2.303RT} + \frac{\Delta S^0}{2.303 \times R} \qquad \ldots \text{(iii)}$$

From equation (i) & (ii)

$$\log \frac{K_f}{K_b} = 5.457 - \frac{5800}{T}$$

$$\Rightarrow \log K = 5.4857 - \frac{5800}{T}$$

$$\log K = -\frac{5800}{T} + 5.457 \qquad \ldots\text{(iv)}$$

From equation (iii) & (iv)

$\Delta S^0 = 104.48 JK^{-1} = 104.5\ JK^{-1}$

35. 00675.00

Sol. Let n moles of gas be present

$$\therefore \quad n = \frac{PV}{RT} = \frac{1.6 \times 10^6 \times 0.0083}{8.3 \times 300} = 5.33$$

$$\text{Given, } C_p = \frac{5}{2}R,\ \therefore\ C_v = \frac{5}{2}R - R = \frac{3}{2}R = \frac{3}{2} \times 8.3 = 12.45\ \text{J/mol} - \text{K}$$

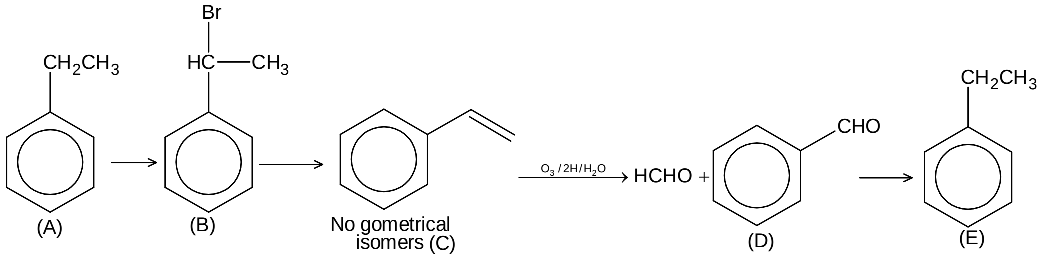
Heat supplied at constant volume = $n \times C_v \times \Delta T$

$\therefore \quad \Delta T = 375$ K

$\therefore \quad$ Final temperature = 300 + 375 = 675 K

36. 00106.00

Sol.



Also A and E are identical

M. Wt. = 96 + 10 = 106

Number of geometrical isomers = 0

x + y = 106

Mathematics PART – III

SECTION – A

37. ACD

Sol. $g'(x) = f'(\tan x)\sec^2 x - f'(\cot x)\operatorname{cosec}^2 x$

For increasing $g'(x) > 0$

$\because f''(x) < 0 \Rightarrow f'(x)$ is decreasing for

$\tan x < \cot x \;\forall\; x \in \left(\frac{\pi}{2}, \frac{\pi}{4}\right)$

$\therefore f'(\tan x) > f'(\cot x)$

also, $\sec^2 x > \operatorname{cosec}^2 x \;\forall\; x \in \left(\frac{\pi}{2}, \frac{\pi}{4}\right)$

$\therefore g'(x) > 0 \Rightarrow g(x)$ is increasing in $\left(\frac{\pi}{2}, \frac{3\pi}{4}\right)$

similarly $g(x)$ is decreasing in $\left(\frac{3\pi}{4}, \pi\right)$

also $g(x)$ has local max at $x = \frac{3\pi}{4}$.

38. ACD

Sol. $\lim\limits_{x\to -4} \frac{\tan \pi x}{x+4} \qquad \left(\frac{0}{0}\right)$

$= \lim\limits_{x\to -4} \frac{\pi \sec^2 \pi x}{1} = \pi$

$\lim\limits_{x\to\infty}\left(1+\frac{1}{x^2}\right)^x = \lim\limits_{x\to\infty} e^{x\cdot\frac{1}{x^2}} = 1$

given limit $= \pi + 1$.

39. BD

Sol. Area A = area of PQRS

$= (b\sin\theta + a\cos\theta)(a\sin\theta + b\cos\theta)$

$= ab + (a^2 + b^2)\sin\theta\cos\theta$

$= ab + \frac{a^2+b^2}{2}\sin 2\theta$

A is maximum when $\sin 2\theta = 1 \Rightarrow \theta = \frac{\pi}{4}$

$A_{max} = ab + \frac{a^2+b^2}{2} = \frac{1}{2}(a+b)^2$.

40. AC

Sol. Here $x^2 - x + 1 = \left(x-\frac{1}{2}\right)^2 + \frac{3}{4} > 0 \;\forall\; x \in R$

gives $(x^2 - x + 1)^{x-1} < 1$

taking log both sides

$(x-1)\log_{10}(x^2 - x + 1) < 0$

Case I: $x - 1 > 0$, $\log_{10}(x^2 - x + 1) < 0$

i.e. $x - 1 > 0$ and $0 < x < 1 \Rightarrow$ no solution.

Case II: $x - 1 < 0$ and $\log_{10}(x^2 - x + 1) > 0$

$\Rightarrow x < 1$ and $x > 1$ or $x < 0$
$\Rightarrow x < 0$.

41. BD

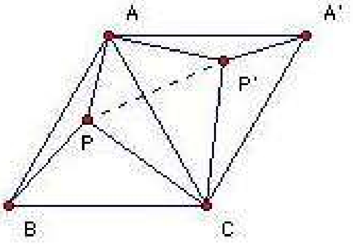
Sol. If n = m then equation becomes $z^m = \bar{z}^m$ and it has infinite solution because any $z \in$ real will satisfy it.
If $n \neq m$, let $n > m$, then
$z^n = \bar{z}^m$
$\Rightarrow |z|^n = |z|^m$
$|z|^m (|z|^{n-m} - 1) = 0 \Rightarrow |z| = 0$ or $|z| = 1$
$|z| = 0 \Rightarrow z = 0 + i0$
$|z| = 1 \Rightarrow z = e^{i\theta}$
$\Rightarrow e^{(m+n)\theta i} = 1 \Rightarrow z = 1^{1/(m+n)}$
$\Rightarrow$ number of solution is m + n + 1.

42. ABCD

Sol. Put x = y = z
$\Rightarrow 3|u + v + w|\,|x| = 3|x| \Rightarrow |u + v + w| = 1$
put y = z = 0
$\Rightarrow |ux| + |vx| + |wx| = |x| \Rightarrow |u| + |v| + |w| = 1$
put z = 0 and y = – x
$\Rightarrow |u - v|\,|x| + |v - w|\,|x| + |w - u|\,|x| = 0$
$\Rightarrow u = v = w$.

43. C
44. A

Sol. **(Sol. for Q.43 and Q.44)**
Take the triangle to be ABC and the point P. Let PA = 3, PB = 4, PC = 5. Rotate the triangle and P through 60^o about C. Let A go to A' and P to P'. Then CP = CP' and $\angle PCP' = 60^o$, so PCP' is equilateral with side 5. So PAP' is a 3, 4, 5 triangle and hence $\angle PAP' = 90^o$. Hence $\angle PAB + \angle P'AA' = 120^o - 90^o = 30^o$. Hence $\angle APB = 150^o$. Now applying the cosine formula to PAB we have $d^2 = 3^2 + 4^2 - 24\cos150^o = 25 + 12\sqrt{3}$.



45. C

Sol. $y = \log_{1/2}\left(x - \frac{1}{2}\right) + \log_2\sqrt{(2x-1)^2}$ But $x > \frac{1}{2}$

$= \log_{1/2}\left(x - \frac{1}{2}\right) + \log_2(2x-1)$

y = 1
$P \equiv (3, 1)$.

46. A

Sol. $\overrightarrow{OP} = 3\hat{i} + \hat{j}$

$Q \equiv (1, 1)$ or $(2, 1)$
$\overrightarrow{OQ} = \hat{i} + \hat{j}$ and $2\hat{i} + \hat{j}$
$\overrightarrow{OP} \cdot \overrightarrow{OQ} = 3 + 1 = 4$ and 6 + 1 = 7.

SECTION – D

47. 00014.60

Sol. Given point is corresponding to t = 2 and $\frac{dy}{dx} = 6t$ $\Rightarrow$ slope of normal at t = 2 is $-\frac{1}{12}$

$\therefore$ equation of normal is $y - 6 = -\frac{1}{12}(x - 1)$

$\Rightarrow a = 73,\ b = \frac{73}{12}$

$\Rightarrow a + 12b = 146.$

48. 00005.50

Sol. $CT_1 = CT_2 = x$

AB = 20

AC = 11

BC = 13

In ΔABC $\sin A = \frac{3}{5}$ and $\sin B = \frac{33}{65}$ also

$$\frac{r}{\sin A} + \frac{r}{\sin B} = AB$$

$$\Rightarrow r = \frac{11}{2}.$$

49. 00020.00

Sol. $g(x) = x^2 + x^2\int_{-1}^{1} tg(t)dt + x^3\int_{-1}^{1} g(t)dt$

by

$g(x) = x^2(1 + A) + Bx^3$

where $A = \int_{-1}^{1} tg(t)dt$, $B = \int_{-1}^{1} g(t)dt$

$A = \int_{-1}^{1} t\left[(1+A)t^2 + Bt^2\right]dt = \frac{2B}{5}.$

Similarly $B = \int_{-1}^{1}\left[(1+A)(1+A)t^2 + Bt^3\right]dt$

$\Rightarrow B = (A + 1)\frac{2}{3}$ $\Rightarrow 3B = 2\left(1+\frac{2B}{5}\right)$

$\Rightarrow A = \frac{4}{11},\ B = \frac{10}{11}$ $\Rightarrow g(x) = \frac{15}{11}x^2 + \frac{10}{11}x^3$

$\therefore \int_{-1}^{1}\left[g(x) + g(-x)\right]dx = \int_{-1}^{1}\left(\frac{15}{11}x^2 + \frac{10}{11}x^3 + \frac{15}{11}x^2 - \frac{10}{11}x^3\right)dx$

$\Rightarrow \int_{-1}^{1}\left[g(x) + g(-x)\right]dx = \frac{30}{11}\int_{-1}^{1} x^2 dx = \frac{20}{11}$ sq. units.

50. 00090.00

Sol. **Case I:** When we use 6, 7 or 8 at ten thousand place then number of numbers

$= 3 \times {}^4P_4 = 72$

Case II: When we use 5 at ten thousand place and 6, 7 or 8 at thousand place then number of numbers is
$= 1 \times 3 \times {}^{3}P_3 = 18$
hence the required numbers of numbers is 72 + 18 = 90.

51. 00058.32
Sol. $T_{r+1} = {}^{6561}C_r\,(a^{1/3})^{6561-r}\,(b)^{r/9} = {}^{6561}C_r\,(a)^{(6561-r)/3}\,(b)^{r/9}$
T_{r+1} will be integral if $\frac{r}{9}$ and $\frac{6561-r}{3}$ both are integer.
r = 0, 9, 18, …, 6561.
Number of values of r = $\frac{6561}{9}+1 = 730$.
So, number of irrational terms = 6562 – 730 = 5832.

52. 00672.00
Sol. N = a (111111) is divisible by 7 × 11 × 3.
Hence for N to be a divisible by 924, a = 4 or 8
and a and β are roots of $x^2 - 11x + \lambda = 0$
$\Rightarrow a + \beta = 11$
$\Rightarrow (a, \beta) \equiv (4, 7), (8, 3)$
$\Rightarrow$ possible value of $\lambda = 28, 24$
$\Rightarrow$ product of $\lambda = 672$.

53. 00100.00
Sol. $2(1 + x^3)^{100} = [a_0 + a_1x + a_2x^2 + \dots + a_{100}x^{100}]$

$$- \left[\cos\frac{\pi}{2}x + \cos\left(\frac{\pi}{2}x + \frac{\pi}{2}\right) + \dots + \cos\left(\frac{\pi}{2}x + 100\frac{\pi}{2}\right)\right] \quad \dots(1)$$

Replace x by – x, we get
$2(1-x^3)^{100} = [a_0 - a_1x + a_2x^2 - \dots + a_{100}x^{100}]$

$$- \left[\cos\left(-\frac{\pi}{2}x\right) + \cos\left(-\frac{\pi}{2}x + \frac{\pi}{2}\right) + \dots + \cos\left(-\frac{\pi}{2}x + \frac{100\pi}{2}\right)\right] \quad \dots(2)$$

Adding (1) and (2), we get
$2(1 + x^3)^{100} + 2(1 - x^3)^{100} = 2(a_0 + a_2x^2 + \dots + a_{100}x^4)$
Put x = 1, we get $a_0 + a_2 + a_4 + \dots + a_{100} = 2^{100}$

54. 00040.00
Sol. Let $g(x) = \frac{2007}{x}$.
Let x decreases from k + 1 to k then g(x) increases from $\frac{2007}{k+1}$ to $\frac{2007}{k}$ $\Rightarrow$ The increase in the value of g(x) is $\frac{2007}{k(k+1)}$.
The increase is less than 1 if k(k + 1) > 2007
$\Rightarrow$ k = 45, 46, …, 2007.
$\Rightarrow$ g(x) does not miss any value as x decrease from 2007, 2006, … till 45.
Also $\left[\frac{2007}{45}\right] = 44$, $\left[\frac{2007}{44}\right] = 45$, $\left[\frac{2007}{43}\right] = 46$, $\left[\frac{2007}{42}\right] = 47$, $\left[\frac{2007}{41}\right] = 48$ and $\left[\frac{2007}{40}\right] = 50$
$\Rightarrow \left[\frac{2007}{x}\right]$ Can never be equal to 49
$\Rightarrow$ The maximum value of k is 40.

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VII

JEE (Advanced)-2019

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01 – 06, 19 – 24, 37 – 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 – 46) *contains 12 questions. Each question has* ***TWO (02)*** *matching lists:* ***LIST-I*** *and* ***LIST-II***. ***FOUR*** *options are given representing matching of elements from* ***LIST-I*** *and* ***LIST-II***. ***ONLY ONE*** *of these four options corresponds to a correct matching.*
   For each question, choose the option corresponding to the correct matching.
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

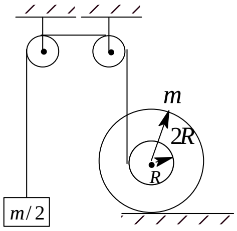
Physics

PART – I

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

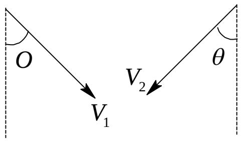


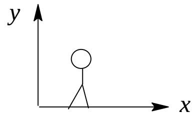
1. System shown in the figure is released from rest and spool does not slip at any point of its motion. Thread and pulley are ideal, thread is of sufficient length. Which of following are correct statements after the spool and block are released:
(A) Spool will keep moving toward right
(B) Spool will leave contact with table after covering certain distance
(C) Block will be at rest when spool will have maximum velocity.
(D) Block and spool will both execute oscillatory motion and their ratio of time period will be 2:1

2. A non- conducting disc of radius $1m$ has charge distributed over its surface. Surface charge density at a point is given by $\sigma = A - Br, 0 \le r \le 1$ r is distance from centre. Disc is rotated with angular velocity ω about an axis passing through centre and perpendicular to disc then:
(A) Magnetic field at centre is zero if $\frac{A}{B} = \frac{4}{5}$
(B) Magnetic field at centre is zero $\frac{A}{B} = \frac{1}{2}$
(C) Magnetic moment of disc is zero if $\frac{A}{B} = \frac{1}{2}$
(D) Magnetic moment of disc is zero if $\frac{A}{B} = \frac{4}{5}$

Space for Rough work

3. V_1 and V_2 are velocity vectors and θ is angle with vertical





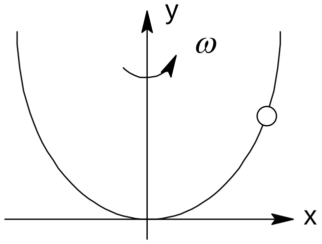
(A) A man moving in positive x direction observes rain in direction of V_1 vector, if it moves with increasing speed it will observe that rain velocity vector is rotating clockwise

(B) A man moving in positive x direction observes rain in direction of V_2 vector, if it moves with decreasing speed it will observe that rain velocity vector is rotating anti-clockwise

(C) A man moving in negative x direction observes rain in direction of V_1 vector, if it moves with decreasing speed it will observe that rain velocity vector is rotating anti-clockwise

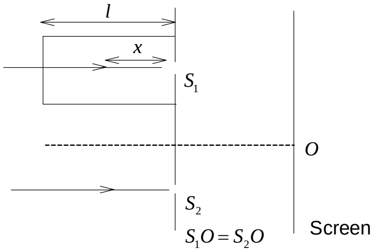
(D) A man moving in negative x direction observes rain in direction of V_2 vector, if it moves with increasing speed it will observe that rain velocity vector is rotating anti anti-clockwise

4. A curved smooth wire as shown in diagram is revolving with constant angular velocity about y-axis, a bead in this wire remain in equilibrium at every position then shape of wire:



(A) May be straight line
(B) Parabolic
(C) $y \propto x^4$
(D) Not possible for any shape

5. In the figure shown, a parallel beam of light is incident on the plane of the slits of a Young's double slit experiment. Light incident on the slit, S, passes through a medium of variable refractive index $\mu = 1 + ax$ (where x is distance from the plane of slits as shown) upto a distance $'l'$ before falling on S_1. Rest of the space is filled with air. If at 'O' a minima is formed, then the minimum value of the positive constant a is:



(A) $\frac{\lambda}{l}$ (B) $\frac{\lambda}{l^2}$

(C) $\frac{l^2}{\lambda}$ (D) $\frac{l^2}{2\lambda}$

Space for Rough work

6. The photon radiated from hydrogen corresponding to 2nd line of Lyman series is absorbed by a hydrogen like atom x in 2nd excited state. As a result the hydrogen like atom 'x' makes a transition to nth orbit. Then

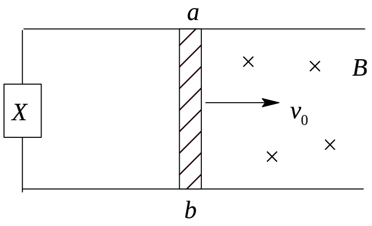
(A) $x = He^{+}, n = 4$ (B) $x = Li^{++}, n = 6$

(C) $x = He^{+}, n = 6$ (D) $x = Li^{++}, n = 9$

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST–I** and **LIST–II**. **FOUR** options are given representing matching of elements from **LIST–I** and **LIST–II**. **ONLY ONE** of these four options corresponds to a correct matching.

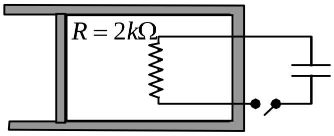
7. A conducting rod shown in figure of mass m and length ℓ moves on two frictionless parallel rails in the presence of uniform magnetic field directed into the page. X is the load connected between parallel rails. The rod is given a velocity v_0 to the right and is released at $t = 0$ match List– I and II:



	List – I		List – II
(P)	If X is a resistor	(1)	The rod moves under action of magnetic force
(Q)	X is ideal inductor	(2)	Energy is consumed
(R)	If X is a capacitor and rod is dragged by a constant force	(3)	velocity of rod increases linearly with time
(S)	X is a capacitor and arrangement are fixed vertically and conductor is released from rest	(4)	rod oscillate simple harmonically

(A) (P) $\rightarrow$(1, 2), (Q) $\rightarrow$(1, 2, 4), (R) $\rightarrow$(1, 2, 3), (S) $\rightarrow$ (1, 2, 3)
(B) (P) $\rightarrow$(2, 1), (Q) $\rightarrow$(4, 3, 1), (R) $\rightarrow$(3, 4, 1), (S) $\rightarrow$(2, 3, 4)
(C) (P) $\rightarrow$(3, 4), (Q) $\rightarrow$ (1, 3, 4), (R) $\rightarrow$(3, 2, 4), (S) $\rightarrow$ (1, 3, 4)
(D) (P)$\rightarrow$(3, 1), (Q) $\rightarrow$ (2, 4, 3), (R) $\rightarrow$(4, 1, 2), (S) $\rightarrow$(1, 2, 4)

Space for Rough work



8. A cylinder fitted with a piston, which can slide without friction contains one mole of an ideal gas. The walls of the cylinder and the piston are adiabatic. The cylinder contains a resistor of resistance R = 2.0 kΩ which is connected to a capacitor of capacity C = 75mF. Initially, potential difference across capacitor is 640/3 volt and the switch is open. When the switch is closed for time =2.5 ln 4 minutes, the gas expands isobarically and its temperature changes by 72*k*. Heat loss through the wires is negligible.

List – I		List – II	
(P)	The work done by the gas (in K J)	(1)	1.6
(Q)	Increment in internal energy of the gas (in K J)	(2)	1
(R)	The value of γ	(3)	0.6
(S)	Energy supplied to the gas (in K J)	(4)	1.3

(A) (P) →(3), (Q) →(2), (R) →(1), (S) →(1)
(B) (P) →(2), (Q) →(1), (R) →(3), (S) →(1)
(C) (P) →(1), (Q)→(2), (R) →(4), (S) →(1)
(D) (P) →(2), (Q) →(2), (R) →(1), (S) →(4)

9. A ray of light falls normally on an equilateral prism of refractive index $\mu = \sqrt{3}$. Match the following table:

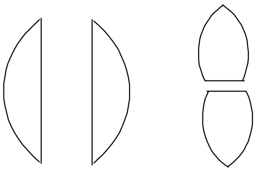
i_1 = Angle of incidence
i_2 = Angle of emergence from second surface of prism
r_1 = Angle of refraction at the first surface of prism
r_2 = Angle of incidence at second surface of prism

List – I		List – II	
(P)	Angle i_1	(1)	0°
(Q)	Angle r_1	(2)	90°
(R)	Angle i_2	(3)	60°
(S)	Angle r_2	(4)	None

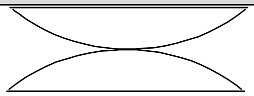
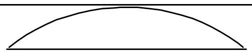
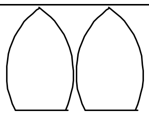
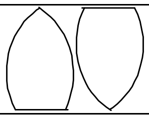
(A) (P) →(4), (Q) →(3), (R) →(2), (S) →(1)
(B) (P) →(3), (Q) →(2), (R) →(1), (S) →(2)
(C) (P) →(2), (Q) →(1), (R) →(3), (S) →(4)
(D) (P)→(1), (Q) →(1), (R) → (4), (S) →(3)

Space for Rough work

10. A thin biconvex lens of small aperture and having focal length 30 cm is cut tow ways as shown in the figure.



Match the focal length of different combination given in list–I with their value in list–II

List – I		**List – II**	
(P)		(1)	Infinite
(Q)		(2)	30 cm
(R)		(3)	60 cm
(S)		(4)	15 cm

(A) (P) →(3), (Q) →(2), (R) →(1), (S) →(4)
(B) (P) →(4), (Q) →(1), (R) →(2), (S) →(3)
(C) (P) →(2), (Q) →(3), (R) →(4), (S) →(1)
(D) (P) →(1), (Q) →(4), (R) →(3), (S) →(2)

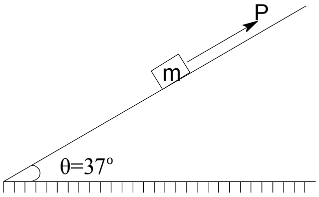
Space for Rough work

SECTION – D
(Numerical Answer Type)

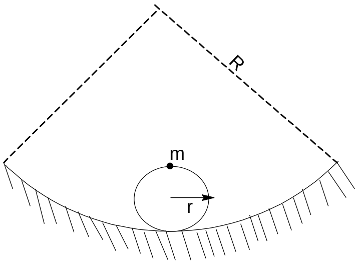
This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

11. Steel has density $7800\,\text{kg/m}^3$ and will break if tensile stress exceeds $7.0\times10^8\ \text{N/m}^2$. A person wants to make a guitar string from 4.0 gm of this steel. The guitar string must be able to withstand a tension of 900 N. The maximum speed of transverse wave can be $\text{x.xx}\times100$ m/s

12. A block of mass m is being pulled up the rough incline, inclined at an angle 37° with horizontal by an agent delivering constant power P. The coefficient of friction between the block and the incline is μ. Find the maximum speed (in km/hr) of the block during the course of ascent. [Take : P = 60 W, m = 1 kg, μ = 0.5]



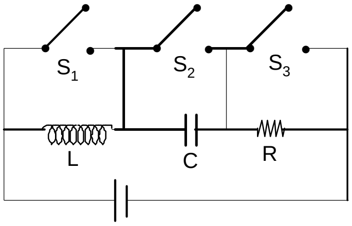
13. A ring of radius r and mass 2m, rests on a rough circular track of radius R.A small point mass of mass m is mounted on its periphery. If friction is sufficient to avoid any slipping then the minimum ratio of $\frac{r}{R}$ for which the system oscillates for small disturbances is



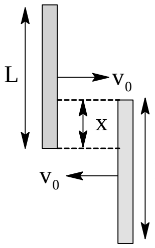
14. The internal energy of a monatomic ideal gas is 1.5 nRT. One mole of helium is kept in a cylinder of cross-section 8.5 cm^2. The cylinder is closed by a light frictionless piston. The gas is heated slowly in a process during which a total of 42 J heat is given to the gas. The temperature rises through 2°C. The distance moved by the piston is given as a × 10^b m in scientific notation. Find the value of a + b. [Take R=25/3 in SI unit, atmospheric pressure = 100 kPa]

Space for Rough work

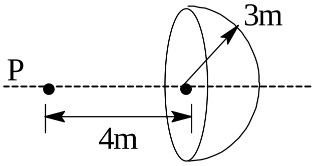
15. Consider the circuit shown in figure. With switch S_1 closed and the other two switches open, the circuit has a time constant 0.05 sec. With switch S_2 closed and the other two switches open, the circuit has a time constant 2 sec. With switch S_3 closed and the other two switches open, the circuit oscillates with a period T. Find T (in sec). (Take $\pi^2 = 10$)



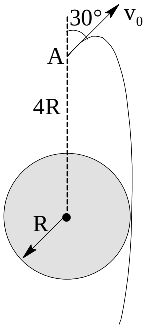
16. Two identical rigid rods, each of mass 1kg & length $\sqrt{3}\mathrm{m}$, are moving opposite to each other without rotation on a smooth horizontal table as shown. For what maximum value of 'x' for which the direction of motion of each rod would not change after collision, irrespective of the type of collision. Assume no sticking.



17. A point source of power 'P' is placed on the axis of a thin hemispherical shell as shown. The shell has a radius of 3m and behaves like a perfect black body. If the steady state temperature of shell is T. Find T^4. (Take $P = 2400\pi\sigma$ W, σ = stefan's const.).



18. A particle is projected from point 'A', that is at a distance 4R from the centre of the Earth, with speed v_0 as shown. If the particle passes grazing the earth's surface, then it is found that $v_0 = 1000 \times N$. Find the value of N [Take $\frac{GM}{R} = 6.4\times10^7\ m^2/s^2$]



Space for Rough work

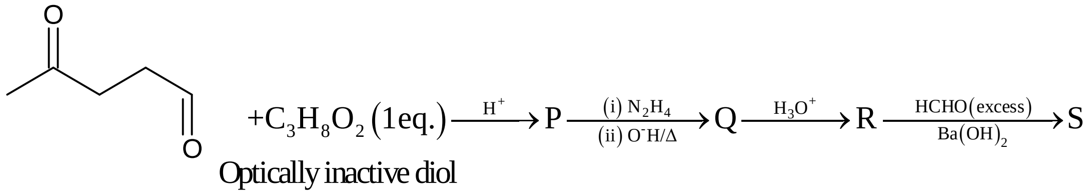
Chemistry PART – II

SECTION – A

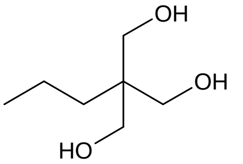
(One or More than one correct type)

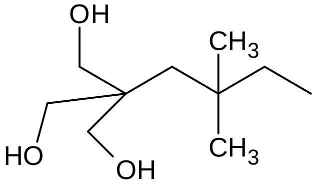
This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

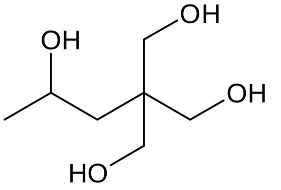
19. Final product 'S' is:


O
O
$+C_3H_8O_2$ (1eq.)
H^+
P
(i) N_2H_4
(ii) O^-H/Δ
Q
H_3O^+
R
HCHO(excess)
$Ba(OH)_2$
S
Optically inactive diol

(A) Compound 'S' is triol

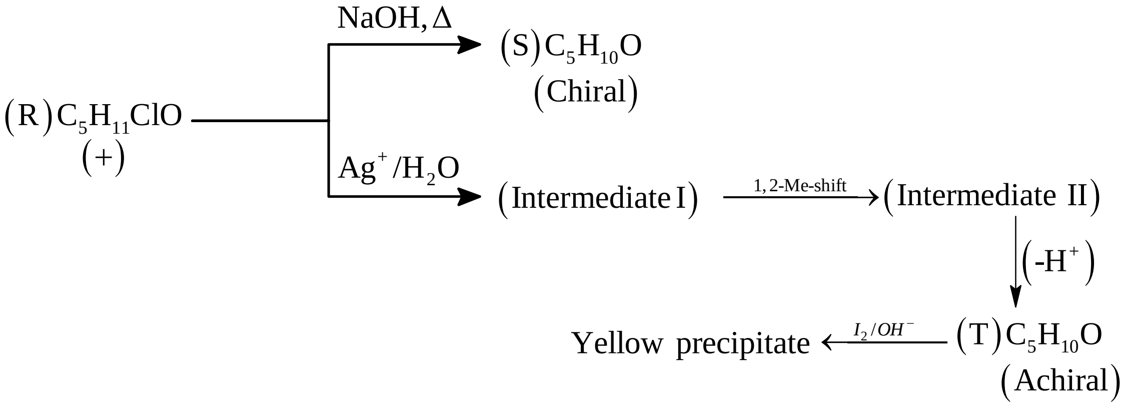
(B)


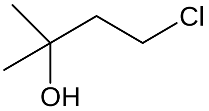
(C)

OH
CH_3
HO
OH
CH_3

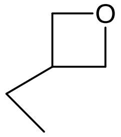
(D)


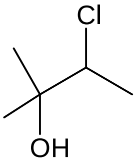
Space for Rough work

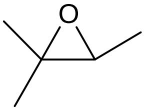
20. The structures of the compounds R and S are:


NaOH, Δ
(S) $C_5H_{10}O$
(Chiral)
(R) $C_5H_{11}ClO$
(+)
Ag^+/H_2O
(Intermediate I)
1, 2-Me-shift
(Intermediate II)
$(-H^+)$
Yellow precipitate
I_2/OH^-
(T) $C_5H_{10}O$
(Achiral)

(A)


(B)


(C)


(D)


Space for Rough work

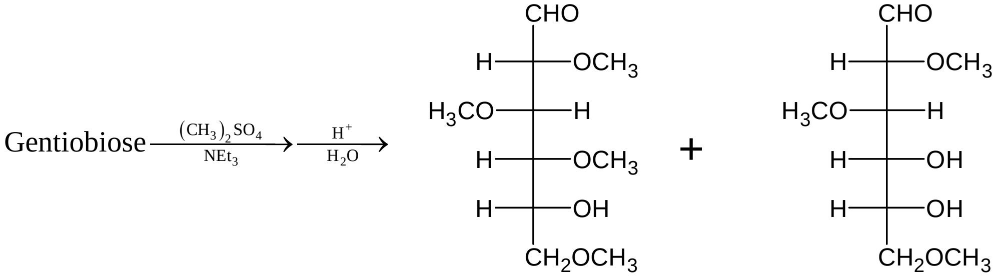
21. Gentiobiose is a disaccharide incorporated into the chemical structure of crocin, the chemical compound that gives saffron its colour. Deduce the structure of gentiobiose from the following information.

(i) Acid hydrolysis of gentiobiose yields only D-glucose

(ii) Gentiobiose is hydrolysed by β- glucosidase enzymes (breaks β- glucosidic linkage) , but not by $\alpha-$glucosidase enzymes

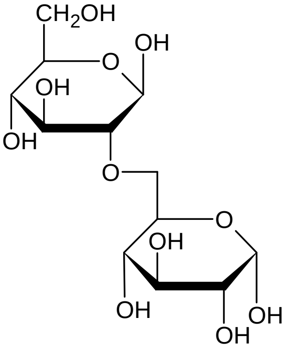
(iii) Gentiobiose is a reducing sugar and reacts with sodium borohydride

(iv) Methylation of gentiobiose followed by hydrolysis of the glycosidic bonds yields the two D-glucose derivatives shown below.

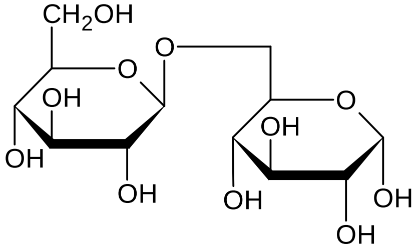

Gentiobiose
$(CH_3)_2SO_4$
NEt_3
H^+
H_2O
CHO
H
OCH_3
H_3CO
H
H
OCH_3
H
OH
CH_2OCH_3
+
CHO
H
OCH_3
H_3CO
H
H
OH
H
OH
CH_2OCH_3

Which can't be the structure of gentiobiose?

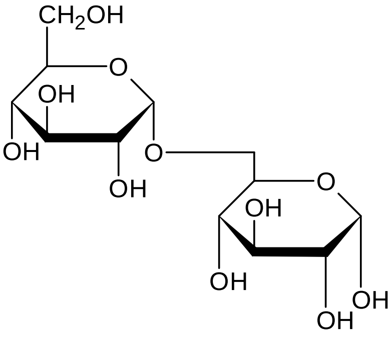
(A)


CH_2OH
O
OH
OH
OH
O
O
OH
OH
OH
OH

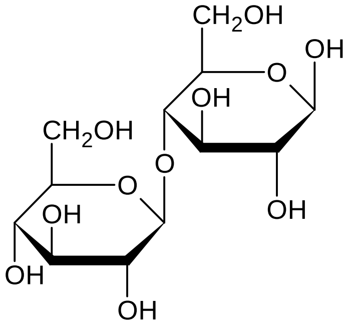
(B)


CH_2OH
O
O
OH
OH
OH
O
OH
OH
OH
OH

(C)


CH_2OH
O
OH
OH
OH
O
O
OH
OH
OH
OH

(D)


CH_2OH
OH
O
OH
OH
O
CH_2OH
O
OH
OH
OH

Space for Rough work

22. Which of the following is/are not lyophilic sol?
(A) Gelatin
(B) Silver sol
(C) Sulphur sol
(D) A_2S_3 sol

23. A 10 mL mixture containing 0.2 g NaOH and $0.25\,g\,Na_2CO_3$ was treated with $xN\,HCl$ required 15 mL of it with phenolphthalein indicator. After end point a $0.5\,g\,NaHCO_3$ was added and it was again titrated with $y\,N\,HCl$ required 25.5 mL of HCl with methyl orange. Which of the following is/are correct?
(A) x is almost 1.5 times of y
(B) If in above titration x N HCl is replaced with y N HCl then for first end point it will require roughly 23mL of HCl.
(C) After first end point instead of 0.5 g if 2.5 g $NaHCO_3$ is added and fitrated with $x\,N\,HCl$ it will require 65.5 mL.
(D) Only (A) and (B) are correct.

24. In which of the following pair the later species is not having higher vapour pressure at a given temperature than former one?
(A) C_2H_6 and C_4H_{10}
(B) CH_3CH_2OH and CH_3CH_2F
(C) Xe and I_2
(D) NH_3 and PH_3

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST–I** and **LIST–II**. **FOUR** options are given representing matching of elements from **LIST–I** and **LIST–II**. **ONLY ONE** of these four options corresponds to a correct matching.

---

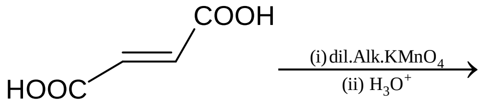
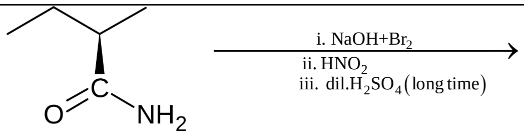
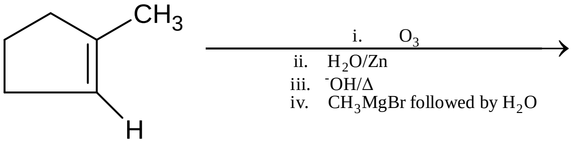
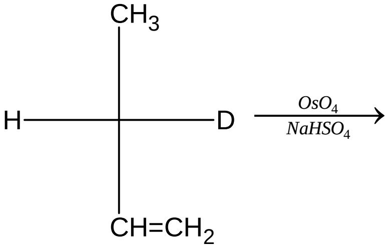
25. Match the list:

	List-I		**List-II**
(P)	$ZnCO_3 \to Zn$	(1)	Calcination
(Q)	$ZnS \to ZnO$	(2)	Roasting
(R)	$PbS(high\ grade) \to Pb$	(3)	Self reduction
(S)	$Cu_2S \to Cu_2O$	(4)	Carbon reduction
		(5)	No change in oxidation state of metal

(A) (P)→(1), (Q)→(2), (R)→(3), (S)→(5)
(B) (P)→(1), (Q)→(4), (R)→(3), (S)→(5)
(C) (P)→(3), (Q)→(2), (R)→(2), (S)→(2)
(D) (P)→(4), (Q)→(2), (R)→(3), (S)→(1)

Space for Rough work

26. Match the list-

	List-I		**List-II**
(P)	 COOH HOOC (i) dil.Alk.KMnO$_4$ (ii) H$_3$O$^+$	(1)	The product (s) consist two chiral centre
(Q)	 C O NH$_2$ i. NaOH+Br$_2$ ii. HNO$_2$ iii. dil.H$_2$SO$_4$(long time)	(2)	The products are diastereomers
(R)	 CH$_3$ H i. O$_3$ ii. H$_2$O/Zn iii. $^-$OH/Δ iv. CH$_3$MgBr followed by H$_2$O	(3)	The product is racemic mixture
(S)	 CH$_3$ H D CH=CH$_2$ OsO$_4$ NaHSO$_4$	(4)	The product consist single chiral centre
		(5)	The Product does not consist chiral centre.

(A) (P)→(1), (Q)→(3), (R)→(4), (S)→(2)
(B) (P)→(3), (Q)→(4), (R)→(5), (S)→(2)
(C) (P)→(1), (Q)→(2), (R)→(4), (S)→(1)
(D) (P)→(5), (Q)→(3), (R)→(4), (S)→(1)

Space for Rough work

27. Match the conditions on left list with solution on right list:

List-I		List-II	
(P)	Has Maximum pH at the end point when titrated against KOH	(1)	$CH_3COOH\left(K_4 = 2\times10^{-5}\right)$
(Q)	Has minimum pH at the end point when titrated against KOH	(2)	$HCN\left(K_2 = 1\times10^{-10}\right)$
(R)	Evolve maximum heat when treated with strong acid	(3)	$CH_3COO^- Na^+$
(S)	Evolve minimum when treated with strong acid	(4)	$NH_3\left(K_b = 2\times10^{-5}\right)$
		(5)	$NaCN$

(A) (P)→(2), (Q)→(1), (R)→(5), (S)→(3)
(B) (P)→(2), (Q)→(1), (R)→(3), (S)→(5)
(C) (P)→(1), (Q)→(2), (R)→(3), (S)→(5)
(D) (P)→(1), (Q)→(2), (R)→(5), (S)→(3)

28. Match the list-

List-I (Radical which can decolorize acidic solution of MnO_4^-)		List-II (Given salt)	
(P)	Only acidic radical	(1)	$Sn\left(NO_3\right)_2$
(Q)	Only basic radical	(2)	KNO_2
(R)	Both radical	(3)	FeC_2O_4
(S)	Neither acidic nor basic radical	(4)	Na_2CO_3
		(5)	$BaSO_3$

(A) (P)→(2), (Q)→(1), (R)→(3), (S)→(4)
(B) (P)→(1), (Q)→(2), (R)→(3), (S)→(4)
(C) (P)→(5), (Q)→(2), (R)→(3), (S)→(4)
(D) (P)→(2), (Q)→(1), (R)→(4), (S)→(3)

Space for Rough work

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

29. A reaction $2A+B \longrightarrow C+2D$ is first order with respect to A and second order with respect to B. Initial concentration of A is 'x' while that of B is '2x'. Initial concentration of C is zero. If at t = 30 minutes, the concentration of C is x/4, the rate expression for decomposition of A at t = 30 minutes is 'rate $=\frac{49x^3kZ}{16}$. (Where 'k' is the overall rate constant) The value of Z is:

30. If 10 g V_2O_5 is dissolved in acid and reduced to V^{2+} by treatment with zinc metal, the mole of I_2 could be reduced by the resulting V^{2+} solution, as it is oxidised to V^{4+} *is* x, then the value of '*x*' *will be*? (At. wt. of V=50)

31. A solution contains a mixture of $\mathrm{Ag}^+ (0.10\mathrm{M})$ and Hg_2^{2+} (0.10 M) which is to be separated by selective precipitation by adding iodide ion at which one of them gets precipitated X% of one metal ion is precipitated till second one starts to precipitate. The value of X is?
[K_{sp}:AgI = 8.5×10^{-17}, Hg_2I_2 = 2.5×10^{-26}]

32. The Henry law constant for dissolution of a gas in aqueous medium is 3×10^2 atm. At what partial pressure of the gas (in atm), the molality of gas in aqueous solution will be $\frac{5}{9}\mathrm{m}$.

Space for Rough work

33 An alloy of Pb-Ag weighing 54 mg was dissolved in sufficient amount of HNO_3 & volume was made upto 500ml. An Ag electrode was dipped in solution and then connected to standard hydrogen electrode anode. Then % of Ag in alloy will be

[Given: $E_{cell} = 0.5V$; $E^0_{Ag^+/Ag} = 0.8V$, $\frac{2.303RT}{F}=0.06$,Atomic weight of silver=108]

34. Given that crystal field stabilization energy for $\left[Co\left(H_2O\right)_6\right]^{3+}$ is -8800 cm^{-1}, pairing energy for Co^{3+} is $20,800\,cm^{-1}$, then the value of Δ_0 is $'x'\times10^3\left(\text{in cm}^{-1}\right), then$ value of 'x' is :

35. The vapour pressure lowering of a 0.1m aqueous solution of non – electrolyte at $75°C$ is $\left(\Delta H^0_v \text{ of water}=9720\,\text{cal/mol and}\, e^{-0.936} = 0.3921, \text{R=2cal/mol/K}\right)$

36. The C – C single bond distance is 1.5Å. The minimum distance between the terminal cartons in propane is $\left(\sin 54°45' = 0.8\right)$

Space for Rough work

Mathematics PART – III

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. If f(x) = $\int_1^x \frac{\ln t}{1+t}dt$, then

(A) $f\left(\frac{1}{x}\right) = -\int_1^x \frac{\ln t}{t(1+t)}dt$
(B) $f\left(\frac{1}{x}\right) = \int_1^x \frac{\ln t}{t(1+t)}dt$
(C) $f(x)+f\left(\frac{1}{x}\right) = 0$
(D) $f(x)+f\left(\frac{1}{x}\right) = \frac{1}{2}(\ln x)^2$

38. The equation $2\sin\frac{x}{2}\cos^2\frac{x}{2} - 2\sin\frac{x}{2}\sin^2 x = \cos^2 x - \sin^2 x$ has a root for which

(A) sin2x = 1
(B) sin2x = – 1
(C) cosx = $\frac{1}{2}$
(D) cos2x = – $\frac{1}{2}$

39. The equation of the circle which touches the axes of coordinates and the line $\frac{x}{3}+\frac{y}{4}=1$ and whose centre lies in the first quadrant is $x^2 + y^2 - 2cx - 2cy + c^2 = 0$ where c is

(A) 1
(B) 2
(C) 3
(D) 6

40. $\sin^{-1}x > \cos^{-1}x$ holds for

(A) all values of x
(B) $x \in \left(0, \frac{1}{\sqrt{2}}\right)$
(C) $x \in \left(\frac{1}{\sqrt{2}}, 1\right)$
(D) x = 0.75

Space for Rough work

41. $2\cot^{-1}7 + \cos^{-1}\frac{3}{5}$ is equal to

(A) $\cot^{-1}\left(\frac{44}{117}\right)$
(B) $\operatorname{cosec}^{-1}\left(\frac{125}{117}\right)$
(C) $\tan^{-1}\left(\frac{4}{117}\right)$
(D) $\cos^{-1}\left(\frac{44}{125}\right)$

42. The interval in which this is valid $\cot\frac{\theta}{2} \geq 1 + \cot\theta$

(A) $0 < \theta < \frac{\pi}{4}$
(B) $\frac{\pi}{4} < \theta < \frac{\pi}{2}$
(C) $0 < \theta < \pi$
(D) none of these

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST–I** and **LIST–II**. **FOUR** options are given representing matching of elements from **LIST–I** and **LIST–II**. **ONLY ONE** of these four options corresponds to a correct matching.

---

43. Match the following:

List – I		**List – II**	
(P)	Domain of $\frac{\log_2(x+3)}{x^2+8x+15}$	(1)	$(-3, \infty)$
(Q)	Domain of $\sqrt{1-\log_3 x}$	(2)	$(0, 3]$
(R)	Domain of $\frac{\sqrt{4-x^2}}{\sin(2-x)}$	(3)	$[1, 2)$
(S)	Domain of $\log[1 - \log_9(x^2 - 3x + 9)]$	(4)	$(0, 3)$
		(5)	$[-4, 1)$

(A) (P) $\rightarrow$(4), (Q) $\rightarrow$(3), (R)$\rightarrow$(2), (S)$\rightarrow$(1)
(B) (P) $\rightarrow$(1), (Q) $\rightarrow$(2), (R)$\rightarrow$(3), (S)$\rightarrow$(4)
(C) (P) $\rightarrow$(4), (Q) $\rightarrow$(2), (R)$\rightarrow$(1), (S)$\rightarrow$(3)
(D) (P) $\rightarrow$(5), (Q) $\rightarrow$(2), (R)$\rightarrow$(4), (S)$\rightarrow$(1)

Space for Rough work

44. Match the list:

	List – I		List – II
(P)	In a ΔABC if area $\Delta = a^2 - (b - c)^2$, then 15tanA is	(1)	$\frac{1}{3}$
(Q)	In a ΔABC a = 6, b = 3 and $\cos(A - B) = \frac{4}{5}$, then area of ΔABC is	(2)	2
(R)	If a, b, c, d are the sides of quadrilateral, then the minimum value of $\frac{a^2+b^2+c^2}{d^2}$ is	(3)	3
(S)	ΔPRQ is right angled triangle where P(3, 1), Q(6, 5) and R(x, y) and area of ΔPRQ = 7, then number of such point R is	(4)	8
		(5)	9

(A) (P) $\rightarrow$(4), (Q) $\rightarrow$(5), (R) $\rightarrow$(1), (S) $\rightarrow$(2)
(B) (P) $\rightarrow$(1), (Q) $\rightarrow$(5), (R) $\rightarrow$(1), (S) $\rightarrow$(1)
(C) (P) $\rightarrow$(2), (Q) $\rightarrow$(5), (R) $\rightarrow$(1), (S) $\rightarrow$(4)
(D) (P) $\rightarrow$(1), (Q) $\rightarrow$(2), (R) $\rightarrow$(3), (S) $\rightarrow$(4)

45. If $\int_0^\infty \frac{\sin x}{x}dx = \frac{\pi}{2}$, then match the following

	List – I		List – II
(P)	$\int_0^\infty \frac{\sin 5x}{x}dx$	(1)	0
(Q)	$\int_0^\infty \frac{\sin ax \cos bx}{x}dx$ (a> b > 0)	(2)	$\frac{\pi}{2}$
(R)	$\int_0^\infty \frac{\sin^2 x}{x^2}dx$	(3)	$\frac{\pi}{4}$
(S)	$\int_0^\infty \frac{\sin^3 x}{x}dx$	(4)	π
		(5)	$\frac{\pi}{6}$

(A) (P) $\rightarrow$(1), (Q)$\rightarrow$(2), (R) $\rightarrow$(3), (S) $\rightarrow$(4, 5)
(B) (P) $\rightarrow$(1), (Q) $\rightarrow$(5), (R) $\rightarrow$(1), (S) $\rightarrow$(1, 4)
(C) (P) $\rightarrow$(2), (Q)$\rightarrow$(2), (R) $\rightarrow$(2), (S)$\rightarrow$(1, 3)
(D) (P) $\rightarrow$(1), (Q) $\rightarrow$(2), (R) $\rightarrow$(3), (S) $\rightarrow$(2, 4)

Space for Rough work

46. Match the following:

	List – I		List – II
(P)	Lines with direction ratios (1, – c, – b), (– c, – 1, – a) and (–b, – a, 1) are coplanar then $a^2 + b^2 + c^2 + 2abc$ is	(1)	–1
(Q)	If the lines x = ay + 1, x = by + 2 and x = cy + 3, z = dy + 4 are perpendicular then ac + bd is equal to	(2)	1
(R)	If (a, b, c) lies on a plane which form ΔABC with axes whose centroid lies on (α, β, γ) then $\frac{a}{\alpha}+\frac{b}{\beta}+\frac{c}{\gamma}$ is equal to	(3)	3
(S)	Let [.] denotes the greatest integer less than or equal to x, then f(x) = [x sinπx] is not differentiable if x =	(4)	0
		(5)	2

(A) (P) → (1), (Q) → (2), (R) → (3), (S) → (4, 5)
(B) (P) → (1), (Q) → (5), (R) → (1), (S) → (1, 4)
(C) (P) → (2), (Q) → (2), (R) → (2), (S) → (1, 3)
(D) (P) → (2), (Q) → (1), (R) → (3), (S) → (1, 2)

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

47. Square of diameter of the circle having tangent at (1, 1) as x + y – 2 = 0 and passing through (2, 2) is ______

48. In an acute angled triangle the minimum value of secA secB secC(1 + secA)(1 + secB)(1 + secC) is k, then k is __

49. P is any point and O being the origin. On the circle with OP as diameter two point Q and R are on same side of OP such that ∠POQ = ∠QOR = θ. Let P, Q, R be z_1, z_2, z_3 such that $2\sqrt{3}z_2^2 = \left(2+\sqrt{3}\right)z_1z_3$. The degree measure of θ is α°, then α is ___________

Space for Rough work

50. The number of solutions of $\theta \in [0, 2\pi]$ satisfying the equation
$\log_{\sqrt{5}} \tan\theta \sqrt{\log_{\tan\theta} 5\sqrt{5} + \log_{\sqrt{5}} 5\sqrt{5}} = -\sqrt{6}$ is __

51. $I = \int_{0}^{1.5} \left[x^2\right] dx$ where [.] is greatest integer function then the value of I is ________

52. If $|z|^2 + (3 - 4i)z + (3 + 4i)\bar{z} + 75 = 0$ and $(1 - i)z + (1 + i)\bar{z} - 16 = 0$ intersect at z_1 and z_2, then the sum of the areas of the quadrilaterals having $(z_1 + z_2)$ and $(z_1 - z_2)$ as diagonals passing through origin is k, then k is ________ (Two vertices of 1st quadrilateral are z_1 and z_2 and of 2nd quadrilateral are z_1 and $-z_2$).

53. If α is the absolute maximum value of the expression $\frac{3x^2 + 2x - 1}{x^2 + x + 1}$ $\forall\, x \in R$, then $[\alpha]$is ___, (where [.] denotes the greatest integer function)

54. In a triangle ABC, side AB = 20, AC = 11, BC = 13, then the diameter of the semicircle inscribed in triangle ABC, whose diameter lies on AB and is touching AC and BC is d, then d is _________

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VII

JEE (Advanced)-2019

PAPER – 2

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. CD

Sol. Take torque of tension about IAOR it will first clockwise and then anticlockwise torque so it will come to rest after covering certain distance. When spool at rest at extreme right block will also be remain at rest but at same initial position (according to energy conservation)

2. BD

Sol. Current disc to rotated $dI = \dfrac{\sigma 2\pi r dr}{\dfrac{2\pi}{\omega}} = \sigma\omega r dr$

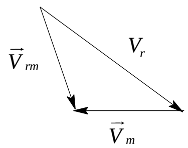
$$B = \sum_{0} \frac{\mu_0 \sigma\omega r dr}{2r} = \frac{\mu_0 \omega}{2}\left[A - B\frac{1}{2}\right]$$

$$M = \sum_{0}^{1} \left(\sigma\omega r dr\right)\pi r^2$$

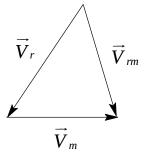
$$M = \omega\pi\left[\frac{A}{4} - \frac{B}{5}\right]$$

3. ABD

Sol. If man is moving in positive x direction



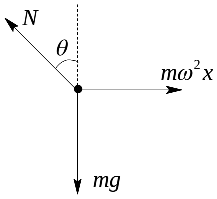
If man is moving in negative x direction



4. B

Sol. $\tan\theta = \dfrac{\omega^2 x}{g}$

$$\frac{dy}{dx} = \frac{\omega^2 x}{g} \Rightarrow y = \frac{\omega^2 x^2}{2g}$$



5. B

Sol. Optical path length of ray entering through S_1

$$x_1 = \int_0^L \mu dx = L + \frac{aL^2}{2}$$

Path difference of ray from S_1 and $S_2 = \Delta x = \dfrac{aL^2}{2}$

For minima at O

$$\frac{aL^2}{2} = \frac{\lambda}{2}$$

6. D

Sol. Energy of nth state in H-atom is same as energy if 3nth state in Li^{++}.

7. A

Sol. (P) X is a resistor

$$m\frac{dv}{dt} = -1\ell B = \frac{-B^2\ell^2 v}{R}$$

$$v = v_0\, e^{-t/T}\ T = \frac{mR}{B^2\ell^2}$$

(Q) X is an inductor

$$x = \frac{v_0}{\omega}\sin\omega t, \omega = \frac{B\ell}{\sqrt{mL}}$$

$$x = \frac{v_0}{\omega}\sin\omega t, \omega = \frac{B\ell}{\sqrt{mL}}$$

(R) $\theta = CV$

$$F = m\frac{dv}{dt} = F_0 - B^2 e^2 C\frac{dv}{dt}$$

$$a = \frac{F_0}{m + B^2 e^2 C}$$

8. A

Sol. Initial charge on the capacitor $q_0 = CV_0 = 75\times 10^{-3}\times\dfrac{640}{3} = 16C$

The charged on the capacitor decays as

$$q = q_0 e^{-t/RC}$$

at $t = 2.5\ln(4)$ minutes = 150 ln(4) s

$$q = 16 \times e^{-\ln(4)} = 4C \quad \because \; RC = 150 \text{ s}$$

Total heat dissipated in the resistor in the given time = $\dfrac{q_0^2 - q^2}{2C} = 1.6kJ$ = heat imparted to the gas

1 Work done by the gas at constant pressure = $P\Delta V = nR\Delta T \approx 0.60kJ$

2 Increment in the internal energy $\Delta U = Q - W = 1.6 - 0.6 = 1kJ$

3 $\gamma = 1 + \dfrac{nR\Delta T}{\Delta U} = 1.6$

9. D
10. C

SECTION – D

11. 00002.99

12. 00001.67

13. 00000.25

14. 00001.00

Sol. The change in internal energy of the gas is DU = 1.5 nR (DT)= 1.5 (1 mol) (253J/mol-K) (2K)
= 25 J.
The heat given to the gas = 42 J
The work done by the gas is DW = DQ – DU= 42 J – 25 J = 17 J.
If the distance moved by the piston is x, the work done is DW = (100 kPa) (8.5 cm^2) x.
Thus, (105 N/m^2) (8.5 × 10–4 m^2) x = 17 J or, x = 0.2m = 20 cm.

15. 00002.00

Sol. t_1 = RC; t_2 = R/L

→LC = t_1t_2 = 0.1 sec -> T = $2\pi\sqrt{\frac{1}{LC}}$

T = 2 sec.

16. 00000.73

Sol. Impulse due to 'N' would act at the centre of the colliding parts
Applying Impulse momentum theorem

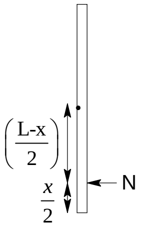
$$-\int N.dt = M\left(v - v_0\right) \qquad ---(1)$$

& Applying Angular impulse, angular momentum theorem

$$\int N\left(\frac{L-x}{2}\right).dt = \frac{ML^2}{12}\omega \qquad ---(2)$$

Also $e = \dfrac{\omega\left(\dfrac{L-x}{2}\right) - v}{v_0} \qquad ---(3)$

From (1), (2) & (3)



$$v\left[1+3\left(\frac{L-x}{2}\right)^2\right]=v_0\left[3\frac{(L-x)^2}{L^2}-e\right]$$

$\therefore$ *for* $v>0$

$$x<L\left[1-\sqrt{\frac{e}{3}}\right]$$

For inequality to hold true for all ‘e’

$$x<L\left[1-\frac{1}{\sqrt{3}}\right]$$

$or\ x<\left(\sqrt{3}-1\right),\ \therefore x_{\max}=0.732$

17. 00008.89

Sol. Power absorbed by shell

$$\Rightarrow \frac{\mathrm{P}\times 2\pi(1\text{-}\cos 37)}{4\pi}$$

$$\Rightarrow \frac{\mathrm{P}}{10}$$

For equilibrium

$$\Rightarrow \frac{P}{10}=3\pi R^2\sigma T^4$$

$$\therefore T^4=\frac{P}{30\pi R^2\sigma}=\frac{2400\sigma\pi}{30\pi\times 9\times\sigma}\Rightarrow 8.89$$

18. 00005.66

Sol. Applying conservation of angular momentum w. r. t. the centre of earth,

$$4R\times mv_0\sin 30=mvR, v=2v_0$$

Applying energy conservation

$$\frac{1}{2}m(2v_0)^2-\frac{GMm}{R}=-\frac{GMm}{4R}+\frac{1}{2}mv_0^2$$

$$\therefore v_0\Rightarrow\sqrt{\frac{GM}{2R}}\Rightarrow\sqrt{\frac{64\times 10^6}{2}}=4\sqrt{2}\times 1000m/s$$

$$\therefore x=4\sqrt{2}\Rightarrow 5.66$$

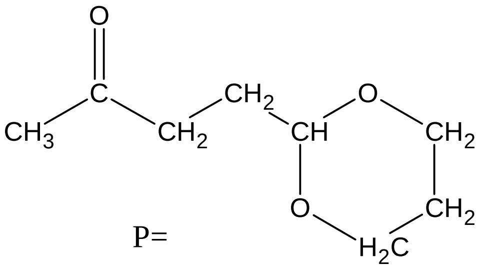
Chemistry PART – II

SECTION – A

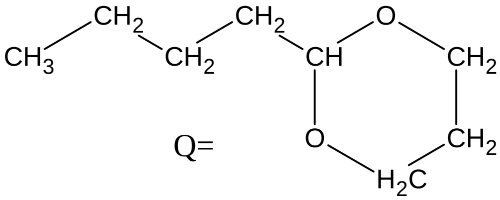
19. AB

Sol.

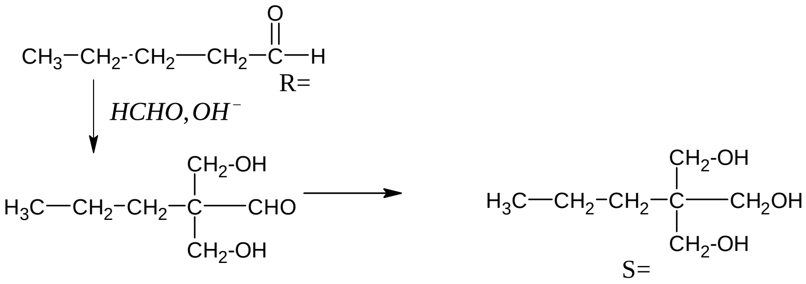
(A)


O
C
CH3
CH2
CH2
CH
O
CH2
O
CH2
H2C
P=

(B)


CH3
CH2
CH2
CH2
CH
O
CH2
O
CH2
H2C
Q=

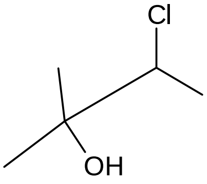
(C)


CH3–CH2-·CH2—CH2–C–H
O
R=
HCHO, OH⁻
H3C—CH2–CH2–C—CHO
CH2-OH
CH2-OH
H3C—CH2–CH2–C—CH2OH
CH2-OH
CH2-OH
S=

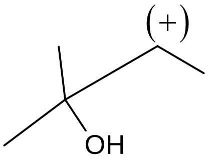
20. CD

Sol.

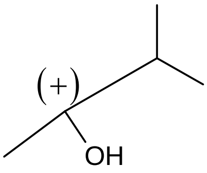
R=



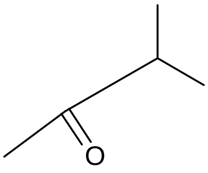
Intermediate I=



Intermediate II=



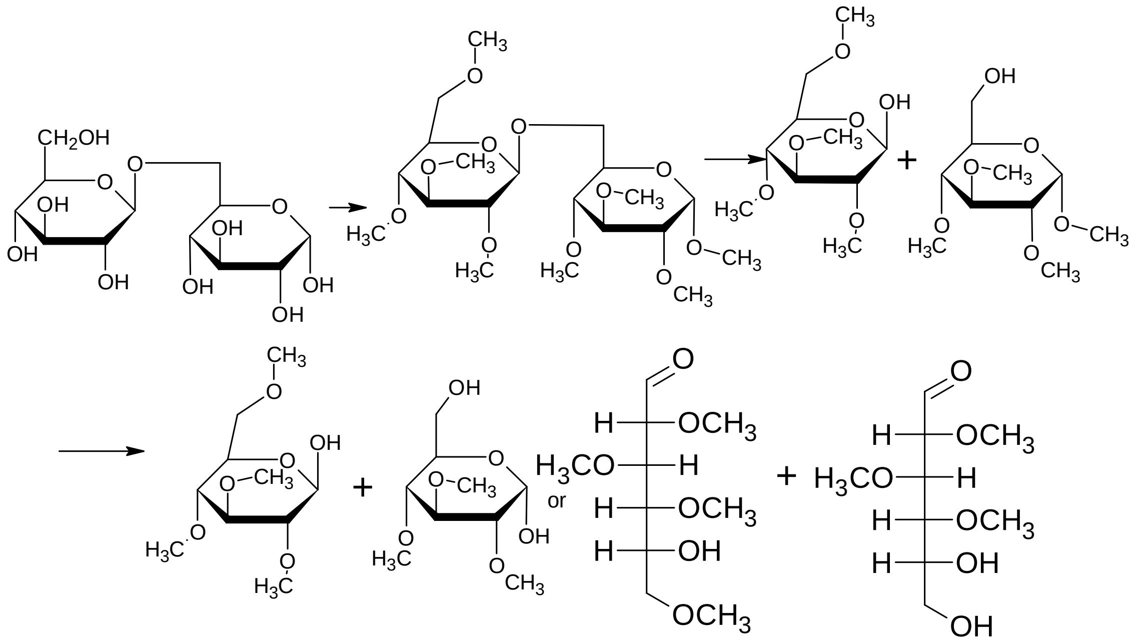
T=



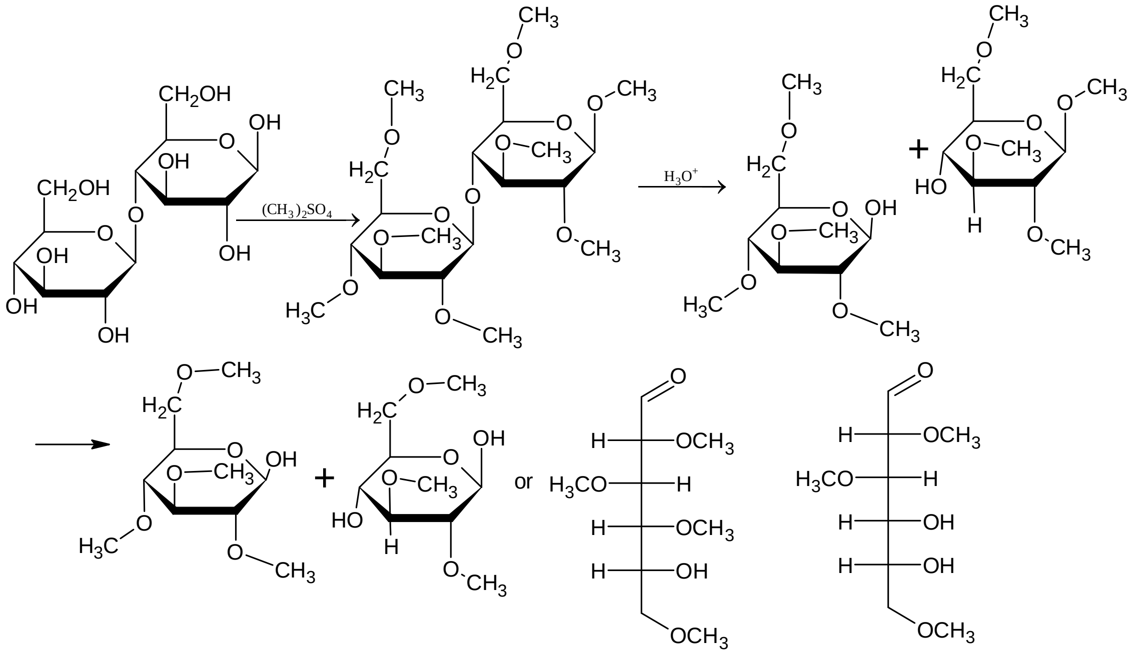
21. ABC

Sol. For A and D there is no $\alpha-\text{linkage}$.

For B part



For D part



22. BCD

Sol. In Lyophilic sols, dispersion medium has affinity with dispersed phase.

23. ABC

Sol. $0.005 \text{mole NaOH} + 0.00235 \text{mole } Na_2CO_3 (0.25/106)$

so H+ required = 0.0073 mole

$0.00735 = x \times 15 \times 10^{-3}$

$x = 0.49$

0.5gm (0.0059 mol) $NaHCO_3$ is added. so total mole of $NaHCO_3$ =0.00825

$0.00825 = y \times 25.5 \times 10^{-3}$

$y = 0.323$

$\frac{x}{y} = 1.5$

$0.00736 = 0.32 \times V(L)$

$y = 23ml$

$0.00235 mole$ of $NaHCO_3$ (already present)+0.02976 mole ($\frac{2.5}{84}$ mole) of $NaHCO_3$ is added so toatal $NaHCO_3$ = 0.03211 mol $NaHCO_3$

$0.03211 = 0.49 \times V \times 10^{-3}$

$V = 65.5ml$

24. AC

Sol. C_4H_{10},CH_3CH_2OH, NH_3 and I_2 have high BP so low vapour pressure.

25. A

Sol. $ZnS \longrightarrow ZnO\,(no\ reduction)$

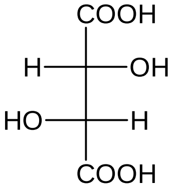
$Zn\ extraction\ does\ not\ involve\ self\ reduction$

$Cu_2S \longrightarrow Cu_2O$ is not calcination.

26. A

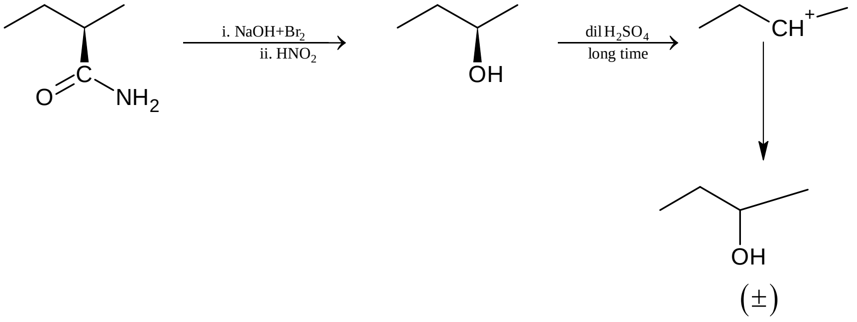
Sol.

(P)

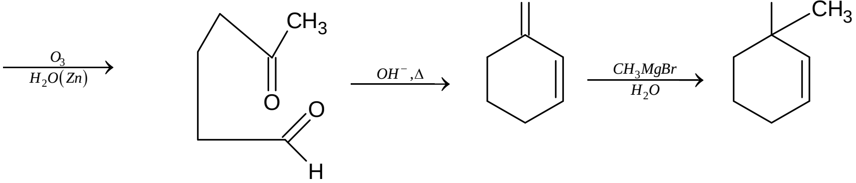

COOH
H
OH
HO
H
COOH

+ mirror image

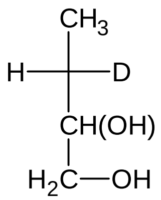
(Q)


C
O
NH2
i. NaOH+Br2
ii. HNO2
OH
dil H2SO4
long time
CH+
OH
(±)

(R)


O3
H2O(Zn)
CH3
O
O
H
OH−,Δ
O
CH3MgBr
H2O
OH
CH3

(S)



27. A

Sol. (P) → (2), (Q) → (1), (R) → (5), (S) → (3)

HCN is a weak acid so maximum pH at end point, CH_3COOH is a stronger acid than HCN, Strong base is CN^-, $K_b = 10^{-4}$, weak base is CH_3COO^- as it's $K_b = 5\times10^{-10}$

28. A

Sol. (P) → (1, 5), (Q) → (1), (R) → (3), (S) → (4)

(1) $Sn\left(NO_3\right)_2 \equiv Sn^{2+}, NO_3^-$

Sn^{+2} can further oxidize into Sn^{+4} and It is basic radical NO_3^- can't further oxidize.

(2) $KNO_3 \equiv K^+, NO_2^-$

K^+ can't be further oxidize but NO_2^- can be oxidize into NO_3^-

(3) $FeC_2O_4 \equiv Fe^{2+}, CO_4^{2-}$

Fe^+ can be oxidize into CO_2 so both radical

(4) $NaCO_3 \equiv Na^+, CO_3^{2-}$

both ions can't be oxidized further so no radical

(5) $BaSO_3 \equiv Ba^{2+}, SO_3^{2-}$

Ba^{2+} can't be oxidized but SO_3^{2-} can be oxidized into SO_4^{2-} only acid radical.

SECTION – D

29. 00004.00

Sol.

$$\begin{array}{llll} 2A \;+ & B \longrightarrow & C \;+ & 2D \\ x & 2x & 0 & \\ (x-\frac{x}{2}) & (2x-\frac{x}{4}) & \frac{x}{4} & \\ \frac{x}{2} & \frac{7x}{4} & \frac{x}{4} & \end{array}$$

$$\text{Rate of reaction} = k(\frac{x}{2})(\frac{7x}{4})^2 = 49kx^3/32$$

$$\text{Rate of decomposition of A} = 2\times49kx^3/32 = 49kx^3/16$$

30. 00000.11

Sol.

$$V_2O_5 + 10H^+ + 3Zn \longrightarrow 2V^{2+} + 5H_2O + 3Zn^{2+}$$

$$2V^{2+} + 2I_2 + 2H_2O \longrightarrow 4I^- + 2VO^{2+} + 4H^+$$

Add

$$V_2O_5 + 6H^+ + 3Zn \;+ 2I_2 \longrightarrow 3Zn^{2+} + 3H_2O + 2VO^{2+} + 4I^-$$

$$10 \text{ gm } V_2O_5 = (10/\ 180) \text{ mol}$$

$$\text{so moles of } I_2 \text{ required} = 2\times\frac{10}{180} = \frac{1}{9} = 0.11$$

31. 00099.83

Sol.

For precipitation of AgI, I^- requires$=\frac{8.5\times10^{-17}}{0.1}=8.5\times10^{-16}$

For precipitation of Hg_2I_2, I^- requires$=\sqrt{\frac{2.5\times10^{-26}}{0.1}}=5\times10^{-13}$

so first AgI will precipitate.

Maximum conc. of I^- at which only AgI will precipitate$=5\times10^{-13}$

Now $[Ag^+]=\frac{8.5\times10^{-17}}{5\times10^{-13}}=1.7\times10^{-4}$

so % precipitation$=\frac{0.1-1.7\times10^{-4}}{0.1}\times100=(1-17\times10^{-4})\times100=(1-17\times10^{-4})\times100=99.83$

32. 00002.97

Sol.

By Henry Law

$$p=\chi\times K_H \text{ --------- } (i)$$

$$\frac{5}{9}\text{molal} \Rightarrow \chi = \frac{5/9}{5/9+1000/18} = \frac{10}{1010}$$

Put in (i)

$$p=\frac{10}{1010}\times300 = \frac{300}{101} = 2.970 atm$$

33. 00001.00

Sol.

$$Ag^+ + e \longrightarrow Ag$$

$$E_{cell}=0.5=0.8+\frac{0.06}{1}\log[Ag^+]$$

$$[Ag^+]=10^{-5}\text{mol/litr} = \frac{\text{mass of Ag}/108}{0.5}$$

$$\text{mass of Ag}=54\times10^{-5} g$$

$$\text{% of silver}=\frac{54\times10^{-5}}{54\times10^{-3}}\times100=1$$

34. 00021.00

Sol.

$$E_{\text{isotpic field}}=PE$$

$$E_{\text{Ligand field}}=6\times(-0.4\Delta_0)+3\times PE$$

$$CFSE= 2\times PE \quad + 6\times(-0.4\Delta_0)$$

$$-8800=2\times20800 - 2.4\times\Delta_0$$

$$\Delta_0 = 21000$$

$$x = 21.000$$

35. 00000.54

Sol.

$$\ln\frac{P_2}{P_1}=\frac{\Delta H}{R}\left[\frac{1}{T_1}-\frac{1}{T_2}\right]$$

$$\ln\frac{P_2}{760}=\frac{9720}{2}\left[\frac{1}{373}-\frac{1}{348}\right]$$

P_2=298torr

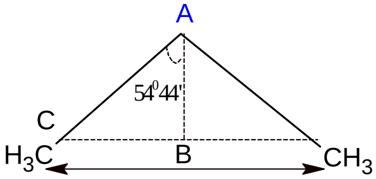
$$\frac{298-P_{sol.}}{298}=\frac{0.1}{0.1+\frac{1000}{18}}$$

P_{sol}=297.46torr

Lowering in VP=(298-297.46)=0.54torr

36. 00002.40

Sol.



$$\text{Sin}(54^0\,44')=\frac{CB}{AC}$$

Terminal carbon carbon distance= $2\times CB$

$$=2\times\ 1.5\ \times \text{Sin}(54^0\,44')$$

$$=2\times\ 1.5\ \times 0.8\ A^0$$

$$=2.4\,\text{Å}$$

Mathematics PART – III

SECTION – A

37. BD

Sol. $f\left(\frac{1}{x}\right) = \int_1^{1/x} \frac{\ln t}{(1+t)} dt = \int_1^x \frac{-\ln u}{\frac{1+u}{u}} \times \frac{-1}{u^2} du = \int_1^x \frac{\ln t}{t(1+t)} dt$

Now, $f(x) + f\left(\frac{1}{x}\right) = \int_1^x \frac{\ln t}{(1+t)}\left(1+\frac{1}{t}\right) dt = \int_1^x \frac{\ln t}{t} dt = \left[\frac{(\ln t)^2}{2}\right]_1^x = \frac{(\ln x)^2}{2}$.

38. ABCD

Sol. $2\sin\left(\frac{x}{2}\right)(\cos^2 x - \sin^2 x) = \cos^2 x - \sin^2 x$

$\left(2\sin\left(\frac{x}{2}\right) - 1\right)\cos 2x = 0$

$\cos 2x = 0$ or $\sin\frac{x}{2} = \frac{1}{2}$

$2x = n\pi + \frac{\pi}{2}$

$\frac{x}{2} = k\pi + (-1)^k \frac{\pi}{6}$ (n, k $\in$ I)

$x = \frac{n\pi}{2} + \frac{\pi}{4}$

or $x = 2k\pi + (-1)^k \frac{\pi}{3}$

$x = \frac{n\pi}{2} + \frac{\pi}{4}$, then $\sin 2x = \pm 1$ and if $x = 2k\pi + (-1)^k \frac{\pi}{3}$

$\cos x = \cos\frac{\pi}{3} = \frac{1}{2}$ and $\cos 2x = \cos\frac{2\pi}{3} = -\frac{1}{2}$.

39. AD

Sol. $\left|\frac{\frac{c}{3}}{\sqrt{\frac{1}{3^2} + \frac{1}{4^2}}}\right| = c \Rightarrow c = 6, 1.$

40. CD

Sol. $\sin^{-1} x > \frac{\pi}{2} - \sin^{-1} x$

$\sin^{-1} x > \frac{\pi}{4}$

$x > \sin\frac{\pi}{4} \Rightarrow x > \frac{1}{\sqrt{2}}$ and $x \in (0, 1)$

$x \in \left(\frac{1}{\sqrt{2}}, 1\right)$.

41. ABD

Sol. $2\cot^{-1}7 = 2\tan^{-1}\frac{1}{7} = \cos^{-1}\left(\frac{1-\frac{1}{49}}{1+\frac{1}{49}}\right) = \cos^{-1}\left(\frac{24}{25}\right)$

$2\cot^{-1}7 + \cos^{-1}\frac{3}{5} = \cos^{-1}\frac{24}{25} + \cos^{-1}\frac{3}{5} = \cos^{-1}\left(\frac{44}{125}\right)$

since $0 < \cos^{-1}\left(\frac{44}{125}\right) < \frac{\pi}{2}$

$\cos\theta = \frac{44}{125}$, $\operatorname{cosec}\theta = \frac{125}{177}$

$\cot\theta = \frac{44}{117}$.

42. ABC

Sol. $1+\cot\theta-\cot\frac{\theta}{2} = 1 + \frac{\cot^2\frac{\theta}{2}-1}{2\cot\frac{\theta}{2}} - \cot\frac{\theta}{2} = \frac{-\cot^2\frac{\theta}{2}-1+2\cot\frac{\theta}{2}}{2\cot\frac{\theta}{2}} = \frac{-\left(\cot\frac{\theta}{2}-1\right)^2}{2\cot\frac{\theta}{2}} \le 0$

$\cot\frac{\theta}{2} > 0$ in $0 < \frac{\theta}{2} < \frac{\pi}{2}$

$\cot\frac{\theta}{2} > 0$ in $0 < \theta < \pi$.

$\therefore\ \theta \in (0, \pi)$.

43. A

Sol. (P). $\frac{\log_2(x+3)}{x^2+8x+15}$

$x + 3 > 0 \Rightarrow x > -3 \quad \therefore x \in (-3, \infty)$

Also, $x^2 + 8x + 15 \ne 0$ or $(x + 3)(x + 5) \ne 0$

$X \ne -3, -5$.

$\therefore$ domain is $(-3, \infty)$.

(Q). Domain of $\sqrt{1-\log_3 x}$

$1 - \log_3 x \ge 0 \Rightarrow \log_3 x \le 1$

$x > 0$ and $\log_3 x \le \log_3 3$

$\Rightarrow x > 0$ and $x \le 3$

$\Rightarrow x \in (0, 3]$.

(R). Domain of $\frac{\sqrt{4-x^2}}{\sin(2-x)}$

$4 - x^2 \ge 0 \Rightarrow x \in [-2, 2] = D_1$

$-1 \le 2 - x \le 1$ or $x \le 3$ or $x \ge 1$

$\therefore x \in [1, 3] = D_2$

But $\sin(2 - x) \ne 0$

$\Rightarrow x \ne 2$

$\therefore$ domain is $D_1 \cap D_2 - \{2\}$

$= [1, 2)$.

(S). Domain of $\log[1 - \log_9(x^2 - 3x + 9)]$

$1 - \log_9(x^2 - 3x + 9) > 0$

$\log_9(x^2 - 3x + 9) < \log_9 9$
$x^2 - 3x + 9 < 9$
$x^2 - 3x < 0$
$x \in (0, 3)$.

44. A

(P). $s = (a + b - c)(a - b + c)$
$s^2 = (2(s - b)\,2(s - c))^2$
$s(s - a)(s - b)(s - c) = 16(s - b)^2 (s - c)^2$

$$\frac{(s-b)(s-c)}{s(s-a)} = \frac{1}{16}$$

$$\tan^2\frac{A}{2} = \frac{1}{16} \text{ or } \tan\frac{A}{2} = \frac{1}{4}$$

$$\tan A = \frac{2\tan\frac{A}{2}}{1-\tan^2\frac{A}{2}} = \frac{8}{15}$$

$$15\tan A = \frac{8}{15}\times 15 = 8.$$

(Q). $\Delta = \frac{1}{2}ab\sin c = 9\sin c$

$$\cos(A-B) = \frac{4}{5} \Rightarrow \frac{1-t^2}{1+t^2} = \frac{4}{5}$$

$$\frac{2t^2}{2} = \frac{1}{9} \text{by CD} \therefore t = \tan\frac{A-B}{2} = \frac{1}{3}$$

$$\frac{a-b}{a+b}\cot\frac{c}{2} = \frac{1}{3} \therefore \frac{3}{9}\cot\frac{c}{2} = \frac{1}{3} \Rightarrow \cot\frac{c}{2} = 1$$

$$\frac{c}{2} = 45 \Rightarrow c = 90°$$

Δ 9 sq. units.

(R). In Δ $a + b > c$ and in quadrilateral $a + b + c > d$
$(a - b)^2 + (b - c)^2 + (c - a)^2 > 0$
$2(a^2 + b^2 + c^2) \geq 2(ab + bc + ca)$
add $a^2 + b^2 + c^2$
$3(a^2 + b^2 + c^2) \geq a^2 + b^2 + c^2 + 2ab + 2bc + 2ca$
$\Rightarrow (a + b + c)^2 > d^2$

$$\therefore \frac{a^2+b^2+c^2}{d^2} \geq \frac{1}{3}$$

= minimum value is $\frac{1}{3}$.

(S). $PR \perp QR \Rightarrow m_1m_2 = -1$
$3x + 4y = 13$

$$\Delta PQR = 7 \Rightarrow \frac{1}{2}(9 - 4x + 3y) = \pm 7$$

$4x - 3y + 5 = 0$ and $4x - 3y - 23 = 0$
There will be two points by solving above equation we will get.

45. C

Sol. (P). Put, $5x = t$ in $\int_0^\infty \frac{\sin 5x}{x}dx$ we get,

$\int_0^\infty \frac{\sin t}{t}dt = \frac{\pi}{2}$.

(Q). $I = \frac{1}{2}\int_0^\infty \frac{\sin(a+b)x + \sin(a-b)x}{x}dx$

If $a > b$, then $I = \frac{\pi}{4} + \frac{\pi}{4} = \frac{\pi}{2}$

If $a < b$, then $I = \frac{\pi}{4} - \frac{\pi}{4} = 0$.

(R). $\int_0^\infty \frac{\sin^2 x}{x^2}dx = \left|\sin^2\left(-\frac{1}{x}\right)\right|_0^\infty - \int_0^\infty \frac{2\sin x\cos x}{x}dx = \frac{\pi}{2}$.

(S). $\int_0^\infty \frac{\sin^3 x}{x}dx = \int_0^\infty \left(\frac{3\sin x - \sin 3x}{4x}\right)dx = \frac{3}{4}\int_0^\infty \frac{\sin x}{x}dx - \frac{1}{4}\int_0^\infty \frac{\sin 3x}{x}dx$

$= \frac{3}{4}\times\frac{\pi}{2} - \frac{1}{4}\times\frac{\pi}{2} = \frac{\pi}{4}$.

46. D

Sol. (P). I l, m, n be the d.r. of the line, then
$l - cm - bn = 0$, $-cl + m - an = 0$, $-bl - am + n = 0$
Eliminating l, m, n we get

$$\begin{vmatrix} 1 & -c & -b \\ -c & 1 & -a \\ -b & -a & 1 \end{vmatrix} = 0 \Rightarrow a^2 + b^2 + c^2 + 2abc = 1.$$

(Q). The equation of the lines in the symmetrical form is $\frac{x-1}{a} = \frac{y-0}{1} = \frac{z-2}{b}$

and $\frac{x-3}{c} = \frac{y-0}{1} = \frac{z-4}{d}$.

The lines are perpendicular if $a \cdot c + 1 \cdot 1 + b \cdot d = 0$.

(R). The equation of plane ABC is $\frac{x}{\alpha} + \frac{y}{\beta} + \frac{z}{\gamma} = 3$ and (a, b, c) lies on it so, $\frac{\alpha}{\alpha} + \frac{b}{\beta} + \frac{c}{\gamma} = 3$.

(S). If $-1 < x < 0$, then $-1 \le \sin\pi x < 0 \Rightarrow 0 < x\sin\pi x < 1 \Rightarrow [x\sin\pi x] = 0$.
If $0 < x < 1$, then $0 < \sin\pi x < 1 \Rightarrow 0 < x\sin\pi x < 1 \Rightarrow [x\sin\pi x] = 0$
$\therefore f(x) = 0\ \forall\ x \in (-1, 1)$, so continuous and differentiable but
$\lim_{x\to1^+} f(x) = -1$ and $\lim_{x\to-1^-} f(x) = -1$
$\therefore$ f(x) is not continuous at x = 1 and – 1 and hence not differentiable at x = – 1, 1.

SECTION – D

47. 00002.00

Sol. Equation of the circle is $(x-1)2 + (y-1)^2 + k(x+y-2) = 0$
As the circle passes through $(2, 2) \Rightarrow x = -1$.
Equation $x^2 + y^2 - 3y + 4 = 0$

Radius = $\sqrt{\frac{9}{4}+\frac{9}{4}-4} = \frac{1}{\sqrt{2}}$

$(\text{diameter})^2 = \left(\sqrt{2}\right)^2 = 2$.

48. 00216.00

Sol. $\sec A \sec B \sec C(1 + \sec A)(1 + \sec B)(1 + \sec C) = \dfrac{\tan^2 A \tan^2 B \tan^2 C}{8\sin^2\frac{A}{2}\sin^2\frac{B}{2}\sin^2\frac{C}{2}}$

or $\tan A \tan B \tan C \ge 3\sqrt{3}$ and $\sin\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2} \le \frac{1}{8}$

$\Rightarrow$ minimum value = 216.

49. 00015.00

Sol. $\frac{z_2}{z_1} = \frac{OQ}{OP}e^{i\theta}$

$\frac{z_3}{z_1} = \frac{OR}{OP}e^{i2\theta}$

$z_2^2 = z_1^2\cos^2\theta \times \frac{z_3}{z_1\cos^2\theta} \Rightarrow \frac{\cos^2\theta}{\cos 2\theta} = \frac{2+\sqrt{3}}{2\sqrt{3}}$

$\Rightarrow \cos^2\theta = \frac{2+\sqrt{3}}{4} \Rightarrow 2\cos^2\theta = \frac{2+\sqrt{3}}{4}$

$\Rightarrow 2\cos^2\theta = 1 + \cos 30° \Rightarrow \theta = 15$

50. 00002.00

Sol. $\log_{\sqrt{5}}\tan\theta\sqrt{\frac{3}{\log_{\sqrt{5}}\tan\theta}+3} = -\sqrt{6}$

$\Rightarrow x\sqrt{\frac{3}{x}+3} = -\sqrt{6}$ … (1) $\left(x = \log_{\sqrt{5}}\tan\theta\right)$

$\Rightarrow \frac{x\sqrt{x+1}}{\sqrt{x}} = -\sqrt{2}$

$\Rightarrow x(x^2 + x - 2) = 0$

$\therefore x = 0, 1, -2$

but $x < 0$ (from (1))

$\therefore x = -2$

$\log_{\sqrt{5}}\tan\theta = -2$

$\therefore$ two solutions.

51. 00000.41

Sol. $I = \int_0^1 0dx + \int_1^{\sqrt{2}} dx + \int_{\sqrt{2}}^{1.5} 2dx$

$= \left(\sqrt{2}-1\right) + 2\left(1.5-\sqrt{2}\right)$

$= 2 - \sqrt{2}$

52. 00052.16

Sol. $|z|^2 + (3 - 4i)z + (3 + 4i)\bar{z} - 92 = 0$ … (1)

$(1 - i)z + (1 + i)\bar{z} - 16 = 0$ … (2)

Let $z = x + iy \Rightarrow \bar{z} = x - iy$

$\therefore z + \bar{z} = 2x, z - \bar{z} = 2iy$ … (3)

From (1),

$|z|^2 + 3(z + \bar{z}) - 4i(z - \bar{z}) - 92 = 0$

$\Rightarrow x^2 + y^2 + 6x + 8y - 92 = 0$ … (4)

From (2),

$(z + \bar{z}) - i(z - \bar{z}) - 16 = 0$

$\Rightarrow 2x + 2y - 16 = 0$

$\Rightarrow x + y = 8$ … (5)

$\Rightarrow y = (8 - x)$

$\therefore$ From () and (5)

$x^2 + (8 - x)^2 + 6x + 8(8 - x) - 92 = 0$

$\Rightarrow x^2 + 64 - 16x + 6x + 64 - 8x - 92 = 0$

$\Rightarrow 2x^2 - 18x + 36 = 0 \Rightarrow x^2 - 9x + 18 = 0$

$\Rightarrow (x - 6)(x - 3) = 0 \Rightarrow x = 3, 6.$

$\therefore$ From (5),

$y = 5, 2$

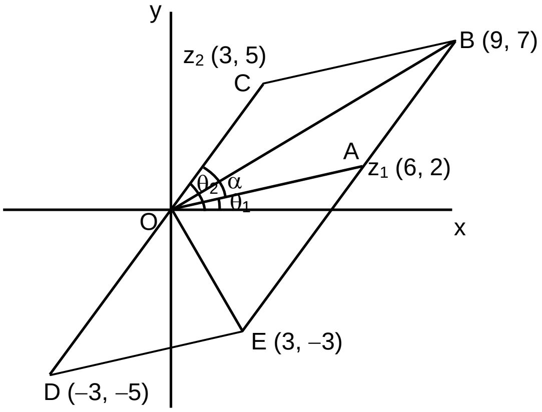
$\therefore z_2 = 3 + 5i = (3, 5)$ and $z_1 = (6 + 2i) = (6, 2)$

$z_1 + z_2 = (3 + 5i) + (6 + 2i) = (9 + 7i) = (9, 7)$

$(z_1 - z_2) = (6 + 2i) - (3 + 5i) = (3 - 3i)$

$= (3, -3)$.

Clearly, quadrilaterals OABC and ODEA are the parallelogram of same area.



$\tan\theta_1 = \frac{z}{6} = \frac{1}{3}$, $\tan\theta_2 = \frac{5}{3}$

$\therefore \alpha = (\theta_2 - \theta_1) \Rightarrow \tan\alpha = \left(\frac{\frac{5}{3} - \frac{1}{3}}{1 - \frac{5}{3} \times \frac{1}{3}}\right)$

$\Rightarrow \tan\alpha = \frac{4/3}{4/3} = 1$

$\Rightarrow \alpha = 45°$.

Total area = 2 area of parallelogram OABC

$= = 2|z_1||z_2|\sin\alpha$

$= 2 \times \sqrt{40} \times \sqrt{34} \times \frac{1}{\sqrt{2}}$

$= 2\sqrt{20} \times \sqrt{34} = 4\sqrt{170}$

$= 4 \times 13.04 = 52.16$ sq. units.

53. 00003.07

Sol. Let $y = \frac{3x^2 + 2x - 1}{x^2 + x + 1}$

$\Rightarrow (y - 3)x^2 + (y - 2)x + y + 1 = 0.$

As $x \in R$, $D \geq 0 \Rightarrow (y - 2)^2 - 4(y - 3)(y + 1) \geq 0$

$\Rightarrow 3y^2 - 4y - 16 \leq 0.$

Clearly y lies between the roots.

Roots of the equation $3y^2 - 4y - 16 = 0$ are

$y = \frac{4 \pm \sqrt{208}}{6} = \frac{2 \pm \sqrt{52}}{3}$.

$\therefore$ absolute maximum of the expression = $\frac{2 + \sqrt{52}}{3}$ = α.

54. 00011.00

Sol. $CT_1 = CT_2 = x$

AB = 20

AC = 11

BC = 13

In ΔABC $\sin A = \frac{3}{5}$ and $\sin B = \frac{33}{65}$ also

$\frac{r}{\sin A} + \frac{r}{\sin B} = AB \Rightarrow r = \frac{11}{2}$.

$\Rightarrow [\alpha] = 3$.

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VIII

JEE (Main)-2019

TEST DATE: 31-03-2019

Time Allotted: 3 Hours **Maximum Marks: 360**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only one section: **Section-A**.

  Section-A (01 – 30, 31 – 60, 61 – 90) *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A radioactive isotope is produced at a constant rate R in a nuclear reactor, by exposing a precursor sample to the neutrons produced in the reactor. The radioactive isotope has a disintegration constant, λ

   (A) If precursor sample is placed in the reactor for a very long time, the maximum no. of isotope atoms produced will be $\frac{R}{2\lambda}$.

   (B) If precursor sample is placed in the reactor for a very short time t, the approximate no. of isotope atoms produced will be Rt^2.

   (C) If precursor sample is placed in the reactor for N half-lives, then the activity of isotope atoms when it is taken out will be $R\left(\frac{1}{2^N}\right)$.

   (D) If precursor sample is (i) introduced for 1-half-life into the reactor (ii) then removed for 1-half-life; and this process is repeated many times – the activity of the sample will become $\frac{R}{3}$ after a very long time, just after steps (i) and (ii) are completed.

2. A particle of mass m moves along x-axis under a force which is given by:

   $F(x) = -Ax\left[1 - e^{-kx^2}\right]$

   Where x is the position; while A, k are constants. If the amplitude of oscillation be a, and the time period be T then

   (A) T is nearly independent of amplitude a for small values of a

   (B) T is nearly independent of amplitude a

   (C) $T \propto \frac{1}{a}\sqrt{\frac{m}{Ak}}$ for small values of amplitude a

   (D) $T \propto \frac{1}{a}\sqrt{\frac{m}{Ak}}$ for large values of amplitude a

3. Sound waves are incident normally onto a wall and are completely reflected off the wall. The waves have constant amplitude and have a fixed wavelength. It is observed that there is no sound at a point P, which is initially at a distance L_0 from the wall. The wall is slowly moved forward with uniform acceleration, and at a time t_0 after it starts: it is observed that the speed of the wall is v_0 and there is maximum sound at P. Which, of the following, is/are possible?

   (A) The wavelength of sound can have the value $\frac{v_0t_0}{3}$.

   (B) The wavelength of sound can be $\frac{2v_0t_0}{3}$.

   (C) $L_0 = \frac{5v_0t_0}{3}$

   (D) $L_0 = v_0t_0$

4. A metallic sphere having density ρ_s falls in glycerin of density ρ_g, which is kept in a cylindrical container of radius R and a very large height h. Assume that the acceleration due to gravity is g, that the radius of the sphere is a and that the viscosity of glycerin is very large (η).

(P) The terminal speed of the sphere is $v_T = \frac{2}{9}\left(\rho_s - \rho_g\right)\frac{a^2 g}{\eta}$.

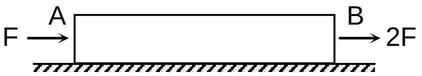
(Q) The terminal speed of the sphere $v_T < \frac{2}{9}\left(\rho_s - \rho_g\right)\frac{a^2 g}{\eta}$.

(R) The viscous force acting on the sphere is $6\pi\eta av$.

(S) The viscous force acting on the sphere is greater than $6\pi\eta av$.
Consider the statements ABOVE and select the correct option BELOW

(A) P & R are correct
(B) Q & S are correct
(C) P & S are correct
(D) Q & R are correct

5. A uniform metallic bar of mass m, length L and cross-sectional area 'A' is acted upon by force 2F, F as shown in the figure – acting along its length. There is no friction between the bar and the ground. Young's modulus of elasticity of the material of the bar is Y.



(A) The longitudinal stress within the bar is uniform and has the value $\frac{3F}{A}$.

(B) The longitudinal stress within the bar is uniform and has the value $\frac{F}{A}$.

(C) The longitudinal stress within the bar becomes zero, at the ends A & B.

(D) The average longitudinal strain in the bar is less than $\frac{F}{AY}$.

6. In a Young's double slit experiment, the fringe pattern is observed on a screen placed at a distance D from the slits. The slits are separated by a distance d, and are illuminated by monochromatic light of wavelength λ. The length of the slits is ℓ, ℓ is usually much greater than d. The slit width w is extremely small, and the slits are otherwise identical.

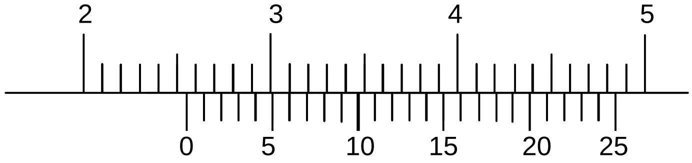
(A) The intensity falls to $\frac{1}{3}$ its maximum value at a distance of $\frac{\lambda D}{6d}$ from the central point.

(B) If the width of one of the slits is doubled (compared to the other), the intensity of the maxima decreases, and that of the minima also increases.

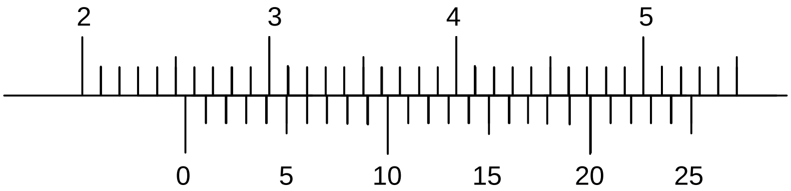
(C) If the length of the slits is decreased so that it is almost equal to w, the intensity of the maxima remains unchanged.

(D) If the length of the slits is decreased so that it is almost equal to w, the fringes become curved.

7. There are two Vernier Calipers both of which have 1 cm divided into 10 equal divisions on the main scale. The Vernier scale of one of the calipers has 25 equal divisions coinciding with 27 divisions on the main scale; while the Vernier scale of the other has 25 divisions coinciding with 23 divisions on the main scale. You have to decide which pair of data correspond to which calipers by referring to the figures below:



Vernier calipers C_1



Vernier calipers C_2

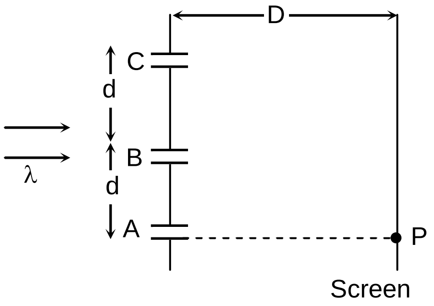
(A) The smallest reading that can be taken on C_1 is 0.004 cm.
(B) The smallest reading that can be taken on C_2 is 0.008 cm.
(C) The reading indicated by C_1 is 2.552.
(D) The reading indicated by C_2 is 2.548.

8. A cubical block is suspended by a uniform light wire. The wire vibrates in its 8th harmonic in unison with a tuning fork. When the block is completely immersed in water, it is found to vibrate in its 10th harmonic with the same turning fork. Find the specific gravity of the block.
(A) 0.7
(B) 1.4
(C) 2.8
(D) 5.6

9. A satellite orbits a spherical planet close to its surface, in a circular path, with an orbital speed v_0. Calculate (approximately) the impulse per unit mass to be delivered to the satellite in the direction of its velocity, so that it reaches a maximum altitude (above the planet's surface) equal to its radius.
(A) $0.3v_0$
(B) $0.15\ v_0$
(C) $0.6\ v_0$
(D) $0.075\ v_0$

10. Two equi-convex lenses of focal lengths 20 cm and 30 cm respectively are placed at a separation 'd' with their principal axes coinciding. An object placed at a distance 'u' from the first lens, forms an image at a distance 'v' from the second lens. Find the ratio $\frac{v}{u}$, if it is observed that u and v have the same set of values for d = 30 cm, 60 cm, 120 cm and 150 cm.
(A) 1/2
(B) 2/3
(C) 2
(D) 3/2

11. Three equidistant slits are illuminated by a monochromatic parallel beam of light falling normally onto them. The screen is parallel to the plane of the slits and the slit separation d << D, the slit-screen separation. The observation point P is directly opposite A. It is given that $BP - AP = \frac{\lambda}{4}$, λ being the wavelength of light. Find the ratio of the intensity at P when all slits are open to the intensity at P when only one slit is open.



(A) 3
(B) 4
(C) 5
(D) 6

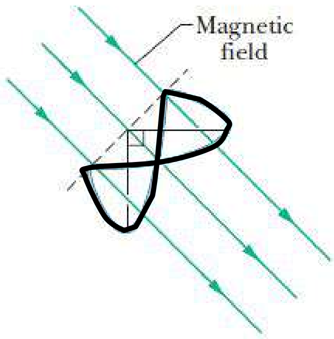
12. An electron moves in a circular orbit in a region containing a uniform magnetic field, B. Assume that Bohr's rule for quantization of angular momentum is valid. The flux of the magnetic field through the electron's orbit varies in integral multiples of $\frac{h}{\lambda e}$, where h is Planck's constant, e is the electronic charge and λ is a constant. Find λ.
(A) 0.5
(B) 2
(C) π
(D) 2π

13. The electric field at a point associated with a light wave is given by

$$E=\left(200\frac{V}{m}\right)\sin\left(2\times10^{15}s^{-1}\right)t\ .\ \cos\left(7\times10^{15}s^{-1}\right)t+\left(100\frac{V}{m}\right)\sin\left(3\times10^{15}s^{-1}\right)t.\sin\left(6\times10^{15}s^{-1}\right)t.$$

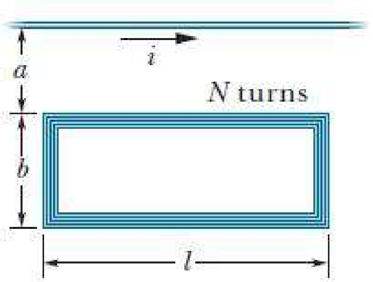
If this light falls on a metal surface having work function 1.9 eV, then find the maximum KE of the emitted photoelectrons. Take h = 4.14×10^{-15} eV-s.
(A) 2 eV
(B) 2.5 eV
(C) 4 eV
(D) 6 eV

14. Figure shows a closed loop of wire that consists of a pair of equal semicircles, of radius R, lying in mutually perpendicular planes. The loop was formed by folding a flat circular loop along a diameter until the two halves became perpendicular to each other. A uniform magnetic field of magnitude B is directed perpendicular to the fold diameter and makes equal angles (of 45°) with the planes of the semicircles, initially (t = 0). The loop is rotated at a constant angular velocity ω about the fold diameter. This induces an emf, which causes a current to flow in the wire. The resistance per unit length of the wire is λ. The magnetic moment of the loop is



(A) $\left(\frac{B\pi R^3\omega}{2\sqrt{2}\lambda}\sin\omega t\right)$
(B) $\left(\frac{B\pi R^3\omega}{2\lambda}\cos\omega t\right)$
(C) $\left(\frac{B\pi R^3\omega}{4\lambda}\cos\omega t\right)$
(D) $\left(\frac{B\pi R^3\omega}{4\lambda}\sin\omega t\right)$

15. A rectangular loop of N closely packed turns is positioned near a long straight wire as shown in figure. The rectangular loop performs linear SHM with its distance 'a' varying as : a = a_0 + Asinωt, where A << a or b. The induced emf in the loop has the peak value.

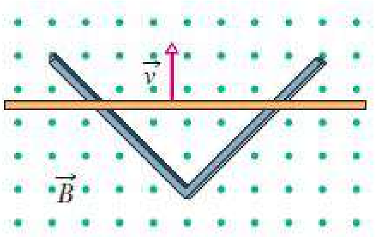


(A) $\frac{\mu_0 Ni}{2\pi}\left(\frac{\ell}{a_0}\right)A\omega$
(B) $\frac{\mu_0 Ni}{2\pi}\left(\frac{\ell b}{a_0\left(a_0+b\right)}\right)A\omega$

(C) $\frac{\mu_0 Ni}{2\pi}\left(\frac{b}{(a_0+b)}\right)A\omega$

(D) $\frac{\mu_0 Ni}{2\pi}\left(\frac{\ell b}{a_0}\right)\omega$

16. In the figure, two straight conducting rails form a right angle. A conducting bar in contact with the rails starts at the vertex at time t = 0 and moves with a constant velocity of v along them. A magnetic field B is directed out of the page. The current in the loop is (λ = resistance per unit length of the rails and bar).



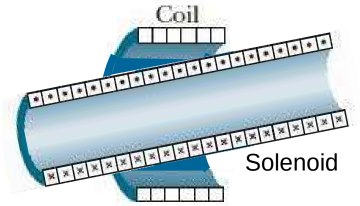
(A) $\frac{2Bv}{\lambda}$

(B) $\frac{Bv}{\lambda\left(1+\sqrt{2}\right)}$

(C) $\frac{\sqrt{2}Bv}{\lambda}$

(D) $\frac{2Bv}{\lambda\left(1+\sqrt{2}\right)}$

17. In the figure, a 120-turn coil of radius 5 cm and resistance 3.6 Ω is wrapped around a long solenoid of 250 turns/cm and diameter 4 cm. The axis of the coil and the axis of the solenoid make angle of 30° with each other. The solenoid current drops from 1.5 A to zero in time interval t = 25 ms. Find the total charge that flows through the coil. Take $\pi^2 \approx 10$.



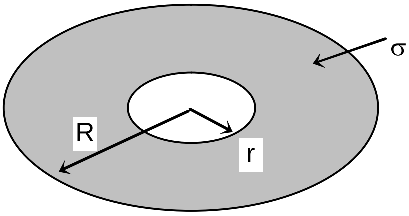
(A) $2\times10^{-3}C$

(B) $4\times10^{-3}C$

(C) $2\sqrt{3}\times10^{-3}C$

(D) $\sqrt{3}\times10^{-3}C$

18. Figure shows a annular disc of outer radius R inner radius r, and uniform surface charge density. Total charge is q. The potential at the centre is $\frac{kq}{r'}$ $\left(k=\frac{1}{4\pi\varepsilon_0}\right)$ where r′ is



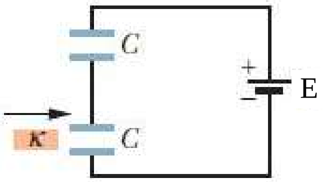
(A) $\frac{R+r}{2}$

(B) $\frac{R-r}{2}$

(C) $R+r$

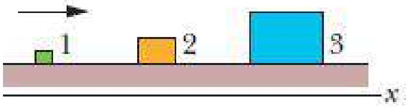
(D) $R-r$

19. The initial charge on each 2μF capacitor is 6 μC, in the steady state. A dielectric slab of dielectric constant K = 4 is inserted slowly between the plates of the lower capacitor at a constant velocity so that its capacitance changes at a constant rate of 2μF/s. The current through the circuit, when the ratio of the voltages on the capacitors is 1 : 2, is



(A) $1.5\mu A$
(B) $3\mu A$
(C) $\frac{2}{3}\mu A$
(D) $\frac{4}{3}\mu A$

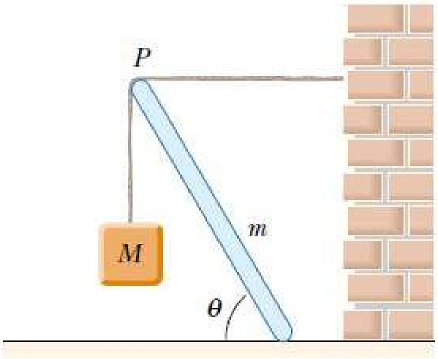
20. In figure, block 1 of mass m_1 slides along an *x* axis on a frictionless floor at speed 9 m/s. Then it undergoes a one-dimensional elastic collision with stationary block 2 of mass $m_2 = 2m_1$. Next, block 2 undergoes a one-dimensional elastic collision with stationary block 3 of mass $m_3 = 2\,m_2$.



Read the following four statement(s) which refer to the situation when the collisions are over.
(P) Block 3 has a speed of 4 m/s
(Q) The speed of Block 3 is less than the initial speed of block 1
(R) The momentum of block 3 is greater than the initial momentum of block 1
(S) The KE (kinetic energy) of block 3 is less than the initial KE of block 1
Select the correct option BELOW after considering the statements above.
(A) Only P, Q are correct
(B) P, Q, S are correct
(C) Q, R, S are correct
(D) All the statements are correct

21. Three flexible chains A, B & C, hanging from the ceiling by means of hooks are joined at their lowest points: all the three of them are horizontal at the common joint & make 120° with each other, in the horizontal plane. The chains A, B make 30° with the vertical at the ceiling, while chain C makes 60° with the vertical at the ceiling. The masses of the chains are m_A, m_B, m_C. The ratio $m_A : m_B : m_C$ equals
(A) $1:1:\sqrt{3}$
(B) $1 : 1 : 3$
(C) $\sqrt{3}:\sqrt{3}:1$
(D) $3 : 3 : 1$

22. A uniform beam of mass *m* is inclined at an angle θ to the horizontal. Its upper end produces a 90° bend in a very rough rope tied to a wall, and its lower end rests on a rough floor (see figure). If the coefficient of static friction between the beam and the floor is μ then the maximum value of M is given by the expression



(A) $M \le \frac{m(2\mu - \cot\theta)}{2(\cot\theta - \mu)}$
(B) $M \le \frac{\mu m}{(1-3\mu)}$

(C) $M \le \frac{m(2\mu - \tan\theta)}{2(\tan\theta - \mu)}$

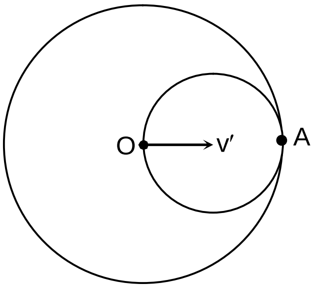
(D) $M \le \frac{m}{(1-3\mu)}$

23. The output current of a 60% modulated AM generator is 1.5 A. If the generator is additionally modulated by another radio wave of modulation index 0.7, the new modulation index is (in percentage)
(A) 20%
(B) 92%
(C) 80%
(D) 55%

24. N moles of an ideal diatomic gas is in an enclosed rigid volume at temperature T. Some heat is supplied to the gas, and it is observed that $\frac{N}{3}$ moles dissociate into atoms while the temperature remains constant. If heat supplied to the gas is Q then
(A) $Q = \frac{NRT}{6}$
(B) $Q = \frac{8}{3}NRT$
(C) $Q > \frac{NRT}{6}$
(D) $Q > \frac{8}{3}NRT$

25. A uniform solid cone of height H is cut at a distance x below its vertex, parallel to its base and the upper part is discarded. The C.M. of the remaining part is found to be 50% lower, w.r.t. to the base. The ratio, $r = \frac{x}{H}$ satisfies.
(A) $7r^3 - 8r^4 = 1$
(B) $r = \frac{1}{2^{1/3}}$
(C) $r = \frac{1}{2}$
(D) $7r^3 - 6r^4 = 1$

26. From a solid sphere of mass M and radius R, a spherical portion of radius $\frac{R}{2}$ is removed. The diameter of the cavity so formed coincides with a radius of the sphere. v_0 was the escape speed of a particle projected from the surface of this sphere without cavity. Then the velocity v′ that must be given to a particle along OA so that it can just reach A, starting from O within the cavity, is:



(A) v_0
(B) $\frac{v_0}{2}$

(C) $\frac{v_0}{\sqrt{2}}$

(D) $\frac{v_0}{4}$

27. A mixture of n_1 moles of a mono atomic gas and n_2 moles of a diatomic gas has $\frac{C_p}{C_v} = \gamma = 1.5$. Then, $\frac{n_1}{n_2}$ equals

(A) 2 : 1
(B) 1 : 2
(C) 1 : 1
(D) 1 : 3

28. The angular width of the central maximum of a diffraction pattern of a single slit pattern is 60°, the slit width being 1 μm. A double slit experiment is now performed with the same wavelength of light and the same slit widths and it is found that the 10^{th} interference maximum is not formed, but all lower maxima are visible. The separation between the double slits is

(A) 9 μm
(B) 10 μm
(C) 20 μm
(D) $10\sqrt{3}\mu$m

29. A Carnot engine converts $\frac{1}{5}$ of the available heat into work. Keeping the temperature of the reservoirs the same, two Carnot engines are used to replace the single Carnot engine: the heat rejected by the first is equal to the heat input to the second and the heat rejected by the second is to the lower reservoir. The efficiency of the second engine is 9.09% (i.e. $\frac{1}{11}$). The efficiency of the first engine is

(A) 11%
(B) 29%
(C) 12%
(D) 31%

30. An AC source producing emf $e = e_0 \cos\left(100\pi s^{-1}\right)t + e_0 \cos\left(500\pi s^{-1}\right)t$ is connected in series with a capacitor and resistor. The steady state current in the circuit is found to be
$i = i_1 \cos\left[\left(100\pi s^{-1}\right)t + \phi_1\right] + i_2 \cos\left[\left(500\pi s^{-1}\right)t + \phi_2\right]$.

(A) $i_1 > i_2$
(B) $i_1 = i_2$
(C) $i_1 < i_2$
(D) The information is insufficient to find the relation between i_1 and i_2.

Chemistry

PART – II

SECTION – A

(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. What is difference in the density (gm/litre) of dry air at 1 atm and 27°C and moist air with relative humidity 40% under same condition. Given that the vapour pressure of water is 19 torr at 27°C and dry air has 80% N_2 and 20% by volume.

(Take $R = \frac{1}{12}\ell$, atm $mol^{-1}K$)

(A) 2.32×10^{-3} g/L
(B) 6.24×10^{-3} g/L
(C) 1.64×10^{-3} g/L
(D) 4.38×10^{-3} g/L

32. Which of the following is not an example of disproportionation:

(A) HCHO + 50% conc. NaOH →
(B) $P_4 + OH^- \rightarrow$
(C) $Br^- + BrO_3^- + H^+ \longrightarrow$
(D) $H_2O_2 \xrightarrow{h\nu}$

33. 2 moles of an ideal gas is slowly compressed from 1.2 L to 0.6 L at a constant temperature of 300 K. Calculate the work done by the gas in this process.

(A) 4.59 kJ
(B) 3.48 kJ
(C) 5.35 kJ
(D) 0

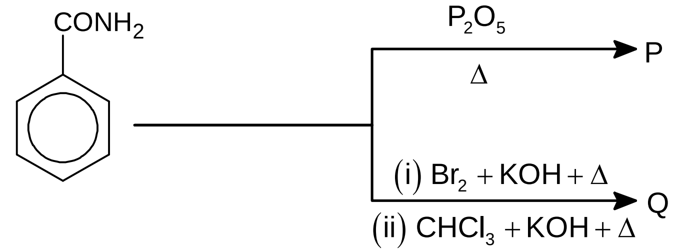
34. Which one of the following statements is **incorrect**?

(A) For CH_3COCH_3 and $CHCl_3$ solution, $\Delta H_{solution} < 0$ and $\Delta V_{solution} < 0$
(B) When mercuric iodide is added to an aqueous solution of KI then freezing point of KI solution is raised and its boiling point is lowered.
(C) NaCl is less soluble in acetone than H_2O.
(D) For H_2O and $(CH_3)_3COH$ solution, $\Delta H_{solution} < 0$ and $\Delta V_{solution} < 0$.

35. (i) S_8 + NaOH (aq) $\longrightarrow$
(ii) $SF_4 + H_2O$ (liq.) $\longrightarrow$
(iii) $Na_2S_2O_3$ + HCl (aq) $\longrightarrow$
(iv) H_2S(aq) + SO_2(g) $\longrightarrow$

Which of the above reaction give one of the product as precipitate?

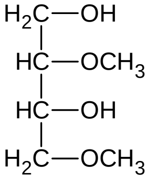
(A) (i) only
(B) (i) and (iii)
(C) (iii) and (IV)
(D) (ii) and (iv)

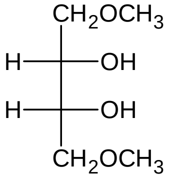
36. 
CONH2
P2O5
Δ
P
(i) Br2 + KOH + Δ
(ii) CHCl3 + KOH + Δ
Q

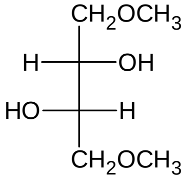
Which statement is **incorrect:**

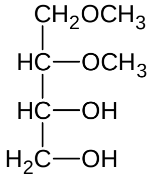
(A) Reduced product of P and Q will be metamers to each other.
(B) By dry distillation of hydrolysed products of P with $Ca(OH)_2$, gives benzophenone.
(C) Hydrolysed product of Q, reacts with $NaNO_2$ + HCl followed by reaction with phenol, give orange red dye.
(D) Electrophile involved in the formation of Q is dichlorocarbene.

37. Match each of the following four structures with one of compounds A – D, on the basis of the following experimental facts. Compounds A, B and C are optically active but compound D is not compound C gives the same products as compound D on treatment with periodic acid, but compound B gives a different product. Compound A does not react with periodic acid.


H2C—OH
HC—OCH3
HC—OH
H2C—OCH3
(I)


CH2OCH3
H
OH
H
OH
CH2OCH3
(II)


CH2OCH3
H
OH
HO
H
CH2OCH3
(III)

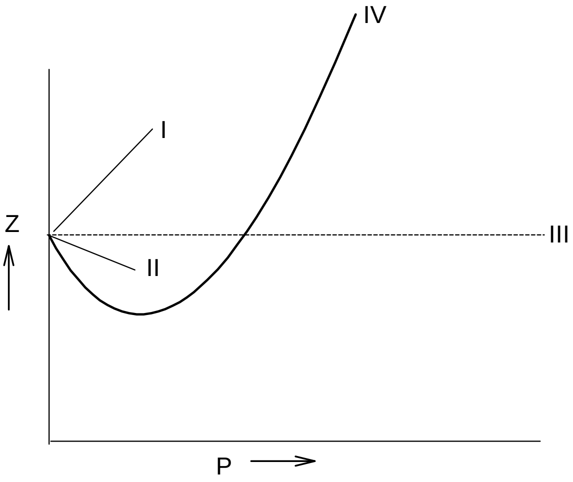

CH2OCH3
HC—OCH3
HC—OH
H2C—OH
(IV)

(A) A – (III), B – (II), C – (I), D – (IV)
(B) A – (III), B – (I), C – (IV), D – (II)
(C) A – (I), B – (IV), C – (III), D – (II)
(D) A – (I), B – (IV), C – (II), D – (III)

38. How many of the following give colourless gas/gases with conc. H_2SO_4?
$H_2C_2O_4$, NaCl, KI, HCOOH, $KClO_3$, Na_2CO_3, KBr, Na_3PO_4, $K_4[Fe(CN)_6]$
(A) 3
(B) 4
(C) 5
(D) 8

39. Which type of crystal systems (of the following) have all their interfacial angles right angle?
(A) Triclinic
(B) Monclinic
(C) Orthorhombic
(D) Hexagonal

40.



For the above plot of the compressibility factor Z versus P for few gases, which of the following statement is **incorrect** for a van der Waal's gas?

(A) The plot I is applicable provided the van der Waal's constant a is negligible.
(B) The plot II is applicable provided the van der Waal's constant b is negligible.
(C) The plot III is applicable provided the van der Waal's constant a and b are negligible.
(D) The plot IV is applicable provided the temperature of the gas is much higher than its critical temperature.

41. Solid BaF_2 is added to a solution containing 0.1 mole of sodium oxalate solution of 1 litre until equilibrium is reached. If the K_{sp} of BaF_2 and BaC_2O_4(s) is 10^{-6} and 10^{-7} respectively. Assume addition of BaF_2 does not cause any change in volume and no hydrolysis of any of the catons or anions. If conc. of Ba^{+2} ions in resulting solution at equilibrium is represented as 2.7×10^{-x}, then x is…… (Given: $\sqrt{116} = 10.77$)

(A) 3
(B) 3.5
(C) 5
(D) 5.4

42. Which of the following involves carbon reduction during extraction of metal from ore?

(i) Bauxite – Al (ii) Copper pyrites – Cu
(iii) Haematite – Fe (iv) Galena – Pb
(v) Carnelite – Mg (vi) Sylvine – K
(vii) Cassiterite – Sn (viii) Zinc blende – Zn

(A) (iii), (iv), (vii), (viii)
(B) (iii), (iv), (vi)
(C) (i), (ii), (iii), (iv), (viii)
(D) (i), (ii), (iii), (viii)

43. Select correct orders of the properties given below:

(A) $CH_2F_2 > CH_3F > CHF_3 > CF_4$, decreasing C – F bond length.
(B) $CCl_4 < CH_3Cl < CH_2Cl_2 < CHCl_3$, increasing dipole moment.
(C) LiCl < NaCl < KCl < RbCl, increasing melting point.
(D) $COF_2 < COCl_2 < COBr_2$, increasing XOX bond angle.

44. Which of the following can give two gases on heating?

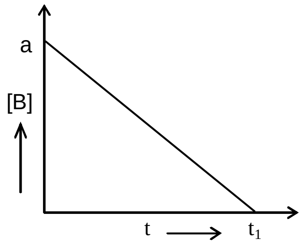
(A) $Zn(ClO_3)_2$
(B) NH_4ClO_4
(C) $K_2Cr_2O_7$
(D) $KMnO_4$

45. In the reaction: $A + 2B \longrightarrow \text{Product}$

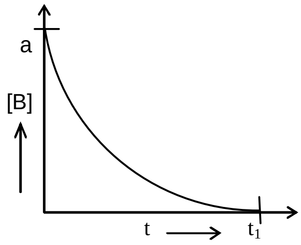
$\text{Rate} = K[A][B]^{o}$

The initial conc. of both A and B are 'a' molar. The graph of conc. of B vs. time is $\left(t_1 = t_{1/2} \text{ for } A\right)$

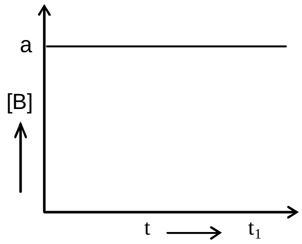
(A)



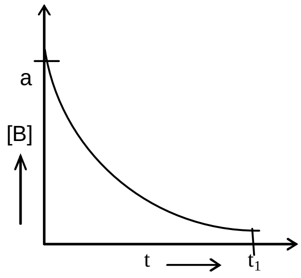
(B)



(C)



(D)



46. Which of the following statement is correct?
(A) Brownian movement is more pronounced for smaller particles than for bigger ones.
(B) Sols of metal sulphides are lyophilic.
(C) Schulze-Hardy law states, the bigger the size of the ion, the greater is its coagulation power.
(D) Charcoal absorb chlorine more strongly than hydrogen suphide.

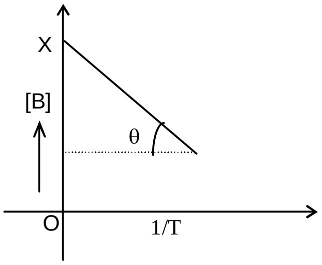
47. Ammonia gas is prepared by:
(A) Reduction of sodium nitrite or sodium nitrate by the reaction of zinc dust and NaOH.
(B) Hydrolysis of calcium cyanamide.
(C) Heating ammonium chloride with slaked lime.
(D) All of the above.

48. Which one of the following statements is **incorrect?**
(A) In the aluminothermite process aluminium acts as reducing agent.
(B) Lead is extracted from its ore by both carbon reduction and self reduction.
(C) Extraction of gold involves the leaching of ore with cyanide solution followed by reduction with zinc.
(D) In Hall-Heroult process, the electrolyte used is a molten mixture of alumina, NaOH and cryolite.

49. $FeCr_2O_4 + Na_2CO_3 + O_2 \xrightarrow{\text{Fusion}} [X] \xrightarrow[H_2O]{H^+} [Y] \xrightarrow[H_2O_2]{H^+} [Z]$
Which of the following statement is true for the compounds [X], [Y] and [Z]?
(A) In all three compounds, the chromium is in +6 oxidation state.
(B) [Z] is a deep blue-violet coloured compound which decomposes rapidly in aq. solution into Cr^{+3} and dioxygen.
(C) Saturated solution of [Y] gives bright orange compounds chromic anhydride with conc. H_2SO_4.
(D) All of these

50. Co-ordination number of Cr in $CrCl_3.6H_2O$ is 6. The volume of 0.1 N $AgNO_3$ needed to precipitate the chorine in ionization sphere in 200 ml of 0.01 M solution of the complex can not be:
(A) 60 ml
(B) 40 ml
(C) 80 ml
(D) 20 ml

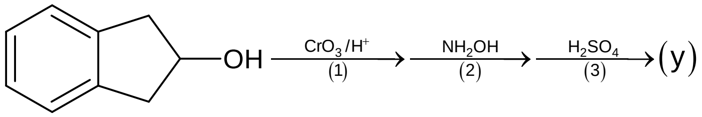
51. Graph between $\log K$ and $\frac{1}{T}$[where K is rate constant (s^{-1}) and T is temperature in (K)] is a straight line with OX = 5, $\theta = \tan^{-1}\left[-\frac{1}{2.303}\right]$. Hence Ea and logA respectively will be:

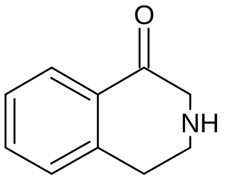


(A) 2.303 × 2 cal, 5
(B) $\frac{2}{2.303}\text{cal}, e^5$
(C) 2 cal, 5
(D) None of these

52. Total number of stereoisomers for the complex $[Pt(NH_3)_2(NO_3)_2\ ClBr]$ is:
(A) 2
(B) 4
(C) 6
(D) 8

53. Major product of the following sequence of reactions could be:



(A)


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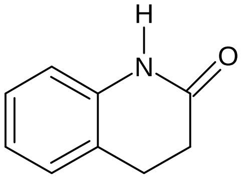
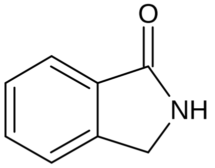
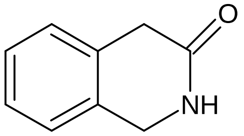
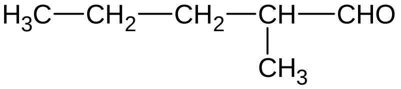
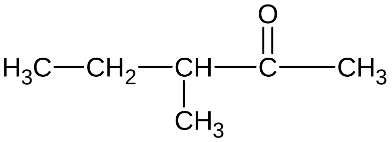


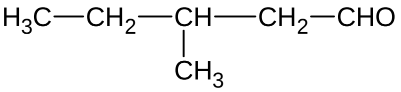
(C)


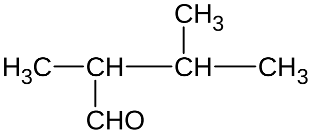
(D)


54. Choose the correct optically active isomer of $C_6H_{12}O$ that gives a positive Tollen's test and does not racemise in base.

(A)

$H_3C-CH_2-CH_2-CH(CH_3)-CHO$

(B)

$H_3C-CH_2-CH(CH_3)-C(=O)-CH_3$

(C)

$H_3C-CH_2-CH(CH_3)-CH_2-CHO$

(D)

$H_3C-CH(CHO)-CH(CH_3)-CH_3$

55. Which of the following statements are correct?
(i) Sucrose is dextrorotatory but after hydrolysis the mixture aquires a levorotatory nature.
(ii) In amylopectin branching occurs by $C_1 - C_6$ glycosidic linkage.
(iii) Glycine is a optically inactive amino acids.
(iv) Pernicious anemia is caused by deficiency of Vitamin B_{12}.
(A) (i), (ii), (iii), (iv)
(B) (i), (iii), (iv) only
(C) (ii), (iii), (iv) only
(D) (i), (ii) only

56. Which of the following reacting substances will not liberate ethyne gas?
(A) CH_3Cl and Ag
(B) CaC_2 and H_2O
(C) CHI_3 and Ag
(D) Vinylic chloride heated with sodamide followed by reaction with water.

57. $BrF_5 + H_2O \longrightarrow X + Y$
X and Y are respectively:
(A) HBr, HOF
(B) HBrO, HF
(C) $HBrO_2$, HF
(D) $HBrO_3$, HF

58. Number of orbital(s) in zinc having at least one angular node:
(A) 11
(B) 7
(C) 6
(D) 5

59. Which one of the following statements is correct?
(A) Potassium iodide solution reacts with $FeCl_3$ (aq) to form precipitate of FeI_3.
(B) XeF_6 reacts with silica to form a compound in which the oxidation state of Xe is 8.
(C) Anhydrous ferric chloride is prepared by heating hydrated ferric chloride with thionyl chloride.
(D) Iron reacts with Cl_2 to form $FeCl_2$.

60. Which is the correct statement for positive deviation of solution from Raoult's law?
(A) The energy released in solvation exceeds the energy used in breaking up interaction /intermolecular forces.
(B) Solute – solvent interaction is weaker than their own interactions (like particle interactions).
(C) Volume would contract during formation of solution.
(D) Boiling point of solution will be higher than expected.

Mathematics PART – III

SECTION – A

(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. A value of θ for which $\frac{(2\cos\theta + i)}{(\sin\theta - 1 - i\cos\theta)}$ is purely real, is

(A) $\frac{\pi}{4}$

(B) $\frac{\pi}{3}$

(C) $-\frac{\pi}{6}$

(D) $-\frac{\pi}{2}$

62. If $n \in N$ and $\int_0^1 e^x \cdot x^n dx = 120 - 44e$, then n is

(A) 3
(B) 4
(C) 5
(D) 6

63. If function $g(x) = x^3 + e^{4x}$ and $f(x) = g^{-1}(x)$, then the value of $f'(1)$ is

(A) $\frac{1}{4}$

(B) 4

(C) $\frac{1}{3 + 4e^4}$

(D) $3 + 4e^4$

64. If x, y, $z \in R^+$ and $16(16x^2 + y^2 - 4xy) = z(16x + 4y - z)$, then
(A) y, z, x are in A.P.
(B) y, z, x are in G.P.
(C) x, y, z are in A.P.
(D) x, y, z are in G.P.

65. The value of the expression $\frac{1}{\sqrt{3}\sin(250^o)} + \frac{1}{\cos(290^o)}$ is

(A) $\frac{\sqrt{3}}{4}$

(B) $\frac{4}{\sqrt{3}}$

(C) $\sqrt{3}$

(D) $\frac{1}{\sqrt{3}}$

66. The coefficient of x^5 in $(1 + x + x^2 + x^3)^{11}$ is
(A) 2,620
(B) 2,682
(C) 2,820
(D) 2,882

67. The number of irrational roots of the equation
$(x^2 - 3x + 1)(x^2 + 3x + 2)(x^2 - 9x + 20) = -30$ is
(A) 6
(B) 4
(C) 2
(D) 0

68. If $\tan(\pi \cos \theta) = \cot(\pi \sin \theta)$, then $\cos^2\left(\theta - \frac{\pi}{4}\right)$ is
(A) $\frac{1}{16}$
(B) $\frac{1}{8}$
(C) $\frac{1}{4}$
(D) $\frac{1}{2}$

69. Let $\vec{a} = \alpha\hat{i} + 2\hat{j} - 3\hat{k}$, $\vec{b} = \hat{i} + 2\alpha\hat{j} - 2\hat{k}$ and $\vec{c} = 2\hat{i} - \alpha\hat{j} + \hat{k}$ where $\alpha \in R$.
If $\{(\vec{a} \times \vec{b}) \times (\vec{b} \times \vec{c})\} \times (\vec{c} \times \vec{a}) = 0$, then the value of α is
(A) $\frac{2}{3}$
(B) $\frac{3}{2}$
(C) $\frac{3}{4}$
(D) $\frac{4}{3}$

70. If $ax^2 + 2hxy - ay^2 = 0$, $a > 0$, represents a pair of straight lines forming with $2x + 3y = -8$ an isosceles triangle which is right angled at origin, then $(a + h)$ is
(A) 7
(B) 17
(C) –7
(D) –17

71. If real numbers x and y satisfy $x^2 + y^2 - 16x + 30y + 280 = 0$, then maximum value of $(x^2 + y^2)^{1/2}$ is
(A) 15
(B) 20
(C) 25
(D) 30

72. The value of $\tan^{-1}\left(\frac{9}{19}\right)+\tan^{-1}\left(\frac{9}{49}\right)+\tan^{-1}\left(\frac{9}{97}\right)+\tan^{-1}\left(\frac{9}{163}\right)+.....\infty$ equals

(A) $\tan^{-1}(3)$

(B) $\tan^{-1}\left(\frac{1}{3}\right)$

(C) $\tan^{-1}\left(\frac{2}{3}\right)$

(D) $\tan^{-1}\left(\frac{3}{2}\right)$

73. In a ΔABC, b = 10 units, c = 24 units and area of triangle is 120 square units (where b is side AC and c is side AB). If 'd' is the distance between vertex A and incentre of the triangle, then the value of d^2 is?

(A) 32
(B) 36
(C) 40
(D) 44

74. The number of positive integral solutions of the equation $\begin{vmatrix} x^3+1 & xy^2 & xz^2 \\ x^2y & y^3+1 & yz^2 \\ x^2z & y^2z & z^3+1 \end{vmatrix} = 37$ is

(A) 1
(B) 3
(C) 6
(D) 12

75. Radius of largest circle which passes through the focus of the parabola $y^2 = 5x$, and is contained in the parabola, is

(A) 4

(B) $\frac{21}{5}$

(C) 5

(D) $\frac{26}{5}$

76. The digits 1, 2, 3, 4, 5, 6, 7 and 8 are written in random order to form an eight digit number with distinct digits. Then the probability that this number is divisible by 36 is

(A) $\frac{11}{56}$

(B) $\frac{3}{14}$

(C) $\frac{13}{56}$

(D) $\frac{1}{4}$

77. A straight line PQ touches ellipse $\frac{x^2}{(3)^2}+\frac{y^2}{(1)^2}=1$ and circle $x^2 + y^2 = 4$. RS is a focal chord of ellipse. If RS is parallel to PQ and RS meets the circle at points R′ and S′, then the length of R′S′ is
(A) 1 unit
(B) 2 units
(C) 3 units
(D) 4 units

78. Let x, y, z and w be whole numbers. Then the number of 4 digit numbers 'xyzw' that can be formed such that $x < y$ and $z > w$ is
(A) 1,008
(B) 1,296
(C) 1,620
(D) 2,025

79. Let P(3 sec α, 2 tan α) and Q(3 sec β, 2 tan β) be two points on hyperbola $H_1 : \frac{x^2}{9}-\frac{y^2}{4}=1$ such that $\alpha-\beta=\frac{2\pi}{3}$. If PQ is tangent to hyperbola $H_2 : \frac{x^2}{a^2}-\frac{y^2}{b^2}=1$, then eccentricity of hyperbola H_2 is
(A) $\frac{\sqrt{10}}{3}$
(B) $\frac{2}{\sqrt{3}}$
(C) $\frac{\sqrt{13}}{3}$
(D) $\frac{\sqrt{5}}{\sqrt{3}}$

80. If matrix $A = [a_{ij}]_{4 \times 4}$ such that $a_{ij}=\begin{cases}3 & ; & i=j\\ 0 & ; & i\neq j\end{cases}$ and det(adj(adj A)) = 3^k, then k is
(A) 12
(B) 20
(C) 28
(D) 36

81. The equation of the image of the plane $x - 2y + 2z - 3 = 0$ in the plane $x + y + z + 1 = 0$ is
(A) $x - 8y + 4z - 7 = 0$
(B) $x - 8y + 4z - 11 = 0$
(C) $x + 8y - 4z - 7 = 0$
(D) $x + 8y - 4z - 11 = 0$

82. The proposition $\sim(p \vee q) \vee (\sim p \wedge q)$ is logically equivalent to
(A) ~p
(B) p
(C) ~q
(D) q

83. The mean of 5 observations is 4 and their variance is 5.2. If three of these observations are 1, 2 and 6, then the other two are
(A) 2, 9
(B) 3, 8
(C) 4, 7
(D) 5, 6

84. A balloon is observed simultaneously from three points A, B and C on a straight road directly under it. The angular elevation at B is twice that of A and at C is thrice that of A. If distance between A and B is 200 metres and distance between B and C is 100 metres, then the height of balloon is given by
(A) 50 m
(B) $50\sqrt{3}$ m
(C) 100 m
(D) $100\sqrt{3}$ m

85. The value of $\lim\limits_{x\to 0}\dfrac{\left(1+4x+x^2\right)^{\frac{1}{x}}-\left(1+4x-5x^2\right)^{\frac{1}{x}}}{x}$ is
(A) $5e^4$
(B) $6e^4$
(C) $7e^4$
(D) $8e^4$

86. If the number of points of discontinuity and number of points of non-differentiability of $f(x)=\text{minimum}\left\{\sin x, \sin^{-1}(\cos x)\right\}$ in (0, 2π) are p and q respectively, then ordered pair (p, q) is
(A) (1, 2)
(B) (1, 3)
(C) (0, 2)
(D) (0, 3)

87. Let f: R → R be a function defined by $f(x) = -x^3 - 3x^2 - 6x + 1$. Number of integers in the solution set of x satisfying the inequality $f(f(x^3 + f(x))) \geq f(f(-f(x) - x^3))$ is
(A) 3
(B) 4
(C) 5
(D) 6

88. $\int \cos(9x)\cdot\cos^7 x\,dx$ equals
(A) $\dfrac{\sin(8x)\cdot\sin^8 x}{8}+c$
(B) $\dfrac{\sin(8x)\cdot\cos^8 x}{8}+c$
(C) $\dfrac{\cos(8x)\cdot\sin^8 x}{8}+c$
(D) $\dfrac{\cos(8x)\cdot\cos^8 x}{8}+c$

89. A continuous function f : R → R satisfies the differential equation $f(x)=(1+x^2)\left[1+\int_0^x \frac{(f(t))^2}{1+t^2}dt\right]$, then f(–3) is

(A) $\frac{13}{10}$

(B) $\frac{8}{5}$

(C) $\frac{10}{13}$

(D) $\frac{5}{8}$

90. Consider two curves $C_1 : y = e^x$ and $C_2 : y = e^{t-x}$, where $t \in R^+$. Let S be the area bounded by C_1, C_2 and y-axis. Then $\lim_{t\to 0}\left(\frac{S}{t^2}\right)$ is

(A) $\frac{1}{4}$

(B) $\frac{1}{2}$

(C) 0

(D) 4

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VIII

JEE (Main)-2019

TEST DATE: 31-03-2019

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. D

Sol. $\frac{dN}{dt} = R - \lambda N,$

Solving,

$N = \frac{R}{\lambda}\left(1 - e^{-\lambda t}\right)$

If the process mentioned in option (D) is performed a large no. of times and the activity when introducing into the reactor is A_0, then:

Just after withdrawing from reactor, the activity is:

$A = \frac{A_0}{2} + \frac{R}{2}$

and after one $\frac{1}{2}$ – life outside it should be A_0:

$A_0 = \frac{A_0}{4} + \frac{R}{4}$ or $A_0 = \frac{R}{3}$.

2. C

Sol. For large values of x, $\left[1 - e^{-kx^2}\right] \to 1$

For small values of x, $\left[1 - e^{-kx^2}\right] \approx kx^2,$

Thus for large x (and 'a') it is like SHM; for small values the time period can be determined from dimensional analysis:

3. B

Sol. It is clear that there is a pressure antinode at the wall and there is pressure node at P when it is silent (no sound).

So, $L_0 = (2m+1)\frac{\lambda}{4}$, $m = \text{integer}$ and λ = wavelength of sound.

Further: $L_0 - \frac{v_0 t_0}{2} = n\frac{\lambda}{2}$, $n = \text{integer}$.

Taking the difference and considering different values of m, n we arrive at the conclusion.

4. B

Sol. As the radius of the container is finite, the viscous force becomes larger then that predicted by Stokes' Law.

5. D

Sol. The stress is compressive on the left end, tensile on the right.

6. D

Sol. When the slits have unequal widths, maximum intensity = $k'(A_1 + A_2)^2$

minimum intensity = $k'(A_1 - A_2)^2$

Where A_1, A_2 are individual amplitudes.

When the length of the slits is decreased, there is less light at the maxima and the fringes become curved.

7. A

Sol. The reading on C_1 is = $2.5 + 6 \times \left(1 - \frac{23}{25}\right) \times 0.1$ = 2.548 cm and the reading on

C_2 is = $2.6 + 6 \times \left(1 - \frac{27}{25}\right) \times 0.1$ = 2.552 cm.

8. C

Sol. $f_0 = \frac{8}{2L}\sqrt{\frac{T_1}{\mu}} = \frac{10}{2L}\sqrt{\frac{T_2}{\mu}}$

$$\frac{T_2}{T_1} = \left(\frac{8}{10}\right)^2 = \frac{(\rho_s - \rho_w)V_g}{\rho_s V_g}$$

$\therefore \quad \frac{\rho_s}{\rho_w} = 2.8$.

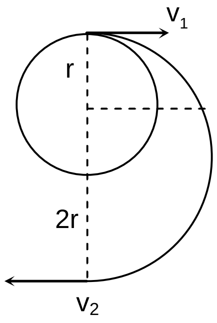
9. B

Sol. Applying conservation of Angular momentum $mv_1.r = mv_2.2r$

Applying conservation of energy, $\frac{1}{2}mv_1^2 - \frac{GMm}{r} = \frac{1}{2}mv_2^2 - \frac{GM}{2r}m$.

Solving, $v_1 = \frac{2v_0}{\sqrt{3}}$.

$\therefore$ The impulse per unit mass = $\frac{mv_1 - mv_0}{m}$.



10. D

Sol. The object and image positions relative to their closest lenses do not depend on the separation between the two lenses. So the rays between the lenses are parallel. Object is at the focus of the first lens and image at the appropriate focus of the second lens.

11. C

Sol. $BP - AP \approx \frac{d^2}{2D} = \frac{\lambda}{4}$ (given)

$CP - AP \approx \frac{4d^2}{2D} = \lambda$

Resultant amplitude at P is A′, where $A'^2 = (A + A)^2 + A^2$

12. B

Sol. $\frac{mv^2}{R} = evB$ …(1)

$mvR = \frac{nh}{2\pi}$ …(2)

Dividing (2) by (1), we get the result.

13. C

Sol. $KE_{max} = h\nu - W = 5.93 - 1.9 = 4\,eV$ nearly.

14. D

Sol. The flux of the magnetic field through the loop when it has rotated through $\theta = \omega t$, is

$\Phi = \frac{B\pi R^2}{2}(2\cos 45^\circ \cos\omega t)$

$EMF = -\frac{d\Phi}{dt} = \frac{B\pi R^2 \omega}{\sqrt{2}}\sin\omega t$

Current, $i = \frac{EMF}{\lambda . 2\pi R}$

Magnetic moment = current × area

$= \left(\frac{B\pi R^3\omega}{4\lambda}\sin\omega t\right)$

15. B

Sol. $EMF \simeq \frac{\mu_0 iN}{2\pi}\left[\frac{1}{a_0} - \frac{1}{a_0 + b}\right]\ell v,$

$v = \omega A \sin \omega t.$

16. B

Sol. $EMF = \frac{d}{dt}(Bvt \times vt) = 2Bv^2 t$

and resistance = $\lambda\left(2vt + 2\sqrt{2}vt\right)$

17. A

Sol. Change in flux (linked)

$$\Delta\Phi = 120 \times \mu_0 ni.\pi\left(\frac{2}{100}\right)^2$$

Charge that flows through coil = $\frac{\Delta\Phi}{R}$, R = 3.6 Ω.

18. A

Sol. $V = k\int_{x=r}^{R} \frac{\sigma.2\pi x dx}{x} = k.\sigma 2\pi(R-r)$

19. D

Sol. $q = \frac{C_0 C'}{C_0 + C'}E$, where E = 6V

$$\frac{dq}{dt} = \frac{C_0}{C_0 + C'}E\frac{dC'}{dt} - \frac{C_0 C'}{(C_0 + C')^2}E\frac{dC'}{dt}$$

$$= \left(\frac{C_0}{C_0 + C'}\right)^2 E\frac{dC'}{dt}$$

Where $C_0 = 2\mu F$, $\frac{dC'}{dt} = 2\mu F/s$.

The value of C′ can be found to be 4 μF at the given instant.

20. D

Sol. For an elastic collision between a mass m_1 and a second mass m_2, at rest, we get the final velocities:

$$v_2 = \frac{2m_1}{m_1 + m_2}v_0$$

$$v_1 = \frac{m_1 - m_2}{m_1 + m_2}v_0$$

When v_0 is speed of approach of m_1.

21. D

Sol. The three horizontal tensions at the lowest points are clearly equal to T_0, say. Then for chain A :

$T_A \cos\theta_A = m_A g$

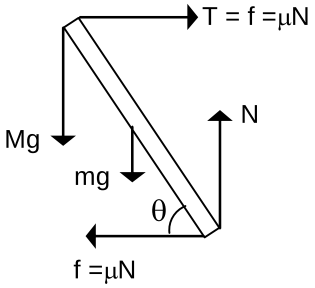
$T_A \sin\theta_A = T_0$

i.e. $m_A g = T_0 \cot\theta_A$

22. A

Sol. If the net torque about the lowest point is set equal to zero, we get, $MgL\cos\theta + mg\frac{L}{2}\cos\theta - \mu N.L\sin\theta = 0$

Where N = (M + m)g.



23. B

Sol. the overall modulation index is found from the expression: $m^2 = m_1^2 + m_2^2$

Where $m_1 = 0.6$ and $m_2 = 0.7$.

24. C

Sol. Since some of the molecules have dissociated, we must take into account the energy required for dissociating the bonds into account.

$$U_i^{kin} = \left(N - \frac{N}{3}\right)\frac{5}{2}RT + \frac{N}{3}\times 2\times\frac{3RT}{2}$$

By 1st Law,

$Q = \Delta Q = \Delta U = \Delta U^{kin} + \Delta U^{bond}$.

25. D

Sol. The final C.M. is at $\frac{H}{8}$ above the base. The volume, and consequently the mass of a cone (of fixed vertical angle) is proportional to the cube of its height. Taking the origin at apex.

$$\frac{7H}{8} = \frac{H^3\frac{3H}{4} - x^3\frac{3x}{4}}{H^3 - x^3}$$

Rearranging, we get the required condition.

26. C

Sol. $\frac{1}{2}v'^2 = \left(\frac{GM}{2R^2}\right).R = \frac{GM}{2R} = \frac{1}{4}.\frac{2GM}{R} = \frac{1}{4}.v_0^2$

27. C

Sol. $C_{v,mix} = \frac{n_1C_{v_1} + n_2Cv_2}{n_1 + n_2}$

$C_{p,\,mix} = C_{v,mix} + R$

$\gamma_{mix} = \frac{C_{p,mix}}{C_{v,mix}}$

28. B

Sol. For the diffraction pattern, (1μm) sin 30° = 1λ

For the interference pattern, dsin30° = 10λ, since the 10th maximum falls on the diffraction minimum.

29. C

Sol. For Carnot engines, efficiency = $1 - \frac{T_2}{T_1} = \frac{1}{5}$, in this case.

Let the intermediate temperature be T′.

Then $1 - \frac{T_2}{T'} = \frac{1}{11}$

Solving, and calculating $e = 1 - \frac{T'}{T_1}$

We get 12%.

30. C

Sol. $i_1 = \dfrac{e_0}{\sqrt{R^2 + \left(\dfrac{1}{\omega_1 C}\right)^2}} = \dfrac{e_0}{Z_1}$, where $\omega_1 = 100\pi$

$i_2 = \dfrac{e_0}{\sqrt{R^2 + \left(\dfrac{1}{\omega_2 C}\right)^2}} = \dfrac{e_0}{Z_2}$, where $\omega_2 = 500\pi$

So, $Z_1 > Z_2$, therefore $i_1 < i_2$.

Chemistry

PART – II

SECTION – A

31. D

Sol. $d = \frac{PM}{RT}$

$M_{(dry\ air)} = \frac{(28 \times 0.8) + (32 \times 0.2)}{1} = 28.8\, gm / mol$

$d_{(dry\ air)} = \frac{P \times 28.8}{RT}$ … (i)

$R.H. = \frac{P_{H_2O}}{\text{Vapour pressure}} \times 100$

$40 = \frac{P_{H_2O}}{19} \times 100$

$P_{H_2O} = \frac{19}{2.5}$ torr

% of H_2O(vapours) in air $= \frac{19 / 2.5}{760 / 1} \times 100$ = 1%

M_{moist} air = (18 × 0.01) + (28.8 × 0.99)
= 28.692

$d_{moist\ air} = \frac{P \times (28.692)}{RT}$ … (ii)

$d_{dry\ air} - d_{moist\ air} = \frac{P}{RT}(28.8 - 28.692)$

$= \frac{12}{300} \times 0.108$

$= 4.38 \times 10^{-3}$ g/L

32. C

Sol. (A) $HCHO + 50\%\ conc.NaOH \longrightarrow HCOO^-Na^+ + CH_3OH$

(B) $P_4 + 3NaOH + 3H_2O \longrightarrow 3NaH_2PO_2 + PH_3 \uparrow$

(C) $5Br^- + BrO_3^- + 6H^+ \longrightarrow 3Br_2 + 3H_2O$

(D) $H_2O_2 \xrightarrow{h\nu} H_2O + \frac{1}{2}O_2$

33. B

Sol. $W = -2.303 \times 2 \times 8.314 \times 300 \log \frac{0.6}{1.2}$

$= 3.48$ kJ

34. D

Sol. For H_2O and $(CH_3)_3COH \Rightarrow$ +ve deviation.

$HgI_2 + 2KI \longrightarrow K_2[HgI_4]$

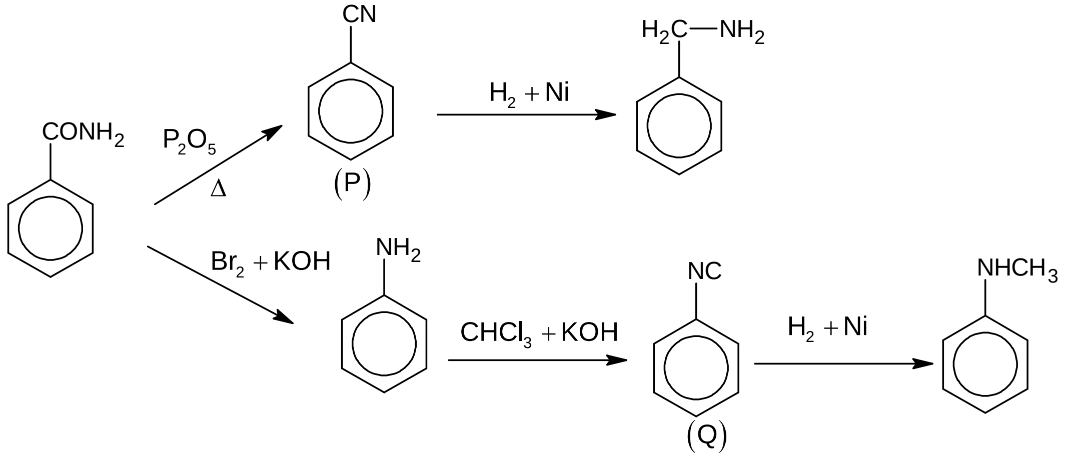
35. C

Sol. (iii) $Na_2S_2O_3 + HCl(aq) \longrightarrow S\downarrow + SO_2 + H_2O + NaCl$

(iv) $H_2S(aq) + SO_2(g) \longrightarrow H_2O + S\downarrow$

36. A

Sol.



37. C

Sol. D – II (meso compound)
C – III
A – I
B – IV

38. C

Sol. $H_2C_2O_4$, NaCl, HCOOH, Na_2CO_3, $K_4[Fe(CN)_6]$

39. C

40. D

41. C

Sol. $BaF_2(s) \longrightarrow \underset{s}{Ba^{+2}(aq)} + \underset{2s}{2F^-(aq)}$ ['s' be the solubility of BaF_2]

$$\underset{y}{Ba^{+2}} + \underset{0.1-s}{C_2O_4^{-2}} \longrightarrow BaC_2O_4(s) \qquad K_{eq} = 10^{-7} \qquad \left[\begin{array}{l}\text{Let y mol / lit. of } Ba^{+2} \text{ is} \\ \text{left after reaching equilbrium}\end{array}\right]$$

$y(0.1 – s) = 10^{-7}$ ...(i)

$y(2s)^2 = 10^{-6}$ ...(ii)

By solving s = 0.096 M

$$\left[C_2O_4^{2-}\right] = 0.1 - 0.096 = 4\times10^{-3}\ M$$

$$\left[F^-\right] = 2s = 2\times0.096 = 0.192\ M$$

$$\left[Ba^{+2}\right] = y = 2.7\times10^{-5}\ M$$

42. A
Sol. Haematite – Fe
Galena – Pb
Cassiterite – Sn
Zinc blende – Zn
Only these will involve carbon reduction.

43. D
Sol. A, B, C are wrong.
(C) – LiCl < RbCl < KCl < NaCl

44. A
Sol.
$$2Zn(ClO_3)_2 \xrightarrow{\Delta} 2ZnO + 2Cl_2\uparrow + 5O_2\uparrow$$
$$NH_4ClO_4 \xrightarrow{\Delta} N_2\uparrow + O_2\uparrow + Cl_2\uparrow + H_2O\uparrow$$
$$K_2Cr_2O_7 \xrightarrow{\Delta} K_2CrO_4 + Cr_2O_3 + O_2\uparrow$$
$$KMnO_4 \xrightarrow{\Delta} K_2MnO_4 + MnO_2 + O_2\uparrow$$

45. B
Sol.

	A	+	$2B \longrightarrow$ Product
t=0	a		a
$t = t,$	$(a-x)$		$(a-2x)$

$$[A]_t = ae^{-kt}$$
$$a - x = ae^{-kt}$$
$$x = a(1-e^{-kt})$$
At $t = t_{1/2} \Rightarrow a - x = \frac{a}{2}$
$$x = \frac{a}{2}$$
$$[B]_t = a - 2x$$
$$= a - 2a(1-e^{-kt})$$
$$= a(2e^{-kt} - 1)$$
At t = 0, [B] = a
$t = t_{1/2}, [B]_t = a - 2x$
= a – a
= 0

46. A
Sol. As particles size increases, the effect of impact average out and the Brownian movement become slow.

47. D
Sol.
$$NO_2^- / NO_3^- \xrightarrow{Zn/NaOH} NH_3 + H_2O$$
$$CaCN_2 + 3H_2O \longrightarrow CaCO_3 + 2NH_3$$
$$NH_4Cl + Ca(OH)_2 \longrightarrow 2NH_3 + CaCl_2 + 2H_2O$$

48. D

Sol. It is a molten mixture of alumina, fluorspar and cryolite.

49. D

Sol.

$$\begin{tikzcd}
 & 4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \arrow[r, "\text{Fusion}"] & Na_2\overset{+6}{Cr}O_4\left[X\right] \arrow[d, "H_3O^+"] \\
Cr^{+3} + O_2 + H_2O & \underset{\substack{(\text{Deep blue violet})\\ \left[Z\right]}}{\overset{+6}{Cr}O\left(O_2\right)_2} \arrow[l, "H_2O"'] & Na_2\overset{+6}{Cr}_2O_7\left[Y\right] \arrow[l, "H^+/H_2O_2"']
\end{tikzcd}$$

$$\underset{(Y)}{Na_2Cr_2O_7} + H_2SO_4 \longrightarrow \underset{(\text{Chromic anhydride})}{2CrO_3} + Na_2SO_4 + H_2O$$

50. C

Sol. (i) $\left[Cr\left(H_2O\right)_6\right]Cl_3 + AgNO_3 \longrightarrow 3AgCl + ...$

$200 \times 0.01 \times 3 = 0.1 \times V$

V = 60 ml

(ii) $\left[Cr\left(H_2O\right)_5 Cl\right]Cl_2.H_2O + 2AgNO_3 \longrightarrow 2AgCl + ...$

$200 \times 0.01 \times 2 = 0.1 \times V$

V = 40 ml

(iii) $\left[Cr\left(H_2O\right)_4 Cl_2\right]Cl.2H_2O + AgNO_3 \longrightarrow AgCl + ...$

$200 \times 0.01 \times 1 = 0.1 \times V$

V = 20 ml

51. C

Sol. $$\log K = \log A - \frac{Ea}{2.303\ RT}$$

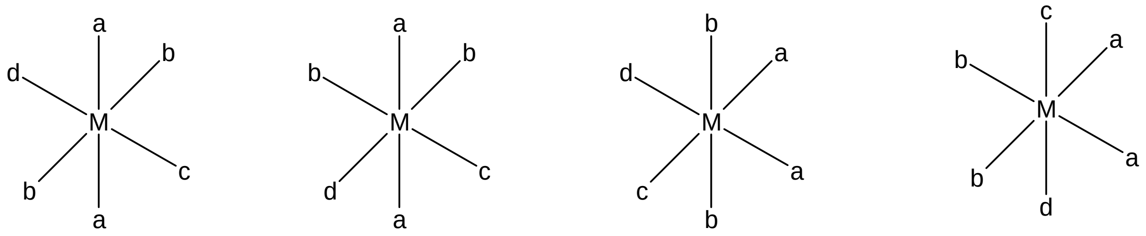
$$\tan\theta = \left[-\frac{1}{2.303}\right] = -\frac{Ea}{2.303R}$$

Ea = R = 2 cal/mol.

52. D

Sol. It is $[Ma_2b_2Cd]$ type complex.

6 → geometrical (4 optically inactive and 2 optically active)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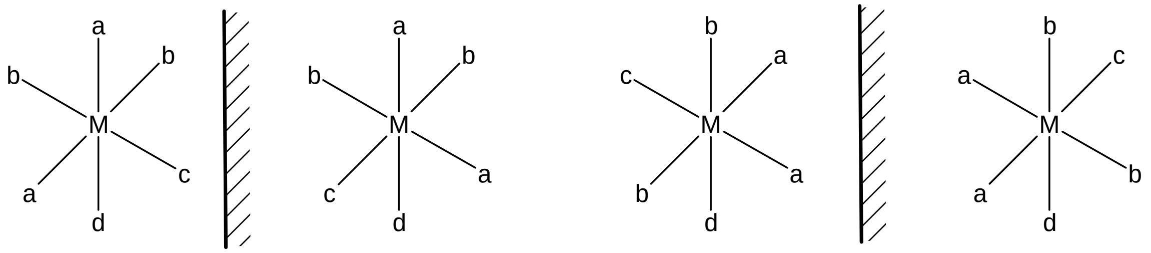
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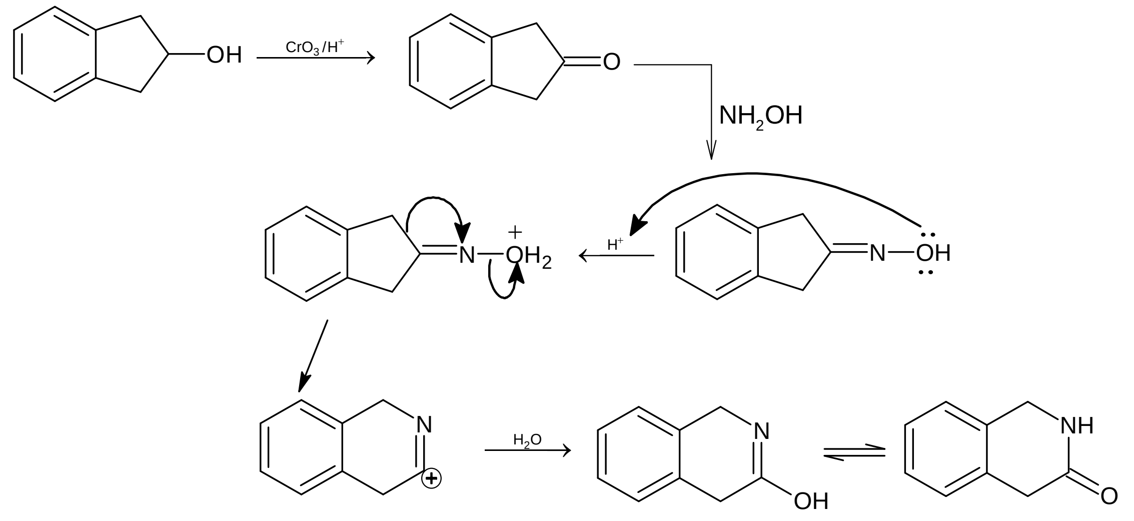
53. D

Sol.


OH
CrO_3/H^+
O
NH_2OH
H^+
N
OH
N
OH_2
+
N
H_2O
N
OH
NH
O

54. C

Sol. Aldehydes having one α-H at chiral centre, can undergo racemisation.

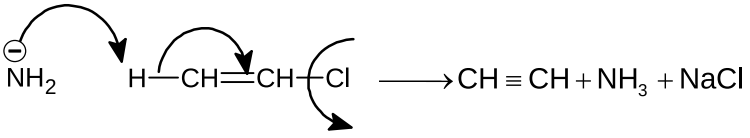
55. A

Sol. Fact

56. A

Sol. $CaC_2 + 2H_2O \longrightarrow C_2H_2 + Ca(OH)_2$

$HC-I_3 + 6Ag + I_3-CH \longrightarrow CH \equiv CH + 6AgI$



$\overset{\ominus}{N}H_2 \quad H-CH=CH-Cl \longrightarrow CH \equiv CH + NH_3 + NaCl$

57. D

Sol. $BrF_5 + H_2O \longrightarrow HBrO_3 + HF$

58. A

Sol. $Zn \rightarrow 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$

p-orbital have one and d-orbitals have two angular node.

59. C

Sol. $Fe^{+3}(aq) + I^-(aq) \longrightarrow Fe^{2+}(aq) + I_3^-(aq)$

$XeF_6 + SiO_2 \longrightarrow XeOF_4 + SiF_4$

$FeCl_3.6H_2O + 6SOCl_2 \longrightarrow FeCl_3 + 12HCl + 6SO_2$

$2Fe(s) + 3Cl_2(g) \longrightarrow 2FeCl_3$

A, B and D are incorrect.

60. B

Sol. $P_{obs} > P_{ideal}$

$\therefore (BP)_{obs} < (P)_{ideal}$

Mathematics

PART – III

SECTION – A

61. C

Sol. $$z = \frac{(2\cos\theta + i)\left((\sin\theta - 1) + i\cos\theta\right)}{(\sin\theta - 1)^2 + \cos^2\theta}$$

$\therefore$ $2\cos^2\theta + \sin\theta - 1 = 0 \Rightarrow (2\sin\theta + 1)(\sin\theta - 1) = 0$

62. C

Sol. $$I_n = \left|x^n e^x\right|_0^1 - n\int_0^1 x^{n-1}e^x dx$$

$\Rightarrow I_n = e - nI_{n-1}$

63. A

Sol. $f(g(x)) = x \Rightarrow f'(g(x))\cdot g'(x) = 1$

$$\Rightarrow f'(g(0)) = \frac{1}{g'(0)} \Rightarrow f'(1) = \frac{1}{g'(0)}$$

64. D

Sol. $(16x)^2 + (4y)^2 + (z)^2 - (16x)(4y) - (4y)(z) - (z)(16x) = 0$

$$\Rightarrow \frac{1}{2}\left[(16x - 4y)^2 + (4y - z)^2 + (z - 16x)^2\right] = 0 \Rightarrow 16x = 4y = z$$

65. B

Sol. $$E = \frac{1}{\sin 20^\circ} - \frac{1}{\sqrt{3}\cos 20^\circ} = \frac{\frac{\sqrt{3}}{2}\cos 20^\circ - \frac{1}{2}\sin 20^\circ}{\frac{\sqrt{3}}{2}\sin 20^\circ \cos 20^\circ} = \frac{\sin(60^\circ - 20^\circ)}{\frac{\sqrt{3}}{4}\cdot\sin 40^\circ}$$

66. D

Sol. S = coefficient of x^5 in $(1 + x)^{11}\cdot(1 + x^2)^{11} = {}^{11}C_1\cdot{}^{11}C_2 + {}^{11}C_3\cdot{}^{11}C_1 + {}^{11}C_5\cdot{}^{11}C_0$

67. A

Sol. $(x^2 + 3x + 2)\cdot(x^2 - 9x + 20) = (x^2 - 3x - 4)(x^2 - 3x - 10)$

Let $x^2 - 3x = t$

$\therefore$ $(t + 1)(t - 4)(t - 10) = -30$

By inspection and trial t = 5

Hence, other 2 roots are $t = 4 \pm \sqrt{30}$

68. B

Sol. $$\pi\cos\theta = n\pi + \frac{\pi}{2} - \pi\sin\theta \Rightarrow \sin\theta + \cos\theta = \frac{2n+1}{2} \Rightarrow \cos\left(\theta - \frac{\pi}{4}\right) = \frac{2n+1}{2\sqrt{2}}$$

$$\Rightarrow \left|\frac{2n+1}{2\sqrt{2}}\right| \le 1 \Rightarrow n = -1, 0$$

$$\therefore \cos\left(\theta - \frac{\pi}{4}\right) = \pm\frac{1}{2\sqrt{2}}$$

69. A

Sol. $\left\{\left[\vec{a}\ \vec{b}\ \vec{c}\right]\vec{b} - \left[\vec{a}\ \vec{b}\ \vec{b}\right]\vec{c}\right\} \times (\vec{c} \times \vec{a}) = 0$

$\Rightarrow \left[\vec{a}\ \vec{b}\ \vec{c}\right]\left((\vec{a}\cdot\vec{b})\vec{c} - (\vec{b}\cdot\vec{c})\vec{a}\right) = 0$

$\Rightarrow \left[\vec{a}\ \vec{b}\ \vec{c}\right] = 0$ (∵ $\vec{a}$ and $\vec{c}$ are not collinear)

70. C

Sol. $m_1 = -\dfrac{2}{3}$; Let one of the lines by y = mx

$$\therefore \tan\left(\frac{\pi}{4}\right) = 1 = \left|\frac{m + \frac{2}{3}}{1 - \frac{2m}{3}}\right| = \left|\frac{3m + 2}{3 - 2m}\right|$$

$\Rightarrow (3 - 2m)^2 = (3m + 2)^2$

$\Rightarrow 9 - 12m + 4m^2 = 9m^2 + 12m + 4$

$\Rightarrow 5m^2 + 24m - 5 = 0$

$\Rightarrow \dfrac{5y^2}{x^2} + \dfrac{24y}{x} - 5 = 0$

$\Rightarrow -5x^2 + 24xy + 5y^2 = 0$

$\Rightarrow 5x^2 - 24xy - 5y^2 = 0$

71. B

Sol. $(x - 8)^2 + (y + 15)^2 = (3)^2 \Rightarrow x = 8 + 3\cos\theta,\ y = -15 + 3\sin\theta$

72. D

Sol. $$S = \lim_{m\to\infty}\sum_{n=1}^{m}\tan^{-1}\left(\frac{9}{9n^2 + 3n + 7}\right) = \lim_{m\to\infty}\sum_{n=1}^{m}\tan^{-1}\left(\frac{1}{1 + n^2 + \frac{n}{3} - \frac{2}{9}}\right)$$

$$= \lim_{m\to\infty}\sum_{n=1}^{m}\tan^{-1}\left(\frac{\left(n + \frac{2}{3}\right) - \left(n - \frac{1}{3}\right)}{1 + \left(n + \frac{2}{3}\right)\left(n - \frac{1}{3}\right)}\right) = \lim_{m\to\infty}\sum_{n=1}^{m}\left[\tan^{-1}\left(n + \frac{2}{3}\right) - \tan^{-1}\left(n - \frac{1}{3}\right)\right]$$

73. A

Sol. $120 = \dfrac{1}{2}\cdot 10\cdot 24\sin A \ \Rightarrow\ A = \dfrac{\pi}{2} \Rightarrow a = 26 \Rightarrow s = 30 \Rightarrow r = 4$

Now, $d = r\ \text{cosec}\left(\dfrac{A}{2}\right)$

74. C

Sol. $R_1 \to \dfrac{R_1}{x},\ R_2 \to \dfrac{R_2}{y},\ R_3 \to \dfrac{R_3}{z}$

$$\therefore\ \Delta = xyz\begin{vmatrix} \frac{x^3 + 1}{x} & y^2 & z^2 \\ x^2 & \frac{y^3 + 1}{y} & z^2 \\ x^2 & y^2 & \frac{z^3 + 1}{z} \end{vmatrix},\ C_1 \to xC_1,\ C_2 \to yC_2,\ C_3 \to zC_3$$

$$\therefore\ \Delta = \begin{vmatrix} x^3+1 & y^3 & z^3 \\ x^3 & y^3+1 & z^3 \\ x^3 & y^3 & z^3+1 \end{vmatrix}$$, $C_1 \to C_1 + C_2 + C_3$ and then $R_2 \to R_2 - R_1$, $R_3 \to R_3 - R_1$ gives

$\Delta = x^3 + y^3 + z^3 + 1 = 37$

$\therefore$ Permutations of (1, 2, 3)

75. C

Sol. Centre of circle is $C\left(r+\frac{5}{4}, 0\right)$. Equation of circle is $\left(x-\left(r+\frac{5}{4}\right)\right)^2 + y^2 = r^2$

Solving with $y^2 = 5x$, we get $\left(x-\left(r+\frac{5}{4}\right)\right)^2 + 5x = r^2$

$\Rightarrow x^2 + \left(\frac{5}{2} - 2r\right)x + \left(\frac{5r}{2} + \frac{25}{16}\right) = 0$, D = 0 $\Rightarrow \left(2r - \frac{5}{2}\right)^2 = 4\left(\frac{5r}{2} + \frac{25}{16}\right)$

76. D

Sol. Sum of digits = 36. Thus number is divisible by 9. For it to be divisible by 36, it should be divisible by 4.

Hence last 2 digits can be 12, 16, 24, 28, 32, 36, 48, 52, 56, 64, 68, 72, 76 or 84

Thus, 14 possibilities $\therefore$ Favourable ways = 14 × 6! $\therefore\ P = \frac{14 \times 6!}{8!}$

77. B

Sol. $T:\ y = mx \pm \sqrt{9m^2+1}\ \therefore\ 2 = \frac{\sqrt{9m^2+1}}{\sqrt{1+m^2}} \Rightarrow m = -\frac{\sqrt{3}}{\sqrt{5}}$

$e = \frac{2\sqrt{2}}{3}\ \therefore\ F\left(2\sqrt{2}, 0\right)$, $RS: y = -\frac{\sqrt{3}}{\sqrt{5}}\left(x - 2\sqrt{2}\right) \Rightarrow \sqrt{5}y + \sqrt{3}x = 2\sqrt{6}$

Let T be foot of perpendicular from O(0, 0) to RS

Then, $OT = \frac{2\sqrt{6}}{2\sqrt{2}} = \sqrt{3}\ \therefore\ R'S' = 2\sqrt{4-3}$

78. C

Sol. $N = {}^9C_2 \cdot {}^{10}C_2$

79. A

Sol. $PQ: \frac{x}{3}\cos\left(\frac{\alpha-\beta}{2}\right) - \frac{y}{2}\sin\left(\frac{\alpha+\beta}{2}\right) = \cos\left(\frac{\alpha+\beta}{2}\right)$

$\Rightarrow \frac{x}{6}\sec\left(\frac{\alpha+\beta}{2}\right) - \frac{y}{2}\tan\left(\frac{\alpha+\beta}{2}\right) = 1$ compare with $T: \frac{x\sec\theta}{a} - \frac{y\tan\theta}{b} = 1$

$\therefore$ a = 6, b = 2

80. D

Sol. $|A| = 3^4$

$|\text{adj}(\text{adj } A)| = ||A|^2 \cdot A| = |A|^8 \cdot |A| = |A|^9$

81. B

Sol. Let $\pi_1 : x - 2y + 2z - 3 = 0$, $\pi_2 : x + y + z + 1 = 0$ (Mirror)

Let $\pi_3 : (x - 2y + 2z - 3) + \lambda(x + y + z + 1) = 0$

$\Rightarrow (\lambda + 1)x + (\lambda - 2)y + (\lambda + 2)z + (\lambda - 3) = 0$

Now, π_2 makes same angle with π_1 and π_3

$$\Rightarrow \cos\theta = \frac{1}{3\sqrt{3}} = \frac{3\lambda+1}{\sqrt{3}\sqrt{(\lambda+1)^2+(\lambda-2)^2+(\lambda+2)^2}} \Rightarrow \lambda = -\frac{2}{3}$$

82. A

Sol. $E = (p+q)' + (p'.q) \Rightarrow p'.q' + p'q = p'.(q'+q) = p'$

83. C

Sol. $9 + a + b = 20 \Rightarrow a + b = 11$ ..... (1)

Also, $\frac{26}{5} = \frac{41+a^2+b^2}{5} - 16 \Rightarrow a^2 + b^2 = 65$ ..... (2)

84. D

Sol. $x + 300 = h\cot\alpha$ ..... (1)

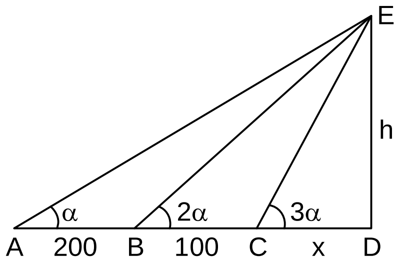
$x + 100 = h\cot 2\alpha$ ..... (2)

$x = h\cot 3\alpha$ ..... (3)

(1) – (3) $\Rightarrow 300 = h(\cot\alpha - \cot 3\alpha)$ ..... (4)

(2) – (3) $\Rightarrow 100 = h(\cot 2\alpha - \cot 3\alpha)$ ..... (5)

$$(4) \div (5) \Rightarrow 3 = \frac{\left(\frac{\cos\alpha}{\sin\alpha} - \frac{\cos 3\alpha}{\sin 3\alpha}\right)}{\left(\frac{\cos 2\alpha}{\sin 2\alpha} - \frac{\cos 3\alpha}{\sin 3\alpha}\right)} = \frac{\sin^2(2\alpha)}{\sin^2\alpha}$$



$\Rightarrow \alpha = \frac{\pi}{6}$ now put in equation (4)

85. B

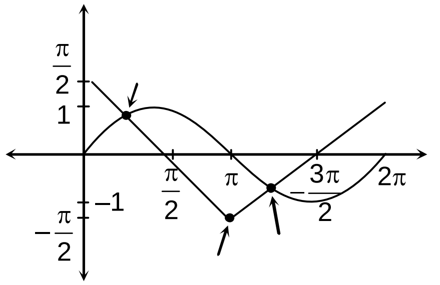
$$\text{Sol.}\quad L = \left(\lim_{x\to 0}\left(\frac{(1+4x+x^2)^{\frac{1}{x}} - e^4}{x}\right)\right) - \left(\lim_{x\to 0}\left(\frac{(1+4x-5x^2)^{\frac{1}{x}} - e^4}{x}\right)\right) = L_1 - L_2$$

$$L_1 = \lim_{x\to 0}\frac{e^{\frac{\ln(1+4x+x^2)}{x}} - e^4}{x} = \lim_{x\to 0}\frac{e^{\frac{1}{x}\left((4x+x^2) - \frac{(4x+x^2)^2}{2} + ...\right)} - e^4}{x}$$

$$= \lim_{x\to 0}\frac{e^4\left(e^{\left(x - \frac{x}{2}(4+x)^2 + ...\right)} - 1\right)}{x} = \lim_{x\to 0} e^4\left(\frac{x - \frac{x}{2}(4+x)^2}{x}\right) = -7e^4 \text{ similarly } L_2 = -13e^4$$

86. D

Sol. Shown in the figure



87. A

Sol. $f'(x) < 0$

$\therefore f(x^3 + f(x)) \le f(-f(x) - x^3)$

$\Rightarrow x^3 + f(x) \ge -f(x) - x^3$

$\Rightarrow f(x) + x^3 \ge 0$

$\Rightarrow 3x^2 + 6x - 1 \le 0$

As $x \in Z$, $x \in \{-2, -1, 0\}$

88. B

Sol. $I = \int \cos(8x + x)\cdot\cos^7 x dx = \int(\cos(8x)\cdot\cos x - \sin(8x)\cdot\sin x)\cdot\cos^7 x dx$

$= \int \cos(8x)\cdot\cos^8 x dx - \int \underbrace{\sin(8x)}_{u}\cdot\underbrace{\sin x\cdot\cos^7 x}_{v} dx$

$= \int \cos(8x)\cdot\cos^8 x dx - \left[-\frac{\sin(8x)\cdot\cos^8 x}{8} + \frac{8}{8}\int\cos(8x)\cos^8 x\, dx\right] = \frac{\sin(8x)\cdot\cos^8 x}{8} + c$

89. C

Sol. $\frac{f(x)}{1+x^2} = 1 + \int_0^x \frac{(f(t))^2}{1+t^2}dt$ differentiating w.r.t. x

$\frac{(1+x^2)f'(x) - 2xf(x)}{(1+x^2)^2} = \frac{f^2(x)}{(1+x^2)} \Rightarrow \frac{1}{y^2}\frac{dy}{dx} - \left(\frac{2x}{1+x^2}\right)\frac{1}{y} = 1$

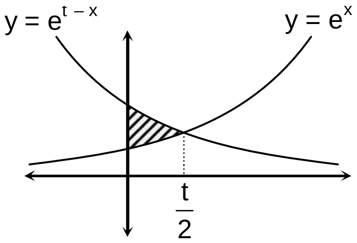
Put $-\frac{1}{y} = t$

$\therefore \frac{dt}{dx} + \left(\frac{2x}{1+x^2}\right)t = 1$, i.f. $= 1 + x^2$

$\therefore$ Solution is $-\frac{(1+x^2)}{y} = x + \frac{x^3}{3} + c$ now $f(0) = 1$

$\therefore c = -1 \Rightarrow y = \frac{-3(1+x^2)}{x^3 + 3x - 3} = f(x)$

90. A



Sol. $S = \int_0^{\frac{t}{2}} (e^{t-x} - e^x)dx = \left|e^{t-x} + e^x\right|_{\frac{t}{2}}^{0} = \left(e^{\frac{t}{2}} - 1\right)^2$

$\therefore \lim_{t\to 0}\frac{S}{t^2} = \lim_{t\to 0}\frac{1}{4}\left(\frac{e^{\frac{t}{2}} - 1}{\frac{t}{2}}\right)^2 = \frac{1}{4}$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VIII

JEE (Advanced)-2019

PAPER – 1

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01– 06, 19 – 24, 37 - 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*

   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 - 46) *contains 12 questions. Based on this section contains* ***TWO (02)*** *paragraphs. Based on each paragraph, there are* ***TWO (02)*** *questions.*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics PART – I

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A particle is projected at an angle $\theta = 30^o$ with the horizontal, with a velocity of 10 m/s then
   (A) After 2 s the velocity of particle makes an angle of 60º with initial velocity vector
   (B) At 1 s the velocity of particle makes an angle of 60º with initial velocity vector
   (C) The magnitude of velocity of particle after 1 s is 10 m/s
   (D) The magnitude of velocity of particle after 1 s is 5 m/s

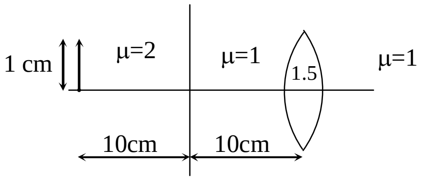
2. An electron in H-atom jumps from second excited state to first excited state and then from first excited to ground state. Let the ratio of wavelength, momentum and energy of photons emitted in these two cases be *a, b* and *c* respectively. Then
   (A) $c = \frac{1}{a}$ (B) $a = \frac{9}{4}$
   (C) $b = \frac{5}{27}$ (D) $c = \frac{5}{27}$

3. If $\vec{A} \times \vec{B} = \vec{C} + \vec{D}$, then select the correct alternative(s).
   (A) $\vec{B}$ is perpendicular to $\vec{C} + \vec{D}$
   (B) $\vec{A}$ is perpendicular to $\vec{C}$
   (C) Component of $\vec{C}$ along $\vec{A}$ = component of $\vec{D}$ along $\vec{A}$
   (D) Component of $\vec{C}$ along $\vec{A}$ = – component of $\vec{D}$ along $\vec{A}$

4. A vibrating string produces 2 beats per seconds when sounded with a tuning fork of frequency 256 Hz. increasing the tension in the string produces 3 beats per second. The initial frequency of the string may have been
   (A) 253 Hz (B) 254 Hz
   (C) 258 Hz (D) 259 Hz

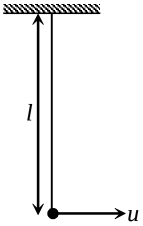
Space for Rough work

5. An object of length 1m is placed on a principle axis of biconvex lens of radius 5 cm. Distance between the lens and object is 20 cm. Space between the lens and object is filled with medium of two different refractive index 2 and 1 as shown in the figure. Refractive index is 1 on the left of the object and on the right side of the lens. Boundary of both medium is mid-way between the object and lens as shown in figure.



(A) The image will be formed at distance of 7.5 cm from the optical centre.
(B) The image will be formed at distance of 10 cm from the optical centre.
(C) The size of the image is 0.5 cm.
(D) The size of the image is 0.4 cm.

6. A particle of mass m is attached to one end of the light inextensible string and other end of the string is fixed in vertical plane as shown. Now particle is given horizontal velocity $u = \sqrt{\frac{5}{2}gl}$, then which of the following statement/s is/are correct.



(A) The string makes angle with the downward vertical is 60^0 when acceleration of the particle is horizontal.
(B) The tension in string is 2 mg when acceleration of the particle is horizontal.
(C) The speed of the particle is $\sqrt{\frac{3}{2}gl}$ when acceleration of the particle is horizontal
(D) The particle will not complete the circle.

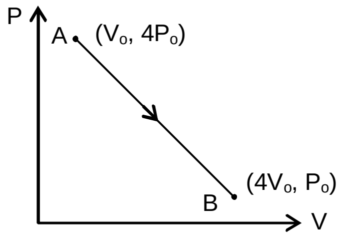
Space for Rough work

(Paragraph Type)

This section contains **TWO** paragraphs. Based on each paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 7 and 8

Consider a monoatomic ideal gas undergoing a process AB as shown in figure.



7. Find the maximum temperature of the gas if temperature at A is T_o.

(A) $\frac{21}{16}T_o$ (B) $\frac{23}{16}T_o$

(C) $\frac{25}{16}T_o$ (D) $\frac{27}{16}T_o$

8. Volume at which the process becomes exothermic from endothermic is

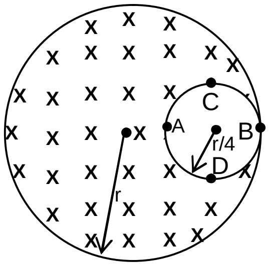
(A) $\frac{19}{8}V_o$ (B) $\frac{21}{8}V_o$

(C) $\frac{23}{8}V_o$ (D) $\frac{25}{8}V_o$

Space for Rough work

Paragraph for Question Nos. 9 and 10

Consider a spherical charge distribution of volume charge density ρ c/m^3



9. Potential difference between A & B

(A) $\frac{2\rho}{3\varepsilon_0}r^2$ (B) 0

(C) $\frac{\rho}{4\varepsilon_0}r^2$ (D) $\frac{\rho r^2}{8\varepsilon_0}$

10. Potential difference between C & D

(A) 0 (B) $\frac{2\rho_r}{3\varepsilon_0}$

(C) $\frac{\rho_r}{4\varepsilon_0}$ (D) none of the above

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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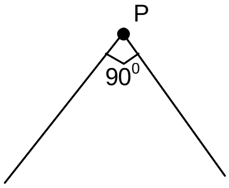
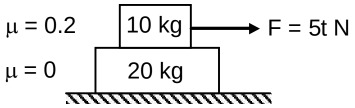
11. A system of two identical rods (L shaped) of mass m, length L. System rest on a peg p as shown in the figure. Period of oscillations $T = 2\pi\sqrt{\frac{n\sqrt{2}\,L}{3g}}$ then n = ?



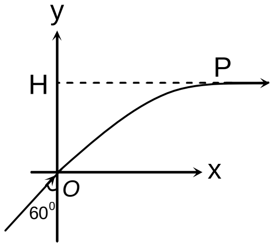
Space for Rough work

12. A monkey of mass m is sitting on a platform of mass M. Monkey can jump with a velocity of 5 m/s making an angle 37^0 with the horizontal with respect to platform. To jump the monkey 1 meter with respect to the ground. Find out the value of m/M.

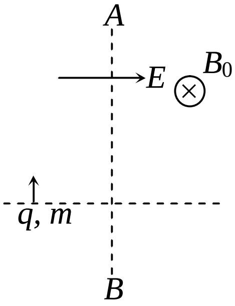
13. What is the speed of 10 kg block at the end of 3 second.



14. A system of coordinates is drawn in a medium whose refractive index varies as $\mu = \frac{2}{1+y^2}$, where $0 \le y \le 1$. A ray of light is incident at origin at an angle 60^0 with y –axis as shown in the figure. At point P ray becomes parallel to x-axis. Find the value of 'H'.



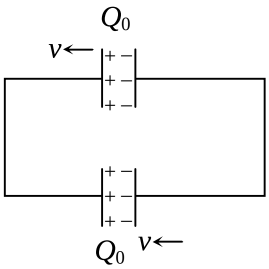
15. A uniform electric field *E* is present horizontally along the paper throughout region but uniform magnetic field B_0 is present horizontally (perpendicular to plane of paper in inward direction) right to the line *AB* as shown. A charge particle having charge *q* and mass *m* is projected vertically upward and crosses the line *AB* after time t_0. The speed of projection if particle moves after t_0 with constant velocity. (given $qE = mg$) is nt_0. Find the value of 'n'. ($g = 9.8\ m/s^2$)



16. The refractive index for water w.r.t. air for a sound wave if the velocities of sound in water and air are 1440 ms^{-1} and 340ms^{-1}, is approximately,

17. When entire Young's double slit apparatus is immersed in a liquid the fringe width decreases by 20%. The refractive index of the liquid is K×0.25. Then find the value of K.

18. Two identical capacitor connected as shown and having initial charge Q_0. Separation between plates of capacitor is d_0. Suddenly the left plate of upper capacitor and right plate of lower capacitor start moving with speed *v* towards left while other plate of capacitor remains fixed. (given $\frac{Q_0 v}{2d}$=1 amp). Find the value of current (in amp) in the circuit.



Space for Rough work

Chemistry PART – II

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. 30 mL of CH_3OH(d = 0.8 g/cc) is mixed with 60 mL of C_2H_5OH (d = 0.92 g/cc) at 25^oC to form a solution of density 0.88 g/cc.
Choose the correct statement(s) from the following.
(A) Molarity of the solution and percentage change in volume are 13.59 and zero respectively.
(B) The mole fraction of solute and molality are 0.385 and 13.59 respectively.
(C) The mole fraction of solvent and molality are 0.615 and 13.59 respectively.
(D) Molarity and molality of resulting solution are 6.33 and 13.59 respectively.

20. Which of the following statement(s) is/are correct for $Na_3[Co(ONO)_6]$?
(A) It's aqueous solution is slightly basic in nature.
(B) It's IUPAC name is sodium hexanitrito cobaltate(III)
(C) It is called sodium cobaltinitrite
(D) One molecule of it forms three ions in water.

21. The total vapour pressure of a binary solution is given by
$P = (80\ X_A + 240\ X_B)$ mm Hg
Where X_A and X_B are the mole fractions of components A and B. Choose the correct statement(s) from the following:
(A) vapour pressure of solution is less than that of the pure B component.
(B) vapour pressure of solution is more than that of pure A component.
(C) vapour pressure of pure A is 80 mm of Hg and that of pure B is 240 mm Hg.
(D) the vapour pressure of pure A and B are 240 and 80 mm Hg respectively.

22. Which of the following cations will turn a borax bead blue in an oxidizing flame?
(A) Fe^{3+} (B) Fe^{2+}
(C) Co^{2+} (D) Cu^{2+}

Space for Rough work

23. Consider the following electrodes with their E^o values:

$E^o_{Cu^{2+}/Cu} = +0.34\,V$, $E^o_{Ni^{2+}/Ni} = -0.25\,V$

$E^o_{Ag^{+}/Ag} = +0.8\,V$, $E_{Zn^{2+}/Zn} = -0.76\,V$

Which of the following reaction(s) is/are spontaneous?

(A) $Cu(s) + Ni^{2+}(aq) \longrightarrow Ni(s) + Cu^{2+}(aq)$

(B) $Cu(s) + 2\,Ag^{+}(aq) \longrightarrow Cu^{2+}(aq) + 2\,Ag(s)$

(C) $Cu(s) + 2H^{+}(aq) \longrightarrow Cu^{2+}(aq) + H_2(g)$

(D) $Zn(s) + 2H^{+}(aq) \longrightarrow Zn^{2+}(aq) + H_2(g)$

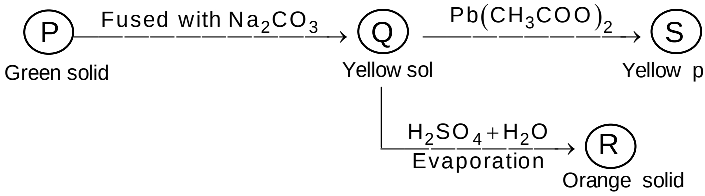
24. Which of the following are intensive properties?

(A) pH
(B) Molarity
(C) Refractive index
(D) Entropy

(Paragraph Type)

This section contains **TWO** paragraphs. Based on each paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 25 and 26



Answer the following questions on the basis of above reaction series.

25. Which of the following is Ⓟ ?

(A) $FeSO_4.7H_2O$
(B) $Cr_2(SO_4)_3$
(C) Anhy.$FeSO_4$
(D) CrO_5

Space for Rough work

26. The yellow solution Ⓠ is

(A) $FeCO_3$ (B) $Cr_2(CO_3)_3$
(C) Na_2CrO_4 (D) Na_4FeO_3

Paragraph for Question Nos. 27 and 28

Activity series	K Na Ca Mg Al Zn Fe Pb H Cu Ag Au

The electrolysis of aqueous solution of an electrolyte is accompanied with deposition of metal or liberation of H_2 gas at cathode. A gas is also liberated at the anode. H_2 gas is liberated if the metal forming the cation of the electrolyte is present above hydrogen in the activity series. The metal will be deposited if it is present below hydrogen in the activity series. The mass of metal deposited at the cathode is directly proportional to the quantity of electricity passed through the electrolyte.

Answer the following questions on the basis of above write up.

27. The electrolysis of which of the following solution liberates H_2 gas at cathode and Cl_2 gas at anode?

(A) $CuCl_2 + H_2O$ (B) $NaCl + H_2O$
(C) $HgCl_2 + H_2O$ (D) $AuCl_3 + H_2O$

28. Which of the following is deposited or liberated at cathode if aqueous solution of potash alum ($K_2SO_4.Al_2(SO_4)_3.24H_2O$) undergoes electrolysis?

(A) K (B) Al
(C) H_2 (D) O_2

Space for Rough work

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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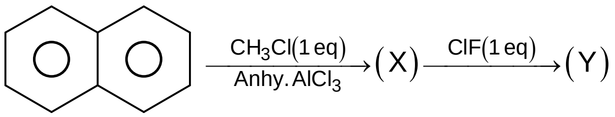
29. An octahedral complex of chromium contains NH_3 and Cl ligands. The oxidation number of chromium in the complex is +3. The complex shows one cis and one trans isomer(no fac or mer isomers). Reaction of the complex with $AgNO_3$ solution forms white precipitate. How much precipitate in gram will be formed if one mole of the complex reacts with excess of $AgNO_3$ solution?

30. HA is a weak acid and NaA is it's salt. An aqueous solution contains HA and NaA in the molar ratio of 10 :1 respectively. The pH of this aqueous solution is 5.38. What is the pK_a of the acid HA?

31. How much heat in Joule unit can be absorbed by heating 4 g of helium gas from 40^oC to 140^oC at constant pressure? $\left[C_P = \frac{5R}{2}\right]$

32. A polychloride(P) reacts with aqueous NaOH to form a monocarboxylic acid(Q). (Q) reduces Tollen's reagents and does not respond to H.V.Z reaction. What is the difference in molar mass between (P) and (Q) in gram unit?

33.


What is the molar mass of (Y) in g unit?

34. At a certain temperature the density of a metal is 1.5 g/cc. due to defect in the solid, the relative number of atoms per unit cell is found to be 0.03. Find the molar mass of the metal in gram unit if the edge length of its unit cell is 1 Å .[N = 6.022 × 10^{23}]

35. One mole of glycol was dissolved in 2 kg water and the resulting solution was cooled to -6^oC. How many gram of ice is separated in the process?
[K_f of H_2O = 1.86 K Kg mol^{-1}]

36. $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$
If above reaction takes place in a 100 L container at 1000 K, 100 moles of CO_2 is produced at equilibrium. What is the equilibrium constant K_P of the reaction in atm unit?

Space for Rough work

]

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. Let z_1, z_2, z_3 be the coordinate of vertices *A*, *B*, *C* of the triangle if $W_1 = z_1 - z_2$, $W_2 = z_3 - z_2$ and $\angle A = 90°$, then

(A) $\text{Re}\left(\frac{W_2}{W_1}\right) = 1$

(B) $\text{Re}(W_1\bar{W}_2) = |W_1|^2$

(C) $\text{Re}(W_1\bar{W}_2) = |W_2|^2$

(D) $\text{Re}\left(\frac{W_1}{W_2}\right) = 1$

38. If $A(\alpha,\beta) = \begin{bmatrix} \cos\alpha & \sin\alpha & 0 \\ -\sin\alpha & \cos\alpha & 0 \\ 0 & 0 & e^{\beta} \end{bmatrix}$, then

(A) $A(\alpha,\beta)' = A(-\alpha, \beta)$

(B) $A(\alpha, \beta)^{-1} = A(-\alpha, -\beta)$

(C) $\text{Adj}(A(\alpha,\beta)) = e^{\beta}A(-\alpha, -\beta)$

(D) $A(\alpha,\beta)' = A(\alpha,-\beta)$

39. If $\int_0^{\alpha} \frac{dx}{1-\cos\alpha\cos x} = \frac{A}{\sin\alpha} + B(a \neq 0)$. Then possible values of A and B are

(A) $A = \frac{\pi}{2}, B = 0$

(B) $A = \frac{\pi}{4}, B = \frac{\pi}{4\sin\alpha}$

(C) $A = \frac{\pi}{6}, B = \frac{\pi}{\sin\alpha}$

(D) $A = \pi, B = \frac{\pi}{\sin\alpha}$

Space for Rough work

40. The solution of the differential equation $\frac{d^2y}{dx^2} = \sin 3x + e^x + x^2$ when $y_1(0) = 1$ and $y(0) = 0$ is

(A) $\frac{-\sin 3x}{9} + e^x + \frac{x^4}{12} + \frac{1}{3}x - 1$

(B) $\frac{-\sin 3x}{9} + e^x + \frac{x^4}{12} + \frac{1}{3}x$

(C) $\frac{-\cos 3x}{3} + e^x + \frac{x^4}{12} + \frac{1}{3}x + 1$

(D) none of these

41. If θ is the angle subtended at $P(x_1, y_1)$ by the circle $S = x^2 + y^2 + 2gx + 2fy + c = 0$, then

(A) $\cot\theta = \frac{\sqrt{S_1}}{\sqrt{g^2 + f^2 - c}}$

(B) $\cot\frac{\theta}{2} = \frac{\sqrt{S_1}}{\sqrt{g^2 + f^2 - c}}$

(C) $\tan\theta = \frac{2\sqrt{g^2 + f^2 - c}}{\sqrt{S_1}}$

(D) $\theta = 2\tan^{-1}\left(\frac{\sqrt{g^2 + f^2 - c}}{\sqrt{S_1}}\right)$

where $S_1 = x_1^2 + y_1^2 + 2gx_1 + 2fy_1 + c$

42. If sines of the angle A and B of a triangle ABC satisfy the equation $c^2x^2 - c(a+b)x + ab = 0$, then the triangle

(A) is acute angled

(B) is right angled

(C) is obtuse angled

(D) satisfies $\sin A + \cos A = \frac{(a+b)}{c}$

Space for Rough work

(Paragraph Type)

This section contains **TWO** paragraphs. Based on each paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 43 and 44

Let $f(x) = 1 + \int_0^1 \left(xe^y + ye^x\right) f(y)\,dy$ when x and y are independent variables.

43. If complete solution set of 'x' for which function $h(x) = f(x) + 3x$ is strictly increasing $(-\infty, k)$ then $\left[\frac{4}{3}e^k\right]$ equals to: (where [.] denotes greatest integer function):

(A) 1 (B) 2
(C) 3 (D) 4

44. If acute angle of intersection of the curve $\frac{x}{2} + \frac{y}{3} + \frac{1}{3} = 0$ and $y = f(x)$ be θ then $\tan\theta$ equals to:

(A) $\frac{8}{25}$ (B) $\frac{16}{25}$
(C) $\frac{14}{25}$ (D) $\frac{4}{5}$

Paragraph for Question Nos. 45 and 46

Consider the function $f(x)$, a fourth degree polynomial such that

$$\lim_{x\to1}\frac{f(x)}{(x-1)^2} = 1,\ f'(0) = -6, f'(2) = 6.$$

45. The minimum value of $f(x)$ is

(A) 0 (B) 1
(C) –1 (D) –2

Space for Rough work

46. The length of subtangent of the curve $y = f(x)$ where it cuts the y – axis is

(A) 1 (B) $\frac{1}{2}$

(C) $\frac{1}{3}$ (D) $\frac{1}{4}$

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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47. Four students appeared in three examinations. The number of possible ways in which we can have result, such that neither any students fails in all the examinations nor there is an examination which is not cleared by any student is k, then find $\frac{k}{100}$

48. If α is a complex seventh root of unity, then the equation whose roots are $\alpha + \alpha^2 + \alpha^4$ and $\alpha^3 + \alpha^5 + \alpha^6$ is $x^2 + x + c = 0$, then $\frac{22c}{7}$ is

49. The straight line $\frac{x}{4} + \frac{y}{3} = 1$ intersects the ellipse $\frac{x^2}{16} + \frac{y^2}{9} = 1$ at two points *A* and *B*, there is a point *P* on this ellipse such that the area of Δ*PAB* is equal to $6(\sqrt{2} - 1)$, the number of such points (*P*) is

50. If the line $3x + 4y = 12$ intersects the hyperbola $\frac{x^2}{16} - \frac{y^2}{4} = 1$ at *P* & P' and its asymptotes at *Q* and *Q'* then value of $\frac{\frac{PQ}{P'Q'} + \frac{PQ'}{P'Q}}{100}$ is

Space for Rough work

51. Let $\vec{b} = 4i + 3j$ and $\vec{c}$ be two vectors perpendicular to each other in the xy – plane. If $\vec{r}_i,\ i = 1, 2, \ldots. n$ are the vectors in the same plane having projection 1 and 2 along b and c respectively $\sum_{i=1}^{n} \left|\vec{r}_i\right|^2$ is equal to k then $\frac{k+20}{3}$ equals to

52. Let f be a continuous function on R such that $f\left(\frac{1}{4n}\right) = \left(\sin e^n\right)e^{-n^2} + \frac{n^2}{n^2+1}$. Then the value of $f(0)$ is

53. If $I = \int_{1/e}^{e} \left|\log x\right| \frac{dx}{x^2}$, then $\frac{I}{4} + \frac{1}{2e} =$______________

54. A bag contain 4 tickets numbered 1, 2, 3, 4 and another bag contains 6 tickets numbered 2, 4, 6, 7, 8, 9. One bag is chosen and a ticket is drawn. The probability that the ticket bears the number 4, is equal to $\frac{A}{B}$ (where A and B are co prime) then the value of $\frac{100A}{B}$ is

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VIII

JEE (Advanced)-2019

PAPER – 1

ANSWERS, HINTS & SOLUTIONS

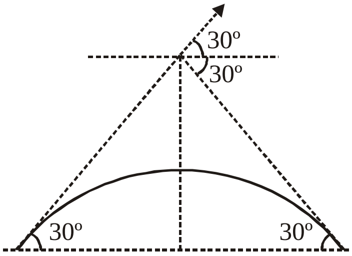
Physics

PART – I

SECTION – A

1. BC

Sol. $T = \frac{2u\sin\theta}{g} = \frac{2\times 10\times \frac{1}{2}}{10} = 1s$.



2. ACD

Sol. As $\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$ and $P = \frac{h}{\lambda}$

Also, $E = \frac{hc}{\lambda}$

3. AD

Sol. $\because\ \vec{B} \perp (\vec{A}\times\vec{B})$

$\vec{A}.\left(\vec{C}+\vec{D}\right) = 0$, $\vec{A}.\,\vec{C} + \vec{A}.\vec{D} = 0$

Component of $\vec{C}$ along $\vec{A}$ =– component of $\vec{D}$ along $\vec{A}$

4. BC

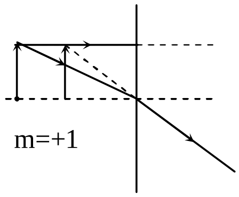
Sol. $\left|f - 256\right| = 2Hz$

$f = (256 \pm 2)\text{Hz} = (254)\text{Hz or } (258)\text{Hz}$

If tension increases, then f' may be 259 Hz.

5. AC

Sol. Apparent position of the object wrt lens.



$$u = \left(\frac{10}{1} + \frac{10}{2}\right) = 15\,\text{cm}$$

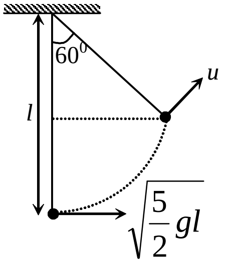
$$\frac{1}{15} + \frac{1}{v} = \frac{2(1.5) - 1}{R}$$

$v = 7.5$ cm

Image size = $\frac{7.5}{15} \times 1 = 0.5$ cm

6. ABCD

Sol. $T - mg\cos 60^0 = \frac{mv^2}{l}$ … (i)



$$\frac{1}{2}m\left(\sqrt{\frac{5}{2}gl}\right)^2 - mg\frac{l}{2} = \frac{1}{2}mv^2 \quad \text{… (ii)}$$

$v = \sqrt{\frac{3}{2}gl}$ and $T = 2mg$

Net force is in horizontal direction when $\theta = 60^0$

7. C

Sol. $P = 5P_o - \frac{P_o V}{V_o}$

$$T = \frac{1}{nR}\left(5P_o V - \frac{P_o V^2}{V_o}\right)$$

$$\frac{dT}{dV} = \frac{1}{nR}\left(5P_o - \frac{2P_o V}{V_o}\right) = 0$$

$\Rightarrow V = \frac{5V_o}{2}$ at maximum temperature.

$\Rightarrow T_{max} = \frac{25}{16}T_o$

8. D

Sol. $\frac{dQ}{ndT} = C_v + \frac{P}{n}\frac{dV}{dT} = 0$

$$C_V + \frac{\left(5P_o - \frac{P_o V}{V_o}\right)}{n} \cdot \frac{nR}{\left(5P_o - \frac{2P_o V}{V_o}\right)} = 0$$

$$\frac{\left(5-\frac{V}{V_o}\right)}{\left(5-\frac{2V}{V_o}\right)}=-\frac{3}{2} \qquad \Rightarrow V = \frac{25}{8}V_o$$

9. D

Sol. $E=\frac{\rho}{4\varepsilon_o}r$

$V_{AB} = E\times\frac{r}{2}$

10. A

Sol. V_{CD} = Er cos 90° = 0

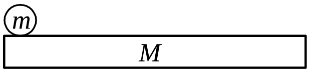
SECTION – D

11. 00002.00

Sol. $X_{cm}=\frac{\ell}{2\sqrt{2}}, I=2m\frac{\ell^2}{3}$

$T=2\pi\sqrt{\frac{I}{2mgcm}}=2\pi\sqrt{\frac{2\sqrt{2}\ell}{3g}}$

12. 00001.40



Sol. $V_{mM}=4\hat{i}+3\hat{j}$

$V_m=u\hat{i}+3\hat{j}$

$V_M=-V\hat{i}$

Here, along horizontal direction $mV_m+MV_M=0$

$\Rightarrow \quad V=\frac{um}{M}=u\eta$ and $u+V=4\Rightarrow u=\frac{4}{1+\eta}$

To move one meter w.r.t. ground

$$1=\frac{2\times\frac{4}{1+\eta}\times 3}{g}\Rightarrow 1+\eta=\frac{24}{g} \text{ or } \eta=\frac{14}{10}=1.40$$

13. 00000.75

Sol. $(Fs)_{max}$ = 20 N. a_{max} of 20 kg black = 1 m/s^2

∴ both black move together till 6 sec.

$\therefore \frac{dv}{dt}=\frac{5t}{30} \Rightarrow \int dv=\frac{1}{6}\frac{t^2}{2}$; $V=\frac{3^2}{12}=\frac{9}{12}$ = 0.75 m/s

14. 00000.39

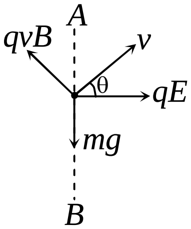
Sol. Applying Snell's law between the points *O* and *P*, we have

$$2\times\sin 60^0=\left(\sin 90^0\right)\times\frac{2}{\left(1+H^2\right)}, \quad 2\times\frac{\sqrt{3}}{2}=1\times\frac{2}{\left(1+H^2\right)}$$

$$\left(1+H^2\right)=\frac{2}{\sqrt{3}},\quad H=\sqrt{\left(\frac{2}{\sqrt{3}}-1\right)}$$

15. 00019.60

Sol. When crosses *AB*



$$qvB_0\cos\theta=mg$$

$$qvB_0\ \sin\theta = qE$$

$$\tan\theta=\frac{qE}{mg}=1$$

$$\theta=\frac{\pi}{4}$$

along horizontal $v\cos\theta=\frac{qE}{m}t_0$

$$u-gt_0=v\sin\theta$$

$$u=\left(g+\frac{qE}{m}\right)t_0\quad = 2gt_0$$

16. 00000.23

Sol. $\mu=\frac{\text{velocity in air}}{\text{velocity in medium}}$

17. 00005.00

Sol. $W=\frac{D\lambda}{d}, W'=\frac{D}{d}\left(\lambda-\frac{\lambda}{5}\right)\quad\Rightarrow W'=\frac{D}{d}\frac{\lambda}{5/4}$

18. 00002.00

Sol. $\frac{q_1}{C_1}=\frac{q_2}{C_2}$ **;** $q_1+q_2=2Q_0$

$$C_1=\frac{\varepsilon_0 A}{d_0+vt};\ C_2=\frac{\varepsilon_0 A}{d_0-vt}$$

$$\frac{q_1}{q_2}=\frac{d_0-vt}{d_0+vt}$$

$$q_2\left(\frac{d_0-vt}{d_0+vt}\right)+q_2=2Q_0$$

$$q_2\left[\frac{2d_0}{d_0+vt}\right]=2Q_0$$

$$q_2=\frac{2Q_0}{2d_0}\left(d_0+vt\right)$$

$$I=\frac{dq_2}{dt}=\frac{Q_0v}{d_0}= 2\text{ amp}$$

Chemistry

PART – II

SECTION – A

19. BC

Sol. V_{CH_3OH} = 30 mL
d = 0.8 g/cc
W = 0.8 × 30 = 24 g
n = $\frac{24}{32}$ = 0.75

$V_{C_2H_5OH}$ = 60 mL
d = 0.92 g/cc
W = 60 × 0.92 = 55.2 g
n = $\frac{55.2}{46}$ = 1.2

Total moles = 0.75 + 1.2 = 1.95
Solute = CH_3OH, Solvent = C_2H_5OH

Molarity = 0.75 × $\frac{1000}{90}$ = 8.33

Molality = 0.75 × $\frac{1000}{55.2}$ = 13.59

Mole fraction of solute (CH_3OH) = $\frac{0.75}{1.2+0.75}$ = 0.385

Mole fraction of solvent (C_2H_5OH) = 1 - 0.385 = 0.615

20. ABC

Sol. $Na_3\left[Co(ONO)_6\right] \xrightarrow{H_2O} 3Na^+ + \left[Co(ONO)_6\right]^{3-}$

$\left[Co(ONO)_6\right]^{3-} + H_2O \longrightarrow H\left[Co(ONO)_6\right]^{2-} + OH^-$

The IUPAC name of the ligand is nitrito.

21. ABC

Sol. For option (A)
$P = 80X_A + 240\ X_B$
$= 80\ X_A + 240\ (1 - X_A)$
$= 80\ X_A + 240 - 240\ X_A$
$= 240 + X_A(80 - 240)$
$= 240 – 160\ X_A$
∴ V.P of solution is less than 240 mm Hg which is V.P of pure(B)
For option (B)
$P = 80X_A + 240\ X_B$
$= 80(1 – X_B) + 240\ X_B$
$= 80 – 80\ X_B + 240\ X_B$
$= 80 + (240 – 80)X_B = 80 + 160\ X_B$
∴ V.P of solution is more than 80 mm Hg which is the V.P of pure(A)
For option (C)
$P = 80X_A + 240X_B$
For pure (A), $X_A = 1$ and $X_B = 0$
V.P of pure (A) = 80 mm Hg
Similarly
∴ V.P of pure (B) = 240 mm Hg.

22. CD

Sol. $Co(BO_2)_2$ and $Cu(BO_2)_2$ are blue substances.

23. BD

Sol. Metals having higher reduction potentials are reduced in presence metals having lower reduction potentials.

24. ABC

Sol. If a solution is prepared with a fixed pH or molarity, it maintains its characteristics whatever amount of it, are used.
Refractive index is fixed for any substance and is mass independent.

25. B

Sol. P = $Cr_2(SO_4)_3$, Q = Na_2CrO_4, R = $Na_2Cr_2O_7$, S = $PbCrO_4$

26. C

Sol. P = $Cr_2(SO_4)_3$, Q = Na_2CrO_4, R = $Na_2Cr_2O_7$, S = $PbCrO_4$

27. B

Sol. At cathode: $2H_2O + 2e \longrightarrow H_2 + 2OH^-$

At anode: $2Cl^- \longrightarrow Cl_2 + 2e$

Among the given electrolytes only sodium is present above hydrogen in the activity series. Hence aqueous NaCl should be electrolysed. Other metals like Cu, Hg and Au are present below hydrogen in the activity series.

28. C

Sol. At cathode: $2H_2O + 2e \longrightarrow H_2 + 2OH^-$

At anode: $2H_2O \longrightarrow O_2 + 4H^+ + 4e^-$

Since K and Al are present above hydrogen in the activity series, H_2 gas will be liberated at the cathode and O_2 at the anode.

SECTION – D

29. 00143.50

Sol. The complex is $[Cr(NH_3)_4Cl_2]Cl$
$\therefore$ Mole of AgCl formed = 1
Mass of AgCl = 143.50 g

30. 00006.38

Sol. $\text{pH} = \text{p}K_a + \log\frac{[\text{NaA}]}{[\text{HA}]}$

or, $5.38 = \text{p}K_a + \log\frac{1}{10}$

$\therefore \text{p}K_a = 5.38 + 1 = 6.38$

31. 02078.50

Sol. $\Delta H = nC_P\Delta T$

$= \frac{4}{4} \times \frac{5}{2} \times 8.314 \times (140 - 40) = 2078.5$ J

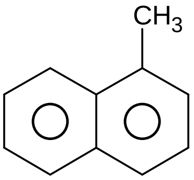
32. 00073.50

Sol. P = $CHCl_3$(Molar mass = 119.5)
Q = HCOOH(molar mass = 46)
$\therefore$ P – Q = 119.5 – 46 = 73.5

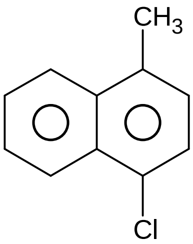
33. 00176.50

Sol.

X =



, Y =



34. 00030.11

Sol. $d = \frac{Z \times A}{N \times a^3} \Rightarrow 1.5 = \frac{0.03 \times A}{6.022 \times 10^{23} \times \left(10^{-8}\right)^3}$

On solving A = 30.11

35. 01690.00

Sol. $\Delta T_f = K_f \times m = K_f \times \frac{w}{M} \times \frac{1000}{W}$

or, $0 - (-6) = 1.86 \times 1 \times \frac{1000}{W}$

On solving W = 310 g

$\therefore$ Mass of ice = 2000 – 310 = 1690.00 g

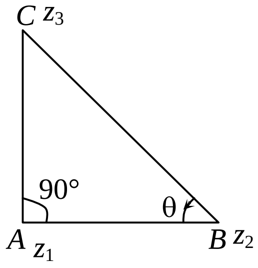
36. 00082.10

Sol. $P = \frac{nRT}{V} = \frac{100 \times 0.0821 \times 1000}{100} = 82.1\,\text{atm}$

Mathematics PART – III

SECTION – A

37. AB



Sol. $\frac{W_2}{|W_2|} = \frac{W_1}{|W_1|}e^{-i\theta}$

$\Rightarrow \quad \frac{W_2}{W_1} = \frac{|W_2|}{|W_1|}e^{-i\theta} = 1 - i\tan\theta$

$W_1\overline{W}_2 = \frac{W_1}{W_2}|W_2|^2 = |W_1|\;|W_2|e^{i\theta} = \left(|W_1|^2 + i|W_1|\;|W_2|\tan\theta\right)$

38. ABC

Sol. We have $A(\alpha,\beta)' = \begin{bmatrix} \cos\alpha & -\sin\alpha & 0 \\ \sin\alpha & \cos\alpha & 0 \\ 0 & 0 & e^{\beta} \end{bmatrix}$

$= \begin{bmatrix} \cos(-\alpha) & \sin(-\alpha) & 0 \\ -\sin(-\alpha) & \cos(-\alpha) & 0 \\ 0 & 0 & e^{\beta} \end{bmatrix} = A(-\alpha, \beta)$

Also, $A(\alpha,\beta)A(-\alpha,-\beta)$

$= \begin{bmatrix} \cos\alpha & \sin\alpha & 0 \\ -\sin\alpha & \cos\alpha & 0 \\ 0 & 0 & e^{\beta} \end{bmatrix}\begin{bmatrix} \cos\alpha & -\sin\alpha & 0 \\ \sin\alpha & \cos\alpha & 0 \\ 0 & 0 & e^{-\beta} \end{bmatrix}$

$= I$

$\Rightarrow A(\alpha,\beta)^{-1} = A(-\alpha, -\beta)$

Next, $\text{Adj}(\alpha,\beta) = |A(\alpha,\beta)|A(\alpha, \beta)^{-1}$

$= e^{\beta}A(-\alpha, -\beta)$

39. AB

Sol. $I = \int_0^{\alpha} \frac{dx}{1-\cos\alpha\cos x}$

$= \int_0^{\alpha} \frac{dx}{\left(\cos^2\frac{x}{2} + \sin^2\frac{x}{2}\right) - \cos\alpha\left(\cos^2\frac{x}{2} - \sin^2\frac{x}{2}\right)}$

$= \int_0^{\alpha} \frac{dx}{(1-\cos\alpha)\cos^2\frac{x}{2} + (1+\cos\alpha)\sin^2\frac{x}{2}}$

$= \int_0^{\alpha} \frac{dx}{2\sin^2\frac{\alpha}{2}\cos^2\frac{x}{2} + 2\cos^2\frac{\alpha}{2}\sin^2\frac{x}{2}}$

$$=\frac{1}{2}\int_0^{\alpha}\frac{\left(\sec^2\frac{\alpha}{2}\right)\sec^2\frac{x}{2}}{\tan^2\frac{\alpha}{2}+\tan^2\frac{x}{2}}dx$$

Put $\tan\frac{x}{2}=t,$ we have

$$I=\int_0^{\tan\frac{\alpha}{2}}\frac{\sec^2\frac{\alpha}{2}dt}{t^2+\tan^2\frac{\alpha}{2}}$$

$$=\sec^2\frac{\alpha}{2}\cot\frac{\alpha}{2}\left[\tan^{-1}\left(\frac{t}{\tan\frac{\alpha}{2}}\right)\right]_0^{\tan\frac{\alpha}{2}}$$

$$=\frac{2}{\sin\alpha}.\frac{\pi}{4}=\frac{\pi}{2\sin\alpha}$$

Thus $\frac{A}{\sin\alpha}+B=\frac{\pi}{2\sin\alpha}.A=\frac{\pi}{2}, B=0$ and $A=\frac{\pi}{4},$

$B=\frac{\pi}{4\sin\alpha}$ satisfy the last equation.

40. A

Sol. Integrating the given differential equation, we have $\frac{dy}{dx}=\frac{-\cos 3x}{3}+e^x+\frac{x^3}{3}+C_1$ but

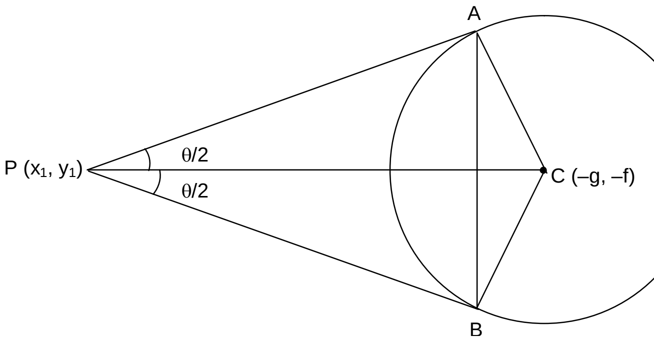
$y_1(0)=1$ so $1=\left(\frac{-1}{3}\right)+1+C_1\Rightarrow C_1=\frac{1}{3}.$

Again integrating, we get $y=\frac{-\sin 3x}{9}+e^x+\frac{x^4}{12}+\frac{1}{3}x+C_2$

but $y(0)=0$ so $0=0+1+C_2\Rightarrow C_2=-1.$ Thus $y=\frac{-\sin 3x}{9}+e^x+\frac{x^4}{12}+\frac{1}{3}x-1$

41. BD

Sol. Let PA and PB be the tangents from $P(x_1,y_1)$ to the given circle with centre $C(-g-f)$, such that $\angle APB=\theta$. Then $\angle APC=\frac{\theta}{2}$ (Figure). Therefore, from $\Delta PAC,$ we get



$$\cot\frac{\theta}{2}=\frac{PA}{AC}=\frac{\sqrt{S_1}}{\sqrt{g^2+f^2-c}}$$

$$\Rightarrow \tan\frac{\theta}{2} = \frac{\sqrt{g^2 + f^2 - c}}{\sqrt{S_1}}$$

$$\Rightarrow \theta = 2\tan^{-1}\left(\frac{\sqrt{g^2 + f^2 - c}}{\sqrt{S_1}}\right)$$

42. BD

Sol. $\sin A + \sin B = \frac{a+b}{c} = \frac{\sin A + \sin B}{\sin C} \Rightarrow \sin C = 1$

$\Rightarrow C = 90^o$

$A + B = 90^o \Rightarrow \cos A = \sin B$

43. C

Sol. $f(x) = 1 + x\int_0^1 e^y f(y)dy + e^x\int_0^1 y f(y)dy$

Let $A = \int_0^1 e^y f(y)dy,\ B = \int_0^1 y f(y)dy$

$\Rightarrow f(x) = 1 + Ax + Be^x \Rightarrow A = \int_0^1 e^x(1 + Ay + Be^y)dy$

$B = -\frac{2}{e+1}, A = -\frac{3}{2}$

$f'(x) + 3 > 0$

$\Rightarrow -\frac{3}{2} - \frac{2e^x}{(e+1)} + 3 > 0 \Rightarrow e^x < \frac{3(e+1)}{4} \Rightarrow \left[\frac{4}{3}e^x\right] = [e+1] = 3$

44. A

Sol. $Ax_1 + Be^{x_1} = -\frac{3x_1}{2} - 2 \Rightarrow Be^{x_1} = -2$

$f'(x_1) = A + Be^{x_1} = m_1$

$m_1 = -\frac{3}{2} - 2 = -\frac{7}{2}$

$m_2 = -\frac{3}{2}$

$\tan\theta = \frac{8}{25}$

45. A

Sol. $\lim_{x\to1}\frac{f(x)}{(x-1)^2} = 1$

$\Rightarrow\ f(1) = 0,\ f'(1) = 0,\ f''(1) = 2$

$\therefore\ f(x) = A(x-1)^4 + B(x-1)^3 + (x-1)^2$

$f'(x) = 4A(x-1)^3 + 3B(x-1)^2 + 2(x-1)$

$f'(0) = -6 \Rightarrow -4A + 3B - 2 = -6$ …….(i)

$f'(2) = 6 \Rightarrow 4A + 3B + 2 = 6$ …….(ii)

(i), (ii) $\Rightarrow A = 1, B = 0$

$\therefore\ f(x) = (x-1)^4 + (x-1)^2 \geq 0$

$f(1) = 0$ is the minimum.

46. C

Sol. $f(x) = (x-1)^4 + (x-1)^2$, $f'(0) = -6$, $f(0) = 2$

$f'(x) = 4(x-1)^3 + 2(x-1)$

Subtangent at $x = 0$ is $\left|\frac{f(0)}{f'(0)}\right| = \frac{2}{6} = \frac{1}{3}$

SECTION – D

47. 00021.61

Sol. The number of ways when no student failed in any examination $= (2^3 - 1)^4$

The number of ways when out of above cases atleast one subject was not cleared by any students $= 3C_1(3)^4$

The number of ways when out of above cases atleast any two subjects were not cleared by any student $= 3C_2(1)^4$. So required cases $= (2^3-1)^4 - 3C_1 3^4 + 3C_2$ = 2161

48. 00006.28

Sol. $S = \alpha + \alpha^2 + \alpha^4 + \alpha^3 + \alpha^5 + \alpha^6 = -1$

$P = (\alpha + \alpha^2 + \alpha^4)(\alpha^3 + \alpha^5 + \alpha^6)$

$= \alpha^4 + \alpha^5 + \alpha^7 + \alpha^6 + \alpha^7 + \alpha^9 + \alpha^7 + \alpha^8 + \alpha^{10}$

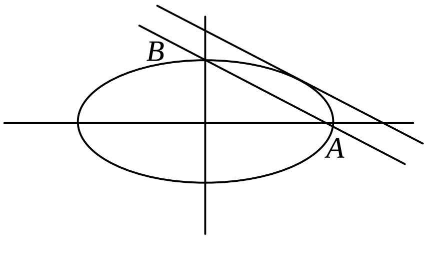
$= 3 + \alpha^4 + \alpha^5 + \alpha^6 + \alpha^2 + \alpha^1 + \alpha^3$

$= 3 - 1 = 2$

$\therefore$ c = 2

49. 00003.00

Sol. Let perpendicular distance of *P* from the line be *h*



$\frac{1}{2} \times h \times 5 = 6(\sqrt{2} - 1)$ (as $\Delta PAB = 6(\sqrt{2} - 1)$)

$\Rightarrow\quad h = \frac{12(\sqrt{2} - 1)}{5}$

Now distance of tangent parallel to *AB* i.e.

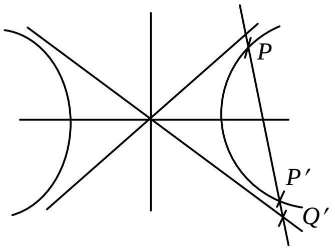
$4y + 3x = 12\sqrt{2}$, from line *AB* is $\frac{12(\sqrt{2} - 1)}{5}$.

There are just three such points.

50. 00000.02

Sol. For any line in case of hyperbola we know that $PQ = P'Q'$

$$\frac{PQ}{P'Q'} + \frac{PQ'}{P'Q} = 1 + \frac{PP' + P'Q'}{PP' + PQ} = 2$$



51. 00013.33

Sol. Let $\vec{r} = \lambda\vec{b} + \mu\vec{c}$ and $\vec{c} = \pm(xi + yj)$. Since $\vec{c}$ and $\vec{b}$ are perpendicular, we have

$$4x + 3y = 0 \qquad \Rightarrow \quad \vec{c} = \pm x\left(i - \frac{4}{3}j\right)$$

$$\pm 1 = \text{ proj. of } \vec{r} \text{ on } \vec{b} = \frac{\vec{r}.\vec{b}}{|\vec{b}|} = \frac{(\lambda\vec{b} + \mu\vec{c}).\vec{b}}{|\vec{b}|} = \frac{\lambda\vec{b}.\vec{b}}{|\vec{b}|}$$

$$\left[\because \vec{b}.\vec{c} = 0\right]$$

$= \lambda|\vec{b}| = 5\lambda$. Hence $\lambda = \pm\frac{1}{5}$

Also, $\pm 2 = \text{proj. of } \vec{r} \text{ on } \vec{c} = \frac{\vec{r}.\vec{c}}{|\vec{c}|}$

$$= \frac{(\lambda\vec{b} + \mu\vec{c}).\vec{c}}{|\vec{c}|} = \mu|\vec{c}| = \frac{5}{3}\mu x$$

Thus, $\mu x = \pm\frac{6}{5}$. Therefore,

$$\vec{r} = \frac{1}{5}(4i + 3j) + \frac{6}{5}\left(i - \frac{4}{3}j\right) = \pm(2i - j)$$

$$\vec{r} = \frac{1}{5}(4i + 3j) - \frac{6}{5}\left(i - \frac{4}{3}j\right) = \pm\left(-\frac{2}{3}i + \frac{11}{5}j\right)$$

Thus there are four such vectors

$$\sum_{i=1}^{4}|\vec{r}_i|^2 = 2|2i - j|^2 + 2\left|-\frac{2}{5}i + \frac{11}{5}j\right|^2 = 20$$

52. 00001.00

Sol. As f is continuous so $f(0) = \lim_{x\to 0} f(x) = \lim_{n\to\infty} f(x_n)$ for any sequence x_n such that

$$\lim_{n\to\infty} x_n = 0. \text{ Thus } f(0) = \lim_{n\to\infty} f\left(\frac{1}{4n}\right) = \lim_{n\to\infty}\left((\sin e^n)e^{-n^2} + \frac{1}{1 + \frac{1}{n^2}}\right) = 0 + 1 = 1$$

$$\left(\lim_{n\to\infty}(\sin e^n)e^{-n^2} = 0 \text{ as } \left|(\sin e^n)e^{-n^2}\right| \le e^{-n^2} \text{ and } e^{-n^2} \to 0 \text{ as } n \to \infty\right)$$

53. 00000.50

Sol. Put $\frac{1}{x} = t$, so that $I = \int_{1/e}^{e} \left|\log x\right|\left(-1\right)dt$

$= \int_{e}^{1/e} \left|\log\frac{1}{t}\right|\left(-1\right)dt$

$= \int_{1/e}^{e} \left|-\log t\right| dt$

$= \int_{1/e}^{1} \left(-\log t\right)dt + \int_{1}^{e} \left(\log t\right)dt$

$= \left(-t\ \log t + t\right]_{1/e}^{1} + \left(t + \log t - t\right]_{1}^{e}$

$= 1 - \frac{1}{e} - \frac{1}{e} + e - e + 1$

$= 2\left(1 - \frac{1}{e}\right)$

54. 00020.83

Sol. E_1 : First bag is chosen, $P\left(E_1\right) = \frac{1}{2}$.

E_2 : Second bag is chosen, $P\left(E_2\right) = \frac{1}{2}$.

A : Drawn number is 4.

Now, $P\left(A\right) = P\left(E_1\right).P\left(\frac{A}{E_1}\right) + P\left(E_2\right).P\left(\frac{A}{E_2}\right)$

$= \frac{1}{2}.\frac{1}{4} + \frac{1}{2}.\frac{1}{6} = \frac{5}{24}$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VIII

JEE (Advanced)-2019

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01 – 06, 19 – 24, 37 – 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*

   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 – 46) *contains 12 questions. Each question has* ***TWO (02)*** *matching lists:* ***LIST-I*** *and* ***LIST-II***. ***FOUR*** *options are given representing matching of elements from* ***LIST-I*** *and* ***LIST-II***. ***ONLY ONE*** *of these four options corresponds to a correct matching.*
   For each question, choose the option corresponding to the correct matching.
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics PART – I

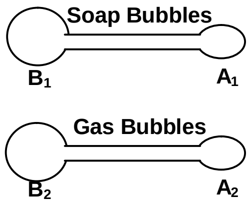
SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. Two pendulums of same amplitude but time period 3s and 7s start oscillating simultaneously from two opposite extreme positions. After how much time they will be in phase?

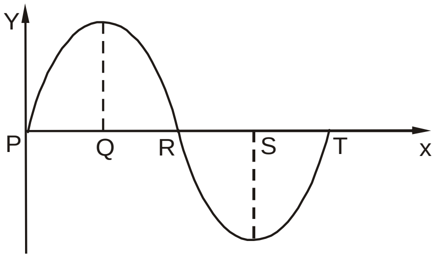
(A) $\frac{21}{8}$s
(B) $\frac{21}{4}$s
(C) $\frac{21}{2}$s
(D) $\frac{63}{8}$s

2. A_1 and B_1 are two bubbles joined by a thin tube, similarly A_2 and B_2 are rubber balloons filled with air joined by another thin tube (Fig shows the situation) As time progress _____choose the correct statement (A_1 and A_2 are smaller in volume, then B_1 and B_2 respectively).



(A) A_1 will shrink : B_2 will shrink
(B) A_1 will shrink : A_2 will expand
(C) A_1 will expand : B_2 will shrink
(D) A_1 will expand : B_2 will expand

3. A sound wave is traveling along positive *x*-direction. Displacement (*y*) of particles from their mean positions at any time *t* is shown in the figure.



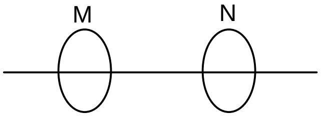
(A) Particle located at S has zero velocity.
(B) Particle located at T has its velocity in the negative direction.
(C) Change in pressure at S is zero
(D) Particles located near R are under compression.

Space for Rough work

4. A convex lens made of glass (μ_g =3/2) has focal length f in air. The image of an object placed in front of it is inverted real and magnified. Now the whole arrangement is immersed in water (μ_w=4/3) without changing the distance between object and lens. Then
(A) the new focal length will become $4f$
(B) the new focal length will become $f / 4$
(C) new image will be virtual and magnified
(D) new image will be real, inverted and smaller in size

5. If the potential difference of Coolidge tube producing X-ray is increased, then choose the correct option(s).
(A) the interval between $\lambda_{k\alpha}$ and $\lambda_{k\beta}$ increases
(B) the interval between $\lambda_{k\alpha}$ and λ_0 increases
(C) the interval between $\lambda_{k\beta}$ and λ_0 increases
(D) λ_0 does not change
Here λ_0 is cutoff wavelength and $\lambda_{k\alpha}$ and λ_{kB} are wavelength of k_α and k_B characteristic X-rays.

6. Two identical circular coils M and N are arranged coaxially as shown in the figure. Separation between the coils is large as compared to their radii. The arrangement is viewed from left along the common axis. The sign convention adopted is that currents are taken to be positive when they appear to flow in clockwise direction. Then



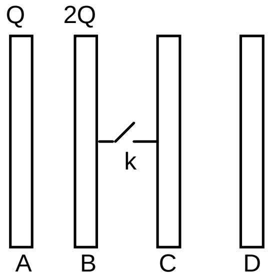
(A) if M carries a constant positive current and is moved towards N, a positive current is induced in N
(B) if M carries a constant positive current and N is moved towards M, a negative current is induced in N
(C) if a positive current in M is switched off, a positive current is momentarily induced in N
(D) if both coils carry positive currents, they will attract each other

Space for Rough work

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

7. Read the following and write the correct pairs.
Initially, the two plates (A and B) are given charges as shown. Find the final charges on the plates after the key k is closed. All plates are conducting, parallel and of infinite length and breadth.



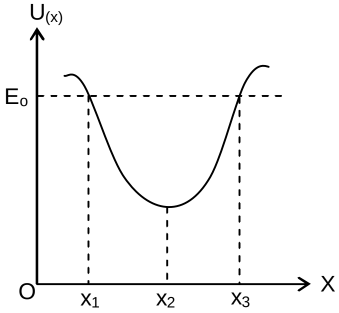
List-I		List-II	
(P)	Final charge on plate A	(1)	Q/2
(Q)	Final charge on plate B	(2)	Q
(R)	Final charge on plate C	(3)	0
(S)	Final charge on plate D	(4)	3Q/2

Codes:

(A) P–2, Q–1, R–4, S–3 (B) P–2, Q–4, R–1, S–3

(C) P–3, Q–1, R–4, S–2 (D) P–2, Q–3, R–2, S–4

8. The potential energy of a particle moving along x-axis is show in figure. Where E_o is the total mechanical energy of the particle.



List-I		List-II	
(P)	Force on the particle is towards +ve x-axis if	(1)	$x_1 < x < x_2$
(Q)	Particle can't be found where	(2)	$x_2 < x < x_3$
(R)	Force is towards the equilibrium position if	(3)	$x < x_1$, $x > x_3$
(S)	Force is towards the –ve x-axis if	(4)	$x_2 > x$
		(5)	$x_1 < x < x_3$

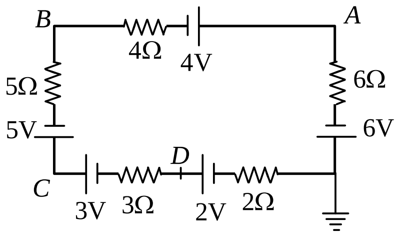
Codes:

(A) P–2, Q–1, R–3,4, S–2,3 (B) P–1,4, Q–3, R–1,2 4,5, S–2

(C) P–2,3, Q–3, R–1,4, S–2,3 (D) P–2,3,4, Q–1, R–2, S–2,4

Space for Rough work

9. Five batteries whose emf and internal resistance are as shown in figure. Match the following



List–I		List–II	
(P)	Potential of point *A*	(1)	– 5V
(Q)	Potential of point *B*	(2)	1 V
(R)	Potential of point *C*	(3)	– 3V
(S)	Potential of point *D*	(4)	2.5V
		(5)	1.5 V

Codes:

(A) P–3, Q–4, R–3, S–1
(B) P–2, Q–4, R–1, S–3
(C) P–3, Q–1, R–4, S–2
(D) P–2, Q–3, R–2, S–4

10. The speed (v) of a particle of mass 1 kg moving along a straight line, when it is at a distance (x) from a fixed point on the line, is given by, $v^2 = 144 - 9x^2$. Match the following:

List–I		List–II	
(P)	Motion is simple harmonic with time period	(1)	$2\pi/3$ units
(Q)	Max. displacement from the fixed point is	(2)	27 units
(R)	Magnitude of acceleration at a distance 3 units from the fixed point is	(3)	4 units
(S)	Potential energy at a distance x = 2 unit from fixed point is	(4)	2 units
		(5)	18 units

Codes:

(A) P–1, Q–4, R–2, S–3
(B) P–1, Q–3, R–5, S–2,5
(C) P–3, Q–1, R–2, S–5
(D) P–1, Q–3, R–2, S–5

Space for Rough work

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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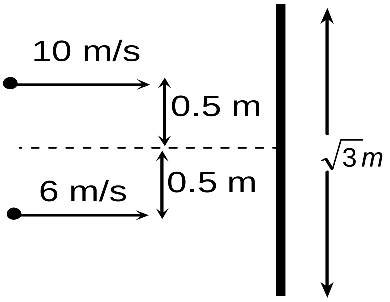
11. Gravitational acceleration on the surface of a planet is $\frac{\sqrt{6}}{11}g$, where g is the gravitational acceleration on the surface of the earth. The average mass density of the planet is $\frac{2}{3}$ times that of the earth. If the escape speed on the surface of the earth is taken to be 11 km s^{-1}, the escape speed on the surface of the planet in kms^{-1} will be

12. A thin uniform bar lies on a frictionless surface and is free to move in any way on the surface. Its mass is 0.16 kg and length $\sqrt{3}$ metres. Two particles each of mass 0.08 kg are moving on the same surface and towards the bar in a direction perpendicular to the bar, one with a velocity 10 m/s and the other with 6 m/s as shown in Figure. The first particle strikes the bar at *A* and the other at the point B. The points A and B are at distances 0.5 m from centre of the bar. The particles strike the bar at the same instant of time and stick to the bar on collision. Calculate the loss of kinetic energy of the system on the above collision process.

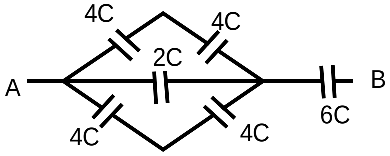


13. A light wooden rod fixed at one end is kept horizontal. A load of 0.4 kg tied to the free end of the rod causes that end to be depressed by 2.8 cm. If this load is set into up and down vibrations, with what frequency will it oscillate?

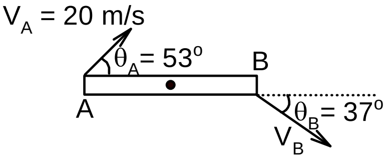
Space for Rough work

14. A moving car encounters air resistance which is proportional to the square of the speed of the car. Find the value of $\frac{2 \times \text{Power required at 40 kmph}}{\text{Power required at 80 kmph}}$

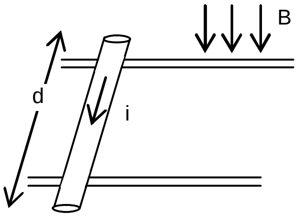
15. The equivalent capacitance between points A and B of the circuit will be (given: C = 1.3)



16. The two ends A and B of a uniform rod of length ℓ = 1m are moving with velocities V_A and V_B as shown. The velocity V_B (m/s) is



17. A cylindrical uniform rod of mass 0.72 kg and radius 6 cm rests on two parallel rails, that are d = 50 cm apart. The rod caries a current I = 48A (In the direction shown) and rolls along the rails without slipping. If it starts from rest, uniform magnetic field of magnitudes 0.25 T is directed perpendicular to the rod and the rail, then find the friction force(In N) between rod and rails



18. A 10 m wide spacecraft moves through the interstellar space at a speed 3 × 10^7 m/s. A magnetic field B = 3 × 10^{-10} T exists in the space in a direction perpendicular to the plane of motion. Treating the spacecraft as a conductor, calculate the emf induced across its width. (in volt)

Space for Rough work

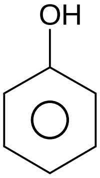
Chemistry PART – II

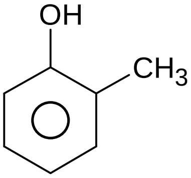
SECTION – A
(One or More than one correct type)

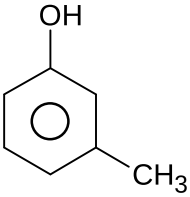
This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

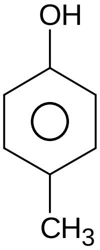
19. Which of the following substance(s) is/are more soluble than $CaSO_4$ in water?
(A) $BeSO_4$
(B) $MgSO_4$
(C) $SrSO_4$
(D) $BaSO_4$

20. Which of the following compound(s) form(s) tribromo derivative(s) as the major product when treated with bromine water?

(A)


(B)


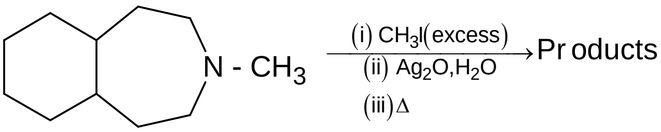
(C)


(D)


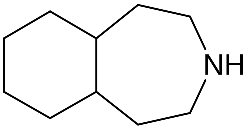
21. Which of the following is/are the anhydride(s) of boric acid(H_3BO_3)?
(A) B_2O_3
(B) HBO_2
(C) $H_2B_2O_3$
(D) $H_2B_4O_7$

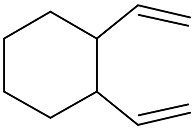
Space for Rough work

22. The molecular formula of which of the following is/are $C_4H_4O_4$?
(A) A cis-dibasic acid
(B) An α, β unsaturated dibasic acid which on heating gives a monobasic acid
(C) A cycic ester of dibasic acid
(D) An keto ester

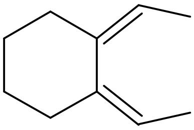
23.


Which of the following product(s) is/are formed in the above reaction?

(A)


(B)


(C) $(CH_3)_3N$

(D)


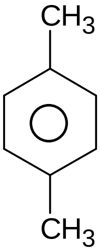
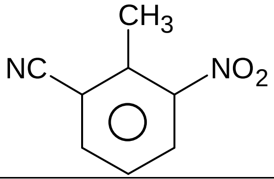
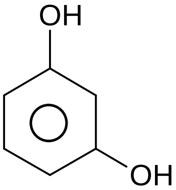
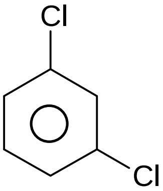
24. Which of the following statement(s) about aminoacids is/are correct?
(A) They are all high melting solids
(B) They are constituents of all proteins
(C) Glycine is the only naturally occurring amino acid which is optically inactive
(D) Most naturally occurring amino acids have D-configuration

Space for Rough work

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

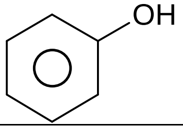
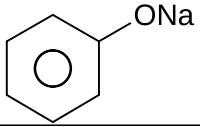
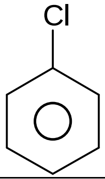
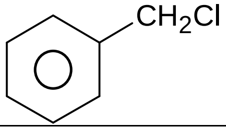
25. Match the compounds mentioned in List-I with their properties mentioned in List-II.

List – I		List – II	
(P)		(1)	Forms one monosubstituted product in electrophilic substitution reactions.
(Q)		(2)	Forms more than one monosubstituted product in electrophilic substitution reactions
(R)		(3)	More reactive than benzene towards EAS reaction
(S)		(4)	Less reactive than benzene towards EAS reaction
		(5)	The substituents exert –I as well as +R effect

(A) P $\rightarrow$ 1, 3; Q $\rightarrow$ 1, 4; R $\rightarrow$ 2, 4, 5; S $\rightarrow$ 2, 4, 5
(B) P $\rightarrow$ 3; Q $\rightarrow$ 3, 5; R $\rightarrow$ 1, 2 ; S $\rightarrow$ 1, 3
(C) P $\rightarrow$ 2; Q $\rightarrow$ 4; R $\rightarrow$ 1, 3; S $\rightarrow$ 5
(D) P $\rightarrow$ 4, 5; Q $\rightarrow$ 2; R $\rightarrow$ 5; S $\rightarrow$ 1, 5

Space for Rough work

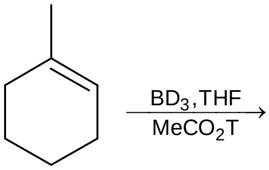
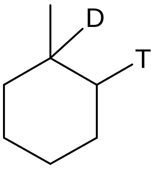
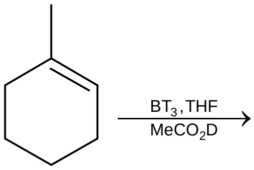
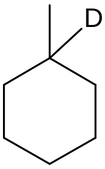
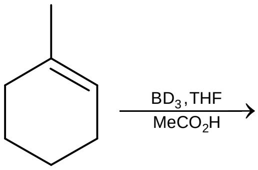
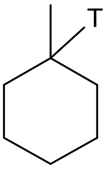
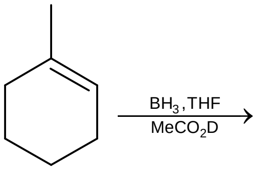
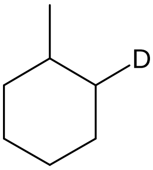
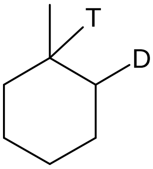
26. Match the compounds mentioned in List – I with their properties mentioned in List – II.

List – I		List – II	
(P)		(1)	More reactive than toluene towards common electrophilic bromination reaction in water
(Q)		(2)	Forms carbocation which is stabilized through resonance
(R)		(3)	Turns blue litmus to red
(S)		(4)	The substituted atom or group shows +R effect
		(5)	The substituted atom or group shows –I effect

(A) P → 2, 3; Q → 5; R → 4; S → 1
(B) P → 4; Q → 3; R → 1, 2; S → 1, 3
(C) P → 1, 3, 4, 5; Q → 1, 4, 5; R → 4, 5; S → 2, 5
(D) P → 3; Q → 1, 4; R → 2, 3, 5; S → 2, 4, 5

Space for Rough work

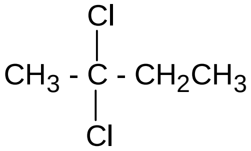
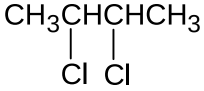
27. Match the following:

	List – I		**List – II**
(P)	 BD3,THF MeCO2T	(1)	
(Q)	 BT3,THF MeCO2D	(2)	
(R)	 BD3,THF MeCO2H	(3)	
(S)	 BH3,THF MeCO2D	(4)	
		(5)	

(A) P → 3, Q → 1, R → 4, S → 5
(B) P → 1; Q → 5; R → 2; S → 4
(C) P → 5, Q → 4, R → 3, S → 2
(D) P → 4, Q → 2, R → 5, S → 1

Space for Rough work

28. Match the substances mentioned in List-I with their properties mentioned in List-II.

List – I		List – II	
(P)	$CH_3CH_2CH_2CHCl_2$	(1)	Forms only terminal alkyne on dehydrohalogenation reaction with $NaNH_2$ followed by H_2O
(Q)	 $CH_3-\overset{Cl}{\underset{Cl}{C}}-CH_2CH_3$	(2)	Forms only internal alkyne on dehydrohalogenation reaction with $NaNH_2$ followed by H_2O
(R)	 $CH_3\underset{Cl}{C}H\underset{Cl}{C}HCH_3$	(3)	Forms both internal and terminal alkyne on dehydrohalogenation reaction with $NaNH_2$ followed by H_2O
(S)	$ClCH_2CH_2CH_2CH_2Cl$	(4)	Forms conjugated diene on dehydrohalogenation reaction

(A) P → 2, 3; Q → 1, 2; R → 4; S → 1
(B) P → 3; Q → 4; R → 1, 2; S → 4
(C) P → 4, Q → 3, R → 3, S → 2
(D) P → 1; Q → 3; R → 2, 4; S → 4

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

29. $NaOH \xrightarrow[\text{Cold}]{Cl_2} P + NaOCl + H_2O$

$NaOH \xrightarrow[\text{Hot}]{Cl_2} P + NaClO_3 + H_2O$

What is the molar mass of 'P' in gram unit?

30. In how many kg water, should 50 moles of $CaCl_2$ be dissolved in order to lower its freezing point by 5^oC? [Assume complete dissociation of $CaCl_2$]
[K_f of water = 1.86 K kg mol^{-1}]

Space for Rough work

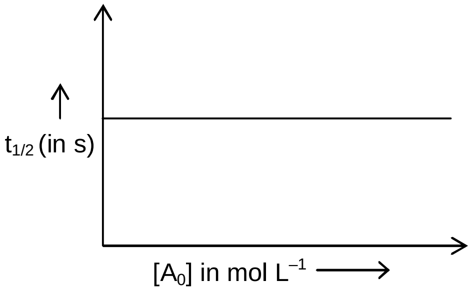
31. Percentage yield of 2-chlorobutane on photochlorination of n-butane is

32. The polymerization of the ethylene to linear polyethylene is represented by the reaction

$$n(CH_2 = CH_2) \longrightarrow \left(CH_2 - CH_2 \right)_n$$

Where n has a large integral value. Given that the average enthalpies of bond dissociation for C = C and C – C at 298 K are +590 kJ/mol & +331 kJ/mol respectively. Calculate the enthalpy of polymerization in kJ per mole of ethylene at 298 K?

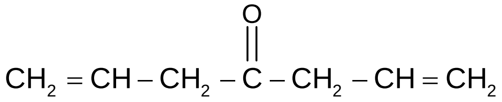
33. For a certain chemical reaction, the variation of half-life($t_{½}$) with different initial concentration(A_0) of reactant has been represented in the following plot.



What will be the half-life period of the reaction in ‘s’ unit if the rate constant is $15 \times 10^{-3}\ s^{-1}$?

34. An orange colour solid(X) upon heating produces a green residue(Y) and evolves a colourless and odourless gas(Z). When treated with aqueous NaOH, (X) produces NH_3 gas and the solution turns yellow. What is the molar mass of ‘X’ in gram unit if the molar mass of ‘Y’ is 152 g?

35.



$$CH_2 = CH - CH_2 - \overset{\overset{O}{||}}{C} - CH_2 - CH = CH_2$$

Above compound undergoes normal acidified permanganate(MnO_4^-/H^+) oxidation to form compound(X), CO_2 and H_2O. (X) is a dicarboxylic acid which on heating forms(Y). Reaction of three moles of (Y) with conc. H_2SO_4 forms compound(Z). What is the molar mass of (Z) in gram unit?

36. 4 g of nitrate of a univalent metal(M) was heated with excess of previously ignited silica. A loss of mass of 1.08 g takes place due to total expulsion of the nitrate part as N_2O_5. If the mass percentage of nitrate group in the salt is X%, what is the value of ‘X’?

$$2MNO_3 + SiO_2 \longrightarrow M_2SiO_3 + N_2O_5$$

Space for Rough work

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. Tangent drawn at point P(1, 3) of a parabola intersects its tangent at vertex at M(–1, 5) and cuts the axis of parabola at T. If R(–5, 5) is a point on SP; where S is focus of the parabola, then

(A) slope of axis is –3

(B) radius of circumcircle of ΔSMP is $\sqrt{\frac{5}{2}}$ units

(C) $(ST)^2 - (SM)^2 = (PM)^2$

(D) tangent cuts the axis of parabola at T (–3, 7)

38. If y = f(x) and y = g(x) are symmetrical about the line x = $\frac{\alpha+\beta}{2}$, then $\int_\alpha^\beta f(x)\,g'(x)dx$ is equal to

(A) $\int_\alpha^\beta f'(x)\,g(x)dx$

(B) $-\int_\alpha^\beta f'(x)\,g(x)dx$

(C) $\frac{1}{2}\int_\alpha^\beta (f(x)\,g'(x) - f'(x)\,g(x))dx$

(D) $\frac{1}{2}\int_\alpha^\beta (f(x)\,g'(x) + f'(x)\,g(x))dx$

39. Suppose that f(x) is a differentiable invertible function, $f(x) \neq 0$ and $h(x) = \int_1^x f(t)dt$. Given that $f(1) = f'(1) = 1$ and g(x) is inverse of f(x).,

Let G(x) = x^2g(x) –xh(g(x)) $\forall x \in R$. Which of the following are correct:

(A) G'(1) = 2

(B) G'(1) = 3

(C) G"(1) = 2

(D) G"(1) = 3

Space for Rough work

40. If the probability of choosing an integer ‘k’ out of 2m integers 1, 2, 3,……..2m is inversely proportional to $k^4\left(1\le k\le m\right)$. If x_1 is the probability that choosen number is odd and x_2 is the probability that chosen number is even, then

(A) $x_1 < \frac{2}{3}$ (B) $x_1 > \frac{1}{2}$

(C) $x_1 > \frac{2}{3}$ (D) $x_2 < \frac{1}{2}$

41. Which of the following functions are twice differentiable at x = 0?

(A) $f(x) = x|x|$ (B) $g(x) = [x^2]\tan^{-1}x - \{x^2\}\cot^{-1}x - [x^2]\frac{\pi}{2}$

(C) $h(x) = |\sin^2 x|$ (D) $h(x) = \begin{cases} x^4\cos\left(\frac{1}{x}\right); & x \ne 0 \\ 0 & ; x = 0 \end{cases}$

42. Let $S_n = \sum_{r=1}^{n}\frac{r^3+n^3}{n^4}$ and $T_n = \sum_{r=0}^{n-1}\frac{r^3+n^3}{n^4}$ for $n = 1, 2, 3, ...$ Then

(A) $S_n > \frac{5}{4}$ (B) $S_n < \frac{5}{4}$

(C) $T_n > \frac{5}{4}$ (D) $T_n < \frac{5}{4}$

Space for Rough work

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

43. Match the list:

List - I		**List - II**	
(P)	Radius of the largest circle which passes through the focus of the parabola $y^2 = 4x$ and is completely contained in it, is	(1)	16
(Q)	If the shortest distance between the curves $y^2 = 4x$ and $y^2 = 2x - 6$ is d then d^2 is	(2)	5
(R)	Let AB be a focal chord of $y^2 = 12x$ with focus S. The harmonic mean of lengths of segments AS and BS is	(3)	6
(S)	Tangents drawn from P meet the parabola $y^2 = 16x$ at A and B. If these two tangents are perpendicular then the least value of $\sqrt{AB}$ is	(4)	4
		(5)	–1
		(6)	0

The correct option is

(A) P → 4; Q → 2; R → 3; S → 5
(B) P → 4; Q → 2; R → 3; S → 4
(C) P → 4; Q → 2; R → 1; S → 6
(D) P → 4; Q → 3; R → 6; S → 5

44. The angles of a triangle are in the ratio 2 : 3 : 7

List – I		**List – II**	
(P)	Smallest side = 2	(1)	Largest side $= \sqrt{3}+1$
(Q)	Smallest side $= \sqrt{2}$	(2)	Largest side $= \sqrt{6}+\sqrt{2}$
(R)	Semi-perimeter $= 3+\sqrt{3}+\sqrt{2}$	(3)	Largest side = 1
(S)	Area of triangle $= (\sqrt{3}-1)/4$	(4)	Largest side $= 2+2\sqrt{3}$
		(5)	No such triangle is possible
		(6)	Angles are in AP

The correct option is

(A) P → 2; Q → 1; R → 4; S → 3
(B) P → 2; Q → 1; R → 3; S → 4
(C) P → 1; Q → 2; R → 4; S → 3
(D) P → 2; Q → 1; R → 5; S → 6

Space for Rough work

45. Each of 4 boys attends a school gathering with both of his parents. The number of ways these 12 people can be divided into groups of three each group containing a boy, a male parents, a female parent such that

List – I		List – II	
(P)	No boy is with both of his parents in his group is N then N is	(1)	5
(Q)	Exactly two boy is with both their parents is N then N is	(2)	453
(R)	Two particulars boys is with both of his parents is N then N is	(3)	3
(S)	Every boy is with both his parents is N then N is	(4)	18
		(5)	1
		(6)	283

The correct option is

(A) P → 6; Q → 4; R → 3; S → 5
(B) P → 2; Q → 1; R → 1; S → 5
(C) P → 6; Q → 2; R → 1; S → 5
(D) P → 2; Q → 4; R → 3; S → 5

46. A (–2, 0) and B (2, 0) are two fixed points and P is a point such that PA – PB = 2. Let S be the circle $x^2 + y^2 = r^2$. Then match the following.

List-I		List-II	
(P)	If $r = 2,$ then the number of points P satisfying $PA - PB = 2$ and lying on $x^2 + y^2 = r^2$ is	(1)	2
(Q)	If $r = 1,$ then the number of points satisfying PA – PB = 2 and lying on $x^2 + y^2 = r^2$ is	(2)	4
(R)	For $r = 2$, then the number of common tangents is	(3)	0
(S)	For $r = \frac{1}{2}$, then the number of common tangents is	(4)	1
		(5)	5
		(6)	6

The correct option is

(A) P → 6; Q → 4; R → 3; S → 5
(B) P → 2; Q → 1; R → 1; S → 5
(C) P → 1; Q → 4; R → 3; S → 1
(D) P → 2; Q → 4; R → 3; S → 5

Space for Rough work

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

47. Given the equation of the ellipse $\frac{(x-3)^2}{16}+\frac{(y-4)^2}{49}$ = 1, a parabola is such that its vertex is the lowest point of the ellipse and it passes through the ends of the minor axis of the ellipse. The equation of the parabola is in the form $16y = A(x - H)^2 - K$. Determine the value of $\frac{A}{7}+\frac{H}{3}+\frac{K}{16}$ is equal to

48. A straight line cuts the x-axis at point $A(1,0)$, and y-axis at point B, such that $\angle OAB=\alpha\left(\alpha>\frac{\pi}{4}\right)$. C is middle point of AB and B' is a mirror image of point B with respect to line OC and C' is a mirror image of point C with respect to line BB', then the ratio of the areas of triangles ABB' and BB'C' is equal to

49. The number of functions from $f : A \to B$ where $A = \{a_1, a_2, a_3, a_4, a_5, a_6\}$, $B = \{1, 2, 3, \ldots, 9\}$ such that $f(a_{i+1}) > f(a_i)\ \forall\ i \in N$ and $f(a_i) \neq i$ is

50. Let $(x^3 + px^2 + 2x - 5)^{19} (x^2 + qx - 41)^8 (x^4 - x^3 + x - 7)^6 = x^{97} + 391x^{96} + a_{95}x^{95} + a_{94}x^{94} + \ldots a_1x + a_0$ be an identity, where p, q, $a_{95} \ldots a_0$ are integers. Compute the smallest positive value of p.

Space for Rough work

51. If number of points common between ||x| - |y|| = 1 and 2a |x| |y| + 1 = 2 |x| + a|y| are 8 then value of 3a (where a < 1) is ____.

52. Let f(x) = 30 – 2x – x^3, then find the number of positive integral values of 'x' which satisfies f(f(f(x))) > f(f(-x)).

53. $\vec{a}, \vec{b}$ and $\vec{c}$ be three non – coplanar vectors, and $\vec{d}$ be a non zero vector, which is perpendicular to $\left(\vec{a}+\vec{b}+\vec{c}\right)$. Now if $\vec{d}=\sin x\left(\vec{a}\times\vec{b}\right)+\cos y\left(\vec{b}\times\vec{c}\right)+2\left(\vec{c}\times\vec{a}\right)$, then minimum value of x^2+y^2 is equal to $\frac{\lambda\pi^2}{4}$, where λ is

54. If $\int \frac{(x-1)dx}{(x+x\sqrt{x}+\sqrt{x})\sqrt{\sqrt{x}(x+1)}} = 4\tan^{-1}[g(x)]+C$, where C is an arbitrary constant of integration. Find g^2 (1).

Space for Rough work

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JEE (Advanced)-2019

PAPER – 2

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. AD

Sol. $y_1 = a\cos\omega_1 t$ and $y_2 = a\cos(\pi + \omega_2 t)$

For same phase $\omega_1 t = \pi + \omega_2 t$

$$t = \frac{\pi}{\omega_1 - \omega_2} = \frac{\pi}{\frac{2\pi}{3} - \frac{2\pi}{7}} = \frac{21}{8}s$$

Or

$$t = \frac{3\pi}{\omega_1 - \omega_2} = \frac{3\pi}{\frac{2\pi}{3} - \frac{2\pi}{7}} = \frac{63}{8}s$$

2. AB

Sol. A_1 will shrink : B_2 will shrink

A_1 will shrink : A_2 will expand

3. ABCD

Sol. Particle velocity $v_p = -v\left(\frac{dy}{dx}\right)$

v is the wave velocity.

$\frac{dy}{dx}$ is the slope.

At point S, slope is zero, there force V_p at S is zero.

At point T, slope is (+)*ve*, there fore V_p will be along –*ve* *x* direction

Excess pressure $dP = -B.\frac{dy}{dx}$

At point S, slope is zero

$\Rightarrow$ dP = 0.

At point R, slope is –*ve*

$\Rightarrow$ dP is (+) ve i.e., particles located near C are under compression.

4. AC

Sol. If the image is real and magnified means object is between *f* and 2*f*.

When lens immersed in water focal length, $f_1 = \frac{(\mu - 1)}{\left(\frac{\mu}{\mu_r} - 1\right)} f = 4f$

Now object is between pole and focus so image is virtual and magnified.

5. BC

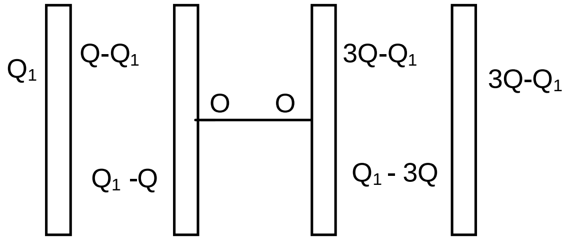
Sol. As $\lambda_0 = \frac{hc}{eV}$ and as *V* increases. λ_0 decreases but characteristic wavelengths do not change so interval between $\lambda_{k\alpha}$ & λ_0 increases and the same for the interval between $\lambda_{k\beta}$ & λ_0

6. BCD

Sol. Apply Faraday law for direction of induced current.

7. A

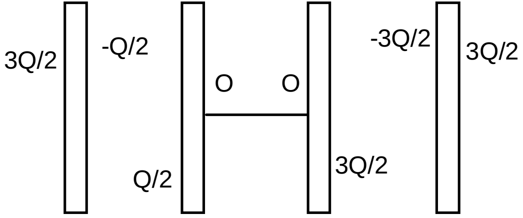
Sol.



Equating net electric field equal to zero in left most plate.

$3Q - Q_1 = Q_1 \Rightarrow Q_1 = \frac{3Q}{2}$.

$\therefore$ the final charges are as shown below.



8. B

Sol. Force $F = (-)\frac{dU}{dx}$

9. C

Sol. $I = \frac{2+3-5+4+6}{2+3+5+4+6} = \frac{1}{2}A$

$V_D = 2 - \frac{1}{2}\times 2 = 1V$; $V_C = V_D + 3 - \frac{1}{2}\times 3 = 2.5V$

$V_B = V_C - 5 - \frac{1}{2}\times 5 = -5V$; $V_A = V_B + 4 - \frac{1}{2}\times 4 = -3V$

10. D

Sol. $v^2 = 144 - 9x^2$

$\omega^2 = 9 \quad \Rightarrow \quad \frac{2\pi}{T} = 3 \Rightarrow T = \frac{2\pi}{3}$

when v = 0, $x = \sqrt{\frac{144}{9}} = \frac{12}{3} = 4$ unit

Acceleration = $v\frac{dv}{dx} = -9x$

Potential energy = $\frac{1}{2}m\omega^2x^2$ = 18 units

SECTION – D

11. 00003.00

Sol. $g = \frac{GM}{R^2} = \frac{G\frac{4\pi}{3}R^3\rho}{R^2} = \frac{4\pi G}{3}\rho R$

$\frac{\sqrt{6}}{11} = \frac{g_1}{g} = \frac{\rho_1 R_1}{\rho R} = \frac{2}{3}\frac{R_1}{R}$

$\frac{R_1}{R} = \frac{3\sqrt{6}}{22}$

$\frac{V_1}{V} = \sqrt{\frac{M_1}{M}\frac{R}{R_1}} = \sqrt{\frac{\rho_1}{\rho}\frac{R_1^3}{R^3}\frac{R}{R_1}} = \sqrt{\frac{2}{3}\left(\frac{3\sqrt{6}}{22}\right)^2} = \frac{3}{22}\sqrt{\frac{2}{3}\times 6}$

$v_1 = 11\times\frac{3}{22}\times 2 = 3\ \text{kms}^{-1}$

12. 00002.72

Sol. Loss in KE = $K_f - K_i$

$K_f = \frac{1}{2}mv_{cm}^2 + \frac{1}{2}I_{cm}\omega^2$

$K_i = \frac{1}{2}(0.08)(10)^2 + \frac{1}{2}(0.08)(6)^2$

Apply conservation of momentum and angular momentum to get V_{cm} and ω.

13. 00002.98

Sol. $T_{sp} = -K\ell^2\theta = \left(\frac{m\ell^2}{3}\right)\alpha$

$$\alpha = -\left(\frac{3K}{m}\right)\theta$$

$$T = 2\pi\sqrt{\frac{m}{3K}} \Rightarrow f = \frac{1}{T}.$$

14. 00000.25

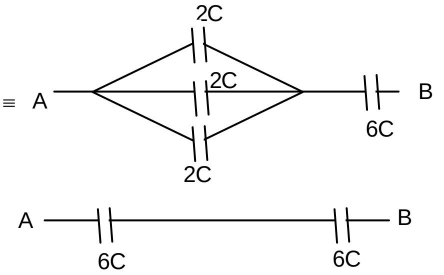
Sol. $P = Fv = kv^2v$

$\Rightarrow$ $P \propto v^3$

$\Rightarrow$ Ratio = 1 : 8

15. 00003.90

Sol. Equivalent circuit of the above figure can be drawn as $C_{AB} = 3C$



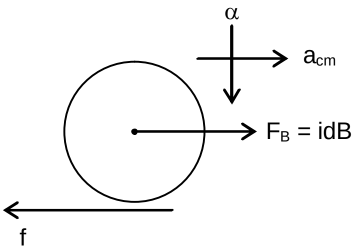
16. 00015.00

Sol. $V_B \cos\theta_B = V_A \cos\theta_A \Rightarrow V_B = 15\,m/s$

17. 00002.00

Sol. $f = \frac{F}{3} = \frac{idB}{3}$

$\Rightarrow$ $\frac{48 \times 0.5 \times 0.25}{3} = 2.00$



18. 00000.09

Sol. $\varepsilon = vB\ell = 3 \times 10^7 \times 10 \times 3 \times 10^{-10} = 9 \times 10^{-2} \approx 0.09$ V

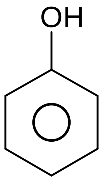
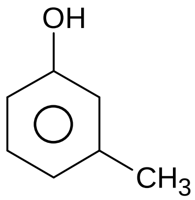
Chemistry PART – II

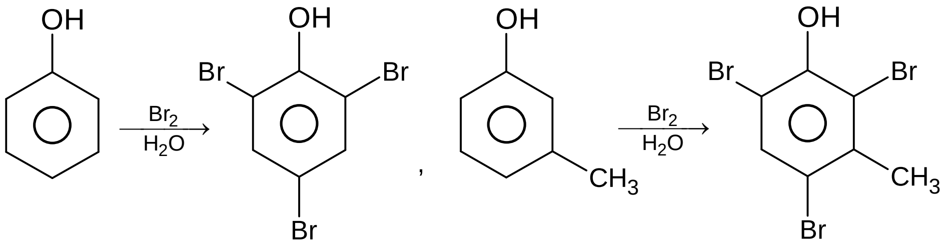
SECTION – A

19. AB

Sol. The solubility of the group-2 sulphates decreases on moving down the group due to decrease in hydration energy.

20. AC

Sol. All the ortho and para positions of  and  are vacant and activated for electrophilic substitution reactions.



21. ABD

Sol. $H_3BO_3 \xrightarrow{-H_2O} HBO_2$

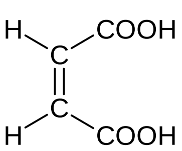
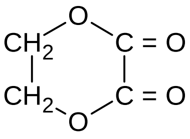
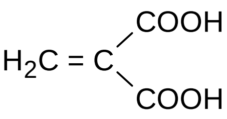
$2H_3BO_3 \xrightarrow{-3H_2O} B_2O_3$

$4H_3BO_3 \xrightarrow{-5H_2O} H_2B_4O_7$

$H_2B_2O_3$ is not an anhydride.

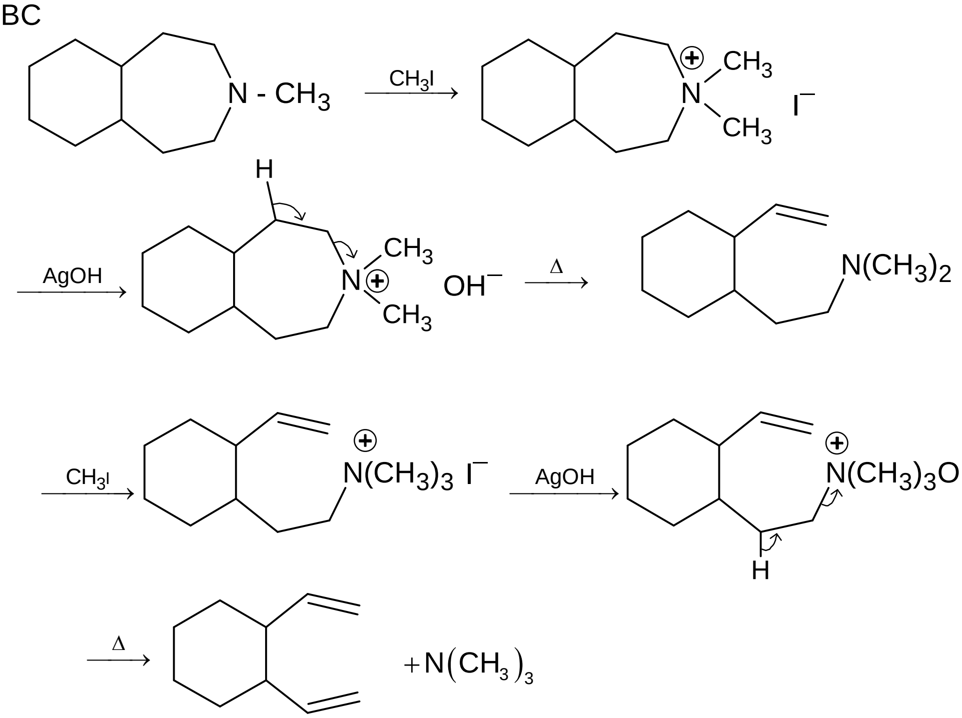
22. ABC

Sol. $C_4H_4O_4$ can be

 ,  and  $\xrightarrow{\Delta} CH_2 = CHCOOH + CO_2$

23. BC

Sol.



24. ABC

Sol. These are facts.

25. A

Sol. (A) forms monosubstituted product, it is more reactive than benzene due to presence two activating CH_3 groups.

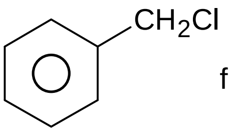
(B) forms monosubstituted product because one position is meta w.r.t electron withdrawing groups and para with respect to CH_3 group. It is less reactive than benzene due to two deactivating and one activating group.

(C) forms more than one monosubstituted product and is more reactive than benzene due to two activating OH groups. The OH groups exert –I and +R effect.

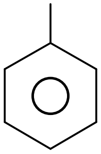
(D) forms more than one monosubstituted product and is less reactive than benzene. The Cl atoms exert –I as well as +R effect.

26. C

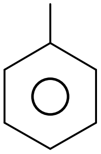
Sol.



forms stable benzylic carbocation which is stabilized by resonance



and



are more reactive than toluene towards bromination

27. B

Sol. Fact based.

28. D

Sol. Fact based

SECTION – D

29. 00058.50

Sol. P is NaCl

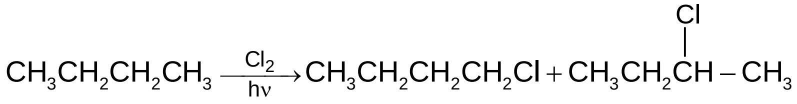
30. 00055.80

Sol. $\Delta T_f = iK_f m = 3 \times 1.86 \times \text{No. of moles} \times \frac{1000}{W}$

or, $5 = 3 \times 1.86 \times 50 \times \frac{1000}{W} \Rightarrow w = 55.8\text{ kg}$

31. 00071.70

Sol.



$$CH_3CH_2CH_2CH_3 \xrightarrow[h\nu]{Cl_2} CH_3CH_2CH_2CH_2Cl + CH_3CH_2\overset{\overset{\displaystyle Cl}{|}}{C}H - CH_3$$

$$\frac{\text{amount of 1-Chlorobutane}}{\text{amount of 2-Chlorobutane}} = \frac{6 \times 1}{4 \times 3.8} = \frac{6}{15.2}$$

% of 2-chlorbutane$= \frac{15.2}{21.2} \times 100 = 71.70\%$

32. 00072.00

Sol. n double bonds dissociate to form 2n single bond.

ΔH for polymerization of 1 mol of ethylene

$$\Delta H = \frac{n}{n}\left(BE_{C=C}\right) - \frac{2n}{n}\left(BE_{C-C}\right)$$

$= +590 - 2 \times 331 = -72\text{ kJ mol}^{-1} = -72.00\text{ kJ mol}^{-1}$

33. 00046.20

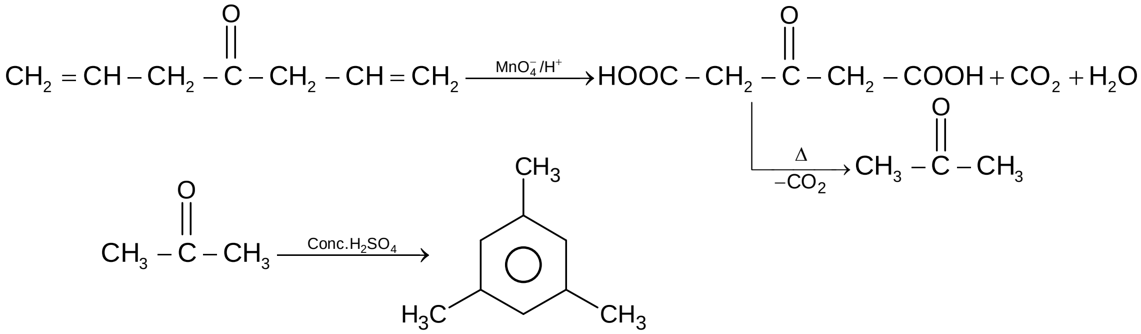
Sol. $t_{1/2} = \frac{0.693}{K} = \frac{0.693}{15 \times 10^{-3}} = 46.2\,s$

34. 00252.00

Sol. X = $(NH_4)_2Cr_2O_7$, Y = Cr_2O_3 & Z = N_2

35. 00120.00

Sol.



$$CH_2 = CH - CH_2 - \overset{\overset{\displaystyle O}{||}}{C} - CH_2 - CH = CH_2 \xrightarrow{MnO_4^-/H^+} HOOC - CH_2 - \overset{\overset{\displaystyle O}{||}}{C} - CH_2 - COOH + CO_2 + H_2O$$

$$\xrightarrow[-CO_2]{\Delta} CH_3 - \overset{\overset{\displaystyle O}{||}}{C} - CH_3$$

$$CH_3 - \overset{\overset{\displaystyle O}{||}}{C} - CH_3 \xrightarrow{Conc.H_2SO_4}$$

(Z)

Molar mass of (Z) = 120

36. 00031.00

Sol. $2NO_3^- \longrightarrow N_2O_5$

Mole of ratio of NO_3^- : N_2O_5 = 2 :1

$\therefore$ Mole of NO_3^- in salt = 2 × Mole of N_2O_5 = $\frac{2\times 1.08}{108} = 0.02$

$\therefore$ Weight of NO_3^- in the salt = 0.02 × 62 = 1.24 g

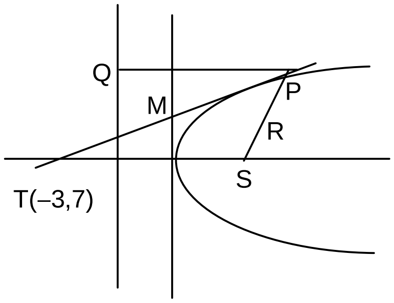
% of NO_3^- = $\frac{1.24}{4}\times 100 = 31\%$

$\therefore$ X = 31.00

Mathematics PART – III

SECTION – A

37. ABCD



Sol. Equation of tangent at P is x+y=4

Clearly mirror image of R(–5,5) lies on line PQ.

Now mirror image R′ or R

$\Rightarrow \frac{\alpha'+5}{1} = \frac{\beta'-5}{1} = \frac{-2(-5+5-4)}{2} = 4$

$\Rightarrow (\alpha',\beta') \equiv (-1,9)$

Let PM cuts the axis at T; As M is midpoint of PT

$\Rightarrow$ T is (–3, 7)

We know that SP = ST and $\angle$SMP= $\frac{\pi}{2}$

Equation SP $\equiv y-3 = -\frac{1}{3}(x-1)$

$\Rightarrow$ x + 3y–10 = 0

Let S $\equiv$ (10 – 3β, β)

Again TS || PQ $\Rightarrow \frac{\beta-7}{13-3\beta} = \frac{9-3}{-1-1} = -3$

$\therefore$ focus is (–2, 4)

38. ABCD

Sol. f(x) = f(α + β - x)

$\Rightarrow$ f(α) = f(β) and g(α) = g(β)

$\int_\alpha^\beta f(x)g'(x)\,dx = f(x)g(x)\Big|_\alpha^\beta - \int_\alpha^\beta f'(x)g(x)dx$

$2I = \int_\alpha^\beta f(x)g'(x) - \int_\alpha^\beta f'(x)g(x)dx$

$I = \frac{1}{2}\int_\alpha^\beta \left(f(x)g'(x) - f'(x)g(x)\right)dx$

39. AD

Sol. h’(x) = f(x) $\Rightarrow$ h”(x) = f’(x)

h(1) = 0, f(1) = f’(1) = h’(1) = h”(1) = g(1)

f(g(x)) = x

f’ (g(x)). g’(x) = 1

f’ (g(1)). g’(1) = 1 $\Rightarrow$ g’ (1) = 1

G(x) = x^2.g(x) – x. h(g(x))

G’(x) = x^2 g’(x) + 2x. g(x) – h(g(x)) – x. h’(g(x)). g’(x)

= 2x.g(x) – h(g(x))

G”(x) = 2.g(x) + x.g’(x)

G’(1) = 2g(1) – h (g(1)) = 2g(1) – h(1) = 2

G”(1) = 2.g(1) + g’(1) = 3

40. BD

Sol. Let one probability of choosing one integer k be $P(k)=\frac{\lambda}{k^4}$. (λ is one constant of proportionality). Then,

$$\sum_{k=1}^{2m}\frac{\lambda}{k^4}=1\Rightarrow\lambda\sum_{k=1}^{2m}\frac{1}{k^4}=1$$

Let x_1 be the probability of choosing the odd number. Then

$$x_1=\sum_{k=1}^{2m}P(2k-1)=\lambda\sum_{k=1}^{m}\frac{1}{(2k-1)^4}$$

Also, $1-x_1=x_2=\sum_{k=1}^{m}P(2k)=\lambda\sum_{k=1}^{m}\frac{1}{(2k)^4}<\lambda\sum_{k=1}^{m}\frac{1}{(2k-1)^4}$

$\Rightarrow\ 1-x_1<x_1 \qquad \Rightarrow\ x_1>\frac{1}{2} \qquad \Rightarrow\ x_2<\frac{1}{2}$

41. BCD

Sol. $f''(x)\Rightarrow\begin{cases}2;\,x>0\\-2;\ x<0\end{cases}\Rightarrow$ not differentiable

$$g(x)\Rightarrow\begin{cases}-x^2\cot^{-1}x; & x>0\\-x^2\cot^{-1}x; & x<0\Rightarrow \text{ twice differentiable}\\ \quad 0\ ;x=0\end{cases}$$

h(x) = $\sin^2 x$ → differentiable

$$k'(x)=\begin{cases}4x^3.\cos\frac{1}{x}+x^2.\sin\frac{1}{x};\,x\neq0\\ \qquad 0;\ x=0\end{cases}$$

twice differentiable

42. AD

Sol. Using integration as sum of limit.

43. B

Sol. (A) $(x-h)^2+y^2=(h-1)^2$

$y^2=4x$

$(x-h)^2+4x=(h-1)^2$

Apply $\Delta=0$

(B) Find the common normal to

$y^2=4x,\ y^2=2x-6$

$y=m(x-3)-m-\frac{1}{2}m^3$ Apply $c=-2am-am^3$

$-4m-\frac{1}{2}m^3=-2m-m^3$

$\frac{m^3}{2}-2m=0$ $m=0,\ m=\pm2$

(C) Length of the semi latusrectum is the H.M between segments of the focal chord.

(D) Tangents at the ends of focal chord are perpendicular

44. A

Sol. Angles of the triangle are 30º, 40º, 105º

then $\frac{a}{\sin 30^\circ} = \frac{b}{\sin 45^\circ} = \frac{c}{\sin 105^\circ}$

$\Rightarrow \quad \frac{a}{1/2} = \frac{b}{1/\sqrt{2}} = \frac{c}{(\sqrt{3}+1)/2\sqrt{2}} = k'$

$\Rightarrow \quad \frac{a}{\sqrt{2}} = \frac{b}{2} = \frac{c}{\sqrt{3}+1} = k$

The smallest side $a = \sqrt{2}k$ and largest side $c = (\sqrt{3}+1)k$

If $a = 2, k = \sqrt{2}, c = \sqrt{6}+\sqrt{2}$

If $a = \sqrt{2}, k = 1, c = \sqrt{3}+1$

If $s = 3+\sqrt{2}+\sqrt{3}, k = 2, c = 2+2\sqrt{3}$

If $\Delta = \frac{\sqrt{3}-1}{4}$, then from $\Delta = \frac{1}{2}bc\sin A$

We have $\frac{\sqrt{3}-1}{4} = \frac{1}{2}\times 2k \times (\sqrt{3}+1)k\sin 30^\circ$

$\Rightarrow \quad k^2 = \frac{\sqrt{3}-1}{2(\sqrt{3}+1)} = \frac{(\sqrt{3}-1)^2}{4} = k = \frac{\sqrt{3}-1}{2}$ and

hence c = 1

45. D

Sol. Let B_1, B_2, B_3, B_4 are boys F_1, F_2, F_3, F_4 and M_1, M_2, M_3, M_4 are corresponding fathers and mothers. Let A; be an event when Bi, Fi, Mi are together in a group.

$n(A_1) = 3!\times 3!$ [Remaining 3 fathers can be grouped with any of 3 boys and similarly 3 mothers can be grouped with 3 boys separately]

Similarly $n(A_2), n(A_3), n(A_4) = 3!\times 3!$

$n(A_1 \cap A_2) = 2!\times 2!$

$n(A_1 \cap A_2 \cap A_3) = 1!1!$

$n(A_1 \cap A_2 \cap A_3 \cap A_4) = 1$

At least are Boy is grouped with his parents

$n(A_1 \cup A_2 \cup A_3 \cup A_4)$

$= \sum_{i=1}^{4} n(A_i) - \sum_{1=i<j}^{j=4} n(A_i \cap A_j) + \sum_{1=i<j<k}^{k=4} n(A_i \cap A_2 \cap A_3) - n(A_1 \cap A_2 \cap A_3 \cap A_4)$

$= {}^4C_1 \times 3!\times 3! - {}^4C_2 \times 2!2! + {}^4C_3\, 1!\times 1! - 1 = 123$

Grouping when any boy can be given any set of parents is $4!\times 4!$

$(P)\ n\left(\overline{A_1 \cup A_2 \cup A_3 \cup A_4}\right) = 4!4! - 123 = 576 - 123 = 453$

(Q) 2 boys selected four both parents in group in ${}^4C_2$ ways say B_1 and B_2 so $F_1B_1M_1$, $F_2B_2M_2$ are 2 groups remaining possibilities are

(i) $F_3B_3M_4$ and $F_4B_4M_3$

(ii) $F_4B_3M_3$ and $F_3B_4M_4$

(iii) $F_4B_3M_4$ and $F_3B_4M_3$ ${}^4C_2 \times 3 = 18$

(R) Boys are not selected for being particular

(S) $n\left(A_1 \cap A_2 \cap A_3 \cap A_4\right) = 1$

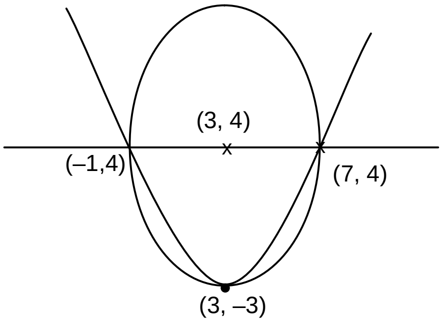
46. C

Sol. Basic definition of hyperbola and common tangent with circle.

SECTION – D

47. 00005.00

Sol. Given ellipse $\frac{(x-3)^2}{4^2} + \frac{(y-4)^2}{7^2} = 1$ (vertical ellipse)

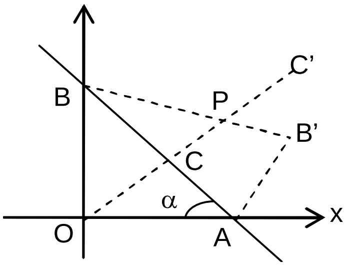


Parabola can be taken as
$(x-3)^2 = A\,(y+3)$
It passes through (-1, 4)
$\Rightarrow 16 = 7A \;\Rightarrow A = 16/7$
$\therefore$ parabola is $7(x-3)^2 = 16y + 48$
$\therefore$ $16y = 7(x-3)^2 - 48$
$\therefore$ A = 7, H = 3, K = 48
$\therefore \ \frac{A}{7} + \frac{H}{3} + \frac{K}{16} = 5$

48. 00002.00

Sol. $A \equiv (1,0)$, $B = \equiv (0, \tan\alpha)$, $C \equiv \left(\frac{1}{2}, \frac{\tan\alpha}{2}\right)$, $B' = \left(\frac{2\tan^2\alpha}{1+\tan^2\alpha}, \frac{\tan^3\alpha - \tan\alpha}{1+\tan^2\alpha}\right)$

$\frac{\Delta ABB'}{\Delta BB'C} = 2$



49. 00028.00

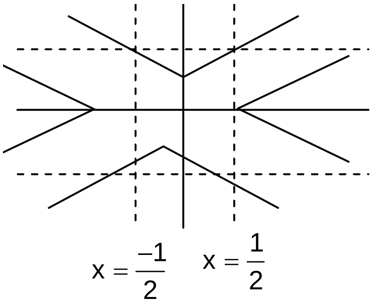
Sol. If a_1 is mapped to 2, we have ${}^7C_5$ ways of mapping rest of the elements.
If a_1 is mapped to 3, we have ${}^6C_5$ ways of mapping rest of the elements.
If a_1 is mapped to 4, we have ${}^5C_5$ ways of mapping rest of the elements.
Hence total number of increasing functions = ${}^7C_5 + {}^6C_5 + {}^5C_5 = 28$.

50. 00007.00

Sol. $\left({}^{19}c_0(x^3)^{19} + {}^{19}c_1(px^2+2x-5)(x^3)^{18} + ...\right)$
$\left({}^{8}c_0x^{16} + {}^{8}c_1(qx-41)x^{14} + ...\right)\left({}^{6}c_0x^{24} + {}^{6}c_1(-x^3+x-1)x^{20} + ...\right)$
$= x^{97} + 391x^{96} + a_{95}x^{95} + ...$
Comparing the coefficient of x^{96} we get
$19p + 8q - 6 = 391$
$\Rightarrow 19p + 8q = 397$ Let $q = 19\lambda + k,\ 0 \le k < 19$
$p = \dfrac{397-8(19\lambda+k)}{19} = 21 - 8\lambda - 2\dfrac{(4k+1)}{19}$
$\dfrac{4k+1}{19}$ must be integer $\Rightarrow k = 14,\ p = 15 - 8\lambda$
For minimum positive value of p, $\lambda = 1 \Rightarrow p = 7$

51. 00002.00

Sol.



52. 00002.00

Sol. $f'(x) = -2 - 3x^2 < 0\ \forall\ x$
$\Rightarrow f(x)$ is decreasing
$f(f(x)) < f(-x)$
$f(x) > -x$
$30 - 2x - x^3 > -x$
$x^3 + x - 30 < 0$
$(x-3)(x^2+3x+10) < 0 \Rightarrow x < 3$

53. 00005.00

Sol. Let $\vec{d}.\vec{a} = \cos y\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right] = -\vec{d}.\left(\vec{b}+\vec{c}\right)$ [as $\vec{d}.\left(\vec{a}+\vec{b}+\vec{c}\right) = 0$]

$\Rightarrow \quad \cos y = -\dfrac{\vec{d}.\left(\vec{b}+\vec{c}\right)}{\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right]}$ ……….(1)

similarly $\sin x = -\dfrac{\vec{d}.\left(\vec{b}+\vec{a}\right)}{\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right]}$ ………..(2)

$$\Rightarrow 2 = -\frac{\vec{d}.\left(\vec{a}+\vec{c}\right)}{\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right]} \qquad \text{……….(3)}$$

Adding these we get $\sin x + \cos y + 2 = 0$

$\Rightarrow \sin x + \cos y = -2$

$\Rightarrow \sin x = -1, \cos y = -1$

$\Rightarrow x = (4n-1)\frac{\pi}{2},\ y = (2n+1)\pi$

Since we want minimum value of $x^2 + y^2$, so $x = -\frac{\pi}{2},\ y = \pi$

$\Rightarrow x^2 + y^2 = \frac{5\pi^2}{4} \Rightarrow \lambda = 5$

54. 00002.00

Sol. Ans. (2)

Put $x = t^2$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – IX

JEE (Advanced)-2019

PAPER – 1

TEST DATE: 28-04-2019

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. A, C

Sol. $a_t = 2\ \text{m/s}^2$

$$S = ut + \frac{1}{2}a_t t^2 = 0 + \frac{1}{2} \times 2t^2 = t^2$$

$\therefore\ S = t^2$

$$v^2 = u^2 + 2a_t S = 2 \times 2S = 4S$$

$\therefore\ a_n = t^4 = S^2$

$a_n = S^2$

$$\therefore\ a = \sqrt{a_t^2 + a_n^2} = \sqrt{4 + S^4}$$

At S = 2m

$$a = \sqrt{4+16} = 2\sqrt{5}\ \text{m/s}^2$$

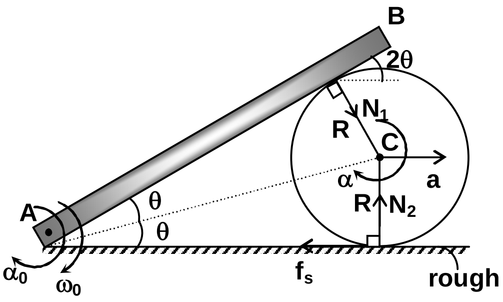
Radius of curvature of its trajectory

$$r = \frac{v^2}{a_n} = \frac{4S}{S^2} = \frac{4}{S}$$

At S = 1m, r = 4m,

2. A, D

Sol. $\omega_0 R\cot\theta = v\sin 2\theta$



a = αR

$$\omega_0 R\frac{\cos\theta}{\sin\theta} = 2v\sin\theta\cos\theta$$

$$\omega_0 R = 2v\sin^2\theta$$

Just after release

$\alpha_0 R = 2a\sin^2\theta$

$$\alpha_0 R = 2a\times\frac{9}{25} \quad \text{(since, } \theta = 37°\text{, initially)}$$

$$\alpha_0 R = \frac{18a}{25} \qquad \text{…(i)}$$

$N_1\sin 2\theta - f_s = ma$ …(ii)

$$f_s R = \frac{2}{5}mR^2\alpha$$

$$f_s = \frac{2}{5}ma \qquad \text{…(iii)}$$

From (ii) and (iii), we get

$$N_1\sin 2\theta = \frac{7}{5}ma$$

$$N_1\frac{24}{25} = \frac{7}{5}ma \Rightarrow N_1 = 3.5\,a \qquad \text{…(iv)}$$

For the rod,

$$m_0 g\frac{\ell}{2}\cos 2\theta - N_1 R\cot\theta = \frac{m_0\ell^2}{3}\alpha_0$$

$$\frac{m_0 g}{2}\times\frac{7}{25} - N_1\times 0.5\times\frac{4}{3} = \frac{m_0}{3}\alpha_0 = \frac{m_0}{3}\times\frac{36a}{25}$$

$$3.5 - N_1\frac{2}{3} = 1.2\,a$$

$$3.5 - 3.5a\times\frac{2}{3} = 1.2a$$

$$\Rightarrow 1.2a + \frac{7a}{3} = 3.5$$

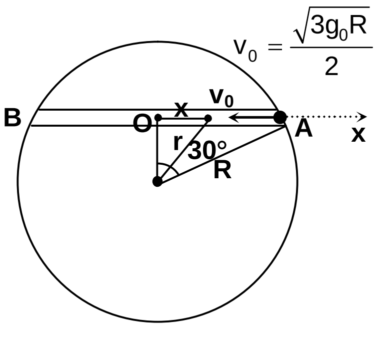
$$a = \frac{10.5}{10.6} \approx 1\text{ m/s}^2$$

From (iv)

$N_1 = 3.5\,a = 3.5 \times 1 = 3.5$ N

3. A, C

Sol. $$\frac{d^2x}{dt^2} = -\frac{GMr\cos\theta}{R^3} = -\left(\frac{GM}{R^3}\right)x = -\left(\frac{g_0}{R}\right)x$$



$$\omega = \sqrt{\frac{g_0}{R}}$$

Now, $x = A\sin(\omega t + \alpha)$

at $t = 0$, $x = +R/2$

$$\frac{R}{2} = A\sin\alpha \qquad \text{…(i)}$$

$V_x = \omega A\cos(\omega t + \alpha)$

at t = 0, $v_x = -\frac{\sqrt{3g_0R}}{2}$

$-\frac{\sqrt{3g_0R}}{2} = \sqrt{\frac{g_0}{R}}A\cos\alpha$

$-\frac{\sqrt{3}}{2}R = A\cos\alpha \qquad \ldots\text{(ii)}$

Solving (i) and (ii), we get

A = R, $\alpha = \frac{5\pi}{6}$

$\therefore\ x = R\sin\left(\sqrt{\frac{g_0}{R}}t + \frac{5\pi}{6}\right)$

$-\frac{R}{2} = R\sin\left(\sqrt{\frac{g_0}{R}}t + \frac{5\pi}{6}\right)$

$\frac{7\pi}{6} = \sqrt{\frac{g_0}{R}}t + \frac{5\pi}{6}$

$\therefore\ t = \frac{\pi}{3}\sqrt{\frac{R}{g_0}}$

$v_{max} = \omega A$

$v_{max} = \sqrt{\frac{g_0}{R}}R = \sqrt{g_0R}$

4. A, B, D

Sol. $A_r = \left(\frac{v_2 - v_1}{v_2 + v_1}\right)A_i = \left(\frac{\sqrt{\frac{F}{\mu_2}} - \sqrt{\frac{F}{\mu_1}}}{\sqrt{\frac{F}{\mu_2}} + \sqrt{\frac{F}{\mu_1}}}\right)A_i = \left(\frac{\sqrt{\mu_1} - \sqrt{\mu_2}}{\sqrt{\mu_1} + \sqrt{\mu_2}}\right)A_i = \left(\frac{3-1}{3+1}\right)3 = 1.5\,\text{cm}$

$$A_t = \left(\frac{2v_2}{v_2 + v_1}\right)A_i = \left(\frac{2\sqrt{\frac{F}{\mu_2}}}{\sqrt{\frac{F}{\mu_2}} + \sqrt{\frac{F}{\mu_1}}}\right)A_i = \left(\frac{2A_i}{1+\sqrt{\frac{\mu_2}{\mu_1}}}\right)_i = \left(\frac{2\times 3}{1+\frac{1}{3}}\right) = 4.5\,\text{cm}$$

Now, $\frac{P_r}{P_i} = \left(\frac{A_r}{A_i}\right)^2 = \left(\frac{1.5}{3}\right)^2 = \frac{1}{4}$

$\therefore$ The percentage of incident power reflected to the first string = $\frac{1}{4}\times 100 = 25\,\%$

The percentage of incident power transmitted to the second string = 100 − 25 = 75%

5. B, C

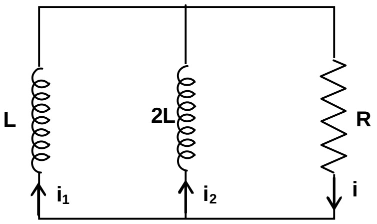
Sol. The electrostatic force between the hemispherical shells is

$F = \frac{\sigma_1\sigma_2\pi R^2}{2\varepsilon_0} = \frac{Q}{2\pi R^2}\frac{2Q}{8\pi R^2}\frac{\pi R^2}{2\varepsilon_0} = \frac{Q^2}{16\pi\varepsilon_0 R^2}$

The net electric potential at the centre 'O' of the sells is

$V_0 = \frac{KQ}{R} + \frac{2KQ}{2R} = \frac{2KQ}{R} = \frac{Q}{2\pi\varepsilon_0 R}$

6. A, D



Sol. $L\frac{di_1}{dt} = 2L\frac{di_2}{dt}$

$L\int_{I_0}^{i_1} di_1 = 2L\int_{I_0}^{i_2} di_2$

$i_1 - I_0 = 2(i_2 - I_0)$

$2i_2 - i_1 = I_0$ ...(i)

Now, $L\frac{di_1}{dt} + iR = 0$

$L\frac{di_1}{dt} + (i_1 + i_2)R = 0$

$L\frac{di_1}{dt} + \left(\frac{3i_1 + I_0}{2}\right)R = 0$

$\int_{I_0}^{i_1} \frac{di_1}{(3i_1 + I_0)} = -\frac{R}{2L}\int_0^t dt \Rightarrow \ell n\left(\frac{3i_1 + I_0}{4I_0}\right) = -\frac{3Rt}{2L}$

$\therefore\ i_1 = \frac{I_0}{3}\left(4e^{-\frac{3Rt}{2L}} - 1\right)$

$i_2 = \frac{I_0}{3}\left[2e^{-\frac{3Rt}{2L}} + 1\right]$

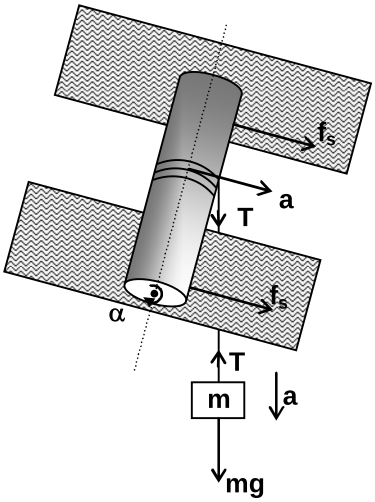
The energy stored in inductance 'L' in steady state = $\frac{1}{2}L\left(\frac{I_0}{3}\right)^2 = \frac{LI_0^2}{18}$

The energy stored in inductance '2L' in steady state = $\frac{1}{2}2L\left(\frac{I_0}{3}\right)^2 = \frac{LI_0^2}{9}$

The net heat dissipated in the resistor = $\frac{1}{2}\times 3LI_0^2 - \left[\frac{LI_0^2}{18} + \frac{LI_0^2}{9}\right] = \frac{4}{3}LI_0^2$

7. D

8. A



Sol. (for Q.7-8)

Current over the surface of cylinder is

$I = \frac{Q\omega}{2\pi}$

$B = \frac{\mu_0 I}{\ell} = \frac{\mu_0 Q\omega}{2\pi\ell}$

Electric field induced on the surface of the cylinder is

$E = \frac{R}{2}\frac{dB}{dt} = \frac{R}{2}\frac{\mu_0 Q}{2\pi\ell}\frac{d\omega}{dt}$

$E = \frac{\mu_0 Q\alpha R}{4\pi\ell} = \frac{\mu_0 Qa}{4\pi\ell}$ ...(i)

mg – T = ma ...(ii)

$TR - 2f_sR - QER = mR^2\alpha$

$T - 2f_s - QE = ma$ ...(iii)

$2f_s = ma$ ...(iv)

Adding (iii) and (iv), we get

$T - QE = 2ma$ …(v)
From (ii) and (v), we get
$mg - QE = 3ma$

$$mg - \frac{\mu_0 Q^2 a}{4\pi\ell} = 3ma$$

$mg - ma = 3ma$
$\therefore\ a = g/4$
Now from equation (ii)
$mg - T = ma$

$$T = mg - \frac{mg}{4} = \frac{3mg}{4}$$

9. C
10. D

Sol. (for Q.9-10)

$\Delta Q_{AB} = nC_P\Delta T = 2 \times \frac{5R}{2}(900 - 300) = 3000R$

In the process 'BC',
VT = constant
$PV^2 =$ constant

$\therefore\quad C = C_V + \frac{R}{1-x} = \frac{3R}{2} + \frac{R}{1-2} = \frac{R}{2}$

$\therefore\quad \Delta Q_{BC} = nC\Delta T = \frac{2R}{2}(300 - 900) = -600R$

$\Delta W_{BC} = \frac{nR\Delta T}{(1-x)} - \frac{2R(300-900)}{(1-2)} = 1200R$

$\Delta Q_{CA} = nRT_0\ell n\left(\frac{V_0}{9V_0}\right) = 2R \times 300\ell n\left(\frac{1}{9}\right) = -1200R\ell n(3) = -1200R \times 1.1 = -1320\ R$

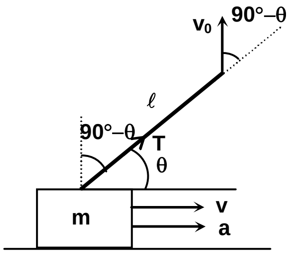
$\therefore\quad \Delta W_{cycle} = \Delta Q_{cycle} = \Delta Q_{AB} + \Delta Q_{BC} + \Delta Q_{CA} = 3000R - 600R - 1320R = 1080R$

$\therefore\quad$ Efficiency of cycle, $\eta = \frac{\Delta W_{cycle}}{\Delta Q_{supplied}} \times 100 = \frac{1080R}{3000R} \times 100 = 36\%$

SECTION – D

11. 00003.20

Sol. $v \cos\theta = v_0 \sin\theta$



$v = v_0 \tan\theta$ …(i)

$$a = v_0 \sec^2\theta \frac{d\theta}{dt}$$

$$a = v_0 \sec^2\theta\left(\frac{v_0\cos\theta + v\sin\theta}{\ell}\right) = \frac{v_0}{\ell}\sec\theta(v_0 + v\tan\theta)$$

$$a = \frac{v_0}{\ell}\sec\theta v_0(1 + \tan^2\theta)$$

a = $= \frac{v_0^2}{\ell}\sec^3\theta$ …(ii)

$T\sin\theta = mg$ …(iii)
$T\cos\theta = ma$ …(iv)
From (iii) and (iv)
$g = a\tan\theta$

$$g = \frac{v_0^2}{\ell}\sec^3\theta\tan\theta$$

$$v_0 = \sqrt{\frac{g\ell}{\sec^3\theta\tan\theta}} = \left(\frac{4}{5}\right)^2\sqrt{\frac{10\times1.5\times5}{3}} = 3.20\text{ m/s}$$

$v_0 = 3.20$ m/s

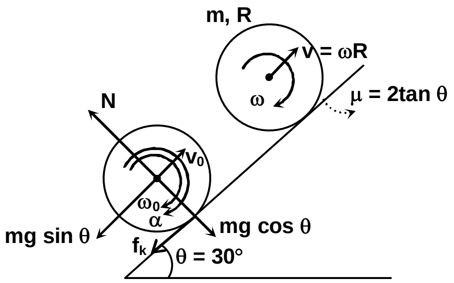
12. 00011.25

Sol. $N = mg\cos\theta$

$$f_k = \mu N = 2\tan\theta mg\cos\theta$$

$$f_k = 2mg\sin\theta$$

$$a = \frac{f_k + mg\sin\theta}{m} = 3g\sin\theta \qquad \ldots(i)$$



$\tau_{CM} = I_{CM}\alpha$

$$f_kR = \frac{2}{5}mR^2\alpha$$

$$\Rightarrow \quad 2mg\sin\theta = \frac{2}{5}m\alpha R$$

$$\alpha = \frac{5g\sin\theta}{R} \qquad \ldots(ii)$$

When pure rolling starts

$v = \omega R$

$v_0 - at = (\omega_0 + \alpha t)R$

$v_0 - 3g\sin\theta t = \omega_0R + 5g\sin\theta t$

$v_0 - \omega_0R = 8g\sin\theta t$

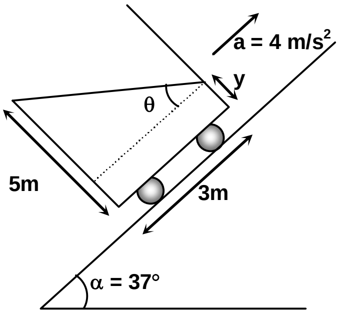
$$\therefore\ t = \frac{v_0}{12g\sin\theta}$$

$$\therefore\ v = v_0 - at = v_0 - 3g\sin\theta\times\frac{v_0}{12g\sin\theta} = v_0 - \frac{v_0}{4} = \frac{3v_0}{4}$$

$$\therefore\ v = \frac{3v_0}{4} = \frac{3\times15}{4} = 11.25\text{ m/s}$$

13. 00010.50

Sol.
$$\tan\theta = \frac{a+g\sin\alpha}{g\cos\alpha} = \frac{a+g\sin\alpha}{g\cos\alpha}$$



$$\frac{5-y}{3} = \frac{4+10\times\frac{3}{5}}{10\times\frac{4}{5}} \Rightarrow \frac{5-y}{3} = \frac{5}{4}$$

$\Rightarrow y = 1.25$ m

Volume of water remained in the container

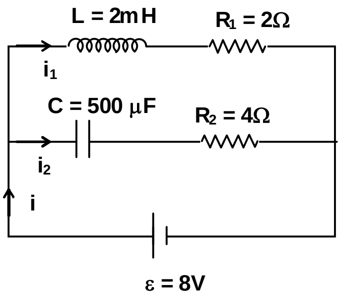
$$V = \frac{1}{2}(5+1.25)\times3\times4 = 6.25\times6 = 37.50\text{ m}^3$$

$\therefore$ volume of water spilt over the tank

$\Delta V = V_0 - V$

$= (3\times4\times4) - 37.50 = 10.50\text{ m}^3$

14. 00003.72



Sol. The current through the resistor ‘R_1’ is

$$i_1 = \frac{\varepsilon}{R_1}\left[1 - e^{\frac{R_1 t}{L}}\right]$$

$$i_1 = 4\left[1 - e^{-\frac{t}{10^{-3}}}\right] \qquad \ldots(i)$$

The current through the resistor ‘R_2’ is

$$i_2 = \frac{\varepsilon}{R_2}e^{-\frac{t}{R_2 C}}$$

$$i_2 = 2e^{-\frac{t}{2\times10^{-3}}} \qquad \ldots(ii)$$

The current through the battery

$I = i_1 + i_2$

$$I = 4\left[1 - e^{\frac{-t}{10^{-3}}}\right] + \left(2e^{\frac{-t}{2\times10^{-3}}}\right)$$

At $t = 1 \times 10^{-3}$ sec

$I = 4(1 - e^{-1}) + 2e^{-0.5}$

$I = 4(1-0.37) + (2 \times 0.60) = 3.72$ amp

15. 00005.25

Sol. Emf induced in the straight segment AC is $\varepsilon_{AC} = 0$

Emf induced in the circular arc CD is

$$\varepsilon_{CD} = \int_a^{5a/2} B\omega r dr = \frac{1}{2}B\omega\left[r^2\right]_a^{\frac{5a}{2}} = \frac{21}{8}B\omega a^2$$

$$= \frac{21}{8}\times 5\times 10\times(0.2)^2 = 5.25\text{ volt}$$

$$\therefore\ \varepsilon_{AD} = \varepsilon_{AC} + \varepsilon_{CD} = 0 + 5.25 = 5.25\text{ volt}$$

16. 00003.74

Sol. Least count of screw gauge, $\text{L.C.} = \frac{1\text{ mm}}{100} = 0.01\text{ mm}$

Diameter of the wire, d = 2 mm + 46 × L.C. + 4 × L.C.

= 2mm + 46 × 0.01 mm + 4 × 0.01 mm = 2.50 mm = 0.250 cm

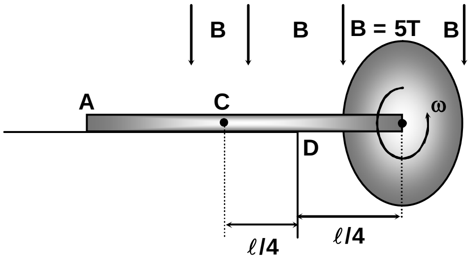
The length of wire, $\ell = 4.76$ cm

$\therefore$ The curved surface area of the wire, $S = \pi d\ell$

$$= \frac{22}{7}\times 0.250\times 4.76 = 3.74\text{ cm}^2$$

17. 00025.60

Sol. The magnetic moment of the disc is



$$M = \frac{q}{2m}\times\frac{mR^2\omega}{2} = \frac{q\omega R^2}{4} \qquad \ldots(i)$$

Magnetic torque on the disc

$$\tau = MB = \frac{q\omega R^2 B}{4} \qquad \ldots(ii)$$

For toppling of the rod about the edge at ‘D’

$$\frac{q\omega R^2 B}{4} > (m_0 - m)\frac{g\ell}{4}$$

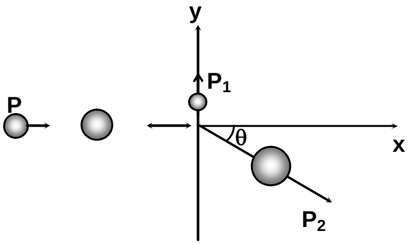
$$\omega > \frac{(m_0 - m)g\ell}{qBR^2}$$

$\omega > 25.60$

$\omega_{min} = 25.60$ rad/s

18. 00003.40

Sol. Using conservation of momentum



$P = P_2 \cos\theta$ …(i)

$P_1 = P_2 \sin\theta$ …(ii)

Squaring and adding, we get

$P^2 + P_1^2 = P_2^2$

$2mk + 2m_1k_1 = 2m_2K_2$

$4k + k_1 = 10k_2$

$10k_2 - k_1 = 4k$

$\therefore$ $10k_2 - k_1 = 44.$ …(iii)

Also, $k_1 + k_2 = k - |Q|$

$k_1 + k_2 = 11. - 2.86$

$k_1 + k_2 = 8.14$ …(iv)

Adding (iii) and (iv), we get

$11k_2 = 52.14$

$\therefore$ $k_2 = 4.74$ MeV

$\therefore$ $k_1 = 8.14 - 4.74$

$k_1 = 3.40$ MeV

Chemistry PART – II

SECTION – A

19. B, C, D

Sol. (A) For real gas $\frac{dU}{dV} = \frac{an^2}{V^2}$ i.e. internal energy is volume dependent also.

(B) $Z > 1 \Rightarrow V_{real} > V_{ideal}$ so forces of repulsion are dominant.

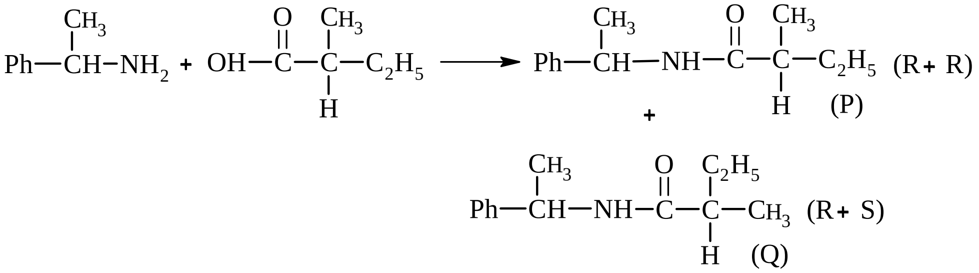
(D) For ideal gas $\Delta U = 0$ but for real gas $\Delta U \neq 0$.

20. A, C

Sol. 1^0 amines give carbylamines reaction

21. A, B

Sol.



$$\mathrm{Ph-\overset{CH_3}{\overset{|}{C}}H-NH_2 + OH-\overset{O}{\overset{\|}{C}}-\underset{H}{\underset{|}{\overset{CH_3}{\overset{|}{C}}}}-C_2H_5 \longrightarrow Ph-\overset{CH_3}{\overset{|}{C}}H-NH-\overset{O}{\overset{\|}{C}}-\underset{H}{\underset{|}{\overset{CH_3}{\overset{|}{C}}}}-C_2H_5\ (R+R)\ (P)}$$

$$\mathrm{+\ Ph-\overset{CH_3}{\overset{|}{C}}H-NH-\overset{O}{\overset{\|}{C}}-\underset{H}{\underset{|}{\overset{C_2H_5}{\overset{|}{C}}}}-CH_3\ (R+S)\ (Q)}$$

22. A, D

Sol. (D) The reducing character of hydrides of 15 group elements increases from NH_3 to BiH_3.

23. A, C, D

Sol. As Ni is added, CO will be consumed to attain the third equilibrium. As concentration of CO decreases, $COCl_2$ will decompose to a higher extent and hence Cl_2 concentration increases which in turn decreases the concentration of PCl_3.

24. B, C

Sol. In $F_2C = C = CF_2$

Terminal C-atoms are sp^2 hybridised, one sp^2 hybridised orbital comes in the horizontal plane and other sp^2 hybridised orbital appears on the vertical plane.

In N_2H_4, the nitrogen atoms are sp^3 hybridised.

25. B

Sol. Meq of $H_3PO_4 = 300 \times 0.1 = 30$

Meq of $NaOH = 50 \times 0.1 = 5$

$H_3PO_4 + NaOH = NaH_2PO_4 + H_2O$

H_3PO_4	$NaOH$	NaH_2PO_4	H_2O
30	5	0	0
25	0	5	5

Solution is buffer

$$pH = P^{ka_1} + \log \frac{5}{25} \Rightarrow 3 + \log 1/5$$

$$\Rightarrow 2.3010$$

26. A

Sol. At point 'C' a buffer of $H_2PO_4^- \; \& \; HPO_4^{2-}$ exists.

27. A

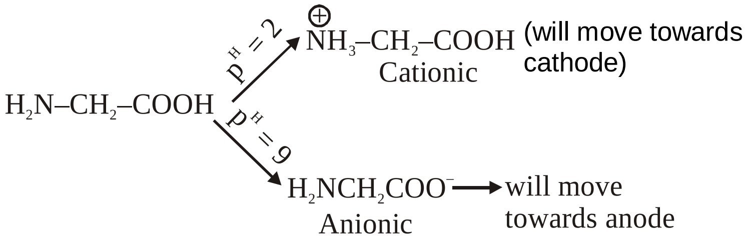
Sol. $\mathrm{pI} = \dfrac{\mathrm{pKa_1} + \mathrm{pKa_2}}{2}$

Isoelectric point (PI) $= \dfrac{\mathrm{pK_{a_1}} + \mathrm{pK_{a_2}}}{2}$

$= \dfrac{1.9 + 3.7}{2} = \dfrac{5.6}{2} = 2.8$

28. A

Sol.


H₂N–CH₂–COOH
pH = 2
⊕NH₃–CH₂–COOH
Cationic
(will move towards cathode)
pH = 9
H₂NCH₂COO⁻
Anionic
will move towards anode

SECTION – D

29. 00001.46

Sol. Suppose relative reactivity for 3° H is x
and suppose relative reactivity for 1° H is Y
So with the given information

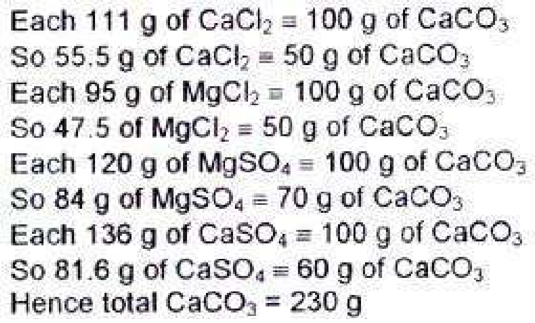
$\dfrac{9y}{9y + x} = 0.86 \; \dfrac{x}{9y + x} = 0.14$

So $\dfrac{9y}{0.86} = \dfrac{x}{0.14}$

Hence, $\dfrac{x}{y} = \dfrac{9 \times 0.14}{0.86} = 1.46$

30. 00023.00

Sol.



Each 111 g of $CaCl_2 \equiv$ 100 g of $CaCO_3$
So 55.5 g of $CaCl_2 \equiv$ 50 g of $CaCO_3$
Each 95 g of $MgCl_2 \equiv$ 100 g of $CaCO_3$
So 47.5 of $MgCl_2 \equiv$ 50 g of $CaCO_3$
Each 120 g of $MgSO_4 \equiv$ 100 g of $CaCO_3$
So 84 g of $MgSO_4 \equiv$ 70 g of $CaCO_3$
Each 136 g of $CaSO_4 \equiv$ 100 g of $CaCO_3$
So 81.6 g of $CaSO_4 \equiv$ 60 g of $CaCO_3$
Hence total $CaCO_3$ = 230 g

Degree of hardness $= \dfrac{230 \text{ g}}{10{,}000 \, \ell\text{t}} = 23 \text{ mg / litre} = 23 \text{ ppm.}$.

31. 00002.81

Sol. $K = \frac{0.693}{12}$

$t = \frac{2.303}{0.693} \times t_{1/2} \log \frac{1}{0.85}$

t = 2.81 mins.

32. 00002.64

Sol. $z = 4 - \frac{4 \times 0.25}{100} = 3.99$

$$\rho = \frac{z \times M}{a^3 \times N_A \times 10^{-30}} \text{ g/cc}$$

$$= \frac{3.99 \times 50}{(500)^3 \times 6.023 \times 10^{23} \times 10^{-30}} \text{ g/cc}$$

$= 2.64 \text{ g/cc}$

33. 00006.44

Sol. $w = \frac{E \times I \times t}{96500}$

$w = d \times V$

$= 19.3 \text{ g cm}^{-3} \times \pi \times 2.5 \times 2.5 \times 0.02 \text{ cm}^{-3}$

$w = 7.575 \text{ g}$

$t = \frac{7.575 \times 96500 \times 3}{197 \times 0.02}$

$= 556589.5 \text{ sec}$

$\approx 6.44 \text{ days}$

34. 00083.50

Sol. $2C_2H_6(g) + 7O_2(g) \longrightarrow 4CO_2(g) + 6H_2O(\ell) \quad \Delta H = -3129\text{KJ}$

$\Delta H = \sum \Delta H_{f(\text{Product})} - \sum \Delta H_{f(\text{reactants})}$

$-3129 = [4 \times (-395) + 6 \times -(286)] - [2 \times \Delta H_f C_2H_6 + 7 \times 0]$

$\Delta H_{fC_2H_6} = -83.5\text{KJ}$

35. 00014.64

Sol.

No. of equivalent of $Na_2S_2O_3 = \frac{100 \times 0.15}{1000} = 0.015$

Let mass of $K_2Cr_2O_7 = a$

Mass of $KMnO_4 = 0.5 - a$

$\therefore$ No of equivalent of $K_2Cr_2O_7 = \frac{a}{49}$

No. of equivalent of $KMnO_4 = = \frac{0.5 - a}{31.6}$

$$\therefore \frac{a}{49} + \frac{0.5 - a}{31.6} = 0.015$$

$a = 0.0732$

% of $K_2Cr_2O_7 = \frac{0.0732}{0.5} \times 100$

= 14.64%

36. 00001.48

Sol.

$$\frac{r_{mix}}{r_{SO_2}} = \sqrt{\frac{M_{SO_2}}{M_{mix}}}, \quad 1.6 = \sqrt{\frac{M_{SO_2}}{M_{mix}}}$$

$M_{mix} = 25$

Let mole fraction of F_2 be 'x'

$$25 = \frac{38x + (1 - x) \times 19}{1}$$

X = 0.3158

$$K_P = \frac{(0.6842P)^2}{0.3158P} = 1.48 \text{ atm } (P = 1)$$

Mathematics PART – III

SECTION – A

37. A, C

Sol. Equation of AB $\Rightarrow$ $y = \frac{4}{3}(x+1)$

AC $\Rightarrow$ $y = -\frac{4}{3}(x-1)$

BC $\Rightarrow$ y = 0

Distance of P from AB = $d_1 = \frac{1}{5}|4x - 3y + 4|$

Distance of P from AC = $d_2 = \frac{1}{5}|4x + 3y - 4|$

Distance of P from BC = $d_3 = |y|$

According to question $d_1d_2 = d_3^2$
$\Rightarrow |16x^2 - (3y - 4)^2| = 25y^2$
$\Rightarrow$ Circle S: $2x^2 + 2y^2 + 3y - 2 = 0$ and hyperbola T: $8x^2 - 17y^2 + 12y - 8 = 0$

38. A, C, D
Sol. Let $f(x) = (1 + x)(1 + x^2) \ldots\ldots (1 + x^{2070})$
Then A must be the sum of coefficient of x^{9k} where k is non-negative integer

$$A = \frac{2^{2070} + 8.2^{230}}{9}$$

39. B, C

Sol. Let $a = a_1 + ia_2$; $c = c_1 + ic_2$, then $\frac{a_1}{a_2} \times \frac{c_1}{c_2} = -1$

$\Rightarrow a_1c_1 + a_2c_2 = 0$
$\Rightarrow \left(\frac{a+\bar{a}}{2}\right)\left(\frac{c+\bar{c}}{2}\right) + \left(\frac{a-\bar{a}}{2i}\right)\left(\frac{c-\bar{c}}{2i}\right) = 0$
$\Rightarrow a\bar{c} + \bar{a}c = 0$
$\therefore$ $a\bar{c}$ is purely imaginary

Also $\frac{a}{c} = -\frac{\bar{a}}{\bar{c}}$

$\Rightarrow \frac{a}{c}$ is purely imaginary

$\Rightarrow \arg\left(\frac{a}{c}\right) = \pm\frac{\pi}{2}$

40. A, B

Sol. $^nC_7 = \frac{n(n-1)(n-2)(n-3)(n-4)(n-5)(n-6)}{7!}$

Obviously one of the seven numerator factors must be divisible by 49.

Of any 49 consecutive integer exactly seven satisfy the condition $P\left(\frac{^nC_7}{7}\right) = \frac{7}{49} = \frac{1}{7}$

$$^{n}C_7 = \frac{n(n-1)(n-2)(n-3)(n-4)(n-5)(n-6)}{7!}$$

So for $\frac{^{n}C_7}{7}$ to be divisible by 12

S = n(n – 1)(n – 2)(n – 3)(n – 4)(n – 5)(n – 6) must be divisible by = 64.27 $\Rightarrow 2^6 \cdot 3^3$

Any one of the seven factors must be divisible by 9. So, here only 7 favourable choices

Also, if n is even then S is divisible by 64 and if n is odd then one after the (n – 1), (n – 3), (n – 5) must be divisible by 16

So we have 13 favourable choices out of 16 consecutive numbers

Required probability that $^{n}C_7$ divisible by 12 = $\frac{7 \times 13}{144}$

41. B, C

Sol. $\Delta = 16\cos^2\theta - 4\cot\theta = 0$

or $4\cot\theta(2\sin 2\theta - 1) = 0$

$2\sin 2\theta - 1 = 0$

$$\theta = \frac{n\pi}{2} + (-1)^n \frac{\pi}{12}$$

$$\theta = \frac{\pi}{12}, \frac{5\pi}{12}$$

42. A, B, C, D

Sol. $I = \frac{1}{2}\int_0^{\pi} 2\cos mx \cdot \sin nx dx = \frac{1}{2}\int_0^{\pi}\left[\sin(m+n)x + \sin(n-m)x\right]dx$

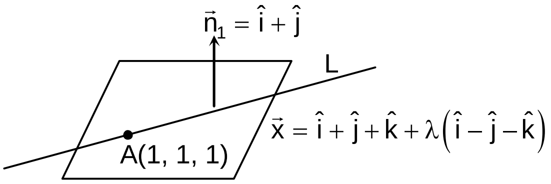
$$= -\frac{1}{2}\left[\left\{\frac{(-1)^{m+n}}{m+n} + \frac{(-1)^{n-m}}{n-m}\right\} - \left\{\frac{1}{m+n} + \frac{1}{n-m}\right\}\right] \text{ for } k \in I \left[\because \cos k\pi = (-1)^k\right]$$

$$\Rightarrow I = \begin{cases} \dfrac{2n}{n^2 - m^2} & \text{If } n-m \text{ is odd} \\ 0 & \text{If } n-m \text{ is even} \end{cases}$$

43. A

44. B

Sol. (43.-44.) $\left(x\hat{i} + y\hat{j} + z\hat{k}\right) \cdot \left(\hat{i} + \hat{j}\right) = 2$


$\vec{n}_1 = \hat{i} + \hat{j}$
L
$\vec{x} = \hat{i} + \hat{j} + \hat{k} + \lambda\left(\hat{i} - \hat{j} - \hat{k}\right)$
A(1, 1, 1)

x + y = 2 ..... plane π_1

$$\overrightarrow{AB} \times \vec{V} = \vec{n}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 0 & 1 \\ 1 & -1 & -1 \end{vmatrix}$$

$$\vec{n}_2 = \hat{i} + 2\hat{j} - \hat{k}$$

$$\cos\theta = \frac{\vec{n}_1 \cdot \vec{n}_2}{|\vec{n}_1||\vec{n}_2|}$$

$$\cos\theta = \left|\frac{\left(\hat{i} + \hat{j}\right) \cdot \left(\hat{i} + 2\hat{j} - \hat{k}\right)}{\sqrt{2}\sqrt{6}}\right| = \frac{3}{\sqrt{2} \cdot \sqrt{6}} = \frac{\sqrt{3}}{2}$$

$$\Rightarrow \theta = \cos^{-1}\frac{\sqrt{3}}{2} \Rightarrow \theta = \frac{\pi}{6}$$

45. B

46. A

Sol. (45.-46.) $|z_1| = 2$

$$3\left(\frac{z_1}{z_2}\right)^2 - 2\left(\frac{z_1}{z}\right) + 2 = 0$$

$$\frac{z_1}{z_2} = \frac{2 \pm \sqrt{-20}}{6} = \frac{1 \pm \sqrt{5}\,i}{2}$$

$$\frac{|z_1|}{|z_2|} = \frac{\sqrt{6}}{3} = \frac{\sqrt{2}}{\sqrt{3}} \Rightarrow |z_2| = \sqrt{6}$$

a = 2, $b = \sqrt{6}$

$$e = \sqrt{1 - \frac{b^2}{a^2}} = \frac{1}{\sqrt{3}}$$

Let $\frac{z_1}{z_2} = \frac{1}{3} + \frac{\sqrt{5}}{3}i = \frac{\sqrt{6}}{3}\left(\frac{1+\sqrt{5}}{\sqrt{6}}i\right)$

$$\sin\theta = \frac{\sqrt{5}}{\sqrt{6}}$$

$$\Delta OPQ = \frac{1}{2}|z_1|\,|z_2|\sin\theta = \frac{1}{2} \times 2 \times \sqrt{6} \times \frac{\sqrt{5}}{\sqrt{6}} = \sqrt{5}$$

SECTION – D

47. 02021.00

Sol. $\lim\limits_{n\to\infty} n^2 \int_{-\frac{1}{n}}^{\frac{1}{n}} (2019\sin x + 2021\cos x)|x|dx$ = $\lim\limits_{n\to\infty} n^2 \cdot 4042\int_0^{\frac{1}{n}} x\cos x\,dx$

$$= \frac{4042 \times \frac{1}{n}\cos\left(\frac{1}{n}\right)\left(-\frac{1}{n^2}\right)}{\frac{2}{n^3}} = 2021$$

48. 02000.00

Sol. Let $\vec{\alpha} = 3\hat{i} + 4\hat{j} + 10\hat{k}$ and $\vec{\beta} = a\hat{i} + b\hat{j} + c\hat{k}$

$$S = \vec{\alpha}\cdot\vec{\beta} = |\vec{\alpha}||\vec{\beta}|\cos\theta \le |\vec{\alpha}||\vec{\beta}| \le \sqrt{2000}$$

49. 00021.00

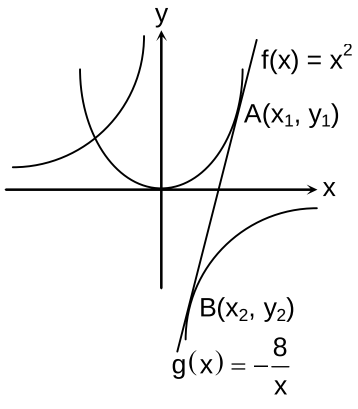
Sol. y = x^2 and $y = -\frac{8}{x}$

$\Rightarrow y_1 = x_1^2$ and $y_2 = -\frac{8}{x_2}$

Equality $\frac{dy}{dx}$ at A and B, we get $2x_1 = \frac{8}{x_2^2}$

$\Rightarrow x_1x_2^2 = 4$

$$m_{AB} \Rightarrow 2x_1 = \frac{x_1^2 + \frac{8}{x_2}}{x_1 - x_2}$$



$\Rightarrow x_1 = 4$ and $x_2 = 1$, $y_1 = 16$ $\therefore$ $x_1 + y_1 + x_2 = 21$

50. 00503.50

Sol. From the relation between the zeros and the coefficient we obtain

$\sum x_1x_2.....x_{1007} = 1008$ and x_1x_2 ..... $x_{1008} = 1$

Hence, $\sum_{i=1}^{1008} \frac{1}{x_i} = 1008$

So we have the equality case in the A.M. – G.M. inequality

So $x_1 = x_2$ ..... $= x_{1008} = 1$

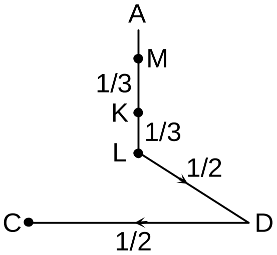
$\Rightarrow a_2 = \frac{1008^2 - 1008}{2}$; $a_1 = -1008$

So $\frac{a_2}{|a_1|} = 503.50$

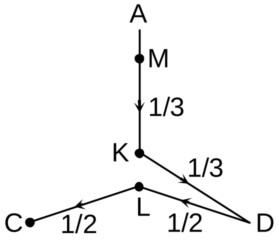
51. 00008.00

Sol. Possible path mouse can reach C

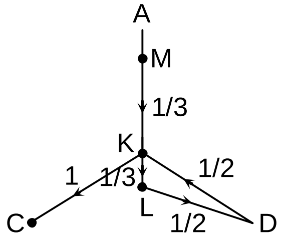
(i)



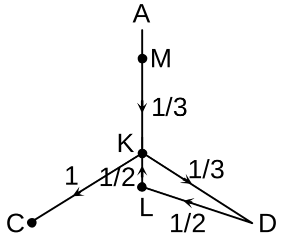
(ii)



(iii)



(iv)



Hence the required probability

$= \frac{1}{3}\times\frac{1}{3}\times\frac{1}{2}\times\frac{1}{2}+\frac{1}{3}\times\frac{1}{3}\times\frac{1}{2}\times\frac{1}{2}+\frac{1}{3}\times\frac{1}{3}\times\frac{1}{2}\times\frac{1}{2}\times1+\frac{1}{3}\times\frac{1}{3}\times\frac{1}{2}\times\frac{1}{2}\times1$

$= \frac{1}{9}$

52. 00071.00

Sol. $\sin\frac{\pi}{7}\sin\frac{2\pi}{7}\sin\frac{3\pi}{7}\sin\frac{4\pi}{7}\sin\frac{5\pi}{7}\sin\frac{6\pi}{7}$

$\Rightarrow \left(\sin\frac{\pi}{7}\sin\frac{2\pi}{7}\sin\frac{4\pi}{7}\right)^2$

Let $7\theta = \pi$

$\Rightarrow 3\theta + 4\theta = \pi$

$\Rightarrow 4\theta = \pi - 3\theta$

$\Rightarrow \sin 4\theta = \sin(\pi - 3\theta)$

$\Rightarrow \sin 4\theta = \sin 3\theta$

$\Rightarrow 4 \sin\theta \cos\theta(\cos 2\theta) = 3 \sin\theta - 4 \sin^3\theta$

$\Rightarrow 16 \cos^2\theta(\cos 2\theta)^2 = (3 - 4 \sin^2\theta)^2$

$\Rightarrow 16(1 - \sin^2\theta)(1 - 2 \sin^2\theta)^2 = (3 - 4 \sin^2\theta)^2$

$\Rightarrow -64 \sin^6 \theta + 80 \sin^4 \theta - 80 \sin^2 \theta + 16 = 16 \sin^4 \theta + 9 - 24 \sin^2 \theta$

$\Rightarrow 64 \sin^6 \theta - 66 \sin^4 \theta + 56 \sin^2 \theta - 7 = 0$

$\Rightarrow \left(\sin\frac{\pi}{7}\sin\frac{2\pi}{7}\sin\frac{3\pi}{7}\right)^2 = \frac{7}{64}$

53. 00002.50

Sol. $y^2 = x^2 - x + 1 \Rightarrow 2y\frac{dy}{dx} = 2x - 1$

$AI_3 + BI_2 + CI_1 = x^2y$

$\Rightarrow \int \frac{Ax^3 + Bx^2 + Cx}{y}dx = x^2y$

$\Rightarrow \frac{Ax^3 + Bx^2 + Cx}{y} = x^2\frac{dy}{dx} + 2xy$

$\Rightarrow Ax^3 + Bx^2 + Cx = 3x^3 - \frac{5x^2}{2} + 2x$

$\Rightarrow A = 3, B = -\frac{5}{2}, C = 2$

So, A + C = 5

54. 00007.00

Sol. Substitute t = sin x and $g(t) = t + \frac{2}{3+t} + b$

Since g(t) is an increasing function in the interval [–1, 1]

It follows that f(b) = max(|g(–1)|, |g(1)|) = $\max\left(|b|, \left|b + \frac{3}{2}\right|\right)$

From the graph we conclude that min f(b) = $f\left(-\frac{3}{4}\right) = \frac{3}{4}$

So p + q = 7

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – IX

JEE (Advanced)-2019

PAPER – 1

TEST DATE: 28-04-2019

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01– 06, 19 – 24, 37 - 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*

   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 - 46) *contains 12 questions. Based on this section contains* ***TWO (02)*** *paragraphs. Based on each paragraph, there are* ***TWO (02)*** *questions.*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics PART – I

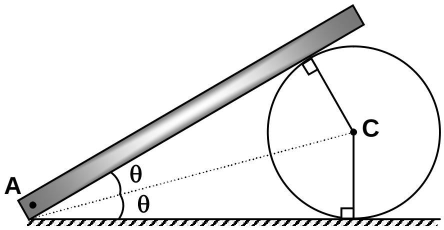
SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

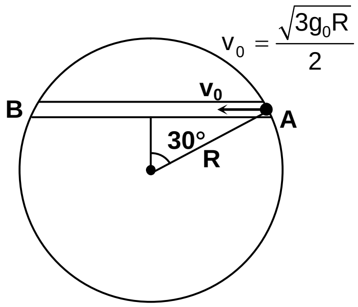
1. A particle starts moving in a plane with constant tangential acceleration a_t = 2 m/s^2 and normal acceleration $a_n = t^4$. Then choose the correct option(s).
   - (A) The acceleration of the particle is $2\sqrt{5}$ m/s^2 after having covered a distance S = 2m.
   - (B) The acceleration of the particle is $2\sqrt{2}$ m/s^2 after having covered a distance S = 2m.
   - (C) The radius of curvature of its trajectory is 4m after having covered a distance S = 1m.
   - (D) The radius of curvature of its trajectory is 2m after having covered a distance S = 1m.

2. A solid sphere of mass m = 2.4 kg and radius R = 0.5 m is placed on a rough horizontal surface. A uniform rod AB of mass m_0 = 2.5 kg and length ℓ = 1m hinged at one end 'A' is resting on the sphere as shown. The rod makes an angle '2θ' = 74° with the horizontal surface initially and then the system is released from rest. There is no slipping between the sphere and horizontal surface and there is no friction between the rod and sphere. Then choose the correct option(s).



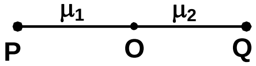
   - (A) The acceleration of sphere just after release is (approx) 1 m/s^2.
   - (B) The acceleration of sphere just after release is (approx) 2 m/s^2.
   - (C) The normal force between the rod and sphere just after release is (approx) 6.5 N.
   - (D) The normal force between the rod and sphere just after release is (approx) 3.5 N.

3. A tunnel is dug across the earth along a chord AB as shown. A particle is projected inside the tunnel from end 'A' with an initial velocity $v_0 = \frac{\sqrt{3g_0R}}{2}$, there is no friction between the tunnel and the particle. Then choose the correct option(s). (where g_0 = gravitational acceleration on the surface of Earth, R = radius of earth)



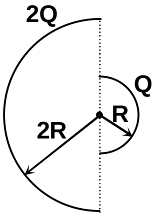
   - (A) The time taken by the particle to move from end 'A' to other end 'B' of the tunnel is $\frac{\pi}{3}\sqrt{\frac{R}{g_0}}$.
   - (B) The time taken by the particle to move from end 'A' to other end 'B' of the tunnel is $\frac{2\pi}{3}\sqrt{\frac{R}{g_0}}$.
   - (C) The maximum speed of the particle inside the tunnel is $\sqrt{g_0R}$.
   - (D) The maximum speed of the particle inside the tunnel is $\sqrt{2g_0R}$.

4. Two strings of equal radii but mass per unit length $\mu_1 = 0.9$ kg/m and $\mu_2 = 0.1$ kg/m are joined together and stretched between two rigid supports as shown. A sinusoidal wave pulse of amplitude 3 cm is incident from end 'P' and transmission and reflection both take place at the joint 'O'. There is no loss of power during propagation of the wave. Then choose the correct option(s).



(A) The amplitude of the reflected wave is 1.5 cm.
(B) The amplitude of the transmitted wave is 4.5 cm
(C) The percentage of incident power transmitted to the second string is 60%.
(D) The percentage of the incident power reflected to the first string is 25%.

5. Two hemispherical thin shells made of insulating materials are concentrically arranged in a free space as shown. The radii of the smaller and larger hemispheres are 'R' and '2R' and they carry positive charges 'Q' and '2Q' respectively. The charges are uniformly distributed over the surfaces of the shells. Then choose the correct option(s).



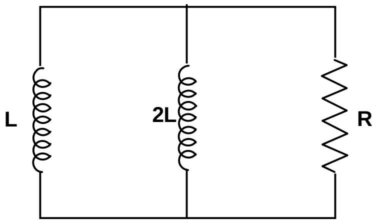
(A) The electrostatic force between the hemispherical shells is $\frac{Q^2}{8\pi\varepsilon_0 R^2}$

(B) The electrostatic force between the hemispherical shells is $\frac{Q^2}{16\pi\varepsilon_0 R^2}$

(C) The net electric potential at the centre 'O' of the shells is $\frac{Q}{2\pi\varepsilon_0 R}$

(D) The net electric potential at the centre 'O' of the shells is $\frac{3Q}{2\pi\varepsilon_0 R}$

6. A parallel circuit consists of the two ideal inductances 'L' and '2L' and a resistance 'R' as shown. At t = 0, the same current 'I_0' is flowing in both the inductances in the same direction. Then choose the correct option(s).



(A) The energy stored in inductance 'L' in steady state is $\frac{LI_0^2}{18}$.

(B) The energy stored inductance '2L' in steady state is zero.

(C) The net heat dissipated in the resistor is $\frac{3LI_0^2}{2}$

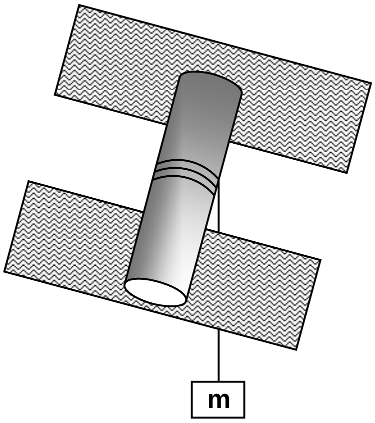
(D) The net heat dissipated in the resistor is $\frac{4}{3}LI_0^2$

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 7 and 8

Charge 'Q' is uniformly distributed on the non conducting surface of a thin uniform long hollow cylinder of mass 'm' radius 'R' and length 'ℓ'. It is placed on two stationary rough horizontal planks. A string is wound over the cylinder whose other end is attached to a block of same mass 'm'. When the system is released from rest, the cylinder starts rolling without slipping relative to the planks. Now answer the following questions. (Take $\frac{\mu_0 Q^2}{4\pi\ell} = m$)



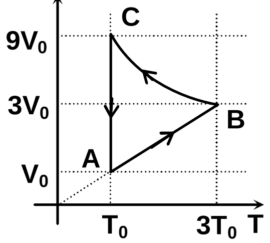
7. The acceleration of the hollow cylinder is
   (A) 2g
   (B) $\frac{3g}{4}$
   (C) $\frac{g}{2}$
   (D) $\frac{g}{4}$

8. The tension in the string is
   (A) $\frac{3mg}{4}$
   (B) $\frac{3mg}{2}$
   (C) $\frac{mg}{4}$
   (D) $\frac{mg}{2}$

Paragraph for Question Nos. 9 and 10

Two moles of an ideal mono-atomic gas is taken through a cyclic process ABCA as shown in the V-T diagram. In the process BC, VT = constant. The temperature at A is T_0 = 300 K. [take $\ell n(3) = 1.1$]

Then answer the following questions.



9. The work done by the gas during the process 'BC' is
   - (A) 600 R
   - (B) 900 R
   - (C) 1200 R
   - (D) 1500 R

10. The efficiency (in percentage) of the cycle is
   - (A) 12
   - (B) 18
   - (C) 24
   - (D) 36

SECTION – D

(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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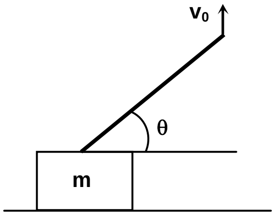
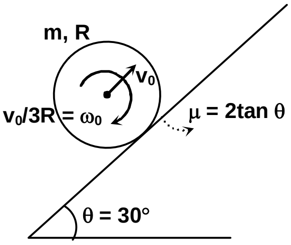
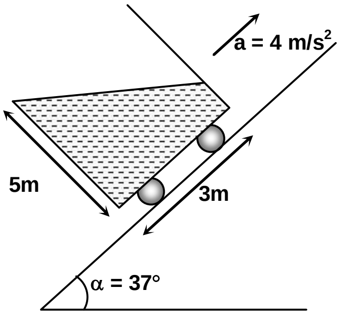
11. A small block of mass m = 2 kg is placed on a smooth horizontal surface. A massless inextensible string of length ℓ = 1.5 m with one end attached to the block is initially held in horizontal position. With what constant velocity v_0 (in m/s) the free end of the string is moved in vertical upward direction so that the block will leave the horizontal surface, when the string makes an angle θ = 37° with the horizontal surface. (take g = 10 m/s^2 and tan 37° = 0.75)



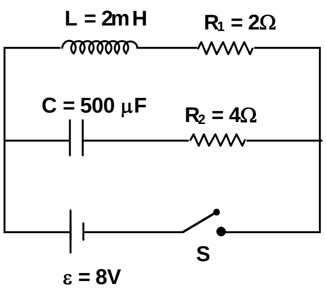
12. A solid sphere of mass m = 3 kg and radius R = 10 cm is projected up an inclined plane of inclination θ = 30° with an initial velocity v_0 = 15 m/s and initial angular velocity $\omega_0 = \dfrac{v_0}{3R}$ as shown. The coefficient of friction between the sphere and inclined plane is μ = 2 tan θ. Then find the velocity (in m/s) of the sphere, when it will start rolling without slipping relative to the inclined plane.



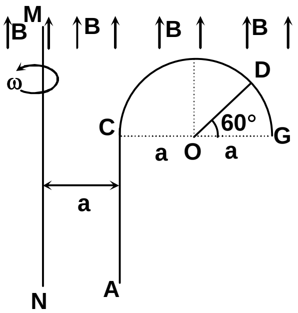
13. An open rectangular tank of base area (3m × 4m) and height 5 m filled with water upto height 4m is accelerated up an inclined plane of inclination α = 37° with an acceleration a = 4 m/s^2. Find the volume (in m^3) of water that will spill over the tank. (take g = 10 m/s^2)



14. In the adjacent circuit the switch 'S' is closed at t = 0. Then find the current (in amp) through the battery at t = 1 × 10^{-3} sec. (take e^{-1} = 0.37, $e^{-0.5}$ = 0.60)

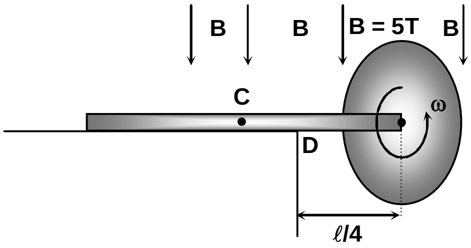


15. A conductor ACDG consists of a straight segment AC = 0.5 m and a semicircular arc CDG of radius a = 20 cm. A uniform vertical magnetic field B = 5 Tesla is existing in the region. Now the conductor is rotated with a constant angular velocity ω = 10 rad/s about a vertical axis MN parallel to the magnetic field as shown. Then find the emf (in volt) induced between the points A and D of the conductor as shown.



16. The pitch of a screw gauge is 1 mm and its cap is divided into 100 divisions. When nothing is placed between its studs, the zero of circular scale is 4 divisions above the reference line. When a wire is placed between its studs, the main scale reading is 2 mm and 46th division of circular scale coincides with the reference line. The length of wire is 4.76 cm. Find the curved surface area (in cm^2) of the wire in true significant figures.

17. Charge q = 0.5 coulomb is uniformly distributed over the surface of a non conducting circular disc of mass m = 0.2 kg and radius R = 0.5 m. The disc is mounted at one end of a uniform rod of mass m_0 = 1 kg and length ℓ = 2m so that the plane of disc is perpendicular to the length of rod and the rod is placed on a rough horizontal surface with $\ell/4$ length of the rod is protruded over the edge of the surface as shown. A uniform vertical downward magnetic field B = 5T is existing in the region. Find the minimum counter clockwise (when viewed from right side of the disc) angular velocity 'ω' (in rad/s) with which the disc is rotated about its horizontal axis so that the rod will topple about the edge (at point D) of the horizontal surface.



18. When an α-particle with kinetic energy K = 11 MeV collides with a stationary lithium nucleus, the following nuclear reaction takes place

$${}^4\text{He} + {}^7\text{Li} \to {}^{10}\text{B} + \text{n}$$

If Q – value of this reaction is E = –2.86 Mev. Find the kinetic energy (in MeV) of the neutron outgoing at right angle to the incoming direction of α-particle.

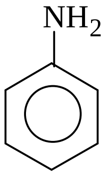
Chemistry PART – II

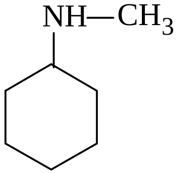
SECTION – A
(One or More than one correct type)

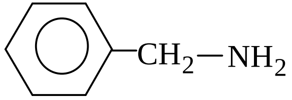
This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

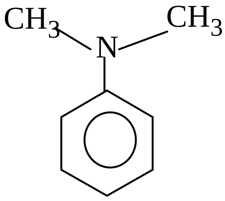
19. For a real gas obeying van der waal's equation which of the following are true?
(A) Internal energy of gas is dependent on temperature only
(B) If Z > 1 then forces of repulsion are dominant
(C) At high pressure $Z = \left(1 + \frac{Pb}{RT}\right)$
(D) Work done in expansion of a real gas is more than for an ideal gas under isothermal conditions.

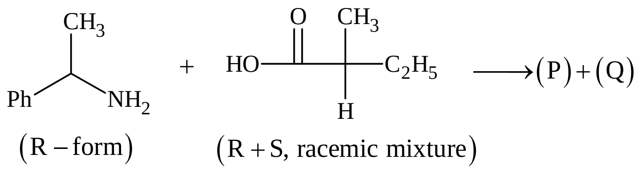
20. Which of the following compounds give carbylamine when reacted with $CHCl_3$ and ethanolic KOH ?

(A)


(B)


(C)


(D)


21.


The correct statement regarding compound (P) & (Q) is/are:
(A) Both are optically active in nature
(B) (P) & (Q) are diastereomers
(C) (P) & (Q) are meso compounds
(D) Out of (P) & (Q) one is optically active and other is optically inactive

22. Which of the following order is/are incorrect ?
    - (A) $H_3PO_4 > H_3PO_3 > H_3PO_2$ (reducing character)
    - (B) $N_2O < NO < N_2O_3 < N_2O_5$ (oxidation state of nitrogen atom)
    - (C) $NH_3 > PH_3 > AsH_3 > SbH_3$ (Basic)
    - (D) $SbH_3 > NH_3 > AsH_3 > PH_3$ (reducing character)

23. Following two equilibria are simultaneously established in a container

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)\ ;\ CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$$

If some Ni(s) is introduced in the container establishing another equilibrium

$$4CO(g) + Ni(s) \rightleftharpoons Ni(CO)_4(g)$$

Which among the following statements is/are definitely true about this system?
- (A) $COCl_2$ concentration decreases as the new equilibrium is established.
- (B) As Ni is a solid it will not have any impact on the existing two equilibrium reactions.
- (C) PCl_3 concentration decreases to re-attain the equilibrium.
- (D) PCl_5 concentration increases to attain the new equilibrium.

24. Which of the following molecules is/are planar?
    - (A) $F_2C = C = CF_2$
    - (B) $F_2B – CH = CH – BF_2$
    - (C) $(SiH_3)_3N$
    - (D) $H_2N – NH_3$

(Paragraph Type)

This section contains **TWO** paragraphs. Based on each paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 25 and 26

When H_3PO_4 solution is titrated against NaOH reactions occurs in three steps

$H_3PO_4 + NaOH \rightarrow NaH_2PO_4 + H_2O$

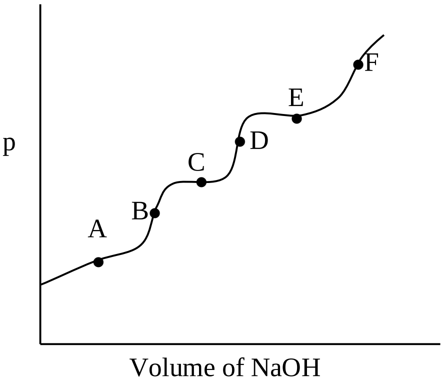
$NaH_2PO_4 + NaOH \rightarrow Na_2HPO_4 + H_2O$

$Na_2HPO_4 + NaOH \rightarrow Na_3PO_4 + H_2O$

If 0.1M of 300ml H_3PO_4 is titrated using 0.1M NaOH then titration curve pH vs volume of NaOH is given below

$Ka_1 (H_3PO_4) = 10^{-3}$ $Ka_2(H_3PO_4) = 10^{-8}$

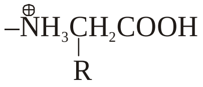
$Ka_3(H_3PO_4) = 10^{-13}$



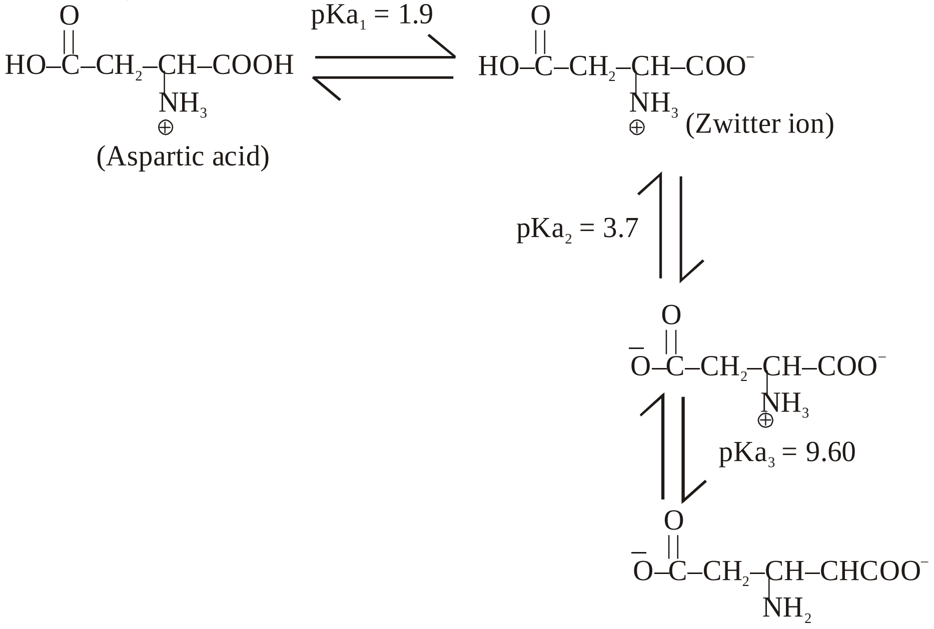
25. What will be the pH of the solution when 50ml of NaOH is added to 0.1M, 300ml $H_3 PO_4$ solution ($M_{NaOH} = 0.1$)?
    - (A) 3
    - (B) 2.3
    - (C) 3.36
    - (D) 4.6

26. What is the composition of solution at point C?
(A) Buffer of $NaH_2\ PO_4$ + $Na_2\ HPO_4$
(B) Buffer of $NaH_2\ PO_4$ + $H_3\ PO_4$
(C) Only $NaH_2\ PO_4$
(D) Only $Na_2\ H\ PO_4$.

Paragraph for Question Nos. 27 and 28

The glycine as well as other amino acids, is amphoteric, means it contains an acidic functional group and a basic functional group. The $-\overset{\oplus}{N}H_3$ is an acidic functional group and basic functional group is $-COO^-$. In a strongly acidic medium the species present is  $-\overset{\oplus}{N}H_3\underset{|\atop R}{C}H_2COOH$ as pH is raised, a proton is removed from this species. Amino acids are crystalline solids it does not melts but on being heated it decomposes. These are practically soluble in water but insoluble in non polar organic solvents. These properties are attributed to fact that the stable form of amino acids is a Zwitter ion or inner salt.

27. In following reaction chain



The isoelectric point of aspartic acid is
(A) 2.8
(B) 4.8
(C) 5.75
(D) 1.9

28. When glycine is dissolved in a solution having pH = 9; at 25°C; it will move towards — in electrolytic cell combination
(A) Anode
(B) Cathode
(C) Will not move towards any electrode
(D) None of above

SECTION – D

(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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29. When fluorine reacts with 2-methyl propane in presence of light gives 14% tert-butyl fluoride and 86% isobutylfluoride. What will be the ratio of relative reactivity of a tertiary hydrogen to primary.

30. If a water tank of 10000 Ltr. contains 55.5 g of $CaCl_2$, 47.5 g of $MgCl_2$, 84 g of $MgSO_4$ and 81.6 g of $CaSO_4$, then what will be the degree of hardness for 1 ltr. of water from this tank? (Assuming density of solution in tank = 1 g/ml)

31. Biacetyl, the flavouring that makes margarine taste "just like butter," is extremely stable at room temperature, but at 200°C it undergoes a first order break down with a half-life of 12.0 min. An industrial flavour enhancing process requires that a biacetyl flavoured food be heated briefly at 200°C. How long (in minutes) can the food be heated and retain 85% of its butter flavour? (log 1.176 = 0.0706)

32. An element crystallises in fcc lattice. If the effective number of atoms of the element per unit cell in the crystal is decreased by 0.25% due to Schottky defect then the density of crystal is (At. Wt. = 50 gm and edge length = 0.50 nm)

33. A thin circular-disk earrings 5.0 cm in diameter is plated with a coating of gold 0.20 mm thick from an Au^{3+} bath. How many days (approx.) does it take to deposit the gold on one side of one earring if the current is 0.02 A (MW. of Au = 197 g, density of Au = 19.3 g/cm, 1 F = 96500 C)?

34. 3129 kJ of heat is liberated when 60 grams of ethane is completely burnt in oxygen. $\Delta H^0{}_f$ for CO_2 and $H_2O(\ell)$ are $-395kJ$ and $-286kJ$ respectively. The magnitude of heat of formation of ethane is

35. 0.5 g mixture of $K_2Cr_2O_7$ and $KMnO_4$ was treated with excess of KI in acidic medium. Iodine so liberated required 100 ml of 0.15 N solution of sodium thiosulphate for titration. The percentage of $K_2Cr_2O_7$ in the mixture is (MW of $K_2Cr_2O_7$ = 294 and $KMnO_4$ = 158)

36. At 800°C, the following equilibrium is established as:
$F_2(g) \rightleftharpoons 2F(g)$
The composition of the equilibrium may be determined by measuring the rate of effusion of the mixture through a pinhole. It is found that at 800°C and 1 atm the mixture effuses 1.6 times as fast as SO_2 effuses under similar conditions (At. wt. of F = 19). The value of K_P for the equilibrium is

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

---

37. In a plane rectangular co-ordinate system xRy there are three points $A\left(0, \frac{4}{3}\right)$, B(–1, 0) and C(1, 0). The distance from point P to line BC is the geometric mean of the distances from this point to lines AB and AC. Then the locus of point P is
(A) $2x^2 + 2y^2 + 3y - 2 = 0$
(B) $2x^2 - 2y^2 - 3y + 2 = 0$
(C) $8x^2 - 17y^2 + 12y - 8 = 0$
(D) $8x^2 + 17y^2 - 12y - 8 = 0$

38. Let S = {1, 2, 3, 4, ..., 2070} and A be the number of subsets of S whose sum of elements in S is divisible by 9. If $A = \frac{2^a\left(2^b+1\right)}{c}$, then
(A) c = 9
(B) b = 1840
(C) a = 233
(D) b = 1837

39. If the lines $a\bar{z} + \bar{a}z + b = 0$ and $c\bar{z} + \bar{c}z + d = 0$ are mutually perpendicular, where a and c are non-zero complex numbers and b and d are real numbers, then
(A) $a\bar{a} + c\bar{c} = 0$
(B) $a\bar{c}$ is purely imaginary
(C) $\text{Arg}\left(\frac{a}{c}\right) = \pm\frac{\pi}{2}$
(D) $\frac{a}{\bar{a}} = \frac{c}{\bar{c}}$

40. Of the following statement which of the below are correct, when n is natural number
(A) probability ${}^nC_7$ is divisible by $7 = \frac{1}{7}$
(B) probability ${}^nC_7$ is divisible by 12 = $\frac{91}{144}$
(C) probability ${}^nC_7$ is divisible by $7 = \frac{13}{49}$
(D) probability ${}^nC_7$ is divisible by $12 = \frac{77}{144}$

41. Let θ be an acute angle such that the equation $x^2 + 4x \cos\theta + \cot\theta = 0$ involving variable x has multiple roots. Then the measure of θ in radians is/are
(A) $\frac{\pi}{6}$
(B) $\frac{\pi}{12}$

(C) $\frac{5\pi}{12}$

(D) $\frac{7\pi}{12}$

42. $I_{(m,\,n)} = \int_0^{\pi} \cos mx \cdot \sin nx\, dx$ where, m, n are integers, then which of the following is/are correct?

(A) $I_{(16,\,2)} = 0$

(B) $I_{(8,\,5)} = -\frac{10}{39}$

(C) $I_{(5,\,2)} = -\frac{4}{21}$

(D) $I_{(3,\,7)} = 0$

(Paragraph Type)

This section contains **TWO** paragraphs. Based on each paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 43 and 44

Read the following write up carefully and answer the following questions:
Let π_1 denotes the equation of the plane to which the vector (1, 1, 0) is normal and which contains the line L whose equation is $r = \hat{i} + \hat{j} + \hat{k} + \lambda\left(\hat{i} - \hat{j} - \hat{k}\right)$ and π_2 denotes the equation of the plane containing the line L and a point whose position vector (0, 1, 0)

43. The vector along a normal to the plane π_2 is

(A) $\hat{i} + 2\hat{j} - \hat{k}$

(B) $\hat{i} - 2\hat{j} + \hat{k}$

(C) $\hat{i} + 2\hat{j} + \hat{k}$

(D) $\hat{i} + \hat{j} - 2\hat{k}$

44. The acute angle between π_1 and π_2 is

(A) $\tan^{-1}1 - \tan^{-1}\left(\sqrt{2} - 1\right)$

(B) $\tan^{-1}1 - \tan^{-1}\left(2 - \sqrt{3}\right)$

(C) $\tan^{-1}1 - \tan^{-1}\left(\sqrt{2} + 1\right)$

(D) $\tan^{-1}1 - \tan^{-1}\left(2 + \sqrt{3}\right)$

Paragraph for Question Nos. 45 and 46

Read the following write up carefully and answer the following questions:
Let z_1 and z_2 are two complex numbers such that $|z_1| = a$ and $|z_2| = b$ satisfying the equation $3z_1^2 - 2z_1z_2 + 2z_1^2 = 0$ and also $\text{Re}\left(\frac{z_1 - 2}{z_1 + 2}\right) = 0$. Also P, Q and O are points in complex plane corresponding to z_1, z_2 and origin respectively

45. Eccentricity of the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$, is

(A) $\frac{1}{\sqrt{2}}$

(B) $\frac{1}{\sqrt{3}}$

(C) $\frac{1}{2}$

(D) $\frac{1}{3}$

46. Area of triangle OPQ is

(A) $\sqrt{5}$

(B) $2\sqrt{5}$

(C) $3\sqrt{5}$

(D) $4\sqrt{5}$

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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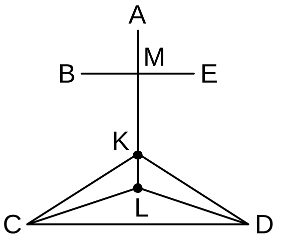
47. The value of $\lim\limits_{n\to\infty} n^2 \int_{-\frac{1}{n}}^{\frac{1}{n}} (2019\sin x + 2021\cos x)|x|dx$ is equal to

48. Given $a^2 + b^2 + c^2 \le 16$ and S = 3a + 4b + 10c where a, b, c $\in$ R. If the maximum value of S is $\sqrt{N}$, then the value of N is equal to

49. There is a point A(x_1, y_1) on the curve f(x) = x^2 and a point B(x_2, y_2) on the curve $g(x) = -\frac{8}{x}$ where $x_1 > 0$ and $x_2 > 0$. If the line AB is tangent to both these curve at these points respectively, then the value of ($x_1 + y_1 + x_2$)

50. If all the roots of the equation $x^{1008} + a_1x^{1007} + a_2x^{1006} + ... + a_{1006}x^2 - 1008x + 1 = 0$ are real, then $\frac{a_2}{|a_1|}$ is

51. The diagram shows a maze used for testing and training mice. A mouse begins at A and at each junction as represented by a dot has equal chances of choosing any of the new path available. The mouse can move in any direction but cannot travel along any path more than once, the probability of the mouse reaching point, C after passing through more than 3 junctions is $\frac{K}{L}$ (where K and L are relatively coprime. Then the value of L – K



52. $\prod_{k=1}^{6} \sin\frac{k\pi}{7} = \frac{\ell}{m}$ (where ℓ, m are relatively coprime), then $\ell + m$ is equal to

53. If $y^2 = x^2 - x + 1$ and $I_n = \int \frac{x^n}{y} dx$ & $AI_3 + BI_2 + CI_1 = x^2y$ for all $x \in R$. Then the value of A + B + C is

54. For any real number be denote by f(b) is the maximal value of $\left|\sin x + \frac{2}{3 + \sin x} + b\right|$. The minimal value of f(b) is $\frac{p}{q}$, where p and q are relatively co-prime positive integers. Then the value of p + q

FIITJEE

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FULL TEST – IX

JEE (Advanced)-2019

PAPER – 2

TEST DATE: 28-04-2019

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. A, C

Sol. $v \cos\theta = v_0$

$v = v_0 \sec\theta$ …(i)

at $\theta = 60°$,

$v = 2 \sec 60° = 2 \times 2 = 4$ m/s

$v = v_0 \sec\theta$

$$\frac{dv}{dt} = v_0 \sec\theta \tan\theta \frac{d\theta}{dt}$$

$$a = v_0 \sec\theta \tan\theta \frac{v \sin\theta}{\ell}$$

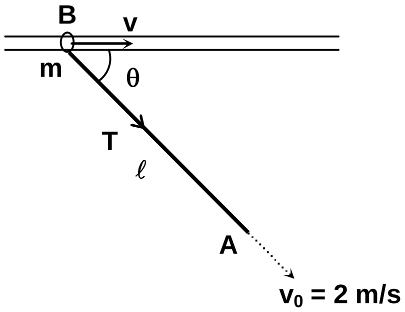
$$a = \frac{v_0^2}{\ell}\tan^2\theta \sec\theta$$

$T \cos\theta = ma$

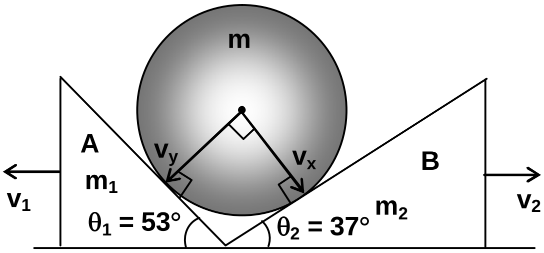
$$T = ma \sec\theta = \frac{mv_0^2}{\ell}\tan^2\theta \sec^2\theta$$

$$T = \frac{0.5 \times 4 \times 3 \times 4}{1} = 24 \text{ N}$$

$T = 24$ N



2. A, D



Sol. $v_x = v_2 \sin\theta_2 = v_2 \sin 37° = \frac{3}{5}v_2$ …(i)

$v_y = v_1 \sin\theta_1 = v_1 \sin 53° = \frac{4}{5}v_1$ …(ii)

using conservation of momentum of system along horizontal direction

$$m_2v_2 - m_1v_1 + m(v_x\sin\theta_2 - v_y\sin\theta_1) = 0$$

$$16v_2 - 9v_1 + 25\left(\frac{9}{25}v_2 - \frac{16}{25}v_1\right) = 0$$

$25v_2 = 25\,v_1$

$\therefore v_1 = v_2$

Velocity of cylinder, $v = \sqrt{v_x^2 + v_y^2} = \frac{v_1}{5}\sqrt{(3)^2 + (4)^2}$

$\therefore v = v_1 = v_2$ …(iii)

Now, using conservation of energy of the system

$$mgh = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 + \frac{1}{2}mv^2$$

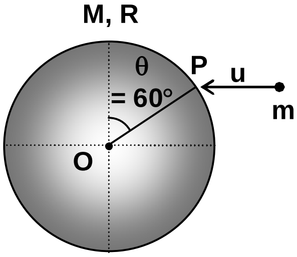
$$mgh = \frac{1}{2}(m_1 + m_2 + m)v^2$$

$$25gh = \frac{1}{2}\times 50v^2$$

$\Rightarrow v = \sqrt{gh} = \sqrt{10\times 0.4} = 2$ m/s

$\therefore v = v_1 = v_2 = 2$ m/s

3. B, C



Sol. Using conservation of angular momentum of the system about a horizontal axis passing through centre O.

$$muR\cos\theta = \left(\frac{MR^2}{2} + mR^2\right)\omega_0$$

$$muR\cos 60° = \left(\frac{M}{2} + m\right)R^2\omega_0$$

$$0.5\times 20\times\frac{1}{2} = 2.5\times\frac{1}{4}\times\omega_0$$

$\Rightarrow \omega_0 = 8$ rad/s

Now, using conservation of energy of the system

$$mgR(1-\cos\theta) = \frac{1}{2}\left(\frac{MR^2}{2} + mR^2\right)\left(\omega_0^2 - \omega^2\right)$$

$$mg\frac{R}{2} = \frac{1}{2}\left(\frac{M}{2} + m\right)R^2\left(\omega_0^2 - \omega^2\right)$$

$$0.5\times\frac{10}{2} = \frac{5}{4}\times\frac{1}{4}\left(\omega_0^2 - \omega^2\right)$$

$\Rightarrow \omega_0^2 - \omega^2 = 8$

$\omega^2 = \omega_0^2 - 8 = 64 - 8 = 56$

$\omega = \sqrt{56}$ rad/s

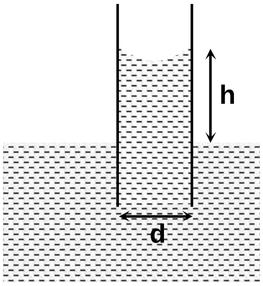
Now, $(M + m)g - F = (M + m)\dfrac{\omega^2 R}{9}$

$45 - F = \dfrac{9}{2}\times 56\times\dfrac{0.25}{9}$

$\therefore$ F = 38 N (vertically upward)

4. A, D

Sol. $2T\ell = \rho d\ell hg$



$$h = \frac{2T}{\rho g d} = \frac{2\times 7\times 10^{-2}}{10^3\times 10\times 1\times 10^{-4}} = 14\times 10^{-2}\,\text{m} = 14\,\text{cm}$$

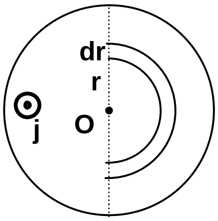
Force of mutual attraction between the plates is

$$F = \int_0^h \rho g y\ell dy = \frac{\rho g \ell h^2}{2}$$

$$= \frac{10^3\times 10\times 0.10\times (14\times 10^{-2})^2}{2} = 19.6/2 = 9.8\text{ N}$$

5. B, C

Sol. When $0 \le r \le R$



$B2\pi r = \mu_0 j\pi r^2$

$B = \dfrac{1}{2}\mu_0 jr$

Magnetic field at r = R/2, $B = \dfrac{\mu_0 jR}{4}$

The linear current density i = jdr

The force of interaction per unit length between two halves is

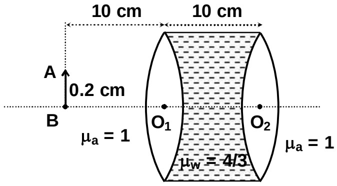
$$F = \int_0^R iB2r = \int_0^R jdr\left(\frac{\mu_0 jr}{2}\right)2r$$

$$= \mu_0 j^2\int_0^R r^2 dr$$

$$F = \left(\frac{\mu_0 j^2 R^3}{3}\right)$$

6. A, C

Sol. For the image formed by the first lens



$$\frac{\mu_3}{v} - \frac{\mu_1}{u} = \left(\frac{\mu_2 - \mu_1}{R_1}\right) + \left(\frac{\mu_3 - \mu_2}{R_2}\right)$$

$$\Rightarrow \frac{4}{3v} - \frac{1}{(-10)} = \frac{\left(\frac{3}{2} - 1\right)}{10} + \frac{\left(\frac{4}{3} - \frac{3}{2}\right)}{-10}$$

$$\frac{4}{3v} + \frac{1}{10} = \frac{1}{20} + \frac{1}{60}$$

$$\Rightarrow \frac{4}{3v} = \frac{1}{15} - \frac{1}{10}$$

$\Rightarrow$ v = –40 cm

Lateral magnification, $m_1 = \dfrac{\mu_1}{\mu_3}\dfrac{v}{u} = \dfrac{1\times 3}{4}\left(\dfrac{-40}{-10}\right) = +3$

For the image formed by the second lens

$$\frac{\mu_3}{v}-\frac{\mu_1}{u}=\left(\frac{\mu_2-\mu_1}{R_1}\right)+\left(\frac{\mu_3-\mu_2}{R_2}\right)$$

$$\Rightarrow \frac{1}{v}-\frac{4}{3(-50)}=\left(\frac{\frac{3}{2}-\frac{4}{3}}{10}\right)+\left(\frac{1-\frac{3}{2}}{-10}\right)$$

$$\Rightarrow \frac{1}{v}+\frac{2}{75}=\frac{1}{60}+\frac{1}{20}$$

$$\Rightarrow \frac{1}{v}=\frac{1}{15}-\frac{2}{75}$$

$\Rightarrow v = +\ 25$ cm

The position of final image formed is 25 cm right to the second lens. Lateral magnification, $m_2=\frac{\mu_1}{\mu_3}\frac{v}{u}=\frac{4}{3\times 1}\left(\frac{25}{-50}\right)=-\frac{2}{3}$

Overall magnification, $m = m_1 \times m_2 = (+3) \times \left(-\frac{2}{3}\right) = -\ 2$

The size of the final image formed = 2 × 0.2 cm = 0.4 cm

7. B

Sol. (P) $x_1 + 2x_2 + 2x_3 + 2x_4 + 2x_5 = x$

$$\frac{F}{k_1}+\frac{4F}{k_2}+\frac{4F}{k_3}+\frac{4F}{k_4}+\frac{4F}{k_5}=x$$

$$\frac{F}{k}+\frac{4F}{k}+\frac{4F}{k}+\frac{4F}{2k}+\frac{4F}{2k}=x$$

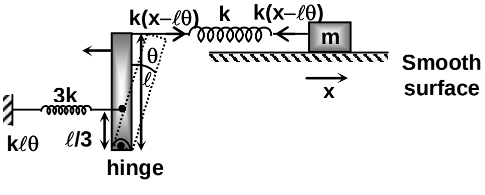
$$\frac{13F}{k}=x \Rightarrow F=\frac{kx}{13} \Rightarrow \frac{d^2x}{dt^2}=-\frac{kx}{13m}$$

$$T=2\pi\sqrt{\frac{13m}{k}}$$

(Q) $m\frac{d^2x}{dt^2}=-8kx \Rightarrow \frac{d^2x}{dt^2}=-\left(\frac{8k}{m}\right)x$

$$\therefore\ T=2\pi\sqrt{\frac{m}{8k}}=\pi\sqrt{\frac{m}{2k}}$$

(R) Since rod is light



$$3\frac{k\ell\theta}{3}\frac{\ell}{3}=K(x-\ell\theta)\ell$$

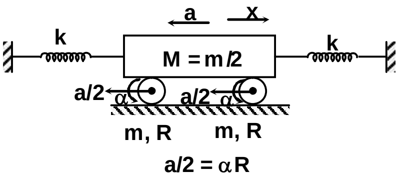
$$\frac{k\ell}{3}\theta=kx-k\ell\theta$$

$$\theta=\frac{3x}{4\ell}$$

$$m\frac{d^2x}{dt^2}=-k(x-\ell\theta)=-k\left(x-\frac{3x}{4}\right)$$

$$\frac{d^2x}{dt^2}=-\frac{kx}{4m}$$

$$\Rightarrow T=2\pi\sqrt{\frac{4m}{k}}=4\pi\sqrt{\frac{m}{k}}$$



(S) $2kx - 2f_1 = Ma = \dfrac{ma}{2}$ …(i)

$f_1 + f_2 = \dfrac{ma}{2}$ …(ii)

$(f_1 - f_2)R = \dfrac{mR^2}{2}\alpha$

$(f_1 - f_2) = \dfrac{m\alpha R}{2} = \dfrac{ma}{4}$ …(iii)

Adding (i), (ii) and (iii), we get

$2kx = \dfrac{5ma}{4} \Rightarrow a = \dfrac{8kx}{5m}$

$\dfrac{d^2x}{dt^2} = -\left(\dfrac{8k}{5m}\right)x \Rightarrow T = 2\pi\sqrt{\dfrac{5m}{8k}} = \pi\sqrt{\dfrac{5m}{2k}}$

8. D

Sol. (P) $n_1 : n_2 : n_3 = \ell_1 : \ell_2 : \ell_3 = 10 : 80 : 10 = 0.5 : 4 : 0.5$

$\Rightarrow \dfrac{5\lambda}{2} = 1 \Rightarrow \lambda = 0.4$ m

$v = \sqrt{\dfrac{Y}{\rho}} = \sqrt{\dfrac{2\times10^{11}}{8000}} = 5000$ m/s

$f = \dfrac{v}{\lambda} = \dfrac{5000}{0.4} = 12500 = 12.5$ kHz '

(Q) $n_1 : n_2 : n_3 = \ell_1 : \ell_2 : \ell_3 = 30 : 40 : 30 = 1.5 : 2 : 1.5$

$\Rightarrow \dfrac{5\lambda}{2} = 1 \Rightarrow \lambda = 0.4$ m

$v = \sqrt{\dfrac{Y}{\rho}} = \sqrt{\dfrac{1.6\times10^{11}}{2500}} = 8000$ m/s

$f = \dfrac{v}{\lambda} = \dfrac{8000}{0.4} = 20000 = 20$ kHz

(R) $n_1 : n_2 : n_3 = \ell_1 : \ell_2 : \ell_3 = 10 : 60 : 30 = 0.5 : 3 : 1.5$

$\Rightarrow \dfrac{5\lambda}{2} = 1 \Rightarrow \lambda = 0.4$ m

$v = \sqrt{\dfrac{Y}{\rho}} = \sqrt{\dfrac{2\times10^{11}}{8000}} = 5000$ m/s

$f = \dfrac{v}{\lambda} = \dfrac{5000}{0.4} = 12500 = 12.5$ kHz

(S) $n_1 : n_2 : n_3 = \ell_1 : \ell_2 : \ell_3 = 15 : 60 : 25 = 1.5 : 6 : 2.5$

$\Rightarrow \dfrac{10\lambda}{2} = 1 \Rightarrow \lambda = 0.2$ m

$v = \sqrt{\dfrac{Y}{\rho}} = \sqrt{\dfrac{1.6\times10^{11}}{2500}} = 8000$ m/s

$f = \dfrac{v}{\lambda} = \dfrac{8000}{0.2} = 40000 = 40$ kHz

9. C

Sol. $\Delta Q_{AB} = nC_V\Delta T = 2\times\frac{3R}{2}\times 300 = 900\ R$

$\Delta W_{AB} = 0$

$\Delta Q_{BC} = nC_P\Delta T = 2\times\frac{5R}{2}\times(1800-600) = 6000\ R$

$\Delta W_{BC} = P\Delta V = nR\Delta T = 2R(1800 - 600) = 2400\ R$

$\Delta Q_{CD} = nC_V\Delta T = 2\times\frac{3R}{2}\times(900-1800) = -2700\ R$

$\Delta W_{CD} = 0$

$\Delta Q_{DA} = nC_P\Delta T = 2\times\frac{5R}{2}\times(300-900) = -3000\ R$

$\Delta W_{DA} = P\Delta V = nR\Delta T = 2R(300 - 900) = -1200\ R$

10. A

Sol. (P) $z = R + (X_L - X_C)i = 3 + (8-4)i = 3 + 4i$

$\left|z\right| = \sqrt{(3)^2 + (4)^2} = 5\,\Omega$

$I_{rms} = \frac{\varepsilon_{rms}}{\left|z\right|} = \frac{100}{5} = 20\ A$

(Q) $\frac{1}{z} = \frac{1}{X_L i} + \frac{1}{-X_C i} + \frac{1}{R} = \frac{1}{6i} - \frac{1}{3i} + \frac{1}{8} = \left(\frac{1}{3} - \frac{1}{6}\right)i + \frac{1}{8} = \frac{1}{8} + \frac{1}{6}i$

$\Rightarrow\ z = \frac{48}{(6+8i)}$

$\Rightarrow\ z = \frac{48(6-8i)}{100}$

$\Rightarrow\ \left|z\right| = \frac{48}{100}\times 10$

$\Rightarrow |z| = 4.8\ \Omega$

$I_{rms} = \frac{\varepsilon_{rms}}{|z|} = \frac{120}{4.8} = 25\ A$

(R) $\frac{1}{z'} = \frac{1}{X_L i} + \frac{1}{-X_C i} = \frac{1}{6i} - \frac{1}{3i} = i\left(\frac{1}{3} - \frac{1}{6}\right) = \frac{i}{6}$

$z' = \frac{6}{i} = -6i$

$z = R + z' = 8 - 6i$

$|z| = \sqrt{(8)^2 + (6)^2} = 10\,\Omega$

$I_{rms} = \frac{\varepsilon_{rms}}{|z|} = \frac{50}{10} = 5\,A$

(S) $z_1 = R_1 + X_L i = 8 + 6i \Rightarrow I_{1(rms)} = \frac{\varepsilon_{rms}}{|z_1|} = \frac{100}{10} = 10\,A$

$z_2 = R_2 - X_C i = 3 - 4i \Rightarrow I_{2(rms)} = \frac{\varepsilon_{rms}}{|z_2|} = \frac{100}{5} = 20\,A$

$\therefore\ I_{rms} = \sqrt{I_{1(rms)}^2 + I_{2(rms)}^2} = \sqrt{(10)^2 + (20)^2} = \sqrt{500} = 10\sqrt{5}\ A$

SECTION – D

11. 00057.76

Sol. The frequency of vibration of air column in the pipe

$$f_0 = \frac{3v}{4\ell_0} = \frac{3\times340}{4\times0.85} = 300\,\text{Hz}$$

$$f_s - f_0 = 4$$

$$f_s = f_0 + 4 = 300 + 4$$

$$\frac{4}{2\ell}\sqrt{\frac{F}{\mu}} = 304$$

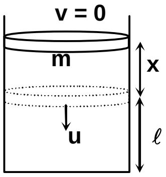
$$\frac{4}{2\times0.5}\sqrt{\frac{F\times0.5}{5\times10^{-3}}} = 304$$

$$\sqrt{\frac{F}{10^{-2}}} = 76$$

$\therefore$ F = 57.76 (Newton)

12. 00001.28

Sol. Let the vertical upward displacement of the piston before coming to a complete stop is ‘x’.



In initial and final equilibrium of the piston

$$PA = \frac{nRT_0}{\ell} = \frac{nRT}{(\ell + x)} = mg$$

$nRT_0 = mg\ell$ …(i)

$nRT = mg(\ell + x)$ …(ii)

Now, $nR\Delta T = mgx$ …(iii)

$$\frac{1}{2}mu^2 = nC_v\Delta T + mgx$$

$$\frac{1}{2}mu^2 = \frac{n3R}{2}(T - T_0) + mgx$$

$$\frac{1}{2}mu^2 = \frac{3nR\Delta T}{2} + mgx$$

$$\frac{1}{2}mu^2 = \frac{5}{2}mgx$$

$$x = \frac{u^2}{5g} = \frac{8\times8}{5\times10} = 1.28\,\text{meter}$$

$\therefore$ vertical upward displacement of the piston = 1.28 meter.

13. 00002.84

Sol. Since the central maxima is formed at point ‘P’

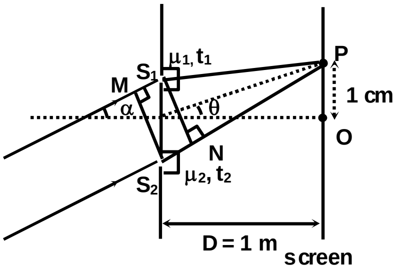
$d\sin\alpha + (\mu_1 - 1)t_1 = (\mu_2 - 1)t_2 + d\sin\theta$

$$2\times10^{-3}\times\sin30^\circ + (1.5-1)t_1 = (1.8-1)3\times10^{-3} + 2\times10^{-3}\times\frac{1}{100}$$

$\Rightarrow 1\times10^{-3} + 0.5t_1 = 2.4\times10^{-3} + 0.02\times10^{-3}$

$\Rightarrow t_1 = 2.84\times10^{-3}$

$\Rightarrow t_1 = 2.84$ mm



14. 00003.98

Sol. Energy of each photon of light incident on the metal surface

$$E = \frac{hC}{\lambda} = \frac{1240}{500} = 2.48\text{ eV}$$

Kinetic energy of fastest photoelectron emitted

$K_{max} = E - \phi = 2.48 - 1.90 = 0.58$ eV

$$\therefore E_n = -13.6\frac{z^2}{n^2}$$

$$E_4 = -13.6 \times \frac{(2)^2}{4 \times 4} = -3.40\text{ eV}$$

Energy of the photon emitted during combination

$\Delta E = K_{max} - E_4 = 0.58 - (-3.40) = 3.98$ eV

15. 00001.44

Sol. The equivalent circuit in steady state is shown.

The current through the battery in steady state is

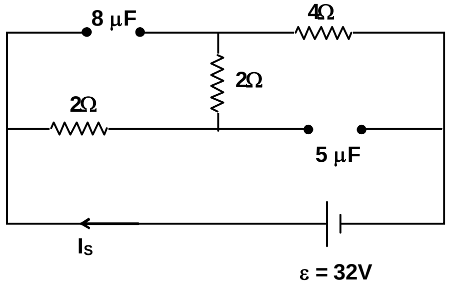
$$I_s = \frac{32}{8} = 4A$$

Potential drop across 5 μF capacitor in steady state,

$V_0 = 4(2 + 4) = 24$ Volt

∴ Energy stored in 5 μF capacitor in steady state

$$U = \frac{1}{2} \times 5 \times 10^{-6} \times (24)^2 = 1.44\text{ milli Joule}$$



16. 00007.50

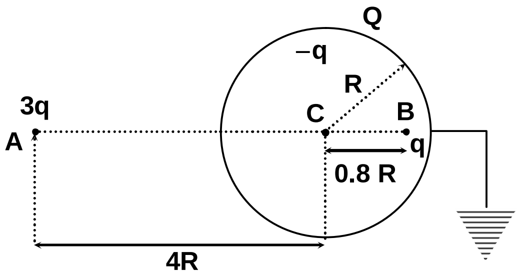
Sol. Let the charge on the conducting shell after being earthed is Q.

$$\frac{KQ}{R} + \frac{3kq}{4R} = 0$$

$$Q = \frac{-3q}{4}$$

∴ Total charge that will flow to the earth is

$$\Delta Q = 3q - \left(\frac{-3q}{4}\right) = \frac{15q}{4} = \frac{15}{4} \times 2 = 7.50\ \mu C$$



17. 00002.70

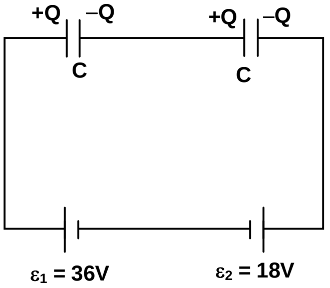
Sol. Charge on each capacitor, when switch S is opened

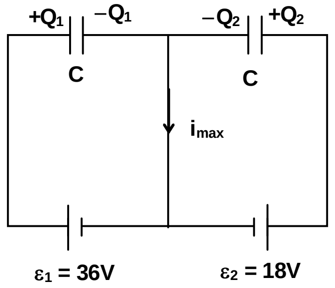
$$Q = \frac{C}{2}(\varepsilon_1 - \varepsilon_2) = \frac{10}{2} \times 18 = 90\ \mu C$$

Charge on the capacitor when the current through the inductor is maximum after closing the switch 'S'.

$Q_1 = C\varepsilon_1 = 10 \times 36 = 360\ \mu C$

$Q_2 = C\varepsilon_2 = 10 \times 18 = 180\ \mu C$





Now, $\Delta Q_1\varepsilon_1 + \Delta Q_2\varepsilon_2 = \left(\frac{1}{2}C\varepsilon_1^2 + \frac{1}{2}C\varepsilon_2^2\right) - \frac{1}{2}\times\frac{C}{2}\left(\varepsilon_1 - \varepsilon_2\right)^2 + \frac{1}{2}Li_{max}^2$

$10^{-6}\left(270\times 36\right) + 10^{-6}(270\times 18)$

$= 10^{-6}\left\{\frac{1}{2}\times 10\times(36)^2 + \frac{1}{2}\times 10\times(18)^2 - \frac{1}{2}\times 5\times(18)^2\right\} + \frac{1}{2}\times 2\times 10^{-3}i_{max}^2$

$14580 = (8100 - 810) + 1\times 10^3\times i_{max}^2$

$10^3\times i_{max}^2 = 7290$

$i_{max} = \sqrt{7.29} = 2.70$ ampere

18. 00052.80

Sol. Thermal resistance of the cylinders are

$R_1 = \int_a^{2a}\frac{dr}{2\pi K_1 r\ell} = \frac{1}{2\pi K_1\ell}\ell n2$

$R_2 = \int_{2a}^{4a}\frac{dr}{2\pi K_2 r\ell} = \frac{1}{2\pi K_2\ell}\ell n2$

Heat current flowing between the innermost and outermost cylindrical walls is

$i = \frac{\theta_1 - \theta_2}{R_1 + R_2}$

$\therefore\ \theta_1 - \theta = iR_1$

$\Rightarrow\ \theta_1 - \theta = \left(\frac{\theta_1 - \theta_2}{R_1 + R_2}\right)R_1$

$\Rightarrow\ \theta_1 - \theta = \frac{(\theta_1 - \theta_2)\frac{1}{k_1}}{\left(\frac{1}{k_1} + \frac{1}{k_2}\right)}$

$\Rightarrow\ \theta_1 - \theta = \frac{(\theta_1 - \theta_2)k_2}{\left(k_1 + k_2\right)}$

$\Rightarrow\ \theta = \left(\frac{k_1\theta_1 + k_2\theta_2}{k_1 + k_2}\right) = \frac{(2k\times 84) + (3k\times 32)}{(2k + 3k)} = \frac{168 + 96}{5} = 52.8°C$

Chemistry PART – II

SECTION – A

19. B, D

20. A, B, C, D

Sol. Through SPM only migration of solvent particle is permissible and hence none will be able to make a mixture.

21. B, C, D

Sol. $SiCl_4 + 4H_2O \longrightarrow H_4SiO_4 + 4HCl$

$BiCl_3 + H_2O \longrightarrow BiOCl + 2HCl$

22. B, C

Sol. (A) $(SiH_3)_3N$ is a weaker base than $(CH_3)_3N$

(B) BF_3 is weaker Lewis acid than BI_3 due to back bonding in BF_3

(C) Solid N_2O_5 is ionic in nature. It exist as $NO_2^+NO_3^-$

(D) PH_3 is less basic than NH_3

23. A, B, C

Sol. $Zn(OH)_2 + 2NaOH \longrightarrow Na_2ZnO_2 + 2H_2O$

$Al(OH)_3 + NaOH \longrightarrow NaAlO_2 + 2H_2O$

$Sn(OH)_2 + 2NaOH \longrightarrow Na_2SnO_2 + 2H_2O$

24. A, B, D

Sol.

	$3A(g)$ $\rightarrow$	$2B(g)$ +	$2C(g)$
t = 0	P_0		
t = 20	$P_0 - x$	$\frac{2x}{3}$	$\frac{2x}{3}$
$t = \infty$	0	$\frac{2P_0}{3}$	$\frac{2P_0}{3}$

$\frac{4P_0}{3} = 4$ P_0 = 3 atm

$P_0 + \frac{x}{3} = 3.5$ $\Rightarrow$ $t_{50\%}$ = 20 is the half life

x = 1.5

$t_{75\%} = 2 \times 20 = 40$ min

$t_{87.5\%} = 3 \times t_{50\%} = 3 \times 20 = 60$

$t_{99\%} = \frac{2}{3} \times t_{99.9\%}$

$= \frac{2}{3} \times 10 \times t_{50\%} = \frac{400}{3}$

25. A

Sol. $\mathrm{NiCl_4^{2-}}$ sp^3 and two unpaired e$^-$ – Tetrahedral

$\mathrm{Ni(CN)_4^{2-}}$ dsp^2 and no unpaired e$^-$ – Square planar

$\mathrm{Ni(CO)_4}$ sp^3 and no unpaired e$^-$ – Tetrahedral

$\mathrm{\left[Pd(NH_3)_4\right]^{2+}}$ dsp^2 and no unpaired e$^-$. – Square planar.

26. D

Sol. (P) $\mathrm{Mg(OH)_2(s) \Leftrightarrow \underset{s}{Mg^{2+}} + \underset{2s}{2OH^-}}$

Ksp = $4s^3 = 4 \times 10^{-12}$

$s = 10^{-4}$

$[OH^-] = 2 \times 10^{-4}$

$\therefore$ pH = 10 + log 2

(Q) Basic buffer is formed. Hence,

pOH = $pk_b = \log\frac{1}{2}$ = 4 – log 2

pH = 10 + log 2

(R) A salt of weak acid and weak base is formed in which $k_a = k_b$

hence, pH = 7 or

pH = $\frac{1}{2}pk_w + \frac{1}{2}pk_a - \frac{1}{2}pk_b$

(S) $H_3PO_4 \Leftrightarrow H^+ + H_2PO_4^-$

$H_2PO_4^- \Leftrightarrow H^+ + HPO_4^{--}$

$HPO_4^{--} \Leftrightarrow H^+ + PO_4^{---}$

pH of 0.01 M Na_2HPO_4 = $\frac{pk_{a_2} + pk_{a_3}}{2} = \frac{8.102 + 12.5}{2}$

pH = $\frac{20.602}{2} = 10.301$

Hence, q and r.

27. A

Sol. Application of Le Chatelier's principle

28. B

SECTION – D

29. 00000.50

Sol.

$\Delta T_f = iK_f m, \qquad m = \frac{20}{172} \times \frac{1000}{50} = \frac{400}{172}$

$i = \frac{\Delta T_f}{K_f \times m} = \frac{2}{1.72 \times \frac{400}{172}}$

$i = 0.5$

30. 00001.09

Sol.

$E^{\circ}_{cell} = -\frac{\Delta G^{\circ}}{nF}$

$= -\frac{(-2746) \times 1000}{26 \times 96500}$

$= 1.09\ V$

31. 00062.50

Sol.

$K_c = \frac{Ka(HOCl)}{Ka(HCN)} = \frac{3 \times 10^{-8}}{4.8 \times 10^{-10}}$

$= 62.50$

32. 00001.81

Sol.

$\frac{\Delta T_b}{\Delta T_f} = \frac{T_b^2 \times Lf}{T_f^2 \times L_v}$

$\frac{0.5}{\Delta T_f} = \frac{373 \times 373 \times 80}{273 \times 273 \times 540}$

$\Delta T_f = 1.81$

33. 03062.5

Sol. $K_2Cr_2O_7 + 4H_2SO_4 + 3H_2S \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O + 3S$

Every 294 g $K_2Cr_2O_7$ gives 96 g of S, so 3062.5 kg of $K_2Cr_2O_7$ is required to produce 1000 kg of sulphur.

34. 00112.5

Sol.

m. moles of $Cu^{2+} = 5$

m.moles of $H^+ = 100 \times 10^{-2} = 1$

m.moles of Cu^{2+} reduced $= \frac{1}{2} = 0.5$

m.moles of Cu^{2+} remaining = 4.5

$2CuSO_4 + 4KI \longrightarrow Cu_2I_2 + 2K_2SO_4 + I_2$

$I_2 + 2Na_2S_2O_3 \longrightarrow 2NaI + Na_2S_4O_6$

n-Factor of $CuSO_4 = 1$

meq. of Cu^{2+} = m. mole of $Cu^{2+} = 4.5$

meq. of Cu^{2+} = meq. of $Na_2S_2O_3$

$4.5 = 0.04 \times V$

V = 112.5 ml.

35. 00001.33

Sol. $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$ at 127^{0}C the no of gaseous mole will remain same because H_2O will be in vapour form. These for the pressure change will be due to change in temperature

$$\frac{P_1}{T_1}=\frac{P_2}{T_2}$$

$$\frac{1}{300K}=\frac{P}{400K}$$

$$P=\frac{400}{300}=\frac{4}{3}=1.33\,atm$$

36. 00003.56

Sol. pH = $\mathrm{pk_{In}}+\log\frac{[\mathrm{In}^-]}{[\mathrm{InH}]}$

5 = $\mathrm{pk_{In}}+\log\frac{75}{25}$ $\mathrm{pk_{In}}$ = 4.523

pH = 4.523 + $\log\frac{10}{90}$ = 4.523 – .954 = 3.56

Mathematics PART – III

SECTION – A

37. A, D

Sol. $x^2 - px - 1 = 0$ roots $x_1 < 0 < x_2$ (assume)
$x^2 - qx - 1 = 0$ roots $y_1 < 0 < y_2$
So (i) $x_1, x_2, y_1, y_2 \to$ not possible as $x_2 > 0$ and $y_1 < 0$
(ii) x_1, y_1, y_2, x_2 are in A.P. then $x_1 + x_2 = y_1 + y_2 \Rightarrow p = q$, not possible
(iii) x_1, y_1, x_2, y_2, then $x_2 - x_1 = y_2 - y_1 \Rightarrow \sqrt{p^2+4} = \sqrt{q^2+4}$
i.e. $p^2 = q^2 \Rightarrow p = -q \neq 0$
Also, $y_1 = \frac{x_1 + x_2}{2} = \frac{p}{2} \Rightarrow \frac{p^2}{2} - \frac{pq}{2} - 1 = 0$
Since $p = -q$
$\Rightarrow p^2 = \frac{4}{3}$; $p = \pm\frac{2}{\sqrt{3}}$
Hence, (p, q) = $\left(\frac{2}{\sqrt{3}}, \frac{-2}{\sqrt{3}}\right), \left(\frac{-2}{\sqrt{3}}, \frac{2}{\sqrt{3}}\right)$

38. B, D

Sol. Differentiate equation to get, $\frac{d^2y}{dx^2} = \frac{\sin x\cos^2 y + \sin y\cos^2 x}{\cos^3 y}$

Let sin x = t then sin y = 1 – t. Also $\cos x = \sqrt{1-t^2}$ and $\cos y = \sqrt{1-\left(1-t^2\right)} = \sqrt{t(2-t)}$

Then, $\frac{d^2y}{dx^2} = t^{-3/2}\frac{1-t+t^2}{(2-t)^{3/2}}$

Since $\lim\limits_{x\to 0}\frac{t}{x} = 1$. So, $\alpha = \frac{3}{2}$ that gives $L = \lim\limits_{x\to 0} x^{\alpha}\frac{d^2y}{dx^2} = \frac{1}{2\sqrt{2}}$

39. B, C, D

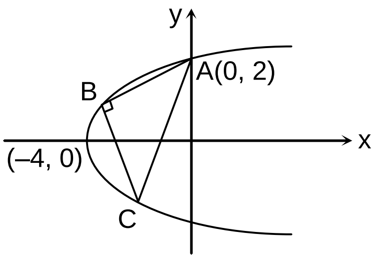
Sol. Centre of circle will lie on perpendicular bisector of MN. Let the centre be S(a, 3 – a)
Equation of circle $(x - a)^2 + (y - 3 + a)^2 = 2(1 + a^2)$
$\angle$MPN reaches maximum value when the circle through M, N and P will be tangent to the x-axis at P
So, $2(1 + a^2) = (a - 3)^2 \to a = 1, -7$
So the points are P(1, 0) and P′(–7, 0)
$\angle MPN > \angle MP'N$ then P is (1, 0)

40. A, B, C, D

Sol. Based on basic concepts

41. B, C, D

Sol. Suppose $B\left(y_1^2 - 4, y_1\right)$ and $C\left(y^2 - 4, y\right)$



$m_{AB} = \frac{1}{y_1 + 2}$

$m_{BC} = -(y_1 + 2)$

So, $y - y_1 = -\left(y_1 + 2\right)\left[y^2 - 4 - \left(y_1^2 - 4\right)\right]$ and $(y \neq y_1)$

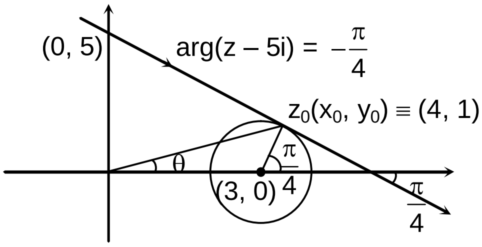
We get, $(2 + y_1)(y + y_1) + 1 = 0$

And that is $y_1^2 + (2+y)y_1 + (2y+1) = 0$

For $D \geq 0$ we obtain $y \leq 0$ and $y \geq 4$

42. B, D

Sol. $\Rightarrow \arg\left(x + i(y-5)\right) = -\frac{\pi}{4}$



$\Rightarrow \tan^{-1}\left(\frac{y-5}{x}\right) = -\frac{\pi}{4}$

$y - 5 = -x \Rightarrow x + y = 5$

Also, $|z-3| \leq \sqrt{2}$

$\Rightarrow (x-3)^2 + y^2 \leq 2$

Let z_0 is point of contact of line and circle

$\Rightarrow z_0 = 4 + i$

$\tan\theta = \frac{1}{4}$; $\tan 2\theta = \frac{8}{15}$ and $|z_0| = \sqrt{17}$ & $|z_0 - 5i| = 4\sqrt{2}$

43. B

Sol. $S_n - 7\left[\frac{S_n}{7}\right] = 5$

44. A

Sol. Area of Δ OCS_1 = $\frac{1}{2} \times b \times 6 = 3b$

Semi-perimeter = $\frac{a+b+6}{2}$

Inradius = $\frac{\Delta}{S} = 1 \Rightarrow 5b = 6 + a$

Also, $b^2 + 36 = a^2$

Solving, we get $a = \frac{13}{2}$, $b = \frac{5}{2}$

Maximum distance of normal from centre = $|a - b|$ = $\frac{13-5}{2} = 4$

Length of latus rectum = $\frac{2b^2}{a} = \frac{2 \times \frac{25}{4}}{\frac{13}{2}} = \frac{25}{13}$

$e \Rightarrow \sqrt{\frac{a^2 - b^2}{a^2}} = \frac{12}{13}$

Distance between directrix = $\frac{2a}{e} = \frac{2 \times \frac{13}{2}}{\frac{12}{13}} = \frac{169}{12}$

45. A

Sol.
(P) $N_1 = 137$
(Q) $N_2 = 276$
(R) $N_3 = 2008$
(S) $N_4 = 8$

46. B

Sol. (P) $f_1(x) = x^2 \operatorname{sgn}(x) = \begin{cases} x^2 & x \ge 0 \\ -x^2 & x < 0 \end{cases}$

$f_1'(x) = \begin{cases} 2x & x > 0 \\ 2x & x < 0 \end{cases}$, $f_1'(0) = 0$

$f_1''(x) = \begin{cases} -2 & x < 0 \\ 2 & x > 0 \end{cases}$

So first derivative exists at x = 0 but second derivative does not exist there

(Q) $f_2(x) = \int_0^x t^2 \sin\left(\frac{1}{t}\right) dt = f_2(0) = 0$

$f_2'(x) = x^2 \sin\frac{1}{x}$, $x \ne 0$, $g'(0) = 0$

$f_2''(0) = 0$ but $\lim_{x\to 0} f_2''(x)$ does not exist

(R) $f_3(x) = x^{-\frac{1}{3}}|\sin x|$, $f_3|0| = 0$, $\lim_{x\to 1} f_3(x) = 0$

$f_3'(0^+) = \lim_{x\to 0} \frac{x^{-\frac{1}{3}} \sin x}{x}$ does not exist

(S) $f_4(x) = \begin{cases} 0 & -1 < x \le 0 \\ -x^3 & 0 < x < 1 \end{cases}$

Second derivative exists and continuous at x = 0

SECTION – D

47. 00002.00

Sol. Average value of –17 and 11 is –3

Let $f(x) = x^3 - 3x^2 + 5x - 3$

$\Rightarrow (x - 1)^3 + 2(x - 1)$

The graph of f(x) is odd w.r.t to x = 1

The if the root of $x^3 - 3x^2 + 5x - 17 = 0$ is $\alpha = 1 + x_1$

Then the root of $x^3 - 3x^2 + 5x + 11 = 0$ is $\beta = 1 - x_1$

So, $\alpha + \beta = 2$

48. 00003.00

Sol. From $\begin{cases} x + 2y > 0 \\ x - 2y > 0 \\ x^2 - 4y^2 = 4 \end{cases}$

We obtain $\begin{cases} x > 2|y| \ge 0 \\ x^2 - 4y^2 = 4 \end{cases}$

In view of x > 0 and y ≥ 0, we have to find the minimum value of x – y

Let x – y = u substituting into $x^2 - 4y^2 = 4$

We obtain $3y^2 - 2uy + (4 - u^2) = 0$

$\Delta = 4u^2 - 12(4 - u^2) \ge 0$

$\therefore\ u \ge \sqrt{3}$

If $x = \frac{4}{\sqrt{3}}$ and $y = \frac{1}{\sqrt{3}}$, we get $u = \sqrt{3}$

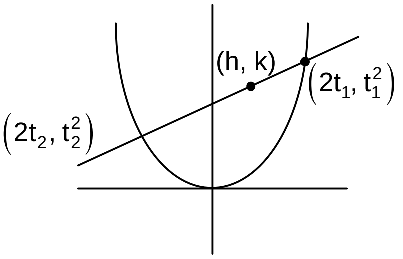
Therefore, minimum value of |x| – |y| = $\sqrt{3}$

49. 07921.00

Sol. $\tan 1^o = \dfrac{\tan(r+1) - \tan r}{1 + \tan r \cdot \tan(r+1)}$

Then $\tan 1^o \cdot \tan 2^o + \tan 2^o \cdot \tan 3^o ..... = \cot^2 1^o - 89$

50. 00512.00



Sol. $\dfrac{t_1^2 - t_2^2}{2(t_1 - t_2)} = \dfrac{1}{2}$

$\Rightarrow t_1 + t_2 = 1$

Also, $h = \dfrac{4t_1 + 2t_2}{3}$; $k = \dfrac{2t_1^2 + t_2^2}{3}$

$\Rightarrow 3h = 4t_1 + 2(t_2 + 1)$; $3k = 2t_1^2 + (1 - t_1)^2$

$t_1 = \dfrac{3h - 2}{2}$; $3k = 3t_1^2 - 2t_1 + 1$

$3k = 3\left(\dfrac{3h-2}{2}\right)^2 - 2\left(\dfrac{3h-2}{2}\right) + 1$

$\Rightarrow \left(h - \dfrac{8}{9}\right)^2 = \dfrac{4}{9}\left(k - \dfrac{2}{9}\right) \Rightarrow a = 8, b = 2, c = 4$

51. 00001.50

Sol. $1 + x + x^2 ..... = \dfrac{1}{1-x}$ infinite G.P. sum

Differentiate w.r.t. x

$1 + 2x + 3x^2 ..... = \dfrac{1}{(1-x)^2}$

Multiply with x and differentiate, we get

$1 + 2^2x + 3^2x^2 + 4^2x^3 ..... = \dfrac{(x-1)^2 - 2x(x-1)}{(x-1)^4}$

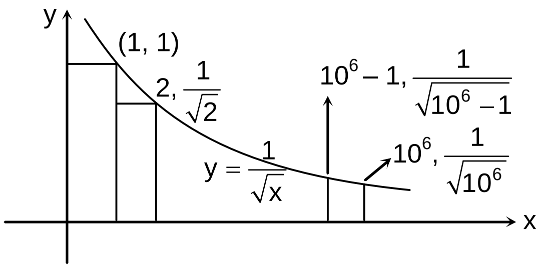
Multiply with x and put x = $\dfrac{1}{3}$, we get $\sum\limits_{k=1}^{\infty} \dfrac{k^2}{3^k} = \dfrac{3}{2}$

So p + q = 5

52. 01025.00

Sol. Let x be the number of switches then the minimum number be attempts required can be found by using. Such that if $2^n < x \le 2^{n+1}$
Then n + 1 will be the answer

53. 01998.00


y
(1, 1)
$2, \frac{1}{\sqrt{2}}$
$10^6 - 1, \frac{1}{\sqrt{10^6 - 1}}$
$y = \frac{1}{\sqrt{x}}$
$10^6, \frac{1}{\sqrt{10^6}}$
x

Sol. Consider $y = \dfrac{1}{\sqrt{x}}$

So, $S < \int\limits_1^{10^6} \dfrac{dx}{\sqrt{x}} + 1$

S < 1999

Also, $\int\limits_1^{10^6+1} \dfrac{dx}{\sqrt{x}} < S$

$\Rightarrow$ 1998.001 < S
So, [S] = 1998

54. 01007.00

Sol. So the sum of real coefficients is equal to $S = \frac{1}{2}\left\{(1+i)^{2015} + (1-i)^{2015}\right\} = 2^{1007}$

$\log_2 2^{1007} = 1007 = N$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – IX

JEE (Advanced)-2019

PAPER – 2

TEST DATE: 28-04-2019

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-D.**

1. ***Section-A (01 – 06, 19 – 24, 37 – 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 – 46) *contains 12 questions. Each question has* ***TWO (02)*** *matching lists:* ***LIST-I*** *and* ***LIST-II***. ***FOUR*** *options are given representing matching of elements from* ***LIST-I*** *and* ***LIST-II***. ***ONLY ONE*** *of these four options corresponds to a correct matching.*
   For each question, choose the option corresponding to the correct matching.
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

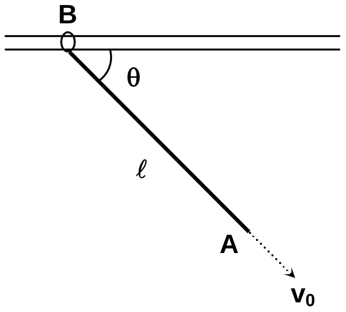
PART – I

SECTION – A

(One or More than one correct type)

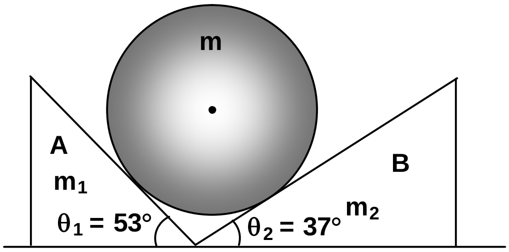
This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A bead B of mass m = 0.5 kg which can slide along a smooth horizontal rod is attached to one end of a light inextensible string of length ℓ = 1m as shown. The other end 'A' of the string is pulled with a constant speed v_0 = 2 m/s always directed along the length of the string. Then choose the correct option(s).



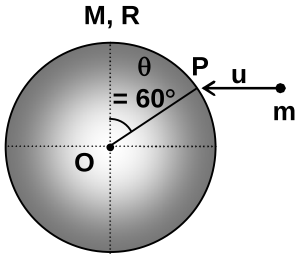
(A) The velocity of the bead at θ = 60° is 4 m/s.
(B) The velocity of the bead at θ = 60° is 1 m/s.
(C) The tension in the string at θ = 60° is 24 N.
(D) The tension in the string at θ = 60° is 12 N.

2. Two smooth triangular wedges A and B of masses m_1 = 9 kg and m_2 = 16 kg and inclination $\theta_1 = 53°$ and $\theta_2 = 37°$ respectively are placed on a smooth horizontal surface touching each other at their bottom edges. A horizontal cylinder of mass m = 25 kg is placed on the triangular wedges and then released from rest. When the centre of mass of the cylinder falls through height h = 0.4 m, then at this instant which of the following statements is/are correct.



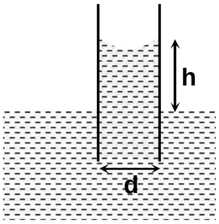
(A) The velocity of the wedge 'A' is 2 m/s.
(B) The velocity of the wedge 'B' is 1 m/s.
(C) The velocity of the cylinder is 1 m/s.
(D) The velocity of the cylinder is 2 m/s.

3. A uniform circular disc of mass M = 4 kg and radius R = 25 cm is suspended in a vertical plane and hinged at its centre 'O'. It is free to rotate about a horizontal axis passing through its centre and perpendicular to its plane. A particle of mass m = 0.5 kg moving horizontally with a velocity u = 20 m/s collides with disc at point 'P' and gets stuck to it as shown. Then choose the correct option(s). ($g = 10\ m/s^2$)



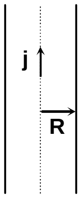
(A) The angular velocity of the disc just after collision is 4 rad/s.
(B) The angular velocity of the disc just after collision is 8 rad/s.
(C) The force on the disc due to hinge at its centre when the particle reaches the highest point is 38 N.
(D) The force on the disc due to hinge at its centre when the particle reaches the highest point is 44N.

4. Two vertical parallel rectangular glass plates are partially submerged in water. The separation between the plates is d = 0.1 mm and the width of each plate is ℓ = 10 cm. Assuming that the water between the plates does not reach the upper edges of the plates and the contact angle is $\theta = 0$. The surface tension of water is $T = 7 \times 10^{-2}$ N/m and the density of water is $\rho = 10^3$ kg/m^3. Then choose the correct option(s). (g = 10 m/s^2)



(A) The water rises upto height h = 14 cm between the plates.
(B) The water rises upto height h = 28 cm between the plates.
(C) The force of mutual attraction between the plates is 4.9 N.
(D) The force of mutual attraction between the plates is 9.8 N.

5. A long current carrying cylindrical conductor of radius 'R' has a uniform current density 'j' over its cross section inside it. If we consider the two halves that are obtained by dividing the conductor by a plane containing the axis of the conductor. Then choose the correct option(s).



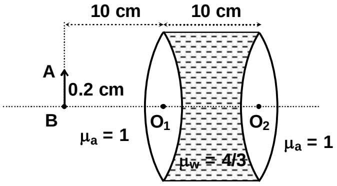
(A) The force of interaction per unit length between the two halves is $F = \left(\frac{\mu_0 j^2 R^3}{6}\right)$.

(B) The force of interaction per unit length between the two halves is $F = \left(\frac{\mu_0 j^2 R^3}{3}\right)$.

(C) The magnetic field inside the conductor at a radial distance $\frac{'R'}{2}$ from its axis is $B = \frac{\mu_0 jR}{4}$.

(D) The magnetic field inside the conductor at a radial distance $\frac{'R'}{2}$ from its axis is $B = \frac{\mu_0 jR}{2}$.

6. Consider an arrangement of two thin equiconvex lenses made of glass ($\mu_g = 3/2$) and each of focal length in air 10 cm are separated by a distance 10 cm. The space between the two lenses is filled with water of refractive index $\mu_w = 4/3$. A small linear object 'AB' of size 0.20 cm is placed perpendicular to the optic axis at a distance 10 cm from the first lens in air as shown. Then choose the correct option(s).

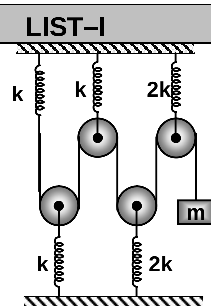
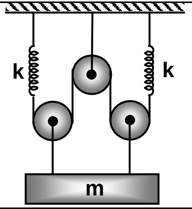
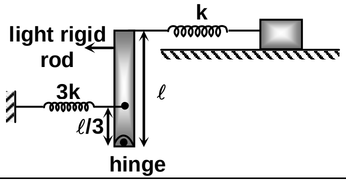
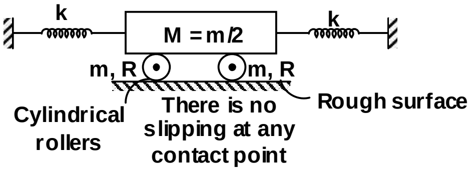


(A) The position of the final image formed is 25 cm right to the second lens.
(B) The position of the final image formed is 40 cm right to the second lens.
(C) The size of the final image formed is 0.40 cm.
(D) The size of the final image formed is 0.60 cm.

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

7. List –I represents the different spring mass systems. All springs and pulleys are ideal. List-II represents their time periods of small oscillations about equilibrium position. Match the systems mentioned in List-I with the corresponding time periods in List-II.

LIST–I		LIST–II	
P.		1.	$\pi\sqrt{\frac{m}{2k}}$
Q.		2.	$\pi\sqrt{\frac{5m}{2k}}$
R.	 k light rigid rod 3k ℓ $\ell/3$ hinge	3.	$2\pi\sqrt{\frac{13m}{k}}$
S.	 k M = m/2 k m, R m, R Cylindrical rollers There is no slipping at any contact point Rough surface	4.	$4\pi\sqrt{\frac{m}{k}}$

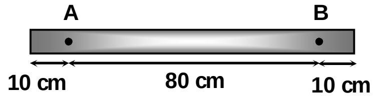
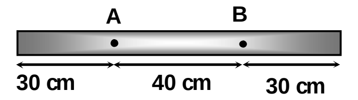
(A) P → 4; Q → 1; R → 3; S → 2

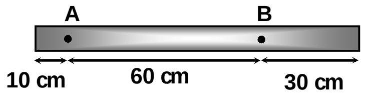
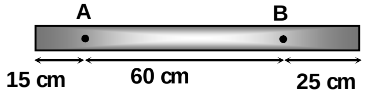
(B) P → 3; Q → 1; R → 4; S → 2

(C) P → 3; Q → 4; R → 1; S → 2

(D) P → 4; Q → 1; R → 2; S → 3

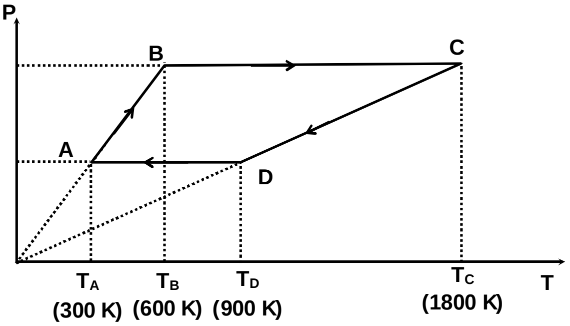
8. List – I represents the longitudinal vibration of metallic rods each of length 1 m and each rod is rigidly clamped at two points A and B. List – II represents their frequency and wavelength of longitudinal vibration in the fundamental mode of vibration. Then match the options of List-I correctly with the options of List-II.

LIST–I		LIST–II	
P.	 A B 10 cm 80 cm 10 cm $Y = 2 \times 10^{11}\ N/m^2$, $\rho = 8000\ kg/m^3$	1.	f = 40 kHz
Q.	 A B 30 cm 40 cm 30 cm $Y = 1.6 \times 10^{11}\ N/m^2$, $\rho = 2500\ kg/m^3$	2.	f = 12.5 kHz

R.	 $Y = 2 \times 10^{11}$ N/m^2, $\rho = 8000$ kg/m^3	3.	f = 20 kHz
S.	 $Y = 1.6 \times 10^{11}$ N/m^2, $\rho = 2500$ kg/m^3	4.	$\lambda = 0.4$ m
		5.	$\lambda = 0.2$ m

(A) P → 1, 5; Q → 3, 4; R → 2, 5; S → 1, 5
(B) P → 2, 5; Q → 3, 5; R → 2, 4; S → 2, 5
(C) P → 3, 4; Q → 3, 5; R → 2, 4; S → 2, 5
(D) P → 2, 4; Q → 3, 4; R → 2, 4; S → 1, 5

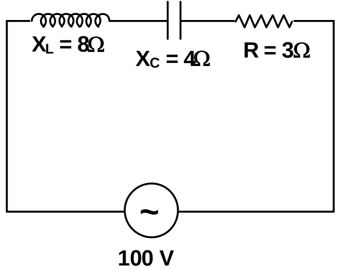
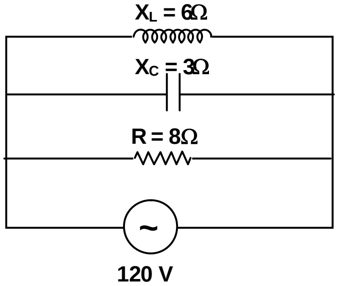
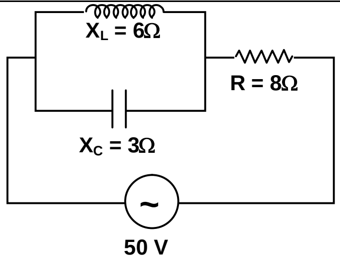
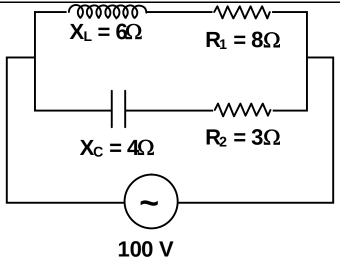
9. Two moles of an ideal monoatomic gas is taken through a cyclic process ABCDA as shown in the P-T diagram. List –I contains the four thermodynamic processes of the given cyclic process and List-II contains the quantities related to these thermodynamics processes. Match the options of List-I correctly with the options of List-II. (ΔQ = Heat supplied to the gas, ΔW = Work done by the gas)



LIST–I		LIST–II	
P.	In the process AB	1.	$\Delta Q = 900$ R
Q.	In the process BC	2.	$\Delta Q < 0$
R.	In the process CD	3.	$\Delta W = 2400$ R
S.	In the process DA	4.	$\Delta W < 0$
		5.	$\Delta W = 0$

(A) P → 2, 5; Q → 3; 4; R → 2, 5; S → 2, 4
(B) P → 1, 5; Q → 3; 4; R → 2, 5; S → 2, 4
(C) P → 1, 5; Q → 3; R → 2, 5; S → 2, 4
(D) P → 2, 4; Q → 3, 4; R → 2, 4; S → 1, 5

10. List –I contains different AC circuits with rms voltage of ac sources as shown. List –II contains the corresponding rms currents supplied by the ac voltage sources. Then match the options of List-I correctly with the options of List-II.

LIST–I		LIST–II	
P.	 $X_L = 8\Omega$ $X_C = 4\Omega$ $R = 3\Omega$ ~ 100 V	1.	$I_{rms} = 25$ A
Q.	 $X_L = 6\Omega$ $X_C = 3\Omega$ $R = 8\Omega$ ~ 120 V	2.	$I_{rms} = 5$ A
R.	 $X_L = 6\Omega$ $R = 8\Omega$ $X_C = 3\Omega$ ~ 50 V	3.	$I_{rms} = 10\sqrt{5}$ A
S.	 $X_L = 6\Omega$ $R_1 = 8\Omega$ $X_C = 4\Omega$ $R_2 = 3\Omega$ ~ 100 V	4.	$I_{rms} = 20$ A

(A) P → 4; Q → 1; R → 2; S → 3
(B) P → 2; Q → 3; R → 1; S → 4
(C) P → 3; Q → 2; R → 4; S → 1
(D) P → 1; Q → 4; R → 2; S → 3

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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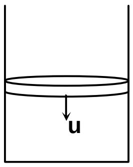
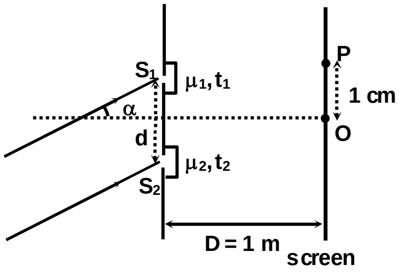
11. A string of mass 5 gram and length 50 cm is fixed at both ends. A pipe closed at one end has a length of 85 cm. When the string vibrates in its third overtone and the air column in the pipe in its first overtone, they produce a beats frequency of 4 Hz. It is observed that increasing the tension in the string increases beats frequency. Neglect the end correction in the pipe. The velocity of sound in air is 340 m/s. Find the tension (in Newton) in the string.

12. Two moles of an ideal monoatomic gas is enclosed in an adiabatic vertical cylinder fitted with a smooth adiabatic massive piston initially at rest. The whole system is placed inside a highly evacuated chamber. If the piston is imparted an initial velocity u = 8 m/s in vertical downward direction, after making a large number of oscillations, the piston finally comes to a complete stop. Find the displacement (in meter) of the piston. (Take $g = 10\ m/s^2$)



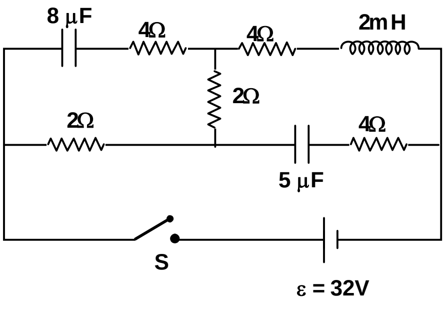
13. In young's double slit experiment two thin films are placed in front of two slits and the coherent parallel beam of light is incident at an angle $\alpha = 30°$ with the normal to the plane of slits as shown in the figure. If $\mu_2 = 1.8$, $\mu_1 = 1.5$ $t_2 = 3$ mm and the central maxima is formed at a distance 1 cm above point 'O' as shown. Find the thickness 't_1' (in mm) of the upper thin film.



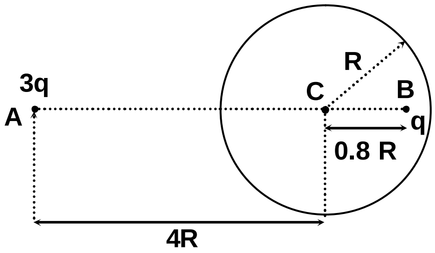
$d = S_1S_2 = 2$ mm

14. When a light of wavelength 5000 Å is incident on a metal surface of work function 1.9 eV, photoelectrons are emitted. When the emitted photoelectrons are passed through a region containing He^{2+} atoms, a fastest photoelectron combines with He^{2+} atom to form He^{+} atom and a photon is emitted. The He^{+} atom thus formed is in its third excited state. Then find the energy (in eV) of the photon emitted during the combination of the fastest photoelectron.

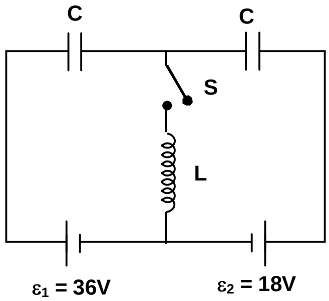
15. In the circuit shown, the switch 'S' is closed at t = 0. Then find the energy (in milli Joule) stored in 5μF capacitor in steady state.



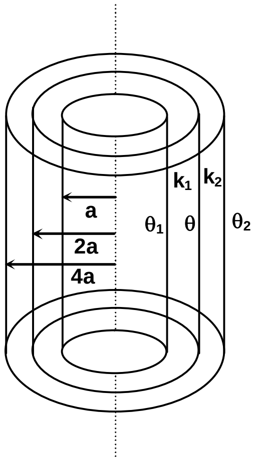
16. A thin conducting spherical shell of radius 'R' is given charge '2q'. Two point charges 'q' and '3q' are placed at distances 0.8 R and 4R from the centre 'C' of the shell respectively as shown. If the shell is earthed, find the charge (in μC) that will flow from conducting shell to the earth. (Given q = 2μC)



17. In the circuit shown, each capacitor has capacitance C = 10 μF and the inductor has inductance L = 2mH. The switch 'S' is opened for a long time. Find the maximum current (in ampere) through the inductor after the switch 'S' is closed.



18. A composite cylinder is made by joining two coaxial hollow cylinders as shown. The thermal conductivity of the material of the cylinder from radius 'a' to '2a' is $K_1 = 2K$ and that for the cylinder from radius '2a' to '4a' is $K_2 = 3K$. The temperature of the innermost wall is maintained at θ_1 = 84°C and the outermost wall is maintained at temperature θ_2 = 32°C. Find the temperature θ (in degree Celsius) of the intermediate cylindrical wall of radius '2a'.



Chemistry

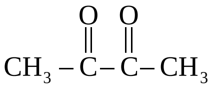
PART – II

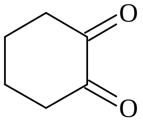
SECTION – A

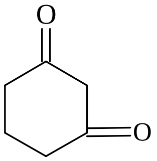
(One or More than one correct type)

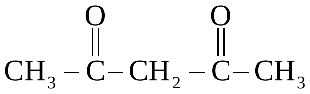
This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. In which of the following cases enol content will be higher than the keto content in n-hexane?

(A)

$CH_3-\overset{\overset{O}{\|}}{C}-\overset{\overset{O}{\|}}{C}-CH_3$

(B)


(C)


(D)

$CH_3-\overset{\overset{O}{\|}}{C}-CH_2-\overset{\overset{O}{\|}}{C}-CH_3$

20. In which of the following cases a mixture of optically active compounds with opposite optical rotation will not form when solutions are separated by semipermeable membrane
(A) 0.1 M D(+)–glucose & 0.1 M D(-) – fructose
(B) 0.2 M D(+)–glucose & 0.1 M D(-) –fructose
(C) 0.1 M D(+)–glucose & 0.2 M D(-) –fructose.
(D) 0.2 M D(+)–glucose & 0.2 M sugar

21. Which of the following compounds does not undergo complete hydrolysis?
(A) $SiCl_4$
(B) $BiCl_3$
(C) NF_3
(D) CCl_4

22. Which of the following statement(s) is/are correct ?
(A) $\left(SiH_3\right)_3N$ is a stronger base than $\left(CH_3\right)_3N$
(B) BF_3 is a weaker Lewis acid than BI_3
(C) Solid N_2O_5 is ionic in nature
(D) Phosphine is more basic than ammonia

23. Which of the following hydroxides dissolves in excess of NaOH?
(A) $Zn\left(OH\right)_2$
(B) $Al\left(OH\right)_3$
(C) $Sn\left(OH\right)_2$
(D) $Fe\left(OH\right)_3$

24. Decomposition of $3A(g) \rightarrow 2B(g) + 2C(g)$ follows 1st order kinetics. Initially only A is present in the container. Pressure developed after 20min and infinite time are 3.5 and 4 atm respectively. Which one is correct?

(A) $t_{50\%}$ = 20 min

(B) $t_{75\%}$ = 40 min

(C) $t_{99\%}$ = 64/3 min

(D) $t_{87.5\%}$ = 60 min

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

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25. Match the following :

List I (Complex)		List II	
P.	$[NiCl_4]^{2-}$	1.	sp^3 hybridization
Q	$[Ni(CN)_4]^{2-}$	2.	dsp^2 hybridization
R	$Ni(CO)_4$	3.	Paramagnetic
S.	$[Pd(NH_3)_4]^{2+}$	4.	Diamagnetic
		5.	Tetrahedral geometry

(A) P → 1, 3, 5; Q → 2, 4; R → 1, 4, 5; S → 2, 4

(B) P → 3, 4; Q → 1, 4, 5; R → 1, 2, 3, 4, 5; S → 3, 5

(C) P → 2, 5; Q → 1, 4, 5; R → 1, 2, 3, 5; S → 3, 5

(D) P → 3, 5; Q → 1, 2, 3; R → 1, 2, 3, 4, 5; S → 2, 4

26. List -I have mixture of solutions and List – II shows pH of the resulting solution. Now, match the column.

	List – I		List – II
P.	A saturated solution of $Mg(OH)_2$ $[K_{sp}Mg(OH)_2 = 4 \times 10^{-12}]$	1.	pH = 7
Q.	300 ml of 0.1 M BOH + 100 ml. of 0.1 M HCl ($K_{b\,(BOH)} = 10^{-4}$)	2.	pH = $\dfrac{pk_{a_2} + pk_{a_3}}{2}$
R.	300 ml. of 0.1 M BOH + 300 ml. of 0.1 M HA $[K_a = K_b = 10^{-4}]$	3.	pH = 10 + log 2
S.	0.01 M aqueous solution Na_2HPO_4 [Given that : $pk_{a_1}(H_3PO_4) = 4.3$; $pk_{a_2}(H_3PO_4) = 8.102$; $pk_{a_3}(H_3PO_4) = 12.5$]	4.	pH = $\frac{1}{2}pK_w + \frac{1}{2}pk_a - \frac{1}{2}pk_b$
		5.	$[H^+] = 10^{-7}$

The correct option is
(A) P → 2; Q → 1, 2, 3; R → 1, 2, 3, 5; S → 2, 4
(B) P → 3; Q → 1, 4, 5; R → 1, 2, 3, 4, 5; S → 3, 5
(C) P → 2; Q → 1, 4, 5; R → 1, 2, 3, 5; S → 3, 5
(D) P → 3; Q → 3; R → 1, 4, 5; S → 2, 3

27. Match the following List I with List II

	List – I		**List – II**
P.	$N_{2(g)} + 3H_{2(g)} \Leftrightarrow 2NH_{3(g)}$; ΔH = –ve	1.	Low pressure favours the yield of the product
Q.	$N_{2(g)} + O_{2(g)} \Leftrightarrow 2NO_{(g)}$; ΔH = +ve	2.	Addition of He at constant pressure decreases the yield of the product
R.	$NH_4HS_{(s)} \Leftrightarrow NH_{3(g)} + H_2S_{(g)}$; ΔH= +ve	3.	Rate constant of forward reaction increases more than the increase of the rate constant of backward reaction with increase of temperature.
S.	$2NO_{2(g)} \Leftrightarrow N_2O_{4(g)}$; ΔH = –ve	4.	High temperature favours consumption of product.
		5.	Homogeneous equilibrium

The correct option is
(A) P → 2, 4, 5; Q → 3, 5; R → 1, 3; S → 2, 4, 5
(B) P → 3, 4; Q → 1, 4, 5; R → 1, 2, 3, 4; S → 3, 5
(C) P → 2, 5; Q → 1, 4, 5; R → 1, 2, 3, 5; S → 3, 5
(D) P → 3, 5; Q → 1, 2, 3; R → 1, 2, 4, 5; S → 2, 4

28. Match the following and choose the correct option.

	List – I		**List – II**
P.	PF_5	1.	Trigonal bipyramidal
Q.	PCl_5	2.	Zero dipole moment
R.	PH_5	3.	All atoms surrounding central atom are at same distance
S.	PCl_3F_2	4.	Solid state contains tetrahedral cation and octahedral anion
		5.	Does not exist

(A) P → 1, 2, 3; Q → 1, 4; R → 5; S → 1, 2, 3
(B) P → 1, 2, 3; Q → 1, 2, 4; R → 5; S → 1, 2
(C) P → 1, 3; Q → 1, 2, 5; R → 5; S → 1, 2, 3
(D) P → 2, 3; Q → 1, 2, 4, 5; R → 5; S → 1, 2, 3

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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29. 20 g of naphthoic acid ($C_{11}H_8O_2$) dissolved in 50 g of benzene(K_f=1.72 K kg mol^{-1}) shows a depression in freezing point of 2K. The Van't Hoff factor is

30. A fuel cell develops an electrical potential from the combustion of butane at 1 bar and 298 K

$C_4H_{10}(g) + 13/2\ O_2(g) \longrightarrow 4CO_2(g) + 5H_2O(\ell)$ $\Delta G° = -2746$ KJ */mole*

The E°_{cell} of the fuel cell is

31. The equilibrium constant for the following reaction will be:

$HClO + CN^- \rightleftharpoons HCN + ClO^-$

Given Ka(HOCl)=3×10^{-8}

Ka(HCN) = 4.8×10^{-10}

32. Boiling point of an aqueous solution is 100.5^0C. Given latent heat of fusion and latent heat of vapourisation of water are 80 cal g^{-1} and 540 cal g^{-1} respectively. The freezing point depression of the solution is nearly

33. Potassium dichromate in acidic medium reacts with H_2S to oxidize it as per given unbalanced equation. How much kg of $K_2Cr_2O_7$ must be required if 1000 kg of sulphur is to be produced by following reaction? (Molar mass of $K_2Cr_2O_7$ = 294 g/mol.)

$K_2Cr_2O_7 + H_2SO_4 + H_2S \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + S + H_2O$

34. 100 ml of 0.05 M $CuSO_4$(aq) solution was electrolysed using inert electrodes by passing current till the pH of the solution was 2. The solution after electrolysis was neutralized and then treated with excess of KI and the I_2 formed is titrated with 0.04 M $Na_2S_2O_3$. The volume of $Na_2S_2O_3$ required is

35. A steel vessel of volume one litre is filled with a mixture of CH_4 and O_2 in $1:2$ mole ratio at a total pressure of 1 atm at 27^0C. The gas mixture is exploded for complete reaction. What would be the final pressure of the gaseous product at 127^0C.

36. A certain acid–base indicator is red in acid solution and blue in basic solution. 75% of the indicator is present in the solution in its blue form at pH = 5, calculate the pH at which the indicator shows 90% red. [given log 3 = 0.477]

Mathematics PART – III

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. If the roots of the equation $x^2 - px - 1 = 0$ and $x^2 - qx - 1 = 0$ form (in a suitable order) an arithmetic progression with four members then

(A) $p = \frac{2}{\sqrt{3}}, q = \frac{-2}{\sqrt{3}}$

(B) $p = \frac{4}{\sqrt{3}}, q = \frac{-4}{\sqrt{3}}$

(C) $p = \frac{-4}{\sqrt{3}}, q = \frac{4}{\sqrt{3}}$

(D) $p = \frac{-2}{\sqrt{3}}, q = \frac{2}{\sqrt{3}}$

38. For the curve sin x + sin y = 1 lying in the first quadrant $L = \lim_{x\to 0} x^{\alpha} \frac{d^2y}{dx^2}$, where L exists and is non zero. Then

(A) $\alpha = \frac{5}{2}$

(B) $\alpha = \frac{3}{2}$

(C) $L = \frac{1}{4\sqrt{2}}$

(D) $L = \frac{1}{2\sqrt{2}}$

39. Let M(–1, 2) and N(1, 4) be two points in a plane rectangular coordinate system XOY. P is a moving point on the x-axis. When $\angle$MPN takes its maximum value, then which of the following is true

(A) P(–7, 0)
(B) Area of triangle PMN is 4 units
(C) Equation of circumcircle of triangle PMN is $(x + 7)^2 + (y - 10)^2 = 100$
(D) P(1, 0)

40. The plane $7x - 2y + z + 21 = 0$

(A) contains the point (–1, 7, 0)

(B) contains the line $\frac{x+2}{1} = \frac{3-y}{-2} = \frac{z+1}{-3}$

(C) is perpendicular to the line $\frac{x}{7} = \frac{y}{-2} = \frac{2}{1}$

(D) is parallel to the plane $7x - 2y + z + 5 = 0$

41. Given A(0, 2) and two point B and C on the parabola $y^2 = x + 4$ such that AB ⊥ BC. Then the y-coordinate of point C may belongs to
(A) $y \in (-2, 2)$
(B) $y \in (-\infty, 0] \cup [4, \infty)$
(C) $y \in [5, \infty)$
(D) $y \in (-\infty, -3]$

42. If principal argument of z_0 satisfying $|z - 3| \le \sqrt{2}$ and $\arg(z - 5i) = -\frac{\pi}{4}$ simultaneously, is θ, then identify the correct statements
(A) $|z_0| = 17$
(B) $\tan 2\theta = \frac{8}{15}$
(C) $\tan\theta = -\frac{1}{4}$
(D) $|z_0 - 5i| = 4\sqrt{2}$

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

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43. If $S_n = \sum_{r=1}^{n} r!$, then for n > 6 (where [.] denotes the greatest integer function)

$\alpha_1 = \sin^{-1}\left(\sin\left(S_n - 7\left[\frac{S_n}{7}\right]\right)\right)$; $\alpha_2 = \cos^{-1}\left(\cos\left(S_n - 7\left[\frac{S_n}{7}\right]\right)\right)$; $\alpha_3 = \tan^{-1}\tan\left(S_n - 7\left[\frac{S_n}{7}\right]\right)$;

$\alpha_4 = \cot^{-1}\cot\left(S_n - 7\left[\frac{S_n}{7}\right]\right)$, then which of the following is correct

LIST – I		LIST – II	
P.	Value of α_1	1.	$5 - \pi$
Q.	Value of α_2	2.	$5 - 2\pi$
R.	Value of α_3	3.	$6 - 2\pi$
S.	Value of α_4	4.	$2\pi - 5$

The correct option is:
(A) P → 2; Q → 4; R → 3; S → 1
(B) P → 2; Q → 4; R → 2; S → 1
(C) P → 4; Q → 2; R → 4; S → 1
(D) P → 4; Q → 2; R → 2; S → 3

44. Consider an ellipse (E) $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$, centred at point 'O' and having AB and CD as its major and minor axes respectively. If S_1 be one of its foci, radius of incircle of triangle OCS_1 be 1 unit and OS_1 = 6 unit

LIST – I		LIST – II	
P.	The length of the major axis of E is	1.	4
Q.	The maximum distance of normal from centre of E is	2.	$\frac{13}{2}$
R.	The distance between the directrix of E is	3.	$\frac{169}{12}$
S.	The length of the latus rectum of E is	4.	$\frac{25}{13}$

The correct option is:
(A) P → 2; Q → 1; R → 3; S → 4
(B) P → 1; Q → 2; R → 4; S → 3
(C) P → 2; Q → 1; R → 4; S → 3
(D) P → 1; Q → 3; R → 4; S → 2

45. N_1 be the number of zero's at the ends of $\prod_{m=5}^{30}(m)^{m+1}$.

N_2 be the number of three digit numbers of form xyz such that $x < y$ and $z \le y$.

N_3 be the value of $\left[\frac{2009!+2006!}{2008!+2007!}\right]$, (where [.] denotes the greatest integer function).

N_4 be the number of positive integral pairs (x, y) satisfying the equation xy = 3370

LIST - I		LIST - II	
P.	The number of divisors of N_1	1.	8
Q.	The number of divisors of N_2	2.	12
R.	The number of divisors of N_3	3.	2
S.	The number of divisors of N_4	4.	4

The correct option is:
(A) P → 3; Q → 2; R → 1; S → 4
(B) P → 3; Q → 4; R → 1; S → 2
(C) P → 4; Q → 2; R → 3; S → 1
(D) P → 4; Q → 3; R → 2; S → 1

46. Each of the following function is defined to be zero at x = 0

$f_1(x) = x^2\,\text{sgn}(x)$

$f_2(x) = \int_0^x t^2 \sin\left(\frac{1}{t}\right)dt$

$f_3(x) = x^{-\frac{1}{3}}|\sin x|$

$f_4(x) = x^3[-x]$

where sgn(x) denotes signum function and [.] denotes the greatest integer function

LIST - I		LIST - II	
P.	The function f_1 is	1.	continuous but not differentiable at x = 0
Q.	The function f_2 is	2.	first derivative exists at x = 0 but second derivative does not exist
R.	The function f_3 is	3.	second derivative exists at x = 0, but it is not continuous there
S.	The function f_4 is	4.	second derivative exists at x = 0 and is continuous

The correct option is:

(A) P → 2; Q → 3; R → 4; S → 1
(B) P → 2; Q → 3; R → 1; S → 4
(C) P → 1; Q → 3; R → 4; S → 2
(D) P → 1; Q → 3; R → 2; S → 4

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

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47. The real numbers α, β satisfy the equation $\alpha^3 - 3\alpha^2 + 5\alpha - 17 = 0$; $\beta^3 - 3\beta^2 + 5\beta + 11 = 0$. Then $\alpha + \beta$ is equal to

48. If $\log_4(x + 2y) + \log_4(x - 2y) = 1$. Then the minimum value of $|x| - |y|$ is $\sqrt{k}$. Then k is equal to

49. The value of tan 1º·tan 2º + tan 2º·tan 3º + ... + tan 88º·tan 89º is equal to $\cot^2 1^\circ - n$, then the value of n^2 is _____

50. Locus of a point P which divides all chords of slope $\frac{1}{2}$ of parabola $x^2 = 4y$ in the ratio 1 : 2 internally is another parabola with vertex $\left(\frac{a}{9}, \frac{b}{9}\right)$ and length of latus rectum $\frac{c}{9}$, then value of ab^2c^2 is

51. If $\sum_{k=1}^{\infty} \frac{k^2}{3^k} = p$, then the value of p is

52. A room contains a single bulb and $2^{2^{10}} + 2^{2^9}$ identical switches. A man can switch on or switch off any number of switches at a time. Find the minimum numbers of attempts required to identify the correct switch for that bulb (Initially all the switch are either on or off)

53. If $S = 1 + \frac{1}{\sqrt{2}} + \frac{1}{\sqrt{3}} + \frac{1}{\sqrt{4}} ..... \frac{1}{\sqrt{1000000}}$, then [S] is equal to
(where [.] denotes the greatest integer function)

54. Let S be the sum of digits of all the real coefficients of $(1 + ix)^{2015}$. If $\log_2 S = N$, then N is equal to

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PART TEST – I

PAPER-1

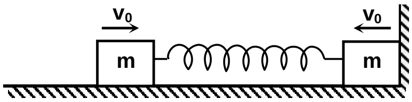
Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**A, B, C, D**	19.	**A, B, D**	37.	**B, C**
2.	**A, C**	20.	**B, C, D**	38.	**A, B**
3.	**A, C, D**	21.	**B, C, D**	39.	**A, B**
4.	**D**	22.	**A, B, C, D**	40.	**A, B**
5.	**A, C, D**	23.	**A, C**	41.	**A, B**
6.	**B, C, D**	24.	**A, B**	42.	**B, C**
7.	**D**	25.	**B**	43.	**C**
8.	**D**	26.	**D**	44.	**A**
9.	**B**	27.	**B**	45.	**D**
10.	**A**	28.	**C**	46.	**D**
11.	**00001.00**	29.	**00001.35**	47.	**00097.20**
12.	**00020.00**	30.	**00009.75**	48.	**00000.75**
13.	**00002.00**	31.	**00030.60**	49.	**00002.50**
14.	**00002.00**	32.	**00046.06**	50.	**00000.50**
15.	**00004.00**	33.	**00037.80**	51.	**00089.00**
16.	**00002.00**	34.	**00012.50**	52.	**–00012.50**
17.	**00007.00**	35.	**00012.25**	53.	**00000.50**
18.	**00003.00**	36.	**00303.90**	54.	**00000.40**

Physics

PART – I

SECTION – A

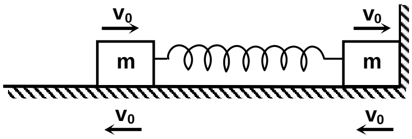
1. Immediately after 1st collision:
Since the situation is symmetric, both will come to rest simultaneously.
x_0 : maximum compression



$$\therefore\quad 2\times\frac{1}{2}mv_0^2=\frac{1}{2}kx_0^2$$

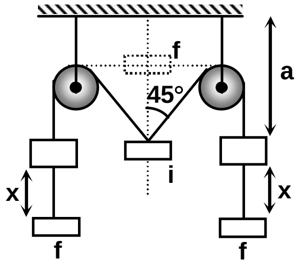
$$\therefore\quad x_0=v_0\sqrt{\frac{2m}{K}}$$

Just before 2nd collision:
Finally:



$$\therefore\quad \Delta\vec{P}=4mv_0(\leftarrow)$$

2. Applying work energy theorem from initial to final state (i to f)



$2Mgx - mgy = 0$

$\Rightarrow\ 2Mx = mg$ …(i)

Keeping length of the string constant

$\Rightarrow\ \sqrt{2}y+0=y+x+a$

$y(\sqrt{2}-1)=x$ …(ii)

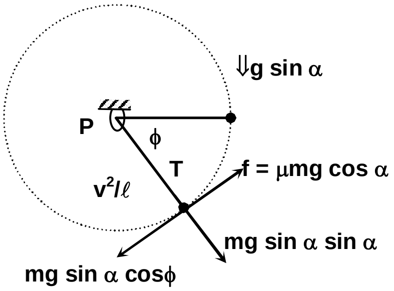
From (i) and (ii)

$\Rightarrow\ 2My(\sqrt{2}-1) = my$

$\Rightarrow\ m = 2M(\sqrt{2}-1)$

In the final state instantaneous acceleration of m has to be g as there will be only one force (That's mg). and the acceleration of masses M are zero at the same moment .

3. $T - mg\sin\alpha\sin\phi = \frac{mv^2}{\ell}$ …(i)



$mg\sin\alpha\cos\phi - \mu mg\cos\alpha = m\frac{dv}{dt}$ …(ii)

work energy theorem

$(mg\sin\alpha)\,\ell\sin\alpha - (\mu mg\cos\alpha)\ell\,\phi = \frac{1}{2}mv^2$ …(iii)

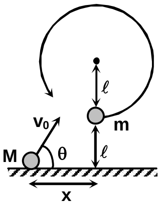
From (i) and (iii)

$\Rightarrow T - mg\sin\alpha\sin\phi = \alpha mg\sin\alpha\sin\phi - 2(\mu mg\cos\alpha)\,\phi$

$\Rightarrow T = mg\,(3\sin\alpha\sin\phi - 2\mu\phi\cos\alpha)$

$$\frac{dT}{d\phi}=0=3\sin\alpha\cos\phi-2\mu\cos\alpha$$

4. $Mv_0\cos\theta + 0 = Mv + mv'$



$e = 1 = \frac{v'-v}{v_0\cos\theta}$

$v'=\frac{2Mv_0\cos\theta}{M+m}\ge\sqrt{5g\ell}$

Also, x = R/2 and ℓ = H

Solving $\therefore\ x \geq \frac{3\sqrt{10}}{4}$

$x \geq 2.37$ m

5. $F_{ext} = kx + mg$ (x : extension at any t)

$\therefore\ W_{ext} = \int_0^{x_0} (kx + mg)dx$, where $kx_0 = mg$

Releasing, total work done = W_{ext} + mg(h), where h : natural length

6. Underestimate the work done against friction, and compare it with the initial gravitational potential energy of the eraser.

First of all, we investigate whether the rubber eraser will start moving at all. It will do so provided that mg sin α>μmg cos α, i.e. μ< tan α = tan 45° = 1. This is clearly the case, since μ = 0.6. So, the eraser will start moving. The trouble is that the determination of how the normal force acting on the eraser varies with position is difficult. A calculation of the work done against friction can be carried out, to any given degree of accuracy, only by using a computer. The trouble is that the determination of how the normal force acting on the eraser varies with position is difficult. However, it is certain that the frictional force is always larger than its initial value of μmg cos α = μmg cos 45° This is because, after the initial release, the angle with the horizontal made by the slope on which the eraser moves decreases, and, in addition, the track has to provide a centripetal force for the moving eraser. The path to reach the lowest point of the track would be one-eighth of a circle, with a length of Rπ/4. The work done against friction can now be underestimated by taking the normal force as if it always had its initial value:

$$\left|W_f\right| > \left|W_{und}\right| = \frac{\mu mg}{\sqrt{2}}\frac{\pi R}{4} \approx 0.333mgR$$

The gravitational potential energy difference between the initial position and the bottom of the track is $\Delta E_p = mgR(1 - \cos\alpha) = mgR(1 - \cos 45^\circ) \approx 0.293mgR$.

It can be seen that $|W_f| > \Delta Ep$, i.e. the work to be done against friction is clearly larger than what can be provided by the gravitational potential energy. So, the rubber eraser cannot reach the very lowest part of the track.

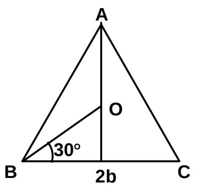
7-8. The pipes just below and just above the sheet which is moving will move the other pipes and the other pipes will remain in the original place. If the sheet is moved by distance greater then 5 cm the centre of gravity of the system would fall outside the base and the system will collapse.

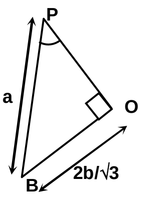
9-10. $\cos 30^\circ = \frac{b}{(BO)} = \frac{\sqrt{3}}{2} \Rightarrow BO = \frac{2b}{\sqrt{3}}$

Let P be particle clearly,

$3T_i \cos\theta = mg$

$T_i = \frac{mg}{3}\sec\theta = \frac{mga}{\sqrt{3(3a^2 - 4b^2)}}$





SECTION – D

11. Imagine the apex of the cone being depressed by Δh, and the radius of its base consequently increasing by Δr, i.e. the perimeter of the base circle increases by 2πΔr. Then the total work done by external forces would be:

$w\Delta h - F(2\pi\Delta r) = 0$

$\Rightarrow \quad F = \frac{w}{2\pi}\frac{\Delta h}{\Delta r}$

However, the changes in height and base circle radius are not independent, the connection between them being determined by the fixed length ℓ of one of the straight edges of the sheet. Using Pythagoras's theorem:

$(r + \Delta r)^2 + (h - \Delta h)^2 = \ell^2 = r^2 + h^2$

from which we have

$\frac{\Delta h}{\Delta r} = \frac{2r + \Delta r}{2h - \Delta h} \approx \frac{r}{h}$

So the force in question has magnitude

$F = \frac{w}{2\pi}\frac{r}{h}$ =1

12. The weight of the chain is balanced by the vertical components of the reaction forces at the two suspension points. The magnitude of each of these components must be $F_0 = \rho Lg/2$, where ρ is the mass of the chain per unit length, and L = 40 cm. If the chain made an angle of θ with the vertical at a suspension point, the horizontal component of the chain's tension would be $F_0 \tan\theta$. Because, in practice, θ = 45°, the horizontal component is the same as the vertical one; it is also constant along the chain, since there are horizontal forces acting on the chain only at its ends.

At the chain's lowest point, the tension is purely horizontal, and, as just shown, its magnitude is F_0. So, around the lowest point, consider a small piece of the chain that subtends an angle 2θ at the centre of the osculating circle, whose radius is the value r_1 we seek. The length of the piece is $2\theta r_1$ and it is pulled down by a gravitational force $2\theta r_1 \rho g$. This force is balanced by the upward net force of $2F_0 \sin\theta$ due to the tension in the chain. In the limit of small angles, when $\sin\theta \approx \theta$, the equilibrium equation

$2\theta r_1 \rho g = 2F_0 \sin\theta$

leads to

$F_0 = \rho g r_1$.

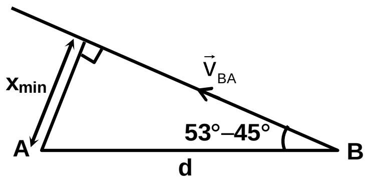
Since $F_0 = \rho Lg/2$, we have the simple result that $r_1 = L/2 = 20$ cm.

13. **Method 1:** Even though the normal force with the floor does no physical work on the person (energy transfers occur internally from the muscles), one can write a mathematically correct expression as though the contact force with the floor does change the person's energy. Hence, we can treat the center of mass motion as Wnet = ΔKcm. Here, we are treating it as though only gravity and the floor act onthe person, and since the person is in contact with the floor until the center of mass is a position h/2 from the ground, then $F_{floor}\frac{h}{4} + (mg)\left(\frac{-h}{2}\right) = 0$

as the student starts and ends this motion at rest. Therefore, $F_{floor} = 2mg$.

Method 2: Since the feet come off the floor at a position h/2 from the ground, then the person accelerates upward from h/4 to h/2 with the same magnitude as the acceleration from h/2 to 3h/4 by symmetry. Therefore, the net force on the student going upward is the same in magnitude as the student in free fall from h/2 to 3h/4. Hence, while in contact with the floor, using Newton's second law, $F_{floor} - mg = mg \Rightarrow F_{floor} = 2mg$.

14. $x_{min} = d \sin(53°-45°) = \dfrac{d}{5\sqrt{2}} = 2$



15. Momentum conservation along x axis

$0 = mv_2 - Mv_1$

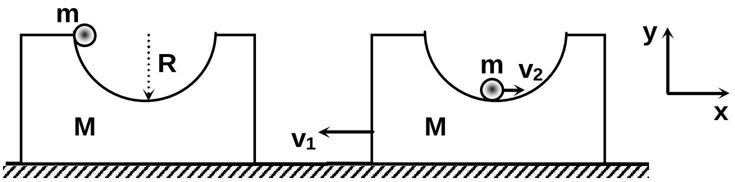
Work energy theorem

$mgR = \frac{1}{2}mv_2^2 + \frac{1}{2}Mv_1^2$

from (i) and (ii)

$\Rightarrow 2mgR = mv_2^2 + \frac{m^2}{M}v_2^2$

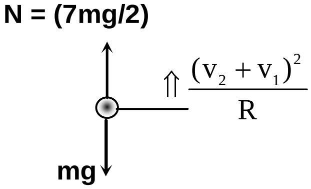
$\sqrt{\frac{2gRM}{M+m}} = v_2$ and $v_1 = \frac{m}{M}\sqrt{\frac{2gRM}{M+m}}$



Making FBD of particle with respect wedge at lowest point.

$\frac{7mg}{2} - mg = \frac{m(v_1+v_2)^2}{R}$

Substituting the values, we get : $\frac{M}{m} = 4$



16. Let us call h the height above the ground at which the projectile explodes and v_{jy} (j=1, 2, 3) the y-component of the velocity at the moment of the explosion for the three fragments. I will label with 1 the fragment which lands after t seconds.

Since the landing time depends only on the y-component of the velocity at the moment of the explosion, we have: $v_{3y} = v_{2y}$. We then need only the equations for fragments 1 and 2, stating that at landing time the y-coordinate will be equal to 0:

$h + v_{1y}t - \frac{gt^2}{2} = 0$

$h + v_{2y}t - \frac{g(2t)^2}{2} = 0$

Since the masses of the three fragments are equal, and the y-component of the projectile momentum at the moment of the explosion is equal to 0 (it explodes at the top of the trajectory), the momentum conservation law reads:

$v_{1y} + v_{2y} + v_{3y} = 0$.

The solution of the above equations is then:

$v_{1y} = \frac{-3}{4}gt$

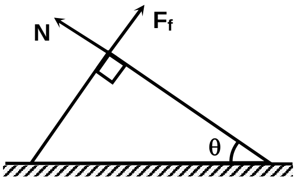
$v_{2y} = v_{3y} = \frac{3}{8}gt$

The height above the ground at which the projectile explodes is then: $h = 5gt^2/4$

17. Tension T = weigth of cat (since cat is at rest).

$\therefore$ Net downward force on rod = T + 4g

$a_{rod} = \frac{3g+4g}{4}$ = 7g/4 m/s^2



18. Let M_l be the mass of the left stick, and let M_r be the mass of the right stick. Then $M_l/M_r = \tan\theta$. Let N and F_f be the normal and friction forces between the sticks. F_f has a maximum value of μN. Balancing the torques on the left stick (around the contact point with the ground) gives $N = (M_lg/2)\sin\theta$. Balancing the torques on the right stick (around the contact point with the ground) gives $F_f = (M_rg/2)\cos\theta$. The condition $F_f \le \mu N$ is therefore

$$M_r\cos\theta \le \mu M_1\sin\theta \Rightarrow \tan^2\theta \ge \frac{1}{\mu}$$

where we have used $M_l/M_r = \tan\theta$.

Chemistry PART – II

SECTION – A

19. $$\underset{4-x}{PCl_5}(g) \rightleftharpoons \underset{x}{PCl_3}(g) + \underset{x}{Cl_2}(g)$$

Total moles at equilibrium = 4 + x + 2 = 6 + x

$$n = \frac{PV}{RT}$$

$$6 + x = \frac{6.568\times 80}{0.0821\times 800}$$

$$6 + x = 8, x = 2$$

$$[PCl_5] = \frac{2}{80}, [PCl_3] = \frac{2}{80}.[Cl_2] = \frac{2}{80}$$

$$K_c = \frac{\frac{2}{80}\times\frac{2}{80}}{\frac{2}{80}} = 0.025$$

$$K_P = K_c(RT)^{\Delta n}$$

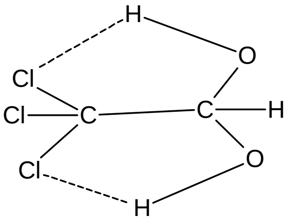
= 0.025 × 0.0821 × 800

= 1.642 atm

20. Bond angle of NH_3 > Bond angle of NF_3

21. $B_2O_3 + P_2O_5 \longrightarrow 2BPO_4$

22.



Chloral hydrate

23. $2KMnO_4 + 5K_2C_2O_4 + 8H_2SO_4 \longrightarrow 2MnSO_4 + 10CO_2 + 6K_2SO_4 + 8H_2O$

24.

$$Zn(OH)_2 + 2NaOH \longrightarrow \underset{(Soluble)}{Na_2ZnO_2} + 2H_2O$$

$$Al(OH)_3 + NaOH \longrightarrow \underset{(Soluble)}{NaAlO_2} + 2H_2O$$

25.

$$\left[Ag^+\right] = \sqrt[3]{\frac{K_{sp}}{\left[PO_4^{3}\right]}}$$

$$= \sqrt[3]{\frac{2.7\times10^{-18}}{0.1}}$$

$= 3 \times 10^{-6}$ M

26.

$$\left[Cl^-\right] = \frac{K_{sp}AgCl}{\left[Ag^+\right]}$$

$$= \frac{1.2\times10^{-10}}{3\times10^{-6}}$$

$$= 4\times10^{-5}$$

27.

$$K_p = P_{NH_3} \times P_{H_2S}$$

$$0.36 = P_{NH_3} \times P_{H_2S}$$

$$P_{NH_3} = P_{H_2S} = 0.6 \text{ atm}$$

$$P_{NH_3} + P_{H_2S} = 0.6 + 0.6 = 1.2 \text{ atm}$$

28.

(i) K_P is constant at a given temperature.

(ii) Addition of inert gas at constant volume does not affect equilibrium.

29.

$$K_c = 0.36,\ Q_c = \frac{1.8\times1.8}{1.8\times1.8} = 1$$

$$\underset{1.8+x}{SO_2(g)} + \underset{1.8+x}{NO_2(g)} \rightleftharpoons \underset{1.8-x}{SO_3(g)} + \underset{1.8-x}{NO(g)}$$

$$\therefore K_c = \frac{(1.8-x)^2}{(1.8+x)^2}$$

$$0.36 = \frac{(1.8-x)^2}{(1.8+x)^2}, \qquad 0.6 = \frac{1.8-x}{1.8+x}$$

$$\therefore x = 0.45$$

Number of mole of SO_3 = 1.8 – 0.45 = 1.35

30.

$$\begin{array}{lllll} & H_3PO_4 & +NaOH & \longrightarrow NaH_2PO_4 & +H_2O \\ \text{M.mole} & 2 & 4 & 0 & \\ & 0 & 2 & 2 & \end{array}$$

$$\begin{array}{lllll} & NaH_2PO_4 & + NaOH & \longrightarrow Na_2HPO_4 & +H_2O \\ \text{M.mole} & 2 & 2 & 0 & \\ & 0 & 0 & 2 & \end{array}$$

pH of $Na_2HPO_4 = \dfrac{pK_{a_2} + pK_{a_3}}{2}$

$= \dfrac{7.2 + 12.3}{2} = 9.75$

31. $KE = 13.6 \times \dfrac{Z^2}{n^2}$

$= 13.6 \times \dfrac{3^2}{2^2} = 30.6\ eV$

32. $k = \dfrac{2.303}{t} \log \dfrac{[A]_o}{[A]}$

$t = \dfrac{2.303 \times 6.93}{0.693} \log \dfrac{0.1}{0.001}$

t = 46.06

33. $\dfrac{E_{a_1}}{T_1} = \dfrac{E_{a_2}}{T_2}$

$\dfrac{42}{500} = \dfrac{E_{a_2}}{450}$

$E_{a_2} = 37.8\ kJ$

$\therefore x = 37.80$

34. $[A] = \dfrac{[A]_o}{2^3} = 0.125[A]_o$

$\therefore$ % of A left $= \dfrac{0.125[A]_o}{[A]_o} \times 100 = 12.50$

35. $K_2Cr_2O_7 + 4H_2SO_4 + 3H_2C_2O_4 \longrightarrow 6CO_2 + 7H_2O + Cr_2(SO_4)_3 + K_2SO_4$

134.4 L of CO_2 produced by $K_2Cr_2O_7$ = 294 g

$\therefore$ 5.6 L of CO_2 produced by $K_2Cr_2O_7 = \dfrac{294}{134.4} \times 5.6$

= 12.25 g

36. $\dfrac{1}{\lambda} = R(Z)^2 \left[\dfrac{1}{1^2} - \dfrac{1}{2^2}\right]$

$\dfrac{1}{\lambda} = R \times 4 \left[\dfrac{3}{4}\right]$

$\lambda = \dfrac{1}{R} \times \dfrac{1}{3} = 911.7 \times \dfrac{1}{3} \overset{o}{A}$

$\lambda = 303.90 \overset{o}{A}$

Mathematics PART – III

SECTION – A

37. $\ln \beta = \lim\limits_{n\to\infty} \frac{1}{n^2}$ [ln 1 + (ln 1 + ln 2) + (ln 1 + ln 2 + ln 3) + ...] – α ln n

$$= \lim_{n\to\infty} \frac{n\ln\frac{1}{n} + (n-1)\ln\frac{2}{n} + ... + \ln\frac{n}{n} + \frac{n(n+1)}{2}\ln n}{n^2} - \alpha \ln n = \lim_{n\to\infty} \frac{n+1-2n\alpha}{2n}\ln n + \frac{1}{n}\sum_{r=1}^{n}\frac{n+1-r}{n}\ln\frac{r}{n}$$

$\Rightarrow \alpha = \frac{1}{2}$ and $\ln \beta = \int\limits_0^1 (1-x)\ln x\,dx = -\frac{3}{4}$

38. Let p = abc and q = [a] [b] [c]. So, q is an integer and $p = \sqrt{\frac{60}{q}}$

q $\le$ min{[a]bc, a[b]c, ab[c]} = 3 $\Rightarrow$ q $\in$ {1, 2, 3}
If q = 1 $\Rightarrow$ ab[c] < 4 but ab[c] = 5 $\Rightarrow$ no solution

If q = 3, as p $\ge$ max{[a]bc, a[b]c, ab[c]} = 5 and $p = \sqrt{\frac{60}{q}}$ $\Rightarrow$ no solution

$\therefore$ q = 2 and p = $\sqrt{30}$. Since q is a product of 3 positive integer, we have 3 cases

If [a] = 2, then $a = \frac{2}{5}\sqrt{30} = \sqrt{\frac{120}{9}} > 3$ $\Rightarrow$ no solution

If [b] = 2, then solution is $\left(\frac{\sqrt{30}}{3}, \frac{\sqrt{30}}{2}, \frac{\sqrt{30}}{5}\right)$

If [c] = 2, then solution is $\left(\frac{\sqrt{30}}{3}, \frac{\sqrt{30}}{4}, \frac{2\sqrt{30}}{5}\right)$

39. Let f′(1) = a and f″(1) = b, putting x = 1 in the given equation we get b = a^2
Differentiating the equation and putting x = 1 gives 2ab + 8 = ab + 2ab $\Rightarrow$ ab = 8
So, a = 2, b = 4

40. $$I_n = \int\limits_{-\pi}^{0} \frac{\sin nx}{(1+2^x)\sin x}dx + \int\limits_{0}^{\pi} \frac{\sin nx}{(1+2^x)\sin x}dx$$

$I_n = \int\limits_{0}^{\pi} \frac{\sin nx}{(1+2^{-x})\sin x}dx + \int\limits_{0}^{\pi} \frac{\sin nx}{(1+2^x)\sin x}dx = \int\limits_{0}^{\pi} \frac{\sin nx}{\sin x}dx$ [Putting –x for x in 1st integral]

$I_{n+2} - I_n = \int\limits_{0}^{\pi} \frac{\sin(n+2)n - \sin nx}{\sin x}dn = 2\int\limits_{0}^{\pi} \cos(n+1)x\,dx = 0$ if $n \in N$

$\Rightarrow$ If n is even $I_n = I_0 = 0$, and if n is odd $I_n = I_1 = \pi$

41. Using LH-Rule twice, we get a = b = ±2

42. $\lim\limits_{x\to1} \frac{(\ln(2-x))^2}{x^2+ax+b} = 1 \Rightarrow 1 + a + b = 0$

Using LH-Rule, we have $\lim\limits_{x\to 1}\frac{2\ln(2-x)}{(x-2)(2x+a)}=1$ ⇒ a + 2 = 0 ⇒ a = –2, b = 1

43. $\frac{f(x)}{1+x^2}=1+\int\limits_0^x\frac{f(t)}{1+t^2}dt \Rightarrow \frac{f'(x)\left(1+x^2\right)-f(x)2x}{\left(1+x^2\right)^2}=\frac{f(x)}{1+x^2} \Rightarrow f'(x)-\frac{2xf(x)}{1+x^2}=f(x)$

$\Rightarrow \frac{f'(x)}{f(x)}=1+\frac{2x}{1+x^2}$ ⇒ ln f(x) = x + ln(1 + x^2) + ln c ⇒ f(x) = ce^x(1 + x^2)

44. Given equation implies $\frac{xf'(g(x))g'(x)}{f(g(x))}=\frac{g'(f(x))f'(x)}{g(f(x))}$

$\Rightarrow \frac{d}{dx}\left(\ln g(f(x))\right)=x\frac{d}{dx}\left(\ln f(g(x))\right)=-2x$ (as f(g(x)) = e^{-2x}),

⇒ g(f(x)) = Ae^{-x^2} and g(f(0)) = 1 ⇒ A = 1

45. Using integration by parts repeatedly

$$\int\limits_1^\infty\frac{(\ln x)^{2018}}{x^{2018}}dx=\left[\frac{(\ln x)^{2018}}{-2017x^{2017}}\right]_1^\infty-\int\limits_1^\infty\frac{2018(\ln x)^{2017}}{-2017x^{2018}}dx=\frac{2018}{2017}\int\limits_1^\infty\frac{(\ln x)^{2017}}{x^{2018}}dx$$

$$= \ldots.. = \frac{2018!}{(2017)^{2018}}\int\limits_1^\infty\frac{dx}{x^{2018}} = \frac{2018!}{(2017)^{2019}}$$

46. $I=2\int\limits_0^1\frac{2x^{332}+x^{998}}{1+x^{666}}dx$, (as $\frac{4x^{1664}\sin x^{691}}{1+x^{666}}$ is an odd function and rest of the integrand is even)

Put $x=t^{\frac{1}{333}} \Rightarrow dx=\frac{1}{333}t^{-\frac{332}{333}}dt$

$$I=\frac{2}{333}\int\limits_0^1\frac{2t^{\frac{332}{333}}+t^{\frac{998}{333}}}{1+t^2}t^{\frac{-332}{333}}dt = \frac{2}{333}\int\limits_0^1\frac{2+t^2}{1+t^2}dt = \frac{2}{333}\left(1+\frac{\pi}{4}\right)$$

SECTION – D

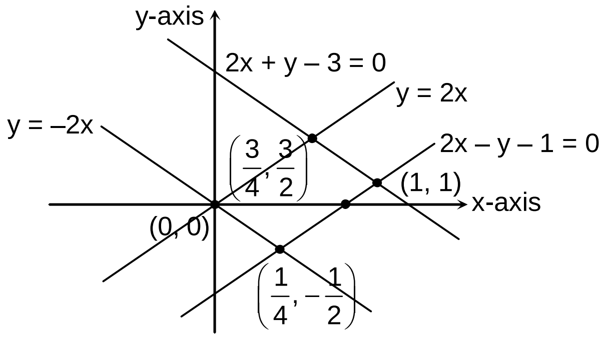
47. $\int\limits_0^1 f(x)f'(x)dx=\left[\frac{(f(x))^2}{2}\right]_0^1=0 \Rightarrow$ f(0) = ±f(1)

$\int\limits_0^1 (f(x))^2 f'(x)dx=\left[\frac{(f(x))^3}{3}\right]_0^1=18 \Rightarrow$ f(1) = 3 and f(0) = –3

48. Lines with slope ±2 and passing through (0, 0) and (1, 1) are y = ±2x and y – 1 = ±2(x – 1) respectively.

By the Mean Value theorem, no point of form (x, f(x)) lies outside this parallelogram. However, we can construct functions which satisfy the given condition and are arbitrarily close to the sides of the parallelogram.

So, b – a = area of parallelogram = $\frac{3}{4}$


y-axis
2x + y – 3 = 0
y = 2x
y = –2x
2x – y – 1 = 0
$\left(\frac{3}{4}, \frac{3}{2}\right)$
(1, 1)
x-axis
(0, 0)
$\left(\frac{1}{4}, -\frac{1}{2}\right)$

49. Let $S_n = \int_{\frac{1}{2^n}}^{\frac{1}{2^{n-1}}} f(x)dx$, then $S_n = \frac{1}{3}\int_{\frac{1}{2^n}}^{\frac{1}{2^{n-1}}} f(2x)dx = \frac{S_{n-1}}{6} = ... = \frac{S_0}{6^n}$

$$\int_0^1 f(x)dx = \lim_{n\to\infty}\left(\int_{\frac{1}{2^n}}^{\frac{1}{2^{n-1}}} f(x)dx + \int_{\frac{1}{2^{n-1}}}^{\frac{1}{2^{n-2}}} f(x)dx + ... + \int_{\frac{1}{2}}^{1} f(x)\right) = \frac{S_0}{5} = 1 \Rightarrow S_0 = 5$$

50. $f(1-x) = 1 - f(x) \Rightarrow f^k(1-x) = 1 - f^k(x)\ \forall\ k \in N$

$$\int_0^1 f^{2004}(x)dx = \int_0^1 \left(1 - f^{2004}(1-x)\right)dx = 1 - \int_0^1 f^{2004}(1-x)dx = 1 - \int_0^1 f^{2004}(x)dx$$ (Put 1 – x for x)

51. If x_1, x_2, x_3 and x_4 are the root of p then $\frac{p'(7)}{p(7)} = \sum \frac{1}{7 - x_i} = 0$ (as 7 is not a root of p(x))

$$\Rightarrow \frac{1}{7-1} + \frac{1}{7-3} + \frac{1}{7-5} + \frac{1}{7-x_4} = 0 \Rightarrow x_4 = \frac{89}{11}$$

52. $L = \lim_{x\to\infty} x^p\left((x+1)^{1/3} + (x-1)^{1/3} - 2x^{1/3}\right) = \lim_{t\to 0} t^{-p}\left(\left(\frac{1}{t}+1\right)^{1/3} + \left(\frac{1}{t}-1\right)^{1/3} - 2\left(\frac{1}{t}\right)^{1/3}\right)$, (putting $x = \frac{1}{t}$)

$= \lim_{t\to 0} t^{-p-\frac{1}{3}}\left((1+t)^{1/3} + (1-t)^{1/3} - 2\right) = -\frac{2}{9}t^{-p+\frac{5}{3}}$ (using expansion for $(1+x)^{1/n}$)

$\therefore\ p = \frac{5}{3}, L = -\frac{2}{9}$

53. $$\frac{d}{dt}\int_{-\infty}^{\infty} e^{tx}f(x)dx = \int_{-\infty}^{\infty} x e^{tx} f(x)dx = \frac{d}{dt}\left(\sin^{-1}\left(t - \sqrt{\frac{1}{2}}\right)\right) = \frac{1}{\sqrt{1 - \left(t - \frac{1}{\sqrt{2}}\right)^2}}$$

Putting t = 0, $\int_{-\infty}^{\infty} x f(x)dx = \sqrt{2}$

54. The tangent at (x, f(x)) meets the y-axis at (0, f(x) –1)

$\therefore$ f′(x) = $\frac{1}{x}$ $\Rightarrow$ f(x) = ln x + c and f(1) = 0 $\Rightarrow$ c = 0

*****

FIITJEE

JEE (Advanced)-2019

ALL INDIA TEST SERIES

PART TEST – I

Paper 1

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into Two sections: **Section-A & Section-D**
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01– 06, 19 – 24, 37 - 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 - 46) *contains 12 questions. Based on* this section contains **TWO (02)** paragraphs. Based on each paragraph, there are **TWO (02)** questions.
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10 \text{ m/s}^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N-m}^2$
Density of water	$\rho_{water} = 10^3 \text{ kg/m}^3$
Atmospheric pressure	$P_a = 10^5 \text{ N/m}^2$
Gas constant	$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
		=	$0.0821 \text{ Lit atm K}^{-1} \text{ mol}^{-1}$
		=	$1.987 \approx 2 \text{ Cal K}^{-1} \text{ mol}^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

PART – I (Physics), PART – II (Chemistry), PART – III (Mathematics):

(SECTION – D)

For questions **11 to 18, 29 to 36, 47 to 54.**
Numerical answer type questions with answer XXXXX. XX

If answer is 348.4 / 251.37 / 213

Correct Method :

0	0	3	4	8	.	4	0
0	0	2	5	1	.	3	7
0	0	2	1	3	.	0	0

Wrong Method :

	3	4	8		.	4	
3	4	8			.		4
		3	4	8	.		4
	3		4	8	.	4	
	2		5	1	.	3	7
		2	1	3	.		
		2	1	3	.	0	
		2	1	3	.		0
		3	4	8	.	4	0
		2	5	1	.	3	7
		2	1	3	.	0	0

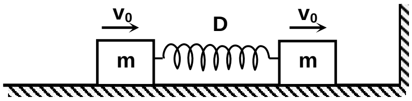
Physics

PART – I

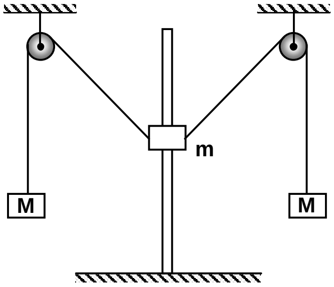
SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

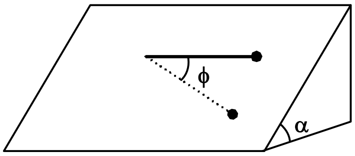


1. Bodies of mass m=0.5 kg, resting on a horizontal frictionless tabletop, are connected with an unstretched spring of length L=20 cm, and of spring constant k =16 N/m. The mass of the spring is negligible. At a certain moment the bodies are given an initial speed of v_0=0.36 m/s, towards the wall on the right. The body at the right collides with the wall totally elastically.
   (A) The greatest compression of the spring during the motion is 9cm .
   (B) The right body hit the wall again, when the spring is unstretched
   (C) The change in the linear momentum of the system after all collisions will be 0.72kgm/s.
   (D) Finally both the bodies will have same velocity .

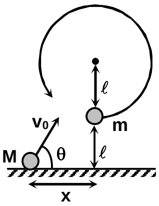


2. A point like object of mass m is able to move up and down on a vertical fixed rod. There is a vertical hole at the centre of the object, and the rod fits into this hole, such that the object can slide along the rod frictionlessly. Two pieces of thin light threads are attached to the object, and initially the angle between both threads and the vertical is α = 45^o. Each thread goes through a pulley, which are at the same height, and at the other end of each thread an object of mass M =1 kg is tied. The system is released from rest. After releasing the system it stops at the position where the threads attached to it are horizontal.
   (A) m = 2M(√2 –1)
   (B) The acceleration of the object of mass m when it starts to move back is zero.
   (C) The acceleration of the object of mass m when it starts to move back is g.
   (D) The acceleration of the other two objects of mass M, when they start to move back is g/2.

Space for Rough work



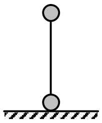
3. One end of a thread of length l = 1 m is attached to an inclined plane of angle of elevation of $\alpha = 30^o$. A point-like body of mass m = 1 kg is attached to the other end of the thread as shown in the figure. The body is released without initial speed, such that the thread is tight and horizontal. The coefficient of friction between the slope and the body is $\mu = 0.2$.
   (A) The tension in the thread when the angle between the thread and the horizontal is φ is $T = (3 \sin \varphi \sin \alpha - 2\mu\varphi \cos \alpha)mg$
   (B) The tension in the string will be maximum when $\varphi = 90^0$.
   (C) The tension in the string will be maximum when $\phi = \cos^{-1}\left(\frac{2\mu}{3\tan\alpha}\right)$
   (D) The maximum speed of the particle will be when $\varphi = \cos^{-1}(\mu\cot\alpha)$



4. A small ball of mass m=0.1 kg is attached to a ℓ =1 m-long thread and is hung to a horizontal peg. The small ball is at rest and another small ball of mass M=0.2 kg, is projected from the ground and collides with it, such that the collision is totally elastic and head on, and after the collision the ball at the end of the thread completes a whole circle around the peg. The distance between the peg and the ground is 2ℓ. The value of x can be :
   (A) 0.5m (B) 1m
   (C) 2m (D) 2.5m

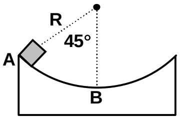
Space for Rough work

5. Two tennis balls of mass 60 g are attached with a massless rubber thread, and held in the vertical position as shown in the figure. In this position the unstretched length of the rubber thread is 40 cm. The upper ball is slowly raised vertically upward, until the lower ball just becomes unsupported by the ground. At this time the length of the thread is 1 m. The rubber thread exerts a force which is proportional to its extension.



(A) Work done by external agent while the upper ball was raised is 0.53J.
(B) Work done by external agent while the upper ball was raised is 0.23J.
(C) Releasing the upper ball, the speed which it hits the lower one is 5.1m/s.
(D) The time that elapses between the release of the upper ball and the collision is 0.34 sec.

6. A small rubber eraser is placed at one edge of a quarter-circle-shaped track of radius *R* that lies in a vertical plane and has its axis of symmetry vertical (*see* figure); it is then released. The coefficient of friction between the eraser and the surface of the track is $\mu = 0.6$. Will the eraser reach the lowest point of the track?



(A) If the particle slides from A to B work done by frictional force will be $\frac{0.6mgR}{\sqrt{2}}$.

(B) If the particle slides from A to B work done by frictional force will be greater than $\frac{0.6mg\pi R}{4\sqrt{2}}$.

(C) The particle will never be able to go from A to B.
(D) If μ is $\sqrt{2}$ the particle will not begin to slide.

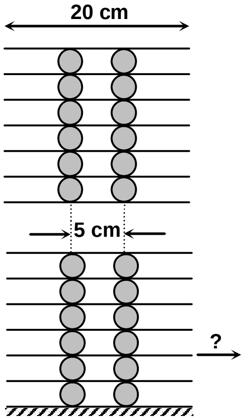
Space for Rough work

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 7 and 8

A tall tower is built from alike tubes, which have thin walls, and from rectangular sheets, which have negligible mass with respect to that of the tubes, as shown *in the figure.* rectangular sheets are numbered from bottom as S_1 , S_2 , S_3 …..(Static friction is big enough, such that the tubes does not slip.) The radius of each tube is 1 cm.



7. The minimum distance by which S_2 should be pulled towards right so that the tower collapses is :
(A) 2cm (B) 3cm
(C) 4cm (D) 5cm

8. The minimum distance by which S_6 should be pulled towards right so that the tower collapses is :
(A) 2cm (B) 3cm
(C) 4cm (D) 5cm

Space for Rough work

Paragraph for Question Nos. 9 and 10

A particle is suspended by three equal strings, of length a, from three points forming an equilateral triangle of side 2b, in the horizontal plane.

9. The tension in the string will be

(A) $\frac{3mga}{\sqrt{3(3a^2 - 4b^2)}}$ (B) $\frac{mga}{\sqrt{3(3a^2 - 4b^2)}}$

(C) $\frac{3mga}{\sqrt{(4a^2 - 3b^2)}}$ (D) $\frac{mga}{\sqrt{(4a^2 - 3b^2)}}$

10. If one string be cut, the tension of each of the other two strings will be changed in the ratio (i.e. the ratio of final tension after cutting the string to tension before cutting the string):

(A) $\frac{3a^2 - 4b^2}{2(a^2 - b^2)}$ (B) $\frac{4a^2 - 3b^2}{2(a^2 - b^2)}$

(C) $\frac{3a^2 - 4b^2}{(a^2 - b^2)}$ (D) $\frac{4a^2 - 3b^2}{(a^2 - b^2)}$

Space for Rough work

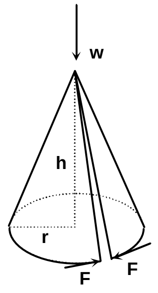
SECTION – D

(Numerical Answer Type)

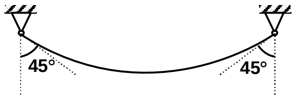
This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

11. A cone with height h= 1 m and a base circle of radius r = 1 m is formed from a sector- shaped sheet of paper. The sheet is of such a size and shape that its two straight edges almost touch on the sloping surface of the cone. In this state the cone is stress-free. The cone is placed on a horizontal, slippery table-top, and loaded at its apex with a vertical force of magnitude w = 2π, without collapsing. The splaying of the cone is opposed by a pair of forces of magnitude F acting tangentially at the join in the base circle (see figure). Ignoring any frictional or bending effects in the paper, find the value of F.



12. The two ends of a 40 cm long chain are fixed at the same height, as shown in the figure. Find the radius of curvature of the chain at its lowest point in cm.

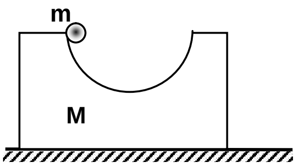


13. A student of height h jumps vertically up from the "squat" position. At the top point of the jump, the student's center of mass is at a height 3h/4 from the ground. Find the average force F acting on the floor prior to the moment when the student loses contact with the floor. It is known that when the student stands on the floor, the center of mass is at a height h/2 from the floor; in the "squat" position, the center of mass is at a height h/4 from the floor. The mass of the student is m= 0.1kg.(take g=10m/s^2)

14. Two points, A and B, are located on the ground a certain distance d = $10\sqrt{2}$m apart. Two rocks are launched simultaneously from points A and B with equal speeds but at different angles. Each rock lands at the launch point of the other. Knowing that one of the rocks is launched at an angle θ = 37° with the horizontal, what is the minimum distance between the rocks during the flight? (given cos 37° = 3/5)

Space for Rough work

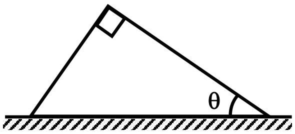
15. A semi-cylinder is cut out of a block and the block is kept on the horizontal surface. A small body of mass m is released at the top of the cylinder shaped hole. (Friction is negligible.)
If the block is able to move on the horizontal surface without friction, then the force exerted on the block by the small body at the lowest point is 7mg/2 . Find the ratio of M/m?



16. A projectile launched from the ground explodes into three fragments of equal mass at the top point of the trajectory. One of the fragments lands t seconds after the explosion two other fragments land simultaneously 2t seconds after the explosion. How high above the ground does the projectile explode? (take t= 2/5 seconds and g= 10m/s^2)

17. A vertical rod of mass 4 kg is hanging on a rope and a 3-kg cat is grasping the bottom end of the rod. The rope is cut off and the frightened cat begins to run up on the rod. While the rod is falling vertically, the cat remains at the same height, with respect to the ground. The acceleration of the rod is kg/4 m/s^2 where g is the acceleration due to gravity. Find k.

18. One stick leans on another as shown in Figure . A right angle is formed where they meet, and the right stick makes an angle θ with the horizontal. The left stick extends infinitesimally beyond the end of the right stick. The coefficient of friction between the two sticks is μ. The sticks have the same mass density per unit length and are both hinged at the ground. The minimum angle θ for which the sticks don't fall is 30^0. Find μ .



Space for Rough work

Chemistry

PART – II

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. A mixture of 2 moles of Argon and 4 moles of PCl_5 (g) were introduced in a 80 litre evacuated vessel at 527^oC. The following equilibrium was established

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

The total pressure of the gaseous mixture in the vessel at equilibrium was found to be 6.568 atm. Which of the following statement(s) regarding the above equilibrium is/are correct?

(A) K_c for the equilibrium is 0.025
(B) K_P for the equilibrium is 1.642 atm
(C) Total number of moles of gaseous species at equilibrium is 6
(D) Number of moles of PCl_5 at equilibrium is 2

20. The correct statement(s) among the following is/are

(A) Bond angle in NH_3 and NF_3 are same
(B) Bond angle in CH_4 and CF_4 are same
(C) Bond angle in PH_3 is greater than AsH_3
(D) Bond angle in BH_4^- and BF_4^- are same

21. The correct reaction(s) among the following is/are

(A) $3B_2O_3 + P_2O_5 \longrightarrow 2P(BO_2)_3 + O_2$
(B) $B_2O_3 + CoO \longrightarrow Co(BO_2)_2$
(C) $H_3BO_3 + 3HF \longrightarrow 2BF_3 + 3H_2O$
(D) $BCl_3 + 3H_2O \longrightarrow H_3BO_3 + 3HCl$

22. Which of the following statement(s) is/are correct?

(A) In the solid $NaHCO_3$ the HCO_3^- ions are linked by hydrogen bond forming an infinite chain.
(B) In the solid H_3BO_3, the $B(OH)_3$ units are linked by hydrogen bond.
(C) In chloral hydrate there is intramolecular hydrogen bond.
(D) In solid $KHCO_3$ the HCO_3^- ions are linked by hydrogen bond to form dimeric anion.

23. $KMnO_4$ reacts with $K_2C_2O_4$ and H_2SO_4 to form $MnSO_4$, CO_2, K_2SO_4 and H_2O. Which of the following statement(s) is/are correct for the reaction?

(A) One mole of $KMnO_4$ reacts completely to produce 112 litre of CO_2(g) at STP.
(B) One mole of $KMnO_4$ requires 5 mole of $K_2C_2O_4$ in presence of H_2SO_4 to react completely.
(C) One mole of $K_2C_2O_4$ reacts completely to produce 2 moles of CO_2.
(D) The ratio of stoichiometric coefficient of $KMnO_4$ and $K_2C_2O_4$ in this reaction is 1 : 2.

24. Which of the following hydroxide(s) is/are soluble in excess of NaOH solution?

(A) $Zn(OH)_2$
(B) $Al(OH)_3$
(C) $Fe(OH)_3$
(D) $Ni(OH)_2$

Space for Rough work

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 25 to 26

The process of selectively precipitating an ion from a solution of more than one ion is called selective precipitation. The selective precipitation of ions from a solution in the form of salt can be done by adding precipitating agent slowly. $AgNO_3$ solid is slowly added to one litre of a solution (without changing the volume) containing 0.1 mole of Cl^- and 0.1 mole of PO_4^{3-}. $K_{sp}AgCl = 1.2 \times 10^{-10}$ and $K_{sp}Ag_3PO_4 = 2.7 \times 10^{-18}$..

Answer the following questions based on the above paragraph.

25. Minimum concentration of Ag^+ required for the precipitation of Ag_3PO_4 is
(A) 1.6×10^{-9} M
(B) 3×10^{-6} M
(C) 9×10^{-6} M
(D) 3×10^{-9} M

26. The concentration of Cl^- in the solution when Ag_3PO_4 starts precipitating is
(A) 1.2×10^{-9} M
(B) 4×10^{-11} M
(C) 4×10^{-6} M
(D) 4×10^{-5} M

Paragraph for Question Nos. 27 to 28

Solid NH_4HS was heated at 100°C in a closed container. The following equilibrium was established

$$NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$$

K_P for the equilibrium was found to be 0.36 atm^2. Answer the following question based on the above equilibrium.

27. The total pressure of the mixture of a gases at equilibrium is
(A) 0.6 atm
(B) 1.2 atm
(C) 0.18 atm
(D) 0.9 atm

28. Which of the following statement is correct for the above equilibrium
(A) Addition of NH_4HS (s) at equilibrium increases the concentration of $NH_3(g)$
(B) Addition of inert gas at constant volume increases the number of moles of H_2S
(C) Addition of inert gas at constant pressure increases the number of moles of $NH_3(g)$
(D) Addition of NH_3 at equilibrium increases K_p for the reaction

Space for Rough work

SECTION – D

(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

29. At a certain temperature, the equilibrium constant (K_c) is 0.36 for the reaction

$$SO_2(g) + NO_2(g) \rightleftharpoons SO_3(g) + NO(g)$$

If 1.8 mole each of all the four gases are added in 1 litre container, the number of moles of $SO_3(g)$ at equilibrium is

30. 20 ml of $\frac{M}{10}$ H_3PO_4 solution is treated with 40 ml of $\frac{M}{10}$ NaOH solution pK_{a_1}, pK_{a_2} and pK_{a_3} of H_3PO_4 are 2.15, 7.2 and 12.3 respectively. The pH of the resulting solution is

31. Total energy of electron in the 1st orbit of hydrogen atom is 13.6 eV/atom. Kinetic energy of electron in the 1st excited state of Li^{2+} ion in eV is

32. The half-life of first order decomposition of NH_2NO_2 is 6.93 hrs. at 12^oC. If 6.2 g of NH_2NO_2 is allowed to decompose, then the time taken in hrs for 99% decomposition of NH_2NO_2 is

33. A catalyst decreases activation energy of a reaction from 42 kJ mol^{-1} to x kJ $mole^{-1}$. The rate of reaction in the absence of the catalyst at 500 K is equal to the rate of the reaction in the presence of catalyst at 450 K. The value of x is:

34. The half-life period of a 1st order reaction is 60 min. What percent of the reactant will be left after 180 min?

35. The weight in gram of $K_2Cr_2O_7$ required to produce 5.6 L of CO_2 at STP from excess of oxalic acid in H_2SO_4 is : (MW of $K_2Cr_2O_7$ = 294)

36. The wavelength of radiation in $\overset{o}{A}$ required to excite an electron in the ground state of He^{2+} to the 2nd energy level is: $\left(\frac{1}{R} = 911.7\,\overset{o}{A}\right)$

Space for Rough work

Mathematics PART – III

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. If $\lim\limits_{n\to\infty} \frac{\sqrt[n^2]{1!\,2!\,.....\,n!}}{n^{\alpha}} = \beta$, where β is a non-zero real number, then

(A) $\alpha = \frac{3}{4}$
(B) $\alpha = \frac{1}{2}$
(C) $\beta = e^{-3/4}$
(D) $\beta = e^{-1/2}$

38. Ordered triple(s) (a, b, c) of positive reals that satisfy [a]bc = 3, a[b]c = 4, ab[c] = 5 (where [.] denotes the greatest integer function) is/are

(A) $\left(\frac{\sqrt{30}}{3}, \frac{\sqrt{30}}{4}, \frac{2\sqrt{30}}{5}\right)$
(B) $\left(\frac{\sqrt{30}}{3}, \frac{\sqrt{30}}{2}, \frac{\sqrt{30}}{5}\right)$
(C) $\left(\frac{\sqrt{20}}{3}, \frac{\sqrt{20}}{3}, \frac{2\sqrt{20}}{5}\right)$
(D) $\left(\frac{\sqrt{20}}{3}, \frac{\sqrt{20}}{3}, \frac{\sqrt{20}}{5}\right)$

39. The function f: R $\to$ R satisfies $f(x^2)f''(x) = f'(x)f'(x^2)$ $\forall$ x $\in$ R, given that f(1) = 1 and $f'''(1) = 8$, then

(A) $f'(1) = 2$
(B) $f''(1) = 4$
(C) $f'(1) = 4$
(D) $f''(1) = 2$

40. For n $\geq$ 0, we have $I_n = \int_{-\pi}^{\pi} \frac{\sin nx}{(1+2^x)\sin x}dx$, then

(A) if n is even, then $I_n = 0$
(B) if n is odd, then $I_n = \pi$
(C) if n is even, then $I_n = \pi$
(D) if n is odd, then $I_n = 0$

Space for rough work

41. Suppose a and b are real numbers such that $\lim_{x\to 0}\frac{\sin^2 x}{e^{ax}-bx-1}=\frac{1}{2}$, then

(A) a = 2, b = 2
(B) a = –2, b = –2
(C) a = 2, b = –2
(D) a = –2, b = 2

42. Let a, b be real numbers such that $\lim_{x\to 1}\frac{\left(\ln(2-x)\right)^2}{x^2+ax+b}=1$, then

(A) a = 2
(B) b = 1
(C) a = –2
(D) b = –1

(Paragraph Type)

This section contains **TWO** paragraphs. Based on the paragraph, there are **TWO** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.

Paragraph for Question Nos. 43 to 44

Read the following write up carefully and answer the following questions:

An equation is called variable separable if it is of the form $\frac{dy}{dx}=f(x)g(y)$. In this case we formally separate the variable and write $\int\frac{dy}{g(y)}=\int f(x)dx$, which after the integration gives the solution in implicit form.

43. Differentiable function f: R → R satisfying the equation $f(x)=\left(1+x^2\right)\left[1+\int_0^x\frac{f(t)}{1+t^2}dt\right]$ is

(A) $f(x) = ce^x(1 - x^2)$
(B) $f(x) = ce^x(1 + x^3)$
(C) $f(x) = ce^x(1 + x^2)$
(D) $f(x) = ce^x(1 - x^3)$

44. Suppose f(x) and g(x) are differentiable functions such that $xg(f(x))f'(g(x))g'(x) = f(g(x))g'(f(x))f'(x)$ $\forall x \in R$. Moreover, f(x) is non-negative, g(x) is positive and $\int_0^x f(g(t))dt = 1-\frac{e^{-2x}}{2}$ $\forall x \in R$.

If g(f(0)) = 1, then g(f(4)) is

(A) e^{-16}
(B) e^{-8}
(C) e^{-4}
(D) e^{-2}

Space for rough work

Paragraph for Question Nos. 45 to 46

Read the following write up carefully and answer the following questions:

If $g'(x) = f(x)$, then $\int_a^b f(x)\,dx = g(b) - g(a)$.

45. Evaluate $\int_1^{\infty}\left(\frac{\ln x}{x}\right)^{2018} dx$

(A) $\frac{2016!}{(2017)^{2019}}$ (B) $\frac{2017!}{(2018)^{2019}}$

(C) $\frac{2017!}{(2019)^{2018}}$ (D) $\frac{2018!}{(2017)^{2019}}$

46. The value of integral $\int_{-1}^{1}\frac{2x^{332}+x^{998}+4x^{1664}\sin x^{691}}{1+x^{666}}dx$

(A) $\frac{2}{333}\left(1+\frac{\pi}{3}\right)$ (B) $\frac{2}{333}\left(1+\frac{\pi}{5}\right)$

(C) $\frac{2}{333}\left(1-\frac{\pi}{4}\right)$ (D) $\frac{2}{333}\left(1+\frac{\pi}{4}\right)$

SECTION – D

(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

47. Let f: R → R be a continuous function with $\int_0^1 f(x)f'(x) = 0$ and $\int_0^1 \left(f(x)\right)^2 f'(x)dx = 18$, then the value of $\int_0^1 \left(f(x)\right)^4 f'(x)dx$ is _____

Space for rough work

48. Let f: R → R be a differentiable function such that f(0) = 0, f(1) = 1 and $|f'(x)| < 2\ \forall\ x \in R$, if a and b are real numbers such that the set of possible values of $\int_0^1 f(x)dx$ is the open interval (a, b), then (b – a) is _____

49. Let f: R → R be a continuous function which satisfies the identity f(2x) = 3f(x) $\forall\ x \in R$.
If $\int_0^1 f(x)dx = 1$, then $\frac{1}{2}\int_1^2 f(x)dx$ is _____

50. Let $f^1(x) = f(x)$ and for $n \geq 1$ $f^{n+1}(x) = f^n(f(x))$. If f(x) = $x^3 - \frac{3}{2}x^2 + x + \frac{1}{4}$, then $\int_0^1 f^{2004}(x)dx$ is _____

51. Let p(x) be a fourth degree polynomial, with derivative p′(x),
such that p(1) = p(3) = p(5) = p′(7) = 0. If x is a real number such that p(x) = 0 and x is not equal to 1, 3 or 5, then 11x is _____

52. If L = $\lim_{x\to\infty} x^p\left(\sqrt[3]{x+1}+\sqrt[3]{x-1}-2\sqrt[3]{x}\right)$, where L is some non-zero real number, then $\frac{p^2}{L}$ is _____

53. If $\int_{-\infty}^{\infty} e^{tx}f(x)dx = \sin^{-1}\left(t-\sqrt{\frac{1}{2}}\right)$, then $\frac{1}{2\sqrt{2}}\int_{-\infty}^{\infty} x f(x)dx$ is _____

54. Let f: R^+ → R be a differentiable function such that the tangent to curve y = f(x) always meets the y-axis at point whose ordinate is one less than the ordinate of the point of contact. If f(1) = 0, then $\frac{1}{5}e^{f(2)}$ is _____

Space for rough work

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PART TEST – I

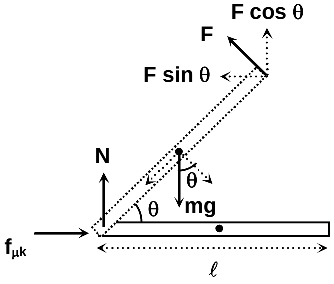
PAPER-2

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**C, D**	19.	**A, B, C**	37.	**C, D**
2.	**A, B**	20.	**A, C**	38.	**B, D**
3.	**C, D**	21.	**C, D**	39.	**A, B, C**
4.	**A, B, C**	22.	**A, B, C**	40.	**A, B, C, D**
5.	**A, B, C, D**	23.	**A, C**	41.	**A, B, D**
6.	**A, C**	24.	**C, D**	42.	**A, B, C, D**
7.	**C**	25.	**B**	43.	**D**
8.	**A**	26.	**D**	44.	**C**
9.	**A**	27.	**B**	45.	**B**
10.	**B**	28.	**A**	46.	**D**
11.	**00002.00**	29.	**00046.06**	47.	**00000.25**
12.	**00005.00**	30.	**00015.50**	48.	**00000.50**
13.	**00001.00**	31.	**00004.74**	49.	**00000.50**
14.	**00002.00**	32.	**00005.27**	50.	**00001.50**
15.	**00003.00**	33.	**00028.04**	51.	**00000.40**
16.	**00002.00**	34.	**01215.60**	52.	**00000.50**
17.	**00006.00**	35.	**00115.15**	53.	**00000.25**
18.	**00002.00**	36.	**02763.60**	54.	**00000.50**

Physics PART – I

SECTION – A

1. Since the rod is raised slowly (quasi-statically), the entire system remains in equilibrium at any moment in time. Thus, the torque about the point of rotation of the rod is zero about any axis, and the net external forces are 0. $F_{fric} = F\sin\theta$



$$\tau = -Fl + \frac{mgl\cos\theta}{2} = 0 \Rightarrow F = \frac{mg\cos\theta}{2}$$

$N = mg - F\cos\theta$

The F sin θ force causes the rod's bottom end to slip in one direction. The friction force counters this force to stop the slipping

when $F_{fric} = \mu_s N \geq F\sin\theta$. Hence,

$$\mu_s \geq \frac{F\sin\theta}{mg - F\cos\theta} = \frac{\sin\theta\cos\theta}{2-\cos^2\theta}$$

Maximum of μs can be found by setting its derivative with respect to theta equal to zero:

$$\frac{d\mu}{d\theta} = \frac{\left(2-\cos^2\theta\right)\left(2\cos^2\theta-1\right)-2\cos^2\theta\left(1-\cos^2\theta\right)}{\left(2-\cos^2\theta\right)^2} = 0 \text{ This gives } \sin\theta = \frac{1}{\sqrt{3}} \text{ and } \mu_{min} = \frac{\sqrt{2}}{4}$$

2. First consider the situation immediately after the perfectly inelastic collision between B and C but before A has begun to slip onto C; label this as the initial configuration "i." Clearly $v_{Ai} = v$ and $v_{Bi} = v_{Ci} = v/2$ by momentum conservation. On the other hand, in the end (labeled "f") all three masses have the same final speed, so that $v_{Af} = v_{Bf} = v_{Cf} = 2v/3$ by again applying momentum conservation. The sum of the kinetic energies of the boards thus changes by

$\Delta K = (K_{Af} + K_{Bf} + K_{Cf}) - (K_{Ai} + K_{Bi} + K_{Ci}) = -(mv^2/12)$ …(1)

where m is the mass of each board. This net loss in mechanical energy is the result of the non conservative "internal work" done by friction, $W_{NC} = -\int f dx_A + \int f dx_C = -\int_0^L f d\left(x_A - x_C\right)$ …(2)

where the equal and opposite internal force of friction between blocks A and C is given by

$f = \mu_k N = \mu_k\, mg(x_A\text{-}x_C)/L$ …(3)

with L the length of each board. Here, x_A and x_C are the rightward displacements of blocks A and C from their initial positions; the ratio $(x_A - x_C)/L$ thus gives the fraction of block A, which is on top of block C, and hence the ratio of the normal force N of A on C to the weight mg of A. Substitute Eq. (3) into Eq. (2) to find

$$W_{NC} = \frac{\mu_K mg}{L}\frac{L^2}{2} \quad \text{…(4)}$$

It is worth pausing to note that it would have been extremely difficult to attempt to separately calculate the two frictional work terms in the middle expression in Eq. (2)! Finally equate the right-hand sides of Eqs. (1) and (4) to obtain the answer,

$$L = \frac{v^2}{6\mu_k g}$$

3. $e = 1 = \dfrac{v_1 + v_2}{2\sqrt{2g\ell}}$ …(i)

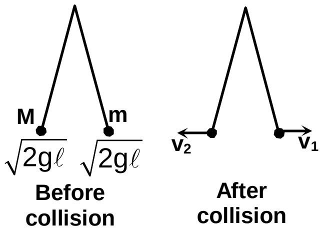
Momentum conservative

$M\sqrt{2g\ell} - m\sqrt{2g\ell} = mv_1 - Mv_2$ …(ii)

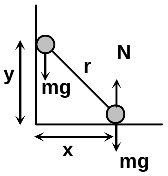
Solving (i) and (ii)

$$v_1 = \left(\frac{3M-m}{M+m}\right)\sqrt{2gL} \ge \sqrt{5gl}$$

$$\Rightarrow \frac{M}{m} \ge \frac{\sqrt{5}+\sqrt{2}}{3\sqrt{2}-\sqrt{5}} = 1.82 = 1.82$$



4. Since the normal force on the top mass is zero and the horizontal acceleration of the top mass is zero at the instant it loses con-tact with the wall, the tension in the rod at that moment must be zero. Thus, free-body diagrams for the two masses are as sketched below Therefore, the top mass has downward velocity v = – dy/dt and acceleration g = – d ^{2}y/dt^2,



While the bottom mass has rightward velocity u = dx/dt and zero acceleration. But y = (r^2-x^2)$^{1/2}$.

$$v = -\frac{dy}{dt} = \frac{x}{\sqrt{r^2-x^2}}\frac{dx}{dt} = \frac{xu}{y}$$

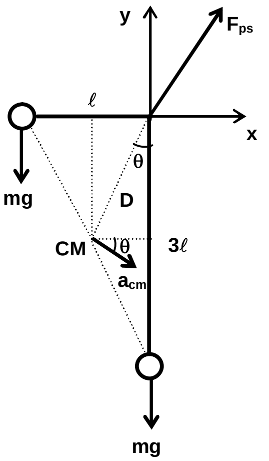
$$g = -\frac{d^2y}{dt^2} = \frac{u}{y}\frac{dx}{dt} - \frac{xu}{y^2}\frac{dy}{dt} = \frac{u^2}{y} + \frac{xuv}{y^2}$$

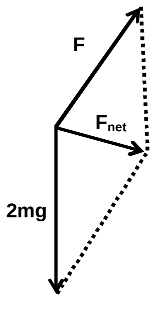
$$mg(r-y) = \frac{1}{2}m(u^2+v^2)$$

$$\Rightarrow 2g(r-y) = u^2\left(1+\frac{x^2}{y^2}\right) = \frac{u^2r^2}{y^2} = gy$$

$$y = \frac{2}{3}r \Rightarrow u = \sqrt{\frac{8gr}{27}}$$

5. According to Newton's third law, the force F_{sp} that the system (s) exerts on the pivot (p) is opposite to the force F_{ps} that the pivot exerts on the system, $F_{sp} = -F_{ps}$. Then, we can use Newton's second law to first deduce Fps and so to obtain the required force F_{sp}. The physical situation is represented in the figure below.





Applying Newton's second law to the system:

$F_{net} = M\,a_{cm}$, (1)

where F_{net} indicates the sum of all external forces on the system, a_{cm} indicates the acceleration of the center of mass of the system, and M is the total mass of the system that is M = 2m because the mass of the "light rod" is neglected. In the present case Fnet is the sum of the gravitational force on the two spheres and the force Fps that exerts the pivot:

$F_{net} = M\,g + F_{ps}$. (2)

The force Fps can be deduced from Eqs. (1) and (2):

$F_{ps} = M\,a_{cm} - M\,g$. (3)

Then, to obtain F_{ps} it is necessary to have a_{cm}. We note that just after the system is released, the acceleration of the center of mass is tangent to the circular trajectory that the center of mass will follow during its oscillation around the pivot (the pivot is the suspension point and the system will behave as a physical pendulum). It allows us to relate the magnitude of this tangential acceleration with the magnitude of the angular acceleration a of the system:

$a_{cm} = \alpha\,D$, (4)

where D is the distance between the pivot and the center of mass. From the figure,

$D = \frac{\sqrt{10}}{2}l$ (5)

Equation (4) is only valid just after the system is released at t = 0, because for t > 0 the system will also have a centripetal acceleration pointing to the pivot. The angular acceleration a is obtained by using Newton's second law in "its rotational version." We have:

$\tau_{net} = I\alpha$ (6)

where τ_{net} has to be measured with respect to an axis that passes through the pivot and is perpendicular to the vertical plane when the system is contained. Since the weight of the upper mass is the only force that produces a torque, the magnitude of this torque can be found as:

$\tau_{net} = mgl$ (7)

Here I is the moment of inertia of the system with respect to the same axis:

$I = 10\,m^2$ (8)

where we have neglected the moment of inertia of the two arms that the light rod forms, due to the assumption $m_{rod} << m$. Combining Eqs. (6), (7), and (8) we obtain

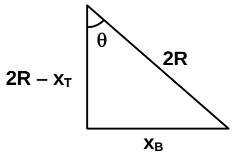
$\alpha = g/10l$ (9)

$a_{cm} = \frac{g}{10\sqrt{2}}$ (10)

$$\overrightarrow{a_{cm}} = \left(\frac{3}{10}i - \frac{1}{20}j\right)\vec{g}$$

$$\overrightarrow{F_{ps}} = 2mg\left(\frac{3}{20}i - \frac{1}{20}j\right)g - 2mg(-j) = mg\left(\frac{3}{10}i + \frac{19}{20}j\right)$$

6. Consider a moment when the center of top the cylinder has moved down a distance x_T and the center of the bottom cylinder has moved to the right a distance x_B. At this moment, the cylinders are moving with speeds v_T and v_B, respectively. From Fig. , v_T and v_B, respectively. From Fig.,



$x_T = 2R(1-\cos\theta)$

Also, energy conservation gives:

$$m\left(\frac{v_B^2 + v_T^2}{2}\right) = mgx_T = 2mgR(1-\cos\theta)$$

$$x_B^2 + (2R - x_T)^2 = (2R)^2$$

Differentiating w.r.t. time

$v_T = v_B x_B/(2R - x_T) = v_B \tan\theta$.

Eliminating v_T from the energy conservation equation gives $v_B^2 = 4gR(1 - \cos\theta)/(1 + \tan^2\theta)$. Setting the derivative with respect to θ equal to zero gives
$\cos\theta_m = 2/3$
for the angle θ_m at which v_B is maximum. At this point, the speed of the bottom cylinder is $v_B = \sqrt{\dfrac{16gR}{27}}$.

Mathematically, it appears that the speed decreases after θ_m. However, for this to happen, the acceleration and, therefore, the horizontal force must be directed to the left (negative) for angles greater than θ_m. But the contact force on the bottom cylinder by the top cylinder cannot be directed to the left. Therefore, the bottom cylinder loses contact with the top one and moves off at the maximum speed of $v_B = \sqrt{\dfrac{16gR}{27}}$

7. Basic concept of collision

8. Taking torque about point A

$$N\sqrt{\ell^2 - (\ell - h)^2} = f_s(\ell - h)$$

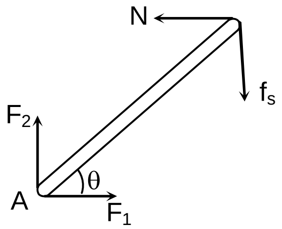
$$\Rightarrow f_s = \frac{N\sqrt{\ell^2 - (\ell - h)^2}}{\ell - h} \le \mu N$$

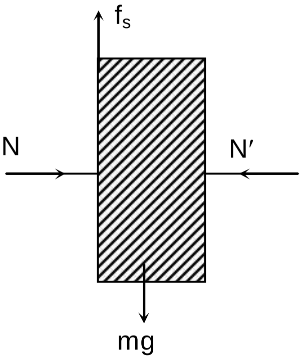
$$\Rightarrow \ell^2 - (\ell - h)^2 \le \mu^2(\ell - h)^2$$

$$\Rightarrow \ell^2 \le (\mu^2 + 1)(\ell - h)^2$$

$$\Rightarrow \quad \frac{\ell}{\sqrt{\mu^2 + 1}} \le (\ell - h)$$

$$\Rightarrow \quad h \le \ell\left[1 - \frac{1}{\sqrt{1 + \mu^2}}\right] \Rightarrow \quad h_{max} = 2m$$





$f_s = 3$ N
$N = 4N$
$F_H = 5$ N.

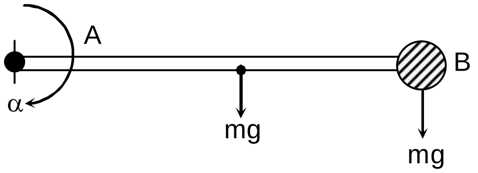
9. (P) $a < \dfrac{g}{3\sqrt{3}} \Rightarrow$ 3, 4

(Q) $\dfrac{g}{\sqrt{3}} < a < \dfrac{g}{3\sqrt{3}} \Rightarrow$ 2

(R) 5

(S) $a > \dfrac{g}{\sqrt{3}} \Rightarrow 1$

10. $$Mg\frac{\ell}{2} + mg\ell = \left(\frac{M\ell^2}{3} + m\ell^2\right)\alpha$$



$$\alpha = \left(\frac{\frac{M}{2} + m}{\frac{M}{3} + m}\right)\frac{g}{\ell} = \frac{40}{3}\ \text{rad/s}^2$$

$$mg + F_1 = m\left(\frac{40}{3} \times 1\right)$$

$$\text{i.e. } F_1 = \frac{40}{3} - 10 = \frac{10}{3}$$

$$Mg + mg - F_H = M\left(\frac{20}{3}\right) + m\left(\frac{40}{3}\right)$$

$$= 40 + \frac{40}{3}$$

$$70 - F_H = \frac{160}{3}$$

$$F_H = 70 - \frac{160}{3} = \frac{50}{3}$$

SECTION – D

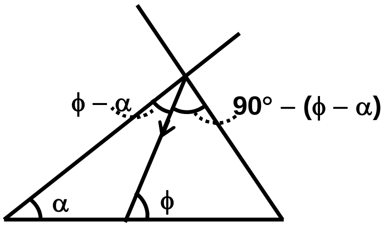
11. $a_1 \cos[90° - (\phi - \alpha)] = a_2 \sin\alpha$

$a_1 \sin(\phi - \alpha) = a_2 \sin\alpha$ …(i)

Conservation has no acceleration x direction

$\Rightarrow Ma_2 = ma_1 \sin\phi$ …(ii)

From (i) and (ii)



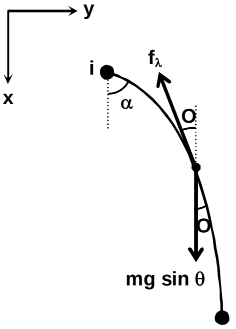
$$\Rightarrow \frac{m}{M}\sin\phi = \frac{\sin(\phi - \alpha)}{\sin\alpha}$$

$$\Rightarrow \frac{m}{M} = \frac{\tan\phi - \tan\alpha}{\tan\alpha}$$

$$\frac{m}{M} = \frac{\tan 60 - \tan 30}{\tan 30} = 2$$

12. $\frac{\sqrt{5}v_o}{2}$ (Apply conservation of energy)

13. Because the block does not accelerate off the plane surface, the normal force N that the surface exerts on the block (of mass m) must balance the component of the block's weight perpendicular to the plane, so that N =mg cos θ, and thus the kinetic frictional force is $f_k = \mu_k$ mg cos θ. On the other hand, the following sketch shows the path of the block (between its initial position "i" and final position "f ") and the components of the forces acting on it in the plane of the incline. I have chosen coordinates with x down the incline and y perpendicular to it. A tangent to the block's path makes angle f with respect to the x-direction, with $\varphi_i = \alpha$. (It is interesting to note that φ must be zero because the block's final speed and hence its final centripetal acceleration must approach zero, which can only happen if the frictional force points up the plane, opposite the weight component down the plane.)



Newton's second law in the x-direction, after dividing both sides by the block's mass, becomes

$$\frac{dv_x}{dt} = g\sin\theta - \mu_k g\cos\theta\cos\phi \qquad (1)$$

where u is the block's speed, with initial value u_0. Writing down the y-component of Newton's second law introduces sin φ, which leads to a mess. A better choice is to instead write down the tangential component of Newton's second law (noting that any direction other than x would give an independent equation),

$$\frac{dv}{dt} = g\sin\theta\sin\phi - \mu_k g\cos\theta \qquad (2)$$

Solve Eq. (1) for cos φ (which is the only time-dependent quantity on the right-hand side of these two equations) and substitute it into Eq. (2) to get

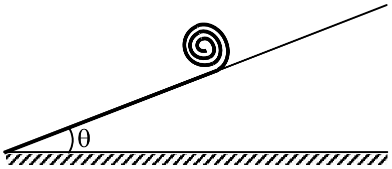
$$\mu_k\frac{dv}{dt} = g\cos\theta\left(\tan^2\theta - \mu_k{}^2\right) - \tan\theta\frac{dv_x}{dt}$$

after simplifying. Now integrate both sides over the time t from the initial to the final point to obtain

$$\mu_k\left(0 - v_0\right) = g\cos\theta\left(\tan^2\theta - \mu_k{}^2\right)t - \tan\theta\left(0 - v_o\cos\alpha\right)$$

$$t = \frac{v_o\left(\mu_k + \tan\theta\cos\alpha\right)}{g\cos\theta\left(\mu_k{}^2 - \tan^2\theta\right)}$$

14. The rolled part of the carpet is a cylinder, and its mass is proportional to x. Applying conservation of mechanical energy, $\left(1+\frac{1}{2}\right)\frac{1}{2}(\lambda x)\left(\frac{dx}{dt}\right)^2 = (\lambda x)g\frac{x\sin\theta}{2}$



∴ $\left(\frac{dx}{dt}\right)^2 = v^2 = \frac{2gx\sin\theta}{3}$

i.e. $a_{carpet} = \frac{g}{3}$.

For the cylinder,

$$\frac{3}{4}mv^2 = mgx\sin\theta$$

i.e. $a_{cyl} = \frac{2g}{3}$

$$\frac{t_1}{t_2} = \sqrt{\frac{a_{cyl}}{a_{carpet}}} = \sqrt{2}$$

15. Maximum trajectory area

Let θ be the angle at which the ball is thrown. Then coordinates are given by x = (v cos θ)t and y = $(v\sin\theta)t - \frac{gt^2}{2}$. The total time in air is 2(v sin θ)/g, so the area under the trajectory, A = ∫ydx, is

$$\int_0^{x_{max}} y\,dx = \int_0^{2v\sin\theta/g}\left((v\sin\theta)t - \frac{gt^2}{2}\right)(v\cos\theta dt) = \frac{2v^4}{3g^2}\sin^3\theta\cos\theta$$

Taking the derivative of this, we find that the maximum occurs when tan θ = √3 that is, when θ = 60°. The maximum area is then $A_{max} = \frac{\sqrt{3}V^4}{8g^2}$. Note that by dimensional analysis we know that the area, which has dimensions of distance squared, must be proportional to $\frac{v^4}{g^2}$.

16. Circling around a pole

Let F be the tension in the string. At the mass, the angle between the string and the radius of the dotted circle is θ = $\sin^{-1}$(r/R). In terms of θ, the radial and tangential F = ma equations are

$F\cos\theta = \frac{mv^2}{R}$, and F sin θ = $m\frac{dv}{dt}$ …(i)

Dividing these two equations gives tan θ = (Rv)/v^2. Separating variables and integrating gives

$$\int_{v_0}^{v}\frac{dv}{v^2}=\frac{\tan\theta}{R}\int_0^t dt$$

$$\Rightarrow \frac{1}{v_0}-\frac{1}{v}=\frac{(\tan\theta)t}{R}\Rightarrow v(t)=\left(\frac{1}{v_0}-\frac{(\tan\theta)t}{R}\right)^{-1} \qquad \ldots\text{(ii)}$$

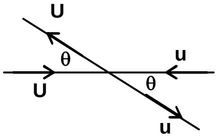
The speed v becomes infinite when

$$t=T=\frac{R}{v_0\tan\theta} \qquad \ldots\text{(iii)}$$

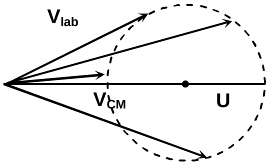
This means that you can keep the mass moving the desired circle only up to time T. After that, it is impossible. (Of course, it will become impossible, for all practical purposes, long before v becomes infinite.) The total distance d = ∫vdt, is infinite, because this integral diverges (barely, like a log) as t approaches T.

17. Let's figure out what the collision looks like in the CM frame. If M has initial speed V in the lab frame, then the CM moves with speed VCM = MV /(M +m). The speeds of M and m in the CM frame therefore equal, respectively,

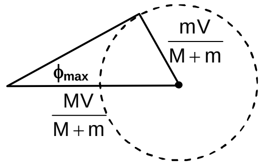
$$U = V - V_{CM} = \frac{mV}{M+m}\text{, and } u = \left|-V_{CM}\right| = \frac{MV}{M+m}$$



In the CM frame, the collision is simple. The particles keep the same speeds, but simply change their directions (while still moving in opposite directions), as shown in Figure.



The angle θ is free to have any value. This scenario clearly satisfies conservation of energy and momentum, so it must be what happens. The important point to note is that since θ can have any value, the tip of the U velocity vector can be located anywhere on a circle of radius U. If we then shift back to the lab frame, we see that the final velocity of M with respect to the lab frame, V_{lab}, is obtained by adding VCM to the vector U, which can point anywhere on the dotted circle in Figure. A few possibilities for V_{lab} are shown. The largest angle of deflection is obtained when V_{lab} is tangent to the dotted circle, in which case we have the situation shown in Figure.

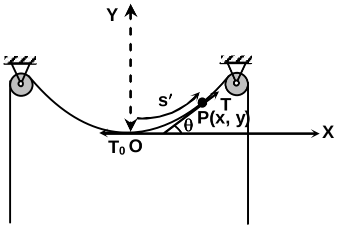


The maximum angle of deflection, φ_{max}, is therefore given by

$$\sin\phi_{max}=\frac{U}{V_{CM}}=\frac{mV/(M+m)}{MV/(M+m)}=\frac{m}{M}$$

If M < m, then the dotted circle passes to the left of the left vertex of the triangle. This means that φ can take on any value. In particular, it is possible for M to bounce directly backward.

18. s′ = the arc length OP.



$$T\cos\theta=T_0 \qquad \ldots(1)$$

$$T\sin\theta=\lambda(s')g \qquad \ldots(2)$$

$$\therefore\quad \tan\theta=\frac{dy}{dx}=\frac{dy}{dx}=\left(\frac{\lambda g}{T_0}\right)s' \qquad \ldots(3)$$

$$\text{Further: }\left.\begin{aligned}dy&=ds'\sin\theta\\ dx&=ds'\cos\theta\end{aligned}\right\} \qquad \ldots(4)$$

Substituting and Solving, we get,

$$T - T_0 = \lambda g y \qquad \ldots(5)$$

And, $$T^2 = T_0^2 + \left(\frac{\lambda s' g}{2}\right)^2 \qquad \ldots(6)$$

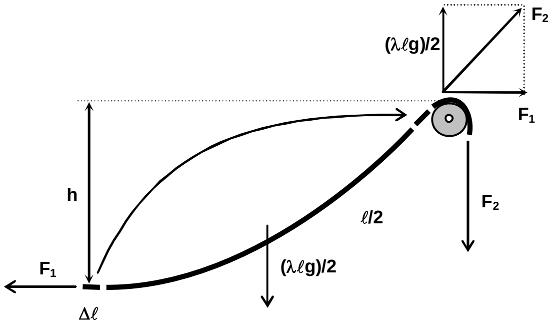
Using these and T = λgs, we get,

$$S = \frac{\ell^2 + 4h^2}{8h} \quad (s' = \ell,\ y = -h)$$

Alternative Solution:

It can be shown that the difference between the tensions in the rope at two arbitrary points on it (denoted by A and B), e.g. the centre and the right-hand pulley, depends only on the height difference between the points and the linear mass density λ of the rope. In an obvious notation:
$F_B - F_A = \lambda g(h_B - h_A)$.
To prove this, consider the energy changes that would be involved if a small length of rope were (notionally) cut out from the neighbourhood of point A and inserted close to point B.

Any arbitrary piece of the rope is in equilibrium, and so the horizontal component of the tension in the rope between the pulleys is constant (equal to F_1, say). The vertical component changes from point to point; it is zero in the middle, and at the pulleys is equal to half the weight of the 'sagging' section, namely $\lambda(\ell/2)g$, where λ is the linear mass density of the rope.



As illustrated in figure, we imagine a small piece of the rope, of length $\Delta\ell$, cut out from the middle of the system, and re-inserted into the rope near one of the pulleys! What energy changes are involved?
Closing the gap in the middle of the rope requires work $F_1\Delta l$ to be done, while the work required to lift the small piece against gravity is $\lambda\,\Delta l\,gh$. Inserting it at the pulley actually allows some energy to be recovered, but formally the work required to do this is $-F_2\,\Delta l$.
As a result of these changes, we have done no more than return the rope to its initial state! It follows that the total work done must be zero, and so

$$F_1\,\Delta l + \lambda\,\Delta l\,gh - F_2\,\Delta l = 0,$$

showing that

$$F_2 - F_1 = \lambda gh.$$

The same thought experiment could have been carried out for any arbitrary pair of points on the rope, and so it is generally true that 'the difference in tension forces at two arbitrary points of the rope is directly proportional to the height difference between those points'.
As can be seen in Fig. 1, the connection between the rope tension F2 (at the pulley) and its components is

$$F_2^{\,2} = F_1^{\,2} + \left(\frac{\lambda\,\mathrm{lg}}{2}\right)^2$$

A third equation, one that involves s, can be established by recognising that the hanging rope segments are each held in place by a force of strength F_2:

$$F_2 = \lambda gs.$$

From equations (1) and (3), we have that $F_1 = \lambda g(s - h)$. Substituting this into (2) gives the final result for the length of the hanging segments as

$$s = \frac{l^2 + 4h^2}{8h}$$

Chemistry PART – II

SECTION – A

19. Increase in concentration of the reactant shifts the equilibrium in the forward direction and vice versa.

20. 2-Ethylanthraquinol on oxidation in air produces H_2O_2.
Acetanilide retards the decomposition of H_2O_2.

21. SF_3Cl – Seesaw
In PCl_2F_3, two F atoms are in axial position and one F atom in equatorial position.

22. $B_3N_3H_6 + 9H_2O \longrightarrow 3NH_3 + 3H_3BO_3 + 3H_2$

23. General formula of cyclic silicate is $\left(SiO_3\right)_n^{2n-}$

24. The correct order are
Li < K < Na < Rb (Density)
$Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2$ (Basic nature)

25. sp^3 – F_2SeO, NF_4^+,
sp^2 = NO_3^-
sp^3d = SF_2Cl_2
sp^3d^2 = IOF_4^-, XeF_5^+

26. (P) 10 ml 0.1 M H_2SO_4 + 40 ml 0.1 M NH_4OH

$$pOH = pK_b + \log \frac{2/50}{2/50} = 4.74$$

pH = 9.26 basic buffer solution

(Q) 20 ml 0.1 M CH_3COOH + 16 ml 0.1 M NaOH

$$pH = 4.74 + \log\frac{1.6}{0.4} = 5.34$$

Acidic buffer solution.

(R) 50 ml 0.1 M CH_3COOH + 50 ml 0.1 M NaOH

$$pH = 7 + \frac{4.74}{2} + \frac{1}{2}\log\frac{5}{100} = 8.72$$

(S) 10 ml 0.1 M NH_4OH + 20 ml 0.1 M NH_4Cl

$$pOH = 4.74 + \log\frac{2}{1} = 5.04$$

pH = 14 – 5.04 = 8.96

27. P → Order of the reaction $= \frac{1}{2}$
Q → 1st order reaction.
R → zero order reaction
S → 2nd order reaction.

28. $$Al_4C_3 + 12H_2O \longrightarrow 4Al(OH)_3 + 3CH_4$$
$$Mg_2C_3 + 4H_2O \longrightarrow 2Mg(OH)_2 + C_3H_4$$
$$CaC_2 + 4H_2O \longrightarrow Ca(OH)_2 + C_2H_4$$

SECTION – D

29. $$t = \frac{2.303}{k}\log\frac{a}{a-x}$$
$$= \frac{2.303}{5\times10^{-2}}\log\frac{20}{2}$$
= 46.06

30. $K_p = P_{CO_2}$

$n = \frac{0.3\times12.315}{0.0821\times1000} = 0.045$ (n = number of moles of CO_2 at equilibrium)

∴ Mole of $CaCO_3$ = 0.2 – 0.045 = 0.155

Wt. of $CaCO_3$ = 0.155 × 100 = 15.50

31. $$2\underset{\substack{5\\0}}{HCl} + \underset{\substack{5\\2.5}}{Ba(OH)_2} \longrightarrow \underset{\substack{0\\2.5}}{BaCl_2} + \underset{\substack{0\\5}}{2H_2O}$$
$$2\underset{\substack{10\\5}}{CH_3COOH} + \underset{\substack{2.5\\0}}{Ba(OH)_2} \longrightarrow \underset{\substack{0\\2.5}}{(CH_3COO)_2Ba} + 2H_2O$$

$$pH = pK_a + \log\frac{\left[CH_3COO^-\right]}{\left[CH_3COOH\right]}$$

$$pH = 4.74 + \log\frac{5}{5} = 4.74$$

32. $$\Delta x = \frac{h}{4\pi m\Delta V}$$
$$= \frac{6.625\times10^{-27}}{4\times3.14\times10^{-12}\times10^{-8}}$$
$$= 0.527\times10^{-7} = 5.27\times10^{-8} \text{ cm}$$
= 5.27 A^o

33. Mol. Wt. of MCl_x = At. Wt. of M + 35.5x

2 × 85.02 = (Eq. wt. × x) + 35.5x

$$x = \frac{2\times85.02}{7.01+35.5} = 4$$

∴ At. Wt. = 7.01 × 4 = 28.04

34. $$\frac{1}{\lambda} = R\times Z^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$
$$\frac{1}{\lambda} = R\times4\times\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$$

$$\frac{1}{\lambda} = R \times 4\left[\frac{3}{16}\right]$$
$$\lambda = \frac{1}{R} \times \frac{4}{3} = 911.7 \times \frac{4}{3} A^{o}$$
$$\lambda = 1215.60 A^{o}$$

35. $t = \frac{2.303 \times 34.65}{0.693} \log \frac{100}{10}$
= 115.15 min.

36. $\Delta G^{o} = -2.303 RT \log K_P$
= - 2.303 × 2 × 300 × log 10^{-2}
= 2763.60 cal

Mathematics PART – III

SECTION – A

37. We may assume m > n $\Rightarrow \lim\limits_{x \to 0} \frac{\sqrt[mn]{\cos^n x} - \sqrt[mn]{\cos^m x}}{x^2}$

$$\lim_{x \to 0} \frac{\cos^n x - \cos^m x}{x^2\left(\sqrt[mn]{\left(\cos^n x\right)^{mn-1}} + ... + \sqrt[mn]{\left(\cos^m x\right)^{mn-1}}\right)} \Rightarrow \lim_{x \to 0} \frac{\cos^n x\left(1 - \cos^{m-n} x\right)}{mn x^2}$$

$$\Rightarrow \lim_{x \to 0} \frac{1 - \cos^{m-n} x}{mn x^2} = \frac{(1 - \cos x)\left(1 + \cos x + ... + \cos^{m-n-1}\right)}{mn\, x^2} \Rightarrow \frac{m-n}{mn} \cdot \lim_{x \to \infty} \frac{1 - \cos x}{x^2} = \frac{m-n}{2mn}$$

38. $g'(x) = \frac{(x-1)\left(x^3 - 3x^2 + 5x + 1\right)e^x}{\left(x^2 + 1\right)^3}$

Now, $x^3 - 3x^2 + 5x + 1$ is strictly increasing and has a root in (–1, 0)

39.
$$g(x) = \begin{cases} f(x) & ; \quad -2 < x < -1 \\ f(-1) & ; \quad -1 \le x < 0 \\ f(0) & ; \quad 0 \le x \le 1 \\ f(x) & ; \quad x > 2 \end{cases}$$

40. We see that f(1, 1) = 1 and f(1, 2) = $1 + \frac{f(2,1)}{2}$ and $f(2,1) = 1 + \frac{f(1,2)}{2}$
So, f(1, 2) = f(2, 1) = 2, then f(3, 1) = f(1, 3) = 3
$\Rightarrow$ f(x, y) = x·y; xy ≥ 0

41. Since the slope of tangent is 1
We have $\frac{1 + x^2}{\left(1 - x^2\right)^2} = \frac{dy}{dx} = 1 \Rightarrow x^4 - 3x^2 = 0 \Rightarrow x = 0, \pm\sqrt{3}$

Now, x = 0, y = 0; x = $\sqrt{3}$, y = $\frac{-\sqrt{3}}{2}$; x = $-\sqrt{3}$, y = $\frac{\sqrt{3}}{2}$

42. Given f(x = y) = f(x) + f(y) + xyf(x + y)
Put x = y = 0 ⇒ f(0) = 0
Put y = –x ⇒ f(–x) = –f(x) ⇒ f(x) is odd
and $f'(x) = \lim_{h\to 0}\frac{f(x+h)-f(x)}{h}$ = $\lim_{h\to 0}\left[\frac{f(h)}{h}+x(x+h)\right]$ $\because$ f(0) = 0
⇒ $f'(0) + x^2$
$f'(x) = x^2 - 1$ ⇒ f is differentiable $f'(3) = 8$ and $f'(x)+f'\left(\frac{1}{x}\right) = -f'(x)\cdot f'\left(\frac{1}{x}\right)$ $\forall\, x \neq 0$

43. (P) If the $\lim_{x\to\infty} x\cdot f'(x)$ exist

So, the $\lim_{x\to\infty}\left(x\cdot f(x)\right)'$

⇒ $x \to \infty$ f(x) + $\lim_{x\to\infty} x\cdot f'(x)$

$$\Rightarrow \lim_{x\to\infty}\left(x\cdot f'(x)\right)' = \lim_{x\to\infty}\frac{\left(xf(x)\right)'}{x'} = \lim_{x\to\infty}\frac{x\cdot f(x)}{x} = \lim_{x\to\infty} f(x)$$

So, $\lim_{x\to\infty} f(x) = \lim_{x\to\infty} f(x) + \lim_{x\to\infty} x\cdot f'(x) = 0$

(Q) $\lim_{x\to a}\frac{e^{f(x)}-e^{g(x)}}{f(x)-g(x)}$; $\lim_{x\to\infty} e^{g(x)}\frac{\left[e^{f(x)-g(x)}-1\right]}{f(x)-g(x)}$ use L.H. Rule

$e^{g(a)}\frac{e^{(f(x)-g(1))}-\left(f'(x)-g'(x)\right)}{\left(f'(x)-g'(x)\right)}$; $e^{g(a)} = e^{\ln 2}$ = 2

(R) Replacing f by f if necessary, we may assume f(b) > f(c) hence f(a) > f(c)
So μ be an absolute minimum of f on [a, b] which exists became the function is continuous then μ ∈ (a, b) and therefore f′(μ) = 0

(S) $I = \int_a^b \frac{e^{\frac{x}{a}}-e^{\frac{b}{x}}}{x}dx$ put $t = \frac{ab}{x}$ $\Rightarrow x = \frac{ab}{t}$ we have $dx = \frac{ab}{t^2}dt$

$I = \int_b^a \frac{e^{\frac{ab}{at}}-e^{\frac{bt}{ab}}}{\frac{ab}{t}}\cdot\left(-\frac{ab}{t^2}\right)dt$; $I = \int_b^a \frac{e^{\frac{b}{t}}-e^{\frac{t}{a}}}{t}(-dt)$ = $\int_a^b \frac{e^{\frac{b}{t}}-e^{\frac{t}{a}}}{t}\cdot dt = -I$ $\therefore$ I = 0

44. (P) Let $\int_{-\pi}^{\pi}\frac{x^2}{1+\sin x+\sqrt{1+\sin^2 x}}dx$ (replace x by –x)

$I = \int_{-\pi}^{\pi}\frac{x^2}{1-\sin x+\sqrt{1+\sin^2 x}}dx$; $2I = \int_{-\pi}^{\pi} x^2\left[\frac{1}{1+\sin x+\sqrt{1+\sin^2 x}}+\frac{1}{1-\sin x+\sqrt{1+\sin^2 x}}\right]dx$

= $\int_{-\pi}^{\pi} x^2 dx$; $2I = 2\int_0^{\pi} x^2 dx$; $I = \frac{\pi^3}{3}$

(Q) Let $y = \frac{1}{x}$, $dy = -\frac{1}{x^2}dx$ then $\frac{dx}{x^2-x+1} = -\frac{dy}{y^2-y+1}$; $\tan^{-1}x+\tan^{-1}y = \frac{\pi}{2}$; $\tan^{-1}\frac{1}{x}$; $\cot^{-1}x$

$$\therefore \frac{1}{2}\left(\int_{1/2}^{2}\frac{\tan^{-1}x}{x^2-x+1}dx+\int_{1/2}^{2}\frac{\frac{\pi}{2}-\tan^{-1}y}{y^2-y+1}\right) = \frac{\pi}{4}\int_{1/2}^{2}\frac{dx}{x^2-x+1} = \frac{\pi^2\sqrt{3}}{18}$$

(R) $\int_{0}^{\pi/2}\frac{\frac{\cos x}{x}-\frac{\sin x}{x^2}}{1+\left(\frac{\sin x}{x}\right)^2}dx$; Put $\frac{\sin x}{x}=t$

$\frac{x\cos x-\sin x}{x^2}dx-dt$; $\int_{1}^{2/\pi}\frac{dt}{1+t^2}$; $\left[\tan^{-1}x\right]_{1}^{2/\pi}$; $\tan^{-1}\frac{2}{\pi}-\frac{\pi}{4}$

(S) As function is odd

45. (P) $|e^x| = (0, \infty)\ \forall\ x \in R$; $\{|e^x|\} \in [0, 1)$; $[\{|e^x|\}] \Rightarrow$ f(x) is constant i.e. many one

(Q) $f(x) = e^{\text{sgn}(x)} + e^{x^2}$;

$x = 0$ $f(0) = 2$

$x > 0$ $f(x) = e + e^{x^2}$

$x < 0$ $f(x) = \frac{1}{e} + e^{x^2}$

$\Rightarrow$ f(x) is many one

46. (P) $f(x) = x - x^2 + \sin^{-1}x,\ x \in [-1, 1]$

$f(x) \le 0,\ \forall\ x \in [-1, 0],\ f(x) \ge 0\ \forall\ x \in [0, 1]$

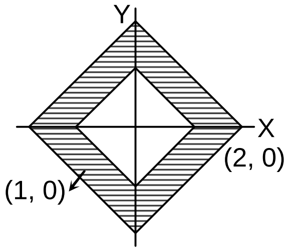
$$A = -\int_{-1}^{0}\left(\sin^{-1}x + x - x^2\right)dx + \int_{0}^{1}\left(\sin^{-1}x + x - x^2\right)dx$$

$= \pi - 1$

(Q) Area will be minimum if (0, 2) is mid-point of chord

(R) $1 \le |X| + |Y| \le 2$

$A = 4\left(2 - \frac{1}{2}\right) = 6$



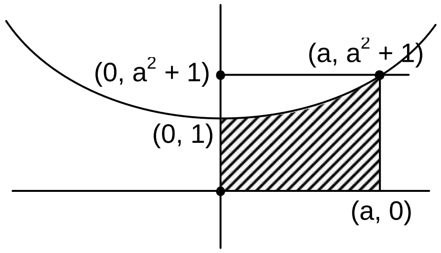
(S) $A = \int_{0}^{\frac{k}{k^2+1}}\left(x - kx^2 + \frac{x^2}{k}\right)dx = \frac{k^2}{6\left(k^2+1\right)^2} = \frac{1}{6\left(k^2 + \frac{1}{k^2} + 2\right)}$

By A.M. $\ge$ G.M. equality holds k = 1

SECTION – D

47. Taking log $-\frac{1}{2}\left(1+\frac{1}{n}\right)\ln n + \frac{1}{n^2}\cdot\sum_{k=1}^{n}k\ln k \Rightarrow \int_{0}^{1}x\ln x = -\frac{1}{4}$

L = $e^{-\frac{1}{4}}$



48. Area of rectangle is $a(a^2 + 1) = a^3 + a$ the portion under the parabola has area $\int_0^a \left(x^2 + 1\right)dx = \frac{a^3}{3} + a$

So, $\frac{\left(a^3 + a\right)}{2} = \frac{a^3}{3} + a$

$\Rightarrow a = \sqrt{3}$

49. Let g: A → A be defined by $g(x) = 1 - \frac{1}{x}$, then $g(g(g(x))) = 1 - \cfrac{1}{1 - \cfrac{1}{1 - \cfrac{1}{x}}} = x$

So, given equation rewrites as $f(x) + f(g(x)) = \log|x|$ ..... (1)

Now, put $x = g(y)$

$f(g(y)) + f(g(g(y))) = \log|g(y)|$ ..... (2)

Again put in equation (1) $x = (g(g(z)))$

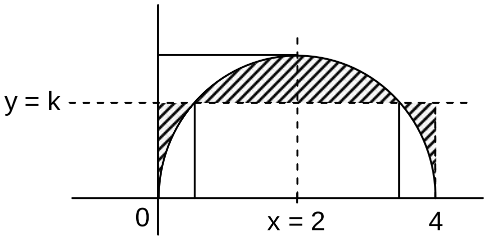
$f(g(g(z))) + (f(g(g(g(z)))) = \log|(g(g(z)))|$ ..... (3)

Now, set y = z = x and by solving these equation (1), (2) and (3), we get

$f(x) = \frac{1}{2}\left(\log|x| - \log\left|g(x) + \log\left|\left(g\left(g(x)\right)\right)\right|\right|\right)$ put x = 2007, we have

$g(x) = \frac{2006}{2007}, g\left(g(x)\right) = -\frac{1}{2006}$

So, that $f(2007) = \log\left(\frac{2007}{2006}\right)$



50. Let $f(x) = x(4 - x)$, and $y = k$

Let A be the region below y = f(x) and above y = k and B be the region below y = k and above y = f(x) then F(k) = A + B

$A = 2\left(\int_0^k f^{-1}(x)dx + \int_k^4 2 - f^{-1}(x)dx\right)$

$\frac{dA}{dk} = 2\left(f^{-1}(k) - 2 + f^{-1}(k)\right), \frac{dA}{dk} = 0$

$f^{-1}(k) = 1 \Rightarrow k = 3$

51. Clearly 0, 2 are fixed points of f and therefore solution.

On the other hand, then is no solution for x < 0, since f is non-negative valued

For $0 < x < 2$, we have $0 \le f(x) < x < 2$ and $f(0) = 0$

For $x > 2$, $f(x) > x$ so there is no other solution

52. Let $h(x) = x(1 + \ln(x))$; h: $[1, \infty) \to [1, \infty)$

h(x) is strictly increasing and h(1) = 1, $\lim_{x\to\infty} h(x) \to \infty$

Hence, h(x) is Bijective

So inverse of h(x) clearly f: $[1, \infty) \to [1, \infty)$; $\lambda \to f(\lambda)$

Now, $f'(x) = \frac{1}{2 + \ln\left(f(\lambda)\right)}$

By using L. Hospital rule $\lim_{\lambda\to\infty} \frac{\frac{f(\lambda)}{\lambda}}{\ln\lambda} = \lim_{\lambda\to\infty} \frac{\frac{1}{f(\lambda)}}{\frac{1}{\lambda} \cdot \frac{1}{2 + \ln(\lambda)}}$

$$= \lim_{\lambda\to\infty} \frac{f(\lambda)}{\lambda}\cdot\left(2+\ln f(x)\right) = \lim_{\lambda\to\infty}\frac{2+\ln f(\lambda)}{1+\ln f(\lambda)} = 1$$

53. $\int\left(x^5+x^2\right)\left(x^6+2x^3\right)^{\frac{1}{3}}dx$; $x^6 + 2x^3 = t$; $(6x^5 + 6x^2)\, dx = dt$

$$\int t^{\frac{1}{3}}\cdot\frac{dt}{6} = \frac{1}{6}\cdot\frac{3}{4}t^{\frac{4}{3}}+c = \frac{1}{8}\left(x^6+2x^3\right)^{\frac{4}{3}}+c$$

54. F(x) = –cos(sin(sin(sin (x))))
For integration put θ = sin(sin(sin (x)))

*****

FIITJEE **JEE (Advanced)-2019**

ALL INDIA TEST SERIES

PART TEST – I

Paper 2

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part is further divided into two sections: **Section-A & Section-D**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. ***Section-A (01 – 06, 19 – 24, 37 - 42)*** *contains 18 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–2** In all other cases.*

   Section-A (07 – 10, 25 – 28, 43 – 46) *contains 12 questions. Each question has* ***TWO (02)*** *matching lists:* ***LIST - I*** *and* ***LIST - II***. ***FOUR*** *options are given representing matching of elements from* ***LIST - I*** *and* ***LIST - II***. ***ONLY ONE*** *of these four options corresponds to a correct matching.*
   For each question, choose the option corresponding to the correct matching.
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-D (11 – 18, 29 – 36, 47 – 54)*** *contains 24 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Name of the Candidate	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
Enrolment No.	☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant	R	=	$8.314\ J\ K^{-1}\ mol^{-1}$
		=	0.0821 Lit atm $K^{-1}\ mol^{-1}$
		=	$1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number	N_a	=	6.023×10^{23}
Planck's constant	h	=	6.625×10^{-34} J·s
		=	6.625×10^{-27} erg·s
1 Faraday		=	96500 coulomb
1 calorie		=	4.2 joule
1 amu		=	1.66×10^{-27} kg
1 eV		=	1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

PART – I (Physics), PART – II (Chemistry), PART – III (Mathematics):

(SECTION – D)

For questions **11 to 18, 29 to 36, 47 to 54.**
Numerical answer type questions with answer XXXXX. XX

If answer is 348.4 / 251.37 / 213

Correct Method :

0	0	3	4	8	.	4	0

0	0	2	5	1	.	3	7

0	0	2	1	3	.	0	0

Wrong Method :

	3	4	8		.	4	

3	4	8			.		4

		3	4	8	.		4

	3		4	8	.	4	

	2		5	1	.	3	7

		2	1	3	.		

		2	1	3	.	0	

		2	1	3	.		0

		3	4	8	.	4	0

		2	5	1	.	3	7

		2	1	3	.	0	0

Physics

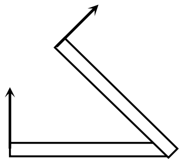
PART – I

SECTION – A

(One or More than one correct type)

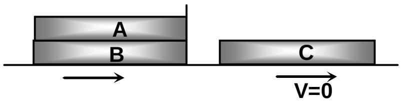
This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A long thin uniform rod lies flat on the table as shown. One end of the rod is slowly pulled up by a force that remains perpendicular to the rod at all times. The rod is to be brought to the vertical position without any slipping of the bottom end? The coefficient of static friction between rod and ground can be:

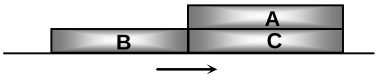


(A) 0.2 (B) 0.3
(C) 0.4 (D) 0.5

2. Board A is placed on board B as shown. Both boards slide, without moving with respect to each other, along a frictionless horizontal surface at a speed v . Board B hits a resting board C "head-on."



Before Collision



After Collision

After the collision, boards B and C move together, and board A slides on top of board C and stops its motion relative to C in the position shown on the diagram. All three boards have the same mass, size, and shape. It is known there is no friction between boards A and B; the coefficient of kinetic friction between boards A and C is μ_k.

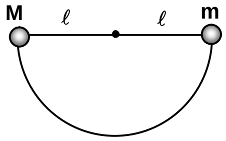
(A) The length of each board is $\frac{v^2}{6\mu_k g}$

(B) The final speed of each board is 2v/3.

(C) Total work done by frictional force on the system is zero.

(D) Total work done by frictional force on C is $\frac{mv^2}{12}$.

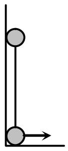
3. Two balls of masses M and m are attached to two threads of length l, such that the two threads are suspended at the same point. The balls are both deflected to the horizontal position of the threads, released from rest at the same time, and they collide head on. (The collision is perfectly elastic.). If the ball of mass m reaches the maximum height which is allowed M/m can be :



(A) 0.5 (B) 1.5
(C) 2 (D) 2.5

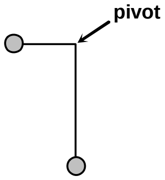
Space for Rough work

4. A dumbbell consists of a light rod of length r and two small masses m attached to it. The dumbbell stands vertically in the corner formed by two frictionless planes. After the bottom end is slightly moved to the right, the dumbbell begins to slide. At the moment the top end loses contact with the vertical plane:



(A) The acceleration of top mass is g.
(B) Horizontal component of acceleration of bottom mass is zero.
(C) The height of the top mass will be 2r/3.
(D) Speed of the bottom mass will be $\frac{2}{3}\sqrt{gR}$.

5. Two small spheres of mass m each are attached to the ends of a light rigid rod bent at a right angle and pivoted in the vertical plane at the vertex of the right angle. The vertical part of the rod is three times as long as the horizontal part. Initially, the rod is held at rest in the position shown in the diagram. The pivot is frictionless. Assume that mass of rods are negligible. Immediately after the system is released.



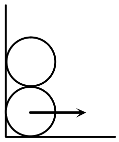
(A) Horizontal component of acceleration of center of mass of the system is $\frac{3}{10}$ m/s^2 towards right.

(B) Vertical component of acceleration of center of mass of the system is $\frac{1}{20}$ m/s^2 downwards.

(C) Horizontal component of hinge reaction is $\frac{3mg}{10}$ towards right.

(D) Vertical component of hinge reaction is $\frac{19mg}{20}$ upwards.

6. Two identical uniform cylinders of radius R each are placed on top of each other next to a wall as shown. After a disturbance, the bottom cylinder slightly moves to the right and the system comes into motion. Neglect friction between all surfaces.



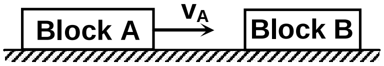
(A) The top cylinder will have maximum acceleration g.
(B) The speed of the bottom cylinder will first increase then decrease.
(C) Minimum acceleration of the bottom cylinder is zero.
(D) Maximum speed of the bottom cylinder is $\frac{2}{3}\sqrt{gR}$

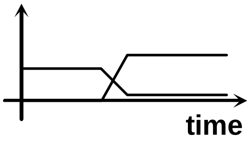
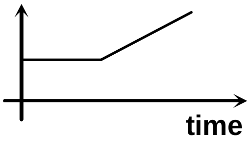
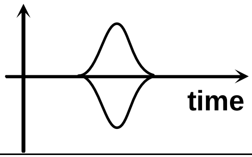
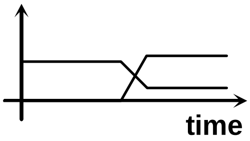
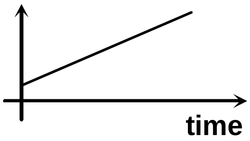
Space for Rough work

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

7. Block a moving on frictionless horizontal plane collides head-on with block B initially at rest. The collision is NOT (0 < e < 1) perfectly elastic. Match the List-I with the related graph in List-II.

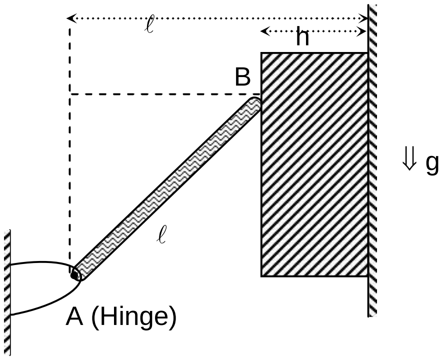


LIST–I		LIST–II	
P.	Forces exerted by the blocks	1.	
Q.	The position of mass centre of the two block system	2.	
R.	Velocity of blocks	3.	
S.	Position of block B	4.	
		5.	

(A) **P → 4; Q → 4; R → 1; S → 4**
(B) **P → 3; Q → 3; R → 1; S → 3**
(C) **P → 3; Q → 5; R → 4; S → 2**
(D) **P → 4; Q → 3; R → 4; S → 1**

Space for Rough work

8. A rectangular block of mass m = 0.3 kg is held stationary with the help of massless rod of length ℓ = 10 m in vertical plane as shown in the figure. Vertical wall is frictionless and coefficient of friction between block and rod is μ = 0.75. Now match the value of physical quantities mentioned in List – I with List – II.

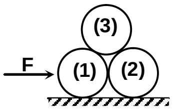


LIST–I		LIST–II (values of a)	
P.	The value of h in meter so that block remains stationary	1.	1.5
Q.	Magnitude of normal force in Newton given by wall to the block	2.	5
R.	Magnitude of Hinge reaction in Newton	3.	4
S.	Magnitude of friction force acting on the block	4.	3
		5.	2

(A) **P → 1, 5; Q → 3; R → 2; S → 4**
(B) **P → 1, 5; Q → 1; R → 2; S → 3**
(C) **P → 3, 1; Q → 2; R → 3; S → 4**
(D) **P → 3, 3; Q → 1; R → 3; S → 4**

Space for Rough work

9. Three identical cylinders are arranged in a triangle as shown in Figure, with the bottom two lying on the ground. The ground and the cylinders are frictionless. You apply a constant horizontal force (directed to the right) on the left cylinder. Let a be the acceleration you give to the system.



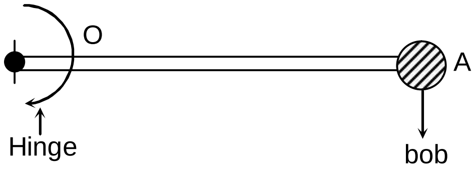
N_{12} is normal reaction between (1) and (2)
N_{13} is normal reaction between (1) and (3)
N_{23} is normal reaction between (2) and (3)
List –II shows various values of a.
Match the functions in List-I with the related charge distributions in List-II.

LIST–I		LIST–II (values of a)	
P.	$N_{12} = 0, N_{13} \neq 0$	1.	g
Q.	$N_{12} \neq 0, N_{13} \neq 0$	2.	$\frac{g}{2\sqrt{3}}$
R.	$N_{12} \neq 0, N_{13} = 0$	3.	$\frac{g}{4\sqrt{3}}$
S.	$N_{23} = 0, N_{13} \neq 0$	4.	$\frac{g}{6\sqrt{3}}$
		5.	Never possible

(A) **P → 3, 4; Q → 2; R → 5; S → 1**
(B) **P → 3, 2; Q → 1; R → 4; S → 3**
(C) **P → 3, 1; Q → 2; R → 3; S → 4**
(D) **P → 3, 3; Q → 1; R → 3; S → 4**

Space for Rough work

10. A uniform rod of mass 6 kg and length 1m is hinged at O and a small bob of mass 1 kg is attached to its other end. The system is kept horizontal and then released. The quantities mentioned under Column I are measured and their magnitudes (in SI) are given in column II, but not necessarily in the proper order. Match the quantities in List I with their corresponding values in List II. Take g = 10 m/s^2.



LIST–I		LIST–II (in SI units)	
P.	Angular acceleration of rod	1.	$\frac{10}{3}$
Q.	Linear acceleration of bob	2.	$\frac{20}{3}$
R.	Force exerted by the rod on the bob	3.	$\frac{40}{3}$
S.	Force exerted by the hinge on the rod	4.	$\frac{50}{3}$
		5.	$\frac{160}{3}$

(A) **P → 5; Q → 3, 4; R → 1; S → 2**
(B) **P → 3; Q → 3; R → 1, 4; S → 5**
(C) **P → 5; Q → 3; R → 1, 2; S → 4**
(D) **P → 4; Q → 2, 3; R → 1; S → 5**

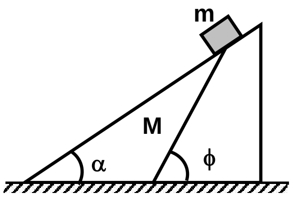
Space for Rough work

SECTION – D
(Numerical Answer Type)

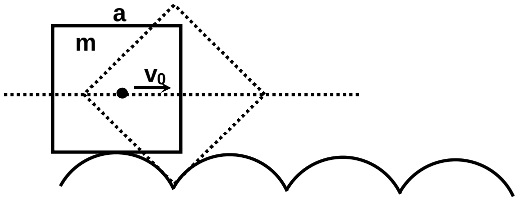
This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

11. The wedge shown in the figure can slide without friction on a horizontal tabletop. The mass of the wedge is M and its angle of elevation is $\alpha = 30^o$. A body of mass m slides down without friction along the wedge, the path of the body makes an angle of $\varphi = 60^o$ with the ground. Find the ratio of the masses, m/M.

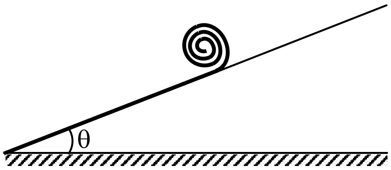


12. A path is made to a uniform density cube of mass m, and of edge a, such that when the cube rolls along the path without skidding, its centre moves along a straight line. At the top of the path a horizontal velocity of center of mass is v_0 and the cube is in pure rolling. The static frictional force is big enough, so the cube do not slide anywhere. The speed of the centre of mass when the cube touches the lowest point of the path is $\frac{\sqrt{k}v_o}{2}$? (The moment of inertia of the cube with respect to its centre of mass is $ma^2/6$). Find k.



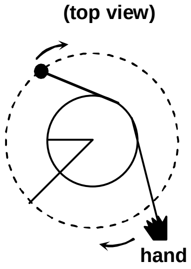
13. A block is placed on a long and wide inclined plane that makes angle $\theta = 45^\circ$ with the horizontal. The coefficient of kinetic friction between the block and the plane is $\mu_k = 2$. After a quick push, the block acquires velocity $v_0 = 6\sqrt{2}$ m/s that makes angle $\alpha = 60^\circ$ with the line of fastest descent. Find the time interval t during which the block is in motion. (take $g = 10 \text{ m/s}^2$)

Space for Rough work



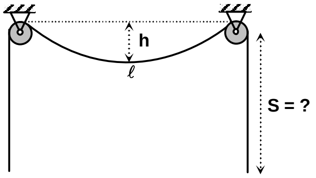
14. A carpet runner is placed onto a long straight inclined plane parallel to the steepest line in the plane, from the bottom of the slope till its top. The carpet is thin and flexible, and it cannot slide down because of the friction, but it can easily be lifted, it does not stick to the plane. The top end of the carpet is rolled, a bit, and this hoop of carpet is released. The hoop rolls down the slope with greater and greater speed, while its diameter increases, and finally it reaches the bottom of the slope during a time of t_1. If a solid cylinder is released at the top of the slope, it reaches the bottom in a time of t_2. The ratio of $\frac{t_1}{t_2} = \sqrt{k}$. Find k .

15. A ball is thrown at speed v from zero height on level ground. The angle at which the particle is thrown is such that the area under the trajectory is maximum? If the angle of projection in □/k . Find k .



16. A mass, which is free to move on a horizontal frictionless surface, is attached to one end of a massless string that wraps partially around a frictionless vertical pole of radius r (see the top view in Figure). You hold on to the other end of the string. At t = 0, the mass has speed v_0 = 1m/s in the tangential direction along the dotted circle of radius R shown. Your task is to pull on the string so that the mass keeps moving along the dotted circle. You are required to do this in such a way that the string remains in contact with the pole at all times. (You will have to move your hand around the pole, of course.) What is the speed of the mass at time $t = \frac{R}{2v_0 \tan\theta}$?

17. A mass M collides elastically with a stationary mass m. If M = 2m, then there is a maximal angle of deflection of M. This maximal angle equals ϕ/k radians. Find k .



18. A uniform flexible rope passes over two small frictionless pulleys mounted at the same height (see figure). The length of rope between the pulleys is $\ell = 2\sqrt{3}$ m, and its 'sag' is h = 1 m. In equilibrium, what is the length s of the rope segments that hang down on either side?

Space for Rough work

Chemistry

PART – II

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. For the equilibrium $SO_2(g) + Cl_2(g) \rightleftharpoons SO_2Cl_2(g)$, the correct statement(s) is/are

(A) Addition of SO_2(g) at constant volume at equilibrium increases the concentration of SO_2Cl_2(g)
(B) Addition of SO_2(g) at constant volume at equilibrium increases the concentration of SO_2(g)
(C) Addition of SO_2Cl_2(g) at constant volume at equilibrium increases the concentration of SO_2Cl_2(g)
(D) Addition of inert gas at constant volume at equilibrium increases the concentration of SO_2Cl_2 (g)

20. The incorrect statement(s) among the following is/are
(A) 2-Ethylantraquinone on oxidation in air produces H_2O_2.
(B) Peroxydisulphuric acid on hydrolysis produces H_2O_2.
(C) Acetanilide catalyses the decomposition of H_2O_2.
(D) H_2O_2 reduces sodium hypochlorite to sodium chloride.

21. The correct statement(s) among the following is/are
(A) The shape of SF_3Cl molecule is tetrahedral
(B) In PCl_2F_3 all the three F atoms remain in the equatorial position.
(C) The shape of ICl_4^- is square planar.
(D) I_2Cl_6 is a planar molecule in the solid state.

22. The product(s) of hydrolysis of $B_3N_3H_6$ is/are
(A) NH_3 (B) H_3BO_3
(C) H_2 (D) B_2H_6

23. Cyclic silicate among the following is/are
(A) $Ca_3Si_3O_9$ (B) Mg_2SiO_4
(C) $Be_3Al_2Si_6O_{18}$ (D) $Sc_2Si_2O_7$

24. The incorrect order among the following is/are
(A) LiH > NaH > KH (Thermal stability)
(B) $MgSO_4 > CaSO_4 > SrSO_4$ (Solubility in water)
(C) Li < Na < K < Rb (Density)
(D) $Be(OH)_2 > Mg(OH)_2 > Ca(OH)_2$ (Basic nature)

Space for Rough work

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

---

25. Match each set of hybrid orbital from List – I with the molecule or ion given in List - II

LIST–I		**LIST–II**	
P.	sp^2	1.	XeF_5^+
Q.	sp^3	2.	NO_3^-
R.	sp^3d	3.	NF_4^+
S.	sp^3d^2	4.	SF_2Cl_2
		5.	IOF_4^-
		6.	F_2SeO

(A) **P → 2; Q → 3; R → 4, 6; S → 1, 5**
(B) **P → 2; Q → 3, 6; R → 4; S → 1, 5**
(C) **P → 4; Q → 2; R → 3, 5; S → 6**
(D) **P → 6; Q → 3, 6; R → 4, 2; S → 1**

26. Match the resulting solution in List-I with one or more properties in List – II and choose the correct option. log2 = 0.3, log5 = 0.7. pK_a CH_3COOH = 4.74, pK_b NH_4OH = 4.74,

LIST–I		**LIST–II**	
P.	10 ml 0.1 M H_2SO_4 + 40 ml 0.1 M NH_4OH	1.	Acidic buffer solution
Q.	20 ml 0.1 M CH_3COOH + 16 ml 0.1 M NaOH	2.	Basic buffer solution
R.	50 ml 0.1 M CH_3COOH + 50 ml 0.1 M NaOH	3.	pH of the solution is 8.72
S.	10 ml 0.1 M NH_4OH + 20 ml 0.1 M NH_4Cl	4.	pH of the solution is 8.96
		5.	pH of the solution 9.26

(A) **P → 2, 4; Q → 1, 5; R → 3; S → 2**
(B) **P → 2, 3; Q → 1, 4; R → 3, 1; S → 2, 4**
(C) **P → 5; Q → 1; R → 3, 4; S → 2**
(D) **P → 2, 5; Q → 1; R → 3; S → 2, 4**

Space for Rough work

27. Match the half-life of the reaction in List-I with the integrated rate equation in List-II(a = initial concentration of reactant and a – x = concentration of reactant at time 't'.)

LIST–I		**LIST–II**	
P.	$t_{1/2} = \frac{0.586}{k}\sqrt{a}$	1.	$k = \frac{x}{t}$
Q.	$t_{1/2} = \frac{0.693}{k}$	2.	$k = \frac{1}{t}\left[\frac{1}{a-x} - \frac{1}{a}\right]$
R.	$t_{1/2} = \frac{a}{2k}$	3.	$k = \frac{2}{t}\left[\sqrt{a} - \sqrt{a-x}\right]$
S.	$t_{1/2} = \frac{1}{ka}$	4.	$k = \frac{2.303}{t}\log\frac{a}{a-x}$
		5.	$k = \frac{2}{t}\left[\frac{1}{\sqrt{a-x}} - \frac{1}{\sqrt{a}}\right]$

(A) **P → 5; Q → 4; R → 1; S → 2**
(B) **P → 3; Q → 4; R → 1; S → 2**
(C) **P → 2; Q → 3; R → 1; S → 2**
(D) **P → 3; Q → 2; R → 4; S → 5**

28. List-I contains carbides and List-II contains the type of carbide and their hydrolysis product.

LIST–I		**LIST–II**	
P.	Al_4C_3	1.	Covalent carbide
Q.	Mg_2C_3	2.	Ionic carbide
R.	CaC_2	3.	CH_4
S.	SiC	4.	C_3H_4
		5.	C_2H_2

(A) **P → 2, 3; Q → 2, 4; R → 2, 5; S → 1**
(B) **P → 1, 3; Q → 1, 4; R → 2, 5; S → 2**
(C) **P → 2, 4; Q → 1, 3; R → 1, 5; S → 5**
(D) **P → 2, 5; Q → 2, 4; R → 2, 3; S → 1**

Space for Rough work

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

29. A first order reaction has a rate constant $5\times10^{-2}\ s^{-1}$. The time required (in sec) for the reaction to reduce 20 gram of the reactant to 2 g is

30. 20 g of $CaCO_3$ is placed in a vessel of volume 12.315 litre at 1000 K. The following equilibrium was established.

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

K_P for the reaction at 1000 K is 0.3 atm. The mass of $CaCO_3$ in gram at equilibrium is

31. 100 ml of 0.1 M CH_3COOH, 50 ml 0.1 M HCl and 50 ml 0.1 M $Ba(OH)_2$ are mixed together. pK_a of CH_3COOH is 4.74. The pH of the resulting solution is

32. The mass of a dust particle is 10^{-12} g and its velocity is 10^{-4} cm/sec. The error in the measurement of velocity is 0.01%. The uncertainty in the measurement of position in A^o unit is $\left(\frac{h}{4\pi} = 0.527\times10^{-27}\text{ erg sec}\right)$

33. Vapour density of a metal chloride is 85.02. The equivalent weight of the metal is 7.01. The atomic weight of the metal is

34. In He^{2+} an electron undergoes transition from 3rd excited state of to 2nd energy level. The wavelength of the light emitted in A^o is $\left(\frac{1}{R} = 911.7A^o\right)$

35. In the thermal decomposition of NH_4NO_2, 50% of the compound decomposed in 34.65 min. The time required in minutes for the 90% decomposition of the compound is

36. The equilibrium constant (K_P) for a reaction at 27^oC for a homogeneous gaseous reaction is 10^{-2}. The standard free energy change (ΔG^o) for the reaction in calorie is (R = 2 cal)

Space for Rough work

Mathematics PART – III

SECTION – A

(One or More than one correct type)

This section contains **6** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. For two positive integers m and n $\lim\limits_{x\to 0}\dfrac{\sqrt[m]{\cos x}-\sqrt[n]{\cos x}}{x^2}$, then which is true?

(A) m = 3, n = 2 it is $\dfrac{1}{6}$
(B) m = 5, n = 2 it is $\dfrac{3}{13}$
(C) m = 3, n = 2 it is $\dfrac{1}{12}$
(D) m = 5, n = 2 it is $\dfrac{3}{20}$

38. Let $f(x)=\dfrac{e^x}{1+x^2}$ and g(x) = f′(x), then

(A) g(x) has two local maxima and two local minima points
(B) g(x) has exactly one local maxima and one local minima point
(C) x = 1 is a point of local maxima of g(x)
(D) there is a point of local maxima for g(x) in the interval (–1, 0)

39. Let f(x) = $x^2 - 2|x|$ and $g(x)=\begin{cases}\min\{f(t), & -2\le t\le x, \quad -2\le x<0\\ \max\{f(t), & 0\le t\le x, \quad 0\le x\le 2\\ f(x) & \quad x>2\end{cases}$, then g(x) is not differentiable at

(A) x = 0
(B) x = –1
(C) x = 2
(D) x = 1

Space for rough work

40. The function f: {0, 1, 2, ...} × {0, 1, 2, ...} → R satisfying

$$f(x, y) = \begin{cases} \frac{1}{2}\{f(x+1, y-1) + f(x-1, y+1)\} + 1 & \text{if} \quad x \cdot y \neq 0 \\ 0 & \text{if} \quad x \cdot y = 0 \end{cases}$$, then which is true

(A) f(3, 5) = 15 (B) f(5, 3) = 15
(C) f(9, 2) = 18 (D) f(2, 9) = 18

41. The equations of the normals to the curve $f(x) = \frac{x}{1-x^2}$ at the points where the tangents make angle of $\frac{\pi}{4}$ with the positive direction of x-axis are

(A) x + y = 0 (B) $x + y = \frac{\sqrt{3}}{2}$
(C) $x + y = 2\sqrt{2}$ (D) $x + y = \frac{-\sqrt{3}}{2}$

42. Let f be a function defined for all real x and let it satisfy the relation f(x + y) = f(x) + f(y) + xy(x + y) if f′(0) = –1, then
(A) f is differentiable for all real x
(B) f′ is differentiable for all real x
(C) f′(3) = 8
(D) f′ satisfies the relation $f'(x) + f'\left(\frac{1}{x}\right) = -f'(x)f'\left(\frac{1}{x}\right) \ \forall x \neq 0$

Space for rough work

(Matching List Type)

This section contains **FOUR** questions. Each question has **TWO** matching lists: **LIST - I** and **LIST - II**. **FOUR** options are given representing matching of elements from **LIST - I** and **LIST - II**. **ONLY ONE** of these four options corresponds to a correct matching.

---

43. Match the following List-I with List-II

LIST–I		**LIST–II**	
P.	If f: R $\to$ R is a differentiable function with the property that $\lim_{x\to\infty} f(x)$ exist and is finite, and if $\lim_{x\to\infty} x\cdot f'(x)$ exists, then this limit is equal to	1.	1
Q.	Let f and g be n-times continuously differentiable function in a neighbourhood of a point 'a', such that f(a) = g(a) = ln 2. $f'(a) = g'(a)$ ..... $f^{n-1}(a) = g^{(n-1}(a)$ and $f^n(a) \neq g^n(a)$, then $\lim_{x\to a} \frac{e^{f(x)} - e^{g(x)}}{f(x)-g(x)}$ is	2.	3
R.	Let f: [a, b] $\to$ R be a function continuous on [a, b] and differentiable on (a, b) if there exist C $\in$ (a, b) such that $\frac{f(b)-f(c)}{f(c)-f(a)} < 0$, then there always exist $\mu \in$ (a, b), then $f'(\mu)$ is equal to	3.	5
S.	Let a and b be positive real numbers, then $\int_a^b \frac{e^{\frac{x}{a}} - e^{\frac{b}{x}}}{x}dx$ is	4.	7
		5.	2
		6.	0

The correct option is:
(A) **P $\to$ 4; Q $\to$ 6; R $\to$ 2; S $\to$ 1**
(B) **P $\to$ 1; Q $\to$ 4; R $\to$ 2; S $\to$ 3**
(C) **P $\to$ 4; Q $\to$ 6; R $\to$ 5; S $\to$ 2**
(D) **P $\to$ 6; Q $\to$ 5; R $\to$ 6; S $\to$ 6**

Space for rough work

44. Match the following List-I with List-II

LIST–I		LIST–II	
P.	$\int_{-\pi}^{\pi} \frac{x^2}{1+\sin x+\sqrt{1+\sin^2 x}}dx$	1.	$\tan^{-1}\frac{2}{\pi}-\frac{\pi}{4}$
Q.	Evaluate $\int_{1/2}^{2} \frac{\tan^{-1} x}{x^2-x+1}dx$	2.	0
R.	$\int_{0}^{\pi/2} \frac{x\cos x-\sin x}{x^2+\sin x}dx$	3.	$\tan^{-1}\frac{3}{\pi}-\frac{\pi}{4}$
S.	$\int_{-1}^{1} \frac{\sqrt[3]{x}}{\sqrt[3]{1-x}+\sqrt[3]{1+x}}dx$	4.	$\frac{\pi\sqrt{3}}{18}$
		5.	$\frac{\pi^3}{3}$
		6.	$\frac{\pi^2\sqrt{3}}{18}$

The correct option is:
(A) **P → 5; Q → 6; R → 2; S → 1**
(B) **P → 1; Q → 4; R → 2; S → 3**
(C) **P → 5; Q → 6; R → 1; S → 2**
(D) **P → 4; Q → 2; R → 3; S → 1**

Space for rough work

45. Match the following List-I with List-II

LIST–I		LIST–II	
P.	f: R → R; $f(x)=\left[\left\{\left\|e^{x}\right\|\right\}\right]$ (where [.] denotes the greatest integer function, and {.} denotes fractional part function)	1.	one-one
Q.	Let f: R → R defined as $f(x)=e^{\text{sgn}(x)}+e^{x^2}$ (where sgn x denotes signum function of x, then f(x))	2.	many one
R.	f: R → R; $f(x)=\left[x+\frac{1}{2}\right]+\left[x-\frac{1}{2}\right]+2\left[-x\right]$ (where [.] denotes the greatest integer function)	3.	into and periodic
S.	f: [–1, ∞) → (0, ∞) defined as $f(x)=e^{x^2+\|x\|}$, then f(x) is	4.	onto
		5.	periodic
		6.	constant

The correct option is:
(A) **P → 4; Q → 6; R → 2; S → 1**
(B) **P → 2; Q → 2; R → 5; S → 2**
(C) **P → 4; Q → 6; R → 5; S → 2**
(D) **P → 2; Q → 2; R → 3; S → 1**

Space for rough work

46. Match the following List-I with List-II

LIST–I		LIST–II	
P.	Area bounded by the curve $y - \sin^{-1} x = x - x^2$, and the x-axis is equal to	1.	0
Q.	The area bounded by $y = x^2 - 3$ and the line $y = ax + 2$ attains its minimum value than the parameter 'a' is equal to	2.	1
R.	The area of the region represented by the expression $\sqrt{2} \le \lvert x+y\rvert + \lvert x-y\rvert \le 2\sqrt{2}$	3.	$\pi - 1$
S.	If k is a positive number and the area of the region bounded by the curves $y = x - kx^2$ and $ky = x^2$ attains its maximum value, then k is equal to	4.	6
		5.	2
		6.	3

The correct option is:
(A) **P → 3; Q → 6; R → 2; S → 1**
(B) **P → 1; Q → 4; R → 2; S → 3**
(C) **P → 4; Q → 6; R → 5; S → 2**
(D) **P → 3; Q → 1; R → 4; S → 2**

SECTION – D
(Numerical Answer Type)

This section contains **EIGHT** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

47. If limit $\lim\limits_{n\to\infty} n^{-\frac{1}{2}\left(1+\frac{1}{n}\right)}\left(1^1 \cdot 2^2 \cdot 3^3 \,.....\, n^n\right)^{\frac{1}{n^2}} = L$, then –ln L is _____

48. The positive value of 'a' such that the parabola $y = x^2 + 1$, bisects the area of the rectangle with vertices (0, 0), (a, 0), $(0, a^2 + 1)$, $(a, a^2 + 1)$, then $\frac{a}{2\sqrt{3}}$ is _____

Space for rough work

49. Let A – rational number between (0, 1), and a function f: A → R has the property that for all x ∈ A $f(x)+f\left(1-\frac{1}{x}\right)=\ln|x|$, then the value and $\frac{2001}{2014}e^{f(2007)}$ is _____

50. The value of $\frac{k}{2}$ which minimizes $F(k)=\int_0^4 |x(4-x)-k|dx$ _____

51. For x a real number, let f(x) = 0 if x < 1 and f(x) = 2x – 2 if x ≥ 1. If number of solutions to the equation $f(f(f(f(x))))=x$ is n, then $\frac{n}{5}$ is equal to _____

52. For any real $\lambda \geq 1$ denote by $f(\lambda)$ the real solution to the equation $x(1 + \ln x) = \lambda$, then $\frac{1}{2}\lim_{\lambda\to\infty}\frac{f(\lambda)}{\left(\frac{\lambda}{\ln\lambda}\right)}$ is _____

53. $\int\left(x^6+x^3\right)\left(x^3+2\right)^{\frac{1}{3}}dx = \lambda\left(x^6+2x^3\right)^{\frac{4}{3}}+c$, then 2λ is equal to _____

54. The differentiable function F: R → R satisfies F(0) = –1 and $\left(F'(x)\right)=\sin\left(\sin\left(\sin\left(\sin(x)\right)\right)\right)\cdot\cos\left(\sin\left(\sin(x)\right)\right)\cdot\cos\left(\sin(x)\right)\cdot\cos(x)$. Then $-\frac{F(\pi)}{2}$ is _____

Space for rough work

FIITJEE **JEE (Main)-2019**

ALL INDIA TEST SERIES

PART TEST – I

Time Allotted: 3 Hours **Maximum Marks: 360**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
4. Each part has only one section: **Section-A**.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with black pen for each character of your Enrolment No. and write your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

1. **Section-A (01 – 30, 31 – 60, 61 – 90)** *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Name of the Candidate	
Enrolment No.	

Useful Data

PHYSICS

Acceleration due to gravity	$g = 10\ m/s^2$
Planck constant	$h = 6.6 \times 10^{-34}$ J-s
Charge of electron	$e = 1.6 \times 10^{-19}$ C
Mass of electron	$m_e = 9.1 \times 10^{-31}$ kg
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\text{-}m^2$
Density of water	$\rho_{water} = 10^3\ kg/m^3$
Atmospheric pressure	$P_a = 10^5\ N/m^2$
Gas constant	$R = 8.314\ J\ K^{-1}\ mol^{-1}$

CHEMISTRY

Gas Constant R = $8.314\ J\ K^{-1}\ mol^{-1}$
= 0.0821 Lit atm $K^{-1}\ mol^{-1}$
= $1.987 \approx 2$ Cal $K^{-1}\ mol^{-1}$
Avogadro's Number N_a = 6.023×10^{23}
Planck's constant h = 6.625×10^{-34} J·s
= 6.625×10^{-27} erg·s
1 Faraday = 96500 coulomb
1 calorie = 4.2 joule
1 amu = 1.66×10^{-27} kg
1 eV = 1.6×10^{-19} J

Atomic No: H=1, He = 2, Li=3, Be=4, B=5, C=6, N=7, O=8, N=9, Na=11, Mg=12, Si=14, Al=13, P=15, S=16, Cl=17, Ar=18, K =19, Ca=20, Cr=24, Mn=25, Fe=26, Co=27, Ni=28, Cu = 29, Zn=30, As=33, Br=35, Ag=47, Sn=50, I=53, Xe=54, Ba=56, Pb=82, U=92.

Atomic masses: H=1, He=4, Li=7, Be=9, B=11, C=12, N=14, O=16, F=19, Na=23, Mg=24, Al = 27, Si=28, P=31, S=32, Cl=35.5, K=39, Ca=40, Cr=52, Mn=55, Fe=56, Co=59, Ni=58.7, Cu=63.5, Zn=65.4, As=75, Br=80, Ag=108, Sn=118.7, I=127, Xe=131, Ba=137, Pb=207, U=238.

Physics

PART – I

SECTION – A

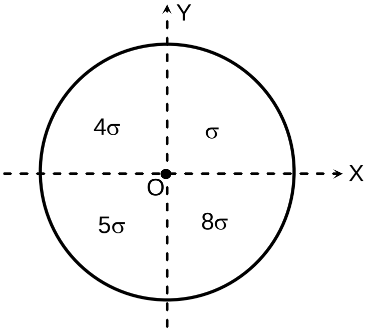
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A man is moving on a circular path of radius R on horizontal ground with constant angular velocity ω. Rain is falling with constant velocity 4 ms^{-1} making an angle 45° with vertical, in the plane containing north-south direction. The magnitude of average velocity of rain with respect to man in one full rotation is

(A) 4 ms^{-1}
(B) $\sqrt{4^2 + \omega^2 R^2 + \sqrt{2}\omega R}$
(C) $\sqrt{4^2 + \omega^2 R^2 - \sqrt{2}\omega R}$
(D) $(4 + \omega R)$

2. Mass per unit area of the disc in first quadrant is σ, in the second quadrant is 4σ, in the third quadrant is 5σ and in the fourth quadrant is 8σ. The coordinates of centre of mass of this system are:

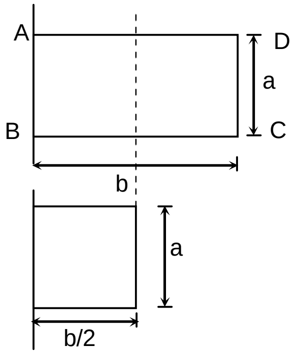


(A) $\left(0, \frac{-16R}{27\pi}\right)$
(B) $\left(0, \frac{-2R}{3\pi}\right)$
(C) $\left(0, \frac{-16R}{65}\right)$
(D) $\left(0, \frac{-4R}{3\pi}\right)$

3. A particle of mass 1 kg, moving with velocity $\vec{u} = \hat{i} + \hat{j}$ in gravity free space strikes a smooth plane and final velocity of particle after collision becomes $\vec{v} = b\hat{j}$. Which of the following vectors **CANNOT** represent a vector perpendicular to plane (b, m and n are real numbers other than zero)?

(A) $\left(m\hat{i} + n\hat{k}\right)$
(B) $\left(\hat{i} + m\hat{j}\right)$
(C) $\left(m\hat{i} + \hat{j}\right)$
(D) $\hat{i}$

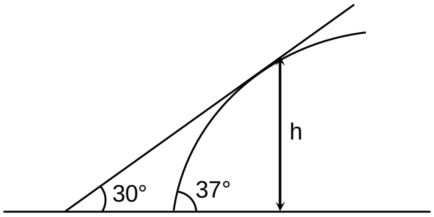
Space for Rough work



4. Moment of inertia of a rectangular plate about one of its side AB is I_0. What is the value of moment of inertia about same side if rectangular sheet is folded as shown in figure.

(A) $\frac{I_0}{2}$ (B) $2I_0$

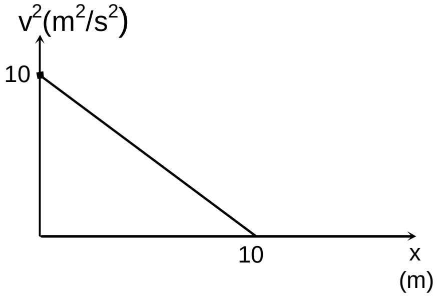
(C) $I_0 + \frac{mb^2}{4}$ (D) $\frac{I_0}{4}$



5. A particle is projected with speed 50 ms^{-1} at an angle 37° with the horizontal and it touches an inclined plane of inclination 30° as shown in figure. Height of the point from the ground where particle touches the incline is ($g = 10\ m/s^{-2}$)

(A) $\frac{55}{3}$m (B) 55 m

(C) 40 m (D) 18 m



6. Graph of square of velocity v^2 versus displacement x for the particle moving in straight line is shown in figure. Magnitude of acceleration of particle when displacement of particle is 5m is

(A) 0.5 ms^{-2}
(B) 0
(C) 2 ms^{-2}
(D) $\sqrt{5}$ ms^{-2}

7. Two cars 1 and 2 of mass m_1 and m_2 ($m_1 > m_2$) are moving in a straight line towards each other on a smooth horizontal road. They collide and both come to rest. If E_1 and E_2 are energies of 1 and 2 respectively, V_1 and V_2 be the speeds of 1 and 2 respectively before collision then choose correct option

(A) $E_1 < E_2$, $V_2 < V_1$ (B) $E_1 < E_2$, $V_1 < V_2$
(C) $E_2 < E_1$, $V_2 < V_1$ (D) $E_2 < E_1$, $V_1 < V_2$

Space for Rough work

8. Moment of inertia of an n sided regular polygon frame made up of n uniform rods each of length a and mass m, about axis perpendicular to plane of polygon and passing through one of its end is I. The change in moment of inertia of frame about the same axis, if length of each side is increased by small amount Δa ($\Delta a << a$) without changing mass is:

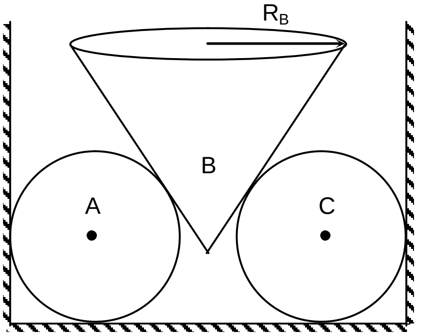
(A) $\left(\frac{I\Delta a}{a}\right)$ (B) $\frac{4I\Delta a}{a}$

(C) $\frac{3I\Delta a}{a}$ (D) $\frac{2I\Delta a}{a}$

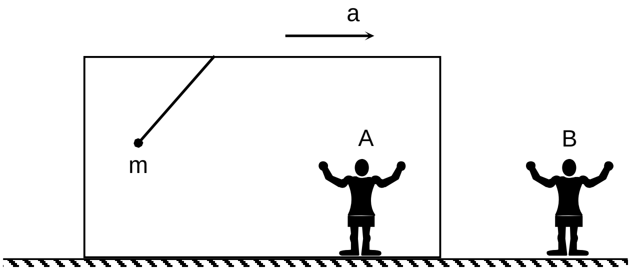
9. If three bodies are in equilibrium as shown in figure then ratio of normal reaction on A from wall to normal reaction on C from the wall is independent of:
(m_B is mass of cone, R_A is radius of sphere A, R_B is radius of cone and ground is smooth.)

(A) m_B (B) R_A

(C) R_B (D) All



10. A pendulum of mass m is connected to the ceiling of a car which in turns moving with constant acceleration $\vec{a}$ on horizontal ground. Pendulum is at rest with respect to car. There are two observers, A sitting in car and B is on ground at rest. Based on above information choose correct option. (where $\vec{T}$ is tension force on mass by the string).



(A) Net force on mass as seen by A is $m\vec{g}+\vec{T}+m\vec{a}$

(B) Net force on mass as seen by B is $m\vec{g}+\vec{T}+m\vec{a}$

(C) Net force on mass as seen by B is $m\vec{g}+\vec{T}$

(D) Net force on mass as seen by A is $m\vec{g}+\vec{T}$

Space for Rough work

11. An engine is attached to a wagon through a shock absorber of length 1.5 m. The system with a total mass of 50,000 kg is moving with a speed of 36 km h^{-1} when the brakes are applied to bring it to rest. In the process of the system being brought to rest, the spring of the shock absorber gets compressed by 1.0 m. If 90% of energy of the wagon is lost due to friction, the spring constant of spring is

(A) $5\times10^4\ \text{N/m}$ (B) $5\times10^3\ \text{N/m}$

(C) $2.5\times10^6\ \text{N/m}$ (D) $2.5\times10^4\ \text{N/m}$

12. A particle of mass m is projected with initial velocity u making an angle θ with horizontal. Angular momentum of particle when radius of curvature of the trajectory is maximum, about point of projection is (where T is time of flight). Consider only the part of projectile for which the final point is at the same horizontal level as point of projection.

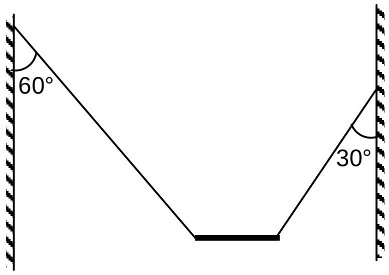
(A) $mg\frac{uT^2}{2}$ (B) $mguT^2$

(C) $\frac{2mu^3\sin^2\theta\cos\theta}{g}$ (D) $\frac{mu^2\cos^2\theta\sin\theta}{g}$

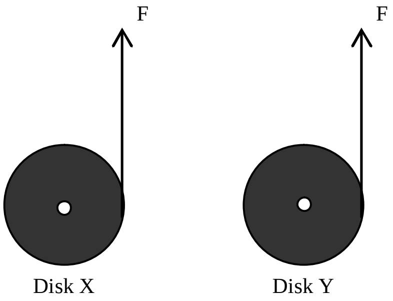
13. A rod of mass 5 kg is suspended with the help of two strings as shown in figure and remains in equilibrium. Linear mass density of rod is given by $\mu = \lambda x^n$ where x is distance from left end of the rod. The value of n is

(A) 3 (B) 2

(C) 5 (D) 4



14. Two uniform disks, X and Y, have masses $m_x < m_y$, equal radii, and equal initial non-zero kinetic energies. Each disk rotates in counter-clockwise sense in the plane of the page about a fixed frictionless axis through its center. As shown in the figure, a force F is applied along tangent to each disk at its right edge for the same amount of time. After the forces are applied, let L represent the magnitude of the angular momentum about the centre of a disk and K represent the kinetic energy of a disk.



Which one of the following choices correctly compares these quantities for disk X and disk Y?

(A) $L_X > L_Y$; $K_X < K_Y$ (B) $L_X > L_Y$; $K_X > K_Y$

(C) $L_X = L_Y$; $K_X = K_Y$ (D) $L_X < L_Y$; $K_X > K_Y$

Space for Rough work

15. Consider three systems, each with three masses, m_1, m_2, m_3 ($m_1 > m_2 > m_3$) with centre of mass at point A, as shown in the figure-1, figure-2 and figure-3 respectively. The same force $\vec{F}$ is applied on the each system separately to just one of the three masses as shown. Which of the following statements is true.

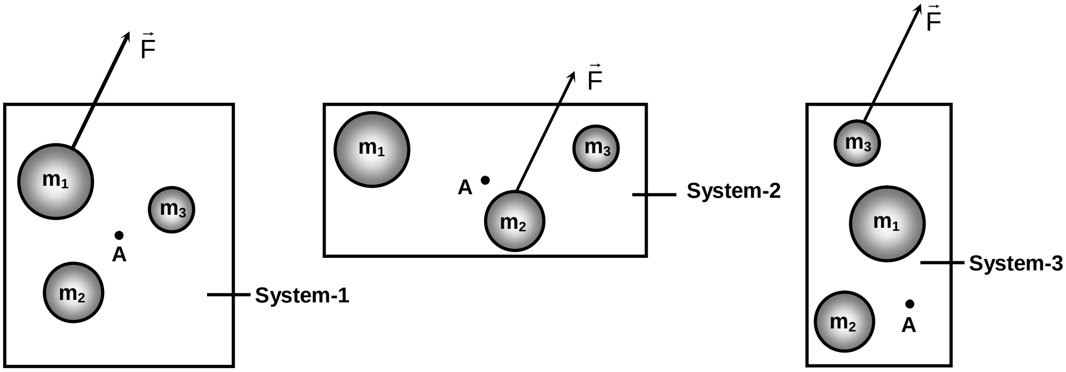
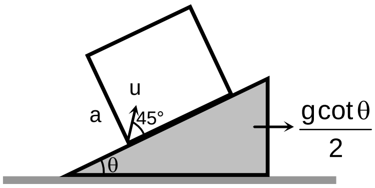


Figure-1 **Figure-2** **Figure-3**

(A) The magnitude of acceleration of centre of mass of the system is largest in figure-1.
(B) The magnitude of acceleration of centre of mass of the system is largest in figure-2.
(C) The magnitude of acceleration of centre of mass of the system is largest in figure-3.
(D) In all cases, the centre of mass of system has same acceleration.

16. The smooth wedge is accelerated at $\frac{g\cot\theta}{2}$ to the right. A cubical box of side a is moving on it. Inside the box a particle is projected with speed u relative to the box at an angle of 45° as shown. Find the time after which the particle will hit the box. [Assuming a is large, so that particle does not collide with top]

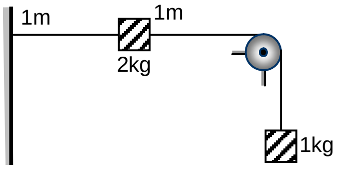


(A) $\frac{u}{\sqrt{2}g\sin\theta}$ (B) $\frac{2\sqrt{2}u}{g\cos\theta}$

(C) $\frac{u}{g\sin\theta}$ (D) $\frac{u}{\sqrt{2}g\cos\theta}$

Space for Rough work

17. The system is released from rest in the position shown. Find the velocity with which the block (negligible in dimension) will hit the wall. The pulley is fixed.
[Use $\sqrt{5} = 2.24$ and g = 10 m/s^2]

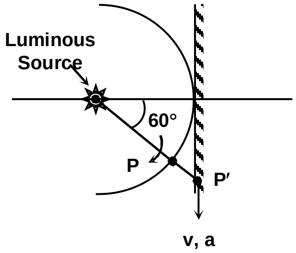


(A) 4m/s (B) 3.2m/s
(C) 2.3m/s (D) 1.6m/s

18. A bird can fly in still air at 15 km/hr. Wind is blowing at 5 km/hr due east. What is the time it takes to reach a point 5 km due North east of its starting point.

(A) $t = \left(\frac{\sqrt{34}+\sqrt{2}}{16}\right)$hrs. (B) $t = \left(\frac{\sqrt{34}-\sqrt{2}}{16}\right)$hrs.
(C) $t = \left(\frac{\sqrt{17}+\sqrt{2}}{16}\right)$hrs. (D) $t = \left(\frac{\sqrt{17}-\sqrt{2}}{16}\right)$hrs.

19. A particle moves in a circular track of radius R (in meter) with uniform ω = 2 rad/s as shown. The velocity and acceleration of its shadow P′ on a horizontal wall when $\theta = 60°$ is



(A) v = 8R, a = $32\sqrt{3}$ R
(B) v = 8R, a = 0
(C) v = 2R, a = $3\sqrt{3}$ R
(D) v = 2R, a = 0

20. A frog of mass m sits at one end of a plank of mass 3m. The length of the plank is ℓ meter and it is kept on a frictionless surface. The frog wants to jump to the opposite end of the board in one jump. Find the minimum speed of the frog with respect to ground that enables it to perform the feat.

(A) $\sqrt{\frac{3}{2}g\ell}$ (B) $\sqrt{\frac{3}{4}g\ell}$
(C) $\sqrt{\frac{1}{2}g\ell}$ (D) $\sqrt{g\ell}$

Space for Rough work

21. A particle is moving with velocity $\vec{v}_i = 2\hat{i} - 3\hat{j} + 4\hat{k}$ m/s collides elastically with a wall whose outward normal is along the direction of $\vec{p} = 3\hat{i} - 6\hat{j} + 2\hat{k}$. Find the unit vector along the direction of final velocity of the particle just after collision.

(A) $\frac{-94\hat{i} + 237\hat{j} + 68\hat{k}}{49\sqrt{29}}$ (B) $\frac{3\hat{i} + 6\hat{j} - 2\hat{k}}{7}$

(C) $\frac{-94\hat{i} + 68\hat{j} - 237\hat{k}}{49\sqrt{29}}$ (D) $\frac{3\hat{i} - 6\hat{j} + 2\hat{k}}{7}$

22. A disc of radius 50 cm is projected from the ground with its plane vertical, such that the velocities of the topmost point (A) and lowest point (B) are :

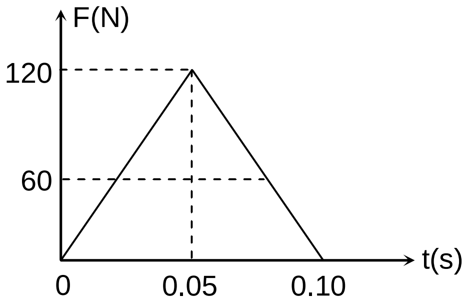
$\vec{v}_A = 20\hat{i} + 10\hat{j}$ m / s

$\vec{v}_B = 10\hat{i} + 10\hat{j}$ m / s

at the instant of projection. Here, $\hat{i}$ and $\hat{j}$ are unit vectors in the plane of the disc, along the horizontal and vertically upward directions respectively. The range of the disc is :

(A) 10 m (B) 20 m
(C) 30 m (D) 40 m

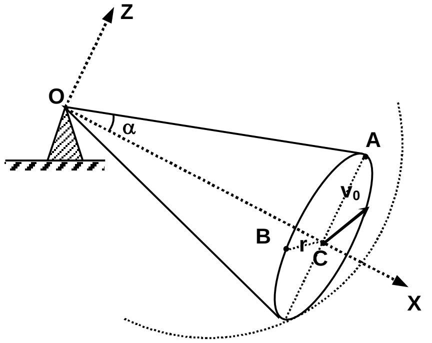
23. When a football is kicked in air, the force by the foot of football player changes with time as shown in the figure.
Assuming that the force is always directed vertically up and mass of ball is 400 gm, determine the maximum height (lifting) of ball (Neglect the air resistance and g = 10 m/s^2)

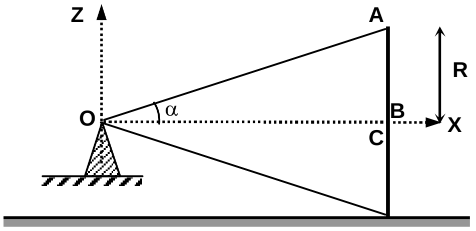


(A) 9.8 m (B) 19.6 m
(C) 15 m (D) 8 m

Space for Rough work

24. A cone rolls without slipping on the horizontal surface so that its apex remains fixed and the axis of cone is horizontal. The radius of base of cone is r and the semi-vertex angle is α. The centre of base of cone is C and it moves with constant speed v_0. Find the speed of point A and point B relative to surface. ($\angle ACB = 90°$). Point A and B lies on circumference of the base of cone.





Front View

(A) $2v_0,\ v_0\sqrt{2+\tan^2\alpha}$ (B) $v_0,\ v_0\sqrt{2+\tan^2\alpha}$

(C) $2v_0,\ v_0\sqrt{1+\tan^2\alpha}$ (D) $v_0,\ v_0\sqrt{1+\tan^2\alpha}$

25. Two identical particles (say particle-1 and particle-2) each of mass m starts moving from rest from origin along x-axis under the action of time dependent forces $F_1 = F_0\sin\omega t$ and $F_2 = F_0\cos\omega t$ (where F_0 and ω are positive constants) respectively. Choose the correct option.

(A) The magnitude of average velocity of particle-1 in the time interval t = 0 to $t = \frac{2\pi}{\omega}$ is $\frac{F_0}{m\omega}$

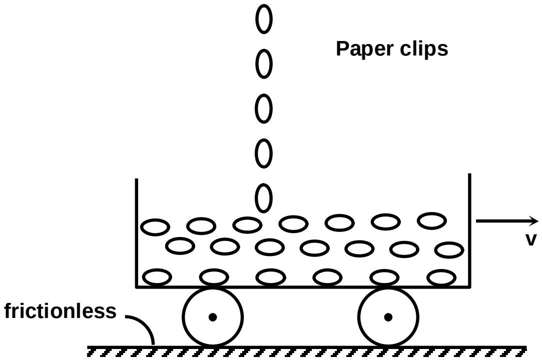
(B) The magnitude of average velocity of particle-2 in the time interval t = 0 to $t = \frac{2\pi}{\omega}$ is $\frac{F_0}{m\omega}$

(C) The magnitude of average velocity of particle-1 in the time interval t = 0 to $t = \frac{2\pi}{\omega}$ is zero

(D) The magnitude of average velocity of particle-2 in the time interval t = 0 to $t = \frac{2\pi}{\omega}$ is non-zero

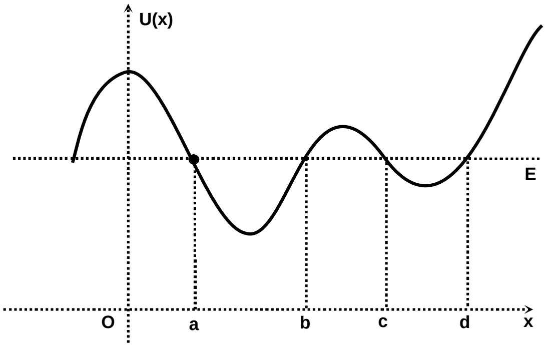
Space for Rough work

26. Suppose you drop paper clips vertically down into an open cart, moving along a straight horizontal road with no friction. Before any paper clips, fell into the cart, the cart is moving with speed v_i and has mass m_i. After all papers clips have fallen into the cart, the cart has mass m_F and speed v_F. The initial horizontal momentum of cart without any paper clips, has magnitude p_i and the initial kinetic energy of the cart without any paper clips is k_i. Component of momentum of the cart with paper clips has momentum p_F and final kinetic energy of the cart with paper clips is k_f. Which of the following statements is true?



(A) $p_f < p_i$, $k_f < k_i$
(B) $p_f = p_i$, $k_f > k_i$
(C) $p_f = p_i$, $k_f < k_i$
(D) $p_f > p_i$, $k_f > k_i$

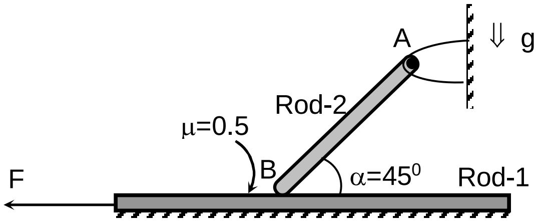
27. The potential energy U(x) for a particle, is shown by solid curve and total mechanical energy E is shown by dotted line in the given figure. If the particle is at x = a, which of the following statements is true about the subsequent motion of the particle?



(A) The kinetic energy k(x) is maximum somewhere in the region a < x < b.
(B) The kinetic energy k(x) is maximum somewhere in the region b < x < c.
(C) The kinetic energy k(x) is maximum somewhere in the region c < x < d.
(D) The kinetic energy is constant for all b < x < c.

Space for Rough work

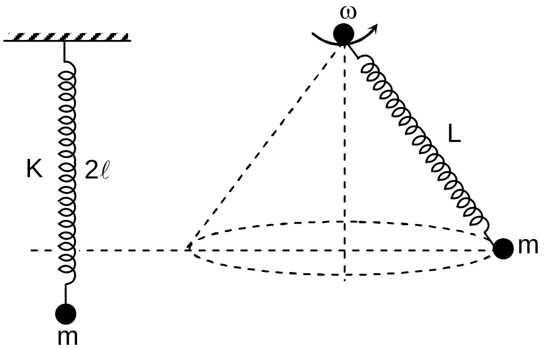
28. Rod-1 of mass M = 3 kg and length L= 2m respectively, is kept on a smooth horizontal surface as shown in the figure. Rod-2 (AB) of mass m = 3kg and length $\ell = 1m$ is hinged at point A and just touches the Rod-2 as shown in the figure.



Find the minimum magnitude of force F, required to move the rod-1.

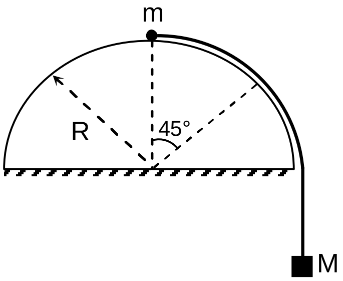
(A) 20N
(B) 15N
(C) 10 N
(D) 5N

29. When a particle of mass m is suspended from a massless spring of natural length ℓ, the length of the spring becomes 2ℓ. When the same mass moves in conical pendulum as shown in figure, the length of the spring becomes L. The radius of the circle of conical pendulum is :



(A) $\frac{L}{L-\ell}\sqrt{L(L-\ell)}$
(B) $\frac{L}{L-\ell}\sqrt{L(L-2\ell)}$
(C) $\sqrt{L(L-\ell)}$
(D) $\sqrt{L^2-2\ell^2}$

30. A small body of mass m is placed to the top of a fixed hemisphere, and is tied by means of a rope to another body of mass M, which hangs vertically. The system is released, the small body of mass m slides along the hemisphere without friction. At which mass ratio m/M will the small body of mass m leave the surface of the hemisphere exactly at the angle of 45° with vertical $\left(\sqrt{2} = 1.4 \text{ and } \frac{\pi}{\sqrt{2}} = 2.3\right)$



(A) 8
(B) 7.5
(C) 6.5
(D) 6

Space for Rough work

Chemistry PART – I

SECTION – A

(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

31. Which of the following molecule having perfect tetrahedral shape, according to VSEPR theory:
(A) SO_2F_2 (B) SO_4^{2-}
(C) SO_3 (D) SF_4

32. In which of the following process energy is required:
(A) $S \rightarrow S^-$ (B) $Na \rightarrow Na^-$
(C) $N \rightarrow N^-$ (D) $P \rightarrow P^-$

33. The lowest unoccupied molecular orbital (LUMO) of O_2 molecule according to MOT is a
(A) σ-bonding molecular orbital (B) σ^* – antibonding molecular orbital
(C) π – bonding molecular orbital (D) π^* - antibonding molecular orbital

34. Which of the following pair of elements will have least electronegativity difference?
(A) Cs, I (B) Li, I
(C) Na, Cl (D) Cs, F

35. For given reaction, at constant temperature
$S_8(g) \rightleftharpoons 4S_2(g)$
at equilibrium, vapour density of mixture is found to be 96. The percentage decomposition of S_8 will be.
(A) 88.89% (B) 11.11%
(C) 44.44% (D) 34.32%

36. Interstitial hydride is formed by
(A) K (B) Si
(C) Hf (D) Co

37. Which of the following is incorrect
(A) $PH_3 < AsH_3 < NH_3 < SbH_3$ (Boiling point)
(B) $HCl < HBr < HI < H_2O$ (Melting point)
(C) $PH_3 < AsH_3 < SbH_3 < NH_3$ (heat of vaporization)
(D) $H_2Te < H_2Se < H_2S < H_2O$ (Boiling point)

Space for Rough work

38. Which of the following statement is incorrect about sodium peroxide?
(A) It decomposes on heating
(B) It is paramagnetic in nature
(C) It can be used in air purification in confined space
(D) It can be used as oxidizing agent

39. Which of the following statement is wrong?
(A) Boron oxides are exclusively acidic
(B) Indium and Thalium oxides are exclusively basic
(C) Boron oxides are exclusively basic
(D) Aluminium and gallium oxides are amphoteric

40. Choose the correct statement about Borazine ($B_3N_3H_6$).
(I) Borazine is iso-electronic with benzene
(II) Chemical properties of borazine and benzene are quite different
(III) Borazine readily undergo addition reaction with polar molecule like HCl
(IV) Borazine is less reactive than benzene.
(A) I & II only (B) I, II, III & IV
(C) I, II & IV (D) I, II & III

41. In the following reaction
$Na_2SO_3 + Na_2CrO_4 \longrightarrow Na_2SO_4 + Cr(OH)_3$
What will be the equivalent weight of oxidizing agent among reactants (Mol. Mass of oxidizing agent = M)
(A) M/2 (B) M/3
(C) M (D) M/6

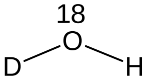
42. The equilibrium constant for the reaction
$2CH_4(g) + 4H_2O(g) \rightleftharpoons 2CO_2(g) + 8H_2(g)$ and $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$ are K_1 and K_2 respectively. The equilibrium constant for the reaction
$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$ will be
(A) $\frac{\sqrt{K_1}}{K_2}$ (B) $\frac{K_1}{K_2}$
(C) $\left(\frac{K_1}{K_2}\right)^{1/2}$ (D) $\frac{K_1 - 2K_2}{2}$

43. Which of the following set of quantum numbers is not possible for 3d orbital?
(A) n = 3, $\ell = 2$, m = + 2, s = +1/2
(B) n = 3, $\ell = 2$, m = 0, s = -1/2
(C) n = 3, $\ell = 1$, m = +1, s = -1/2
(D) n = 3, $\ell = 2$, m = -2, s = +1/2

Space for Rough work

44. Pauling suggested an equation to predict the acidic strength of oxy acid
$pK_a \simeq 9 - 7n$ at 25°C
Where 'n' is the number of non-hydrogenated oxygen atom per molecule. According to Pauling equation which of the following is incorrect?

(A) $pK_a(H_3PO_4) \simeq 2$ (B) $pK_a(HClO_4) \simeq -12$
(C) $pK_a(HOCl) \simeq 9$ (D) $pK_a(H_2SO_3) \simeq -5$

45. If x = total number of neutron and y = total number of proton in  molecule. The value of x – y will be?

(A) 0 (B) 1
(C) 2 (D) 3

46. For the reaction,
$MnO_4^- + M^{2+} \longrightarrow MO_3^- + Mn^{2+}$
Number of moles of MnO_4^- required for complete oxidization of 2 mole of M^{2+} ion will be

(A) 2 mole (B) 1.2 mole
(C) 2.4 mole (D) 2.1 mole

47. The pH of resulting solution, made by mixing of 400 mL, 0.05 M sodium acetate and 100 ml, 0.20 M HCl will be $\left(pK_{a(CH_3COOH)} = 4.75, \log 25 = 1.4\right)$

(A) 1.68 (B) 10.93
(C) 3.08 (D) 12.33

48. An object having mass 50 g is moving with velocity 200 ms^{-1}. If the percentage error in velocity measurement is 0.2%, the uncertainty in its position will be?
($h = 6.4 \times 10^{-34}$ Js. and $\pi = 3.2$)

(A) 1.25×10^{-36} (B) 2.5×10^{-36}
(C) 2.5×10^{-33} (D) 1.25×10^{-33}

49. The rate constant of a reaction $A \longrightarrow Product$ is 4.606×10^{-5} s^{-1}. What will be the fraction of 'A' decomposed after 4 hr. ($Antilog_{10}$ (0.288) = 1.94)

(A) 0.52 (B) 0.48
(C) 0.24 (D) 0.26

50. A closed vessel containing NH_4SH solid is in equilibrium according to following equaiton
$NH_4SH(s) \rightleftharpoons NH_3(g) + H_2S(g)$
$H_2S(g)$ is added, such that its new partial pressure is equal to 3/2 times of original total pressure. The ratio of partial pressure of $NH_3(g)$ now to its original value is

(A) 3 : 1 (B) 1 : 3
(C) 2 : 3 (D) 3 : 2

Space for Rough work

51. Calculate the pH of resulting mixture prepared by dissolving 2.12 g of Na_2CO_3 in 100 ml of an aqueous solution and 20 ml of 0.5 M HCl. $\left(pK_a\left(HCO_3^-\right)=10.25\right)$

(A) 10.55
(B) 3.75
(C) 10.25
(D) 3.45

52. A saturated solution of $CaSO_4$ is prepared at 25°C. When 200 ml of this solution is allowed to complete evaporation of water, 0.34 g of residue was obtained. The K_{sp} of $CaSO_4$ at 25°C will be

(A) 1.56×10^{-4}
(B) 1.25×10^{-4}
(C) 1.56×10^{-2}
(D) 1.25×10^{-2}

53. The time gap between 1/3rd to 2/3rd completion of a first order reaction is 100 min. What is the time required for completion of 75% of the same reaction.

(A) 50 min
(B) 100 min
(C) 400 min
(D) 200 min

54. The spin only magnetic moment of Cr^{x+} and Mn^{y+} are identical and equal to 3.87 BM. The value of x – y will be?

(A) +1
(B) +2
(C) - 1
(D) - 2

55. A gas phase chemical reaction

$2A(g) \longrightarrow 2B(g) + 4C(g)$ in a closed vessel. The concentration of 'A' is decreased by 4×10^{-2} mol L^{-1} in 40 seconds. What will be the rate of appearance of 'C'

(A) 4×10^{-2} mol L^{-1} s^{-1}
(B) 8×10^{-2} mol L^{-1} s^{-1}
(C) 8×10^{-3} mol L^{-1} s^{-1}
(D) 2×10^{-3} mol L^{-1} s^{-1}

56. For a gas phase reaction:

$A(g) + 2B(g) \rightleftharpoons C(g) + D(g)$

The backward reaction is favoured

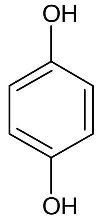
(i) By introducing inert gas at constant volume
(ii) By introducing inert gas at constant pressure
(iii) By adding 'A(g)' at constant volume
(iv) By adding 'D(g)' at constant volume

The correct statements is/are

(A) (i), (ii) & (iv)
(B) (ii) & (iv)
(C) (i) & (iii)
(D) (iv) only

Space for Rough work

57. Molecule with non-zero dipole moments is/are

(i) PCl_5
(ii) PCl_3F_2
(iii) 
(iv) PF_3Cl_2

(A) (ii) & (iii)
(B) (i) & (iii)
(C) (ii), (iii) & (iv)
(D) (iii) & (iv)

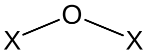
58. What will be the binding energy per nucleon of ${}_{1}^{2}H$ atom, which has actual mass of 2.0064 amu mass of neutron = 1.0086 and the mass of ${}_{1}^{1}H$ atom is 1.0078 amu.

Given 1 amu ≡ 931.5 Mev.

(A) 18.63 Mev
(B) 0.9315 Mev
(C) 9.315 Mev
(D) 93.15 Mev

59. Choose the correct statement

(A) Graphite has greater electrical resistivity than diamond.
(B) Density of graphite is greater than diamond.
(C) Standard molar entropy of diamond is greater than graphite.
(D) Graphite is thermodynamically more stable than diamond at room temperature.

60. Which of the following has least  bond angle (X = halogens).

(A) COF_2
(B) $COCl_2$
(C) SOF_2
(D) $SOBr_2$

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Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. Let A = {f |f: R → R} and 'B' be a relation defined on set A such that $B = \left\{(f, g) \mid \lim\limits_{x \to 2019} \frac{f(x)}{g(x)} \in R; f, g \in A\right\}$, then relation B is
(A) reflexive, symmetric and transitive
(B) reflexive, transitive but not symmetric
(C) reflexive, symmetric but not transitive
(D) reflexive but neither symmetric nor transitive

62. If the enclosed figure formed by the lines |x| = 3 and |y| = 3 is revolved about y-axis, then the volume of the solid so formed is equal to
(A) 9π (B) 36π
(C) 54π (D) 81π

63. The negation of compound statement $(p \wedge q) \Leftrightarrow (r \wedge q)$ is equivalent to
(A) $[(p \wedge q) \vee (q \wedge r)] \wedge [\sim(p \wedge q \wedge r)]$ (B) $(p \wedge q \wedge r) \vee [(p \wedge q) \vee (q \wedge r)]$
(C) $\sim(p \wedge q \wedge r) \vee [(p \wedge q) \vee (q \wedge r)]$ (D) none of these

64. If f: R → R be a function satisfying $f(x + y^2) + 1 + 2x = f(x) + f(y^2) + 2x\, f(y)\ \forall\ x, y \in R$, then which of the following statements is true?
(A) 'f' is odd function (B) 'f' is even function
(C) 'f' is neither even nor odd (D) 'f' is both odd and even

65. If $\int \frac{x^{18} - 1}{\left(x^{54} + 3x^{42} + 2x^{36}\right)^{\frac{1}{6}}} dx$ can be expressed as $\frac{\left[P(x)\right]^n}{10x^5} + c$ where P(x) is polynomial in 'x' of lowest possible degree, then number of distinct real solution(s) of P(x) = 0 is
(A) 0 (B) 1
(C) 2 (D) 4

Space for rough work

66. If f(x) be a differentiable function which satisfies the functional equation $f(x + y) = f(x)e^y + f(y)e^x + 2xye^xe^y$ $\forall$ x, y $\in$ R and $f'(0) = 0$, then the number of solution(s) of the equation f(x) = 0 is

(A) 0 (B) 1

(C) 2 (D) none of these

67. If f(x) be a differentiable function such that $\frac{d^n}{dx^n}f(x)$ exists $\forall$ x $\in$ R, n $\in$ N; and $f'(\alpha) = f'(\beta) = 0$, $f''(\alpha)\,f''(\beta) < 0$, then which of the following statements can be true

(A) points (α, f(α)), (β, f(β)) are local maxima (B) points (α, f(α)), (β, f(β)) are local minima

(C) (α, f(α)), (β, f(β)) are points of inflection (D) none of these

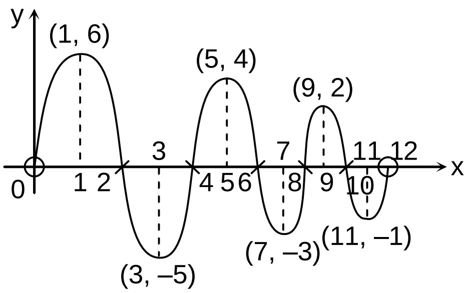
68. Given graph of $y = f'(x)$, for a function f: (0, 12) → R, then determine which of the following statements is false

(A) number of points where f(x) has local maxima are 3

(B) number of points where f(x) has local minima are 3

(C) number of points of inflection of f(x) are 6

(D) none of these



69. Given that $f(x) = \tan x - x^{1000}$, $x \geq 0$ has positive roots $x_1, x_2, x_3, x_4, ...$ such that $x_i < x_j$ if i < j $\forall$ i, j $\in$ N, then area of region enclosed by f(x) with x-axis between lines x = 0 and x = π/2, is

(A) $\ln|\sec x_1| - \frac{x_1^{1001}}{1001}$ (B) $\frac{x_1^{1001}}{1001} - \ln|\sec x_1|$

(C) $\frac{x_2^{1001}}{1001} - \frac{2x_1^{1001}}{1001} + 2\ln\left|\frac{\sec x_1}{\sqrt{\sec x_2}}\right|$ (D) $\frac{x_2^{1001}}{1001} - \frac{x_1^{1001}}{1001} + \ln\left|\frac{\sec x_1}{\sqrt{\sec x_2}}\right|$

70. A triangle is formed by lines 2x + y – 4 = 0, 2y – x – 8 = 0 and x-axis. A circle is drawn with the side of the triangle along x-axis as diameter. The area of the region lying inside the circle but outside the triangle is

(A) $25\pi - 20$ (B) $5\pi - 4$

(C) $25\pi - 10\sqrt{2}$ (D) $5\pi - 2\sqrt{2}$

Space for rough work

71. If the nth term of the sequence 0, 1, 1, 2, 3, 5, 8, 13, 21, ... be given by a_n and $\lim\limits_{n\to\infty}\frac{a_{n+1}}{a_n} = m$, then value of [2m] is (where [.] denotes the greatest integer function)
(A) 0 (B) 1
(C) 2 (D) 3

72. If $f(x) = \max\left\{mx, \frac{x}{m}\right\}$, $g(x) = \min\left\{mx, \frac{x}{m}\right\}$; $(m \neq 0)$ and $h(x) = (\underbrace{fofofo.....f}_{\text{2018 times}}\, o\, \underbrace{gogog.....og}_{\text{2018 times}})(x)$, then which of the following is **INCORRECT**?
(A) $h'(1) = 1$ (B) $h''(0) = 0$
(C) $h'''(3) = 3$ (D) none of these

73. Solution f(x, y) = 0 of the differential equation $(6x^6y - 2y^4)dx = (2xy^3 + 3x^7)dy$; $(x, y \neq 0)$ which satisfies the condition f(1, 1) = 0 is
(A) $\frac{x^6}{y^2} - \ln(exy) = 0$ (B) $\frac{x^6}{y^3} - \ln(exy) = 0$
(C) $\frac{x^6}{y^3} - 2\ln\left(\sqrt{e}xy\right) = 0$ (D) $\frac{x^6}{y^2} - 2\ln\left(\sqrt{e}xy\right) = 0$

74. If f(x) = sin x and $g(x) = \underbrace{f(f(f.....(f}_{\text{2018 times}}(x))))$, then value of $g'(0) + g''(0) + g'''(0)$ equals
(A) 0 (B) –2017
(C) –2018 (D) $1 - (2018)^2$

75. If $f(a - x) = f(a + x)\ \forall\ a \in R$, then which of the following statements must be correct?
(A) f(x) is an odd function (B) $f'(x) = 1$ for some $x \in R$
(C) $\int_{\alpha}^{\beta} f(x)dx = 0$, $\forall\ \alpha, \beta \in R$ (D) Fundamental period of f(x) doesn't exist

76. If $x\cos\alpha + y\sin\alpha = p$ is tangent to the curve $y = -\sqrt{x}$, then range of α is
(A) $\bigcup\limits_{n\in N}\left(2n\pi, (2n+1)\pi\right)$ (B) $\bigcup\limits_{n\in N}\left(n\pi, \left(n+\frac{1}{2}\right)\pi\right)$
(C) $\bigcup\limits_{n\in N}\left(\frac{n\pi}{2}, (n+1)\frac{\pi}{2}\right)$ (D) $(-\infty, \infty)$

Space for rough work

77. Area of the triangle formed by tangent and normal to a curve f(x, y) = 0 at any point P on the curve, along with x-axis equals square of ordinate of P, then f(x, y) represents

(A) circle (B) parabola

(C) hyperbola (D) pair of lines

78. Let $y = f(x) = (x + a)^2 + (x + b)^2 + c(x + d) + e$ where a, b, c, d, e are arbitrary constants. Let order and degree of differential equation formed from y = f(x), be m, n respectively, then m + n equals

(A) 3 (B) 4

(C) 6 (D) 7

79. Solution of the differential equation $\frac{x - y\frac{dy}{dx}}{x\frac{dy}{dx} - y} = \frac{1}{2}\cos\left(\frac{y}{x}\right)\left(1 - \frac{y^2}{x^2}\right)$ is

(A) $\ln\left|\frac{c}{x^2 - y^2}\right| + \sin\left(\frac{y}{x}\right) = 0$ (B) $\ln\left|c\left(x^2 - y^2\right)\right| + \cos\left(\frac{y}{x}\right) = 0$

(C) $\ln\left|c\left(x^2 - y^2\right)\right| + \sin\left(\frac{y}{x}\right) = 0$ (D) $\ln\left|\frac{c}{x^2 - y^2}\right| + \cos\left(\frac{y}{x}\right) = 0$

80. Let $f(x) = \frac{\sin x}{x}$, then value of $\left[\lim_{m\to\infty}\sum_{n=1}^{m}\left(\int_{\pi/6}^{\pi/2}(f(x))^n + \int_{(3/\pi)^n}^{(2/\pi)^n}\left(f^{-1}(x)\right)^{1/n}\right)dx\right]$ is (where [.] denotes the greatest integer function)

(A) 8 (B) –8

(C) 9 (D) –9

81. Let f(x) be a periodic differentiable function, $g(x) = \int f(x)dx$; $h(x) = \int_a^b f(x)dx$, where a, b are constants. Consider the statements

(i) g(x) may be a periodic function (ii) h(x) may be a periodic function

(iii) g(x) may not be a periodic function (iv) h(x) may not be a periodic function

Then number of statements(s) which is/are true is

(A) 1 (B) 2

(C) 3 (D) 4

Space for rough work

82. If $\lim\limits_{x\to 0}\left(\dfrac{a\sin 2x - x^{x+1}}{\ln(2x+1)}\right)^{\frac{2x}{x^2+x}} = \dfrac{9}{4}$, a ∈ R, then sum of all possible values of 'a' is

(A) –1 (B) 1
(C) 2 (D) 3

83. Let $\int e^{x^2+x}\left(4x^3+4x^2+5x+1\right)dx = e^{x^2+x}P(x)+c$ where P(x) is polynomial in x, then P(1) is equal to

(A) 2 (B) 3
(C) 4 (D) none of these

84. If f(x) be a differentiable function such that $\lim\limits_{x\to\infty} f(x)$ exists and is equal to a finite number 'ℓ', then which of the following will always be true

(A) $\lim\limits_{x\to\infty}\int\limits_0^x f(t)dt = 0$ (B) $\lim\limits_{x\to\infty} f'(x) = 0$
(C) $\lim\limits_{x\to\infty} x f'(x) = 0$ (D) none of these

85. The limit $\lim\limits_{x\to\infty}\dfrac{\sum\limits_{r=1}^{2018}(x+r)^{2019}}{\prod\limits_{r=1}^{2019}(x+r)}$

(A) does not exist (B) exists and equal to 0
(C) exists and is non-zero finite number (D) none of these

86. The number of points where the function,
$f(x) = \cos|2018\pi - x| + \sin|2020\pi - x| + (x-\pi)|x^2 - 3\pi x + 2\pi^2|$ is non-differentiable is/are

(A) 0 (B) 1
(C) 2 (D) 3

87. If Rolle's theorem can be applied to f(x) = xlnx, x > 0 in interval $\left[\dfrac{1}{a},\dfrac{1}{b}\right]$ where a, b ∈ I^+, then b equals

(A) 1 (B) 2
(C) 3 (D) infinite possible values exist

Space for rough work

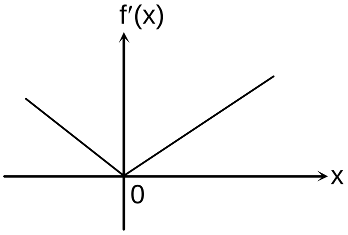
88. The value of the integral $\int_0^{\infty} \frac{\tan^{-1} x}{x^2 + 1 + 2x} dx$ is

(A) $\frac{\pi}{2}$ (B) $\frac{\pi}{4}$

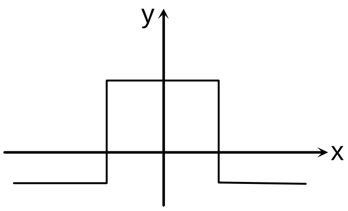
(C) $\frac{\pi}{8}$ (D) none of these

89. If f: R → R be a differentiable function, then which of the following cannot be graph of $f'(x)$?

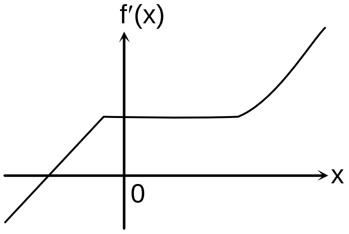
(A)



(B)



(C)



(D) none of these

90. In a class of 100 students, 60 like Mathematics, 72 like Physics, 68 like Chemistry and no student likes all three subjects. Then number of students who don't like Mathematics and Chemistry is

(A) 0 (B) 4

(C) 8 (D) cannot be solved with given information

Space for rough work

FIITJEE **JEE(Main)-2019**

ALL INDIA TEST SERIES

ANSWERS, HINTS & SOLUTIONS

PART TEST – I
(Main)

Q. No.	PHYSICS	Q. No.	CHEMISTRY	Q. No.	MATHEMATICS
1.	**A**	31.	**B**	61.	**B**
2.	**A**	32.	**C**	62.	**C**
3.	**A**	33.	**B**	63.	**A**
4.	**D**	34.	**B**	64.	**B**
5.	**A**	35.	**B**	65.	**A**
6.	**A**	36.	**C**	66.	**B**
7.	**B**	37.	**D**	67.	**D**
8.	**D**	38.	**B**	68.	**B**
9.	**D**	39.	**C**	69.	**C**
10.	**C**	40.	**D**	70.	**A**
11.	**A**	41.	**B**	71.	**D**
12.	**C**	42.	**A**	72.	**C**
13.	**B**	43.	**C**	73.	**C**
14.	**D**	44.	**D**	74.	**B**
15.	**D**	45.	**B**	75.	**D**
16.	**B**	46.	**B**	76.	**B**
17.	**C**	47.	**C**	77.	**D**
18.	**B**	48.	**C**	78.	**A**
19.	**A**	49.	**B**	79.	**A**
20.	**B**	50.	**B**	80.	**D**
21.	**A**	51.	**C**	81.	**C**
22.	**C**	52.	**A**	82.	**C**
23.	**A**	53.	**D**	83.	**B**
24.	**A**	54.	**C**	84.	**B**
25.	**A**	55.	**D**	85.	**C**
26.	**C**	56.	**B**	86.	**C**
27.	**A**	57.	**D**	87.	**B**
28.	**D**	58.	**C**	88.	**B**
29.	**B**	59.	**D**	89.	**B**
30.	**C**	60.	**C**	90.	**A**

Physics

PART – I

SECTION – A

1. $$\vec{v}_{rm} = \vec{v}_r - \vec{v}_m$$

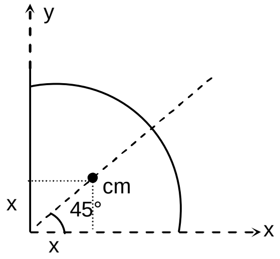
$$\frac{\int v_{rm}dt}{\int dt} = \frac{\int \vec{v}_r dt}{\int dt} - \frac{\int \vec{v}_m dt}{\int dt}$$

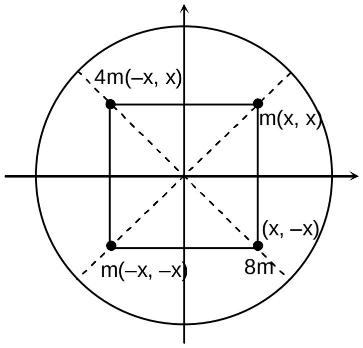
$$< \vec{v}_{rm} > = \vec{v}_r - 0\,.$$

2. $$x_{cm} = \frac{m(x)+4m(-x)+5m(-x)-8m(x)}{m+4m+5m+8m} = 0$$

$$y_{cm} = \frac{m(x)+4m(x)+5m(-x)+8m(-x)}{18m}$$

$$= -\frac{8mx}{18m} = \frac{-4}{9}x = \frac{-4}{9}\times\left(\frac{4R}{3\pi}\right) = -\frac{16R}{27\pi}$$





3. Vector along the normal of plane is

$-\hat{i} - \hat{j}(1-b)$

Coefficient of $\hat{k}$ is zero always also it becomes $\hat{i}$ when b = 1.

4. $$I_0 = Kmb^2$$

$$I' = K.(m).\left(\frac{b}{2}\right)^2$$

$$I' = \left(Kmb^2\right)\frac{1}{4}$$

$$\Rightarrow \quad I' = \frac{I_0}{4}.$$

5. $$\frac{v\sqrt{3}}{2} = 50\times\frac{4}{5} \Rightarrow v = \frac{80}{\sqrt{3}}$$

Now using conservation of mechanical energy

$$\frac{(80)^2}{3} - (50)^2 = -2gh$$

$$\Rightarrow \quad \frac{-6400+7500}{3} = 2gh$$

$$\Rightarrow \quad \frac{1100}{3\times 10\times 2} = h \Rightarrow h = \left(\frac{55}{3}\right)\text{m}$$

6. $v^2 + x = 10$

$2va + v = 0$

$\Rightarrow \quad a = -\frac{1}{2}\text{ms}^{-2}$

7. $p_1 = p_2$

$V_1 < V_2$

$\frac{p^2}{2m} = E$

$\Rightarrow \quad E_1 < E_2$

8. $I = k\,.\,ma^2$

$\Delta I = \frac{2kma^2.\Delta a}{a}$

$= \frac{2I.\Delta a}{a}$

9. Basic concept of FBD and equilibrium

10. Basic concept of pseudo force

11. $KE = \frac{1}{2}mv^2 = \frac{1}{2}\times 5\times 10^4 \times 10^2 = 2.5\times 10^5\,J$.

10% of this is stored in the spring.

$\frac{1}{2}kx^2 = 2.5\times 10^4$

x = 1 m

$k = 5 \times 10^4$ N/m.

12. Basic concept of projectile

13. $X_{cm} = \frac{\lambda L^{n+2}}{(n+2)}.\frac{n+1}{\lambda L^{n+1}} = \frac{3L}{4}$.

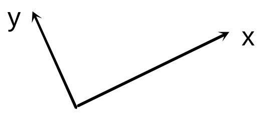
$\frac{n+1}{n+2} = \frac{3}{4}$

n = 2

14. With equal initial kinetic energy, one can write for these rotating disks that KE = ½ $I\omega^2 = L^2/2I$. As a result L = $\sqrt{2I(KE)}$ which means $L_X < L_y$ as object Y has more mass. By applying the same force on the outside of each disk, the torque from the centre of each disk is the same. From the angular impulse momentum theorem, $(\tau)\Delta t = \Delta L$ and since the torques and times are equal, the change in angular momentum is the same for each. Consequently, $L_X < L_Y$ after the push as well. The kinetic energy depends on the total distance through which each force acted. Since disk X is rotating at a higher rate than disk Y and the applied force will increase the angular speed of each disk, there will be a greater angle swept out by a disk X compared to disk Y. As a result, the kinetic energy change for disk X is greater than for disk Y meaning that after the pus, $K_X > K_Y$.

15. $\vec{a}_{CM} = \dfrac{\vec{F}_{net}}{\Sigma mi}$

16. $\vec{a}_{Bg} = -g\sin\theta\,\hat{i} - \dfrac{g\cos\theta}{2}\hat{j} \Rightarrow$ Acceleration of box with respect to ground

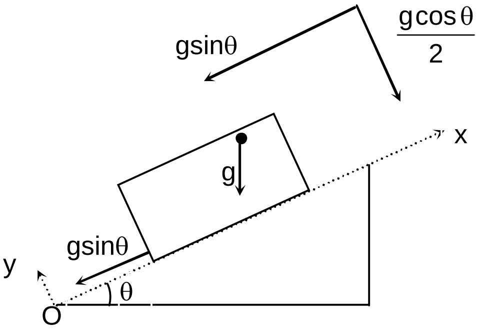


$\vec{a}_{Pg} = -g\sin\theta\,\hat{i} - g\cos\theta\,\hat{j} \Rightarrow$ Acceleration of particle with respect to ground

$\vec{a}_{PB} = -\dfrac{g\cos\theta}{2}\hat{j} \Rightarrow$ Acceleration of particle with respect to Box

$\vec{u}_{PB} = u\cos 45^\circ\,\hat{i} + u\sin 45^\circ\,\hat{j} \Rightarrow$ Initial velocity of particle with respect to Box

Time of flight = $\dfrac{2u\sin 45^\circ}{\frac{g\cos\theta}{2}} = \dfrac{2\sqrt{2}u}{g\cos\theta}$



17. $A'P = \sqrt{2^2+1} = \sqrt{5}.$

$\Rightarrow \Delta h = \left(\sqrt{5}-1\right)$

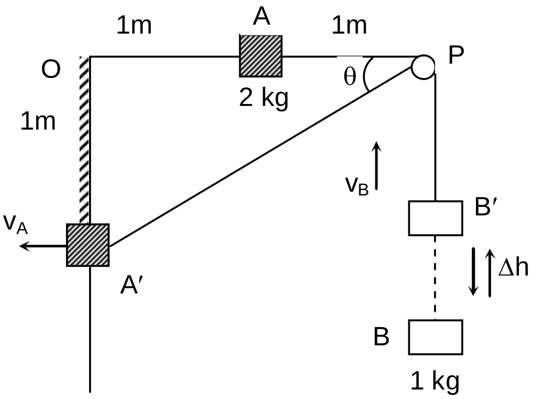
From work energy theorem :

$+2g \times 1 - 1 \times g\Delta h = \frac{1}{2}2v_A^2 + \frac{1}{2} \times 1 \times v_B^2$

Where $v_B = v_A\cos\theta;\ \cos\theta = \dfrac{2}{\sqrt{5}}$

On solving :

$7.5 = \frac{7}{5}v_A^2 \Rightarrow v_A = 2.3\ \text{m/sec}.$



18. Bird has to fly away from wind direction as shown so as to reach P.

$\because V_{Bird} > V_{wind}$

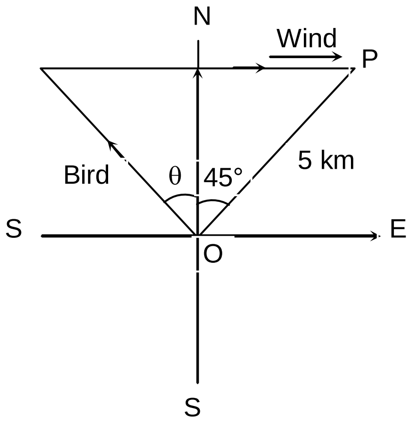
If t is time taken;

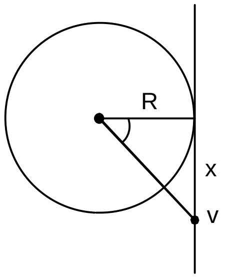
$\frac{5}{\sqrt{2}} \times \frac{1}{15\cos\theta} = t$ …(i)

$\left(5 - 15\sin\theta\right)t = \frac{5}{\sqrt{2}}$ …(ii)

Solving for t we get

$8t^2 + \sqrt{2}t - 1 = 0 \Rightarrow t = \left(\dfrac{\sqrt{34}-\sqrt{2}}{16}\right)$hrs.





19. $\frac{x}{R} = \tan\theta$

$x = R\tan\theta$

$\Rightarrow \frac{dx}{dt} = R\sec^2\theta\frac{d\theta}{dt} = R\omega\sec^2\theta$

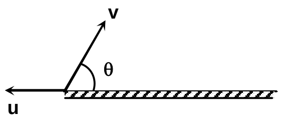
$\Rightarrow v = R\omega\sec^2\theta$

$\Rightarrow \frac{dv}{dt} = R\omega\left[2\sec\theta.\sec\theta\tan\theta\frac{d\theta}{dt}\right].$

$\Rightarrow a = 2R\omega^2\sec^2\theta\tan\theta$

$v = R(2)\sec^2 60^\circ = 2R(4) = 8R$

$a = 2(R)(4)(4)\left(\sqrt{3}\right) = 32\sqrt{3}R$



20. Let frog takes off at θ angle with v speed from ground frame

$v_P = \frac{mv\cos\theta}{3m} = \frac{v\cos\theta}{3}$

$\Rightarrow \left(\vec{v}_{f/P}\right)_x = \vec{v}_f - \vec{v}_P = v\cos\theta + \frac{v\cos\theta}{3} = \frac{4}{3}v\cos\theta$

$\left(\vec{v}_{f/p}\right)_y = v\sin\theta \Rightarrow R_{f/P} = \frac{2\left(\frac{4}{3}\right)v\cos\theta v\sin\theta}{g} = \ell$

$\Rightarrow v^2\sin 2\theta = \frac{3}{4}g\ell \Rightarrow v_{min} = \sqrt{\frac{3}{4}g\ell}$

21. $\hat{v}_i = \frac{2\hat{i} - 3\hat{j} + 4\hat{k}}{\sqrt{29}}$

$\hat{p} = \frac{3\hat{i} - 6\hat{j} + 2\hat{k}}{7}$

$\hat{v}_f = \vec{v}_i - 2(\hat{v}_i.\hat{p})\hat{p}$

$= \frac{2\hat{i} - 3\hat{j} + 4\hat{k}}{\sqrt{4+9+16}} - \frac{2(6+18+8)\left(3\hat{i} - 6\hat{j} + 2\hat{k}\right)}{\sqrt{29}\times 49}$

$= \frac{-94\hat{i} + 237\hat{j} + 68\hat{k}}{49\sqrt{29}}$

22. Time of flight = $\frac{2\times 10}{10} = 2s;$

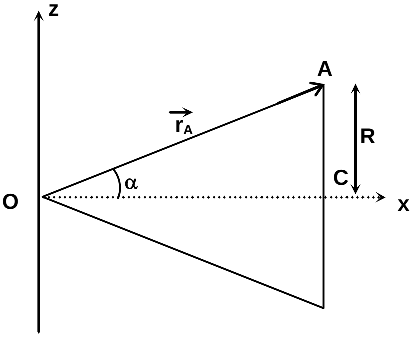
Range = 2 × 15 = 30 m

23. Area = $\frac{1}{2}\times 0.10\times 120 = 6$ Ns

Change in momentum = 6 – $400\times 10^{-3}\times 10\times 0.10$ (Due to Gravitation) = 6 – 0.4 = 5.6 Ns

mv = 5.6 $\Rightarrow$ v = 14 m/s

$H = \frac{v^2}{2g} = 9.8$ m



24. $\omega_r = v_0R$, and $\omega_z = \frac{v_0}{O'O}$

$OO' = R\cot\alpha$

$\vec\omega = \left[\omega_Z\hat k + \omega_r(-\hat i)\right]$

$\therefore\ \vec v_A = \vec\omega\times\vec r_A = \vec\omega\times\left[R\cot\alpha(\hat i) + R(\hat k)\right]$

$= \left[\frac{v_0}{R\cot\alpha}\hat k - \frac{v_0}{R}\hat i\right]\times\left[R\cot\alpha\,\hat i + R\hat k\right]$

$\Rightarrow \vec v_A = (v_0 + v_0)\hat i = 2v_0\hat i \Rightarrow v_A = 2v_0$

Similarly, $\vec v_B = \vec\omega\times\vec r_B$

Where, $\vec r_B = R\cot\alpha\,\hat i - R\hat j$

$\Rightarrow\ \vec v_B = -v_0\hat k + \frac{v_0}{\cot\alpha}\hat i + v_0\hat j$

$\Rightarrow\ v_B = \sqrt{v_0^2 + \frac{v_0^2}{\cot^2\alpha} + v_0^2} = v_0\sqrt{2+\tan^2\alpha}$

25. $a_1 = \frac{F_0}{m}\sin\omega t = \left(\frac{F_0}{m\omega^2}\right)\omega^2\sin\omega t = \omega^2R\sin\omega t$

$a_2 = \frac{F_0}{m}\cos\omega t = \left(\frac{F_0}{m\omega^2}\right)\omega^2\cos\omega t = \omega^2R\cos\omega t$

Here $R = \frac{F_0}{m\omega^2}$

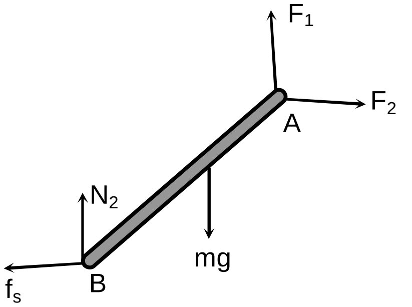
$v_1 = \frac{F_0}{m\omega}(1-\cos\omega t)$ & $v_2 = \frac{F_0}{m\omega}\sin\omega t \Rightarrow x_1 = R(\omega t - \sin\omega t)$ & $y_2 = R(1-\cos\omega t)$

$<v_1> = \frac{F_0}{m\omega}$, and $<v_2> = 0$

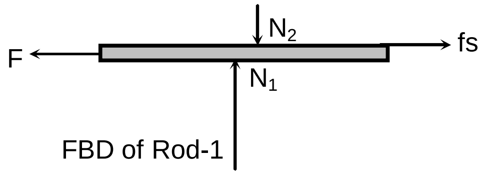
26. No external force is acting along horizontal direction

27. E = U + K, for a given E, k will be maximum where U will be minimum.

28. Taking torque about A $mg\frac{\ell}{2}\cos\alpha = f_s\ell\sin\alpha + N_2\ell\cos\alpha$



FBD of Rod-2

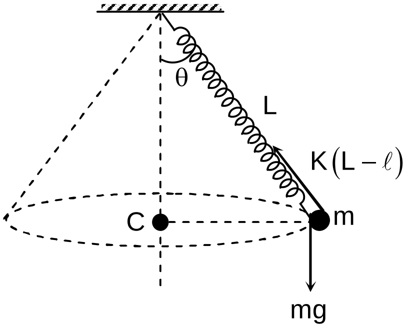


FBD of Rod-1

$\Rightarrow N_2 = \frac{mg}{2(1+\mu\tan\alpha)}$

$$F \ge f_s \;\Rightarrow\; F_{min} = f_{smax} = \mu N_2 \Rightarrow F_{min} = F_2 = \frac{\mu mg}{2\left(1+\mu\tan\alpha\right)} = \frac{0.5\times3\times10}{2\left(1+0.5\times1\right)} = 5N$$

29.



$$mg = K\left(2\ell-\ell\right) = K\ell$$
$$K\left(L-\ell\right)\cos\theta = mg$$
$$\frac{mg}{\ell}\left(L-\ell\right)\frac{\sqrt{L^2-r^2}}{L} = mg$$
$$\Rightarrow \sqrt{L^2-r^2} = \frac{L\ell}{L-\ell}$$
$$\Rightarrow L^2-\left(\frac{L\ell}{L-\ell}\right)^2 = r^2$$
$$\Rightarrow L^2\left(1-\frac{\ell^2}{\left(L-\ell\right)^2}\right) = r^2$$
$$\Rightarrow r^2 = L^2\left(\frac{L^2-2L\ell}{\left(L-\ell\right)^2}\right)$$
$$\Rightarrow r = \frac{L}{\sqrt{L-\ell}}\sqrt{L\left(L-2\ell\right)}$$

30.

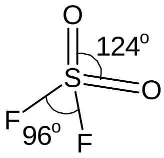
$$\frac{mv^2}{R} = mg\cos\theta \qquad \ldots(1)$$
$$\frac{1}{2}\left(M+m\right)v^2 = mg\left(1-\cos\theta\right)R+\frac{\pi R}{4}Mg \qquad \ldots(2)$$
$$\frac{1}{2}\left(M+m\right)g\cos\theta = mg\left(1-\cos\theta\right)+\frac{\pi Mg}{4}$$
$$\Rightarrow \left(M+m\right)\cos\theta = 2m\left(1-\cos\theta\right)+\frac{\pi}{2}M$$

Chemistry

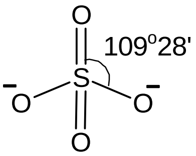
PART – II

SECTION – A

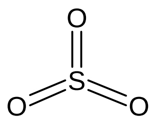
31.



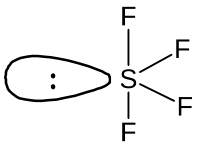
sp^3 but not ideal tetrahedral.



Ideal tetrahedral

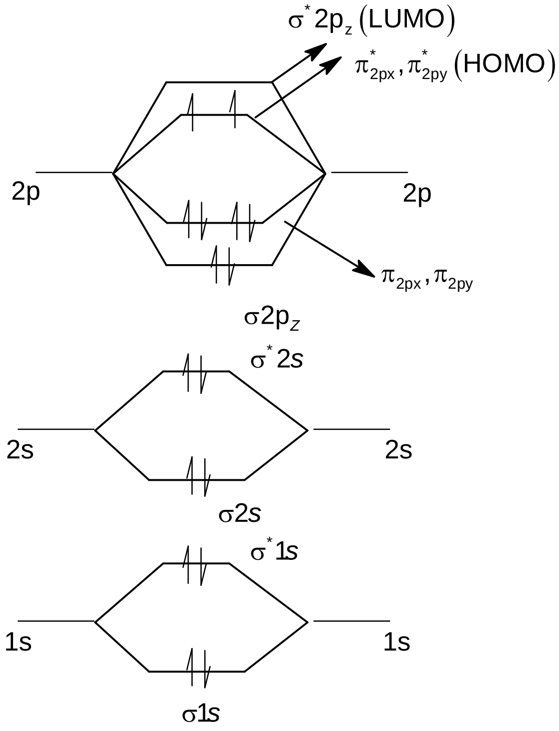


Trigonal planer



See-saw

33.


σ* 2p_z (LUMO)
π*_2px , π*_2py (HOMO)
2p
2p
π_2px , π_2py
σ2p_z
σ* 2s
2s
2s
σ2s
σ* 1s
1s
1s
σ1s

35. $S_8(g) \rightleftharpoons 4S_2(g)$

$C \qquad 0$

$C - C\alpha \qquad 4C\alpha$

$$\frac{V.D_{initial}}{V.D_{eqm}} = \frac{(moles)_{eqm}}{(moles)_{initial}}$$

$$\frac{(32 \times 8)/2}{96} = \frac{C - C\alpha + 4C\alpha}{C}$$

$$\Rightarrow \frac{4}{3} = 1 + 3\alpha$$

$$\Rightarrow \alpha = \frac{1}{9}$$

% decomposition $\frac{1}{9} \times 100 = 11.11\%$

36. ‘Hf’ form interstitial hydride, e.g. $HfH_{1.98}$

→ KH is an ionic hydride

→ SiH_4 is a covalent hydride

→ ‘Co’ don’t form hydride (hydride gap)

37. Actual boiling point order

$H_2S < H_2Se < H_2Te < H_2O$

38. On heating

$$Na_2O_2 \xrightarrow{\Delta} Na_2O + \frac{1}{2}O_2$$

$\Rightarrow Na_2O_2 \Rightarrow O_2^{2-} \Rightarrow$ it is diamagnetic in nature.

$\Rightarrow Na_2O_2 + CO_2 \longrightarrow Na_2CO_3$ (Suitable for use in air purification)

$\Rightarrow Na_2O_2$ is good oxidizing agent.

41. $\overset{+4}{S} \longrightarrow \overset{+6}{S} + 2e^-$ (Oxidation half reaction)

$Cr^{+6} + 3e^- \longrightarrow Cr^{+3}$ (Reduction half reaction)

$\therefore Na_2CrO_4$ is oxidizing agent

$\therefore$ Eq. wt. of Na_2CrO_4 (oxidizing agent) = M/3

42. $2CH_4(g) + 4H_2O(g) \rightleftharpoons 2CO_2(g) + 8H_2(g)$ … (i)

$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$ … (ii)

Equation (i) – 2 × Equation (ii)

$2CH_4(g) + 2H_2O(g) \rightleftharpoons 2CO(g) + 6H_2(g)$ … (iii)

Equilibrium constant for Equation (iii) $= \dfrac{K_1}{K_2^2}$

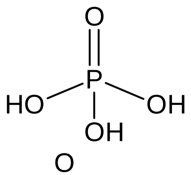
By multiplying Eq. (iii) by $\dfrac{1}{2}$ we get

$CH_4(g) + 4H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$

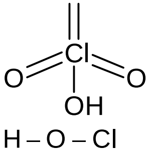
$\therefore$ Equilibrium constant $= \left(\dfrac{K_1}{K_2^2}\right)^{1/2} = \dfrac{\sqrt{K_1}}{K_2}$

43. Possible value of quantum number of 3d orbital.
n = 3, $\ell = 2$, m = -2, - 1, 0, +1, +2
s = +1/2, - 1/2

44.

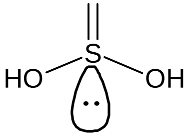


$n = 1$ $pK_a \simeq 9 - 7 \times 1 = 2$



$n = 3$ $pK_a \simeq 9 - 7 \times 3 = -12$

$H - O - Cl$ $n = 0$ $pK_a \simeq 9 - 7 \times 0 = 9$



$n = 1$ $pK_a \simeq 9 - 7 \times 1 = 2$

45.

	n	P
D	1	1
O^{18}	10	8
H	0	1
x = 11		y = 10

x – y = 1

46. $\overset{+7}{Mn}O_4^- + \overset{+2}{M}{}^{2+} \longrightarrow \overset{+5}{M}O_3^- + \overset{+2}{Mn}{}^{2+}$

n-Factor of Mn = 5

n-Factor of M = 3

Number of equivalent of MnO_4^- = Number of M^{2+}

5 × mole of MnO_4^- = 3 × 2

$\therefore$ Mole of $MnO_4^- = \frac{6}{5} = 1.2$

47.

CH_3COONa	+ HCl	$\longrightarrow$ CH_3COOH	+ $NaCl$
400×0.05	100×0.2		
20 meq.	20 meq.	0	0
0	0	20 meq.	20 meq.

$$\therefore [CH_3COOH] = \frac{20}{500} = 0.04\ M$$

$$pH = \frac{1}{2}(pK_a - \log C) = \frac{1}{2}(4.75 - \log(0.04))$$

$$= \frac{1}{2}\left(4.75 - \log\left(\frac{1}{25}\right)\right)$$

$$= \frac{1}{2}(4.75 + \log(25))$$

$$= \frac{1}{2}(4.75 + 1.4) = 3.075$$

48. Uncertainty in velocity

$$\Delta v = \frac{0.2 \times 200}{100} = 0.4\ ms^{-1}$$

$$\Delta x.\Delta p \geq \frac{h}{4\pi}$$

$$\Delta x \geq \frac{h}{4 \times m \times \pi \times \Delta v}$$

$$= \frac{6.4 \times 10^{-34}}{4 \times 50 \times 10^{-3} \times 0.4 \times 3.2}$$

$$= \frac{10^{-34}}{40 \times 10^{-3}} = 2.5 \times 10^{-33}$$

49. $k = \frac{2.303}{t}\log\left(\frac{A_0}{A_t}\right)$

$$\log\left(\frac{A_0}{A_t}\right) = \frac{k.t}{2.303} = \frac{4.606 \times 10^{-5} \times 4 \times 3600}{2.303}$$

$= 2 \times 4 \times 3600 \times 10^{-5}$

$= 0.288$

$\left(\frac{A_0}{A_t}\right) =$ Anti log (2.88)

$= 1.94$

Fraction remain $= \frac{A_t}{A_0} = \frac{1}{1.94}$

Fraction decomposed $= 1 - \frac{1}{1.94}$

$0.4845 \simeq .48$

$$NH_4SH(s) \rightleftharpoons NH_3(g) + H_2S(g)$$

50. At eqm P P

$P_{total} =$ 2P

$K_P = P^2$

When H_2S is added

$$NH_4SH(s) \rightleftharpoons \underset{(P'_{NH_3})}{NH_3(g)} + \underset{(P'_{H_2S})}{H_2S(g)}$$

According to question

$P'_{H_2S} = \frac{3}{2} \times P_{total} = \frac{3}{2} \times 2P = 3P$

$K_P = P'_{H_2S}.P'_{NH_3}$

$P^2 = P'_{NH_3}.3P$

$\therefore P'_{NH_3} = \frac{P}{3}$

$\therefore \frac{P'_{NH_3}}{P_{NH_3}} = \frac{\frac{P}{3}}{P} = 1:3$

51.

	Na_2CO_3	$+$ HCl	$\longrightarrow NaHCO_3$	$+NaCl$
m.eq. initial	$\frac{2.12}{106} \times 1000$	20×0.5	0	0
	20 m.eq.	10 m.eq.		
m.eq. after mixing	10 m.eq.	0	10 m.eq.	10 m.eq.

Now,

Mixture contains Na_2CO_3 and $NaHCO_3$ so it will acts as buffer.

$\therefore pH = pK_a + \log\frac{[Na_2CO_3]}{[NaHCO_3]}$

= 10.25 + log10/10 = 10.25

52. Moles of $CaSO_4$ in 200 ml solution $= \frac{0.34}{136} = 0.25 \times 10^{-2}$

$\therefore$ Molarity $= \frac{0.25 \times 10^{-2}}{200} \times 1000$

$= 1.25 \times 10^{-2}$ mol/lit.

$K_{sp} = \left[Ca^{2+}\right]\left[SO_4^{2-}\right]$

$= \left(1.25 \times 10^{-2}\right)^2$

$= 1.5625 \times 10^{-4}$

53. $t_{2/3}rd - t_{1/3}rd = \frac{2.303}{K}\log\left(\frac{A_0}{1/3A_0}\right) - \frac{2.303}{K}\log\frac{A_0}{\frac{2}{3}A_0}$

$= \frac{2.303}{K}\log 2$

$\Rightarrow 100 \text{ min} = \frac{0.693}{K} \Rightarrow$ half life

$\therefore$ Time taken for completion of 75% $\left(2t_{1/2}\right) = 2 \times 100 = 200$ min

54. Cr^{+x} $\mu = 3.87$

$\sqrt{n\left(n+2\right)} = 3.87$

$\Rightarrow \therefore n = 3$ (unpaired e^-)

$\therefore Cr^{+3} \Rightarrow x = 3$ $\therefore y = 4\left(Mn^{+4}\right)$

$\sqrt{n\left(n+2\right)} = 3.87$

$\Rightarrow \therefore n = 3$ (unpaired e^-)

$\therefore Mn^{+4}$

$\therefore x = 3 \quad y = 4$

$x - y = -1$

55. Rate of disappearance of 'A' $= -\frac{\Delta[A]}{\Delta t} = \frac{4 \times 10^{-2}}{40} = 10^{-3}$ mol L^{-1} s^{-1}

We know

$-\frac{1}{2}\frac{\Delta[A]}{\Delta t} = \frac{1}{2}\frac{\Delta[B]}{\Delta t} = \frac{1}{4}\frac{\Delta[C]}{\Delta t}$

$\therefore$ Rate of appearance of 'C'

$\Rightarrow \frac{\Delta[C]}{\Delta t} = -2\frac{\Delta[A]}{\Delta t}$

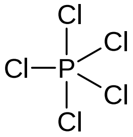
$= 2 \times 10^{-3}$ mol L^{-1} s^{-1}

56. Here $\Delta n = -ve$

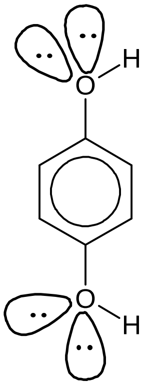
$\therefore$ By adding inert gas backward reaction favoured

$\Rightarrow$ By adding D(g) backward reaction takes place.

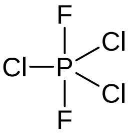
57.


Cl
Cl
Cl
P
Cl
Cl

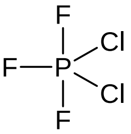
$\mu = 0$



$\mu \neq 0$



$\mu = 0$



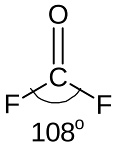
$\mu \neq 0$

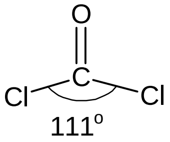
58. Mass of ${}_1^2H$ = Mass of ${}_1^1H$ + mass of neutron
= 1.0086 + 1.0078
= 2.0164 amu
Actual mass = 2.0064 amu
$\therefore$ mass defect = 2.0164 – 2.0064
= 0.01 amu.
$\therefore$ Bond Energy = 0.01 × 931.5 Mev
= 9.315 Mev.

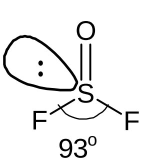
59.

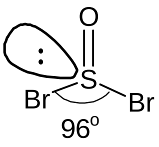
	Diamond	Graphite
Resistivity	10^{11}	1.375×10^{-5}
Standard molar entropy	2.377	5.740
Density	3.513	2.260

60.









Mathematics PART – III

SECTION – A

61. If $\lim\limits_{x\to a} f(x) = \ell$ and $\lim\limits_{x\to a} g(x) = m \Rightarrow \lim\limits_{x\to a} f(x)\cdot g(x) = \ell m$

62. Volume = $\pi\cdot 3^2\cdot 2\cdot 3 = 54\pi$

63. $(p \wedge q) \Leftrightarrow (r \wedge q)$ is equivalent to $[\sim(p \wedge q) \vee (r \wedge q)] \wedge [\sim(r \wedge q) \vee (p \wedge q)]$

64. $y = x \Rightarrow f(x + x^2) + 1 + 2x = f(x) + f(x^2) + 2x\, f(x)$
$y = -x \Rightarrow f(x + x^2) + 1 + 2x = f(x) + f(x^2) + 2x\, f(-x)$
$\Rightarrow f(x) = f(-x)$

65. $$\int \frac{x^{18} - 1\,dx}{x^7\left(x^{12} + 3 + 2x^{-6}\right)^{1/6}} = \frac{1}{12}\int \frac{12x^{11} - 12x^{-7}dx}{\left(x^{12} + 3 + 2x^{-6}\right)^{1/6}}$$
$$= \frac{1}{12}\frac{\left(x^{12} + 3 + 2x^{-6}\right)^{5/6}}{5/6} + c = \frac{\left(x^{18} + 3x^6 + 2\right)^{5/6}}{10x^5} + c$$
$\Rightarrow P(x) = x^{18} + 3x^6 + 2$

66. $$f'(x) = \lim_{h\to 0}\frac{f(x)e^h + f(h)e^x + 2xhe^xe^h - f(x)}{h}$$
$\Rightarrow f'(x) = f(x) + 2xe^x \Rightarrow f(x) = x^2e^x$

67. One of them has to be maxima and other minima

68. There are only 2 points where f(x) has local minima

69. Area = $\displaystyle\int_0^{x_1} \tan x - x^{1000}dx + \int_{x_1}^{x_2} x^{1000} - \tan x\,dx$

70. Circle is circumcircle of the triangle

71. $a_{n+1} = a_n + a_{n-1}$
$\Rightarrow \lim\limits_{n\to\infty}\dfrac{a_{n+1}}{a_n} = 1 + \lim\limits_{n\to\infty}\dfrac{a_{n-1}}{a_n}$
Let $\lim\limits_{n\to\infty}\dfrac{a_{n+1}}{a_n} = \ell$
$\Rightarrow \ell^2 - \ell - 1 = 0$
$\Rightarrow \ell = \dfrac{1 + \sqrt{5}}{2}$

72. $f^{-1}(x) = g(x) \Rightarrow h(x) = x$

73. $$3x^4\frac{\left(2xydx - x^2dy\right)}{y^2} = 2y^2\frac{(xdy + ydx)}{xy} \Rightarrow 3\left(\frac{x^2}{y}\right)^2 d\left(\frac{x^2}{y}\right) = 2\frac{d(xy)}{xy}$$

74. Apply chain rule

75. f(x) is constant function

76. cot $\alpha > 0$

77. $\frac{dy}{dx} = \pm 1 \Rightarrow y + x = 0,\ y - x = 0$

78. $\frac{d^2y}{dx^2} = 4$

79. Substitute x = r sec θ. y = r tan θ

$$\Rightarrow \frac{rdr}{r^2 \sec\theta d\theta} = \frac{1}{2}\cos(\sin\theta)\cos^2\theta$$

$$\Rightarrow \ell n|r| = \frac{1}{2}\sin(\sin\theta) + \frac{\ell n c}{2}$$

$$\Rightarrow \ell n\left|x^2 - y^2\right| = \sin\left(\frac{y}{x}\right) + \ell n c$$

80. $$\lim_{m\to\infty}\sum_{n=1}^{m}\left(\int_{\pi/6}^{\pi/2} f^n(x) + \int_{(3/\pi)^n}^{(2/\pi)^n}\left(f^{-1}(x)\right)^{1/n} dx\right)$$

$$= \lim_{m\to\infty}\sum_{n=1}^{m}\left(\frac{\pi}{2}\cdot\left(\frac{2}{\pi}\right)^n - \frac{\pi}{6}\left(\frac{3}{\pi}\right)^n\right) = \frac{\frac{\pi}{2}\cdot\frac{2}{\pi}}{1-\frac{2}{\pi}} - \frac{\frac{\pi}{6}\cdot\frac{3}{\pi}}{1-\frac{3}{\pi}} = \frac{\pi}{\pi-2} - \frac{\pi}{2\pi-6}$$

81. h(x) is a constant function and is always periodic

82. $$\lim_{x\to 0}\left(\frac{a\frac{\sin 2x}{2x} - x^x\cdot\frac{x}{2x}}{\frac{\ell n(1+2x)}{2x}}\right)^{\frac{2}{x+1}} = \frac{9}{4}$$

$$\left(\frac{a-\frac{1}{2}}{1}\right)^2 = \frac{9}{4} \Rightarrow a = 2$$

83. $$\int e^{x^2+x}\left(4x^3+4x^2+5x+1\right)dx = \int e^{x^2+x}\left(\left(2x+1\right)\left(2x^2+x\right)+4x+1\right)dx = e^{x^2+x}\left(2x^2+x\right)+c$$

84. For $\lim_{x\to\infty} f(x)$ to exist, $\lim_{x\to\infty} f'(x)$ must be 0

85. $$\lim_{x\to\infty}\frac{\sum_{r=1}^{2018}\left(1+\frac{r}{x}\right)^{2019}}{\prod_{r=1}^{2019}\left(1+\frac{r}{x}\right)} = 2018$$

86. $x = 2020\pi$, 2π are points of non-differentiability

87. $x = \frac{1}{e}$ is point of global minima

$\Rightarrow 1 > \frac{1}{b} > \frac{1}{e} \Rightarrow b = 2$

88. Let $I = \int_0^\infty \frac{\tan^{-1} x}{(x+1)^2} dx$

Let $x = \frac{1}{t} \Rightarrow I = \int_0^\infty \frac{\cot^{-1} t}{(t+1)^2} dt$

$\Rightarrow I = \frac{1}{2}\frac{\pi}{2}\int_0^\infty \frac{1}{(x+1)^2} dx = \frac{\pi}{4}$

89. If f(x) is differentiable, then $f'(x)$ should have a unique value at that point

90. If $n(P \cup M \cup C) = 100 \Rightarrow n(M' \cap C') \le 0 \Rightarrow n(M' \cap C') = 0$

FIITJEE

ALL INDIA TEST SERIES

PART TEST – II

JEE (Advanced)-2018-19

PAPER –1

TEST DATE: 18-11-2018

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

Section-A (01– 07, 19 – 25, 37 - 43) *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 mark*** *for wrong answer*
Partial Marks **+1** for each correct option provided no incorrect options is selected.

Section-A (08 – 13, 26 – 31, 44 - 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S).*
Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-C (14 – 18, 32 – 36, 50 - 54) *contains 15 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

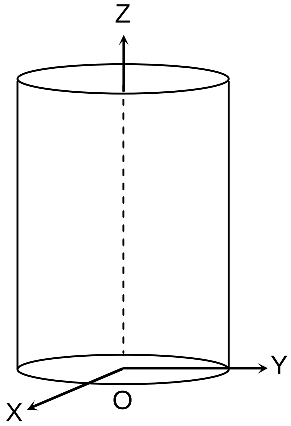
PART – I

SECTION – A
(More Than One Correct Type)

This section contains **7 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

1. The electric field in the space is given by $\vec{E} = E_0\left(x\hat{i} + y\hat{j} + z\hat{k}\right)$.

Consider a right circular cylindrical surface whose radius is 'a' and height 'h', as shown in the figure.
Now choose the correct option(s).



(A) The electric flux through lower circular base is zero.

(B) The electric flux through upper circular top is $\pi a^2 hE_0$

(C) The electric flux through lateral surface is $2\pi a^2 hE_0$

(D) The total electric flux through cylindrical surface is $4\pi a^2 hE_0$

Ans. **A, B, C**

Sol. Let, S_1, S_2 and S_3 be the surface areas of the lower circular base, upper circular top and lateral surface of the cylinder respectively.

$$\phi_1 = \int_{S_1}\vec{E}.d\vec{S} = 0 \qquad \ldots(1)$$

$$\phi_2 = \int_{S_2}\vec{E}.d\vec{S} = \pi a^2 hE_0 \qquad \ldots(2)$$

$$\phi_3 = \int_{S_3}\vec{E}.d\vec{S} = E_0\int_{S_3}\vec{r}.d\vec{S} \qquad \ldots(3)$$

$$\vec{r}.d\vec{S} = \left(x\hat{i} + y\hat{j} + z\hat{k}\right).\left(\frac{x\hat{i} + y\hat{j}}{a}\right)dS = \frac{x^2 + y^2}{a}dS$$

Putting this value in equation (3), we have

$$\phi_3 = aE_0\int_{S_3} dS = aE_0 \times 2\pi ah = 2\pi a^2 hE_0$$

$$\phi = \text{Total flux} = \phi_1 + \phi_2 + \phi_3 = 3\pi a^2 hE_0$$

Second Method

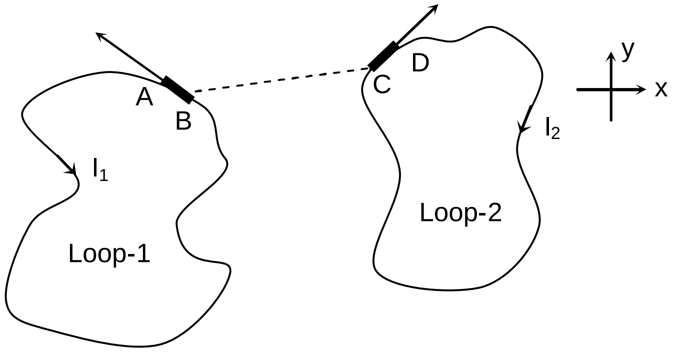
$$\nabla \cdot \vec{E} = \frac{\rho}{\varepsilon_0} \Rightarrow 3E_0 = \frac{\rho}{\varepsilon_0} \Rightarrow \rho = 3\varepsilon_0 E_0$$

$Q_{en} =$ Total charge enclosed within the cylinder $= \pi a^2 h\rho$

$= 3\pi a^2 h\varepsilon_0 E_0$

Total flux = $\frac{Q_{en}}{\varepsilon_0} = 3\pi a^2 h E_0$

2. Consider two current carrying loops in x-y plane, carrying current I_1 and I_2 respectively as shown in the figure.



Now consider two arbitrary elementary current elements AB & CD of lengths $d\ell_1$ and $d\ell_2$ on the loop-1 and loop-2 respectively. Let $d\vec{F}_{12}$ be the force which the current carrying element $I_2\, d\vec{\ell}_2$ exerts on the current carrying element $I_1 d\vec{\ell}_1$ & $\vec{F}_{12}$ represent the net force on 1st loop by the 2nd loop, developed due to interaction between current carrying loops. Similarly $d\vec{F}_{21}$ be the force which the current carrying element $I_1\, d\vec{\ell}_1$ exerts on the current carrying element $I_2 d\vec{\ell}_2$ & $\vec{F}_{21}$ represent the net force on 2nd loop by the 1st loop, developed due to interaction between current carrying loops. Choose the correct option(s)

(A) $d\vec{F}_{12} + d\vec{F}_{21} = \vec{0}$

(B) $d\vec{F}_{12} + d\vec{F}_{21} \neq \vec{0}$

(C) $\vec{F}_{12} + \vec{F}_{21} = \vec{0}$

(D) $\vec{F}_{12} + \vec{F}_{21} \neq \vec{0}$

Ans. **B, C**

Sol. $d\vec{B}_{12} =$ Magnetic field at any point on the elementary element AB due to current carrying element $I_2 d\vec{\ell}_2$.

$$d\vec{B}_{12} = \frac{\mu_0}{4\pi}\left(\frac{I_2 d\vec{\ell} \times \vec{r}_{12}}{r_{12}^3}\right)$$

$$d\vec{F}_{12} = I_1 d\vec{\ell}_1 \times d\vec{B}_{12} = \left(\frac{\mu_0}{4\pi}\right)\frac{I_1 d\vec{\ell}_1 \times \left(I_2 d\vec{\ell}_2 \times \vec{r}_{12}\right)}{r_{12}^3}$$

The force $d\vec{F}_{12}$ will be in the plane of loop and perpendicular to the current carrying element $I_1 d\vec{\ell}_i$ (say along $\hat{p}_{12}$).

Similarly $d\vec{F}_{21} = \frac{\mu_0}{4\pi}\frac{I_2 d\vec{\ell}_2 \times \left(I_1 d\vec{\ell}_1 \times \vec{r}_{21}\right)}{r_{21}^3}$ [Say along $\hat{p}_{21}$]

$\therefore$ $\hat{p}_{12}$ is not parallel to $\hat{p}_{21}$, in general

So, $d\vec{F}_{12} + d\vec{F}_{21} \neq \vec{0}$

But $\vec{F}_{12} = \frac{\mu_0 I_1 I_2}{4\pi}\int_{L_1}\int_{L_2}\frac{d\vec{\ell}_1 \times \left(d\vec{\ell}_2 \times \vec{r}_{12}\right)}{r_{12}^3}$

$\vec{F}_{21} = \frac{\mu_0 I_1 I_2}{4\pi}\int_{L_2}\int_{L1}\frac{d\vec{\ell}_2 \times \left(d\vec{\ell}_1 \times \vec{r}_{21}\right)}{r_{21}^3}$.

Hence, $\vec{F}_{12} + \vec{F}_{21} = \vec{0}$

3. Consider an isolated sphere of radius 'b', made of a material with permittivity ε_0 and electrical conductivity γ, whose volume charge density varies with time t and is given as

$$\rho = \begin{cases} \rho_0 e^{-t/\tau} & \text{if} \quad 0 \le r < a \\ 0 & \text{if} \quad a < r < \infty \end{cases}$$

Where $\tau = \frac{\varepsilon_0}{\gamma}$ and 0 < a < b. The spherical layer between radii 'a' and 'b' is neutral. Then choose the correct option(s).

(A) The surface charge density at outer surface of sphere is $\frac{a^3\rho_0}{8b^2}$ at $t = \tau\ell n2$.

(B) The total current in the region 0 < r < a increases with the radius.

(C) The electric field in the region b < r < ∞ is independent of time.

(D) The total current in the region a < r < b is independent of radius.

Ans. **B, C, D**

Sol.
$$Q(t) = \begin{cases} \frac{4\pi}{3}a^3\rho_0 e^{-t/\tau} = Q_0 e^{-t/\tau} & \text{if} \quad 0 \le r < a \\ 0 & \text{if} \quad a < r < b \end{cases}$$

Here $Q_0 = \frac{4\pi}{3}a^3\rho_0$

According Gauss' Law, we can write

$$E = \begin{cases} \frac{Q_0 r\, e^{-t/\tau}}{4\pi\varepsilon_0 a^3} & \text{if} \quad 0 \le r < a \\ \frac{Q_0\, e^{-t/\tau}}{4\pi\varepsilon_0 r^2} & \text{if} \quad a < r < b \\ \frac{Q_0}{4\pi\varepsilon_0 r^2} & \text{if} \quad b < r < \infty \end{cases}$$

Using conservation of charge we can write surface charge density at the outer surface of sphere as,

$$\sigma = \frac{Q_0 - Q(t)}{4\pi b^2} = \frac{Q_0}{4\pi b^2}\left(1 - e^{-t/\tau}\right)$$

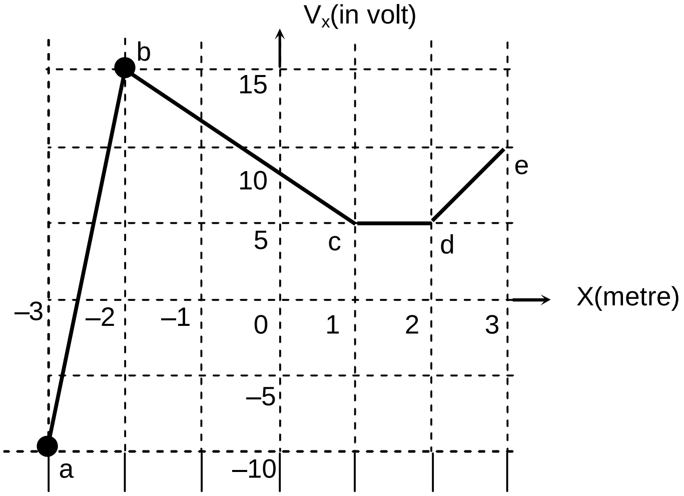
If $t = \tau\ell n2 \Rightarrow 1 - e^{-\ell n2} = \frac{1}{2}$, So, $\sigma = \frac{4}{3}\pi a^3\rho_0 \times \frac{1}{4\pi b^2} \times \frac{1}{2} = \frac{a^3\rho_0}{6b^2}$

J = current density = γE

I = current = $J\pi r^2$

Hence in the region $0 \le r < a$, the volume is source of conduction current while the region a < r < b has no source of conduction current.

4. The variation of potential along x-axis is shown in the figure. The potential does not vary along the y-axis or z-axis. Ignore the behaviour at the end points of interval. Now choose the correct option(s) for given interval –3m < x < 3m.



(A) The greatest absolute value of E_x is 25 V/m.

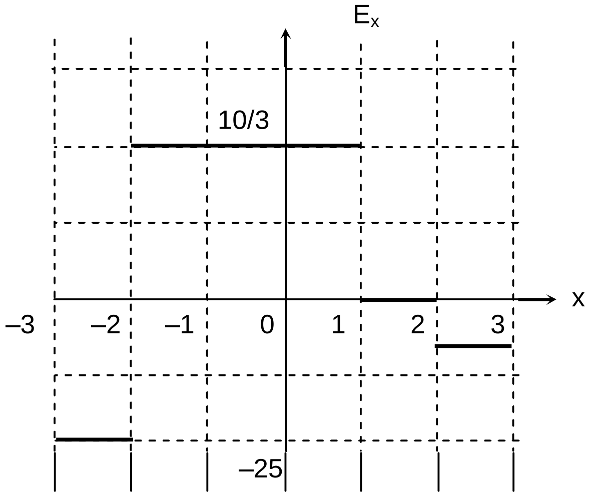
(B) An electron is released at point (– 1m, 0), it will move along positive x-axis.

(C) A proton is released at point (1.5 m, 0), it will move along positive x-axis.

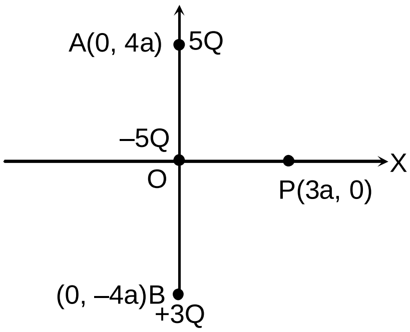
(D) An electron is released at point (– 2.5 m, 0), it will move along positive x-axis.

Ans. **A, D**

Sol.



5. Three point charges are kept at points A(0, 4a), O(0, 0) and B(0, –4a) as shown in the figure.



(A) Work was done on the external agent who assembled these charges in moving them from infinity to the point.

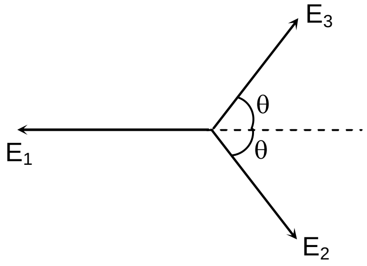
(B) The electric field at point P is $\vec{E}_p = E_X\hat{i} + E_y\hat{j}$, then E_x is negative and E_y is positive.

(C) The electric field at point P is $\vec{E}_p = E_x\hat{i} + E_y\hat{j}$, then both E_x and E_y are negative.

(D) A positive charge $\frac{975Q}{8}$ has to be put at point P to make the potential energy of system of all four point charges to be zero.

Ans. **A, C**

Sol. Potential energy of the system is negative so option A is correct



$$\theta = 53°,\ E_1 = \frac{5KQ}{9},\ E_2 = \frac{KQ}{5},\ E_3 = \frac{3KQ}{25}$$

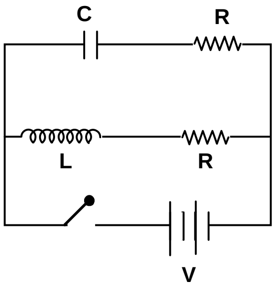
$$E_x = -\frac{5KQ}{9} + \frac{KQ}{5} \times \frac{3}{5} + \frac{3KQ}{25} \times \frac{3}{5} = \frac{-5KQ}{9} + \frac{24KQ}{125} < 0$$

$$E_y = \frac{-K\theta}{5} \times \frac{4}{5} + \frac{3K\theta}{25} \times \frac{4}{5} = \frac{-8K\theta}{125} < 0$$

$$\frac{-25Q^2}{4} + \frac{15Q^2}{8} + \frac{5xQ}{5} + \frac{-5Qx}{3} + \frac{-15Q^2}{4} + \frac{3Qx}{5} = 0$$

$$\frac{-65Q^2}{8} = \frac{8Qx}{5} - \frac{5Qx}{3} = 0 \Rightarrow \frac{(24-25)x}{15} = \frac{65Q}{8} \Rightarrow x = \frac{-65 \times 15Q}{8}$$

6. In the circuit shown in figure, the switch S is closed at the moment t = 0. At the moment t = RCℓn2, the currents through both resistors are found to be ‘I’. Then choose the correct option(s)



(A) $I = \frac{V}{R}$

(B) $I = \frac{V}{2R}$

(C) $R = \sqrt{\frac{L}{2C}}$

(D) $R = \sqrt{\frac{L}{C}}$

Ans. **B, D**

Sol. $I_1 = \frac{V}{R}\left(1 - e^{-\frac{Rt}{L}}\right)$, and $I_2 = \frac{V}{R}e^{-\frac{t}{RC}}$

According to question at t = RCℓn2, we have

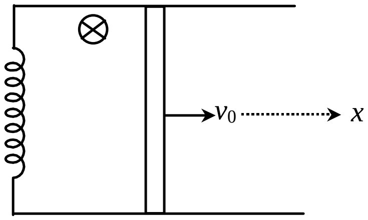
$I_1 = I_2 \Rightarrow \frac{V}{R}\left(1 - e^{-\frac{Rt}{L}}\right) = \frac{V}{R}e^{-\frac{t}{RC}} \Rightarrow 1 - e^{-\frac{Rt}{L}} = e^{-\frac{t}{RC}}$ …………..(1)

Given t = RCℓn2$\Rightarrow e^{-\frac{t}{RC}} = e^{-\ell n2} = \frac{1}{2}$, Putting this value in equation (1), we have

$\Rightarrow R = \sqrt{\frac{L}{C}}$

$1 - e^{-\frac{Rt}{L}} = \frac{1}{2} \Rightarrow e^{-\frac{Rt}{L}} = \frac{1}{2} \Rightarrow \frac{Rt}{L} = \ell n2 \Rightarrow \frac{R}{L} \times RC\ell n2 = \ell n2$

7. A loop is formed by two fixed parallel conductors connected by a solenoid with inductance L = 2H and a conducting rod of mass m = 8 kg which can freely slide without friction, over the conductors. The conductors are located in a horizontal plane and in a uniform vertical magnetic field B = π Tesla directed into the plane of the paper. The distance between the conductors is ℓ = 2 m. At the moment t = 0, the rod is imparted an initial velocity v_0 = 2 m/s directed to the right. The resistance of loop is negligible. Choose the correct option(s)



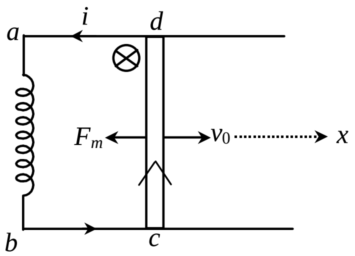
(A) The rod will perform periodic motion, but not SHM

(B) The rod will perform SHM

(C) The time period of oscillation of rod is 4 s

(D) The amplitude of oscillation of rod is $\frac{4}{\pi}$ metre.

Ans. **B, C, D**



Sol. Suppose that at any instant of time, velocity of the rod is *v* towards right.

The current in the circuit is *i*. In the figure,

$$V_a - V_b = V_d - V_c$$

i.e. $L\,di = Bl\,dx$

Integrating, we get $Li = Blx$

Magnetic force on the rod at this instant is

$$F_m = i\ell B = \frac{B^2\ell^2}{L}x \qquad \ldots \text{(i)}$$

Since, this force is in opposite direction of $\vec{v}$, so from Newton's second law we can write,

$$m\left(\frac{d^2x}{dt^2}\right) = -\frac{B^2l^2}{L}x$$

Comparing this with equation of SHM, i.e.

$$\frac{d^2x}{dt^2} + \omega^2 x = 0 \Rightarrow x = A\sin\omega t \Rightarrow v = A\omega\cos\omega t \ \ldots \text{(ii)}$$

We have, $\omega = \dfrac{Bl}{\sqrt{mL}}$

So $T = \dfrac{2\pi}{\omega} = 2\pi\dfrac{\sqrt{mL}}{Bl} = 2\pi\dfrac{\sqrt{8\times 2}}{\pi\times 2} = 4\text{ s}$

At t = 0, $v = v_0 \Rightarrow v_0 = A\omega \Rightarrow A = \dfrac{v_0}{\omega} = \dfrac{4}{\pi}\text{m}$

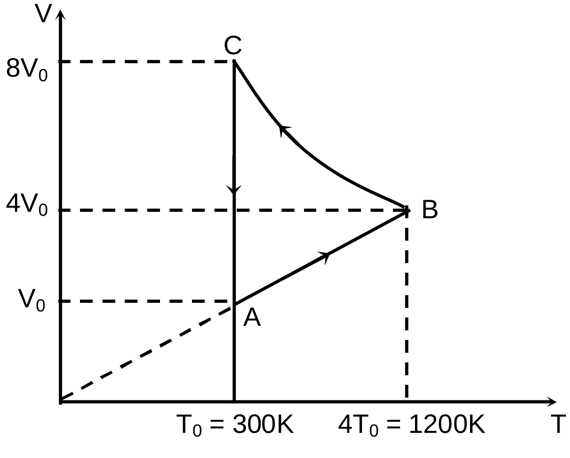
(Matching Type)
(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

Two moles of an ideal mono-atomic gas is taken through a cyclic process ABCA as shown in the V-T diagram. In the process BC, TV^2 = constant. Answer the questions by referring to the data in the table.

(Take $\ell n(2) = 0.7$)



Column –1 shows the processes. Column –2 shows the work done in that process and Column –3 shows the energy supplied in that process.

Column – 1		**Column – 2**		**Column – 3**	
(I)	$A \rightarrow B$	(i)	1800 R	(P)	–1800 R
(II)	$B \rightarrow C$	(ii)	–1260 R	(Q)	– 3060 R
(III)	$C \rightarrow A$	(iii)	900 R	(R)	4500 R
(IV)	$B \rightarrow C \rightarrow A \rightarrow B$	(iv)	1440 R	(S)	1440 R

8. Pick a combination in which work done is maximum

(A) (I) (i) (R)

(B) (II) (i) (P)

(C) (III) (iv) (S)

(D) (III) (ii) (R)

Ans. **A**

9. Pick a combination in which thermal energy supplied is maximum

(A) (II) (iii) (P)

(B) (IV) (iii) (S)

(C) (I) (i) (R)

(D) (I) (ii) (Q)

Ans. **C**

10. Pick a correct combination

(A) (I) (ii) (P)

(B) (I) (ii) (Q)

(C) (IV) (iv) (S)

(D) (II) (i) (Q)

Ans. **C**

Sol.8-10. The equation of the process BC is

$TV^2 = \text{constant}$

$PV^3 = \text{constant}$

Molar heat capacity of the gas in the process BC is

$$\therefore \quad C = C_V + \frac{R}{1-x}$$

$$= \frac{3R}{2} - \frac{R}{2} = R$$

The work done by the gas during the process BC is

$$\therefore \quad \Delta W_{BC} = \frac{nR\Delta T}{1-x} = \frac{2R(-900)}{1-3} = 900R$$

$$\Delta Q_{AB} = nCp\Delta T = 2 \times \frac{5R}{2}(1200 - 300) = 4500R$$

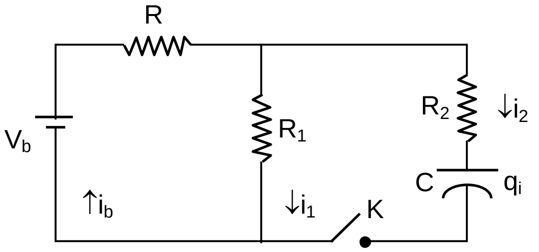
$$\Delta Q_{BC} = nC\Delta T = 2 \times R(300 - 1200) = -1800R$$

$$\Delta Q_{CA} = \Delta W_{CA} = nRT_0 \ln\left(\frac{V_0}{8V_0}\right) = 2R300(-3\ell n2) = -1800R \times 0.7 = -1260R$$

$$\therefore \quad \Delta W_{cycle} = \Delta Q_{cycle} = \Delta Q_{AB} + \Delta Q_{BC} + \Delta Q_{CA} = 4500R - 1800R - 1260R = 1440\,R$$

$$\therefore \quad \text{Efficiency, } \eta = \frac{\Delta W_{cycle}}{\Delta Q_{supplied}} \times 100 = \frac{1440R}{4500R} \times 100 = 32\%$$

Answer 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.



q_i is the initial charge on the capacitor. The key K is closed at t = 0

Column – 1 Battery		**Column – 2 Resistance**		**Column – 3 Capacitance & Initial charge**	
(I)	V_b = 0 V	(i)	$R_1 = R_2 = 5\ \Omega$ $R = 10\ \Omega$	(P)	C = 5 μF $q_i = 0$
(II)	V_b = 30 V	(ii)	$R_1 = 5\ \Omega$ $R_2 = 10\ \Omega$ $R = 10\ \Omega$	(Q)	C = 20 μF $q_i = 0$
(III)	V_b = –30 V	(iii)	$R_1 = 10\ \Omega$ $R_2 = 5\ \Omega$ $R = 10\ \Omega$	(R)	C = 5 μF q_i = 100 μC
(IV)	V_b = 60 V	(iv)	$R_1 = R_2 = R = 10\ \Omega$	(S)	C = 20 μF q_i = 100 μC

11. In which of the following cases, will the current i_1 = 5/3 A, initially?

(A) (I) (i) (P)

(B) (II) (iv) (R)

(C) (II) (iv) (P)

(D) (I) (iii) (Q)

Ans. **B**

12. In which of the following cases will the net charge flowing through the capacitor be equal to 300 μC?

(A) (II) (i) (S)

(B) (I) (ii) (R)

(C) (IV) (i) (S)

(D) (III) (iii) (P)

Ans. **C**

13. In which case will the current through R decay exponentially to zero with a time constant of 0.2 ms?

(A) (IV) (ii) (Q)

(B) (I) (iii) (S)

(C) (II) (i) (R)

(D) (I) (iii) (Q)

Ans. **B**

Sol.11-13. $V_b - i_b R - i_1 R_1 = 0$

$-i_2 R_2 - q / C + i_1 R_1 = 0$

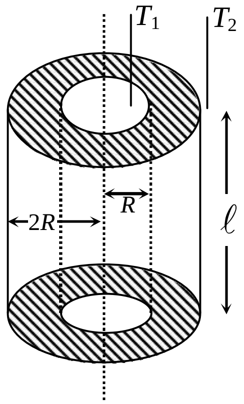
With $i_2 = \frac{dq}{dt}$

Substituting the given values, we get the result.

SECTION – C
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

14. Inner surface of a cylindrical shell of length ℓ and of material of thermal conductivity k is kept at constant temperature T_1 and outer surface of the cylinder is kept at constant temperature T_2 such that $(T_1 > T_2)$ as shown in figure. Heat flows from inner surface to outer surface radially outward. Inner and outer radii of the shell are R and 2R respectively. Due to lack of space this cylinder has to be replaced by a smaller cylinder of length $\frac{\ell}{2}$, inner and outer radii $\frac{R}{4}$ and R respectively and thermal conductivity of material nk. If rate of radial outward heat flow remains same for same temperatures of inner and outer surface i.e. T_1 and T_2, then find the value of n.

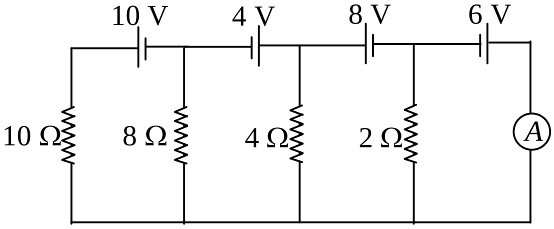


Ans. 4

Sol. Since rate of heat flow remains same in both the cases, so

$$\int_{R}^{2R}\frac{dx}{k2\pi x\ell}=\int_{\frac{R}{4}}^{R}\frac{dx}{nk(2\pi x)\frac{\ell}{2}} \Rightarrow nk=4k \Rightarrow n=4$$

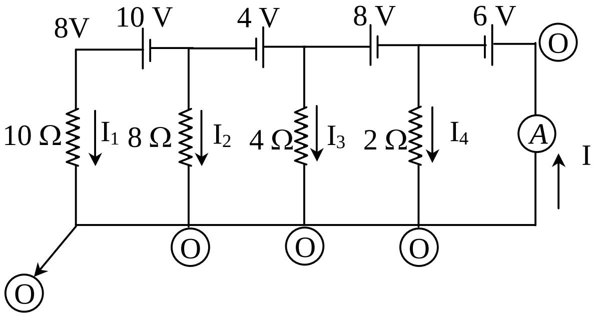
15. If the reading of the ideal ammeter connected in the given circuit is $n\left(\frac{13}{20}\right)$ ampere, find the value of n. Assume that the cells have negligible internal resistance.



Ans. 3

Sol. $I = I_1 + I_2 + I_3 + I_4 = \frac{8}{10}-\frac{2}{8}+\frac{2}{4}-\frac{6}{2}$

$$\frac{32-10+20-120}{40}=\frac{-78}{40} \text{ Amp}$$



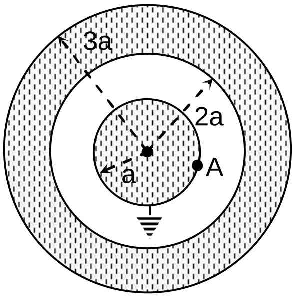
16. To disperse all the mass of the Earth to infinity against its own gravitational field would require 2.4×10^{32}J of energy. Mass of the earth is 6×10^{24} kg and radius of earth is 6400 km. Since earth is mostly iron, therefore, its specific heat capacity is about 500J kg^{-1} K^{-1}. Assuming that the earth was formed by very cold objects falling from a great distance away, if its maximum possible temperature soon after its formation is $\eta \times 10^4$ K. Find the value of η

Ans. 8

Sol. $2.4\times10^{32} = 6\times10^{24}\times500\times T$

$$\Rightarrow T=\frac{.4\times10^{8}}{500}=\frac{4\times10^{5}}{5}=8\times10^{4}\text{K}$$

17. A conducting sphere of radius a is in side a hollow conducting sphere of radii 2a and 3a as shown in the figure. The inner sphere is earthed. The capacitance of system of sphere and hollow sphere is $5\pi k\varepsilon_0 a$. Find the value of k.

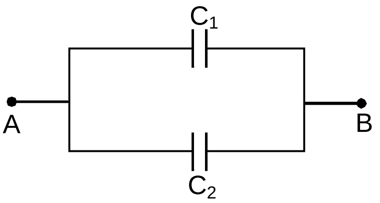


Ans. 4

Sol. $C_1 = 12\pi\varepsilon_0 a$

$$C_2 = \frac{4\pi\varepsilon_0\left(b\times a\right)}{b-a} = 8\pi\varepsilon_0 a$$

$C_{eq} = C_1 + C_2 = 20\pi\varepsilon_0 a$



18. A current I = 20 ampere flows through a wire shaped in the form of an infinite parabola of latus rectum 4a (a = 1 mm). If the magnetic field at the focus of the parabola is $\eta\pi\times 10^{-\beta}$ tesla, where η and β are the positive integer, less than 9. Find the value of $\eta\times\beta$.

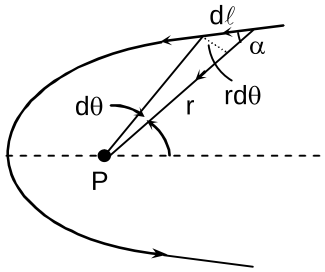
Ans. 6

Sol. The magnetic field at the focus P of the parabola is given by the Biot-Savart law:

$$\vec{B} = \frac{\mu_0}{4\pi}\int\frac{Id\vec{\ell}\times\vec{r}}{r^3},$$

Where $\vec{r}$ and $d\vec{l}_0$ are as shown in figure. The direction of $\vec{B}$ is perpendicular to the plane of the parabola and out of it. We note that

$$\frac{\left|d\vec{\ell}\times\vec{r}\right|}{r^3} = \frac{r\,d\ell\sin\alpha}{r^3} = \frac{r\,d\theta}{r^2} = \frac{d\theta}{r}.$$



Therefore, $B = \left(\mu_0 I/4\pi\right)\int_0^{2\pi}\left(d\theta/r\right)$. The equation of the parabola is $r\left(1-\cos\theta\right) = 2a$, so that

$$B = \frac{\mu_0 I}{4\pi}\int_0^{2\pi}\frac{\left(1-\cos\theta\right)}{2a}d\theta = \frac{\mu_0 I}{4a} = \frac{4\times\pi\times 10^{-7}\times 20}{4\times 10^{-3}} = 2\pi\times 10^{-3}\text{ tesla}$$

Chemistry PART – II

SECTION – A
(More Than One Correct Type)

This section contains **7 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

19. Which of the following statement(s) is/are incorrect?

(A) Major part of energy needed for the heterolysis of C – X bond in S_N1 reaction mechanism is obtained by the solvation of X^- by polar protic solvent.

(B) Greater solvation of attacking nucleophile and poor solvation of transition state promotes the reaction by S_N2 mechanism.

(C) Increase in the number of phenyl ring at C of C – X causes a shift in mechanism from S_N1 to S_N2.

(D) Allyl and benzyl halides shows both S_N1 and S_N2 reaction.

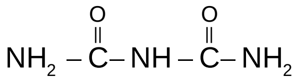
Ans. **B, C**

20. Select the correct statements:

(A) $NH_2 – NH_2$ does not give Lassaigne's test for detection of nitrogen.

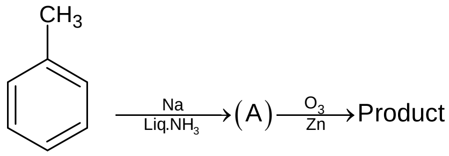
(B) HCOOH gives (+ve) $HgCl_2$ test.

(C) α-D-glucopyranosyl-β-D-fructofuranose shows muta rotation.

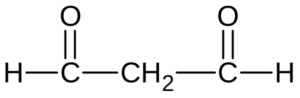
(D) 
$NH_2-\overset{\overset{O}{||}}{C}-NH-\overset{\overset{O}{||}}{C}-NH_2$ gives Biuret test.

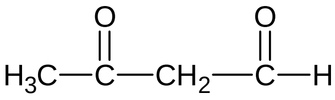
Ans. **A, B, D**

Sol. $HgCl_2 + HCOOH \xrightarrow{\Delta} \underset{\text{(Grey deposit)}}{Hg} + CO_2 + 2HCl$

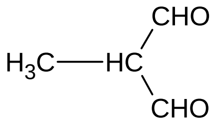
21. 

Which of the following product can be obtained as major product(s) in above reaction?

(A) 
$H-\overset{\overset{O}{||}}{C}-CH_2-\overset{\overset{O}{||}}{C}-H$

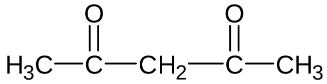
(B) 
$H_3C-\overset{\overset{O}{||}}{C}-CH_2-\overset{\overset{O}{||}}{C}-H$

(C)



$H_3C-\underset{CHO}{\overset{CHO}{HC}}$

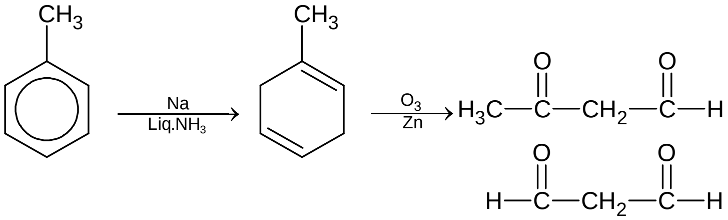
(D)



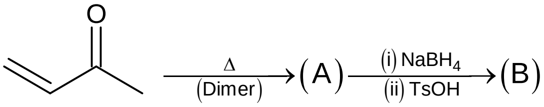
$H_3C-\overset{O}{\overset{\|}{C}}-CH_2-\overset{O}{\overset{\|}{C}}-CH_3$

Ans. **A, B**

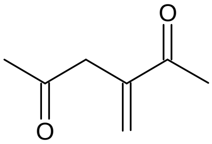
Sol.


CH3
Na
Liq.NH3
CH3
O3
Zn
H3C—C(=O)—CH2—C(=O)—H
H—C(=O)—CH2—C(=O)—H

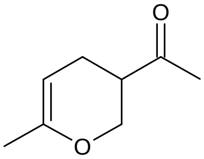
22. The major product A and B in the following reaction sequence are:


O
Δ
(Dimer)
(A)
(i) NaBH4
(ii) TsOH
(B)

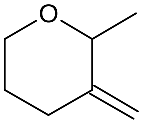
(A)



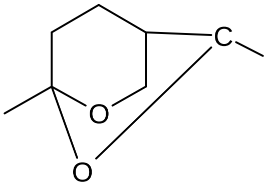
(B)



(C)

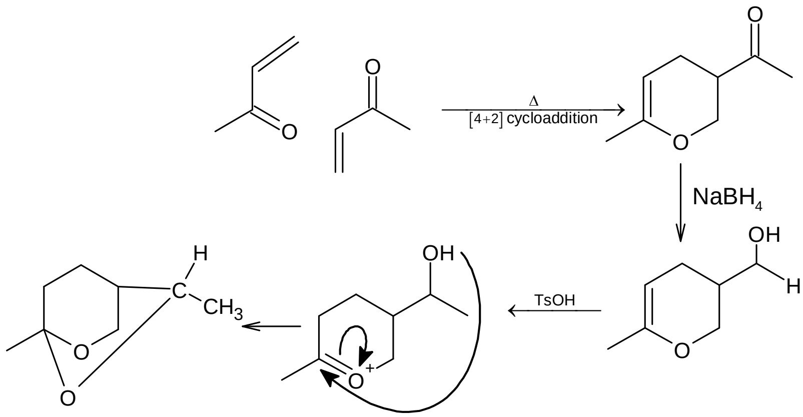


(D)



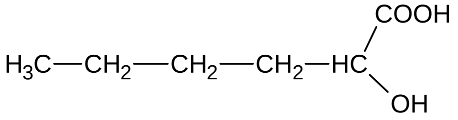
Ans. **B, D**

Sol.



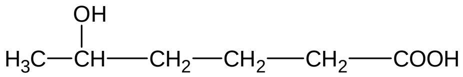
23. Which of the followings will give cyclic product upon heating?

(A)



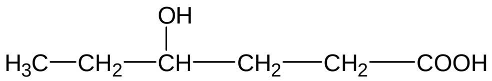
$H_3C-CH_2-CH_2-CH_2-HC\begin{matrix}COOH\\OH\end{matrix}$

(B)



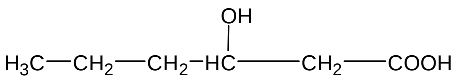
$H_3C-\overset{OH}{\overset{|}{CH}}-CH_2-CH_2-CH_2-COOH$

(C)



$H_3C-CH_2-\overset{OH}{\overset{|}{CH}}-CH_2-CH_2-COOH$

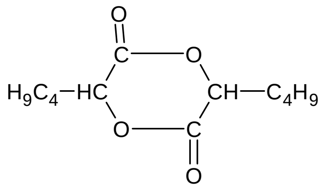
(D)



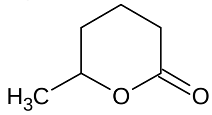
$H_3C-CH_2-CH_2-\overset{OH}{\overset{|}{HC}}-CH_2-COOH$

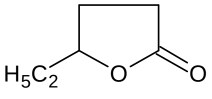
Ans. **A, B, C**

Sol. A will form lactide



B, C form lactone





24. Which of the following are correct statements?

(A) In carboxylate, nucleophile prefer to attack on acyl carbon while in sulfonates nucleophile prefer to attack on alkyl carbon.

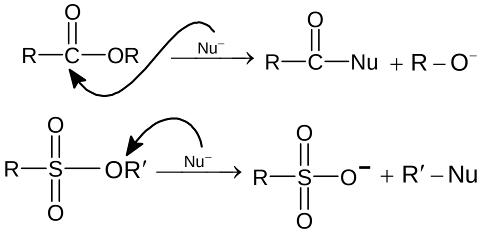
(B) Carboxylate anion is stronger base than sulfonate anion.

(C) Sulfonate anion is a better leaving group than carboxylate anion.

(D) Carboxylate anion is a better leaving group than sulfonate anion.

Ans. **A, B, C**

Sol.



Sulfonoic acid is stronger acid than carboxylic acid.

25. Which of the following statement(s) is/are correct?

(A) Sucrose has a pyranose and a furanose ring hold together by glycosidic linkage.

(B) Maltose has one glycosidic linkage and free hemiaccetal form

(C) Glucose, fructose and galactose forms same osazone

(D) ΔG^o for reaction, $\alpha - \text{D} - \text{Glucose} \rightleftharpoons \beta - \text{D} - \text{Glucose}$, is positive.

Ans. **A, B**

Sol.

$\alpha - \text{D} - \text{Glucose} \rightleftharpoons \beta - \text{D} - \text{Glucose}$

36% 64%

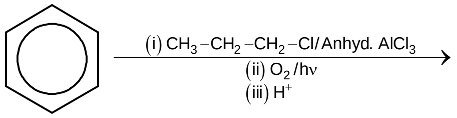
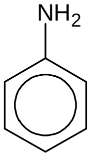
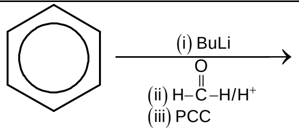
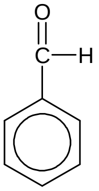
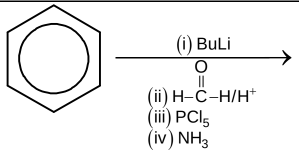
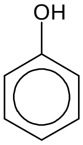
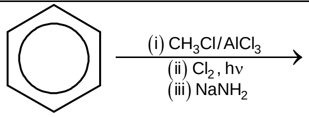
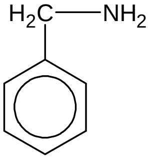
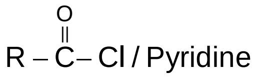
$$K_{eq} = \frac{64\%}{36\%} = \frac{16}{9} = 1.77$$

$$\Delta G^o = -2.303RT \log k_{eq} = -ve$$

(Matching Type)
(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer Q. 26, Q. 27 and Q. 28 by appropriately matching the information given in the three columns of the following table.

Column 1		Column 2		Column 3	
(I)	 (i) CH3–CH2–CH2–Cl/Anhyd. AlCl3 (ii) O2/hν (iii) H+	(i)		(P)	Give ppt. when treated with Br_2/H_2O
(II)	 (i) BuLi (ii) H–C(=O)–H/H+ (iii) PCC	(ii)		(Q)	In presence of strong base self disproportionation reaction takes place
(III)	 (i) BuLi (ii) H–C(=O)–H/H+ (iii) PCl5 (iv) NH3	(iii)		(R)	Form foul smelling compound with $CHCl_3/NaOH$
(IV)	 (i) CH3Cl/AlCl3 (ii) Cl2, hν (iii) NaNH2	(iv)		(S)	Form acetyl derivative with $R-\overset{O}{\overset{\|}{C}}-Cl$ / Pyridine

26. Which of the following combination is CORRECT for **I** ?

(A) (I) (ii) (R)

(B) (I) (iii) (P)

(C) (I) (ii) (P)

(D) (I) (iii) (Q)

Ans. **B**

27. Which of the following combination is CORRECT?

(A) (II) (ii) (Q)

(B) (II) (ii) (R)

(C) (III) (ii) (R)

(D) (IV) (i) (Q)

Ans. **A**

28. Which of the following combination is CORRECT for **IV** ?

(A) (IV) (i) (P)

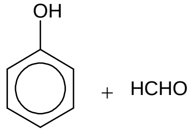
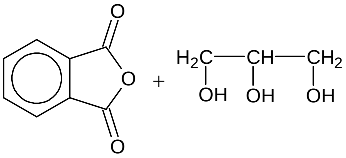
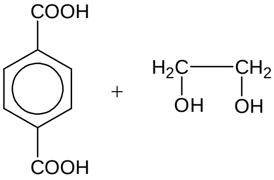
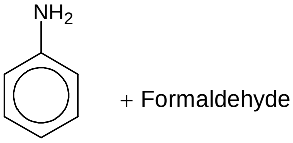
(B) (IV) (iv) (R)

(C) (IV) (i) (R)

(D) (IV) (i) (Q)

Ans. **B**

Answer Q. 29, Q. 30 and Q. 31 by appropriately matching the information given in the three columns of the following table.

Column 1		**Column 2**		**Column 3**	
(I)	Novolac	(i)		(P)	Cross linked
(II)	Bakelite	(ii)		(Q)	Linear chain
(III)	Dacron	(iii)		(R)	Branched chain
(IV)	Glyptal	(iv)		(S)	Fibre

29. Which of the following combination is CORRECT for Glyptal?

(A) (IV) (ii) (P)

(B) (IV) (ii) (Q)

(C) (IV) (iv) (P)

(D) (IV) (i) (P)

Ans. **A**

30. Which of the following combination is CORRECT for Bakelite?

(A) (II) (i) (Q)

(B) (II) (i) (P)

(C) (II) (iv) (R)

(D) (II) (iv) (P)

Ans. **B**

31. Which of the following combination is CORRECT?

(A) (IV) (iii) (P)

(B) (I) (iv) (P)

(C) (III) (iii) (S)

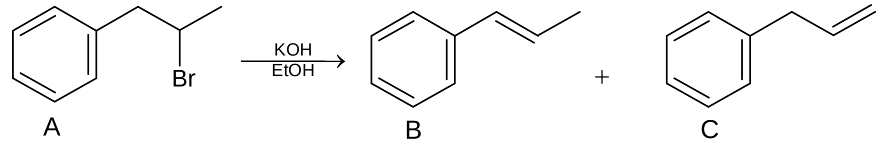
(D) (II) (iii) (S)

Ans. **C**

SECTION – C
Single Integer Answer Type

This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

32.



1.99 gram of A on above reaction produces 1.062 gram mixture of B and C ratio of 2 : 1. if percentage of B formed will be x % then find the value of x/10.

Ans. **6**

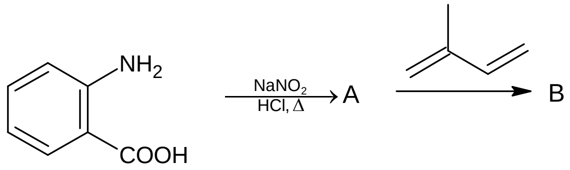
Sol. The theoretical yield will be $= \dfrac{118 \times 1.99}{199} = 1.18$ gram

Hence percentage yield will be $= \dfrac{1.062}{1.18} \times 100\% = 90\%$

Hence, B formed will be $= 90\% \times \dfrac{2}{3} = 60\%$

x = 6.

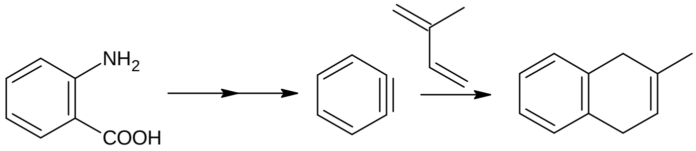
33.



What is the double bond equivalent of B.

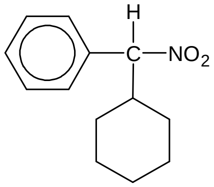
Ans. **6**

Sol.



34. How many of given below compounds will form red colour with HNO_2 and followed by addition of NaOH?

$(CH_3)_2CHNO_2$, $CH_3CH_2\text{-}NO_2$, $(CH_3)_3NO_2$,



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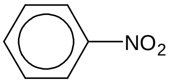

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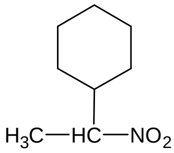
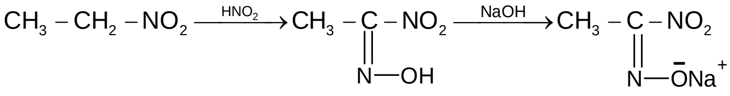


Ans. 1

Sol.



$$CH_3-CH_2-NO_2\xrightarrow{HNO_2}CH_3-\underset{\underset{N-OH}{||}}{C}-NO_2\xrightarrow{NaOH}CH_3-\underset{\underset{N-\bar{O}Na^+}{||}}{C}-NO_2$$

Nitrolic acid Red colour

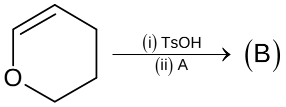
35. Find the number of nucleophile whose nucleophilicity is greater than pyridine in S_N2 reaction

$RS^-, ArS^-, I^-, CN^-, OH^-, F^-, NO_3^-$

Ans. 5

Sol. $RS^-, ArS^-, I^-, CN^-, OH^-$

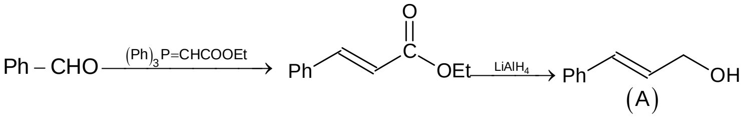
36. $$Ph-CHO\xrightarrow[(ii)\,LiAlH_4,Et_2O-78^oC]{(i)\,(Ph)_3P=CHCOOEt}(A)$$

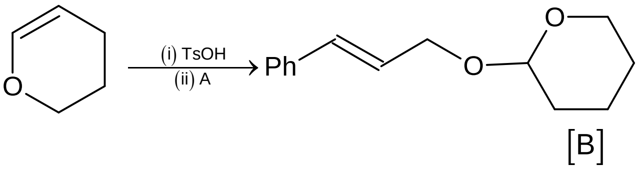

O
(i) TsOH
(ii) A
(B)

How many oxygen atoms are there in B.

Ans. 2

Sol.


Ph – CHO
(Ph)3P=CHCOOEt
Ph
O
C
OEt
LiAlH4
Ph
OH
(A)


O
(i) TsOH
(ii) A
Ph
O
O

[B]

Mathematics PART – III

SECTION – A

(More Than One Correct Type)

This section contains **7 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

37. If obtuse angle bisectors of the lines $\tan^2 bx + 4y + 7 = 0$ and $x + \frac{\tan b}{4} y + 2 = 0$; $\left(b \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)\right)$ is

$$\frac{\tan^2 bx + 4y + 7}{\sqrt{\tan^4 b + 16}} = \frac{-\left(x + \frac{\tan b}{4} y + 2\right)}{\sqrt{1 + \frac{\tan^2 b}{16}}}$$, then b can lie in the interval

(A) $\left(-\frac{\pi}{4}, -\frac{\pi}{12}\right)$

(B) $\left(-\frac{\pi}{4}, 0\right)$

(C) $\left(-\frac{\pi}{12}, -\frac{\pi}{18}\right)$

(D) $\left(\frac{\pi}{12}, \frac{\pi}{4}\right)$

Ans. **A, B, C**

Sol. $a_1a_2 + b_1b_2 < 0$

$\therefore \tan^2 b + \tan b < 0$

$-\frac{\pi}{4} < b < 0$

38. The global minimum value of

$|\cot x - 1| + |\cot x - 2| + |\cot x - 31| + |\cot x - 32| + |\cot x - 24| + |\cot x - 5| + |\cot x - 6|$
$+ |\cot x - 17| + |\cot x - 8| + |\cot x - 9| + |\cot x - 10| + |\cot x - 11| + |\cot x - 12|$

occurs at $x = \sec^{-1}\left(\frac{\alpha}{\beta}\right)$, then **INCORRECT** statements is/are (where [.] denotes the greatest integer function)

(A) $\sqrt{\alpha} + \beta = 31$

(B) $[\alpha + \beta] = 18$

(C) $\left[\frac{\alpha}{\beta}\right] = 2$

(D) $\left[\frac{\alpha^2}{\beta}\right] = 11$

Ans. **A, B, C, D**

Sol. Minimum sum occurs at cot x = 10

$\therefore$ x = $\sec^{-1}\left(\frac{\sqrt{101}}{10}\right)$

39. If $f(x) = \sin^{-1}\left(\frac{4x}{4+x^2}\right)$, then

(A) $f\left(\sqrt{8}-2\right) = \pi - 2\tan^{-1}\left(\sqrt{2}-1\right)$

(B) $f\left(\sqrt{12}-\sqrt{3}\right) = \frac{2\pi}{3}$

(C) $f\left(-\frac{3}{\sqrt{8}-2}\right) = -\pi + 2\tan^{-1}\left(\frac{3}{\sqrt{8}-2}\right)$

(D) $f(\pi) = \pi - 2\tan^{-1}\left(\frac{\pi}{2}\right)$

Ans. **A, B, C, D**

Sol. $$\sin^{-1}\left(\frac{4x}{4+x^2}\right) = \begin{cases} -\pi - 2\tan^{-1}\left(\frac{x}{2}\right) & ; \quad x < -2 \\ 2\tan^{-1}\left(\frac{x}{2}\right) & ; \quad -2 \le x \le 2 \\ \pi - 2\tan^{-1}\left(\frac{x}{2}\right) & ; \quad x > 2 \end{cases}$$

40. Minimum value of $\sqrt{2x^2+2x+1} + \sqrt{2x^2-10x+13}$ is $\sqrt{\alpha}$, then

(A) α is an even number

(B) sum of digits of α is 2

(C) number of prime factors of α is 2

(D) number of prime factors is 3

Ans. **A, B, C**

Sol. $\sqrt{(\alpha+1)^2 + (\alpha+2-2)^2} + \sqrt{(\alpha-2)^2 + (\alpha+2-5)^2}$

Line is y = x + 2 and P(α, α + 2) is any point on this line and A ≡ (2, 5) and B(–1, 2)

41. Let ABC be a triangle and D be the mid-point of side BC. Suppose ∠DAB = ∠BCA and ∠DAC = 15º, then

(A) ∠ADC is obtuse

(B) ∠ADC is acute

(C) if O is the circumcentre of ΔADC, then ΔAOD is equilateral

(D) if O is the circumcentre of ΔADC, then triangle AOD is isosceles

Ans. **A, C**

Sol. $\frac{AD}{\sin B} = \frac{BD}{\sin\alpha}, \frac{CD}{\sin(15^o)} = \frac{AD}{\sin\alpha}$

Finally, we get ∠ADC is obtuse

42. A hexagon inscribed in a circle has three consecutive sides of length 3 and three consecutive sides of length 5, and then the radius of the circle is

(A) $\frac{7}{\sqrt{3}}$

(B) $\frac{5}{\sqrt{2}}$

(C) $2\sqrt{3}$

(D) 4

Ans. **A**

Sol. Let the hexagon be ABCDEF with AB = BC = CD = 3 and DE = EF = FA = 5
So, ∠AOB = ∠BOC = ∠COD = α and ∠DOE = ∠EOF = ∠FOA = β
So, $\alpha + \beta = 120^o$
Now, $3 = 2r\sin\left(\frac{\alpha}{2}\right)$ and $5 = 2r\sin\left(\frac{\beta}{2}\right)$

$$5 = 2r\sin\left(\frac{120^o-\alpha}{2}\right);\ 5 = r\left(\sqrt{3\left(1-\frac{9}{4r^2}\right)}-\frac{3}{2r}\right);\ r = \frac{7}{\sqrt{3}}$$

43. If $S = \sum_{\beta=1}^{20}\sum_{\alpha=1}^{20}\tan^{-1}\left(\frac{\alpha}{\beta}\right)$, then S is equal to

(A) 100 π

(B) 300 π

(C) 400 π

(D) 225 π

Ans. A

Sol. $S = \sum_{\beta=1}^{20}\sum_{\alpha=1}^{20}\tan^{-1}\left(\frac{\alpha}{\beta}\right) = \left(20\times\frac{\pi}{4}\right)+\frac{\pi}{2}\times 190 = 100\pi$

(Matching Type)
(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer Q. 44, Q. 45 and Q. 46 by appropriately matching the information given in the three columns of the following table.

Column-1: contains the curve; Column-2: number of irrational points on the curve; Column-3: number of integral points on the curve (irrational points means both coordinates are irrational and integral points means both coordinates are integer)

Column-1	Column-2	Column-3
(I) $\frac{x^2}{9}+\frac{y^2}{4}=1$	(i) infinite	(P) 2
(II) $\frac{x^2}{35}+y^2=1$	(ii) 800	(Q) 4
(III) $x^2 - y^2 = (200)^2$	(iii) 200	(R) 30
(IV) $x^4 - y^4 = 2401$	(iv) 16	(S) 100

44. Which of the following combination is **CORRECT**?

(A) (IV) (i) (P)

(B) (IV) (i) (R)

(C) (III) (i) (Q)

(D) (IV) (ii) (S)

Ans. A

45. Which of the following combination is **CORRECT**?

(A) (III) (i) (Q)

(B) (III) (ii) (R)

(C) (III) (i) (R)

(D) (I) (i) (P)

Ans. C

46. Which of the following combination is **INCORRECT**?

(A) (IV) (i) (P)

(B) (III) (i) (Q)

(C) (II) (i) (P)

(D) (IV) (ii) (S)

Ans. **D**

Sol. (II) For $\frac{x^2}{35} + y^2 = 1$, $\left(\sqrt{35}\cos\theta, \sin\theta\right)$

Let $\tan\theta = k\sqrt{35} \equiv \left(\frac{\sqrt{35}}{\sqrt{1+35k^2}}, \frac{k\sqrt{35}}{1+35k^2}\right)$

Let $\sqrt{\frac{1+35k^2}{35}} = k'$, $k'^2 - k^2 = \frac{1}{35}$

$(k'-k)(k'+k) = \frac{1}{35}$ infinite possible ways

(III) For $x^2 - y^2 = (200)^2$, $(x - y)(x + y) = 2^4 \times 5^4$

Let (x > 0, y > 0) assign one 2 to each (x + y) and (x – y)

Now, number of ways = $\frac{3\times5-1}{2} = 7$

So, total integral points = 30

(IV) Number of integral points on $x^4 - y^4 = 2401$ is 2

Answer Q.47, Q.48 and Q.49 by appropriately matching the information given in the three columns of the following table.

Column-1: contains conics; Column-2: number of common tangents; Column-3: number of common normals

Column-1	Column-2	Column-3
(I) $2y^2 = 2x - 1$ and $2x^2 = 2y - 1$	(i) 0	(P) 0
(II) $(y-1)^2 = \frac{4}{\sqrt{3}}\left(x + \frac{\sqrt{3}}{4}\right)$ and $\frac{\left(x+\frac{\sqrt{3}}{4}\right)^2}{9} + \frac{(y-1)^2}{3} = 1$	(ii) 1	(Q) 1
(III) $x^2 = y - 2$ and $y + x^2 - 2x + 3 = 0$	(iii) 2	(R) 2
(IV) $y^2 = -4x$ and $x^2 = -4y$	(iv) 3	(S) 3

47. Which of the following options is the only **CORRECT** combination?

(A) (I) (iv) (Q)

(B) (I) (iv) (S)

(C) (II) (i) (S)

(D) (II) (ii) (S)

Ans. **A**

48. Which of the following options is the only **CORRECT** combination?

(A) (IV) (i) (Q)

(B) (IV) (i) (P)

(C) (IV) (ii) (Q)

(D) (I) (iv) (P)

Ans. **C**

49. Which of the following options is the only **INCORRECT** combination?

(A) (III) (iii) (Q)

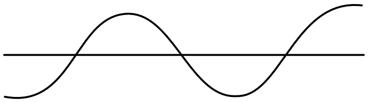
(B) (II) (i) (S)

(C) (II) (iii) (S)

(D) (IV) (ii) (Q)

Ans. **B**

Sol. (I) $2y^2 = 2x - 1$ and $2x^2 = 2y - 1$



Equation of tangents are $y = m\left(x - \frac{1}{2}\right) + \frac{1}{4m}$

and $y - \frac{1}{2} = mx - \frac{m^2}{4}$ respectively

So, $-\frac{m}{2} + \frac{1}{4m} = \frac{1}{2} - \frac{m^2}{4}$; $m^3 - 2m^2 - 2m + 1 = 0$

This equation has 3 real and distinct roots i.e., 3 common tangents

For common normals they are symmetric about $y = x$

So, only one common normal

(II) After shifting at origin, we get $y^2 = \frac{4}{\sqrt{3}}x$ and $\frac{x^2}{9} + \frac{y^2}{3} = 1$

Equation of normals are $y = mx - \frac{2}{\sqrt{3}}m - \frac{1}{\sqrt{3}}m^3$ and $y = mx \pm \frac{m\left(a^2 - b^2\right)}{\sqrt{a^2 + b^2m^2}}$

So, $\frac{2}{\sqrt{3}}m + \frac{1}{\sqrt{3}}m^3 = \frac{6m}{\sqrt{9 + 3m^2}}$; $m = 0, \pm 1$. Hence, 3 common normals

(III) $y = x^2$ and $y = -(x - 1)^2$ equation of tangents are $y = mx - \frac{m^2}{4}$

and $y = m(x - 1) + \frac{m^2}{4}$ respectively

So, we get $m = 0, 2$; 2 common tangents

Common normals: equation are $y = mx + \frac{1}{2} + \frac{1}{4m^2}$ and $y = mx - m - \frac{1}{4m^2} - \frac{1}{2}$

So, we get $2m^3 + 2m^2 + 1 = 0$ only one real root is 1 common normals

(IV) $y^2 = -4x$ and $x^2 = -4y$
Number of common tangents will be same
For $y^2 = 4x$ and $x^2 = 4y$ only one common tangents
Common normals: $2m + m^3 = -2 - \frac{1}{m^2}$
$f(m) = m^5 + 2m^3 + 2m^2 + 1$ only one root negative
So, only one common normals

SECTION – C
(One Integer Value Correct Type)

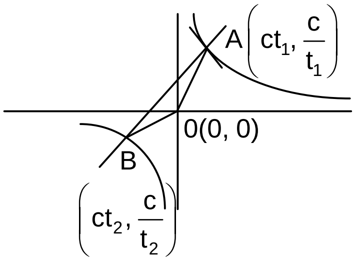
This section contains **5 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

---

50. If a chord AB of the curve $y = \frac{3x-2}{x-2}$ is a normal to the curve at a point A, subtending an angle θ at the point P(2, 3). Then the value of $\frac{\sin(\theta - \angle PAB)}{\sin(\theta + \angle PAB)}$ is equal to _____

Ans. 3

Sol. Shift the curve so that centre is origin, $xy = 4$



A $\left(ct_1, \frac{c}{t_1}\right)$
0(0, 0)
B
$\left(ct_2, \frac{c}{t_2}\right)$

$\because\ t_2 = \frac{-1}{t_1^3};\ m(OA) = \frac{1}{t_1^2}, m(OB) = \frac{1}{t_2^2} = t_1^6;\ \tan\theta - \frac{1-t_1^4}{t_1^2}$

Also, $\tan(\angle OAB) = \frac{t_1^2 - \frac{1}{t_1^2}}{1+1} = \frac{t_1^4 - 1}{2t_1^2}$

$\therefore\ \frac{\tan\theta}{\tan(\angle OAB)} = -2$

So, $\frac{\sin(\theta - A)}{\sin(\theta + A)} = 3$

51. Assuming that no three circles passing through same points and every two circles intersects in two distinct points. If the number of regions that points are created by 7 mutually non over-lapping circles in a plane is 11k, then k is _____

Ans. 4

Sol. $T_n = T_{n-1} + 2(n-1)$: $n \geq 2$
$T_n = n^2 - n + 2$
$T_7 = 7^2 - 7 + 2 = 44$

52. The combined equation of the principal axes of the hyperbola $2x^2 + 12xy - 7y^2 - 16x + 2y - 5 = 0$ is $ax^2 + 2hxy + by^2 - x + 7y + c = 0$, then $|a + b - 2h + c|$ is equal to _____

Ans. 6

Sol. $c \equiv (1, 1)$; The axes are the bisectors of the angle between the asymptotes

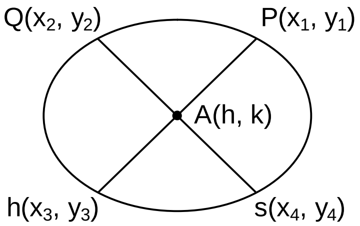
So, $\frac{(x-1)^2-(y-1)^2}{(x-1)(y-1)}=\frac{2-(-7)}{6}$

$2x^2 - 3xy - 2y^2 - x + 7y - 3 = 0$

53. From the point (1, 1) normals are drawn to the ellipse $\frac{x^2}{9}+\frac{y^2}{4}=1$, then locus of conormal points is $\lambda_1xy + \lambda_2x + \lambda_3y + \lambda_4x^2 + \lambda_5y^2 + \lambda_6 = 0$, then $\lambda_1 + \lambda_2 + \lambda_3 - \lambda_4 - \lambda_5 - \lambda_6$ is equal to _____

Ans. 0

Sol. Equation of normal at $P(x_1, y_1)$; $\frac{x-x_1}{\frac{x_1}{a^2}}=\frac{y-y_1}{\frac{y_1}{b^2}}$



$\Rightarrow (a^2 - b^2)x_1y_1 + b^2yx_1 - a^2xy_1 = 0$
Point (h, k) lies on it
So; $(a^2 - b^2)x_1y_1 + b^2kx_1 - a^2hy_1 = 0$
Similarly, for points Q, R and S are
$(a^2 - b^2)x_2y_2 + b^2kx_2 - a^2hy_2 = 0$
$(a^2 - b^2)x_3y_3 + b^2kx_3 - a^2hy_3 = 0$ and $(a^2 - b^2)x_4y_4 + b^2kx_4 - a^2hy_4 = 0$
Thus, P, Q, R, S lie on the curve $(a^2 - b^2)xy + b^2kx - a^2hy = 0$ i.e., $5xy + 4x - 9y = 0$

54. Three circles C_1, C_2 and C_3 with radii 2, r, 8 respectively are given. They are placed such that C_2 lies to the right of C_1 and touches it externally, C_3 lies to the right of C_2 and touches it externally. Further, there exist two straight lines each of which is a direct common tangent simultaneously to all three circles, then r is _____

Ans. 4

Sol. $r=\sqrt{2\times 8}$

FIITJEE

ALL INDIA TEST SERIES

PART TEST – II

JEE (Advanced)-2018-19

PAPER – 2

TEST DATE: 18-11-2018

Time Allotted: 3 Hours **Maximum Marks: 231**

General Instructions:

- The test consists of total 69 questions.
- Each subject (PCM) has 23 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Three Sections**: **Section-A, Section-C & Section-D.**

Section-A (01 – 03, 24 – 26, 47 – 49) *contains 9 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-A (04 – 08, 27 – 31, 50 – 54) *contains 15 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 mark*** *for wrong answer.*
Partial Marks **+1** for each correct option provided no incorrect options is selected.

Section-A (09 – 10, 32 – 33, 55 – 56) *contains 3 paragraphs. Based upon paragraph, 2 multiple choice questions have to be answered. Each question has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Section-C (11 – 20, 34 – 43, 57 – 66) *contains 30 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Section-D (21 – 23, 44 – 46, 67 – 69) *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

PART – I

SECTION – A
Single Correct Choice Type

This section contains **3 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.

1. A conducting disc of conductivity σ has radius a and thickness δ. A uniform magnetic field $\vec{B}$ is applied in a direction perpendicular to the plane of the disc. If the magnetic field changes with time at the rate of dB/dt, then the power dissipated in the disc due to the induced current.

(A) $\frac{\pi\delta\sigma a^4}{8}\left(\frac{dB}{dt}\right)^2$

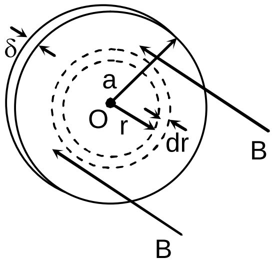
(B) $\frac{\pi\delta\sigma a^4}{12}\left(\frac{dB}{dt}\right)^2$

(C) $\frac{\pi\delta\sigma a^4}{4}\left(\frac{dB}{dt}\right)^2$

(D) $\frac{\pi\delta\sigma a^4}{6}\left(\frac{dB}{dt}\right)^2$

Ans. A

Sol. Consider two circles of radii r and r + dr concentric with the disc (0 < r < a) (figure). The induced e.m.f. in the circular path of radius r is



$$\varepsilon = -\frac{d}{dt}\left(\pi r^2 B\right) = -\pi r^2\frac{dB}{dt}.$$

The resistance of the circular path between radii r and r + dr is

$$R = \frac{1}{\sigma}\frac{2\pi r}{\delta dr},$$

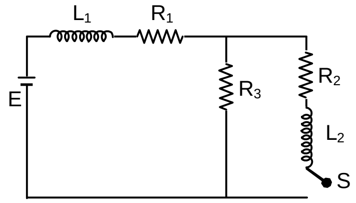
The length of the path being $2\pi r$ and the cross sectional area of current flow being δdr. The power dissipated inside this path is

$$dP = \frac{\varepsilon^2}{R} = \frac{\pi\delta\sigma}{2}\left(\frac{dB}{dt}\right)^2 r^3 dr.$$

The total dissipated power P is

$$P = \frac{\pi\delta\sigma}{2}\left(\frac{dB}{dt}\right)^2\int_0^a r^3 dr = \frac{\pi\delta\sigma a^4}{8}\left(\frac{dB}{dt}\right)^2.$$

2. In the circuit shown in figure, the switch 'S' is closed at t = 0. The value of current in the resistor R_3, when it becomes steady (as compared to the steady current before closing the switch S)



(A) Increases

(B) Decreases

(C) Remains constant

(D) Becomes zero

Ans. B

Sol. Initial current in R_3, $i_i = \dfrac{E}{R_1 + R_3}$

Final current $i_f = \dfrac{E}{R_1 + \dfrac{R_2R_3}{R_2+R_3}} \times \dfrac{R_2}{R_2+R_3} = \dfrac{R_2E}{R_1(R_2+R_3)+R_2R_3}$

$I_f = \dfrac{E}{\dfrac{R_1R_3}{R_2} + R_1 + R_3}$

As $i_f < i_i$, so current in the resistor R_3 will decrease.

3. A straight segment OP of length L of a circuit carrying current I ampere is placed along x-axis. Two infinitely long straight wires A and B each extending from z = $-\infty$ to $+\infty$ are fixed at y = $-\ell$ meter to y = $+\ell$ meter respectively. Wires A and B, each carry current I ampere along positive z-axis. Given that O is origin of the coordinate system. The magnitude of force on segment OP is

(A) $\dfrac{\mu_0}{\pi} I^2 \ell n\left(1+\dfrac{L^2}{\ell^2}\right)$

(B) $\dfrac{\mu_0}{2\pi} I^2 \ell n\left(1+\dfrac{L^2}{\ell^2}\right)$

(C) $\dfrac{\mu_0}{\pi} I^2 \ell n\left(1+\dfrac{\ell^2}{L^2}\right)$

(D) $\dfrac{\mu_0}{2\pi} I^2 \ell n\left(1+\dfrac{\ell^2}{L^2}\right)$

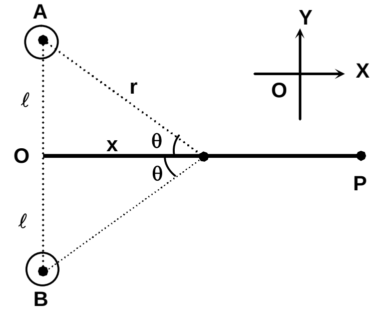
Ans. B

Sol. Net B at distance x from O along x-axis

$= \frac{\mu_0}{2\pi}\frac{I}{r}2\cos\theta$

$\Rightarrow F = \int dF = \int I\frac{\mu_0}{2\pi}\frac{I}{r}2\cos\theta dx$

$= \frac{\mu_0}{2\pi}I^2\ell n\left(1+\frac{L^2}{\ell^2}\right)$



(One or More than one correct type)

This section contains **5 questions**. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

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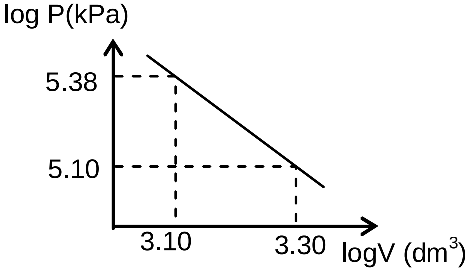
4. Logarithms of reading of pressure and volume for an ideal gas were plotted in the graph. By measuring the gradient it can be shown that



(A) The gas may be Mono-atomic

(B) The gas may be Diatomic

(C) The process is an adiabatic change

(D) The process is an isothermal change.

Ans. **B, C**

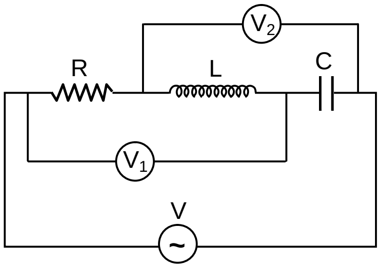
Sol. log P = m log V + C …(i)

Where C is constant and m is slope

$m = \left[\frac{5.38-5.10}{3.10-3.30}\right] = -1.4$

So, from (i) $PV^{1.4}$ = K (constant)

5. In a RLC series circuit shown in the figure, the readings of voltmeters V_1 and V_2 are 100 V and 120 V respectively. The source voltage (V) of alternating source is 130 V. Mark the correct option(s).



(A) Voltage across resistor, inductor and capacitor are 50 V, 86.6 V and 186.6 V respectively.

(B) Voltage across resistor, inductor and capacitor are 50 V, 86.6, 206.6V respectively.

(C) Circuit is capacitive and power factor is $\frac{5}{13}$.

(D) Circuit is inducting and power factor is $\frac{5}{13}$.

Ans. **B, C**

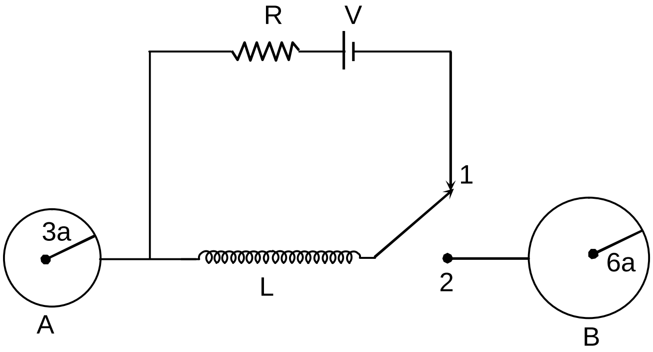
Sol. Let voltage across resistor, inductor and capacitor be V_R, V_L and V_C. Also since $V_2 > V_1$ so $V_C > V_L$.

$\therefore$ $V_R^2 + V_L^2 = V_1^2 = 100^2$ and $V_C - V_L = 120$ and $V_R^2 + (V_C - V_L)^2 = 130^2$

Solving $V_R = 50V, V_L = 86.6V, V_C = 206.6V$

Power factor = $\cos\phi = \frac{V_R}{V_Z} = \frac{50}{130} = \frac{5}{13}$

6. An electrical circuit is shown in the figure. It has two conducting spheres A and B of radii 3a and 6a respectively. When the inductor of inductance L is in its steady state the switch is shifted from position-1 to position-2. Now choose the correct option(s)



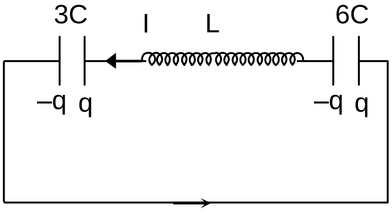
(A) Maximum charge on the sphere A is $\frac{V}{R}\sqrt{8\pi\varepsilon_0 aL}$.

(B) Maximum charge on the sphere B is $\frac{V}{R}\sqrt{4\pi\varepsilon_0 aL}$.

(C) The circuit contains only magnetic energy at time $t = \sqrt{8\pi^3\varepsilon_0 aL}$.

(D) The circuit contains only electrical energy at time $t = \sqrt{2\pi^3\varepsilon_0 aL}$.

Ans. **A, C, D**



Sol. $I_0 = \frac{V}{R}$, $3C = 4\pi\varepsilon_0 a \times 3 \Rightarrow C = 4\pi\varepsilon_0 a$

$\frac{dI}{dt} < 0$

$\frac{q}{3C} + \frac{q}{6C} - L\left|\frac{dI}{dt}\right| = 0$

$\Rightarrow \quad L\frac{d^2q}{dt^2} + \frac{q}{2C} = 0 \Rightarrow \frac{d^2q}{dt^2} + \frac{q}{2LC} = 0$

$\Rightarrow \quad q = q_0 \sin\omega t,\ I = q_0\omega\cos\omega t,\ \omega = \sqrt{\frac{1}{2LC}}$

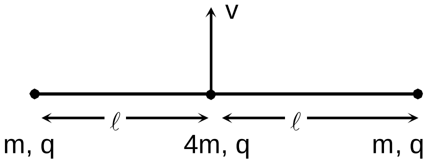
At $t = 0,\ I = I_0 \Rightarrow q_0 = \frac{I_0}{\omega} = I_0\sqrt{2LC}$

$q_0 = \frac{V}{R}\sqrt{8\pi\varepsilon_0 aL}$

$T = \frac{2\pi}{\omega} = 2\pi\sqrt{8\pi\varepsilon_0 aL}$

$\frac{T}{4} = \sqrt{2\pi^3\varepsilon_0 aL}$

7. Three small metallic charged balls (radius tends to zero) have equal charges q and masses m, 4m and m as shown in the figure. The balls are connected by light string (Non-conducting) of length ℓ each, and placed on horizontal frictionless, non-conducting table. Initially balls are at rest and form a straight line. A sharp horizontal impulse gives the central ball a speed v directed perpendicular to strings connecting the balls. Choose correct option(s):



(A) The minimum distance during subsequent motion between the balls of mass m is $\frac{6q^2\ell}{3q^2 + 16\pi m\varepsilon_0 v^2\ell}$

(B) The minimum distance during subsequent motion between the balls of mass m is $\frac{3q^2\ell}{3q^2 + 16\pi m\varepsilon_0 v^2\ell}$

(C) The maximum difference in electrostatic potential energy of the system during subsequent motion is $\frac{2mv^2}{3}$

(D) The maximum difference in electrostatic potential energy of the system during subsequent motion is $\frac{4mv^2}{3}$

Ans. **A, C**

Sol. $v_{CM} = \frac{4mv}{6m} = \frac{2v}{3}$

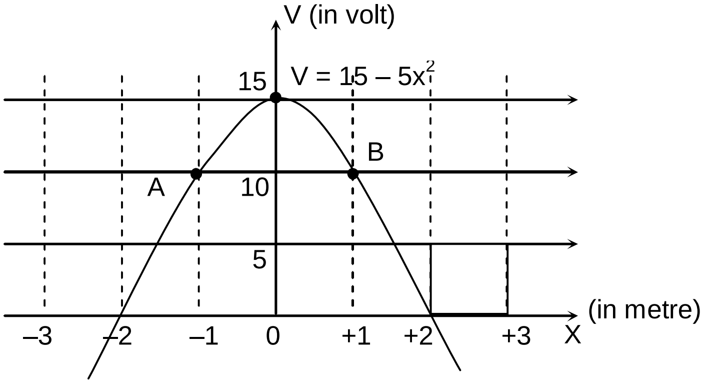
In centre of mass frame

Gain in P.E. = Loss in KE

$$\frac{q^2}{4\pi\varepsilon_0}\left[\frac{1}{D} - \frac{1}{2\ell}\right] = 2mv^2 - \frac{4mv^2}{3}$$

$$\Rightarrow \quad D = \frac{6q^2\ell}{3q^2 + 16m\pi\varepsilon_0 v^2\ell}$$

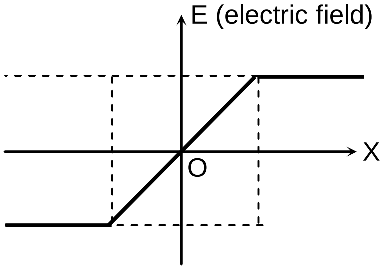
8. The figure shows the variation of electrostatic potential V in volt with the distance of position of point along x-axis from origin due to continuous volume charge distribution. In the region x = – 1m to x = + 1m, the graph is parabolic ($V = 15 - 5x^2$) and rest portion of graph is straight line. Choose the correct option(s) ($\varepsilon_0 \Rightarrow$ permittivity of free space = $8.85 \times 10^{-12}\ N^{-1}\ m^{-2} C^2$). The direction of $\vec{E}$ along positive x-axis is considered as positive.



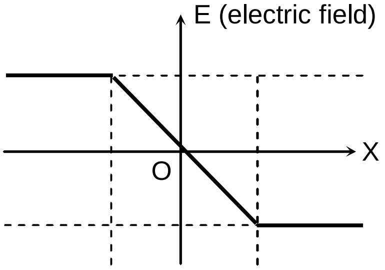
(A) This graph of potential may be due to a thick sheet of infinite dimension (– 1m ≤ x ≤ 1, – ∞ < y < ∞ and – ∞ < z < ∞) with constant volume charge density 1.77×10^{-10} C/m³.

(B) This graph of potential may be due to a thick sheet of infinite dimension (– 1m ≤ x ≤ 1, – ∞ < y < ∞ and – ∞ < z < ∞) with constant volume charge density 0.885×10^{-10} C/m³.

(C)



(D)



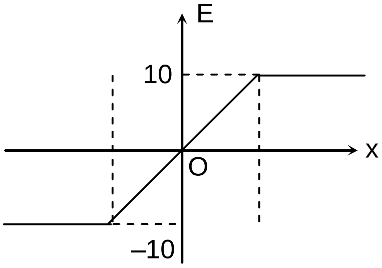
Ans. **A, C**

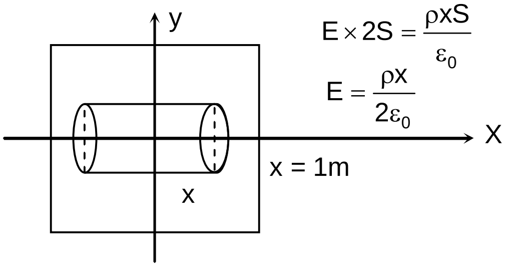
Sol. $dV = -Edx = \frac{-\rho}{2\varepsilon_0}xdx$

$$\int_{V_0}^{V} dv = \frac{-\rho}{2\varepsilon_0}\int_0^x xdx \quad \Rightarrow V = V_0 - \frac{\rho}{4\varepsilon_0}x^2, \text{ so}$$

$V_0 = 15$ volt

$$\frac{\rho}{4\varepsilon_0} = 5 \Rightarrow \rho = 20\varepsilon_0 = 20\times 8.85\times 10^{-12} = 1.77\times 10^{-10}\ C/m^3$$





$$E\times 2S = \frac{\rho xS}{\varepsilon_0}$$

$$E = \frac{\rho x}{2\varepsilon_0}$$

Paragraph type (One Option Correct)

This section contains **1 paragraph** each describing theory, experiment, data etc. **Two questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Questions 9 & 10

The melting point of wax is measured by using a thermometer which is not exact, and it indicates a temperature of 50°C as shown in figure-I.

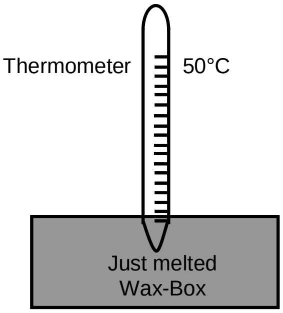


Figure-I

A Wheatstone bridge is used to measure this melting point exactly. The deviation from 50°C is being measured by observing the variation of the resistance of a coil embedded in wax.

The Wheatstone bridge is setup so that the resistance of each arm is 50Ω exactly at 50°C, and there is no current in the galvanometer as shown in figure-II. The resistance of the galvanometer is 50Ω.

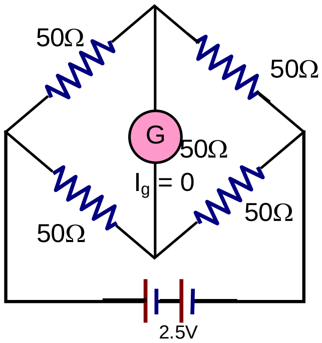


Figure-II

One arm of the bridge containing the coil of resistance 50Ω is now immersed in a wax-box. The wax is just melted as shown in the figure-III. It is now observed that the current through the galvanometer is 0.1 μA.

Given, temperature coefficient of resistance is 10^{-3} per °C. Resistances other than inside wax-box are assumed to be constant and are exactly 50Ω while the resistance of wax box is very close to 50Ω.

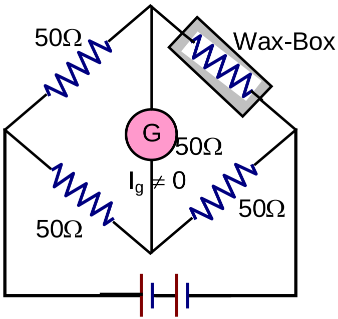


Figure-III

9. The variation in the resistance inside the wax-box from its initial value of 50Ω is

(A) $1\times10^{-4}\Omega$

(B) $2\times10^{-4}\Omega$

(C) $4\times10^{-4}\Omega$

(D) $8\times10^{-4}\Omega$

Ans. D

10. Calculate the deviation in the melting point from 50°C.

(A) 0.004°C

(B) 0.008°C

(C) 0.016°C

(D) 0.036°C

Ans. C

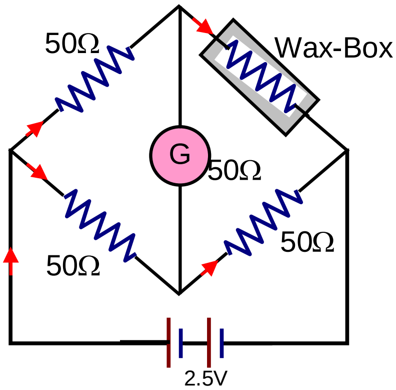
Sol. 9-10.

When the four arms have equal resistances, the off-balance galvanometer current for a small change ΔR in the resistance of the third arm is

$$I_G = \frac{V_B \Delta R}{8R^2}.$$

Here $I_G = 10^{-7}$ A, $R = 50\Omega$, and $V_B = 2.5V$. Hence

$$\Delta R = \frac{8\times10^{-7}\times25\times10^{2}}{2.5} = 8\times10^{-4}\Omega.$$



If the corresponding change in temperature is δT, we have

$R\alpha\Delta T = \Delta R_3$,

Where α = temperature coefficient of resistance = 10^{-3}/°C.

Therefore, $\Delta T = \dfrac{8\times10^{-4}}{50\times10^{-3}} = 1.6\times10^{-2} = 0.016°C$.

SECTION – C
(Single digit integer type)

This section contains **10 questions**. The answer to each question is a **Single Digit Integer** ranging from 0 to 9, both inclusive.

11. An air-filled capacitor of capacitance 50 pF is charged to a voltage V and connected across another uncharged capacitor of capacitance 100 pF, the final voltage across each capacitor is V_1 volt. Now an identical air-filled capacitor of capacitance 50 pF is totally filled with a solid dielectric of dielectric constant 2n & again charged to the same voltage V as before. It is now connected across another uncharged capacitor of capacitance 100 pF, the final voltage across each capacitor is V_2 volt. If $\dfrac{V_1}{V_2}$ is $\dfrac{2}{5}$ then find the value of n.

Ans. 5

Sol. In the first case,
Charge = CV = (C + C_e)V_1, …(i)
Where C = 50 pF, C_e = 100 pF
In the second case,
Charge = KCV = (KC + C_e)V_2, …(ii)
Dividing (ii) by (i) we obtain

$$K = \frac{KC + C_e}{C + C_e}.\frac{V_2}{V_1} = \frac{KC + C_e}{C + C_e}\times 2.5 = \frac{2.5KC + 2.5C_e}{C + C_e}$$

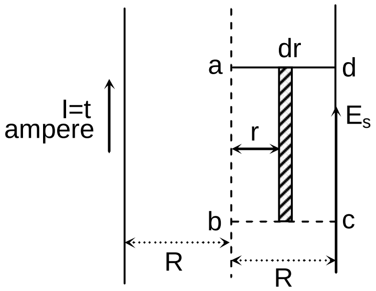
$$\Rightarrow \quad 1.5KC = (K - 2.5)C_e \quad \Rightarrow \; 1.5K = (K - 2.5)\frac{C_e}{C} = 2(K - 2.5)$$

$$\Rightarrow \quad 0.5\,K = 5 \quad \Rightarrow \quad K = 10 \;\Rightarrow\; n = 5.$$

12. A long thin copper wire of the radius 2mm, carries a time-varying current I = t ampere (uniformly distributed), then the induced electric field on its surface is equal to k X10^{-7} Vm^{-1}. Find the value of k. Take the induced field along the axis of the wire to be zero.

Ans. 1

Sol. Let the radius of the wire be R. Consider a rectangle abcd in the wire with the side ab along the axis. The magnetic induction at a distance r from the axis (r < R) is $B = \dfrac{\mu_0 Ir}{2\pi R^2}$



The flux through the elementary shaded area within abcd is Bldr, where ℓ = ab = cd. The flux Φ through abcd is

$$\Phi = \int_0^R \frac{\mu_0 Ir}{2\pi R^2}\ell dr = \frac{\mu_0 I\ell}{4\pi}.$$

The induced emf along the curve abcd is

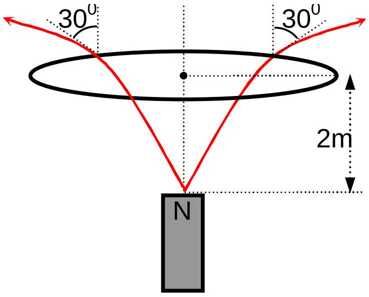
$$|\varepsilon| = \frac{d\phi}{dt} = \frac{\mu_0\ell}{4\pi}\frac{dI}{dt} = \frac{\mu_0\ell}{4\pi} \quad \text{…(i)}$$

The wire being thin, cd >> da. If E_s is the induced electric field at the surface and E_0 that along the axis, then $|\varepsilon| = (E_s - E_0)\ell$. Since E_0 = 0, we obtain from (i)

$$E_s = \frac{\mu_0}{4\pi} = 10^{-7}\,Vm^{-1}.$$

Clearly, E_s is independent of the radius of the wire.

13. A conducting ring of radius R & mass 300 g, carrying current I ampere as shown in the figure. A bar magnet with its north pole up is placed along the symmetric axis below the conducting ring at a distance of 2m from the centre of ring. At the location of ring, the magnetic field makes an angle 30^0 with vertical and its magnitude is $\frac{1}{3\pi}$ Tesla. If ring remains at rest in its position, find the product of current I in the ring and radius R of ring in ampere-meter. $\left(g = 10\ m/s^2\right)$



Ans. 9

Sol. $F_{mag} = mg \Rightarrow \left(B\sin 30^\circ\right)\times I\times\left(2\pi R\right) = mg$

$$\Rightarrow IR = \frac{mg}{2\pi B\sin 30^\circ} = \frac{0.3\times 10\times 3\pi\times 2}{2\pi} = 9 \text{ A-m}$$

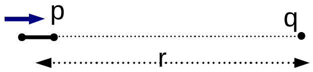
14. A neutral metal sphere is placed at a large distance from a point charge. The magnitude of Coulomb electrostatic interaction force between the charge and sphere is F_0. If the distance between them is doubled, the new magnitude of Coulomb electrostatic interaction force between the charge and sphere is $2^{-n}F_0$. Find the value of n. (Assuming that the radius of sphere is very small as compared to the distance between them)

Ans. 5

Sol. Due to induction, the sphere behaves as dipole whose dipole moment is directly proportional to inducing field generated by point charge. So

$p = \frac{a}{r^2}$, a is a constant and r is the distance between them.

$$F_0 = \frac{bqp}{r^3} = \frac{baq}{r^5} \Rightarrow F = \frac{baq}{(2r)^5} = \frac{baq}{2^5 r^5} = 2^{-5}F_0$$



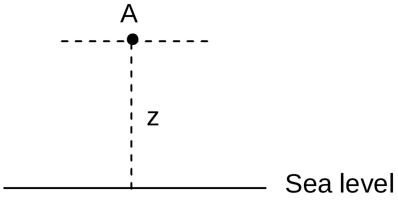
15. On a sunny day, the temperature and pressure of atmosphere varying with height z from sea level as

$$T = T_0\left(1 - \frac{z}{z_0}\right), \text{ and } P = P_0\left(1 - \frac{z}{z_0}\right)^\alpha$$

Where T_0 and z_0, are 25°C and 25 km. The temperature pressure and density of air at sea level is T_0 = 25°C, P_0 = 1 atm and 1.2 kg/m^3 respectively. Assume that air follows ideal gas law in the given condition, i.e., $\frac{\rho T}{P} = \text{constant}$.

Find the value of α.

1 atm = 10^5 N/m^2 and g = 10 m/s^2 (g is uniform)



Ans. 3

Sol. $dp = -\rho g dz$

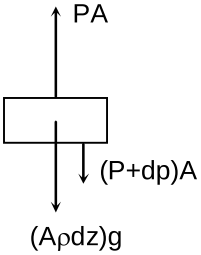
$$\Rightarrow \quad \frac{dp}{dz} = -\frac{\rho_0 g T_0 P}{P_0 T}$$

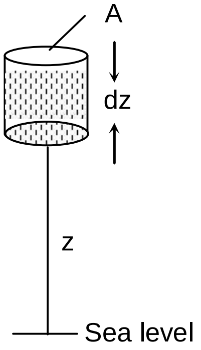
$$\Rightarrow \int_{P_0}^{P} \frac{dP}{P} = -\frac{\rho_0 g}{P_0} \int_{0}^{z} \frac{dz}{\left(1 - \frac{z}{z_0}\right)}$$

$$\Rightarrow \quad \ell n\left(\frac{P}{P_0}\right) = \frac{\rho_0 g z_0}{P_0} \ell n\left(1 - \frac{z}{z_0}\right)$$

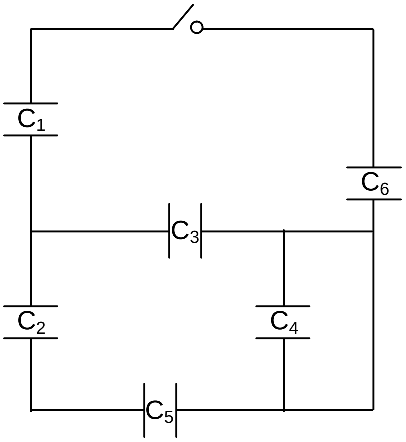
$$\Rightarrow \quad P = P_0\left(1 - \frac{Z}{Z_0}\right)^{\alpha}, \text{ where}$$

$$\alpha = \frac{\rho_0 g z_0}{p_0} = \frac{1.2 \times 10 \times 25 \times 10^3}{10^5} = 3$$



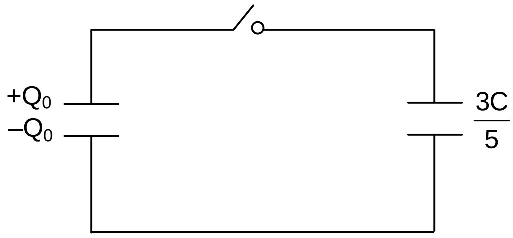


16. In the circuit shown, all capacitors are identical. Initially, the switch is open and capacitor-C_1 is the only charged capacitor. After the switch is closed, the equilibrium is re-established and the charge on the capacitor – C_1 is Q. If initial charge on the capacitor – C_1 was $Q_0 = \frac{a}{b}Q$, where a and b are positive integer, lying between 0 to 9. Find the value a – b.

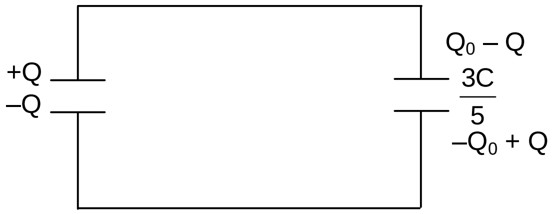


Ans. 3

Sol. $\frac{Q}{C} + \frac{-Q_0 + Q}{\frac{3C}{5}} = 0 \Rightarrow 3Q - 5Q_0 + 5Q = 0 \Rightarrow Q_0 = \frac{8Q}{5}$



Just before closing the switch



Just after closing the switch

17. A point charge Q = 500 mC and mass m = 10^{-6} kg is moving in a uniform magnetic field $\vec{B} = 1\,\text{tesla}\left(\hat{k}\right)$ with speed v = 10^6 m/s and follows path as shown in figure-1. If a wire with shape same as the trajectory of charged particle carrying current I = 2A is kept in same magnetic field, each point of the wire experiences a tension T (in newton) in magnitude. Find the value of T.

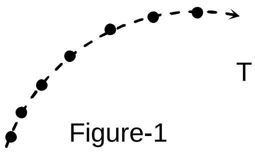


Figure-1

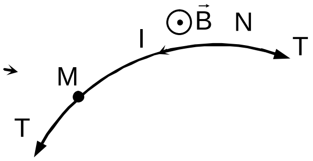


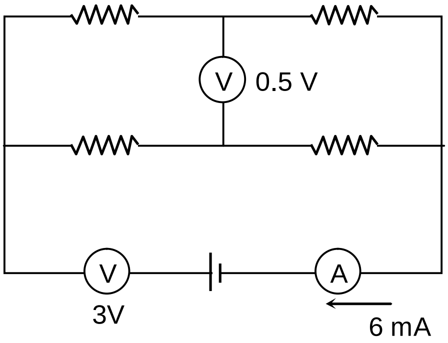
Figure-2

Ans. 4

Sol. $R_1 = R_2 \Rightarrow \dfrac{mv}{qB} = \dfrac{T}{BI} \Rightarrow T = \dfrac{mvI}{Q}$

$$\Rightarrow \quad T = \frac{10^{-6} \times 10^{6} \times 2}{500 \times 10^{-3}} = 4 \text{ newton}$$

18. Four resistance R, 3R, R and 3R are connected as shown in figure. The two real voltmeters are identical and Ammeter is ideal. If the value of R is 25NΩ, find the value of N. You decide arrangement of the resistances so that the given conditions are satisfied.



Ans. 5

Sol. $x + y = 6 \Rightarrow x = 3.5$ mA

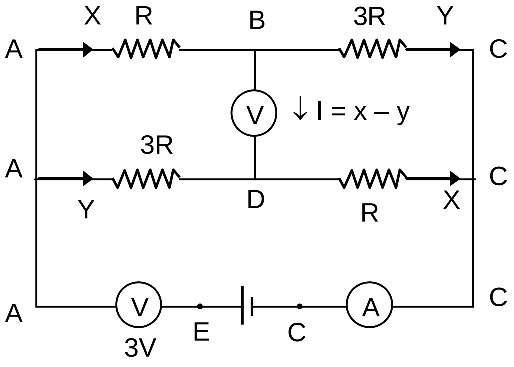
$x = 1 + y \quad y = 2.5$mA

KVL:

$-3.5R - 500 + 2.5 \times 3R = 0$

$\Rightarrow \quad 4R = 500 \Rightarrow R = 125\ \Omega$

$R_v = \dfrac{0.5}{10^{-3}} = 500\Omega$



19. Particle A with charge 2q and mass m_A, and particle B with charge 4q and mass m_B are accelerated with potential difference of V & 4 V respectively. Both particles are deflected by a uniform magnetic field into semicircular paths. The radius of trajectories of particle A and B are R and 2R respectively. The direction of magnetic field is perpendicular to the velocity. Find value of $\dfrac{m_B}{m_A}$.

Ans. 2

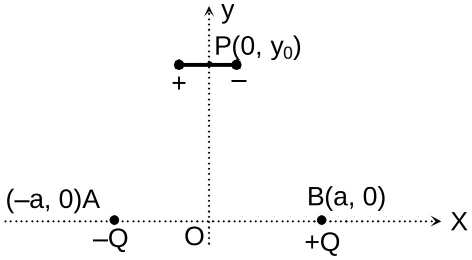
Sol. $q\Delta V = \frac{1}{2}mv^2 \Rightarrow mv = \sqrt{2qm\Delta V}$

$$R = \frac{mv}{Bq} = \frac{\sqrt{2qm\Delta V}}{Bq} \Rightarrow R \ \alpha \ \sqrt{\frac{m\Delta V}{q}}$$

$$R = \sqrt{\frac{m_A\Delta V}{2q}}, \ \& \ 2R = \sqrt{\frac{m_B 4\Delta V}{4q}} = \frac{1}{2}$$

$$\Rightarrow \sqrt{\frac{m_A}{m_B}.\frac{1}{2}} = \frac{1}{2} \Rightarrow \frac{m_A}{m_B}.\frac{1}{2} = \frac{1}{4} \Rightarrow \frac{m_A}{m_B} = \frac{1}{2}$$

20. Two point charges +Q and –Q are kept at points (a, 0) and (–a, 0).
A dipole of dipole strength p and mass m is released from point P(0, y_0), where y_0 >>> a; as shown in the figure. If the maximum speed of dipole is $\sqrt{\frac{5Qp}{\eta\pi\varepsilon_0 ma^2}}$, find the value of η



Ans. 5

Sol. The force acting on the dipole is along negative y-axis.

$$E_i = 0, \ E_f = \frac{1}{2}mv^2 - \vec{p}.\vec{E} = \frac{1}{2}mv^2 - p(-\hat{i}).\frac{2KQ}{a^2}(-\hat{i})$$

Using COME, we have

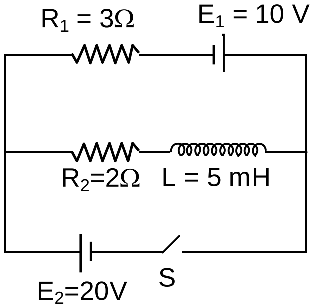
$$\frac{1}{2}mv^2 = \frac{Qp}{2\pi\varepsilon_0 a^2} \Rightarrow v = \sqrt{\frac{Qp}{\pi\varepsilon_0 ma^2}}$$

SECTION – D
(Numerical Answer Type)

This section contains **3 questions**. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

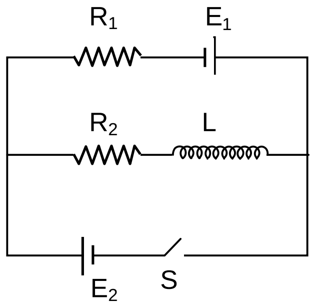
---

21. Consider the circuit shown in the figure. E_1, E_2 are sources of emf and R_1, R_2 are fixed resistances. E_1 = 10V, E_2 = 20V while R_1 = 3Ω, R_2 = 2Ω. The inductance L = 5 mH.
Take $\ell n2 = 0.7, \ell n3 = 1.1, \ell n10 \approx 2.3$.
The switch S is closed for a long time. The energy stored (in joule) in the inductor is



Ans. 00000.25

Sol. After the switch S, has been closed for a long time, the current through the inductor L can be found using Kirchoff's Law: $E_2/R_2 = I_2$. The stored energy is: $\frac{1}{2}L\left(\frac{E_2}{R_2}\right)^2$.



After the switch S is opened, the current through the inductor L is given by:

$i = -I_1\left(1-e^{-R't/L}\right)+I_2e^{-R't/L}$

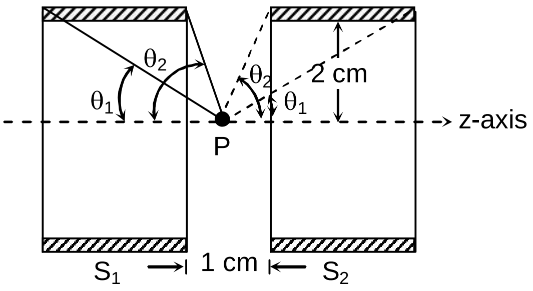
where $R' = R_1 + R_2$,

$I_1 = E_1/\left(R_1+R_2\right)$,

$I_2 = E_2/R_2$.

22. Two solenoids, each of radius 2 cm are placed coaxially with a gap of 1 cm between them. Determine the magnetic field (in Gauss) at the centre of the gap if a current of 2 A flows through the two solenoids in series. Assume that each solenoid contains 40 turns per cm.

$\cos\theta_1 = 0.907$, $\cos\theta_2 = 0.242$, $\pi = \frac{22}{7}$.



Ans. 00066.88

Sol. Let the two solenoids be S_1 and S_2, as shown in figure. The magnetic field at the centre-point p of the gap due to the solenoid S_1 is

$$B_1 = \frac{\mu_0 NI}{2L}[\cos\theta_1 + \cos\left(\pi-\theta_2\right)] = \frac{\mu_0 NI}{2L}\left(\cos\theta_1 - \cos\theta_2\right),$$

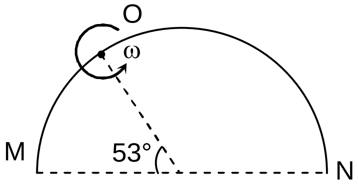
Where the angles θ_1 and θ_2 are as shown in figure. The field B_1 is along the z-axis. By symmetry, the field at p due to the solenoid S_2 has the same magnitude and direction as B_1. Thus the net magnetic field at P is

$$B = 2B_1 = \frac{\mu_0 NI}{L}\left(\cos\theta_1 - \cos\theta_2\right).$$

N/L = 40 $\text{cm}^{-1} = 4\times10^3 \text{m}^{-1}$, $\mu_0 = 4\pi\times10^{-7}$ Henry / m, and $I = 2A$.

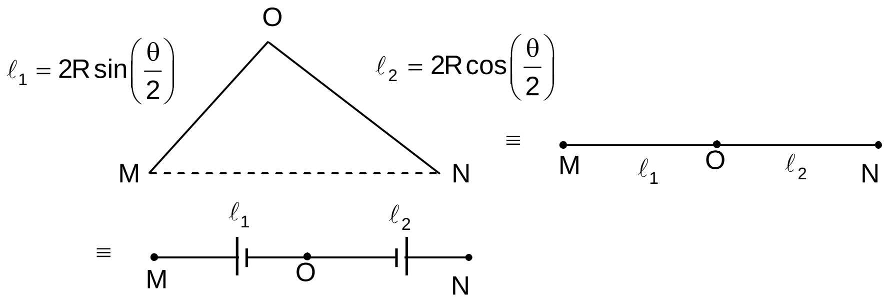
Therefore, $B = 4\pi\times10^{-7}\times4\times10^3\times2\times\left(0.907-.242\right)$ = 66.88 Gauss.

23. A semi-circular conducting wire of radius 2m is rotated in a uniform magnetic field $\vec{B} = 0.1$ Tesla $\left(\hat{k}\right)$ about point O with angular speed ω = 10 rad/s as shown in the figure. The axis of rotation is parallel to $\vec{B}$. Find the potential difference (in volt) between point M and point N. $\left(\tan 53° = \frac{4}{3}\right)$.

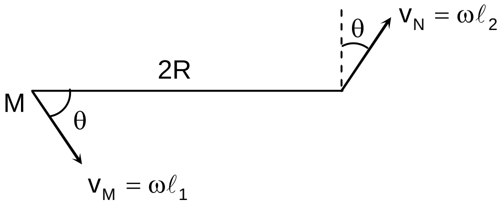


Ans. 00004.80

Sol. $e_1 = \frac{B\omega\ell^2}{2}$, $e_2 = \frac{B\omega\ell_2^2}{2} \Rightarrow V_N - V_M = e_2 - e_1 = \frac{B\omega}{2}\left(\ell_2^2 - \ell_1^2\right) = 2B\omega R^2\cos\theta = 4.8\,\text{volt}$


O
$\ell_1 = 2R\sin\left(\frac{\theta}{2}\right)$
$\ell_2 = 2R\cos\left(\frac{\theta}{2}\right)$
M
N
≡
M
ℓ_1
O
ℓ_2
N
≡
ℓ_1
ℓ_2
M
O
N

Second Method


$v_N = \omega\ell_2$
θ
2R
M
θ
$v_M = \omega\ell_1$

$$v = \frac{1}{2}\left|\vec{V}_{N\perp} + \vec{V}_{M\perp}\right| = \omega R\cos\theta$$

$$e = B\ell v = B(2R)\omega R\cos\theta$$

$$= 2B\omega R^2\cos\theta$$

$$= 2\times 0.1\times 10\times 4\times\frac{3}{5} = 4.8\text{ Volt}$$

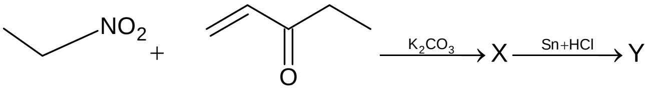
Chemistry

PART – II

SECTION – A
Straight Objective Type

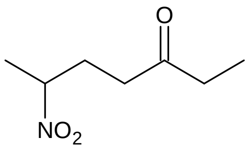
This section contains **3 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **Only One** is correct.

24. In the following reaction sequence the correct structure for the major products X & Y are

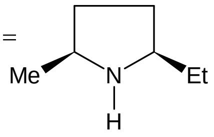

NO2
+
O
K2CO3
X
Sn+HCl
Y

(A)

X =

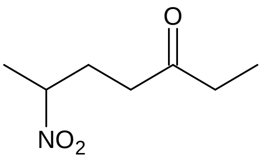


Y =

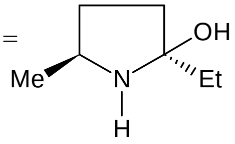


(B)

X =

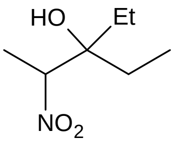


Y =

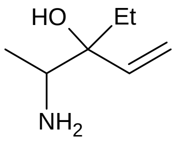


(C)

X =

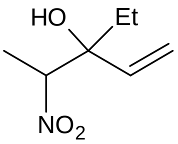


Y =

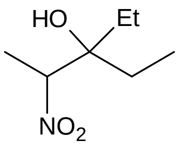


(D)

Y =

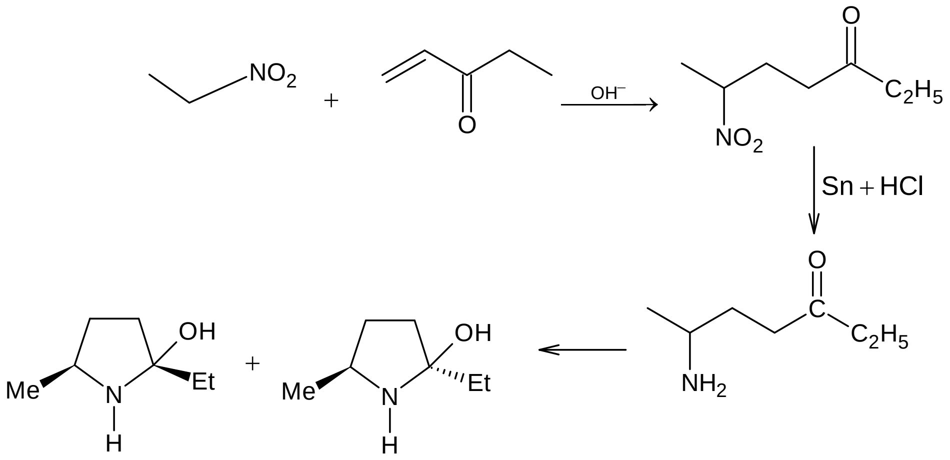


Y =



Ans. **B**

Sol.


NO2
+
O
OH−
O
C2H5
NO2
Sn + HCl
O
C
C2H5
NH2
OH
Me
N
H
Et
+
OH
Me
N
H
Et

25. Compound A, $C_5H_{10}O_5$ gives a tetraacetate with $\left(CH_3-\overset{\overset{O}{\|}}{C}\right)_2O$ and oxidation of A with $Br_2 - H_2O$ gives an acid, $C_5H_{10}O_6$. Reduction of A with red P and HI gives iso-pentane, there are two possible structures for compound A which can be distinguished by using

(A) HIO_4

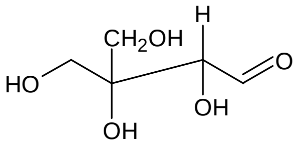
(B) Red P + HI

(C) Phenyl hydrazine

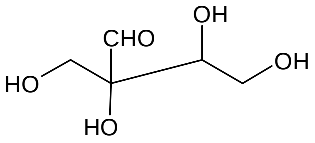
(D) Tollen's reagent

Ans. **C**

Sol.


H
CH2OH
O
HO
OH
OH

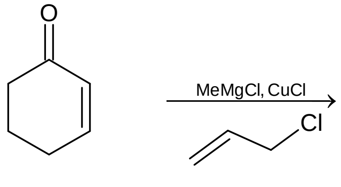
(i)


OH
CHO
OH
HO
HO

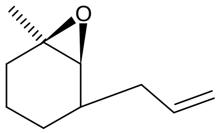
(ii)

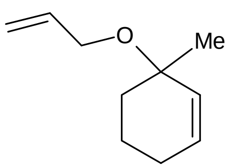
(i) will form osazone derivatives whereas (ii) will not.

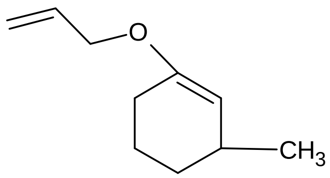
26. The major product formed in the following reaction is:

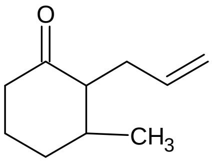

O
MeMgCl, CuCl
Cl

(A)

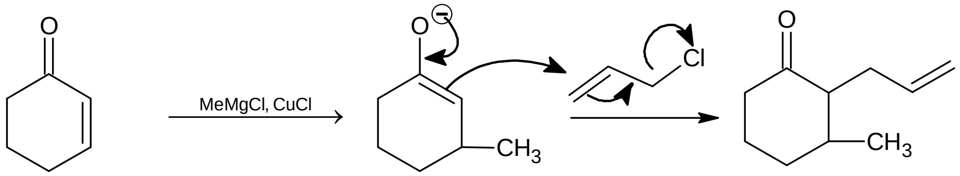


(B) 

(C) 

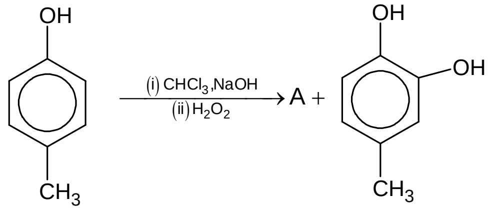
(D) 

Ans. **D**

Sol. 

(More Than One Correct Type)

This section contains **5 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **MORE THAN ONE** is/are correct.

27. 

(A) A will give +ve test with Tollen’s reagent

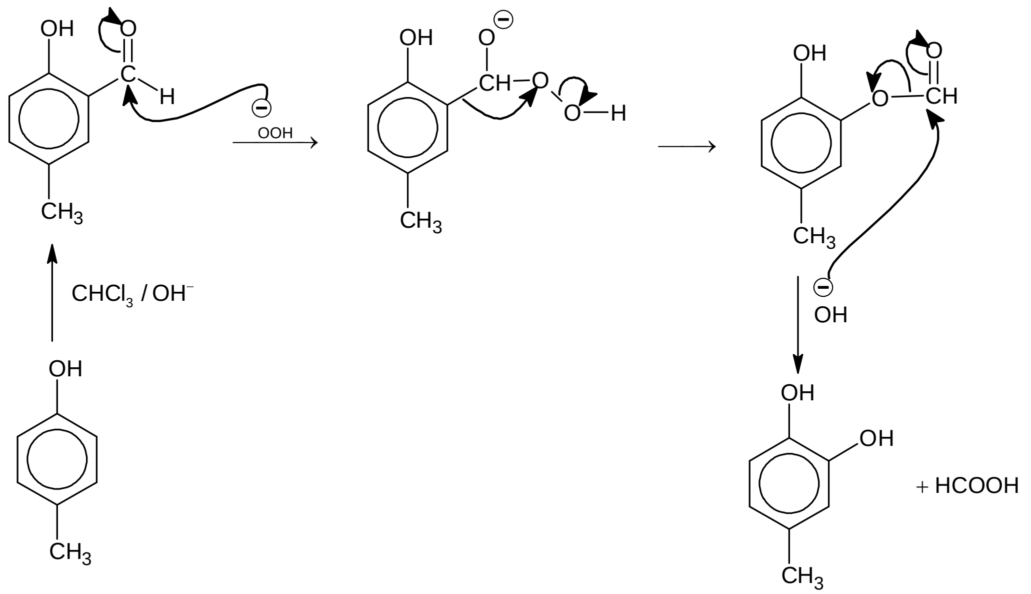
(B) A is a weak organic monobasic acid

(C) A is a aldehyde

(D) A on reaction with conc. H_2SO_4 produces a neutral gas which is a very good reducing agent.

Ans. **A, B, D**

Sol.



Hence A will be HCOOH.
HCOOH + conc. $H_2SO_4 \rightarrow CO$
CO is a neutral gas as well as very good reducing agent.

28. An organic compound contains C, H, S, N and Cl, for detection of chlorine, the sodium extract of compound is first heated with a few drop of conc. HNO_3, and than $AgNO_3$ is added to get a white ppt. of AgCl, why was HNO_3 added before the addition of $AgNO_3$.

(A) To prevent the formation of NO_2.

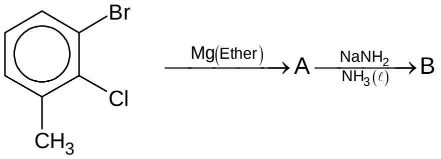
(B) To create a common ion effect.

(C) To convert CN^- and S^{-2} to volatile HCN and H_2S, else they will interfere with the test forming AgCN and Ag_2S.

(D) To prevent the hydrolysis to NaCN and Na_2S.

Ans. C

29.



(A) Both A and B are aromatic in nature.

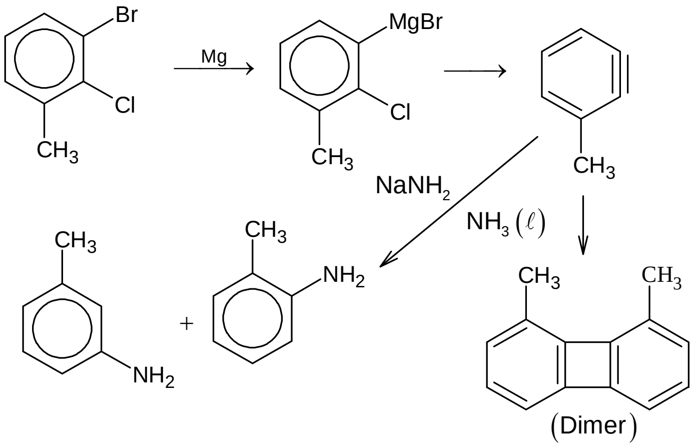
(B) Product A can show nucleophilic addition reaction.

(C) If potential nucleophile is not present then A will form dimer.

(D) B is a mixture of two structural isomers.

Ans. A, B, C, D

Sol.



30. $CH_3-CH_2-NO_2\,(X)\xrightarrow{Sn+HCl}K\,(\text{Organic compound})$, then which of the following is/are true for K?

(A) K (form solid oxamide) with diethyl oxalate.

(B) K (form liquid oxamide) with diethyl oxalate.

(C) K will not give Liberman nitroso test.

(D) K will form blue colour complex with Cu^{+2} salt.

Ans. **A, C, D**

Sol. $CH_3-CH_2-NO_2\xrightarrow{Sn+HCl}CH_3-CH_2-NH_2\,[K]$

1^o amine form solid oxamide
2^o amine form liquid oxamide
Liberman Nitroso test is given by 2^o amine

$$Cu^{+2}+4C_2H_5NH_2\longrightarrow\underset{\text{(Blue)}}{\left[Cu\left(C_2H_5NH_2\right)_4\right]^{+2}}$$

31. In which case charge in transition state is more dispersed than starting material?

(A) $CH_3X+NaNH_2$

(B) CH_3X+NH_3

(C) $\left(CH_3\right)_4N^+X^-+OH^-$

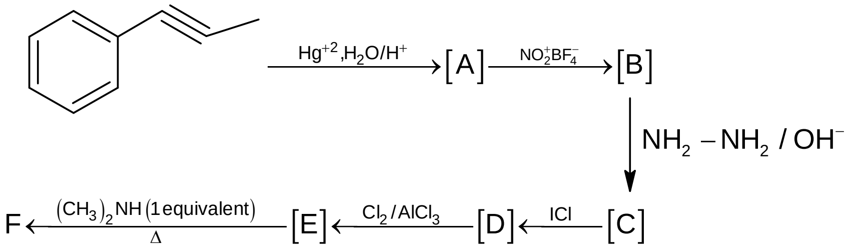
(D) $\left(CH_3\right)_4N^+X^-+RSH$

Ans. **A, C, D**

Paragraph type (One Option Correct)

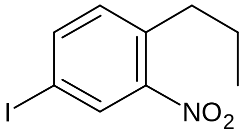
This section contains **1 paragraph** each describing theory, experiment, data etc. **Two questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 32 to 33

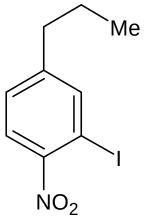

$Hg^{+2}, H_2O/H^+$
[A]
$NO_2^+BF_4^-$
[B]
NH_2-NH_2 / OH^-
[C]
ICl
[D]
$Cl_2/AlCl_3$
[E]
$(CH_3)_2NH$ (1 equivalent)
Δ
F

32. The compound (D) is

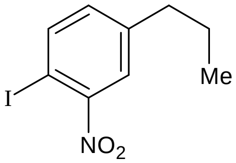
(A)



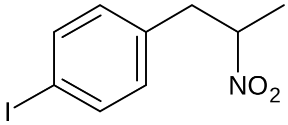
(B)



(C)



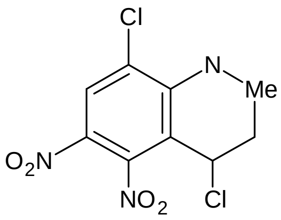
(D)



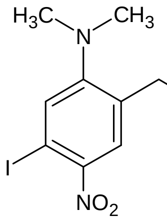
Ans. **C**

33. The compound F is

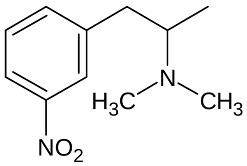
(A)


Cl
N
Me
O_2N
NO_2
Cl

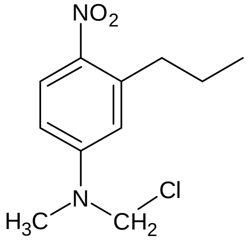
(B)


H_3C
N
CH_3
I
NO_2

(C)

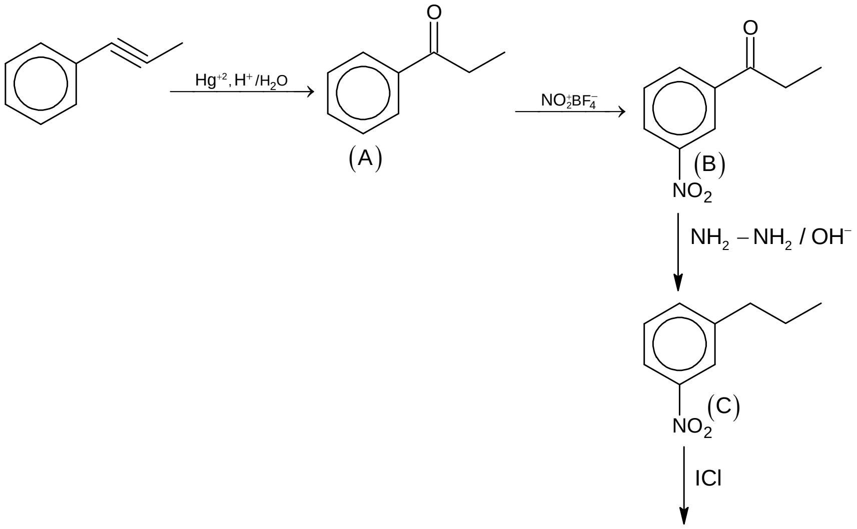

H_3C
N
CH_3
NO_2

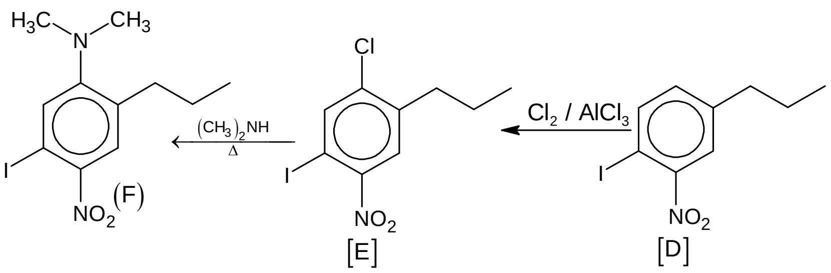
(D)


NO_2
H_3C
N
CH_2
Cl

Ans. B

Solution for the Q. No. 32 and 33.


$Hg^{+2}, H^+/H_2O$
O
(A)
$NO_2^+BF_4^-$
O
(B)
NO_2
NH_2-NH_2 / OH^-
(C)
NO_2
ICl


(F)
$(CH_3)_2NH$
Δ
[E]
Cl_2 / $AlCl_3$
[D]

Single Integer Answer Type

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

34. 2.79 gm of nitrogenous compound on reaction with CS_2 and $HgCl_2$ forms a black ppt. of 0.09 mol. If same amount of nitrogenous compound is reacted with HNO_2. How many litres of gas at STP would be formed.

Ans. 2

Sol.

$$\underset{0.09}{RNH_2} + CS_2 + HgCl_2 \longrightarrow RNCS + \underset{0.09}{HgS}\downarrow$$

$$\underset{0.09}{RNH_2} + HNO_2 \longrightarrow ROH + \underset{0.09}{N_2}\uparrow$$

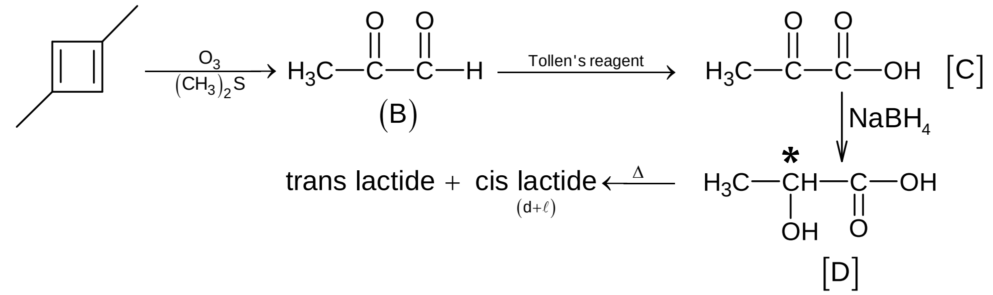
Volume in litres at STP = 0.09 × 22.4 = 2.016 $\cong 2$

35. $$C_6H_8\,(\text{anti aromatic}) \xrightarrow{O_3,(CH_3)_2S} \underset{\text{Only product}}{B} \xrightarrow{\text{Tollen's reagent}} C \xrightarrow{NaBH_4} \underset{\text{Optically active}}{D}$$

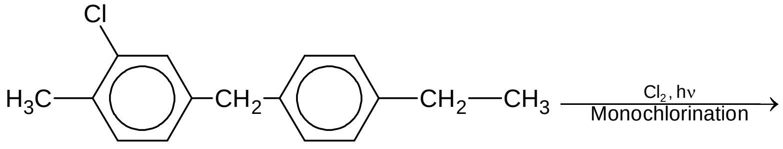
D on heating gives a major product having x number of stereoisomer, x is:

Ans. 3

Sol.


O_3
$(CH_3)_2S$
$H_3C—C(=O)—C(=O)—H$
(B)
Tollen's reagent
$H_3C—C(=O)—C(=O)—OH$
[C]
$NaBH_4$
*
$H_3C—CH(OH)—C(=O)—OH$
[D]
Δ
trans lactide + cis lactide
(d+ℓ)

36.


Cl
H_3C
CH_2
$CH_2—CH_3$
Cl_2, hν
Monochlorination

If x = maximum number of monochloroisomer possible

y = Monochloro isomer on fractional distillation will separate. Then find $\dfrac{(x+y)}{2}$

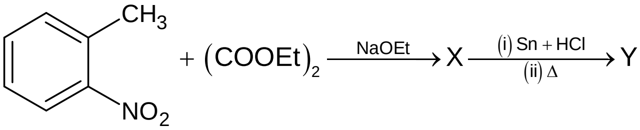
Ans. 5

Sol. x = 6

$y = 4$

$$\frac{(x+y)}{2} = 5$$

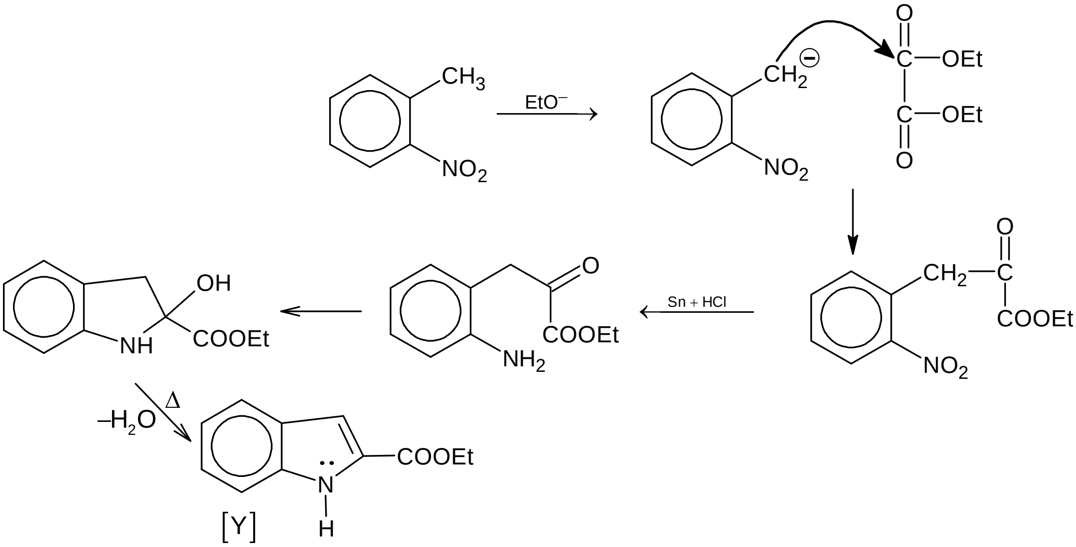
37.



Find the number of π-bond in the Y?

Ans. 5

Sol.

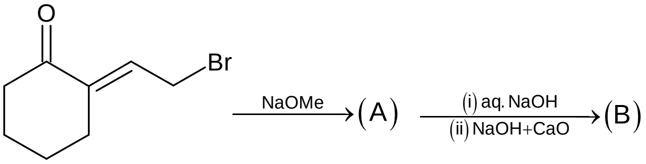


38. How many of the following are cross-linked polymer?
Bakelite, Urea-formaldehyde, Melamine-formaldehyde, Nylon-6,6, Terylene.

Ans. 3

Sol. Bakelite, Urea-formaldehyde, Melamine-formaldehyde.

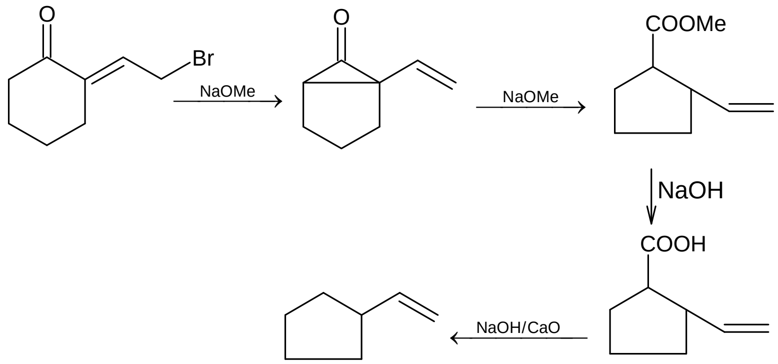
39.



The number of π-bond in product (B) is:

Ans. 1

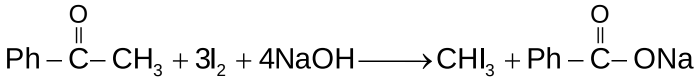
Sol.


O
Br
NaOMe
O
NaOMe
COOMe
NaOH
COOH
NaOH/CaO

40. 1.2 gram of acetophenone on reaction with 76.2 gram of I_2 in presence of NaOH give solid iodoform with 75% yield. Find the weight of iodoform formed in gram.

Ans. 3

Sol.



$$Ph-\overset{\overset{O}{||}}{C}-CH_3 + 3I_2 + 4NaOH \longrightarrow CHI_3 + Ph-\overset{\overset{O}{||}}{C}-ONa$$

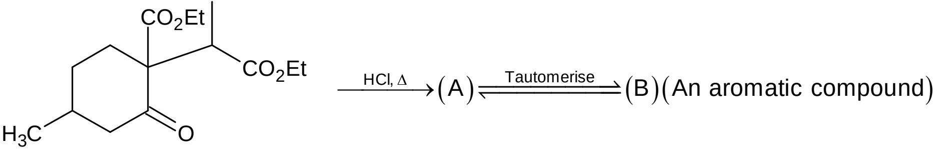
1 mole of $Ph-\overset{\overset{O}{||}}{C}-CH_3$ will give 1 mole of CHI_3

120 gram will give $\equiv$ 394 g CHI_3
1.2 gram will give $\equiv$ 3.94 g CHI_3

Hence, with 75% yield $= 3.94 \times \dfrac{75}{100} = 2.955$ gram

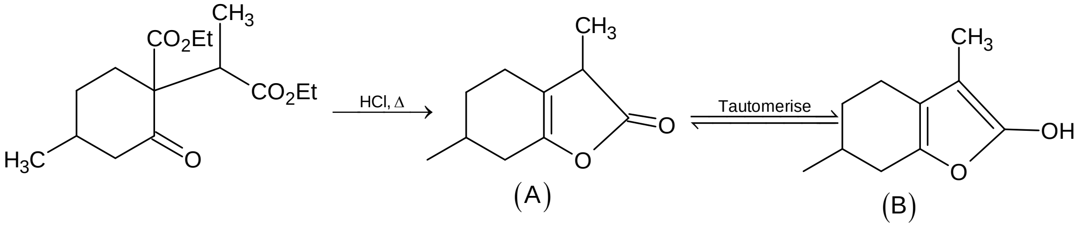
$\cong$ 3 gram.

41. In the following sequence of reaction the degree of unsaturation in the (B) is


CO2Et
CO2Et
H3C
O
HCl, Δ
(A)
Tautomerise
(B)(An aromatic compound)

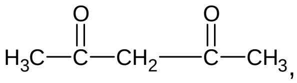
Ans. 4

Sol.

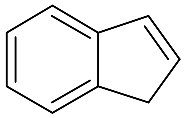

CH3
CO2Et
CO2Et
H3C
O
HCl, Δ
CH3
O
O
(A)
Tautomerise
CH3
OH
O
(B)

Degree of unsaturation = 4

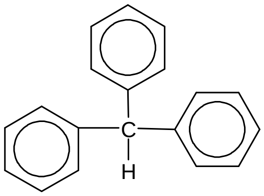
42. How many will liberates CO_2 gas on reaction with $NaHCO_3$?

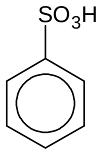


$H_3C-\overset{\overset{O}{||}}{C}-CH_2-\overset{\overset{O}{||}}{C}-CH_3$,



, $CH_3-SO_2CHSO_2CH_3$,

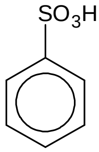




, CN – CH_2 – CN

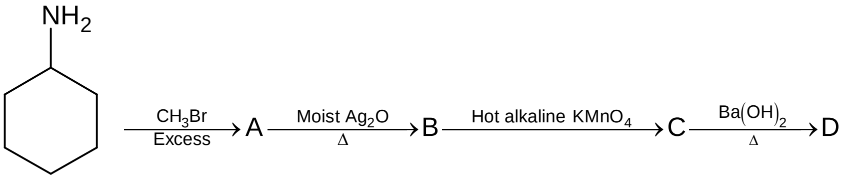
Ans. **1**

Sol.



, Rest all have pK_a value greater than H_2CO_3.

43.

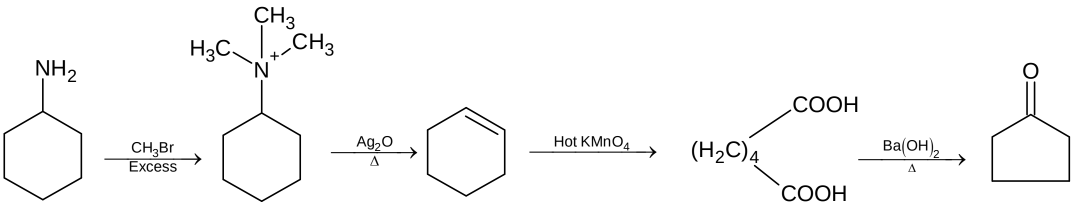


$\xrightarrow[\text{Excess}]{CH_3Br} A \xrightarrow[\Delta]{\text{Moist } Ag_2O} B \xrightarrow{\text{Hot alkaline } KMnO_4} C \xrightarrow[\Delta]{Ba(OH)_2} D$

If number of carbon atom in D is x and π-bond is y.
Find x + y?

Ans. **6**

Sol.



SECTION – D
(Numerical Answer Type)

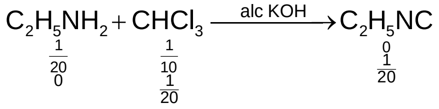
This section contains **3 questions**. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

44. 2.25 g of a nitrogenous compound having molecular formula (C_2H_7N) is reacted with 11.95 g of $CHCl_3$ in presence of alc. KOH to form a bad smelling gas. One of the remaining reactant after some times becomes poisonous due to aerial oxidation. This poisonous gas is now removed by C_2H_5OH to form a precipitate. Find the weight of precipitate (in gram).

Ans. **00005.90**

Sol.



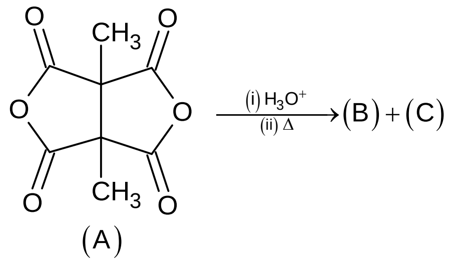
$$\underset{\substack{\frac{1}{20}\\0}}{C_2H_5NH_2}+\underset{\substack{\frac{1}{10}\\\frac{1}{20}}}{CHCl_3}\xrightarrow{\text{alc KOH}}\underset{\substack{0\\\frac{1}{20}}}{C_2H_5NC}$$

$$CHCl_3\xrightarrow{O_2,\,h\nu}COCl_2$$

$$COCl_2+2C_2H_5OH\longrightarrow(C_2H_5)_2CO_3$$

Hence precipitate = $\frac{1}{20}\times118=5.9$ gram

45.



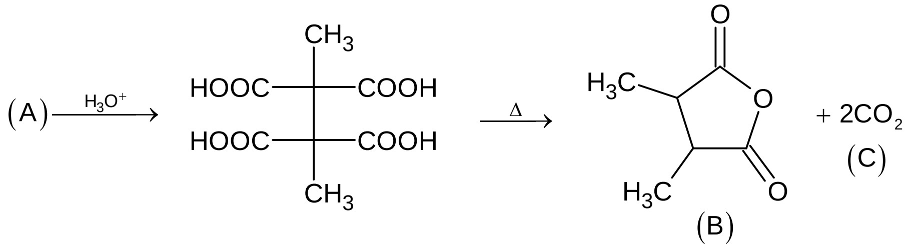
$\xrightarrow[\text{(ii) }\Delta]{\text{(i) }H_3O^+}(B)+(C)$

(A)

1.1 mole of (A) was reacted according to above reaction. 'C' is the gas produced which turns lime water milky. The amount of C formed in gram will be? (Given At. Wt. of C, O, H are 12, 16, 1 gm respectively).

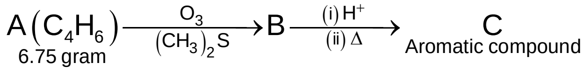
Ans. **00096.80**

Sol.



1.1 mole of (A) produce 2.2 mole of CO_2(g)
$\therefore$ wt. of CO_2 = 2.2 × 44 = 96.8 gm.

46.

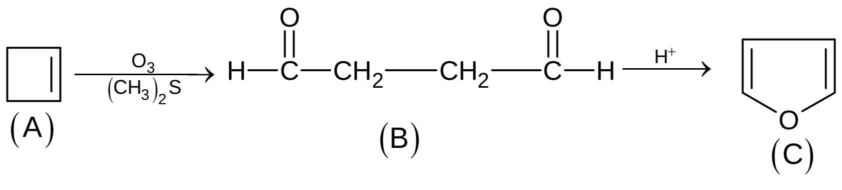


$$\underset{6.75\text{ gram}}{A(C_4H_6)}\xrightarrow[(CH_3)_2S]{O_3}B\xrightarrow[\text{(ii) }\Delta]{\text{(i) }H^+}\underset{\text{Aromatic compound}}{C}$$

A is a cyclic isomer having molecular formula C_4H_6. How many gram of C would be formed if 6.75 g of A was taken?

Ans. **00008.50**

Sol.



Moles of A $=\frac{6.75}{54}=\frac{1}{8}$ mole

Hence, $\frac{1}{8}$ mole of C would be formed

Wt. of C = $\frac{1}{8}\times68=8.5$ gm

Mathematics

PART – III

SECTION – A

Straight Objective Type

This section contains **3 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which only **one** is correct

---

47. The length of medians of a triangle are 3, 4 and 5 cm. The area (in square cm) of the triangle is

(A) 8

(B) 12

(C) 24

(D) 32

Ans. A

Sol. $A = \frac{4}{3} \times \frac{1}{2} \times 3 \times 4 = 8$

48. The number of right-angled ΔABC (∠A = 90º) with integers side length whose inradius is 3 are

(A) 3

(B) 4

(C) 5

(D) 8

Ans. A

Sol. $\because (s-a)\tan\left(\frac{A}{2}\right) = r$ (∠A = 90º)

(s – a) = r, 2s – 2a = 2r, b + c – a = 2r, a = (b + c – 2r)
$(b - 6)(c - 6) = 2 \times 3^2$

49. P is a point inside an equilateral triangle ABC such that PA = 9, PB = 12 and PC = 15, then side length of the ΔABC is

(A) $\sqrt{225+108\sqrt{5}}$

(B) $\sqrt{225-\sqrt{33}}$

(C) $\sqrt{49+5\sqrt{2}}$

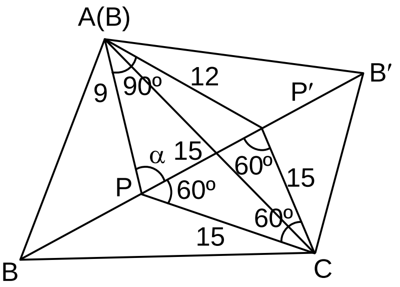
(D) none of these

Ans. **A**

Sol. $\cos(\alpha + 60^o) = \dfrac{15^2 + 9^2 - (AC)^2}{2.15.9}$ ..... (1)

Also, $\cos\alpha = \dfrac{9}{15} = \dfrac{3}{5}$

So, $a = \sqrt{225 + 108\sqrt{5}}$



One OR More Than One Choice Type

This section contains **5 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **one or more than one** is/are correct

---

50. Which of the following are **INCORRECT?**

(A) $(\sin x)^{\sin x} > (\cos x)^{\cos x}\ \forall\ x \in \left(0, \dfrac{\pi}{4}\right)$

(B) $(\cos x)^{\sin x} < (\sin x)^{\cos x}\ \forall\ x \in \left(0, \dfrac{\pi}{12}\right)$

(C) $x \cot x < \dfrac{\sqrt{3}}{\pi}\ \forall\ x \in \left(0, \dfrac{\pi}{3}\right)$

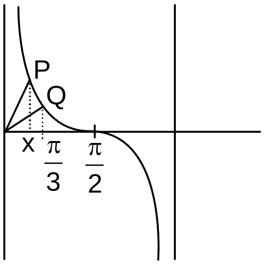
(D) $\sqrt{\sin x + \cos 2x} < \sqrt{\sin x} + \sqrt{\cos 2x}\ \ \forall\ x \in \left(0, \dfrac{\pi}{4}\right)$

Ans. **A, B, C**

Sol. (A) Use Jensen's inequality for sin x < cos x < sin x + cos x with weights
$\lambda_1 = \tan x$ and $\lambda_2 = 1 - \tan x$ ($\because\ 0 < x < \pi/4$), λ_1 and λ_2 are positive)
So, $\log(\cos x) = \log(\tan x \sin x + (1 - \tan x)(\sin x + \cos x))$
$> \tan x \log(\sin x) + (1 - \tan x)\log(\sin x + \cos x)$
$\because\ \sin x + \cos x > 1$ and $\tan x < 1$. So, $\log(\cos x) > \tan x \log(\sin x)$

(B) For $x \in \left(0, \dfrac{\pi}{12}\right)$; cos x > sin x. So, $\ln\dfrac{(\cos x)}{\cos x} > \ln\dfrac{(\sin x)}{\sin x}$

(C) Shown in the figure
m(OP) > m(OQ)



(D) $\because\ (a + b)^p \le a^b + b^p$ for a, b > 0 and $0 \le p \le 1$

51. Which of the following are **INCORRECT?**

(A) $\frac{1}{3} > \sin 20^{o} > \frac{7}{20}$

(B) $\cos x < 1 - \frac{x^2}{2} + \frac{x^4}{16}\ \forall\ x \in \left(0, \frac{\pi}{2}\right)$

(C) $\tan x < x + \frac{x^3}{3} + \frac{2x^5}{15}\ \forall\ x \in \left(0, \frac{\pi}{2}\right)$

(D) cos 2º and cos 7º are irrational

Ans. A, C

Sol. Use sin 3t = 3 sin t – 4 $\sin^3$ t
Let t = 20º

52. Let x – 2y – 5 = 0 be the directrix of a parabola and x – y – 7 = 0 be the tangent drawn to the parabola at the point P(4, –3), then which of the following are **INCORRECT?**

(A) length of latus rectum = $\frac{16}{\sqrt{5}}$

(B) harmonic mean of length of segments of the focal chord = $\frac{8}{\sqrt{5}}$

(C) intersection point of the directrix and the given tangent is (9, 2)

(D) circle drawn on assuming P(4, –3) and Q as diameter, always passes through focus of the parabola (where Q is the intersection point of tangent and directrix)

Ans. A, B

Sol. Foot of perpendicular P(4, –3) to the directrix is (3, –1)

Now, find its image about the tangent $\frac{\alpha - 3}{1} = \frac{\beta + 1}{-1} = \frac{-2(3+1-7)}{2}$

α = 6, β = –4. So, focus ≡ (6, –4)

Now, distance of focus from the directrix = $\frac{|6+8-5|}{\sqrt{5}} = \frac{9}{\sqrt{5}}$

53. Let ABCD be a quadrilateral inscribed in a circle. Suppose $AB = \sqrt{2+\sqrt{2}}$ and AB subtends 135º at the centre of the circle, the maximum possible area of ABCD is

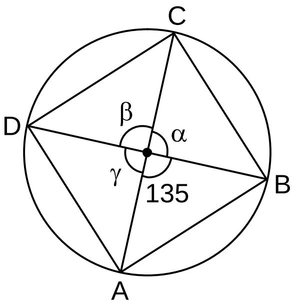
(A) $\frac{5+3\sqrt{3}}{4\sqrt{2}}$

(B) $\frac{8+\sqrt{7}}{\sqrt{3}}$

(C) $\frac{19+\sqrt{3}}{2}$

(D) none of these

Ans. **A**



Sol. $\because$ $\alpha, \beta, \gamma < \pi$ and y = sin x is concave downward on $(0, \pi)$

So, $\frac{\sin\alpha+\sin\beta+\sin\gamma}{3} \le \sin\left(\frac{\alpha+\beta+\gamma}{3}\right) = \sin 75^o$

So, area of ABCD $\le \frac{1}{2}\sin(135^o) + \frac{1}{2}(\sin\alpha+\sin\beta+\sin\gamma)$

$= \frac{5+3\sqrt{3}}{4\sqrt{2}}$

Equality holds if $\alpha = \beta = \gamma = 75^o$

54. If the vertices of an equilateral Δ lies on the curve $8x^3 + y^3 + 6xy = 1$, then

(A) side length of the triangle is $\frac{6}{\sqrt{15}}$

(B) side length of the triangle is $\frac{\sqrt{3}}{2}$

(C) area of the triangle is $\frac{3\sqrt{3}}{5}$

(D) area of the triangle is $\frac{3\sqrt{3}}{16}$

Ans. **A, C**

Sol. $(2x + y - 1)(4x^2 + y^2 + 1 - 2xy + y + 2x) = 0$ and side length of the $\Delta = \frac{6}{\sqrt{15}}$

So, area = $\frac{3\sqrt{3}}{5}$

Paragraph type (One Option Correct)

This section contains **1 paragraph** each describing theory, experiment, data etc. **Two questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 55 to 56

Read the following write up carefully and answer the following questions:

Diameter of ellipse is a line passing through the centre of the ellipse. Consider the set of parabola(s) having common chord of minimum length with the diameter of the ellipse $x^2 + y^2 + xy = 8$ and the line $mx - y + 4 = 0$ as directrix

55. The set of value(s) of m for which only one parabola is possible is

(A) $\left\{-\sqrt{2}, \sqrt{2}\right\}$

(B) $\left\{-\sqrt{5}, \sqrt{3}\right\}$

(C) $\{-2, 2\}$

(D) none of these

Ans. **A**

56. The range of value(s) of m for which two parabola(s) are possible is

(A) $\left(-\infty, -\sqrt{2}\right) \cup \left(\sqrt{2}, \infty\right)$

(B) $(-\infty, -2) \cup (2, \infty)$

(C) $\left(-\infty, -\sqrt{3}\right) \cup \left(\sqrt{3}, \infty\right)$

(D) none of these

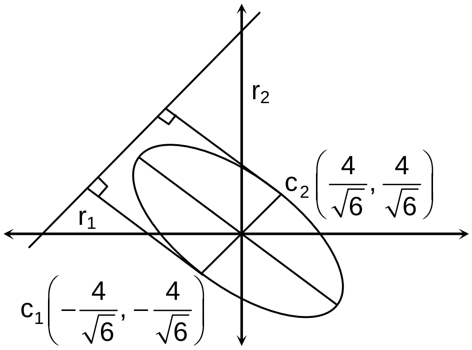
Ans. **A**

Sol. (55.-56.)

For the ellipse $x^2 + y^2 + xy = 8$, $c \equiv (0, 0)$

For one parabola $\frac{8}{\sqrt{m^2+1}} = \frac{8}{\sqrt{3}}$: ($\because$ $C_1C_2 = r_1 + r_2$)

For two parabola(s) : $C_1C_2 < r_1 + r_2$


r2
r1
$c_2\left(\frac{4}{\sqrt{6}}, \frac{4}{\sqrt{6}}\right)$
$c_1\left(-\frac{4}{\sqrt{6}}, -\frac{4}{\sqrt{6}}\right)$

SECTION – C

(One Integer Value Correct Type)

This section contains **10 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

57. Consider the ellipse $4x^2 + y^2 - 8x + 4y + 4 = 0$. Pair of tangents PT_1 and PT_2 are drawn to the ellipse from P(–8, –2). Let $S_1^{'}$ be the image of S_1 about PT_1 and $S_2^{'}$ be the image of S_2 about PT_2, then if $\angle PS_1S_2^{'} = \alpha$ and $\angle PS_1^{'}S_2 = \beta$, then $\frac{\alpha}{\beta}$ is equal to _____

Ans. **1**

Sol. $\Delta PS_1^{'}S_2$ and $\Delta PS_1S_2^{'}$ are similar

58. If tangents drawn to the parabola at A(1, 2) and B(5, 8) intersect at (–1, 8), then slope of directrix is $\frac{a}{b}$ where gcd(a, b) = 1, then a + b is _____

Ans. **7**

Sol. Q = mid-point of AB = (3, 5), let P $\equiv$ (–1, 8), m(PQ) = $-\frac{3}{4}$

Slope of directrix = $\frac{4}{3}$

59. Given a point (3, 2), then the minimum perimeter of a triangle with one vertex at (3, 2) one on the x-axis and one on the line y = x (you may assume that a triangle with minimum perimeter exists) is $\sqrt{\alpha}$, then sum of digits of α is _____

Ans. **8**

Sol. For minimum perimeters (2, 3), (d, d) (c, 0), (3, –2) are collinear
Hence, mini perimeter = $\sqrt{26}$

60. If focus of the parabola which touches x = 0, y = 0, x – y + 1 = 0 and –2x – y – 8 = 0 is (α, β), then $\left|\frac{\alpha}{\beta}\right|$ is _____

Ans. **3**

Sol. Focus is intersection point of circles x(x + 1) + y(y – 1) = 0 and (x)(x + 4) + (y)(y + 8) = 0
$\equiv \left(-\frac{6}{5}, \frac{2}{5}\right)$

61. If $3\sqrt{2}$, $4\sqrt{2}$ and $\frac{12}{5}\sqrt{2}$ be the altitudes of a triangle, then $r\sqrt{2}$ (r is inradius of the triangle) is equal to _____

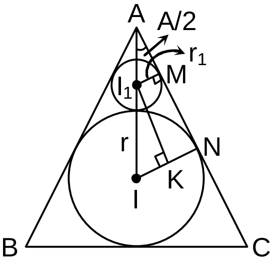
Ans. **2**

Sol. $\because$ Harmonic mean of the altitudes of a triangle is 3 times its inradius

So, $r = \frac{1}{19}\left(\frac{5}{12\sqrt{2}} + \frac{1}{4\sqrt{2}} + \frac{1}{3\sqrt{2}}\right)$

62. Let ABC be a triangle (with $\angle A = \pi/3$) and a circle C_1 be drawn lying in side the triangle, touching its in-circle externally and also touching the two sides AB and AC, then ratio of the radii of the circles C_1 and C is k, then 3k is equal to _____

Ans. **1**



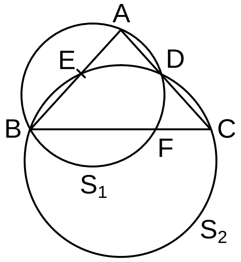
Sol. In triangle II_1K

$$\sin\left(\frac{A}{2}\right)=\frac{IK}{II_1}=\frac{r-r_1}{r+r_1} \Rightarrow \frac{1-\sin\left(\frac{A}{2}\right)}{1+\sin\left(\frac{A}{2}\right)}=\frac{r+r_1-r+r_1}{r+r_1+r-r_1}$$

$\tan^2\left(\frac{\pi-A}{4}\right)=\frac{r_1}{r}$. So, $\frac{r_1}{r}=\tan^2\left(30^o\right)=\frac{1}{3}$

63. Let BD be the internal angle bisectors of angle B in triangle ABC with D on side AC. The circumcircle of triangle BDC meets AB at E, while the circumcircle of triangle ABD meets BC at F. if AE = 3, then CF is equal to

Ans. 3



Sol. Let circumcircle of triangle BDC be S_1 and the circumcircle of triangle ABD be S_2

So, $\frac{AD}{CD}=\frac{AB}{BC}$ ..... (1)

Now, for circle S_1:

AE × AB = AD × AC

$\Rightarrow AE=\frac{AD\times AC}{AB}$ ..... (2)

For circle S_2:

CF × CB = CD × CA

$\Rightarrow CF=\frac{CD\times CA}{CB}$ ..... (3)

From equation (2) and (3), we get

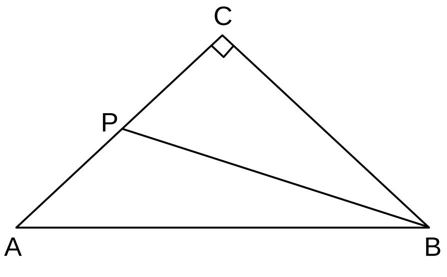
$\frac{AE}{CF}=\frac{AD\times CB}{AB\times CD}$ ..... (4)

From equation (1) and (4), AE = CF

So, CF = 3

64. In an isosceles right angled triangle ΔABC, CA = CB = 1, and P is an arbitrary point on the perimeter of ΔABC, then if maximum value of PA·PB·PC is α, then $6\sqrt{2}\alpha$ is _____

Ans. 3



Sol. **(I):** Let P ∈ AC

$PA\cdot PC\le\frac{1}{4}$ and $PB\le\sqrt{2}$

Thus $PA\cdot PC\cdot PB\le\frac{\sqrt{2}}{4}$

The two equality sign can not be valid at the same time

So, $PA\cdot PC\cdot PB<\frac{\sqrt{2}}{4}$

(II): P $\in$ AB

$AP = x \in \left(0, \sqrt{2}\right]$

So, let f(x) = $(PA)^2(PB)^2)PC)^2$

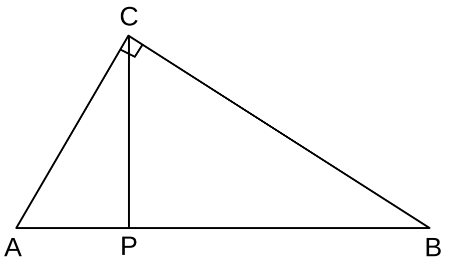
$$= x^2\left(\sqrt{2}-x\right)^2\left(1+x^2-x\sqrt{2}\right)$$

Let $t = x\left(\sqrt{2}-x\right) : t \in \left[0, \frac{1}{2}\right]$

So, f(x) = g(t) = $t^2(1 - t)$

$\therefore\ f(x) \le g(t) \le g\left(\frac{1}{2}\right) = \frac{1}{8}$

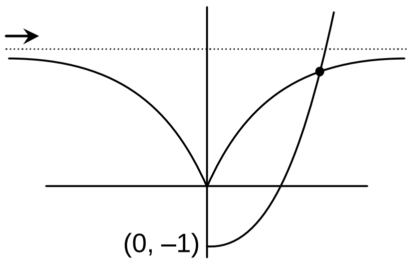
$PA \cdot PB \cdot PC \le \frac{1}{2\sqrt{2}}$. Clearly P is the mid-point of AB



65. Number of solution of the equation $\left(\cos^{-1}\left(\frac{1-4x^2}{1+4x^2}\right)\right)^{\frac{3}{4}} = x^2 - x\sin x - \cos x$ is

Ans. 2

Sol. Shown in the figure



66. Two circles C_1, C_2 of radii $\frac{1}{3}$ and $\frac{2}{7}$ touch each other externally and they both touch a unit circle C internally. A circle C_3 of radius R is inscribed to touch the circles C_1, C_2 externally and the circle C internally, then 19R is equal to _____

Ans. 2

Sol. $R = \dfrac{\frac{1}{3}\cdot\frac{2}{7}}{1-\frac{1}{3}\cdot\frac{2}{7}} = \frac{2}{19}$

SECTION – D
(Numerical Answer Type)

This section contains **3 questions**. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

67. If the exhaustive set of x $\in$ (0, 2π) for which ∀ n the inequality sin x + sin 2x + sin 3x + ... + sin(nx) $\le \frac{\sqrt{3}}{2}$ is valid $\ell_1 \le x \le \ell_2$, k $\in$ I, then $\frac{3|\ell_1 - \ell_2|}{2\pi}$ is _____

Ans. **00002.00**

Sol. Clearly, $0 < x < \frac{2\pi}{3}$ not valid, for $\frac{2\pi}{3} \le x \le 2\pi$

$$\sin x = \frac{\cos\left(\frac{x}{2}\right) - \cos\left(\frac{2x+1}{2}\right)x}{2\sin\left(\frac{x}{2}\right)} \le \frac{\cos\left(\frac{x}{2}\right)+1}{2\sin\left(\frac{x}{2}\right)} = \frac{\cot\left(\frac{x}{4}\right)}{2} \le \frac{\sqrt{3}}{2}$$

68. The least numbers A such that for any two squares of combined area 1 and a rectangle, of area A exists such that the two squares can be packed in the rectangle (without interior overlap). You may assume that the sides of the squares are parallel to the sides of the rectangle, is _____

Ans. **00001.20**

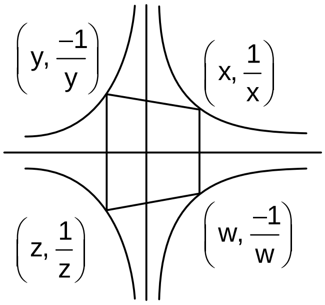
Sol. If x and y are the sides of two squares then $x^2 + y^2 = 1$
Let without loss of generality $x \ge y$
So, shorter side of the rectangle should be at least x
Longer side at least and (x + y)
So, $A \equiv x(x + y)$
Put $x = \cos\theta$, $y = \sin\theta$, $\theta \in \left[0, \frac{\pi}{4}\right]$

$$A = \frac{1}{2} + \frac{\sqrt{2}}{2}\cos\left(2\theta - \frac{\pi}{4}\right) \le \frac{1+\sqrt{2}}{2} \text{ equality holds if } \theta = \frac{\pi}{8}$$

69. The least possible area of a convex set in plane that intersects both branches of the hyperbola xy = 1 and both branches of the hyperbola xy = –1 is _____

Ans. **00004.00**

Sol. For minimum area x = y = z = w
$A_{min} = 4$


$\left(y, \frac{-1}{y}\right)$
$\left(x, \frac{1}{x}\right)$
$\left(z, \frac{1}{z}\right)$
$\left(w, \frac{-1}{w}\right)$

FIITJEE

ALL INDIA TEST SERIES

PART TEST – II

JEE (Main)-2018-19

TEST DATE: 11-11-2018

Time Allotted: 3 Hours **Maximum Marks: 360**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only one section: **Section-A**.

  Section-A (01 – 30, 31 – 60, 61 – 90) *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

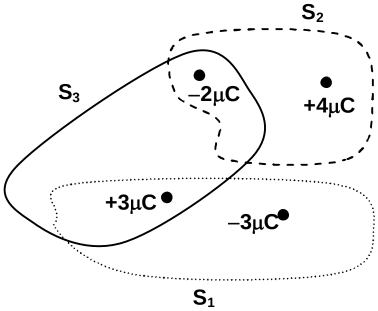
Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. An array of point charges and a set of closed Gaussian surfaces S_1, S_2, and S_3 are illustrated in the figure. Choose the correct statement:



(A) Flux passing through S_1 is $\frac{1\mu C}{\varepsilon_0}$

(B) Flux passing through S_2 is $\frac{2\mu C}{\varepsilon_0}$

(C) Flux passing through S_3 is $\frac{4\mu C}{\varepsilon_0}$

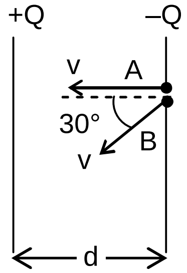
(D) Flux passing through S_1 is $\frac{2\mu C}{\varepsilon_0}$

Ans. B

Sol. Gauss' Law

flux = $\frac{q_{\text{enclosed}}}{\varepsilon_0}$

2. Two electrons enter a region at same point between charged capacitor plates with equal speed v. Electron A is moving horizontally to the left while electron B's velocity is directed at 30° below the horizontal. Each electron reaches left plate. Which one of the following choice best compares the speeds of electron upon arrival at the left plate? Ignore mutual interaction between electrons, gravity, any fringing effect of the fields and relativistic effects. Assume electric field between plates does not change due to electrons. (v_A : speed of electron A when it reaches left plate. v_B : speed of electron B when it reaches left plate.)



(A) $v_A > v_B$

(B) $v_A = v_B$

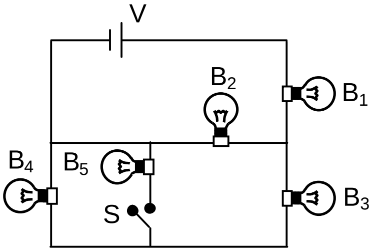
(C) $v_A < v_B$

(D) The answer depends on magnitude of the charge, Q on each plate.

Ans. B

Sol. Using conservation of mechanical energy for the particle field system as the particle cross the region between the plates, we write $\Delta KE + \Delta PE = 0$ where $\Delta PE = q\Delta V$. Since the potential difference between the plates will be the same for each charge, the change in PE of the charge field system is the same in each case, meaning the change in KE is the same for each charge. Hence, each charge reaches the other side with the same speed.

3. Five identical light bulbs are connected in a circuit as shown. All wires are ideal with no resistance, and the ideal battery has emf V. When the switch S in the circuit is closed, aside from bulb B_5, which of the other bulbs glow brighter than before.



(A) Only Bulb B_4

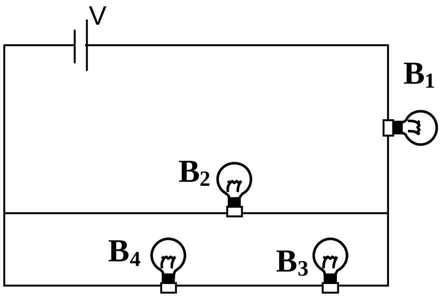
(B) Only Bulb B_1 and B_3

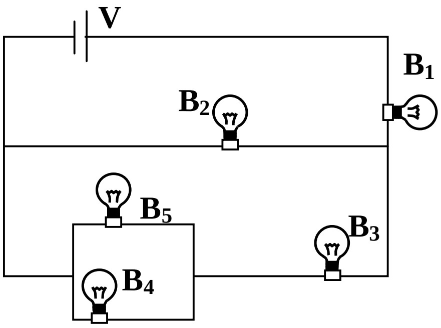
(C) Only Bulb B_3 and B_4

(D) Only Bulb B_2, B_3, and B_4

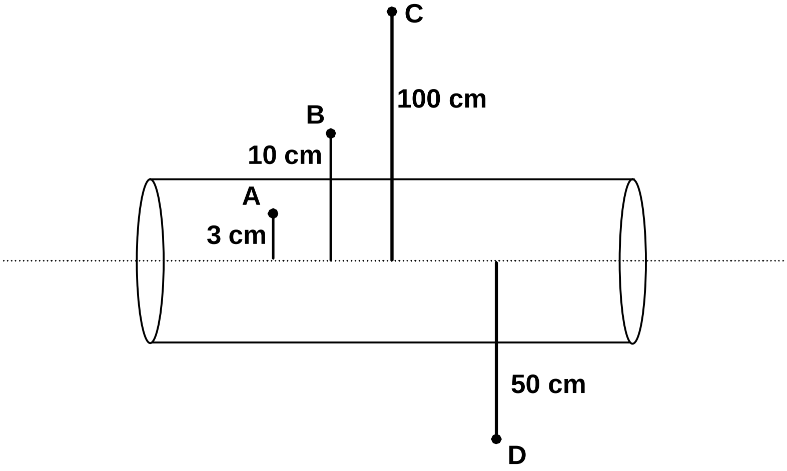
Ans. B

Sol. The equivalent circuit before and after the switch is closed for the resistors is shown in the figure. In words, by closing the switch the resistance of the entire circuit goes down since the resistance of the bottom branch drops from 2R to (3/2)R. Since there is less resistance in the circuit, there is more current, meaning that there is more current through bulb B_3 from Kirchhoff's loop rule with the battery and bulb B_1. Bulb B_2 is dimmer. Finally, since the resistance of the bottom branch decreased, it now gets a higher amount of current.





4. An infinite long cylindrical shell of radius 5 cm has a charge of 30 nC/m per unit axial length on its surface (uniformly distributed), as shown in the figure. Choose the **INCORRECT** statement.



(A) The electric field at point A at distance of 3 cm from axis of cylinder is 0 N/C

(B) The electric field at point B at distance of 10 cm from axis of cylinder is 5400 N/C

(C) The electric field at point C at distance of 100 cm from axis of cylinder is 540 N/C

(D) The electric field at point D at distance of 50 cm from axis of cylinder is 1800 N/C

Ans. **D**

Sol. $E = \frac{\lambda}{2\pi\varepsilon_0 r} = \frac{9\times10^9\times2\times30\times10^{-9}}{r} = \frac{540}{r}\text{N/C}$

5. Eight identical charged particles are located on a circle as shown in the figure-(1). Which vector shown in figure-(2), best represents the direction of net force acting on the charged particle-4 due to other charged particles.

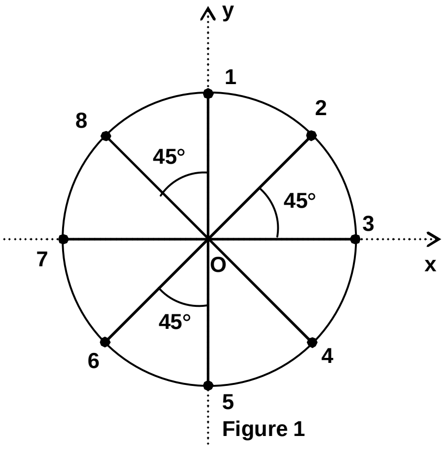


Figure 1

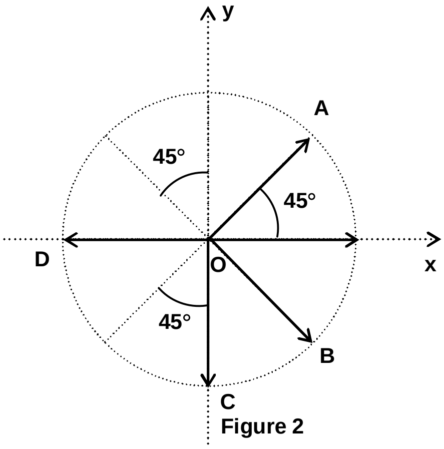


Figure 2

(A) A

(B) B

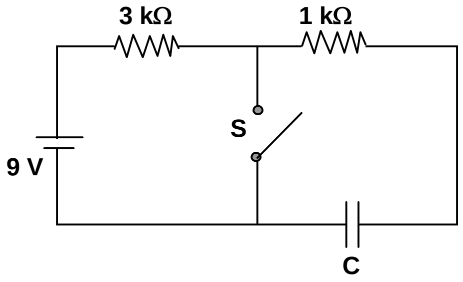
(C) C

(D) D

Ans. **B**

Sol. Since all of the charges around the circle are equal, the forces between them are repulsive. Particle 3 and 5 are at same distance away from particle-4 and repel the particle-4 with the same force in magnitude and resulting force will be along $\overrightarrow{OB}$. Likewise for particles 2 and 6 and particle 1 and 7. The force of particle-8 on particle-4 will be along $\overrightarrow{OB}$. Hence net force on particle-4 will be along $\overrightarrow{OB}$.

6. In the circuit shown, the switch S has been left open for a very long time. All circuit elements are considered to be ideal. Which one of the following statements best describes the behaviour of the current through the switch S once it is closed?



(A) The current initially is 12 mA and decreases to a steady 3 mA

(B) The current initially is 3 mA and increases to a steady 12 mA

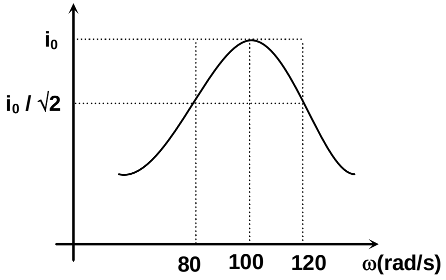
(C) The current initially is 9 mA and decreases to a steady 3 mA

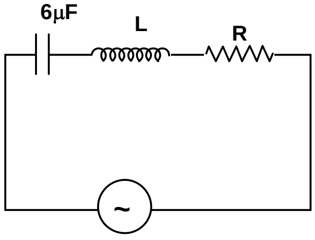
(D) The current initially is 6 mA and decreases to a steady 3 mA

Ans. **A**

Sol. Using Kirchoff loop Rule around the outside of the circuit reveals that the potential difference across the capacitor is 9V since there is no current after a long time. Once the switch is closed, there is a loop that encloses the battery and 3 kΩ resistor resulting in a total of 9 = 3000 I ⇒ I = 3 mA through the resistor. For the other branch on the right, there is a capacitor initially charged and a 1 kΩ resistor.

7. An LCR series circuit is connected to a sinusoidal AC voltage of variable angular frequency and the graph between peak current and angular frequency is plotted as shown in the figure. If capacitance of capacitor used is 6 μF, then choose the correct alternative.





(A) L = 16.67 H, R = 1.3 kΩ

(B) L = 3.34 H, R = 12 kΩ

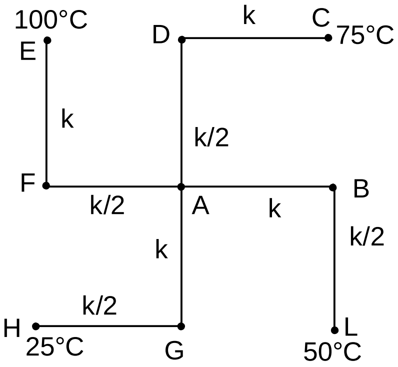
(C) L = 16.67 H, R = 0.67 kΩ

(D) can't be calculated

Ans. C

Sol.
$$Q = \frac{\omega}{2\Delta\omega} = \frac{100}{40} = \frac{5}{2}$$
$$Q = \frac{\omega_0 L}{R} \Rightarrow \frac{5}{2}\omega_0 C = \frac{1}{R}$$
$$R = \frac{2}{5} \times \frac{1}{100 \times 6 \times 10^{-6}} \Rightarrow R = \frac{2}{30} \times 10^4$$
$$= \frac{2}{3} \times 10^3 = 0.67\ \text{k}\Omega$$
$$\omega_0 = \frac{1}{\sqrt{LC}} \Rightarrow L = \frac{1}{\omega^2 C} = \frac{10^6}{10^4 \times 6} = 16.67\text{H}$$

8. All rods have identical length and cross-sectional area. Find the temperature at junction A. The thermal conductivity of rod-AF, rod-GH rod-BL & rod-AD are $\frac{k}{2}$ and the thermal conductivity of rod-EF, rod-CD, rod-AB & rod-AG are k.



(A) $\frac{125°\text{C}}{4}$

(B) $\frac{125°\text{C}}{2}$

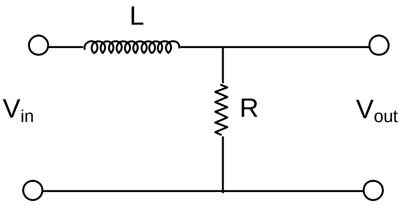
(C) Zero

(D) 125°C

Ans. B

Sol.
$$\frac{x-100}{3R} + \frac{x-75}{3R} + \frac{x-25}{3R} + \frac{x-50}{3R} = 0$$
$$4x - 250 = 0$$
$$x = \frac{250°\text{C}}{4}$$

9. An L–R circuit is made so that the AC - input (angular frequency : ω) is applied across the combination of L and R. The output is taken across R. The circuit works as a filter circuit. If the time constant of the DC (L – R) circuit is τ, then the ratio: $\left|\frac{V_{out}}{V_{in}}\right|$ equals
(where V_{out} and V_{in} are peak values of output and input voltage respectively.)



(A) $\frac{1}{\sqrt{1+(\omega\tau)^2}}$

(B) $\omega\tau$

(C) $\sqrt{1+(\omega\tau)^2}$

(D) $\frac{1}{\omega\tau}$

Ans. A

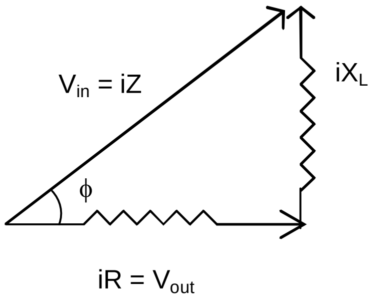
Sol. The phasor diagram of the circuit, in operation, is shown in the adjacent figure

$Z = \sqrt{R^2 + x_1^2}$,

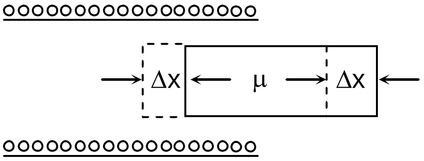
where $X_L = \omega L$

The ratio $\left|\frac{V_{out}}{V_{in}}\right|$

$$= \frac{R}{\sqrt{R^2 + X^2_L}} = \frac{1}{\sqrt{1+\left(\frac{\omega L}{R}\right)^2}}$$



10. A solenoid of cross sectional area α, N turns and length ℓ carries a constant current I. An iron rod of constant permeability μ and cross sectional area α is partially inserted in the solenoid along its axis. Calculate the force acting on the iron rod. (Neglect the end effects and assume that when the iron rod is moved slightly through a distance Δx from its position, the field structure remains the same.)



(A) $\frac{(\mu-\mu_0)N^2I^2\alpha}{\ell^2}$

(B) $\frac{(\mu-\mu_0)N^2I^2\alpha}{2\ell^2}$

(C) $\dfrac{(\mu-\mu_0)N^2I^2\alpha}{4\ell^2}$

(D) $\dfrac{2(\mu-\mu_0)N^2I^2\alpha}{\ell^2}$

Ans. B

Sol. The only difference is that a length Δx of the rod is effectively transferred from the extreme right hand end of the rod (outside the field region) to the uniform field region within the solenoid. The difference in the magnetic energy of the two configurations is

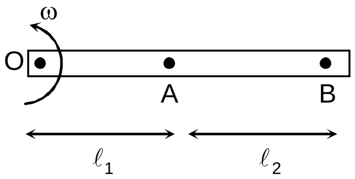
$$\Delta U = U(x+\Delta x) - U(x) = \frac{1}{2}(\mu-\mu_0)\int_V H^2 dV, \qquad \text{(i)}$$

Where $V = \alpha\Delta x$ and H = NI/ℓ = the magnetic field intensity inside the solenoid. Since H is constant, we obtain from (i)

$$\Delta U = \frac{1}{2}(\mu-\mu_0)\frac{N^2I^2}{\ell^2}\alpha\Delta x.$$

The force on the rod is $F_x = \left.\dfrac{\Delta U}{\Delta x}\right|_I = \dfrac{1}{2}(\mu-\mu_0)\dfrac{N^2I^2\alpha}{\ell^2}$

11. A conducting rod of length ℓ rotates about its one end with angular velocity ω. Find the potential difference between A and B (e : charge on electron, m : mass of electron).



(A) $\dfrac{m\omega^2\left(\ell^2-\ell_1^2\right)}{e}$

(B) $\dfrac{m\omega^2\left(\ell^2-\ell_2^2\right)}{e}$

(C) $\dfrac{m\omega^2\left(\ell^2-\ell_1^2\right)}{2e}$

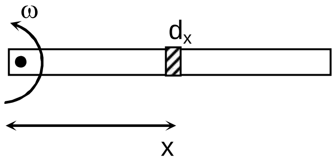
(D) $\dfrac{m\omega^2\left(\ell^2-\ell_2^2\right)}{2e}$

Ans. C

Sol. $V_{AB} = \dfrac{W_{AB}}{q}$

dV = mω^2xdx/e

$dV = \dfrac{mw^2xdx}{e}$

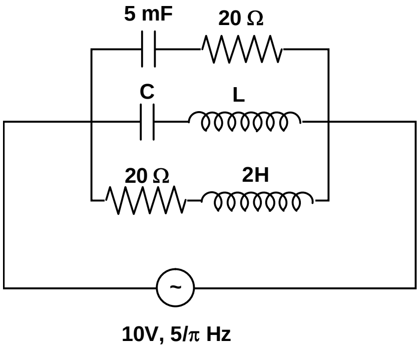


$$\int_0^{\omega} dV = \frac{m\omega^2}{e}\int_{\ell_1}^{\ell} x dx$$

$$V = \frac{m\omega^2}{2e}\left(\ell^2 - \ell_1^2\right)$$

$$\therefore \quad V_{AB} = \frac{m\omega^2\left(\ell^2 - \ell_1^2\right)}{2e}$$

12. In the circuit shown, find the value of C and L if net current from the source is to lead net voltage by a time $\frac{\pi}{40}$ seconds.



(A) 2.5 mF, 2H

(B) 5 mF, 2H

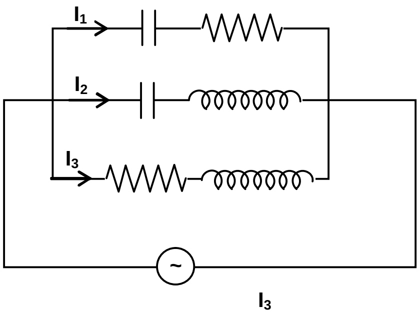
(C) 5 mF, 1 H

(D) 2.5 mF, 1 H

Ans. **A**

Sol. Phasor diagram :

To lead by $\frac{\pi}{40}s\left(\equiv\frac{\pi}{4}\right)$,

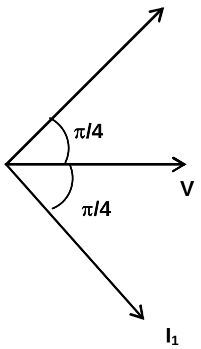


$$I_3 = \frac{V}{\sqrt{R^2 + X_L^2}}$$

$$I_2 = \frac{V}{\sqrt{(X_C - X_L)^2}}$$

$$I_1 = \frac{V}{\sqrt{R^2 + X_C^2}}$$

$$I_2 = \sqrt{I_1^2 + I_3^2}$$



13. A metallic charged ball, having charge q_0 is immersed into the liquid of dielectric constant K and low resistivity ρ. Find the time constant of disappearance of charge on the ball

(A) $\frac{1}{2}\varepsilon_0\rho K$

(B) $\varepsilon_0\rho K$

(C) $2\varepsilon_0\rho K$

(D) $\frac{3}{2}\varepsilon_0\rho K$

Ans. B

Sol. As we know that

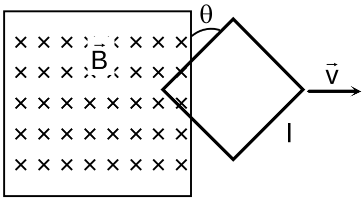
$$J = \frac{E}{\rho} = \frac{q}{4\pi\varepsilon_0 Kr^2\rho}$$

$$I = s \times J = 4\pi r^2 \times \frac{q}{4\pi\varepsilon_0 Kr^2\rho} = \frac{q}{\varepsilon_0 K\rho}$$

$$\Rightarrow \quad I_0 = \frac{q_0}{\varepsilon_0 K\rho}$$

$$\tau = \frac{q_0}{I_0} = \varepsilon_0 K\rho$$

14. An external force is applied to move a square loop of dimension 5 cm × 5 cm and resistance 10Ω at a constant speed across a region of uniform magnetic field B = 0.20 Tesla. The side of the square loop makes an angle θ = 45° with the boundary of the field region, as shown in figure. At t = 0, the loop is completely inside the field region, with its right vertex at the boundary. Total charge flown through loop when loop is completely outside the magnetic region.



(A) 0.05 milli coulomb

(B) 0.10 milli coulomb

(C) 0.4 milli coulomb

(D) 1 milli coulomb

Ans. A

Sol. $\Delta Q = \frac{\Delta\phi}{R} = \frac{Ba^2}{R}$

15. Two bar magnets having same geometry with magnetic moments 1.5 M and 2.5 M are placed in such a way that their similar poles are on the same side, and its time period of oscillations is T_1. Now if the polarity of one of the magnets is reversed, keeping other quantities same, then the time period of oscillation is T_2. Choose the correct option.

(A) $\frac{T_1}{T_2} = \frac{1}{2}$

(B) $\frac{T_1}{T_2} = \frac{2}{1}$

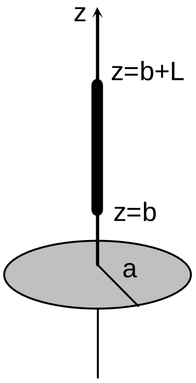
(C) $\frac{T_1}{T_2} = \frac{1}{4}$

(D) $\frac{T_1}{T_2} = \frac{4}{1}$

Ans. A

Sol. $T \propto \frac{1}{\sqrt{M}} \Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{M_2}{M_1}} = \sqrt{\frac{2.5M - 1.5M}{2.5M + 1.5M}} = \frac{1}{2}$

16. A uniform charged (thin) non-conducting rod is located on the central axis a distance b from the center of an uniformly charged non-conducting disk. The length of the rod is L and has a linear charge density λ. The disk has radius a and a surface charge density σ. The electrostatic force on the rod due to disc is



(A) $\vec{F} = \frac{\lambda\sigma}{2\varepsilon_0}\left(L + \sqrt{a^2 + b^2} - \sqrt{(b+L)^2 + a^2}\right)\hat{k}$

(B) $\vec{F} = \frac{\lambda\sigma a^2 L}{4\varepsilon_0 b^2}\hat{k}$

(C) $\vec{F} = \frac{\lambda\sigma a^2 L}{8\varepsilon_0 b^2}\hat{k}$

(D) $\vec{F} = \frac{\sigma}{2\varepsilon_0}\left(1 - \frac{L}{\sqrt{L^2 + a^2}}\right)\hat{k}$

Ans. A

Sol. The electric field created at any point along the central axis is given by

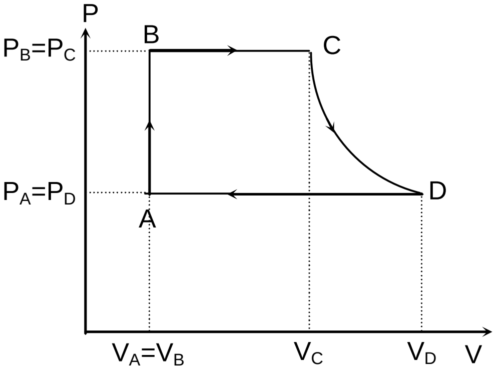
$$\vec{E}(z) = \frac{\sigma}{2\varepsilon_0}\left(1 - \frac{z}{\sqrt{a^2 + z^2}}\right)\hat{k}$$

Breaking up the rod into an infinite number of infinitesimally small point charges dq, we have that the net force on each tiny charge is $d\vec{F} = dq\vec{E}(z)$. Summing up all these contributions, and using the fact that dq = λ dz gives

$$\vec{F} = \int dq\frac{\sigma}{2\varepsilon_0}\left(1-\frac{z}{\sqrt{a^2+z^2}}\right)\hat{k} = \frac{\lambda\sigma}{2\varepsilon_0}\hat{k}\int_b^{b+L} dz\left(1-\frac{z}{\sqrt{a^2+z^2}}\right)$$
$$= \frac{\lambda\sigma}{2\varepsilon_0}\left(L-\sqrt{a^2+(b+L)^2}+\sqrt{a^2+b^2}\right)\hat{k}$$

17. A cycle followed by an engine (using one mole of an ideal gas in a cylinder with a piston) is shown in figure. Heat exchanged by the engine, with the surroundings for each section of the cycle is (C_v = (3/2) R).

AB : constant volume
BC : constant pressure
CD : adiabatic
DA : constant pressure



(A) $Q_{AB} = \frac{5}{2}V_A(P_B - P_A)$, $Q_{BC} = (3/2)P_B(V_C - V_A)$, $Q_{CD} = 0$, $Q_{DA} = (5/2)P_A(V_A - V_D)$

(B) $Q_{AB} = \frac{3}{2}V_A(P_B - P_A)$, $Q_{BC} = (5/2)P_B(V_C - V_A)$, $Q_{CD} = 0$, $Q_{DA} = (5/2)P_A(V_A - V_D)$

(C) $Q_{AB} = \frac{3}{2}V_A(P_B - P_A)$, $Q_{BC} = (5/2)P_B(V_C - V_A)$, $Q_{CD} = 0$, $Q_{DA} = (3/2)P_A(V_A - V_D)$

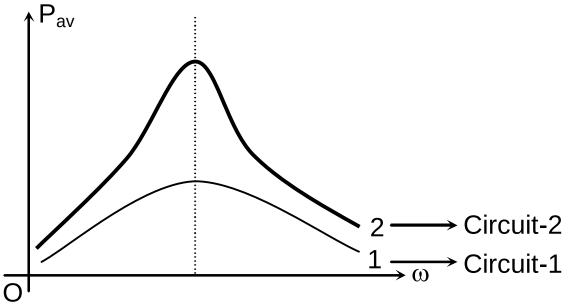
(D) $Q_{AB} = \frac{5}{2}V_A(P_B - P_A)$, $Q_{BC} = (5/2)P_B(V_C - V_A)$, $Q_{CD} = 0$, $Q_{DA} = (5/2)P_A(V_A - V_D)$

Ans. **B**

Sol. $Q_{AB} = U_{AB} = \frac{3}{2}R(T_B - T_A) = \frac{3}{2}V_A(P_B - P_A)$

$Q_{BC} = U_{BC} + W_{BC}$
$= (3/2)P_B(V_C - V_B) + P_B(V_C - V_B)$
$= (5/2)P_B(V_C - V_A)$
$Q_{CA} = 0$
$Q_{DA} = (5/2)P_A(V_A - V_D)$

18. The figure shows the variation of average power versus angular frequency of source voltage of two series. LCR-Circuits connected to same voltage source (the circuit-1 has resistance R_1, capacitance C_1, inductance L_1 and quality factor Q_1 while circuit-2 has resistance R_2, capacitance C_2, inductance L_2 and quality factor Q_2 respectively.
Choose the correct option:



(A) $Q_1 < Q_2$ and $R_1 < R_2$, $L_1L_2 = C_1C_2$

(B) $Q_1 > Q_2$ and $R_1 < R_2$, $L_1C_2 = L_2C_1$

(C) $Q_1 < Q_2$ and $R_1 > R_2$, $L_1C_1 = L_2C_2$

(D) $Q_1 > Q_2$ and $R_1 > R_2$, $L_1 / L_2 = C_1 / C_2$

Ans. C

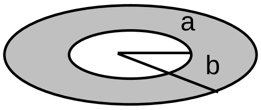
Sol. Quality Factor = $Q = \frac{\omega}{2\Delta\omega}$

$Q = \frac{\omega_0 L}{R}$ $Q_1 < Q_2$

$(P_{av})_{max} = \frac{V_0}{R} \Rightarrow R_1 > R_2$

$\omega_{10} = \omega_{20} \Rightarrow L_1C_1 = L_2C_2$

19. The figure shows a non-conducting (thin) disk with a hole. The radius of the disk is b and the radius of the hole is a. A total charge Q is uniformly distributed on its surface. Assuming that the electric potential at infinity is zero, what is the electric potential at the center of the disk?



(A) $\frac{Q}{2\pi\varepsilon_0(b+a)}$

(B) $\frac{Q}{2\pi\varepsilon_0(b-a)}$

(C) $\frac{Q}{2\pi\varepsilon_0(b^2-a^2)}$

(D) 0

Ans. A

Sol. The potential produced by a charged disk of radius R, at a distance z from it, along its central axis was

$$\frac{\sigma}{2\varepsilon_0}\left(\sqrt{z^2+R^2}-z\right) \qquad \ldots(1)$$

By superposition, we can think of the potential created by disk with the hole as the sum of two disks, with the same but opposite surface densities:

$$V(z)=\frac{\sigma}{2\varepsilon_0}\left(\sqrt{z^2+b^2}-z\right)-\frac{\sigma}{2\varepsilon_0}\left(\sqrt{z^2+a^2}-z\right)=\frac{\sigma}{2\varepsilon_0}\left(\sqrt{z^2+b^2}-\sqrt{z^2+a^2}\right)$$

Since we are only interested at the center, we have

$$V(0)=\frac{\sigma}{2\varepsilon_0}(b-a)$$

The total area of the disk with the hole is $A=\pi\left(b^2-a^2\right)$, thus

$$\sigma=\frac{Q}{\pi\left(b^2-a^2\right)}$$

Finally

$$V(0)=\frac{1}{2\varepsilon_0}(b-a)\frac{Q}{\pi\left(b^2-a^2\right)}=\frac{2kQ(b-a)}{(b-a)(b+a)}=\frac{2kQ}{b+a}$$

20. Choose the **INCORRECT** Statement

(A) The paramagnetic material displays greater magnetization when cooled, for the same magnetizing field.

(B) The diamagnetic property of material is almost independent temperature.

(C) If a toroid uses bismuth for its core, the magnetic field in the core will be slightly greater than when core is empty.

(D) The permeability of a ferromagnetic material depends on the magnetic field.

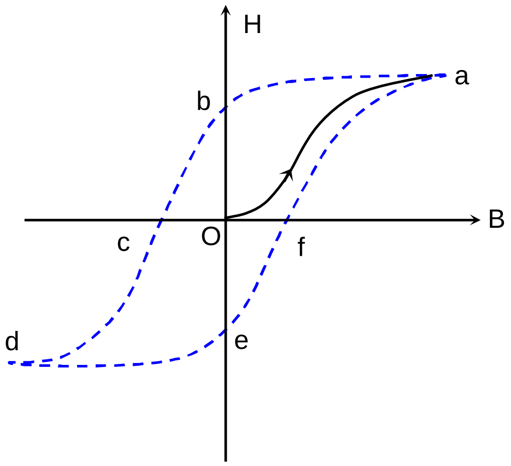
Ans. C

Sol. (A) On cooling, the tendency of thermal agitations to disrupt the alignment of magnetic dipoles decreases in case of paramagnetic materials. These they display greater amount of magnetism.

(B) on placing a sample of diamagnetic material in magnetic field, the magnetization (Induced dipole moment) is opposite direction of magnetizing field. Thus it does not affected by temperature.

(C) The field in core will be slightly less than when core is empty as Bismuth is a diamagnetic material ($B=\mu_0\mu_r\,nI$).

(D) $\mu = \frac{B}{H}$, so permeability of ferromagnetic material is dependent on the applied magnetic field. As shown in graph for B & H, B is larger for smaller value of H, thus permeability is greater for lower fields.



21. If 100 gm water at 20°C is mixed with 100 gm ice at –20°C. Let in final state system consists of m_1 gm ice and m_2 gm water. Choose the correct option.
Specific heat capacity of ice is 0.5 cal/g/°C.
Specific heat capacity of water is 1 cal/g/°C.
Latent heat of fusion of water is a 80 cal/g.
Latent heat of vaporisation of water is a 540 cal/g.

(A) $m_1 = 200$ gm, $m_2 = 0$ gm, $\theta = -5°C$

(B) $m_1 = 87.5$ gm, $m_2 = 112.5$ gm, $\theta = 0°C$

(C) $m_1 = 112.5$ gm, $m_2 = 87.5$ gm, $\theta = 0°C$

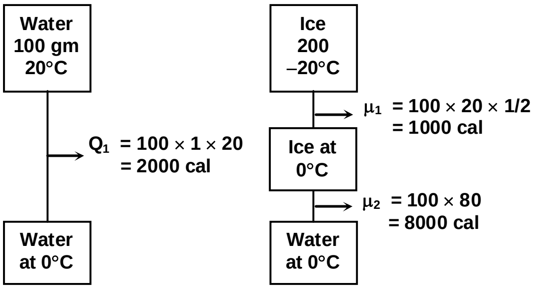
(D) $m_1 = 200$ gm, $m_2 = 0$ gm, $\theta = -3°C$

Ans. B

Sol. All ice will not melt. It means in final state, the system will contain both ice and water at 0°C. Let x gm of ice melts due excess heat.

$$x = \frac{1000}{80} = 12.5\text{gm}$$

Water in final state = 112.5 gm
ice in final state = 87.5 gm

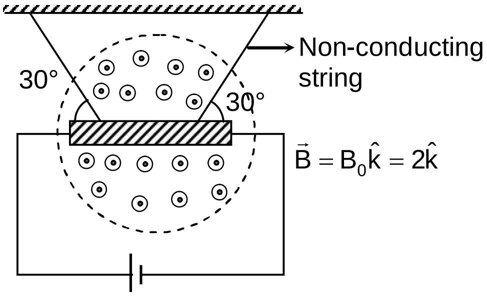


Second method : Let whole system is at 0°C in the state of water so.
Heat constant = $Q_1 - H_1 - H_2 = -7000$ cal
It means the heat available will force the water to freeze to compensate the –7000 cal (negative heat). Let x gm of water to fulfil the condition so

$$x = \frac{7000}{80} = 87.5 \text{ gm}$$

Water = 112.5 gm

22. A conducting rod of mass = 1 kg, length = 1m suspended in uniform magnetic field $\vec{B} = (2T)\hat{k}$. The rod is attached with two different string as shown in the figure. Tension in each string is 20 N. Find the value of current in the wire. (g = 10 m/s^2).


30°
30°
Non-conducting string
$\vec{B} = B_0\hat{k} = 2\hat{k}$

(A) 10 Amp

(B) 5 Amp

(C) 2.5 Amp

(D) 0.5 Amp

Ans. B

Sol. $2T\sin 30° = B_0 i\ell + mg$

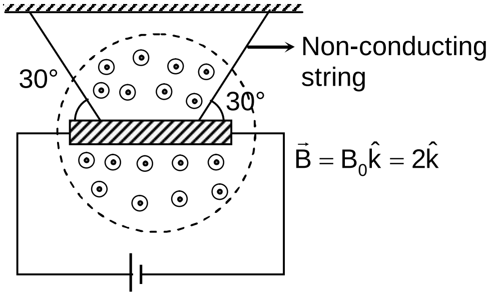
$\Rightarrow T = B_0 i\ell + mg$

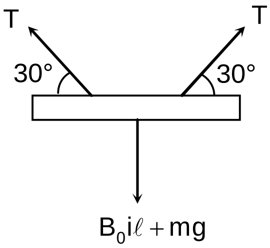
$\Rightarrow 20 = B_0 i\ell + 10$

$\Rightarrow B_0 i\ell = 10$

$\Rightarrow i = \dfrac{10}{B_0 \times \ell} = \dfrac{10}{B_0}$

= 5A.


30°
30°
Non-conducting string
$\vec{B} = B_0\hat{k} = 2\hat{k}$


T
T
30°
30°
$B_0 i\ell + mg$

23. An ideal mutual inductor is made from a primary coil of inductance 5mH and a secondary coil of inductance 10 mH. Find the value of the Mutual inductance (Approximately).
Assume no flux leakage.

(A) 28 mH

(B) 21 mH

(C) 14 mH

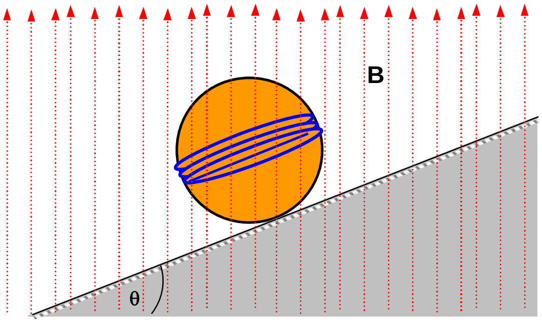
(D) 7 mH

Ans. D

Sol. $M = \sqrt{L_p L_s} = \sqrt{5 \times 10^{-3} \times 10 \times 10^{-3}} = \sqrt{50} \times 10^{-3} H$ = 7 mH

24. A non-conducting sphere has mass m = 88 g and radius r = 20.0 cm. A flat compact coil of wire with 5 turns is wrapped tightly around it, with each turn concentric with the sphere, as shown. The sphere is placed on a rough inclined plane that slopes downward to the left, making an angle θ with the horizontal, so that the coil is parallel to the inclined plane. A uniform magnetic field of 0.350 T vertically upward exists in the region of the sphere.

Take $\pi = \frac{22}{7}; g = 10\,m/s^2$.



(A) The current in the coil, that will enable the sphere to rest in equilibrium on the inclined plane is 2.5 A.

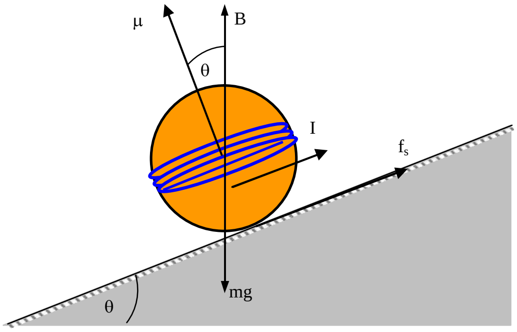
(B) The current in the coil, that will enable the sphere to rest in equilibrium on the inclined plane is 1.25 A.

(C) The current in the coil, that will enable the sphere to rest in equilibrium on the inclined plane is 0.8 A.

(D) The current in the coil, that will enable the sphere to rest in equilibrium on the inclined plane is 0.6 A.

Ans. **C**

Sol. The diagram shows a free-body diagram for the sphere on the incline. We will use the following notation: f is the force of static friction; B is the external magnetic filed given as B = 0.350 T; I is the unknown current in the coil; μ is the magnetic moment of the current in the coil; m= 0.088 kg is the mass of the sphere; g = 10 m/s^2 is the free fall acceleration; r = 0.200 m is the radius of the sphere; and N = 5 is the number of turns in the coil. We will use everywhere three significant digits as given in the problem statement.



The sphere is in translational equilibrium, thus

$f_s - mg\sin\theta = 0$ ……………….. (1)

The sphere is in rotational equilibrium. If torques are taken about the center of the sphere, the magnetic field produces a clockwise torque of magnitude

μB sinθ, and the frictional force a counter-clockwise torque of magnitude f_s R. Thus:

f_s R – μBsinθ = 0 …………………. (2)

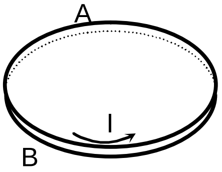
From (1): fs= Mg sinθ. Substituting this in (2) and cancelling out sinθ , one obtains

$$\mu B = MgR \Rightarrow I = \frac{mgr}{N\pi r^2 B} = \frac{mg}{N\pi rB} = \frac{\left(88\times10^{-3}\right)\times10}{5\times\left(22/7\right)\times0.2\times.35} = 0.8\,A$$

The current must be counter-clockwise as seen from above.

The result does not depend upon the angle of inclination θ.

25. Two circular loops A and B have their planes parallel to each other, as shown in figure. Loop A has a current flowing in the counterclockwise direction, viewed from above.



(A) If the current in loop A decreases with time, the two loops attract each other.

(B) If the current in loop A increases with time, the two loops attract each other

(C) If current in loop A decreases current in B is clockwise.

(D) If current in loop A increases, current in B will be anticlockwise.

Ans. **A**

Sol. Apply Lenz's law

26. If magnetic dip in India is found to be 18°. One of the option, that is closer to the magnetic dip in Britain, is

(A) 18°

(B) 70°

(C) –18°

(D) 16°

Ans. **B**

Sol. Britain is closer to magnetic north.

27. In the system of three charged particles, each charge particle is in equilibrium under their electrostatic forces only. Choose the **INCORRECT** option

(A) The particle must be collinear.

(B) All the charges cannot have the same magnitude.

(C) All the charges cannot have the same sign.

(D) The equilibrium is stable.

Ans. **D**

Sol. Basic concept

28. In a moving coil galvanometer the number of turns N = 30, area of the coil A = 4×10^{-3} m^2 and the magnetic field strength B = 0.3T. (The resistance per unit length of the wire of coil is λ). Choose the **INCORRECT** option

(A) To increase its voltage sensitivity by 50% we increase number of turns to 60

(B) To increase its voltage sensitivity by 50% we increase area to 9×10^{-3} m^2

(C) To increase its voltage sensitivity by 50% we increase magnetic field to 0.45 T

(D) To increase its voltage sensitivity by 50% we change the material of wire such that its specific resistance would be 2/3rd of the specific resistance of the present wire.

Ans. A

Sol. BINA = $C\theta$

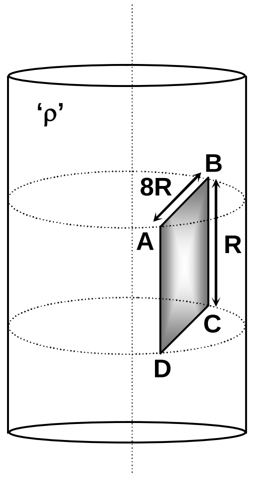
$$I = \frac{C\theta}{BNA}$$

$$V = IR = \frac{C\theta R}{BNA} \qquad \ldots(1)$$

$$R = \frac{\rho\ell}{a} = \lambda\ell = C_1\lambda\sqrt{A}\,N$$ where C_1 is a constant.

$$V = \frac{\lambda\theta C_1 C}{B\sqrt{A}} \Rightarrow S_V = \frac{d\theta}{dV} = \frac{B\sqrt{A}}{\lambda C C_1}.$$

29. A non conducting solid cylinder of infinite length having uniform charge density ρ and radius of cylinder is 5R. Find the flux passing through the surface ABCD as shown in figure.



(A) $\frac{12\rho R^3}{\varepsilon_0}$

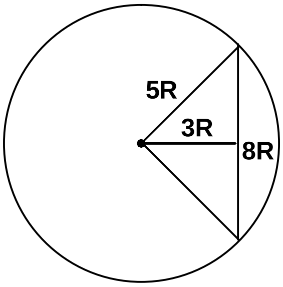
(B) $\frac{6\rho R^3}{\varepsilon_0}$

(C) $\frac{\rho R^3}{\varepsilon_0}$

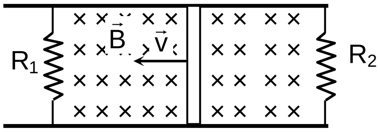
(D) $\frac{3\rho R^3}{\varepsilon_0}$

Ans. A

Sol. $$\phi = \frac{q_{in}}{\varepsilon_0} = \frac{\rho\left(\frac{1}{2}8R\cdot 3R\right)R}{\varepsilon_0} = \frac{12\rho R^3}{\varepsilon_0}$$



30. A conducting rod of length 25 cm is free to slide on two parallel conducting bars as shown in the figure. In addition, two resistors 5Ω and 10Ω are connected across the ends of the bars. There is a uniform magnetic field 0.02 tesla pointing inside the plane of paper. Suppose an external agent pulls the bar towards the left at a constant speed 5 ms^{-1}.



Sliding rod

(A) Current through 5Ω resistor is 5 mA

(B) Current through 10 Ω resistor is 10 mA

(C) Force applied by agent to maintain constant 5 ms^{-1} velocity is 20 N

(D) Power delivered by external agent is 50 watt.

Ans. A

Sol. $B\ell v = iR$

$$0.02\times\frac{1}{4}\times 5 = i\times 5$$

Chemistry PART – II

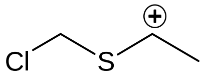
SECTION – A

Straight Objective Type

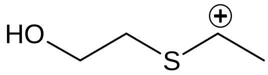
This section contains **30 multiple choice** questions. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

31. Hydrolysis of mustard gas give HCl and a diol. Which of the following intermediate will form during the hydrolysis

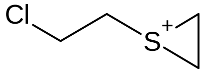
(A)



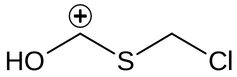
(B)



(C)

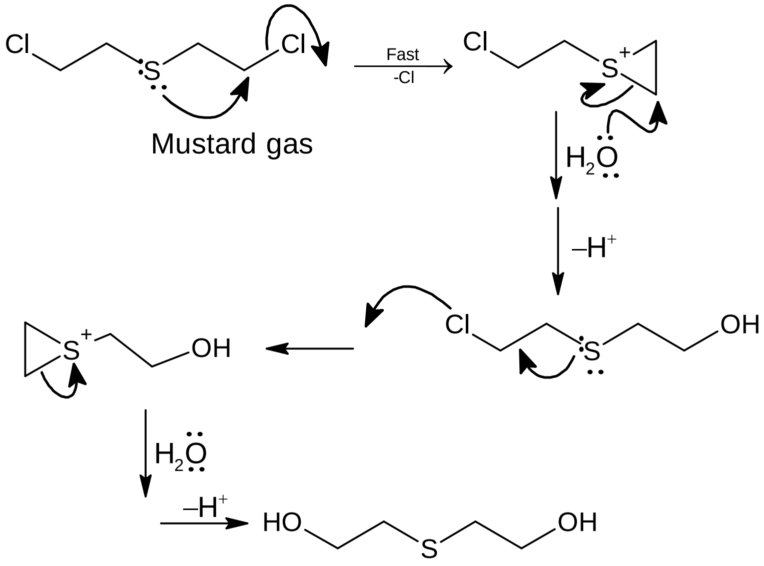


(D)

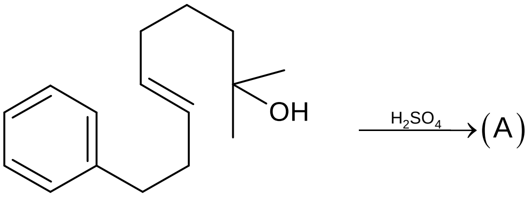


Ans. **C**

Sol.

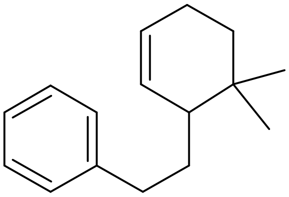


32.

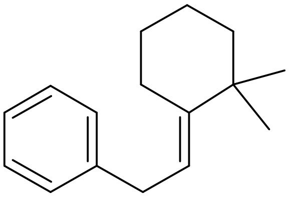


Major product formed in the above reaction (A) is:

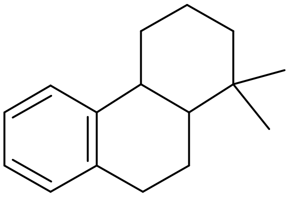
(A)



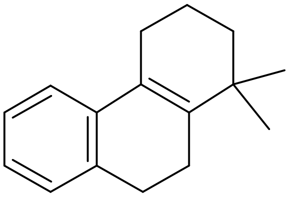
(B)



(C)

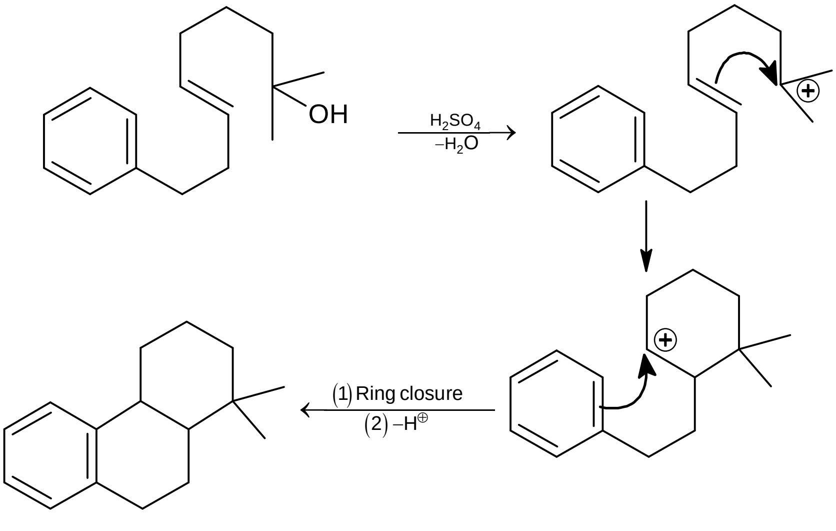


(D)

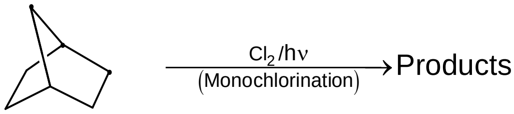


Ans. **C**

Sol.


OH
H_2SO_4
$-H_2O$
⊕
⊕
(1) Ring closure
(2) $-H^{\oplus}$

33. Number of monochloro structural isomers form when A undergoes monchlorination


$Cl_2/h\nu$
(Monochlorination)
Products

(A) 1

(B) 2

(C) 3

(D) 7

Ans. **C**

34. Which of the following is correct?

(A) An achiral molecule which is superimposable on its mirror image cannot exist as two enantiomers.

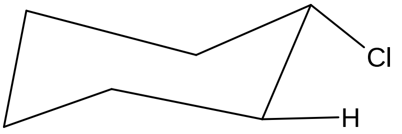
(B) Changing the configuration of a molecule always means that bonds are broken.

(C) Both (A) and (B)

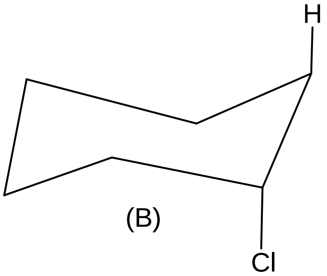
(D) None of these

Ans. **C**

35. Which of the following correct for E2 elimination in chloro cyclohexanes:



(A)



(B)

(A) Rate of E_2 elimination in (A) is faster than (B).

(B) Rate of E_2 elimination in (B) is faster than (A).

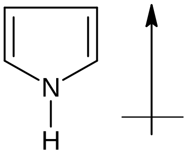
(C) (B) can undergo E_2 elimination only if (B) undergoes ring inversion.

(D) Both (A) and (B) are correct.

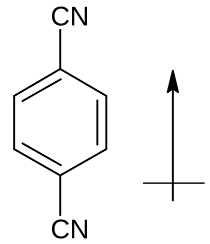
Ans. **B**

36. Which of the following molecule showing the correct direction of dipole moment:

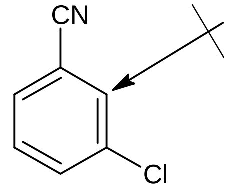
(A)



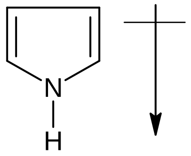
(B)



(C)

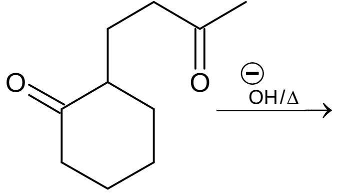


(D)

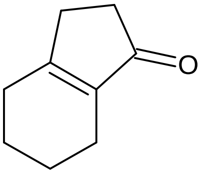


Ans. **A**

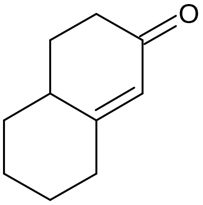
37. Predict the major product formed when the following reaction occurs in dilute base:



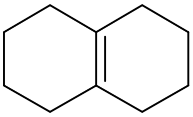
(A)

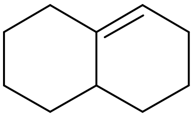


(B)



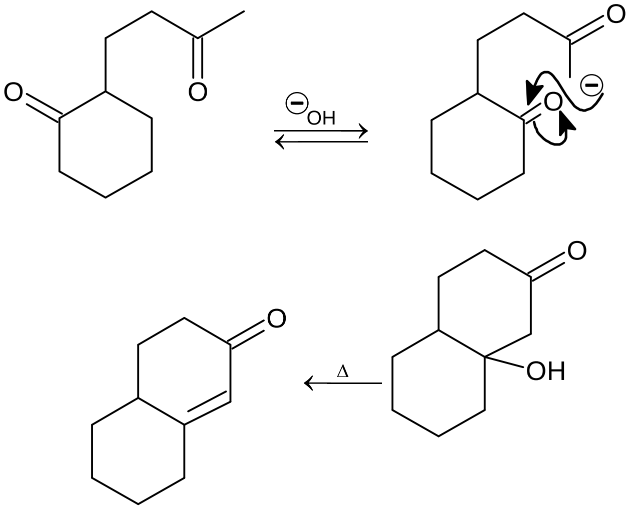
(C)



(D) 

Ans. **B**

Sol.



38. Propanol is more volatile as compared to glycerol because of

(A) Less extent of hydrogen bonding

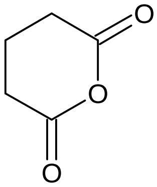
(B) High molar mass of propanol

(C) Hybridization

(D) All of the above

Ans. **A**

39. The IUPAC name of the following compound is:



(A) Cyclopentanedioic anhydride

(B) Pentanedicarboxylic anhydride

(C) Pentanedioic anhydride

(D) Dicyclopentane anhydride

Ans. **C**

40. Predict the product of the following reaction:

$$\underset{1:1}{RCOOAg + I_2} \longrightarrow (A) + CO_2 + AgI$$

(A) Alkyl iodide

(B) Carboxylic acid

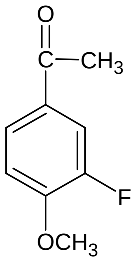
(C) Ester

(D) Alcohol

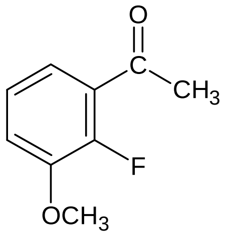
Ans. **A**

41. Which of the following compound will form when acetic anhydride reacts with o-Fluoroanisole in presence of dry $AlCl_3$.

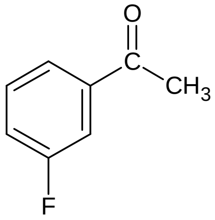
(A)



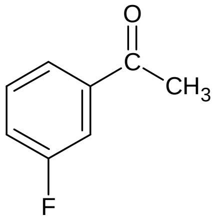
(B)



(C)

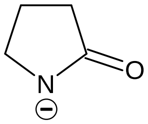


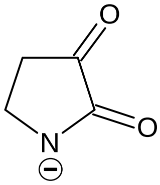
(D)

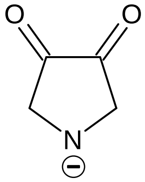


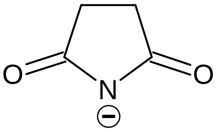
Ans. **A**

42. Which of the following species is most stable?

(A) 

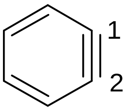
(B) 

(C) 

(D) 

Ans. D

43. The hybridization of C-1 and C-2 carbon atoms marked in the following structure of benzyne intermediate?



(A) sp^2 and sp^2

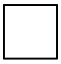
(B) sp and sp

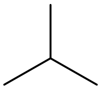
(C) sp and sp^2

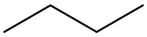
(D) None of these

Ans. A

44. Predict the major product formed in the following reaction:

 $+ H_2 \xrightarrow[200^0 C]{Ni}$

(A) 

(B) 

(C) C_2H_6

(D) No reaction

Ans. **B**

45. Alcohol $\xrightarrow[\text{(ii) AgNO}_2]{\text{(i) I}_2\text{/Red P}}$ (A)

Compound A does not react with HNO_2 and gives a colourless solution with NaOH. Degree of the alcohol taken initially

(A) 1

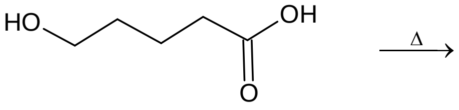
(B) 2

(C) 3

(D) None of these

Ans. **C**

46. Predict the product of the following reaction:



(A) Lactone

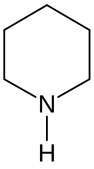
(B) Anhydride

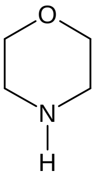
(C) Alcohol

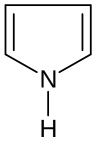
(D) Alkene

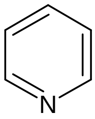
Ans. **A**

47. The correct order of basic strength of the following compound is:

(1)


(2)


(3)


(4)


(A) 1 > 2 > 3 > 4

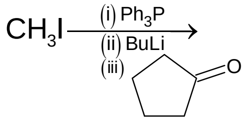
(B) 1 > 3 > 2 > 4

(C) 4 > 3 > 2 > 1

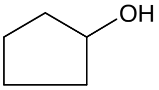
(D) 1 > 2 > 4 > 3

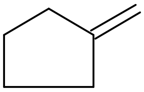
Ans. **D**

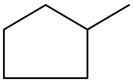
48. Predict the product of the following reaction?



(A) CH_3CHO

(B)


(C)


(D)


Ans. **C**

49. Which mechanism the following reaction will follows:

$$C_2H_5OH \xrightarrow[\text{Pyridine}]{SOCl_2} C_2H_5Cl + SO_2$$

(A) S_N1

(B) S_N2

(C) S_Ni

(D) None of the above

Ans. **B**

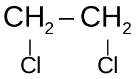
50. In the following reaction

$$CH_2 = CH_2 \xrightarrow{Ag_2O} (A) \xrightarrow{H^+/H_2O} (B) \xrightarrow{PCl_3} (C)$$

The compound (C) is:

(A) $CH_3 - CH_3$

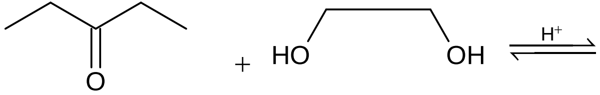
(B) $CH_3 - CH_2 - Cl$

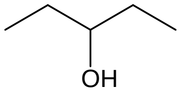
(C)

$\underset{Cl}{CH_2} - \underset{Cl}{CH_2}$

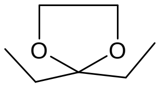
(D) $CH_3 - Cl$

Ans. **C**

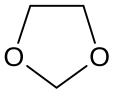
51. Which of the following product will form in the following reaction:



(A) 

(B) 

(C) CHO
|
CHO

(D) 

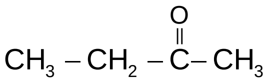
Ans. **B**

52. The possible product of the following reaction:

$$H_3C-CH_2-COOH\xrightarrow[(ii)\,H_3O^+]{(i)\,CH_3MgBr}$$

(A) CH_3-CH_3

(B) CH_3CH_2OH

(C) 
$CH_3-CH_2-\overset{\overset{\large O}{||}}{C}-CH_3$

(D) CH_4

Ans. **D**

53. $$CH_3CHO\xrightarrow[KCN]{NH_4Cl}(A)\xrightarrow[(ii)\,\overset{-}{O}H]{(i)\,H_2O,\,HCl,\Delta}(B)$$

Compound B formed in the above reaction is:

(A) Glycine

(B) Alanine

(C) Threonine

(D) Serine

Ans. **B**

54. The only two pK_a values of an amino acid are 2.32 and 9.62. The isoelectric point of the amino acid is:

(A) 7.3

(B) 11.94

(C) 5.97

(D) 9.62

Ans. C

55. Which of the following products will form when cellulose undergoes complete hydrolysis:

(A) D-fructose

(B) D-ribose

(C) L-glucose

(D) D-glucose

Ans. D

56. Neoprene is prepared by polymerization of:

(A) 2-Chloro-1,3-butadiene

(B) Butadiene

(C) Acrylonitrile

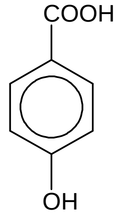
(D) Styrene

Ans. A

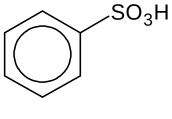
57. An organic compound ‘X’ gives CO_2 gas on reaction with $NaHCO_3$. The compound ‘X’ is:

(A) Picric acid

(B)



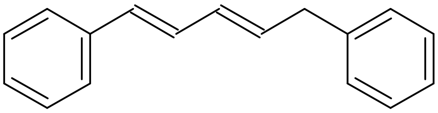
(C)



(D) All of these

Ans. D

58. The degree of unsaturation in the following compound is:



(A) 8

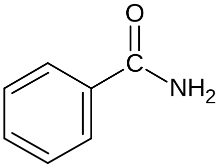
(B) 10

(C) 2

(D) 6

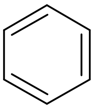
Ans. B

59. Predict the compound ‘X’ in the following reaction:

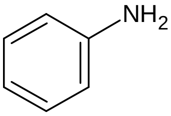


$+Br_2 + NaOH \xrightarrow{\Delta} X + Na_2CO_3 + 2NaBr + 2H_2O$

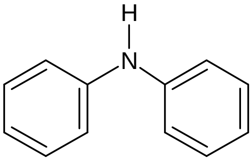
(A)



(B)



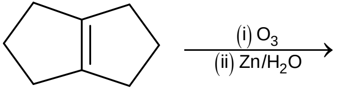
(C)



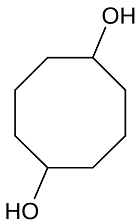
(D) CH_3NH_2

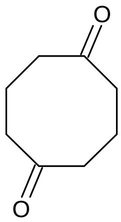
Ans. B

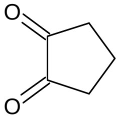
60. Compound ‘A’ on reductive ozonolysis will give:

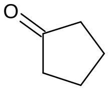


(A)



(B) 

(C) 

(D) 

Ans. **B**

Mathematics PART – III

SECTION – A

Straight Objective Type

This section contains **30 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** is correct

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61. Normals having slope m_1, m_2, m_3; ($m_1 < 0$) are drawn at points P(a, b), Q, R respectively on the curve $y^2 - 6y - 16x + 73 = 0$ so as to intersect at point S(19, 6), then a + b is equal to

(A) 24

(B) 28

(C) 32

(D) 36

Ans. B

Sol. Roots of the equation $4m^3 - 7m + 3 = 0$ are m_1, m_2, m_3 solving $m_1 = -\frac{3}{2}$

$\therefore\ a = 4\left(1+\frac{9}{4}\right),\ b = 3-8\left(-\frac{3}{2}\right)$

a = 13, b = 15

62. The locus of the centroid of triangle PSQ, where PQ is any chord of the parabola $y^2 = 8(x + 2)$ subtending right angle at the vertex and S be its focus is also a parabola whose latus rectum is equal to

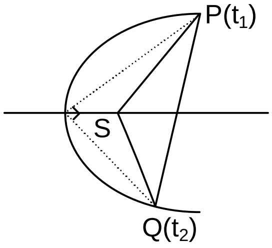
(A) $\frac{1}{3}$

(B) $\frac{4}{3}$

(C) $\frac{8}{3}$

(D) 2

Ans. C



Sol. $t_1t_2 = -4$

If (h, k) is the centroid of ΔPSQ,

Then $\frac{3h+4}{2} = t_1^2 + t_2^2$, $\frac{3k}{4} = t_1 + t_2$

$\Rightarrow k^2 = \frac{8}{3}(h-4)$

$\therefore$ Latus rectum = $\frac{8}{3}$

63. A hyperbola having foci A(4, –1) and B(4, 5) has x + y – 7 = 0 as one of its tangent, then the point of contact of this tangent is

(A) $\left(\frac{9}{2}, \frac{5}{2}\right)$

(B) (1, 6)

(C) (0, 7)

(D) (2, 5)

Ans. **C**

Sol. Image of A(4, –1) about the tangent x + y – 7 = 0 is P(8, 3)

$\because$ Equation of line passing through P(8, 3) and B(4, 5) is 2y + x – 14 = 0

Solving this with tangent, we get point of contact

64. The equation of circle touching the parabola $y = 1 - x^2$ at the point (2, –3) and having its centre on the line y + x = 0 is

(A) $(x-3)^2 + (y+3)^2 = 1$

(B) $\left(x - \frac{14}{5}\right)^2 + \left(y + \frac{14}{5}\right)^2 = \frac{17}{25}$

(C) $\left(x + \frac{14}{25}\right)^2 + \left(y - \frac{14}{25}\right)^2 = \frac{17}{25}$

(D) $(x-4)^2 + (y+4)^2 = 5$

Ans. **B**

Sol. Normal to the parabola $y = 1 - x^2$ at (2, –3) is 4y – x + 14 = 0

Let centre of circle is (α, $-\alpha$) which lies on the normal

$\therefore \alpha = \frac{14}{5}$

$\therefore$ Radius is $\frac{\sqrt{17}}{5}$

65. If the ellipse $\frac{x^2}{16}+\frac{y^2}{b^2}=1$, b > 0 and the hyperbola $\frac{x^2}{81}-\frac{y^2}{63}=\frac{1}{16}$ intersect orthogonally, then the value of b^2 is

(A) 5

(B) 7

(C) 9

(D) $\frac{81}{7}$

Ans. B

Sol. Foci of the two curves are coincident

66. If the line joining the foci of the hyperbola $S_1 \equiv \frac{x^2}{a^2}-\frac{y^2}{b^2}+1=0$ does not subtend a right angle at any point on the hyperbola $S_2 \equiv \frac{x^2}{4a^2}-\frac{y^2}{b^2}=1$, then number of integral values of $4e^2$ is/are (e is eccentricity of $S_2 = 0$)

(A) 1

(B) 2

(C) 3

(D) 4

Ans. B

Sol. Circle having foci of the hyperbola S_1 as the extremities of diameter should not intersect the hyperbola S_2 at real points
$\Rightarrow a^2 + b^2 < 4a^2$
$\Rightarrow b^2 < 3a^2$
$\Rightarrow e^2 < 7/4$
$\Rightarrow 4 < 4e^2 < 7$

67. One of the sides of a triangle is divided into segments of 4 and 6 units by the point of tangency of the inscribed circle which has radius $2\sqrt{2}$ units, then the largest side of triangle is

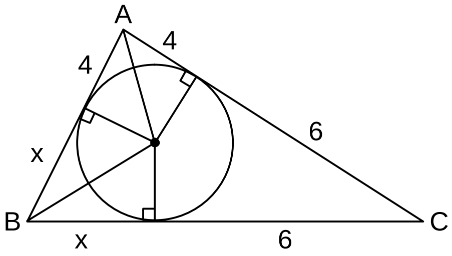
(A) 10

(B) $\frac{21}{2}$

(C) $\frac{43}{4}$

(D) 11

Ans. **D**



Sol. $\tan\frac{A}{2} = \frac{1}{\sqrt{2}}$, $\tan\frac{C}{2} = \frac{\sqrt{2}}{3}$

$\therefore\ \tan\frac{(A+C)}{2} = \frac{5}{2\sqrt{2}}$

$\Rightarrow \cot\frac{B}{2} = \frac{x}{2\sqrt{2}} = \frac{5}{2\sqrt{2}}$

$\Rightarrow x = 5$

Alternate: Use $\Delta = rs$

68. Let $S_n = 1^3 + 2^3 + 3^3 + \ldots.. + n^3$; $n \in N$, then $64S_n$ is always less than

(A) $(2n-1)^4$

(B) $(n+2)^4$

(C) $(2n+1)^4$

(D) $2(n+1)^4$

Ans. **C**

Sol. $64\sum n^3 = 16(n(n+1))^2 < 16\left(n^2 + n + \frac{1}{4}\right)^2$

69. A line is drawn from A(–4, 0) to intersect the curve $\frac{x^2}{8} + \frac{y^2}{4} = 1$ at P and Q above x-axis. If $\frac{1}{AP} + \frac{1}{AQ} \ge \frac{\sqrt{3}}{2}$, then the maximum value of the slope of line is

(A) $2\sqrt{3}$

(B) $\frac{1}{\sqrt{3}}$

(C) $\frac{4}{5}$

(D) $\sqrt{3}$

Ans. **B**

Sol. AP and AQ are the roots of the equation $(r\cos\theta - 4)^2 + 2(r\sin\theta)^2 = 8$

$\Rightarrow r^2(\cos^2\theta + 2\sin^2\theta) - 8\cos\theta\, r + 8 = 0$

$\therefore\ \frac{1}{AP} + \frac{1}{AQ} = \left|\frac{8\cos\theta}{8}\right| \ge \frac{\sqrt{3}}{2}$

$\Rightarrow |\cos\theta| \ge \frac{\sqrt{3}}{2} \Rightarrow \tan\theta \le \frac{1}{\sqrt{3}}$

70. If two distinct chords drawn from the point $\left(2\sqrt{2}\sin\theta, \frac{1}{\sqrt{2}}\right)$ to the circle $x^2 + y^2 = 2\sqrt{2}\sin\theta\, x + \frac{1}{\sqrt{2}}y$, ($\theta$ is a parameter) are bisected by x-axis, then the exhaustive set in which θ lies is

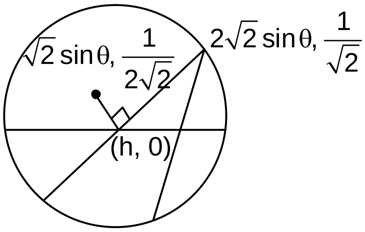
(A) $\left(n\pi + \frac{\pi}{4}, n\pi + \frac{3\pi}{4}\right); n \in I$

(B) $\left(n\pi + \frac{\pi}{6}, n\pi + \frac{5\pi}{6}\right); n \in I$

(C) $\left(2n\pi + \frac{\pi}{4}, 2n\pi + \frac{3\pi}{4}\right); n \in I$

(D) $(2n\pi, (2n + 1)\pi); n \in I$

Ans. A


$\sqrt{2}\sin\theta, \frac{1}{2\sqrt{2}}$
$2\sqrt{2}\sin\theta, \frac{1}{\sqrt{2}}$
(h, 0)

Sol. $$\frac{\frac{1}{2\sqrt{2}}}{\sqrt{2}\sin\theta - h} \times \frac{1}{\sqrt{2}\left(2\sqrt{2}\sin\theta - h\right)} = -1$$

$$\Rightarrow h^2 - 3\sqrt{2}\sin\theta \cdot h + 4\sin^2\theta + \frac{1}{4} = 0$$

For distinct real roots

$D > 0 \Rightarrow \sin^2\theta > \frac{1}{2} \Rightarrow \theta \in \left(n\pi + \frac{\pi}{4}, n\pi + \frac{3\pi}{4}\right); n \in I$

71. Let A be (100, 50), a point B on the line y = x and point C on x-axis such that AB + BC + CA is minimum, then the coordinates of C is

(A) (50, 0)

(B) $\left(\frac{200}{3}, 0\right)$

(C) $\left(\frac{250}{3}, 0\right)$

(D) $\left(\frac{400}{3}, 0\right)$

Ans. C

Sol. Image of A(100, 50) about x-axis is P(100, –50) and about y = x is Q(50, 100)
Equation of line PQ is y + 3x – 250 = 0
Putting y = 0, $x = \frac{250}{3}$

72. A line $L_1 \equiv \frac{x}{10} + \frac{y}{8} = 1$ intersects the coordinate axes at points A and B. Another line L_2 perpendicular to L_1 intersects the coordinate axes at C and D. The locus of circumcentre of ΔABD is

(A) $5x - 4y = 9$

(B) $5x - 4y = 18$

(C) $4x - 5y = 9$

(D) $4x - 5y = 18$

Ans. **A**

Sol. Circumcentre will lie on the perpendicular bisector of AB

73. The value of $\cot^4\frac{\pi}{16} - 4\cot^3\frac{\pi}{16} - 6\cot^2\frac{\pi}{16} + 4\cot\frac{\pi}{16} + 2$ is

(A) 0

(B) –1

(C) 2

(D) 1

Ans. **D**

Sol. $\cot 4A = \frac{1-\tan^2 2A}{2\tan 2A} \Rightarrow 1 = \frac{\left(1-\tan^2 A\right)^2 - 4\tan^2 A}{4\tan A\left(1-\tan^2 A\right)}$; $A = \frac{\pi}{16}$

$\Rightarrow \tan^4\frac{\pi}{16} + 4\tan^3\frac{\pi}{16} - 6\tan^2\frac{\pi}{16} - 4\tan\frac{\pi}{16} + 1 = 0$

74. The equation of two sides of a triangle are 3x + 4y – 12 = 0, 2x + y – 8 = 0. If the circumcentre is (0, 3), then the centroid of the triangle is

(A) $\left(0, \frac{7}{3}\right)$

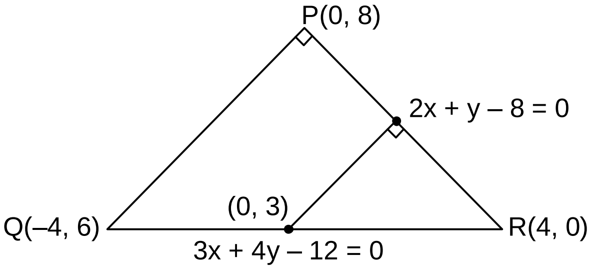
(B) $\left(0, \frac{14}{3}\right)$

(C) $\left(0, \frac{16}{3}\right)$

(D) (0, 6)

Ans. **B**

Sol. Foot of perpendicular from (0, 3) on the line $2x + y - 8 = 0$ is (2, 4)
Hence, P is (0, 8) which is orthocentre
$\therefore$ Centroid is $\left(0, \frac{14}{3}\right)$



75. The value of $\sec^{-1}(\text{cosec } A) + \tan^{-1}(\cot^3 A) - \cot^{-1}\left(\frac{\cot A}{\cot^2 A - 1}\right)$, $0 < A < \frac{\pi}{6}$ is

(A) 0

(B) $3 \tan^{-1} 1$

(C) $3 \tan^{-1} \frac{1}{\sqrt{3}}$

(D) $\tan^{-1} 1$

Ans. **C**

Sol. $-\cot^{-1}\left(\frac{\cot A}{\cot^2 A - 1}\right) + \tan^{-1}(\cot A) + \tan^{-1}(\cot^3 A)$

$= -\left(\pi - \cot^{-1}\left(\frac{\cot A}{1 - \cot^2 A}\right)\right) + \pi + \tan^{-1}\frac{\cot A}{1 - \cot^2 A} = \frac{\pi}{2}$

76. If the incircle of a triangle ABC passes through the circumcentre, then value of $(\cos A + \cos B + \cos C)^2$ is

(A) 1

(B) $\sqrt{2}$

(C) 2

(D) $\frac{9}{4}$

Ans. **C**

Sol. Distance between circumcentre and incentre = $\sqrt{R^2 - 2Rr}$

$\therefore \sqrt{R^2 - 2Rr} = r$

$\Rightarrow \frac{r}{R} = \sqrt{2} - 1$

77. The minimum value of the expression $(t^2 + 1 - \alpha)^2 + (2t - \alpha - 4)^2$, $(t, \alpha \in R)$ is

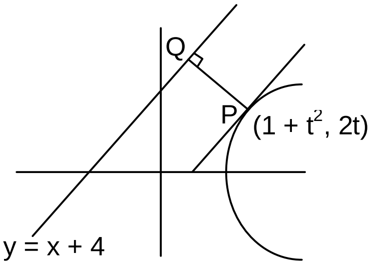
(A) 2

(B) 3

(C) 8

(D) 10

Ans. C



Sol. Slope of tangent $\frac{1}{t} = 1 \Rightarrow t = 1$

$\therefore P(2, 2) \Rightarrow PQ = \left|\frac{2-2+4}{\sqrt{2}}\right| = 2\sqrt{2}$

78. In ΔABC, $\angle A = \frac{\pi}{6}$, then the maximum value of $\sin^2 B + \sin^2 C$ is

(A) $\sqrt{3}-1$

(B) $1+\frac{\sqrt{3}}{2}$

(C) $\frac{3}{2}$

(D) $2-\frac{\sqrt{3}}{2}$

Ans. B

Sol. $\sin^2 B + \sin^2\left(\frac{5\pi}{6} - B\right) = 1 + \frac{\sqrt{3}\sin 2B - 3\cos 2B}{4}$

79. If $8\cos y = \frac{4x^2+4x+7}{x^2+x+1}$; $x \in R$, then the range of $\sin^2 y + \cos y + 1$ is

(A) $\left[1, \frac{9}{4}\right]$

(B) $\left[1, \frac{13}{4}\right)$

(C) $\left[2, \frac{9}{4}\right)$

(D) $\left[3, \frac{13}{4}\right)$

Ans. C

Sol. $8\cos y = 4 + \frac{3}{x^2 + x + 1} \Rightarrow \frac{1}{2} < \cos y \le 1$

80. Two tangents to the hyperbola $\frac{x^2}{100} - \frac{y^2}{81} = 1$ having slopes m_1 and m_2 cuts the coordinate axes at four concyclic points. If m_1 and m_2 satisfy the equation $2\alpha^2 - 5\alpha + k = 0$, then the value of k is

(A) 1

(B) 2

(C) $\frac{3}{2}$

(D) $\frac{5}{4}$

Ans. B

Sol. $m_1m_2 = 1$

81. A parabola is drawn through two given points A(2, 0) and B(–2, 0) such that its directrix always touch the circle $x^2 + y^2 = 16$, then locus of focus of the parabola is

(A) $3x^2 + 4y^2 = 48$

(B) $4x^2 + 3y^2 = 48$

(C) $3x^2 + 4y^2 = 60$

(D) $4x^2 + 3y^2 = 60$

Ans. A

Sol. Let focus be S(h, k), then
$(h - 2)^2 + k^2 = 4(\cos\theta - 2)^2$ ..... (1)
$(h + 2)^2 + k^2 = 4(\cos\theta + 2)^2$ ..... (2)
$\Rightarrow \cos\theta = \frac{h}{4}$
$\Rightarrow (h-2)^2 + k^2 = 4\left(\frac{h}{4} - 2\right)^2 \Rightarrow \frac{h^2}{16} + \frac{k^2}{12} = 1$

82. The locus of foot of perpendicular from (1, 2) on each member of the family of lines
$(1 + 2t)x + (1 - t)y + t - 1 = 0;\ t \in R$ is

(A) $x^2 + y^2 + x - 3y + 2 = 0$

(B) $x^2 + y^2 - x - 3y + 2 = 0$

(C) $x^2 + y^2 - x - 3y - 4 = 0$

(D) none of these

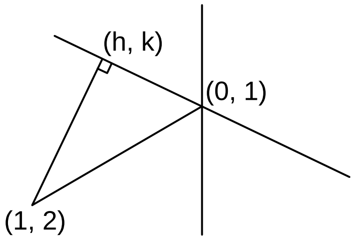
Ans. **B**

Sol. Given family passes through the point (0, 1)

$$\Rightarrow \frac{k-2}{h-1} \times \frac{k-1}{h} = -1$$

$x(x - 1) + (y - 1)(y - 2) = 0$

$x^2 + y^2 - x - 3y + 2 = 0$



83. Consider point P with ordinate t lying on the curve $\frac{x^2}{4} - y^2 = 1$; t $\in$ N. If S_n represents the minimum distance from point P to the line 2y – x = 0, then $\lim_{t\to\infty}(tS_n)$ is

(A) $\frac{1}{2}$

(B) $\frac{3}{4}$

(C) $\frac{1}{\sqrt{5}}$

(D) $\frac{2}{\sqrt{5}}$

Ans. **C**

Sol. $P\left(2\sqrt{1+t^2}, t\right)$

$$\therefore\ S_n = \frac{2\left(\sqrt{1+t^2} - t\right)}{\sqrt{5}} = \lim_{t\to\infty} t \cdot S_n = \lim_{t\to\infty} \frac{2t\left(\sqrt{1+t^2} - t\right)}{\sqrt{5}} = \frac{1}{\sqrt{5}} \text{ (By rationalizing)}$$

84. In ΔABC, if medians from B and C are mutually perpendicular, then the possible value of cot B + cot C is

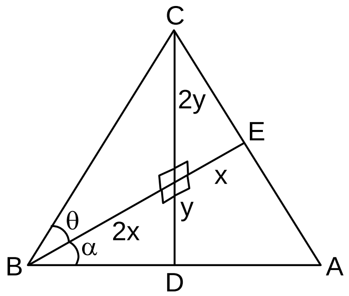
(A) $\frac{1}{3}$

(B) $\frac{2}{5}$

(C) $\frac{1}{2}$

(D) $\frac{3}{4}$

Ans. D



Sol. $\tan\theta = \frac{y}{x} \Rightarrow \tan\alpha = \frac{y}{2x}$

$$\cot B = \frac{1-\frac{y}{x}\cdot\frac{y}{2x}}{\frac{y}{x}+\frac{y}{2x}} = \frac{2x^2-y^2}{3xy}$$

Similarly $\cot C = \frac{2y^2-x^2}{3xy}$

$$\therefore\ \cot B + \cot C = \frac{x^2+y^2}{3xy} \geq \frac{2}{3}$$

85. If $\sum_{n=1}^{89}\frac{1}{\sin\left((n+1)k\right)\sin nk}+\frac{\cot 90k}{\sin k}=\frac{2}{3}$, then k is given by

(A) $n\pi \pm \frac{\pi}{3}; n \in I$

(B) $2n\pi \pm \frac{\pi}{3}; n \in I$

(C) $n\pi \pm \frac{\pi}{6}; n \in I$

(D) $2n\pi \pm \frac{\pi}{6}; n \in I$

Ans. B

Sol. $\sum_{n=1}^{89}\frac{1}{\sin(n+1)k\sin nk}$ = $\frac{1}{\sin k}\sum_{k=1}^{89}\frac{\sin\left((n+1)k-nk\right)}{\sin(n+1)k\sin nk}$

= $\frac{1}{\sin k}\sum_{n=1}^{89}\cot(nk)-\cot(n+1)k = \frac{\cot k}{\sin k}-\frac{\cot 90k}{\sin k}$

$\Rightarrow \frac{\cos k}{\sin^2 k}=\frac{2}{3}\ \therefore\ k = 2n\pi \pm \frac{\pi}{3}$; n ∈ I

86. Let two tangents 3x – 4y + 20 = 0 and x – y – 3 = 0 of a parabola intersect the tangent at vertex at points P(0, 5) and Q(3, 0) respectively, then the length of latus rectum is

(A) $\frac{12}{\sqrt{34}}$

(B) $\frac{18}{\sqrt{34}}$

(C) $\frac{24}{\sqrt{34}}$

(D) $\sqrt{34}$

Ans. C

Sol. Focus is (6, –3) and equation of tangent at vertex is $5x + 3y - 15 = 0$

$\therefore$ LR = $4\left|\frac{30-9-15}{\sqrt{34}}\right| = \frac{24}{\sqrt{34}}$

87. From point P(8, t); t being the parameter, tangents are drawn to the ellipse $\frac{x^2}{16}+\frac{y^2}{12}=1$ so as to touch the curve at A and B. The locus of the image of P about AB is

(A) $x = -4$

(B) $x + y = 2$

(C) $x = -8$

(D) $x + y = 4$

Ans. A

Sol. $\frac{h+8}{2}=2$, $\frac{k+t}{2}=0 \Rightarrow h = -4$

88. Let the equation of incircle of ΔABC be $4(x^2 + y^2) = 25$ which touches the sides BC, CA, and AB at D, E and F respectively. If BD, CE and AF are in AP with common difference 2.5, then the circumradius of ΔABC is

(A) 5

(B) 6.25

(C) 7.5

(D) 10

Ans. B

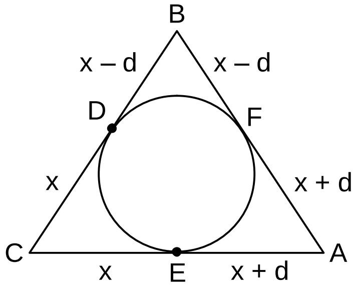
Sol. $s = 3x$

$r=\frac{\Delta}{s}=\frac{\sqrt{3x^2\left(x^2-d^2\right)}}{3x}=2.5$

$\Rightarrow x = 5$

$\therefore$ Sides are 7.5, 10, 12.5

$\therefore$ $R=\frac{7.5\times10\times12.5}{4\times37.5}=6.25$



89. The number of solutions of the equation $\sin^{-1}(\cos 3x) + \cos^{-1}(\sin 3x) = \frac{\pi}{2}$; $x \in [-\pi, \pi]$ is/are

(A) 2

(B) 3

(C) 5

(D) 6

Ans. **D**

Sol. $\sin^{-1}(\cos 3x) = \sin^{-1}(\sin 3x) \Rightarrow \cos 3x - \sin 3x = 0 \Rightarrow \cos\left(3x + \frac{\pi}{4}\right) = 0$

$\Rightarrow x = \frac{n\pi}{3} + \frac{\pi}{12}$; $n \in I$

90. The lower one-fifth portion of a vertical tower subtends an angle $\alpha = \tan^{-1}\frac{1}{5}$ at a point A in the horizontal plane through its foot and at a distance 100 m from the foot. If the angle subtended by the upper four fifth portion of tower at point A is β, then $\beta - \alpha$ is

(A) $\tan^{-1}\frac{5}{17}$

(B) $\tan^{-1}\frac{17}{7}$

(C) $\tan^{-1}\frac{7}{17}$

(D) $\tan^{-1}\frac{11}{17}$

Ans. **C**

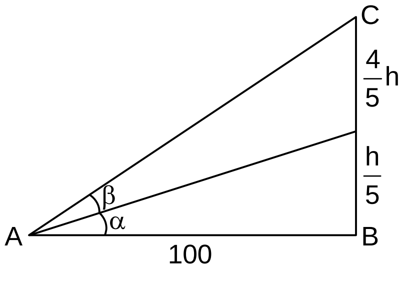
Sol. $\because \tan\alpha = \frac{h}{500} = \frac{1}{5}$

$\Rightarrow h = 100$ m

Hence $\tan(\beta + \alpha) = 1$

$$\Rightarrow \frac{\tan\beta + \frac{1}{5}}{1 - \frac{\tan\beta}{5}} = 1 \Rightarrow \tan\beta = \frac{2}{3}$$

Also, $\tan(\beta - \alpha) = \dfrac{\frac{2}{3} - \frac{1}{5}}{1 + \frac{2}{15}} = \frac{7}{17}$



FIITJEE

ALL INDIA TEST SERIES

PART TEST – III

JEE (Advanced)-2019

PAPER –1

TEST DATE: 16-12-2018

Time Allotted: 3 Hours **Maximum Marks: 264**

General Instructions:

- The test consists of total 60 questions.
- Each subject (PCM) has 20 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Three Sections**: **Section-A, Section-B & Section-C.**

__Section–A (01 – 10, 21 – 30, 41 – 50)__ contains 30 multiple choice questions which have one or more than one correct answer. Each question carries __+4 marks__ for correct answer and __–2 marks__ for wrong answer.

__Section–B (11 – 12, 31 – 32, 51 – 52)__ contains 6 Match the following Type questions. Each question having 4 statements in Column I & 5 statements in Column II with any given statement in Column I having correct matching with 1 or more statement (s) given in Column II. Each statement carries __+2 marks__ for correct answer and __–1 mark__ for wrong answer.

__Section–C (13 – 20, 33 – 40, 53 – 60)__ contains 24 Numerical based questions with answers as numerical value from __0 to 9__ and each question carries __+4 marks__ for correct answer. There is no negative marking.

Physics

PART – I

SECTION – A
(One OR More Than One Choice Type)

This section contains **10 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **one or more than one** is/are correct

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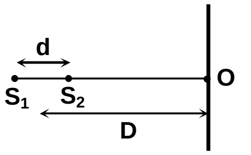
1. Two spherical planets P and Q have the same uniform density ρ, masses M_P and M_Q and surface areas A and 4A respectively. A spherical planet R also has uniform density ρ and its mass is $(M_P + M_Q)$. The escape velocities from the planets P, Q and R are v_P, v_Q and v_R respectively. Then
   (A) $v_Q > v_R > v_P$
   (B) $v_R > v_Q > v_P$
   (C) $\frac{v_R}{v_P} = 3$
   (D) $\frac{v_P}{v_Q} = \frac{1}{2}$

2. Two identical blocks are floating once in water (case-I) and once in mercury container (case –II). They are floating very near to each other. Choose the correct option(s).
   (A) In case –I, both blocks get attracted to each other.
   (B) In case –I, both blocks get repelled from each other.
   (C) In case –II, both blocks get attracted to each other.
   (D) In case –II, both blocks get repelled from each other.

3. The pitch of a screw gauge is 0.5 mm and there are 100 divisions on it's circular scale. The instrument reads 2 circular divisions when nothing is put in between its jaws. In measuring the diameter of a wire, there are 8 divisions on the main scale and 83rd division coincides with the reference line. Then choose the correct option(s).
   (A) Screw gauge is having zero error of –0.01 mm.
   (B) Screw gauge is having zero error of –0.49 mm.
   (C) Diameter of the wire is 4.405 mm.
   (D) Diameter of the wire is 4.425 mm.

4. Heavy stable nucleus have more neutrons than protons. This is because of the fact that
   (A) neutrons are heavier than protons.
   (B) electrostatic force between protons are repulsive.
   (C) neutrons decay into protons through beta decay.
   (D) nuclear forces between neutrons are weaker than that between protons.

5. Two point monochromatic and coherent sources of light of wavelength λ are each placed as shown in the figure. The initial phase difference between the sources is zero. If D >>d, select the correct option(s). (during the counting exclude fringes at infinity)



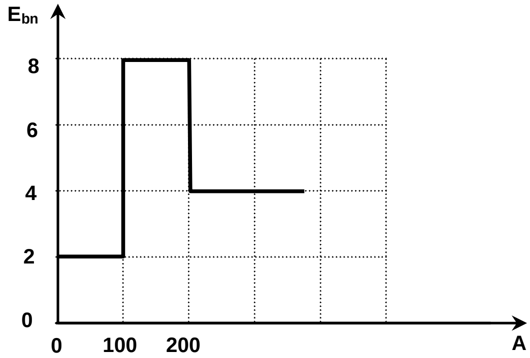
Screen (planar)

   (A) If $d = \frac{7\lambda}{2}$, O will be minima.
   (B) If d = λ, only one maxima can be observed on screen.
   (C) If d = 4.8 λ, then a total 8 minima would be there on screen.
   (D) If $d = \frac{5\lambda}{2}$, then intensity at O would be minimum.

6. Sound of wavelength λ passes through a Quincke's tube, which is adjusted to give a maximum intensity I_0. Through what distance should the sliding tube be moved to give an intensity $\frac{I_0}{2}$.

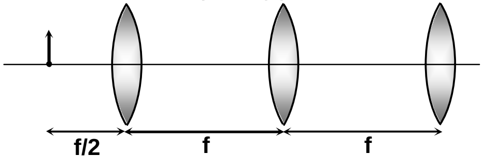
(A) $\frac{7\lambda}{8}$
(B) $\frac{3\lambda}{4}$
(C) $\lambda/4$
(D) $\lambda/8$

7. Assume that the nuclear binding energy per nucleon (E_{bn}) versus mass number (A) is as shown in the figure. Use this plot to choose the correct choice(s) given below:



(A) Fusion of two nuclei with mass number lying in the range of 1 < A < 50 will release energy.
(B) Fusion of two nuclei with mass numbers lying in the range of 51 < A < 100 will release energy.
(C) Fission of a nucleus lying in the mass range of 100 < A < 200 will release energy when breaks into two equal fragments.
(D) Fission of a nucleus lying in the mass range of 200 < A < 260 will release energy when broken into two equal fragment.

8. Three identical biconvex lenses of focal length f are aligned with two neighbouring lenses separated by a distance f as shown in the figure. A small object is located at a distance f/2 in front of the leftmost lens. Choose the correct option(s).



(A) The final image formed is real and inverted.
(B) The final image formed is virtual and erect.
(C) The final image is of same size as that of object.
(D) The final image formed is virtual and inverted.

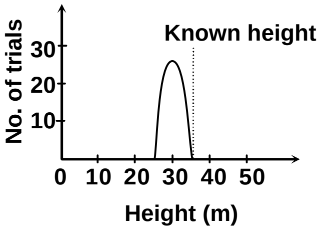
9. Kepler's law states that
I. the orbit of planets are elliptical with one focus at the sun.
II. A line connecting the sun and a planet sweeps out equal areas in equal times and
III. the square the period of a planet's orbit is proportional to the cube of its semi-major axis.

Which of these laws would remain true if the force of gravity were proportional to $\frac{1}{r^{2.5}}$, rather than $\frac{1}{r^2}$?

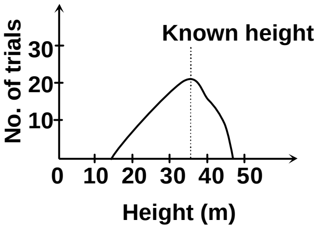
(A) only I
(B) only II
(C) only I and II
(D) none of these

10. Four classes of students measures the height of a building. Each class uses a different method and each measures the height many different times. The data for each class are plotted below. Which class made the most PRECISE measurement?

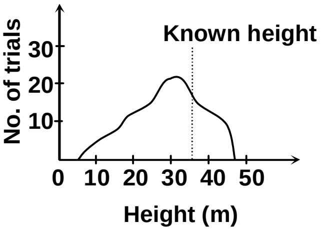
(A)



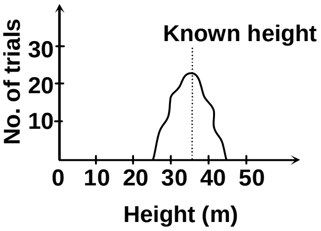
(B)



(C)



(D)



SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.**

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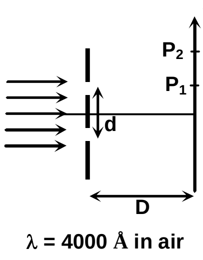
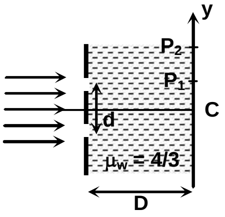
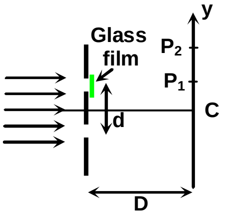
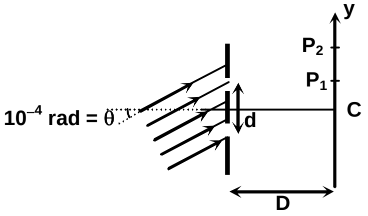
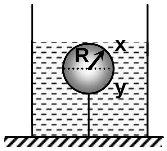
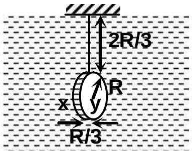
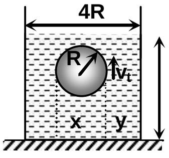
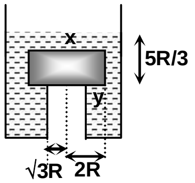
11. Column –I contains four different YDSE systems and Column –II contains intensity measured at some points on the screen. Do the correct match(es) in Column-I and Column –II. (CP_1 = 0.3 mm and CP_2 = 1.2 mm)

Column I			**Column II**	
(A)		d = 1 mm D = 1 m Intensity at each slit = I_0	(p)	$I_C = 4I_0$

(B)	 **λ = 4000 Å in air**	d = 1 mm D = 1 m Intensity at each slit = I_0 and no absorption of light by water ($\mu_w = 4/3$)	(q)	$I_{P_1} = 2I_0$
(C)	 **λ = 4000 Å in air**	d = 1 mm D = 1 m Film thickness t = 0.8 μm refractive index of film = 3/2 Intensity at each slit = I_0 and no absorption of light by glass	(r)	$I_{P_1} = 4I_0$
(D)	 **λ = 4000 Å in air**	d = 1 mm D = 1 m Intensity at each slit = I_0	(s)	$I_{P_1} = 0$
			(t)	$I_{P_2} = 2I_0$

12. Column-I contains some systems having a solid body and fluid. Column-II contains some physical quantities for the systems in column-I. Match column- II with column-I.

Column I			**Column II**	
(A)	Atmospheric pressure = P_0  Density of liquid = ρ Density of solid = σ(σ≠ρ)	A solid sphere of radius R is tied inside a non-viscous liquid and the system is in equilibrium (sphere just touching the top surface of the liquid). x-upper half spherical surface y-lower half spherical surface.	(p)	F_x (force on surface x applied by liquid) $= P_0\pi R^2 + \frac{1}{3}\pi R^3\rho g$
(B)	Atmospheric pressure = P_0  Density of liquid = ρ Density of solid = σ(σ≠ρ)	A solid disc of radius R, thickness R/3 is tied inside a non-viscous liquid and the system is in equilibrium x-rim of the disc y-one of the flat faces of disc.	(q)	F_y (Force on surface y applied by liquid) $= P_0\pi R^2 + \frac{5}{3}\pi R^3\rho g$

(C)	Atmospheric pressure = P_0  Density of liquid = ρ Density of solid = $\sigma(\sigma \neq \rho)$	A solid sphere of radius R is moving upward with a terminal velocity v_t inside a viscous liquid and the beaker is at rest. x-surface of the beaker base just below the sphere y-remaining surface of the beaker base	(r)	Force of buoyancy on sphere or disc (F_B) – weight of sphere or disc (W) is certainly positive
(D)	Atmospheric pressure = P_0  Density of liquid = ρ Density of solid = $\sigma(\sigma \neq \rho)$	A solid disc of radius 2R and height 4R/3 is placed inside a liquid, whose lower part is partially open to atmosphere and the disc is in equilibrium. x-top surface of the disc y-bottom surface of the disc which is in contact with liquid.	(s)	$\sigma < \rho$ (necessarily)
			(t)	$\sigma > \rho$ (necessarily)

SECTION – C
(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

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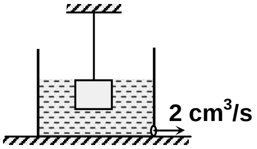
13. At a depth $h_1 = \frac{R}{2}$ from the surface of a planet (radius R = 3000 km), acceleration due to gravity is g_1. It's value changes by Δg_1, when one moves down further by 1 km. At a height h_2 above the surface of the earth acceleration due to gravity is g_2. It's value changes by Δg_2 when moves up further by 1 km. If $\Delta g_1 = \Delta g_2$ and $h_2 = d \times 10^2$ km. Find d. (Assume the planet to be a uniform sphere of radius R) (Take $2^{1/3} = 1.3$)

14. A massless metal plate is placed on a horizontal tabletop lubricated with oil. The sheet is a square of side length ℓ = 1.0 m and the oil layer has thickness h = 1.0 mm. Initially one edge of the sheet coincides with one edge of the table. The sheet is pulled outwards without rotation with a constant force F = 15 N. If coefficient of viscosity of the oil is η = 0.2 N-s/m^2, how long (in second) will it take to pull half of the sheet out of the table?

15. Figure shows a cubical block of side 10 cm and relative density 1.5 suspended by a wire of cross sectional area 10^{-6} m^2. The breaking stress of the wire is 7×10^6 N/m^2. The block is placed in a beaker of base area 200 cm^2 and initially at t = 0, the top surface of water and block coincide. There is a pump at the bottom corner which ejects 2 cm^3 of water per second. If the wire breaks at t = 10^k seconds, find k. (Take g = 10 m/s^2)

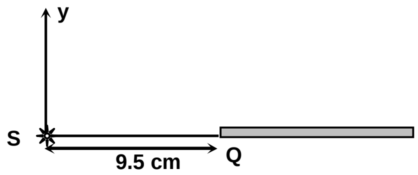


16. If is found that the spectral line of a certain star periodically becomes a doublet indicating that the radiation comes actually from two stars revolving about their centre of mass. Assuming the masses of the stars to be equal, find the distance between them if the maximum splitting of the spectral lines is equal to $\frac{\Delta\lambda}{\lambda} = 1.2 \times 10^{-4}$ and it occurs every τ = 30 days. Give your answer in terms of d × 10^7 km (approximately) and write d.

17. Find the second longest resonance wavelength (in m) in a string of length ℓ = 6 m for which a point at x = $\frac{9}{4}$ m is an anti-node, where x is distance measured along the length of the string from a fixed end. (string is fixed at both ends)

18. An ideal fluid flows through a pipe of circular cross section of radius r at speed v_0 = 4m/s. Now a viscous liquid is made to flow through the same pipe at the same volume flow rate (measured in m^3/s). Find the maximum speed of the viscous liquid particle in the pipe in m/s.

19. A string SQ is connected to a long heavier string at Q. Linear mass density of the heavier string is 4 times of the string SQ. Length of SQ is 9.5 cm. Both the strings are subjected to same tension. A 50 Hz source connected at S produces transverse disturbance in the string. Wavelength of the wave in string SQ is observed to be 1 cm. If the source is switched on at time t = 0 and the smallest time (in sec) at which a point in the heavier string would oscillate in phase with the source at S is $\frac{T}{10}$. Find T.



20. A particle of mass m = 9 gm is trapped between two perfectly rigid parallel walls. The particle bounces back and forth between the walls without losing any energy. From a wave point of view, the particle trapped between the walls is like a standing wave in stretched string between the walls. Distance between the two walls is L = 1 m. Calculate the energy difference between third energy state and the ground state (lowest energy state) of the particle. Answer the energy difference in C × 10^{-65} Joule. (Take Planck's constant h = 6 × 10^{-34} J-sec)

Chemistry PART – II

SECTION – A
(One OR More Than One Choice Type)

This section contains **10 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **one or more than one** is/are correct

21. Which of the following gives precipitate with $(NH_4)_2S$ in aqueous medium?
(A) Fe^{3+}
(B) Al^{3+}
(C) Cr^{3+}
(D) Co^{2+}

22. Which of the following statement is correct? (Neglect vibrational degree of freedom)
(A) Molar internal energy due to motion is $\frac{5}{2}RT$ of diatomic gas molecules.
(B) Molar internal energy due to motion is 3RT of bent triatomic gas molecule.
(C) Molar internal energy due to motion is $\frac{5}{2}RT$ of triatomic linear gas molecules.
(D) Molar internal energy due to motion is $\frac{3}{2}RT$ of monoatomic gas molecules.

23. Select the incorrect statement (s)
(A) above Kraft's temperature and critical micelle concentration, micelle formation take place.
(B) tetra ethyl lead acts as positive catalyst when mixed with petrol for combustion.
(C) higher the gold number more will be the protecting power towards coagulation.
(D) alum purify the water by forming silicate complex with mud particles.

24. 1.350 gm sample of $Co(NH_3)_5SO_4^{2-}Br^-$ (molar mass = 320) is dissolved to prepare 200 ml solution. Osmotic pressure of this solution is found to be 1.039 atm at 27°C. Which statement/s is/are correct for this solution? [The above complex does not form yellow ppt. with $AgNO_3$]
(A) Each molecule gives two ions in solution.
(B) The complex $Co(NH_3)_5SO_4Br$ is completely soluble under given condition.
(C) Molarity of complex ion $[Co(NH_3)_5Br]^{2+}$ is 0.021 M in the solution.
(D) The van't Hoff factor of the complex is = 2.

25. Which of the following is/are correct for spontaneous isothermal chemical reaction?
(A) $\Delta H = 0$, because $\Delta T = 0$
(B) $\Delta S = 0$
(C) $\Delta U = 0$, because $\Delta T = 0$
(D) $\Delta G < 0$

26. The order of hybridization of the central atom in the following species:
$[PtCl_4]^{2-}, [AuCl_4]^-, [Ni(CO)_4], [Au(CN)_2]^-$
Along with increasing order of oxidation state are
(A) sp^3, sp, sp^3, dsp^2
(B) sp^3, sp, sp^3, sp^3
(C) sp^3, sp, dsp^2, dsp^2
(D) sp^3, sp, dsp^2, sp^3

27. There are three bottles having halides in a lab. One of them containing a yellow compound another has red compound and the last one has touch sensitive explosive. Which of the following combination is possible?
(A) AgI, HgI_2, $SnCl_4$
(B) $PbBr_2$, HgI_2, NI_3
(C) AgBr, $SbCl_3$, $SnCl_2$
(D) $FeCl_3$, $CrCl_3$, NF_3

28. By which of the following method(s) Cl_2 can be prepared?
(A) $2KMnO_4 + 16HCl \longrightarrow 2KCl + 2MnCl_2 + 8H_2O + 5Cl_2$
(B) At anode, by the electrolysis of aqueous NaCl
(C) $4HCl + MnO_2 \longrightarrow MnCl_2 + Cl_2 + 2H_2O$
(D) $HOCl + HCl \longrightarrow Cl_2 + H_2O$

29. Which of the following statement(s) is/are correct?
(A) Trapping of an electron in the anion vacancy leads to the formation of F-centre defects.
(B) In a fcc unit cell, the body centre is an octahedral voids.
(C) The edge length of the unit cell in NaCl is 552 pm $\left(r_{Na^+} = 95\text{ pm}, r_{Cl^-} = 181\text{ pm}\right)$
(D) The coordination number of ions in cesium halide crystal is 8.

30. Which of the following statements is/are correct?
(A) Temperature of an ideal gas does not change when it expands adiabatically in vacuum.
(B) $\Delta H, \Delta U, \Delta T, Q$ are zero for expansion in vaccum under adiabatic.conditions.
(C) On increasing the temperature compressibility of real gas decreases.
(D) Dalton's law of partial pressure is applicable at equilibrium for a reacting gaseous mixture.

SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.**

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31. Match the characteristics of Column – I with the characteristics in Column – II

$$\begin{bmatrix} \lambda_m = \text{molar conductance at molarity M} \\ \lambda_m^o = \text{molar conductance at infinite dilution} \end{bmatrix}$$

Column-I		Column-II	
(A)	Conductivity of an electrolytic solution decreases	(p)	$C\lambda_m^2 / \lambda_m^o \left(\lambda_m^o - \lambda_m\right)$ where C is conc.
(B)	$\lambda^o_{CH_3COOH}$ at 25°C	(q)	With increase of concentration
(C)	K_a of weak electrolyte	(r)	$> \lambda^o_{KCl}$ at 25°C
(D)	Conductivity of an electrolytic solution increases	(s)	$< \lambda^o_{KCl}$ at 25°C
		(t)	On decreasing the concentration

32. Match the characteristics of Column – I with the characteristics in Column – II

Column-I		Column-II	
(A)	$Co^{2+} + KNO_2 + CH_3COOH \longrightarrow$	(p)	Brown ppt.
(B)	$Ni^{2+} + DMG \longrightarrow$	(q)	Blue ppt.
(C)	$Cu^{2+} + K_4\left[Fe(CN)_6\right] \longrightarrow$	(r)	White ppt.
(D)	$Al^{3+} + (NH_4)_2S \xrightarrow{H_2O}$	(s)	Red ppt.
		(t)	Yellow ppt.

SECTION – C

(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

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33. λ_m of 10^{-3} M of a weak acid is $0.0142 \times 10^{+x}\ \text{ohm}^{-1}\text{cm}^2/\text{mol}$. $\lambda_m^o = 450\ \text{ohm}^{-1}\text{cm}^2/\text{mol}$ at 25^oC, K_a of acid is 10^{-6}. The value of 'x' is

34. The rate of diffusion of hydrogen gas is $5\sqrt{5}$ times of that of a hydrocarbon at identical temperature and pressure if the molecular formula of hydrocarbon is C_nH_{2n-2}. The value of (n/2) is

35. In Fluorite type structure of X^{2+} & Y^- compound if we remove anions from one body diagonal and cations from all the corners then unit cell formula becomes $X_nY_m : n + m = z,\ z$ is:

36. EMF of the following half-cell Pt | H_2(g) | H^+ (aq) is 0.177 if the $p_{H_2} = 1$ atm then calculate the pH of solution?

37. ΔG for the reaction at 500^oC is

$$\frac{2}{3}Al_2O_3 \longrightarrow \frac{4}{3}Al + O_2 \qquad \Delta G = +1930\ kJ/mole$$

The potential difference for this electrolytic reduction of Al_2O_3 at 500^oC is 'V' volt.
'V' is

38. Calculate the volume (in ml) of 0.1 M $AgNO_3$ required for complete precipitation of chloride ions present in 20 ml of 0.03 M solution of $[Cr(H_2O)_5Cl_2]Cl$, as AgCl is:

39. How many of the following reaction are correct?
(i) $XeF_6 + NaF \longrightarrow Na^+\left[XeF_7\right]^-$
(ii) $XeF_4 + SbF_5 \longrightarrow \left[XeF_3\right]^+\left[SbF_6\right]^-$
(iii) $6XeF_4 + 12H_2O \longrightarrow 4Xe + 2XeO_3 + 24HF + 3O_2$
(iv) $XeF_6 + H_2O \longrightarrow XeOF_4 + 2HF$
(v) $XeF_6 + 2H_2O \longrightarrow XeO_2F_2 + 4HF$
(vi) $NaNO_3 + Zn(\text{powder}) + NaOH \xrightarrow{\Delta} NH_3 + Na_2ZnO_2$

40. How many of these gives metal by self reduction method?
HgS, PbS, Cu_2S, FeS, ZnS, Na_2S

Mathematics PART – III

SECTION – A
(One OR More Than One Choice Type)

This section contains **10 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **one or more than one** is/are correct

41. A matrix of order 3 × 3 is given as A = $[a_{ij}]$, where $a_{ij} \in \{-1, 1\}\ \forall$ i, j then possible values of |A| is (where |A| is determinant of matrix A)
(A) 2
(B) –2
(C) 0
(D) –4

42. If value of $3P = {}^{30}C_5 - {}^{30}C_6 + {}^{30}C_7 - ..... - {}^{30}C_{28} + 29$, and value of
${}^{Q}C_R = {}^{100}C_6 + 4\,{}^{100}C_7 + 6\,{}^{100}C_8 + 4\,{}^{100}C_9 + {}^{100}C_{10}$, then
(A) number of positive divisors of P are 16
(B) Q + R can be divisible either by 9 or 19
(C) if abcd = P, a, b, c, d $\in I^+$, then possible number of order pairs of (a, b, c, d) are 4^4
(D) P is an even integer

43. The number of integral solution of the equation $\alpha + \beta + \gamma + \delta = 18$, with the condition that $1 \le \alpha \le 5$, $-2 \le \beta \le 4$, $0 \le \gamma \le 5$, $3 \le \delta \le 9$, is k, then
(A) Total number of prime factors of k are 7
(B) Exponent of 5 in k! is 13
(C) Number of non negative integer solutions of the equation $x + y + z = \left[\frac{k}{12}\right]$ is 15
(where [.] denotes the greatest integer function)
(D) Number of ordered pair of (a, b, c) such that $abc = k^4$ is 225 (a, b, c $\in$ I)

44. If A(1, 2, 3), B(1, 1, 1), C(1, 1, 2) and D(3, –1, 2) are vertices of a tetrahedron, then
(A) if $\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 1$ is a variable plane which is equidistant from all the four vertices A, B, C, D, then maximum number of possible triplet of (a, b, c) are 7
(B) the volume of tetrahedron is 2 unit^3
(C) length of altitude from point D to the plane ABC is 2 unit
(D) if the acute angle between edges AB and CD is θ, then $\cos\theta = \frac{1}{\sqrt{10}}$

45. Let A(0, 6, 8) and B(6, 12, 0) be two given points and P(α, 0, 0) be a point on x-axis such that PA + PB is minimum, then
(A) if point Q is on the y-axis such that QA + QB is minimum then area of ΔPOQ is $\frac{90}{7}$ unit^2, where O is origin
(B) the volume of tetrahedron OPAB (where O is origin) is $\frac{240}{11}$ unit^3
(C) perpendicular distance from the point A to the plane containing the points P, Q, B is 8 unit
(D) the volume of tetrahedron OPAB (where O is origin) is $\frac{480}{11}$ unit^3

46. If $z_1 = 4 + 3i$, $z_2 = 1 - i$ and $z_3 = 7 + ki$, $k \in R$ such that z_1, z_2, z_3 are vertices of an isosceles triangle for different values of k, then

(A) if $k_1, k_2, \ldots k_n$ are distinct possible values of k, then value of $[|k_1|] + [|k_2|] + \ldots + [|k_n|]$ is 11 (where [.] denotes the greatest integer function)

(B) one of the possible values of area of ΔABC is 12 unit^2

(C) if $k_1, k_2, \ldots, k_n$ are distinct possible values of k, then value of $[|k_1|] + [|k_2|] + \ldots + [|k_n|]$ is 3 (where [.] denotes the greatest integer function)

(D) if $k_1, k_2, \ldots k_n$ are distinct possible value of k, then value $[|k_1 + k_2 + k_3 + \ldots + k_n|]$ is 3 (where [.] denotes the greatest integer function)

47. If P is a non null matrix of order 3 × 3 with real number as entries, such $P^3 = O$, where O is null matrix of order 3 × 3, then (where I is the identity matrix of order 3 × 3)

(A) det of $(4P^2 - 2P + I)$ is a non-zero number

(B) $I - 2P$ is an invertible matrix

(C) if matrix P has all integer entries, then $\det(I - 4P^2) = 0$

(D) if matrix P has all integer entries, then absolute value of $\det(I - 4P^2) = 1$

48. Let $\vec{a}$, $\vec{b}$ and $\vec{c}$ are three unit vectors such that $\left|\vec{a}-\vec{b}\right|^2 + \left|\vec{b}-\vec{c}\right|^2 + \left|\vec{c}+\vec{a}\right|^2 = 3$, then

(A) $\frac{3}{2} < \left|\vec{a}+\vec{b}+\vec{c}\right| < \frac{5}{2}$

(B) $\left|\vec{a}+\vec{b}\right| > \left|\vec{b}+\vec{c}\right|$

(C) $\left|\vec{a}+2\vec{b}+3\vec{c}\right| < 20$

(D) $\vec{a}$, $\vec{b}$, $\vec{c}$ form a system of orthogonal vectors

49. Let z_1, z_2, z_3 be complex numbers representing vertices A, B, C of a triangle. It is known that $|z_1| = |z_2| = |z_3| = 1$, and there exists $\alpha \in \left(0, \frac{\pi}{2}\right)$ such that $z_1 + z_2 \cos\alpha + z_3 \sin\alpha = 0$, then

(A) ΔABC can be an isosceles triangle, with greatest side length of 2 unit

(B) the maximum value of area of ΔABC is $\frac{1}{2\left(\sqrt{2}-1\right)}$ unit^2

(C) triangle ABC can be a right angled triangle

(D) triangle ABC can not be an equilateral triangle

50. On the side AB and AD of a scalene triangle ABD draw externally squares ABEF and ADGH with centres O and Q respectively if M is mid-point of side BD, then

(A) OM : QM is equal to 1 : 2

(B) OM : QM is equal to 1 : 1

(C) $(OM)^2 + (QM)^2 > (OQ)^2$

(D) $(OM)^2 + (QM)^2 = (OQ)^2$

SECTION - B

Matrix – Match Type

This section contains 2 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column I** are labelled A, B, C and D, while the statements in **Column II** are labelled p, q, r, s and t. Any given statement in **Column I** can have correct matching with **ONE OR MORE** statement(s) in **Column II.**

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51. Match the following Column-I with Column-II

	Column – I	**Column – II**	
(A)	If the coefficient of x^{2r} is greater than half of the coefficient of x^{2r-1} in the expansion of $(1 + x)^{15}$, then possible value(s) of $\|r - 4\|$ is/are	(p)	2
(B)	The number of 3-digit number pqr such that we can construct an isosceles triangle with side length p, q and r is λ, then λ is divisible by	(q)	3
(C)	Let a, b, c be complex numbers such that $\|a\| = \|b\| = \|c\| > 0$ and $az^2 + bz + c = 0$, then possible value(s) of $\|z\| + 2$ is/are	(r)	4
(D)	If the number of ordered triplets of (x, y, z) such that x, y, z $\in$ {1, 2, 3, 4, 5, 6, 7, 8} with the condition that z > max{x, y} is k, then factors of k is/are	(s)	5
		(t)	6

52. Match the following Column-I with Column-II

	Column – I	**Column – II**	
(A)	The probability that a randomly selected positive divisor of 10^{99} is an integer multiple of 10^{88}, is $\frac{p}{q}$, (p and q are coprime), then possible divisors of (q – p) is/are	(p)	2
(B)	Three distinct vertices are randomly selected among the vertices of a cube. The probability that these vertices form an isosceles triangle is $\frac{a}{b}$, (where a, b are coprime), then (b + a) is divisible by	(q)	3
(C)	A man can take either 1 step or 3 steps at a time. If he covers a distance of 10 steps in N number of different ways (without retracing his path at any point), then possible factors of $(N)^2$ is/are	(r)	4
(D)	If N be the number of equilateral triangles formed by joining vertices of a 2018 sided regular polygon, then N is divisible by	(s)	5
		(t)	6

SECTION – C

(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

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53. Let a^b be (where 'a' is a prime number) the number of function f: A $\rightarrow$ B, where A = {1, 2, 3, ..., 2019} and B = {2019, 2020, 2021, 2022}, such that f(1) + f(2) + ... + f(2019) is odd number, then last digit of number b is _____

54. Let A and B be points (2, 0, 0) and (0, 4, 0) respectively. If E is mid-point of AB and F is mirror image of origin with respect to edge AB and let D the point on the line $\frac{x-1}{0} = \frac{y-2}{0} = \frac{z}{1}$ at 6 unit distance from the edge AB, then volume of tetrahedron DFAB is _____

55. If A(z_1), B(z_2), C(z_3) and D(z_4) are four points in the Argand plane such that z_1, z_2, z_3, z_4 are roots of equation $z^4 - 5z^3 + 18z^2 - 17z + 13 = 0$, and $|z_1| \neq |z_3|$. Let P is a point of intersection of line $z\left(i+\sqrt{3}\right)+\bar{z}\left(\sqrt{3}-i\right)-2\sqrt{3}=0$ with the real axis, then value of [(PA)(PC)] is equal to _____ (where [.] denotes the greatest integer function)

56. Let ω be a complex cube root of unity and $A = \begin{bmatrix} 1 & p & q \\ \omega^{2017} & 1 & r \\ \omega^{2018} & \omega^{2020} & \omega^{2019} \end{bmatrix}$ where p, q, r are either ω or ω^2, then number of such distinct non singular matrix/matrices A is _____

57. Let $\vec{p} = \hat{i} + \hat{j} + \hat{k}$, $\vec{q} = a\hat{i} + b\hat{j} + c\hat{k}$, where a, b, c $\in$ {–3, –2, –1, 0, 1, 2} if the number of possible vectors $\vec{q}$ such that $\vec{p} \cdot \vec{q} = 0$ is R, then $\frac{R}{5}$ is _____

58. If $\vec{a}, \vec{b}, \vec{c}$ are mutually perpendicular unit vectors and $\vec{d}$ is a unit vector which makes equal angle with $\vec{a}, \vec{b}$ and $\vec{c}$, then the sum of squares of the possible values of $\left|\vec{a} + \vec{b} + \vec{c} + \vec{d}\right|$ is _____

59. Number of isosceles triangles formed by joining the vertices of a 2019 sided regular polygon is M, then the digit at tens place of M is _____

60. Let x, y, z be positive real numbers such that $xyz \geq \left(\frac{x}{3}+\frac{y}{3}+\frac{z}{3}\right)^3$ and $3x + 4y + 5z = 12$, then the value of $x^3 + y^4 + z^5$ is equal to _____

FIITJEE

ALL INDIA TEST SERIES

PART TEST – III

JEE (Advanced)-2019

PAPER –1

TEST DATE: 16-12-2018

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. B, D

Sol. $v_{esc} = \sqrt{\frac{2GM}{R}} = \sqrt{\frac{8}{3}G\rho\pi R^2}$

Given that, $4(4\pi R_P^2) = (4\pi R_Q^2)$ $\therefore R_Q = 2R_P$

Mass of R is $M_R = M_P + M_Q$

$R_R^3 = R_P^3 + R_Q^3$

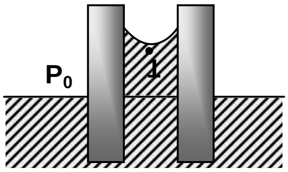
So, $R_R = 9^{1/3} R_P$

So, $R_R > R_Q > R_P \Rightarrow v_R > v_Q > v_P$

Also, $\frac{v_R}{v_P} = 9^{1/3}$ and $\frac{v_P}{v_Q} = \frac{1}{2}$

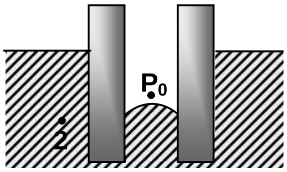
2. A, C

Sol.



$P_1 < P_0$

Case-I



$P_2 > P_0$

Case-II

3. C

Sol. Least count = $\frac{0.5}{100} = 0.005$ mm

Zero error = 0 + 0.005 × 2 = 0.01 mm

So, true diameter = 0.5 × 8 + 0.005 × 83 – 0.01 = 4.405 mm

4. B

Sol. Repulsive force between protons forbids heavy nucleus.

5. A, B, D

Sol. Δx at O = d(path difference is maximum at O)

So, for $d = \frac{5\lambda}{2}$ and $\frac{7\lambda}{2}$, O will be a minimum and for d = λ, O will be a maximum.

There would be total 5 minima for d = 4.8 λ.

6. A, D

Sol. $\frac{I_0}{2} = 4\frac{I_0}{4}\cos^2\left(\frac{\Delta\phi}{2}\right)$

and $\Delta\phi = \frac{2\pi}{\lambda}(2\Delta x)$

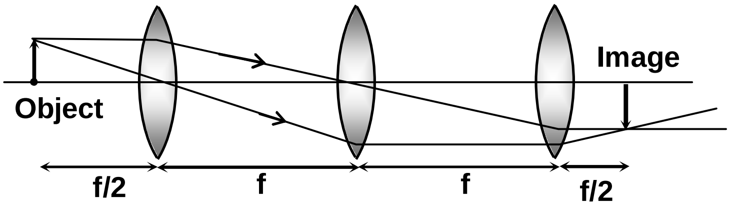
7. B, D

Sol. If two nuclei in the range 51 < A < 100 will fuse then they will produce an element with mass number above 100 and less than 200 which has more E_{bn} thus energy is released hence option (B) is correct.

Similarly a nucleus in the range 200 < A < 260 when broken into two equal fragments then the E_{bn} of these fragments will be more than that of the nucleus hence option (D) is correct.

8. A, C

Sol.



9. B

Sol. The second law is consequence of conservation of angular momentum, which is still true.

10. A

Sol. Accuracy describes how close to the correct or true value a measurement is, while precision in a measurement of how closely grouped or how well a result can be reproduced of the plots given (A) demonstrates the closest grouping at data points.

SECTION – B

11. (A) → (p, q); (B) → (p, r); (C) → (p, q); (D) → (s, t)

Sol. (A) $\Delta\phi_{P_1} = \frac{2\pi}{4\times10^{-7}}\frac{(10^{-3})(3\times10^{-4})}{1} = \frac{3\pi}{2}$

$\Delta\phi_{P_2} = \left(\frac{3\pi}{2}\right)(4) = 6\pi$

So, $I_C = I_{P_2} = 4I_0$ and $I_{P_1} = 2I_0$

(B) $\Delta\phi_{P_1} = \left(\frac{3\pi}{2}\right)\left(\frac{4}{3}\right) = 2\pi$

$\Delta\phi_{P_2} = (2\pi)(4) = 8\pi$

So, $I_C = I_{P_1} = I_{P_2} = 4I_0$

(C) $\Delta\phi_C = \frac{2\pi}{4\times10^{-7}}\left(\frac{3}{2}-1\right)\times 8\times10^{-7} = 2\pi$

$\Delta\phi_{P_1} = 2\pi - \frac{3\pi}{2} = \frac{\pi}{2}$

$\Delta\phi_{P_2} = |2\pi - 6\pi| = 4\pi$

So, $I_C = I_{P_2} = 4I_0$ and $I_{P_1} = 2I_0$

(D) $\Delta\phi_C = \frac{2\pi}{4\times10^{-7}}(10^{-3})(10^{-4}) = \frac{\pi}{2}$

$\Delta\phi_{P_1} = \left(\frac{3\pi}{2} - \frac{\pi}{2}\right) = \pi$

$\Delta\phi_{P_2} = \left(6\pi - \frac{\pi}{2}\right) = \frac{11\pi}{2}$

So, $I_C = I_{P_2} = 2I_0$ and $I_{P_1} = 0$

12. (A) → (p, q, r, s); (B) → (q, t); (C) → (r, s); (D) → (q)

Sol. (A) From free body diagram of the liquid above the sphere, $F_x = P_0\pi R^2 + \frac{1}{3}\pi R^3\rho g$

Force of buoyancy on the sphere = $\frac{4}{3}\pi R^3\rho g$

So, $F_y = P_0\pi R^2 + \frac{5}{3}\pi R^3\rho g$

(B) Force of buoyancy on the disc $F_x = \frac{1}{3}\pi R^3\rho g$

$F_y = P_0\pi R^2 + \frac{5}{3}\pi R^3\rho g$

(C) From the free body diagram of the liquid in the container F_x and F_y are different with option (p) and (q)

(D) $F_x = \left(P_0 + \rho g\frac{R}{3}\right)4\pi R^2 = 4\pi P_0 R^2 + \frac{4}{3}\rho g\pi R^3$

$F_y = \left(P_0 + \rho g\frac{5R}{3}\right)\pi R^2 = P_0\pi R^2 + \frac{5}{3}\rho g\pi R^3$

Force on the part open to atmosphere = $P_0 3\pi R^2$

So, $F_B = \frac{1}{3}\rho g\pi R^3 = 4\pi R^2\frac{4R}{3}\sigma g - N$ (N = normal reaction)

$\therefore\ \sigma \ge \frac{\rho}{16}$

SECTION – C

13. 9

Sol. $g_1 = g\left(1 - \frac{h_1}{R}\right)$ $\therefore\ \Delta g_1 = -\frac{g}{R}\Delta h_1$

and $g_2 = g\frac{R^2}{(R+h_2)^2}$ $\therefore\ \Delta g_2 = -\frac{2gR^2}{(R+h_2)^3}\Delta h_2$

given that, $\Delta g_1 = \Delta g_2$

So, $h_2 = R\left[2^{1/3} - 1\right] = 900$ km

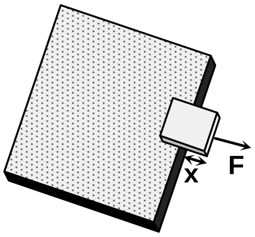
14. 5

Sol. In this case,

$$F = \eta\frac{v}{h}\ell(\ell - x)$$

$$\therefore\ v = \frac{Fh}{\eta\ell(\ell - x)} = \frac{dx}{dt}$$

$$\text{So, } t = \frac{3\eta\ell^3}{8Fh} = 5 \text{ sec}$$



15. 2

Sol. Tension in the wire at t = 0 is, $T_0 = (0.1)^3(10^3)(1.5 - 1)(10) = 5\text{N}$

Wire breaks at tension, $T = 7 \times 10^6 \times 10^{-6} = 7\text{N}$

So volume of ejected water = 200 cm^3

So time taken = 100 sec.

16. 3

Sol. One star is approaching, while the other is receding.

$$\text{So, } \lambda' - \lambda'' = \frac{c+v}{c}\lambda - \frac{c-v}{c}\lambda = \frac{2v}{c}\lambda$$

$$\text{So, } \Delta\lambda = \frac{2\omega R\lambda}{c}$$

$$\therefore\ 2R = \frac{\Delta\lambda c}{\omega\lambda} = \frac{\Delta\lambda c\tau}{\pi\lambda} = 3\times 10^7\text{km}$$

17. 1

Sol. Possible frequencies which will satisfy condition of both ends rigid

$f_1 = \frac{m}{2\ell}\sqrt{\frac{T}{\mu}}$, where ℓ is length of the string

and all possible frequencies which will satisfy condition of string of length $\frac{3\ell}{8}$ with one end rigid and one end free

$$f_2 = \frac{2n+1}{4\left(\frac{3\ell}{8}\right)}\sqrt{\frac{T}{\mu}}$$

So, $f_1 = f_2 \Rightarrow 3m - 8n = 4$

So, $\lambda = \ell/6 = 1$ m

18. 8

Sol. Volume flow rate of ideal fluid = $v_0\pi R^2$

Volume flow rate of the viscous fluid = $\int_0^R v_0'\left(1-\frac{r^2}{R^2}\right)2\pi r dr$

$$= v_0' 2\pi\left[\frac{R^2}{2}-\frac{R^2}{4}\right] = \frac{v_0'\pi R^2}{2} = v_0\pi R^2$$

$\therefore\ v_0' = 2v_0 = 8\ \text{m/s}$

19. 2

Sol. Speed of wave in the lighter string = (50)(1) = 50 cm/s = $\sqrt{\frac{T}{\mu}}$

Speed of wave in the heavier string $= \sqrt{\frac{T}{4\mu}} = 25\ \text{cm/s}$

So wavelength in heavier string = 0.5 cm

$$\therefore\ \Delta\phi = \frac{2\pi}{(1\,\text{cm})}(9.5\ \text{cm}) = (9.5)(2\pi)$$

A point that will oscillate in phase with S must be ahead in phase by (0.5)(2π) with respect to Q. If x is the distance of this point from Q then,

$$\frac{2\pi}{0.5\ \text{cm}}x = (0.5)(2\pi)$$

$\therefore$ x = 0.25 cm

So time required is $\frac{9.5}{50}+\frac{0.25}{25} = 0.2\,\text{sec}$

20. 4

Sol. The permitted wavelength are $\lambda = \frac{2L}{n}$

So, de-Broglie wavelength $\lambda_d = \frac{h}{p} = \frac{h}{\sqrt{2mk_n}}$

$$\therefore\ \frac{2L}{n} = \frac{h}{\sqrt{2mk_n}}$$

$$\therefore\ k_n = \frac{n^2h^2}{8mL^2}\ \ (n = 1, 2, 3, \ldots\ldots\ldots)$$

$$\therefore\ E_3 - E_1 = (3^2 - 1^2)\frac{h^2}{8mL^2} = \frac{h^2}{mL^2} = 4\times10^{-65}\ \text{J}$$

Chemistry

PART – II

SECTION – A

21. A, B, C, D

Sol. $Fe^{3+} + (NH_4)_2S \longrightarrow FeS\downarrow + S\downarrow$

$Al^{3+} + (NH_4)_2S + H_2O \longrightarrow Al(OH)_3\downarrow + H_2S\uparrow$

$Cr^{3+} + (NH_4)_2S + H_2O \longrightarrow Cr(OH)_3\downarrow + H_2S\uparrow$

$Co^{2+} + (NH_4)_2S \longrightarrow CoS\downarrow$

22. A, B, C, D

Sol. In linear molecule → 3 translation + 2 Rotation = 5 motion

$\therefore$ Energy contribution $= 5\times\frac{1}{2}KT = \frac{5}{2}KT$ by one molecule

$\frac{5}{2}N_{av}KT = \frac{5}{2}RT$ by one mole.

In bent triatomic ⇒ 3 translation + 3 Rotation = 6 motion

$\therefore$ Energy contribution $= 6\times\frac{1}{2}KT$ = 3 KT by one molecule

$\therefore$ By one mole = 3 KT × N_{av} = 3RT

In monoatomic ⇒ 3 translation motion

$\therefore$ Energy contribution $= \frac{3}{2}RT$ by one molecule.

23. B, C, D

Sol. Facts.

24. A, B, C, D

Sol. W = 1.350 gm

Molar mass = 320

Moles = $\frac{1.35}{320}$

$$\pi_{calc.} = CRT = \left(\frac{1.350}{320}\times\frac{1000}{200}\right)\times 0.0821\times 300$$

= 0.5195 atm

$\pi_{obs.} = 1.039$

$$\frac{\pi_{obs.}}{\pi_{calc.}} = i = \frac{1.039}{0.5195} = 2$$

$$\alpha = \frac{i-1}{n-1} = 1$$

n = 2

	$[Co(NH_3)_5Br]SO_4 \longrightarrow$	$[Co(NH_3)_5Br]^{2+}$	SO_4^{2-}
Initial	0.021		
at equ.	–	0.021	0.021

25. D

26. C

Sol.

	Oxidation number	Hybridization
$[Ni(CO)_4] \rightarrow$	0	sp^3
$\left[Au(CN)_2\right]^-$	+1	sp
$\left[PtCl_4\right]^{2-}$	+2	dsp^2
$\left[AuCl_4\right]^-$	+3	dsp^2

27. B

Sol. $PbBr_2$, AgI, AgBr and $FeCl_3$ solution is yellow.
$HgI_2 \rightarrow$ Red
$NI_3 \rightarrow$ Touch sensitive explosive

28. A, B, C, D

Sol. All are preparation methods of Cl_2.

29. A, B, C, D

Sol. Facts.

30. A, B, C, D

Sol. Facts.

SECTION – B

31. A → t; B → r; C → p; D → q

Sol.
$$K_a = \frac{C\alpha^2}{1-\alpha} = \frac{C\left(\lambda m / \lambda_m^o\right)^2}{\left(1-\lambda m / \lambda_m^o\right)}$$
$$= \frac{C\lambda_m^2 / \lambda_m^{o\,2}}{\frac{\lambda_m^o - \lambda_m}{\lambda_m^o}} = \frac{C\lambda_m^2}{\lambda_m^o\left(\lambda_m^o - \lambda_m\right)}$$

32. A → t; B → s; C → p; D → r

Sol.
$$Co^{2+} + KNO_2 + CH_3COOH \longrightarrow \underset{\text{Yellow ppt.}}{K_3\left[Co\left(NO_2\right)_6\right]} \downarrow$$
$$Ni^{2+} + DMG \longrightarrow \text{Red ppt.}$$
$$Cu^{2+} + K_4\left[Fe(CN)_6\right] \longrightarrow \underset{\text{Brown ppt.}}{Cu_2\left[Fe(CN)_6\right]} \downarrow$$
$$Al^{3+} + \left(NH_4\right)_2 S \xrightarrow{H_2O} \underset{\text{White ppt.}}{Al(OH)_3} \downarrow$$

SECTION – C

33. 3

Sol.
$$HA \rightleftharpoons H^+ + A^-$$
$$K_a = \frac{c\alpha^2}{1-\alpha}$$

$$1-\alpha \simeq 1$$

$$K_a = c\alpha^2, \alpha = \sqrt{\frac{10^{-6}}{10^{-3}}} = 0.0316$$

$$\frac{\lambda_m}{\lambda_m^o} = \alpha$$

$$\lambda_m = 0.0316 \times 450 = 14.22$$

34. 9

Sol. $\frac{r_{H_2}}{r_{C_nH_{2n-2}}} = \sqrt{\frac{M_{C_nH_{2n-2}}}{2}} = 5\sqrt{5}$

$\therefore M_{C_nH_{2n-2}} = 250$

$\therefore 12n + (2n-2) = 250$

$\therefore n = 18$ and $n/2 = 9$

35. 9

Sol. $X_3Y_6 \quad \therefore n + m = 9$

36. 3

Sol. $H_2 \longrightarrow 2H^+ + 2e^-$

$$E = E^o - \frac{0.059}{2}\log\frac{[H^+]^2}{P_{H_2}}$$

$$0.177 = 0 - \frac{0.059}{2}\log\frac{[H^+]^2}{1}$$

$$\therefore -\log[H^+] = \frac{0.177}{0.059} = 3$$

37. 5

Sol. $\Delta G = -nFE$

$$E = -\frac{1930000}{4 \times 96500} = -5.0 \text{ V}$$

V = 5

38. 6

Sol. $[Cr(H_2O)_4 Cl_2]Cl + AgNO_3 \longrightarrow AgCl$

$20 \times 0.03 = 0.1 \text{ V}$

$$V = \frac{20 \times 0.03}{0.1} = 6 \text{ ml}$$

39. 6

Sol. All are correct.

40. 3

Sol. Only HgS, PbS and Cu_2S gives self reduction.

Mathematics PART – III

SECTION – A

41. C, D

Sol. Fix first row as [1, 1, 1], and possibility are $\begin{bmatrix} 1 & 1 & 1 \\ 1 & -1 & 1 \\ -1 & 1 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$

42. A, B, C

Sol. $\Rightarrow \left({}^{29}C_4 + {}^{29}C_5\right) - \left({}^{29}C_5 + {}^{29}C_6\right) + ... - \left({}^{29}C_{27} + {}^{29}C_{28}\right) = {}^{29}C_4 - 29$

$\Rightarrow 3P = {}^{29}C_4 \Rightarrow P = 3 \times 7 \times 13 \times 29$

${}^{Q}C_R = {}^{104}C_{94} \Rightarrow Q = 104, R = 94$ or 10

43. B, C

Sol. The equation can be written as $t_1 + t_2 + t_3 + t_4 = 16$, $0 \le t_1 \le 4$, $0 \le t_2 \le 6$, $0 \le t_3 \le 5$ and $0 \le t_4 \le 6$
Let P_1 is property that $t_1 \ge 5$, t_2 is property is $t_2 \ge 7$, p_3 is property $t_3 \ge 6$ and p_4 is property that $t_4 \ge 7$ and A_i is denote the subset of S satisfying condition p_i when S is total number of solutions $= {}^{19}C_{16} = 969$

So, $\bar{A}_1 \cap \bar{A}_2 \cap \bar{A}_3 \cap \bar{A}_4 = S - \sum A_i + \sum A_i \cap A_j - \sum A_i \cap A_j \cap A_k + ... \Rightarrow k = 55$

So, number of ordered pair satisfying condition $abc = k^4$, $a, b, c \in I \Rightarrow 4 \times 225 = 900$

44. A, C, D

Sol. There are maximum 7 distinct planes which are at equidistance from all the vertices
The volume of tetrahedron is 1/3 unit^3

45. A, C, D

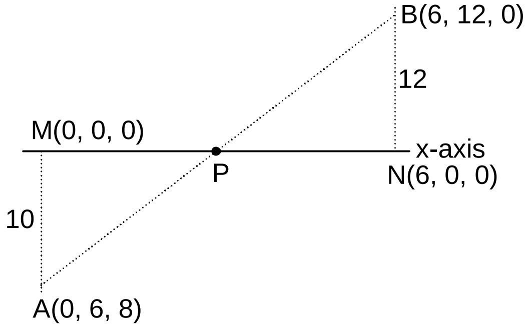
Sol. $\alpha = \frac{30}{11}$, $Q\left(0, \frac{66}{7}, 0\right)$

PA + PB is minimum, then

So, $\frac{MP}{PN} = \frac{AM}{BN} = \frac{5}{6}$

So, $P = \left(\frac{30}{11}, 0, 0\right)$

Similarly Q is $\left(0, \frac{66}{7}, 0\right)$



46. B, C, D

Sol. The possible value of k are –1, $-\frac{19}{8}$ and k = 7 is not possible, because all points will be collinear

47. A, B, D

Sol. $(2P + I)(4P^2 - 2P + I) = 8P^3 + I^3 = I$
Similarly, $(I - 2P)(I + 2P + 4P^2) = I$, if P has integer entries, then $|I - 2P|$ and $|I + 2P|$ will be equal to either 1 or –1

48. A, C

Sol. $\left|\vec{a}-\vec{b}\right|^2+\left|\vec{b}-\vec{c}\right|^2+\left|\vec{c}+\vec{a}\right|^2=3 \Rightarrow \left|\vec{a}+\vec{c}-\vec{b}\right|^2=0$, $\vec{a}+\vec{c}=\vec{b} \Rightarrow \vec{a}\cdot\vec{c}=-\frac{1}{2}$

So, $\left|\vec{a}+\vec{b}+\vec{c}\right|=2\left|\vec{b}\right|=2$, $\left|\vec{a}+2\vec{b}+3\vec{c}\right|=\left|3\vec{a}+5\vec{c}\right|=\sqrt{19}$

49. B, D

Sol. $1 = |z_1|^2 = |z_2 \cos\alpha + z_3 \sin\alpha|^2$

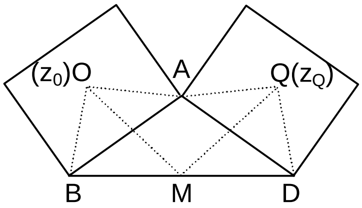
$$1=1+\frac{z_2^2+z_3^2}{z_2z_3}\cos\alpha\sin\alpha \Rightarrow z_2^2+z_3^2=0 \Rightarrow z_3=\pm iz_2$$

Now take cases for z_1 as $z_1 = -z_2(\cos\alpha \pm i\sin\alpha) \Rightarrow z_1=-z_2e^{\pm i\alpha}$

α can not equal to zero or $\frac{\pi}{2}$ so option A and C are not possible

50. B, D

Sol. Let z_1, z_2, z_3 be complex number represents A, B, and D point



$$\frac{z_1-z_0}{z_2-z_0}=\frac{z_3-z_Q}{z_1-z_Q}=i$$

$$\Rightarrow z_0=\frac{z_1+z_2+(z_1-z_2)i}{2};\ z_Q=\frac{z_1+z_3+(z_3-z_1)i}{2}$$

$$z_M=\frac{z_2+z_3}{2}$$

$$\frac{z_0-z_m}{z_Q-z_m}=\frac{(z_1-z_3)+(z_1-z_2)i}{(z_1-z_2)+(z_3-z_1)i}=i \Rightarrow QM \perp OM \text{ and } OM = QM$$

SECTION – B

51. (A) → (p, q), (B) → (q, s), (C) → (q), (D) → (r, s)

Sol. (A) ${}^{15}C_{2r} > \frac{1}{2}\,{}^{15}C_{2r-1}$

$r < \frac{16}{3} \Rightarrow r \le 5$ ($r \in N$)

(B) Let side of triangle is (x, x, y), y < 2x
For x = 1, 2, 3, 4, 5 number of possible value of y is 1, 3, 5, 7, 9 respectively
For x > 5, y has 9 possibilities so total number of the ordered pair of (x, x, y) is
1 + 3 + 5 + 7 + 5 × 9 = 61
So, total possibility are 52 × 3 + 9 = 165

(C) $|az^2| = |-bz - c| \le |b|\,|z| + |c| \Rightarrow |z|^2 - |z| - 1 \le 0$, $|z| \le \frac{1+\sqrt{5}}{2}$

and $|c| \le |a|\,|z|^2 + |b|\,|z| \Rightarrow |z|^2 + |z| - 1 \ge 0$, $|z| \ge \frac{\sqrt{5}-1}{2}$

(D) z > x > y, z > y > x and z > y = x
So total number of cases = ${}^8C_3 + {}^8C_3 + {}^8C_2 = 140$

52. (A) → (p, r), (B) → (p, s), (C) → (p, r, s), (D) → (p, q, r, s, t)

Sol. (A) Let the form of divisor is $2^a\,5^b$
So, $88 \le a, b \le 99$, 12 cases for each a and b
So, $p(E)=\frac{12\times12}{100\times100}=\frac{9}{625}$

(B) On each face there are 4 such triangles are possible, so total triangles are 4 × 6 = 24

Total number of triangle are = 56

$p(E) = \frac{24}{56} = \frac{a}{b}$

(C) Possible cases

$\underbrace{1\ 1\ 1.....1}_{10\text{ times}} \rightarrow 1$

$\underbrace{1\ 1\ 1.....1}_{7\text{ times}}\ 3 \rightarrow \frac{8!}{7!} = 8$

$1\ \ 1\ \ 1\ \ 1\ \ 3\ \ 3 \rightarrow \frac{6!}{4!\,2!} = 15$

$1\ \ 3\ \ 3\ \ 3\ \rightarrow \frac{4!}{3!} = 4$

So total number of cases will be = 28

(D) No such equilateral triangle is possible, so N = 0

SECTION – C

53. 7

Sol. Choices for f(1), f(2), ..., f(2018), are 4, but f(2019) have two possibility
So, $a^b = 2 \times 4^{2018}$

54. 8

Sol. Volume of DFAB = $\frac{1}{3} \times \text{height} \times \text{base area} = \frac{1}{3} \times 6 \times 4 = 8$
Given line is perpendicular to edge AB and passing through point E

55. 3

Sol. $z^4 - 5z^3 + 18z^2 - 17z + 13 = (z - z_1)(z - z_2)(z - z_3)(z - z_4)$
$10 = (1 - z_1)(1 - z_2)(1 - z_3)(1 - z_4)$
$10 = (PA)^2(PC)^2 \Rightarrow (PA)(PC) = \sqrt{10}$

56. 2

Sol. det(A) = $(r\omega - 1)(p\omega - 1)$, total number of matrices are 8,
the number of matrices has |A| = 0, are 6

57. 5

Sol. Coefficient of x^6 in $(x^5 + x^4 + ... + 1)^3$
$\Rightarrow$ Coefficient x^6 in $(x^6 - 1)^3(x - 1)^{-3}$
$\Rightarrow 28 - 3 = 25$, R = 25

58. 8

Sol. $\vec{d} = \lambda\left(\vec{a} + \vec{b} + \vec{c}\right) \Rightarrow \lambda = \pm\frac{1}{\sqrt{3}}$

$\left|\vec{a} + \vec{b} + \vec{c} + \vec{d}\right| = |\lambda + 1|\left|\vec{a} + \vec{b} + \vec{c}\right| = \left|\sqrt{3} \pm 1\right|$

59. 2

Sol. $M = \left({}^{2019}C_1 \times {}^{1008}C_1\right) + \frac{2019}{3} = 2035825$

60. 3

Sol. Only equality holds in A.M. ≥ G.M. so x = y = z = 1

FIITJEE

ALL INDIA TEST SERIES

PART TEST – III

JEE (Advanced)-2019

PAPER –2

TEST DATE: 16-12-2018

Time Allotted: 3 Hours **Maximum Marks: 240**

General Instructions:

- The test consists of total 60 questions.
- Each subject (PCM) has 20 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

__Section–A (01 – 08, 21 – 28, 41 – 48)__ contains 24 multiple choice questions which have one or more correct answer. Each question carries __+4 marks__ for correct answer and __–2 marks__ for wrong answer.

__Section–A (09 – 12, 29 – 32, 49 – 52)__ contains 12 paragraphs with each having 2 questions with one or more than one correct answer. Each question carries __+4 marks__ for correct answer and __–2 marks__ for wrong answer.

__Section–C (13 – 20, 33 – 40, 53 – 60)__ contains 24 Numerical based questions with answers as numerical value from 0 to 9 and each question carries __+4 marks__ for correct answer. There is no negative marking.

Physics

PART – I

SECTION – A
(One OR More Than One Choice Type)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **one or more than one** is/are correct

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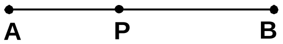


1. A particle of mass m = 3kg is constrained to move along a straight line. A and B are two fixed points on the line at a separation of L = ℓ m. When the particle is at some point P between A and B, it is acted upon by two forces $\vec{F}_1 = (200\ \text{N/m})\overrightarrow{PA}$ and $\vec{F}_2 = (100\ \text{N/m})\overrightarrow{PB}$, where magnitudes of $\overrightarrow{PA}$ and $\overrightarrow{PB}$ are in metre. At time t = 0, the particle is projected from A towards B with speed v = $\frac{10}{\sqrt{3}}$ m/s. Then

(A) Particle reaches to B at t = $\frac{\pi}{30}$ sec

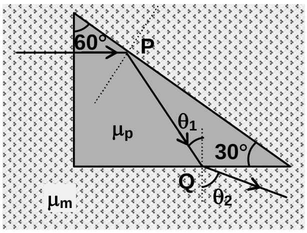
(B) Particle reaches to B at t = $\frac{\pi}{15}$ sec

(C) Oscillation energy of the particle is $\frac{200}{3}$ J

(D) Oscillation energy of the particle is $\frac{100}{3}$ J

2. In the Bohr's hydrogen atom model, R, V and E represent the radius of the orbit, speed of the electron and total energy of the electron respectively. Which of the following quantities are proportional to the quantum number n?

(A) VR
(B) RE
(C) VE^{-1}
(D) RE^{-1}



3. A ray of light is incident normally on one face 30° – 60° – 90° prism of refractive index μ_p = 5/3 immersed in water of refractive index μ_m = 4/3 as shown in the figure.

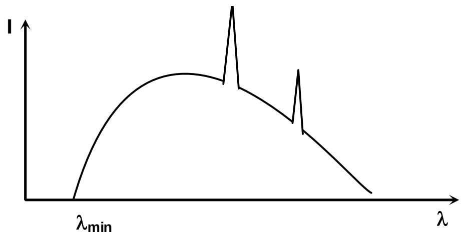
(A) The exit angle θ_2 of the ray is $\sin^{-1}\left(\frac{5}{8}\right)$

(B) The exit angle θ_2 of the ray is $\sin^{-1}\left(\frac{5}{4\sqrt{3}}\right)$

(C) Total internal reflection at point P ceases if the refractive index of water is increased to $n > \frac{5}{2\sqrt{3}}$ by dissolving some substance.

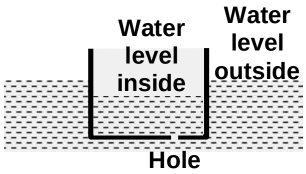
(D) Total internal reflection at point P ceases if the refractive index of water is increased to $n > \frac{5}{6}$ by dissolving some substance.

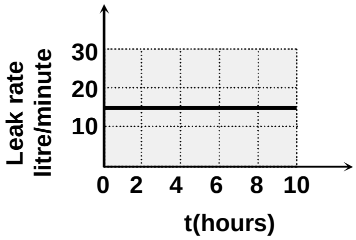
4. A beam of electrons striking a copper target produces X-rays. Its spectrum is as shown in the figure. Keeping the voltage same if the copper target is replaced with a different metal, the cut off wavelength and characteristic lines of the new spectrum will change in comparison with old as

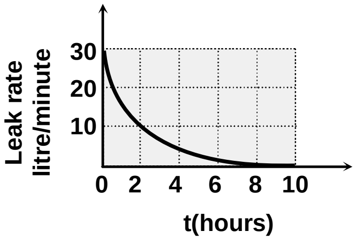


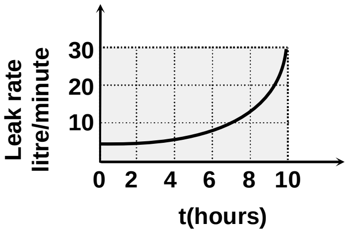
(A) Cut off wavelength will remain unchanged.
(B) Both cut off wavelength and characteristic lines must remain unchanged.
(C) Characteristic lines may be different.
(D) Cut off wavelength will be different while characteristic lines may remain unchanged.

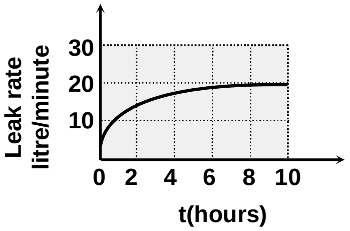
5. A small hole is punched into the bottom of a rectangular boat, allowing water to enter the boat. As the boat sink into the water, which of the following graph best shows how the water flow rate through the hole varies with time? Assume that the boat remains horizontal as it sinks.



(A)


(B)


(C)


(D)


6. A very large number of small particles forms a spherical cloud. Initially they are at rest, have uniform mass density per unit volume ρ_0 and occupy a region of radius r_0. The cloud collapses due to gravitation, the particles do not interact with each other in any other way. How much time passes until the cloud collapse fully?

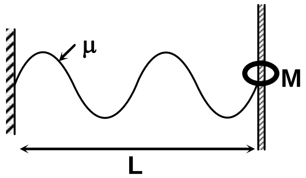
(A) $\sqrt{\frac{3\pi}{8G\rho_0}}$

(B) $\sqrt{\frac{\pi}{32G\rho_0}}$

(C) $\sqrt{\frac{3\pi}{32G\rho_0}}$

(D) $\sqrt{\frac{\pi}{8G\rho_0}}$

7. Small amplitude standing waves of wavelength λ occur on a string with tension, T, mass per unit length μ and length L. One end of the string is fixed and the other end is attached to a ring of mass M that slides on a frictionless rod, as shown in the figure above. When gravity is neglected, which of the following conditions correctly determines the wavelength?



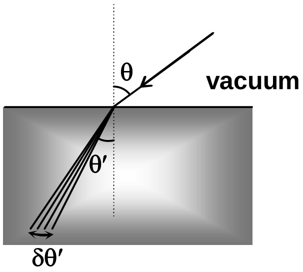
(A) $\frac{\mu}{M} = \frac{2\pi}{\lambda}\cot\left(\frac{2\pi L}{\lambda}\right)$

(B) $\frac{\mu}{M} = \frac{2\pi}{\lambda}\tan\left(\frac{2\pi L}{\lambda}\right)$

(C) $\lambda = \frac{2L}{n},\ n = 1, 2, 3, \ldots\ldots\ldots\ldots$

(D) $\lambda = \frac{2L}{\left(n + \frac{1}{2}\right)},\ n = 1, 2, 3, \ldots\ldots\ldots\ldots$

8. A beam of light has a small wavelength spread $\delta\lambda$ above a central wavelength λ. The beam travels in vacuum until it enters a glass plate at an angle θ relative to the normal to the plate as shown in the figure. The index of refraction of the glass is given by $n(\lambda)$. The angular spread $\delta\theta'$ of the refracted beam is given by



(A) $\delta\theta' = \left|\frac{d\mu(\lambda)}{d\lambda}\delta\lambda\right|$

(B) $\delta\theta' = \left|\frac{\tan\theta'}{n}\frac{dn(\lambda)}{d\lambda}\delta\lambda\right|$

(C) $\delta\theta' = \left|\frac{\sin\theta}{\sin\theta'}\frac{\delta\lambda}{\lambda}\right|$

(D) $\delta\theta'$ remains constant for different values of θ in the range $\frac{\pi}{6} \le \theta \le \frac{\pi}{3}$.

Comprehension Type

This section contains **2 paragraphs** each describing theory, experiment, data etc. Each question has **four** options (A), (B), (C) and (D). **One or more than one** of these four option(s) is(are) correct

Paragraph for Questions 09 & 10

Gaseous products of burning are released into the atmosphere of temperature T_a through a high chimney of cross section A and height h as shown in the figure. The solid matter is burnt in the furnace which is at temperature T_S. due to burning smoke (gas) generation rate (volume per unit time) is Q.

It can be assume that

→ the velocity of the smoke (gas) in the furnace is negligibly small.

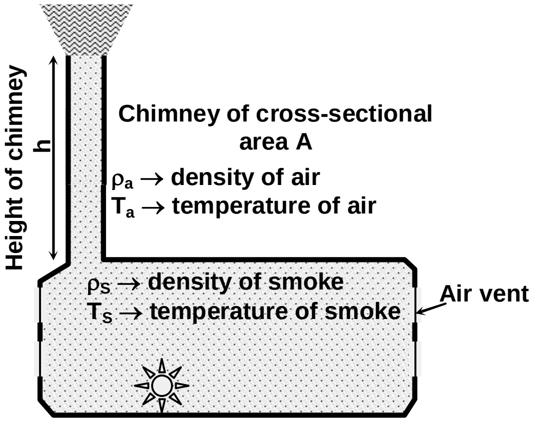
→ the density of the smoke (gas) does not differ from that air at the same temperature and pressure.

→ the gases can be treated as ideal while in furnace.

→ the pressure of the air changes with height according to the hydrostatic law. The change of the density of the air with height is negligible.

→ the flow of gases in the chimney follows Bernoulli's equation.

→ the change of the density of the gas (smoke) is negligible throughout the chimney.


Height of chimney
h
Chimney of cross-sectional area A
ρ_a → density of air
T_a → temperature of air
ρ_S → density of smoke
T_S → temperature of smoke
Air vent

A furnace with chimney

9. What is the minimum height of the chimney needed in order that chimney functions efficiently, so that it can release all of the produced smoke(gas) into the atmosphere? Express your answer in terms of Q, A, g, T_a, ρ_a, ρ_s and ΔT, where $\Delta T = T_S - T_a$

(A) $\frac{\rho_s T_a Q^2}{gA^2 \Delta T(\rho_a - \rho_s)}$

(B) $\frac{T_a Q^2}{2gA^2 \Delta T}$

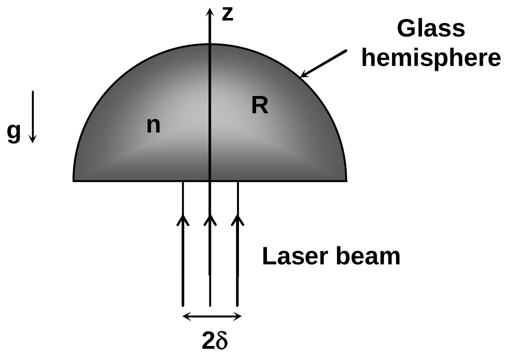
(C) $\frac{Q^2 \rho_s}{2(\rho_a - \rho_s)A^2 g}$

(D) $\frac{Q^2(T_a + \Delta T)}{2gA^2 \Delta T}$

10. Assume that two chimneys are built to serve exactly the same purpose. Their cross sections are identical, but are designed to work in different parts of the world, one in cold regions designed to work at an average atmospheric temperature of −23°C and the other in warm regions, designed to work at an average atmospheric temperature of 27°C. The temperature of the furnace is 327°C. It was calculated that the height of the chimney designed to work in cold regions is 100 m. How high is the other chimney?

(A) 71.4m
(B) 280 m
(C) 140 m
(D) 100 m

Paragraph for Questions 11 & 12



In a hypothetical experiment light is used to levitate a transparent glass hemisphere with radius R and mass m having refractive index n. In the medium outside the hemisphere, the index of refraction is equal to one. A parallel beam of monochromatic laser light is incident uniformly and normally onto the central portion of its planar surface as shown in figure. The acceleration of gravity g is vertically downwards. The radius δ of the circular cross section of the laser beam is much smaller than R. Both the glass hemisphere and the laser beam are axially symmetric with respect to z-axis.

The glass hemisphere does not absorb any laser light. Its surface has been coated with a thin layer of transparent material so that reflections are negligible when light enters and leaves the glass hemisphere. The optical path traversed by laser light passing through the non-reflecting surface layer is also negligible.

11. Find the laser power P required to balance the weight of the glass hemisphere.
    (A) $\frac{2mgR^2c}{(n-1)^2\delta^2}$
    (B) $\frac{4mgR^2c}{(n-1)^2\delta^2}$
    (C) $\frac{2mgR^2c}{(n^2-1)\delta^2}$
    (D) $\frac{mgR^2c}{(n^2-1)\delta^2}$

12. If the frequency of the laser beam is f, then the number of photons striking the hemisphere per unit time is
    (A) $\frac{2mgR^2c}{(n-1)^2\delta^2hf}$
    (B) $\frac{4mgR^2c}{(n-1)^2\delta^2hf}$
    (C) $\frac{2mgR^2c}{(n^2-1)\delta^2hf}$
    (D) $\frac{mgR^2c}{(n^2-1)\delta^2hf}$

SECTION – C

(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

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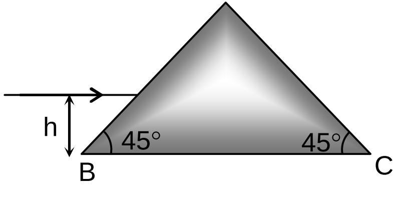
13. A ray of light is incident parallel to BC at a height h = 3.0 cm from BC. Find the height (in cm) above BC at which the emergent ray leaves the surface AC. It is given that $\mu = \sqrt{2}$ and length BC = 20 cm. Take tan 15° = 0.25.

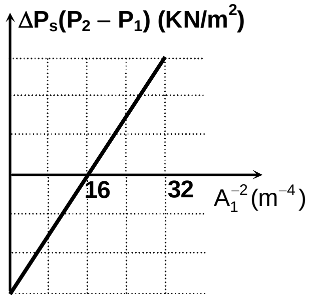


14. A compound microscope is used to enlarge an object kept at a distance of 3 cm from its objective. The objective consists of several convex lenses is contact and has a focal length of 2 cm. If a lens of focal length 10 cm is removed from the objective, the eyepiece has to be moved by x cm to refocus the image. The value of x is

15. Consider a nuclear reaction A + B → C. A nucleus A moving with kinetic energy of 5 MeV collides with a nucleus B moving with kinetic energy of 3 MeV and forms a nucleus C in excited state. Find the kinetic energy of nucleus C (in MeV) just after its formation if it is formed in a state with excitation energy 10.65 MeV. Take masses of nuclei of A, B and C as 25.0, 10.0 and 34.995 amu, 1 amu ≈ 930 MeV/c^2

16. A small sphere of radius R = 10 cm is arranged to pulsate so that its radius varies in simple harmonic motion between a range 10.0cm ± 0.1cm with frequency f = 100 Hz. This produces sound waves in the surrounding air of density ρ =1.6 kg/m^3 and bulk modulus B = 10^5 Pascal. Find the total acoustic power radiated by the sphere (in watt). (take $\pi^3 = \frac{225}{8}$)

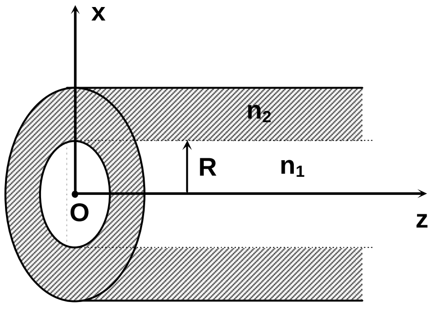
17. Fresh water flows horizontally from pipe section 1 of cross sectional area A_1 into pipe section 2 of cross-sectional area A_2. Figure gives a plot of the pressure difference ($P_2 - P_1$) versus the inverse area squared A_1^{-2} that would be expected for a volume flow rate of a certain value if the waver flow were laminar under all circumstances. The scale on the vertical axis is set by ΔP_S = 100 KN/m^2. For the condition of the figure, what is the volume flow rate in m^3/s? (take $\sqrt{6} = 2.4$)

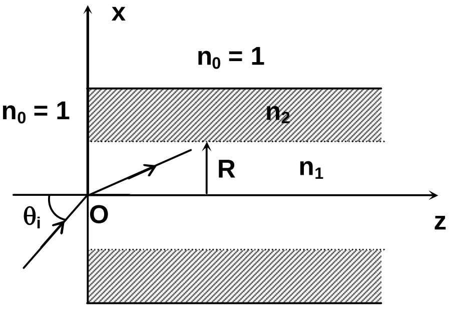


18. A plano-convex lens is placed on a plane glass surface. A thin film of air is formed between the curved surface of the lens and the plane glass plate. The thickness of the air film is zero at the point of contact and increases as one moves away from the point of contact. In the arrangement light containing two wavelengths 4000 Å and 4002 Å is allowed to fall normally on the flat face of the lens. Calculate the minimum distance (in cm) from the point of contact at which the rings will disappear. Assume that the radius of curvature of the curved surface is 400 cm. (assume identical intensities for both wavelengths)

19. An optical fiber consists of a cylindrical core of radius R, made of transparent material with refraction index varying gradually from the value n = n_1 on the axis to n = n_2 (with 1 < n_2 < n_1) at a distance R from the axis, according to the formula

$$n = n(x) = n_1\sqrt{1-\alpha^2x^2}$$





Where x is the distance from the core axis and α is a constant. The core is surrounded by a cladding made of a material with constant refraction index n_2. Outside the fibre is air of refractive index n_0. Let Oz be the axis of the fiber, with O – the centre of the fiber end. Given n_0 = 1, n_1 = 1.5 and n_2 = 1.46, R = 25 μm. A monochromatic light ray enters the fiber at point O under an incident angle $\theta_i = 30^\circ$, the incident plane being the plane xOz. At each point on the trajectory of the light in the fiber, the refractive index n and the angle θ between the light ray and the Oz axis satisfy the relationship $n\cos\theta = \sqrt{C}$. Find C.

20. Two thin lenses with lens powers D_1 and D_2 diopter are located at distance L = 25 cm from each other and their optical axes coincide. This system creates an erect real image of the object, located at the optical axis closer to lens D_1 with the net magnification $M_1 = 1$. If the position of the two tenses are exchanged, the system again produces an erect real image with the net magnification $M_2 = 4$. What is the difference between lens powers $\Delta D = D_1 - D_2$ (in diopter)?

Chemistry PART – II

SECTION – A
(One OR More Than One Choice Type)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **one or more than one** is/are correct

21. Which of the following statement(s) is/are correct?
(A) AgBr shows both Frenkel and Schottky defect.
(B) When crystals of NaCl are heated in an atmosphere of Na vapours. Crystal shows yellow colour due to metal excess defect.
(C) ZnO on heating turns yellow this is because of metal excess defect due to the presence of extra cations at interstitial sites.
(D) Schottky defect is shown by ionic compounds in which cation and anion are of almost similar sizes.

22. Which of the following statement(s) is/are correct?
(A) Melting point order: $PH_3 < AsH_3 < SbH_3 < NH_3$
(B) Boiling point order: $PH_3 < AsH_3 < NH_3 < SbH_3$
(C) NCl_3 on hydrolysis give HOCl while PCl_3 gives HCl
(D) Melting point order: HCl < HBr < HF < HI

23. Molarity of solution, prepared by mixing CaO in 200 ml water. The CaO is obtained by heating 100 gm of limestone which was 80% pure?
(A) 5
(B) 4
(C) 3
(D) 2

24. Which of the following statement(s) is/are correct?
(A) Fe^{3+} ion forms a charge transfer complex with SCN^- ions.
(B) When KCN is added to $CuSO_4$ solution, KCN acts as a reducing agent as well as a complexing agent.
(C) ZnO is reduced to Zn by H_2.
(D) In Baeyer's process Al_2O_3 goes in to $Al(OH)_4^-$ while other basic oxides remains insoluble.

25. Correct order among the following is/are?
(A) HF > HCl > HBr > HI (Dipole moment)
(B) $HOCl < HClO_2 < HClO_3 < HClO_4$ (Acidic strength)
(C) $H_2S < H_2Se < H_2Te < H_2O$ (Boiling point)
(D) $NH_3 > PH_3 > AsH_3 > SbH_3$ (Bond angle)

26. The E^o value of the following reaction are given

$Sn^{2+} \longrightarrow Sn^{4+} + 2e^-$ $E^o = -0.15\ V$

$Fe \longrightarrow Fe^{2+} + 2e^-$ $E^o = +0.44\ V$

$Fe^{2+} \longrightarrow Fe^{3+} + e^-$ $E^o = -0.771\ V$

$Fe \longrightarrow Fe^{3+} + 3e^-$ $E^o = -0.036\ V$

$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$ $E^o = +1.51\ V$

Under standard condition which of the following reaction is spontaneous?

(A) $Fe + MnO_4^- \xrightarrow{H^+} Fe^{2+} + Mn^{2+} + H_2O$

(B) $Fe^{2+} + MnO_4^- \xrightarrow{H^+} Fe^{3+} + Mn^{2+} + H_2O$

(C) $Fe + MnO_4^- \xrightarrow{H^+} Fe^{3+} + Mn^{2+} + H_2O$

(D) $Fe^{2+} + Sn^{4+} \longrightarrow Fe^{3+} + Sn^{2+}$

27. When one mole of triatomic (bent) ideal gas at 300 K undergoes reversible adiabatic change under a constant external pressure of 1 atm from 1 lit volume to 27 litre. What would be the final temperature (in Kelvin)? [$\gamma = 1 + \frac{2}{f}$: where f is degree of freedom].

(A) 100
(B) 80.27
(C) 11.11
(D) 33.33

28. 1 mole of an ideal gas at 300 K expands isothermally and reversibly ten times of its initial volume. Energy used in non useful work is

(A) 5.744 kJ/mol
(B) 0.0191 kJ/mol
(C) 2.303 nRT log V_2/V_1
(D) 2.303 nR log V_2/V_1

Comprehension Type

This section contains **2 paragraphs** each describing theory, experiment, data etc. Each question has **four** options (A), (B), (C) and (D). **One or more than one** of these four option(s) is(are) correct

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Paragraph for Question Nos. 29 to 30

$Mn(NO_3)_2 \xrightarrow{\Delta} \underset{(Brown)}{A(s)} + B(g)\uparrow$

$\text{Conc. } H_2SO_4 + A \longrightarrow D(aq.) + E(g) + H_2O$

$D + NaOH \longrightarrow \underset{\text{White ppt.}}{F} \xrightarrow{E} (Brown)$

29. $D + PbO_2 + \text{Conc. } HNO_3 \longrightarrow \underset{(Purple)}{Y}$

Y is:

(A) H_2MnO_4
(B) $HMnO_4$
(C) Pb_3O_4
(D) $Mn(NO_3)_2$

30. Which of the following is/are correct?

(A) $D + NaBiO_3 + \text{dil. } HNO_3 \longrightarrow \text{Purple colour}$

(B) $D + IO_4^- + H_2O \xrightarrow{H^+} \text{Purple colour}$

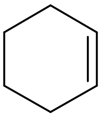
(C) $B + \underset{(Excess)}{FeSO_4} \longrightarrow \text{Brown ring}$

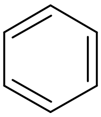
(D) $B + KI \xrightarrow{\text{Starch paper}} \text{Blue spot}$

Paragraph for Question Nos. 31 to 32

Resonance energy of A molecule is equal to the difference between potential energy of most stable resonating structure and the hybrid (actual) structure. More the magnitude of resonance energy, more will be the stability of the molecule.

31. Calculate the magnitude of resonance energy of benzene

Given : $\Delta H_{\text{Hydrogenation}}$ of  = - 28.6 kcal/mole

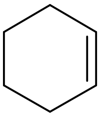
$\Delta H_{\text{Hydrogenation}}$ of  = - 49.8 kcal/mole

(A) 35
(B) 36
(C) 70
(D) 72

32. Which of the following statement is/are correct?

Given: $\Delta H_{\text{hydrogenation}}$ of benzene $= -49.8$ kcal / mole

$\Delta H_{\text{hydrogenation}}$ of naphthalene $= -82$ kcal / mole

$\Delta H_{\text{hydrogenation}}$ of  $= -28.6$ kcal / mole

(A) Magnitude of resonance energy of naphthalene is = 61 k cal/mole
(B) Thermodynamically benzene is more stable than naphthalene
(C) Thermodynamically naphthalene is more stable than benzene
(D) Magnitude of resonance energy of naphthalene is 72 kcal/mole

SECTION – C
(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

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33. Oxidation number of Cr in K_3CrO_8 is:

34. Coordination number of cation present in a void when r^+ / r^- lies in between 0.155 to 0.225.

35. A 6 ampere current is passed through a solution of $CuSO_4$ for 59 minutes. The amount of Cu (in grams) deposited at cathode is:

36. What is the normality of 28 V H_2O_2 solution ?

37. What is the percentage of SO_3 by mass in 101.8% oleum?

38. The n-factor of Br_2 in following reaction is x

$Br_2 + KOH \xrightarrow{\text{hot}} Br^- + BrO_3^-$

Than 3x = y : value of y is:

39. At $90^{o}C$ vapour pressure of pure liquid A is 500 mm Hg and that of pure liquid B is 900 mm Hg. If a mixture of solution of A and B boils at $90^{o}C$ and 1 atm pressure mole fraction of A is X_A:
$X_A \times 20 = n$, value of n is

40. Mixture of Fe_2O_3 and Al is used in solid fuel rocket. What is the fuel value (magnitude only) per ml of mix (in Kcal/ml).
Given: $\Delta H_{Al_2O_3} = -399.0\ \text{Kcal / mol}, \Delta H_{Fe_2O_3} = -199.0\ \text{Kcal / mol}$
Density of Fe_2O_3 and Al are 5 gm/ml and 3 gm/ml respectively.

Mathematics PART – III

SECTION – A

(One OR More Than One Choice Type)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **one or more than one** is/are correct

41. Let U_n be the set of the nth roots of unity. If $A = \prod_{\alpha \in U_n} \left(\alpha + \frac{1}{\alpha}\right)$, then which of following is/are correct?
(A) $A = 0$, if $n = 4k$, $k \in N$
(B) $A = -4$, if $n = 4k + 2$, $k \in N$
(C) $A = 2$ if $n = 4k + 1$, $k \in N$
(D) $A = 2$, if $n = 4k + 3$, $k \in N$

42. Let $R_n = |b_{ij}|_{n \times n}$ be a determinant such that $b_{ij} = \begin{cases} 1 , & |i-j| = 1 \\ 3 , & |i-j| = 0 \\ 0 , & \text{otherwise} \end{cases}$, then $n \in N$
(A) $R_{2019} + R_{2017} = 3R_{2018}$
(B) $R_{2019} + R_{2017} = 9R_{2018}$
(C) The value of R_4 is 54
(D) R_5 is multiple of 9

43. If P and Q are two 3 × 3 non-identity matrices with real entries such that $PP^T = I$, $QQ^T = I$ (P^T, Q^T are transpose of matrices P and Q respectively) and $\det(PQ) < 0$, then which of the following is/are always correct (where det stands for determinant of a matrix)
(A) $\det(P + Q) < 0$
(B) $\det(P + Q) = 0$
(C) atleast one of the $\det(P - I)$ or $\det(Q - I)$ will be zero
(D) $\det(P^{-1} + Q^{-1}) = \det(P + Q)$

44. Given in the Argand plane two curves $C_1 : \arg\left(\frac{z+1}{z-1}\right) = -\frac{\pi}{3}$ and $C_2 : \arg\left(\frac{z+1}{z-1}\right) = -\frac{2\pi}{3}$ where $z = x + iy$, $x, y \in R$, then
(A) sum of areas enclosed by the real axis and C_1, and the real axis and C_2 is equal to $\frac{4\pi^2}{3}$
(B) the number of complex numbers satisfying curve C_1 and C_2 simultaneously, is zero
(C) if α moves on curve C_2, then $\sqrt{\frac{1}{3}} \le |\alpha| < 1$, where $|\alpha|$ is modulus of α
(D) if β moves on curve C_1, then $|\beta|$ can be 1 unit, where $|\beta|$ is modulus of α

45. There are 6 red balls and 8 green balls in a bag, five balls are drawn out at random and placed in a red box and the remaining 9 balls are put in a green box. If the number of red balls in the green box is R_g and the number of green balls in the red box is G_r, then which of the following is/are **INCORRECT?**
(A) probability that $R_g + G_r$ is a prime number is $\frac{788}{1001}$
(B) probability that $R_g + G_r$ is a prime number is $\frac{213}{1001}$

(C) probability that $R_g + G_r$ is an even number is $\frac{708}{1001}$

(D) probability that $R_g + G_r$ is an odd number is $\frac{213}{1001}$

46. A five digit number $a_1a_2a_3a_4a_5$ is said to satisfy property P if $a_i \in \{1, 2, 3, 4, 5, 6, 7\}$ $\forall$ $1 \le i \le 5$, and let $k = a_1 + a_2 + a_3 + a_4 + a_5$, then

(A) number of five digit numbers satisfying P such that k is divisible by 3 is $\left(\frac{7^5-1}{3}\right)$

(B) number of five digit numbers satisfying P such that k is divisible by 2 is $\left(\frac{7^5-1}{2}\right)$

(C) number of five digit numbers satisfying P such that k is divisible by 4 is $\left(\frac{7^5-3}{4}\right)$

(D) number of five digit numbers satisfying P such that that k = 33, is less than 20

47. An urn contains ω white balls ($\omega \ge 3$) and r red balls. If 3 balls were to the drawn without replacement, the probability that they would all be white is P. Introducing an extra white ball in the urn changed this probability to $\frac{4P}{3}$, then

(A) the maximum value of r can be 108
(B) the maximum value of r can be 88
(C) ω can be 6
(D) ω can be 9

48. Object A and B start moving simultaneously in the coordinate plane via a sequence of steps. each of length one with the same speed, object A starts at (0, 0) and each of its step is either right or up, both equally likely object B starts at (3, 5) and each of its steps is either left or down both equally likely, then which of the following is/are true

(A) the probability that object A and B meets is $\frac{5}{32}$

(B) the probability that object A and B will not meet is $\frac{25}{32}$

(C) the probability that A and B meet at point (a, b), such that a < b is $\frac{7}{64}$

(D) the probability that A and meet at point (a, b) where a = b is $\frac{3}{32}$

Comprehension Type

This section contains **2 paragraphs** each describing theory, experiment, data etc. Each question has **four** options (A), (B), (C) and (D). **One or more than one** of these four option(s) is(are) correct

Paragraph for Question Nos. 49 to 50

Read the following write up carefully and answer the following questions:

Let $A = \begin{bmatrix} x & 0 & 0 \\ 0 & y & 0 \\ 0 & 0 & z \end{bmatrix}$; x, y, z $\in$ I with the condition that det(adj(adj A)) = $2^{12} \times 3^8 \times 5^4$, S_1 is set of all the matrices A, S_2 is set of all such matrices A where trace of A is divisible by 2, and x, y, z $\in$ N and S_3 is set of all such matrices A, where (trace A^3) – 3 det A = 0, and x, y, z $\in$ N. Let the number of elements in set S_1, S_2 and S_3 be **2α, β** and γ respectively.

49. Then $\frac{\alpha+\gamma}{\beta}$ is divisible by

(A) 2 (B) 3
(C) 5 (D) 7

50. Which of the following is/are correct?

(A) $\frac{\alpha}{\beta+\gamma} < 10$ (B) $\frac{\alpha}{\beta-\gamma} > 15$

(C) $\frac{\alpha}{\beta+\gamma} > 9$ (D) $\frac{\alpha}{\beta-\gamma} < 14$

Paragraph for Question Nos. 51 to 52

Read the following write up carefully and answer the following questions:

Consider a tetrahedron Die that has four integers 1, 2, 3 and 4 written on its faces. Roll the Die 2000 times and for each i, $1 \le i \le 4$ let f(i) represent the number of times i is written on the bottom face.
Let A denote total sum of the numbers on the bottom face for these 2000 rolls, it A^4 = 6144 f(1) f(2) f(3) f(4), then

51. The value of $\left|\frac{f(1)-f(2)}{f(4)}\right|$ is equal to

(A) $\frac{f(2)}{f(4)}$

(B) $\frac{f(2)}{f(3)}$

(C) $\frac{f(1)}{f(2)}$

(D) none of these

52. Let g(x) is a polynomial equation such that, g(x) = 0, has all real roots, where
let $g(x) = x^4 + (f(1) - d)x^3 + (f(2) - c)x^2 + (f(3) - b)x + (f(4) - a)$, a, b, c, d $\in$ R |g(–i)| = 1, where $i = \sqrt{-1}$, then which of the following is/are **INCORRECT**?
(A) g′(5) > 4
(B) g(5) = 2000
(C) c + d < a + b
(D) g(4) > f(4)

SECTION – C
(One Integer Value Correct Type)

This section contains **8 questions**. Each question, when worked out will result in **one integer** from 0 to 9 (both inclusive).

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53. Let $A = \begin{bmatrix} 4 & 1 \\ -9 & -2 \end{bmatrix}$ and $A^{100} = \begin{bmatrix} a_1 & a_3 \\ a_2 & a_4 \end{bmatrix}$, then value of $a_1 + a_4$ is equal to _____

54. Let $f(x)=\begin{vmatrix} 7 & 2 & x^2-12 \\ 6 & x^2-12 & 3 \\ x^2-12 & 2 & 7 \end{vmatrix}$, then the number of real roots of $f''(x) = 0$ is equal to _____

55. For real a, b, c; a + b + c = 2, $a^2 + b^2 + c^2 = 6$ and $a^3 + b^3 + c^3 = 8$, then $\frac{(1-a)(1-b)(1-c)}{5}$ is equal to _____

56. If $R_n = \sqrt{1+\left(1-\frac{1}{n}\right)^2} + \sqrt{1+\left(1+\frac{1}{n}\right)^2}$, where $n \geq 1$, then $\sum_{n=1}^{20} \frac{1}{R_n}$ is equal to _____

57. The radius of circumscribing sphere of a regular tetrahedron the coordinates of whose vertices are A(0, 0, 0), B(3, 0, 0), C(0, 3, 0), D(0, 0, 3) is R, then [R], is equal to _____ (where [.] denotes the greatest integer function)

58. A variable line passing through the point of intersection of the lines $\frac{x-1}{7} = \frac{y-2}{1} = \frac{z+2}{-5}$ and x + 3 = y – 4 = –z. If S(x, y, z) = 0 is the locus of mirror image of the point (8, 3, –7) in the variable line and S′(x, y, z) = 0 is locus of foot of the perpendicular from (8, 3, –7) to the variable line, then the ratio of volumes of S to S′ is equal to _____

59. Let $P = \begin{bmatrix} a_1 & a_2 & a_3 \\ a_4 & a_5 & a_6 \\ a_7 & a_8 & a_9 \end{bmatrix}$, where $a_i \in \{0, 1, 2\}\ \forall\ i \in \{1, 2, 3, \ldots, 9\}$. If possible values of det(P) are $P_1, P_2, P_3, \ldots, P_n$, then $P_1 + P_2 + P_3 + \ldots + P_n$ is equal to _____

60. Let R be the number of non-empty subsets of the set {1, 2, 3, ..., 9) satisfying the property that no two consecutive numbers are elements of a set, then number of prime divisors of R is/are_____

FIITJEE

ALL INDIA TEST SERIES

PART TEST – III

JEE (Advanced)-2019

PAPER –2

TEST DATE: 16-12-2018

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. B, C

Sol. $m\vec{a} = -200\vec{x} + 100(\vec{L} - \vec{x})$

$\therefore \quad a = -\frac{300}{3}\left(x - \frac{1}{3}\right)$

So, ω = 10 rad/s

For amplitude, $\frac{10}{\sqrt{3}} = 10\sqrt{A^2 - \frac{1}{9}}$

$\therefore \quad A = \frac{2}{3}m$

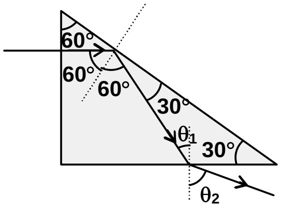
So, $t_{AB} = \frac{T}{12} + \frac{T}{4} = \frac{T}{3}$, where $T = \frac{2\pi}{10}$ sec

and $E_{osc} = \frac{1}{2}(3)(100)\left(\frac{4}{9}\right) = \frac{200}{3}J$

2. A, C

Sol. From Bohr's theory, $R \propto \frac{n^2}{z}$, $V \propto \frac{Z}{n}$ and $E \propto \frac{Z^2}{n^2}$

3. A, C



Sol. $\mu_1 \sin \theta_1 = \mu_2 \sin \theta_2$

$$\frac{5}{3}\sin 30° = \frac{4}{3}\sin\theta_2$$

$$\therefore\ \theta_2 = \sin^{-1}\left(\frac{5}{8}\right)$$

for total internal reflection at P, we use

$$\frac{5}{3}\sin 60° < n$$

$$n > \frac{5}{2\sqrt{3}}$$

4. A, C

Sol. Cut off wavelength depends upon the accelerating potential difference so it will remain same and characteristic lines are dependent upon the energy gap between the energy levels of the elements. So these may change.

5. A

Sol. Difference in the outer and inner water levels always remains the same. Then the pressure difference across the hole remains same.

6. C

Sol. From Kepler's law, $T^2 = \dfrac{4\pi^2}{G\frac{4}{3}\pi r_0^3}\left(\dfrac{r_0}{2}\right)^3$

7. B

Sol. consider the case for M → 0 and M → ∞

8. B

Sol. (1) $\sin\theta = n(\lambda)\sin\theta'$

So, $0 = \sin\theta'\dfrac{dn(\lambda)}{d\lambda} + n(\lambda)\cos\theta'\dfrac{d\theta'}{d\lambda}$

$$\therefore\ d\theta' = -\frac{\sin\theta'}{\cos\theta}\frac{1}{n(\lambda)}\frac{dn(\lambda)}{d\lambda}d\lambda$$

$$\therefore\ \delta\theta' = -\frac{\tan\theta'}{n(\lambda)}\frac{dn(\lambda)}{d\lambda}\delta\lambda$$

9. B, C

10. C

Sol. (for Q. 9-10)

Applying Bernoulli's theorem between top and bottom of chimney

$P + \rho_s gh + \frac{1}{2}\rho_s v^2 = P_0$, where v = Q/A

So, $P = P_0 - \rho_s gh - \dfrac{1}{2}\rho_s\dfrac{Q^2}{A^2} = P_0 - \rho_a gh$

So, $h = \dfrac{\rho_s Q^2}{2(\rho_a - \rho_s)A^2 g}$

For ideal gas, $\dfrac{\rho_a}{\rho_s} = \dfrac{T_s}{T_a}$, So h = $\dfrac{T_a Q^2}{2gA^2\Delta T}$

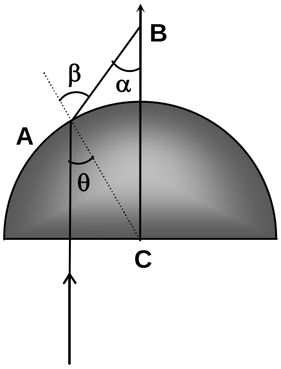
$\frac{h_W}{h_C} = \frac{(273+27)}{(327-27)}\frac{(327+23)}{(273-23)}$, where h_C = 100 m

So, h_w = 140 m

11. B

12. B

Sol. (for Q. 11 to 12)



For small θ, $n\theta = \beta$

So, $\alpha = (n-1)\theta$

Initial photon momentum per unit time = P/c

Final photon momentum per unit time

$= \int \frac{P}{\pi\delta^2}\frac{2\pi r dr}{c}\cos\alpha = \frac{2P}{c\delta^2}\int\left(1-\frac{\alpha^2}{2}\right)rdr$

$= \frac{2P}{c\delta^2}\int_0^\delta\left(1-\frac{(n-1)r^2}{2R^2}\right)rdr$, Because $\theta = \frac{r}{R} = \frac{\alpha}{n-1}$

$= \frac{P}{c}\left[1-\frac{(n-1)\delta^2}{4R^2}\right]$

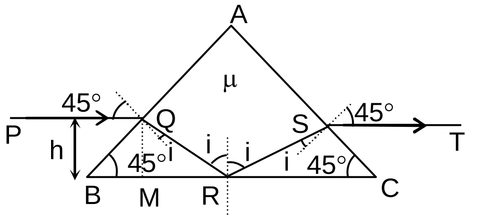
So, $P = \frac{mg4R^2c}{(n-1)^2\delta^2}$

No. of photons/time = $\frac{P}{hf}$

SECTION – C

13. 1

Sol. sin 45° = μ sin r ⇒ r = 30°



From ΔBQR and ΔCSR

$\frac{BQ}{SC} = \frac{BR}{RC}$

$\therefore\ h' = 3\left(\frac{RC}{BR}\right)$

i = 45°+ r = 75°

So, $\frac{QM}{MR} = \tan 15°$, so MR = 12 cm

So, BR = 15 cm and RC = 5 cm

So, h′ = 1cm

14. 9

Sol. In Ist case: $\frac{1}{v_1} - \frac{1}{-3} = \frac{1}{2} \Rightarrow v_1 = 6$ cm

When one lens is removed, the new focal length of the objective is

$\frac{1}{f'} = \frac{1}{f} - \frac{1}{f_1} = \frac{1}{2} - \frac{1}{10} \Rightarrow f' = 2.5$ cm

The new position of image is

$\frac{1}{v_2} - \frac{1}{-3} = \frac{1}{2.5}$

$\therefore v_2 = 15$ cm

So, shifting = 15 – 6 = 9 cm

15. 2

Sol. $m_Ac^2 + K_A + m_Bc^2 + K_B = m_Cc^2 + K_C + \text{excitation energy}$

So, $K_C = 2\text{ MeV}$

16. 9

Sol. Intensity at the surface of sphere = $2\pi^2 f^2(\Delta R)^2 \rho\sqrt{\frac{B}{\rho}}$

So, total power = $2\pi^2 f^2(\Delta R)^2 \rho\sqrt{\frac{B}{\rho}}4\pi R^2$

= $8\pi^3\sqrt{\rho B}f^2R^2(\Delta R)^2 = 9$ Watt.

17. 6

Sol. $P_2 - P_1 = \frac{1}{2}\rho\left(V_1^2 - V_2^2\right) = \frac{1}{2}\rho\left(\frac{A_2^2V_2^2}{A_1^2} - V_2^2\right)$

$= \frac{1}{2}\rho V_2^2A_2^2\left(A_1\right)^{-2} - \frac{1}{2}\rho V_2^2$

From the graph,

$\frac{1}{2}\rho V_2^2A_2^2 = \frac{300\times10^3}{16}$ N/m^2 and $\frac{1}{2}\rho V_2^2 = 300\times10^3$ N/m^2

So, $A_2 = \frac{1}{4}\text{m}^2$ and $V_2 = \sqrt{600}$ m/s

So, volume rate Q = A_2V_2 = 6 m^3/s

18. 4

Sol. For newton's ring, $t = \frac{r_m^2}{2R}$

For fringe system to disappear completely

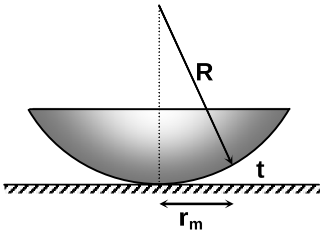
$2t = m\lambda_1 = \left(m + \frac{1}{2}\right)\lambda_2$

So, $\frac{2t}{\lambda_1} - \frac{2t}{\lambda_2} = \frac{1}{2}$

So, $2t\frac{\lambda_2 - \lambda_1}{\lambda_1\lambda_2} = \frac{1}{2}$

So, $2\frac{r_m^2}{2R}\frac{2\times10^7}{16\times10^{-14}} = \frac{1}{2}$

$\therefore r_m = 4 \times 10^{-2}$ m



19. 2

Sol. Refraction at the air and core (at x = 0) interface gives

(1) sin θ_i = n_1 sin r

Now for refraction at various parallel interfaces at different x.

$n_1 \cos r = n_1 \sin\left(\frac{\pi}{2} - \theta\right) = n \cos\theta$

So, $n\cos\theta = n_1\sqrt{1 - \frac{\sin^2\theta}{n_1^2}}$

$$= \sqrt{n_1^2 - \sin^2\theta_i} \; = \; = \sqrt{\frac{9}{4} - \frac{1}{4}} = \sqrt{2}$$

20. 3

Sol. Both the lenses must be converging

If x is the distance of object from the first lens

So, $m_1 = \frac{f_1}{f_1 - x}$ where f_1 is focal length of first lens

and $m_2 = \frac{f_2}{f_2 - \left(L - \frac{xf_1}{f_1 - x}\right)}$ where f_2 is focal length of the second lens and L is separation between the lenses.

So, $\frac{1}{M_1} = \frac{1}{m_1 m_2} = \frac{f_1 - x}{f_1}\frac{f_2 - \left(L - \frac{xf_1}{x - f_1}\right)}{f_2} = 1 - \frac{L}{f_2} - \frac{x(f_1 + f_2 - L)}{f_1 f_2}$

When the lenses are interchanged, in the above expression only the second term changes

So, $\frac{1}{M_2} = 1 - \frac{L}{f_1} - \frac{x(f_1 + f_2 - L)}{f_1 f_2}$

$\therefore \; \frac{1}{M_1} - \frac{1}{M_2} = L\left(\frac{1}{f_1} - \frac{1}{f_2}\right) = L(D_1 - D_2)$

So, $1 - \frac{1}{4} = \frac{1}{4}(D_1 - D_2)$

$\therefore \; D_1 - D_2 = 3$ diopter

Chemistry PART – II

SECTION – A

21. A, B, C, D
Sol. Facts.

22. A, B, C, D
Sol. Facts.

23. B
Sol. $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

100 gm sample contains 80 gm $CaCO_3$

$\therefore$ Moles of $CaCO_3 = \frac{80}{100} = 0.8$

$\therefore$ Moles of CaO formed = 0.8 mole

Molarity $= \frac{0.8}{200} \times 1000 = 4.0$

24. A, B, D

25. A, B, C, D

26. A, B, C
Sol. For feasibility of reaction $E^o = +ve$ & $\Delta G^o = -ve$

$[Fe \longrightarrow Fe^{2+} + 2e^- \quad] \times 5$

$[MnO_4^- + 5e^- + 8H^+ \longrightarrow Mn^{2+} + 4H_2O] \times 2$

$5Fe + 2MnO_4^- + 8H^+ \longrightarrow 2Mn^{2+} + 5Fe^{2+} + 8H_2O$

$\Delta G_1^o = -2 \times F \times 0.44$

$\Delta G_2^o = -5 \times F \times 1.51$

$\Delta G_3^o = -10 \times FE^o = 5\Delta G_1^o + 2\Delta G_2^o$

$E^o = 0.44 + 1.51 = 1.95$

$Fe \longrightarrow Fe^{3+} + 3e^-$

$MnO_4^- + 5e^- + 8H^+ \longrightarrow Mn^{2+} + 8H_2O$

$E^o = 0.036 + 1.51 = 1.546$

$Fe^{2+} \longrightarrow Fe^{3+} + e^-$

$MnO_4^- + 5e^- + 8H^+ \longrightarrow Mn^{2+} + 8H_2O$

$5Fe^{2+} + MnO_4^- + 8H^+ \longrightarrow Mn^{2+} + 8H_2O + Fe^{3+}$

$E^o = (-0.771) + (1.51) = 0.739$

$Fe^{2+} \longrightarrow Fe^{3+} + e^- \qquad E^o = -0.771$

$Sn^{4+} + 2e^- \longrightarrow Sn^{2+} \qquad E^o = +0.15$

$2Fe^{2+} + Sn^{4+} \longrightarrow 2Fe^{3+} + Sn^{2+}$

$E^o = (+0.15) + (-0.771) = -0.621$

27. A

Sol. $T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$

$8/6 = \gamma$

$$T_2 = \frac{T_1(1)^{2/6}}{(27)^{2/6}} = \frac{T_1}{3} = \frac{300}{3} = 100$$

28. A, C

Sol. $\Delta G = \Delta H - T\Delta S$

$T\Delta S = 2.303nRT\log\frac{V_2}{V_1}$

$= 2.303 \times 1 \times 8.314 \times 300\log\frac{10}{1}$

= 5744.14 J mol^{-1} K^{-1}

29. B

30. A, B, C, D

Sol. **(for Q. 29 to 30)**

$Mn(NO_3)_2 \xrightarrow{\Delta} MnO_2 + 2NO_2$

$MnO_2 + \text{Conc. } H_2SO_4 \longrightarrow MnSO_4 + O_2 + H_2O$

$MnSO_4 + NaOH \longrightarrow \underset{(\text{White})}{Mn(OH)_2} \xrightarrow{O_2} \underset{(\text{Brown})}{MnO(OH)_2}$

$PbO_2 + MnSO_4 \xrightarrow{H^+} \underset{(\text{Purple})}{HMnO_4} + Pb^{2+}$

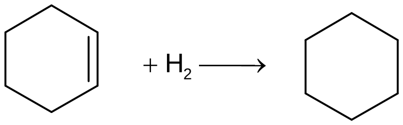
$Mn^{2+} + NaBiO_3 \xrightarrow{H^+} HMnO_4 + Bi^{3+}$

$Mn^{2+} + IO_4^- \xrightarrow{H^+} HMnO_4 + IO_3^-$

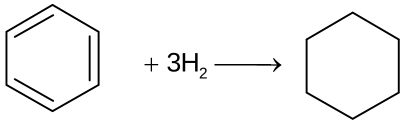
$NO_2 + KI \xrightarrow[\text{Paper}]{\text{Starch}} \text{Blue spot}$

31. B

Sol.

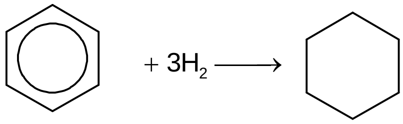


$\Delta H = -28.6 \text{ kcal/mole}$



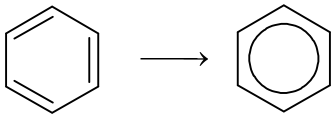
$\Delta H = (-28.6) \times 3 \text{ kcal/mole}$

Non resonating



$\Delta H = -49.8 \text{ kcal/mole}$

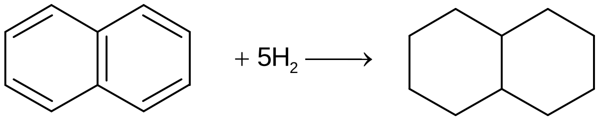
Benzene



$$\Delta_{\text{resonance}}H = (-85.8) - (-49.8) = -36 \text{ kcal / mole}$$

32. A, B

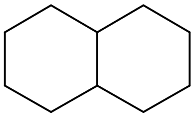
Sol.



$$+ 5H_2 \longrightarrow \qquad \Delta H = 5 \times (-28.6) = -143 \text{ kcal / mole}$$

Stable resonating structure

Naphthalene $+ 5H_2 \longrightarrow$



$\Delta H = -82 \text{ kcal / mole}$

$\therefore \Delta_{\text{resonance}}\ H_{\text{naphthalene}} = (-143) - (-82) = -61$

Resonance energy of benzene = - 36

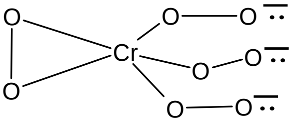
One naphthalene ring equivalent to two benzene ring

$\therefore$ Magnitude of resonance energy of naphthalene (-61), is less than two benzene ring (-72). So benzene ring is more stable.

SECTION – C

33. 5

Sol.



34. 3

Sol. $\frac{r^+}{r^-} = 0.155 - 0.225$, trigonal planar.

35. 7

Sol. $W = zit = \frac{63.5}{2 \times 96500} \times 6 \times 59 \times 60$

= 7 gm

36. 5

Sol. $N = \frac{28}{5.6} = 5$

37. 8

Sol. $\%SO_3 = \frac{101.8 - 100}{18} \times 80 = 8$

38. 5

Sol. $x = \frac{5}{3}$

$\therefore y = \frac{5}{3} \times 5 = 5$

39. 7

Sol. $760 = p_A^o X_A + p_B^o X_B$

$760 = 500X_A + 900(1 - X_A)$

$X_A = 0.35$

$\therefore n = 0.35 \times 20 = 7$

40. 4

Sol. $2Al + \frac{3}{2}O_2 \longrightarrow Al_2O_3 \quad \Delta H = -399.0 \text{ kcal}$

$2Fe + \frac{3}{2}O_2 \longrightarrow Fe_2O_3 \quad \Delta H = -199.0 \text{ kcal}$

By using these. We get

$2Al + Fe_2O_3 \longrightarrow Al_2O_3 + 2Fe \quad \Delta H = -200 \text{ kcal}$

Vol. of fusion mixture = vol. of Al + vol. of Fe_2O_3 $= \frac{54}{3} + \frac{160}{5} = 50 \text{ ml}$

$\therefore$ Fuel value $= \frac{200}{50} = 4 \text{ kcal/ml}$

Mathematics PART – III

SECTION – A

41. A, B, C, D

Sol. Let $f(x) = x^n - 1 = \prod_{\alpha \in U_n} (x - \alpha)$

$$A = \prod_{\alpha \in U_n} \left(\alpha + \frac{1}{\alpha}\right) = \prod_{\alpha \in U_n} \frac{\alpha^2 + 1}{\alpha} = \frac{\prod_{\alpha \in U_n} (\alpha + i)(\alpha - i)}{\prod_{\alpha \in U_n} \alpha} = \frac{\left((-i)^n - 1\right)\left((i)^n - 1\right)}{(-1)^{n-1}}$$

42. A, D

Sol.
$$R_n = \begin{vmatrix} 3 & 1 & 0\,0\ldots \\ 1 & 3 & 1\,0\,0\ldots \\ 0 & 1 & \\ . & 0 & \\ . & . & \end{vmatrix}_{n\times n} \Rightarrow R_n = 3\begin{vmatrix} 3 & 1 & 0\ldots \\ 1 & & \\ 0 & & \\ . & & \end{vmatrix}_{(n-1)\times(n-1)} + \begin{vmatrix} 1 & 1 & 00\ldots \\ 0 & 3 & \\ 0 & 1 & \\ . & 0 & \\ . & . & \end{vmatrix}_{(n-1)\times(n-1)}$$

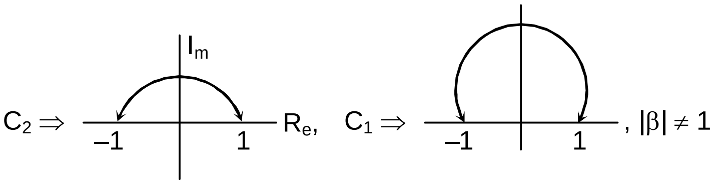
$\Rightarrow R_n = 3R_{n-1} - R_{n-2}$
$\Rightarrow R_n + R_{n-2} = 3R_{n-1}$

43. B, C, D

Sol. $P^T(P+Q)Q^T = (P+Q)^T \Rightarrow |P + Q| = 0,\ P^T(P-I) = -(P-I)^T$
Either $|P|\,|P - I| = -|P - I|$ or $|Q||Q - I| = -|Q - I|$, because $|P|\,|Q| < 0$
$P\left(P^{-1} + Q^{-1}\right)Q = P + Q \Rightarrow \left|P^{-1} + Q^{-1}\right| = -\left|P + Q\right| = 0$

44. B, C

Sol. Shown in the figure



45. B, C, D

Sol.
$$\begin{array}{|l|} 5 \text{ balls} \\ R_g \text{ green} \\ 5 - R_g \text{ red} \\ \hline \end{array} \qquad \begin{array}{|l|} 9 \text{ balls} \\ 8 - R_g \text{ green} \\ R_g + 1 \text{ red} \\ \hline \end{array}$$

Red box Green box

So, $G_r = R_g + 1$
$R_g + G_r = 2R_g + 1$ (cannot be even number)
$1 \le 2R_g + 1 \le 11$

For $R_g + G_r$ non-prime $\Rightarrow R_g = 0$ or $4 \Rightarrow$ so the probability $= \dfrac{{}^6C_5 + {}^8C_4 \times {}^6C_1}{{}^{14}C_5} = \dfrac{213}{1001}$

46. A, B, C, D

Sol. The each number $a_1a_2 \ldots\ldots a_5$ will correspond to a term in expansion
$\left(a_1^1 + a_1^2 + \ldots\ldots + a_1^7\right)\left(a_2^1 + a_2^2 + \ldots\ldots + a_2^7\right)\left(a_3^1 + \ldots\ldots + a_3^7\right)\ldots\ldots\left(a_5^1 + a_5^2 + \ldots\ldots + a_5^7\right)$

So find sum of coefficient of x^{3k}, x^{2k}, x^{4k} in expansion of $\Rightarrow \left(x^1+.....+x^7\right)^5$, for the A, B, C respectively (where k $\in$ N), if k = 33 then number possible case will be 5 + ${}^5C_2$ = 15

47. B, D

Sol. $P=\frac{{}^{\omega}C_3}{{}^{\omega+r}C_3}$, $\frac{4}{3}P=\frac{{}^{\omega+1}C_3}{{}^{\omega+r+1}C_3}$

Equality value of P, $r=\frac{-\omega^2+\omega+2}{\omega-11}$

$r=-\omega-10+\frac{108}{11-\omega}$

r_{max} = 88, ω can not 6 as r will not be integer

48. B, C, D

Sol. There are 8 steps between (0, 0) and (3, 5) so A and B can be meet at (0, 4), (1, 3), (2, 2) and (3, 1) point

Let a_i and b_i denote the number of paths to P_i from (0, 0) to (3, 5) respectively, because A has to take r steps to right and B has to take r + 1 steps down the number of ways A and B can meet at P_i is

$a_i \cdot b_i = {}^4C_i \cdot {}^4C_{i+1}$, because A and B can each take 2^4 path in 4 ways, so probability they will meet is $\frac{1}{2^8}\sum_{i=0}^{3} a_i b_i$

49. A, C

50. C, D

Sol. xyz = $\pm(2^3 \times 3^2 \times 5)$, number of possible triplet of (x, y, z) are = ${}^5C_2 \times {}^4C_2 \times {}^3C_2$ = 180

so $2\alpha = 8 \times 180 = 1440$, if x + y + z = even so possible cases are odd + odd + even, even + even + even

For odd + odd + even, total number of cases = 54

For even + even + even, total number of cases = 18, so β = 72

Trace of $A^3 = x^3 + y^3 + z^3$, $x^3 + y^3 + z^3 = 3xyz \Rightarrow$ Either x = y = z or x + y + z = 0 , so γ = 0

51. A, C

Sol. f(1) + f(2) + f(3) + f(4) = 2000, By A.M. $\geq$ G.M., $A^4 \geq$ 6144 f(1) f(2) f(3) f(4)

Only equality holds true so f(1) = 2f(2) = 3f(3) = 4f(4)

so f(1) = 960, f(2) = 480, f(3) = 320, f(4) = 240

52. B, C, D

Sol. Let g(x) = $(x-\alpha)(x-\beta)(x-\gamma)(x-\delta)$, α, β, γ, δ are the roots of polynomial g(x) = 0

$1=\sqrt{1+\alpha^2}\sqrt{1+\beta^2}\sqrt{1+y^2}\sqrt{1+\delta^2} \Rightarrow \alpha = \beta = \gamma = \delta = 0$

So, g(x) = x^4 and f(1) = d, f(2) = c, f(3) = b, f(4) = a

SECTION – C

53. 2

Sol. A = B + I, $B=\begin{bmatrix}3 & 1\\ -9 & -3\end{bmatrix}$, $B^2=\begin{bmatrix}0 & 0\\ 0 & 0\end{bmatrix}$

54. 4

Sol. f′(x) = 0, has five distinct and real roots

55. 0

Sol. $\sum a = 2$, $\sum ab = -1$, abc = –2

So, a, b, c are roots and equation $x^3 - 2x^2 - x + 2$

$\Rightarrow$ (a, b, c) = (1, –1, 2)

56. 7

Sol. $\frac{1}{R_n} = \frac{1}{4}\left(\sqrt{n^2+(n+1)^2} - \sqrt{n^2+(n-1)^2}\right)$, find R_1, R_2, ..., R_{20} it will be a telescopic sum

57. 2

Sol. Form a cube of edge length 3, $R = \frac{(\text{length of body diagonal})}{2} = \frac{3\sqrt{3}}{2}$

58. 8

Sol. Point Q(8, 3, –7) lies on the line $\frac{x-1}{7} = \frac{y-2}{1} = \frac{z+2}{-5}$, let P is point of intersection of the given lines P(–6, 1, 3)

S is sphere with radius PQ and S′ is sphere with diameter PQ

59. 0

Sol. If possible value the value of det P is k, then –k al also possible for each positive k

60. 2

Sol. Let a_n is total of such subset for a n number of element set . So in that subset let either 1, is appeared or not, if 1 appeared then total number of subset will be a_{n-2}, if 1 is not appeared total number of subset is a_{n-1},

so $a_n = a_{n-1} + a_{n-2}$ provide $a_1 = 1$, $a_2 = 2$ find $a_9 = 55$

FIITJEE

ALL INDIA TEST SERIES

PART TEST – III

JEE (Main)-2019

TEST DATE: 9-12-2018

Time Allotted: 3 Hours **Maximum Marks: 360**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only one section: **Section-A**.

  Section-A (01 – 30, 31 – 60, 61 – 90) *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

PART – I

SECTION – A
Straight Objective Type

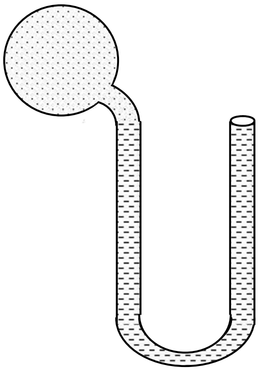
This section contains **30 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** option is correct

1. Match the quantities having same unit / dimension and choose the correct option

	Column – I		Column – II
(P)	Resistance 'R'	(1)	$\frac{\phi^2}{L}$, where ϕ is Magnetic flux and L is Self inductance
(Q)	Time 't'	(2)	$\sqrt{LC}$, where C is Capacitance and L is Self inductance
(R)	Energy 'E'	(3)	$\sqrt{\frac{L}{C}}$, where C is Capacitance and L is Self inductance
(S)	Force 'F'	(4)	q v B, where v is velocity, q is charge and B is Magnetic Field

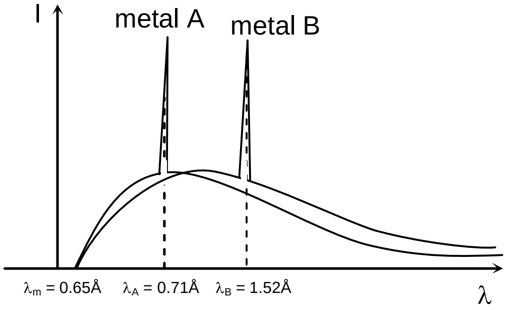
(A) P–1 Q–3 R–4 S–2
(B) P–3 Q–2 R–1 S–4
(C) P–1 Q–3 R–2 S–4
(D) P–3 Q–4 R–1 S–2

2. A vertical U tube of uniform cross sectional area A contains a liquid of density ρ. One end of tube is connected to a flask containing mono atomic gas (as shown in fig.) while other end opens to atmosphere ($P_{atm} = P_0$). Volume of flask and U tube are equal to V_0 each (neglect volume of horizontal portion). The flask is now slowly heated till half of liquid remain in U tube. Given $\frac{\rho g}{A} = \frac{P_0}{V_0}$, the ratio $\frac{\Delta U}{\Delta W}$ is
(ΔU = change in internal energy of the gas and ΔW = Work done by the gas)



(A) 1
(B) 2
(C) 3
(D) $\frac{12}{5}$

3. High energy electron beam is incident on target metals A and B in two different experiments. Graph between intensity I of rays generated and their wavelength is plotted on same scale and depicted as shown in figure. If metal A is identified as an element of mass no. Z = 41, choose the correct statement (given that σ = screening constant = 1, $\sqrt{2} = 0.7$).



(A) Metal B is copper with Z = 29
(B) Energy of electron beam is more for experiment with metal A.
(C) Metal B is iron with Z = 26
(D) None

4. A satellite of mass ‘m’ is orbiting a planet of mass M in a circular orbit of radius R. The satellite changes its orbit by expelling small amount of fuel [5% of its existing mass] with high speed U in a direction opposite to the direction of its orbital velocity. Find U_{max} (approximately) of the expelled mass for which, satellite cannot escape the gravitational field of planet.

(A) $\left[\frac{GM}{R}\right]^{1/2}$

(B) $5\left[\frac{GM}{R}\right]^{1/2}$

(C) $7\left[\frac{GM}{R}\right]^{1/2}$

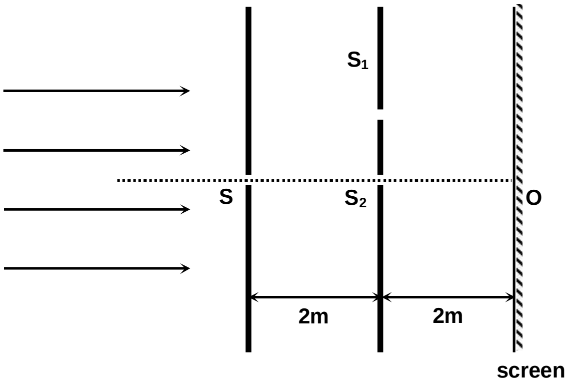
(D) $3\left[\frac{GM}{R}\right]^{1/2}$

5. A nucleus is kept at rest. It breaks into two parts which fly off with velocity in the ratio 27 : 8. Then the ratio of radii of the parts is
(A) 27 : 8
(B) 8 : 27
(C) 2 : 3
(D) 3 : 2

6. A monochromatic light of wavelength 6500 Å is used in YDSE. Now both slits are covered by two thin slits of refractive index 3.2 and 2.7 respectively. By doing so central bright fringe shifts to original 7th bright fringe. If both slits have same thickness then it is equal to
(A) 7.8 μm
(B) 9.1 μm
(C) 6.5 μm
(D) 9.8 μm

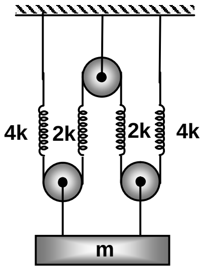
7. E, L, p and r are the energy, angular momentum, linear momentum and orbital radius of an electron in a atom corresponding to the quantum number n. Then EprL is
(A) proportional to n^2
(B) proportional to n.
(C) proportional to 1/n
(D) independent of n.

8. A parallel beam of light of wavelength 5000 Å is incident on slit S. Another two slits S_1 and S_2 are placed at a distance 2 meter as shown in the figure. The minimum distance between S_1 and S_2 such that maximum intensity will occur at O is



(A) $\sqrt{10}$ mm
(B) 1 mm
(C) $\frac{1}{2}$ mm
(D) $\sqrt{5}$ mm

9. A plank of mass M is connected with three massless pullies and four massless springs as shown in the figure in vertical plane. Plank is slightly displaced from its mean position. Assuming plank remain in horizontal position throughout the motion, the frequency of oscillation of plank is



(A) $\frac{1}{2\pi}\sqrt{\frac{32K}{3m}}$

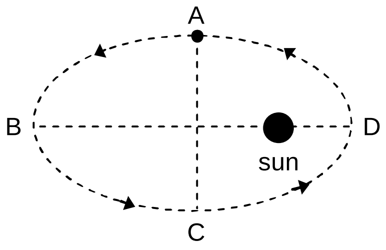
(B) $\frac{1}{2\pi}\sqrt{\frac{8K}{3m}}$

(C) $\frac{1}{2\pi}\sqrt{\frac{4K}{3m}}$

(D) $\frac{1}{2\pi}\sqrt{\frac{16K}{3m}}$

10. If the gravitational constant 'G'. Plank's constant 'h' and velocity of light 'v' are assumed to be as fundamental units then dimension of length in new system is given by
(A) $[G^2 h^2 v^{3/2}]$
(B) $[G^{1/2} h^{1/2} v^{3/2}]$
(C) $[G^{1/2} h^{1/2} v^{-3/2}]$
(D) $[G^2 h^2 v^{-3/2}]$

11. A satellite is moving around the sun in an elliptical orbit. 'M' is the mass of sun and 'a' is semi major axis of elliptical orbit. The velocity of satellite when it reaches at A is



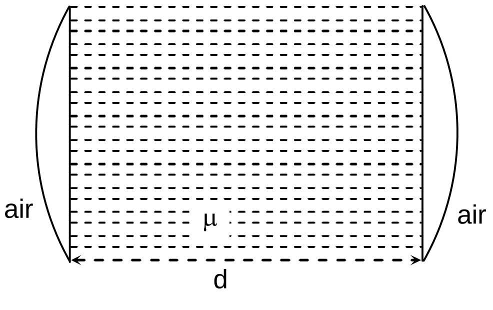
(A) $\sqrt{\frac{4GM}{a}}$

(B) $\sqrt{\frac{2GM}{a}}$

(C) $\sqrt{\frac{GM}{2a}}$

(D) $\sqrt{\frac{GM}{a}}$

12. Two thin plano-convex lenses, each of focal length $f = \frac{1}{3}m$ in air, are placed at some distance 'd' from each other as shown in the figure. The space between the lenses are filled with a substance with refractive index μ.
The distance 'd' between the lenses are so adjusted that a parallel beam of light passes through such an optical system remains parallel. Choose correct option(s).



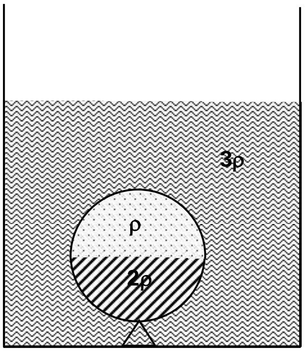
(A) If $\mu = \frac{3}{2}$, $d = 90\,cm$

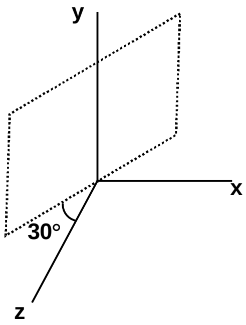
(B) If $\mu = \frac{3}{2}$, d = 100 cm

(C) If $\mu = \frac{4}{3}$, d = 100 cm

(D) If $\mu = \frac{4}{3}$, d = 80 cm

13. A solid sphere has density ρ in the top half and 2ρ in the bottom half. It is kept in a uniform fluid of density 3ρ with a hinge at the bottom (as shown) such that it can freely perform oscillations about any horizontal axis through the hinge (Radius of sphere is R). Find the period of small oscillations if all the points of the sphere are to oscillate in their respective planes parallel to the plane $x = -\sqrt{3}z$ (shown).





(A) $2\pi\sqrt{\frac{64R}{35g}}$

(B) $2\pi\sqrt{\frac{32R}{35g}}$

(C) $2\pi\sqrt{\frac{46R}{45g}}$

(D) $2\pi\sqrt{\frac{24R}{35g}}$

14. Two friends are located at the same point on the circumference of a circular track of radius R. One friend starts cycling around the track with angular speed ω and simultaneously blowing a whistle of frequency f_0. Assuming v_s to be the speed of sound in air, the minimum frequency heard by the stationary friend is

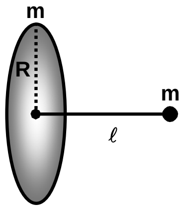
(A) $\frac{f_0}{1+\frac{\omega R}{v_s}}$

(B) $f_0\left(1-\frac{\omega R}{v_s}\right)$

(C) f_0

(D) Infinite

15. A thin homogeneous disc of radius R and mass m and a small sphere of same mass is placed at a distance ℓ from the disc on its axis of symmetry. Initially both are in rest and then released from rest. They collide because of gravitation attraction. Assume ℓ >> R, Find the magnitude of relative velocity of approach just before the collision.



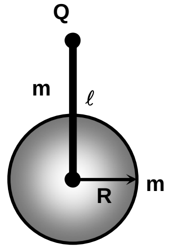
(A) $\sqrt{4Gm\left(\frac{2}{R}-\frac{1}{\ell}\right)}$

(B) $\sqrt{2Gm\left(\frac{2}{R}-\frac{1}{\ell}\right)}$

(C) $\sqrt{Gm\left(\frac{2}{R}-\frac{1}{\ell}\right)}$

(D) $\sqrt{\frac{Gm}{2}\left(\frac{2}{R}-\frac{1}{\ell}\right)}$

16. A meter stick connected with disc of same mass which is joint one end of stick and disc can freely rotates about its joint. System swings in a vertical plane about a fixed horizontal axis passing through its one end, undergoes small oscillation of frequency ‘f_0’. If disc is removed from the stick, then its new frequency of small oscillation would become. (take $R = \ell/2$)



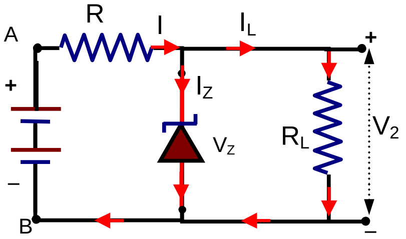
(A) $\sqrt{\frac{29}{6}}\,f_0$

(B) $\sqrt{\frac{4}{3}}\,f_0$

(C) $2f_0$

(D) $\sqrt{\frac{13}{3}}\,f_0$

17. In the given circuit, the supply voltage is V = 15 volt. The 12 volt, 0.36 watt Zener-diode operates at a minimum diode current of 2mA. Calculate the range over which load resistance R_L can be varied.

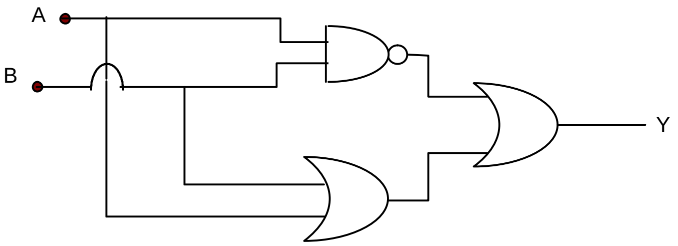


(A) $100\ \Omega < R_L < 500\ \Omega$
(B) $430\ \Omega \le R_L < 1000\ \Omega$
(C) $0 \le R_L < 5000\ \Omega$
(D) $430\ \Omega \le R_L$

18. The width of a slit in a diffraction experiment is doubled (2x). The intensity of light at the central maximum
(A) remains the same.
(B) increases by 2 times.
(C) increases by 4 times.
(D) decreases by a factor of 2.

19. How high should a transmitter be located, above the surface of the earth, so that it covers $\frac{1}{4}$ of the earth’s surface through direct transmission? Assume that “R” is the radius of the earth.
(A) $\sqrt{3}R$
(B) 2R
(C) R
(D) $\left(\sqrt{3}-1\right)R$

20. The truth table for the circuit shown in the figure is



(A)

A	B	Y
1	1	1
0	1	0
1	0	0
0	0	1

(B)

A	B	Y
1	1	0
0	0	1
1	0	0
0	1	1

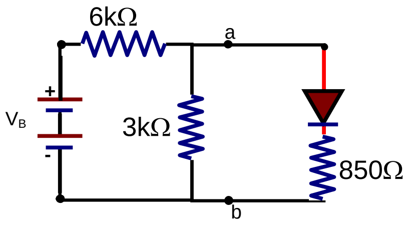
(C)

A	B	Y
1	1	0
0	1	0
1	0	0
0	0	0

(D)

A	B	Y
1	1	1
0	1	1
1	0	1
0	0	1

21. The p-n junction diode used as shown in the figure, has a cut in voltage of 0.6 V and a forward resistance of 150 ohm. If the diode can dissipate a maximum power of 200 mW, the maximum permissible value of the battery voltage V_B is nearly



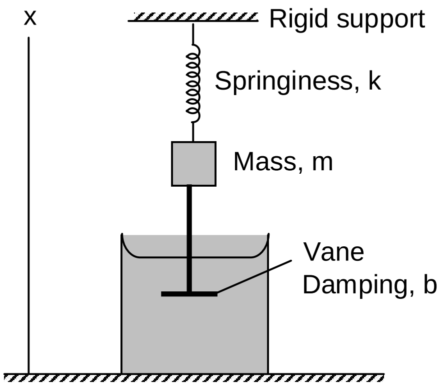
(A) 330 V
(B) 110 V
(C) 220 V
(D) 440 V

22. A student performs an experiment to determine the Young's modulus of a wire, exactly 2m long, by Searle's method. In a particular reading, the student measures the extension in the length of the wire to be 0.8 mm with an uncertainty of ± 0.05 mm at a load of exactly 1.0 kg. The student also measures the diameter of the wire to be 0.4 mm with an uncertainty of ± 0.01 mm. Take g = 9.8 m/s^2 (exact) and $\pi = \frac{49}{16}$ (exact). The Young's modulus obtained from the reading is
(A) $(2.0 \pm 0.3) \times 10^{11}$ N/m^2
(B) $(2.0 \pm 0.2) \times 10^{11}$ N/m^2
(C) $(2.0 \pm 0.1) \times 10^{11}$ N/m^2
(D) $(2.0 \pm 0.05) \times 10^{11}$ N/m^2

23. The equation of a traveling wave in a uniform string of mass per unit length μ is given as y = A sin(ωt − kx). The total energy transferred through the origin in time interval from t = 0 to $t = \frac{\pi}{12\omega}$ is
(A) $\frac{(\pi+3)\mu A^2\omega^2}{24k}$
(B) $\frac{(\pi+3)\mu A^2\omega^2}{12k}$
(C) $\frac{\mu A^2\omega^2\pi}{24k}$
(D) $\frac{\mu A^2\omega^2\pi}{8k}$

24. The flow rate from a tap of diameter 1.25 cm is x litre/min. The coefficient of viscosity of water is 10^{-3} Pa s. For what value of x will the flow be turbulent?
(p) x = 6, (q) x = 3 (r) x = 0.5 (s) x = 0.1. Choose the correct option.
(A) p, q
(B) p, q, r
(C) p
(D) p, q, r, s

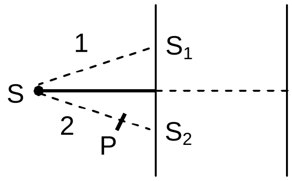
25. For the damped oscillator shown in figure, the mass m of the block is 200 g, k = 90 N m^{-1} and the damping constant b is 40 g s^{-1}. Calculate the time taken for its amplitude of vibrations to drop to half of its initial value.
(A) 1 s
(B) 3.5 s
(C) 7 s
(D) 14 s



A damped simple harmonic oscillator. A vane immersed in a liquid exerts a damping force on the block as it oscillates up and down

26. The human eye has an approximate angular resolution of $\phi = 6 \times 10^{-4}$ rad and a printer prints a minimum of 100 dpi (dots per inch, 1 inch = 2.54 cm). At what minimal distance z should a printed page be held so that one does not see the individual dots?
(A) 30 cm
(B) 45 cm
(C) 100 cm
(D) 200 cm

27. Figure shows a Young's double slit experiment with a source which emits un-polarised light. In addition, P is a polarizer with axis whose direction is not given, but it completely polarizes the light falling on S_2. Calculate the ratio of the intensities of the principal maximum to the first minimum i.e. I_{max}/I_{min}, when the polarizer is present.



(A) 2
(B) 4
(C) 5
(D) 8

28. A small metal sphere of radius r and density ρ falls from rest in a viscous liquid of density σ and coefficient of viscosity η. Due to friction heat is produced. The expression for the rate of production of heat when the sphere has acquired the terminal velocity is
(A) $\left[\frac{8\pi g}{27\eta}(\rho-\sigma)^2\right]r^5$
(B) $\left[\frac{8\pi g^2}{27\eta}(\rho-\sigma)^2\right]r^5$
(C) $\left[\frac{8\pi g^2}{27\eta}(\rho-\sigma)\right]r^5$
(D) $\left[\frac{8\pi g^2}{27\eta^2}(\rho-\sigma)\right]r^5$

29. A light bulb is immersed in water. Light travels out in all directions from the bulb, but only some of the light escapes the water's surface. What happens to the fraction f of light that escapes the water's surface as the bulb is moved deeper into the water? Assume that light is not absorbed by water and that 100% of light is transmitted at the air-water interface during refraction.
(A) f increases
(B) f decreases
(C) f remains the same
(D) the answer depends on the index of refraction of water.

30. Equation of a stationary and a traveling wave are as follows:
$y_1 = a \sin(kx)\cos(\omega t)$ and $y_2 = a \sin(\omega t - kx)$
The phase difference between two points $x_1 = \frac{\pi}{3k}$ and $x_2 = \frac{3\pi}{2k}$ are $\Delta\phi_1$ and $\Delta\phi_2$ respectively for the two waves. Then ratio $\frac{\Delta\phi_1}{\Delta\phi_2}$ is
(A) 1
(B) 5/6
(C) 3/4
(D) 6/7

Chemistry

PART – II

SECTION – A
Straight Objective Type

This section contains **30 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** option is correct

31. Which of the following property is *not correct* for colloidal solutions?
    (A) Finest gold sol is red in colour, as the size of particle increases, it appears purple, then blue finally golden.
    (B) The nature of charge on colloidal particle is same on all particles in a given colloidal solution.
    (C) The values of colligative properties of colloidal solution are of small order as compared to true solution.
    (D) The mixing of two oppositely charged sols prevents coagulation.

32. The *incorrect* statement for p-block elements is:
    (A) Nitrous oxide and nitric oxide are neutral oxides.
    (B) Zinc reacts with dilute nitric acid to give N_2O and with conc. nitric acid to give NO_2.
    (C) α-Black phosphorous is prepared by heating white phosphorous at 473 K under high pressure.
    (D) Fluorine and chlorine are gases, bromine is liquid and iodine is a solid at room temperature.

33. In an ionic compound A^+X^-, the radii of A^+ and X^- are 1 pm and 2 pm respectively. The volume of unit cell of crystal AX is …….. and structure is similar to ………
    (A) 27 pm^3, CsCl
    (B) 64 pm^3, ZnS
    (C) 125 pm^3, KCl
    (D) 216 pm^3, NaCl

34. Which of the following physical and chemical characteristics of interstitial compounds formed by d-block elements (TiC, Fe_3H etc.) is correct?
    (A) They have low melting point than those of pure metals.
    (B) They are very soft.
    (C) They retain metallic conductivity.
    (D) They are chemically very reactive.

35. The number of geometrical isomers and number of enantiomeric pairs of $[Co(gly)_3]$ respectively are:
    (A) 2, 1
    (B) 2, 2
    (C) 3, 2
    (D) 3, 1

36. Two experiments were performed. In the first experiment $[Ti(H_2O)_6]\ Cl_3$ is heated and in second experiment ethane-1,2-diamine (en) is added to $[Ni(H_2O)_6]^{2+}$ in the molar ratio en : Ni is 3 : 1. Which of the following colour changes occur in respective experiments?
    (A) No colour change in both the experiments.
    (B) In first experiment violet to colourless and in second experiment green to violet.
    (C) In first experiment colourless to violet and in second experiment no change in colour.
    (D) In first experiment colourless to violet and in second experiment violet to green is observed.

37. Pervoskite, a mineral of titanium is found to contain calcium atoms at corners, oxygen atoms at the face centres and titanium atoms at the centre of the cube. Oxidation number of titanium in the mineral is
(A) +2
(B) +3
(C) +4
(D) +1

38. Vapour phase refining of nickel is carried out using
(A) I_2
(B) HCl
(C) CO
(D) HBr

39. For the coagulation of 100 ml of arsenous sulphide sol, 4 ml of 1 M NaCl is required. What would be the flocculation value of NaCl?
(A) 40
(B) 20
(C) 60
(D) 80

40. Equal volume of 2 M each of $KMnO_4$ and $K_2Cr_2O_7$ are used to oxidise Fe(II) solution in acidic medium. The amount of Fe oxidized will be
(A) equal with both oxidizing agents.
(B) more with $KMnO_4$.
(C) more with $K_2Cr_2O_7$.
(D) cannot be determined.

41. One mole of CCl_4 vapour at 77^oC occupies a volume of 35 L. If van der Waals constants are a = 20.39 L^2 atm mol^{-2} and b = 0.138 L mol^{-1}. Calculate the compressibility factor (z) under high pressure region.
(A) 1.004
(B) 0.2
(C) 0.5
(D) 2

42. Which of the following is incorrect?
(A) Reducing property of dioxide increases from SO_2 to TeO_2.
(B) XeF_6 has a distorted octahedral structure.
(C) Basicity decreases in order $NH_3 > PH_3 > AsH_3 > SbH_3$.
(D) Acidic character increases from H_2O to H_2Te.

43. Addition of KI to Pb salt gives a precipitate. The colour of precipitate is
(A) Black
(B) Green
(C) Yellow
(D) White

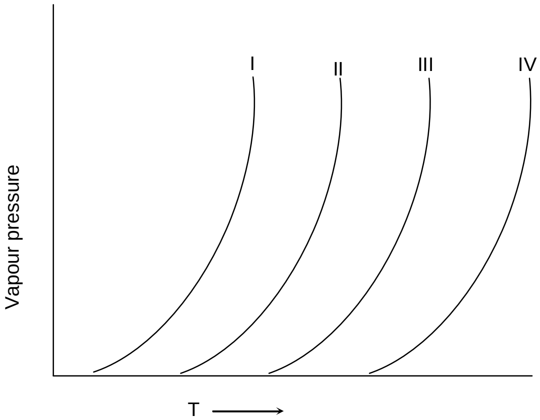
44. Consider the redox reaction:

$$Cu_2S + KMnO_4 + H_2SO_4 \longrightarrow CuSO_4 + MnSO_4 + K_2SO_4 + H_2O$$

Moles of Cu_2S oxidised by two moles of $KMnO_4$ are:
(A) 0.5
(B) 1
(C) 2
(D) 3

45. A balloon filled with an ideal gas shrink when cooled. When shrinking completes, which of the following is same as it was originally?
(A) The RMS velocity of gas particles.
(B) The density of gas.
(C) The pressure in the balloon.
(D) The kinetic energy of gas particle.

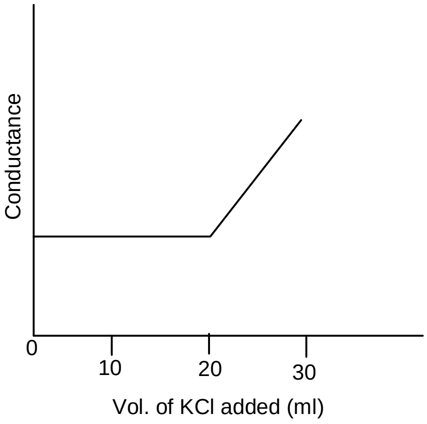
46. The following diagram shows the vapour pressure curves for CH_4, CH_3OH, CH_3COOH and H_2CO, which of the following match is correct?



(A) CH_3OH – I CH_4 – II CH_3COOH – III H_2CO – IV
(B) CH_3OH – III CH_4 – I CH_3COOH – IV H_2CO – II
(C) CH_3OH – IV CH_4 – III CH_3COOH – I H_2CO – II
(D) CH_3OH – II CH_4 – I CH_3COOH – III H_2CO – IV

47. The aqueous solutions of following substances were electrolysed. In which case the pH of solution doesn't change if inert electrodes are used
(A) $AgNO_3$
(B) $CuSO_4$
(C) NaCl
(D) K_2SO_4

48. 20 ml of $AgNO_3$ solution was titrated with 0.20 mol L^{-1} KCl solution in the conductivity cell. The data were plotted as follows.



The moles of $AgNO_3$ in the solution initially was
(A) 2×10^{-3}
(B) 4×10^{-3}
(C) 8×10^{-3}
(D) 2×10^{-2}

49. Which of the following chloride is most soluble in water?
(A) Hg_2Cl_2
(B) AgCl
(C) $PbCl_2$
(D) $CaCl_2$

50. Which of the class of drug is used for reducing or abolishing pain without causing impairment of consciousness?
(A) Antacids
(B) Antihistamines
(C) Analgesics
(D) Antimicrobials

51. The total number of protons present in 124 g of NO_3^- are:
(A) 124
(B) 62 N_A
(C) 31 N_A
(D) 62

52. Consider a binary mixture of volatile liquids. If at $X_A = 0.2$, the vapour pressure of solution is 580 torr, then the mixture could be $\left(P_A^o = 200 \text{ torr}, P_B^o = 600 \text{ torr}\right)$
(A) $CHCl_3 + CH_3COCH_3$
(B) C_2H_5OH + Hexane
(C) $H_2O + HNO_3$
(D) $nC_6H_{14} + nC_7H_{16}$

53. In the reaction

$$A \longrightarrow B \qquad \Delta H = +90 \text{ kcal/mol}$$

$$B \longrightarrow C \qquad \Delta H = -70 \text{ kcal/mol}$$

Rank the magnitudes of enthalpies of formation of A, B and C in increasing order.
(A) A, C, B
(B) A, B, C
(C) C, A, B
(D) C, B, A

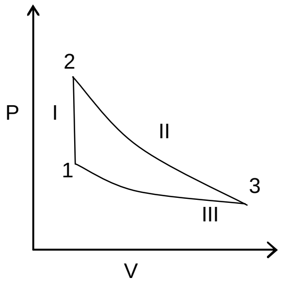
54. Density of NaCl is 1.8 g / cc. KCl has similar unit cell as NaCl and the following relationship among ionic radii exist $r\left(Na^+\right) = 0.5r\left(Cl^-\right), r\left(K^+\right) = 0.8\, r\left(Cl^-\right).$ The density of KCl is
(A) 2.44 g/cc
(B) 1.9 g/cc
(C) 1.33 g/cc
(D) 0.86 g/cc

55. A compound is known to be a salt of sodium (NaX). If 2 g of salt is dissolved in 100 g of water, the solution freezes at – 1.27°C. What will be the compound NaX? (K_f of water is 1.86 K kg/mol.)
(A) NaF
(B) NaCl
(C) NaBr
(D) NaI

56. A galvanic cell has a potential 3.5 V. In a particular experiment, if 2 moles of electrons were passed through this cell, what is magnitude of the maximum useful work (W_{max}) that would be obtained.
(A) 7×10^8 J
(B) 6.75×10^8 J
(C) 8×10^5 kJ
(D) 6.75×10^2 kJ

57. Which of the following is correct international standards for drinking water?
(A) The minimum limit of nitrate in drinking water is 50 ppm.
(B) The prescribe lower limit of lead in drinking water is 50 ppb.
(C) Soluble fluoride is often added to drinking water to bring its conc. up to 1 ppm.
(D) All of the above mentioned are correct.

58. One mole of ideal gas ($C_V = 5/2\ R$) beginning at 1 atm and 300 K is put through the following cycle
Step – I: Heating to twice its initial pressure at constant volume.
Step – II: Adiabatic reversible expansion to its initial temperature.
Step – III: Isothermal compression back to 1 atm.
What is the volume at point 3?



(A) 40.4 L
(B) 65.0 L
(C) 139 L
(D) 279 L

59. In the extraction of copper from its sulphide ore, iron is removed as slag ($FeSiO_3$) by mixing
(A) sulphate salt
(B) silica
(C) oxygen
(D) carbon

60. Which of the following percentage strength is not possible for sample of oleum?
(A) 108%
(B) 110%
(C) 121%
(D) 135%

Mathematics PART – III

SECTION – A
Straight Objective Type

This section contains **30 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which only **ONE** option is correct

61. a, b, c, d are zeroes of P(x) = $5x^4 + px^3 + qx^2 + rx + s$ and a, c, d are zeroes of Q(x) = $x^3 - 9x^2 + ax - 24$ (a < b < c < d) if a, c, d be in arithmetic progression and a, b, c, d be in harmonic progression, then the value of $\left|\frac{P(1)}{Q(1)}\right|$ is equal to

(A) 5
(B) 7
(C) 3
(D) none of these

62. If 1, α, α^2, α^3 ..... α^{n-1} are the nth roots of unity, then ${}^nC_1 + {}^nC_2 \cdot \alpha + {}^nC_3 \cdot \alpha^2 + ... + {}^nC_n \cdot \alpha^{n-1}$ is equal to

(A) $\frac{2}{\alpha}$
(B) $\frac{1}{\alpha}$
(C) $\frac{1}{\alpha}\left[(1+\alpha)^n - 1\right]$
(D) $\frac{1}{\alpha}\left(2^n - 1\right)$

63. Standard deviation of the first 2n + 1 natural numbers is

(A) $\sqrt{\frac{n(n+1)}{2}}$
(B) $\sqrt{\frac{n(n+1)(2n+1)}{3}}$
(C) $\sqrt{\frac{n(n+1)}{3}}$
(D) $\sqrt{\frac{n^2(n+1)}{2}}$

64. If a and b are odd integers then number of real roots of $[x]^2 + a[x] + b = 0$ (where [.] denotes the greatest integer function)] is

(A) 3
(B) 1
(C) infinite
(D) 0

65. If $\frac{a^{n-\frac{1}{2}}+b^{n-\frac{1}{2}}}{a^{n+\frac{1}{2}}+b^{n+\frac{1}{2}}}$ is geometric mean of $\frac{1}{a}, \frac{1}{b}$ (a ≠ b), then the quadratic equation $bx^2+nx+b=0$ has
(A) rational and equal roots
(B) rational and distinct roots
(C) irrational roots
(D) imaginary roots

66. A natural number k is chosen from the set {1, 2, 3, ..., 100} at random and ω is a non-real cube root of unity. A is the event that ω^k is real and B is the event that i^k is real (where $i^2 = -1$), then $P(A \cup B)$ is equal to
(A) $\frac{16}{100}$
(B) $\frac{67}{100}$
(C) $\frac{8}{100}$
(D) $\frac{50}{100}$

67. Let z = x + iy and $\text{amp}\left(e^{z^2}\right)=\text{amp}\left(e^{(z+i)}\right)$. If y = f(x) is a function, then f(3) is equal to
(A) $\frac{1}{4}$
(B) $\frac{1}{3}$
(C) $\frac{1}{2}$
(D) $\frac{1}{5}$

68. If the points z_1, z_2 lie on the curves |z| = 2 and |z| = 3 respectively and the angle between the vectors representing z_1, z_2 is 60º, then $\left|\frac{z_1+z_2}{z_1-z_2}\right|$ is equal to
(A) $\sqrt{\frac{19}{7}}$
(B) $\sqrt{19}$
(C) $\sqrt{7}$
(D) $\sqrt{133}$

69. The number of distinct real roots of the equation $\left(\log_{\sqrt{3}}\tan x\right)\left(\sqrt{\log_{\sqrt{3}}3\sqrt{3}+\log_{\tan x}3}\right)=-1$ in interval $[0, 2\pi]$ is
(A) 0
(B) 2
(C) 4
(D) 6

70. Let 1, 4 , 7, 10 ..... and 9, 14, 19, 24 ..... be two arithmetic progressions. Then the total number of distinct integers in the collection of first 500 terms of each of the progressions is
(A) 833
(B) 835
(C) 837
(D) 901

71. A bag contains 20 white balls and 20 red balls. (Assume that balls of same colour are distinguishable). Pairs of balls are drawn at random without replacement until the bag is empty. The probability that each pair consists of one white and one real red ball is
(A) $\frac{2^{20} \times (20!)^2}{40!}$
(B) $\frac{2^{20} \times 20!}{40!}$
(C) $\frac{2^{20} \times 20!}{(40!)^2}$
(D) $\frac{2^{10} \times 20!}{40!}$

72. If D, E and F are the mid points of the sides BC, CA, AB respectively of a triangle ABC $\overrightarrow{AD} + \frac{2}{3}\overrightarrow{BE} + \frac{1}{3}\overrightarrow{CF} = K\overrightarrow{AC}$, then 2K is equal to
(A) 1
(B) 3
(C) 2
(D) 5

73. Let A be a square matrix such that then $A(\text{Adj } A) = \begin{bmatrix} 4 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 4 \end{bmatrix}$, then $\frac{|\text{Adj}(\text{Adj } A)|}{|\text{Adj } A|}$ is equal to
(A) 16
(B) 27
(C) 91
(D) none of these

74. The shortest distance between the y-axis and the line 2x + 3y + 5z + 1 = 0 = 3x + 4y + 6z + 2 is $\frac{2}{\sqrt{k}}$, then k is equal to
(A) 2
(B) 3
(C) 5
(D) 6

75. If $a_1, a_2, ..., a_n$ are real numbers with $a_n \neq 0$ and $\cos\alpha + i\sin\alpha$ is a root of
$z^n + a_1 z^{n-1} + a_2 z^{n-2} + ... + a_{n-1} z + a_n = 0$, then the sum
$a_1 \cos\alpha + a_2 \cos 2\alpha + a_3 \cos 3\alpha + ... + a_n \cos n\alpha$ is
(A) 0
(B) 1
(C) –1
(D) $\frac{1}{2}$

76. If a singular matrix $A = \left[a_{ij}\right]_{2\times2}$ always commute with $B = \begin{bmatrix} 1 & 1 \\ 2 & 1 \end{bmatrix}$ such that $\left(\frac{a_{11}}{a_{12}}\right)^2 = k$, then k is equal to

(A) 1
(B) 2
(C) 3
(D) 4

77. If z_1, z_2 are complex numbers such that $z_1^2 + z_2^2$ is real. If $z_1\left(z_1^2 - 3z_2^2\right) = 2$ and $z_2\left(3z_1^2 - z_2^2\right) = 11$, then the value of $z_1^2 + z_2^2$ is equal to

(A) 25
(B) 5
(C) $\sqrt{5}$
(D) 1

78. If z is a complex number such that |z – 1| = 1 then $\arg\left(\frac{1}{z} - \frac{1}{2}\right)$ may be

(A) $\frac{\pi}{6}$
(B) $-\frac{\pi}{2}$
(C) $\frac{\pi}{4}$
(D) $-\frac{\pi}{4}$

79. Let $\vec{r} = \left(\vec{a}\times\vec{b}\right)\sin x + \left(\vec{b}\times\vec{c}\right)\cos y + 2\left(\vec{c}\times\vec{a}\right)$ where $\vec{a}, \vec{b}, \vec{c}$ are three non-zero non-coplanar vectors. If $\vec{r}$ is perpendicular to $\vec{a}+\vec{b}+\vec{c}$, then minimum value of $x^2 + y^2$ is

(A) π^2
(B) $\frac{\pi^2}{4}$
(C) $\frac{5\pi^2}{4}$
(D) $\frac{7\pi^2}{4}$

80. If the line $\frac{x-2}{-1} = \frac{y+2}{1} = \frac{z+k}{4}$ is one of the angle bisector of the lines $\frac{x}{1} = \frac{y}{-2} = \frac{z}{3}$ and $\frac{x}{-2} = \frac{y}{3} = \frac{z}{1}$ then the value of k is

(A) 1
(B) 2
(C) 4
(D) 8

81. The coefficient of x^{20} in (1 + x) (1 + 2x) (1 + 4x) (1 + 8x) .... $(1 + 2^{20}x)$ is
(A) $2^{211} - 2^{190}$
(B) $2^{191} - 2^{171}$
(C) $2^{231} - 2^{209}$
(D) $2^{161} - 2^{142}$

82. If the intercept made by the plane $\vec{r} \cdot \vec{n} = q$ on x, y, z axis are respectively are a_1, a_2 and a_3 respectively, then
(A) $\vec{n} = \frac{q}{a_1}\hat{i} + \frac{q}{a_2}\hat{j} + \frac{q}{a_3}\hat{k}$
(B) $\vec{n} = (qa_1)\hat{i} + (qa_2)\hat{j} + (qa_3)\hat{k}$
(C) $\vec{n} = \left(\frac{1}{a_1q}\right)\hat{i} + \left(\frac{1}{a_2q}\right)\hat{j} + \left(\frac{1}{a_3q}\right)\hat{k}$
(D) $\vec{n} = \frac{a_1}{q}\hat{i} + \frac{a_2}{q}\hat{j} + \frac{a_3}{q}\hat{k}$

83. Matrices of order 3 × 3 are formed by using the elements of the set $A = \{-3, -2, -1, 0, 1, 2, 3\}$, then probability that matrix is either symmetric or skew symmetric is
(A) $\frac{1}{7^6} + \frac{1}{7^3}$
(B) $\frac{1}{7^9} + \frac{1}{7^3} - \frac{1}{7^6}$
(C) $\frac{1}{7^3} + \frac{1}{7^9}$
(D) $\frac{1}{7^3} + \frac{1}{7^6} - \frac{1}{7^9}$

84. If the equation of the plane through the straight line $\frac{x-1}{2} = \frac{y+2}{-3} = \frac{z}{5}$ and perpendicular to the plane x – y + z + 2 = 0 is ax – by + cz + 4 = 0, then the value of $10^3a + 10^2b + 10c$ is equal to
(A) 342
(B) 684
(C) 1710
(D) 2018

85. The coefficient of $a^8b^4c^9d^9$ in $\{ab(c + d) + cd (a + b)\}^{10}$ is
(A) $\frac{10!}{8!\,4!\,9!\,9!}$
(B) 10!
(C) 2520
(D) none of these

86. If A, B and C are exhaustive events satisfying $P((A \cup B) \cap \bar{C}) = \frac{1}{5}$,

$P(B \cap C) - P(A \cap B \cap C) = \frac{1}{15}$ and $P(A \cap C) = \frac{1}{10}$, then $P\left(C \cap \left(\overline{A \cup B}\right)\right)$ is equal to
(A) $\frac{17}{30}$

(B) $\frac{18}{30}$

(C) $\frac{19}{30}$

(D) $\frac{20}{30}$

87. Number of ordered triplets of natural number (a, b, c) for which abc $\le$ 11 is
(A) 52
(B) 53
(C) 55
(D) 56

88. The equation $a_8x^8 + a_7x^7 + a_6x^6 + ... + a_0 = 0$ has all its roots positive and real $\left(\text{where } a_8 = 1, a_7 = -4, a_0 = \frac{1}{2^8}\right)$, then
(A) $a_1 = \frac{1}{2^8}$
(B) $a_1 = -\frac{1}{2^4}$
(C) $a_2 = \frac{7}{2^5}$
(D) $a_2 = \frac{7}{2^8}$

89. If Z is a non-real complex number, then the minimum value of $\frac{\operatorname{Im} Z^5}{\operatorname{Im}^5 Z}$ is
(A) – 1
(B) – 2
(C) – 4
(D) – 5

90. The number of polynomials of the form $x^3 + ax^2 + bx + c$ which are divisible by $x^2 + 1$ where a, b, c $\in$ {1, 2, 3, ..., 10} is equal to
(A) 10
(B) 20
(C) 30
(D) 40

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – I

JEE (Advanced)-2020

PAPER – 1

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B.**

1. ***Section-A (01– 7, 19 – 25, 37 – 43)*** *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect option is selected.

   Section-A (08 – 13, 26 – 31, 44 – 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S). Each multiple choice question with 4 options has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section–B (14 – 18, 32 – 36, 50 – 54)*** *contains 15 Numerical based questions with answers as numerical value from 0 to 9 and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics PART – I

SECTION – A
(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

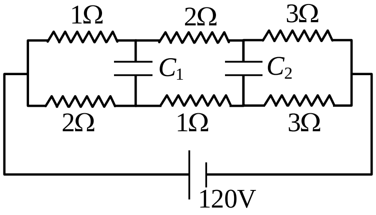
1. If the dimensions of length are expressed as $G^x c^y h^z$; where G, c and h are the universal gravitational constant, speed of light and Planck's constant respectively, then

(A) $x = \frac{1}{2}, y = \frac{1}{2}$
(B) $x = \frac{1}{2}, z = \frac{1}{2}$
(C) $y = \frac{1}{2}, z = \frac{3}{2}$
(D) $y = -\frac{3}{2}, z = \frac{1}{2}$

2. A traveling wave pulse is given by $y = \frac{6}{2 + (x + 3t)^2}$ where symbols have their usual meanings, *x, y* are in metre and t is in second. Then

(A) the pulse is traveling along +ve *x*-axis with velocity 3 m/s
(B) the pulse is traveling along –ve *x*-axis with velocity 3 m/s
(C) the amplitude of the wave pulse is 3 m
(D) the pulse is a symmetric pulse

3. In the circuit shown in figure $C_1 = C_2 = 2\mu F$. Then charge stored in



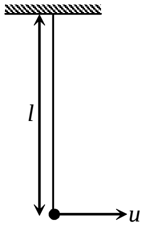
(A) capacitor C_1 is zero
(B) capacitor C_2 is zero
(C) both capacitors is zero
(D) capacitor C_1 is 40 μC

Space for Rough work

4. A particle of mass *m* moves in a straight line. If *v* is the velocity at a distance *x* from a fixed point on the line and $v^2 = a - bx^2$, where *a* and *b* are constant, then
(A) the motion continues along the positive *x*-direction only
(B) the motion is simple harmonic\
(C) the particle oscillates with a frequency equal to $\frac{\sqrt{b}}{2\pi}$
(D) the total energy of the particle is *ma*

5. When a monochromatic point source of light is at a distance of 0.2 m from a photoelectric cell, the cut off voltage and the saturation current are respectively 0.6V and 18.0 mA. If the same source is placed 0.6 m away from the photoelectric cell, then:
(A) the stopping potential will be 0.2 volt
(B) the stopping potential will be 0.6 volt
(C) the saturation current will be 6.0 mA
(D) the saturation current will be 2.0 mA

6. A particle of mass m is attached to one end of the light inextensible string and other end of the string is fixed in vertical plane as shown. Now particle is given horizontal velocity $u = \sqrt{\frac{5}{2}gl}$, then which of the following statement/s is/are correct.



(A) The string makes angle with the downward vertical is 60^0 when acceleration of the particle is horizontal.
(B) The tension in string is 2 mg when acceleration of the particle is horizontal.
(C) The speed of the particle is $\sqrt{\frac{3}{2}gl}$ when acceleration of the particle is horizontal
(D) The particle will not complete the circle.

7. The potential energy φ in joule of a particle of mass 1 kg moving in the x – y plane, obeys the law $\varphi = 3x + 4y$, where (x, y) are the coordinate of the particle in metre. If the particle is at rest at (6, 4) at time t = 0, then (only conservative force are acting on particle).
(A) the particle has constant acceleration
(B) the work done by the conservative forces from position of rest of the particle to the instant of the particle crossing x axis is 25 J
(C) the speed of the a particle when it crosses the y axis is 10 ms^{-1}
(D) the coordinates of the particle at time t = 4s are (–18, –28)

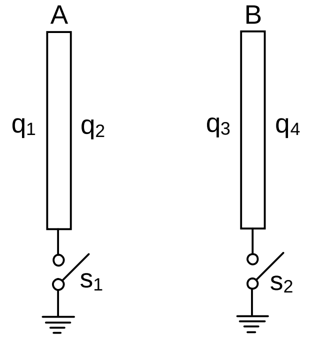
Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

In the figure given below, plate A has 100μC charge, while plate B has 60 μC charge. Switches S_1 and S_2 are connected to the ground. q_1, q_2, q_3 and q_4 are charges on faces of plates as shown in figure



Column 1	Column 2	Column 3
(I) $q_1 = 80$ μC	(i) $q_2 = 100$ μC	(P) $q_3 = -20$ μC
(II) $q_1 = 60$ μC	(ii) $q_2 = 0$ μC	(Q) $q_3 = -100$ μC
(III) $q_1 = 0$ μC	(iii) $q_2 = 20$ μC	(R) $q_3 = 60$ μC
(IV) $q_1 = -60$ μC	(iv) $q_2 = 60$ μC	(S) $q_3 = 0$ μC

8. Which of the following options correctly represents the case when switch S_1 is closed and S_2 is open?
(A) (IV)(ii) (P) (B) (III) (i) (R)
(C) (III) (iv) (S) (D) (II) (iii) (Q)

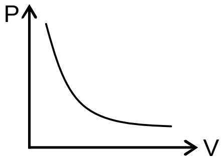
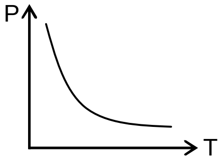
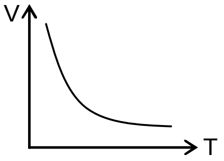
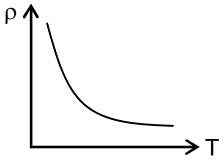
9. Which of the following options correctly represents the case when switch S_2 is closed and S_1 is open?
(A) (IV)(ii) (P) (B) (III) (i) (Q)
(C) (II) (i) (Q) (D) (II) (iii) (Q)

10. Which of the following options correctly represents the case when both the switches S_1 and S_2 is open?
(A) (I)(ii) (P) (B) (IV) (iv) (P)
(C) (I) (ii) (S) (D) (II) (iii) (Q)

Space for Rough work

Answer questions 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

Column 1 shows rectangular hyperbola graphs, Column 2 shows molar heat capacities for monoatomic gases and Column 3 shows work done when process goes from initial state 1 to final state 2.

Column 1	**Column 2**	**Column 3**
(I) 	(i) $C = \frac{7R}{2}$	(P) $\Delta W = nR(T_2 - T_1)$
(II) 	(ii) $C = \frac{R}{2}$	(Q) $\Delta W = -nR(T_2 - T_1)$
(III) 	(iii) $C = \frac{5R}{2}$	(R) $\Delta W = 2nR(T_2 - T_1)$
(IV) 	(iv) $C = \infty$	(S) $\Delta W = nRT \ln\frac{V_2}{V_1}$

11. Which option matches the data for an isobaric process?

(A) (IV) (iv) (P) (B) (III) (iii) (P)
(C) (IV) (iii) (P) (D) (III) (i) (Q)

12. Which of the following options is a correct combination?

(A) (II) (iii) (R) (B) (III) (ii) (Q)
(C) (III) (iii) (Q) (D) (II) (ii) (Q)

13. Which option matches the data for a process whose $\Delta U = 0$?

(A) (IV) (ii) (S) (B) (II) (iv) (S)
(C) (I) (ii) (Q) (D) (I) (iv) (S)

Space for Rough work

SECTION – B

(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

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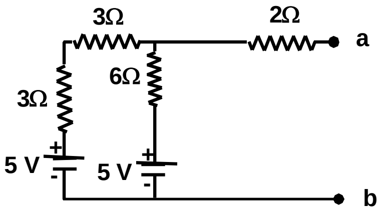
14. If voltage V = (100 ± 5) V and current I = (10 ± 0.2) A, the percentage error in resistance R is

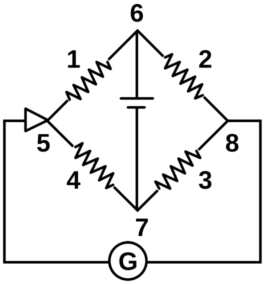
15. Determine the resistance in ohm is to be connected across a, b in given circuit to dissipate maximum power through it.



16. An ideal gas is expanding such that PT^2 = constant. The coefficient of volume expansion of the gas is A/T where T is temperature in Kelvin. Find the value of A.

17. A point source of power 4W is placed 1m below the free surface of liquid whose refractive index is '$\frac{2}{\sqrt{3}}$'. Find the rate of transfer of energy (in watt) from the liquid surface to air. Ignore any absorption or scattering of light energy.

18. Four wires of equal length 8 m are arranged as shown in the figure. Wires, 2, 3 and 4 are of equal cross sectional area and wire 1 is of half the cross section of these wires. By how much distance pointer at point 5 must be moved to get null point?



Space for Rough work

Chemistry PART – II

SECTION – A
(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Which of the following statement(s) is/are correct for the following reaction?

$(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} Cr_2O_3 + N_2 + 4H_2O$

(A) The equivalent mass of $(NH_4)_2Cr_2O_7$ (Mol. mass = M) is $\frac{M}{6}$
(B) It is a disproportionation reaction
(C) It is an intermolecular redox reaction
(D) One mole of reactant on complete reaction produces 22.4 L of N_2 gas at NTP.

20. Which of the following solution(s) behave(s) as buffer?

(A) HCOOH + HCOOK
(B) $NaH_2PO_4 + Na_2HPO_4$
(C) $H_2SO_4 + NaHSO_4$
(D) $H_2CO_3 + NaHCO_3$

21. $H_2O_2 + H^+ + I^- \longrightarrow I_2 + H_2O$

On investigation of the above reaction, the following results were obtained.

Initial conc. of reactant in M			Initial rate of formation of I_2 in mol dm^{-3} s^{-1}
$[H_2O_2]$	$[I^-]$	$[H^+]$	
0.01	0.01	0.30	2×10^{-6}
0.03	0.01	0.30	6×10^{-6}
0.03	0.02	0.10	1.2×10^{-5}
0.03	0.02	0.20	1.2×10^{-5}

Choose the correct statement(s)

(A) The rate equation for the reaction is Rate = $k[H_2O_2][I^-]$.
(B) The reaction is zero order with respect to acid.
(C) The reaction is termolecular.
(D) The rate constant is 2×10^{-1} mol^{-2} dm^6 s^{-1}.

Space for Rough work

22. Which of the following gas(es) can effuse faster than CH_4 under identical conditions?
(A) H_2 (B) He
(C) SO_2 (D) CO_2

23. Which of the following substance(s) produce(s) halogen gas when react(s) with conc. H_2SO_4?
(A) NaI (B) KF
(C) NaCl (D) KBr

24. Which of the following ion(s) maintain an identical d-orbital configuration while forming octahedral complexes with strong field as well as weak field ligands according to crystal field theory?
(A) Fe^{2+} (B) Co^{2+}
(C) Ni^{2+} (D) Zn^{2+}

25. Choose correct statement(s) about the following compound.
$CH_3 – CH = CH – CH = CH – CH_3$
(A) It shows three geometrical isomers
(B) It shows four geometrical isomers
(C) It forms a dicarboxylic acid on acidified permanganate oxidation
(D) It forms two moles of CH_3COOH on oxidation

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 26, 27 and 28 by appropriately matching the information given in the three columns of the following table.

Column – 1		**Column – 2**		**Column – 3**	
(I)	Primitive cubic	(i)	8	(P)	Corner
(II)	Face centre cubic	(ii)	6	(Q)	Body centre
(III)	Body centre cubic	(iii)	12	(R)	Edge centre
(IV)	Hexagonal close packing	(iv)	4	(S)	Voids

26. Which combination is correct for the position of Na^+ in NaCl solid?
(A) (IV), (iv) & (R) (B) (II), (iii) & (Q)
(C) (II), (ii) & (R) (D) (III), (i) & (Q)

Space for Rough work

27. Which combination is correct for the lattice of CsCl?
(A) (III), (i) & (R) (B) (II), (i) & (P)
(C) (III), (i) & (Q) (D) (IV), (iii) & (Q)

28. Which combination is correct for a metallic solid having simple cubic unit cell?
(A) (IV), (ii) & (R) (B) (I), (i) & (P)
(C) (II), (i) & (Q) (D) (I), (ii) & (P)

Answer questions 29, 30 and 31 by appropriately matching the information given in the three columns of the following table.

Column – 1		**Column – 2**		**Column – 3**	
(I)	CH_3COCH_3	(i)	HNO_2	(P)	Disproportionation reaction takes place
(II)	HCHO	(ii)	Conc. NaOH	(Q)	Colourless and acidic gas is formed
(III)	CH_3COOH	(iii)	$NaHCO_3$	(R)	Sweet fruity smell is observed
(IV)	$CH_3CH_2NH_2$	(iv)	C_2H_5OH/H^+	(S)	Colourless and neutral gas is formed

29. Which combination is correct for Cannizzaro reaction?
(A) (I), (iii) & (R) (B) (II), (ii) & (P)
(C) (IV), (ii) & (P) (D) (III), (i) & (R)

30. Which combination produces an alcohol?
(A) (III), (ii) & (Q) (B) (I), (iii) & (S)
(C) (IV), (i) & (S) (D) (I), (iv) & (Q)

31. Which combination produces an ester?
(A) (IV), (iii) & (R) (B) (II), (i) & (S)
(C) (III), (iv) & (R) (D) (I), (iii) & (S)

Space for Rough work

SECTION – B

(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

32. The rate of effusion of an unknown gas is four times that of SO_2. What is the molecular mass of the unknown gas?

33. The solubility product of a salt MX is 16×10^{-4}. If the molarity of its saturated solution is expressed as $x \times 10^{-y}$, the value of (x + y) is:

34. How many structural isomer(s) containing four membered ring(s) is/are possible with formula C_4H_5F?

35. How many maximum no. of moles of CH_3I can be absorbed by one mole of $C_2H_5NH_2$?

36. What is the coordination number of Zn^{2+} in ZnS crystal?

Space for Rough work

Mathematics PART – III

SECTION – A

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. Consider the function $f(x) = \left[\cos\left(\tan^{-1}\left(\sin\left(\cot^{-1}x\right)\right)\right)\right]^2$. Which of the following is correct?
(A) Range of f is (0, 1)
(B) f is even
(C) $f'(0) = 0$
(D) The line y = 1 is asymptote to the graph $y = f(x)$

38. Let $\vec{a} = \begin{bmatrix} 1 \\ 0 \\ -3 \end{bmatrix}, \vec{b} = \begin{bmatrix} 2 \\ 1 \\ 0 \end{bmatrix}, \vec{c} = \begin{bmatrix} 1 \\ -1 \\ 1 \end{bmatrix}$. If the numbers α, β and γ are such that $\alpha\vec{a} + \beta\vec{b} + \gamma\vec{c} = \begin{bmatrix} -2 \\ -5 \\ 6 \end{bmatrix}$ then

(A) $\alpha = -1$	(B) $\beta = -2$
(C) $\gamma = 3$	(D) $\alpha + \beta + \gamma = 0$

39. Two tangents can be drawn to the different branches of hyperbola $\frac{x^2}{1} - \frac{y^2}{4} = 1$ from the point (α, α^2), if:

(A) $\alpha \in (-2, 0)$	(B) $\alpha \in (0, 2)$
(C) $\alpha \in (-\infty, -2)$	(D) $\alpha \in (2, \infty)$

Space for Rough work

40 3 married couples are to seated around a circular table. Let x denotes the number of ways where atmost two couples sit together and let y denotes the number of ways where two particular couples sit together, then identify the correct option(s)

(A) $x-8y=60$ (B) $x+y=112$

(C) $x=13y$ (D) $x=12y$

41. If $\left(9+\sqrt{80}\right)^n = I+f$ where I and n are integers and $0<f<1$, then:

(A) I is an odd integer (B) I is an even integer

(C) $(I+f)(1-f)=1$ (D) $1-f=\left(9-\sqrt{80}\right)^n$

42. If $f(x)$ and $g(x)$ are function such that $f(x+y)=f(x)g(y)+g(x)f(y)$, then $\begin{vmatrix} f(\alpha) & g(\alpha) & f(\alpha+\theta) \\ f(\beta) & g(\beta) & f(\beta+\theta) \\ f(\gamma) & g(\gamma) & f(\gamma+\theta) \end{vmatrix}$ is independent of:

(A) α (B) β

(C) γ (D) θ

43. The equation $\dfrac{b\cos x}{2\cos 2x-1}=\dfrac{b+\sin x}{\left(\cos^2 x-3\sin^2 x\right)\tan x}$ possess a solution if

(A) $b<\dfrac{1}{2}$ (B) $0<b<\dfrac{1}{2}$

(C) $b<0$ (D) $b=\dfrac{1}{2}$

Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 44, 45 and 46 by appropriately matching the information given in the three columns of the following table.

Consider three plans:

$P_1 \equiv 2x + y + z = 1$

$P_2 \equiv x - y + z = 2$

$P_3 \equiv \alpha x - y + 3z = 5$

The three planes intersects each other at point P on XOY plane and at point Q on YOZ plane. O is the origin.

Column 1	Column 2	Column 3
(I) The value of α is	(i) 1	(P) root of equation $x^2 - x(4+i) + 4i = 0$
(II) The length of projection of PQ on x – axis is	(ii) 2	(Q) root of equation $x^2 - 1 = 0$
(III) If the coordinates of point R situated at minimum distance from point O on the line PQ are (a, b, c), then the value of $7a + 14b + 14c$ is	(iii) 4	(R) root of equation $x^3 - 8 = 0$
(IV) If the area of ΔPOQ is $\sqrt{\frac{a}{b}}$. Then the value of a – b is where a and b are co – prime numbers	(iv) 3	(S) root of equation $x^2 + 2x - 15 = 0$

44. Which is correct combination?
(A) (I) (i) (P) (B) (I) (iii) (P)
(C) (II) (ii) (Q) (D) (III) (ii) (Q)

Space for Rough work

45. Which is correct combination?
(A) (I) (ii) (Q) (B) (II) (i) (Q)
(C) (III) (iii) (R) (D) (IV) (iv) (Q)

46. Which is correct combination
(A) (I) (ii) (Q) (B) (III) (ii) (R)
(C) (IV) (iv) (R) (D) (I) (ii) (R)

Answer questions 47, 48 and 49 by appropriately matching the information given in the three columns of the following table.

Let $A = \begin{bmatrix} 1 & 0 & 0 \\ 2 & 1 & 0 \\ 3 & 2 & 1 \end{bmatrix}$ and X_1, X_2, X_3 be three column matrices such that $AX_1 = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$, $AX_2 = \begin{bmatrix} 2 \\ 3 \\ 0 \end{bmatrix}$ and $AX_3 = \begin{bmatrix} 2 \\ 3 \\ 1 \end{bmatrix}$ and X is a 3×3 matrix whose columns are X_1, X_2, X_3 then

Column 1	Column 2	Column 3
(I) Value of $\det(X)$ is	(i) –3	(P) 7th term of A.P. whose first 3 terms are $\frac{1}{2}, \frac{13}{18}, 1$ respectively
(II) $3\det(A)$ is	(ii) 3	(Q) 11th term of A.P. whose first 3 terms are $\frac{1}{2}, \frac{3}{4}, 1$ respectively
(III) $\left[\det(\text{adj})X\right]^{1/2}$	(iii) 0	(R) 9th term of A.P. whose first 3 terms are $\frac{1}{3}, \frac{7}{24}, \frac{1}{4}$ respectively
(IV) Sum of the elements of X^{-1} is	(iv) –1	(S) 10th term of A.P. whose first 3 terms are $\frac{1}{3}, \frac{7}{24}, \frac{1}{4}$ respectively

47. Which is correct combination?
(A) (I) (i) (P) (B) (I) (iii) (P)
(C) (II) (ii) (Q) (D) (III) (ii) (R)

Space for Rough work

48. Which is correct combination?
(A) (I) (ii) (Q)
(B) (II) (i) (Q)
(C) (III) (iii) (R)
(D) (IV) (iv) (Q)

49. Which is correct combination?
(A) (I) (ii) (S)
(B) (III) (ii) (Q)
(D) (IV) (iv) (S)
(D) (I) (ii) (R)

SECTION – B

(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

50. If α, β, γ are roots of equation $f(x) = 0$ where $f(x) = x^3 - cx^2 + 4x - 2$ and $f\left(\frac{1}{\alpha} + \frac{1}{\beta} + \frac{1}{\gamma}\right) = 2$ then value of c is:

51. Let $0 \le \beta_r \le 1$ and $\sum_{r=1}^{k} \cos^{-1}\beta_r = \frac{k\pi}{2}$ for any $k \ge 1$ and $A = \sum_{r=1}^{k}(\beta_r)^r$, then $\lim_{x \to A} 498.\frac{(1+x^2)^{1/3} - (1-2x)^{1/4}}{x + x^2}$ is equal to λ, where $\frac{\lambda}{83} =$

Space for Rough work

52. The vertices of a triangle are A (1, 0, 0), B (0, 2, 0) and C (0, 0, 3). If $\left(a\hat{i}+b\hat{j}+c\hat{k}\right)$ is position vector of othrocenter of ΔABC then $\sqrt{\frac{6}{(a-b-c)}}$ is

53. Let Δ_1 be the area of ΔPQR inscribed in an ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1(a>b)$ and Δ_2 be the area of the $\Delta P'Q'R'$ whose vertices are the points lying on the auxiliary circle corresponding to the points P, Q, R, respectively. If the eccentricity of the ellipse is $\frac{4\sqrt{3}}{7}$, then the ratio $\frac{\Delta_2}{\Delta_1}$ must be ___

54. Let PQ be a variable normal chord of the parabola $y^2=4x$ whose focus is S. If the locus of the centroid of the triangle SPQ is the curve $gy^2(3x-5)=ky^4+w$ where g, k, w, $\in N$, find the value of $w-(g+k+2)$

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

PART TEST – III

JEE (Main)-2019

TEST DATE: 9-12-2018

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. B

Sol. Basic Concepts

2. C

Sol. $W = A\int_0^{V_0/2A}(P_0 + \rho g y)dy = \frac{P_0V_0}{2} + \frac{\rho g A}{2}\left(\frac{V_0}{2A}\right)^2 = \frac{5P_0V_0}{8}$

Also $n = \frac{P_0V_0}{RT_0} = \frac{\left(P_0 + \rho g\frac{V_0}{2A}\right)\frac{3V_0}{2}}{RT} \Rightarrow T = \frac{\frac{3}{2}\left(P_0 + \rho g\frac{V_0}{2A}\right)T_0}{P_0} = \frac{9T_0}{4}$

$\therefore \quad \Delta U = nC_v\Delta T = \left(\frac{P_0V_0}{RT_0}\right)\left(\frac{3R}{2}\right)\left(\frac{9T_0}{4} - T_0\right) = \frac{15}{8}P_0V_0$

$\therefore \quad \frac{\Delta U}{\Delta W} = 3$.

3. A

Sol. $\frac{\lambda_A}{\lambda_B} = \left(\frac{Z_B - 1}{Z_A - 1}\right)^2$

4. C

Sol. $V_0 = \sqrt{\frac{GM}{R}}$

Binding energy of satellite = $\frac{GMm}{2R}$

If V_e is escape speed, then $\frac{1}{2}mV_e^2 = \frac{1}{2}mV_0^2 + \frac{GMm}{2R}$

$\Rightarrow \quad V_e = \sqrt{2}\left[\frac{GM}{R}\right]^{1/2} = \sqrt{2}V_0$

Using conversation of momentum;

$mV_0 = (m - \Delta m)V_e - \Delta m U_{max}$

$\Rightarrow \quad mV_0 = \left[m - \frac{5}{100}m\right]\sqrt{2}V_0 - \frac{5m}{100}U_{max}$

$U_{max} = \frac{(\sqrt{2}\times 95 - 100)}{5}V_0 \approx 7V_0$

5. C

Sol. $\frac{v_1}{v_2} = \frac{27}{8}$

So, $\frac{m_1}{m_2} = \frac{8}{27}$ (from conservation of momentum)

$r \propto A^{1/3}$

$\frac{r_1}{r_2} = \left(\frac{8}{27}\right)^{1/3} = \frac{2}{3}$

6. B

Sol. $7 \times \frac{D\lambda}{d} = \frac{(\mu_1 - \mu_2)t \cdot D}{d}$

$t = 9.1\ \mu m$

7. D

Sol. $E \propto \frac{1}{n^2}$

$r \propto n^2$

$p \propto \frac{1}{n}$

$L \propto n$

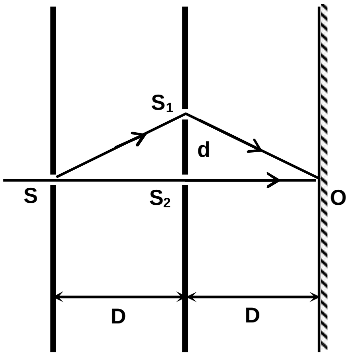
8. B

Sol. path difference = $(SS_1 + S_1O) - SO$

$= 2\sqrt{D^2 + d^2} - 2D = \frac{d^2}{D}$

$\frac{d^2}{D} = n\lambda$

$d = \sqrt{D\lambda}$ (n = 1)



9. A

Sol. Let plank is slight displacement a distance x.

$$F_r = \frac{32}{3}kx$$

$$a = \frac{32k}{3m}x$$

$$\omega = \sqrt{\frac{32k}{3m}}$$

10. C

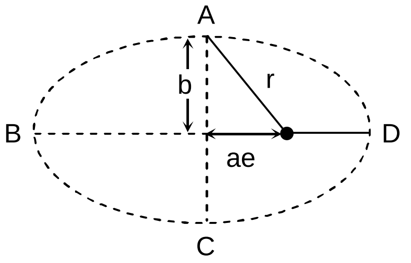
Sol. $v = LT^{-1}$
$G = M^{-1}L^{3}T^{-2}$
$h = ML^{2}T^{-1}$
So, $\frac{v}{h} = \frac{1}{ML}$
and $\frac{G}{h^2} = \frac{1}{M^3L}$
Hence, $L = G^{1/2}, h^{1/2}, v^{-3/2}$

11. D

Sol. $r^2 = b^2 + a^2e^2$
...(1)
$b^2 = a^2\left(1 - e^2\right)$
...(2)
From equation (1) & (2)
r = a
Now from conservation of energy

$$-\frac{GMm}{2a} = \frac{1}{2}mv^2 - \frac{GMm}{a}$$

$$v = \sqrt{\frac{GM}{a}}$$



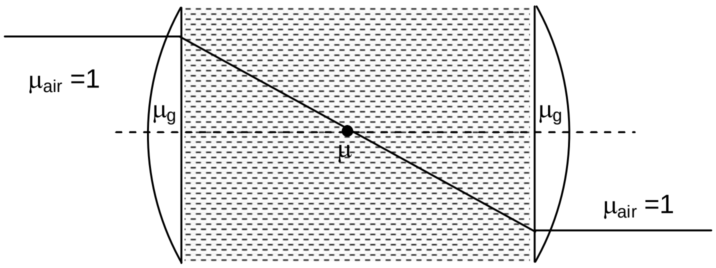
12. B

Sol.

$$\frac{\mu}{d/2} - \frac{1}{\infty} = \frac{\mu_g - 1}{R} - \frac{\mu_g - \mu}{\infty}$$

$$\Rightarrow \quad d = \frac{2\mu R}{\mu_0 - 1} = 2\mu f$$

$$\left(\text{where}\,\frac{1}{f} = \frac{\mu_0 - 1}{R}\right)$$



13. C

Sol.

$$(3\rho)VgR\theta - \frac{V}{2}2\rho g\frac{5R}{8}\theta - \frac{V}{2}\rho g\frac{11R}{8}\theta = \left[2\rho\frac{V}{2}R^2\left(\frac{2}{5} - \frac{9}{64} + \frac{25}{64}\right) + \rho\frac{V}{2}R^2\left(\frac{2}{5} - \frac{9}{64} + \frac{121}{64}\right)\right]\alpha$$

So $\omega = \sqrt{\dfrac{45g}{46R}}$.

14. A

Sol. $f' = f_0\left(\dfrac{1-v_1/v_s}{1-v_2/v_s}\right)$, $v_1 = 0$ and $v_2 = -\omega R$

15. A

Sol. Gravitation potential due to disc is

$$V = -\frac{2Gm}{R^2}(\sqrt{R^2+\ell^2}-\ell)$$

So, $U_i = -\dfrac{Gmm}{\ell}$ (R<<ℓ)

$$U_f = -\frac{2Gmm}{R} \quad (\ell \to 0)$$

$$\Delta U = U_i - U_f = Gmm\left(\frac{2}{R}-\frac{1}{\ell}\right)$$

$$\frac{1}{2}mv^2 + \frac{1}{2}mv^2 = Gmm\left(\frac{2}{R}-\frac{1}{\ell}\right)$$

$$v = \sqrt{Gm\left(\frac{2}{R}-\frac{1}{\ell}\right)}$$

So, relative velocity

$$v_R = 2v = \sqrt{4Gm\left(\frac{2}{R}-\frac{1}{\ell}\right)}$$

16. B

Sol. $T = 2\pi\sqrt{\dfrac{I}{mgd}}$

$$f = \frac{1}{2\pi}\sqrt{\frac{mgd}{I}}$$

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{(2m)(g)(3\ell/4)}{\left(\dfrac{m\ell^2}{3}+m\ell^2\right)}} = \frac{1}{2\pi}\sqrt{\frac{9g}{8\ell}}$$

When disc is removed

$$f = \frac{1}{2\pi}\sqrt{\frac{mg(\ell/2)}{m\ell^2/3}} = \frac{1}{2\pi}\sqrt{\frac{3g}{2\ell}}$$

$$\frac{f}{f_0} = \sqrt{\frac{3}{2}\times\frac{8}{9}} = \frac{2}{\sqrt{3}}$$

17. D

Sol. The maximum allowable zener current = $\dfrac{0.36}{12} = 0.03A = 30$ mA

Case I: If $R_L \to \infty \Rightarrow V_R = V - V_2 = 15 - 12 = 3$ volt $\Rightarrow R = \dfrac{V_R}{I_2} = \dfrac{3}{0.03} = 100\Omega$

Case II: If R_L is finite
$I = I_L + I_2$
As $R_L \downarrow \Rightarrow I_L \uparrow \Rightarrow I_2 \downarrow$, so for minimum value of R_L, the I_2 will be 2mA, so $I_L = 30 - 2 = 28$ mA

$$R_{L_{min}} = \frac{12}{I_L} = \frac{12}{0.028} = 430\Omega \quad \Rightarrow \quad 430\ \Omega \le R_L < \infty$$

18. C

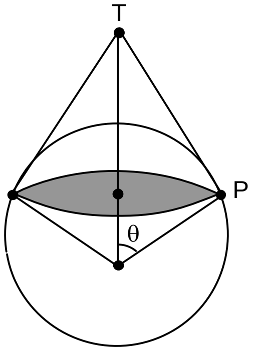
Sol. The amplitude is doubled, the intensity is quadrupled.

19. C

Sol. To cover $\left(\frac{1}{4}\right)^{th}$ of the earth's surface, the direct transmission reaches a point 'θ' from the transmitters where:

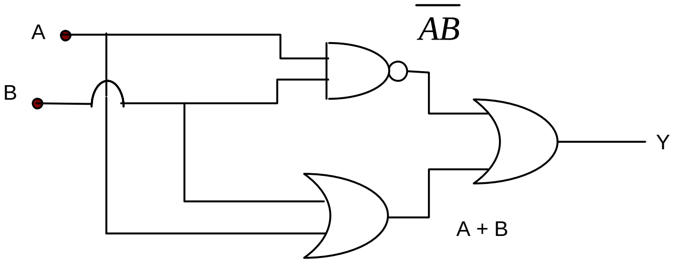
$$2\pi(1 - \cos\theta)R^2 = \frac{1}{4}.4\pi R^2$$

$\therefore$ $\theta = 60°$.
$\therefore$ height, $h = 2R - R = R$



20. D

Sol. $Y = A + B + \overline{AB}$
$\Rightarrow Y = A + B + \overline{A} + \overline{B} = 1$



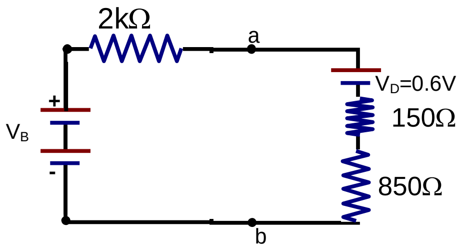
21. A

Sol. As shown in the Figure, the diode is replaced by its equivalent circuit and the circuit to the left of the terminals a, b.

Since the diode can dissipate a maximum power of 200 mW, the maximum safe diode current I will satisfy the relationship

$$P = 200 \times 10^{-3} = i^2 r = 150 i^2$$

$$\Rightarrow \quad i = \sqrt{\frac{0.2}{150}} = 0.0365\,\text{A} = 36.5\text{ mA}.$$



As shown in the Figure, $i = \dfrac{(V_B/3) - 0.6}{3} = 36.5 \quad \Rightarrow V_B = 330$ V,

Which is the maximum permissible battery voltage.

22. B

Sol. $Y = \dfrac{4F\ell}{\pi d^2 \Delta\ell}$

$\therefore\ \dfrac{\Delta Y}{Y} = -\left(2\dfrac{\Delta d}{d} + \dfrac{\Delta(\Delta\ell)}{\Delta\ell}\right) = \pm\left(2\times\dfrac{0.01}{0.4} + \dfrac{0.05}{0.8}\right) = \pm\dfrac{9}{80}$

$\therefore$ Y = $(2 \pm 0.2)\times10^{11}$ N/m^2

23. A

Sol. E = energy stored in the string = $\mu A^2\omega^2 \int_0^{\Delta\pi} \cos^2 kx dx$

Where Δx is distance traveled by the wave in the $\dfrac{\pi}{12\omega} = \dfrac{\pi}{12\omega}\dfrac{\omega\lambda}{2\pi} = \dfrac{\lambda}{24}$

So, $E = \dfrac{(\pi+3)\mu A^2\omega^2}{24k}$

24. A

Sol. Let the speed of the flow be v and the diameter of the tap be d = 1.25 cm. The volume of the water flowing out per second is

$Q = v \times \pi d^2 / 4$

$v = 4Q/\pi d^2$

We then estimate the Reynolds number to be

$R_e = 4\rho Q/\pi d\eta$

$= 4\times10^3 \times Q/\left(3.14\times1.25\times10^{-2}\times10^{-3}\right)$

$= 1.109\times10^8 Q$.

For x = 3, $R_e = 5100$ and for x = 6, $R_e = 10200$

and for others it is much lower than the critical value.

25. C

Sol. Now, from equation the time, $T_{1/2}$, for the amplitude to drop to half of its initial value is given by,

$T_{1/2} = -2\pi\dfrac{\ln(1/2)}{b/2m}$

$= \dfrac{0.693}{40}\times2\times200\,\text{s} \approx 7$ s

26. B

Sol. The linear distance between two dots is $\ell = \dfrac{2.54}{100}\text{cm} \simeq 2.54\times10^{-2}\text{cm}$.

At a distance of Z cm this subtends an angle $\phi \sim \ell/z \ \therefore z = \dfrac{1}{\phi} = \dfrac{2.54\times10^{-2}\text{cm}}{6\times10^{-4}} \approx 45$ cm.

27. C

Sol. Without P:

$A = A_\perp + A_{||}$

$A_{\perp} = A_{\perp}^{1} + A_{\perp}^{2} = A_{\perp}^{0}\sin(kx - \omega t) + A_{\perp}^{0}\sin(kx - \omega t + \phi)$

$A_{||} = A_{||}^{(1)} + A_{||}^{(2)}$

$A_{||} = A_{||}^{0}\left[\sin(kx - \omega t) + \sin(kx - \omega t + \phi)\right]$

Where $A_{\perp}^{0}, A_{||}^{0}$ are the amplitudes of either of the beam in ⊥ and || polarizations.

$\therefore$ Intensity =

$= \left\{\left|A_{\perp}^{0}\right|^2 + \left|A_{||}^{0}\right|^2\right\}\left[\sin^2(kx - \omega t)\left(1 + \cos^2\phi + 2\sin\phi\right) + \sin^2(kx - \omega t)\sin^2\phi\right]_{\text{average}}$

$= \left\{\left|A_{\perp}^{0}\right|^2 + \left|A_{||}^{0}\right|^2\right\}\left(\frac{1}{2}\right).2(1 + \cos\phi)$

$= 2\left|A_{\perp}^{0}\right|^2.(1 + \cos\phi)\text{since}\left|A_{\perp}^{0}\right|_{\text{average}} = \left|A_{||}^{0}\right|_{\text{average}}$

With P:

Assume $A_{\perp}^{0}$ is blocked:

Intensity = $\left(A_{||}^{1} + A_{||}^{2}\right)^2 + \left(A_{\perp}^{1}\right)^2$

$= \left|A_{\perp}^{0}\right|^2(1 + \cos\phi) + \left|A_{\perp}^{0}\right|^2.\frac{1}{2}$

Given $I_0 = 4\left|A_{\perp}^{0}\right|^2 =$ Intensity without polarizer at principal maxima.

Intensity at principal maxima with polarizer

$= \left|A_{\perp}^{0}\right|^2\left(2 + \frac{1}{2}\right) = \frac{5}{8}I_0$

Intensity at first minima with polarizer

$= \left|A_{\perp}^{0}\right|^2 a(1 - 1) + \frac{\left|A_{\perp}^{0}\right|^2}{2} = \frac{I_0}{8}.$

28. B

Sol. P = Fv = $6\pi\eta r\left[\frac{2}{9}\frac{r^2}{\eta}(\rho - \sigma)g\right]^2$

= $\frac{8\pi g^2}{27\eta}(\rho - \sigma)^2 r^5$

29. C

Sol. Fraction depends only upon the critical angle for the medium.

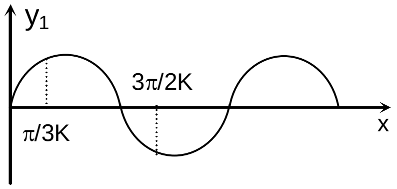
30. D

Sol. At t = 0, shape of standing wave is

So, $\Delta\phi_1 = \pi$

Phase difference $\Delta\phi_2 = k\left(\frac{3\pi}{2k} - \frac{\pi}{3k}\right) = \frac{7\pi}{6}$

$\frac{\Delta\phi_1}{\Delta\phi_2} = \frac{6}{7}$



Chemistry

PART – II

SECTION – A

31. D

Sol. The mixing of two oppositely charge sols cause coagulation.

32. C

Sol. α-black phosphorous is formed when red phosphorous is heated in a sealed tube at 803 K.

33. D

Sol. $\frac{r_{A^+}}{r_{X^-}} = \frac{1}{2} = 0.5,$ it lies in range 0.414 – 0.732, AX has structure like that of NaCl.

Hence, edge length $(a) = 2(r^+ + r^-)$

$= 2\ (1 + 2)$ pm

$= 6$ pm

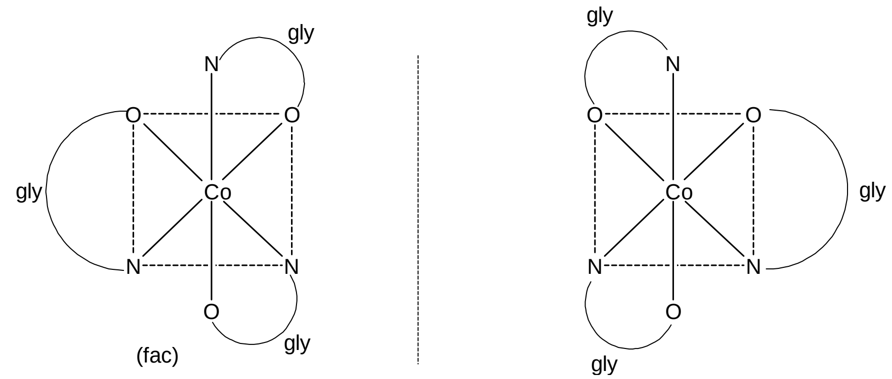
Volume of unit cell = $a^3\ (6\text{ pm})^3 = 216\text{ pm}^3$

34. C

Sol. They have high melting point, are hard and chemically inert.

35. B

Sol.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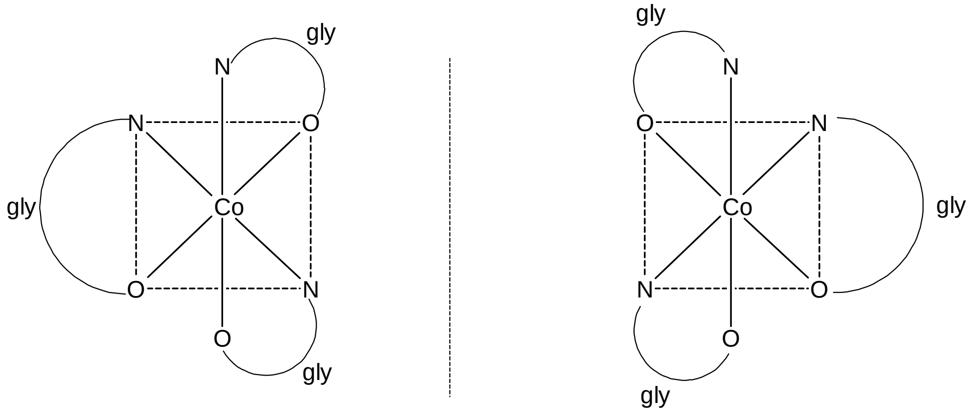
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36. B

Sol. Removal of water from $[Ti(H_2O)_6]\,Cl_3$ on heating render it colourless.

$$\underset{\text{Green}}{\left[Ni(H_2O)_6\right]^{2+}} + 3(en)(aq) \longrightarrow \underset{\text{Violet}}{\left[Ni(en)_3\right]^{2+}}(aq) + 6H_2O$$

37. C

Sol. Ca → 1
O → 3
Ti → 1
So, compound is $CaTiO_3$
Oxidation state of Ti is
$+ 2 + x – 6 = 0$
$x = + 4$.

38. C

Sol. $$Ni + 4CO \xrightarrow{330-350\text{ K}} \underbrace{Ni(CO)_4}_{\text{Volatile complex}}$$

39. A

Sol. Millimoles of NaCl = 4 m mole
100 ml requires = 4 m mole
1000 ml requires 40 m mole and this is flocculation value.

40. C

Sol. Equivalents of $K_2Cr_2O_7$ = Equivalents of Fe^{2+}
$M \times V \times nf = n \times nf$
$2 \times V \times 6 = n$
$12 \times V = n$
Equivalents of $KMnO_4$ = Equivalents of Fe^{2+}
$M_1 \times V_1 \times nf_1 = n \times nf$
$2 \times V \times 5 = n \times 1$
$10\,V = n$

41. A

Sol. $P(Vm – b) = RT$

$$\frac{P}{RT} = \frac{1}{Vm - b}$$

$$Z = \frac{PVm}{RT} = \frac{Vm}{Vm - b} = \frac{1}{1-(b/Vm)} = \frac{1}{1-\left(\frac{0.138}{35}\right)} = 1.004$$

42. A

Sol. SO_2 is reducing while TeO_2 is an oxidizing agent.

43. C

Sol. PbI_2 is formed which is yellow in colour.

44. B

Sol. $Cu_2S + 2KMnO_4 + 4H_2SO_4 \longrightarrow 2CuSO_4 + 2MnSO_4 + K_2SO_4 + 4H_2O$

45. C

Sol. At constant P and n $V \propto T$.

46. B

Sol. Greater the intermolecular attraction, lesser the volatility at a given temperature.

47. D

Sol. Overall reaction for electrolysis of K_2SO_4 is $2H_2O(\ell) \longrightarrow 2H_2 + O_2$

48. B

Sol. At equivalence point
Moles of $AgNO_3$ = Moles of KCl
$10^{-3} \times 20 \times M = 0.20 \times 20 \times 10^{-3}$
M = 0.20
Moles of $AgNO_3$ initially = M × V
$= \frac{0.20}{100} \times 20 \times 10^{-3}$
$= 4 \times 10^{-3}$.

49. D

Sol. Chloride salts of mercury, silver and lead are not readily soluble in water.

50. C

Sol. Analgesics reduce or abolish pain without causing impairment of consciousness.

51. B

Sol. Protons in $NO_3^- = 31$

Moles of $NO_3^- = \frac{124}{62} = 2$ mole

1 mole $NO_3^- = 31\,N_A$ protons

2 mole $NO_3^- = 62\,N_A$

52. B

Sol. P(ideal) = 0.2 × 200 + 0.8 × 600
= 520 torr < P(obs)
Solution showing positive deviation.

53. A

Sol. $\Delta H_{reaction} = \sum \Delta H_f(\text{Products}) - \sum \Delta H_f(\text{Reactants})$
$\Delta H_f(B) - \Delta H_f(A) = 90$ kcal

$\Delta H_f(B) > \Delta H_f(A)$

$\Delta H_f(C) - \Delta H_f(B) = -70$ kcal

$\Delta H_f(B) > \Delta H_f(C)$

$A \longrightarrow C \qquad \Delta H = 20$ kcal

$\Delta H_f(C) > \Delta H_f(A)$

A < C < B

54. C

Sol. Density $= \dfrac{4 \times M}{N_A \times a^3}$

$$\frac{d_{NaCl}}{d_{KCl}} = \frac{58.5}{74.5}\left(\frac{a_{KCl}}{a_{NaCl}}\right)^3$$

$$d_{KCl} = 1.8 \times \frac{74.5}{58.5}\left[\frac{1.5\,r(Cl^-)}{1.8\,r(Cl^-)}\right]^3 = 1.33 \text{ g / cc.}$$

55. B

Sol. NaX = i = 2

$\Delta T_f = i \times K_f \times m$

$$1.27 = 2 \times 1.86 \times \frac{2}{M} \times \frac{1000}{100}$$

M = 58.5 = Molar mass of NaCl

56. D

Sol. Magnitude of W_{max} = nEF = 2 × 3.5 × 96500 J

$= 6.75 \times 10^5$ J.

$= 6.75 \times 10^2$ kJ.

57. C

Sol. The maximum limit of nitrate in drinking water is 50 ppm.

The prescribe upper limit of lead in drinking water is 50 ppb.

58. C

Sol. For Step-II

$$P_3 = \left(\frac{T_2}{T_3}\right)^{\frac{\gamma}{1-\gamma}} P_2 = \left(\frac{600}{300}\right)^{-\frac{7}{2}} \times 2$$

$$= 2^{-\frac{7}{2}} \times 2 = \frac{1}{4\sqrt{2}} \text{atm}$$

$$V_3 = \frac{RT_3}{P_3} = \frac{0.082 \times 300}{\frac{1}{4\sqrt{2}}} = 139 \text{ L.}$$

59. B

Sol. $\underset{}{FeO} + \underset{(silica)}{SiO_2} + \underset{(slag)}{FeSiO_3}$

60. D

Sol. If all the oleum is SO_3 then maximum weight of H_2SO_4 will be

$$100 + 100 \times \frac{18}{80} = 122.5$$

So % oleum cannot exceed 122.5%.

Mathematics PART – III

SECTION – A

61. B

Sol. Roots of $x^3 - 9x^2 + ax - 24 = 0$ are in A.P.
$\Rightarrow 3c = 9 \Rightarrow c = 3$
$\Rightarrow a = 2, d = 4$
$\Rightarrow$ 2, 3, 4 also roots of equation $5x^4 + px^3 + qx^2 + rx + s = 0$
$\Rightarrow$ 2, b, 3, 4 are in H.P.
$\Rightarrow b = \frac{12}{5}$

$$\Rightarrow \left|\frac{P(x)}{Q(x)}\right| = \left|\frac{5(x-2)(x-3)(x-4)\left(x-\frac{12}{5}\right)}{1\cdot(x-2)(x-3)(x-4)}\right| = |(5x-12)|$$

62. C

Sol. $^nC_1 + {}^nC_2\cdot\alpha + {}^nC_3\cdot\alpha^2 + \ldots\ldots + {}^nC_n\cdot\alpha^{n-1}$

$= \frac{1}{\alpha}\left[{}^nC_1\cdot\alpha + {}^nC_2\cdot\alpha^2 + \ldots\ldots + {}^nC_n\cdot\alpha^{n-1}\right]$

$= \frac{1}{\alpha}\left[(1+\alpha)^n - 1\right]$

63. C

Sol. Given numbers are 1, 2, 3, 4, ..., 2n + 1

Mean of these numbers = $\bar{x} = \frac{1+2+3+\ldots\ldots+2n+1}{2n+1} = n+1$

$$\sigma^2 = \frac{1}{2n+1}\sum_{r=0}^{2n}\{(1+r)-(1+n)\}^2 = \frac{1}{2n+1}\sum_{r=0}^{2n}(n-r)^2 = \frac{2\left(1^2+2^2+\ldots\ldots+n^2\right)}{2n+1}$$

$$\sigma^2 = \frac{n(n+1)}{3} \Rightarrow \sigma = \sqrt{\frac{n(n+1)}{3}}$$

64. D

Sol. Let $y = [x] \Rightarrow y^2 + ay + b = 0$
Let a = 2m + 1, b = 2n + 1
$\Rightarrow \Delta = a^2 - 4b = (2m+1)^2 - 4(2n+1) = 8K + 5$
If $8K + 5 = (2P+1)^2$ {where $P \in I$}
$\Rightarrow 4P^2 + 4P = 4(2K+1)$
$\Rightarrow P(P+1) = 2K + 1$ which is not possible
So, [x] = irrational $\Rightarrow x \in \phi$

65. D

Sol. $\dfrac{a^{n-\frac{1}{2}}+b^{n-\frac{1}{2}}}{a^{n+\frac{1}{2}}+b^{n+\frac{1}{2}}}=\dfrac{1}{\sqrt{ab}}$

$\Rightarrow \left(a^{\frac{1}{2}}-b^{\frac{1}{2}}\right)\left(a^n-b^n\right)=0 \Rightarrow n = 0 \text{ as } n \neq b$

66. B

Sol. $P(A)=\dfrac{33}{100}$, $P(B)=\dfrac{50}{100}$, $P(A\cap B)=\dfrac{16}{100}$

$P(A\cup B)=\dfrac{33+50-16}{100}=\dfrac{67}{100}$

67. D

Sol. $\left(e^{z^2}\right)=e^{\left(x^2-y^2\right)+2ixy}$

$\text{amp}\left(e^{z^2}\right)=2xy$

Similarly $\text{amp}\left(e^{(z+i)}\right)=(y+1)$

$2xy = y + 1 \Rightarrow y=\dfrac{1}{(2x-1)}$

$f(3)=\dfrac{1}{5}$

68. A

Sol. Take $z_1=1+i\sqrt{3}$ and $z_2 = 3$

$\left|\dfrac{z_1+z_2}{z_1-z_2}\right| = \sqrt{\dfrac{19}{7}}$

69. B

Sol. Put $\log_{\sqrt{3}}\tan x = t,\ t<0$

$t\sqrt{2t+3}=-1 \Rightarrow 2t^3 + 3t^2 - 1 = 0 \Rightarrow t = -1$

$\tan x=\dfrac{1}{\sqrt{3}} \Rightarrow x=\dfrac{\pi}{6} \text{ or } \dfrac{7\pi}{6}$

70. D

Sol. We require $t_n = t_m \Rightarrow 3n - 2 = 5m + 4,\ m, n \in N$,

$3n = 5m + 6 \Rightarrow \dfrac{m}{3}=\dfrac{n-2}{5} = k$ (where $k \in I$)

as $m, n \leq 500 \Rightarrow k \leq 99$

$(m, n) = (3, 7)$ or $(6, 12)$ or $(9, 17)$ or .....

71. A

Sol. Required probability = $\frac{{}^{20}C_1 \cdot {}^{20}C_1}{{}^{40}C_2} \cdot \frac{{}^{19}C_1 \cdot {}^{19}C_1}{{}^{38}C_2} \cdot \frac{{}^{18}C_1 \cdot {}^{18}C_1}{{}^{36}C_2} \ldots\ldots \frac{{}^{1}C_1 \cdot {}^{1}C_1}{{}^{2}C_2}$ = $\frac{2^{20} \times (20!)^2}{40!}$

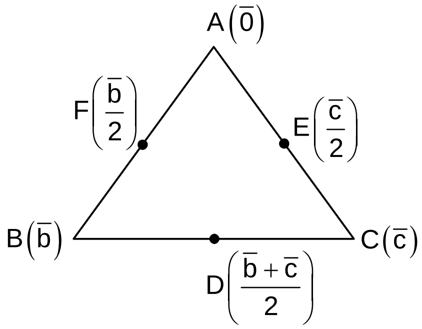
72. A

Sol. Consider A as origin LHS $\overrightarrow{AD} + \frac{2}{3}\overrightarrow{BE} + \frac{1}{3}\overrightarrow{CF}$

$\left(\frac{\bar{b}+\bar{c}}{2} - 0\right) + \frac{2}{3}\left(\frac{\bar{c}}{2} - \bar{b}\right) + \frac{1}{3}\left(\frac{\bar{b}}{2} - \bar{c}\right)$

$= \bar{b}\left(\frac{1}{2} - \frac{2}{3} + \frac{1}{6}\right) + \bar{k}\left(\frac{1}{2} + \frac{1}{3} - \frac{1}{3}\right) = 0\bar{b} + \frac{1}{2}\bar{c}$

$= \frac{1}{2}\bar{A}C \ \therefore\ k = \frac{1}{2} \Rightarrow 2K = 1$



$A(\bar{0})$
$F\left(\frac{\bar{b}}{2}\right)$
$E\left(\frac{\bar{c}}{2}\right)$
$B(\bar{b})$
$C(\bar{c})$
$D\left(\frac{\bar{b}+\bar{c}}{2}\right)$

73. A

Sol. We know that $A(\text{adj } A) = |A|I$

A(Adj A) = 4I $\Rightarrow$ |A| = 4

Again we know that $|\text{Adj } A| = |A|^{n-1}$

$$\frac{|\text{Adj}(\text{Adj } A)|}{|\text{Adj } A|} = \frac{|A|^4}{|A|^2} = |A|^2 = 4^2 = 16$$

74. C

Sol. The plane containing the given line is (2x + 3y + 5z + 1) + λ(3x + 4y + 6z + 2) = 0
$\because$ The plane is parallel to y-axis
$\Rightarrow \lambda = -\frac{3}{4}$
$\Rightarrow$ A point on y-axis is the origin and the perpendicular distance from the origin to the plane x – 2z + 2 = 0 is $\frac{2}{\sqrt{5}}$

75. C

Sol. cos α + i sin α is a root of $a_n\left(\frac{1}{z}\right)^n + a_{n-1}\left(\frac{1}{z}\right)^{n-1} + \ldots\ldots + a_2\left(\frac{1}{z}\right)^2 + a_1\left(\frac{1}{z}\right) + 1 = 0$. Equating real parts on both sides, $a_n \cos n\alpha + a_{n-1} \cos (n-1)\alpha + \ldots\ldots + a_1 \cos \alpha + 1 = 0$

76. B

Sol. AB = BA
$\Rightarrow a_{21} = 2a_{12}$ ..... (1)
$a_{11} = a_{22}$ ..... (2)
$|A| = 0 \Rightarrow a_{11}\, a_{22} = a_{21} \cdot a_{12}$ ..... (3)

From equation (1), (2) and (3), we get $\left(\frac{a_{11}}{a_{12}}\right)^2 = 2$

77. B

Sol. $z_1\left(z_1^2 - 3z_2^2\right) = 2.....(1)$; $z_2\left(3z_1^2 - z_2^2\right) = 11....(2)$ multiplying (2) by i add to (1) which gives $\left(z_1 + iz_2\right)^3 = 2 + 11i.....(3)$ and multiplying (2) by i and subtracting from (1) gives
$\left(z_1 - iz_2\right)^3 = 2 - 11i....(4)$
Now multiply (3) and (4) then $z_1^2 + z_2^2 = 5$

78. B

Sol. Since |z – 1| = 1 ⇒ z – 1 = cis θ ⇒ $z = (1 + \cos\theta) + i\sin\theta = 2\cos\frac{\theta}{2}\text{cis}\frac{\theta}{2}$
$\therefore\ \frac{1}{z} - \frac{1}{2} = \frac{\text{cis}\left(-\frac{\theta}{2}\right)}{2\cos\frac{\theta}{2}} - \frac{1}{2} = -\frac{i}{2}\tan\frac{\theta}{2}$ which is purely imaginary

79. C

Sol. $\vec{r} = \left(\vec{a}\times\vec{b}\right)\sin x + \left(\vec{b}\times\vec{c}\right)\cos y + 2\left(\vec{c}\times\vec{a}\right)$
$\vec{r}\cdot\left(\vec{a} + \vec{b} + \vec{c}\right) = 0$
$\Rightarrow \left[\vec{a}\ \vec{b}\ \vec{c}\right]$ (sin x + cos y + 2) = 0
$\left[\vec{a}\ \vec{b}\ \vec{c}\right] \neq 0$ ⇒ sin x + cos y = –2
this is possible only when sin x = – 1 and cos y = –1
for $x^2 + y^2$ to be minimum x = $-\frac{\pi}{2}$ and y = π
⇒ Minimum value of $(x^2 + y^2)$ is = $\frac{\pi^2}{4} + \pi^2 = \frac{5\pi^2}{4}$

80. D

Sol. Since point of intersection of the given lines is (0, 0, 0). It must lie on the angle bisector so
$\frac{0-2}{-1} = \frac{0+2}{1} = \frac{0+k}{4}\quad \Rightarrow k = 8$

81. A

Sol. $(x + 1)(2x + 1)(2^2x + 1)(2^3x + 1) ...... (2^{20}x + 1)$
$= 1\cdot 2\cdot 2^2\cdot 2^3......2^{20}(x+1)\left(x+\frac{1}{2}\right)\left(x+\frac{1}{2^2}\right)\left(x+\frac{1}{2^3}\right)........\left(x+\frac{1}{2^{20}}\right)$
$= 2^{\frac{20\times 21}{2}}(x+1)\left(x+\frac{1}{2}\right)\left(x+\frac{1}{2^2}\right)........\left(x+\frac{1}{2^{20}}\right)$

Coefficient of $x^{20} = 2^{210}\left(1+\frac{1}{2}+\frac{1}{2^2}+.........+\frac{1}{2^{20}}\right)$

$= \left(2^{21}\right)^{10}\left(\frac{1-\frac{1}{2^{21}}}{1-\frac{1}{2}}\right) = (2^{21})^9\ 2(2^{21} - 1) = 2^{211} - 2^{190}$

82. A

Sol. For x axis $\vec{r} = a_1\hat{i} \Rightarrow \vec{n}\cdot\hat{i} = \frac{q}{a_1}$

$\vec{n}\cdot\hat{j} = \frac{q}{a_2}$

$\vec{n}\cdot\hat{k} = \frac{q}{a_3}$

$\vec{n} = \left(\vec{n}\cdot\hat{i}\right)\hat{i} + \left(\vec{n}\cdot\hat{j}\right)\hat{j} + \left(\vec{n}\cdot\hat{k}\right)\hat{k}$

$\vec{n} = \frac{q}{a_1}\hat{i} + \frac{q}{a_2}\hat{j} + \frac{q}{a_3}\hat{k}$

83. D

Sol. Probability that matrix is symmetric = $\frac{7^6}{7^9} = \frac{1}{7^3}$

Again that matrix is skew symmetric = $\frac{7^3}{7^9} = \frac{1}{7^6}$

One matrix containing all elements = 0; is common in both type of matrices

Required probability = $\frac{1}{7^3} + \frac{1}{7^6} - \frac{1}{7^9}$

84. C

Sol. $\because$ Plane contains the line $\frac{x-1}{2} = \frac{y+2}{-3} = \frac{z}{5}$

a(x – 1) + b(y + 2) + cz = 0 ..... (1)
2a – 3b + 5c = 0 ..... (2)
a – b + c = 0 ..... (3)
Required plane is 2x + 3y + z + 4 = 0

85. C

Sol. $(abc + abd + acd + bcd)^{10}$

$= a^{10}b^{10}c^{10}d^{10}\left(\frac{1}{a}+\frac{1}{b}+\frac{1}{c}+\frac{1}{d}\right)^{10}$

$\therefore$ Coefficient of $a^8b^4c^9d^9$ = coefficient of $a^{-2}b^{-6}c^{-1}d^{-1}$ in $\left(\frac{1}{a}+\frac{1}{b}+\frac{1}{c}+\frac{1}{d}\right)^{10}$ = 2520

86. C

Sol. By Venn diagram $P\left(C\cap\left(\overline{A\cup B}\right)\right)=1-\left(\frac{1}{10}+\frac{1}{15}+\frac{1}{5}\right)=\frac{19}{30}$

87. D

Sol. abc = 1 in 1 ways
abc = 2, 3, 5, 7, 11 in 15 ways
abc = 4, 9 in 12 ways
abc = 8 in 10 ways
abc = 6, 10 in 18 ways
So, total number of solution is 56

88. B

Sol. Let the roots be $\alpha_1, \alpha_2, ..., \alpha_8$

$\Rightarrow \alpha_1+\alpha_2+.....+\alpha_8=4$, $\alpha_1\alpha_2.....\alpha_8=\frac{1}{2^8}$

$\Rightarrow (\alpha_1\alpha_2 ..... \alpha_8)^{\frac{1}{8}}=\frac{1}{2}=\frac{\alpha_1+\alpha_2+.....+\alpha_8}{8}$

$\Rightarrow$ AM = GM $\Rightarrow$ all the roots are equal to $\frac{1}{2}$

$\Rightarrow a_1=-\,{}^8C_7\left(\frac{1}{2}\right)^7=-\frac{1}{2^4}$

$\Rightarrow a_2={}^8C_6\left(\frac{1}{2}\right)^6=\frac{7}{2^4}$

89. C

Sol. Let Z = a + ib, b $\neq$ 0 where Im Z = b
$Z^5 = (a + ib)^5 = a^5 + {}^5C_1a^4bi + {}^5C_2a^3b^2i^2 + {}^5C_3a^2b^3i^3 + {}^5C_4ab^4i^4 + i^5b^5$

$\text{Im } Z^5 = 5a^4b - 10a^2b^3 + b^5$

$y=\frac{\text{Im}Z^5}{\text{Im}^5 Z}=5\left(\frac{a}{b}\right)^4-10\left(\frac{a}{b}\right)^2+1$

Let $\left(\frac{a}{b}\right)^2=x(\text{say}),\ x\ge 0$

$y=5x^2-10x+1=5\left[x^2-2x\right]+1=5\left[(x-1)^2\right]-4$

Hence, $y_{\min}=-4$

90. A

Sol. $x^2 + 1 = (x + i)(x - i)$
b = 1, a = c
Number of ways of choosing a, b, c = 10 = 10 × 1
$\therefore$ K = 1

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JEE (Advanced)-2020

PAPER – 1

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. BD

Sol. Length $\propto G^x c^y h^z$

$$L = \left[M^{-1}L^3T^{-2}\right]^x \left[LT^{-1}\right]^y \left[ML^2T^{-1}\right]^z$$

By comparing the power of M, L and T in both sides we get

$-x + z = 0, 3x + y + 2z = 1$ and $-2x - y - z = 0$

By solving above three equations we get

$$x = \frac{1}{2}, y = -\frac{3}{2}, z = \frac{1}{2}$$

2. BCD

Sol. Sign between *x* and *t* is $\oplus$ hence wave is propagating in negative *x* direction.

$$\text{wave velocity} = \frac{\text{coefficient of t}}{\text{coefficient of x}} = \frac{3}{1}$$

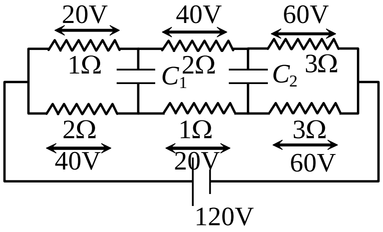
Max value of *y* is amplitude, *y* has maximum value when denominator is least i.e. when $(x + 3t)^2$ is zero

$$y = 3m$$

shape of pulse is given by $y = \dfrac{6}{2 + x^2}$ $(t = 0)$

shape of pulse is symmetrical out y-axis

3. BD



Sol. Now, potential difference across C_1 is 20 V and across C_2 is zero.
$\therefore$ charge stored in C_1 is 40 μC and in C_2 is zero.

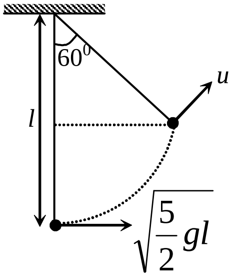
4. BC

Sol. $v^2 = a - bx^2$
differentiating both side w.r.t. time
$2v\frac{dv}{dt} = -2bx\left(\frac{dx}{dt}\right)$ $\frac{dv}{dt} = A$ (acceleration)
$A = -bx$
Hence motion will be S.H.M. $\omega^2 = b$, $4\pi^2 f^2 = b$, $f = \frac{\sqrt{b}}{2\pi}$
$\text{T.E.} = \frac{1}{2}m\omega^2 (\text{Amplitude})^2 = \frac{1}{2}m\,b\,\frac{a}{b} = \frac{1}{2}ma$

5. BD

Sol. Stopping potential does not depend on intensity and saturation current depends on intensity. Intensity I due to point source $\propto \frac{1}{r^2}$ where r is distance from the source.

6. ABCD



Sol. $T - mg\cos 60^0 = \frac{mv^2}{l}$ … (i)
$\frac{1}{2}m\left(\sqrt{\frac{5}{2}gl}\right)^2 - mg\frac{l}{2} = \frac{1}{2}mv^2$ … (ii)
$v = \sqrt{\frac{3}{2}gl}$ and $T = 2mg$
Net force is in horizontal direction when $\theta = 60^0$

7. ABCD

Sol. $\vec{F} = 3\hat{i} - 4\hat{j}, W_{con.f} = U_i - U_f = 34 - 9 = 25\ \&\ \frac{1}{2}mv^2 - 16 = 34$

8. B

Sol. $Q_{outside}$ = earthed plate will have zero charge on outer surface for its zero potential condition.

9. B

Sol. Earthed plate will have zero charge on outer surface for its zero potential condition.

10. A

Sol. $Q_{outside} = (Q_1+Q_2)/2$, and conservation of charge.

11. C

Sol. $P = \dfrac{\rho RT}{M}$

12. B

Sol. VT = constant

$\Rightarrow$ PV^2 = constant

Thus, $\Delta W = \dfrac{nR(T_2 - T_1)}{1-2}$

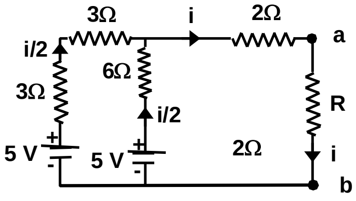
13. D

Sol. $\Delta U = 0$

$\Rightarrow$ $\Delta T = 0$, process is isothermal.

SECTION – B

14. 7



Sol. Given, voltage V = (100 ± 5)V

Current I = (10 ± 0.2)A

According to Ohm's law, V = IR or R = V/I

Taking log of both sides,

Log R = log V – log I

Differentiating, we get

$$\frac{\Delta R}{R} = \frac{\Delta V}{V} - \frac{\Delta I}{I}$$

For maximum error, $\dfrac{\Delta R}{R} = \dfrac{\Delta V}{V} + \dfrac{\Delta I}{I}$

Multiplying both sides by 100 for taking percentage, we get

$$\frac{\Delta R}{R} \times 100 = \frac{\Delta V}{V} \times 100 + \frac{\Delta I}{I} \times 100$$

Percentage error in resistance R

$$= \frac{\Delta V}{V} \times 100 + \frac{\Delta I}{I} \times 100$$

$$= \frac{5}{100} \times 100 + \frac{0.2}{10} \times 100 = 7\%.$$

15. 5

Sol. $5 = \dfrac{i}{2}(6) + i(2) + iR$

$\Rightarrow$ $5 = 3i + 2i + iR$

$\Rightarrow$ $i = \dfrac{5}{5+R}$

$$P = i^2R = \left(\frac{5}{5+R}\right)^2 R$$

$P = i^2R$

$$\frac{dP}{dR} = 0$$

$$R = 5\Omega.$$

16. 3

Sol. $PT^2 = k$

$$\gamma = \frac{1}{V}\left(\frac{dV}{dT}\right) \qquad \ldots(i)$$

$$\left(\frac{nRT}{V}\right)T^2 = k$$

$$\Rightarrow \frac{T^3}{V} = k'$$

$$\Rightarrow V = \frac{T^3}{k'} \qquad \ldots(ii)$$

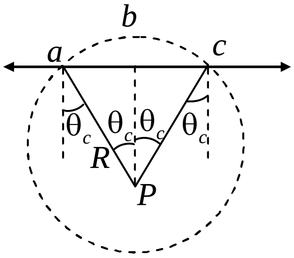
$$\frac{dV}{dT} = \frac{3T^2}{K'} \qquad \ldots(iii)$$

From (i), (ii) and (iii)

$$\gamma = \left(\frac{k'}{T^3}\right)\times\left(\frac{3T^2}{k'}\right) = \frac{3}{T}$$

17. 1

Sol. The light escape is confined within a cone of apex angle '$2\theta_c$' where θ_c is the critical angle. Imagine a sphere with source of light as its centre and the surface area abc is A.



$$\text{here } A = \int_0^{\theta_c} 2\pi R^2 \sin\theta\, d\theta = 2\pi R^2(1-\cos\theta_c)$$

$$= \pi R^2 \qquad \left[\therefore \theta_c = \sin^{-1}\left(\frac{\sqrt{3}}{2}\right) = 60^o\right]$$

$$\therefore \text{Power transfer} = P\times\frac{A}{4\pi R^2} = 4\times\frac{1}{4} = 1W$$

18. 2

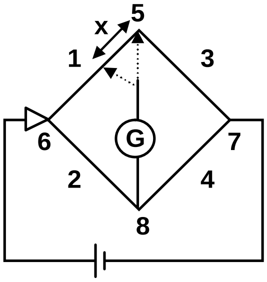
Sol. For getting null point

$$\frac{R_1}{R_3} = \frac{R_2}{R_4}$$

as R2 = R4

R1 = R3

Let the pointer at point 5 is moved to left by distance x to get nul point as shown in the figure. If resistance per unit length of wire 3 is r then that of wire 1 will be 2r.



(8 – x)2r = x × 2r + 8 × r

4x = 8

x = 2m

Chemistry PART – II

SECTION – A

19. AD
Sol. The n-factor of $(NH_4)_2Cr_2O_7$ is 6.

20. ABD
Sol. They contain weak acid and salt of strong base.

21. AB
Sol. The overall order of the reaction is 2.

22. AB
Sol. H_2 and He are lighter than CH_4.

23. AD
Sol. $2NaI + 2H_2SO_4 \longrightarrow Na_2SO_4 + SO_2 + I_2 + 2H_2O$
KBr reacts in the same way.

24. CD
Sol. Ni^{2+} contains eight and Zn^{2+} contains 10 electros.
$\therefore$ $Ni^{2+} = t_{2g}^6 e_g^2$ and $Zn^{2+} = t_{2g}^6 e_g^4$

25. ACD
Sol. It has three geometrical isomers.

26. C
Sol. Coordination number of $Na^+ = Cl^- = 6$. It has fcc lattice and Na^+ occupies the octahedral voids.

27. C
Sol. CsCl has b.c.c unit cell. The coordination number of Cs^+ is 8.

28. D
Sol. Simple cubic is a primitive unit cell. It's coordination number is 6.

29. B
Sol. $2\ HCHO \xrightarrow{NaOH} HCOONa + CH_3OH$

30. C
Sol. $C_2H_5NH_2 + HNO_2 \longrightarrow C_2H_5OH + N_2 + H_2O$

31. C
Sol. $CH_3COOH + C_2H_5OH \xrightarrow{H^+} CH_3COOC_2H_5 + H_2O$.

SECTION – B

32. 4

Sol. $\frac{r_x}{r_{SO_2}} = \sqrt{\frac{M_{SO_2}}{M_X}} \Rightarrow \frac{4\,r_{SO_2}}{r_{SO_2}} = \sqrt{\frac{64}{M_X}}$

$\therefore M_X = 4$

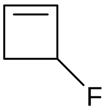
33. 6

Sol. $K_{sp} = S^2 \Rightarrow S = \sqrt{16 \times 10^{-4}} = 4 \times 10^{-2}$

$= x \times 10^{-y} \Rightarrow x + y = 4 + 2 = 6$

34. 4

Sol. The isomers are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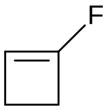
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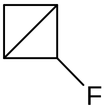
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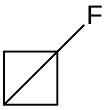


35. 3

Sol. $C_2H_5NH_2 \xrightarrow{CH_3I} C_2H_5NHCH_3 \xrightarrow{CH_3I} C_2H_5N(CH_3)_2 \xrightarrow{CH_3I} (C_2H_5)N^+(CH_3)_2 I^-$

36. 4

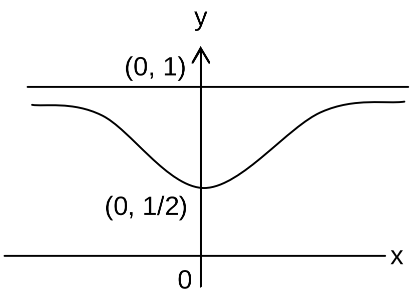
Sol. The unit cell F.C.C is formed by S^{2-} ions. Zn^{2+} occupies half of the tetrahedral voids.

Mathematics PART – III

SECTION – A

37. BCD

Sol. Domain is $x \in R$



Also $f(x) = \left[\cos\left(\tan^{-1}(\sin\theta)\right)\right]^2$

where $\cot\theta = x$

$$= \left[\cos\left(\tan^{-1}\left(\frac{1}{\sqrt{1+x^2}}\right)\right)\right]^2$$

$$= (\cos\phi)^2 \text{ where } \tan\phi = \frac{1}{\sqrt{1+x^2}} = \left(\frac{\sqrt{1+x^2}}{\sqrt{2+x^2}}\right)^2$$

$$f(x) = \frac{1+x^2}{2+x^2} = 1 - \frac{1}{2+x^2}$$

Range is $\left[\frac{1}{2}, 1\right); f'(x) = \frac{2x}{\left(2+x^2\right)^2}$

Hence $f'(0) = 0$

Also $\lim\limits_{x\to\infty} f(x) = 1$

Hence (B), (C), (D)

38. ABCD

Sol. We have $\alpha\left(\hat{i} - 3\hat{k}\right) + \beta\left(2\hat{i} + \hat{j}\right) + \gamma\left(\hat{i} - \hat{j} + \hat{k}\right) = -2\hat{i} - 5\hat{j} + 6\hat{k}$

On comparing, we get

$\alpha + 2\beta + \gamma = -2$ ………(i)

$\beta - \gamma = -5$ ……….(ii)

$-3\alpha + \gamma = 6$ ……….(iii)

Solving the equations (i), (ii) and (iii), we get

$\alpha = -1, \beta = -2, \gamma = 3$

39. CD

Sol. $\left(\alpha, \alpha^2\right)$ lie on the parabola $y = x^2$

$\left(\alpha, \alpha^2\right)$ must lie between the asymptotes on hyperbola

$\frac{x^2}{1} - \frac{y^2}{4} = 1$ in 1st and 2nd quadrant.

$\therefore$ Asymptotes are $y = \pm 2x$.

$\Rightarrow$ $2\alpha < \alpha^2$

$\Rightarrow$ $\alpha < 0$ or $\alpha > 2$

and $-2\alpha < \alpha^2$

$\alpha < -2$ or $\alpha > 0$

$\therefore$ $\alpha \in (-\infty, -2)$ or $\alpha \in (2, \infty)$

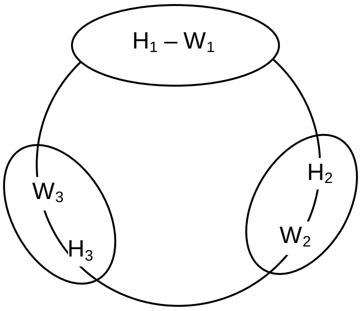
40. BC

Sol. n (All couples are together)

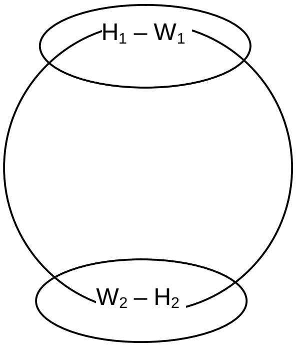
$= 2 \times 2 \times 2 \times 2 = 16$ ways

$\therefore$ $x =$ Total – 16

$x = 5! - 16 = 104$



To find y, first Let H_1, W_1, H_2, W_2 sit in $2 \times 2 = 4$ ways



Now H_3, and W_3 can sit in 2 ways

$\therefore y = 4 \times 2 = 8$

41. A

Sol. $\left(9 + 4\sqrt{5}\right)^n = I + f$

Let $\left(9 - 4\sqrt{5}\right)^n = f'$

$I + f + f' = \left(9 + 4\sqrt{5}\right)^n + \left(9 - 4\sqrt{5}\right)^n$

= Even integer

$0 < f + f' < 2$

$\therefore$ I is an odd integer

$\Rightarrow (a)$

42. ABCD

Sol. Now, applying $C_3 \to C_3 - g(\theta)C_1 - f(\theta)C_2$

$$\begin{vmatrix} f(\alpha) & g(\alpha) & f(\alpha+\theta) \\ f(\beta) & g(\beta) & f(\beta+\theta) \\ f(\gamma) & g(\gamma) & f(\gamma+\theta) \end{vmatrix} = 0$$

$\left[\because f(x+y) = f(x)g(y) + g(x)f(y)\right]$

43. ABC

Sol. The conditions for the existence of a solution are

1. $2\cos 2x - 1 \neq 0 \Rightarrow \cos 2x \neq \frac{1}{2} \Rightarrow 2x \neq \frac{\pi}{6}$
2. $\tan x \neq 0 \Rightarrow x \neq n\pi$
3. $\cos^2 x - 3\sin^2 x \neq 0 \Rightarrow \tan^2 x \neq \frac{1}{3} \Rightarrow x \neq \pm\frac{\pi}{6}$

As $2\cos x - 1 = 2\left(\cos^2 x - \sin^2 x\right) - 1$

$= 2\left(\cos^2 x - \sin^2 x\right) - \left(\cos^2 x + \sin^2 x\right)$

$= \cos^2 x - 3\sin^2 x$

So the given equation can be written as $b\sin x = b + \sin x$

$\Rightarrow \quad \sin x = \frac{b}{b-1}$

Which is possible if $-1 \leq \frac{b}{b-1} \leq 1$

$\Rightarrow \quad \frac{2b-1}{b-1} \geq 0$ and $\frac{1}{b-1} \leq 0$

$\Rightarrow \quad 2b - 1 \leq 0 \Rightarrow b \leq \frac{1}{2}$

But for $b = \frac{1}{2}, \sin x = -1$ which is not possible as $x \neq -\frac{\pi}{2}$.

Hence equation has a solution if $b < \frac{1}{2}$.

44. B
45. B
46. B

Sol. (for Q. 44 – 46)

$$\begin{vmatrix} 2 & 1 & 1 \\ 1 & -1 & 1 \\ \alpha & -1 & 3 \end{vmatrix} = 0 \Rightarrow \alpha = 4$$

Put $z = 0$ in P_1 and P_2

$2x + y = 1$ and $x - y = 2$

$\therefore \quad P \equiv (1, -1, 0)$

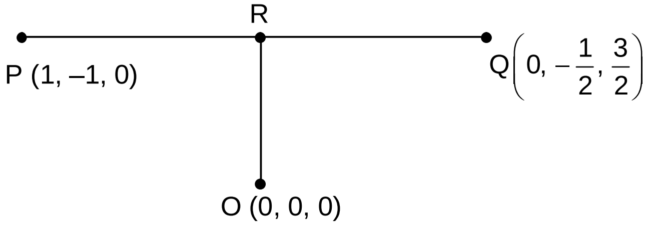
Put x = 0 in P_1 and P_2

$y + z = 1$ and $-y + z = 2$

$\therefore \ Q \equiv \left[0, -\frac{1}{2}, \frac{3}{2}\right]$

$\vec{PQ} = -\hat{i} + \frac{1}{2}\hat{j} + \frac{3}{2}\hat{k}$

Projection of PQ on x – axis $= \left|\vec{PQ}.\hat{i}\right| = 1$



Equation of line PQ is

$$\frac{x-1}{-1} = \frac{y+1}{1/2} = \frac{z}{3/2} = \lambda$$

Let $R \equiv \left(-\lambda + 1, \frac{\lambda}{2} - 1, \frac{3\lambda}{2}\right)$

$$\vec{OR}.\vec{PQ} = 0$$

$$\Rightarrow\ -1(-\lambda+1) + \frac{1}{2}\left(\frac{\lambda}{2} - 1\right) + \frac{9\lambda}{4} = 0$$

$$\Rightarrow\quad \lambda = \frac{3}{7}$$

$$\therefore\quad R \equiv \left(\frac{4}{7}, -\frac{11}{14}, \frac{9}{14}\right)$$

$$\Rightarrow\quad 7a + 14b + 14c = 2$$

$$\text{Area } = \frac{1}{2}\left[\vec{PQ} \times \vec{OQ}\right] = \sqrt{\frac{19}{16}}$$

$$\therefore\quad a - b = 3$$

47. C
48. A
49. B

Sol. (for Q. 47 – 49)

$$A^{-1} = \begin{bmatrix} 1 & 0 & 0 \\ -2 & 1 & 0 \\ 1 & -2 & 1 \end{bmatrix}$$

$$X_1 = A^{-1}\begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 \\ -2 \\ 1 \end{bmatrix}, X_2 = A^{-1}\begin{bmatrix} 2 \\ 3 \\ 0 \end{bmatrix} = \begin{bmatrix} 2 \\ -1 \\ -4 \end{bmatrix}$$

$$X_3 = A^{-1}\begin{bmatrix} 2 \\ 3 \\ 1 \end{bmatrix} = \begin{bmatrix} 2 \\ -1 \\ -3 \end{bmatrix}$$

$$\therefore\quad X = \begin{bmatrix} 1 & 2 & 2 \\ -2 & -1 & -1 \\ 1 & -4 & -3 \end{bmatrix}$$

$$\therefore\quad \det X = 3$$

$$\det A = 1$$

$$\det(\text{adj}\, X) = 3^2 = 9$$

Sum of the elements of X^{-1} is zero because $X^{-1} = \frac{1}{3}\begin{bmatrix} -1 & -2 & 0 \\ -7 & -5 & -3 \\ 9 & 6 & 3 \end{bmatrix}$

SECTION – B

50. 3

Sol. $\alpha+\beta+\gamma=c$

$\therefore \quad \alpha\beta+\beta\gamma+\gamma\alpha=4; \alpha\beta\gamma=2$

$\therefore \quad \frac{1}{\alpha}+\frac{1}{\beta}+\frac{1}{\gamma}=\frac{\alpha\beta+\beta\gamma+\gamma\alpha}{\alpha\beta\gamma}=\frac{4}{2}=2$

$\because \quad f\left(\frac{1}{\alpha}+\frac{1}{\beta}+\frac{1}{\gamma}\right)=2$

$\Rightarrow \quad f(2)=2$

$\Rightarrow \quad 8-4c+8-2=2$

$\Rightarrow \quad c = 3$

51. 3

Sol. Since maximum value of $\cos^{-1}x$ in $[0,1]=\frac{\pi}{2}, \sum_{r=1}^{k}\cos^{-1}\beta_r=\frac{k\pi}{2}$ is possible if and only if each $\cos^{-1}\beta_r=\frac{\pi}{2}\Leftrightarrow \beta_r=0$.

$A=\sum_{r=1}^{k}(\beta_r)^r=0$

Thus, $\lim_{x\to 0}\frac{(1+x)^{1/3}-(1-2x)^{1/4}}{x+x^2}$

$=\lim_{x\to 0}\frac{\left(1+\frac{x^2}{3}+0(x^4)\right)-\left(1-\frac{x}{2}+0(x^2)\right)}{x(1+x)}$

$=\lim_{x\to 0}\frac{\frac{1}{2}+\frac{x}{3}+0(x^2)}{1+x}=\frac{1}{2}$. Thus the required limit is 249.

52. 7

Sol. Position vector of orthocenter is $H\left(a\hat{i}+b\hat{j}+c\hat{k}\right)$

$\overrightarrow{AH}\perp\overrightarrow{BC}\Rightarrow\left((a-1)\hat{i}+b\hat{j}+c\hat{k}\right).\left(-2\hat{j}+3\hat{k}\right)=0$

$\Rightarrow -2b+3c=0$

$\overrightarrow{BH}\perp\overrightarrow{AC}\Rightarrow\left(a\hat{i}+(b-2)\hat{j}+c\hat{k}\right).\left(-\hat{i}+3\hat{k}\right)=0$

$\Rightarrow -a+3c=0$ and $\overrightarrow{CH}\perp\overrightarrow{AB}\Rightarrow\left(a\hat{i}+b\hat{j}+(c-3)\hat{k}\right)\left(-\hat{i}+2\hat{j}\right)=0$

$\Rightarrow -a+2b=0\Rightarrow a=2b=3c=\lambda$ (say)

$\Rightarrow H=\left(\lambda\hat{i}+\frac{\lambda}{2}\hat{j}+\frac{\lambda}{3}\hat{k}\right)$

H lies on plane ABC

So, points A, B, C and H are collinear.

$$\therefore \begin{vmatrix} 1-0 & 0-2 & 0-0 \\ 1-0 & 0-0 & 0-3 \\ 1-\lambda & 0-\frac{\lambda}{2} & 0-\frac{\lambda}{3} \end{vmatrix} = 0$$

$$\Rightarrow 6-6\lambda-\frac{2\lambda}{3}-\frac{3\lambda}{2}=0 \Rightarrow \lambda=\frac{36}{49}$$

Hence, position vector of orthocenter is $\left(\frac{36}{49}\right)\left(\text{i}+\frac{1}{2}\hat{j}+\frac{1}{3}\hat{k}\right)$.

$$\therefore \sqrt{\frac{6}{a-b-c}} = \sqrt{\frac{6}{\frac{36}{49}-\frac{18}{49}-\frac{12}{49}}} = 7$$

53. 7

Sol. Let $P(a\cos\theta_1, b\sin\theta_1), Q(a\cos\theta_2, b\sin\theta_2)$ and $R(a\cos\theta_3, b\sin\theta_3)$ be the vertices of the triangle inscribed in the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$. The points on the auxiliary circle corresponding to these points are $P'(a\cos\theta_1, a\sin\theta_1)$, $Q'(a\cos\theta_2, a\sin\theta_2)$ and $R'(a\cos\theta_3, a\sin\theta_3)$

$\therefore\ \Delta_1 =$ Area of ΔPQR

$$= \frac{1}{2}\begin{vmatrix} a\cos\theta_1 & b\sin\theta_1 & 1 \\ a\cos\theta_2 & b\sin\theta_2 & 1 \\ a\cos\theta_3 & b\sin\theta_3 & 1 \end{vmatrix}$$

$$= \frac{1}{2}ab\begin{vmatrix} \cos\theta_1 & \sin\theta_1 & 1 \\ \cos\theta_2 & \sin\theta_2 & 1 \\ \cos\theta_3 & \sin\theta_3 & 1 \end{vmatrix} \text{ and } \Delta_2 = \text{ Area of } \Delta P'Q'R'$$

$$= \frac{1}{2}\begin{vmatrix} a\cos\theta_1 & a\sin\theta_1 & 1 \\ a\cos\theta_2 & a\sin\theta_2 & 1 \\ a\cos\theta_3 & a\sin\theta_3 & 1 \end{vmatrix}$$

$$= \frac{1}{2}a^2\begin{vmatrix} \cos\theta_1 & \sin\theta_1 & 1 \\ \cos\theta_2 & \sin\theta_2 & 1 \\ \cos\theta_3 & \sin\theta_3 & 1 \end{vmatrix}$$

Clearly, $\frac{\Delta_1}{\Delta_2}=\frac{1}{7} \Rightarrow \frac{\Delta_2}{\Delta_1}=7$

54. 9

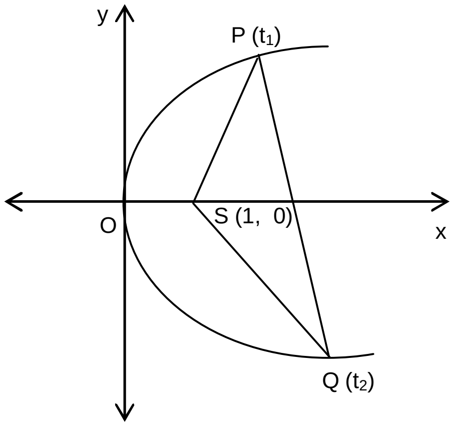
Sol. We have $3h=\left(t_1^{\ 2}+t_2^{\ 2}+1\right)$ ....(1)

$3k=2(t_1+t_2)$ ....(2)

and $t_2=-t_1-\frac{2}{t_1}$ ....(3)

$$\Rightarrow t_1 + t_2 = \frac{-2}{t_1}$$

Eliminate t_1 and t_2 to get



$$\therefore \ \frac{3k}{2} = \frac{-2}{t_1} \Rightarrow t_1 = \frac{-4}{3k}$$

$$t_2 = \frac{3k}{2} + \frac{4}{3k}$$

Substitute the values of t_1 and t_2 in (1) we get

$$3h = \frac{16}{9k^2} + \left(\frac{3k}{2} + \frac{4}{3k}\right)^2 + 1$$

$$3h = \frac{32}{9k^2} + \frac{9k^2}{4} + 5$$

$$(3x - 5)36y^2 = 128 + 81y^4$$

Hence $g = 36; k = 81$ and $w = 128$

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – I

JEE (Advanced)-2020

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **One Section**: **Section-A.**

1. ***Section–A (01 – 07, 19 – 25, 37 – 43)*** *contains 21 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (08– 14, 26 – 32, 44 – 50) *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect option is selected.

   Section–A (15 – 18, 33 – 36, 51 – 54) *contains 6 paragraphs. Each paragraph is having 2 multiple choice questions having 4 options with* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. The height at which the acceleration due to gravity decreases by 36% of its value on the surface of the earth. (The radius of the earth is R)

(A) $\frac{R}{6}$ (B) $\frac{R}{4}$

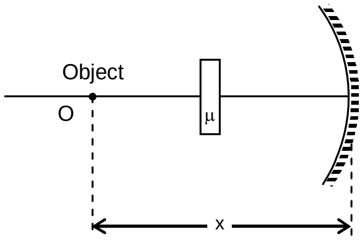
(C) $\frac{R}{2}$ (D) $\frac{2}{3}R$

2. A string of mass m is fixed at both ends. The fundamental tone oscillation are excited in the string with angular frequency ω and maximum displacement amplitude A. Find the total energy contained in the string.

(A) $\frac{1}{2}m\omega^2A^2$ (B) $\frac{1}{4}m\omega^2A^2$

(C) $\frac{1}{6}m\omega^2A^2$ (D) $\frac{1}{8}m\omega^2A^2$

3. A glass slab of thickness t = 3 cm, R.I. $\mu = \frac{3}{2}$ is placed between the object O and the concave mirror of focal length f = 4.5 cm. It is observed that the image is formed at the object. If we withdraw the slab, the image will be formed at a distance of



(A) 10 cm/11 (B) 30 cm/11

(C) 80 cm/11 (D) 90 cm/11

Space for Rough work

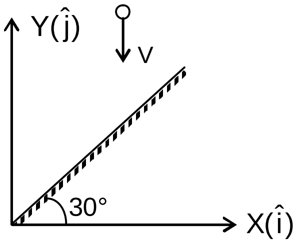
4. When a beam of accelerated electrons hits a target, a continuous X-ray spectrum is emitted from the target. Which of the following wavelength is absent in the X-ray spectrum, if the X-ray tube is operating at 40.000 volts?

(A) 0.25 Å (B) 0.5 Å
(C) 1.5 Å (D) 1.0 Å

5. The electric potential between a proton and an electron is given by $V = V_0 \ln\frac{r}{r_0}$, where r_0 is a constant. Assuming Bohr's model to be applicable, write variation of r_n with n, n being the principal quantum number.

(A) $r_n \propto n$ (B) $r_n \propto 1/n$
(C) $r_n \propto n^2$ (D) $r_n \propto 1/n^2$

6. An object moves with velocity $V(-\hat{j})$ towards the inclined plane mirror as shown in figure. The velocity of the image is



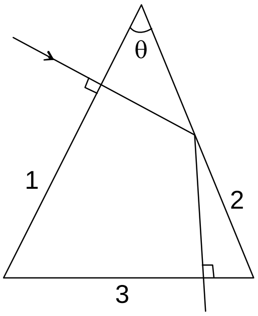
(A) $V\hat{j}$

(B) $V\frac{\sqrt{3}}{2}(-\hat{i}) + \frac{V}{2}\hat{j}$

(C) $V\frac{\sqrt{3}}{2}\hat{i} + \frac{V}{2}\hat{j}$

(D) $\frac{V}{2}(-\hat{i}) + V\frac{\sqrt{3}}{2}(\hat{j})$

7. A ray of light enters into the prism normally with the face-1 and comes out normally with the face-3. The minimum R.I. of the prism is



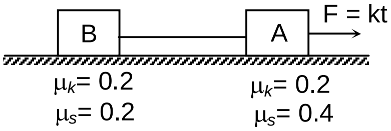
(A) cosec $\frac{\theta}{2}$ (B) tan θ
(C) sec θ (D) cosec θ

Space for Rough work

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

8. A horizontal disc rotates freely about a vertical axis through its centre. A ring, having the same mass and radius as the disc, is now gently placed on the disc. After some time, they rotate with a common angular speed.
(A) some friction exists between the disc and the ring.
(B) the angular momentum of the disc plus ring is conserved.
(C) the final common angular speed is $\frac{2}{3}$rd of the initial angular velocity of the disc.
(D) $\frac{2}{3}$ rd of the initial kinetic energy changes to heat.

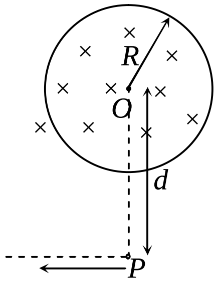


9. Two block *A* and *B* each of mass $\frac{1}{2}$ kg is connected by a massless inextensible string and kept on horizontal surface. Coefficient of friction between block and surface shown in figure. A force $F = kt$ (where *k* = 1 N/s and *t* is time in second) applied on *A.* Then (g = 10 m/s^2)
(A) work done by friction force on block *B* is zero in time interval *t* = 0 to *t* = 3s.
(B) work done by friction force on block *A* is zero in time interval *t* = 0 to *t* = 3s.
(C) work done by tension on *B* is also zero in time interval *t* = 0 to *t* = 3s.
(D) speed of blocks at *t* = 10s is 27.5 m/s.

10. If electron of the hydrogen atom is replaced by another particle of same charge but of double the mass, then:
(A) Bohr radius will increase
(B) ionisation energy of the atom will be doubled
(C) speed of the new particle in a given state will be lesser than the electron's speed in same orbit
(D) gap between energy levels will now be doubled

Space for Rough work

11. In a cylindrical region of radius R, there exists a time varying magnetic field B such that $\frac{dB}{dt} = k(>0)$. A charged particle having charge q is placed at the point P at a distance d (> R) from its centre O. Now, the particle is moved in the direction perpendicular to OP (see figure) by an external agent upto infinity so that there is no gain in kinetic energy of the charged particle. Choose the correct statement/s.



(A) Work done by external agent is $\frac{q\pi R^2}{4}k$ if d = 2R

(B) Work done by external agent is $\frac{q\pi R^2}{8}k$ if d = 4R

(C) Work done by external agent is $\frac{q\pi R^2}{4}k$ if d = 4R

(D) Work done by external agent is $\frac{q\pi R^2}{4}k$ if d = 6R

12. Two projectile are thrown at the same time from two different points. The projectile thrown from the origin has initial velocity $3\hat{i} + 3\hat{j}$ with respect to earth. The projectile has initial velocity $a\hat{i} + b\hat{j}$ with respect to earth thrown from the point (10, 5). ($\hat{i}$ is a unit vector along horizontal, $\hat{j}$ along vertical). If the projectile collides after two second, then the

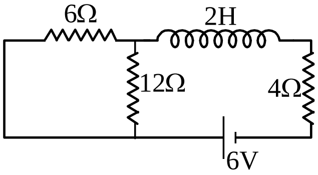
(A) value of a is -2

(B) value of a is $\frac{1}{2}$

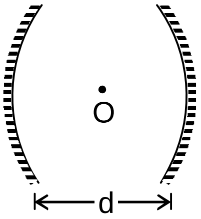
(C) value of b is $\frac{1}{2}$

(D) value of b is –2

Space for Rough work



13. For the circuit shown in the figure, which of the following statements is/are correct
(A) Its time constant is 0.25 second
(B) In steady sate, current through inductance will be equal to zero.
(C) in steady state, current through the battery will be equal to 0.75 amp.
(D) none of these



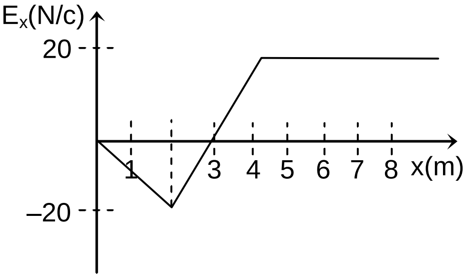
14. The distance d between two identical concave mirrors of radius of curvature R. So, as to coincide the image I on the object O itself, which is placed at the mid point can be
(A) R (B) 2R
(C) 3R (D) R/2

Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 15 and 16

A graph of the x-component of the electric field as a function of x in a region of space is shown in the figure. The y and z-components of the electric field are zero in this region. The electric potential at the origin is zero.



15. The electric potential at x = 2m is:
(A) 10 V (B) 20 V
(C) 30 V (D) 40 V

Space for Rough work

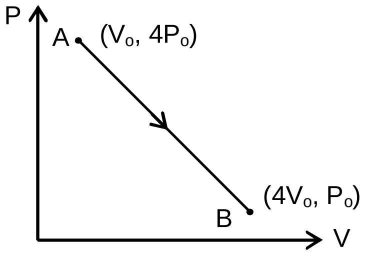
16. The greatest positive value of electric potential for points of the x-axis for which $0 \le x \le 6\text{m}$ is:

(A) 10 V (B) 20 V

(C) 30 V (D) 40 V

Paragraph for Question Nos. 17 and 18

Consider a monoatomic ideal gas undergoing a process AB as shown in figure.



17. Find the maximum temperature of the gas if temperature at A is T_o.

(A) $\frac{21}{16}T_o$ (B) $\frac{23}{16}T_o$

(C) $\frac{25}{16}T_o$ (D) $\frac{27}{16}T_o$

18. Volume at which rate of heat exchange is zero.

(A) $\frac{19}{8}V_o$ (B) $\frac{21}{8}V_o$

(C) $\frac{23}{8}V_o$ (D) $\frac{25}{8}V_o$

Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

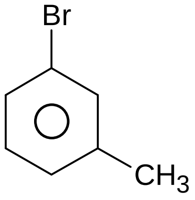
This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

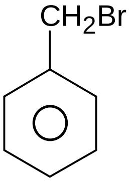
19. The incorrect statement for I_3^- ion is:
(A) The central iodine atom undergoes sp^3d hybridization
(B) It is a linear ion.
(C) The central atom contains no lone pair.
(D) The electron in the hybridized d-orbital, forms sigma bond.

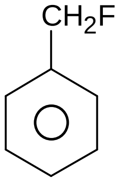
20. $HCN(aq) \rightleftharpoons H^+(aq) + CN^-(aq)$
Which of the following characteristic of the above system increases by increasing temperature?
(A) K_a (B) p^{K_a}
(C) pH (D) K_b of CN^-

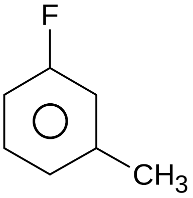
21. Which of the following characteristic of a chemical reaction decreases by increasing temperature?
(A) Temperature coefficient (B) Hal-life period
(C) Rate constant (D) Activation energy

22. Which of the following compound is most reactive towards OH^- ion through S_N1 path?

(A)


(B)


(C)


(D)


Space for Rough work

23. Aqueous solution of which of the following complex has maximum conductivity?

(A) $[Fe(H_2O)_4Cl_2]Cl$ (B) $[Fe(H_2O)_5Cl]Cl_2$

(C) $[Fe(H_2O)_6]Cl_3$ (D) $[Fe(H_2O)_3Cl_3]$

24. $CH_3CH_2NH_2 + CHCl_3 \xrightarrow{KOH} \text{Product}$

The organic product of above reaction is:

(A) CH_3CH_2CN (B) CH_3CH_2NC

(C) CH_3CH_2Cl (D) $CH_3CH_2CH_3$

25. How many coordination isomer(s) is/are possible for the following complex?

$[Cr(NH_3)_6][Co(CN)_6]$

(A) 4 (B) 7

(C) 5 (D) 8

(One or More than one correct type)

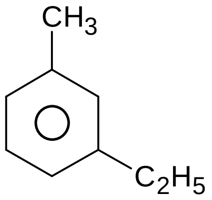
This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

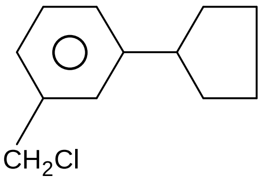
26. Which expressions are correct for a real gas at extremely high pressure?

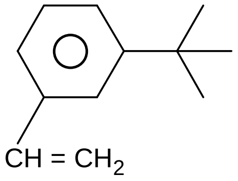
(A) $PV = RT + Pb$ (B) $Z > 1$

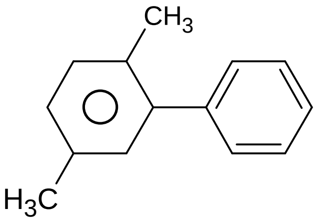
(C) $a \simeq 0$ (D) $PV > nRT$

27. Which of the following compound(s) form dicarboxylic acid(s) on alkaline permanganate oxidation?

(A)


(B)


(C)


(D)


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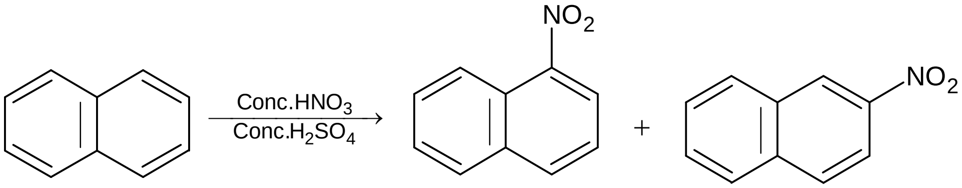
28.



Which of the following statement(s) is/are correct for the above product(s)?
(A) α-nitronaphthalene is the major product
(B) β- nitronaphthalene is the minor product
(C) for β-nitronaphthalene two of the sigma complexes display aromaticity.
(D) for α-nitronaphthalene two of the sigma complexes display aromaticity.

29. Which of the following reaction(s) undergo disproportionation?
(A) $H_3PO_3 \xrightarrow{\Delta}$
(B) $P_4 + NaOH \longrightarrow$
(C) $H_2SO_4 + C_6H_{12}O_6 \xrightarrow{\Delta}$
(D) $H_2O_2 \xrightarrow{\Delta}$

30. In which of the following reaction(s) heat is always evolved?
(A) Neutralization reactions
(B) Hydrogenation reactions
(C) Dehydration reactions
(D) Synthesis reactions

31. Which of the following property/properties of a solid change(s) due to Frenkel defect?
(A) Density decreases
(B) Melting point decreases
(C) Conductivity increases
(D) Density increases

32. At pH = 4, glycine exists as
(A) $NH_2 - CH_2 - COOH$
(B) $\overset{+}{N}H_3 - CH_2 - COO^-$
(C) $\overset{+}{N}H_3 - CH_2 - COOH$
(D) $NH_2 - CH_2 - COO^-$

Space for Rough work

Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 33 and 34

An aqueous solution of $CuSO_4$ was prepared by completely dissolving 25.52 g of anhydrous copper sulphate in 401.08 mL water. The resulting solution was electrolyzed by passing 193 ampere current for one minute through platinum electrodes. In the process, a certain amount of copper gets deposited at cathode and O_2 gas is evolved at anode.
[Mol. mass of $CuSO_4$ = 159.5 g mol^{-1}]
Answer the following questions on the basis of above write up.

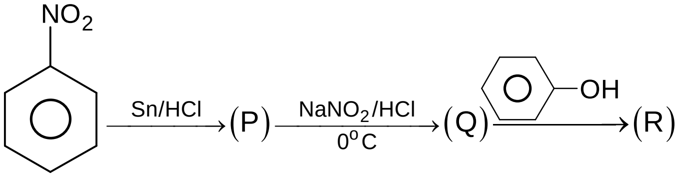
33. What is the molarity of the solution after electrolysis?

(A) 0.4 M	(B) 0.25 M
(C) 0.15 M	(D) 0.32 M

34. The mass of O_2 gas liberated at anode is:

(A) 0.32 g	(B) 0.48 g
(C) 0.96 g	(D) 0.16 g

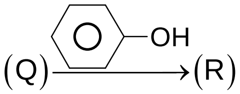
Paragraph for Question Nos. 35 and 36



Answer the following questions on the basis of above reaction sequence.

35. How many pi-bond(s) is/are present in one molecule of (R)?

(A) 4	(B) 6
(C) 7	(D) 8

36. 

The yield of (R) according to the above reaction will be maximum if the pH of the solution is:

(A) 3	(B) 4
(C) 8	(D) 13

Space for Rough work

Mathematics

PART – III

SECTION – A

(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. If $1, \alpha_1, \alpha_2, \alpha_3, \alpha_4$ are the fifth roots of unity then $\sum_{r=1}^{4} \frac{1}{2-\alpha_r} =$

(A) $\frac{51}{31}$
(B) $\frac{49}{31}$
(C) $\frac{25}{32}$
(D) $\frac{25}{16}$

38. If α, β and γ are three real roots of the equation $x^3 - 6x^2 + 5x - 1 = 0$, then the value of $\alpha^4 + \beta^4 + \gamma^4$ is:

(A) 250
(B) 650
(C) 150
(D) 950

39. If α, β, γ are roots of equation $x^3 - 2x^2 - 1 = 0$ and $T_n = \alpha^n + \beta^n + \gamma^n$, then value of $\frac{T_{11} - T_8}{T_{10}}$ is equal to

(A) 1
(B) 2
(C) –1
(D) 3

40. If $f(x) = \left(1 + \frac{1}{x}\right)^x$ then $\lim_{n \to \infty} \left\{ f\left(\frac{1}{n}\right).f\left(\frac{2}{n}\right).f\left(\frac{3}{n}\right)....f\left(\frac{n}{n}\right) \right\}^{1/n}$ equals:

(A) $\sqrt{2}e$
(B) $\sqrt{2e}$
(C) $2\sqrt{e}$
(D) $\sqrt{e}$

Space for Rough work

41. If it is known that $f'\left(\frac{2^x - 2^{-x}}{2^x + 2^{-x}}\right) > 0 \,\forall\, x \in R$, then function $g(x) = f\left(e^x\right)$ is necessarily increasing on:

(A) $x \in \left(-\frac{1}{2}, \frac{1}{2}\right)$ (B) $x \in \left(\frac{1}{2}, \infty\right)$

(C) $x \in (-\infty, 0)$ (D) $x \in (-\infty, e)$

42. For the line $\frac{x-1}{1} = \frac{y-2}{2} = \frac{z-3}{3}$, which one of the following is incorrect?

(A) it lies in the plane $x - 2y + z = 0$

(B) it is same as line $\frac{x}{1} = \frac{y}{2} = \frac{z}{3}$

(C) it passes through (2, 3, 5)

(D) it is parallel to the plane $x - 2y + z - 6 = 0$

43. From a pack of 52 playing cards; half of the cards are randomly removed without looking at them. From the remaining cards, 3 cards are drawn randomly. The probability that all are king

(A) $\frac{1}{(25)(17)(13)}$ (B) $\frac{1}{(25)(15)(13)}$

(C) $\frac{1}{(52)(17)(13)}$ (D) $\frac{1}{(13)(51)(17)}$

Space for Rough work

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

44. For $k \in N$, let $b_k = \int_1^e \frac{1}{(k+\log x)(k+1+\log x)} \frac{dx}{x}$ and $a_n = \sum_{k=1}^{n} b_k$. Then

(A) $b_k = \log\left(\frac{(k+1)^2}{k(k+2)}\right)$
(B) $a_n = \log\left(\frac{2n+2}{n+2}\right)$
(C) $\lim_{n\to\infty} a_n = \log 2$
(D) $\lim_{n\to\infty} a_n < 1$

45. There exists a triangle ABC satisfying

(A) $\tan A + \tan B + \tan C = 0$
(B) $\frac{\sin A}{2} = \frac{\sin B}{3} = \frac{\sin C}{7}$
(C) $(a+b)^2 = c^2 + ab$ and $\sqrt{2}(\sin A + \cos A) = \sqrt{3}$
(D) $\sin A + \sin B = \frac{\sqrt{3}+1}{2}$, $\cos A \cos B = \frac{\sqrt{3}}{4} = \sin A \sin B$

46. Let $\vec{a}$, $\vec{b}$ and $\vec{c}$ be vectors forming right hand triad. Let $\vec{p} = \frac{\vec{b}\times\vec{c}}{[\vec{a}\ \vec{b}\ \vec{c}]}$, $\vec{q} = \frac{\vec{c}\times\vec{a}}{[\vec{a}\ \vec{b}\ \vec{c}]}$ and $\vec{r} = \frac{\vec{a}\times\vec{b}}{[\vec{a}\ \vec{b}\ \vec{c}]}$. If $x \in R^+$, then

(A) $x[\vec{a}\ \vec{b}\ \vec{c}] + \frac{[\vec{p}\ \vec{q}\ \vec{r}]}{x}$ has least value 2
(B) $x^4[\vec{a}\ \vec{b}\ \vec{c}]^2 + \frac{[\vec{p}\ \vec{q}\ \vec{r}]}{x^2}$ has least value $\left(\frac{3}{2^{\frac{2}{3}}}\right)$
(C) $[\vec{p}\ \vec{q}\ \vec{r}] > 0$
(D) none of the above

Space for Rough work

47. The solution of $y_1\left(x^2y^3+xy\right)=1$ is

(A) $\frac{1}{x}=2-y^2+Ce^{-y^2/2}$

(B) the solution of an equation which is reducible to linear equation

(C) $\frac{2}{x}=1-y^2+e^{-y/2}$

(D) $e^{y^2/2}\left(\frac{1-2x}{x}+y^2\right)=C$

48. Consider the functions $f(x)$ and $g(x)$, both defined from $R\to R$ and are defined as $f(x)=2x-x^2$ and $g(x)=x^n$ where $n\in N$. If the area between $f(x)$ and $g(x)$ in first quadrant is $\frac{1}{2}$ then n is a divisor of

(A) 12 (B) 15
(C) 20 (D) 30

49. If $S_r=\sqrt{r+\sqrt{r+\sqrt{r+\sqrt{.....\infty}}}}$, $r>0$ then which the following is/are correct.

(A) S_2,S_6,S_{12},S_{20} are in AP (B) S_4,S_9,S_{16} are irrational
(C) $(2S_4-1)^2,(2S_5-1)^2\,(2S_6-1)^2$ are in AP (D) S_2,S_{12},S_{56} are in GP

50. Let a, b, c be the sides of triangle ABC such that $2b=a+c$. If

$$\frac{2!}{1!9!}+\frac{2!}{3!7!}+\frac{1!}{5!5!}=\frac{8^a}{(2c)!},$$ then

(A) area of ΔABC is 6 (B) circumradius of ΔABC is 5
(C) inradius of ΔABC is 1 (D) ΔABC is right angled triangle

Space for Rough work

Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 51 and 52

Suppose f, g and h be three real valued functions defined on R. Let
$f(x) = 2x + |x|$, $g(x) = \frac{1}{3}(2x - |x|)$ and $h(x) = f(g(x))$

51. The range of the function $k(x) = 1 + \frac{1}{\pi}\left(\cos^{-1}(h(x)) + \cot^{-1}(h(x))\right)$ is equal to:

(A) $\left[\frac{1}{4}, \frac{7}{4}\right]$ (B) $\left[\frac{5}{4}, \frac{11}{4}\right]$

(C) $\left[\frac{1}{4}, \frac{5}{4}\right]$ (D) $\left[\frac{7}{4}, \frac{11}{4}\right]$

52. The domain of definition of the function $l(x) = \sin^{-1}(f(x) - g(x))$ is equal to:

(A) $\left[\frac{3}{8}, \infty\right)$ (B) $(-\infty, 1]$

(C) $\left(-\infty, \frac{3}{8}\right)$ (D) $\left(-\infty, \frac{3}{8}\right]$

Paragraph for Question Nos. 53 and 54

Each side of a square has length 4 units and its centre is at (3, 4). If one of the diagonals is parallel to the line $y = x$, then answer the following questions.

53. The radius of the circle inscribed in the triangle formed by any three vertices is:

(A) $2\sqrt{2}\left(\sqrt{2}+1\right)$ (B) $2\sqrt{2}\left(\sqrt{2}-1\right)$

(C) $2\left(\sqrt{2}+1\right)$ (D) none of these

54. The radius of the circle inscribed in the triangle formed by any two vertices of square and the centre is:

(A) $2\left(\sqrt{2}-1\right)$ (B) $2\left(\sqrt{2}+1\right)$

(C) $\sqrt{2}\left(\sqrt{2}-1\right)$ (D) none of these

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – I

JEE (Advanced)-2020

PAPER – 2

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. B

Sol. $g' = \frac{g}{\left[1+\frac{h}{R}\right]^2}$

2. B

Sol. y = A sin (kx) cos (ωt)

$k = \frac{2\pi}{\lambda} = \frac{\pi}{\ell}$

$\ell \rightarrow$ length of sting

U = $\int dU$

$= \int_{x=0}^{x=\ell} \frac{1}{2}(dm)\,\omega^2 A^2 \sin^2\left(\frac{\pi x}{\ell}\right)$ and $dm = \frac{m}{\ell}dx$

3. D

Sol. $\frac{1}{v} - \frac{1}{10} = -\frac{2}{9}$

4. A

Sol. $\lambda_{min} = \frac{12375}{40,000} = 0.30$ Å. Hence wavelength less than 0.30 Å is not possible.

5. A

Sol. Potential energy U = eV = $eV_0 \ln\frac{r}{r_0}$

$\therefore$ Force $F = \left|\frac{dU}{dt}\right| = \frac{eV_0}{r}$.

$\therefore$ The force will provide the necessary centripetal force.

Hence, $\frac{mv^2}{r} = \frac{eV_0}{r} \Rightarrow v = \sqrt{\frac{eV_0}{m}}$ …(i)

and $mvr = \frac{nh}{2\pi}$ …(ii)

From equations (i) and (ii), $mr = \left(\frac{nh}{2\pi}\right)\sqrt{\frac{m}{eV_0}}$ or $r \propto n$.

6. B

Sol. $\vec{v}$ = 2V cos 30° sin 30° $(-\hat{i})$ + V(cos^2 30° – sin^2 30°) $\hat{j}$

7. D

Sol. $\mu_{\text{minima}} = \frac{1}{\sin\theta}$ = cosec θ

8. ABD

Sol. By conservation of angular momentum,

$$I_1\omega_i = (I_1 + I_2)\omega_f$$

$$\omega_f = \omega_1/3$$

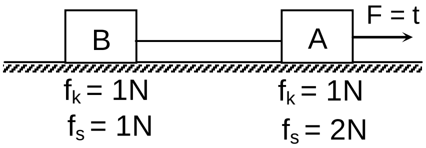
$$E_i = \frac{1}{2}I_1\omega_i^2$$

$$E_f = \frac{1}{2}(I_1 + I_2)\omega_f^2$$

Ratio of the heat produced to initial kinetic energy $= \frac{E_i - E_f}{E_i} = \frac{2}{3}$

9. ABC

Sol. When *t* = 3s block just about to move and acceleration of block given by $a = \frac{t-2}{1}$ *t* > 3



$$\int_0^v dv = \int_3^{10} (t-2)\,dt$$

$$v = \frac{t^2}{2} - 2t\Big|_3^{10} = (50-20) - \left(\frac{9}{2} - 6\right)$$

$$= 30 + 1.5 = 31.5 \text{ m/s}$$

10. BD

Sol. $E \propto m$ and $r \propto \dfrac{1}{m}$

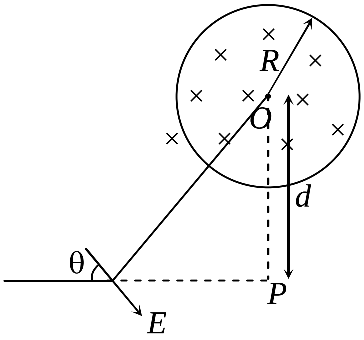
11. ACD

Sol. $\int \vec{E}\cdot d\vec{l} = A\dfrac{dB}{dt}$

$E2\pi\sqrt{x^2+d^2} = \pi R^2 k$

$E = \dfrac{\pi R^2 k}{2\sqrt{x^2+d^2}}$

$W_{ext} = \int_0^\infty q\vec{E}\cdot dx = \dfrac{q\pi R^2}{4}k$



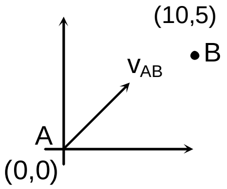
12. AC

Sol. $\vec{v}_{AB} = (3-a)\hat{i} + (3-b)\hat{j}$

$\vec{a}_{AB} = \vec{o}$

$(3-a)\times 2 = 10$ and $(3-b)\times 2 = 5$

a = –2 and b = $\dfrac{1}{2}$



13. AC

Sol. $\tau = \dfrac{L}{Req} = \dfrac{2}{8} = \dfrac{1}{4}$

at steady state inductor short circuited

Hence i = 0.75

14. AB

Sol. $\dfrac{1}{v} + \dfrac{1}{u} = \dfrac{1}{f}$

15. C

Sol. $\Delta V = -\int E_x dx =$ Area under $E_x - x$ graph.

16. C

Sol. $\Delta V = -\int E_x dx =$ Area under $E_x - x$ graph.

17. C

Sol. $P = 5P_o - \dfrac{P_o V}{V_o}$

$T = \dfrac{1}{nR}\left(5P_o V - \dfrac{P_o V^2}{V_o}\right)$

$$\frac{dT}{dV} = \frac{1}{nR}\left(5P_o - \frac{2P_oV}{V_o}\right) = 0$$

$$\Rightarrow \; V = \frac{5V_o}{2} \text{ at maximum temperature.}$$

$$\Rightarrow \; T_{max} = \frac{25}{16}T_o$$

18. D

Sol. $\frac{dQ}{ndT} = C_v + \frac{P}{n}\frac{dV}{dT} = 0$

$$C_V + \frac{\left(5P_o - \frac{P_oV}{V_o}\right)}{n} \cdot \frac{nR}{\left(5P_o - \frac{2P_oV}{V_o}\right)} = 0$$

$$\frac{\left(5 - \frac{V}{V_o}\right)}{\left(5 - \frac{2V}{V_o}\right)} = -\frac{3}{2}$$

$$\Rightarrow \; V = \frac{25}{8}V_o$$

Chemistry PART – II

SECTION – A

19. C
Sol. It is a linear molecule and contains three lone pairs.

20. A
Sol. $p^{K_a} = -\log K_a, K_b = \frac{k_w}{k_a}$

21. B
Sol. $t_{½}$ is inversely proportional to rate constant(k). k increases by increasing temperature.

22. B
Sol. Benzyl halides undergo S_N1 and S_N2 reactions with equal extent.

23. C
Sol. It forms maximum number of ions.

24. B
Sol. It is called carbylamine reaction.

25. C
Sol. Five coordination isomers are possible because
$[Cr(NH_3)_3(CN)_3][Co(NH_3)_3(CN)_3]$ does not exist.

26. ABCD
Sol. P(V – b) = RT at high pressure.

27. ABD
Sol. Benzylic hydrogen is needed for oxidation of side chain.

28. ABD
Sol. α-nitronaphthalene has more stable resonating structure than β-nitronaphthalene.

29. ABD
Sol. The products are
(A) $H_3PO_4 + PH_3$, (B) $PH_3 + Na_2HPO_2$, (C) $C + H_2O$, (D) $H_2O + O_2$

30. AB
Sol. Dehydration reaction is endothermic.
Synthesis reaction may be exothermic or endothermic.

31. BC
Sol. This is due to decrease in lattice energy.

32. C
Sol. In acidic medium, glycine adopts this structure.

33. C

Sol. W = Zit, $Cu^{2+} + 2e \rightarrow Cu$

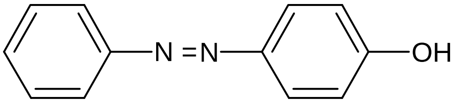
34. C

Sol. $2H_2O \longrightarrow O_2 + 4H^+ + 4e^-$

35. C

Sol.

R is



36. C

Sol. It should be moderately basic.

Mathematics PART – III

SECTION – A

37. B

Sol. $z^5 - 1 = (z-1)(z-\alpha_1)(z-\alpha_2)(z-\alpha_3)(z-\alpha_4)$

$\ln\left(z^5-1\right) = \ln(z-1) + \ln(z-\alpha_1) + \ln(z-\alpha_2) + \ln(z-\alpha_3) + \ln(z-\alpha_4)$

Differentiating

$$\frac{5z^4}{z^5-1} = \frac{1}{z-1} + \frac{1}{z-\alpha_1} + \frac{1}{z-\alpha_2} + \frac{1}{z-\alpha_3} + \frac{1}{z-\alpha_4}$$

Setting $z = 2,\ \sum_{r=1}^{4}\frac{1}{2-\alpha_r} = \frac{80}{31} - 1 = \frac{49}{31}$

38. B

Sol. $\alpha + \beta + \gamma = 6$

$\alpha\beta + \beta\gamma + \alpha\gamma = 5$

$\alpha\beta\gamma = 1$

$\Rightarrow\ \alpha^2 + \beta^2 + \gamma^2 = 26$

$\alpha^2\beta^2 + \beta^2\gamma^2 + \alpha^2\gamma^2 = 13$

39. B

Sol. $x^3 - 2x^2 - 1 = 0$ or $\alpha^3 - 1 = 2\alpha^2$

$$\therefore \frac{T_{11} - T_8}{T_{10}} = \frac{\alpha^{11} + \beta^{11} + \gamma^{11} - \left[\alpha^8 + \beta^8 + \gamma^8\right]}{\alpha^{10} + \beta^{10} + \gamma^{10}}$$

$$= \frac{\alpha^8\left(\alpha^3 - 1\right) + \beta^8\left(\beta^3 - 1\right) + \gamma^8\left(\gamma^3 - 1\right)}{\alpha^{10} + \beta^{10} + \gamma^{10}} = \frac{2\left(\alpha^{10} + \beta^{10} + \gamma^{10}\right)}{\alpha^{10} + \beta^{10} + \gamma^{10}} = 2$$

40. D

Sol. $I = \left(\lim_{n\to\infty}\prod_{k=1}^{n}\left(1 + \frac{n}{k}\right)^{k/n}\right)^{1/n}$

$\left\{\text{Given } f(x) = \left(1 + \frac{1}{x}\right)^x \text{ and } f\left(\frac{k}{n}\right) = \left(1 + \frac{n}{k}\right)^{k/n}\right\}$

Taking log,

$$\ln I = \lim_{n\to\infty}\frac{1}{n}.\sum_{k=1}^{n}\ln\left(1 + \frac{n}{k}\right)^{k/n}$$

$$= \lim_{n\to\infty}\frac{1}{n}.\sum_{k=1}^{n}\frac{k}{n}\ln\left(1 + \frac{1}{\frac{k}{n}}\right)$$

$$= \int_0^1 \underbrace{x}_{II}\underbrace{\ln\left(1 + \frac{1}{x}\right)dx}_{I}$$

$$= \ln\left(1+\frac{1}{x}\right).\frac{x^2}{2}\Bigg]_0^1 + \int_0^1 \left(\frac{1}{x}-\frac{1}{x+1}\right).\frac{x^2}{2}dx$$

$$= \frac{1}{2}\ln 2 + \frac{1}{2}\left[x - \ln(x+1)\right]_0^1$$

$$= \frac{1}{2}\ln 2 + \frac{1}{2}\left[(1-\ln 2) - 0\right] = \frac{1}{2}$$

$$I = \sqrt{e}$$

41. C

Sol. $g(x) = f\left(e^x\right)$

$g'(x) = f'\left(e^x\right)e^x$

$g'(x) > 0 \Rightarrow f'\left(e^x\right) > 0$

$\because \dfrac{2^x - 2^{-x}}{2^x + 2^{-x}} = \dfrac{2^{2x}-1}{2^{2x}+1} \in (-1, 1)$

$\Rightarrow \quad -1 < e^x < 1$

$\Rightarrow \quad x \in (-\infty, 0)$

42. C

Sol. On (1, 2, 3) satisfies the plane $x - 2y + z = 0$ and also $\left(\hat{i}+2\hat{j}+3\hat{k}\right).\left(\hat{i}-2\hat{j}+\hat{k}\right) = 0$

$\Rightarrow (a)$

Since the lines $\dfrac{x-1}{1} = \dfrac{y-2}{2} - \dfrac{z-3}{3}$ both satisfy $t+1, 2t+2$ and $3t+3$

Hence both are same $\Rightarrow (b)$.

Given lines is obviously $||$ to the plane $x - 2y + z = 6 \Rightarrow (d)$

43. A

Sol. E_1 "No card is king from removed cards"

E_2 "1 card is king from removed cards"

E_3 "2 card is king from removed cards"

E_4 "3 card is king from removed cards"

E_5 "4 card is king from removed cards"

F = 3 cards are drawn from pack those are kings.

$$P(F) = \sum_{i=1}^{S} P(E_i).P\left(\frac{F}{E_i}\right) = \frac{{}^{48}C_{26}}{{}^{52}C_{26}}.\frac{{}^{4}C_{3}}{{}^{26}C_{3}} + \frac{{}^{48}C_{25}\,.\,{}^{4}C_{1}}{{}^{52}C_{26}}.\frac{{}^{3}C_{3}}{{}^{26}C_{3}} + 0 + 0 + 0$$

$$= \frac{4}{{}^{52}C_{26}\,.\,{}^{26}C_{3}}\left({}^{48}C_{26} + {}^{48}C_{25}\right) = \frac{4 \times {}^{49}C_{26}}{{}^{52}C_{26}\,.\,{}^{26}C_{3}} = \frac{1}{(13)(17)(25)}$$

44. ABCD

Sol. Put $k + \log x = t$, then $b_k = \int_k^{k+1} \dfrac{1}{t(t+1)}dt = \int_k^{k+1}\left[\dfrac{1}{t} - \dfrac{1}{t+1}\right]dt$

$$= \log\left(\frac{k+1}{k}\right) - \log\frac{k+2}{k+1} = \log\frac{(k+1)^2}{k(k+2)}$$

$$a_n = \sum_{k=1}^{n} b_k = \sum_{k=1}^{n}\left[\log\frac{k+1}{k} - \log\frac{k+2}{k+1}\right]$$

$$= \log 2 - \log\frac{n+2}{n+1} = \log\frac{2n+2}{n+2}$$

$$\lim_{n\to\infty} a_n = \log 2 < 1$$

45. CD

Sol. (a) In a triangle ABC, $A+B+C=\pi$, so $\tan A + \tan B + \tan C = \tan A \tan B \tan C$. Since none of $\tan A, \tan B, \tan C$ can be zero, a triangle given in (a) is not possible.

(b) $\frac{(\sin A)}{2} = \frac{(\sin B)}{3} = \frac{(\sin C)}{7}$, so that by the laws of sines $\frac{a}{2} = \frac{b}{3} = \frac{c}{7} \Rightarrow \frac{a+b}{c} = \frac{5}{7}$ which is not possible, as the sum of two sides of a triangle is greater than the third.

(c) We have $(a+b)^2 = c^2 + ab$, so that $\frac{a^2+b^2-c^2}{2ab} = -\frac{1}{2}$

$\Rightarrow \cos C = -\frac{1}{2} \Rightarrow C = 120^o$ and $\sqrt{2}(\sin A + \cos A) = \sqrt{3}$

$\Rightarrow \frac{1}{\sqrt{2}}\sin A + \frac{1}{\sqrt{2}}\cos A = \frac{\sqrt{3}}{2}$

$\Rightarrow \sin\left(A + \frac{\pi}{4}\right) = \frac{\sqrt{3}}{2} \Rightarrow A + \frac{\pi}{4} = \frac{\pi}{3}$

That is, $A = \frac{\pi}{12} = 15^o$ and $B = 45^o$. Such a triangle is possible.

(d) Since $\cos A \cos B = \sin A \sin B = \frac{\sqrt{3}}{4}$, we get $\cos(A+B) = 0$, i.e. $A+B = \frac{\pi}{2}$. Also, from $\cos(A-B) = \frac{\sqrt{3}}{2}$, we get $A - B = \frac{\pi}{6}$, so that $A = \frac{\pi}{3}, B = \frac{\pi}{6}$ and

$\sin A + \sin B = \frac{\sqrt{3}}{2} + \frac{1}{2} = \frac{\sqrt{3}+1}{2}$

Hence, such a triangle is also possible.

46. AC

Sol. We have $\left[\vec{p}\ \ \vec{q}\ \ \vec{r}\right] = \frac{1}{\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right]}$

Therefore, $\left[\vec{p}\ \ \vec{q}\ \ \vec{r}\right] > 0$

(a) $x > 0,\ x\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right] + \frac{\left[\vec{p}\ \ \vec{q}\ \ \vec{r}\right]}{x} \ge 2$ (Using $AM \ge GM$)

(b) similarly, use $AM \ge GM$

47. ABD

Sol. Rewriting the given equation, we have $\frac{dx}{dy} = x^2y^3 + xy$

$\Rightarrow x^{-2}\frac{dx}{dy} - x^{-1}y = y^3$, which is reducible to linear form.

Putting $x^{-1} = u$, we have $\frac{du}{dy} + yu = -y^3$

This I.F. of this equation $e^{y^2/2}$. So the solution is

$ue^{y^2/2} = -\int y^3 e^{y^2/2}dy + C = -\left(y^2e^{y^2/2} - 2e^{y^2/2}\right) + C$

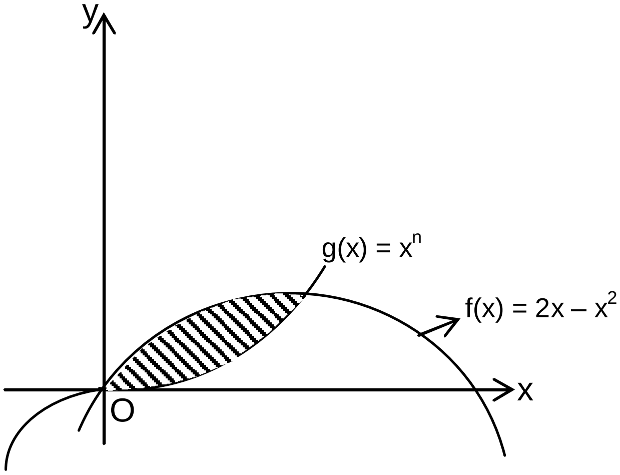
$\Rightarrow \frac{1}{x} = \left(2 - y^2\right) + Ce^{-y^2/2}$ or $(1-2x)/x = -y^2 + Ce^{-y^2/2}$

48. BCD

Sol. Solving $f(x) = 2x - x^2$ and $g(x) = x^n$

We have $2x - x^2 = x^n \Rightarrow x = 0$ and $x = 1$

$$A = \int_0^1 \left(2x - x^2 - x^n\right)dx = \left. x^2 - \frac{x^3}{3} - \frac{x^{n+1}}{n+1}\right]_0^1$$



$= 1 - \frac{1}{3} - \frac{1}{n+1} = \frac{2}{3} - \frac{1}{n+1}$

Hence, $\frac{2}{3} - \frac{1}{n+1} = \frac{1}{2} \Rightarrow \frac{2}{3} - \frac{1}{2} = \frac{1}{n+1}$

$\Rightarrow \frac{4-3}{6} = \frac{1}{n+1} \Rightarrow n+1 = 6 \Rightarrow n = 5$

Hence n is a divisor of 15, 20, 30

49. ABCD

Sol. $\because S_r = \sqrt{r + \sqrt{r + \sqrt{+\sqrt{\ldots_\infty}}}} = \sqrt{r + s_r}$

$\Rightarrow \quad S_r^{\,2} - S_r - r = 0$

$\therefore \quad S_r = \dfrac{1+\sqrt{(1+4r)}}{2} \qquad [\because r > 0]$

Alternate (a) S_2, S_6, S_{12}, S_{20} i.e. 2, 3, 4, 5 are in AP.

Alternate (b) S_4, S_9, S_{16} i.e. $\dfrac{1+\sqrt{17}}{2}, \dfrac{1+\sqrt{37}}{2}, \dfrac{1+\sqrt{65}}{2}$ are irrational

Alternate (c) $(2S_4-1)^2, (2S_5-1)^2, (2S_6-1)^2$ i.e. 17, 21, 25 are in A.P.

Alternate (d) S_2, S_{12}, S_{56} i.e. 2, 4, 8 are in G.P.

50. ACD

Sol. $\dfrac{1}{10!}\left\{ {}^{20}C_1 + 2.\ {}^{10}C_3 + {}^{10}C_5 \right\}$

$= \dfrac{{}^{10}C_1 + {}^{10}C_3 + {}^{10}C_5 + {}^{10}C_7 + {}^{10}C_9}{10!}$

$= \dfrac{2^9}{10!} = \dfrac{8^3}{(2.5)!} = \dfrac{8^n}{(2.c)!} \Rightarrow a = 3, b = 4, c = 5$

51. B

Sol. We have $f(x) = \begin{cases} 3x, & x \ge 0 \\ x, & x < 0 \end{cases}$ and $g(x) = \begin{cases} \dfrac{x}{3}, & x \ge 0 \\ x, & x < 0 \end{cases}$

Clearly f and g are inverse of each other

Now, $h(x) = f(g(x)) = \begin{cases} 3\left(\dfrac{x}{3}\right) = x, & x \ge 0 \\ x, & x < 0 \end{cases}$

As, $h(x) = x \forall x \in R$

$\Rightarrow k(x) = 1 + \dfrac{1}{\pi}\left(\cos^{-1}x + \cot^{-1}x\right)$

Domain of $k(x) = [-1, 1]$ and $k(x)$ is decreasing function on $[-1, 1]$

As $k(x)$ is continuous function on $[-1, 1]$

Now, $k_{\min}(x=1) = 1 + \dfrac{1}{\pi}\left(\cos^{-1}1 + \cot^{-1}1\right)$

$= 1 + \dfrac{1}{\pi}\left(0 + \dfrac{\pi}{4}\right) = 1 + \dfrac{1}{4} = \dfrac{5}{4}$

$k_{\max.}(x=-1) = 1 + \dfrac{1}{\pi}\left(\cos^{-1}(-1) + \cot^{-1}(-1)\right)$

$= 1 + \dfrac{1}{\pi}\left[\pi + \dfrac{3\pi}{4}\right] = 1 + \dfrac{7}{4} = \dfrac{11}{4} \Rightarrow$ Range of $k(x) = \left[\dfrac{5}{4}, \dfrac{11}{4}\right]$

52. D

Sol. We have $f(x) - g(x) = (2x + |x|) - \dfrac{1}{3}(2x - |x|)$

$$=\frac{4x}{3}+\frac{4}{3}|x|=\begin{cases}\frac{8}{3}x\ ; & x\ge 0\\ 0\ ; & x<0\end{cases}$$

$\therefore$ For domain of function, $0\le\frac{8x}{3}\le 1$

$\Rightarrow$ Domain of $I(x)=\left(-\infty,\frac{3}{8}\right]$

(Note : Range of function $I(x)=\left[0,\frac{\pi}{2}\right]$)

53. B
54. A

Sol. (Q. 53 – 54)

It is given that one of the diagonals of the square is parallel to the line $y=x$.

Also, the length of the diagonal of the square is $4\sqrt{2}$.

Hence, the equation of one of the diagonal is $\frac{x-3}{\frac{1}{\sqrt{2}}}=\frac{y-4}{\frac{1}{\sqrt{2}}}=r=\pm 2\sqrt{2}$

Hence, $x-3=y-4=\pm 2$

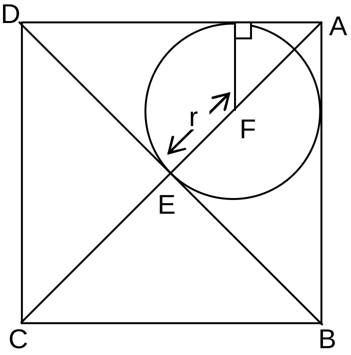
$\Rightarrow\quad x=5,1$ and $y=6,2$

Hence, two vertices are (1, 2) and (5, 6).

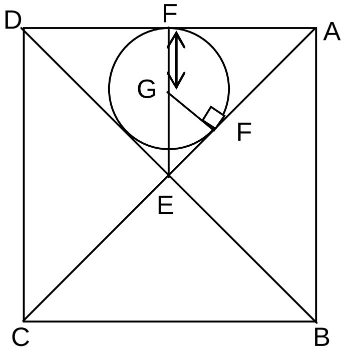
The other diagonal is parallel to the line $y=-x$, so that its equation is $\frac{x-3}{-\frac{1}{\sqrt{2}}}=\frac{y-4}{\frac{1}{\sqrt{2}}}=r=\pm 2\sqrt{2}$

Hence, the two vertices on this diagonal are (1, 6) and (5, 2).

(i)



(ii)



$AB=4,\ AC=4\sqrt{2}\qquad\Rightarrow\ AE=2\sqrt{2}$

In figure (i) $EF+FA=AE$

$\Rightarrow\quad r+\sqrt{2}r=2\sqrt{2}\qquad\Rightarrow\ r=\frac{2\sqrt{2}}{\sqrt{2}+1}=2\sqrt{2}\left(\sqrt{2}-1\right)$

In figure (ii), EG + GF = EF

$\Rightarrow\quad \sqrt{2}r+r=2\qquad\Rightarrow\ r=\frac{2}{\sqrt{2}+1}=2\left(\sqrt{2}-1\right)$

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – I

JEE (Main)-2020

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 75 questions.
- Each subject (PCM) has 25 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only three sections: **Section-A**, **Section-B and Section-C**.

Section-A (01 – 20, 26 – 45, 51 – 70) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-B (21 – 22, 46 – 47, 71 – 72) *contains 6 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

Section-C (23 – 25, 48 – 50, 73 – 75) *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

Physics

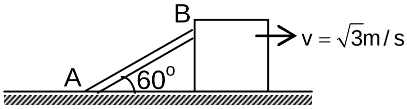
PART – I

SECTION – A

(One Options Correct Type)

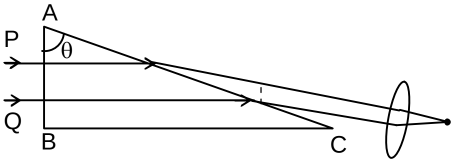
This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A rod AB is shown in figure. End A of the rod is fixed on the ground. Block is moving with velocity $\sqrt{3}$ m/s towards right. The speed of end B of the rod when rod makes an angle of 60^o with the ground is



(A) 3 m/s (B) 2 m/s
(C) 5 m/s (D) 2.5 m/s

2. Two parallel beams of light P and Q are incident normally on a prism and the transmitted rays are brought to focus with the help of convergent lens as shown in figure. If intensities of the upper and lower beams immediately after transmission from face AC are 4I and I respectively. If resultant intensity at the focus is



(A) I (B) 5I
(C) 17I (D) 9I

3. A thin prism P_1 with angle 4^o and made from glass (μ = 1.54) is combined with another prism P_2 made of another glass of μ = 1.72 to produce dispersion without deviation. The angle of prism P_2 is

(A) 53.3^o (B) 4^o
(C) 3^o (D) 2.6^o

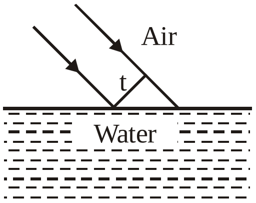
4. A light emitting diode (LED) has a voltage drop of 2V across it and passes a current of 10 mA. When it operates with a 6V battery through a limiting resistor R, the value of R is:

(A) 40 k Ω (B) 4 k Ω
(C) 200 Ω (D) 400 Ω

Space for Rough work

5. A mirror ($\mu = 3/2$) is 10 cm thick. An object is placed 15 cm in front of it. The position of image from the front surface is
(A) 15 cm
(B) 21.67 cm
(C) 28.34 cm
(D) 35 cm

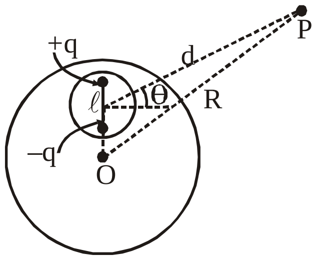
6. A monochromatic beam of width t is incident at 45° on an air water interface as shown in the figure. The refractive index of water is μ and that of air is 1. The width of the beam in water is,



(A) $(\mu - 1)$ T
(B) μ T
(C) $\frac{\sqrt{\mu^2 - 1}}{\mu}t$
(D) $\frac{\left(\sqrt{2\mu^2 - 1}\right)}{\mu}t$

7. An object is placed at a distance of 12 cm from a converging lens on its principal axis and a virtual image of certain size is formed. Now the lens is moved 4 cm away from the object and a real image of the same size as that of the (previous) virtual image is formed. The focal length in cm of the lens is:
(A) 14
(B) 16
(C) 18
(D) 20

8. A spherical cavity is created in a neutral solid conducting sphere. Inside the cavity, a dipole is placed as shown in the figure. Electrostatic potential at point P only due to charge induced on the inner surface of the cavity is (assume that $\ell << d$)

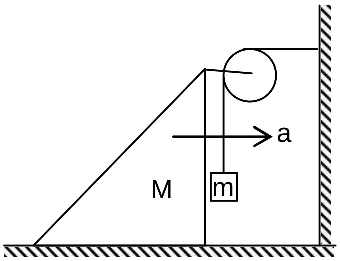


(A) $\frac{q\ell}{4\pi\varepsilon_0}\frac{\sin\theta}{d^2}$
(B) $\frac{-q\ell\sin\theta}{4\pi\varepsilon_0 d^2}$
(C) $-\frac{q\ell}{4\pi\varepsilon_0}\frac{\sin\theta}{d}$
(D) $\frac{q\ell\sin\theta}{4\pi\varepsilon_0 d}$

9. The mass of a body is measured as 10.1 kg. The possible percentage error in the measurement is
(A) ± 1%
(B) ± 0.1%
(C) ± 10%
(D) ± 0.01%

Space for Rough work

10. If wedge is moving with acceleration a as shown in the figure then value of net force on m is



(A) ma
(B) $\sqrt{2}$ ma
(C) mg
(D) zero

11. Hydrogen (H), deuerium (D), singly ionised helium $(He)^+$ and doubly ionised (Li^{++}) all have one electron round the nucleus. Consider n = 2 to n = 1 transition. The wavelength of emitted radiations are λ_1, λ_2, λ_3 and λ_4 respectively. Then approximately

(A) $\lambda_1 = \lambda_2 = 4\lambda_3 = 9\lambda_4$
(B) $4\lambda_1 = 2\lambda_2 = 2\lambda_3 = \lambda_4$
(C) $\lambda_1 = 2\lambda_2 = 2\sqrt{2}\lambda_3 = 3\sqrt{2}\lambda_4$
(D) $\lambda_1 = \lambda_2 = 2\lambda_3 = 3\lambda_4$

12. A tunnel is made across the earth passing through its centre. A ball is dropped from a height h in the tunnel. The motion will be periodic with time period

(A) $2\pi\sqrt{\frac{R}{g}} + \sqrt{\frac{2h}{g}}$
(B) $2\pi\sqrt{\frac{2R}{g}} + 4\sqrt{\frac{h}{g}}$
(C) $2\pi\sqrt{\frac{R}{g}} + 4\sqrt{\frac{2h}{g}}$
(D) $2\pi\sqrt{\frac{2R}{g}} + \sqrt{\frac{h}{g}}$

13. An open organ pipe of length l is sounded together with another organ pipe of length l + x in their fundamental tones (x << l). The beat frequency heard will be (speed of sound is v):

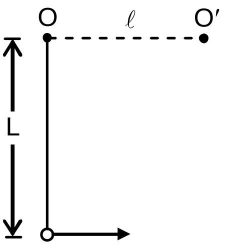
(A) $\frac{vx}{4l^2}$
(B) $\frac{4l^2}{2x}$
(C) $\frac{vx}{2l^2}$
(D) $\frac{vx^2}{2l}$

Space for Rough work

14. A rain drop of radius 1.5 mm, experiences a drag force $F = \left(2 \times 10^{-5} v\right) N$, while falling through air from a height 2km, with a velocity v. The terminal velocity of the rain drop will be nearly (use g = $10 m/s^{2-}$)

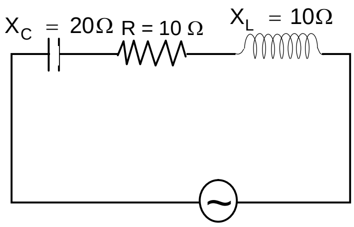
(A) 200 m/s (B) 80 m/s
(C) 4.7 m/s (D) 3 m/s

15. A particle is hanging from a fixed pint 0 by means of a string of length L. There is a small nail O′ in the same horizontal line with O at a distance $\ell(<L)$ from O. The minimum velocity with which particle should be projected from its lowest position in order that it may make a complete revolution round the nail.



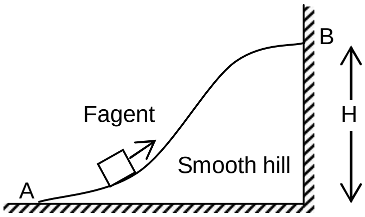
(A) $\sqrt{3gL}$ (B) $\sqrt{5gL}$
(C) $\sqrt{g(5L - 3\ell)}$ (D) $\sqrt{g(5\ell - 3L)}$

16. In LCR circuit shown in figure, then choose incorrect option



(A) Current will lead the voltage
(B) rms value of current is 20 A
(C) Power factor of the circuit is $\frac{1}{\sqrt{2}}$
(D) Voltage drop across resistance = voltage drop across inductor

17. A external agent moves the block m slowly from A to B, along a smooth hill such that every time he applies the force tangentially. Find the work done by agent in this interval.



(A) $\frac{m^2g^2H^2}{L}$ (B) $\frac{mgH^2}{L}$
(C) mg(H+L) (D) mgH

Space for Rough work

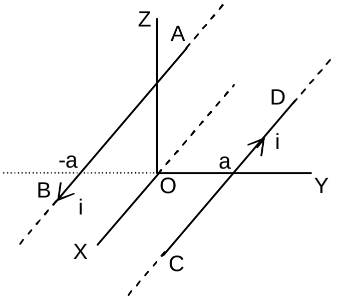
18. Two long parallel wires, AB and CD, carry equal currents in opposite directions. They lie in the xy plane, parallel to the x-axis, and pass through the points (0, –1, 0) and (0, 1, 0) respectively. The resultant magnetic field is

(A) zero on the x-axis

(B) maximum on the x-axis

(C) directed along the z-axis at the origin, but not at other points on the z-axis

(D) none of these

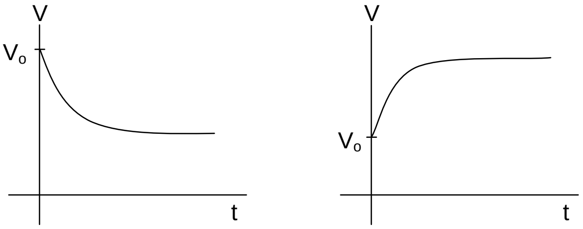


19. A tank has a hole made at its bottom. The time needed to empty the tank from level h_1 to h_2 will be proportional to

(A) $h_1 + h_2$ (B) $\sqrt{h_1} + \sqrt{h_2}$

(C) $h_1 - h_2$ (D) $\sqrt{h_1} - \sqrt{h_2}$

20. A capacitor is charged upto a potential V_o. It is then connected to a resistance R and a battery of emf E. Two possible graphs of potentials across capacitor vs time are shown.



What is the most reasonable explanation of these graphs?

(A) The first graph shows what happens when the capacitor has a lesser than E potential initially and the second shows what happens when it has a greater than E potential initially.

(B) The first graph shows what happens when the capacitor has a greater than E potential initially and the second shows what happens when it has a lesser than E potential initially.

(C) The first graph is the correct qualitative shape for any initial potential, but the second is not possible.

(D) The second graph is the correct qualitative shape for any initial potential, but the first is not possible.

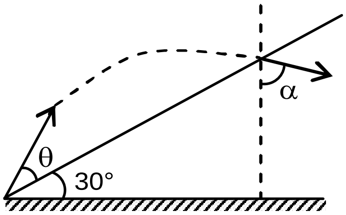
Space for Rough work

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

21. A particle is projected horizontally from the top of a tower with a velocity v_0. If v be its velocity at any instant, then the radius of curvature of the path of the particle at the point (where the particle is at that instant) is directly proportional to v^n, then find the value of 'n'.

22. A particle is projected at an angle $\theta = \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$ with the inclined plane of angle 30° with horizontal. If α is the angle that its velocity vector makes with vertical at the point of collision (with the inclined plane) if $\alpha = 5K°$. Find the value of 'K'.



SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

23. A boat which has a speed of 6 km/h in still water crosses a river of width 1 km along the shortest possible path in 20 min. The velocity of the river water in km/h is

24. A uniform solid brass sphere is rotating with angular speed ω_0 about a diameter. If its temperature is now increased by 100^0C. What will be its new angular speed (Given: $\alpha_{brass} = 2.0 \times 10^{-5} \text{per}^0\text{C}$)

25. A cube with a mass *m* = 20 *g* wettable by water floats on the surface of water. Each side of the cube has length *l* = 3 cm. The angle of contact between water and glass is zero degree and the surface tension of the water is 7.5×10^{-2} N/m. The distance between the lower face of the cube and the surface of the water is

Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

26. Which of the following molecule experiences the lowest bond pair-bond pair repulsion?

(A) BF_3 (B) CH_4

(C) $BeCl_2$ (D) NCl_3

27. 400 mL of 0.2 M NaOH solution was mixed with 500 mL of 0.2 M HCl solution. What is the molarity of H^+ in the resulting solution?

(A) $\frac{1}{90}$ (B) $\frac{1}{45}$

(C) $\frac{2}{45}$ (D) $\frac{1}{30}$

28. If the average kinetic energy of N_2 gas is x J at a certain temperature, what will be the average kinetic energy of N gas in J at the same temperature?

(A) 2x (B) $\frac{x}{2}$

(C) 4x (D) x

29. $X(g) + 2Y(g) \longrightarrow \text{Products}$

The rate equation of above reaction is given as follows:

Rate = $k[X][Y]^{0.5}$

What is the unit of rate constant of the reaction?

(A) $mol^{1/2}L^{-1/2}s^{-1}$ (B) $mol^{-1/2}L^{1/2}s^{-1}$

(C) $mol^{3/2}L^{-3/2}s^{-1}$ (D) $mol^{-3/2}L^{3/2}s^{-1}$

Space for Rough work

30. $A(s) \rightleftharpoons 2B(g) + C(\ell)$

What will be the equilibrium partial pressure of 'B' in terms of the equilibrium constant K_P?

(A) $\sqrt{K_P}$ (B) $(K_P)^2$

(C) $K_P/2$ (D) $2K_P$

31. The strongest $p\pi - d\pi$ back bonding is observed in:

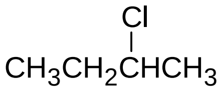
(A) CCl_4 (B) $SiCl_4$

(C) $GeCl_4$ (D) $SnCl_4$

32. Which of the following halide forms a ketone upon hydrolysis?

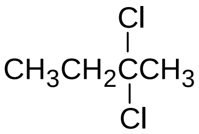
(A) $CH_3CH_2CH_2CHCl_2$

(B)



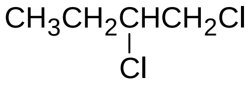
$CH_3CH_2\overset{\overset{Cl}{|}}{C}HCH_3$

(C)



$CH_3CH_2\underset{\underset{Cl}{|}}{\overset{\overset{Cl}{|}}{C}}CH_3$

(D)



$CH_3CH_2\underset{\underset{Cl}{|}}{C}HCH_2Cl$

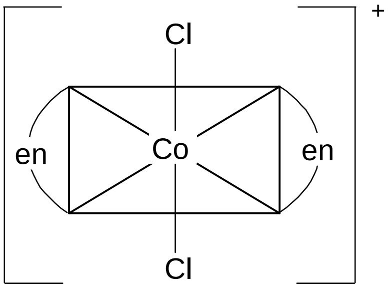
33. Which of the following aqueous solution is colourless?

(A) $CuSO_4$ (B) $Zn(NO_3)_2$

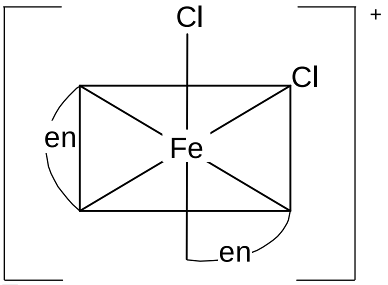
(C) $FeCl_2$ (D) $KMnO_4$

34. Which of the following complex displays optical isomerism?

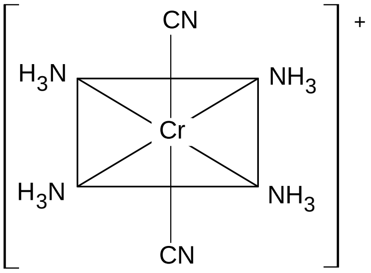
(A)



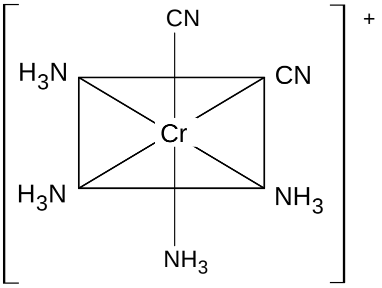
(B)



(C)



(D)



Space for Rough work

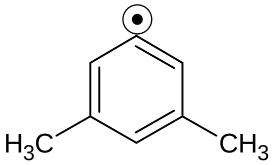
35. Which of the following interhalogen compound does NOT exist?

(A) ICl_3 (B) FCl_3

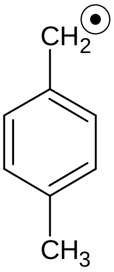
(C) IF_5 (D) IF_7

36. Which of the following free radical is most stable?

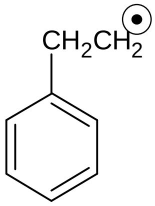
(A)



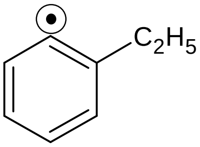
(B)



(C)

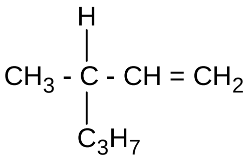


(D)



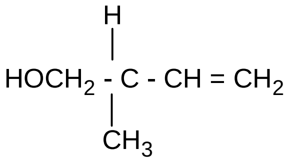
37. Which compound loses its optical activity due to hydrogenation reaction in presence of nickel?

(A)



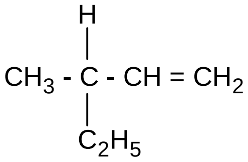
$CH_3-\underset{C_3H_7}{\overset{H}{C}}-CH=CH_2$

(B)



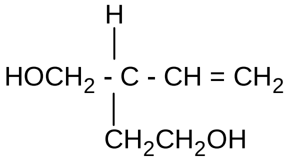
$HOCH_2-\underset{CH_3}{\overset{H}{C}}-CH=CH_2$

(C)



$CH_3-\underset{C_2H_5}{\overset{H}{C}}-CH=CH_2$

(D)



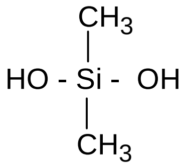
$HOCH_2-\underset{CH_2CH_2OH}{\overset{H}{C}}-CH=CH_2$

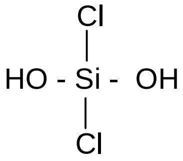
Space for Rough work

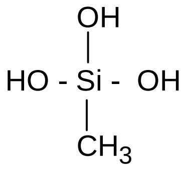
38. Which of the following substance cannot form silicate when reacts with silica(SiO_2)?
(A) NaOH (B) Na_2CO_3
(C) Na_2O (D) $NaNO_3$

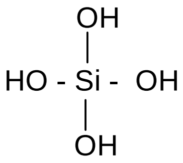
39. The compound formed by the reaction between borazine($B_3N_3H_6$) and HCl is:
(A) $B_3N_3H_7Cl$ (B) $B_3N_3H_8Cl_2$
(C) $B_3N_3H_9Cl_3$ (D) $B_3N_3H_{10}Cl_4$

40. Heating of which substance forms silica gel?

(A) 
$\mathrm{HO-\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{Si}}-OH}$

(B) 
$\mathrm{HO-\overset{\displaystyle Cl}{\underset{\displaystyle Cl}{Si}}-OH}$

(C) 
$\mathrm{HO-\overset{\displaystyle OH}{\underset{\displaystyle CH_3}{Si}}-OH}$

(D) 
$\mathrm{HO-\overset{\displaystyle OH}{\underset{\displaystyle OH}{Si}}-OH}$

41. Which of the following is NOT a property of borax?
(A) It is soluble in water
(B) It is crystallized from aqueous solution as a decahydrated salt
(C) It's anion undergoes hydrolysis in water
(D) On heating it forms sodium boride

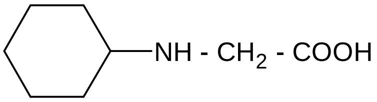
42. Which of the following group exerts electronic effects only due to sigma electrons?
(A) OH (B) CH_3
(C) NO_2 (D) CN

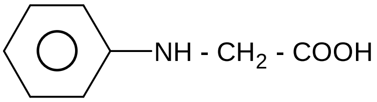
43. Which of the following compound is paramagnetic in nature?
(A) OCl_2 (B) ClO_2
(C) Cl_2O_3 (D) Cl_2O_5

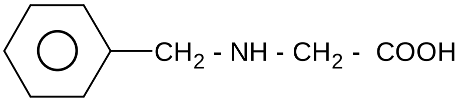
Space for Rough work

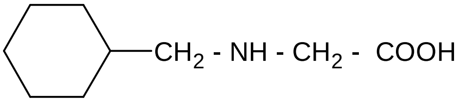
44. Which of the following is most reactive towards CH_3ONa?
(A) $CH_3COOC_2H_5$ (B) CH_3COCl
(C) CH_3CONH_2 (D) $CH_3COOCOCH_3$

45. Which of the following amino acid cannot form Zwitter ion?

(A) 

(B) 

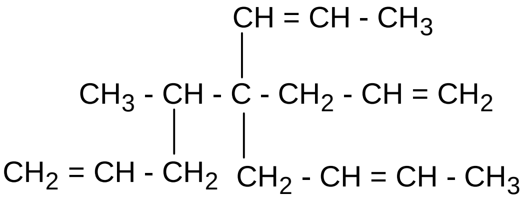
(C) 

(D) 

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

46. How many moles of unpaired electron(s) is/are present in a mixture containing 32 g of dioxygen (O_2) gas and 32 g of monoatomic (O) gas?

47. 

$$\begin{array}{l} \qquad\qquad\qquad\quad CH=CH-CH_3 \\ \qquad\qquad\qquad\quad | \\ \qquad CH_3-CH-C-CH_2-CH=CH_2 \\ \qquad\qquad\quad |\qquad | \\ CH_2=CH-CH_2\ \ CH_2-CH=CH-CH_3 \end{array}$$

How many minimum number of moles of NBS(N-bromosuccinamide) is needed for complete reaction of one mole of the above compound in presence of sunlight?

Space for Rough work

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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48. The radial wave function of an atomic orbital of hydrogen atom is given below

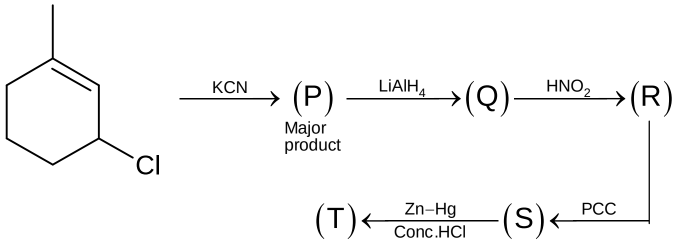
$$R_{2,1} = \frac{1}{2\sqrt{6}}\left(\frac{Z}{a_0}\right)^{3/2}\left(\frac{Zr}{a_0}\right)e^{-Zr/2a_0}$$

The radial probability versus the radial distance curve of the orbital has a maxima. What is the distance of the maxima form the nucleus of the atom in $\overset{o}{A}$ unit? [$a_0 = 0.53\,\overset{o}{A}$]

49. How much heat is absorbed in joule unit by two moles of N_2 gas by heating it from 1000 K to 1315 K at constant pressure?

[$R = 8.314\ J\ K^{-1}\ mol^{-1}$] $\left[C_P = \frac{7R}{2}\right]$

50.



What is the molar mass of (T) in g mol^{-1} unit?

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

51. Let $f: R \to R$, $f(x) = 8x^3 + 3x$. Then $\lim_{x \to \infty} \frac{f^{-1}(8x) - f^{-1}(x)}{x^{1/3}}$ equals

(A) 1
(B) $1 - \frac{1}{3^{1/3}}$
(C) $1 - \frac{1}{2^{1/3}}$
(D) $\frac{1}{2}$

52. f is differentiable function such that $f(f(x)) = x$ where $x \in [0, 1]$. Also, $f(0) = 1$. Then the value of $\int_0^1 (x - f(x))^{2018} dx$ is

(A) $\frac{1}{2018}$
(B) $\frac{2}{2016}$
(C) $\frac{1}{2019}$
(D) $\frac{2}{2019}$

53. Two straight lines one being a tangent to $y^2 = 4ax$ and the other to $x^2 = 4by$ are at right angles. The locus of their point of intersection is given by

(A) $(x^2 + y^2)(ax + by) + (ay + bx)^2 = 0$
(B) $(x^2 + y^2)(ax - by) + (ay - bx)^2 = 0$
(C) $(x^2 + y^2)(ax - by) - (ay + bx)^2 = 0$
(D) $(x^2 + y^2)(ax + by) + (ay - bx)^2 = 0$

Space for Rough work

54. Let z_1, z_2, z_3, z_4 be distinct complex numbers when $|z_1| = |z_2| = |z_3| = |z_4| = 1$ Such that $0 \le \arg(z_1) < \arg(z_2) < \arg(z_3) < \arg(z_4)$ and
$\arg(z_2) + \arg(z_4) - \arg(z_1) - \arg(z_3) = \pi$, then
$|z_1z_3 - (z_1 - z_3)(z_2 - z_4)|^2 - |(z_1 - z_3)(z_2 - z_4)|^2$ equals ________

(A) 1 (B) 2
(C) 3 (D) 4

55. Let M be a 3×3 matrix with all entries being 0 or 1. Then all possible values for $\det(M)$ are

(A) $\{0, \pm 1\}$ (B) $\{0, \pm 1, \pm 2\}$
(C) $\{0, \pm 1, \pm 3\}$ (D) $\{0, \pm 1, \pm 2, \pm 3\}$

56. Suppose Bunty has 4 identical green tennis balls and 5 identical red tennis balls. In how many ways can Bunty arrange these 9 balls so that no two green balls are together and no three red balls are together.

(A) 8 (B) 9
(C) 11 (D) 12

57. Let $f(x) = \frac{1}{2}x\sin x - (1 - \cos x)$. The smallest positive integer k such that $\lim_{x \to 0} \frac{f(x)}{x^k}$ exists finitely and is non zero is

(A) 3 (B) 4
(C) 5 (D) 6

Space for Rough work

58. The eccentricity of conic given by the equation $\left(x\tan 10^o + y\tan 20^o + \tan 30^o\right)\left(x\tan 120^o + y\tan 220^o + \tan 320^o\right) + 2019 = 0$ is

(A) $e = \sqrt{3}$ (B) $\frac{1}{\sqrt{3}}$

(C) $\frac{1}{\sqrt{2}}$ (D) $\sqrt{2}$

59. Let $f : (0,\infty) \to R$ be defined by $f(x) = \lim\limits_{n\to\infty} \cos^n\left(\frac{1}{n^x}\right)$. Let $x = c$ be the point where f(x) is discontinuous. Then f(c) =

(A) 0 (B) $e^{1/2}$

(C) 1 (D) $e^{-1/2}$

60. The integral $\int \frac{3x^4 + 2x^3 - 2x + 1}{x^5 + x + 1} dx$ equals

(A) $\frac{2}{3}\tan^{-1}\left(\frac{2x+1}{\sqrt{3}}\right) + \tan^{-1}\left(x^3 - x^2 + 1\right) + c$ (B) $\frac{2}{\sqrt{3}}\tan^{-1}\left(\frac{2x+1}{\sqrt{3}}\right) + \ell n\left|x^3 - x^2 + 1\right| + c$

(C) $\frac{2}{\sqrt{3}}\tan^{-1}\left(\frac{2x-1}{\sqrt{3}}\right) + \tan^{-1}\left(x^3 - x^2 + 1\right) + c$ (D) $\frac{2}{\sqrt{3}}\tan^{-1}\left(\frac{2x-1}{\sqrt{3}}\right) + \ell n\left|x^3 - x^2 + 1\right| + c$

61. $\lim\limits_{n\to\infty} \frac{1}{n} \sum_{0\le i\le j\le n}\sum \frac{1}{\sqrt{n^2 + (i+j)n + ij}}$ equal

(A) $2\left(3 + 2\sqrt{2}\right)$ (B) $3\left(2 + 3\sqrt{3}\right)$

(C) $2\left(3 - 2\sqrt{2}\right)$ (D) $3\left(2 - 3\sqrt{3}\right)$

62. If $S_n = {}^{n}C_0 - {}^{n-1}C_1 + {}^{n-2}C_2 - {}^{n-3}C_3 + ...$ then which of the following is always true

(A) $S_n = 0$ (B) $S_n = 1$

(C) $S_n = -1$ (D) S_n is periodic with period 6

Space for Rough work

63. Suppose 36 objects are placed along a circle at equal distances. In how many ways can 3 objects be chosen from amongst them so that no two of the three chosen objects are adjacent nor diametrically opposite.

(A) 5002 (B) 5400
(C) 5412 (D) 5500

64. Find all values of ‘a’ so that the equation $x^2 + (3-2a)x + a = 0$ has exactly one root on $(-1, 2)$.

(A) $a \in \left(-\infty, \frac{2}{3}\right) \cup \left(\frac{10}{3}, \infty\right)$ (B) $a \in \left(-\infty, \frac{2}{3}\right] \cup \left[\frac{10}{3}, \infty\right)$
(C) $a \in \left(\frac{2}{3}, \frac{10}{3}\right)$ (D) $a \in \left[\frac{2}{5}, \frac{10}{3}\right]$

65. Suppose the sum of the first m – terms of an A.P. is n and the sum of the first n – terms is m. Than the sum of first $(m+n)$ terms is

(A) 1 – mn (B) mn – 5
(C) – (m + n) (D) m + n

66. A parking lot has 16 spaces in a row. Twelve cars arrive, each of which required one parking space, and their drivers choose spaces at random from among the available spaces. Uncle Sam then arrives in his mini – truck, which requires two adjacent parking spaces. What is the probability that Uncle Sam is able to park his min – truck.

(A) $\frac{13}{28}$ (B) $\frac{17}{28}$
(C) $\frac{11}{28}$ (D) $\frac{1}{20}$

Space for Rough work

67. $f:[0,8]\to[0,8]$ be twice differentiable function with continuous and positive first derivative such that $f(0)=0;\ f(4)=1;\ f(8)=1$, then

(P) There exist some $c\in(0,8)$ where $f'(c_1)=\frac{1}{4}$

(Q) There exist some $c\in(0,8)$ where $f'(c)=\frac{1}{12}$

(R) There exist $c_1,c_2\in[0,8]$ where $8f'(c_1)f(c_2)=1$

(S) There exist some $c\in[0,8]$ such that $f(f(8))-f(f(0))=8(f'(c))^2$

Then which of the following is correct
(A) P, Q are correct
(B) P, Q, R are correct
(C) P, R are correct
(D) P, Q, R, S are correct

68. Equation of three lines $\vec{r}=\mu(\hat{i}+\hat{j});\vec{r}=\mu(\hat{i}+\hat{j});\vec{r}=r(\hat{i}+\hat{j}+\hat{k})$ and a plane x + y + z = 1 are given them area of triangle formed by point of intersection of line and plane is Δ, then $(6\Delta)^2$ equals

(A) 0.75	(B) 0.25
(C) 0.50	(D) 0.40

69. An ellipse touches X – axis at O(0, 0) and has its centre at (3, 4). It is known that slope of major axis is 1. The eccentricity of the ellipse is

(A) $\sqrt{\frac{3}{4}}$	(B) $\sqrt{\frac{4}{5}}$
(C) $\sqrt{\frac{5}{6}}$	(D) $\sqrt{\frac{6}{7}}$

70. The negation of $(\sim p\wedge q)\vee(p\wedge\sim q)$ is

(A) $(p\vee\sim q)\vee(\sim p\vee q)$	(B) $(p\vee\sim q)\wedge(\sim p\vee q)$
(C) $(p\wedge\sim q)\wedge(\sim p\vee q)$	(D) $(p\wedge\sim q)\wedge(p\vee\sim q)$

Space for Rough work

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

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71. The value of $a \in R$, such that $f : R \to R$ defined by $f(x) = x^3 + x^2 + a\cos x$ is injective

72. $S = \frac{1}{2} + \frac{1}{4} + \frac{2}{8} + \frac{3}{16} + \frac{5}{32} + \frac{8}{64} + \frac{13}{128} + ...\infty =$

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

73. Point 'O' is the centre of the ellipse with major axis AB and minor axis CD. Point F is one focus of the ellipse. If OF = 6 and the diameter of the inscribed circle of ΔOCF is 2, then the product (AB) (CD) is $\sqrt{(AB)(CD) - 1}$ equals

74. If $\vec{a}, \vec{b}, \vec{c}$ are unit vectors satisfying $|\vec{a} - \vec{b}|^2 + |\vec{b} - \vec{c}|^2 + |\vec{c} - \vec{a}|^2 = 9,$ then value of $|2\vec{a} + 5\vec{b} + 5\vec{c}|$ is _____________

75. If $\sum_{i=1}^{9}(x_i - 5) = 9$ and $\sum_{i=1}^{9}(x_i - 5)^2 = 45,$ then the standard deviation of the 9 items $x_1, x_2, ...x_9$ is

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Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – I

JEE (Main)-2020

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. B

Sol. Let the length of rod is ℓ and co-ordinate of B is (x, y)

$\vec{v}_B = v_x\hat{i} + v_y\hat{j} = \sqrt{3}\hat{i} + v_y\hat{j}$

$x^2 + y^2 = \ell^2 \Rightarrow 2xv_x + 2yv_y = 0 \Rightarrow \sqrt{3} + \frac{y}{x}v_y = 0$

$\Rightarrow \sqrt{3} + \tan 60^o v_y = 0$ $v_y = -1$ m/s

$\vec{v}_B = \sqrt{3}\hat{i} - 1\hat{j}$

$|\vec{v}_B| = \sqrt{3+1} = 2m/s$

2. D

Sol. At focus path diff. = 0

$\Rightarrow I = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2 = 9I.$

3. C

Sol. For no deviation

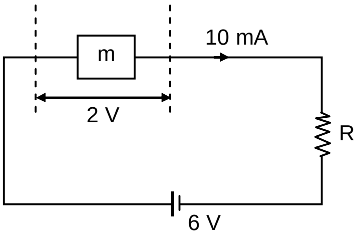
$(\mu_1 - 1)A_1 = (\mu_2 - 1)A_2$

$4^o(1.54 - 1) = (1.72 - 1)A_2$

$A_2 = \frac{4 \times 0.54}{0.72} = 3°.$

4. D

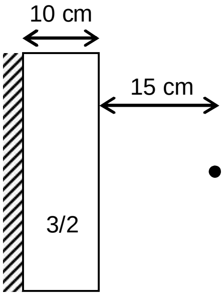
Sol. The potential drop across R is 4 V while current is 10 mA hence, $10 \times 10^{-3} \times R = 4$.
$R = 400\ \Omega$.



5. C

Sol. $X_{app} = \frac{10}{3/2} + \frac{10}{3/2} + \frac{15}{1}$

$= \frac{40}{3} + 15 = 28.33$



6. D

Sol. Apply Snell's law and use geometry.

7. A

Sol. $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$; $\frac{u}{v} = 1 + \frac{u}{f}$

$m = \frac{v}{u} = \frac{f}{u+f}$; $\frac{f}{-12+f} = -\left[\frac{f}{-16+f}\right]$ ($\because$ m is same in both the cases).

f = 14 cm.

8. B

Sol. If there is any charge inside the cavity of the conductor, the charge induced on the inner surface of the cavity is such that it will produce same amount of electric field but in opposite direction at each and every point outside the cavity as produced by the charge in the cavity.

9. A

Sol. $\Delta m = 0.1$ kg ; $\frac{\Delta m}{m} = \frac{0.1}{10}$

$\therefore$ Error $= \pm\frac{\Delta m}{m} \times 100 = \pm 1\%$.

10. B

Sol. Net force $F = m\,a_{net} = m\sqrt{a^2 + a^2} = ma\sqrt{2}$.

11. A

Sol. $\frac{hc}{\lambda} = RhCZ^2\left(1 - \frac{1}{4}\right)$

$\Rightarrow \dfrac{1}{\lambda_1} : \dfrac{1}{\lambda_2} : \dfrac{1}{\lambda_3} : \dfrac{1}{\lambda_4} = 1 : 1 : 4 : 9$

$\Rightarrow \lambda_1 : \lambda_2 : \lambda_3 : \lambda_4 = 1 : 1 : \dfrac{1}{4} : \dfrac{1}{9}$

12. C

Sol. $T = T_{shm} + 4\sqrt{\dfrac{2h}{g}}$

13. C

Sol. $f_1 = \dfrac{n}{2\ell}\sqrt{\dfrac{\gamma RT}{M}}$; $f_2 = \dfrac{n}{2(\ell + x)}\sqrt{\dfrac{\gamma RT}{M}}$

14. C

Sol. F = mg

$F = 2 \times 10^{-5}\, v = \dfrac{4}{3}\pi(1.5 \times 10^{-3})^3 \times 10^3 \times 10$

$\Rightarrow \quad v = \dfrac{2\pi}{3} \times (2.25) = 4.7$ m/s

15. C

Sol. From conservation of mechanical energy.

$\dfrac{1}{2}mv^2 = mg\,L + \dfrac{1}{2}m3(L - \ell)g$

$\therefore \quad v = \sqrt{g(5L - 3\ell)}$

16. B

Sol. $\tan\theta = \dfrac{X_c - X_L}{X_R}$

and $\cos\theta$ = power factor.

17. D

Sol. $W_{agent} - mgH = 0$

$W_{agent} = mgH$

18. B

Sol. $\because$ Field at the x-axis due to both current one same (along + z-axis) which is minimum distance between them.

19. D

Sol. $A_1V_1 = A_2V_2 \Rightarrow a\sqrt{2gh} = A\left(-\dfrac{dh}{dt}\right)$

$\Rightarrow \dfrac{a}{A}\int_0^t dt = -A\int_{h_1}^{h_2} \dfrac{dh}{\sqrt{2gh}}$

20. B

Sol. If the capacitor has greater than E potential initially its potential will decrease and graph is first one. When capacitor has less than E potential initially it will follow the second graph.

SECTION – B

21. 3

Sol. $R = \frac{V^2}{gv_o} \cdot V = \frac{V^3}{gV_o}$; $R \alpha V^3$

22. 6

Sol. Time of height, $T = \frac{4V}{g\sqrt{7}}$, V = speed of projection

$V_H = \frac{V\sqrt{3}}{2\sqrt{7}}$

$V_\perp = \frac{3V}{2\sqrt{7}}$, when projectile with incline.

Tan $\alpha = \frac{1}{\sqrt{3}}$, $\alpha = 30°$.

SECTION – C

23. 00005.19

Sol. $t = 20 \text{ min} = \frac{1}{3}\text{hr}$

$1 \text{ km} = \sqrt{(6)^2 - V^2} \times \left(\frac{1}{3}\text{hr}\right)$

$V = 3\sqrt{3}$ km/hr

24. 00000.99

Sol. Variation of moment of inertia with temperature

$I = I_o (1 + 2\alpha \Delta T)$

C.O.A.M:

$I_i\omega_i = I_f \omega_f$

25. 00002.32

Sol. $F_{\text{upthrust}} = F_{\text{surface tension}} + \text{Weight}$

$l^2 x\rho g = 4lT + mg$

$(.03)^2 \times 10^3 \times 10 = .009 + .2$

$9x = .209$

$x = .02322 \text{ m} = 2.322 \text{ cm}$

Chemistry

PART – II

SECTION – A

26. C
Sol. Because the bond angle is maximum (180^o)

27. B
Sol. M_{eq} of HCl – M_{eq} of NaOH = 100 – 80 = 20

Moles of HCl in 900 mL = $\frac{20}{1000}$

Hence M = $\frac{1}{45}$

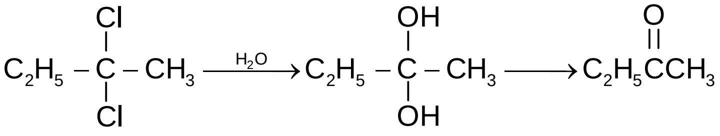
28. D
Sol. $\overline{E_K} = \frac{3}{2}nRT \Rightarrow \overline{E_K}\ \alpha\ T$

29. B
Sol. $K = \frac{\text{Rate}}{[X][Y]^{0.5}} = \frac{\text{mol}L^{-1}s^{-1}}{\text{mol } L^{-1} \times \left(\text{mol } L^{-1}\right)^{0.5}} = \text{mol}^{-1/2} L^{1/2} s^{-1}$

30. A
Sol. $K_p = \left(p_B\right)^2 \Rightarrow p_B = \sqrt{K_p}$

31. B
Sol. Due to nearly same energy of the overlapping orbitals.

32. C
Sol. Geminal halides from ketone upon hydrolysis.



$$C_2H_5-\underset{Cl}{\overset{Cl}{C}}-CH_3 \xrightarrow{H_2O} C_2H_5-\underset{OH}{\overset{OH}{C}}-CH_3 \longrightarrow C_2H_5\overset{O}{\overset{||}{C}}CH_3$$

33. B
Sol. Due to completely filled 3d-orbtials.

34. B
Sol. It contains no symmetry element.

35. B
Sol. Fluorine cannot expand its valency from one.

36. B
Sol. Due to resonance or delocalization of unpaired electrons.

37. C

Sol. Both ethyl groups are attached to the same carbon atom.

38. D

Sol. $NaNO_3$ is not basic in nature. Hence it does not react with silica.

39. C

Sol. $B_3N_3H_6 + 3HCl \longrightarrow B_3N_3H_9Cl_3$

40. D

Sol. $Si(OH)_4 \xrightarrow{\Delta} SiO_2 + 2H_2O$

41. D

Sol. $Na_2B_4O_7 \xrightarrow{\Delta} 2NaBO_2 + B_2O_3$

42. B

Sol. CH_3 has no pi-electrons.

43. B

Sol. ClO_2 contains one unpaired electron.

44. B

Sol. Nucleophilic substitution takes place at carbonyl carbon. Cl^- is the best leaving group among the four.

45. B

Sol. The lone pair of N is in resonance with benzene ring. Hence, it can't accept proton from –COOH group.

SECTION – B

46. 6

Sol. Each O_2 molecule contains two unpaired electrons. Each O atom contains two unpaired electrons.

47. 5

Sol. Monobromination takes place at allylic positions. There are five allylic positions in the molecule.

SECTION – C

48. 00002.12

Sol. $\frac{d}{dr}\left(R^2 4\pi r^2\right) = 0$ at the maxima

On solving, r = $\frac{4a_0}{Z}$ at maxima

$$= \frac{4 \times 0.53}{1} = 2.12\,\overset{o}{A}$$

49. 18332.37

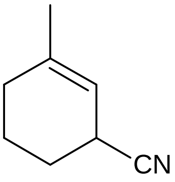
Sol. $\Delta H = nC_P\Delta T = 2 \times \frac{7}{2} R \times (1315 - 2000)$

$= 2 \times \frac{7}{2} \times 8.314 \times 315 = 18332.37$ J

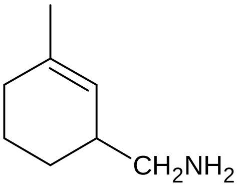
50. 00146.50

Sol.

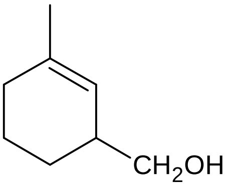
P =



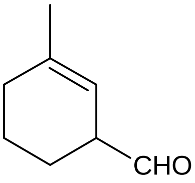
Q =



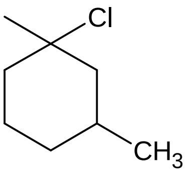
R =



S =



T =



Mathematics PART – III

SECTION – A

51. D

Sol. Let $y = f^{-1}(8x) \Rightarrow 8x = f(y) = 8y^3 + 3y = 8y^3\left(1 + \frac{3}{8y^2}\right)$

$$\Rightarrow 2x^{1/3} = 2y\left(1 - \frac{3}{y^2}\right)^{1/3} \Rightarrow y = \frac{x^{1/3}}{\left(1 + \frac{3}{y^2}\right)^{1/3}}$$

Similarly, let $z = f^{-1}(x) \Rightarrow x = f(z) = 8z^3 + 3z = 8z^3\left(1 + \frac{3}{8z^2}\right)$

$$\Rightarrow x^{1/3} = 2z\left(1 + \frac{3}{8z^2}\right)^{1/3} \Rightarrow z = \frac{x^{1/3}}{2\left(1 + \frac{3}{8z^2}\right)^{1/3}}$$

Thus, $\lim\limits_{x\to\infty} \frac{f^{-1}(8x) - f^{-1}(x)}{x^{1/3}}$

$$= \lim_{x\to\infty} \frac{y - z}{x^{1/3}}$$

$$= \lim_{x\to\infty} \frac{y - z}{x^{1/3}}$$

$$= \lim_{\substack{y\to\infty \\ z\to\infty}} \left(\frac{1}{\left(1 + \frac{3}{8y^2}\right)^{1/3}} - \frac{1}{2\left(1 + \frac{3}{8z^2}\right)^{1/3}}\right)$$

$$= 1 - \frac{1}{2}$$

$$= \frac{1}{2}$$

52. C

Sol. Let $I = \int_0^1 (x - f(x))^{2018}\,dx$

Put $x = f(t) \Rightarrow dx = f'(t)dt$.

Also $f(1) = f(f(0)) = 0$

$$\therefore I = \int_1^0 (f(t) - t)^{2018} f'(t)dt$$

$$= -\int_0^1 \left(t - f\left(t\right)\right)^{2018} f'\left(t\right)dt$$

$$= -\int_0^1 \left(t - f\left(t\right)\right)^{2018} \left(-1 + f'\left(t\right) + 1\right)dt$$

$$= -\int_0^1 \left(t - f\left(t\right)\right)^{2018} \left(-1 + f'\left(t\right) + 1\right)dt$$

$$= +\int_0^1 \left(t - f\left(t\right)\right)^{2018} \left(1 - f'\left(t\right)\right)dt - \int_0^1 \left(t - f\left(t\right)\right)^{2018} dt$$

$$= \int_0^1 \left(t - f\left(t\right)\right)^{2018} \left(1 - f'\left(t\right)\right)dt - I$$

$$2I = \int_0^1 \left(t - f\left(t\right)\right)^{2018} \left(1 - f'\left(t\right)\right)dt = \left.\frac{\left(t - f\left(t\right)\right)^{2019}}{2019}\right|_0^1$$

$$= \frac{1}{2019} + \frac{1}{2019} = \frac{2}{2019}$$

$$\Rightarrow I = \frac{1}{2019}$$

53. D

Sol. Let $P\left(h, k\right)$ be the point of intersection

Equation of tangent to $y^2 = 4ax$ is

$y = m_1 x + \frac{a}{m_1}$ ………..(1)

Also, equation of tangent to $x^2 = 4by$ is

$y = m_2 x - bm_2^2 = -\frac{1}{m_1}x - \frac{b}{m_1^2}$ ……(2) $\left(\because m_1 m_2 = -1\right)$

Since P (h, k) is their point of intersection

We have by substituting P (h, k) in (1) and (2)

$hm_1^2 - km_1 + a = 0$

$km_1^2 + hm_1 + b = 0$

Eliminating m_1

$$\frac{m_1^2}{-bk - ah} = \frac{m_1}{ak - bh} = \frac{1}{h^2 + k^2}$$

We get

$$\left(h^2+k^2\right)\left(ah+bk\right)+\left(ak-bh\right)^2=0$$

$\Rightarrow$ Locus of P (h, k) is

$$\left(x^2+y^2\right)\left(ax+by\right)+\left(ay-bx\right)^2=0$$

54. A

Sol. $\arg\left(z_2\right)+\arg\left(z_4\right)-\arg\left(z_1\right)-\arg\left(z_3\right)=\pi$

$$\Rightarrow \arg\left(\frac{z_2z_4}{z_1z_3}\right)=\pi \Rightarrow \frac{z_2z_4}{z_1z_3}=-k \text{ (where } k>0\text{)}$$

$$\Rightarrow k=\left|\frac{z_2z_4}{z_1z_3}\right|=1$$

$$\Rightarrow z_2z_4=-z_1z_3$$

$$\left|z_1z_3-\left(z_1-z_3\right)\left(z_2-z_4\right)\right|^2-\left|\left(z_1-z_3\right)\left(z_2-z_4\right)\right|^2$$

$$=\left|z_1z_3\right|^2+\left|\left(z_1-z_3\right)\left(z_2-z_4\right)\right|^2-\bar{z}_1\bar{z}_3\left(z_1-z_3\right)\left(z_2-z_4\right)$$

$$-z_1z_3\left(\bar{z}_1-\bar{z}_3\right)\left(\bar{z}_2-\bar{z}_1\right)-\left|\left(z_1-z_3\right)\left(z_2-z_4\right)\right|^2$$

$$=1-\left\{\frac{\left(z_1-z_3\right)\left(z_2-z_4\right)}{z_1z_3}+\frac{\left(z_1-z_3\right)\left(z_2-z_4\right)}{z_2z_4}\right\}=1$$

55. B

Sol. $\begin{vmatrix}1&1&1\\1&1&1\\0&0&0\end{vmatrix}=0$

$\begin{vmatrix}1&0&0\\0&1&0\\0&0&1\end{vmatrix}=1,-1$ can be obtained by interchanging any two adjacent row/column

$\begin{vmatrix}1&1&0\\0&1&1\\1&0&1\end{vmatrix}=2,-2$ may be obtained by interchanging any two adjacent row/column

Let $M=\begin{bmatrix}a_1&b_1&c_1\\a_2&b_2&c_2\\a_3&b_3&c_3\end{bmatrix}$ be matrix with only 0 or 1 as its entries.

Now, every 2 × 2 sub – matrix of M has determinant 0 or ±1

So if some row has at least one '0' , then expanding the determinant w.r.t. that row we see that it can be at most 2.

Hence for $\det(M)$ to be equal to 3, all rows must have only 1's, in which case $\det(M) = 0$, So, there is no matrix M of the given type whose determinant is 3.

56. D

Sol. _R_R_R_R_R_
1 2 3 4 5 6
Number of ways of select 4 places for the four green balls from available 6 spaces $= {}^6C_4 = 15$ ways
But we have to exclude those arrangements in which three (or more) red balls are together.
Gaps 2, 3 cannot be left vacant.
Similarly 3, 4 cannot be left vacant
And 4, 5 cannot be left vacant
$\Rightarrow$ Required number of ways = 15 – 3 = 12

57. B

Sol.
$$\lim_{x\to0}\frac{f(x)}{x^k} = \lim_{x\to0}\frac{\frac{1}{2}x\sin x - 1 + \cos x}{x^k}$$
$$= \lim_{x\to0}\frac{\frac{1}{2}\sin x + \frac{1}{2}x\cos x - \sin x}{k\,x^{k-1}}$$
$$= \lim_{x\to0}\frac{\frac{1}{2}\cos x + \frac{1}{2}\cos x - \frac{1}{2}x\sin x - \cos x}{k(k-1)x^{k-2}}$$
$$= \lim_{x\to0}\frac{-\frac{1}{2}\sin x}{k(k-1)x^{k-3}}$$

If $k - 3 = 1$ i.e. $k = 4$, $\lim_{x\to0}\frac{f(x)}{x^k} = \frac{-\frac{1}{2}}{4\times3} = \frac{-1}{24}$

58. D

Sol. Obviously $x\tan10^\circ + y\tan20^\circ + \tan30^\circ = 0$ and $x\tan120^\circ + y\tan220^\circ + \tan320^\circ = 0$ are asymptotes of a hyperbola.
Since, these lines are perpendicular, we have a rectangular hyperbola
$\therefore e = \sqrt{2}$

59. D

Sol. $\ell n f(x) = \lim\limits_{n\to\infty} n \ell n\left(\cos\left(\frac{1}{n^x}\right)\right)$

Let $n = \frac{1}{\mu}$

$$\Rightarrow \ell n f(x) = \lim_{\mu\to 0^+} \frac{\ell n\left(\cos \mu^x\right)}{\mu} = \lim_{x\to 0^+} -\tan\left(\mu^x\right).x.\mu^{x-1}$$

$$= -\lim_{\mu\to 0^+} \frac{\tan\left(\mu^x\right)}{\mu^x}.x.\mu^{2x-1}$$

$$= \begin{cases} -\infty, & 0 < x < \frac{1}{2} \\ -\frac{1}{2} & x = \frac{1}{2} \\ 0 & x > \frac{1}{2} \end{cases}$$

$$f(x) = \begin{cases} 0, & 0 < x < \frac{1}{2} \\ e^{-\frac{1}{2}} & x = \frac{1}{2} \\ 1 & x > \frac{1}{2} \end{cases}$$

So, clearly $c = \frac{1}{2}$ and $f(c) = e^{-1/2}$

60. B

Sol. $x^5 + x + 1 \equiv \left(x^2 + x + 1\right)\left(x^3 - x^2 + 1\right)$

Thus $3x^4 + 2x^3 - 2x + 1 \equiv x^3 - x^2 + 1 + \left(3x^2 - 2x\right)\left(x^2 + x + 1\right)$

61. C

Sol. $\frac{1}{n}\sum\limits_{0\le i<j\le n}\sum \frac{1}{\sqrt{(n+i)(n+j)}}$

$$= \frac{1}{2n}\left(\sum_{i=1}^{n}\frac{1}{\sqrt{n+i}}\right)^2 - \frac{1}{2n}\sum_{i=1}^{n}\frac{1}{n+i}$$

$$=\frac{1}{2}\left(\frac{1}{\sqrt{n}}\sum_{i=1}^{n}\frac{1}{\sqrt{n+i}}\right)^{2}-\frac{1}{2n}\sum_{i=1}^{n}\frac{1}{n+i}$$

$$=\frac{1}{2}\left(\frac{1}{n}\sum_{i=1}^{n}\frac{1}{\sqrt{1+\frac{i}{n}}}\right)^{2}-\frac{1}{2n}\sum_{i=1}^{n}\frac{1}{n+i}$$

$$=\frac{1}{2}\left(\int_{0}^{1}\frac{1}{\sqrt{1+x}}dx\right)^{2}-\frac{1}{2n}\sum_{i=1}^{n}\frac{1}{n+i}$$

$$=\frac{1}{2}\left(2\sqrt{2}-2\right)^{2}-L$$

$$=2\left(3-2\sqrt{2}\right)-L$$

$$L=\lim_{n\to\infty}\frac{1}{2n}\sum_{i=1}^{n}\frac{1}{n+i}$$

Now, $0\le\frac{1}{n}\sum_{i=1}^{n}\frac{1}{n+1}\le\frac{1}{n+1}$

$\Rightarrow L=0$

So, required limit $=2\left(3-2\sqrt{2}\right)$

62. D

Sol. $S_n=\sum_{j\ge0}(-1)^{j}\,{}^{n-j}C_j$

$$S_{n+1}=\sum_{j\ge0}(-1)^{j}\,{}^{n+1-j}C_j$$

$$=\sum_{j\ge0}(-1)^{j}\left({}^{n-j}C_j+{}^{n-j}C_{j-1}\right)$$

$$=\sum_{j\ge0}(-1)^{j}\left({}^{n-j}C_j\right)-\sum_{j\ge0}(-1)^{j-1}\left({}^{n-1-(j-1)}C_{j-1}\right)$$

$$=S_n-S_{n-1}$$

$S_1=1;\ S_2=0,$ so S_n is $1,0,-1,-1,0,1,1,0,-1,-1,0,1,.......$

Which is a periodic sequence.

63. C

Sol. ${}^{36}C_3-36-36(36-4)-(18\times30)=5412$

64. B

Sol. $f(-1)=1+2a-3+a=3a-2$

$f(2)=4+6-4a+a=10-3a$

Case I

$f(-1)f(2)<0\Rightarrow(3a-2)(10-3a)<0$

$$\Rightarrow a \in \left(-\infty, \frac{2}{3}\right) \cup \left(\frac{10}{3}, \infty\right)$$

Case II

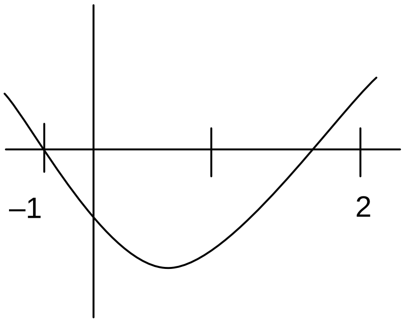
$f(-1) = 0 \Rightarrow a = \frac{2}{3}$

$f(2) = 10 - 3a = 10 - 2 = 8 > 0$

Also, x – coordinate of vertex lies in (–1, 2)

$\Rightarrow$ Exactly one root lies between –1 and 2

for this value of a $\left(= \frac{2}{3}\right)$



Case III

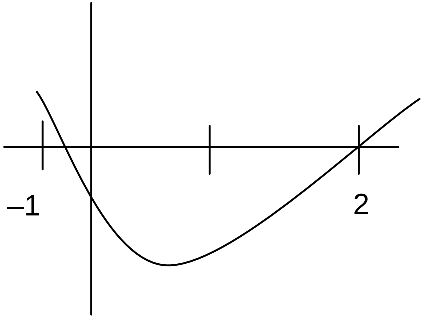
$f(2) = 0 \Rightarrow a = \frac{10}{3}$

$f(-1) = 3a - 2 = 3\left(\frac{10}{3}\right) - 2 = 8 > 0$

x – coordinate of vertex $= \frac{2a-3}{2} = \frac{11}{6} < 2$

$\Rightarrow$ Exactly one root lies between –1 and 2

for this value of a $\left(= \frac{10}{3}\right)$



$$\therefore a \in \left(-\infty, \frac{2}{3}\right] \cup \left[\frac{10}{3}, \infty\right)$$

65. C

Sol. $2a + (m-1)d = \frac{2n}{m}; \; 2a + (n-1)d = \frac{2m}{n} \Rightarrow d = \frac{-2(m+n)}{mn}$

and $2a + \frac{(m+n-2)d}{2} = \frac{n}{m} + \frac{m}{n}$ (on adding)

$\Rightarrow 2a + (m+n-1)d + \frac{(m+n-2)d}{2} - (m+n-1)d = \frac{n}{m} + \frac{m}{n}$

$\Rightarrow 2a + (m+n-1)d - \frac{(m+n)}{2}d = \frac{m^2+n^2}{mn}$

$2a + (m+n-1)d = \frac{m^2+n^2}{mn} + \frac{(m+n)d}{2}$

$= \frac{m^2+n^2}{mn} + \frac{m+n}{2}\left\{\frac{-2(m+n)}{mn}\right\}$

$= \frac{m^2+n^2-(m+n)^2}{mn} = -2$

Required sum $= \frac{m+n}{2}\left[2a + (m+n-1)d\right] = -(m+n)$

Thus C.

66. B

Sol. Uncle Sam will not be able to park when none of the four left over parking spaces are adjacent.

Number of ways in which the 12 drivers may leave 4 spaces $= {}^{16}C_4$

Number of ways in which the 12 – drivers leave 4 spaces so that none of four left over spaces are adjacent $= {}^{13}C_4$

$\Rightarrow$ Required probability = 1 – P (Uncle Sam doesn' t park)

$$= 1 - \frac{{}^{13}C_4}{{}^{16}C_4} = 1 - \frac{13.12.11.10}{16.15.14.15} = 1 - \frac{12.11.10}{16.15.14} = 1 - \frac{11}{28} = \frac{17}{28}$$

67. D

Sol. Applying LMVT on $[0, 4]$, we get $f(c_1) = \frac{f(4)-f(0)}{4-0} = \frac{1-0}{4} = \frac{1}{4}$ for atleast one $c_1 \in (0,4)$. Hence (P).

Applying Rolle's theorem on $[4,8]$, we get $f'(d) = 0$ for some $d \in (4, 8)$

Since derivative is continuous, by Intermediate Value Properly Theorem for function $y = f'(x)$ on the interval $[c_1, d]$ there exists at least one $c \in [c_1, d]$ where $f'(c) = \frac{1}{2}$

$\left(\because 0 < \frac{1}{12} < \frac{1}{4}\right)$

Hence, (Q).

By LMVT on $[0, 4]$ we have $f'(c_1) = \frac{1}{4}$ and by IVPT on $[0, 4]$ we have $f(c_2) = \frac{1}{2}$ for some $c_2 \in (0, 4)$

$\Rightarrow 8f'(c_1)f(c_2) = 1$

Hence (R)

$$f(f(8)) - f(f(0)) = \frac{f(f(8)) - f(f(0))}{f(8) - f(0)} \frac{f(8) - f(0)}{8-0} \times 8$$

$= 8f'(e_1)f'(e_2)$

$= 8(f'(c))^2 \quad (f'(c) \text{ is G.M. of } f'(e_1) \text{ and } f'(e_2))$

Hence (S)

68. A

Sol. Point of intersections are $(1,0,0), \left(\frac{1}{2}, \frac{1}{2}, 0\right), \left(\frac{1}{3}, \frac{1}{3}, \frac{1}{3}\right)$

69. D

Sol. Since ellipse touches X – axis at O(0, 0), Y – axis is therefore normal to be ellipse.

$\Rightarrow$ Y – axis is thus internal angular bisector of $\angle F_1OF_2$ (F_1 and F_2 being the two focii).

$\Rightarrow$ Equation of OF_1 and OF_2 can therefore be assumed as $y = kx$ and $y = -kx$.

Equation of major axis is $y = x + 1$. Solving OF_1 and OF_2 with major axis.

We get $F_1 \equiv \left(\frac{1}{k-1}, \frac{k}{k-1}\right)$ and $F_2 \equiv \left(\frac{1}{k+1}, -\frac{k}{k+1}\right)$

$C \equiv$ Mid point of $F_1F_2 \equiv (3, 4)$

$\Rightarrow k = \frac{2}{\sqrt{3}} \Rightarrow F_1 \equiv \left(3+2\sqrt{3},\ 4+2\sqrt{3}\right)$ and $F_2 = \left(3-2\sqrt{3},\ 4-2\sqrt{3}\right)$

$CF_1 = ae = \sqrt{\left(2\sqrt{3}\right)^2 + \left(2\sqrt{3}\right)^2} = 2\sqrt{6}$

Also major axis

$= 2a = OF_1 + OF_2 = \sqrt{\left(3+2\sqrt{3}\right)^2 + \left(4+2\sqrt{3}\right)^2} + \sqrt{\left(3-2\sqrt{3}\right)^2 + \left(4-2\sqrt{3}\right)^2} = 4\sqrt{7}$

$\Rightarrow a = 2\sqrt{7}$

$\Rightarrow e = \sqrt{\frac{6}{7}}$

70. B

Sol. Let $S : (\sim p \wedge q) \vee (p \wedge \sim q)$

$\Rightarrow \sim S : \sim \left[(\sim p \wedge q) \vee (p \wedge \sim q)\right]$

$\Rightarrow \sim S : \sim (\sim p \wedge q) \wedge \sim (p \wedge \sim q)$

$\Rightarrow \sim S : (p \vee \sim q) \wedge (\sim p \vee q)$

SECTION – B

71. 2

Sol. $f'(x) = 3x^2 + 2x - a\sin x$

Clearly $f'(0) = 0$

$\Rightarrow x = 0$ must be point of minima of $y = f'(x)$ (if sign of derivative should not change)

i.e. $f''(0) = 0$

$\Rightarrow f''(x) = 6x + 2 - a\cos x$

$f''(0) = 2 - a = 0 \Rightarrow a = 2$

$f'''(x) = 6 + a\sin x \Rightarrow f'''(0) = 6 + a = 6 + 2 = 8 > 0$

72. 2

Sol. Numerators of the terms are 1, 1, 2, 3, 5, 8, 13,…… which are terms of Fibbonacci sequence

$F_1 = 1;\ F_2 = 1;\ F_3 = 2; \ldots\ldots; F_n = F_{n-1} + F_{n-2}$

$$S = \sum_{n=1}^{\infty} \frac{F_n}{2^n} = \frac{1}{2} + \frac{1}{4} + \sum_{n=3}^{\infty} \frac{F_{n-1} + F_{n-2}}{2^n}$$

$$\Rightarrow S = \frac{1}{2} + \frac{1}{4} + \sum_{n=3}^{\infty} \frac{F_{n-1}}{2^n} + \sum_{n=3}^{\infty} \frac{F_{n-2}}{2^n}$$

$$\Rightarrow S = \frac{1}{2} + \frac{1}{4} + \frac{1}{2}\sum_{n=3}^{\infty} \frac{F_{n-1}}{2^{n-1}} + \frac{1}{4}\sum_{n=3}^{\infty} \frac{F_{n-2}}{2^{n-2}}$$

$$\Rightarrow S = \frac{1}{2} + \frac{1}{4} + \frac{1}{2}\left(S - \frac{1}{2}\right) + \frac{1}{4}S$$

$$\Rightarrow S = 2$$

SECTION – C

73. 00065.00

Sol. $(x+5)^2 = (x+1)^2 + 36$

$10x + 25 = 2x + 1 + 36$

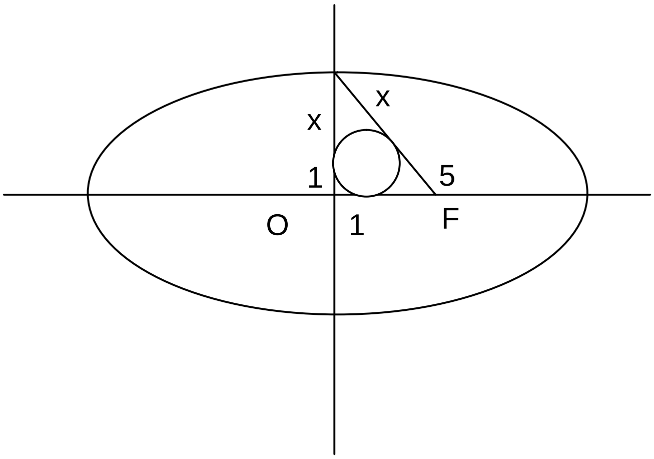
$8k = 37 - 25 = 12$

$x = \frac{12}{8} = \frac{3}{2}$

$CD = 2(x+1) - \frac{5}{2} \times 2 = 5$

$AB = 2(x+5) = \frac{13}{2} \times 2 = 13$

(AB) (CD) = 65



74. 00003.00

Sol. $\left|\vec{a} - \vec{b}\right|^2 + \left|\vec{b} - \vec{c}\right|^2 + \left|\vec{c} - \vec{a}\right|^2 = 9,$

We get $\vec{a}.\vec{b} + \vec{b} + \vec{c} + \vec{c}.\vec{a} = -\frac{3}{2} \Rightarrow 2\vec{a}.\vec{b} + 2\vec{b}.\vec{c} + 2\vec{c}.\vec{a} + 3 = 0$

$\Rightarrow \left|\vec{a} + \vec{b} + \vec{c}\right|^2 = 0$

$\Rightarrow \vec{a} + \vec{b} + \vec{c} = 0$

So, $\vec{a}, \vec{b}, \vec{c}$ from an equilateral triangle

$\Rightarrow \vec{a}.\vec{b} = \vec{b}.\vec{c} = \vec{c}.\vec{a} = -\frac{1}{2}$

$\Rightarrow \left|2\vec{a} + 5\vec{b} + 5\vec{c}\right|^2 = 4a^2 + 25b^2 + 25c^2 + 20\vec{a}.\vec{b} + 50\vec{b}.\vec{c} + 20\vec{c}.\vec{a}$

$= 54 + 90\left(-\frac{1}{2}\right)$

$= 54 - 45$

= 9

$\Rightarrow \left|2\vec{a} + 5\vec{b} + 5\vec{c}\right| = 3$

75. 00002.00

Sol. $\sum x_i - 45 = 9 \Rightarrow \sum x_i = 54$

Now, $\sum x_i^2 - 10 \times 54 + 25 \times 9 = 45 \Rightarrow \sum x_i^2 = 360$

$\therefore \quad \sigma = \sqrt{\frac{360}{9} - \left(\frac{54}{9}\right)^2} = 2$

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – II

JEE (Advanced)-2020

PAPER – 1

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section–A (01 – 04, 19 – 22, 37 – 40)*** *contains 12 multiple choice questions which out of 4 options have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (05 – 12, 23 – 30, 41 – 48) *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*

   *Negative Marks : **–1** In all other cases.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics PART – I

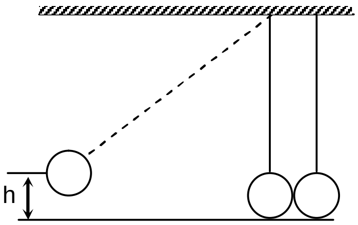
SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. Two glass plates are separated by water. If surface tension of water is 75 dynes per cm and area of each plate wetted by water is 8 cm^2 and the distance between the plates is 0.12 mm, then the force applied to separate the two plates is

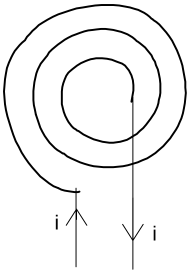
(A) 10^2 dynes (B) 10^4 dynes
(C) 10^5 dynes (D) 10^6 dynes

2. In the arrangement shown, the pendulum on the left is pulled aside. It is then released and allowed to collide with other pendulum which is at rest. A perfectly inelastic collision occurs and the system rises to a height $\frac{1}{4}$h. The ratio of the masses of the pendulums is



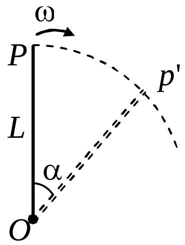
(A) 1 (B) 2
(C) 3 (D) 4

3. A thin insulate wire forms a plane spiral of N = 100 turns carrying a current I = 2.3 A. The inner and outer radii are equal to a = 5 cm and b = 10cm. Find the magnetic field (In 10^{-3} T) at the centre of spiral [In 2 = 0.69] is



(A) 1 (B) 2
(C) 3 (D) 4

4. A rod of uniform mass and of length L can freely rotate in a vertical plane about an axis passing through O. The angular velocity of the rod when it falls from position P and P' through and angle α is

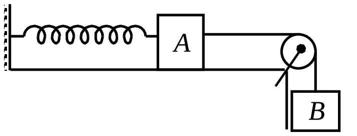


(A) $\sqrt{\frac{6g}{5L}}\sin\alpha$ (B) $\sqrt{\frac{6g}{L}}\sin\frac{\alpha}{2}$
(C) $\sqrt{\frac{6g}{L}}\cos\frac{\alpha}{2}$ (D) $\sqrt{\frac{6g}{L}}\sin\alpha$

Space for Rough work

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.



5. In the adjoining figure block A is of mass m and block B is of mass 2m. The spring has a force constant k. All the surfaces are smooth and the system is released from rest with spring unstretched

   (A) The maximum extension of the spring is $\frac{4mg}{k}$

   (B) The speed of block A when extension in spring is $\frac{2mg}{k}$, is $2g\sqrt{\frac{2m}{3k}}$

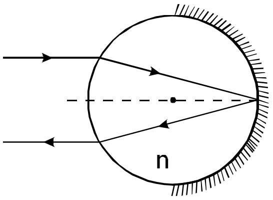
   (C) Net acceleration of block B when the extension in the spring is maximum, is $\frac{2}{3}g$.

   (D) Tension in the thread for extension of $\frac{2mg}{k}$ in spring is mg.

6. 1 gm of a radioactive substance takes. 50 sec to loose 0.01 gm then the half life of the sample will be

   (A) $\frac{50\ln(2)}{\ln\left(\frac{100}{99}\right)}$ (B) $\frac{50\ln(2)}{\ln(100)}$

   (C) $\frac{50\ln(2)}{\ln(99)}$ (D) $\frac{50\ln(2)}{\ln(0.99)}$



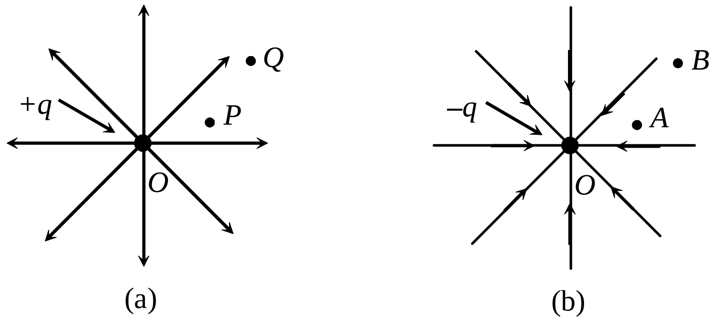
7. A transparent cylinder has its right half polished so as to act as a mirror. A paraxial light ray is incident from left that is parallel to principal axis, exits parallel to the incident ray as shown. Find the refractive index n of the material of the cylinder.

   (A) 2 (B) 4

   (C) 8 (D) 0

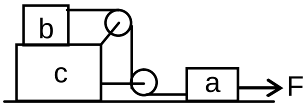
Space for Rough work

8. Figures shows the lines of force of the electric field of a positive charge (+q) and a negative charge (–q) respectively. Which of the following statements are correct?



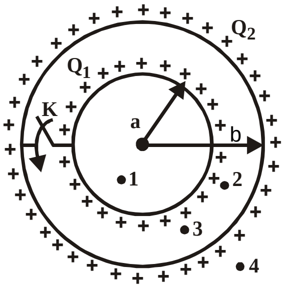
(A) potential at P is greater than that at Q.
(B) potential at A is greater than that at B.
(C) potential at P is less than that at Q.
(D) potential at B is greater than that at A.

9. Three blocks a, b, and c of masses 10 kg, 10 kg and 20 kg are arranged as shown in figure. All the surfaces are frictionless and string is inextensible. Pulleys are light. A constant force F = 20 N is applied on block a as shown. Pulleys and string are light. Part of the string connecting both pulleys is vertical and part of the strings connecting pulleys with blocks a and b are horizontal.



(A) Acceleration of mass blocks a, b and c is 0.5 m/s^2.
(B) Acceleration of mass block b is 1.
(C) Tension in the string is 10 N.
(D) Acceleration of mass block c is 0.5

10. Two concentric conducting shells as shown in figure having charge Q_1 and Q_2. If switch K is closed find points where potential will be same



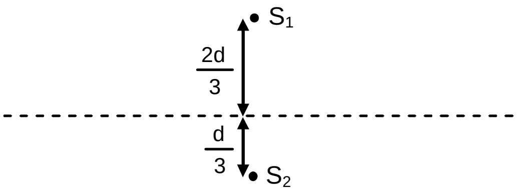
(A) 1
(B) 2
(C) 3
(D) 4

Space for Rough work

11. A charge q is moving with a velocity $\vec{V}_1 = 1\hat{i}$ m/s at a point in a magnetic field and experience a force $\vec{F}_1 = q[-1\hat{j} + 1\hat{k}]N$. If the charge is moving with a velocity $\vec{V}_2 = 1\hat{j}$ m/s at the same point, it experience a force $\vec{F}_2 = q[1\hat{i} - 1\hat{k}]N$. If the magnetic induction $\vec{B}$ at that point is $\vec{B} = a\hat{i} + b\hat{j} + c\hat{k}$ calculate a + b + c.

(A) 1 (B) 2
(C) 3 (D) 4

12. Two coherent point sources of frequency $(f = \frac{10v}{d}$ where v is speed of light in air) are placed at a distance d apart as shown in figure. The receiver is free to move along the dotted line shown in the figure. The total number of maxima observed by receiver is

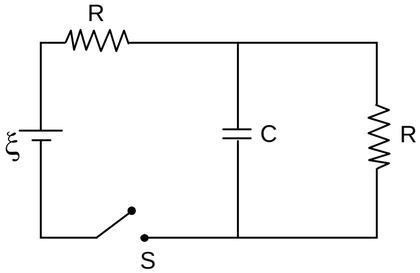


(A) 2 (B) 4
(C) 6 (D) 8

SECTION – C
(Numerical Answer Type)

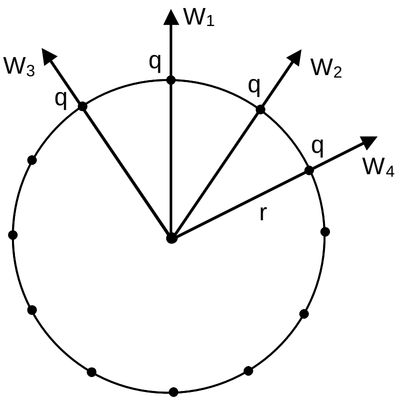
This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded ‑ off to the **second decimal place**; e.g. XXXXX.XX).

13. As situation shown in figure if the maximum value of rate of energy stored in the capacitor after the switch is closed is $n\frac{\xi^2}{R}$ then find the value of 'n'.



Space for Rough work

14. N identical charges each of charge ‘q’ are symmetrically placed on the circumference of circle of radius ‘r’. Four adjacent charges are slowly taken to infinity in the sequence a shown in figure. If W_1, W_2, W_3 and W_4 is the respective work done in slowly displacing q_1, q_2, q_3 and q_4. If $(W_3 - W_4)$ is $x\left[\frac{-q^2}{4\pi t_0 r \sin\frac{3\pi}{n}}\right]$ then

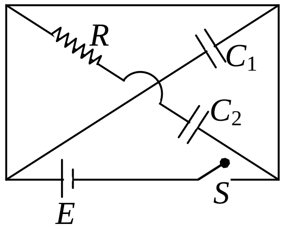


15. A particle is projected with speed u at an angle θ (< 60°) with the horizontal. If the time taken by it, so that its velocity makes an angle 60° with the initial velocity is $n\frac{y}{g}\frac{1}{\sin(\theta+30^\circ)}$

16. The equation of a particle executing SHM is given by $x = 3\cos\left(\frac{\pi}{2}\right)t$ cm, where *t* is in second. Find the distance travelled by the particle in the first 8.5 s

17. Three infinitely long thin conductors are joined at the origin of coordinates and lies along the *x*, *y* and *z* axes. A current *i* flowing along the conductor lying along the negative *x*-axis divides equally into the other two at the origin. If the magnitude of magnetic field at the point (0, –*a*, 0) is $n\frac{\mu_0 i}{4\pi a}$ then find the value of ‘n’.

18. In the circuit shown, the capacitors C_1 and C_2 have capacitance *C* each. The switch *S* is closed at time $t = 0$. Taking $Q_0 = CE$ and $\tau = RC$, if the charge on C_2 after time $t = RC\, n\theta_0$ then find the value of ‘n’.



Space for Rough work

Chemistry

PART – II

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

19. Which of the following is not a property of NaOH?
(A) It is hygroscopic in nature
(B) It decolourizes chlorine gas
(C) It behaves as a dehydrating agent
(D) Heat is liberated when it reacts with HCl

20. For the gaseous reaction, $A(g) \rightarrow 4B(g) + 3C(g)$ is found to be first order with respect to A. If at the starting the total pressure was 100 mm Hg and after 20 minutes it is found to be 400 mm Hg. The rate constant of the reaction is
(A) 20 min^{-1} (B) 1.2×10^{-3} sec^{-1}
(C) 5.7×10^{-4} sec^{-1} (D) 3.4×10^{-2} sec^{-1}

21. Which of the following compound is formed if PbS reacts with H_2O_2?
(A) $PbSO_3$ (B) $PbSO_4$
(C) PbS_2O_3 (D) PbS_4O_6

22. $Zn(s)|Zn^{2+}(aq)||Cu^{2+}(aq)|Cu(s)$
Which of the following activity can increase the cell potential of the above electrochemical cell?
(A) Addition of water to the anode half-cell
(B) Addition of water to the cathode half-cell
(C) Increasing temperature
(D) Addition of same amount of water to both half-cells

Space for Rough work

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

23. In which of the following option(s) the dipole moment of the left side molecule is greater than that of the right side molecule?

(A) NH_3, NF_3 (B) SCl_2, $BeCl_2$
(C) SF_4, CF_4 (D) PF_5, IF_5

24. K_C for the reaction $2A(g) + B(g) \rightleftharpoons A_2B(g)$ is 2×10^{-2} at 25°C and it is 2×10^{-1} at 50°C. Choose the incorrect statement (s) from the following

(A) Decomposition of A_2B is favoured at low temperature
(B) Formation of A_2B is favoured at low pressure.
(C) Formation of A_2B is favoured by introducing an inert gas at constant pressure.
(D) Decomposition of A_2B is favoured by removing B(g) from the reaction mixture

25. Which of the following ion(s) form(s) precipitate with NaOH solution?

(A) Ca^{2+} (B) Fe^{3+}
(C) Cr^{3+} (D) Al^{3+}

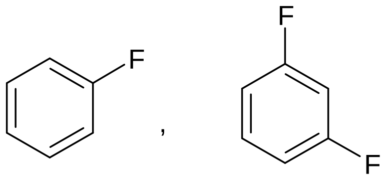
26. Which of the following ion(s) maintain an identical d-orbital configuration while forming octahedral complexes with strong field as well as weak field ligands according to crystal field theory?

(A) Fe^{2+} (B) Co^{2+}
(C) Ni^{2+} (D) Zn^{2+}

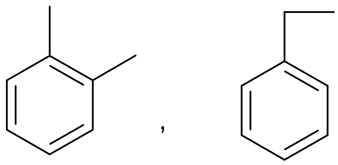
Space for Rough work

27. Which of the following pair has same net dipole moment

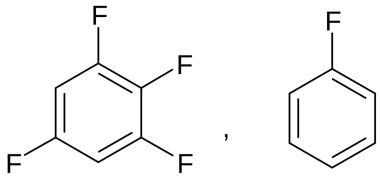
(A)



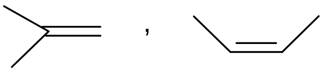
(B)



(C)



(D)



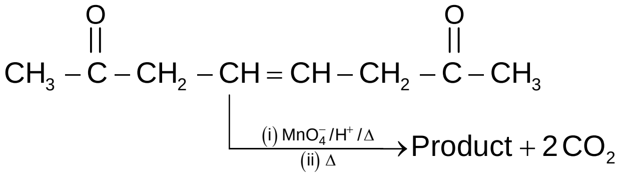
28. Which of the following are the common metallurgical processes which are used for the extraction of zinc from ZnS and $ZnCO_3$?

(A) Calcination
(B) Roasting
(C) Carbon reduction
(D) Distillation

29. In NaCl unit cell Na^+ ions are present at

(A) corners of the unit cell
(B) face centres of the unit cell
(C) edge centres of the unit cell
(D) body centre of the unit cell

30.



$$\mathrm{CH_3-\overset{\overset{O}{||}}{C}-CH_2-CH=CH-CH_2-\overset{\overset{O}{||}}{C}-CH_3}\xrightarrow[\text{(ii) }\Delta]{\text{(i) }MnO_4^-/H^+/\Delta}\text{Product}+2CO_2$$

How many carbon atom(s) is/are present in the unknown product of above reaction?

(A) 3
(B) 4
(C) 1
(D) 6

Space for Rough work

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded ‐ off to the **second decimal place**; e.g. XXXXX.XX).

---

31. What is the sum of azimuthal quantum number of all the valence electrons of aluminum? [At. No. of Al = 13]

32. How many S – O single bonds are present in Caro's acid (H_2SO_5)?

33. The formula of a spinel is $MgAl_2O_4$. How many effective no. of anionic vacancy for unit cell will be created if the oxide ions of the spinel are replaced by $X^{-8/3}$ ions?

34. The radiator of a car contains 52 g water. If 6.2 g of glycol ($HOCH_2CH_2OH$) is added to it, the solution freezes at –4°C. How many gram of ice will be separated in the process? [K_f = 1.86 K kg mol^{-1}]

35. What is the pH of a solution which contains CH_3COOH and it's sodium salt in the molar ratio of 10 : 1?
[p^{K_a} of CH_3COOH = 4.74]

36. The r.m.s velocity of NO gas at 500 K is equal to the most probable velocity of an unknown gas at 314 K. What is the molecular mass of the unknown gas?

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. The locus of mid points of the chords of the circle $x^2 - 2x + y^2 - 2y + 1 = 0$ which are of unit length is

(A) $(x - 1)^2 + (y - 1)^2 = \frac{3}{4}$
(B) $(x - 1)^2 + (y - 1)^2 = 2$
(C) $(x - 1)^2 + (y - 1)^2 = 4$
(D) none of these

38. Suppose we define the distance between two points $P(x_1, y_1)$ and $Q(x_2, y_2)$ as $d(P, Q) = \max.\{|x_2 - x_1|, |y_2 - y_1|\}$, then the area of the region bounded by the locus of a point P satisfying d(P, A) = 4, where A is (1, 2) is

(A) 64 sq. units
(B) 54 sq. units
(C) 16π sq. units
(D) none of these

39. Let $z_1 = a + ib$ and $z_2 = c + id$ be two complex numbers such that $|z_1| = |z_2| = 1$ and $\text{Re}\left(z_1\bar{z}_2\right) = 0$.If a, b > 0 and c < 0, then

(A) $0 \le \left|z_1 - \bar{z}_2\right| \le 2$
(B) $0 < \left|z_1 - \bar{z}_2\right| < \sqrt{2}$
(C) $\sqrt{2} < \left|z_1 - \bar{z}_2\right| \le 2$
(D) $\sqrt{2} < \left|z_1 - \bar{z}_2\right| < 2$

40. If $a_1, a_2, a_3\ (a_1 > 0)$ are in G. P. with common ratio r, then the value of r, for which the inequality $9a_1 + 5a_3 \le 14a_2$ holds, can not lie in the interval

(A) $[1, \infty)$
(B) $\left[1, \frac{9}{5}\right]$
(C) $\left[\frac{4}{5}, 1\right]$
(D) $\left[\frac{5}{9}, 1\right]$

Space for Rough work

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

41. If $\int \frac{xe^x}{\sqrt{(1+e^x)}}dx = f(x)\sqrt{(1+e^x)} - 2\ln g(x) + c$, then

(A) $f(x) = x-1$

(B) $g(x) = \frac{\sqrt{(1+e^x)}-1}{\sqrt{(1+e^x)}+1}$

(C) $g(x) = \frac{\sqrt{(1+e^x)}+1}{\sqrt{(1+e^x)}-1}$

(D) $f(x) = 2(x-2)$

42. Which of the following are true:

(A) $\sqrt{e^\pi} > \left(\frac{\pi}{2}\right)^e$

(B) $e^\pi > \pi^e$

(C) $e^3 > 3^e$

(D) $e^2 > 2^e$

43. If ${}^{100}C_6 + 4.{}^{100}C_7 + 6.{}^{100}C_8 + 4.{}^{100}C_9 + {}^{100}C_{10}$ has the value equal to ${}^xC_y$; then the possible value (s) of $x+y$ can be:

(A) 112

(B) 114

(C) 196

(D) 198

44. If $\vec{a} = \hat{i} + 6\hat{j} + 3\hat{k}; \vec{b} = 3\hat{i} + 2\hat{j} + \hat{k}$ and $\vec{c} = (\alpha+1)\hat{i} + (\beta-1)\hat{j} + \hat{k}$ are linearly dependent vectors and $|\vec{c}| = \sqrt{6}$; then the possible value(s) of $(\alpha+\beta)$ can be:

(A) 1

(B) 2

(C) 3

(D) 4

Space for Rough work

45. If $A = \begin{bmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{bmatrix}$, then

(A) $\operatorname{adj}(\operatorname{adj} A) = A$
(B) $|\operatorname{adj}(\operatorname{adj} A)| = 1$
(C) $|\operatorname{adj} A| = 1$
(D) none of these

46. There exists a triangle ABC satisfying the conditions

(A) $b\sin A = a,\ A < \frac{\pi}{2}$
(B) $b\sin A > a,\ A > \frac{\pi}{2}$
(C) $b\sin A > a,\ A < \frac{\pi}{2}$
(D) $b\sin A < a,\ A < \frac{\pi}{2},\ b > a$

47. If $I_n = \int_0^{\pi/4} \tan^n x\, dx$, then

(A) $I_5 + I_3 = \frac{1}{4}$
(B) $I_8 + I_6 = \frac{1}{7}$
(C) $I_6 - I_{10} = \frac{2}{63}$
(D) $I_6 + 2I_8 + I_{10} = \frac{16}{63}$

48. If A, A_1, A_2, A_3 are the areas of the inscribed and escribed circle of a ΔABC, then

(A) $\sqrt{A_1} + \sqrt{A_2} + \sqrt{A_3} = \sqrt{\pi}(r_1 + r_2 + r_3)$
(B) $\frac{1}{\sqrt{A_1}} + \frac{1}{\sqrt{A_2}} + \frac{1}{\sqrt{A_3}} = \frac{1}{\sqrt{A}}$
(C) $\frac{1}{\sqrt{A_1}} + \frac{1}{\sqrt{A_2}} + \frac{1}{\sqrt{A_3}} = \frac{s^2}{\sqrt{\pi}\, r_1 r_2 r_3}$
(D) $\sqrt{A_1} + \sqrt{A_2} + \sqrt{A_3} = \sqrt{\pi}(4R + r)$

Space for Rough work

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded ‑ off to the **second decimal place**; e.g. XXXXX.XX).

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49. In a triangle ABC, the equation of the side BC is 2x – y = 3 and its circumcentre and orthocentre are at (2, 4) and (1, 2) respectively. The value of '$\sqrt{61}$ sin B sin C' is equal to.

50. The integral values of n, the value of $\lim\limits_{n\to-\infty}\left(\sqrt{n^2-n+1}-\left[\sqrt{n^2-n+1}\right]\right)$, where [.] → Greatest Integer Function.

51. The solution of the differential equation $\frac{d^3y}{dx^3}-8\frac{d^2y}{dx^2}=0$ satisfying $y(0)=\frac{1}{8},\ y_1(0)=0$ and $y_2(0)=1$ is $y=\frac{e^{8x}-8x+7}{\lambda}$. The numerical value of $\frac{\lambda}{10}$ is.

52. If $\int_{-\sqrt{2}}^{\sqrt{2}}\frac{\left(2x^7+3x^6-10x^5-7x^3-12x^2+x+1\right)}{\left(x^2+2\right)}dx=\frac{\sqrt{2}}{20}\left(5\pi+k^2\right)$, then the value of $\frac{k}{5}$ must be.

53. Let $\left|\vec{a}\right|=1, \left|\vec{b}\right|=1$ and $\left|\vec{a}+\vec{b}\right|=\sqrt{3}$. If $\vec{c}$ be a vector such that $\vec{c}=\vec{a}+2\vec{b}-3\left(\vec{a}\times\vec{b}\right)$ and $p=\left|\left(\vec{a}\times\vec{b}\right)\times\vec{c}\right|$, then p^2 is equal to.

54. In a ΔABC, if $\begin{vmatrix}1 & a & b\\ 1 & c & a\\ 1 & b & c\end{vmatrix}=0$, then the value of $\left(\sin^2 A+\sin^2 B+\sin^2 C\right)$ equals______.

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – II

JEE (Advanced)-2020

PAPER – 1

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

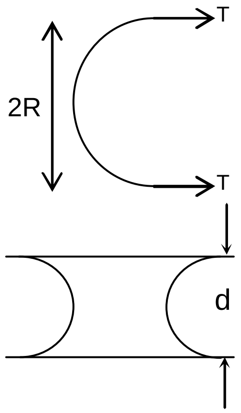
1. C

Sol. The shape of water layer between the two plates is shown in the figure.

Thickness d of the film = 0.12 mm = 0.012 cm.

Radius R of cylindrical face $= \frac{d}{2}$.

F = T(2l) = $P\left(l \times 2R\right)$



$P = \frac{T}{R}$

Pressure difference across the cylindrical surface $= \frac{T}{R} = \frac{2T}{d}$.

Area of each plate wetted by water = A.

Force F required to separate the two plates is given by

F = pressure difference × area $= \frac{2T}{d}A$

$= \frac{2 \times 75 \times 8}{0.012} = 10^5$ dynes

2. A

Sol. $(\text{Loss in K.E. of combined system}) = (\text{Gain in P.E. of combined system})$

$$\Rightarrow \frac{1}{2}(m_1 + m_2)V^2 = (m_1 + m_2)\frac{gh}{4}$$

$$\Rightarrow V = \sqrt{2g\left(\frac{h}{4}\right)} \qquad \ldots(1)$$

$$m_1gh = \frac{1}{2}m_1v^2 \quad \Rightarrow v = \sqrt{2gh}$$

Further by Law of Conservation of Momentum $(m_1 + m_2)V = m_1v$

$$\Rightarrow (m_1 + m_2)\sqrt{\frac{2gh}{4}} = m_1\sqrt{2gh}$$

$$\Rightarrow \frac{1}{2}(m_1 + m_2) = m_1 \quad \Rightarrow m_1 = m_2$$

3. B

Sol. Consider an elementary part of radius x and width dx.

$$B = \int dB = \int_{R_1}^{R_2} \frac{\mu_0 I}{2\ x} \frac{100}{(R_2 - R_1)} dx$$

$$= \frac{2.3 \times 2\pi \times 10^{-7} \times 100}{5 \times 10^{-2}} \ln 2 = 2.003 \times 10^{-4}\ T$$

4. B

Sol. When the rod falls through an angle α the C.G. falls through a height h.

In $\Delta OB'B$,

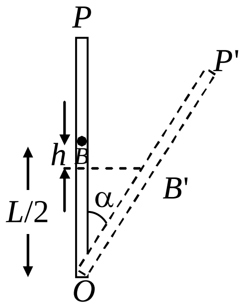
$$\cos\alpha = \frac{\left(\frac{L}{2} - h\right)}{L/2}$$

$$\text{i.e. } h = \frac{L}{2}(1 - \cos\alpha)$$

K.E. rotation = Decrease in P.E.

$$\text{i.e. } \frac{1}{2}I\omega^2 = mgh$$

$$\text{i.e. } \frac{1}{2}\left(\frac{mL^2}{3}\right)\omega^2 = mg\frac{L}{2}(1 - \cos\alpha) \quad \text{or } \omega = \sqrt{\frac{6g}{L}}\sin\frac{\alpha}{2}$$



5. ABC

Sol. (A) At maximum extension $V_A = V_B = 0$

$$2mgx = \frac{1}{2}kx^2$$

$$x_m = \frac{4mg}{k}$$

(B) $2mg\frac{2mg}{k}=\frac{1}{2}k\left(\frac{2mg}{k}\right)^2+\frac{1}{2}(m+2m)v^2$

$V=2g\sqrt{\frac{2m}{3k}}$

(C) Spring force $\Rightarrow \frac{4mg}{k}\times k=4mg$

net downward force $\Rightarrow$ 2 mg

$a=\frac{4mg-2mg}{3m}\ =\frac{2}{3}g$

(D) for $x=\frac{2mg}{k}$, a = 0

$\therefore$ T = 2 mg

6. A

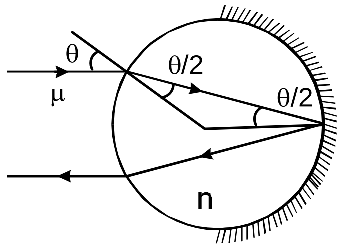
Sol. $50=\frac{T_{Y_2}}{\ln 2}\ln\frac{1}{1-0.01}$

$\Rightarrow\ T_{Y_2}=\frac{50\ln(2)}{\ln\frac{100}{99}}$

7. A

Sol. $\frac{\sin\theta}{\sin\theta/2}=\frac{\theta}{\theta/2}=\mu$

$\therefore\ \mu=2$

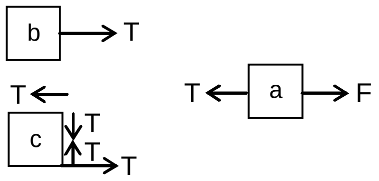


8. AD

Sol. Negative of potential gradient is equal to electric field.

9. BC

Sol. F – T = 10 × a …(1)
T = 10 × a …(2)
F = 20a $\Rightarrow$ a = 1
T = 10 N, $a_a=a_b=1,\ a_c=0$



10. ABC

Sol. When switch is closed, all charges will go on outer surface of outer shell and inside E = 0 therefore equipotential at all points 1, 4 and 3 and at point 4 has some potential.

11. C

Sol. $\because\ \vec{B}\text{ and }\vec{F}_2 \perp,\quad \vec{V}_1 \perp \vec{F}_1\ \vec{V}_2 \perp \vec{F}_2$

$\therefore$ qa – qc = 0

a = C

12. C

Sol. $\lambda = \frac{d}{10}$, path define = $n\lambda$ [n = ± 1, + 2 ± 3]

$\therefore\quad |n = \pm 1, \pm 2, \pm 3|$

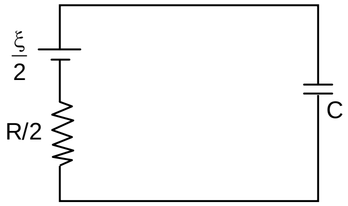
$\therefore\ |n| = 6.$

SECTION – C

13. 00000.12

Sol. Equivalent ckt.

$$P_{max} = \left(\frac{\xi}{4}\right)\cdot\frac{\xi/2}{R} = \frac{\xi^2}{8R} = 0.125\,\frac{\xi^2}{R}$$



14. 00000.50

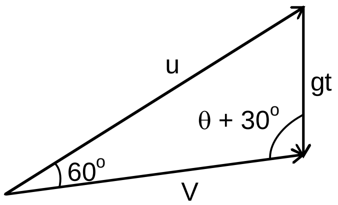
Sol. $$W_3 - W_4 = -\frac{1}{4\pi t_0}\frac{q^2}{r_{34}} = -\frac{1}{4\pi t_0}\frac{q^2}{r2\sin\frac{3\pi}{n}}$$

$$= \frac{-q^2}{8\pi\varepsilon_o r\sin\frac{3\pi}{n}} = 0.5\left[\frac{-q^2}{4\pi t_0 r\sin\left(\frac{3\pi}{n}\right)}\right]$$

15. 00000.86

Sol. $$\frac{gt}{\sin 60^o} = \frac{u}{\sin(30+\theta)}$$

$$t = \frac{\sqrt{3}u}{2g}\,\frac{1}{\sin(\theta + 30^o)}$$



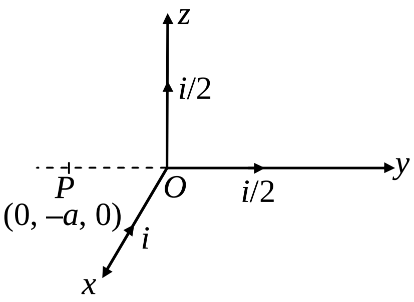
16. 00024.88

Sol. In one oscillation, distance covered = 4 × 3 = 12 cm

Here, $\omega = \frac{2\pi}{T} \Rightarrow T = 4\text{s}.$ Now, 8.5 = 4 × 2 + 0.5

$$24 + \left(3 - 3\cos\frac{\pi}{2}\times 0.5\right) = \left(27 - \frac{3}{\sqrt{2}}\right)\text{cm} = (27 - 1.5 \times 1.414)\text{ cm} = 24.88\text{ cm}$$

17. 00001.11



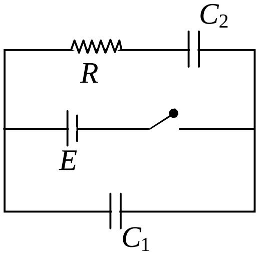
Sol. The field at *P* due to current *i* along x-axis is $\frac{\mu_0 i}{4\pi a}\hat{k}$,

and due to the current $\frac{i}{2}$ along z-axis is $\frac{\mu_0 i}{8\pi a}(-\hat{i})$.

The resultant field at *P* is $\frac{\mu_0 i}{4\pi a}\sqrt{1^2+\left(\frac{1}{2}\right)^2} = \frac{\sqrt{5}}{8}\frac{\mu_0 i}{\pi a}$

$= \frac{\sqrt{5}}{2}\frac{\mu_0 i}{4\pi a} = 1.118\frac{\mu_0 i}{4\pi a}$

18. 00000.63



Sol. Rearranging the circuit, we observed that C_1 is joined directly to the cell and acquires its full charge when *S* is closed. It plays no part in the charging of C_2 through *R*.

So, $q_2 = Q_0(1-e^{-t/\tau})$ = $\theta_0(1 - 0.37) = 0.63\ \theta_0$

Chemistry PART – II

SECTION – A

19. C

Sol. NaOH is not used as a dehydration agent.

20. C

Sol.

$$\begin{array}{llll} & A(g) & \rightarrow 4B(g) & + \ 3C(g) \\ \text{At } t=0: & P_o & 0 & 0 \\ \text{At } t=20\,\text{min}: & P_o - x & 4x & 3x \end{array}$$

$$P_o - x + 4x + 3x = 400 \Rightarrow P_o + 6x = 400 \Rightarrow 6x = 400 - 100 = 300$$

x = 50

$$K = \frac{0.693}{t_{1/2}} = \frac{0.693}{20 \times 60} = 5.7 \times 10^{-4}\ \text{sec}^{-1}$$

21. B

Sol. $PbS + 4H_2O_2 \longrightarrow PbSO_4 + 4H_2O$

22. A

Sol. $E_{cell} = E^o - \frac{0.0591}{2}\log\frac{[Zn^{2+}]}{[Cu^{2+}]}$

E_{cell} can be increased by diluting the concentration of $[Zn^{2+}]$

23. ABC

Sol. Dipole moment of $NH_3 > NF_3$, $SCl_2 > BeCl_2$(zero value)
$SF_4 > CF_4$(zero value)

24. BC

Sol. It is an endothermic reaction as the equilibrium constant increases with increasing temperature.

25. BCD

Sol. Gr-III, radicals are precipitated with NaOH.

26. CD

Sol. For Ni^{2+} the configuration is $t_{2g}^6 e_g^2$ and Zn^{2+} is $t_{2g}^6 e_g^4$.

27. AC

Sol. $\mu = 2\mu\cos\frac{\theta}{2}$ [When two diploes are identical]

28. CD

Sol. Carbon reduction and distillation(refining) are common for both the ores

$ZnO + C \longrightarrow Zn + CO$

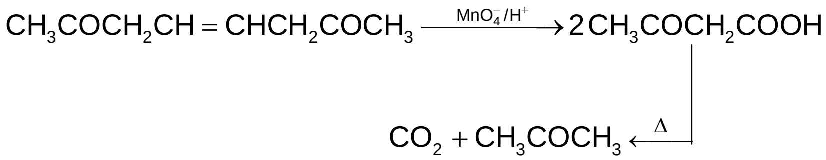
$Zn(\text{impure}) \xrightarrow{\text{distillation}} Zn(\text{pure})$

29. CD

Sol. Na^+ ions are present at octahedral voids, which are body centre and edge centre positions.

30. A

Sol.



$$CH_3COCH_2CH=CHCH_2COCH_3 \xrightarrow{MnO_4^-/H^+} 2CH_3COCH_2COOH \xrightarrow{\Delta} CO_2 + CH_3COCH_3$$

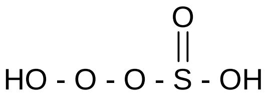
SECTION – C

31. 00001.00

Sol. The valence electrons are $3s^23p^1$ for which $\ell = 0$ and 1.

32. 00002.00

Sol. The structure of H_2SO_5 is:



$$HO-O-O-\overset{\overset{\displaystyle O}{||}}{S}-OH$$

33. 00001.00

Sol. Total charge on four oxide ions = -2 × 4 = -8

Let 'n' no. of $X^{-8/3}$ ions will replace O^{2-} ions

$\therefore\ n \times \frac{-8}{3} = -8 \Rightarrow n = 3$

$\therefore$One vacancy will be created.

34. 00005.50

Sol. $\Delta T_f = K_f \times n \times \frac{1000}{W}$

Or, $4 = 1.86 \times \frac{6.2}{62} \times \frac{1000}{W}$

$\therefore\ W = 46.5$ g

$\therefore$ Mass of water converted to ice = 52 – 46.5 = 5.5

35. 00003.74

Sol. It is a buffer solution

$$pH = p^{K_a} + \log\frac{[CH_3COONa]}{[CH_3COOH]} = 4.74 + \log\frac{1}{10} = 3.74$$

36. 00012.56

Sol. $\sqrt{\frac{3RT}{M}} = \sqrt{\frac{2RT}{M}}$

or, $\sqrt{\frac{3R \times 500}{30}} = \sqrt{\frac{2R \times 314}{M}}$

On solving, M = 12.56

Mathematics PART – III

SECTION – A

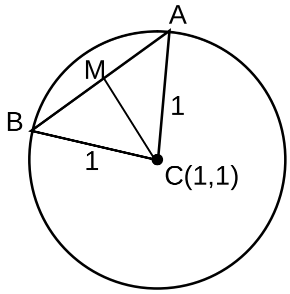
37. A

Sol. The given circle is $(x-1)^2 + (y-1)^2 = 1$.

In the figure $MC = 1 \times \frac{\sqrt{3}}{2}$

$\Rightarrow$ locus of the point M is

$(x-1)^2 + (y-1)^2 = \frac{3}{4}$.



38. A

Sol. We have max.{|x – 1|, |y – 2|} = 4.
If $|x-1| \geq |y-2|$ then $|x-1| = 4$,
i.e. if $(x+y-3)(x-y+1) \geq 0$ then $x = -3$ or 5,
If $|y-2| \geq |x-1|$ then $|y-2| = 4$
i.e. $(x+y-3)(x-y+1) \leq 0$, then $y = -2$ or 6.
So, the locus of P bounds a square, the equation of whose sides are
$x = -3$, $x = 5$, $y = -2$, $y = 6$.
Thus the area is $(8)^2 = 64$.

39. C

Sol. a, b > 0 and c < 0

angle between OA and OB is $\frac{\pi}{2}$.

Since z_2 lie in 2nd quadrant

$\Rightarrow$ $\bar{z}_2$ will lie in 3rd quadrant.

$\Rightarrow \sqrt{2} < \left|z_1 - \bar{z}_2\right| \leq 2$.

Also true if z_2 lies in 3rd quadrant.

40. B

Sol. Hint : $a_1 = \frac{a}{r}, a_2 = a, a_3 = ar$

Solution : If $a_1, a_2, a_3\ (a_1 > 0)$ are in G.P.

$\Rightarrow 9a_1 + 5a_3 \leq 14a_2$

$\Rightarrow 9\frac{a}{r} + 5ar \leq 14a$

$\Rightarrow \frac{9}{r} + 5r \leq 14$

$\Rightarrow 5r^2 - 14r + 9 \leq 0$

$\Rightarrow 5r^2 - 5r - 9r + 9 \leq 0$

$\Rightarrow 5r(r-1) - 9(r-1) > 0$

$\therefore$ The interval is $\left[1, \frac{9}{5}\right]$

41. BD

Sol. Let $I = \int \frac{x\ e^x}{\left(1+e^x\right)} dx$

$$= \int x.\frac{e^x}{\sqrt{\left(1+e^x\right)}} dx$$

$$= x.2\sqrt{\left(1+e^x\right)} - \int 1.2\sqrt{\left(1+e^x\right)}\,dx$$

$$= 2x\sqrt{\left(1+e^x\right)} - 2\int \sqrt{\left(1+e^x\right)}\,dx$$

In second integral

Put $1+e^x = t^2$

$\therefore$ $dx = \frac{2t\ dt}{t^2-1}$

Then, $= 2x\sqrt{\left(1+e^x\right)} - 4\int \frac{t^2-1+1}{\left(t^2-1\right)} dt$

$$= 2x\sqrt{\left(1+e^x\right)} - 4\int \left(1+\frac{1}{t^2-1}\right) dt$$

$$= 2x\sqrt{\left(1+e^x\right)} - 4\left\{t + \frac{1}{2}\ln\left(\frac{t-1}{t+1}\right)\right\} + c$$

$$= 2x\sqrt{\left(1+e^x\right)} - 4\sqrt{\left(1+e^x\right)} - 2\ln\left(\frac{\sqrt{\left(1+e^x\right)}-1}{\sqrt{\left(1+e^x\right)}+1}\right) + c$$

$$= \left(2x-4\right)\sqrt{\left(1+e^x\right)} - 2\ln\left(\frac{\sqrt{\left(1+e^x\right)}-1}{\sqrt{\left(1+e^x\right)}+1}\right) + c$$

On comparing

$$f\left(x\right) = 2x-4,\ g\left(x\right) = \frac{\sqrt{\left(1+e^x\right)}-1}{\sqrt{\left(1+e^x\right)}+1}$$

42. ABCD

Sol. Let $f\left(x\right) = e^x - x^e$

$f'\left(x\right) = e^x - ex^{e-1} = 0$ if $e^x = ex^{e-1}$

$\Rightarrow e^{x-1} = x^{e-1} \rightarrow x = e$

If $x > e$, $f'\left(x\right) > 0 \Rightarrow f\left(x\right) > f\left(e\right)$

If $x < e$, $f'\left(x\right) < 0$, $f\left(x\right) > f\left(e\right)$

as $\frac{\pi}{2} < e$, $e^{\frac{\pi}{2}} > \left(\frac{\pi}{2}\right)^e$

as $\pi > e,\ e^{\pi} > \pi^{e}$

as $\pi > e, e^{\pi} > \pi^{e}$

as $3 > e,\ e^{3} > 3^{e}$

as $2 < e, e^{2} > 2^{e}$

43. BD

Sol. ${}^{100}C_6 + 4.\,{}^{100}C_7 + 6.{}^{100}C_8 + 4.\,{}^{100}C_9 +{}^{100}C_{10}$

$={}^{4}C_0.{}^{100}C_6 +{}^{4}C_1.{}^{100}C_7 +{}^{4}C_2{}^{100}C_8 +{}^{4}C_3.{}^{100}C_9.{}^{100}C_9 +{}^{4}C_4.{}^{100}C_{10}$

$={}^{4}C_0.{}^{100}C_{94} +{}^{4}C_1 \times{}^{100}C_{93} +{}^{4}C_2 \times{}^{100}C_{92} +{}^{4}C_3 \times{}^{100}C_{91} +{}^{4}C_4 \times{}^{100}C_{90}$

$={}^{104}C_{94} ={}^{104}C_{10}$

$\Rightarrow 104 + 94 = 198,\ 104 + 10 = 114$

44. AC

Sol. Take $\left[\bar{a}\quad \bar{b}\quad \bar{c}\right] = 0$

$\Rightarrow \beta = 3$

$\therefore \vec{c} = (\alpha + 1)\hat{i} + 2\hat{j} + \hat{k}$

$|\vec{c}| = \sqrt{6}$

$(\alpha + 1)^2 + 4 + 1 = 6 \qquad \Rightarrow \alpha = 0, -2$

$\therefore \alpha + \beta = 3, 1$

45. ABC

Sol. $\because |A| = \begin{vmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{vmatrix} = 3(-3+4) - 2(-3+4) + 0 = 1$

$\because \quad \text{adj}(\text{adj}\,A) = |A|^{3-2} A = A$ and $|\text{adj}(\text{adj}\ A)| = |A| = 1$

Also, $|\text{adj}\ A| = |A|^{3-1} = |A|^2 = 1^2 = 1$

46. AD

Sol. $\because \sin B = \dfrac{b\sin A}{a}, \sin B < 1$

Then, $\dfrac{b\sin A}{a} < 1 \Rightarrow \sin A < \dfrac{a}{b} \Rightarrow$ For triangle to be possible a < b

$\therefore \quad b\sin A < a$

If $b\sin A = a \Rightarrow \angle B = \dfrac{\pi}{2} \Rightarrow \angle A < \dfrac{\pi}{2}$

47. ABCD

Sol. $\because \quad I_n = \int_0^{\pi/4} \tan^{n-2} x\left(\sec^2 x - 1\right)dx$

$= \int_0^{\pi/4} \tan^{n-2} x.\sec^2 x\,dx - I_{n-2}$

or $\quad I_n + I_{n-2} = \dfrac{1}{(n-1)}$

For $\quad n = 5,\ I_5 + I_3 = \dfrac{1}{4} \qquad \ldots(i)$

For $\quad n = 8,\ I_8 + I_6 = \dfrac{1}{7} \qquad \ldots(ii)$

For $\quad n = 10, I_{10} + I_8 = \dfrac{1}{9} \qquad \ldots.(iii)$

Subtracting Eq. (iii) from (ii), then

$$I_6 - I_{10} = \frac{2}{63} \qquad \ldots.(iv)$$

Adding Eqs. (ii) and (iii), we get $I_6 + 2I_8 + I_{10} = \dfrac{16}{63}$

48. ABCD

Sol. $A_1 = \pi r_1^2;\ A_2 = \pi r_2^2;\ A_3 = \pi r_3^2$

$$\sqrt{A_1} + \sqrt{A_2} + \sqrt{A_3} = \sqrt{\pi}\left(r_1 + r_2 + r_3\right) = \sqrt{\pi}\left(4R + r\right)$$

$$\frac{1}{\sqrt{A_1}} + \frac{1}{\sqrt{A_2}} + \frac{1}{\sqrt{A_3}} = \frac{1}{\sqrt{\pi}}\left(\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}\right) = \frac{1}{\sqrt{\pi}}\left(\frac{1}{r}\right) = \frac{1}{\sqrt{\pi r^2}} = \frac{1}{A}$$

$$\frac{s^2}{\sqrt{\pi}\, r_1 r_2 r_3} = \frac{s.s(s-c)(s-b)(s-c)}{\sqrt{\pi}\,\Delta^3} = \frac{s\Delta^2}{\sqrt{\pi}\,\Delta^2} = \frac{1}{A}$$

SECTION – C

49. 00004.50

Sol. R cos A = $\dfrac{3}{\sqrt{5}}$ $\Rightarrow$ – R cos B cos C + R sin B sin C = $\dfrac{3}{\sqrt{5}}$ and 2R cos B cos C = $\dfrac{3}{\sqrt{5}}$

$\Rightarrow$ R sin B sin C = $\dfrac{3}{\sqrt{5}} + \dfrac{3}{2\sqrt{5}} = \dfrac{9}{2\sqrt{5}}$

sin B sin C = $\dfrac{9}{2\sqrt{5}} \times \sqrt{\dfrac{5}{61}} = \dfrac{9}{2\sqrt{61}}$.

50. 00000.50

Sol. For n$\in$N, $n < \sqrt{n^2 + n + 1} < n + 1$

So required answer $= \lim\limits_{n\to\infty}\left(\sqrt{n^2+n+1} - \left[\sqrt{n^2+n+1}\right]\right)$

$$= \lim_{n\to\infty}\left(\sqrt{n^2+n+1} - n\right) = \lim_{n\to\infty}\frac{n+1}{\sqrt{n^2+n+1}+n} = \frac{1}{2}$$

51. 00006.40

Sol. $\dfrac{\dfrac{d^3y}{dx^3}}{\dfrac{d^2y}{dx^2}} = 8$

$\Rightarrow \quad \ln\frac{d^2y}{dx^2} = 8x + c$

or $\quad \ln y_2 = 8x + c$

Putting x = 0, we have $c = 0$.

$\therefore \quad \ln y_2 = 8x \Rightarrow y_2 = e^{8x}$

$\therefore \quad y_1 = \frac{e^{8x}}{8} + D$

Again putting $x = 0,\ D = -\frac{1}{8}$.

$\Rightarrow \quad y_1 = \frac{e^{8x}}{8} - \frac{1}{8}$

$\Rightarrow \quad y = \frac{e^{8x}}{64} - \frac{x}{8} + E$

Putting $x = 0,\ E = \frac{1}{8} - \frac{1}{64} = \frac{7}{64}$.

Hence, $y = \frac{e^{8x}}{64} - \frac{x}{8} + \frac{7}{64} = \frac{e^{8x} - 8x + 7}{64}$.

52. 00001.60

Sol. Let $I_i = \frac{\left(2x^7 + 3x^6 - 10x^5 - 7x^3 - 12x^2 + x + 1\right)}{\left(x^2 + 2\right)}dx$

$$= \int_{-\sqrt{2}}^{\sqrt{2}} \frac{\left(2x^7 - 10x^5 - 7x^3 + x\right)}{\left(x^2 + 2\right)}dx + \int_{-\sqrt{2}}^{\sqrt{2}} \frac{\left(3x^6 - 12x^2 + 1\right)}{\left(x^2 + 2\right)}dx$$

$$= 0 + 2\int_0^{\sqrt{2}} \frac{3x^2\left(x^4 - 4\right) + 1}{\left(x^2 + 2\right)}dx$$

$$= 2\int_0^{\sqrt{2}} \left(3x^2\left(x^2 - 2\right) + \frac{1}{x^2 + 2}\right)dx$$

$$= 2\left\{\frac{3x^5}{5} - 2x^3 + \frac{1}{\sqrt{2}}\tan^{-1}\left(\frac{x}{\sqrt{2}}\right)\right\}_0^{\sqrt{2}}$$

$$= 2\left\{\frac{12\sqrt{2}}{5} - 4\sqrt{2} + \frac{1}{\sqrt{2}}.\frac{\pi}{4}\right\}$$

$$= \frac{24\sqrt{2}}{5} - 8\sqrt{2} + \sqrt{2}.\frac{\pi}{4} = \frac{\sqrt{2}}{20}\left(5\pi + 64\right)$$

$\therefore k^2 = 64 \Rightarrow k = 8$

53. 00005.25

Sol. $\left|\vec{a}\right| = 1,\ \left|\vec{b}\right| = 1,\ \left|\vec{a} + \vec{b}\right| = \sqrt{3}$

$3 = 1 + 1 + 2\vec{a}.\vec{b} \Rightarrow \vec{a}.\vec{b} = \frac{1}{2}$

$$\vec{C} = \vec{a} + 2\vec{b} - 3\left(\vec{a}\times\vec{b}\right)$$

$$p = \left(\vec{a}\times\vec{b}\right)\times\vec{c} \Rightarrow \left(\vec{a}\times\vec{b}\right)\times\left(\vec{a} + 2\vec{b} - 3\left(\vec{a}\times\vec{b}\right)\right)$$

$$= \left(\vec{a}\times\vec{b}\right)\times\vec{a} + 2\left(\vec{a}\times\vec{b}\right)\times\vec{b}$$

$$= \left(\vec{a}.\vec{a}\right)\vec{b} - \left(\vec{b}.\vec{a}\right)\vec{a} + 2\left(\left(\vec{a}.\vec{b}\right)\vec{b} - \left(\vec{b}.\vec{b}\right).\vec{a}\right)$$

$$= \vec{b} - \frac{1}{2}\vec{a} + 2\times\left(\frac{1}{2}\vec{b} - \vec{a}\right) = 2\vec{b} - \frac{5}{2}\vec{a}$$

$$\left|\vec{p}\right| = \sqrt{4 + \frac{25}{4} + 10\vec{a}.\vec{b}} = \sqrt{\frac{41}{4} - 5} = \frac{\sqrt{21}}{2}$$

54. 00002.25

Sol. $a^2 + b^2 + c^2 = ab + bc + ca \Rightarrow \frac{1}{2}\left\{(a-b)^2 + (b-c)^2 + (c-a)^2\right\} = 0$

$\Rightarrow a = b = c \Rightarrow A = B = C = 60^o$

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – II

JEE (Advanced)-2020

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section-A (01 – 08, 19 – 26, 37 – 44)*** *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–1** In all other cases.*

   Section-A (09 – 12, 27 – 30, 45 – 48) *contains 6 List-Match sets with 12 questions (each set has 2 questions). Each question has 4 statements in LIST-I & 5 or 6 statements in LIST-II. The codes for Lists have choices (A), (B), (C), (D) out of which only one is correct.*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A

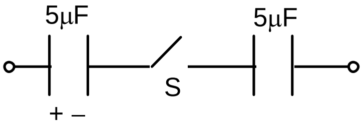
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. Let I_A and I_B be moments of inertia of a body about two axes A and B respectively. The axis A passes through the centre of mass of the body but B does not, then

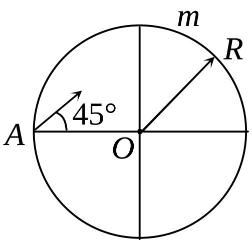
(A) I_A may be greater than I_B
(B) I_B may be greater than I_A
(C) I_A may be equal to I_B
(D) I_A must be smaller than I_B

2. In the circuit shown, one of the capacitors is charged to 10V as shown by some external means and then connected to another uncharged capacitor as shown. After closing s, charge flown through 'S' (switch) will be



(A) 0 μC
(B) 25 μC
(C) 50 μC
(D) None of these

3. A ring of mass m and radius R is placed on a frictionless horizontal surface. A particle of mass m is projected from point A with velocity v at an angle of 45° with AO as shown. The correct statements are



(A) The particle reaches the same point A on the ring after time $\frac{4R\sqrt{2}}{v}$.

(B) Magnitude of impulse transformed during first collision is $\frac{mv}{\sqrt{2}}$.

(C) Magnitude of impulse transformed during second collision is $\frac{mv}{\sqrt{2}}$.

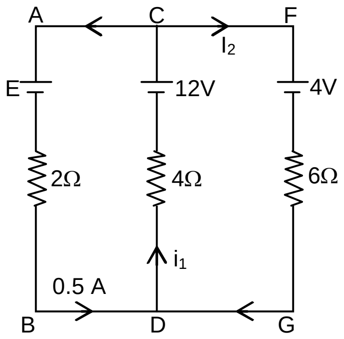
(D) Particle reaches diametrically opposite point on the ring in time $\frac{2R}{v}$.

Space for Rough work

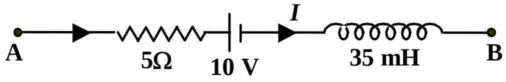
4. In the circuit shown in figure

(A) E = 6.6 V (B) i_1 = 1.1 A

(C) i_2 = 0.5 A (D) E = 4.4 V



5. The network shown in Figure is part of a complete circuit. If at a certain instant the current (I) is 5A, and is decreasing at a rate of 10^3 A/s, then find the value of $V_B - V_A$ in (V).



(A) 0 (B) 10

(C) 15 (D) 20

6. Using screw gauge the radius of the wire is found to be 2.50 mm. The length of wire is measured by using a scale and is found to be 50.0 cm. If mass of wire is measured as 25 g, then mark the correct statement(s) [Take π = 3.14]

(A) The density has to be computed upto 2 significant digit.

(B) The least count of scale used to measure length of wire is 1 mm.

(C) The density of wire is 2.5 g/cm^3.

(D) The least count of screw gauge is 0.01 mm

7. Light of wavelength 3500A^o is incident on two metals A and B, A of work function 4.2 eV and B of work function 1.19 eV respectively. The photoelectrons will be emitted by

(A) metal A (B) metal B

(C) both A and B (D) neither metal A nor metal B

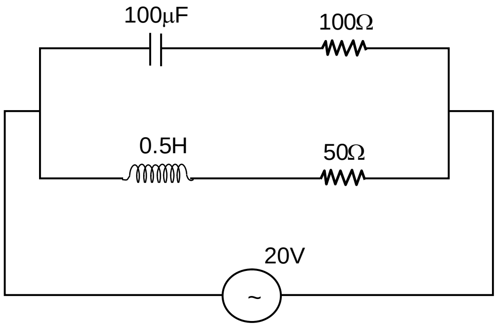
8. In the given circuit, the AC source has ω = 100 rad/s. Considering the inductor and capacitor to be ideal, the

(A) the current through the circuit, I is 0.3 A

(B) the current through the circuit, I is $0.3\sqrt{2}$A

(C) the voltage across 100 Ω resistor = $10\sqrt{2}$ V

(D) the voltage across 50Ω resistor = 10 V



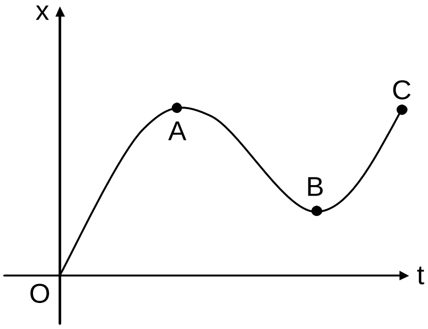
Space for Rough work

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO (02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

The displacement time (x – t) graph of a body acted by some forces is shown in the figure.



List – I		List – II	
(I)	From 'O' to just before 'A', the physical quantity of the body is	(P)	Zero
(II)	In between the points 'A' and 'B' the physical quantity of the body is	(Q)	Positive
(III)	In between the points 'B' and 'C' the physical quantity of the body is	(R)	Negative
(IV)	At the point 'A' the physical quantity of the body is	(S)	First negative then positive
		(T)	First positive then negative
		(U)	Cannot be explained.

9. If the physical quantity of the body is velocity then the correct match List-I and List-II.

(A) I → Q, II → R, III → Q, IV → P
(B) I → R, II → Q, III → P, IV → Q
(C) I → U, II → R, III → Q, IV → P
(D) I → T, II → U, III → S, IV → P

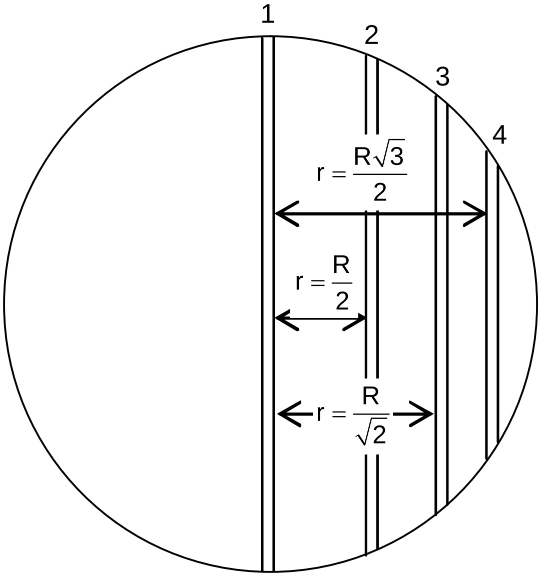
Space for Rough work

10. If the physical quantity of the body is acceleration then the correct match List-I and List-II.

(A) I $\rightarrow$ S, II $\rightarrow$ T, III $\rightarrow$ Q, IV $\rightarrow$ R
(B) I $\rightarrow$ R, II $\rightarrow$ S, III $\rightarrow$ Q, IV $\rightarrow$ R
(C) I $\rightarrow$ T, II $\rightarrow$ S, III $\rightarrow$ Q, IV $\rightarrow$ P
(D) I $\rightarrow$ S, II $\rightarrow$ Q, III $\rightarrow$ T, IV $\rightarrow$ P

Answer the following by appropriately matching the list based on the information given in the paragraph.

Consider a planet of radius R having density ρ. The four tunnels (1, 2, 3 and 4) are dug side at the distances from its centre are r = 0, $r = \frac{R}{2}$, $r = \frac{R}{\sqrt{2}}$ and $r = \frac{R\sqrt{3}}{2}$ respectively as shown. Four objects each of mass 1 kg are dropped inside the tunnel from the surface of plant at t = 0.



List-I gives the above four tunnels while List-II the magnitude of some quantity.

List – I		List – II	
(I)	Tunnel '1'	(P)	0
(II)	Tunnel '2'	(Q)	$\frac{2\pi G\rho R}{3}$
(III)	Tunnel '3'	(R)	$\frac{2\sqrt{2}\pi G\rho R}{3}$
(IV)	Tunnel '4'	(S)	$\frac{2\pi G\rho R}{\sqrt{3}}$
		(T)	$\frac{4\pi G\rho}{3}R$

Space for Rough work

11. The normal reaction between objects and mid of tunnels, the correct match is
(A) I → P, II → Q, III → R, IV → S (B) I → S, II → R, III → Q, IV → P
(C) I → Q, II → P, III → R, IV → S (D) I → P, II → Q, III → S, IV → R

12. The magnitude of maximum acceleration of the objects in the tunnels
(A) I → T, II → S, III → R, IV → Q (B) I → S, II → T, III → R, IV → Q
(C) I → T, II → S, III → S, IV → R (D) I → Q, II → R, III → S, IV → T

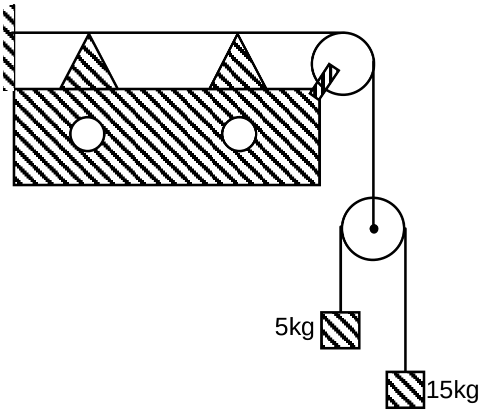
SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded ‑ off to the **second decimal place**; e.g. XXXXX.XX).

---

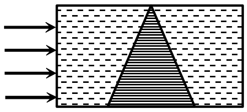
13. A proton is fired from very far away towards a nucleus with charge = 120 e, where e is the electronic charge. It makes a closest approach of 10 fm to the nucleus. The de Broglie wavelength (in units of fm) of the proton at its start is: (take the proton mass, $m_p = (5/3) \times 10^{-27}$ kg ; $h/e = 4.2 \times 10^{-15}$ J.s./C; $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ m/F; 1 fm = 10^{-15} m)

14. In a sonometer wire, When the tension is maintained by suspending a 20 kg mass from the free end of the wire, the fundamental frequency of vibration is 300 Hz. If the tension is provided by two masses of 5 kg and 15 kg suspended form a pulley (massless and friction less) as shown in the figure, if the fundamental frequency will approximately n65 Hz then find the value of 'n'



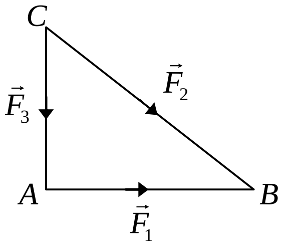
Space for Rough work

15. A thin isosceles prism with angle 4^0 and refractive index 1.5 is placed inside a transparent tube with water $\left(\text{refractive index} = \frac{5}{4}\right)$ as shown. Find the deviation of light (in degree) due to prism



16. A particle is projected with speed u at an angle θ above horizontal. There are two times for which a projectile is at the same height. If the sum of these two times is equal to n $\frac{2u\sin\theta}{g}$, then find the value of 'n'.

17. Three forces $\vec{F}_1, \vec{F}_2$ and $\vec{F}_3$ starts acting on a particle of mass m. These forces are represented in magnitude and direction by three sides of triangle *ABC* as shown in figure. Find the acceleration of particle is $\frac{n\vec{F}_2}{m}$ then find the value of 'n'



18. An artificial satellite of mass m is moving in a circular orbit at a height h equal to radius of the earth from the earth's surface. Suddenly due to internal explosion the satellite breaks into two parts of equal masses. One part of the satellite stops just after the explosion and then falls to the surface of the earth. If find the increase in mechanical energy of the system (satellite + earth) due to explosion. (Acceleration due to gravity on the earth's surface is g) is n. (mgR) then find the value of 'n'.

Space for Rough work

Chemistry PART – II

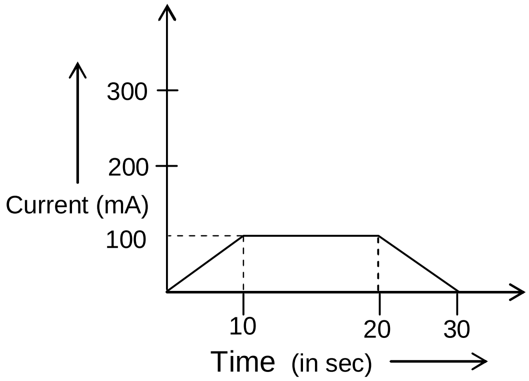
SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. A plot of ln $[A]_t$ vs t (where, $[A]_t$ is the concentration of the reactant at time t) for a reaction is linear with a negative slope of 0.0231 sec^{-1}. Then
(A) The initial concentration of the reactant will reduce to half in 30 seconds.
(B) A plot of $t_{1/2}$ vs concentration of reactant will give a straight line passing through origin.
(C) The reaction will be 90% complete in 100 seconds.
(D) The line in $\ln[A]_t$ vs t plot will be steeper at higher temperature.

20. In which of the following the value of a (van der Waal's) constant of the left side gas is greater than that of the right side gas?
(A) SO_2, CH_4
(B) H_2, NH_3
(C) CO, N_2
(D) He, SO_2

21. When $CuSO_4$ solution is electrolysed in a copper voltameter for 30 sec, then 'm' gram of copper was deposited. The time-current graph for the electrolysis is:



How much charge was passed through copper voltameter?
(A) 1 coulomb
(B) 4 coulomb
(C) 2 coulomb
(D) $\frac{1}{2}$ coulomb

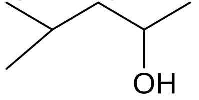
Space for Rough work

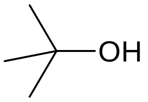
22. Which of the following molecule(s) has/have zero dipole moment?
(A) CH_2Cl_2 (B) PCl_2Br_3
(C) XeF_6 (D) SF_6

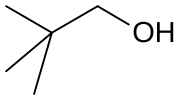
23. $Al(OH)_3(s) \rightleftharpoons Al^{3+}(aq) + 3OH^-(aq)$

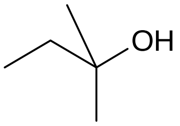
Which of the following substance(s) can increase the solubility of $Al(OH)_3$ according to above reaction?
(A) NH_4Cl (B) KCN
(C) $FeSO_4$ (D) KOH

24. Which of the following alcohol(s) can be prepared by acidic hydrolysis of the corresponding alkenes?

(A)


(B)


(C)


(D)


25. $$\begin{pmatrix} CH_3CH_2COONa \\ CH_3COONa \end{pmatrix} \xrightarrow{\text{Electrolysis}} \text{Products}$$

Which of the following product(s) is/are formed in the above reaction?
(A) C_2H_6 (B) C_3H_8
(C) C_4H_{10} (D) C_3H_6

26. Which of the following statement(s) is/are correct for the following complex?
$[Cr(NH_3)_4(Cl)_2]Br$
(A) It's coordination number is six
(B) It exhibits ionization isomerism
(C) The effective atomic number of chromium is 33
(D) It shows geometrical isomerism

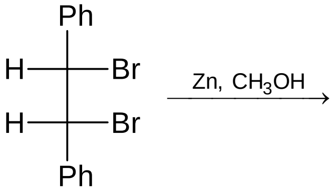
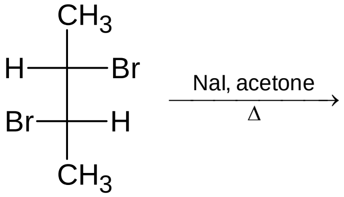
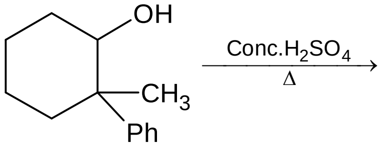
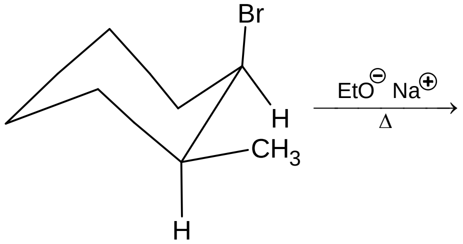
Space for Rough work

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO (02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

27. Answer the following by appropriately matching the lists.

List – I		**List – II**	
(I)		(P)	Anti elimination
(II)		(Q)	Rearrangement
(III)		(R)	Carbocation
(IV)		(S)	Transition state

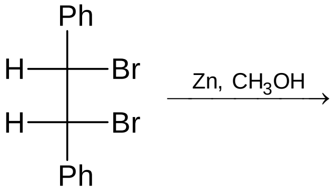
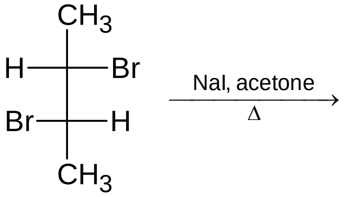
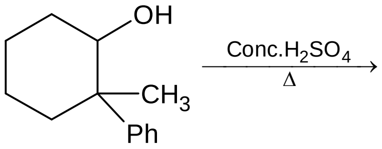
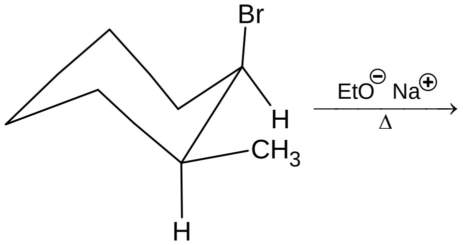
Which of the following options has the correct combination considering List-I and List-II?

(A) III→ QR (B) IV→ RS

(C) III→ PS (D) IV→ PR

Space for Rough work

28. Answer the following by appropriately matching the lists.

List – I		List – II	
(I)	 Ph H Br H Br Ph Zn, CH₃OH	(P)	Anti elimination
(II)	 CH3 H Br Br H CH3 NaI, acetone Δ	(Q)	Rearrangement
(III)	 OH CH3 Ph Conc.H2SO4 Δ	(R)	Carbocation
(IV)	 Br H CH3 H EtO⊖ Na⊕ Δ	(S)	Transition state

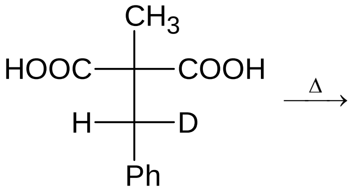
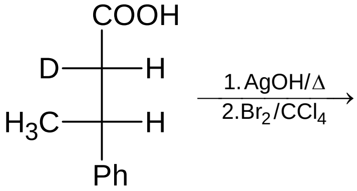
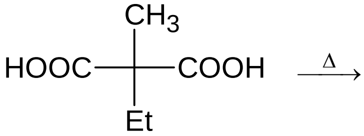
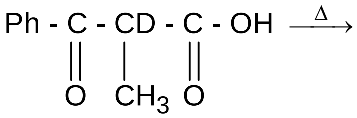
Which of the following options has the correct combination considering List-I and List-II?

(A) I → RS (B) II → QR

(C) I → PS (D) II → PQ

Space for Rough work

29. Answer the following by appropriately matching the lists.

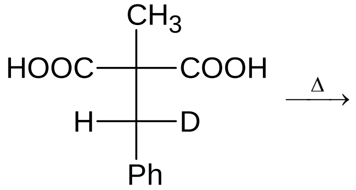
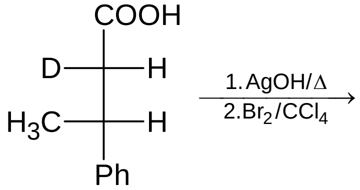
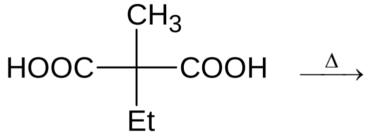
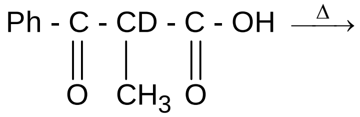
List – I		List – II	
(I)		(P)	Diastereomers
(II)		(Q)	Racemic mixture
(III)		(R)	Optically active
(IV)	 $\mathrm{Ph-\underset{\displaystyle O}{\underset{\Vert}{C}}-\underset{\displaystyle CH_3}{\underset{\vert}{CD}}-\underset{\displaystyle O}{\underset{\Vert}{C}}-OH}\xrightarrow{\Delta}$	(S)	CO_2 will evolve

Which of the following options has the correct combination considering List-I and List-II?

(A) III→ QR
(B) IV→ PS
(C) III→ QS
(D) IV→ PR

Space for Rough work

30. Answer the following by appropriately matching the lists.

List – I		List – II	
(I)		(P)	Diastereomers
(II)		(Q)	Racemic mixture
(III)		(R)	Optically active
(IV)	 $\text{Ph - }\underset{\underset{O}{\Vert}}{C}\text{ - }\underset{\underset{CH_3}{\vert}}{CD}\text{ - }\underset{\underset{O}{\Vert}}{C}\text{ - OH}\xrightarrow{\Delta}$	(S)	CO_2 will evolve

Which of the following options has the correct combination considering List-I and List-II?

(A) I → QS
(B) II → PRS
(C) I → PQR
(D) II → PQ

SECTION – C

(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded ‐ off to the **second decimal place**; e.g. XXXXX.XX).

31. How many elements of group-15 do not form pentachloride?

Space for Rough work

32. How many moles of copper atom(s) is/are deposited on the cathode if 8 faradays of electricity is passed through the aqueous solution of $CuSO_4$ which contains sufficient Cu^{2+} ions?

33. The average life of a radioactive element is 7.2 min. Calculate the time interval (in min) between the stags of 33.33% and 66.66% decay.

34. The radioactive decay ${}^{211}_{83}Bi \longrightarrow {}^{207}_{81}Tl$ takes place in 100 L closed vessel at 27^oC starting with 2 moles of ${}^{211}_{83}Bi\left(t_{1/2} = 130\,sec\right)$, the pressure developed in the vessel after 520 sec will be ____ atm

35. The measured voltage of the reaction with the indicated concentrations is 1.50 V. Calculate E^o. $\left[Cr(s) + 3Ag^+(aq, 0.10\,M) \longrightarrow 3Ag(s) + Cr^{3+}(aq, 0.30\,M)\right]$

36. A solution containing H^+ and D^+ ions is in equilibrium with a mixture of H_2 and D_2 gases at 25^oC. If the partial pressure of both gases are 1.0 atm, find the ratio of $[D^+]/[H^+]$
$\left[\text{Given } E^o_{D^+/D_2} = -0.003\,V\right]$

Space for Rough work

Mathematics PART – III

SECTION – A

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. Two sides of a rhombus OABC (lying entirely in first quadrant or fourth quadrant) of area equal to 2 sq. units, are $y = \frac{x}{\sqrt{3}}$, $y = \sqrt{3}x$. Then possible coordinates of B is / are ('O' being the origin)

(A) $\left(1+\sqrt{3},\ 1+\sqrt{3}\right)$
(B) $\left(-1-\sqrt{3},\ -1-\sqrt{3}\right)$
(C) $\left(\sqrt{3}-1,\ \sqrt{3}-1\right)$
(D) none of these

38. Let 'z' be a complex number and 'a' be a real parameter such that $z^2 + az + a^2 = 0$, then

(A) locus of z is a pair of straight lines
(B) locus of z is a circle
(C) $\arg(z) = \pm\frac{2\pi}{3}$
(D) $|z| = |a|$

39. $f(x) = \tan^{-1}(\sin x + \cos x)$, then f(x) is increasing in;

(A) $\left(-\frac{\pi}{2}, \frac{\pi}{4}\right)$
(B) $\left(-\frac{\pi}{4}, \frac{\pi}{4}\right)$
(C) $\left(\frac{5\pi}{4}, \frac{3\pi}{2}\right)$
(D) $\left(-2\pi, -\frac{7\pi}{4}\right)$

40. Consider the planes $3x - 6y + 2z + 5 = 0$ and $4x - 12y + 3z = 3$. The plane $67x - 162y + 47z + 44 = 0$ bisects the angle between the given planes which

(A) contains the origin
(B) is acute
(C) is obtuse
(D) none of these

Space for Rough work

41. Probability if n heads in 2n tosses of a fair coin can be given by

(A) $\prod_{r=1}^{n}\left(\frac{2r-1}{2r}\right)$ (B) $\prod_{r=1}^{n}\left(\frac{n+r}{2r}\right)$

(C) $\sum_{r=0}^{n}\left(\frac{{}^{n}C_{r}}{2^{n}}\right)^{2}$ (D) $\frac{\sum_{r=0}^{n}\left({}^{n}C_{r}\right)^{2}}{\left(\sum_{r=0}^{2n}{}^{2n}C_{r}\right)}$

42. Let $f(n)=\begin{vmatrix} n & n+1 & n+2 \\ {}^{n}P_{n} & {}^{n+1}P_{n+1} & {}^{n+2}P_{n+2} \\ {}^{n}C_{n} & {}^{n+1}C_{n+1} & {}^{n+2}C_{n+2} \end{vmatrix}$ where the symbols have their usual meanings. Then f(n) is divisible by

(A) n^2+n+1 (B) $(n+1)!$

(C) $n!$ (D) none of these

43. $\int\sqrt{1+\text{cosec } x}\,dx$ equals

(A) $2\sin^{-1}\sqrt{\sin x}+c$ (B) $\sqrt{2}\cos^{-1}\sqrt{\cos x}+c$

(C) $c-2\sin^{-1}(1-2\sin x)$ (D) $\cos^{-1}(1-2\sin x)+c$

44. Let $A=\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{bmatrix}$, then

(A) $A^2-4A-5I_3=O$ (B) $A^{-1}=\frac{1}{5}(A-4I_3)$

(C) A^3 is not invertible (D) A^2 is invertible

Space for Rough work

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO (02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

The chord AC of the parabola $y^2 = 4x$ subtends 90° angle at points B and D on the parabola. If A, B, C and D are represented by t_1, t_2, t_3 and t_4, then match the following

List–I		List–II	
(I)	$\left\lvert\dfrac{t_2+t_4}{t_1+t_3}\right\rvert$	(P)	–1
(II)	$\lvert t_2t_4 - t_1t_3\rvert$	(Q)	0
(III)	minimum value of $\lvert t_1 - t_3\rvert$	(R)	1
(IV)	The y-coordinate of the mid point of the points of intersection of the tangents at A, C and B, D is	(S)	4
		(T)	3
		(U)	4

45. Which of the following is the only correct combination?

(A) II→U (B) II→Q

(C) I→U (D) I→S

46. Which of the following is the only correct combination?

(A) IV→Q (B) III→R

(C) IV→U (D) I→P

Space for Rough work

Answer the following by appropriately matching the list based on the information given in the paragraph.

The number of real roots of

List–I		List–II	
(I)	$\sqrt{x+9}+\sqrt{x}=2.7$	(P)	0
(II)	$\frac{\sqrt{13-x^2}}{\lvert x+1\rvert}=1$	(Q)	1
(III)	$\sqrt{x+5}-\sqrt{x}=1$	(R)	2
(IV)	$\sqrt{x+2\sqrt{x-1}}-\sqrt{x-2\sqrt{x-1}}=2$	(S)	3
		(T)	4
		(U)	Infinite

47. Which of the following is the only correct combination?
(A) II→U (B) II→Q
(C) I→P (D) I→S

48. Which of the following is the only correct combination?
(A) IV→Q (B) III→R
(C) IV→U (D) I→P

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded - off to the **second decimal place**; e.g. XXXXX.XX).

49. If in a triangle ABC, b + c = 4a. Then $\tan\frac{B}{2}\tan\frac{C}{2}$ is equal to

Space for Rough work

50. Two rays of light coming along the lines y = 1 and y = –2 from the positive direction of x–axis and strikes a concave mirror whose intersection with the x – y plane is a parabola $y^2 = x$ at A and B respectively. The reflected rays pass through a fixed point C, then the area of the triangle ABC is

51. If $\cos 4x = a_0 + a_1 \cos^2 x + a_2 \cos^4 x$ is true for all values of $x \in R$, then the value of $\frac{18a_0 + a_1 + a_2}{2}$

52. $\lim\limits_{x \to 0} \frac{x \tan 2x - 2x \tan x}{(1 - \cos 2x)^2} =$

53. If $\frac{\pi}{2} < \alpha < \frac{2\pi}{3}$ and $I = \int_0^{\sin 2\alpha} \frac{dx}{\sqrt{(4\cos^2 \alpha - x^2)}}$ then the value of $\frac{(I + \alpha)}{5\pi}$ must be

54. If in a ΔABC, $BC = 5$, $CA = 4$, $AB = 3$ and D, E are the points on BC such BD = DE = EC, then $2\tan\theta$ is

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – II

JEE (Advanced)-2020

PAPER – 2

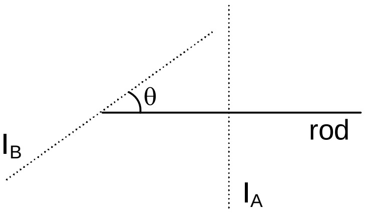
ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. ABC

Sol. $I_B = \frac{m\ell^2}{3}\sin^2\theta,\ I_A = \frac{m\ell^2}{12}$



2. A

Sol. For open circuit, current = 0.

3. ABC

Sol. Assume x-axis along OA and y-axis perpendicular to it in the plane of ring.
After 1st collision
Velocity of particle = $\frac{v}{\sqrt{2}}$ along x-axis
And velocity of ring = $\frac{v}{\sqrt{2}}$ along y-axis
After second collision velocity of ring = $\frac{v}{\sqrt{2}}\hat{i} + \frac{v}{\sqrt{2}}\hat{j}$
Velocity of particle = 0
Time to return at point A = $4 \times \frac{R\sqrt{2}}{v}$

4. AB

Sol. $$\frac{\frac{E}{2}+\frac{12}{4}+\frac{4}{6}}{\left(\frac{1}{2}+\frac{1}{4}+\frac{1}{6}\right)}=E-2\times\frac{1}{2}$$

$$\Rightarrow E = 6.6,\ \frac{12-(6.6+2\times0.5)}{4}=1.1$$

5. A

Sol. $V_B+35\times10^{-3}\times(-10)^3+10+5\times5=V_A$

$\Rightarrow V_A - V_B = 0.$

6. ABCD

Sol. L.C. = pitch / number of division on circular scale. The result has to be expressed upto least number of significant figures.

7. B

Sol. $E_{3500\overset{0}{A}}=\frac{12420}{3500}\text{eV}=3.55\text{ eV}$

$\therefore\ \phi_B < E_{3500\overset{0}{A}} < \phi_A$

8. AC

Sol. $\omega_L = 50\ \Omega$

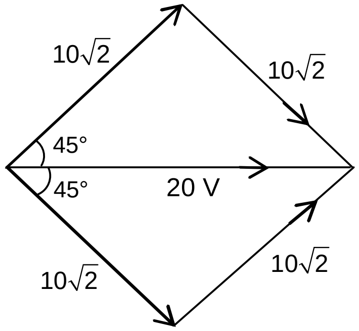
$X_C=\frac{1}{\omega_C} = 100\ \Omega$

$i_C=\frac{10\sqrt{2}}{100}=\frac{\sqrt{2}}{10}$; $i_L=\frac{10\sqrt{2}}{50}=\frac{\sqrt{2}}{5}$

$i=\sqrt{i_C^2+i_L^2}$

$=\frac{\sqrt{2}}{10}\sqrt{1+4}=\frac{\sqrt{10}}{10} = 0.316\text{ A}$

$V_{100\,\Omega} = 10\sqrt{2}$



9. A

Sol. O to A the slope is positive.
A to B the slope is negative.
B to C the slope is positive.
At A the slope is zero

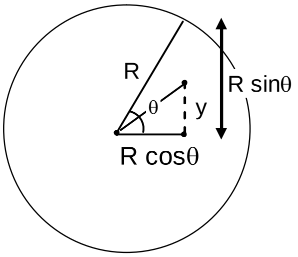
10. B

Sol. O to A the graph is convex.
A to B the graph is first convex and then concave.
B to C the graph is concave.
At point A the graph is convex.

11. A

12. A

Sol. (for Q.11 & Q.12)



$$N = \frac{4\pi G\rho}{3} R\cos\theta$$

$$a = -\frac{4\pi G\rho}{3} y$$

$$|a_{max}| = \frac{4\pi G\rho}{3} R\sin\theta$$

SECTION – C

13. 00007.00

Sol. $$\frac{P^2}{2m} = KE = \frac{9\times10^9 \times 120e^2}{10\times10^{-15}}$$

$$\lambda = \frac{h}{P} = \frac{h}{e\sqrt{360\times10^{-3}}} = \frac{4.2\times10^{-15}}{0.6} = 7.$$

14. 00004.00

Sol. $$300 = f = \frac{1}{2L}\sqrt{\frac{20g}{\mu}}, f' = \frac{1}{2L}\sqrt{\frac{4\times5\times15g}{(5+15)\mu}} \Rightarrow \frac{f'}{300} = \sqrt{\frac{15}{20}} \Rightarrow f' = 259.80 \text{ Hz}$$

15. 00000.80

Sol. $$\delta = \left(\frac{\mu_2}{\mu_1} - 1\right)A = \left(\frac{1.5}{5/4} - 1\right)\times 4^0 = 0.8^0 \text{ downward}$$

16. 00001.00

Sol. $$h = u_y t - \frac{1}{2}gt^2$$

$$\Rightarrow \quad t_1 + t_2 = \frac{-u_y}{-\frac{1}{2}g} = \frac{2u_T}{g} = \frac{2u\sin\theta}{g}$$

17. 00002.00

Sol. $\vec{F}_3 + \vec{F}_1 = \vec{F}_2$ (triangle law), so resultant force $= 2\vec{F}_2$.

$$\vec{a} = \frac{2\vec{F}_2}{m}$$

18. 00000.25

Sol. Applying conservation of momentum $mv = \frac{m}{2}\times0 + \frac{m}{2}v' \Rightarrow v' = 2v$

Increase in mechanical energy of the system $= \frac{1}{2}\frac{m}{2}(2v)^2 - \frac{1}{2}mv^2 = \frac{1}{2}mv^2 = \frac{GMm}{2\times(2R)}$

$$= \frac{mgR^2}{4R} = \frac{mgR}{4}$$

Chemistry PART – II

SECTION – A

19. ACD

Sol. ln $[A]_t$ = ln $[A]_0$ – kt (for 1st order reaction)
slope of ln $[A]_t$ vs t = -k

$k = 0.0231\ \text{sec}^{-1}$

$$t_{1/2} = \frac{0.693}{0.0231} = 30\ \text{sec}$$

Half life is independent of initial concentration. So a plot of $t_{1/2}$ vs concentration will give a straight line parallel to x – axis.

$$t_{90\%} = \frac{1}{0.0231}\ln\frac{100}{10} = 100\ \text{sec}$$

At higher temperature, value of rate constant k increases. So, the slope of the plot ln$[A]_t$ vs t will increase and the line will become steeper.

20. AC

Sol. $SO_2 > CH_4$ (depends on van der Waal's force)
$CO > N_2$ (CO is polar and N_2 is non-polar)

21. C

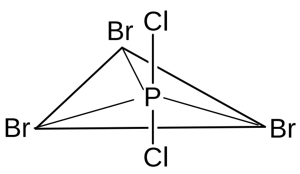
Sol. Charge = Area of (I vs t) curve

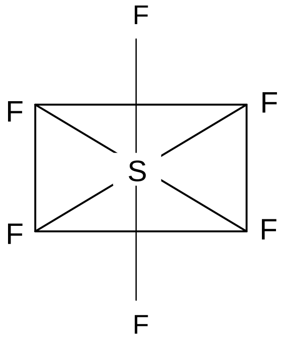
$$= \frac{1}{2} \times 10 \times (100 \times 10^{-3}) + 10 \times (100 \times 10^{-3}) + \frac{1}{2} \times 10 \times (100 \times 10^{-3})$$

$$= \frac{1}{2} + 1 + \frac{1}{2} = 2 \text{ coulomb}$$

22. BD

Sol. Both the molecules have symmetrical structure.





23. AC

Sol. $NH_4^+ + H_2O \rightleftharpoons NH_4OH + H^+$

$Fe^{2+} + H_2O \rightleftharpoons [Fe(OH)]^+ + H^+$

The H^+ ions combine with or remove OH^- ions by forming water and drives the reaction towards forward direction.

24. ABD
Sol. (C) cannot be prepared by hydrolysis of any alkene.

25. ABC
Sol. $RCOONa \longrightarrow RCOO^- + Na^+$

$RCOO^- \longrightarrow R^\bullet + CO_2$

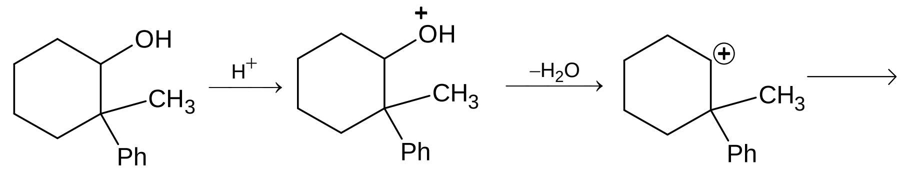
$CH_3CH_2^\bullet + CH_3CH_2^\bullet \longrightarrow CH_3CH_2CH_2CH_3$

$CH_3CH_2^\bullet + CH_3^\bullet \longrightarrow CH_3CH_2CH_3$

$CH_3^\bullet + CH_3^\bullet \longrightarrow C_2H_6$

26. ABCD
Sol. All the statements are correct.

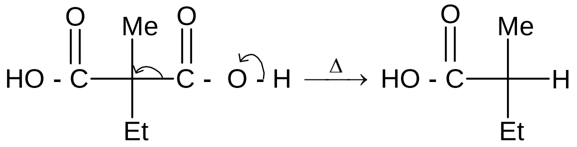
27. A
Sol.


OH
CH3
Ph
H+
+OH
CH3
Ph
–H2O
⊕
CH3
Ph

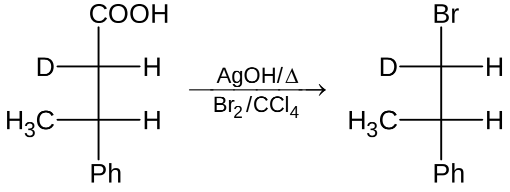
Rearranges to more stable carbocation

28. C
Sol. Self explained

29. C
Sol.


O
Me
O
HO - C
C - O - H
Et
Δ
O
Me
HO - C
H
Et

30. B
Sol.


COOH
D
H
H3C
H
Ph
AgOH/Δ
Br2/CCl4
Br
D
H
H3C
H
Ph

SECTION – C

31. 00002.00
Sol. Nitrogen and bismuth do not form pentachloride. In case of 'N', no vacant orbitals are present and for 'Bi', inert-pair effect is most prominent.

32. 00004.00
Sol. 1F deposits 1 eq or ½ mole of Cu

$\therefore$ 8F will deposit 4 mole of Cu

33. 00005.00

Sol. $\lambda = \frac{1}{t_{avg}} = \frac{1}{t}\ln\frac{[A_0]}{[A_t]};\frac{1}{7.2} = \frac{1}{t_1}\ln\frac{100}{100-\frac{100}{3}}$

$$\frac{1}{7.2} = \frac{1}{t_2}\ln\frac{100}{100-\frac{200}{3}}$$

$t_2 - t_1 = 7.2 \ln 3 - 7.2\ln\frac{3}{2} = 5$

34. 00000.46

Sol. ${}_{83}Bi^{211} \longrightarrow {}_{81}Tl^{207} + {}_{2}He^{4}$; total time = n × half-life

Moles of substance left after n halves = $\frac{\text{initial moles}}{2^n} = \frac{2}{2^4} = 0.125$

Moles of He produced = 2 – 0.125 = 1.875

Pressure developed due to

$He = \frac{1.875 \times 0.0821 \times 300}{100} = 0.4618 \text{ atm}$

35. 00001.55

Sol. $1.50 = E^o - \frac{0.0591}{3}\log\left[\frac{0.3}{(0.1)^3}\right]$

$\therefore E^o = 1.55$

36. 00001.12

Sol. $E^o_{Cell} = \frac{0.0591}{2}\log K_{eq}$

$$0.003 = \frac{0.0591}{2}\log\frac{[D^+]^2}{[H^+]^2} \Rightarrow \frac{[D^+]}{[H^+]} = 1.123$$

Mathematics

PART – III

SECTION – A

37. AB

Sol. Let the length of the sides of the rhombus be l

$\Rightarrow$ Area $= l^2 \sin 30^\circ = 2 \Rightarrow l = 2$ unit

$OB^2 = OA^2 + AB^2 - 2OA.AB\cos 150^\circ$

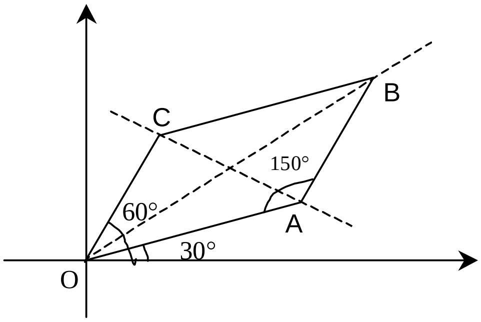
$= 4 + 4 - 2(4).\left(-\frac{\sqrt{3}}{2}\right) = 4(2+\sqrt{3})$

$OB = 2\sqrt{2+\sqrt{3}}$

$B \equiv \left(\sqrt{4+2\sqrt{3}},\ \sqrt{4+2\sqrt{3}}\right) \equiv \left(1+\sqrt{3},\ 1+\sqrt{3}\right)$

Hence coordinates of B can be $\left(1+\sqrt{3},\ 1+\sqrt{3}\right)$

or $\left(-1-\sqrt{3},\ -1-\sqrt{3}\right)$



38. ACD

Sol. $z^2 + az + a^2 = 0$

$\Rightarrow$ $z = a\omega,\ a\omega^2$ (where 'ω' is non real root of cube unity)

$\Rightarrow$ locus of z is a pair of straight lines

and arg (z) =arg(a) + arg(ω) or arg(a) + arg(ω²)

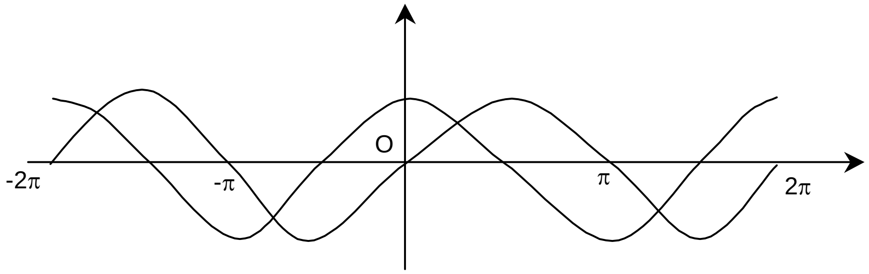
$\Rightarrow \arg(z) = \pm\frac{2\pi}{3}$

also, $|z| = |a||\omega|$ or $|a|\,|\omega^2| \Rightarrow |z| = |a|$

39. ABCD

Sol. $f'(x) = \frac{\cos x - \sin x}{1+(\sin x + \cos x)^2} > 0 \ \Rightarrow\ \cos x > \sin x$

$\Rightarrow x \in \left(-2\pi, -\frac{7\pi}{4}\right) \cup \left(-\frac{3\pi}{4}, \frac{\pi}{4}\right) \cup \left(\frac{5\pi}{4}, 2\pi\right)$



40. AB

Sol. $3x - 6y + 2z + 5 = 0$

$-4x + 12y - 3z + 3 = 0$

Bisectors are $\frac{3x-6y+2z+5}{\sqrt{9+36+4}} = \pm\frac{-4x+12y-3z+3}{\sqrt{16+144+9}}$

The plane which bisects the angle between the planes that contains the origin.

$13(3x-6y+2z+5)=7(-4x+12y-3z+3)$

$67x-162y+47z+44=0$

Further, $3x(-4)+(-6)(12)+2\times(-3)<0$

Hence, the origin lies in the acute angle.

41. ACD

Sol. $P(E)=\frac{{}^{2n}C_n}{2^{2n}}=\frac{(2n)!}{n!n!2^n\,2^n}$

$$=\frac{1\times2\times3\times....x(2n)}{n!n!2^n\,2^n}$$

$$=\frac{1\times3\times5\times....\times(2n-1)}{n!2^n}$$

Now,

$$\prod_{r=1}^{n}\left(\frac{2r-1}{2r}\right)=\frac{1\times3\times5\times....\times(2n-1)}{2\times4\times6\times.......\times(2n)}$$

$$=\frac{1\times3\times5\times.......\times(2n-1)}{(1\times2\times3\times....\times n)2^n}$$

$$\sum_{r=0}^{n}\left(\frac{{}^{n}C_r}{2^n}\right)^2=\frac{1}{2^n\,2^n}\sum_{r=0}^{n}\left({}^{n}C_r\right)^2$$

$$=\frac{1}{2^n2^n}\,{}^{2n}C_n$$

Also,

$$\frac{\sum_{r=0}^{n}\left({}^{n}C_r\right)^2}{\left(\sum_{r=0}^{2n}{}^{2n}C_r\right)}=\frac{{}^{2n}C_n}{2^{2n}}$$

42. AC

Sol. $f(n)=\begin{vmatrix}n & n+1 & n+2\\ n! & (n+1)! & (n+2)!\\ 1 & 1 & 1\end{vmatrix}=\begin{vmatrix}n & 1 & 1\\ n! & nn! & (n+1)(n+1)!\\ 1 & 0 & 0\end{vmatrix}$

[Applying $C_3\to C_3-C_2$ and $C_2\to C_2-C_1$]

$=(n+1)(n+1)!-nn!=n!\left[(n+1)^2-n\right]=n!=n!\left(n^2+n+1\right)$

Thus, $f(n)$ is divisible by n! and n^2+n+1

43. AD

Sol. $I=\frac{\sqrt{(1+\sin x)(1-\sin x)}}{\sqrt{\sin x(1-\sin x)}}=\frac{\cos x}{\sqrt{\sin x(1-\sin x)}}=\frac{\cos x}{\sqrt{\frac{1}{4}-\left(\frac{1}{2}-\sin x\right)^2}}=\int\frac{-dt}{\sqrt{\left(\frac{1}{2}\right)^2-t^2}}$

44. ABD

Sol. $A^2 - 4A - 5I_3 = \begin{bmatrix} 9 & 8 & 8 \\ 8 & 9 & 8 \\ 8 & 8 & 9 \end{bmatrix} - \begin{bmatrix} 4 & 8 & 8 \\ 8 & 4 & 8 \\ 8 & 8 & 4 \end{bmatrix} - \begin{bmatrix} 5 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & 5 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} = 0$

Multiplying by A^{-1}, $A - 4I - 5A^{-1} = 0 \Rightarrow A^{-1} = \frac{1}{5}(A - 4I)$

$|A| \neq 0 \Rightarrow |A|^2 \neq 0 \Rightarrow A^2$ is invertible.

45. A
46. A
Sol. (for Q.45 & Q.46)
We have $(t_2 + t_3)(t_2 + t_1) = -4$
$\Rightarrow t_2^2 + t_2(t_1 + t_3) + t_1t_3 + 4 = 0$ … (1)
$\Rightarrow (t_1 + t_3)^2 - 4(t_1t_3 + 4) \geq 0 \Rightarrow (t_1 - t_3)^2 \geq 16$
$\Rightarrow t_2 + t_4 = -(t_1 + t_3)$ and $t_2t_4 = t_1t_3 + 4$(Because t_2 and t_4 are the roots of the equation (1))
also let y_1 and y_2 are y-coordinates of intersection points of the tangents at (A, C) and (B, D) then
$y_1 = t_1 + t_3$ and $y_2 = t_2 + t_4$ $\Rightarrow y_1 + y_2 = 0$.

47. C
48. C
Sol. (for Q.47 & Q.48)
(I) $x \geq 0 \Rightarrow \sqrt{x+9} \geq 3$
(II) $13 - x^2 = (x+1)^2 \Rightarrow x^2 + x - 6 = 0$
$\Rightarrow x = -3, 2$
(III) $x + 5 = 1 + x + 2\sqrt{x} \Rightarrow \sqrt{x} = 2 \Rightarrow x = 4$
(IV) Put $x - 1 = t^2$, to obtain
$|t+1| - |t-1| = 2$
which is satisfied for each $t \geq 1$

SECTION – C

49. 00000.60
Sol. b + c = 4a
sinB + sinC = 4sinA

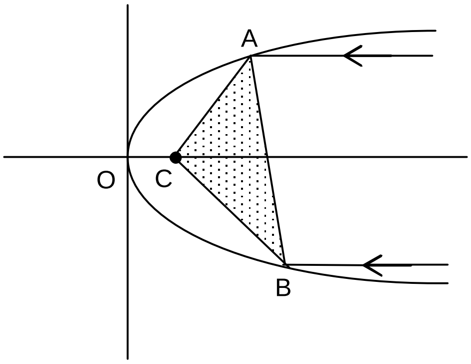
$$\cos\frac{B-C}{2} = 4\cos\frac{B+C}{2}$$

$$\cos\frac{B}{2}\cos\frac{C}{2} + \sin\frac{B}{2}\sin\frac{C}{2} = 4\left[\cos\frac{B}{2}\cos\frac{C}{2} - \sin\frac{B}{2}\sin\frac{C}{2}\right]$$

$$3\cos\frac{B}{2}\cos\frac{C}{2} = 5\sin\frac{B}{2}\sin\frac{C}{2}$$

50. 00002.62

Sol. Solving y = 1 and $y^2 = x$
then A = (1, 1)
and solving y = –2
and $y^2 = x$
then B = (4, –2)
$\because$ After reflection both reflected rays pass through focus of the parabola $y^2 = x$
i.e. $C = \left(\frac{1}{4}, 0\right)$



51. 00009.50

Sol. $\cos 4x = 2\cos^2 2x - 1$

$= 2\left(2\cos^2 x - 1\right)^2 - 1$

$= 2\left(4\cos^4 x + 1 - 4\cos^2 x\right) - 1$

$= 8\cos^4 x - 8\cos^2 x + 1$

$\therefore a_0 = 1, a_1 = -8, a_2 = 8$

$\therefore 5a_0 + a_1 + a_2 = 5$

52. 00000.50

Sol. $\lim\limits_{x\to 0} \frac{x\tan 2x - 2x\tan x}{4\sin^4 x}$

$= \lim\limits_{x\to 0} \frac{x}{4\sin^4 x}\left[\frac{2\tan x}{1-\tan^2 x} - 2\tan x\right]$

$= \lim\limits_{x\to 0} \frac{2x\tan x}{4\sin^4 x}\left[\frac{1-1+\tan^2 x}{1-\tan^2 x}\right]$

$= \lim\limits_{x\to 0} \frac{2x\tan^3 x}{4\sin^4 x\left(1-\tan^2 x\right)}$

$= \frac{1}{2}\lim\limits_{x\to 0} \frac{x}{\sin x}\ \frac{1}{\cos^3 x}\frac{1}{1-\tan^2 x}$

$= \frac{1}{2}.1.\frac{1}{1^3}.\frac{1}{1-0} \quad = \frac{1}{2}$

53. 00000.20

Sol. $I = \left\{\sin^{-1}\left(\frac{x}{2\cos\alpha}\right)\right\}_0^{\sin 2\alpha} = \sin^{-1}\left(\frac{\sin 2\alpha}{2\cos\alpha}\right)$

$= \sin^{-1}\left(\sin\alpha\right)$

$= \pi - \alpha \quad \left(\because \pi < \alpha < \frac{2\pi}{3}\right)$

$\Rightarrow I = \pi - \alpha \qquad \text{or} \quad \frac{I+\alpha}{\pi} = 1$

54. 00000.75

Sol. In ΔCAE, $AE^2 = AC^2 + CE^2 - 2AC.CE\cos C = \frac{73}{9}$

Also, in ΔCAE

$$\cos\theta = \frac{AC^2 + AE^2 + CE^2}{2.AC.AE} = \frac{8}{\sqrt{73}} \Rightarrow \tan\theta = \frac{3}{8}$$

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – II

JEE (Main)-2020

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 75 questions.
- Each subject (PCM) has 25 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only three sections: **Section-A**, **Section-B and Section-C**.

Section-A (01 – 20, 26 – 45, 51 – 70) *contains 60 multiple choice questions which have **only one correct answer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.*

***Section-B (21 – 22, 46 – 47, 71 – 72)** contains 6 Numerical based questions with answer as numerical value from **0 to 9** and each question carries **+4 marks** for correct answer. There is no negative marking.*

***Section-C (23 – 25, 48 – 50, 73 – 75)** contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries **+4 marks** for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A

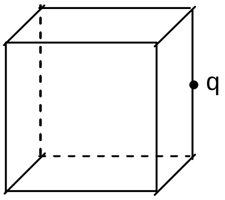
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. An object of mass 40 kg and having velocity 4 m/s collides with another object of mass 60 kg, having velocity 2 m/s in the same direction. The loss of energy when the collision is perfectly inelastic is

(A) 392 J (B) 440 J
(C) 48 J (D) 110 J

2. The total flux of electric lines of forces of a charge q placed at the mid point of the edge of a side of rectangular box, as shown in figure through the box is



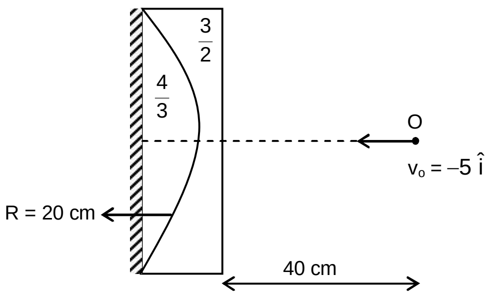
(A) $\frac{q}{2\in_o}$ (B) $\frac{q}{4\in_o}$
(C) $\frac{q}{8\in_o}$ (D) $\frac{q}{16\in_o}$

3. 1 gm of a radioactive substance takes. 50 sec to loose 0.01 gm then the half life of the sample will be

(A) $\frac{50\ln(2)}{\ln\left(\frac{100}{99}\right)}$ (B) $\frac{50\ln(2)}{\ln(100)}$
(C) $\frac{50\ln(2)}{\ln(99)}$ (D) $\frac{50\ln(2)}{\ln(0.99)}$

Space for Rough work

4. The lens combination having refractive indices $\frac{4}{3}$ & $\frac{3}{2}$ as shown in the figure, is silvered. The velocity of image will be?



(A) $1.8\,\hat{i}$

(B) $3\,\hat{i}$

(C) $3.6\,\hat{i}$

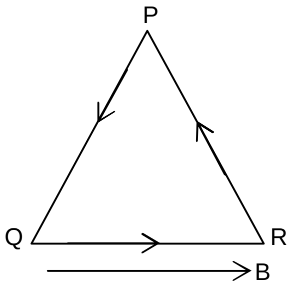
(D) $5\,\hat{i}$

5. Two soap bubbles of radii 2mm and 4mm are brought in contact. If the surface tension of liquid is 7 x 10^{-2} Nm^{-1}. Then the radius of the common surface is

(A) 2×10^{-3}m (B) 4×10^{-3}m

(C) 6×10^{-3}m (D) 8×10^{-3}m

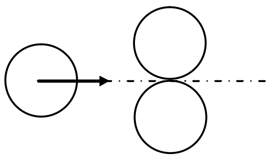
6. An equilateral triangular loop PQR of side l carries a currents i in the direction shown. The loop is kept in uniform magnetic field B, directed parallel to the base of triangle QR as shown. Net torque τ acting on loop is



(A) $F = \frac{\sqrt{3}}{2}\mu^2 B$ (B) $F = \sqrt{3}$ ilB

(C) $\tau = 0$ (D) $\tau = \frac{\sqrt{3}\, l^2 iB}{4}$

7. Two smooth identical stationary spheres are kept touching each other on a smooth horizontal floor as shown. A third identical sphere moving horizontally with a constant speed hits both stationary spheres symmetrically. If after collision the third sphere moves in same direction with one fourth of its initial speed , the coefficient of restitution will be



(A) 2/3 (B) 1/3

(C) 1/4 (D) 1/6

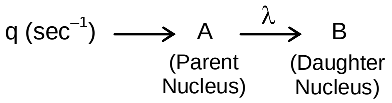
Space for Rough work

8. A beaker containing a liquid of density ρ moves up with an acceleration a. The pressure due to the liquid at a depth h below the free surface of the liquid is

(A) $h\rho g$ (B) $h\rho(g-a)$

(C) $h\rho(g+a)$ (D) $2h\rho g\left(\frac{g+a}{g-a}\right)$

9. In a radioactive reaction an unstable nucleus A dis-integrates into a stable nucleus B. But A is generated at a constant rate of q nucleus per second. Then at steady state number of nucleus of A will be



(A) $q\lambda$ (B) $\frac{q}{\lambda}$

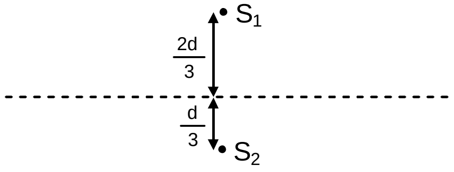
(C) $q-\lambda$ (D) $\frac{\lambda}{q}$

10. A particle moves in x-y plane such that its position vector varies with time as $\vec{r} = (2\sin 3t)\hat{i} + 2(1-\cos 3t)\hat{j}$. The equation of trajectory of the particle will be

(A) $x^2 + y^2 = 1$ (B) $x^2 + (2-y)^2 = 4$

(C) $(2-x)^2 + y^2 = 4$ (D) $(1-x)^2 + (1-y)^2 = 4$

11. Two coherent point sources of frequency $(f = \frac{10v}{d}$ where v is speed of sound in air) are placed at a distance d apart as shown in figure. The receiver is free to move along the dotted line shown in the figure. Find total number of maxima heard by receiver.



(A) 6 (B) 7

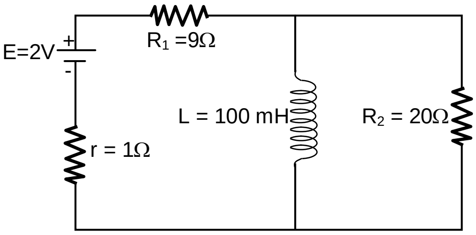
(C) 5 (D) 8

Space for Rough work

12. In the displacement method, magnification for two positions of the lens are 2 and 0.5 and the distance between the two positions of the lens is 30 cm. If the focal length of lens is
(A) 15 cm
(B) 20 cm
(C) 25 cm
(D) 30 cm

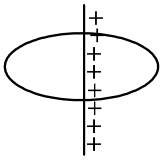
13. A concave mirror of focal length 15 cm is placed in water of refractive index $\mu = 4/3$. Water is filled upto 30 cm. An object of height 1 cm is placed at a distance of 20 cm in front of the mirror. If the size of image is n times size of object, then n =
(A) 3
(B) 2
(C) 2.5
(D) 5

14. The value of time constant for the electric circuit shown in the figure is: (r is the internal resistance of the cell of emf E)
(A) 15s
(B) 1.5s
(C) 0.15s
(D) 0.015s



15. A simple circuit contains an ideal battery and a resistance R. If a second resistor is placed in parallel with the first,
(A) the potential across R will decrease
(B) the current through R will decreased
(C) the current delivered by the battery will increase
(D) the power dissipated by R will increased

16. A very long uniformly charged rod falls with a constant velocity *V* through the center of a circular loop. Then the magnitude of induced emf in loop is (charge per unit length of rod = λ)

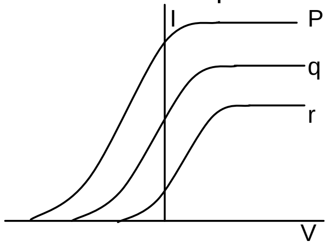


(A) $\frac{\mu_0}{2\pi}\lambda V^2$
(B) $\frac{\mu_0}{2}\lambda V^2$
(C) $\frac{\mu_0}{2\lambda}V$
(D) zero

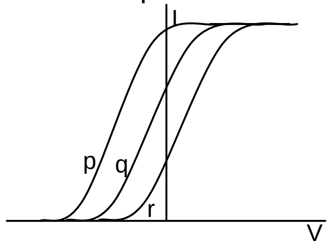
Space for Rough work

17. Photoelectric effect experiments are performed using three different metal plates p, q and r having work functions $\phi_p = 2.0$ eV, $\phi_q = 2.5$ eV and $\phi_r = 3.0$ eV, respectively. A light beam containing wavelengths of 550 nm, 450 nm and 350 nm with equal intensities illuminates each of the plates. The correct I-V graph for the experiment is

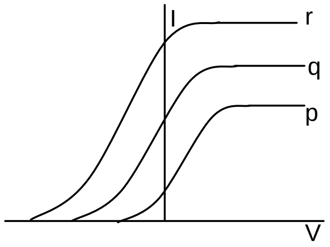
(A)



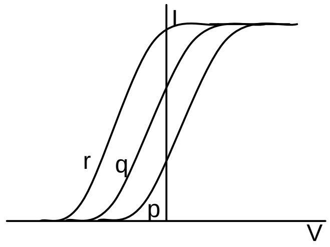
(B)



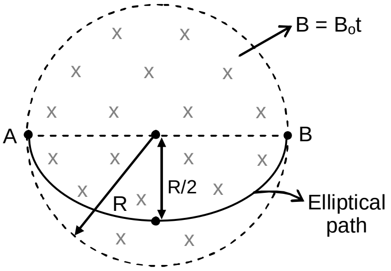
(C)



(D)



18. There is a uniform time varying magnetic field in a circular region as shown in the figure. Find out the potential difference across 2 point along an elliptical path as shown in figure.



(A) $\frac{\pi R^2}{2} B_o$

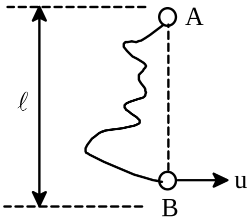
(B) $\frac{\pi R^2}{2} B_o$

(C) $\frac{\pi R^2}{4} B_o$

(D) $\frac{\pi R^2}{5} B_o$

Space for Rough work

19. Two balls A & B both of mass m & connected by a light inextensible string of length 2ℓ. Whole system is on a frictionless horizontal table. Ball B is given a velocity u (as shown) ⊥r to AB. The velocity of ball A just after the string becomes taut is



(A) $\frac{u\sqrt{3}}{4}$ (B) $u\sqrt{3}$

(C) $\frac{u\sqrt{3}}{2}$ (D) $\frac{u}{2}$

20. A block of mass 2 kg rest on a rough inclined plane making an angle 30° with horizontal of coefficient of friction 0.8. ($g = 10$ m/s^2). The magnitude of resultant of friction and normal reaction on the block will be

(A) $\sqrt{292}$ N (B) $\sqrt{364}$ N

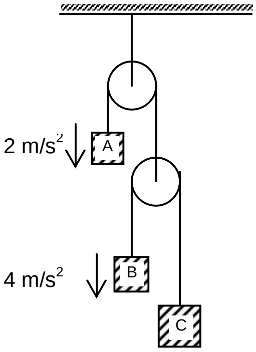
(C) 20 N (D) 18 N

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

21. Water rises in a capillary tube to a height of 2 cm, In another capillary whose radius is one third of it, how high the water will rise (in cm)?

22. In the figure (in m/s^2) shown acceleration of blocks A and B are as shown. Find the magnitude of acceleration of block C.



Space for Rough work

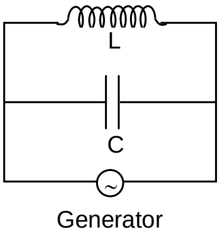
SECTION – C

(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

23. A hollow sphere and a solid sphere have equal mass and equal moment of inertia about the respective diameter. Find the ratio of their square of radii is given by

24. For the circuit shown in the figure, the current through the inductor is 0.6 A, while the current through the capacitor is 0.4 A. Find the current (in A) drawn from the generator



25. If 10% of the current passes through a moving coil galvanometer of resistance 99 ohm, then the shunt resistance will be:

Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

26.
$$\begin{tikzcd}
KO_2 + S \arrow[r, "\Delta"] & (P) \arrow[r, "BaCl_2"] & (Q)\downarrow(\text{White ppt.}) \arrow[dl, "\text{Carbon}"', "\Delta"] \\
\underset{\text{gas}}{(S)}\uparrow & (R) \arrow[l, "HCl"'] &
\end{tikzcd}$$

The unknown compounds P, Q, R and S in the above reaction sequence are respectively

(A) K_2SO_3, $BaSO_3$, BaS, H_2S (B) K_2S, BaS, CS_2, H_2S
(C) K_2SO_4, $BaSO_4$, BaS, H_2S (D) K_2SO_4, $BaSO_4$, $BaCO_3$, CO_2

27. Find ΔH at 358 K for the reaction,
$Fe_2O_3(s) + 3H_2(g) \longrightarrow 2Fe(s) + 3H_2O(\ell)$
Given that, $\Delta H_{298} = -33.29\ kJ/mole$ and C_p for Fe_2O_3(s), Fe(s), $H_2O(\ell)$ and $H_2(g)$ are 103.8, 25.1, 75.3 and 28.8 J/K mole.

(A) 85.9 kJ/mole (B) –28.136 kJ/mole
(C) +28.136 kJ/mole (D) 85.9 J/mole

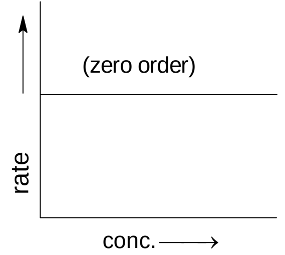
28. An acid-base indicator has $K_a = 3 \times 10^{-5}$. The acid form of the indicator is red and the basic form of the indicator is blue. By how much must the pH change in order to change the indicator from 75% red to 75% blue? [log 3 = 0.4770]

(A) 4.05 (B) 0.95
(C) 5 (D) 9

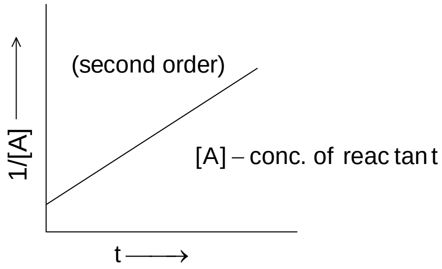
Space for Rough work

29. Select the incorrect graph

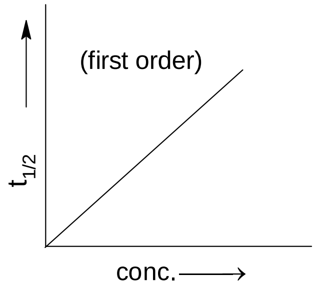
(A)



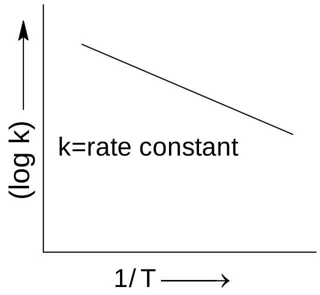
(B)



(C)



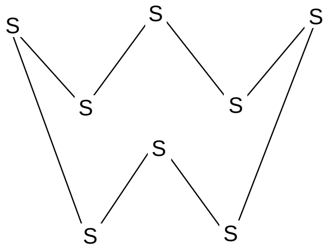
(D)



30. For the reaction,
$C_7H_8(l) + 9O_2(g) \rightarrow 7CO_2(g) + 4H_2O(l)$, calculated heat of reaction is 232.6 kJ/mol and observed heat of reaction is 50.4 kJ/mol, then the resonance energy is
(A) – 182.2 kJ / mol
(B) + 182.2 kJ / mol
(C) 172 kJ/ mol
(D) None of these

31. Heat of neutralization of four monobasic acids A, B, C and D are -13.7, - 9.4, - 11.2 and – 12.4 Kcal / mole respectively, when they are neutralized by a common base. The acidic character obeys the order
(A) A > B > C > D
(B) A > D > C > B
(C) D > C > B > A
(D) D > B > C > A

32. The oxidation number and hybridization of sulphur in S_8 molecule are respectively:
(A) +2 and sp^2
(B) +2 and sp^3
(C) zero and sp^2
(D) zero and sp^3



Space for Rough work

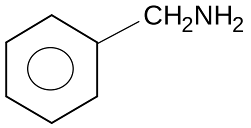
33. The relation between the molar conductance ($\wedge_m$) and equivalent conductance ($\wedge_e$) of the solution of $MgCl_2.KCl.6H_2O$ is

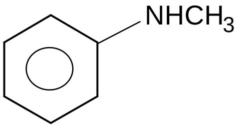
(A) $\wedge_m = \wedge_e \times 8$ (B) $\wedge_m = \wedge_e \times 3$
(C) $\wedge_e = \wedge_m \times 3$ (D) $\wedge_e = \wedge_m \times 8$

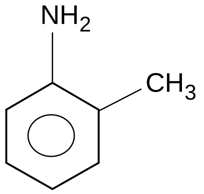
34. For which of the following aqueous solution, there is maximum difference between the normal and abnormal colligative properties?

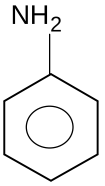
(A) 0.1 m $C_6H_{12}O_6$ (B) 0.1 m CH_3COOH
(C) 0.1 m HCOOH (D) 0.1 m CH_3OH

35. Which of the following is the strongest base?

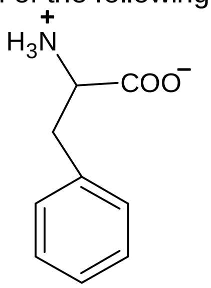
(A)


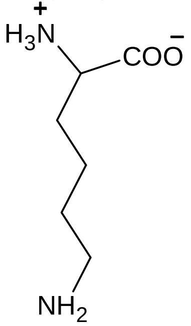
(B)


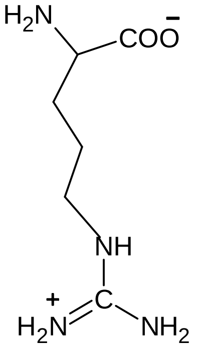
(C)


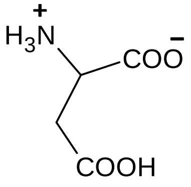
(D)


36. Which of the following zwitter ionic form is not correctly represented for an amino acid?

(A)


(B)


(C)


(D)


Space for Rough work

37. How many effective no. of Na^+ ions are present in the unit cell of NaCl if the ions along all the body diagonals of the unit cell are removed?

(A) 4 (B) 3
(C) 2 (D) 1

38. Which one of the following has aromatic character?

(A) Cyclopentadienyl cation (B) Cyclopentadienyl radical
(C) Cyclopentadienyl anion (D) Cyclopentadiene

39. $Zn(s)|\ Zn^{2+}(1M)||\ Cu^{2+}(1M)|Cu(s)$

$E^0_{Zn^{2+}/Zn} = -0.76\,V$ and $E^0_{Cu^{2+}/Cu} = 0.34\,V$

Which of the following relation(s) is/are correct for the above electrochemical cell?

(A) $E^0_{cell} > 0$ (B) $E_{cell} > 0$
(C) $E_{cell} = E^0_{cell}$ (D) All are correct

40. Number of C = C bonds present in anthracene is:–

(A) 5 (B) 3
(C) 9 (D) 7

41. Which of the following interhalogen compound does NOT exist?

(A) IF_3 (B) IF_4
(C) IF_5 (D) IF_7

42. The fraction of chlorine precipitated by $AgNO_3$ solution from $[Cr(NH_3)_5Cl]Cl_2$ is:–

(A) $\frac{1}{2}$ (B) $\frac{1}{3}$
(C) $\frac{2}{3}$ (D) $\frac{1}{4}$

Space for Rough work

43. The following two equilibria exist simultaneously in a closed container of volume 2 L

$A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$

$A_2(g) + C(g) \rightleftharpoons A_2C(g)$

Which of the following change does not affect the concentration of AB(g)

(A) Increase in pressure
(B) Addition of C
(C) Addition of He gas at constant volume
(D) All of these

44. In borax bead test, which compound is formed?

(A) Meta borate
(B) Ortho borate
(C) Tetra borate
(D) Double oxide

45. The normal boiling point of a liquid 'X' is 500 K. Which of the following statement(s) is/are incorrect for the following process?

$X(\text{liquid}) \longrightarrow X(\text{gas})$

(A) At 500 K and 1 atm pressure, $\Delta G = 0$
(B) At 500 K and 1.5 atm pressure, $\Delta G = +ve$
(C) At 500 K and 0.2 atm pressure, $\Delta G = -ve$
(D) At 520 K and 1 atm pressure, $\Delta G = +ve$

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

46. How many visible lines are emitted during transition from 5th orbit to ground state in hydroen emission spectrum?

47. For the reactoin at $25^{o-}C$

$A(g) + 2B(g) \rightleftharpoons 2C(g) + D(g)$

The intial concentratoin of B is 1.5 times the metal conc. of A. If at equilirbium, the concentration of A and D are equal. The equilibrium constant at 25^oC is

Space for Rough work

SECTION – C

(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

48. Find the wavelength of light (in $\overset{o}{A}$) emitted by an electron during transition from n = 3 to n = 1 level in C^{+5} ion. Given $R_H = 1.077 \times 10^7\ m^{-1}$

49. The sum of lone pairs on central atom of SF_4, SF_6 and H_2O is X. Calculate X/2.

50. In Na^+, Mg^{2+}, Al^{3+}, O^{2-}, F^-, Cl^- atoms. If x atoms have more radius as compared to Al^{3+} then find $\frac{x}{2}$?

Space for Rough work

Mathematics

PART – III

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

51. A function y = f(x) satisfies $(x+1).f'(x)-2(x^2+x)f(x)=\frac{e^{x^2}}{(x+1)}$, $\forall x>-1$. If f(0) = 5, then f(x) is

(A) $\left(\frac{3x+5}{x+1}\right).\ e^{x^2}$
(B) $\left(\frac{6x+5}{x+1}\right).e^{x^2}$
(C) $\left(\frac{6x+5}{(x+1)^2}\right).e^{x^2}$
(D) $\left(\frac{5-6x}{x+1}\right).e^{x^2}$

52. The relation R on the set of complex numbers, defined by z_1Rz_2 if and only if $\frac{z_1-z_2}{z_1+z_2}$ is real, is

(A) reflexive but not symmetric
(B) reflexive but not transitive
(C) symmetric but not transitive
(D) an equivalence relation

53. If $\alpha\in\left(0,\frac{\pi}{2}\right)$, then the expression $\sqrt{x^2+x}+\frac{\tan^2 x}{\sqrt{x^2+x}}$ is always greater than or equal to

(A) $2\tan\alpha$
(B) 2
(C) 1
(D) $\sec^2\alpha$

54. Let the function $f(x)=x^2+x+\sin x-\cos x+\log(1+|x|)$ be defined on the interval $[0,1]$. The function $g(x)$ on $[-1,1]$ satisfying $g(-x)=-f(x)$ is

(A) $x^2+x+\sin x+\cos x-\log(1+|x|)$
(B) $-x^2+x+\sin x+\cos x-\log(1+|x|)$
(C) $-x^2+x+\sin x-\cos x+\log(1+|x|)$
(D) none of these

Space for Rough work

55. Let $a = a_1 i + a_2 j + a_3 k$, $b = b_1 i + b_2 j + b_3 k$ and $c = c_1 i + c_2 j + c_3 k$ be three non zero vectors such that c is a unit vector perpendicular to both a and b. If the angle between a and b is $\frac{\pi}{6}$, then $\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}^2$ is equal to

(A) 0

(B) 1

(C) $\frac{1}{4}\left(a_1^2 + a_2^2 + a_3^2\right)\left(b_1^2 + b_2^2 + b_3^2\right)$

(D) $\frac{3}{4}\left(a_1^2 + a_2^2 + a_3^2\right)\left(b_1^2 + b_2^2 + b_3^2\right)\left(c_1^2 + c_2^2 + c_3^2\right)$

56. If $I = \int_0^\pi e^{\left|\left(\frac{1}{2}\right)\cos x\right|}\left\{2\sin\left(\frac{1}{2}\cos x\right) + 3\cos\left(\frac{1}{2}\cos x\right)\right\}\sin x\,dx$, then I equals

(A) $7\sqrt{e}\,\cos\left(\frac{1}{2}\right)$

(B) $7\sqrt{e}\left[\cos\left(\frac{1}{2}\right) - \sin\left(\frac{1}{2}\right)\right]$

(C) 0

(D) none of these

57. If x is real, then the maximum value of $y = 2(a - x)\left(x + \sqrt{x^2 + b^2}\right)$

(A) $a^2 + b^2$

(B) a^2

(C) $\sqrt{a^2 + b^2}$

(D) $a\sqrt{a^2 + b^2}$

58. If $\tan^{-1}\frac{1}{1+2} + \tan^{-1}\frac{1}{1+(2)(3)} + \tan^{-1}\frac{1}{1+(3)(4)} + ... + \tan^{-1}\frac{1}{1+n(n+1)} = \tan^{-1}\theta$, then $\theta =$

(A) $\frac{n}{n+1}$

(B) $\frac{n+1}{n+2}$

(C) $\frac{n}{n+2}$

(D) $\frac{n-1}{n+2}$

Space for Rough work

59. If $x_{n+1}=\sqrt{\frac{1}{2}(1+x_n)}$, then $\cos\left[\frac{\sqrt{1-x_0^2}}{x_1x_2x_3......\text{to infinite}}\right](-1<x_0<1)$ is equal to

(A) –1 (B) 1

(C) x_0 (D) $\frac{1}{x_0}$

60. If $f(x)=x^2+2bx+2c^2$ and $g(x)=-x^2-2cx+b^2$ are such that min. $f(x)>$ max g(x), then the relation between b and c is

(A) no relation (B) $0<c<\frac{b}{2}$

(C) $|c|<|b|\sqrt{2}$ (D) $|c|>|b|\sqrt{2}$

61. Two unit vectors $\vec{a}$ and $\vec{b}$ having angle θ between them. Now $\phi(\theta)=\int_{-(\vec{a}.\vec{b})^2}^{|\vec{a}\times\vec{b}|^2} f^2(x).dx$

and f satisfies the condition $f(x)+f(y)=\frac{x+y}{xy}\forall x,y\in R-\{0\}$. Then the fundamental period of $\phi(\theta)$ is

(A) Not Defined (B) π

(C) 2π (D) $\frac{\pi}{2}$

62. Consider parabola $y^2=40x$, A circle $S=0$ is drawn taking one of its focal chord as diameter. The extremeties of the focal chord being P_1 and P_2

(A) A point 'P' is taken on the circumference of S = 0, Then $\angle P_1PP_2=\frac{\pi}{4}$

(B) x = 10 is a tangent to S = 0

(C) Combined equation of the tangents at P_1 and P_2 has (coefficient x^2) + (coefficient y^2) = –2

(D) ΔP_1PP_2 has its orthocentre which lies on it

Space for Rough work

63. The remainder when $x = 5^{5^{5^5}}$ is divided by 24 is

(A) 1 (B) 3

(C) 5 (D) 23

64. Let f be a function with domain $[-5, 5]$ and let $g(x) = |3x + 4|$. Then the domain of $(fog)(x)$ is

(A) $\left(-3, \frac{1}{3}\right)$ (B) $\left[-3, \frac{1}{3}\right]$

(C) $\left(-3, \frac{1}{3}\right]$ (D) N.O.T.

65. Sum of maximum and minimum values of $\left(\sin^{-1}x\right)^4 + \left(\cos^{-1}x\right)^4$ is _________

(A) $\frac{137\pi^2}{128}$ (B) $\frac{\pi^4}{17}$

(C) $\frac{17\pi^4}{16}$ (D) $\frac{137\pi^4}{128}$

66. Number of solutions of the equation $3\tan x + x^3 = 2$ in $\left(0, \frac{\pi}{4}\right)$, are

(A) 0 (B) 2

(C) 3 (D) None of these

67. If the vectors $\vec{b} = \left(\tan\alpha, -1, 2\sqrt{\tan\frac{\alpha}{2}}\right)$, $\vec{c} = \left(\tan\alpha, \tan\alpha, \frac{-3}{\sqrt{\tan\frac{\alpha}{2}}}\right)$ are orthogonal and vectors $\vec{a} = (1, 3, \sin 2\alpha)$ makes obtuse angle with the z axis the α equals

(A) $(2n+1)\pi + \tan^{-1}2$ (B) $(2n+1)\pi - \tan^{-1}2$

(C) $n\pi - \tan^{-1}2$ (D) None of these

Space for Rough work

68. The Real value of ‘m’ for which the substitution $y = u^m$ will transform the differential equation $2x^4 y\frac{dy}{dx} + y^4 = 4x^6$ into a homogeneous equation, is

(A) $\frac{1}{2}$ (B) 1

(C) $\frac{3}{2}$ (D) 2

69. Sign of $(x-1)(x-3)(x-4)(x-6)+10$ is

(A) Positive for all real values of x (B) Negative for all $x \in R$

(C) Can be positive, negative or zero (D) Can’t say

70. A parallelogram is constructed with its sides parallel to the asymptotes of the hyperbola $x^2 - 2y^2 - 4x + 4y - 2 = 0$ and one of its diagonals is a chord of the same hyperbola. If the other diagonal passes through a fixed point (a, b) $a, b \in R$ then

(A) $a + b = 4$ (B) $a - b = 3$

(C) $\sum_{r=1}^{a+b} r = 6$ (D) $\sum_{r=1}^{a-b} r = 6$

SECTION – B

(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

71. An urn contain 3 red balls and n white balls. Mr. A draws two balls together from the urn. The probability that they have the same colour is 1/2. Mr. B draws one ball from the urn, notes its colour and replaces it. He then draws a second ball from the urn and finds probability that both balls have the same colour is $\frac{5}{8}$. The possible value of n is_________

72. The 20th term of an arithmetic sequence is $\log_{10} 20$ and the 32nd term is $\log_{10} 32$. If exactly one term of the arithmetic sequence is a rational number which in lowest form is $\frac{p}{q}; (p, q \in N)$ then (p + q) = _____

Space for Rough work

SECTION – C

(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

73. If $f:[0,1] \to R$ is a continuous function satisfying $\int_0^1 f(x)dx = \frac{1}{3} + \int_0^1 \left(f\left(x^2\right)\right)^2 dx$, then the reciprocal of $\frac{1}{8}f\left(\frac{1}{4}\right)$ is __________

74. Any chord of conic $x^2 + y^2 + xy = 1$ passing through origin is bisected at point (p, q), then $\frac{(p+q+1)}{8}$ equals __________

75. Let z and ω be complex numbers such that $z + \omega = i$ and $z^2 + \omega^2 = 1$. If area of triangle formed by z, ω and origin is equal to A, then find the value of $10A^2$.

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – II

JEE (Main)-2020

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. C

Sol. Loss in KE = $k_i - k_f$

$$= \frac{1}{2}(40)\times 4^2 + \frac{1}{2}(60)(2)^2 - \frac{1}{2}(100)\times(2.8)^2 = 48 \text{ J.}$$

2. B

Sol. The charge q is completely closed by four identical given box. Therefore, the required flux = $\frac{1}{4}\frac{q}{\epsilon_o}$.

3. A

Sol. $N = N_o e^{-\lambda t}$

$0.99 = 1\, e^{-\lambda t} \Rightarrow \lambda t = \ln\left(\frac{100}{99}\right)$

$$50 \text{ sec} = t = \frac{\ln\left(\frac{100}{99}\right)}{\lambda}$$

$$\Rightarrow \quad t_{1/2} = \frac{50\ln(2)}{\ln(100/99)}$$

4. A

Sol. $v_I = -m^2 v_o$

$$= -\frac{9}{25}\times(-5\hat{i}) = 1.8\,\hat{i}$$

5. B

Sol. $\frac{1}{r} = \frac{1}{r_1} - \frac{1}{r_2} \Rightarrow$ r = 4 mm.

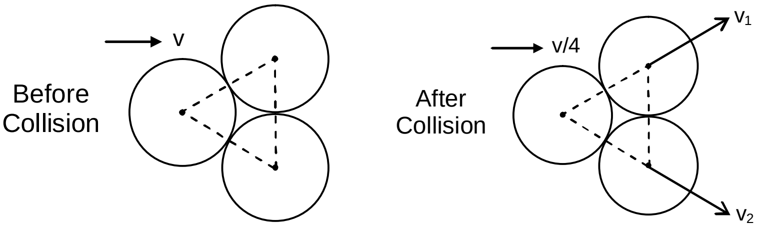
6. D

Sol. $\vec{\tau} = \vec{\mu} \times \vec{B}$

$= (i\vec{A}) \times \vec{B}$

7. C

Sol.



$$2mv_1\cos 30° + m\frac{v}{4} = mv \qquad \ldots(i)$$

$$e = \frac{v_1 - \frac{v}{4}\cos 30^o}{v\cos 30^o} \qquad \ldots(ii)$$

8. C

Sol. $P = \rho(g + a)h$

9. B

Sol. At steady state.

Rate of generation of A = Rate of decay of A.

$q = \lambda N_A$

$\Rightarrow \; N_A = \frac{q}{\lambda}$

10. B

Sol. $x = 2\sin 3t$

$y = 2 - 2\cos 3t$

$\sin^2 3t + \cos^2 3t = 1$

11. A

Sol. $f\lambda = v = \frac{10\lambda v}{d} \Rightarrow \lambda = \frac{d}{10}$.

Maximum path diff. can be $\frac{d}{3}$. Hence, number of maximum will be 6.

12. B

Sol. Displacement method

$\frac{u}{D-u} = 2$ (I) & D – u – u = 30 cm ...(II)

3u = 2D (I) & D – 2u = 30 cm

And $\frac{1}{f}=\frac{1}{D-u}+\frac{1}{u}$

$\Rightarrow$ f = 20 cm.

13. A

Sol. Inside water

u = –20 cm

f = –15 cm

$\Rightarrow$ v = –60 cm

$m=\frac{-v}{u}$ = –3

$\Rightarrow$ n = 3

14. D

Sol. $\tau=\frac{i_{finel}}{\left(\frac{di}{dt}\right)_{initial}}=\frac{\left(\frac{2}{10}\right)}{\left(\frac{\Delta V_L}{L}\right)}$

$=\frac{\frac{1}{5}}{\frac{2}{3}\times 2}=\frac{3}{20}$ seconds.

15. C

Sol. The net resistance across the cell is decreased to R/2 hence the current delivered by the battery will increase while potential across R will remain same.

16. D

Sol. $\phi_B = 0$

$\because$ $\vec{B}\perp\vec{S}$

$\therefore$ $\frac{d\phi_B}{dt} = 0$

17. A

Sol. As λ increases saturation current also increases.

18. C

Sol. $\Delta V=\left|\frac{d\phi}{dt}\right|$ = (Area)$\times\frac{dB}{dt}=\frac{\pi R}{2}\left(\frac{R}{2}\right)(B_o)$

$\Delta V_{AB}=\frac{\pi R^2}{4}B_o$

19. A

Sol. Applying momentum conservation in the direction of string

$mu\frac{\sqrt{3}}{2}$ = 2 mv $\Rightarrow$ $v=\frac{\sqrt{3}}{4}(u)$

20. C

Sol. $\vec{N}+\vec{F}_s+m\vec{g} = 0$

$\therefore \quad \left|\vec{N}+\vec{F}_s\right| = \left|-m\vec{g}\right| = 20\text{ N}$

SECTION – B

21. 6

Sol. $h = \dfrac{2T\cos\theta}{r\rho g}$

22. 8

Sol. Constraint equation.

SECTION – C

23. 00000.60

Sol. $\dfrac{2}{3}MR_1^2 = \dfrac{2}{5}MR_2^2$

24. 00000.20

Sol. I_L and I_C will be in opposite phases.

$I_{net} = I_L - I_C$

$= 0.6 - 0.4 = 0.2\text{ A}$

25. 00011.00

Sol. $I_1 = \left(\dfrac{s}{s+99}\right)\times I$

Chemistry PART – II

SECTION – A

26. C

Sol. P = K_2SO_4, Q = $BaSO_4$, R = BaS, S = H_2S

27. B

Sol. $\Delta C_p = 2\times 25.1 + 3\times 75.3 - (103.8 + 3\times 28.8) = 85.9\ \text{J/mole}$

$$\frac{\Delta H_{358} - \Delta H_{298}}{T_2 - T_1} = \Delta C_p$$

$\Delta H_{358} = -28.136\ \text{kJ/mole}$

28. B

Sol. $HIn \rightleftharpoons H^+ + In^-$

$$K_a = \frac{\left[H^+\right]\left[In^-\right]}{[HIn]} = \frac{\left[H^+\right][\text{base}]}{[\text{Acid}]}$$

$$\text{or,}\left[H^+\right] = Ka\frac{[\text{Acid}]}{[\text{Base}]}$$

For 75% red, $\left[H^+\right] = \dfrac{Ka\times 75}{25} = \dfrac{3\times 10^{-5}\times 75}{25} = 9\times 10^{-5};\ pH = 4.05$

For 75% blue, $\left[H^+\right] = \dfrac{\left(3\times 10^{-5}\right)\times 25}{75} = 1\times 10^{-5};\ pH = 5$

The change in pH = 5-4.05 = 0.95

29. C

Sol. $t_{1/2}$ is independent of concentration of reactant for 1st order reaction

30. A

Sol. (A) As we know that,

Resonance energy = ΔH° (observed) – ΔH° (calculated)

= (50.4 – 232.6) kJ / mol = – 182.2 kJ mol^{-1}

31. B

Sol. In case of weak acid heat of neutralization is greater than – 13.7 KCl / mole because extra energy is required to dissociate the acid.

32. D

Sol. Sulphur forms two sigma bonds with two lone pairs.

33. B

Sol. $\dfrac{\Lambda_m}{\Lambda_e} = 3 \Rightarrow \Lambda_m = 3\Lambda_e$

n-factor of $MgCl_2.KCl.6\ H_2O$ = 3.

34. C

Sol. HCOOH is stronger than CH_3COOH. Hence the solution of HCOOH will contain more no. of ions than that of CH_3COOH.

35. A

Sol. Aliphatic amines are stronger base than aromatic amines

36. B

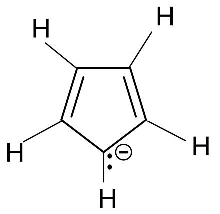
Sol. In (B) the NH_2 group which is at a larger distance from the COOH group, should be more basic it should accept H^+ ion from acid.

37. B

Sol. One Na^+ is removed and remaining three(effective no. per unit cell) are present.

38. C

Sol. In cyclopentadienyl anion, each carbon is sp^2 hybridized

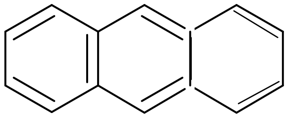


39. D

Sol. $E^0_{cell} = E^0_{cell} > 0$ (due to 1 M concentration of ions)

40. D

Sol.



41. B

Sol. Halogen atoms except fluorine form compounds with valency 1, 3, 5 and 7.

42. C

Sol. The fraction is $\frac{2}{3}$

43. C

Sol. Increases in pressure or addition of C affect the second equilibrium hence concentration of A_2 changes which further affect the first equilibrium. Addition of inert gas at constant volume does not affect the equilibrium

44. A

Sol. $$Na_2B_4O_7.10H_2O \xrightarrow[-10H_2O]{heat} Na_2B_4O_7 \xrightarrow{740^{o}C} \underset{\text{Sodium metaborate}}{2NaBO_2} + B_2O_3$$

$$\begin{array}{l} B_2O_3 + CuSO_4 \longrightarrow CuO.B_2O_3 + SO_3 \\ \qquad\qquad\qquad\qquad\quad \downarrow \\ \qquad\qquad\qquad\quad Cu(BO_2)_2 \text{ (blue)} \\ \qquad\qquad\qquad \text{Copper metaborate} \end{array}$$

45. D

Sol. At normal boiling point (500 K), the following equilibrium exists between the two physical states at 1 atm.

$$X(\text{liquid}) \rightleftharpoons X(\text{gas})$$

For the equilibrium $\Delta G = 0$

If the pressure increases the change shifts to backward direction for which ΔG = +ve.

If pressure decreases the change shifts towards forward direction, for which ΔG = -ve.

If temperature increase, the change will proceed towards forward direction, for which ΔG = -ve.

SECTION – B

46. 3

Sol. $5 \rightarrow 2,\ 4 \rightarrow 2,\ 3 \rightarrow 2$

47. 4

Sol. $A(g) + 2B(g) \rightleftharpoons 2C(g) + D(g)$

a	1.5 a	0	0
(a - x)	$1.5^a - 2x$	2x	2x

Now, a – x = x

$\Rightarrow$ x = a/2

SECTION – C

48. 00028.66

Sol. $\frac{1}{\lambda} = 1.09 \times 10^7 \times 36\left[\frac{1}{1} - \frac{1}{9}\right]$

49. 00001.50

Sol. SF_4 $\ell p = 1$

SF_6 $\ell p = 0$

H_2O $\ell p = 2$

50. 00002.50

Sol. Na^+, Mg^{2+}, O^{2-}, F^- & Cl^- will have more radius

So, $\frac{x}{2} = 2.5$

Mathematics PART – III

SECTION – A

51. B

Sol. $f'(x)-\frac{2x(x+1)}{x+1}f(x)=\frac{e^{x^2}}{(x+1)^2}$

$\text{IF} = e^{\int -2x\,dx} = e^{-x^2}$

$\Rightarrow \quad f(x).\left(-e^{-x^2}\right)=\int\frac{dx}{(x+1)^2}$

$\Rightarrow \quad f(x).e^{-x^2} = \frac{1}{x+1}+C$

At x = 0, f(0) = 5

$\Rightarrow \quad C = 6$

$\therefore \quad f(x)=\left(\frac{6x+5}{x+1}\right).e^{x^2}$

Hence, (b) is the correct answer.

52. D

Sol. Clearly, R is reflexive and symmetric.

Let z_1Rz_2 and z_2Rz_3

$\Rightarrow \quad \frac{z_1-z_2}{z_1+z_2}$ is real, say k

and $\quad \frac{z_2-z_3}{z_2+z_3}$ is real, say l

Now, $\frac{z_1-z_2}{z_1+z_2}=k \Rightarrow \frac{z_1}{z_2}=\frac{1+k}{1-k}$

and $\frac{z_2-z_3}{z_2+z_3}=l \Rightarrow \frac{z_2}{z_3}=\frac{1+l}{1-l}$

Thus, $\frac{z_1}{z_3}=\frac{(1+k)(1+l)}{(1-k)(1-l)}$

$\Rightarrow \quad \frac{z_1-z_3}{z_1+z_3}=\frac{(1+k)(1+l)-(1-k)(1-l)}{(1+k)(1+l)+(1-k)(1-l)}$

which is real.

53. A

Sol. Since A.M. ≥ G.M., We get

$$\frac{1}{2}\left[\sqrt{x^2+x}+\frac{\tan^2\alpha}{\sqrt{x^2+x}}\right]\geq\sqrt{\sqrt{x^2+x}\times\frac{\tan^2 x}{\sqrt{x^2+x}}}=|\tan\alpha|$$

54. B

Sol. All the function in (a), (b), (c) are defined on $[-1, 1]$. Let $g(x) = -x^2 + x + \sin x + \cos x - \log(1+|x|)$. (The choice of g is clear as $x^2, \cos x \log(1+|x|)$ are even function and $x, \sin x$ are odd function). Then

$$g(-x) = -x^2 - x - \sin x + \cos x - \log(1+|x|) = -(x^2 + x + \sin x - \cos x + \log(1+|x|)) = -f(x).$$

55. C

Sol. According to the given conditions, $c_1^2 + c_2^2 + c_3^2 = 1,\ a.c - 0,\ b.c = 0$ and

$$\frac{\sqrt{3}}{2} = \cos\frac{\pi}{6} = \frac{a_1b_1 + a_2b_2 + a_3b_3}{\sqrt{a_1^2 + a_2^2 + a_3^2}\sqrt{b_1^2 + b_2^2 + b_3^2}}$$

Thus $a_1c_1 + a_2c_2 + a_3c_3 = 0,\ b_1c_1 + b_2c_2 + b_3c_3 = 0$ and

$$\frac{\sqrt{3}}{2}\left(a_1^2 + a_2^2 + a_3^2\right)^{1/2}\left(b_1^2 + b_2^2 + b_3^2\right)^{1/2} = a_1b_1 + a_2b_2 + a_3b_3$$

Now, $$\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}^2 = \begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}$$

$$= \begin{vmatrix} a_1^2 + a_2^2 + a_3^2 & a_1b_1 + a_2b_2 + a_3b_3 & a_1c_1 + a_2c_2 + a_3c_3 \\ a_1b_1 + a_2b_2 + a_3b_3 & b_1^2 + b_2^2 + b_3^2 & b_1c_1 + b_2c_2 + b_3c_3 \\ a_1c_1 + a_2c_2 + a_3c_3 & b_1c_1 + b_2c_2 + b_3c_3 & c_1^2 + c_2^2 + c_2^2 \end{vmatrix}$$

$$= \begin{vmatrix} a_1^2 + a_2^2 + a_3^2 & a_1b_1 + a_2b_2 + a_3b_3 & 0 \\ a_1b_1 + a_2b_2 + a_3b_3 & b_1^2 + b_2^2 + b_3^2 & 0 \\ 0 & 0 & 1 \end{vmatrix}$$

$$\left(a_1^2 + a_2^2 + a_3^2\right)\left(b_1^2 + b_2^2 + b_3^2\right) - \left(a_1b_1 + a_2b_2 + a_3b_3\right)^2$$

$$= \left(a_1^2 + a_2^2 + a_3^2\right)\left(b_1^2 + b_2^2 + b_3^2\right) - \frac{3}{4}\left(a_1^2 + a_2^2 + a_3^2\right)\left(b_1^2 + b_2^2 + b_3^2\right)$$

$$= \frac{1}{4}\left(a_1^2 + a_2^2 + a_3^2\right)\left(b_1^2 + b_2^2 + b_3^2\right)$$

56 D

Sol. Put $\frac{1}{2}\cos x = t$, so that $-\sin x\, dx = 2dt$ and $I = \int_{1/2}^{-1/2} e^{|t|}(2\sin t + 3\cos t)(-2)dt$

As $e^{|t|}\sin t$ is an odd function, and $e^{|t|}\cos t$ is an even function,

$$I = 12\int_0^{1/2} e^t \cos t\ dt = 12e^t \cos t\Big]_0^{1/2} + 12\int_0^{1/2} e^t\ \sin t\, dt$$

$$I = 12\left[\sqrt{e}\cos\left(\frac{1}{2}\right) - 1\right] + 12e^t \sin t\Big]_0^{1/2} - 12\int_0^{1/2} e^t \cos t\ dt$$

$$\Rightarrow 2I = 12\sqrt{e} = \left(\cos\left(\frac{1}{2}\right) + \sin\left(\frac{1}{2}\right) - 1\right).$$

57. A

Sol. Let $t = x + \sqrt{x^2 + b^2}$

$\Rightarrow \frac{1}{t} = \frac{1}{x + \sqrt{x^2 + b^2}} = \frac{\sqrt{x^2 + b^2} - x}{b^2}$

$\therefore\ t - \frac{b^2}{t} = 2x$ and $t + \frac{b^2}{t} = 2\sqrt{x^2 + b^2}$

Thus $2(a-x)\left(x + \sqrt{x^2 + b^2}\right) = \left(2a - t + \frac{b^2}{t}\right)(t)$

$= 2at - t^2 + b^2 = a^2 + b^2 - \left(a^2 - 2at + t^2\right)$

$= a^2 + b^2 - (a-t)^2$

Therefore, $y = 2(a-x)\left(x + \sqrt{x^2 + b^2}\right) \le a^2 + b^2$.

Hence, the maximum value of y is $a^2 + b^2$. This value is attained at $t = a$ or $x = \frac{\left(a^2 - b^2\right)}{2a}$.

58. C

Sol. $\tan^{-1}\frac{1}{1+n(n+1)} = \tan^{-1}\frac{n+1-n}{1+n(n+1)}$

$= \tan^{-1}(n+1) - \tan^{-1}(n)$

So that L.H.S. of the given equation is

$\tan^{-1}2 - \tan^{-1}1 + \tan^{-1}3 - \tan^{-1}2 + ... + \tan^{-1}(n+1) - \tan^{-1}n$.

$= \tan^{-1}(n+1) - \tan^{-1}1 = \tan^{-1}\frac{n+1-1}{1+(n+1)}$

$= \tan^{-1}\frac{n}{n+2}$

So that $\tan^{-1}\frac{n}{n+2} = \tan^{-1}\theta = \theta = \frac{n}{n+2}$.

59. C

Sol. Let $x_0 = \cos\theta$, then $x_1 = \sqrt{\frac{1}{2}(1+\cos\theta)} = \cos\frac{\theta}{2}$, $x_2 = \cos\left(\frac{\theta}{2^2}\right)$, $x_3 = \cos\left(\frac{\theta}{2^3}\right)$.... and so on.

So that $\left[\frac{\sqrt{1-x_0^2}}{x_1x_2x_3.......\text{to infinite}}\right]$

$$= \frac{\sin\theta}{\cos\frac{\theta}{2}\cos\frac{\theta}{2^2}......\cos\frac{\theta}{2^n}......\text{infinite}}$$

$$= \frac{2\sin\frac{\theta}{2}\cos\frac{\theta}{2}}{\cos\frac{\theta}{2}\cos\frac{\theta}{2^2}.....\cos\frac{\theta}{2^n}.....\text{infinite}}$$

$$= \frac{2^2 \sin\frac{\theta}{2^2}\cos\frac{\theta}{2^2}}{\cos\frac{\theta}{2^2}\cos\frac{\theta}{2^3}.......\cos\frac{\theta}{2^n}.....\text{infinite}}$$

$$= \lim_{n\to\infty}\frac{2^n\sin\frac{\theta}{2^n}}{\cos\frac{\theta}{2^{n+1}}} = \lim_{n\to\infty}\theta\left(\frac{\sin\frac{\theta}{2^n}}{\frac{\theta}{2^n}}\right)\frac{1}{\cos\frac{\theta}{2^{n+1}}} = \theta$$

So that $\cos\left[\frac{\sqrt{1-x_0^2}}{x_1 x_2.....\text{inf}}\right] = \cos\theta = x_0$

60. D

Sol. We have $f(x) = x^2 + 2bx + 2c^2 = (x+b)^2 + 2c^2 - b^2$

$\Rightarrow \quad \min f(x) = 2c^2 - b^2$

Also $\quad g(x) = -x^2 - 2cx + b^2$

$= b^2 + c^2 - (x+c)^2$

so $\quad \max g(x) = b^2 + c^2$

Since $\quad \min f(x) > \max g(x)$,

so $\quad 2c^2 - b^2 > b^2 + c^2$

$\Rightarrow \quad c^2 > 2b^2 = |c| > \sqrt{2}|b|$.

61. D

Sol. $|\vec{a}| = 1 = |\vec{b}|$

$\phi(\theta) = \int_{-\cos^2\theta}^{\sin^2\theta} f^2(x).dx$

$2f(x) = \frac{2x}{x^2} \Rightarrow \boxed{\frac{1}{x} = f(x)}$

$\phi(\theta) = \int_{-\cos^2\theta}^{\sin^2\theta} \frac{1}{x^2}.dx$

$= \left[\frac{-1}{x}\right]_{-\cos^2\theta}^{\sin^2\theta}$

$= (-\text{cosec}^2\theta) - (\sec^2\theta)$

$= -\text{cosec}^2\theta.\sec^2\theta$

$\phi(\theta) = \frac{-4}{\sin^2 2\theta} = -4\,\text{cosec}^2 2\theta$

Fundamental period is $\left(\frac{\pi}{2}\right)$

62. D

Sol. $x = -10$ is the directrix of the given parabola. Hence the circle S = 0 will touch it. P_1P_2 is the diameter. So $\angle P_1P\,P_2 = 90^o$ and hence ΔP_1PP_2 is right angled and its orthocentre is point P.

Tangents at extremeties of focal chord are perpendicular. Hence in their combined equation (coefficient x^2) + (coefficient y^2) = 0.

63. C

Sol. 5^{5^5} is an odd natural number.

$\therefore x = 5^{5^5} = 5^{2m+1} = \left(25^m\right).5$

$m \in N$

$x = \left(24+1\right)^m.5 = 5 + a$ multiple of 24

Hence Remainder = 5

64. B

Sol. $f\left(g\left(x\right)\right) = f\left(\left|3x+4\right|\right)$

$-5 \le 3x+4 \le 5$

$x \in \left[-3, \frac{1}{3}\right]$

65. D

Sol. $y = \left(\sin^{-1}x\right)^4 + \left(\cos^{-1}x\right)^4$

$$\frac{dy}{dx} = \frac{4\left(\sin^{-1}x\right)^3}{\sqrt{1-x^2}} - \frac{4\left(\cos^{-1}x\right)^3}{\sqrt{1-x^2}} = 0$$

$\Rightarrow \sin^{-1}x = \cos^{-1}x$

$\Rightarrow x = \frac{1}{\sqrt{2}}$

$f\left(1\right) = \frac{\pi^4}{16}$

$f\left(-1\right) = \frac{\pi^4}{16} + \pi^4 = \frac{17\pi^4}{16}$ (Maximum)

$F\left(\frac{1}{\sqrt{2}}\right) = \frac{\pi^4}{128}$ (Minimum)

66. D

Sol. Let $f\left(x\right) = 3\tan x + x^3 - 2$

Then $f'\left(x\right) = 3\sec^2 x + 3x^2 > 0$

Hence $f\left(x\right)$ increases.

Also $f\left(0\right) = -2$ and $f\left(\frac{\pi}{4}\right) > 0$

So, by intermediate value theorem, $f\left(c\right) = 2$ for some c in $\left(0, \frac{\pi}{4}\right)$

Hence $f\left(x\right) = 0$ has only one root.

67. B

Sol. $\vec{b}.\vec{c}=0$

$\tan\alpha=-2, 3$

$\tan\alpha=-2$

$\Rightarrow\alpha\rightarrow 2^{nd}$ or 4^{th} quadrant

$\tan\alpha=3$

$\Rightarrow\alpha\rightarrow 1^{st}$ or 3^{rd} quadrant

Now,

$\vec{a},\hat{k}<0$

$\sin 2\alpha<0$

$(2n-1)\pi<2\alpha<2n\pi$

$\frac{(2n-1)\pi}{2}<\alpha<n\pi$

$\alpha\rightarrow 2^{nd}$ quadrant

or, $\tan\alpha=-2$

or, $\alpha=(2n+1)\pi-\tan^{-1}2$

68. C

Sol. $y=u^m$

$\frac{dy}{dx}=m.u^{m-1}\frac{du}{dx}$

The given differential equation becomes $2x^4u^m.\ mu^{m-1}\frac{du}{dx}+u^{4m}=4x^6$

or $\frac{du}{dx}=\frac{4x^6-u^{4m}}{2mx^4x^{2m-1}}$

For homogeneous equation, degree should be same for numerator and denominator,

hence $6=4m=4+2m-1\Rightarrow m=\frac{3}{2}$

69. A

Sol. $(x^2-7x+6)(x^2-7x+12)+10$

Taking first and last terms together and middle terms together. Now make quadratic in $x^2-7x=t$.

We get, $(t+6)(t+12)+10$

$=t^2+18t+82$

D = –4 <0

Hence value is always positive $\forall x\in R$.

70. C

Sol. Second diagonal will pass through the centre of the hyperbola.

SECTION – B

71. 1

Sol. In the 1st case,

P (they match) $= \frac{{}^{3}C_2 + {}^{n}C_2}{{}^{n+3}C_2} = \frac{1}{2}; \frac{6+n(n-1)}{(n+3)(n+2)} = \frac{1}{2}$

$\Rightarrow 2(n^2 - n + 6) = n^2 + 5n + 6$

$\Rightarrow n^2 - 7n + 6 = 0$

$\Rightarrow n = 1$ or 6

In the 2nd case,

$\frac{3}{n+3} \times \frac{3}{n+3} + \frac{n}{n+3} \times \frac{n}{n+3} = \frac{5}{8}$

Solving, $n^2 - 10n + 9 = 0$

n = 9 or 1 ……………(ii)

From equation (i) and (ii), n = 1

72. 9

Sol. Given,

$a + 19d = \log_{10} 20$ ………..(1)

$a + 31d = \log_{10} 32$ ……….(2)

(2) – (1)

$12d = \log_{10} \frac{32}{20} = \log_{10} 16 - 1$

$12d = 4\log_{10} 2 - 1$

$\log_{10} 2 = \frac{12d+1}{4}$ ……….(A)

Again (2) + (1)

$2a + 50d = \log_{10} 640 = 6\log_{10} 2 + 1$

$\log_{10} 2 = \frac{2a + 50d - 1}{6}$ ………..(B)

$\therefore \frac{12d+1}{4} = \frac{2a+50d-1}{6} \Rightarrow 36d + 3 = 4a + 100d - 2$

$4a + 64d = 5$

$\underbrace{a + 16d}_{17^{th}\text{ term}} = \frac{5}{4}$

Hence, 17th term is rational and its value is $\frac{5}{4} = \frac{p}{q} \Rightarrow (p+q) = 9$

SECTION – C

73. 00000.25

Sol. Given $\int_0^1 f(x)dx = \frac{1}{3} + \int_0^1 \left(f(x^2)\right)^2 dx$

Consider, $I_1 = \int_0^1 \left(f(x^2)\right)^2 dx$

Put $x^2 = t \Rightarrow 2x\,dx = dt$

$$I_1 = \frac{1}{2}\int_0^1 \frac{\left(f(t)\right)^2}{\sqrt{t}}dt$$

$\therefore$ Equation (1) becomes

$$\int_0^1 \frac{t}{2\sqrt{t}}dt + \int_0^1 \frac{\left(f(t)\right)^2 - 2\sqrt{t}\,f(t)}{2\sqrt{t}}dt \Rightarrow \int_0^1 \left(f(t) - \sqrt{t}\right)^2 dt = 0$$

$\therefore f(t) = \sqrt{t}$

So, $f\left(\frac{1}{4}\right) = \frac{1}{2}$

So, reciprocal of $f\left(\frac{1}{4}\right) = 2$

74. 00000.12

Sol. Given curve is ellipse having centre (0, 0). All chords of ellipse through origin are bisected at origin

$\Rightarrow p = q = 0$

75. 00001.87

Sol. Given, $z + \omega = i$ ……(1)

and $z^2 + \omega^2 = 1$ …….(2)

$\therefore$ From (1), on squaring we get

$z^2 + \omega^2 + 2z\omega = -1 \quad \Rightarrow \quad 1 + 2z\omega = -1$ [Using (2)]

$\Rightarrow \; zw = -1$ …..(3)

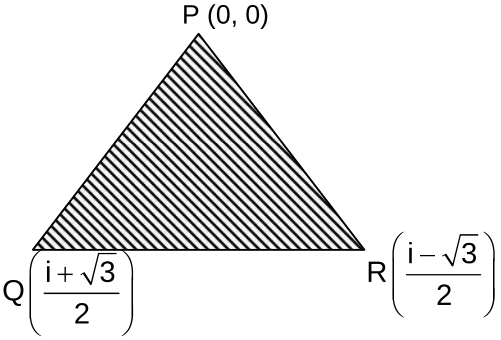
Now, let us consider a quadratic equation in x whose roots are z and ω.

$\Rightarrow \quad x^2 - ix - 1 = 0$

$$\therefore \quad x = \frac{i \pm \sqrt{i^2 + 4}}{2} = \frac{i \pm \sqrt{3}}{2}$$

Let x

$\omega = \frac{i + \sqrt{3}}{2}$ $\quad z = \frac{i - \sqrt{3}}{2}$


P (0, 0)
$Q\left(\frac{i+\sqrt{3}}{2}\right)$
$R\left(\frac{i-\sqrt{3}}{2}\right)$

$$\text{So, ar.}(\Delta PQR) = \frac{1}{2}\left|\begin{vmatrix} 0 & 0 & 1 \\ \frac{\sqrt{3}}{2} & \frac{1}{2} & 1 \\ \frac{-\sqrt{3}}{2} & \frac{1}{2} & 1 \end{vmatrix}\right| = \frac{1}{2}\left(\frac{\sqrt{3}}{4} + \frac{\sqrt{3}}{4}\right) = \frac{\sqrt{3}}{4}$$

FIITJEE
ALL INDIA TEST SERIES
CONCEPT RECAPITULATION TEST – III
JEE (Advanced)-2020
PAPER – 1

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B.**

1. ***Section-A (01– 7, 19 – 25, 37 – 43)*** *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect option is selected.

   Section-A (08 – 13, 26 – 31, 44 – 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S). Each multiple choice question with 4 options has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section–B (14 – 18, 32 – 36, 50 – 54)*** *contains 15 Numerical based questions with answers as numerical value from 0 to 9 and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A
(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. An L-C-R series circuit with 100 Ω resistance is connected to an *ac* source. When only the capacitance is removed, the current lags behind voltage by $\frac{\pi}{4}$. When only the inductance is removed, the current leads voltage by $\frac{\pi}{4}$. Then
(A) Inductive reactance is 100 Ω
(B) Capacitive reactance is 100 Ω
(C) Impedance of L-C-R circuit is 100 Ω
(D) Maximum potential difference across inductor is equal to maximum potential difference across capacitor when all are connected in circuit.

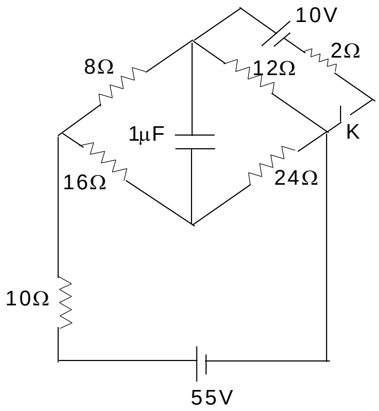
2. When a monochromatic point source of light is at a distance of 0.2 m from a photoelectric cell, the cut-off voltage and the saturation current are respectively 0.6 V and 18.0 mA. If the same source is placed 0.6 m away from the photoelectric cell, then
(A) the stopping potential will be 0.2 V
(B) the stopping potential will be 0.6 V
(C) the saturation current will be 6.0 mA
(D) the saturation current will be 2.0 mA

3. A wave disturbance in a medium is described by $y(x,t) = 0.02\cos\left(50\pi t + \frac{\pi}{2}\right)\cos(10\pi x)$
where *x* and *y* are in meter and *t* is in second. Then
(A) First node occurs at $x = 0.15$m
(B) First antinode occurs at $x = 0.3$ m
(C) The speed of interfering waves is 5.0 m/s
(D) The wavelength is 0.2 m

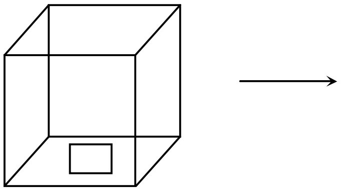
4. A planet of mass *m* moves along an ellipse around the sun of mass *M* (the sun is at one focus) so that its maximum and minimum distances from the sun are r_1 and r_2 and velocities at these points are v_1 and v_2 respectively. Then
(A) $v_1 r_1 = v_2 r_2$
(B) total energy of planet is always constant
(C) angular momentum of planet is $m\sqrt{\frac{2GM(r_1 r_2)}{(r_1 + r_2)}}$
(D) $v_2 r_1 = v_1 r_2$

Space for Rough work

5. In the given circuit,
(A) current flowing through the 10Ω resistor is 2.36 A when key is open
(B) Net charge on capacitor is 4.8 μc when key is open
(C) Net charge on capacitor is 4.8 μc when key is closed
(D) current flowing through 10Ω resistor is 2.7 A, when key is closed

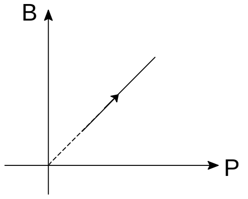


6. A solid block of mass 2 kg is resting inside a cube as shown in the figure. The cube is moving with the velocity $\vec{v} = 5t\hat{i} + 2\hat{j}$ m/s (*t* is time in second). The block is at rest with respect to the cube and coefficient of friction between the surfaces of cube and the block is 0.6. Then (g = 10 m/s^2)
(A) force of friction acting on the block is 10 N.
(B) force of friction acting on the block is 4 N.
(C) the total force exerted by the block on the cube is 14 N.
(D) the total force exerted by the block on the cube is $10\sqrt{5}$ N.

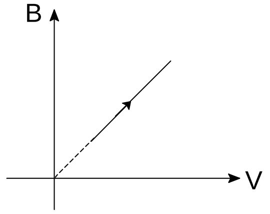


7. A sample of gas follow process represented by PV^2 = constant. Bulk modulus for this process is B. Then which of the following graph is correct?

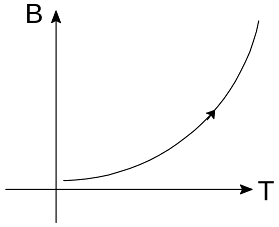
(A)



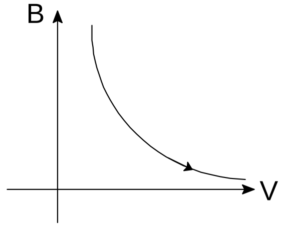
(B)



(C)



(D)



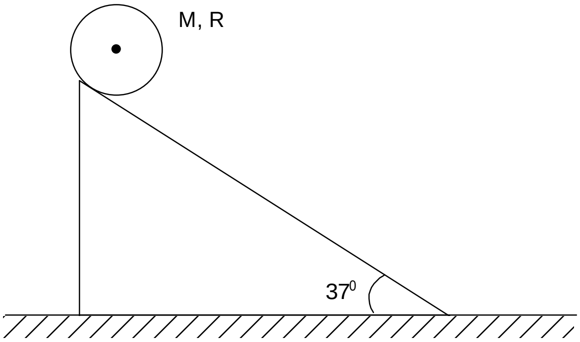
Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

A body of mass M and radius R released from the top of inclined plane of length L. If friction is sufficient to prevent slipping. Then column – 1 represent shape of rigid body, column – 2 represent friction acting on rigid body and column – 3 time to reach of bottom of Incline plane. Answer the following:-



Column – 1		Column – 2		Column – 3	
(I)	Solid sphere	(i)	$\frac{mg}{5}$	(P)	$\sqrt{\frac{20L}{3g}}$
(II)	Disc	(ii)	$\frac{6mg}{35}$	(Q)	$\sqrt{\frac{50L}{9g}}$
(III)	Ring	(iii)	$\frac{6mg}{25}$	(R)	$\sqrt{\frac{5L}{g}}$
(IV)	Hollow sphere	(iv)	$\frac{3mg}{10}$	(S)	$\sqrt{\frac{14L}{3g}}$

8. Choose the correct alternative which will take maximum time to reach at bottom of incline

(A) $(I)(ii)(P)$ (B) $(II)(iv)(P)$

(C) $(IV)(i)(P)$ (D) $(III)(iv)(P)$

Space for Rough work

9. Combination which takes minimum time to reach at the bottom of incline

(A) $(\text{II})(\text{i})(\text{S})$ (B) $(\text{IV})(\text{iii})(\text{S})$

(C) $(\text{I})(\text{ii})(\text{S})$ (D) $(\text{III})(\text{iv})(\text{S})$

10. Pick the correct combination

(A) $(\text{II})(\text{i})(\text{Q})$ (B) $(\text{IV})(\text{iii})(\text{R})$

(C) $(\text{IV})(\text{iii})(\text{Q})$ (D) $(\text{II})(\text{iii})(\text{R})$

Answer questions 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

A charged particle (elelctron or proton) is introduced at the origin (0, 0, 0) with a given initial velocity $\vec{v}$, electric field $\vec{E}$ and magnetic field $\vec{B}$ are given in column I, 2, 3 respectively. The quantities E_0, B_0 are +ve in nature.

Column – 1		**Column – 2**		**Column – 3**	
(I)	Electron with $\vec{V} = 2\frac{E_0}{B_0}\hat{i}$	(i)	$\vec{E} = E_0\hat{K}$	(P)	$\vec{B} = -B_0\hat{i}$
(II)	Electron with $\vec{V} = \frac{E_0}{B_0}\hat{j}$	(ii)	$\vec{E} = -E_0\hat{j}$	(Q)	$\vec{B} = B_0\hat{i}$
(III)	Proton with $\vec{V} = 0$	(iii)	$\vec{E} = -E_0\hat{i}$	(R)	$\vec{B} = B_0\hat{j}$
(IV)	Proton with $\vec{V} = \frac{2E_0}{B_0}\hat{i}$	(iv)	$\vec{E} = E_0\hat{i}$	(S)	$\vec{B} = B_0\hat{k}$

11. In which case particle will move in a straight line with constant velocity.

(A) $(\text{II})(\text{iii})(\text{S})$ (B) $(\text{IV})(\text{i})(\text{S})$

(C) $(\text{III})(\text{ii})(\text{R})$ (D) $(\text{III})(\text{iii})(\text{P})$

Space for Rough work

12. In which case particle describe a helical path along +Z direction.

(A) (II)(ii)(R) (B) (IV)(ii)(R)

(C) (IV)(i)(S) (D) (III)(iii)(P)

13. In which case, would the particle move in a straight line along –ve direction of y – axis.

(A) (IV)(ii)(S) (B) (III)(ii)(P)

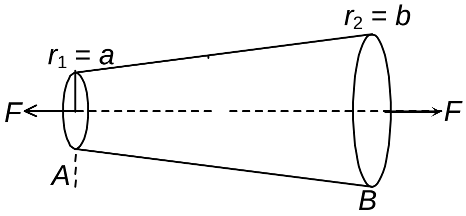
(C) (II)(iii)(Q) (D) (III)(ii)(R)

SECTION – B
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

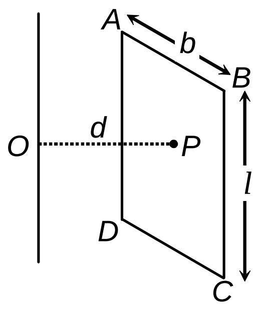
14. An infinitesimally small bar magnet of dipole moment M =1 A-m^2 is pointing and moving with the speed v = 1m/s in the x-direction. A small closed circular conducting loop of radius a = 1cm and of negligible self-inductance lies in the y-z plane with its centre at x = 0, and its axis coinciding with the x-axis. The force opposing the motion of the magnet when x = 1m is found to be 4y × 10^{-22} N. The resistance of the loop R = 10Ω. Find the value of y.

15. A slightly tapering wire of length L = 8 m and end radii a = 1 mm and b = 4 mm is subjected to stretching forces $F = 10^3$N as shown in Figure. If $Y = \pi \times 10^{11}$ N/m^2 is Young's modulus, calculate the extension produced in the wire. ($\pi^2 = 10$)

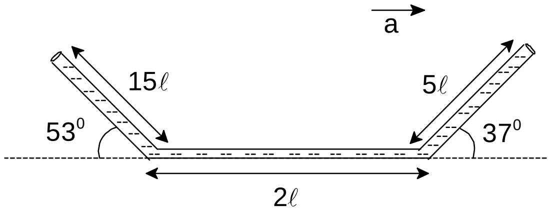


Space for Rough work

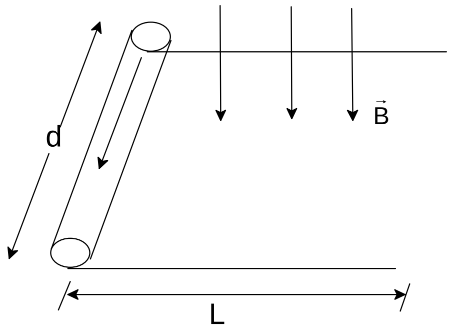
16. Find the electric flux (in SI unit) crossing the wire frame *ABCD* of length *l* = 1m width *b* and whose center is at a distance *OP* = *d* (=*b*/2) from an infinite line of charge with linear charge density $\lambda = \pi/18 \times 10^{-9}$ c/m. Consider that the plane of frame is perpendicular to line *OP*.



17. In the given tube a liquid of density ρ is filled. If the acceleration of the tube towards right direction such that no liquid will falls out of the tube is $\frac{\eta g}{5}$. Find the value of η



18. A rod of mass M = 3 kg and radius 5 cm rests on two parallel rails that are d (10 cm) apart and L (2 m) long. The rod carries a current I = 50A (in the direction shown) and rolls along the rails without slipping. If it starts from rest at one end. And a uniform magnetic field of magnitude 0.4T is directed perpendicular to the rods and the rails. It leaves the rail at a speed of $\frac{K}{3}$ m/s. Find K.



Space for Rough work

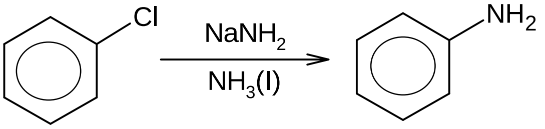
Chemistry PART – II

SECTION – A
(One or More than one correct type)

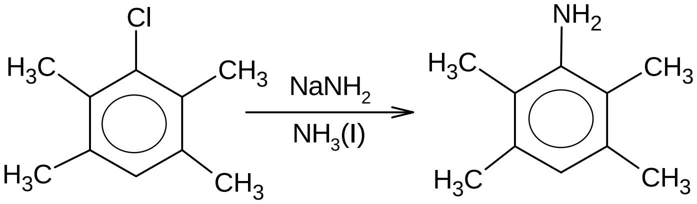
This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Which of the following reaction(s) is/are not feasible?

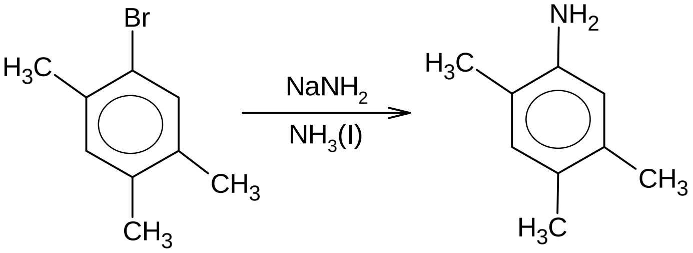
(A)


Cl
NaNH$_2$
NH$_3$(l)
NH$_2$

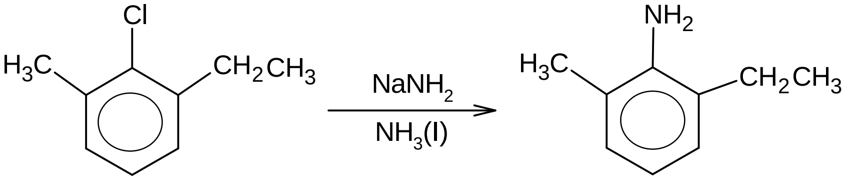
(B)


Cl
H$_3$C
CH$_3$
H$_3$C
CH$_3$
NaNH$_2$
NH$_3$(l)
NH$_2$
H$_3$C
CH$_3$
H$_3$C
CH$_3$

(C)


Br
H$_3$C
CH$_3$
CH$_3$
NaNH$_2$
NH$_3$(l)
NH$_2$
H$_3$C
CH$_3$
H$_3$C

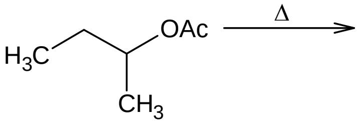
(D)


Cl
H$_3$C
CH$_2$CH$_3$
NaNH$_2$
NH$_3$(l)
NH$_2$
H$_3$C
CH$_2$CH$_3$

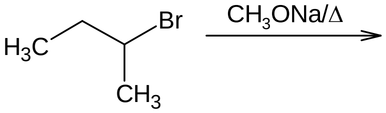
Space for Rough work

20. In which of the following reaction(s), product formation takes place by Hofmann rule?

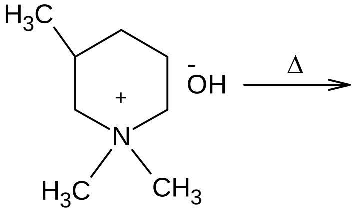
(A)



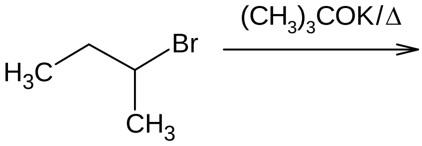
(B)



(C)



(D)



21. An electrochemical cell is made by combining two half cells

(X) $AgNO_3$(0.05) M) | Ag(s) and

(Y) $AgNO_3$ (0.01) M) | Ag(s)

Choose the correct statement

(A) The E_{cell} can be increased if concentration of $AgNO_3$ in half cell X is increased

(B) The E_{cell} will increase if concentration of $AgNO_3$ in cell Y is increased

(C) The E_{cell} will increase if concentration of $AgNO_3$ in cell X is decreased

(D) The E_{cell} will increase if concentration of $AgNO_3$ in cell Y is decreased

22. For a sample containing O_2 and SO_2 mark out the correct statement(s):

(A) At same temperature average speed of O_2 is greater than that of SO_2.

(B) If absolute temperature of O_2 is half to that of SO_2 gas than the speed distribution curves will be different.

(C) At same temperature & at lower speed, fraction of molecules of SO_2 will be greater than that of O_2.

(D) At same temperature & at higher speed, fraction of molecules of O_2 will be greater than that of SO_2.

23. Which among the following have square planar geometry?

(A) $[Ni(CO)_4]$

(B) $[Cu(NH_3)_4]^{2+}$

(C) $[Pt(NH_3)_2Cl_2]$

(D) $[Ni(CN)_4]^{2-}$

Space for Rough work

24. 1 mol of NH_3 gas (γ=1.33) at 27° C is expanded reversibly under adiabatic conditions to increase volume 8 times the initial volume. Correct option(s) is/are

(A) final temp. = 150 K
(B) work done = –400 cal
(C) final temp. = 250 K
(D) work done = –900 cal

25. Which of the following statement is correct about the compound of Xe?

(A) 3 mole XeF_4 on hydrolysis gives 2 mole XeO_3 and 1 mole Xe
(B) $XeO_3 + XeOF_4 \longrightarrow$ product (having see-saw shape)
(C) with RbF , both XeF_4 and XeF_6 act as Lewis acid
(D) with SbF_5 , both XeF_2 and XeF_4 act as Lewis base

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 26, 27 and 28 by appropriately matching the information given in the three columns of the following table.

Column – 1 (compound)	Column – 2 (test)	Column – 3 (properties)
(I) $(CH_3)_2CH-OH$	(i) +ve iodoform test	(P) strongest C – O bond
(II) CH_3-CH_2-OH	(ii) turbidity with Lucas reagent in 2 min.	(Q) evolves CO_2 on oxidation followed by heating with soda-lime
(III) $(CH_3)_3C-OH$	(iii) violet colouration with neutral $FeCl_3$	(R) most acidic
(IV) (p-NO_2) Ph – OH	(iv) blue colour in Victor – Meyer test	(S) least acidic

26. Correct match among the following:

(A) (I) (iv) (Q)
(B) (IV) (iii) (R)
(C) (II) (i) (S)
(D) (III) (ii) (P)

27. Correct match among the following:

(A) (I) (iii) (R)
(B) (IV) (i) (Q)
(C) (II) (iv) (P)
(D) (III) (ii) (S)

Space for Rough work

28. Correct match among the following:
(A) (I) (iv) (P)
(B) (IV) (ii) (S)
(C) (II) (i) (Q)
(D) (III) (iii) (R)

Answer questions 29, 30 and 31 by appropriately matching the information given in the three columns of the following table.

Column – 1 (cation)	**Column – 2 (group reagent)**	**Column – 3 (appearence)**
(I) Fe^{+3}	(i) H_2S in presence of HCl	(P) reddish brown precipitate with $K_4[Fe(CN)_6]$
(II) Ni^{+2}	(ii) NH_4Cl in presence of NH_4OH	(Q) blue precipitate with $K_4[Fe(CN)_6]$
(III) Cu^{+2}	(iii) $(NH_4)_2CO_3$ in presence of NH_4Cl and NH_4OH	(R) red precipitate with dimethyl glyoxime in alkaline medium
(IV) Ba^{+2}	(iv) H_2S in presence of NH_4OH	(S) apple green colour in Bunsen flame

29. Correct match among the following:
(A) (I) (i) (P)
(B) (IV) (ii) (S)
(C) (II) (iv) (R)
(D) (III) (iii) (Q)

30. Correct match among the following:
(A) (I) (iii) (S)
(B) (IV) (ii) (R)
(C) (II) (iv) (Q)
(D) (III) (i) (P)

31. Correct match among the following:
(A) (I) (ii) (Q)
(B) (IV) (iii) (P)
(C) (II) (i) (R)
(D) (III) (iv) (S)

Space for Rough work

SECTION – B

(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

32. A 0.001 molal solution of a complex $[MA_8]$ in water has the freezing point of –0.0054°C. Assuming 100% ionization of the complex salt and K_f for H_2O = 1.86 km^{-1}, what is the ratio of observed and expected osmotic pressure?

33. How many number of maxima's in radial probability function curve of a 5p orbital?

34. In Hall – Heroult process, to obtain 4 kg of aluminium, how much amount (in kg) of graphite is approximately consumed?

35. How many moles NH_3 must be added to 2.0 litre of 0.80 M $AgNO_3$ in order to reduce the Ag^+ concentration to 5×10^{-8} M. (Given : K_f of $[Ag(NH_3)_2^+] = 10^8$)

36. Glycine, Alanine and Phenyl alanine on combining can form how many dipeptides?

Space for Rough work

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. Let f : R → R, such that $f''(x) - 2f'(x) + f(x) = 2e^x$ and $f'(x) > 0$ $\forall$ x $\in$ R, then which of the following can be correct

(A) $|f(x)| = -f(x), \forall x \in R$
(B) $|f(x)| = f(x), \forall x \in R$
(C) $f(3) = -5$
(D) f(3) = 7

38. $(\vec{a} \times \vec{b}).(\vec{c} \times \vec{d})$ is equal to

(A) $\vec{a}\left\{\vec{b} \times (\vec{c} \times \vec{d})\right\}$
(B) $\left\{(\vec{a} \times \vec{b}) \times \vec{c}\right\}.\vec{d}$
(C) $(\vec{a}.\vec{c})(\vec{b}.\vec{d}) - (\vec{a}.\vec{d})(\vec{b}.\vec{c})$
(D) $(\vec{d} \times \vec{c}).(\vec{b} \times \vec{a})$

39. Let $|f(x)| \le \sin^2 x, \forall\ x \in R$, then

(A) f(x) is continuous at x = 0
(B) f(x) is differentiable at x = 0
(C) f(x) is continuous but not differentiable at x = 0
(D) f(0) = 0

40. If the reflection of the line $\bar{a}z + a\bar{z} = 0$ in the real axis is $\bar{\alpha}z + \alpha\bar{z} = 0$ in the simplest form then

(A) $\alpha + a$ is purely real
(B) $\frac{\bar{\alpha}}{a} = \frac{\alpha}{\bar{a}}$
(C) $\bar{\alpha}\,\bar{a} = a\alpha$
(D) $\bar{\alpha} - \bar{a}$ is purely imaginary

Space for Rough work

41. Let A = [a_{ij}] where $a_{ij} = u_i v_j$ $1 \le i \le n$ and $i \le j \le n$ $u_i, v_j \in R$ satisfies $A^5 = 16A$ then $T_r(A)$ is $(T_r \equiv \text{Trace of matrix})$

(A) 2
(B) 4
(C) –2
(D) –4

42. If $\left(1+ax+bx^2\right)^4 = a_0 + a_1x + a_2x^2 + ... + a_8x^8$ where $a, b, a_0, a_1, a_2.....a_8 \in R$ such that $a_0 + a_1 + a_2 \neq 0$ and $\begin{vmatrix} a_0 & a_1 & a_2 \\ a_1 & a_1 & a_0 \\ a_2 & a_0 & a_1 \end{vmatrix} = 0$ then

(A) $a_0 = a_1 \neq a_2$
(B) $a_1 = a_2 = 1$
(C) $a_0 = a_1 = a_2 = 4a$
(D) $b = \frac{5}{32}$

43. A parabola touches the bisectors of the angle obtained by the lines $x + 2y + 3 = 0$ and $2x + y + 3 = 0$ at the point (1, 1) and (0, -2). then

(A) The focus of parabola is $\left(\frac{1}{5}, \frac{-7}{5}\right)$
(B) The focus of parabola is (-2, 3)
(C) The equation of directrix is $3x + y + 4 = 0$
(D) The length of latus rectum is $\frac{16\sqrt{5}}{2^{\frac{3}{2}}}$

Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 44, 45 and 46 by appropriately matching the information given in the three columns of the following table.

$f(x) = x + \log_e x - x\log_e x,\ x \in (0, \infty)$.

List I contains information about zero of f(x), f'(x) and f''(x).
List II contains information about the limiting behavior of f(x), f'(x) and f''(x) at infinity
List III contains information about increasing/decrasing nature of f(x) and f'(x)

Column – 1		**Column – 2**		**Column - 3**	
(I)	$f(x) = 0$ for some $x \in (1, e^2)$	(i)	$\lim\limits_{x\to\infty} f(x) = 0$	(P)	f is increasing in (0, 1)
(II)	$f'(x) = 0$ for some $x \in (1, e)$	(ii)	$\lim\limits_{x\to\infty} f(x) = -\infty$	(Q)	f is decreasing in (e, e^2)
(III)	$f'(x) = 0$ for some $x \in (0, 1)$	(iii)	$\lim\limits_{x\to\infty} f'(x) = 0$	(R)	f' is increasing in (0, 1)
(IV)	$f''(x) = 0$ for some $x \in (1, e)$	(iv)	$\lim\limits_{x\to\infty} f''(x) = 0$	(S)	f' is decreasing in (e, e^2)

44. Which of the following option is the only CORRECT combination?
(A) (IV) (i) (S)
(B) (I) (ii) (R)
(C) (III) (iv) (P)
(D) (II) (iii) (S)

45. Which of the following option is the only CORRECT combination?
(A) (III) (iii) (R)
(B) (I) (i) (R)
(C) (IV) (iv) (S)
(D) (II) (ii) (Q)

46. Which of the following option is the only INCORRECT combination?
(A) (II) (iii) (P)
(B) (II) (iv) (Q)
(C) (I) (iii) (P)
(D) (III) (i) (R)

Space for Rough work

Answer questions 47, 48 and 49 by appropriately matching the information given in the three columns of the following table.

Column – 1		**Column – 2**		**Column – 3**	
(I)	Minimum value of $\frac{1}{3}\left[\lvert z\rvert^2 + \lvert z-3\rvert^2 + \lvert z-6i\rvert^2\right]$	(i)	$M = 1$	(P)	$\lvert z-2-3i\rvert^2 + \lvert z-4-3i\rvert^2 = M$ represent the equation of circle with least radius
(II)	If $\lvert z-2-2i\rvert \le 1.$ Then minimum value of $\frac{1}{2}\lvert 2iz+4\rvert = M$	(ii)	$M = 4$	(Q)	$\lvert z-2-3i\rvert + \lvert z+2+i\rvert = M$ represent an ellipse
(III)	$\lvert z+2-i\rvert = 5,$ Maximum value of $\frac{1}{5}\lvert 3z+9-7i\rvert = M$	(iii)	$M = 10$	(R)	$\frac{\lvert z-z_1\rvert}{\lvert z-z_2\rvert} = M$ represent equation of bisector
(IV)	If $\left\lvert z-\frac{4}{z}\right\rvert = 2$ Maximum value of $[\lvert z\rvert] = M$ (where [.] denotes the greatest integer function)	(iv)	$M = 3$	(S)	$\omega(1+\omega)^M + \omega^2(\omega+\omega^2)^M + (-1)^M = 0$ ω is cube root unity

47. Which of the following option is the only CORRECT combination?
(A) (I) (ii) (S)
(B) (I) (iii) (P)
(C) (I) (iii) (Q)
(D) (I) (ii) (Q)

48. Which of the following option is the only CORRECT combination?
(A) (II) (ii) (P)
(B) (II) (i) (R)
(C) (II) (i) (S)
(D) (II) (iv) (R)

49. Which of the following option is the only INCORRECT combination?
(A) (III) (ii) (S)
(B) (III) (iii) (R)
(C) (III) (i) (P)
(D) (III) (ii) (P)

Space for Rough work

SECTION – B
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

50. If two pts P and Q on the hyperbola $\frac{x^2}{9}-\frac{y^2}{16}=1$ whose centre is C be such that CP is perpendicular to CQ and a < b, then $\frac{1}{CP^2}+\frac{1}{CQ^2}=\frac{\alpha}{\beta}$ $(\alpha, \beta$ have no common divisor) then $\alpha+\beta-150=$ ___________.

51. Two numbers of integral points on the hyperbola $x^2-y^2=(2000)^2$ is α. (An integral points is a point both of whose coordinates are integer). Then $\frac{\alpha}{49}=$ ____________.

52. The graph of $x^2+y^2+6x-24y+72=0$ and $x^2-y^2+6x+16y-46=0$ intersect at four points. Sum of the distance of these four points from the point (-3, 2) be α, then $\frac{\alpha}{20}=$ _____________.

53. Let $(x^3 + px^2 + 2x - 5)^{19} (x^2 + qx - 41)^8 (x^4 - x^3 + x - 7)^6 = x^{97} + 391x^{96} + a_{95}x^{95} + a_{94}x^{94} + ... a_1x + a_0$ be an identity, where p, q, $a_{95}....a_0$ are integers. Compute the smallest positive value of p.

54. $f(x + 1) = (-1)^{x+1} x - 2f(x)$ for $x \in N$ and f(1) = f(1986). Compute the sum of digit of numbers (f(1) + f(2) +...... f(1985))

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – III

JEE (Advanced)-2020

PAPER – 1

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. ABCD

Sol. $X_L = X_C = R$

2. BD

Sol. Stopping potential will not change.

$I \propto \frac{1}{r^2}$

3. CD

Sol. $K = 10\pi = \frac{2\pi}{\lambda}$

$\omega = 50\pi$

4. ABC

Sol. Angular momentum of the planet about the sum is constant.

5. ACD

Sol. When K is open, circuit is balanced wheatstone

$\therefore R_{eq} = \frac{20 \times 40}{20+40} + 10 = \frac{70}{3}\Omega$

$\therefore i = \frac{55}{R_{eq}} = 2.36 \text{ A}$

Now when key is closed

We get

$8I_1 + 12(I_1 - I_2) - 40(I' - I_1) = 0$ ......(i)

$2I_2 - 12(I_1 - I_2) = -10$ ....(ii)

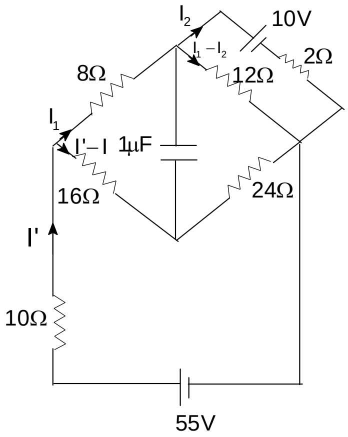
$8I_1 + 12(I_1 - I_2) + 10I' = 55$ .....(iii)

solving(i), (ii) and (iii)

$I_1 = 2A,\ I' = 2.7A,\ I_2 = 1A$

Hence,

Charge on capacitor = 4.8 μc



6. AD

Sol. ∵ Friction is static in nature.

$f = 10N$

Normal contact force = mg

7. ACD

Sol. $B = -\frac{dp}{\left(\frac{dv}{v}\right)}$ and $PV^2 = \text{constant}$

$v^2dp + P(2V)dv = 0$

$vdp = -2pdv$

$\frac{vdp}{dv} = -2P$

$\therefore B = 2P$

Similarly we can do for others.

8. D

Sol. If I = CMR^2 then

$a = \frac{g\sin\theta}{1+C}$

$f = \frac{cmg\sin\theta}{1+C}$

$L = \frac{1}{2}at^2 \Rightarrow t = \sqrt{\frac{2L}{a}}$

and

for solid sphere, c = $\frac{2}{5}$

for hollow sphere c = $\frac{2}{3}$

for disc sphere c = $\frac{1}{2}$

for ring sphere c = 1

9. B

Sol. If I = CMR^2 then

$$a = \frac{g\sin\theta}{1+C}$$

$$f = \frac{cmg\sin\theta}{1+C}$$

$$L = \frac{1}{2}at^2 \Rightarrow t = \sqrt{\frac{2L}{a}}$$

and

for solid sphere, c = $\frac{2}{5}$

for hollow sphere c = $\frac{2}{3}$

for disc sphere c = $\frac{1}{2}$

for ring sphere c = 1

10. B

Sol. If I = CMR^2 then

$$a = \frac{g\sin\theta}{1+C}$$

$$f = \frac{cmg\sin\theta}{1+C}$$

$$L = \frac{1}{2}at^2 \Rightarrow t = \sqrt{\frac{2L}{a}}$$

and

for solid sphere, c = $\frac{2}{5}$

for hollow sphere c = $\frac{2}{3}$

for disc sphere c = $\frac{1}{2}$

for ring sphere c = 1

11. A

Sol. Use Lorentz force

$$\vec{F} = \vec{F}_e + \vec{F}_B$$

$$\vec{F} = q\vec{E} + q\left(\vec{V} \times \vec{B}\right)$$

12. C

Sol. Use Lorentz force

$$\vec{F} = \vec{F}_e + \vec{F}_B$$

$$\vec{F} = q\vec{E} + q\left(\vec{V} \times \vec{B}\right)$$

13. D

Sol. Use Lorentz force

$\vec{F} = \vec{F}_e + \vec{F}_B$

$\vec{F} = q\vec{E} + q\left(\vec{V} \times \vec{B}\right)$

SECTION – B

14. 9

Sol. Field due to the bar magnet at distance x (near the loop)

$$B = \frac{\mu_0}{4\pi} \cdot \frac{2M}{x^3}$$

$\Rightarrow$Flux linked with the loop : $\phi = BA = \pi a^2 \cdot \frac{\mu_0}{4\pi} \cdot \frac{2M}{x^3}$

Emf induced in the loop : $e = -\frac{d\phi}{dt} = \frac{\mu_0}{4\pi} \cdot \frac{6\pi Ma^2}{x^4} \cdot \frac{dx}{dt} = \frac{\mu_0}{4\pi} \cdot \frac{6\pi Ma^2}{x^4} v.$

$\Rightarrow$ Induced current : $i = \frac{e}{R} = \frac{\mu_0}{4\pi} \cdot \frac{6\pi Ma^2}{Rx^4}.v.$

Let F = force opposing the motion of the magnet

Power due to the opposing force = Heat dissipated in the coil per second

$\Rightarrow Fv = i^2R \Rightarrow F = \frac{i^2R}{v} = \left(\frac{\mu_0}{4\pi}\right)^2 \times \left(\frac{6\pi Ma^2}{Rx^4}\right)^2 \times v^2 \times \frac{R}{v}$

$= \frac{9}{4}\left(\frac{\mu_0^2 M^2 a^4 v}{Rx^8}\right) = 36 \times 10^{-22}$ N $\quad \therefore$ y = **9**

15. 2

Sol. Consider a small element of width dx, radius r situated at a distance x from A. The gradient in radius is uniform. Let it be k.

$\therefore \quad k = \frac{b-a}{L}$ ... (i)

If r is the radius of the elementary portion at ef and $(r + dr)$ at gh, then

$k = \frac{dr}{dx}$ ... (ii)

$\therefore \quad \frac{dr}{dx} = \frac{b-a}{L}$ ... (iii)

$dx = \frac{dr}{k}$

If dl is the extension produced in length dx due to stretching force F using the relation $Y = \frac{\frac{F}{A}}{\frac{\Delta L}{L}}$ we get $\Delta L = \frac{FL}{AY}$

$$\therefore \quad dl = \frac{F \cdot dx}{\pi r^2 Y}$$

$$= \frac{F \cdot dr}{\pi r^2 Yk} \quad \text{since } dx = \frac{dr}{k}$$

The variable on R.H.S. is r which varies from a to b.

$$\therefore \text{ Total extension produced} = \int dl = \int_a^b \frac{Fdr}{\pi r^2 Yk}$$

$$l = \frac{F}{\pi Yk}\int_a^b \frac{dr}{r^2} = -\frac{F}{\pi Yk}\left[\frac{1}{r}\right]_a^b$$

$$= \frac{F}{\pi Yk}\left[\frac{1}{a} - \frac{1}{b}\right]$$

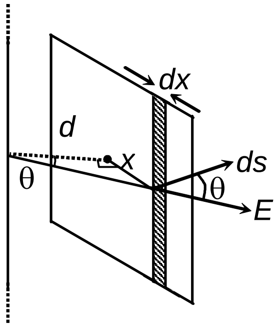
$$= \frac{F(b-a)}{\pi Ykab}$$

But $k = \dfrac{b-a}{L}$

$$\therefore \quad l = \frac{F.L}{\pi Yab} = 2 \text{ mm}$$

16. 5

Sol. Flux through the element of width dx as shown in figure is



$$\phi = \int \vec{E}.\overrightarrow{ds}, \ E = \frac{\lambda}{2\pi\varepsilon_0 d \sec\theta} \text{ and } ds = ldx$$

$$\phi = \int_{-b/2}^{b/2} \frac{\lambda}{2\pi\varepsilon_0} \frac{\cos\theta}{d\sec\theta} ldx$$

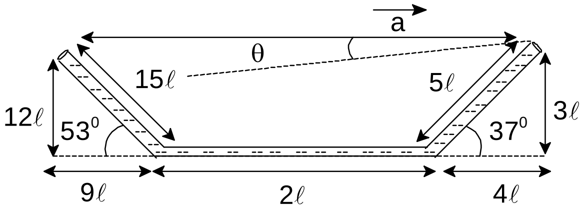
$$= \frac{\lambda l}{2\pi\varepsilon_0 d}\int_{-b/2}^{b/2}\left(\frac{d}{\sqrt{x^2+d^2}}\right)^2 dx$$

$$= \frac{\lambda l}{\pi\varepsilon_0} tan^{-1}\left(\frac{b}{2d}\right) = 5$$

17. 3

Sol. $\dfrac{9\ell}{15\ell} = \dfrac{3}{5} = \dfrac{a}{g}$

$a = \dfrac{3}{5} g$



18. 4

Sol. F = idB = (50) (0, 1) (0, 4) = 2 N ……….(1)

As then is no slipping

$F - f = Ma$ ....(i)

$fR = I\alpha$ .....(iii)

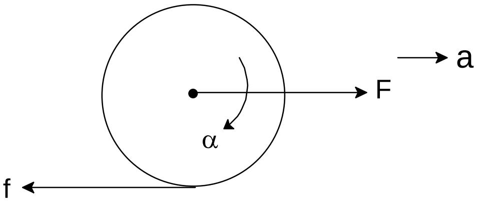
and

$a = \alpha R$ .....(iv)

from(i), (ii), (iii) and (iv), we get

$$a = \frac{2F}{3M} = \frac{4}{9}\ m/s^2$$

$$\therefore V = \sqrt{2aL} = \frac{4}{3}\ m/s$$



Chemistry

PART – II

SECTION – A

19. BD

Sol. The above reaction represent the case of Ar_{SN} (aromatic nucleophilic substitution) which occurs through the formation of benzyne. For the formation of benzyne intermediate, it is essential that an H should be available in on ortho position to the halogen.

20. ACD

Sol. In option A, C, D , less substituted alkene is formed according to Hofmann rule. In option B, more substituted alkene is formed according to Saytzeff rule.

21. AD

Sol. Use Nerst equation, E_{cell} increases when [cathode] increases and that [anode] decreases.
Half cell X is cathode, while Y is anode.

22. ACD

Sol. Average velocity = $\frac{v_1+v_2+v_3+...+v_n}{N}=\sqrt{\frac{8RT}{\pi M}}=\sqrt{\frac{8PV}{\pi M}}=\sqrt{\frac{8P}{\pi d}}$

23. BCD

Sol. $[Cu(NH_3)_4]^{2+}$, $[Pt(NH_3)_2Cl_2]$, $[Ni(CN)_4]^{2-}$ have square planar geometry.

24. AD

Sol. $T_2 = T_1\left(\frac{V_1}{V_2}\right)^{\gamma-1}$, w = –dE = $-C_V dT = -C_V(T_2 - T_1)$

25. BCD

Sol. $3XeF_4 + 6H_2O \rightarrow 2Xe + XeO_3 + 12HF + 3/2\ O_2$
$XeO_3 + XeOF_4 \rightarrow 2XeO_2F_2$
$XeF_2 + MF_5 \rightarrow [XeF]^+[MF_6]^-$ (M = As, Sb, P)
$XeF_4 + SbF_5 \rightarrow [XeF_3]^+[SbF_6]^-$

26. B

Sol. factual

27. D

Sol. factual

28. C

Sol. factual

29. C

Sol. factual

30. D

Sol. factual

31. A

Sol. factual

SECTION – B

32. 3

Sol. Ratio of observed and expected osmotic pressure = van't Hoff factor (i) $= \dfrac{\Delta T_f}{K_f m}$

33. 4

Sol. number of maxima's in radial probability function curve = $n - l$

34. 2

Sol. In Hall – Heroult process, to obtain each kg of aluminium, almost 0.5 kg of graphite is approximately consumed.

35. 4

Sol. $Ag^+ + 2NH_3 \rightleftharpoons [Ag(NH_3)_2^+]$

36. 9

Sol. Number of dipeptides $3^2 = 9$

Mathematics

PART – III

SECTION – A

37. BD

Sol. The equation can be written as

$$\frac{d}{dx}\left(e^{-x}\left(f'(x)-f(x)\right)\right)=2$$

$$\Rightarrow e^{-x}\left(f'(x)-f(x)\right)=2x+c_1$$

$\Rightarrow$ f(x) = $\left(x^2+c_1x+c_2\right)e^x$ and $f'(x)=\left(x^2+\left(c_1+2\right)x+c_1+c_2\right)e^x$

Given that $f'(x)>0 \Rightarrow {c_1}^2-4c_2+4<0$

$$\Rightarrow {c_1}^2-4c_2<0$$

$$\Rightarrow f(x)>0$$

$\therefore$ (B), (D) can be correct.

38. ABCD

Sol. Assume scalar triple product of three vectors

39. ABD

Sol. $|f(0)|\le 0 \Rightarrow f\left(0\right)=0$

$$f'\left(0\right)=\lim_{n\to 0}\frac{f(n)}{n}$$

Now $\left|\frac{f(n)}{n}\right|\le\frac{\sin^2 n}{n} \Rightarrow \frac{-\sin^2 n}{n}\le\frac{f(n)}{n}\le\frac{\sin^2 n}{n}$

$$0\le\lim_{n\to 0}\frac{f(n)}{n}\le 0 \Rightarrow \lim_{n\to 0}\frac{f(n)}{n}=0$$

$$\Rightarrow f'\left(0\right)=0$$

40. BC

Sol. The image of $\bar{a}z+a\bar{z}=0$ with respect to real axis is

$$\bar{a}\,\bar{z}+az=0$$

41. AC

Sol.

$$A=\underset{B}{\begin{bmatrix}u_1\\u_2\\u_3\end{bmatrix}}\underset{C}{\begin{bmatrix}v_1 & v_2 & v_3\end{bmatrix}}$$

$$A^5=\left(BC\right)^5=BCBCBCBCBC=16A$$

$$B\left(TrA\right)^4C=16A$$

$$\left(TrA\right)^4A=16A$$

$$\Rightarrow\left(TrA\right)^4=16$$

$$\Rightarrow TrA=\pm 2$$

42. BCD

Sol. $x = 0 : a_0 = 1$

Differentiations $4\left(1+ax+bx^2\right)^3\left(a+2bx\right) = a_1 + 2a_2x + ...$

Let $x = 0 \quad 4a = a_1$

The value of the determinant is $-\left(a_0^3 + a_1^3 + a_2^3 - 3a_0a_1a_2\right) = 0$

$\Rightarrow \quad \because a_0 + a_1 + a_2 \neq 0$ the $a_0 = a_1 = a_2 = 4a$

Differentially again and putting $x = 0$

$$a = \frac{1}{4} : b = \frac{5}{32}$$

43. AC

Sol. Equation of bisectors are given by x – y = 0 and x + y + z = 0
Bisector intersect at the point P(- 1, - 1)
Focus S, is the foot of parallel from P to MN
Where M(1, 1) and N (0, - 2)

$\text{MN} \Rightarrow 3x - y - z = 0, \quad \text{PS} = x + 3y + 4 = 0$

$$\therefore \text{Focus} = \left(\frac{1}{5}, \frac{-7}{5}\right), \text{MS} = \sqrt{\frac{2}{5}}, \text{NS} = 4\sqrt{\frac{2}{5}}$$

$$\text{LR} = \frac{16\sqrt{2}}{5^{3/2}}$$

Circle through PMN is $x^2 + y^2 - x + y - 2 = 0$

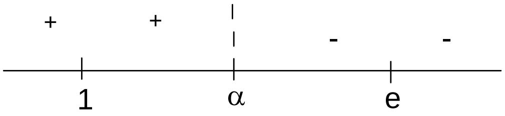
Equation of directrix = equation of tangents at (- 1, -1) is 3x + y + 4 = 0

44. D

Sol. $f(x) = x + \log_e x - x\log_e x$

$$f'(x) = 1 + \frac{1}{x}\log_e x - x\left(\frac{1}{x}\right) = \frac{1}{x} - \log_e x$$

$$f''(x) = -\frac{1}{x^2} - \frac{1}{x} < 0 \forall x \in (0, \infty).$$

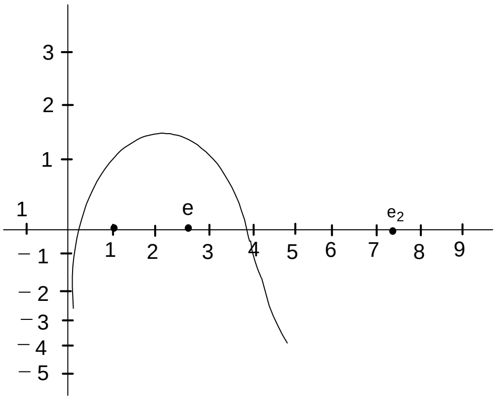


Thus, $f'(x)$ is strictly decreasing function for $x \in (0, \infty)$.

$$\left.\begin{array}{l} \lim\limits_{x\to\infty}\left(\frac{1}{x} - \log_e x\right) = \lim\limits_{x\to\infty} f'(x) = -\infty \\ \lim\limits_{x\to 0^+}\left(\frac{1}{x} - \log_e x\right) = \lim\limits_{x\to 0^+} f'(x) = \infty \end{array}\right\}$$

i.e., $f'(x) =$ has only one real root in $(0, \infty)$

$f'(1) = 1 > 0$



$$f'(e) = \frac{1}{e} - 1 < 0$$

so, $f'(x) = 0$ has one root in $(1, e)$.

Let $f'(\alpha) = 0$, where $\alpha \in (1, e)$

Therefore, f(x) is increasing in $(0, \alpha)$ and decreasing in (α, ∞).

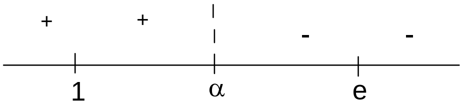
$f(1) = 1$ and $f\left(e^2\right) = e^2 + 2 - 2e = 2 - e^2 < 0$

The graph of the function is as shown in the given figure.
So, f(x) = 0 has one root in $\left(1, e^2\right)$

From Column I : I and II are correct.
From Column II : ii, iii and iv are correct.
From Column III : P, Q, S are correct.

45. D

Sol. $f(x) = x + \log_e x - x\log_e x$



$$f'(x) = 1 + \frac{1}{x}\log_e x - x\left(\frac{1}{x}\right) = \frac{1}{x} - \log_e x$$

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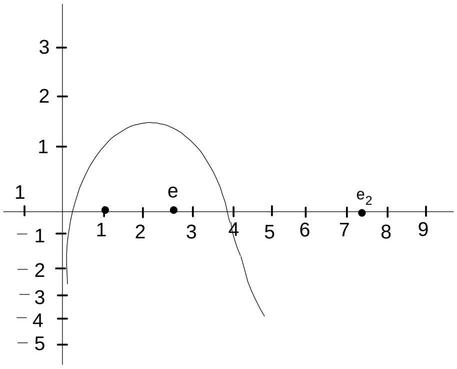
Thus, $f'(x)$ is strictly decreasing function for $x \in (0,\infty)$.



$$\left.\begin{aligned} \lim_{x\to\infty}\left(\frac{1}{x} - \log_e x\right) &= \lim_{x\to\infty} f'(x) = -\infty \\ \lim_{x\to 0^+}\left(\frac{1}{x} - \log_e x\right) &= \lim_{x\to 0^+} f'(x) = \infty \end{aligned}\right\}$$

i.e., $f'(x) =$ has only one real root in $(0, \infty)$

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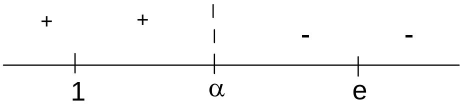
The graph of the function is as shown in the given figure.
So, f(x) = 0 has one root in $\left(1, e^2\right)$

From Column I : I and II are correct.
From Column II : ii, iii and iv are correct.
From Column III : P, Q, S are correct.

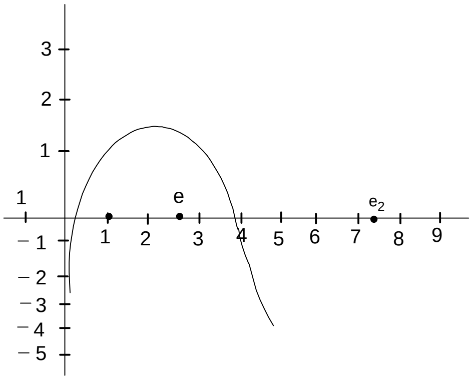
46. D

Sol. $f(x) = x + \log_e x - x\log_e x$



$$f'(x) = 1 + \frac{1}{x}\log_e x - x\left(\frac{1}{x}\right) = \frac{1}{x} - \log_e x$$

$$f''(x) = -\frac{1}{x^2} - \frac{1}{x} < 0 \forall x \in (0, \infty).$$



Thus, $f'(x)$ is strictly decreasing function for $x \in (0,\infty)$.

$$\left.\begin{aligned}\lim_{x\to\infty}\left(\frac{1}{x}-\log_e x\right) &= \lim_{x\to\infty} f'(x) = -\infty\\ \lim_{x\to 0^+}\left(\frac{1}{x}-\log_e x\right) &= \lim_{x\to 0^+} f'(x) = \infty\end{aligned}\right\}$$

i.e., $f'(x) =$ has only one real root in $(0,\infty)$

$f'(1) = 1 > 0$

$f'(e) = \frac{1}{e} - 1 < 0$

so, $f'(x) = 0$ has one root in $(1, e)$.

Let $f'(\alpha) = 0$, where $\alpha \in (1, e)$

Therefore, f(x) is increasing in $(0, \alpha)$ and decreasing in (α, ∞).

$f(1) = 1$ and $f(e^2) = e^2 + 2 - 2e = 2 - e^2 < 0$

The graph of the function is as shown in the given figure.
So, f(x) = 0 has one root in $(1, e^2)$

From Column I : I and II are correct.
From Column II : ii, iii and iv are correct.
From Column III : P, Q, S are correct.

47. C

Sol. $z = x + iy$

$$|z|^2 + |z-3|^2 + |z-6i|^2$$
$$= x^2 + y^2 + (x-3)^2 + y^2 + x^2 + (y-6)^2$$
$$= 3x^2 - 6x - 12y + 3y^2 + 45$$
$$= 3\left[(x-1)^2 + (y-2)^2 + 10\right]$$

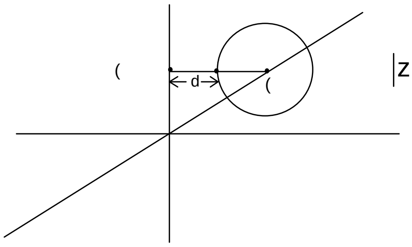
$\therefore$ Minimum value of $\frac{|z|^2 + |z-3|^2 + |z-6i|^2}{3} = 10$

48. B

Sol. $\frac{1}{2}|2iz + 4|$

$= |z - 2i|$

Minimum value of $|z - 2i| = d = 1$

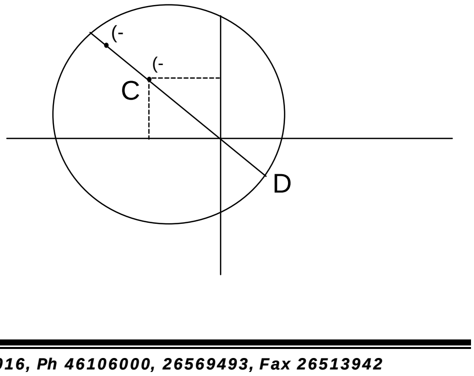


$|z - 2 - zi| = 1$

49. D

Sol. Minimum value of

$$\frac{3}{5}\left|z - \left(-3 + \frac{7}{3}i\right)\right| = \frac{3}{5}(CD) = \frac{3}{5}\cdot\frac{20}{3} = 4$$



SECTION – B

50. 1

Sol. In hyperbola use property that $x^2/a^2 - y^2/b^2 = 1(a < b)$, if $CP \perp CQ$

Where C is centre then $\frac{1}{CP^2} + \frac{1}{CQ^2} = \frac{1}{a^2} - \frac{1}{b^2}$

51. 2

Sol. $(x^2 - y^2) = (2000)^2$

$(x+y)(x-y) = 2^2 \times 10^6 = 2^8 \times 5^6$

$(x+y)(x-y) = 2^8 \times 5^6$ (even number)

$\Rightarrow (x+y)$ and $(x-y)$ are even is only possiblity.

no of factors. $7 \times 7 \times 2 = 98$

$\left(\frac{\alpha}{49} = 2\right)$

52. 2

Sol. $x^2 + y^2 + 6x - 2y + 72 = 0$ ......(i)

$x^2 - y^2 + 6x + 16y - 46 = 0$ .....(ii)

$(i) + (ii)$

$2x^2 + 12x - 8y + 26 = 0$

$x^2 + 6x - 4y + 13 = 0$

$(x+3)^2 = 4(y-1)$ ......(iii)

pt of intersecting also satisfy equation ...(iii)

$\sum_{i=1}^{4}\sqrt{(xi+3)^2 + (yi-2)^2} = \sum_{i=1}^{4}\sqrt{4(yi-1) + (yi-2)^2} = \sum|yi|$

Similarly equation also satisfy

$2y^2 - 40y + 118 = 0$

$y^2 - 20y + 59 = 0$

$\Rightarrow \sum_{i=1}^{4} yi = 2 \times 20 = 40$

53. 7

Sol. $\left({}^{19}c_0(x^3)^{19} + {}^{19}c_1(px^2 + 2x - 5)(x^3)^{18} + ...\right)$

$\left({}^{8}c_0x^{16} + {}^{8}c_1(qx - 41)x^{14} + ...\right)\left({}^{6}c_0x^{24} + {}^{6}c_1(-x^3 + x - 1)x^{20} + ...\right)$

$= x^{97} + 391x^{96} + a_{95}x^{95} + ...$

Comparing the coefficient of x^{96} we get

$19p + 8q - 6 = 391$

$\Rightarrow 19p + 8q = 397$ Let $q = 19\lambda + k,\ 0 \le k < 19$

$p = \frac{397 - 8(19\lambda + k)}{19} = 21 - 8\lambda - 2\frac{(4k+1)}{19}$

$\frac{4k+1}{19}$ must be integer $\Rightarrow k = 14,\ p = 15 - 8\lambda$

For minimum positive value of p, $\lambda = 1 \Rightarrow p = 7$

54. 7

Sol. $\sum_{x=1}^{1985} f(x+1) = \sum_{x=1}^{1985} (-1)^{x+1}x - 2\sum_{x=1}^{1985} f(x)$

As f(1) = f(1986)

$\Rightarrow 3\sum_{x=1}^{1985} f(x) = \sum_{x=1}^{1985} (-1)^{x+1}x$

$\Rightarrow \sum_{x=1}^{1985} f(x) = 331.$

Sum of the digits = 3 + 3 + 1 = 7

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – III

JEE (Advanced)-2020

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **One Section**: **Section-A.**

1. ***Section–A (01 – 07, 19 – 25, 37 – 43)*** *contains 21 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (08– 14, 26 – 32, 44 – 50) *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect option is selected.

   Section–A (15 – 18, 33 – 36, 51 – 54) *contains 6 paragraphs. Each paragraph is having 2 multiple choice questions having 4 options with* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A
(One Options Correct Type)

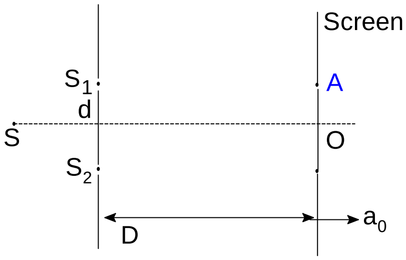
This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. The pitch of a screw gauge is 0.5 mm and there are 100 division on its circular scale. When there is nothing between jaws, the instrument reads +5 division. In measuring the diameter of a wire, there are 6 division on main scale and 74th division coincide with main scale, then the diameter of wire is

(A) $3.370\ mm$ (B) $6.370\ mm$

(C) $3.345\ mm$ (D) $3.335\ mm$

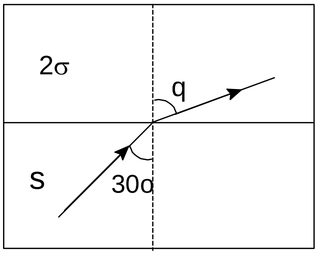
2. In the given YDSE apparatus as shown in figure, wavelength of light used is λ. The initial distance between screen and plane of slits is 'D'. Point A is point on screen where 4th order maxima lies. Now, screen is moved from rest with constant acceleration a_0 towards right. Then find the time after which second order maxima is formed at point A.



(A) $\sqrt{\frac{2D}{a_0}}$ (B) $\sqrt{\frac{D}{a_0}}$

(C) $2\sqrt{\frac{D}{a_0}}$ (D) $\sqrt{\frac{D}{2a_0}}$

3. Figure shows the two conducting medium of electric conductivity $\sigma\ and\ 2\sigma$ the direction of electric current density are as shown by the arrow. The dotted line shows the normal of the boundary surface. Then, find the value of θ.



(A) $\tan^{-1}\left(\frac{1}{2}\right)$ (B) $\sin^{-1}\left(\frac{1}{4}\right)$

(C) $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$ (D) $\tan^{-1}\left(\frac{2}{\sqrt{3}}\right)$

Space for Rough work

4. Two concentric spherical conducting shell of radius ‘R’ and Radius ‘2R’ has dielectric medium having dielectric constant K=3 between these. The dielectric strength of dielectric is $E_0 = 8\ Volt/m.$ Then find dielectric breakdown voltage between the shell. (Take $R = \frac{1}{2}m$)

(A) 4 Volt
(B) 2 Volt
(C) $\frac{1}{2}$ Volt
(D) 0.25 Volt

5. Two spheres of masses 1 kg and 3 kg are on a horizontal smooth surface. Sphere of mass 3 kg is given velocity $V_0 = \frac{8}{3}m/s$ towards other sphere such that it makes an angle of 30° with line of impact. Then, find maximum possible loss of kinetic energy of two sphere during collision.

(A) 8/3 Joule
(B) 4 Joule
(C) 2 Joule
(D) 2/3 Joule

6. A long straight conductor, having a circular cross section of radius 2m carries a current along its length such its magnetic field varies as $B = Kr^2, 0 \le r \le 2m,$ where K is a positive constant. The slope of the current density (j)vs radial distance ‘r’ at $r = \frac{1}{2}m\ is\ \frac{\alpha K}{\mu_0}.$ The value of α is.

(A) 4
(B) 8
(C) 2
(D) 3

7. A particle is moving in anticlockwise in a circle under the influence of a force $\vec{F} = \left[\left(x^2 - y\right)\hat{i} + \left(x + 5y - z\right)\hat{j} + \left(3x - 4y + z\right)\hat{k}\right]N$ where x, y and z are in meter. The circle lies in the xy plane with its centre at the origin and has radius of 2m. The work done by the force as the particle completes one revolution is (in Joule)

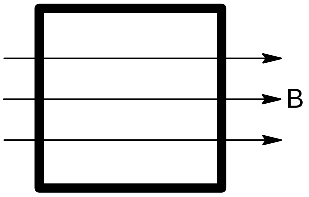
(A) 4π
(B) 8π
(C) 2π
(D) 16π

Space for Rough work

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

8. A uniform rigid square wire frame of side length 'ℓ' and mass '4m' is placed on smooth horizontal surface where exists uniform horizontal magnetic field of Intensity B. Now, current that is double of minimum current required to flip over frame is switched on in the coil. Then, just after current is switched on



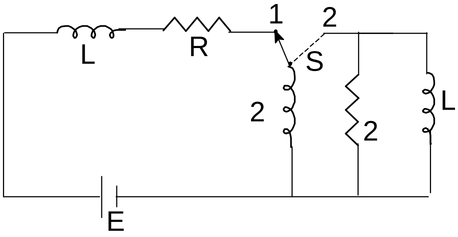
(A) The normal force acting on coil is $\frac{32mg}{5}$

(B) The normal force acting on coil is $\frac{23mg}{20}$

(C) Angular acceleration of coil is $\frac{6g}{5\ell}$

(D) Angular acceleration of coil is $\frac{3g}{10\ell}$

9. In the given circuit, the switch S is connected to point 1 till steady state is achieved. At t = 0; it is shifted to point 2 till steady state is achieved.



(A) The final current in inductor having inductance 2L is $\frac{E}{2R}$.

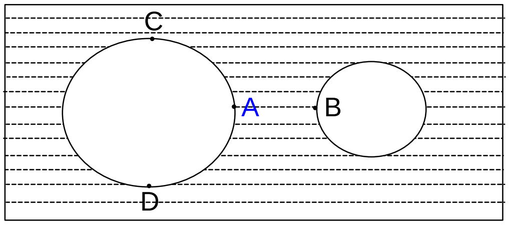
(B) The total amount of heat dissipated through 2R is $\frac{LE^2}{3R^2}$

(C) The total charge which flows through resistor 2R is $\frac{LE}{3R^2}$

(D) The final energy stored in inductor having inductance L is $\frac{2LE^2}{9R^2}$

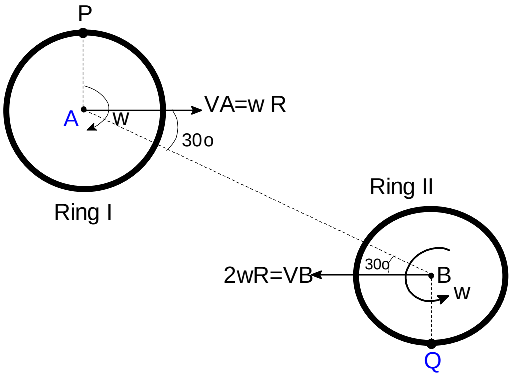
Space for Rough work

10. Figure shows a rectangular plate having two circular holes of radii a and b (a>b). Now plate is heated such that there is temperature rise of ΔT. Then



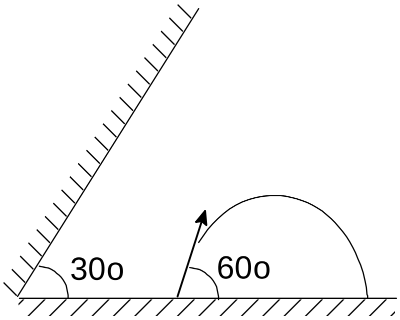
(A) Distance between centre of two holes remain constant
(B) Distance between A and B will increase
(C) Distance between C and D will decrease
(D) Distance between C and D will increase

11. Two identical ring I and II of equal mass 'm' and radius 'R' are moving in opposite direction with linear speed $\omega R \text{ and } 2\omega R$ respectively. Rings are rotating with equal angular speed in opposite direction. The line joining the centres make an angle of 30° with the velocity. Then, at the given instant (AB = 6R)



(A) The angular momentum of ring I about point P is $2mR^2\omega$
(B) The angular momentum of ring I about point Q is $7mR^2\omega$
(C) The angular momentum of ring II about point Q is $2mR^2\omega$
(D) The angular momentum of ring II about point P is $15mR^2\omega$

12. A plane mirror is inclined at an angle 30° with the horizontal surface. A particle is projected from ground (at t = 0) with velocity $V = 20\ m/s$ at an angle of 60° with the horizontal. The image of particle is observed. (The particle does not collide with the mirror). Then



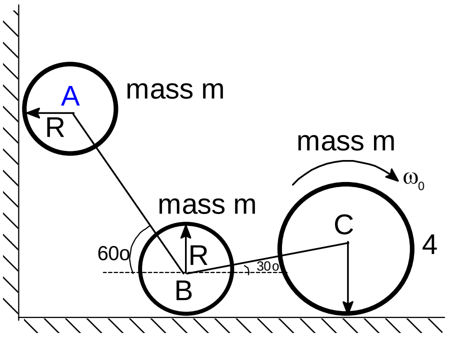
(A) The time when image is at rest with respect to particle is $\frac{2}{\sqrt{3}}$ second
(B) The time when the image is at rest with respect to particle is $\sqrt{3}$ second
(C) Path of image of particle as seen by itself is parabolic
(D) Path of image of particle as seen by itself is straight line

Space for Rough work

13. The energy, the magnitude of linear momentum and the orbital radius of an electron in a hydrogen atom corresponding to the quantum number n are E, P and r respectively. Then according to Bohr's theory of hydrogen atom

(A) Pr is proportional to n
(B) $E\,\mathrm{Pr}^2$ is proportional to n
(C) $\frac{E}{P}$ is proportional to n^2
(D) $E\,r^2$ is proportional to n^2

14. Two identical disc A and B of equal mass 'm' and radius 'R' are connected by a massless rod. The centres of disc C of mass 'm' and radius 4R and disc B are connected by massless rod which makes an angle of 30^0 with the horizontal. There is no slipping between each disc and surface on which it rolls. When angular speed of disc C is ω_0, rod connecting disc A and B makes an angle 60° with horizontal. Then, at the given instant



(A) Angular speed of disc A is $4\omega_0/\sqrt{3}$
(B) Angular speed of disc A is $2\omega_0/\sqrt{3}$
(C) The total kinetic energy of the system is $28m\omega_0^2R^2$
(D) The total kinetic energy of the system is $26m\omega_0^2R^2$

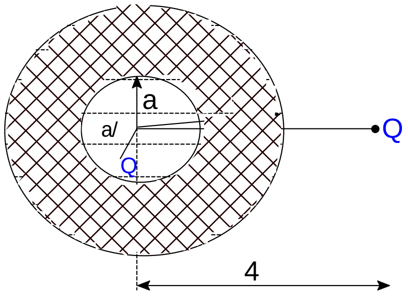
Space for Rough work

Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 15 and 16

A positive point charge having charge Q is placed at a distance a/2 from centre of an unchanged spherical conductor of inner radius a and outer radius '2a'. Another positive point charge having charge 'Q' is placed at a distance 4a from centre of a conducting sphere. Then



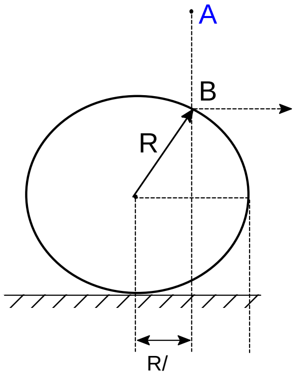
15. Which of the following is incorrect?
    (A) The Surface charge density on inner and outer surface of sphere would be non uniform
    (B) The Electrostatic potential on outer surface of conductor is $\frac{3KQ}{2a}$
    (C) Electric potential at centre of sphere is $\frac{7KQ}{4a}$
    (D) Electric field inside cavity is non-uniform.

16. If conductor is earthed. Then, amount of charge which flows through earthed wire is
    (A) $\frac{3Q}{2}$
    (B) Q
    (C) $\frac{Q}{2}$
    (D) Zero

Space for Rough work

Paragraph for Question Nos. 17 and 18

A particle of mass 1 kg is released from point A. It collides with sphere of mass 2 kg kept on smooth horizontal surface. After collision velocity of particle becomes horizontal. There is no friction at any point of contact (Given $AB = 20m,\ g = 20\ m/s^2$)

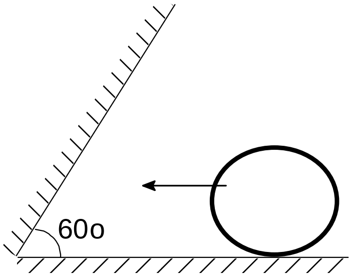


17. The coefficient of restitution between particle and sphere is

(A) $\frac{1}{2}$ (B) $\frac{2}{3}$

(C) $\frac{1}{\sqrt{3}}$ (D) $\frac{\sqrt{3}}{2}$

18. Above sphere moves towards left and collides elastically with smooth inclined plane having angle of inclination 60°. Then, find Impulse of normal force applied by fixed inclined surface on sphere during collision.



(A) $\frac{80}{\sqrt{3}} N\,S$ (B) $\frac{80}{3} N\,S$

(C) $\frac{20}{3} N\,S$ (D) $80\sqrt{3}\, N\,S$

Space for Rough work

Chemistry

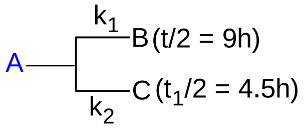
PART – II

SECTION – A

(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

19. A radioactive isotope A undergoes simultaneous decay to yield B and C nuclei as shown



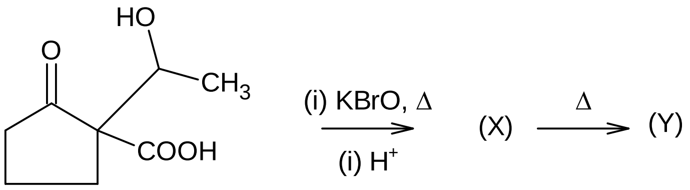
Assume antially no amount of B or C was present, after how many hours will the amount of C be just double to amount of A remaining

(A) 6 h
(B) 2 hr
(C) 8 hr
(D) 12 hr

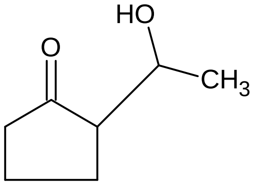
20. The standard reduction potential of metal sparingly soluble salt (AgCl) is 0.209 V and for silver electrode is 0.80 V. If the moles of AgCl that can dissolve in 10 L of a 0.01M NaCl solution is represented as 10^{-z} then z is

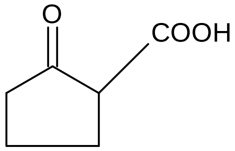
(A) 6
(B) 7
(C) 8
(D) 14

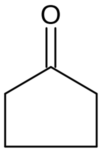
21.

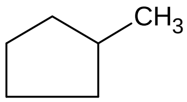


Product Y is

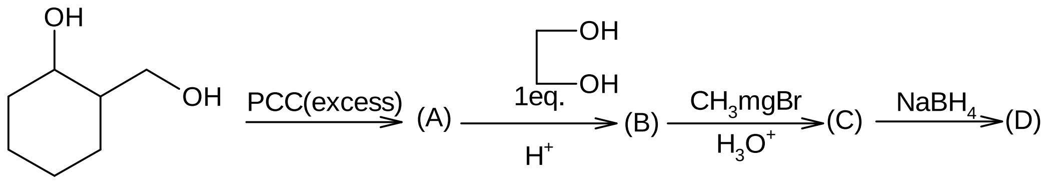
(A)


(B)


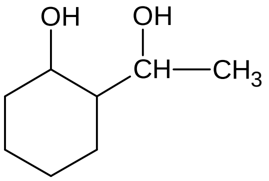
(C)


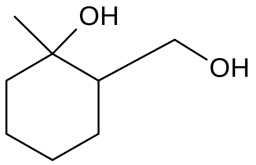
(D)


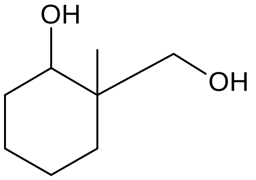
Space for Rough work

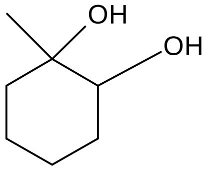
22. 

Product D is

(A) 

(B) 

(C) 

(D) 

23. Two butter (x) and y of ph 4 & 6 are prepared form HA and the salt NaA. Both the buffer are 0.5 M in HA. What would be the pH of the solution obtained by mixing equal volume of the buffer Ka(HA) = 10^{-5}

(A) 4.7 (B) 5.7
(C) 6.7 (D) 8.7

24. The first and second ionization potential of an element M (atomic weight = 25) are 800 and 1500 kj/mol. Calculate the percentage of M^{+2}(g) ions formed if 5g of M absorbs 250 kj of energy.

(A) 70 (B) 40
(C) 60 (D) 30

25. Ballons of 4L capacities are to be filled with hydrogen at a pressure of 1atm and 27^0C from 8L cylinder containing hydrogen at 10 atm at the same temperature. The no of ballons that can the filled is

(A) 20 (B) 18
(C) 40 (D) 38

Space for Rough work

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

26. The correct statement regarding adiabatic process is/are
    (A) In case of reversible adiabatic expansion of ideal gas $\Delta S_{\text{system}} = 0$
    (B) In case of reversible ideal gas comparession Δ Ssystem = 0 and Δ Ssorrounding = 0
    (C) final temp in irreversible adiabatic process is more as compared to reversible process for both expansion and compression of ideal gas. Initial temperature is kept constant
    (D) In adiabatic compression Δu decreases

27. The total pressure is of a binary solution is given by $P = (100 \times A + 260 \times B)\,\text{mm Hg}$ where X_A and X_B are mole fraction of A and B choose correct statement
    (A) vapour pressure of solution is less than the pure B component
    (B) vapour pressure of solution is more than that of pure A component
    (C) vapour pressure of pure A is 100 mm Hg and that of pure B is 260 mm Hg
    (D) the vapour pressure of pure A and B are 260mm Hg and 100mm Hg respectively

28. A mixture contains H atom and Li^{2+} ions. Electron is H-atom is in 3rd excited state and e in Li^{2+} is in 5th excited state. Then which is /are true about the spectral lines observed for the mixture
    (A) emitted radiation will contain 21 lines
    (B) emitted radiation will contain 19 lines
    (C) more than 10 lines are in u.v range
    (D) if sample contains only H atom then emission spectrum contains two visible lines

29. Which can form square planar complex
    (A) Pt(II), Pd(II) with strong and weak field ligand
    (B) Au(III) with strong and weak field ligand
    (C) Ni(II) with CN = 4 and strong field ligand
    (D) Hg(II) with CN = 4 and strong field ligand

30. For which of the following metal carbon reduction cannot be used
    (A) Pb (B) Mn
    (C) W (D) Fe

Space for Rough work

31. Select the correct statement
(A) The fraction of edge not occupied by atom in BCC lattice is 0.139
(B) The next nearest neighbour in BCC lattice is 6
(C) Void fraction in ABCABC type structure is 0.32
(D) Distance between two consecutive layer in ccp is $2\sqrt{\frac{2}{3}}R$

32. Identify the correct statement
(A) Hybridisation of carbon in C_3O_2 is sp
(B) $N(Me)_3$ and $N(SiMe_3)_3$ are isostructural
(C) In TBP arrangement ione pair of $\bar{e}$ are usually occupied at equatorial position
(D) Dipole moment of CH_3F is greater than that of CH_3Cl

Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 33 and 34

A quantity of 25 mL of solution containing both Fe^{2+} and Fe^{3+} ions is titrated with 25 mL of 0.0200M $KMnO_4$ 2n dilute H_2SO_4. As a result all the Fe^{2+} ions are oxidiced to Fe^{3+}ions. Next 25 mL of the original solution is treated with zn metal. Finally, the solution requires 40 mL of the same $KMnO_4$ solution for oxidation to Fe^{3+}.

$$MnO4^- + 5Fe^{2+} + 8H^+ \longrightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$$

33. Molar concentration of Fe^{2+} in the original solution is

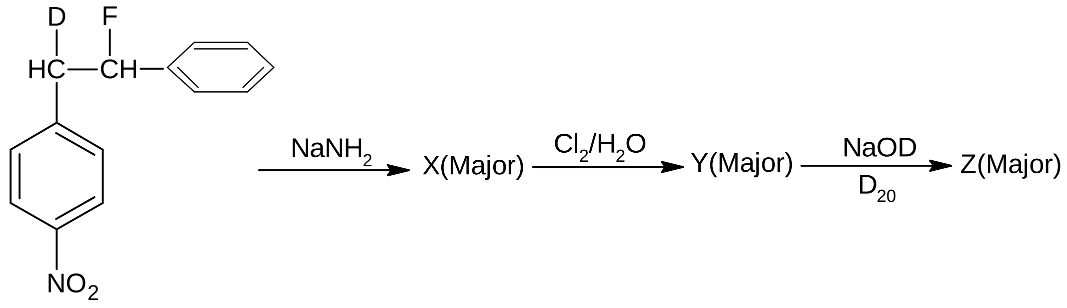
(A) 0.01 M	(B) 0.02 M
(C) 0.10 M	(D) 0.20 M

34. Molar concentration of Fe^{3+} in original solution is

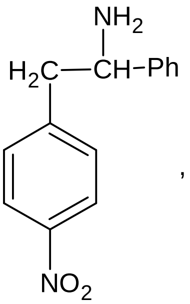
(A) 0.06 M	(B) 0.16 M
(C) 0.032 M	(D) 0.012 M

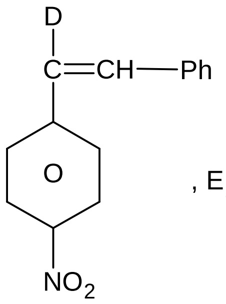
Space for Rough work

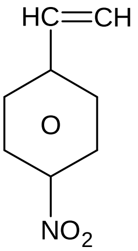
Paragraph for Question Nos. 35 and 36


D
F
HC—CH—
NO2
NaNH2
X(Major)
Cl2/H2O
Y(Major)
NaOD
D20
Z(Major)

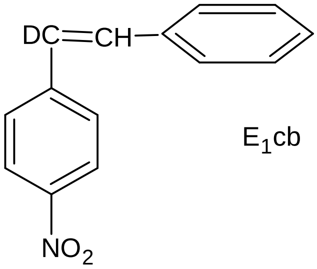
35. The product X and the most possible mechanism of its formation are

(A)

NH2
H2C—CH-Ph
NO2
, SN_2

(B)

D
C=CH—Ph
O
NO2
, E_1

(C)


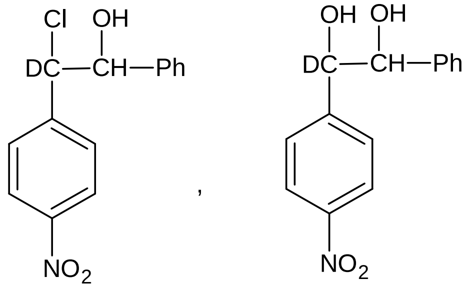
, E_2

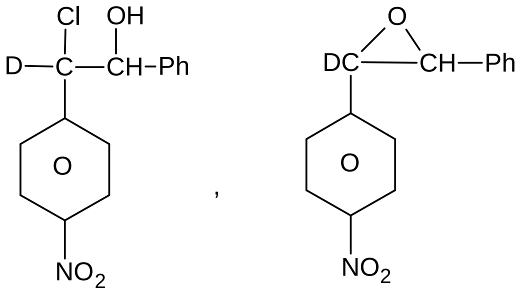
(D)


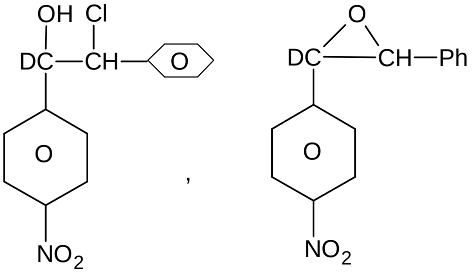
E_1cb

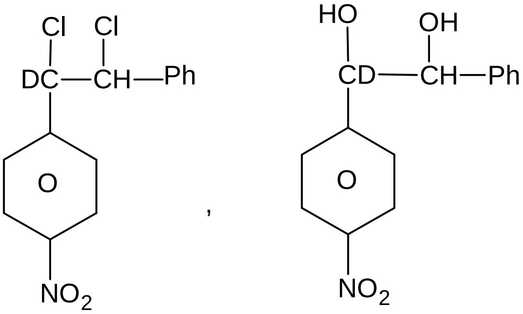
Space for Rough work

36. Product (Y) and (Z) are

(A)

Cl
OH
DC
CH
Ph
NO2
,
OH
OH
DC
CH
Ph
NO2

(B)

Cl
OH
D
C
CH
Ph
O
NO2
,
O
DC
CH
Ph
O
NO2

(C)

OH
Cl
DC
CH
O
O
NO2
,
O
DC
CH
Ph
O
NO2

(D)

Cl
Cl
DC
CH
Ph
O
NO2
,
HO
OH
CD
CH
Ph
O
NO2

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. If ω is any complex number such that $z\omega = |z|^2$ and $|z-\bar{z}|+|\omega+\bar{\omega}|=4,$ then as ω varies, the area of locus of z is

(A) 4 sq. units (B) 8 sq. units
(C) 16 sq. units (D) 12 sq. units

38. If $\rho \neq 1$ is an nth root of unity, then $1 + 5\rho + 9\rho^2 + \ldots.. + (4n-3)\rho^{n-1} = \dfrac{an}{\rho-1}$ and deduce the values of the following.

$$1+5\cos\left(\frac{2\pi}{n}\right)+9\cos\left(\frac{4\pi}{n}\right)+\ldots..+(4n-3)\cos\left(\frac{2(n-1)\pi}{n}\right)=bn$$

$$5\sin\left(\frac{2\pi}{n}\right)+9\sin\left(\frac{4\pi}{n}\right)+\ldots..+(4n-3)\sin\left(\frac{2(n-1)\pi}{n}\right)=c\ n\cot\left(\frac{\pi}{n}\right)$$

for $n \geq 2$, then find the value of a – b – c.

(A) 5 (B) 6
(C) 7 (D) 8

39. Let $I_1 = \int_1^{10^4} \frac{\{\sqrt{x}\}}{\sqrt{x}}dx$ and $I_2 = \int_1^{10} x\{x^2\}dx$ where {.} denotes fractional part of x. Then

(A) $I_1 = I_2$ (B) $I_1 < I_2$
(C) $I_1 = 4I_2$ (D) $I_1 = 200$

40. Let f(x) = $\int_0^x \left[(a-1)(t^2+t+1)^2-(a+1)(t^4+t^2+1)\right]dt.$ Then the value of 'a' for which $f'(x) = 0$ has two distinct real roots are

(A) $(-\infty, -2) \cup (2, \infty)$ (B) $(-2, \infty)$
(C) $(-2, 2)$ (D) $(-\infty, 2)$

Space for Rough work

41. Let f(x) = min $\left(\ell n(\tan x), \ell n(\cot x)\right)$, which of the following statement are incorrect

(A) f(x) is continuous for x $\in \left(0, \frac{\pi}{2}\right)$

(B) Lagrange's mean value theorem is applicable on f(x) for x $\in \left[\frac{\pi}{8}, \frac{\pi}{4}\right]$

(C) Rolle's theorem is not applicable on f(x) for x $\in \left[\frac{\pi}{4}, \frac{3\pi}{8}\right]$

(D) Rolle's theorem is applicable on f(x) for x $\in \left[\frac{\pi}{8}, \frac{3\pi}{8}\right]$

42. Let X be the set of three digit numbers, which when divided by its sum of its digits give maximum value and Y be the set of all possible real values of a for which the $x^3 - 3ax^2 + 3(298a + 299)x - 2 = 0$ have a positive point of maxima, then the number of elements in X∩Y, is

(A) 0
(B) 6
(C) 7
(D) 9

43. The domain of the function f(x) = $\sqrt{\log_{\sin x+\cos x}(|\cos x| + \cos x)}$, $0 \le x \le \pi$ is

(A) (0, π)
(B) $\left(0, \frac{\pi}{2}\right)$
(C) $\left(0, \frac{\pi}{3}\right)$
(D) none of these

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

44. If the global maximum value of f(x) = $-x^2 + ax - a^2 - 2a - 2$ for x ∈ [0, 1] be '- 5', then 'a' can take the value

(A) $\frac{-4+2\sqrt{13}}{3}$
(B) $\frac{-4-2\sqrt{13}}{3}$
(C) 1
(D) –3

Space for Rough work

45. A tangent is drawn to the curve y = f(x) at P(x, y), cuts the x-axis at A. Now a perpendicular drawn from P(x, y) to x-axis meets the x-axis at B. If B is mid-point of OA (O being origin) and f(1) = 1, then

(A) general point on the curve is $\left(t, \frac{1}{t}\right)$, where t is a real parameter (≠ 0)
(B) y = f(x) is a circle
(C) tangent at P(1, 1) is x + y = 2
(D) f ′(2) = –1/4

46. One vertex of the triangle of maximum area that can be inscribed in the curve $|z-2i|=2$ is $2+2i$, remaining vertices are

(A) $-1+i(2+\sqrt{3})$
(B) $-1-i(2+\sqrt{3})$
(C) $-1+i(2-\sqrt{3})$
(D) $-1-i(2-\sqrt{3})$

47. For $f(x)=\left[\log\left(\sin^{-1}\left(\sqrt{x^2+3x+2}\right)\right)\right]$ ([.] G.I.F.) choose the correct one is

(A) Domain $\left[\frac{-3-\sqrt{5}}{2},-2\right)\cup\left(-1,\frac{-3+\sqrt{5}}{2}\right]$
(B) Domain $\left[\frac{-3+\sqrt{5}}{2},-1\right)$
(C) Range is set of all non positive integers
(D) Range is set of all positive integers

48. The co-ordinates of the point of inter section of the curves $y=\cos x, y=\sin 3x, \ -\pi/2\le x\le\frac{\pi}{2}$
.

(A) $\left(\frac{\pi}{8},\cos\frac{\pi}{8}\right)$
(B) $\left(\frac{\pi}{4},-\cos\frac{\pi}{4}\right)$
(C) $\left(\frac{\pi}{4},\cos\frac{\pi}{4}\right)$
(D) $\left(-\frac{3\pi}{8},\cos\frac{3\pi}{8}\right)$

Space for Rough work

49. Consider the inequality $(x + 3)^n (x - 2) < 0$, $x \in N$. Then the correct statement(s) is/are
(A) the largest integral x satisfying the inequality is 1, if n is even
(B) the least integral x satisfying the inequality is –2, if n is odd
(C) the number of integral x satisfying the inequality is 3, if n is odd
(D) the number of positive integral x satisfying the inequality is 1, if n is even

50. The equation $|x^2 - 1| = a - 1$ can have real solutions for x if a lies in
(A) $[1, \infty)$
(B) $(-\infty, 0)$
(C) $[0, 2]$
(D) none of these

Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 51 and 52

Consider a hyperbola $xy = 4$ and a line $y + 2x = 4$. O is centre of hyperbola. Tangent at any point P of hyperbola intersect the co-ordinate axis at A and B.

51. Area of ΔOAB is
(A) Constant and equal to 16
(B) Constant and equal to 32
(C) Constant and equal to 64
(D) Variable

52. Locus of circumcentre of ΔOAB is
(A) An ellipse with eccentricity $\frac{1}{\sqrt{2}}$
(B) an ellipse with eccentricity $\frac{1}{\sqrt{3}}$
(C) a hyperbola with eccentricity $\sqrt{2}$
(D) a circle of radius $\sqrt{2}$

Space for Rough work

Paragraph for Question Nos. 53 and 54

Let t be a real number satisfying
$2t^3 - 9t^2 + 30 - a = 0$ . . . (1)
And $x + \frac{1}{x} = t$ . . . (2)

53. If equation (1) has three real and distinct roots then
(A) $a > 30$
(B) $a < 3$
(C) $3 < a < 30$
(D) $a < 3$ or $a > 30$

54. If $x + \frac{1}{x} = t$ gives six real and distinct values of x, then
(A) $3 < a < 30$
(B) $a \in \phi$
(C) $a \in (2, 5)$
(D) none of these

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – III

JEE (Advanced)-2020

PAPER – 2

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. C

Sol. Least count $= \frac{0.5}{100} = 0.005\,mm$

Diameter will be $0.5 \times 6 + 0.005 \times 74 - 0.5 \times 0.005 = 3.345\,mm$

2. A

Sol. $$\frac{4\lambda D}{d} = \frac{3\lambda\left(D + \frac{1}{2}a_0 t^2\right)}{d}$$

$$t = \sqrt{\frac{2D}{a_0}}$$

3. D

Sol. Direction of electric field is along direction of current

$$\frac{2\sigma}{\tan\theta} = \frac{\sigma}{\tan 30^\circ}$$

$$\theta = \tan^{-1}\left(\frac{2}{\sqrt{3}}\right)$$

4. B

Sol. $$\frac{Q}{4\pi \in_0 KR^2} = E_0 = 8$$

$$\Delta V = \frac{Q}{4\pi \in_0 K}\frac{(2R-R)}{R\times 2R}$$

$$= \frac{Q}{8\pi \in_0 KR} = 2Volt$$

5. C

Sol. Maximum possible loss occurs in case of perfectly inelastic collision loss in

$$KE = \frac{1}{2}\mu(V_r)^2 - \frac{1}{2}\mu(U_r)^2$$

$$= \frac{1}{2}\times\frac{3}{4}\times\left(\frac{8}{3}\right)^2 - \frac{1}{2}\times\frac{3}{4}\times\left(\frac{4}{3}\right)^2 = 2\,Joule$$

6. C

Sol. $B2\pi r = \mu_0 I_{in}$

$$Kr^2 2\pi r = \mu_0\int_0^r J2\pi r dr$$

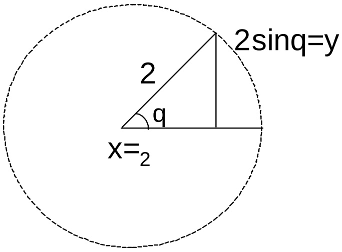
On differentiating both side

$$K\frac{d(r^3)}{dr} = \mu_0 Jr, \frac{dj}{dr} = \frac{3K}{\mu_0}$$

7. B

Sol. Since particle moves in xy plane

So, z = 0



$$d\vec{r} = dx\hat{i} + dy\hat{j}$$

$$dw = \vec{f}.\,d\vec{r} = \int(x^2 - y)dx + (x+5y)dy$$

$$w = \int dw = 4\int_0^{2\pi} d\theta = 8\pi$$

8. AC

Sol. Let I_0 be minimum current required to flip, then

$$I_0\ell^2 B = \frac{4mg\ell}{2}$$

$$I_0 = \frac{2mg}{\ell B}$$

$$I = \frac{4mg}{\ell B} = 2I_0$$

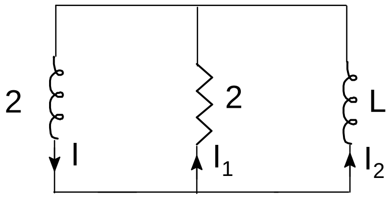
Net torque about one edge

$$\frac{5m\ell^2}{3}\alpha = I\ell^2 B - \frac{4mg\ell}{2} \quad \Rightarrow \alpha = \frac{6g}{5\ell}$$

$$a_{cm} = \frac{\alpha\ell}{2} = \frac{3g}{5}, \quad N - 4mg = \frac{4m3g}{5}, \quad N = \frac{32mg}{5}$$

9. BCD

Sol. After time 't'



$$2L\frac{dI}{dt}+L\frac{dI_2}{dt}=0$$

$$2\int_{E/R}^{I} dI+\int_{0}^{I} dI_2=0, \qquad I=\frac{2E}{3R}$$

$$2L\frac{dI}{dt}+IR=0$$

$$2L\frac{dI}{dt}+\frac{dq}{dt}2R=0$$

$$2L\int_{E/R}^{2E/3R} dI+\int_{0}^{Q} dq2R=0$$

$$Q=\frac{LE}{3R^2}$$

$$\Delta H=U_i-U_f=\frac{1}{2}2L\left(\frac{E}{R}\right)^2-\frac{1}{2}3L\times\frac{4E^2}{9R^2}=\frac{LE^2}{3R^2}$$

$$U_L=\frac{1}{2}L\left(\frac{2E}{3R}\right)^2=\frac{2LE^2}{9R^2}$$

10. BD

Sol. Expansion of body is like photographic enlargement.

11. ACD

Sol. Angular momentum of rigid body about any point is given as

$$L=\overrightarrow{r_{cm}}\times m\overrightarrow{V}_{cm,p}+I_{cm}\overrightarrow{\omega}$$

For Ring I

$$L_P=\left(mR^2+mR^2\right)\omega=2mR^2\omega$$

$$L_Q=2m\omega R\times 4R+mR^2\omega=9mR^2\omega$$

For Ring II

$$L_P=4m\omega R\times 4R-mR^2\omega=15m\omega R^2$$

$$L_Q=\left(mR^2+mR^2\right)\omega=2mR^2\omega$$

12. AD

Sol. Image will be at rest with respect to object when velocity of particle is parallel to mirror

$$\tan 30^\circ=\frac{10\sqrt{3}-10t}{10}\Rightarrow t=\frac{2}{\sqrt{3}}Second$$

13. ABD

Sol. $E\propto\frac{1}{n^2},\ r\propto n^2,\ P\propto\frac{1}{n}$

14. AC

Sol. Let angular velocity of disc A and B be ω_1 and ω_2 respectively. Component of velocity of points on rod along rod would be same

$$\omega_2 R\cos 30^0 = 4\omega_0 R\cos 30^0$$

$$\omega_2 = 4\omega_0$$

$$\omega_1 R\cos 30^0 = \omega_2 R\cos 60^0$$

$$\omega_1 = \frac{4\omega_0}{\sqrt{3}}$$

$$K = \frac{1}{2}\times\frac{3}{2}mR^2\omega_1^2 + \frac{1}{2}\times\frac{3}{2}mR^2\omega_2^2 + \frac{1}{2}\times\frac{3}{2}m16R^2\omega_0^2$$

$$= 28m\omega_0^2R^2$$

15. B

Sol. Electric potential on surface of conductor = $\frac{KQ}{2a} + \frac{KQ}{4a} = \frac{3KQ}{4a}$

Electric potential at centre = $\frac{2KQ}{a} - \frac{KQ}{a} + \frac{3KQ}{4a} = \frac{7KQ}{4a}$

16. A

Sol. When conductor is earthed potential becomes zero. Let charge on outer surface of conductor be q. $\frac{Kq}{2a} + \frac{KQ}{4a} = 0,\ q = -\frac{Q}{2}$

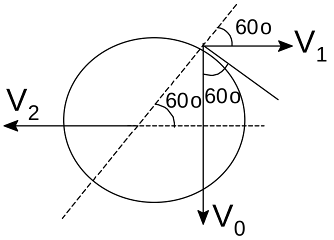
So, amount of charge flowing through wire $= Q - \left(-\frac{Q}{2}\right) = \frac{3Q}{2}$

17. A

Sol. Velocity acquired by particle will be $V_0 = \sqrt{2g\times 20} = 20\,m/s$

$$V_0\cos 60^\circ = V_2\sin 60^\circ$$

$$V_1 = \frac{20}{\sqrt{3}}$$



From conservation of momentum for system of particle along horizontal

$$1V_1 = 2V_2 \quad \Rightarrow V_2 = \frac{10}{\sqrt{3}}, \quad e = \frac{\frac{V_1}{2} + \frac{V_2}{2}}{\frac{V_0\sqrt{3}}{2}} = \frac{1}{2}$$

18. B

Sol. Let N be normal force exerted by inclined surface on sphere

$$\int N\cos 30^\circ = 2\times 2V_2$$

$$\int Ndt = \frac{80}{3}$$

Chemistry

PART – II

SECTION – A

19. A

Sol. C will formed at will the rate of B

K of A is = $K_1 + K_2 = \frac{0.693}{3}$

Let at time t [C] = 2[A] and [B] = X %

So, $2x = (100-3x)\times 2$

$\Rightarrow x = 25$

applying 1^{st} order kinetics

$\frac{\ln_2}{3}\times t = \ln\frac{100}{100-3x} \Rightarrow t = 6n$

20. B

Sol. $0.209 = 0.80 + \frac{0.0591}{1}10gKSP$

$KSP = 10^{-10}$

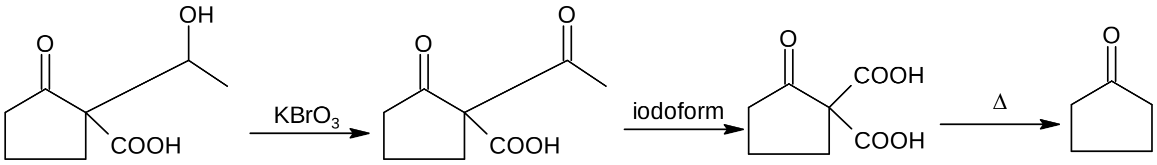
⇒ solubility of AgCl in 0.01M solution is x

KSP = x(x + 0.1)

$\Rightarrow x = 10^{-8}$, mole of AgCl dissolve in 10L = 10^{-7} z = 7

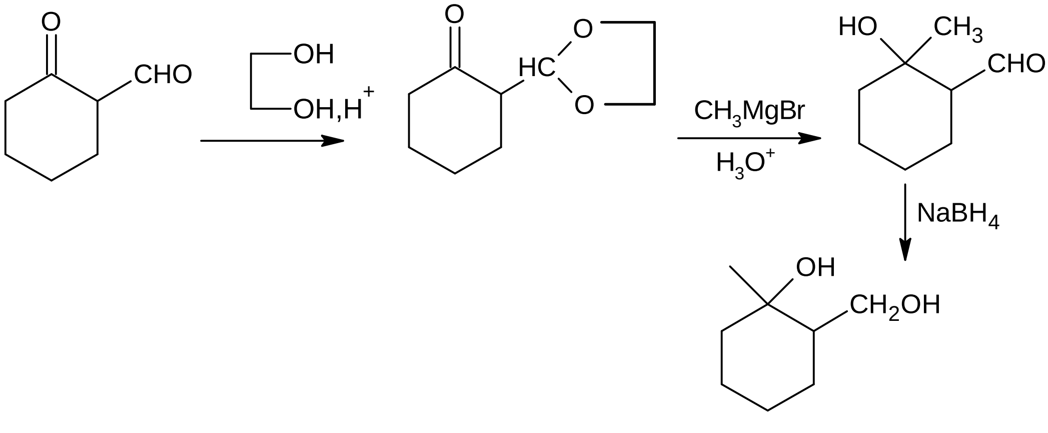
21. C

Sol.


OH
O
COOH
$KBrO_3$
O
O
COOH
iodoform
O
COOH
COOH
Δ
O

22. A

Sol.


O
CHO
OH
OH,H+
O
HC
O
O
CH_3MgBr
H_3O^+
HO
CH_3
CHO
$NaBH_4$
OH
CH_2OH

23. B

Sol. For X apply buffer formula of ph, we get [salt] = $5\times10^{-2}M$ for y $[salt]_2$ = 5M on mixing equal volume, final [Acid] = 0.5 M & [sat] = 2.5025 so $pH = 5 + \log\frac{2.5025}{0.5} = 5.7$

24. D

Sol. $M \rightarrow M^{+} + e^{-}$

$n = \frac{5}{25} = 0.2$ energy required to form M^{+}ions = 0.2 × 800 = 160 kj/mole

Remaining 90 kj used in the conversion of M^{+} to M^{+2}

So no of mole of M^{+2} formed = $\frac{90}{1500} = 0.06$

$\%M^{2+} = \frac{0.06}{0.2} \times 100 = 30\%$

25. B

Sol. $P_1V_1 = P_2V_2$, so expanded vel^{m} = 80L
available volume to fill the ballons = 80 – 8 =72 L
so no of ballons = 18

26. ABC

Sol. fact

27. ABC

Sol. conceptual

28. CD

Sol. Total line for H atom and li^{2+} ion are 6,15. But 2 → 1 has same energy as 3 → 6 in li^{2+}ions so total line = 20 if sample is containing only H then there are 2 balmer lines in li^{2+} all lyman lines are in u.v = 5 all balmer lines in u.v = 4 in li^{2+} few more lines can be in u.v

29. ABC

Sol. $Pt^{+2}, Pd^{+2} Au^{+3}$ for I.O.C dsp^2 with SFL and WFL when CN = 4 $Hg^{2+}(Sd^{10})$ always form outer orbital complex Sp^3 when CN = 4

30. BC

Sol. manganese, Tungsten

31. ABD

Sol. fact

32. AC

Sol. $N(Me)_3$ is pyramidal while $Ni(Sime_3)_3$ is trigonal planar

33. C

Sol. Only Fe^{2+} will oxidice, so $25 \times [Fe]^{2+} = 25 \times 0.02 \times 5$ M = 0.10 M

Total Fe^{2+} in second part $25 \times y = 40 \times 0.02 \times 5$ y = 0.16 M = 0.16N

So, Fe^{3+} = 0.16 – 0.10 $\Rightarrow$ 0.06M

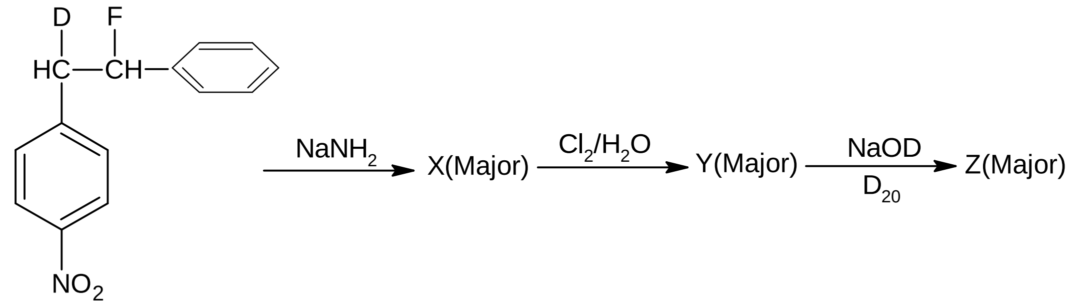
34. A

Sol. Only Fe^{2+} will oxidice, so $25 \times [Fe]^{2+} = 25 \times 0.02 \times 5$ M = 0.10 M

Total Fe^{2+} in second part $25 \times y = 40 \times 0.02 \times 5$ y = 0.16 M = 0.16N

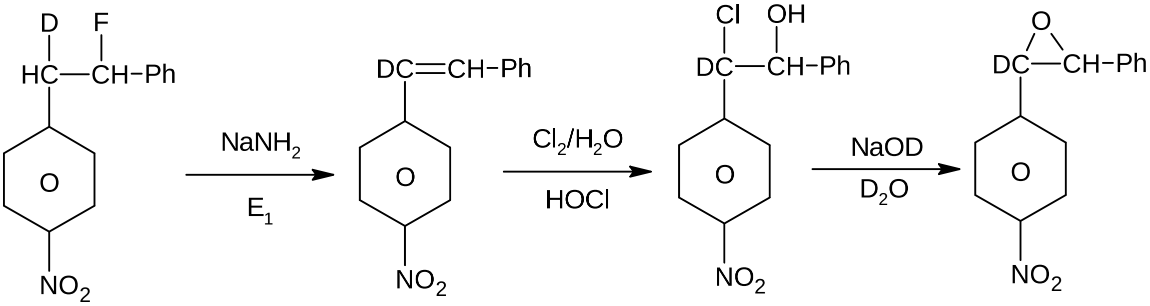
So, Fe^{3+} = 0.16 – 0.10 $\Rightarrow$ 0.06M

P – 11


D
F
HC—CH—
NO2
NaNH2
X(Major)
Cl2/H2O
Y(Major)
NaOD
D20
Z(Major)

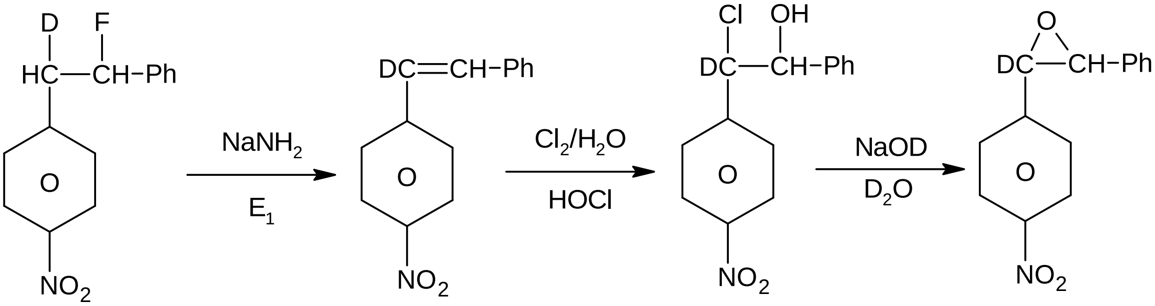
35. D

Sol.


D
F
HC—CH–Ph
O
NO2
NaNH2
E1
DC═CH–Ph
O
NO2
Cl2/H2O
HOCl
Cl
OH
DC—CH–Ph
O
NO2
NaOD
D2O
O
DC—CH–Ph
O
NO2

36. B

Sol.


D
F
HC—CH–Ph
O
NO2
NaNH2
E1
DC═CH–Ph
O
NO2
Cl2/H2O
HOCl
Cl
OH
DC—CH–Ph
O
NO2
NaOD
D2O
O
DC—CH–Ph
O
NO2

Mathematics PART – III

SECTION – A

37. B

Sol. $z\omega = |z|^2 \Rightarrow \omega = \bar{z}$

$|z+\bar{z}|+|\omega+\bar{\omega}|=4$

$|x| + |y| = 2$

which is a square $\therefore$ Area = 8 sq. units

38. D

Sol. Let $S = 1 + 5\rho + 9\rho^2 + \ldots\ldots + (4n-3)\rho^{n-1}$

Then $\rho S = \rho + 5\rho^2 + \ldots\ldots + (4n-7)\rho^{n-1} + (4n-3)\rho^n$

Subtracting

$(1-\rho)S = 1 + 4\rho + 4\rho^2 + \ldots\ldots + 4\rho^{n-1} - (4n-3)\rho^n$

Hence $S = \dfrac{4n}{\rho-1}$ Taking $\rho = e^{2\pi i/n}$

We have

$$1+5e^{2\pi i/n}+9e^{4\pi i/n}+\ldots\ldots+(4n-3)e^{2(n-1)\pi in} = \frac{4n}{e^{2\pi i/n}-1}$$

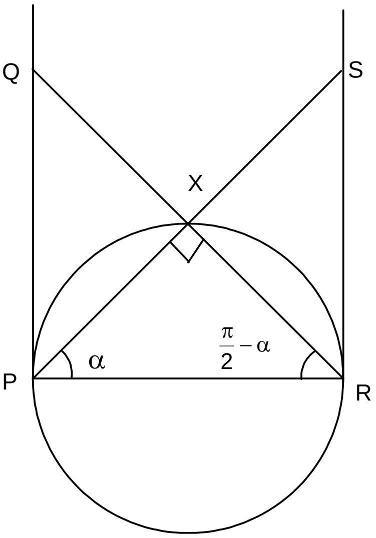
$$\frac{4n\left\{\left(\cos\frac{2\pi}{n}\right)-1-i\sin\frac{2\pi}{n}\right\}}{\left(\cos\frac{2\pi}{n}-1\right)^2+\sin^2\left(\frac{2\pi}{n}\right)} = \frac{n\left(\cos\frac{2\pi}{n}-1-i\sin\frac{2\pi}{n}\right)}{\sin^2\frac{\pi}{n}}$$

We see that

$$1+5\cos\left(\frac{2\pi}{n}\right)+9\cos\left(\frac{4\pi}{n}\right)+\ldots\ldots+(4n-3)\cos\left(\frac{2(n-1)\pi}{n}\right)=-2n$$

$$5\sin\frac{2\pi}{n}+9\sin\left(\frac{4\pi}{n}\right)+\ldots\ldots+(4n-3)\sin\left(\frac{2(n-1)\pi}{n}\right)=-2n\cot\left(\frac{\pi}{n}\right)$$

$\therefore$ a – b – c = 4 + 2 + 2 = 8.



39. C

Sol. $I_1 = 2\int_1^{10^2}\{t\}dt$ $\left[\text{Put } \sqrt{x}=t,\ \dfrac{dx}{2\sqrt{x}}=dt\right]$

$I_2 = \int_1^{10}\left(x\{x^2\}\right)dx$ [$x^2 = N$, $2x\,dx = dN$]

$$I_2 = \int_0^{10^2}\frac{\{N\}dN}{2}$$

$$\frac{I_1}{I_2}=4,\quad I_1 = 200\int_0^1\{t\}dt$$

$$I_1 = 200\left[\frac{x^2}{2}\right]_0^1 = 100$$

40. A

Sol. $f'(x) = (a-1)(x^2+x+1)^2 - (a+1)(x^4+x^2+1)$

for $f'(x) = 0$

$(x^2+x+1)[(a-1)(x^2+x+1) - (a+1)(x^2-x+1)] = 0$

$\Rightarrow$ either $x^2+x+1 = 0$ or $x^2 - ax + 1 = 0$

For distinct roots, $D > 0$.

41. D

Sol. f(x) is not differentiable at $x = \frac{\pi}{4}$

$\therefore$ option (D) is incorrect.

42. C

Sol. Clearly X = {100, 200, 300, 400, 500, 600, 700, 800, 900}

And for the equation $x^3 - 3ax^2 + (298a + 299)x - 2 = 0$ to have positive point of maxima. The equation $f'(x) = 0$ should have both the roots positive and unequal, which gives $a > 299$.

$\therefore$ Y = {a; a > 299}

$\therefore$ Number of elements in $X \cap Y = 7$.

43. D

Sol. $|\cos x| + \cos x > 0 \to x \in \left[0, \frac{\pi}{2}\right)$

For $x \in \left[0, \frac{\pi}{2}\right)$

$1 \le \sin x + \cos x \le \sqrt{2}$

But $\sin x + \cos x \ne 1 \Rightarrow x \in \left(0, \frac{\pi}{2}\right)$

Now for $x \in \left(0, \frac{\pi}{2}\right)$

$\log_{\sin x + \cos x}(|\cos x| + \cos x) \ge 0$

$\Rightarrow \quad \cos x \ge \frac{1}{2} \Rightarrow x \in \left(0, \frac{\pi}{3}\right]$

44. AD

Sol. Vertex of f(x) will be at $x = \frac{a}{2}$

Case – I : If $a < 0$, then maximum value of f(x) is at $x = 0$

$\therefore$ $f(0) = -5 \Rightarrow a^2 + 2a - 3 = 0$

$\Rightarrow$ $a = -3$ or 1 $\Rightarrow$ $a = -3$

Case – II : If $a > 2$, then maximum value of f(x) is at $x = 1$

$\therefore$ $f(1) = -5$ $\Rightarrow$ $a^2 + a - 2 = 0$

$\Rightarrow$ $a = -2$ or 1 which is not possible.

Case – III : If $0 < a < 2$, then maximum value is at $x = \frac{a}{2}$

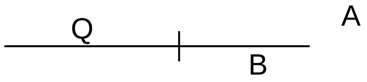
$\Rightarrow f\left(\frac{a}{2}\right) = -5 \quad \Rightarrow 3a^2 + 8a - 12 = 0 \quad \Rightarrow a = \frac{-4 \pm 2\sqrt{13}}{3}$

$\Rightarrow a = \frac{-4 + 2\sqrt{13}}{3}$ is possible

45. ACD

Sol. $Y - y - \frac{dy}{dx}(X - x)$

$$A\left(x - \frac{\frac{y}{dy}}{dx}, 0\right), \quad B(x, 0)$$



$$x - \frac{y}{\frac{dy}{dx}} = 2x, \quad -y = x\frac{dy}{dx}$$

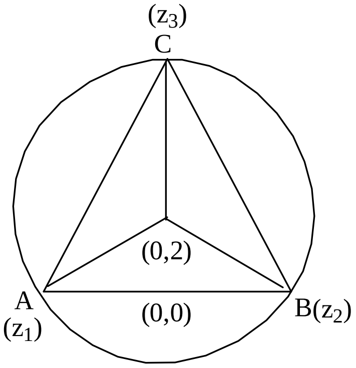
$$\frac{dy}{y} = -\frac{dx}{x}$$

ln |y| = –ln|x| + c
curve is passing from (1, 1), c = 0
xy = 1

46. AC

Sol. $\frac{z_2 - z_0}{z_1 - z_0} = e^{i2\pi/3}$

$$\frac{z_3 - z_0}{z_1 - z_0} = e^{-i\frac{2\pi}{3}}$$



47. AC

Sol. $x^2 + 3x + 2 > 0$

$\Rightarrow \quad x \in (-\infty, -2) \cup (-1, \infty)$

$x^2 + 3x + 2 \le 1$

$$\Rightarrow \quad x \in \left[\frac{-3-\sqrt{5}}{2}, \frac{-3+\sqrt{5}}{2}\right]$$

$$x \in \left[\frac{-3-\sqrt{5}}{2}, -2\right) \cup \left(-1, \frac{-3+\sqrt{5}}{2}\right]$$

$$0 < \sin^{-1}\left(\sqrt{x^2 + 3x + 2}\right) \le \frac{\pi}{2}$$

$$-\infty < \log\left(\sin^{-1}\left(\sqrt{x^2 + 3x + 2}\right)\right) \le \log\frac{\pi}{2}$$

$\therefore$ set of all non positive integers.

48. ABCD

Sol. $\sin 3x = \cos x = \sin x\left(\frac{\pi}{2} - x\right)$

$3x = n\pi + (-1)^n\left(\frac{\pi}{2} - x\right)$

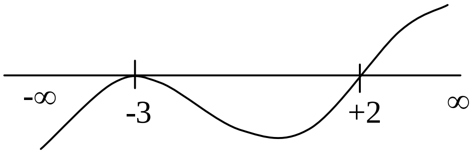
If n is even $x = \frac{m\pi}{2} + \frac{\pi}{8}$

If n is odd $x = m\pi + \frac{\pi}{4}$

$-\frac{\pi}{2} \le x \le \frac{\pi}{2}, \;\; x = \frac{\pi}{8}, \frac{\pi}{4}, \frac{-3\pi}{8}$

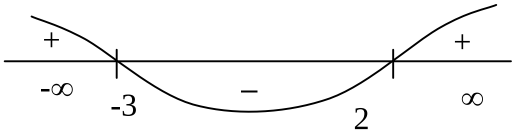
49. ABD

Sol. If n is even



x∈ (–∞, –3) ∪(–3, +2)

If n is odd



x∈(–3, +2)

Options (A), (B), (D) are correct.

50. AC

Sol. $\left|x^2 - 1\right| \ge 0$

$\Rightarrow a - 1 \ge 0 \;\; \Rightarrow a \ge 1$

$a \in [1, \infty)$

Again, $\left|x^2 - 1\right| = a - 1$

$\Rightarrow x^2 - 1 = \pm(a - 1)$

$\Rightarrow x^2 = 1 \pm (a - 1)$

$x^2 = 1 + a - 1 = a$ and $1 - a + 1 = 2 - a$

$a \ge 0$ and $2 - a \ge 0 \Rightarrow a \le 2$ (since $x^2 \ge 0$)

$\Rightarrow \; 0 \le a \le 2$

$a \in [0, 2]$.

51. A

Sol. Equation of tangent at $\mathrm{P}\left(2\mathrm{t}, \frac{2}{\mathrm{t}}\right)$ is

x + yt^2 = 4t.

A = (4t, 0)

$$B = \left(0, \frac{4}{t}\right)$$

Hence area = 16 sq. units (constant).

52. C

Sol. s xy = 4, which is a rectangular hyperbola.

Hence $e = \sqrt{2}$.

53. C

Sol. Let f(t) = $2t^3 - 9t^2 + 30 - a$

$f'(t) = 6t^2 - 18t = 0 \Rightarrow$ t = 0, 3

$\therefore$ For three real and distinct roots

f(0). F(3) < 0

(30 – a) (3 – a) < 0

$\Rightarrow$ a $\in$ (3, 30)

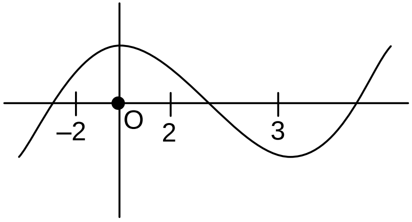
54. B

Sol. $x + \frac{1}{x} = t$ gives six real and distinct values then

Equation (1) should have three real and distinct roots and equation (2) should have two real distinct roots

3 < a < 30 …… (1)

Graph of (t) = $2t^3 - 9t^2 + 30 - a$, is



From the graph it is clear that

f(- 2) > 0 and f(2) > 0

$\Rightarrow$ a < - 22 and a < 10

$\Rightarrow$ a $\in$ (- ∞, - 22) …… (2)

From (1) and (2) a $\in$ ϕ.

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – III

JEE (Main)-2020

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 75 questions.
- Each subject (PCM) has 25 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only three sections: **Section-A**, **Section-B and Section-C**.

  Section-A (01 – 20, 26 – 45, 51 – 70) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

  Section-B (21 – 22, 46 – 47, 71 – 72) *contains 6 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

  Section-C (23 – 25, 48 – 50, 73 – 75) *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A
(One Options Correct Type)

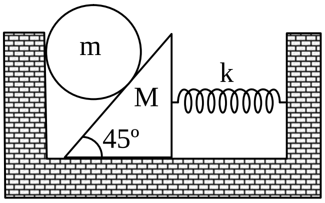
This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A hollow vertical cylinder of radius R and height 'h' has smooth internal surface. A small particle is placed in contact with the inner side of the upper rim at a point P. It is given a horizontal speed v_0 tangential to rim. It leaves the lower rim at point Q, vertically below P. The number of revolutions made by the particle will

(A) $\frac{h}{2\pi R}$ (B) $\frac{v_0}{\sqrt{2gh}}$

(C) $\frac{2\pi R}{h}$ (D) $\frac{v_0}{2\pi R}\left(\sqrt{\frac{2h}{g}}\right)$

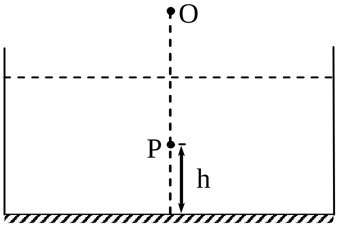
2. All surfaces shown in figure are smooth. System is released with the spring unstretched. In equilibrium, compression in the spring will be



(A) $\frac{2mg}{k}$ (B) $\frac{(M+m)g}{\sqrt{2}k}$

(C) $\frac{mg}{\sqrt{2}k}$ (D) $\frac{mg}{k}$

3. A plane mirror in placed at bottom of a tank containing a liquid of refractive index μ. P is a small object at a height 'h' above the mirror. An observer "O" vertically above P outside the liquid observes P & its image in the mirror. The apparent distance between these two will be

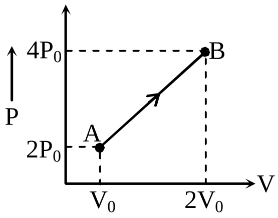


(A) $2\mu h$ (B) $\frac{2h}{\mu}$

(C) $\frac{2h}{\mu-1}$ (D) $h\left(1+\frac{1}{\mu}\right)$

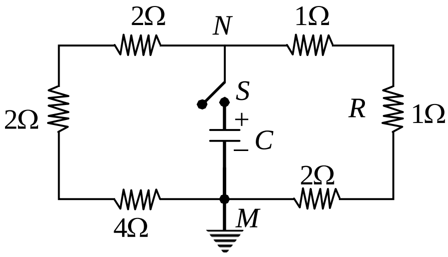
Space for Rough work

4. One mole of a monoatomic gas undergoes the process A → B in the given P-V diagram. The specific heat for this process is



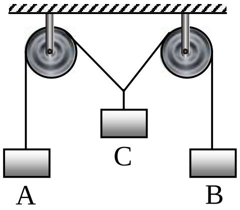
(A) $\frac{3}{2}$R (B) 2R
(C) $\frac{30}{7}$ R (D) $\frac{20}{7}$ R

5. A capacitor of capacity 6 μF and initial charge 160 μC is connected with a key *S* and resistance as shown in figure. Point *M* is earthed. If key is closed at *t* = 0 then the current through resistance *R* = 1 Ω at *t* = 16 μ sec is



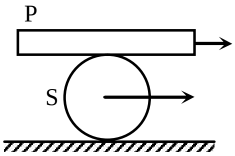
(A) $\frac{10}{3e}A$
(B) $\frac{10}{e}A$
(C) $\frac{20}{3e}A$
(D) None of these

6. Three blocks A, B and C are suspended as shown below. Mass of each of block A and B is *m*. If system is in equilibrium and mass of C is M then



(A) M < 2m (B) M > 2m
(C) M = 2m (D) M ≤ 2m

7. A plank P is placed on a solid cylinder S, which rolls on a horizontal surface. The two are of equal mass. There is no slipping at any of the surfaces in contact. The ratio of kinetic energy of P to the kinetic energy of S is



(A) 1 : 1 (B) 2 : 1
(C) 8 : 3 (D) 11 : 8

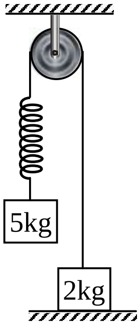
Space for Rough work

8. A particle is projected at an angle of elevation α and after t second it appears to have an angle of elevation β as seen from point of projection. The initial velocity will be

(A) $\frac{gt}{2\sin(\alpha-\beta)}$ (B) $\frac{gt\cos\beta}{2\sin(\alpha-\beta)}$

(C) $\frac{\sin(\alpha-\beta)}{2gt}$ (D) $\frac{2\sin(\alpha-\beta)}{2gt\cos\beta}$

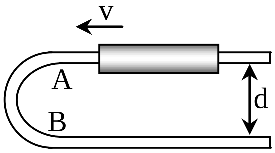
9. System shown in the figure is released from rest with mass 2 kg in contact with the ground. Pulley and spring are massless and the friction is absent everywhere. The speed of 5 kg block when 2 kg block leaves the contact with the ground is (force constant of the spring k = 40 N/m and g = 10 m/s^2)



(A) $\sqrt{2}$ m/s (B) $2\sqrt{2}$ m/s

(C) 2 m/s (D) $\sqrt{2}$ m/s

10. A U-shaped wire has a semicircular bending between A and B as shown. A bead of mass m moving with uniform speed 'v' through a wire enters the semicircular bend at A leaves at B with velocity v/2 after time T. The average force exerted by the bead on the part AB of the wire is



(A) 0 (B) $\frac{3mv}{2T}$

(C) $\frac{3mv}{T}$ (D) None of these

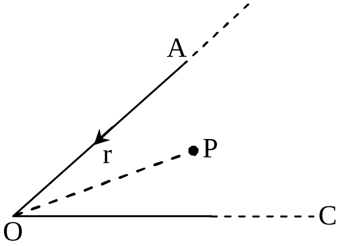
11. There are two thin wire rings, each of radius R, whose axes coincide. The charges on the rings are q and –q. Evaluate the potential difference between the centres of the rings separated by a distance *a*.

(A) $\frac{q}{\pi\varepsilon_0}\left[\frac{1}{R}+\frac{1}{\sqrt{R^2+a^2}}\right]$ (B) $\frac{q}{2\pi\varepsilon_0}\left[\frac{1}{R}+\frac{1}{\sqrt{R^2+a^2}}\right]$

(C) $\frac{q}{2\pi\varepsilon_0}\left[\frac{1}{R}-\frac{1}{\sqrt{R^2+a^2}}\right]$ (D) $\frac{2q}{\pi\varepsilon_0}\left[\frac{1}{R}-\frac{1}{\sqrt{R^2+a^2}}\right]$

Space for Rough work

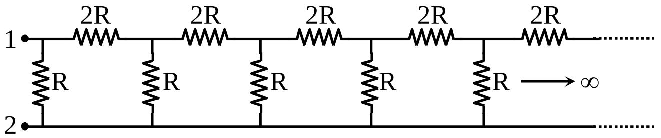
12. Two wires AO and OC carry equal currents i as shown in figure. One end of both the wires extends to infinity. Angle AOC is α



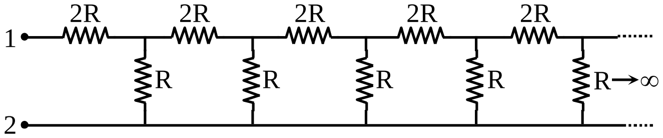
The magnitude of magnetic field at a point P on the bisector of these two wires at a distance *r* from point O is

(A) $\frac{\mu_0}{2\pi}\frac{i}{r}\cot\left(\frac{\alpha}{2}\right)$
(B) $\frac{\mu_0}{4\pi}\frac{i}{r}\cot\left(\frac{\alpha}{2}\right)$
(C) $\frac{\mu_0}{2\pi}\frac{i}{r}\frac{\left(1+\cos\frac{\alpha}{2}\right)}{\sin\left(\frac{\alpha}{2}\right)}$
(D) $\frac{\mu_0}{4\pi}\frac{i}{r}\left(\frac{\alpha}{2}\right)$

13. Two circuits (as shown in figure) are called Circuit A and Circuit B. The equivalent resistance of Circuit A is *x* and that of Circuit B is *y* between 1 and 2



Circuit A

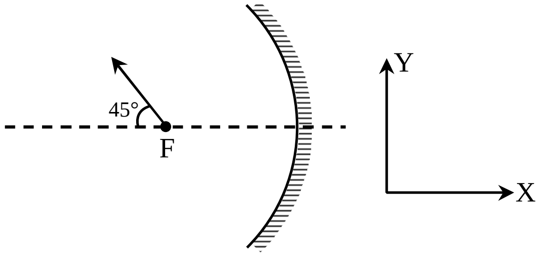


Circuit B

(A) y = x
(B) y = ($\sqrt{3}$ +2)R
(C) xy = $2R^2$
(D) x + y = 2R

Space for Rough work

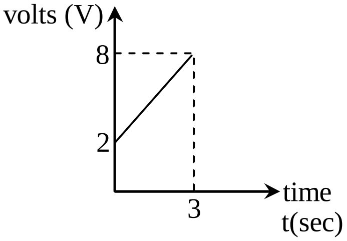
14. A particle is projected on a horizontal (x-z plane) at an angle 45° with horizontal as shown. The particle is projected from focus F of a concave mirror of radius of curvature R with speed v = $\sqrt{gR}$. Velocity of image of the particle as it is just about to strike the horizontal plane is



(A) $\frac{v}{4\sqrt{2}}\hat{i}-\frac{v}{4\sqrt{2}}\hat{j}$ (B) $\frac{v}{4\sqrt{2}}\hat{i}+\frac{v}{2\sqrt{2}}\hat{j}$
(C) $\frac{v}{4\sqrt{2}}\hat{i}-\frac{v}{2\sqrt{2}}\hat{j}$ (D) $\frac{-v}{4\sqrt{2}}\hat{i}+\frac{v}{4\sqrt{2}}\hat{j}$

15. A string of length 1.5 m with its two ends clamped is vibrating in fundamental mode. Amplitude at the centre of string in 4 mm. Distance two point having amplitude 2 mm is
(A) 1 m (B) 75 cm
(C) 60 cm (D) 50 cm

16. A circuit element is placed in a closed box. A time t = 0, a constant current generator supplying a current of I amp is connected across the box. Potential difference across the box varies according to graph as shown in the figure. The element in the box is



(A) a resistance of 2Ω
(B) a battery of emf 6V
(C) an inductance of 2H
(D) a capacitance

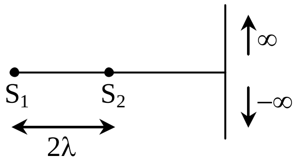
17. A charged particle of specific charge α mass with a velocity $\vec{v}=v_0\hat{i}$ in a magnetic field $\vec{B}=\frac{B_0}{\sqrt{2}}(\hat{j}+\hat{k})$, then
(A) Path of the particle is a helix
(B) Path of the particle is a ellipse
(C) Distance moved by the particle in time $t=\frac{\pi}{B_0\alpha}$ is $\frac{\pi v_0}{B_0\alpha}$
(D) Velocity of particle after the time t = $\frac{\pi}{B_0\alpha}$ is $\left(\frac{v_0}{2}\hat{i}+\frac{v_0}{2}\hat{j}\right)$

Space for Rough work

18. The shape of a wave propagating in positive X-direction or negative x-direction is given by, y = $\frac{1}{\sqrt{1+x^2}}$ at t = 0 and y = $\frac{1}{\sqrt{2-2x+x^2}}$ at t = 1 sec where x & y are in metres. The shape of wave disturbance does out hange during propagation. The velocity of wave is
(A) 1 m/sec in positive X-direction (B) 1 m/sec in negative X-direction
(C) $\frac{1}{2}$ m/sec in positive X-direction (D) $\frac{1}{2}$ m/sec in negative X-direction

19. A steel rod is 4 cm is diameter at 30º. A brass ring has an interior diameter 3.992 cm at 30ºC. In order that the ring just slides onto the steel rod, the common temperature of the two should be (α_{steel} = 11 × 10^{-6}/ºC & α_{brass} = 19 × 10^{-6}/ºC)
(A) 200ºC (B) 350ºC
(C) 280ºC (D) 300ºC

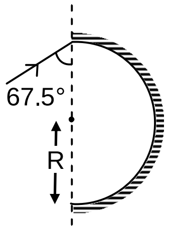
20. There are two source kept at distance of 2λ. A large screen is perpendicular to line joining the sources. Number of maximas on the screen in this case is (λ wavelength of light) [Excluding at ∞ and –∞]
(A) 1 (B) 3
(C) 5 (D) 7



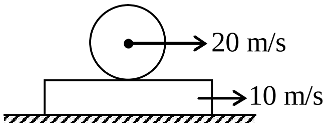
SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

21. A Ray incident on a spherical mirror which subtends an angle θ on its center of curvature where θ is slightly greater than 180°. Find number of reflection that may occurs before the ray comes out of the mirror. (including the first reflection)



22. A solid cylinder is rolling without slipping on a plank which also moving with speed 10 m/s on a horizontal surface as shown. The speed of centre of cylinder is 20 m/s. The mass of cylinder is 2 kg. The kinetic energy of the cylinder when observed from ground is 90 nJ. Then find value of n.



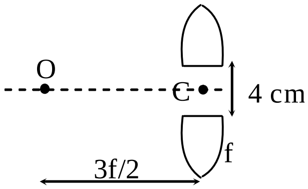
Space for Rough work

SECTION – C

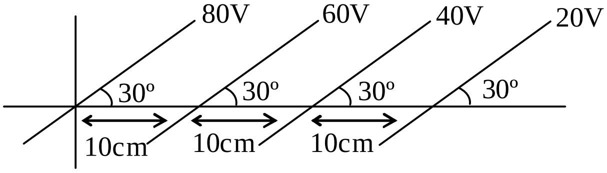
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

23. A split lens has two parts separated by 4 cm and focal length is f. An object is placed at a distance 3f/2 from C as shown in figure. The distance between the images formed by the two halves (in cm) is.



24. In a space, equipotential surfaces are shown below.



Then electric field in the space is

25. In an α - decay, the kinetic energy of α -particle is 48 MeV and Q value of the reaction is 50 MeV. The mass number of the mother nucleus will be (assume that daughter nucleus is in ground state).

Space for Rough work

Chemistry

PART – II

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

26. A beer has pH of 4.3. What is the $[H_3O^+]$?

(A) 3×10^{-4}	(B) 2×10^{-4}
(C) 3×10^{-5}	(D) 5×10^{-5}

27. In the given plot of lnKeq versus 1/T: (T = temperature) for a reaction is shown below the reaction must be

(A) exothermic	(B) endothermic
(C) one with negligible enthalpy change	(D) highly spontaneous at ordinary temperature

28. Which gas shows real behaviour?
(A) 16 g O_2 at 1 atm and 273 K occupies 11.2 L
(B) 1 g H_2 in 0.5 L flask exerts pressure of 24.63 atm at 300 K
(C) 1 mole NH_3 at 300 K and 1 atm occupies volume 22.4 L
(D) 5.6 of CO_2 at 1 atm and 273 K is equal to 11 gm

29. Which set of quantum numbers is impossible for an electron?

(A) n = 1, l = 0, ml = 0, ms = +1/2	(B) n = 9, l = 7, ml = –6, m_s = –1/2
(C) n = 2, l = 1, ml = 0, m_s = +1/2	(D) n = 3, l = 2, ml = –3, m_s = +1/2

30. Balmer gave an equation for wavelength for visible region of H – spectrum as $\lambda = \frac{Kn^2}{n^2 - 4}$ (n = principal quantum no.) then 'K' in terms of 'R'. (R = Rydberg constant)

(A) R	(B) R/2
(C) 4/R	(D) 5/R

31. Cadmium amalgam is prepared by electrolysis of a solution of $CdCl_2$ using a mercury cathode. How long should a current of "4A" be passed in order to prepare 10% by mass Cd in Cd – Hg amalgam on cathode of 4.5 g of Hg? (atomic mass of Cd = 112)

(A) 400 sec	(B) 215.40 sec
(C) 861.6 sec	(D) 430.8 sec

Space for Rough work

32. The value of $\frac{T_{0.875}}{T_{0.5}}$ for nth order of reaction is

(A) $2^{(2n-2)}$
(B) $2^{2(n-1)-1}$
(C) $\frac{8^{n-1}-1}{2^{n-1}-1}$
(D) none of these

33. When two mole of an ideal gas $\left(C_{p,m} = \frac{5}{2}R\right)$ heated from 300 K to at constant pressure, the change in entropy of gas (Δs) is

(A) $\frac{3}{2}R\ln 2$
(B) $-\frac{3}{2}(\ln 2)R$
(C) 5Rln2
(D) $\frac{5}{2}R\ln 2$

34. Which of the following layering pattern will have a void fraction of 0.26?

(A) ABCCBAABC
(B) ABBABBA
(C) ABCABCABC
(D) ABCAABCA

35. The $"O-\hat{N}-O"$ bond angle is maximum in

(A) NO_2
(B) NO_2^+
(C) NO_2^-
(D) NO_3^-

36. Which of the following are isoelectronic and isostructural?

(A) NO_3^-, CO_3^{2-}
(B) SO_3, NO_3^-
(C) ClO_3^-, CO_3^{2-}
(D) CO_3^{2-}, ClO_3^-

37. Which of the following statement is not correct

(A) bis (glycinato) zinc (II) is optically active
(B) $[NiCl_4]^{2-}$ and $[PtCl_4]^{2-}$ have different shape
(C) $[Ni(CN)_4]^{4-}$ is square planar complex
(D) $[Ni(CN)_4]^{2-}$ and $[Ni(CO)_4]$ have the same magnetic moment

38. In the alumino – thermite process, Al metal act as

(A) oxidizing agent
(B) reducting agent
(C) catalyst
(D) flux

Space for Rough work

39. Which of the given complex species is following E.A.N rule?

(A) $\left[Ca(EDTA)\right]^{2-}$
(B) $\left[Cr(en)_3\right]^{3+}$
(C) $K_3\left[COBr_2Cl_2(NO_3)_2\right]$
(D) $[Ni(dmg)_2]$

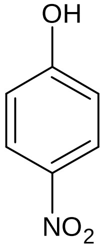
40. BHC and DDT act as

(A) carcinogens
(B) allergens
(C) asthmatic agents
(D) all of these

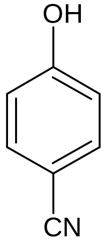
41. For this compound $\overset{+}{N}(Me)_3-CH_2CH_2I$, which form is most stable?

(A) anti form about C – C
(B) gauche form about C – C
(C) partially eclipsed about C – C
(D) fully eclipsed about C – C

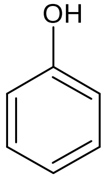
42. Correct order of acidic strength for the following compounds



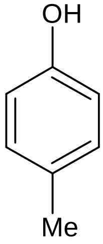
(i)



(ii)



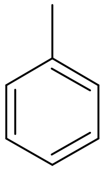
(iii)

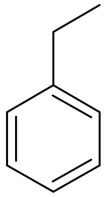


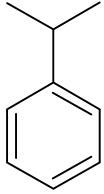
(iv)

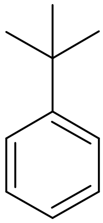
(A) i < ii < iii < iv
(B) ii > i > iii > iv
(C) i > ii > iv > iii
(D) i > ii > iii > iv

43. Correct order of stability for the following compound


(i)

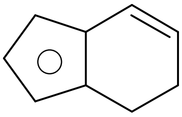

(ii)


(iii)

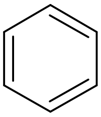

(iv)

(A) i > ii > iii > iv
(B) i < ii < iv < iii
(C) i > ii > iv > iii
(D) i < ii < iii < iv

Space for Rough work

44.  $\xrightarrow{\text{cold dil. KMnO}_4}$ product of the reaction is

(A) meso compound
(B) enantiomeric pair
(C) diastereomers
(D) optically pure enantiomer

45.  $\xrightarrow[\text{Liq.NH}_3]{\text{Na}}$ (A) $\xrightarrow[\text{Zn}]{O_3}$ (B) $\xrightarrow{Ph_3P = CH_3 \text{ (2 mole)}}$ (C)

Product (C) of the above reaction is
(A) 1, 3-hexadiene
(B) 1, 4-pentadiene
(C) 1, 3-butadiene
(D) 1, 3-heptadiene

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

46. Number of S – S bond in $H_2S_nO_6$ is 7 then what is the value of 'n' …

47. 10 ml of N – HCl, 20 ml of N/2 H_2SO_4 and 30 ml of N/3 HNO_3 are mixed together and volume made to 2 litre. The normality of H^+ in the resulting solution 'x' then $\frac{200x}{N} = ?$

Space for Rough work

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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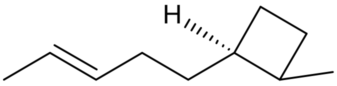
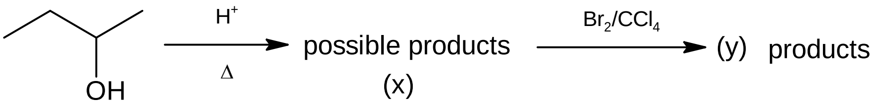
48. Total numbers of geometrical isomers of the following compound is x then x =?



49. How many carbon-hydrogen bond orbitals are available for overlap with the vacant p-orbital in ethylcarbocation?

50.



The number of possible products for x and y is z and w then “z + w” equal to …

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

51. $3\tan^6\left(\frac{\pi}{18}\right)-27\tan^4\left(\frac{\pi}{18}\right)+33\tan^2\left(\frac{\pi}{18}\right)$ equals.

(A) 0 (B) 1
(C) 2 (D) 3

52. Consider the cubic equation
$x^3-(1+\cos\theta+\sin\theta)x^2+(\cos\theta\sin\theta+\cos\theta+\sin\theta)x-\sin\theta\cos\theta=0$ where x_1, x_2, x_3 are roots of cubic.
Number of values of θ in $[0, 2\pi]$ for which at least two roots are equal.

(A) 3 (B) 4
(C) 5 (D) 6

53. The number of positive integral solution of $x^4-y^4=3789108$

(A) 0 (B) 1
(C) 2 (D) 4

54. If p, q, r are the substatement with truth values, T, T, F then the statement.
$r\rightarrow(p\wedge\sim q)\vee(\sim q\wedge\sim r)$ will be

(A) True (B) False
(C) May be true or false (D) None of these

55. A void relation on set A is
(A) Reflexive (B) Symmetric and Transitive
(C) Reflexive and Symmetric (D) Reflexive and Transitive

Space for Rough work

56. All values of 'θ' between 0 and π which satisfy the equation $\cos\theta\cos2\theta\cos3\theta=\frac{1}{4}$ is

(A) $\frac{\pi}{8},\frac{\pi}{3},\frac{3\pi}{8},\frac{5\pi}{8},\frac{2\pi}{3},\frac{7\pi}{8}$ (B) $\frac{\pi}{8},\frac{\pi}{3},\frac{5\pi}{8},\frac{2\pi}{3},\frac{7\pi}{8}$

(C) $\frac{\pi}{8},\frac{\pi}{3},\frac{3\pi}{8},\frac{5\pi}{8},\frac{7\pi}{8}$ (D) None of these

57. Let $f:R\to R$ and $g:R\to R$ be two one – one onto functions such that they are mirror image of each other about y = 0 then $h(x)=f(x)+g(x)$ is:-

(A) One – One and onto (B) One – One but not, onto

(C) Not one one but onto (D) Neither one – one nor onto

58. If $\sum_{i=1}^{2n}\sin^{-1}x_i=n\pi$ then $\sum_{i=1}^{2n}x_i$ is

(A) n (B) 2n

(C) 4n (D) 0

59. $\lim_{n\to\infty}\frac{n^k\cos n!}{n+1};\ (0<k<1)=$

(A) 0 (B) 1!

(C) 2! (D) None of these

60. Let $f(x)=\sqrt{\sin^{-1}x}+\sqrt{\cos^{-1}x}$ defined, In$[0,1]$ then

(A) $f(x-3)$ will be continuous, In$[3,4]$ (B) $f(x-3)$ will be continuous, In$[0,1]$

(C) $f(x-3)$ will be continuous, In$[0,1)$ (D) $f(x-3)$ will be continuous, In$(0,1)$

61. If $\sqrt{1-x^6}+\sqrt{1-y^6}=a^3\left(x^3-y^3\right)$ then $\frac{dy}{dx}$ is

(A) $\frac{x^2}{y^2}\sqrt{\frac{1-x^6}{1-y^6}}$ (B) $\frac{y^2}{x^2}\sqrt{\frac{1-y^6}{1-x^6}}$

(C) $\frac{x^2}{y^2}\sqrt{\frac{1-y^6}{1-x^6}}$ (D) $\frac{y^2}{x^2}\sqrt{\frac{1-x^6}{1-y^6}}$

Space for Rough work

62. Let f(x) = $1+x^m(x-1)^n$ where m, n then In (0, 1) the equation $f'(x)=0$ has
(A) No root
(B) At least one root
(C) At most one root
(D) Exactly one

63. For the curve $\frac{c^4}{r^2}=\frac{a^2}{\sin^2\theta}+\frac{b^2}{\cos^2\theta}$, the maximum value of r is
(A) $\frac{c^2}{a+b}$
(B) $\frac{a+b}{c^2}$
(C) $\frac{c^2}{a-b}$
(D) $c^2(a+b)$

64. Let $L=\prod_{n=3}^{\infty}\left(1-\frac{4}{n^2}\right)$; $M=\prod_{n=2}^{\infty}\left(\frac{n^3-1}{n^3+1}\right)$ and $N=\prod_{n=1}^{\infty}\frac{\left(1+n^{-1}\right)^2}{\left(1+2n^{-1}\right)}$ then value of $L^{-1}+M^{-1}+N^{-1}$
(A) 6
(B) 8
(C) 10
(D) 12

65. $\sin\frac{\pi}{900}\left\{\sum_{r=1}^{10}(r-\omega)(r-\omega^2)\right\}=\{\text{where '}\omega\text{' is cube root of unity}\}$
(A) 0
(B) $\frac{1}{2}$
(C) 1
(D) $\frac{1}{\sqrt{2}}$

66. Let A, B, C are three mutually independent events, consider two statements S_1 and S_2
S_1: A and $B\cup C$ independent
S_2: A and $B\cap C$ independent
Then
(A) Both S_1 and S_2 are true
(B) Only S_1 is true
(C) Only S_2 is true
(D) Both S_1 and S_2 are false

Space for Rough work

67. A bag constants 12 pair of socks, 4 socks are drawn of random. The probability that there is at least one pair is

(A) $\frac{7}{25}$ (B) $\frac{40}{161}$

(C) $\frac{41}{161}$ (D) $\frac{8}{25}$

68. If A is a square matrix of order 3, then correct statement is

(A) det (-A) = - det A (B) det (-A) = 0

(C) det (-A + I) = I + det (A) (D) det (2A) = 2 det A

69. If $\vec{p}, \vec{q}, \vec{r}$ be three mutually perpendicular vectors of same magnitude. If a vector $\vec{x}$ staties the equation

$\vec{p}\times\left(\left(\vec{x}-\vec{q}\right)\times\vec{p}\right)+\vec{q}\times\left(\left(\vec{x}-\vec{r}\right)\times\vec{q}\right)+\vec{r}\times\left(\left(\vec{x}-\vec{p}\right)\times\vec{r}\right)=0$ then $\vec{x}$ is given by

(A) $\frac{1}{2}\left(\vec{p}\times\vec{q}\times-2\vec{r}\right)$ (B) $\frac{1}{2}\left(\vec{p}+\vec{q}+\vec{r}\right)$

(C) $\frac{1}{3}\left(\vec{p}+\vec{q}+\vec{r}\right)$ (D) $\frac{1}{3}\left(2\vec{p}+\vec{q}-\vec{r}\right)$

70. The value of $\int\frac{dt}{t^2+2xt+1}\left(x^2>1\right)$is

(A) $\frac{1}{\sqrt{1-x^2}}\tan^{-1}\left(\frac{t+x}{\sqrt{1+x^2}}\right)+C$ (B) $\frac{1}{2\sqrt{x^2-1}}\log\left(\frac{t+x-\sqrt{x^2-1}}{t+x+\sqrt{x^2-1}}\right)+C$

(C) $\frac{1}{2}\log\left(t^2+2xt\right)+C$ (D) None of these

Space for Rough work

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

---

71. The reflection of curve xy = 1 the line y = 2x is the curve $12x^2 - rxy + 5y^2 + t = 0$ then value of r is

72. The least value of $2\log_{100} a - \log_a 0.0001, a > 1$ is

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

73. If $L = \lim_{x \to 0} \frac{ae^x - \cos 2x + \sin bx}{x^2}$ exists and is infinite then value of L is

74. Number of ways of arranging the letters of word ALGEBRA in which either vowels or constant, but not both appear in alphabetical order is.

75. In a right angled isosceles triangle, orthocenter is (2, –3) and circumcenter is 9–1, 1). The radius of the circle scribed in it is. (Take $\sqrt{2} = 1.414$)

Space for Rough work

FIITJEE

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CONCEPT RECAPITULATION TEST – III

JEE (Main)-2020

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. D

Sol. $T_1 = \frac{2\pi R}{v_0}$

$T_2 = \sqrt{\frac{2h}{g}}$

$N = \sqrt{\frac{2h}{g}} \times \frac{v_0}{2\pi R}$

2. D

Sol. $Kx = \frac{N}{\sqrt{2}} = mg$

$x = \frac{mg}{K}$

3. B

Sol. Let *x* be the depth of point *P* from surface

App. depth of point *P* from surface = $\frac{x}{\mu}$

App. depth of image of P from surface = $\frac{x+2h}{\mu}$

So, separation between two = $\frac{x+2h}{\mu} - \frac{x}{\mu}$

$\Rightarrow \frac{2h}{\mu}$

4. B

Sol. $\Delta Q = \Delta U + W$

$nCdT = nCvdT + PdV$

$$C = C_V + P\frac{dV}{dT} \qquad \ldots(1)$$

$$P = 2P_0 + \frac{2P_0}{V_0}(V - V_0)$$

$$= 2P_0 + \frac{2P_0V}{V_0} - 2P_0$$

$$P = \frac{2P_0V}{V_0}$$

$PV = RT$

$$\frac{RT}{V} = \frac{2P_0V}{V_0}$$

$$RT = \frac{2P_0}{V_0}V^2$$

$$\frac{dT}{T} = \frac{2dV}{V}$$

$$\frac{dV}{dT} = \frac{V}{2T} \qquad \ldots(2)$$

from (1) and (2)

$$C = \frac{3R}{2} + \frac{nRT}{V} \times \frac{V}{2T}$$

$$\Rightarrow \frac{3R}{2} + \frac{R}{2} \Rightarrow 2R$$

5. C

Sol. Resistance across capacitor,

$$R = \frac{4\times8}{4+8} = \frac{32}{12}\Omega$$

$\tau_C = CR = 16\ \mu$ sec

$$i = i_0e^{-t/\tau c} = \left(\frac{160/6}{32/12}\right)e^{-t/\tau c} \qquad \Rightarrow 10\,e^{-t/\tau c}$$

After $t = \tau_c$, $i = \frac{10}{e}A$

This is distributed in inverse ratio of resistance,

$$i_{1\Omega} = \frac{2}{3}\left(\frac{10}{e}\right) = \frac{20}{3e}\text{A}$$

6. A

Sol. $Mg = 2T\cos\theta$

$T = mg$

7. C

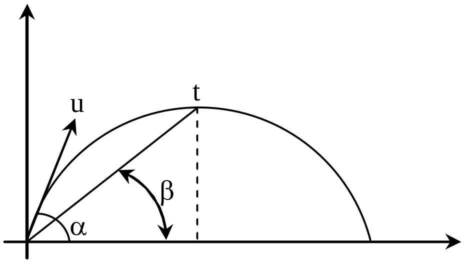
Sol. $P_{KE} = \frac{1}{2}m(2v)^2 = 2mvR$

KE of S = $\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 \Rightarrow \frac{3}{4}mv^2$

$\frac{(KE_P)}{(KE_S)} = \frac{8}{3}$

8. B

Sol. $\tan\beta = g/x = \frac{\mu\sin\alpha t - 1/2gt^2}{\mu\cos\alpha t} = \tan\beta$



$\sin\alpha - \tan\beta . u\cos\alpha = gt/2$

$u = \frac{gt\cos\beta}{2\sin(\alpha-\beta)}$

9. B

Sol. $Kx = 2g$; $x = \frac{2g}{k} = \frac{1}{2}$

$mgx = \frac{1}{2}kx^2 + \frac{1}{2}mv^2$

$v = \sqrt{2gx - \frac{kx^2}{m}} = 2\sqrt{2}$

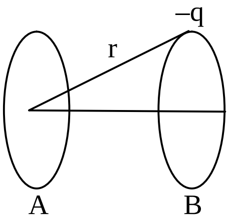
10. B

Sol. $\int \Delta P = \int Fdt$

$P_2 - P_1 \Rightarrow F\int_0^t dt$

11. C

Sol. $V_A = V_1 + V_2$



$V_A = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{R} - \frac{1}{\sqrt{R^2+a^2}}\right)$

$V_B = \frac{q}{4\pi\varepsilon_0}\left[-\frac{1}{R} + \frac{q}{r}\right]$

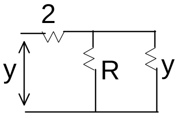
$$V_A - V_B = \frac{2q}{4\pi\varepsilon_0}\left(\frac{1}{R} - \frac{1}{\sqrt{R^2 + a^2}}\right)$$

12. C

Sol. $B = \frac{\mu_0}{4\pi}\frac{1^0}{d}(\sin\alpha + \sin\beta)$

13. C

Sol.



$y = \frac{Ry}{R+y} + 2R$

& $x = \frac{Ry}{R+y}$

14. B

Sol. $\vec{v}_{1m} = -m^2\ \vec{v}_{0m}$ (along x-axis)

$\vec{v}_{1m} = m\,\vec{v}_{0m}$ (along y-axis)

The Range of projective will be

Range = $\frac{v^2 \sin 2\theta}{g} = \frac{(gR)\sin 90°}{g} = R$

So particle will at 3f from pole of mirror with velocity $\frac{-v}{\sqrt{2}}\hat{i} - \frac{v}{\sqrt{2}}\hat{j}$

15. A

Sol. Here the string is fixed at both the ends so equation of standing wave as a function of distance is given, y = A sin x

where A is maximum amplitude

2 = 4 sin kx & kx = $\frac{\pi}{6}$ and $\frac{5\pi}{6}$

Where k = $\frac{2\pi}{\lambda}$ & λ = 300 cm.

$\frac{2\pi}{\lambda}x_1 = \frac{\pi}{6} \Rightarrow \frac{2\pi}{300}x_1 = \frac{\pi}{6} \Rightarrow x_1 = 25$ cm

$\frac{2\pi}{\lambda}x_2 = \frac{5\pi}{6} \Rightarrow \frac{2\pi}{300}x_2 = \frac{5\pi}{6} \Rightarrow x_2 = 125$ cm

So, separation between two points = 125 – 25

= 100 cm

16. D

Sol. I = $\frac{dq}{dt}$

q = it + a

V = $\frac{q}{C}$

V = $\frac{it + a}{C}$

$\therefore$ V is proportional to time.

17. C

Sol. $\vec{V} \perp \vec{B}$ Therefore path of particle is a circle. In magnetic field speed to particle of remains constant. Therefore distance moved by particle in time t = $\frac{\pi}{B_0\alpha}$ is v_0t or $\frac{\pi v_0}{B_0\alpha}$ and magnitude of velocity is always v_0.

18. A

Sol. y = f(ax ± bt) is general wave equation

At t = 0, y = $\frac{1}{\sqrt{1+x^2}}$

At t = 1, y = $\frac{1}{\sqrt{2-2x+x^2}} = \frac{1}{\sqrt{1+(x-1)^2}}$

Here a = 1 and b = 1

wave velocity, v = $\frac{b}{a}$ = 1 m/sec towards +ve x.

19. C

Sol. $4[1 + 11 \times 10^{-6}\,\Delta\theta] = 3.992[1 + 19 \times 10^{-6}\Delta\theta]$

$\Delta\theta = 250^\circ C$

So $\theta = 250 + 30 = 280^\circ C$

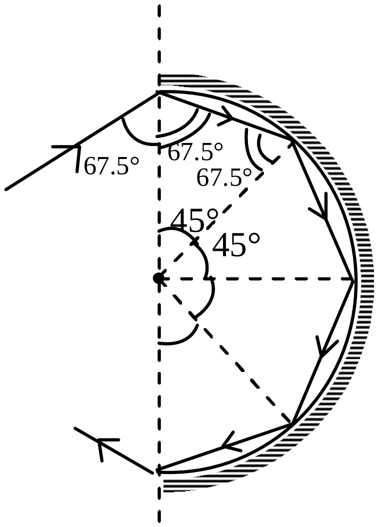
20. B

Sol. Excluding at ∞ and $-\infty$, one maxima will be observed at symmetrical position and one each over both this central one.

SECTION – B

21. 5

Sol.



22. 5

Sol. Velocity of centre of mass of cylinder w.r.t. plank, $v_{cp} = 20 - 10 = 10$ m/s

We have $v_{cp} = R\omega \Rightarrow \omega = \frac{10}{R}$

Kinetic energy KE = $\frac{1}{2}mv_{cm}^2 + \frac{1}{2}I\omega^2$

$= \frac{1}{2} \times 2 \times 400 + \frac{1}{2} \times 2 \times \frac{R^2}{2} \times \frac{100}{R^2}$

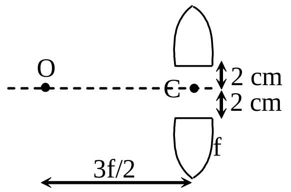
= 450 J

i.e. $\boxed{n = 5}$

SECTION – C

23. 00006.00

Sol.



For upper part of lens

$u = -\frac{3f}{2}$, $h_0 = 2$ cm

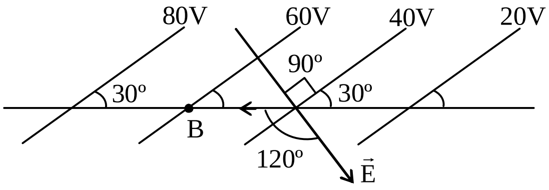
$m = \frac{h_i}{h_0} = \frac{f}{f + \left(\frac{-3f}{2}\right)} = 0.5$

$h_i = 2 \times 0.5 = 1$ cm

i.e. image is formed at a height of 3 cm (i.e. 2 + 1) from main principle axis. (above principle axis) Similarly for lower part, image is formed 3 cm below main principle axis. Hence distance between image = 3 + 3 = 6 cm.

24. 00400.00

Sol. Electric field lines are perpendicular to equipotential surfaces and electric potential decreases along electric field.



From A → B

$| dV | = -E\,dr \cos 120^\circ$

$20 = E \times (10 \times 10^{-2}) \times \frac{1}{2}$

E = 400 N/C

25. 00100.00

Sol. Let, ${}^{A}_{Z}X \rightarrow {}^{A-4}_{A-2}Y + {}^{4}_{2}He$

$$K_\alpha = \frac{m_y}{m_y + m_\alpha}Q = \frac{A-4}{A}Q$$

$$48 = \frac{A-4}{A} \times 50 \Rightarrow A = 100$$

Chemistry PART – II

SECTION – A

26. D

Sol. $pH = -\log\left[H^+\right]$ and $\left[H^+\right] = \left[H_3O^+\right]$

27. A

Sol. in exothermic reaction $\Delta H < 0$

$$\ln K_{eq} = \ln K_0 - \frac{\Delta H}{RT}$$

28. C

Sol. for ideal gas 'v' at given T and P should be 24.63 L

29. D

Sol. m = - ℓ to ℓ

30. C

Sol. $\frac{1}{\lambda} = Rz^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \Rightarrow \frac{1}{\lambda} = Rz^2\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$

31. B

Sol. no. of equivalent of substance deposite or liberated = change passed in faraday
Since 10% Cd by mass with 4.5 gm of Hg i.e. 90%

$$\therefore 10\% = \frac{4.5}{90} \times 10 = 0.5 \text{ gm Cd}$$

32. C

Sol. $(n-1)K.t = \left(\frac{1}{A_t^{n-1}} - \frac{1}{A_0^{n-1}}\right)$

33. C

Sol. $\Delta S = n.c.p.\ln\frac{T_2}{T_1}$

34. C

Sol. F_{CC} has 0.26 as void fraction

35. B

Sol. $\theta = 180^o$

36. A

Sol. no. of e^- in $NO_3^- = 32 =$ no. of e^- in CO_3^{2-}

37. A

Sol. inactive due to pos

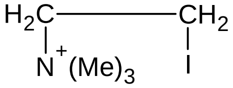
38. B

Sol. Al act as R.A

39. C
Sol. EAN = [atomic no. – O.S + 2 × L.P]

40. A
Sol. properties based

41. A
Sol. anti form is most stable



$$\begin{array}{ccc} H_2C & \text{———} & CH_2 \\ | & & | \\ \overset{+}{N}(Me)_3 & & I \end{array}$$

42. D
Sol. acidic strength ∝ stability of C.B

43. A
Sol. stability ∝ no. of ∝ - H

44. B
Sol. product having chiral centre

45. B
Sol. explanation ozonolysis

SECTION – B

46. 8
Sol. as (n – 1) = 7

47. 3
Sol. $x = \frac{3N}{2 \times 100} \therefore \frac{200x}{N} = 3$

SECTION – C

48. 00004.00
Sol. Here G.I generating system = 2, no. G.I. = 2^2 = 4

49. 00003.00
Sol. $CH_3 - C\overset{+}{H}_2$
∝H = 3

50. 00008.00
Sol. z = 3
w = 5 ∴ z + w = 8

Mathematics

PART – III

SECTION – A

51. B

Sol. $\tan\left(3\times\frac{\pi}{18}\right)=\frac{3\tan\left(\frac{\pi}{18}\right)-\tan^3\left(\frac{\pi}{18}\right)}{1-3\tan^2\left(\frac{\pi}{18}\right)}$

52. C

Sol. Roots are $\cos\theta, \sin\theta, 1$

$\cos\theta=1 \quad \Rightarrow 0, 2\pi$

$\sin\theta=1 \quad \Rightarrow \frac{\pi}{2}$

$\sin\theta=\cos\theta \quad \Rightarrow \theta=45^0, 225^0$

53. A

Sol. $\left(x^2-y^2\right)\left(x^2+y^2\right)=\underbrace{3789108}_{\downarrow}$

$(x-y)(x+y)\left(x^2+y^2\right)$ even

For LHS to be even, x and y both must be, even or both must be odd.

$\Rightarrow (x-y), (x+y), \left(x^2+y^2\right)$ must be even integer.

$\Rightarrow (x-y)(x+y)\left(x^2+y^2\right)$ must be divisible by 8.

But RHS is not divisible by 8.

No solution.

54. A

Sol. $F\to(T\wedge F)\vee(F\wedge T)$

$F\to(F\vee F)$

$F\to F=T$

55. B

Sol. It is a concept.

56. A

Sol. $4\cos\theta\cos2\theta\cos3\theta=1$

$\Rightarrow 2(\cos3\theta+\cos\theta)\cos3\theta=1$

$\Rightarrow 2\cos^2 3\theta+2\cos3\theta\cos\theta=1$

$\Rightarrow 1+\cos6\theta+\cos4\theta+\cos2\theta=1$

$\Rightarrow \cos4\theta(2\cos2\theta+1)=0$

$\Rightarrow 4\theta=(2n+1)\frac{\pi}{2}$

or $2\theta=2n\pi+\frac{2\pi}{3}$

$\theta=(2n+1)\frac{\pi}{8} \qquad \theta=n\pi\pm\frac{\pi}{3}$

θ between 0 & π

$\theta = \frac{\pi}{8}, \frac{\pi}{3}, \frac{3\pi}{8}, \frac{2\pi}{3}, \frac{5\pi}{8}, \frac{7\pi}{8}$

57. D

Sol. $g(x) = -f(x)$

$\therefore h(x) = 0$ which is many one into.

58. B

Sol. $-\frac{\pi}{2} \le \sin^{-1}{}_{xi} \le \frac{\pi}{2}$

so only possible if

$x_1 = x_2 = x_3 = ... = x2n = 1$

$\sum_{i=1}^{2n} xi = 2n$

59. A

Sol. $\lim_{n\to\infty} \frac{\cos n!}{(n^{1-l})\left(1+\frac{1}{n}\right)}$

$0 < k < 1$

$\Rightarrow k-1$ is negative

as $n \to \infty$

$-1 \le \cos n! \le 1 \Rightarrow$ finite

$n^{1-k} \to \infty$

$1+\frac{1}{n} \to 1$

so, $\lim_{n\to\infty} \frac{\cos n!}{n^{1-k}\left(1+\frac{1}{n}\right)}$

60. A

Sol. Replace $x \to x-3$

$f(x-3) = \sqrt{\sin^{-1}(x-3)} + \sqrt{\cos^{-1}(x-3)}$

$0 \le x-3 \le 1$

$3 \le x \le 4$

$xt[3, 4]$

61. C

Sol. $\sqrt{1-x^6} + \sqrt{1-y^3} = a^3\left(x^3 - y^3\right)$

put $x^3 = \sin\theta$ & $y^3 = \sin\theta$

62. D

Sol. $f(0) = 1, f(1)$

$f'(x) = 0$ must have at least one root in (0, 1)

$$f'(x) = x^{m-1}m(x-1)^n + nx^m(x-1)^{n-1}$$
$$= x^{m-1}(x-1)^{n-1}\left[(m+n)x-n\right]$$
$$x = 0, 1, \frac{m}{m+n}$$

63. A

Sol. $\frac{c^4}{r^2} = a^2\operatorname{cosec}2\theta + b^2\sec 2\theta$

$$r^2 = \frac{c^2}{\left(a^2\operatorname{cosec}2\theta + b^2\sec 2\theta\right)_{\min}}$$
$$= \frac{c^4}{(a+b)^2}$$
$$r_{\max} = \frac{c^2}{a+b}$$

64. B

Sol. $L = \prod_{n=3}^{\infty}\frac{n-2}{n}\times\frac{n+2}{n}$

$$\lim_{n\to\infty}\frac{1}{3}\times\frac{2}{4}\times\frac{3}{5}\times..........\times\frac{n-3}{n-1}\times\frac{n-2}{n}\times......\frac{n+1}{n-1}\times\frac{n+2}{n}$$
$$\lim_{n\to\infty}\frac{2\left(n^2+3n+2\right)}{l_2\left(n^2-n\right)} = \frac{1}{16}$$

Similarly find M & N also

$$L^{-1} = 6, M^{-1} = \frac{3}{2}, \ N^{-1} = \frac{1}{2}$$

65. C

Sol. $\sin\left\{\frac{\pi}{900}\left[\sum_{r=1}^{10}\left(r^2+r+1\right)\right]\right\}$

$$\Rightarrow \sin\left\{\frac{\pi}{900}\left[\frac{10\times11\times21}{6}+\frac{10\times11}{2}+10\right]\right\}$$
$$\sin\left(\frac{\pi}{900}\times450\right) = 1$$

66. A

Sol. Both S_1 & S_2 are true.

67. C

Sol. Total ways of choosing 4 socks out of 12 pair (24 socks) is = $24\times23\times22\times21$

The number of ways in which on pair is seteated = $24\times22\times20\times18$

The prob. of not getting a pair.

$$= \frac{24\times22\times20\times18}{24\times23\times22\times21} = \frac{120}{161}$$

Hence prob. of getting at least me pair.

$$1-\frac{120}{161} = \frac{41}{161}$$

68. A

Sol. Property of determinant

69. B

Sol. Let $\vec{p} = a\hat{i}, \vec{q} = a\hat{j}, \vec{r} = a\hat{k}$

let $\vec{x} = x\hat{i} + y\hat{j} + \hat{k}$

Put in given equation

70. B

Sol. $\int \frac{dt}{t^2 + 2xt + x^2 - x^2 + 1}$

$\int \frac{dt}{(t+x)^2 - (x^2-1)}$ $\quad \therefore x^2 > 1$

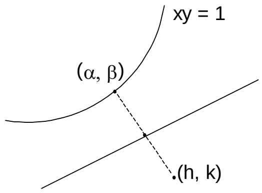
$= \frac{1}{2\sqrt{x^2-1}} \log\left(\frac{t+x-\sqrt{x^2-1}}{t+x+\sqrt{x^2-1}}\right) + C$

SECTION – B

71. 7

Sol.

$\frac{\beta+k}{2} = 2\left(\frac{\alpha+h}{2}\right)$.........(i)



$\frac{k-\beta}{h-\alpha} = -\frac{1}{2}$ ......(ii)

from (i) & (ii)

$\alpha = \frac{4k-3h}{5} \Big| \beta = \frac{4h+3k}{5}$

$\alpha\beta = 1$ get curve.

72. 4

Sol. $\log_{10}^{\alpha} - \log_{a}^{10^{-4}}$

$\frac{\log_{10}^{a} + 4\log_{a}^{10}}{2} \geq (4)^{\frac{1}{2}}$

SECTION – C

73. 00002.50

Sol. $a - 1 = 0 \Rightarrow a = 1$

$$L = \lim_{x\to 0} \frac{ae^x + 2\sin 2x + b\cos bx}{2}$$

$1 + b = 0 \Rightarrow b = -1$

$$L = \lim_{x\to 0} \frac{ae^x + 4\cos 2x - b^2 \sin bx}{2} = \frac{a+4}{2} = \frac{5}{2} = 2.5$$

74. 00943.00

Sol. $^7P_4 \times 1 + \frac{^7P_3}{2} \times 1 - 2 = 943.$

75. 00002.07

Sol. $R = SH = 5$

sides are $5\sqrt{2}, 5\sqrt{2}, 10$

$r = \frac{\Delta}{S}$

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – IV

JEE (Advanced)-2020

PAPER – 1

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section–A (01 – 04, 19 – 22, 37 – 40)*** *contains 12 multiple choice questions which out of 4 options have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (05 – 12, 23 – 30, 41 – 48) *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*

   *Negative Marks : **–1** In all other cases.*

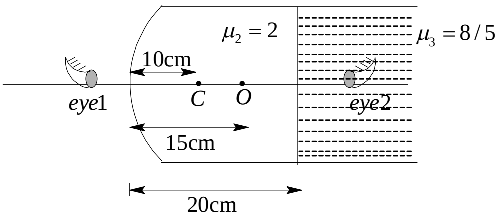
2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics PART – I

SECTION – A
(One Options Correct Type)

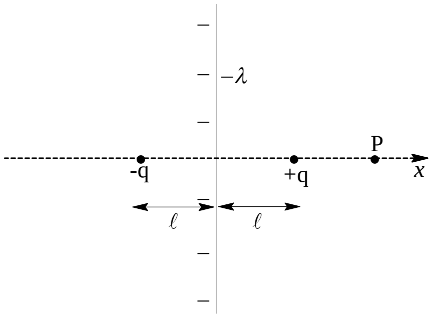
This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. The separation between the images seen by the two eyes of the object O is (C is centre of curvature):



(A) 4cm
(B) 10cm
(C) 11cm
(D) 14cm

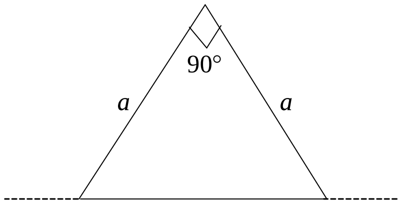
2. An infinite line charge is placed along y-axis and two point charges are placed on the x-axis as shown in the figure. Find x for which field on the positive x-axis is zero $(x >> \ell)$ and $\frac{q\ell}{\lambda} = 2$:



(A) 2
(B) 1
(C) $\frac{1}{2}$
(D) 4

3. A wooden block is partially submerged in a liquid contained in a vessel. Now the vessel is suddenly accelerated upwards with constant acceleration. Then:
(A) Volume of block submerged will start to increase
(B) Volume of block submerged will start to decrease
(C) Buoyant force will increase
(D) Buoyant force will decrease

4. The moment of inertia of an isosceles triangular plate of mass m and side a about an axis through the side shown in the figure is:



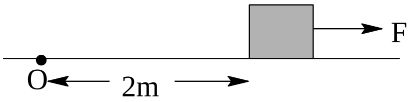
(A) $\frac{ma^2}{6}$
(B) $\frac{2ma^2}{3}$
(C) $\frac{ma^2}{4}$
(D) $\frac{ma^2}{12}$

Space for Rough work

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

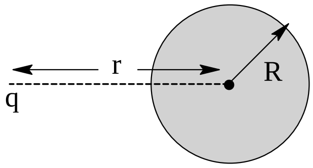
5. A cube of side 1m and mass 1kg is pulled by a force F acting along the central line so that it slides with an acceleration of 1 m/s^2 on a rough surface $(\mu = 0.1)$. Consider a point **O** on the rough surface. Then



(A) Torque of force F about O is 1N-m
(B) Torque of force F about O is $\frac{1}{2}\text{N-m}$
(C) Torque of all forces acting on the cube about O is $\frac{1}{2}\text{N-m}$
(D) Torque of all forces acting on the cube about O is 1N-m

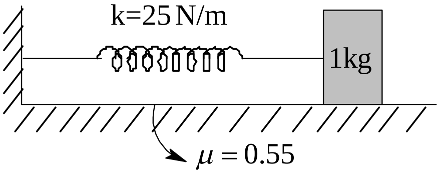
6. In case of walking on a rough surface:
(A) Friction force acts in the direction of motion
(B) Friction force acts opposite to the direction of motion
(C) Change in kinetic energy is due to work done by friction
(D) Change in kinetic energy is due to work done by internal forces.

7. A point q is placed outside an uncharged conducting sphere as shown in the figure. Then:



(A) The potential of the sphere is zero.
(B) The potential of the sphere is $\frac{kq}{r}$
(C) If the sphere is earthed charge appearing on its surface is $\frac{R}{r}(-q)$
(D) If the sphere is earthed charge appearing on its surface is $\frac{r}{R}(-q)$

Space for Rough work



8. One end of a spring of force constant 25 N/m is connected with a block of mass 1kg and the other end is fixed to a vertical wall. The block is given velocity 6 m/s towards the wall (when the spring is in natural length) on a horizontal rough surface having coefficient of friction 0.55. Then:
(A) The compression in the spring when the block stops momentarily for the Ist time is 1m.
(B) The compression in the spring when the block stops momentarily for the Ist time is 0.5m.
(C) The acceleration of the block when it stops momentarily for the IInd time is 12.5m/s^2
(D) The acceleration of the block when it stops momentarily for the IInd time is 8.5m/s^2

9. If the face of a woman is 8.5 inches wide, distance between pupil of her two eyes is 2.5 inches and top of head to chin seperation is 9 inches. Then the minimum dimension of a rectangular mirror so that she can see her complete face is:
(A) Height $= 4.5\,\text{inches}$ (B) Height $= 2.25\,\text{inches}$
(C) Width $= 3\,\text{inches}$ (D) Width $= 3.5\,\text{inches}$

10. A two particle system of masses 2 kg and 3 kg present at (15, 0) and (0, 20) in a x, y plane then its centre of mass lies on lines:
(A) $y = 2x$ (B) $\frac{x}{12} + \frac{y}{24} = 1$
(C) $3x - y = 6$ (D) $y = x$

11. If a cylinder performs rolling without slipping on a horizontal accelerated rough plank. Then:
(A) The mechanical energy of cylinder is conserved
(B) The mechanical energy of cylinder is not conserved.
(C) The mechanical energy of the system of plank and cylinder is conserved.
(D) The mechanical energy of the system of plank and cylinder is not conserved.

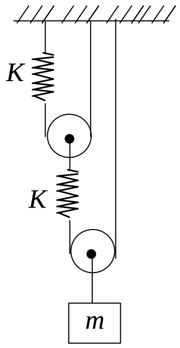
12. Two particles are projected from a horizontal plane with the same initial velocity v_0 at two different angles of projection θ_1 and θ_2, such that their ranges are the same. The ratio of their maximum heights reached is:
(A) $\tan^2\theta_1$ (B) $\theta = 60°$
(C) $t = \frac{20}{\sqrt{3}} s$ (D) $t = \frac{10}{\sqrt{3}} s$

Space for Rough work

SECTION – C
(Numerical Answer Type)

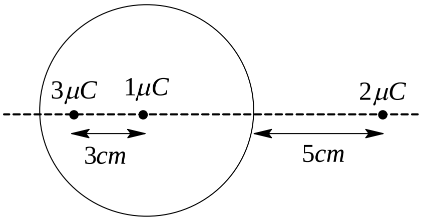
This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

13. A block of mass hangs in equilibrium with the help of two spring as shown in the figure. Find the time period of vertical oscillation of the block. Take m = 10kg and $K = 50N/m$: (in second)



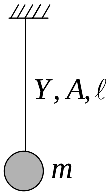
14. In an experiment for calculation of focal length of convex lens the distance between a screen and an object is 120 cm. A convex lens is placed close to the object and is moved along the line joining object and screen, towards the screen. If the ratio of magnification of two real images is $1:16$ then find the focal length of the convex lens: (in cm)

15. A spherical conducting shell of radius 5 cm is having a point charges placed inside and outside the shell as shown in figure. Find the electric force on $1\mu C$ at the centre due to induce charges on the outer surface of shell (in Newton)

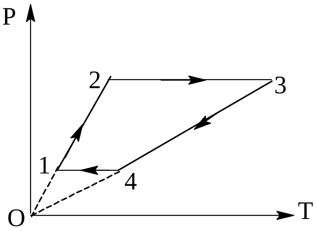


Space for Rough work

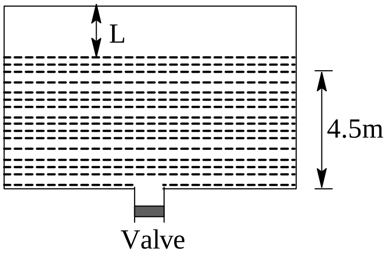
16. A spherical ball is hanging from an elastic rubber wire of young modulus Y, length ℓ and area A as shown in the figure. Find the time period of small vertical oscillations of the bob.
[Take $Y=10^6 N/m^2, A=1mm^2, \ell=1m$ and $m=1kg$]



17. Three moles of an ideal monoatomic gas performs a cyclic process as shown in the figure. The temperature in different states are $T_1 = 400k;\ T_2 = 800k,\ T_3 = 2400k$ and $T_4 = 1200k$. Determine the work done by the gas during the cycle (in KJ) [Given $R = 8.31 J/mole - KJ$]



18. The vertical water tank, shown has uniform cross section, closed at the top and initial level of water in it is 4.5 m from bottom. The empty space of length L contains air at atmospheric pressure (10^5 Pa), that can be considered as an ideal gas. When the value at the bottom is opened, the level of water decreases by 0.5 m when the flow of water ceases through valve remains opened. Neglecting any variation in temperature during the process, find initial length of empty space L in cm. ($g = 10 m/s^2$, density of water = 1000 kg/m^3)



Space for Rough work

Chemistry

PART – II

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

---

19. Which of the following ion is most stable in aq. solution?

(A) NH_4^+
(B) H_2F^+
(C) H_2O^+
(D) CH_5^+

20. What are the possible oxidation state(s) of the Cr in the complex $K_2\left[Cr(NO)(NH_3)(CN)_4\right]$.

Given (magnetic moment) $\mu = 1.73\ BM$.

(A) +2
(B) +3
(C) +1
(D) All are possible

21. Which of the following statements concerning a weak acid-strong base titration is true?

(A) The pH after the equivalence point of the weak acid strong base titration is determined by using the K_b expression for the conjugate base
(B) A buffer solution of the weak acid and its conjugate base is formed before the equivalence point is reached
(C) The pH at the equivalence point of a weak monoprotic acid strong base titration is equal to the pH at the equivalence point of a strong acid-strong base titration
(D) The increase in pH in the region near the equivalence point of the weak acid strong base titration is greater than the pH change in the same region of a strong acid strong base titration

22. A hypothetical reaction

$A_2 + B_2 \longrightarrow 2AB$ Follows mechanism as given below:

$$A_2 \underset{k_b}{\overset{k_c}{\rightleftharpoons}} A + A \text{...............}(\text{fast})$$

$$A + B_2 \xrightarrow{k_1} AB + B \text{...............}(\text{slow})$$

$$A + B \xrightarrow{k_2} AB \text{...............}(\text{fast})$$

The order of overall reaction is

(A) 2.5
(B) 1
(C) 3/2
(D) zero

Space for Rough work

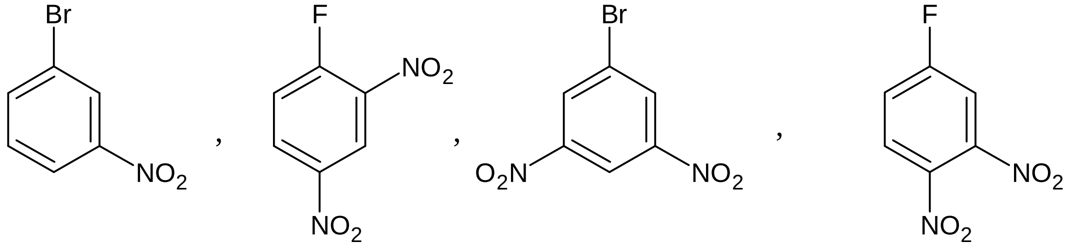
(One or More than one correct type)

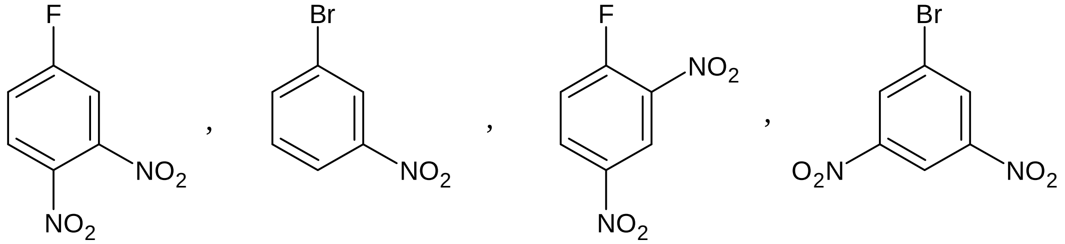
This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

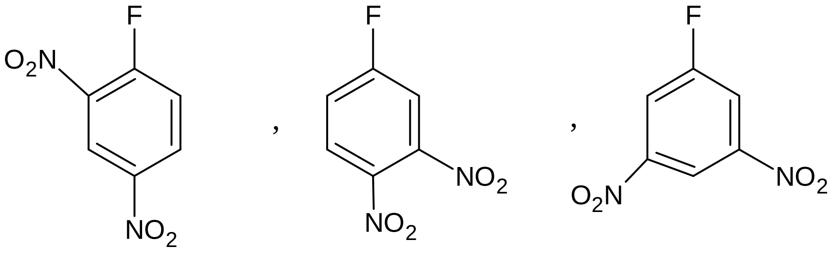
---

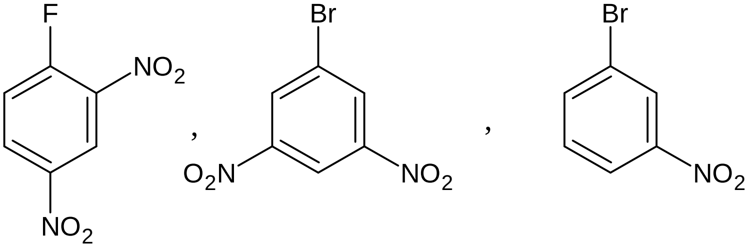
23. Which of the following statement is/are true?
(A) Alkali metals are soft metals and softness increases down the group
(B) Lattice energy of alkali metal salts with same anion decreases with increase in size of cations
(C) Paramagnetic character of $\mathrm{Na - Liq\ \ NH_3}$ solution decreases in increase in the conc. of $\mathrm{NH_3}$
(D) LiF has lowest solubility among all alkali metal halides

24. Which of the following correctly ranks the aryl halides in decreasing order of reactivity toward sodium methoxide in methanol?

(A)

Br
NO2
,
F
NO2
NO2
,
Br
O2N
NO2
,
F
NO2
NO2

(B)

F
NO2
NO2
,
Br
NO2
,
F
NO2
NO2
,
Br
O2N
NO2

(C)

F
O2N
NO2
,
F
NO2
NO2
,
F
O2N
NO2

(D)

F
NO2
NO2
,
Br
O2N
NO2
,
Br
NO2

Space for Rough work

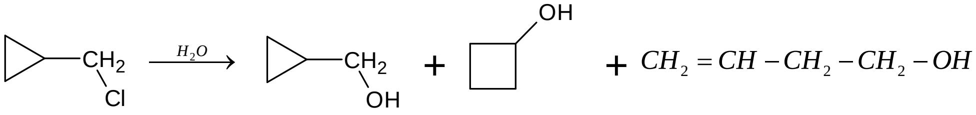
25. The solubility of alkaline earth metal salts in water decreases down the group, the salts are
(A) phosphates
(B) sulphates
(C) carbonates
(D) hydroxides

26. In the extraction of Li, a mixture of dry lithium chloride and potassium chloride is fused and electrolysed, the following fact(s) is/are correct regarding this
(A) KCl increases the conductivity
(B) M.P. of LiCl lowers due to presence of KCl
(C) Reduction potential of Li^+ is higher than K^+ in fused state
(D) Reduction potential of Li^+ is lower than K^+ in fused state

27. Which of the following is/are not a characteristic of effusion/diffusion?
(A) The rate of effusion/diffusion is inversely proportional to average speed of the gas particles
(B) Gases mix as a result of the random motion and frequent collision of gas particles
(C) The rate of effusion/diffusion decreases with increasing temperature
(D) Rate of effusion/diffusion is directly proportional to molar mass of the gas

28. Which of the following is/are characteristic of a tetrahedral complex?
(A) the $d_{x^2-y^2}$ and d_{z^2} orbitals are the low energy orbitals
(B) most tetrahedral complex are high spin
(C) crystal filed splitting is about twice found in octahedral complexes
(D) the splitting pattern is just opposite of that in octahedral complexes

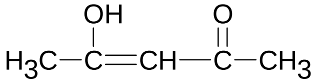
29. Which product/s is/are possible?

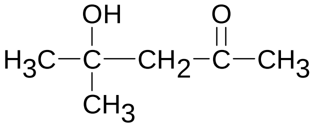


A B C

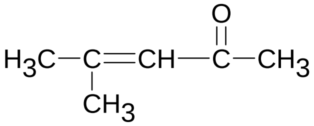
(A) A
(B) B
(C) C
(D) none of these

30. When one equivalent of CH_3MgBr is treated with $CH_3COCH_2COCH_3$ and subsequently acid hydrolysed. Which of the following compounds may be formed/present in the solution/container?

(A) 
$H_3C-C(OH)=CH-C(=O)-CH_3$

(B) 
$H_3C-C(OH)(CH_3)-CH_2-C(=O)-CH_3$

(C) CH_4

(D) 
$H_3C-C(CH_3)=CH-C(=O)-CH_3$

Space for Rough work

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

31. One mole of an ideal gas is expanded isothermally at 298 K until its volume is tripled. Find the value of ΔS_{sys} (entropy of system) if the expansion is a free expansion (in vacuum). Given (log3= 0.477 R = 8.3 $JK^{-1}mol^{-1}$). Give your answer in JK^{-1} upto two decimals only.

32. Gold metal is extracted from its ore by treating the crushed rock with an aerated cyanide solution. The unbalanced equation for the reaction is

$Au(s) + CN^-(aq) + O_2(g) \rightarrow Au(CN)_2^-(aq)$

Use any of the following data at 27^oC to calculate ΔG° for this reaction in basic solution.

Given K_f for $Au(CN)_2^- = 10^{38}$

$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(\ell)$ $E^\circ = 1.2$ V

$Au^{3+}(aq) + 3e^- \rightarrow Au(s)$ $E^\circ = 1.5$ V

$Au^{3+}(aq) + 2e \rightarrow Au^+$ $E^\circ = 1.5$ V

Use equation $\Delta G^\circ = -2RT\log_{10}Q$ and R = 8 $Jmol^{-1}K^{-1}$, F = 96500 C. Give your answer (magnitude only) in kJ.

33. At certain temperature the dissociation constants of formic acid and acetic acid are 1.8×10^{-4} and 1.8×10^{-5} respectively. The concentration of acetic acid solution(molarity) in which the hydrogen ion has the same concentration as 0.001 M formic acid solution is equal to

Space for Rough work

34. If 250 ml O_2 over water at 30°C and a total pressure of 740 torr is mixed with 300 ml of N_2 over water at 25^oC at total pressure of 780 torr. What will be total pressure if the mixture is in a 500 ml vessel over water at 35°C. (Given aq. tension of water at 25^oC, 30^oC and 35^oC are 23.8, 31.8 and 42.2 torr.)

35. The solubility product of $Co_2\left[Fe\left(CN\right)_6\right]$ in water is $K\times10^{-16}$. The value of K is

Given $\lambda^{\circ}_{m}Co^{+2} = 80\Omega^{-1}\ cm^{-1}\ mol^{-1}$

$\lambda^{\circ}_{m}[Fe(CN)_6]^{-4} = 40\Omega^{-1}\ cm^{-1}\ mol^{-1}$

Specific conductivity of saturated solution $= 2\times10^{-6}\Omega^{-1}c\ m^{-1}$

Specific conductivity of water used = $= 4\times10^{-7}\Omega^{-1}c\ m^{-1}$

36. In a eudiometer 14 ml of CH_4 and 38.5 ml of O_2 was introduced. After explosion and cooling to initial temperature $\left(23^oC\right)$ the volume of eudiometer was found to be 25 ml. Calculate the vapour pressure (in mm of Hg) of aqueous solution containing a non-volatile solute (A) at 23^oC. Mole fraction of (A) is 0.1. The pressure of eudiometer is 1 atm and is constant.

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. If $f(\theta) = \sin\theta + \cos\theta + \tan\theta + \cot\theta - \sec\theta - \operatorname{cosec}\theta;\ \theta \in \left(0, \frac{\pi}{2}\right)$, then

(A) $f(\theta) > 1$
(B) $f(\theta) \le \sqrt{2}$
(C) $f(\theta) \le 2$
(D) $f(\theta) < 1$

38. For a certain complex number c, the polynomial $P(x) = (x^2 - 2x + 2)(x^2 - cx + 4)(x^2 - 4x + 8)$ has exactly 4 distinct roots. The value of $|c|$ is.

(A) 2
(B) $\sqrt{6}$
(C) $2\sqrt{2}$
(D) $\sqrt{10}$

39. Let α, β, γ are roots of $x^3 + px + r = 0$ and $\frac{\alpha}{2}, \beta, 2\gamma$ are the roots of equation $x^3 + qx + r = 0$, then

(A) $\left(\frac{q}{7}\right)^3 + \left(\frac{r}{6}\right)^2 = 0$
(B) $p = 2q$
(C) $(pq) = 5r^{\frac{2}{3}}$
(D) None of these

Space for Rough work

40. If area of triangle whose vertices are $\left(a,a^2\right),\left(b,b^2\right),\left(c,c^2\right)$ is 1 and area of another triangle whose vertices are $\left(\alpha^2,\alpha\right),\left(\beta^2,\beta\right)$ and $\left(\gamma^2,\gamma\right)$ is 2, then the absolute value of $\begin{vmatrix}(a+\alpha)^2 & (b+\alpha)^2 & (c+\alpha)^2\\(a+\beta)^2 & (b+\beta)^2 & (c+\beta)^2\\(a+\gamma)^2 & (b+\gamma)^2 & (c+\gamma)^2\end{vmatrix}$ is equal to:

(A) 2 (B) 4

(C) 8 (D) 16

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

41. Which of the following statement(s) is/are correct?

(A) If the discriminant of the quadratic trinomial $P(x)=ax^2+bx+c\left(a,b,c\in R\right)$ vanishes then the range of $P(x)$ is $[0,\infty)$

(B) If $\sin^2 x+\sec^2 y=1$, then number of ordered pairs (x,y) of real number where $x,y,\in[0,2\pi]$ is equal to 9

(C) If triangle ABC, let $a, b\, and\, c$ denote the lengths of the sides opposite to vertices $A, B\, and\, C$ respectively. If $(a+c-b)(a-c+b)=bc$, then angle A is equal to $\frac{\pi}{3}$.

(D) If $a,b>0$ then minimum value of $\left(\frac{8a}{b}+\frac{b}{2a}\right)$ is equal to 4.

Space for Rough work

42. A sequence of number is defined recursively by $a_1 = 1, a_2 = \frac{3}{7}$ and $a_n = \frac{a_{n-2} \cdot a_{n-1}}{2a_{n-2} - a_n - 1}$ for all $n \geq 3$. Then

(A) $\left|\frac{1}{a_{2019}} - \frac{1}{a_{2018}}\right| = \frac{4}{3}$

(B) $a_{2019} = \frac{3}{8075}$

(C) $\left|\frac{1}{a_{2019}} - \frac{1}{a_{2018}}\right| = \frac{3}{4}$

(D) $a_{2019} = \frac{4}{8075}$

43. If $f : \mathbb{R} \to \mathbb{R}$ is defined as $f(x) = \log_2\left(\frac{3\sin x - 4\cos x + 15}{10}\right)$, then:

(A) $f(x)$ is not injective

(B) $f(x)$ is surjective

(C) If range of $f(x)$ also satisfies the inequality $-t^2 - 2at + a < 0$, then $a \in (-1, 0)$

(D) Minimum value of $g(x) = \frac{1}{\sin^4 x + \cos^4 x}$ defined on real numbers is equal to maximum value of $f(x)$

44. Let x, y, z be real numbers with $x \geq y \geq z \geq \frac{\pi}{12}$, such that $x + y + z = \frac{\pi}{2}$ and let $P = \cos x.\sin y.\cos z$, then

(A) Minimum value of P is $\frac{1}{8}$

(B) Maximum value of P is $\frac{2+\sqrt{3}}{8}$

(C) Minimum value of P is $\frac{1}{4}$

(D) Maximum value of P is $\frac{2+\sqrt{3}}{4}$

Space for Rough work

45. If $\left|\sum_{r=1}^{n} a_r \sin(rx)\right| \le |\sin x| \; \forall x \in R$ for real numbers $a_1 a_2 .....a_n$, then $\left|\sum_{r=1}^{n} r\, a_r\right|$ can be equal to

(A) $\frac{1}{\pi}$
(B) $\frac{2}{\pi}$
(C) 2
(D) 1

46. Let $P\left(2\sqrt{3}, \frac{5}{2}\right)$ is any point on the ellipse $\frac{x^2}{16} + \frac{y^2}{25} = 1$ having centre at C. Let $Q \, and \, R$ are feet of perpendicular from foci $S_1 \, and \, S_2$ on the tangent at P, tangent at P intersect y-axis at $T \, and \, N$ is foot of perpendicular from centre C on the normal at P and normal at P intersect major and minor axes at $A \, and \, B$, then

(A) $(CA)(CT) = 9$
(B) $(PN)(PB) = 25$
(C) $(S_1Q)(S_2R) = 16$
(D) $(S_1P)(S_2P) = \frac{90}{4}$

47. Let $PA \, and \, PB$ be the pair of tangents drawn to hyperbola $9x^2 - 4y^2 = 36$ from point $P(2,-1)$, then

(A) Equation of tangent from point P is $x + 2 = 0$
(B) Equation of tangent from point P is $x - 2 = 0$
(C) Equation of tangent from point P is $5x + 2y - 8 = 0$
(D) Area of ΔPAB is $\frac{1}{4}$ sq units

Space for Rough work

48. Let A and B be two square matrices of order 3 given as $A=\begin{bmatrix} x & 0 & 0 \\ 0 & x^2 & 0 \\ 0 & 0 & 1/x^3 \end{bmatrix}$ and $B=\begin{bmatrix} 3 & 2 & 3 \\ 2 & 0 & 1 \\ 3 & 1 & 1 \end{bmatrix}$ then:

(A) Minimum value of trace $\left(A^2B\right)$ is 4.

(B) If $CA^2 = B,$ then minimum value of trace $\left(C\right)$ is 4

(C) $AB - BA$ is a singular matrix

(D) det. $\left(\operatorname{adj}\left(A^{2015}B\left(A^T\right)^{2015}\right)\right)$ equals 25.

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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49. If $I = \int_1^3 \left(\tan^{-1}\left(\frac{x^2-5x+6}{x^3-6x^2+12x-7}\right) + \tan^{-1}\left(\frac{1}{x^2-4x+4}\right) dx \right)$, then find the value of $[I]$.

[Note: $[k]$ denotes greatest integer less than or equal of k]

50. If $f\left(y\right) = \lim_{n\to\infty} \sum_{n=1}^{n} \frac{e^{n+y}\left(e-1\right)}{\left(e^n-1\right)\left(e^{n+1}-1\right)}$ then find the value of $\int_0^1 f\left(x\right)dx$.

Space for Rough work

51. Let the line $y = 100x - 199$ be intersect the graph of a function $f(x) = x^3 - 6x^2 + ax - 2a + 17, a \in R$ at three distinct points whose abscissae are x_1, x_2 and x_3 $(x_1 < x_2 < x_3)$ such that $x_3 - x_1 = 6$. If $\int_{x_1}^{x_3} \left(f(x) - 98x + 198 \right) dx = \lambda,$ then find the value of λ.

52. Let $S_n = \sum_{k=0}^{n} (-4)^k \cdot {}^{n+k}C_{2k}$, then value of $S_{2011} + 2.S_{2010} + S_{2009}$ is ___________

53. Six identical balls are randomly dropped into three boxes A, B, C which can hold any number of balls. If the probability that one of the box contain 1 and the other two contains 2 and 3 balls is expressed as $\frac{p}{q}$ in lowest rational. Find $(p+q)$:

54. Sum of solution of the equation $\cos^{-1}\frac{x^2-1}{x^2+1} + \tan^{-1}\frac{2x}{x^2-1} = \frac{2\pi}{3}$ is ___________

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – IV

JEE (Advanced)-2020

PAPER – 1

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. D

Sol. $\frac{1}{V_1}-\frac{2}{-15}=\frac{1-2}{-10}\Rightarrow V_1=-30\,\text{cm}$ and $h=5\left(\frac{8/5}{2}\right)=4\,\text{cm}$

So seperation between two images $=14\text{cm}$

2. A

Sol. $\frac{\lambda}{2\pi\varepsilon_0 x}=\frac{2q\ell}{2\pi\varepsilon_0 x^3}\Rightarrow x^2=\frac{2q\ell}{\lambda}\Rightarrow x=2$

3. C

Sol. Buoyant force will become $=V\rho\left(g+a\right)$ and the sudden increment in it will provide the required acceleration to block.

4. D

Sol. M.I. about diagonal of a square is $\frac{ma^2}{12}$.

5. AC

Sol. $F-umg=ma\Rightarrow F=2N$

$T_F=2\times\frac{1}{2}=1\,\text{N-m}$

$$\vec{T}=\vec{T}_F+\vec{T}_g+\vec{T}_f+\vec{T}_N=1+10\times\frac{5}{2}-10\times\frac{51}{20}=\frac{1}{2}\text{ N-m}$$

6. AD

Sol. As the point of application of friction does not move so work done by friction force is zero.

7. BC

Sol. Potential of the centre of sphere $=\frac{kq}{r}$

When earthed $V=0=\frac{kq}{r}+\frac{k(q')}{R}\Rightarrow q'=\frac{R}{r}(-q)$

8. AD

Sol. Using work energy theorem

$-\mu\text{mgx}-\frac{1}{2}kx^2=-\frac{1}{2}mv^2$

$11x+25x^2-36=0$

$\Rightarrow x=1m$

Now when it stops momentary for the second time

$-\mu\text{mgd}-\left[\frac{1}{2}k\,d_2^2-\frac{1}{2}k\,d_1^2\right]=0$

$11d+25d_2^2-25d_1^2=0$

$11d_1+11d_2+25d_2^2-25d_1^2=0$

So, $25d_2^2+11d_2-14=0\;[as\,d=1m]$

$d_2=0.56m$

So acceleration $a=\frac{kd_2-\mu mg}{m}$

$a=8.5m/s^2$

9. AC

10. ABC

Sol. $\text{x}_{CM}=\frac{2\times15}{5}=6$

$\text{y}_{CM}=\frac{3\times10}{5}=12$

11. BC

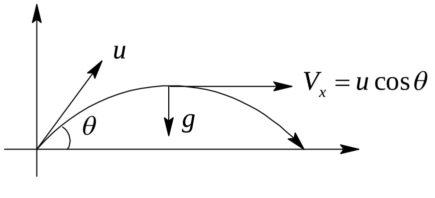
12. BCD

Sol. At highest point

$V_y=0$

$V_x=u\cos\theta$

Hence $\overline{V}\perp\overline{a}$ and speed is maximum.



SECTION – C

13. 00001.57

Sol. $K_{eq} = \dfrac{16K}{5}$

$K_{eq} = \dfrac{16K}{5}$

Use $T = 2\pi\sqrt{\dfrac{m}{K_{eq}}}$

14. 00019.20

Sol. $v + u = 120 - - - - - (1)$

$\dfrac{v^2}{u^2} = \dfrac{1}{16} \Rightarrow \dfrac{v}{u} = \dfrac{1}{4} - - - - (2)$

$\Rightarrow v = 24 \text{ and } u = 96$

$\Rightarrow \dfrac{1}{f} = \dfrac{1}{v} - \dfrac{1}{u} = \dfrac{1}{24} + \dfrac{1}{96}$

$\Rightarrow f = 19.2\,cm$

15. 00001.80

Sol. $F = \dfrac{9\times10^9 \times 2\times10^{-6}\times10^{-6}}{\left(10\times10^{-2}\right)^2} = 1.8\,\text{Newton}$

16. 00006.28

Sol. $Y = \dfrac{mg/A}{\Delta\ell/\ell}$ at equilibrium

$\Rightarrow T - mg = ma$ at general position where $Y = \dfrac{T/A}{\left(\Delta\ell + x\right)/\ell}$

$\Rightarrow \dfrac{YA\Delta\ell}{\ell} + \dfrac{YAx}{\ell} - mg = ma$

$\Rightarrow a = \dfrac{YA}{m\ell}\left(-x\right)$ so time period $= 2\pi\sqrt{\dfrac{m\ell}{YA}} = 6.28\,\text{sec}$

17. 00019.94

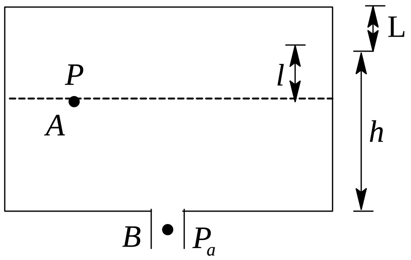
Sol. Process 1 – 2 and 3 – 4 are isochoric so no work in these processes. Other two processes are isobaric

Nett work done $= \Delta W_{2-3} + \Delta W_{4-1}$

$$= nR\left(T_3 - T_2\right) + nR\left(T_1 - T_4\right)$$
$$= nR\left[T_3 - T_2 + T_1 - T_4\right]$$
$$= 3\times8.31\left[800\right] = 19.94KJ$$

18. 00075.00

Sol. $P_a + 0 + 0 = P + \rho g\left(h - l\right) + 0$



Here l is the distance by which the water level has descended. $\left(l = 0.5\,m\right)$

$P_a\left(AL\right) = PA\left(L + l\right)$

As process can be taken as isothermal for air,

$P_a\left(AL\right) = PA\left(L + l\right)$

$L\left(P_a - P\right) = Pl$

$$L = \frac{\left[P_a - \rho gh + \rho gl\right]l}{\rho g\left(h - l\right)}$$

$$= \frac{10^4\left[10 - 4.5 + 0.5\right]l}{10^4\left[4.5 - 0.5\right]}$$

$= 0.75\,cm$

$= 75\,cm$

Chemistry

PART – II

SECTION – A

19. A

20. C

21. B

22. C

Sol. $r = k[A][B_2]$ & $k_c = \dfrac{[A][A]}{[A_2]}$

$\therefore [A] = K^{1/2}[A_2]^{1/2}$

Thus $r = K.K_c^{1/2}[A_2]^{1/2}[B_2] = K'[A_2]^{1/2}[B_2]$

Hence order reaction s 3/2

23. ABCD

24. CD

25. ABC

26. ABC

27. ABCD

28. ABD

29. ABC

30. ABCD

SECTION – C

31. 00009.11

Sol. $Q_{rev.} = nRT\ln\left(\dfrac{V_2}{V_1}\right) = 1\times 8.3\times 298\times 2.303\times 0.477 = 2717.67\ J$

$Q_{rev.} = 2717.67$

$\Delta S_{system} = \dfrac{Q_{rev.}}{T} = 9.11$

32. 00345.00

Sol. Balance eq. is

$4Au + 8CN^- + O_2 + 2H_2O \rightarrow 4Au(CN)_2^- + 4OH^-$

$$\begin{array}{lll}
\text{(i)} & 4Au \rightarrow 4Au^+ + 4e & \Delta G^\circ = 4\times 96500\times 1.5\ J \\
 & 4Au^+ + 8CN^- \rightarrow 4Au(CN)_2^- & \Delta G^\circ = -2\times 8\times 300\times 38\times 4\ J \\
\hline
 & 4Au + 8CN^- \rightleftharpoons 4Au(CN)_2^- + 4e & \Delta G_J^\circ = 579 - 729.6\ KJ = -150.6\ KJ \\
\text{(ii)} & O_2 + 4H^+ + 4e \rightarrow 2H_2O & \Delta G'^\circ = -4\times 96500\times 1.2\ J \\
 & 4H_2O \rightarrow 4H^+ + 4OH^- & \Delta G_2'^\circ = 2\times 8\times 300\times 56 \\
\hline
 & O_2 + 2H_2O + 4e \rightarrow 4OH^- & \Delta G_3'^\circ = -463.2 + 268.8\ kJ = -194.4\ kJ
\end{array}$$

$\Delta G^\circ_{reaction} = \Delta G_3^\circ + \Delta G_3'^\circ = -345\ \ kJ$

33. 00000.01

Sol. $\text{HCOOH} \rightleftharpoons \text{HCOO}^- + \text{H}^+$

$$K_{a_1} = \frac{[\text{HCOO}^-][\text{H}^+]}{[\text{HCOOH}]} = \frac{[\text{H}^+]^2}{[\text{HCOOH}]}$$

$\text{CH}_3\text{COOH} \rightleftharpoons \text{CH}_3\text{COO}^- + \text{H}^+$

$$K_{a_2} = \frac{[\text{CH}_3\text{COO}^-][\text{H}^+]}{[\text{CH}_3\text{COOH}]} = \frac{[\text{H}^+]^2}{[\text{CH}_3\text{COOH}]}$$

As $[\text{H}^+]$ in both case are equal

$K_{a_1} \times [\text{HCOOH}] = K_{a_2}[\text{CH}_3\text{COOH}]$

$$\therefore \quad [\text{CH}_3\text{COOH}] = \frac{K_{a_1}}{K_{a_2}} \times [\text{HCOOH}] = \frac{1.8\times10^{-4}}{1.8\times10^{-5}} \times 10^{-3} = 0.01\,\text{M}$$

34. 00871.10

Sol. $p_{O_2} + p_{H_2O} = 740$

$p_{O_2} = 740 - 31.8$ at 30°C

= 708.2 torr

$p_{N_2} = 780 - 23.8$ at 25°C

= 756.2 torr

Mix at 35°C

$$\frac{p_1V_1}{T_1} + \frac{p_2V_2}{T_2} = \frac{pV}{T}$$

$$\frac{708.2\times250}{303} + \frac{756.2\times300}{298} = \frac{p\times500}{308}$$

p = 828.9 torr

Final pressure = p + aqueous tension = 828.9 + 42.2 = 871.1

35. 00020.48

Sol. $$\lambda_M = \frac{K\times1000}{M} \Rightarrow (80\times2+40) = \frac{(2.00\times10^{-6} - 0.40\times10^{-6})\times1000}{M}$$

So, $M = 8\times10^{-6}$

$K_{sp} = 2048\times10^{-18} = 20.48\times10^{-16}$

36. 00013.68

Sol. $\text{CH}_4 + 2\text{O}_2 \longrightarrow \text{CO}_2 + 2\text{H}_2\text{O}$

14 38.5

0 10.5 14

So 25-24.5=0.5 ml of H_2O vap is present

So, vap. Pressure of water at this temperature$= \frac{0.5}{25} = \frac{1}{50}\text{atm}$

Now apply $\frac{P_A^o - P_{solution}}{P_A^o} = 0.1$ and $P_A^o = \frac{1}{50}$

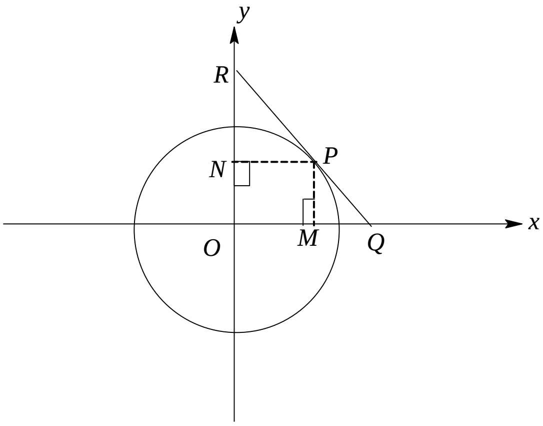
$\Rightarrow P_{solution} = 13.68\text{mm of Hg}$

Mathematics PART – III

SECTION – A

37. D

Sol.



Consider a unit circle having centre at origin.

$ON = PM = \sin\theta$ $PQ = \tan\theta$ $OQ = \sec\theta$ $OP = 1$

$OM = PN = \cos\theta$ $PR = \cot\theta$ $OR = \cos ec\,\theta$ $MN = 1$

$$\begin{aligned}\therefore f(\theta) &= PM + PN + PQ + PR - OQ - OR\\ &= PM + PN + QR - OQ - OR\\ &= PM + PN + QR - (OM + MQ) - (ON + NR)\\ &= QR - MQ - NR\\ &< MN\end{aligned}$$

(Since, $NR + MN + MQ > QR$)

$\therefore f(\theta) < 1$

38. D

Sol. $P(x) = (x-(1-i))(x-(1+i))(x-(2-2i))(x-(2+2i))(x^2 - cx + 4)$

Since the first four roots are all distinct, the term $(x^2 - cx + 4)$ must be a product of any combination of two (not necessarily distinct) factors from the set $(x-(1-i)), (x-(1+i))$ $(x-(2-2i))$ $(x-(2+2i))$. The only combinations are

$(x-(1-i))\&(x-(2+2i))$ *or* $(x-(1+i))\&(x-(2-2i))$

$\therefore c = 3 \pm i$

$|c| = \sqrt{10}$

39. A

Sol. $\alpha + \beta + \gamma = 0, \dfrac{\alpha}{2} + \beta + 2\gamma = 0$

$$\Rightarrow \frac{\alpha}{2} = \gamma \Rightarrow \beta + 3\gamma = 0 \Rightarrow \gamma = -\frac{\beta}{3}$$

$$\frac{\alpha}{2} = \gamma = -\frac{\beta}{3}$$

$$\alpha = 2\gamma, \beta = -3\gamma$$

$$p = \alpha\beta + \beta\gamma + \gamma\alpha = -6\gamma^2 + 3\gamma^2 + 2\gamma^2 = -7\gamma^2$$

$$q = \frac{\alpha\beta}{2} + 2\beta\gamma + \alpha\gamma = -3\gamma^2 - 6\gamma^2 + 2\gamma^2 = -7\gamma^2$$

$$p = q, r = -\alpha\beta\gamma = 6\gamma^3 \Rightarrow \gamma = \left(\frac{r}{6}\right)^{\frac{1}{3}}$$

$$p = q = -7\left(\frac{r}{6}\right)^{\frac{2}{3}} \Rightarrow \left(\frac{q}{7}\right)^3 + \left(\frac{r}{6}\right)^2 = 0$$

40. D

41. BCD

Sol. (A) $D = 0$ therefore range cannot be $\left[0, \infty\right)$ because leading coefficient 'a' must also be positive

(B) $x = 0, \pi, 2\pi \quad y = 0, \pi, 2\pi \;\therefore 9$ ordered pairs

(C) $a^2 - c^2 - b^2 = -bc$

$2bc\cos A = bc$

$$A = \frac{\pi}{3}$$

$AM \geq GM$ minimum value is 4

42. AB

Sol.
$$a_n = \frac{a_{n-2} \cdot a_{n-1}}{2a_{n-2} - a_{n-1}}$$

$$\Rightarrow a_{n-1} = \frac{2a_{n-2} \cdot a_n}{a_{n-2} + a_n}$$

$$\Rightarrow a_{n-2}, a_{n-1}, a_n \to H.P.$$

43. ACD

Sol. Domain of f is $\mathbb{R}$ and since $\sin x$ and $\cos x$ repeats its value

$\therefore f$ is not injective.

Also, $0 \leq \log_2\left(\frac{3\sin x - 4\cos x + 15}{10}\right) \leq 1$

$\therefore f(x) \in [0,1]$

$f(x)$ is not surjective.

Now $-t^2 - 2at + a < 0 \quad \forall t \in [0,1]$

$\therefore f(0) < 0$ & $f(1) < 0$

$\Rightarrow a \in (-1, 0)$

Now, $g(x) = \dfrac{2}{2 - \sin^2 2x}$ $\qquad (g(x))_{\min} = 1$

44. AB

Sol. $P = \dfrac{1}{2}\cos x\left(\sin(y+z) + \sin(y-z)\right) \ge \dfrac{1}{2}\cos x \sin(y+z) = \dfrac{1}{2}\cos^2 x$

But $x = \dfrac{\pi}{2} - (y+z) \le \dfrac{\pi}{2} - 2\cdot\dfrac{\pi}{12} = \dfrac{\pi}{3}$

$\therefore P \ge \dfrac{1}{8}$

$P = \dfrac{1}{2}\cos z\left(\sin(x+y) - \sin(x-y)\right)$

Again $P \le \dfrac{1}{2}\cos^2 z = \dfrac{1 + \cos 2z}{4}$

$P \le \dfrac{2 + \sqrt{3}}{8}$

45. ABD

Sol. Let $f(x) = \sum_{r=1}^{n} a_r \sin(r\,x)$

$\left|f'(0)\right| = \left|\sum_{r=1}^{n} r\,a_r\right| and\ f(0) = 0$

$f'(0) = \lim_{x\to 0}\dfrac{f(x) - f(0)}{x} = \lim_{x\to 0}\dfrac{f(x)}{\sin x} \le 1$

46. ABC

Sol. $(CA)(CT) = (CS)^2 = b^2e^2$

$(PN)(PB) = b^2$

$(S_1Q)(S_2R) = a^2$

$(S_1P)(S_2P) = (b + ey_1)(b - ey_1)$

47. BCD

Sol. Equation of tangents $PA \& PB$ is

$y = mx \pm \sqrt{4m^2 - 9}$

$(2m+1)^2 = 4m^2 - 9$

$$\Rightarrow 4m = -10 \Rightarrow m = -\frac{5}{2}$$

$$\Rightarrow y+1 = -\frac{5}{2}(x-2)$$

$$\Rightarrow 2y+2 = -5x+10$$

$$\therefore 5x+2y = 8$$

Equation of AB

$$18x+4y = 36$$

$$\Rightarrow 9x+2y = 18$$

x Coordinate of B

$$4x = 10, x = \frac{5}{2}$$

48. ABCD

SECTION – C

49. 00003.00

Sol. $$I = \int_1^3 \left(\tan^{-1}\left(\frac{x^2-5x+6}{x^3-6x^2+12x-7}\right) + \tan^{-1}\left(\frac{1}{x^2-4x+4}\right)\right)dx$$

$$= \int_1^3 \left(\tan^{-1}\left(\frac{(x-2)^2-(x-2)}{(x-2)^3+1}\right) + \tan^{-1}\left(\frac{1}{(x-2)^2}\right)\right)dx$$

$$x-2 = t \Rightarrow dx = dt$$

$$= \int_{-1}^{1} \left(\tan^{-1}\left(\frac{t^2-t}{1+t^3}\right) + \tan^{-1}\left(\frac{1}{t^2}\right)\right)dt$$

$$= \int_{-1}^{1} \left(\tan^{-1}(t^2) - \tan^{-1}(t) + \tan^{-1}\left(\frac{1}{t^2}\right)\right)dt$$

$$= \frac{\pi}{2}(1+1) = \pi$$

$$\therefore [I] = 3$$

50. 00001.00

Sol. $$f(y) = \lim_{n\to\infty} \sum_{n=1}^{n} \frac{e^y e^n (e-1)}{(e^n-1)(e^{n+1}-1)}$$

$$= e^y \lim_{n\to\infty} \sum_{n=1}^{n} \left(\frac{(e^{n+1}-1)-(e^n-1)}{(e^n-1)(e^{n+1}-1)}\right)$$

$$= e^y \lim_{n\to\infty} \sum_{n=1}^{n} \left(\frac{1}{e^n} - \frac{1}{e^{n+1}-1}\right)$$

$$= e^y \lim_{n\to\infty}\left(\left(\frac{1}{e-1}-\frac{1}{e^2-1}\right)+\left(\frac{1}{e^2-1}-\frac{1}{e^3-1}\right)+......+\left(\frac{1}{e^n-1}-\frac{1}{e^{n+1}-1}\right)\right)$$

$$=\frac{e^y}{e-1}$$

$$\int_0^1 f(x)dx=\frac{1}{e-1}\int_0^1 e^x dx=1$$

51. 00018.00

Sol. $f(x)=x^3-6x^2+ax-2a+17$

$f'(x)=3x^2-12x+a$

$f''(x)=6x-12$

$f''(x)=0 \Rightarrow x=2$

$f(2)=1$

$(2,1)$ is the point of inflection on the graph

$y=f(x)$

Straight line $y=100x-199$ is also passing through $(2,1)$

$x_1+x_3=4 \, and \, x_3-x_1=6$

$$\int_{x_1}^{x_3}\left(f(x)-98+198\right)dx$$

$$=\int_{x_1}^{x_3}\left(f(x)-100x+199+2x-1\right)dx$$

$$\int_{x_1}^{x_3}(2x-1)dx$$

$$=\left(x^2-x\right)_{x_1}^{x_3}=x_3^2-x_3-\left(x_1^2-x_1\right)$$

$$=\left(x_3-x_1\right)\left(x_3+x_1\right)-\left(x_3-x_1\right)$$

$$=4\times6-6=18$$

$$\therefore \lambda=18$$

52. 00000.00

Sol. $S_n=\sum_{k=0}^{n}(-4)^k \; {}^{n+k}C_{2k}$

$S_{n+1}=\sum_{k=0}^{n+1}(-4)^k \; {}^{n+k+1}C_{2k}$

$S_{n-1}=\sum_{k=0}^{n-1}(-4)^k \; {}^{n-1+k}C_{2k}$

Consider ${}^{n+1}C_r + {}^{n-1}C_r - 2\,{}^{n}C_r$ = coefficient of x^r in $\{(1+x)^{n+1}+(1+x)^{n-1}-2(1+x)^n\}$

= coefficient of x^r in $(1 + x)^{n-1}\{(1 + x)^2 + 1 - 2(1 + x)\}$
= coefficient of x^r in $(1 + x)^{n-1}\{x^2 + 2x + 2 - 2x - 2\}$
= coefficient of x^{r-2} in $(1 + x)^{n-1} = {}^{n-1}C_{r-2}$
Put $n \to n + k$ and $r \to 2k$
$\Rightarrow {}^{n+k+1}C_{2k} + {}^{n+k-1}C_{2k} - 2\,{}^{n+k}C_{2k} = {}^{n+k-1}C_{2(k-1)}$.
Multiplying by $(-4)^k$ and applying summation on both sides

$$\sum_{k=0}^{n+1}(-4)^k\ {}^{n+k+1}C_{2k} + \sum_{k=0}^{n-1}(-4)^k\ {}^{n+k-1}C_{2k} - 2\sum_{k=0}^{n}(-4)^k\ {}^{n+k}C_{2k} = \sum_{k=1}^{n+1}(-4)^k\ {}^{n+k-1}C_{2(k-1)}$$

(Note that the limits of summation are different for each term)

$$\Rightarrow S_{n+1} + S_{n-1} - 2S_n = \sum_{k=1}^{n+1}(-4)^k\ {}^{n+k-1}C_{2(k-1)}$$

Let $k - 1 = t$

$$\sum_{t=0}^{n}(-4)^t(-4)^1\ {}^{n+t}C_{2t} = -4S_n$$

$S_{n+1} + 2S_n + S_{n-1} = 0$
Put n = 2010.

53. 00017.00

54. 00002.00

Sol. $\cos^{-1}\dfrac{1-x^2}{1+x^2} + \tan^{-1}\dfrac{2x}{1-x^2} = \pi/3$

Put $x = \tan\theta$, $-\dfrac{\pi}{2} < \theta < \dfrac{\pi}{2}$

$\cos^{-1}(\cos 2\theta) + \tan^{-1}(\tan 2\theta) = \pi/3$

For $-\pi < 2\theta < -\pi/2$
$-2\theta + 2\theta + \pi = \pi/3$ (Not possible)

For $\dfrac{-\pi}{2} < 2\theta \le 0$
$-2\theta + 2\theta = \pi/3$ (Not possible)

For $0 < 2\theta < \pi/2$
$2\theta + 2\theta = \pi/3$
$\theta = \dfrac{\pi}{12}$
$x = 2 - \sqrt{3}$

For $\dfrac{\pi}{2} < 2\theta < \pi$
$2\theta + 2\theta - \pi = \pi/3 \Rightarrow \theta = \pi/3$
$x = \sqrt{3}$
sum = $2 - \sqrt{3} + \sqrt{3} = 2$

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – IV

JEE (Advanced)-2020

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section-A (01 – 08, 19 – 26, 37 – 44)*** *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*

   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–1** In all other cases.*

   Section-A (09 – 12, 27 – 30, 45 – 48) *contains 6 List-Match sets with 12 questions (each set has 2 questions). Each question has 4 statements in LIST-I & 5 or 6 statements in LIST-II. The codes for Lists have choices (A), (B), (C), (D) out of which only one is correct.*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

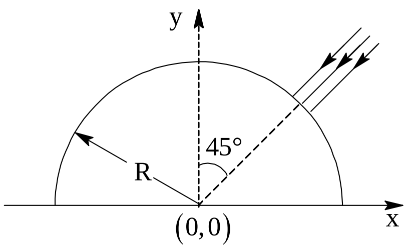
PART – I

SECTION – A

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. If a narrow beam of light falls on a glass hemisphere of refraction index 2 as shown in the figure. Then the image formed.



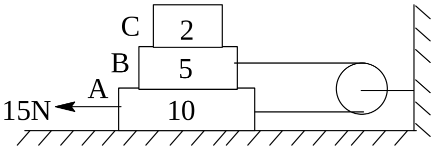
(A) Due to first surface has co-ordinates $\left(-\sqrt{2}R, -\sqrt{2}R\right)$

(B) Due to first surface has co-ordinates $\left(-\sqrt{3}R, -\sqrt{3}R\right)$

(C) Due to second surface has co-ordinates $\left(-R/\sqrt{2},\ R/\sqrt{2}\right)$

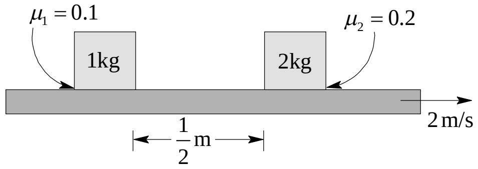
(D) Due to second surface has co-ordinates $\left(-R/\sqrt{3},\ R/\sqrt{3}\right)$

2. All surfaces are smooth, string is light and pulley is frictionless. Mark the correct statement(s):



(A) Acceleration of block A is 1 m/s^2
(B) Acceleration of block A and B will be same
(C) Acceleration of block C is zero
(D) Tension is string between pulley and wall is 10N

3. Two blocks kept on a rough plank are moving with the plank with velocity of $2\,\text{m/s}$. The plank is retarded uniformly for $1\,\text{sec}$ and brought to rest:
Assuming the plank to be sufficiently long then:



(A) The velocity of block of mass $2\,\text{kg}$ after collision with $1\,\text{kg}$ block is $1\,\text{m/s}$

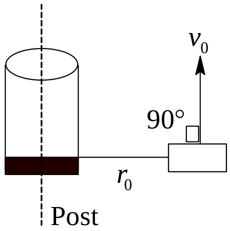
(B) The velocity of block of mass $2\,\text{kg}$ after collision with $1\,\text{kg}$ block is $\frac{1}{2}\,\text{m/s}$

(C) The final separation between two blocks is $\frac{1}{16}\,\text{m}$

(D) The final separation between two blocks is $\frac{1}{8}\,\text{m}$

Space for Rough work

4. A puck on a frictionless plane is given an initial speed v_0. The puck is attached to a string that wraps around a fixed vertical post:

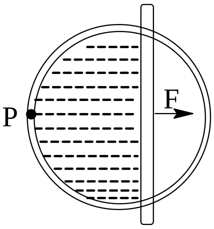


(A) Mechanical energy of puck remains constant in the interval of motion
(B) Angular momentum of the puck about axis of post remains constant
(C) No torque acts on the puck about the axis of post.
(D) Work done by tension is zero.

5. A particle is executing SHM on a straight line. A and B are two points at which its velocity is zero. It passes through a certain point P (AP < BP) at successive intervals of 0.5 second and 1.5 second with a speed of 3 m/s:

(A) The maximum speed of particle is $3\sqrt{2}\, m/s$
(B) The maximum speed of particle is $\sqrt{2}\, m/s$
(C) The ratio $\frac{AP}{BP}$ is $\frac{\sqrt{2}-1}{\sqrt{2}+1}$
(D) The ratio $\frac{AP}{BP}$ is $\frac{1}{\sqrt{2}}$

6. A circular wire, 10cm in diameter, with a slider wire on it, is in a horizontal plane. A liquid film is formed, bounded by the wires, on the left side of the slider, as shown. The surface tension of the liquid is 0.1 N/m. An applied force 16 mN, perpendicular to the slider, maintains the film in equilibrium. Ignore the sag in the film. What can be the distance between point F and slider?



(A) 8 cm
(B) 2 cm
(C) 5 cm
(D) Slider cannot be in equilibrium

Space for Rough work

7. 50 gm ice at $-10°C$ is mixed with 20 gm steam at $100°C$. When the mixture finally reaches its steady state inside a calorimeter of water equivalent 1.5 gm then: [Assume calorimeter was initially at 0°C, Take latent heat of vaporization of water = 540 cal/gm, Latent heat of fusion of water = 80 cal/gm, Specific heat capacity of water = 1 cal/gm-°C, Specific heat capacity of ice = 0.5 cal/gm-°C]

(A) Mass of water remaining is: $67.4\,gm$

(B) Mass of water remaining is $67.87\,gm$

(C) Mass of steam remaining is $2.6\,gm$

(D) Mass of steam remaining is $2.13\,gm$

8. 2 moles of He are mixed with 2 moles of H_2 in a closed adiabatic container. Initially the mixture occupies 3 litres at 27°C. The volume is suddenly decreased to $\left(\frac{3}{2}\right)$ liters. Choose the correct option(s):

(H_2 and He can be treated as ideal gases):

(A) γ for mixture is $\frac{3}{2}$

(B) Final temperature $=300\sqrt{2}\,K$

(C) C_p for mixture is $2R$

(D) Work done in compression is totally converted into internal energy.

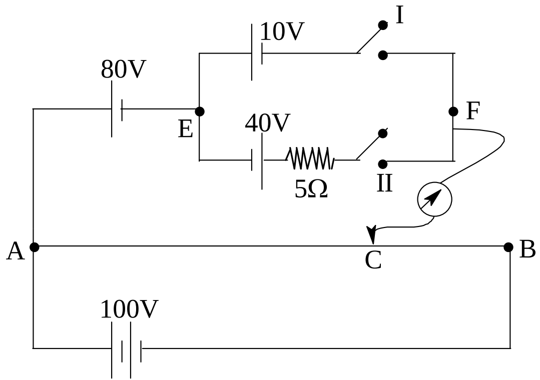
Space for Rough work

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO (02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

In the potentiometer setup shown below all cells are ideal and all connecting wires offer zero resistance. Then answer the following question: (Take AB = 100 cm)



List – I		List – II	
(I)	Null deflection length AC	(P)	$90\,\text{cm}$
(II)	Current through 5Ω	(Q)	$40\,\text{cm}$
(III)	Current through 10V cell	(R)	$10\,\text{A}$
(IV)	Potential difference across EF	(S)	Zero
		(T)	$10\,\text{V}$
		(U)	$40\,\text{V}$
		(V)	$5\,\text{A}$

9. If only switch II is closed:

(A) $\text{I} \rightarrow Q,\ \text{II} \rightarrow \text{S},\ \text{III} \rightarrow \text{S},\ \text{IV} \rightarrow \text{U}$
(B) $\text{I} \rightarrow \text{P},\ \text{II} \rightarrow \text{S},\ \text{III} \rightarrow \text{U},\ \text{IV} \rightarrow \text{T}$
(C) $\text{I} \rightarrow \text{Q},\ \text{II} \rightarrow \text{S},\ \text{III} \rightarrow \text{S},\ \text{IV} \rightarrow \text{T}$
(D) $\text{I} \rightarrow P,\ \text{II} \rightarrow \text{S},\ \text{III} \rightarrow \text{S},\ \text{IV} \rightarrow \text{U}$

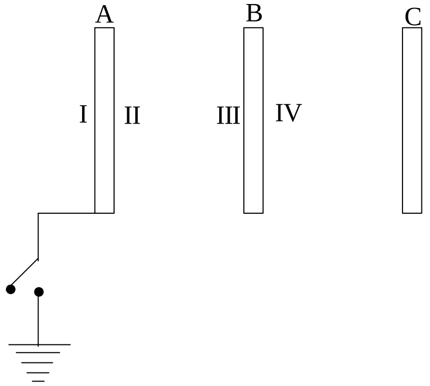
10. If both the switch are closed:

(A) $\text{I} \rightarrow \text{P},\ \text{II} \rightarrow \text{S},\ \text{III} \rightarrow \text{S},\ \text{IV} \rightarrow \text{S}$
(B) $\text{I} \rightarrow \text{Q},\ \text{II} \rightarrow \text{V},\ \text{III} \rightarrow \text{S},\ \text{IV} \rightarrow \text{S}$
(C) $\text{I} \rightarrow \text{P},\ \text{II} \rightarrow \text{R},\ \text{III} \rightarrow \text{R},\ \text{IV} \rightarrow \text{T}$
(D) $\text{I} \rightarrow \text{Q},\ \text{II} \rightarrow \text{R},\ \text{III} \rightarrow \text{R},\ \text{IV} \rightarrow \text{S}$

Space for Rough work

Answer the following by appropriately matching the list based on the information given in the paragraph.

Three rectangular conducting plates are placed closely parallel to each other as shown in figure. Plates A, C are given charges Q, and 2Q respectively.



The respective marking of surfaces is given on list I and List II provides with charges.

List – I		**List – II**	
(I)	I	(P)	$3Q/2$
(II)	II	(Q)	Zero
(III)	III	(R)	$-Q/2$
(IV)	IV	(S)	$Q/2$
		(T)	Q
		(U)	$-Q$

11. If switch is open:

(A) I → P, II → R, III → S, IV → R
(B) I → Q, II → T, III → U, IV → U
(C) I → S, II → S, III → R, IV → S
(D) I → P, II → P, III → R, IV → S

12. If switch is closed:

(A) I → P, II → R, III → S, IV → R
(B) I → Q, II → T, III → U, IV → U
(C) I → Q, II → Q, III → Q, IV → Q
(D) I → Q, II → Q, III → U, IV → U

Space for Rough work

SECTION – C
(Numerical Answer Type)

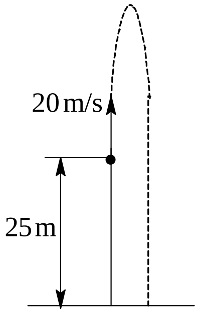
This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

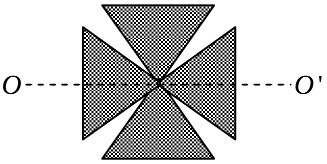
13. A box of mass 1kg is lying on a rough horizontal floor and a horizontal force acting on box has a magnitude of F = $3t^2$N, where t is in seconds. If the box starts from rest, determine its speed (in m/s) at t = 3 second. The coefficient of static and kinetic friction between the box and horizontal floor are $\mu_s = 0.3$ and $\mu_k = 0.2$

14. Sunset is defined as the instant that the top of the sun dissappears below the horizon. How long is it from the time when the bottom of the sun hits the horizon until the instant of sunset assuming that you are standing on the equator on March 21? Call this time t_{sunset} and find it in seconds. Take diameter of Sun = 14 × 10^8 m and sun-earth distance = 1.5 × 10^{11} m. (take $\pi = 3.15$)

15. A boy throws a ball at time t = 0 with upward initial velocity = 20 m/s, from the corner of the roof of a building, whose height above the ground is 25 m. If the velocity of the ball is simply reversed after collision from the ground (magnitude remaining same), and the 3^{rd} collision of the ball with the ground occurs at t = t_1 sec. What is the value of t_1?



16. Moment of inertia of an equilateral triangular plate of side length a, about an axis passing through one of its vertices perpendicular to its plane is equal to I_0. If the following symmetric structure is made from the same material, then its moment of inertia about the axis OO' is found to be equal to NI_0. Find N



17. A block is placed on a horizontal platform vibrating up and down, simple harmonically. It is observed that the block loses its contact with the platform when its angular frequency is 5 rad/s. The amplitude of oscillations cannot be less than 'A' cm, then find the value of A:

18. End A of a rod AB of length L = 0.5 m and of uniform cross-sectional area is maintained at some constant temperature. The heat conductivity of the rod is K = 11.34 $Wm^{-1}K^{-1}$. The other end B of this rod is radiating energy into vacuum and the wavelength with maximum energy density emitted from this end is $\lambda_0 = 75000\AA$. If the emissivity of the end B, e = 1, determine the temperature of the end A (in Kelvin). Assume that lateral surface is insulated. (Take Wien's constant = 3 × 10^{-3} mK, Stefan's constant $\sigma = 5.67 \times 10^{-8}$ W/m^2K^4)

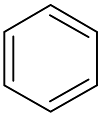
Space for Rough work

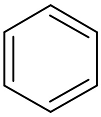
Chemistry PART – II

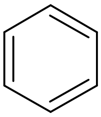
SECTION – A
(One or More than one correct type)

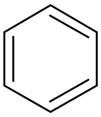
This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. If x is the number of chlorine atoms and y is the degree of unsaturation then which of these reactions will give a product with maximum value of $x+y$:

(A)  $+ \underset{(\text{excess})}{\mathrm{CH_3COCl}} \xrightarrow[\mathrm{AlCl_3}]{\text{anhyd}}$

(B)  $+ \underset{(\text{excess})}{\mathrm{Cl_2}} \xrightarrow[\text{Cold, dark}]{\text{Anhyd. AlCl}_3}$

(C)  $+ \underset{(\text{excess})}{\mathrm{CH_3Cl}} \xrightarrow[\mathrm{AlCl_3}]{\text{Anhyd.}}$

(D)  $+ \underset{(\text{excess})}{\mathrm{Cl_2}} \xrightarrow[500\,\mathrm{K}]{h\nu}$

20. Select the incorrect statement(s):

(A) Second period of modern periodic table contains maximum number of gaseous elements and sixth period contains maximum number of solid elements.

(B) $\mathrm{SrSO_4}$ is the most stable towards heat among all the sulphates of alkaline earth metals.

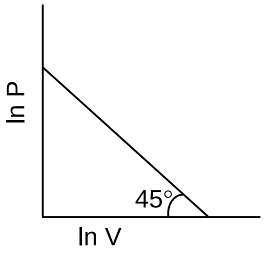
(C) Molten hydrides of all alkali metals liberate $\mathrm{H_2}$ gas at anode on electrolysis.

(D) The coordination number of Zn in Wurtzite structure is 4.

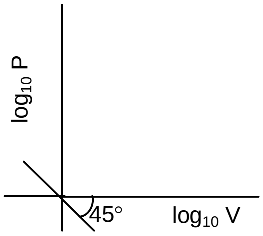
Space for Rough work

21. For one mole of an ideal gas at R Kelvin, which of the following graphs is/are correct (M. W. = 100) (R = $\frac{1}{0.0821}$ K) (P is in atm and V is in litre)

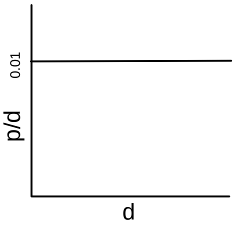
(A)



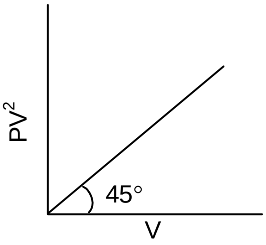
(B)



(C)



(D)



22. A solution is prepared by dissolving 1.5 g of a monoacidic base into 1.5 kg of water at 300 K, which showed a depression in freezing point by $0.165^\circ C$. When 0.496 g of the same base titrated, after dissolution, requires 40 ml of semimolar H_2SO_4 solution. If K_f of water is 1.86 K kg mol^{-1}, then select the correct statement(s) out of the following (assuming molarity = molality):
(A) The pH of the solution of weak base is 11.903
(B) Ionisation constant of the base is 8×10^{-4}
(C) The osmotic pressure of the aq. Solution of base is 2.167 atm
(D) The base is 10% ionized in aq. Solution

23. Complete the reaction:
$CS_2 + \text{Aq. NaOH} \rightarrow$ _______ + ________ + H_2O
(A) Na_2S
(B) Na_2CS_3
(C) Na_2SO_3
(D) $Na_2\text{-}CO_3$

Space for Rough work

24. If for an equation like $N_2O_4\left(g\right)\rightleftharpoons 2NO_2\left(g\right)$, the ΔG (reaction) expression given is

$$\Delta G = 4.73\ \text{KJ mol}^{-1} + 2.5\ \text{KJ mol}^{-1}\ \ell n\left\{\frac{P^2_{NO_2}}{P_{N_2O_4}}\right\}\ \text{then}$$

(A) If small amount of N_2O_4 is introduced in a closed container, then reaction moves in forward direction spontaneously.

(B) Initially, ΔG° value is negative for the given decomposition.

(C) At equilibrium, $Q_P = K_P =$ antilog $\left[\frac{-\Delta G^0}{RT}\right]$

(D) If mole fraction of N_2O_4 >mole fraction of NO_2 still reaction can be spontaneous in backword direction.

25. Identify the correct statements from the following reactions:

(i) $SnCl_2 + H_2O \rightarrow X + HCl$

(ii)

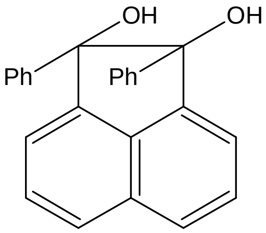
$$\begin{tikzcd} SnCl_2 + 2NaOH \arrow[r] & Y + 2NaCl \arrow[d, "2NaOH(excess)"] \\ & Z + H_2O \end{tikzcd}$$

(iii) $3SnCl_2 + 2AuCl_3 \rightarrow 3SnCl_4 + P$

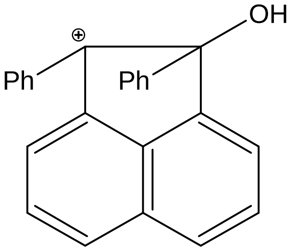
(iv) $SnCl_2 + 2HCl + I_2 \rightarrow SnCl_4 + Q$

(A) X shows white turbidity and is basic
(B) Y is white ppt. and Z is soluble in water
(C) P is a metal
(D) Q is an acid

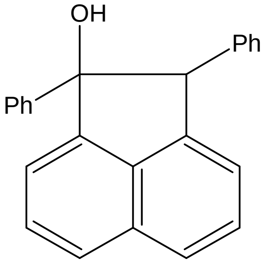
Space for Rough work

26. When  is treated with H_2SO_4 and heated then what are the intermediate and products formed?

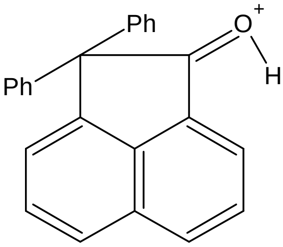
(A)



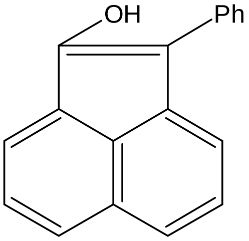
(B)



(C)



(D)



Space for Rough work

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO (02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

Match the product of following reactions.

List – I		List – II	
(I)	$NH_2CONH_2 + HNO_2 \rightarrow$	(P)	N_2
(II)	$CaCN_2 + H_2O \rightarrow$	(Q)	CO_2
(III)	$CaOCl_2 + NH_3 \rightarrow$	(R)	H_2O
(IV)	$N_2H_4 + HNO_2 \rightarrow$	(S)	NH_3
		(T)	N_3H
		(U)	$CaCO_3$

27. Choose the correct options
(A) I-P,Q,S,T
(B) II-P,Q,U
(C) II-P,Q,S
(D) I-P,Q,R

28. Choose the correct options
(A) III-P,R,S,U
(B) IV-P,R,S
(C) IV-R,T
(D) III-P,R,T

Space for Rough work

Answer the following by appropriately matching the list based on the information given in the paragraph.

Match List – I with List – II.

List – I		**List – II**	
(I)	A blue solution	(P)	$Cu(OH)_2$
(II)	A blue precipitate	(Q)	$CuSO_4.5H_2O$
(III)	Red colour compound	(R)	$[Co(SCN)_4]^{2-}$
(IV)	Tetra coordinated compound	(S)	$KFe[Fe(CN)_6]$
		(T)	Pb_3O_4
		(U)	HgI_2

29. Choose the correct options
(A) III-P,Q,S
(B) II-P,Q,S,T
(C) I-Q,R
(D) IV-Q,R,T

30. Choose the correct options
(A) I-Q,R,S,U
(B) II-Q,T,S,U
(C) III-T,U
(D) IV-Q,R,U

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

31. An equilibrium $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$ is obtained by starting with1 mole of PCl_5 in a 1L vessel. A vapour density of equilibrium mixture was found to be 250.2. Now, the equilibrium mixture is transferred into a vessel of 2L capacity, its new degree of dissociation is.

Space for Rough work

32. A glow-worm of mass 5.0g emits red-light (650 nm) with power of 0.10 W entirely in the backward direction. What velocity (v) in m/sec, will it have accelerated to after 10 years, if released in free space (and assumed to live). Then v is?

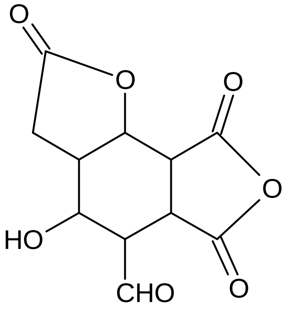
33. In the unbalanced reaction:

$$\mathrm{Al + KMnO_4 + H_2SO_4 \longrightarrow KHSO_4 + Al_2(SO_4)_3 + MnSO_4 + H_2O}$$

If the stoichiometric coefficients of $\mathrm{Al, H_2SO_4, MnSO_4 and\ H_2O}$ are w, x, y and z respectively, the numerical value of $\left(\frac{x}{y}+\frac{z}{w}\right)$ will be

34. In acid rain in Delhi it was found that 1 litre rain water consist of 2.463 litre equimolar mixture of SO_3 and NO_2 gas dissolved at a partial pressure of 0.1 atm. Find out the pH of the solution if HNO_2 produced is 60% dissociated under given condition at $27°C$. (R = 0.0821 litre atm/mole K) (log 1.8 = 0.25)

35. If molecule shown below has molar mass→x then find the mass of CH_3MgBr (in grams) which can react (max.) with $\frac{x}{2}$ grams of compounds $[\text{Mg-24.3,Br-80}]$



36. $H_2C{=}C{=}O \xrightarrow{(1)\,Br_2\,(\text{anddition})\,1eq.} A \xrightarrow[2eq.]{CH_3MgBr} B$ suppose both reactions occur by 100% efficiency then the molar mass of B:

Space for Rough work

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. If $S_1 = \sum_{r=0}^{n} {}^nC_r\left(-\frac{1}{2}\right)^r$; $S_2 = \sum_{r=0}^{n} {}^nC_r\left(-\frac{3}{4}\right)^r$ ....$S_m = \sum_{r=0}^{n} {}^nC_r\left(-\left(\frac{2^m-1}{2^m}\right)\right)^r$ then:

(A) $\sum_{k=1}^{4} S_k = \frac{2^{4n}-1}{2^{4n}\left(2^n-1\right)}$

(B) $\sum_{k=1}^{16} \left(S_k\right)^{\frac{1}{n}} = 1-\frac{1}{2^{16}}$

(C) $\sum_{k=1}^{4} S_k = 1-\frac{1}{2^{16}}$

(D) $\sum_{k=1}^{16} \left(S_k\right)^{\frac{1}{n}} = \frac{1}{15}\left(1-\frac{1}{2^{16}}\right)$

38. If $a,\ b,\ x,\ y$ are positive natural numbers and $\frac{1}{x}+\frac{1}{y}=1$ then $\frac{a^x}{y}+\frac{b^y}{x}$ is same as:

(A) $\frac{xa^y + yb^x}{x+y}$

(B) $\frac{a^x + b^y}{x+y}$

(C) $\frac{a^x}{x}+\frac{b^y}{y}$

(D) $\frac{a^y}{x}+\frac{b^x}{y}$

39. If $\lim\limits_{n\to\infty}\left(\frac{1}{1^2}+\frac{1}{2^2}+.....+\frac{1}{n^2}\right)=\frac{\pi^2}{6}$ *and* $S=\lim\limits_{n\to\infty}\left(\frac{1}{1^3.2^3}+\frac{1}{2^3.3^3}+\frac{1}{3^3.4^3}+........+\frac{1}{n^3.\left(n+1\right)^3}\right)$,

then $S+\pi^2$ is equal to

(A) A non-integral number

(B) An rational number

(C) A transcendental number

(D) An integer

Space for Rough work

40. The ends of a line segment are $P(1,3)$ and $Q(1,1)$. R is a point on the line segment PQ such that $PR:QR = 1:\lambda$. If R is an interior point of the parabola $y^2 = 4x$, then

(A) $\lambda \in (0,1)$

(B) $\lambda \in \left(-\frac{3}{5},1\right)$

(C) $\lambda \in \left(\frac{1}{2},\frac{3}{5}\right)$

(D) None of these

41. $f : N \to A$ and $g : N \to B$ are two onto functions such that $f(n) = \left[n\sec^2\theta\right]$ and $g(n) = \left[n\cos ec^2\theta\right]$, for some θ. If $\sec^2\theta$ is irrational, then (where $[.]$ denotes the greatest integer function)

(A) $A \cap B = \phi$

(B) $A \cup B = N$

(C) f and g are bijective

(D) $A \cap B$ is non-empty finite set

42. A triangle with vertices $P(2,5), Q(5,2)\, and\, R(-1,-1)$ is inscribed in the rectangular hyperbola $xy - x - y - 3 = 0$ and let $H \equiv (\lambda, \lambda)$ is orthocentre of ΔPQR, let $A, B\, and\, C$ be the feet of perpendicular from P, Q and QR, RP and PQ respectively and r is in radius of ΔABC, then

(A) Circumcentre of ΔPQR is $\left(-\frac{3}{2},-\frac{3}{2}\right)$

(B) Incentre of ΔABC is $(3,3)$

(C) Equation of AB is $x + y - \frac{26}{5} = 0$

(D) $r = \frac{2\sqrt{2}}{5}$

Space for Rough work

43. The x that satisfying the equation $\left(2\sec x-1\right)^{\frac{1}{3}}+\left(\sec x-1\right)^{\frac{1}{3}}=1$ can be in the interval

(A) $x\in\left(-\frac{\pi}{3},\frac{\pi}{3}\right)$

(B) $x\in\left(-\frac{\pi}{6},\frac{\pi}{12}\right)$

(C) $x\in\left(\frac{3\pi}{4},\frac{5\pi}{4}\right)$

(D) None of these

44. Let all the letters of the word 'MATHEMATICS' are arranged in all possible order. Three events A, B and C are defined as:
A: Both M are together
B: Both T are together
C: Both A are together
Which of the following hold(s) good?

(A) $P\left(A\right)=P\left(B\right)=\frac{2}{11}$

(B) $P\left(A\cap B\right)=P\left(B\cap C\right)=P\left(C\cap A\right)=\frac{2}{55}$

(C) $P\left(A\cap B\cap C\right)=\frac{4}{495}$

(D) $P\left[\left(A\cap\overline{B}\right)/\overline{C}\right]=\frac{58}{405}$

Space for Rough work

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO (02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

Consider the following equations of curves:

$C_1 : x^2 + y^2 = 4$

$C_2 : y^2 = 8\sqrt{6}x$

$C_3 : \frac{x^2}{1} + \frac{y^2}{5} = 1$

$C_4 : \frac{x^2}{25} - \frac{y^2}{1} = 1$

List-I : Contains the equation of common tangent between two of the given curves
List-II: Contains some information

	List – I		**List – II**
(I)	$y = \sqrt{2}\left(x + \sqrt{6}\right)$	(P)	Is a chord of C_1
(II)	$y = \sqrt{3}x + 2\sqrt{2}$	(Q)	Is not a chord of C_4
(III)	$y = \frac{1}{\sqrt{3}}x + \frac{4}{\sqrt{3}}$	(R)	Common tangent of $C_1 \,\&\, C_3$
(IV)	$y = x + 2\sqrt{6}$	(S)	Common tangent of $C_2 \,\&\, C_4$
		(T)	Common tangent of $C_1 \,\&\, C_2$
		(U)	Common tangent of $C_2 \,\&\, C_3$

45. Which of the following is the only correct combination?

(A) $\text{II} \rightarrow \text{RQ}$ (B) $\text{I} \rightarrow \text{SP}$

(C) $\text{II} \rightarrow \text{PU}$ (D) $\text{I} \rightarrow \text{TP}$

Space for Rough work

46. Which of the following is the only correct combination?

(A) $\text{III} \rightarrow \text{SP}$
(B) $\text{III} \rightarrow \text{RQ}$
(C) $\text{IV} \rightarrow \text{TP}$
(D) $\text{IV} \rightarrow \text{SQ}$

Answer the following by appropriately matching the list based on the information given in the paragraph.

Consider the following functions:

$$f(x) = \frac{32}{4 + x^2 + x^4}$$

$$g(x) = 9 + x^2$$

List-I: Contains new functions defined with the help of given functions
List-II: Contains some information about them

List – I		**List – II**	
(I)	$p(x) = f(x) - g(x)$	(P)	Is an odd function
(II)	$q(x) = (f(x) + g(x))x$	(Q)	Is an even function
(III)	$r(x) = f(x) \cdot g(x)$	(R)	Function never intersect X-axis
(IV)	$s(x) = \frac{f(x)}{g(x)}$	(S)	Range is a subset of $(0, \infty)$
		(T)	Range is a subset of $(-\infty, 0)$
		(U)	Function intersect X-axis exactly once

47. Which of the following is the only correct combination?

(A) $\text{II} \rightarrow \text{PST}$
(B) $\text{I} \rightarrow \text{QUS}$
(C) $\text{II} \rightarrow \text{PRU}$
(D) $\text{I} \rightarrow \text{QRT}$

48. Which of the following is the only correct combination?

(A) $\text{III} \rightarrow \text{QSU}$
(B) $\text{IV} \rightarrow \text{QS}$
(C) $\text{III} \rightarrow \text{QTR}$
(D) $\text{IV} \rightarrow \text{PS}$

Space for Rough work

SECTION – C

(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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49. The value of $\lim\limits_{t\to 0}\ln\left(\frac{1}{t}\int_0^1 \left(1+2\sin 3x\right)^{4/x}dx\right)$ is equal to:

50. Consider a square matrix of order 2 given by $D_{r_1,r_2}=\begin{bmatrix}\tan^{-1}\frac{r_1}{r_2} & -4\\ \cot^{-1}\frac{r_1}{r_2} & 4\end{bmatrix}$ if $\Delta_n=\sum\limits_{r_1=1}^{n}\sum\limits_{r_2=1}^{n}D_{r_1.r_2}$, then find the determinant value of the matrix A defined by $A=\lim\limits_{n\to\infty}\dfrac{\Delta_n}{n^3\sin\left(\frac{\sqrt{\pi}}{n}\right)}$

51. Let $y=f\left(x\right)\left(f:R\to R\right)$ be an explicit function defined by the implicit equation $x^3+y^3+3\left(x^2+y^2\right)+3\left(x+y\right)=14$ and g be the inverse of f. If $f\,\frac{d}{dx}\left(f\left(x+g\left(x\right)\right).g\left(x+f\left(x\right)\right)\right)$ at $x=-1+\sqrt[3]{15}$ is equal $\lambda\left(15\right)^{2/3}$, where $\lambda\in I,$ then find the value of $\left|\lambda\right|$:

Space for Rough work

52. If l_1 and l_2 are the least and greatest distance between parallel tangents drawn to the curve $f(x) = x - \sin x$ where $x \in \left(\frac{-\pi}{6}, \frac{13\pi}{6}\right)$, then find the value $(l_1 + l_2)$.

[Use: $\pi = 3.14$]

53. If $\sum_{n=0}^{\infty} \tan^{-1}\left(\frac{\cot^{-1}(n^2+3n+3)}{1+\cot^{-1}(n+1)\cot^{-1}(n+2)}\right) = \tan^{-1}\left(\frac{p}{4}\right)$ then find the value of $\cos^{-1}(\cos(p-1))$

.

[Use: $\pi = 3.14$]

54. If $z_1, z_2, z_3 \in \mathbb{C}$ satisfy the system of equations given by $|z_1| = |z_2| = |z_3| = 1,\ z_1 + z_2 + z_3 = 1$ $and\ z_1z_2z_3 = 1$ such that $\operatorname{Im}(z_1) < \operatorname{Im}(z_2) < \operatorname{Im}(z_3)$ then find the value of $|z_1 + z_2^2 + z_3^3|$ is.

Space for Rough work

FIITJEE

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CONCEPT RECAPITULATION TEST – IV

JEE (Advanced)-2020

PAPER – 2

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. AC

Sol. For first refraction

$$\frac{\mu_2}{V} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

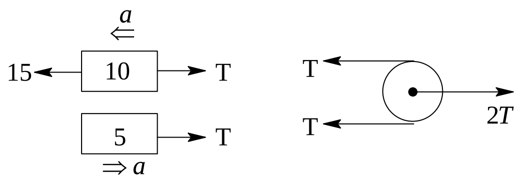
$$\frac{2}{v} - \frac{1}{\alpha} = \frac{2-1}{R} \Rightarrow v = 2R$$

As 45° is greater than critical angle of 30° so the rays gets totally reflected at the second face. So the plane surface will behave like plane mirror.

2. ACD

Sol. $15 - T = 10a$

$$T = 5a$$



So, $a = 1 m/s^2$

and $T = 5N$

So, $2T = 10N$

3. BC

Sol. As the plank retards 1kg block will move relative to the plank but 2kg block will remain at rest distance travelled by 1kg block in 1 sec.

$$S_r = \frac{1}{2} \times a_r \times t^2 = \frac{1}{2} m$$

Relative velocity of 1kg after 1 sec $V_r = 1 m/s$

Then using conservation of linear momentum and Newtons experimental Law

$$V_1 + 2V_2 = 1 ----(1)$$

$$V_1 - V_2 = -\frac{1}{2} ----(2)$$

$$\Rightarrow V_1 = 0 \;\&\; V_2 = \frac{1}{2}\,\text{m/s}$$

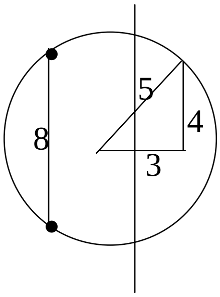
Final separation between blocks $= \frac{(1/2)^2}{2 \times 2} = \frac{1}{16} m$

4. AD

5. AC

6. AB

Sol. $16 \times 10^{-3} = 2T \times l$



$$l = \frac{16 \times 10^{-3}}{2 \times 0.1}$$

$$= 8cm$$

$\Rightarrow$ distance from centre = 3cm

$\Rightarrow 5 + 3 \; or \; 5 - 3cm$

7. ACD

8. ABD

Sol. Degree of freedom of He = 3

Degree of freedom of H_2 = 5

Average degree of freedom $= \frac{3 \times 2 + 5 \times 2}{2 + 2} = 4$

Now $\gamma = 1 + \frac{2}{f} = \frac{3}{2}$

For adiabatic process $\Delta Q = 0$ and $PV^{\gamma} = \text{constant}$ or $TV^{\gamma - 1} = \text{constant}$

From first law $\Delta U = \Delta W$ $[\because \Delta Q = 0]$

9. A

10. C

11. A

12. C

SECTION – C

13. 00022.00

Sol. Motion will start when $\mathrm{F} \geq \mu_s mg$ at $t = 1s$

After that $F - \mu_k mg = ma$

$$3t^2 - 2 = a \ or \ 3t^2 - 2 = \frac{dv}{dt}$$

$$\Rightarrow v = \int_1^3 \left(3t^2 - 2\right) dt = 22 \, m/s$$

14. 00128.00

Sol. $$\theta = \frac{14 \times 10^8}{1.5 \times 10^{11}} = \frac{14}{1.5} \times 10^{-3}$$

$$\omega = \frac{2\pi}{24 \times 3600}$$

$$t = \frac{\theta}{\omega}$$

$$t = \frac{14}{1.5} \times 10^{-3} \times \frac{24 \times 3600}{2\pi}$$

$$t = \frac{14 \times 8 \times 3.6}{\pi} \simeq 128 \sec$$

15. 00017.00

Sol. $0 = 20 - 10t' \Rightarrow t' = 2 \sec$

$45 = 5t''^2 \Rightarrow t'' = 3$

So, $t_1 = 2 + 5 \times 3 = 17 \sec$

16. 00002.00

17. 00040.00

Sol. Maximum acceleration $= \omega^2 A = g$

$$A = \frac{g}{\omega^2} = 40 \, cm$$

18. 00464.00

Sol. $75000 \times 10^{-10} \times T_{\max} = 3 \times 10^{-3}$

$\Rightarrow T_{\max} = 400 \, K = T_B$

$$\frac{T_A - 400}{\frac{1}{K} \times \frac{l}{A}} = \sigma A T_B^4 \quad \Rightarrow T_A = 464K$$

Chemistry PART – II

SECTION – A

19. B

20. CD

Sol. Electrolysis of molten LiH only gives H_2 at anode and the other hydrides tend to decompose before they melt. NaH has crystal structure similar to $NaCl$

21. BCD

Sol. (B) PV = nRT

$$P = \frac{nRT}{V} \therefore \ln p = \ln nRT - \ln V$$

$$\Rightarrow \log_{10} P = \log_{10}(nRT) - \log_{10}(V)$$

$\therefore$ slope = – 1

Intercept value = ln(nRT)

$$= \ln\left(1 \times 0.0821 \times \frac{1}{0.0821}\right) = 0$$

(C) PM = dRT

$$\frac{p}{d} = \frac{RT}{m} = \frac{1}{m} = \frac{1}{100} = 0.01$$

(D) $PV^2 = nRTV$

Slope = nRT $\Rightarrow$ 1

22. ABCD

Sol. Calculation of mol. wt. of BOH:

eq. of the base = eq. of H_2SO_4 used

$$\frac{0.496}{m_B} \times 1 = 40 \times 10^{-3} \times \frac{1}{2} \times 2 \Rightarrow m_B = 12.4 \text{ gmol}^{-1}$$

Now:

$$\Delta T_f = i \times K_f \times m$$

$$0.165 = i \times 1.86 \times \frac{1.5}{12.4} \times \frac{1000}{150}$$

$$i = \frac{0.165 \times 12.4}{1.86} = 1 - 1 = 1 + \alpha \therefore \alpha = 0.1$$

So, $\left(OH^-\right) = C\alpha = 0.08 \times 0.1 = 8 \times 10^{-3}$ $\therefore pH = 11.903$

So, $K_b = C\alpha^2 = 0.8 \times (0.1)^2 = 8 \times 10^{-4}$

Also, $\pi = iCRT$

$= 1.1 \times 0.08 \times 0.0821 \times 300$

= 2.167 atm

23. BD

Sol. $3CS_2 + 6\ NaOH \longrightarrow Na_2CO_3 + 2Na_2CS_3 + 3H_2O$

24. ACD

Sol. From the given expression, $\Delta G^\circ = +4.73$ KJ / mol & RT = + 2.5 KJ/mol.

This gives T = 300 K

Initially, $P_{NO_2} \to 0$ hence $\dfrac{P^2_{NO_2}}{P_{N_2O_4}} \to 0$ & $\ln\left[\dfrac{P^2_{NO_2}}{P_{N_2O_4}}\right] \to -\infty$

Hence ΔG expression is (–)ve & reaction moves in forward direction spontaneously.

Mole fraction of N_2O_4 is much larger than that of NO_2. Thus $P_{N_2O_4} > P_{NO_2}$

But for $\dfrac{P^2_{NO_2}}{P_{N_2O_4}}$ we can't say, hence comparison of K_p value = + antilog $\left[\dfrac{-\Delta G^0}{RT}\right] = 1.909$ with

$Q_P = \dfrac{P^2_{NO_2}}{P_{N_2O_4}}$ is inclusive. Hence $Q_P > K_P$ or $Q_P < K_P$ or even $Q_P = K_P$ can be possible

25. ABCD

Sol. $X \to Sn(OH)Cl$

$Y \to Sn(OH)_2$

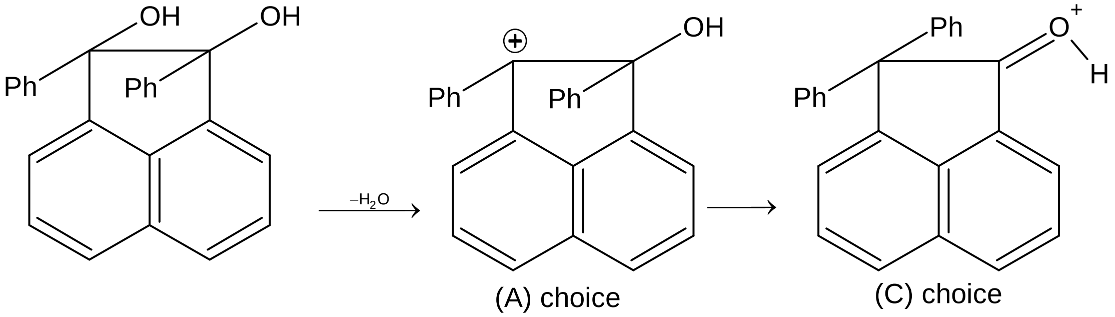
$Z \to Na_2SnO_2$

P → Au

Q → HI

26. AC

Sol.



(A) choice (C) choice

Hence (A) and (C) are correct while (B) and (D) are incorrect.

27. D

28. C

Sol. (for Q. 27-28)

A – (i), (ii), (iii)

B – (iv), (vi)

C – (i), (iii), (ix)

D – (iii), (vii)

29. C

30. C

Sol. (for Q. 29-30)

A – (ii, iii, v)

B – (I, iv)

C – (vi, vii)

D – (ii, iii)

SECTION – C

31. 00000.09

Sol.
$$\underset{1-\alpha}{\overset{1}{PCl_5}} \rightleftharpoons \underset{\alpha}{\overset{0}{PCl_3}} + \underset{\alpha}{\overset{0}{Cl_2}}$$

$$1+\alpha = \frac{D}{d}$$

$$1+\alpha = \frac{250.2}{208.5}$$

$$\alpha = 0.2$$

Mole of PCl_5 = 0.8, PCl_3 Cl_2 = 0.2

$$\therefore K = \frac{0.2\times 0.2}{0.8} = \frac{1}{20}$$

Now, when it transferred to 2L vessel reaction proceeds in forward direction.

$$\underset{0.8-x}{PCl_5} \rightleftharpoons \underset{0.2+x}{PCl_3} + \underset{0.2+x}{Cl_2}$$

$$\frac{(0.2+x)^2}{(0.8-x)\times 2} = \frac{1}{20}$$

$$\therefore x = 0.07$$

Degree of dissociation $= \frac{0.07}{0.08} = 0.0875(\text{approx}) = 0.09$

32. 00021.00

Sol. According to the law of conservation of momentum, momentum lost by photons
= momentum gained by glow-worm
Momentum lost by photons
= no of photons x momentum lost by one photon

$$= \frac{\text{Total energy}}{\text{energy of 1photon}}\times\frac{h}{\lambda}\left[\text{Debroglie' equation } \lambda = \frac{h}{p}.p = \frac{h}{\lambda}\right]$$

$$= \frac{\text{power}\times\text{time}}{\frac{hc}{\lambda}}\times\frac{h}{\lambda}$$

$$= \frac{\cancel{\lambda}}{\cancel{h}c}\times\text{power}\times\text{time}\times\frac{\cancel{h}}{\cancel{\lambda}}$$

$$= \frac{0.1\times 365\times 24\times 60\times 60\times 10}{3\times 10^8} \Rightarrow (1)$$

Momentum gained by glow-worm = $\frac{5}{1000}\times(v)\,\text{in m/sec} \longrightarrow (2)$

(1) = (2)

Hence v = 21 m/sec

Ans. $\frac{v}{7} = 3$.

33. 00006.90

Sol. $10Al + 6KMnO_4 + 27H_2SO_4 \longrightarrow 6KHSO_4 + 5Al_2(SO_4)_3 + 6MnSO_4 + 24H_2O$

34. 00001.75

Sol: H_2SO_4 produced = $\dfrac{2.463\times 0.01}{2\times 0.0821\times 300} = \dfrac{10^{-2}}{2}\text{M}$

$2NO_2 + H_2O \rightleftharpoons HNO_2 + HNO_3$

Conc. of $NO_2 = \dfrac{10^{-2}}{2}\text{M}$

So $HNO_2 = \dfrac{10^{-2}}{2}\text{M}$

$HNO_3 = \dfrac{10^{-2}}{2}\text{M}$

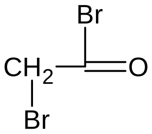
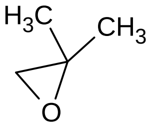
Net $\left[H^+\right] = \dfrac{10^{-2}}{2}\times 2 + \dfrac{10^{-2}}{2} + \dfrac{10^{-2}}{2}\times\dfrac{60}{100} = 1.8\times 10^{-2}$

pH = 1.75

35. 00357.90

Sol. One mole of compound consume 6 moles of CH_3MgBr so half mole will consume 3 moles of CH_3MgBr

36. 00072.00

Sol. A is 
$CH_2Br{-}C(Br){=}O$
and B is 

Mathematics PART – III

SECTION – A

37. AB

Sol.
$$S_m = \sum_{r=0}^{n} {}^nC_r \left[-\left(\frac{2^m-1}{2^m}\right)\right]^r$$
$$S_m = \left[1-\left(\frac{2^m-1}{2^m}\right)\right]^n$$
$$S_m = \left(\frac{1}{2^m}\right)^n$$
$$\therefore \sum_{k=1}^{4} S_k = \left(\frac{1}{2}\right)^n + \left(\frac{1}{4}\right)^n + \left(\frac{1}{8}\right)^n + \left(\frac{1}{16}\right)^n$$
$$= \frac{\left(\frac{1}{2}\right)^n \left[1-\left(\frac{1}{2}\right)^{4n}\right]}{1-\frac{1}{2^n}}$$
$$= \frac{2^{4n}-1}{2^{4n}\left(2^n-1\right)}$$

38. ACD

Sol.
$$\frac{1}{x}+\frac{1}{y}=1$$
$$\Rightarrow x+y=xy$$
$$\Rightarrow (x-1)(y-1)=1$$
$$\Rightarrow x=2, \quad y=2$$

39. BD

Sol. Let
$$t_r = \left(\frac{1}{r(r+1)}\right)^3 = \left(\frac{1}{r}-\frac{1}{r+1}\right)^3 = \frac{1}{r^3}-\frac{1}{(r+1)^3}-\frac{3}{r(r+1)}\left(\frac{1}{r(r+1)}\right)$$
$$= \frac{1}{r^3}-\frac{1}{(r+1)^3}-3\left(\frac{(r+1)-r}{r(r+1)}\right)^2, \quad t_r = \frac{1}{r^3}-\frac{1}{(r+1)^3}-3\left(\frac{1}{r^2}+\frac{1}{(r+1)^2}\right)+6\left(\frac{1}{r}-\frac{1}{r+1}\right)$$
$$\sum_{r=1}^{n} t_r = \left(1-\frac{1}{(n+1)^3}\right)-3\left(\frac{\pi^2}{6}+\frac{\pi^2}{6}-1\right)+6\left(1-\frac{1}{n+1}\right)$$
$$\lim_{n\to\infty}\sum t_r = 10-\pi^2$$

40. ABC

Sol. $R = \left(1, \frac{1+3\lambda}{1+\lambda}\right)$, $\quad \therefore \left(\frac{1+3\lambda}{1+\lambda}\right)^2 - 4 < 0 \qquad \Rightarrow \lambda \in \left(-\frac{3}{5}, 1\right)$

41. ABC

Sol. Since $\sec^2\theta > 1$

$\Rightarrow \left[(n+1)\sec^2\theta\right] > \left[n\sec^2\theta\right]$

Hence, f *and* g are both one-one

Let $k < n\sec^2\theta < k+1 \, and \, k < m\cos ec^2\theta < k+1$

$k\cos^2\theta < n < (k+1)\cos^2\theta \, and \, k\sin^2\theta < m < (k+1)\sin^2\theta$

Adding gives $k <$ integer $< k+1$

$\Rightarrow A \cap B = \phi$

Suppose $k \notin A$

$\Rightarrow n\sec^2\theta < k \, and \, (k+1) < (n+1)\sec^2\theta$

$\Rightarrow n < k\cos^2\theta and \, n+1 > (k+1)\cos^2\theta$

$\Rightarrow k < (k-n)\cos ec^2\theta, k+1 > (k-n)\cos ec^2\theta$

$\Rightarrow \left[(k-n)\cos ec^2\theta\right] = k$

$\Rightarrow k \in B$

42. BCD

Sol. Orthocentre of ΔPQR lies on hyperbola

$\Rightarrow \lambda = 3$

Incentre of ΔABC is orthocentre of ΔPQR

Equation of AB is $x + y - \frac{26}{5} = 0$

43. AB

Sol. $(3\sec x - 2) + 3(2\sec x - 1)^{\frac{1}{3}}(\sec x - 1)^{\frac{1}{3}} = 1$

$\Rightarrow (2\sec x - 1)^{\frac{1}{3}}(\sec x - 1)^{\frac{1}{3}} = (1 - \sec x)$

$(2\sec x - 1)^{\frac{1}{3}} = -(\sec x - 1)^{\frac{2}{3}} \, or \sec x - 1 = 0$

$\Rightarrow x = 2n\pi, n \in 1$

44. ABCD

45. C

46. B

47. D

48. B

SECTION – C

49. 00024.00

Sol. $$l = \ln \lim_{t\to 0} \frac{\int_0^t (1+2\sin 3x)^{4/x}\, dx}{t}$$

$$= \ln \lim_{t\to 0} (1+2\sin 3t)^{4/t}$$ (Using L' Hospital's rule)

$$= \ln e^{\lim_{t\to 0}\frac{4}{t}(2\sin 3t)}$$

$$= \lim_{t\to 0} \frac{2.3.4.\sin 3t}{3t} = 24$$

50. 00002.00

51. 00000.00

Sol. $$(x+1)^3 + (y+1)^3 = 16$$

$$y = -1 + \left(16-(x+1)^3\right)^{1/3} = f(x)$$

$$x = -1 + \left(16-(y+1)^3\right)^{1/3}$$

$$\therefore f^{-1}(x) = -1 + \left(16-(x+1)^3\right)^{1/3} = g(x)$$

$$\Rightarrow f(x) = g(x)$$

$$f\left(-1+\sqrt[3]{15}\right) = g\left(-1+\sqrt[3]{15}\right) = 0$$

$$\left(f\left(x+g(x)\right).g\left(x+f(x)\right)\right) = \left(f\left(x+f(x)\right)\right)^2$$

$$\frac{d}{dx}\left(f\left(x+f(x)\right)\right)^2 = 2f\left(x+f(x)\right)$$

$$f'\left(x+f(x)\right).\left(x+f'(x)\right)$$

$$\frac{d}{dx}\left(f\left(x+f(x)\right)\right)^2 \; at \;\; x = -1+\sqrt[3]{15} = 0$$

52. 00007.70

Sol. $$f(x) = x - \sin x$$

$$f'(x) = 1 - \cos x$$

$$f'(x) = 0 \Rightarrow 1-\cos x = 0$$

$$\Rightarrow \cos x = 1$$

$$x = 0, 2\pi$$

$y = 0$ *and* $y = 2$ are two parallel tangents and distance between them $l_1 = 2\pi$

Also other two parallel tangents are parallel to the line $y = x$

$$f'(x) = 1 \Rightarrow 1-\cos x = 1 \quad \Rightarrow \cos x = 0 \quad \Rightarrow x = \frac{\pi}{2}, \frac{3\pi}{2}$$

Tangent at $x = \frac{\pi}{2}$

$$y - \left(\frac{\pi}{2} - 1\right) = 1\left(x - \frac{\pi}{2}\right)$$

$$x - y = 1$$

$$l_2 = 2\left|\frac{1}{\sqrt{2}}\right| = \sqrt{2}$$

$$\therefore l_1 + l_2 = 2\pi + \sqrt{2} = 7.70$$

53. 00002.14

Sol. $$\sum_{n=0}^{\infty} \tan^{-1}\left(\frac{\tan^{-1}\left(\frac{(n+2)-(n+1)}{1+(n+1)(n+2)}\right)}{1+\tan^{-1}\left(\frac{1}{n+1}\right)\tan^{-1}\left(\frac{1}{n+2}\right)}\right)$$

$$= \sum_{n=0}^{\infty} \tan^{-1}\left(\frac{\tan^{-1}\left(\frac{1}{n+1}\right) - \tan^{-1}\left(\frac{1}{n+2}\right)}{1+\tan^{-1}\left(\frac{1}{n+1}\right).\tan^{-1}\left(\frac{1}{n+2}\right)}\right)$$

$$= \sum_{n=0}^{\infty}\left(\tan^{-1}\left(\frac{1}{n+1}\right)\right) - \tan^{-1}\left(\tan^{-1}\left(\frac{1}{n+2}\right)\right)$$

$$= \tan^{-1}\left(\tan^{-1}(1)\right) = \tan^{-1}\left(\frac{\pi}{4}\right)$$

$$\therefore p = \pi$$

$$\cos^{-1}\left(\cos(\pi - 1)\right) = \pi - 1 = 2.14$$

54. 00002.24

Sol. Since $z_1 + z_2 + z_3 = 1$

$$\Rightarrow \overline{z_1 + z_2 + z_3} = 1$$

$$\Rightarrow \frac{1}{z_1} + \frac{1}{z_2} + \frac{1}{z_3} = 1 \qquad \Rightarrow z_2z_3 + z_3z_1 + z_1z_2 = 1$$

Now, consider a cubic equation having roots z_1, z_2, z_3

$$(z - z_1)(z - z_2)(z - z_3) = z^3 - (z_1 + z_2 + z_3)z^2 + (z_1z_2 + z_2z_3 + z_3z_1)z - z_1z_2z_3 = 0$$

$$\Rightarrow z^3 - z^2 + z - 1 = 0$$

$$\Rightarrow z^2(z-1) + 1(z-1) = 0$$

$$\Rightarrow z = 1, z = \pm\, i$$

$$\therefore \text{Roots } z_1 = -i \quad z_2 = 1 \quad z_3 = i$$

$$\left|z_1 + z_2^2 + z_3^3\right| = \sqrt{5}$$

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – IV

JEE (Main)-2020

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 75 questions.
- Each subject (PCM) has 25 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only three sections: **Section-A**, **Section-B and Section-C**.

Section-A (01 – 20, 26 – 45, 51 – 70) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-B (21 – 22, 46 – 47, 71 – 72) *contains 6 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

Section-C (23 – 25, 48 – 50, 73 – 75) *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. If A × B = C, then which of the following statements is wrong-

(A) $C \perp A$ (B) $C \perp B$

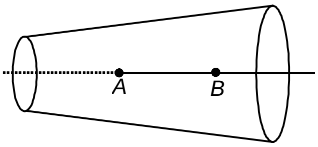
(C) $C \perp (A + B)$ (D) $C \perp (A \times B)$

2. A particle moving in a straight line is acted by a force, which works at a constant power and changes its velocity from u to v in passing over a distance x. The time taken will be:

(A) $x\left(\frac{v-u}{v^2+u^2}\right)$ (B) $x\left(\frac{v+u}{v^2+u^2}\right)$

(C) $\frac{3}{2}x\left(\frac{v^2-u^2}{v^3-u^3}\right)$ (D) $x\left(\frac{v}{u}\right)$

3. A resistance of frustum shape is shown in figure. If a current *i* passes through the resistance, the electric field at *A* and *B* are related as



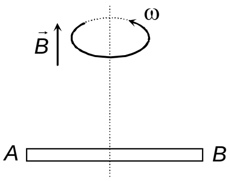
(A) $E_A > E_B$

(B) $E_B > E_A$

(C) $E_A = E_B$

(D) there is no relation

4. A conducting rod of length 2*l* is rotating with constant angular speed ω about its perpendicular bisector. A uniform magnetic field $\vec{B}$ exists parallel to the axis of rotation. The emf induced between two ends of the rod is

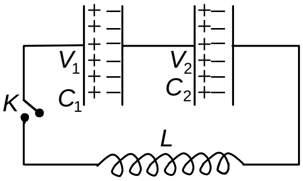


(A) $B\omega l^2$ (B) $\frac{1}{2}B\omega l^2$

(C) $\frac{1}{8}B\omega l^2$ (D) zero

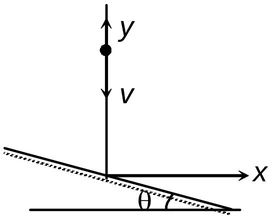
Space for Rough work

5. Two capacitors of capacitance C_1 and C_2 are charged to a potential difference of V_1 and V_2 respectively and are connected to an inductor of inductance *L* as shown in the figure. Initially key *k* is open. Now key *k* is closed and current in the circuit starts increasing. When current in the circuit is maximum



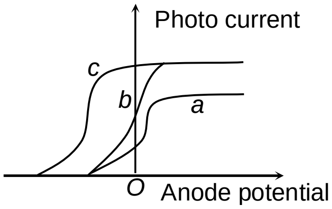
(A) charge on both the capacitors is same
(B) induced emf in the inductor is zero
(C) potential difference across both the capacitors is half of the induced emf
(D) electrostatic potential energy stored in both the capacitors is same

6. An object is moving towards a mirror with a velocity *v* as shown in figure. If the collision between the mirror and the object is perfectly elastic, then the velocity of the image after collision with mirror in vector form is



(A) $-v\hat{j}$
(B) $-v\cos 2\theta\hat{j} + v\sin 2\theta\hat{i}$
(C) $-v\hat{i}$
(D) $-v\cos 2\theta\,\hat{j} - v\sin 2\theta\hat{i}$

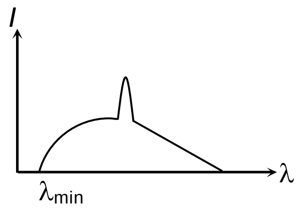
7. The figure shows the variation of photo current with anode potential for a photo-sensitive surface for three different radiations. Let I_a, I_b and I_c be the intensities and f_a, f_b and f_c be the frequencies for the curves *a*, *b* and *c* respectively;



(A) $f_a = f_b$ and $I_a \neq I_b$
(B) $f_a = f_c$ and $I_a = I_C$
(C) $f_a = f_b$ and $I_a = I_b$
(D) $f_b = f_c$ and $I_b = I_c$

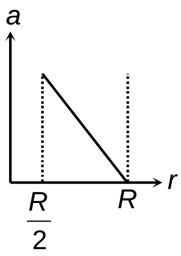
Space for Rough work

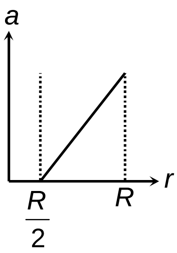
8. An X-ray tube has three main controls.
(i) the target material (its atomic number *Z*)
(ii) the filament current (I_f) and
(iii) the accelerating voltage (V)
Figure shows a typical intensity distribution against wavelength. Which of the following is incorrect?

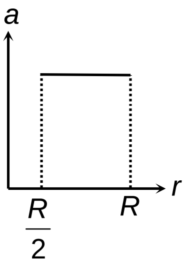


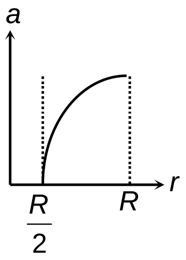
(A) The limit λ_{min} is proportional to V^{-1}
(B) The sharp peak shifts to the right as *Z* is increased
(C) The penetrating power of *X* ray increases if *V* is increased
(D) The intensity everywhere increases if filament current I_f is increased

9. A frictionless tunnel is dug along a chord of the earth at a perpendicular distance $\frac{R}{2}$ from the centre of earth (where *R* is radius of earth). An object is released from one end of the tunnel. The correct graph, showing the variation of acceleration of particle with its distance *r* from centre of earth is

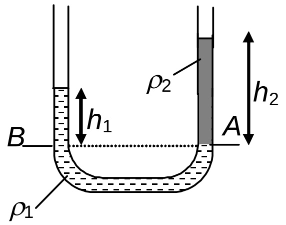
(A)


(B)


(C)


(D)


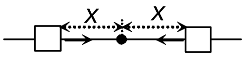
10. Two immiscible liquids are poured in a *U*-tube having densities ρ_1 and ρ_2. The ratio of height of the liquids above their interface (h_1/h_2) is



(A) directly proportional to their densities
(B) inversely proportional to their densities
(C) directly proportional to square of their densities
(D) equal

Space for Rough work

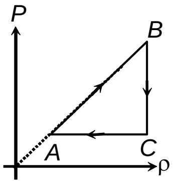
11. Two particles are performing simple harmonic motion with same amplitude and same frequency. When they are at same distance from mean position on opposite sides, their speeds are one fourth of maximum speed. Also at these positions their direction of velocities are opposite, the phase difference between the two simple harmonic motions is



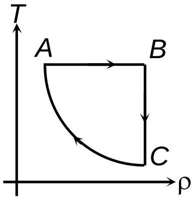
(A) $\frac{\pi}{2}$ (B) π

(C) $\frac{3\pi}{2}$ (D) $\frac{5\pi}{4}$

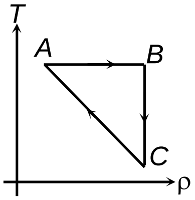
12. Pressure versus density of an ideal gas is shown in the graph. Then the correct temperature versus density of gas graph is



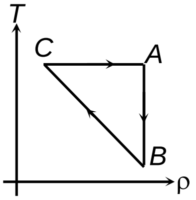
(A)



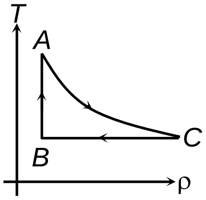
(B)



(C)



(D)



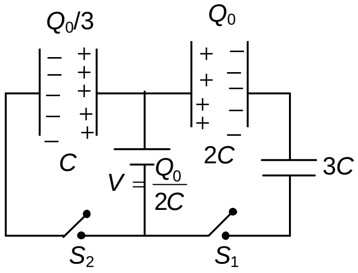
13. P-V diagram of a diatomic gas is straight line parallel to P-axis. The molar heat capacity of the gas in the process will be

(A) $4R$ (B) $2.5\ R$

(C) $3R$ (D) $4R/3$

Space for Rough work

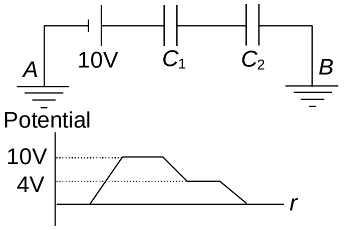
14. In the given circuit, the initial charges on the capacitors are shown in the figure. The charge flown through the switches S_1 and S_2 respectively after closing the switches are



(A) zero, $\frac{Q_0}{6}$ (B) $\frac{Q_0}{5}$, $\frac{Q_0}{2}$

(C) zero, $\frac{Q_0}{2}$ (D) $\frac{3}{5}Q_0$, $\frac{Q_0}{6}$

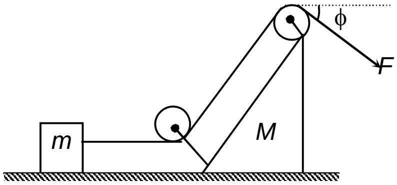
15. Figures shows two capacitors C_1 and C_2 connected with 10 V battery and terminal *A* and *B* are earthed. The graph shows the variation of potential as one moves from left to right. Then the ratio of C_1/C_2 is



(A) 5/2 (B) 2/3

(C) 2/5 (D) 4/3

16. In the given arrangement pulleys and string are massless and frictionless and all surfaces are smooth. Find the magnitude of acceleration of wedge of mass *M*.



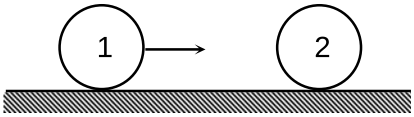
(A) $\frac{F\cos\phi}{M}$

(B) $\frac{F(1-\cos\phi)}{M}$

(C) $\frac{F}{m+M}$

(D) $\frac{F\cos\phi}{m+M}$

17. Ball 1 collides with an another identical ball 2 at rest as shown in figure. For what value of coefficient of restitution *e*, the velocity of second ball becomes two times that of 1 after collision?

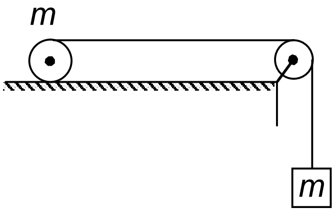


(A) 1/3 (B) 1/2

(C) 1/4 (D) 1/6

Space for Rough work

18. In the given figure a ring of mass *m* is kept on a horizontal surface while a body of equal mass '*m*' attached through a string, which is wounded on the ring. When the system is released the ring rolls without slipping. Consider the following statements and choose the correct option.



(i) acceleration of the centre of mass of ring is $2g/3$

(ii) acceleration of the hanging particle is $4g/3$

(iii) frictional force (on the ring) acts along forward direction

(iv) frictional force (on the ring) acts along backward direction

(A) statement (i) and (ii) only (B) statement (ii) and (iii) only
(C) statement (iii) and (iv) only (D) none of these

19. A uniform rope of length 12 metre & mass 6 kg, is swinging vertically from rigid base. From its free end, one 2 kg mass is attached. At its bottom end one transverse wave is produced of wavelength 0.06 metre. At upper end of rope, wavelength will be-

(A) 1.2 m (B) 0.12 m
(C) 0.12 cm (D) 0.12 mm

20 In a two slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance from the plane of slits. If the screen is moved by 5×10^{-2} m towards the slits, the change in fringe width is 3×10^{-5} cm. If the distance between the slits is 10^{-3} m, calculate the wavelength of the light used.

(A) 7000Å (B) 5000Å
(C) 6000Å (D) 4000Å

Space for Rough work

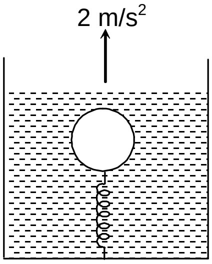
SECTION – B

(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

---

21. A ball of mass 10 kg and density 1 gm/cm^3 is attached to the base of a container having a liquid of density 1.1 gm/cm^3, with the help of a spring as shown in the figure. The container is going up with an acceleration 2 m/s^2. If the spring constant of the spring is 200 N/m, the elongation in the spring is: (in cm)
(A) 2 cm (B) 4 cm
(C) 6 cm (D) 8 cm



22. A very small sphere of mass 80 g having a charge q is held at a height 9 m vertically above the centre of a fixed non conducting sphere of radius 1 m, carrying an equal charge q. When released it falls until it is repelled just before it comes in contact with the sphere. Calculate the charge q is $7 \times K$. The value of K is:
(in μC) [g = 9.8 m/s^2]

SECTION – C

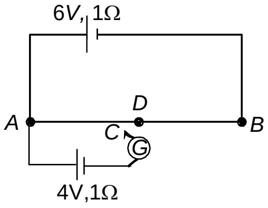
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

23. The dimensional formula of a physical quantity x is $\left[M^{-1}L^{3}T^{-2}\right]$. The error in measuring the quantities M, L, and T are 2%, 3% and 4%. The maximum percentage of error that occurs in measuring, the quantity x is:

24. A 6 volt battery of internal resistance 1Ω is connected across a uniform wire AB of length 100 cm. The positive terminal of another battery of emf 4V and internal resistance 1Ω is joined to the point A as shown. Find the distance of point D from A if there is no current through galvanometer. (resistance of *AB* = 5Ω)



25. A brass scale is graduated at 10ºC. What is the true length of a zinc rod which measures 60.00 cm on this scale at 30ºC. Coefficient of linear expansion of brass = 18 × 10^{-6} K^{-1}.

Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

26. 0.15 M aqueous solution of potassium sulfate has on osmotic pressure of 8.21 atm at 27°C. Which of the following is correct about the properties of solution?

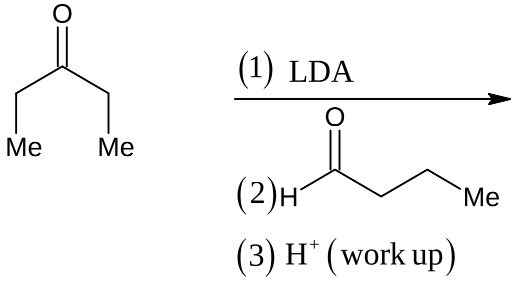
(A) The value of Vant Hoff factor of K_2SO_4 is 3.

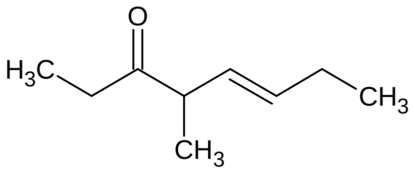
(B) The value of i for K_2SO_4 is less than 3 due to partial dissociation of solute.

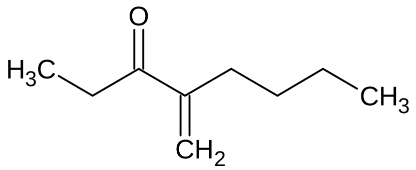
(C) The value of i for K_2SO_4 is more than 3 due to complete dissociation of solute.

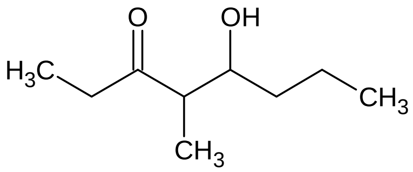
(D) The freezing point o solution would be more than 0°C.

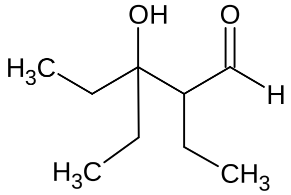
27. Provide the product of the following crossed aldol reaction?



(A)


(B)


(C)


(D)


Space for Rough work

28. A solution is made by equilibrating the two solids barium sulfite $\left(K_{sp}=8\times10^{-7}\right)$ and barium sulfate $\left(K_{sp}=1.0\times10^{-8}\right)$ with water. What are the concentrations of the three ions at equilibrium, if same of each of the solids remain?

(A) $\left[Ba^{2+}\right]=9\times10^{-4}M$

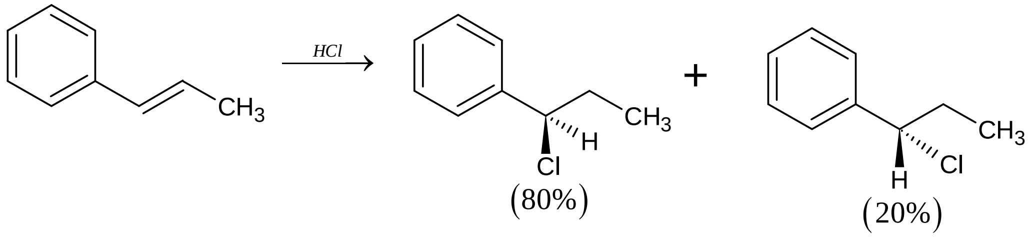
(B) $\left[SO_4^{2-}\right]=\frac{1}{9}\times10^{-3}M$

(C) $\left[SO_3^{2-}\right]=\frac{1}{9}\times10^{-3}M$

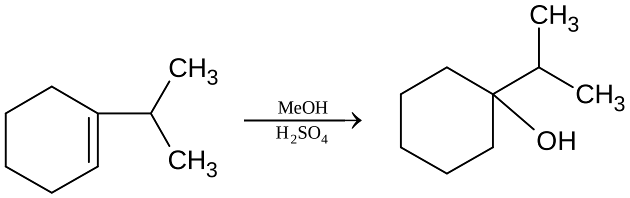
(D) All are correct.

29. Which of the following reactions are correctly matched with the product?

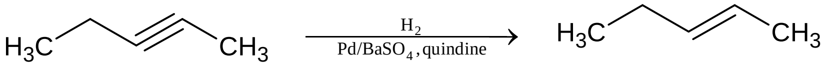
(A)


CH3
HCl
H
CH3
Cl
(80%)
+
CH3
Cl
H
(20%)

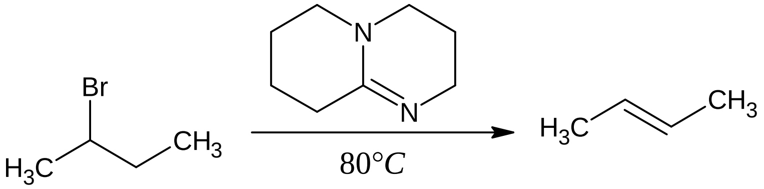
(B)


CH3
CH3
MeOH
H2SO4
CH3
CH3
OH

(C)


H3C
CH3
H2
Pd/BaSO4, quindine
H3C
CH3

(D)


Br
H3C
CH3
N
N
80°C
H3C
CH3

Space for Rough work

30. If we take into account electron spin we effectively double the number of available quantum states for a given set of quantum numbers n, ℓ, m_ℓ. Including spin, how many different quantum states are accessible to an electron with $n = 2$?

(A) 6
(B) 2
(C) 8
(D) 4

31. What is potentially, this single most important property/ability of all matter/material that causes them to react?

(A) Gibbs energy
(B) Enthalpy of formation
(C) Entropy of compound
(D) Octet rule.

32. What is the change in pressure when 10 grams of molecule A (mw=150 g/mol) reacted with 200ml of 0.20M solution of B and the resulting gas fills a volume of 200ml vessel at 300K?

$$2A(s) + B(aq.) \longrightarrow X(g) + 2Y(aq.)$$

(A) $5.105 atm$
(B) $4.105 atm$
(C) $2.05 atm$
(D) $2.0547 atm$

33. Which of the following element is not correctly matched with its compound?

(A) The chloride XCl_3 is oxidizing, but XCl is stable and insoluble in water: $T\ell$

(B) The oxide XO_2 has high melting point and is very abundant in nature: Si

(C) X (group 14) forms compounds mainly in +2 oxidation state, through some compounds in the state +4 do exist: Sn

(D) X_4 exists in various allotropic forms and one of the allotrope shows disproportionation reaction with $\mathrm{NaOH} : P$

34. $\mathrm{CoCl_2.6H_2O(s)}$ salt is dissolved in water, which of the following statement is incorrect about this solution:

(A) When 12 M HCl is added to the solution, its color changes to blue.
(B) When the solution is heated, the color of solution becomes blue.
(C) On adding large amount of water, the color of solution becomes pink.
(D) On passing $H_2S(g)$ through the solution, pink colored ppt is formed.

Space for Rough work

35. A volume of 4.0 L of gases A(g) and B(g) react to form solid C(s). During the reaction, the system looses 1150J of heat to the surroundings. The volume of the system is negligibly small at the end of the reaction as the gases disappear under atmospheric pressure. What is the change in internal energy of the system?

(A) $-1150J$
(B) $-744.7J$
(C) $-1555.3J$
(D) $+1150J$

36. $\underset{(1:20)}{Xe+F_2} \xrightarrow[60\text{-}70\,bar]{300^oC} 'A'$ $A+H_2O \longrightarrow B+2HF$

$A+2H_2O \longrightarrow C+4HF$

$A+6H_2O \longrightarrow D+6HF$

Which of the following statement is correct about the structure of Xe compounds?

(A) Compound B has square pyramidal geometry
(B) Compound C has two lone pairs on control atom.
(C) Compound D is XeO_4.
(D) Compound A has square planer geometry.

37. Which of the ore is correctly matched with its chemical group present?

(A) Cuprite : Sulphate ore
(B) Cerussite : carbonate ore
(C) Kainite : Oxide ore
(D) Calmine : Chloride ore

38. Which of the following combinations in an aqueous medium will give a red colour or precipitate?

(A) $Fe^{2+} + \left[Fe(CN)_6\right]^{3-}$
(B) $Co^{2+} + SCN^-$
(C) $Cu^{2+} + OH^-$
(D) $Fe^{3+} + SCN^-$

39. The value of CFSE of the complex formed in Brown ring test is:

(A) $-1.8\Delta_o$
(B) $-2.4\Delta_o$
(C) $-0.4\Delta_o$
(D) $-0.8\Delta_o$

Space for Rough work

40. $Mn^{3+} + e^- \longrightarrow Mn^{2+} \quad E^o = 1.50V$

$Fe^{3+} + e^- \longrightarrow Fe^{2+} \quad E^o = 0.77V$

$O_2 + 4H^+ + 4e^- \longrightarrow 2H_2O \quad E^o = 1.23V$

Which of the following statement is correct based on the information given above?

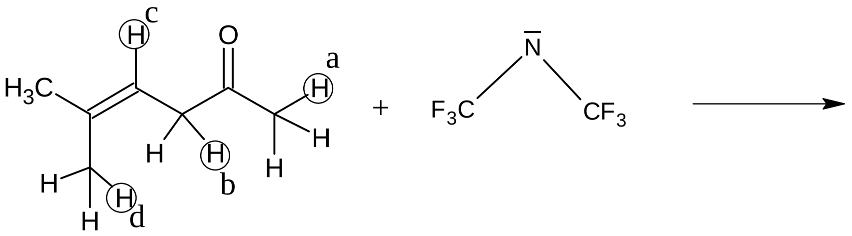
(A) O_2 oxidizes Mn^{2+} to Mn^{3+}.

(B) Mn^{3+} oxidizes H_2O to O_2

(C) O_2 oxidizes both Mn^{2+} to Mn^{3+} and Fe^{2+} to Fe^{3+}

(D) O_2 can not oxidizes Fe^{2+} to Fe^{3+}

41. Which of the following labelled can be removed by base in the above reaction?



(A) a
(B) b
(C) c
(D) d

42. $A \rightarrow 2B$ mol A consumed/(L.s)=0.1[A]

$B \rightarrow C$ mole C generated /(L.s)=0.2 [B]

The reactor is initially charged with pure A at a concentration of 1.00 mol/L. Which of the following statement is true , about the concentrations at any moment?

(A) [A]+2[B]+[C]=1 mol/L
(B) [A]+[B]+[C]=1 mol/L
(C) 2[A]+[B]+[C]=2 mol/L
(D) 2[A]+[B]+2[C]=2 mol/L

Space for Rough work

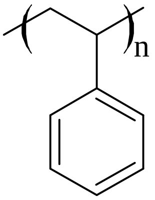
43. Which of the following relationship between radii of Gallium and nitrogen in GaN, and the lattice parameter, a for gallium nitride is correct. Gallium nitride has hcp lattice of nitride ions and Ga^{3+} occupying half of the tetrahedral voids.

(A) $c=\sqrt{\frac{2}{3}}.r_{N^{3-}}$
(B) $r_{Ga^{3+}} = 0.414\, r_{N^{3-}}$
(C) $a=2\times r_{Ga^{3+}}$
(D) $a=0.89r_{N^{3-}}$

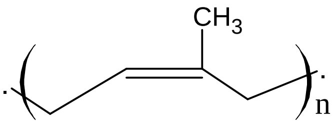
44. Which of the following prospering is incorrect about the complex $\left[Cr\,Br_2\left(en\right)\left(NH_3\right)_2\right]Cl_2$?

(A) The complex compound can show optical isomerism.
(B) The compound can show ionization isomerism.
(C) The compound can show geometrical isomerism.
(D) The compound forms white ppt (A) with $AgNO_3 sol^n$. These white ppts are soluble in liquid ammonia but insoluble in hypo solution.

45. Which of the following polymer can be easily biodegradable?

(A)


(B) Bakelite

(C)


(D) $-\!\left(CH_2 - CH_2\right)\!\!-_n$

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

46. The number of ions given below for which all octahedral complexes are paramagnetic irrespective of ligand?

$Sc^{3+}, Ti^{3+}, V^{3+}, Cr^{3+}, Mn^{3+}, Fe^{3+}, Co^{3+}, Ni^{3+}$

47. H_2O_2 is oxidising agent, how many of ions/molecules can be oxidized by H_2O_2?

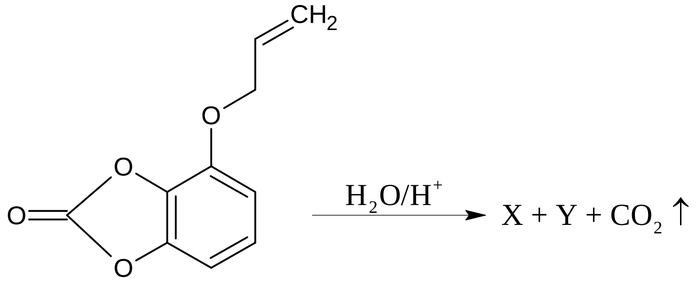
Fe^{2+} ion, $\left[Fe\left(CN\right)_6\right]^{4-}, NH_2OH, SO_3^{2-}, MnO_4^-, Ce\left(SO_4\right)_2, Cl_2, KIO_4$ ...

Space for Rough work

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

48.



$$Y \xrightarrow{\text{Lucas reagent}} \text{turbidity appears immediately}$$

The molecular mass (in g/mol) of compound Y is?
(Consider atomic masses C=12g/mol, H=1 g/mol and O=16g/mol)

49. What is resistance (in a cell with constant 0.2 cm^{-1}) of an 0.18 M solution of acetic acid at 25^oC? Given, $K_a = 1.8 \times 10^{-5}$, $\wedge^o_m(CH_3COOH) = 390\ ohm^{-1}\,cm^2\,mol^{-1}$

[Write the answer upto one decimal point in ohm]

50. Amino acid lysine has $p^{Ka_1}(\text{-COOH})=2.20, p^{Ka_2}(\alpha\text{-}NH_3)=8.95 \text{ and } p^{Ka_3}(\text{R-group})=10.53$.
p^I of lysine at 25^oC is?

Space for Rough work

Mathematics

PART – III

SECTION – A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

51. The order and degree of the differential equations of the family of hyperbolas centred at origin; principal axis along co-ordinate axis and of length $\sqrt{a^2+\lambda}$ and $\sqrt{b^2+\lambda}$ where a, b are fixed real numbers and λ is a real parameter is

(A) 1, 1 (B) 2, 1
(C) 1, 2 (D) 3, 2

52. The n^{th} derivative of the function $f(x) = \frac{1}{1-x^2}$ ($x \in (-1, 1)$) at the point x = 0 where n is even is

(A) 0 (B) n!
(C) $n\,{}^nC_2$ (D) $2\,{}^nC_2$

53. Let $f(x) = (x^n - 1)^{1/n}$ ($x > 0$), then $\int \left(f^6(x)\right)^n dx$, where $f^n(x)$ denotes $\underbrace{fofof.....(x)}_{\text{n times f}}$, equals

(A) $\frac{x^{n+1}}{n+1} - 6x + c$ (B) $\frac{x^n}{n} - 64x + c$
(C) $\frac{x^n}{n} - 6x + c$ (D) $\frac{x^{n+1}}{n+1} - 64x + c$

54. If $f(x) = \prod_{k=1}^{2n} \sin(kx)$ where $\prod$ denotes continued product then $f'(x)$ is

(A) $\sum_{k=1}^{2n} (k\cos kx) f(x)$ (B) cosx(2cos2x)(3cos3x)…(2ncos2nx)
(C) $\sum_{k=1}^{2n} (k\cos kx) \sin kx$ (D) $\sum_{k=1}^{2n} (k\cot kx) f(x)$

Space for Rough work

55. The number of points at which the function $f(x) = \begin{cases} \min\left(|x|,\ x^2\right); & -\infty < x < 1 \\ \min\left(2x-1,\ x^2\right); & \text{otherwise} \end{cases}$ is not differentiable, is

(A) 0 (B) 1

(C) 2 (D) more than 2

56. $\lim\limits_{x\to\infty} \dfrac{30 + 4\sqrt{x} + 7\sqrt[3]{x}}{2 + \sqrt{4x-7} + \sqrt[3]{6x-2}}$ equals

(A) 15 (B) 2

(C) $\dfrac{3}{2}$ (D) 0

57. $\lim\limits_{n\to\infty} \left(\dfrac{n!}{n^n}\right)^{\sum_{r=1}^{3n} \frac{r}{n^2\sqrt{16n^2+r^2}}}$ equals

(A) e (B) $\dfrac{1}{e^3}$

(C) e^3 (D) $\dfrac{1}{e}$

58. Let f: [k, k + 1, …, 2007] → [1, 2, 3, …, n] be defined by $f(x) = \left[\dfrac{2007}{x}\right]$ (where [.] denotes the greatest integer function). The maximum value of k such that it is not possible to make f an onto function for any vale of n is

(A) 50 (B) 40

(C) 51 (D) none of these

59. Let f and g be continuous and differentiable functions. If f(0) = f(2) = f(4); f(1) + f(3) = 0; g(0) = g(2) = g(4) = 0 and if f(x) = 0 and g′(x) = 0 do not have a common root, then the minimum number of zeros of $f'(x)g'(x) + f(x)\,g''(x)$ in [0, 4] is

(A) 3 (B) 4

(C) 5 (D) 2

Space for Rough work

60. Suppose f and g are functions with f'' and g'' existing everywhere. If $f(x)\,g(x) = 2 \;\forall\; x$ and $f'(x)$, $g'(x) \neq 0$, then $\frac{f''(x)}{f'(x)} - \frac{g''(x)}{g'(x)} = 0$

(A) has at least one real root (B) may have real roots
(C) has at most one real root (D) has no real roots

61. Consider a square ABCD of side length 1. Let P be the set of all segments of length 1 with end points on adjacent sides of square ABCD. The mid points of segments in P enclose a region with area A, the value of A is

(A) $\frac{\pi}{4}$ (B) $1 - \frac{\pi}{4}$
(C) $4 - \frac{\pi}{4}$ (D) none of these

62. A curve in the coordinate plane is given by the parametric equations $x = t^2 + t + 2$; $y = t^2 - t + 2$, where $t \geq 0$. The number of straight lines passing through the point (2, 2) which are tangent to the curve is / are

(A) 2 (B) 0
(C) 1 (D) 3

63. $\int_{-5}^{2} \frac{3x^2 + x - 3}{x^2 + 3x + 3}\,dx$ equals

(A) 15 (B) 21
(C) 30 (D) 42

64. A car is to be driven 200 kms on a highway at an uniform speed of x km/hr (speed rules of the highway require $40 \leq x \leq 70$). The cost of diesel is Rs 30/litre and is consumed at the rate of $100 + \frac{x^2}{60}$ litres per hour. If the wage of the driver is Rs 200 per hour then the most economical speed to drive the car is

(A) 55.5 (B) 70
(C) 40 (D) 80

Space for Rough work

65. Let $0 < \alpha, \beta, \gamma < \frac{\pi}{2}$ are the solutions of the equations cosx = x, cos(sinx) = x and sin(cosx) = x respectively then

(A) $\alpha < \beta < \gamma$ (B) $\gamma < \alpha < \beta$
(C) $\beta < \alpha < \gamma$ (D) $\gamma < \beta < \alpha$

66. If f(x) is a real valued function satisfying $f(x-y) = \frac{f(x)}{f(y)}$ $\forall$ x, y $\in$ R and if $f'(0) = p$; $f'(5) = q$, then $f'(-5)$ equals

(A) $\frac{p^2}{q}$ (B) $\frac{p}{q}$
(C) $\frac{q}{p}$ (D) q

67. $\bar{a}$, $\bar{b}$, $\bar{c}$ are the edges of cube of unit length and $\hat{r}$ be a unit vector in the cube, then $|\hat{r}\times\bar{a}|^2 + |\hat{r}\times\bar{b}|^2 + |\hat{r}\times\bar{c}|^2$ is

(A) 0 (B) 1
(C) 2 (D) 3

68. The number of ways in which 2n white and 2n black balls can be arranged such that no consecutive 'n' white balls are together are

(A) ${}^{2n+1}C_2 + {}^{4n}C_{2n}$ (B) ${}^{2n+1}C_2 - {}^{2n+1}C_1\,{}^{3n}C_n\,(-1)^n + {}^{4n}C_{2n}$
(C) ${}^{2n+1}C_2 + (-1)^n\,{}^{2n+1}C_1\,{}^{3n}C_n + {}^{4n}C_{2n}$ (D) ${}^{2n+1}C_2 + (-1)^n\,{}^{3n}C_n\,{}^{2n+1}C_1$

69. If the equation $x^2 + 2|a|x + 4 = 0$ has integral roots, then minimum value of a is

(A) 4 (B) –5/2
(C) 0 (D) –4

70. If line through P(a, 2) meets the ellipse $\frac{x^2}{9} + \frac{y^2}{4} = 1$ at A and D and meets the axes at B and C, so that PA, PB, PC, PD are in G.P., then

(A) $a \in [6, \infty)$ (B) $a \in R$
(C) $a \in (-\infty, -6] \cup [6, \infty)$ (D) none of these

Space for Rough work

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

---

71. If matrix A = $\begin{bmatrix} 3 & 2 & 1 \\ 6x^2 & 2x^3 & x^4 \\ 1 & a & a^2 \end{bmatrix}$, then $\frac{d^2}{dx^2}(|A(\text{adj}A)|^{1/3})$ at x = a is ________.

72. The system of equation $2x+3y-z=0$, $3x+2y+kz=0$, $4x+y+z=0$ have a set of nonzero integral solution then the least positive value of z is _________

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

73. The maximum integral value of the function $f(x)=\int_{\pi/2}^{x}(\cos t-2\sin t)dt$ in the interval $\left[\frac{\pi}{2},\pi\right]$ is _____

74. The differential equation $dy = x\tan y(\sin y-1)dx$ has solution $y=\sin^{-1}\left(\frac{1}{k+ce^{x^2/2}}\right)$ then $k =$ _____

75. Y-axis is a tangent to one ellipse with foci (2, 0) and (6, 4). If the length of the major axis is x then $\frac{[x]}{5}$ =

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – IV

JEE (Main)-2020

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. D

Sol. From the property of vector product, we notice that **C** must be perpendicular to the plane formed by vector **A** and **B**. Thus **C** must be perpendicular to **A** and to **B**. Thus the statements (1) and (2) are correct. Now **A** + **B** vector also must lie in the plane formed by vector **A** and **B**. Thus **C** must be perpendicular to **A** + **B** also the cross product (**A** × **B**) gives a vector **C** which cannot be perpendicular to itself. Thus the statement (4) is wrong.

2. C

Sol. The force acting on the particle = $\frac{mdv}{dt}$

Power of the force = $\left(\frac{mdv}{dt}\right)$ v = k (constant)

$$m\,\frac{v^2}{2} = kt + c \qquad ...(1)$$

at t = 0, v = u $\therefore$ c = $\frac{mu^2}{2}$

Now from (1),

$$m\frac{v^2}{2} = kt + \frac{mu^2}{2}$$

$$\frac{1}{2}m\,(v^2 - u^2) = kt \qquad ...(2)$$

Again $\frac{mdv}{dt}v = k$

$$m.v\,\frac{dv}{dx}v = k$$

$$\int_u^v mv^2dv = \int_0^x k\,dx$$

Intergrating, $\frac{1}{3}$m ($v^3 - u^3$) = kx ...(3)

From eqn (2) and (3),

t = $\frac{3}{2}\left(\frac{v^2 - u^2}{v^3 - u^3}\right)$ x

3. A

Sol. From ohm's law

Electric field α current density

4. D

Sol. $e = \int_{-\ell/2}^{\ell/2} B\omega r dr = 0$

5. B

Sol. When current is maximum $= \frac{di}{dt} = 0$

6. D

7. A

Sol. Saturation for A and B are different hence intensities are different. Stopping potentials for A and B are equal hence frequencies are equal.

8. B

Sol. Characteristic wavelengths shift of left if z is increased hence B is incorrect

9. D

10. B

Sol. $\rho_1 g h_1^2 = \rho_2 g h_2$

$\frac{h_1}{h_2} = \frac{\rho_2}{\rho_1}$

11. B

12. A

Sol. Process A $\rightarrow$ B is isothermal

Process B $\rightarrow$ C isochoric

Process C $\rightarrow$ A is isobaric

13. C

Sol. The process described is isochoric

Therefore molar heat capacity $= C_v = 2.5R$

14. A

15. B

Sol. Capacitors are in series therefore

$\frac{C_1}{C_2} = \frac{V_2}{V_1} = \frac{2}{3}$

16. B

17. A

Sol. $mu = 3mv$

$V = u/3$

$e = -\frac{2u/3 - u/3}{-u} \Rightarrow e = 1/3$

18. D

Sol. Friction will be absent

$T = ma$

$mg - T = 2ma$

Acceleration of $a = g/3$

Acceleration of block $= 2g/3$

19. B

Sol. Tension at bottom end of rope = $T_1 = 2\times9.8$ N

$\because$ weight of rope acts on gravity centre,

Therefore, tension at upper end of rope,

$T_2 = (6 + 2) \times 9.8 = 8 \times 9.8$ N

Thus, $T_2 = 4T_1$

if v_1 & v_2 are respective velocity at bottom & upper end, then $v_1 = \sqrt{\frac{T_1}{m}}$ & $v_2 = \sqrt{\frac{T_2}{m}}$

$\therefore v_2 = 2v_1 \quad (\because T_2 = 4T_1)$

Frequency n does not depend on medium,

therefore $v \propto \lambda$

if λ_1 & λ_2 are respective wavelength at bottom & upper end

$\lambda_2 = 2\lambda_1 = 2 \times 0.06 = 0.12$ m

20. C

Sol. The fringe–width β is given by

$\beta = \frac{\lambda D}{2d}$ and $\beta' = \frac{\lambda D'}{2d}$

where λ is the wavelength of light used, D is the distance of the screen from the two slits and 2 d is the separation between two slits.

Now $\beta - \beta' = \frac{\lambda(D - D')}{2d}$

$\Rightarrow \lambda = \frac{(\beta - \beta')2d}{D - D'}$

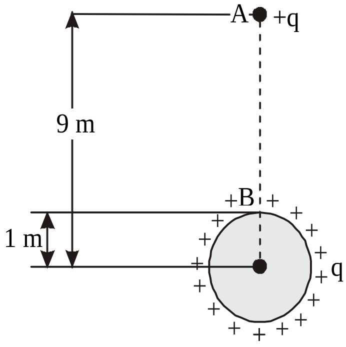
$\lambda = \frac{(3\times10^{-5})(10^{-3})}{5\times10^{-2}}$

$= 0.6 \times 10^{-6}$ m = 6000 Å

SECTION – B

21. 6

22. 4



Sol. Keeping in mind that here both electric and gravitational potential energy are changing and for external point a charged sphere behaves as whole of its charge were concentrated at its centre, applying conservation of energy between initial and final position, we have

$$\frac{1}{4\pi\varepsilon_0}\frac{qq}{9} + mg \times 9 = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{1} + mg \times 1$$

or $q^2 = \frac{80\times10^{-3}\times9.8}{10^9}$

or q = 28 mC

SECTION – C

23. 00019.00

24. 00080.00

Sol. Distance $AD = \frac{4}{5}\times100 = 80\,cm$

25. 00060.02

Sol. Since the scale is graduated at 10ºC,
1 cm of the scale at 10ºC = exactly 1 cm
$\therefore$ 1 cm of the scale at 30ºC
= exactly $(1 + 18 \times 10^{-6} \times 20)$cm
$\therefore$ 60 cm of the scale at 30ºC
= exactly $60.00\,(1 + 36 \times 10^{-5})$
= 60.02 cm

Chemistry

PART – II

SECTION – A

26. B

Sol. $\pi = i.CRT$

$$i = \frac{8.21}{0.15 \times 0.0821 \times 300} = 2.22$$

27. C

28. A

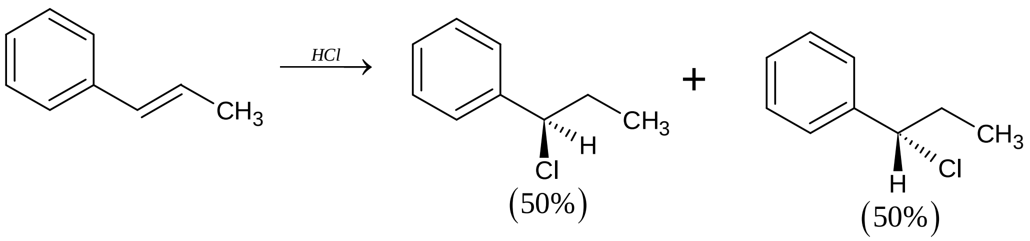
Sol. Let solubility barium sulphite is x mol/L and that of barium sulphate is y mol/L.

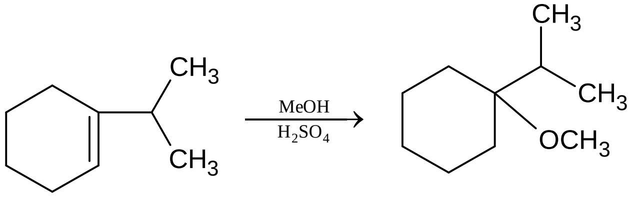
$$(x+y)x = 8 \times 10^{-7}$$

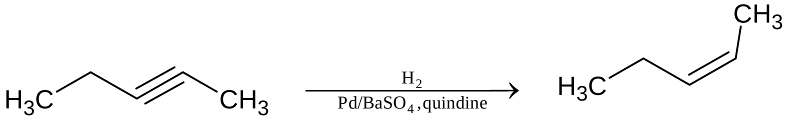
$$(x+y)y = 1 \times 10^{-8}$$

29. D

Sol.


HCl
CH3
CH3
H
Cl
(50%)
+
CH3
H
Cl
(50%)


CH3
CH3
MeOH
H2SO4
CH3
CH3
OCH3


H3C
CH3
H2
Pd/BaSO4,quindine
H3C
CH3

30. C

31. A

32. B

Sol. Numbers of mole of A=10/150=1/15
Moles of B=0.20*(200/1000)=0.04
A is limiting reagent hence moles of X formed=(1/15)/2
P=(1/30)*0.0821*300/0.2=4.105atm

33. C

Sol. Due to inert pair effect, +2 oxidation state stability increases down the group in group 14. Hence element should be Pb(Lead).

34. D

Sol. CoS is black colour ppt.

35. B

36. A
Sol. A =XeF_6

37. B
Sol. Cerussite=$PbCO_3$

38. D
Sol. $Fe(SCN)_3$ is red colour

39. D
Sol. Brown ring complex is $[Fe(H_2O)_5(NO)]^{+2}$

40. B

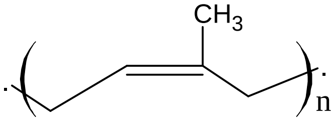
41. B
Sol. Conjugate base formed after removal of H (b) is resonance stabilized by both keto and alkene group.

42. C

43. A

44. D
Sol. AgCl is soluble in both liquid ammonia and in hypo solution

45. C
Sol.



is natural rubber

SECTION – B

46. 6
Sol. If ion has unpaired electron it is paramagnetic in nature

47. 4

SECTION – C

48. 00058.00
Sol. Y is allylic alcohol

49. 00284.90

Sol. Degree of dissociation $(\alpha) = \frac{\wedge_m}{\wedge_m^o}$

$$\Rightarrow \wedge_m = \wedge_m^o \times \alpha$$

$$= \wedge_m^o \times \sqrt{\frac{K_a}{C}} \text{ (by Ostwald dilution law)}$$

$$= 390 \times \sqrt{\frac{1.8\times10^{-5}}{0.18}} = 3.90 \text{ ohm}^{-1}\text{ cm}^2\text{ mol}^{-1}$$

$$\text{Conductivity} = \frac{\text{molarity} \times \wedge_m}{1000}$$

$$= 7.02 \times 10^{-4}\ \text{ohm}^{-1}\ \text{cm}^{-1}$$

$$\text{Also conductivity} = \text{Cell constant} \times \frac{1}{\text{Resistance}}$$

$$\Rightarrow \text{Resistance} = \frac{\text{Cell constant}}{\text{Conductivity}}$$

$$= \frac{0.2}{7.02 \times 10^{-4}} = 284.9\ \text{ohm}$$

50. 00009.74

Sol. $p^I = (8.95 + 10.53)/2$

Mathematics PART – III

SECTION – A

51. C

Sol. Differential equation is $\frac{x^2}{a^2+\lambda}-\frac{y^2}{b^2+\lambda}=\frac{1}{4}$ $(\lambda \in R)$

Order is 1 as differential solution has 1 effective parameter λ.
Degree is 2 as highest power of effective parameter is 2 in differential solution.

52. B

Sol. $f(x) = 1 + x^2 + x^4 + x^6 + \ldots \infty$ $|x| \le 1$
$\Rightarrow f^n(0) = n!$, where n is even.

53. A

Sol. $f^r(x) = (x^n - 2r)^{1/n} \Rightarrow \int \left(f^6(x)\right)^n dx = \int \left(x^n - 12\right)dx = \frac{x^{n+1}}{n+1} - 12x + c$.

54. D

Sol. $\frac{d}{dx}(\sin kx) = k\cot kx \sin kx$

$\Rightarrow \frac{d}{dx}\left(\prod_{k=1}^{2n} \sin(kx)\right) = \sum_{k=1}^{2n}(k\cot kx) f(x)$.

55. B

Sol. $f'(-1)^- = -1$; $f'(-1)^+ = -2$
$\Rightarrow$ non-differentiable at $x = -1$.

56. B

Sol. Divide numerator and denominator by $\sqrt{x}$

$\Rightarrow$ given limit = $\frac{4}{\sqrt{4}} = 2$.

57. D

Sol. $\left(\lim\limits_{n\to\infty}\left(\frac{n!}{n^n}\right)^{1/n}\right)^{\lim\limits_{n\to\infty}\frac{1}{n}\sum\limits_{r=1}^{3n}\frac{r/n}{\sqrt{16+(r/n)^2}}} = \left(\frac{1}{e}\right)^{\int_0^3 \frac{x}{\sqrt{16+x^2}}dx} = \frac{1}{e}$.

58. B

Sol. Let $g(x) = \frac{2007}{x}$.

Let x decreases from k + 1 to k then g(x) increases from $\frac{2007}{k+1}$ to $\frac{2007}{k}$ $\Rightarrow$ The increase in the value of g(x) is $\frac{2007}{k(k+1)}$.

The increase is less than 1 if $k(k + 1) > 2007$
$\Rightarrow k = 45, 46, \ldots, 2007$.
$\Rightarrow$ g(x) does not miss any value as x decrease from 2007, 2006, … till 45.

Also $\left[\frac{2007}{45}\right] = 44$, $\left[\frac{2007}{44}\right] = 45$, $\left[\frac{2007}{43}\right] = 46$, $\left[\frac{2007}{42}\right] = 47$, $\left[\frac{2007}{41}\right] = 48$ and $\left[\frac{2007}{40}\right] = 50$

$\Rightarrow \left[\frac{2007}{x}\right]$ can never be equal to 49

$\Rightarrow$ the maximum value of k is 40.

59. A

Sol. f(x) = 0 has minimum 2 solutions in [0, 4]
g(x) = 0 has minimum 3 solutions in [0, 4]
$g'(x) = 0$ has minimum 2 solutions in [0, 4]
$f(x)\,g'(x) = 0$ has minimum 4 solutions in [0, 4]
$\frac{d}{dx}\left(f(x)g'(x)\right) = 0$ has minimum 3 solutions in [0, 4].

60. D

Sol. $f(x)g(x) = 2$ …(a)

$\Rightarrow f'(x)g(x) + f(x)g'(x) = 0$ …(1)

$\Rightarrow f''(x)g(x) + 2f'(x)g'(x) + f(x)g''(x) = 0$

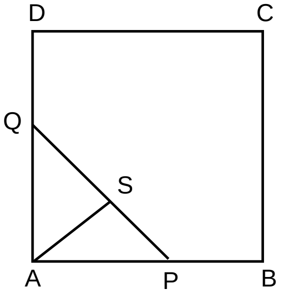
$\Rightarrow \frac{f''(x)g(x)}{f(x)g'(x)} + \frac{2f'(x)}{f(x)} + \frac{g''(x)}{g'(x)} = 0$ (dividing throughout by $f(x)g'(x)$)

$\Rightarrow \frac{f''(x)}{f'(x)} - \frac{g''(x)}{g'(x)} = \frac{2f'(x)}{f(x)}$ $\left(\text{Replacing } \frac{g(x)}{f(x)g'(x)} = -\frac{1}{f'(x)} \text{ from}(1)\right)$

$\frac{2f'(x)}{f(x)} = 0$ has no real roots since $f(x) \neq 0$ for any x. (from (a))

61. B

Sol. Let S be the mid point of PQ.



Since $\angle PAQ = \frac{\pi}{2}$, we get $AS = SP = SQ = \frac{1}{2}$

$\Rightarrow$ S lies on the quarter circle of radius $\frac{1}{2}$ with centre at A.

Similarly S can also lie on quarter circle of radius $\frac{1}{2}$ with centre at B, C or D

$\Rightarrow$ area $A = 1 - \frac{\pi}{4}$.

62. C

Sol. Equation of tangent is $y - (t^2 - t + 2) = \frac{2t-1}{2t+1}\left(x - (t^2 + t + 2)\right)$

Putting x = 2, y = 2, we get t = 0.

63. B

Sol. $I = \frac{1}{2}\int_a^b \left(f(x) + f(a+b-x)\right)dx$

$= \frac{1}{2}\int_{-5}^{2} \frac{(6x^2 + 18x + 18)}{x^2 + 3x + 3}dx = 21$ $\left(f(x) = \frac{3x^2 + x - 3}{x^2 + 3x + 3}\right)$

64. B

Sol. Let cost incurred to travel 200 kms be c(x)

$\Rightarrow c(x) = \left(100+\frac{x^2}{60}\right)\frac{200}{x}\times 30+200\times\frac{200}{x} = \frac{640000}{x}+100x$

$\Rightarrow c'(x) < 0$ in $x \in [40, 70]$

$\Rightarrow c(x)$ is minimum for $x = 70$ in $x \in [40, 70]$.

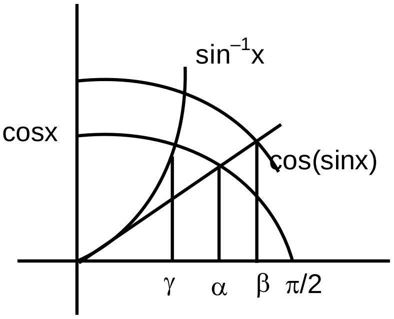
65. B

Sol. Equation (1) is cosx = x equation (2) is cos(sinx) = x and equation (3) is cosx = $\sin^{-1}x$

since $\sin x \le x \Rightarrow \cos(\sin x) \ge \cos x$

now drawing the graphs of the functions

we see that $\gamma < \alpha < \beta$.



66. A

Sol. $f'(x) = \lim\limits_{h\to 0}\frac{f(x)\left(\frac{f(x+h)}{f(x)}-1\right)}{h} = f(x)\lim\limits_{h\to 0}\frac{f(h)-1}{h}$ (Putting x = x + h, y = x)

$= f(x)\,f'(0)$ ($\because f(0) = 1$ putting x = y)

$= pf(x)$

$\Rightarrow f(x) = e^{px}$

$f'(-5) = \frac{p}{e^{5p}} = \frac{p^2}{q}$ ($\because f'(5) = pe^{5p} = q$).

67. C

Sol. $|\hat{r}\times\bar{a}|^2 = \sin^2\alpha$

$\Rightarrow |\hat{r}\times\bar{a}|^2 + |\hat{r}\times\bar{b}|^2 + |\hat{r}\times\bar{c}|^2 = \sin^2\alpha+\sin^2\beta+\sin^2\gamma$

$= 3 - (\cos^2\alpha + \cos^2\beta + \cos^2\gamma) = 2.$

68. B

Sol $x_1B\ x_2B\ x_3B \ldots Bx_{2n+1}$

Let black balls are arranged 1st and between every black balls there are (2n + 1) number of places in which white balls from 0 to (n – 1) to be arranged.

Let x_i, i = 1, 2, 3, …, (2n + 1) denotes the number of balls at place denoted by $x_1, x_2, x_3, \ldots, x_{2n+1}$.

$\Rightarrow \sum\limits_{i=1}^{2n+1} x_i = 2n$, where $0 \le x_i \le n - 1$, i = 1, 2, 3, …, 2n + 1

$\Rightarrow$ Number of such arrangements = coefficients of x^{2n} in $(1 + x + x^2 + \ldots + x^{n-1})^{2n+1}$

$= {}^{2n+1}C_2 - {}^{2n+1}C_1\,{}^{3n}C_n\,(-1)^n + {}^{4n}C_{2n}$.

69. B

Sol. Let α, β be the roots

$\Rightarrow \alpha + \beta = -2|a|$ and $\alpha\beta = 4$.

Since $\alpha, \beta \in I$ hence possible values are $(\alpha, \beta) \equiv (-1, -4)$ or $(-2, -2)$

For a to be minimum |a| should be maximum

$\Rightarrow |\alpha + \beta|$ should be maximum.

Hence roots are – 1 and – 4 $\Rightarrow$ a = – 5/2.

70. C

Sol. Any point on the line through P(a, 2) is (a + r cosθ, 2 + r sinθ) and meet the ellipse $\frac{x^2}{9}+\frac{y^2}{4}=1$ at two distinct points A and D

$\Rightarrow \frac{(a+r\cos\theta)^2}{9}+\frac{(2+r\sin\theta)^2}{4}=1$

$\Rightarrow (4\cos^2\theta + 9\sin^2\theta)r^2 + 4(2a\cos\theta + 9\sin\theta)r + 4a^2 = 0.$

$\Rightarrow PA\,.\,PD = \frac{4a^2}{4\cos^2\theta+9\sin^2\theta}$

also line meets the axes at B and C

$\Rightarrow PB\,.\,PC = \frac{2a}{\sin\theta\cos\theta}$

since PA, PB, PC and PD are in G.P.

$\Rightarrow \frac{4a^2}{4\cos^2\theta+9\sin^2\theta} = \frac{2a}{\sin\theta\cos\theta}$

$\Rightarrow 2a\sin 2\theta + 5\cos 2\theta = 13$

$\Rightarrow -1 \le \frac{13}{\sqrt{4a^2+25}} \le 1$

$\Rightarrow a \le -6$ or $a \ge 6$.

SECTION – B

71. 0

Sol . $|A\,(\text{adj }A)|^{1/3} = |A| \Rightarrow \frac{d^2}{dx^2}(|A(\text{adj}A)|^{1/3}) = \begin{vmatrix} 3 & 2 & 1 \\ 12 & 12x & 12x^2 \\ 1 & a & a^2 \end{vmatrix} = 0$ at x = a.

= 0.

72. 5

Sol. The system has a nonzero solution

$\therefore |A| = 0$

$$\begin{vmatrix} 2 & 3 & -1 \\ 3 & 2 & k \\ 4 & 1 & 1 \end{vmatrix} = 0$$

The solution is $(2a,-3a,-5a)$

Least positive integer value of z is 5.

SECTION – C

73. 00000.00

Sol. $f(x)=\int_{\frac{\pi}{2}}^{x}(\cos t-2\sin t)dt$

$f'(x)=\cos x-2\sin x<0$ in $\left[\frac{\pi}{2},\pi\right]$

$\therefore f(x)$ is decreasing function

$\therefore$ Greatest value = $f\left(\frac{\pi}{2}\right)=0$.

74. 00001.00

Sol. $dy = x\tan y(\sin y - 1)dx$

$$\frac{dy}{dx} + x\tan y = x\tan y.\sin y$$

$$\cos y\frac{dy}{dx} + x\sin y = x\sin^2 y$$

Let $\sin y = t$

$$\frac{dt}{dx} + xt = xt^2$$

$$\frac{1}{t^2}\frac{dt}{dx} + x\left(\frac{1}{t}\right) = x$$

$$\frac{1}{t} = u$$

$$= -\frac{du}{dx} + xu = x$$

$$\frac{du}{dx} + (-x)u = -x$$

$$ue^{-\int xdx} = \int -xe^{-\int xdx}dx$$

$$ue^{-\frac{x^2}{2}} = -\int xe^{-\frac{x^2}{2}}dx \quad = e^{-\frac{x^2}{2}} + c$$

$$u = 1 + ce^{\frac{x^2}{2}}$$

$$t = \frac{1}{1 + ce^{\frac{x^2}{2}}}$$

$$\sin y = \frac{1}{1 + ce^{\frac{x^2}{2}}}.$$

75. 00001.60

Sol. Distance between the foci

$2ac = 4\sqrt{2}$

$ac = 2\sqrt{2}$

Product of distances of foci from tangent $= b^2$

$2 \times 6 = b^2$

$b^2 = a^2 - a^2e^2$

$12 = a^2 - 8$

$a^2 = 20$

$a = \sqrt{20}$

Major axis $2a = \sqrt{80}$

$[2a] = 8$.

$$\frac{[x]}{5} = \frac{8}{5} = 1.6$$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – I

JEE (Advanced)-2020

PAPER – 1

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B.**

1. ***Section-A (01– 7, 19 – 25, 37 – 43)*** *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect option is selected.

   Section-A (08 – 13, 26 – 31, 44 – 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S). Each multiple choice question with 4 options has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section–B (14 – 18, 32 – 36, 50 – 54)*** *contains 15 Numerical based questions with answers as numerical value from 0 to 9 and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

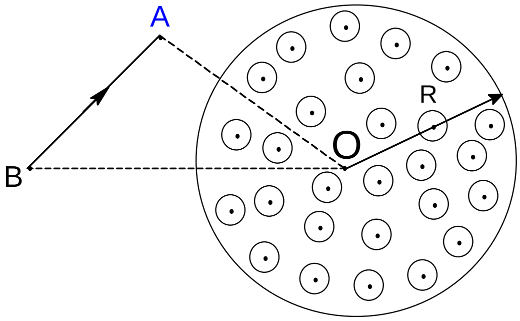
PART – I

SECTION – A
(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. Figure shows cross-sectional view of a long solid cylinder of radius 'R'. Current 'I' flows along outward direction along length of cylinder. Then, $find\ \int \vec{B}\cdot\vec{d\ell}\ along\ \overrightarrow{\mathrm{BA}}$

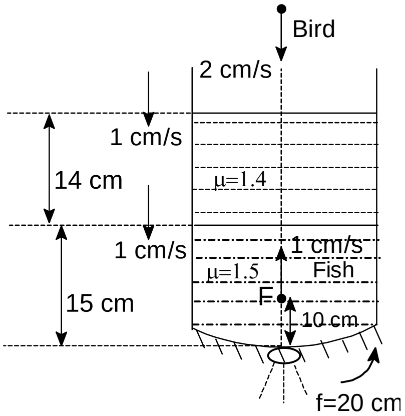
Given: $OB = \left(\sqrt{3}+1\right)R,\ OA = 2R,\ \angle OBA = 45^\circ.$ Where 'O' is point of axis of cylinder.



(A) $\mu_0 \dfrac{I}{6}$ (B) $-\mu_0 \dfrac{I}{6}$

(C) $\dfrac{\mu_0 I\sqrt{7}}{6}$ (D) $\dfrac{-\mu_0 I}{12}$

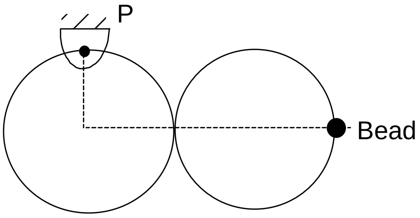
2. A glass cylindrical vessel with base concave mirror of focal length 20 cm is filled with two immiscible liquid of refractive index 1.5 and 1.4. Thickness of liquid level are 15 cm and 14 cm respectively. A fish is moving vertically upward along principle axis of mirror with speed of 1 cm/s. A bird is moving along vertically downward direction with 2 cm/s. A small hole is made at bottom surface of vessel. When distance of fish from pole of mirror is 10 cm, the rate of liquid level falling is 1 cm/s. (focal length of concave mirror is 20 cm). Then, at the given instant



(A) Velocity of image of fish formed after reflection from mirror as seen by bird is 1 cm/s along upward direction.
(B) Velocity of image of fish after formed after reflection of mirror as seen by bird is 1 cm/s along downward direction
(C) Velocity of image of fish as seen by itself is 5 cm/s along downward direction
(D) Velocity of image of fish as seen by itself is 5 cm/s along vertically upward direction

Space for Rough work

3. Two identical ring of equal mass ‘m’ and radius ‘R’ rigidly attached wears a bead of mass ‘m’. Bead can freely slide without friction. It is hinged at point ‘P’ in such a way that it can freely rotates about horizontal axis passing through point ‘P’. The ring and bead are released from rest from give position. Then, just after release



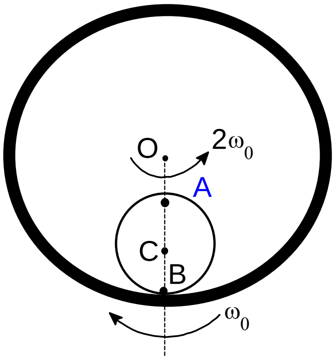
(A) The magnitude of angular acceleration of ring is $\frac{5g}{17R}$

(B) The magnitude of angular acceleration of rod is $\frac{2g}{9R}$

(C) The magnitude of acceleration of bead is $\frac{2g}{7}$

(D) The magnitude of acceleration of bead is $\frac{\sqrt{85}\,g}{9}$

4. A hollow cylinder of radius 4R is rotating about fixed horizontal axis passing through point ‘O’ with angular velocity ω_0. A solid cylinder of radius ‘R’ is rolling without slipping with respect to inner surface of hollow cylinder. At the given instant, the line OC has angular velocity of $2\omega_0$. Point A and B are topmost and bottom most point of solid cylinder respectively and C is its centre. Then, at the given instant



(A) Angular velocity of solid cylinder about its own axis is $10\ \omega_0$

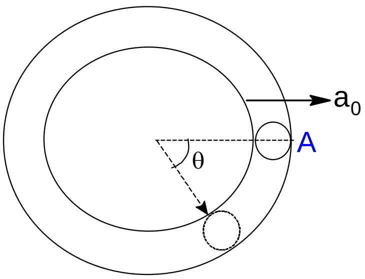
(B) Magnitude of acceleration of point A of solid cylinder is $88\omega_0^2R$

(C) Magnitude of acceleration of point B of solid cylinder with respect to contact surface of hollow cylinder is $112\omega_0^2R$

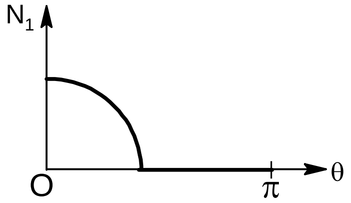
(D) Radius of curvature of point A is $\frac{32R}{11}$

Space for Rough work

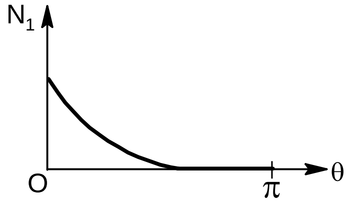
5. A hollow tube containing a ball is kept on smooth horizontal surface. Now, tube is accelerated horizontally and ball is slightly displaced from point ‘A’. Let N_1 *and* N_2 be the magnitude of normal force applied by inner and outer surface respectively. Then, which of the following is/are correctly represent approximate nature of N_1 *and* N_2 *Vs* θ $\left(0 \le \theta \le \pi\right)$



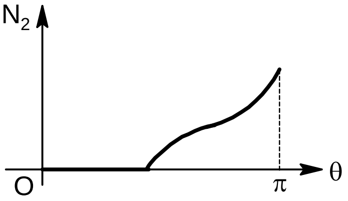
(A)



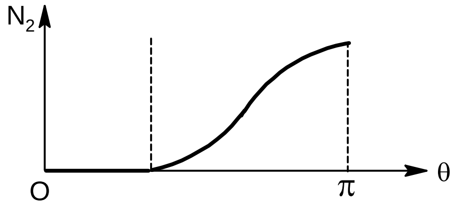
(B)



(C)



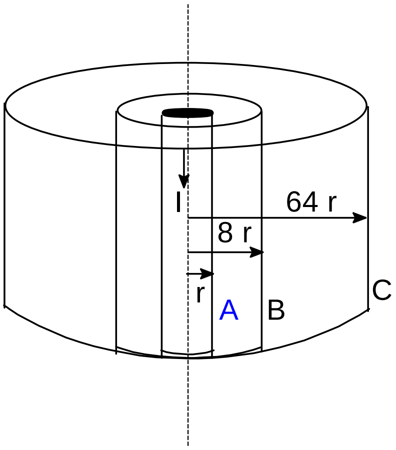
(D)



Space for Rough work

6. A long uniform solid cylinder of radius r and resistivity ρ carries current 'I' along its length which is uniformly distributed throughout its cross sectional area. Two long hollow cylinder B and C of radii 8 r and 64 r surrounds the solid cylinder. The surface of all cylinder A, B and C are perfectly black. At equilibrium, the temperature of B is 400 K.

$\left[\text{Take } \frac{\sigma r^3}{\rho} = \frac{10^{-8}}{\pi^2} \text{S.I unit}, \ \sigma = \text{Stefan's constant}\right]$. Then, at equilibrium.



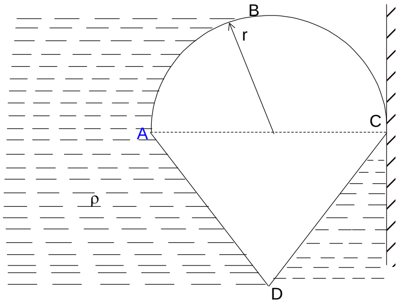
(A) Temperature of A is approximately $565(3)^{\frac{1}{4}} K$

(B) Temperature of C is 200 K

(C) The ratio of temperature of B and C is 2

(D) The current 'I' in solid conductor is $32\sqrt{2}$ A

7. Figure shows cross-sectional view of solid semi cylinder of radius 'r' rigidly attached with solid triangular prism. It floats on a liquid having density 'ρ'. It is in contact with smooth vertical wall. Part BC is not in contact with liquid. The length of object is 'ℓ'. Given (AC = CD = DA). The atmospheric pressure is P_0.



(A) Buoyant force acting on object is independent of atmospheric pressure.

(B) Normal force exerted by vertical wall is $\frac{\rho g r^2 \ell}{2}$

(C) The pressure force exerted by liquid on slant surface ADC of prism is $\left(2+\sqrt{3}\right) r^2 \rho \ell g$

(D) Weight of object is $\left(\sqrt{3}+1+\frac{\pi}{4}\right) r^2 \ell \rho g$

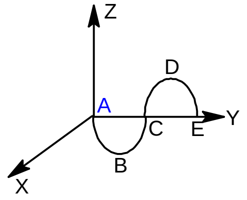
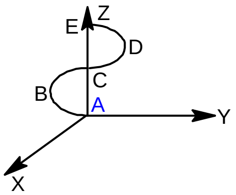
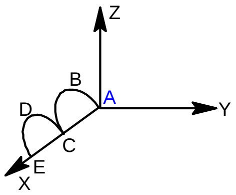
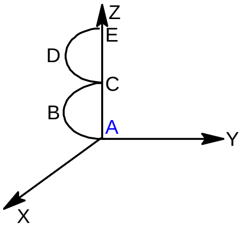
Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

In the Column 1, there are conducting loop ABCDE in shape of two semicircular wire of radius 'R'. Column 2 and 3 represent velocity imparted to loop and magnetic field respectively.

	Column – 1		**Column – 2**		**Column – 3**
(I)	 Loop lies in xy plane	(i)	$\vec{v} = v\hat{i}$	(P)	$\vec{B} = B\hat{i}$
(II)	 Loop lies in yz plane	(ii)	$\vec{v} = v\hat{j}$	(Q)	$\vec{B} = B\hat{j}$
(III)	 Loop lies in xz plane	(iii)	$\vec{v} = v\hat{k}$	(R)	$\vec{B} = B\hat{k}$
(IV)	 Loop lies in xz plane	(iv)	$\vec{v} = -v\hat{i}$	(S)	$\vec{B} = -B\hat{i}$

8. In which of the following case, $v_E - v_A$ is positive

(A) (I), (i), (R)　　(B) (II), (ii), (P)

(C) (III), (iii), (Q)　　(D) (IV), (ii), (S)

Space for Rough work

9. In which of the following case, the magnitude of Induced emf is zero

(A) (I), (i), (R) (B) (II), (ii), (P)

(C) (III), (ii), (P) (D) (IV), (i), (Q)

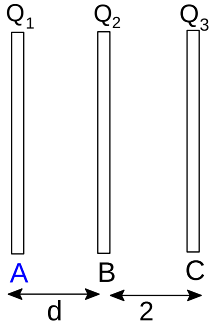
10. In which of the following case, the magnitude of Induced emf is $4vBR$

(A) (I), (i), (Q) (B) (II), (ii), (Q)

(C) (III), (ii), (P) (D) (IV), (ii), (P)

Answer questions 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

Three parallel plates A, B & C of large area carry charge Q_1, Q_2 *and* Q_3 respectively. Values of Q_1, Q_2 *and* Q_3 are listed in Column – 1, Column – 2 and Column – 3 respectively. The separation between A and B is d whereas between B and C is 2d.



	Column – 1		Column – 2		Column – 3
(I)	0	(i)	Q	(P)	0
(II)	Q	(ii)	0	(Q)	-Q
(III)	- Q	(iii)	+2Q	(R)	+2Q
(IV)	2Q	(iv)	-Q	(S)	Q

11. If plate A and C are connected by conducting wire, then in which of the following case the charge flowing through conducting wire is Q/3.

(A) (I), (i), (P) (B) (II), (iii), (R)

(C) (III), (ii), (Q) (D) (IV), (iv), (*S*)

Space for Rough work

12. If plate A and C are earthed, then in which of the following case, the charge on left surface of plate B is 4Q/3.

(A) (I), (ii), (R)
(B) (II), (iii), (Q)
(C) (III), (i), (P)
(D) (IV), (ii), (S)

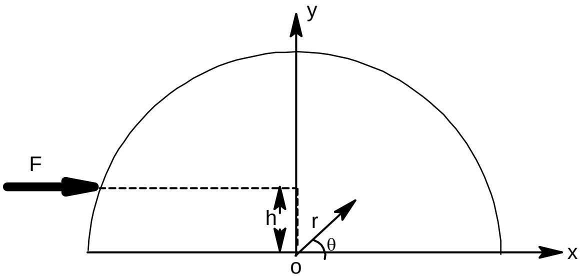
13. If plate B is earthed then, in which of the following cases, the sum of charge of plate A and Plate C is 2Q.

(A) (I), (iv), (R)
(B) (II), (iii), (Q)
(C) (III), (iv), (P)
(D) (IV), (iv), (S)

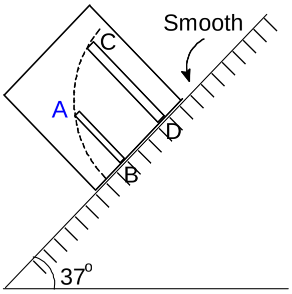
SECTION – B
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

14. The surface mass density (mass per unit area) of a semi circular disc of radius 'R' varies as $\sigma = \left|\vec{a} \times \vec{r}\right|$, where $\vec{a}$ is a constant velocity along positive x axis and $\vec{r}$ is positive vector with respect to origin. It is kept on smooth horizontal surface with flat surface in contact with surface. Now, force 'F' is applied in such a way that it moves translationally without any rotation. The value of h is $\frac{k\pi R}{16}$ then find value of k.

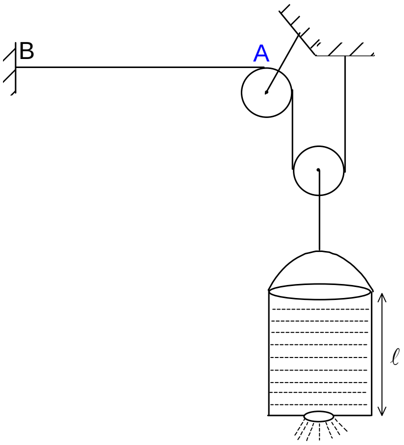


15. Two plate AB and CD are rigidly attached perpendicular to base of a massive box. Box is released on smooth inclined plane having angle of inclination 37°. With what minimum speed with respect to box a particle is projected so as to graze top point A and C of plate $AB = 2m$, $CD = 3m$. Given Separation between top of plate is 3m. Take $g = 10 m/s^2$.



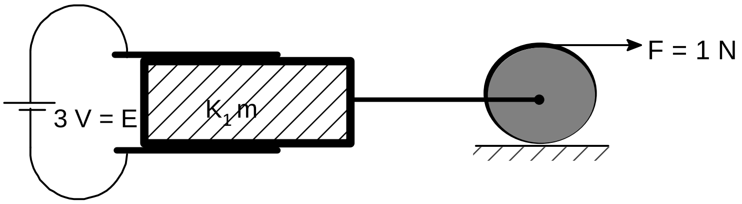
Space for Rough work

16. In the given diagram, there is a cylindrical can of cross sectional area A and length $\ell = 0.4m$ completely filled with liquid of density 'ρ'. It is attached to massless pulley. A small hole of area $'a' = \frac{A}{100}$ is made at the base of can. A wave pulse is generated at point A at an instant when small hole is made at base of can. When can gets empty, the wave pulse reaches point B. Then, find length AB (in meter) $\left(\frac{\rho A}{\mu} = \frac{1}{16} S.I\ unit\right)$ μ is linear mass density of string 'AB' Neglect mass of can and thrust force due to efflux of liquid.



17. There is spherical symmetric charge distribution around origin. The electrostatic potential at a distance 'r' from origin is given as $V = \frac{-K r^4}{4}$ where K is a positive constant. The slope of tangent to density vs 'r' graph at $r = \frac{1}{2} m\ is\ \alpha K \in_0$. Then find value of "α'.

18. A parallel square plate capacitor of side 'a' is connected to a cell of emf 3 volt. A dielectric of mass $m = 0.1\ kg$ and dielectric constant 'K' initially completely fills the space between plate of parallel plate capacitor. The dielectric is connected to a solid cylinder of mass $m = 0.1\ kg$ through the string. Cylinder is pulled by a tangential force F=1 N and acting on top of cylinder. The surface between cylinder and horizontal surface is enough rough to prevent slipping. The distance between plate is d. The graph between the current through the cell V.S time 't' is a straight line till dielectric leaves the capacitor. Find the slope of straight line $\left[Given \frac{\in_0 a(K-1)}{d} = \frac{1}{9}\right]$.



Space for Rough work

Chemistry

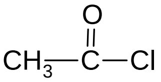
PART – II

SECTION – A
(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

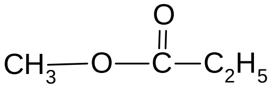
19. Which of the following compound when react with PhMgBr (excess) followed by acidification will yield 3^o – alcohol.

(A)



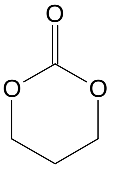
$CH_3-\overset{O}{\overset{||}{C}}-Cl$

(B)

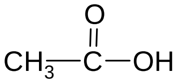


$CH_3-O-\overset{O}{\overset{||}{C}}-C_2H_5$

(C)

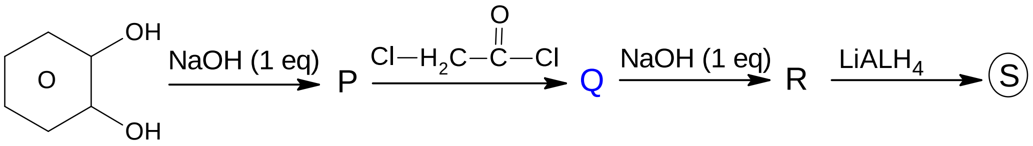


(D)



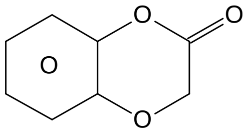
$CH_3-\overset{O}{\overset{||}{C}}-OH$

20.

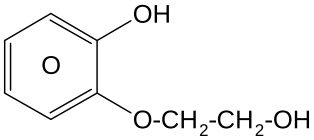


Select the correct statement

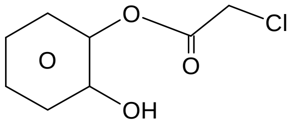
(A) Q is



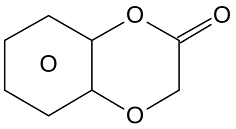
(B) S is



(C) Q is



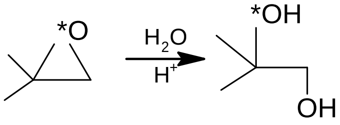
(D) R is



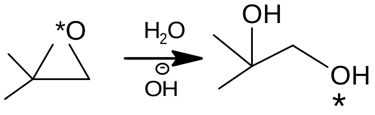
Space for Rough work

21. Select the Incorrect Reaction (s).

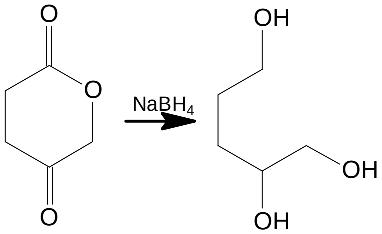
(A)



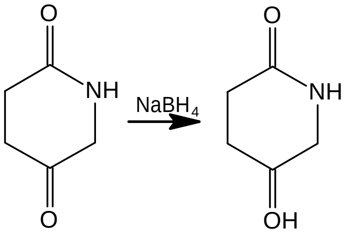
(B)



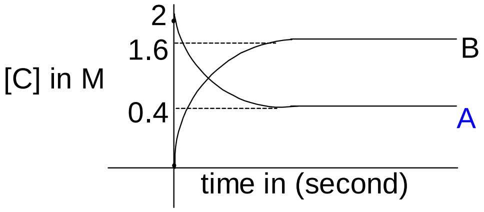
(C)



(D)



22. For the reaction $A \underset{K_2 \sec^{-1}}{\overset{K_1 \sec^{-1}}{\rightleftharpoons}} B$



Where is / are correct statement

(A) Equilibrium constant is 4

(B) Time taken for the completion of 50 % of equilibrium concentration of B is 14 sec

(C) Time taken for the completion of 10 % of initial concentration of A is 2.8 sec

(D) Rate constant of backward reaction is $10^{-2}\ \sec^{-1}$

23. Select the correct statement (s) about compound $NOBF_4$

(A) It has $5\sigma\ and\ 2\pi$ bond

(B) N – O bond length in this compound is longer than Nitric Oxide (NO)

(C) It is diamagnetic species

(D) B – F and length in this compound is lower that BF_3

Space for Rough work

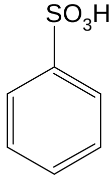
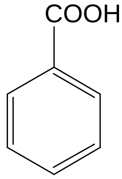
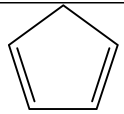
24. Assume the complex $\left[Ni\left(PPh_3\right)_2\left(SCN\right)_2\right]$ is paramagnetic
The analogous complex of Pd (II) is diamagnetic
The Isomerism shown by Pd (II) complex is/are
(A) Linkage
(B) Optical
(C) Geometrical
(D) Polymerization

25. If the radius of First orbit of H - atom is x, which of the following is the correct conclusion
(A) The De Broglie wavelength in the third Bohr orbit of $H - atom = 6\pi x$
(B) The fourth Bohr radius of $He^{+}\ ion = 8x$
(C) The De Broglie wavelength in third Bohr orbit of $Li\ 2+ = 2\pi x$
(D) The second Bohr radius of $Be^{2+} = x$

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 26, 27 and 28 by appropriately matching the information given in the three columns of the following table.

	Column – 1		Column – 2 (Pka)		Column – 3
(I)		(i)	16	P	Give effervescence with $NaHCO_3$
(II)		(ii)	15.2	Q	React with NaOH
(III)		(iii)	-6.5	R	More Acidic than water
(IV)	CH_3OH	(iv)	4.2	S	Give H_2 gas on reaction with sodium metal

26. Which of the following option is correct.
(A) $I - iii - P$
(B) $II - ii - P$
(C) $III - iv - Q$
(D) $IV - i - P$

Space for Rough work

27. Which of the following option is incorrect.
(A) $I - iii - R$
(B) $II - i - S$
(C) $III - i - S$
(D) $IV - ii - R$

28. Which of the following option is correct.
(A) $I - ii - Q$
(B) $II - iii - R$
(C) $III - i - S$
(D) $IV - ii - P$

Answer questions 29, 30 and 31 by appropriately matching the information given in the three columns of the following table.

Column 1, 2, 3 contains mainly reagent and conditions:

	Column – 1		**Column – 2**		**Column – 3**
(I)	$Conc.\ HNO_3$ / $Conc.\ H_2SO_4$	(i)	$1. O_2;\ 2 Dil. H_2SO_4$	P	$1. Mg / Et_2O; 2. CO_2; 3. H_3O^+$
(II)	$HeCl / AlCl_3$	(ii)	$Br_2 / NaOH$	Q	$Conc.\ HNO_3 / Conc.\ H_2SO_4$
(III)	$Ac_2O / AlCl_3$	(iii)	Br_2 / Fe	R	$CO_2 / NaOH;\ H_3O^+$
(IV)	$Propene,\ H_3PO_4$	(iv)	$K_2Cr_2O_7 / Conc. H_2SO_4$	S	H_3O^+

29. Benzene is converted into a mixture of two carboxylic acid using the reagent from the above table in the sequence.
(A) $(II)(iv)(Q)$
(B) $(II)(iii)(P)$
(C) $(III)(ii)(S)$
(D) $(IV)(iv)(R)$

30. Which of the following combination of reagent convert benzene to salicyclic acid.
(A) $(IV)(i)(R)$
(B) $(III)(ii)(S)$
(C) $(II)(iv)(R)$
(D) $(I)(i)(P)$

31. Benzene become benzoic acid on treatment with
(A) $(II)(ii)(R)$
(B) $(III)(iv)(Q)$
(C) $(III)(ii)(S)$
(D) $(IV)(i)(R)$

Space for Rough work

SECTION – B

(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

32. For the equilibrium

$$CuSO_4 \cdot 5H_2O(s) \rightleftharpoons CuSO_4 \cdot 3H_2O + 2H_2O(g)$$

$$kp = 2.25 \times 10^{-4}\, atm^2$$

Vapour pressure of water is 22.8 torr at 298 k the percentage relative humidity is expressed as $x\%$ find $\frac{x}{10}$.

33. The rate constant of a reaction at $27^\circ C$ *is* $3 \times 10^{-3} \min^{-1}$. The fraction of molecule crossing the energy barrier if the reaction at that temperature is $10^{-3}\%$. If temperature is increased, the maximum value of rate constant K can be attained is $x \times 100 \min^{-1}$. The value of x is

34. Number of B – O bond in Peroxoborate is x and number of mole of $H_2(g)$ given by hydrolysis of 1 mole of B_2H_6 is y then find $\frac{x+y}{2}$

35. 2 L of a butter solution is prepared that is $1M\ NaH_2PO_4$ *and* $1M\ Na_2HPO_4$. The solution is divided into two halves between two compartment of an of an electrolyte cell using Pt-electrodes. Assume that the only reaction is the electrolysis of water. If the electrolysis is carried out for 212 min with a current of 1.25 A. pH of the anode compartment is approximately $\left[Pka\left(H_2PO_4^-\right) = 7.1\right]$

36. A gaseous substance A_n remains partially dissociated $A_n(g) \rightleftharpoons nA(g)$. If the given sample of gas has $A_n(g)$ 52% dissociated and the equilibrium mixture diffuses 1.25 times slower than pure oxygen gas under identical condition determine 'n' Atomic weight of A is 32.

Space for Rough work

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. Which of the following is (are) correct.
(A) The three co-ordinate plane divide the whole system in 8 octane
(B) The perpendicular distance of the point $(3\cos\theta, 3\sin\theta, 4)$ from the z axis is constant
(C) In a tetrahedron, each of four vertices is the intersection of four lines
(D) The Y-Z plane divide the line joining the points $(2, 4, 5), (3, 5, -4)$ in the ratio 2 : 3 (internally)

38. Given the equation of two circles as
$C_1 : z\bar{z} + \bar{\alpha}z + \alpha\bar{z} + Y = 0$ *and* $C_2 : z\bar{z} + \bar{\beta}z + \beta\bar{z} + \delta = 0$ *where* $\alpha, \beta \in C$ & $Y, \delta \in R$
(A) C_1 & C_2 will touch externally if $|\alpha - \beta| = \sqrt{|\alpha|^2 - Y} + \sqrt{|\beta|^2 - \delta}$
(B) C_1 & C_2 will intersect orthogonally iff $\alpha\bar{\beta} + \bar{\alpha}\beta = Y + \delta$
(C) Radius of circle C_1 is $\sqrt{|\alpha|^2 - Y}$
(D) None of these

39. $I = \int_0^1 \frac{dx}{1 + x^{\frac{\pi}{2}}}$ then
(A) $I > \ell n2$
(B) $I < \ell n2$
(C) $I > \frac{\pi}{4}$
(D) $I < \frac{\pi}{4}$

Space for Rough work

40. The Value (s) of ‘a’ for which the area of the triangle included between the axes and any tangent to the curve $x^a y = \lambda^a$ is constant is/are

(A) $-\frac{1}{2}$ (B) -1

(C) $\frac{1}{2}$ (D) 1

41. The solution of $P + \cos Px \sin y = \sin Px \cos y \left(P = \frac{dv}{dx}\right)$

(A) $y = 0$ (B) $cx^2 - y = \sin^{-1} x$

(C) $cx - y = \sin^{-1} c$ (D) $y = \sqrt{x^2 - 1} - \sin^{-1} \frac{\sqrt{x^2 - 1}}{x}$

42. Let $h(x) = f(x) - (f(x))^2 + (f(x))^3$ for all real values of x, then incorrect option is

(A) $h(x)$ is increasing wherever $f(x)$ is increasing

(B) $h(x)$ is increasing whenever $f(x)$ is decreasing

(C) $h(x)$ is decreasing whenever $f(x)$ is decreasing

(D) Nothing can be said in general

43. $\underset{n\to\infty}{\ell t}\left(\frac{3nc_n}{2nc_n}\right)^{\frac{1}{n}} = \frac{a}{b}$ where a & b are relative prime then

(A) $a + b = 43$ (B) $ab = 390$

(C) $a + b = 41$ (D) $ab = 432$

Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 44, 45 and 46 by appropriately matching the information given in the three columns of the following table.

	Column – 1 $\left[I(\alpha)\right]b$		**Column – 2** $\left[I(\alpha_1)\right]$		**Column – 3** $\left[I(\alpha_2)\right]$
(I)	$I(\alpha)=\int_0^1 \frac{x^\alpha - 1}{\ell nx}dx$	(i)	$\frac{\pi}{2}\ell n\frac{3}{2}$	(P)	$\pi\ell n\left(\frac{\sqrt{5}}{2}\right)$
(II)	$I(\alpha)=\int_0^1 \frac{\tan^{-1}\alpha x}{x\sqrt{1-x^2}}dx$	(ii)	$\ell n\frac{3}{2}$	(Q)	$\frac{\pi}{4}\left(\sqrt{15}-4\right)$
(III)	$I(\alpha)=\int_0^1 \frac{\ell n\left(1-\alpha^2x^2\right)}{x^2\sqrt{1-x^2}}dx$	(iii)	$\frac{\pi}{2}\left(\sqrt{3}-2\right)$	(R)	$\frac{\pi}{2}\ell n\left(\frac{\sqrt{17}+4}{4}\right)$
(IV)	$I(\alpha)=\int_0^\infty \frac{\tan^{-1}\alpha x}{x\left(1+x^2\right)}dx$	(iv)	$\frac{\pi}{2}\ell n\left(\frac{\sqrt{5}+1}{2}\right)$	(S)	$2\ell n\left(\frac{\sqrt{5}}{2}\right)$

44. If $\alpha_1 = \frac{1}{2}$ & $\alpha_2 = \frac{1}{4}$ then which of the following option is correct?

(A) $I, (i), P$ (B) $I, (ii), S$

(C) $I, (i), S$ (D) $I, (ii), P$

45. If $\alpha_1 = \frac{1}{2}$ & $\alpha_2 = \frac{1}{4}$ then which of the following option is correct?

(A) $II, (iv), Q$ (B) $II, (iii), R$

(C) $III, (iii), Q$ (D) $III, (iv), Q$

Space for Rough work

46. If $\alpha_1 = \frac{1}{2}$ & $\alpha_2 = \frac{1}{4}$ then which of the following option is correct?

(A) $IV, (i), S$
(B) $IV, (ii), S$
(C) $IV, (i), P$
(D) $IV, (ii), P$

Answer questions 47, 48 and 49 by appropriately matching the information given in the three columns of the following table.

$(1-\alpha)x^2 - 2\alpha xy + (1-\alpha)y^2 + (18\alpha - 2)x + (18\alpha - 4)y + (5 - 81\alpha) = 0$ represent a conic section.

	Column –I (α)		**Column – II (Conic section)**		**Column – III (Latus rectum)**
(I)	$\frac{1}{8}$	(i)	Parabola	(P)	$2\sqrt{2}$
(II)	$\frac{1}{2}$	(ii)	Ellipse	(Q)	$4\sqrt{2}$
(III)	1	(iii)	Hyperbola	(R)	$8\sqrt{2}$
(IV)	2	(iv)	Rectangular hyperbola	(S)	8

47. Which of the following is correct combination?

(A) $I, (iii), P$
(B) $I, (iv), P$
(C) $II, (i), Q$
(D) $II, (ii), P$

48. Which of the following is correct combination?

(A) $III, (i), S$
(B) $III, (iv), S$
(C) $III, (ii), S$
(D) $III, (iii), S$

49. Which of the following is correct combination?

(A) $I, (ii), P$
(B) $III, (iii), P$
(C) $II, (iii), R$
(D) $IV, (iii), R$

Space for Rough work

SECTION – B
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

50. If $y^2\left(y^2-6\right)+x^2-8x+24=0$ and the minimum value of x^2+y^4 is m and maximum value is M, then find the value of $\frac{M}{6m}$

51. Let e the eccentricity of a hyperbola and $f\left(e\right)$ be the eccentricity of its conjugate hyperbola. If n is an even positive integer, then $\int_1^3 \underbrace{fofofo.....of\left(e\right)}_{n\ times}$ is equal to 'a' then 2a equal to

52. $P\left(x\right)=x^5+x^2+1\ has\ roots\ x_1,\ x_2,\ x_3,\ x_4,\ x_5\ and\ g\left(x\right)=x^2-2\ then$
$g\left(x_1\right)\cdot g\left(x_2\right)\cdot g\left(x_3\right)\cdot g\left(x_4\right)\cdot g\left(x_5\right)-30g\left(x_1\cdot x_2\cdot x_3\cdot x_4\cdot x_5\right)=4x+3$
then n equal to

53. The equation of the curve obtained by reflecting the ellipse $\frac{\left(x-4\right)^2}{16}+\frac{\left(y-3\right)^2}{9}=1$ about the line $x-y-2=0\ is\ 16x^2+9y^2+k_1x-36y+k_2=0$ then number of prime factor of $\left(k_1+k_2\right)$ is

54. $\bar{a},\ \bar{b}\ \&\ \bar{c}$ be three non-coplaner vector $\&\ \bar{d}$ be a non zero vector, which is perpendicular to $\left(\bar{a}+\bar{b}+\bar{c}\right)\ and\ \bar{d}=\sin x\left(\bar{a}\times\bar{b}\right)+\cos y\left(\bar{b}\times\bar{c}\right)+2\left(\bar{c}\times\bar{b}\right)$ then minimum value $x^2+y^2=\frac{a\pi^2}{b}\ where\ a\ \&\ b$ are coprime then $a+b$ is

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – I

JEE (Advanced)-2020

PAPER – 1

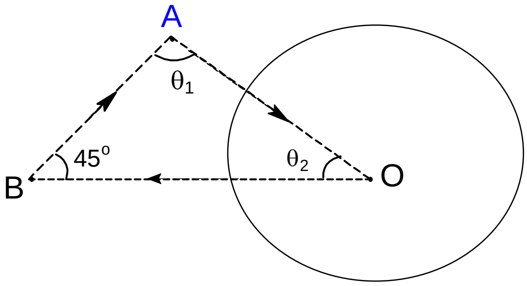
ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. BD



Sol. $$\frac{\left(\sqrt{3}+1\right)R}{\sin\theta_1}=\frac{2R}{\sin 45^\circ}$$

$$\theta_1=105^\circ \ or \ 75^0$$

$$so \ \theta_2=30^0 \ or \ 60^0$$

$$\oint_{OBAO}\vec{B}\cdot\vec{d\ell}=\mu_0 I_{in}$$

$$\oint_{BA}\vec{B}\cdot\vec{d\ell}=\frac{-\mu_0 I}{6} \quad or \quad \frac{-\mu_0 I}{12}$$

2. BC

Sol. For mirror, from mirror formula

$$\frac{1}{V}+\frac{1}{-10}=\frac{1}{-20}\Rightarrow V=+20$$

$$m=\frac{-V}{u}=2$$

For spherical mirror

$$v_1=-m^2\ v_0=-4\times1=-4\ cm/s$$

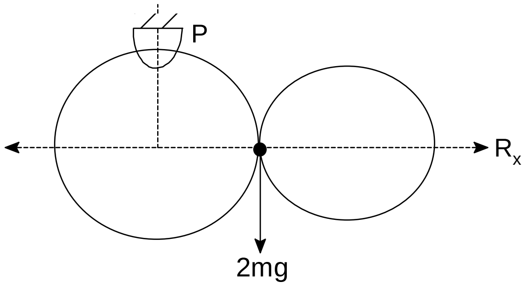
Now using concept of apparent depth

$v_{IB}=1cm/s$ along downward

$v_{IF} = 5 cm/s$ along downward

3. BD

Sol. For Bead



$$2mgR - R_x R = 8mR^2\alpha \qquad (1)$$

$$\mathrm{R}_x = ma_x \qquad (2)$$

$$\mathrm{a}_x = \alpha R \qquad (3)$$

$$From\ (1), (2)\ \&\ (3)$$

$$\alpha = \frac{2g}{9R}$$

$$mg = ma_y \Rightarrow a_y = g$$

$$acceleration\ of\ bead = \frac{\sqrt{85}g}{9}$$

4. ABD

Sol. Condition of no. slipping $\omega R - 6\omega_0 R = 4\omega_0 R \qquad \omega = 10\ \omega_0$

Acceleration of Point A

$$\vec{a}_A = \vec{a}_{A,C} + \vec{a}_C \qquad \uparrow 12\omega_0{}^2 R$$

$$\overset{\bullet A}{}$$

$$a_A = 88\omega_0{}^2 R \downarrow \qquad \downarrow\ (10\omega_0)^2\ R$$

Radius of curvature

$$\rho = \frac{v_A{}^2}{a_n} = \frac{(16\omega_0 R)^2}{88\omega_0{}^2 R} = \frac{32R}{11}$$

Acceleration of point B with respect to surface $\left(\vec{a}_B - \vec{a}_{Surface}\right)$,

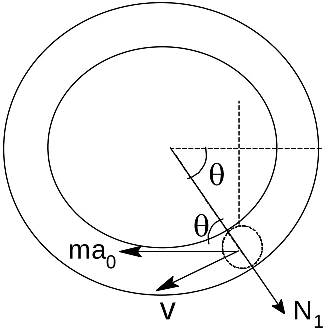
$$\vec{a}_B = \vec{a}_{B,C} + \vec{a}_C$$

$$\vec{a}_S = \omega_0{}^2 4R = 4\omega_0{}^2 R$$

$$\vec{a}_{PS} = (112 - 4)\omega_0{}^2 R = 108\omega_0{}^2 R$$

5. AD

Sol. From Work energy theorem



$$ma_0R(1-\cos\theta)=\frac{1}{2}mv^2$$

$$v^2=2a_0R(1-\cos\theta) \quad ---(1)$$

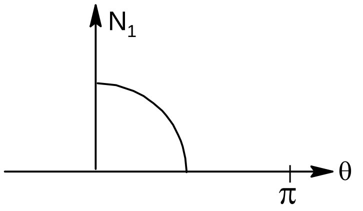
$$ma_0\cos\theta-N_1=\frac{mv^2}{R} \quad ---(2)$$

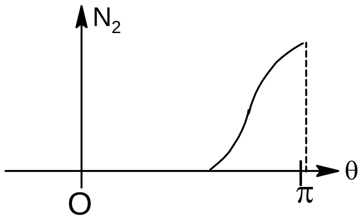
$$N_1=(3\cos\theta-2)ma_0$$

$$when\ \cos\theta=\frac{2}{3} \qquad N_1=0$$

$$for\ \theta>\cos^{-1}\left(\frac{2}{3}\right) \qquad N_1=0$$

$$N_2=ma_0(2-3\cos\theta)$$





6. ABCD

Sol. Let temperature of A, B and C are $T_1, T_2\ and\ T_3$ respectively. Then Equating power for C

$$T_2=2T_3 \qquad ---(1)$$

$$T_1^4=(256-64)T_3^4$$

$$T_1=2\sqrt{2}\ 3^{\frac{1}{4}}T_3 \qquad ---(2)$$

$$T_1^4+64T_3^4=16T_2^4 \qquad ---(3)$$

$$\frac{i^2\rho\ell}{\pi r^2}+\sigma 2\pi 8r\ell T_2^4=\sigma 2\pi r\ell T_1^4 \quad .---(4)$$

7. ABCD

Sol. Normal force will balance pressure force exerted along horizontal direction. Weight of object is equal to pressure force exerted along vertical direction.

$$N = \frac{\rho g r^2 \ell}{\ell}$$

$$w = \left(\sqrt{3} + 1 + \frac{\pi}{4}\right) r^2 \rho \ell g$$

8. D

Sol. use induced emf for a moving conductor $E = \left(\vec{V} \times \vec{B}\right).\overrightarrow{\Delta\ell}$

9. C

Sol. use induced emf for a moving conductor $E = \left(\vec{V} \times \vec{B}\right).\overrightarrow{\Delta\ell}$

10. D

Sol. use induced emf for a moving conductor $E = \left(\vec{V} \times \vec{B}\right).\overrightarrow{\Delta\ell}$

11. D

Sol. use the concept net field inside conducting plate is zero and for isolated plate the charge is conserved. When plate A and C are connected by conducting wire, the potential difference between A and C is zero.

12. B

Sol. use the concept net field inside conducting plate is zero and for isolated plate the charge is conserved. When plate A and C are earthed, the potential difference between A and C is zero.

13. A

Sol. use the concept net field inside conducting plate is zero and for isolated plate the charge is conserved. The sum of charge on plate A and C is constant.

SECTION – B

14. 3

Sol. Disc will move translationally if line of action of force passes through c.m of semi circular disc.

$$y_{cm} = \frac{\int y\,dm}{\int dm} = \frac{3\pi R}{16}$$

So value of $K = 3$

15. 8 m/s

Sol. Acceleration of particle with respect to box is along perpendicular to inclined plane

$$v_{\min} = \sqrt{g\cos 37^\circ\left(AB + CD + AC\right)}$$

$$= \sqrt{8\left(2+3+3\right)} = 8\,m/\text{s}$$

16. 5m

Sol. Using Bernoulli's equation and continuity equation

$$\ell' = \frac{A}{a}\sqrt{\frac{\rho A}{4\mu}}\ell$$

Where H is length of Can $\ell' = 5\,m$

17. 5

Sol. From Gauss law for spherical space charge density

$$\frac{dE}{dr}+\frac{2E}{r}=\frac{\rho}{\epsilon_0}$$

$$\rho = 5K \epsilon_0 r^2$$

$$\left.\frac{d\rho}{dr}\right|_{r=\frac{1}{2}m} = 5K \epsilon_0$$

So, value of α is 5

18. 2

Sol. Force on dielectric due to induced charge is $F=\frac{1}{2}$

From Force and Torque equation on cylinder and dielectric

The acceleration of dielectric will be $6\,m/s^2$

$$I=\frac{\epsilon_0\, a(K-1)E}{d}v$$

$$\frac{dI}{dt}=\frac{\epsilon_0\, a(K-1)E}{d}\frac{dv}{dt}=2$$

Chemistry

PART – II

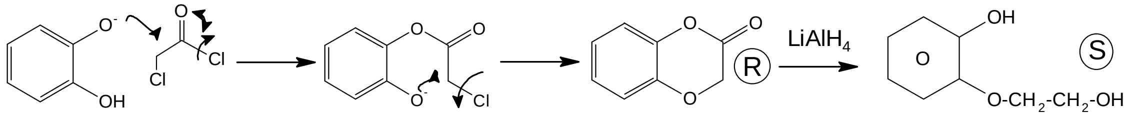
SECTION – A

19. ABC

Sol. In option – D, Acid / base reaction will take place

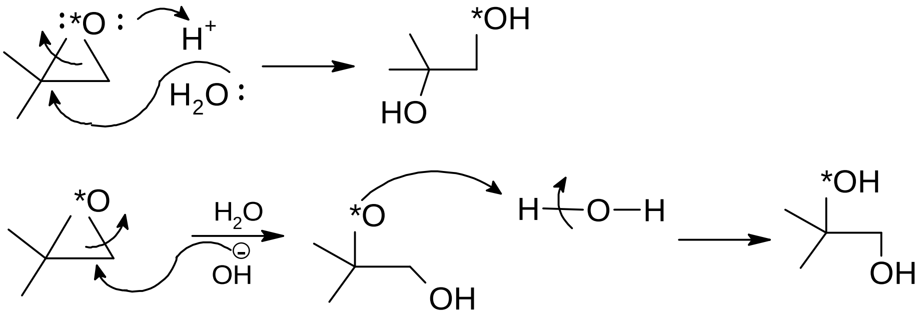
20. BCD

Sol.



21. ABC

Sol.



22. ABCD

Sol. $k_{eq} = 4, \frac{k_1}{k_2}$

$so,\ k_2 = 10^{-2}$

$t\,o.s = 28 \text{ sec}$

23. AC

Sol. $B.O\ of\ NO^+ = 3,16,\ 2\pi\ bond$

$BO\ of\ NO = 2.5$

$Both\ NO^+,\ BF^-\ is\ \text{diam}\,agnetic$

B – F bonds are longer in $BF_4^-\ than\ in\ BF_3$ due to absence at $P\pi - d\pi\ B \cdot B\ in\ [BF_4]^-$

24. ACD

Sol. Due to presence of SCN^- it will show linkage isomerism. It will be optically inactive as plane of symmetric is present. IT will also show geometrical isomerism and polymerization.

25. AC

Sol.

$n\lambda = 2\pi r \qquad so,\ \lambda_3 = \frac{2\pi \times 3}{} \times x \Rightarrow 6\pi x$

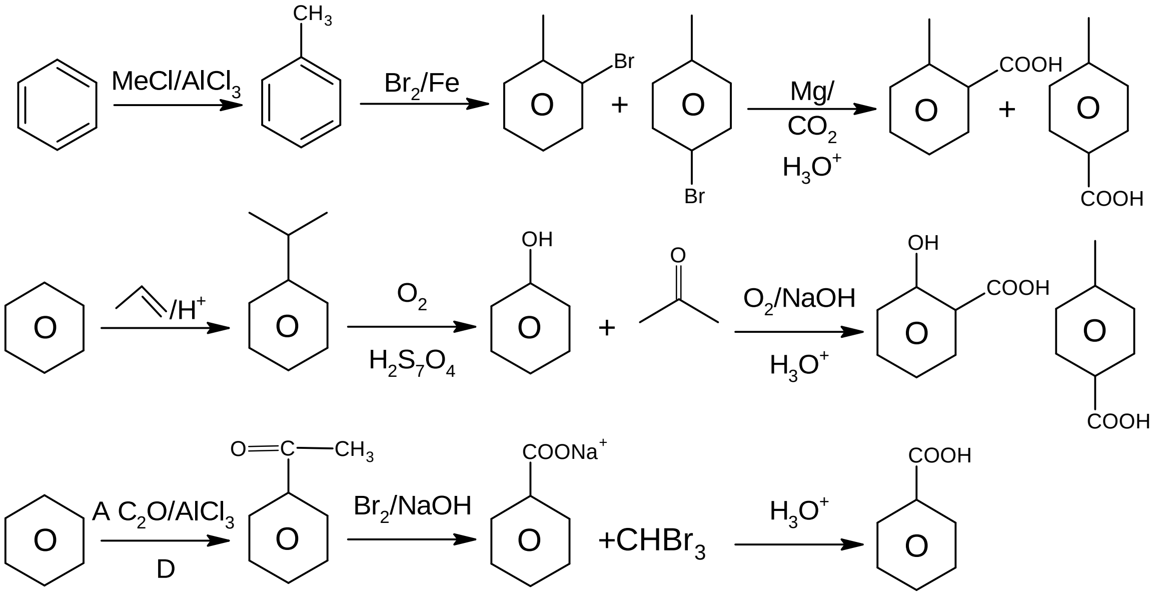
$\lambda_3(11^{2+}) = 2\pi x$

26. A
Sol. Conceptual

27. B
Sol. Conceptual

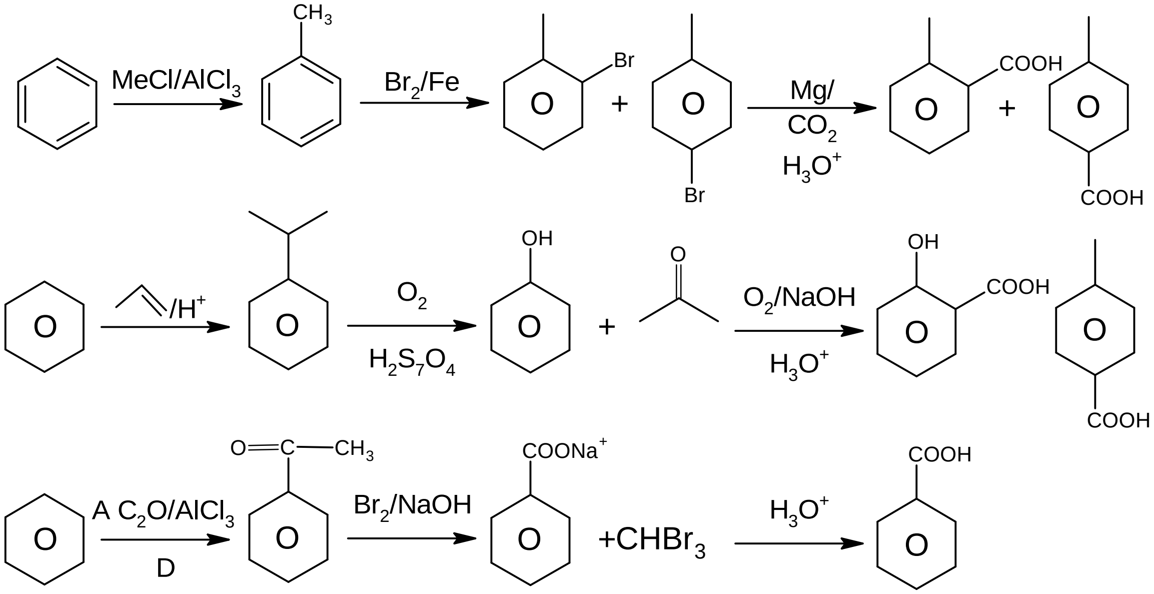
28. C
Sol. Conceptual

29. B
Sol.



CH_3
MeCl/AlCl$_3$
Br$_2$/Fe
Br
+
Br
Mg/
CO$_2$
H$_3$O$^+$
COOH
+
COOH
/H$^+$
OH
O$_2$
H$_2$S$_7$O$_4$
+
O
O$_2$/NaOH
H$_3$O$^+$
OH
COOH
COOH
O=C—CH$_3$
A C$_2$O/AlCl$_3$
D
Br$_2$/NaOH
COONa$^+$
+CHBr$_3$
H$_3$O$^+$
COOH

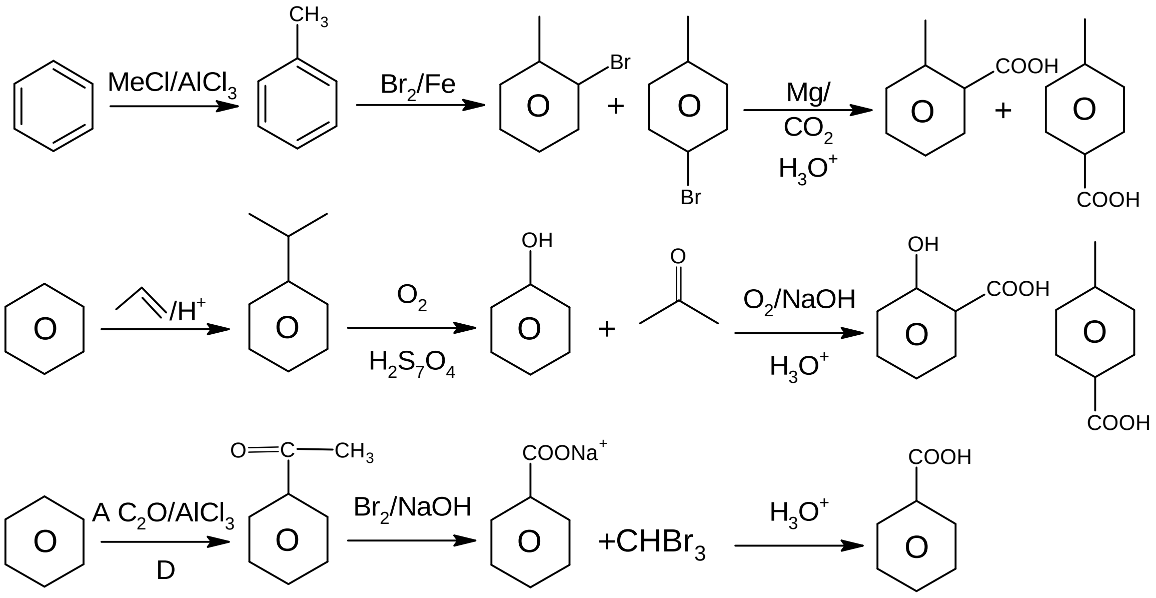
30. A
Sol.



CH_3
MeCl/AlCl$_3$
Br$_2$/Fe
Br
+
Br
Mg/
CO$_2$
H$_3$O$^+$
COOH
+
COOH
/H$^+$
OH
O$_2$
H$_2$S$_7$O$_4$
+
O
O$_2$/NaOH
H$_3$O$^+$
OH
COOH
COOH
O=C—CH$_3$
A C$_2$O/AlCl$_3$
D
Br$_2$/NaOH
COONa$^+$
+CHBr$_3$
H$_3$O$^+$
COOH

31. C

Sol.


CH3
MeCl/AlCl3
Br2/Fe
Br
O
+
Br
Mg/
CO2
H3O+
COOH
COOH
/H+
O2
H2S7O4
OH
O2/NaOH
H3O+
O═C—CH3
A C2O/AlCl3
D
Br2/NaOH
COONa+
+CHBr3
H3O+
COOH

SECTION – B

32. 5

Sol. $kp = \left(P_{H_{20}}\right)^2 = P_{H_{20}} = 15\times10^{-3}$

$$R.H = \frac{P_{H_{20}}}{S.U.P} = \frac{15\times10^{-3}}{\frac{22.8}{760}} = 0.5$$

$$\%RH = 50\%,\ \ so,\ \frac{x}{10} = 5$$

33. 3

Sol. $f = e^{\frac{-Ea}{RT}} \Rightarrow \frac{10^{-3}}{100} = 10^{-5}$

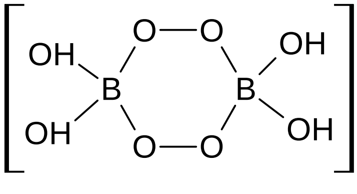
$$x = Ae^{\frac{-Ea}{RT}}$$

$$3\times10^{-3} = A\times10^{-5} \Rightarrow A = 300\,Min^{-1}$$

Maximum value of rate constant is equal to A is

34. 7

Sol. $B_2H_6 + 6H_2O \rightarrow 2H_3BO_3 + 6H_2$


O—O
OH
B
B
OH
OH
O—O
OH

35. 7

Sol. Number of Faraday's $= \frac{1.25 \times 212 \times 60}{96000} \Rightarrow 0.165$

$\Rightarrow 0.16\ mol\ of\ HPO_4^-$ will be converted in to $H_2PO_4^-$ because $0.16\ mol\ H^+$ will be produced at anode

So, $pH = Pka + \log\frac{(1-0.16)}{(1+0.16)} \Rightarrow 7.1 - 0.1 = 7$

36. 4

Sol. $An_{(g)} \rightleftharpoons nA(g)$

$100 \qquad 0$

$48 \qquad 52n$

$$M\ mix = \frac{48}{48+52n} \times 32n + \frac{n \times 52}{48+2n} \times 32$$

$$= \frac{32n \times 100}{48+52n}$$

$$now, \quad \frac{1}{1.25} = \sqrt{\frac{32}{\frac{32n \times 100}{48+52n}}}$$

$on\ solving\ we\ get\ n = 4$

Mathematics PART – III

SECTION – A

37. AB

Sol. 1 $\perp$ distance of P(x, y, z) from $z - ax = \sqrt{x^2 + y^2}$

38. ABC

Sol. $r_1 = \sqrt{(\alpha)^2 - \gamma},\ r_2 = \sqrt{(\beta)^2 - \delta}$

External touch $c_1c_2 = r_1 + r_2$

c_1 & c_2 is orthogonal if $|\alpha - \beta|^2 = |\alpha|^2 - \gamma + |\beta|^2 - \delta$

39. AD

Sol. $\frac{\pi}{2} > 1 \ \&\ \frac{\pi}{2} < 2$

$x^{\frac{\pi}{2}} < x^1 \ (0 < x < 1) \ \&\ x^{\frac{\pi}{2}} > x^2 \ (0 < x < 1)$

$$\int_0^1 \frac{1}{1+x^{\frac{\pi}{2}}} > \int_0^1 \frac{1}{1+x} \ \&\ \int_0^1 \frac{1}{1+x^{\frac{\pi}{2}}} < \int_0^1 \frac{1}{1+x^2}$$

$I > \ell n_2 \ \&\ I < \frac{\pi}{4}$

40. BD

Sol. Let $(\lambda, 1)$ is a point on the given curve

$\frac{dy}{dx} = -\frac{a}{\lambda}\ (at\ \lambda, 1)$

$y - 1 = -\frac{a}{\lambda}(x - \lambda)$

$Now,\ x = 0$

$y = 1 + a$

$y = 0$

$x = \frac{\lambda}{a} + \lambda = \frac{\lambda(1+a)}{a}$

$$\frac{dA}{da} = \frac{1}{2}\left(\frac{a \cdot 2 \cdot (1+a) - (1+a)^2}{a^2}\right) \cdot \lambda = 0$$

$a = 1, -1$

41. ACD

Sol. $px - y = \sin^{-1} p$

$$\left(x-\frac{1}{\sqrt{1-p^2}}\right)\frac{dp}{dx}=0 \;\Rightarrow p=c \;\&\; x=\frac{1}{\sqrt{1-p^2}}$$

42. BD

Sol. $h^{'}(x)=f^{'}(x)-2f(x)f'(x)+3f^{2}(x)+f^{'}(x)$

$$f^{'}(x)\left[1-\underbrace{2f(x)+}_{+ve}3\left(f(x)\right)^{2}\right]$$

43. AD

Sol. $p=\dfrac{3nc_n}{2nc_n}=\underset{n\to\infty}{\ell t}\left[\left(1+\dfrac{n}{n+1}\right)\left(1+\dfrac{n}{n+2}\right)-----\left(1+\dfrac{n}{n+n}\right)\right]^{\frac{1}{n}}$

$$\ell n\, p=\underset{n\to\infty}{\ell t}\frac{1}{n}\sum_{r=1}^{n}\ell n\left(1+\frac{1}{1+r/n}\right)$$

$$\ell n\, p=\int_{0}^{1}\ell n\left(\frac{x+2}{x+1}\right)$$

$$p=\frac{27}{16}$$

44. B

Sol. I.

$$I'(\alpha)=\int_{0}^{1}\frac{x^{\alpha}\ell n\, x}{\ell n\, x}$$

$$I'(\alpha)=\ell n|\alpha+1|$$

II.

$$I'(\alpha)=\int_{0}^{1}\frac{x\,dx}{x\sqrt{1-x^2}\left(1+a^2x^2\right)}$$

$$I(\alpha)=\frac{\pi}{2}\ell n\left|\alpha+\sqrt{1+\alpha^2}\right|$$

III.

$$I'(\alpha)=\int_{0}^{1}\frac{-2\alpha x^2}{\left(1-a^2x^2\right)\cdot x^2\sqrt{1-x^2}}dx$$

$$I(\alpha)=\pi\left|\sqrt{1-\alpha^2}-1\right|$$

IV.

$$I(\alpha)=\int_{0}^{\infty}\frac{ta^{2}\alpha x}{x\left(1+x^2\right)}dx$$

$$I'(\alpha)=\int_{0}^{\infty}\frac{1}{1+\alpha^2x^2}\cdot\frac{x}{x\left(1+x^2\right)}dx$$

$$I(\alpha)=\frac{\pi}{2}\ell n(\alpha+1)$$

45. C

Sol. I.

$$I'(\alpha)=\int_0^1 \frac{x^{\alpha}\ell n\,x}{\ell n\,x}$$

$$I'(\alpha)=\ell n|\alpha+1|$$

II.

$$I'(\alpha)=\int_0^1 \frac{x\,dx}{x\sqrt{1-x^2}\left(1+a^2x^2\right)}$$

$$I(\alpha)=\frac{\pi}{2}\ell n\left|\alpha+\sqrt{1+\alpha^2}\right|$$

III.

$$I'(\alpha)=\int_0^1 \frac{-2\alpha x^2}{\left(1-a^2x^2\right)\cdot x^2\sqrt{1-x^2}}dx$$

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$$I'(\alpha)=\int_0^{\infty} \frac{1}{1+\alpha^2x^2}\cdot\frac{x}{x\left(1+x^2\right)}dx$$

$$I(\alpha)=\frac{\pi}{2}\ell n(\alpha+1)$$

46. C

Sol. I.

$$I'(\alpha)=\int_0^1 \frac{x^{\alpha}\ell n\,x}{\ell n\,x}$$

$$I'(\alpha)=\ell n|\alpha+1|$$

II.

$$I'(\alpha)=\int_0^1 \frac{x\,dx}{x\sqrt{1-x^2}\left(1+a^2x^2\right)}$$

$$I(\alpha)=\frac{\pi}{2}\ell n\left|\alpha+\sqrt{1+\alpha^2}\right|$$

III.

$$I'(\alpha)=\int_0^1 \frac{-2\alpha x^2}{\left(1-a^2x^2\right)\cdot x^2\sqrt{1-x^2}}dx$$

$$I(\alpha)=\pi\left|\sqrt{1-\alpha^2}-1\right|$$

IV. $$I\left(\alpha\right)=\int_0^{\infty}\frac{ta^2\alpha x}{x\left(1+x^2\right)}dx$$

$$I'\left(\alpha\right)=\int_0^{\infty}\frac{1}{1+\alpha^2x^2}\cdot\frac{x}{x\left(1+x^2\right)}dx$$

$$I\left(\alpha\right)=\frac{\pi}{2}\ell n\left(\alpha+1\right)$$

47. C

Sol. $\left(x-1\right)^2+\left(y-2\right)^2=\alpha\left(x+y-9\right)^2$

$e^2\left(\frac{x+y-9}{\sqrt{2}}\right)^2$

$\alpha=e^2/2$

48. B

Sol. $\left(x-1\right)^2+\left(y-2\right)^2=\alpha\left(x+y-9\right)^2$

$e^2\left(\frac{x+y-9}{\sqrt{2}}\right)^2$

$\alpha=e^2/2$

49. D

Sol. $\left(x-1\right)^2+\left(y-2\right)^2=\alpha\left(x+y-9\right)^2$

$e^2\left(\frac{x+y-9}{\sqrt{2}}\right)^2$

$\alpha=e^2/2$

SECTION – B

50. 6

Sol. $\left(y^2-3\right)^2+\left(x-4\right)^2=1$

$x=4+\cos\theta,\ y^2=3+\sin\theta$

$M=36,\ m=1$

51. 8

Sol. If e & e_1 are eccentricity of hyperbola & in conjugate

$\frac{1}{e^2}+\frac{1}{e_1^2}=1 \quad \Rightarrow f\left(e\right)=\frac{e}{\sqrt{e^2-1}} \quad \Rightarrow fof\left(e\right)=e$

$$\underbrace{fofo---f\left(e\right)}_{n\ time}=\left[\begin{array}{ll} e & if\ \ n\ \ is\ \ even \\ \frac{e}{\sqrt{e^2-1}} & if\ \ n\ \ is\ \ odd \end{array}\right.$$

$$=\left[\begin{array}{ll} 4 & if\ \ n\ \ is\ \ even \\ 2\sqrt{2} & if\ \ n\ \ is\ \ odd \end{array}\right.$$

52. 1

Sol. $Let\ y=x^2-2=g\left(x\right)$

$\Rightarrow x=\sqrt{y+2}$

$p\left(x\right)=0\Rightarrow p\left(\sqrt{y+2}\right)=0$

$\left(\sqrt{y+2}\right)^5+\left(\sqrt{y+2}\right)^2+1=0$

$y^5+20y^4+40y^3+79y^2+74y+23=0$

53. 3

Sol. $Let\ h=4+4\cos\phi,\ \mathrm{k}=3+3\sin\phi$

Reflection about line $x-y-z=0$ & taken 10cm of (h, k)

We get,

$16x^2+9y^2-160x-36y+292=0$

$k_1+k_2=132=2^2\cdot 3\cdot 11$

54. 9

Sol. $\sin x+\cos y=-2$

$\sin x=-1$ & $\cos y=-1$

$x=-\frac{\pi}{2}$ & $y=\pi\Rightarrow\left(x^2+y^2\right)\min$

$=\frac{\pi^2}{4}+\pi^2=\frac{5}{4}\pi^2$

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PAPER – 2

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. C

Sol. Use $\int_0^4 F dt = mv - m(5)$

$$\text{work}_F = \frac{1}{2}mv^2 - \frac{1}{2}m(5)^2$$

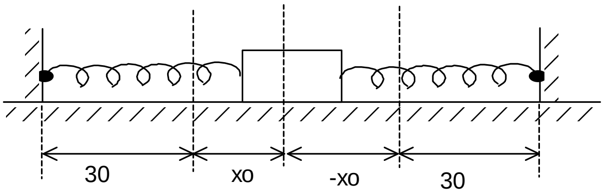
2. A

Sol. For equilibrium of the block

$$K_1(x_o + 30 - 20) = K_2[30 - x_o - 20]$$

$\Rightarrow x_o = 5$ cm

$$T = 2\pi\sqrt{\frac{m}{K_i + K_2}} = \frac{\pi}{100} \text{ sec}$$



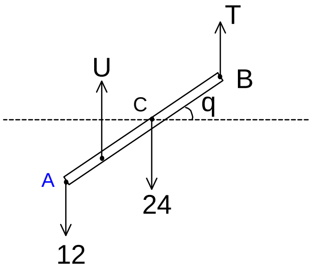
3. C

Sol. U = up thrust = $A\left(\frac{\ell}{2}\right)P_w g$

T + U = 12 g + 24 g

Taking torque about B,

$$U\left(\frac{\ell}{2} + \frac{\ell}{4}\right)\cos\theta = 12g(\ell\cos\theta) + 24g\left(\frac{\ell}{2}\cos\theta\right)$$



4. D

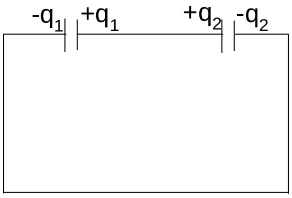
Sol. After a very long time inductor behaves like zero resistance.

5. B

Sol. $\because \lambda_1 N_1 = \lambda_2 N_2 \Rightarrow \frac{N_{Ra}}{N_{Rn}} = \frac{\lambda_{Rn}}{\lambda_{Ra}} = \frac{t^{\frac{1}{2}}_{Ra}}{t^{\frac{1}{2}}_{Rn}}$

6. B

Sol. Let q_1 and q_2 be the charge on each capacitor when current its maximum.



$q_1 + q_2 = 10CV_0$ .....(i)

$\frac{q_1}{2c} = \frac{q_2}{4C}$

$\Rightarrow q_2 = 2q_1$

From (i) and (ii), $q_1 = \frac{10CV_0}{3}$ .....(ii)

$\therefore$ PD across each capacitor is $\frac{5V_0}{3}$

From conservation of energy.

$$\frac{1}{2}(2C)V_0^2 + \frac{1}{2}(4C)(9V_0^2) = \frac{1}{2}(6C)\left(\frac{5V_0}{3}\right)^3 + \frac{1}{2}Li^2$$

$\therefore i = 8V_0\sqrt{\frac{C}{3L}}$

7. B

Sol. $h = u\cos\theta t - \frac{1}{2}gt^2$

This is a quadratic equation in t, which will have two roots – say t_1 & t_2

$\therefore t_1 + t_2 = \frac{2u\cos\theta}{g} \Rightarrow \frac{2u\cos\theta}{g} = 4$

& $t_1 t_2 = \frac{2h}{g}$

maximum height = $\frac{(u\cos\theta)^2}{2g}$

8. BCD

Sol. $\overrightarrow{v_B} = 8\hat{j} + 2t\hat{k}$

$\overrightarrow{v_C} = \overrightarrow{v_o} = v_x\hat{i} + v_y\hat{j} + v_z\hat{k}$

$\overrightarrow{r_B} = 8t\hat{j} + t^2\hat{k}$

$\overrightarrow{r_C} = v_x t\hat{i} + v_y t\hat{j} + v_z t\hat{k}$

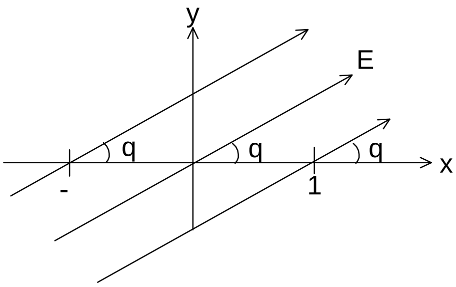
At 4 sec, $\overrightarrow{r_B} = \overrightarrow{r_C} \Rightarrow v_x = 0, v_y = 8m/s$ & $v_z = 4m/s$

$\therefore \overrightarrow{v_o} = \left(8\hat{j} + 4\hat{k}\right) m/s$

9. BCD

Sol. $\left(E\cos\theta\right)2 = 20$, where $0 \le \theta < 90^o$

$\Rightarrow E\cos\theta = 10$



10. ACD

Sol. When a compression pulse strikes a fixed surface, it reflects as compression pulse.

11. BC

Sol. Use $\Delta x = n\lambda$ (for maxima)

& $\Delta x = \left(n + \frac{1}{2}\right)\lambda$ (for minima)

12. AC

Sol. $\vec{E} = 54\hat{i} + 72\hat{j},\ E = 90 NC^{-1}$

$90 = \frac{9\times10^9 Q}{r^2}$ ....(i)

$V = 1800 = \frac{9\times10^9 Q}{r}$ .....(ii)

From equations (i) and (ii)

r = 20 m, q = 4 mC

Now , $\frac{(9-x_0)\hat{i} + (4-y_0)\hat{j}}{20} = \frac{54\hat{i}+72\hat{j}}{90}$

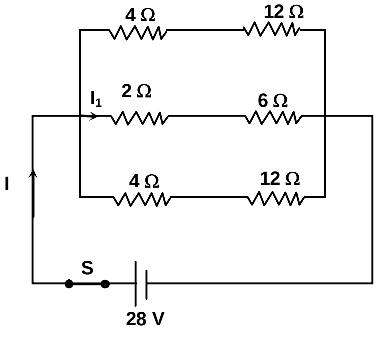
$\Rightarrow x_0 = -3, y_0 = -12$

13. BD

Sol. $V = \int_2^4 \left(\frac{25t - 50}{10}\right) dt$

14. BC

Sol. Equivalent circuit is

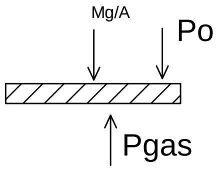


15. B

Sol. $Q = nC_P\Delta T = C_P\left(\frac{P\Delta V}{R}\right)$

16. A

Sol.



17. B

Sol. Apply conservation of energy and conservation of angular momentum.

18. B

Sol. Area velocity $= \frac{\text{Angular momentum}}{2m}$.

Chemistry

PART – II

SECTION – A

19. B

Sol. $H^+ + OH^- \longrightarrow H_2O(l)$

$$\left(\Delta H_{neut}\right)_{SA+SB} = \left(\Delta H_{neut}\right)_{H^+ + OH^-} = -285 + 227.3 = -57.7 \text{ kJ}$$

$$-55 = \left(\Delta H_{ion}\right)_{CH3COOH} - 57.7$$

$$\left(\Delta H_{ion}\right)_{CH3COOH} = 2.7 \text{ kJ/mol}$$

20. D

Sol. Zn^{+2} forms soluble complex with excess KCN but does not react with excess KI
Pb^{+2} is soluble in excess KI but insoluble in excess KCN
Ag^+ is soluble in excess KCN but insoluble in excess KI
Hg_2^{+2} gives ppt of Hg when reacts with KI as well as well as excess KCN

$$Hg_2^{2+} + 2I^- \longrightarrow Hg_2I_2\downarrow$$

$$Hg_2I_2\downarrow + 2I^- \longrightarrow [HgI_4]^{2-} + Hg\downarrow$$

$$Hg_2^{2+} + 2CN^- \longrightarrow \underset{\text{(soluble)}}{Hg(CN)_2} + Hg\downarrow$$

21. C

Sol.

	C_2H_2	+	CO	+	O_2	$\longrightarrow$	CO_2	+	H_2O
Volume initially	x ml		(20 – x) ml		30 ml				
Volume left					8 ml		26 ml		

2 × Volume of C_2H_2 taken + volume of CO taken = Volume of CO_2.

2 x + 20 – x = 26 ; x = 6 ml.

Volume of C_2H_2 taken = 6 ml and volume of CO taken = 14 ml.

22. B

Sol. Cell reaction is:

$$Ag(s)/AgBr(s)/Br^-(aq)\,||\,Cl^-(aq)/AgCl(s)/Ag(s)$$

$$Ag_c^+ \longrightarrow Ag_a^+$$

$$E_{cell} = 0 - 0.059\log\left(\frac{\left[Ag^+\right]_a}{\left[Ag^+\right]_c}\right)$$

$$\Rightarrow 0 = 0 - 0.059\log\left(\frac{\left[Ag^+\right]_a}{\left[Ag^+\right]_c}\right)$$

$$\therefore \left[Ag^+\right]_a = \left[Ag^+\right]_c \Rightarrow \frac{K_{sp}\text{ of AgBr}}{\left[Br^-\right]} = \frac{K_{sp}\text{ of AgCl}}{\left[Cl^-\right]}$$

$$\text{or, } \frac{8\times10^{-13}}{10^{-10}} = \frac{\left[Br^-\right]}{\left[Cl^-\right]}$$

23. D

Sol. Tertiary amine does not form H-bond among themselves because H-atoms are not directly joined with N- atom

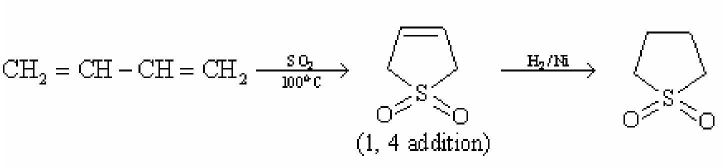
24. D

Sol. For a Bcc lattice, $\frac{X^{+}}{Y^{-}} = 0.732 \Rightarrow Y^{-} = \frac{0.4}{0.732} = 0.546^{0}\text{A}$

Now for fcc lattice, $\frac{Z^{+}}{Y^{-}} = 0.414 \Rightarrow Z^{+} = 0.546 \times 0.414 = 0.226^{0}\text{A}$

25. B

Sol.



26. B

Sol. Theory based

27. ABCD

Sol. The atom directly joined with phenyl contains lone pair of electron and hence o-& p-director

28. ABC

Sol. (A) is Hoffman degradation
(C) is NGP reaction and hence retention takes place
(D) is Gatterman aldehyde synthesis

29. ACD

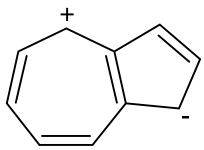
Sol. Theory based

30. BC

Sol. For Q using steady state concept
Rate of appearance of Q = rate of disappearance of Q
$K_1[P] = K_2[Q]$
Number of nuclei of Q = $\frac{k_1}{k_2} \times \text{no. of nuclei of P} = \frac{10/60}{1000} \times 6 \times 10^{23} = 10^{20}$
For R, since rate constant is very high for second step than first step
Number of nuclei of R = Number of nuclei of P disintegrated = 6×10^{23}

31. ABC

Sol.



32. AD

Sol. New compound is brown ring, $[Fe(H_2O)_5(NO)]SO_4$ where NO has +1 charge. Due to NO^{+1}, only $4s^1$ electron is paired up in 3d subshell.

33. B

Sol. $\underset{(A)}{FeSO_4.7H_2O} \xrightarrow{\Delta} \underset{(B)}{Fe_2O_3}(s) + SO_2(g) + SO_3(g) + H_2O\ (vap.)$

34. D

Sol. F is $CuSO_4.5H_2O$

35. B

Sol. $\underset{(S)}{CH_3-CH_2-COOH} \xrightarrow{N_3H, H^+/\Delta} \underset{(P)}{CH_3-CH_2-NH_2} \xleftarrow{Br_2/KOH} \underset{(Q)}{CH_3-CH_2-CONH_2} \xrightarrow{LiAlH_4} \underset{(R)}{CH_3-CH_2-CH_2-NH_2}$

36. D

Sol. $\underset{(S)}{CH_3-CH_2-COOH} \xrightarrow{N_3H, H^+/\Delta} \underset{(P)}{CH_3-CH_2-NH_2} \xleftarrow{Br_2/KOH} \underset{(Q)}{CH_3-CH_2-CONH_2} \xrightarrow{LiAlH_4} \underset{(R)}{CH_3-CH_2-CH_2-NH_2}$

The conversion of (S) to (P) is Schmidt reaction.

Mathematics PART – III

SECTION – A

37. A

Sol. From the figure,

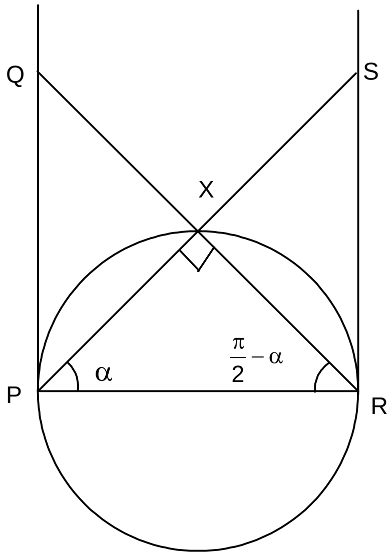
$\tan\alpha = \frac{RS}{PR} = \frac{RS}{2r}$ ….(i)

and $\tan\left(\frac{\pi}{2}-\alpha\right) = \frac{PQ}{PR} = \frac{PQ}{2r}$ ….(ii)

Multiplying (i) and (ii), we get

$\tan\alpha\cot\alpha = \frac{RS.\ PQ}{(2r)^2}$

$\therefore\ 2r = \sqrt{(RS)(PQ)}$



38. D

Sol. For ${}^{10}C_x$ to be defined $x \in I,\ 0 \le x \le 10$.

$\frac{x}{{}^{10}C_x} \le 1 \Rightarrow x \ne 10$ $[x] = x,\ \{x\} = 0$ as $x \in I$

$\Rightarrow 5x^2 - 60x + 160 > 0$

$\Rightarrow x^2 - 12x + 32 > 0$

$\Rightarrow x \notin [4,8]$

39. B

Sol. $n(E) = \frac{1}{2}\left[{}^4C_1.{}^2C_1 + {}^{24}C_1.{}^3C_1 + {}^{36}C_1.{}^4C_1\right] = 112$

$\Rightarrow P(E) = \frac{112}{{}^{64}C_2} = \frac{1}{18}$

40. D

Sol. Clearly incentre of ΔDEF is orthocenter of ΔABC is i.e (α,α) which lies on hyperbola

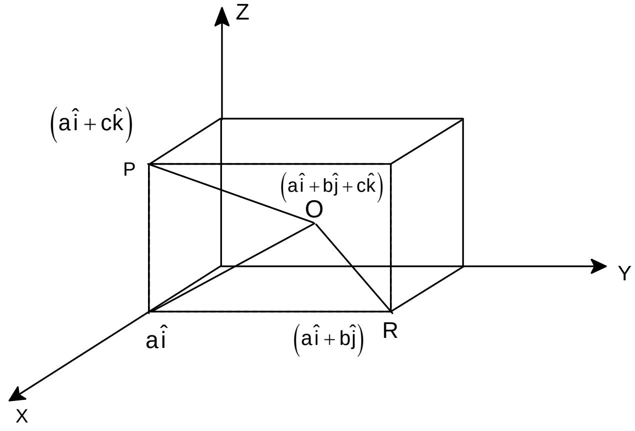
$xy - x - y - 3 = 0 \Rightarrow \alpha = 3$

Again equation of DE is $x + y - \frac{26}{5} = 0$

$\Rightarrow r =$ length of perpendicular from $I(3,3)$ on DE $\Rightarrow r = \frac{2}{5}\sqrt{2}$ units

41. C

Sol.


Z
$\left(a\hat{i}+c\hat{k}\right)$
P
$\left(a\hat{i}+b\hat{j}+c\hat{k}\right)$
O
Y
$a\hat{i}$
$\left(a\hat{i}+b\hat{j}\right)$
R
X

42. A

Sol. Take m = [x]

Observe that $\sqrt{m^2+2(n+1)^2}-\sqrt{m^2+2n^2}=\dfrac{4n+2}{\sqrt{m^2+2(n+1)^2}+\sqrt{m^2+2n^2}}$

Which is less than $\dfrac{2n+1}{m}$.Taking

$m \le \sqrt{m^2 2n^2} < m+1$ or $0 \le n < \sqrt{m}$

We get $\sqrt{m^2+2(n+1)^2}-\sqrt{m^2+2n^2} < \dfrac{2}{\sqrt{m}}+\dfrac{1}{m} \le \dfrac{3}{\sqrt{m}}$

Hence we conclude that 0 < $\left|x-\sqrt{m^2+2n^2}\right| < \dfrac{3}{\sqrt{m}}$

Applying squeeze play rule $\lim\limits_{x\to\infty}$ f(x) = $\lim\limits_{x\to\infty}$ f(x) = 0

43. C

Sol. Differentiating both sides w.r.t b, we get

$$\int_0^{\frac{\pi}{2}}\frac{-\cos x}{(a+b\cos x)^2}dx=\frac{1}{b^2-a^2}-\frac{b}{(b^2-a^2)^{\frac{3}{2}}}\text{In}\left(\frac{b+\sqrt{b^2-a^2}}{a}\right)$$

$$\therefore\int_0^{\frac{\pi}{2}}\frac{\cos x}{(3+5\cos x)^2}dx=-\frac{1}{16}+\frac{5}{64}\text{In}3$$

44. A, C

Sol. $k_1=\tan 27\theta-\tan\theta=(\tan 27\theta-\tan 9\theta)+(\tan 9\theta-\tan 3\theta)+(\tan 3\theta-\tan\theta)$

Now, $\tan 3\theta-\tan\theta=\dfrac{\sin 2\theta}{\cos 3\theta\cos\theta}=\dfrac{2\sin\theta}{\cos 3\theta}$

Similarly, $\tan 9\theta-\tan 3\theta=\dfrac{2\sin 3\theta}{\cos 9\theta}$

and $\tan 27\theta-\tan 9\theta=\dfrac{2\sin 9\theta}{\cos 27\theta}$

$$\therefore\ k_1 = 2\left(\frac{\sin 9\theta}{\cos 27\theta} + \frac{\sin 3\theta}{\cos 9\theta} + \frac{\sin\theta}{\cos 3\theta}\right) = 2k_2$$

45. A, C, D

Sol. $f(x+y) = 2^x f(y) + 4^y f(x)$ ....(1)

replace x into y and x, we get

$f(x+y) = 2^y f(x) + 4^x f(y)$

$\Rightarrow 2^x f(y) + 4^y f(x) = 2^y f(x) + 4^x f(y)$..........(2)

$\Rightarrow \dfrac{f(x)}{4^x - 2^x} = \dfrac{f(y)}{4^y - 2^y} = k$

$\Rightarrow f(x) = k\left(4^x - 2^x\right)$

since, $f'(0) = \ln 2$, we get $k = 1$.

Hence, $f(x) = 4^x - 2^x$.

46. A, D

Sol. Let O be the intersection of diagonals AC and BD.

Let position vector of A $(\vec{a})$,B$(\vec{b})$,C$(\vec{c})$,D$(\vec{d})$. Let position vector of G be $(\vec{g})$

Let $\dfrac{AM}{AB} = m, \dfrac{BN}{BC} = n, \dfrac{DP}{DC} = p$

Now, $\overrightarrow{OM} = (1-m)\vec{a} + m\vec{b}$

$\overrightarrow{OP} = (1-p)\vec{d} + p\vec{c}$

$\Rightarrow \vec{g} = \dfrac{(1-m)\vec{a} + n\vec{b} + (1-n)\vec{b} + n\vec{c} + (1-p)\vec{d} + p\vec{c}}{3}$ as $\vec{a} = -\vec{c}$ and $\vec{d} = -\vec{b}$

$\vec{g} = (m+n+p-1)\vec{c} + (m-n+p)\vec{b}$

If $G(\vec{g})$ is collinear with AC

$\Rightarrow m - n + p = 0$

If $G(\vec{g})$ is collinear with BD

$\Rightarrow m + n + p - 1 = 0.$

47. A, B, C

Sol. The tangent 3x + 4y – 25 = 0 is tangent at vertex and axis is 4x – 3y = 0

So, PS = a = 5

Latus rectum = Ab = 20

48. A, C, D

Sol. $M^T M = I, M^T I = M^T$

$M^T M_1 = M_2$

$|M_1| = |M_2|$

49. A, B, C, D

Sol. $I = \displaystyle\int_0^{1/2}\left(\frac{1}{4} - x^2\right)^4 dx = \int_0^{1/2}\left(\frac{1}{4} - \left(\frac{1}{2} - x\right)^2\right)^4 dx = \int_0^{1/2}\left(x - x^2\right)^4 dx = \int_0^{1/2} x^4 (1-x)^4 dx$

Also, by replacing x by (1 – x) we get, I = $\int_{1}^{1/2}(1-x)^4 x^4 dx = \int_{1/2}^{1} x^4 (1-x)^4 dx$

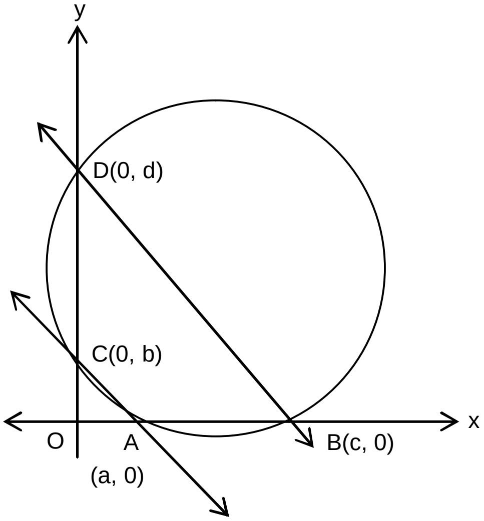
Adding we get, $2I = \int_0^1 x^4(1-x)^4 dx \Rightarrow I = \frac{1}{2}\int_0^1 x^4(1-x)^4 dx.$ On putting x = $\sin^2\theta$ we get;

$$I = \int_0^{\pi/2} \sin^9\theta\cos^9\theta d\theta = \frac{(8\times6\times4\times2)(8\times6\times4\times2)}{18\times16\times14\times12\times10\times8\times6\times4\times2} = \frac{1}{1260}$$

50. A, B, C, D

Sol. If points A, B, C, D are concyclic, then ac = bd. The coordinates of the points of intersection of lines are $\left(\frac{ac(b-d)}{bc-ad}, \frac{bd(c-a)}{bc-ad}\right)$

Let coordinates of the point of intersection be (h, k)



Then, $h = \frac{ac(b-d)}{bc-ad}, k = \frac{bd(c-a)}{bc-ad}$

Given, $c^2 + a^2 = b^2 + d^2$. Since, ac= bd,

So, $(c-a)^2 = (b-d)^2$ or $(c-a) = \pm(b-d)$

Then the locus of the points of intersection is $y = \pm x$

51. C

Sol. Homogenizing, we get $3x^2 - y^2 - 2x(ax+by) + 4y(ax+by) = 0$. Since AB subtends a right angle at the origin, coefficient of x^2 + coefficient of y^2 = 0. This gives $(3-2a)+(-1+4b)=0$ or $a-2b=1$.

52. A, D

Sol. $a - 2b = 1$

$ax + by = 1$

Clearly, the line always passes through the point $(1,-2)$. Hence, $(h, k) = (1, -2)$.

53. D

Sol. $\cos 3n\alpha + i\sin 3n\alpha + \cos 3n\beta + i\sin 3n\beta + \cos n\gamma + i\sin 3n\gamma = 3$

$\left(\cos n\left(\alpha+\beta+\gamma\right)+i\sin\left(\alpha+\beta+\gamma\right)\right)$

54. C

Sol. $\cos 3n\alpha + i\sin 3n\alpha + \cos 3n\beta + i\sin 3n\beta + \cos n\gamma + i\sin 3n\gamma = 3$

$\left(\cos n\left(\alpha+\beta+\gamma\right)+i\sin\left(\alpha+\beta+\gamma\right)\right)$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – I

JEE (Advanced)-2020

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **One Section**: **Section-A.**

1. ***Section–A (01 – 07, 19 – 25, 37 – 43)*** *contains 21 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (08– 14, 26 – 32, 44 – 50) *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect option is selected.

   Section–A (15 – 18, 33 – 36, 51 – 54) *contains 6 paragraphs. Each paragraph is having 2 multiple choice questions having 4 options with* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

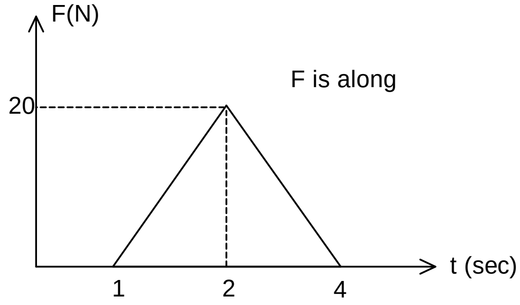
Physics

PART – I

SECTION – A
(One Options Correct Type)

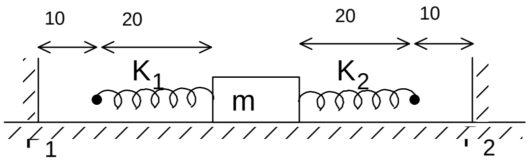
This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A particle of mass 2 kg is moving along x-axis with a velocity of 5 m/s. It crosses the origin at t = 0. A time varying force whose variation is as shown starts acting on a particle at t = 1 sec. For this situation, mark out the correct statement.



(A) the particle will come to rest instantaneously at t = 6.8 sec
(B) the final velocity of the particle will be 18 m/s.
(C) work done by the force F on the particle is 375 J.
(D) all of the above

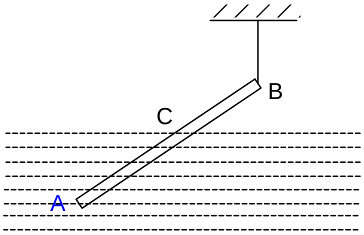
2. Two springs, each of unstretched length 20 cm but having different spring constants K_1 = 1000 N/m and K_2 = 3000 N/m are attached to two opposite faces of a block of mass m = 100 g kept on a smooth horizontal surface as shown in the figure. The outer ends of the two springs are now attached to two pins P_1 & P_2 whose locations are shown in the figure, as a result of this, the block acquires a new equilibrium position. The block has been displaced by small amount from its equilibrium position and released to perform simple harmonic motion, then



(A) new equilibrium position is at 35 cm from P_1 and time period of simple harmonic motion is $\frac{\pi}{100}$ sec.
(B) new equilibrium position is at 20 cm from P_1 and time period of simple harmonic motion is $\frac{\pi}{100}$ sec.
(C) new equilibrium position is at 35 cm from P_1 and time period of simple harmonic motion is $\frac{\pi}{26}$ sec.
(D) new equilibrium position is at 30 cm from P_1 and time period of simple harmonic motion is $\frac{\pi}{26}$ sec.

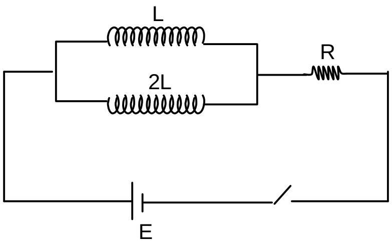
Space for Rough work

3. A uniform thin rod AB, 12 m long weighing 24 kg, is supported at end B by a flexible light string and a lead weight (of very small size) of 12 kg is attached at end A. The rod floats in a river with one-half of its length submerged. For this situation, mark out the correct statement. [Take g = 10 m/s^2, density of water = 1000 kg/m^3]



(A) the tension in the string is 36 g
(B) the tension in the string is 4 g
(C) the volume of the rod is 60000 m^3
(D) the point of application of the buoyancy force is passing through C (centre of mass of the rod).

4. Two ideal inductor of inductance L and 2L are connected in parallel. Combination of inductor are connected in series with a resistor of resistance R along with a battery of emf E. Switch S is closed at t = 0. After long time energy stored in inductor of inductance L will be?



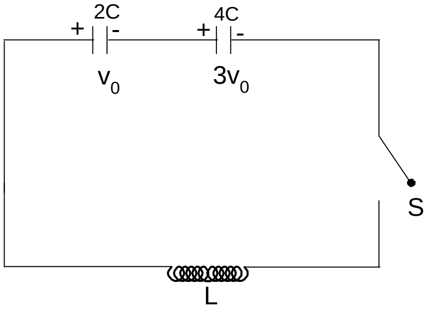
(A) $\frac{LE^2}{2R^2}$
(B) $\frac{E^2}{R}$
(C) $\frac{LE^2}{9R^2}$
(D) $\frac{2LE^2}{9R^2}$

5. Radium $\left({}_{88}Ra^{226}\right)$ decays by emitting an α-particle into Rn^{222} with a half life of 1620 years, which then decays into Po^{218} by emitting another α-particle with a half life of 3.82 days. The ratio of Ra^{226} to Rn^{222} nuclei in a sample when Rn is in radioactive equilibrium:

(A) $1:1$
(B) $1.55\times10^5:1$
(C) $1.78\times10^5:1$
(D) $1.63\times10^5:1$

Space for Rough work

6. Two capacitors 2C and 4C initially charged to V_0 and $3V_0$ in the polarity shown are connected to an inductor of inductance 'L'. Initial current in the inductor is zero. Now the switch 'S' is closed. The maximum current in the circuit is



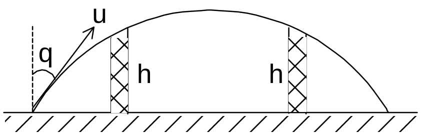
(A) $\frac{v_0}{8}\sqrt{\frac{C}{3L}}$

(B) $8V_0\sqrt{\frac{C}{3L}}$

(C) $\frac{v_0}{4}\sqrt{\frac{C}{3L}}$

(D) $4V_0\sqrt{\frac{C}{3L}}$

7. A particle is thrown with velocity u making an angle θ with the vertical. It just crosses the top of two poles each of height h after 1 sec & 3 sec respectively. The maximum height of projectile is



(A) 9.8 m (B) 19.6 m
(C) 39.2 m (D) 4.9 m

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

8. A t = 0, two particles B & C are located at the origin of the coordinate system. Then they start moving simultaneously. B moves under a constant acceleration of $2\hat{k}\,m/s^2$ with an initial velocity of $8\hat{j}\,m/s$. Particle C moves with constant velocity $\vec{V}_o$ in such a way that B & C collides at t = 4 sec. Then mark the incorrect statement(s).

(A) $\vec{v}_o = 8\hat{j} + 4\hat{k}\,m/s$

(B) position vector of location where two particles collide is $16\hat{i} + 32\hat{k}$ m.

(C) both (A) & (B) are correct

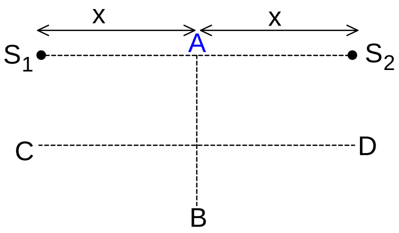
(D) It is not possible that B & C collide with each other for any value of $\vec{V}_o$

Space for Rough work

9. The gravitational potential changes uniformly from – 20 J/kg to – 40 J/kg as one moves along x-axis from x = -1 m to x = +1 m. Mark the correct statement about gravitational field intensity (E) at origin.
(A) E at x = 0 must be equal to 10 N/kg.
(B) E at x = 0 may be equal to 10 N/kg.
(C) E at x = 0 may be greater than 10 N/kg.
(D) E at x = 0 must not be less than 10 N/kg.

10. Mark the correct statement(s).
(A) when a sound wave strikes a wall, the compression pulse is reflected as compression pulse.
(B) when a sound wave strikes a wall, the compression pulse is reflected as rarefaction pulse.
(C) when a sound wave is coming out after passing through a narrow pipe, then reflection would be there at open end.
(D) when a sound wave is coming out after passing through a narrow pipe, then compression pulse is reflected as rare fraction pulse.

11. Two speakers are placed as shown in the figure below. Mark the correct statement(s).

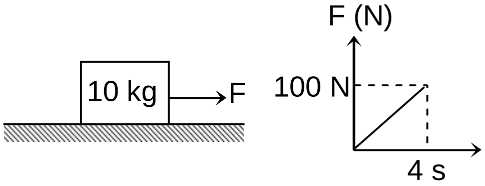


(A) if a person is moving along AB, he will hear sound loud, faint, loud and so on.
(B) if a person moves along CD, he will hear sound loud, faint, loud and so on.
(C) if a person moves along AB, he will hear maximum intensity sound which will continuously keep on decreasing
(D) if a person moves along CD, he will hear uniform intense sound.

12. A small sphere is charged uniformly and placed at some point A(x_0, y_0) so that at point B(9 m, 4m) electric field strength is $\vec{E} = (54\hat{i} + 72\hat{j})NC^{-1}$ and potential is 1800 V. Then
(A) The magnitude of charge on the sphere is 4μC
(B) The magnitude of charge on the sphere is 2μC
(C) Coordinates of A are : $x_0 = -3$, $y_0 = -12$
(D) Coordinates of A are $x_0 = 4$, $y_0 = -1$

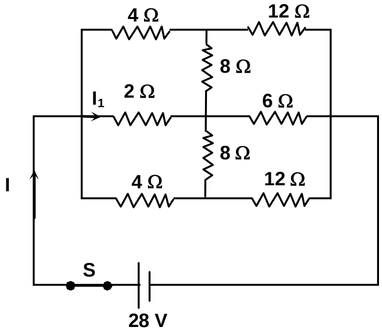
Space for Rough work

13. A 10 kg block is resting on a rough horizontal surface. A horizontal force F is applied to it for 4s. The variation of force with time is shown in the figure. ($\mu_s = \mu_k = 0.5$, g = 10 m/s^2). Then



(A) At t = 1 sec, velocity of block is 5 m/s
(B) At t = 1 sec, velocity of block is zero
(C) At t = 4 sec, velocity of block is 20 m/s
(D) At t = 4 sec, velocity of block is 5 m/s

14. In the circuit shown, the current
(A) I = 8 A
(B) I = 7 A
(C) I_1 = 3.5 A
(D) I_1 = 4 A

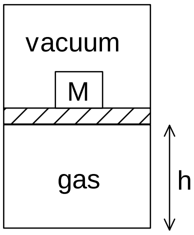


Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 15 and 16

One mole of an ideal diatomic gas is contained in the lower part of the cylinder beneath a piston of area 50 cm^2 as shown in the figure. The piston has negligible mass but a block of mass M = 100 kg is kept on the piston. Initially the gas is maintained at a temperature of 300 K and piston is at a height h from the bottom of the cylinder. The gas is now heated to raise the weight by 10 cm. [Take g = 10 m/s^2, atmospheric pressure = 10^5 N/m^2]



15. The thermal energy supplied to the gas in the process is
(A) 249 J (B) 348.6 J
(C) 99.6 J (D) 100 J

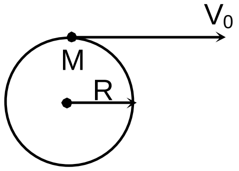
Space for Rough work

16. If a small hole has been created in the upper part of the cylinder, then the value of h before heating the gas is
(A) 1.66 m (B) 2.49 m
(C) 1.40 m (D) none of these

Paragraph for Question Nos. 17 and 18

Since gravitational field is conservative, we can conserve the total mechanical energy of the system of interacting particles. As the net force acting on a closed system is zero, we can conserve the linear momentum of the system. Since the gravitational forces between two interacting particles are action-reaction pair, the net torque experience by the system about any inertial point is zero. Hence, angular momentum of the system remains constant about any inertial point.

A body of mass m (<<M) is projected tangentially to earth's surface with a speed $v_0 = \sqrt{\frac{4GM}{3R}}$



17. The maximum height attained by the body is
(A) 2R (B) R
(C) 2/3 R (D) None of these

18. The areal velocity of the body at any instant is
(A) v_0R (B) $v_0R/2$
(C) $2v_0R/3$ (D) None of these

Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

19. Given: Enthalpy of formation of $H_2O(l)$ and $OH^-(aq.)$ are -285 kJ/mol and -227.3 kJ/mol respectively.
Enthalpy of neutralization of CH_3COOH with NaOH = -55 kJ/mol
The enthalpy of dissociation of CH_3COOH is:
(A) 2.3 kJ/mol (B) 2.7 kJ/mol
(C) 1.3 kJ/mol (D) 1.7 kJ/mol

20. Which salt is soluble in excess KCN as well as in excess KI solution?
(A) $Zn(NO_3)_2(s)$ (B) $Pb(NO_3)_2(s)$
(C) $AgNO_3(s)$ (D) $Hg_2(NO_3)_2(s)$

21. 20 ml of a mixture of C_2H_2 and CO was exploded with 30 ml of oxygen. The gases after the reaction had a volume of 34 ml. On treatment with KOH, 8 ml of oxygen gas remain unreacted. Which of the following options show a correct composition of the mixture?
(A) $\mathbf{V_{C_2H_2}}$ = 6 ml and V_{CO} = 14 ml (B) $\mathbf{V_{C_2H_2}}$ = 4 ml and V_{CO} = 16 ml
(C) $\mathbf{V_{C_2H_2}}$ = 2 ml and V_{CO} = 18 ml (D) $\mathbf{V_{C_2H_2}}$ = 5 ml and V_{CO} = 15 ml

22. Consider the cell: $Ag(s)/AgBr(s)/Br^-(aq)\,||\,Cl^-(aq)/AgCl(s)/Ag(s)$ at 298 K. The solubility product of AgBr and AgCl are 8 × 10^{-13} and 10^{-10} respectively. For what ratio of the concentrations of Br^- and Cl^- ions would the emf of the cell be zero?
(A) 7 × 10^{-3} (B) 8 × 10^{-3}
(C) 8 × 10^{-3} (D) None of these

Space for Rough work

23. Which of the following does not involve the role of H – bonding?
(A) Acetic acid dimerises in gaseous state
(B) In $NaHCO_3$, HCO_3^- ions are linked into an infinite chain
(C) 2nd ionisation constant in maleic acid is less than 2nd ionisation constant in fumaric acid
(D) Tertiary amine has the lowest boiling point than its isomeric primary and secondary amine

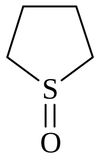
24. XY crystallizes in a bcc lattice in which the radius of $X^+ = 0.4\,\mathring{A}$. If all the X^+ ions are removed and another cation Z^+ is inserted, what should be the maximum radius of the cation Z^+ to crystallize in a fcc lattice with Y^-?

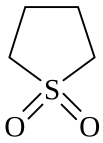
(A) $0.548\,\mathring{A}$
(B) $0.010\,\mathring{A}$
(C) $0.400\,\mathring{A}$
(D) $0.226\,\mathring{A}$

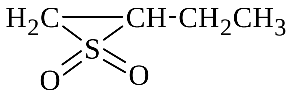
25. 'Sulpholane' is an industrial solvent. The reaction sequence of its preparation is given below

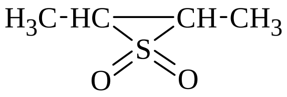
1, 3-butadiene + $SO_2 \xrightarrow{100^\circ C}$ Addition product $\xrightarrow{H_2/Ni}$ Sulpholane

The structure of sulpholane is

(A)


(B)


(C)


(D)


(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

26. The correct statement(s) regarding defects in solids is/are
(A) Frenkel defect is usually favoured by small difference in sizes of cations and anions
(B) Frenkel defect is a dislocation effect
(C) Paramagnetic substances are repelled by magnetic field
(D) Schottky defect has no effect on the physical properties of solids

Space for Rough work

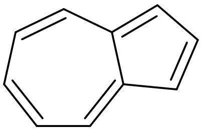
27. Which of the following is/are ortho & para directing for incoming electroiphile?
(A) Ph-SOEt (B) Ph-N=O
(C) Ph-CH=CH-CHO (D) $Ph\text{-}CH{=}CH_2$

28. Which of the following reactions are giving correct results?
(A) $NH_2-CO-NH_2 \xrightarrow{Br_2+KOH} NH_2-NH_2$
(B) $Ph-CO-COOH \xrightarrow{\text{conc. } H_2SO_4/\Delta} Ph-COOH+CO$
(C) $(R)-CH_3-CH(Br)COONa \xrightarrow{NaOH} (R)-CH_3-CH(OH)COONa$
(D) $\text{Benzene}+HCN \xrightarrow{HCl/H_2O} \text{Benzamide}$

29. Which of the following statement(s) is/are CORRECT?
(A) At 369 K, both α and β forms of sulphur are stable to exist and this temperature is called transition temperature
(B) BiF_3 is predominantly covalent
(C) Diborane catches fire spontaneously upon exposure to air
(D) I_2O_5 is used in the estimation of carbon monoxide

30. Radionucleide 'P' decays into 'Q' and 'Q' decays into 'R' as:
$P \xrightarrow{t_{1/2}=1000\text{ hrs}} Q \xrightarrow{t_{1/2}=10\text{ min}} R$
Number of nuclei of Q and R after 1000 hrs, if we start with 2 moles of P, are [$N_A = 6 \times 10^{23}$]
(A) $N_Q = 6 \times 10^{23}$ (B) $N_Q = 10^{20}$
(C) $N_R = 6 \times 10^{23}$ (D) $N_R = 10^{23}$

31. Which of the following statement/s is/are correct regarding Azulene?



(A) Azulene is an isomer of naphthalene and is blue in colour
(B) Azulene has very high dipole moment while naphthalene has dipole moment zero
(C) Seven membered ring of azulene is electrophilic and five membered ring is nucleophilic
(D) Seven membered ring of azulene is nucleophilic and five membered ring is electrophilic

Space for Rough work

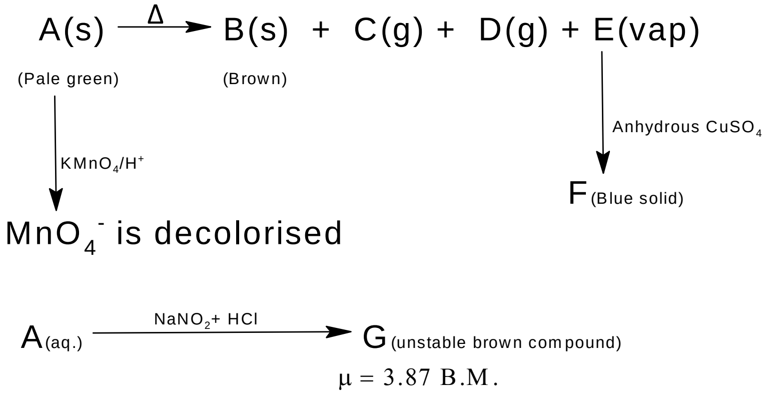
32. When $FeSO_4$ absorbs NO in aq. Solution, a new compound is formed. Select the correct statement about new compound.
(A) It is brown in colour
(B) It has d^2sp^3 hybridisation
(C) It has four unpaired electron
(D) Oxidation number of Fe is +1

Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 33 and 34

Consider the following reaction(s)


A(s)
Δ
B(s) + C(g) + D(g) + E(vap)
(Pale green)
(Brown)
Anhydrous $CuSO_4$
$KMnO_4/H^+$
F (Blue solid)
MnO_4^- is decolorised
A(aq.)
$NaNO_2$ + HCl
G (unstable brown compound)
$\mu = 3.87$ B.M.

33. Sum of oxidation state of the central atom in C(g) and D(g) is
(A) 6
(B) 8
(C) 10
(D) 4

34. Select INCORRECT statement about compound 'F'.
(A) It absorb orange-red light for d-d transition
(B) 4 water molecules are directly bonded with each Cu^{+2}
(C) It is paramagnetic
(D) It's dipole moment = $\sqrt{8}$ B.M.

__Space for Rough work__

Paragraph for Question Nos. 35 and 36

For the given reaction sequence:

$$\underset{(S)}{CH_3-CH_2-COOH}\xrightarrow{N_3H, H^+/\Delta}(P)\xleftarrow{Br_2/KOH}(Q)\xrightarrow{LiAlH_4}(R)$$

35. Choose the incorrect option.
(A) (P) and (R) are homologous to each other
(B) Basic strength order is: (Q) > (P) > (R)
(C) (P) and (Q) can be distinguished by carbyl amine test
(D) (Q) can be obtained by reacting (S) with NH_3, Δ

36. Choose the correct option.
(A) (P) is propyl amine
(B) (R) is ethyl amine
(C) (Q) is acetamide
(D) Schmidt reaction is involved in reaction sequence

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. Let PQ and RS be tangents at the extremities of the diameter PR of a circle of radius r. If PS and RQ intersect at a point X on the circumference of the circle, then 2r equals

(A) $\sqrt{PQ.RS}$ (B) $\frac{PQ+RS}{2}$

(C) $\frac{2PQ.RS}{PQ+RS}$ (D) $\sqrt{\frac{PQ^2+RS^2}{2}}$

38. If $f(x)=\frac{\sin^{-1}\left(\frac{x}{{}^{10}C_x}\right)+\cos^{-1}\left(\frac{x}{{}^{10}C_x}\right)}{\sqrt{5[x]^2+6\{x\}^2-60[x]+77\{x\}+160}}$, (where [.] denotes the GIF and {.} denotes the fractional part) then domain of f(x) is :

(A) $\{x \mid x \in I, 0 \le x \le 10\}$ (B) {0, 1, 2, 3, 4, 9}

(C) {0, 1, 2, 3, 4, 9, 10} (D) {0, 1, 2, 3, 9}

39. On 8×8 Chess board. If two squares of 1×1 are selected randomly, what is probability that, they have one side common.

(A) $\frac{1}{16}$ (B) $\frac{1}{18}$

(C) $\frac{1}{20}$ (D) $\frac{1}{22}$

40. A triangle ABC with vertices $A\equiv(2,5)$, $B\equiv(5,2)$ and $C\equiv(-1,-1)$ inscribed on the curve $xy-x-y-3=0$ and H $\equiv(\alpha,\alpha)$ is orthocenter. Let D, E and F be the feet of perpendiculars from A, B and C on BC, CA and AB respectively and inradius of ΔDEF is r then

(A) Orthocenter of triangle ABC is (-1, -1) (B) Equation of DE is $x+y-\frac{13}{5}=0$

(C) $r=\frac{4}{5}\sqrt{2}$ units (D) $r=\frac{2}{5}\sqrt{2}$ units

Space for Rough work

41. Let PQ and QR be diagonals of adjacent faces of a rectangular box, with its centre at O. if $\angle QOR, \angle ROP \text{ and } \angle POQ$ are θ, ϕ and ψ respectively then the value of $'\cos\theta + \cos\phi + \cos\psi'$ is

(A) –2 (B) $-\sqrt{3}$
(C) –1 (D) 0

42. For x > 0, let f(x) be the minimum value of $\left|X - \sqrt{m^2 + 2n^2}\right|$ for all integers m, n. Then $\lim\limits_{x\to\infty}$ f(x) is equal to

(A) 0 (B) 1
(C) 2 (D) 4

43. If $\int_0^{\frac{\pi}{2}} \frac{dx}{a + b\cos x} = \frac{1}{\sqrt{b^2 - a^2}} \ln \frac{b + \sqrt{b^2 - a^2}}{a}$, (where b > a), then the value of $\int_0^{\frac{\pi}{2}} \frac{\cos x}{(3 + 5\cos x)^2} dx$ is

(A) $\frac{1}{16} + \frac{5}{64}\ln 3$ (B) $\frac{1}{16} - \frac{5}{64}\ln 3$
(C) $-\frac{1}{16} + \frac{5}{64}\ln 3$ (D) $-\frac{1}{16} + \frac{64}{5}\ln 3$

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

44. If $k_1 = \tan 27\theta - \tan\theta$ and $k_2 = \frac{\sin\theta}{\cos 3\theta} + \frac{\sin 3\theta}{\cos 9\theta} + \frac{\sin 9\theta}{\cos 27\theta}$, then

(A) $k_1 = 2k_2$ (B) $k_1 = k_2$
(C) $\frac{k_1 + k_2}{2k_1 - k_2} = 1$ (D) $\frac{k_1 + k_2}{2k_1 - k_2} = 2$

45. Consider a differentiable f : R → R for which $f'(0) = \ln 2$ and $f(x + y) = 2^x f(y) + 4^y f(x) \forall x, y \in R$. Which of the following is(are) correct

(A) f(4) = 240 (B) $f'(2) = 24\ln 2$
(C) the minimum value of y = f(x) is $-\frac{1}{4}$ (D) the number of solution of $f(x) = 2$ is 1

Space for Rough work

46. ABCD is a rhombus. If M, N, P are points taken on sides AB, BC, CD respectively such that centroid of ΔMNP is G. If AM = $\frac{1}{12}$ units, BN = $\frac{1}{5}$ units then

(A) if G lies on AC, PD = $\frac{7}{60}$ units
(B) if G lies on BD, PD = $\frac{31}{60}$ units
(C) if G lies of AC, PC = $\frac{13}{20}$ units
(D) If G lies on BD, PC = $\frac{17}{60}$ units

47. A parabola C whose focus is S(0, 0) and passing through P(3,4) Equation of tangent at P to parabola is 3x + 4y -25 = 0. A chord through S parallel to tangent at P intersects the parabola at A and B

(A) length of AB is 20 units
(B) latus rectum of parabola is 20 units
(C) the point from which three real and coincident normal are drawn to parabola is (-3, ,-4)
(D) the point from which three real and coincident normal are drawn to parabola is (-6, -8)

48. Let M be a 3×3 orthogonal matrix. Let A be the 2×2 matrix in the upper – left corner of M and let B the 1×1 matrix in the lower – right corner of M. Let M_1 be the 3×3 matrix whose first 2 columns are first 2 columns of M and whose remaining 1 columns is the last column of I_3. Let M_2 be the 3×3 matrix whose first 2 columns identical to I_3 and the last 1 columns those of M. Which of the following is(are) correct?

(A) $MM_2 = M_1$
(B) $M^TM_2 = M_1$
(C) $\left|\det(M_1)\right| = \left|\det(M_2)\right|$
(D) $\left|\det(A)\right| = \left|\det(B)\right|$

49. Let $I = \int_0^{1/2}\left(\frac{1}{4}-x^2\right)^4 dx$. then

(A) $I = \int_0^{1/2} x^4(1-x)^4 dx$
(B) $I = \frac{1}{2}\int_0^{1} x^4(1-x)^4 dx$
(C) $I = \int_0^{\pi/2} \sin^9\theta\cos^9\theta\, d\theta$
(D) $I = \frac{1}{1260}$

50. If $\left(\frac{x}{a}\right)+\left(\frac{y}{b}\right)=1$ and $\left(\frac{x}{c}\right)+\left(\frac{y}{d}\right)=1$ intersect the axes at four concyclic points and $a^2+c^2=b^2+d^2$, then these lines can intersect at $(a,b,c,d>0)$

(A) (1, 1)
(B) (1, –1)
(C) (2, –2)
(D) (3, 3)

Space for Rough work

Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 51 and 52

Let ax + by = 1 be a chord of the curve $3x^2 - y^2 - 2x + 4y = 0$ intersecting the curve at the points A and B such that AB subtends a right angle at the origin O.

51. The value of a – 2b + 1 is equal to

(A) 0 (B) 1
(C) 2 (D) –1

52. If a and b are parameters , then $ax + by = 1$ always passes through the point (h, k), where

(A) $h + k = -1$ (B) $h + k = 1$
(C) $|h| + |k| = 1$ (D) $|h| + |k| = 3$

Paragraph for Question Nos. 53 and 54

If $\cos\alpha + \cos\beta + \cos\gamma = 0 = \sin\alpha + \sin\beta + \sin\gamma$ and $\delta = \frac{\alpha+\beta+\gamma}{3}$. The difference of any two of the angles α, β, γ is equivalent to $\frac{2\pi}{3}$. Then

53. The value of $\sin 6\alpha + \sin 6\beta + \sin 6\gamma$ interms of δ is

(A) 3 sin2δ (B) sin6δ
(C) 3 sin3δ (D) 3 sin6δ

54. If one of the angles α, β, γ is $\frac{\pi}{36}$ then the $\cos 12\alpha + \cos 12\beta + \cos 12\gamma =$

(A) 0 (B) 3
(C) $\frac{3}{2}$ (D) $\frac{2049}{2048}$

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – I

JEE (Main)-2020

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 75 questions.
- Each subject (PCM) has 25 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only three sections: **Section-A**, **Section-B and Section-C**.

  Section-A (01 – 20, 26 – 45, 51 – 70) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

  Section-B (21 – 22, 46 – 47, 71 – 72) *contains 6 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

  Section-C (23 – 25, 48 – 50, 73 – 75) *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

Physics

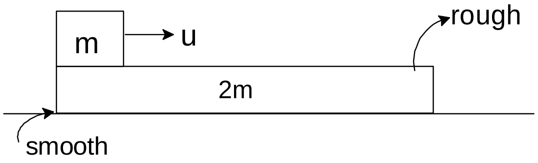
PART – I

SECTION – A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. The total work done by friction (assuming plank is sufficiently long) is:



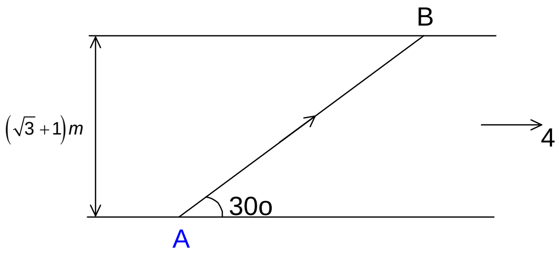
(A) $\frac{1}{3}mu^2$

(B) $-\frac{1}{3}mu^2$

(C) $\frac{3mu^2}{18}$

(D) $-\frac{3mu^2}{18}$

2. A person has to cross the river along the path shown, velocity of river flow is 4 m/s. Speed of person in still water is $2\sqrt{2}$ m/s. Time taken by the person to cross the river may be



(A) 2 s

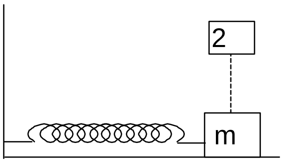
(B) $(2-\sqrt{3})s$

(C) $(2+\sqrt{3})s$

(D) $\left(1+\frac{\sqrt{3}}{2}\right)s$

Space for Rough work

3. An object of mass 'm' is performing SHM on a smooth horizontal surface. When the object reaches extreme position, another object of mass '2m' is gently placed on the oscillating object and sticks to it. The correct statements are
(A) amplitude of oscillation will change
(B) time period of oscillation remains unchanged
(C) total mechanical energy of the system remains constant
(D) maximum speed of the oscillating object does not change



4. Maximum spectral radiancy of a black body corresponds to 'λ' wavelength. If temperature is now changed so that maximum spectral radiancy now corresponds to $\frac{3\lambda}{4}$ then;
(A) new temperature is $\frac{3}{4}$ times of the old temperature
(B) new temperature is $\frac{4}{3}$ times of the old temperature
(C) Power radiated by the body changes by a factor of $\frac{100}{81}$
(D) power radiated by the body changes by a factor of $\frac{81}{256}$

5. Two equal spheres A & B lie on a smooth horizontal circular groove at opposite ends of a diameter. Sphere A is projected along the groove and at the end of time 'T' impinges on sphere B. If 'e' is the coefficient of restitution, the second impact will occur after a time equal to
(A) T
(B) eT
(C) $\frac{2T}{e}$
(D) 2eT

6. Two bodies of masses M_1 = m and M_2 = 4 m are placed at a distance r. The gravitational potential at a point on the line joining them where the gravitational field is zero is
(A) zero
(B) $-\frac{4Gm}{r}$
(C) $-\frac{6Gm}{r}$
(D) $-\frac{9Gm}{r}$

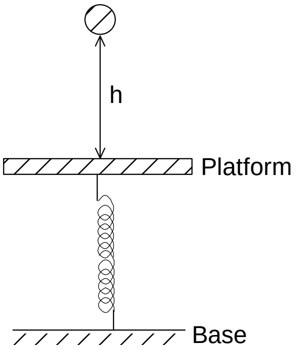
Space for Rough work

7. A solid metallic sphere of radius R having moment of inertia equal to I about its diameter is melted and recast into a solid disc of radius r of uniform thickness. The moment of inertia of the disc about an axis passing through its edge and perpendicular to its plane is also equal to I. The ratio $\left(\frac{r}{R}\right)$ is

(A) $\frac{2}{\sqrt{15}}$
(B) $\frac{2}{\sqrt{10}}$
(C) $\frac{2}{\sqrt{5}}$
(D) $\frac{1}{\sqrt{2}}$

8. A body of mass m = 1 kg is dropped from a height h = 40 cm on a horizontal platform fixed to one end of an elastic spring, the other being fixed to a base, as shown. As a result the spring is compressed by an amount x = 10 cm. What is the force constant of the spring. (g = 10 ms^{-2}).

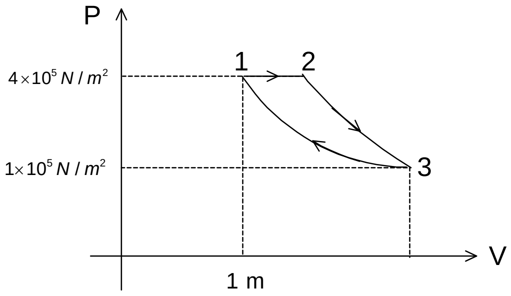
(A) 600 N m^{-1}
(B) 800 N m^{-1}
(C) 1000 N m^{-1}
(D) 1200 N m^{-1}



9. An organ pipe, open at the both ends and another organ pipe, closed at one end, will resonate with each other, if their lengths are in the ratio of

(A) 1 : 1
(B) 1 : 4
(C) 2 : 1
(D) 1 : 2

10. A system undergoes three quasi-static processes sequentially. 1 – 2 is an isobaric process, 2 – 3 is a polytropic process with $\gamma = \frac{4}{3}$ and 3 – 1 is an isothermal process. The heat transfer for the cycle is ΔQ, the change in internal energy is ΔU an the work done is ΔW. Then



(A) $\Delta W = 0$
(B) $\Delta Q = 10^5$ J
(C) $\Delta U = 0$
(D) $\Delta Q > \Delta W$

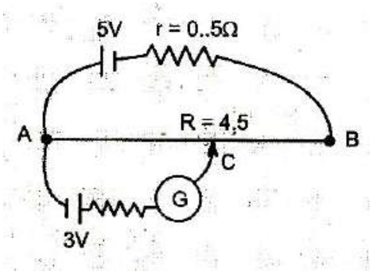
Space for Rough work

11. The density of a solid at normal pressure is ρ when the solid is subjected to an excess pressure P, the density changes to ρ'. It the bulk modulus of the solid is K then the ratio $\frac{\rho'}{\rho}$ is approximately

(A) $1+\frac{\rho}{K}$ (B) $1-\frac{\rho}{K}$

(C) $2+\frac{\rho}{K}$ (D) $z-\frac{\rho}{K}$

12. In the given potentiometer circuit length of the wire AB is 3 m and resistance is R = 4.5Ω. The length AC for no deflection in galvanometer is :



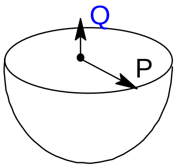
(A) 2 m
(B) 1.8 m
(C) dependent on r_1
(D) None of these

13. A point charge $q = 50\mu C$ is located in the x – y plane at the point of position vector $\vec{r_o} = 2\hat{i} + 3j$. What is the electric field at the point of position vector $\vec{r} = 8\hat{i} - 5j$

(A) $1200\frac{v}{m}$ (B) $4\times10^{-2}\frac{v}{m}$

(C) $900\frac{v}{m}$ (D) $4500\frac{v}{m}$

14. A point charge Q is located just above the centre of the flat face of hemisphere as shown in figure. The electric flux through the flat face and curved face of hemisphere are respectively

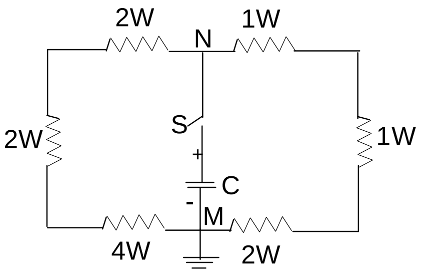


(A) $\frac{Q}{2\in_o}, \frac{-Q}{2\in_o}$ (B) $\frac{-Q}{2\in_o}, \frac{Q}{2\in_o}$

(C) $\frac{Q}{\in_o}, \frac{-Q}{\in_o}$ (D) $\frac{-Q}{\in_o}, \frac{Q}{\in_o}$

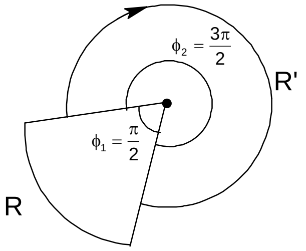
Space for Rough work

15. A capacitor of capacity $6\mu F$ and initial charge $160\mu C$ is vconnected with key S and resistance as shown in figure point M is earthed if key is closed at t = 0 then the current through resistance R $(= 1\Omega)$ at t = $16\mu s$ is



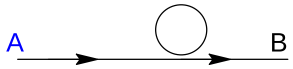
(A) $\frac{10}{3e}A$
(B) $\frac{10}{e}A$
(C) $\frac{20}{3e}A$
(D) None

16. A current of I ampere is flowing through each of the bent wires as shown. The magnitude and direction of magnetic field at O is.



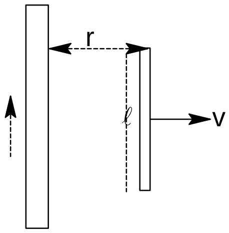
(A) $\frac{\mu_o i}{4}\left(\frac{1}{R}+\frac{2}{R}\right)$
(B) $\frac{\mu_o i}{4}\left(\frac{1}{R}+\frac{3}{R}\right)$
(C) $\frac{\mu_o i}{8}\left(\frac{1}{R}+\frac{3}{2R}\right)$
(D) $\frac{\mu_o i}{8}\left(\frac{1}{R}+\frac{3}{R}\right)$

17. In the arrangement shown in given figure current from A to B is increasing in magnitude induced current in the loop will



(A) have clockwise direction
(B) have anticlockwise direction
(C) be zero
(D) oscillate between clockwise and anticlockwise

18. A conducting rod moves with constant velocity v perpendicular to the long, straight wire carrying a current I as shown compute that the emf generated between the ends of the rod.



(A) $\frac{\mu_o v I \ell}{\pi r}$
(B) $\frac{\mu_o v I \ell}{2\pi r}$
(C) $\frac{2\mu_o v I \ell}{\pi r}$
(D) $\frac{\mu_o v I \ell}{4\pi r}$

Space for Rough work

19. A charged particle goes undeflected in a region containing electric and magnetite fields. It is possible that:

(A) $\vec{E} \parallel \vec{B}, \vec{V} \parallel \vec{E}$
(B) $\vec{E}$ is parallel to $\vec{B}$
(C) $\vec{V} \parallel \vec{B}$ but $\vec{E}$ is not parallel to $\vec{B}$
(D) $\vec{E} \parallel \vec{B}$ but $\vec{V}$ is not parallel to $\vec{E}$

20. When the electron in a hydrogen atom makes the transition $n_1 \rightarrow n_2$, the time period of the electron in its orbit becomes one – eighth of the original. Then (n_1, n_2) can be

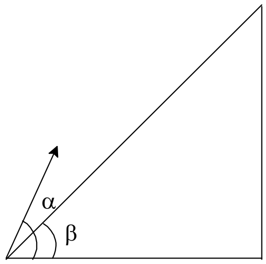
(A) (4, 2)
(B) (8, 2)
(C) (8, 1)
(D) (4, 3)

SECTION – B

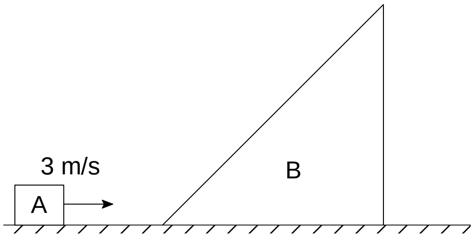
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

21. A particle is projected up an inclined plane of inclination β to be horizontal as shown. The angle of projection of particle with horizontal is α. If the particle strikes the plane horizontally, then $\tan\beta = \frac{\tan\alpha}{x}$, find the value of x.



22. In the figure shown A is of mass 1 kg and B of mass 2 kg. A moves with velocity 3 m/s and rises on B which is initially at rest. All the surfaces are smooth. By the time A reaches the highest point on B, find the work done by A on B in joule.



Space for Rough work

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

23. Three wave forms travelling along a straight line have the forms $2A\sin\left(Kx-\omega t+\frac{\pi}{3}\right)$, $\sqrt{3}A\cos\left(Kx-\omega t-\frac{\pi}{3}\right)$, $2\sqrt{3}A\cos\left(Kx-\omega t+\frac{\pi}{3}\right)$. If the amplitude of the resulting wave front is $\sqrt{\frac{95}{x}}A$ unit then X is

24. Two thin symmetrical lenses of different nature have equal radii of curvature of all faces R = 20 cm. The lenses are put close together and immersed in water. The focal length of the system is 24 cm. The difference between refractive indices of the lenses is $\left(\frac{5}{n}\right)$. Find n. The refractive index of water is $\frac{4}{3}$.

25. Sounds from 2 identical sources S_1 & S_2 reach a point P. When the sounds reach in phase, the intensity at P is I_o. The power of S_1 is now reduced by 64% and the phase difference between S_1 & S_2 is varied continuously. The maximum and minimum intensities recorded at P are now I_{max} and I_{min}, then the value of $\frac{I_{max}}{I_{min}}$

Space for Rough work

Chemistry

PART – II

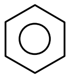
SECTION – A
(One Options Correct Type)

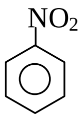
This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

26. Diamond exists in FCC unit cell with 50% tetrahedral sites also occupied. The effective number of carbon atoms in a unit cell of diamond is
(A) 4 (B) 6
(C) 8 (D) 12

27. Van Arkel method of purification of metals involves converting the metal to a:
(A) volatile stable compound. (B) non-volatile stable compound.
(C) volatile unstable compound. (D) non-volatile unstable compound.

28. Identify the correct order of reactivity in electrophilic substitution reaction of the following compounds


1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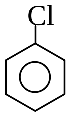
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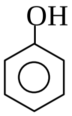

4

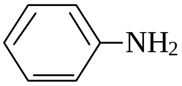
(A) 1 > 2 > 3 > 4 (B) 4 > 1 > 2 > 3
(C) 4 > 3 > 2 > 1 (D) 4 > 1 > 3 > 2

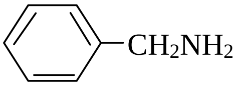
29. The reaction, $\frac{1}{2}H_2(g) + AgCl(s) \longrightarrow H^+(aq) + Cl^-(aq) + Ag(s)$, occurs in the galvanic cell:
(A) Ag(s) | AgCl(s) | KCl (solution) || $AgNO_3$(solution) | Ag(s)
(B) Pt | H_2(g) | HCl (solution) || $AgNO_3$(solution) | Ag(s)
(C) Pt | H_2(g) | HCl (solution) || AgCl(s) | Ag(s)
(D) Pt | H_2(g) | KCl (solution) || AgCl(s) | Ag(s)

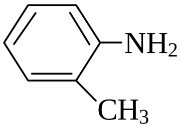
30. Which of the following will have highest coagulating power for As_2S_3 colloid?
(A) PO_4^{3-} (B) SO_4^{2-}
(C) Al^{3+} (D) Na^+

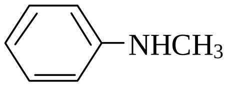
Space for Rough work

31. Which one of the following amines is the weakest base?

(A) 

(B) 

(C) 

(D) 

32. Which of the following is not soluble in NaOH?
(A) $Fe(OH)_3$
(B) $Zn(OH)_2$
(C) $Al(OH)_3$
(D) $Sn(OH)_2$

33. Which one of the following polymers may be classified as step growth polymer?
(A) Teflon
(B) Polythene
(C) PVC
(D) Nylon 66

34. At 550 K, the K_c for the following reaction is 10^4 mol^{-1} L

$X(g) + Y(g) \rightleftharpoons Z(g)$

At equilibrium, it was observed that

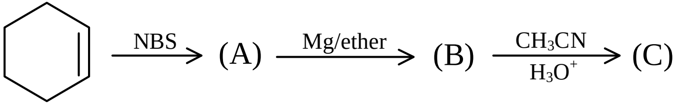
$[X] = \frac{1}{2}[Y] = \frac{1}{2}[Z]$

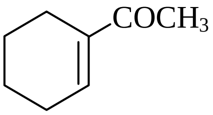
What is the value of [Z] at equilibrium
(A) 2×10^{-4} mol L^{-1}
(B) 10^{-4} mol L^{-1}
(C) 2×10^{4} mol L^{-1}
(D) 10^{4} mol L^{-1}

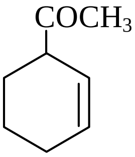
35. Which one of the following solutions in water will have the highest freezing point?
(A) Solution which is 0.1 M in KNO_3 and 0.2 M in $Ba(NO_3)_2$.
(B) Solution which is 0.1 M in $Ca(NO_3)_2$ and 0.1 M $Ba(NO_3)_2$.
(C) Solution which is 0.2 M in urea and 0.2 M glucose.
(D) Solution which is 0.1 M both in $Al_2(SO_4)_3$ and 0.1 M K_2SO_4.

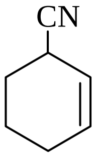
Space for Rough work

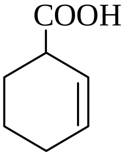
36. End product of the following sequence of reaction is:


NBS
(A)
Mg/ether
(B)
CH3CN
H3O+
(C)

(A) 

(B) 

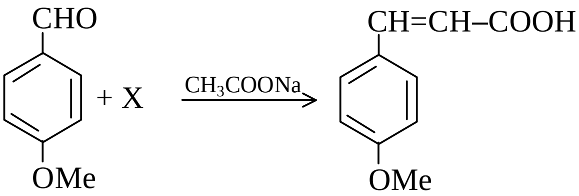
(C) 

(D) 

37. Which one of the following species is paramagnetic?

(A) O_2 (B) CN^-

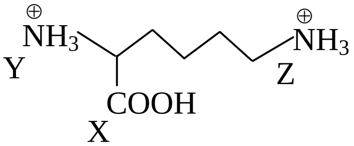
(C) CO (D) NO^+

38. 
CHO
OMe
+ X
CH3COONa
CH=CH–COOH
OMe

what is X?

(A) CH_3COOH (B) $BrCH_2COOH$

(C) $(CH_3CO)_2O$ (D) CHO—COOH

39. 
⊕
NH3
Y
COOH
X
⊕
NH3
Z

the acid strengths are:

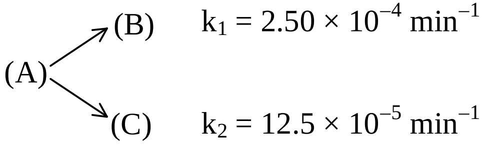
(A) X > Y > Z (B) X > Z > Y

(C) Y > Z > X (D) Z > X > Y

Space for Rough work

40. The number of P–O–P bonds in cyclic trimetaphosphoric acid is
(A) Zero (B) Two
(C) Three (D) Four

41. In the following parallel reaction,

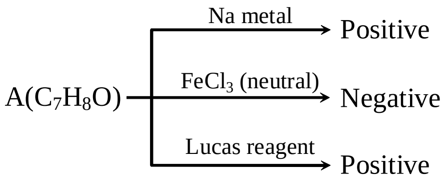

(A)
(B) $k_1 = 2.50 \times 10^{-4}\ \text{min}^{-1}$
(C) $k_2 = 12.5 \times 10^{-5}\ \text{min}^{-1}$

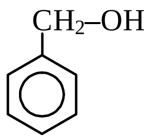
The percentage of product C formed at any time is
(A) 66.6% (B) 50%
(C) 33.3% (D) 12.5%

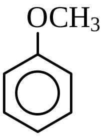
42. Which of the following ions is responsible for the brown colour in the ring test for a nitrate?
(A) $[Fe(H_2O)_5NO]^{2+}$ (B) $[Fe(CN)_5NO]^{2-}$
(C) $[Fe(NO_2)_6]^{4-}$ (D) $[Fe(H_2O)_5NO_2]^{+}$

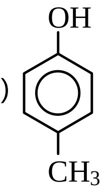
43. Which pair of the gaseous species diffuses through a small jet with the same rate of diffusion at same P and T?
(A) NO and CO (B) NO and CO_2
(C) NH_3 and PH_3 (D) NO and C_2H_6

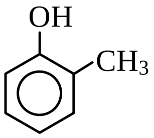
44. Identify an aromatic compound $A(C_7H_8O)$ which gives following tests with the given reagents.


$A(C_7H_8O)$
Na metal
Positive
$FeCl_3$ (neutral)
Negative
Lucas reagent
Positive

(A)


(B)


(C)


(D)


Space for Rough work

45. Identify the unknown products (A) and (B) in the given reaction:

Glucose + 3 $C_6H_5NH–NH_2 \xrightarrow{H^{\oplus}/\Delta}$ Osazone + (A) + (B)

(A) $C_6H_5NH_2$ and NH_3
(B) $C_6H_5NH_2$ and NH_2OH
(C) $C_6H_5NH—NHOH$ and NH_3
(D) NH_2OH and H_2O

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

---

46. In phosphorus atom (Z = 15) in ground state, the difference in number of occupied orbitals and occupied sub-shells are _____

47. The number of geometrical isomers for $[Pt(NH_3)_2Cl_2]$ is ____

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

48. 0.535 g mixture of ethanol and acetaldehyde when heated with Fehling solution gave 1.2 g of a red precipitate. What is the percentage of acetaldehyde in the mixture?

49. The relative rate of abstraction per hydrogen atom of 3°H, 2°H and 1°H of alkane during photo chlorination is 5.0 : 3.8 : 1. Determine the percentage of the major product formed in the chlorination of 2,2–dimethyl butane.

50. The pK_b value of ammonium hydroxide is 4.75. An aqueous solution of ammonium hydroxide is titrated with HCl. The pH of the solution at the point where half of ammonium hydroxide has been neutralised will be ________

Space for Rough work

Mathematics PART – III

SECTION – A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

51. If $|z| = Max.\{|z-1|, |z+1|\}$, then

(A) $|z+\bar{z}| = \frac{1}{2}$ (B) $z+\bar{z} = 1$

(C) $|z+\bar{z}| = 1$ (D) None of these

52. If x is real, then the maximum value of $3-6x-8x^2$ is

(A) $\frac{17}{8}$ (B) $\frac{33}{8}$

(C) $\frac{21}{8}$ (D) none

53. The maximum number of points into which 4 circles and 4 straight lines intersect is

(A) 26 (B) 50

(C) 56 (D) 72

54. $7^9 + 9^7$ is divisible by

(A) 16 (B) 24

(C) 64 (D) 72

55. The minimum no. of terms of the series 1 + 3 + 9 + 27 + ……….. So that the sum may exceed 1000 is

(A) 7 (B) 5

(C) 3 (D) none of these

56. $\lim_{n\to\infty}\left(\cos\frac{x}{n}\right)^n$ is equal to

(A) e (B) e^{-1}

(C) 1 (D) none of these

Space for Rough work

57. Solution of the equation $\left(xy^4 + y\right)dx - xdy = 0$ is

(A) $4x^4y^3 + 3x^3 = cy^3$ (B) $3x^3y^4 + 4y^3 = cx^3$

(C) $3x^4y^3 + 4x^3 = cy^3$ (D) none

58. The point $(1,\beta)$ lies on or inside the triangle formed by the lines y = x, x – axis and x + y = 8, if

(A) $0 < \beta < 1$ (B) $0 \le \beta \le 1$

(C) $0 < \beta < 8$ (D) none of these

59. From any point on the circle $x^2 + y^2 = a^2$ tangents are drawn to the circle $x^2 + y^2 = a^2 \sin^2 \alpha$. The angle between them is

(A) $\frac{\alpha}{2}$ (B) α

(C) 2α (D) none of these

60. The equation of common tangent to the curves $y^2 = 8x$ and xy = - 1 is

(A) 3y = 9x + 2 (B) y = 2x + 1

(C) 2y = x + 8 (D) y = x + 2

61. If $\vec{u} = \vec{a} - \vec{b}, \vec{v} = \vec{a} + \vec{b}$ and $\left|\vec{a}\right| = \left|\vec{b}\right| = 2$, then $\left|\vec{u} \times \vec{v}\right| =$

(A) $2\sqrt{\left[16 - (a.b)^2\right]}$ (B) $\sqrt{\left[16 - (a.b)^2\right]}$

(C) $2\sqrt{\left[4 - (a.b)^2\right]}$ (D) $\sqrt{\left[4 - (a.b)^2\right]}$

62. If 25% of the items are less than 20 and 25% are more than 40, the quartile deviation is

(A) 20 (B) 30

(C) 40 (D) 10

63. The no. of solutions of the equation $\sin x = \cos 3x$ in $[0,\pi]$ is

(A) 1 (B) 2

(C) 3 (D) 4

Space for Rough work

64. The function $f\left(x\right)=\sec\left[\log\left(x+\sqrt{1+x^2}\right)\right]$ is

(A) even (B) odd
(C) const. (D) none of these

65. If $\Delta=\begin{vmatrix}1 & 3\cos\theta & 1\\ \sin\theta & 1 & 3\cos\theta\\ 1 & \sin\theta & 1\end{vmatrix}$, then maximum value of Δ is

(A) 10 (B) 14
(C) 1 (D) none of these

66. If $g\left(x\right)=\left(x^2+2x+3\right)f\left(x\right), f\left(0\right)=5$ and $\lim\limits_{x\to 0}\frac{f\left(x\right)-5}{x}=4$, then g'(0) is equal to

(A) 22 (B) 20
(C) 18 (D) none of these

67. $f\left(x\right)=1+\left[\cos x\right]x,\ in\ \ 0<x\le\frac{\pi}{2}$

(A) has a minimum value 0 (B) has a maximum value 2
(C) is continuous in $\left[0,\frac{\pi}{2}\right]$ (D) is not differentiable at $x=\frac{\pi}{2}$

68. $\int\frac{dx}{\cos x\sqrt{\cos 2x}}$ is equal to

(A) $\sin^{-1}\left(\tan x\right)+c$ (B) $\cos^{-1}\left(\tan x\right)+c$
(C) $\tan^{-1}\left(\sin x\right)+c$ (D) none of these

Space for Rough work

69. The value of the integral $\int_0^{2[x]} \left(x-[x]\right)dx$ is

(A) [x]
(B) $\frac{1}{2}[x]$
(C) $3[x]$
(D) $2[x]$

70. Seven chits are numbered 1 to 7. Four are drawn one by one with replacement. The probability that the least number on any selected chit is 5, is

(A) $\left(\frac{2}{7}\right)^4$
(B) $4\left(\frac{2}{7}\right)^4$
(C) $\left(\frac{3}{7}\right)^3$
(D) none

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

---

71. The co-eff. of x in the expansion of $\left[\sqrt{1+x^2}-x\right]^{-1}$ in ascending power of x, when $|x|<1$, is

72. If $x=2+2^{\frac{2}{3}}+2^{\frac{1}{3}}$, then the value of x^3-6x^2+6x is

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

73. If f(x + y) = 2f(x).F(y) $\forall$ x, y where $f'(0)$ = 3 and f(4) = 2, then $f'(4)$ is equal to

74. A bag contains 10 mangoes out of which 4 are rotten, two mangoes are taken out together. If one of them is found to be good, then the probability that other is also good is

75. How many non-negative integral solutions does the equation 3x + y + z + w = 30 have?

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – I

JEE (Main)-2020

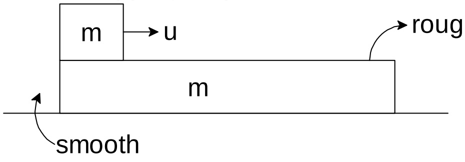
ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. B

Sol. Where slipping stops both moves with same speed



$\therefore\ mu = 3mv \quad \therefore v = \frac{u}{3}.$

$\therefore$ W.D by friction $= \Delta KE$

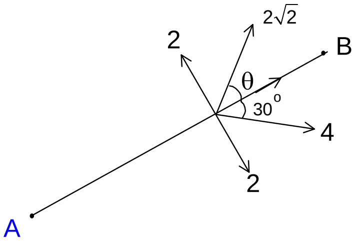
$$= \left[\frac{1}{2}2m\left(\frac{u}{3}\right)^2 + \frac{1}{2}m\left(\frac{u}{3}\right)^2\right] - \frac{1}{2}mu^2$$

$$= -\frac{1}{3}mu^2 \text{ Joule.}$$

2. C

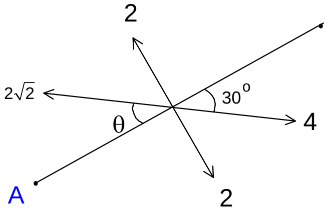
Sol. (i) $2\sqrt{2}\sin\theta = 2$

$\Rightarrow \theta = 45^o$



$$\Rightarrow t_1 = \frac{2\left(\sqrt{3}+1\right)}{4\frac{\sqrt{3}}{2}+2}$$

(ii) $2\sqrt{2}\ \sin\theta\ = 2$



$\theta = 45^o$

$$\Rightarrow t_2 = \frac{2\left(\sqrt{3}+1\right)}{4\frac{\sqrt{3}}{2}-2}$$

3. C

Sol. Time period of oscillation changes as it depends upon mass. Amplitude of the oscillation does not change, as another object is attached at extreme position. Total energy does not change as at extreme position, energy is in the form of potential energy. K.E. does not change, but maximum speed changes as mass changes.

4. B

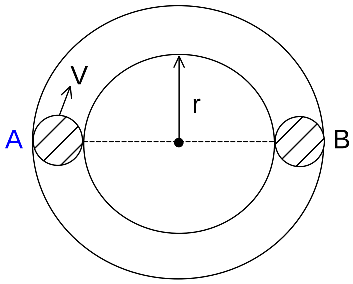
Sol. By wien's law

$\lambda_m T = \text{constant}$

$\text{Power} \propto \left(T^4\right)$

5. C

Sol. $\because \pi r = VT$



$$e = \frac{V_B - V_A}{V - 0}$$

$\Rightarrow V_B - V_B = eV$

one sphere will overtake the other after travelling a distance = $2\pi r$.

$$\therefore \Delta t = \frac{2\pi r}{eV} = \frac{2VT}{eV} = \frac{2T}{e}$$

6. D

Sol. Let g = 0 at x from M_1

$$\Rightarrow \frac{GM}{x^2} = \frac{GM_2}{\left(r-x\right)^2} \Rightarrow x = \frac{r}{3}$$

$$\Rightarrow V \text{ at } x = \frac{r}{3} \text{ is}$$

$$V = -\frac{GM_1}{x} - \frac{GM_2}{\left(r-x\right)}$$

$$\Rightarrow V = \left(-\right)\frac{9Gm}{r}$$

7. A

Sol. $\because I_{\text{sphere}} = I_{\text{disc}}$

$$\Rightarrow \frac{2}{5}MR^2 = M\frac{r^2}{2} + Mr^2$$

$$\Rightarrow \frac{r}{R} = \frac{2}{\sqrt{15}}$$

8. C

Sol. From conservation of mechanical energy

$$\frac{1}{2}Kx^2 = mg(h + x)$$

$$\Rightarrow K = 1000\,N/m$$

9. C

Sol. $\because \nu_{\text{open}} = \nu_{\text{closed}}$

$$\Rightarrow \frac{v}{2\ell_1} = \frac{v}{4\ell_2} \Rightarrow \frac{\ell_1}{\ell_1} = 2:1$$

10. C

Sol. For process 3 → 1

$P_1V_1 = P_3V_3 \Rightarrow V_3 = 4\ m^3$

For process 2 → 3

$P_2V_2^{\gamma} = P_3V_3^{\gamma} \Rightarrow V_2 = \sqrt{2}\,m^3$

For process 1 → 2

$$W_{12} = P_1(V_2 - V_1) = \left(\sqrt{2} - 1\right)4 \times 10^5\,J$$

For the process 2 → 3

$$W_{23} = \frac{P_2V_2 - P_3V_3}{(\gamma - 1)} = 12\left(\sqrt{2} - 1\right) \times 10^5\,J$$

For the process 3 → 1

$$W_{31} = -P_1V_1 \ln\left(\frac{V_3}{V_1}\right)$$

$$= -4 \times 10^5 \times 1 \times \ln\left(\frac{4}{1}\right)$$

$\Delta U = 0$

For the process 1 → 2 → 3 → 1

$$\Delta Q = \Delta U + \Delta W$$

$$= 0 + W_{12} + W_{23} + W_{31}$$

$$= 1.08 \times 10^5\,J$$

11. A

Sol. $$\frac{\Delta v}{V} = \frac{\dfrac{M}{\rho'} - \dfrac{M}{\rho}}{\dfrac{M}{\rho}} = \frac{\rho - \rho'}{\rho'} \qquad ....(1)$$

Bulk nodulus $K = \dfrac{-P}{(\Delta V / v)}$ or $\dfrac{\Delta V}{V} = \dfrac{-P}{K}$ ....(2)

from (1)&(2) $\dfrac{\rho'}{\rho} = \left(1 - \dfrac{P}{K}\right)^{-1} = 1 + \dfrac{P}{K}$

12. A

Sol. Let ℓ is the length on potentiometer $i = \frac{5V}{5R} = 1A$

$(1.5\ell)A = 3 \Rightarrow \dagger = 2m$

13. D

Sol. $r = \sqrt{(8-2)^2 + (-5-3)^2} = 10$

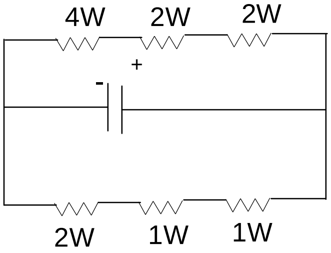
$E = \frac{9\times10^9 \times 50\times10^{-6}}{100} = \frac{9}{2}\times10^3 = 4500\,V/m$

14. B

Sol. Place another identical hemisphere on given one, so that flat faces of two coincide. The total flux linked with cross- section of bottom half (lower hemisphere) is $\frac{Q}{2\in_0}$ as charge enclosed by given hemisphere is zero. So flux linked with flat face of hemisphere is $\frac{-Q}{2\in_0}$

15. C

Sol. $q_0 = 160\mu c$



$c = 6\mu F$

$q = 160e^{t8/3\times6}$

$q = 160\times e^{-t/16}$

$I = \frac{160}{16}e^{-t/16}$

$I = 10e^{-t/16}$

$I(16) = 10e^{-1} = \frac{10}{e}$

$I_1 \times 4 = \left(\frac{10}{e} - I_1\right)\times 8$

$12I_1 = 80/e$

$I_1 = \frac{80}{12e} = \frac{20}{3e}A$

16. D

Sol. Magnetic field induction due to circular Arc $B_o = \frac{\mu_o I}{4\pi R}\cdot\phi$

Here $\phi_1 = \frac{\pi}{2}, \phi_2 = \frac{3\pi}{2}$

17. B

Sol. The current in wire AB, increase the flux through circular loop. Hence current in circular loop will be anticlockwise.

18. B

Sol. $emf = VBl$

$B = \frac{\mu_o I}{2\pi r}$

$$\text{emf} = V\cdot\frac{\mu_o I}{2\pi r}\cdot\ell = \frac{\mu_o VI\ell}{2\pi r}$$

19. A

Sol. Electric field and magnetite field will be parallel and velocity will also parallel to electric filed
$\Rightarrow$ All three are parallel
Hence only electric force will act on it

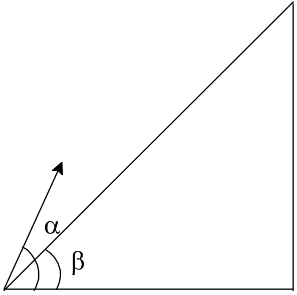
20. A

Sol. $r \propto n^2$
and, $L \propto n \quad \Rightarrow \omega r^2 \propto n$
$\therefore T \propto \omega^{-1} \propto n^3$
So, $n_1 = 2n_2$

SECTION – B

21. 2

Sol. As the particle strikes the plane horizontally so its velocity is parallel to the horizontal axis and vertical velocity is zero.



$0 = u\sin\alpha - gt \qquad ......(i)$

$u\sin\alpha = g\left[\frac{2u\sin(\alpha-\beta)}{g\cos\beta}\right]$

$\Rightarrow \sin\alpha\cos\beta = 2\sin\alpha\cos\beta - 2\cos\alpha\sin\beta$

$\Rightarrow 2\tan B = \tan\alpha \Rightarrow \tan\beta = \frac{\tan\alpha}{2}$

22. 1

Sol. $W = \Delta K.E \qquad (1\,Kg).3\,m/s = (3kg).v$ by momentum conservation

$W = \frac{1}{2}(2)(1)^2 = 1$ Joule $\qquad v = 1\,m/s$

SECTION – C

23. 00005.00

Sol. By phasor diagram
Amplitude of resulting waveform = $\sqrt{19}$A
X = 5

24. 00009.00

Sol. $\because\ \frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$

$$\Rightarrow \frac{1}{24} = \left[\left(\frac{\mu_1}{\frac{4}{3}} - 1\right)\left(\frac{1}{20} + \frac{1}{20}\right) + \left(\frac{\mu_2}{\frac{4}{3}} - 1\right)\left(\frac{1}{-20} - \frac{1}{20}\right)\right]$$

$$\Rightarrow (\mu_1 - \mu_2) = \left(\frac{5}{9}\right).$$

25. 00016.00

Sol. $I_o = K(2A)^2$

Later, $A_1 = 0.6\,A,\ A_2 = A$

So, $I_{max} = K(1.6\,A)^2 = 0.64 I_o$

& $I_{min.} = K(0.4\,A)^2 = 0.04 I_o$

$\therefore I_{max} : I_{min} = 16$

Chemistry PART – II

SECTION – A

26. C

Sol. Effective number of carbon atoms present at corners = $\frac{1}{8}\times 8$ = 1

Effective number of carbon atoms present at face centers = $\frac{1}{2}\times 6$ = 3

Effective number of carbon atoms present in tetrahedral holes = 8 × $\frac{1}{2}$ = 4.

∴ Total number of effective carbon atoms present in a unit cell of diamond is **8**.

27. A

Sol. $$Ti + 2I_2 \xrightarrow{500K} \underset{\text{Volatile stable compound}}{TiI_4} \xrightarrow{1700K} \underset{\text{Pure metal}}{Ti} + 2I_2$$

28. D

Sol. –OH ⟶ strongly activating group because of +R effect.
–Cl ⟶ weakly deactivating group because of –I effect.
$-NO_2$ ⟶ strongly deactivating group because of –R effect and –I effect.
So, 4 > 1 > 3 > 2.

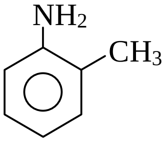
29. C

Sol. At anode: $\frac{1}{2}H_2(g) \longrightarrow H^+(aq.) + e^-$
At cathode: $AgCl(s) + e^- \longrightarrow Ag(s) + Cl^-(aq.)$
$\frac{1}{2}H_2(g) + AgCl(s) \longrightarrow H^+(aq) + Cl^-(aq) + Ag(s).$

30. C

Sol. As_2S_3 sol is negatively charged and hence the ion with maximum positive charge shall be required in minimum concentration to cause its precipitation.

31. C

Sol. 

is the weakest base as its conjugate acid is the least stable because of steric repulsion experienced by extra proton and existing $-CH_3$ group at ortho position.

32. A

Sol. $Fe(OH)_3 + NaOH \longrightarrow$ no reaction. Other hydroxides make soluble mettalate in cases of $Zn(OH)_2$ and $Al(OH)_3$ or mettalite in case of $Sn(OH)_2$.

33. D

Sol. Step growth polymers (or condensation polymers) are prepared by reaction between two functional groups and thereby eliminating small molecules during polymerization. Nylon-66 is an example of step growth polymer.

34. A

Sol. $K_c = \frac{[Z]}{[X][Y]}$

$[X] = \frac{1}{2}[Y] = \frac{1}{2}[Z] = a$ (let)

$\therefore$ [Z] = 2a, [Y] = 2a, [X] = a

$\therefore$ $10^4 = \frac{2a}{a \times 2a}$

a = 10^{-4}

$\therefore$ [Z] = 2a = 2 × 10^{-4} mol L^{-1}.

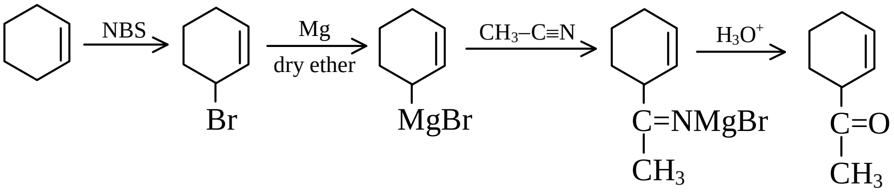
35. C

Sol. $\Delta T_f = i \times K_f \times m = T_f^0 - T_f$

for urea and glucose, $i = 1$

36. B

Sol.



37. A

Sol. Only O_2 has unpaired electrons in molecular orbital.

38. C

Sol. This is a Perkin reaction. Aromatic aldehyde which does not have α hydrogen reacts with alkanoic anhydrides in presence of alkanoate give $\alpha,\beta-$ unsaturated acid.

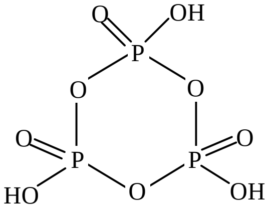
39. A

Sol. $pK_a = x < y < z$

Closer the –I group, stronger the acid.

40. C

Sol.



There are three P–O–P bonds.]

41. C

Sol. In the given two parallel first order reactions

$$\frac{[B]}{[C]} = \frac{k_1}{k_2} = \frac{2.50 \times 10^{-4}}{12.5 \times 10^{-5}}$$

Percentage of C = $\frac{k_2 \times 100}{k_1 + k_2} = \frac{1.25 \times 10^{-4} \times 100}{3.75 \times 10^{-4}}$ = 33.3%.

42. A

Sol. $NO_3^- + 3Fe^{+2} + 4H^+ \longrightarrow NO + 3Fe^{+3} + 2H_2O$

$$\left[Fe(H_2O)_6\right]^{+2} + NO \longrightarrow \underset{\text{Brown ring}}{\left[Fe(H_2O)_5(NO)\right]^{+2}} + H_2O$$

43. D

Sol. Both have same molecular mass.

44. A

Sol. Compound 'A' give positive test with Na metal. That means it contains polar Hydrogen i.e., alcoholic group. It gives negative test with neutral $FeCl_3$ implies it does not contain of a phenolic group. It gives positive Lucas test means it is an alcohol.

45. A

Sol. $A = Ph - NH_2$

$B = NH_3$

SECTION – B

46. 4

Sol. Electronic configuration: $1s^2 2s^2 2p^6 3s^2 3p^3$

Number of occupied orbitals = 9

Number of occupied subshells = 5

47. 2

Sol. Two geometrical forms are possible. (cis + trans)

SECTION – C

48. 00069.16

Sol. Let the mass of acetaldehyde is *x* g, then mass of ethanol is (0.535 – *x*)g. When acetaldehyde is heated with Fehling solution, it gives 1.2 g of a red precipitate.

$CH_3CHO + 2CuO \rightarrow CH_3COO^- + \underset{\text{Red ppt.}}{Cu_2O}$

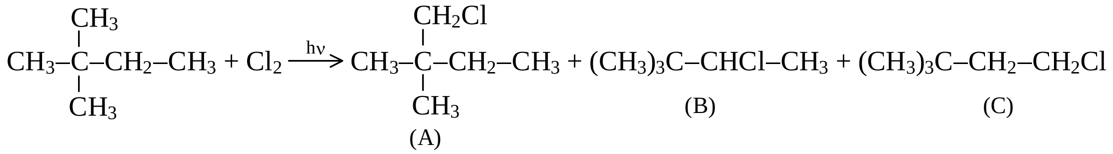
$\because$ 143 g of Cu_2O is coming from = 44 g of CH_3CHO

$\therefore$ 1.2 g of Cu_2O is coming from $\frac{44}{143} \times 1.2$ = 0.37 g of CH_3CHO

% of CH_3CHO = $\frac{0.37}{0.535} \times 100$ = 69.16 %

49. 00045.92

Sol. Photochlorination of 2,2–dimethylbutane gives three products as shown below



$$CH_3-\underset{CH_3}{\overset{CH_3}{\overset{|}{\underset{|}{C}}}}-CH_2-CH_3 + Cl_2 \xrightarrow{h\nu} \underset{(A)}{CH_3-\underset{CH_3}{\overset{CH_2Cl}{\overset{|}{\underset{|}{C}}}}-CH_2-CH_3} + \underset{(B)}{(CH_3)_3C-CHCl-CH_3} + \underset{(C)}{(CH_3)_3C-CH_2-CH_2Cl}$$

Reactivity factor × Probability factor (no. of H) = Number of parts

(A) :	1	×	9	=	9
(B) :	3.8	×	2	=	7.6
(C) :	1	×	3	=	3
	Total number of parts			=	19.6

The compound is the major product. Its percentage is given by

Percentage of (A) = $\frac{9\times100}{19.6}$ = 45.92**%**.

50. 00009.25

Sol. When half of the ammonium hydroxide is neutralised a base buffer is formed.

$$\text{pOH} = \text{pK}_b + \log\frac{[\text{Salt}]}{[\text{Base}]}$$

= 4.75 + log(1)

pH = **9.25**

Mathematics

PART – III

SECTION – A

51. C

Sol. $\because |z| = |z-1|$

$\therefore |z|^2 = |z-1|^2 \Rightarrow z\bar{z} = (z-1)(\bar{z}-1) \Rightarrow z+\bar{z} = 1$

Also, $|z| = |z+1|$

$\therefore |z|^2 = |z+1|^2 \Rightarrow z+\bar{z} = 1$

$\therefore |z+\bar{z}| = 1$

52. B

Sol. Let $y = 3-6x-8x^2$

$\therefore 8x^2+6x+(y-3)=0$

for real x

$D \geq 0$

$\therefore y \leq \dfrac{33}{8}$

53. B

Sol. Required no. of ways = $4_{C_2} + 4_{P_2} + 32 = 50$

54. C

Sol. $\because 7^9 + 9^7 = (1+8)^7 - (1-8)^9$

55. A

Sol. Let the sum of n terms exceed 1000.

$\therefore \dfrac{1(1-3^n)}{1-3} > 1000 \Rightarrow 3^n > 2001$

$\therefore n = 7,8,9........$

56. C

Sol. $$\lim_{n\to\infty}\left(\cos\frac{x}{n}\right)^n = e^{\lim\limits_{n\to\infty} n\left(\cos\frac{x}{n}-1\right)}$$

$$= e^{\lim\limits_{n\to\infty} -n.2\sin^2\left(\frac{x}{2n}\right)}$$

$$= e^{-2\cdot\lim\limits_{n\to\infty}\frac{x^2}{4n}=e^0=1}$$

57. C

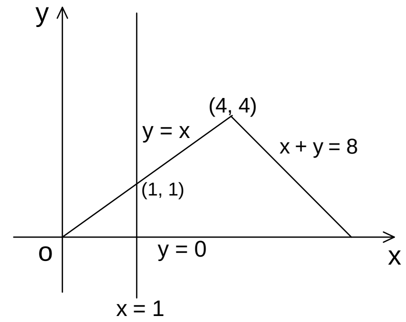
Sol. $\because x^3dx + \left(\frac{x}{y}\right)^2 \cdot \frac{ydx - xdy}{y^2} = 0$

$$\therefore \int x^3dx + \int \left(\frac{x}{y}\right)^2 \cdot d\left(\frac{x}{y}\right) = \int 0$$

$$\therefore \frac{x^4}{4} + \frac{1}{3}\left(\frac{x}{y}\right)^3 = c'$$

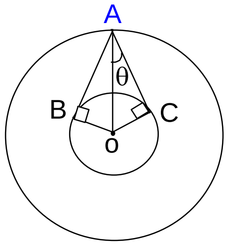
58. B

Sol.



59. C

Sol.



$$\because \sin\theta = \frac{a\sin\alpha}{a} = \sin\alpha$$

$$\therefore \theta = \alpha$$

∴ Required angle = 2θ = 2α

60. D

Sol. Do yourself

61. A

Sol. $u \times v = (a-b)\times(a+b) = 2a \times b$

$$\therefore |u\times v| = 2|\vec{a}\times b| = 2\sqrt{\left[a^2b^2\sin^2\theta\right]} = 2\sqrt{\left(a^2b^2 - a^2b^2\cos^2\theta\right)} = 2\sqrt{\left[16-(a-b)^2\right]}$$

62. D

Sol. $Q.D. = \frac{40-20}{2} = 10$

63. C

Sol. $\because \sin x = 4\cos^3 x - 3\cos x$

$$\therefore \sec^2 x.\tan x + 3\sec^2 x - 4 = 0$$
$$\therefore \tan^3 x + 3\tan^2 x + \tan x - 1 = 0$$
$$\therefore \tan x = -1, \quad \tan 2x = 1$$
$$\therefore x = \frac{3\pi}{4}, \frac{\pi}{8}, \frac{5\pi}{8}$$

64. A

Sol. $\because$ secx is even function and $\log\left(x + \sqrt{1+x^2}\right)$ is odd function, therefore given function is even function.

65. A

Sol. $\Delta = \begin{vmatrix} 1 & 3\cos\theta & 1 \\ \sin\theta & 1 & 3\cos\theta \\ 1 & \sin\theta & 1 \end{vmatrix} Apply \;\; R_3 \to R_3 \to R_1$

$$= \left(3\cos\theta - \sin\theta\right)^2 \le 10$$

66. A

Sol. $\because \lim\limits_{x\to 0} \frac{f(x)-5}{x} = 4$

$$= \lim_{x\to 0} \frac{f(x)-f(0)}{x} = 4$$
$$f^{'}(0) = 4$$
$$\because g(x) = \left(x^2 + 2x + 3\right) f(x)$$
$$\therefore g^{'}(x) = \left(x^2 + 2x + 3\right) f^{'}(x) + (2x+2) f(x)$$
$$\therefore g^{'}(0) = 3f^{'}(0) + 2f(0) = 22$$

67. C

Sol. $\because f(x) = 1 \; in \;\; 0 < x < \frac{\pi}{2}$ (as [Cosx] = 0)

$\therefore$ f(x) is continuous in $\left[0, \frac{\pi}{2}\right]$

68. A

Sol. $\int \frac{dx}{\cos x\sqrt{\cos 2x}} = \int \frac{dx}{\cos x\sqrt{\frac{1-\tan^2 x}{1+\tan^2 x}}}$

Let tan x = t

$$= \int \frac{dt}{\sqrt{1-t^2}} = \sin^{-1}\left(\tan x\right) + c$$

69. A

Sol. $\int_0^{2[x]}\left(x-[x]\right)dx=\int_0^{2(x).1}\left[x-(x)\right]dx=2(x)\,dx\int_0^1\left[x-(x)\right]$

∵ x – (x) is periodic function with period = 1

$$=2(x)\left[\frac{x^2}{2}\int_0^1-\int_0^1 xdx\right]=2(x)\left(\frac{1}{2}-0\right)=(x)$$

70. C

Sol. P(5 or 6 or 7) in one draw = $\frac{3}{7}$

∴ Probability that in each of 3 draws, the unit bears 5 or 6 or 7 = $\left(\frac{3}{7}\right)^3$

SECTION – B

71. 1

Sol. $\left[\sqrt{1+x^2}-x\right]^{-1}=\frac{1}{\sqrt{1+x^2}-x}\times\frac{\sqrt{1+x^2}+x}{\sqrt{1+x^2}+x}=\left(1+x^2\right)^{\frac{1}{2}}+x$

∴ co – eff of x = 1

72. 2

Sol. $\because x-2=2^{\frac{2}{3}}+2^{\frac{1}{3}}$

$\therefore (x-2)^3=6+6(x-2)$

$\therefore x^3-6x^2+6x=2$

SECTION – C

73. 00012.00

Sol. $F^{'}(4)=\lim\limits_{h\to0}\frac{F(4+h)-F(4)}{h}=\lim\limits_{h\to0}\frac{F(4+h)-F(4+10)}{h}$

$=\lim\limits_{h\to0}\frac{2F(4).F(h)-2F(4).F(0)}{h}$

$=2F(4)\lim\limits_{h\to0}\frac{F(h)-F(0)}{h}=2F(4).F^{'}(0)$

$$=2\times2\times3=12$$

74. 00000.28

Sol. $\text{Required Prob.}=\frac{6C_2}{6C_1\times9C_1}=\frac{15}{54}$

75. 01215.00

Sol. Let a = x – 1, b = y – 1, c = z – 1, d = w
then,
3a + b + c + d = 25 , where a, b, c, d ≥ 0--------------(i)
Clearly 0 ≤ a ≤ 8. If a = k, then
b + c + d = 25 – 3---------------------(ii)
No. of non-negative integral solution of equation (ii)

$$n+r-1_{C_r} = 3+25-3k-1_{C_{25-3k}}$$

$$= 27-3k_{C_2}$$

$$=\frac{3}{2}\left(3k^2-53k-234\right)$$

∴ Required number

$$=\frac{3}{2}\sum_{k=0}^{8}\left(3k^2-53k-234\right)=1215$$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – X

JEE (Advanced)-2020

PAPER – 1

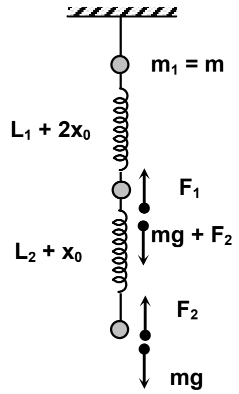
TEST DATE: 20-09-2020

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. B



Sol. Since tensions in the 2 springs are different so they have different natural lengths. Let the natural length of upper and lower spring be L_1 and L_2 respectively.

Since, in equilibrium $\therefore$ $F_2 = kx_2 = mg$

$$\Rightarrow x_2 = \frac{mg}{k} = x_0(\text{say})$$

and $F_1 = mg + F_2 \Rightarrow F_1 = 2mg$

$$\Rightarrow kx_1 = 2mg \Rightarrow x_1 = \frac{2mg}{k} = 2x_0$$

Given $L_1 + 2x_0 = L_2 + x_0 \Rightarrow L_2 = L_1 + x_0$

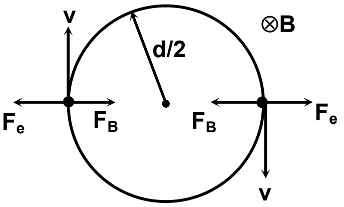
When the springs are at their natural lengths, the distance of centre of mass from top ball will be

$$x_{CM} = \frac{0 + mL_1 + m(L_1 + L_2)}{3m} = L_1 + \frac{x_0}{3}$$

$\therefore$ CM is at a distance $\frac{x_0}{3} = \frac{mg}{3k}$ below the second ball.

2. D

Sol. For distance to remain constant, electrons need to move in a circle of radius d/2.



$$\therefore\ F_B - F_e = \frac{mv^2}{d/2}$$

$$\text{If } evB - \frac{ke^2}{d^2} = \frac{mv^2}{d/2} \Rightarrow v^2 - \frac{eBd}{2m}v + \frac{ke^2}{2md} = 0$$

This is quadratic in v

$$v = \frac{edB}{4m} \pm \frac{1}{2}\sqrt{\left(\frac{edB}{2m}\right)^2 - \left(\frac{4ke^2}{2md}\right)}$$

The situation can be realized if value of v is real and positive i.e. discriminant ≥ 0

$$\Rightarrow \left(\frac{edB}{2m}\right)^2 \geq \frac{4ke^2}{2md}$$

$$\Rightarrow d_{min} = \left[\frac{2m}{\pi\varepsilon_0 B^2}\right]^{1/3} = d_{critical}$$

If d < $d_{critical}$ then problem has no solution
If d = $d_{critical}$ then problem has one solution
If d > $d_{critical}$ then problem have two solutions with different values for v.

3. C

Sol. $F = -\frac{dU}{dr} = -2B(r - r_0)$

Equilibrium is at r = r_0
When displaced by x from equilibrium position.

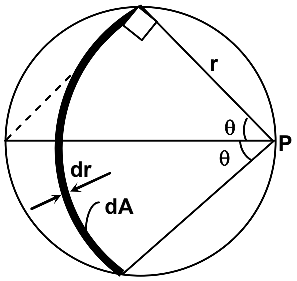
$F_{restoring} = -2B\left[(r_0 + x) - r_0\right] = -2Bx$ $\quad\therefore$ SHM

and $a = \frac{-2B}{m_{reduced}} \cdot x = -\omega^2 x$

where $\omega^2 = \frac{2B(m_1 + m_2)}{m_1 m_2}$

4. D

Sol. Work done in moving a unit positive charge from infinity to a point on the circumference will be numerically equal to the potential at that point.
So we need to calculate potential at any point on the circumference of this charged disc.
Let choose an element of area dA in the form of a ring of radius r and width dr, where dA = $2\theta r\,dr$
r = 2R cos θ $\quad\therefore$ dr = –2R sin θdθ
Potential at point P due to the charge on this element is



$$dV = -\frac{\sigma R}{\pi\varepsilon_0}\theta\sin\theta d\theta$$

$$\therefore\ V = \int dV = -\frac{\sigma R}{\pi\varepsilon_0}\int_{\pi/2}^{0}\theta\sin\theta d\theta = -\frac{\sigma R}{\pi\varepsilon_0}\left[-\theta\cos\theta + \sin\theta\right]_{\pi/2}^{0} = \frac{\sigma R}{\pi\varepsilon_0}$$

5. A, C, D

Sol. Mass of iron block = $2 \times 10^{-3} \times 7.8 \times 10^3 = 15.6$ kg
Upthrust on iron block = $2 \times 10^{-3} \times 10^3 = 2$ kg-wt
For cube to be in equilibrium, tension in the cord should be $15.6 - 2 = 13.6$ kg-wt
And this tension should balance the weight of the water in the bucket and the reaction of the upthrust (downward on the bucket).
$\therefore$ T = wt of water + 2 (kg-wt)
$\therefore$ mass of water = $13.6 - 2 = 11.6$ kg
So volume of water is 11.6 litres
When water is poured, bucket will gradually move down and cube will rise. If additional water is more than 4 litre then weight of water in the bucket become greater than the weight of the cube.
When water in the bucket evaporates, then bucket will rise and block will gradually sink to the bottom and finally tension will be half the weight of the cube and water i.e. 7.8 kg-wt

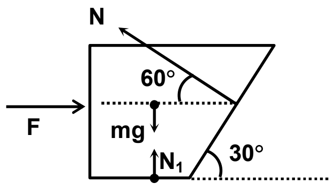
6. B, C, D

Sol. $\Delta U_{\text{gravitational}} = 0$
So, the work done by external agent is dissipated in doing work against friction force.
$$40 = 2f_r L = 2\mu mg\cos\theta\frac{h}{\sin\theta} = \frac{2\mu mgh}{\tan\theta}$$
Since, block does not slide $\therefore$ $\mu \ge \tan\theta \Rightarrow \dfrac{40\tan\theta}{2mgh} \ge \tan\theta \Rightarrow h \le 1$ m
Now, $W_{up} = mg\sin\theta\, L + \mu mg\cos\theta L = mgh + \mu mgx$
$W_{down} = -mg\sin\theta L + \mu mg\cos\theta L = -mgh + \mu mgx$
$\therefore$ $W_{total} = 2\,\mu mgx$
$$\therefore\ x = \frac{W_{total}}{2mg\mu}$$
So x is independent of θ
$\therefore$ B, C, D are correct.

7. A, D

Sol. Let length of pendulum be ℓ. For the motion along arc AP, acceleration of bob in vertical downward direction is less than equal to g. Hence the time required to cover this arc is clearly greater than it would be if the bob undergoes free fall from A to P. i.e.,
$$t_1 > \sqrt{\frac{2\ell\sin 30^\circ}{g}} \Rightarrow t_1 > \sqrt{\frac{\ell}{g}} \qquad \ldots\text{(i)}$$
Now $v_P = \sqrt{2gL\sin 30^\circ} = \sqrt{gL}$ and $v_Q = \sqrt{2gL\sin 60^\circ} = \sqrt{\sqrt{3}gL}$
Since, $v_Q > v_P$
$\therefore$ $t_3 < t_2 < t_1$ and the ball covers the arc PQ and QB with speed greater than v_P and v_Q respectively.
$$t_{PB} < \frac{\ell\pi}{6v_P} + \frac{\ell\pi}{6v_Q} \approx 0.92\sqrt{\frac{\ell}{g}} \qquad \ldots\text{(ii)}$$
Comparing (i) and (ii) $t_1 > t_{PB}$
i.e., $t_1 > t_2 + t_3$

8. B, C



Sol. $a = \frac{3F - F}{m + m} = \frac{F}{m}$ (towards left)

$N\cos 60° - F = ma = m\frac{F}{m}$

$\Rightarrow N \times \frac{1}{2} = 2F \Rightarrow N = 4F$

Also, $N \sin 60° + N_1 = mg$

$N_1 = mg - N \sin 60°$

For no slipping relative to each other, $N_1 \geq 0$

$\Rightarrow mg \geq N \sin 60° \Rightarrow mg \geq \frac{\sqrt{3}N}{2}$

$\Rightarrow N \leq \frac{2mg}{\sqrt{3}}$

$\Rightarrow N \leq \frac{2 \times 3 \times 10}{\sqrt{3}}$

$\Rightarrow N \leq 34.64$ Newton

9. B, C

Sol. $v = \sqrt{2gh_2}$

and for a given h_1, $v_{max} = \sqrt{2\left(\frac{P_{atm}}{\rho} - gh_1\right)}$

And when h_1 is reduced then v will further increase and will have the maximum possible value when $h_1 = 0$

$\therefore v_{max} = \sqrt{\frac{2P_{atm}}{\rho}} = 14.14$ m/s

10. A, B, C

Sol. Since, block is half submerged

$\therefore \rho_S vg = \frac{v}{2}\rho_L g \Rightarrow 2\rho_S = \rho_L$

(B) when temperature is decreased by ΔT (say) then fraction of volume submerged $= \frac{\rho'_S}{\rho'_L} = \frac{\rho_S}{(1-\gamma_S\Delta T)} \times \frac{(1-\gamma_L\Delta T)}{\rho_L} = \frac{(1-\gamma_L\Delta T)}{2(1-\gamma_S\Delta T)}$, as $\gamma_L > \gamma_S$ so fraction of volume submerged is decreased

(C) Let the length of the submerged part be x then

$$\frac{x}{L} = \frac{\rho_S}{\rho_L} \quad \text{...(i)}$$

and

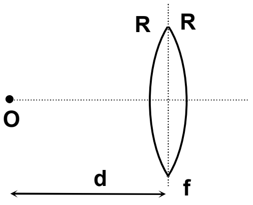
$$\frac{x}{L\left(1 - \frac{\gamma_S}{3}\Delta T\right)} = \frac{\rho_s(1-\gamma_L\Delta T)}{\rho_L(1-\gamma_S\Delta T)} \quad \text{...(ii)}$$

from (i) and (ii), $2\gamma_S = 3\gamma_L$

(D) upon heating density of liquid will increase so block will rise.

11. A, B, D

Sol. $\frac{1}{f} = \left(\frac{3}{2} - 1\right)\left(\frac{1}{R} + \frac{1}{R}\right) = \frac{1}{R} \Rightarrow f = R$



$\frac{1}{f_w} = \left[\frac{3/2}{4/3} - 1\right]\left(\frac{1}{R} + \frac{1}{R}\right) = \frac{1}{4f} \Rightarrow f_w = 4f$

When in water: $\frac{1}{4f} = \frac{1}{v'} + \frac{1}{d} \Rightarrow \frac{1}{v'} = \frac{1}{4f} - \frac{1}{d}$

$\Rightarrow v' = \frac{4fd}{d - 4f} < 0$ and $\frac{v'}{u'} > 1$

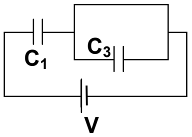
$\therefore$ Image is virtual, magnified and erect.

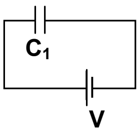
12. A, B, C

Sol. When $C_2 \to \infty \Rightarrow$ shorted

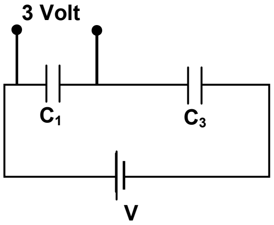
Then the circuit becomes

$\therefore V_1 = V = 12$ volt





Where $C_2 = 0$ then circuit becomes



$\therefore V_{C_3} = 12 - 3 = 9$ V

Since, C_1 and C_3 are in series, so charge will be same on both the capacitors

$\therefore C_1 \times 3 = C_3 \times 9 \Rightarrow \frac{C_1}{C_3} = 3$

SECTION – C

13. 00002.50

Sol. For not toppling of the cylinder, $ma\frac{H}{2} \le mg\frac{H}{8} \Rightarrow a \le \frac{g}{4}$, whereas for no slipping between m and M, $a_{max} = \frac{g}{3}$.

So for equilibrium of m with respect to M, $a_{max} = \frac{g}{4} = 2.5$ m/s^2

Now x = A sin(10t)

$\therefore \frac{d^2x}{dt^2} = a = -100A\sin(10t)$

$\therefore a_{max} = 100A = 2.5$

$\Rightarrow A = \frac{2.5}{100}m = 2.5$ cm

14. 00008.00

Sol. Initially $P_{in} = \frac{4T}{r}$, where P_{in} = inside pressure …(i)

$P_{outside} = 0$ (always)

When charge is sprayed, for equilibrium $P'_{in} + \frac{\sigma^2}{2\varepsilon_0} = \frac{4T}{2r}$ …(ii)

Since, isothermal process

$\therefore P'_{in} = \frac{P_{in}V_i}{V_f} = \frac{P_{in}}{8}$ …(iii)

Using equations (i), (ii) and (iii) we have, $\frac{4T}{8r} + \frac{\sigma^2}{2\varepsilon_0} = \frac{4T}{2r} \Rightarrow \sigma = \sqrt{\frac{3T\varepsilon_0}{r}}$

$\therefore Q = 4\pi(2r)^2\sigma = 16\pi r^2\sqrt{\frac{3T\varepsilon_0}{r}} = 8\sqrt{12\pi^2 r^3 T\varepsilon_0}$

15. 00002.20

Sol. E = σT^4

$\Rightarrow \frac{E_2}{E_1} = \frac{T_2^4}{T_1^2} = 256 = 4^4$

$\Rightarrow T_2 = 4T_1$

Also, $\lambda_1 T_1 = \lambda_2 T_2$ gives $\lambda_2 = \frac{\lambda_1}{4} = 1000$ Å

$KE_{max} = \frac{hC}{\lambda_2} - \phi \Rightarrow \frac{12400}{1000} - \phi = 12.4 - \phi$ …(i)

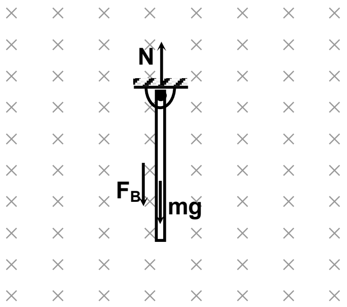
$\Delta E_{2\to4} = 13.6 \times 2^2 \times \left[\frac{1}{2^2} - \frac{1}{4^2}\right] = 13.6 \times 4 \times \frac{3}{16} = 10.2$ eV …(ii)

From (i) and (ii) $12.4 - \phi = 10.2$

$\Rightarrow \phi = 2.2$ eV

16. 00032.50

Sol. Loss in gravitational potential energy = Gain in kinetic energy



$$Mg\left[\frac{L}{2} - \frac{L}{2}\cos 60°\right] = \frac{1}{2}\frac{ML^2}{3}\omega^2$$

$\omega = \sqrt{\frac{3g}{2L}} = \sqrt{15}$ rad/s

When rod is at its lowest position the forces acting on it are as shown in the diagram.

Magnetic force on the rod

$$F_B = \int dq(\vec{v} \times \vec{B}) = \int_{x=0}^{x=L}\left(\frac{q}{L}dx\right) \times (\omega x) \times B = \frac{1}{2}qBL\omega$$

$\therefore N - mg - F_B = m\omega^2\frac{L}{2}$

$N = mg + F_B + m\omega^2\frac{L}{2}$

$= 1 \times 10 + \frac{1}{2} \times 1 \times \sqrt{15} \times 2\sqrt{15} \times 1 + 1 \times (\sqrt{15})^2 \times \frac{1}{2}$

$= 10 + 15 + 7.5 = 32.5$ N

17. 00001.25

Sol. Let T be the tension in the wire at the middle. Considering rotational equilibrium of the half wire about fixed end.

Torque due to tension = torque due to its weight

$$Td = \mu \frac{L}{2} g \frac{L}{4}$$

$$\Rightarrow\ T = \frac{\mu L^2}{8d} g$$

$$\therefore\ v = \sqrt{\frac{T}{\mu}} = L\sqrt{\frac{g}{8d}} = 10\sqrt{\frac{10}{8 \times 8 \times 10^{-3}}} = 125\ \text{m/s}$$

= 1.25×10^2 m/s

18. 00989.80

Sol. Since potential difference across all the inductors are same

So, $L_1 \frac{di_1}{dt} = L_2 \frac{di_2}{dt} = L_3 \frac{di_3}{dt}$

$\Rightarrow i_1 = i_2 + C_2 = i_3 + C_3$

$\Rightarrow 1 = 2 + C_2 = 4 + C_3$

$\Rightarrow C_2 = -1$ and $C_3 = -3$

Also $L_1 \frac{di_1}{dt} + \frac{q}{C} = 0$ or $\frac{L}{3} \frac{d^2q}{dt^2} + \frac{q}{C} = 0$ or $\frac{d^2q}{dt^2} = -\left(\frac{3}{LC}\right) q = -\omega^2 q$

$\therefore q = q_{max} \sin \omega t$

and $i = q_{max}\omega \cos \omega t$

at t = 0, i = 1 + 2 + 4 = 7A

$\therefore 7 = q_{max}\omega$

$\Rightarrow q_{max} = \frac{7}{\omega} = 7\sqrt{\frac{LC}{3}} = 989.8 \times 10^{-6} C = 989.8\ \mu C$

Chemistry

PART – II

SECTION – A

19. A

Sol. Since closed chamber is there, hence there will be an equilibrium. So relative lowering of vapour pressure will be same.

$$\chi_{C_6H_{12}O_6} = \chi_x$$

$$\frac{40/180}{\frac{40}{180}+\frac{60}{18}} = \frac{10/M_x}{\frac{10}{M_x}+\frac{90}{18}}$$

$$\frac{4/18}{\frac{4}{18}+\frac{60}{18}} = \left(\frac{10/M_x}{\frac{10}{M_x}+5}\right)$$

$$\Rightarrow \frac{4}{64} = \frac{1}{16} = \frac{10/M_x}{\left(\frac{10}{M_x}+5\right)}$$

$$\frac{10}{M_x}+5 = \frac{16\times 10}{M_x}$$

$$\frac{15\times 10}{M_x} = 5$$

$$M_x = 30$$

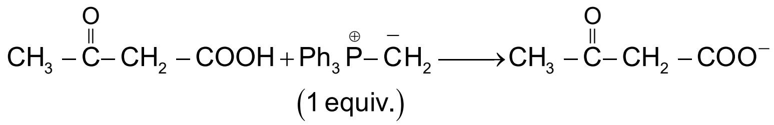
20. B

Sol. Order of K_a values y > z > x

10^{-9} 10^{-13} 10^{-20}

21. C

Sol.



$$CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-CH_2-COOH+Ph_3\overset{\oplus}{P}-\overset{-}{C}H_2 \xrightarrow{} CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-CH_2-COO^-$$

$$(1\ \text{equiv.})$$

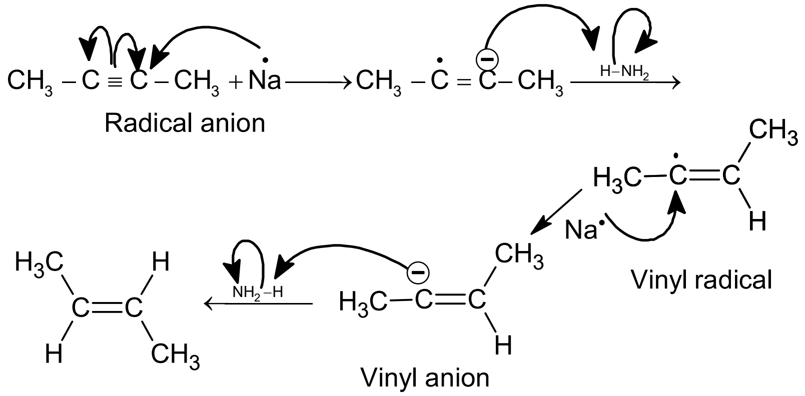
$Ph_3\overset{\oplus}{P}-\overset{-}{C}H_2$, it's one equivalent work as base.

22. B

Sol. - NH_2 is 1° amine and in rest of option lone pair of star (*) marked nitrogen is taking part in resonance. Or sp^2 hybridized.

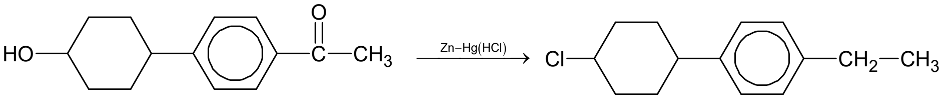
23. A, B, C, D

Sol. - 78°C temperature is required for above reaction.


Radical anion
H–NH$_2$
Vinyl radical
Na•
NH$_2$–H
Vinyl anion

24. B, C, D

Sol. Option A is incorrect. Rest are correct.


HO
C
O
CH$_3$
Zn–Hg(HCl)
Cl
CH$_2$—CH$_3$

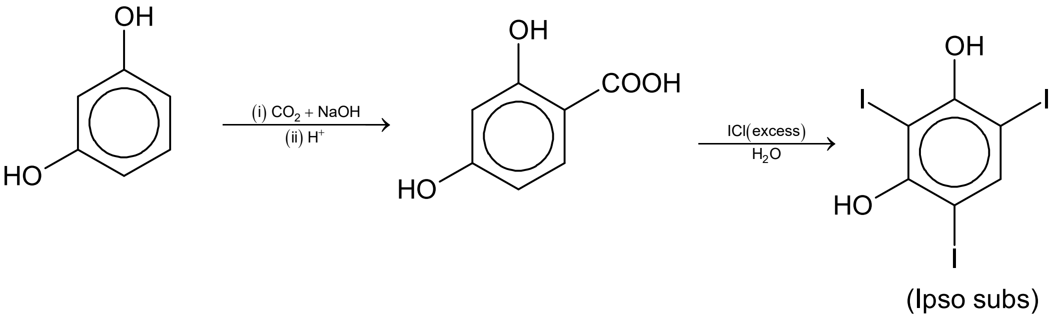
25. C, D

Sol. Lactose is present in milk.
Maltose formed by α-D glucose and α-D glucose.
Hydrolysis of sugar change dextro to laevo.

26. B, C, D

27. B, D

Sol.


OH
HO
(i) CO$_2$ + NaOH
(ii) H$^+$
OH
COOH
HO
ICl(excess)
H$_2$O
OH
I
I
HO
I
(Ipso subs)

28. A, B, C, D

Sol. Mirror images are non super-imposable.

29. A, B, C

Sol. D is incorrect.

$$CrO_2Cl_2 + 4NaOH \longrightarrow 2NaCl + Na_2CrO_4 + 2H_2O$$

30. A, B, C, D

SECTION – C

31. 00001.25

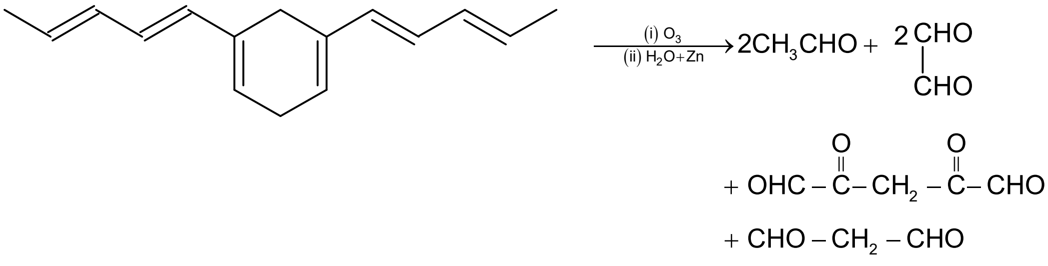
Sol. Emulsion → Butter, milk, blood, shampoo, polish, x = 5

Gels → Cheese, curd, jam, jellies, y = 4

$$\frac{x}{y}=\frac{5}{4}=1.25$$

32. 00004.50

Sol.



$$\xrightarrow[\text{(ii) } H_2O+Zn]{\text{(i) } O_3} 2CH_3CHO + 2\,\begin{matrix}CHO\\|\\CHO\end{matrix}$$

$$+\ OHC-\overset{\overset{O}{\|}}{C}-CH_2-\overset{\overset{O}{\|}}{C}-CHO$$

$$+\ CHO-CH_2-CHO$$

a=36, b= 6 then 36/(6+2) = 4.50

33. 00002.50

Sol. a, c, d, e, f are compounds which give Reimer Tiemann and other do not give.

So 5/2 = 2.5

34. 00001.20

Sol.

$$3Cl_2+6NaOH(conc.)\longrightarrow 5NaCl+NaClO_3+H_2O$$

$$3Br_2+6NaOH(conc.)\longrightarrow 5NaBr+NaBrO_3+3H_2O$$

$$3I_2+6NaOH(conc.)\longrightarrow 5NaI+NaIO_3+3H_2O$$

$$3H_2O+P_4+Conc.3NaOH\longrightarrow PH_3+3NaH_2PO_2$$

$$(CH_3)_2CHCHO+Conc.NaOH\longrightarrow (CH_3)_2CHCOO^-Na^+ + (CH_3)_2CHCH_2OH$$

$$HCHO+Conc.NaOH\longrightarrow HCOO^-Na^+ + CH_3OH$$

Total 6 compound undergo disproportionation.

So x= 6 & y= 5 x/y=1.2

35. 00012.50

Sol.

$$\begin{array}{lll} & 7A\longrightarrow & B\\ t=0 & a & 0\\ t=15hr & a-b & \frac{b}{7}\end{array}$$

for point P $\Rightarrow a-b=\frac{b}{7}\Rightarrow a=\frac{8b}{7}$

$$b=\frac{7a}{8}$$

then a – b $\Rightarrow a-\frac{7a}{8}=\frac{a}{8}$

$$a\xrightarrow{t_{1/2}}\frac{a}{2}\xrightarrow{2t_{1/2}}\frac{a}{4}\xrightarrow{3t_{1/2}}\frac{a}{8}$$

3 half lives will be 900 hrs

$3t_{1/2} = \frac{900}{24}\text{days}$

$t_{1/2}$ = 12.5 days

36. 00003.50

Sol. $x \rightarrow 3$

$y \rightarrow 4$

$\frac{x+y}{2} = \frac{3+4}{2} = 3.50$

Compounds

Chile salt petre → $NaNO_3$, Lunar caustic → $AgNO_3$, Borax → $Na_2B_4O_7.10H_2O$,

Milon's base → $NH_2HgOHgI$

Heating effect

$2Ag_2CO_3 \xrightarrow{\Delta} 4Ag + 2CO_2 + O_2$

$(NH_4)_2CO_3 \xrightarrow{\Delta} NH_4HCO_3 + NH_2COONH_4 + H_2O + NH_3$

$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

$2NaHCO_3 \longrightarrow Na_2CO_3 + H_2O + CO_2$

$2Hg_2CO_3 \longrightarrow 4Hg + 2CO_2 + O_2$

Mathematics

PART – III

SECTION – A

37. B

Sol. $f^2(x) + xf(x) = 3 \Rightarrow f'(x) = \frac{-f(x)}{x+2f(x)}$

$$\Rightarrow \int \frac{3x^3+6x^2f(x)+2f(x)}{(x+2f(x))(x^3-2f(x))^2}dx = \int \frac{3x^2(x+2f(x))+2f(x)}{(x+2f(x))(x^3-2f(x))^2}dx$$

$$\Rightarrow \int \frac{3x^2-2f'(x)}{(x^3-2f(x))^2}dx = \frac{1}{2f(x)-x^3}+c$$

38. D

Sol. Required probability = $\frac{1}{2}+\frac{1}{2}\left(\frac{1}{2}\cdot\frac{1}{2}+\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{2}\right)=\frac{22}{32}$

39. A

Sol. Required probability = $\dfrac{\frac{{}^5C_2}{x}}{\frac{{}^5C_2+{}^5C_3}{x}}=\frac{1}{2}$

40. B

Sol. $D = (2n + 1)^2 – 4(2m + 1)(2p + 1)$

$\Rightarrow$ Roots are rational if D is perfect square.

$\Rightarrow (2n + 1)^2 – 4(2m + 1)(2p + 1) = I^2$ (I = Integer)

$\Rightarrow (2n + 1)^2 – (2r + 1)^2 = 4(2m + 1)(2p + 1)$, $I = 2r + 1$, r = Integer

$\Rightarrow 4(n + r + 1)(n – r) = 4(2m + 1)(2p + 1)$

$\Rightarrow (n + r + 1)(n – r)$ = odd (not possible)

Hence, roots are irrational.

41. B, D

Sol. $\Rightarrow \tan^{-1}\left(\frac{r^2+2r+1-r^2}{1+r^2(r^2+2r+1)}\right)$

$$\Rightarrow \tan^{-1}\left(\frac{(r+1)^2-r^2}{1+r^2(r+1)^2}\right)=\tan^{-1}(r+1)^2-\tan^{-1}(r^2)$$

42. B, D

Sol. $L=\lim\limits_{n\to\infty}\left(1+\frac{1}{n}\right)^n\left(1+\frac{1}{2n}\right)^n\left(1+\frac{1}{2^2n}\right)^n.....\left(1+\frac{1}{2^{n-1}\cdot n}\right)^n$

$\Rightarrow L=e^{1+\frac{1}{2}+\frac{1}{4}+.....} \Rightarrow e^2 \Rightarrow |k| = 2 \Rightarrow k = \pm 2$

43. A, B, C

Sol. $\Rightarrow \left(\sum\limits_{r=1}^{n}\left(r\sum\limits_{p=1}^{r}(\omega^{p-1})\right)\right)-155\omega$ is real

$\Rightarrow$ 2 + 5 + 8 + ….. k terms = 155 $\Rightarrow$ k = 10
Hence, n can be 29, 30, 31 only

44. A, C
Sol. $y = \lambda_1 \cos 2x + \lambda_2$

$\Rightarrow$ Differential equation is $(\sin 2x)\frac{d^2y}{dx^2} = 2\cdot\frac{dy}{dx}\cdot\cos 2x$

$\Rightarrow \lambda = 0$, f(x) = sin 2x

45. A, C
Sol. Put $\sec^2 x = t$

$\Rightarrow$ The given expression will be converted to $\sqrt{t-4} + 2\sqrt{6-t}$

$\Rightarrow$ Minimum value = $\sqrt{2}$, Maximum value = $\sqrt{10}$

46. A, B, C
Sol. $\frac{\sin(x+a)}{\sin(x+b)} = \cos(a-b) + \cot(x+b)\sin(a-b)$

$\Rightarrow$ If a – b = nπ, n ∈ I then the function is constant

47. A, B, C
Sol. $A^3 = \begin{bmatrix} 29 & 35 & 45 \\ 45 & 54 & 70 \\ 25 & 30 & 39 \end{bmatrix}$

48. B, D
Sol. Let the pair of lines be $(y = mx + c_1)(y - m^2x + c_2) = 0$

$\Rightarrow a = m^3$ and $m^2 + m = 6$

$\Rightarrow m = -3, 2 \Rightarrow a = -27, 8$

SECTION – C

49. 00002.00
Sol. $f(k) = \frac{k^2(k^2+1)}{2},\ g(k) = \left(\frac{k(k+1)}{2}\right)^2 \Rightarrow \lim\limits_{x\to\infty}\frac{f(x)}{g(x)} = 2$

50. 00007.00
Sol. $\alpha = \lim\limits_{k\to\infty}\sum_{r=1}^{2k}\frac{k+2r}{k^2+kr+r^2} \Rightarrow \alpha = \lim\limits_{k\to\infty}\sum_{r=1}^{2k}\left(\frac{1+2\cdot\left(\frac{r}{k}\right)}{1+\left(\frac{r}{k}\right)+\left(\frac{r}{k}\right)^2}\right)$

$\Rightarrow \alpha = \int_0^2 \frac{1+2x}{1+x+x^2}dx \Rightarrow \alpha = \ln 7$

51. 00002.00
Sol. $f(x) = \frac{x}{1+x^2} \Rightarrow \int_{-\pi/4}^{\pi/4}\frac{f(x)+x^2-x^3+x+1}{\cos^2 x}dx = \int_{-\pi/4}^{\pi/4}\sec^2 x\,dx = 2$

52. 00256.00

Sol. $m = 0$, $n = -4 \Rightarrow m^4 + n^4 = 256$

53. 00000.00

Sol. $y = \left(\frac{8x^3}{7-6x^4}\right)^{\frac{1}{3}} \Rightarrow \lim\limits_{x\to\infty} y = 0$

54. 00001.57

Sol. Area bounded = $2\left[\frac{1}{2}\cdot 2^2\cdot\frac{\pi}{6}-\frac{1}{2}\cdot 1^2\cdot\frac{\pi}{6}\right] \Rightarrow$ Area = $\frac{\pi}{2} = 1.57$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – X

JEE (Advanced)-2020

PAPER – 1

TEST DATE: 20-09-2020

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section–A (01 – 04, 19 – 22, 37 – 40)*** *contains 12 multiple choice questions which out of 4 options have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (05 – 12, 23 – 30, 41 – 48) *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–1** In all other cases.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

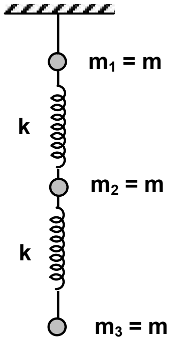
Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. Three identical balls of equal mass (m) are suspended vertically from a thread and two springs of same spring constant k as shown in the figure. The distance between the first and second ball and the second and third ball are same at equilibrium. The centre of mass of the whole system coincides with the second ball. The thread supporting the upper ball is cut and the system starts to fall freely. At some later time, it is observed that both the springs acquire their natural lengths. (Assume this happens) Find the distance of the centre of mass of the system from the second ball at that instant.



(A) $\left(\sqrt{3}-1\right)\frac{mg}{2k}$

(B) $\frac{mg}{3k}$

(C) $\frac{mg}{2k}$

(D) zero

2. Two electrons initially at rest and having a charge e and mass m each, are placed at a separation d apart. They are given identical speeds v in opposite direction in the same plane and it is observed that in the subsequent motion they move so that the distance between them remain constant at d. A uniform homogeneous magnetic field(B) is present perpendicular to the plane, Ignoring the magnetic effects of the moving charges on each other, identify the correct option for the separation between the charges to remain constant.

(A) The minimum distance between the electrons should be $d_{min} = \sqrt{\frac{1}{4\pi\varepsilon_0 evB}}$

(B) The minimum distance between the electrons should be $d_{min} = \left[\frac{m}{2\pi\varepsilon_0 B^2}\right]^{1/3}$

(C) The minimum distance between the electrons should be $d_{min} = \sqrt{\frac{1}{2\pi\varepsilon_0 evB}}$

(D) The minimum distance between the electrons should be $d_{min} = \left[\frac{2m}{\pi\varepsilon_0 B^2}\right]^{1/3}$

3. A diatomic molecule having atoms of masses m_1 and m_2 and its potential energy function about the equilibrium position r_0 is given by $U(r) = -A + B(r - r_0)^2$, where A and B are positive constants. When the atoms vibrate at high temperature condition, the square of angular frequency of vibration will be

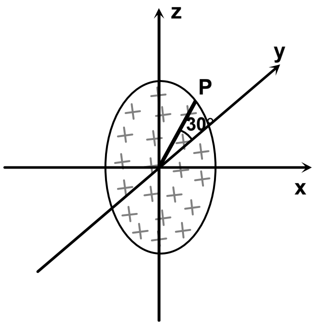
(A) $\frac{2B}{m_1}$

(B) $\frac{2B}{m_2}$

(C) $\frac{2B(m_1 + m_2)}{m_1 m_2}$

(D) $\frac{B(m_1 + m_2)}{2m_1 m_2}$

4. A uniformly charged non-conducting circular disc is placed in the y-z plane with its centre at origin. Its surface charge density is σ C/m² and radius R meter. A unit positive charge is brought very slowly from infinity to the point P on its circumference (as shown in the figure). The work done (in Joule) by the external agent in this process is



(A) $\frac{\sigma R}{2\varepsilon_0}$

(B) $\frac{\sqrt{3}\sigma R}{2\varepsilon_0}$

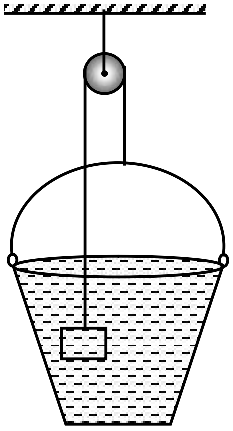
(C) $\frac{\sigma R}{\sqrt{3}\varepsilon_0}$

(D) $\frac{\sigma R}{\pi\varepsilon_0}$

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

5. A solid iron cube of volume 2 × 10^{-3} m³ is fastened to one end of a light cord and the other end of the cord is attached to a light plastic bucket containing water. The cord has negligible mass and passed over the pulley and the iron cube is suspended in water as shown in the figure. It is found that the system is in equilibrium. If density of iron and water is 7.8 gm/cc and 1 gm/cc respectively, then

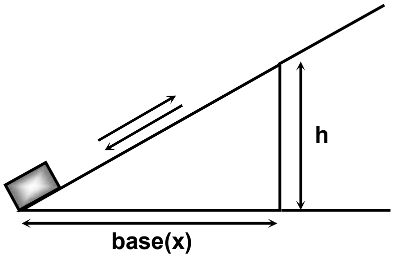


(A) volume of water in the bucket is 11.6 litre

(B) volume of water in the bucket is 13.6 litre

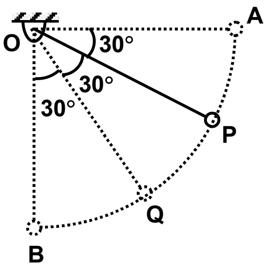
(C) If more water is very slowly poured in the bucket then the maximum additional volume of water that can be poured in the bucket without disturbing the equilibrium of the system is 4 litres.
(D) If the whole water in the bucket is allowed to evaporate then the final tension in the string is 7.8 kg-wt.

6. A block of mass 2 kg is placed on the inclined plane on which it does not spontaneously start to slide. It is pulled up and then down the incline to the initial position very slowly in such a manner that the applied force is always parallel to the slope. (Refer to the figure). The work done by the external agent is 40 Joule. Assume co-efficient of static and kinetic frictions are same.



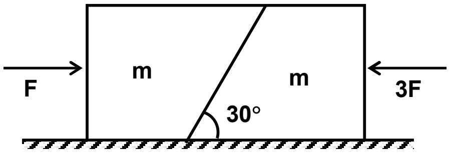
(A) The maximum possible value of h is 0.5 m
(B) The maximum possible value of h is 1 m
(C) For a given value of total work done by the external agent, the length of the incline's base depends on the co-efficient of friction.
(D) For a given value of total work done by the external agent, the length of the incline's base does not depend upon the angle of inclined plane.

7. A simple pendulum is released from rest from point A with its string horizontal. It moves along the path APB as shown in the figure. If t_1, t_2 and t_3 be the time taken to move from A to P, P to Q and Q to B respectively. Then,



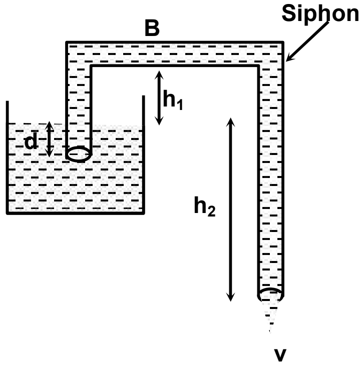
(A) $t_1 > t_2 + t_3$
(B) $t_1 < t_2 + t_3$
(C) $t_1 < t_2 < t_3$
(D) $t_1 > t_2 > t_3$

8. Two blocks each of mass m = 3kg move under the application of forces F and 3F as shown in the figure. The blocks do not slide with respect to each other and all of contact surfaces are smooth. The normal reaction between the blocks can have the value/values. ($g = 10\ m/s^2$)



(A) 35 N
(B) 30 N
(C) 20 N
(D) all the above

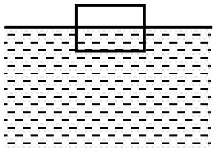
9. A liquid of density ρ = 1gm/cc is taken out of the container (shown in the diagram) by a siphon. The liquid comes out with a speed v. h_1, h_2 and d are as shown in the diagram. Assume the liquid to be ideal and atmospheric pressure is 10^5 pascal. Mark the correct alternative(s).



(A) v depends on h_1 and h_2 only but not on d
(B) If h_1 is decreased and h_2 and d both are gradually increased then v will also increase.

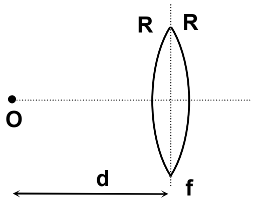
(C) Maximum speed with which the liquid can come out is 14.14 m/s.
(D) Maximum speed with which the liquid can come out is 10 m/s

10. A solid cubical body of density ρ_S is floating half submerged in a liquid of density ρ_L at temperature T. If γ_S and γ_L are coefficient of volume expansion of solid and liquid respectively and $\gamma_L > \gamma_S$. Identify the correct option(s).



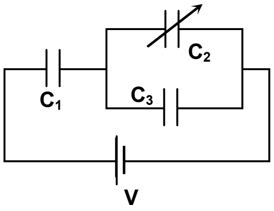
(A) $2\rho_S = \rho_L$, at temperature T
(B) If temperature of the system is decreased then the fraction of volume of solid submerged in liquid decreases.
(C) If depth of the block submerged in the liquid does not change on decreasing temperature then $2\gamma_S = 3\gamma_L$
(D) If the block does not expand on heating and the liquid contracts on heating then the block begins to sink in the liquid.

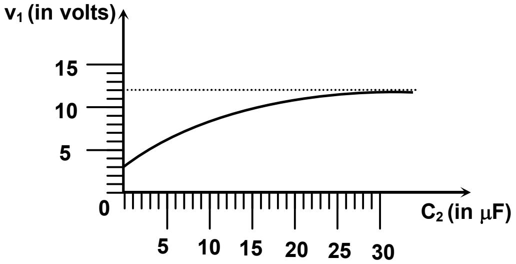
11. A thin equiconvex lens made of a material having refractive index $\mu_L = 3/2$, has a focal length f in air. Image of an object placed in front of it, is inverted, real and magnified. Now the whole arrangement is immersed in water $(\mu_w = \frac{4}{3})$ without changing distance between the object and the lens. Then



(A) The focal length of lens relative to water will be 4f.
(B) New image will be virtual, erect and magnified.
(C) New image will be real, inverted and diminished.
(D) If this lens is cut laterally and then longitudinally into four identical parts (inside water) then the focal length of each part will be 8f.

12. In the given circuit C_2 is a variable capacitor. The graph represents the variation in potential difference (V_1) across C_1 when the capacitance C_2 is gradually increased from 0 to ∞. It is also observed that as $C_2 \to \infty$, V_1 approaches 12 V.



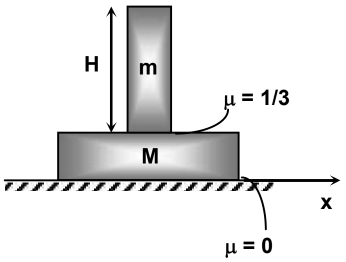


(A) Potential difference (V) across the battery is 12 Volt.
(B) $\frac{C_1}{C_3}$ has a value of 3.
(C) As C_2 is increased the energy stored in C_1 increases
(D) As C_2 is increased the energy stored in capacitor C_3 increases.

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

13. A solid cylinder of mass m, height H and diameter H/4 is placed on a plank of mass M as shown in the figure. The coefficient of friction between the plank and cylinder is 1/3 and that between the plank and ground is zero. The plank is made to oscillate along x-axis as given by the equation x = Asin(10t). Find the maximum amplitude of oscillation (in cm) for which the cylinder remains in equilibrium with respect to the plank.

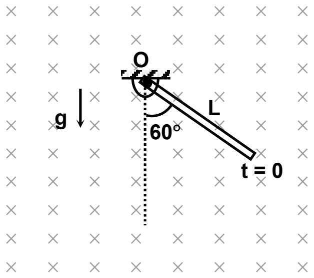


14. A soap bubble of radius r and surface tension T is formed in vacuum. It is slowly sprayed with some amount of charge, as a result of which it slowly expands and finally stops expanding when radius becomes 2r. If the amount of charge given to the bubble is $N\sqrt{12\pi^2 r^3 T\varepsilon_0}$, then find N. (assume temperature of the gas to be constant during expansion)

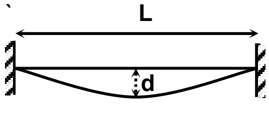
15. Peak emission from a black body at a certain temperature occurs at a wavelength of 4000 Å. On increasing its temperature, the total radiation emitted is increased to 256 times. These radiations are allowed to fall on a metal surface. The photoelectrons emitted by peak emission wavelength at higher temperature can be brought to rest by applying a potential which is equivalent to the excitation potential corresponding to the transition from level n = 2 to level n = 4 in the singly ionised Helium atom (obeys Bohr's Model). The work function of the metal (in eV) is

[Given $E(\text{in eV}) = \dfrac{12400}{\lambda(\text{in } \overset{o}{A})}$]

16. A non conducting uniform rod of mass 1 kg and length 1 m is hinged at one end as shown in the figure. A charge q = 1 C is uniformly distributed over its length. The rod is released from rest in a uniform magnetic field of $2\sqrt{15}$ T at time t = 0 from the position shown. Find the hinge reaction (in Newton) when the rod becomes vertical. (Take g = 10 m/s^2)

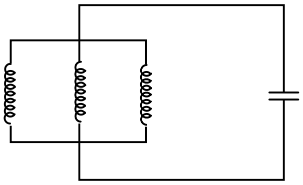


17. A very thin wire having mass per unit length μ is kept in tension between two fixed vertical walls at a separation (L = 10m). Due to its own weight the wire sags downwards in the middle by a small amount d = 8 mm. Assuming tension to be constant along the wire (due to its small mass). The speed of transverse wave in the wire can be expressed by N × 10^2 m/s. Find N. (Take g = 10 m/s^2)



(d <<L)

18. A circuit consists of three coils of inductance 6mH each and 10 μF capacitance. At an instant when the charge on the capacitor is zero, currents 1.0 A, 2.0 A and 4.0 A are flowing in the same direction in these three coils. Find the maximum charge (in μC) stored in the capacitor. (Given $\sqrt{2} = 1.414$)



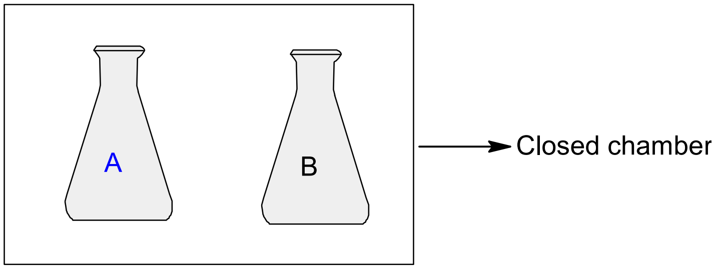
Chemistry PART – II

SECTION – A

(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

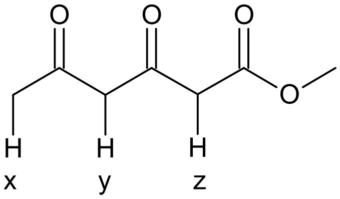
19. Aqueous solution of glucose and compound X are place in beaker A and B respectively in closed chamber.



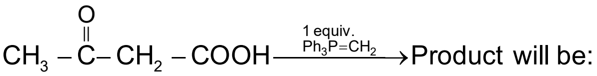
‘A’ contains 40% (w/W) $C_6H_{12}O_6$ aq. Solution and ‘B’ contains 10% aq. (w/W) Solution of X (non-electrolyte). What is the molecular mass of compound X?

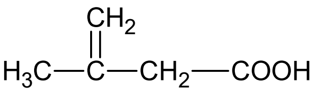
(A) 30
(B) 40
(C) 50
(D) 35

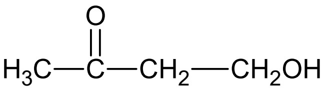
20. x, y and z are marked for hydrogen atoms in the following molecule which have K_a values respectively as

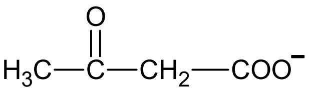


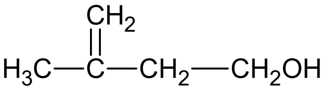
(A) 10^{-9}, 10^{-20} and 10^{-13}
(B) 10^{-20}, 10^{-9} and 10^{-13}
(C) 10^{-20}, 10^{-13} and 10^{-9}
(D) 10^{-9}, 10^{-13} and 10^{-20}

21. 
$CH_3-\overset{\overset{\displaystyle O}{||}}{C}-CH_2-COOH\xrightarrow[Ph_3P=CH_2]{\text{1 equiv.}}$Product will be:

(A) 
$H_3C-\overset{\overset{\displaystyle CH_2}{||}}{C}-CH_2-COOH$

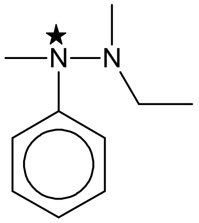
(B) 
$H_3C-\overset{\overset{\displaystyle O}{||}}{C}-CH_2-CH_2OH$

(C) 
$H_3C-\overset{\overset{\displaystyle O}{||}}{C}-CH_2-COO^-$

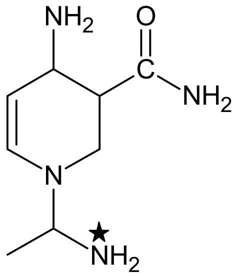
(D) 
$H_3C-\overset{\overset{\displaystyle CH_2}{||}}{C}-CH_2-CH_2OH$

22. In the following compound (*) marked atom is most basic in that compound. Identify the correct representation?

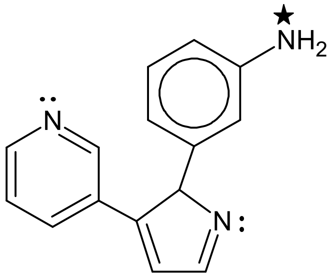
(A)



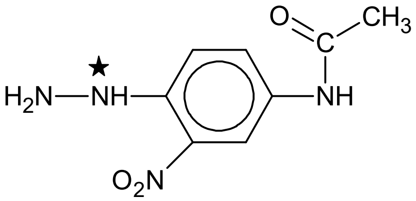
(B)



(C)



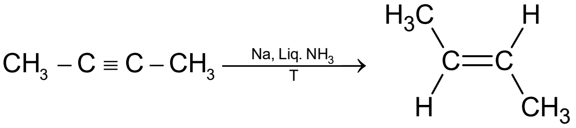
(D)



(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

23. For the given reaction:



$$CH_3-C\equiv C-CH_3 \xrightarrow[T]{\text{Na, Liq. } NH_3} \begin{matrix} H_3C & & H \\ & C=C & \\ H & & CH_3 \end{matrix}$$

The correct statement(s) for the reaction mechanism and conditions is(are):

(A) Low temperature is required to keep NH_3 in liquid state by using dry ice/acetone.

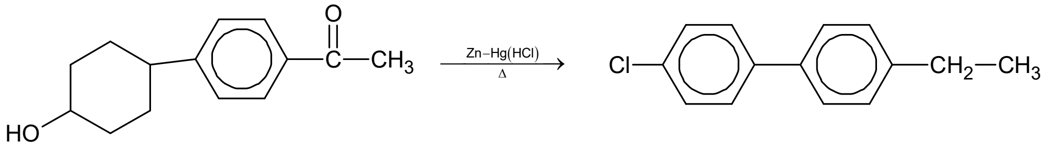
(B) Radical anion is formed.

(C) Vinyl radical is formed.

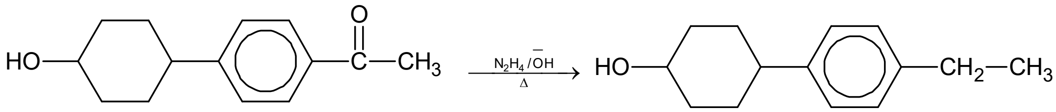
(D) Vinyl anion is formed.

24. Which reactions are correct as per the given conditions?

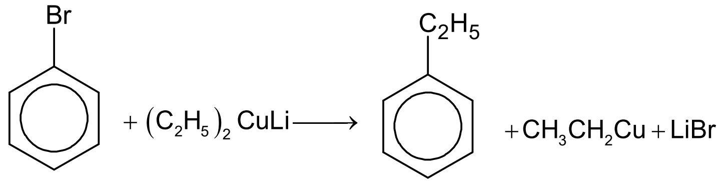
(A)


O
HO
CH3
Zn–Hg(HCl)
Δ
Cl
CH2—CH3

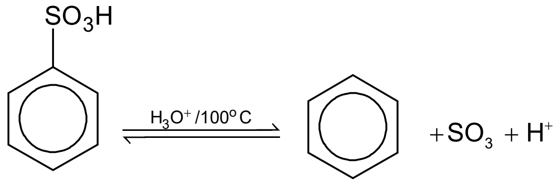
(B)


O
HO
CH3
N2H4/OH⁻
Δ
HO
CH2—CH3

(C)


Br
+ (C2H5)2 CuLi
C2H5
+CH3CH2Cu + LiBr

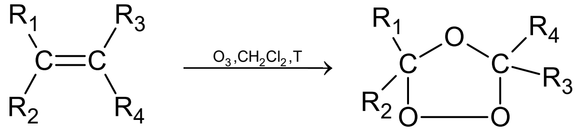
(D)


SO3H
H3O+/100°C
+SO3 + H+

25. Identify the correct statements?

(A) Hydrolysis of sucrose brings about a change in sign of rotation, from laevo (–) to dextro (+) and the product is named as invert sugar.
(B) Maltose composed of two α-D glucose and α-D galactose units.
(C) Lactose is more commonly known as milk sugar.
(D) Amylopectin is insoluble in water.

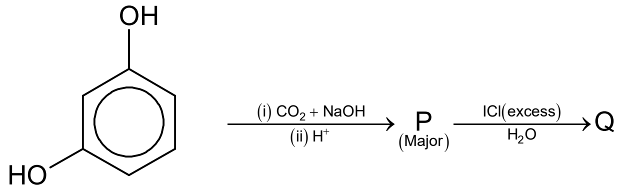
26.


R1
R3
R2
R4
O3,CH2Cl2,T
R1
O
R4
R3
R2
O
O

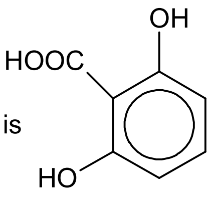
The above reaction involves

(A) Reaction occurs at 25°C.
(B) Reaction occurs below – 50°C.
(C) Formation of peroxy Zwitter ion take place.
(D) It is an example of 1, 3-dipolar addition.

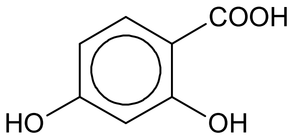
27.


OH
HO
(i) CO2 + NaOH
(ii) H+
P
(Major)
ICl(excess)
H2O
Q

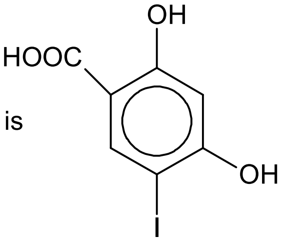
(A) Compound P is



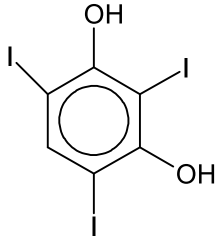
(B) Compound P is



(C) Compound Q is



(D) Compound Q is



28. Optical isomerism is/are possible in
(A) $[Cr(C_2O_4)_3]^{-2}$
(B) $[Pt(en)_3]^{+3}$
(C) $[Co(en)_2(NH_3)Cl]^{+2+}$
(D) $[Pt(Py)_2(NH_3)_2Cl_2]^{+2}$

29. Identify the correct reaction:
(A) $NiSO_4 + 2DMG + 2NH_4OH \longrightarrow \left[Ni(DMG)_2\right] + (NH_4)_2SO_4 + 2H_2O$
(B) $2H_2S + SO_2 \longrightarrow \underset{(\text{Colloidal sulphur})}{2H_2O + 3S}$
(C) $4FeCl_3 + 3K_4\left[Fe(CN)_6\right] \longrightarrow Fe_4\left[Fe(CN)_6\right]_3 + 12KCl$
(D) $2CrO_2Cl_2 + 4NaOH \longrightarrow 2NaCl + Na_2Cr_2O_7 + 2H_2O$

30. Identify correct statements:
(A) Cl_2O is used as a bleaching agent for paper pulp and textile.
(B) Iodine oxides I_2O_4, I_2O_5 and I_2O_7 are insoluble solids in water.
(C) SO_2 is used in bleaching wool and silk.
(D) Pure ozone in violet black in solid state.

SECTION – C
(Numerical Answer Type)

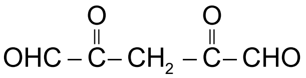
This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

31. In the given compounds number of emulsion and gels are x and y respectively.
Butter, milk, jam, curd, shampoo, polish, fog, mist, rubber, smoke, blood, cheese, jellies.
Find the value of x/y?

32. $\text{Compound}(\text{A}) \xrightarrow[\text{(ii) } H_2O+Zn]{\text{(i) } O_3} \text{Products}$

(alkene)

Ozonolysis of 1 mole compound A gives in products 2 mole CH_3CHO, 2 mole CHO – CHO, 1 mole OHC – CH_2 – CHO and 1 mole

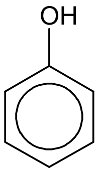


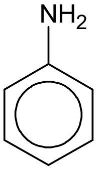
$OHC-\overset{\overset{\displaystyle O}{\|}}{C}-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}-CHO$

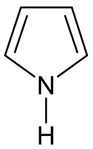
If a= number of sigma bonds in compound A
b= number of pi bonds in compound A

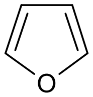
find the value of $\frac{a}{(b+2)}$?

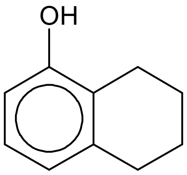
33. In the following compounds, find the ratio of total number of compound which give Reimer Tiemann reaction with the total number of compound which do not give Reimer Tiemann reaction.

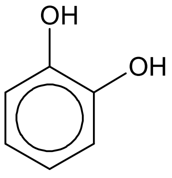
(a) 

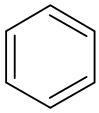
(b) 

(c) 

(d) 

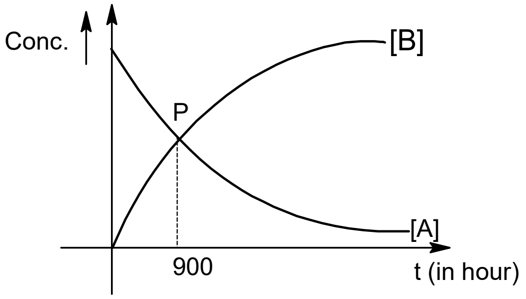
(e) 

(f) 

(g) 

34. In the following compunds some undergo disproportionation with conc. NaOH and some do not give disproportionation with conc. NaOH.
F_2, Cl_2, Br_2, N_2, CH_3COCH_3, CCl_3CHO, $(C_6H_5)_3CCHO$, P_4, I_2, $(CH_3)_2CHCHO$, HCHO.
'x' are the number of compound which undergo disproportionation and 'y' are the number of compound which do not undergo disproportionation then x/y is

35. Concentration vs time graph is given below for first order reaction $7A \longrightarrow B$



Half-life for A in days is.

36. Find the value of $\frac{x+y}{2}$ if

(i) x is number of compound which contain nitrogen in the following
(Chile salt petre, Lunar caustic, Borax, Milon's base)

(ii) y is number of compound which evolve CO_2 on heating.
(Ag_2CO_3, Na_2CO_3, $(NH_4)_2CO_3$, $CaCO_3$, $NaHCO_3$, Hg_2CO_3.)

Mathematics

PART – III

SECTION – A

(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. Let $f(x)$ be a differential function such that $f^2(x)+xf(x)=3$, then $\int \frac{3x^3+6x^2f(x)+2f(x)}{(2f(x)+x)\left(x^3-2f(x)\right)^2}dx$ is equal to

(A) $\frac{1}{x^3-2f(x)}+c$

(B) $\frac{1}{2f(x)-x^3}+c$

(C) $\frac{1}{2f(x)+x}+c$

(D) $\frac{1}{x^3+2f(x)}+c$

38. A gambler has one rupee in his pocket. He tosses an unbiased normal coin unless either he is ruined or unless the coin has been tossed for a maximum of five times. If for each head he wins a rupee and for each tail he looses a rupee, then the probability that the gambler is ruined is

(A) $\frac{1}{2}$

(B) $\frac{5}{8}$

(C) $\frac{3}{8}$

(D) $\frac{22}{32}$

39. 5 out of 6 persons who usually work in an office prefer coffee in the mid morning, the other one always drink tea. This morning of the usual 6, only 3 are present. The probability that one of them drinks tea is

(A) $\frac{1}{2}$

(B) $\frac{1}{12}$

(C) $\frac{25}{72}$

(D) $\frac{5}{72}$

40. If the quadratic equation $(2m+1)x^2+(2n+1)x+(2p+1)=0$, where $m,n,p \in I$, has real roots then both roots are
(A) Rational
(B) Irrational
(C) Positive
(D) Can't say

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

---

41. If the value of $\left(\lim\limits_{n\to\infty}\sum\limits_{r=1}^{n}\tan^{-1}\left(\frac{1+2r}{r^4+2r^3+r^2+1}\right)\right)$ is α, then
(A) $\sin\alpha=\frac{1}{2}$
(B) $\sin\alpha=\frac{1}{\sqrt{2}}$
(C) $\cos\alpha=\frac{\sqrt{3}}{2}$
(D) $\cos\alpha=\frac{1}{\sqrt{2}}$

42. If $L=\lim\limits_{n\to\infty}n^{-n^2}\left((n+1)\left(n+\frac{1}{2}\right)\left(n+\frac{1}{2^2}\right)........\left(n+\frac{1}{2^{n-1}}\right)\right)^n$ and $|k|=\ln L$, then possible value(s) of k is/are
(A) –1
(B) –2
(C) 1
(D) 2

43. If ω is the imaginary cube root of unity such that
$\left|\left(\sum\limits_{r=1}^{n}\left(r\sum\limits_{p=1}^{r}\left(\omega^{p-1}\right)\right)\right)-155\omega\right|=\left(\sum\limits_{r=1}^{n}\left(r\sum\limits_{p=1}^{r}\left(\omega^{p-1}\right)\right)\right)-155\omega$, then the value of n is equal to
(A) 29
(B) 30
(C) 31
(D) 32

44. If differential equation corresponding to family of curves $y=A\cos 2x+B\sin^2 x+C$ is given by $\lambda\frac{d^3y}{dx^3}+f(x)\frac{d^2y}{dx^2}=2\frac{dy}{dx}\cos 2x$ where λ is a real constant and $f(x)$ is some function in x, then
(A) $\lambda=0$
(B) $\lambda=1$
(C) Number of solutions of the equation $f(x)=\lambda$ in $(0,4)$ are 2
(D) Number of solutions of the equation $f(x)=\lambda$ in $(0,4)$ are 3

45. The extreme value (s) of the expression, $\frac{|\sec x|}{\sqrt{2}}\left[\sqrt{-2-4\cos 2x}+2\sqrt{2}\sqrt{2+3\cos 2x}\right]$ is/are

(A) $\sqrt{2}$
(B) $2\sqrt{2}$
(C) $\sqrt{10}$
(D) none of these

46. The function $\frac{\sin(x+a)}{\sin(x+b)}$ has no maxima or minima if

(A) $b - a = n\pi$, $n \in I$
(B) $b - a = (2n + 1)\pi$, $n \in I$
(C) $b - a = 2n\pi$, $n \in I$
(D) none of these

47. Let $A = \begin{bmatrix} 1 & 2 & 1 \\ 2 & 2 & 3 \\ 1 & 1 & 2 \end{bmatrix}$, then

(A) $A^3 - 5A^2 + I = 0$
(B) $A^{-2} = 5I - A$
(C) $-A^{-1} = \text{adj}A$
(D) A^3 is non-invertible matrix

48. If the equation $ax^2 - 6xy + y^2 + bx + cy + d = 0$ represents pair of straight lines whose slopes are m and m^2, then the value(s) of $'a'$ can be

(A) -8
(B) 8
(C) 27
(D) -27

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

49. If $f(k) = \lim_{x\to 0}\sum_{r=1}^{k^2}\frac{\ln(1+rx)}{x}$, $g(k) = \lim_{x\to 0}\sum_{r=1}^{k}\frac{e^{r^3x}-1}{x}$, then the value of $\lim_{x\to\infty}\frac{f(x)}{g(x)}$ is

50. If $\alpha = \lim_{k\to\infty}\left(\frac{k+2}{k^2+k+1}+\frac{k+4}{k^2+2k+4}+\frac{k+6}{k^2+3k+9}+.......+\frac{5}{7k}\right)$, then the value of e^{α} is

51. Let $y = f(x)$ be a differential function satisfying $\int_2^x f(t)dt + 2 = \frac{x^2}{2} + \int_x^2 t^2 f(t)dt$, then the value of

$$\int_{-\pi/4}^{\pi/4}\frac{f(x)+x^9-x^3+x+1}{\cos^2 x}dx$$ is equal to

52. Let f be a function such that $f : R \to R$, $f(x) = \frac{3x^2 + mx + n}{x^2 + 1}$ and the range of $f(x)$ is $[-4, 3)$, then the value of $m^4 + n^4$ is equal to

53. If y satisfies the differential equation $xdy = y\left(xy^3 + 1\right)dx$ and $y(1) = 2$, then the value of $\lim\limits_{x \to \infty} y$ is equal to

54. The area bounded by the circles $x^2 + y^2 = 1$, $x^2 + y^2 = 4$ and the pair of lines $\sqrt{3}\left(x^2 + y^2\right) = 4xy$ is equal to

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PAPER – 2

TEST DATE: 20-09-2020

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. A, C

Sol. When speed is maximum, then $F_{electrostatics} = F_{friction}$

$$\Rightarrow \frac{Kq^2}{r^2} = \mu mg \Rightarrow r = 3m$$

$\therefore$ C is correct

$$\frac{Kq^2}{1} = \frac{Kq^2}{3} + 2\times\frac{1}{2}mv^2 + \mu mg(3-1) \Rightarrow v = 2\text{ m/s}$$

$\therefore$ A is correct

The particle will again come to rest at a finite separation where the potential energy will not be zero. $\therefore$ D is incorrect.

2. A, B, C, D

Sol. $R \propto A^{1/3}$

As nucleus has equal no of protons and neutrons, so A = 2z.

$$\therefore \frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{1/3} = \left(\frac{z_1}{z_2}\right)^{1/3}$$

$$\Rightarrow \frac{z_1}{z_2} = \left(\frac{R_1}{R_2}\right)^3 = \frac{27}{8}$$

Radius of the 1st Bohr's orbit $r \propto 1/z$

$$\therefore \frac{r_1}{r_2} = \frac{z_2}{z_1} = \frac{8}{27}$$

Velocity of e^- in the first Bohr's orbit $v \propto z$

$\therefore \frac{v_1}{v_2} = \frac{z_1}{z_2} = \frac{27}{8}$

Ionisation energy E = $13.6z^2\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right]$

$\frac{E_1}{E_2} = \frac{z_1^2}{z_2^2} = \left(\frac{27}{8}\right)^2 = \frac{729}{64}$

Angular momentum L = $\frac{nh}{2\pi}$

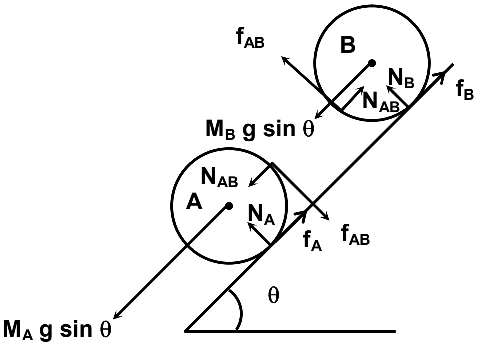
$\therefore \frac{L_1}{L_2} = 1$

3. A, B, D

Sol. Maximum Kinetic energy of β_1^- = {(197.968233 – 197.966760) × 931.5} – 1.088 = 0.284 MeV
Maximum kinetic energy of β_2^- = {(197.968233 – 197.966760) × 931.5} – 0.412 = 0.960 MeV
So, option A and B are correct.
Energy associated with γ_1 is 1.088 MeV. So option (C) is incorrect.
From the nuclear energy level diagram of $^{198}_{80}Hg$ it is clear that energy released during emission of γ_3 is (1.088 – 0.412) MeV = 0.676 MeV.

4. A, B, C

Sol. For rotational equilibrium of cylinder A: $f_A = f_{AB}$
For rotational equilibrium of cylinder B: $f_B = f_{AB}$
For translational equilibrium of (A + B)
$f_A + f_B = (M_A + M_B)\, g \sin\theta$
$\Rightarrow f_A = f_B = f_{AB} = \left(\frac{M_A + M_B}{2}\right) g\sin\theta$
For A to be in equilibrium
$N_{AB} + M_A g \sin\theta = \left(\frac{M_A + M_B}{2}\right) g\sin\theta$
$\Rightarrow N_{AB} = \left(\frac{M_B - M_A}{2}\right) g\sin\theta$
For 2 cylinders to be in contact $N_{AB} > 0$
$\Rightarrow M_B > M_A$

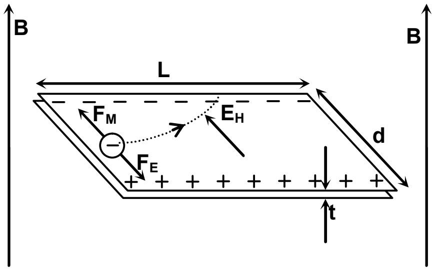


5. A, B, C, D

Sol. $P = K\frac{E}{V}$
$\therefore$ PV = KE
Also for ideal gas PV = nRT.

6. B, D

Sol. Due to motion of electron in magnetic field it will experience magnetic force (F_m). As a result of this they will accumulate on one side leaving behind positive charges on the other as shown in the figure. This results in development of an electric field E_H, and will finally become constant when $F_E = F_M$. At this instant $V = E_H d$



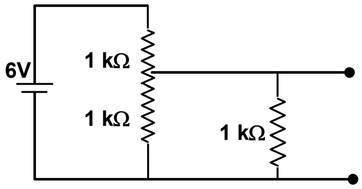
$$\therefore \quad E_H = \frac{V}{d} \Rightarrow E_H = \frac{3\times10^{-6}}{10^{-2}} = 3\times10^{-4}\ \text{V/m}$$

Electric force on e^- is $F_E = qE_H = 1.6 \times 10^{-19} \times 3 \times 10^{-4} = 4.8 \times 10^{-23}$ N

Drift velocity of the e^- is $\frac{E_H}{B} = \frac{3\times10^{-4}}{2} = 1.5\times10^{-4}$ m/s

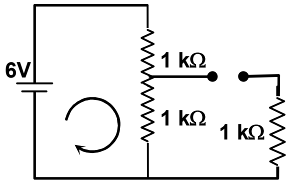
7. A, C, D

Sol. Before switch S_2 is opened, the circuit is as follows:



$$\therefore\ i_{\text{battery}} = \frac{6}{\frac{3}{2}\times10^3} = 4\ \text{mA}$$

$i_{R'} = 2\text{mA} \qquad \therefore\ V_0 = i_{R'} \times R' = 2\text{V}$



For t > 0 and at steady state, $\Delta V_C = V_1 = 3\text{V}$

$$\therefore\ \frac{V_1}{V_0} = \frac{3}{2}$$

$\therefore$ option (A) is correct and (B) is incorrect.

Time constant of the circuit when the capacitor is getting charged is

$$\tau = R_{eq}C = \frac{3}{2}\times10^3\times8\times10^{-3} = 12\,\text{s}$$

$$\therefore\ V_C = 3\left[1-e^{-\frac{t}{12}}\right],\ q = CV = 24\left[1-e^{-\frac{t}{12}}\right]$$

$$i_C = \frac{dq}{dt} = 24\times\frac{1}{12}e^{-\frac{t}{12}} = 2e^{-\frac{t}{12}}(\text{mA})$$

$P_C = V_C i_C$

$$P_C = 6\left[1-e^{-\frac{t}{12}}\right]e^{-\frac{t}{12}} = 6(1-x)x$$

$\therefore$ P_C will be maximum when x = 1/2

i.e., $e^{-\frac{t}{12}} = \frac{1}{2} \Rightarrow -\frac{t}{12} = -\ell n(2) \Rightarrow t = 12\ \ell n(2)$

$$\therefore\ (P_C)_{\max} = 6\left(1-\frac{1}{2}\right)\times\frac{1}{2} = 1.5\,\text{mW}$$

$\therefore$ option (C) is correct

Total heat dissipated across R′ after opening S_2,

$$H = \int_0^\infty i_C^2 R' dt = \int_0^\infty 4\times10^{-6}\times e^{-\frac{t}{6}}\times10^3 dt$$

$$= 4\times10^{-3}\int_0^{\infty} e^{-\frac{t}{6}}dt = 24 \text{ mJ}$$

$\therefore$ option (D) is correct

8. A, B, C, D

Sol. For refraction at AB: 1 sin 45° = $\sqrt{2}$ sin $r_1 \Rightarrow r_1 = 30°$

$\therefore$ Ray within prism is parallel to BC

$\therefore$ D is correct

For refraction at AC: $\sqrt{2}$ sin 30° = 1 sin i_2 $\Rightarrow i_2 = 45°$

Deviation is $\delta = (i_1 + i_2) - A = 30°$, and the ray after emerging from prism will be incident on the concave mirror parallel to its principal axis (from geometry). So, the final image formed after reflection from mirror will be at its focus i.e. 15 cm from its pole and the image will be real, inverted and diminished.

$\therefore$ B is correct.

Y-coordinate of the final image is 15 sin 15° = $\frac{15(\sqrt{3}-1)}{2\sqrt{2}}$ cm.

$\therefore$ C is also correct.

9. D

10. B

Sol. **(for Q.9–Q.10):**

$$T = \frac{2\pi}{\sqrt{GM}} r_0^{3/2}$$

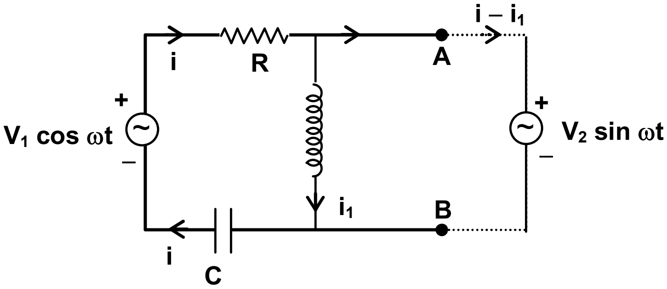
$$E_1 = \frac{GMm(3R^2 - r_L^2)}{2R^3} - \frac{GMm}{r_0}$$

$$E_2 = \frac{GMm}{2r_0}$$

11. C

12. A

Sol. **(for Q.11–Q.12):**



Using KVL in outer loop

$$v_0 \cos\omega t - iR - v_0 \sin\omega t - \frac{q}{C} = 0$$

$$\Rightarrow v_0(\cos\omega t - \sin\omega t) - iR - \frac{q}{C} = 0$$

$$\Rightarrow \sqrt{2}v_0 \cos\left(\omega t + \frac{\pi}{4}\right) - iR - \frac{q}{C} = 0$$

$$\therefore\ i = \frac{\sqrt{2}v_0}{\sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}} \cos\left(\omega t + \frac{\pi}{4} + \phi\right) = i_0 \cos\left(\omega t + \frac{\pi}{4} + \phi\right)$$

$$\phi = \tan^{-1}\left(\frac{x_C}{R}\right) = \tan^{-1}\left(\frac{1}{\omega CR}\right)$$

$$v_R = iR = \frac{\sqrt{2}v_0R}{\sqrt{R^2+\left(\frac{1}{\omega C}\right)^2}}\cos\left(\omega t+\frac{\pi}{4}+\phi\right)$$

Phase difference between i and $v_1 \cos \omega t$ is $\phi' = \frac{\pi}{4}+\phi$

Case 1: when $\omega = 0$ then $v_1 = v_0$, $v_2 = 0$, $i_0 = 0$, $\phi = \pi/2$

$\therefore \ \phi' = \frac{3\pi}{4}$

Case 2: when $\omega = \frac{R}{L} = \frac{1}{RC}$, then $\omega = \frac{1}{\sqrt{LC}}$, $i_0 = \frac{v_0}{R}$, $\phi = \pi/4$

$\therefore \ \phi' = \frac{\pi}{2}$

Case 3: when $\omega = \frac{2R}{L} = \frac{1}{RC}$ then $i_0 = \frac{v_0}{R}$, $\phi = \pi/4$

$\therefore \ \phi' = \frac{\pi}{2}$

Case 4: when $\omega = \frac{R}{L} = \frac{1}{\sqrt{3}RC}$ then $i_0 = \frac{v_0}{\sqrt{2}R}$, $\phi = \pi/3$

$\therefore \ \phi' = \frac{7\pi}{12}$

SECTION – C

13. 00001.50

Sol. $T \propto P^a d^b E^c$

$\Rightarrow [M^0L^0T] = [ML^{-1}T^{-2}]^a\,[ML^{-3}]^b\,[ML^2T^{-2}]^c$

Equating exponents of M and T, we get

$a + b + c = 0$ and $-2a - 2c = 1$

$\Rightarrow a + c = -\frac{1}{2}$

$\Rightarrow b = \frac{1}{2}$

Hence $a + 4b + c = 3/2 = 1.5$

14. 00003.25

Sol. $r_{AB} = \int_0^1 \lambda dx = \int_0^1 (1+2x)dx = 2\Omega$

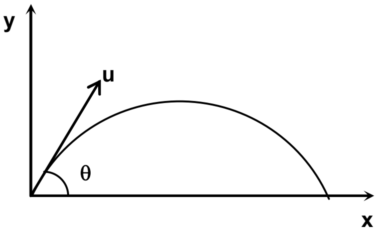
$r_{AC} = \int_0^{0.5} (1+2x)dx = \frac{3}{4}\Omega$

Potential difference between X and Y = 4V = potential difference between A and C when $i_G = 0$

$\therefore \ 4 = \frac{28}{(r+2)} \times \frac{3}{4} \Rightarrow r = 3.25\ \Omega$

15. 00195.00

Sol. Coordinates of the ball at t = t is



$x = u\cos\theta t$

$y = u\sin\theta t - \frac{1}{2}gt^2$

and time of flight is $\frac{2u\sin\theta}{g}$

Area under trajectory is

$$A = \int_0^x y\,dx = \int_0^{\frac{2u\sin\theta}{g}} \left(u\sin\theta t - \frac{gt^2}{2}\right) u\cos\theta dt$$

$\therefore$ $A = \frac{2u^4}{3g^2}\sin^3\theta\cos\theta$

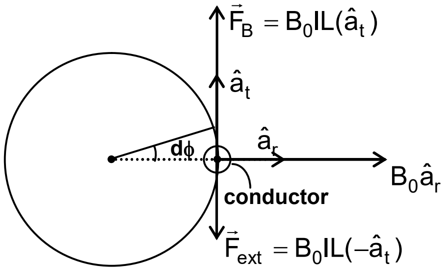
For A to be maximum, $\frac{dA}{d\theta} = 0$

$\Rightarrow$ $\theta = 60°$

$\therefore$ $A_{max} = \frac{\sqrt{3}u^4}{8g^2} = 194.85 \approx 195\ m^2$

16. 00000.50

Sol. $\vec{F}_B = I(\vec{L}\times\vec{B}) = I(L\hat{K}\times B_0\hat{a}_r) = B_0 IL\hat{a}_t$


$\vec{F}_B = B_0IL(\hat{a}_t)$
$\hat{a}_t$
$d\phi$
$\hat{a}_r$
$B_0\hat{a}_r$
conductor
$\vec{F}_{ext} = B_0IL(-\hat{a}_t)$

$\vec{F}_{external} = B_0 IL(-\hat{a}_t)$

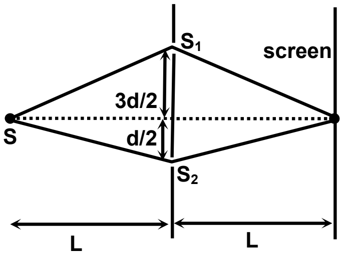
Work done by external agent to turn the conductor by 2π radian

$$W = \int_0^{2\pi} B_0 IL(-\hat{a}_t)\cdot r\,d\phi\hat{a}_t = -2\pi r B_0 IL$$

$P = 2\pi r B_0 ILN = 0.5\ W$

17. 04800.00

Sol. $\frac{3}{4}I_{max} = I_{max}\cos^2\frac{\phi}{2} \Rightarrow \cos\frac{\phi}{2} = \frac{\sqrt{3}}{2}$



$\Rightarrow \frac{\phi}{2} = \frac{\pi}{6} \Rightarrow \phi = \pi/3$

$\phi = \frac{2\pi}{\lambda}\Delta x = \frac{\pi}{3} \Rightarrow \Delta x = \frac{\lambda}{6}$

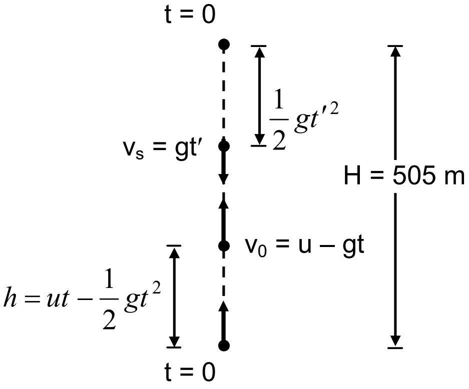
Given d = 200 μm = 2×10^{-4} m

$$2\left[\sqrt{L^2+\frac{9d^2}{4}} - \sqrt{L^2+\frac{d^2}{4}}\right] = \frac{\lambda}{6}$$

$\Rightarrow \frac{2d^2}{L} = \frac{\lambda}{6}$ $\quad\Rightarrow \lambda = \frac{12d^2}{L} = \frac{12\times4\times10^{-8}}{1}$ = 4800Å

18. 01800.00

Sol. Let t′ be the time at which the source emits sound wave which is detected at t = 5s. Then,



$$H - \frac{1}{2}gt'^2 - h = v(t - t')$$

or $$505 - \frac{1}{2}gt'^2 - \left(ut - \frac{1}{2}gt^2\right) = v(t - t')$$

using t = 5s ; g = 10 ms^{-2} ; v = 300 ms^{-1}, we get

$505 - 5t'^2 - 125 = 300\,(5 - t')$

or $t'^2 - 60\,t' + 224 = 0$

$\Rightarrow$ $t' = 4$s

Using Doppler's formula

$$f = f_0\left(\frac{v + v_0}{v - v_s}\right)$$

here $v_s = gt' = (10)\,(4) = 40$ ms^{-1}

$v_0 = u - gt = 50 - (10)\,(5) = 0$

$\therefore$ $f = 1560\left(\frac{300}{300 - 40}\right) = 1800$ Hz

Chemistry PART – II

SECTION – A

19. A, B

Sol. Both gases will have same pressure

$P_A = P_B$

Chamber 1: $P_AV_A = n_ART_A$ … (i)

Chamber 2: $P_AV_B = n_BRT_B$ … (ii)

Eqn. (i) ÷ (ii)

$$\frac{P_AV_A}{P_BV_B} = \frac{n_ART_A}{n_BRT_B}$$

$$3 = \frac{1}{3}.\frac{T_A}{T_B}$$

$T_A = 9T_B$

$T_A > T_B$

Heat will not flow 1 to 2 because chamber is insulating and piston is non conducting.

20. A, B, C, D

Sol. Borax bead test is given by Cu, Fe, Cr, Mn, Co and Ni metals.

21. A, C

Sol.

$$As_2S_3 + (NH_4)_2S_2 \longrightarrow As_2S_5 + (NH_4)_2S$$

$$As_2S_5 + 3(NH_4)_2S \longrightarrow \underset{\text{ammonium thioarsenate}}{2(NH_4)_3AsS_4}$$

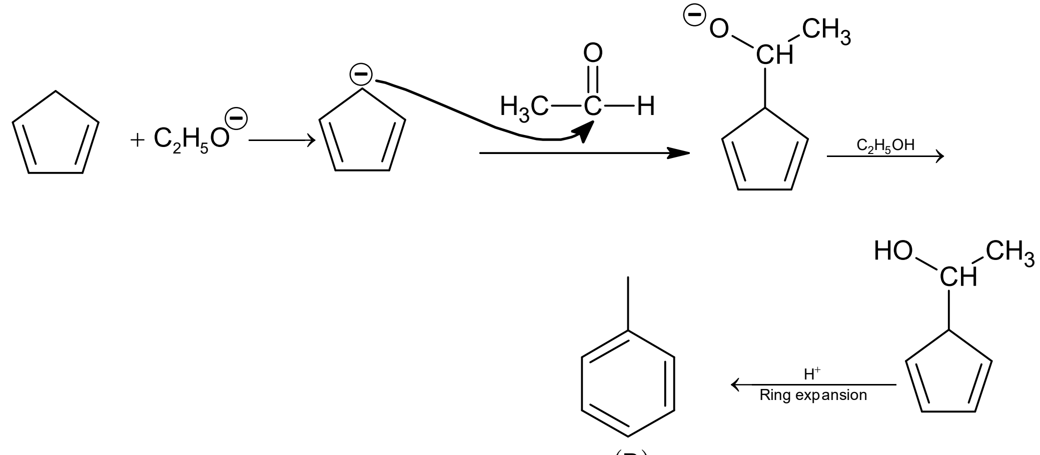
$$NH_4Cl + NaOH \longrightarrow NaCl + H_2O + NH_3(g)$$

22. B, C, D

Sol. Compound with white colour – $PbCl_2$, $Al(OH)_3$, $BaCO_3$, $SrCO_3$, $Mg(NH_4)HPO_4$.

23. B, C, D

Sol.



(B)

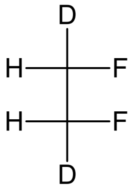
24. A, C, D

Sol.
- (i) Process AB → V increases, T increase ΔT > 0, ΔU > 0
- (ii) Process BC → V decreases, T decrease ΔT < 0.
- (iii) Process CD → pressure decreases, T decreases ΔT < 0, ΔQ < 0.
- (iv) Process DA → pressure increase, ΔQ > 0.

25. A, B, C

26. A, C

Sol. A and C are identical and have meso form.



(meso form)

27. C

28. B

Sol. **(for Q.27 – Q.28):**

Glyptal – Lacquers
Bakelite – Computer discs
Polystyrene – Radio cabinets
Urea-formaldehyde resin – Unbreakable cups, Laminated sheets

29. C

30. B

Sol. **(for Q.29 – Q.30):**

Dolomite – $MgCO_3.CaCO_3$
Limonite – $2Fe_2O_3.3H_2O$
Azurite – $Cu(OH)_2.2CuCO_3$
Alunite – $K_2SO_4.Al_2(SO_4)_3.2Al(OH)_3$

SECTION – C

31. 00001.25

Sol. Total number of correct statements are 5
a, b, c, e, h are correct. So x = 5
Total incorrect statements are 4
d, f, g, i are incorrect. So y = 4

$$\frac{x}{y} = \frac{5}{4} = 1.25$$

32. 00018.75

Sol. a is edge length of unit cell, r is the radius of carbon atom. In diamond unit cell carbon atoms are present at C.C.P. and alternate tetrahedral void position.

$$\frac{a\sqrt{3}}{2} = 4r \Rightarrow a\sqrt{3} = 8r$$

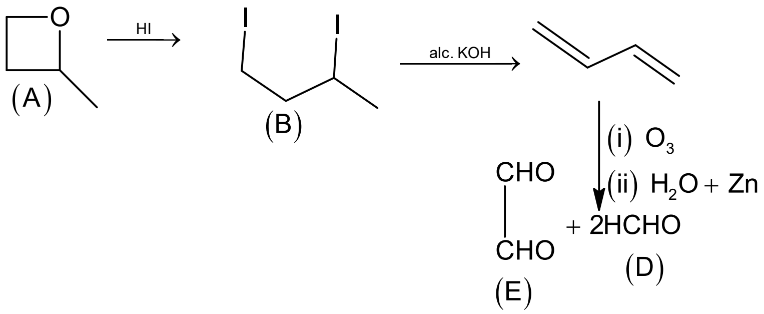
Net atoms present one face = 2

% age of area occupied by atoms $= \frac{2\pi r^2}{a^2} = \frac{2\pi r^2}{\left(\frac{8r}{\sqrt{3}}\right)^2} \times 100$

$$= \frac{2\pi r^2 \times 100 \times 3}{64r^2} = \frac{300\pi}{32}$$

33. 00001.50

Sol.

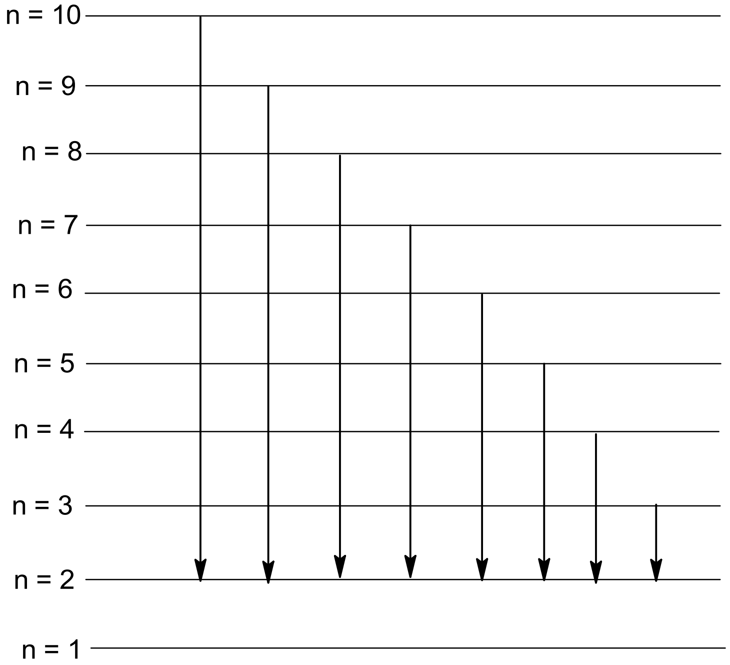

O
HI
(A)
I
I
(B)
alc. KOH
(i) O3
(ii) H2O + Zn
CHO
CHO
(E)
+ 2HCHO
(D)

Number of atom in E = 6
Number of atom in D = 4

$$\frac{6}{4} = 1.5$$

34. 00001.60

Sol.


n = 10
n = 9
n = 8
n = 7
n = 6
n = 5
n = 4
n = 3
n = 2
n = 1

y = 8

so value of $\frac{y}{5} = 1.6$

35. 00000.25

Sol. B is incorrect

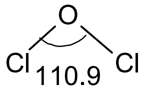
$$\text{AlCl}_3 + 2\text{ICl}(\text{melt}) \longrightarrow [\text{I}_2\text{Cl}]^+ + [\text{AlCl}_4]^-$$

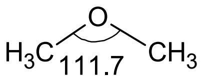
A, C, D and E are correct.

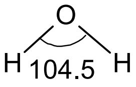
$$\frac{\text{number of incorrect reaction}}{\text{number of correct reaction}} = \frac{1}{4} = 0.25$$

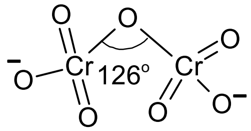
36. 00002.50

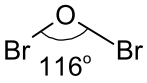
Sol.

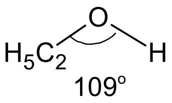


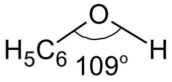

O
H3C
CH3
111.7

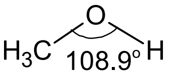


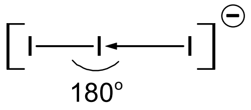

O
O
O
O
O
O
O
Cr
Cr
126°











Total number of compound which have bond angle greater than 109° 28′ are x = 5.

So, $\frac{x}{2} = \frac{5}{2} \Rightarrow 2.5$

Mathematics PART – III

SECTION – A

37. A, B, C, D

Sol. $\beta = 2\alpha + 3$ and $4 \le |\alpha - \beta + 1| < 6 \Rightarrow \alpha \in (-8, -6] \cup [2, 4) \Rightarrow \alpha = \{-7, -6, 2, 3\}$

38. A, C

Sol. Point M can be $\left(\frac{3}{\sqrt{5}}, \frac{4}{\sqrt{5}}\right)$ or $\left(\frac{-3}{\sqrt{5}}, \frac{-4}{\sqrt{5}}\right)$

$\Rightarrow$ Equation of tangent is $x + 3y - 3\sqrt{5} = 0$ or $x + 3y + 3\sqrt{5} = 0$

39. B, C, D

Sol. Locus is hyperbola with foci (4, 2) and (–4, –2) and length of transverse axis = 4

40. A, B, C

Sol. Locus is $x^2 = \frac{4}{3}(y - 3)$

41. A, B, C, D

Sol. $\left(1 + x + x^2 + x^3\right)^{100} = a_0 + a_1x + a_2x^2 + ... + a_{300}x^{300}$

Put x = 1 $\Rightarrow a_0 + a_1 + ... + a_{300} = 4^{100} = (1024)^{20}$

Put x = –1 $\Rightarrow a_0 - a_1 + a_2 ..... + a_{300} = 0$

Put $x = \frac{1}{x} \Rightarrow a_r - a_{300-r} = 0$

By differentiating both sides and put x = 0, we get $a_1 = 100$

42. B, C

Sol. $\alpha = 5\pi - 15$, $\beta = 2\pi - 5 \Rightarrow \alpha - 3\beta = -\pi \Rightarrow \sin^2 \alpha + \cos^2 3\beta = 1$

43. A, B, C, D

Sol. Vector parallel to the line of intersection of planes $\vec{r} \cdot \vec{n}_1 = q_1$, $\vec{r} \cdot \vec{n}_2 = q_2$ is $\left(\vec{n}_1 \times \vec{n}_2\right)$

44. A, B, C, D

Sol. The lines bisecting the angles between the line $\frac{x-2}{2} = \frac{y-3}{3} = \frac{z-6}{6}$ and $\frac{x-2}{3} = \frac{y-3}{6} = \frac{z-6}{2}$ are $\frac{x-2}{5} = \frac{y-3}{9} = \frac{z-6}{8}$ and $\frac{x-2}{1} = \frac{y-3}{3} = \frac{z-6}{-4}$

45. D

46. B

Sol. **(for Q.45 – Q.46)**

(I) $f(x) = \cos 2x - 10 \cos x - 11 \Rightarrow f(x) = 2 \cos^2 x - 10 \cos x - 12$
$\Rightarrow f(x) = 2[\cos^2 x - 5 \cos x - 6] \Rightarrow$ Range of f(x) is [–20, 0]

(II) Period of function = $\frac{\pi}{\pi / 10} = 10$

(III) $m = \frac{\pi / 2}{5\pi / 2} \Rightarrow m = \frac{1}{5}$

(IV) f(x) = constant

47. D

48. C

Sol. **(for Q.47 – Q.48)**

(I) (x, y) can be (0, 0) only

(II) $4a = \frac{4 \times 6 \times 2}{6 + 2} = 6$

(III) $(a, b) = (-2, -8) \Rightarrow 2a - b = 4$

(IV) $a \in R$

SECTION – C

49. 00003.00

Sol. $\vec{z} = \frac{8\hat{i} + 10\hat{j} + 19\hat{k}}{7}$

50. 00045.00

Sol. $(6\{x\})^2 = 2[x]\cdot 3x \Rightarrow x = \frac{3}{2} \Rightarrow S = \frac{9}{20} \Rightarrow 100S = 45$

51. 11332.20

Sol. $(a - b)(a + b) = c \Rightarrow a - b = 1 \Rightarrow a = 3, b = 2 \Rightarrow c = 5 \Rightarrow d = 7$

52. 00005.00

Sol. $\cos 2x = \cos^3 x - \sin^3 x$

$\Rightarrow \cos^2 x - \sin^2 x = \cos^3 x - \sin^3 x \Rightarrow \cos x = 1$ or $\sin x = 1$ or $\sin x = \cos x$

53. 00000.00

Sol. $\tan 70° - \tan 20° = 2 \tan 50° \Rightarrow z = 2y$

54. 00010.00

Sol. $|z|_{\min} = \frac{3}{\sqrt{13}}$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST –X

JEE (Advanced)-2020

PAPER – 2

TEST DATE: 20-09-2020

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section-A (01 – 08, 19 – 26, 37 – 44)*** *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–1** In all other cases.*

   Section-A (09 – 12, 27 – 30, 45 – 48) *contains 6 List-Match sets with 12 questions (each set has 2 questions). Each question has 4 statements in LIST-I & 4, 5 or 6 statements in LIST-II. The codes for Lists have choices (A), (B), (C), (D) out of which only one is correct.*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. Two identical charged particles having charge 10 μC and mass 100 gm each are released on a rough horizontal plane surface at a distance of 1 m from each other. Coefficient of friction between the particles and horizontal plane surface is 0.1 and acceleration due to gravity is 10 m/s^2.

(A) Maximum speed acquired by each particle is 2 m/s.

(B) Maximum speed acquired by each particle is $\sqrt{2}$ m/s.

(C) Magnitude of the displacement of each particle with respect to their initial position when they have their maximum velocity is 1m.

(D) Initial electrostatic potential energy is totally lost in the form of heat in doing work against the friction force.

2. Ratio of the radii of nuclei of two hydrogen like atoms is 3 : 2. Assume their nuclei to be having equal no of protons and neutrons. Identify the correct option(s)

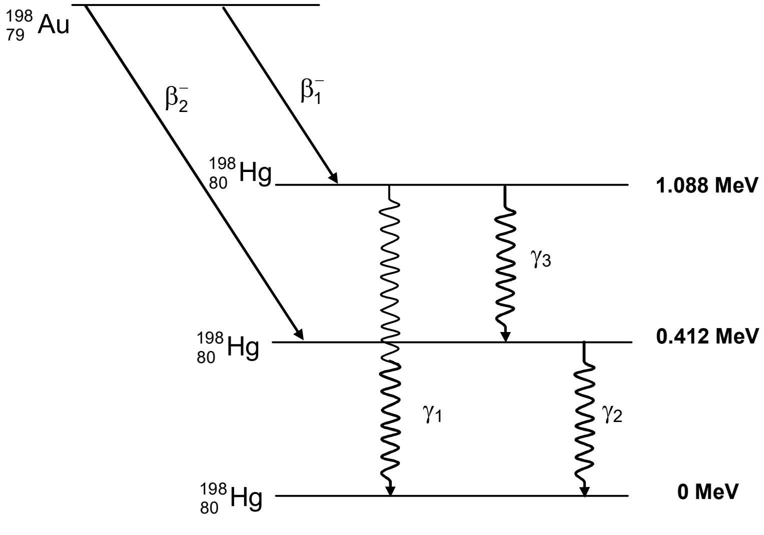
(A) Ratio of orbital radius for K-shell electrons is $\frac{8}{27}$.

(B) Ratio of velocity of the electrons in K shells is $\frac{27}{8}$.

(C) Ratio of ionisation energy of the electrons from these two H like atoms is $\frac{729}{64}$

(D) Ratio of the angular momentum of the electrons orbiting in the first excited state is 1 : 1.

3. In the decay process of a nucleus given below, identify the correct statement.
[given: m(Au^{198}) = 197.968233 u, m(Hg^{198}) = 197.966760 u] (1u = 931.5 MeV/C^2)



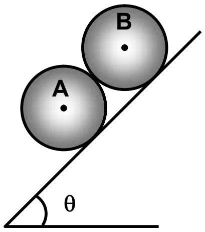
(A) maximum K.E. of $\beta_1^- = 0.284$ MeV

(B) maximum K.E. of $\beta_2^- = 0.960$ MeV

(C) Energy associated with γ_1 is 0.412 MeV

(D) Energy associated with γ_3 is 0.676 MeV

4. Two solid cylinders A and B are placed in contact on an inclined plane as shown in the diagram. Their dimensions are equal and they are in equilibrium.



Let M_A and M_B be the mass of cylinders A and B respectively.
f_A be friction force between cylinder A and inclined plane
f_B be friction force between cylinder B and inclined plane.
f_{AB} be friction force between cylinder A and cylinder B.
N_{AB} be the normal force between cylinders A and B.
Choose the correct option(s).

(A) $f_A = f_B = f_{AB}$

(B) $N_{AB} = \left(\frac{M_B - M_A}{2}\right) g\sin\theta$

(C) $M_B > M_A$

(D) $f_A > f_B > f_{AB}$

5. The pressure of an ideal gas is written by $P = K\frac{E}{V}$, where E is some type of kinetic energy of random motion, K is a constant and V is the volume of gas. Consider the following statements and mark the correct option(s).

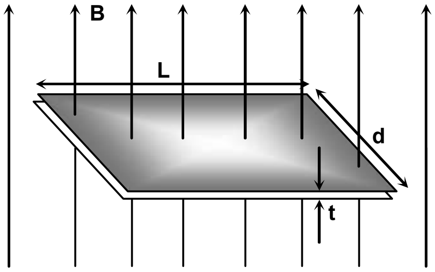
(A) The gas is di-atomic, $K = \frac{2}{5}$ and E = total kinetic energy

(B) The gas is di-atomic, K = 1 and E = rotational kinetic energy

(C) The gas is monoatomic, $K = \frac{2}{3}$ and E = total kinetic energy

(D) The gas is mono atomic or diatomic, $K = \frac{2}{3}$ and E = translational kinetic energy.

6. A long metal strip of thickness t = 1 mm and width d = 1 cm carries current along its length (L). The current in the metal strip is flowing towards the left. It is placed in a uniform transverse magnetic field B = 2 T (as shown in the figure). The potential difference recorded across the width d of the plate is found to be 3 × 10^{-6} V. Now mark the correct option(s).

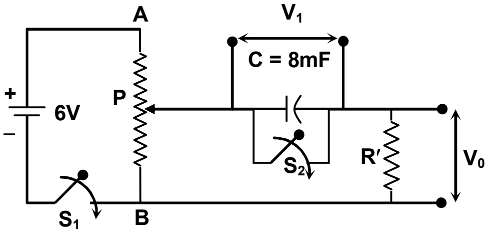


(A) Electric field resulted across the width 'd' is 3 × 10^{-3} V/m.

(B) Electric field resulted across the width 'd' is 3 × 10^{-4} V/m.

(C) Magnitude of electric force on the electrons due to the electric field that is resulted due to motion of the electrons inside metal strip is 4.8 × 10^{-22} N.

(D) The drift velocity of the electron is 1.5 × 10^{-4} m/s.



7. In the adjacent circuit, AB is a rheostat of 2 kΩ and it is tapped at the central point P. Initially both the switches S_1 and S_2 are closed and potential difference recorded across R′ = 1kΩ is found to be V_0. At t = 0, S_2 is opened and the final potential difference recorded across the 8 mF capacitor is found to be V_1. Then choose the correct option(s).

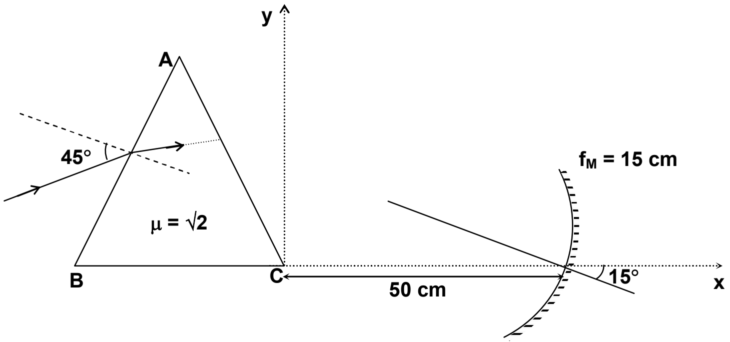
(A) $\frac{V_1}{V_0} = \frac{3}{2}$

(B) $\frac{V_1}{V_0}$ is independent of position of the tapping point P.

(C) maximum rate at which energy is increasing in the capacitor after opening S_2 is 1.5 mW.

(D) the total heat dissipated across R′ after opening S_2 is 24 mJ.

8. A narrow parallel beam of light coming from a distant object is incident on an equilateral triangular prism of refractive index $\mu = \sqrt{2}$ with its base BC along the x-axis. A concave mirror of radius of curvature 30 cm is placed at a distance of 50 cm from the point C of the triangular prism. The principal axis of the mirror is inclined at angle of 15° with x-axis as shown in the diagram. Mark the correct option(s). Assume paraxial object is valid.



(A) Deviation in the beam of light after emerging from the prism is 30°.

(B) Final image formed after reflection from mirror is real, inverted and diminished.

(C) Y-coordinate of the final image formed after reflection from mirror is $\frac{15\left(\sqrt{3}-1\right)}{2\sqrt{2}}$ cm.

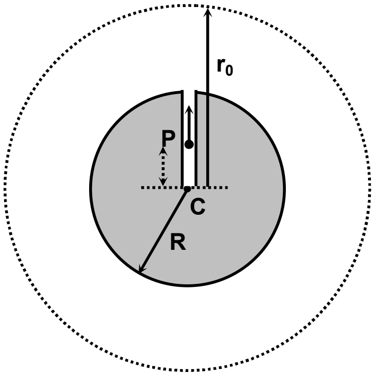
(D) Ray undergoes minimum deviation after passing through the prism.

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

A satellite is to be launched in a circular orbit of radius r_0 around a planet of radius R. For this two stage rocket is to be used. First stage rocket is used to lift the satellite vertically up to the desired height r_0 (measured from the center C of the planet), after launching it from a launch point P. Distance of launch point P from centre of the planet is r_L. Launch point P lies inside the tunnel as shown in the figure. Second stage rocket is used to impart it a tangential velocity so as to put it in a circular orbit. Let E_1 and E_2 are the energies delivered by the first and second stage of the rocket. Assume that the mass of the rocket is negligible with respect to the mass of the planet and atmospheric resistance to be zero. List-I gives 4 values of r_0 and r_L and List-II gives magnitude of some quantity.



	List – I		List – II
(I)	$r_0 = R$ $r_L = \frac{R}{\sqrt{2}}$	(P)	$\frac{1}{2}$
(II)	$r_0 = \frac{3R}{2}$ $r_L = R$	(Q)	1
(III)	$r_0 = 4R$ $r_L = R$	(R)	$\frac{11}{6}$
(IV)	$r_0 = 4R$ $r_L = \frac{R}{\sqrt{2}}$	(S)	4
		(T)	6
		(U)	8

9. The correct match for the time period of the satellite for the values of r_0 given in List-I in terms of T_0 is

(Take $T_0 = \frac{2\pi}{\sqrt{GM}} R^{3/2}$ and $\sqrt{6} = \frac{22}{9}$ if required)

Options

(A) I → Q, II → R, III → P, IV → U
(B) I → Q, II → P, III → U, IV → U
(C) I → Q, II → T, III → U, IV → P
(D) I → Q, II → R, III → U, IV → U

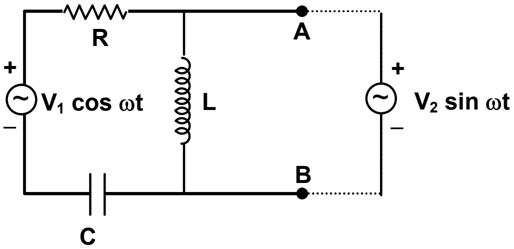
10. The correct match for $\frac{E_1}{E_2}$ for the values of r_0 and r_L given in List-I is

Options

(A) I → S, II → T, III → U, IV → P
(B) I → P, II → Q, III → T, IV → U
(C) I → S, II → T, III → R, IV → P
(D) I → P, II → S, III → Q, IV → T

Answer the following by appropriately matching the list based on the information given in the paragraph.

A series LCR circuit is fed by an alternating voltage $v_1 \cos \omega t$. Another alternating voltage source $v_2 \sin \omega t$ is now connected across the terminals A and B as shown in the figure.



List–I gives the possible values of ω and List–II gives different magnitudes of some quantity.

	List – I		List – II
(I)	$\omega \to 0$	(P)	0
(II)	$\omega = \frac{R}{L} = \frac{1}{RC}$	(Q)	$\frac{1}{2}$
(III)	$\omega = \frac{2R}{L} = \frac{1}{RC}$	(R)	$\frac{1}{\sqrt{2}}$
(IV)	$\omega = \frac{R}{L} = \frac{1}{\sqrt{3}RC}$	(S)	1
		(T)	$\frac{3}{4}$
		(U)	$\frac{7}{12}$

11. If $v_1 = v_2 = v_0$, then maximum values of current through resistance R (in terms of $\frac{v_0}{R}$) for different values of ω given in List-I will be

Options

(A) I → P, II → Q, III → S, IV → R
(B) I → P, II → Q, III → R, IV → S
(C) I → P, II → S, III → S, IV → R
(D) I → P, II → S, III → Q, IV → T

12. If $v_1 = v_2 = v_0$, and $\phi' = n\pi$ is the phase difference between $v_1 \cos \omega t$ and the current through the resistance then find the correct matches of n from List-II for the values of ω given in List-I.

Options

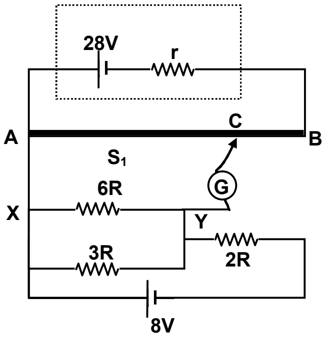
(A) I → T, II → Q, III → Q, IV → U
(B) I → P, II → Q, III → R, IV → S
(C) I → T, II → S, III → S, IV → U
(D) I → P, II → S, III → Q, IV → T

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

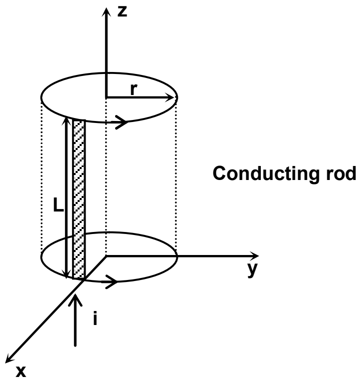
13. A gas bubble produced from an under water explosion oscillates with period T. The period T is found to be proportional to the a^{th} power of pressure (P), b^{th} power of density (d) and c^{th} power of the total energy (E) of explosion. Using dimensional analysis find the value of (a + 4b + c).

14. In the given potentiometer circuit, the resistance per unit length (in Ω/m) 'λ' of the potentiometer wire varies with distance x (from end A) as λ = 1 + 2x. The length of the potentiometer wire is 1 m. While measuring the potential difference between the points X and Y, the balancing length (AC) is obtained exactly at the middle of the wire. The internal resistance (r) of the driving cell (in ohm) is

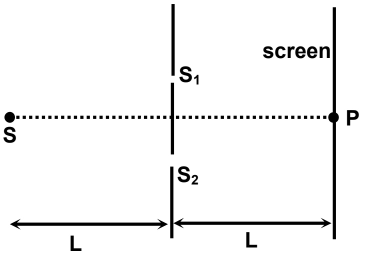


15. A ball is thrown with a speed u = $10\sqrt{3}$ m/s so that the area enclosed by the balls trajectory with the horizontal surface is maximum. Taking g = 10 m/s^2 and $\sqrt{3} = 1.732$, the maximum area (in m^2) enclosed by the balls trajectory with the horizontal surface is closest to the whole number……

16. A conducting rod of length L = $\frac{1}{4}$m is carrying a current I = 1A as shown in the diagram. It is made to move in a circular path of radius $r = \frac{2}{\pi}$ m in a magnetic field $\vec{B} = B_0\hat{a}_r$ with 10 revolutions per minute (Where B_0 = 3T and $\hat{a}_r$ is a unit vector in radial direction). Find the power (in watt) required to make this rod move with a constant angular speed.



17. Light from a monochromatic point source S is incident on the two slits of an opaque wall placed at a distance L as shown in the diagram. Intensity of interference pattern is observed at the point P on the screen placed at a distance L behind the slits. When the upper slit is shifted upward then the distance between the slits increases. It is observed that when the distance between the slits is changed from 200 μm to 400 μm, the intensity at P changes from I_{max} to $\frac{3}{4}I_{max}$. If L = 1 m, then find the wave length of the light used (in Å)



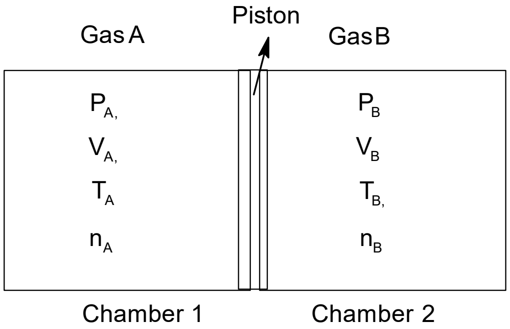
18. A sound source of frequency f_0 = 1560 Hz is dropped from a height H = 505 m above the ground at t = 0. At the same time a detector is thrown upwards with a velocity u = 50 ms^{-1} along the same line. If the velocity of sound is v = 300 ms^{-1}, find the frequency (in Hz) detected by the detector at t = 5s.

Chemistry PART – II

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Two gas samples A and B are placed in a chamber and separated by non conducting frictionless piston.



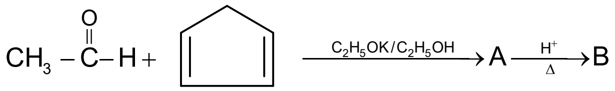
If $n_A : n_B :: 1 : 3$, $V_A : V_B :: 3 : 1$ and piston is in equilibrium then the correct statements are:
(A) $P_A = P_B$
(B) $T_A > T_B$
(C) Heat will flow from chamber 1 to chamber 2.
(D) $T_A = T_B$

20. Borax bead test is given by the metals
(A) Cu
(B) Fe
(C) Mn
(D) Ni

21. Identify the correct statements:
(A) Lead is placed in group 1st and 2nd because it's chloride is partially soluble in water.
(B) Ferric ions give a deep green precipitate on adding $K_4[Fe(CN)_6]$ soln.
(C) As_2S_3 is soluble in yellow ammonium sulphide solution.
(D) Heating of NH_4Cl with NaOH form N_2 gas.

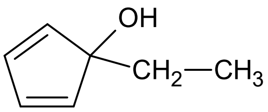
22. Compounds having white colour.
(i) ZnS (ii) CdS (iii) $PbCl_2$ (iv) SnS_2 (v) $AlOH)_3$
(vi) $BaCO_3$ (vii) $SrCO_3$ (viii) $Mg(NH_4)HPO_4$
(A) $Al(OH)_3$, SnS_2, $BaCO_3$
(B) $BaCO_3$, $Mg(NH_4)HPO_4$
(C) $SrCO_3$, $CaCO_3$
(D) ZnS, $PbCl_2$, $BaCO_3$

23.



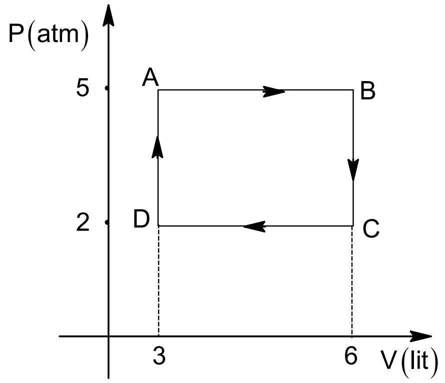
Find the correct options for the above

(A) Compound A will be



(B) Compound B will be toluene
(C) Compound B give etard’s reaction
(D) Compound A is not an aromatic compounds.

24. For 2 mole of He gas (assuming ideal behaviour), study P – V curve.

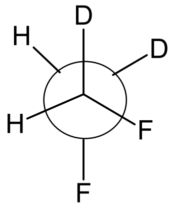


For the given system
(A) Process AB, $\Delta U > 0$
(B) For process BC, $\Delta T > 0$
(C) For process CD, $\Delta Q < 0$
(D) For process DA, $\Delta Q > 0$

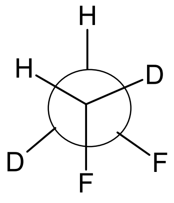
25. Identify the correct statements related to alloy with their uses?
(A) Brass is used in the cartridges cases.
(B) Bronze is used in the formation of bells.
(C) Phosphorous bronze is used in propellers.
(D) Gun metal is used in preparation of T.V.

26. Identify the identical compounds?

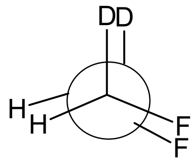
(A)



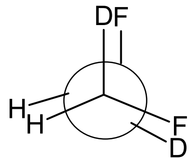
(B)



(C)



(D)



(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

Every polymers has some uses, so based on the uses (List –II) of polymers (List –I) given here.

List -I (Polymer)		**List II (Uses)**	
(I)	Glyptal	(P)	Radio cabinets
(II)	Bakelite	(Q)	Laminated sheets
(III)	Polystyrene	(R)	Fibres
(IV)	Urea – formaldehyde resin	(S)	Unbreakable cups
		(T)	Lacquers
		(U)	Computer discs

27. Which of the following options have correct combinations considering List-I and List-II
(A) I – (S)
(B) III – (Q)
(C) II – (U)
(D) IV – (R)

Every polymers has some uses, so based on the uses (List –II) of polymers (List –I) given here.

List -I (Polymer)		**List II (Uses)**	
(I)	Glyptal	(P)	Radio cabinets
(II)	Bakelite	(Q)	Laminated sheets
(III)	Polystyrene	(R)	Fibres
(IV)	Urea – formaldehyde resin	(S)	Unbreakable cups
		(T)	Lacquers
		(U)	Computer discs

28. Which of the following options has the correct combination considering List-I and List-II?
(A) IV – (U)
(B) III – (P)
(C) I – (S)
(D) II – (Q)

Answer the following by appropriately matching the list based on the information given in the paragraph.

Ore contain metals with some other elements. List –I contains ores and List –II contain element present in that

List -I		**List II**	
(I)	Dolomite	(P)	C
(II)	Limonite	(Q)	Cu
(III)	Azurite	(R)	Al
(IV)	Alunite	(S)	S
		(T)	Fe
		(U)	Mg

29. Which of the following options has correct combination considering List –I and List –II?
(A) I – (T)
(B) IV – (T)
(C) III – (Q)
(D) II – (R)

Ore contain metals with some other elements. List –I contains ores and List –II contain element present in that

List -I		List II	
(I)	Dolomite	(P)	C
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(III)	Azurite	(R)	Al
(IV)	Alunite	(S)	S
		(T)	Fe
		(U)	Mg

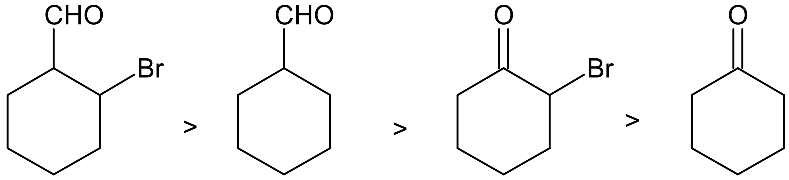
30. Which of the following options has correct combinations considering List –I and List –II?
(A) IV – (P)
(B) II – (T)
(C) III – (R)
(D) IV – (Q)

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

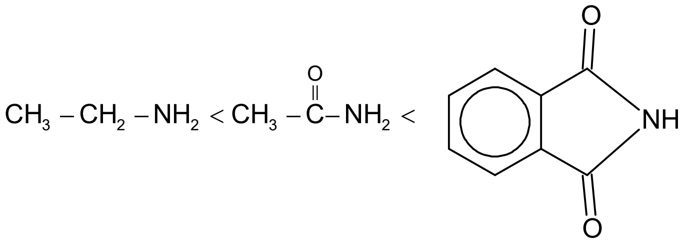
31. 'x' are the total number of correct orders and 'y' are the total number of incorrect orders as properties mentioned. Find out x/y?

(a)



(Extent of hydration toward nucleophilic addition reaction)

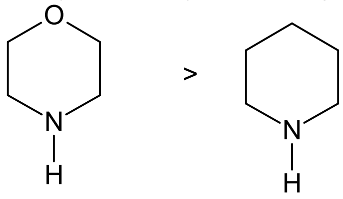
(b)



$CH_3-CH_2-NH_2 < CH_3-\overset{O}{\overset{\|}{C}}-NH_2 <$ (acidic strength)

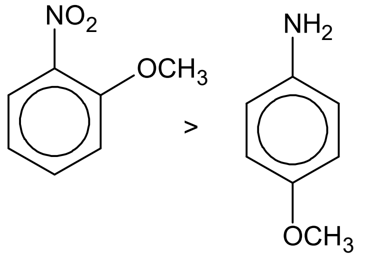
(c) Pyridine > Pyrrole (Basic strength)

(d)



(Basic strength)

(e) N-methyl aniline > Aniline (Basic strength)

(f)  (Basic strength)

(g) PhC ≡ CH_2 and PhCH = CH_2 can be differentiated by Br_2/CCl_4 test.

(h) 1-Butyne and 2-butyne can be distinguished by ammonical $AgNO_3$ solution.

(i) Compound containing $-\overset{OH}{\overset{|}{C}H}-\overset{O}{\overset{||}{C}}-$ group and that containing $-\overset{O}{\overset{||}{C}}-H$ group can be distinguished by Tollen's reagent.

32. Carbon crystalizes into its allotrope diamond. If x is percentage of area occupied by carbon atoms in one face of a unit cell then what is value of $\frac{2x}{\pi}$?

33. $\underset{C_4H_8O}{A} \xrightarrow{HI(excess)} B \xrightarrow{alc.\,KOH} C \xrightarrow[(ii)\,H_2O+Zn]{(i)\,O_3} D + E$

Compound A is cyclic optically active ether. Both D and E compounds give Cannizzaro reaction. Number of carbon in compound E is greater than D. What is ratio of total number of atoms in compound E with total number of atoms in compound D.

34. Total number of maximum possible visible lines when electrons jump from energy level
n = 10 to n = 1 for sample of hydrogen atoms are 'y'. What is the value of y/5?

35. Ratio of number of incorrect reactions with the number of correct reactions is:

(A) $CsI_3 \xrightarrow{heat} CsI + I_2$

(B) $AlCl_3 + \underset{(melt)}{ICl} \longrightarrow I^+ + [AlCl_4]^-$

(C) $UF_4 + ClF_3 \longrightarrow UF_6 + ClF$

(D) $XeF_4 + 2SF_4 \longrightarrow Xe + 2SF_6$

(E) $4KClO_3 \xrightarrow{low\ T} 3KClO_4 + KCl$

36. Total number of compounds which contain bond angle (E – O – E) greater than 109° 28′ are 'x'.
Cl_2O, CH_3OCH_3, H_2O, $Cr_2O_7^{-2}$, Br_2O, C_2H_5OH, C_6H_5OH, CH_3OH, I_3^-.
Find out the x/2?

Mathematics

PART – III

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. In a ΔABC, $A \equiv (\alpha, \beta)$, $B \equiv (1,2)$, $C \equiv (2,3)$ and point A lies on $y = 2x + 3$, where $\alpha, \beta \in I$ and area S of the triangle is such that $2 \le S < 3$. Then coordinates of A can be

(A) $(-6,-9)$

(B) $(-7,-11)$

(C) $(2,7)$

(D) $(3,9)$

38. From the intersection point of the circle $x^2 + y^2 = 9$ and the line $y = 2x$ perpendicular is drawn to the major axis of the ellipse $\frac{x^2}{9} + \frac{y^2}{4} = 1$, which meets the ellipse at point M, then equation of tangent at M to the ellipse is/are

(A) $x + 3y - 3\sqrt{5} = 0$

(B) $4x + 3y - \sqrt{5} = 0$

(C) $x + 3y + 3\sqrt{5} = 0$

(D) $4x + 3y + \sqrt{5} = 0$

39. The equation $\left|\sqrt{(x-4)^2 + (y-2)^2} - \sqrt{(x+4)^2 + (y+2)^2}\right| = 4$ represents

(A) Ellipse with centre (0, 0)

(B) Hyperbola with centre (0, 0)

(C) Conic with eccentricity $\sqrt{5}$

(D) Conic whose auxillary circle is $x^2 + y^2 = 4$

40. If PQ is a chord of parabola $x^2 = 4y$ which subtends right angle at the vertex. Then locus of centroid of triangle PSQ (S is focus) is a parabola whose

(A) vertex is $(0,3)$

(B) Length of latus rectum is $\frac{4}{3}$

(C) axis is $x = 0$

(D) Tangent at the vertex is $x = 3$

41. If $\left(1 + x + x^2 + x^3\right)^{100} = a_0 + a_1x + a_2x^2 + ... + a_{300}x^{300}$, then

(A) $a_0 + a_1 + a_2 + a_3 + ... + a_{300}$ is divisible by 1024

(B) $a_0 + a_2 + a_4 + ... + a_{300} = a_1 + a_3 + ... + a_{299}$

(C) $a_r - a_{300-r} = 0$, $r = \{0, 1, 2, ..., 300\}$

(D) $a_1 = 100$

42. If z is the complex number satisfying $\left|z-3-4i\right|\le 10$ and $\alpha=\sin^{-1}\left(\sin\left|z\right|_{\max}\right)$,

$\beta=\cos^{-1}\left(\cos\left(-\frac{\left|z\right|_{\max}}{3}\right)\right)$, then

(A) $\alpha-3\beta=\pi$

(B) $\alpha-3\beta=-\pi$

(C) $\sin^2\alpha+\cos^2 3\beta=1$

(D) $\sin^2\alpha+\cos^2 3\beta=-1$

43. The correct statement(s) is/are

(A) The lines of intersection of planes $\vec{r}.\vec{n}_1=q_1$, $\vec{r}.\vec{n}_2=q_2$ and $\vec{r}.\vec{n}_3=q_3$, $\vec{r}.\vec{n}_4=q_4$ are perpendicular if $\left(\vec{n}_1.\vec{n}_3\right)\left(\vec{n}_2.\vec{n}_4\right)=\left(\vec{n}_1.\vec{n}_4\right)\left(\vec{n}_2.\vec{n}_3\right)$.

(B) If three distinct planes $\vec{r}.\vec{n}_1=q_1$, $\vec{r}.\vec{n}_2=q_2$, $\vec{r}.\vec{n}_3=q_3$ intersect in a line which is contained by the plane $\vec{r}.\vec{n}_4=q_4$, then $\left[\vec{n}_1\ \ \vec{n}_2\ \ \vec{n}_4\right]\vec{n}_3=\left[\vec{n}_1\ \ \vec{n}_2\ \ \vec{n}_3\right]\vec{n}_4$

(C) If four distinct planes $\vec{r}.\vec{n}_1=q_1$, $\vec{r}.\vec{n}_2=q_2$, $\vec{r}.\vec{n}_3=q_3$, $\vec{r}.\vec{n}_4=q_4$ intersect in a line then, $\left[\vec{n}_1\ \ \vec{n}_2\ \ \vec{n}_4\right]\vec{n}_3=\left[\vec{n}_1\ \ \vec{n}_2\ \ \vec{n}_3\right]\vec{n}_4$

(D) If a plane contains line of intersection of planes $\vec{r}.\vec{n}_1=q_1$, $\vec{r}.\vec{n}_2=q_2$ and is parallel to the line of intersection of the planes $\vec{r}.\vec{n}_3=q_3$, $\vec{r}.\vec{n}_4=q_4$, then $\left[\vec{n}_1\ \ \vec{n}_2\ \ \vec{n}_4\right]\vec{n}_3=\left[\vec{n}_1\ \ \vec{n}_2\ \ \vec{n}_3\right]\vec{n}_4$

44. Points that lie on the lines bisecting the angles between the lines $\frac{x-2}{2}=\frac{y-3}{3}=\frac{z-6}{6}$ and $\frac{x-2}{3}=\frac{y-3}{6}=\frac{z-6}{2}$ are

(A) $(7,12,14)$

(B) $(0,-3,14)$

(C) $(1,0,10)$

(D) $(-3,-6,-2)$

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

MM-I. Match the following list(s)

LIST-I		LIST-II	
(I)	Number of integers in the range of the function $f(x) = \cos 2x - 10\cos x - 11$ is	(P)	10
(II)	The period of the function $f(x) = \left(\sec^2\left(\frac{\pi x}{10}\right) - \tan^2\left(\frac{\pi x}{10}\right)\right)^{\cos^4 4\pi x + 100x - [100x]}$ (where [.] denotes greatest integer function) is	(Q)	14
(III)	If the number of the solution of the equation $\sin^{-1}(\sin x) - mx = 0$, $(m > 0)$ is 5, then $70m$ is equal to	(R)	21
(IV)	The period of the function $f(x) = \sum_{r=1}^{n}\left[r^2 + e^{-x^2-1} - r + 1\right]$ is equal to (where [.] denotes greatest integer function)	(S)	28
		(T)	29
		(U)	37

45. Which of the following is the only CORRECT combination?
(A) (I), (P)
(B) (II), (Q)
(C) (III), (R)
(D) (IV), (S)

46. Which of the following is the only INCORRECT combination?
(A) (I), (R)
(B) (II), (S)
(C) (IV), (P)
(D) (IV), (T)

Answer the following by appropriately matching the list based on the information given in the paragraph.

MM-II. Match the following list(s)

	LIST-I		LIST-II
(I)	The number of point(s) (x, y), (where both x and y are perfect squares of integers) on the parabola $y^2 = px$, p being a prime number, is	(P)	1
(II)	If AFB is a focal chord of the parabola $y^2 = 4ax$ and AF = 2, FB = 6 then the length of latus rectum is (where F is focus of the parabola)	(Q)	4
(III)	The coordinates of the point on the parabola $y = x^2 + 7x + 2$ which is nearest to the straight line $y = 3x - 3$ is (a, b) the $2a - b$ is equal to	(R)	6
(IV)	The value of a for which at least one tangent to the parabola $y^2 = 4ax$ becomes normal to the circle $x^2 + y^2 - 2ax - 4ay + 3a^2 = 0$ is	(S)	8
		(T)	9
		(U)	12

47. Which of the following is the only CORRECT combination?
(A) (I), (Q)
(B) (II), (P)
(C) (III), (S)
(D) (IV), (R)

48. Which of the following is the only INCORRECT combination?
(A) (I), (P)
(B) (II), (R)
(C) (III), (S)
(D) (IV), (T)

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

49. Let $\vec{x} = \hat{i} + 3\hat{j} - 2\hat{k}$, $\vec{y} = 2\hat{i} + 4\hat{j} + \hat{k}$ and a vector $\vec{z}$ satisfying $\vec{x} \times \vec{z} = \vec{x} \times \vec{y}$ and $\vec{z}.\vec{x} = 0$, then $\left[|\vec{z}|_{\max}\right]$ is equal to (where [.] denotes greatest integer function)

50. Let $2[x]$, $6\{x\}$ and $3x$ be first three terms of a G.P. where $x \in R^+$ and (where [.] and {.} represents greatest integer and fractional part functions respectively). If there is another G.P. whose terms are square of reciprocal of the terms of the given G.P. and sum of infinite terms of this G.P. is S, then 100S is equal to

51. If a, b, c, d are prime numbers such that $a^2 - b^2 = c$ and $d = b + c$, then sum of all the 4 digit numbers formed by using the digits a, b, c, d without repetition is λ, then $\frac{\lambda}{10}$ is

52. Number of solution(s) of the equation $\cos 2x = \cos^3 x - \sin^3 x$ in $\left[0, 2\pi\right]$ is/are

53. If $x = 2\tan 10^\circ + \tan 50^\circ$, $y = \tan 20^\circ + \tan 50^\circ$, $w = 2\tan 10^\circ + \tan 70^\circ$, $z = \tan 20^\circ + \tan 70^\circ$, then the value of $\left(\frac{z - 2y}{x + w}\right)$ is equal to

54. If z is a complex number satisfying $(2 + 3i)z + (2 - 3i)\bar{z} - 6 = 0$, then minimum value of $\left[13|z|\right]$ is (where [.] denotes greatest integer function)

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – XI

JEE (Advanced)-2020

PAPER – 1

TEST DATE: 23-09-2020

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. D

Sol. At t = 10 sec

$$x_{cm} = 100 \times \frac{4}{5} \times 10 = 800\text{ m}$$

$$y_{cm} = 100 \times \frac{3}{5} \times 10 - 5 \times 100 = 100\text{ m}$$

$$x_{cm} = \frac{m_1x_1 + m_2x_2}{m_1 + m_2}$$

$$800 = \frac{m \times 400 + 2mx_2}{3m}$$

$\Rightarrow x_2 = 1000$ m

$$y_{cm} = \frac{m_1y_1 + m_2y_2}{m_1 + m_2}$$

$$100 = \frac{m \times 60 + 2my_2}{3m}$$

$\Rightarrow y_2 = 120$ m

2. B

Sol. $f_P = \frac{3v_P}{4\ell_P},\ f_Q = \frac{3v_{mix}}{2\ell_Q}$

$$\frac{f_P}{f_Q} = \frac{\ell_Q}{2\ell_P}\frac{v_{Hz}}{v_{mix}}\sqrt{\frac{\gamma_{H_2}}{\gamma_{mix}} \times \frac{T_{Hz}}{T_{mix}} \times \frac{M_{mix}}{M_{H_2}}} = \sqrt{\frac{7}{5} \times \frac{2}{3} \times \frac{400}{420} \times \frac{3}{2}} = \frac{2}{\sqrt{3}}$$

3. C

Sol. In equilibrium

$Mg = m\omega^2 r$

When the weight is displaced by a small distance x downwards and released.

From conservation of angular momentum

$m\omega r^2 = m\omega'(r - x)^2$

Acceleration of the weight a = $\dfrac{Mg - T}{M} = \dfrac{m\omega^2 r - m\omega'^2(r - x)}{M}$

$$= \frac{m}{M}\left[\omega^2 r - \frac{\omega^2 r^4}{(r - x)^4}(r - x)\right] = \frac{m}{M}\omega^2 r\left[1 - \frac{r^3}{(r - x)^3}\right]$$

$$= \frac{m\omega^2 r}{M}\left[1 - \left(1 - \frac{x}{r}\right)^{-3}\right] = \frac{m\omega^2 r}{M}\left(\frac{-3x}{r}\right)$$

from binomial approximation $\left[\begin{array}{l}\left(1 - \dfrac{x}{r}\right)^{-3} \approx 1 + \dfrac{3x}{r} \\ \text{since } x << r\end{array}\right]$

$$\Rightarrow a = -\frac{3m\omega^2 x}{M}$$

$$\Rightarrow \text{frequency } f = \frac{1}{2\pi}\sqrt{\frac{3m\omega^2}{M}}$$

4. C

Sol. $x = u \cos \theta t$

$y = u \sin \theta\, t - \dfrac{1}{2}gt^2$

$v_x = u \cos \theta$, $v_y = u \sin \theta - gt$

The stone is at the greatest distance from the point of projection O. when its velocity is perpendicular to the position vector.

The condition for this is

$\dfrac{y}{x} = -\dfrac{v_x}{v_y}$ $\quad \vec{v} = u\cos\theta\hat{i} + (u\sin\theta - gt)\hat{j}$, $\quad \vec{r} = u\cos\theta t\hat{i} + \left(u\sin\theta t - \dfrac{1}{2}gt^2\right)\hat{j}$

$$\Rightarrow t^2 - \frac{3u\sin\theta}{g}t + \frac{2u^2}{g^2} = 0$$

If this is not happen, discriminate D < 0

$$\Rightarrow \left(\frac{3u\sin\theta}{g}\right)^2 < 4\frac{2u^2}{g^2}$$

$$\Rightarrow \sin\theta < \sqrt{\frac{8}{9}}$$

$$\sin\theta_{max} = \frac{\sqrt{8}}{3}$$

5. A, C

Sol. The upper ball will ultimately receives the largest possible fraction of total energy if after collision between the two balls m_2 comes to rest.

$$\Rightarrow \frac{(m_2 - m_1)\sqrt{2gh} - 2m_1\sqrt{2gh}}{m_1 + m_2} = 0 \quad \Rightarrow m_2 = 3m_1$$

If $m_2 >> m_1$

$v_1 = -u_1 + 2u_2 = 2gh + 2\sqrt{2gh} = 3\sqrt{2gh}$

$$h_{max} = \frac{v_1^2}{2g} = 9h$$

6. B, C, D

Sol. From conservation of angular momentum

$$(2mx^2 + I)\omega' = (2mR^2 + I)\omega$$

$$\Rightarrow \omega' = \frac{(2mR^2 + I)\omega}{2mx^2 + I}$$

Force exerted by insect on the turntable

$$F = m\omega'^2 x = m\frac{(2mR^2 + I)^2\omega^2}{(2mx^2 + I)^2}x$$

For F to maximum $\frac{dF}{dx}$ =0

$$\Rightarrow x = \sqrt{\frac{I}{6m}} = \sqrt{\frac{\frac{2}{3}mR^2}{6m}} = \frac{R}{3}$$

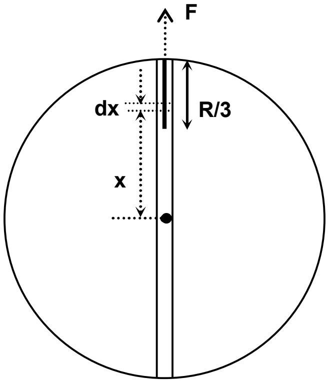
$$\omega' = \left(\frac{2mR^2 + \frac{2}{3}mR^2}{2m\frac{R^2}{9} + \frac{2}{3}mR^2}\right)\omega = 3\omega$$

$$F_{max} = m\omega'^2 x = m \times 9\omega^2 \times \frac{R}{3} = 3m\omega^2 R$$

7. A, B

Sol. (A) Required force F = weight of the chain

$$= \int_{2R/3}^{R} (\lambda dx)\frac{gx}{R} = \frac{5\lambda gR}{18}$$



(B) Initial potential energy of the chain

$$U_i = \int_{2R/3}^{R} -\lambda dx \frac{GM}{2R}\left(3 - \frac{x^2}{R^2}\right)$$

$$= \int -\lambda dx \frac{gR^2}{2R}\left(3 - \frac{x^2}{R^2}\right) = -\frac{31\lambda gR^2}{81}$$

Final potential energy of the chain

$$U_f = \int_{0}^{R/3} -\lambda dx \frac{gR^2}{2R}\left(3 - \frac{x^2}{R^2}\right) = -\frac{40\lambda gR^2}{81}$$

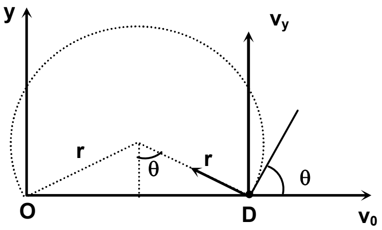
$$\frac{1}{2}mv^2 = U_i - U_f \Rightarrow v = \sqrt{\frac{2gR}{3}}$$

$$U_i = -31\lambda\frac{gR^2}{81}$$

$$U_f = -\frac{GMm}{R} = -\frac{\left(gR^2\lambda\frac{R}{3}\right)}{R} = -\frac{\lambda gR^2}{3}$$

$$W = \Delta U = \frac{4\lambda gR^2}{81}$$

8. A, C



Sol. $d = v_0\sqrt{\frac{2\times\frac{d}{2}}{qE_0/m}} = v_0\sqrt{\frac{md}{qE_0}}$

$$E_0 = \frac{mv_0^2}{qd}$$

When the particle strike at D

$$v_y = \sqrt{2\frac{qE_0}{m}\frac{d}{2}} = \sqrt{\frac{qE_0d}{m}}$$

$$d = 2r\sin\theta = 2\frac{mv}{qB}\sin\theta = \frac{2m}{qB}\sqrt{\frac{qE_0d}{m}}$$

$$\Rightarrow B = 2\sqrt{\frac{mE_0}{qd}} = = 2\sqrt{\frac{m}{qd}\times\frac{mv_0^2}{qd}} = \frac{2mv_0}{qd}$$

9. A, C, D

Sol. Current passing through the cell at any time t

$$I = \frac{\varepsilon}{R}\left(1-e^{-Rt/2}\right)+\frac{\varepsilon}{R}e^{-t/RC}$$

$$= \frac{\varepsilon}{R}\left(1-e^{-t/2\tau}\right)+\frac{\varepsilon}{R}e^{-t/\tau} \text{ (where } \tau = RC)$$

I will minimum when $\frac{dI}{dt} = 0$ and $\frac{dI^2}{dt^2} > 0$

$$\frac{dI}{dt} = \frac{\varepsilon}{2R\tau}e^{-t/2\tau}-\frac{\varepsilon}{R\tau}e^{-t/\tau}$$

$$\frac{d^2I}{dt^2} = \frac{\varepsilon}{4R\tau^2}e^{-t/2\tau}-\frac{\varepsilon}{R\tau^2}e^{-t/\tau}$$

$$\Rightarrow \frac{\varepsilon}{2R\tau}e^{-t/2\tau}-\frac{\varepsilon}{R\tau}e^{-t/\tau} = 0$$

$$\Rightarrow e^{t/2\tau} = 2 \Rightarrow t = 2\tau\ell n2 = 2RC\ell n2$$

$$I = \frac{\varepsilon}{R}\left(1-\frac{1}{2}\right)+\frac{\varepsilon}{R}\times\frac{1}{4} = \frac{3\varepsilon}{4R}$$

Charge on capacitor at this time

$$q = \varepsilon C\left(1-e^{-t/\tau}\right) = \varepsilon C\left(1-\frac{1}{4}\right) = \frac{3C\varepsilon}{4}$$

10. A, B, D

Sol. $z_1 = \sqrt{R^2 + X_C^2} = \sqrt{(100)^2 + \left(\frac{1}{50 \times 2 \times 10^{-4}}\right)^2} = 100\sqrt{2}\,\Omega$

$z_2 = \sqrt{R^2 + X_L^2} = \sqrt{(50)^2 + (50 \times 1)^2} = 50\sqrt{2}\,\Omega$

$\tan\phi_1 = \frac{X_C}{R} = \frac{100}{100} \Rightarrow \phi_1 = \frac{\pi}{4}, I_1 = \frac{200}{100\sqrt{2}} = \sqrt{2}$ A

$\tan\phi_2 = -\frac{X_L}{R} = \frac{-50}{50} \Rightarrow \phi_2 = -\frac{\pi}{4}, I_2 = \frac{200}{50\sqrt{2}} = 2\sqrt{2}$ A

rms current through ac mains = $\sqrt{I_1^2 + I_2^2}$ = $\sqrt{10}$A

rms potential difference across the inductor = I_2X_L= $2\sqrt{2} \times 50 = 100\sqrt{2}$ V

phase difference between the currents passing through the capacitor and inductor = $\frac{\pi}{4} - \left(-\frac{\pi}{4}\right) = \frac{\pi}{2}$

11. A, C, D

Sol. If the angular position of the point on the screen where phase difference is zero equals θ, then

$\frac{5}{3} d\sin 30° - \frac{25}{18} d\sin\theta = 0$

$\Rightarrow \sin\theta = \frac{3}{5} \Rightarrow \tan\theta = \frac{3}{4}$

$\Rightarrow \frac{y}{1} = \frac{3}{4} \Rightarrow$ y = 0.75 m

If phase difference at point O

$\phi = \frac{2\pi}{\lambda}(\mu d\sin 30°) = \frac{2\pi}{3 \times 10^{-4}} \times \frac{5}{3} \times 1.5 \times 10^{-3} \times \frac{1}{2} = \frac{25\pi}{3}$

Intensity at O, $I = 4I_0 \cos^2 \frac{25\pi}{6} = 3I_0$

Path difference at O

$\Delta x = \frac{\lambda}{2\pi} \times \frac{25\pi}{3} = \frac{25\lambda}{6}$

The path difference at the nearest minima below O

$\Delta x = \frac{9\lambda}{2}$

$\Rightarrow \frac{25}{18} d\sin\theta = \frac{9\lambda}{2} - \frac{25\lambda}{6} = \frac{\lambda}{3}$

$\Rightarrow \sin\theta = \frac{18\lambda}{75d} = \frac{6}{125}$

Since, sin θ << 1

$\sin\theta \simeq \tan\theta = \frac{y}{D}$

$\Rightarrow \frac{y}{1} = \frac{6}{125} m \Rightarrow$ y = 48 m

12. C, D

Sol. From conservation of angular momentum

$$mv_0\ell = \left(m\ell^2 + 2m\frac{\ell^2}{3}\right)\omega \Rightarrow \omega = \frac{3v_0}{5\ell}$$

From conservation of mechanical energy

$$\frac{1}{2}\times\frac{5}{3}m\ell^2\left(\frac{3v_0}{5\ell}\right)^2 = mg\ell + 2mg\frac{\ell}{2}$$

$$\Rightarrow v_0 = \sqrt{\frac{20g\ell}{3}}$$

At horizontal position

$\tau = I\alpha$

$$mg\ell + 2mg\frac{\ell}{2} = \frac{5m\ell^2}{3}\alpha$$

$$\alpha = \frac{6g}{5\ell}$$

When the rod is at horizontal position horizontal component of hinge force $F_x = 3m\,a_{cm}$

$$3mg - F_y = 3m\frac{4g}{5}$$

$$F_y = \frac{3mg}{5}$$

SECTION – C

13. 00008.00

Sol. Let the new pressure inside the bubble after expansion be P′

$$P' = \frac{P\frac{4}{3}\pi R_1^3}{\frac{4}{3}\pi R_2^3} = P\frac{R_1^3}{R_2^3}$$

$$P - P' = \frac{\sigma^2}{2\varepsilon_0}$$

$$P - P\frac{R_1^3}{R_2^3} = \frac{q^2}{32\pi^2\varepsilon_0 R_2^3} \qquad \Rightarrow q = \sqrt{32\pi^2\varepsilon_0 P R_2\left(R_2^3 - R_1^3\right)}$$

$\Rightarrow$ n = 8

14. 00003.11

Sol. For image formed by the refraction at water surface

$$\frac{4/3}{v_1} - \frac{1}{-48} = \frac{\frac{4}{3}-1}{\infty}$$

$\Rightarrow v_1 = -64$ cm

For the lens

$u_2 = -(64 + 11) = -75$ cm

focal length of the lens in water f_w can be found by

$$\frac{f_w}{f_{air}} = \frac{(\mu - 1)}{\left(\frac{\mu}{\mu_w} - 1\right)} = \frac{1.5 - 1}{\left(\frac{1.5}{4/3} - 1\right)}$$

$\Rightarrow f_w = 4f_{air} = 60$ cm

For image formed by the lens

$$\frac{1}{v_2} - \frac{1}{-7.5} = \frac{1}{60}$$

$v_2 = 300$ cm

distance of final image for water surface = 300 cm + 11 cm = 3.11 m

15. 00001.25

Sol. Tension in the string at a distance x from the lower end

$$T = \int_0^x (\mu_0 x dx) g = \frac{\mu_0 x^2}{2} g$$

Speed of wave at this point v = $\sqrt{\frac{T}{\mu}} = \sqrt{\frac{xg}{2}}$

$$\Rightarrow \frac{dx}{dt} = \sqrt{\frac{gx}{2}} \qquad \Rightarrow t = \sqrt{\frac{2}{g}}\int_0^L \frac{dx}{\sqrt{x}} = \sqrt{\frac{8L}{g}} = \sqrt{\frac{8 \times \frac{125}{64}}{10}} = 1.25\,\text{sec}$$

16. 00001.00

Sol. Let the speed of the cylinder after a long time be v.

The particle moving from left reach the body with a relative speed $v_0 - v$ and rebound with same relative speed. In a short time interval Δt the particle coming from a distance $(v_0 - v)\Delta t$ reach the cylinder and each imparts an impulse proportional to $2(v_0 - v)$ to the body. Thus the force from the left is proportional to $2(v_0 - v)^2$. Similarity particle in elastically colliding with the right at a negative speed $(v + v_0)$ produce a force proportional to $(v_0 + v)^2$. The condition for constant speed of the body is $2(v_0 - v)^2 = (v_0 + v)^2$

$$\Rightarrow v = \frac{\sqrt{2}-1}{\sqrt{2}+1} v_0 = \left(\frac{\sqrt{2}-1}{\sqrt{2}+1}\right)(3 + 2\sqrt{2}) = 1\,\text{m/s}$$

17. 00003.95

Sol. Energy of the emitted photon = $13.6 \times 3^2\left(\frac{1}{3^2} - \frac{1}{4^2}\right)\text{eV} = 5.95\,\text{eV}$

Since, $r = \frac{\sqrt{2mK}}{qB}$

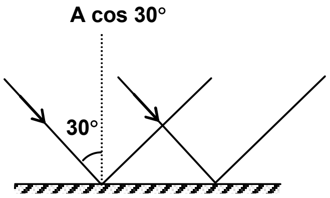
Maximum kinetic energy of the photoelectrons

$$K_{max} = \frac{r^2q^2B^2}{2m} = \frac{\left(\frac{9.1}{1.6}\right) \times 10^{-4} \times (1.6)^2 \times 10^{-38} \times 4 \times 10^{-8}}{2 \times 9.1 \times 10^{-31}} \text{J} = 2\text{eV}$$

$h\nu = \phi + k_{max}$

$\Rightarrow \phi = h\nu - k_{max} = 5.95 - 2 = 3.95$ eV

18. 00008.00



Sol. I = rate of flow of energy through unit area = nhν, where n is the no. of photons following through unit area per sec. Rate of flow of momentum (momentum flux) through unit area = $\frac{nh}{\lambda} = \frac{nh\nu}{C} = \frac{I}{C}$.

Consider a cylindrical beam of parallel rays whose section the mirror is A.

Rate of flow of momentum through this beam = $\frac{I}{C} A\cos\theta$

Normal component of the momentum flux = $\left(\frac{IA\cos\theta}{C}\right)\cos\theta$

Momentum flux of the reflected photon = $-0.6\left(\frac{IA\cos^2\theta}{C}\right)$

Force = Rate of change of momentum = $(1.6)\frac{IA\cos^2\theta}{C}$

Pressure = $\frac{F}{A} = \frac{(1.6)I\cos^2\theta}{C} = \frac{1.6\times2\times10^3\times\frac{3}{4}}{3\times10^8} = 8\times10^{-6}$ N/m^2

Chemistry

PART – II

SECTION – A

19. B

Sol. $Na_2S + Na_2\left[Fe(CN)_5(NO)\right] \longrightarrow \underset{\text{Purple colour}}{Na_4\left[Fe(CN)_5(NOS)\right]}$

20. C

Sol. $\log\frac{x}{m} = \log k + \frac{1}{n}\log P$

$\log\frac{x}{m} = 0.4 + \log 2$

$\log\frac{x}{m} = 0.4 + 0.3$

$\log\frac{x}{m} = 0.7$

$\frac{x}{m} = 5$

21. B

Sol. $N_3S_{\frac{1}{2}\times 6+\frac{1}{8}\times 6}$

$N_3S_{3+\frac{3}{4}}$

N_4S_5

22. C

Sol. Angular nodes in $4d_{z^2}$ = 2

Radial nodes in $4d_{z^2}$ = 1

23. A, B, C

Sol. $P_{ext} = 0$ $q = 0$ $\Delta S_{sys} = nC_v \ell n\frac{T_2}{T_1} + nR\ell n\frac{V_2}{V_1}$

$W = -P_{ext}\ \Delta V$ $\Delta U = 0$ $T_1 = T_2$

$W = 0$ $\Delta H = 0$

$T_1 = T_2$ $\Delta S_{surrounding} = 0$ $\Delta S_{sys} = nR\ell n\frac{V_2}{V_1}$

24. A, B, C

Sol. $\underset{\substack{(3)\\3-x}}{X(g)} \longrightarrow \underset{2x}{2Y(g)} + \underset{x}{Z(g)}$

$\frac{r_1}{r_2} = \frac{P_1}{P_2}\sqrt{\frac{M_2}{M_1}}$

$\frac{1}{2} = \frac{3-x}{2x}\sqrt{\frac{4}{16}}$

$\frac{1}{2} = \frac{3-x}{2x}\times\frac{1}{2}$

X = 2 mole
Y = 2 mole
Z = 1 mole
Total moles = 5
PV = nRT

$P = \frac{5\times 0.08\times 300}{10}$

= 12 atm

3 – x = 2x
x = 1

$$r = +\frac{dY}{dt} = \frac{(2-0)}{10} = 0.2 \text{ mol L}^{-1} \sec^{-1}$$

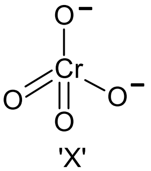
$$K = \frac{1}{10}\ell n\frac{3}{2} = \frac{1}{10}[1.1 - 0.7]$$

$$= \frac{0.4}{10} = 4 \times 10^{-2} / \sec$$

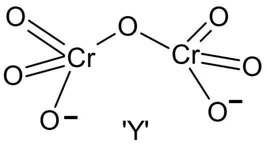
25. A, C

Sol. $FeCr_2O_4 + Na_2CO_3 + O_2 \longrightarrow \underset{'X'}{Na_2CrO_4} + Fe_2O_3 + CO_2$

$Na_2CrO_4 + H^+ \longrightarrow \underset{'Y'}{Na_2Cr_2O_7} + H_2O$



'X'



'Y'

26. A, C

Sol. $\underset{\substack{5\\5-x}}{PCl_5(g)} \rightleftharpoons \underset{x}{PCl_3(g)} + \underset{x}{Cl_2(g)}$

$m_T = 4 + 5 - x + x + x$
= 9 + x

PV = nRT

$$n = \frac{4.8 \times 49.2}{0.082 \times 240}$$

9 + x = 12
x = 12 – 9
x = 3

$$\alpha = \frac{3}{5} = 0.6$$

$$K_P = \frac{\frac{3}{12} \times 4.8 \times \frac{3}{12} \times 4.8}{\frac{2}{12} \times 4.8}$$

$$= \frac{3}{12} \times \frac{4.8 \times 3}{2}$$

= 1.8 atm

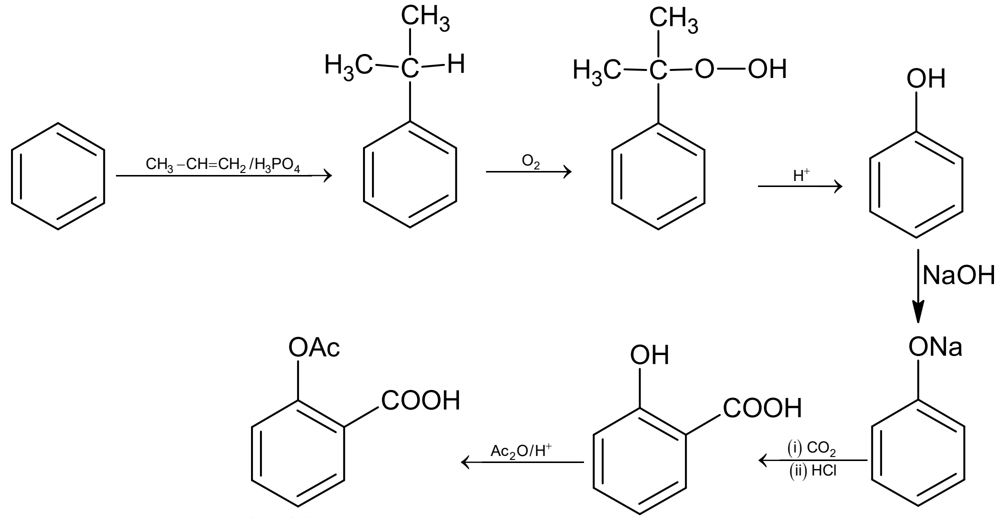
27. B, C

28. C, D

Sol. Sucrose is non-reducing sugar.
α-D-(-) fructofuranose and α-(L)-(+) fructofuranose are enantiomers.

29. A, B, D

Sol.


CH$_3$–CH=CH$_2$/H$_3$PO$_4$
O$_2$
H$^+$
NaOH
(i) CO$_2$
(ii) HCl
Ac$_2$O/H$^+$
OH
ONa
COOH
OAc

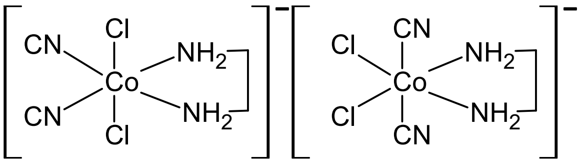
Aspirin

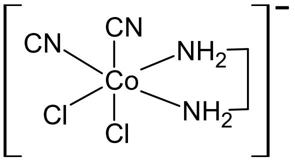
30. A, C

SECTION – C

31. 00004.00

Sol. $\left[Co(CN)_2(en)Cl_2\right]^-$

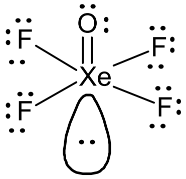




optically active hence mirror image

32. 00014.00

Sol.

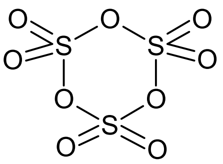


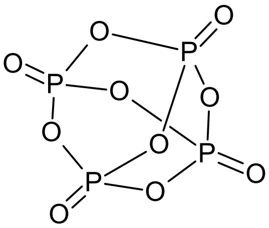
x = 15 x - y = 14

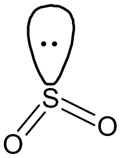
y = 1

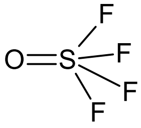
33. 00005.00

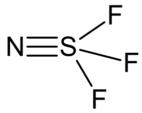
Sol.











34. 00001.81

Sol. Range 1.81 – 1.82

$$AgCN(s) \rightleftharpoons Ag^{+}(aq) + CN^{-}(aq)$$

$$\begin{array}{cc} s-s & s \\ y & \end{array}$$

$$Ag^{+} \; + \; 2NH_3 \rightleftharpoons \left[Ag^{+}(NH_3)_2\right]^{+}$$

$$\begin{array}{lll} s-s & 0.4-2s & s \\ y & 0.4-2s+2y & s-y \end{array}$$

$$5\times10^{13} = \frac{s}{(0.4-2s)^2 \times y}$$

$$5\times10^{-3} = s\times y$$

$$25 = \frac{s^2}{(0.4-2s)^2}$$

$$5 = \frac{s}{0.4-2s}$$

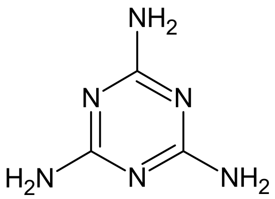
2 – 10s = s

11s = 2

$$s = \frac{2}{11} = 1.81\times10^{-1}$$

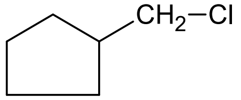
35. 00006.00

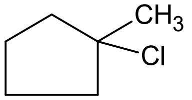
Sol.

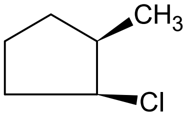


36. 00008.00

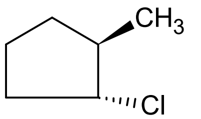
Sol.



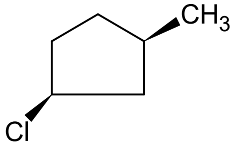


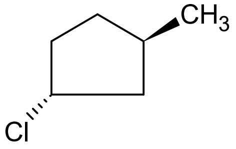


and its mirror image



and its mirror image



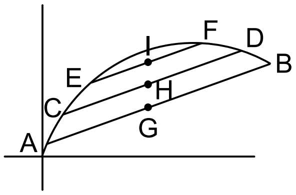


Mathematics PART – III

SECTION – A

37. B

Sol. Let $y = x^{1/7} \Rightarrow \frac{d^2y}{dx^2} < 0$ for x > 0 and $\frac{dy}{dx} > 0$ for x > 0 ⇒ y is increasing and convex graph



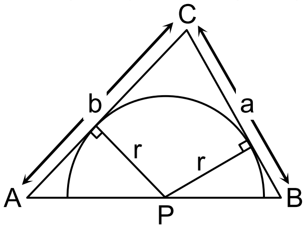
$A\left(2, 2^{1/7}\right)$, $B\left(8, 8^{1/7}\right)$, $E\left(4, 4^{1/7}\right)$, $F\left(6, 6^{1/7}\right)$, $C\left(3, 3^{1/7}\right)$, $D\left(7, 7^{1/7}\right)$

$GI\left(5, \frac{4^{1/7} + 6^{1/7}}{2}\right)$, $H\left(5, \frac{3^{1/7} + 2^{1/7}}{2}\right)$, $G\left(5, \frac{2^{1/7} + 8^{1/7}}{2}\right)$

⇒ $I(5, 2x_3)$, $H(5, 2x_2)$, $G(5, 2x_1) \Rightarrow x_1 < x_2 < x_3$

38. C

Sol. Area (ABC) = Area (APC) + Area (BPC)



$\Delta = \frac{1}{2}(br) + \frac{1}{2}a(r) \Rightarrow r = \frac{2\Delta}{a+b}$

39. D

Sol. Put $x = \sqrt{J}\sqrt{t} \Rightarrow dx = \sqrt{J}\cdot\frac{1}{2\sqrt{t}}dt$

$$\int_0^\infty e^{-x^2}dx = a \Rightarrow \int_0^\infty \frac{e^{-Jt}}{2\sqrt{t}}\sqrt{J}\,dt = a \Rightarrow \int_0^\infty \frac{e^{-Jt}}{\sqrt{t}}dt = \frac{2a}{J} \Rightarrow \int_0^\infty \frac{e^{-Jx}}{\sqrt{x}}dx = \frac{2a}{J}$$

40. C

Sol. Given $A^5 = I = BA^5 = B \Rightarrow (BA)A^4 = B \Rightarrow AB^2A^4 = B$

$\Rightarrow ABAB^2A^3 = B \Rightarrow AAB^2B^2A^3 = B \Rightarrow A^2B^4AA^2 = B \Rightarrow A^2B^3(BA)A^2 = B$

$\Rightarrow A^2B^3AB^2A^2 = B \Rightarrow A^2AB^8A^2 = B \Rightarrow A^3AB^{16}A = B = A^4AB^{32} = B$

$IB^{32} = B \Rightarrow B^{31} = I$

41. A, B

Sol. In all cases both are even. Let x = 2p, y = 2q

$\frac{2}{2p} + \frac{5}{2q} = \frac{1}{6} \Rightarrow 6q + 15p - pq = 0 \Rightarrow (p - 6)(q - 15) = 90$

$\Rightarrow (p - 6)(q - 15) = 2 \times 3^2 \times 5$

(A) When both p and q are even, then (p – 6) is even and (q – 15) is odd so number of solutions
$= 1 \times 3 \times 2 = 6$

(B) p and q both are odd ⇒ 6 solutions

(C) p even and q odd ⇒ (p – 6)(q – 15) is multiple of 4 which is not true

(D) p odd and q even, then also (p – 6)(q – 15) is multiple of 4 which is not true

42. A, B, C, D

Sol. $\int \frac{9x^9 - 60}{5x^{13} + 3x^{10} - 5x}\,dx = \int \frac{\left(9x^{-4} - 60x^{-13}\right)}{5 + 3x^{-3} - 5x^{-12}}\,dx$

Put $5 + 3x^{-3} - 5x^{-12} = t \Rightarrow (-9x^{-4} + 60x^{-13})dx = dt = \int \frac{-dt}{t} = \ln|t|$

43. A, B, C, D

Sol. (A) $\sqrt{x} + \sqrt{y} = 1 \Rightarrow x + y + 2\sqrt{xy} = 1 \Rightarrow 4xy = (1 - (x + y))^2$

$\Rightarrow 4xy = 1 + (x + y)^2 - 2(x + y) \Rightarrow (x - y)^2 - 2(x + y) + 1 = 0$ is a parabola

(B) $\frac{1}{x} + \frac{1}{y} = 1 \Rightarrow xy - t - y = 0$ is a hyperbola

(C) $\frac{1}{x} + \frac{1}{y} = \frac{1}{x + y} \Rightarrow t^2 + 3xy + y^2 = 0$ is a pair of lines

(D) $x + y = \frac{1}{x + y} \Rightarrow (x + y)^2 = 0$ pair of lines

44. B, C

Sol. For n = 41, $n^2 - n + 41$ is not a prime

(B) $\left(\frac{\ln 2}{1!} + \frac{\ln^2 2}{2!} + \frac{\ln^3 2}{3!} + ...\right) + \frac{\ln 4}{1!} + \frac{\ln^2 4}{2!} + ...$

$= \left(e^{\ln 2} - 1\right) + \left(e^{\ln 4} - 1\right) = 1 + 3 = 4$ = a rational number ⇒ B is correct

(C) $T_n = \frac{2n + 1 - 1}{(2n - 1)!} = \frac{1}{(2n)!} - \frac{1}{(2n + 1)!} = \frac{1}{2!} - \frac{1}{3!} + \frac{1}{4!} - \frac{1}{5!} + ...\infty$

$= 1 - \frac{1}{1!} + \frac{1}{2!} - \frac{1}{3!} + \frac{1}{4!} - \frac{1}{5!} + ...\infty = \frac{1}{e}$, $\ln\left(\frac{1}{e}\right) = -1$ = integer ⇒ C is correct

45. A, C

Sol. If we have 4 girls and 100 boys and we want to select 10 students from total of 104 students then the ways will be ${}^4C_1 \times {}^{100}C_9 + {}^4C_2 \times {}^{100}C_8 + {}^4C_3{}^{100}C_7 + {}^4C_4{}^{100}C_6 + {}^4C_0{}^{100}C_{10}$

$= 4\,{}^{100}C_9 + 6\,{}^{100}C_8 + 4\,{}^{100}C_7 + {}^{100}C_6 + {}^{100}C_{10} = {}^{104}C_{10} = {}^{104}C_{94}$

x + y = 104 + 10 = 114 or x + y = 104 + 94 = 198

46. A, B, D

Sol. $|\bar{a} + \bar{b}| = 1 \Rightarrow 2 = 2\bar{a}\cdot\bar{b} = 1 \Rightarrow \cos\theta = \frac{1}{2} \Rightarrow \theta = 120°$

$(\bar{a} \times \bar{b}) \times \bar{a} = (\bar{a}\cdot\bar{a})\bar{b} - (\bar{a}\cdot\bar{b})\bar{a} = \bar{b} - \frac{1}{2}\bar{a}$

$((\bar{a} \times \bar{b}) \times \bar{a}) \times \bar{a} = \left(\bar{b} - \frac{1}{2}\bar{a}\right) \times \bar{a} = \bar{b} \times \bar{a}$

$(((\bar{a} \times \bar{b}) \times \bar{a}) \times \bar{a}) \times \bar{a} = (\bar{b} \times \bar{a}) \times \bar{a} = (\bar{b}\cdot\bar{a})\bar{a} - (\bar{a}\cdot\bar{a})\bar{b} = \frac{1}{2}\bar{a} - \bar{b}$

$\Rightarrow \bar{\alpha} = \left(\frac{1}{2}\bar{a} - \bar{b}\right)\times\bar{b} = \frac{1}{2}\bar{a}\times\bar{b}$

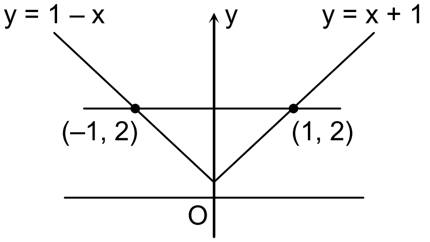
47. B, C

Sol. For $0 \le x \le \pi$, $f(|x|) + |f(x)| = \cos|x| + |\cos x|$, then $g(x) = 0$ for $\frac{\pi}{2} \le x \le \pi$

$\Rightarrow$ Infinitely roots

48. A, C

Sol. From graph it is clear that f(x) is continuous every where but not differentiable at x = 1 and x = –1



SECTION – C

49. 00004.50

Sol. $\frac{4}{\sin x} + \frac{1}{1-\sin x} = 2a$. Let $f(x) = \frac{4}{\sin x} + \frac{1}{1-\sin x}$

$f'(x) = 0 \Rightarrow \sin x = \frac{2}{3}$ least f(x) = $\frac{4}{\frac{2}{3}} + \frac{1}{1-\frac{2}{3}} = 9$

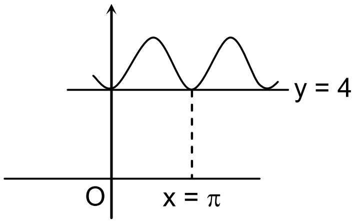
sin 2a $\ge 9 \Rightarrow a \ge 4.5$

50. 00002.00

Sol. $f'(x) = \begin{cases} \frac{-4}{x^3} + \frac{1}{x^2} & , \quad x < 2 \\ \frac{-1}{x^2} + \frac{4}{x^3} & , \quad x > 2 \end{cases}$ $\Rightarrow$ f(x) is not differentiable at x = 2 also $f'(x) = 0 \Rightarrow x = 4$

51. 00004.00

Sol. Given in the figure



52. 00001.00

Sol. $z_1 + z_2 = -z_3 \Rightarrow |z_1 + z_2| = z_3$

$z_1z_2 + z_2z_3 + z_3z_1 = 0 \Rightarrow |z_3(z_1 + z_2)| = |z_1z_2| \Rightarrow |z_3|^2 = |z_1||z_2|$

53. 00050.00

Sol. $x, x^2 - 24, x + x^2$ are in A.P. $\Rightarrow 2x^2 - 48 = 2x + x^2 \Rightarrow x = 8$ or -6
Possible sequences are 8, 40, 72 $\Rightarrow d_1 = 32$
$-6, 12, 30 \Rightarrow d_2 = 18$, sum = 50

54. 00445.00

Sol. Let C_1, C_2, C_3, C_4 be coins P(S) = 1 – coin is not discarded = (1 – P(HH) = $1 - \frac{1}{4} = \frac{3}{4}$
Hence, S can take the value 0, 1, 2, 3, 4, P(S = 3 or 4) = P(S = 3) + P(S = 4)
$\Rightarrow \frac{189}{256} = \frac{m}{n} \Rightarrow m + n = 445$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – XI

JEE (Advanced)-2020

PAPER – 1

TEST DATE: 23-09-2020

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section–A (01 – 04, 19 – 22, 37 – 40)*** *contains 12 multiple choice questions which out of 4 options have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (05 – 12, 23 – 30, 41 – 48) *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–1** In all other cases.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics PART – I

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

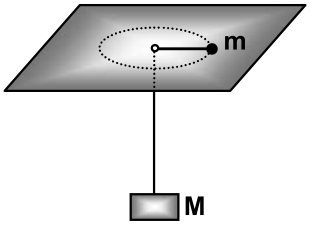
1. At t = 0, an object is projected from ground with an initial velocity of 100 m/s directed at angle 37° above the horizontal. At t = 4 sec it explodes in air into two parts with the mass ratio 1 : 2. Take the point of projection as origin and horizontal and vertical directions as x and y axes respectively. The motion of object is confined to the xy plane. At t = 10 sec, the coordinates of the lighter part is (400m, 60m). Find the coordinates of the heavier part at this moment. (i.e. t = 10 sec) (Given g = 10 m/s^2, $\cos 37° = \frac{4}{5}$)

(A) (500 m, 140 m)
(B) (500 m, 140 m)
(C) (500 m, 120 m)
(D) (1000 m, 120 m)

2. A pipe P open at one end but closed at the other end is filled with hydrogen gas at temperature 127°C. An another pipe Q open at both ends and having length equal to twice the length of pipe P is filled with a mixture of 1 mole of Hydrogen and 1 mole of Helium gases at temperature 147°C. The pipe P is vibrating in its first overtone and pipe Q is vibrating in its second overtone. The ratio of their frequencies of vibration $\frac{f_P}{f_Q}$ is

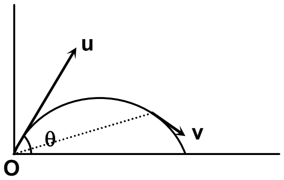
(A) $\sqrt{\frac{3}{5}}$
(B) $\sqrt{\frac{4}{3}}$
(C) $\sqrt{\frac{2}{3}}$
(D) $\sqrt{\frac{1}{3}}$

3. A particle of mass m is attached to one end of a light inextensible string which passes through a hole in a frictionless table top. At the other end of the string is attached a block of mass M. Initially the particle is moving in a circle of radius r with angular velocity ω. If the hanging block is pulled slightly downwards and then released, it will undergo small oscillation. Find the frequency of the oscillation.



(A) $\frac{1}{\pi}\sqrt{\frac{3m\omega^2}{M}}$
(B) $\frac{2}{\pi}\sqrt{\frac{3m\omega^2}{M}}$
(C) $\frac{1}{2\pi}\sqrt{\frac{3m\omega^2}{M}}$

(D) $\frac{3}{2\pi}\sqrt{\frac{3m\omega^2}{M}}$



4. A stone is projected in air directed at an angle θ above the horizontal. The maximum angle of projection θ with the horizontal so that the stone always moves away from the thrower during its motion in air, is (neglect air resistance)

(A) $\sin^{-1}\left(\frac{1}{3}\right)$

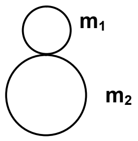
(B) $\sin^{-1}\left(\frac{2}{3}\right)$

(C) $\sin^{-1}\left(\frac{\sqrt{8}}{3}\right)$

(D) $\sin^{-1}\left(\frac{\sqrt{5}}{3}\right)$

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.



5. Two elastic balls of masses m_1 and m_2 are placed on top of each other (with a small gap between them) and then dropped onto the ground. Then

(A) The upper ball ultimately receives the largest possible fraction of total energy if $\frac{m_2}{m_1} = 3$

(B) The upper ball will reach a maximum height of 4h if $\frac{m_1}{m_2} = 3$

(C) If $m_2 >> m_1$ the maximum height attained by ball m_1 after collision will be 9h.

(D) If $m_2 >> m_1$, the maximum height attained by the ball 2h.

6. Two insects each of mass m are at opposite ends of a diameter of a turntable of radius R. Moment of inertia of the turntable about its central vertical fixed axis is $I = \frac{2}{3}mR^2$. The turntable is rotating freely with angular speed ω and both the insects start crawling slowly towards each other on the turntable. Then

(A) The insect have to apply maximum horizontal force on the turntable when they are at a distance $\frac{R}{2}$ from the centre of the turntable.

(B) The insects have to apply maximum horizontal force on the turntable when they are at a distance $\frac{R}{3}$ from the centre of the turntable.

(C) The angular speed of the turntable when the insects exert maximum force on the turntable equal 3ω.

(D) The maximum force exerted by an insect on the turn table during the motion is equal to $3m\omega^2R$.

7. Consider a frictionless tunnel is made in Earth along a diameter. A uniform string of mass per unit length λ and length R/3 (where R is the radius of the earth) is suspended in the tunnel with its upper end at the surface of the earth. (Given acceleration due to gravity at the surface of the earth = g)

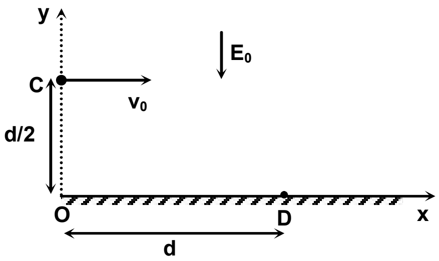
(A) The minimum force required to hold the string in the tunnel is $\frac{5\lambda gR}{18}$

(B) If the string is released in the tunnel from rest the speed of the string when its lower end touches the centre of the earth is $\sqrt{\frac{2gR}{3}}$

(C) If the string is released in the tunnel from rest the speed of the string when its lower end touches the centre of the earth is $\sqrt{\frac{gR}{3}}$

(D) The minimum work required to pull the chain completely to the surface of the earth is $\frac{2\lambda gR^2}{81}$

8. A particle of mass m and charge q moving in gravity free space with velocity v_0 parallel to x-axis enters a region of uniform electric field $\vec{E} = -E_0\hat{j}$ at point C. At the moment particle collides elastically with a smooth surface at D the electric field E is switched off and a magnetic field $\vec{B} = -B_0\hat{k}$ is switched on. If the particle hits the surface directly at point O after rebounding from point D, then which of the following option(s) is/are correct.



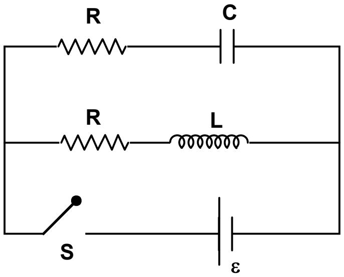
(A) $E_0 = \frac{mv_0^2}{qd}$

(B) $E_0 = \frac{mv_0^2}{2qd}$

(C) $B_0 = \frac{2mv_0}{qd}$

(D) $B_0 = \frac{mv_0}{qd}$

9. In the circuit shown in the figure initially the switch 'S' was open and capacitor uncharged. Now the switch 'S' is closed at time t = 0, then which of the following statement(s) is/are correct. (Given $C = \frac{L}{2R^2}$)



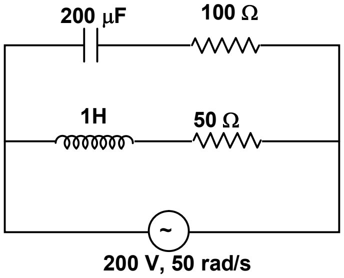
(A) The minimum current passing through the cell is $\frac{3\varepsilon}{4R}$.

(B) The current passing through the cell will be minimum at time t = $RC\ell n2$.

(C) The charge on the capacitor when current passing through the cell is minimum, is $q = \frac{3C\varepsilon}{4}$

(D) When the current in the circuit is minimum, the ratio of potential difference across the inductor and the capacitor equals $\frac{2}{3}$.

10. In the given AC circuit as shown in the figure.



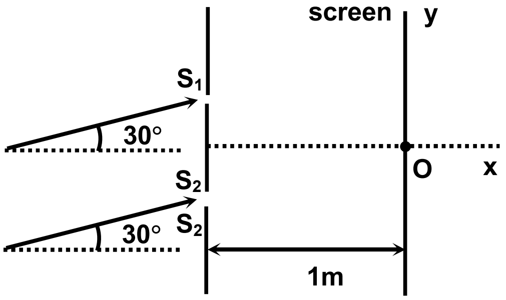
(A) The rms current through the ac mains is $\sqrt{10}$ A

(B) Total power dissipated in the circuit is 600 W

(C) The rms potential difference across the inductor is 100 V

(D) The phase difference between the currents passing in the capacitor and inductor is $\frac{\pi}{2}$

11. In a Young's double slit apparatus a parallel beam of light of wavelength λ = 0.3 mm with respect to air is incident on the slits at angle 30° with x-axis as shown in the figure. Distance of slits S_1 and S_2 from point O are equal. The medium to the left and right side of the plane of the slits have refractive indices $\frac{5}{3}$ and $\frac{25}{18}$ respectively. Distance between the slits S_1 and S_2 equals 1.5 mm. Distance between the plane of the slits and the screen is 1m. Then



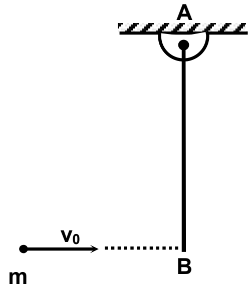
(A) The y-coordinate of the point on the screen where the phase difference between interfering waves is zero equals 0.75 m.

(B) The y-coordinate of the point on the screen where the phase difference between interfering wave is zero equals 0.36 m.

(C) If the intensity due to each light wave at point O is I_0 then the resultant intensity at point O equal $3I_0$.

(D) The y-coordinate of the nearest minima from the origin O is approximately y = –48 mm.

12. A thin uniform rod of length ℓ and mass 2m suspended vertically is free to rotate about a smooth horizontal axis which passes through its upper end A. A point mass m moving horizontally with velocity v_0 hits the lower end B of the rod and sticks to it. After collision the rod just reaches the horizontal position. Which of the following statement(s) is/are correct?



(A) The value of v_0 is $\sqrt{4g\ell}$

(B) The angular acceleration of the rod when it reaches the horizontal position is $\frac{9g}{8\ell}$

(C) The magnitude of vertical component reaction force by the hinge on the rod in horizontal position is $\frac{3mg}{5}$

(D) The magnitude of acceleration of centre of mass of the system (rod + point mass) when the rod is in horizontal position is $\frac{4g}{5}$.

SECTION – C

(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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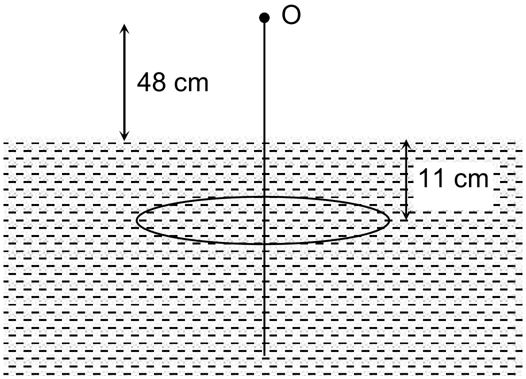
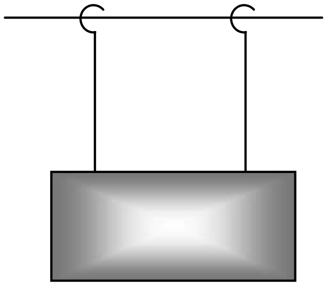
13. A soap bubble of radius R_1 is slowly given a charge q. Because of mutual repulsion of the surface charges, the radius increases slightly to R_2. The air pressure inside the bubble drops, because of the expansion, to $p\left(\frac{v_1}{v_2}\right)$, where p is the atmospheric pressure, v_1 is the initial volume and v_2 is the final volume. If q = $4n\pi^2\varepsilon_0 PR_2(R_2^3 - R_1^3)$. Find the value of n. (neglect the surface tension).

14. A convex lens has a focal length 15 cm in air. The refractive index of lens is 1.5. The lens is placed inside the water at a depth 11 cm below the water surface. A point object is placed in air on the principal axis of the lens at a height 48 cm above the water surface as shown in the figure. The distance (in m) of final image of the object from the water surface, is



15. A non-uniform string of length $L = \frac{125}{64}$m and mass m has a non-uniform linear density given by $\mu = \mu_0 x$ where x is distance from lower end of the string and μ_0 is a constant. Find the time required (in sec) for a transverse pulse generated at lower end of the string to travel to the other end of the string.

16. Consider a cylindrical body that can move without friction along a straight wire parallel to its axis of symmetry as shown in the figure. Particles moving horizontally at speed $v_0 = (3 + 2\sqrt{2})$ m/s collide the body uniformly from both left and right. Collisions with the left end of the body are elastic while those with the right end are completely inelastic though the particles do not stick to the cylinder after the collision. The speed (in m/s) of the cylinder after a long time will be (Assume that temperature of body remains constant)



17. The radiation emitted when an electron jumps from the third excited state to second excited state in doubly ionized Li^{++} ion (z = 3) falls on a metal surface to produce photoelectron, when the photoelectron with maximum kinetic energy is made to move perpendicular to a magnetic field of 2×10^{-4} T, its traces out a circular path of radius $\sqrt{\frac{9.1}{1.6}}$ cm. The work function of the metal (in eV) is (Given mass of electron = 9.11×10^{-31} kg)

18. A plane light wave of intensity I = 2kW/m^2 falls on a plane mirror. The intensity of reflected light is 60% of intensity of the incident light. The angle of incidence is 30°. If the pressure exerted by the light on the mirror is $n \times 10^{-6}$ N/m^2, find the value of n.

Chemistry PART – II

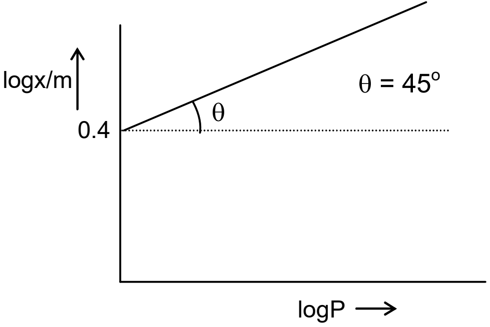
SECTION – A

(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

19. The purple colour produced in test of S^{2-} ion with sodium nitro prusside reagent is due to
   (A) $Na_2[Fe(CN)_5NO]$
   (B) $Na_4[Fe(CN)_5(NOS)]$
   (C) $Na_4[Fe(CN)_6]$
   (D) $Na_2[Fe(CN)_5(NOS)]$

20. According to Freudlisch's adsorption isotherm, the graph between log x/m and logP is given below, where x/m is extent of adsorption and P is the pressure



   The extent of adsorption at pressure 2 atm is (Given log2 = 0.3 and log5 = 0.7)
   (A) 8
   (B) 2
   (C) 5
   (D) 9

21. A compound N_pS_q has cubic close packing (ccp) arrangement of S. N is present at alternative tetrahedral voids. If all the atoms along one body diagonal are removed. The empirical formula of the compound is:
   (A) N_5S_{14}
   (B) N_4S_5
   (C) NS_2
   (D) NS

22. The number of angular nodes and radial nodes in $4d_{z^2}$ are respectively
   (A) 0, 2
   (B) 1, 1
   (C) 2, 1
   (D) 2, 0

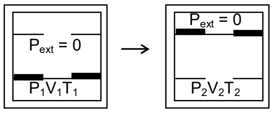
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

23. An ideal gas in thermally insulated container, at internal pressure P_1, volume V_1 and absolute temperature T_1 expands irreversibly against zero external pressure so that the pressure of gas becomes P_2, volume V_2 and temperature T_2. Which of the following statement(s) is/are correct?

(A) $\Delta S_{\text{surrounding}} = 0$

(B) $\Delta S_{\text{system}} = nR\ell n\frac{V_2}{V_1}$



(C) $\Delta H = 0$

(D) $P_1V_1^{\gamma} = P_2V_2^{\gamma}$

24. For a first order reaction $X(g) \longrightarrow 2Y(g) + Z(g)$, initially only 3 moles of X(g) was taken in 10 L rigid closed container at 300 K. After 10 seconds the reaction was stopped forcefully and a pinhole was made in the container at the same temperature. The molar ratio of X(g) and Y(g) gases coming out is 1 : 2. The correct option(s) is/are:
(Given molar masses of X, Y and Z are 16, 4 and 8 g/mole respectively $\ell n2 = 0.7$ and $\ell n3 = 1.1$, R = 0.08 atm L^{-1} K^{-1} mol^{-1})

(A) The total pressure inside the container when reaction was just stopped is 12 atm.

(B) The rate constant of reaction is 4×10^{-2} sec^{-1}.

(C) Moles of Z just after reaction was stopped forcefully is 1.0.

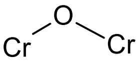
(D) The rate of formation of Y after 10 second is 0.4 mol L^{-1} sec^{-1}.

25. Fusion of chromite ore ($FeCr_2O_4$) with Na_2CO_3 in the presence of O_2 gives X which on acidification with conc. H_2SO_4 gives Y. Both X and Y contain chromium ion. Correct statement(s) is/are:

(A) Both X and Y are colourful compound and colour of these compounds is due to ligand to metal charge transfer.

(B) Both X and Y are paramagnetic in nature.

(C) Acidified solution of Y can convert Sn^{2+} ion into Sn^{4+} ion.

(D) Both X and Y have  bond..

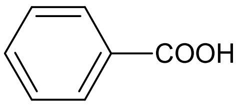
26. In an evacuated vessel of capacity 49.2 L, 4 moles of Ar(g) and 5 moles of PCl_5(g) were introduced and the temperature is maintained at 240 K (assume that at this temperature decomposition of PCl_5 takes place). At equilibrium, the total pressure of the mixture was found to be 4.8 atm. (Given R = 0.082 atm L mol^{-1} K^{-1}). Correct statement(s) is/are

(A) The degree of dissociation of PCl_5(g) into PCl_3(g) and Cl_2(g) is 0.6.

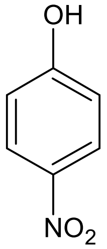
(B) K_P for the reaction $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ is 2.7 atm.

(C) At equilibrium total moles of gases are 12.

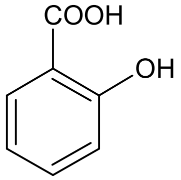
(D) On removing Ar(g) from the equilibrium mixture at constant pressure and temperature, the extent of dissociation of PCl_5 will increase.

27. Which of the following is/are stronger acid than  (benzoic acid)

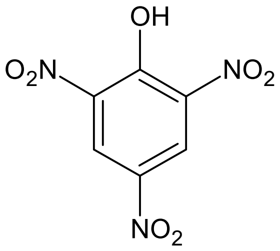
(A)



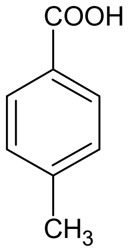
(B)



(C)

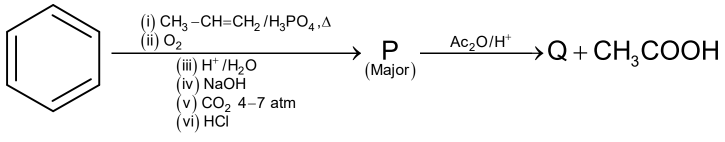


(D)



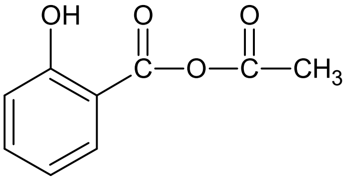
28. Which of the following statement(s) is/are true?
(A) Sucrose on reaction with Fehling solution gives red precipitate.
(B) α-D-(-) fructofuranose and α-(L)-(+) fructofuranose are diasteomers.
(C) Glucose on reaction with nitric acid gives glucaric acid.
(D) In Lactose reducing half is β-D-glucose and non reducing half is β-D-Galactose.

29. Choose the correct option(s) for the following reaction sequence



(A) Compound 'Q' has antipyretic action.
(B) Compound 'P' gives test with neutral ferric chloride.

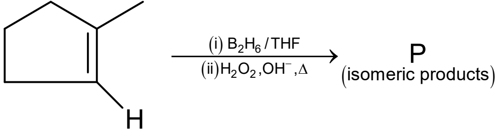
(C) Compound ‘Q’ is



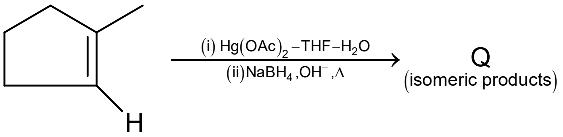
(D) Compound ‘P’ can also be prepared by reaction of salicyaldehyde with Fehling solution followed by acidification.

30. The correct statement (s) for the following addition reactions is/are

(i)



(ii)



(A) Only one product is formed in (ii) reaction.
(B) Addition of water proceeds through syn-addition in both the reactions.
(C) Hydroboration in (i) reaction is controlled by steric factor.
(D) The product ‘Q’ is oxidized by CrO_3 while product ‘P’ is not oxididised by CrO_3.

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

31. The total numbers of stereoisomers obtained if NH_3 is replaced by bidentate en ligand in complex $\left[Co(CN)_2(NH_3)_2Cl_2\right]^-$ (en = $NH_2CH_2CH_2NH_2$)

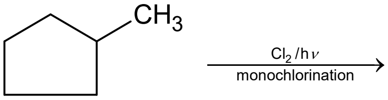
32. Calculate the value of [x – y] for $XeOF_4$ where x = total number of lone pair in $XeOF_4$, y = total number of $d\pi$ - $p\pi$ bonds in $XeOF_4$.

33. Among S_3O_9, P_4O_{10}, SO_2, SOF_3, SNF_4, N_2O_4, Al_2O_3 the total number of molecules containing $d\pi$ - $p\pi$ bond is

34. The solubility of AgCN(s) in 1 L of 0.4 M NH_3 is Y × 10^{-1} mol/L. The value of Y is…..
(Given that the value of K_{SP} AgCN = 5 × 10^{-10} and K_f of $[Ag(NH_3)_2]^+$ is 5 × 10^{10}

35. Melamine formaldehyde is a condensation polymer of melamine and formaldehyde. The number of nitrogen atoms in one molecule of melamine is X. X is…..

36. Total number of products (including both structural and stereoisomers) formed by monochlorination of the following compound is…….



Mathematics

PART – III

SECTION – A

(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. Let $x_1 = \sqrt[7]{2} + \sqrt[7]{8}$, $x_2 = \sqrt[7]{3} + \sqrt[7]{7}$ and $x_3 = \sqrt[7]{4} + \sqrt[7]{6}$, then
    (A) $x_1 > x_2 > x_3$
    (B) $x_1 < x_2 < x_3$
    (C) $x_1 + x_3 < 2x_2$
    (D) $x_1 + x_3 > 2x_2$

38. In a triangle ABC with sides a, b and c a semicircle touching the sides AC and BC is inscribed whose diameter lies on AB, then the radius of the semicircle is
    (A) $\frac{a}{2}$
    (B) $\frac{2abc}{s(a+b)}\sin\frac{A}{2}\sin\frac{B}{2}\sin\frac{C}{2}$
    (C) $\frac{2\Delta}{a+b}$
    (D) $\frac{2abc}{s(a+b)}\cos\frac{A}{2}\cos\frac{B}{2}\cos\frac{C}{2}$

39. If $\int_0^\infty e^{-x^2}dx = a$, then $\int_0^\infty \frac{e^{-Jx}}{\sqrt{x}}dx$ where J > 0 is
    (A) $2a\sqrt{J}$
    (B) $\frac{a}{\sqrt{J}}$
    (C) $a\sqrt{J}$
    (D) $\frac{2a}{\sqrt{J}}$

40. Let A and B are two non singular matrices such that $B \neq I$, $A^5 = I$ and $AB^2 = BA$, then the least value of n for which $B^n = I$ is
    (A) 63
    (B) 64
    (C) 31
    (D) 32

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

41. Considering the equation $\frac{2}{x}+\frac{5}{y}=\frac{1}{6}$ where x, y $\in$ N the number of solutions of the equation is
    - (A) 6 if both x and y are multiple of 4
    - (B) 6 if both x and y are the type 4n + 2, n $\geq$ 0
    - (C) 0 if x is multiple of 4 where y is of the form 4n + 2, n $\geq$ 0
    - (D) 0 if x is of the type 4n + 2, n $\geq$ 0 and y is the multiple of 4

42. If $\int \frac{9x^9 - 60}{5x^{13} + 3x^{10} - 5x} dx = -\ell n\left|5x^p + 3x^q - 5x^r\right| + c$ where p, q, r $\in$ **I**, then p + q + r is
    - (A) –3
    - (B) –5
    - (C) 3
    - (D) 15

43. Upon t – y plane the path defined by the equation $\frac{1}{x^{2m}}+\frac{1}{y^{2m}}=\frac{k}{(x+y)^n}=0$ is
    - (A) A parabola when $m=\frac{-1}{4}$, k = 1, n = 0
    - (B) A hyperbola when $m=\frac{1}{2}$, k = 1, n = 0
    - (C) A pair of lines of $m=\frac{1}{2}$, n = k = 1
    - (D) A pair of lines if $m=\frac{-1}{2}$, n = 1, k = 1

44. Which of the following statements are true?
    - (A) $n^2 - n + 41$ is a prime number for every n $\in$ N
    - (B) $\sum_{n=1}^{\infty}\frac{1+2^n}{n!}(\ln 2)^n$ is rational
    - (C) $\ln\left(\frac{1}{1\cdot 3}+\frac{1}{1\cdot 2\cdot 3\cdot 5}+\frac{1}{1\cdot 2\cdot 3\cdot 4\cdot 5\cdot 7}+.....\infty\right)$ can be simplified to an integer
    - (D) The coefficient of x^5 in $(1 - t)^{-6}$ is ${}^{10}C_6$

45. If ${}^{100}C_6 + 4\ {}^{100}C_7 + 6\ {}^{100}C_8 + 4\ {}^{100}C_9 + {}^{100}C_{10}$ has the value equal to ${}^{x}C_{y}$, then the value of (x + y) can be
    - (A) 114
    - (B) 115
    - (C) 198
    - (D) 199

46. Let $\bar{a}$ and $\bar{b}$ are unit vectors such that $|\bar{a}+\bar{b}|=1$. Let $\bar{\alpha}=\left(\left(\left((\bar{a}\times\bar{b})\times\bar{a}\right)\times\bar{a}\right)\times\bar{a}\right)\times\bar{b}$, then
(A) $|\bar{\alpha}|=\frac{\sqrt{3}}{4}$
(B) $\bar{\alpha}$ is perpendicular to $\bar{b}$
(C) $\bar{\alpha}$ is parallel to $\vec{a}$
(D) $\vec{\alpha}$ is parallel to $\vec{a}\times\vec{b}$

47. Let $f(x)=\begin{cases}\sin x & , \ -\pi \le x \le 0 \\ \cos x & , \ 0 < x \le \pi\end{cases}$ g(x) = f(|x|) + |f(x)| $\forall$ x $\in$ [–π, π], then
(A) g(x) = 0 has three real roots
(B) g(x) = 0 has infinitely many real roots
(C) $\lim\limits_{x\to 0} g(x)$ does not exist
(D) g(x) is a periodic with period π

48. The function of f(x) = max{(1 – x), (1 + x), 2}, x ∈ (–∞, ∞) is
(A) continuous at all points
(B) differentiable at all points
(C) differentiable at all points except at x = 1 and x = –1
(D) continuous at all points except at x = 1 and x = –1

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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49. The least value of a for which the expression $4\operatorname{cosec} x+\left(\frac{1}{1-\sin x}\right)-2a\left(\operatorname{sgn}\left(\lim\limits_{n\to\infty}\left(\frac{1}{2}\right)^n\right)\right)$ has at least one solution in $\left(0,\frac{\pi}{2}\right)$

50. Total number of critical points in the domain of $f(x)=\frac{|2-x|}{x^2}$ are equal to

51. The equation of tangent to the curve y = 4 + $\sin^2$ x at x = π is y = k, then the value of k is

52. Let z_1, z_2 and z_3 be three non zero complex numbers such that $z_1 + z_2 + z_3 = z_1z_2 + z_2z_3 + z_3z_1 = 0$, then $\frac{|z_1||z_2|}{|z_3|^2}$ is equal to

53. Suppose x, $x^2 - 24$ and $x + x^2$ are consecutive terms of A.P., then the sum of all possible values of common differences of sequence is

54. A person flips 4 fair coins and discards those which turn up tails. He again flip the remaining coins and then discards those which turn up tails. If $P=\frac{m}{n}$ (m and n are coprimes) denotes the probability that he discards at least three coins, then the value of (m + n) is

FIITJEE

ALL INDIA TEST SERIES

FULL TEST –XI

JEE (Advanced)-2020

PAPER – 2

TEST DATE: 23-09-2020

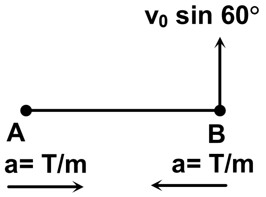
ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. D

Sol. Looking at B with respect to A : $2T = \frac{m(v_0 \sin 60^\circ)^2}{\ell}$

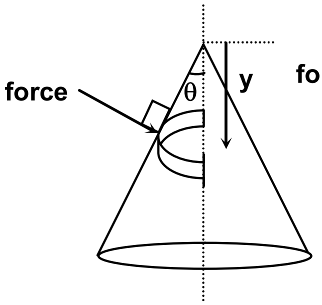


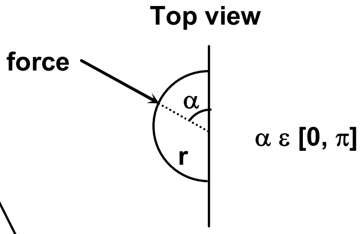
2. A, D

Sol. For ring: $(\mu Nr)dt = I\omega_0$ (Rotation)
$(N \cos \theta + \mu N \sin \theta)dt = m\sqrt{2gH}$ (translation)
For wedge : $(N \sin \theta)\, dt = (\mu\, N \cos \theta)dt$

3. B

Sol. Net force on the element at depth y,
$dF(y) = \rho gy\left(\frac{dy}{\cos\theta} \times rd\alpha \times \cos\theta \times \sin\alpha\right)$





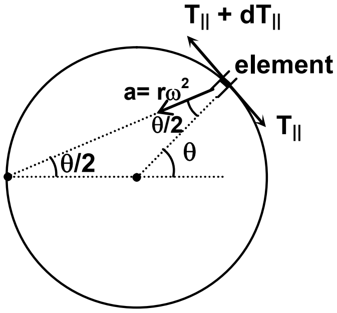
$$\therefore\ F = \int_0^H dF(y)$$

and effective point of application = $\dfrac{\int_0^H y\,dF(y)}{\int_0^H dF(y)}$

4. B

Sol. $dT_{||} = (dm)r\omega^2 \sin\dfrac{\theta}{2}$

$\Rightarrow T = T_A + \dfrac{MR\omega^2}{2\pi}(1-\cos\theta)$



5. A, C, D

Sol. $\Delta Q_{AB} = nC_P\Delta T = 2\times\dfrac{5R}{2}(900-300) = 3000R$

In the process BC, P = αT^2

PV^2 = constant

Molar heat capacity in the process BC,

$C = C_V + \dfrac{R}{(1-x)} = \dfrac{3R}{2} + \dfrac{R}{(1-2)}$

$C = \dfrac{R}{2}$

$\Delta Q_{BC} = nC\Delta T = 2\times\dfrac{R}{2}(300-900) = -600R$

$\Delta Q_{CA} = \Delta W_{CA} = nRT\ell n\left(\dfrac{P_C}{P_A}\right) = 2R\times 300\ell n\left(\dfrac{1}{9}\right) = -1200R\ell n(3)$

$\Delta Q_{CA} = -1320R$

$\Delta W_{cycle} = \Delta Q_{cycle} = 3000R - 600R - 1320R = 1080R$

Efficiency of cycle, $\eta = \dfrac{\Delta W_{cycle}}{\Delta Q_{supplied}}\times 100$

$\eta = \dfrac{1080R}{3000R}\times 100 = 36\%$

6. A, D

Sol. $\vec{B}$ due to body diagonal $= \vec{0}$

$\vec{B}$ due to edge $\frac{\mu_0 i}{4\pi(a/\sqrt{2})}\left(\sqrt{\frac{1}{3}}+\sqrt{\frac{1}{3}}\right)$along$\frac{-\hat{i}-\hat{j}}{\sqrt{2}}$ (using the result $\frac{\mu_0 i}{4\pi r}(\sin\alpha+\sin\beta)$)

$\vec{B}$ due to face diagonal = $\frac{\mu_0 i}{4\pi(a/2)}\left(\sqrt{\frac{2}{3}}+\sqrt{\frac{2}{3}}\right)$along $\frac{-\hat{i}-\hat{j}}{\sqrt{2}}$

Also, magnetic moment $\vec{\mu} = i\vec{A}$.

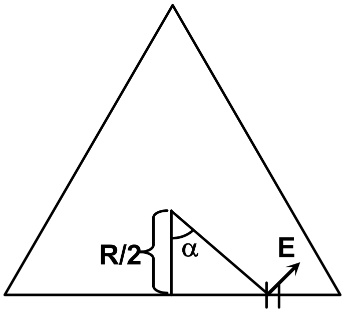
7. B, C, D

Sol. The motion will be helical. Also, at each collision, the motion will be mirror image of the motion that would have happened without collision (mirror being the wall).

8. A, C

Sol. $E_{\text{induced}} = \frac{B_0 r}{2}$

Net torque $= 6\int_0^{60^0} \lambda\left(\frac{R}{2}\sec^2\alpha d\alpha\right)\times E\times\frac{R/2}{\cos\alpha} = I\alpha$



9. B

10. B

Sol. **(for Q.9-Q.10):**

For any case, Buoyancy $\vec{B} = -V\rho_{\text{liquid}}\vec{g}_{\text{eff}}$

where $\vec{g}_{\text{eff}} = \vec{g} - \vec{a}$ and $\vec{T} + \vec{B} + m\vec{g} = m\vec{a}$

11. D

Sol. Find time constant by shorting the battery finding R_{eff} across C_0. Then $\tau = R_{\text{eff}} \times C_0$.

12. A

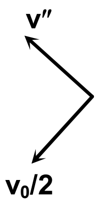
Sol. Find time constant by shorting the battery finding C_{eff} across R_0. Then $\tau = R_0 \times C_{\text{eff}}$.

SECTION – C

13. 00001.69

Sol. Let A : $\downarrow \mathbf{v_0}$ & B : ← v_0 before collision

Let A :



& B : ← v′ after collision

e = 1 $\Rightarrow v_0\left(\frac{1}{2}+\frac{\sqrt{3}}{2}\right)=v''-\frac{v'}{2}$ . . . (i)

Conserving momentum horizontally $\Rightarrow mv_0 = mv' + m\left(\frac{v''}{2}+\frac{v_0\sqrt{3}}{4}\right)$ . . . (ii)

Solve for v′.

14. 00002.30

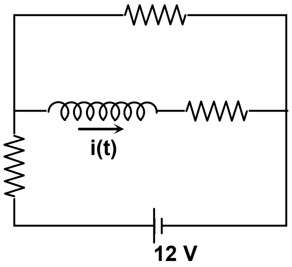
Sol. $i(t) = i_{max}(1 - e^{-t/\tau})$

here, $i_{max} = V/3R$

$\tau = 2L/3R$

$\Rightarrow i_{bulb}(t) = \frac{V}{6R}(2+e^{-3Rt/2L})$

$\Rightarrow \Delta t = \frac{2L}{3R}\ln 2$.



15. 00500.00

Sol. $X_L = \omega L = 100 \times 0.1 = 10\ \Omega$

$\frac{1}{Z'}=\frac{1}{R_2}+\frac{1}{X_L i}=\frac{1}{10}+\frac{1}{10i}=\frac{1-i}{10}$

$Z'=\frac{10}{(1-i)}=\frac{10}{2}(1+i)=5(1+i)$

$Z'=5(1+i)$

Net impedance of the circuit, $|Z|=\frac{250}{10}=25\,\Omega$

$Z=(R_1-X_C i)+Z'=(15-X_C i)+5(1+i)$

$Z=20+(5-X_C)i$

$|5-X_C|=\sqrt{(25)^2-(20)^2}$

$|5-X_C|=15$

$X_C-5=15$

$X_C = 20\ \Omega$

$\Rightarrow \frac{1}{\omega C}=20$

$\Rightarrow C=\frac{1}{20\omega}=\frac{1}{20\times 100}=500\mu F$

C = 500 μF

16. 00004.70

Sol. $\frac{13.6Z^2}{n^2}=36\%$ of 13.6 . . . (i)

Also, ${}^nC_2 = 10$ . . . (ii)

and, $eV_0 = \frac{hc}{\lambda} - \phi$ . . . (iii)

17. 00000.40

Sol. $W(t) = N_0e^{-4\lambda t}$ . . . (i)

$\frac{dZ}{dt} = +\lambda W(t)$ . . . (ii)

$\frac{dX}{dt} = +3\lambda W(t) - 2\lambda X(t)$ . . . (iii)

Solve the three equations.

18. 00003.14

Sol. After passing through prism, ray from upper prism becomes horizontal & ray from lower prism is inclined at 2^0 to the horizontal.

$\Rightarrow$ $\Delta x = d \sin 1^0 + d \sin \theta$ . . . (i)

Also, $I = 4I_0 \cos^2\left(\frac{\Delta\phi}{2}\right) = \frac{1}{2}(4I_0) = 2I_0$

$\Rightarrow$ $\cos^2\left(\frac{\Delta\phi}{2}\right) = \frac{1}{2}$ . . . (ii)

Solve (1) & (2).

Chemistry

PART – II

SECTION – A

19. B, C, D

Sol.
$$Cu + conc.HNO_3 \longrightarrow \underset{'K'}{Cu(NO_3)_2} + \underset{'L'}{NO_2} \uparrow + \underset{'M'}{H_2O}$$
$$Cu(NO_3)_2 + KCN(excess) \longrightarrow \underset{'T'}{K_3\left[Cu(CN)_4\right]} + \underset{'S'}{(CN)_2} \uparrow + KNO_3$$

20. A, B, D

Sol.
$$\underset{'Q'}{Al_2O_3.xH_2O + NaOH} \longrightarrow \underset{'R'}{Na\left[Al(OH)_4\right]}$$
$$\underset{'R'}{Na\left[Al(OH)_4\right]} + \underset{'S'}{CO_2} \longrightarrow \underset{'T'}{Al_2O_3.xH_2O} \downarrow + NaHCO_3$$

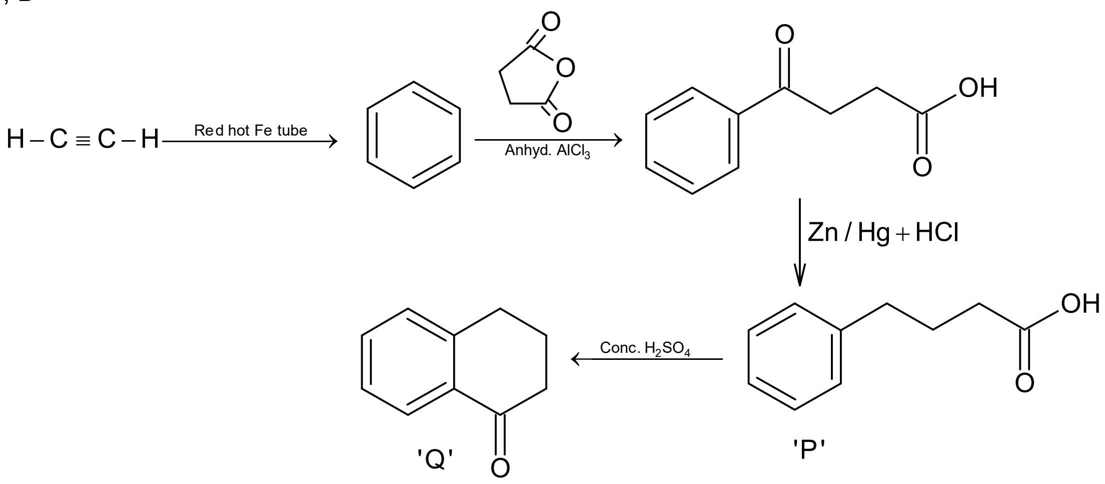
21. A, B

Sol.
$$\underset{Excess}{3Cl_2} + NH_3 \longrightarrow NCl_3 + 3HCl$$
$$Cl_2 + \underset{hot\ conc.}{NaOH} \longrightarrow NaCl + NaClO_3 + H_2O$$

22. C, D

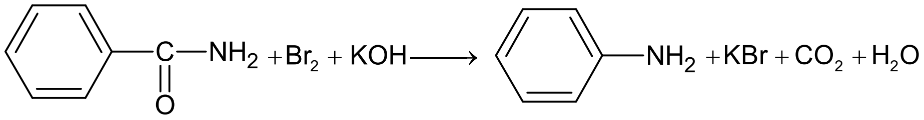
23. C, D

Sol.


H – C ≡ C – H
Red hot Fe tube
O
O
O
Anhyd. AlCl3
O
OH
O
Zn / Hg + HCl
OH
O
Conc. H2SO4
'Q'
O
'P'

24. B, C, D

Sol.


C
NH2 + Br2 + KOH
O
NH2 + KBr + CO2 + H2O

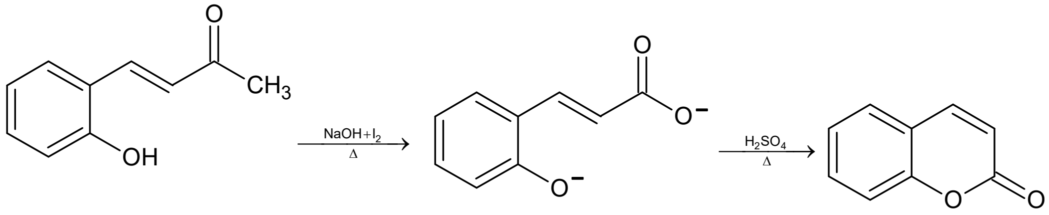
25. C, D

26. B, C

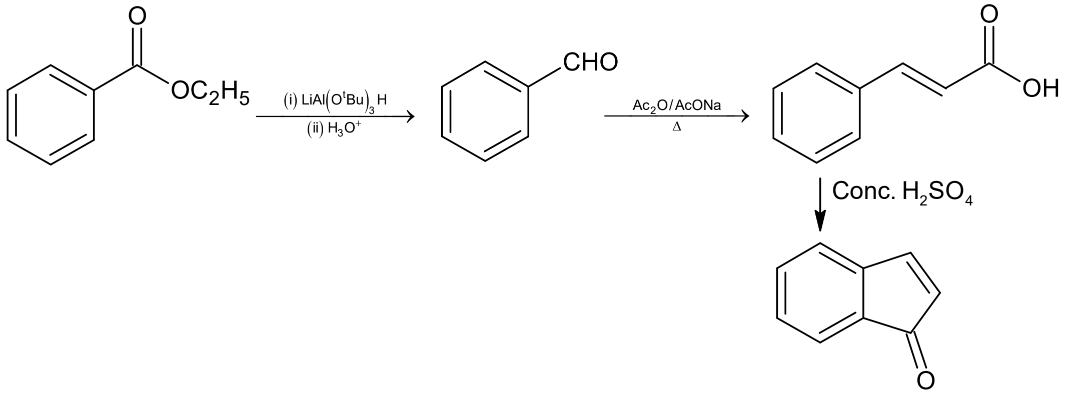
27. D

28. C

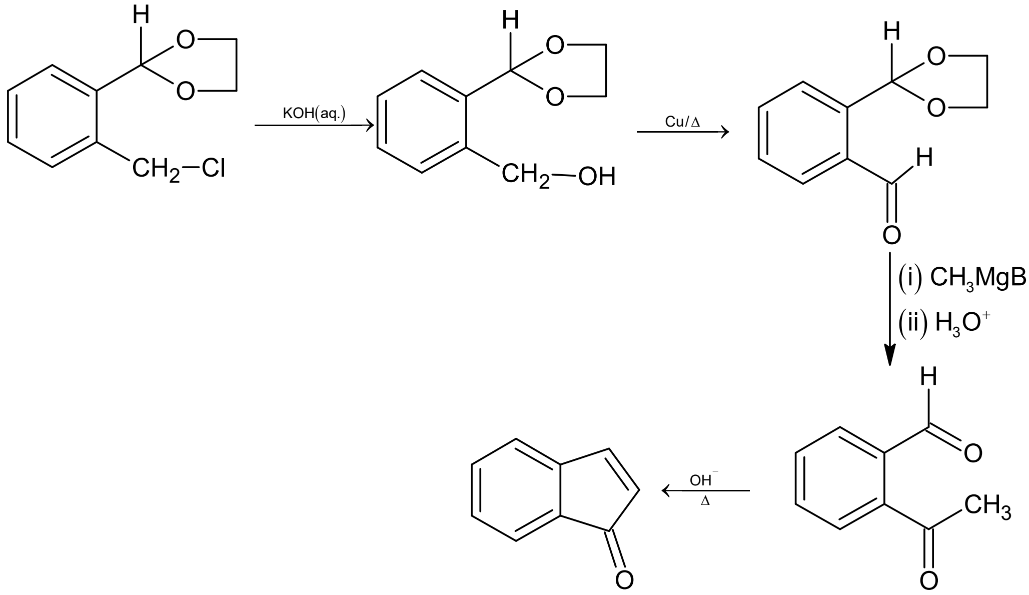
Sol. (I)


O
CH3
OH
NaOH+I2
Δ
O
O−
O−
H2SO4
Δ
O
O

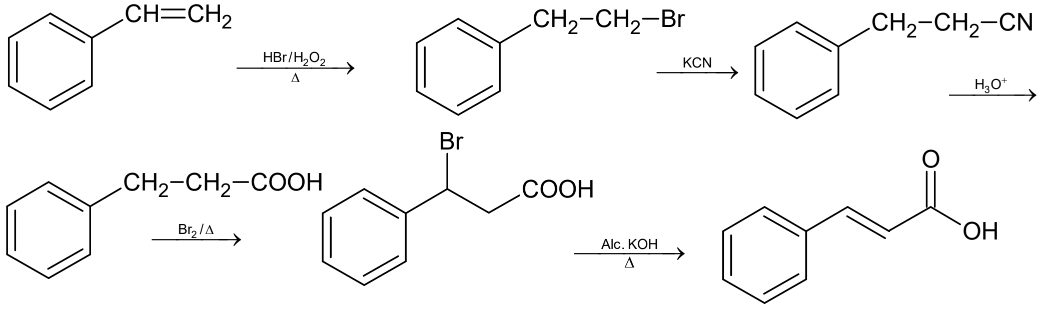
(II)


O
OC2H5
(i) LiAl(OtBu)3H
(ii) H3O+
CHO
Ac2O/AcONa
Δ
O
OH
Conc. H2SO4
O

(III)


H
O
O
CH2–Cl
KOH(aq.)
H
O
O
CH2—OH
Cu/Δ
H
O
O
H
O
(i) CH3MgBr
(ii) H3O+
H
O
CH3
O
OH−
Δ
O

(IV)


CH=CH2
HBr/H2O2
Δ
CH2–CH2–Br
KCN
CH2–CH2–CN
H3O+
CH2–CH2–COOH
Br2/Δ
Br
COOH
Alc. KOH
Δ
O
OH

29. D

30. C

SECTION – C

31. 00003.00

Sol. $Cu^{2+} + 2e^- \longrightarrow Cu \qquad H_2O \longrightarrow 2H^+ + \frac{1}{2}O_2 + 2e^-$

Q = 9.65 × 10 = 96.5 C

Moles of H_2SO_4 produced = moles of Cu^{2+} reduced $= \frac{96.5}{2 \times 96500} = 5.0 \times 10^{-4}$

Conc. of H_2SO_4 (M) = $\frac{5 \times 10^{-4}}{1} = 5 \times 10^{-4}$ mole / L

$[H^+] = 2 \times 5 \times 10^{-4} = 10^{-3}$ mole / L

pH = - log[H^+] = 3

32. 00002.60

Sol. $\Delta T_f = iK_f.m$

$= 2 \times 1.86 \times \frac{0.65 \times 1000}{930} = \frac{2 \times 186 \times 0.65}{93} = 4 \times 0.65 = 2.6$

33. 00082.00

Sol. ${}^{238}_{92}X \longrightarrow {}^{234}_{90}Y \longrightarrow {}^{234}_{88}Z \longrightarrow {}^{234}_{89}L \xrightarrow{-7\alpha} {}^{206}_{(75)}M$

7 + 75 = 82.00

34. 00001.25

Sol. $(NH_4)_2SO_4 + 2NaOH \longrightarrow 2NH_3 + Na_2SO_4 + 2H_2O$

n = 2.5 n = 5

$CuSO_4.5H_2O + 4NH_3 \longrightarrow [Cu(NH_3)_4]SO_4 + 5H_2O$

n = 2 n = 5

limiting

Hence, moles of $[Cu(NH_3)_4]SO_4$ = $\frac{5}{4} = 1.25$

35. 00006.00

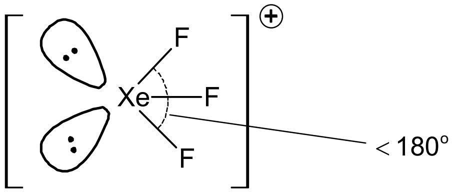
Sol. $XeF_4 + H_2O \longrightarrow \underset{'A'}{Xe} + \underset{'B'}{XeO_3} + HF + O_2$

Oxidation state of Xe = 0

Oxidation of Xe in XeO_3 = +6

36. 00000.00

Sol.



Mathematics PART – III

SECTION – A

37. A, B, C

Sol. We have $\log_{1/3}\left(x^2+2Px+P^2+1\right) \ge 0 \Rightarrow x^2 + 2Px + P^2 + 1 \le 1$
$\Rightarrow (x + P)^2 \le 0 \Rightarrow x = -P$. Now $x = -P$ satisfy $kx^2 + kx - k^2 \le 0$
$\Rightarrow kP^2 - kP - k^2 \le 0 \Rightarrow k^2 + kP - k P^2 \ge 0 \Rightarrow k^2 - k(P^2 - P) \ge 0$
Apply $D < 0$, $(P^2 - P)^2 \le 0 \Rightarrow P^2 - P = 0 \therefore P = 0$ or 1

38. A, C

Sol. $8x^3 = 3x^2 + 3x + 1 \Rightarrow 9x^3 = x^3 + 3x^2 + 3x + 1$
$9x^3 = (x + 1)^3$, $x + 1 = \sqrt[3]{9}x$
$$x = \frac{1}{\sqrt[3]{9}-1} = \frac{9^{2/3}+9^{1/3}+1}{9-1}$$
$$= \frac{\sqrt[3]{81}+\sqrt[3]{9}+1}{8}$$

39. A, D

Sol. $(5x - y) + x + 2y = 2(2x + y) \Rightarrow 2x = y$
$(x - 1)^2(y + 1)^2 = (xy + 1)^2 \Rightarrow (x - 1)(y + 1) = \pm(xy + 1) \Rightarrow -x - 1 = 1$
$\Rightarrow x = -2, y = -4$ and $2x^2 - x - 1 = -2x^2 - 1 \Rightarrow x = \frac{1}{4}, y = \frac{1}{2}$

40. B, C, D

Sol. $|z|(z + 1)^8 = z^8|z + 1| \Rightarrow |z|\,|z + 1|^8 = |z|^8\,|z + 1| \Rightarrow |z + 1|^7 = |z|^7 \Rightarrow |z| = |z + 1|$

41. A, C, D

Sol. $${}^{100}C_{50} = \frac{100!}{50!50!}$$
Exponent of 2 in 100! = 97
Exponent of 2 in 50! = 47

42. C, D

Sol. $x^2 - x + 1 = 2$, $x^2 - x - 1 = 0$
$x = \frac{1+\sqrt{1+4}}{2} \Rightarrow x = \frac{\sqrt{5}+1}{2}$, (since $x > 0$)
$x^2 - x + 1 = 1 \Rightarrow x^2 - x = 0 \Rightarrow x = 0, x = 1$ since $x \in (0, 2)$

43. A, D

Sol. Replace x by $\frac{1}{x}$ and differentiate and put $x = 1$

44. A, B

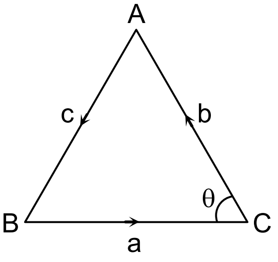
Sol. $f'(x) = \frac{2x\left(x^4-5x^2+4\right)}{2+e^x} = 0 \Rightarrow 2x(x^2 - 4)(x^2 - 1) = 0 \Rightarrow 2x(x - 2)(x + 2)(x - 1)(x + 1) = 0$

45. B

46. D

Sol. **(for Q.45-Q.46):**

$\overline{AB} = |\overline{c}| = 2\sqrt{3}$, $AC = |\overline{b}| = 2$, $BC = |\overline{a}| = 2$, $\cos\theta = \frac{4+4-12}{2\cdot 2\cdot 2} = \frac{1}{2} \Rightarrow \theta = \frac{2\pi}{3}$



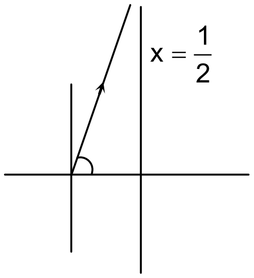
(I) (Q) $\int_a^b (f(x) - 3x)dx = a^2 - b^2 \Rightarrow \int_a^b f(x)dx = \frac{1}{2}(b^2 - a^2)$ $\Rightarrow$ f(x) = x $\Rightarrow$ $f\left(\frac{\pi}{6}\right) = \frac{\pi}{6}$

(II) (P)

(III) (S) $I = \frac{\pi^3}{\ln 3}\cdot\frac{1}{\pi}(\ln|\sec\pi x + \tan\pi x|)_{7/6}^{5/6}$ = $\frac{\pi}{\ln 3}\left(\ln\sqrt{3} - \ln\frac{1}{\sqrt{3}}\right) = \pi$

(IV) Let $u = \frac{1}{1-z} \Rightarrow \frac{u-1}{u} = z$, |z| = 1 $\Rightarrow$ |u – 1| = |u|

Locus of u is $x = \frac{1}{2}$ maximum argument of u is approaches towards $\frac{\pi}{2}$



47. A

48. D

Sol. **(for Q.47-Q.48):**

(I) (S) $\text{Re}\left(\frac{2iz}{1-z^2}\right) = \left(\frac{2i}{\frac{1}{z} - z}\right) = \frac{-1}{\sin\theta}$ if z = cos θ + i sin θ, since |z| = 1

Range of $\frac{-1}{\sin\theta}$ is (–∞, –1] ∪ [1, ∞)

(II) (R) $R_1 \to R_1 + R_3$

$$f(\theta) = \begin{vmatrix} 0 & 0 & 2 \\ -\tan\theta & 1 & \tan\theta \\ -1 & -\tan\theta & 1 \end{vmatrix} = 2(1+\tan^2\theta)$$ = 2 sec² θ ⇒ Range (2, ∞)

(III) (T) $-1 \le \frac{8(3^{x-2})}{1-3^{2x-2}} \le 1 \Rightarrow x \in (-\infty, 0] \cup (2, \infty)$

(IV) (R) $f(x) = x^{3/2}(3x - 10)$, $x \ge 0 \Rightarrow f'(x) = \frac{3}{2}x^{1/2}(3x-10) + 3x^{3/2}$ = $\frac{15}{2}x^{1/2}(x-2) \ge 0 \Rightarrow x \ge 2$

SECTION – C

49. 00007.00

Sol. $a_n = \dfrac{\sqrt{n^2+(n-1)^2}+\sqrt{n^2+(n+1)^2}}{n} = \dfrac{4}{\sqrt{n^2+(n+1)^2}-\sqrt{(n-1)^2+n^2}}$

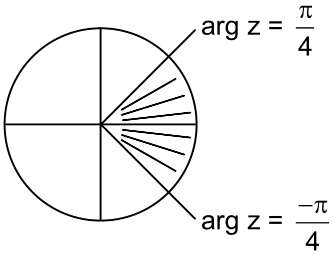
$\sum_{n=1}^{20} \dfrac{1}{a_n} = \dfrac{1}{4}\left(\sqrt{20^2+21^2}-\sqrt{1}\right) = 7$

50. 00005.00

Sol. Total sum = 4^{37}, $\left(4^{37}-2^{37}-2\right)$ = sum of coefficients divisible by 37 ⇒ $\dfrac{a+b+c+2}{2}$ = 5

51. 00004.00

Sol. Given in the figure, $P = \dfrac{1}{4}$



52. 00016.00

Sol. f(x) – f(–x) = 6x, f(4) – f(–4) = 24 ⇒ N = f(4) = 24 + 2286 = 2310 = 2.3.5.7.11
Number of divisors = 2^{n-1} = 16

53. 00006.00

Sol. If tangent of P and Q meet at T, then $ST^2 = SP \times SQ \Rightarrow ST^2 = 36$, ST = 6

54. 00003.00

Sol. $f(x) = f\left(\dfrac{x}{7}\right) = \dfrac{x}{7} \Rightarrow f\left(\dfrac{x}{7^{n-1}}\right) - f\left(\dfrac{x}{7^n}\right) = \dfrac{x}{7^n} = f(x) - f\left(\dfrac{x}{7^n}\right) = \dfrac{x}{7}\left(1+\dfrac{1}{7}+\dfrac{1}{7^2}-\dfrac{1}{7^{n-1}}\right)$

Taking x → ∞, f(x) – f(0) = $\dfrac{x}{6}$. Area = $\int_0^6 \left(1+\dfrac{x}{6}\right)dx = 3$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST –XI

JEE (Advanced)-2020

PAPER – 2

TEST DATE: 23-09-2020

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section-A (01 – 08, 19 – 26, 37 – 44)*** *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
*Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
*Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
*Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
*Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
*Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
*Negative Marks : **–1** In all other cases.*

   Section-A (09 – 12, 27 – 30, 45 – 48) *contains 6 List-Match sets with 12 questions (each set has 2 questions). Each question has 4 statements in LIST-I & 4, 5 or 6 statements in LIST-II. The codes for Lists have choices (A), (B), (C), (D) out of which only one is correct.*
Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

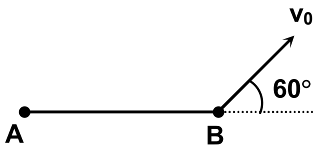
Physics

PART – I

SECTION – A
(One or More than one correct type)

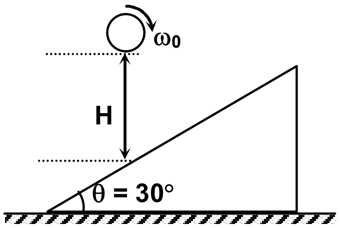
This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. Two identical small balls (mass m each) are connected to each other with the help of an inextensible massless string of length ℓ. The whole arrangement is placed on a horizontal frictionless table with the string just slack. Now ball B is given a sudden horizontal velocity v_0 as shown in the figure Then ($m = 1$ kg, $\ell = 1$ m and $v_0 = 1$ m/s) just after string becomes taut:



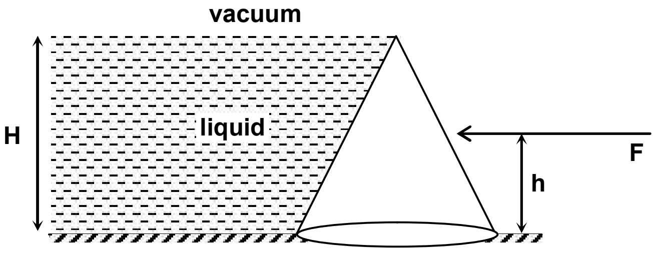
(A) Tension in the string is 0.25 N.
(B) Tension in the string is 0.75 N
(C) Tension in the string is 0.125 N
(D) Relative acceleration between A and B has magnitude 0.75 m/s^2.

2. A ring (mass m and radius r) is rotating with angular speed ω_0 in a vertical plane and is released on an inclined plane of mass M. Friction exists only between ring and wedge (coefficient = μ). It is observed that just after collision, everything is momentarily at rest. Which of the following set(s) of values can satisfy the above observation:



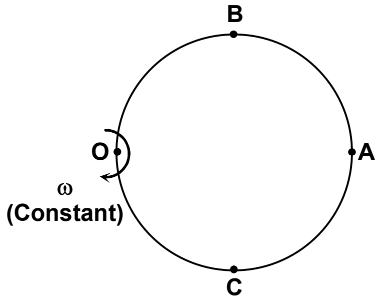
(A) M = 2kg, $\mu = \frac{1}{\sqrt{3}}$, r = 50 cm, H = 5 cm, ω_0 = 1 rad/s, m = 1 kg
(B) M = 1kg, $\mu = \sqrt{3}$, r = 50 cm, H = 10 cm, ω_0 = 1 rad/s, m = 0.5 kg
(C) M = 1kg, $\mu = \frac{1}{2}$, r = 100 cm, H = 20 cm, ω_0 = 2 rad/s, m = 1 kg
(D) M = 1kg, $\mu = \frac{1}{\sqrt{3}}$, r = 100 cm, H = 10 cm, $\omega_0 = \frac{1}{\sqrt{2}}$ rad/s, m = 0.5 kg

3. Imagine a uniform hollow cone of mass M and radius R whose left half is surrounded by a liquid (density ρ). The cone is on a smooth horizontal surface and is kept in equilibrium by applying a particular horizontal force F at a particular height h from ground as shown. Then:



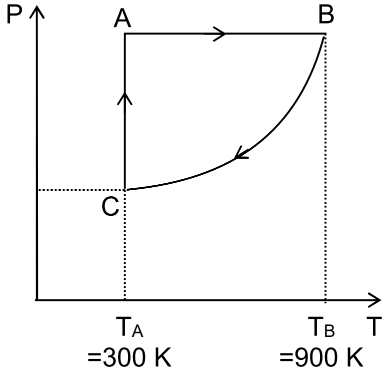
(A) $F = \frac{1}{3} g\rho RH^2$
(B) $h = \frac{H}{4}$
(C) $h = \frac{H}{5}$
(D) $h = \frac{H}{3}$

4. Suppose a uniform steel ring (mass M and radius R) is kept on a smooth horizontal surface with its plane horizontal. It is hinged about a point O on the perimeter & is made to rotate in a horizontal plane as shown (A, B, & C are points on the ring). Then, regarding longitudinal stress developed in the ring:



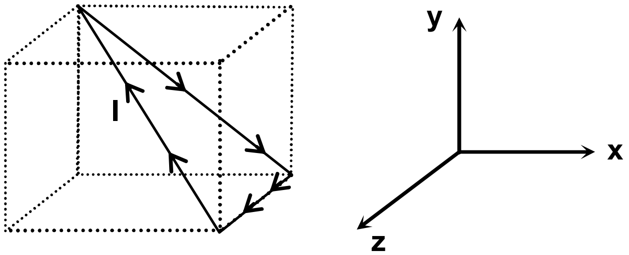
(A) It will be maximum at A
(B) It will be minimum at A
(C) It will be equal at B and C and that value will be maximum.
(D) It will be more at O than A by an amount $\frac{M\omega^2}{\pi^2 R}$.

5. Two moles of an ideal monoatomic gas is taken through a cyclic process ABCA as shown in the P-T diagram. In the process BC, $P = \alpha T^2$, where α is a constant. Then choose the correct option(s). (R = ideal gas constant) [Take $\ell n(3) = 1.1$]



(A) The heat absorbed by the gas during the process AB is 3000 R.
(B) The heat absorbed by the gas during the process BC is 1200 R.
(C) The heat rejected by the gas during the process BC is 600 R.
(D) The efficiency of the cycle is 36%.

6. A current carrying loop is in the form of a triangle whose geometry is as follows:



Dotted (imaginary) lines form a cube of side a. I: current

Then, regarding this loop :

(A) Magnetic field at centre of cube is $-\frac{6\mu_0 i}{4\sqrt{3}\pi a}(\hat{i}+\hat{j})$
(B) Magnetic field at centre of cube is $-\frac{\sqrt{3}\mu_0 i}{6\pi a}(\hat{i}+\hat{j})$
(C) Magnetic field at centre of cube is $+\frac{\sqrt{3}\mu_0 i}{6\pi a}(\hat{i}+\hat{j})$
(D) Magnetic moment of the loop has no z-component.

7. A positive charge (having charge q_0)is thrown from orgin with velocity $v_0(\hat{j}+\hat{k})$ in a gravity-free space. Everywhere in space, there exists a uniform & constant magnetic field $\vec{B}=B_0\ \hat{k}$. Two infinite, rigid, perfectly elastic planar walls are kept at z = $\pm z_0$. Taking mass of the particle to be m_0 & assuming $v_0 > 0$, $z_0 > 0$, choose the correct option(s) :

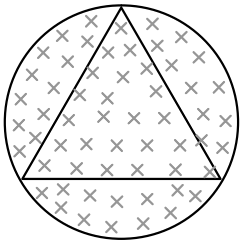
(A) The motion is periodic with period $\frac{4z_0}{v_0}$, for any value of z_0.

(B) The motion is periodic with period $\frac{4z_0}{v_0}$, if z_0 is of the form of $n\frac{2\pi m_0 v_0}{B_0 q_0}$, $n \in I^+$

(C) The motion is periodic with period $\frac{4z_0}{v_0}$, if z_0 is of the form of $\left(\frac{2n-1}{4}\right)\frac{2\pi m_0 v_0}{B_0 q_0}$,, $n \in I^+$

(D) The motion is periodic & the particle crosses origin only once every cycle, if z_0 is of the form $\left(\frac{2n-1}{4}\right)\frac{2\pi m_0 v_0}{B_0 q_0}$, $n \in I^+$

8. In space, there exists a uniform magnetic field in an infinitely long cylindrical region of radius R. The field is given by $\vec{B} = B_0 t \otimes$, where $B_0 > 0$. An insulating charged rigid loop in the shape of an equilateral triangle carries a uniform linear charge density λ and is initially at rest (t = 0). This triangle inscribes the boundary of cylindrical region as shown:



This whole arrangement is in a gravity –free space & take the mass of the triangular loop to be M_0. Then (initially), regarding the triangular loop:

(A) There is no acceleration of centre of mass

(B) There is no angular acceleration of centre of mass

(C) There is angular acceleration = $\frac{3\sqrt{3}}{2}\frac{\lambda B_0 R}{M_0}$ anticlockwise

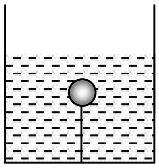
(D) There is angular acceleration = $\frac{9\sqrt{3}}{2}\frac{\lambda B_0 R}{M_0}$ anticlockwise

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

A solid spherical ball is attached to a rigid rod radially and this arrangment is kept inside a liquid (density twice the ball) as shown (with the rod fixed to the container at the bottom):



Now the container is given possible accelerations as in List-I. Some numbers are given in List-II.

	List-I		List-II
(I)	$\vec{a} = \vec{0}$	(P)	2
(II)	$\vec{a} = \frac{g}{2}\downarrow$	(Q)	1
(III)	$\vec{a} = g\downarrow$	(R)	0
(IV)	$\vec{a} = g\uparrow$	(S)	$\frac{3}{2}$
		(T)	$\frac{1}{2}$
		(U)	3

9. If the experiment is done on earth (acceleration due to gravity : g), then match the ratio $\frac{\text{tension(magnitude) in rod}}{\text{weight(magnitude)of ball on earth}}$. Here, weight of ball on earth means mass x acceleration due to gravity.

Options

(A) I → S, II → Q, III → P, IV → T
(B) I → Q, II → T, III → R, IV → P
(C) I → T, II → P, III → R, IV → S
(D) I → T, II → R, III → S, IV → P

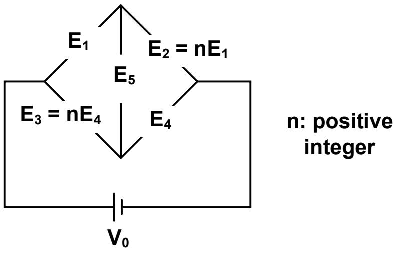
10. Imagine now that the experiment is repeated on a different planet whose density is same as that of earth but radius is twice as that of earth. Then match the ratio $\frac{\text{tension(magnitude) in rod}}{\text{weight(magnitude)of ball on earth}}$.

Options

(A) I → T, II → U, III → P, IV → S
(B) I → P, II → S, III → Q, IV → U
(C) I → Q, II → P, III → S, IV → T
(D) I → T, II → Q, III → R, IV → S

Answer the following by appropriately matching the list based on the information given in the paragraph

E_1, E_2, E_3, E_4, E_5 are five circuit elements such that E_1, E_2, E_3 and E_4 are of same nature (resistive or capacitive) and corresponding E_5 is capacitive or resistive respectively for a given experiment. Four value of n(= 1, 2, 3, 4) give rise to four possible circuits: Circuit-1 (n = 1), circuit -2(n = 2), circuit -3(n = 3) and circuit -4 (n = 4). List I gives the possible four circuit and List II gives some numbers.



.

	List-I		List-II
(I)	Circuit-1	(P)	$\frac{4}{3}$
(II)	Circuit-2	(Q)	$\frac{3}{2}$
(III)	Circuit-3	(R)	1
(IV)	Circuit-4	(S)	$\frac{5}{2}$
		(T)	$\frac{8}{5}$
		(U)	2

11. If $E_1 = E_4 = R_0$ (resistive) and $E_5 = C_0$(capacitive), then the correct match for the time constant of the voltage acorss the capacitor, as a factor of R_0C_0, is:

Options

(A) I $\rightarrow$ R, II $\rightarrow$ Q, III $\rightarrow$ T, IV $\rightarrow$ P
(B) I $\rightarrow$ S, II $\rightarrow$ P, III $\rightarrow$ R, IV $\rightarrow$ T
(C) I $\rightarrow$ P, II $\rightarrow$ Q, III $\rightarrow$ R, IV $\rightarrow$ S
(D) I $\rightarrow$ R, II $\rightarrow$ P, III $\rightarrow$ Q, IV $\rightarrow$ T

12. If $E_1 = E_4 = C_0$ (capacitive) and $E_5 = R_0$ (resistive), then the correct match for the time constant of the voltage across the resistor, as a factor of R_0C_0, is:

Options

(A) I $\rightarrow$ R, II $\rightarrow$ Q, III $\rightarrow$ U, IV $\rightarrow$ S
(B) I $\rightarrow$ S, II $\rightarrow$ P, III $\rightarrow$ R, IV $\rightarrow$ U
(C) I $\rightarrow$ R, II $\rightarrow$ P, III $\rightarrow$ Q, IV $\rightarrow$ T
(D) I $\rightarrow$ P, II $\rightarrow$ Q, III $\rightarrow$ R, IV $\rightarrow$ S

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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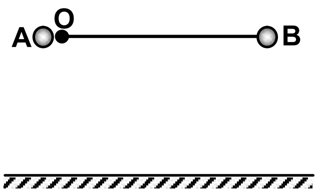
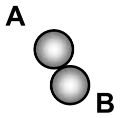
13. Two identical discs (each of radius r) are arranged such that one is made to fall freely & the other is tied to a string of length ℓ (>>r) as shown:

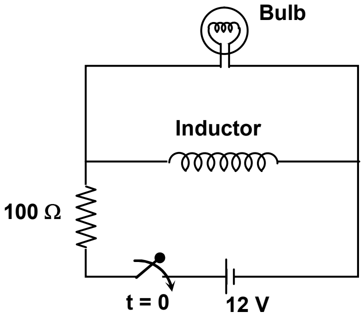


Initially, both discs are at same level (with the string horizontal and disc A just left to the point of suspension (of disc B) O. Now, disc B is released and A is released at such a moment such that following situation arises just before collision (at the lowest point of B):



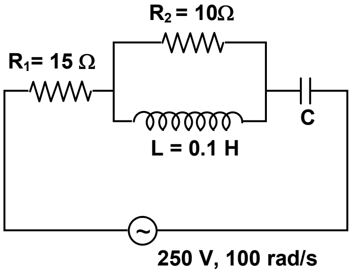
Assuming collision to be perfectly elastic, find the max height in cm, to which B rises (from its lowest position) after the collision. Take $\sqrt{3}$ =1.73. L = 2 m and truncate the final answer to two decimal places.

14. A bulb (purely resistive of resistance 100 Ω) is connected in a circuit using a DC battery of 12 V as shown :



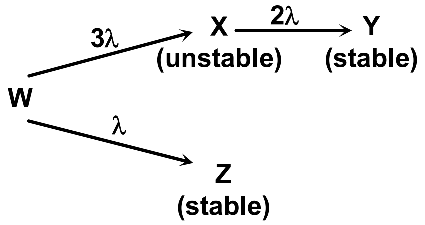
The inductor has an inductance of 0.5 mH & resistance of 100 Ω. The bulb stops glowing if current passing through it becomes any less than 50 mA. Then for what time interval (in μs), after closing the switch, will the bulb glow for. (Take ℓn 2 = 0.69)

15. In the circuit shown, if the current supplied by the ac voltage source is 10 A. Find the value of capacitance 'C' in μF.



16. A container consists of a sample of hydrogen like ions of the same element & in the same state. In this state, the ionization energy of an ion in the above sample is 36% of a hydrogen atom. This sample is now allowed to reach its most stable configuration, thereby resulting in 10 distinct types of photons. The most energetic Paschen – line photons from this sample are made to incident on a metal. The stopping potential of the ejected photoelectrons is observed to be 4V. Find the work function (in eV) of the metal. (Take ionisation energy of a hydrogen atom= 13.6 eV and truncate your final answer to two decimal places)

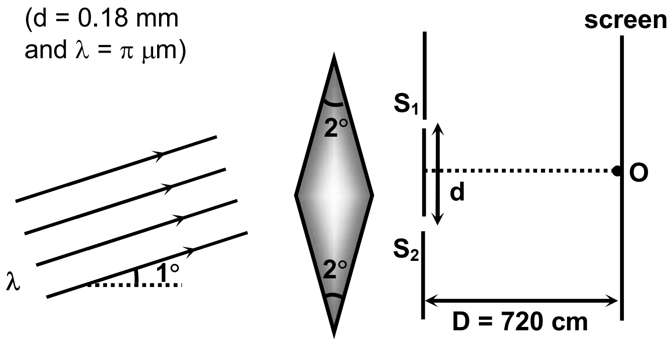
17. A radioactive element W exhibits radioactivity in the following way:



The decay constants have been shown (λ = 2 minutes^{-1}). Initially, only element W was present. Find in how many minutes, will the number of nuclei of element X would equal the number of nuclei of element Z. Take $\ell n5 = 1.61$ & truncate yours final answer to two decimal places).

18. A very thin biprism is made up of a material of refractive index 1.5 & angle of 2^0 for both upper apex & lower apex. This is used in a YDSE setup such that upper prism is near upper slit & lower prism is near lower slit is as shown:

(d = 0.18 mm and $\lambda = \pi$ μm)



A parallel beam of light (inclined at 1^0 to the horizontal) is incident on the setup as shown. Find (in cm) the separation between the point O (which is the geometrically symmetric point of the YDSE) & the closest point on the screen where intensity is half the maximum possible.
(Take $\pi = 3.14$, $\sin\theta = \theta = \tan\theta$ for small angles)

Chemistry PART – II

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Consider the following reactions (unbalanced)

$$Cu + conc.HNO_3 \longrightarrow K + L \uparrow + M$$

$$K + KCN(excess) \longrightarrow T + S \uparrow + KNO_3$$

Choose the correct option(s)

(A) The oxidation state of Cu in T is +2.
(B) 'S' has 4π bonds.
(C) 'L' is brown gas.
(D) 'T' on reaction with H_2S does not give precipitate of CuS.

20. In Baeyer's process (extraction for aluminium metal), bauxite ore is first digested with reagent 'Q' to form 'R'. The solution of 'R' is then neutralized by passing gas 'S' and 'T' is precipitated out. Choose the correct option(s)

(A) 'Q' is NaOH
(B) 'R' is $Na[Al(OH)_4]$
(C) Bauxite ore is $Al(OH)_3$
(D) 'S' is CO_2 gas

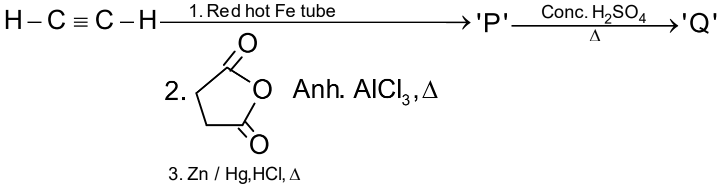
21. With reference to Cl_2, choose the correct option(s):

(A) Excess amount Cl_2 when react with NH_3 gives an explosive substance NCl_3.
(B) Cl_2 on reaction with hot and conc. NaOH gives chloride and chlorate.
(C) Bleaching action of Cl_2 is due to reduction.
(D) Cl_2 water convert ferric ion into ferrous ion in acidic medium.

22. Each of the following options contains a set of four molecules. Identify the option(s) where all bond lengths in a molecules are equal in all four molecules in an option

(A) OF_2, SF_4, XeF_2, ClF_3
(B) $NO_3^-, O_3, [SF_5]^+, [ClF_4]^+$
(C) $NO_3^-, BF_3, SiF_4, SH_2$
(D) $XeF_2, P_4, I_3^-, SO_4^{2-}$

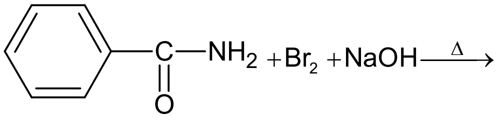
23. Choose the correct option(s) for the following reaction sequence:



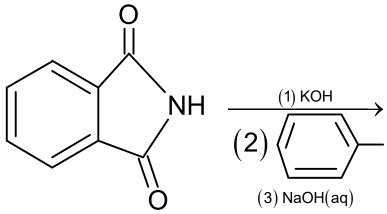
(A) The compound 'P' gives 2,4-DNP test.
(B) The compound 'Q' gives effervescence of CO_2 with $NaHCO_3$.
(C) The conversion of 'P' to 'Q' is a type of electrophilic substitution reaction.
(D) The compound 'P' is soluble in NaOH.

24. Which of the following reaction (s) do not/does not give aniline as major product?

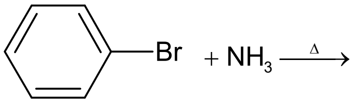
(A)


C—NH2 +Br2 +NaOH
O
Δ

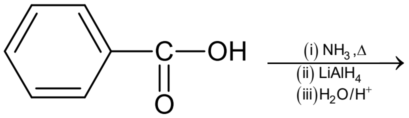
(B)


O
NH
O
(1) KOH
(2)
Cl
(3) NaOH(aq)

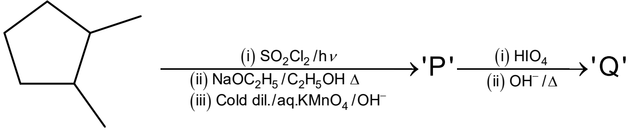
(C)



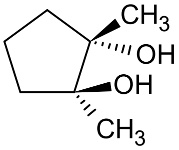
(D)


C—OH
O
(i) NH3,Δ
(ii) LiAlH4
(iii)H2O/H+

25. Choose the correct option(s) for the following reaction sequence

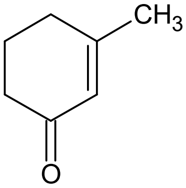

(i) SO2Cl2/hν
(ii) NaOC2H5/C2H5OH Δ
(iii) Cold dil./aq.KMnO4/OH⁻
'P'
(i) HIO4
(ii) OH⁻/Δ
'Q'

(A) The compound ‘P’ is

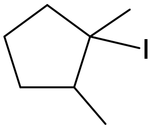

CH3
OH
OH
CH3

(B) Total ‘P’ products formed are two.

(C) The compound ‘Q’ is



(D) Compound ‘P’ on reaction with excess of HI gives



26. Consider the following reaction:

$X(C_6H_{12}O) \xrightarrow{Na}$ gas evolved

(chiral)

$\xrightarrow[\Delta]{H_2/Ni} Y(C_6H_{14}O)$

Optically inactive

(A) Only ‘X’ gives yellow solid with NaOH/I_2

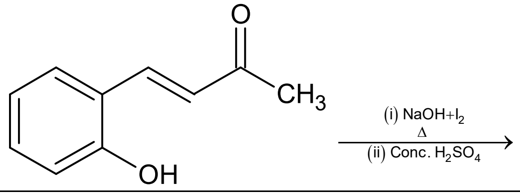
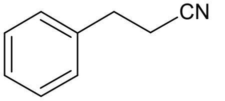
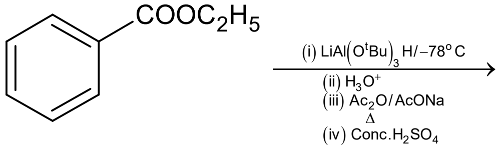
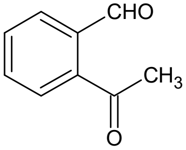
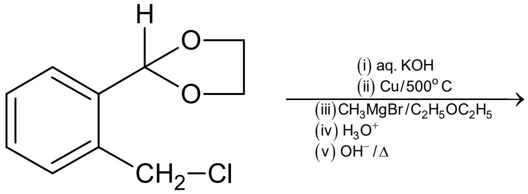
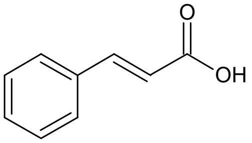
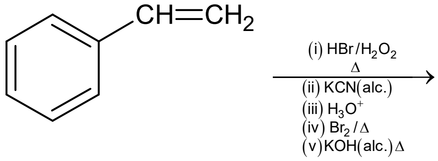
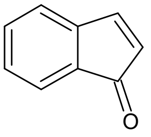
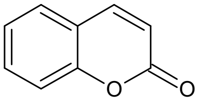
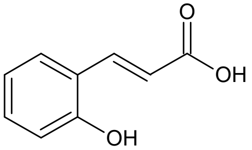
(B) Both X and Y form immediate turbidity with HCl in the presence of anh. $ZnCl_2$.
(C) Only 'X' decolourises the colour of acidic solution $KMnO_4$.
(D) Dehydrogenation takes place when 'Y' is heated with Cu at 300°C.

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the lists based on the information given in the paragraph.

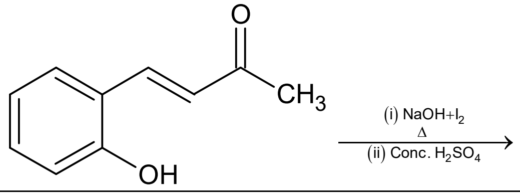
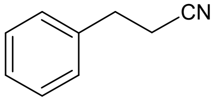
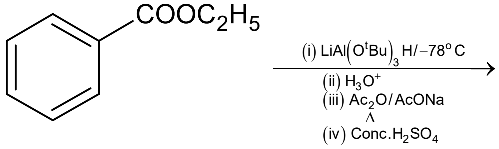
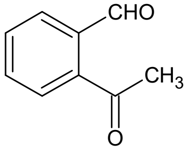
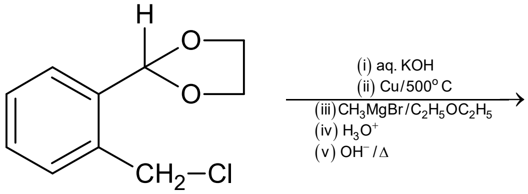
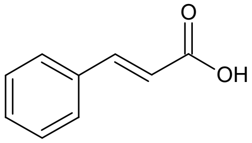
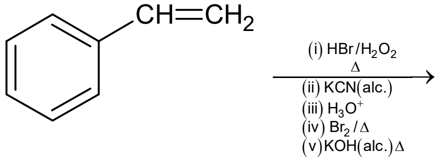
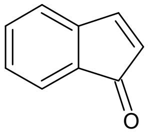
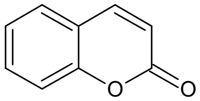
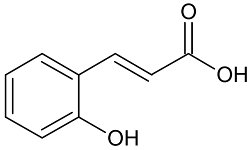
List-I includes starting materials and reagents of selected chemical reactions. List-II gives structures of compounds that may be formed as intermediate products and/or final products from the reactions of List-I.

LIST–I		LIST–II	
(I)	 O CH3 OH (i) NaOH+I2 Δ (ii) Conc. H2SO4	(P)	
(II)	 COOC2H5 (i) LiAl(OtBu)3H/−78° C (ii) H3O+ (iii) Ac2O/AcONa Δ (iv) Conc.H2SO4	(Q)	
(III)	 H O O CH2−Cl (i) aq. KOH (ii) Cu/500° C (iii)CH3MgBr/C2H5OC2H5 (iv) H3O+ (v) OH−/Δ	(R)	
(IV)	 CH=CH2 (i) HBr/H2O2 Δ (ii) KCN(alc.) (iii) H3O+ (iv) Br2/Δ (v)KOH(alc.)Δ	(S)	
		(T)	
		(U)	

27. Which of the following options has correct combination considering List-I and List-II?
(A) (III), (T), (U)
(B) (IV), (R), (T)
(C) (IV), (P), (S)
(D) (III), (Q), (S)

Answer the following by appropriately matching the lists based on the information given in the paragraph.

List-I includes starting materials and reagents of selected chemical reactions. List-II gives structures of compounds that may be formed as intermediate products and/or final products from the reactions of List-I.

LIST–I		LIST–II	
(I)	 (i) $NaOH+I_2$, Δ (ii) Conc. H_2SO_4	(P)	
(II)	 (i) $LiAl(O^tBu)_3H/-78^\circ C$ (ii) H_3O^+ (iii) $Ac_2O/AcONa$, Δ (iv) Conc.H_2SO_4	(Q)	
(III)	 (i) aq. KOH (ii) $Cu/500^\circ C$ (iii) $CH_3MgBr/C_2H_5OC_2H_5$ (iv) H_3O^+ (v) OH^-/Δ	(R)	
(IV)	 (i) HBr/H_2O_2, Δ (ii) KCN(alc.) (iii) H_3O^+ (iv) Br_2/Δ (v) KOH(alc.)Δ	(S)	
		(T)	
		(U)	

28. Which of the following options has correct combination considering List-I and List-II?

(A) (I), (U), (S)
(B) (II), (R), (T)
(C) (I), (U), (T)
(D) (II), (P), (T)

Answer the following by appropriately matching the lists based on the information given in the paragraph.

In the following List-I contains equation of state of a gas in different conditions of pressure and List-II contains properties of that gas (P = pressure of gas, V_m = molar volume of gas, T = temperature of gas, Z = compressibility factor, U_{rms} = root mean square velocity of gas, M = molar mass of gas, a and b are van der Waals constant, R = gas constant)

LIST–I		LIST–II	
(I)	$P(V_m - b) = RT$	(P)	At constant temperature the value of PV_m does not change by changing pressure
(II)	$PV_m = RT - \frac{a}{V_m}$	(Q)	$Z < 1$
(III)	$PV_m = \frac{1}{3}MU_{rms}^2$	(R)	Z is independent of P and T
(IV)	$PM = dRT$	(S)	Attractive forces are dominant between gas molecules
		(T)	Z increases with increasing P.
		(U)	$Z = 0$

29. Which of the following options has correct combination considering List-I and List-II?
(A) (II), (P)
(B) (III), (T)
(C) (III), (Q)
(D) (II), (S)

Answer the following by appropriately matching the lists based on the information given in the paragraph.

In the following List-I contains equation of state of a gas in different conditions of pressure and List-II contains properties of that gas (P = pressure of gas, V_m = molar volume of gas, T = temperature of gas, Z = compressibility factor, U_{rms} = root mean square velocity of gas, M = molar mass of gas, a and b are van der Waals constant, R = gas constant)

LIST–I		LIST–II	
(I)	$P(V_m - b) = RT$	(P)	At constant temperature the value of PV_m does not change by changing pressure
(II)	$PV_m = RT - \frac{a}{V_m}$	(Q)	$Z < 1$
(III)	$PV_m = \frac{1}{3}MU_{rms}^2$	(R)	Z is independent of P and T
(IV)	$PM = dRT$	(S)	Attractive forces are dominant between gas molecules
		(T)	Z increases with increasing P.
		(U)	$Z = 0$

30. Which of the following options has correct combination considering List-I and List-II?
(A) (IV), (U)
(B) (I), (R)
(C) (I), (T)
(D) (IV), (Q)

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

31. A current strength of 9.65 A is passed for 10 seconds through 1 L of solution of 0.1 M aqueous $CuSO_4$. The pH of solution is…..(Assuming that during the process there is no change in volume).

32. AB_2 dissociates in A^{2+} and B^- ions in an aqueous solution. What is depression of freezing point of aqueous AB_2 solution containing 0.65 mole fraction of AB_2 in 930 gm of water, if the ratio of the observed depression of freezing point of the aqueous solution to the value of the depression of freezing point in the absence of ionic dissociation is 2. Given K_f of water is 1.86 K kg mol^{-1}.

33. In the sequence of the following:

$${}^{238}_{92}X \xrightarrow[(\alpha)]{-(1)^4_2He} Y \xrightarrow[(\beta^+)]{-(2)^0_1e} Z \xrightarrow[(\beta^-)]{-(1)^0_{-1}e} L \xrightarrow[(\alpha)]{-(n)^4_2He} {}^{206}_{(a)}M$$

The value of (n + a) is

34. The ammonia prepared by treating ammonium sulphate with NaOH is used by $CuSO_4.5H_2O$ to form a stable coordination compound. If 330 g of pure ammonium sulphate and 499 g of pure $CuSO_4.5H_2O$ are used in preparation and NaOH is used the excess, the moles of copper – ammonia coordination compound produced is
(Atomic weight in g mol^{-1} H = 1, N = 14, O = 16, S = 32, Na = 23, Cu = 63.5)

35. Consider the following reaction
$$XeF_4 + H_2O \longrightarrow A + B + HF + O_2$$
A and B are Xe containing compounds. The oxidation state of Xe in compound 'A' is x and in compound 'B' is y. Then what is x + y?

36. Based on VSEPR theory, the number of 180° F – Xe – F angles in a molecule of $[XeF_3]^+ [SbF_6]^-$ is

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. If all the values of x which satisfies the inequality $\log_{1/3}\left(x^2+2Px+P^2+1\right)\geq 0$ also satisfy the inequality $kx^2 - kx - k^2 \leq 0$ for all real values of k, then all possible values of p lies in the interval
(A) [–1, 1]
(B) [0, 1]
(C) [0, 2]
(D) [–2, 0]

38. The real root of the equation $8x^3 - 3x^2 - 3x - 1 = 0$ can be written in the form $\frac{\sqrt[3]{m}+\sqrt[3]{n}+1}{P}$ where m, n and P are the positive integers ($m \geq n \geq P$), then
(A) m + n + P = 98
(B) m + n + P = 97
(C) m + n = 90
(D) n + P = 17

39. If 5x – y, 2x + y, x + 2y are in A.P. and $(x-1)^2$, $(xy+1)$, $(y+1)^2$ are in G.P. $x \neq 0$, then (x + y) equals
(A) $\frac{3}{4}$
(B) 3
(C) –5
(D) –6

40. If the equation $|z|(z+1)^8 = z^8|z+1|$ where z is a complex number and $z(z+1) \neq 0$ has distinct roots $z_1, z_2, z_3 \ldots.. z_n$ (where $n \in N$), then
(A) $z_1, z_2, z_3, \ldots.. z_n$ are cyclic points
(B) $z_1, z_2, z_3, \ldots.. z_n$ are collinear points
(C) $\sum_{r=1}^{n} \text{Re}\left(z_r\right) = \frac{-7}{2}$
(D) $\sum_{r=1}^{m} I_m\left(z_r\right) = 0$

41. If $^{100}C_{50}$ can be prime factorized as $2^{\alpha}\cdot 3^{\beta}\cdot 5^{\gamma}\cdot 7^{8}$ ….. where α, β, γ, δ are non negative integers, then
(A) α < β
(B) γ < δ
(C) α + δ = β + γ – 1
(D) γ + δ = 0

42. $f(x) = [x^2 - x + 1]$, x ∈ (0, 2), then f(x) is discontinuous at (where [.] denotes greatest integer function)

(A) $\frac{1+\sqrt{2}}{2}$
(B) $\frac{1+\sqrt{3}}{2}$
(C) $\frac{1+\sqrt{5}}{2}$
(D) 1

43. Let (x + 1)(x + 2)(x + 3) ….. (x + 100) = $a_0 + a_1x + a_2x^2 + \ldots\ldots a_{100}x^{100}$, then $100a_0 + 99a_1 + 98a_2 + \ldots\ldots a_{99}$ is equal to

(A) $(101)!\left(\frac{1}{2}+\frac{2}{3}+\ldots\ldots+\frac{100}{101}\right)$
(B) $(101)!\left(1+\frac{1}{2}+\frac{2}{3}+\ldots\ldots+\frac{1}{100}\right)$
(C) $(101)!\left(1+\frac{1}{2}+\frac{2}{3}+\ldots\ldots+\frac{100}{101}\right)$
(D) $(101)!\sum_{n=4}^{103}\left(\frac{n-3}{n-2}\right)$

44. Let $f(x) = \int_0^{x^2} \frac{t^2 - 5t + 4}{2 + e^t}$, then f(x) has

(A) minimum at x = –2, 0, 2
(B) maxima at x = –1, 1
(C) minima at x = –2, 2
(D) maxima at x = –1, 0, 1

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the lists based on the information given in the paragraph.

MM-I. Match the following list(s)

LIST-I		LIST-II	
(I)	If $\vec{a} = \hat{j} + \sqrt{3}\hat{k}$, $\vec{b} = \hat{j} + \sqrt{3}\hat{k}$ and $\vec{c} = 2\sqrt{3}\hat{k}$ from a triangle, then the internal angles of the triangle between $\vec{a}$ and $\vec{b}$ is	(P)	$\frac{\pi}{6}$
(II)	If $\int_a^b (f(x) - 3x)dx = a^2 - b^2$, then the value of $f\left(\frac{\pi}{6}\right)$ is	(Q)	$\frac{2\pi}{3}$
(III)	The value of $\frac{\pi^2}{\ln 3}\int_{7/6}^{5/6} \sec(\pi x)dx$ is	(R)	$\frac{\pi}{3}$
(IV)	The maximum value of $\left|\arg\left(\frac{1}{1-z}\right)\right|$ for |z| = 1, z ≠ 1 is approaching to the value	(S)	π
		(T)	$\frac{\pi}{2}$
		(U)	$\frac{\pi}{4}$

45. Which of the following is the only CORRECT combination?
(A) (I), (P)
(B) (II), (P)
(C) (III), (P)
(D) (IV), (Q)

46. Which of the following is the only INCORRECT combination?
(A) (I), (Q)
(B) (III), (S)
(C) (IV), (T)
(D) (III), (T)

Answer the following by appropriately matching the lists based on the information given in the paragraph.

MM-II. Match the following list(s)

	LIST-I		LIST-II
(I)	The set $\left\{\mathrm{Re}\left(\frac{2iz}{1-z^2}\right) z \text{ is a complex number } \lvert z\rvert = 1, z \neq \pm 4\right\}$ is	(P)	$(-\infty, -1) \cup (1, \infty)$
(II)	If $f(\theta) = \begin{vmatrix} 1 & \tan\theta & 1 \\ \tan\theta & 1 & \tan\theta \\ -1 & \tan\theta & 1 \end{vmatrix}$, then the set $\left\{f(\theta), 0 \le \theta < \frac{\pi}{2}\right\}$ is	(Q)	$(-\infty, 0) \cup (0, \infty)$
(III)	The domain of the function $f(x) = \sin^{-1}\left(\frac{8(3)^{x-2}}{1-3^{2(x-1)}}\right)$ is	(R)	$[2, \infty)$
(IV)	If $f(x) = x^{3/2}(3x - 10)$, $x \ge 0$, then f(x) is increasing in	(S)	$(-\infty, -1] \cup [1, \infty)$
		(T)	$(-\infty, 0] \cup [2, \infty)$
		(U)	$(0, \infty)$

47. Which of the following is the only CORRECT combination?
(A) (I), (S)
(B) (II), (T)
(C) (III), (R)
(D) (IV), (S)

48. Which of the following is the only INCORRECT combination?
(A) (II), (R)
(B) (III), (T)
(C) (IV), (R)
(D) (I), (Q)

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

49. If $a_n = \sqrt{1+\left(1-\frac{1}{n}\right)^2} + \sqrt{1+\left(1+\frac{1}{n}\right)^2}$ $(n \ge 1)$, then the value of $\sum_{i=1}^{20} \frac{1}{a_i}$ is equal to

50. Sum of the coefficients in the expansion of $(2x + y + z)^{37}$ which are divisible by 37 can be written as $(a^p - b^p - c)$ where p is a prime number and a, b, c are even, then $\left(\frac{a+b+c+2}{2}\right)$ is equal to

51. A point P is randomly selected from the region described by $3 \le |z| \le 5$ (where z is a complex number). If the probability that argument of P lies in the interval $\left[-\frac{\pi}{4}, \frac{\pi}{4}\right]$ is $\frac{1}{N}$, then N is

52. Let $f(x) = ax^4 + 6x^2 + 3x + 7$ and $f(-4) = 2286$ and $f(4) = N$. Then the number of ways in which the number N can be resolved as a product of two divisor which are relatively prime

53. If the distance of two points P and Q from the focus of a parabola $y^2 = 4ax$ are 4 and 9 respectively, then the distance of the point of intersection of tangents at P and Q from the focus is

54. Let f(x) be continuous function such that $f(0) = 1$, $f(x) - f\left(\frac{x}{7}\right) = \frac{x}{7}$ $\forall\ x \in R$. The area of region bounded by the curve $y = f(x)$ and coordinate axes is

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – II

JEE (Advanced)-2020

PAPER – 1

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section–A (01 – 04, 19 – 22, 37 – 40)*** *contains 12 multiple choice questions which out of 4 options have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*
   Section-A (05 – 12, 23 – 30, 41 – 48) *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*

   *Negative Marks : **–1** In all other cases.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A

(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

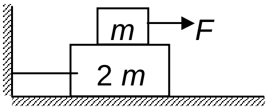
1. The pitch of a screw gauge is 1 mm and there are 100 divisions on its circular scale. When nothing is put in between its jaws, the zero of the circular scale lies 4 divisions below the reference line. When a steel wire is placed between the jaws, two main scale divisions are clearly visible and 67 divisions on the circular scale are observed. The diameter of the wire is

(A) 2.71 mm (B) 2.67 mm
(C) 2.63 mm (D) 2.65 mm

2. Two boys are standing at the points A and B on the ground, where $AB = a$. The boy at B starts running in a direction perpendicular to AB with velocity v_1. The boy at A starts running simultaneously with constant velocity v and catches the other in time t then t is

(A) $\frac{a}{\sqrt{v^2 + v_1^2}}$ (B) $\frac{a}{v + v_1}$
(C) $\frac{a}{v - v_1}$ (D) $\frac{a}{\sqrt{v^2 - v_1^2}}$

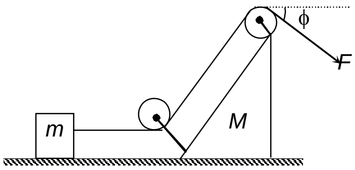
3. Two blocks of masses m & $2m$ are placed one over the other as shown in figure. The coefficient of friction between m and $2m$ is μ and between $2m$ and ground is $\mu/3$. If a horizontal force F is applied on upper block and T is tension developed in string then choose the incorrect alternative



(A) If $F = \frac{\mu}{3}mg$, $T = 0$ (B) If $F = \mu mg$, $T = 0$
(C) If $F = 2\mu mg$, $T = \mu mg/3$ (D) If $F = 3\mu mg$, $T = 0$

Space for Rough work

4. In the given arrangement pulleys and string are massless and frictionless and all surfaces are smooth. Find the magnitude of acceleration of wedge of mass M.



(A) $\dfrac{F\cos\varphi}{M}$

(B) $\dfrac{F(1-\cos\varphi)}{M}$

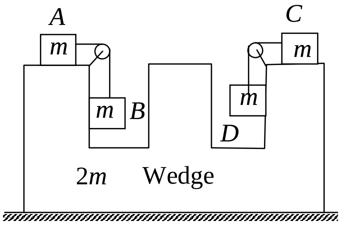
(C) $\dfrac{F}{m+M}$

(D) $\dfrac{F\cos\varphi}{m+M}$

(One or More than one correct type)

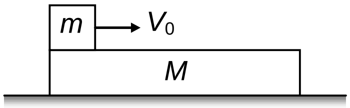
This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

5. In the given figure, all surface are frictionless and strings and pulleys are massless, then



(A) Acceleration of block *B* is *g*/2.
(B) Acceleration of block *B* is zero.
(C) Acceleration of block wedge is zero.
(D) Acceleration of block wedge is *g*/2.

6. The coefficient of friction between the block and plank is μ and its value is such that block becomes stationary with respect to plank before it reaches the other end. Then

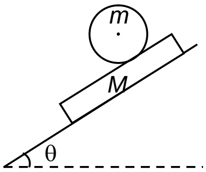


(A) the work done by friction on the block is negative
(B) the work done by friction on the plank is positive
(C) the net work done by friction is negative
(D) net work done by the friction is zero

Space for Rough work

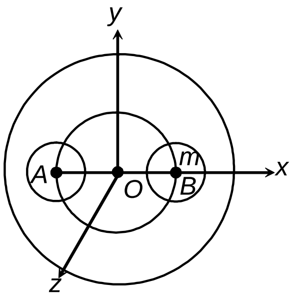
7. A chain of length L and mass per unit length ρ is piled on a horizontal surface. One end of the chain is lifted vertically with constant velocity by a force P.
(A) P as a function of height x of the end above the surface will be $\rho(gx + v^2)$.
(B) No energy will loss in this process.
(C) Work done by force will be $\frac{1}{2}\rho gL^2 + \rho v^2 L$
(D) Loss in energy $\frac{1}{2}\rho gLv^2$.

8. A solid sphere of mass m is released on the plank of mass M which lies on an inclined plane of inclination θ as shown in figure. There is sufficient frictional force between sphere and plank and the minimum value of co-efficient of friction between plank and surfaces is μ to keep the plank at rest. Then



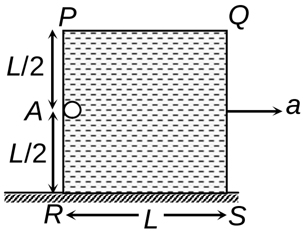
(A) Frictional force between sphere and plank is $\frac{2}{7}mg\sin\theta$, when plank is at rest.
(B) The value of μ is $\frac{7M+2m}{7(M+m)}\tan\theta$.
(C) If there is no friction between the plank and inclined plane, then acceleration of plank is less than $g \sin \theta$.
(D) If there is no friction between plank and inclined plane, then friction force on the sphere is zero.

9. A solid sphere of uniform density and radius 4 unit is located with its center at the origin O of co-ordinates. Two spheres of equal radii 1 unit, with their centres at $A(-2,0,0)$ and $B(2, 0, 0)$ respectively, are taken out of the solid leaving behind spherical cavities as shown in figure. Then



(A) The gravitational field due to this object at the origin is zero.
(B) The gravitational field at the point $B(2, 0, 0)$is zero
(C) The gravitational potential is same at all points on the circle $y^2 + z^2 = 36$
(D) The gravitational potential is same at all points on the circle $y^2 + z^2 = 4$

Space for Rough work



10. A small solid ball of density ρ is held inside at point A in a closed cubical container of side L, filled with an ideal liquid of density 4ρ as shown in the figure. Now, if the container starts moving with constant acceleration a horizontally and the ball is released from point A simultaneously, then
(A) For ball to hit the top of container at end Q, a = 3g
(B) For ball to hit the top of container at end Q, a = 2g
(C) Ball hits the top of container at end Q after a time $t = \sqrt{L/3g}$
(D) Ball hits the top of container at end Q after a time $t = \sqrt{2L/3g}$

11. A particle of mass m moves in a straight line. If v is the velocity at a distance x from a fixed point on the line and $v^2 = a - bx^2$, where a and b are constant, then
(A) The motion continues along the positive x-direction only
(B) The motion is simple harmonic
(C) The particle oscillates with a frequency equal to $\frac{\sqrt{b}}{2\pi}$
(D) The total energy of the particle is ma

12. A sound wave of frequency ν travels horizontally to the right. It is reflected from a large vertical plane surface moving to the left with a speed V. The speed of sound in the medium is c.
(A) The number of wave pulse striking the surface per second is $\frac{\nu(c+V)}{c}$
(B) The wavelength of the reflected wave is $\frac{c(c-V)}{\nu(c+V)}$
(C) The frequency of the reflected wave is $\frac{\nu(c+V)}{(c-V)}$
(D) The number of beats heard by a stationary listener to the left of the reflecting surface is $\frac{v\,V}{c-V}$

Space for Rough work

SECTION – C

(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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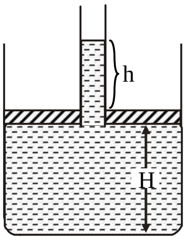
13. A barometer has become faulty because some air has leaked into the space above the mercury column. The height of the mercury column is 70 cm and the length of the space above the mercury is 10 cm. The barometer tube is then pushed further down into the mercury through. The length of space above mercury reduces to 6cm and the height of the mercury column is found to decrease to 67cm. This information shows that the true atmospheric pressure must be:

14. The distance between the parallel plates of a charged condenser is d = 5cm and the intensity of the field E = 300 V cm^{-1}. A slab of dielectric constant K = 5 and 1 cm wide is inserted parallel to the plates. Determine the potential difference between the plates, after the slab is inserted. (in volt)

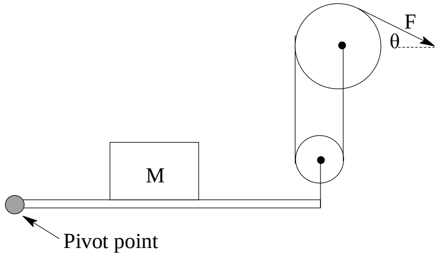
15. A piston weighing W = 3 kg has the form of a circular disc of radius R = 4 cm. The disc has a hole into which a thin - walled pipe of radius r = 1 cm in inserted. Initially the piston is at the bottom of the cylinder. What height will the piston rise to if m = 700 g of water is poured into the pipe?



16. A uniform rod of length l = 1m is free to move and rotate in gravity-free space. When an impulse is given to one end of the rod, perpendicular to its length, its centre of mass moves with velocity v = 1 m/s. What will be its angular velocity (in rad/s) about its centre of mass?

Space for Rough work

17. A pulley system is attached to a massless board as shown below. The board pivots only at the pivot point. A 10 kg mass M sits exactly in the middle of the board.



If the angle θ is 60°. The force F (in N) necessary to hold the board in the position shown is $5\times x$, find x?

18. The peak emission from a black body at a certain temperature occurs at a wavelength of 6000 Å. On increasing its temperature, the total radiation emitted is increased 16 times. These radiations are allowed to fall on a metal surface. Photoelectrons emitted by the peak radiation at higher temperature can be bought to rest by applying a potential equivalent to the excitation potential corresponding to the transition for the level n = 4 to n = 2 in the Bohr's hydrogen atom. The work function of the metal is given by $\frac{\alpha}{100}\text{eV}$ where α is the numerical constant. The value of α is found $53\times x$, find x?

[Take: he = 12420 eV-Å]

Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

19. Which of the following ions is expected to be colourless?

(A) Ni^{2+} (B) Mn^{+2}

(C) Zn^{2+} (D) Cu^{2+}

20. A definite mass of a monoatomic ideal gas at 1 bar and 27°C expands against vacuum from 1.2 dm^3 to 2.4 dm^3. The change in free energy of the gas, $\Delta G,$ is (R = 0.80 bar – L/K-mol, ln 2 = 0.7)

(A) 0 (B) $-64\,\text{bar}-1$

(C) $+84\,J$ (D) $-84\,J$

21. In a galvanic cell, the salt bridge:
(A) Does not participate chemically in the cell reaction.
(B) Stops the diffusion of ions from one electrode to another.
(C) Is necessary for the occurrence of the cell reaction.
(D) Ensures mixing of the two electrolytic solutions.

22. In the system, $\mathrm{LaCl_3(s)+H_2O(g)+heat \rightleftharpoons LaClO(s)+2HCl(g)}$, equilibrium is established. More water vapour is added to disturb the equilibrium. If the pressure of water vapour at new equilibrium is double of that at initial equilibrium, the factory by which pressure of HCl is changed is:

(A) 2 times (B) $\sqrt{2}$ times

(C) $\frac{1}{\sqrt{2}}$ times (D) 4 times

Space for Rough work

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

23. Which of the following information(s) is/are incorrect regarding the voids formed in three dimensional HCP of identical spheres?
(A) A tetrahedral void is formed when a sphere of the second layer is present above the triangular void of the first layer.
(B) All the triangular voids are not covered by the spheres of the second layer.
(C) Tetrahedral voids are formed when the triangular voids in the second layer lie above the triangular voids in the first layer and the triangular voids in the first layer and the triangular shapes of these voids do not overlap.
(D) Octahedral voids are formed when the triangular voids in the second layer exactly overlap with similar voids in the first layer.

24. Consider 0.1m-aqueous solutions of two solutes X and Y. The solute X behaves as a univalent electrolyte, while the solute Y dimerizes in solution. Which of the following statement(s) is/are correct regarding these solutions?
(A) The boiling point of the solution of X will be higher than that of Y.
(B) The osmotic pressure of the solution of X will be higher than that of Y.
(C) The freezing point of the solution of X will be higher than that of Y.
(D) The relative lowering of vapour pressure of both the solution will be the same.

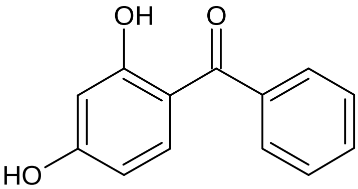
25. Select the correct statement:
(A) Chelation effect is maximum for five and six membered rings
(B) Greater the charge on the central metal cation, greater the value of $\Delta\left(\mathrm{CFSE}\right)$
(C) In complex ion $\left[\mathrm{CoF_6}\right]^{3-}$, $\mathrm{F^-}$ is a weak field ligand, so that $\Delta_{oct} < P$ (Pairing energy) and it is low spin complex.
(D) $\left[\mathrm{CoCl_2\left(NH_3\right)_2\left(en\right)}\right]^+$ complex ion will have four different isomers

26. Roasting of copper pyrites is done:
(A) to remove moisture
(B) to oxidise free sulphur
(C) to decompose pyrite into $\mathrm{Cu_2S}$ and FeS
(D) to remove volatile organic impurities

27. Select the incorrect statement(s):
(A) $\mathrm{Cs^+}$ is more hydrated than the other alkali metal ions
(B) Among the alkali metals Li, Na, K and Rb, lithium has the highest melting point
(C) Ionic mobility of $\mathrm{Li^+}$ is maximum among alkali metal cations
(D) Ionisation potential of Li is lower than that of Na.

Space for Rough work

28. A sunburn prevention agent must be non-toxic, non-staining, non-volatile, reasonably water soluble. It should filter of the burning rays of sunlight. Given structure is one such compound:



which method/s for synthesis of above compound starting from m-dimethoxybenzene:

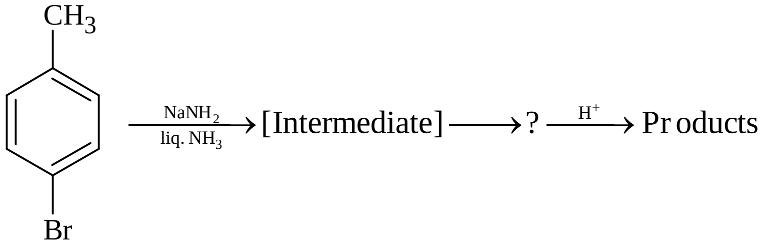
(A) $(\text{i})\text{Ph-COCl}, (\text{ii})\text{dil. NaOH}$

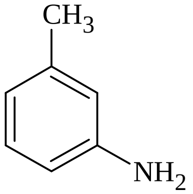
(B) $(\text{i})\text{Conc.HI}(\text{ii})\text{Ph-COCl}, \text{AlCl}_3$

(C) $(\text{i})\text{Ph-COCl}, \text{AlCl}_3\ (\text{ii})\ \text{conc.HI}$

(D) All of these

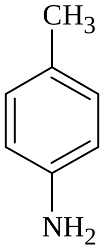
29. Choose the correct statement(s)



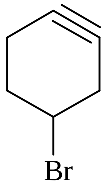
(A) 

is formed.

(B) Intermediate formed is aromatic

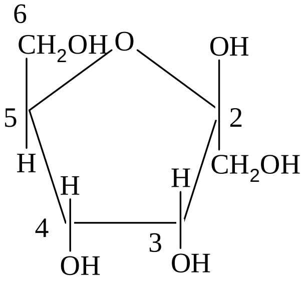
(C) 

is formed involving non-aromatic intermediate

(D) The intermedaite is 

Space for Rough work

30. Select correct statement/s for structure



(A) β–D–fructofuranose
(B) α–D–fructofuranose
(C) is a reducing sugar
(D) is a non-reducing sugar

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

31. An optically active substance, A, decomposes into optically active substances 'B' and 'C' as:

$$A \xrightarrow{K=0.001\ \text{min}^{-1}} 2B + C$$

The specific rotations of A, B and C are +40°, +10° and $-30°$ per mole, respectively. If initially A and C were present in $4:3$ mole ratio, the time (in min), after which the sample becomes optically inactive, is (ln 2=0.7, ln 5=1.6, ln 7=2.0, ln 13=2.5)

32. A hydrogenation reaction is carried out at 500K. If the same reaction is carried out in the presence of a catalyst at the same rate, the temperature required is 400 K. The activation energy of reaction (in kJ/mol), if the catalyst lowers the activation energy by 20 kJ/mol, is:

Space for Rough work

33. A volume of 100 ml of a liquid contained in an isolated container at a pressure of 1 bar. The pressure is steeply increases to 100 bar by which the volume of liquid is decreased by 1 ml. The change in enthalpy, $\Delta H,$ of the liquid (in bar mL)

34. At 20°C, the vapour pressure of 0.1 molal aqueous solution of urea is 0.03 mm less than that of water and the vapour pressure of 0.1 molal solution if KCl is 0.0594 mm less than that of water. The apparent percentage dissociation of KCl in water at the given temperature is (Neglect the moles of solute particles in comparison to the moles of water in both solutions).

35. If x and y are total number of electrons which are present in non-axial and axial set of d-orbitals respectively in Ni cation of $\left[\mathrm{Ni}\left(\mathrm{DMG}\right)_2\right]$, then calculate value of $\frac{2x^2}{y}$.

36. Total energy of electron in the 1st orbit of hydrogen atom is 13.6 eV/atom. Kinetic energy of electron in the 1st excited state of Li^{2+} ion in eV is:

Space for Rough work

Mathematics

PART – III

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. If $f(x) = -1 + ax + a$ neither touches nor cuts the curve $f(x) = \ln x$, then minimum value of a may lies in

(A) $\left(\frac{1}{e}, \frac{1}{\sqrt{e}}\right)$ (B) $\left(e, e^2\right)$

(C) $\left(\frac{1}{\sqrt{e}}, e\right)$ (D) None of these

38. If $A(z_1), B(z_2), C(z_3)$ are vertices of a triangle such that $z_3 = \left(\frac{z_2 - iz_1}{1-i}\right)$ and $|z_1| = 3, |z_2| = 4$ and $|z_2 + i\,z_1| = |z_1| + |z_2|$, then area of triangle ABC is

(A) $\frac{5}{2}$ (B) 0

(C) $\frac{25}{4}$ (D) $\frac{25}{2}$

39. Let $A = \{1, 2, 3, 4, 5\}$ *and* $B = \{3, 4, 5, 6, 7, 8, 9\}$ are two sets, then the number of one-one functions $f : A \to B$ such that $|f(i) - i| \le 4 \forall i \in A$, is equal to

(A) 243 (B) 120

(C) 149 (D) 219

Space for Rough work

40. A curve is represented parametrically by the equation $x = f(t) = a^{\ln(b^t)}$ $and\ y = g(t) = b^{-\ln(a^t)}$, $a, b > 0$ and $a \neq 1, b \neq 1$ where $t \in R$ the value of $\frac{d^2y}{dx^2}$ at the point where $f(t) = g(t)$ is

(A) 0 (B) $\frac{1}{2}$

(C) 1 (D) 2

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

---

41. Let $A\, and\, B$ are commutative square matrices of order three such that A is symmetric and B is skew symmetric, if $C = (A+B)^T (A+B)(A-B)^{-1}$ (where X^T and $|x|$ denotes transpose and determinant value of x respectively), then

(A) $A + B - C = 0$ (B) $A - B - C = 0$

(C) $|B| = 0$ (D) $2A - C = C^T$

42. If $\lim\limits_{n\to\infty}\left(\frac{1}{1^2} + \frac{1}{2^2} + ... + \frac{1}{n^2}\right) = \frac{\pi^2}{6}$ $and\ S = \lim\limits_{n\to\infty}\left(\frac{1}{1^3 \cdot 2^3} + \frac{1}{2^3 \cdot 3^3} + \frac{1}{3^3 \cdot 4^3} + ... \frac{1}{n^3 \cdot (n+1)^3}\right)$, then $S + \pi^2$ is equal to

(A) A non-integral number (B) An rational number

(C) A transcendental number (D) An integer

43. $f(x)$ is a differentiable function such that $f(x) = x^2 + \int_0^x e^{-t} f(x-t)dt$, then

(A) $f(x) = \frac{x^3}{3} + x$ (B) $f(x) = \frac{x^3}{3} + x^2$

(C) $f'(x) = x^2 + 2x$ (D) $\int_{-2}^{2} \left(f(x) - x^2\right)dx = 0$

Space for Rough work

44. Which of the following is/are true?

(A) If $y = f(x)$ is a strictly monotonic function in (a,b) with $f(x) \neq 0$, then the area bounded by $y = f(x)$, the lines $x = a, x = b\, and\ y = f(c)$ where $c \in (a,b)$ is minimum when $c = \frac{a+b}{2}$.

(B) $y = f(x)$ is a strictly monotonic function in (a,b) with $f(x) \neq 0$, then the area bounded by the lines $x = a, x = b\, and\ y = f(c)$ where $c \in (a,b)$ is minimum when $c = \frac{2a+b}{3}\, or\, c = \frac{a+2b}{3}$.

(C) If the area bounded by $f(x) = \frac{x^2}{3} - x^2$ and the lines $x = 0, x = 2$ and the x-axis is minimum when $a = \frac{2}{3}$

(D) If the area bounded by $f(x) = \frac{x^3}{3} - x^2$ and the lines $x = 0, x = 2$ and the x-axis is minimum when $a = \frac{28}{81}$

45. Mr. A randomly picks 3 distinct numbers from the set $\{1, 2, 3, ..., 9\}$ and arranges them in descending order to form a three digit number. Mr. B randomly picks 3 distinct numbers from the set $\{1, 2, 3, ..., 8\}$ and also arranges them in descending order to form 3 digit numbers.

(A) Probability that Mr. A's 3 digit number is always greater then Mr. B's 3 digit number is $\frac{1}{3}$

(B) Probability that Mr. A and Mr. B has the same 3 digit numbers is $\frac{1}{84}$

(C) Probability that Mr. A's 3 digit number is greater then Mr.B's 3 digit number is $\frac{37}{56}$

(D) Probability that Mr. A's 3 digit number is greater then Mr.B's 3 digit number is $\frac{1}{3}$

Space for Rough work

46. Let $H:\frac{(x-1)^2}{9}-\frac{(y+2)^2}{4}=1$ be the hyperbola with centre at C. Now if from any point 'Q' on the asymptotes a straight line be drawn perpendicular to the transverse axis to meet the hyperbola at P and P'. Again a tangent is drawn to the hyperbola at P which meet the asymptotes at L and G, then

(A) $PQ.QP'=4$ (B) $PQ.QP'=9$

(C) area of $\Delta CLG=6$ (D) area of $\Delta CLG=8$

47. If $I_1=\int_0^{\frac{\pi}{2}}\frac{\sin(\sin x)}{\sin x}dx; I_2=\int_0^{\frac{\pi}{2}}\frac{\sin x}{x}dx; I_3=\int_0^{\frac{\pi}{2}}\frac{\sin(\tan x)}{\tan x}dx$, then which of the following is true

(A) $I_1>I_3$ (B) $I_2>I_3$

(C) $I_1>I_2$ (D) $I_1<I_2$

48. An ellipse whose major axes is parallel to x-axis is such that the segment of a focal chord are of length 1 and 3 unit. The family of lines $ax+by+c=0$ are the chords of the ellipse such that a,b,c are in $A.P.$ and bisected by the point at which they are concurrent and the equation of auxiliary circle is.

$x^2+y^2+2\alpha x+2\beta y-2\alpha+1=0$, then make all the correct alternative(s)

(A) The equation of the auxiliary circle is $x^2+y^2-2x+4y+1=0$

(B) Eccentricity of ellipse if $\frac{1}{2}$

(C) Length of major axis are $4,\sqrt{3}$

(D) Eccentricity of the ellipse is $\frac{\sqrt{3}}{2}$

Space for Rough work

SECTION – C

(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

49. The line $\frac{x-2}{3}=\frac{y+1}{2}=\frac{z-1}{-1}$ intersects the curve $xy=c^2$, in xy plane if c^2 is equal to_____

50. If $a+b+c=4,$ then maximum value of $\sqrt{3a+5}+\sqrt{3b+5}+\sqrt{3c+5}$ is equal to________ $\left(where\ a,b,c\in R^+\right)$

51. If K^{th} term is the greatest term in the square $a_n=\frac{n}{70+n^2},n\in N,$ then k is____

52. A triangle is so placed that the midpoints of its sides one placed on the co-ordinate axes, if a, b and c are the sides of the triangle, then the equation of the triangle is $\frac{x}{x_1}+\frac{y}{y_1}+\frac{z}{z_1}=1$ where $a^2+b^2+c^2\ =k\ \left(x_1^2+y_1^2+z_1^2\right)$, then the value of k is______

53. The value of $\tan 1^\circ \tan 2^\circ+\tan 2^\circ \tan 3^\circ+.......+\tan 88^\circ \tan 89^\circ$ is equal to $\cot^2 1^\circ-n$, where n is a two digit number ab, then the value of $b-a$ is_______

54. All the three vertices of an equilateral triangle lie on the parabola $y=x^2$, and one of its sides has a slope of 2. The x-coordinates of the three vertices have a sum equal to $\frac{p}{q}$ where p and q are relatively prime positive integers. Find the value of (q-p)

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – II

JEE (Advanced)-2020

PAPER – 1

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

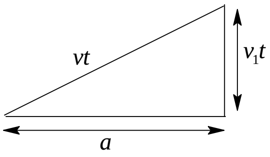
1. A

Sol. $d = 2 + (0.01 \times 67) + (0.01 \times 4)\,mm$

$d = 2.71\,mm$

2. D

Sol. $a^2 + v_1^2 t^2 = v^2 t^2$



$t = \dfrac{a}{\sqrt{v^2 - v_1^2}}$

3. C

Sol. Tension in the string will always be zero.

4. B

Sol. $F - F\cos\phi = Ma$

$a = \dfrac{F(1-\cos\phi)}{a}$ towards left.

5. AC

Sol. Wedge will not move since net horizontal force on the wedge is zero.
For block B $T = ma$
$mg - T = ma \Rightarrow \quad a = g/2$

6. ABC
Sol. Friction on block and it's velocity are opposite, hence work is negative.
Friction on plank and its displacement are in same direction, hence work is positive.

7. ACD
Sol. P = weight of the vertical part + force required to provide momentum to the part which is being lefted per unit time
Hence,

$$P = \delta gx + \frac{(\delta vdt)v}{dt}$$

$$P = \delta\left[gx + v^2\right]$$

8. ABD

9. ACD
Sol. Due to symmetrically placed cavities field at center will be zero and potential at equidistant points from center on y-z plane would be equal.

10. ACD
Sol. Buoyant force should be towards point θ.

11. BC
Sol. $v^2 = a - bx$
Differentiating w.r.t. x

$$\frac{2vdv}{dx} = -2bx$$

$$\frac{d^2x}{dt^2} = -bx \Rightarrow motion\,is\,SHM$$

Comparing with

$$\frac{d^2x}{dt^2} = -\omega^2 x$$

$$f = \frac{\sqrt{b}}{2\Pi}$$

12. ABC
Sol. Frequency observed by wall $f' = v\frac{c+V}{C}$ $\quad (moving\ observee)$

=number of pulse striking persecond

Frequency of reflected wave $f'' = f'\frac{c}{C-V} = v\frac{C+V}{C-V}$

Wavelength $f'' = f'\frac{c}{C-V} = v\frac{C+V}{C-V}$

SECTION – C

13. 00074.50

Sol. Pressure of air above Hg column

$$P_1 = P_0 - 70 \qquad cm\,of\ Hg$$

$$P_2 = P_0 - 67$$

$$P_2 = P_1 \times \frac{10}{6}$$

$$\frac{10}{6}P_1 = P_0 - 67$$

$$P_1 = \frac{6P_0}{10} - 40.2$$

$$P_0 - 70 = \frac{6P_0}{10} - 40.2$$

$$\frac{4P_0}{10} = 29.8$$

$$P_0 = \frac{29.8 \times 10}{4} = 74.5cm$$

14. 01260.00

Sol. Potential difference without introducing the slab is given by

V_0 = E × d = 300 × 5 = 1500 volt

The capacitance C_0 is given by

$$C_0 = \frac{\epsilon_0 A}{d} = \frac{\epsilon_0 A}{0.05} \text{ farad}$$

$\therefore \quad \epsilon_0 A = 0.05\ C_0$ ...(1)

when the slab is inserted, the capacitance C is given by

$$C = \frac{\epsilon_0 A}{d - t + t/K} \text{ where t = thickness of slab}$$

$$= \frac{0.05C_0}{0.04 + \frac{0.01}{5}} = \frac{25C_0}{21} \qquad ...(2)$$

Now $C_0 V_0 = CV$

$$C_0 \times 1500 = \frac{25C_0}{21} \times V$$

$$\text{or} \quad V = \frac{1500 \times 21}{25} = 1260 \text{ volt}$$

15. 00010.00

Sol. Area of the piston = $\pi (R^2 - r^2)$

Pressure on the base = $\rho g (H + h)$ where

ρ = density of water.

Also pressure on the base

$$= \frac{(W + m)g}{\pi R^2}$$

$\therefore$ ρg (H + h) = $\frac{(W+m)g}{\pi R^2}$

$\Rightarrow$ H + h $\frac{(W+m)}{\pi R^2 \rho}$ ....(i)

Considering the equilibrium of the piston
Upward thrust = weight of the piston
$\pi(R^2 - r^2)$ □gh = Wg

$\Rightarrow$ h = $\frac{W}{\pi(R^2 - r^2)\rho}$ ....(ii)

From (i) and (ii)

$$H = \frac{W+m}{\pi R^2 \rho} - \frac{W}{\pi(R^2 - r^2)\rho}$$

$$\Rightarrow H = \frac{1}{\pi R^2 \rho}\left(m - W\frac{r^2}{R^2 - r^2}\right)$$

$$\Rightarrow H = \frac{1}{\pi \times 4^2 \times 10^{-4} \times 1000}$$

$$= \left(0.7 - \frac{3\times 1^2 \times 10^{-4}}{(4^2 - 1^2)\times 10^{-4}}\right)$$

= 10 cm

16. 00006.00

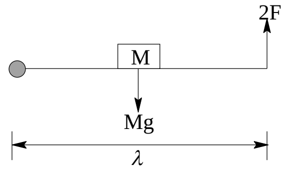
Sol. By linear momentum conservation impulse (J) = mV.

By angular momentum conservation, angular impulse $= J\frac{\lambda}{2} = I\omega$

So $mv\frac{\lambda}{2} = I\omega \text{ or } \omega = \frac{mv\lambda}{2I} = \frac{mv\lambda}{2\left(\frac{m\lambda^2}{12}\right)} = \frac{6v}{\lambda} = 6\,rad/s$

17. 00005.00

Sol.



For equilibrium

$$\left|Mg\frac{\lambda}{2}\right| = |2F|1$$

$$F = \frac{mg}{4} = \frac{100}{4} = 25\,N$$

18. 00003.00

Sol. From Wien's displacement law and Stefen Boltzman law the wavelength of the peak radiation is halved.

So, $\lambda = 3000\mathring{A}$

$$\frac{hc}{\lambda} - \frac{\alpha}{100} = 13.6\left[\frac{1}{4} - \frac{1}{16}\right]$$

$$\frac{hc}{\lambda} - \frac{\alpha}{100} = 2.55$$

$$\frac{12420}{3000} - \frac{\alpha}{100} = 2.55$$

$$\frac{\alpha}{100} = 4.14 - 2.55 = 1.59$$

$$\alpha = 159 = 53x$$

$$x = 3$$

Chemistry PART – II

SECTION – A

19. C

Sol. Fully filled d-subshell is colourless in nature.

20. D

Sol. $\Delta S = RLn\frac{V_2}{V_1}$

$\Delta H = 0$

$\Delta G = \Delta H - T\Delta S$

21. A

Sol. Salt bridge does not participate in chemical reaction.

22. C

23. CD

24. AB

Sol. Solute X will dissociate into the solution so i>1.

25. ABD

Sol. $\left[\mathrm{CoF_6}\right]^{3-}$ is a high spin complex.

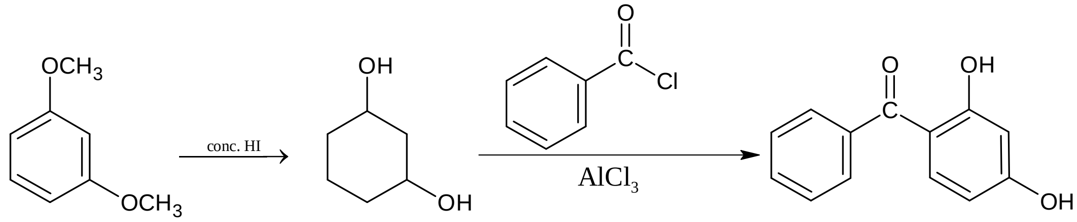
26. ABCD

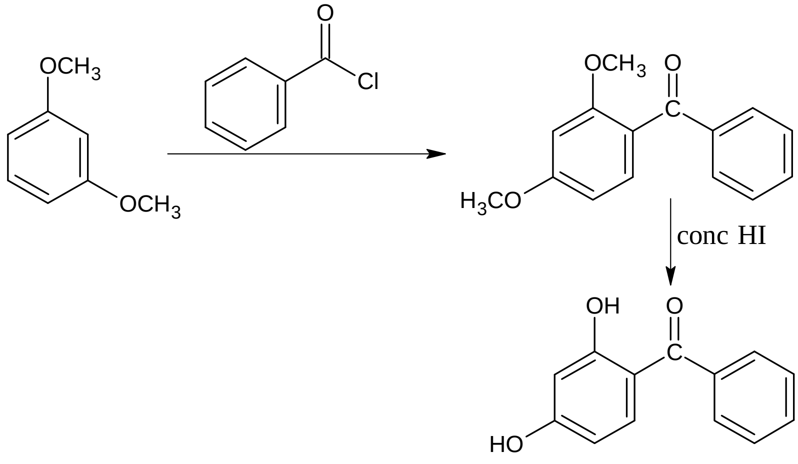
27. ACD

Sol. Due to the more cohesive energy in Li, it has highest melting point among alkali metals.

28. BC

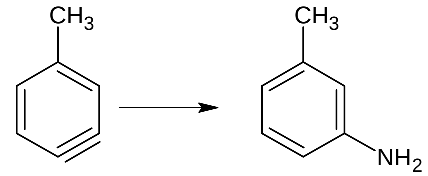
Sol.


OCH3
OCH3
conc. HI
OH
OH
O
C
Cl
AlCl3
O
C
OH
OH


OCH3
OCH3
O
Cl
OCH3
O
C
H3CO
conc HI
OH
O
C
HO

29. AB

Sol.



Intermediate product

30. AC

Sol. This is β-D- fructofuranose and a reducing sugar.

SECTION – C

31. 00500.00

32. 00100.00

Sol. $K = Ae^{-Ea/RT}$

33. 09900.00

Sol. $\Delta U = q\ tw$

For adiabatic process $q = 0$

$\Delta U = w$

$\Delta U = P\Delta V = -P\left(V_2 - V_1\right)$

$\Delta U = -100\left(99-100\right) = 100\,\text{bar mL}$

Now $\Delta H = \Delta U + \Delta\left(PV\right)$

$\Delta H = 100 + \left[100\times 99 - 1\times 100\right]$

$\Delta H = 9900\,\text{bar mL}$

34. 00098.00

Sol. $T = 20°C$ $\quad 0.1m$ solution of urea $\Delta\text{P=0.03mm}$

$KCl \to 0.1m \quad \Delta P = 0.0594$

$$\frac{\Delta P}{P} = x_\beta \to 0.1 mole\, in 1kg$$

$$\frac{0.03}{P} = \frac{0.1}{0.1+55.5}$$

$$P = \frac{0.03\times 55.65}{0.1} = 16.695$$

$$\frac{\Delta P}{P} = iX_\beta$$

$$\frac{0.0594}{16.695} = i\left[0.00179\right]$$

$i = 1.987$

35. 00036.00

36. 00030.60

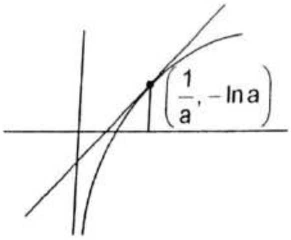
Sol. $KE = 13.6\times\dfrac{Z^2}{n^2} = 13.6\times\dfrac{3^2}{2^2} = 30.6\text{eV}$

Mathematics PART – III

SECTION – A

37. A

Sol.



$$f(x) = \ln x$$

$$f'(x) = \frac{1}{x}$$

$$\Rightarrow x = \frac{1}{a} \text{at point of tangency}$$

$$\frac{-\ln a + 1}{1 + \frac{1}{a}} = a \Rightarrow a + \ln a = 0$$

Let $f(a) = a + \ln a = 0$

$$f\left(\frac{1}{e}\right) < 0 \, and \; f\left(\frac{1}{\sqrt{e}}\right) > 0$$

$$\Rightarrow a \in \left(\frac{1}{e}, \frac{1}{\sqrt{e}}\right)$$

38. C

Sol. $|z_2 + i z_1| = |z_1| + |z_2|$

$\Rightarrow z_2, i z_1, 0$ are collinear

$$\Rightarrow \arg(i z_1) = \arg z_2$$

$$z_3 = \frac{z_2 - i z_1}{1 - i} \Rightarrow (1 - i) z_3 = z_2 - i z_1$$

$$\Rightarrow i = \frac{z_3 - z_2}{z_3 - z_1} \Rightarrow \arg\left(\frac{z_3 - z_2}{z_3 - z_1}\right) = \frac{\pi}{2}$$

$$and \, |z_3 - z_2| = |z_3 - z_1|$$

$$\Rightarrow AC = BC, AB^2 = AC^2 + BC^2$$

$$\Rightarrow AC = \frac{5}{\sqrt{2}}; \Delta = \frac{1}{2} \times \frac{5}{\sqrt{2}} \times \frac{5}{\sqrt{2}} = \frac{25}{4} sq.units$$

39. A

Sol. $\left({}^3C_1\right)^5$

40. D

Sol. $f(t) = g(t) \Rightarrow f(t) = -f(t) \Rightarrow = 0$

$\because \{f(t)\text{is one} - \text{one function}\}$

$t = 0, x = y = 1$

$\because \frac{dy}{dx} = -\frac{1}{x^2}\, and\, \frac{d^2y}{dx^2} = \frac{2}{x^3}$

$at\; x = 1, \frac{d^2y}{dx^2} = 2$

41. ACD

Sol: $\because (A+B)(A-B) = (A-B)(A+B)$

Now $C = \left(A^T + B^T\right)(A+B)(A-B)^{-1}$

$= (A-B)(A+B)(A-B)^{-1}$

$= (A+B)(A-B)(A-B)^{-1}$

$= A+B$

Now $C^T = A^T + B^T = A - B$

$C + C^T = 2A$

42. BD

Sol: Let $t_r = \left(\frac{1}{r(r+1)}\right)^3 = \left(\frac{1}{r} - \frac{1}{r+1}\right)^3 = \frac{1}{r^3} - \frac{1}{(r+1)^3} - \frac{3}{r(r+1)}\left(\frac{1}{r(r+1)}\right)$

$= \frac{1}{r^3} - \frac{1}{(r+1)^3} - 3\left(\frac{(r+1)-r}{r(r+1)}\right)^2$

$t_r = \frac{1}{r^3} - \frac{1}{(r+1)^3} - 3\left(\frac{1}{r^2} + \frac{1}{(r+1)^2}\right) + 6\left(\frac{1}{r} - \frac{1}{r+1}\right)$

$\sum_{r=1}^{n} t_r = \left(1 - \frac{1}{(n+1)^3}\right) - 3\left(\frac{\pi^2}{6} + \frac{\pi^2}{6} - 1\right) + 6\left(1 - \frac{1}{n+1}\right)$

$\lim_{x\to\infty} \sum t_r = 10 - \pi^2$

43. BCD

Sol. $f(x) = x^2 + \int_0^x e^{-t} f(x-t)\,dt$

$$= x^2 + \int_0^x e^{-(x-t)}.f\left(x(x-t)\right)dt$$

$$= x^2 + e^{-x}.\int_0^x e^t.f(t)\,dt$$

$$\therefore e^x.f(x) = x^2.e^x + \int_0^x e^t.f(t)\,dt$$

Differentiate with respect to x, we get $f'(x) = x^2 + 2x$

$$\Rightarrow f(x) = \frac{x^3}{3} + x^2 + x, also\ f(0) = 0$$

$$\Rightarrow c = 0$$

$$\Rightarrow f(x) = \frac{x^3}{3} + x^2$$

44. AC

Sol. Obvious

45. ABC

Sol. When 9 is not included $= \frac{{}^8C_3.{}^8C_3 - {}^8C_3}{2}$

and required probability is $= \frac{1}{3} + = \frac{{}^8C_3.{}^8C_3 - {}^8C_3}{2.{}^9C_3.{}^8C_3} = \frac{37}{56}$

46. AB

Sol. By property: $PQ \cdot P'Q = b^2$ and area of $\Delta CLG = ab$

47. ABC

Sol. $0 < x < \frac{\pi}{2} \Rightarrow \frac{\sin x}{x}$ is decreasing and $\sin x < x < \tan x$

$$\Rightarrow \frac{\sin(\sin x)}{\sin x} > \frac{\sin x}{x} > \frac{\sin(\tan x)}{\tan x}$$

$$\Rightarrow I_1 > I_2 > I_3$$

48. ABC

Sol. a, b, c in $A.P.$ so line concurrent at $(1, -2)$

$\therefore$ Centre of auxiliary circle $(-\alpha, -\beta) = (1, -2)$ radius of circle $= 2$

Length of major axis $= 4 = 2A$

$$\because \frac{1}{SP} + \frac{1}{SQ} = \frac{2A}{B^2}$$

$$\Rightarrow B = \sqrt{3}$$

Hence, $e = \frac{1}{2}$

SECTION – C

49. 00005.00

Sol. Put $z = 0$ in the given equation $x = 5 \, and \, y = 1$

$\Rightarrow 5.1 = c^2$

50. 00009.00

Sol. Let $\sqrt{3a+5} = x, \sqrt{3b+5} = y, \sqrt{3c+5} = z$

$(x+y+z)^2 \le 3\sum x^2; \left(\because \sum x^2 \ge \sum xy\right)$

51. 00008.00

Sol. Let $f(x) = \dfrac{x}{70+x^2}; \ f'(x) = \dfrac{70-x^2}{\left(70+x^2\right)^2}$

So $f(x)$ increase in $\left(0, \sqrt{70}\right) and \ f(x)$ decrease in $\left(\sqrt{70}, \infty\right)$

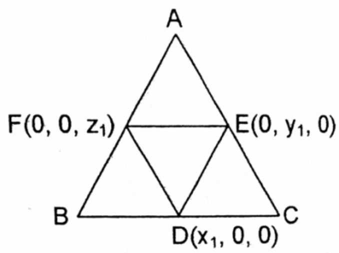
So, greater term may be $a_8 \, or \, a_9$

But $\dfrac{a_8}{a_9} > 1$

$\Rightarrow k = 8$

52. 00008.00

Sol.



Let the intercept of plane on the axes be

$(x_1, 0, 0), (0, y_1, 0), (0, 0, z_1)$

So, equation is $\dfrac{x}{x_1} + \dfrac{y}{y_1} + \dfrac{z}{z_1} = 1$

$\because EF \Big\| BC \, and \, EF = \dfrac{1}{2} BC = 4\left(y_1^2 + z_1^2\right) = a^2$

Similarly $4\left(x_1^2 + y_1^2\right) = c^2 \, and \, 4\left(z_1^2 + x_1^2\right) = b^2$

$\Rightarrow a^2 + b^2 + c^2 = 8\left(x_1^2 + y_1^2 + z_1^2\right)$

$\Rightarrow k = 8$

53. 00001.00

Sol. $\tan(2-1) = \dfrac{\tan 2 - \tan 1}{1 + \tan 2 \cdot \tan 1}$

$$\Rightarrow \tan 1^\circ \tan 2^\circ = \frac{\tan 2 - \tan 1}{\tan 1} - 1$$ (Similarly)

54. 00008.00

Sol. $t_1 + t_2 = 2$

$$\frac{2-m_2}{1+2m_2} = \sqrt{3}$$

$$\text{and} \frac{m_3-2}{1+2m_3} = \sqrt{3}$$

$$t_1 + t_2 + t_3 = \frac{p}{q} = \frac{3}{11}$$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – II

JEE (Advanced)-2020

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section-A (01 – 08, 19 – 26, 37 – 44)*** *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–1** In all other cases.*

   Section-A (09 – 12, 27 – 30, 45 – 48) *contains 6 List-Match sets with 12 questions (each set has 2 questions). Each question has 4 statements in LIST-I & 5 or 6 statements in LIST-II. The codes for Lists have choices (A), (B), (C), (D) out of which only one is correct.*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

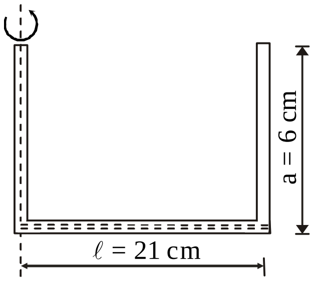
1. In a large room a person receives direct sound waves from a source 120 m away from him. He also receives waves from the same source which reach him, being reflected from the 25 m high ceiling at point half way between them. For which wavelength will these two sound waves interfere constructively?

(A) 10m (B) 5m
(C) 8 m (D) 4 m

2. 4 moles of an ideal gas having γ = 1.67 are mixed with 2 moles of another ideal gas having γ = 1.4. Then which of the following is not the equivalent value of γ for the mixture.

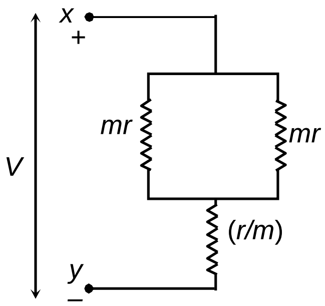
(A) 1.54 (B) 2.34
(C) 1.23 (D) 1.87

3. Length of a horizontal arm of a U-tube is l = 21cm and ends of both of the vertical arms are open to surroundings of pressure 10500 Nm^{-2}. A liquid of density ρ =10^3 kg m^{-3} is poured into the tube such that liquid just fills horizontal part of the tube. Now, one of the open ends is sealed and the tube is then rotated about a vertical axis passing through the other vertical arm with angular velocity ω_0 = 10 radians/sec. If length of each vertical arm be a = 6 cm, calculate the length of air column in the sealed arm.



(A) 5cm (B) 4cm
(C) 7cm (D) 8cm

4. In the given circuit the value of *m* is varying. The correct statements about the circuit are



(A) The condition for maximum current flowing from *x* is *m* =2.

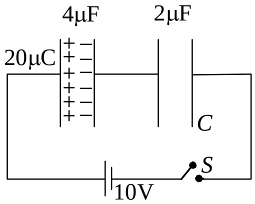
(B) The maximum current is $\frac{V}{\sqrt{2}r}$.

(C) The condition for maximum current flowing from *x* is $m = \sqrt{2}$.

(D) The maximum current is $\frac{3V}{2r}$.

Space for Rough work

5. A $4\mu F$ capacitor is given $20\mu C$ charge and is connected with an uncharged capacitor of capacitance $2\mu F$ as shown in figure. When switch *S* is closed.



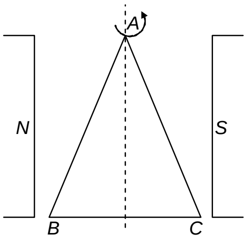
(A) Charged flown through the battery is $\frac{40}{3}\mu C$

(B) charge flown through the battery is $\frac{20}{3}\mu C$

(C) Work done by the battery is $\frac{200}{3}\mu J$

(D) work done by the battery is $\frac{100}{3}\mu J$

6. A coil in the shape of an equilateral triangle of side 0.02 m is suspended from vertex such that it is hanging in a vertical plane between the pole-pieces of a permanent magnet producing a horizontal magnetic field of 5 × 10–2T. Current in loop is 0.1 A. Then:



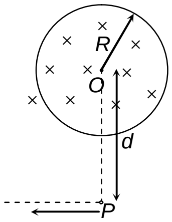
(A) Magnetic moment of the loop is $\sqrt{3}\times10^{-5} A-m^2$

(B) Magnetic moment of the loop is $1\times10^{-6} A-m^2$

(C) Couple acting on the coil is $5\sqrt{3}\times10^{-7} N/m$

(D) Couple acting on the coil is $\sqrt{3}\times10^{-7} N-m$

Space for Rough work



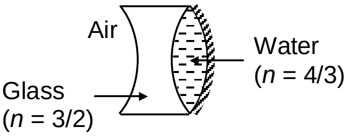
7. In a cylindrical region of radius *R*, there exists a time varying magnetic field *B* such that $\frac{dB}{dt} = k(>0)$. A charged particle having charge *q* is placed at the point *P* at a distance *d* (> *R*) from its centre *O*. Now, the particle is moved in the direction perpendicular to *OP* (see figure) by an external agent upto infinity so that there is no gain in kinetic energy of the charged particle. Choose the correct statement/s.

(A) Work done by external agent is $\frac{q\pi R^2}{4}k$ if *d* = 2*R*

(B) Work done by external agent is $\frac{q\pi R^2}{8}k$ if *d* = 4*R*

(C) Work done by external agent is $\frac{q\pi R^2}{4}k$ if *d* = 4*R*

(D) Work done by external agent is $\frac{q\pi R^2}{4}k$ if *d* = 6*R*



8. The radius of curvature of the left and right surface of the concave lens are 10 cm and 15 cm respectively. The radius of curvature of the mirror is 15 cm
(A) equivalent focal length of the combination is –18 cm
(B) equivalent focal length of the combination is +36 cm
(C) the system behaves like a concave mirror
(D) the system behaves like a convex mirror

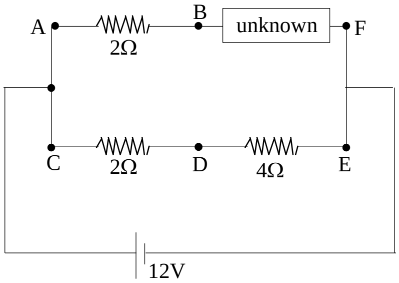
Space for Rough work

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

Consider a circuit shown in figure.



List – I		List – II	
(I)	Current through A – B	(P)	Zero
(II)	Voltage across A – B	(Q)	12V
(III)	Current through B – F	(R)	4A
(IV)	Voltage across B – F	(S)	2A
		(T)	4V
		(U)	8V

9. If unknown box contains a resistor of 4Ω:

(A) $\text{I} \rightarrow \text{S}, \text{II} \rightarrow \text{U}, \text{III} \rightarrow \text{P}, \text{IV} \rightarrow \text{P}$

(B) $\text{I} \rightarrow \text{S}, \text{II} \rightarrow \text{T}, \text{III} \rightarrow \text{S}, \text{IV} \rightarrow \text{U}$

(C) $\text{I} \rightarrow \text{R}, \text{II} \rightarrow \text{U}, \text{III} \rightarrow \text{R}, \text{IV} \rightarrow \text{T}$

(D) $\text{I} \rightarrow \text{S}, \text{II} \rightarrow \text{P}, \text{III} \rightarrow \text{S}, \text{IV} \rightarrow \text{U}$

Space for Rough work

10. If the unknown box contains a $2\mu F$ capacitor then in steady state:

(A) $I \to P,\ II \to P,\ III \to P,\ IV \to Q$

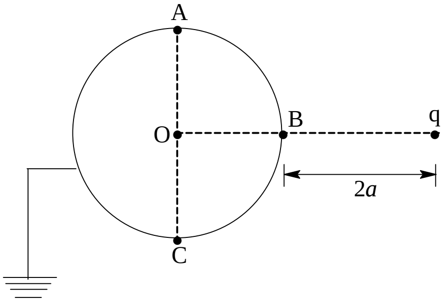
(B) $I \to P,\ II \to T,\ III \to P,\ IV \to U$

(C) $I \to R,\ II \to U,\ III \to R,\ IV \to T$

(D) $I \to S,\ II \to T,\ III \to S,\ IV \to U$

Answer the following by appropriately matching the list based on the information given in the paragraph.

Consider a conducting sphere as shown in figure.



Radius of sphere = a

List – I gives the four points.

List – II gives the values for potentials.

List – I		**List – II**	
(I)	A	(P)	Zero
(II)	B	(Q)	$\frac{-1}{4\pi\varepsilon_0}\frac{q}{3a}$
(III)	C	(R)	$\frac{-1}{4\pi\varepsilon_0}\frac{q}{a\sqrt{10}}$
(IV)	O	(S)	$-\frac{1}{4\pi\varepsilon_0}\frac{q}{2a}$
		(T)	$\frac{1}{4\pi\varepsilon_0}\frac{q}{3a}$
		(U)	None of these

11. If list – II gives the potential due to all changes then:

(A) $I \to P,\ II \to Q,\ III \to P,\ IV \to P$

(B) $I \to U,\ II \to U,\ III \to R,\ IV \to S$

(C) $I \to P,\ II \to P,\ III \to P,\ IV \to P$

(D) $I \to Q,\ II \to R,\ III \to U,\ IV \to P$

Space for Rough work

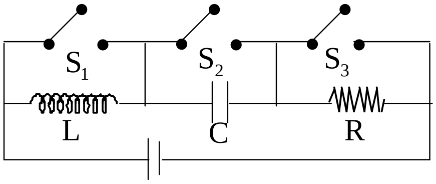
12. If list – II gives potential only due to surface charge (on the surface of the sphere), then:
(A) $I \to R,\ II \to S,\ III \to R,\ IV \to Q$
(B) $I \to Q,\ II \to P,\ III \to T,\ IV \to Q$
(C) $I \to P,\ II \to P,\ III \to R,\ IV \to Q$
(D) $I \to R,\ II \to Q,\ III \to T,\ IV \to U$

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

13. A positively charged particle starts at rest 25cm from a second positively charged particle which is held stationary throughout the experiment. The first particle is released and accelerates directly always from the second particle. When the first particle has moved 25cm, it has reached a velocity of $10\sqrt{2}$ m/s. The maximum velocity (in m/s) that the first particle will reach is $10 \times x$, find x?

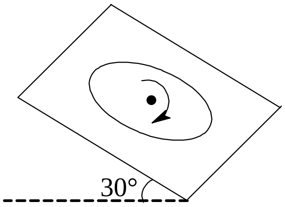
14. Consider the circuit shown in figure. With switch S_1 closed and the other two switches open, the circuit has a time constant 0.05 sec. With switch S_2 closed and the other two switches open, the circuit has a time constant 2 sec. With switch S_3 closed and the other two switches open, the circuit oscillates with a period T. Find T (in sec). (Take $\pi^2 = 10$)



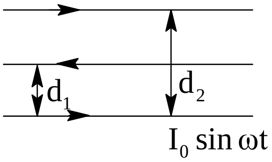
15. In a slow reaction, heat is being evolved at a rate about 10mW in a liquid. If the heat were being generated by the decay of ^{32}P, a radioactive isotope of phosphorus that has half-life of 14 days and emits only beta-particles with a mean energy of 700KeV. The number of ^{32}P atoms in the liquid is $A \times 77 \times 10^{15}$ find a:
[Take: ln2 = 0.7]

Space for Rough work

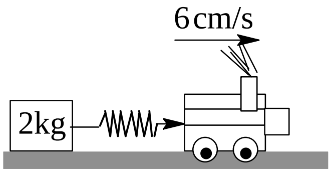
16. An old record player of 10 cm radius turns at 10 rad/s while mounted on a 30° incline as shown in the figure. A particle of mass m can be placed anywhere on the rotating record. If the least possible coefficient of friction μ that must exist for no slipping to occur is μ, find $2\sqrt{3}\mu$. [Take g = 10 m/s^2]



17. Two long straight wires of telephone circuit inside a house are coplanar with and run parallel to a third long straight conductor that carries a current $i = i_0 \sin \omega t$. The wires are at a distance of d_1 and d_2 from the conductor. The conductor induced a noise in the telephone circuit. The rms voltage per unit length of this induced emf is $x \times 5$, find x? Express your answer in μV. Take $d_2 = 2d_1, i_0 = \dfrac{2\sqrt{2}}{\ln 2} A\ \omega = 50\,\text{rad/s}$



18. Figure shows a spring attached to a 2.0 kg block. The other end of the spring is pulled by a motorized toy train that moves forward at constant speed 6.0 cm/s. The spring constant is 50 N/m and the coefficient of static friction between the block and the surface is 0.60. The spring is at its natural length at t=0s when the train starts to move. When does the block slip (express your answer in second)?



Space for Rough work

Chemistry PART – II

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Which of the following statement(s) is/are correct?
(A) Sodium bicarbonate is more soluble than sodium carbonate
(B) Sodium hydroxide is known as caustic soda
(C) Mg^{2+} ions are precipitated with the addition of NH_4OH in the presence of NH_4Cl
(D) CaO_2 is less stable than MgO_2

20. Froth floatation:
(A) is a physical method of separating mineral from the gangue
(B) is a method to concentrate the ore depending on the difference in wettability of gangue and the ore
(C) is used for the sulphide ores
(D) is a method in which impurities sink to the bottom.

21. Which is/are correct statements?
(A) $LiCl$ is more soluble in polar solvent (water) than $NaCl$
(B) K_{a_2} fumaric acid is more than K_{a_2} of Maleic acid
(C) The $O-O$ bond length in $O_2\left[AsF_4\right]$ is shorter than KO_2
(D) In $CF_2=C=CF_2$ molecule all the four fluorine atoms are in the same plane.

22. Which of the following statement(s) is/are correct?
(A) The coordination number of each type of ions in $CsCl$ crystal is 8.
(B) A metal that crystallizes in BCC structure has a coordination number of 12.
(C) A unit cell of an ionic crystal shares some of its ions with other unit cells.
(D) The length of the unit cell in NaCl is 552 pm. $\left(r_{Na^+}=95pm, r_{Cl^-}=181pm\right)$

Space for Rough work

23. Which of the following relations(s) is/are true for alkaline solution?

(A) $pH > \frac{pK_w}{2}$ (B) $pH > pOH$

(C) $pOH < \frac{pK_w}{2}$ (D) $pH < pOH$

24. Which of the following are characteristics of thermosetting polymers?
(A) Heavily branched cross linked polymers
(B) Linear slightly branched long chain molecules
(C) Become infusible on moulding so cannot be reused
(D) Soften on heating and harden on cooling, can be reused

25. Select the correct statements about Ag$^+$/Ag electrode.

(A) $E_{RP_{Ag^+/Ag}} = E^0_{RP_{Ag^+/Ag}} + \frac{0.059}{1}\log[Ag^+]$

(B) Addition of CN^- in Ag^+/Ag electrode shows a decrease in the value of $E_{RP_{Ag^+/Ag}}$

(C) Addition of CN^- in Ag^+/Ag electrode shows a increase in the value of $E_{OP_{Ag/Ag^+}}$

(D) Addition of CN^- in Ag^+/Ag electrode shows a decrease in $E^0_{OP_{Ag/Ag^+}}$ and an increase in $E^0_{RP_{Ag^+/Ag}}$

26. Mixture of $Ph\text{-}CHO$ & $HCHO$ is treated with $NaOH$ then Cannizzaro reaction involves:

(A) Oxidation of $HCHO$ (B) Hydride transfer from $HCHO$

(C) Oxidation of $Ph-CHO$ (D) Reduction of $Ph-CHO$

Space for Rough work

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Five** entries (P), (Q), (R), (S) and (T). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

List – I		**List – II**	
(I)	Zero dipole moment	(P)	$BeCl_2$
(II)	Bond angle 180°	(Q)	ClF_3
(III)	Paramagnetic	(R)	CO^+
(IV)	Polar	(S)	PCl_3F_2
		(T)	NO^+

27. Which of the following represent the correct combination?
(A) $I \rightarrow P,\ II \rightarrow S,\ III \rightarrow R,\ IV \rightarrow Q$
(B) $I \rightarrow P,\ II \rightarrow R,\ III \rightarrow S,\ IV \rightarrow Q$
(C) $I \rightarrow S,\ II \rightarrow P,\ III \rightarrow S,\ IV \rightarrow T$
(D) $I \rightarrow S,\ II \rightarrow S,\ III \rightarrow R,\ IV \rightarrow P$

28. Which of the following represent the incorrect combination?
(A) $I \rightarrow P,\ II \rightarrow P,\ III \rightarrow R,\ IV \rightarrow T$
(B) $I \rightarrow R,\ II \rightarrow S,\ III \rightarrow R,\ IV \rightarrow T$
(C) $I \rightarrow S,\ II \rightarrow P,\ III \rightarrow R,\ IV \rightarrow T$
(D) $I \rightarrow P,\ II \rightarrow P,\ III \rightarrow R,\ IV \rightarrow Q$

Space for Rough work

Answer the following by appropriately matching the list based on the information given in the paragraph.

List – I		List – II	
(I)	$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$	(P)	$K_p > K_c$ at $300K$
(II)	$2NO_2(g) \rightleftharpoons N_2O_4(g)$	(Q)	$K_p < K_c$ at $300K$
(III)	$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$	(R)	P is increased, reaction moves to right side
(IV)	$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$	(S)	Inert gas added at constant volume, equilibrium will not be affected
		(T)	Inert gas at constant pressure, equilibrium will shift right

29. Which of the following represent the correct combination?
(A) $I \rightarrow P,\ II \rightarrow Q,\ III \rightarrow Q,\ IV \rightarrow R$
(B) $I \rightarrow Q,\ II \rightarrow R,\ III \rightarrow S,\ IV \rightarrow T$
(C) $I \rightarrow P,\ II \rightarrow Q,\ III \rightarrow S,\ IV \rightarrow R$
(D) $I \rightarrow T,\ II \rightarrow P,\ III \rightarrow Q,\ IV \rightarrow R$

30. Which of the following represent the incorrect combination?
(A) $I \rightarrow P,\ II \rightarrow Q,\ III \rightarrow S,\ IV \rightarrow S$
(B) $I \rightarrow S,\ II \rightarrow Q,\ III \rightarrow S,\ IV \rightarrow S$
(C) $I \rightarrow Q,\ II \rightarrow Q,\ III \rightarrow S,\ IV \rightarrow R$
(D) $I \rightarrow T,\ II \rightarrow Q,\ III \rightarrow S,\ IV \rightarrow R$

Space for Rough work

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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31. One mole of nitrogen gas at 0.8 atm takes 38 seconds on diffuse through a pinhole, whereas one mole of a compound of xenon with fluorine at 1.6 atm takes 57 seconds to diffuse through the same hole. Calculate molecular weight of the compound.

32. Calculate $\Delta_f H^\circ$ (magnitude only) for chloride ion (aq.) from the following data:

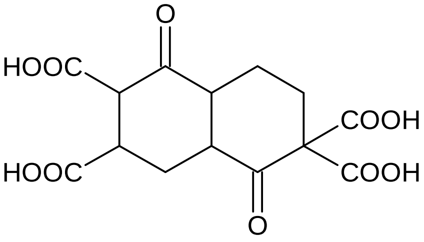
$$\frac{1}{2}H_2(g)+\frac{1}{2}Cl_2(g)\rightarrow HCl(g); \qquad \Delta_f H^\circ=-92.4\,kJ$$

$$HCl(g)+H_2O(\ell)\rightarrow H_3O^+(aq)+Cl^-(aq); \qquad \Delta H^\circ=-74.8\,kJ$$

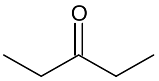
$$\Delta_f H^\circ\, of\ H^+(aq)=0.0\,kJ$$

33. K_{sp} of $PbBr_2$ (Molar mass $= 367$) is 3.2×10^{-5}. If the salt is 80% dissociated in solution, calculate the solubility of salt in g per litre.

34. How many moles of CO_2 will released when following compound is heated



35. Examine the structural formulas of compounds given below and identify number of compounds which show positive iodoform test.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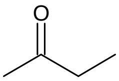
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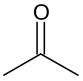
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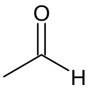

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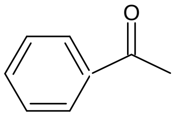

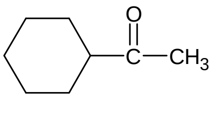

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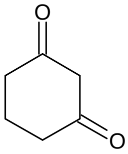
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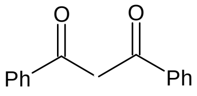

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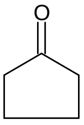

36. Calculate the value $X-Y$, for $XeOF_4$. (X=Number of σ bond pair and Y=Number of lone pair on central atom).

Space for Rough work

Mathematics

PART – III

SECTION – A

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. Let $A_1, A_2, ..., A_n$ be a regular n-sided polygon inscribed in a circle, three points A_i, A_j, A_k are randomly chosen, where i, j, k are distinct integer between 1 and n both inclusive. Denote by P_n the probability that the triangle $A_iA_jA_k$ is obtuse which of the following statements is/are true:

(A) P_5 equals $\frac{1}{2}$
(B) P_{10} equals $\frac{1}{2}$
(C) P_{10} equals $\frac{2}{3}$
(D) P_{15} equals $\frac{9}{13}$

38. The equation $\frac{1}{(x+1)^5} - 7x + 2\sin x = 0$ has:

(A) One positive root
(B) One negative root
(C) None of the root $\in (-1, 0)$
(D) Three real roots

39. Let x, y, z be real numbers with $x \geq y \geq z \geq \frac{\pi}{12}$, such that $x + y + z = \frac{\pi}{2}$ and let $P = \cos x . \sin y . \cos z$, then:

(A) minimum value of P is $\frac{1}{8}$
(B) maximum value of P is $\frac{2+\sqrt{3}}{8}$
(C) minimum value of P is $\frac{1}{4}$
(D) maximum value of P is $\frac{2+\sqrt{3}}{4}$

Space for Rough work

40. The equation of two lines making an angle 45° with a given line $\bar{a}z + a\bar{z} + b = 0$ (where 'a' is a complex number and b is real) and passing through a given point c (c is a complex number), is/are:

(A) $\frac{z+c}{a} + i\left(\frac{\bar{z}-\bar{c}}{a}\right) = 0$
(B) $\frac{z-c}{a} + i\frac{\bar{z}-\bar{c}}{\bar{a}} = 0$
(C) $\frac{z-c}{a} - i\left(\frac{\bar{z}-\bar{c}}{\bar{a}}\right) = 0$
(D) $\frac{z+c}{a} - i\frac{\bar{z}-\bar{c}}{\bar{a}} = 0$

41. If the equation $|x^2 - 9| + |x^2 - 5| = |\lambda - 5|$ has infinite solution, then λ is:

(A) 9
(B) 1
(C) 4
(D) 2

42. Five circles $S_i = 0, i = 1, 2, 3, 4, 5$ have centres respectively at $C_1(0,0), C_2(2,2), C_3(6,10), C_4(1,-2), C_5(4,-3)$ and the line $y = mx + c$ is common tangent to all five circles such that C_1, C_2, C_3 lie on one side and C_4, C_5 lie on other side of the tangent it is given that the sum of radii of $S_1 = 0$ and $S_2 = 0$ is equal to radius of $S_4 = 0$ and also sum of radii of $S_2 = 0$ and $S_3 = 0$, is equal to the radius of $S_5 = 0$, then:

(A) $m = c$
(B) $m + c = 0$
(C) $m^2 + c^2 = 2$
(D) $|m| = |c|$

43. If $\begin{vmatrix} 2bc - a^2 & c^2 & b^2 \\ c^2 & 2ca - b^2 & a^2 \\ b^2 & a^2 & 2ab - c^2 \end{vmatrix} = \left(a^3 + b^3 + c^3 + kabc\right)^2$, then k is equal to

(A) 2
(B) -2
(C) 3
(D) -3

Space for Rough work

44. If $\sum_{i=0}^{\infty}\sum_{j=0}^{\infty}\frac{1}{a^i a^j} = \frac{\lambda a^2}{(a-1)^2(a+1)}$ where $a > 1$, then possible values of λ may be:

(A) 1 (B) 2

(C) 3 (D) 4

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Five/Six** entries (P), (Q), (R), (S), (T) or (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

If e₁ and e₂ are the roots of the equation $x^2 - ax + 2 = 0$, then there are same expressions given in the list – I whose values are given in list – II below:

List – I		**List – II**	
(I)	If e_1 and e_2 are the eccentricities of the ellipse and hyperbola respectively, then the possible values of $'a'$ is/are	(P)	5
(II)	If both e_1 and e_2 are the eccentricities of hyperbola then the possible value of a is/are	(Q)	$\frac{5}{2}$
(III)	If e_1 and e_2 are eccentricities of hyperbola and its conjugate hyperbola, then the possible values of a is/are	(R)	6
(IV)	If e_1 is the eccentricity of the hyperbola for which there exist infinite points from which perpendicular tangents can be drawn and e_2 is the eccentricity of the hyperbola from which no such points exists then the possible of $'a'$ is/are	(S)	$2\sqrt{2}$

45. Which of the following is the only correct combination?

(A) $\text{IV} \rightarrow \text{QS}$ (B) $\text{II} \rightarrow \text{PR}$

(C) $\text{I} \rightarrow \text{PR}$ (D) $\text{III} \rightarrow \text{Q}$

Space for Rough work

46. Which of the following is the only incorrect combination?

(A) $\text{II} \rightarrow \text{QS}$
(B) $\text{II} \rightarrow \text{PR}$
(C) $\text{I} \rightarrow \text{PR}$
(D) $\text{IV} \rightarrow \text{PR}$

Answer the following by appropriately matching the list based on the information given in the paragraph.

The equation of the ellipse with area $\frac{3\text{P}}{2}$ passing through the point of intersection of $\text{x}^2 + 4y^2 = 4$ and $x - 1 = 0$, having x-axis as its major axis and eccentricity equal to $\frac{\sqrt{3}}{2}$, is $ax^2 + 2hxy + by^2 + 2gx + 2fy - 2 = 0$. There are same expressions given in the list – I whose values are given in list – II below

List – I		List – II	
(I)	a	(P)	0
(II)	b	(Q)	1
(III)	$2h + f$	(R)	-1
(IV)	g	(S)	4
		(T)	6
		(U)	$\sqrt{6}$

47. Which of the following is the only correct combination?

(A) $\text{II} \rightarrow \text{P}$
(B) $\text{II} \rightarrow \text{S}$
(C) $\text{I} \rightarrow \text{T}$
(D) $\text{I} \rightarrow \text{R}$

48. Which of the following is the only incorrect combination?

(A) $\text{IV} \rightarrow \text{U}$
(B) $\text{III} \rightarrow \text{P}$
(C) $\text{II} \rightarrow \text{S}$
(D) $\text{I} \rightarrow \text{Q}$

Space for Rough work

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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49. Mr. A lists all the positive divisors of the number $N(2010)^2$ and selects two divisors from the list then the probability that exactly one of the selected divisors is perfect squares is:

50. If $\dfrac{(x-3)^{\frac{-|x|}{x}}\sqrt{(x-4)^2}\,(17-x)}{\sqrt{-x}\left(-x^2+x-1\right)\left(|x|-32\right)} < 0$ then no. of integers x satisfying the inequality is:

51. Let f be real function defined on R (the set of real numbers) such that $f'(x) = 100\ (x-1)(x-2)^2(x-3)^3.......(x-100)^{100}$, for all $x \in R$. If g is a function defined on R such that $\int_a^x e^{f(t)}dt = \int_0^x g(x-t)dt + 2x + 3$, If some of the all the values of x for which g(x) has a local extremum be λ then find $\dfrac{\lambda}{3}$

52. Let z_1, z_2 and z_3 be complex numbers such that $|z_1| = |z_2| = |z_3| = |z_1+z_2+z_3| = 2$. If $|z_1 - z_2| = |z_1 - z_3|$ *and* $z_2 \neq z_3$. Then find the value of $|z_1+z_2||z_1+z_3|$.

53. If $\lim\limits_{x\to 1} \dfrac{100}{1-x^{100}} - \dfrac{50}{1-x^{50}} = 5A$; find the value of A.

54. Let $H_n = 1 + \dfrac{1}{2} + \dfrac{1}{3} + ... + \dfrac{1}{n}$ and $T_n = \dfrac{1}{(n+1)H_nH_{n+1}}$, then the value of $(T_1 + T_2 + T_3 + ... + \infty)$ is:

Space for Rough work

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PAPER – 2

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. AB

Sol. As shown in fig. for reflection from the ceiling

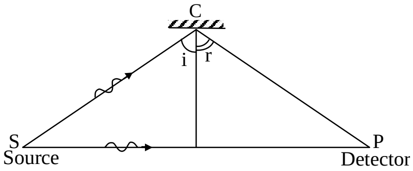
Path SCP = SC + CP = 2SC

[as ∠i = ∠r, SC = CP]

path SCP = $2\sqrt{60^2+25^2}$ = 130 m

So path difference between interfering waves along paths SCP and SP

$\Delta x = 130 - 120 = 10$ m



Now for constructive interference at P

$\Delta x = n\lambda$, i.e. $10 = n\lambda$

or $\lambda = \frac{10}{n}$ with n = 1,2,3........

i.e. λ = 10m, 5m, (10/3) m and so on

2. BCD

Sol. Let,

C_V' = molar heat capacity of the first gas,

C_V'' = molar heat capacity of the second gas,

C_V = molar heat capacity of the mixture,

and similar symbols for other quantities. Then,

$\gamma = \frac{C'_P}{C'_V} = 1.67$

and

$C'_P = C'_V + R$

This gives

$C'_V = 3/2R$ and $C'_P = 5/2$ R.

Similarly, $\gamma = 1.4$ gives $C''_V = 5/2R$

and $C''_P = 7/2R$

Suppose the temperature of the mixture is increased by dT. The increase in the internal energy of the first gas = $n_1C'_V dT$.

The increase in internal energy of the second gas = $n_2C''_V dT$.

Thus,

$$(n_1 + n_2)C_V dT = n_1C'_V dT + n_2C''_V dT$$

or, $C_V = \frac{n_1C'_V + n_2C''_V}{n_1 + n_2}$ ...(1)

$$C_P = C_V + R = \frac{n_1C'_V + n_2C''_V}{n_1 + n_2} + R$$

$$= \frac{n_1(C'_V + R) + n_2(C''_V + R)}{n_1 + n_2}$$

$$= \frac{n_1C'_P + n_2C''_P}{n_1 + n_2} \quad ...(2)$$

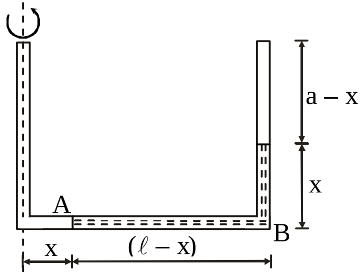
From (1) and (2),

$$\gamma = \frac{C_P}{C_V} = \frac{n_1C'_P + n_2C''_P}{n_1C'_V + n_2C''_V}$$

$$= \frac{4 \times \frac{5}{2}R + 2 \times \frac{7}{2}R}{4 \times \frac{3}{2}R + 2 \times \frac{5}{2}R} = 1.54$$

3. A

Sol. When tube is rotated, liquid starts to flow radially outward and air in sealed arm is compressed. Let the shift of liquid be x as shown in figure.



Let cross-sectional area of tube be S. Initial volume of air, V_0 = Sa and initial pressure

$P_0 = 10500$ Nm^{-2}

Final volume, V = S (a – x)

$\therefore$ Final pressure, $P = \frac{P_0V_0}{V} = \frac{P_0.a.}{(a-x)}$

or Pressure at B, $P_2 = P + x\rho g = \frac{P_0 a}{(a-x)} + x\rho g$

Centripetal force required for circular motion of vertical column of height x of liquid is provided by reaction of the tube while that to horizontal length (l –x) is provided by excess pressure at B.
Force exerted by pressure difference is

$F_1 = (P_B - P_A)\ S = (P_2 - P_0)$

$S = \left[\frac{P_0 x}{(a-x)} + x\rho g\right]$

Mass of horizontal arm AB of liquid is,

$m = S\,(l - x)\,\rho$

Radius of circular path traced by its centre of mass is $r = x + \frac{\ell - x}{2} = \left(\frac{\ell + x}{2}\right)$

$\therefore$ Centripetal force, $F_2 = m\,\omega_0^2 r$

But $F_2 = F_1$ or

$S\,\rho(l - x)\}\left\{\frac{\ell + x}{2}\right\}\omega_0^2 = \left\{\frac{P_0 x}{(a-x)} + x\rho g\right\}\ S$

or $x = .01\text{ m} = 1\text{ cm}$

$\therefore$ Length of air column in sealed arm=(a – x)
= 5 cm Ans.

4. BC

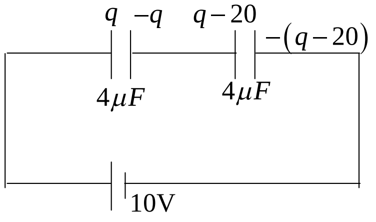
Sol. Current $I = \frac{2mV}{\left(m^2+2\right)r}$

On maximizing $m = \sqrt{2}$

$I_{\max} = \frac{V}{\sqrt{2}r}$

5. BC

Sol. $\frac{q}{4} + \frac{1}{2}\left(q - 20\right) = 10$



$q + 2q - 40 = 40\mu C$

$3q = 80\mu C \Rightarrow q = \frac{80}{3}\mu C$

Charge flow $= \frac{80}{3} - 20 = \frac{20}{3}\mu C$

$\omega_{battery} = \frac{20}{3}\times 10 = \frac{200}{3}\mu J$

6. AC

Sol. Magnetic moment $=\mathrm{IA}$

Torque $=\vec{\mathrm{m}}\times\vec{\mathrm{B}}$

7. ACD

Sol. Electric field at distance x from the center (outside the region) is given by

$\mathrm{E}=\frac{kR^2}{2x}\Rightarrow$ force required $F=\frac{kqR^2}{2x}$

Take line integral of dot product of force and displacement along a straight line from point P of infinity.

8. AC

Sol. $P_{glass}=-\frac{1}{12}$

$P_{water}=\frac{2}{45}$

$P_{mirror}=\frac{2}{15}$

$P_{combination}=-2P_{lens}+P_m$

$=\frac{2}{12}-\frac{4}{45}-\frac{2}{15}=\frac{-10}{180}=\frac{-1}{18}$

$f_{combination}=-18cm$

Focal length is negative hence it behaved like a concave mirror.

9. B

Sol. It box contains a 4Ω resistor equivalent resistance $=3\Omega$

Current $I=4A$ equally divided in both branches

$\mathrm{P.d.}$ across $\mathrm{AB=2\times2=4V}$

10. A

Sol. In steady state current through upper branch = 0

$\mathrm{I}=\frac{12}{6}=2A$

$P.d.$ across $\mathrm{AB}=4V$

11. C

Sol. Potential at every point on sphere = 0

12. A

Sol. Potential due to surface charges at any point on the sphere = - potential due to point charge q at that point.

SECTION – C

13. 00002.00

Sol. Using conservation of mechanical energy $\frac{1}{2}m\left(10\sqrt{2}\right)^2=\frac{kq_1q_2}{2\times\left(25cm\right)}$

$$\frac{1}{2}mV^2{}_{\max} = \frac{kq_1q_2}{25cm}$$

$$\therefore V_{\max}^2 = 2\times\left(10\sqrt{2}\right)^2$$

$$V_{\max} = 20m/s$$

14. 00002.00

Sol. $\tau_1 = \mathrm{RC}$

$$\tau_2 = \frac{\mathrm{L}}{\mathrm{R}}$$

$$\Rightarrow \mathrm{LC} = t_1t_2 = 0.1\sec$$

$$\Rightarrow \mathrm{T} = 2\pi\sqrt{\mathrm{LC}} = 2\pi\sqrt{\frac{1}{10}} = 2\sec$$

15. 00002.00

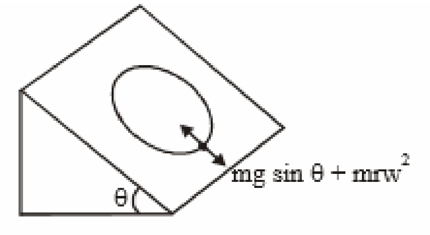
Sol. $Heat = 700\times10^3\times1.6\times10^{-19}\times\frac{\mathrm{dn}}{\mathrm{dt}} = 10\times10^{-3}$

$$\frac{\mathrm{dN}}{\mathrm{dt}} = \frac{10^{-1}}{10^{-14}}\times\frac{1}{7\times16} = \frac{10^{12}}{11.2} = \lambda\mathrm{N}_0$$

$$\lambda = \frac{\ln 2}{14\times86400} \Rightarrow \mathrm{N}_0 = \frac{14\times86400\times10^{12}}{11.2\ln 2} = 154\times10^{15}$$

16. 00006.00

Sol. $\mathrm{f} \ge \mathrm{mg}\sin\theta + \mathrm{mrw}^2$



$$\mu\,\mathrm{mg}\cos\theta \ge \mathrm{mg}\sin\theta + \mathrm{mrw}^2$$

$$\text{or } \mu \ge \tan\theta + \frac{\mathrm{w}^2\mathrm{r}}{\mathrm{g}\cos\theta}$$

17. 00004.00

Sol. $d\phi = \frac{\mu_0 i}{2\pi x}\times l\,dx$

$$\phi = \frac{\mu_0 i}{2\pi}l\,\ln\left(\frac{d_2}{d_1}\right)$$

$$\varepsilon = \frac{d\phi}{dt} = \frac{\mu_0}{2\pi}l\,\ln\left(\frac{d_2}{d_1}\right)\times i_0\omega\,\cos wt$$

$$\varepsilon_{rms} = \frac{\mu_0}{2\pi} l \ln\left(\frac{d_2}{d_1}\right)\frac{i_0\omega}{\sqrt{2}}$$

$$= \frac{4\pi\times10^{-7}}{2\pi}\times1\times\ln 2\times\frac{2\sqrt{2}}{\ln 2}\times\frac{50}{\sqrt{2}}$$

18. 00004.00

Sol. The block slips when the static friction force reaches its maximum value $f_{s\,max} = \mu_s n = \mu_s mg$ .This occurs when the train has moved

$$\Delta x = \frac{f_{smax}}{k} = \frac{\mu_s mg}{k} = \frac{(0.60)(2.0\text{kg})(10\text{m/s}^2)}{50\text{N/m}} = 24\,\text{cm}$$

The time at which the block slips is

$$t = \frac{\Delta x}{v} = \frac{24\text{cm}}{6\,\text{cm/s}} = 4\text{s}$$

Chemistry PART – II

SECTION – A

19. BC

20. ABCD
Sol. Froth floatation method is used for the sulphide ores.

21. ABC
Sol. $LiCl$ has more covalent character than $NaCl$

22. ACD
Sol. A metal that crystallizes in BCC structure has a coordination number of 8.

23. ABC
Sol. For alkaline solution PH>POH

24. AC
Sol. Fact

25. ABC
Sol. $\mathrm{Ag}^{+}_{(\mathrm{aq})} + e^- \rightarrow \mathrm{Ag}(\mathrm{s})$ and $\mathrm{AgCN}(\mathrm{s})$

26. ABD

27. A

28. B

29. C
Sol. Inert gas added at constant volume, equilibrium will not be affected.

30. C
Sol. $Kp = K_c\left(RT\right)^{\Delta ng}$

SECTION – C

31. 00252.00
Sol. $\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}} \times \frac{P_1}{P_2}$

Or $\frac{n_1}{t_1} \times \frac{t_2}{n_2} = \sqrt{\frac{M_2}{M_1}} \times \frac{P_1}{P_2}$

Or $\frac{1}{38} \times \frac{57}{1} = \sqrt{\frac{M}{28}} \times \frac{0.8}{1.6}$

$\therefore$ $M = 252$

32. 00167.20
Sol. $\frac{1}{2}H_2\left(g\right)+\left(Aq\right)\rightarrow H^+\left(aq\right);$ $\Delta H^\circ = 0$.....................(i)

$$\frac{1}{2}H_2(g)+\frac{1}{2}Cl_2(g)\rightarrow HCl(g); \qquad \Delta H^\circ=-92.4kJ\ldots\ldots\ldots..(\text{ii})$$

$$HCl(g)+H_2O(l)\rightarrow H_3O^+(aq)+Cl^-(aq); \qquad \Delta H=-74.8kJ\ldots\ldots\ldots\ldots.(\text{iii})$$

By inspection method: Eqs.$(\text{ii})+(\text{iii})-(\text{i})$ reveals that

$$\frac{1}{2}Cl_2(g)+(Aq)\rightarrow Cl^-(aq); \qquad \Delta H=-167.2kJ$$

i.e. Heat of formation of $Cl^-(aq)=-167.2kJ$

33. 00019.17

Sol. Let solubility of $PbBr_2$ is $S\ mol\ litre^{-1}$

$$PbBr_2(s)+Aq\rightleftharpoons PbBr_2(aq)\rightleftharpoons \underset{\frac{S\times 80}{100}}{Pb^{2}}+\underset{\frac{2S\times 80}{100}}{2Br^-}$$

Since, $PbBr_2$ ionises to 80% only.

Now $K_{sp}=\left[Pb^{2+}\right]\left[Br^-\right]^2$

Or $3.2\times10^{-5}=\left[\frac{S\times80}{100}\right]\left[\frac{2S\times80}{100}\right]^2$

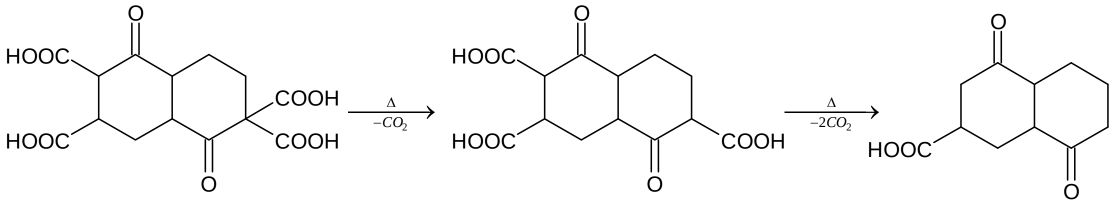
$$S=0.025\,mol\,litre^{-1}$$

$$=0.025\times367\,g\,litre^{-1}$$

$$=19.175\,g\,litre^{-1}$$

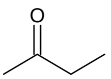
34. 00003.00

Sol.



35. 00006.00

Sol. These compounds will give iodoform test



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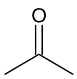

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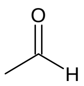

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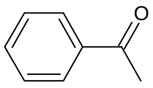

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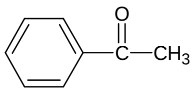

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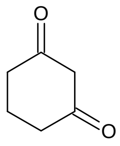

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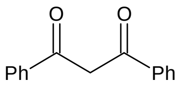
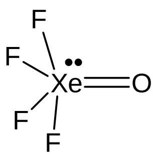


36. 00004.00

Sol. $XeOF_4$



Mathematics PART – III

SECTION – A

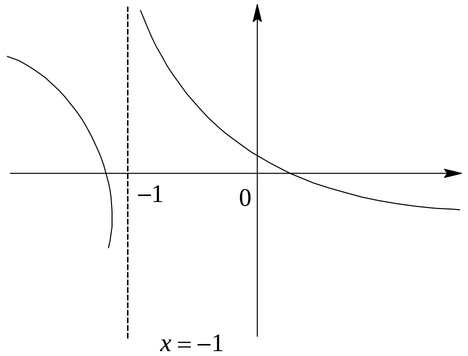
37. AD

Sol. Required probability $= \dfrac{{}^nC_1 \times {}^{\frac{n-1}{2}}C_2}{{}^nC_3} \left(n \text{ is even}\right)$

And if n is odd $\dfrac{{}^nC_1 \times {}^{\frac{n-1}{2}}C_2}{{}^nC_3}$

38. ABC

Sol. $f'(x) = \dfrac{-5}{(x+1)^6} - 7 + 2\cos x < 0 \;\forall x \in R$



39. AB

Sol. $P = \dfrac{1}{2}\cos x\left(\sin(y+z) + \sin(y-z)\right) \geq \dfrac{1}{2}\cos x \sin(y+z) = \dfrac{1}{2}\cos^2 x$

But, $x = \dfrac{\pi}{2} - (y+z) \leq \dfrac{\pi}{2} - 2.\dfrac{\pi}{12} = \dfrac{\pi}{3}$

$\therefore P \geq \dfrac{1}{8}$

$P = \dfrac{1}{2}\cos z\left(\sin(x+y) - \sin(x-y)\right)$

Again $P \leq \dfrac{1}{2}\cos^2 z = \dfrac{1+\cos 2z}{4}$

$P \leq \dfrac{2+\sqrt{3}}{8}$

40. BC

Sol. z_1, z_2 be the two points on the given line then

$$\frac{z_1 - z_2}{\bar{z}_1 - \bar{z}_2} = -\frac{a}{\bar{a}} \qquad ....(1)$$

Also, $\frac{z_1 - z_2}{\bar{z}_1 - \bar{z}_2} = \pm i \frac{z - c}{\bar{z} - \bar{c}}$ ....(2)

From (1) and (2), we get $\frac{z-c}{a} \pm i \frac{z-c}{a} = 0$

41. AB

Sol. $|\lambda - 5| = 4$

42. BCD

Sol. The line y = mx + c, passes through centroid of $\Delta C_1C_2C_4$ and $\Delta C_2C_3C_5$

$\Rightarrow y = x - 1 \Rightarrow m = 1, c = -1$

43. D

Sol. We have, $\begin{vmatrix} 2bc - a^2 & c^2 & b^2 \\ c^2 & 2ca - b^2 & a^2 \\ b^2 & a^2 & 2ab - c^2 \end{vmatrix}$

$$= \begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix} \times \begin{vmatrix} -a & b & c \\ -b & c & a \\ -c & a & b \end{vmatrix}$$

$$= \begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix} \begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix} = \begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix}^2$$

$$= \left[a\left(bc - a^2\right) + b\left(ac - b^2\right) + c\left(ab - c^2\right)\right]^2$$

$$= \left[a^3 + b^3 + c^3 - 3abc\right]^2$$

$k = -3$

44. CD

Sol. When no restriction on i and j

$$S = \sum_{i=0}^{\infty}\sum_{j=0}^{\infty}\frac{1}{a^i a^j} = \left(1 + \frac{1}{a} + \frac{1}{a^2} + ...\infty\right)^2 = \frac{a^2}{(a-1)^2}$$

$$\Rightarrow S = \frac{\lambda a^2}{(a-1)^2(a+1)} \Rightarrow \lambda > 2$$

45. C

46. B

Sol. **(for Q. No. 45 – 46)**

(I) $e_1 < 1 < e_2$ P $f(1) < 0 P a > 3$

(II) Both roots are greater than $1P\ D^3\ 0P|a|^3\ 2$ and $f(1) > 0P\ a < 3$ and also

$\frac{a}{2} > 1P\ a > 2P\ a\hat{I}(2,3)$

(III) $\frac{1}{e_1^2}+\frac{1}{e_2^2}=1\text{P}\ \frac{a^2-4}{4}=1\text{P}\ a=\pm 2\sqrt{2}\ \&\ \text{D}>0\text{P}\left|a\right|\ge 2$

(IV) $e_2<\sqrt{2}<e_1 P\ \ f\left(\sqrt{2}\right)<0\,\text{P}\ a>2\sqrt{2}$

Equation of such ellipse is $x^2+4y^2-4+l\left(x-1\right)=0$ with area $=\frac{3P}{2}$

47. B

48. A

SECTION – C

49. 00000.32

50. 00031.00

Sol. $$\frac{\left(\text{x}-3\right)^{\frac{-|\text{x}|}{\text{x}}}\sqrt{\left(\text{x}-4\right)^2}\ \left(17-\text{x}\right)}{\sqrt{-\text{x}}\left(-\text{x}^2+\text{x}-1\right)\left(|\text{x}|-32\right)}<0$$

For $\sqrt{-x}$ to be defined $x<0$

$\Rightarrow \frac{-|x|}{x}=1$

Since $\sqrt{\left(x-4\right)^2},\sqrt{-x}$ are positive & $-x^2+x-1$ is always negative

$\frac{\left(x-3\right)\left(x-17\right)}{x+32}>0$

$x<0$

$\Rightarrow \frac{1}{x+32}>0\Rightarrow x=31$

51. 00833.33

Sol. $\because\ \int_a^x e^{f(t)}dt=\int_0^x g(x-t)dt+2x+3$

$\Rightarrow\ \int_a^x e^{f(t)}dt=\int_0^x g(t)dt+2x+3$ (Using King Property)

Differential both sides, we get

$e^{f(x)}=g(x)+2$

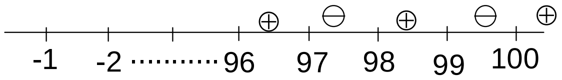
$\Rightarrow g(x)=e^{f(x)}-2$

$\Rightarrow g'(x)=e^{f(x)}.f'(x)$

$\because e^{f(x)}$ is always greater than zero.

$\therefore$ Sign of g'(x) is same as sign of $f'(x)$.

$\therefore$ Sign of g'(x)



Clearly, local extremum (maximum or minimum) will occur at
x=99,97,95,….,3,1

∴ Sum of all the values=1+3+5+…+99=$\frac{50}{2}[2\times1+(50-1)\times2]=2500$

52. 00008.00

Sol. The triangle has circumcentre at origin and its orthocentre laying on the circumcircle.

53. 00005.00

Sol. $$\lim_{y\to1}\frac{100y^{100}}{y^{100}-1}-\frac{50.y^{50}}{y^{50}-1}$$

$$\lim_{y\to1}100-50-\left(\frac{100}{1-y^{100}}-\frac{50}{1-y^{50}}\right)$$

$$\text{L=50-L} \therefore \text{L=}\frac{50}{2}=25$$

54. 00001.00

Sol. $$T_n=\frac{H_{n+1}\text{-}H_n}{H_nH_{n+1}}$$

As $H_{n+1}\text{-}H_n=\frac{1}{n+1}$

$$\Rightarrow T_n=\frac{1}{H_n}-\frac{1}{H_{n+1}}$$

$$\Rightarrow T_1=\frac{1}{H_1}-\frac{1}{H_2}$$

$$T_2=\frac{1}{H_2}-\frac{1}{H_3}$$

$$\vdots \quad \vdots \quad \vdots$$

$$T_n=\frac{1}{H_n}\text{-}\frac{1}{H_{n+1}}$$

$$T_1+T_2+...+T_n=\frac{1}{H_1}\text{-}\frac{1}{H_{n+1}}$$

$$\text{As}\, n\to\infty,\quad T_1+T_2+...+0=1$$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – II

JEE (Main)-2020

TEST DATE: 22-12-2019

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 75 questions.
- Each subject (PCM) has 25 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only three sections: **Section-A**, **Section-B and Section-C**.

Section-A (01 – 20, 26 – 45, 51 – 70) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-B (21 – 22, 46 – 47, 71 – 72) *contains 6 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

Section-C (23 – 25, 48 – 50, 73 – 75) *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. During a rainy day, rain is falling vertically down with a velocity 2 m/s. A boy at rest starts his motion with a constant acceleration of 2 m/s^2 along a straight road. Find the rate at which the angle of the axis of the umbrella with vertical should be changed so that the rain always appears to fall parallel to the axis of the umbrella.

(A) $\frac{1}{1+t^2}$

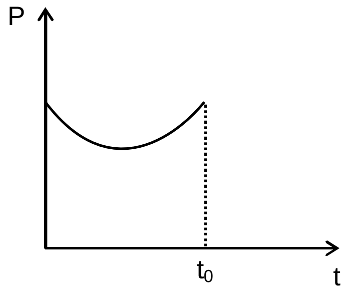
(B) $\frac{2}{1+t^2}$

(C) $\frac{1}{2+t^2}$

(D) $\frac{1}{1+2t^2}$

2. Power versus time graph for a given force is shown in the figure. Then work done by the force upto time t($\leq t_0$).

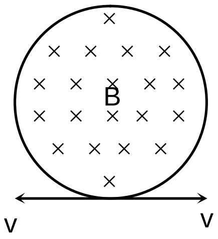
(A) First increases then decreases.
(B) First decreases then increases.
(C) Always increases.
(D) Always decreases.



3. A cobalt (atomic no. = 27) target is bombarded with electrons and the wave lengths of its characteristic X-rays spectrum are measured. A second weak characteristic spectrum is also found due to an impurity in the target. The wavelength of the K_α lines are 225.0 pm (cobalt) and 100.0 pm (impurity). Atomic number of the impurity is

(A) 39
(B) 40
(C) 59
(D) 60

4. A circular conducting loop of radius r_0 and having resistance λ per unit length as shown in the figure is placed in a magnetic field B which is constant. The ends of the loop are crossed and pulled in opposite directions with a velocity v such that the loop always remains circular and the radius of the loop goes on decreasing, then



(A) current induced in the loop is $\frac{Bv}{2\pi\lambda}$.

(B) current induced in the loop is $\frac{Bv}{\pi\lambda}$.

(C) current induced in the loop is $\frac{2Bv}{\pi\lambda}$.

(D) current induced in the loop is $\frac{Bv}{2\lambda}$.

5. When a particle of mass m is suspended vertically by a spring of unstretched length 'a', the spring is stretched to a total length 'ℓ'. The particle is pulled down by a small distance 'b' from equilibrium position and then released. The angular frequency of the simple harmonic motion executed by the particle is

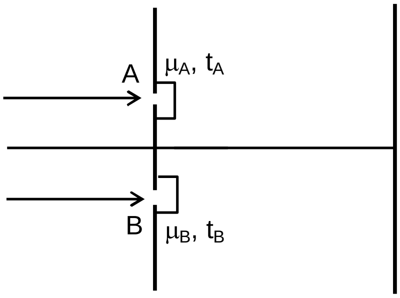
(A) $\sqrt{\frac{g\ell}{(\ell-a)^2}}$

(B) $\sqrt{\frac{ga}{(\ell-a)^2}}$

(C) $\sqrt{\frac{g}{(\ell-a)}}$

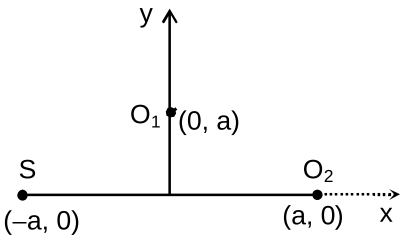
(D) $\sqrt{\frac{gb}{(\ell-a)^2}}$

6. In YDSE, let A and B be two slits as shown. Thin films of thickness t_A and t_B and refractive indices μ_A and μ_B are placed in front of A and B respectively. If $\mu_A t_A = \mu_B t_B$, then the central maxima will



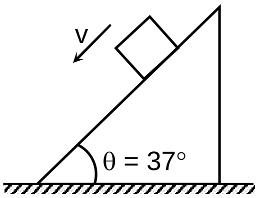
(A) not shift
(B) shift towards A, if $t_B > t_A$
(C) shift towards B, if $t_B > t_A$
(D) shift towards A, if $t_A > t_B$

7. A sound source S and observer O_1 and O_2 are placed as shown in figure. S is always at rest and O_1 and O_2 start moving along positive y-axis and positive x-axis respectively with the same constant speed v_0 at t = 0 away from S. At t = 5 sec, f_1 and f_2 represent apparent frequencies of sound received by O_1 and O_2 respectively. Then the ratio $\left(\frac{f_1}{f_2}\right)$ is



(A) zero
(B) between zero and one
(C) one
(D) more than one

8. A cubical block of side 'a' and density 'ρ' slides down a fixed inclined plane of inclination θ = 37° with a constant velocity v as shown. There is a thin film of viscous liquid of thickness 't' between the inclined plane and the block. Then the coefficient of viscosity of the liquid will be



(A) $\frac{3\rho agt}{5v}$

(B) $\frac{4\rho agt}{5v}$

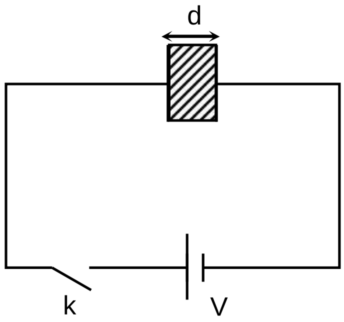
(C) $\frac{\rho agt}{v}$

(D) $\frac{5\rho agt}{3v}$

9. A diverging lens of focal length f_1 is placed infront of and coaxially with a concave mirror of focal length f_2. The separation between the lens and the mirror is d. A parallel beam of light incident on the lens returns as a parallel beam from the arrangement.
(A) The beam diameter of the incident and reflected beams will not be same.
(B) $d = 2|f_2| - |f_1|$
(C) If the entire arrangement is immersed in water, the conditions will remains unaltered.
(D) none of the above

10. A parallel plate capacitor with initial plate distance d_0 is charged upto voltage V_0 and then detached from the charger. Now the distance between the plates is varied periodically according to the law $d = d_0 + d_1 \sin \omega t$. The value of d_1 if the potential difference across the capacitor changes according to the law
$V = V_0\left(1+\frac{1}{2}\sin\omega t\right)$ is
(A) d_0
(B) $\frac{d_0}{2}$
(C) $\frac{3d_0}{2}$
(D) $2d_0$

11. The area of each plate of a capacitor is S and it is completely filled with a dielectric as shown in figure. The dielectric constant and resistivity of the material of the slab inserted in the capacitor are K and ρ respectively. The emf of the ideal cell is V. The current flowing through dielectric slab immediately after the key is switched on is



(A) $\frac{V}{\rho d}S$
(B) $\frac{2V}{\rho d}S$
(C) $\frac{V}{2\rho d}S$
(D) zero

12. A thin insulating rod of length ℓ carries a charge q distributed uniformly on it. The rod is pivoted at its mid point and is rotated at a frequency f about a fixed axis perpendicular to the rod and passing through the pivot. The magnetic moment of the rod system is
(A) $\frac{1}{12}\pi qf\ell^2$
(B) $\pi qf\ell^2$
(C) $\frac{1}{6}\pi qf\ell^2$
(D) $\frac{1}{3}\pi qf\ell^2$

13. A particle of charge q and mass m starts moving from the origin under the action of an electric field $\vec{E} = E_0\hat{i}$ and $\vec{B} = B_0\hat{i}$ with a velocity $\vec{v} = v_0\hat{j}$. The speed of the particle will become $2v_0$ after a time

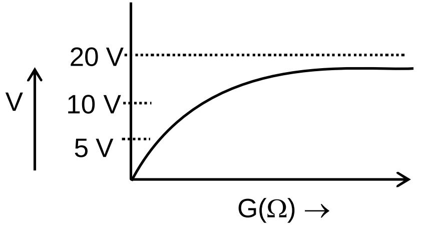
(A) $t = \frac{2mv_0}{qE_0}$

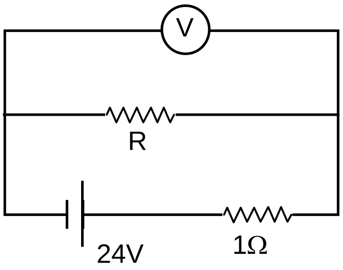
(B) $t = \frac{2B_0q}{mv_0}$

(C) $t = \frac{\sqrt{3}B_0q}{mv_0}$

(D) $t = \frac{\sqrt{3}mv_0}{qE_0}$

14. A cell of internal resistance 1 Ω is connected across a resistor R. A voltmeter having variable resistance G is used to measure potential difference across the resistor. The plot of voltmeter reading V against G is shown. What is the value of external resistor R?



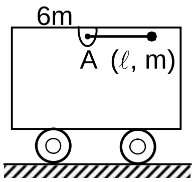


(A) 5 Ω
(B) 4 Ω
(C) 3 Ω
(D) 1 Ω

15. Consider the equation $\frac{d}{dt}\left[\int \vec{F}\cdot d\vec{s}\right] = A\left[\vec{F}\cdot\vec{P}\right]$. Then dimensions of A will be (where $\vec{F}$ = force, $d\vec{s}$ = small displacement, t = time and $\vec{P}$ = linear momentum)

(A) $[M^0L^0T^0]$
(B) $[M^1L^0T^0]$
(C) $[M^{-1}L^0T^0]$
(D) $[M^0L^0T^{-1}]$

16. In the figure shown the cart of mass 6 m is initially at rest on a smooth horizontal surface. A particle of mass m is attached to the end of the light rigid rod which can rotate freely about end A in a vertical plane. If the rod is released from rest from the horizontal position as shown, find the velocity (v_{rel}) of the particle with respect to the cart when the rod is vertical.



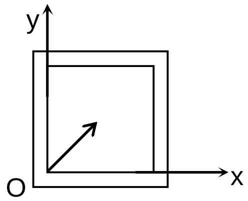
(A) $\sqrt{\frac{7}{3}g\ell}$

(B) $\sqrt{\frac{7}{6}g\ell}$

(C) $\sqrt{\frac{14}{3}g\ell}$

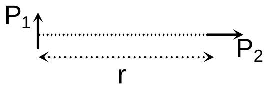
(D) $\sqrt{\frac{8}{3}g\ell}$

17. The figure shows a square carrom board without any pockets. A coin is pushed from the corner, which is the origin, with a velocity $\vec{v} = \left(2\hat{i} + 3\hat{j}\right)$. Assume gravity and friction to be absent. The coin collides with edges of the carrom board elastically. What is the velocity vector of coin after the 3rd collision?



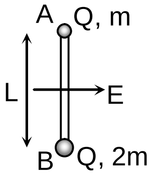
(A) $2\hat{i} + 3\hat{j}$
(B) $2\hat{i} - 3\hat{j}$
(C) $-2\hat{i} + 3\hat{j}$
(D) $-2\hat{i} - 3\hat{j}$

18. Two point electric dipoles with dipole moments P_1 and P_2 are separated by a large distance 'r' with their dipole axes mutually perpendicular as shown. The electric force between the dipoles is (where $K = \frac{1}{4\pi\varepsilon_0}$)



(A) $\frac{6KP_1P_2}{r^4}$
(B) $\frac{3KP_1P_2}{r^4}$
(C) $\frac{2KP_1P_2}{r^4}$
(D) $\frac{KP_1P_2}{r^4}$

19. Two small balls A and B of positive charge Q each and masses m and 2m respectively are connected by a non conducting light rigid rod of length L. This system is released in a uniform electric field of strength E as shown. Just after the release (assume no other force acts on the system).



(A) rod has zero angular acceleration.
(B) rod has angular acceleration $\frac{QE}{2mL}$ in anticlockwise direction.
(C) acceleration of point A is $\frac{2QE}{m}$ towards right
(D) acceleration of point A is $\frac{QE}{m}$ towards right

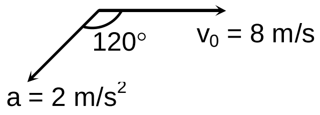
20. The plane polarised light is passed through a polaroid. On viewing through the polaroid, we find that when the polaroid is given a complete rotation about an axis coinciding with the direction of the incident light, one of the following is observed,
(A) the intensity of light gradually decreases to zero and remains zero.
(B) the intensity of light gradually increases to a maximum and remains maximum.
(C) there is no change in intensity
(D) the intensity of light is twice maximum and twice zero.

SECTION – B

(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

21. The following figure shows the velocity and acceleration of a point like body at the initial moment of its motion. The acceleration vector of the body remains constant. The time (in sec) after which its speed becomes 8 m/s again is



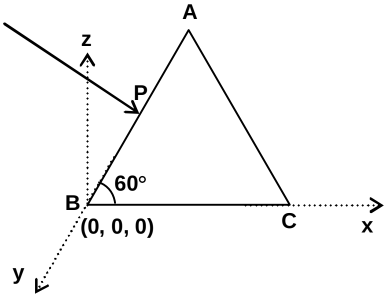
22. A rod has variable coefficient of linear expansion $\alpha = \frac{x}{5000}$, where x is the distance from one end of the rod. If the length of the rod is 1m then find the increase in length of the rod (in cm) on increasing temperature of the rod by 100°C.

SECTION – C

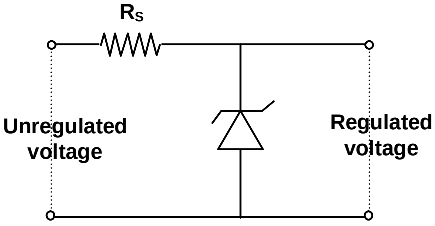
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

23. An equilateral prism ABC having edge length 10 cm is placed in air with its base BC lying horizontally along x-axis as shown in figure. A ray of light represented by equation $\sqrt{3}z + x = 10$ is incident at a point P on the face AB of the prism. Find the value of μ for which the ray grazes the face AC.



24. A Zener of power rating 1 W is to be used as voltage regulator. If Zener has a breakdown of 5V and it has to regulate voltage which fluctuated between 3V and 7V, what should be the value of R_S(in Ω) for safe operation as shown in the figure.



25. A stone is projected at an angle 45° with horizontal. A bee follows the trajectory of the stone at a constant speed equal to the initial speed of the stone. Neglect air resistance for motion of stone. Find the magnitude of acceleration (in m/s^2) of the bee at the topmost point of its trajectory: (g = 9.8 m/s^2)

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

26. Which of the following relation is correct regarding one mole of an ideal gas for adiabatic reversible process?

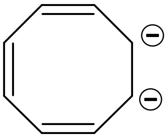
(A) $\ln\frac{T_2}{T_1} = \frac{R}{C_V}\ln\frac{V_2}{V_1}$

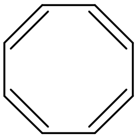
(B) $\ln\frac{T_2}{T_1} = \frac{R}{C_P}\ln\frac{P_1}{P_2}$

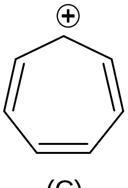
(C) $\ln\frac{T_2}{T_1} = \frac{R}{C_P}\ln\frac{P_2}{P_1}$

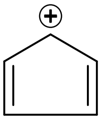
(D) $\frac{R}{C_V}\ln\frac{V_1}{V_2} = \frac{R}{C_P}\ln\frac{P_1}{P_2}$

27. Among the following molecules


(A)


(B)


(C)


(D)

Choose the correct option:

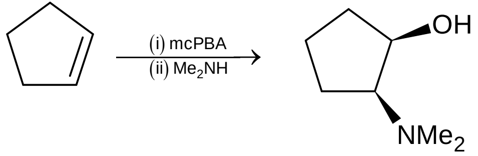
(A) 'A' and 'B' are non-aromatic.
(B) 'B' and 'D' are antiaromatic.
(C) 'B' is antiaromatic and 'C' is aromatic.
(D) 'A' is an aromatic and 'B' is non-aromatic.

28. Which of the following statement is not correct?

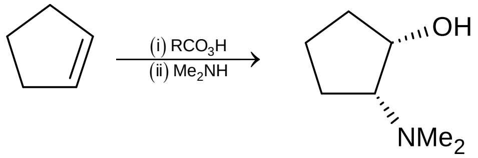
(A) Except glycine all other α-amino acids are optically active.
(B) At isoelectric point solubility of amino acid in H_2O is minimum
(C) At isoelectric point molecule has no net change.
(D) All disaccharides are reducing sugar.

29. Which of the following option is correctly shows the major product of given reaction?

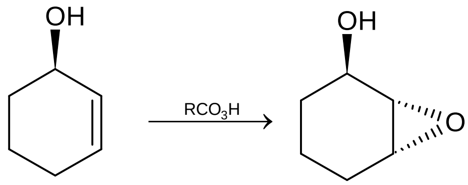
(A)



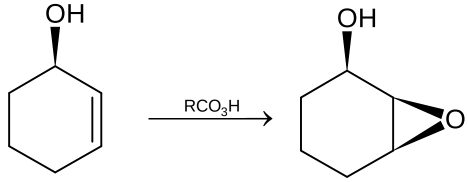
(B)



(C)



(D)

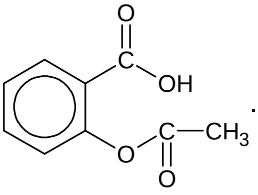


30. An acid base indicator (HIn) is 50% ionized at pH = 6.0. What will be the dissociation constant of HIn?
    (A) 10^{-6}
    (B) 10^{-5}
    (C) 10^{-4}
    (D) 0.5×10^{-6}

31. Which of the following order is incorrect?
    (A) $F_2 < Cl_2 < Br_2 < I_2$ [Bond length]
    (B) $F_2 > Cl_2 > Br_2 > I_2$ [Oxidizing power]
    (C) $F_2 > Cl_2 > Br_2 > I_2$ [Bond dissociation energy]
    (D) $F_2 < Cl_2 < Br_2 < I_2$ [Boiling point]

32. A crystalline solid has three types of atoms X, Y and Z. X forms fcc lattice, Y at each octahedral voids and Z at each tetrahedral voids. If all the atoms along one body diagonal and from one face has been removed. What will be the formulae of compound?
    (A) $X_{22}Y_{16}Z_{48}$
    (B) $X_{23}Y_{16}Z_{48}$
    (C) $X_{11}Y_{4}Z_{24}$
    (D) $X_{15}Y_{6}Z_{8}$

33. Which of the following statement is wrong about aspirin?
    (A) It has anti blood clotting action.
    (B) Its structure is



.

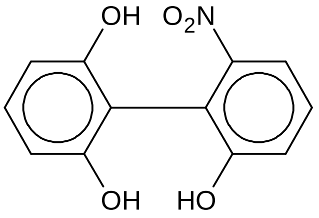
    (C) It is a pain killer.
    (D) It is a narcotic drug.

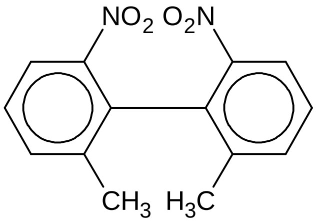
34. According to law of equipartition of energy. How many degree of freedoms are active for energy distribution in SO_2 (g) molecule at low temperature.
    (A) 6
    (B) 5
    (C) 9
    (D) 3

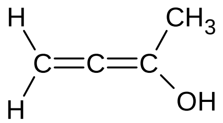
35. Among NF_3 and NCl_3 which statement is not correct?
    (A) Melting point of NF_3 is lower than NCl_3.
    (B) Bond angle of F – N – F is greater than Cl – N – Cl.

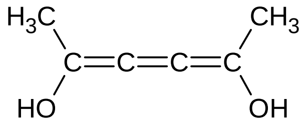
(C) The bond length of N – F is shorter than N – Cl.
(D) Dipole moment of NCl_3 is greater than NF_3.

36. Choose the correct statement.
(A) If a gas gets adsorbed on the surface of a solid, the gas and the solid are known as adsorbent and adsorbate respectively.
(B) The entropy of adsorbed gas molecule is higher than that of the molecule in gaseous state.
(C) Solutes causing positive adsorption are called surface active agent.
(D) Chemiosoption is independent of temperature.

37. Which of the following molecule is optically active?
(A)


(B)


(C)


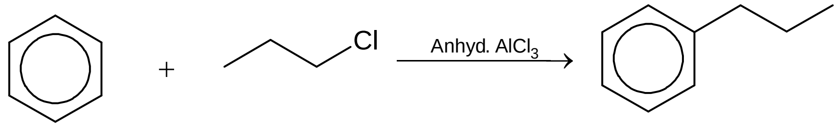
(D)


38. 5 litre of an unknown ideal gas weigh 10 g at 1.5 atm pressure. What will be the RMS speed of unknown gas molecule.
(A) 477 m/s
(B) 492 m/s
(C) 323 m/s
(D) 172 m/s

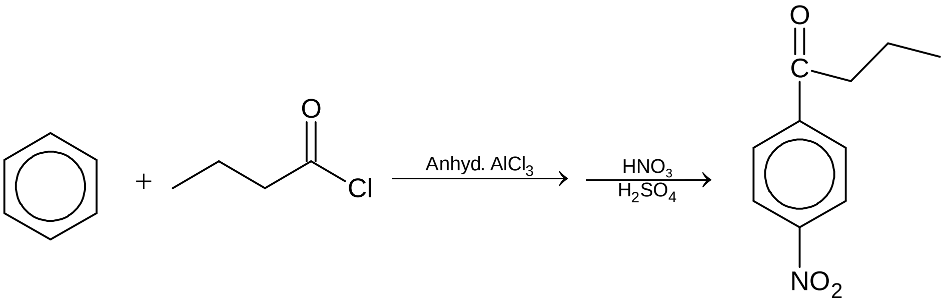
39. Relative reactivity of carbonyl compounds towards nucleophile?
(A) Acyl halide > Acid anhydride > Aldehyde > Carboxylic acid.
(B) Carboxylic acid > Aldehyde > Acid anhydride > Acyl halide.
(C) Acyl halide > Aldehyde > Acid anhydride > Carboxylic acid.
(D) Acid anhydride > Acyl halide > Carboxylic acid > Aldehyde.

40. Which of the following reaction is correct for major product?

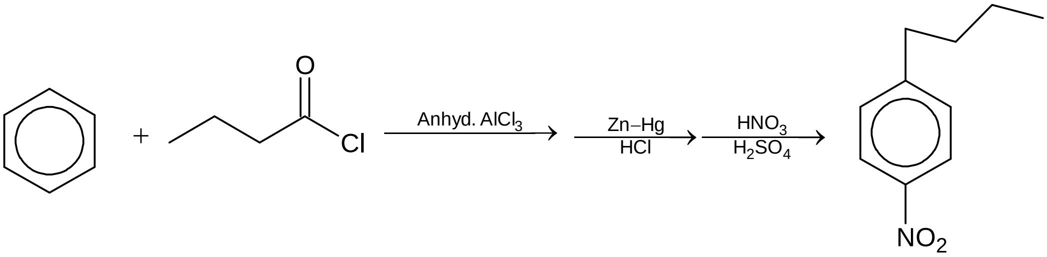
(A)


Cl
Anhyd. AlCl3

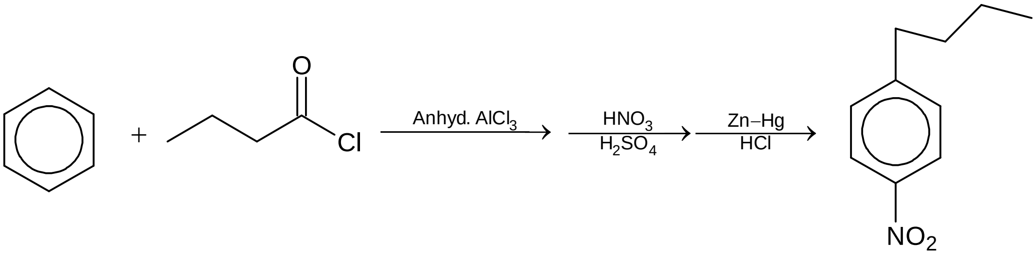
(B)


O
Cl
Anhyd. AlCl3
HNO3
H2SO4
O
C
NO2

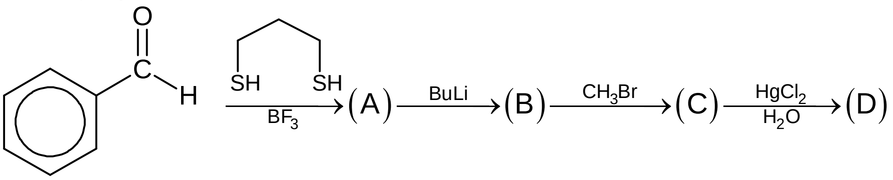
(C)


O
Cl
Anhyd. AlCl3
Zn–Hg
HCl
HNO3
H2SO4
NO2

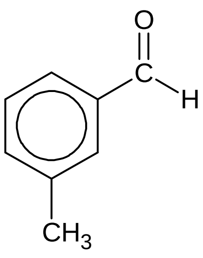
(D)


O
Cl
Anhyd. AlCl3
HNO3
H2SO4
Zn–Hg
HCl
NO2

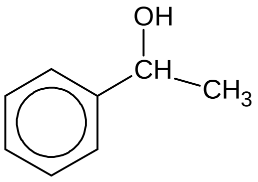
41. The major product 'D' will be:


O
C
H
SH
SH
BF3
(A)
BuLi
(B)
CH3Br
(C)
HgCl2
H2O
(D)

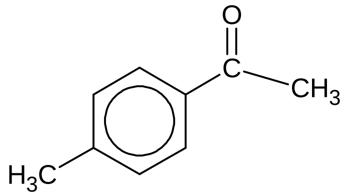
(A)



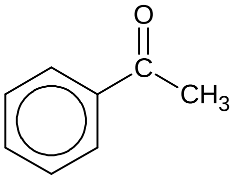
(B)



(C)

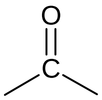


(D)

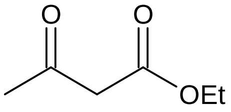


42. Which of the following molecule has maximum enol content in their pure liquid state?

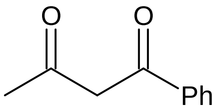
(A)



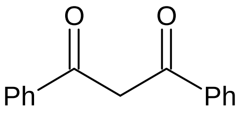
(B)



(C)



(D)

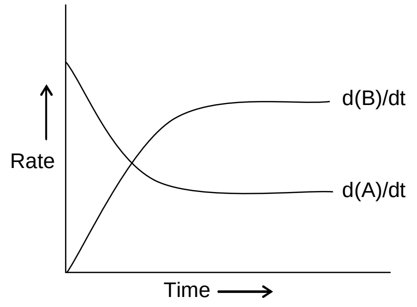


43. Which of the following statemet is false?
- (A) In photoelectric effect, the number of electrons ejected is proportional to the intensity of the light used.
- (B) In any orbital, there is 100% probability of finding of electron.
- (C) The photoelectric effect can't be explained by wave nature of light, but by its particle nature.
- (D) Bohr's theory is only applicable for one electron system.

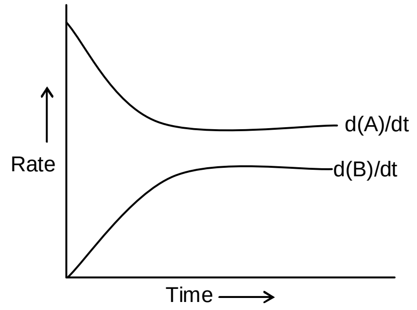
44. The species that does not contains peroxide linkage is
- (A) CrO_5
- (B) $H_2S_2O_8$
- (C) BaO_2
- (D) PbO_2

45. Which of the following graph will show the equilibrium condition for the reaction $A \rightleftharpoons B$?

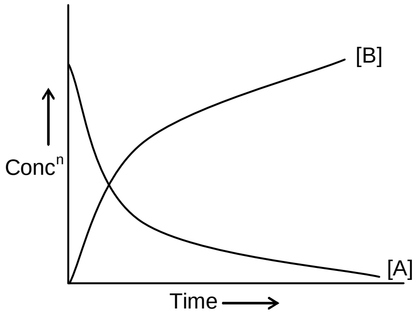
(A)



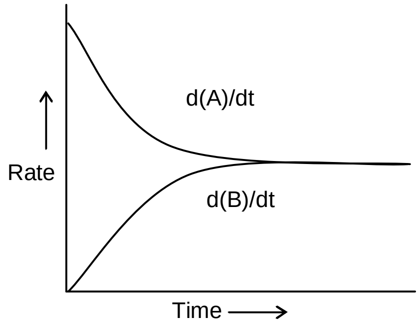
(B)



(C)



(D)

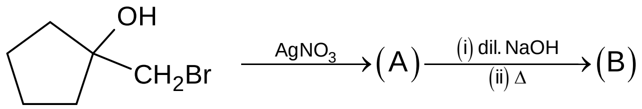


SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

46. According to crystal field theory, total number of unpaired electrons present in the following molecules

$[NiCl_4]^{2-}, [Ni(CN)_4]^{2-}$ and $[Ni(H_2O)_6]^{2+}$ will be

47. 

The degree of unsaturation in major product (B) will be:

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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48. The equilibrium constant of following reaction at 500 K is 10 atm^{-1}.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

What would be the partial pressure of O_2 (in atm) at equilibrium, if at equilibrium the partial pressure of SO_2 (g) is half of that of SO_3 (g).

49. What will be the value of Van't Hoff factor (i) for $K_3\left[Fe(CN)_6\right]$, if it undergoes 75% dissociation in aqueous medium?

50. How many gram of NH_3(g) will be required to add in 500 ml, 0.6 N H_2SO_4 to reduce the normality of H_2SO_4 to 0.1 N.

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

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51. The director circle of a hyperbola is $x^2 + y^2 – 6x – 8y + 5 = 0$. If one end of the transverse axis of hyperbola is (3, –1), then one of the focus of this hyperbola is
(A) $\left(3+5\sqrt{6}, 4\right)$
(B) $\left(3+5\sqrt{30}, 4\right)$
(C) $\left(3,\ 4+\sqrt{30}\right)$
(D) none of these

52. Let α, β, γ be the roots of the equation $10x^3 – mx^2 – 54x – 27 = 0$. If α, β, γ are in H.P., then the value of m is
(A) 6
(B) 7
(C) 9
(D) 18

53. The remainder when $(2017)^{2018} + (2018)^{2019} + (2019)^{2020}$ is divided by 5 is
(A) 2
(B) 4
(C) 3
(D) 0

54. The sum of the series $8!+\frac{9!}{2!}+\frac{10!}{3!}+\frac{11!}{4!}+.....$ upto 20 terms is
(A) $7!\left({}^{27}C_{19}-1\right)$
(B) $8!\left({}^{27}C_{20}-1\right)$
(C) $7!\left({}^{28}C_{20}-1\right)$
(D) $8!\left({}^{28}C_{20}-1\right)$

55. If A B and C are three non singular square matrices of same order such that $B = CAC^{-1}$, then CA^5C^{-1} is equal to
(A) B
(B) B^{-5}
(C) B^5A^5
(D) B^5

56. Let α_1, α_2 and β_1, β_2 are roots of the equation $ax^2 + bx + c = 0$ and $px^2 + qx + r = 0$ respectively. If the system of equations α, $y + \alpha_2 z = 0$ and β, $y + \beta_2 z = 0$ has a non trivial solution, then
(A) $bpr^2 = qac^2$
(B) $b^2pr = q^2ac$
(C) $bp^2r = qa^2c$
(D) none of these

57. The value of $\left|3+\frac{9}{z}\right|^2+|3-z|^2$ if |z| = 3 is
(A) 18
(B) 1
(C) 3
(D) 36

58. Tangents are drawn from a point P to the parabola $y^2 = 8x$. If the angle between the tangents is 45°, then point P moves on a curve whose centre is
(A) (12, 0)
(B) (–6, 0)
(C) (–12, 0)
(D) (–8, 0)

59. If $x\,dy - y\,dx = \sqrt{x^2-y^2}\,dx$ is the differential equation of the equation y = f(x). If f(1) = 0, then $f\left(e^{\frac{\pi}{2}}\right)$ is
(A) $\frac{\pi}{2}$
(B) 1
(C) $e^{\frac{\pi}{2}}$
(D) 0

60. If a pair of variable straight lines $x^2 + 4y^2 + \alpha xy = 0$ (where α is a real parameter) cut the ellipse $x^2 + 4y^2 = 4$ at two points, then locus of the point of intersection of tangents at A and B is
(A) $4x^2 - y^2 = 0$
(B) $x^2 - 4y^2 = 0$
(C) $x^2 + 4y^2 - 16 = 0$
(D) $x^2 - 4y^2 - 32 = 0$

61. A circle S passes through (0, 1) and is orthogonal to the circles $(x - 1)^2 + y^2 = 16$ and $x^2 + y^2 = 1$. If the radius of S is r and centre is (a, b), then a + b + r is equal to
(A) 0
(B) 1
(C) –7
(D) 9

62. The value of k for which the common tangent in 1st quadrant to the circle $x^2 + y^2 = 16$ and the ellipse $\frac{x^2}{25}+\frac{y^2}{4}=1$ makes an intercept of $\frac{14}{\sqrt{k}}$ between the coordinate axes is
(A) 5
(B) 3
(C) 11
(D) none of these

63. Bag A contains 5 white and 5 black balls. Bag B is empty initially, 5 balls are drawn from bag A and placed in bag B. Then 4 balls are drawn from bag B and placed in an empty bag C. The probability that bag C contains exactly 3 white balls is $\frac{k}{{}^{10}C_5}$, then k is
(A) 20
(B) 80
(C) 60
(D) 33

64. If a, b, c represents the sides opposite to angle A, B, C respectively in ΔABC.
If $\cos A + 2\cos B + \cos C = 2$, then a, b, c are in
(A) A.P.
(B) H.P.
(C) G.P.
(D) none of these

65. If the standard deviation of 0, 1, 2, 3, ….. 9 is k, then the standard deviation of 10, 11, 12, 13, ….. 19 is
(A) k
(B) k + 10
(C) $k+\sqrt{10}$
(D) 10 k

66. The inverse of the proposition $(p \wedge \sim q) \to r$ is
(A) $\sim r \to (\sim p \vee q)$
(B) $(\sim p \vee q) \to \sim r$
(C) $r \to p \wedge \sim q$
(D) $(p \wedge \sim q) \to \sim r$

67. Let S be the set of real values of λ for which the function $f(x) = x^3 - 3(2\lambda - 1)x^2 + 6\lambda x$ has exactly one local maximum and exactly one local minimum, then S can be
(A) (0, 6)
(B) (1, 4)
(C) $(-\infty, 0)$
(D) $(0, \infty)$

68. The line $\frac{x-1}{\lambda}=\frac{y}{2}=\frac{z+3}{-12}$ makes an isosceles triangle with the planes $x + 2y - 3z + 5 = 0$ and $2x + 3y - z + 2 = 0$, then value of λ can be
(A) 5
(B) 11
(C) 22
(D) 9

69. Let p(x) be a polynomial of degree 3 such that $p(x)=\frac{2}{3+x}$ for x = 0, 1, 2, 3, then p(6) is equal to
(A) 2
(B) 0
(C) –2
(D) –3

70. Let f(x) be a function defined on R such that $f'(x) = 2f'(6 - 2x)$ with $f(2) = 4$, then $f(1) + f(4)$ is equal to
(A) 4
(B) 0
(C) 8
(D) –4

SECTION – B

(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

---

71. $\lim\limits_{n\to\infty} \dfrac{n\times 5^n}{n(x-3)^n + n\times 5^{n+2} - 5^n} = \dfrac{1}{25}$, (n $\in$ N), then the highest positive integral value of x is

72. If α and β are roots of the equation $x^2 - 10x - 6 = 0$ and $P_n = \alpha^n - \beta^n$, then the value of $\dfrac{P_{16} - 6P_{14}}{2P_{15}}$ is equal to

SECTION – C

(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

73. $\int \dfrac{(x^4 - x)^{\frac{1}{4}}}{x^5}\,dx = \dfrac{m}{k}\left(\dfrac{x^3 - 1}{x^3}\right)^{\frac{5}{4}} + c$, then k – 2m is equal to (where m and k are coprime)

74. The locus of the image of the focus of the ellipse $9x^2 + 25y^2 = 225$ with respect to any tangent to the ellipse is a circle whose radius is k, then $\dfrac{k}{4}$ is equal to

75. If the portion of the line x + 4y – 3 intercepted between the lines ax – y + 3 = 0 and x + by – 1 = 0 subtends a right angle at the origin, then $\dfrac{2a + 9b}{20}$ is equal to

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – II

JEE (Main)-2020

TEST DATE: 22-12-2019

ANSWERS, HINTS & SOLUTIONS

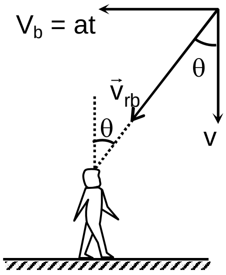
Physics

PART – I

SECTION – A

1. A

Sol. $\vec{v}_{r,b} = \vec{v}_r - \vec{v}_b$



$$\tan\theta = \frac{at}{v} = t$$

$$\Rightarrow \sec^2\theta\frac{d\theta}{dt} = 1$$

$$\frac{d\theta}{dt} = \frac{1}{\sec^2\theta} = \frac{1}{(1+t^2)}$$

2. C

Sol. Work done = area under P-t graph
(as t increases, area increases)

3. B

Sol. Using Mosely’s law for both cobalt and impurity

$$\sqrt{\nu} = K(Z-1)$$

$$\Rightarrow \sqrt{\frac{c}{\lambda}} = K(Z-1)$$

$$\Rightarrow \sqrt{\frac{c}{\lambda_{CO}}} = K(Z_{CO}-1) \text{ and } \sqrt{\frac{c}{\lambda_x}} = k(Z_x-1)$$

$$\sqrt{\frac{\lambda_{CO}}{\lambda_x}} = \frac{Z_x-1}{Z_{CO}-1} \Rightarrow Z_x = 40$$

4. B

Sol. given that, perimeter is decreasing at a rate of 2v

$$\therefore -\frac{d}{dt}(2\pi r) = 2v$$

$$\Rightarrow \frac{dr}{dt} = -\frac{v}{\pi}$$

$$\phi = B\pi r^2$$

$$\varepsilon = \left|-\frac{d\phi}{dt}\right|$$

$$\varepsilon = B2\pi r\left|\frac{dr}{dt}\right| = B2\pi r\frac{v}{\pi} = 2Brv$$

$$\Rightarrow I = \frac{\varepsilon}{R} = \frac{2Brv}{R}$$

$$I = \frac{2Brv}{\lambda(2\pi r)}$$

$$I = \frac{Bv}{\pi\lambda}$$

5. C

Sol. $\omega = \sqrt{\frac{k}{m}}$

At equilibrium $k(\ell - a) = mg$

$$\Rightarrow \quad \frac{k}{m} = \frac{g}{(\ell - a)}$$

$\Rightarrow$ Angular frequency, $\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{g}{(\ell - a)}}$

6. B

Sol. $\Delta r = (\mu_A - 1)t_A - (\mu_B - 1)t_B$

$= \mu_A t_A - t_A - \mu_B t_B + t_B$

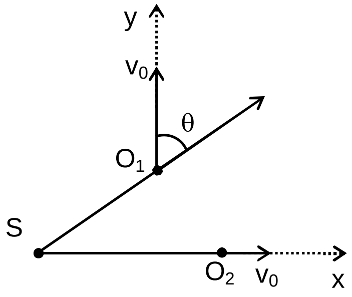
$= t_B - t_A$

$\Rightarrow$ If $\Delta r > 0$, then fringe pattern will shift upwards (towards A)

$\Rightarrow$ If $\Delta r < 0$, then fringe pattern will shift downwards (towards B)

7. D

Sol. $f_1 = f_0\left(\frac{v - v_0\cos\theta}{v}\right)$



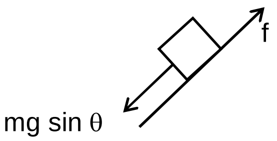
$f_2 = f_0\left(\frac{v - v_0}{v}\right)$

$f_1 > f_2 \qquad (\because v_0\cos\theta < v_0)$

$$\Rightarrow \quad \left(\frac{f_1}{f_2}\right) > 1$$

8. A

Sol. $mg\sin\theta = \eta A\frac{v}{t}$



$a^3\rho g\times\frac{3}{5} = \eta\times a^2\times\frac{v}{t}$

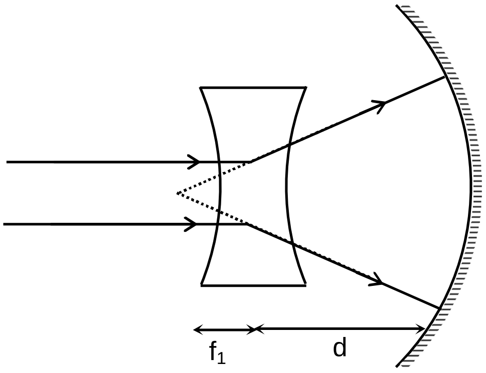
$\frac{3}{5}a\rho g = \frac{\eta v}{t}$

$\eta = \frac{3\rho agt}{5v}$

9. B

Sol. $(d + |f_1|) = 2|f_2|$

$\Rightarrow d = 2|f_2| - |f_1|$



10. B

Sol. As charge on the capacitor is conserved

$\Rightarrow C_0V_0 = C'V$

$\Rightarrow \frac{\varepsilon_0 A}{d_0}V_0 = \frac{\varepsilon_0 A}{d}V$

$\Rightarrow \frac{V_0}{d_0} = \frac{V_0}{d}\left(1+\frac{1}{2}\sin\omega t\right)$

After putting the values

$d_1 = \frac{d_0}{2}$

11. A

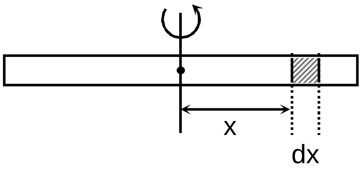
Sol. Current, I = $\left(\frac{V}{\rho d/S}\right) = \frac{VS}{\rho d}$

12. A

Sol. $dM = IA = (dq)f\pi x^2$

$= \frac{q}{\ell}dxf\pi x^2$

$M = \frac{qf\pi}{\ell}\int_{-\ell/2}^{\ell/2} x^2dx = \frac{q\pi f\ell^2}{12}$



13. D

Sol. $\vec{E}$ is parallel to $\vec{B}$. $\vec{v}_0$ is perpendicular to both. Therefore path of the particle is a helix with increasing pitch. Speed of particle at any time t is

$v = \sqrt{v_x^2 + v_y^2 + v_z^2}$ …(i)

Here, $v_y^2 + v_z^2 = v_0^2$

$v = 2v_0$

putting this in equation (i)

$v_x = \sqrt{3}v_0$ and $v_x = \frac{qE_0}{m}t$

$t = \frac{\sqrt{3}mv_0}{qE_0}$

14. A

Sol. $I = \frac{24}{\frac{RG}{R+G}+1}$

V = 24 – potential difference across 1 Ω

= 24 – I

$$V = 24 - \left(\frac{24}{\frac{1}{\frac{I}{R}+\frac{1}{G}}+1}\right)$$

For G → ∞ ⇒ $\frac{1}{G}$ → 0 and V = 20 volts

⇒ 20 = 24 – $\frac{24}{R+1}$ ⇒ R = 5Ω

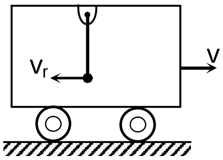
15. C

Sol. $A = \frac{\frac{d}{dt}\left[\int \vec{F}.d\vec{s}\right]}{\left[\vec{F}\cdot\vec{P}\right]}$

$= \frac{[\text{work}]}{\text{time}\times\frac{\text{work}}{\text{displacement}}\times P} = \frac{1}{M}$

16. A

Sol. Using conservation of momentum :



$m(v_r - v) = 6mv$

$\Rightarrow v_r = 7v$ …(i)

Now, using conservation of energy:

$mg\ell = \frac{1}{2}m(6v)^2 + \frac{1}{2}6mv^2$

$\Rightarrow v = \sqrt{\frac{g\ell}{21}}$

$\therefore v_r = 7v = \sqrt{\frac{7g\ell}{3}}$

17. C

Sol. After each collision normal components of velocity gets reversed.

$\therefore$ after 1st collision, velocity of coin, $\vec{v}_1 = 2\hat{i} - 3\hat{j}$

after 2st collision, velocity of coin, $\vec{v}_2 = -2\hat{i} - 3\hat{j}$

after 3rd collision, velocity of coin, $\vec{v}_3 = -2\hat{i} + 3\hat{j}$

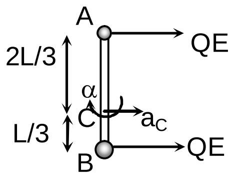
18. B

Sol. $E_1 = \dfrac{KP_1}{r^3}$

$$F = P_2\left|\frac{dE_1}{dr}\right| = \frac{3KP_1P_2}{r^4}$$

19. D

Sol. Acceleration of centre of mass of the system,



$$a_C = \frac{2QE}{3m}$$

$$QE\left(\frac{2L}{3}\right) - QE\left(\frac{L}{3}\right) = \left(m \times \frac{4L^2}{9} + 2m \times \frac{L^2}{9}\right)\alpha$$

$$\frac{QEL}{3} = \frac{2mL^2}{3}\alpha$$

$$\alpha = \frac{QE}{2mL} \text{ clockwise}$$

$$a_A = a_C + \alpha\left(\frac{2L}{3}\right) = \frac{2QE}{3m} + \frac{QE}{2mL}\left(\frac{2L}{3}\right) = \frac{QE}{m}$$

20. D

Sol. As it passes twice the transmission axis in one rotation.

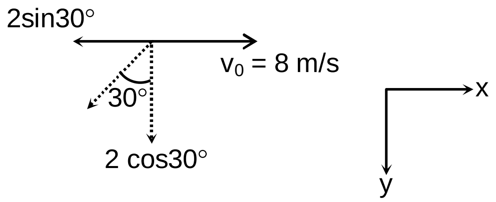
SECTION – B

21. 4

Sol. $v_x^2 + v_y^2 = 8^2$

$(8-t)^2 + (\sqrt{3}t)^2 = 8^2$

$\Rightarrow$ t = 4 sec



22. 1

Sol. Increase in length (dx) = α(dx)ΔT

$$(d\ell) = = \frac{x}{5000} \times (dx) \times 100 = \frac{x}{50}dx$$

$$\therefore \text{ total expansion, } \Delta\ell = \int_0^1 \frac{x}{50}\, dx = \frac{1}{100}m = 1\,cm.$$

SECTION – C

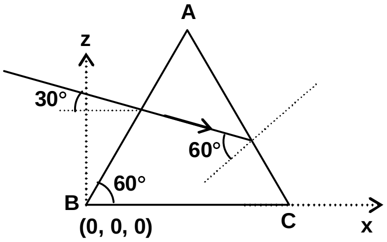
23. 00001.15

Sol. Since, $\sqrt{3}z + x = 10$

$\Rightarrow z = -\frac{x}{\sqrt{3}} + \frac{10}{\sqrt{3}}$

Slope = $-\frac{1}{\sqrt{3}} = \tan\theta$

$\Rightarrow \theta = -30°$



So, the ray is incident normally on the face AB. Thus angle of incidence on the face AC is 60° for grazing the face AC,

$\mu \sin(60°) = 1 \times \sin 90°$

$\mu = \frac{2}{\sqrt{3}}$ = 1.1547

24. 00010.00

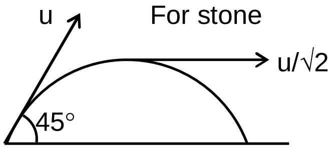
Sol. According to the problem, power = 1W.
Zener breakdown voltage, $V_z = 5V$
Minimum voltage, $V_{min} = 3V$
Maximum voltage, $V_{max} = 7V$
We know, P = VI

So, current $I_{Z_{max}} = \frac{P}{V_Z} = \frac{1}{5} = 0.2\,A$

For safe operation, $R_s = \frac{V_{max} - V_z}{I_{Z_{max}}} = \frac{7-5}{0.2} = 10\,\Omega$

25. 00019.60

Sol. For stone, at the highest point



Radius of curvature, $R = \frac{\left(u/\sqrt{2}\right)^2}{g} = \frac{u^2}{2g}$

The bee follows the stone's trajectory with the constant speed u

$a = \frac{u^2}{R} = \frac{u^2}{u^2/2g} = 2g$

a = 2g = 19.6 m/s^2

Chemistry

PART – II

SECTION – A

26. C

Sol. For adiabatic process

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1} = \left(\frac{P_1}{P_2}\right)^{\frac{1-\gamma}{\gamma}}$$

$$\Rightarrow \frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\frac{R}{C_V}} = \left(\frac{P_2}{P_1}\right)^{\frac{R}{C_P}}$$

or $\ln\frac{T_2}{T_1} = \frac{R}{C_V}\ln\frac{V_1}{V_2} = \frac{R}{C_P}\ln\frac{P_2}{P_1}$

27. D

Sol. A $\rightarrow$ Aromatic

B $\rightarrow$ Non-aromatic

C $\rightarrow$ Aromatic

D $\rightarrow$ Antiaromatic

28. D

Sol. Sucrose is non-reducing disaccharide.

29. D

Sol. Due to hydrogen bonding.

30. A

Sol. pH = 6 $\therefore H^+ = 10^{-6}$

$$HIn \rightleftharpoons H^+ + In^-$$

$$\begin{array}{lll} C & 0 & 0 \\ \frac{C}{2} & \frac{C}{2} & \frac{C}{2} \end{array}$$

$$K_{HIn} = \frac{\left[H^+\right]\left[In^-\right]}{[HIn]}$$

$$= \frac{10^{-6} \times C/2}{C/2} = 10^{-6}$$

31. C

Sol. Correct order for bond dissociation energy is

$$\begin{array}{lcccc} & Cl_2 > & Br_2 > & F_2 > & I_2 \\ kJ/mol & (242) & (193) & (159) & (151) \end{array}$$

32. B

Sol. Number of X atom left in unit cell $= 4 - \frac{1}{8}\times 5 - \frac{1}{2}\times 1$

$= \frac{32-5-4}{8} = \frac{23}{8}$

Number of Y atom left in unit cell $= 4 - \frac{1}{4} \times 4 - 1 = 2$

Number of Z atom left in unit cell $= 8 - 2 = 6$

$\therefore$ Formula = $X_{\frac{23}{8}}Y_2Z_6$

$= X_{23}Y_{16}Z_{48}$

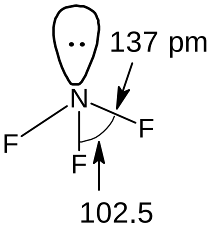
33. D

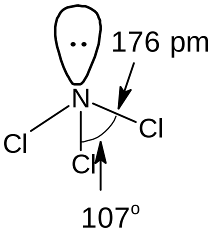
34. A

Sol. SO_2 is a non-linear molecule.
$\therefore$ Translational degree of freedom = 3
Rotational degree of freedom = 3
Vibrational degree of freedom = (3 × 3 – 6) = 3
But, vibration degree of freedom is inactive at low temperature.
$\therefore$ Active degree of freedom = 3 + 3 = 6

35. B

Sol.





$\mu = 0.24$ D	0.37 D
M.P. = 66 K	230 K

36. C

37. B

Sol. ‘A’ and ‘C’ has place of symmetry. ‘D’ is a planar molecule.

38. A

Sol. $PV = \frac{W}{M}RT$

$\Rightarrow \frac{T}{M} = \frac{PV}{WR} = \frac{5 \times 1.5}{10 \times 0.0821} = 9.135\ K/gm = 9.135 \times 10^3$ K/kg

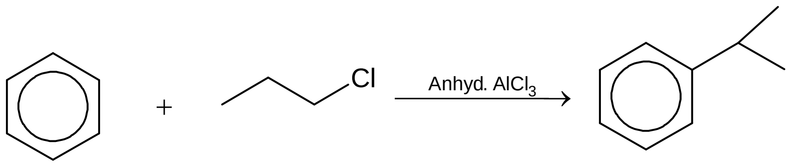
$V_{rms} = \sqrt{3R\left(\frac{T}{M}\right)} = \sqrt{3 \times 8.314 \times 9.135 \times 10^3}$

= 477.33 m/sec.

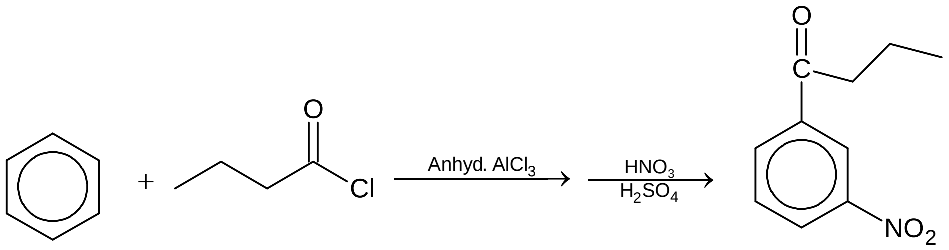
39. A

40. C

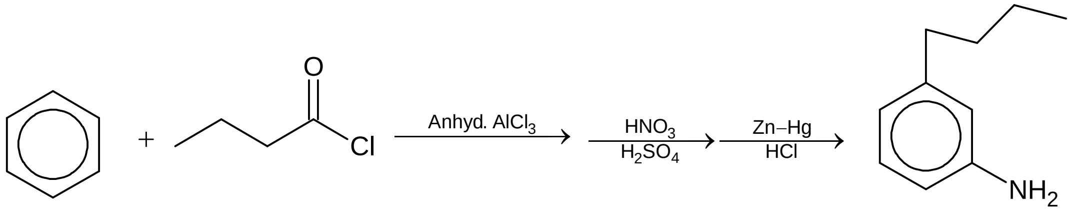
Sol. (A)


+
Cl
Anhyd. AlCl3

(B)

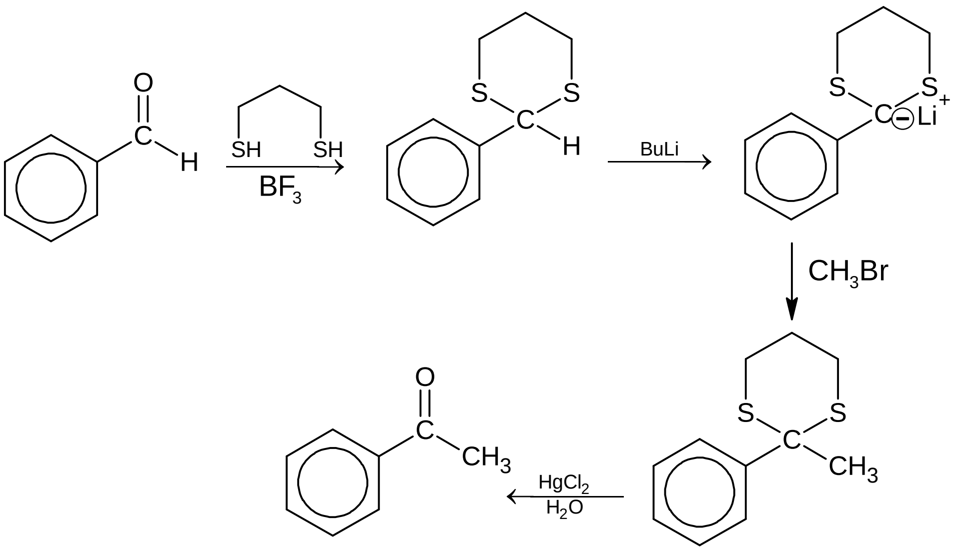

+
O
Cl
Anhyd. AlCl3
HNO3
H2SO4
O
C
NO2

(D)


+
O
Cl
Anhyd. AlCl3
HNO3
H2SO4
Zn–Hg
HCl
NH2

41. D

Sol.


O
C
H
SH SH
BF3
S S
C
H
BuLi
S S+
C Li
CH3Br
S S
C
CH3
HgCl2
H2O
O
C
CH3

42. D

Sol. Order of enol content in pure liquid state

D > C > B > A

43. B

44. D

Sol. In PbO_2 Pb is in +4 oxidation state.

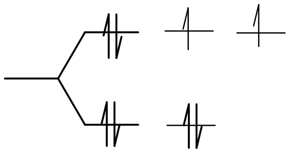
45. D

SECTION – B

46. 4

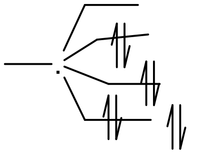
Sol.

$\left[NiCl_4\right]^{2-}$ Ni^{2+} (Td)



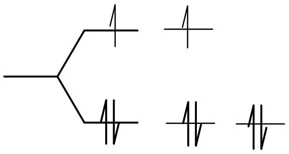
$n_1 = 2$

$\left[Ni(CN)_4\right]^{2-}$ Ni^{2+} (Sq. planar)



$n_2 = 0$

$\left[Ni(H_2O)_6\right]^{2+}$ Ni^{2+} (Oh)

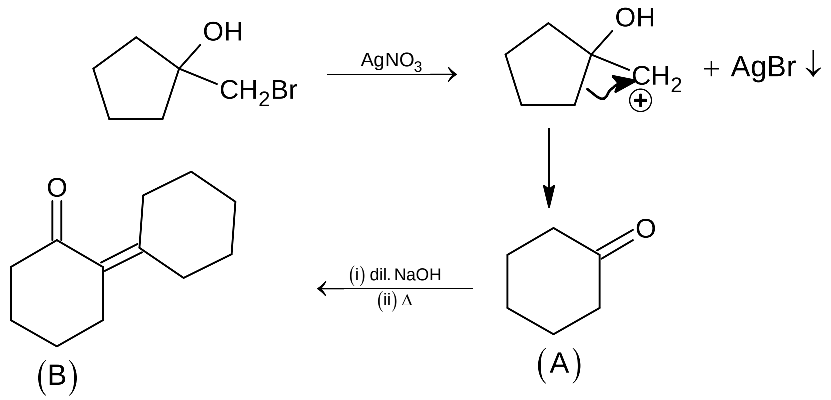


$n_3 = 2$

Total number of unpaired electrons = $n_1 + n_2 + n_3 = 4$

47. 4

Sol.



Degree of unsaturation = 4.

SECTION – C

48. 00000.40

Sol. $$K_P = \frac{\left(P_{SO_3}\right)^2}{\left(P_{SO_2}\right)^2\left(P_{O_2}\right)}$$

$$10 = \frac{\left(P_{SO_3}\right)^2}{\left(\frac{P_{SO_3}}{2}\right)^2 .P_{O_2}}$$

$$10 = \frac{4}{P_{O_2}}$$

$$\therefore P_{O_2} = \frac{4}{10} = 0.4 \text{ atm}$$

49. 00003.25

Sol.

$$\begin{array}{cccc} K_3\left[Fe(CN)_6\right] \longrightarrow & 3K^+ & + & \left[Fe(CN)_6\right]^{3-} \\ C & 0 & & 0 \\ C - C\alpha & 3C\alpha & & C\alpha \end{array}$$

$$i = \frac{C - C\alpha + 3C\alpha + C\alpha}{C} = 1 + 3\alpha$$

Given $\alpha = 0.75$

$\therefore i = 1 + 3 \times 0.75 = 3.25$

50. 00004.25

Sol. M.eq. of NH_3 = 500 × 0.6 – 500 × 0.1

= 250 M.eq.

$$\frac{W}{E} \times 1000 = 250$$

$$\therefore W = \frac{250 \times 17}{1000} = 4.25\,\text{gm}$$

Mathematics

PART – III

SECTION – A

51. C

Sol. Centre of hyperbola is (3, 4) one end of transverse axis is (3, –1)

$\therefore$ Transverse axis is parallel to y-axis $\Rightarrow b = 5$ and $b^2 - a^2 = 20 \Rightarrow a = \sqrt{5}$

$\therefore$ Equation of hyperbola is $\frac{(x-3)^2}{5} - \frac{(y-4)^2}{25} = -1$

52. C

Sol. $\frac{1}{\alpha}, \frac{1}{\beta}, \frac{1}{\gamma}$ are in A.P., $\frac{1}{\alpha} + \frac{1}{\beta} + \frac{1}{\gamma} = \frac{\alpha\beta + \beta\gamma + \gamma\alpha}{\alpha\beta\gamma} = \frac{-54/10}{27/10} - 2 \Rightarrow \frac{3}{\beta} = -2 \Rightarrow \beta = \frac{-3}{2}$

$\therefore 10\left(\frac{-27}{8}\right) - m\left(\frac{9}{4}\right) - 54\left(\frac{-3}{2}\right) - 27 = 0 \Rightarrow m = 9$

53. A

Sol. Last digit of $(2017)^{2018}$ is 9, last digit of $(2018)^{2019}$ is 2, last digit of $(2019)^{2020}$ is 1

54. C

Sol. Add and subtract 7! , $7! + 8! + \frac{9!}{2!} + \frac{10!}{3!} + ... \frac{27!}{20!} - 7! = 7!\left(1 + \frac{8!}{1!7!} + \frac{9!}{2!7!} + \frac{10!}{3!7!} + ... \frac{27!}{20!7!}\right) - 7!$

$7!\left({}^{7}C_0 + 8C_1 + 9C_2 + 10C_3 + ... {}^{27}C_{20}\right) - 7! = 7!\left(8C_0 + 8C_1 + 9C_2 + 10C_3 + ... {}^{27}C_{20}\right) - 7!$

$= 7!\left({}^{28}C_{20}\right) - 7!$

55. D

Sol. $C^{-1}B = AC^{-1} \Rightarrow C^{-1}BC = A \Rightarrow A^2 = C^{-1}BCC^{-1}BC = C^{-1}B^2C$

$\Rightarrow A^3 = C^{-1}B^2CC^{-1}BC = C^{-1}B^3C$

Similarly proceeding $A^5 = C^{-1}B^5C \therefore CA^5C^{-1} = CC^{-1}B^5CC^{-1} = B^5$

56. B

Sol. $\begin{vmatrix} \alpha_1 & \alpha_2 \\ \beta_1 & \beta_2 \end{vmatrix} = 0 \Rightarrow \alpha_1\beta_2 - \alpha_2\beta_1 = 0 \Rightarrow \frac{\alpha_1}{\beta_1} = \frac{\alpha_2}{\beta_2}$

Using componendo and dividendo $\frac{\alpha_1 + \beta_1}{\alpha_1 - \beta_1} = \frac{\alpha_2 + \beta_2}{\alpha_2 - \beta_2} \Rightarrow \frac{-b/a}{\sqrt{\frac{b^2}{a^2} - \frac{4c}{a}}} = \frac{-q/p}{\sqrt{\frac{q^2}{p^2} - \frac{4r}{p}}}$

$\Rightarrow \frac{b}{\sqrt{b^2 - 4ac}} = \frac{q}{\sqrt{q^2 - 4pr}} \Rightarrow b^2pr = q^2ac$

57. D

Sol. $|z|^2 = 9 \Rightarrow z\bar{z} = 9 \Rightarrow \left|3 + \frac{9}{z}\right|^2 + |3 - z|^2 \Rightarrow \left|3 + \frac{9}{9/\bar{z}}\right|^2 + |3 - z|^2$

$\Rightarrow |3 + \bar{z}|^2 + |3 - z|^2 = 2\left(9 + |z|^2\right) = 36$

58. B

Sol. Let point P be (h, k) $\therefore$ Equation of pair of tangents is $T^2 = SS_1$

$\Rightarrow (ky - 4x - 4h)^2 = (y^2 - 8x)(k^2 - 8h) \Rightarrow 16x^2 + y^2(8h) - 8xyk - 32hx + 8xk^2 - 16h^2 + 8hky = 0$

$\because$ Angle is 45° $\Rightarrow \tan 45° = 1 = \dfrac{2\sqrt{16k^2 - 16 \times 8h}}{16 + 8h} \Rightarrow 16 + 8h = 2 \times 4\sqrt{k^2 - 8h}$

$\Rightarrow 2 + h = \sqrt{k^2 - 8h} \Rightarrow 4 + h^2 + 4h = k^2 - 8h \Rightarrow h^2 + 12h - k^2 + 4 = 0 \Rightarrow (x + 6)^2 - y^2 = 32$

59. C

Sol. $\dfrac{x\,dy - y\,dx}{x^2} = \dfrac{x\sqrt{1-\left(\frac{y}{x}\right)^2}\,dx}{x^2} \Rightarrow d\left(\dfrac{y}{x}\right) = \dfrac{\sqrt{1-\left(\frac{y}{x}\right)^2}\,dx}{x} \Rightarrow \dfrac{d(y/x)}{\sqrt{1-\left(\frac{y}{x}\right)^2}} = \dfrac{dx}{x}$

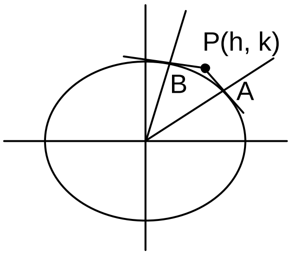
$\Rightarrow \sin^{-1}\left(\dfrac{y}{x}\right) = \ln x + c$

At x = 1, y = 0 $\Rightarrow$ 0 = 0 + c $\Rightarrow$ c = 0

$\Rightarrow \sin^{-1}\left(\dfrac{y}{x}\right) = \ln x$

$\Rightarrow$ y = x sin(ln x)

60. B



Sol. Equation of AB is $x^2 + 4y^2 + \alpha xy = 0$ ….. (1)

AB is chord of contact with respect to point P

$\Rightarrow$ Equation of AB is hx + 4ky = 4

Combined equation of AB is $x^2 + 4y^2 - 4\left(\dfrac{hx + 4ky}{4}\right)^2 = 0$

$\Rightarrow x^2(4 - h^2) + y^2)(16 - 16k^2) - 8hxy = 0$ ….. (2)

Equation (1) and (2), represent same equation

$\therefore \dfrac{4 - h^2}{1} = \dfrac{16 - 16k^2}{4} = \dfrac{-8hk}{\alpha} \Rightarrow x^2 = 4y^2$

61. B

Sol. Let equation of circle is $x^2 + y^2 + 2gx + 2fy + c = 0 \Rightarrow 1 + 2f + c = 0$

$2 \times g \times (-1) + 2 \times f \times 0 = -15 + c$ and $2 \times g \times 0 + 2f \times 0 = -1 + c \Rightarrow c = 1$

$-2g = -15 + c$

$\Rightarrow g = 7 \Rightarrow f = -1$

62. B

Sol. Let $y = mx + \sqrt{25m^2 + 4}$ be a tangent to a given ellipse

$\because$ It is a common tangent $\therefore \dfrac{\left|0 - 0 + \sqrt{25m^2 + 4}\right|}{\sqrt{m^2 + 1}} = 4 \Rightarrow m = \pm\dfrac{2}{\sqrt{3}}$

$\therefore$ Equation of common tangent is $y = \pm\dfrac{2}{\sqrt{3}}x \pm \dfrac{\sqrt{112}}{\sqrt{3}}$

$\therefore$ Length of intercept = $\dfrac{14}{\sqrt{3}}$

63. C

Sol. E_k : k white balls and (5 – k) black balls are taken from bag A

C : bag C contains 3 white balls exactly

$$P(C) = P\left(\frac{C}{E_3}\right)P(E_3)+P\left(\frac{C}{E_4}\right)P(E_4)+P\left(\frac{C}{E_5}\right)P(E_5)$$

$$= \frac{{}^5C_3\times{}^5C_2}{{}^{10}C_5}\times\left(\frac{{}^3C_3\times{}^2C_1}{{}^5C_4}\right)+\frac{{}^5C_4\times{}^5C_1}{{}^{10}C_5}\times\left(\frac{{}^4C_3\times{}^1C_1}{{}^5C_4}\right)+\frac{{}^5C_5}{{}^{10}C_5}\left(\frac{0}{{}^5C_4}\right)$$

$$= \frac{10\times10\times2}{{}^{10}C_5\times5}\times\frac{5\times5}{{}^{10}C_5}\times\frac{4}{5}+0=\frac{60}{{}^{10}C_5}$$

64. A

Sol. cos A + 2 cos B = 2 – 2 cos C $\Rightarrow 2\cos\left(\frac{A+C}{2}\right)\cos\left(\frac{A-C}{2}\right)=4\sin^2\frac{B}{2}$

$$\Rightarrow \cos\left(\frac{A-C}{2}\right)=2\sin\frac{B}{2} \Rightarrow \cos\frac{A}{2}\cos\frac{C}{2}+\sin\frac{A}{2}\sin\frac{C}{2}=2\sin\frac{B}{2}$$

$$\Rightarrow \sqrt{\frac{s(s-a)}{bc}}\sqrt{\frac{s(s-c)}{ab}}+\sqrt{\frac{(s-b)(s-c)}{bc}}\times\sqrt{\frac{(s-a)(s-b)}{ab}}=2\sqrt{\frac{(s-a)(s-c)}{ac}}$$

$$\Rightarrow \frac{s}{b\sqrt{ac}}+\frac{s-b}{b\sqrt{ac}}=\frac{2}{\sqrt{ac}} \Rightarrow a + c = 2b$$

65. A

Sol. Standard deviation doesn't change if we increase or decrease each number by a particular amount

66. B

Sol. $\sim(p \wedge \sim q) \to \sim r$

$= \sim p \vee q \to \sim r$

67. C

Sol. $f'(x) = 0$ must have two real and unequal roots

$f'(x) = 3x^2 - 6(2\lambda - 1)x + 6\lambda = 0$ must have $D > 0 \Rightarrow 36(2\lambda - 1)^2 - 72\lambda > 0$

$\Rightarrow 4\lambda^2 + 1 - 4\lambda - 2\lambda > 0 \Rightarrow 4\lambda^2 - 6\lambda + 1 > 0,\ \lambda \in \left(-\infty, 3-\sqrt{5}\right)\cup\left(3+\sqrt{5}, \infty\right)$

68. C

Sol. Line makes equal angles with both planes and hence equal angles with normals of both planes

$$\frac{\lambda+4+36}{\sqrt{\lambda^2+4+144}\sqrt{1^2+2^2+3^2}}=\frac{2\lambda+6+12}{\sqrt{\lambda^2+4+144}\sqrt{1^2+2^2+3^2}} \quad \therefore \lambda = 22$$

69. B

Sol. Let $g(x) = p(x)(3 + x) - 2$ ….. (1)

Then g(x) is 4 degree polynomial whose roots are 0, 1, 2, 3

$\Rightarrow g(x) = kx(x-1)(x-2)(x-3) \Rightarrow g(-3) = -2 \Rightarrow -2 = k \times -3 \times -4 \times -5 \times -6 \Rightarrow k = \frac{-1}{180}$

$\therefore\ g(x)=\frac{-x(x-1)(x-2)(x-3)}{180}=p(x)(3+x)-2$, put x = 6

$\frac{-6\times5\times4\times3}{180}=p(6)9-2 \Rightarrow p(6) = 0$

70. C

Sol. Integrating both sides $f(x)=\frac{2f(6-2x)}{-2}+c$

f(x) + f(6 – 2x) = c, put x = 2, f(2) + f(2) = c ⇒ c = 8
⇒ f(x) + f(6 – 2x) = 8
Put x = 1 ⇒ f(1) + f(4) = 8

SECTION – B

71. 7

Sol. Divide numerator and denominator by $n5^n$ ⇒ $\lim\limits_{n\to\infty} \dfrac{1}{\left(\dfrac{x-3}{5}\right)^n + 25 - \dfrac{1}{n}} = \dfrac{1}{25}$

$$\Rightarrow -1 < \frac{x-3}{5} < 1 \Rightarrow -2 < x < 8$$

72. 5

Sol. $$\frac{\alpha^{16}-\beta^{16}-6\left(\alpha^{14}-\beta^{14}\right)}{2\left(\alpha^{15}-\beta^{15}\right)} = \frac{\alpha^{14}\left(\alpha^{2}-6\right)-\beta^{14}\left(\beta^{2}-6\right)}{2\left(\alpha^{15}-\beta^{15}\right)} = \frac{10\alpha^{15}-10\beta^{15}}{2\left(\alpha^{15}-\beta^{15}\right)} = 5$$

SECTION – C

73. 00007.00

Sol. $I = \displaystyle\int \frac{x\left(1-\dfrac{1}{x^3}\right)^{\frac{1}{4}}}{x^5}\,dx = \int \frac{\left(1-\dfrac{1}{x^3}\right)^{\frac{1}{4}}}{x^4}\,dx$. Let $1-\dfrac{1}{x^3} = t^4 \Rightarrow \dfrac{3}{x^4}dx = 4t^3dt$

$$\Rightarrow I = \int t \times \frac{4}{3}t^3dt = \frac{4}{15}\left(1-\frac{1}{x^3}\right)^{\frac{5}{4}} + c \quad \therefore m = 4, k = 15$$

74. 00002.50

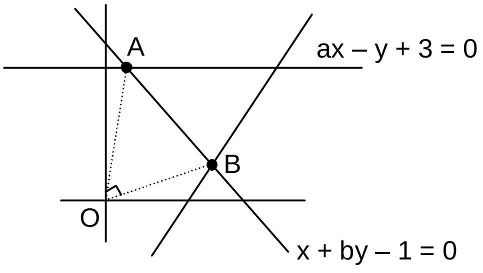
Sol. Foot of perpendicular of focus on any tangent lies on auxiliary circle

Let image be (h k), focus is (4, 0) or (–4, 0) ⇒ $\dfrac{h+4}{2}, \dfrac{k}{2}$ lies on auxiliary circle

∴ Locus is $(x + 4)^2 + y^2 = 100$

75. 00000.50

Sol. For equation of OA



x + 4y – 3 + λ(ax – y + 3) = 0
It passes through (0, 0) ∴ λ = 1
∴ Equation of OA is (a + 1)x + 3y = 0
Similarly equation of OB is –2x + (4 – 3b)y = 0

$$\therefore \frac{-(a+1)}{3} \times \frac{2}{(4-3b)} = -1 \Rightarrow 2a + 2 = 12 - ab$$

⇒ 2a + 9b = 10

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – III

JEE (Advanced)-2020

PAPER – 1

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B.**

1. ***Section-A (01– 7, 19 – 25, 37 – 43)*** *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect option is selected.

   Section-A (08 – 13, 26 – 31, 44 – 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S). Each multiple choice question with 4 options has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section–B (14 – 18, 32 – 36, 50 – 54)*** *contains 15 Numerical based questions with answers as numerical value from 0 to 9 and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

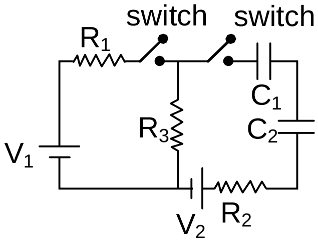
PART – I

SECTION – A

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. In the given circuit $C_1 = C$, $C_2 = 2C$, $V_1 = V_2 = V$ & $R_1 = R_2 = R_3 = R$ and all switches-are closed at t = 0 then choose the incorrect statement at time t = RC (initially all capacitors are uncharged)



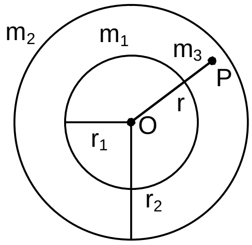
(A) Current through V_1 is less than $\frac{V}{2Re}[e-1]$

(B) Power delivered by V_2 is less than $\frac{V^2}{3eR}$

(C) Current through V_1 is greater than $\frac{V}{2Re}[e-1]$

(D) Power delivered by V_2 is greater than $\frac{V^2}{3eR}$

2. Two concentric spherical shells masses m_1 and m_2 and radii r_1 and r_2. Then



(A) outer shell will have no contribution in gravitational field at point P

(B) force on P is directed towards O

(C) force on P is $\frac{Gm_1m_2}{r^2}$

(D) force on P is $\frac{Gm_1m_3}{r^2}$

3. A ball of mass m is attached to the lower end of light vertical spring of force constant k. The upper end of the spring is fixed. The ball is released form rest with the spring at its normal (un- stretched) length, and comes to rest again after descending through a distance x. Then,

(A) x = mg/k

(B) x = 2mg/k

(C) The ball will have no acceleration at the position where it has descended through x/2.

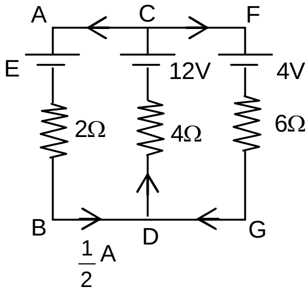
(D) The ball will have an upward acceleration equal to g at its lowermost position

Space for Rough work

4. If the potential difference of Coolidge tube producing X-ray is increased, then choose the correct option(s).
(A) the interval between $\lambda_{k\alpha}$ and $\lambda_{k\beta}$ increases
(B) the interval between $\lambda_{k\alpha}$ and λ_0 increases
(C) the interval between $\lambda_{k\beta}$ and λ_0 increases
(D) λ_0 does not change
Here λ_0 is cutoff wavelength and $\lambda_{k\alpha}$ and λ_{kB} are wavelength of k_α and k_B characteristic X-rays.

5. A microammeter has a resistance of 100Ω and a full scale range of 50μA. It can be used as a voltmeter or as a higher range ammeter provided a resistance is added to it. Pick the correct range and resistance combinations
(A) 50 V range with 10 kΩ resistance in series
(B) 10 V range with 200 kΩ resistance in series
(C) 5 mA range with 1 Ω resistance in parallel
(D) 10 mA range with 1 Ω resistance in parallel

6. In the circuit shown in figure
(A) E = 6.6 V
(B) i_1 = 1.1 A
(C) i_2 = 0.5 A
(D) E = 4.4 V



7. A closed organ pipe of length 28 cm closed at one end is found to be at resonance when a tuning fork of frequency 850 Hz is sounded near the open end. If velocity of sound in air is 340 m/s, then the
(A) air in the pipe is vibrating in fundamental mode
(B) air in the pipe is vibrating in first overtone
(C) end correction of the pipe is 1 cm
(D) end correction of the pipe is 2 cm

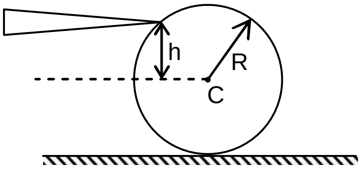
Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions Q. 8, Q. 9 and Q. 10 by appropriately matching the information given in the three columns of the following table.

A billiard ball, initially at rest, is given a sharp impulse by a cue. The cue is held horizontally a distance h above the central line as shown in adjacent figure. The ball leaves the cue with a speed V_0.



Column 1	Column 2	Column 3
(I) Clockwise	(i) $h = \frac{4R}{5}$	(P) Anticlock-wise
(II) Friction acts in forward direction.	(ii) $h = \frac{2R}{5}$	(Q) $t = \frac{2V_0}{7\mu g}$
(III) $\omega = \frac{9V_0}{7R}$	(iii) $\alpha = \frac{5\mu g}{2R}$	(R) Initial angular velocity $\omega_0 = \frac{2V_0}{R}$
(IV) Friction acts in backward direction.	(iv) $\alpha = \frac{2\mu g}{5R}$	(S) Initial angular velocity $\omega_0 = \frac{V_0}{R}$

8. In subsequent forward motion, the ball eventually acquires a final speed of $\frac{9}{7}V_0$, then which one of the combination in true,
(A) (I) (iii) (R)
(B) (II) (i) (R)
(C) (III) (i) (S)
(D) (IV) (ii) (S)

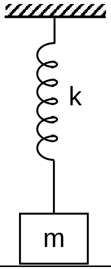
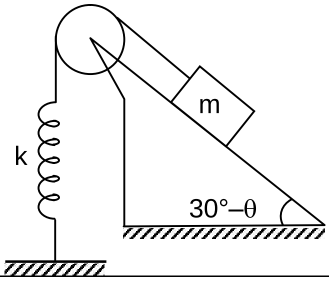
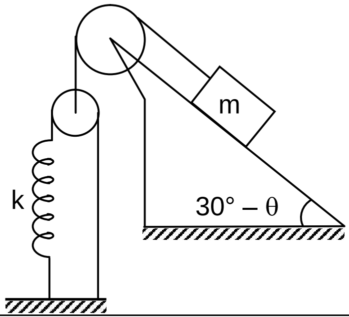
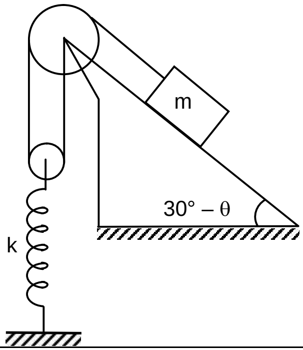
9. If μ is the coefficient of friction between the ball and the surface and α in the angular acceleration of the ball then which combination holds true for μ and α.
(A) (I) (iii) (R)
(B) (II) (iii) (P)
(C) (III) (iii) (S)
(D) (IV) (iv) (P)

10. If ω is the final angular velocity after time t the ball starts pure rolling, while the coefficient of friction is μ, then which combination holds true.
(A) (III) (iii) (Q)
(B) (IV) (i) (Q)
(C) (III) (ii) (R)
(D) (III) (ii) (S)

Space for Rough work

Answer questions Q. 11, Q. 12 and Q. 13 by appropriately matching the information given in the three columns of the following table.

Column-1 represents some systems, in which the mass is released for rest with spring relaxed. All contact surface are smooth, strings light, inextensible and pulleys light and smooth. Column-2 contains amplitude of small oscillations and column-3 contains time period for the oscillations.

Column 1	Column 2	Column 3
(I) 	(i) $\frac{mg}{2k}$	(P) $2\pi\sqrt{\frac{2m}{k}}$
(II) 	(ii) $\frac{mg}{k}$	(Q) $\pi\sqrt{\frac{m}{k}}$
(III) 	(iii) $\frac{2mg}{k}$	(R) $4\pi\sqrt{\frac{m}{k}}$
(IV) 	(iv) $\frac{mg}{8k}$	(S) $2\pi\sqrt{\frac{m}{k}}$

Space for Rough work

11. Which of the following options is a correct combination?
(A) (II) (i) (Q) (B) (II) (i) (S)
(C) (III) (ii) (R) (D) (II) (ii) (P)

12. Which of the following options is a correct combination?
(A) (III) (ii) (S) (B) (III) (iv) (R)
(C) (III) (iv) (Q) (D) (III) (ii) (P)

13. Which of the following options is a correct combination?
(A) (IV) (iii) (R) (B) (IV) (iii) (Q)
(C) (IV) (ii) (P) (D) (IV) (i) (S)

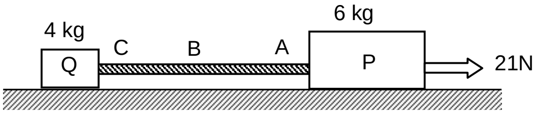
SECTION – B
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

14. A drop of water of mass m = 0.4 g is placed between two clean glass plates, the distance between which is 0.01 cm. If the force needed to hold one of the plates is 3.2x N, find 'x'. (Surface tension of water = 0.08 N/m).

15. A bus is moving towards a huge wall with a velocity of 5 m/s. the driver sounds a horn of frequency 200 Hz. What is the frequency of beats heard by a passenger of the bus, if the speed of sound in air is 330 m/s?

16. Two blocks of masses 6 kg and 4 kg connected by a rope of mass 4 kg are resting on frictionless floor as shown. If a constant force of 21 Newton is applied to 6 kg block, tension (In N) in the rope at point B is (CB : BA = 1 : 1)



17. Potential energy of a particle moving along x-axis is given by U = $\frac{x^3}{3} - \frac{9x^2}{2} + 20x$. Find out position of stable equilibrium state.

18. A perfectly absorbing surface intercepts a parallel beam of monochromatic light of power 100 W (λ = 500 nm) incident on it normally. If the force exerted by light beam on the surface is $\frac{10^{-6}}{n}$ N, then n =

Space for Rough work

Chemistry

PART – II

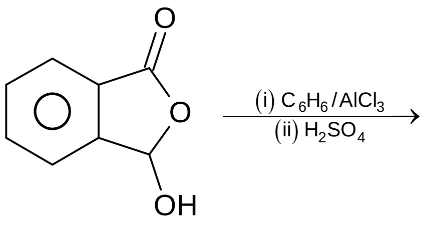
SECTION – A

(One or More than one correct type)

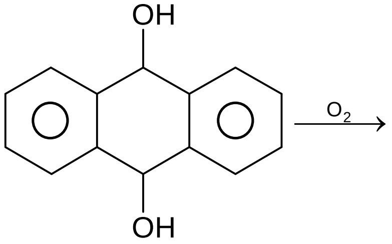
This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Which of the following reaction(s) will give Anthraquinone as major product?

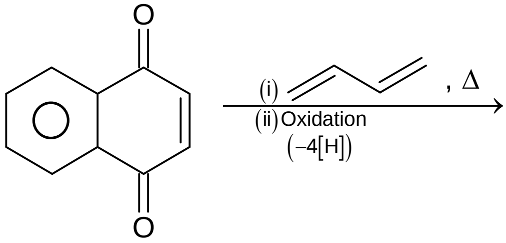
(A)



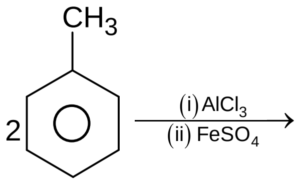
(B)



(C)

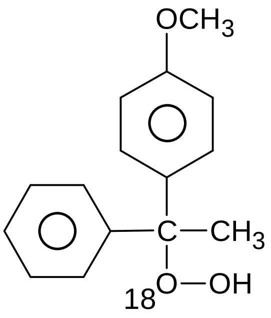


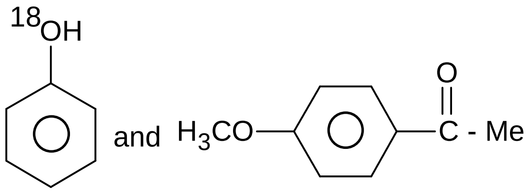
(D)

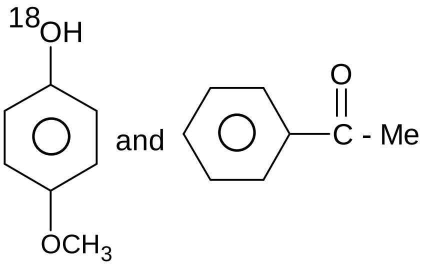


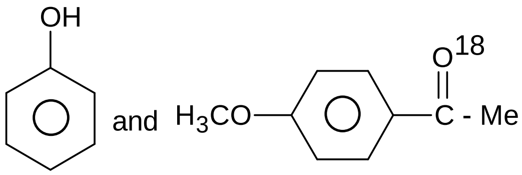
20. When O_2 is adsorbed on a metallic surface, electron transfer occurs form the metal to O_2. The TRUE statement(s) regarding this adsorption is(are)
(A) O_2 is physisorbed
(B) heat is released
(C) occupancy of π^*_{2p} of O_2 is increased
(D) bond length of O_2 is decreased

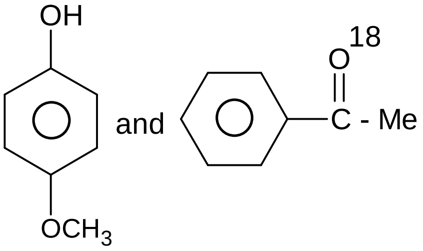
21. Which of the following pairs produce same gas?
(A) (Ca_3N_2 + dil. HCl) and (NH_4NO_2 on heating)
(B) [$(NH_4)_2Cr_2O_7$ on heating] and (NH_4NO_2 on heating)
(C) (NH_4NO_3 on heating) and [$Hg(NO_3)_2$ on heating]
(D) (NH_4Cl on heating) and [$NaNO_3$ + Zn + $NaOH_{(aq.)}$ on heating]

22. 
OCH3
C—CH3
18O—OH
$\xrightarrow[H_2O]{H^{\oplus}} A + B$, A and B are

(A) 
18OH
and
H3CO
O
C - Me

(B) 
18OH
OCH3
and
O
C - Me

(C) 
OH
and
H3CO
O18
C - Me

(D) 
OH
OCH3
and
O18
C - Me

23. For the reaction:

$I^- + ClO_3^- + H_2SO_4 \longrightarrow Cl^- + HSO_4^- + I_2$

The correct statement(s) in the balanced equation is/are

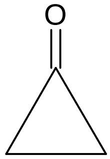
(A) stoichiometric coefficient of HSO_4^- is 6
(B) iodide is oxidised
(C) sulphur is reduced
(D) H_2O is one of the products

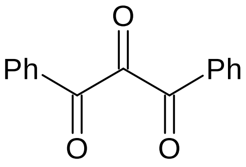
Space for Rough work

24. Many carbonyl compounds undergo reversible hydration in aqueous solution as

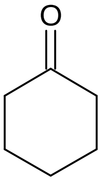
$$R_2C=O+H_2O \rightleftharpoons R_2C(OH)_2$$

For which of the carbonyl compounds, the above equilibrium is shifted towards the product at 25°C.

(A) 

(B) 

(C) Cl_3CCHO

(D) 

25. Choose the correct relations regarding basic strength?

(A) o-$MeC_6H_4NH_2$ < $C_6H_5NH_2$ < C_6H_5NHMe < p-$MeC_6H_4NH_2$

(B) o-$NO_2C_6H_4NH_2$ < o-$MeC_6H_4NH_2$ < o-$MeOC_6H_4NH_2$ < o-$HOC_6H_4NH_2$

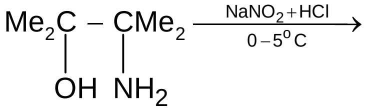
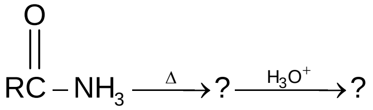
(C) C_4H_5N(Pyrrole) < MeCN < $C_6H_5NH_2$ < C_5H_5N(Pyridine)

(D) All of these

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions Q. 26, Q. 27 and Q. 28 by appropriately matching the information given in the three columns of the following table.

Column – 1 (Reaction condition)		Column – 2 (Intermediate)		Column – 3 (Reaction type)	
(I)	 $Me_2\underset{OH}{C}-\underset{NH_2}{C}Me_2 \xrightarrow[0-5^oC]{NaNO_2+HCl}$	(i)	Carbocation	(P)	Carbyl amine
(II)	 $R\overset{O}{\overset{\parallel}{C}}-NH_3 \xrightarrow{\Delta} ? \xrightarrow{H_3O^+} ?$	(ii)	Carbanion	(Q)	Claisen
(III)	$RNH_2 \xrightarrow{CHCl_3/KOH}$	(iii)	Isocyanate	(R)	Pinacol
(IV)	$CH_3COOC_2H_5 \xrightarrow{NaOEt}$	(iv)	Carbene	(S)	Curtius

26. Which of the following is the correct combination?

(A) (I), (i) & (R)
(B) (I), (ii) & (R)
(C) (II), (ii) & (S)
(D) (II), (i) & (S)

Space for Rough work

27. Which of the following is the correct combination?
(A) (I), (i) & (S) (B) (IV), (ii) & (Q)
(C) (IV), (i) & (Q) (D) (IV), (ii) & (S)

28. Which of the following is the incorrect combination?
(A) (II), (iii) & (S) (B) (III), (ii) & (P)
(C) (III), (iv) & (P) (D) (IV), (ii) & (Q)

Answer questions Q. 29, Q. 30 and Q. 31 by appropriately matching the information given in the three columns of the following table.

Column – 1 (Reaction condition)		**Column – 2 (Intermediate)**		**Column – 3 (Reaction type)**	
(I)	White P_4 + alkali	(i)	$H_4P_2O_6$	(P)	+3
(II)	Red P_4 + alkali	(ii)	H_3PO_2	(Q)	+5
(III)	$P_4O_{10} + H_2O$	(iii)	H_3PO_4	(R)	+4
(IV)	$PCl_3 + H_3PO_3$	(iv)	$H_4P_2O_5$	(S)	+1

29. Which of the following is the correct combination?
(A) (I), (ii) & (R) (B) (I), (ii) & (S)
(C) (II), (ii) & (R) (D) (II), (iv) & (R)

30. Which of the following is the correct combination?
(A) (II), (i) & (R) (B) (II), (ii) & (R)
(C) (III), (iii) & (P) (D) (IV), (iv) & (Q)

31. Which of the following is the incorrect combination?
(A) (IV), (iv) & (P) (B) (III), (iii) & (Q)
(C) (II), (i) & (R) (D) (IV), (iv) & (R)

SECTION – B
(Single digit integer type)

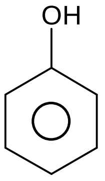
This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

32. A decapeptide (Mol. Wt. 796) on complete hydrolysis gives glycine (Mol. Wt. 75), alanine and phenylalanine. Glycine contributes 47.0 % to the total weight of the hydrolyzed products. The number of glycine units present in the decapeptide is

Space for Rough work

33. No. of S – S linkage in $S_3O_9 = m_1$
No. of P – P linkage in$(HPO_3)_3 = m_2$
No. of S – S linkage in $S_2O_8^{2-} = m_3$
No. of O – O linkage in $S_2O_6^{2-} = m_4$
Find out $m_1 + m_2 + m_3 + m_4$

34.

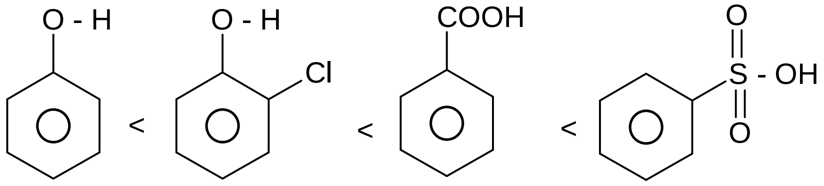


$$\xrightarrow[\text{(iv) AlCl}_3\text{ (v)NaBH}_4\text{/EtOH}]{\text{(i) NaOH (ii) CO}_2\text{ (iii)H}^+\text{/Ac}_2\text{O}} P(\text{Major})$$

Total number of oxygen atoms in the aromatic product(P) is

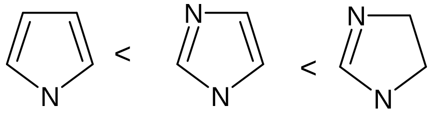
35 Osmotic pressure of a solution containing non-volatile solute is given by π = CRT. Calculate the work involved (in kcal) when the concentration of a solution at 163 °C is changed from 1 M to 0.1 M by adding solvent. [Take R = 2 calorie unit]

36. How many are indicating correct order for given characteristic or property?
(i) $NH_3 > SbH_3 > AsH_3 > BiH_3$ [B.P]
(ii) $CH_4 < CH_3Cl < CH_2Cl_2 < CHCl_3 < CBrCl_3$ [density]
(iii) $CCl_4 < CHCl_3 < CH_2Cl_2 < CH_3Cl$ [dipole moment]
(iv) RF < RCl < RBr < RI [reactivity]
(v)



[acidic strength]

(vi)



[basic strength

(vii) $H_2O < H_2S < H_2Se < H_2Te$ [reducing power]
(viii) $CHF_3 < CHCl_3 < CHBr_3$ [acidic strength]
(ix) RI < RBr < RCl < R – F [thermal stability]

Space for Rough work

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. If $\sec(2\theta - 2\alpha), \frac{1}{2}\operatorname{cosec}^2\theta, \sec(2\theta + 2\alpha)$ are in H.P., then:

(A) $-\frac{\pi}{4} < \alpha < \frac{\pi}{4}$ (B) $\frac{\pi}{4} < \alpha < \frac{3\pi}{4}$

(C) $\frac{3\pi}{4} < \alpha < \frac{5\pi}{4}$ (D) $\frac{5\pi}{4} < \alpha < \frac{7\pi}{4}$

38. Which of the following definite integral(s) vanishes?

(A) $\int_0^{\pi/2} \ln(\cot x)\,dx$ (B) $\int_0^{2\pi} \sin^3 x\,dx$

(C) $\int_{1/e}^{e} \frac{dx}{x(\ln x)^{1/3}}$ (D) $\int_0^{\pi} \sqrt{\frac{1+\cos 2x}{2}}\,dx$

39. With usual notation, in a ΔABC the value of $\prod(r_1 - r)$ can be simplified as:

(A) $abc\prod \tan\frac{A}{2}$ (B) $4rR^2$

(C) $\frac{(abc)^2}{R(a+b+c)^2}$ (D) $4Rr^2$

40. The value (s) of t for which the lines $2x + 3y = 5$, $t^2x + ty - 6 = 0$ and $3x - 2y - 1 = 0$ are concurrent, can be:

(A) t = 2 (B) t = –3

(C) t = –2 (D) t = 3

Space for Rough work

41. Let ΔPQR be formed by the common tangents to the circles $x^2+y^2+6x=0$ and $x^2+y^2-2x=0,$ then which of the following is (are) true?

(A) Centroid of ΔPQR is (1, 0)

(B) Radius of circle intscribed in ΔPQR is 1.

(C) Area of ΔPQR is $3\sqrt{3}$

(D) The y – intercept of common tangent having negative slope is 3.

42. If $\left(9+\sqrt{80}\right)^n = I + f$ where I and n are integers and $0<f<1,$ then:

(A) I is an odd integer

(B) I is an even integer

(C) $(I+f)(1-f)=1$

(D) $1-f=\left(9-\sqrt{80}\right)^n$

43. Let $f(x)=\begin{cases} \dfrac{e^x-1+ax}{x^2}, & x>0 \\ b, & x=0 \\ \dfrac{\sin\frac{x}{2}}{x}, & x<0 \end{cases}$ then:

(A) $f(x)$ is continuous at x = 0 if $a=-1, b=\dfrac{1}{2}$

(B) $f(x)$ is discontinuous at x = 0, if $b\neq\dfrac{1}{2}$

(C) $f(x)$ has non – removable discontinuity at x = 0 if $a\neq-1$

(D) $f(x)$ has removable discontinuity at x = 0 if a = –1, $b\neq\dfrac{1}{2}$.

Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions Q. 44, Q. 45 and Q. 46 by appropriately matching the information given in the three columns of the following table.

Columns 1, 2 and 3 contains conics, equations of tangents to the conics and points of contact, respectively.

Column 1	Column 2	Column 3
(I) $x^2 + y^2 = 9$	(i) $my = m^2x + 3$	(P) $\left(\frac{3}{m^2}, \frac{6}{m}\right)$
(II) $y^2 = 12x$	(ii) $y = mx \pm \sqrt{9m^2 + 9}$	(Q) $\left(\frac{3m}{\sqrt{1+m^2}}, \frac{-3}{\sqrt{1+m^2}}\right)$
(III) $16x^2 + 9y^2 = 144$	(iii) $y = mx \pm \sqrt{9m^2 + 16}$	(R) $\left(\frac{-9m}{\sqrt{9m^2+16}}, \frac{16}{\sqrt{9m^2+16}}\right)$
(IV) $9x^2 - y^2 = 9$	(iv) $y = mx \pm \sqrt{m^2 - 9}$	(S) $\left(\frac{-m}{\sqrt{m^2-9}}, \frac{-9}{\sqrt{m^2-9}}\right)$

44. Which is correct combination?

(A) (I) (i) (P)
(B) (II) (i) (P)
(C) (II) (i) (Q)
(D) (III) (ii) (Q)

45. Which is incorrect – combination?

(A) (I) (ii) (Q)
(B) (II) (i) (P)
(C) (III) (iii) (R)
(D) (IV) (iv) (Q)

46. Which is incorrect combination

(A) (I) (ii) (Q)
(B) (III) (iii) (R)
(D) (IV) (iv) (S)
(D) (I) (ii) (R)

Space for Rough work

Answer questions Q. 47, Q. 48 and Q. 49 by appropriately matching the information given in the three columns of the following table.

Column 1	Column 2	Column 3
(I) $f(x) = \sin^{-1}\left(\frac{2x}{1+x^2}\right)$	(i) $x = \pm 1$	(P) Non Differentiable
(II) $f(x) = \cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)$	(ii) $x = 0$	(Q) Differentiable
(III) $f(x) = \cos^{-1}(2x^2 - 1)$	(iii) $x = 2$	(R) Discontinuous
(IV) $f(x) = \sin^{-1}\left(\frac{1-x^2}{1+x^2}\right)$	(iv) $x = \frac{1}{2}$	(S) Continuous

47. Which is correct combination

(A) (I) (ii) (Q)
(B) (I) (i) (P)
(C) (II) (ii) (Q)
(D) (II) (ii) (R)

48. Which is correct combination

(A) (II) (ii) (P)
(B) (II) (ii) (R)
(C) (II) (ii) (Q)
(D) None of these

49. Which is incorrect combination

(A) (I) (ii) (R)
(B) (I) (i) (P)
(C) (II) (ii) (S)
(D) (IV) (ii) (P)

Space for Rough work

SECTION – B

(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

50. Using the identity, $\sin^4 x = \frac{3}{8} - \frac{1}{2}\cos 2x + \frac{1}{8}\cos 4x$ or otherwise, if the value of $\sin^4\left(\frac{\pi}{7}\right) + \sin^4\left(\frac{3\pi}{7}\right) + \sin^4\left(\frac{5\pi}{7}\right) = \frac{a}{b}$, where a and b are co – prime then value of a – b is

51. Let $S = \frac{1}{\sin 8^o} + \frac{1}{\sin 16^o} + \frac{1}{\sin 32^o} + ... + \frac{1}{\sin 4096^o} + \frac{1}{\sin 8192^o}$. If $S = \frac{1}{\sin\alpha}$ where $\alpha \in \left(0, 90^o\right)$, then find α (in degree).

52. Let L denotes the number of surjective functions $f : A \to B,$ where set A contains 4 elements and set B contains 3 elements.
M denotes number of elements in the range of the function.
$f(x) = \sec^{-1}(\operatorname{sgn} x) + \operatorname{cosec}^{-1}(\operatorname{sgn} x)$ where $\operatorname{sgn} x$ denotes signum function of x.
And N denotes coefficient of t^5 in $\left(1+t^2\right)^5\left(1+t^3\right)^8$. Find the value of $\frac{(LM+N)}{19}$.

53. Let $f(x)$ be a differentiable function in $[-1, \infty)$ and $f(0) = 1$ such that $\lim\limits_{t \to x+1} \frac{t^2 f(x+1) - (x+1)^2 f(t)}{f(t) - f(x+1)} = 1$. Find the value of $\lim\limits_{x \to 1} \frac{\ln(f(x)) - \ln 2}{x-1}$.

54. If $\alpha \neq 1$ is a fifth root of unity, then find the value of $\log_{\sqrt{3}}\left|1 + \alpha + \alpha^2 + \alpha^3 - \frac{2}{\alpha}\right|$

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – III

JEE (Advanced)-2020

PAPER –1

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. ABD

Sol. $q = \frac{CV}{3}\left(1 - e^{-t/RC}\right)$

Current through V_2 $\quad i_2 = \frac{V}{3R}\left(e^{-t/RC}\right)$

Current through V_1 $\quad i_1 = \frac{V}{2R} - \frac{V}{6R}e^{-1/RC}$

at t = RC, power delivered by $V_2 = Vi_2 = \frac{V^2}{3Re}$

2. ABD

Sol. Gravitational field intensity inside the spherical shell is zero.
Gravitational force is always directed centre of spherical mass for outside points.
Force on P act only due to m_1 because point P is outside the spherical shell of mass m_1.
So choices (A), (B) and (D) are correct.

3. BCD

Sol. Apply conservation of mechanical energy to obtain x.

4. BC

Sol. As $\lambda_0 = \frac{hc}{eV}$ and as V increases. λ_0 decreases but characteristic wavelengths do not change so interval between $\lambda_{k\alpha}$ & λ_0 increases and the same for the interval between $\lambda_{k\beta}$ & λ_0

5. BC

Sol. $50 \times 10^{-6} = \frac{r \times i}{100 + r} \Rightarrow$ for I = 5 mA

$r = 1\Omega$.

$V = 50 \times 10^{-6} (100 + r_o) = 50 \times 10^{-6} r_o$

6. AB

Sol. Assume unknwon currents and apply KVL twice.

7. BD

Sol. For nth mode of vibration $\lambda_n = \frac{4\ell}{(2n-1)}$.

8. B

9. B

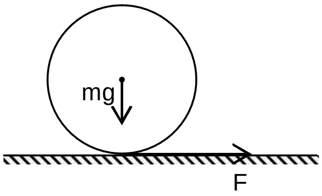
10. A

Sol. **(for Q.8 -10)**

Linear impulse $\int F dt = mv_0$ …(i)

Angular impulse $\int F h dt = I_c \omega_0$ …(ii)

$\Rightarrow \quad mv_0 h = I_c\omega_0$ and $I_c = \frac{2}{5} mR^2$



Force of friction is forward.

$\therefore \quad fR = I_c\alpha \quad \therefore \quad \alpha = \frac{\mu m f R}{I_c}$

$a_{cm} = \frac{F}{m} = \frac{\mu m g}{m} = \mu g$ forward.

11. B

Sol. $k_{effective}$ in (II) is k and $g_{effective} = \frac{g}{2}$.

12. C

Sol. $k_{effective}$ in (III) is 4k and $g_{effective} = \frac{g}{2}$.

13. A

Sol. $k_{effective}$ in (IV) is $\frac{k}{4}$ and $g_{effective} = \frac{g}{2}$.

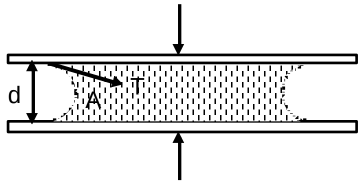
SECTION – B

14. 2

Sol. Let R be the radius of the circular layer of water.

Then, $\pi R^2 d \times \rho = m$ …(1)

Pressure at $A = p_0 - \frac{2T}{d}$ …(2)



Thus pressure between the plates is less than the atmospheric pressure and so the plates are pressed together as though attracted towards each other.

F, force of attraction = $\Delta p \times$ area $\Rightarrow F = \frac{2T}{d} \times \pi R^2$

$$\Rightarrow F = \frac{2T}{d} \times \frac{m}{d \cdot \rho} = \frac{2Tm}{d^2 \cdot \rho} = \frac{2 \times 0.4 \times 10^{-3} \times 0.08}{0.01^2 \times 10^{-4} \times 1000} = 6.4 \text{ N}$$

15. 6

Sol. As source (horn of bus) is approaching stationary wall (say, listener), therefore, apparent frequency striking the wall is

$$v' = \frac{\upsilon v}{\upsilon - \upsilon_s} \qquad \ldots(1)$$

Sound of this frequency will be reflected by the wall (now, source). The passenger is the listener moving towards source. Therefore, frequency heard by the listener

$$v'' = \frac{(\upsilon + \upsilon_L)v'}{\upsilon}$$

using (1)

$$v'' = \frac{\upsilon + \upsilon_L}{\upsilon} \times \frac{\upsilon v}{\upsilon - \upsilon_s} = \frac{(\upsilon + \upsilon_L)v}{\upsilon - \upsilon_s}$$

$$= \frac{(330+5) \times 200}{330-5} = \frac{335}{325} \times 200$$

$v'' = 206$Hz

$\therefore$ Beat frequency = $(v'' - v)$

$= 206 - 200 = 6$ Hz

16. 9

Sol. a = $\frac{21}{14}$, T_B = 6a = $\frac{6 \times 21}{14}$ = 9 N.

17. 5

Sol. As stable equilibrium, U is minimum. Thus $\frac{d^2U}{dx^2} > 0$.

And $\frac{dv}{dx} = 0$.

$$= \frac{1}{dx}\left(\frac{x^3}{3} - \frac{ax^2}{2} + 20x\right) = 0.$$

$\Rightarrow$ $x^2 - 9x + 20 = 0$. $\Rightarrow$ $(x - 5)(x - 4) = 0$.

x = 5 and x = 4 are points of equilibrium.

And U minimum when $\frac{d^2U}{dx^2} > 0$. i.e. at x = 5.

18. 3

Sol. $F = \frac{dP}{dt}$ = rate of change of momentum of the photons. Thus, in case of complete absorption, F = Intensity of the wave / speed of light.

Chemistry PART – II

SECTION – A

19. ABC

Sol. (A) EAS, (B) Oxidation & (C) Diel's alder reaction gives Anthraquinone.

20. BC

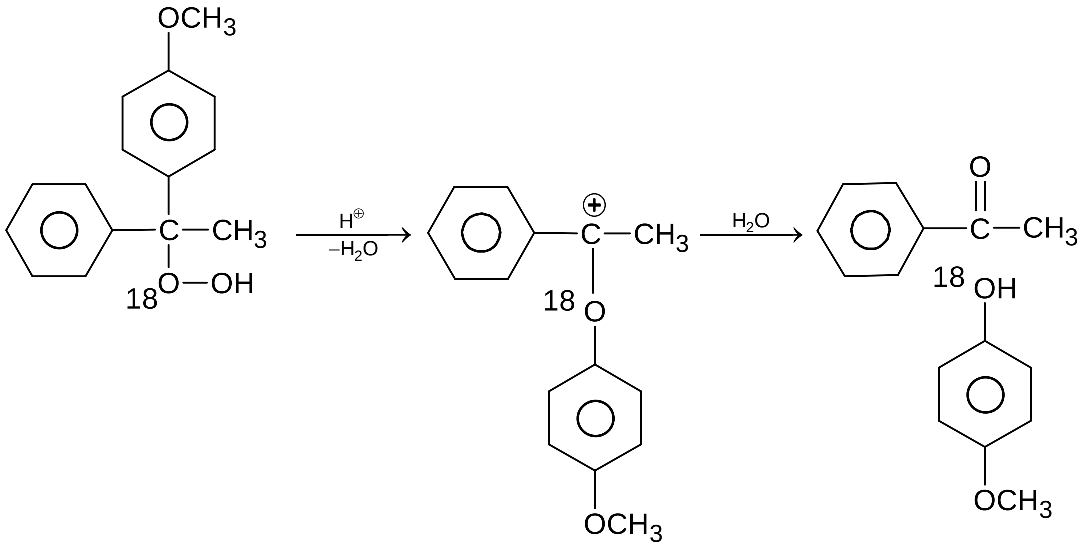
Sol. Its chemisorption, so heat is released and $O_2 \longrightarrow O_2^-$ electrons in π^*_{2p} increases.

21. BD

Sol. (B) both give N_2
(D) both give NH_3

22. B

Sol.



23. ABD

Sol. Balanced equation is

$$6I^- + ClO_3^- + 6H_2SO_4 \longrightarrow Cl^- + 6HSO_4^- + 3I_2 + 3H_2O$$

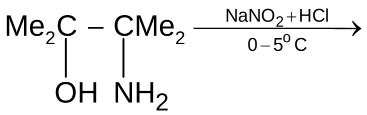
24. ABC

Sol. In (A) angle strain is relieved. B & C have strong electron withdrawing groups, so forms hydrates.

25. AB

Sol. (A) Ortho effect makes O – Me $C_6H_4NH_2$ weakest base. C_6H_5NHMe (PK_a 4.84) P – Me – $C_6H_4NH_2$(Pka 5.10)
(B) O – NO_2 $C_6H_4NH_2$ (Steric effect and H - bonding)
O – Me $C_6H_4NH_2$(PK_a 4.38) < O - MeO $C_6H_4NH_2$(PK_a 4.49) < O – OH $C_6H_4NH_2$(PK_a 4.72)

26. A

Sol. 

$$\underset{OH}{Me_2C} - \underset{NH_2}{CMe_2} \xrightarrow[0-5^oC]{NaNO_2+HCl}$$ Pinacol rearrangement

InvolvesCarbocation

27. B

Sol. $CH_3COOC_2H_5 \xrightarrow{NaOEt}$ Claisen condensation & involves carbanion

28. B

Sol. Its carbylamine reaction, involving carbene

29. A

Sol. $P_4 + \overset{-}{O}H \longrightarrow PH_3 + H_3\overset{+1}{P}O_2$

30. B

Sol. $Red\ P_4 + \overset{-}{O}H \longrightarrow H_4\overset{+4}{P_2}O_6$

31. C

Sol. $PCl_3 + H_3PO_3 \longrightarrow H_4\overset{+3}{P_2}O_5$

SECTION – B

32. 6

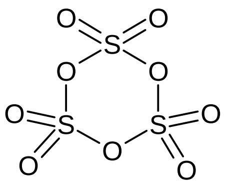
Sol. No. of peptide bonds = 9

Mass of hydrolysed products = 796 + 18 × 9 = 958

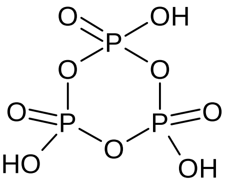
No. of glycine units = $958 \times \frac{47}{100} \times \frac{1}{75} = 6$

33. 0

Sol.

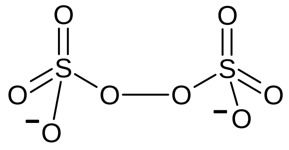


$m_1 = 0$

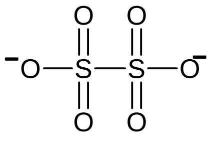


$(HPO_3)_3$

$m_2 = 0$



$m_3 = 1$

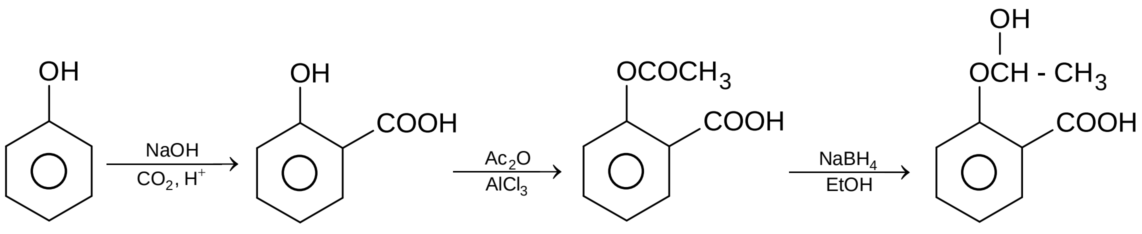


$(S_2O_6^{2-})$

$m_4 = 1$

34. 4

Sol.



Aspirin

35. 2

Sol. $\pi = iCRT$

For monobasic acid $i = (1 + \alpha)$

$2.69 = (1 + \alpha)\ 0.1 \times 0.082 \times 298$

$\Rightarrow \alpha = 0.1$

$|H^+| = C\alpha = 10^{-2}$

pH = 2

36. 8

Sol. Except (viii) all are correct.

Mathematics PART – III

SECTION – A

37. AC

Sol. The given condition implies

$$\cos(2\theta-2\alpha)+\cos(2\theta+2\alpha)=4\sin^2\theta$$

$$\Rightarrow \quad \cos 2\theta(1+\cos 2\alpha)=1$$

$$\Rightarrow \quad 2\cos^2\alpha=\sec 2\theta\ge 1$$

$$\Rightarrow \quad |\cos\alpha|\ge\frac{1}{\sqrt{2}}$$

38. ABC

Sol. (A) $$I=\int_0^{\pi/2}\ln(\cot x)dx\Rightarrow I=\int_0^{\pi/2}\ln(\tan x)dx$$

$$I=-\int_0^{\pi/2}\ln(\cot x)dx\Rightarrow I=-I\Rightarrow I=0$$

(B) $$I=\int_0^{2\pi}\sin^3 x\,dx=-\int_0^{2\pi}\sin^3 x\,dx\Rightarrow I=0$$

(C) $$\int_e^{1/e}\frac{-\left(\frac{1}{t^2}\right)dt}{\frac{-1}{t}(\ln t)^{1/3}}=-\int_{1/e}^{e}\frac{dt}{t(\ln t)^{1/3}}$$

$$I=-I$$
$$I=0$$

(D) $$\sqrt{\frac{1+\cos 2x}{2}}>0$$

$$\int_0^{\pi}\sqrt{\frac{1+\cos 2x}{2}}\,dx>0$$

39. ACD

Sol. $$(r_1-r)(r_2-r)(r_3-r)$$

$$=\left(\frac{\Delta}{s-a}-\frac{\Delta}{s}\right)\left(\frac{\Delta}{s-b}-\frac{\Delta}{s}\right)\left(\frac{\Delta}{s-c}-\frac{\Delta}{s}\right)$$

$$=\frac{\Delta^3 abc}{s(s-a)(s-b)(s-c).s^2}=\frac{\Delta abc}{s^2}\quad=\frac{4abc\Delta}{(a+b+c)^2}=\frac{(abc)^2}{R(a+b+c)^2}\ \text{etc.}$$

40. AB

Sol. As $2x+3y-5=0$ and $3x-2y-1=0$ intersect at (1, 1) so this point lies on

$$t^2x+ty-6=0$$

$$\Rightarrow \quad t^2+t-6=0$$

$\Rightarrow \; (t+3)(t-2)=0$

Hence, $t=-3, 2$

41. ABC

Sol. Let equation of direct common tangent(s) be

$(y-0)=m(x-3)$

$\Rightarrow \; mx-y-3m=0$

As, $p=r$

$$\Rightarrow \quad \frac{|m(1)-0-3m|}{\sqrt{1+m^2}}=1$$

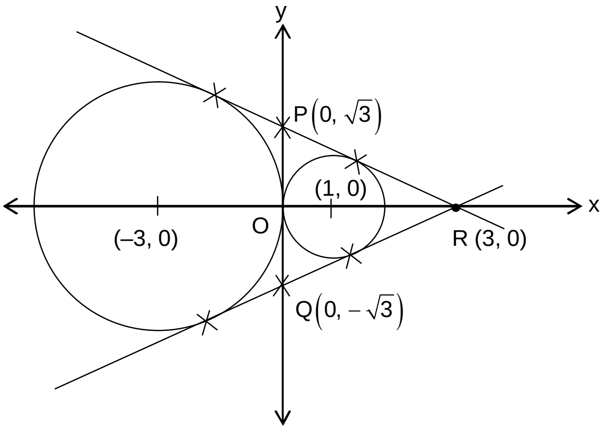
$$\Rightarrow \quad 4m^2=1+m^2$$

$$\Rightarrow \quad m^2=\frac{1}{3}$$

$$\Rightarrow \quad m=\pm\frac{1}{\sqrt{3}}$$

Clearly, ΔPQR is an equilateral triangle.

Now, verify alternatives.



42. ACD

Sol. $\left(9+4\sqrt{5}\right)^n = I+f$

Let $\left(9-4\sqrt{5}\right)^n = f'$

$I+f+f' = \left(9+4\sqrt{5}\right)^n + \left(9-4\sqrt{5}\right)^n$

= Even integer

$0<f+f'<2$

$\therefore$ I is an odd integer

$\Rightarrow (a)$

43. ABCD

Sol. (A) $\lim\limits_{x\to0^+} f(x) = \lim\limits_{x\to0^+} \frac{e^x+a}{2x} = \frac{1}{2} \Rightarrow a=-1$

If $a=-1$, then $\lim\limits_{x\to0^+} f(x)=\frac{1}{2}, \; \lim\limits_{x\to0^-} f(x)=\frac{1}{2}$

$\therefore f(x)$ is continuous at $x=0$, if $a=-1, b=\frac{1}{2}$

(B) $f(x)$ is discontinuous at $x=0$ if $b\neq\frac{1}{2}$.

(C) If $a\neq-1$, then $\lim\limits_{x\to0}\frac{e^x+a}{2x}$ does not exist.

$\therefore x=0$ is a point of irremovable type of discontinuity.

(D) If $a=-1$, then $\lim\limits_{x\to 0} f(x)=\frac{1}{2}$

$\therefore b\neq\frac{1}{2}\Rightarrow$ removable type of discontinuity at x = 0

44. B

Sol. For parabola $y^2=4ax$, equation of tangent with slope m is $y=mx+\frac{a}{m}$ and point of contact $P\left(\frac{a}{m^2},\frac{2a}{m}\right)$

45. D

Sol. For hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$, equation of tangent with slope m is $y=mx\pm\sqrt{a^2m^2-b^2}$ and point of contact $\left(\pm\frac{a^2}{\sqrt{a^2-m^2b^2}},\mp\frac{mb^2}{\sqrt{a^2-m^2b^2}}\right)$

46. D

Sol. For circle $x^2+y^2=r^2$, equation of tangent with slope m is $y=mx\pm r\sqrt{1+m^2}$ and point of contact $\left(\mp\frac{rm}{\sqrt{1+m^2}},\pm\frac{r}{\sqrt{1+m^2}}\right)$

47. B

Sol. $$f(x)=\sin^{-1}\left(\frac{2x}{1+x^2}\right)=\begin{cases}-\pi-2\tan^{-1}x, & x\le -1\\ 2\tan^{-1}x & -1\le x\le 1\\ \pi-2\tan^{-1}x, & x\ge 1\end{cases}$$

$\therefore$ It is non differentiable for $x=\pm 1$

48. A

Sol. $$f(x)=\cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)=\begin{cases}-2\tan^{-1}x, & x\le 0\\ 2\tan^{-1}x, & x\ge 0\end{cases}$$

It is non differentiable at x = 0

49. A

Sol. $$f(x)=\sin^{-1}\left(\frac{2x}{1+x^2}\right)=\begin{cases}-\pi-2\tan^{-1}x, & x\le -1\\ 2\tan^{-1}x & -1\le x\le 1\\ \pi-2\tan^{-1}x, & x\ge 1\end{cases}$$

It is continuous at x = 0

SECTION – B

50. 5

Sol. $\sin^4\left(\frac{\pi}{7}\right)=\frac{3}{8}-\frac{1}{2}\cos\left(\frac{2\pi}{7}\right)+\frac{1}{8}\cos\left(\frac{4\pi}{7}\right)$ ………(i) and $\sin^4\left(\frac{3\pi}{7}\right)=\frac{3}{8}-\frac{1}{2}\cos\left(\frac{6\pi}{7}\right)+\frac{1}{8}\cos\left(\frac{12\pi}{7}\right)$

or $\sin^4\left(\frac{3\pi}{7}\right)=\frac{3}{8}+\frac{1}{2}\cos\left(\frac{\pi}{7}\right)-\frac{1}{8}\cos\left(\frac{5\pi}{7}\right)$ ……….(ii)

Similarly, $\sin^4\left(\frac{5\pi}{7}\right)=\frac{3}{8}-\frac{1}{2}\cos\left(\frac{10\pi}{7}\right)+\frac{1}{8}\cos\left(\frac{20\pi}{7}\right)$

or $\sin^4\left(\frac{5\pi}{7}\right)=\frac{3}{8}+\frac{1}{2}\cos\left(\frac{3\pi}{7}\right)-\frac{1}{8}\cos\left(\frac{\pi}{7}\right)$ ……….(iii)

Equation (i) + (ii) + (iii)

$\sin^4\left(\frac{\pi}{7}\right)+\sin^4\left(\frac{3\pi}{7}\right)+\sin^4\left(\frac{5\pi}{7}\right)$

$=\frac{9}{8}+\frac{1}{2}\cos\left(\frac{5\pi}{7}\right)-\frac{1}{8}\cos\left(\frac{3\pi}{7}\right)+\frac{1}{2}\cos\left(\frac{\pi}{7}\right)$

$-\frac{1}{8}\cos\left(\frac{5\pi}{7}\right)+\frac{1}{2}\cos\left(\frac{3\pi}{7}\right)-\frac{1}{8}\cos\left(\frac{\pi}{7}\right)$

$=\frac{9}{8}+\frac{3}{8}\left[\cos\left(\frac{\pi}{7}\right)+\cos\left(\frac{3\pi}{7}\right)+\cos\left(\frac{5\pi}{7}\right)\right]$

$=\frac{9}{8}+\frac{3}{16}=\frac{21}{16}$

$\therefore a-b=21-16=5$

51. 4

Sol. $T_1=\frac{1}{\sin 8^\circ}=\frac{\sin(8^\circ-4^\circ)}{\sin 4^\circ \sin 8^\circ}=\cot 4^\circ-\cot 8^\circ$ and so on

Given $S=\frac{1}{\sin 8^\circ}+\frac{1}{\sin 16^\circ}+\frac{1}{\sin 32^\circ}+.....+\frac{1}{\sin 4096^\circ}+\frac{1}{\sin 8192^\circ}$

$=(\cot 4^\circ-\cot 8^\circ)+(\cot 8^\circ-\cot 16^\circ)+(\cot 16^\circ-\cot 32^\circ)$

$+......+(\cot 2048^\circ-\cot 4096^\circ)+(\cot 4096^\circ-\cot 8192^\circ)$

$=(\cot 4^\circ-\cot 8192^\circ)$

Also $\cot 8192^\circ=\cot(45\times 180^\circ+92^\circ)$

$=\cot 92^\circ$ (As $45\times 180^\circ=8100^\circ$)

$\therefore\ S=\cot 4^\circ-\cot 92^\circ=\frac{1-\tan^2 2^\circ}{2\tan 2^\circ}+\tan 2^\circ$

$=\frac{1+\tan^2 2^\circ}{2\tan 2^\circ}=\frac{\sec^2 2^\circ}{2\tan 2^\circ}=\frac{1}{\sin 4^\circ}\Rightarrow \alpha=4^\circ$

52. 4

Sol. $L:3^4-\left[{}^3C_1\left(2^4-2\right)+{}^3C_2\right]=36$

$M:$ If $x>0$, $\text{sgn}(x)=1$

$f(x) = 0 + \frac{\pi}{2} = \frac{\pi}{2}$

For $x = 0 f(x)$ is not defined

$\therefore$ For $x < 0,\ f(x) = \pi - \frac{\pi}{2} = \frac{\pi}{2}$

$\therefore M = 1$

N : Coefficient of t^5 = coefficient of t^2 in $\left(1+t^2\right)^5 \times$ coefficient of t^3 in $\left(1+t^3\right)^8$

$= 5 \times 8 = 40$

Hence, L = 36; M = 1 and N = 40

$\Rightarrow LM + N = 36 + 40 = 76$

53. 1

Sol. $\lim\limits_{t \to x+1} \frac{t^2 f(x+1) - (x+1)^2 f(t)}{f(t) - f(x+1)} = 1 \left(\frac{0}{0}\right)$

$\Rightarrow \lim\limits_{t \to x+1} \frac{2t f(x+1) - (x+1)^2 f'(t)}{f'(t)} = 1$

$\Rightarrow 2(x+1) f(x+1) - (x+1)^2 f'(x+1) = f'(x+1)$

$\Rightarrow 2(x+1).f(x+1) = \left[1 + (x+1)^2\right] f'(x+1)$

$\Rightarrow \frac{f'(x+1)}{f(x+1)} = \frac{2(x+1)}{1+(x+1)^2}$

Integrating, we get

$\ln(f(x+1)) = \ln\left(1+(x+1)^2\right) + \ln c$

Put $x = -1$

$0 = 0 + \ln c$

$\Rightarrow c = 1$

$\Rightarrow f(x+1) = 1 + (x+1)^2$

So, $f(x) = 1 + x^2$

Hence, $\lim\limits_{x \to 1} \frac{\ln(f(x)) - \ln 2}{x-1} = \lim\limits_{x \to 1} \frac{\ln\left(1+x^2\right) - \ln 2}{(x-1)} = 1$

54. 2

Sol. $1 + \alpha + \alpha^2 + \alpha^3 + \alpha^4 = 0,\ \alpha^5 = 1$

$1 + \alpha + \alpha^2 + \alpha^3 - \frac{2}{\alpha} = -\alpha^4 - \frac{2}{\alpha} = -3\alpha^4$

$\left|1 + \alpha + \alpha^2 + \alpha^3 - \frac{2}{\alpha}\right| = \left|-3\alpha^4\right| = 3$

$\therefore \log_{\sqrt{3}} 3 = 2$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – III

JEE (Advanced)-2020

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **One Section**: **Section-A.**

1. ***Section–A (01 – 07, 19 – 25, 37 – 43)*** *contains 21 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (08– 14, 26 – 32, 44 – 50) *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect option is selected.

   Section–A (15 – 18, 33 – 36, 51 – 54) *contains 6 paragraphs. Each paragraph is having 2 multiple choice questions having 4 options with* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. In the Young's double slit experiment using a monochromatic light of wavelength λ, the path difference (in terms of an integer n) corresponding to any point having half the peak intensity is

(A) $(2n+1)\frac{\lambda}{2}$ (B) $(2n+1)\frac{\lambda}{4}$

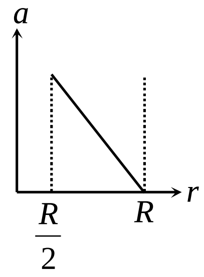
(C) $(2n+1)\frac{\lambda}{8}$ (D) $(2n+1)\frac{\lambda}{16}$

2. The speed of a wave on a string is 150 m/s when the tension is 120 N. The percentage increase in the tension in order to raise the wave speed by 20% is:

(A) 44% (B) 40%

(C) 20% (D) 10%

3. A frictionless tunnel is dug along a chord of the earth at a perpendicular distance $\frac{R}{2}$ from the centre of earth (where R is radius of earth). An object is released from one end of the tunnel. The correct graph, showing the variation of acceleration of particle with its distance r from centre of earth is

(A)


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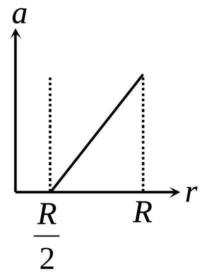

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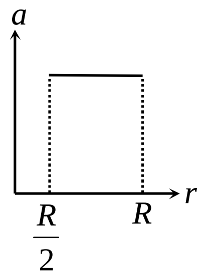

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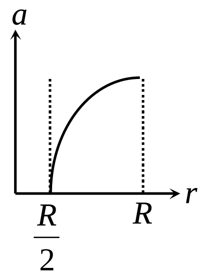
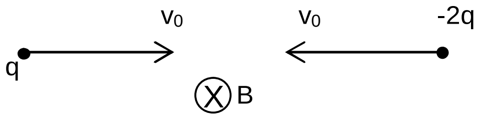


4. A closed organ pipe of length L is vibrating in its first overtone. There is a point Q inside the pipe at a distance $7L/9$ from the open end. The ratio of pressure amplitude at Q to the maximum pressure amplitude in the pipe is

(A) 1 : 2 (B) 2 : 1
(C) 1 : 1 (D) 2 : 3

5. A charge particle q of mass m is placed at a distance d from another charge particle – 2q of mass 2m in a uniform magnetic field B as shown. If particles are projected towards each other with equal speed v_0, so that the two particles touches each other without collision during its motion. (Assume only force due to magnetic field acts on the particle)



(A) $\frac{qBd}{m}$ (B) $\frac{qBd}{2m}$
(C) $\frac{2qBd}{m}$ (D) $\frac{3qBd}{2m}$

6. When the electron in a hydrogen atom jumps from the second orbit to the first orbit, the wavelength of the radiation emitted is λ. When the electron jumps from the third to the first orbit, the wavelength of the radiation emitted as

(A) $\frac{9}{4}\lambda$ (B) $\frac{4}{9}\lambda$
(C) $\frac{27}{32}\lambda$ (D) $\frac{32}{27}\lambda$

7. The image of an object, formed by a plano-convex lens at a distance of 8 m behind the lens, is real and is one-third the size of the object. The wavelength of light inside the lens is $\frac{2}{3}$ times the wavelength in free space. The radius of the curved surface of the lens is

(A) 1 m (B) 2 m
(C) 3 m (D) 6 m

Space for Rough work

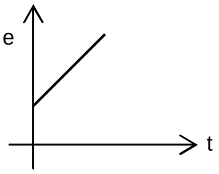
(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

8. A bimetallic strip is formed by two identical strips, one of copper and the other of brass. The coefficients of linear expansion of the two metals are α_C and α_B. On heating, the temperature of the strip goes up by ΔT and the strip bends to from an arc of radius of curvature R. Then R is

(A) proportional to ΔT
(B) inversely proportional to ΔT
(C) proportional to $|\alpha_B - \alpha_C|$
(D) inversely proportional to $|\alpha_B - \alpha_C|$

9. Two parallel long straight conductors lie on a smooth horizontal surface. Two other parallel conductors rest on them at right angles so as to form a square of side a initially. A uniform magnetic field B exists in vertical direction. Now all the four conductors start moving outwards with a constant velocity v. The induced e.m.f. e and induced current i will vary with time t as

(A)


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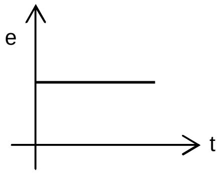
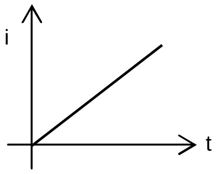
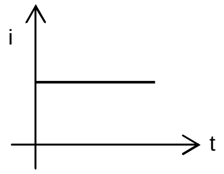


(C)


(D)


Space for Rough work

10. Consider the decay $^{238}Pu \rightarrow ^{234}U + ^{4}He$

The atomic masses are given as

$^{238}_{238.04955\,u}Pu \quad ^{234}_{234.04095\,u}U \quad ^{4}_{4.002633\,u}He$

Neglecting the recoil of the residual nucleus

(A) the kinetic energy of the α particle emitted is 5.58 MeV

(B) the kinetic energy of the α particle emitted is 5.58 eV

(C) conservation of electric charge is valid for the given reaction

(D) conservation of electric charge is not valid for the given reaction

11. In a thermodynamic process Helium gas obeys the law $TP^{-2/5}$ constant. If temperature of 2 moles of the gas is raised from T to 3T, then

(A) Heat given to the gas is 9 RT

(B) Heat given t the gas zero

(C) Work done by the gas is –6RT

(D) $\int VdP$ for the process in the given temperature range is 10RT

12. Sounds from two identical sources S_1 and S_2 reach a point P. when the sounds reach directly and in the same phase the intensity at P is I_0. The power of S_1 is now reduced by 64% and the phase difference between S_1 and S_2 is varied continuously the maximum and minimum intensities recorded at P are now I_{max} and I_{min}

(A) $I_{max} = 0.64\ I_0$

(B) $I_{min} = 0.36\ I_0$

(C) $I_{max}/I_{min} = 16$

(D) $I_{max}/I_{min} = 1.64/0.36$

13. A wave disturbance in a medium is described by

$y(x, t) = 0.02 \cos(50\pi t + \pi/2) \cos(10\pi x)$,

where ‘x’ and ‘y’ are in metre and ‘t’ in seconds.

(A) A node occurs at x = 0.15 m

(B) An antinode occurs at x = 0.3 m

(C) The speed of the component wave is 5.0 m/s

(D) The wavelength is 0.2 m.

Space for Rough work

14. A cannon shell is fired to hit a target at a horizontal distance R, however it breaks into two equal parts at its highest point, one part returns to the cannon. The other part
(A) will fall at a distance R beyond target (B) will fall at a distance 3R beyond target
(C) will hit the target (D) have nine times kinetic energy of first

Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 15 and 16

In a photoelectric effect, a point source of green light of power 40 W emits mono-energetic photons that can just emit photoelectrons from an isolated metallic sphere of radius r = 1 cm, placed at a distance of 1m from the light source. Now, four other separate sources of violet, blue, red and yellow light emitting same number of photons as that of green light are brought near the source of green light.

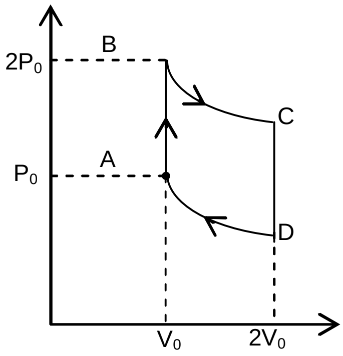
Assume one photoelectron is emitted out of every 10^6 incident photons on sphere.
(Take $\lambda_{violet} = 4136$ Å, $\lambda_{blue} = 5000$ Å, $\lambda_{red} = 7200$ Å, $\lambda_{green} = 4963$ Å, hc = 12408 eV Å)

15. No. of photoelectrons emitted from the sphere per second is
(A) 2.5×10^9 (B) 2.5×10^8
(C) 2.5×10^7 (D) 2.5×10^6

16. The potential of the sphere when emission of photoelectrons will stop is
(A) 0.7 V (B) 0.5 V
(C) 0.6 V (D) 0.8 V

Space for Rough work

Paragraph for Question Nos. 17 and 18



One mole of a monatomic gas undergoes the cycle shown in the diagram: The pressure, volume and temperature at A are P_0, V_0 and T_0 respectively; the pressure at B is $2P_0$ and the volume at D is $2V_0$. The processes AB and CD are isochoric. During BC DA, the gas undergoes the processes such that during an infinitesimal contraction or expansion, the heat absorbed dQ, the change in internal energy dU and dW, the work done satisfy the relation:

$$dQ = \frac{1}{2}dU + \frac{2}{3}dW$$

For the process BC, DA, we can write

$$dQ = \frac{1}{2}dU + \frac{2}{3}dW = dU + dW$$

$$\text{or,}\quad +\frac{1}{2}dU = -\frac{1}{3}dW \quad ; \quad \text{or,}\ \frac{1}{2}\cdot\frac{3}{2}RdT = -\frac{1}{3}dW$$

$$pdV + Vdp \Rightarrow RdT \quad ; \quad \text{or,}\ \frac{13}{9}pdV + Vdp = 0$$

$$\text{or,}\ pV^{\frac{13}{9}} = \text{constant}$$

17. Find the temperature at C
(A) $2T_0$ (B) $3T_0$
(C) $2^{5/9}T_0$ (D) $3^{5/9}T_0$

18. What is the efficiency of the cycle? Assume $2^{5/9} = 1.5, 2^{4/9} = 4/3$ approximately
(A) 24% (B) 30%
(C) 36% (D) 42%

Space for Rough work

Chemistry

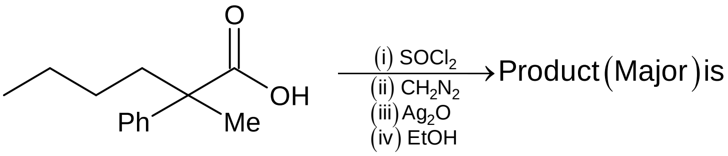
PART – II

SECTION – A

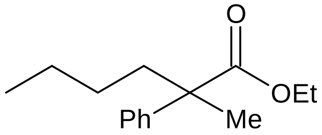
(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

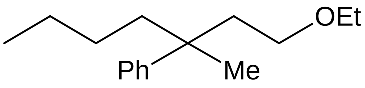
19.


O
OH
Ph
Me
(i) SOCl2
(ii) CH2N2
(iii) Ag2O
(iv) EtOH
Product (Major) is

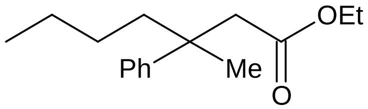
(A)



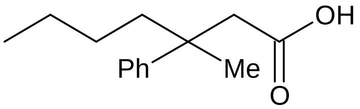
(B)



(C)

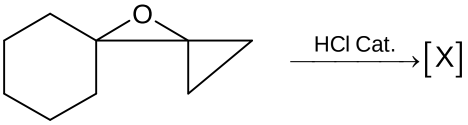


(D)



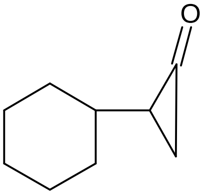
20. Which one of the following reagent can be used for differentiating the Cu^{2+} and Bi^{3+}?
(A) H_2S gas in presence of dil HCl (B) NH_4OH(excess)
(C) $K_4[Fe(CN)_6]$ (D) (B) and (C) both

21.

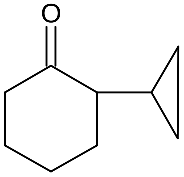


The compound[X] is

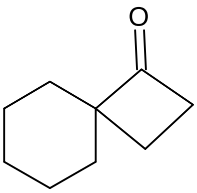
(A)



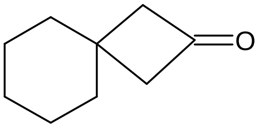
(B)



(C)



(D)

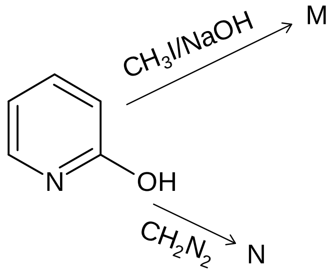


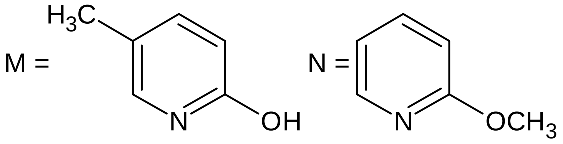
Space for Rough work

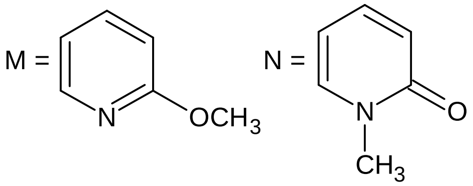
22. The compound formed by dissolving gold and platinum in aqua-regia is
(A) $[AuCl_4]^{3-}$ and $[PtCl_6]^{2-}$
(B) $[AuCl_4]^{-}$ and $[PtCl_6]^{4-}$
(C) $[AuCl_4]^{-}$ and $[PtCl_6]^{2-}$
(D) $[AuCl_4]^{-}$ and $[PtCl_6]^{2-}$

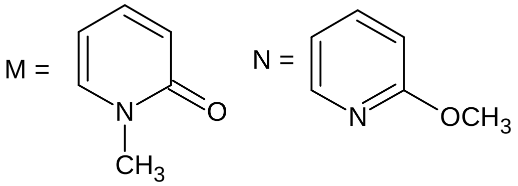
23. The pair of compounds having the same hybridization for the central atom is
(A) $[Cu(NH_3)_4]^{2+}$ and $[Ni(NH_3)_4]^{2+}$
(B) $[NiCl_4]^{2-}$ and $[PtCl_4]^{2-}$
(C) $[Cu(NH_3)_4]^{2+}$ and $[Zn(NH_3)_4]^{2+}$
(D) $[Co(NH_3)_6]^{3+}$ and $[Co(H_2O)_6]^{3+}$

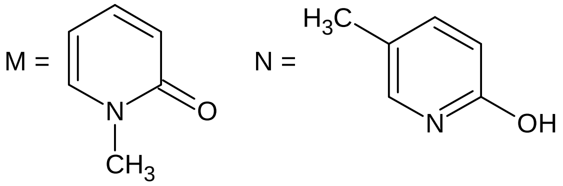
24. The major products M and N formed in the following reactions are:–


CH3I/NaOH
M
N
OH
CH2N2
N

(A)

M =
H3C
N
OH
N =
N
OCH3

(B)

M =
N
OCH3
N =
N
O
CH3

(C)

M =
N
O
CH3
N =
N
OCH3

(D)

M =
N
O
CH3
N =
H3C
N
OH

Space for Rough work

25. The highest occupied MO in N_2 and O_2^+ respectively are (take x-axis as inter nuclear axis)
(A) $\sigma 2px$, $\pi^* 2py$ (B) $\pi 2py$, $\pi 2pz$
(C) $\sigma^* 2px$, $\sigma 2px$ (D) $\pi^* 2py$, $\pi^* 2pz$

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

26. Which of the following statement(s) are correct?
(A) $CH_3 - Cl > CH_3 - F > CH_3 - Br > CH_3 - I$ (Order of dipole moment)
(B) $Cl_2 > F_2 > Br_2 > I_2$ (Order of bond energy)
(C) $S_2O_3^{2-}, S_2O_4^{2-}, S_2O_5^{2-}$ (All have S – S linkage)
(D) $PCl_5 > SiCl_4 > AlCl_3 > MgCl_2$ (Order of hydrolysis)

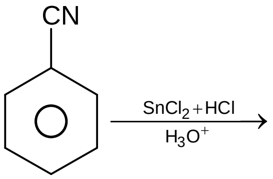
27. Which of the following statements is/are true about the transition metal alkene complexes?
$K[PtCl_3C_2H_4]$
(A) Back bonding weakens the double bond of the alkene
(B) σ bonding and back-bonding synergistically strengthen metal alkene interaction
(C) Electron withdrawing substituents on alkene reduce back bonding
(D) π–acidic co-ligands on metal strengthen back bonding

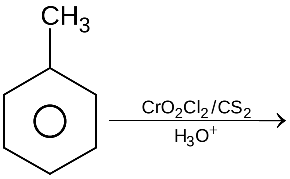
28. On electrolysis, in which of the following, O_2 would be liberated at the anode?
(A) dil H_2SO_4 with Pt electrode (B) aq. $AgNO_3$ with Pt electrode
(C) dil H_2SO_4 with Cu electrode (D) aq. NaOH with Pt electrode

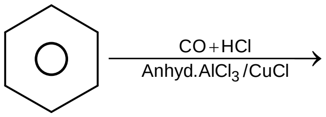
29. Which of them can act as oxidizing agent in acidic as well as in alkaline medium?
(A) $KMnO_4$ (B) $K_2Cr_2O_7$
(C) H_2O_2 (D) Cl_2

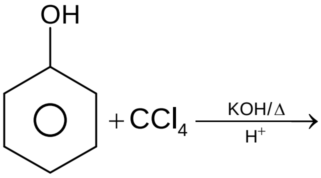
Space for Rough work

30. In which of the following reactions benzaldehyde will form in final product.

(A)

CN
$SnCl_2 + HCl$
H_3O^+

(B)

CH_3
CrO_2Cl_2/CS_2
H_3O^+

(C)

$CO + HCl$
Anhyd.$AlCl_3$/CuCl

(D)

OH
$+ CCl_4$
KOH/Δ
H^+

31. A dilute solution contains 't' moles of solute X in 1 kg of solvent with molal elevation constant K_b. The solute dimerises in the solution according to the following equation. The degree of association is α.

$$2X \rightleftharpoons X_2$$

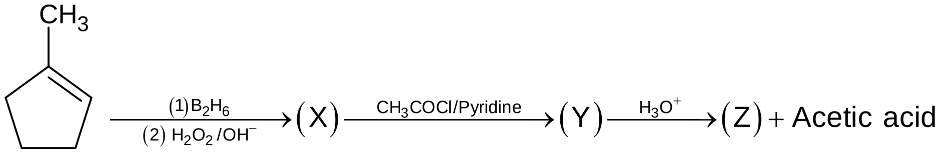
(A) The degree of association $\alpha = \frac{2(K_b t - \Delta T_b)}{K_b T}$

(B) The molecular mass observed will be lesser than actual molecular mass

(C) The colligative properties observed will be $\Delta T_{b\ obs} < \Delta T_{b\ theoretical}$; $\Delta T_{f\ obs} < \Delta T_{f\ theoretical}$; $\Delta P_{obs} < \Delta P_{theoretical}$

(D) The equilibrium constant for the process can be expressed as: $K = \frac{K_b(K_b t - \Delta T_b)}{[2\Delta T_b - K_b t]^2}$

32. The correct statements about the following reaction are


CH_3
(1) B_2H_6
(2) H_2O_2/OH^-
(X)
CH_3COCl/Pyridine
(Y)
H_3O^+
(Z) + Acetic acid

(A) (X) is transisomer of 2-Methylcyclopentan-1-ol

(B) (Y) is Cis isomer of ester

(C) (Z) is geometrical isomers of (X)

(D) (X) and (Z) have identical boiling point

Space for Rough work

Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 33 and 34

MnO_2 is the most important oxide of manganese. MnO_2 occurs naturally as the black coloured mineral pyrolusite. It is an oxidizing agent and decomposes to Mn_3O_4 on heating to 530°C. It is used in the preparation of potassium permanganate and in the production of Cl_2 gas. Over half a million tons per year of MnO_2 is used in dry batteries.

33. In the laboratory, MnO_2 is made by
(A) Heating Mn in O_2
(B) Oxidizing Mn^{2+} in air
(C) Electrolytic oxidation of $MnSO_4$
(D) Precipitating MnO_2 from solution when performing titration of $KMnO_4$ in alkaline medium

34. In which of the following species, the colour is due to charge transfer.
(I) $[Mn(OH)_4]^{2-}$ (ii) MnO_4^{2-} (iii) MnO_2 (iv) $KMnO_4$
(A) I, II, III correct
(B) II, IV are correct
(C) I, III are correct
(D) only IV is correct

Space for Rough work

Paragraph for Question Nos. 35 and 36

Acid-base indicators are either weak organic acids or weak organic bases. Indicators change colour in dilute solution when the hydronium ion concentration reaches a particular value. For example, phenolphthalein is a colourless substance in any aqueous solution with pH less than 8.3. In between the pH range 8.3 to 10, transition of colour(colourless to pink) takes place and if pH of solution is greater than 10 solution is dark pink. Considering an acid indicator HIn, the equilibrium involving it and it's conjugate base(In^-) can be represented as:

$$\underset{\text{acidic form}}{HIn} \rightleftharpoons H^+ + \underset{\text{basic form}}{In^-}$$

pH of solution can be computed as: $pH = pK_{In} + \log\frac{[In^-]}{[HIn]}$

In general, transition of colour takes place in between the pH range, $pK_{In} \pm 1$.

35. An indicator is a weak acid and pH range is 4.0 to 6.0. If indicator in 50% ionized in a given solution, then what is the ionization constant of the acid?
(A) 10^{-4}
(B) 10^{-5}
(C) 10^{-6}
(D) None of these

36. Select the correct statement(s)
(A) at midway in the transition of an acidic indicator pH = pK_{In}
(B) Methyl orange(3.1 to 4.4) is suitable indicator for titration of weak acid and strong base
(C) Bromothymol blue(6.0 to 7.6) is not a good indicator for titration of HCl and NaOH
(D) Thymol blue(1.2 to 2.8) is a very good indicator for titration of 100 mL of 0.1 M NH_4OH (pK_b = 1.74) and 0.1 M HCl

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. If roots of quadratic equation $x^2 + (a^2 + 7)x - 15a = 0$ lie on either side of 2, then complete set of values of a is:

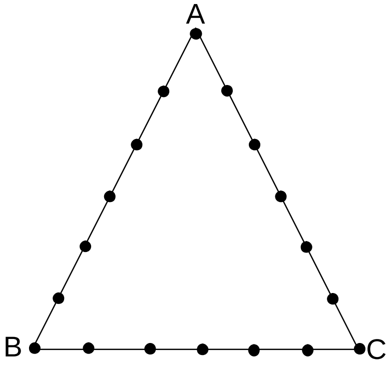
(A) (–2, 4)
(B) $\left(-2, \frac{9}{2}\right)$
(C) $\left(-\frac{9}{2}, 2\right)$
(D) $\left(\frac{3}{2}, 6\right)$

38. Consider a triangle ABC and let a, b and c denote the lengths of the sides opposite to vertices A, B and C respectively. If $a = 1, b = 3$ and $C = 60^o$, then $\sin^2 B$ is equal to:

(A) $\frac{27}{28}$
(B) $\frac{3}{28}$
(C) $\frac{81}{28}$
(D) $\frac{1}{3}$

39. 18 points are indicated on the perimeter of a triangle ABC (see figure). How many triangles are there with vertices at these points?

(A) 331
(B) 408
(C) 710
(D) 711



Space for Rough work

40. If the mapping $f(x) = mx + c,\ m > 0$ maps [–1, 1] onto [0, 2] then $\tan\left(\tan^{-1}\frac{1}{7} + \cot^{-1}8 + \cot^{-1}18\right)$ is equal to:

(A) $f\left(\frac{2}{3}\right)$ (B) $f\left(\frac{1}{3}\right)$

(C) $f\left(\frac{-1}{3}\right)$ (D) $f\left(\frac{-2}{3}\right)$

41. $\lim\limits_{x\to1}\frac{nx^{n+1} - (n+1)x^n + 1}{(e^x - e)\sin\pi x}$ where $n = 100$ is equal to:

(A) $\frac{5050}{\pi e}$ (B) $\frac{100}{\pi e}$

(C) $-\frac{5050}{\pi e}$ (D) $-\frac{4950}{\pi e}$

42. Let $f(x) = \begin{bmatrix} x^{3/5} & \text{if} & x \le 1 \\ -(x-2)^3 & \text{if} & x > 1 \end{bmatrix}$ then the number of critical points on the graph of the function is:

(A) 1 (B) 2

(C) 3 (D) 4

43. The equation to the orthogonal trajectories of the system of parabolas $y = ax^2$ is:

(A) $\frac{x^2}{2} + y^2 = c$ (B) $x^2 + \frac{y^2}{2} = c$

(C) $\frac{x^2}{2} - y^2 = c$ (D) $x^2 - \frac{y^2}{2} = c$

Space for Rough work

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

44. If $2\cos\theta + \sin\theta = 1$, then the value of $4\cos\theta + 3\sin\theta$ is equal to:

(A) 3
(B) –5
(C) $\frac{7}{5}$
(D) –4

45. $\int \frac{x\,dx}{x^4 + x^2 + 1}$ equals:

(A) $\frac{2}{3}\tan^{-1}\left(\frac{2x^2+1}{\sqrt{3}}\right) + C$
(B) $\frac{1}{\sqrt{3}}\left[\tan^{-1}\left(\frac{2x-1}{\sqrt{3}}\right) - \tan^{-1}\left(\frac{2x+1}{\sqrt{3}}\right)\right] + C$
(C) $\frac{1}{\sqrt{3}}\tan^{-1}\left(\frac{2x^2+1}{\sqrt{3}}\right) + C$
(D) $\frac{1}{\sqrt{3}}\left[\tan^{-1}\left(\frac{2x-1}{\sqrt{3}}\right) + \tan^{-1}\left(\frac{2x+1}{\sqrt{3}}\right)\right] + C$

Where C is an arbitrary constant.

46. The co – ordinates of the point (s) on the graph of the function, $f(x) = \frac{x^3}{3} - \frac{5x^2}{2} + 7x - 4$ where the tangent drawn cut off intercepts from the co – ordinate axes which are equal in magnitude but opposite in sign, is:

(A) $\left(2, \frac{8}{3}\right)$
(B) $\left(3, \frac{7}{2}\right)$
(C) $\left(1, \frac{5}{6}\right)$
(D) none of these

47. Let $f(x) = \frac{x-1}{x^2}$ then which of the following is correct?

(A) $f(x)$ has minima but no maxima.
(B) $f(x)$ increases in the interval (0, 2) and decreases in the interval $(-\infty, 0) \cup (2, \infty)$.
(C) $f(x)$ is concave down in $(-\infty, 0) \cup (0, 3)$
(D) x = 3 is point of inflection

Space for Rough work

48. If $2xy\,dy = \left(x^2 + y^2 + 1\right)dx, y(1) = 0$ and $y(x_0) = \sqrt{3}$, then x_0 can be:

(A) 2 (B) –2
(C) 3 (D) –3

49. A line L passing through the point P (1, 4, 3), is perpendicular to both the lines $\frac{x-1}{2} = \frac{y+3}{1} = -\frac{z-2}{4}$ and $\frac{x+2}{3} = \frac{y-4}{2} = \frac{z+1}{-2}$.

If the position vector of point Q on L is (a_1, a_2, a_3) such that $(PQ)^2 = 357$, then $(a \ + a_2 + a_3)$ can be:

(A) 16 (B) 15
(C) 2 (D) 1

50. Solutions of the differential equation $\left(1 - x^2\right)\frac{dy}{dx} + xy = ax$ where $a \in R$, is:

(A) a conic which is an ellipse or a hyperbola with principal axes parallel to coordinates axes.
(B) centre of the conic is (0, a).
(C) length of one of the principal axes is 1
(D) length of one of the principal axes is equal to 2.

Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 51 and 52

Let $f(x) = x^2 + (a+2)x + a^2 - a + 2$. Given $a, \alpha, \beta \ (\alpha < \beta)$ be real numbers and α, β are the roots of the equation $f(x) = 0$.

51. If $\alpha < -2 < \beta$, then a lies in the interval:

(A) (0, 1) (B) (1, 2)
(C) (2, 3) (D) (3, 4)

Space for Rough work

52. If both roots of the equation $f(x)=0$ lies in interval $(0,\infty)$, then range of a, is :

(A) $\left(\frac{2}{3}, 2\right)$ (B) $(-\infty, -2)$

(C) $(0,\infty)$ (D) ϕ

Paragraph for Question Nos. 53 and 54

Let f be an even function satisfying $f(x-2)=f\left(x+\left[\frac{6x^2+13}{x^2+2}\right]\right) \forall x \in R$ and

$$f(x)=\begin{cases} 3x, & 0 \le x < 1 \\ 4-x, & 1 \le x \le 4 \end{cases}$$

[**Note:** [y] denotes greatest integer function of y.]

53. The area bounded by the graph of $f(x)$ and the x – axis from x = –1 to x = 9 is:

(A) $\frac{31}{2}$ (B) 15

(C) 12 (D) $\frac{15}{2}$

54. The value of $f(-89)-f(-67)+f(46)$ is equal to :

(A) 4 (B) 5

(C) 6 (D) 7

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – III

JEE (Advanced)-2020

PAPER – 2

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. B

Sol. $\Delta\phi = \frac{2\pi}{\lambda}\Delta x = (2n+1)\frac{\pi}{2}$

2. A

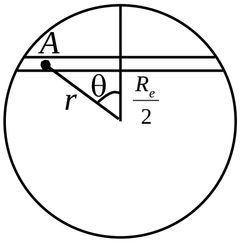
Sol. $v = \sqrt{\frac{T}{\mu}}$ $\qquad V' = \frac{6V}{5}$

$V' = \sqrt{\frac{T'}{\mu}}$ $\qquad T' = \frac{36}{25}T$

% T = 44 %

3. D

Sol. Let mass of the earth is M_e and mass of object is m.



Force on object at $A = \left(\frac{GM_e m}{R^3}r\right)$ towards centre.

Force on object along the tunnel $= \left(\frac{GM_e m}{R^3}r\right)\frac{\sqrt{r^2 - \frac{R^2}{4}}}{r}$

Acceleration of object along the tunnel $= \left(\frac{GM_e}{R^3}\right)\sqrt{r^2 - \frac{R^2}{4}}$

4. A

Sol. $\Delta P_m = 2\Delta P_0 \cos kx$ (assuming closed end as origin)

At point Q, $x = L - \frac{7L}{9} = \frac{2L}{9}$

$\Delta P_m = 2\Delta P_0 \cos\left(\frac{2\pi}{\lambda} \times \frac{2L}{9}\right) = \Delta P_0$

$\therefore$ Required ratio = 1 : 2

5. B

Sol. $d = \frac{mv_0}{qB} + \frac{2mv_0}{2qB}$

6. C

Sol. $\frac{hc}{\lambda} = R\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = \frac{3}{4}R$ …(i)

$\frac{hc}{\lambda'} = R\left(\frac{1}{1^2} - \frac{1}{3^2}\right) = \frac{8}{9}R$ …(ii)

$\frac{\lambda'}{\lambda} = \frac{3}{4} \times \frac{9}{8}$, $\lambda' = \frac{27}{32}\lambda$

7. C

Sol. $\mu = \frac{3}{2}$; $V = 8$; $m = \frac{1}{3}$

$1 + m = \frac{V}{f} = \frac{V}{2R}$

8. BD

Sol. $R = \frac{l}{|\alpha_B - \alpha_C|\Delta t}$

9. AD

Sol. $\frac{d(\text{emf})}{dt} = Bu\frac{d\ell}{dt}$ = constant

$i = \frac{Bu}{\lambda}$ = constant

10. AC

Sol. All the mass defect will convert into KE of α-particle.

11. BCD

Sol. $TP^{-2/5}$ = constant

$\Rightarrow$ $PV^{5/3}$ = constant or $P^{3/5} V = k$

This an adiabatic process.

$\Rightarrow$ $\Delta H = 0$

Work done = $-\Delta U = 6RT$

$$\int VdP = \int \frac{k\,dP}{P^{3/5}} = \frac{nR\Delta T}{(5/2)} = 10\ RT$$

12. AC

Sol. Let I be the power of source S_1 and S_2.

Initially $I_o = 4I$, finally $I_{max} = \left(\sqrt{I} + \sqrt{0.36I}\right)^2 = 2.56I$

and $I_{min} = \left(\sqrt{I} - \sqrt{0.36I}\right)^2 = 0.16I$

13. ABCD

Sol. y = 2a cos (ωt + ϕ) cos (Kx) comparison with given equation gives

$$K = \frac{2\pi}{\lambda} = 10\pi \Rightarrow \lambda = \frac{1}{5}m$$

$\omega = 2\pi f = 50\pi \Rightarrow f = 25$ Hz

$\therefore v = 5\ ms^{-1}$

at x = 0.15 m

cos (10 π × 0.15) = cos (1.5π) = –1 for all t

at x = 0.3

cos (10 π × 0.3) = cos 3π = – 0 for all t

14. AD

Sol. At highest point, linear momentum
2 mv = mv_1 – mv
v_1 = 3v
At highest point, velocity of other part after explosion = 3v
Centre of mass of particles will be at a distance R from initial point on ground.

15. A

Sol. Work function of the metal (ϕ) = $\frac{hc}{\lambda_{green}} = \frac{12408}{4963} = 2.5\,eV$

No. of photon emitted from the power source per unit time = $\frac{40}{2.5 \times 1.6 \times 10^{-19}} = 10^{20}$ photons

No. of photons incident on the metallic surface per unit time = $\frac{10^{20} \times \pi \times (1 \times 10^{-2})^2}{4\pi(1)^2} = 2.5 \times 10^{15}$ photons

No. of photoelectrons coming out from the metal surface per unit time

= $\frac{2.5 \times 10^{15}}{10^6}$ = 2.5 × 10^9 photoelectrons

16. B

Sol. The emission of photoelectron will stop when $\frac{hc}{\lambda_{violet}} = \varphi + eV$, where V is the potential of sphere.

$$\frac{12408}{4136} = 2.5 + eV \quad ; \quad V = 0.5\,V$$

17. C

Sol. $T_B = \frac{P_B}{P_A} T_A = 2T_0$

$$(2T_0)V_0^{\frac{13}{9}-1} = T_C \cdot (2V_0)^{\frac{13}{9}-1} \Rightarrow T_C = 2^{5/9} T_0$$

18. B

Sol. Heat is absorbed during the process AB and BC

$$Q_{AB} = \frac{3}{2}R(T_B - T_A) = \frac{3}{2}RT_0$$

$$Q_{BC} = \left(\frac{3}{2}R - \frac{9}{4}R\right)(T_C - T_B) = \frac{3}{4}R \times (2 - 2^{5/9})T_0$$

$$Q_{abs} = \frac{3}{4}(4 - 2^{5/9})RT_0 \cong \frac{15}{8}RT_0[2^{5/9} \cong 1.5]$$

$$Q_{rej} = \frac{3}{8}(2 + 2^{5/9})RT_0 \cong \frac{21}{16}RT_0$$

$$Q_{CD} = \frac{3}{2}R(T_D - T_C)$$

$$Q_{DA} = \left(\frac{3}{2}R - \frac{9}{4}R\right)(T_A - T_D)$$

$$W = \frac{9}{16}RT_0 \quad ; \quad \eta = \frac{W}{Q_{abs}} = 30\%$$

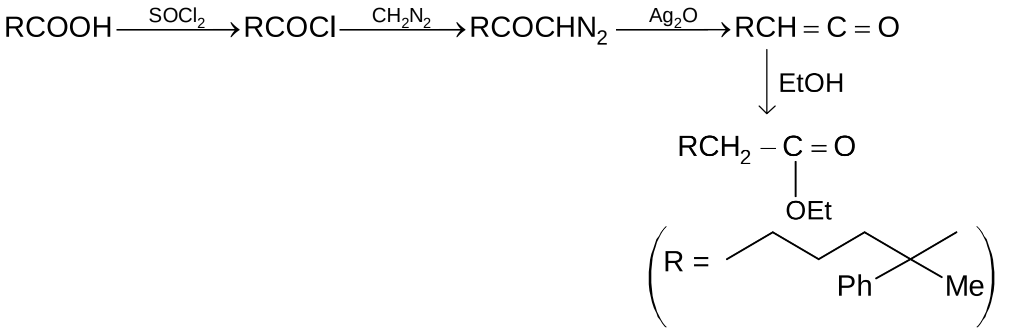
Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

19. C

Sol.



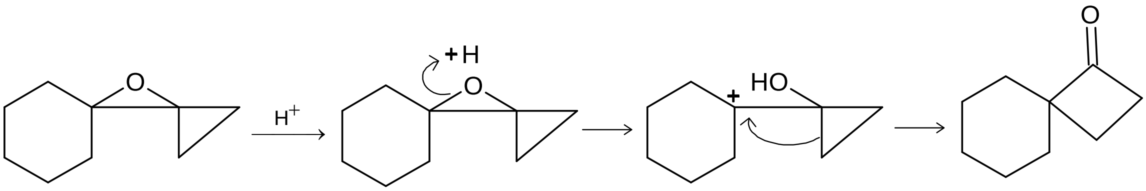
$$RCOOH \xrightarrow{SOCl_2} RCOCl \xrightarrow{CH_2N_2} RCOCHN_2 \xrightarrow{Ag_2O} RCH=C=O \xrightarrow{EtOH} RCH_2-\underset{\displaystyle OEt}{\underset{|}{C}}=O$$

20. D

Sol. Fact based.

21. C

Sol.



22. C

Sol. $Au + 4H^+ + NO_3^- + 4Cl^- \longrightarrow AuCl_4^- + NO + 2H_2O$

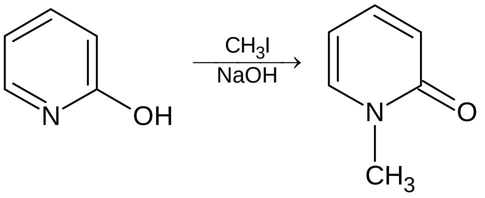
$3Pt + 16H^+ + 4NO_3^- + 18Cl^- \longrightarrow 3PtCl_6^{2-} + 4NO + 8H_2O$

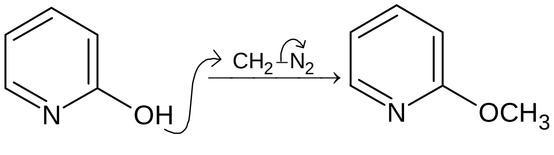
23. A

Sol. Fact based.

24. C

Sol.





25. A

Sol. For N_2

$$KK\ \sigma 2s^2 < \sigma^* 2s^2 < \sigma 2P_X^2 < \begin{matrix}\pi 2P_Y^2 \\ \pi 2P_Z^2\end{matrix} < \sigma 2P_X^2$$

For O_2^+

$$KK\ \sigma 2s^2 < \sigma^* 2s^2 < \sigma 2P_X^2 < \begin{matrix}\pi^* 2P_Y^2 \\ \pi^* 2P_Z^2\end{matrix} < \begin{matrix}\pi 2P_Y^1 \\ \pi 2P_Z\end{matrix} < \sigma^* 2P_Z$$

26. ACD

Sol. (B) is incorrect, correct order is $Cl_2 > Br_2 > F_2 > I_2$.

27. AB

Sol. Fact based.

28. ABD

Sol. (A) $2H_2O \longrightarrow O_2 + 4H^+ + 4e^-$ (at anode)

(B) Aq. $AgNO_3$ at anode $4OH^- \longrightarrow 2H_2O + O_2 + 4e^-$

(D) Aq. NaOH at anode $4OH^- \longrightarrow 2H_2O + O_2 + 4e^-$

29. ACD

Sol. $K_2Cr_2O_7/H^+$ acts as oxidant not in basic medium, rest all acts as oxidizing agent in acidic as well as alkaline medium.

30. ABC

Sol. (A) Stephan's reduction, (B) Etard's reaction, (C) Gattermann Koch synthesis

31. ACD

Sol. $\underset{1-\alpha}{2X} \rightleftharpoons \underset{\frac{\alpha}{2}}{X_2} \qquad i = 1 - \frac{\alpha}{2}$

$$\frac{(\Delta t_b)_{0.65}}{K_b t} = i = 1 - \frac{\alpha}{2}$$

$$\frac{\alpha}{2} = 1 - \frac{\Delta t_b}{K_b t} = \frac{K_b t - \Delta t_b}{K_b t}$$

$$(A) \quad \alpha = \frac{2(K_b t - \Delta t_b)}{K_b t}$$

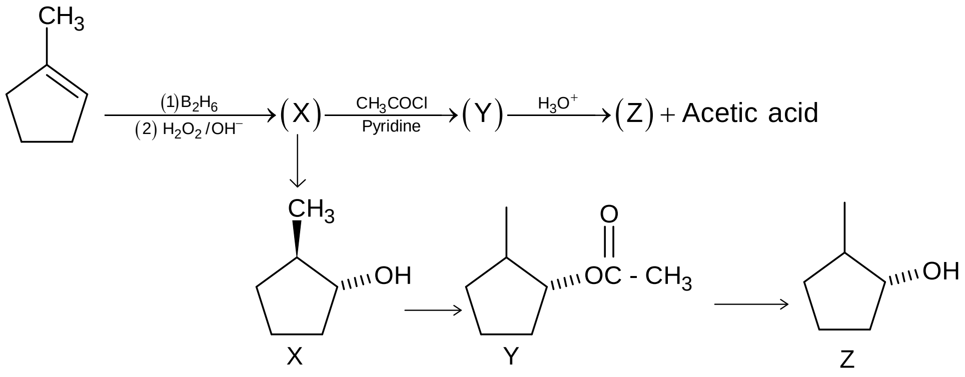
and as $i < 1$

$\frac{M_C}{M_o} < 1$ so $M_C < M_o$

$$\frac{(C.P)_{obs}}{(C.P)_{cal}} < 1 \qquad \text{......(C)}$$

32. AD

Sol.


CH3
(1)B2H6
(2) H2O2/OH⁻
(X)
CH3COCl
Pyridine
(Y)
H3O⁺
(Z) + Acetic acid
CH3
OH
X
O
OC - CH3
Y
OH
Z

33. D

Sol. $MnO_4^- + OH^- \longrightarrow MnO_2$

34. D

Sol. $KMnO_4$ is purple coloured due to charge transfer.

35. B

Sol. For 50% ionization(In^-) = [HIn]

$\therefore$ pH = PK_{In}

Thus PK_{In}= 10^{-5} (as pH = 5)

36. A

Sol. At midway pH = PK_{In}

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. D

Sol. $f(2) < 0$

$\Rightarrow (a-6)(2a-3) < 0 \Rightarrow a \in \left(\frac{3}{2}, 6\right)$

38. A

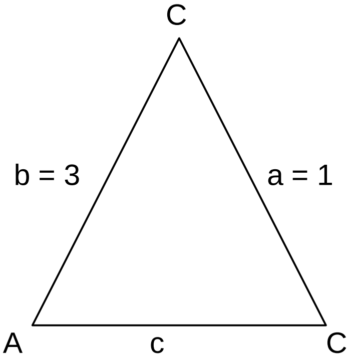
Sol. By Cosine law, $\cos 60^o = \frac{1^2 + 3^2 - c^2}{2.1.3}$

$\Rightarrow c = \sqrt{7}$

Now, $\frac{b}{\sin B} = \frac{c}{\sin C}$ (By sine law)

$\Rightarrow \quad \sin B = \frac{b \sin C}{c} = \frac{3 \times \frac{\sqrt{3}}{2}}{\sqrt{7}} = \frac{3\sqrt{3}}{2\sqrt{7}}$

Hence, $\sin^2 B = \frac{27}{28}$



39. D

Sol. ${}^{18}C_3 - 3.{}^{7}C_3 = 816 - 105 = 711$

40. D

Sol. Clearly, $f(x) = x + 1 (\text{As } m = 1, c = 1)$

Now, $\tan\left(\tan^{-1}\frac{1}{7} + \tan^{-1}\frac{1}{8} + \tan^{-1}\frac{1}{18}\right)$

$$= \tan\left(\tan^{-1}\left(\frac{\frac{1}{7}+\frac{1}{8}}{1-\frac{1}{7}\times\frac{1}{8}}\right) + \tan^{-1}\frac{1}{18}\right)$$

$$= \tan\left(\tan^{-1}\left(\frac{15}{55}\right) + \tan^{-1}\left(\frac{1}{18}\right)\right) = \tan\left(\tan^{-1}\left(\frac{3}{11}\right) + \tan^{-1}\left(\frac{1}{18}\right)\right)$$

$$= \tan\left(\tan^{-1}\left(\frac{\frac{3}{11}+\frac{1}{18}}{1-\frac{3}{11}\times\frac{1}{18}}\right)\right) = \tan\left(\tan^{-1}\frac{1}{3}\right) = \frac{1}{3} = f\left(\frac{-2}{3}\right)$$

41. C

Sol. $I = \lim\limits_{x \to 1} \dfrac{nx^n(x-1) - (x^n - 1)}{(e^x - e)\sin \pi x}$

Put $x = 1 + h$ so that as $x \to 1, h \to 0$

$\therefore I = -\lim\limits_{h \to 0} \dfrac{h.n(1+h)^n - \left((1+h)^n - 1\right)}{e\left(e^h - 1\right)\sin \pi h}$

$n.h\left(1 + {}^nC_1 h + {}^nC_2 h^2 + {}^nC_3 h^3 + ...\right)$

$I = \lim\limits_{h \to 0} \dfrac{-\left(1 + {}^nC_1 h + {}^nC_2 h^2 + {}^nC_3 h^3 + ... - 1\right)}{\pi e\left(h^2\right)\left(\dfrac{e^h - 1}{h}\right)\left(\dfrac{\sin \pi h}{\pi h}\right)}$

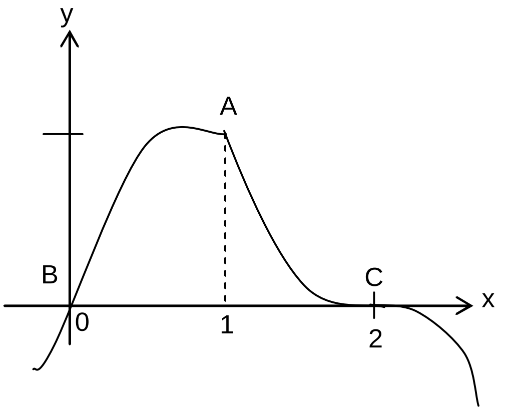
$= -\dfrac{n^2 - {}^nC_2}{\pi e} = -\left[\dfrac{2n^2 - n(n-1)}{2\pi e}\right] = -\dfrac{n^2 + n}{2(\pi e)} = -\dfrac{n(n+1)}{2(\pi e)}$

If $n = 100$

$\Rightarrow I = -\left(\dfrac{5050}{\pi e}\right)$

42. C

Sol. A, B, C are the 3 critical points of $y = f(x)$



43. A

Sol. $\dfrac{dy}{dx} = 2ax = 2x\left(\dfrac{y}{x^2}\right)$

$\dfrac{dy}{dx} = \dfrac{2y}{x}$

Now $m\dfrac{dy}{dx} = -1 \quad \Rightarrow \quad m = -\dfrac{x}{2y} \quad \Rightarrow \quad \dfrac{dy}{dx} = -\dfrac{x}{2y}$

$y^2 = -\dfrac{x^2}{2} + c$

44. AC

Sol. $(2\cos\theta)^2 = (1 - \sin\theta)^2 \Rightarrow 5\sin^2\theta - 2\sin\theta - 3 = 0$

$\Rightarrow \sin\theta = 1$ or $-\frac{3}{5}$, now

If $\sin\theta = 1 \Rightarrow \cos\theta = 0 \Rightarrow E = 3$; If $\sin\theta = -\frac{3}{5}$

Hence $E = \frac{7}{5}$

45. BC

Sol. $I = \frac{1}{2}\int \frac{dt}{t^2+t+1} = \frac{1}{2}\int \frac{dt}{\left(t+\left(\frac{1}{2}\right)\right)^2 + \left(\frac{3}{4}\right)} = \frac{1}{2}.\frac{2}{\sqrt{3}}\tan^{-1}\left(\frac{t+\left(\frac{1}{2}\right)}{\frac{\sqrt{3}}{2}}\right) = \frac{1}{\sqrt{3}}\tan^{-1}\left(\frac{2t+1}{\sqrt{3}}\right)$

$= \frac{1}{\sqrt{3}}\tan^{-1}\left(\frac{2x^2+1}{\sqrt{3}}\right) + C$

46. AB

Sol. Since intercepts are equal in magnitude but opposite in sign.

$\Rightarrow \left.\frac{dy}{dx}\right|_P = 1$

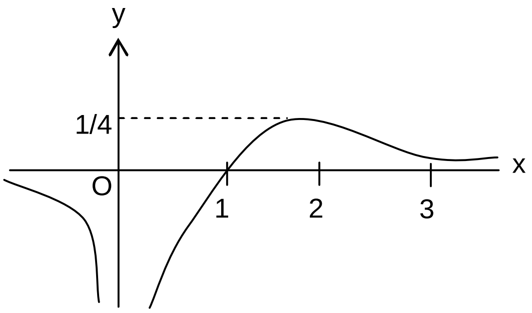
Now $\frac{dy}{dx} = x^2 - 5x + 7 = 1$

$\Rightarrow x^2 - 5x + 6 = 0$

$\Rightarrow x = 2$ or 3

47. BCD

Sol. $f'(x) = \frac{2-x}{x^3}$ and $f''(x) = \frac{x-3}{x^4}$.



48. AB

Sol. $2xy\frac{dy}{dx} = x^2 + y^2 + 1$

Put $y^2 = t$, $x\frac{dt}{dx} = x^2 + t + 1$

$\frac{dt}{dx} - \frac{t}{x} = \frac{x^2+1}{x}$

I.F. $= \frac{1}{x}$

Hence $\frac{t}{x} = \int \frac{x^2+1}{x^2}dx = x - \frac{1}{x} + C$

$\therefore\ y^2 = x^2 - 1,\ C = 0$ as $y(1) = 0$

Now, $y(x_0) = \sqrt{3}$

$\Rightarrow\ 3 = x_0^2 - 1$

$\Rightarrow\ x_0^2 = 4$

$\therefore\ x_0 = \pm 2$

49. BD

Sol. Equation of the line passing through P(1, 4, 3) is: $\frac{x-1}{a} = \frac{y-4}{b} = \frac{z-3}{c}$ …….(i)

Since equation (i) is perpendicular to $\frac{x-1}{2} = \frac{y+3}{1} = \frac{z-2}{4}$ and $\frac{x+2}{3} = \frac{y-4}{2} = \frac{z+1}{-2}$

Hence $2a + b + 4c = 0$ and $3a + 2b - 2c = 0$

$\therefore\ \frac{a}{-2-8} = \frac{b}{12+4} = \frac{c}{4-3} \Rightarrow \frac{a}{-10} = \frac{b}{16} = \frac{c}{1}$

Hence the equation of the lines is $\frac{x-1}{-10} = \frac{y-4}{16} = \frac{z-3}{1}$ ………(ii)

Now any point Q on (2) can be taken as $(1-10\lambda,\ 16\lambda+4,\ \lambda+3)$

$\therefore$ Distance of Q from P (1, 4, 3) $= (10\lambda)^2 + (16\lambda)^2 + \lambda^2 = 357$

$\Rightarrow\ (100+256+1)\lambda^2 = 357$

$\Rightarrow\ \lambda = 1$ or -1

$\therefore$ Q is $(-9, 20, 4)$ or $(11, -12, 2)$

Hence $a_1 + a_2 + a_3 = 15$ or 1

50. ABD

Sol. $\frac{dy}{dx} + \frac{x}{1-x^2}y = \frac{ax}{1-x^2}$

I.F. $e^{\int \frac{x}{1-x^2}dx} = e^{-\frac{1}{2}\log|1-x^2|} = \frac{1}{\sqrt{|1-x^2|}}$

$$\frac{y}{\sqrt{|1-x^2|}} = a\int \frac{x}{|1-x^2|^{3/2}}dx + C$$

Let $|1-x^2| = \nu^2$

$-2x\,dx = 2\nu\ d\nu$

$x\ dx = -\nu\ d\nu$

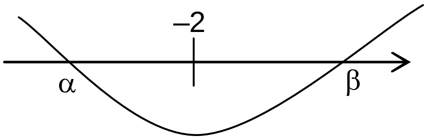
Hence $\frac{y}{\nu} = -a\int \frac{\nu\ d\nu}{\nu^3} = +\frac{a}{\nu} + C$

$y = a + C\nu$

$y = a + C\sqrt{|1-x^2|}$

$$(y-a)^2 = C^2\left|1-x^2\right|$$
$$= C^2\left(1-x^2\right) \text{ or } C^2\left(x^2-1\right)$$
$$(y-a)^2 + C^2x^2 = C^2 \text{ or } (y-a)^2 - C^2x^2 = -C^2$$
$$\frac{(y-a)^2}{C^2} + \frac{x^2}{1} = 1 \text{ or } \frac{(y-a)^2}{C^2} - \frac{x^2}{1} = -1 \quad \Rightarrow \text{ Centre } (0, a)$$

51. B



Sol. $f(x) = x^2 + (a+2)x + a^2 - a + 2 = 0$

$f(-2) < 0$

$\Rightarrow 4 - 2a - 4 + a^2 - a + 2 < 0$

$\Rightarrow a^2 - 3a + 2 < 0 \quad \Rightarrow 1 < a < 2 \qquad \therefore a \in (1, 2)$

Not integral values of a.

52. D

Sol. Given, $x^2 + (a+2)x + a^2 - a + 2 = 0$

Now, $D > 0 \Rightarrow \frac{2}{3} < a < 2$ ………(i)

Product of roots > 0

$\Rightarrow a^2 - a + 2 > 0$, which is true $\forall a \in R$ ……….(ii)

and sum of roots > 0

$\Rightarrow -(a+2) > 0$

$\Rightarrow a < -2$ ……….(iii)

$\therefore$ Equation $(i) \cap (ii) \cap (iii)$

$\Rightarrow a \in \phi$

53. B

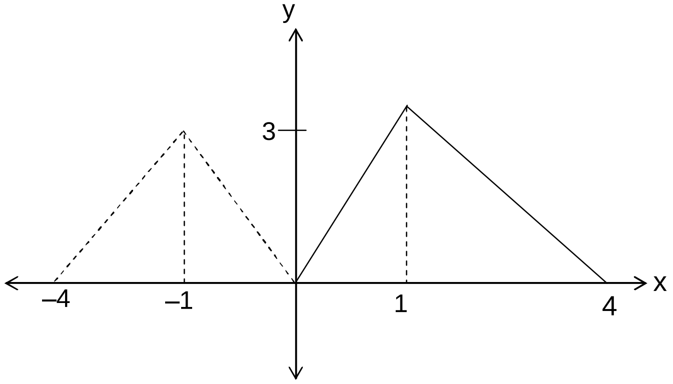
Sol. Required area $= 2 \times \frac{1}{2} \times 4 \times 3 + 2 \times \frac{1}{2} \times 1 \times 3 = 15$

54. A

Sol. $f(-89) - f(-67) + f(46) = f(-1) - f(-3) + f(-2)$

$= 3 - 1 + 2 = 4$

$f(x-2) = f(x+6) \quad \Rightarrow \quad f(x) = f(x+8)$



FIITJEE

ALL INDIA TEST SERIES

FULL TEST – III

JEE (Main)-2020

TEST DATE: 29-12-2019

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. B

Sol. Maximum range up the inclined plane = $\frac{u^2}{g(1+\sin\theta)}$

Maximum range down the inclined plane = $\frac{u^2}{g(1-\sin\theta)}$

The maximum possible distance between the two bullets after they hit the inclined plane

$$\therefore\ d_{max} = \frac{u^2}{g(1+\sin\theta)} + \frac{u^2}{g(1-\sin\theta)}$$

$$d_{max} = \frac{2u^2}{g\cos^2\theta}$$

2. B

Sol. Use the basic concept of interference of light waves.

3. C

Sol. Acceleration of block = –3 m/s^2

Acceleration of plank = –7 m/s^2

After 3 sec, the plank will come to rest. In 3 sec, the block will move $\frac{1}{2}\times 4\times 3\times 3 = 18$ m relative to the plank.

Now, let the block will cover remaining 18 m relative to plank in next t seconds.

$$12t - \frac{1}{2}\times 3t^2 = 18$$

$8t - t^2 = 12 \Rightarrow t = 2$ sec
Total time after which the block will get off the plank, $t_0 = 3 + 2 = 5$ sec.

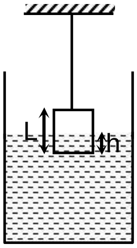
4. B
Sol. At θ_{min}

$$\lambda gR(1-\sin\theta) - \lambda gR(1-\cos\theta) - \mu\lambda gR(\sin\theta + \cos\theta) = 0$$

$$\Rightarrow \cos\theta - \sin\theta - \frac{\sin\theta}{3} - \frac{\cos\theta}{3} = 0$$

$\therefore \theta = \tan^{-1}(1/2)$

5. B
Sol. $f \propto \sqrt{T}$



$T_0 = n\rho_w L^3 g$

$$T_{new} = n\rho_w L^3 g - 2\rho_w L^2 hg = \rho_w L^2 g(nL - 2h)$$

$$\therefore \frac{f_{new}}{f_0} = \sqrt{\frac{\rho_w L^2 g(nL-2h)}{n\rho_w L^3 g}}$$

$$f_{new} = \left(\frac{nL-2h}{nL}\right)^{1/2} f_0$$

6. C
Sol. $\phi = \frac{\pi}{2}$

$$\frac{t}{T} = \frac{\pi/2}{2\pi}$$

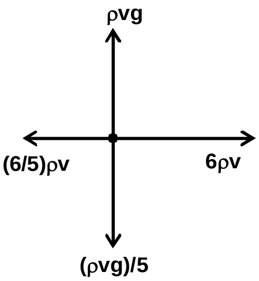
$\therefore t = T/4 = \frac{\pi}{2}\sqrt{\frac{m}{k}}$

7. D
Sol. $3L(1+\alpha_{eff}\Delta\theta) = L(1+2\alpha\Delta\theta) + 2L(1+\alpha\Delta\theta)$

$3L\alpha_{eff}\Delta\theta = 4\alpha L\Delta\theta$

$\therefore \alpha_{eff} = \frac{4}{3}\alpha$

8. A
Sol. F.B.D.



9. A
Sol. $I = neAv_d$
$I = kV^2$

10. D

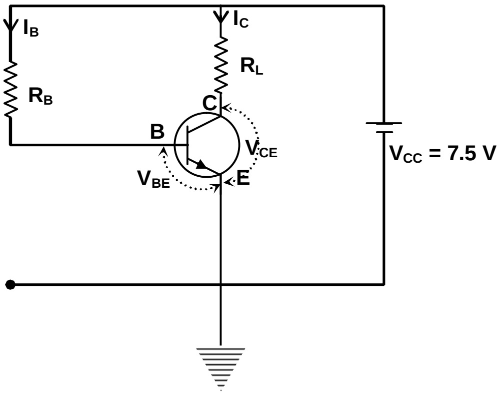
Sol. $V_{CC} = I_B R_B + V_{BE}$

$$I_B = \frac{V_{CC} - V_{BE}}{R_B} = \frac{7.5 - 1}{130 \times 10^3} = 50 \times 10^{-6} = 50\mu A$$

$$I_C = \beta I_B = 100 \times 5 \times 10^{-5} = 5 \times 10^{-3} A = 5\,mA$$

Now, $I_C R_L + V_{CE} = V_{CC}$

$$R_L = \frac{V_{CC} - V_{CE}}{I_C} = \frac{7.5 - 3.5}{5 \times 10^{-3}} = \frac{4000}{5} = 800\Omega$$



11. A

Sol. d(K.E.) = mv× Δv

Change in velocity Δv has fixed magnitude

Greatest change in kinetic energy is achieved when impulse is parallel to the velocity and when the speed is as large as possible.

12. C

Sol. Then intensity of the emerging light, $I = \frac{I_0}{2}\cos^2(37°) = \frac{I_0}{2} \times \left(\frac{4}{5}\right)^2$

$$I = \frac{8I_0}{25} = 8\ W/m^2$$

13. C

Sol. $V_0 = \frac{k\rho a^2}{\varepsilon_0}$ = potential at the centre of a cube of side 'a'

$k\rho \times \frac{4a^2}{\varepsilon_0} = 4V_0$ = potential at the centre of a cube of side '2a'

Six such pyramids make a cube

Potential at the tip of pyramid = $\frac{4V_0}{6} = \frac{2V_0}{3}$

14. B

Sol. $\frac{dQ_1}{T_1} + \frac{dQ_2}{T_2} = 0$

$\frac{dT_1}{T_1} = -\frac{dT_2}{T_2} \Rightarrow T_1T_2$ = constant

When their temperatures become equal

$T_1T_2 = T^2$

⇒ Final temperature, T = $\sqrt{T_1T_2}$

15. A

Sol. t = 1.5 h

Total charge transferred = 4.5 Ah

Q_{max} = 60 Ah

Percentage charged = $\frac{4.5}{60} \times 100 = 7.5\,\%$

16. C
Sol. Use Faraday's Law

17. A
Sol. $nh\nu = \frac{100\times 60}{100}$ = 60 J

$n = \frac{60\lambda}{hc} = \frac{60\times 3.9\times 10^{-7}}{6.63\times 10^{-34}\times 3\times 10^{8}}$ = 1.18 × 10^{20}

18. A
Sol. Using conservation of momentum
$mu = mv_1 + Mv_2$
$\Rightarrow 2v_2 + v_1 = u$ …(i)
$v_2 - v_1 = u$ …(ii)
from (i) and (ii)
$v_2 = 2u/3$

∴ Fraction of kinetic energy lost by neutron= $\frac{\frac{1}{2}\times 2m\times\left(\frac{2u}{3}\right)^2}{\frac{1}{2}mu^2} = \frac{8}{9}$

19. C
Sol. $2\times\frac{1}{2g}\left(\frac{p\sin\theta}{m}\right)^2 = \frac{2p\sin\theta}{mg}\times\frac{p\cos\theta}{m}$

$\frac{1}{2}\sin^2\theta = \sin\theta\cos\theta \Rightarrow \tan\theta = 2$

$\therefore\ \cos\theta = \frac{1}{\sqrt{5}}$

Minimum kinetic energy = $\frac{(p\cos\theta)^2}{2m} = \frac{p^2}{2m}\times\frac{1}{5} = \frac{p^2}{10m}$

20. D
Sol. $A = A_0 e^{-\frac{bt}{2m}}$

$A = A_0 e^{-\frac{\ell n2}{10\times 2}\times\frac{20}{2}} = A_0 e^{-\ell n\sqrt{2}} = \frac{A_0}{\sqrt{2}}$

SECTION – B

21. 5
Sol. $H = B/\mu_0$
$ni = 2\times 10^4$
$40\times 100\ i = 2\times 10^4$
$i = \frac{20}{4}A = 5A$

22. 7
Sol. $m_1 g - T_1 = m_1 a$ …(i)
$T_2 - m_2 g = m_2 a$ …(ii)

$$T_1 - T_2 \pm \frac{m_1g}{2} = m_1a \quad \ldots(iii)$$

$$(m_1 - m_2)g \pm \frac{m_1g}{2} = (2m_1 + m_2)a$$

$$a = \frac{2m_2g \pm \frac{3gm_2}{2}}{7m_2}$$

$$a_{max} = \frac{g}{2}$$

$$a_{min} = \frac{g}{14}$$

$$\frac{a_{max}}{a_{min}} = 7$$

SECTION – C

23. 00004.80

Sol. $(\mu_S - 1)t_0 = \frac{d \times y}{D}$

$y = (\mu_S - 1)t_0 \frac{D}{d}$

⇒ velocity of central maxima,

$v = \frac{dy}{dt} = (2t + 12) \times \frac{2.4 \times 10^{-4} \times 2}{2 \times 10^{-3}}$

At t = 4 sec

$v = 20 \times 2.4 \times 10^{-1} = 4.80$ m/s

24. 00086.60

Sol. $N = mg\cos\alpha - F\sin\theta$

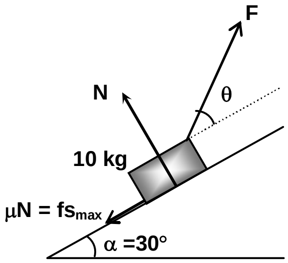
$F\cos\theta = \mu N + mg\sin\alpha$

$F(\cos\theta + \mu\sin\theta) = mg(\sin\alpha + \mu\cos\alpha)$

$F = \frac{mg(\sin\alpha + \mu\cos\alpha)}{(\cos\theta + \mu\sin\theta)}$

$\therefore F_{min} = \frac{mg(\sin\alpha + \mu\cos\alpha)}{\sqrt{1+\mu^2}}$ [when $\theta = \tan^{-1}(\mu) = 30°$]

$\therefore F_{min} = 86.60$ N



25. 00000.25

Sol. $\frac{5\lambda}{4} = \ell_1 + e \quad \ldots(i)$

$\frac{9\lambda}{4} = \ell_2 + e \quad \ldots(ii)$

From (i) and (ii)

$\lambda = \ell_2 - \ell_1 = 200 - 111 = 89$ cm

From (i), end correction

$e = \frac{5\lambda}{4} - \ell_1 = \frac{5}{4} \times 89 - 111$

⇒ e = 0.25 cm

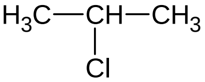
Chemistry

PART – II

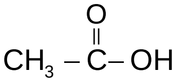
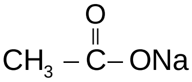
SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

26. A

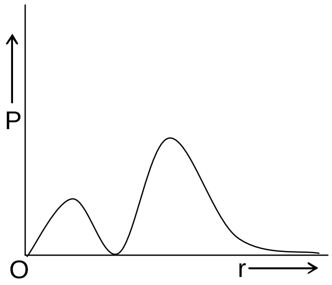
Sol. 
$H_3C-\underset{Cl}{\underset{|}{CH}}-CH_3$ will respond the test.

27. A

Sol. Aqueous solution of 
$CH_3-\overset{O}{\overset{\|}{C}}-OH$ and 
$CH_3-\overset{O}{\overset{\|}{C}}-ONa$ is a buffer solution.

28. D

Sol. Sketch for 2s orbital is



29. A

Sol. E_{cell} is an intensive property, where as mass, internal energy, heat capacity are extensive properties.

30. C

Sol. $$dE = dq + dW$$

$$dE + PdV = dq \Rightarrow \frac{dE}{dT} + P\frac{dV}{dT} = \frac{dq}{dT}$$

$$\Rightarrow nC_{V,\,m} + \frac{PdV}{dT} = \frac{dq}{dT}$$

$$\Rightarrow 1\times\frac{fR}{2} + \frac{PdV}{dT} = \frac{dq}{dT}$$

$$\Rightarrow \frac{5R}{2} + \frac{PdV}{dT} = \frac{dq}{dT} \qquad \text{.... (1)}$$

$$PV = RT \Rightarrow V^3 = RT$$

$$\Rightarrow 3V^2\frac{dV}{dT} = R \Rightarrow \frac{PdV}{dT} = \frac{R}{3}$$

$$\frac{5R}{2} + \frac{R}{3} = \frac{dq}{dT}$$

$$\frac{17R}{6} = \frac{dq}{dT}$$

31. A

Sol. Forsterite [$Mg_2(SiO_4)$] is orthosilicate.

32. B

Sol. Given complex have four possible coordination isomers.

en	CN	CN	en
3	$0]^{3+}$	6	$0]^{3-}$
2	$2]^{1+}$	4	$1]^{1-}$
1	$4]^{-1}$	2	$2]^{+1}$
0	$6]^{-3}$	0	$3]^{3+}$

$$\left[Co(en)_3\right]\left[Cr(CN)_6\right]$$

$$\left[Co(en)_2(CN)_2\right]\left[Cr(CN)_4(en)\right]$$

$$\left[Co(en)_1(CN)_4\right]\left[Cr(CN)_2(en)_2\right]$$

$$\left[Co(CN)_6\right]\left[Cr(en)_3\right]$$

33. A

Sol. Number of streo isomers possible for the given complex is 8.

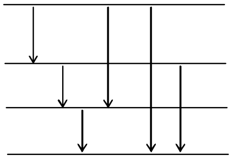
34. A

Sol. P_4O_{10} is not an oxidizing agent.

$$P_4O_{10} + NaCl \longrightarrow POCl_3 + Na_3PO_4$$

35. A

Sol. Minimum 4 hydrogen atom should be present in sample to get 6 different spectral lines.

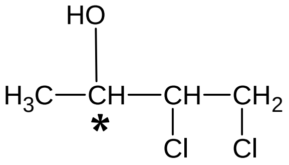


36. B

Sol. Barytes is a sulphate ore.

37. C

Sol. Two optical isomers are possible for the given organic molecule



$$H_3C-\underset{*}{\overset{HO}{CH}}-\underset{Cl}{CH}-\underset{Cl}{CH_2}$$

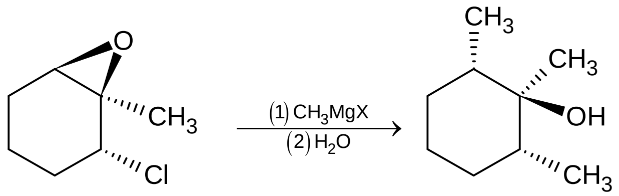
38. A

Sol. Total 5 dihalogen derivatives are formed including stereoisomers in which two are diastereomers.

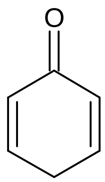
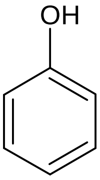
$\therefore x + y = 10$.

39. C

Sol.

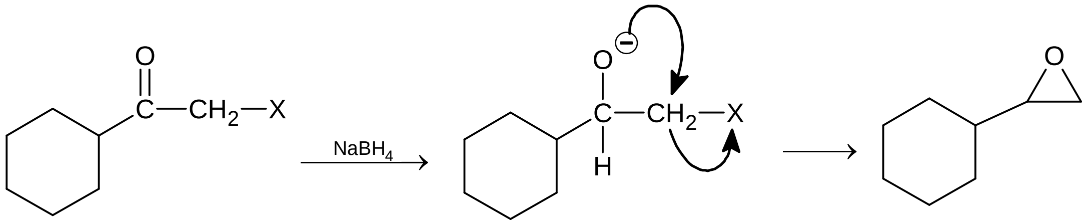

O
CH3
Cl
(1) CH3MgX
(2) H2O
CH3
CH3
OH
CH3

40. C

Sol.  will tautomerise to form  .

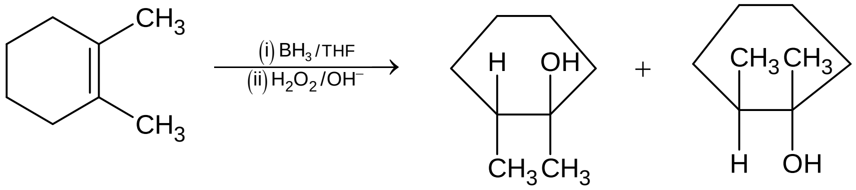
41. B

Sol.


O
C—CH2—X
NaBH4
O⊖
C—CH2—X
H
O

42. D

Sol.


CH3
CH3
(i) BH3/THF
(ii) H2O2/OH⁻
H OH
CH3 CH3
+
CH3 CH3
H OH

Number of products = 2.

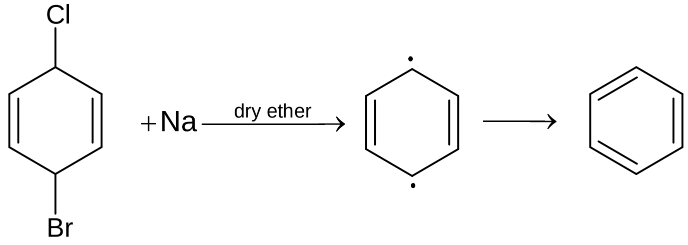
43. C

Sol. $$Z = \frac{PV_m}{RT} = \frac{V_m}{V_m - b} = \frac{11b}{11b - b} = \frac{11}{10}$$

$$\because \frac{P(V - nb)}{n} = RT \Rightarrow \frac{RT}{P} = \frac{V - nb}{n} = V_m - b$$

44. B

Sol.


Cl
Br
+Na
dry ether

45. B

Sol. $B + 3D \longrightarrow 4A + 4C$

Rate of reaction $= \frac{-d[B]}{dt} = \frac{-1}{3}\frac{d[D]}{dt} = \frac{1}{4}\frac{d[A]}{dt} = \frac{1}{4}\frac{d[C]}{dt}$

SECTION – B

46. 1

Sol. $Be_2^+ : \sigma 1^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^1$

B. O. = $\frac{1}{2}[4-3] = 0.5$

$\Rightarrow$ 2x = 1

47. 4

Sol. Following are dibasic acid
H_2SO_4, H_3PO_3, H_2SO_5 and $H_2S_2O_7$.

SECTION – C

48. 00200.00

Sol. Let the final composition, liquid (10 mole)
A = x mole, B = (10 – x) mole
Vapour (10 moles), A = 10 – x mole; B = x mole

Now, $\frac{Y_A}{Y_B} = \frac{X_A}{X_B}\frac{P_A^o}{P_B^o} \Rightarrow \frac{10-x}{x} = \frac{x}{10-x} \times \frac{400}{100}$

x = $\frac{10}{3}$

Now, $P = X_A P_A^o + X_B P_B^o$

$= \frac{x}{10} \times 400 + \frac{10-x}{10} \times 100$

= 200.00

49. 00085.40

Sol. $K_2Cr_2O_7 + 14HCl \longrightarrow 2KCl + 2CrCl_3 + 3Cl_2 + 7H_2O$

n-factor of $K_2Cr_2O_7$ = 6 and

n-factor of HCl $= \frac{3}{7}$

$\therefore E_{HCl} = \frac{M}{\frac{3}{7}} = \frac{7M}{3} = 85.40$

= 85.40

50. 00006.50

Sol. pH at isoelectric point = $\frac{pKa_1 + pKa_2}{2} = \frac{4+9}{2} = 6.5$

Mathematics PART – III

SECTION – A

51. B

Sol. Area is minimum when $c = \frac{-3+9}{2} = 3$

52. B

Sol. $\frac{25!\left(-1\right)^2}{22!\,2!\,1!} = 6900$

53. A

Sol. b + 3 = ±4, b = –7, 1

54. A

Sol. Coefficient of x° in $(x^{-3} + x^{-2} + \ldots + x^4)^3 - 1 = {}^{11}C_9 - 3 \times {}^3C_1 - 1 = 46 - 1 = 45$

55. B

Sol. Number of even divisor of 80 is 8

56. B

Sol. k = 2, a > 3

57. A

Sol. x + y = 47, number of matrix = $^{46}C_1 = 46$

58. D

Sol. $\alpha = -\sqrt{\frac{17}{2}}$, β = 0, $\gamma = \sqrt{\frac{17}{2}}$

59. A

Sol. Using graph clearly see

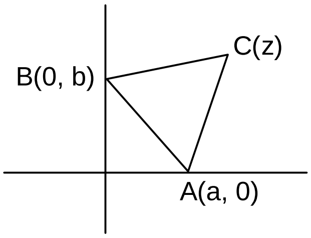
f(x) is continuous everywhere but not differentiable at exactly 3 points

60. A

Sol. m = 10 and n = 12

61. A

Sol. Let A(a, 0), B(0, b)



$\frac{z-a}{z-ib} = e^{i\theta} = \frac{3}{5} + i\frac{4}{5}$

5(z – a) = (z – ib)(3 + 4i)

5(x – a + iy) = (x + iy – bi)(3 + 4i)

Comparing, we get 5(x – a) = 3x – 4(y – b)

2x + 4y = 5a + 4b ….. (1)

5y = 4x + 3(y – b)

4x – 2y = 3b ….. (2)

$2x + 4y = 5a + \frac{4\left(4x-2y\right)}{3} \Rightarrow 2x - 4y + 3a = 0$

62. D

Sol. $\frac{1}{\ell_1}+\frac{1}{\ell_2}=\frac{1}{4a}$

63. A

Sol. $a^2=\frac{5}{2},\ b^2=\frac{5}{12}$

64. D

Sol. $P(x) = (x + 3)(x - 3)^3 + x^2 + 2$

65. B

Sol. Radius of circle = $\sqrt{34}$

66. C

Sol. Required probability = $\frac{91^{10}-82^{10}}{91^{10}}$

67. C

Sol. It is neither tautology nor contradiction

68. D

Sol. Data are multiplied by 7, then variance should be 49 times

69. A

Sol. $tx = y \Rightarrow dt=\frac{dy}{x}\ \therefore\ \frac{1}{x}\int_0^x f(y)dy = nf(x)\ \therefore\ \int_0^x f(y)dy = x\cdot n\cdot f(x)$

Differentiating $f(x) = n(f(x) + xf'(x)) \Rightarrow \frac{f'(x)}{f(x)}=\frac{1-n}{nx}$

Integrating, $\ln f(x)=\left(\frac{1-n}{n}\right)\ln(cx) \Rightarrow f(x)=(cx)^{\left(\frac{1-n}{n}\right)} \Rightarrow f(x)=c\cdot(x)^{\left(\frac{1-n}{n}\right)}$

70. D

Sol. $\lambda = 0 \Rightarrow x + y = \frac{\pi}{4} \Rightarrow$ Equation of mirror image is $x - y = \frac{\pi}{4}$

SECTION – B

71. 1

Sol. $A = -1,\ B = 1,\ f\left(-\frac{\pi}{4}\right)=-1$

72. 1

Sol. Use A.M. ≥ G.M.

SECTION – C

73. 00001.75

Sol. $\theta=\tan^{-1}\left(\frac{2}{\sqrt{3}}\right)=\sin^{-1}\left(\frac{2}{\sqrt{7}}\right) \Rightarrow \frac{a}{2b}=\frac{7}{4}=1.75$

74. 00000.44

Sol. $\frac{x-3}{1}=\frac{y-2}{2}=\frac{z-0}{1}=-2\left(\frac{3+4+1}{1+4+1}\right)=\frac{-8}{3}$; $x=\frac{1}{3}$; $y=\frac{-10}{3}$; $z=\frac{-8}{3}$; $\frac{\lambda}{3}-\frac{10}{3}+3\lambda\left(\frac{8}{3}\right)+7=0$

$25\lambda = -11$, $\lambda=\frac{-11}{25}$

75. 00001.65

Sol. $$\frac{14\times\frac{12!}{5!\times 2!}}{\frac{7!}{2!}\times {}^{8}P_{5}}=1.65$$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – III

JEE (Main)-2020

TEST DATE: 29-12-2019

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 75 questions.
- Each subject (PCM) has 25 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only three sections: **Section-A**, **Section-B and Section-C**.

  Section-A (01 – 20, 26 – 45, 51 – 70) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

  Section-B (21 – 22, 46 – 47, 71 – 72) *contains 6 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

  Section-C (23 – 25, 48 – 50, 73 – 75) *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A man standing on an inclined plane of inclination 'θ' with the horizontal, fires one bullet up the plane and another bullet down the plane. Both the bullets get stuck to the plane after hitting the inclined plane. The value of maximum possible distance between the two bullets after they hit the inclined plane is:

(A) $\frac{2u^2}{g}$

(B) $\frac{2u^2}{g\cos^2\theta}$

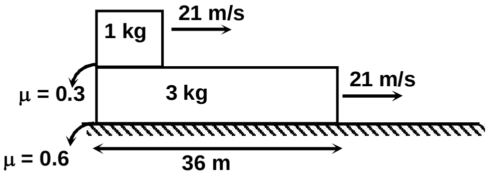
(C) $\frac{u^2}{g}$

(D) $\frac{u^2}{g\cos^2\theta}$

2. In Young's double slit experiment, if we increase the separation between the plane of slits and the screen by keeping everything constant, then

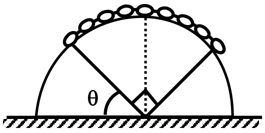
(A) Intensity of central maxima will increase but fringe width will decrease
(B) Intensity of central maxima will decrease but fringe width will increase.
(C) Both intensity of central maxima and fringe width will increase
(D) Both intensity of central maxima and fringe width will decrease.

3. On a plank of length 36 m and mass 3 kg, a small block of mass 1 kg is kept as shown. Friction coefficient between the block and the plank is 0.3 where as that between the plank and the ground is 0.6. At some instant an impulse is given to both of them such that they acquire a common initial velocity of 21 m/s as shown. After what time will the block get off the plank?



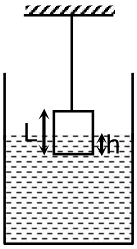
(A) $3\sqrt{2}$ sec
(B) 4 sec
(C) 5 sec
(D) $4\sqrt{2}$ sec

4. On a fixed hemispherical wedge a uniform chain is in equilibrium. Length of the chain is $\frac{\pi R}{2}$, where 'R' is the radius of the fixed wedge. Find the minimum value of 'θ' as shown in the figure. (take μ = 1/3)



(A) $\tan^{-1}(1)$
(B) $\tan^{-1}(1/2)$
(C) $\tan^{-1}(1/3)$
(D) $\tan^{-1}(1/4)$

5. A cube (edge length L) of specific gravity 'n' is suspended from a thin metal wire. The fundamental frequency for transverse standing waves in the wire is f_0. When the same cube is partially immersed in a liquid of specific gravity 2 upto a depth of 'h', the new fundamental frequency will be



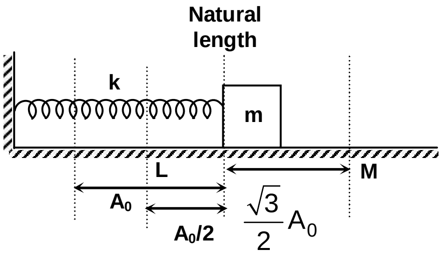
(A) $\left(\frac{nL-2h}{L}\right)^{1/2} f_0$

(B) $\left(\frac{nL-2h}{nL}\right)^{1/2} f_0$

(C) $\left(\frac{L}{nL-2h}\right)^{1/2} f_0$

(D) $\left(\frac{nL}{nL-2h}\right)^{1/2} f_0$

6. From a spring of spring constant 'k', a small block of mass 'm' is attached and the system is placed on a smooth horizontal surface as shown in the figure. The spring is compressed by distance A_0 from its natural length and then released. Find the time taken by the block to move from point 'L' to point 'M'.



(A) $\frac{\pi}{4}\sqrt{\frac{m}{k}}$

(B) $\frac{\pi}{3}\sqrt{\frac{m}{k}}$

(C) $\frac{\pi}{2}\sqrt{\frac{m}{k}}$

(D) $\frac{\pi}{6}\sqrt{\frac{m}{k}}$

7. Two thin rods of length L and 2L at certain temperature have coefficient of linear expansion 2α and α respectively. Both are joined end to end. Then, the effective coefficient of linear expansion of the composite rod is

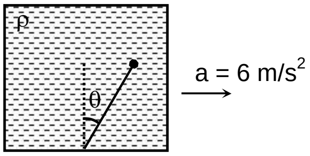
(A) 3α

(B) $4\,\alpha$

(C) $\frac{2}{3}\alpha$

(D) $\frac{4}{3}\alpha$

8. In an ideal liquid of density 'ρ', a small spherical ball of density $\frac{\rho}{5}$ is tied to a string which is connected to the bottom of a container as shown. If the container is having a horizontal acceleration of 6 m/s^2, then the angle made by the string with the vertical is: (Take g = 10 m/s^2)



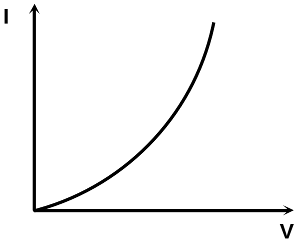
(A) $\tan^{-1}\left(\frac{3}{5}\right)$

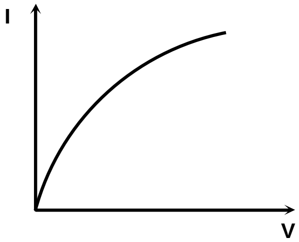
(B) $\tan^{-1}\left(\frac{4}{5}\right)$

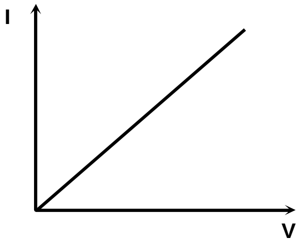
(C) $\frac{\pi}{4}$

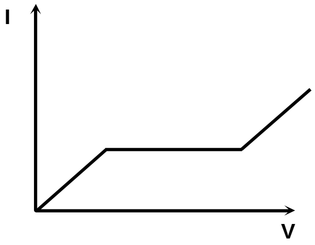
(D) $\tan^{-1}(5)$

9. Drift velocity of electrons in a cylindrical conductor is directly proportional to E^2 where E is the electric field applied along the axis of the cylinder. For this kind of material, which of the following graphs represents the correct relation between the current through the material (I) and voltage applied across the material (V)?

(A)


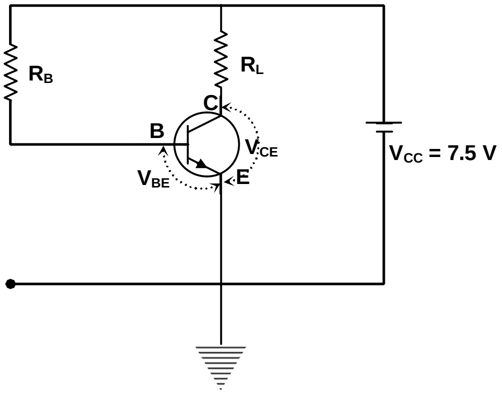
(B)


(C)


(D)


10. An n-p-n transistor in a common emitter mode is used as a simple voltage amplifier. The terminal of a 7.5 V battery is connected to the collector through a load resistance R_L and to the base through a resistance $R_B = 130\ k\Omega$ as shown. If the base-emitter voltage $V_{BE} = 1V$, the collector-emitter voltage $V_{CE} = 3.5$ V and $\beta = 100$. Then the value of load resistance R_L is

(A) 500 Ω
(B) 600 Ω
(C) 700 Ω
(D) 800 Ω



11. A satellite is following an elliptical orbit around earth. Its engines are capable of providing a one time impulse of a fixed magnitude. In order to maximize energy of satellite the impulse should be given
(A) Along satellite's velocity when satellite is at perigee
(B) Along satellite's velocity when satellite is at apogee
(C) Away from earth, when satellite is at perigee
(D) Away from earth, when satellite is at apogee

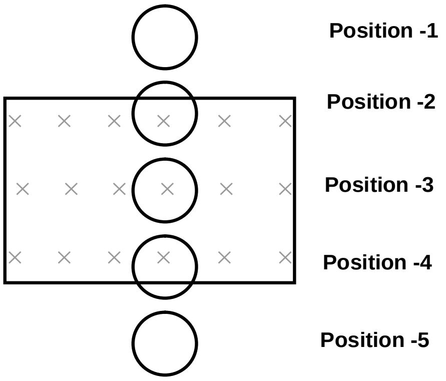
12. An unpolarized light of intensity 25 W/m^2 is passed normally through two polaroids placed parallel to each other with their transmission axes making an angle 37° with each other. Then the intensity of the emerging light is
(A) 2 W/m^2
(B) 4 W/m^2
(C) 8 W/m^2
(D) 16 W/m^2

13. Electric potential at the centre of a cube having uniform volumetric charge density 'ρ' and side 'a' is given by V_0. Then, electric potential at the tip of a square pyramid having same volumetric charge density (ρ), of base area 4a^2 and height 'a' is:
(A) $\frac{V_0}{4}$
(B) $\frac{V_0}{6}$
(C) $\frac{2V_0}{3}$
(D) can't be determined

14. Consider two objects with equal heat capacities and initial temperatures T_1 and T_2. A Carnot engine is run using these two objects as its hot and cold reservoir until they are at equal temperatures. Assume that the temperature change of both hot and cold reservoirs are very small compared to temperature change of Carnot engine during any one cycle. Which option is most appropriate value of final temperature?
(A) $\frac{T_1 + T_2}{2}$
(B) $\sqrt{T_1 T_2}$
(C) $\frac{(T_1 - T_2)}{2}$
(D) $\sqrt{\frac{T_1^3}{T_2}}$

15. A fully discharged battery (emf = 12 V, capacity 60 Ah) is connected with a charging device that can supply the battery a steady current i = 3A. Battery is connected to charging device for 90 minutes. Final charging level of battery (in percentage) is:
(A) 7.5%
(B) 10%
(C) 75%
(D) 15%

16. In the figure shown, there is a constant magnetic field in a rectangular region of space. The field is directed perpendicular into page. A conducting ring moves through region from position 1 to position 5. Induced current is zero when the ring passes through position.
(A) 1 and 5 only
(B) 2 only
(C) 1, 3 and 5 only
(D) 2 and 3 only



17. Number of photons emitted by 10 W sodium vapour lamp in 10 second is : (Assume that 60% of energy is converted into light. Wavelength of sodium light = 390 nm)
(A) 1.18×10^{20}
(B) 1.77×10^{18}
(C) 3.4×10^{19}
(D) 3.4×10^{18}

18. A neutron collides elastically with initially stationary deuteron. The fraction of kinetic energy lost by neutron is (assume head on collision)
(A) $\frac{8}{9}$
(B) 1
(C) $\frac{2}{3}$
(D) $\frac{1}{2}$

19. An object of mass m is projected with a momentum p at an angle with the horizontal such that its maximum height (H) is half of its Range (R). Minimum kinetic energy of the particle in its path will be
(A) $\frac{p^2}{8m}$
(B) $\frac{3p^2}{4m}$
(C) $\frac{p^2}{10m}$
(D) $\frac{p^2}{5m}$

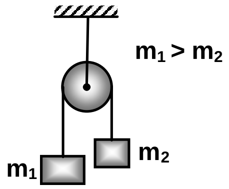
20. A particle of mass 2 kg is executing simple harmonic motion with amplitude A_0. At t = 0, a small resistive force also starts acting on the particle which is given by $\vec{F} = \frac{-\vec{v}k\ell n2}{10}$. The value of amplitude of the particle after 20 second will be: (where k = 1 kg/sec)
(A) $A_0/2$
(B) $A_0/4$
(C) A_0
(D) $A_0/\sqrt{2}$

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

21. The coercive force for certain permanent magnet is 2 × 10^4 A/m. This magnet is placed inside a long solenoid of 40 turns/cm and a current is passed in the solenoid to demagnetize the magnet. The value of current (in A) is

22. Pulley of atwood machine has mass m_1 and is free to rotate about its geometrical center without friction. Centre of mass of the pulley is at a distance R/2 from geometrical centre, where R is the radius of the pulley. There is no slipping between the string and pulley. The ratio of maximum acceleration to minimum acceleration of block of mass m_1 is
(Take m_1R^2 as moment of inertia of pulley about axis of rotation, $\frac{m_1}{m_2} = 3$)

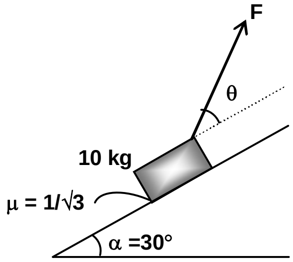


SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

23. In a YDSE experiment, one of the slits is covered with a glass plate of thickness (2.4 × 10^{-4}) meter refractive index of which varies with time as $\mu_S = t^2 + 12t + 8$. The separation between the slits is 2 × 10^{-3} meter and the distance between the plane of slits and the screen is 2 meters. Find the velocity (in m/s) of the central maxima at t = 4 sec. (Take refractive index of air = 1)

24. A block of mass 10 kg is kept on an inclined plane of inclination 30° and friction coefficient between the block and inclined plane is $\mu = \frac{1}{\sqrt{3}}$. Find the minimum value of force (in newton) required to move the block up the inclined plane.
(Take $\sqrt{3} = 1.732$, g = 10 m/s^2)



25. In a resonance tube experiment, 3rd resonance occurs at 111 cm and 5th resonance occurs at 200 cm. Find the end correction (in cm).

Chemistry

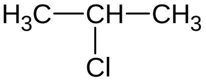
PART – II

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

26. Among the following, which one give iodoform test?

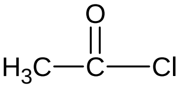
(A)



$H_3C-\underset{Cl}{\underset{|}{CH}}-CH_3$

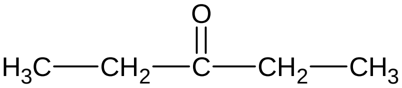
(B) $H_3C-CH_2-CH_2-OH$

(C)



$H_3C-\overset{O}{\overset{||}{C}}-Cl$

(D)



$H_3C-CH_2-\overset{O}{\overset{||}{C}}-CH_2-CH_3$

27. Which one of the following solution behave as buffer solution?

(A) Aqueous solution of $CH_3-\overset{O}{\overset{||}{C}}-OH$ and $CH_3-\overset{O}{\overset{||}{C}}-ONa$.

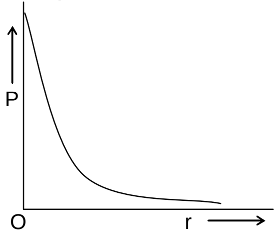
(B) Aqueous solution of $CH_3-\overset{O}{\overset{||}{C}}-OH$ and HCl.

(C) Aqueous solution of NH_4OH and NaOH.

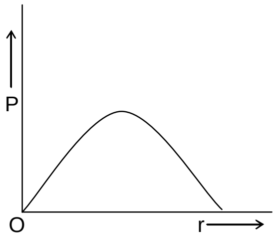
(D) Aqueous NaCl solution.

28. P is the probability of finding the 2s electron of hydrogen atom in a spherical shell of infinitesimal thickness, dr at a distance r from nucleus, the volume of this shell is $4\pi r^2 dr$. The qualitative sketch of the dependence of P on r is

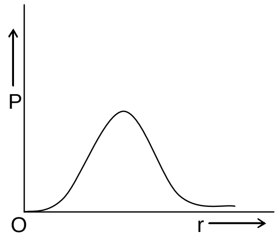
(A)



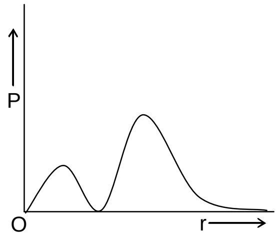
(B)



(C)



(D)



29. Among the following, intensive property is
(A) E_{cell}
(B) Mass
(C) Internal energy
(D) Heat capacity

30. A diatomic ideal gas undergoes a process in which the ratio of P to V^2 at any instant is constant and equals to 1. What is molar heat capacity of gas [excluding vibrational degree of freedom]
(A) 2R
(B) $\frac{5R}{2}$
(C) $\frac{17R}{6}$
(D) $\frac{4R}{3}$

31. Which one of the following is orthosilicate?
(A) Forsterite
(B) Hemimorphite
(C) Barysilite
(D) Thortveitite

32. Number of coordination isomers possible for the given complex $\left[\overset{III}{Co}(en)_3\right]\left[\overset{III}{Cr}(CN)_6\right]$ is (including itself)
(A) 6
(B) 4
(C) 2
(D) Not possible.

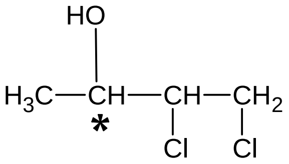
33. Number of stereo isomers possible for the given complex [Ma_2b_2cd] [Where a, b, c, and d are monodentate ligand] is
(A) 8
(B) 6
(C) 5
(D) 7

34. Among the following, the incorrect statement is
(A) P_4O_{10} is an oxidizing agent
(B) P_4O_{10} is simple anhydride
(C) P_4O_{10} at high temperature react with sodium chloride to form phosphoryl chloride
(D) P_4O_{10} is a dehydrating agent.

35. The number of minimum hydrogen atom in sample to get maximum number of different spectral lines for the transition n = 4 to n = 1 is
(A) 4
(B) 6
(C) 10
(D) 1

36. Among the following, sulphate ore is
(A) Zinc blend
(B) Barytes
(C) Pitch blend
(D) Dolomite

37. Number of optical isomers possible for the given organic molecule

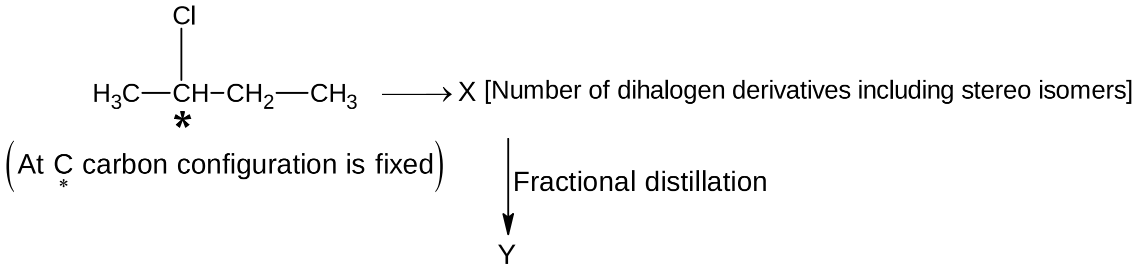


$$H_3C—\underset{*}{\overset{\overset{HO}{|}}{C}H}—\underset{\underset{Cl}{|}}{C}H—\underset{\underset{Cl}{|}}{C}H_2$$

is

[at '$\underset{*}{C}$' carbon configuration is fixed]
(A) 4
(B) 3
(C) 2
(D) 6

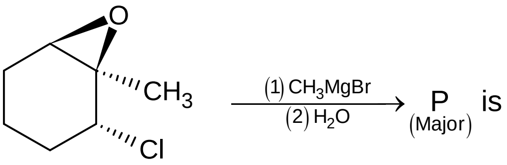
38.


Cl
$H_3C—\underset{*}{C}H—CH_2—CH_3$
X [Number of dihalogen derivatives including stereo isomers]
Fractional distillation
Y

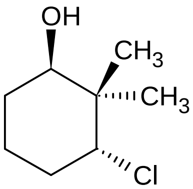
$\left(\text{At } \underset{*}{C} \text{ carbon configuration is fixed}\right)$

Then the value of (X + Y) is
(A) 10
(B) 9
(C) 4
(D) 8

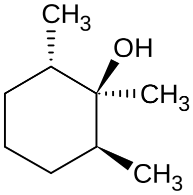
39.


O
CH3
Cl
(1) CH3MgBr
(2) H2O
P
(Major)
is

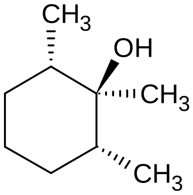
(A)



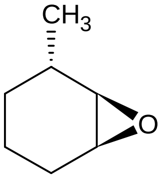
(B)



(C)

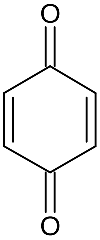


(D)

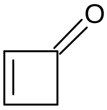


40. Among the following, in which tautomerism is possible?

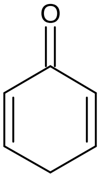
(A)



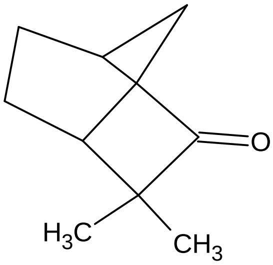
(B)



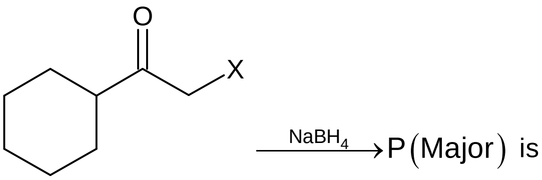
(C)



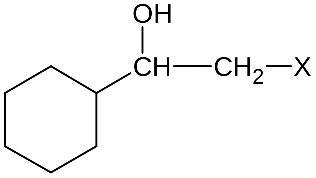
(D)



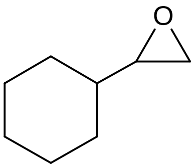
41.


O
X
NaBH4
P(Major) is

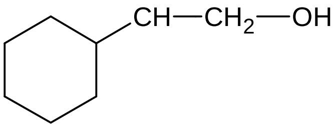
(A)



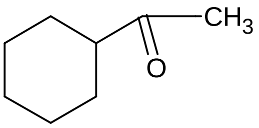
(B)



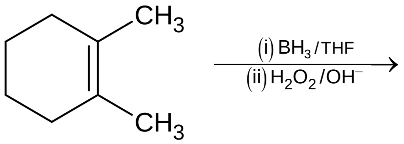
(C)



(D)



42.


CH3
CH3
(i) BH3/THF
(ii) H2O2/OH−

Among the following correct statement is:

(A) Number of product in given reaction is one.

(B) Reaction is regioselective.

(C) Number of products in given reaction is four.

(D) Number of products in given reaction is two.

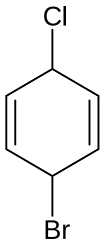
43. The equation of state for a given gas is P(V – nb) = nRT, where b & R are constant, if the pressure and temperature are such that $V_m = 11b$, then what is the compressibility factor of gas in this condition:

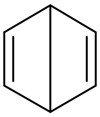
(A) $\frac{10}{9}$

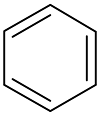
(B) $\frac{9}{11}$

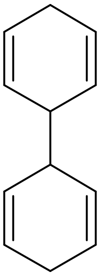
(C) $\frac{11}{10}$

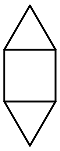
(D) $\frac{10}{11}$

44.  $+\text{Na}\xrightarrow{\text{dry ether}}\text{P}(\text{Major})$ is

(A) 

(B) 

(C) 

(D) 

45. The rate of reaction may be expressed as
$\frac{1}{4}\frac{d(C)}{dt}=\frac{-1}{3}\frac{d(D)}{dt}=\frac{1}{4}\frac{d(A)}{dt}=\frac{-d(B)}{dt}$, the reaction is

(A) $4A+B\longrightarrow 2C+3D$

(B) $B+3D\longrightarrow 4A+4C$

(C) $4A+2C\longrightarrow B+3D$

(D) $2C+3D\longrightarrow 4A+2B$

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

---

46. Bond order of Be_2^+ is x, then what is the value of 2x:

47. Number of dibasic acid in the following oxoacid is
H_3BO_3, H_2SO_4, H_2SO_5, H_3PO_3, H_3PO_4, $H_2S_2O_7$.

SECTION – C

(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

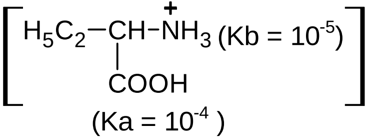
48. Pressure over an ideal binary liquid solution containing 10 moles of each of liquid A and B is gradually decreased isothermally. At what pressure (in torr), half of the total amount of liquid will get converted into vapour? $\left(P_A^o = 400 \text{ torr}, P_B^o = 100 \text{ torr}\right)$

49. For the given redox reaction

$$K_2Cr_2O_7 + 14HCl \longrightarrow 2KCl + 2CrCl_3 + 3Cl_2 + 7H_2O$$

What is the equivalent mass of HCl? [Given : M_{HCl} = 36.6 g/mol]

50. In an amino acid the carboxylic acid group has $K_a=10^{-4}$ and amino group has $K_b= 10^{-5}$. pH at isoelectric point of that amino acid is



$$\left[\underset{\substack{|\\ \text{COOH}}}{H_5C_2-CH}-\overset{+}{N}H_3\ (Kb = 10^{-5})\right]$$

$(Ka = 10^{-4})$

Mathematics

PART – III

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

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51. If $y = f(x)$ is monotonic function in $(–3, 9)$, then the area bounded by the ordinates $x = –3$, $x = 9$, $y = f(x)$ and $y = f(c)$ where $c \in (–3, 9)$ is minimum when c is equal to
(A) 0
(B) 3
(C) 6
(D) none of these

52. The digit at hundredths place in coefficient of x^{22} in the expansion of $(1 – x^7 + x^8)^{25}$ is equal to
(A) 0
(B) 9
(C) 6
(D) 2

53. If $a^{2x} – 14a^x + 53 + | |b + 3| – 4| = |4 \cos \theta|$ where x, a, b and $\theta \in R$, then the sum of the possible values of b is equal to
(A) –6
(B) 6
(C) 4
(D) –4

54. If $\vec{r} = \hat{i} + \hat{j} + \hat{k}$ and $\vec{r}_1 = \left(a\hat{i} + b\hat{j} + c\hat{k}\right)$ where a, b, c $\in$ {–3, –2, –1, 0, 1, 2, 3, 4}, then number of possible non-zero vector $\vec{r}_1$ perpendicular to $\vec{r}$ is
(A) 45
(B) 55
(C) 46
(D) none of these

55. Let $f(x) = x + x^3 + x^7 + x^{12} + x^{19} + \ldots..$ the coefficient of x^{15} in f(f(x)) is p, then number of even divisor of p is equal to
(A) 10
(B) 8
(C) 18
(D) 80

56. If A is a square matrix of order 2, and $(\text{tr}(A))^2 – \text{tr}(A^2) = k \det(A)$, where k lies between roots of equation $x^2 – ax + (a – 1) = 0$, then least integral value of a is
(A) 3
(B) 4
(C) 5
(D) 2

57. Let matrix A = $\begin{bmatrix} x & y & 2 \\ 1 & 2 & 3 \\ 1 & 1 & 2 \end{bmatrix}$ where x, y $\in$ N. If |adj(adj(adj(adj A)))| = $3^{32} \cdot 5^{16}$, then number of such matrix A is equal to
(A) 46
(B) 47
(C) 48
(D) none of these

58. Let f(x) = $(x^2 - 5x + 4)(x^2 + 5x + 4)$ and α, β, γ (where $\alpha < \beta < \gamma$) are roots of $f'(x) = 0$, then the value of $\frac{[\alpha]^2 + [\beta + 1]}{[\gamma]}$ is equal to (where [.] denote greatest integer function)
(A) 0
(B) $\frac{5}{3}$
(C) $\frac{5}{2}$
(D) 5

59. Let f(x) = max{cos x, x, x^2} in $-3 \le x \le 3$, then
(A) f(x) is continuous everywhere but not differentiable at exactly 3 points
(B) f(x) is continuous everywhere but not differentiable at exactly 2 points
(C) f(x) is not differentiable at four points
(D) none of these

60. If a, b, c $\in R^+$ such that a + b + c = 27 and maximum value of $a^2 b^3 c^4 = 2^m \times 3^n$, then sum of six Am's between m and n is
(A) 66
(B) 132
(C) 120
(D) 176

61. In a ΔABC vertex A and B lies on x-axis and y-axis respectively, where A(a, 0) is a fixed point, B is a variable point such that $\angle C = \tan^{-1}\frac{4}{3}$ and AC = BC, then locus of C
(A) 2x – 4y + 3a = 0
(B) 4x + 2y – 3a = 0
(C) 2x + 4y + 7a = 0
(D) 4x – 2y + 5a = 0

62. If ℓ_1 and ℓ_2 are lengths of two perpendicular focal chord of parabola $y^2 = 16(x + 1)$, then harmonic mean of ℓ_1 and ℓ_2 is
(A) 4
(B) 8
(C) 16
(D) 32

63. Eccentricity of curve represented by $8x^2 + 4\sqrt{6}xy + 6y^2 = 5$
(A) $\sqrt{\frac{5}{6}}$

(B) $\sqrt{\frac{7}{6}}$
(C) $\frac{1}{\sqrt{6}}$
(D) none of these

64. Let P(x) is polynomial of degree four with leading coefficient one and satisfying the condition P(3) = 11; P(–3) = 11, P′(3) = 6, P″(3) = 2, then value of P(5) is equal to
(A) 75
(B) 87
(C) 27
(D) 91

65. Locus of image of point (–2, 3) about the line (x + y + 7) + k(x + 2y + 9) = 0 (k is non-zero real numbers is
(A) straight line
(B) circle with radius = $\sqrt{34}$
(C) ellipse whose $e = \frac{2}{3}$
(D) hyperbola whose $e = \sqrt{2}$

66. A dice is constructed such that probability of occurrence of a number is proportional to the square of number, then probability that three occur at least once when dice throw 10 times is equal to
(A) ${}^{10}C_1 \times \left(\frac{82}{91}\right)^9 \left(\frac{9}{91}\right)$
(B) $\left(\frac{82}{91}\right)^{10}$
(C) $\frac{91^{10} - 82^{10}}{91^{10}}$
(D) none of these

67. Let p and q be two statements, then (~p $\vee$ q) $\wedge$ (~p $\wedge$ ~q) is a
(A) tautology
(B) contradiction
(C) neither tautology nor contradiction
(D) none of these

68. The variance of α, β, γ and δ is 9, then variance of 7α, 7β, 7γ and 7δ is
(A) 63
(B) $\frac{9}{7}$
(C) $\frac{7}{9}$
(D) 441

69. A function f(x) satisfying $\int_0^1 f(tx)\,dt = nf(x)$, where x > 0, is
(A) $f(x) = c \cdot x^{\left(\frac{1-n}{n}\right)}$

(B) $f(x) = c \cdot x^{\left(\frac{n}{n-1}\right)}$

(C) $f(x) = c \cdot x^{\left(\frac{1}{n}\right)}$

(D) $f(x) = c \cdot x^{(1-n)}$

70. Equation of image of the line $x + y = \sin^{-1}(\lambda^6 + 1) + 5\cos^{-1}(\lambda^4 + 1) - \tan^{-1}(\lambda^2 + 1)$, where $\lambda \in R$ about x-axis is given by

(A) $x - y = 0$

(B) $x - y = \frac{\pi}{2}$

(C) $x - y = \pi$

(D) $x - y = \frac{\pi}{4}$

SECTION – B

(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

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71. If $\int \frac{\operatorname{cosec}^2 x - 2020}{\cos^{2020} x} dx = \frac{Af(x)^B}{(g(x))^{2020}}$ + c ; where $f\left(\frac{\pi}{6}\right) = \sqrt{3}$, then value of $A^2 + B^2 + f\left(-\frac{\pi}{4}\right)$ is equal to

72. The minimum value of $\frac{r_1 r_2 r_3}{(3r)^3}$ in a triangle is (where r is in radius and r_1, r_2, r_3 are exradii)

SECTION – C

(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

73. Angle of intersection between the curve $\frac{x^2}{36} + \frac{y^2}{4} = 1$ and $x^2 + y^2 = 12$ is $\theta = \sin^{-1}\left(\frac{b}{\sqrt{a}}\right)$, then the value of $\frac{a}{2b}$ is equal to

74. Image of point (3, 2, 0) about the plane $x + 2y + z + 1 = 0$ lies on plane $\lambda x + y - 3\lambda z + 7 = 0$, then $|\lambda|$ is

75. Number of words that can be formed using letters of word CAULIFLOWERS in which vowels are in alphabetic order is m and the words in which no two vowels are together is n, then $\frac{14m}{n}$ is equal to

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – IV

JEE (Advanced)-2020

PAPER – 1

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section–A (01 – 04, 19 – 22, 37 – 40)*** *contains 12 multiple choice questions which out of 4 options have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (05 – 12, 23 – 30, 41 – 48) *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–1** In all other cases.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

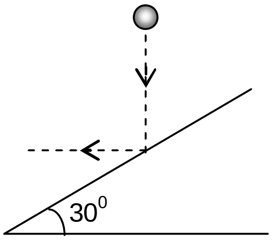
PART – I

SECTION – A

(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

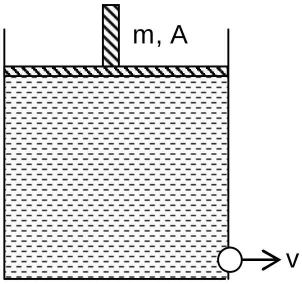
1. A ball is released form a point, it goes vertically downwards and collides with a fixed smooth inclined plane of angle of inclination of 30^0. After the collision the ball goes horizontally. The coefficient of restitution between the ball and the inclined plane is



(A) $\frac{1}{2}$ (B) $\frac{1}{3}$

(C) 1 (D) None of these

2. A cylindrical vessel contains a liquid of density ρ up to height h. The liquid is closed by a piston of mass m and area of cross section A. There is a small hole at the bottom of the vessel. The speed v with which the liquid comes out of the hole is



(A) $\sqrt{2gh}$

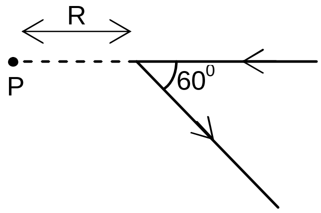
(B) $\sqrt{2\left(gh+\frac{mg}{\rho A}\right)}$

(C) $\sqrt{2\left(gh+\frac{mg}{A}\right)}$

(D) $\sqrt{2gh+\frac{mg}{A}}$

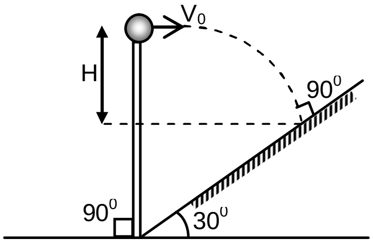
Space for Rough work

3. A long straight wire, carrying a current I is bent at its mid point to form an angle of 60^o. AT a point P, distance R from the point of bending the magnetic field is



(A) $\frac{(\sqrt{2}-1)\mu_0 i}{4\pi R}$
(B) $\frac{(\sqrt{2}+1)\mu_0 i}{4\pi R}$
(C) $\frac{\mu_0 i}{4\sqrt{3}\pi R}$
(D) $\frac{\mu_0 i}{8R}$

4. In the given figure, the angle of inclination of the inclined plane is 30^0. The horizontal velocity V_0 so that the particle hits the inclined plane perpendicularly is



(A) $v_0 = \sqrt{\frac{2gH}{3}}$
(B) $V_0 = \sqrt{\frac{2gH}{7}}$
(C) $V_0 = \sqrt{\frac{gH}{5}}$
(D) $V_0 = \sqrt{\frac{gH}{7}}$

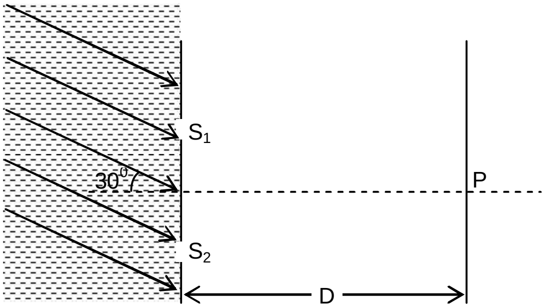
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

5. In the series L – C – R circuit, the voltage across resistance, capacitance and inductance are 30V each at frequency $f = f_0$.
(A) It the inductor is short-circuited, the voltage across the capacitor will be $30\sqrt{2}$ V.
(B) If the capacitor is short-circuited, the voltage drop across the inductor will be $\frac{30}{\sqrt{2}}$ V.
(C) If the frequency is changed to $2f_0$, the ratio of reactance of the inductor to that of the capacitor is 4 : 1.
(D) If the frequency is changed to $2f_0$, the ratio of the reactance of the inductor to that of the capacitor is 1 : 4.

Space for Rough work

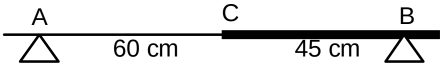
6. The given figure shows a YDSE apparatus. Parallel monochromatic coherent light rays are incident on slits S_1andS_2 ($S_1S_2 = \frac{2}{3}$mm) at an angle 30^o with the horizontal. The medium on left side of the slits is water $(\mu_w = 4/3)$. To obtain the central maxima at point P, a glass slab $(\mu_g = 3/2)$ inside water is introduced in front of slit S_1. The thickness of the glass slab required for this purpose is



(A) 2mm (B) 4/3 mm
(C) 4 mm (D) 8/3 mm

7. When photons of energy 4.25 eV strike the surface of a metal A, the ejected photoelectrons have maximum kinetic energy T_A eV and de-Broglie wavelength λ_A. The maximum kinetic energy of photoelectrons liberated from another metal B by photons of energy 4.70 eV is $T_B=(T_A - 1.50)$ eV. If the de-Broglie wavelength of these photoelectrons is $\lambda_B = 2\lambda_A$ then
(A) the work function of A is 2.25 eV (B) the work function of B is 4.20 eV
(C) T_A = 2.00 eV (D) T_B = 2.75 eV

8. A steel wire of length 60 cm and area of cross section $10^{-6}m^2$ is joined with an aluminium wire of length 45 cm and area of cross section $3 \times 10^{-6}m^2$. The composite string is stretched by a tension of 80 N. Density of steel is 7800 kg m^{-3} and that of aluminium is 2600 kg m^{-3}. The minimum frequency of turning fork, which can produce standing wave in it with node at joint is



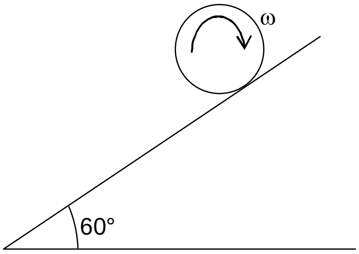
(A) 357.3 Hz (B) 375.3 Hz
(C) 337.5 Hz (D) 325.3 Hz

Space for Rough work

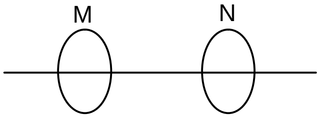
9. A point mass of 1 kg collides elastically with a stationary point mass of 5 kg. After their collision, the 1 kg mass reverses its direction and moves with a speed of 2 ms^{-1}. Which of the following statement(s) is (are) correct for the system of these two masses?
(A) Total momentum of the system is 3 kg ms^{-1}
(B) Momentum of 5 kg mass after collision is 4 kg ms^{-1}
(C) Kinetic energy of the centre of mass is 0.75 J
(D) Total kinetic energy of the system is 4 J

10. A strip of wood of mass M and length ℓ is placed on a smooth horizontal surface. An insect of mass m starts at one end on the strip and walks to the other end in time t, moving with a constant speed.
(A) the speed of the insect as seen from the ground is $< \frac{\ell}{t}$.
(B) the speed of the strip as seen from the ground is $\frac{\ell}{t}\left(\frac{M}{M+m}\right)$
(C) the speed of the strip as seen from the ground is $\frac{\ell}{t}\left(\frac{m}{M+m}\right)$
(D) the total kinetic energy of the system is $\frac{1}{2}(m+M)\left(\frac{\ell}{t}\right)^2$

11. A cylinder is rotated clockwise and lowered slowly on a rough inclined plane with (μ = 0.8). Then:
(A) cylinder will start going upwards
(B) cylinder will start going downwards.
(C) frictional force will act upwards.
(D) frictional force will act downwards.



Space for Rough work

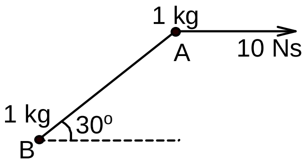


12. Two identical circular coils M and N are arranged coaxially as shown in the figure. Separation between the coils is large as compared to their radii. The arrangement is viewed from left along the common axis. The sign convention adopted is that currents are taken to be positive when they appear to flow in clockwise direction. Then
    (A) if M carries a constant positive current and is moved towards N, a positive current is induced in N
    (B) if M carries a constant positive current and N is moved towards M, a negative current is induced in N
    (C) if a positive current in M is switched off, a positive current is momentarily induced in N
    (D) if both coils carry positive currents, they will attract each other

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded ‑ off to the **second decimal place**; e.g. XXXXX.XX).

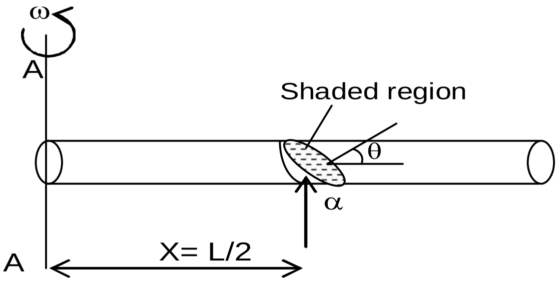
13. A rocket of mass 40kg has 360 kg of fuel. The exhaust velocity of the fuel is 2.0 km/sec. Calculate minimum rate of consumption of fuel in kg/s so that the rocket may rise from the ground (g = 10 m/sec2).



14. Two balls A and B of masses 1 kg each are connected by an inextensible massless string. The system is resting on a smooth horizontal surface. An impulse of 10 Ns is applied to the ball A at an angle 30^o with the line joining two balls in horizontal direction as shown in the figure. Assuming that the string remains taut after the impulse, if the magnitude of kinetic energy of ball A is $\frac{175}{k}$. Find the value of K.

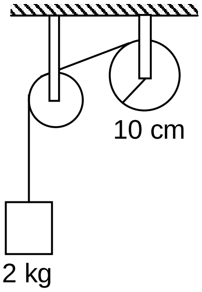
Space for Rough work

15. A thin uniform metallic rod of mass m, length L, Young modulus of elasticity Y and cross–sectional area A is rotated by angular velocity ω about extreme end AA'. Consider a section on the rod at midpoint of rod. What will be the normal stress in N/m^2 on the shaded region? (Take the value of $\frac{M\omega^2L^2\cos^2\theta}{A} = 10\,N/m^2$)

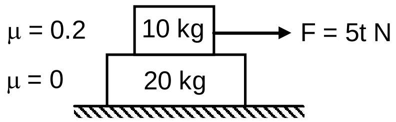


16. The thickness of a glass plate is measured to be 2.17 mm, 2.17 mm and 2.18 mm at three different places. Find the average thickness of the plate from this data. (in mm).

17. A string is wrapped on a wheel of moment of inertia 0.20 kg m^2 and radius 10 cm and goes through a light pulley to support a block of mass 2.0 kg as shown in figure. Find the acceleration of the block. (in m/s^2)



18. Find the speed of 10 kg block at the end of 3 second.



Space for Rough work

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

19. In a photoelectric experiment with a particular incident radiation, the emission of the number of photoelectrons depends on
(A) the frequency of incident radiation (B) the intensity of incident radiation
(C) the wavelength of incident radiation (D) the wave number of incident radiation

20. The most thermally unstable complex is
(A) $[Cr(NH_3)_6]\ [Co(CN)_6]$ (B) $[Cr(NH_3)_2(CN)_4][Co(NH_3)_4(CN)_2]$
(C) $[Cr(NH_3)_3(CN)_3]\ [Co(NH_3)_3(CN)_3]$ (D) $[Cr(NH_3)(CN)_5][Co(NH_3)_5(CN)]$

21. If Λ_m = molar conductivity of the solution of an electrolyte.
Λ_m^0 = limiting molar conductivity of the solution
α = degree of dissociation of the electrolyte,
Then the relation among the three terms is
(A) $\frac{\Lambda_m^0}{\Lambda_m} = \alpha$ (B) $\frac{\Lambda_m}{\Lambda_m^0} = \alpha$
(C) $\Lambda_m^0 \times \Lambda_m = \alpha$ (D) $\Lambda_m^0 - \Lambda_m = \alpha$

22. P_4O_{10} can react with
(A) HCl (B) HNO_3
(C) HBr (D) HI

Space for Rough work

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

23. The correct statement(s) regarding CH_4 is
(A) it is a tetrahedral molecule
(B) it undergoes substitution reaction
(C) it can be formed by the reaction between CH_3MgBr and phenol
(D) it diffuses at a faster rate than dioxygen

24. Which of the following compound(s) is/are more basic than CH_3NH_2 in gaseous state?

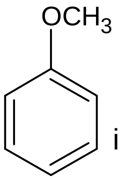
(A) CH_3NHCH_3	(B) $(CH_3)_3N$
(C) CH_3CN	(D) CH_3NO_2

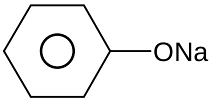
25. $A(s) + 2B(g) \rightleftharpoons C(g)$
Correct statement(s) are
(A) the reaction will proceed towards forward direction by increasing pressure.
(B) if the concentrations of B and C are halved at equilibrium, then the reaction will proceed towards backward direction
(C) addition of A makes the reaction proceed towards forward direction
(D) if the volume of reaction containers are halved, the reaction will proceed towards forward direction.

26. Which of the following substances on heating produces PH_3?

(A) PH_4Cl	(B) H_3PO_3
(C) H_3PO_4	(D) Ca_3P_2

Space for Rough work

27. The correct statement(s) regarding anisole  is/are

(A) it can be formed by treating phenol with hot CH_2N_2.
(B) it can undergo halogenation reaction(both electrophilic and free radical mechanism).
(C) it is oxidized to benzoic acid.
(D) it can be produced by treating  with CH_3Br.

28. $CN^- + H_2O \rightleftharpoons HCN + OH^-$
Addition of which of the following reagent can make the reaction proceed towards forward direction.
(A) H_2O (B) HCl
(C) NaBr (D) KOH

29. Which wave functions(ψ) do/does not represent any atomic orbital?
(A) $\psi_{2,1,2}$ (B) $\psi_{3,0,0}$
(C) $\psi_{4,2,-1}$ (D) $\psi_{3,3,1}$

30. Which of the following factor(s) increase(s) the rate of a zero order reaction?
(A) increasing temperature
(B) increasing reactant concentration
(C) decreasing half-life period
(D) increasing pressure for gaseous reactants

Space for Rough work

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded ‑ off to the **second decimal place**; e.g. XXXXX.XX).

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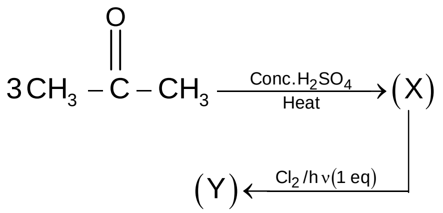
31. $2A(s) \rightleftharpoons B(g) + 2C(g)$
Above reaction attains equilibrium at 240°C and 19.5 atm pressure when initially only A(s) is taken for reaction. What is the equilibrium constant K_P of the reaction?

32. 'X' is an aliphatic monocarboxylic acid. It is the simplest acid which can form only one alpha(α)-chloroproduct(Y), upon treatment with Cl_2 in presence of red phosphorus (H.V.Z reaction). What is the molar mass of Y in g mol^{-1} unit?

33. AB is a polar molecule It's bond length is $5\overset{o}{A}$. If the maximum dipole moment of the molecule is $b \times 10^{-29}$ coulomb m, what is the value of 'b'? [charge of e^- = 1.602×10^{-19} C]

34. One litre aqueous solution contains 0.1 mole of a weak monobasic acid HA and 1 mole of its sodium salt NaA. If the pH of the solution is 6.49 what is the pK_a of HA?

35.



$$3CH_3-\overset{\overset{\displaystyle O}{||}}{C}-CH_3 \xrightarrow[\text{Heat}]{\text{Conc.}H_2SO_4} (X) \xrightarrow{Cl_2/h\nu(1\text{ eq})} (Y)$$

What is the molar mass of compound (Y) in g mol^{-1} unit?

36. Salt(A) produces golden yellow flame on flame test. Aqueous solution of (A) produces a white precipitate with barium chloride solution. The precipitate is insoluble in dilute mineral acids. On thermal decomposition in presence of SiO_2, (A) forms a salt (B) and gas(C). When treated with an acid(D), salt(B) forms NaCl, SiO_2 and H_2O. What is the molar mass of (D)?

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. The number of values of k for which the equation $x^3 - 3x + k = 0$ has two distinct roots lying in the interval (0, 1) is
(A) three (B) two
(C) infinitely many (D) zero

38. If $f: A \to B$, where $A = \{a, b, c, d\}$ and $B = \{x, y, z\}$ and $f(a) = x$ then number of such INTO functions is
(A) 27 (B) 15
(C) 21 (D) none of these

39. If α is a root of $x^2 + ax + 1 = 0$, then $\lim\limits_{x \to 1/\alpha} \dfrac{\sin(x^2 + ax + 1)}{(\alpha x - 1)}$ is equal to
(A) $2a\alpha$ (B) $a\alpha^2$
(C) $\dfrac{1-\alpha^2}{\alpha^2}$ (D) does not exist

40. If $f(x) = x^4 \tan(x^3) - x \ln(1 + x^2)$, then the value of $\dfrac{d^4(f(x))}{dx^4}$ at x = 0 is
(A) 0 (B) 6
(C) 12 (D) 24

Space for Rough work

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

41. Which of the following is /are true ?

(A) $\int_0^1 \sin\left(x^2 + 2x + 1\right)dx - \int_1^2 \sin x^2 dx = 0$

(B) $\int_{-1}^1 e^{\sin x}dx - \int_0^1 e^{\sin(2x+1)}dx = 0$

(C) $\int_{-5}^{-4} \sin\left(x^2 - 3\right)dx + \int_{-2}^{-1} \sin\left(x^2 + 12x + 33\right)dx = 0$

(D) $\int_{-4}^{4} \cos x^2 \, dx - 8\int_0^1 \cos 16(2x-1)^2 dx = 0$

42. If A and B are two events such that $P(A) = 3/4$ and $P(B) = 5/8$, then

(A) $P(A \cup B) \ge 3/4$ (B) $P(A' \cap B) \le 1/4$

(C) $3/8 \le P(A \cap B) \le 5/8$ (D) $3/8 \le P(A \cap B) \le 5/8$

43. Consider a sequence $\{a_n\}$ with $a_1 = 2$ and $a_n = \frac{a_{n-1}^2}{a_{n-2}}$ for all $n \ge 3$, terms of the sequence being distinct. Given that a_2 and a_5 are positive integers and $a_5 \le 162$ then the possible value(s) of a_5 can be

(A) 162 (B) 64

(C) 32 (D) 2

Space for Rough work

44. Consider the planes $3x-6y+2z+5=0$ and $4x-12y+3z=3$. The plane $67x-162y+47z+44=0$ bisects the angle between the given planes which

(A) contains the origin
(B) is acute
(C) is obtuse
(D) none of these

45. If h_1, h_2, h_3 are length of altitudes of a triangle and $\frac{1}{h_1}+\frac{1}{h_2}+\frac{1}{h_3}=\frac{2}{R}$, where R is the radius of its circumcircle, then

(A) $2h_1=3k$
(B) $3h_1=2R$
(C) $2h_2=3R$
(D) $3h_2=2R$

46. A vector of magnitude $\sqrt{29}$ which makes equal angles with vectors $\hat{i}+\hat{j}-2\hat{k},\ 2\hat{i}-\hat{j}+3\hat{k},\ \hat{i}-\hat{j}+\hat{k}$ is $a\hat{i}+b\hat{j}+c\hat{k}$ then $a+b+c$ can be

(A) 1
(B) 2
(C) –2
(D) –1

47. If $f(x)=\int_0^x \frac{\sin t}{t}dt,\ x>0$ then

(A) $f(x)$ has a local maxima at $x=n\pi\left(n=2k,\ k\in I^+\right)$

(B) $f(x)$ has a local minima at $x=n\pi\left(n=2k,\ k\in I^+\right)$

(C) $f(x)$ has neither maxima nor minima at $x=n\pi\left(n\in I^+\right)$

(D) $f(x)$ has local maxima at $x=n\pi\left(n=2k-1,\ k\in I^+\right)$

48. If $x\in R$, then the roots of the equation $x^4+4x^3-8x^2+k=0$ with respect to the values of k, $\left(k\in[0,2014]\right)$, are :

(A) for $k\in[0,3]$: 4 real and distinct roots

(B) for $k\in(3,128)$: two real and two imaginary roots

(C) for $k\in(128,583)$: no real root

(D) for $k\in(0,3)$: four real and distinct roots

Space for Rough work

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded - off to the **second decimal place**; e.g. XXXXX.XX).

---

49. Let $a_1, a_2, a_3 ....., a_{4001}$ are in A.P such that $\frac{1}{a_1a_2} + \frac{1}{a_2a_3} + ... + \frac{1}{a_{4000}a_{4001}} = 10$ and $a_2 + a_{4000} = 50$ then $|a_1 - a_{4001}|$ is equal to

50. If $|z – 3| = \text{Re } z$, $|w – 3| = \text{Re } w$ and $\arg(z - w) = \frac{\pi}{4}$, then find the value of $\text{Im}(z + w)$.

51. The number of functions from $f : A \to B$ where $A = \{a_1, a_2, a_3, a_4, a_5, a_6\}$, $B = \{1, 2, 3, …, 9\}$ such that $f(a_{i+1}) > f(a_i)\ \forall\ i \in N$ and $f(a_i) \neq i$ is

52. Let $(x^3 + px^2 + 2x – 5)^{19} (x^2 + qx – 41)^8 (x^4 – x^3 + x – 7)^6 = x^{97} + 391x^{96} + a_{95}x^{95} + a_{94}x^{94} + ... a_1x + a_0$ be an identity, where p, q, $a_{95}....a_0$ are integers. Compute the smallest positive value of p.

53. $\vec{a}, \vec{b}$ and $\vec{c}$ be three non – coplanar vectors, and $\vec{d}$ be a non zero vector, which is perpendicular to $\left(\vec{a} + \vec{b} + \vec{c}\right)$. Now if $\vec{d} = \sin x\left(\vec{a} \times \vec{b}\right) + \cos y\left(\vec{b} \times \vec{c}\right) + 2\left(\vec{c} \times \vec{a}\right)$, then minimum value of $x^2 + y^2$ is equal to $\frac{\lambda\pi^2}{4}$, where λ is

54. If $\int \frac{(x-1)dx}{(x + x\sqrt{x} + \sqrt{x})\sqrt{\sqrt{x}(x+1)}} = 4\tan^{-1}[g(x)] + C$, where C is an arbitrary constant of integration. Find $g^2(1)$.

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – IV

JEE (Advanced)-2020

PAPER – 1

ANSWERS, HINTS & SOLUTIONS

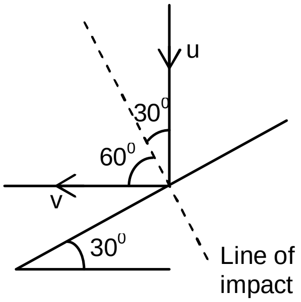
Physics PART – I

SECTION – A

1. B

Sol. Let velocity of ball just before collision is u and just after collision is v.
u sin 30° = v sin 60°

$$e = \frac{v\cos 60^0}{u\cos 30^0} = \frac{1}{3}$$



2. B

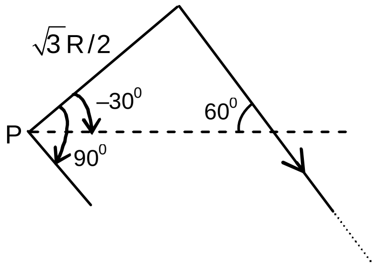
Sol. $$\frac{1}{2}\rho v^2 + 0 + P_o = \left(P_o + \frac{mg}{A}\right) + \rho gh + \frac{1}{2}\rho O^2$$

$$\therefore \quad v = \sqrt{2\left(gh + \frac{mg}{\rho A}\right)}$$

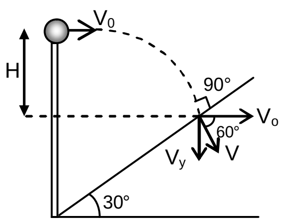
3. C

Sol. $$B = \frac{\mu_o I}{4\pi\sqrt{3}\,R/2}\left[\sin 90^o + \sin(-30^o)\right]$$

$$= \frac{\mu_o I}{4\sqrt{3}\,R}$$



4. A



Sol. $v_y = \sqrt{2gH}$

$$\frac{v_y}{v_x} = \frac{\sqrt{2gH}}{v_o} = \tan 60^o = \sqrt{3}$$

$$v_0 = \sqrt{\frac{2gH}{3}}$$

5. BC

Sol. $v_L = v_C = v_R$;

$\Rightarrow x_L = x_C = R$

when inductor is short circuited

$Z = \sqrt{R^2 + x_C^2} = \sqrt{2}R$

$\therefore I = \frac{30}{Z} = \frac{30}{\sqrt{2}R}$

$\therefore V_L = ix_L = \frac{30}{\sqrt{2}R} \times R = \frac{30}{\sqrt{2}}$

$\therefore$ (A) is incorrect and with similar calculations (B) will be correct.

Here f_0 is the resonance frequency as $v_L = v_C$

$\omega_0 = 2\pi f_0 = \frac{1}{\sqrt{LC}}$

$\frac{x_L}{x_C} = \frac{\omega L}{1/\omega C} = \omega^2 LC$

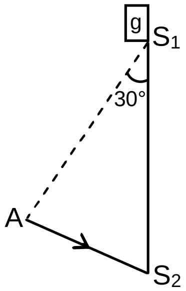
Given $f = 2f_0$

$\Rightarrow \omega = 2\omega_0$

$\therefore \frac{x_L}{x_C} = 4$

$\therefore$ (C) is also correct.

6. D



Sol. Extra phase change in glass = phae change in water of length AS_2.

$$\frac{2\pi t}{\lambda g} - \frac{2\pi}{\lambda\omega}t = \frac{2\pi}{\lambda\omega}\cdot\frac{2}{3}\sin 30^o$$

$$\Rightarrow t\left[\frac{3}{2} - \frac{4}{3}\right] = \frac{4}{3}\times\frac{1}{3}$$

$$\Rightarrow t = \frac{8}{3}\text{mm}.$$

7. ABC

Sol. KE = $h\nu - \phi$

8. C

Sol. Mass per unit length, $\mu = \frac{m}{\ell} = \frac{SA\ell}{\ell} = \rho A$

$\mu_s = \mu_{A\ell} = 78 \times 10^{-4}$ kg/m

$\therefore$ Speed of wave is same in both wire

$$V = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{80 \times 10^4}{78}} = \frac{2 \times 10^2}{\sqrt{3.9}}$$

$$\nu_{\min} = \frac{V}{\lambda_{\max}} = \frac{200}{\sqrt{3.9} \times 0.3} \quad \left[\frac{\lambda_{\max}}{2} = 15 \text{ cm for C as a node}\right]$$

$$= 337.4\ H_2$$

9. AC

Sol. $e = \frac{v_2 - v_1}{u_1 - u_2}$

$1 = \frac{v_2 - (-2)}{u_1}$

$u_1 = v_2 + 2$

$u_1 = 1(-2) + 5(u_1 - 2)$

$u_1 = -2 + 5u_1 - 10$

$u_1 = \frac{12}{4} = 3 \text{m/s}$

$v_2 = 1 \text{ m/s}$

Kinetic energy of the centre of mass = $\frac{1}{2} \times (1+5) \times \left(\frac{3}{1+5}\right)^2 = \frac{3}{4}$ J

10. AC

Sol. Velocity of insect w.r.t. strip = $\frac{\ell}{t}$

Let strip moves with speed ν
Initial momentum was 0

$\Rightarrow \quad 0 = m\left(\frac{\ell}{t} + v\right) + Mv$

$v = -\frac{m\ell/t}{M+m}$ i.e. $\frac{m\ell/t}{M+m}$ toward left

$\therefore$ Velocity of insect w.r.t. ground = $\frac{\ell}{t} - \frac{m\ell/t}{M+m} < \frac{\ell}{t}$.

11. BC

Sol. Cylinder will move downwards as mg sin $\theta > \mu$ mg cos θ although frictional force acts upwards.

12. BCD

Sol. Apply Faraday law for direction of induced current.

SECTION – C

13. 00002.00

Sol. We have relation $M\frac{dv}{dt} = F_{ext} + v_{rel}\frac{dM}{dt}$.

In the question, we have the force by the gravity as the external force. As the rocket is to lift from the ground the minimum acceleration of the rocket to do so is, o, beyond which, with a slight increase it will zoom into the sky.

Therefore, $\frac{dv}{dt} = 0$

Putting these into the equation, we obtain

$$0 = Mg + v_{rel}\left(-\frac{dM}{dt}\right)$$

($\frac{dM}{dt}$ is rate of decrease of mass hence negative. Mg is in the direction of the relative velocity of the fuel with respect to the rocket)

Hence, $\frac{dM}{dt} = \frac{M}{V}g = \frac{400 \times 10}{2 \times 1(10^3)} = 2 \text{ kg/sec}$

14. 00008.00

Sol. Let u is the velocity of A and B along the string

10 cos 30 = 2u

$\Rightarrow u = \frac{5\sqrt{3}}{2} m/s$

Let v is velocity of A $\perp$ to the string.

10 sin 30 = v

$\Rightarrow v = 5$ m/s

$\therefore V_A = \sqrt{u^2 + v^2} = \frac{\sqrt{175}}{2}$

$KE_A = \frac{175}{8} J$

15. 00003.75

Sol. $T = \frac{3}{8} M\omega^2 L^2$

Stress = $\frac{F_\perp}{(A/\cos\theta)} = \frac{3}{8}\frac{M\omega^2L^2\cos^2\theta}{A}$

16. 00002.17

Sol. $\frac{2.17 + 2.17 + 2.18}{3}$ = 2.1733 ….. ≈ 2.17 mm upto 3 significant figure.

17. 00000.89

Sol. $2g - T = 2a$ …(i)

$TR = I\alpha$ …(ii)

$a = R\alpha$ …(iii)

From (ii) and (iii) $T = \frac{Ia}{R^2}$

$\therefore \quad 2g = a\left(2+\frac{I}{R^2}\right)$

$\Rightarrow \quad a = \frac{2g}{\left(2+\frac{I}{R^2}\right)} = \frac{2\times 9.8}{2+\frac{0.2}{0.01}} = \frac{9.8}{11} \approx 0.89 \text{ m/s}^2$

18. 00000.75

Sol. $(Fs)_{max}$ = 20 N. a_{max} of 20 kg black = 1 m/s^2

$\therefore$ both black move together till 6 sec.

$\therefore \quad \frac{dv}{dt} = \frac{5t}{30} \quad \Rightarrow \quad \int dv = \frac{1}{6}\,\frac{t^2}{2} \quad ; \quad V = \frac{3^2}{12} = \frac{9}{12} = 0.75 \text{ m/s}$

Chemistry

PART – II

SECTION – A

19. B

Sol. Each photon strikes out one electron form the metal surface. Intensity will increase the number of photons, so number of photoelectrons increase.

20. C

Sol. In(C), the complex ions have zero charge. So there is no attraction between the two.

21. B

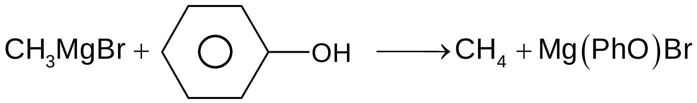
Sol. $\alpha = \frac{\Lambda_m}{\Lambda_m^0}$

22. B

Sol. $P_4O_{10} + 4HNO_3 \longrightarrow 2N_2O_5 + 4HPO_3$

23. ABCD

Sol.



24. AB

Sol. 2^o and 3^o amines are more basic than 1^o amine.

25. ABD

Sol. It is derived from Le-Chateliers's principle.

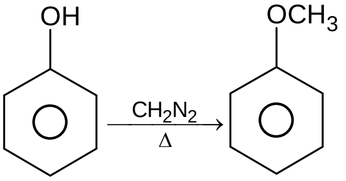
26. AB

Sol. $PH_4Cl \xrightarrow{\Delta} PH_3 + HCl$

$4H_3PO_3 \xrightarrow{\Delta} 3H_3PO_4 + PH_3$

27. ABD

Sol.



28. AB

Sol. $h = \sqrt{\frac{K_w}{K_a \times C}}$

H^+ remove OH^- forming weaker acid H_2O as compared to HCN.

29. AD

Sol. $\psi_{n, \ell, m}$ represents atomic orbitals.

30. AC

Sol. $t_{1/2} = \frac{a}{2k} \Rightarrow t_{1/2} \alpha \frac{1}{k}$

Pressure only changes the concentration of reactants. It has no effect.

SECTION – C

31. 01098.5

Sol. $P_{equilibrium} = p_B + 2p_C = 19.5$ atm

Since $p_B + 2p_C = 3x = 19.5$

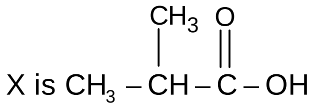
or x = 6.5

$\therefore$ $p_B = 6.5$ atm, $p_C = 13$ atm

$\therefore$ $K_p = p_B \times (2p_C)^2 = 6.5 \times (2 \times 6.5)^2 = 1098.5$

32. 00122.5

Sol.



X is $CH_3-\underset{|}{\overset{CH_3}{CH}}-\overset{O}{\overset{||}{C}}-OH$

33. 00008.01

Sol. $\mu_{max} = q \times d = 1.602 \times 10^{-19} \times 5 \times 10^{-10} = 8.01 \times 10^{-29}$ cou.m

34. 00005.49

Sol. $pH = pK_a + \log \frac{[NaA]}{[HA]}$

or $6.49 = pK_a + \log \frac{1}{0.1} = pKa_a + 1$

$\therefore$ $pK_a = 6.49 - 1 = 5.49$

35. 00154.5

Sol. X is mesitylene.

Y is Chloro mestiylene

36. 00036.5

Sol. A = $Na_2SO_4.10H_2O$, B = Na_2SiO_3, C = SO_3, D = HCl, PPt = $BaSO_4$

Mathematics PART – III

SECTION – A

37. D

Sol. Let there be a value of k for which $x^3 - 3x + k = 0$ has two distinct roots between 0 and 1.

Let a, b be two distinct roots of $x^3 - 3x + k = 0$ lying between 0 and 1 such that $a < b$. Let $f(x) = x^3 - 3x + k$. Then $f(a) = f(b) = 0$. Since between any two roots of a polynomial f(x) there exist at least one root of its derivative $f'(x)$. Therefore $f'(x) = 3x^2 - 3$ has at least one root between a and b. But $f'(x) = 0$ has two roots equal to ± 1 which do not lie between a and b. Hence $f(x) = 0$ has no real roots lying between 0 and 1 for any value of k.

38. B

Sol. Total number of such function =27 out of which 12 are ONTO

39. C

Sol. Since coefficient of $x^2 + ax + 1$ are symmetrical so roots will be α, $\frac{1}{\alpha}$

$$\lim_{x \to 1/\alpha} \frac{\sin(x^2 + ax + 1)}{(\alpha x - 1)} = \lim_{x \to 1/\alpha} \frac{\sin\left[\left(x - \frac{1}{\alpha}\right)(x - \alpha)\right]}{\left(x - \frac{1}{\alpha}\right)(x - \alpha)} \cdot \frac{\left(x - \frac{1}{\alpha}\right)(x - \alpha)}{(\alpha x - 1)}$$

$$= \lim_{x \to 1/\alpha} \frac{(x - \alpha)}{\alpha} = \frac{\frac{1}{\alpha} - \alpha}{\alpha} = \frac{1 - \alpha^2}{\alpha^2}$$

40. A

Sol. As, f (x) = $x^4 \tan(x^3) - x \ln(1 + x^2)$ is odd, $\frac{d^4 f(x)}{dx^4} = 0$ at x = 0.

41. AD

Sol. Since $\int_a^b f(x)dx = (b - a)\int_0^1 f\{(b - a)x + a\}dx$,

$$\int_1^2 \sin x^2 dx = \int_0^1 \sin(x + 1)^2 dx = \int_0^1 \sin(x^2 + 2x + 1)dx$$

$$\int_{-4}^4 \cos x^2\, dx = 8\int_0^1 \cos(8x - 4)^2\, dx = 8\int_1^0 \cos 16(2x - 1)^2\, dx.$$

42. ABCD

Sol. $A \subseteq A \cup B$

$\Rightarrow P(A) \le P(A \cup B) \Rightarrow P(A \cup B) \ge \frac{3}{4}$

Also, $P(A \cap B) = P(A) + P(B) - P(A \cup B)$

$\ge P(A) + P(B) - 1$

$= \frac{3}{4} + \frac{5}{8} - 1 = \frac{3}{8}$

Now,

$A \cap B \subseteq B$

$\Rightarrow P(A \cap B) \le P(B) = \frac{5}{8}$

$\therefore \quad \frac{3}{8} \le P(A \cap B) = \frac{5}{8}$

and

$P(A \cap B') = P(A) - P(A \cap B)$

$\Rightarrow \frac{3}{4} - \frac{5}{8} \le P(A \cap B') \le \frac{3}{4} - \frac{3}{8}$

$\Rightarrow \frac{1}{8} \le P(A \cap B') \le \frac{3}{8}$

$\therefore\ P(A \cap B) = P(B) = P(A' \cap B)$ [Using Equation (1)]

$\Rightarrow \frac{3}{8} \le P(B) - P(A' \cap B) \le \frac{5}{8}$

$\Rightarrow 0 \le P(A' \cap B) \le \frac{1}{4}$

43. AC

Sol. Given $a_1 = 2;\ \frac{a_n}{a_{n-1}} = \frac{a_{n-1}}{a_{n-2}}$

$\Rightarrow a_1, a_2, a_3, a_4, a_5, ...$ in G.P.

Let $a_2 = x$ then for n = 3 we have

$\frac{a_3}{a_2} = \frac{a_2}{a_1} = \frac{x_2}{2}$

$\Rightarrow a_1^{\ 2} = a_1 a_3$

$\Rightarrow a_3 = \frac{x^2}{2}$

i.e. $2, x, \frac{x^2}{2}, \frac{x^3}{4}, \frac{x^4}{8}, ...$ with common ratio $r = \frac{x}{2}$

given $\frac{x^4}{8} \le 162$

$\Rightarrow x^4 \le 1296 \le x \le 6$

Also $x \frac{x^4}{8}$ and are integers

$\Rightarrow x$ must be even then only $\frac{x^4}{8}$ will be an integer

Hence possible value of x is 4 and 6. ($x \neq 2$ as terms are distinct)

Hence possible value of $a_5 = \frac{x^4}{8}$ is $\frac{4^4}{8}, \frac{6^4}{8}$

44. AB

Sol. $3x - 6y + 2z + 5 = 0$

$-4x + 12y - 3z + 3 = 0$

Bisectors are $\frac{3x-6y+2z+5}{\sqrt{9+36+4}} = \pm\frac{-4x+12y-3z+3}{\sqrt{16+144+9}}$

The plane which bisects the angle between the planes that contains the origin is

$13(3x - 6y + 2z + 5) = 7(-4x + 12y - 3z + 3)$

$67x - 162y + 47z + 44 = 0$

Further, $3x(-4) + (-6)(12) + 2\times(-3) < 0$

Hence, the origin lies in the acute angle.

45. AC

Sol. $\frac{a+b+c}{2\Delta} = \frac{2}{R} \Rightarrow R = 2r$ and $h_1 = \frac{2\Delta}{a} = 3r$

46. AD

Sol. Let $\hat{d}$ be the unit vector along the desired vector then $\hat{d}$ is along $\left(-2\hat{j}+3\hat{k}\right)\times\left(-\hat{i}-2\hat{k}\right)$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & -2 & 3 \\ -1 & 0 & -2 \end{vmatrix} = 4\hat{i} - 3\hat{j} - 2\hat{k}$$

47. BD

Sol. $f'(x) = \frac{\sin x}{x}$

For $f'(x) = 0$, $\frac{\sin x}{x} = 0 \Rightarrow x = n\pi (n \in I, n \neq 0)$

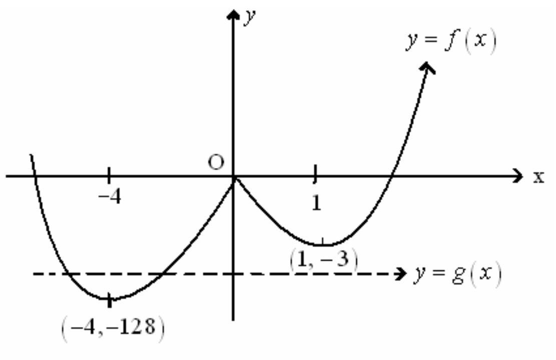
$f''(x) = \frac{x\cos x - \sin x}{x^2}$

$f''(n\pi) = \frac{\cos n\pi}{n\pi} < 0$ if $n = 2k - 1$ and > 0 if $n = 2k, k \in I^+$

Hence, $f(x)$ has local maxima at $x = n\pi,$ where n = 2k – 1 and

local minima at x = $n\pi$, n = 2k, where $k \in I^+$.

48. BCD



Sol. $x^4 + 4x^3 - 8x^2 = -k$

$\Rightarrow \quad f(x) = -k$

Where

$f(x) = x^4 + 4x^3 - 8x^2 = x^2\left(x^2 + 4x - 8\right)$

Let $g(x) = -k$

From the graph the following cases arise :

1. When $-3 \le -k \le 0, \Rightarrow 0 \le k \le 3$

In this case, $y = -k$ intersect at four points.

2. When $-4 \le -k < -3, \Rightarrow 3 < k \le 4$

In this case, $y = -k$ intersect at two points, the given equation has two real roots.

3. When $k < 0, \Rightarrow -k > 0$

In this case, there are two points of intersection. So, the equation has two real roots.

SECTION – C

49. 00030.00

Sol. $\frac{4000}{a_1a_{4001}} = 10 \Rightarrow a_1a_{4001} = 400$

also $a_1 + a_{4001} = 50$

$\Rightarrow |a_1 - a_{4001}|^2 = 2500 - 1600$

$\Rightarrow |a_1 - a_{4001}| = 30$

50. 00006.00

Sol. Let $z = x_1 + iy_1, w = x_2 + iy_2$

$\therefore |z-3| = \text{Re}\, z \Rightarrow (x_1-3)^2 + y_1^2 = x_1^2$ ....(i)

$|w-3| = \text{Re}\, w \Rightarrow (x_2-3)^2 + y_2^2 = x_2^2$ ...(ii)

$\arg(z-w) = \frac{\pi}{4} \Rightarrow \frac{y_1-y_2}{x_1-x_2} = \tan\frac{\pi}{4} = 1$ ...(iii)

By solving (i), (ii) and (iii) we get

$\Rightarrow \frac{y_1-y_2}{x_1-x_2} = \frac{6}{y_1+y_2}$

From (iii) $y_1 + y_2 = 6$

51. 00028.00

Sol. If a_1 is mapped to 2, we have ${}^7C_5$ ways of mapping rest of the elements.
If a_1 is mapped to 3, we have ${}^6C_5$ ways of mapping rest of the elements.
If a_1 is mapped to 4, we have ${}^5C_5$ ways of mapping rest of the elements.
Hence total number of increasing functions = ${}^7C_5 + {}^6C_5 + {}^5C_5 = 28$.

52. 00007.00

Sol. $\left({}^{19}c_0(x^3)^{19} + {}^{19}c_1(px^2 + 2x - 5)(x^3)^{18} + ...\right)$

$\left({}^{8}c_0x^{16} + {}^{8}c_1(qx - 41)x^{14} + ...\right)\left({}^{6}c_0x^{24} + {}^{6}c_1(-x^3 + x - 1)x^{20} + ...\right)$

$= x^{97} + 391x^{96} + a_{95}x^{95} + ...$

Comparing the coefficient of x^{96} we get
$19p + 8q - 6 = 391$
$\Rightarrow 19p + 8q = 397$ Let $q = 19\lambda + k,\ 0 \le k < 19$
$p = \frac{397 - 8(19\lambda + k)}{19} = 21 - 8\lambda - 2\frac{(4k+1)}{19}$
$\frac{4k+1}{19}$ must be integer $\Rightarrow k = 14,\ p = 15 - 8\lambda$
For minimum positive value of p, $\lambda = 1 \Rightarrow p = 7$

53. 00005.00

Sol. Let $\vec{d}.\vec{a} = \cos y\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right] = -\vec{d}.\left(\vec{b}+\vec{c}\right)$ [as $\vec{d}.\left(\vec{a}+\vec{b}+\vec{c}\right) = 0$]

$$\Rightarrow \quad \cos y = -\frac{\vec{d}.\left(\vec{b}+\vec{c}\right)}{\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right]} \qquad \ldots\ldots\ldots(1)$$

similarly $$\sin x = -\frac{\vec{d}.\left(\vec{b}+\vec{a}\right)}{\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right]} \qquad \ldots\ldots\ldots\ldots(2)$$

$$\Rightarrow 2 = -\frac{\vec{d}.\left(\vec{a}+\vec{c}\right)}{\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right]} \qquad \ldots\ldots\ldots\ldots(3)$$

Adding these we get $\sin x + \cos y + 2 = 0$
$\Rightarrow \sin x + \cos y = -2$
$\Rightarrow \sin x = -1, \cos y = -1$
$\Rightarrow x = (4n-1)\frac{\pi}{2},\ y = (2n+1)\pi$

Since we want minimum value of $x^2 + y^2$, so $x = -\frac{\pi}{2},\ y = \pi$

$$\Rightarrow x^2 + y^2 = \frac{5\pi^2}{4} \Rightarrow \lambda = 5$$

54. 00002.00

Sol. Ans. (2)
Put $x = t^2$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – IV

JEE (Advanced)-2020

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section-A (01 – 08, 19 – 26, 37 – 44)*** *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–1** In all other cases.*

   Section-A (09 – 12, 27 – 30, 45 – 48) *contains 6 List-Match sets with 12 questions (each set has 2 questions). Each question has 4 statements in LIST-I & 6 statements in LIST-II. The codes for Lists have choices (A), (B), (C), (D) out of which only one is correct.*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

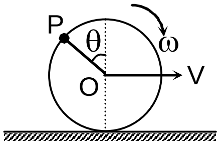
PART – I

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A cubical block of wood of edge 10cm and mass 0.92 kg floats on a tank of water with oil of rel. density 0.6 to a depth of 4 cm above water. When the block attains equilibrium with four of its sides edges vertical
(A) 1 cm of it will be above the free surface of oil
(B) 5 cm of it will be under water
(C) 2 cm of it will be above the common surface of oil and water
(D) 8 cm of it will be under water

2. A disc of radius *R* rolls on a horizontal surface with linear velocity *V* and angular velocity ω. There is a point *P* on circumference of disc at angle θ with upward vertical diameter measured anticlockwise see figure, which has a vertical velocity. Here θ is equal to



(A) $\pi + \sin^{-1}\frac{V}{R\omega}$ (B) $\frac{\pi}{2} - \sin^{-1}\frac{V}{R\omega}$
(C) $\pi - \cos^{-1}\frac{V}{R\omega}$ (D) $\pi + \cos^{-1}\frac{V}{R\omega}$

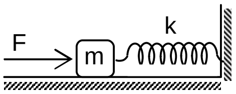
3. A point moves with deceleration along the circle of radius R so that at any time its tangential and normal acceleration are equal in magnitude. At the initial moment t =0, the velocity of the point is v_0. The velocity of the point will be
(A) $v = \frac{v_0}{1 + \frac{v_0 t}{R}}$ at t second (B) $v = v_0 e^{-S/R}$ after displacements
(C) $v = v_0 e^{-SR}$ after displacements (D) $v = \frac{v_0}{1 - \frac{v_0 t}{R}}$ at t second

Space for Rough work

4. A horizontal disc rotates freely about a vertical axis through its centre. A ring, having the same mass and radius as the disc, is now gently placed on the disc. After some time, they rotate with a common angular speed.
(A) some friction exists between the disc and the ring.
(B) the angular momentum of the disc plus ring is conserved.
(C) the final common angular speed is $\frac{2}{3}$rd of the initial angular velocity of the disc.
(D) $\frac{2}{3}$ rd of the initial kinetic energy changes to heat.

5. If electron of the hydrogen atom is replaced by another particle of same charge but of double the mass, then:
(A) Bohr radius will increase
(B) ionisation energy of the atom will be doubled
(C) speed of the new particle in a given state will be lesser than the electron's speed in same orbit
(D) gap between energy levels will now be doubled

6. A constant force F is applied on a spring block system as shown in figure. The mass of the block is m and spring constant is k. The block is placed over a smooth surface. Initially the spring was unstretched. Choose the correct alternative(s).

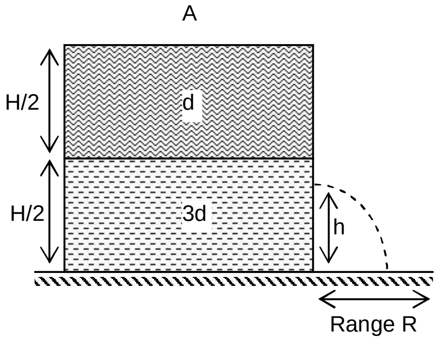


(A) the block will execute SHM
(B) amplitude of oscillation is F/2k
(C) time period of oscillation is $2\pi\sqrt{\frac{m}{k}}$
(D) the maximum speed of block is $\sqrt{\frac{2Fx - kx^2}{m}}$
(here x = F/k)

Space for Rough work

7. For an ideal gas:
   (A) the change in internal energy in a constant pressure process from temperature T_1 to T_2 is equal to $nC_v (T_2 - T_1)$, where C_v is the molar specific heat at constant volume and n the number of moles of the gas.
   (B) the change in internal energy of the gas and the work done by the gas are equal in magnitude in an adiabatic process.
   (C) the internal energy does not change in an isothermal process.
   (D) no heat is added or removed in an adiabatic process.

8. A container of large uniform cross sectional area A resting on a horizontal surface holds two immiscible non viscous and incompressible liquids of density d and 3d, each of height H/2. The lower density liquid is open to the atmosphere having pressure P_0. A tiny hole of area $a(a<<A)$ is punched to the vertical side of lower container at a height h $(0<h<H/2)$ for which range is maximum.



(A) $h = H/3$
(B) Range $R = \frac{2H}{3}$
(C) Range $R = \frac{3H}{2}$
(D) Velocity of efflux $v = \sqrt{\frac{2}{3}gH}$

Space for Rough work

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

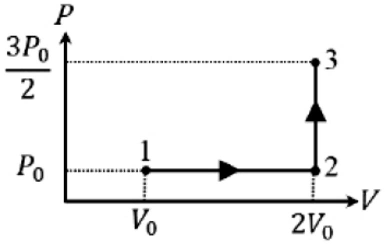
Answer the following by appropriately matching the list based on the information given in the paragraph.

In the thermodynamic process on an ideal monatomic gas, the infinitesimal heat absorbed by the gas is given by $T\Delta X$. where T is temperature of the system and ΔX is the infinitesimal change in a thermodynamic quantity X of the system. For a mole of monatomic ideal gas $X = \frac{3}{2}R\,\ln\left(\frac{T}{T_A}\right) + R\ln\left(\frac{V}{V_A}\right)$. Here R is gas constant. V is volume of gas. T_A and V_A are constants.

The List-I below gives some quantities involved in a process and List-II gives some possible values of these quantities.

List – I		List – II	
(I)	Work done by the system in process $1\to2\to3$	(P)	$\frac{1}{3}RT_0\ln2$
(II)	Change in internal energy in process $1\to2\to3$	(Q)	$\frac{1}{3}RT_0$
(III)	Heat absorbed by the system in process $1\to2\to3$	(R)	RT_0
(IV)	Heat absorbed by the system in process $1\to2$	(S)	$\frac{3}{3}RT_0$
		(T)	$\frac{1}{3}RT_0\left(3+\ln2\right)$
		(U)	$\frac{5}{6}RT_0$

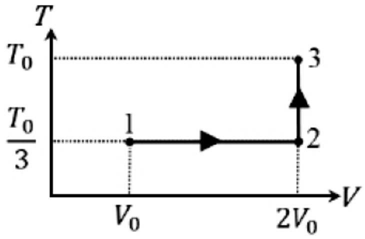
9. If the process carried out on one mole of monatomic ideal gas is as shown in figure in the PV-diagram with $P_0V_0 = \frac{1}{3}RT_0$, the correct match is.



(A) I $\to$ Q, II $\to$ R, II I$\to$ S, IV $\to$ U
(B) I $\to$ Q, II $\to$ S, III $\to$ R, IV $\to$ U
(C) I $\to$ Q, II $\to$ R, III $\to$ P, IV $\to$ U
(D) I $\to$ S, II $\to$ R, III $\to$ Q, IV $\to$ T

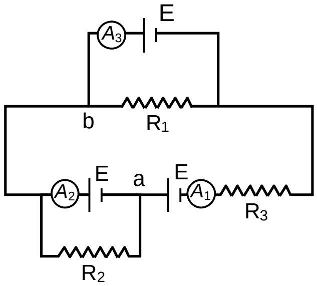
Space for Rough work

10. If the process carried out on one mole of monatomic ideal gas is as shown in figure in the PV-diagram with $P_0V_0 = \frac{1}{3}RT_0$, the correct match is.



(A) I → P, II → T, III → Q, IV → T
(B) I → S, II → T, III → Q, IV → U
(C) I → P, II → R, III → T, IV → S
(D) I → P, II → R, III → T, IV → P

Referring to the given circuit match List-I with List-II in question no. 11 and 12.



List – I		List – II	
(I)	Reading of ammeter A_1 in ampere is	(P)	4/3
(II)	Reading of ammeter A_2 in ampere is	(Q)	8/3
(III)	Reading of ammeter A_3 in ampere is	(R)	4
(IV)	Potential difference between point a and point b in volt is	(S)	zero
		(T)	2
		(U)	–1

11. In the above circuit, $R_1 = R_2 = R_3 = 3\Omega$ and e.m.f. of each cell is E = 4V and negligible internal resistance. All ammeters are ideal. Match the following:

(A) I → P, II → Q, III → R, IV → S
(B) I → T, II → P, III → S, IV → Q
(C) I → P, II → Q, III → S, IV → R
(D) I → S, II → R, III → T, IV → U

Space for Rough work

12. In the above circuit if R_2 is removed and $R_1 = R_3 = 4\ \Omega$

(A) I → P, II → P, III → S, IV → R (B) I → T, II → P, III → S, IV → Q

(C) I → P, II → Q, III → S, IV → R (D) I → S, II → R, III → T, IV → U

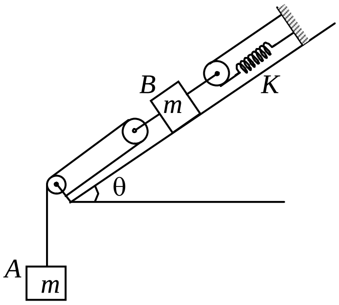
SECTION – C

(Numerical Answer Type)

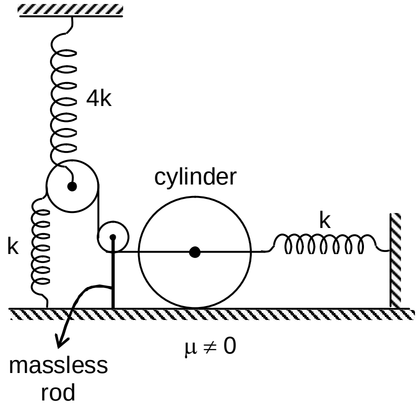
This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded - off to the **second decimal place**; e.g. XXXXX.XX).

13. A uniform disc of radius R having charge Q distributed uniformly all over its surface is placed on a smooth horizontal surface. A magnetic field, $B = kxt^2$, where k is a constant, x is the distance (in metre) from the centre of the disc and t is the time (in second), is switched on perpendicular to the plane of the disc. Find the torque (in N-m) acting on the disc after 15 sec. (Take 4kQ = 2.50 S.I. unit and R = 1m).

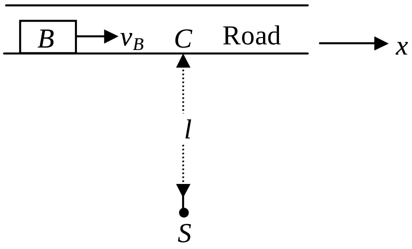
14. Two blocks *A* and *B*, each of mass *m* are connected by means of a pulley-spring system on a smooth inclined plane of inclination θ as shown in the figure. All the pulleys and spring are ideal. Now, *B* is slightly displaced from its equilibrium position. It starts to oscillate. Time period of oscillation of *B* will be (Take *m* = 4 kg, *K* = 5 N/m, π = 3.14)



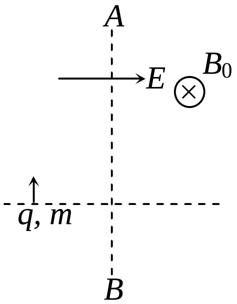
15. A cylinder of mass m = 3 kg and radius R = 2 m is attached to a massless spring-pulley system as shown in the figure and all the springs are in their natural length at t = 0. The friction is sufficient to cause pure rolling of the cylinder. What is the time period (in sec.) of cylinder for small horizontal displacement? (spring constant k = 2 N/m and π = 3.14)



Space for Rough work



16. A bus B is moving with a velocity v_B in the positive x-direction along a road as shown in the figure. A shooter 'S ' is at a distance l from the road. He has a detector which can detect signals only of frequency 1500Hz. The bus blows horn of frequency 1000 Hz. When the detector detects a signal the shooter immediately shoots towards the road along SC and the bullet hits the bus. Find the velocity of the bullet if velocity of sound in air is v = 340 m/s and $\frac{v_B}{v} = \frac{2}{3\sqrt{3}}$.



17. A uniform electric field E is present horizontally along the paper throughout region but uniform magnetic field B_0 is present horizontally (perpendicular to plane of paper in inward direction) right to the line AB as shown. A charge particle having charge q and mass m is projected vertically upward and crosses the line AB after time t_0. The speed of projection if particle moves after t_0 with constant velocity. (given $qE = mg$) is nt_0. Find the value of 'n'. ($g = 9.8$ m/s^2)

18. In a moving coil galvanometer, torque on the coil can be expressed as $\tau \propto i$, where i is current through the wire. The rectangular coil of the galvanometer having number of turns N, area A and moment of inertia I is placed in magnetic field B. The torsion constant of spring in the galvanometer is C and charge Q is passed through the coil almost instantaneously. If the maximum angle through which coil deflected is $\frac{KNABQ}{\sqrt{4CI}}$. (Ignore the damping in mechanical oscillations).

Space for Rough work

Chemistry

PART – II

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. The bond order of which of the following substance(s) is/are greater than one?
(A) BF_3 (B) NH_3
(C) CO_2 (D) PCl_5

20. In which of the following reaction(s), carbocation intermediate(s) is/are formed
(A) $CH_3-CH=CH_2+HBr\longrightarrow$ (B) $CH_3-CH=CH_2+HBr\xrightarrow{(CH_3CO)_2O_2}$
(C) $CH_3-CH=CH_2+NBS\xrightarrow{\text{Radiation}}$ (D) $CH_3-CH=CH_2\xrightarrow[NaBH_4]{Hg(OCOCH_3)_2,\ H_2O}$

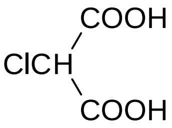
21. Which of the following nucleophile(s) can form products that show functional isomerism?
(A) CN^- (B) SH^-
(C) NO_2^- (D) NH_3

22. $Zn(s) \mid Zn^{2+}(C_1) \parallel Ag^+(C_2) \mid Ag(s)$
Under which of the following conditions, E_{Cell} will be equal to E^0_{Cell} ?
(A) $C_1 = C_2 = 1$ M (B) $C_2 = \sqrt{C_1}$
(C) $C_1 = C_2 = 0.1$ M (D) $C_2 - C_1 = 1$ M

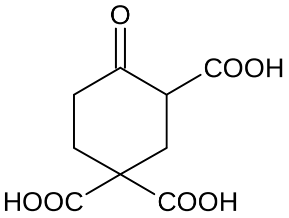
23. The correct statement(s) regarding the halides of boron is/are
(A) BI_3 undergo the easiest hydrolysis than the other halides
(B) $BF_3+BCl_3\longrightarrow BF_2Cl+BFCl_2$
(C) Inorganic benzene is formed when BCl_3 reacts with NH_4Cl followed by reaction with $NaBH_4$
(D) Lewis acidity order: $BBr_3 > BCl_3 > BF_3$

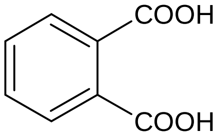
Space for Rough work

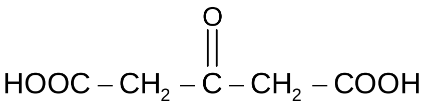
24. Which of the following substituted polycarboxylic acids are converted to their corresponding monocarboxylic acids on heating?

(A) 

$ClCH(COOH)_2$

(B) 

(C) 

(D) 

$HOOC-CH_2-\overset{\overset{O}{||}}{C}-CH_2-COOH$

25. Which of the following salts produce(s) gas(es) when treated with dilute mineral acids?

(A) $BaCO_3$
(B) K_2SO_3
(C) $Ca_3(PO_4)_2$
(D) KNO_2

26. Which of the following reaction(s) is/are exothermic in nature?

(A) $CH_2=CH_2(g)+H_2(g)\xrightarrow{Ni}C_2H_6(s)$
(B) $NaOH+HCN\longrightarrow NaCN+H_2O$
(C) $HCl+H_2O\longrightarrow H^+(aq)+Cl^-(aq)$
(D) $H_2(g)\longrightarrow H(g)+H(g)$

Space for Rough work

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

List-I contains ionic solids and list-II states regarding their crystal structure.

	List-I		List-II
(I)	NaCl	(P)	Cations occupy half of the tetrahedral voids of FCC unit cell
(II)	CsCl	(Q)	Cations occupy octahedral voids of FCC unit cells
(III)	ZnS	(R)	Coordination number of the cation is eight
(IV)	CaF_2	(S)	Cations and anions have different coordination numbers
		(T)	Coordination number of both cations and anions is four
		(U)	Anions occupy the voids of the unit cell

27. The correct combination out of the following is

(A) (I) → (T) (B) (III) → (Q)

(C) (II) → (R) (D) (IV) → (P)

List-I contains ionic solids and list-II states regarding their crystal structure.

	List-I		List-II
(I)	NaCl	(P)	Cations occupy half of the tetrahedral voids of FCC unit cell
(II)	CsCl	(Q)	Cations occupy octahedral voids of FCC unit cells
(III)	ZnS	(R)	Coordination number of the cation is eight
(IV)	CaF_2	(S)	Cations and anions have different coordination numbers
		(T)	Coordination number of both cations and anions is four
		(U)	Anions occupy the voids of the unit cell

28. Which of the following combination is correct

(A) (IV) → (Q) (B) (III) → (P)

(C) (I) → (U) (D) (II) → (S)

Space for Rough work

List-I contains complexes and their behaviour is mentioned in list-II.

	List-I		List-II
(I)	[Cu $(NH_3)_4$ $(H_2O)_2]^{2+}$	(P)	Colourless complex
(II)	$[FeF_6]^{3-}$	(Q)	Back donation from metal to ligand takes place
(III)	$[Cr(en)_3]^{3+}$	(R)	Prone to Jahn Teller distortion
(IV)	$[Ni(CO)_4]$	(S)	Square planar complex
		(T)	Chelate complex
		(U)	Coordination number is six

29. The correct combination out of the following is

(A) (I) → (T)
(B) (II) → (P)
(C) (III) → (Q)
(D) (IV) → (S)

List-I contains complexes and their behaviour is mentioned in list-II.

	List-I		List-II
(I)	[Cu $(NH_3)_4$ $(H_2O)_2]^{2+}$	(P)	Colourless complex
(II)	$[FeF_6]^{3-}$	(Q)	Back donation from metal to ligand takes place
(III)	$[Cr(en)_3]^{3+}$	(R)	Prone to Jahn Teller distortion
(IV)	$[Ni(CO)_4]$	(S)	Square planar complex
		(T)	Chelate complex
		(U)	Coordination number is six

30. The correct combination out of the following is

(A) (I) → (R)
(B) (II) → (Q)
(C) (III) → (P)
(D) (IV) → (T)

Space for Rough work

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded - off to the **second decimal place**; e.g. XXXXX.XX).

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31. What volume in mL of 0.5 M acidified potassium permanganate solution can completely oxidize 523.15×10^{-3} moles of Sn^{2+} ions to Sn^{4+} ions?
$$MnO_4^- + Sn^{2+} + H^+ \longrightarrow Mn^{2+} + Sn^{4+} + H_2O$$

32. The kinetic energy of a moving electron is 50 kJ. If the de-Broglie wavelength associated with the electron motion is expressed as $y \times 10^{-z}$ m, and the value of z is 20. What is the value of (y + z)?
[Assume that $m_e = 9 \times 10^{-31}$ kg and $h = 6.6 \times 10^{-34}$ Js]

33. Reaction of phenol(PhOH) with bromine water(Br_2/H_2O) forms a precipitate. What is the molar mass of the precipitate in g mol^{-1} unit?
[Molar mass of bromine = 79.9]

34. One mole of ethylene glycol was dissolved in 640.8 g water and the resulting solution was cooled to $-3.72^{o}C$ temperature. How many gram of ice is formed due to freezing of water?
[$K_f = 1.86$ K kg mol^{-1}]

35. Treatment of NaCl with acidified solution of (X) forms a red vapour(Y). Treatment of (Y) with aqueous NaOH forms a yellow solution(Z). $Pb(CH_3COO)_2$ gives a yellow precipitate when treated with solution of (Z). What is the molar mass of (Y) in g mol^{-1} unit? [At. Mass of Cr = 51.9]

36. How much current in ampere unit is to be passed through $CuSO_4$ for four minutes in order to deposit 190.5 g copper on the unattacked cathode?

Space for Rough work

Mathematics PART – III

SECTION – A

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. If the pair of asymptotes of a hyperbola H is xy – 2x – y + 2 = 0. Its conjugate hyperbola H' passes through (3, 0) then

(A) eccentricity of H' is $\sqrt{2}$

(B) focus of H' is $\left(2+\frac{1}{\sqrt{2}}, 2+\frac{1}{\sqrt{2}}\right)$

(C) focus of H is $\left(\sqrt{2}, -\sqrt{2}\right)$

(D) equation of transverse axis of H is x – y + 1 = 0

38. If $\sum_{r=0}^{n} \frac{2r}{{}^nC_r} = \sum_{r=0}^{n} \frac{n^2 - 3n + 3}{{}^nC_r}$, then

(A) n = 1 (B) n = 2

(C) n = 3 (D) n = 4

39. The values of m for which it is possible to draw the chord $y = \sqrt{m}x + 1$ to the curve $x^2 + 2xy + \left(2 + \sin^2 \alpha\right)y^2 = 1$, which subtends of right angle at origin for some value of α is/are

(A) m = 2 (B) $m = \frac{3}{2}$

(C) $m = 3$ (D) $m = \frac{7}{2}$

Space for Rough work

40. If y = f(x) and y = g(x) are symmetrical about the line x = $\frac{\alpha+\beta}{2}$, then $\int_\alpha^\beta f(x)\, g'(x)\,dx$ is equal to

(A) $\int_\alpha^\beta f'(x)\, g(x)\,dx$
(B) $-\int_\alpha^\beta f'(x)\, g(x)\,dx$
(C) $\frac{1}{2}\int_\alpha^\beta (f(x)\, g'(x) - f'(x)\, g(x))\,dx$
(D) $\frac{1}{2}\int_\alpha^\beta (f(x)\, g'(x) + f'(x)\, g(x))\,dx$

41. If the probability of choosing an integer 'k' out of 2m integers 1, 2, 3,……..2m is inversely proportional to $k^4\,(1 \le k \le m)$. If x_1 is the probability that choosen number is odd and x_2 is the probability that chosen number is even, then

(A) $x_1 < \frac{2}{3}$
(B) $x_1 > \frac{1}{2}$
(C) $x_1 > \frac{2}{3}$
(D) $x_2 < \frac{1}{2}$

42. Which of the following functions are twice differentiable at x = 0?

(A) $f(x) = x\,|x|$
(B) $g(x) = [x^2]\tan^{-1} x - \{x^2\}\cot^{-1} x - [x^2]\frac{\pi}{2}$
(C) $h(x) = |\sin^2 x|$
(D) $h(x) = \begin{cases} x^4 \cos\left(\frac{1}{x}\right); & x \ne 0 \\ 0 \quad ; & x = 0 \end{cases}$

43. Let z_1, z_2, z_3 be the coordinate of vertices A, B, C of the triangle if $W_1 = z_1 - z_2$, $W_2 = z_3 - z_2$ and $\angle A = 90°$, then

(A) $\text{Re}\left(\frac{W_2}{W_1}\right) = 1$
(B) $\text{Re}(W_1\overline{W}_2) = |W_1|^2$
(C) $\text{Re}(W_1\overline{W}_2) = |W_2|^2$
(D) $\text{Re}\left(\frac{W_1}{W_2}\right) = 1$

Space for Rough work

44. If $A(\alpha,\beta)=\begin{bmatrix}\cos\alpha & \sin\alpha & 0\\ -\sin\alpha & \cos\alpha & 0\\ 0 & 0 & e^{\beta}\end{bmatrix}$, then

(A) $A(\alpha,\beta)'=A(-\alpha,\beta)$
(B) $A(\alpha,\beta)^{-1}=A(-\alpha,-\beta)$
(C) $\text{Adj}(A(\alpha,\beta))=e^{\beta}A(-\alpha,-\beta)$
(D) $A(\alpha,\beta)'=A(\alpha,-\beta)$

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

A plane π passes through the point (1, 1, 1) and is parallel to the vectors $\vec{b}=(1,0,-1)$ and $\vec{a}=(-1,1,0)$ π meets the axes in A, B and C forming the tetrahedron OABC.

	List-I		List-II
(I)	Volume of the tetrahedron OABC in cubic units.	(P)	$\frac{9}{2}$
(II)	Area of a face of the tetrahedron in square units.	(Q)	$\frac{9\sqrt{3}}{2}$
(III)	Distance of the points, $\left(\frac{3\sqrt{3}}{2}, 3\sqrt{3}, 3\right)$ from the plane π in units.	(R)	$\sqrt{3}$
(IV)	Distance of a face of the tetrahedron from the vertex	(S)	3
		(T)	4
		(U)	$\frac{1}{2}$

45. Which of the following is the only correct combination?

(A) II→U
(B) II→T
(C) I→P
(D) I→S

Space for Rough work

46. Which of the following is the only correct combination?

(A) IV→Q (B) III→R
(C) IV→S (D) III→Q

Answer the following by appropriately matching the list based on the information given in the paragraph.

Suppose a, b, c are three distinct real numbers and f(x) is a real quadratic polynomial such that

$$\begin{bmatrix} 4a^2 & 4a & 1 \\ 4b^2 & 4b & 1 \\ 4c^2 & 4c & 1 \end{bmatrix}\begin{bmatrix} f(-1) \\ f(1) \\ f(1) \end{bmatrix} = \begin{bmatrix} 3a^2+3a \\ 3b^2+3b \\ 3c^2+3c \end{bmatrix}$$

	List-I		**List-II**
(I)	x – coordinates (s) of the point of intersection of $y = f(x)$ with the x – axis	(P)	4
(II)	Area bounded by $y = \frac{3}{2}f(x)$ and the x – axis	(Q)	2
(III)	Maximum value of $f(x)$	(R)	1
(IV)	Length of the intercept made by $y = f(x)$ on the x – axis	(S)	–2
		(T)	0
		(U)	3

47. Which of the following is the only correct combination?

(A) II→U (B) II→P
(C) I→P (D) I→U

48. Which of the following is the only correct combination?

(A) IV→Q (B) III→R
(C) IV→S (D) III→Q

Space for Rough work

SECTION – C

(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded - off to the **second decimal place**; e.g. XXXXX.XX).

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49. Four students appeared in three examinations. The number of possible ways in which we can have result, such that neither any students fails in all the examinations nor there is an examination which is not cleared by any student is k, then find $\frac{k}{100}$

50. The straight line $\frac{x}{4}+\frac{y}{3}=1$ intersects the ellipse $\frac{x^2}{16}+\frac{y^2}{9}=1$ at two points *A* and *B*, there is a point *P* on this ellipse such that the area of ΔPAB is equal to $6(\sqrt{2}-1)$, the number of such points (*P*) is

51. Let $\vec{b}=4i+3j$ and $\vec{c}$ be two vectors perpendicular to each other in the xy – plane. If $\vec{r}_i$, $i=1,2,....n$ are the vectors in the same plane having projection 1 and 2 along b and c respectively $\sum_{i=1}^{n}\left|\vec{r}_i\right|^2$ is equal to k then $\frac{k+20}{3}$ equals to

52. If $I=\int_{1/e}^{e}\left|\log x\right|\frac{dx}{x^2}$, then $\frac{I}{4}+\frac{1}{2e}=$______________

53. If $f(x)+f(y)=f\left(\frac{x+y}{1-xy}\right)$ for all $x,y\in R$, $xy\neq 1$ and $\lim_{x\to 0}\frac{f(x)}{x}=2$, then the value of $\frac{f\left(\sqrt{3}\right)}{f'(-2)}$ is

54. The minimum value of $(\tan A-\cos B)^2+(\cot A-\sin B)^2$, where A and B are independent variables, is of the form $a-b\sqrt{c}$, where a, b, c are natural numbers. The value of $a+b+c$ is equal to

Space for Rough work

FIITJEE

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JEE (Advanced)-2020

PAPER – 2

ANSWERS, HINTS & SOLUTIONS

Physics

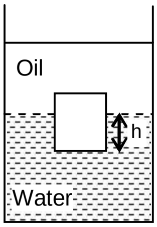
PART – I

SECTION – A

1. CD

Sol. $\left[\rho_w \times 10^{-2} \times h\right] + \left[\rho_o \times 10^{-2}(0.1-h)\right]$ = 0.92

$\Rightarrow$ h = 8 cm



2. CD

Sol. Particle *P* will have a velocity in vertical direction.

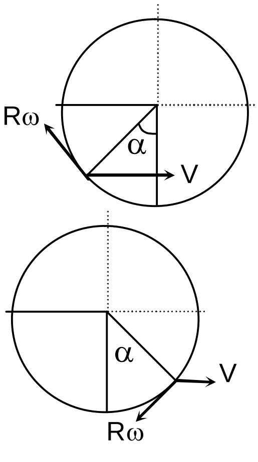
i.e. $R\,\omega \cos\alpha = V$

$$\alpha = \cos^{-1}\frac{V}{R\omega}$$

Required angle θ is $\theta = \pi - \alpha = \pi - \cos^{-1}\frac{V}{R\omega}$

And in second case $R\omega\cos\alpha = V$

$$\alpha = \cos^{-1}\frac{V}{R\omega},\ \theta = \pi + \cos^{-1}\frac{V}{R\omega}$$



3. AB

Sol. $-\frac{dv}{dt} = \frac{v^2}{R}$ & $-v\frac{dv}{ds} = \frac{v^2}{R}$

4. ABD

Sol. By conservation of angular momentum,

$$I_1\omega_i = (I_1 + I_2)\omega_f$$

$$\omega_f = \omega_1 / 3$$

$$E_i = \frac{1}{2} I_1 \omega_i^2$$

$$E_f = \frac{1}{2}(I_1 + I_2)\omega_f^2$$

Ratio of the heat produced to initial kinetic energy $= \frac{E_i - E_f}{E_i} = \frac{2}{3}$

5. BD

Sol. $E \propto m$ and $r \propto \frac{1}{m}$

6. ACD

Sol. $Fx = \frac{1}{2}kx^2$

$\Rightarrow \quad x = \frac{2F}{k}$, $A = \frac{2F}{k} - \frac{F}{k} = \frac{F}{k}$

7. BCD

Sol. dQ = dU + dW ; dQ = 0 in adiabatic process.

8. ABD

Sol. Bernoulli's Th^m for an orifice at depth 'x' in liquid '3d'.

$$P_o + \left(dg\frac{H}{2} + 3dg.x\right) = P_o + \frac{1}{2} \times 3d \times v^z \quad \text{…(1)}$$

$$\frac{H}{2} - x = \frac{1}{2}gt^2 \quad \text{…(2)}$$

$$R = Vt \quad \text{…(3)}$$

Solve for R and apply maxima/minima.

9. A

Sol. Degree of function = 3

W. O. = Area PV graph = $\frac{RT_o}{3}$

Charge in internal Energy

$$\Delta U = nC_V\Delta T$$

$$= \frac{f}{2}nR\Delta T = \frac{f}{2}(P_f v_f - P_i V_i)$$

$$= \frac{3}{2}\left(\frac{3P_o}{2}2V_o - P_o V_o\right) = 3P_oV_o$$

$$\Delta U = RT_o$$

Heat absorbed $(1 \to 2 \to 3)$

$$\Delta Q = \Delta U + W$$

$$\Delta Q = RT_o + \frac{RT_o}{3}$$

$$\Delta Q = \frac{4T_oR}{3}$$

Heat observer $(1 \to 2)$

$\Delta Q = \Delta U + W$

$$= \frac{f}{2}(P_fV_f - P_iV_i) + W$$

$$= \frac{3}{2}(P_0 2V_o - P_oV_o) + P_oV_o$$

$$= \frac{5}{2}P_oV_o = \frac{5}{2}\left(\frac{RT_o}{3}\right)$$

10. D

Sol. Process $1 \to 2$ (Isothermal)

$2 \to 3$ (Isochoric)

W.O. $(1 \to 2 \to 3)$

$$= nRT\ln\left(\frac{V_f}{V_i}\right) + W_{2\to3}$$

$$= \frac{RT_o}{3}\ln 2 + 0$$

$\Delta U \ (1 \to 2 \to 3)$

$$\Delta U = \frac{f}{2}nR(T_f - T_i)$$

$$= \frac{3}{2}R\left(T_o - \frac{T_o}{3}\right)$$

$\Delta U = RT_o$

For $1 \to 2 \to 3$

$\Delta = \Delta U + W$

$$\Delta Q = RT_o + \frac{RT_o}{3}\ln 2$$

For $1 \to 2$

$$Q = \frac{f}{2}nR(T_f - T_i) + nRT\ln\left(\frac{V_f}{V_i}\right)$$

$$= 0 + \frac{RT_o}{3}\ln 2$$

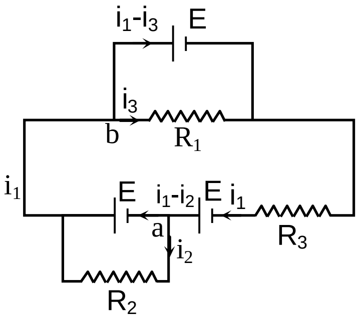
11. C

Sol. On solving by KVL we get, $i_1 = \frac{E}{R}$, $i_2 = -\frac{E}{R}$, $i_3 = \frac{E}{R}$

$\Rightarrow\ i_1 - i_2 = \frac{2E}{R}$ and $i_1 - i_3 = 0$

So reading of ammeter A_1 is $E/R = 4/3$

A_2 is $2E/R = 8/3$, A_3 is zero and $\Delta V_{ab} = 4V$



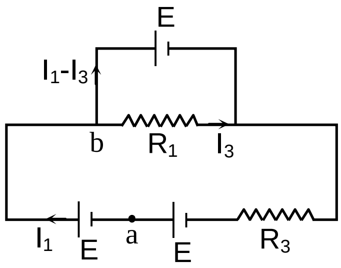
12. A

Sol. Apply KVL

$-I_1 \times 3 + 4 + 4 - 3I_3 = 0$ …(1)

$I_3 = \frac{4}{3}$ …(2)

$I_1 = \frac{4}{3}$



SECTION – C

13. 00002.50

$d\phi = (2\pi x dx)kxt^2$

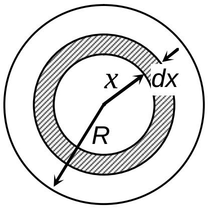
$\phi = \frac{2}{3}kt^2\pi x^3$

$\frac{d\phi}{dt} = \frac{4k\pi tx^3}{3}$

$E2\pi x = \frac{4\pi ktx^3}{3}$; $E = \frac{2}{3}ktx^2$; $d\tau = \left(\frac{2}{3}ktx^2\right)\frac{Q}{\pi R^2}(2\pi x dx)x$

$\int d\tau = \frac{4}{3}\frac{ktQ}{R^2}\int_0^R x^4 dx$ $\Rightarrow\ \tau = \frac{4}{3}\frac{ktQ}{R^2}\frac{R^5}{5}$

At *t* = 15sec, τ = 2.50 Nm



14. 00006.28

Sol. Let elongation of spring be x_0 in equilibrium. Then,

$2T + mg\sin\theta = 2kx_0$ …(i)

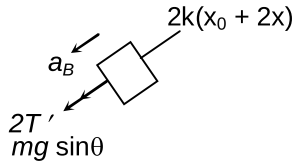
and $T = mg$ …(ii)

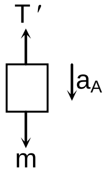
Let Block B is displaced by x down the inclination

F.B.D. of B

$-ma_B = 2k(x_0 + 2x) - 2T' - mg\sin\theta$ …(iii)

F.B.D. of *A*





$mg - T' = ma_A$

Also, $a_A = 2a_B$

$T' = mg - 2ma_B$

$-ma_B = 2kx_0 + 4kx - 2mg + 4ma_B - mg\sin\theta$

$-ma_B = 4kx + 4ma_B$

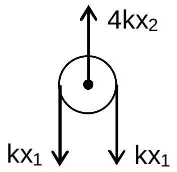
$a_B = -\frac{4k}{5m}x$

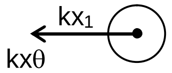
$\therefore\ T = 2\pi\sqrt{\frac{5m}{4k}}$

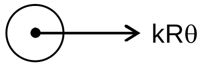
T = 6.28 s.

15. 00008.56

Sol. When the cylinder is displaced towards right, (θ is angle of rotation of diameter of the cylinder about the contact point) then







$x_1 + 2x_2 = R\theta$

$x_1 + x_1 = R\theta$

$x_1 = \frac{R\theta}{2}$

$\tau = -[kx_1R + kR\theta R]$

$\frac{3}{2}mR^2\alpha = -\left[\frac{KR^2\theta}{2} + KR^2\theta\right]$

$\alpha = -\frac{k}{m}\theta \quad ; \quad t_1 = \pi\sqrt{\frac{m}{k}}$

When cylinder moves towards left, then

Torque about the contact point

$-kR^2\theta = \frac{3}{2}mR^2\alpha$

$\alpha = -\left(\frac{2}{3}\frac{k}{m}\right)\theta \quad ; \quad t_2 = \pi\sqrt{\frac{3m}{2k}}$

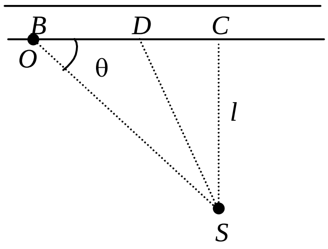
So, time period of oscillation

$T = t_1 + t_2$

$= \frac{\pi}{2}\left(3 + \sqrt{6}\right) = 5.56$ sec.

16. 00136.00

Sol. Let the bus be at O when it sends a signal that is detected by the detector as of frequency = 1500 Hz



$\therefore \quad f' = \left(\frac{v}{v - v_B\cos\theta}\right) \times 1000 = 1500$

$\therefore \quad \cos\theta = \frac{\sqrt{3}}{2} \quad \Rightarrow \quad \theta = 30°$

By the time signal reaches at S the bus reaches at D. Let this time be t_0

∴ $t_0 = \frac{OS}{v} = \frac{l\operatorname{cosec}\theta}{v}$ … (1)

Now man fires and the bullet reaches C in time t_1 (say). In the same time bus moves from D to C

∴ $t_1 = \frac{l}{u}$; where u = speed of bullet

Also, OD + DC = $l\cot\theta$

$v_B t_0 + v_B t_1 = l\cot\theta$

$v_B\left(\frac{l\operatorname{cosec}\theta}{v}\right) + v_B (l/u) = l\cot\theta$

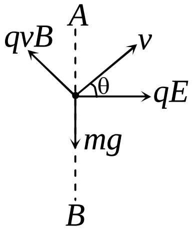
$\frac{2}{3\sqrt{3}}\times 2+\frac{2}{3\sqrt{3}}\frac{v}{u}=\sqrt{3}$

∴ $\frac{v}{u}=\frac{5}{2}$

∴ $u = \frac{2}{5}v=\frac{2}{5}\times 340$ = 00136.00 m/s

17. 00019.60

Sol. When crosses *AB*



$qvB_0\cos\theta = mg$

$qvB_0 \sin\theta = qE$

$\tan\theta = \frac{qE}{mg} = 1$

$\theta = \frac{\pi}{4}$

along horizontal $v\cos\theta = \frac{qE}{m}t_0$

$u - gt_0 = v\sin\theta$

$u = \left(g + \frac{qE}{m}\right)t_0 = 2gt_0$

18. 00002.00

Sol. $\int \tau dt = NAB\int i dt$

$I\omega_0 = NABQ$ ……(i)

$\frac{1}{2}I\omega_0^2 = \frac{1}{2}C\theta_{max}^2$ …….(ii)

From equation (i) and (ii)

$\theta_{max} = \frac{NABQ}{\sqrt{CI}}$

Chemistry PART – II

SECTION – A

19. AC

Sol. In BF_3 due to $p\pi$- $p\pi$ back bond and existence of pi-bond in CO_2.

20. A

Sol. In B & C free radical intermediates are formed. In (D) no full-fledged intermediate is formed.

21. AC

Sol. The nucleophiles contains two donor atoms.

22. AB

Sol.
$$E_{Cell} = E^0_{Cell} - \frac{0.0591}{2}\log\frac{\left[Zn^{2+}\right]}{\left[Ag^{+}\right]^2}$$

$$= E^0_{Cell} - \frac{0.0591}{2}\log\frac{C_1}{(C_2)^2}$$

$E_{Cell} = E^0_{Cell}$, when $C_1 = C_2 = 1$ M or $C_2 = \sqrt{C_1}$

23. ABCD

Sol.
$$\begin{tikzcd} 3NH_4Cl + 3BCl_3 \arrow[r, "C_6H_5Cl", "140\text{–}150^0C"'] & B_3N_3H_3Cl_3 \arrow[dl, "NaBH_4"] \\ B_3N_6H_6 & \end{tikzcd}$$

24. AB

Sol. (D) forms acetone on heating
(C) forms anhydride on heating

25. ABD

Sol. CO_3^{2-}, SO_3^{2-},NO_2^- form CO_2, SO_2 and NO or NO_2 gases when treated with dil. acids.

26. ABC

Sol. Heat of hydrogenation, heat of neutralisation and acid dilution are exothermic processes.

27. C

Sol. CsCl has b.c.c unit cell, which coordination number equal to eight.

28. B

Sol. In ZnS crystal, cations occupy half of tetrahedral voids and anions form the fcc lattice.

29. B

Sol. Due to half-filled $t_{2g}^3e_g^2$ configuration $[FeF_6]^{3-}$ complex is colourless.

30. A

Sol. Due to $3d^9$ $\left(t_{2g}^6e_g^3\right)$ configuration.

SECTION – C

31. 00418.52

Sol. Moles of Sn^{2+} = 523.15×10^{-3}

Moles of MnO_4^- required = $\frac{2}{5} \times 523.15 \times 10^{-3}$

Volume = $\dfrac{\frac{2}{5} \times 523.15 \times 10^{-3} \times 1000}{0.5}$ = 418.52 mL

32. 00020.22

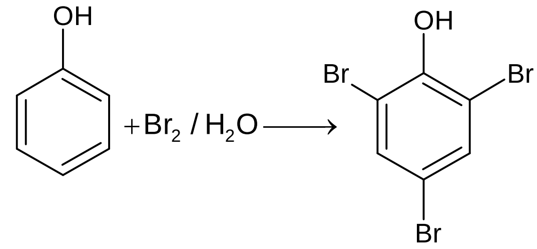
Sol. $\lambda = \dfrac{h}{\sqrt{2mE}} = \dfrac{6.6 \times 10^{-34}}{\sqrt{2 \times 9 \times 10^{-31} \times 50 \times 10^{3}}} = \dfrac{6.6 \times 10^{-34}}{\sqrt{900 \times 10^{-28}}}$

$= \dfrac{6.6 \times 10^{-34}}{30 \times 10^{-14}} = 0.22 \times 10^{-20} = y \times 10^{-z}$

$\therefore$ y + z = 20.22

33. 00330.70

Sol.



34. 00140.80

Sol. $\Delta T_f = K_f m = 1.86 \times \text{one mole} \times \dfrac{1000}{W}$

or $1.86 \times \dfrac{1000}{W} = 3.72$

or W = 500 g

$\therefore$ Mass of ice formed = 640.8 – 500 = 140.8

35. 00154.90

Sol. X = $K_2Cr_2O_7$, Y = CrO_2Cl_2, Z = Na_2CrO_4, Yellow ppt. = $PbCrO_4$

36. 02412.50

Sol. Q = It

190.5 g Cu = 3 mole

½ mole Cu deposited by 1 F

3 mole Cu deposited = 6 F = 6 × 96500 = 579000 coulomb

579000 = I × 60 × 4

or $I = \dfrac{579000}{240} = 2412.5$ amp

Mathematics PART – III

SECTION – A

37. AD

Sol. $\because$ (x – 1) (x – 2) = 4

conjugate hyperbola (x – 1) (x – 2) = -4

$\therefore \frac{a^2}{2} = 4 \therefore a = 2\sqrt{2}$

focus of H' $\equiv \left(-2\sqrt{2}, 2\sqrt{2}\right) \& \left(2\sqrt{2}, -2\sqrt{2}\right)$

focus of H $\equiv \left(1-2\sqrt{2}, 2+2\sqrt{2}\right) \& \left(1+2\sqrt{2}, 2-2\sqrt{2}\right)$

Equation of transverse axis y – 2 = x – 1 $\Rightarrow$ x – y + 1 = 0.

38. AC

Sol. We have $\sum_{r=0}^{n} \frac{r}{{}^nC_r} = \sum_{r=0}^{n} \frac{n-r}{{}^nC_{n-r}} = \sum_{r=0}^{\infty} \frac{n-r}{{}^nC_r} \Rightarrow \sum_{r=0}^{n} \frac{2r}{{}^nC_r} = \sum_{r=0}^{n} \frac{n}{{}^nC_r} \Rightarrow n = n^2 - 3n + 3$

$\Rightarrow$ n = 1, 3

39. ABC

Sol. Combined equation of pair of lines through the origin joining the points of intersection of lien $y = \sqrt{m}x + 1$ with the given curve is $x^2 + 2xy + (2 + \sin\alpha)y^2 - (y - mx)^2 = 0$ for the chord to subtend a right angle at the origin $(1-m) + \left(2 + \sin^2\alpha - 1\right) = 0$ (as sum of the coefficient of $x^2 + y^2 = 0$)

$\Rightarrow \sin^2\alpha = m - 2$

$\Rightarrow 0 \le m - 2 \le 1$

$\Rightarrow 2 \le m \le 3$

40. ABCD

Sol. f(x) = f(α + β - x)

$\Rightarrow$ f(α) = f(β) and g(α) = g(β)

$$\int_{\alpha}^{\beta} f(x)g'(x)\,dx = f(x)g(x)\Big|_{\alpha}^{\beta} - \int_{\alpha}^{\beta} f'(x)g(x)dx$$

$$2I = \int_{\alpha}^{\beta} f(x)g'(x) - \int_{\alpha}^{\beta} f'(x)g(x)dx$$

$$I = \frac{1}{2}\int_{\alpha}^{\beta} \left(f(x)g'(x) - f'(x)g(x)\right)dx$$

41. BD

Sol. Let one probability of choosing one integer k be $P(k) = \frac{\lambda}{k^4}$. ($\lambda$ is one constant of proportionality). Then,

$$\sum_{k=1}^{2m}\frac{\lambda}{k^4}=1\Rightarrow\lambda\sum_{k=1}^{2m}\frac{1}{k^4}=1$$

Let x_1 be the probability of choosing the odd number. Then

$$x_1=\sum_{k=1}^{2m}P(2k-1)=\lambda\sum_{k=1}^{m}\frac{1}{(2k-1)^4}$$

Also, $1-x_1=x_2=\sum_{k=1}^{m}P(2k)=\lambda\sum_{k=1}^{m}\frac{1}{(2k)^4}<\lambda\sum_{k=1}^{m}\frac{1}{(2k-1)^4}$

$$\Rightarrow\ 1-x_1<x_1\qquad\Rightarrow\qquad x_1>\frac{1}{2}\qquad\Rightarrow\qquad x_2<\frac{1}{2}$$

42. BCD

Sol. $f''(x)\Rightarrow\begin{cases}2\,;x>0\\-2\,;\ x<0\end{cases}\Rightarrow$ not differentiable

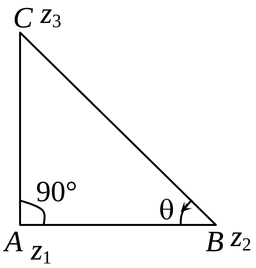
$g(x)\Rightarrow\begin{cases}-x^2\cot^{-1}x; & x>0\\-x^2\cot^{-1}x; & x<0\Rightarrow\text{ twice differentiable}\\\quad 0\ ;x=0\end{cases}$

h(x) = $\sin^2 x\ \rightarrow$ differentiable

$k'(x)=\begin{cases}4x^3.\cos\frac{1}{x}+x^2.\sin\frac{1}{x}\,;x\neq0\\\qquad 0\,;\ x=0\end{cases}$

twice differentiable

43. AB



Sol. $\frac{W_2}{|W_2|}=\frac{W_1}{|W_1|}e^{-i\theta}$

$$\Rightarrow\qquad\frac{W_2}{W_1}=\frac{|W_2|}{|W_1|}e^{-i\theta}=1-i\tan\theta$$

$$W_1\overline{W}_2=\frac{W_1}{W_2}|W_2|^2=|W_1|\ |W_2|e^{i\theta}=\left(|W_1|^2+i|W_1|\ |W_2|\tan\theta\right)$$

44. ABC

Sol. We have $A(\alpha,\beta)'=\begin{bmatrix}\cos\alpha & -\sin\alpha & 0\\\sin\alpha & \cos\alpha & 0\\0 & 0 & e^{\beta}\end{bmatrix}$

$$=\begin{bmatrix}\cos(-\alpha) & \sin(-\alpha) & 0\\-\sin(-\alpha) & \cos(-\alpha) & 0\\0 & 0 & e^{\beta}\end{bmatrix}=A(-\alpha,\beta)$$

Also, $A(\alpha,\beta)A(-\alpha,-\beta)$

$$=\begin{bmatrix}\cos\alpha & \sin\alpha & 0\\ -\sin\alpha & \cos\alpha & 0\\ 0 & 0 & e^{\beta}\end{bmatrix}\begin{bmatrix}\cos\alpha & -\sin\alpha & 0\\ \sin\alpha & \cos\alpha & 0\\ 0 & 0 & e^{-\beta}\end{bmatrix}$$

= I

$\Rightarrow A(\alpha,\beta)^{-1} = A(-\alpha, -\beta)$

Next, $\text{Adj}(\alpha,\beta) = \left|A(\alpha,\beta)\right| A(\alpha, \beta)^{-1}$

$= e^{\beta} A(-\alpha, -\beta)$

45. C
46. C

Sol. (for Q. 45 – 46):

(I). Equation of the plane π is $A(x-1)+B(y-1)+C(z-1)=0$ where $A+0$. B –1, C = 0 and $-A+B+0.C=0$

$\Rightarrow$ $A=B=C$ and the equation of π is $x+y+z=3x$. Which meets the coordinates axes at A (3, 0, 0), B (0, 3, 0) and C (0, 0, 3). So volume of the tetrahedron

$$OABC=\frac{1}{6}\begin{vmatrix}0 & 0 & 0 & 1\\ 3 & 0 & 0 & 1\\ 0 & 3 & 0 & 1\\ 0 & 0 & 3 & 1\end{vmatrix}=\frac{1}{6}\times 27=\frac{9}{2}$$

(II). $AB=BC=CA=3\sqrt{2}$, so the area of the face ABC which is an equilateral triangle $=\frac{\sqrt{3}}{4}\times\left(3\sqrt{2}\right)^2=\frac{9\sqrt{3}}{2}$. Each of the face OAB, OBC, OCA is an isosceles triangle with sides $3,\ 3\sqrt{2}$

So area of each of these faces is $\frac{1}{2}\times 3\sqrt{2}\times\sqrt{9-\frac{9}{2}}=\frac{9}{2}$

(III). required distance is $\left|\frac{3\sqrt{3}+3\sqrt{3}-3-3}{\sqrt{1+1+1}}\right|=\frac{9}{2}$

(IV). Distance of O from the face $ABC=\left|\frac{0+0+0-3}{\sqrt{1+1+1}}\right|=\sqrt{3}$ distance of A, B, C from opposite faces OBC, OCA, OAB are equal and is 3.

47. B
48. B

Sol. (for Q. 47 – 48):

a, b, c are three roots of the quadratic equation

$\left(\left(4f(-1)-3\right)x^2+\left(4f(1)-3\right)\right)x+f(2)=0$

$\Rightarrow 4f(-1)=3, 4f(1)=3$ and $f(2)=0$

Let $f(x)=(x-2)(Ax+B)$

Now, $3=4f(-1)=4(-3)(-A+B)\Rightarrow A-B=\frac{1}{4}$

$3 = 4f(-1) = 4(-1)(A+B) \Rightarrow A+B = \frac{-3}{4}$

$\therefore\ A = \frac{-1}{4}, B = \frac{-2}{4}$

Thus, $f(x) = \frac{1}{4}(4-x^2)$.

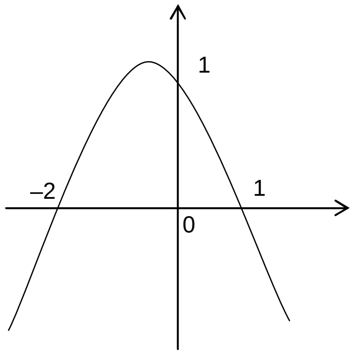
The graph of $y = f(x)$ is given in Figure.

(I). x coordinates of points of intersection of $y = f(x)$ when the x – axis are ± 2.

(II). Area $= \frac{3}{2}\int_{-2}^{2}\frac{1}{4}(4-x^2)dx = \frac{3}{8}(2)\left(4x-\frac{x^2}{3}\right)\Big]_0^2 = 4$

(III). Maximum value of f(x) is 1

(IV). Length of intercept on the x – axis is 4.



SECTION – C

49. 00021.61

Sol. The number of ways when no student failed in any examination $=(2^3-1)^4$

The number of ways when out of above cases atleast one subject was not cleared by any students $=3C_1(3)^4$

The number of ways when out of above cases atleast any two subjects were not cleared by any student $=3C_2(1)^4$. So required cases $=(2^3-1)^4-3C_1 3^4+3C_2$ = 2161

50. 00003.00

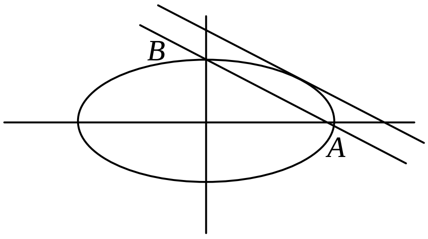
Sol. Let perpendicular distance of *P* from the line be *h*

$\frac{1}{2}\times h\times 5 = 6(\sqrt{2}-1)$ (as $\Delta PAB = 6(\sqrt{2}-1)$)

$\Rightarrow h = \frac{12(\sqrt{2}-1)}{5}$

Now distance of tangent parallel to *AB* i.e. $4y+3x = 12\sqrt{2}$, from line *AB* is $\frac{12(\sqrt{2}-1)}{5}$.

There are just three such points.



51. 00013.33

Sol. Let $\vec r = \lambda\vec b + \mu\vec c$ and $\vec c = \pm(xi + yj)$. Since $\vec c$ and $\vec b$ are perpendicular, we have

$$4x + 3y = 0 \quad \Rightarrow \quad \vec c = \pm x\left(i - \frac{4}{3}j\right)$$

$$\pm1 = \text{ proj. of } \vec r \text{ on } \vec b = \frac{\vec r.\vec b}{|\vec b|} = \frac{(\lambda\vec b + \mu\vec c).\vec b}{|\vec b|} = \frac{\lambda\vec b.\vec b}{|\vec b|}$$

$$\left[\because \vec b.\vec c = 0\right]$$

$= \lambda|\vec b| = 5\lambda$. Hence $\lambda = \pm\frac{1}{5}$

Also, $\pm2 = \text{proj. of } \vec r \text{ on } \vec c = \frac{\vec r.\vec c}{|\vec c|}$

$$= \frac{(\lambda\vec b + \mu\vec c).\vec c}{|\vec c|} = \mu|\vec c| = \frac{5}{3}\mu x$$

Thus, $\mu x = \pm\frac{6}{5}$. Therefore,

$$\vec r = \frac{1}{5}(4i + 3j) + \frac{6}{5}\left(i - \frac{4}{3}j\right) = \pm(2i - j)$$

$$\vec r = \frac{1}{5}(4i + 3j) - \frac{6}{5}\left(i - \frac{4}{3}j\right) = \pm\left(-\frac{2}{3}i + \frac{11}{5}j\right)$$

Thus there are four such vectors

$$\sum_{i=1}^{4}|\vec r_i|^2 = 2|2i - j|^2 + 2\left|-\frac{2}{5}i + \frac{11}{5}j\right|^2 = 20$$

52. 00000.50

Sol. Put $\frac{1}{x} = t$, so that $I = \int_{1/e}^{e} |\log x|(-1)\,dt$

$$= \int_{e}^{1/e} \left|\log\frac{1}{t}\right|(-1)\,dt$$

$$= \int_{1/e}^{e} |-\log t|\,dt$$

$$= \int_{1/e}^{1}(-\log t)\,dt + \int_{1}^{e}(\log t)\,dt$$

$$= (-t\log t + t]_{1/e}^{1} + (t + \log t - t]_{1}^{e}$$

$$= 1 - \frac{1}{e} - \frac{1}{e} + e - e + 1 \quad = 2\left(1 - \frac{1}{e}\right)$$

53. 00005.24

Sol. Given, $f(x) + f(y) = f\left(\frac{x + y}{1 - xy}\right)$

Putting x = 0, y = 0, we get f (0) = 0 ………………..(i) and putting y = –x, we get

$$f(x)+f(-x)=f(0)=0$$

$$\therefore \quad f(x)=-f(-x) \qquad \ldots\ldots\ldots\ldots\ldots\ldots\text{(ii)}$$

$$\text{Now, } f'(x)=\lim_{h\to 0}\frac{f(x+h)-f(x)}{h}$$

$$=\lim_{h\to 0}\frac{f(x+h)+f(-x)}{h} \qquad \text{[from Eq. (ii)]}$$

$$=\lim_{h\to 0}\frac{f\left(\dfrac{x+h-x}{1+(x+h)x}\right)}{h}$$

$$=\lim_{h\to 0}\frac{f\left(\dfrac{h}{1+x^2+xh}\right)}{\left(\dfrac{h}{1+x^2+xh}\right).\left(1+x^2+xh\right)}$$

$$\Rightarrow \quad f'(x)=\frac{2}{1+x^2} \qquad \left(\because \lim_{x\to 0}\frac{f(x)}{x}=2\right)$$

$$\therefore f'(-2)=\frac{2}{1+4}=\frac{2}{5}$$

and $\quad f(x)=2\tan^{-1}x+c$

$$f(0)=0+c=0$$

$\therefore \quad c = 0$

$\therefore \quad f(x)=2\tan^{-1}x$

$$\Rightarrow \quad f\left(\sqrt{3}\right)=2\tan^{-1}\sqrt{3}=\frac{2\pi}{3}$$

54. 00007.00

Sol. The given expression can be interpreted as the square of the distance between the points $(\tan A, \cot A)$ and $(\cos B, \sin B)$.

The minimum value of this distance is the minimum distance between the curves $xy=1$ and $x^2+y^2=1$.

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – IV

JEE (Main)-2020

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 75 questions.
- Each subject (PCM) has 25 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only three sections: **Section-A**, **Section-B and Section-C**.

  Section-A (01 – 20, 26 – 45, 51 – 70) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

  Section-B (21 – 22, 46 – 47, 71 – 72) *contains 6 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

  Section-C (23 – 25, 48 – 50, 73 – 75) *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. In order to convert a miliammeter of range 1.0 mA and resistance 1.0 ohm into a voltmeter of range 10 V, a resistance of how many ohms should be connected with it and in what manner?

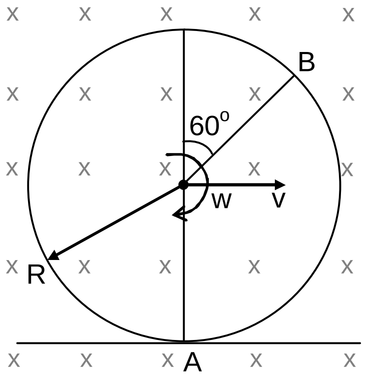
(A) 999 Ω in series (B) 999 Ω in parallel
(C) 9,999 Ω in series (D) 9,999 Ω in parallel

2. The electron emitted in β-radiation originates from :

(A) inner orbits of atoms (B) free electrons existing in nuclei
(C) decay of a neutron in a nucleus (D) photon escaping from the nucleus

3. A conducting wheel is rolling on the ground in a uniform magnetic field B_o then the emf induced between points A and B; $V_A - V_B$ will be

(A) $B_o w^2(\sqrt{3}R)$
(B) $-\frac{\sqrt{3}}{2}Bw^2 R$
(C) $B_o w^2\sqrt{2}R$
(D) $-B_o w^2\left(\frac{\sqrt{5}}{2}\right)R$

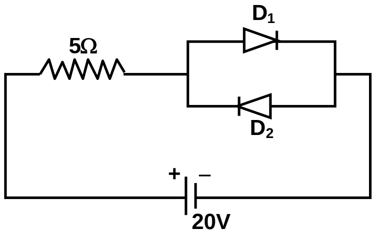


4. Forces acting on a particle moving in a straight line varies with the velocity of the particle as $F = \frac{\alpha}{v}$ where α is constant. The work done by this force in time interval Δt is

(A) $\alpha\Delta t$ (B) $\frac{1}{2}\alpha\Delta t$
(C) $2\alpha\Delta t$ (D) $\alpha^2\Delta t$

Space for Rough work

5. In the figure shown below, chose the correct answer.
(A) Voltage across D_2 is 20 Volt.
(B) Voltage across D_1 is 20 Volt.
(C) Current through diode D_1 is 4A.
(D) Current through diode D_1 is 0 A.



6. A ferromagnetic substance when heated beyond curie temperature becomes

(A) diamagnetic.	(B) ferromagnetic.
(C) nonmagnetic.	(D) paramagnetic.

7. The resultant of $\vec{A}$ and $\vec{B}$ is perpendicular to $\vec{A}$. What is the angle between $\vec{A}$ and $\vec{B}$?

(A) $\cos^{-1}\left(\frac{A}{B}\right)$	(B) $\cos^{-1}\left(-\frac{A}{B}\right)$
(C) $\sin^{-1}\left(\frac{A}{B}\right)$	(D) $\sin^{-1}\left(-\frac{A}{B}\right)$

8. In a radioactive reaction an unstable nucleus A dis-integrates into a stable nucleus B. But A is generated at a constant rate of q nucleus per second. Then at steady state number of nucleus of A will be

$$q\ (\text{sec}^{-1}) \longrightarrow \underset{\substack{\text{(Parent}\\\text{Nucleus)}}}{A} \xrightarrow{\lambda} \underset{\substack{\text{(Daughter}\\\text{Nucleus)}}}{B}$$

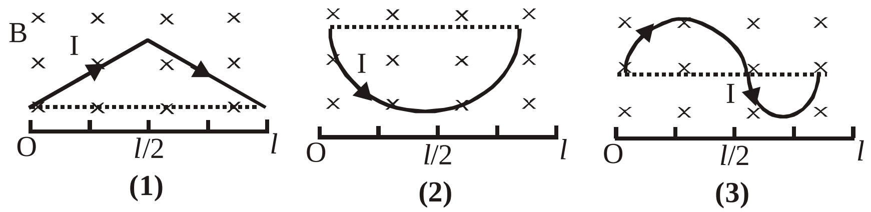
(A) $q\lambda$	(B) $\frac{q}{\lambda}$
(C) $q-\lambda$	(D) $\frac{\lambda}{q}$

9. A block slides down an inclined plane of inclination θ with constant velocity. It is then projected up the plane with an initial speed u. How far up the incline will it move before coming to rest

(A) $\frac{u^2}{4g\sin\theta}$	(B) $\frac{u^2}{g}\sin\theta$
(C) $\frac{u^2}{2g}\sin\theta$	(D) $\frac{u^2}{4g}$

Space for Rough work

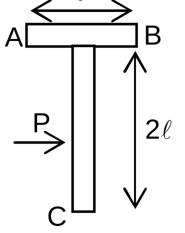
10. Three conductors 1, 2, and 3 each carrying the same current I are placed in a uniform magnetic field B, as shown in figure. The forces experienced by conductors 1, 2 and 3 are F_1, F_2 and F_3, respectively



(1) **(2)** **(3)**

(A) $F_3 > F_2 > F_1$
(B) $F_1 \neq 0$; $F_1 \neq 0$; $F_3 = 0$
(C) F_1 acts upwards, F_2 acts downwards ; $F_3 = 0$
(D) All experience the same force in same direction

11. A T-shaped object with dimensions shown in the figure, is lying on a smooth floor. A force $\vec{F}$ is applied at the point P parallel to AB, such that the object has only the translational motion without rotation. Find the location of P with respect to C.



(A) $\frac{4\ell}{3}$ (B) ℓ
(C) $\frac{2\ell}{3}$ (D) $\frac{3\ell}{2}$

12. A communication earth satellite which takes 24hours to complete one circular orbit eventually has to be replaced by another satellite which has twice the mass of the first. If the new satellite is also to have an orbital period of 24 hr, what is the ratio of radius of the new orbit to the radius of the original orbit?
(A) 1 : 1 (B) 2 : 1
(C) $\sqrt{2} : 1$ (D) 1 : 2

Space for Rough work

13. Imagine a Young's double slit interference experiment performed with wave associated with fast moving electrons produced from an electron gun. The distance between successive maxima will decrease maximum if
(A) the accelerating potential in the electron gun is decreased.
(B) the accelerating potential is increased and the distance of screen from slit is decreased.
(C) the distance of the screen from the slit is increased.
(D) the distance between the slits is decreased.

14. If a person walking at the rate of 3km/hour, the rain appears him to fall vertically. When he increase his speed to 6 km/hr it appears to meet him at angle of 30^0 with vertical. The speed of rain is

(A) $3\sqrt{2}$ km/hr	(B) $\frac{3}{\sqrt{2}}$ km/hr
(C) $6\sqrt{2}$ km/hr	(D) 6 km/hr

15. A pendulum bob of mass 10^{-2} kg is raised to a height 5×10^{-2}m and then released. At the bottom of its swing, it picks up a mass 10^{-3}kg. To what height will the combined mass rise?

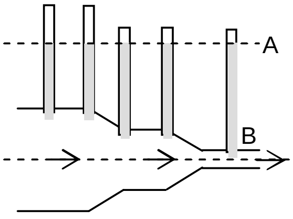
(A) 0.6 m	(B) 0.54 m
(C) 0.41 m	(D) 0.8 m

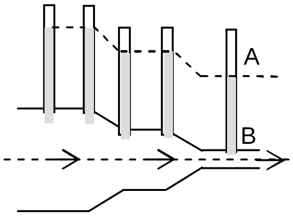
16. A particle performs harmonic motions along y-axis about the origin. The angular frequency is, ω = 4rad/s. At a certain instant the particle has a coordinate y' = 25 cm and its velocity v' = 100cm/s. The coordinate y and the velocity of the particle at t = 2.4s after that moment, will be

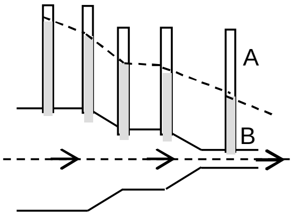
(A) -28.68 cm, -82.18 cm/s	(B) -28.68 cm, 0
(C) 0, -82.18 cm/s	(D) 28.68 cm, 82.18 cm/s

Space for Rough work

17. A non-viscous liquid flows through a horizontal pipe of varying cross sectional area. Identify the option which correctly represents the variation of height of rise of liquid in each vertical tube

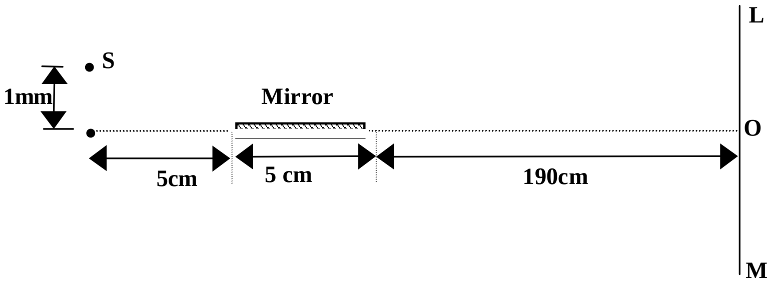
(A)


(B)


(C)


(D) None Of these

18. The arrangement of the Lloyd's mirror experiment is shown in the figure. 'S' is a point source of frequency 6×10^{14} Hz. A and B represent the two ends of a mirror placed horizontally, and LOM represents the screen.



If the number of fringes on the screen is 8x, then x =

(A) 4 (B) 5

(C) 6 (D) 7

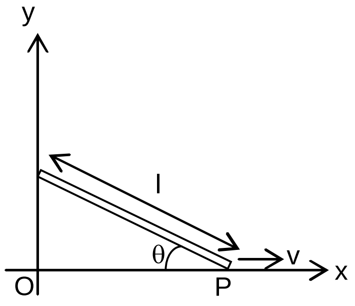
Space for Rough work

19. Two narrow cylindrical pipes A and B have the same length. Pipe A is open at both ends and is filled with a monatomic gas of molar mass M_A. Pipe B is open at one end and closed at the other end, and is filled with a diatomic gas of molar mass M_B. Both gases are at the same temperature. If the frequency of the second harmonic in pipe A is equal to the frequency of the third harmonic in pipe B, what is the value of M_A/M_B?

(A) $\frac{100}{189}$ (B) $\frac{200}{189}$

(C) $\frac{400}{189}$ (D) $\frac{500}{189}$

20. The end of a rigid rod of length l is moved with a constant velocity v. Find the speed of the midpoint of the rod



(A) $\frac{v}{2\sin\theta}$ (B) $\frac{v}{2}\tan\theta$

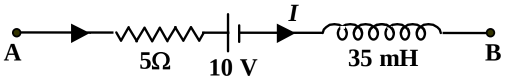
(C) $\frac{v}{2}\cot\theta$ (D) $\frac{v}{2\cos\theta}$

SECTION – B

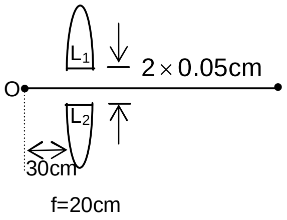
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

21. The network shown in Figure is part of a complete circuit. If at a certain instant the current (I) is 5A, and is decreasing at a rate of 10^3 A/s, then $V_B – V_A$ =



22. A point object O is placed at a distance of 0.3 m from a convex lens (focal length 0.2 m) cut into two halves each of which is displaced by 0.0005 m as shown in figure. Find the distance between the images (in mm)



Space for Rough work

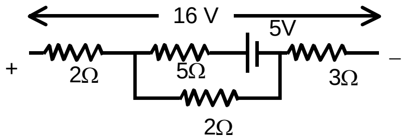
SECTION – C

(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

23. A beam of light wavelength 600 nm from a distant source falls on a single slit 1.00 mm wide and the resulting diffraction pattern is observed on a screen 2 m away. The distance (in mm) between the first dark fringes on either side of the central bright fringe is

24. In the circuit shown below, determine the current through 5V cell



25. A 200 W and a 100 W bulb, both meant for operation at 220 V are connected to a 220 V supply in series. Find total power consumed by them.

Space for Rough work

Chemistry

PART – II

SECTION – A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

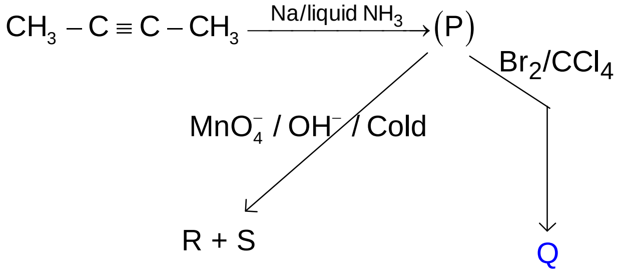
26. The bond order of which molecule is greater than one?

(A) NF_3	(B) BF_3
(C) CF_4	(D) CHF_3

27. Which of the following two compounds of potassium evolve gases when react with water?

(A) KNO_3 and K_2CO_3	(B) KO_2 and K_2S
(C) $KHCO_3$ and KOH	(D) K_2O_2 and K_2SO_4

28.



Which of the following statement is correct about the products of above reaction?

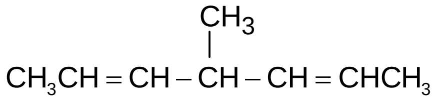
(A) ‘Q’ contains no asymmetric carbon atom

(B) ‘P’ and ‘Q’ are functional isomers

(C) 50% of R and 50% of Q makes a racemic mixture

(D) ‘P’ has one stereoisomer

Space for Rough work

29. 

$$CH_3CH=CH-\overset{\overset{CH_3}{|}}{CH}-CH=CHCH_3$$

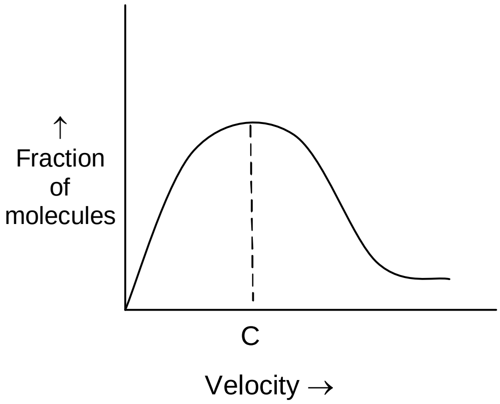
How many stereoisomer(s) is/are possible for the above compound?

(A) 2
(B) 3
(C) 4
(D) 6

30. What is the wavelength of the motion of the electron of hydrogen atom along the fourth orbit?

[r_0 = Radius of first orbit of 'H' atom]

(A) $2\pi r_0$
(B) $4\pi r_0$
(C) $8\pi r_0$
(D) $16\pi r_0$

31. 

Which of the following velocity is mentioned at C?

(A) $\sqrt{\frac{2RT}{M}}$
(B) $\sqrt{\frac{3RT}{M}}$
(C) $\sqrt{\frac{8RT}{\pi M}}$
(D) $\sqrt{\frac{4RT}{\pi M}}$

Space for Rough work

32. $CO_2(g) + C(s) \rightleftharpoons 2CO(g)$

Which of the following factor cannot affect the product yield of above reaction?

(A) Pressure
(B) Temperature
(C) Catalyst
(D) Addition of inert gas at constant pressure

33. $SrCO_3(s) \rightleftharpoons Sr^{2+}(aq) + CO_3^{2-}(aq)$

Addition of which of the following substance can increase the solubility of $SrCO_3$ according to above reaction?

(A) NaCl (B) HCl
(C) K_2CO_3 (D) NaOH

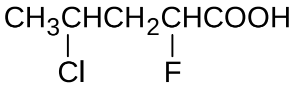
34. Neither expansion nor compression work is done in

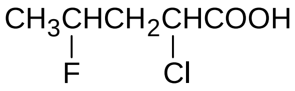
(A) isothermal process (B) adiabatic process
(C) isobaric process (D) isochoric process

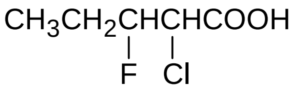
35. Which of the following is not identical between inorganic benzene and organic benzene?

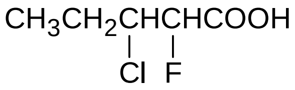
(A) No. of atoms (B) No. of electrons
(C) No. of π - bonds (D) No. of polar covalent bonds

36. Which of the following is the strongest acid?

(A)

$\mathrm{CH_3\underset{\underset{Cl}{|}}{C}HCH_2\underset{\underset{F}{|}}{C}HCOOH}$

(B)

$\mathrm{CH_3\underset{\underset{F}{|}}{C}HCH_2\underset{\underset{Cl}{|}}{C}HCOOH}$

(C)

$\mathrm{CH_3CH_2\underset{\underset{F}{|}}{C}H\underset{\underset{Cl}{|}}{C}HCOOH}$

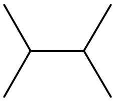
(D)

$\mathrm{CH_3CH_2\underset{\underset{Cl}{|}}{C}H\underset{\underset{F}{|}}{C}HCOOH}$

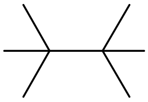
Space for Rough work

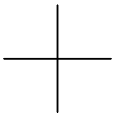
37. Which of the following substance on heating produces Glauber's salt?
(A) $NaHCO_3$ (B) $NaHSO_4$
(C) $Na_2S_2O_3$ (D) NaHS

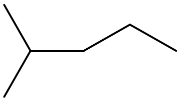
38. Which of the following are heating products of borax?
(A) Na_3B and $NaBO_2$ (B) Na_2O and B_2H_6
(C) $NaBO_2$ and B_2O_3 (D) Na_3B and $B_2O_{3=}$

39. Which of the following substance forms the maximum number of monochloro products?

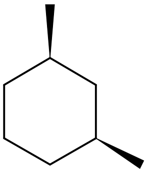
(A)


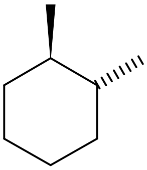
(B)


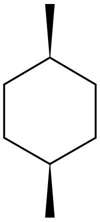
(C)


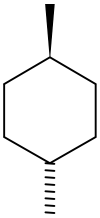
(D)


40. Which of the following compounds has maximum number of stereoisomers?

(A)


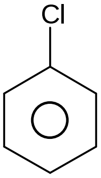
(B)


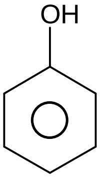
(C)


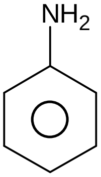
(D)


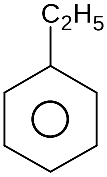
Space for Rough work

41. Which is most reactive towards $CH_2 = CH_2/H^+$?

(A)


(B)


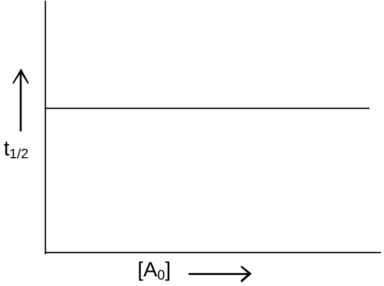
(C)


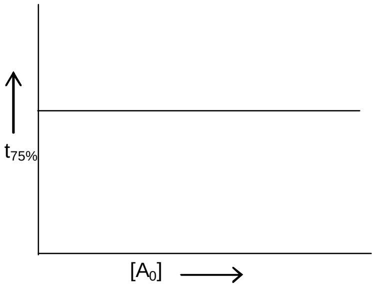
(D)


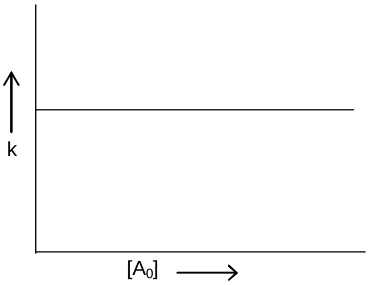
42. Which of the following molecule has square planer shape?

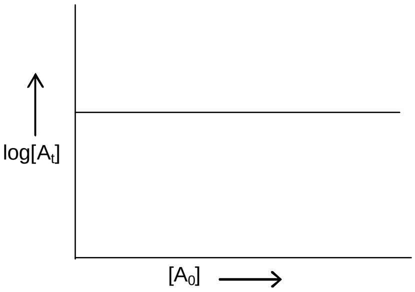
(A) CF_4
(B) SF_4
(C) XeF_4
(D) SeF_4

43. Which of the following graph is correct for a zero order reaction?

(A)


(B)


(C)


(D)


Space for Rough work

44. What is the pH of 10^{-2} M NaH_2PO_4?
[$p^{K_{a1}}$, $p^{K_{a2}}$ and $p^{K_{a3}}$ of H_3PO_4 are 7.2, 10.6 and 12.8]
(A) 9.7
(B) 8.01
(C) 10.6
(D) 8.9

45. In which of the following compound, nitrogen exhibits its lowest oxidation state?
(A) NH_2OH
(B) NH_2NH_2
(C) NH_4Cl
(D) KNO_3

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

---

46. How many of the following species are paramagnetic.
C_2, N_2, O_2, O_2^+, O_2^{2-} F_2, H_2^+, NO

47. How many lone pairs of electrons are present in ICl_2^-.

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

48. pH of 10^{-3} M solution of acetic acid ($K_a = 1.8 \times 10^{-5}$) is

49. Calculate the spin only magnetic moment of M^{2+}(aq) ion (Z = 27) in BM?

50. If molar mass of the product formed by reaction of phenol with Br_2/Cs_2 is M_o then $m_o/4$ is

Space for Rough work

Mathematics

PART – III

SECTION – A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

51. Let $a > 1$ be a real number and $f(x) = \log_a x^2$ for $x > 0$. If f^{-1} is the inverse function of f and b and c are real numbers then $f^{-1}(b+c)$ is equal to

(A) $f^{-1}(b).f^{-1}(c)$
(B) $f^{-1}(b)+f^{-1}(c)$
(C) $\frac{1}{f(b+c)}$
(D) $\frac{1}{f^{-1}(b)+f^{-1}(c)}$

52. The function f (x) = $\frac{\log(\pi + x)}{\log(e + x)}$ (x ≥ 0) is

(A) increasing in [0, ∞)
(B) decreasing in [0, ∞)
(C) increasing in $\left[0, \frac{\pi}{e}\right)$ and decreasing in $\left[\frac{\pi}{e}, \infty\right)$
(D) decreasing in $\left[0, \frac{\pi}{e}\right)$ and increasing in $\left[\frac{\pi}{e}, \infty\right)$

53. Locus of all point P (x, y) satisfying $x^3 + y^3 + 3xy = 1$ consists of union of

(A) a line and an isolated point
(B) a line pair and an isolated point
(C) a line and a circle
(D) a circle and an isolated point

Space for Rough work

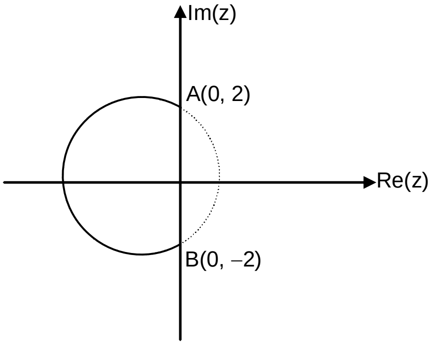
54. If $\tan\theta_1$, $\tan\theta_2$, $\tan\theta_3$ and $\tan\theta_4$ are the roots of the equation $x^4 - x^3 \sin 2\beta + x^2 \cos 2\beta - x\cos\beta - \sin\beta = 0$ then $\tan\left(\theta_1 + \theta_2 + \theta_3 + \theta_4\right)$ is equal to

(A) $\sin\beta$ (B) $\cos\beta$

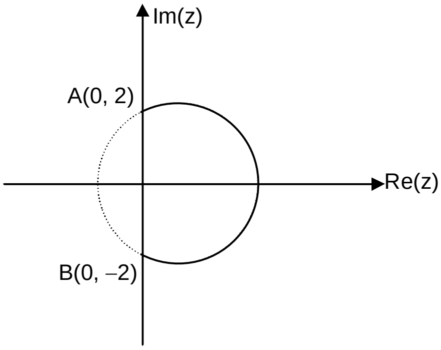
(C) $\tan\beta$ (D) $\cot\beta$

55. If $\arg\left(\frac{z-2i}{z+2i}\right) = \frac{\pi}{6}$, then which of the following options gives the correct locus of z ?

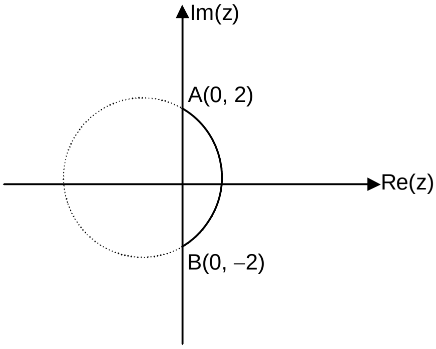
(A)


Im(z)
A(0, 2)
Re(z)
B(0, −2)

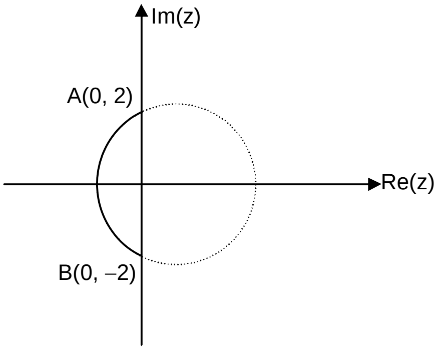
(B)


Im(z)
A(0, 2)
Re(z)
B(0, −2)

(C)


Im(z)
A(0, 2)
Re(z)
B(0, −2)

(D)


Im(z)
A(0, 2)
Re(z)
B(0, −2)

Space for Rough work

56. If $I = \int \sin x.\cos x.\cos 2x.\cos 4x.\cos 8x.\cos 16x\,dx$, then the value of I is

(A) $\frac{\sin 16x}{1024} + c$ (B) $-\frac{\cos 32x}{1024} + c$

(C) $\frac{\cos 32x}{1096} + c$ (D) $-\frac{\cos 32x}{1096} + c$

57. $y = f(x)$ is a function which satisfies:

(i) $f(0) = 0$

(ii) $f''(x) = f'(x)$ and

(iii) $f'(0) = 1$

then the area bounded by the graph of $y = f(x)$, the lines $x = 0$, $x - 1 = 0$ and $y + 1 = 0$, is:

(A) e (B) $e - 2$

(C) $e - 1$ (D) $e + 1$

58. Let z_1, z_2, z_3 be three distinct points $|z| = 1$. If θ_1, θ_2 and θ_3 be the arguments of z_1, z_2, z_3 respectively then $\cos(\theta_1 - \theta_2) + \cos(\theta_2 - \theta_3) + \cos(\theta_3 - \theta_1)$

(A) $\geq -\frac{3}{2}$ (B) $\leq -\frac{3}{2}$

(C) $\geq \frac{3}{2}$ (D) ≤ 2

59. If the function $f(x) = -4e^{\frac{1-x}{2}} + 1 + x + \frac{x^2}{2} + \frac{x^3}{3}$ and $g(x) = f^{-1}(x)$, then the value of $g'\left(-\frac{7}{6}\right)$ equals

(A) $\frac{1}{5}$ (B) $-\frac{1}{5}$

(C) $\frac{6}{7}$ (D) $-\frac{6}{7}$

Space for Rough work

60. If α, β are two real numbers satisfying $\alpha^2 + \beta^2 = 5$ and $3\left(\alpha^5 + \beta^5\right) = 11\left(\alpha^3 + \beta^3\right)$, then $\alpha\beta$ is:

(A) 2 (B) 1
(C) 7 (D) 9

61. Two teachers are interviewing top 6 students in **FTRE 2016** exam in two different subjects, starting at the same time. Each teacher interviews a student for 15 minutes. The number of ways in which the interviews can be scheduled is

(A) 6! (B) 5!
(C) 44 x 6! (D) 265 x 6!

62. The length of the perpendicular from the origin to the plane passing through the point $\vec{a}$ and containing the line $\vec{r} = \vec{b} + \lambda\vec{c}$ is

(A) $\dfrac{\left[\vec{a}\ \vec{b}\ \vec{c}\right]}{\left|\vec{a}\times\vec{b}+\vec{b}\times\vec{c}+\vec{c}\times\vec{a}\right|}$ (B) $\dfrac{\left[\vec{a}\ \vec{b}\ \vec{c}\right]}{\left|\vec{a}\times\vec{b}+\vec{b}\times\vec{c}\right|}$

(C) $\dfrac{\left[\vec{a}\ \vec{b}\ \vec{c}\right]}{\left|\vec{b}\times\vec{c}+\vec{c}\times\vec{a}\right|}$ (D) $\dfrac{\left[\vec{a}\ \vec{b}\ \vec{c}\right]}{\left|\vec{c}\times\vec{a}+\vec{a}\times\vec{b}\right|}$

63. If $A = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$, then $\lim\limits_{n\to\infty} \dfrac{A^n}{n}$ is (where $\theta \in R$)

(A) a zero matrix (B) an identity matrix

(C) $\begin{bmatrix} 0 & 1 \\ 0 & -1 \end{bmatrix}$ (D) $\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$

Space for Rough work

64. A line is drawn from the point P (1, 1, 1) and perpendicular to a line with direction ratios 1, 1, 1 to intersect the plane $x+2y+3z=4$ at Q. The locus of Q is

(A) $\frac{x}{1}=\frac{y-5}{-2}=\frac{z+2}{1}$ (B) $\frac{x}{-2}=\frac{y-5}{1}=\frac{z+2}{1}$

(C) $x=y=z$ (D) $\frac{x}{2}=\frac{y}{3}=\frac{2}{5}$

65. The lines $2x^2-3y^2+xy-3x-7y+2=0$ represent two normals of a circle which passes through the focus of the parabola $(5x+15)^2+\left(5y-\frac{5}{2}\right)^2=\left(3x+4y-\frac{1}{2}\right)^2$. The equation of the circle is

(A) $4x^2+4y^2-8x-8y-65=0$ (B) $4x^2+4y^2-8x+8y-65=0$

(C) $x^2+y^2-2x-2y-73=0$ (D) $x^2+y^2-2x+y+73=0$

66. The asymptotes of the hyperbola $y=x+\frac{1}{x}$ are

(A) $y=0,\ y=x$ (B) $y=0,\ y=-x$

(C) $x=0,\ y=-x$ (D) $x=0,\ y=x$

67. If $x\frac{dy}{dx}=y(\log_e y-\log_e x+1)$, then the solution of the equation is

(A) $y\log_e\left(\frac{x}{y}\right)=cx$ (B) $x\log_e\left(\frac{y}{x}\right)=cy$

(C) $\log_e\left(\frac{y}{x}\right)=c\,x$ (D) $\log_e\left(\frac{x}{y}\right)=cy$

Space for Rough work

68. $\frac{1}{4}+\frac{1(3)}{4(6)}+\frac{1(3)(5)}{4(6)(8)}+......\infty$

(A) 1
(B) 2
(C) 3
(D) 4

69. The minimum value of $(\tan A-\cos B)^2+(\cot A-\sin B)^2$ for all permissible independent variables A and B is

(A) 0
(B) $\sqrt{2}-1$
(C) $3-2\sqrt{2}$
(D) cannot be determined

70. The constant term in the expansion of $\left(x^2+\frac{1}{x^2}+y+\frac{1}{y}\right)$ is:

(A) 4900
(B) 4950
(C) 5050
(D) 5151

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

71. The total number of solutions of $|\cot x|=\cot x+\frac{1}{\sin x}$, $x\in[0, 3\pi]$ is

72. Cosine of the acute angle between the curves $y=3^{x-1}\ln x$ and $y=x^x-1$ is

Space for Rough work

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

73. Let $T = \int_0^{\ln 2} \frac{2e^{3x} + e^{2x} - 1}{e^{3x} + e^{2x} - e^x + 1} dx$, then e^T equals:

74. Three parallel chords of a circle have lengths 2,3,4 and subtend angles $\alpha, \beta, \alpha + \beta$ at the centre respectively (given $\alpha + \beta < \pi$) **,** then $1000 \cos\alpha$ is equal to

75. From a set of numbers $\{1, 2, 3, ..., 999\}$, six distinct numbers are chosen. Out of these six numbers three are chosen and labeled as a_1, a_2, a_3. The remaining are labeled as b_1, b_2, b_3. The probability that a brick of dimensions $a_1 \times a_2 \times a_3$ fits in a box of dimensions $b_1 \times b_2 \times b_3$ is equal to (assume that the brick can be rotated before putting into the box)

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – IV

JEE (Main)-2020

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. C

Sol. $10^{-3}(1 + R) = 10$

$\therefore R = 9999\Omega$

2. C

Sol. Factual

3. B

Sol. $\Delta V = \frac{B\omega^2(\ell)}{2} = \frac{B\omega^2(\sqrt{3}\,R)}{2}$ = $V_B - V_A$.

4. A

Sol. $W = \int Fvdt$

5. C

Sol: Since, D_1 will be acting as short circuit, D_2 will act as open circuit so,

Current through 5Ω resistance and diode D_1 is $\frac{20}{5}$ = 4 A

6. D

Sol. Factual

7. B

Sol: $\cos(180 - \theta) = A/B \Rightarrow \theta = \cos^{-1}\left(-\frac{A}{B}\right)$

8. B

Sol. At steady state.

Rate of generation of A = Rate of decay of A.

$q = \lambda N_A$

$\Rightarrow \; N_A = \dfrac{q}{\lambda}$

9. A

Sol. $\dfrac{1}{2}mu^2 = 2mg\sin\theta\,\ell$

10. D

Sol. F is same for all.

Use $F = I(\vec{\ell} \times \vec{B})$

11. A

Sol. P must be applied at centre of mass.

$\Rightarrow \; \dfrac{4\ell}{3}$

12. A

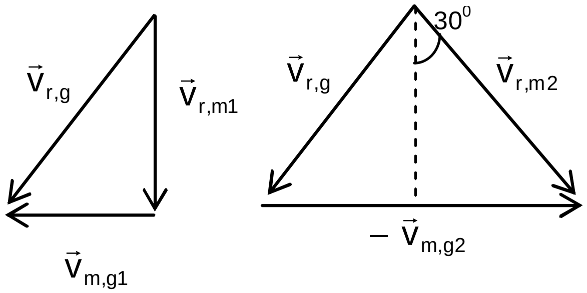
Sol. Time period is independent of mass and depends only upon the distance from the planet.

13. B

Sol. If ΔV is increased λ will decrease and hence fringe width will decrease.

14. D

Sol.



15. C

Sol: Velocity of pendulum bob in mean position

$v_1 = \sqrt{2gh} = \sqrt{2\times\ 10\times5\times10^{-2}} = 1$ m/s

When the bob picks up a mass 10^{-3} kg at the bottom, then by conservation of linear momentum the velocity of coalesced mass is given by

$m_1v_1 + m_2v_2 = (m_1 + m_2)v$

$10^{-2} + 10^{3}\times0 = (10^{-2}+10^{-3})\,v$

or $v = \dfrac{10^{-2}}{1.1\ \times10^{-2}} = \dfrac{10}{11}$ m/s

if h′ is the height risen by combined mass, we have

$$\frac{1}{2}\left(m_1+m_2\right)v^2 = \left(m_1+m_2\right)\ gh$$

$$\therefore h' = \frac{v^2}{2g} = \frac{\left(\frac{10}{11}\right)^2}{2 \times 10}\ m = \frac{5}{121}\ m = 0.413m$$

16. A

Sol. In S.H.M. displacement

$y = a\sin(\omega t + \phi)$; velocity, $v = a\omega\cos(\omega t + \phi)$

Let $t = t'$ be the instant, when $y = y' = 25$cm

And $v = v' = 100$ cm/s.

Given, $\omega = 4$ rad/s

Then, $25 = a\sin(\omega t' + \phi)$ and $100 = a\omega\cos(\omega t' + \phi)$

Or $25 = a\sin(4t' + \phi)$ and $100 = a4\cos(4t' + \phi)$

Squaring and adding we get

$625 + 625 = a^2$ or $a = 25\sqrt{2}$ cm

Dividing, we get;

$\tan(4t' + \phi) = 1$ or $4t' + \phi = \frac{\pi}{4}$

After time 2.4sec from the instant t′, the time from the beginning, $t = t' + 2.4$, we have

$y = 25\sqrt{2}\sin[4(t' + 2.4) + \phi]$

$= 25\sqrt{2}\sin[4t' + 9.6 + \phi]$

$=25\sqrt{2}\sin\left[\frac{\pi}{4} + 9.6\right] = -28.68$ cm

and $v = 25\sqrt{2} \times 4\cos[4(t' + 2.4) + \phi]$

$= 100\sqrt{2} \times 4\cos\left[\frac{\pi}{4} + 9.6\right] = -82.18$ cm/s.

17. B

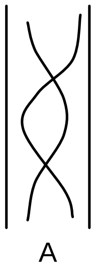
Sol. As the velocity increases pressure decreases hence the height decreases.

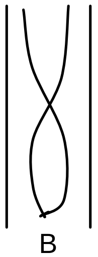
18. B

Sol. Using path difference.

19. C

Sol. (a) $2\frac{V_A}{2L_A} = 3\frac{V_B}{4L_B}$


A


B

$$\Rightarrow \frac{V_A}{V_B} = \frac{3}{4} \qquad \left[\because L_A = L_B\right]$$

$$V_A = \sqrt{\frac{\gamma_A RT}{M_A}}, \qquad V_B = \sqrt{\frac{\gamma_B RT}{M_B}}$$

$$\Rightarrow \sqrt{\frac{\gamma_A \quad M_B}{\gamma_B \quad M_A}} = \frac{3}{4},$$

$$\gamma_A = \frac{5}{3}, \qquad \gamma_B = \frac{7}{5}$$

$$\Rightarrow \frac{M_A}{M_B} = \frac{400}{189}$$

20. A

Sol. $\omega = \dfrac{v}{\ell \sin\theta}$

$V_c = \dfrac{v}{2\sin\theta}$

SECTION – B

21. 0

Sol. $V_A - V_B = i(5\Omega) + 10V + L\dfrac{di}{dt}$

$= 5(5) + 10 + L(-10^{+3})$

$V_A - V_B = 35 - 35 \times 10^{-3} \times 10^{+3} = 0.$

22. 3

Sol. V = 0.6 m

$\Rightarrow \quad \dfrac{h_I}{h_o} = \dfrac{h_I}{0.05} = 2 \Rightarrow \quad h_I = 0.1$ cm.

$\Rightarrow$ Distance between them = 0.3 cm = 3 mm.

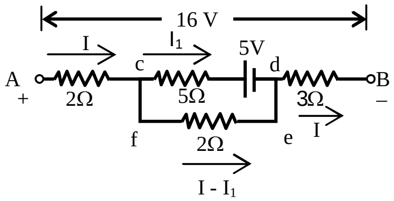
SECTION – C

23. 00002.40

Sol. Required distance = $2 \times \dfrac{D\lambda}{d} = \dfrac{2\times 2\times 600\times 10^{-9}}{1\times 10^{-3}}\text{m} = 2.40$ mm.

24. 00000.06

Sol. $\phi_A - \phi_B = 16$ …(i)



Apply KVL on loop (cd efc)

$0 - 5I_1 - 5 + 2(I - I_1) = 0$

$\Rightarrow I_1 = \dfrac{1}{7}(2I - 5)$ …(ii)

Apply KVL on path (AC d B)

$\phi_A - 2I - 5I_1 - 5 - 3I = \phi_B$

$\Rightarrow \phi_A - \phi_B = 5I + 5I_1 + 5$

$\Rightarrow 16 = 5I + 5\left(\dfrac{2I-5}{7}\right) + 5$

$\Rightarrow 16 - 5 + \dfrac{25}{7} = I\left(5 + \dfrac{10}{7}\right)$

$\Rightarrow I = \dfrac{34}{15}$ Amp

(i) and (ii) give

$I_1 = -\frac{1}{15}$ Amp

Current through battery (5V) = $\frac{1}{15}$ Amp = 0.06 Amp

25. 00066.66

Sol. For series combination $R = 220^2\left(\frac{1}{200} + \frac{1}{100}\right) = 220^2 \times \frac{3}{200}$

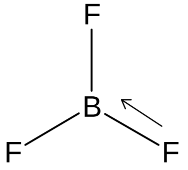
$\therefore$ Power $= \frac{220^2}{R} = \frac{200}{3}$ W = 66.66

Chemistry PART – II

SECTION – A

26. B

Sol. Due to existence of pπ – pπ back bonding in BF_3.

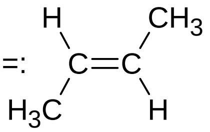
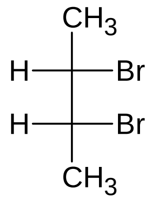
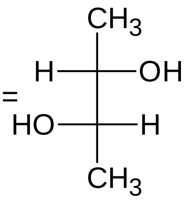
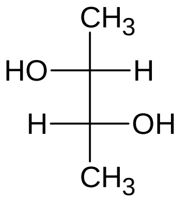


27. B

Sol. $KO_2 \xrightarrow{H_2O} KOH + H_2O_2 + O_2$

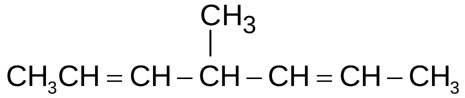
$K_2S \xrightarrow{H_2O} KOH + H_2S$

28. D

Sol. P =:  Q =  R or S =  or 

29. C

Sol. Due to double bond, the geometrical isomers are:



$$CH_3CH = CH - \overset{\overset{\displaystyle CH_3}{|}}{C}H - CH = CH - CH_3$$

Cis	Cis	
Trans	Trans	
Cis	Trans	Identical
Trans	Cis	

When the double bonds are Cis and trans, the molecule becomes optically active.

∴ For trans Cis(two optical isomers are possible)

∴ Total no. of stereoisomers are:

Geometrical(2) + Optical(2) = 4

30. C

Sol. $2\pi r = n\lambda \Rightarrow \lambda = \frac{2\pi r}{n} = \frac{2\pi n^2 r_0}{n \times z} = 2\pi n r_0 = 2\pi \times 4 \times r_0 = 8\pi r_0$

31. A

Sol. C represents most probable velocity.

32. C

Sol. Catalyst only fastens the reaction.

33. B

Sol. $CO_3^{2-} + H^+ \longrightarrow HCO_3^-$ (Weak base does not dissociate much). Therefore, the reaction proceeds to forward direction by removing CO_3^{2-} as HCO_3^-.

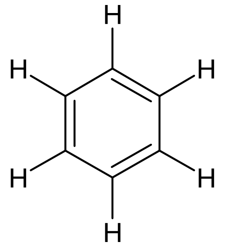
34. D

Sol. Isochoric process have $\Delta V = 0$, so work $W = P\Delta V = 0$

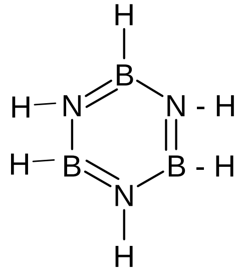
35. D

Sol.

Organic benzene



Inorganic benzene



36. D

Sol. The nearer the –I groups towards COOH group, stronger is the acid.

37. B

Sol. $2NaHSO_4 \xrightarrow{\Delta} Na_2SO_4 + SO_3 + H_2O$

38. C

Sol. $Na_2B_4O_7 \xrightarrow{\Delta} 2NaBO_2 + B_2O_3$

39. D

Sol. (D) contains maximum number of non-identical 'H' atoms which are to be substituted by chlorine.

40. B

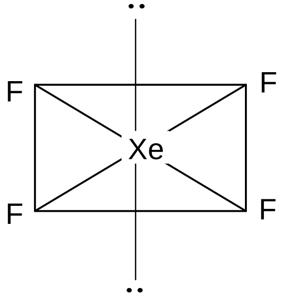
Sol. A, C, D will show geometrical isomerism. (B) will show geometrical as well as optical isomerism.

41. B

Sol. Aniline will be deactiviated in presence of H^+.

42. C

Sol. The structure of XeF_4 is:



43. C

Sol. For zero order reaction,
Rate = K
Both rate and rate constant are independent of concentration.

44. D

Sol. pH of $NaH_2PO_4 = \frac{p^{K_{a_1}} + p^{K_{a_2}}}{2} = \frac{7.2+10.6}{2} = 8.9$

45. C

Sol. In NH_4Cl, the oxidation state of nitrogen is -3.

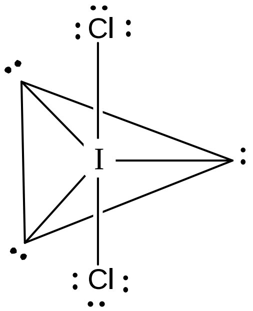
SECTION – B

46. 4

Sol. O_2, O_2^+, H_2^+ and NO are paramagnetic

47. 9

Sol. Structure of ICl_2^-



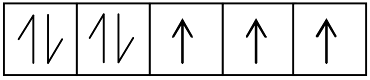
SECTION – C

48. 00003.87

Sol. $H^+ = \sqrt{K_a C} = \sqrt{1.8\times10^{-5}\times10^{-3}} = 1.34\times10^{-4}$
pH = -log[H^+] = 3.87

49. 3.87

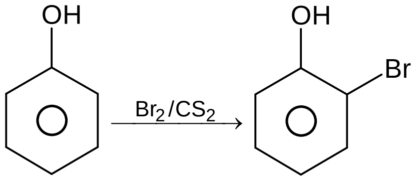
Sol. EC = [Ar] $3d^7$



$\mu \text{spin} = \sqrt{n(n+2)} = \sqrt{3 \times 5} = 3.87$

50. 00043.25

Sol.



$M_o = 173$

So, $\frac{M_o}{4} = 43.25$

Mathematics

PART – III

SECTION – A

51. A

Sol. $y = 2\log_a x$

$\Rightarrow \log_a x = \dfrac{y}{2}$

$\Rightarrow x = a^{y/2}$

$\Rightarrow f^{-1}(y) = a^{y/2}$

$\Rightarrow f^{-1}(b+c) = a^{\frac{b+c}{2}} = f^{-1}(b).f^{-1}(c)$

52. B

Sol. $f(x) = \dfrac{\ln(\pi + x)}{\ln(e+x)}$

$$f'(x) = \frac{\dfrac{\ln(e+x)}{(\pi+x)} - \dfrac{\ln(\pi+x)}{(e+x)}}{\left(\ln(e+x)\right)^2}$$

Now, consider the function $g(y) = y\ln y$

$g'(y) = \ln y + 1$

$g'(y) > 0$ when $y > \dfrac{1}{e}$

$g(y)$ is an increasing function when $x > \dfrac{1}{e}$

$\Rightarrow (e+x)\ln(e+x) < (\pi+x)\ln(\pi+x) \qquad (x \ge 0)$

$\Rightarrow \dfrac{\ln(e+x)}{(\pi+x)} - \dfrac{\ln(\pi+x)}{(e+x)} < 0$

$\Rightarrow f'(x) < 0\ \forall x \ge 0$

$\Rightarrow f(x)$ is decreasing is $[0, \infty)$

53. A

Sol. $x^3 + y^3 + (-1)^3 - 3(x)(y)(-1) = 0$

$\Rightarrow (x + y - 1) = 0$ OR $x^2 + y^2 - xy + x + y + 1 = 0$

54. D

Sol. From the given equation we get

$S_1 = \tan\theta_1 + \tan\theta_2 + \tan\theta_3 + \tan\theta_4 = \sin 2\beta$.

$S_2 = \sum \tan\theta_1 \tan\theta_2 = \cos 2\beta$

$S_3 = \sum \tan\theta_1 \tan\theta_2 \tan\theta_3 = \cos\beta$

and $S_4 = \tan\theta_1 \tan\theta_2 \tan\theta_3 \tan\theta_4 = -\sin\beta$

Now $\tan(\theta_1 + \theta_2 + \theta_3 + \theta_4) = \dfrac{S_1 - S_3}{1 - S_2 + S_4}$.

$$= \frac{\sin 2\beta - \cos\beta}{1 - \cos 2\beta - \sin\beta} = \frac{\cos\beta(2\sin\beta - 1)}{\sin\beta(2\sin\beta - 1)} = \cot\beta$$

55. A

Sol. $\arg\left(\dfrac{z - 2i}{z + 2i}\right) = \dfrac{\pi}{6}$

$\Rightarrow \arg(z - 2i) - \arg(z + 2i) = \dfrac{\pi}{6}$

$\Rightarrow \tan^{-1}\left(\dfrac{y - 2}{x}\right) - \tan^{-1}\left(\dfrac{y + 2}{x}\right) = \dfrac{\pi}{6}$

$\Rightarrow \dfrac{xy - 2x - xy - 2x}{x^2 + y^2 - 4} = \dfrac{1}{\sqrt{3}}$

$\Rightarrow x^2 + y^2 - 4 = -4\sqrt{3}\,x$

$\Rightarrow x^2 + y^2 + 4\sqrt{3}\,x - 4 = 0$

$\Rightarrow \left(x + 2\sqrt{3}\right)^2 + y^2 = 12 + 4 = 4^2$

$\therefore$ centre$\left(-2\sqrt{3}, 0\right)$, radius = 4

56. B

Sol. $I = \displaystyle\int \frac{\sin 3x}{32}\,dx$

57. C

Sol. $\dfrac{f''(x)}{f'(x)} = 1$

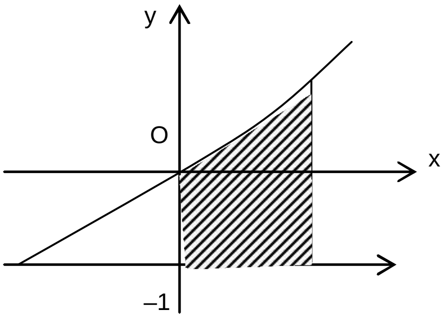
Integrating $\ln f'(x) = x + c,\ f'(0) = 1 \Rightarrow c = 0$

$f'(x) = e^x$

$f(x) = e^x + k,\ f(0) = 0 \Rightarrow k = -1$

$f(x) = e^x - 1$

Area $= \displaystyle\int_0^1 \left(e^x - 1 + 1\right)dx = e^x\Big]_0^1 = e - 1$



58. A

Sol. $\cos(\theta_1 - \theta_2) + \cos(\theta_2 - \theta_3) + \cos(\theta_3 - \theta_1) \ge -\dfrac{3}{2}$

59. A

Sol. $$\frac{dy}{dx}=\frac{4}{2}e^{\frac{1-x}{2}}+1+x+x^2=2e^{\left(\frac{1-x}{2}\right)}+x^2+x+1$$

$$g'(y)=\frac{dx}{dy}=\frac{1}{2e^{-\left(\frac{x-1}{2}\right)}+x^2+x+1}$$

When $y=-\frac{7}{6}$ then $x=1$

$$\left.\frac{dy}{dx}\right]_{x=-7/6}=\frac{1}{2+3}=\frac{1}{5}$$

60. A

Sol. $$\frac{\left(\alpha^5+\beta^5\right)}{\left(\alpha^3+\beta^3\right)}=\frac{11}{3}$$

$$\frac{1}{\left(\alpha^2+\beta^2-\alpha\beta\right)}\left(\alpha^4+\beta^4-\alpha\beta\left(\alpha^2+\beta^2-\alpha\beta\right)\right)=\frac{11}{3}$$

$$\frac{\left(\alpha^4+\beta^4\right)}{\left(\alpha^2+\beta^2-\alpha\beta\right)}-\alpha\beta=\frac{11}{3}$$

$$\frac{25-2\left(\alpha\beta\right)^2}{5-\alpha\beta}-\alpha\beta=\frac{11}{3}$$

Let $\alpha\beta=t$; by coefficient $\alpha\beta=2$

61. D

Sol. Number of ways = (Number of one-one function from set A = {s_1, s_2 ….s_6} to A such that $f(s_i)\neq s_i\times 6!=D_6\times 6!$

62. C

Sol. The given plane passes through $\vec{a}$ and is parallel to the vector $\vec{b}-\vec{a}$ and $\vec{c}$. So it is normal to $\left(\vec{b}-\vec{a}\right)\times\vec{c}$. Hence, its equation is $\left(\vec{r}-\vec{a}\right).\left(\left(\vec{b}-\vec{a}\right)\times\vec{c}\right)=0$ or

$$\vec{r}.\left(\vec{b}\times\vec{c}+\vec{c}\times\vec{a}\right)=\left[\vec{a}\quad\vec{b}\quad\vec{c}\right]$$

The length of the perpendicular from the origin to this plane is $\dfrac{\left[\vec{a}\quad\vec{b}\quad\vec{c}\right]}{\left|\vec{b}\times\vec{c}+\vec{c}\times\vec{a}\right|}$

63. A

Sol. $$A^n=\begin{bmatrix}\cos n\theta & \sin n\theta\\ -\sin n\theta & \cos n\theta\end{bmatrix}$$

$$\therefore \lim_{n\to\infty}\frac{A^n}{n}=\begin{bmatrix}0 & 0\\ 0 & 0\end{bmatrix}$$

64. A

Sol. D.R's of PQ are $x_1-1,\ y_1-1,\ z_1-1$

$\Rightarrow 1(x_1-1)+1(y_1-1)+1(z_1-1)=0$

$\Rightarrow x_1+y_1+z_1=3$

Also $x_1+2y_1+3z_1=4$

$x_1+y_1+z_1=3$

$\Rightarrow (x_1,y_1,z_1)$ is a point on the two planes

$x+2y+3z=4$

$x+y+z=3$

$\therefore$ line of intersection of these two planes will be the required locus which is

$$\frac{x}{1}=\frac{y-5}{-2}=\frac{z+2}{1}$$

65. B

Sol. Parabola is of the form $(x+3)^2+\left(y-\frac{1}{2}\right)^2=\left(\frac{3x+4y-\frac{1}{2}}{5}\right)^2$ having focus $\left(-3,\frac{1}{2}\right)$ and point of intersection of lines given by the equation $2x^2-3y^2+xy-3x-7y+2=0$ can be obtained by solving equations $4x+y-3=0$ and $-6x+x-7=0$ (partial differentiation method), i.e $(1-1)\equiv$ centre (point of intersection of normals).

Hence required circle is $(x-1)^2+(y+1)^2=(1+3)^3+\left(-1-\frac{1}{2}\right)^2$

Or $x^2+y^2-2x+2y+2=16+\frac{9}{4}$ i.e. $4x^2+4y^2-8x+8y-65=0$

66. D

Sol. Asymptotes equations are $x^2-xy+k=0$

67. C

Sol. $\frac{dy}{dx}=\frac{y}{x}\left(\ell n\frac{y}{x}-1\right)$

Put $\frac{y}{x}=t$

68. A

Sol. $T_1=\frac{1}{4}(4-3)=1-\frac{3}{4}$

$T_2=\frac{1(3)}{4(6)}[6-5]=\frac{3}{4}-\frac{1(3)(5)}{4(6)}$

$T_3=\frac{1(3)(5)}{4(6)(8)}[8-7]=\frac{1(3)(5)}{4(6)}-\frac{1(3)(5)(7)}{4(6)(8)}$

$\vdots$

$\therefore T_1+T_2+T_3.............=1$

69. C

Sol. The expression can be interpreted as the square of distance between the points $(\tan A, \cot A)$ and $(\cos B, \sin B)$

The minimum value of this distance is the minimum distance between the curves $xy = 1$ and $x^2 + y^2 = 1$

70. A

Sol. Any element, is of the form of $\frac{8!}{t_1!t_2!t_3!t_4!}(x^2)^{t_1}\left(\frac{1}{x^2}\right)^{t_2}(y)^{t_3}\left(\frac{1}{y}\right)^{t_4}$ where

$t_1 + t_2 + t_3 + t_4 = 8;\ t_1 \geq 0$

The constant term occur when $t_1 = t_2$ and $t_3 = t_4$

So, $t_1 + t_3 = 4 \Rightarrow (0,4),(4,0);(1,3),(3,1);(2,2)$

$\Rightarrow$ Constant term:

$$\frac{8!}{0!0!4!4!}+\frac{8!}{4!4!0!0!}+\frac{8!}{1!1!3!3!}+\frac{8!}{3!3!1!1!}+\frac{8!}{2!2!2!2!}$$

SECTION – B

71. 2

Sol. When $\cot x \geq 0$

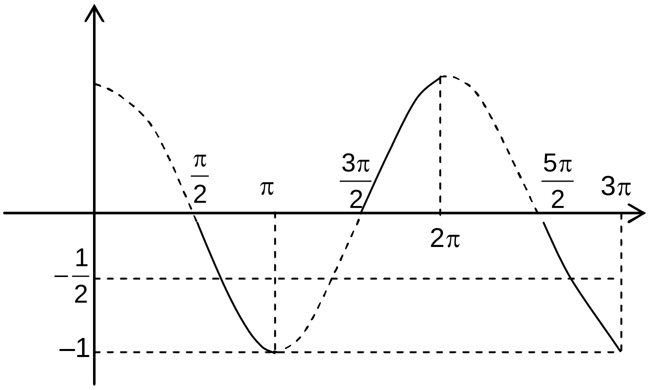
$\Rightarrow \frac{1}{\sin x} = 0$

$\Rightarrow$ No possible value of x.

When $\cot x < 0 \quad \Leftrightarrow \quad x \in \left(\frac{\pi}{2}, \pi\right) \cup \left(\frac{3\pi}{2}, 2\pi\right) \cup \left(\frac{5\pi}{2}, 3\pi\right)$

$\Rightarrow -\cot x = \cot x + \frac{1}{\sin x}$

$\Rightarrow \cos x = \frac{-1}{2}$



Number of solution = 2

72. 1

Sol. Point of intersection of curves is (1, 0)

$y = 3^{x-1}\ln x$

$\Rightarrow y' = \dfrac{3^{x-1}}{x} + \ln x.3^{x-1}.\ln 3$

$\therefore\ m_1 = 1$

Now, $y = x^x(1+\ln x)$

$\therefore\ m_2 = 1$

So, $\tan\theta = \tan\theta = \left|\dfrac{1-1}{1+1}\right| = 0$

$\Rightarrow \theta = 0 \Rightarrow \cos 0^o = 1$

SECTION – C

73. 00002.75

Sol. We have $T = \int_0^{\ln 2}\dfrac{\left(3e^{3x}+2e^{2x}-e^x\right)-\left(e^{3x}+e^{2x}-e^x+1\right)}{e^{3x}+e^{2x}-e^x+1}dx$

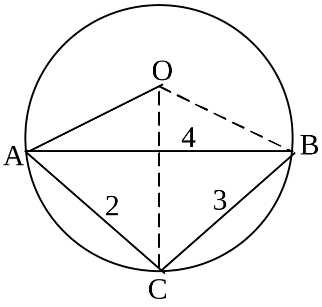
$= \left[\ln\left(e^{3x}+e^{2x}-e^x+1\right)-x\right]_0^{\ln 2}$

$= \ln\dfrac{11}{2} - \ln 2 = \ln\dfrac{11}{4}$

$\Rightarrow e^T = e^{\ln\frac{11}{4}} = \dfrac{11}{4}$

74. 00531.25

Sol. Using the property that equal chords subtends equal angles at centre of circle, then problem can be converted to the diagram in adjoining figure



$AB = 4, AC = 2, BC = 3$

$\angle ABC = \alpha/2$

$\cos(\alpha/2) = \dfrac{9+16-4}{2\times3\times4} = \dfrac{7}{8} \Rightarrow \cos\alpha = 2\cos^2(\alpha/2) - 1$

$= 2\times\dfrac{49}{64} - 1 = \dfrac{98-64}{64} \Rightarrow \cos\alpha = \dfrac{34}{64} = \dfrac{17}{32}$

75. 00000.25

Sol. For every selection of 6 numbers without loss of generality there will be 5 favorable cases out of every 20 cases.

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – V

JEE (Advanced)-2020

PAPER – 1

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B.**

1. ***Section-A (01– 7, 19 – 25, 37 – 43)*** *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect option is selected.

   Section-A (08 – 13, 26 – 31, 44 – 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S). Each multiple choice question with 4 options has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section–B (14 – 18, 32 – 36, 50 – 54)*** *contains 15 Numerical based questions with answers as numerical value from 0 to 9 and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A
(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. The position vector of a particle moving in space is given by $\vec{r} = (1+2\cos 2\omega t)\hat{i} + (3\sin^2\omega t)\hat{j} + (3t)\hat{k}$ in the ground frame. All the units are in SI. Choose the correct statement (s):

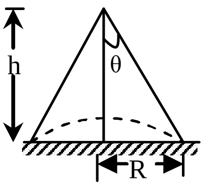
(A) The particle executes SHM in the ground frame about the mean position $\left(1, \frac{3}{2}, 3t\right)$

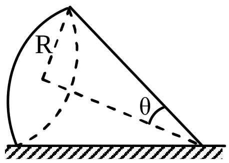
(B) The particle executes SHM in a frame *S* moving along the positive z–axis with a velocity of 3 m/s.

(C) The amplitude of the SHM of the particle in frame *S* is $\frac{5}{2}m$.

(D) The line of the SHM of the particle is parallel to the vector $\left(\frac{4}{5}\hat{i} - \frac{3}{5}\hat{j}\right)$.

2. A solid cone is placed on a horizontal surface with height '*h*' and radius '*R*'. Its apex angle is 'θ'. To change the position of the cone from figure (A) to figure (B), no work is required, then





(A) $\theta = \sin^{-1}\left(\frac{1}{3}\right)$

(B) $\theta = \frac{\pi}{4}$

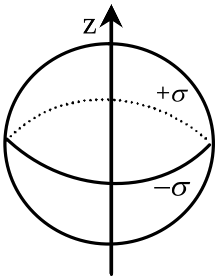
(C) $\frac{h}{R} = 1$

(D) $\frac{h}{R} = 2\sqrt{2}$

Space for Rough work

3. A standing wave is setup in a string fixed at both ends. Then
   (A) The sum of total energy per unit length at nodes and antinodes is constant
   (B) The total energy of a point midway between a node and an adjacent antinode is constant
   (C) If the string has a standing wave and a component of travelling wave, then the kinetic energy of the points of minimum amplitude is non-zero at some instant of time.
   (D) If the string has a standing wave and a component of travelling wave, then the potential energy of the points of maximum amplitude is non zero at some instant of time.

4. A hollow, insulating spherical shell has a surface charge distribution placed upon it, such that the upper hemisphere has a uniform surface charge density $+\sigma$, while the lower hemisphere has a uniform surface charge density $-\sigma$,as shown in the figure. Their interface lies in *x*-*y* plane. Which of the following statement(s) is/are correct?

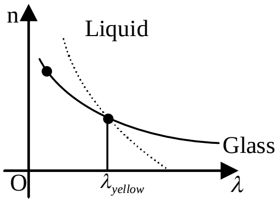


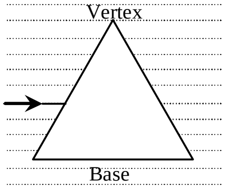
   (A) The field at all points of *x*-*y* plane within the sphere points in the –ve *z*-direction
   (B) All points of the *x*-*y* plane within the sphere are equipotential
   (C) The field at all points on *z*-axis outside the sphere point along positive *z*-direction
   (D) The field at points on *z*-axis which are on either side of origin outside the sphere is in opposite directions

5. A planoconvex lens $(\mu = 1.5)$ of focal length 20 cm has its plane side silvered. Which of the following statements is/are correct?
   (A) The radius of curvature of its curved surface is half that of a surface of equiconvex lens of focal length 20 cm made of same material
   (B) An object placed at 15 cm on the axis on the convex side gives rise to an image at a distance of 30cm from it
   (C) An object placed at a distance of 20 cm on the axis on the convex side gives rise to an image at 40cm from it
   (D) It acts as a convex mirror

Space for Rough work

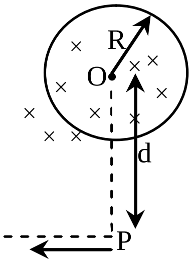
6. A glass prism is immersed in a hypothetical liquid. The curves showing the refractive index *n* as a function of wavelength λ for glass and liquid are as shown in the figure. When a ray of white light is incident on the prism parallel to the base:





(A) Yellow ray travels without deviation
(B) Blue ray is deviated towards the vertex
(C) Red ray is deviated towards the base
(D) There is no dispersion

7. In a cylindrical region of radius *R*, there exists a time varying magnetic field *B* such that $\frac{dB}{dt} = (>0)$. A charged particle having charge *q* is placed at the point *P* at a distance $d(>R)$ from its centre *O*. Now, the particle is moved in the direction perpendicular to *OP* (see figure) by an external agent upto infinity so that there is no gain in kinetic energy of the charged particle. Choose the correct statement/s.



(A) Work done by external agent is $\frac{q\pi R^2}{4}k$ if $d = 2R$
(B) Work done by external agent is $\frac{q\pi R^2}{8}k$ if $d = 4R$
(C) Work done by external agent is $\frac{q\pi R^2}{4}k$ if $d = 4R$
(D) Work done by external agent is $\frac{q\pi R^2}{4}k$ if $d = 6R$

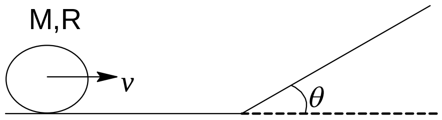
Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

An object of mass M and radius R is pure rolling on a horizontal surface. It smoothly climbs over an rough incline with sufficient friction to ensure no slipping. The following grid has 3-columns: Column- 1 represents the type of object. Column -2 represents the maximum height attained by the object and column -3 represents the time taken to reach the maximum height.



Column –1 (Object)		**Column –2 (Height)**		**Column –3 (Time)**	
(I)	Ring	(i)	$\frac{7v^2}{10g}$	(P)	$7v/5g\sin\theta$
(II)	Disc	(ii)	$\frac{3v^2}{4g}$	(Q)	$2v/g\sin\theta$
(III)	Hollow sphere	(iii)	v^2/g	(R)	$3v/2g\sin\theta$
(IV)	Solid sphere	(iv)	$\frac{5v^2}{6g}$	(S)	$5v/3g\sin\theta$

8. Pick the correct combination:-

(A) $(\mathrm{I})\ (\mathrm{i})\ (\mathrm{P})$

(B) $(\mathrm{III})\ (\mathrm{ii})\ (\mathrm{Q})$

(C) $(\mathrm{II})\ (\mathrm{ii})\ (\mathrm{R})$

(D) $(\mathrm{IV})\ (\mathrm{iv})\ (\mathrm{P})$

Space for Rough work

9. The combination where the total mechanical energy is maximum will be

(A) (I) (iii) (Q)

(B) (II) (ii) (R)

(C) (III) (iv) (P)

(D) (IV) (i) (S)

10. The combination for which maximum friction acts between the body and the incline is

(A) (I) (iii) (Q)

(B) (II) (ii) (R)

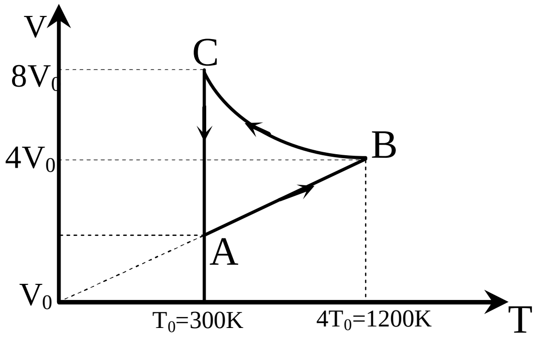
(C) (III) (iv) (S)

(D) (IV) (i) (P)

Space for Rough work

Answer questions 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

Two moles of an ideal mono-atomic gas is taken through a cyclic process ABCA as shown in the V-T diagram. In the process BC, TV_2 = constant. Answer the questions by referring to the data in the table. (Take $\ell n(2) = 0.7$)



Column –1 shows the processes. Column –2 shows the work done in that process and Column –3 shows the energy supplied in that process.					
	Column–1		**Column–2**		**Column–3**
(I)	$A \to B$	(i)	1800 R	(P)	-1800 R
(II)	$B \to C$	(ii)	-1260 R	(Q)	-3060 R
(III)	$C \to A$	(iii)	900 R	(R)	4500 R
(IV)	$B \to C \to A \to B$	(iv)	1440 R	(S)	1440 R

11. Pick a combination in which work done is maximum

(A) $(I)\ (i)\ (R)$

(B) $(II)\ (i)\ (P)$

(C) $(III)\ (iv)\ (S)$

(D) $(III)\ (ii)\ (R)$

Space for Rough work

12. Pick a combination in which thermal energy supplied is maximum
    (A) (II) (iii) (P)
    (B) (IV) (iii) (S)
    (C) (I) (i) (R)
    (D) (I) (ii) (Q)

13. Pick a correct combination
    (A) (I) (ii) (P)
    (B) (I) (ii) (Q)
    (C) (IV) (iv) (S)
    (D) (II) (i) (Q)

SECTION – B
(Single digit integer type)

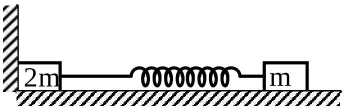
This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

14. A container filled with air under pressure P_0 contains a soap bubble of radius *R*. The air pressure has been reduced to half isothermally and the new radius of the bubble becomes $\frac{5R}{4}$. If the surface tension of the soap water solution is S, P_0 is found to be $\frac{16nS}{R}\text{SI unit}$. Find *n*.

15. In an L–C circuit, oscillations of energy *E* are sustained. The capacitor plates are now slowly drawn apart to increase the oscillation frequency three times. The work done in the process is *nE*. Find *n*.

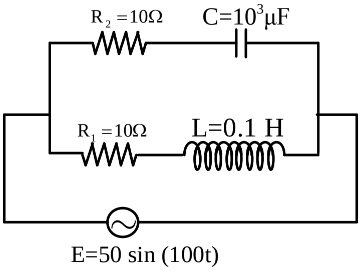
Space for Rough work

16. Two blocks of mass *m* and 2m connected by a weightless spring of stiffness *k* rest on a smooth horizontal plane. Block of mass *m* is shifted to a small distance *x* to the left and then released. If the duration between releasing mass *m* and breaking off of mass 2m is Δt, then average force(in newton) exerted by wall on mass 2m is given as $\frac{x}{\Delta t}\sqrt{mkn}$. Find the value of *n*.



17. One end of a string of length *L* = 15m is tied to the ceiling of an elevator accelerating upwards with an acceleration $20\ \text{m/s}^2$. The other end of the string is free. The linear mass density of the string varies linearly from 0 to λ_0 from bottom to top. Find the time taken by a pulse (in seconds) to reach from bottom to the top. $\left(\text{g}=10\ \text{ms}^{-2}\right)$

18. For the circuit shown in the figure, find the peak current (in ampere) through the source.



Space for Rough work

Chemistry

PART – II

SECTION – A

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

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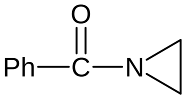
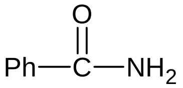
19. In the following compound

(i)

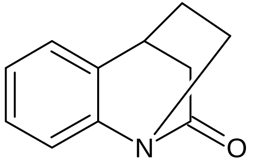


(ii)

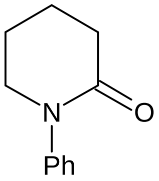


$Ph-\overset{O}{\overset{||}{C}}-NH_2$

(iii)



(iv)



The rate of alkaline hydrolysis of the amide:

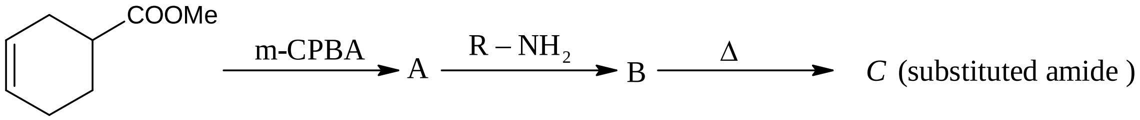
(A) I>II

(B) III>IV

(C) III<IV

(D) I<II

20.



R=Methyl

(A) The compound ‘A’ has a three membered ring.

(B) Degree of unsaturation in C is 3

(C) In ‘B’, $-NHR$ and OH group are Trans to each other

(D) In B, $-COOMe$ and OH group are Trans to each other.

Space for Rough work

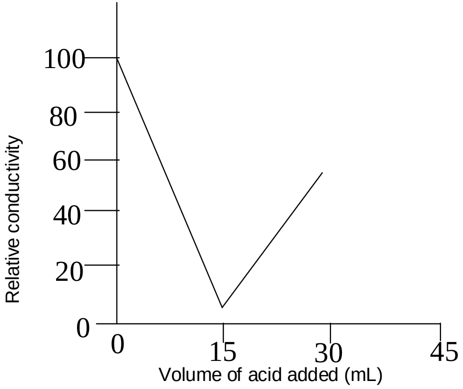
21. Identify the incorrect statement (s)?
    (A) The ratio of the observed molar volume to ideal volume under similar condition is called compressibility factor.
    (B) The value of van der Waals constants ‘a’ and ‘b’ is independent of the nature of gas.
    (C) At high temperature and low pressure, $\left(P+\frac{an^2}{V^2}\right)(V-nb)=nRT$ is used to explain the behaviour of any gas.
    (D) H_2 and He gases are difficult to liquefy because their Critical temperature is very small.

22. In which of the following reactions, the stiochiometric ratio of H_2SO_4 to H_2 gas is the same?
    (A $Zn(s)\text{and}\,H_2SO_4$
    (B) $Na(s)\text{and}\,H_2SO_4$
    (C) $Al(s)\text{and}\,\textit{conc}.H_2SO_4$
    (D) $Cu(s)\text{and}\,H_2SO_4$

23. A 10 mL mixture containing 0.2 g NaOH and $0.25\,g\,Na_2CO_3$ was treated with $xN\,HCl$ required 15 mL of it with phenolphthalein indicator. After end point a $0.5\ g\ NaHCO_3$ was added and it was again titrated with $y\ N\ HCl$ required 25.5 mL of HCl with methyl orange. Which of the following is/are correct?
    (A) x is almost 1.5 times of y
    (B) If in above titration x N HCl is replaced with y N HCl then for first end point it will require 23mL of HCl.
    (C) After first end point instead of 0.5 g if 2.5 g $NaHCO_3$ is added and fitrated with $x\ N\ HCl$ it will require 65.5 mL.
    (D) Only (A) and (B) are correct.

Space for Rough work

24. $20\,\text{mL}$ of KOH solution was titrated with $0.20\,\text{mol}\,\text{L}^{-1}\ \text{H}_2\text{SO}_4$ solution in a conductively cell. The data obtained were plotted to give the graph shown below:



The concentration of the KOH solution was:

(A) $0.30\,\text{mol}\,\text{L}^{-1}$

(B) $0.15\,\text{mol}\,\text{L}^{-1}$

(C) $0.12\,\text{mol}\,\text{L}^{-1}$

(D) $0.075\,\text{mol}\,\text{L}^{-1}$

25. For the reaction $NH_3(g) \rightleftharpoons \frac{1}{2}N_2(g)+\frac{3}{2}H_2(g)$. If Kp of the above reaction is 78.1 at 400°C which is not correct:

(A) At pressure P degree of dissociation of NH_3 is $\left[1+\frac{3\sqrt{3}P}{4k_p}\right]^{-1/2}$

(B) $K_c = 1.413\,mol/\ell$

(C) If we increase pressure it will decrease K

(D) If we increase P by bringing piston down, then, degree of dissociation α will decrease

Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 26, 27 and 28 by appropriately matching the information given in the three columns of the following table.

	Column -1 (Ores)		Column -2 (Type of Ore)		Column -3 (Process involved in extraction/refining)
(I)	Dolomite	(i)	Chloride	(P)	Self reduction
(II)	Cassiterite	(ii)	Carbonate	(Q)	Carbon reduction
(III)	Chalcocite	(iii)	Sulphide	(R)	Fused electrolysis
(IV)	Azurite	(iv)	Oxide	(S)	Poling

26. Which of the following is suitable for calcium?

(A) $(\mathrm{I})\ (\mathrm{ii})\ (\mathrm{P})$

(B) $(\mathrm{I})\ (\mathrm{ii})\ (\mathrm{R})$

(C) $(\mathrm{I})\ (\mathrm{ii})\ (\mathrm{S})$

(D) $(\mathrm{III})\ (\mathrm{ii})\ (\mathrm{R})$

27. Which is correct for tin?

(A) $(\mathrm{II})\ (\mathrm{iii})\ (\mathrm{P})$

(B) $(\mathrm{II})\ (\mathrm{iv})\ (\mathrm{R})$

(C) $(\mathrm{II})\ (\mathrm{i})\ (\mathrm{Q})$

(D) $(\mathrm{IV})\ (\mathrm{ii})\ (\mathrm{Q})$

Space for Rough work

28. Which of the following is used for extraction of copper?

(A) (III) (iii) (R)

(B) (IV) (iii) (Q)

(C) (III) (iii) (P)

(D) (II) (iv) (Q)

Answer questions 29, 30 and 31 by appropriately matching the information given in the three columns of the following table.

Consider all the gases as ideal and irreversible process is carried out at constant P_{Final}.

	Column -1		Column -2		Column -3
(I)	$A(g) \rightarrow A(g)$ (10atm, 1mol, 300K, V, ideal gas) → (1atm, 1mol, 10V)	(i)	$q=0$	(P)	$\Delta U=0$
(II)	$B(s) \xrightarrow{\text{At } 0^0\text{C, 1atm.}} B(liq)$ (melting)	(ii)	$W=0$	(Q)	$\Delta H=0$
(III)	$A(g) \rightarrow A(g)$ (10atm, 1mol, 300K, C_v=1.5R) → (1atm, 1mol)	(iii)	$\Delta S_{system}>0$	(R)	$Vol._{Final}<Vol._{Inital}$
(IV)	Mixing of ideal gases at constant T and P in an isolated container	(iv)	$\Delta G=0$	(S)	$T_{\text{Final for irr. process}} > T_{\text{Final for rev. process}}$

29. Which of the following combination represents isothermal reversible process?

(A) (II) (ii) (Q)

(B) (I) (iii) (S)

(C) (I) (iii) (Q)

(D) (IV) (iv) (P)

Space for Rough work

30. Which of the following is correct combination when “B” as H_2O and others are gases as specified?

(A) (II) (ii) (Q)

(B) (II) (iv) (R)

(C) (IV) (iii) (S)

(D) (II) (iii) (S)

31. Which of the following combination represents the adiabatic process?

(A) (III) (i) (P)

(B) (III) (i) (Q)

(C) (III) (i) (S)

(D) (IV) (iii) (S)

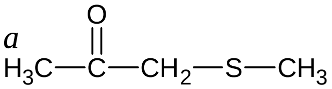
SECTION – B
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

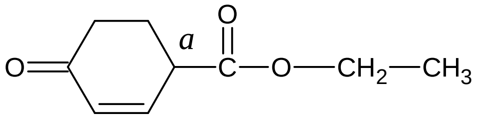
32. How many compounds are having most acidic hydrogen attached to the carbon indicated as (a)?

(i)

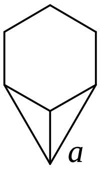


$\overset{a}{H_3C}-\overset{\overset{O}{||}}{C}-CH_2-S-CH_3$

(ii)



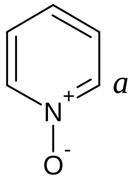
(iii)



(iv) $CH_3-\overset{a}{C}\equiv C-H$

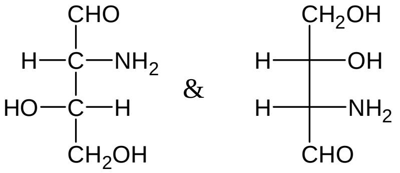
(v) $CH_3-CO-\overset{a}{CH_2}-COOC_2H_3$

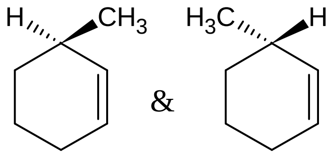
(vi)

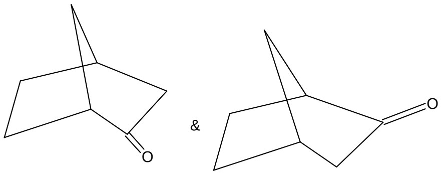


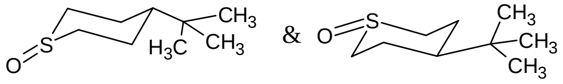
Space for Rough work

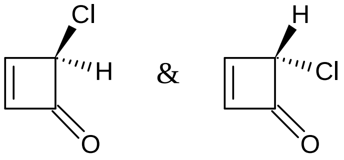
33. How many pairs are Enantiomers?

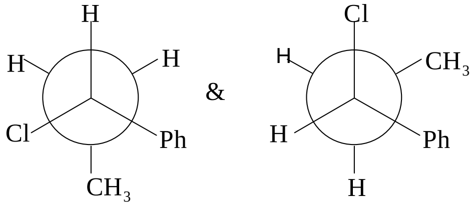
(i) 

(ii) 

(iii) 

(iv) 

(v) 

(vi) 

34. How many statements are true?

(a) At constant $\mathrm{T\,and\,P}, \Delta_{mix}G$ must be negative for an ideal solution.

(b) At constant $\mathrm{T\,and\,P}, \Delta_{\mathrm{mix}}\mathrm{G}$ must be negative for every solution.

(c) At constant $\mathrm{T\,and\,P}, \Delta_{\mathrm{mix}}\mathrm{S} = \Delta_{\mathrm{mix}}\mathrm{H/T}$ for an ideal solution.

(d) For equilibrium between a solution and its vapor, $\mathrm{G_m}$ of the solution must equal $\mathrm{G_m}$ of the vapor.

(e) For equilibrium between an ideal solution and an ideal vapor x_B^l must equal x_B^υ.

(f) In an ideal solution, the partial molar volume of a component equals the molar volume of the pure substance.

35. Positronium is a species consisting of an electron bound to a positron. The ionization potential of positronium is 'A' ev, the value of $\frac{\mathrm{A}}{3.4}$ will be:

36. Choose the correct reactions?

(i) When $\mathrm{CuSO_4}$ reacts with $\mathrm{NH_3}$ red color complex is formed

(ii) When $\mathrm{CuSO_4}$ reacts with $\mathrm{PH_3}$, Cu_3P is formed

(iii) $\mathrm{NH_3(excess)+Cl_2 \longrightarrow NH_4Cl+N_2}$

(iv) $\mathrm{NH_3+Cl_2(excess) \longrightarrow NCl_3+HCl}$

(v) $\mathrm{HNO_3+P_4O_{10} \xrightarrow{\Delta} HPO_3+N_2O_5}$

(vi) $\mathrm{SbF_5+XeF_4 \longrightarrow [SbF_4]^+[XeF_5]^-}$

(vii) $\mathrm{XeF_6+SiO_2 \longrightarrow XeOF_4+SiF_4}$

Space for Rough work

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. If the equation $x^3 + 2x^2 + x + k = 0$ has three real roots in which two roots are equal, then value of k is/are

(A) 0 (B) $k = \frac{27}{4}$

(C) $k = \frac{4}{27}$ (D) None of these

38. For a given parabola $y^2 = 4ax$, two variable chords *PQ* and *RS* at right angles are drawn through the fixed point $A(x_1, y_1)$ inside the parabola, making variable angles θ and α with *x*–axis. If r_1, r_2, r_3, r_4 are distances of *P*, *Q*, *R* and *S* from *A*, then the value of $\frac{1}{r_1 r_2} + \frac{1}{r_3 r_4}$

(A) Independent of θ (B) Independent of α
(C) Depends upon both θ and α (D) Is a constant

39. From (1, 2), tangents are drawn to the curve $y^2 - 2x^3 - 4y + 8 = 0$. Then
(A) Sum of *x*–coordinates of points of contact is zero
(B) Sum of *x*–coordinates of points of contact is 4
(C) Sum of *y*–coordinates of points of contact is zero
(D) Sum of *y*–coordinates of points of contact is 4

40. If $\left|\int_a^b f(x)dx\right| = \int_a^b |f(x)|dx \ (a \neq b)$ also $f(x) \neq 0$ for any $x \in (a, b)$ and $g(x) = \int_0^x f(x)dx$, then $\int_a^b f(x)g(x)dx$ when *a* and *b* are positive

(A) Cannot be positive (B) Cannot be negative
(C) Cannot be equal to zero (D) Nothing can be said

Space for Rough work

41. If $\alpha, \beta, \gamma \in R$, then the determinant

$$\Delta = \begin{vmatrix} (e^{i\alpha}+e^{-i\alpha})^2 & (e^{i\alpha}-e^{-i\alpha})^2 & 4 \\ (e^{i\beta}+e^{-i\beta})^2 & (e^{i\beta}-e^{-i\beta})^2 & 4 \\ (e^{i\gamma}+e^{-i\gamma})^2 & (e^{i\gamma}-e^{-i\gamma})^2 & 4 \end{vmatrix} \text{ is}$$

(A) Equal to 0
(B) Equal to $e^{i(\alpha+\beta+\gamma)}$
(C) Independent of α, β and γ
(D) Dependent of α, β and

42. If AB = A and BA = B, where A and B are square matrices, then
(A) $A^2 = A$
(B) $A^2 = B$
(C) $B^2 = B$
(D) $B^2 = A$

43. If a complex number satisfies the equation $|z| - \log_2(z + 2) = 0$ (Re z > 0), then
(A) $z = -\bar{z}$
(B) $|z| = 2$
(C) $\arg(z) = \frac{\pi}{2}$
(D) $\arg(z) = 0$

Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 44, 45 and 46 by appropriately matching the information given in the three columns of the following table.

	Column -1		Column -2		Column -3
(I)	The value of $\sum_{n=0}^{\infty} 2^{-n+(-1)^n}$ is	(i)	The value of $\left[\sum_{n=0}^{\infty} \tan^{-1}\left(\frac{2}{\sqrt{n+2}+\sqrt{n}+(n+2)\sqrt{n}+n\left(\sqrt{n+2}\right)}\right)\right]$ (where [.] denotes greatest integer function) is	(P)	2
(II)	Number of solutions of equation $16\sin^3 x = 14+\sqrt[3]{\sin x+7}$ in $[0,4\pi]$ is	(ii)	If a, b, c are sides of a triangle, then $\frac{2\left(a^2+b^2+c^2\right)}{ab+bc+ca}$ is always less than	(Q)	3
(III)	Number of solutions of equation $\tan^{-1}(2\sin x) = \cot^{-1}(\cos x)$ in $[0,10\pi]$ is	(iii)	If a, b, c are distinct real numbers such that $a^2(b+c) = b^2(a+c) = 2$, then the value of $c^2(a+b)$ is	(R)	4
(IV)	If the sum of roots of the quadratic equation $(-a+1)x^2+(a^2-a+4)x-2a+3=0$ is minimum, then the value of a(a>1) is	(iv)	If $\mathrm{P}=\sin \mathrm{A}\sin \mathrm{B}, \mathrm{Q}=\sin \mathrm{C}\cos \mathrm{A}$, $\mathrm{R}=\sin \mathrm{A}\cos \mathrm{B}$ $\mathrm{S}=\cos \mathrm{A}\cos \mathrm{C}$, then the value of $5\left(\mathrm{P}^2+\mathrm{Q}^2+\mathrm{R}^2+\mathrm{S}^2\right)$ is	(S)	5

44. Which of the following options is the only **CORRECT** combination?

(A) $(\mathrm{I})\ (\mathrm{ii})\ (\mathrm{R})$

(B) $(\mathrm{II})\ (\mathrm{iv})\ (\mathrm{S})$

(C) $(\mathrm{III})\ (\mathrm{i})\ (\mathrm{Q})$

(D) $(\mathrm{IV})\ (\mathrm{iv})\ (\mathrm{S})$

Space for Rough work

45. Which of the following options is the only **CORRECT** combination?

(A) (II) (i) (P)

(B) (I) (iii) (R)

(C) (II) (ii) (P)

(D) (IV) (iii) (Q)

46. Which of the following options is the only **CORRECT** combination?

(A) (IV) (i) (P)

(B) (III) (iii) (R)

(C) (II) (iii) (P)

(D) (I) (iii) (Q)

Space for Rough work

Answer questions 47, 48 and 49 by appropriately matching the information given in the three columns of the following table.

	Column -1		Column -2		Col. -3
(I)	If S={Z:$\left\|Z+\bar{Z}\right\|+2\left\|Z-\bar{Z}\right\|=4$ and $\|Z\|$ is minimum} then $\frac{25}{8}A$ is (where A is area of polygon formed of all points in S taking as vertices)	(i)	If the Point $(\sec\alpha, \text{cosec}\,\alpha)$ moves in the plane of circle $x^2+y^2=3$ and the minimum distance of this point from circle is $a-\sqrt{b}(a,b\in N)$ then $a+b$	(P)	2
(II)	Let $S=\left\{Z\left\|Z\bar{Z}-(3-4i)Z-(3+4i)\bar{Z}+21=0\right\|\right\}$ If M and m be maximum value and minimum value of $\frac{Z-\bar{Z}}{i(Z+\bar{Z})}$ then $\frac{1}{M}+\frac{1}{m}$ is	(ii)	Two circles $x^2+y^2+2n_1x+2y+\frac{1}{2}=0$ and $x^2+y^2+n_2x+n_2y+n_1=\frac{1}{2}$ intersect each other orthogonally where n_1,n_2 are integers then the number of possible ordered pairs (n_1,n_2) is	(Q)	3
(III)	Let x is the minimum value of $\|Z\|^2+\|Z-3\|^2+\|Z-6i\|^2$ then $\frac{x}{10}$ is	(iii)	If $a_n=\sqrt{1+\left(1+\frac{1}{n}\right)^2}+\sqrt{1+\left(1-\frac{1}{n}\right)^2}$, then the value of $\left(\sum_{n=1}^{20}\frac{1}{a_n}\right)-3$ is	(R)	4
(IV)	Consider a triangle formed by the points $A\left(\frac{2}{\sqrt{3}}e^{i(\pi/2)}\right),B\left(\frac{2}{\sqrt{3}}e^{-i\left(\frac{\pi}{6}\right)}\right),C\left(\frac{2}{\sqrt{3}}e^{-i\left(\frac{5\pi}{6}\right)}\right)$ Let P(Z) is any point on it's in-circle, then $AP^2+BP^2+CP^2$ is	(iv)	The ea^n $9x^3+9x^2y-45x^2=4y^3+4xy^2-20y^2$ represents 3 straight lines two of which pass through origin then $\frac{1}{10}$(Area of triangle formed by these lines)	(S)	5

47. Which of the following options is the only **CORRECT** combination?

(A) (I) (ii) (R)

(B) (II) (iv) (S)

(C) (III) (i) (Q)

(D) (IV) (iv) (S)

Space for Rough work

48. Which of the following options is the only **CORRECT** combination?

(A) $(\text{II})\ (\text{i})\ (\text{P})$

(B) $(\text{I})\ (\text{iii})\ (\text{R})$

(C) $(\text{II})\ (\text{ii})\ (\text{P})$

(D) $(\text{IV})\ (\text{iii})\ (\text{Q})$

49. Which of the following options is the only **INCORRECT** combination?

(A) $(\text{IV})\ (\text{i})\ (\text{P})$

(B) $(\text{III})\ (\text{iii})\ (\text{R})$

(C) $(\text{II})\ (\text{iii})\ (\text{P})$

(D) $(\text{I})\ (\text{iii})\ (\text{Q})$

SECTION – B
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

50. Find number of positive integral solution of equation $\tan^{-1} x + \cos^{-1} \frac{y}{\sqrt{1-y^2}} = \sin^{-1} \frac{3}{\sqrt{10}}$

51. Tangent are drawn from any point on the hyperbola $x^2/9 - y^2/4 = 1$ to the circle $x^2 + y^2 = 9$. If the locus of the mid-point of the chord of contact is a $a\left(x^2 + y^2\right)^2 = bx^2 - cy^2$, then the value of $a^2 + b^2 + c^2 - 7870$ is equal to……………

Space for Rough work

52. If $A = \begin{pmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{pmatrix}$ and $A^2 - 4A - 5I = O$ where I and O are the unit matrix and the null matrix of order 3 respectively. If $15A^{-1} = \lambda \begin{vmatrix} -3 & 2 & 2 \\ 2 & -3 & 2 \\ 2 & 2 & -3 \end{vmatrix}$ then the find the value of λ.

53. The plane $2x - 2y + z = 3$ is rotated about the line where it cuts the xy plane by an acute angle α. If the new position of plane contains the point (3, 1, 1) then $9\cos\alpha$ equal to:

54. If $0 < \alpha, \beta < 2\pi$, then the number of ordered pairs (α, β) satisfying $\sin^2(\alpha + \beta) - 2\sin\alpha \sin(\alpha + \beta) + \sin^2\alpha + \cos^2\beta = 0$ is

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – V

JEE (Advanced)-2020

PAPER –1

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. BCD

Sol. In a frame moving with a velocity of 3 m/s along the z–axis, the displacement of the particle from the equilibrium position is given by

$$\Delta\vec{r} = \left(2\hat{i} - \frac{3}{2}\hat{j}\right)\cos 2\omega t\,.$$

2. AD

Sol. Centre of mass should be at the same height in both cases

3. ABCD

Sol. $y = 2A\sin\left(kx - \omega t\right)$

$$\left(\frac{\partial K}{\partial x}\right)_{antinodes} = 2\mu A^2\omega^2\cos^2\omega t$$

$$\left(\frac{\partial U}{\partial x}\right)_{nodes} = 2\mu A^2\omega^2\cos^2\omega t$$

$$\left(\frac{\partial U}{\partial x}\right)_{antinodes} + \left(\frac{\partial U}{\partial x}\right)_{nodes} = 2\mu A^2\omega^2\text{constant}$$

For a point midway between a node and an adjacent antinode

$$\frac{\partial K}{\partial x} = \mu A^2\omega^2\sin^2\omega\text{t}$$

$$\frac{\partial U}{\partial x} = \mu A^2\omega^2\cos^2\omega\text{t}$$

Let $y = A\sin\left(kx-\omega t\right)+2A\sin kx\cos\omega t$

$$\frac{\partial K}{\partial x} = \frac{1}{2}\mu\left(\frac{\partial y}{\partial t}\right)^2 = \frac{1}{2}\mu[-2A\omega\sin kx\sin\omega t - A\omega\cos(kx-\omega t)]^2$$

$$\frac{\partial U}{\partial x} = \frac{1}{2}T\left(\frac{\partial y}{\partial t}\right)^2 = \frac{1}{2}V^2\mu[2A\omega\cos kx\cos\omega t + Ak\cos(kx-\omega t)]^2$$

4. ABC

5. AB

Sol. $\frac{1}{F} = \frac{\left(\mu-1\right)}{R} = \frac{1}{20}$

$\Rightarrow 20 = \frac{R}{\left(\mu-1\right)}$................(1)

If equiconvex lens of *f* = 20

Then $\frac{1}{20} = \left(\mu-1\right)\frac{2}{R}$

From equation (1) and (2) we conclude

$\therefore\ R = 40\left(\mu-1\right)$

That option (A) is correct.

$-\frac{1}{f_L} = \left(\mu-1\right)\left[\frac{1}{R}-\frac{1}{\infty}\right] = \frac{\left(\mu-1\right)}{R}$ for refraction at the convex surface

$\therefore power\ P_L = \frac{1}{f_L} = -\frac{\left(\mu-1\right)}{R}$

For reflection at the silvered plane surface

$F_M = \alpha$

$\therefore power\ P_M = 0$

For refraction at the convex surface again

$P_L = \frac{\left(\mu-1\right)}{R}$

Hence power of the system

$P = P_L + P_M + P_L$

$= 2P_L + P_M = -2\frac{\left(\mu-1\right)}{R}$

$\therefore$focal length of the system

$F = \frac{1}{P} = -\frac{R}{2\left(\mu-1\right)} = -10cm$

$u = -15cm$

$$\frac{1}{v}+\frac{1}{u}=-\frac{1}{10}$$

$$\frac{1}{v}=\frac{1}{15}-\frac{1}{10}$$

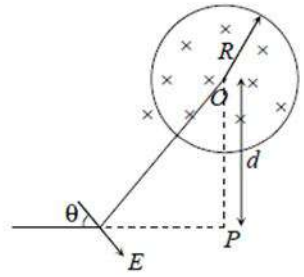
$$\Rightarrow v=-30cm\, so\, B\, is\, correct$$

6. ABC

7. ACD

Sol: $\int \vec{E}.d\vec{l}=A\frac{dB}{dt}$

$$E2\sqrt{x^2+d^2}=\pi R^2 k$$



$$E=\frac{\pi R^2 k}{2\sqrt{x^2+d^2}}$$

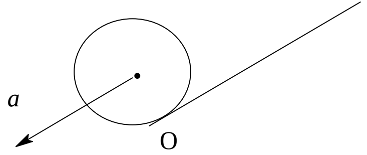
$$W_{ext}=\int_0^\infty q\vec{E}.dx=\frac{q\pi R^2}{4}k$$

8. C

9. A

10. D

Sol. **(for Q. 8 to 10):**



Taking torques about $\text{ICR}\Rightarrow$

$$\text{mg}\sin\theta\ .\ \text{R}=\left(\text{I}_{\text{CM}}+\text{mR}^2\right)\alpha$$

$$a=\alpha R\Rightarrow\frac{mg\sin\theta\, R^2}{\left(\text{I}_{\text{CM}}+\text{mR}^2\right)}$$

Final $\text{V}_{\text{cm}}=0\therefore \text{t}=\frac{V}{a}=\frac{V\left(I_{CM}+mR^2\right)}{mg\sin\theta R^2}$

Also, Applying energy conservation:-

$$\text{mg h}=\frac{1}{2}\left(\text{I}_{\text{CM}}+\text{mR}^2\right)\left(\frac{\text{V}}{\text{R}}\right)^2$$

$$\therefore h=\frac{1}{2}\left[\frac{I_{Cm}}{mR^2}+1\right]\frac{V^2}{g}$$

11. A

12. C

13. C

Sol. **(for Q. 11-13):** The equation of the process BC is

$\text{TV}^2=$ constant

$\text{PV}^3=$ constant

Molar heat capacity of the gas in the process BC is

$$\therefore C=C_V+\frac{R}{1-x}$$

$$=\frac{3R}{2}-\frac{R}{2}=R$$

The work done by the gas during the process BC is

$$\therefore \Delta W_{BC}=\frac{nR\Delta T}{1-x}=\frac{2R(-900)}{1-3}=900R$$

$$\Delta\text{Q}_{\text{AB}}=\text{nCp}\Delta\text{T}=2\times\frac{5\text{R}}{2}\left(1200\text{-}300\right)=4500\text{R}$$

$$\Delta\text{Q}_{\text{BC}}=\text{nC}\Delta\text{T}=2\times\text{R}\left(300\text{-}1200\right)=\text{-}1800\text{R}$$

$$\Delta\text{Q}_{\text{CA}}=\Delta\text{W}_{\text{CA}}=\text{nRT}_0\ln\left(\frac{\text{V}_0}{8\text{V}_0}\right)=2\text{R}300\left(\text{-}3\ln 2\right)=\text{-}1800\text{R}\times 0.7=\text{-}1260\text{R}$$

$$\therefore \Delta\text{W}_{\text{cycle}}=\Delta\text{Q}_{\text{cycle}}=\Delta\text{Q}_{\text{AB}}+\Delta\text{Q}_{\text{BC}}+\Delta\text{Q}_{\text{CA}}=4500\text{R-}1800\text{R-}1260\text{R}=1440\text{R}$$

$$\therefore \text{Efficiency},\eta=\frac{\Delta\text{W}_{\text{cycle}}}{\Delta\text{Q}_{\text{supplied}}}\times 10=\frac{1440R}{4500R}\times 100=32\%$$

SECTION – B

14. 6

Sol. $$\left(P_0+\frac{4S}{R}\right)\left(\frac{4}{3}\pi R^3\right)=\left(\frac{P_0}{2}+\frac{4S\times 4}{5R}\right)\times\frac{4}{3}\pi\left(\frac{5R}{4}\right)^3$$

$$\Rightarrow P_0+\frac{4S}{R}=\frac{125P_0}{128}+\frac{25S}{4R} \quad \Rightarrow P_0=\frac{96S}{R}=\frac{16nS}{R}$$

$$\therefore n=6$$

15. 8

Sol. $W = U_f - U_i = \frac{Q_0^2}{2C'} - \frac{Q_0^2}{2C}, \qquad v \propto \frac{1}{\sqrt{C}} \Rightarrow C' = \frac{C}{9}$

$= \frac{9Q_0^2}{2C} - \frac{Q_0^2}{2C} = 9E - E = 8E$

$\therefore n = 8$

16. 1

Sol. As impulse exerted by wall is equal to change in momentum of the system.

$F_{av}.\Delta t = 3m.V_{cm} = 3m.\frac{x}{3}\sqrt{\frac{k}{m}}$

$\Rightarrow F_{av} = \frac{x}{\Delta t}\sqrt{km} = \frac{x}{\Delta t}\sqrt{km}.n(given)$

$\therefore n = 1$

17. 2

Sol. $T = \int_0^x \frac{\lambda_0 x}{L} g_{eff}\, dx = \frac{\lambda_0}{2L} x^2 g_{eff}$

$\therefore v = \sqrt{\frac{\lambda_0 x^2 g_{eff}.L}{2L.\lambda_0 x}} = \sqrt{15x}$

$\therefore \int_0^{15} \frac{dx}{\sqrt{15x}} = \int_0^t dt$

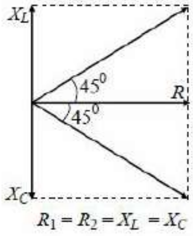
$\Rightarrow t = 2s$

18. 5

Sol. Peak current through $R_1, I_1 = \frac{50}{10\sqrt{2}} = \frac{5}{\sqrt{2}} A$

Peak current through R_2

$I_2 = \frac{50}{10\sqrt{2}} = \frac{5}{\sqrt{2}} A$



Phase difference between I_1 *and* I_2 is $\frac{\pi}{2}$

$\therefore$ Peak current through the source is

$I = \sqrt{I_1^2 + I_2^2} = \sqrt{\left(\frac{5}{\sqrt{2}}\right)^2 + \left(\frac{5}{\sqrt{2}}\right)^2} = \frac{5}{\sqrt{2}} \times \sqrt{2} \qquad \therefore \quad I = 5A$

Chemistry

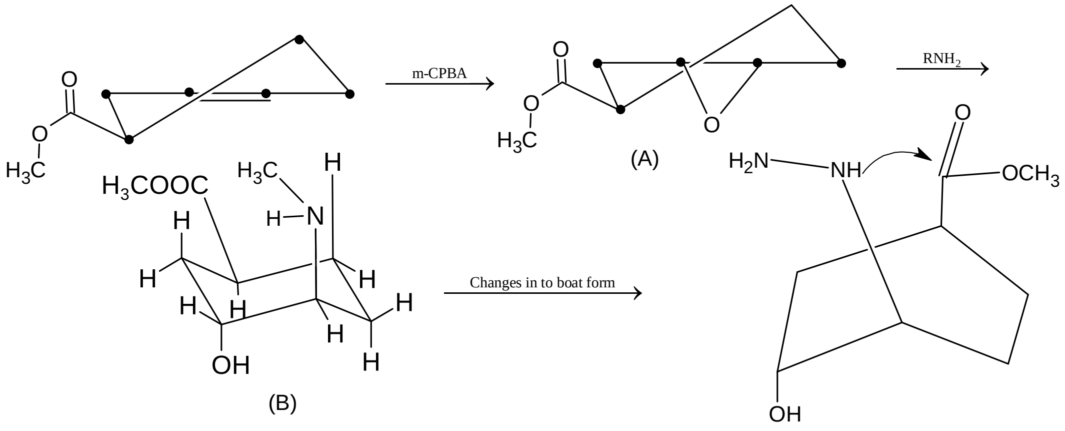
PART – II

SECTION – A

19. AB

$I > II$, because strain is associated with nitrogen, III>IV because III is less stable as lone pair of nitrogen cannot show the resonance with antibonding MO of C=O

20. ABCD



21. BC

Sol. $Z = \frac{V_{m,real}}{V_{m,ideal}}$

at high temperature and low pressure the gas follows PV = nRT

22. AB

Sol. $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$

$2Na + H_2SO_4 \longrightarrow Na_2SO_4 + H_2$

$2Al + 6H_2SO_4 \longrightarrow Al_2(SO_4)_3 + 3SO_2 + 6H_2O$

23. ABC

Sol. $0.005\text{mole NaOH} + 0.00235\text{mole } Na_2CO_3 (0.25/106)$

so H+ required = 0.0073 mole

$0.00735 = x \times 15 \times 10^{-3}$

$x = 0.49$

$0.5\text{gm } (0.0059 \text{ mol}) NaHCO_3$ is added. so total mole of $NaHCO_3$ =0.00825

$0.00825 = y \times 25.5 \times 10^{-3}$

$y = 0.323$

$\frac{x}{y} = 1.5$

$0.00736 = 0.32 \times V(L)$

$y = 23ml$

$0.03211 = 0.49 \times V \times 10^{-3}$

$V = 65.5ml$

24. A

Sol. Volume of H_2SO_4 used at equivalence point is 15mL.

$15 \times 0.2 \times 2 = 20 \times conc.$

Conc. = 0.3

25. C

Sol. $NH_3 \uparrow \rightleftharpoons \frac{1}{2} N_2 \uparrow + \frac{3}{2} H_2 \uparrow$

$$\begin{array}{lll} n & 0 & 0 \\ n(1-\alpha) & \frac{n\alpha}{2} & \frac{3n\alpha}{2} \end{array}$$

Partial pressure at equation $\left(\frac{1-\alpha}{1+\alpha}\right)P; \frac{\alpha}{2(1+\alpha)}P; \frac{3}{2}\left(\frac{\alpha}{1+\alpha}\right)P$

$$K_p = \frac{\left(P_{N_2}\right)^{1/2}\left(P_{H_2}\right)^{3/2}}{P_{NH_3}} = \frac{3\sqrt{3}P}{4}\left[\frac{\alpha^2}{1-\alpha^2}\right]$$

$$\therefore \alpha = \left[1 + \frac{3\sqrt{3}}{4}\frac{P}{K_p}\right]^{-1/2}$$

26. B

27. C

28. C

Sol. **(for Q. 26 - 28):**

Dolomite : $CaCO_3 .MgCO_3, \ CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

Cassiterite : $SnO_2 + C \xrightarrow{\Delta} SnO + CO$

Chalcocite : $Cu_2S + 2Cu_2O \xrightarrow{\text{self reduction}} 6Cu + SO_2$

29. C

30. B

31. C

Sol. **(for Q. 29 – 31):**

(I) Isothermal expansion

(II) Water & Ice will remain in equilibrium to 0°C & 1 atm pressure so $\Delta G=0$

(III) For adiabatic reversible $T_2 P_2^{\frac{1-\gamma}{\gamma}} = T_1 P_1^{\frac{1-\gamma}{\gamma}} \Rightarrow T_2 = 300\left(\frac{P_1}{P_2}\right)^{-2/5} = 300\left(\frac{10}{1}\right)^{-2/5} = 120K$

For adiabatic irreversible

$$C_v(T_2-T_1) = -P_{ext}(V_2-V_1) = -P_2\left[\frac{nRT_2}{P_2} - \frac{nRT_1}{P_1}\right]$$

$$\frac{C_v}{nR}(T_2\text{-}T_1) = \text{-}P_2\left[\frac{T_2}{P_2}\text{-}\frac{T_1}{P_1}\right]$$

$$\frac{(T_2\text{-}T_1)}{\gamma\text{-}1} = \text{-}T_2 + \frac{T_1P_2}{P_1}$$

$$T_2 = T_1\left[\frac{(\gamma\text{-}1)}{\gamma}\frac{P_2}{P_1} + \frac{1}{\gamma}\right]$$

$$T_2 = 192K$$

(IV) Mixing of ideal gas at constant T & P in an isolated container

$\Rightarrow q = 0, w = 0, \Delta U = 0, \Delta S_{system} > 0, \Delta G < 0$

SECTION – B

32. 4

Sol. ii, iii, v and vi

33. 4

Sol. ii, iii, v, vi are enantiomers

34. 3

Sol. (a) true, (b) true, (c) false, (d) false, (e) false, (f) true

For d : G_{molar} of solvent molecules in solution = G_{molar} of solvent molecules in vapour ≠ G_{molar} of solution.

35. 2

Sol. $\mu = \frac{m_{e^-} \times m_{e^+}}{m_{e^-} + m_{e^+}} = \frac{m_e}{2}$

$$IE = \frac{\mu \times 13.6}{m_e}\text{eV} = \frac{\frac{m_e}{2} \times 13.6}{m_e} = 6.8\text{eV}$$

$A = 6.8$

36. 5

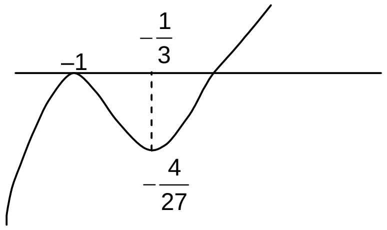
Sol. iii , iv, v, vii is correct. P4O10 is a dehydrating agent.

Mathematics PART – III

SECTION – A

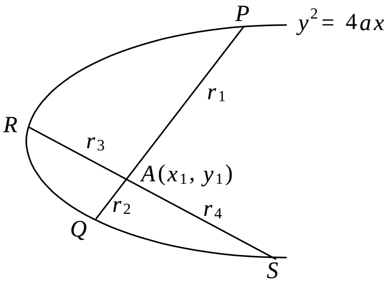
37. AC

Sol.



38. ABD

Sol. Let two perpendicular chords through $A(x_1, y_1)$ be PQ and RS.



Equation of PQ is $\frac{x - x_1}{\cos\theta} = \frac{y - y_1}{\sin\theta} = r$ where $\tan\theta$ = slope of PQ.

Any point on this line may be taken as $(x_1 + r\cos\theta, y_1 + r\sin\theta)$. As the point lies on $y^2 = 4ax$,

$$\therefore \quad (y_1 + r\sin\theta)^2 = 4a(x_1 + r\cos\theta).$$

$$\Rightarrow \quad r^2\sin^2\theta + 2y_1\sin\theta . r - 4a\cos\theta r + y_1^2 - 4ax_1 = 0$$

$$\therefore \quad r_1r_2 = \frac{-\left(y_1^2 - 4ax_1\right)}{\sin^2\theta}$$

Similarly $r_3r_4 = \frac{-\left(y_1^2 - 4ax_1\right)}{\sin^2\alpha}$ where $\tan\alpha$ = slope of RS

Since PQ is perpendicular to RS,

$\therefore \quad \alpha = 90 + \theta$ or $\theta - 90$

In either case; $\sin^2\alpha = \cos^2\theta$

Now $\frac{1}{r_1r_2} + \frac{1}{r_3r_4} = \frac{\sin^2\theta + \cos^2\theta}{-\left(y_1^2 - 4ax_1\right)} = \frac{1}{-\left(y_1^2 - 4ax_1\right)}$ which is constant

39. BD

Sol. Curve is $(y - 2)^2 = 2x^3 - 4$ (1)

$$\frac{dy}{dx} = \frac{3x^2}{y - 2}$$

$\therefore$ Equation of tangent at (x_1, y_1)

$$y - y_1 = \frac{3x_1^2}{y_1 - 2}\left(x - x_1\right)$$

As it passes through (1, 2)

$$\Rightarrow \quad 2 - y_1 = \frac{3x_1^2}{y_1 - 2}\left(1 - x_1\right)$$

or $(y_1 - 2)^2 = 3x_1^2(x_1 - 1)$

or $2x_1^3 - 4 = 3x_1^3 - 3x_1^2$ [As (x_1, y_1) lies on the curve]

or $x_1^3 - 3x_1^2 + 4 = 0$

or $(x_1 + 1)(x_1 - 2)^2 = 0$

$\therefore$ $x_1 = -1$ or 2

But $x_1 \neq = -1$ (it is clear from equation (1))

$\therefore$ $x_1 = 2$

$\therefore$ $y_1 = 2 \pm 2\sqrt{3}$

Points of contact are $(2, 2 + 2\sqrt{3})$ and $(2, 2 - 2\sqrt{3})$

$\therefore$ sum of x–coordinates of points of contact is 4

$\therefore$ sum of y–coordinates of points of contact is 4.

40. BC

Sol. If $\left|\int_a^b f(x)dx\right| = \int_a^b |f(x)|dx$

$\Rightarrow$ $f(x)$ is either positive in (a, b)

or $f(x)$ is negative in (a, b) and also $b > a$

Also $g'(x) = f(x)$

When $f(x) > 0 \Rightarrow g'(x) > 0 \Rightarrow g(x)$ is increasing function

When $f(x) < 0 \Rightarrow g'(x) < 0 \Rightarrow g(x)$ is decreasing function

also $g(0) = 0$

$$\int_a^b f(x)g(x)dx = \int_a^b g(x)g'(x)dx$$

$= \dfrac{(g(b))^2 - (g(a))^2}{2}$ which will be positive for $0 < a < b$.

41. AC

Sol. $C_1 \to C_1 - C_2$

$$\Rightarrow \Delta = \begin{vmatrix} 4 & (e^{i\alpha} - e^{-i\alpha})^2 & 4 \\ 4 & (e^{i\beta} - e^{-i\beta})^2 & 4 \\ 4 & (e^{i\gamma} - e^{-i\gamma})^2 & 4 \end{vmatrix} = 0 \qquad (\because C_1 \text{ \& } C_3 \text{ are identical}).$$

42. AC

Sol. We have AB = A

$\Rightarrow$ A (BA) = A $[\because BA = B]$

$\Rightarrow$ (AB) A = A

$\Rightarrow$ AA = A $[\because AB = A]$

$\Rightarrow$ $A^2 = A$

Again BA = B

$\Rightarrow$ B (AB) = B $[\because AB = A]$

$\Rightarrow$ (BA) B = B

$\Rightarrow$ BB = B $\Rightarrow B^2 = B$

43. BD

Sol. $|z| - \log_2(z + 2) = 0$

$z + 2 = 2^{|z|}$

$x + 2 = 2^x$ and $y = 0$

hence x = 2, y = 0.

44. D

45. A

46. C

Sol. **(for Q. 44 to 46):**

(I) $\left(2+\frac{1}{2}+\frac{1}{2^3}+.......\right)+\left(\frac{1}{2^2}+\frac{1}{2^4}+....\right)$

(II) $f(t)=f^{-1}(t)$ $(t=\sin x)$ (t=1)

(III) $x=2n\pi+\frac{\pi}{4}$

(IV) $\alpha+\beta=a-1+\frac{4}{a-1}+1\geq 5$

(i) $\sum_{n=0}^{\infty}\tan^{-1}\sqrt{n+2}-\tan^{-1}\sqrt{n}$

(ii) $a^2+b^2+c^2<2(ab+bc+ca)$

(iii) $(ab+bc+ca)(a-b)=0$

$\Rightarrow ab+bc+ca=0$

(iv) $P^2+Q^2+R^2+S^2=1$

47. D

48. A

49. C

Sol. **(for Q. 47 to 49):**

(I) $|x|+|2y|=2$ and points are $\left(\pm\frac{2}{5},\pm\frac{4}{5}\right)$

(II) $(x-3)^2+(y-4)^2=4$ required minimum and maximum slopes of target from origin

(III) $3[(x-1)^2+(y-2)^2+10]$

(IV) Points are on

$|Z|=\frac{2}{\sqrt{3}}$

$AP^2+BP^2+CP^2=3|Z|^2+|Z_1|^2+|Z_2|^2+|Z_3|^2$

$-Z(\bar{Z}_1+\bar{Z}_2+\bar{Z}_3)-Z(Z_1+Z_2+Z_3)$

$=1+3\times\frac{4}{3}=5$

(i) Minimum distance

$\sqrt{4+(\tan\alpha-\cot\alpha)^2}-\sqrt{3}=2-\sqrt{3}$

(ii) $n_2=1-\frac{1}{1+n_1}$

(0 ,0) and (-2, 2)

(iii) $T_n \frac{\sqrt{n^2+(n-1)^2}-\sqrt{n^2-(n-1)^2}}{4}$

(iv) $(x+y-5)(3x+2y)(3x-2y)=0$

SECTION – B

50. 2

Sol. $\tan^{-1}x+\tan^{-1}\frac{1}{y}=\sin^{-1}\frac{3}{\sqrt{10}}$

$\tan^{-1}\frac{1}{y}=\tan^{-1}3-\tan^{-1}x$

$\tan^{-1}\frac{1}{y}=\tan^{-1}\frac{3-x}{1+3x}$

$y=\frac{3x+1}{3-x}$ x=1,2 and corresponding y=2,7, thus two solution

51. 3

52. 3

Sol. $A = \begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{bmatrix}$

$$A^2 = \begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{bmatrix}\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{bmatrix} = \begin{bmatrix} 9 & 8 & 8 \\ 8 & 9 & 8 \\ 8 & 8 & 9 \end{bmatrix}$$

$$4A = \begin{bmatrix} 4 & 8 & 8 \\ 8 & 4 & 8 \\ 8 & 8 & 4 \end{bmatrix}$$

$$A^2 - 4A - 5I = 0$$

$$\begin{bmatrix} 9 & 8 & 8 \\ 8 & 9 & 8 \\ 8 & 8 & 9 \end{bmatrix} - \begin{bmatrix} 4 & 8 & 8 \\ 8 & 4 & 8 \\ 8 & 8 & 4 \end{bmatrix} - \begin{bmatrix} 5 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & 5 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} = 0 \qquad A^2 - 4A - 5I = 0$$

Multiplying by A^{-1} both sides,

$$A^{-1}\left[A^2 - 4A - 5I\right] = A^{-1}0$$

$$A - 4I - 5A^{-1} = 0$$

$$A - 4I = 5A^{-1}$$

$$A^{-1} = \frac{1}{5}(A - 4I) = \frac{1}{5}\left(\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & 2 \\ 2 & 2 & 1 \end{bmatrix} - \begin{bmatrix} 4 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 4 \end{bmatrix}\right)$$

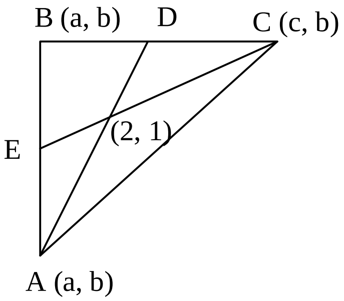
$$A^{-1} = \frac{1}{5}\begin{bmatrix} -3 & 2 & 2 \\ 2 & -3 & 2 \\ 2 & 2 & -3 \end{bmatrix}.$$

53. 7

Sol. Let equation of new plane $2x - 2y + z - 3 + \lambda z = 0$

Point (3, 1, 1) lie on $it \Rightarrow \lambda = -2$

Hence equation of new plane 2x – 2y –z = 3



$$\cos\alpha = \frac{4+4-1}{3.3} = \frac{7}{9}$$

54. 4

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – V

JEE (Advanced)-2020

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **One Section**: **Section-A.**

1. ***Section–A (01 – 07, 19 – 25, 37 – 43)*** *contains 21 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (08– 14, 26 – 32, 44 – 50) *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect option is selected.

   Section–A (15 – 18, 33 – 36, 51 – 54) *contains 6 paragraphs. Each paragraph is having 2 multiple choice questions having 4 options with* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

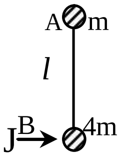
Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

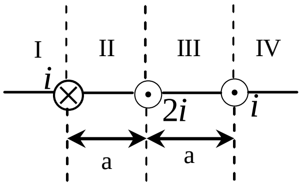
1. An inextensible string connects two masses *m* and 4m and the system rests on a smooth horizontal floor. An impulse *J* is imparted to *B* as shown in figure. The tension in the string in the subsequent motion is



(A) $\frac{J^2}{ml}$ (B) $\frac{J^2}{5ml}$

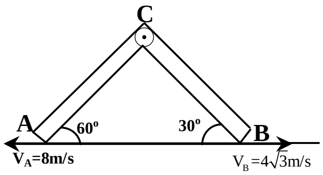
(C) $\frac{4J^2}{5ml}$ (D) $\frac{J^2}{20ml}$

2. Three very long current carrying wires are placed parallel to each other and perpendicular to the plane of paper as shown in the figure. All the wires are equally spaced. The magnetic field will be zero at



(A) Two points in region I
(B) One point in region I and one point in region II
(C) Two points in region III
(D) One point in region I and one point in region III

3. Two rods AC and BC are hinged at the end 'C' and the ends A and B are moving along the surface with velocities $v_A = 8$ m/s and $v_B = 4\sqrt{3}$ m/s respectively as shown. The velocity of hinged point 'C' is

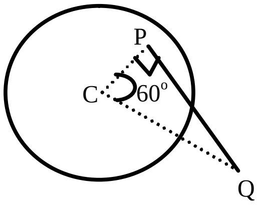


(A) $\sqrt{13}$ m/s (B) $2\sqrt{13}$ m/s

(C) $3\sqrt{13}$ m/s (D) $4\sqrt{13}$ m/s

Space for Rough work

4. A magnetic field, confined in a cylindrical region of radius *R*, is changing at the rate of 4 T/s. A conducting rod *PQ* of length $\sqrt{\frac{3}{2}}R$ is placed in the region as shown. The induced emf across the rod will be

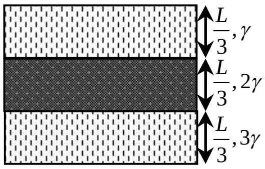


(A) $\frac{R^2}{24}(\pi+6)V$
(B) $\frac{R^2\pi}{24}V$
(C) $\frac{R^2\pi}{6}V$
(D) $\frac{R^2}{6}(\pi+6)V$

5. A steel ball of volume $0.02\ \mathrm{m}^3$ is sinking at a speed of 10 m/s in a closed jar filled with a liquid of density $2000\ \mathrm{kg/m^3}$. The momentum of the liquid is

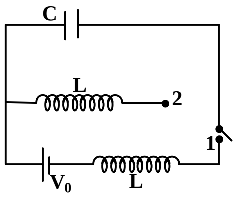
(A) 400 N-s
(B) 200 N-s
(C) 100 N-s
(D) 300 N-s

6. Three immiscible liquids are filled in a container as shown. The base area of the container is A and coefficient of cubical expansion of the material of the container is $\frac{3\gamma}{2}$ while the coefficient of cubical expansion of the liquids are shown in the figure. The temperature of the system is increased by ΔT. The volume of the liquid flown out of the container is



(A) $\frac{Al\gamma\Delta T}{3}$
(B) $Al\gamma\Delta T$
(C) $2Al\gamma\Delta T$
(D) $\frac{Al\gamma\Delta T}{2}$

7. At *t* = 0, switch is closed to position 1. Capacitor is initially uncharged. At $t=\frac{\pi}{2\omega}$, switch is shifted to position 2. Then current as a function of time t is (ω is the angular frequency $=\frac{1}{\sqrt{LC}}$)

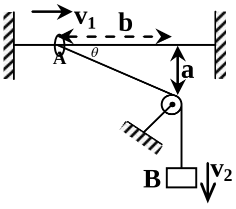


(A) $CV_0\omega\cos\omega t$
(B) $CV_0\omega(1-\cos\omega t)$
(C) $CV_0\omega(1-\sin\omega t)$
(D) $CV_0\omega\sin\omega t$

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

8. Ring *A* can slide on a smooth horizontal rod and block *B* can move vertically. Both are attached by an inextensible string. At a certain instant velocity of ring is v_1 and of block is v_2. At that instant ring is at a horizontal distance *b* from pulley as shown. Then



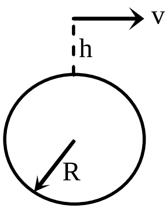
(A) $v_2 = v_1 \cos\theta$

(B) $a_2 = a_1 \cos\theta$, where $a_2 \, and \, a_1$ represent the accelerations of block and ring respectively at that instant

(C) $v_1 = v_2 \cos\theta$

(D) Angular velocity of the ring with respect to an observer on the pulley is $\dfrac{v_1 \sin\theta}{\sqrt{a^2+b^2}}$

9. A particle is taken to a height h from earth's surface and is projected with a velocity *v* as shown. Assume $h << R$, g= 10 m/s^2, *R* = 6400 km. Choose the correct alternative



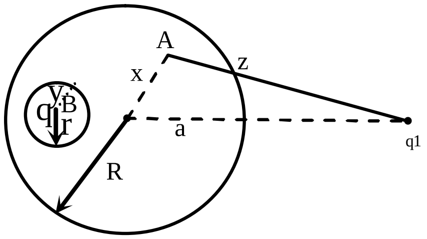
(A) If *v* = 8 km/s, path of the particle will be circular.
(B) If *v* = 10 km/s, path of the particle will be an ellipse.
(C) If *v* = 11.2 km/s, path of the particle will be parabolic.
(D) If *v* = 6 km/s, path of the particle will be an ellipse.

10. In a photoelectric effect experiment, the frequency of incident radiation is increased *n* times $(n > 1)$. Then

(A) Saturation current remains constant
(B) Stopping potential becomes more than n times of initial stopping potential
(C) The difference of the two stopping potentials is equal to $(n-1)\left(V_s + \dfrac{\phi}{e}\right)$, where f is the work function and V_s is the initial stopping potential
(D) The maximum kinetic energy of the photoelectrons increases.

Space for Rough work

11. A cavity is made inside a solid conducting sphere and a charge *q* is placed inside the cavity at the centre. *A* charge q_1 is placed outside the sphere as shown in the figure. Point *A* is inside the sphere and point *B* is inside the cavity. Then



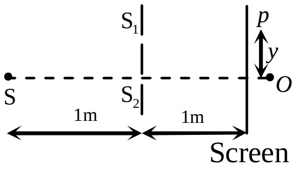
(A) Electric field at point *A* is zero.

(B) Electric field at point *B* is $\frac{1}{4\pi\varepsilon_0}\frac{q}{y^2}$

(C) Potential at point *A* is $\frac{1}{4\pi\varepsilon_0}\left[\frac{q_1}{a}+\frac{q}{R}\right]$

(D) Potential at point *B* is $\frac{1}{4\pi\varepsilon_0}\left[\frac{q_1}{a}+\frac{q}{R}+\frac{q}{y}-\frac{q}{r}\right]$

12. In an arrangement shown in the figure, $d << D$, where *d* is the distance of separation of the slits S_1 and S_2 and *D* is the distance between the slits and the screen. Source *S* is emitting monochromatic light of wavelength λ. Then



(A) Minimum value of *d* for the dark fringe at *O* is $\sqrt{\frac{\lambda}{2}}$

(B) Minimum value of *d* for the dark fringe at *O* is $\sqrt{\frac{\lambda}{3}}$

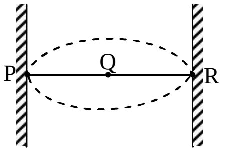
(C) For this value of *d*, the fringe width is $\sqrt{2\lambda}$

(D) For this value of *d*, the fringe width is $\sqrt{\frac{\lambda}{2}}$

13. An escalator is moving down with constant speed. You are moving on it such that you remain at rest with respect to ground. Choose correct statements from ground frame:
(A) Work done by you is zero
(B) Work done by escalator on you is zero
(C) Work done by gravity on you is zero
(D) Work done by escalator on you is negative

Space for Rough work

14. A string *PQR* is fixed between two rigid supports separated by distance *L*. The string is vibrating in its fundamental mode as shown in the figure. Choose the correct alternative(s). (Point *Q* is the mid-point of the string)
(A) Point *Q* on the string will never have potential energy.
(B) Energy of the portion *PQ* is constant.
(C) Point *Q* on the string will have maximum potential energy when its kinetic energy is zero.
(D) Energy of the string *PQR* is constant but transfer of energy takes place between portions *PQ* and *QR*.

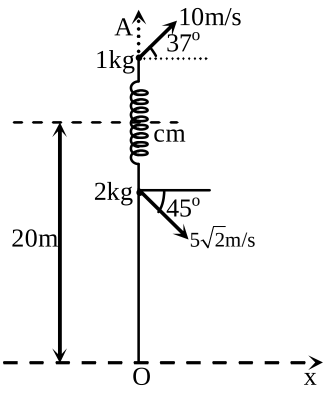


Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 15 and 16

A system consists of two small spheres of mass 1kg and 2kg interconnected by a weightless spring. At t = 0, the spheres are set in motion with initial velocities as shown in figure. Position vector of centre of mass at t = 0 is $20\,\hat{j}$. Initially spring is in its natural length. System moves in earth's gravitational field.



15. The momentum of the system at t=2sec in kg m/s is $(g = 10\text{m/s}^2)$

(A) $\left(12\hat{i} - 32\hat{j}\right)$
(B) $\left(16\hat{i} - 64\hat{j}\right)$
(C) $\left(18\hat{i} - 64\hat{j}\right)$
(D) $\left(12\hat{i} - 18\hat{j}\right)$

Space for Rough work

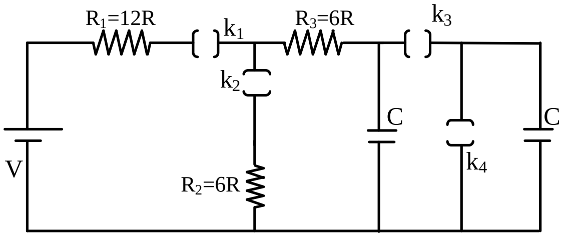
16. The position vector of centre of mass of the system at t=1s is

(A) $4\hat{i}+\frac{24}{25}\hat{j}$ (B) $6\hat{i}+\frac{39}{2}\hat{j}$

(C) $4\hat{i}+\frac{29}{3}\hat{j}$ (D) $6\hat{i}+\frac{41}{3}\hat{j}$

Paragraph for Question Nos. 17 and 18

The ability of a capacitor to store potential energy is the basis of defibrillator devices, which are used in emergency by medical team to stop the fibrillation of heart attack victims. In a portable defibrillator device, a battery charges a capacitor to a high potential difference, storing a large amount of energy in less than a minute. The battery maintains only a modest potential difference; an electronic circuit repeatedly uses that potential difference for greatly increasing the potential difference of the capacitor. When a control switch is closed, the capacitor lends a portion of its stored energy from paddle to paddle through the victim. The figure shows an arrangement, to understand the working of a defibrillator.



17. If k_1, k_2 and k_3 are closed (keeping k_4 open) at $t=0$, then current in the resistor R_2 at $t=t$ is given by

(A) $\frac{V}{15R}e^{-\frac{t}{10RC}}$ (B) $\frac{V}{11R}e^{-\frac{t}{20RC}}$

(C) $\frac{V}{90R}\left(1+5e^{-\frac{t}{20RC}}\right)$ (D) $\frac{V}{90R}\left(5-2e^{-\frac{t}{20RC}}\right)$

18. Long time after closing k_1, k_2 and k_3, if k_1, k_3 are opened and k_4 is closed, then heat produced in R_2 will be

(A) $\frac{1}{36}\mathrm{CV}^2$ (B) $\frac{1}{9}\mathrm{CV}^2$

(C) $\frac{1}{4}\mathrm{CV}^2$ (D) $\frac{1}{6}\mathrm{CV}^2$

Space for Rough work

Chemistry

PART – II

SECTION – A

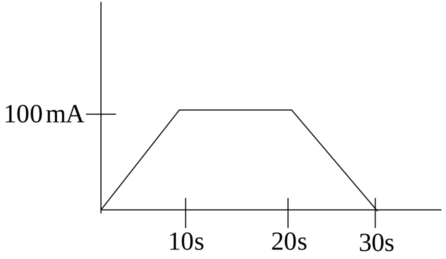
(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

19. Of the following, which will not show chromyl chloride test?
(I) Rubidium chloride
(II) Benzene diazonium chloride
(III) K_2PtCl_6
(IV) Mercurous chloride
(A) II, III and IV (B) III and IV
(C) IV only (D) II and III

20. Marbles of diameter 2cm are to be placed either inside or upon an equilateral triangle (edge length 4cm) drawn on a floor. The maximum number of marbles that can be accommodated is/are:
(A) 1 (B) 2
(C) 3 (D) 6

21. In a Cu voltameter, mass deposited in 30 seconds in 100 grams. Carefully analyse the current-time graph shown below and identify the incorrect statement:



(A) Electrochemical equivalent for Cu is 50
(B) A constant current of 66.66 mA would also discharge the same amount in the same time.
(C) 33.33 grams got discharged in 10 seconds.
(D) 50 grams got discharged in 15 seconds.

Space for Rough work

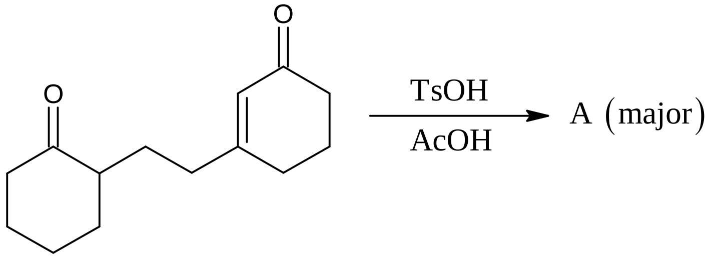
22. Which of the following statements is correct about the conduction of electricity in pure crystal of silicon at room temperature?
(A) The conduction is due to the holes formed from the release of electrons
(B) The conduction is due to the movement of both the electrons released and holes formed
(C) The conduction is only due to the electrons present in fully occupied lowest energy states
(D) The conduction is due to only some electrons capable of leaving the bonds at room temperature

23. The vapour pressures of benzene, toluene and a xylene are 75 Torr, 22 Torr and 10 Torr at $20°C$. Which of the following is not a possible value of the vapour pressure of an equimolar binary/ ternary solution of these at $20°C$? Take all solutions as ideal in nature.
(A) $48\frac{1}{2}$ (B) 16
(C) $35\frac{2}{3}$ (D) $53\frac{1}{2}$

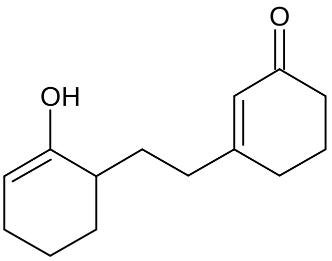
24. White phosphorus when dissolves in boiling $NaOH$ solution in an inert atmosphere, moles of salt of an inorganic salt formed if 24.8 gm of white phosphorus is taken.
(A) 0.2 (B) 0.3
(C) 0.4 (D) 0.6

Space for Rough work

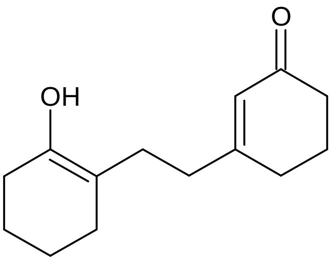
25. Which enol form is involved in this intramolecular aldol?



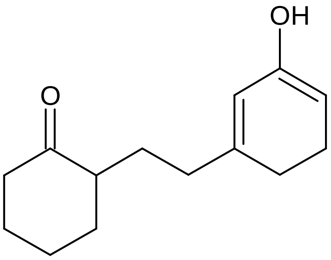
(A)



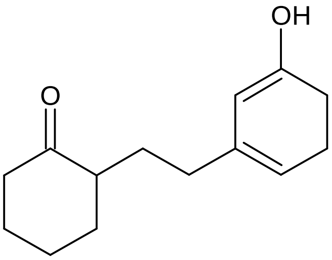
(B)



(C)



(D)



(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

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26. Identify A, B, C and D in the following reaction sequence.

$$\begin{tikzcd}
\mathrm{Si}+\mathrm{CH_3Cl} \arrow[r, "\text{Cu powder, 570K}"] \arrow[d, "O_2"] & (A) \arrow[r, "H_2O"] & (B) \arrow[r, "\text{Polymerization}"] & \text{silicone} \\
(C) \arrow[r, "\text{Excess of coke, electric arc}"] & (D)
\end{tikzcd}$$

(A) The compound A is $(CH_3)_2SiCl_2$
(B) The compound C and D are SiO_2 and SiC respectively
(C) The compound B is $(CH_3)_2$ $Si(OH)_2$
(D) The compound B is $(CH_3)_2$ Si = 0

Space for Rough work

27. When colourless crystals of KI are added to a beaker containing hydrogen peroxide, a clear solution(S) is formed along with a grey-violet precipitate (P). Identify the correct statement:
(A) S reacts with ammonium salts to evolves NH_3.
(B) S conducts Saponification of tristearin to 'hard soap'
(C) P dissolves in CCl_4
(D) P does not dissolve in an aqueous solution of KI

28. The volume of which of the following unit cells will be independent of α, β, γ (interfacial angles):
(A) Orthorhombic
(B) Monoclinic
(C) Hexagonal
(D) Rhombohedral

29. A complex is represented as $CoCl_3.xNH_3$. It's 0.1 molal solutions in water shows $\Delta T_f = 0.558°$. If the cryoscopic and Ebullioscopic constants for H_2O are 1.86 and 0.52 respectively, identify the correct versions assuming 100% ionisation of the complex:
(A) Hexaammine cobalt (III) chloride is the IUPAC name for the complex
(B) The above solution will boil between 100°C to 101°C
(C) The central metal ion is d^2sp^3 hybridised
(D) The coordination sphere is incapable of exhibiting geometrical isomerism

30. Which of the following is/are oxidising agent?
(A) H_2S
(B) H_2SO_5
(C) $H_2S_2O_8$
(D) H_3PO_2

31. Identify the correct statements regarding $\left[Cr(en)_2 Cl_2\right]^+ \; and \left[Co(C_2O_4)_2 (NH_3)_2\right]^-$ complex ions:
(A) Both are chelate complexes
(B) Both have octahedral geometry
(C) Both can have three – three geometrical isomers
(D) Both are organometallic compound

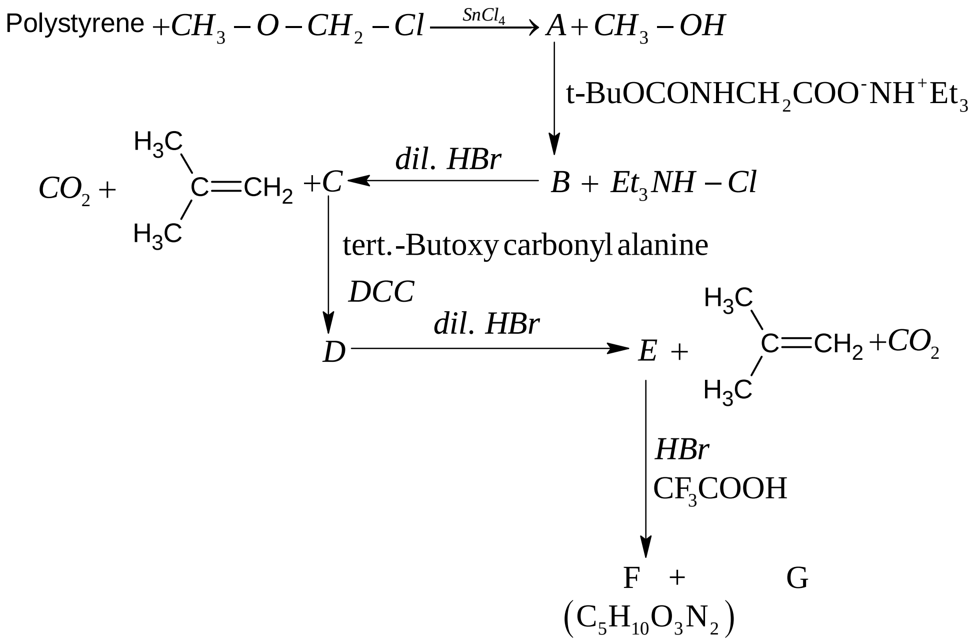
32. The correct statements about some of the ions of 3d-series in aqueous solution
(A) Cr^{2+} is better reducing agent than Fe^{3+}
(B) Co^{3+} is better oxidising agent than Fe^{3+}.
(C) When Fe^{3+} is used as oxidising agent, it attains $3d^7$ electronic configuration
(D) Cu is the only metal in 3d series, which is not having ability to displace hydrogen as H_2 from acidic solution (consider thermodynamic aspects).

Space for Rough work

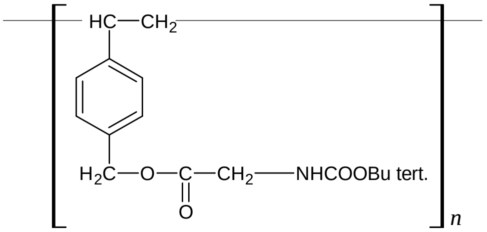
Paragraph Type (One Option Correct)

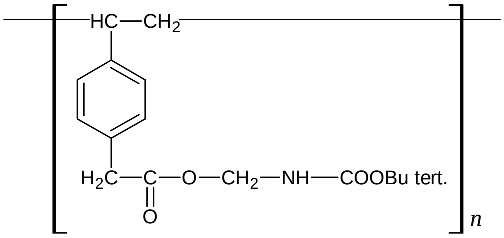
This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

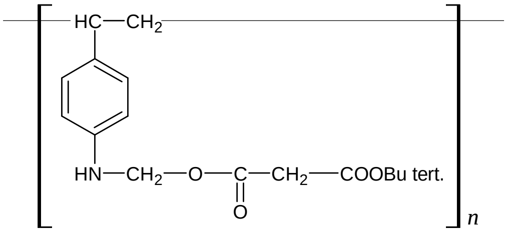
Paragraph for Question Nos. 33 and 34


Polystyrene $+CH_3-O-CH_2-Cl \xrightarrow{SnCl_4} A+CH_3-OH$
t-BuOCONHCH$_2$COO$^-$NH$^+$Et$_3$
B + Et_3NH-Cl
dil. HBr
CO_2 + H$_3$C, H$_3$C C=CH$_2$ +C
tert.-Butoxy carbonyl alanine
DCC
D
dil. HBr
E + H$_3$C, H$_3$C C=CH$_2$ +CO_2
HBr
CF$_3$COOH
F + G
$(C_5H_{10}O_3N_2)$

33. The compound 'B':

(A)

HC—CH$_2$
H$_2$C—O—C—CH$_2$—NHCOOBu tert.
O
n

(B)

HC—CH$_2$
H$_2$C—C—O—CH$_2$—NH—COOBu tert.
O
n

(C)

HC—CH$_2$
HN—CH$_2$—O—C—CH$_2$—COOBu tert.
O
n

(D) None of these

Space for Rough work

34. The F will be:

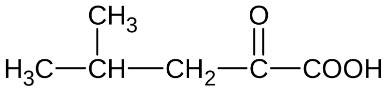
(A) Alanyl glycine (B) glycyl alanine
(C) Alanine (D) Lecinyl glycine

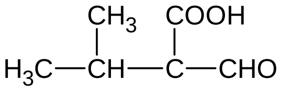
Paragraph for Question Nos. 35 and 36

Ethyl isovalerate + ethyloxalate $\xrightarrow{NaOC_2H_5} \mathrm{A}\left(\mathrm{C_{11}H_{18}O_5}\right)$

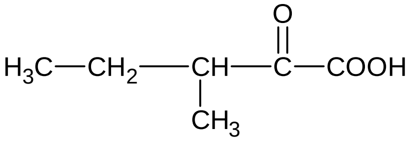
$\mathrm{A}+10\%\,\mathrm{H_2SO_4} \xrightarrow{\text{boil}} B\left(C_6H_{10}O_3\right)+CO_2+C_2H_5OH$

35. The structure of 'B' will be:

(A)

$H_3C-\overset{CH_3}{\overset{|}{C}H}-CH_2-\overset{O}{\overset{\|}{C}}-COOH$

(B)

$H_3C-\overset{CH_3}{\overset{|}{C}H}-\overset{COOH}{\overset{|}{C}}-CHO$

(C) $H_3C-CH_2-CH_2-COOH$

(D)

$H_3C-CH_2-\underset{CH_3}{\underset{|}{C}H}-\overset{O}{\overset{\|}{C}}-COOH$

36. $\mathrm{B}+\mathrm{NH_3}+\mathrm{H_2} \xrightarrow{\mathrm{Pd},\,\Delta} \mathrm{C}$, natural occuring amino acid:

'C' will be:

(A) leucine (B) isoleucine
(C) alanine (D) glycine

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. Suppose f and g are functions having second derivatives f'' and g'' everywhere, if f(x) g(x) = 1 for all x and f ' (x) and g' are never zero, then $\frac{f''(x)}{f'(x)}-\frac{g''(x)}{g'(x)}$ equals

(A) $\frac{f'(x)}{f(x)}$ (B) $2\frac{f'(x)}{f(x)}$

(C) $-\frac{2g'(x)}{g(x)}$ (D) $-\frac{2f'(x)}{f(x)}$

38. Let a real valued differentiable function f(x) be strictly monotonic on [a, b], then

(A) $\int_a^b \left[(f(x))^2-(f(b))^2\right]dx=\int_{f(a)}^{f(b)} 2x\left(b-f^{-1}(x)\right)dx$

(B) $\int_a^b \left[(f(x))^2-(f(a))^2\right]dx=\int_{f(a)}^{f(b)} 2x\left(b-f^{-1}(x)\right)dx$

(C) $\int_a^b \left[f(x)-f(a)\right]^2 dx=\int_{f(a)}^{f(b)} x\left(b-f^{-1}(x)\right)^2 dx$

(D) None of these

39. Let A be the point of intersection of the curve $y=\log_{\frac{1}{3}}\left(x-\frac{1}{3}\right)+\log_3\sqrt{9x^2-6x+1}$ and the circle $x^2+y^2=17$. B is also a point on the curve but lies inside the given circle such that its abscissa is an integer, then max {AB} is

(A) 2 units (B) 3 units

(C) 4 units (D) None of these

Space for Rough work

40. If S_n denotes the sum of first n terms of an AP and $a_n = \frac{S_{3n}}{S_{2n} - S_n}$, then $\underset{n\to\infty}{\text{Lt}} \sum_{r=1}^{2n} \frac{a_r}{n}$ is equal to

(A) 2 (B) 4
(C) 6 (D) 8

41. The possible value of a for which $e^{2x} - (a - 2)\, e^x + a < 0$ holds for at least one positive x is
(A) 2 (B) 3
(C) 4 (D) 7

42. Solution of the differential equation $\frac{dy}{dx} = \frac{3x^2y^4 + 2xy}{x^2 - 2x^3y^3}$ is

(A) $x^2y^3 + \frac{x}{y^2} = c$ (B) $x^3y^2 + \frac{x^2}{y} = c$

(C) $\frac{x^2}{y^3} + xy^2 = c$ (D) $x^3y^2 - \frac{x^2}{y} = c$

43. Angle between $\bar{a}\ \&\ \bar{b}$ is $\frac{\pi}{4}$; $|\bar{a}| = 2\sqrt{2}$, $|\bar{b}| = 3$. Length of longer diagonal of the parallelogram having adjacent sides represented by $5\bar{a} + 2\bar{b}$ and $\bar{a} - 3\bar{b}$ is
(A) $\sqrt{593}$ (B) $\sqrt{26}$
(C) 15 (D) none of these

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

44. $\int_{-1}^{1} \left(e^{x^3} + e^{-x^3}\right) dx$ is less than

(A) 2 (B) $2e + \frac{2}{e}$

(C) $e + \frac{1}{e} + 2$ (D) 2e

Space for Rough work

45. Let $f(x)=e^{-\frac{1}{x^2}}+\int_0^{\frac{\pi x}{2}}\sqrt{1+\sin t}\,dt\,\forall x\in(0,\infty)$ then-

(A) f' exists and is continuous $\forall x\in(0,\infty)$

(B) f'' exists $\forall x\in(0,\infty)$

(C) f' is bounded

(D) There exists $\alpha>0$ such that $|f(x)|>|f'(x)|\,\forall x\in(\alpha,\infty)$

46. Let x,y,z are positive real numbers and ℓ_1 is the least value of $2x^4+2y^4+4z^4-8xyz$ and ℓ_2 is the least value of $x^4y+xy^4+\frac{4}{x^2y^3}+\frac{1}{x^3y^2}+8$, then-

(A) $\ell_1=-1$

(B) $\ell_2>-1$

(C) $\ell_2=10$

(D) $\ell_2>10$

47. Consider the equation in x, $8x^4-16x^3+16x^2-8x+a=0$, then sum of all the non-real roots of equation can be $(a\in R)$

(A) 1

(B) 2

(C) $\frac{1}{2}$

(D) None of these

48. For the equation $\frac{40}{x-1}-\frac{160}{x-4}-\frac{200}{x-5}+\frac{320}{x-8}=6x^2-27x$

(A) Number of real solution of above equation is 3

(B) If E denotes the product of non-zero or complex roots of equation, then sum of divisors of E is 2904

(C) It S denotes the set of all real roots of equation then, sum of elements of S taken two at a time is 81

(D) If $\alpha_1,\alpha_2\in R$ be two roots of equation such that $\log_{\alpha_2}(2\alpha_1)$ is defined it must be 1.

Space for Rough work

49. Let a, b, c be the positive integers such that a<b<c. If the two curves $y = |x-a| + |x-b| + |x-c|$ and $2x + y = 2003$ have exactly one point in common, then-
(A) Least possible value of c is 1002
(B) Greatest possible value of b is 1001
(C) Least possible value of b is 1002
(D) Greatest possible of a is 1000

50. Consider the equation tan (5π cos θ) = cot (5π sin θ) for θ ∈ (0, 2π), then
(A) number of real solution is 28
(B) number of real solution is 14
(C) $\sin\theta + \cos\theta = \frac{2n+1}{10}$
(D) $\sin\theta - \cos\theta = \frac{2n+1}{10}$

Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 51 and 52

Locus of the centre of a circle touching the circle $x^2 + y^2 - 4y - 2x = \frac{7}{4}$ internally and tangents on which from (1, 2) is making an angle 60^o with each other is director circle (*C*) of a variable ellipse *E*. On this basis given answers to the following questions

51. The equation of the director circle (*C*) is
(A) $(x-2)^2 + (y-1)^2 = \sqrt{3}$
(B) $(x-1)^2 + (y-2)^2 = 3$
(C) $(x+1)^2 + (y-2)^2 = \sqrt{3}$
(D) $(x-1)^2 + (y+2)^2 = 3$

Space for Rough work

52. Locus of focus of variable ellipse (*E*) when major axis is parallel to *x*–axis, is

(A) $\left\{(x,\ y)/\sqrt{\frac{3}{2}} < |x-1| < \sqrt{3} \text{ and } y = 2\right\}$

(B) $\left\{(x,\ y)/0 < |x| < \sqrt{3} \text{ and } y = 2\right\}$

(C) $\left\{(x,\ y)/0 < |x+1| < \sqrt{3} \text{ and } y = 2\right\}$

(D) $\left\{(x,\ y)/0 < |x-1| < \sqrt{3} \text{ and } y = 2\right\}$

Paragraph for Question Nos. 53 and 54

Let S = {1, 2, 3,…..n} be a set and two numbers x and y are drawn with replacement from S. Let P_k be the probability that $x^2 - y^2$ is divisible by k & [x] denotes greatest integer less than or equal to x.

53. The value of P_2 is equal to

(A) $\frac{1}{2}$

(B) $\left(\frac{\left[\frac{n}{2}\right]}{n}\right)^2$

(C) $1-2.\frac{\left[\frac{n}{2}\right]}{n}+2\left(\frac{\left[\frac{n}{2}\right]}{n}\right)^2$

(D) $1-\frac{2-\left[\frac{n}{2}\right]}{n}-2\left(\frac{\left[\frac{n}{2}\right]}{n}\right)^2$

54. The value of P_3 is equal to

(A) $\frac{\left[\frac{n}{3}\right]}{n}$

(B) $\left(\frac{\left[\frac{n}{3}\right]}{n}\right)^2$

(C) $1+\frac{\left[\frac{n}{3}\right]}{n}+\left(\frac{\left[\frac{n}{3}\right]}{n}\right)^2$

(D) $1-2.\frac{\left[\frac{n}{3}\right]}{n}+\left(\frac{\left[\frac{n}{3}\right]}{n}\right)^2$

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – V

JEE (Advanced)-2020

PAPER – 2

ANSWERS, HINTS & SOLUTIONS

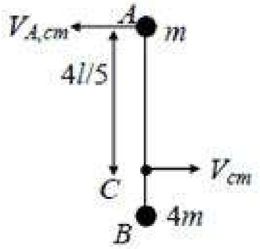
Physics PART – I

SECTION – A

1. D

Sol. $J = 5m \times V_{cm}$

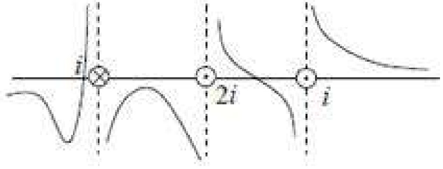
In the COM frame, particles will be in circular motion.



$$T = \frac{m\left(V_{A,cm}\right)^2}{(4l/5)} = \frac{m\left(\frac{J}{5m}\right)}{(4l/5)} = \frac{J^2}{20ml}$$

2. D

Sol. If upward direction of *B* is considered positive the variation can be shown as



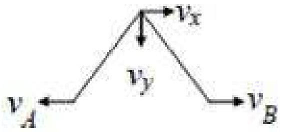
3. B

Sol. $v_x \cos 30^o + v_y \cos 60^o = v_B \cos 30^o$

$v_x\sqrt{3} + v_y = 12$.............(1)

$v_y \cos 30^o - v_x \cos 60^o = v_A \cos 60^o$

$v_y\sqrt{3} - v_x = 8$................(2)



Solving (i) and (ii), we get

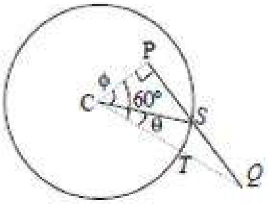
$v_x\left(3\sqrt{3}-2\right)m/s\, and\, v_y = \left(3+2\sqrt{3}\right)m/s$

$\therefore v_C = \sqrt{v_x^2 + v_y^2} = 2\sqrt{13} m/s$

4. D

Sol. $\tan 60^o = \dfrac{PQ}{CP}$

$\sqrt{3}CP = \dfrac{\sqrt{3}R}{\sqrt{2}}$



$CP = \dfrac{R}{\sqrt{2}}$

$CQ = \sqrt{\dfrac{3R^2}{2} + \dfrac{R^2}{2}} = \sqrt{2}R$

$\cos\phi = \dfrac{CP}{CS} = \dfrac{R}{\sqrt{2}R} = \dfrac{1}{\sqrt{2}}$

$\phi = 45^o \Rightarrow \theta = 15^o; PS = \dfrac{R}{\sqrt{2}}$

area of CPST = area ΔCPS + area of sector CST

$\left(\dfrac{1}{2} \times \dfrac{R}{\sqrt{2}} \times \dfrac{R}{\sqrt{2}}\right) + \dfrac{R^2}{2}\left(15^o \times \dfrac{\pi}{180^o}\right)$

$= \dfrac{R^2}{4} + \dfrac{R^2\pi}{24} = \dfrac{R^2}{24}(\pi + 6)m^2$

$emf = A\dfrac{dB}{dt} = \dfrac{R^2}{24}(\pi+6)\times 4 = \dfrac{R^2}{6}(\pi+6)V$.

5. A

Sol. $p = mv = 0.02 \times 2000 \times 10 = 400N - s$

6. D

Sol. Let *V* be the volume of liquid flown out of container

$$V = \frac{AL}{3}\left[\gamma\Delta T + 2\gamma\Delta T + 3\gamma\Delta T\right] - \left[A\left(1+\gamma\Delta T\right)L\left(1+\frac{\gamma}{2}\Delta T\right) - AL\right]$$

$$= 2AL\gamma\Delta T - AL\left(1+\frac{3\gamma}{2}\Delta T\right) + AL = \frac{AL\gamma\Delta T}{2}$$

7. A

Sol. At position 1, *q* = 0, *t* = 0

$$q = CV_0\left(1-\cos\omega t\right)$$

At $t = \frac{\pi}{2\omega}, q = CV_0\left(1-\cos\omega\frac{\pi}{2\omega}\right) = CV_0 = q_0$

$$t' = t - \frac{\pi}{2\omega}, t' \geq 0$$

$$q = q_0\cos\omega t' = q_0\cos\left(\omega t - \frac{\pi}{2}\right) = q_0\sin\omega t$$

In position $2 : q = q_0\sin\omega t \ for\, t \geq \frac{\pi}{2\omega}$

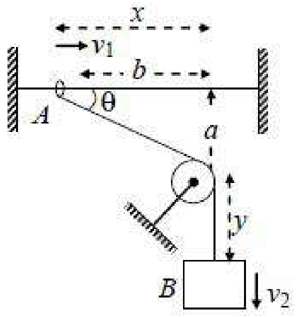
$$i = \omega q_0\cos\omega t = CV_0\omega\cos\omega t$$

8. AD

Sol. By constraint relation, $\mathrm{y}+\sqrt{\mathrm{x}^2+\mathrm{a}}=\mathrm{constant}$

$$\frac{dy}{dt} + \frac{2x}{2\sqrt{x^2+a^2}}\frac{dx}{dt} = 0$$

$$v_2 + \cos\theta\left(-v_1\right) = 0$$

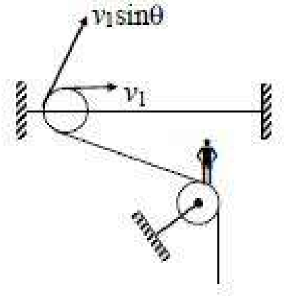


$$v_2 = v_1\cos\theta$$

$$\frac{dv_2}{dt} = \frac{dv_1}{dt}\cos\theta - v_1\sin\theta\frac{d\theta}{dt}$$

$$a_2 = a_1\cos\theta - v_1\sin\theta\frac{d\theta}{dt}$$

If ring is observed with respect to an observer at pulley,



$$\omega = \frac{v_1 \sin\theta}{\sqrt{a^2 + b^2}}$$

9. ABCD

Sol. If h<<H

Orbit velocity $= \sqrt{gr} = 8km/s$

Escape velocity $= \sqrt{2gr} = 11.2km/s$

If $v < ve$, total energy is negative and trajectory will be bound.

If $v \geq ve$, total energy is zero or positive and trajectory will be unbound.

10. ABCD

Sol. $K_{\max} = eV_s = hf - \phi$

$$\Rightarrow V_s = \frac{hf}{e} - \frac{\phi}{e}$$

$$K'_{\max} = eV'_s = nhf - \phi = n(eV_s + \phi) - \phi$$

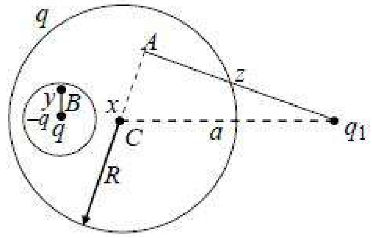
$$eV'_s = neV_s + (n-1)\phi \quad (n > 1)$$

$$V'_s = nV_s + \frac{(n-1)\phi}{e}$$

$$V'_s - V_s = (n-1)\left(V_s + \frac{\phi}{e}\right)$$

11. ABCD

Sol. The charge distribution is shown in figure. Due to q_1, the charge induction is non – uniform but net induced charge due to q_1 is zero. At point *A* field is zero and potential is equal to the potential at center.



$$V_A = V_C = \frac{1}{4\pi\varepsilon_0}\frac{q}{R} + \frac{1}{4\pi\varepsilon_0}\frac{q_1}{a}$$

At point *B*, field is due to charge *q* only

$$E_B = \frac{1}{4\pi\varepsilon_0}\frac{q}{y^2}$$

At point *B*, potential is due to charge *q* at center of cavity, -*q* induced on inner surface of cavity in addition to the potential at the center.

$$\therefore V_B = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1}{a}+\frac{q}{R}+\frac{q}{y}-\frac{q}{r}\right]$$

12. AC

Sol. Minima will be formed at *O*, if $SS_1 + S_1O - SS_2 - S_2O = \frac{n\lambda}{2}, n = 1, 2, ...$

For minimum value of d, n=1

$$\therefore \frac{\lambda}{4} = \sqrt{1+d^2} - 1$$

$$\left(1+d^2\right)^{1/2} - 1 = \frac{\lambda}{4}$$

$$1 + \frac{d^2}{2} - 1 = \frac{\lambda}{4}\,(Negative\,smaller\,terms)$$

$$\Rightarrow d = \sqrt{\frac{\lambda}{2}};\ \beta = \frac{D\lambda}{d} = \sqrt{2\lambda}$$

13. CD

14. AB

Sol. At point Q, slope is zero always, so there will not be any potential energy stored at Q

15. C

Sol. $\vec{p}_i = 1\left(8i + 6\hat{j}\right) + 2\left(5\hat{i} - 5\hat{j}\right) = 18\hat{i} - 4\hat{j}$

$$\vec{p}_f = \vec{f}_{ext}.\Delta t + \vec{p}_i = -60\hat{j} + 18\hat{i} - 4\hat{j} = 18\hat{i} - 64\hat{j}$$

16. D

Sol. Initial velocity of centre of mass

$$u_{cm} = \frac{\vec{p}_i}{m_1 + m_2} = \frac{18\hat{i} - 4\hat{j}}{3} = 6\hat{i} - \frac{4}{3}\hat{j}$$

$$\therefore \vec{r}_{cm(t=1)} = \vec{r}_{cm(t=0)} + \vec{u}_{cm}(1) + \frac{1}{2}a_{cm}(1)^2$$

$$= 20\hat{j} + \left(6\hat{i} - \frac{4}{3}\hat{j}\right) + \frac{1}{2}\left(-10\hat{j}\right) = 6\hat{i} + \frac{41}{3}\hat{j}$$

17. D

Sol. $k_1, k_2\ and\ k_3$ are closed

Time constant $= \left(\frac{12\times 6}{12+6} + 6\right)R \times 2C = RC$

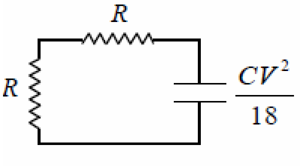
Initial current in $R_2 = \frac{V}{30R}$

Final current in $R_2 = \frac{V}{18R}$

Current in R_2 at an instant $t = \frac{V}{18R} + \left(\frac{V}{30R} - \frac{V}{18R}\right)e^{\frac{t}{20RC}}$

18. A

Sol. When k_1, k_3 opened, k_4 closed



Heat $= \frac{CV^2}{36}$.

Chemistry

PART – II

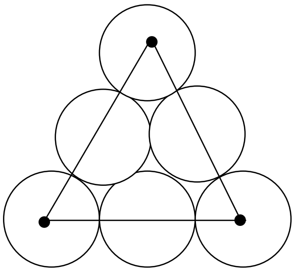
SECTION – A

19. B

Sol. Chromyl chloride test is shown by ionic chlorides. $K_2[PtCl_6]$ and $Cl-Hg-Hg-Cl$ have covalently bonded chlorine atoms.

20. D

Sol.



21. C

Sol. Area under curve = charge passed = 2 coulombs

$$w = Zit = Z = \frac{w}{q} = \frac{100}{2} = 50$$

For constant current; $q = it \Rightarrow 2 = i \times 30$

$$i = \frac{2}{30}A = \frac{200}{3}mA$$

22. C

23. D

Sol. Possible binary solutions are, Benzene + Toluene; Benzene + Xylene; Toluene + Xylene and ternary solution is Benzene + Toluene + Xylene.

In equimolar solutions, mole fractions are 1/2 in binary solution and 1/3rd in ternary solution for each component.

$\therefore$ For Benzene + Toluene, $P = \frac{1}{2}(75) + \frac{1}{2}(22) = \frac{97}{2} = 48.5 \ or \ 48\frac{1}{2}$

For Benzene + Xylene $P = \frac{1}{2}(75) + \frac{1}{2}(10) = \frac{85}{2} = 42.5$

For Xylene + Toluene $P = \frac{1}{2}(22+10) = 16$

For Ternary solution $P = \frac{1}{3}(75+22+10) = \frac{107}{3} = 35\frac{2}{3}$

Hence, option (D) is not possible

24. D

Sol. $P_4 + 3NaOH + 3H_2O \rightarrow PH_3 + 3NaH_2PO_2$

Mole of $NaH_2PO_2 = 0.6$

25. D

Sol. More conjugated product is formed.

26. ABC

Sol.

$$\begin{tikzcd}
\mathrm{Si+CH_3Cl} \arrow[r, "\text{Cu powder, 570K}"] \arrow[d, "\mathrm{O_2}"] & \mathrm{(CH_3)_2SiCl_2} \arrow[r, "\mathrm{H_2O}"] & \mathrm{(CH_3)_2Si(OH)_2} \arrow[r, "\text{Polymerization}"] & \mathrm{[(CH_3)SiO]_n} \\
\mathrm{SiO_2} \arrow[r, "\text{Excess of coke, electric arc}"] & \mathrm{SiC + CO}
\end{tikzcd}$$

27. AC

Sol. $S = KOH$

$P = I_2 \downarrow$

$\bullet\, C_{17}H_{35}COOK$ *is a 'soft soap'*

$\bullet\, KI(aq) + I_2(s) \longrightarrow KI_2(aq)$

28. A,C

Sol. Monoclinic : $\alpha = \gamma = 90^0$, $\beta \neq 90^0$ so depends on β.

Rohmbohedral: $\alpha \neq \beta \neq \gamma$ so depends on angles.

29. BCD

Sol. $\Delta T_f = i.K_f.m$

$0.558 = i \times 1.86 \times .1$

$i = 3$

$\therefore \left[Co(NH_3)_5 Cl\right]Cl_2$

30. BC

Sol. $H_2SO_5, H_2S_2O_8$ due to peroxy linkage want to convert into normal oxide and acts as good oxidising agent.

31. ABC

32. ABD

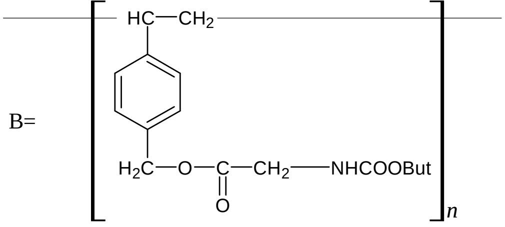
Sol. $E^0_{Cr^{3+}/Cr^{2+}} < E^0_{Fe^{3+}/Fe^{2+}} < E^0_{Co^{3+}/Co^{2+}}$

33. A

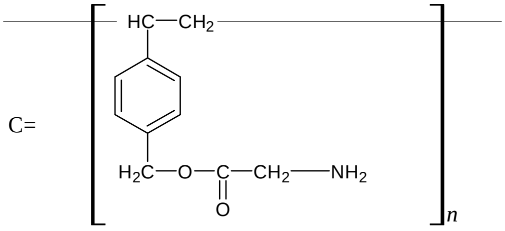
34. A

Sol. (for Q. 33 -34)

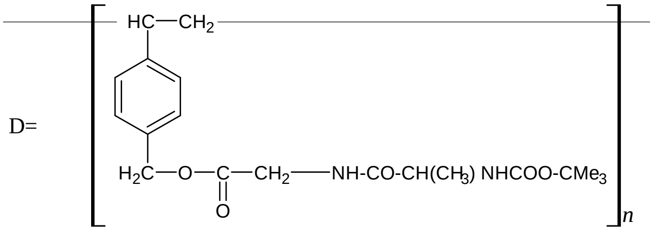
B=



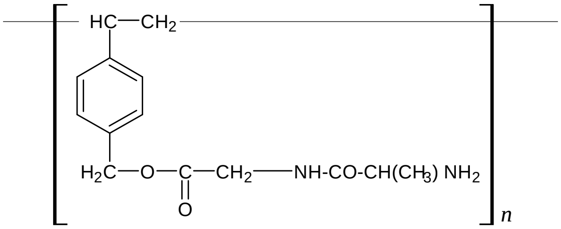
C=



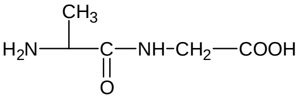
D=



E=



F=



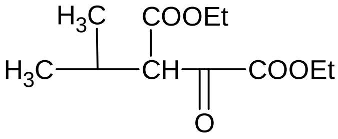
$H_2N-CH(CH_3)-C(=O)-NH-CH_2-COOH$

35. A

36. A

Sol. (for Q. 35 – 36):

A=



$(H_3C)_2CH-CH(COOEt)-C(=O)-COOEt$

Mathematics PART – III

SECTION – A

37. B

Sol. $\frac{f''(x)}{f'(x)}-\frac{g''(x)}{g'(x)} = \frac{\frac{d}{dx}\left(f'(x)/g'(x)\right)}{\frac{f'(x).g'(x)}{(g'(x))^2}} = \frac{g'}{f'}.\frac{d}{dx}\left(\frac{f'}{g'}\right)=\frac{2f'(x)}{f(x)}[\because f(x).g(x)=1].$

38. B

Sol. Let $f^{-1}(x) = t \Rightarrow f(t) = x$

$\int\limits_{f(a)}^{f(b)} 2x\left(b-f^{-1}(x)\right)dx = \int\limits_{a}^{b} 2f(t).(b-t).f'(t)dt$ = b $[((f(t))^2]_a^b$ - b $\int\limits_a^b$ t .2f(t) .f '(t) dt

= $\int_a^b\left[(f(x))^2-(f(a))^2\right]dx$

39. B

Sol. y = $\log_{1/3}\left(x-\frac{1}{3}\right)+\log_3\sqrt{9x^2-6x+1}$ = $\log_{1/3}\left(x-\frac{1}{3}\right)+\log_3|3x-1|$ = 1.

Since $x>\frac{1}{3}$, maximum {AB} = 3.

40. C

Sol. $a_n = \frac{\frac{3n}{2}\left[a+(3n-1)d\right]}{\frac{2n}{2}\left[a+(2n-1)d\right]-\frac{n}{2}\left[a+(n-1)d\right]}=3; \quad \therefore \underset{n\to\infty}{\text{Lt}}\sum_{r=1}^{2n}\frac{1}{n}.3=6.$

41. D

Sol. $e^{2x} + 2e^x < a(e^x-1) \Rightarrow (e^x-1)^2 + 4(e^x - 1) + 3 < a(e^x-1)$

$\Rightarrow (e^x-1) + \frac{3}{e^x-1}+4 < a \Rightarrow a > 4 + 2\sqrt{3}$.

42. B

Sol. $2x^3y\,dy+3x^2y^2dx=\frac{2yxdx-x^2dy}{y^2}$

$\int d\left(x^3y^2\right)=\int d\left(\frac{x^2}{\hat{j}}\right)$

43. A

Sol. $\frac{1-|x|}{2-|x|}\geq 0 \Rightarrow \frac{|x|-1}{|x|-2}\geq 0 \quad \Rightarrow use\ wavy\ curve\ of\ \frac{(x-1)(x+1)}{(x-2)(x+2)}\geq 0$

44. BCD

Sol. $I = \int_{-1}^{1}\left(e^{x^3} + e^{-x^3}\right)dx > 2$

Graph is concave upwards

$\Rightarrow I < f(0) + f(1)$

45. ACD

Sol. $f'(x) = e^{-\frac{1}{x^2}}.\frac{2}{x^3} + \frac{\pi}{2}\sqrt{1+\sin\frac{\pi x}{2}}$

And $\lim\limits_{x\to 0^+}\frac{e^{-\frac{1}{x^2}}}{x^3} = 0$

Also $\lim\limits_{x\to\infty} f(x) = \infty$

f''(x) does not exist for x=3, 7, 11….

46. AD

Sol. $\frac{2x^4 + 2y^4 + 4z^4 + 1}{4} \geq 2xyz$

And $x^4y + xy^4 + \frac{4}{x^2y^3} + \frac{1}{x^3y^2} + 8 \geq 5 - 2$

$\Rightarrow \ell_2 > 10$ (equality cannot hold)

47. AB

Sol. (Put $x = y + \frac{1}{2}$)

48. AB

Sol. $\left(\frac{1}{x-1}+1\right) - \left(\frac{4}{x-4}+1\right) - \left(\frac{5}{x-5}+1\right) + \left(\frac{8}{x-8}+1\right) = \frac{6x^2 - 27x}{40}$

$\Rightarrow x = 0$

Also $\frac{2x-9}{(x-1)(x-8)} - \frac{2x-9}{(x-4)(x-5)} = \frac{3}{40}(2x-9)$

And x=9

49. ABD

Sol. Condition is satisfied for (a, b+c-2a)

$\Rightarrow b + c = 2003$

49. ABD

Sol. Condition is satisfied for (a, b+c-2a)

$\Rightarrow b + c = 2003$

50. BC

Sol. Since tan (5π cos θ) = cot (5π sin θ)

Or $\sin\theta + \cos\theta = \dfrac{2n+1}{10}$, $n \in I$

$\Rightarrow -1 < \dfrac{2n+1}{10\sqrt{2}} < 1 \Rightarrow -\left(\dfrac{10\sqrt{2}+1}{2}\right) < n < \left(\dfrac{10\sqrt{2}-1}{2}\right)$

hence total number of solution is 14.

51. B

Sol. Let r & R be radius of required & given circle resp. & let centre is (h, k).

By given condition

$\sqrt{(h-1)^2 + (k-2)^2} = R - r$

Now, $\dfrac{r}{AB} = \sin 30°$

$r = AB/2$

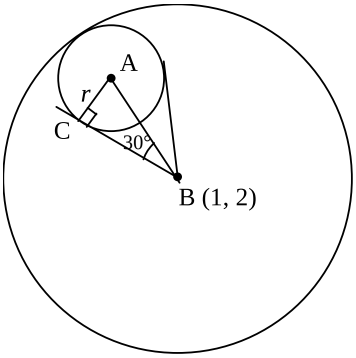
$= (R - r)/2$ (AB = $R - r$) $\Rightarrow r = \dfrac{R}{3}$

$\Rightarrow \sqrt{(h-1)^2 + (k-2)^2} = R - \dfrac{R}{3} = \dfrac{2R}{3}$

Now, $R = \dfrac{3\sqrt{3}}{2}$

$\Rightarrow \sqrt{(h-1)^2 + (k-2)^2} = \dfrac{2}{3} \times \dfrac{3\sqrt{3}}{2} = \sqrt{3}$

$\therefore$ Locus is $(x - 1)^2 + (y - 2)^2 = 3$ which is C.



52. D

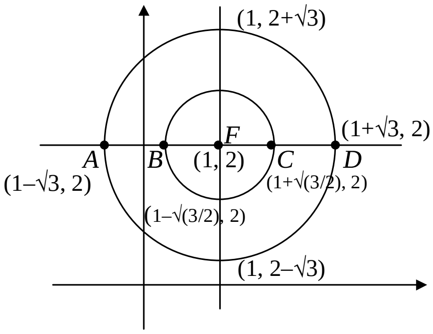
Sol. When major axis of ellipse (E) is parallel to x–axis then equation of E will be

$$\frac{(x-1)^2}{a^2} + \frac{(y-2)^2}{b^2} = 1 \quad (1)$$

Such that $a^2 + b^2 = 3$

In this case one focus will lie in between F and D and other in between A and F.

i.e., $0 < |x - 1| < \sqrt{3}$ and $y = 2$.



53. C

Sol. If one number is drawn from the set {1, 2, 3.……n} the probability α that it is divisible by 2 is given by $\alpha = \frac{\left[\frac{n}{2}\right]}{n}$.

$\Rightarrow$ P (the number is not divisible by 2) = 1 - α.
Now, $x^2 - y^2 = (x - y)(x + y)$
$\therefore P_2 = \alpha \cdot \alpha + (1 - \alpha)(1 - \alpha) = 1 - 2\alpha + 2\alpha^2$

54. D

Sol. Prob. β that the number is divisible by 3 = $\frac{[n/3]}{n}$
$\therefore$ P (the number is not divisible by 3) = 1 - β.
$\therefore P_3 = \beta^2 + (1 - \beta)^2 = 1 - 2\beta + \beta^2$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – V

JEE (Main)-2020

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 75 questions.
- Each subject (PCM) has 25 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only three sections: **Section-A**, **Section-B and Section-C**.

Section-A (01 – 20, 26 – 45, 51 – 70) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-B (21 – 22, 46 – 47, 71 – 72) *contains 6 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

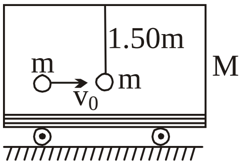
Section-C (23 – 25, 48 – 50, 73 – 75) *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

Physics PART – I

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A ball of mass m = 1kg is hung vertically by a thread of length ℓ = 1.50 m. Upper end of the thread is attached to the ceiling of a trolley of mass M = 4kg. Initially, trolley is stationary and it is free to move along horizontal rails without friction. A shell of mass m = 1kg, moving horizontally with velocity v_0 = 6 ms^{-1}, collides with the ball and gets stuck with it. As a result, thread starts to deflect towards right. Calculate its maximum deflection with the vertical. (g = 10 ms^{-2})



(A) 37°
(B) 53°
(C) 30°
(D) 60°

2. The torque $(\vec{\tau} = \vec{r} \times \vec{F})$ of a force **F** = $-3\hat{i} + \hat{j} + 5\hat{k}$ acting at the point **r** = $7\hat{i} + 3\hat{j} + \hat{k}$ is -

(A) $14\hat{i} - 38\hat{j} + 16\hat{k}$
(B) $4\hat{i} + 4\hat{j} + 6\hat{k}$
(C) $-21\hat{i} + 4\hat{j} + 4\hat{k}$
(D) $-14\hat{i} + 34\hat{j} - 16\hat{k}$

3. In a two slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance from the plane of slits. If the screen is moved by 5×10^{-2} m towards the slits, the change in fringe width is 3×10^{-5} cm. If the distance between the slits is 10^{-3} m, calculate the wavelength of the light used.

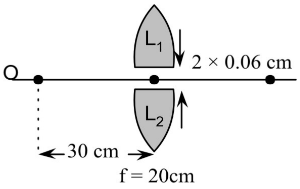
(A) 4500 Å
(B) 3000 Å
(C) 9000 Å
(D) 6000 Å

4. A certain physical quantity is calculated from the formula $\frac{\pi}{3}$ $(a^2 - b^2)$ h, where h, a and b are all length. The quantity being calculated is-

(A) Velocity
(B) Length
(C) Area
(D) Volume

Space for Rough work

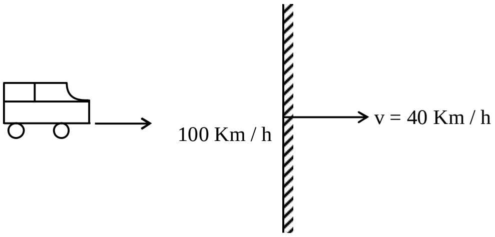
5. A point object O is placed at a distance of 0.3 m from a convex lens (focal length 0.2 m) cut into two halves each to which is displacement by 0.005 m as shown in fig. Find the position of the image. find the distance between the images.



(A) 0.003 m (B) 0.002 m
(C) 0.004 m (D) 0.001 m

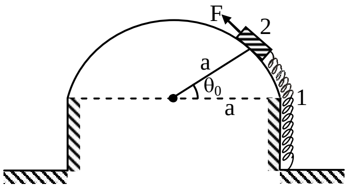
6. A truck starts from rest with an acceleration of 1.5 metre/sec^2 while a car 150 metre behind starts from rest with an acceleration of 2 metre/sec^2. How long will it take before both the truck and car to be side by side, and how much distance is travelled by each?
(A) 2.45 sec (B) 5 sec
(C) 24.5 sec (D) 5.3 sec

7. The back side of the truck which is moving with 40 km/h has shining surface. The surface can be treated as a plane mirror. A motorist trying to overtake the truck from behind is moving with speed of 100 km/h. Find the velocity of the image of motorist observed to himself and to a person standing on the roadside.



(A) 10 kmph (B) 30 kmph
(C) 20 kmph (D) 5 kmph

8. In the position 1 (figure) the spring of constant K is undeformed. Find the work done by the force $\vec{F}$ (which is always directed along the tangent to the smooth hemi spherical surface) on the small block of mass m to shift it from the position 1 to position 2 slowly.

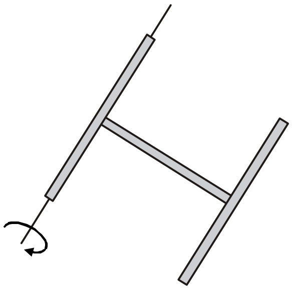


(A) mg R sin $\theta_0 + \frac{KR^2\theta_0^{\,2}}{2}$ (B) mg R sin θ_0
(C) mg R sin θ_0 + $\frac{KR^2\theta_0^{\,2}}{4}$ (D) Zero

9. The ionization potential of Li^{++} ion is 122.4 V. Find the value of its first excitation potential.
(A) 91.8v (B) 45.9 V
(C) 122.4V (D) 28.4 V

Space for Rough work

10. A rigid body is made of three identical thin rods, each of length L fastened together in the form of the letter H. The body is free to rotate about a horizontal axis that runs along the length of one of the legs of the H. The body is allowed to fall from rest from a position in which the plane of the H is horizontal. What is the angular speed of the body when the plane of H is vertical $\frac{3}{2}\sqrt{\frac{g}{L}}$



(A) $\frac{5}{2}\sqrt{\frac{g}{L}}$
(B) $\frac{3}{2}\sqrt{\frac{g}{L}}$
(C) $\frac{3}{4}\sqrt{\frac{g}{L}}$
(D) $\sqrt{\frac{g}{L}}$

11. A radioactive sample has 6.0 × 10^{18} active nuclei at a certain instant. How many of these nuclei will still be in the same active state after two half-lives?
(A) 3 × 10^{18}
(B) 1.5 × 10^{18}
(C) 0.75 × 10^{18}
(D) 6 × 10^{18}

12. One solid sphere, having mass 1kg & diameter 0.3m is suspended from a wire. If the twisting couple per unit twist for the wire is 6 × 10^{-3} N-m/radian, then the time period of small oscillations will be:
(A) 0.7 sec
(B) 7.7 sec
(C) 77 sec
(D) 777 sec

13. Find the constant b in Moseley's equation $\sqrt{\nu}$ = a (Z – b) from the following data.

Element	Z	Wavelength of K_aX-ray
Mo	42	71 pm
Co	27	178.5 pm

(A) 1.43
(B) 1.11
(C) 1
(D) 1.37

14. A 70 cm long sonometer wire is in unison with a tuning fork. If the length of the wire is decreased by 1.0 cm, it produces 4 beats per sec. with the same tuning fork. Find the frequency of the tuning fork -
(A) 276 sec^{-1}
(B) 272 sec^{-1}
(C) 269 sec^{-1}
(D) 280 sec^{-1}

Space for Rough work

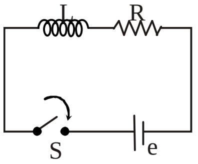
15. Mr. Sanjay wants to calculate the current and power dissipated in an LCR series circuit. He connected 100W resistance to an AC source of 200 V and angular frequency 300 radian/sec. When he removed only the capacitance, the current was found to be lagging behind the voltage by 60°. While on removing the inductance he found, the current leading the voltage by 60°. Find the value of current and the power dissipated obtained by him

(A) 200 Watt (B) 100 Watt
(C) 400 Watt (D) 300 Watt

16. The length of a wire between the two ends of a sonometer is 105 cm. Where should the two bridges be placed so that the fundamental frequencies of the three segments are in the ratio of 1:3:15.

(A) 75 cm, 25 cm, (B) 25 cm, 75 cm,
(C) 75 cm, 100 cm, (D) None of these

17. In an LR circuit as shown in fig. when the switch is closed how much time will it take the current to grow a value $\frac{\eta\varepsilon}{R}$ (where $\eta < 1$)



(A) (L/R) In $\left|\frac{1}{\eta}\right|$ (B) (L/R) In $\left|\frac{1}{1-\eta}\right|$
(C) (2L/R) In $\left|\frac{1}{\eta}\right|$ (D) None of these

18. An infinite number of charges each equal to q are placed along the x-axis at x = 1, x = 2, x = 4, x = 8 ...... and so on. Find the electric field at the point x = 0 due to this set of charges.

(A) $\frac{1}{4\pi\varepsilon_0}\left[\frac{2}{3}q\right]$ (B) $\frac{1}{4\pi\varepsilon_0}\left[\frac{8}{3}q\right]$
(C) $\frac{1}{4\pi\varepsilon_0}\left[\frac{4}{3}q\right]$ (D) $\frac{1}{4\pi\varepsilon_0}\left[\frac{5}{3}q\right]$

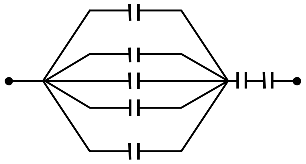
19. A large plane charge sheet having surface charge density $\sigma = 2.0 \times 10^{-6}$ C/m^2 lies in the X-Y plane. Find the flux of the electric field through a circular area of radius 1 cm lying completely in the region where x, y, z are all positive and with its normal making an angle of 60° with the Z-axis.

(A) 15 N-m^2/C (B) 12.5 N-m^2/C
(C) 17.5 N-m^2/C (D) None of these

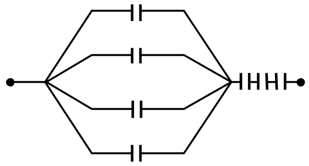
Space for Rough work

20. Seven capacitors each of capacitance 2 mF are to be connected in a configuration to obtain an effective capacitance of (10/11)mF. Which of the combination(s) shown in fig. will achieve the desired result?

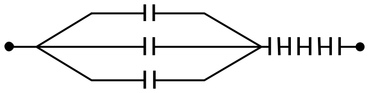
(A)



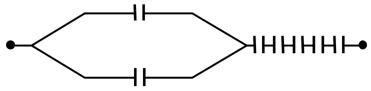
(B)



(C)



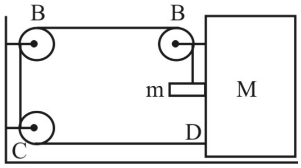
(D)



SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

21. In figure the acceleration of m is $\frac{2\sqrt{x}mg}{M+5m}$, assuming that there is no friction between m and M, and all other surfaces are smooth and pulleys light. Find the value of x.



22. A non-conducting thin spherical shell of radius R has uniform surface charge density σ. The shell rotates about a diameter with constant angular velocity ω. The magnetic induction B at the centre of the shell is $\frac{2}{x}\mu_0\ \sigma\omega$ R. Find the value of x.

Space for Rough work

SECTION – C

(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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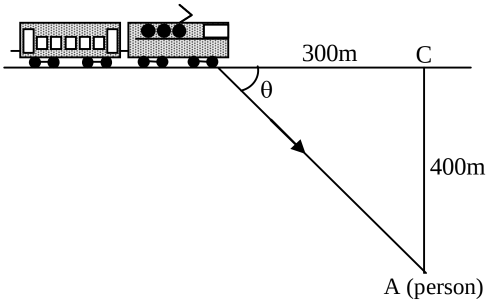
23. A gun kept on a straight horizontal road is used to hit a car travelling along the same road away from the gun with a uniform speed of 72 km h^{-1}. The car is at a distance of 500 m from the gun, when the gun is fired at an angle of 45° with the horizontal. Find the speed of projection of the shell from the gun. (in m/s^{-1})

24. An ideal monatomic gas is confined in a cylinder by a spring loaded piston of cross-section 8×10^{-3} m^2. Initially the gas is at 300K and occupies a volume of $2.4 \times 10^{-3} m^3$ and the spring is in its relaxed position. The gas is heated by a small electric heater until the piston moves out slowly by 0.1m. Calculate the heat supplied (in J) by the heater. The force constant of the spring is 8000 N/m and atmospheric pressure $1 \times 10^5\ N/m^2$.

25. A train approaching a railway crossing at a speed of 120 km/h sounds a short whistle at frequency 640 Hz when it is 300m away from the crossing. The speed of sound in air is 340 m/s. What will be the frequency heard by a person standing on a road perpendicular to the track through the crossing at a distance of 400 m from the crossing. (in Hz)



Space for Rough work

Chemistry

PART – II

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

26. Most soluble hydroxide in benzene is:

(A) $LiOH$ (B) $NaOH$
(C) KOH (D) $RbOH$

27. Referring to figure-1, identify the three spots obtained by electrophoresis at $p^H = 7$ of a mixture of the proteins pepsin $\left(p^I = 1.1\right)$ haemoglobin $\left(p^I = 6.8\right)$ and Lysozyme $\left(p^I = 11.0\right)$:

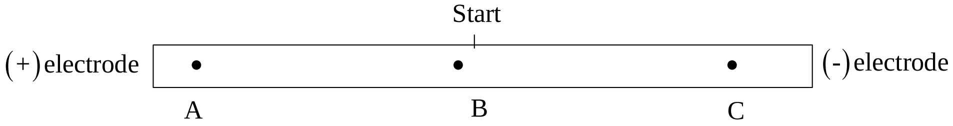


Fig-1

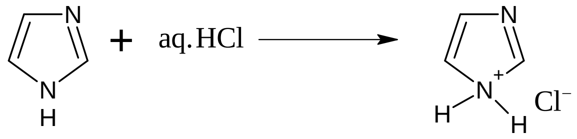
Which of the following options are correct about position of various proteins?
(A) Lysozyme will be present at spot A
(B) pepsin will be present at spot B
(C) pepsin will be present at spot A
(D) haemoglobin will be present at spot C

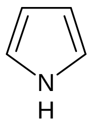
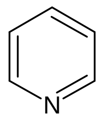
28. Silver sulphide dissolves in sodium cyanide solution to form the complex?

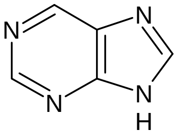
(A) $Na_2\left[Ag\left(CN\right)_4\right]$ (B) $Na\left[Ag\left(CN\right)_2\right]$
(C) $Na_3\left[Ag\left(CN\right)_4\right]$ (D) $Na_3\left[Ag\left(CN\right)\right]$

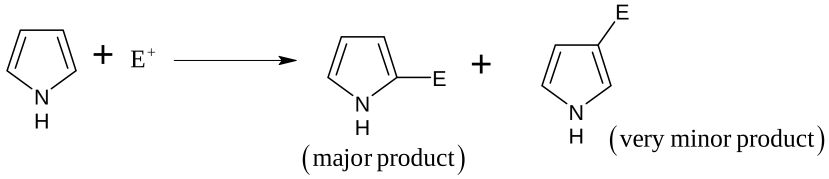
Space for Rough work

29. Which of the following is incorrect statement/reaction?

(A) 

(B)  is less basic than 

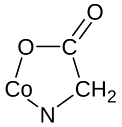
(C)  purine has 3 N's as basic sites

(D) 
E⁺
(major product)
(very minor product)

30. Which of the following statement is wrong about complex anion $\left[Co\left(EDTA\right)\right]^{-}$?

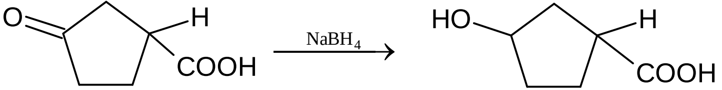
(A) oxidation state of Co is $+3$

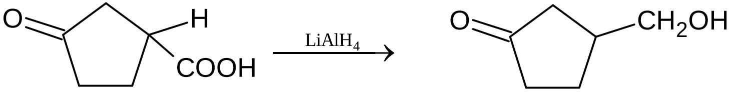
(B) compound is optically active

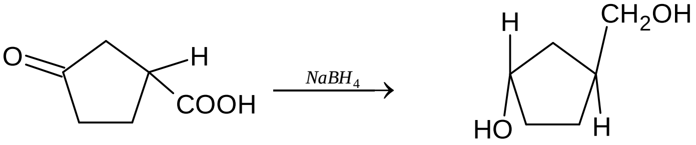
(C) number of  rings is 4

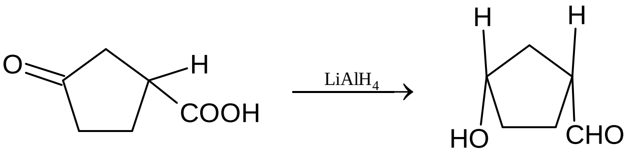
(D) total number of five member rings is 6

31. Which of the following reaction can be used for preparation of alcohol from carbonyl compound

(A) 

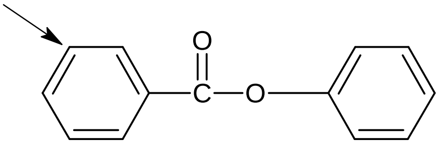
(B) 

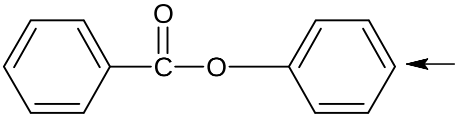
(C) 

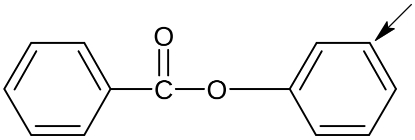
(D) 

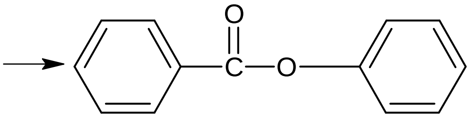
Space for Rough work

32. When phenyl benzoate ($PhOCOPh$) undergoes electrophilic substitution, which of the following indicates the site for attack of electrophile as major product?

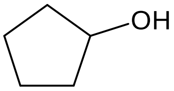
(A)


(B)


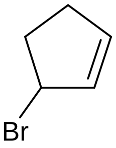
(C)


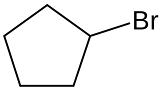
(D)


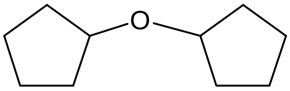
33. Which of the following statement about diffusion of gas is true?
(A) Rate of diffusion of a gas will increase if an inert gas is added to gaseous mixture and allowed to diffuse through a pin hole
(B) Rate of effusion of O_2 is $\sqrt{2}$ times that of SO_2, for every composition of O_2 and SO_2 mixture
(C) Rate of effusion decrease on increasing the temperature
(D) All are true.

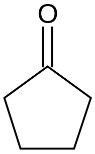
34.


$\xrightarrow[120°C]{H_2SO_4}$ 'A' $\xrightarrow{NBS}$ 'B'

(A) 'B' is


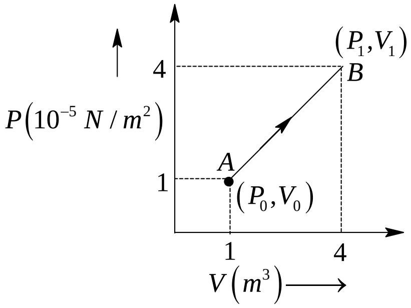
(B) 'B' is


(C) 'A' is


(D) 'A' is


Space for Rough work

35. The work done in changing state from A to B in following system is:



(A) $-7.5\times10^{-5}\,J$ (B) $-7.5\times10^{5}\,J$

(C) $+7.5\times10^{-5}\,J$ (D) $+7.5\times10^{5}\,J$

36. $P_4 + HNO_3 \longrightarrow H_3PO_4 + NO_2\uparrow + H_2O$

Product mixture is titrated with $0.1M\ \ NaOH$, indicator shows colour change at second end point and $100ml$ of $NaOH$ is used for that. How much volume of $1M\ \ HNO_3$ is used is above reaction?

(A) $20ml$ (B) $10ml$

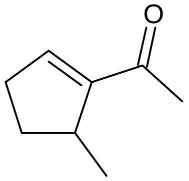
(C) $25ml$ (D) $\frac{50}{3}ml$

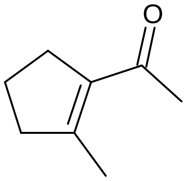
37. When Lithium di-(3-pentyl) cuprate reacts with ethyl bromide produces:

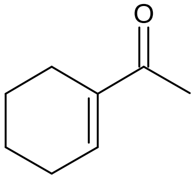
(A) heptane (B) triethyl methane

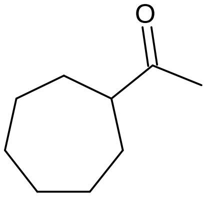
(C) 2-ethylpentane (D) 3-methyl hexane

38. 2, 7-Octanedione on treatment with aq. KOH and 100°C produces?

(A)


(B)


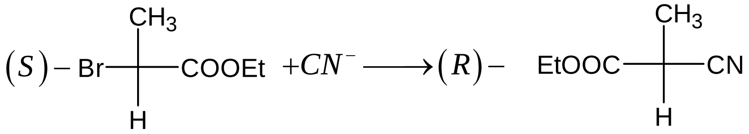
(C)


(D)


Space for Rough work

39. Which of the following salts are soluble in NH_4OH?
(A) $CuSO_4$ (B) $AlCl_3$
(C) $FeCl_3$ (D) all of the above

40. Which of the following substitution reaction $\left(SN^2\right)$ does not give product as shown is reactions?
(A) $(R)-CH_3CH(Br)CH_2CH_3 + MeO^- \longrightarrow (S)-CH_3CH(OMe)CH_2CH_3$
(B) $(S)-CH_3CH(Br)CH_2CH_3 + MeO^- \longrightarrow (R)-CH_3CH(OMe)CH_2CH_3$
(C)



$(S)-Br-\underset{H}{\overset{CH_3}{C}}-COOEt + CN^- \longrightarrow (R)-EtOOC-\underset{H}{\overset{CH_3}{C}}-CN$

(D) $\text{cis-4-iodoethylcyclohexane+OH}^- \longrightarrow \text{trans-4-ethylcyelohexanol}$

41. The aqueous solution of which salt is coloured
(A) $Zn(NO_3)_2$ (B) $LiNO_3$
(C) $Co(NO_3)_2$ (D) Potash alum

42. Potassium crystallizes in BCC lattice with a unit cell length $a = 5.0\,Å$. What is the distance between next nearest neighbours?
(A) 5.0Å (B) 4.33Å
(C) 3.5Å (D) 7.07Å

43. Crystal field splitting energy (Δ_0) of complexes $\left[CrCl_6\right]^{3-}, \left[Cr(CN)_6\right]^{3-}$ and $\left[Cr(NH_3)_6\right]^{3+}$ are x, y and z cm^{-1} respectively. Then correct order Δ_0 values is:
(A) $x < y < z$ (B) $x < z < y$
(C) $x > y > z$ (D) $x > z > y$

44. Optical isomerism is not shown by the complex:
(A) $\left[Cr(ox)_3\right]^{3-}$ (B) $Cis\left[Co(en)_2Cl_2\right]^+$
(C) $Trans\left[Co(en)_2Cl_2\right]^+$ (D) $\left[Cr(en)_3\right]^{3+}$

Space for Rough work

45. What concentration of Ag^{+} is solution will just fail to give a precipitate of Ag_2CrO_4 with a solution in which $\left[CrO_4^{2-}\right]=3\times10^{-4}M$?

$\left(Given\ K_{sp}\left(Ag_2CrO_4\right)=1.2\times10^{-11}\right)$

(A) $10^{-3}M$
(B) $2\times10^{-1}M$
(C) $2\times10^{-3}M$
(D) $2\times10^{-4}M$

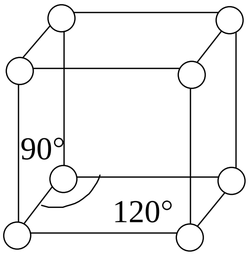
SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

46. How many statement(s) are correct?

(a) if the critical micelle concentration (CMC) of a soap is $10^{-3}M$, then $10^{-4}M$ solution of this soap will have colloidal nature.
(b) charge on the colloidal particles may be determined with the help of dialysis
(c) peptization is the process of conversion of a colloidal sol into precipitate by adding some electrolyte
(d) when some oil-soluble dye is added in the water in oil emulsion, the back ground becomes coloured
(e) For the coagulation of a particular colloidal solution, the order of coagulation power of some electrolytes is in the order: $Na_3PO_4 > BaSO_4 > AlCl_3,$ in electro-osmosis, the dispersion medium move towards the anode
(f) diffused layer around colloidal particles in the electric double layer mostly contains negatively charged particles.(colloid is of ‘e’ part)
(g) it may be basic dye such as methylene blue (colloid is of ‘e’ part)
(h) it may be metal sol (colloid is of ‘e’ part)

47. Ice crystallizes is an hexagonal lattice. At the low temperatures at which the structure was determined, the lattice constants were $a = 4.53\mathring{A}$ and $b = 7.41\mathring{A}$ as shown in the figure. How many H molecules are contained in a unit cell? (Given that density of ice $= 0.92\,g/cm^3$)?



Space for Rough work

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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48. If value of spin quantum number(s) $=-1/2, 0, +1/2$ then calculate number of groups in the new form of periodic table if all other rules of electronic configuration are remain same.

49. Calculate value of $\frac{X+Y+Z}{10}$, here X is $O-N-O$ bond angle in NO_3^- Y is $O-N-O$ bond angle in NO_2^+ and Z is $F-Xe-F$ adjacent bond angle in XeF_4.

50. Calculate $x+y+z$ for H_3PO_3 acid, where x is number of lone pairs, y in number of σ bonds and z in number of π bonds.

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

51. $\int \frac{3x^2+4x-1}{\left(x^2+1\right)^2\sqrt{x+1}}dx$ is equal to:

(A) $\frac{\sqrt{x+1}}{x^2+1}+c$
(B) $-\frac{2\sqrt{x+1}}{x^2+1}+c$
(C) $\frac{2}{\left(x^2+1\right)\sqrt{x+1}}$
(D) $\frac{-x}{\left(x^2+1\right)\sqrt{x+1}}+c$

52. The general solution of the differential $y\left(xy-\left(x^2-y^2\right)^2\right)dx=\left\{y^3-x\left(x^2-y^2\right)^2\right\}dy$ is:

(A) $\frac{y}{x}+\frac{1}{x^2-y^2}=c$
(B) $\frac{x}{y}-\frac{1}{2}\ln\left|\frac{x-y}{x+y}\right|=c$
(C) $\frac{2x}{y}+\frac{1}{x^2-y^2}=c$
(D) $\frac{2x}{y}-\frac{1}{x^2-y^2}=c$

53. A line is drawn at an angle θ with positive direction of x-axis. It intersects the parabola $y^2=8x$ at A and B. If AB is a normal chord which subtend a right angle at the vertex of the parabola, then $\tan^2\theta$ equals:

(A) $\frac{1}{2}$
(B) $\frac{3}{4}$
(C) 1
(D) 2

Space for Rough work

54. The equation of a circle whose diameter is the common chord of the circle $x^2+y^2-4x-8y-5=0$ and $x^2+y^2-12x+2y+29=0$ is:

(A) $41x^2+41y^2-396x-38y+781=0$

(B) $2x^2+2y^2-16x-6y+25=0$

(C) $41x^2+41y^2+396x-38y-781=0$

(D) $17x^2+17y^2-300x+154y+901=0$

55. $\int_0^{\frac{11\pi}{3}} \sqrt{1+\cos 2x}\,\mathrm{dx}$ is equal to:

(A) $\frac{11\sqrt{3}}{2}$

(B) $8\sqrt{2}-\sqrt{\frac{3}{2}}$

(C) $8\sqrt{2}-\frac{\sqrt{3}}{2}$

(D) $\frac{22}{3}$

56. Consider the vectors $\vec{a}=2\hat{i}+\hat{j}-2\hat{k}$ and $\vec{b}=3\hat{i}-\hat{j}+\hat{k}$. A parallelogram is constructed such that its diagonal are along $2\vec{a}-\vec{b}$ and $\vec{a}-2\vec{b}$. The area of the parallelogram is:

(A) $9\sqrt{5}\,sq.units$

(B) $\frac{9\sqrt{10}}{2}sq.units$

(C) $9\sqrt{10}\,sq.units$

(D) $18\sqrt{5}\,sq.units$

57. Let $\frac{\tan\left(\frac{\pi}{4}+\alpha\right)}{5}=\frac{\tan\left(\frac{\pi}{4}+\beta\right)}{3}=\frac{\tan\left(\frac{\pi}{4}+\gamma\right)}{2}$. Then $12\sin^2(\alpha-\beta)+15\sin^2(\beta-\gamma)-7\sin^2(\gamma-\alpha)$ is equal to?

(A) $-\frac{1}{2}$

(B) $\frac{1}{2}$

(C) 1

(D) 0

Space for Rough work

58. The angle of intersection of the curves $y=(1+x)^{\cos x}+\sin x$ and $y=\frac{1}{2}\left(x^2+x+2\right)$ at (h,k) where h and k are integers, is θ, then $\tan\theta$ equals:

(A) $\frac{3}{4}$ (B) $\frac{4}{3}$

(C) 1 (D) 0

59. A plane $2x+3y+6z=12$ intersects the x-axis, y-axis and z-axis at A, B, C respectively. The orthocentre of the triangle ABC is:

(A) $\left(\frac{24}{49},\frac{36}{49},\frac{72}{49}\right)$ (B) $\left(\frac{36}{49},\frac{72}{49},\frac{27}{49}\right)$

(C) $\left(\frac{24}{49},\frac{16}{49},\frac{1}{49}\right)$ (D) $\left(\frac{36}{49},\frac{72}{49},\frac{24}{49}\right)$

60. The domain of the function given by $f(x)=\log_3\left(\log_{\frac{1}{2}}\left(\log_2\left(\log_{\frac{1}{3}}(x)\right)\right)\right)+\frac{x+1}{\sqrt{1-3x-4x^2}}$ is:

(A) $\left(-1,\frac{1}{3}\right)$ (B) $\left(\frac{1}{4},\frac{1}{3}\right)$

(C) $\left(\frac{1}{9},\frac{1}{4}\right)$ (D) $\left(\frac{1}{9},\frac{1}{3}\right)$

61. If $f(x)=\frac{3^{x-3}}{3^{1-x}+3^x}$ for all $x\in Q,$ then the value of $f\left(\frac{1}{109}\right)+f\left(\frac{2}{109}\right)+f\left(\frac{3}{109}\right)+....+f\left(\frac{108}{109}\right)$ is:

(A) 54 (B) 55

(C) 108 (D) 2

Space for Rough work

62. The value of $\cot\sum_{n=1}^{\infty}\cot^{-1}\left(\frac{2}{n^2}\sum_{k=1}^{n}k^3\right)$

(A) $\frac{1}{2}$
(B) $\frac{1}{4}$
(C) $\frac{1}{3}$
(D) $\frac{1}{6}$

63. The graph of the function $y = f(x)$ has a unique tangent at $\left(\pi^a, 0\right)$. If $A = \lim_{x\to\pi^a}\frac{\ln\left(1+9f(x)\right)-\sin f(x)}{2f(x)}$, then $\sum_{n=1}^{\infty}A^{-n}$ is equal to:

(A) $\frac{1}{3}$
(B) $\frac{1}{2}$
(C) 4
(D) $\frac{1}{4}$

64. Let $a_{r'}$ $r = 1, 2, 3, 4$ represent four positive real numbers other than unity such that $\left(\log_e a_r, \frac{1}{\log_e, a_r}\right)$ is a point on a circle whose abscissa of end of diameter are α and $-\alpha$, then the minimum value of $a_1 + a_2 + a_3 + a_4$ is:

(A) 2
(B) 3
(C) 4
(D) 5

65. The chord of contact of tangents drawn from any point on the circle $x^2 + y^2 = p^2$ to the circle $x^2 + y^2 = q^2$ touches the circle $x^2 + y^2 = r^2$, then $2a - \log_e p, 4a - \log_e q, 6a - \log_e r$ are in (a is real value):

(A) AP
(B) GP
(C) HP
(D) AGP

Space for Rough work

66. If t_1, t_2 and t_3 are distinct, the points $\left(t_1, 2at_1 + at_1^3\right), \left(t_2, 2at_2 + at_2^3\right)$ and $\left(t_3, 2at_3 + at_3^3\right)$ are collinear, then $\frac{4^{t_1}.6^{t_2}.8^{t_3}}{2^{t_1}.3^{t_2}.4^{t_3}}$ is equal to:

(A) 0 (B) 4

(C) 2 (D) 1

67. The area of the triangle formed by the line $x + y = 2$ and angle bisectors of the pair of straight lines $x^2 - y^2 + 2y = 1$ is a and coordinate of orthocentre of triangle is (b, c), then $4a + b + c$ is equal to:

(A) 0 (B) 4

(C) 2 (D) 3

68. If z is the complex 5th root of unity, then $\frac{z^4}{z^4+1} + \frac{z}{1+z} + \frac{z^2}{z^2+1} + \frac{z^4}{z+z^4}$ is:

(A) 2 (B) 0

(C) 4 (D) 1

69. If a tangent of slope 3 of the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ is normal to the circle $x^2 + y^2 + 4x + 1 = 0$ then the maximum value of ab is:

(A) 2 (B) 3

(C) 4 (D) 6

70. If $F(x) = \int_0^x f(t).dt$ and $F\left(x^2\right) = x^2(1+x)$, then value of $f(4) = n$. Then unit place of $(985697)^{n^2}$ is:

(A) 3 (B) 7

(C) 1 (D) 9

Space for Rough work

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

---

71. A nine digit number is formed from $1,2,3,4,5$ such that product of all digits is always 1920. The total number of ways is $393\left({}^{9}P_r\right),$ where the value of r is________

72. The sum $\sum_{i=0}^{5m}\binom{20}{i}\binom{30}{5m-i}, {}^{p}C_q=\binom{p}{q}=0$ if $p<q$, is maximum, then m equals________

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

73. Let $\mathrm{f}(x)$ be a function such that $f(x)+f(x+2)=\sqrt{3}f(x+1)$ for all $x\in R,$ then f is periodic with period T. Then value of T is_______

74. If the sum of first n terms of the A. P. $85,90,95,....$ is equal to the sum of first 3n terms of the A. P. $9,11,13,...,$ then $n+10$ equals_____

75. Let f be a continuous and differentiable function in (a,b), if $f(x).f'(x)\geq x\sqrt{1-(f(x))^4}$ and $\lim_{x\to a^+}(f(x))^2=1$ and $\lim_{x\to b^-}(f(x))^2=\frac{1}{2}$.Then the minimum value of $\left[a^2-b^2\right]+80$ is $([.]\to\text{represent greatest integer function})$:

Space for Rough work

FIITJEE

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ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. A

Sol. When shell strikes the ball and gets stuck with it, combined body of mass 2m starts to move to the right. Let velocity of combined body (just after collision) be v_1.

According to law of conservation of momentum,

$(m + m)\,v_1 = mv_0$ or $v_1 = \frac{v_0}{2} = 3\ \text{ms}^{-1}$.

As soon as the combined body starts to move rightwards, thread becomes inclined to the vertical. Horizontal component of its tension retards the combined body while trolley accelerates rightwards due to the same component of tension.

Inclination of thread with the vertical continues to increase till velocities of both (combined body and trolley) become identical or combined body comes to rest relative to trolley. Let velocity at that instant of maximum inclination of thread be v. According to law of conservation of momentum.

$(2m + M)\,v = 2m.v_1$ or $v = 1\ \text{ms}^{-1}$

During collision of ball and shell, a part of energy is lost. But after that, there is no loss of energy. Hence, after collision, kinetic energy lost is used up in increasing gravitational potential energy of the combined body.

If maximum inclination of thread with the vertical be □ then according to law of conservation of energy,

$$\frac{1}{2}(2m)\,v_1^2 - \frac{1}{2}(2m + M)\,v^2$$

$$= 2mg\,(\ell - \ell\cos\theta)$$

$\therefore \quad \cos\theta = 0.8$ or $\theta = 37°$

2. A

Sol. The torque is defined as

$\tau = r \times F$

$$r \times F = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 7 & 3 & 1 \\ -3 & 1 & 5 \end{vmatrix}$$

$$= \hat{i}\begin{vmatrix} 3 & 1 \\ 1 & 5 \end{vmatrix} + \hat{j}\begin{vmatrix} 1 & 7 \\ 5 & -3 \end{vmatrix} + \hat{k}\begin{vmatrix} 7 & 3 \\ -3 & 1 \end{vmatrix}$$

$$= \hat{i}(15 - 1) + \hat{j}(-3 - 35) + (7 - (-9))$$

$$= 14\hat{i} - 38\hat{j} + 16\hat{k}$$

Thus the answer is (1)

3. D

Sol. The fringe–width β is given by

$$\beta = \frac{\lambda D}{2d} \quad \text{and} \quad \beta' = \frac{\lambda D'}{2d}$$

where λ is the wavelength of light used, D is the distance of the screen from the two slits and 2 d is the separation between two slits.

Now $$\beta - \beta' = \frac{\lambda(D - D')}{2d}$$

$\Rightarrow$ $$\lambda = \frac{(\beta - \beta')2d}{D - D'}$$

$$\lambda = \frac{(3 \times 10^{-5})(10^{-3})}{5 \times 10^{-2}}$$

$$= 0.6 \times 10^{-6} \text{ m} = 6000 \text{ Å}$$

4. D

Sol. Given quantity is = $(a^2 - b^2)\,h$

dimension of h = [L]

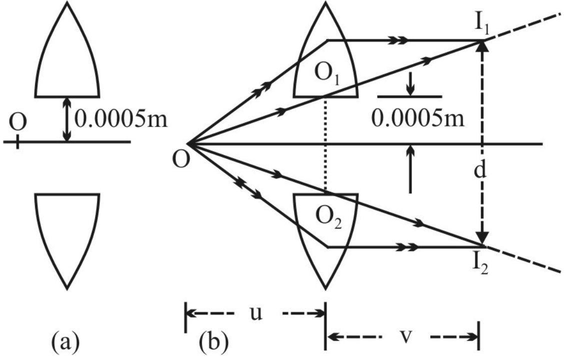
dimensions of $a^2 - b^2 = [L^2 - L^2] = L^2$

Therefore the dimensions of the given quantity are $[L^3]$. Thus the quantity being measured is volume

Ans. (D)

5. A

Sol. The image formation is shown in fig.



The rays through optical centres O_1 and O_2 pass undeflected. The image of O are formed at I_1 and I_2 due to upper and lower lenses respectively.
The number of images formed = two
For a convex lens, $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$
Here u = – 0.3 m and f = 0.2 m

$\therefore \quad \frac{1}{v} = \frac{1}{u} + \frac{1}{f} = -\frac{1}{0.3} + \frac{1}{0.2} = \frac{1}{0.6}$

u = 0.6 m

Let d be the distance between the two images I_1 and I_2. From ΔOO_1O_2 and $\Delta\, II_1I_2$, we have

$$\frac{d}{O_1O_2} = \frac{u+v}{u}$$

or $$\frac{d}{0.0005+0.0005} = \frac{0.3+0.6}{0.3}$$

Solving we get d = 0.003 m

6. C

Sol. Let x be the distance travelled by the truck when both truck and car are side by side. The distance travelled by the car will be
(x + 150) as the car is 150 metre behind the truck. Applying the formula
s = ut + (1/2) a t^2, we have
x = 1/2 × (1.5) t^2 ....(1)
and (x + 150) = (1/2) × (2) t^2 ....(2)
Here t is the common time.
From eqs. (1) and (2) we have

$$= \frac{x+150}{x} = \frac{2}{1.5}$$

Solving we get x = 450 metre (truck) and
x + 150 = 600 metre (car).
Substituting the value of x in eq. (1),
we get 450 = 1/2 (1.5) t^2

$\therefore \quad t = \sqrt{\frac{450\times 2}{1.5}} = \sqrt{600} = 24.5$ sec.

Hence correct answer is (C)

7. C

Sol. Velocity of object = 100 km/h.
Velocity of mirror = 40 km/h
Due to velocity of mirror the image will move towards right with double the velocity i.e., 80 km/h. and due to the motion of the object the image will move with velocity 100 km/h towards left. Hence net velocity of the image is 100 – 80 = 20 kmph towards left.
Velocity of image observed to the motorist = 20 + 100 = 120 kmph towards left.
Velocity of image observed to the standing person = 20 kmph.

8. A

Sol. Let us locate the block at an arbitrary angular position $\theta < \theta_o$

$dW = \vec{F} \cdot \vec{dr} = Fds = F(Rd\theta)$ ...(1)

Now from the condition of equilibrium of the block , we have

$$F = mg\cos\theta + KR\theta \qquad ...(2)$$

from eq. (1) & (2)

$$dW = mgR\cos\theta\, d\theta + KR^2\theta\, d\theta$$

Hence the sought work

$$W = \int dW = \int_0^{\theta_0} \cos\theta\, d\theta + KR^2 \int_0^{\theta_0} \theta\, d\theta$$

$$W = mgR\sin\theta_0 + \frac{KR^2\theta_0^2}{2}$$

9. A

Sol. According to given data, ionization energy of Li^{++} ion is 122.4 eV

$\therefore$ Excitation energy of this ion

$$= 122.4\left[\frac{1}{1^2} - \frac{1}{2^2}\right]$$

$$= 122.4\left[1 - \frac{1}{4}\right]$$

$$= 122.4 \times \frac{3}{4}\ \text{eV}$$

$\therefore$ $E_{ex} = 91.8$ eV

Hence, the value of the first excitation potential

= 91.8 V

10. B

Sol. Moment of inertia of the system about the given axis

$$I = I_A + I_B + I_C$$

Now as rod is thin

$$I_A = \Sigma m \times 0^2 = 0$$

Rod B is rotating about one end

$$I_B = ML^2 / 3$$

And for rod C all points are always at distance L from the axis of rotation, so

$$I_C = \Sigma mL^2 = ML^2$$

$$\therefore \quad I = 0 + (ML^2/3) + ML^2 = 4ML^2/3$$

So if ω is the desired angular speed, gain in kinetic energy due to rotation of H from horizontal to vertical position.

$$K_R = \frac{1}{2} I\omega^2 = \frac{1}{2}\left[\frac{4}{3}ML^2\right]\omega^2$$

And loss in potential energy of the system in doing so

$$= 0 + Mg\frac{L}{2} + MgL = \frac{3}{2}MgL$$

So by conservation of mechanical energy

$$(2/3)ML^2\omega^2 = (3/2)MgL$$

or $$\omega = \frac{3}{2}\sqrt{\frac{g}{L}}$$

11. B

Sol. In one half-life the number of active nuclei reduces to half the original number. Thus, in two half-lives the number is reduced to $\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)$ of the original number. The number of remaining active nuclei is, therefore, $6.0 \times 10^{18} \times \left(\frac{1}{2}\right) \times \left(\frac{1}{2}\right) = 1.5 \times 10^{18}$

12. B

Sol. $T = 2\pi\sqrt{\frac{I}{C}}$ ......(1)

$I = \frac{2}{5}MR^2$ ......(2)

By equation (1) & (2)

$$T = 2\pi\sqrt{\frac{2MR^2}{5C}}$$

given, M = 1kg

R = 0.15 m

$C = 6 \times 10^{-3}$ N-m/rad.

T = ?

$$\Rightarrow \quad T = 6.28\sqrt{\frac{0.4 \times 1 \times (0.15)^2}{6 \times 10^{-3}}}$$

$$T = 6.28\sqrt{\frac{9 \times 10^{-3}}{6 \times 10^{-3}}} = 6.28 \times \sqrt{1.5}$$

T = 7.7 sec.

13. D

Sol. Moseley's equation is

$$\sqrt{\nu} = a(Z - b).$$

Thus $\sqrt{\frac{c}{\lambda_1}} = a(Z_1 - b)$ …(i)

and $\sqrt{\frac{c}{\lambda_2}} = a(Z_2 - b)$ …(ii)

Using equations (i) and (ii), we get

$$\sqrt{c}\left(\frac{1}{\sqrt{\lambda_1}} - \frac{1}{\sqrt{\lambda_2}}\right) = a(Z_1 - Z_2)$$

$$\Rightarrow \quad a = \frac{\sqrt{c}}{(Z_1 - Z_2)}\left(\frac{1}{\sqrt{\lambda_1}} - \frac{1}{\sqrt{\lambda_2}}\right)$$

Putting given values

$a = 5.06 \times 10^7$ Hz

Dividing equation (i) by (ii), we get

$$\sqrt{\frac{\lambda_2}{\lambda_1}} = \frac{Z_1 - b}{Z_2 - b}$$

$$\Rightarrow \quad \sqrt{\frac{178.5}{71}} = \frac{42 - b}{27 - b}$$

$\Rightarrow$ b = 1.37

14. A

Sol. Let the frequency of the fork be n. In the first case, the length of the wire is 70 cm (0.70 m). Therefore,

$$n = \frac{1}{2 \times 0.70}\sqrt{\frac{T}{m}} \qquad ...(1)$$

On decreasing the length of the wire, its frequency will increase. Hence in the second case when the length is 69 cm = 0.69 m, then

$$n + 4 = \frac{1}{2 \times 0.69}\sqrt{\frac{T}{m}} \qquad ...(2)$$

dividing equation (1) by (2), we get

$$\Rightarrow \frac{n}{n+4} = \frac{0.69}{0.70}$$

$\Rightarrow$ n × 0.70 = (n + 4) × 0.69

$$\Rightarrow n = \frac{4 \times 0.69}{0.01} = 276 \text{ sec}^{-1}$$

15. A

Sol. $\tan 60^o = \frac{\omega L}{R}$, $\tan 60^o = \frac{1/\omega C}{R}$.

$\therefore \omega L = \frac{1}{\omega C}$.

$\therefore$ impedance of the circuit,

$$Z = \left[R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2\right]^{\frac{1}{2}} = R.$$

Current in the circuit,

$$i_0 = \frac{V_0}{Z} = \frac{V_0}{R} = \frac{200}{100} = 2 \text{ ampere.}$$

Average power, $\overline{P} = \frac{1}{2} V_0 i_0 \cos\phi$.

But $\tan\phi = \frac{\omega L - 1/\omega C}{R} = 0$, $\therefore \cos\phi = 1$.

$$\therefore \overline{P} = \frac{1}{2} \times 200 \times 2 \times 1 = 200$$

16. C

Sol. From the law of length of stretched string, we have $n_1\ell_1 = n_2\ell_2 = n_3\ell_3$

Here $n_1 : n_2 : n_3 = 1 : 3 : 15$

$$\therefore \frac{\ell_1}{\ell_2} = \frac{n_1}{n_2} = \frac{3}{1} \text{ and } \frac{\ell_1}{\ell_3} = \frac{n_3}{n_1} = 15/1$$

$$\ell_2 = \frac{\ell_1}{3} \text{ and } \ell_3 = \frac{\ell_1}{15}$$

The total length of the wire is 105 cm.

Therefore $\ell_1 + \ell_2 + \ell_3 = 105$

or $\ell_1 + \frac{\ell_1}{3} + \frac{\ell_1}{15} = 105$ or $\frac{21\ell_1}{15} = 105$

$$\ell_1 = \frac{105 \times 15}{21} = 75 \text{ cm.}$$

$$\therefore \ell_2 = \frac{\ell_1}{3} = \frac{75}{3} = 25 \text{ cm}$$

$$\ell_3 = \frac{\ell_1}{15} = \frac{75}{15} = 5 \text{ cm}$$

Hence the bridge should be placed at 75 cm and (75 + 25) = 100 cm from one end.

17. B

Sol. We know that

$$i = \frac{\varepsilon}{R}(1 - e^{t/\tau})$$

$$i = \eta\frac{\varepsilon}{R} \text{ (given)}$$

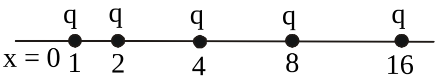
$$n\frac{\varepsilon}{R} = \frac{\varepsilon}{R}(1 - e^{-t/\tau})$$

or $e^{-t/\tau} = 1 - \eta$

or $t = \tau \ln\left|\frac{1}{1-\eta}\right|$

18. C

Sol. As potential V and intensity E due to a point charge at position x are respectively given by-



$$E = \frac{1}{4\pi\varepsilon_0}\left[\frac{q}{1^2} + \frac{q}{2^2} + \frac{q}{4^2} + ...\right]$$

$$= \frac{q}{4\pi\varepsilon_0}\left[1 + \frac{1}{4} + \frac{1}{16} + \frac{1}{64} ....\right]$$

i.e.,

$$E = \frac{q}{4\pi\varepsilon_0}\frac{1}{[1-(1/4)]} = \frac{1}{4\pi\varepsilon_0}\left[\frac{4}{3}q\right]$$

19. C

Sol. The electric field near the plane charge sheet is $E = \sigma/2\varepsilon_0$ in the direction away from the sheet. At the given area, the field is along the Z-axis.

The area = $\pi r^2 = 3.14 \times 1\ cm^2$
$= 3.14 \times 10^{-4}\ m^2$.
The angle between the normal to the area and the field is 60º.

Hence, the flux = $\vec{E}.\Delta\vec{S} = E\Delta S \cos\theta$

$= \frac{\sigma}{2\varepsilon_0} pr^2 \cos 60^\circ$

$= \frac{2.0\times10^{-6}C/m^2}{2\times8.85\times10^{-12}C^2/N-m^2} \times$

$(3.14 \times 10^{-4}m^2)\ \frac{1}{2}$

= 17.5 N-m^2/C

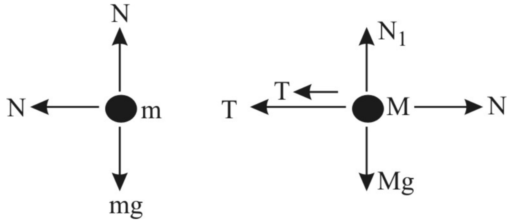
20. A

Sol. Capacitances are -
(A) 10/11 µF (B) 8/13 µF
(C) 6/13 µF (D) 4/11 µF

SECTION – B

21. 5

Sol. Let X' be the leftward displacement of A and x and y be the leftward and downward displacements of m. Then by constraint
$x = X \Rightarrow x = X \Rightarrow a_x = A_x$
and $l_1 - x + l_2 + l_3 - x + l_4 + y$
$= l_1 + l_2 + l_3 + l_4$
where l_1, l_2, l_3, l_4 are the instantaneous lengths of the segments of the string
$\Rightarrow 2x = y \Rightarrow 2x = y \Rightarrow 2a_x = a_y$
$N = ma_x$ and $mg - T = ma_y$
and $2T - N = MA_x = Ma_x$



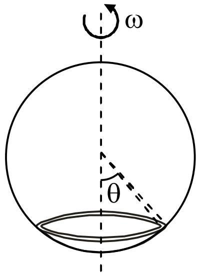
Eliminating T, A_x and N

$a_x = \frac{2mg}{M+5m}$ and $a_y = \frac{4mg}{M+5m}$

$\therefore \quad a = \sqrt{a_x^2 + a_y^2} = \frac{2\sqrt{5}mg}{M+5m}$

22. 3

Sol. When the shell rotates, current is induced due to motion of charge. To calculate magnetic induction at centre of the shell, rotating shell can be assumed to be composed of thin circular current carrying rings. Such a ring can be assumed as follows:
Consider a radius of the shell inclined at angle 'θ' with the axis of rotation. This radius is rotated about the axis keeping θ constant. Thus a circle is traced as shown in fig.



Its radius, $r = R \sin\theta$

Distance of its centre from centre of the shell, $x = R\cos\theta$.

Now consider another radius inclined at angle ($\theta + d\theta$). It is also rotated in the same way and another circle is traced. The portion between two circles forms a circular ring.

Area of this ring = $2\pi r\, R\, d\theta = 2\pi R^2 \sin\theta\, d\theta$

Charge on this ring, $dq = \sigma.\, 2\pi R^2 \sin\theta\, d\theta$

Since, angular velocity of the shell is ω, therefore, it completes $\frac{\omega}{2\pi}$ revolutions per second.

Hence, current associated with the ring considered,

$$i = \frac{\omega}{2\pi} dq = \sigma\omega R^2 \sin\theta\, d\theta$$

Since, centre of the shell is a point lying on the axis of a circular coil of radius r, carrying current i at a distance x from centre of the coil, therefore, magnetic induction at centre of the shell due to this coil is

$$dB = \frac{\mu_0 i r^2}{2(r^2 + x^2)^{3/2}}$$

$$= \frac{1}{2}\mu_0 \sigma\omega R \sin^3\theta\, d\theta$$

Hence, resultant magnetic induction at centre of the shell

$$B = \int dB = \frac{1}{2}\mu_0 \sigma\omega R \int_0^{\pi} \sin^3\theta\, d\theta = \frac{2}{3}\mu_0 \sigma\omega R$$

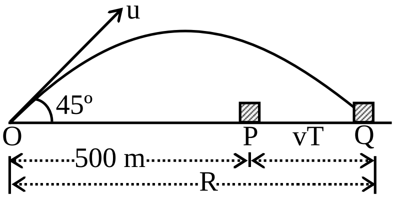
SECTION – C

23. 00088.55

Sol. Consider that at the instant, the shell is fired from the gun at point O, the car is at point P The shell will move along parabolic path for T its time of flight and will then strike the ground at point Q at a distance R, equal to the horizontal range. Therefore, the shell will hit the car, if in the time T (time of flight), the car moves the distance PQ= v T, where v is velocity of the car. Since the car is initially at a distance of 500 m from the gun, it follows that

$R = 500 + v\,T$ .....(1)

(a) Let u be the speed of projection of shell.



Now, $R = \frac{u^2 \sin 2\theta}{g}$

Here $\theta = 45^o$

$$R = \frac{u^2 \sin 2\times 45^o}{9.8} = \frac{u^2 \sin 90^o}{9.8} = \frac{u^2}{9.8}$$

Also, $T = \frac{2u\sin\theta}{g} = \frac{2u\sin 45^o}{9.8}$

$$= \frac{2u}{9.8} \times \frac{1}{\sqrt{2}} = \frac{\sqrt{2}u}{9.8}$$

Further, velocity of the car, v = 72 km h^{-1}
= 72 × (1000m) × (60 × 60 s)$^{-1}$ = 20 m s^{-1}

Substituting for R, T and v in equation (1), we have $\frac{u^2}{9.8} = 500 + 20 \times \frac{\sqrt{2}u}{9.8}$

or $u^2 - \sqrt{2}\,u - 500 \times 9.8 = 0$
On solving for u we have
$u = 10\,(\sqrt{2} + \sqrt{51})$
u = 10 (1.414 + 7.141)
= 10× 8.555 = 85.55 m s^{-1}

24. 00120.00

Sol. As here initially

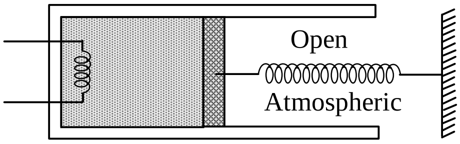
$P_I = P_0 = 1 \times 10^5$ N/m^2,
$V_I = V_0 = 2.4 \times 10^{-3}$m^3,
$T_I = T_0 = 300$K

and finally

$$P_F = P_0 + \frac{Kx}{A} = 1 \times 10^5 + \frac{8000\times 0.1}{8\times 10^{-3}}$$
$= 2 \times 10^5$ N/m^2,

$V_F = V_0 + Ax = 2.4 \times 10 + 0.1 \times 8 \times 10^{-3}$
$= 3.2 \times 10^{-3}$m^3,
So from gas equation PV = μRT, i.e.

$$\frac{P_I V_I}{T_I} = \frac{P_F V_F}{T_F}$$



we have

$$T_F = \frac{P_F}{P_I} \times \frac{V_F}{V_I} \times T_I$$

$$= \frac{2\times 10^5}{1\times 10^5} \times \frac{3.2\times 10^{-3}}{2.4\times 10^{-3}} \times 300 = 800 \text{ K}$$

As $\Delta W = \int PdV$,
here $P = P_0 + (kx/A)$

so $\Delta W = \int_0^{0.1} \left[P_0 + \frac{kx}{A}\right] A\,dx$

$$= \int_0^{0.1} (P_0A + kx)dx$$

i.e. $= P_0Ax + ½ kx^2$

$= [10^5 \times 8 \times 10^{-3} \times 0.1 + ½ \times 8000 \times (0.1)^2]$

i.e. $\Delta W = 80 + 40 = 120J$

25. 00680.00

Sol. The observer A is at rest with respect to the air and the source is travelling at a velocity of 120 km/h i.e., 100/3 m/s. As is clear from the figure, the person receives the sound of the whistle in a direction BA making an angle θ with the track where $\cos\theta = 300/500 = 3/5$. The component of the velocity of the source (i.e., of the train.) along with this direction AB is $\frac{100}{3} \times \frac{3}{5}$ m/s = 20m/s. As the source is approaching the person with this component, the frequency heard by the observer is.

$$\nu' = \frac{v}{v - v\cos\theta}\nu = \frac{340}{340 - 20} \times 640\text{Hz} = 680 \text{ Hz}.$$

Chemistry PART – II

SECTION – A

26. A

27. C

28. B

Sol. $Na\left[\overset{+I}{A}g\left(CN\right)_2\right]$

29. A

30. D

Sol. $EDTA^{4-}$ is Hexadentate and form optically active compounds.

31. C

32. B

33. C

Sol. Rate of effusion $\propto \frac{1}{\sqrt{T}}$

34. A

35. B

Sol. Area under the curve $= -1\times3\times10^{-5} - \frac{1}{2}\times3\times3\times10^{-5} = -7.5\times10^{-5}\ J$

36. C

Sol. $P_4 + 20HNO_3 \longrightarrow 4H_3PO_4 + 20\,NO_2\uparrow + 4H_2O$

$$m.moles\,of\ NaOH = 2\times m.moles\,of\ H_3PO_4 \Rightarrow m.moles\,H_3PO_4 = \frac{100\times0.1}{2} = 5$$

$$m.moles\,of\ HNO_3 = \frac{20}{4}\times5 = 25$$

Volume of $HNO_3 = 25\,ml$

37. B

38. B

39. A

40. C

41. C

Sol. Zn^{2+}, Li^{+}, K^{+}, Al^{3+} are colourless where as Co^{2+} is coloured.

42. A

43. B

44. C

45. D

SECTION – B

46 4

Sol. d,e,f,g are correct and Colloid is +ve.

47. 4

Sol. Volume of unit cell$=\frac{\sqrt{3}}{4}\times(4.53)^2\times7.41\times10^{-24}\text{cm}^3$

so mass$=60.57\times10^{-24}$g

moles$=3.365\times10^{-24}$

molecules of $H_2O=2.025$

number of H atom=4

SECTION – C

48. 00027.00

49. 00039.00

Sol. X=120 (sp^2-hybridization)
Y=180 (sp-hybridization)
Z=90 (sp^3d^2-hybridization)

$$\frac{120+180+90}{10}=\frac{390}{10}=39$$

50. 00013.00

Mathematics

PART – III

SECTION – A

51. B

Sol.
$$\int \frac{3x^2+4x-1}{\left(x^2+1\right)^2\sqrt{x+1}}dx$$
$$=\int \frac{4x^2+4x-x^2-1}{\left(x^2+1\right)^2\sqrt{x+1}}dx$$
$$=4\int \frac{x\left(x+1\right)dx}{\left(x^2+1\right)^2\sqrt{x+1}}-\int \frac{dx}{\left(x^2+1\right)\sqrt{x+1}}$$
$$4\int \frac{x\left(x+1\right)dx}{\left(x^2+1\right)^2\sqrt{x+1}}.\left[\frac{2\sqrt{x+1}}{x^2+1}\int \frac{-1\quad 2x.2\sqrt{x+1}}{\left(x^2+1\right)^2}.dx\right]$$
$$=4\int \frac{x\left(x+1\right)dx}{\left(x^2+1\right)^2\sqrt{x+1}}-\frac{2\sqrt{x+1}}{x^2+1}$$
$$=\frac{-2\sqrt{x+1}}{x^2+1}+c$$

52. C

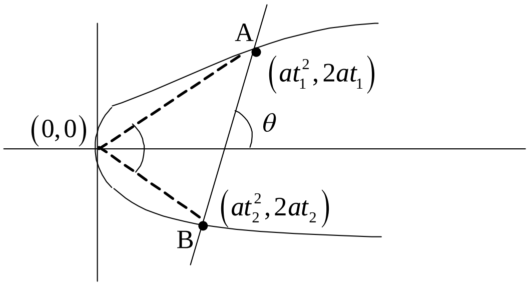
Sol.
$$y\left(xy-\left(x^2-y^2\right)^2\right).dx=\left\{y^3-x\left(x^2-y^2\right)^2\right\}dy$$
$$\Rightarrow xy^2dx-y\left(x^2-y^2\right)^2dx=y^3dy-x\left(x^2-y^2\right)^2dy$$
$$\Rightarrow y^2\left(xdx-ydy\right)=\left(x^2-y^2\right)^2\left(ydx-xdy\right)$$
$$\Rightarrow xdx-ydy=\left(x^2-y^2\right)^2\frac{\left(ydx-xdy\right)}{y^2}$$
$$\frac{2\left(xdx-ydy\right)}{\left(x^2-y^2\right)^2}=\frac{2\left(ydx-xdy\right)}{y^2}$$
$$\int \frac{d\left(x^2-y^2\right)}{\left(x^2-y^2\right)^2}=2\int d\left(\frac{x}{y}\right)$$
$$\frac{-1}{x^2-y^2}=\frac{2x}{y}+C$$
$$\therefore \frac{2x}{y}+\frac{1}{x^2-y^2}=C$$

53. D

Sol. $y^2 = 8x$

Now, $t_1 t_2 = -4$

And $t_2 = -t_1 - \frac{2}{t_1}$



$$\frac{-4}{t_1} = -t_1 - \frac{2}{t_1}$$

$$\Rightarrow -t_1^2 = -2$$

$$\Rightarrow t_1^2 = 2$$

$$y^2 = 4ax$$

$$\frac{dy}{dx} = \frac{4ax}{2y}$$

$$\frac{dy}{dx} = \frac{1}{t}$$

Slope of normal $= -t$

And $\tan^2\theta = t_1^2 = 2$

54. A

Sol. $C : \left(x^2 y^2 - 4x - 8y - 5\right) + \lambda\left(x^2 + y^2 - 12x + 2y + 29\right) = 0$

Centre : $\left(\frac{2+6\lambda}{1+\lambda}, \frac{4-\lambda}{1+\lambda}\right)$

Common chord $4x - 5y - 17 = 0$

Centre lies on common chord

$\therefore \lambda = \frac{29}{12}$

$\therefore$ centre $\left(\frac{1+6(29/12)}{1+29/12}, \frac{4-29/12}{1+29/12}\right)$

$\therefore$ centre $\left(\frac{198}{41}, \frac{19}{41}\right)$

55. B

Sol.
$$\int_0^{\frac{11\pi}{3}} \sqrt{1+\cos 2x}.dx$$
$$=\int_0^{\frac{11\pi}{3}} \sqrt{2}\left|\cos x\right|.dx$$
$$=\int_0^{3\pi} \left|\sqrt{2}\cos x\right|.dx+\int_{3\pi}^{3\pi+2\pi/3} \sqrt{2}\left|\cos x\right| dx$$
$$3\sqrt{2}\int_0^{\pi} \left|\cos x\right|.dx+\sqrt{2}\int_0^{2\pi/3} \left|\cos x\right|.dx$$
$$=6\sqrt{2}\int_0^{\pi/2} \left(\cos x\right) dx+\sqrt{2}\int_0^{\pi/2} \cos x.dx-\sqrt{2}\int_{\pi/2}^{2\pi/3} \cos x.dx$$
$$=6\sqrt{2}+\sqrt{2}\frac{-\sqrt{3}}{\sqrt{2}}+\sqrt{2}$$
$$=\sqrt{2}-\sqrt{\frac{3}{2}}$$

56. B

Sol.
$$2\vec{a}-\vec{b}=\hat{i}+3\hat{j}-5\hat{k}$$
$$\vec{a}-2\vec{b}=-4\hat{i}+4\hat{j}-4\hat{k}$$
Area of $=\frac{1}{2}\left|\left(2\vec{a}-\vec{b}\right)\times\left(\vec{a}-2\vec{b}\right)\right|$
$$\left(2\vec{a}-\vec{b}\right)\times\left(\vec{a}-2\vec{b}\right)=3\hat{i}+24\hat{j}+15\hat{k}$$
Area $=\frac{9\sqrt{10}}{2}$

57. D

Sol. Taking first two
$$\frac{\tan\left(\pi/4+\alpha\right)}{\tan\left(\pi/4+\beta\right)}=\frac{5}{3}$$
$$\therefore \frac{\cos\left(\alpha+\beta\right)}{\sin\left(\alpha-\beta\right)}=\frac{8}{2}=4$$
$$\therefore \cos\left(\alpha+\beta\right)=4\sin\left(\alpha-\beta\right)-------(1)$$
Similarly
$$\cos\left(\beta+\alpha\right)=\sin\left(\beta-\alpha\right)------(2)$$
$$3\cos\left(\gamma+\alpha\right)=-7\sin\left(\gamma-\alpha\right)-----(3)$$
After marking $\sin^{-2}$ terms
$$(1)+(2)-(3)$$
Then,
$$12\sin^2\left(\alpha-\beta\right)+15\sin^2\left(\beta-\gamma\right)-7\sin\left(\gamma-\alpha\right)=0$$

58. A

Sol. At $x=0, y=1$ for both curves intersect

Now $y=(1+x)^{\cos x}+\sin x$

$\therefore \frac{dy}{dx}=2\,at\;\;x=0$

And $y=\frac{1}{2}\left(x^2+x+2\right)$

$\frac{dy}{dx}=\frac{1}{2}\;at\;\;x=0$

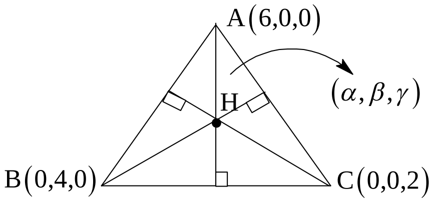
Now $m_1=2,\; m_2=\frac{1}{2}$

$\therefore \tan\theta=\left|\frac{2-1/2}{1+(2)(1/2)}\right|=\left|\frac{3/2}{2}\right|\Rightarrow\frac{3}{4}$

59. A

Sol. Now $AH\perp BC$

Now D^r of $AH=(\alpha-6,\beta,\gamma)$



$D^r\;of\;\;BC=(0,4,-2)$

Now for 1 lines,

$a_1a_2+b_1b_2+c_1c_2=0$

$\therefore 0(\alpha-6)+\beta(4)-2\gamma=0$

$\therefore 4\beta-2\gamma=0$

$2\beta=\gamma---(1)$

Similarly

$-6\alpha+2\gamma=0-----(2)$

$-6\alpha+4\beta=0-----(3)$

$\therefore 2\beta=\gamma;\;\frac{2\beta}{3}=\alpha$

Now may lie on

$2x+3y+6z=12$

$\therefore 2\alpha+3\beta+6\gamma=12$

$2\left(\frac{2\beta}{3}\right)+3\beta+6(2\beta)=12$

$$4\beta + 9\beta + 36\beta = 36$$
$$49\beta = 36$$
$$\beta = \frac{36}{49}$$

Now, $\alpha = \frac{24}{49}$ and $\gamma = \frac{72}{49}$

$$(\alpha, \beta, \gamma) = \left(\frac{24}{49}, \frac{36}{49}, \frac{72}{49}\right)$$

60. C

Sol. $f(x) = \log_3\left(\log_{1/2}\left(\log_2\left(\log_{1/3}\right)\right)\right)$

$$\frac{x+1}{\sqrt{1-3x-4x^2}}$$

Now, $\sqrt{1-3x-4x^2} > 0$

$$4x^2 + 3x - 1 < 0$$
$$\therefore (4x-1)(x+1) < 0$$
$$\therefore x \in (-1, 1/4)$$
$$\log_{1/2}\left(\log_2\left(\log_{1/3}(x)\right)\right) > 0$$
$$\log_2\left(\log_{1/3}(x)\right) < 1$$
$$\log_{1/3}(x) < 2$$
$$x > 1/9$$

Now $F\left(f(x)\right) \in x > \frac{1}{9} \cap x \in (-1, 1/4)$

$$\therefore x \in \left(\frac{1}{9}, \frac{1}{4}\right)$$

61. D

Sol. $f(x) + f(1-x) = \frac{1}{27}$

$$\frac{54}{27} = 2$$

62. C

Sol. $\cot\sum_{n=1}^{\infty}\cot^{-1}\frac{1}{n^2}\times n^2\frac{(n+1)^2}{2}$

$$= \cot \sum_{n=1}^{\infty} \tan^{-1} \frac{2}{(n+1)^2}$$

$$= \cot \sum_{h=1}^{\infty} \left(\tan^{-1}(n+2) - \tan^{-1} n \right)$$

$$s_n = \begin{bmatrix} \tan^{-1} 3 - \tan^{-1} 1 \\ \tan^{-1} 4 - \tan^{-1} 2 \\ \tan^{-1}(n+2) - \tan^{-1} n \end{bmatrix}$$

$$s_n = \tan^{-1}\left(\frac{3n^2 + 7n}{n^2 + 9n + 10} \right)$$

$$s_\infty = \tan^{-13}$$

$$\cot \tan^{-13} = \cot \cot^{-1} \frac{1}{3} \Rightarrow \frac{1}{3}$$

63. A

Sol. $$\lim_{x\to\pi} a \frac{\left\{ \frac{1}{1+9f(x)} \right\} 9f'(x) - \cos(f(x)) f'(x)}{2f'(x)}$$

$$= \frac{9-1}{2} = 4$$

$$\sum_{h=1}^{\infty} 4^{-n} = \frac{1}{4} + \frac{1}{4^2} + ...\infty$$

$$= \frac{1}{3}$$

64. C

Sol. Centre $(0, -f)$

Equation of circle

$$x^2 + y^2 + 2fy + c = 0$$

$$(\log_e a_r)^2 + \frac{1}{(\log_e a_r)^2} + 2f\left(\frac{1}{\log_e a_r} \right) + c = 0$$

$$(\log a_r)^4 + c(\log a_r)^2 + 2f(\log a_r) = 0$$

$\log a_1, \log a_2, \log a_3, \log a_4$ are roots of equation

$$\therefore \log(a_1.a_2.a_3.a_4) = 0$$

$$a_1 a_2 a_3 a_4 = 1$$

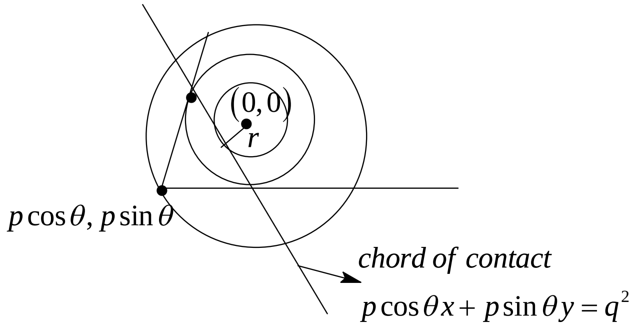
$$\frac{a_1 + a_2 + a_3 + a_4}{4} \geq (1)^{1/4}$$

$$\therefore a_1 + a_2 + a_3 + a_4 \geq 4$$

65. A

Sol. $\perp$ distance from (centre) to chord of contact

$$r = \left| \frac{p\cos\theta \times 0 + p\sin\theta \times 0 - q^2}{p} \right|$$


$(0,0)$
r
$p\cos\theta, p\sin\theta$
chord of contact
$p\cos\theta x + p\sin\theta y = q^2$

$$q^2 = rp$$

$$p, q, r \text{ are in } GP$$

$$\therefore 2a - \log_e^p,\ 4a - \log_e^q,\ 6a - \log_e^r \text{ are in } AP$$

66. D

Sol. G.E. of line

$$Ax + By + C = 0$$

$$At_1 + B\left(2at_1 + at_1^3\right) + c = 0$$

$$Bat_1^3 + \left(2aB + A\right)t_1 + c = 0$$

Sum of roots

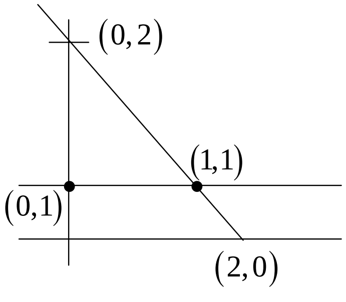
$$t_1 + t_2 + t_3 = 0$$

$$2^{t_1}.2^{t_2}.2^{t_3} = 2^\circ = 1$$

67. D

Sol. $x^2 - y^2 + 2y - 1 = 0$

$$x^2 - (y-1)^2 = 0$$



$$(x + y - 1)(x - y + 1) = 0$$

Angle bisector

$$\frac{x+y-1}{\sqrt{2}}=\pm\frac{x-y+1}{\sqrt{2}}$$

$$x+y-1=x-y+1$$

$$x+y-1=-x+y-1$$

$$\Rightarrow y=1 \qquad \Rightarrow x=0$$

Area $a=\frac{1}{2}\times1\times1=\frac{1}{2}$

Orthocentre $(0,1)\Rightarrow b=0, c=1$

$\therefore 4a+b+c=2+0+1=3$

68. A

Sol. $z^5=1$

$$\frac{z^5}{z^5+z}+\frac{z}{z+1}+\frac{z^2}{z^2+1}+\frac{z^5}{z^2+z^5}$$

$$=\frac{1}{1+z}+\frac{z}{1+z}+\frac{z^2}{z^2+1}+\frac{1}{z^2+1}$$

$$=1+1=2$$

69. D

Sol. Equation of tangent $y=3x\pm\sqrt{9a^2+b^2}$

This is normal to circle

$$x^2+y^2+4x+1=0$$

Panes – 1 brought $(-2,0)$

$$\Rightarrow 0=-6\pm\sqrt{9a^2+b^2}$$

$$36=9a^2+b^2$$

$$AM\geq GM$$

$$\frac{9a^2+b^2}{2}\geq\sqrt{9a^2b^2}$$

$$18\geq 3ab$$

$$6\geq ab$$

70. C

Sol. $F(x)=\int_0^x f(t)dt$

$$F(x^2)=\int_0^{x^2} f(t)dt$$

$$=x^2(1+x)$$

Diff. both side

$$F'(x^2).2x=2x+3x^2$$

$$f\left(x^2\right)=1+\frac{3}{2}x$$
$$x=2,\ f\left(4\right)=1+\frac{3x}{2}$$
$$x=2,\ f\left(4\right)=1+\frac{3}{2}\times 2=4$$

Unit place $\left(985697\right)^{16}=1$

SECTION – B

71. 2

Sol. $1920=5\times 3\times 2^7=5\times 3\times 2\times 2\times 2\times 2\times 2\times 2\times 2=\frac{9!}{7!}=9\times 8$

$1920=5\times 3\times 4\times 2\times 2\times 2\times 2\times 2\times 1=\frac{9!}{5!}=9\times 8\times 7\times 6$

$1920=3,5,4,4,2,2,2,1,1$

$\frac{9!}{2!2!3!}$

$3,5,4,4,4,2,1,1,1$

$\frac{9!}{3!3!}$

Total = $\frac{9!}{7!}+\frac{9!}{5!}+\frac{9!}{2!2!3!}+\frac{9!}{3!3!}$

$=\frac{9!}{7!}\left(1+42+210+140\right)$

$=393\ {}^9P_2$

72. 5

Sol. $20c_0\times 30c_{5m}+20c_1\times 30c_{5m-1}$

$+......+20c_{5m}\times 30c_0$

Coeff of $x^{5m}\rightarrow\left(1+x\right)^{20}\left(1+x\right)^{30}$

$50c_{5m},5m=\frac{50}{2}=25$

$m=5$

SECTION – C

73. 00012.00

Sol. $f\left(x\right)+f\left(x+2\right)=\sqrt{3}f\left(x+1\right)$

$x\rightarrow x+2------\left(1\right)$

$$f(x+2)+f(x-14)=\sqrt{3}f(x+3)------(2)$$

$$(1)+(2)$$

$$f(x)+2+(x+2)+f(x+14)$$

$$=\sqrt{3}\{f(x+1)+f(x+3)\}$$

$$=3f(x+2)$$

$$f(x)+f(x+4)=f(x+2)$$

$$x\to x+2-----(3)$$

$$f(x+2)+f(x-16)=f(x+4)---(4)$$

$$(3)+(4)$$

$$f(x)+f(x+6)=0$$

$$f(x+6)=-f(x)$$

$$f(x+12)=-f(x+6)$$

$$=f(x)$$

Period $T=12$

74. 00019.00

75. 00081.00

Sol. Given $\dfrac{f(x)f'(x)}{\sqrt{1-(f(x))^4}}\geq x$

$$\frac{2f(x)f'(x)}{\sqrt{1-(f(x))^4}}-2\times\geq 0$$

Let $g(x)=\sin^{-1}(f(x))^2-x^2$ is non decreasing function

$$\lim_{x\to a^-}g(x)\leq\lim_{x\to b^+}g(x)$$

$$\frac{\pi}{2}-a^2\leq\frac{\pi}{6}-b^2$$

$$a^2-b^2\geq\frac{\pi}{3};\ \left[a^2-b^2\right]=1$$

FIITJEE

ALL INDIA TEST SERIES

OPEN TEST

JEE (Advanced)-2020

PAPER – 1

TEST DATE: 13-09-2020

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section–A (01 – 04, 19 – 22, 37 – 40)*** *contains 12 multiple choice questions which out of 4 options have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (05 – 12, 23 – 30, 41 – 48) *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*

   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–1** In all other cases.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics PART – I

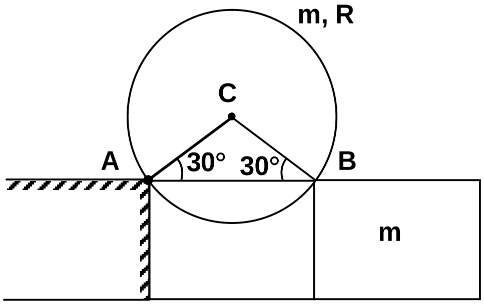
SECTION – A

(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

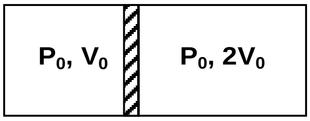
1. A particle moves along a circle of radius R = 10m with retardation so that at any time the modulus of tangential acceleration is twice the modulus of normal acceleration. If initial speed of the particle is v_0 = 20m/s. Then the speed of the particle after having covered a distance s = 10m would be (take $e^{-2} = 0.135$)
(A) 1.7 m/s
(B) 2.7 m/s
(C) 3.7 m/s
(D) 4.7 m/s

2. A uniform circular ring of mass m = 5 kg and radius R = 30 cm is hinged at the point ‘A’ of a stationary surface with the line joining point ‘A’ to the centre ‘C’ of the ring is initially vertical. The ring is also in contact with the Plank of mass m = 5 kg at point ‘B’ which is placed on a smooth horizontal surface. Initially points ‘A’ and ‘B’ are almost touching and the line AC is vertical and the system is released from rest. Then the velocity of the Plank when the line AC makes an angle 30° with the horizontal as shown will be (there is no friction between the ring and the plank and g = 10 m/s^2)



(A) 1 m/s
(B) 2 m/s
(C) 3 m/s
(D) 4 m/s

3. A horizontal cylinder is divided into two chambers by a thin smooth heat insulating piston of mass ‘m’ and cross section area ‘A’ initially. When the piston is in equilibrium, pressure of gas in each chamber is P_0 and volumes of the chambers are V_0 and $2V_0$ as shown in the figure. The ideal gases in the two chambers are kept at constant temperatures T_1 and T_2. The piston is slightly displaced from equilibrium position and then released. Then the time period of small oscillations of the piston is



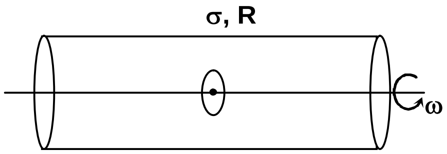
(A) $2\pi\sqrt{\dfrac{mv_0}{3P_0A^2}}$

(B) $2\pi\sqrt{\dfrac{2mv_0}{3P_0A^2}}$

(C) $2\pi\sqrt{\dfrac{3mv_0}{2P_0A^2}}$

(D) $2\pi\sqrt{\dfrac{mv_0}{2P_0A^2}}$

4. The curved surface of a very long hollow non conducting cylinder of radius 'R' is uniformally charged with surface charge density 'σ'. A non conducting small circular ring of radius 'a' and mass 'm' having charge 'q' uniformly distributed over its length is placed coaxially inside the hollow cylinder at its centre. The arrangement is located in a gravity free space.



If the cylinder is rotated with a constant angular velocity 'ω' about its axis as shown in the figure. Then the angular velocity acquired by the ring is

(A) $\dfrac{4\mu_0 q\sigma\omega R}{m}$

(B) $\dfrac{2\mu_0 q\sigma\omega R}{m}$

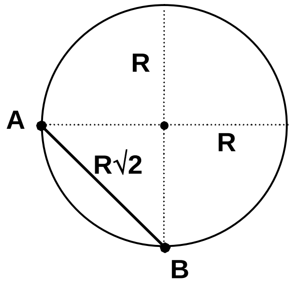
(C) $\dfrac{\mu_0 q\sigma\omega R}{m}$

(D) $\dfrac{\mu_0 q\sigma\omega R}{2m}$

(One or More than one correct type)

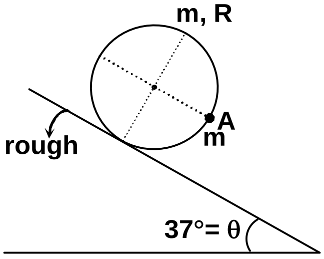
This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

5. Two small balls 'A' and 'B' of masses 0.3 kg and 0.6 kg respectively are rigidly attached to the ends of a light rigid rod of length $R\sqrt{2}$ and placed inside a fixed smooth spherical cavity of radius R = 0.5 m with the ball 'B' is located at the lowest point of cavity as shown in the figure. Then choose the correct option(s) immediately after the rod is released from rest. (Take g = 10 m/s^2)



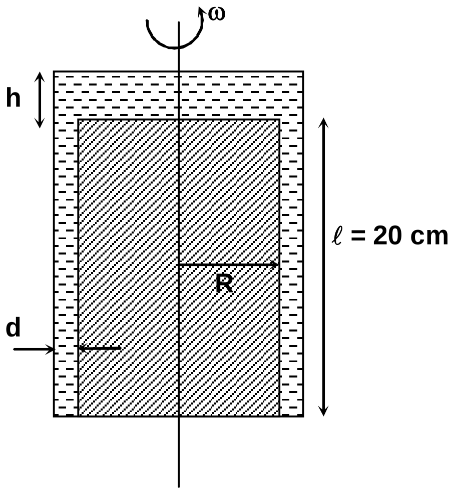
(A) The normal force on the ball 'A' due to surface of cavity is 2N.
(B) The normal force on the ball 'A' due to surface of cavity is 4N.
(C) The normal force on the ball 'B' due to surface of cavity is 8N.
(D) The force acting on the ball 'B' due to light rod is $2\sqrt{2}$ N.

6. A particle of mass m = 1 kg is rigidly attached to the circumference at point 'A' of a uniform circular ring of mass m = 1kg and radius R = 20 cm placed on a rough inclined plane of inclination $\theta = 37°$ as shown in the figure. Then choose the correct option(s) just after the ring is released from rest. (there is no slipping between the ring and inclined plane and g = 10 m/s^2)



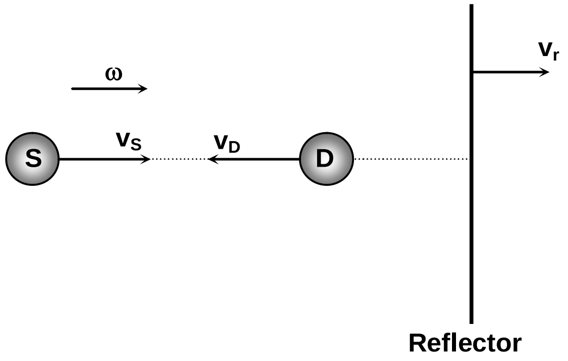
(A) The frictional force acting on the ring due to inclined plane is 4N.
(B) The frictional force acting on the ring due to inclined plane is 2N.
(C) The normal force acting on the ring due to inclined plane is 22 N.
(D) The normal force acting on the ring due to inclined plane is 11N.

7. A uniform solid cylinder of radius R = 10 cm and length ℓ = 20 cm is placed coaxially inside a stationary cylindrical cavity. The gap between the cylinder and the cavity is filled with the viscous liquid of viscosity η = 0.07 poise as shown in the figure. The cylinder is rotated with a constant angular velocity ω = 50 rad/s about its vertical axis. Then choose the correct option(s). (Given h = 1 mm, d = 0.5 mm)



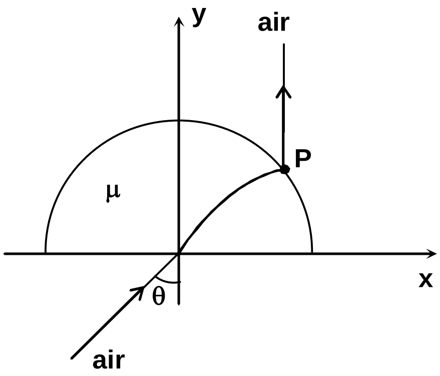
(A) The net torque of viscous force acting on the cylinder is 0.935 N-m.
(B) The net torque of viscous force acting on the cylinder is 0.880 N-m.
(C) The power developed due to viscous force acting on the cylinder is 42.50 Watt.
(D) The power developed due to viscous force acting on the cylinder is 46.75 Watt.

8. In the arrangement shown in the figure, a reflector is moving towards right with a velocity v_r = 20 m/s. Source and detector are moving towards each other with the velocities v_S = 30 m/s and v_D = 10 m/s respectively. The wind is blowing with a velocity ω = 10 m/s towards the reflector. The frequency of sound emitted by the source is f = 527 Hz and the velocity of sound with respect to air is v = 330 m/s. Then choose the correct option(s).



(A) The frequency of the reflected wave received by the detector is 595 Hz
(B) The frequency of the reflected wave received by the detector is 496 Hz
(C) The wavelength of the reflected wave received by the detector is $\left(\frac{5}{8}\right)$ meter.
(D) The wavelength of the reflected wave received by the detector is $\left(\frac{10}{17}\right)$ meter.

9. A hemisphere of radius $\frac{a}{2}$ and made up of a material of variable refractive index is placed with its base centre 'O' at the origin as shown in the figure. The refractive index of the material of the hemisphere varies as $\mu = \left(\frac{a}{a-x}\right)$. A ray of light is incident at the point 'O' at an angle θ(=0) with the normal in the x-y plane and it comes out through a point 'P' on its curved surface. Then choose the correct option(s).



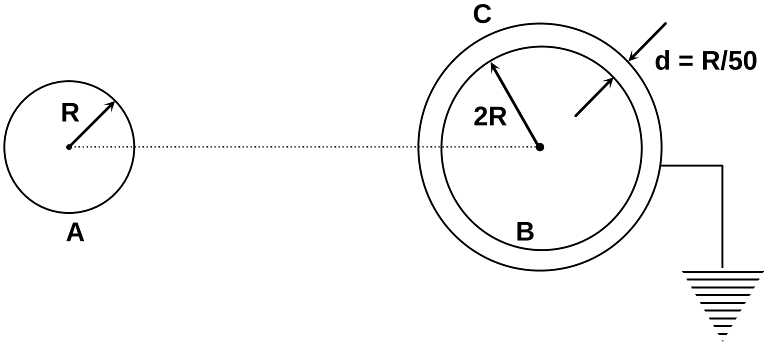
(A) The equation of trajectory of ray of light inside the hemisphere is $y = \sqrt{2ax - x^2}$

(B) The equation of trajectory of ray of light inside the hemisphere is $y = \sqrt{ax - 4x^2}$

(C) The x and y coordinates of point 'P' are $\left(\frac{a}{8}, \frac{a}{8}\sqrt{15}\right)$

(D) The x and y coordinates of point 'P' are $\left(\frac{a}{2}, \frac{a}{2}\sqrt{15}\right)$

10. Two conducting spheres A and B of radius R and 2R are connected by a thin conducting wire. The conducting sphere 'B' is surrounded by a grounded thin concentric conducting shell 'C' with radius $\left(\frac{101}{50}R\right)$. The connecting wire between the spheres A and B is not touching the thin shell 'C'. If conducting sphere 'B' is given a charge 'Q' and the separation between the spheres A and B is much larger than their radii. Then choose the correct option(s).



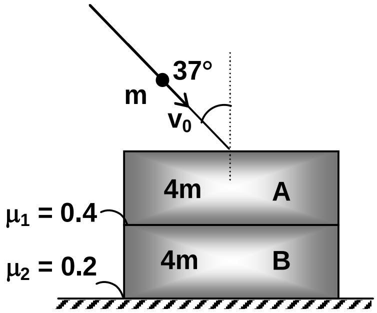
(A) The charge appearing on the conducting sphere 'A' is $\frac{Q}{201}$.

(B) The charge appearing on the conducting sphere 'A' is $\frac{Q}{101}$.

(C) The charge appearing on the conducting sphere 'B' is $\frac{100Q}{101}$.

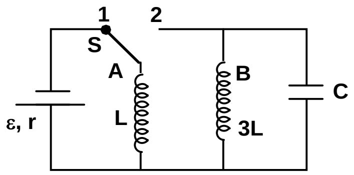
(D) The charge appearing on the conducting sphere 'B' is $\frac{200Q}{201}$.

11. A block 'A' of mass 4m is placed on the block 'B' of same mass 4m which is placed on a rough horizontal surface with coefficient of friction $\mu_2 = 0.2$. The coefficient of friction between the blocks is $\mu_1 = 0.4$. A ball of mass m moving with a velocity $v_0 = 10$ m/s collides with the block 'A' at an angle $\theta = 37°$ with the normal to the surface as shown and gets stuck to it. Then choose the correct option(s).



(A) The velocity of block 'A' just after collision is 0.56 m/s.
(B) The velocity of block 'A' just after collision is 0.28 m/s.
(C) The velocity of block 'B' just after collision is 0.40 m/s.
(D) The velocity of block 'B' just after collision is 0.20 m/s.

12. A circuit consists of two inductors 'A' and 'B' of inductances L and 3L respectively and capacitor of capacitance 'C' as shown in the figure. The emf of battery is ε and its internal resistance 'r'. Initially the switch was in position '1' for a long time and then it is shifted to position '2'. Then choose the correct option(s).



(A) The maximum charge on the capacitor is $\frac{\varepsilon}{r}\sqrt{3LC}$

(B) The maximum charge on the capacitor is $\frac{\varepsilon}{2r}\sqrt{3LC}$

(C) The maximum current through the inductor 'B' is $\frac{\varepsilon}{2r}$

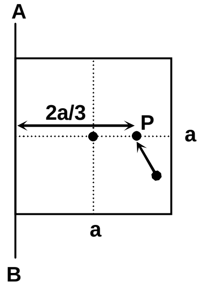
(D) The maximum current through the inductor 'B' is $\frac{3\varepsilon}{4r}$

SECTION – C

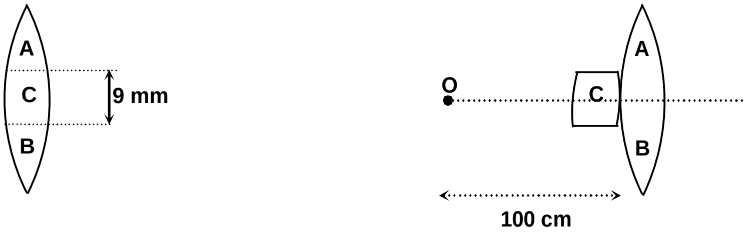
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

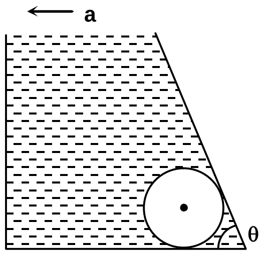
13. A thin uniform square plate of side a = 1m and mass M = 2kg can freely rotate about a stationary vertical axis AB coinciding with one of its sides. A small ball of mass m = 0.5 kg moving with a horizontal velocity v_0 = 6 m/s at right angle to the plate collides elastically at point 'P' of the plate which is located at a distance $\frac{2a}{3}$ from the vertical axis AB as shown in the figure. Find the horizontal component of the resultant force (in Newton) that will be exerted by the axis AB on the plate after collision.



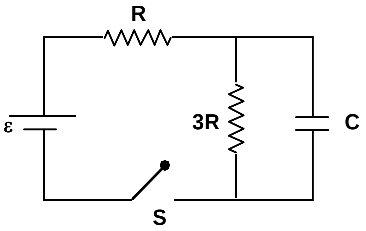
14. A thin convex lens of focal length 50 cm is cut into three parts A, B and C by the planes parallel to its optic axis. The thickness of the middle layer C is 9 mm. The middle layer is now removed and the two parts A and B are stuck together. Then the part C is also placed in contact of this lens symmetrically as shown in the figure. Now, a point object 'O' is placed at a distance 100 cm left on the optic axis of the part C. Find the distance (in mm) between the two images formed by the parts A and B.



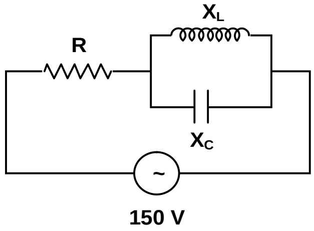
15. A glass sphere of volume V = 500 cm^3 is placed in a vessel filled with water A side wall of the vessel is inclined at an angle θ = 37° with the horizontal bottom of the vessel. The container is moving with a uniform leftward acceleration a = 6 m/s^2. The density of the glass is ρ = 2500 kg/m^3 and the density of water is ρ_w = 1000 kg/m^3 and g = 10 m/s^2. Find the normal force (in newton) between the bottom of the vessel and the glass sphere.



16. In the circuit shown, the power dissipated in the resistances R and 3R at an instant after the switch is closed are 16 W and 3W respectively. Find the rate of increase in the energy stored in the capacitor at this instant (in watt).



17. In the ac circuit shown in the figure, X_L = 8 Ω, X_C= 4 Ω and R = 6Ω. The rms voltage of ac source is 150 V. Find the rms current (in ampere) through the inductor.



18. Consider the following nuclear fusion reaction
$_{1}^{2}H + _{1}^{2}H \rightarrow _{1}^{3}H + _{1}^{1}P$
Assume binding energy per nucleon of deuterium and tritium are 1 MeV and 2.80 MeV respectively. Neglect the kinetic energy of the nuclei before the fusion. Find the kinetic energy (in MeV) of the tritium produced in the above nuclear reaction.

Chemistry PART – II

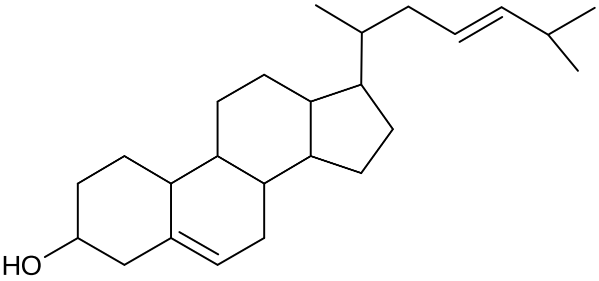
SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

19. Identify the compound which differ in its colour from rest of the three:
    - (A) Potassium hexanitritocobaltate(III)
    - (B) Tetraamminecopper(II) sulphate
    - (C) Ferric ferrocyanide
    - (D) Hexaamminenickel(II) chloride

20. Identify the only 'INCORRECT' statement among the following:
    - (A) In general, all stereospecific reactions are stereoselective but the reverse is not necessarily true.
    - (B) A free radical can be generated at bridge head position.
    - (C) During hydrogenation of olefins by Wilkinson's catalyst conjugated double bond is preferred over a non-conjugated double bond.
    - (D) Singlet carbene $\left(:CCl_2\right)$ is more stable than triplet carbene $\left(:CCl_2\right)$

21. Consider the following molecule



The number of stereocentres and stereoisomers respectively of the above molecule are:
- (A) 8, 2^8
- (B) 9, 2^9
- (C) 10, 2^{10}
- (D) 10, 2^9

22. In a sample of H-atoms, all atoms are initially in their 4th excited state and now these atoms are allowed to de-excite to the ground state. Now, choose the only INCORRCT statement of the following: (Assume multiple excitation of atoms is not allowed)
    - (A) If the sample contains only two H-atoms, then a maximum of six distinct spectral lines can be observed in its emissions spectrum.
    - (B) Minimum five hydrogen atoms, the sample should contain in order to show all possible spectral lines in its emission spectrum
    - (C) If the sample contains 8 H-atoms, then maximum number of 10 spectral lines can be observed, in its emission spectrum
    - (D) If the sample contains minimum 6 H-atoms, then a maximum of 10 spectral lines can be observed in its emission spectrum.

(One or More than one correct type)

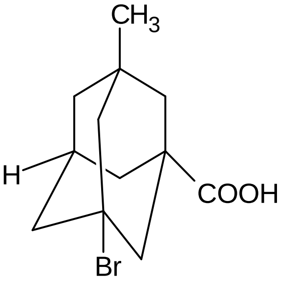
This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

---

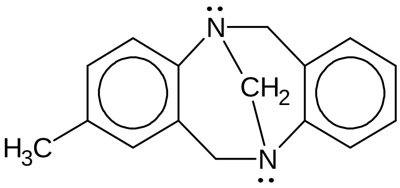
23. During an adiabatic reversible expansion, a gas obeys VT^3 = constant. The gas may be:
    (A) O_2
    (B) O_3
    (C) He
    (D) SO_2

24. Following two equilibria are established on mixing two gases A_2 and C.
    (i) $3A_2(g) \rightleftharpoons A_6(g), K_p = 1.6\ \text{atm}^{-2}$
    (ii) $A_2(g) + C(g) \rightleftharpoons A_2C(g)$
    A_2 and C are mixed in 2 : 1 molar ratio in seal container at a constant temperature. If the total pressure of the reaction mixture is given to be 1.4 atm and partial pressure of A_6 to be 0.2 atm at equilibrium, then identify the correct statement(s) of the following:
    (A) Equilibrium partial pressure of A_2 (g) is 0.5 atm.
    (B) Equilibrium partial pressure of 'C' is 0.4 atm
    (C) Equilbirium partial pressure of A_2C (g) is 0.3 atm
    (D) K_P of reaction (ii) is 1.5 atm^{-1}

25. Consider the structure of two compounds P and Q:



(P)



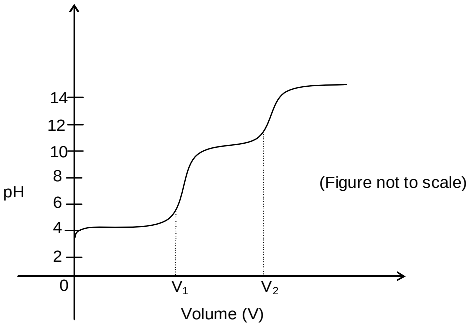
(Q)

Which of the following statement(s) is/are correct regarding P and Q?
    (A) P is chiral
    (B) Q is chiral
    (C) In 'Q' nitrogen inversion is prevented
    (D) 'P' exists as two pair of enantiomers

26. A mixture containing acetone and its next two homologues are heated with hydroxyl amine in presence of catalytic amount of sulphuric acid. Choose the correct statement(s) regarding this reaction from the options given below:
    (A) It is a nucleophilic addition reaction.
    (B) It is a condensation reaction.
    (C) Attack of H^+ ion is the slow step in this reaction.
    (D) A mixture of eight oximes will be produced in this reaction.

27. A transient blue/violet colouration may be obtained by mixing
(A) $Na_2S_2O_3$ and Fe^{3+} (acidified)
(B) $Na_2S_2O_3$ and Fe^{3+} (neutral)
(C) $KI + F_2$
(D) $FeSO_4 + K_3[Fe(CN)_6]$

28. A weak acid is titrated against a strong base and the volume (V) of titrant added, is plotted against pH as shown below:



Which of the following statement(s) regarding above titration is/are correct?
(A) The substance in beaker is a solution of a weak dibasic acid.
(B) $V_2 = 2V_1$.
(C) The pH corresponding to $\left(\frac{V_1}{2}\right)$ corresponds to pK_{a_1} of the weak dibasic acid being titrated.
(D) The pH corresponding to $\left(\frac{3V_1}{2}\right)$ corresponds to pK_{a_2} of the weak dibasic acid to be titrated.

29. $$[X] + H_2O_2 + H^+ \longrightarrow \underset{(\text{Blue colour})}{[Y]} + H_2O$$
$$[Y] + H^+ \longrightarrow \underset{(\text{Green soln})}{[Z]} + M\uparrow + H_2O$$
Now, identify the correct statement(s) regarding above sequence of reactions:
(A) 'X' may be K_2CrO_4 or $K_2Cr_2O_7$.
(B) 'Y' is CrO_3.
(C) Green colour of (Z) is due to the presence of Cr^{3+}.
(D) Gas (M) is O_2.

30. A crystalline cubic solid is made up of atoms A, B, C and D such that atoms 'A' are present at each of the corner, 'B' atoms at each of face centre, 'C' atoms in each of octahedral void and 'D' atoms in each of the tetrahedral voids of the unit cell. Now choose the correct statement(s) regarding the above solid.
(Atoms from the lattice sites of the unit cell have to removed completely and not partially)
(A) If all atoms lying along or inside one of the octant are removed, then the formula of resulting solid would be $A_7B_{16}C_{12}D_{56}$.
(B) If all atoms lying along one of the C_4 – axis of symmetry are removed, then the formula of the resulting solid would be $AB_2C_3D_8$.
(C) If all atoms lying along one of the C_3 – axis of symmetry are removed, then the formula of resulting solid would be $AB_4C_4D_8$.
(D) If all the atoms lying along one of the C_2 – axis of symmetry are removed, then the formula of resulting solid would be $A_2B_6C_5D_{16}$.

SECTION – C

(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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31. The collision frequency of a sample of an ideal gas molecules is defined as the ratio of the average speed of gas molecule to their mean free path. So, if the pressure and temperature of the gas molecules is made 8 times of its initial pressure and temperature, then ratio of new collision frequency to that of original collision frequency will be (given $\sqrt{2}$ = 1.41, $\sqrt{3}$ = 1.73)

32. The mechanism of the reaction, $A \longrightarrow C$ is given below:

$$A \underset{k_b}{\overset{k_f}{\rightleftharpoons}} B(\text{fast})$$

$$B \xrightarrow[K_2]{} C(\text{slow})$$

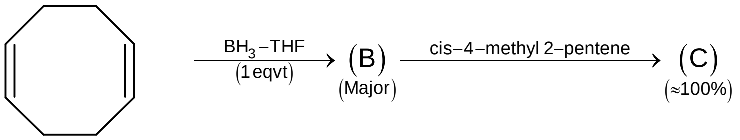
By using steady state approximation, the rate law of the above reaction is given by

$r = k[A]$

Where k is the rate constant of the overall reaction $(A \longrightarrow C)$.

So, if $k_f = 2\ \text{sec}^{-1}$, $k_b = 0.4\ \text{sec}^{-1}$, and $k_2 = 0.1\ \text{sec}^{-1}$, the value of 'k' will be (in units of sec^{-1})

33.



(A)

Now, let, the degree of unsaturation of (B) = x
the degree of unsaturation of (C) = y
Total number of stereoisomers of (B) = z
Total number of stereoisomers of (C) = m

Then, calculate the value of $\frac{(xy+1)}{(m+z)}$.

34. Iodine reacts with ozone gas to form a dark yellow solid (X). Let, the number of lone – pair of electrons in un-ionised form of (X) be m, number of lone pair of electrons in the anionic moiety of (X) be 'n' and the positive charge on the cationic moiety of (X) be 'p' units. Then the value of $\frac{(m-p)}{n}$ is…..

35. The ratio of the sum of number of resonating structures and number of plane of symmetry in the anionic moiety of gypsum to the number of resonating structures in the anionic moiety of calcium phosphate is...

36. Ferric sulphide reacts with oxygen gas to produce ferrous sulphate and sulphur dioxide. The gram equivalent weight of ferric sulphide in the above reaction is:
(Atomic weight : Fe = 56, S = 32)

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. If $z = x + iy$, $x, y \in R$, $i = \sqrt{-1}$, such that $|z| = 1$, then the maximum value of $|z^3 - z + 2|$ is?
(A) 2
(B) 4
(C) $\sqrt{17}$
(D) $\sqrt{13}$

38. If $E_1, E_2, E_3, \ldots, E_{12}$ are distinct numbered edges of a cube, then the number of unordered pairs (E_i, E_j) where $1 \le i, j \le 12$ that determine a plane is?
(A) 38
(B) 42
(C) 36
(D) 12

39. If $1+\frac{p}{q} = \sum_{i=0}^{1000} \frac{^{1000}C_i}{^{2020}C_i}$, where p, q are coprime, then p + q is equal to?
(A) 3020
(B) 1510
(C) 2021
(D) 2019

40. If $I = \int_0^{\pi/4} \frac{\tan^2 x}{x^2 + \tan^2 x - 2x\tan x - 3x + 3\tan x + 2} dx$, then value of I is?
(A) $\frac{1}{2}\ln 2$
(B) $-\ln\left(\frac{16-2\pi}{12-\pi}\right)$
(C) $\ln\left(\frac{16-2\pi}{12-\pi}\right)$
(D) $-\frac{1}{2}\ln 2$

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

41. If PQRS is a tetrahedron such that $\overrightarrow{PQ} = \vec{p}$, $\overrightarrow{PR} = \vec{q}$, $\overrightarrow{PS} = \vec{r}$, $|\vec{p}| = \sqrt{3}$, $|\vec{q}| = \sqrt{2}$, $|\vec{r}| = \sqrt{5}$, $\vec{p}\cdot\vec{q} = 2$, $\vec{q}\cdot\vec{r} = -1$ and $\vec{r}\cdot\vec{p} = -1$, then?
(A) volume of tetrahedron is 1 unit^3
(B) length of altitude from vertex S to the opposite face is $\frac{3}{\sqrt{2}}$ unit

(C) volume of tetrahedron is $\frac{1}{2}$ unit^3

(D) length of altitude from vertex S to the opposite face is $3\sqrt{2}$ unit

42. Let $\omega = -\frac{1}{2} + i\frac{\sqrt{3}}{2}$, and S denote the set of all the complex numbers in the Argand plane of the form a + bω+ cω^2, where a, b, c $\in$ [0, 1]?
(A) length of perimeter of region traced by S is $\sqrt{3}\pi$ unit
(B) area of region traced by S is $\frac{3\sqrt{3}}{2}$ unit^2
(C) length of perimeter of region traced by S is 6 unit
(D) area of region traced by S is $\frac{\pi\sqrt{3}}{2}$ unit^2

43. If A_n is the number of sequences of 0's and 1's of length n that begin with a 0, end with a 0, contain no two consecutive 0's and contain no three consecutive 1's, then?
(A) $A_5 = 1$
(B) $A_6 = 2$
(C) $A_{10} = A_8 + A_9$
(D) $A_{11} = A_8 + A_9$

44. There are 17 identical red balls and 10 identical white balls be distributed among 4 distinct boxes, then which of the following is/are CORRECT?
(A) number of ways such that number of red balls is greater then number of white balls in each box is ${}^6C_3 \cdot {}^{13}C_3$
(B) number of way such that number of red balls is greater than the number of white balls in each box is ${}^6C_2 \cdot {}^{20}C_3$
(C) number of ways such that exactly 2 boxes have red balls is ${}^4C_2 \times {}^{16}C_1 \times {}^{12}C_2$
(D) number of ways such that exactly 3 boxes have white balls and each box has different number of white balls is ${}^4C_3 \times 3! \times {}^{20}C_3 \times {}^4C_1$

45. Let a_n and b_n be the sequence of real numbers such that $(2 + i)^n = a_n + b_n i$, for all integers $n \geq 0$ where $i = \sqrt{-1}$, then?
(A) $\sum_{n=0}^{\infty} \frac{a_n b_n}{7^n} = \frac{7}{16}$
(B) $\sum_{n=0}^{\infty} \frac{a_n b_n}{7^n} = \frac{1}{20}$
(C) $\sum_{n=0}^{\infty} \frac{a_n^2 - b_n^2}{7^n} = -\frac{1}{20}$
(D) $\sum_{n=0}^{\infty} \frac{a_n^2 - b_n^2}{7^n} = \frac{7}{8}$

46. Let $S_k = \alpha^k + \beta^k + \gamma^k$, where α, β, γ are the roots of the equation $x^3 - 5x^2 + 8x - 13 = 0$, then?
(A) $S_0 + S_1 + S_2 = 17$
(B) $S_0 - S_1 + S_2 = 7$
(C) if $S_4 = aS_3 + bS_2 + cS_1$, then a + b + c = 10
(D) if $S_4 = aS_3 + bS_2 + cS_1$, then a – b + c = 10

47. If $P(x) = x^5 + ax^4 + bx^3 + cx^2 + dx - 32$ (where a, b, c d $\in$ R) has the property that whenever r is a root of P(x) so is $r\omega$ (where $\omega = e^{i\frac{2\pi}{3}}$), then?
(A) the value of a can be –4
(B) the value of b can be 4
(C) the value of a can be 2
(D) the value of P(2) can be –7

48. Given a nine-sided regular polygon whose vertices are $A_1\ A_2\ A_3\ A_4$ ….. A_9. Let S = {A_1, A_2, ….., A_9}, then which of the following is/are correct?
(A) Number of distinct isosceles triangles, all of whose vertices belong to the set S is 30
(B) Number of distinct equilateral triangles, at least two of whose vertices belong to the set S is 72
(C) Number of distinct isosceles triangles, all of whose vertices belong to the set S is 33
(D) Number of distinct equilateral triangles, at least two of whose vertices belong to the set S is 66

SECTION – C

(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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49. The value of $600\sum_{a=1}^{\infty}\sum_{b=1}^{\infty}\sum_{c=1}^{\infty}\frac{ab(3a+c)}{4^{a+b+c}(a+b)(b+c)(c+a)}$ is?

50. Let a, b, c $\in$ R and $a^2 + b^2 + c^2 = 1$, then the maximum value of $|a - b| + |b - c| + |c - a|$ is?

51. Let $z = \frac{1+i}{\sqrt{2}}$, then the value of $\left(z^{1^2} + z^{2^2} + z^{3^2} + ... + z^{12^2}\right)\left(\frac{1}{z^{1^2}} + \frac{1}{z^{2^2}} + ... + \frac{1}{z^{12^2}}\right)$ is equal to?

52. The area of region traced by the point P(x, y) in Cartesian plane which satisfies the inequation $\sin^2 \pi x + \sin^2 \pi y > 1$, if $x, y \in [-1, 1]$ is?

53. Let f(x) be a third degree polynomial with real coefficients satisfying the equation
$|f(1)| = |f(2)| = |f(3)| = |f(5)| = |f(6)| = |f(7)| = 12$, then the value of $|f(0)|$ is?

54. If $P(n) = \prod_{r=3}^{n}\frac{(r^3 + 3r)^2}{r^6 - 64}$, then value of $\lim_{n\to\infty}$ P(n) is, ($n \in N$)?

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JEE (Advanced)-2020

PAPER – 1

TEST DATE: 13-09-2020

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. B

Sol. Given $|a_t| = 2|a_n|$

$-a_t = 2a_n$

$$-v\frac{dv}{ds} = 2\frac{v^2}{R}$$

$$-\int_{v_0}^{v}\frac{dv}{v} = \frac{2}{R}\int_0^s ds$$

$$\ell n\left(\frac{v}{v_0}\right) = -\frac{2s}{R}$$

$$v = v_0 e^{-\frac{2s}{R}}$$

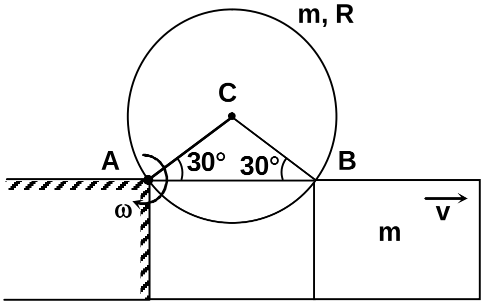
When s = 10 m, $v = 20e^{-\frac{20}{10}} = 20e^{-2} = 20\times 0.135 = 2.7$ m/s

V = 2.7 m/s

2. A

Sol. $v\cos 30° = \omega R\sqrt{3}\cos 60°$

$v = \omega R$ …(i)



Now, using conservation of energy

$$mgR(1-\sin 30°) = \frac{1}{2}\times 2mR^2\omega^2 + \frac{1}{2}mv^2$$

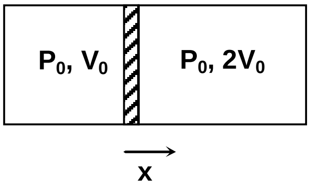
$$\frac{mgR}{2} = \frac{3}{2}mv^2$$

$\Rightarrow$ $gR = 3v^2$

$\Rightarrow$ $v = \sqrt{\frac{gR}{3}} = \sqrt{\frac{10\times 0.3}{3}} = 1\,\text{m/s}$

3. B

Sol. Since the ideal gas in each chamber undergoes an isothermal process



$$\frac{dP}{dV} = -\left(\frac{P}{V}\right)$$

$$dP = -\left(\frac{P}{V}\right)dV$$

When the piston is slightly displaced from equilibrium position by a distance 'x' the net restoring force acting on the piston is

$$F = \left(\frac{P_0}{2V_0} + \frac{P_0}{V_0}\right)A^2x$$

$$F = \left(\frac{3P_0}{2V_0}\right)A^2x$$

Now, $\frac{md^2x}{dt^2} = -F \Rightarrow \frac{md^2x}{dt^2} = -\left(\frac{3P_0}{2V_0}\right)A^2x \Rightarrow \frac{d^2x}{dt^2} = -\left(\frac{3P_0A^2}{2mv_0}\right)x$

$\therefore$ Time period, $T = 2\pi\sqrt{\frac{2mV_0}{3P_0A^2}}$

4. D

Sol. $I = \frac{Q\omega}{2\pi} = \frac{\sigma 2\pi R\ell\omega}{2\pi} = \sigma\omega R\ell$

The magnetic field produced inside the long hollow cylinder

$$B = \frac{\mu_0 I}{\ell} = \mu_0\sigma\omega R$$

$$\int qE\,adt = ma^2\omega_0$$

$$qa\int\frac{a}{2}dB = ma^2\omega_0$$

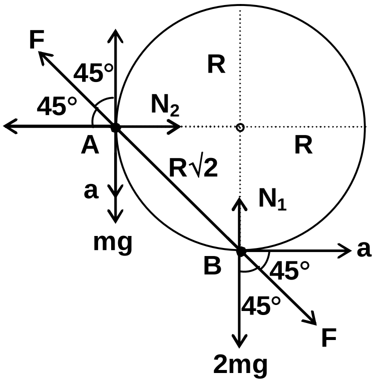
$$\frac{qa^2}{2}B = ma^2\omega_0$$

$\therefore\ \omega_0 = \frac{qB}{2m} = \frac{q}{2m}(\mu_0\sigma\omega R)$ $\Rightarrow$ $\omega_0 = \frac{\mu_0 q\sigma\omega R}{2m}$

5. A, C, D

Sol. $m_A = m = 0.3$ kg

$m_B = 2m = 0.6$ kg



$N_1 = 2mg + \frac{F}{\sqrt{2}}$ …(i)

$\frac{F}{\sqrt{2}} = 2ma$ …(ii)

$N_2 = \frac{F}{\sqrt{2}}$ …(iii)

$mg - \frac{F}{\sqrt{2}} = ma$ …(iv)

From (ii) and (iv)

$mg = 3ma \Rightarrow a = g/3$

from (ii), $\frac{F}{\sqrt{2}} = 2ma = \frac{2mg}{3} = 2$

$\therefore\ F = 2\sqrt{2}$ N

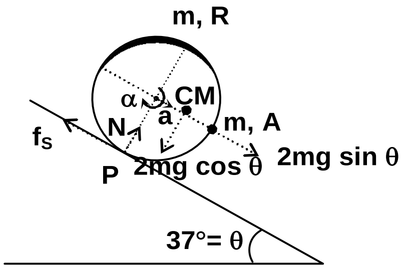
$\therefore\ N_2 = \frac{F}{\sqrt{2}} = 2N \Rightarrow N_2 = 2N$

From (i) $N_1 = 2mg + \frac{F}{\sqrt{2}} = 2mg + \frac{2mg}{3} = \frac{8mg}{3} = 8$ N

$\Rightarrow\ N_1 = 8N$

6. B, D

Sol. For pure rolling motion, $a = \alpha R$



$2mg\cos\theta \times \frac{R}{2} + 2mg\sin\theta \times R = 4mR^2\alpha$

$mg(\cos\theta + 2\sin\theta) = 4m\alpha R$

$g(\cos 37° + 2\sin 37°) = 4\alpha R$

$g\left(\frac{4}{5} + 2 \times \frac{3}{5}\right) = 4\alpha R$

$2g = 4\alpha R \Rightarrow \alpha = \frac{g}{2R}$

$\therefore\ a = \alpha R = g/2$

Now, $2mg\sin\theta - f_S = 2ma$

$\frac{6mg}{5} - f_s = 2m\frac{g}{2} \Rightarrow f_s = \frac{6mg}{5} - mg = \frac{mg}{5} = 2N$

Also, $2mg\cos\theta - N = 2m\alpha\frac{R}{2}$

$\frac{8mg}{5} - N = \frac{mg}{2}$

$\Rightarrow N = \frac{8mg}{5} - \frac{mg}{2} = \frac{11}{10}mg$

N = 11N

7. A, D

Sol. The net torque of viscous force acting on the cylinder,

$$\tau = \int_0^R \eta 2\pi r dr \frac{\omega r}{h} r + \eta 2\pi R\ell \frac{\omega R}{d} R$$

$$= \frac{\pi\eta R^4\omega}{2h} + \frac{2\pi\eta R^3\ell\omega}{d} = \pi\eta R^3\left(\frac{R}{2h} + \frac{2\ell}{d}\right)\omega$$

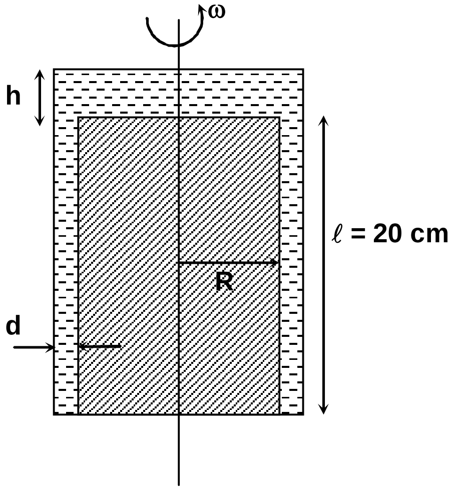
$$= \frac{22}{7} \times 7 \times 10^{-6}\left(\frac{10}{0.2} + \frac{40}{0.05}\right)50$$

$\tau = 22 \times 10^{-6} \times 850 \times 50 = 0.935$ N-m

Power developed by the viscous force acting on the cylinder

$P = \tau\omega = 0.935 \times 50 = 46.75$ Watt

$P = 46.75$ Watt



8. B, C

Sol. The frequency received by the reflector is

$$f_1 = \left(\frac{v + w - v_r}{v + w - v_s}\right)f$$

The frequency of the reflected wave received by the detector is

$$f_2 = \left(\frac{v - w - v_D}{v - w + v_r}\right)f_1$$

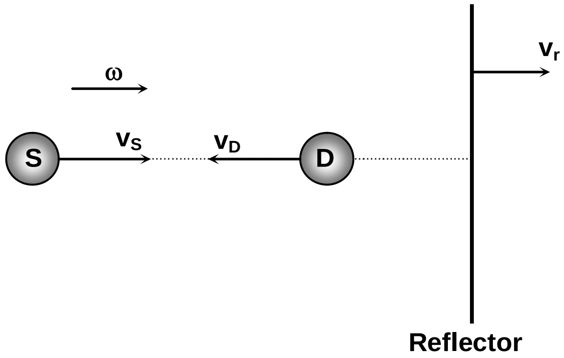
$$f_2 = \left(\frac{v - w - v_D}{v - w + v_r}\right)\left(\frac{v + w - v_r}{v + w - v_s}\right)f$$

$$= \left(\frac{330 - 10 - 10}{330 - 10 + 20}\right)\left(\frac{330 + 10 - 20}{330 + 10 - 30}\right)527$$

$$f_2 = \left(\frac{310}{340}\right)\left(\frac{320}{310}\right) \times 527 = 496 \text{ Hz}$$

The wavelength of the reflected wave received by the detector is

$$\lambda_2 = \frac{v - w - v_D}{f_2} = \frac{330 - 10 - 10}{496} = \frac{5}{8} \text{ m}$$



9. A, C

Sol. $\frac{dy}{dx} = \tan i$

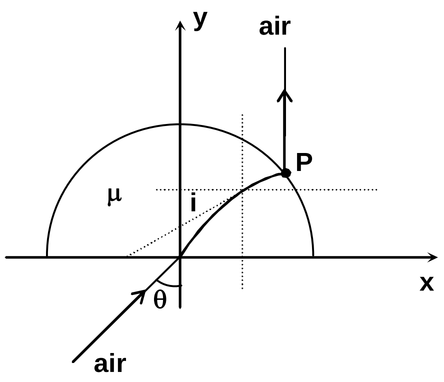
Now using snell's law

$1 \times \sin 90° = \mu \sin i$

$$\sin i = \frac{1}{\mu} = \left(\frac{a - x}{a}\right)$$

$$\sin i = \left(\frac{a - x}{a}\right)$$

$$\tan i = \frac{(a - x)}{\sqrt{a^2 - (a - x)^2}}$$



$\frac{dy}{dx} = \frac{(a-x)}{\sqrt{(2ax-x^2)}}$ from equation (i)

$\int_0^y dy = \int_0^x \frac{(a-x)}{\sqrt{2ax-x^2}} dx \Rightarrow y = \sqrt{2ax-x^2}$

Also, $y^2 + x^2 = \frac{a^2}{4}$ …(iii)

Solving (ii) and (iii) we get

$2ax = \frac{a^2}{4} \Rightarrow x = \frac{a}{8}$ and $y = \frac{a}{8}\sqrt{15}$

The x and y coordinates of point 'P' are ($\frac{a}{8}$, $\frac{a}{8}\sqrt{15}$)

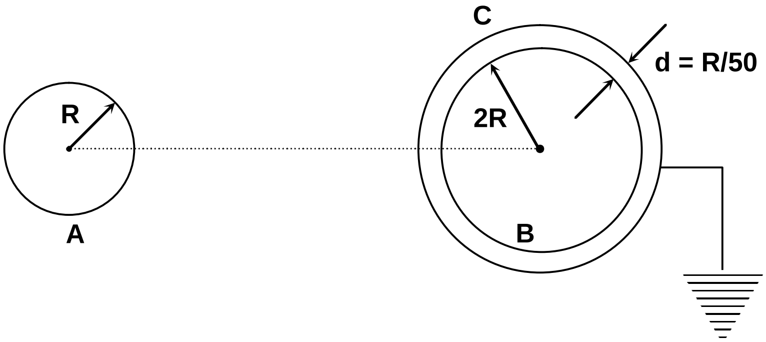
10. A, D

Sol. $C_1 = 4\pi\varepsilon_0 r_1 = 4\pi\varepsilon_0 R$

$C_2 = \frac{4\pi\varepsilon_0 r_2^2}{d} = \frac{4\pi\varepsilon_0 4R^2}{R/50} = 800\pi\varepsilon_0 R$

If charges appearing on the conducting spheres 'A' and 'B' are q_1 and q_2 respectively.

$\frac{q_1}{q_2} = \frac{C_1}{C_2} = \frac{4\pi\varepsilon_0 R}{800\pi\varepsilon_0 R}$



$\Rightarrow \frac{q_1}{q_2} = \frac{1}{200}$

$\Rightarrow q_2 = 200\ q_1$ …(i)

Now, $q_1 + q_2 = Q$

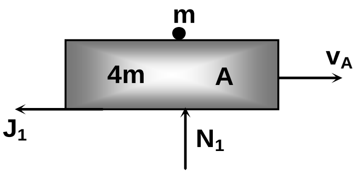
$q_1 + 200q_1 = Q$

$\Rightarrow q_1 = \frac{Q}{201}$

$q_2 = \frac{200Q}{201}$

11. A, C

Sol. $\int N_1 dt = 8\ m$

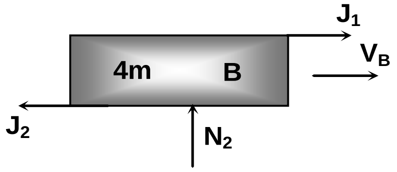


Impulse due to friction on the block 'A'

$J_1 = \mu_1 \int N_1 dt = 0.4 \times 8m = 3.2\ m$ …(i)

$J_1 = 6m - 5mv_A$

$3.2\ m = 6m - 5mv_A$



$$\Rightarrow v_A = \frac{2.8}{5} = 0.56\text{ m/s}$$

$$\int N_2 dt = 8m$$

Impulse due to friction of horizontal surface on the block 'B'

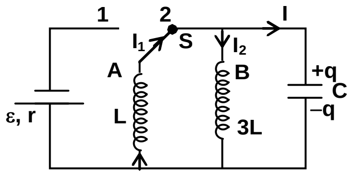
$J_2 = \mu_2 \int N_2 dt = 0.2 \times 8$ m = 1.6 m ….(ii)

Now, $J_1 - J_2 = 4mv_B$

$\Rightarrow 4mv_B = 1.6$ m

$\Rightarrow v_B = 0.40$ m/s

12. B, C



Sol. $I_0 = \frac{\varepsilon}{r}$

$$L\frac{dI_1}{dt} + 3L\frac{dI_2}{dt} = 0$$

$$\int_{I_0}^{I_1} dI_1 = -3\int_0^{I_2} dI_2$$

$I_1 - I_0 = -3I_2$

$I_1 + 3I_2 = I_0$ …(i)

$I_1 - I_2 = I$ …(ii)

When the charge on the capacitor is maximum, I = 0

$I_1 = I_2$ …(iii)

From equation (1) and (iii)

$4I_2 = I_0 \Rightarrow I_2 = \frac{I_0}{4}$ and $I_1 = \frac{I_0}{4}$

Now, $\frac{1}{2}LI_0^2 - \frac{1}{2}(L + 3L)\left(\frac{I_0}{4}\right)^2 = \frac{q_{max}^2}{2C}$

$$LI_0^2 - \frac{LI_0^2}{4} = \frac{q_{max}^2}{C}$$

$\Rightarrow \frac{3L}{4}I_0^2 = \frac{q_{max}^2}{C}$ $\Rightarrow q_{max} = \frac{I_0}{2}\sqrt{3LC} = \frac{\varepsilon}{2r}\sqrt{3LC}$

Now, when the current through the inductor 'B' is maximum, q = 0

$$\frac{1}{2}LI_0^2 = \frac{1}{2}LI_1^2 + \frac{1}{2}3LI_2^2$$

$I_0^2 = I_1^2 + 3I_2^2$

$\Rightarrow I_0^2 - I_1^2 = 3I_2^2$

$$(I_0 + I_1)(3I_2) = 3I_2^2$$

$\Rightarrow I_0 + I_1 = I_2$

$I_2 - I_1 = I_0$ …(iv)

Solving equation (i) and (iv) we get

$4I_2 = 2I_0 \Rightarrow I_2 = I_0/2 = \frac{\varepsilon}{2r}$

SECTION – C

13. 00020.25

Sol. Let the ball rebounds with a velocity ‘v’ after collision.

Using conservation of angular momentum about the axis AB.

$$mv_0\frac{2a}{3} = \frac{Ma^2}{3}\omega - \frac{mv2a}{3}$$

$$\frac{m2a}{3}(v_0 + v) = \frac{Ma^2}{3}\omega$$

$v_0 + v = 2\,\omega a$ …(i)

$v + \frac{2\omega a}{3} = v_0$ …(ii)

Solving (i) and (ii)

$v_0 + v = 3v_0 - 3v$

$4v = 2v_0 \Rightarrow v = v_0/2 = 3$ m/s

$$\Rightarrow\ \omega = \frac{v_0 + v}{2a} = \frac{6+3}{2\times 1} = 4.5\ \text{rad/s}$$

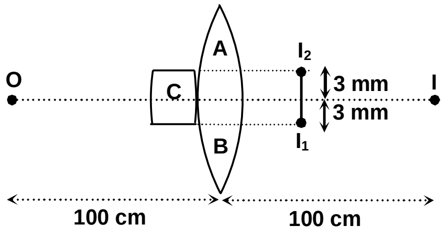
Horizontal component of the resultant force that will be exerted by the axis AB on the plate after the collision

$$F_x = M\omega^2\frac{a}{2} = 2\times 4.5\times 4.5\times\frac{1}{2} = 20.25\ \text{N}$$

$F_x = 20.25$ N

14. 00006.00

Sol. The image I of point object ‘O’ formed by the part ‘C’ is at a distance 100 cm right on the optic axis of the lens part ‘C’.



Now,

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} - \frac{1}{100} = \frac{1}{50}$$

$$v = +\frac{100}{3}\text{cm}$$

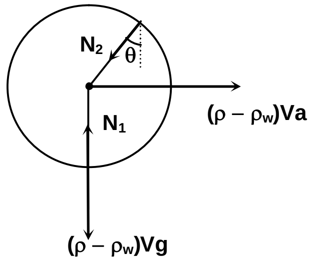
$$\therefore\ m = \frac{v}{u} = +\frac{1}{3}$$

∴ the distance between the two images formed by the parts A and B

d = 3 mm + 3mm = 6mm

15. 00013.50

Sol. $N_2 \sin\theta = (\rho - \rho_w)Va$ …(i)



$N_1 = N_2 \cos\theta + (\rho - \rho_w)Vg$

$N_1 = (\rho - \rho_w)\,Va\cot\theta + (\rho - \rho_w)Vg$

$N_1 = (\rho - \rho_w)V\,(g + a\cot\theta)$

$$N_1 = (2500 - 1000)\times 0.5\times 10^{-3}\left(10 + 6\times\frac{4}{3}\right)$$

$= 1500 \times 0.5 \times 10^{-3} \times 18$

$N_1 = 13.50$ newton

16. 00009.00

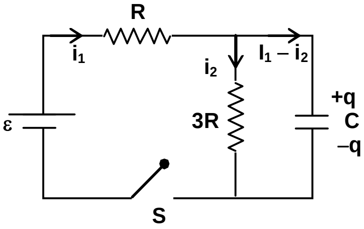
Sol. $i_1^2R = 16 \quad \ldots(i)$

$i_2^2 3R = 3$

$i_2^2R = 1 \quad \ldots(ii)$

From (i) and (ii)

$\frac{i_1^2R}{i_2^2R} = 16 \Rightarrow i_1 = 4i_2$ `



Energy stored in the capacitor at this instant

$U = \frac{q^2}{2C}$

$\frac{dU}{dt} = \frac{q}{C}\frac{dq}{dt} = (i_2 3R)(i_1 - i_2)$

$= (i_2 3R)3i_2 = 9i_2^2R = 9 \times 1 = 9$ watt

$\therefore \frac{dU}{dt} = 9$ watt

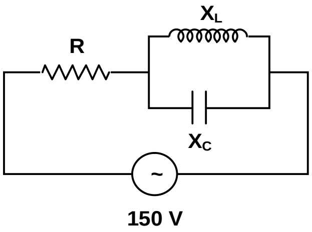
17. 00015.00

Sol. $Z_1 = X_Li = 8i$

$Z_2 = -X_Ci = -4i$

$\frac{1}{Z'} = \frac{1}{Z_1} + \frac{1}{Z_2} = \frac{1}{8i} - \frac{1}{4i} = -\frac{i}{8} + \frac{i}{4}$

$\frac{1}{Z'} = \frac{i}{8} \Rightarrow Z' = \frac{8}{i} = -8i$



Net impedance of the circuit

Z = R – 8i

Z = 6 – 8i

$|Z| = \sqrt{(6)^2 + (8)^2} = 10\,\Omega$

rms current through the soruce, $I_{rms} = \frac{\varepsilon_{rms}}{|Z|} = \frac{150}{10} = 15$ A

rms current through $X_L = \frac{V_{rms}}{8}$

rms current through $X_C = \frac{V_{rms}}{4}$

Now, $\frac{V_{rms}}{4} - \frac{V_{rms}}{8} = 15$

$\frac{V_{rms}}{8} = 15 \Rightarrow V_{rms} = 120$ Volt

$\therefore$ rms current through $X_L = \frac{V_{rms}}{8} = 15$ A

18. 00001.10

Sol. $^{2}_{1}H + ^{2}_{1}H \rightarrow ^{3}_{1}H + ^{1}_{1}P$

Using momentum conservation

$\vec{P}_1 + \vec{P}_2 = 0$

$\vec{P}_1 = -\vec{P}_2$

$P_1^2 = P_2^2$

$2m_1k_1 = 2m_2k_2$

$3k_1 = k_2$ …(i)

Also,

$k_1 + k_2 = 8.4 – 4$

$k_1 + k_2 = 4.4.$ …(ii)

solving (i) and (ii) we get

$4k_1 = 4.4.$

$k_1 = 1.1$ MeV and $k_2 = 3.3$ MeV

kinetic energy of the tritium, $k_1 = 1.1$ MeV

kinetic energy of the proton, $k_2 = 3.3$ MeV

Chemistry PART – II

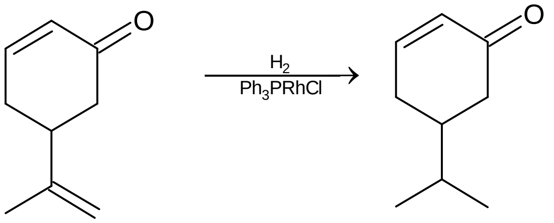
SECTION – A

19. A

Sol. (A) is yellow while (B), (C) and (D) all are blue.

20. C

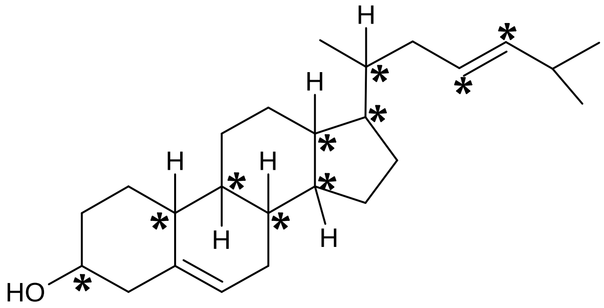
Sol.



So, A non-conjugated double bond is reduced more easily than a conjugated double bond by Wilkinson's catalyst.

21. D

Sol.



Where (∗) represents a stereocentre.
So, total number of stereoisomers = 2^9.

22. B

Sol. A minimum of 6-H-atoms should be present in the sample, so that all the 10 spectral lines can be observed.

23. B, D

Sol. For an adiabatic expansion,

$$T\times V^{\gamma-1} = \text{Constant}(K)$$

Or $V\times T^{\frac{1}{\gamma-1}} = (K)^{\frac{1}{\gamma-1}} = \text{Constant}$

So, $\frac{1}{\gamma-1}=3 \qquad \therefore \gamma=\frac{4}{3}$

So, gas must be non-linear polyatomic.

24. A, B, C, D

Sol. (i) $3A_2(g) \rightleftharpoons A_6(g)$

$$K_p = 1.6 = \frac{P_{A_6}}{\left(P_{A_2}\right)^3} \Rightarrow P_{A_2} = \sqrt[3]{\frac{0.2}{1.6}} = 0.5 \text{ atm}$$

Also, pressure of A_2 used for the formation of A_6 = 0.6 atm.

(ii)

$$\begin{array}{llll} & A_2(g) + & C(g) \rightleftharpoons & A_2C(g) \\ \text{at } t=0 & 2P & P & 0 \\ \text{At eqbm}: & (2P-p-0.6) & (P-p) & p \end{array}$$

$$\begin{array}{lll} & 3A_2(g) & \rightleftharpoons A_6(g) \\ \text{Also, for at } t=0 & 2P & 0 \\ \text{At eqbm}: & (2P-p-0.6) & 0.2 \end{array}$$

Since, P_{A_2} at equilibrium is 0.5 atm for simultaneous equilibria

Also, $P_{A_2} + P_C + P_{A_2C} + P_{A_6}$

$$= (2P - p - 0.6) + (P - p) + p + 0.2 = 1.4$$

P = 0.7 atm

Now, 2P – p – 0.6 = 0.5

1.4 – p – 0.6 = 0.5

p = 0.3 atm

So, $P_{A_2} = 0.5 \text{ atm}, P_C = 0.7 - 0.3 = 0.4 \text{ atm}, P_{A_2C} = 0.3 \text{ atm.}$

Also, $A_2(g) + C(g) \rightleftharpoons A_2C(g)$

$$K_{p_2} = \frac{P_{A_2C}}{P_{A_2} \times P_C} = \frac{0.3}{0.5 \times 0.4} = 1.5 \text{ atm}^{-1}$$

25. A, B, C

Sol. Although 'P' exhibits four stereocentres, yet it exists only as one pair of enantiomers (due to increased symmetry)

In compound 'Q', the N-atom is at bridge head position, therefore, nitrogen inversion does not occur.

So, 'Q' is chiral.

26. A, B, D

Sol. Acetone and its next two homologues (2-butanone, 2-pentanone, 3-pentanone and isopropyl methyl ketone) reacts with hydroxyl amine to produce a total of eight oximes.

27. B, C

Sol. $$2S_2O_3^{2-} + \underset{(\text{neutral})}{Fe^{3+}} \longrightarrow \underset{\text{Violet complex}}{\left[Fe(S_2O_3)_2\right]^-} \xrightarrow{Fe^{3+}} \underbrace{2Fe^{2+} + S_4O_6^{2-}}_{(\text{Colourless})}$$

$$F_2 + \underset{(\text{excess})}{2KI} \longrightarrow 2KF + \underset{(\text{Violet})}{I_2} \xrightarrow{I^-} \underset{(\text{Brown})}{I_3^-}$$

$$Fe^{2+} + \left[Fe(CN)_6\right]^{3-} \longrightarrow \underset{\begin{pmatrix}\text{Turnbull's blue} \\ \text{Permanent colour}\end{pmatrix}}{Fe\left[Fe(CN)_6\right]^-}$$

28. A, B, C, D

Sol. $H_2A + OH^- \longrightarrow HA^- + H_2O$

$HA^- + OH^- \longrightarrow A^{2-} + H_2O$

At first equivalent point, volume of base used is V_1 and at second equivalence point, it is V_2. So, $V_2 = 2V_1$.

When, $V = \frac{3V_1}{2}$, conc. of HA^- and A^{2-} will be equal and a buffer will be formed, so, $pH = pK_{a_2}$.

Also, when $V = \frac{V_1}{2}$, first buffer will be formed containing H_2A and A^- in equal concentration.

So, $pH = pK_{a_1}$.

29. A, C, D

Sol. $$\underbrace{CrO_4^{2-} \text{ or } Cr_2O_7^{2-}}_{(X)} + H_2O_2 + H^+ \longrightarrow \underset{(Y)}{CrO_5} + H_2O$$

$$CrO_5 + H^+ \longrightarrow \underset{\left(\substack{\text{Green soln}\\ Z}\right)}{Cr^{3+}} + \underset{(M)}{O_2(g)} + H_2O$$

30. B, C, D

Sol. Option B: Formula of solid would be $AB_2C_3D_8$.
Option C: Formula of solid would be $AB_4C_4D_8$.
Option A: Formula of solid would be $A_2B_6C_5D_{16}$.

SECTION – C

31. 00002.82

Sol. Mean free path $(\lambda) = \frac{1}{\sqrt{2}\pi d^2 N}$

Where, d = collision diameter of gas molecules.
N = Number of gas molecules per unit volume.

Average speed $= \sqrt{\frac{8RT}{\pi M}}$

32. 00000.40

Sol. $$A \underset{k_b}{\overset{k_f}{\rightleftharpoons}} B(\text{fast})$$

$$B \xrightarrow[K_2]{} C(\text{slow})$$

By writing steady state approximation for 'B'

$$\frac{d[B]}{dt} = k_f[A] - k_b[B] - k_2[B] = 0$$

$$[B] = \frac{k_f[A]}{(k_b + k_2)}$$

Now, rate $= k_2[B]$

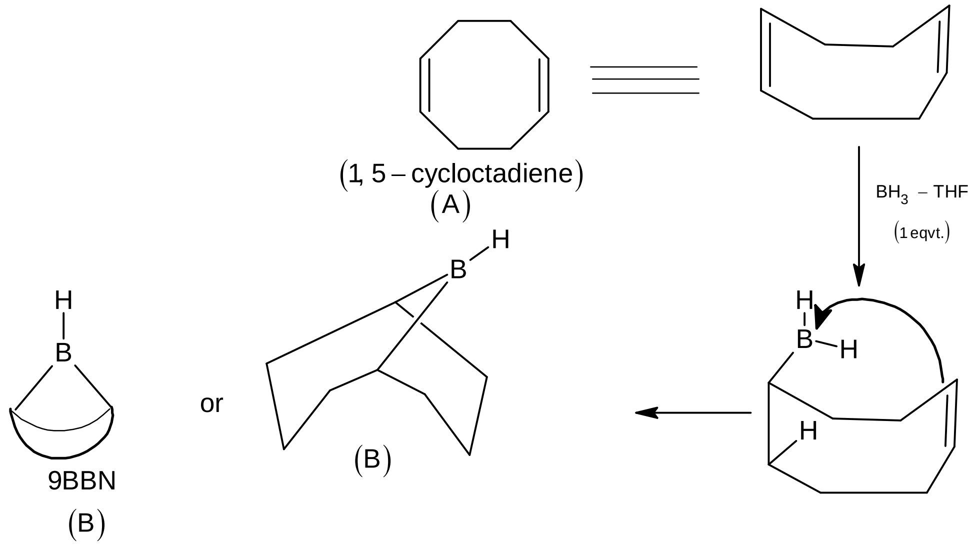
$$r = \frac{k_2 \times k_f[A]}{(k_b + k_2)}$$

So, $k = \frac{k_2 \times k_f}{(k_b + k_2)}$

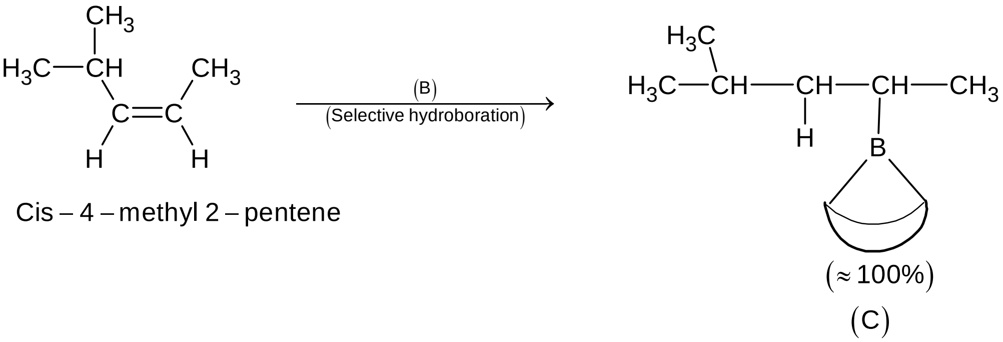
$$k = \frac{2 \times 0.1}{0.4 + 0.1} = \frac{0.2}{0.5} = 0.40 \text{ sec}^{-1}$$

33. 00002.50

Sol.


(1, 5 – cycloctadiene)
(A)
BH₃ – THF
(1 eqvt.)
H
B
H
B
H
H
H
or
(B)
9BBN
(B)

(9BBN = 9-Borabicyclo[3.3.1]nonane.)


CH3
H3C—CH
CH3
C=C
H
H
Cis – 4 – methyl 2 – pentene
(B)
(Selective hydroboration)
H3C
H3C—CH—CH—CH—CH3
H
B
(≈ 100%)
(C)

So, x = 2, y = 2, z = 0, m = 2

So, $\frac{xy+1}{(m+z)} = 2.50$

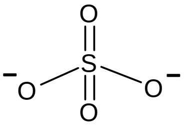
34. 00002.50

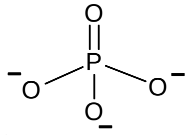
Sol. X = I_4O_9 $\underbrace{I(OIO_2)_3}_{\text{unionised form}} \longrightarrow \underbrace{I^{3+} + IO_3^-}_{\text{Ionised form}}$

So, m = 23, n = 8 and p = 3

35. 00003.00

Sol.





Number of resonating structure of $SO_4^{2-} = 6$

Number of plane of symmetry in $SO_4^{2-} = 6$

Number of resonating structure of $PO_4^{3-} = 4$

So, $\frac{6+6}{4} = 3$

36. 00010.40

Sol. $Fe_2S_3 + 5O_2 \longrightarrow 2FeSO_4 + SO_2$

So, equivalent weight of Fe_2S_3 = $= \frac{208}{20} = 10.40$ g

Mathematics PART – III

SECTION – A

37. D

Sol. $|z^3 - z + 2|^2 = 16x^3 - 4x^2 - 16x + 8$, where $y^2 = 1 - x^2$, $x \in [-1, 1]$

So, max is $\sqrt{13}$

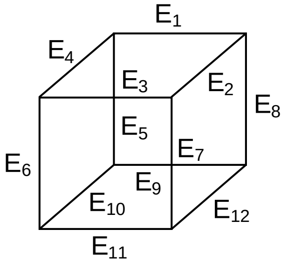
38. B

Sol. Let we can select two edges, from each vertex

$= {}^3C_2 \times 8 = 24$

From each parallel edges = ${}^4C_2 \times 3 = 18$

Total = 42



39. C

Sol. $$1 + \frac{p}{q} = \sum_{i=0}^{1000} \frac{{}^{1000}C_i}{{}^{2020}C_i} = \frac{1}{{}^{2020}C_{1000}} \sum_{i=0}^{1000} {}^{2020-i}C_{1020}$$

$$1 + \frac{p}{q} = \frac{2021}{1021} \Rightarrow \frac{p}{q} = \frac{1000}{1021}$$

40. C

Sol. $$I = \int_0^{\pi/4} \frac{(\sec^2 x - 1)}{(\tan x - x)^2 + 3(\tan x - x) + 2} dx \text{ . Let } \tan x - x = t \Rightarrow I = \int_0^{1-\frac{\pi}{4}} \frac{dt}{t^2 + 3t + 2} dx = \log_e\left(\frac{16 - 2\pi}{12 - \pi}\right)$$

41. B, C

Sol. $$\left[\vec{p}\ \vec{q}\ \vec{r}\right]^2 = \begin{vmatrix} \vec{p}\cdot\vec{p} & \vec{p}\cdot\vec{q} & \vec{p}\cdot\vec{r} \\ \vec{q}.\vec{p} & \vec{q}.\vec{q} & \vec{q}.\vec{r} \\ \vec{r}\cdot\vec{p} & \vec{r}.\vec{q} & \vec{r}.\vec{r} \end{vmatrix} = 9 \text{, volume = } \frac{1}{2} \text{ unit}^3\text{. Base area = } \frac{1}{2}|\vec{p} \times \vec{q}|, |\vec{p} \times \vec{q}|^2 = |\vec{p}|^2 |\vec{q}|^2 - (p \cdot q)^2$$

42. B, C

Sol. Region traced by S is regular hexagon of side length 1 unit

43. A, B, D

Sol. Clearly $A_5 = 1$ with only possibility 01010 and $A_6 = 2$, with 011010 and 010110 only possible

Now, we have recursive function $A_n = A_{n-2} + A_{n-3}$ as 0 followed by either 10 or 110

44. A, D

Sol. If red balls is more than white balls, number ways = ${}^{13}C_3 \times {}^6C_3$

Number of ways such that white balls in exactly three boxes = ${}^4C_3 \times 3! \times {}^{20}C_3 \times {}^4C_1$

45. A, D

Sol. $$\sum_{n=0}^{\infty} \frac{a_n b_n}{7^n} = \frac{1}{2} \text{Im}\left(\sum_{n=0}^{\infty}\left(\frac{3+4i}{7}\right)^n\right); \sum_{n=0}^{\infty} \frac{a_n^2 - b_n^2}{7^n} = \text{Re}\left(\sum_{n=0}^{\infty}\left(\frac{3+4i}{7}\right)^n\right)$$

46. A, B, C

Sol. $\Sigma\alpha^3 - 5\Sigma\alpha^2 + 8\Sigma\alpha = 39$; $S_3 - 5S_2 + 8S_1 = 39$, as $S_0 = 3$

So $S_3 = 5S_2 - 8S_1 + 13S_0$ and $S_4 = 5S_3 - 8S_2 + 13S_1$

47. A, B, C

Sol. The possible of roots can be either 2, 2, 2, 2ω, $2\omega^2$ or 2, 2ω, $2\omega^2$, 2ω, $2\omega^2$

48. A, D

Sol. Number of isosceles triangle are 30

Number of equilateral triangles whose at least two of the vertices belongs to set S = 66

SECTION – C

49. 00011.11

Sol. Let $N = \sum_{a=1}^{\infty}\sum_{b=1}^{\infty}\sum_{c=1}^{\infty}\frac{ab(3a+c)}{4^{a+b+c}(a+b)(b+c)(c+a)} \Rightarrow 6N = 3\sum_{a=1}^{\infty}\sum_{b=1}^{\infty}\sum_{c=1}^{\infty}\frac{1}{4^{a+b+c}}$

$$N = \frac{1}{2}\left(\sum_{a=1}^{\infty}\frac{1}{4^a}\right)^3 = \frac{1}{54} \Rightarrow 600N = \frac{100}{9} = 11.11$$

50. 00002.83

Sol. Let assume $a \ge b \ge c$; $(|a-b| + |b-c| + |c-a|)^2 \le 4(a-c)^2 \le 8 \Rightarrow |a-b| + |b-c| + |c-a| \le 2\sqrt{2}$

51. 00036.00

Sol. $\left(z^{1^2} + z^{2^2} + z^{3^2} + \ldots.. + z^{12^2}\right)\left(\frac{1}{z^{1^2}} + \frac{1}{z^{2^2}} + \frac{1}{z^{3^2}} \ldots.. + \frac{1}{z^{12^2}}\right) = 36$

52. 00002.00

Sol. The area is 2 unit^2

53. 00072.00

Sol. Let f(x) – 12 = 0, has roots 1, 5, 6 with leading coefficients –2 as f(2) – 12 – 24 = –2(1)(–3) (–4)

So, f(x) = –2(x – 1)(x – 5)(x – 6) + 12 $\Rightarrow$ |f(0)| = 72

Similarly for f(x) – 12 = 0 with roots 2, 3 and 7

54. 00010.29

Sol. $\prod_{r=3}^{n}\frac{(r^3+3r)^2}{r^6-64} = \prod_{r=3}^{n}\frac{r}{r-2}\prod_{r=3}^{n}\frac{r}{r+2}\prod_{r=3}^{n}\frac{r^2+3}{(r+1)^2+3}\prod_{r=3}^{n}\frac{r^2+3}{(r-1)^2+3}$

So, $P(n) = \frac{n(n-1)}{2}\cdot\frac{12}{(n+1)(n+2)}\cdot\frac{12}{(n+1)^2+3}\cdot\frac{n^2+3}{7}$

$$\lim_{n\to\infty} P(n) = \frac{72}{7}$$

FIITJEE

ALL INDIA TEST SERIES

OPEN TEST

JEE (Advanced)-2020

PAPER – 2

TEST DATE: 13-09-2020

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section-A (01 – 08, 19 – 26, 37 – 44)*** *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–1** In all other cases.*

   Section-A (09 – 12, 27 – 30, 45 – 48) *contains 6 List-Match sets with 12 questions (each set has 2 questions). Each question has 4 statements in LIST-I & 4, 5 or 6 statements in LIST-II. The codes for Lists have choices (A), (B), (C), (D) out of which only one is correct.*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

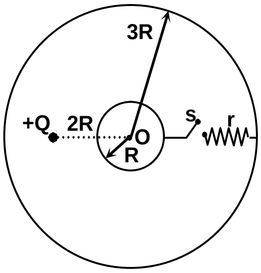
PART – I

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

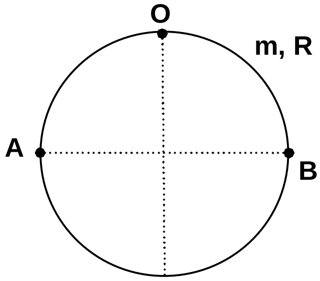
1. A soap bubble of radius ‘r’ and wall thickness ‘h’ is made in vacuum by blowing an ideal diatomic gas in it. The surface tension of the soap solution is ‘σ’ and density of the soap solution is ‘ρ’. Assume that the heat capacity of the soap film is much greater than that of the gas in the bubble. Then choose the correct option(s). (R = ideal gas constant)
   (A) The molar heat capacity of the gas in the bubble is 4R.
   (B) The molar heat capacity of the gas in the bubble is 3R.
   (C) The time period of small radial oscillations of the soap film is $2\pi\sqrt{\dfrac{\rho h r^2}{8\sigma}}$
   (D) The time period of small radial oscillations of the soap film is $2\pi\sqrt{\dfrac{\rho h r^2}{4\sigma}}$

2. Two uncharged thin concentric spherical conducting shells ‘A’ and ‘B’ of radii R and 3R are connected through a resistance ‘r’ and switch ‘S’ initially opened as shown in the figure. A positive point charge ‘Q’ is fixed at a distance 2R from the centre of the shells. At t = 0, the switch ‘S’ is closed till the steady state is reached. Then choose the correct option(s).



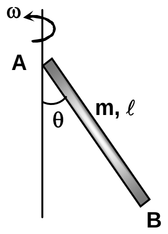
   (A) The total heat dissipated in the resistor ‘r’ is $\dfrac{Q^2}{96\pi\varepsilon_0 R}$
   (B) The total heat dissipated in the resistor ‘r’ is $\dfrac{Q^2}{192\pi\varepsilon_0 R}$
   (C) The charge on the outer surface of shell ‘A’ after steady state reached is $-\dfrac{Q}{4}$.
   (D) The charge on the outer surface of shell ‘B’ after steady state reached is +Q.

3. A uniform circular ring of mass ‘m’ and radius ‘R’ is hinged at its top point ‘O’ and suspended in a vertical plane so that it can freely rotate about a horizontal axis passing through the hinge ‘O’ as shown in the figure. The bead ‘A’ is rigidly attached to the ring and the bead ‘B’ can slide without friction on the ring. The mass of each bead is ‘m’. The system is released from rest from the initial position shown in the figure. Then choose the correct option(s), immediately after the system is released from rest. (Take g = 10 m/s^2)



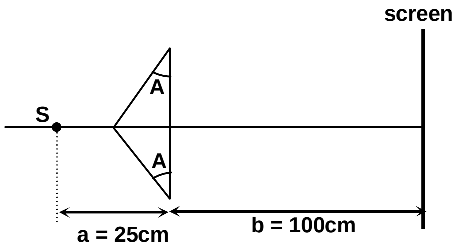
   (A) The acceleration of bead ‘A’ is $2\sqrt{2}$ m/s^2.
   (B) The acceleration of bead ‘A’ is 2 m/s^2.
   (C) The acceleration of bead ‘B’ is 2 m/s^2.
   (D) The acceleration of bead ‘B’ is $2\sqrt{26}$ m/s^2.

4. A thin uniform rod AB of mass m = 1kg and length ℓ = 1m is hinged at end 'A'. The rod makes an angle $\theta = 53°$ with the vertical axis and it is rotating with a constant angular velocity 'ω' about the vertical axis passing through end 'A' as shown in the figure. Then choose the correct option(s).



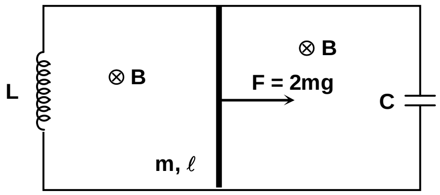
(A) The angular velocity 'ω' must be 5 rad/s.
(B) The angular velocity 'ω' must be 10 rad/s.
(C) The net hinge reaction on the rod at end 'A' is $10\sqrt{2}$ N.
(D) The net hinge reaction on the rod at end 'A' is 10 N.

5. Consider an arrangement of a thin biprism and screen as shown in the figure. The refraction angle of the biprism is A = 4° and the refractive index of its material is $\mu = 1.5$. The wavelength of the monochromatic light emitted by the source 'S' is λ = 6000 Å. Then choose the correct option(s).



(A) The fringe width of the interference pattern obtained on the screen is 21.5 μm.
(B) The fringe width of the interference pattern obtained on the screen is 43 μm.
(C) If the source 'S' is located at large distance from the biprism then the fringe width obtained on the screen will be 8.6 μm.
(D) If the source 'S' is located at large distance from the biprism then the fringe width obtained on the screen will be 17.2 μm.

6. A conducting rod of mass 'm' and length 'ℓ' is placed on a pair of smooth horizontal conducting parallel rails connected at one end by an inductor of inductance L and by a capacitor of capacitance 'C' at the other end as shown in the figure. A uniform vertical magnetic field 'B' exists in the region perpendicular to the plane of rails. The conductor starts from rest at t = 0 from the left end of the rails due to constant external horizontal force F = 2mg applied to it. Then choose the correct option(s). (Take $CB^2\ell^2 = m$)



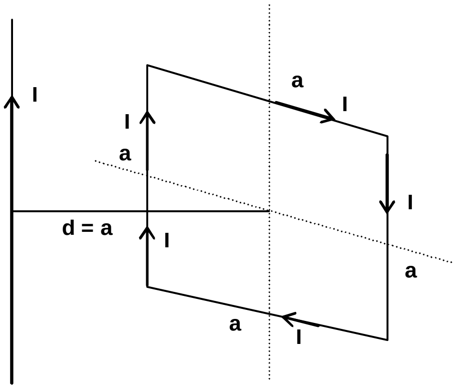
(A) The maximum horizontal displacement of the rod is $\frac{8mgL}{B^2\ell^2}$

(B) The maximum horizontal displacement of the rod is $\frac{4mgL}{B^2\ell^2}$

(C) The angular frequency of the oscillations of the rod is $\frac{B\ell}{\sqrt{mL}}$

(D) The angular frequency of the oscillations of the rod is $\frac{B\ell}{\sqrt{2mL}}$

7. A square loop of side 'a' and carrying current 'I' is placed at a distance d = a from an infinitely long straight wire carrying the same current 'I' as shown in the figure. The perpendicular bisector plane of the square loop contains the long straight current carrying wire. Then choose the correct options(s).



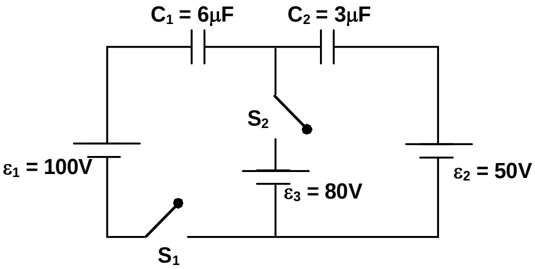
(A) The magnitude of force acting on the square loop due to long current carrying wire is $\frac{2\mu_0 I^2}{5\pi}$

(B) The magnitude of force acting on the square loop due to long current carrying wire is $\frac{\mu_0 I^2}{5\pi}$

(C) The torque experienced by the square loop due to long current carrying wire is $\frac{2\mu_0 I^2 a}{5\pi}$

(D) The torque experienced by the square loop due to long current carrying wire is $\frac{\mu_0 I^2 a}{5\pi}$

8. In the circuit as shown in the adjoining figure the switch S_1 is closed at t = 0. After steady state is reached, the switch S_2 is also closed for a long time. Then choose the correct option(s).



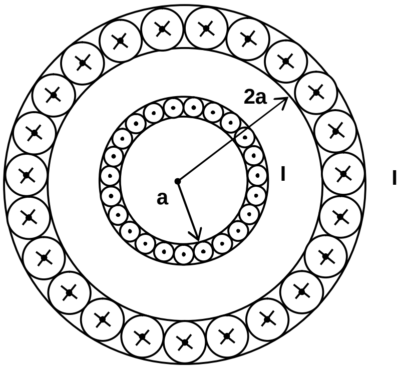
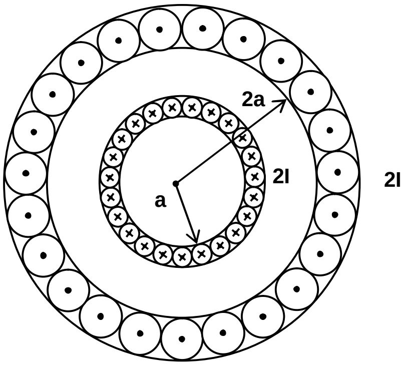
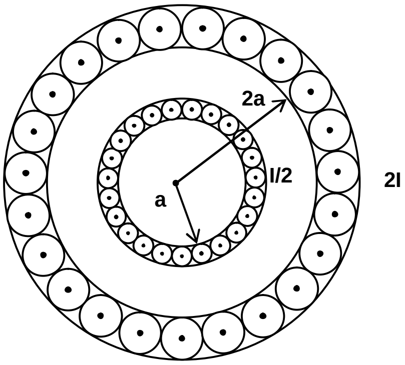
(A) The heat dissipated in the circuit after the switch 'S_2' is closed will be 100 μJ.
(B) The heat dissipated in the circuit after the switch 'S_2' is closed will be 50 μJ.
(C) The charge flown through the battery ε_1 after closing the switch 'S_2' is 20 μC.
(D) The charge flown through the battery ε_2 after closing the switch 'S_2' is 10 μC.

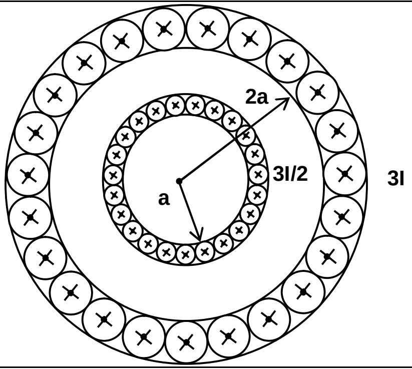
(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

Two long current carrying thin walled coaxial cylinders are depicted in List-I and List-II gives the magnitude of magnetic pressure exerted on the wall of the cylinders.

List– I		List- II	
(I)		(P)	$\frac{\mu_0 I^2}{32\pi^2 a^2}$
(II)		(Q)	$\frac{\mu_0 I^2}{8\pi^2 a^2}$
(III)		(R)	$\frac{3\mu_0 I^2}{16\pi^2 a^2}$

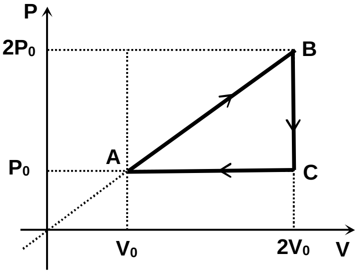
(IV)		(S)	$\frac{9\mu_0 I^2}{32\pi^2 a^2}$
		(T)	$\frac{\mu_0 I^2}{2\pi^2 a^2}$
		(U)	$\frac{9\mu_0 I^2}{16\pi^2 a^2}$

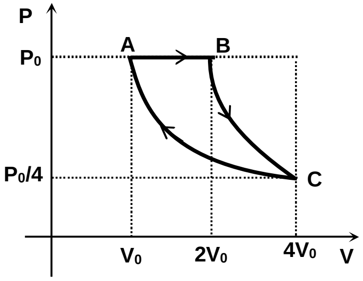
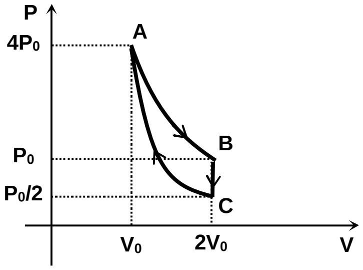
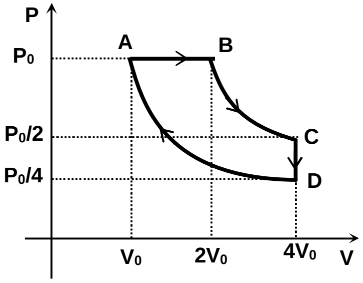
9. Find the correct match for the magnetic pressure exerted on the wall of each inner cylinder.
   (A) (I) → (Q), (II) → (T), (III) → (P), (IV) → (S)
   (B) (I) → (P), (II) → (T), (III) → (S), (IV) → (R)
   (C) (I) → (Q), (II) → (T), (III) → (R), (IV) → (S)
   (D) (I) → (P), (II) → (S), (III) → (R), (IV) → (Q)

10. Find the correct match for the magnetic pressure exerted on the wall of each outer cylinder.
   (A) (I) → (P), (II) → (Q), (III) → (T), (IV) → (S)
   (B) (I) → (Q), (II) → (S), (III) → (R), (IV) → (U)
   (C) (I) → (P), (II) → (Q), (III) → (R), (IV) → (U)
   (D) (I) → (S), (II) → (T), (III) → (R), (IV) → (P)

Answer the following by appropriately matching the list based on the information given in the paragraph.

One mole of an ideal gas is taken through four different cyclic processes as depicted in the List-I and List-II gives the values of total work done and total heat absorbed by the gas during four different cyclic processes.

List– I		List- II	
(I)	 **monoatomic gas is taken**	(P)	$\frac{P_0V_0}{2}$

(II)	 P A B P_0 $P_0/4$ C V_0 $2V_0$ $4V_0$ V **monoatomic gas is taken** (For the process BC, PV^2 = constant and process CA is an isothermal process)	(Q)	P_0V_0
(III)	 P A $4P_0$ B P_0 $P_0/2$ C V_0 $2V_0$ V **Diatomic gas is taken** (For the process AB, PV^2 = constant and for the process CA, PV^3 = constant)	(R)	$2P_0V_0(1 - \ell n2)$
(IV)	 P A B P_0 $P_0/2$ C $P_0/4$ D V_0 $2V_0$ $4V_0$ V **Diatomic gas is taken** (Processes BC and DA are isothermal)	(S)	$\frac{5P_0V_0}{2}$
		(T)	$6P_0V_0$
		(U)	$\frac{P_0V_0}{2}(7+4\ell n2)$

11. Find the correct match for the total work done by the gas during each cyclic process.
    (A) (I) → (S), (II) → (R), (III) → (P), (IV) → (T)
    (B) (I) → (P), (II) → (R), (III) → (P), (IV) → (Q)
    (C) (I) → (P), (II) → (Q), (III) → (R), (IV) → (T)
    (D) (I) → (Q), (II) → (P), (III) → (S), (IV) → (R)

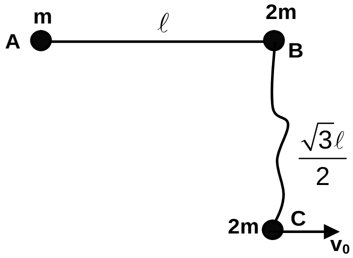
12. Find the correct match for the total heat absorbed by the gas during each cyclic process.
    (A) (I) → (Q), (II) → (S), (III) → (T), (IV) → (P)
    (B) (I) → (T), (II) → (S), (III) → (Q), (IV) → (R)
    (C) (I) → (T), (II) → (S), (III) → (T), (IV) → (U)
    (D) (I) → (P), (II) → (S), (III) → (R), (IV) → (Q)

SECTION – C
(Numerical Answer Type)

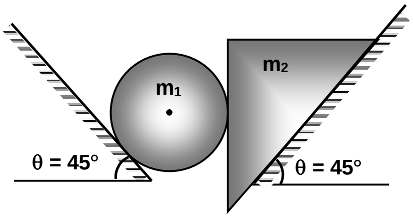
This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

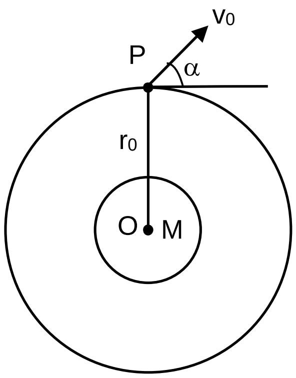
13. Three small balls A, B and C of masses m, 2m and 2m respectively are placed on a smooth horizontal surface. Balls A and B as well as B and C are connected by light inextensible strings each of equal length ℓ. The string connecting balls A and B is taut. The initial distance between the balls B and C is $\frac{\ell\sqrt{3}}{2}$ and BC is perpendicular to AB. The ball 'C' is given a horizontal velocity v_0 = 20.7 m/s parallel to AB as shown in the figure. Find the initial velocity (in m/s) of the ball 'A'.



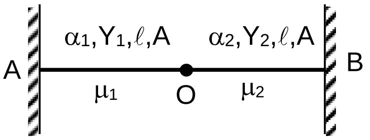
14. A cylinder and a wedge with a vertical face touching each other, move along two smooth inclined planes making the same angle θ = 45° with the horizontal as shown in the figure. The masses of the cylinder and the wedge are m_1 = 5 kg and m_2 = 3 kg respectively. There is no friction between the cylinder and the wedge. Find the normal force (in Newton) acting between the cylinder and the wedge. (Take g = 10 m/s^2)



15. A satellite is projected into space from a point 'P' at a distance 'r_0' from the centre of the earth with an initial velocity $v_0 = \sqrt{\frac{GM}{r_0}}$ at an angle α = 37° with the horizontal at point 'P' as shown in the figure. It is found that the satellite is propelled into an elliptical orbit. Find the eccentricity of the elliptical orbit.



16. Two wires of same length ℓ = 1 m and same cross-sectional area A = 10 mm^2 are welded together and their ends are rigidly clamped between two walls as shown in the figure. Given
$\alpha_1 = 2 \times 10^{-5}\ C^{-1}$, $Y_1 = 1 \times 10^{10}$ N/m^2, μ_1 = 0.4 kg/m
$\alpha_2 = 1 \times 10^{-5}\ C^{-1}$, $Y_2 = 2 \times 10^{10}$ N/m^2, μ_2 = 0.1 kg/m
The tension in the wires is produced by reducing the temperature of system by 20°C. Find the first overtone frequency (in Hz) of transverse vibration of the system with joint 'O' as a node.



17. A metallic surface is illuminated alternatively with electromagnetic radiations of wavelengths 4500 A^0 and 6000 A^0. It is observed that the maximum speeds of the photoelectrons emitted under these illuminations are in the ratio 2 :1. Find the work function (in eV) of the metal. (Take hC = 1242 eV-nm)

18. The pitch of a screw gauge is 1 mm and its circular scale is divided into 100 divisions. When nothing is placed between its studs, the zero of the circular scale lies 6 divisions below the reference line. When a wire is placed between its studs, the main scale reading is 2 mm and 56th division of circular scale coincides with the reference line of the main scale. The length of wire is 8.68 cm. Find the curved surface area (in cm^2) of the wire in true significant figures.

Chemistry PART – II

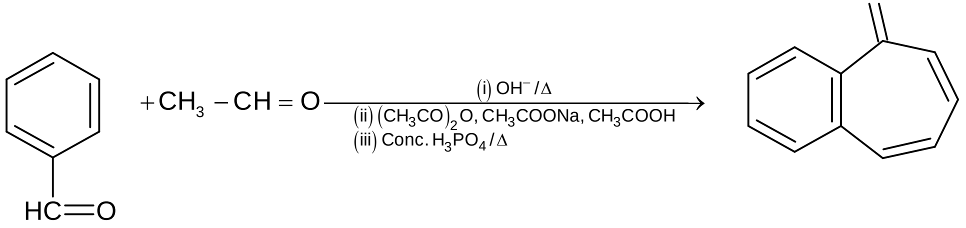
SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

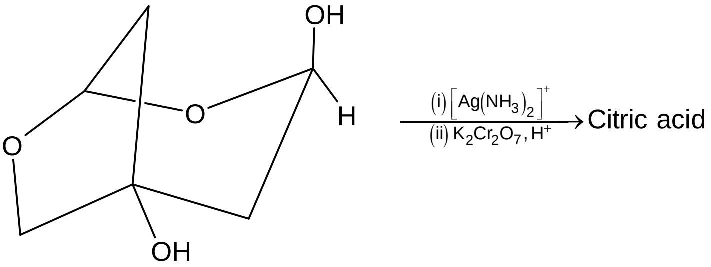
19. Identify the complex(es) in which C – O bond length is less than the C – O bond length in $Fe(CO)_5$:
    - (A) $[Cr(CO)_6]$
    - (B) $[Cr(NH_3)(CO)_5]$
    - (C) $[Cr(NH_3)_2(CO)_4]$
    - (D) $[Cr(NH_3)_3(CO)_3]$

20. Identify the reaction(s) with their correct major product?

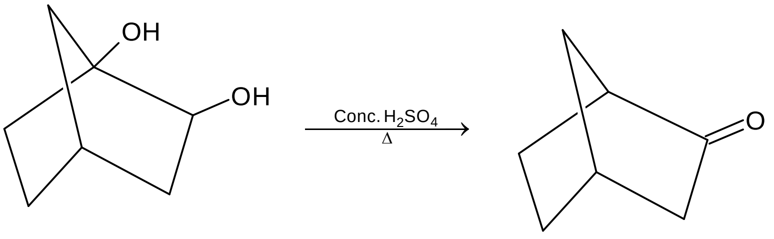
(A)


HC═O
+CH₃ – CH = O
(i) OH⁻/Δ
(ii) (CH₃CO)₂O, CH₃COONa, CH₃COOH
(iii) Conc. H₃PO₄/Δ
O

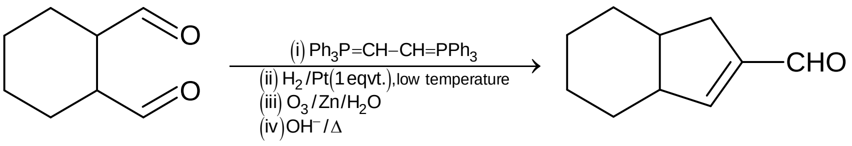
(B)


OH
O
O
H
OH
(i) [Ag(NH₃)₂]⁺
(ii) K₂Cr₂O₇, H⁺
Citric acid

(C)


OH
OH
Conc. H₂SO₄
Δ
O

(D)


O
O
(i) Ph₃P=CH–CH=PPh₃
(ii) H₂/Pt(1 eqvt.),low temperature
(iii) O₃/Zn/H₂O
(iv) OH⁻/Δ
CHO

21. ACl_3 is an unstable compound and gradually changing into A_2O_5 by its reaction with atmospheric oxygen, according to the following partial reaction:

$2ACl_3 \longrightarrow A_2O_5$

The above reaction follows second order kinetics. The reaction is started by taking 1 mole of ACl_3 in a container of volume 1 L and allowed to stand for some time. After 10 min, the reaction mixture requires 250 mL of 0.8 M acidified $KMnO_4$ solution; where ACl_3 is oxidized into AO_3^- and assume A_2O_5 do not react with $KMnO_4$. Now, choose the correct statement(s) of the following:

(A) Half-life time of the reaction is 10 minutes.
(B) Rate constant of the reaction is 0.05 $\ell mol^{-1} min^{-1}$.
(C) Rate constant of the reaction is 0.10 $\ell mol^{-1} min^{-1}$.
(D) After 20 mins from the start, 33.33% of ACl_3 is left unreacted.

22. 100 ml of 0.1 M aqueous solution of sodium phosphate is titrated using 0.1 M HCl. Now, choose the correct statement(s) of the following:

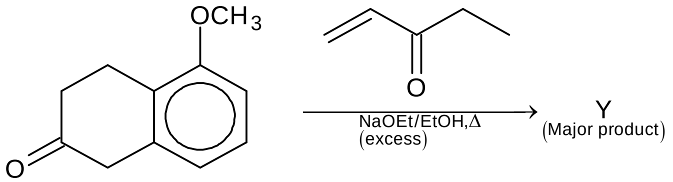
(For H_3PO_4 : $K_{a_1} = 10^{-3}; K_{a_2} = 10^{-8}$ and $K_{a_3} = 10^{-13}$ at 25^oC)

(A) The pH of the solution is 13 at 25°C, when the titre value is 50 mL.
(B) pH of the solution is 10.5 at 25°C, when the titre value is 100 mL.
(C) pH of the solution is 8 at 25°C, when the titre value is 150 mL.
(D) pH of the solution is 3 at 25°C, when the titre value is 200 mL.

23. Choose the correct statement(s) among the following:

(A) When ideal gases are mixed isothermally, the entropy of mixing is always positive.
(B) At equilibrium state, chemical potential of a species is the same in all the phases of the system.
(C) A reversible adiabatic process is always isoentropic.
(D) When a gas is allowed to expand, the maximum work is obtained when the process is carried out irreversibly.

24.

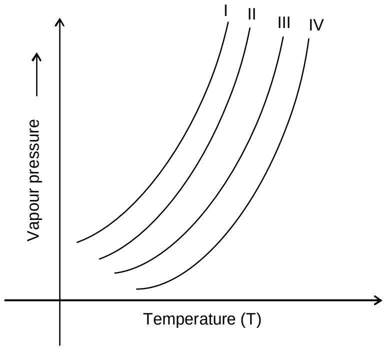


(X)

Identify the correct statement (s) about (X) and (Y)

(A) Both (X) and (Y) gives +ve Bromine water test.
(B) Both (X) and (Y) gives positive 2,4-dinitro phenyl hydrazine (D.N.P.) test.
(C) Degree of unsaturation of (Y) is 8.
(D) (Y) on heating with triphenyl phosphine ethylidene gives a product which also gives Bromine water test.

25. The following diagram shows the vapour pressure curves for CH_3F, CH_3OH, CH_3COOH and CH_2O.



Now choose the correct match from the options given below:
(A) III = CH_3OH
(B) II = CH_3F
(C) I = CH_2O
(D) IV = CH_3COOH

26. Identify the correct statement(s) of the following:
(A) The mineral kionite ($Ca_2Cu_2Si_3O_{10}.2H_2O$) is a chain silicate.
(B) HF is used as etching agent in glass industry.
(C) In the titration of Fe^{3+} with Sn^{2+}, KCNS can be used as a suitable indicator.
(D) On reaction of red lead with conc. HCl, a golden yellow gas is evolved.

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

Some statement(s) are given in List-I and some thermodynamic properties in List-II:

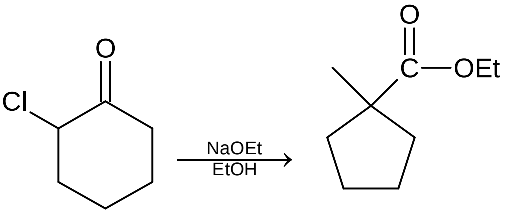
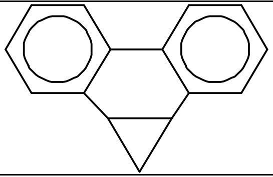
LIST–I		LIST–II	
(I)	A process in which heat change is positive at constant volume (V) and constant pressure (P)	(P)	W = 0
(II)	An isobaric process in which ΔU is negative and $\Delta S = 0$	(Q)	$\Delta U = 0$
(III)	An adiabatic process in which ΔS is positive and work done is zero.	(R)	Process must be reversible
(IV)	An isobaric, iso-entropic process in which ΔH is negative.	(S)	ΔV must be equal to 0 for spontaneity
		(T)	$\Delta H = 0$
		(U)	The process must be spontaneous

27. Choose the INCORRECT match from the options given below:
(A) (I), (U)
(B) (II), (S)
(C) (III), (R)
(D) All are incorrect

28. Identify the correct matching from the following options:
(A) (II), (U)
(B) (III), (U)
(C) (I), (U)
(D) (IV), (T)

Answer the following by appropriately matching the list based on the information given in the paragraph.

Some reactions/processes are given in List-I and some reaction intermediates (which can be formed in the reaction given in List - I) are given in List-II:

LIST–I		LIST–II	
(I)	To determine the sequence of amino acids in a polypeptide chain by using 2,4-Dinitrofluorobenzene	(P)	Carbocation
(II)		(Q)	Carbanion
(III)	Cyclohexanone oxime $\xrightarrow{AlCl_3}$ Caprolactam	(R)	Free radical
(IV)	 $\xrightarrow{h\nu}$ Phenanthrene	(S)	Benzyne
		(T)	Nitrene
		(U)	Carbene

29. Choose the correct match from the options given below:
(A) (I), (S)
(B) (IV), (U)
(C) (III), (Q)
(D) (II), (P)

30. Choose the INCORRECT match from the options given below:
(A) (IV), (R)
(B) (II), (Q)
(C) (III), (P)
(D) All are correct

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

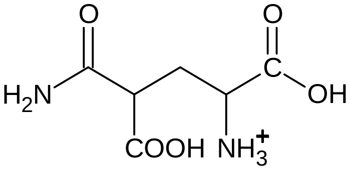
31. Half the number of compounds (given below) which reacts with PCl_5 to give $POCl_3$; is:
Sulphuric acid, orthophosphoric acid, sulphurous acid, ethanoic anhydride, benzene sulphonic acid, H_2O, P_4O_6, P_4O_{10}, SO_2, SO_3, ethoxy ethane, CO_2 Palmitic acid, N_2.

32. To an aqueous solution of weak acid (HA), 20 mL NaOH solution is added and connected to a reference Ag|AgCl|Cl⁻ (0.1 M) electrode. EMF of the cell was found to be 0.56 V. To this solution of HA, 30 mL of NaOH from same stock solution was added further and new EMF was found to be 0.62 V. Determine the dissociation constant (pK_a) of the weak acid (HA) [Take partial pressure of H_2 = 1 bar and temperature of reaction is 298 K, $\log_{10} 2 = 0.3, \frac{2.303RT}{F} = 0.06$]

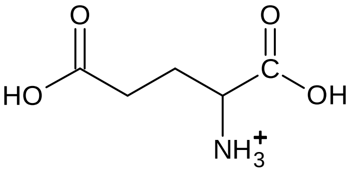
$\left(E^{o}_{Cl^-|AgCl/Ag} = 0.20\ V\right)$

33. Some amino acids are given below:

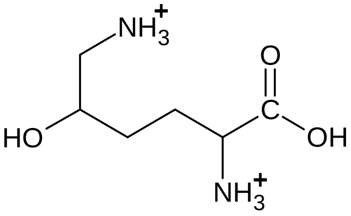
(I)



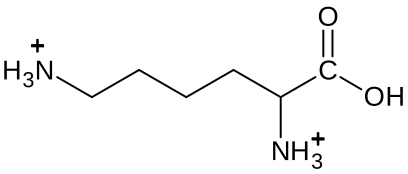
(II)



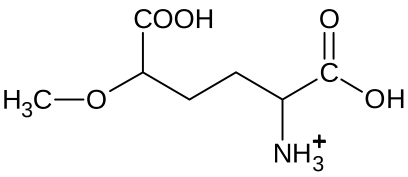
(III)



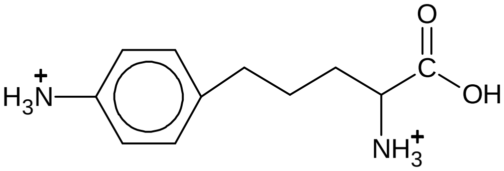
(IV)



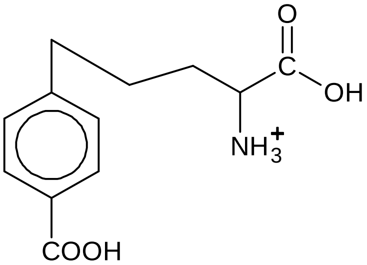
(V)



(VI)



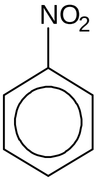
(VII)



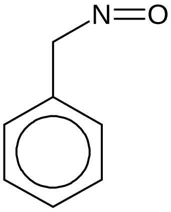
Let, the number of amino acids which exists as cation at pH = 7 be ‘x’ and the number of amino acids which exists as anion at pH = 7 be ‘y’, then find the value of $\frac{x}{y}$.

34. Consider the following compounds:

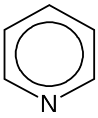
(I)



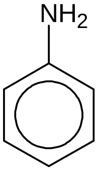
(II)



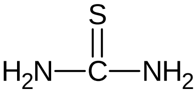
(III)



(IV)

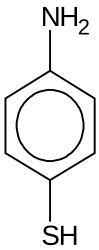


(V)

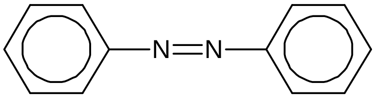


$H_2N-\overset{\overset{\displaystyle S}{\|}}{C}-NH_2$

(VI)



(VII)

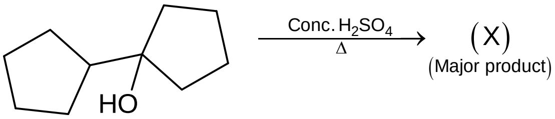


Let, the compound(s) which cannot be Kjeldahlised be ‘x’
the compound(s) which gives blue colour in Lassaigne’s test of nitrogen be y and
the compound(s) which gives red colour in Lassaigne’s test of nitrogen be z.

So, the value of $\left(\frac{x+y}{z}\right)$ will be:

35. The chromium in a 1.0 g sample of chromite ($FeCr_2O_4$) was oxidized to Cr^{+6} state by fusion with Na_2O_2. The fused mixture was treated with excess of water and boiled to destroy the excess of peroxide. After acidification, the sample was treated with 50 mL of 0.16 M $FeSO_4$ solution. 3.67 mL of 0.05 M $Cr_2O_7^{2-}$ solution was required to oxidize the Fe^{2+} ion left unreacted. Determine the mass % of chromite in the original sample. [Cr = 52, Fe = 56]

36.



Let, the degree of unsaturation in ‘X’ be ‘x’ and the number of peaks in the energy profile for the whole course of the above reaction be ‘y’, then find the value of $\frac{2x}{y}$.

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. The roots α, β of the quadratic equation $ax^2 + bx + c = 0$, $a \neq 0$ lie in the interval [0, 1], then?

(A) the maximum value of $\frac{(a-b)(2a-b)}{a(a-b+c)}$ is 3

(B) the minimum value of $\frac{(a-b)(2a-b)}{a(a-b+c)}$ is 2

(C) if $\frac{(a-b)(2a-b)}{a(a-b+c)}$ is at its maximum value, then $\alpha^2 + \beta^2$ can be 2

(D) if $\frac{(a-b)(2a-b)}{a(a-b+c)}$ is at its maximum value, then $\alpha^2 + \beta^2$ can be 1

38. Let a_1, a_2, a_3, ….., a_n be a sequence of real numbers which satisfies the relation $a_{n+1} = \sqrt{a_n^2 + 1}$ $\forall$ $n \in N$. Suppose that there exists a positive integer n_0 such that $a_{2n_0} = 3a_{n_0}$, then?

(A) $\lim\limits_{n\to\infty} \frac{2a_n}{\sqrt{n+2020}} = 2$

(B) if $T_r = \sum\limits_{n=1}^{n=r} a_n^2$, the $\min(T_1, T_2, \ldots, T_r) = -1$

(C) $\lim\limits_{n\to\infty} (a_{n+1} + a_n) n^{-\frac{1}{2}} = 2$

(D) $\left[\frac{1}{2}\sum\limits_{n=1}^{49}\sqrt{\frac{8}{8a_n^2+7}}\right] = 6$, (where [.] denotes the greatest integer function)

39. If exactly one number from the set {1, 2, 3, ….., 8} is assigned to the each vertex of a cube $A_1A_2A_3$ ….. A_8, then?

(A) number of ways of assigning the numbers such that the sum of any two numbers with a common edge is always odd is $2 \times (4!)^2$

(B) number of ways of assigning the numbers such that the sum of any two numbers with a common body diagonal is always even is $6 \times (4!)^2$

(C) number of ways of assigning the numbers such that the sum of any two numbers with a common edge is always even in $(4!)^2$

(D) the number of equilateral triangles formed by joining vertices of the given cube is equal to 8

40. The lines L_1, L_2, L_3 are parallel to each other and L_2 lies between L_1 and L_3, the distance between L_1 and L_2 is 'a' unit and that between L_2 and L_3 is 'b' unit. If the area of an equilateral triangle having one vertex on each of the three given parallel lines is a function g(a, b), then?

(A) $g(1,1) = \sqrt{3}$ unit^2

(B) minimum value of g(1, b) is $\frac{\sqrt{3}}{4}$ unit^2

(C) eccentricity of the curve g(x, y) = $\sqrt{3}$ is $\frac{2\sqrt{2}}{3}$

(D) $g(2,1)=\frac{7}{\sqrt{3}}$ unit^2

41. If all the pairs (x, y) such that x, y $\in$ I and x, y satisfying the following system of inequalities, $x^2 + x + y \le 3$ and $y^2 + y + x \le 3$, then?
(A) total number of such pair of (x, y), x, y $\in$ I are 9
(B) total number of squares formed by joining such point are 14
(C) total number of such pairs of (x, y) are 17
(D) total number of squares formed by joining such point are 20

42. A bug starts from the origin O(0, 0) in the co-ordinate plane jumping from one point to another at the rate of one jump per second. It moves according to the rule that from (m, n), it jumps to either (m, n + 1) or (m + 1, n), (m, n $\in$ W), either been equally likely. Five second from the start the bug reaches (α, β), then?
(A) the number of different values that $|\alpha - \beta|$ can take is 3
(B) probability that bug reaches (α, β) if $|\alpha - \beta| = 1$, is $\frac{10}{16}$
(C) probability that bug reaches (α, β) if $|\alpha - \beta| > 1$ is $\frac{1}{8}$
(D) probability that bug reaches (α, β) if $|\alpha - \beta| > 4$ is $\frac{1}{3}$

43. Let ABC be a triangle and r, r_1, r_2, r_3 denote its in-radius and the exradii opposite to vertices A, B C respectively. If $a > r_1$, $b > r_2$ and $c > r_3$, then?
(A) $\angle$B is obtuse angle
(B) $\angle$A is acute angle
(C) 3r > s, where s is semi-perimeter
(D) 3r < s, where s is semi-perimeter

44. Let S be the curve $y = x^2$ and S′ be the mirror image of S with respect to the line passing through the points A(0, –10) and B(2, 0), then?
(A) if C is a point on S′, then the minimum value of area of triangle ABC is $\frac{15}{2}$ unit^2
(B) shortest distance between S and S′ is $\frac{15}{2\sqrt{26}}$ unit
(C) if D is a point on S′, then the minimum area of triangle ABD is 0 unit^2
(D) if C (α, β) is point on S′ such that the area of the ΔABC is minimum then the value of $(\alpha - 2)^2 + \beta^2$ is $\frac{629}{16}$ unit^2

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

MM-I. Let $S_1 : x^2 - y^2 - 4 = 0$, $S_2 : y^2 - 4x = 0$, $S_3 : x^2 + y^2 - 4 = 0$ and $S_4 : \frac{x^2}{4} + \frac{y^2}{1} - 1 = 0$ are four given conics and A, B, C, D are set of all the tangents of S_1, S_2, S_3 and S_4 respectively.
List-I contains the sets A, B, C and D. List-II contains information regarding the elements in these sets

LIST-I		LIST-II	
(I)	A	(P)	$4x - 2y + 1 = 0$
(II)	B	(Q)	$2x - y + 2\sqrt{3} = 0$
(III)	C	(R)	$x - y - \sqrt{5} = 0$
(IV)	D	(S)	$2x - y + 2\sqrt{5} = 0$
		(T)	$x - 2 = 0$
		(U)	$x + 2 = 0$

45. Which of the following is the only CORRECT combination?
    (A) (I), (P), (T)
    (B) (III), (R), (S)
    (C) (I), (Q), (U)
    (D) (II), (P), (T)

46. Which of the following is the only CORRECT combination?
    (A) (IV), (P), (T), (U)
    (B) (I), (Q), (T), (U)
    (C) (II), (P), (S)
    (D) (IV), (R), (S)

Answer the following by appropriately matching the list based on the information given in the paragraph.

MM-II. Let $f(x)=\frac{x}{2}+\frac{\sin 2x}{4}$, $g(x)=\left(\frac{x}{2}+\frac{\sin 2x}{4}\right)e^{\sin x}$ and

$$h(x)=\begin{cases}\left(x\sin\frac{1}{x^4}\right)e^{-\frac{1}{x^2}} & ; \ x\neq 0\\ 0 & ; \ x=0\end{cases},\quad t(x)=\begin{cases}e^{-\frac{1}{x^2}} & ; \ x\neq 0\\ 0 & ; \ x=0\end{cases}$$ are four real functions.

List-I contains some functions related to functions f, g, h and t and List-II contains some information regarding functions given in List-I

LIST-I		LIST-II	
(I)	$\frac{f(x)}{g(x)}$	(P)	Limit x tends to 0 exist
(II)	$\frac{f'(x)}{g'(x)}$	(Q)	Limit x tends to 0 does not exist
(III)	$\frac{h(x)}{t(x)}$	(R)	Limit x tends to ∞ exist
(IV)	$\frac{h'(x)}{t'(x)}$	(S)	Limit x tends to ∞ does not exist
		(T)	Limit x tends to ∞ is equal 0
		(U)	Limit x tends to 0 is equal 1

47. Which of the following is the only CORRECT combination?
    - (A) (I), (P), (R)
    - (B) (II), (Q), (T)
    - (C) (III), (P), (T)
    - (D) (II), (P), (S)

48. Which of the following is the only INCORRECT combination?
    - (A) (IV), (Q), (T)
    - (B) (I), (P), (S)
    - (C) (II), (P), (T), (U)
    - (D) (IV), (P), (S)

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

49. A red ball and a green ball are randomly and independently tossed into bins numbered 1, 2, 3 ….. such that for each ball the probability that it gets tossed into bin k is 2^{-k} $\forall$ k $\in$ N. If P is the probability that the red ball is tossed into a higher numbered bin than the green ball, then 7P is?

50. Let $(a^2 + 1)(b^2 + 1)(c^2 + 1) = 9$, where a, b, c $\in$ R, then the number of integers in the range of ab + bc + ca is?

51. If $\int_a^b e^{\cos x}\left(380 - x - x^2\right)dx$ attains its maximum value for some a, b such that a ≤ b, then the maximum value of b – a is?

52. The number of continuous functions f : R → R, such that $(2f(x) + x)(6f^2(x) + 5xf(x) + x^2) = 0$, ∀ x ∈ R is equal to ?

53. If [p, q) is the exhaustive interval of values of x, satisfying the equation $\left[\frac{x^2+x-1}{x^2-x+1}\right] = \left[\frac{x-1}{x+1}\right]$, (where [.] denotes the greatest integer function), then $\left(q+p+\frac{1}{2}\right)^2$ is equal to?

54. If f(x) is a function continuous at all points except at x = 0, such that f: R – {0} → R, f(2020) = 1, f(–3) = –1, and $f(x)f(y) = 2f(xy) - f\left(\frac{2020}{x}\right)f\left(\frac{2020}{y}\right)$, ∀ x, y ∈ R – {0}, then the value of $\int_{-1}^{2019} f(x)dx$ is equal to?

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PAPER – 2

TEST DATE: 13-09-2020

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. A, C

Sol. $P = P_0 + \frac{4\sigma}{r}$

Since outside pressure, $P_0 = 0$

$P = \frac{4\sigma}{r} \Rightarrow PV^{1/3}$ = constant

Hence molar heat capacity of the gas, $C = C_V + \frac{R}{(1-x)} = \frac{5R}{2} + \frac{3R}{2}$

$\Rightarrow C = 4R$

Now, when the radius of the soap bubble is increased by dr = x(say) from equilibrium, then the net restoring force acting on the soap bubble

$F = 2 \times \frac{4\sigma}{r^2} dr 4\pi r^2 = 32\sigma\pi dr = 32\sigma\pi x$

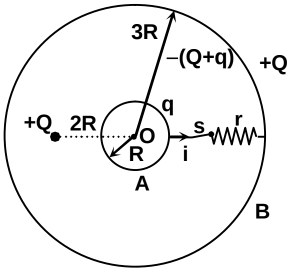
Now, $\rho 4\pi r^2 h \frac{dv}{dt} = -32\sigma\pi x$

$$\frac{d^2x}{dt^2} = -\left(\frac{8\sigma}{\rho h r^2}\right)x$$

Time period of small radial oscillations of the soap film, $T = 2\pi\sqrt{\frac{\rho h r^2}{8\sigma}}$

2. B, C, D

Sol. In steady state,



$V_A = V_B$

$$\frac{kq}{R}+\frac{kQ}{2R}-\frac{kq}{3R}=\frac{kQ}{3R}$$

$$\frac{2kq}{3R}=-\frac{kQ}{6R}$$

$$\Rightarrow q = -\frac{Q}{4}$$

At any time 't' the current through the resistor 'r' is

$$ir=\left(\frac{kq}{R}-\frac{kq}{3R}+\frac{kQ}{2R}\right)-\frac{kQ}{3R}$$

$$ir=\frac{2kq}{3R}+\frac{kQ}{6R}=\frac{k}{6R}(4q+Q)$$

$$i=\frac{k}{6Rr}(4q+Q)=\alpha(4q+Q) \qquad \left[\text{where } \alpha=\frac{k}{6Rr}\right]$$

$$-\frac{dq}{dt}=\alpha(4q+Q)\ \Rightarrow -\int_0^q\frac{dq}{(4q+Q)}=\alpha\int_0^t dt$$

$$\Rightarrow \ell n\left(\frac{4q+Q}{Q}\right)=-4\alpha t$$

$$q=\frac{Q}{4}\left[e^{-4\alpha t}-1\right]$$

$$i=-\frac{dq}{dt}=Q\alpha e^{-4\alpha t}$$

Now the total heat dissipated in the resistance 'r' is

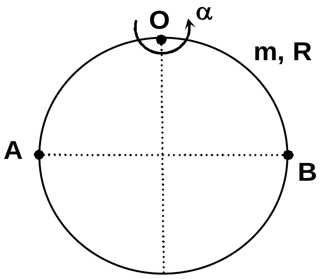
$$H=\int_0^\infty i^2rdt=Q^2\alpha^2r\int_0^\infty e^{-8\alpha t}dt=\frac{Q^2\alpha^2r}{8\alpha}$$

$$H=\frac{Q^2\alpha r}{8}=\frac{Q^2r}{8}\left(\frac{k}{6Rr}\right)=\frac{kQ^2}{48R}$$

$$H=\frac{Q^2}{192\pi\varepsilon_0R}$$

3. A, D

Sol. $\tau = I\alpha$



$mgR - NR = 4mR^2\alpha$

$mg - N = 4m\alpha R$ …(i)

$N = m\alpha R$ …(ii)

From (i) and (ii)

$mg = 5m\alpha R$

$\alpha = g/5R$

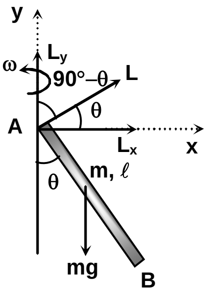
∴ acceleration of bead 'A' is

$$a_A=\alpha R\sqrt{2}=\frac{g\sqrt{2}}{5}=2\sqrt{2}\text{ m/s}^2$$

∴ acceleration of bead 'B' is $a_B=\frac{g}{5}\sqrt{26}=2\sqrt{26}\text{ m/s}^2$

Then normal force on the bead 'B' due to ring $N = m\alpha R = mg/5$

4. A, C



Sol. Total angular momentum of the rod about end 'A' is $L = \frac{m\ell^2}{3}\omega\sin\theta$

$$L_x = L\cos\theta = \frac{m\ell^2}{3}\omega\sin\theta\cos\theta$$

$$L_y = L\sin\theta = \frac{m\ell^2}{3}\omega\sin^2\theta$$

$$\vec{L} = \vec{L}_x + \vec{L}_y$$

$$\frac{d\vec{L}}{dt} = \frac{d\vec{L}_x}{dt} + \frac{d\vec{L}_y}{dt}$$

$$\frac{d\vec{L}}{dt} = \frac{d\vec{L}_x}{dt}$$

$$\vec{\tau} = \frac{d\vec{L}}{dt} = \frac{d\vec{L}_x}{dt}$$

$$mg\frac{\ell}{2}\sin\theta = L_x\omega$$

$$mg\frac{\ell}{2}\sin\theta = \frac{m\ell^2}{3}\omega^2\sin\theta\cos\theta$$

$$\omega = \sqrt{\frac{3g}{2\ell\cos\theta}} = \sqrt{\frac{3\times10\times5}{2\times1\times3}} = 5 \text{ rad/s}$$

Now let F_h and F_v are the horizontal and vertical components of hinge reaction acting on the rod at end 'A'

$$F_h = \frac{m\omega^2\ell}{2}\sin\theta = 1\times25\times\frac{1}{2}\times\frac{4}{5} = 10 \text{ N}$$

$F_V = mg = 10$ N

The net hinge reaction

$$F = \sqrt{F_h^2 + F_v^2} = 10\sqrt{2} \text{ N}$$

5. B, C

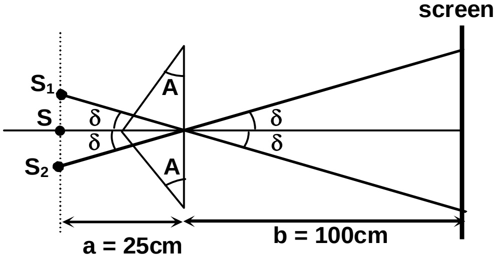
Sol. $\delta = (\mu - 1)A = (1.5 - 1)4 = 2 = 2\times\frac{\pi}{180} = \frac{\pi}{90}$ radian

The separation between two images formed is $S_1S_2 = 2a\delta$

$d = 2a\delta$

and $D = (a + b)$

$$\therefore \text{ fringe width, } \omega = \frac{\lambda D}{d} = \frac{\lambda(a+b)}{2a\delta} = \frac{6\times10^{-7}}{2\times\frac{\pi}{90}}\left(\frac{125}{25}\right) = 43\ \mu\text{m}$$



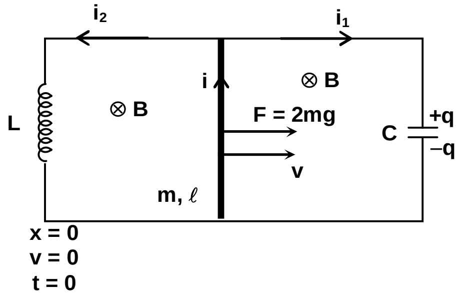
If the source is located at large distance form the biprism (a → ∞)

$\therefore$ fringe width, $\omega = \frac{\lambda}{2\delta}\left(\frac{a+b}{a}\right) = \frac{\lambda}{2\delta}\left(1+\frac{b}{a}\right) = \frac{\lambda}{2\delta}$

$$\omega = \frac{\lambda}{2\delta} = \frac{6\times10^{-7}}{2\times\frac{\pi}{90}} = 8.6\ \mu\text{m}$$

6. B, D

Sol. $\varepsilon = Bv\ell$



$q = C\varepsilon = CBv\ell$

$$i_1 = \frac{dq}{dt} = CB\ell\frac{dv}{dt} \qquad \ldots(i)$$

$$\frac{Ldi_2}{dt} = Bv\ell$$

$$\int di_2 = \left(\frac{B\ell}{L}\right)\int vdt$$

$$\int_0^{i_2} di_2 = \frac{B\ell}{L}\int_0^x dx$$

$$i_2 = \left(\frac{B\ell}{L}\right)x \qquad \ldots(ii)$$

$$m\frac{dv}{dt} = F - Bi\ell$$

$$\frac{mdv}{dt} = F - B\ell(i_1 + i_2)$$

$$\frac{mdv}{dt} = F - B\ell i_1 - B\ell i_2$$

$$m\frac{dv}{dt} = 2mg - B\ell\left(CB\ell\frac{dv}{dt}\right) - B\ell\left(\frac{B\ell}{L}\right)x$$

$$(m + CB^2\ell^2)\frac{d^2x}{dt^2} = -\frac{B^2\ell^2}{L}\left(x - \frac{2mgL}{B^2\ell^2}\right)$$

$$\frac{d^2x}{dt^2} = -\frac{B^2\ell^2}{2mL}\left(x - \frac{2mgL}{B^2\ell^2}\right) \quad [\because CB^2\ell^2 = m)$$

$\therefore$ angular frequency of SHM executed by the rod is

$$\omega = \frac{B\ell}{\sqrt{2mL}}$$

The amplitude of SHM executed by the rod is

$$A = \frac{2mgL}{B^2\ell^2}$$

The maximum horizontal displacement of the rod

$$x_{max} = 2A = \frac{4mgL}{B^2\ell^2}$$

7. A, C

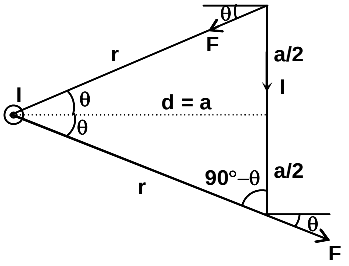
Sol. The net force acting on the square loop,

$F_0 = 2F \sin\theta$

$= 2BIa \sin\theta$

$= \dfrac{2\mu_0 I^2 a}{2\pi r}\dfrac{a}{2r}$

$F_0 = \dfrac{2\mu_0 I^2}{5\pi}$


θ
F
r
a/2
I
I
θ
d = a
θ
90°–θ
a/2
r
θ
F

The torque experienced by the square loop,

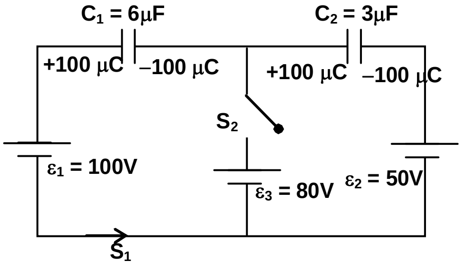
$\tau = BIa \cos\theta\, a = BIa^2 \cos\theta$

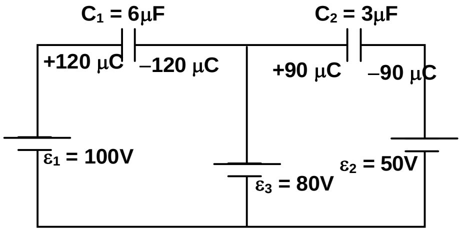
$\tau = \dfrac{\mu_0 I^2 a^2}{2\pi r}\dfrac{a}{r} = \dfrac{2\mu_0 I^2 a}{5\pi}$

$\tau = \dfrac{2\mu_0 I^2 a}{5\pi}$

8. B, C, D

Sol.


C₁ = 6μF
C₂ = 3μF
+100 μC
–100 μC
+100 μC
–100 μC
S₂
ε₁ = 100V
ε₃ = 80V
ε₂ = 50V
S₁


C₁ = 6μF
C₂ = 3μF
+120 μC
–120 μC
+90 μC
–90 μC
ε₁ = 100V
ε₃ = 80V
ε₂ = 50V

The charge flown through the battery ε_1 and ε_2 after closing the switch 'S_2',

$\Delta Q_1 = 120 - 100 = 20\ \mu C$

$\Delta Q_2 = -90 - (-100) = 10\ \mu C$

Now, $\Delta W_b = \Delta U + \Delta H$

$20 \times 10^{-6} \times 100 + 10 \times 10^{-6} \times 50 - 30 \times 10^{-6} \times 80 =$

$\dfrac{1}{2}\times 6\times 10^{-6}\times 400 + \dfrac{1}{2}\times 3\times 10^{-6}\times 900 - \dfrac{1}{2}\times 2\times 10^{-6}\times 2500 + \Delta H$

$\Rightarrow 100 \times 10^{-6} = 50 \times 10^{-6} + \Delta H$

$\Rightarrow \Delta H = 50 \times 10^{-6} = 50\ \mu J$

9. A

Sol. The magnetic pressure exerted on the wall of inner cylinder.

(I) $P_i = \dfrac{\mu_0}{2}\left(\dfrac{I}{2\pi a}\right)^2 = \dfrac{\mu_0 I^2}{8\pi^2 a^2}$

(II) $P_i = \dfrac{\mu_0}{2}\left(\dfrac{2I}{2\pi a}\right)^2 = \dfrac{\mu_0 I^2}{2\pi^2 a^2}$

(III) $P_i = \dfrac{\mu_0}{2}\left(\dfrac{I}{2\times 2\pi a}\right)^2 = \dfrac{\mu_0 I^2}{32\pi^2 a^2}$

(IV) $P_i = \dfrac{\mu_0}{2}\left(\dfrac{3I}{2\times 2\pi a}\right)^2 = \dfrac{9\mu_0 I^2}{32\pi^2 a^2}$

10. C

Sol. The magnetic pressure exerted on the wall of outer cylinder.

(I) $$P_0 = \frac{I}{4\pi a}\left(\frac{\mu_0 I}{4\pi a} - \frac{\mu_0 I}{8\pi a}\right) = \frac{\mu_0 I^2}{32\pi^2 a^2}$$

(II) $$P_0 = \frac{2I}{4\pi a}\left(\frac{\mu_0 2I}{4\pi a} - \frac{\mu_0 2I}{8\pi a}\right) = \frac{\mu_0 I^2}{8\pi^2 a^2}$$

(III) $$P_0 = \frac{2I}{4\pi a}\left(\frac{\mu_0 I}{8\pi a} + \frac{\mu_0 2I}{8\pi a}\right) = \frac{3\mu_0 I^2}{16\pi^2 a^2}$$

(IV) $$P_0 = \frac{3I}{4\pi a}\left(\frac{\mu_0 3I}{8\pi a} + \frac{\mu_0 3I}{8\pi a}\right) = \frac{9\mu_0 I^2}{16\pi^2 a^2}$$

11. B

12. C

Sol. **(For Q.11 to Q.12):**

(I) $\Delta W_{cycle} = \frac{1}{2} \times V_0 \times P_0 = \frac{P_0 V_0}{2}$

$\Delta Q_{AB} = nC\Delta T = n2R(4T_0 - T_0) = 6nRT_0 = 6P_0V_0$

$\Delta Q_{BC} = nC_V\Delta T = n\frac{3R}{2}(2T_0 - 4T_0) = -3nRT_0 = -3P_0V_0$

$\Delta Q_{CA} = nC_P\Delta T = \frac{5}{2}nR(T_0 - 2T_0) = -\frac{5}{2}nRT_0 = -\frac{5}{2}P_0V_0$

Total heat absorbed by the gas = $6P_0V_0$

(II) $\Delta Q_{AB} = nC_P\Delta T = \frac{5}{2}nR\Delta T = \frac{5}{2}P_0V_0$

$\Delta Q_{BC} = nC\Delta T = n\frac{R}{2}(T_0 - 2T_0) = -\frac{nRT_0}{2} = -\frac{P_0V_0}{2}$

$\Delta Q_{CA} = nRT_0 \ell n\left(\frac{V_0}{4V_0}\right) = -2nRT_0\ell n2 = -2P_0V_0 \ln 2$

$\Delta W_{cycle} = \frac{5P_0V_0}{2} - \frac{P_0V_0}{2} - 2P_0V_0\ell n2 = 2P_0V_0(1 - \ell n2)$

Total heat absorbed by the gas = $\frac{5P_0V_0}{2}$

(III) $\Delta Q_{AB} = nC\Delta T = n\frac{3R}{2}\left(\frac{T_0}{2} - T_0\right) = -\frac{3}{4}nRT_0 = -\frac{3}{4} \times 4P_0V_0 = -3P_0V_0$

$\Delta Q_{BC} = nC_V\Delta T = n\frac{5R}{2}\left(\frac{T_0}{4} - \frac{T_0}{2}\right) = -\frac{5}{2}\frac{nRT_0}{4} = -\frac{5P_0V_0}{2}$

$\Delta Q_{CA} = nC\Delta T = n2R\Delta T = 2nR\left(T_0 - \frac{T_0}{4}\right) = \frac{6nRT_0}{4} = 6P_0V_0$

$\Delta W_{cycle} = \Delta Q_{cycle} = 6P_0V_0 - 3P_0V_0 - \frac{5P_0V_0}{2} = \frac{P_0V_0}{2}$

Total heat absorbed by the gas = $6P_0V_0$

(IV) $\Delta Q_{AB} = nC_P\Delta T = \frac{7}{2}nR\Delta T = \frac{7}{2}P_0V_0$

$\Delta Q_{BC} = nR2T_0\ell n2 = 2P_0V_0\ell n2$

$\Delta Q_{CD} = nC_V\Delta T = n\frac{5R}{2}(T_0 - 2T_0) = -\frac{5}{2}nRT_0 = -\frac{5}{2}P_0V_0$

$\Delta Q_{DA} = nRT_0\ell n\left(\frac{1}{4}\right) = -2nRT_0\ell n2 = -2P_0V_0\ell n2$

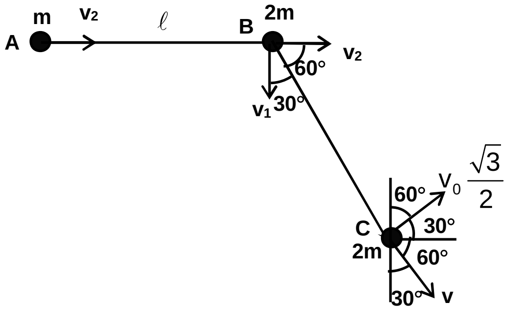
$\Delta W_{cycle} = \Delta Q_{cycle} = \frac{7P_0V_0}{2} - \frac{5P_0V_0}{2} = P_0V_0$

Total heat absorbed by the gas = $\frac{7P_0V_0}{2} + 2P_0V_0\ell n2 = \frac{P_0V_0}{2}(7 + 4\ell n2)$

SECTION – C

13. 00001.80

Sol. Using conservation of momentum of system.



$2mv_0 = 3mv_2 + 2m\left(\frac{3v_0}{4} + \frac{v}{2}\right)$

$2v_0 = 3v_2 + v + \frac{3v_0}{2}$

$3v_2 + v = \frac{v_0}{2}$ ...(i)

$2mv_1 = 2m\left(\frac{\sqrt{3}v_0}{4} - \frac{v\sqrt{3}}{2}\right)$

$v_1 = \frac{\sqrt{3}v_0}{4} - \frac{\sqrt{3}v}{2}$

$\sqrt{3}v_1 = \frac{3v_0}{4} - \frac{3v}{2}$ ...(ii)

Also, $v_1\cos30° + v_2\cos60° = v$

$\frac{\sqrt{3}v_1}{2} + \frac{v_2}{2} = v$

$\sqrt{3}v_1 = 2v - v_2$ ...(iii)

From equation (ii) and (iii)

$2v - v_2 = \frac{3v_0}{4} - \frac{3v}{2}$

$7v - 2v_2 = \frac{3v_0}{2}$ ....(iv)

Solving equation (i) and (iv)

$23v_2 = 2v_0$

$v_2 = \frac{2v_0}{23} = \frac{2 \times 20.7}{23} = 1.8$ m/s

14. 00037.50

Sol. $a_1 \cos\theta = a_2 \cos\theta$

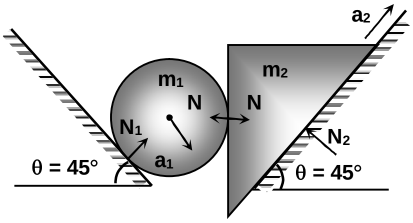
$a_1 = a_2 = a$ (say)

$m_1 g \sin\theta - N\cos\theta = m_1 a$ …(i)

$N\cos\theta - m_2 g\sin\theta = m_2 a$ …(ii)

Solving (i) and (ii) we get

$$a = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) g\sin\theta \quad \text{…(iii)}$$



From equation (i) and (iii)

$N\cos\theta = m_1 g\sin\theta - m_1 g\sin\theta$

$$\left(\frac{m_1 - m_2}{m_1 + m_2}\right)$$

$$N\cos\theta = \frac{2m_1m_2 g\sin\theta}{(m_1 + m_2)}$$

$$N = \frac{2m_1m_2 g\tan\theta}{(m_1 + m_2)} = \frac{2\times5\times3\times10\times1}{8} = 37.5\text{ N}$$

N = 37.50 N

15. 00000.60

Sol. Total mechanical energy

$$\varepsilon = \frac{-GMm}{r_0} + \frac{1}{2}mv_0^2$$

$$= -\frac{GMm}{r_0} + \frac{1}{2}mv_0^2$$

$$= -\frac{GMm}{r_0} + \frac{GMm}{2r_0}$$

$$\varepsilon = -\frac{GMm}{2r_0}$$

$$\frac{-GMm}{2a} = -\frac{GMm}{2r_0}$$

$\therefore$ Length of semi-major axis, $a = r_0$

Hence point 'P' must be an extreme

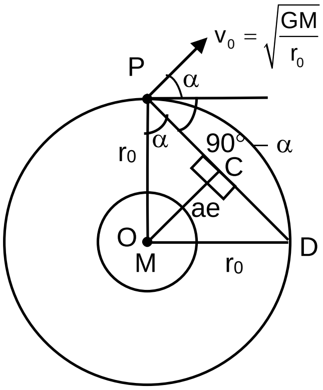
Point of the minor axis of the elliptical orbit

$\because$ $a\sin\alpha = ae$

$e = \sin\alpha = \sin 37° = 0.6$

Hence the eccentricity of the elliptical orbit

e = 0.60



16. 00020.00

Sol. The tension produced in each wire,

$$F = \frac{(\alpha_1 + \alpha_2)\ell\Delta\theta}{\frac{\ell}{A}\left(\frac{1}{Y_1} + \frac{1}{Y_2}\right)} = \frac{3\times10^{-5}\times20\times10^{-5}}{1.5\times10^{-10}} = 40\text{N}$$

Now, $\frac{n_1}{2\ell}\sqrt{\frac{F}{\mu_1}} = \frac{n_2}{2\ell}\sqrt{\frac{F}{\mu_2}}$

$\Rightarrow \dfrac{n_1}{n_2} = \sqrt{\dfrac{\mu_1}{\mu_2}} = \sqrt{\dfrac{0.4}{0.1}} = 2$

In first overtone, $n_1 = 4$, $n_2 = 2$

Hence the first overtone frequency of the transverse vibration of the system,

$f = \dfrac{n_1}{2\ell}\sqrt{\dfrac{F}{\mu_1}}$

$f = \dfrac{4}{2 \times 1}\sqrt{\dfrac{40}{0.4}} = \dfrac{4}{2} \times 10 = 20$ Hz

17. 00001.84

Sol. $E_1 = k_1 + \phi$ …(i)

$E_2 = k_2 + \phi$ …(ii)

Also, $\dfrac{k_1}{k_2} = 4 \Rightarrow k_1 = 4k_2$ …(iii)

From (i) and (ii)

$\dfrac{E_1}{E_2} = \dfrac{k_1 + \phi}{k_2 + \phi}$

$\dfrac{\lambda_2}{\lambda_1} = \dfrac{4k_2 + \phi}{k_2 + \phi}$

$\dfrac{6000}{4500} = \dfrac{4k_2 + \phi}{k_2 + \phi}$

$\dfrac{4}{3} = \dfrac{4k_2 + \phi}{k_2 + \phi}$

$\Rightarrow 4k_2 + 4\phi = 12k_2 + 3\phi$

$\Rightarrow \phi = 8k_2$ …(iv)

Now form (ii) and (iv)

$E_2 = k_2 + 8k_2$

$\Rightarrow \dfrac{hC}{\lambda_2} = 9k_2$

$\Rightarrow \dfrac{1242}{600} = 9k_2$

$\Rightarrow 2.07 = 9k_2$

$\Rightarrow k_2 = 0.23$ eV

$\therefore \phi = 8k_2 = 8 \times 0.23 = 1.84$ eV

18. 00006.82

Sol. The pitch of screw gauge, P = 1mm

Least count, $L.C. = \dfrac{P}{N} = \dfrac{1}{100} = 0.01$ mm

Diameter of the wire,

d = 2mm + 56 × L.C. – 6 × L.C.

= 2mm + 56 × 0.01 mm – 6 × 0.01 mm

d = 2.50 mm = 0.250 cm

$\ell = 8.68$ cm

Curved surface area of the wire,

$S = \pi d\ell$

$= \dfrac{22}{7} \times 0.250 \times 8.68 = 6.82\ \text{cm}^2$

Chemistry PART – II

SECTION – A

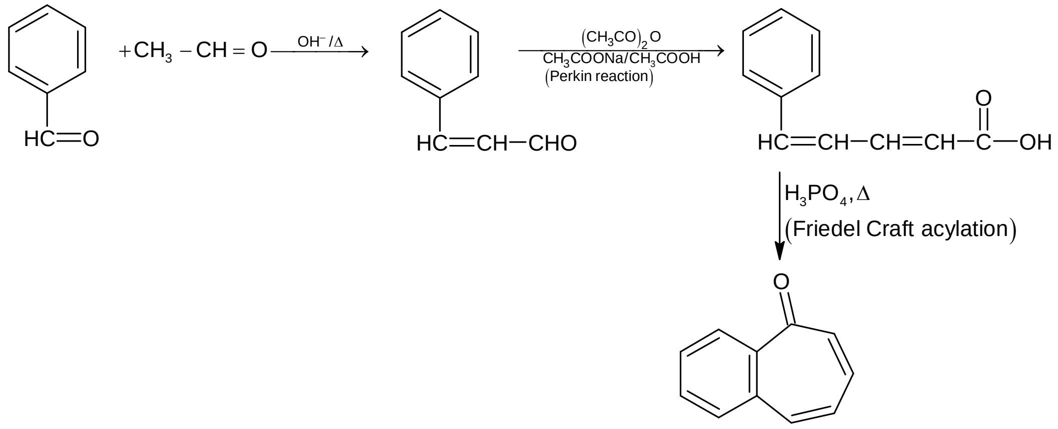
19. A, B, C

Sol. Average C – O bond length in metal compounds $\propto \dfrac{\text{No. of } d\pi - \text{electron pairs}}{\text{No. of CO groups}}$

Complex	Ratio
$[Fe(CO)_5]$	0.8
$[Cr(CO)_6]$	0.5
$[Cr(NH_3)(CO)_5]$	0.6
$[Cr(NH_3)_2(CO)_4]$	0.75
$[Cr(NH_3)(CO)_3]$	1.0

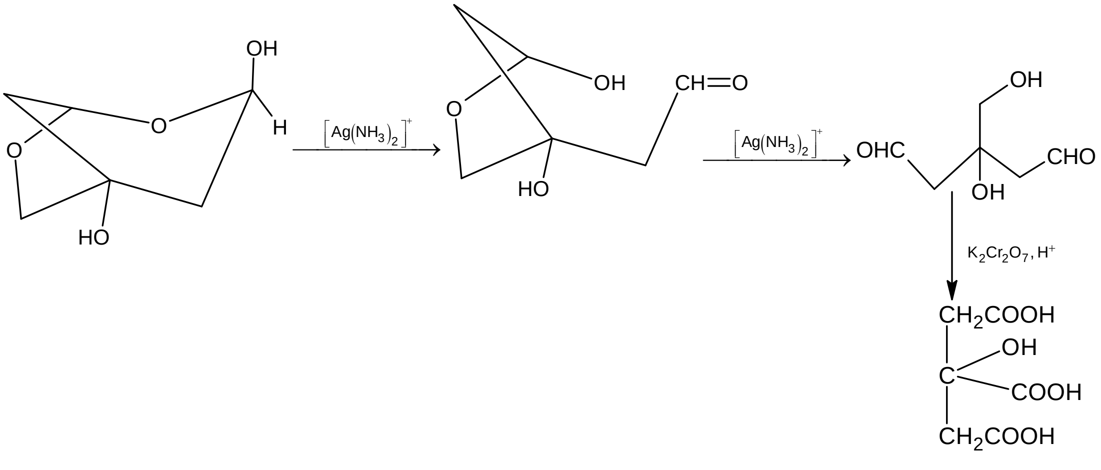
20. A, B, C, D

Sol. (A)



HC=O
+CH3 – CH = O
OH⁻/Δ
HC=CH–CHO
(CH3CO)2O
CH3COONa/CH3COOH
(Perkin reaction)
HC=CH–CH=CH–C–OH
O
H3PO4, Δ
(Friedel Craft acylation)
O

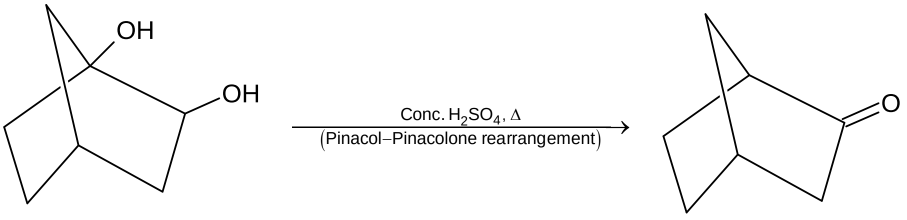
(B)



OH
H
O
O
HO
[Ag(NH3)2]⁺
O
OH
CH=O
HO
[Ag(NH3)2]⁺
OHC
OH
CHO
OH
K2Cr2O7, H⁺
CH2COOH
OH
C
COOH
CH2COOH

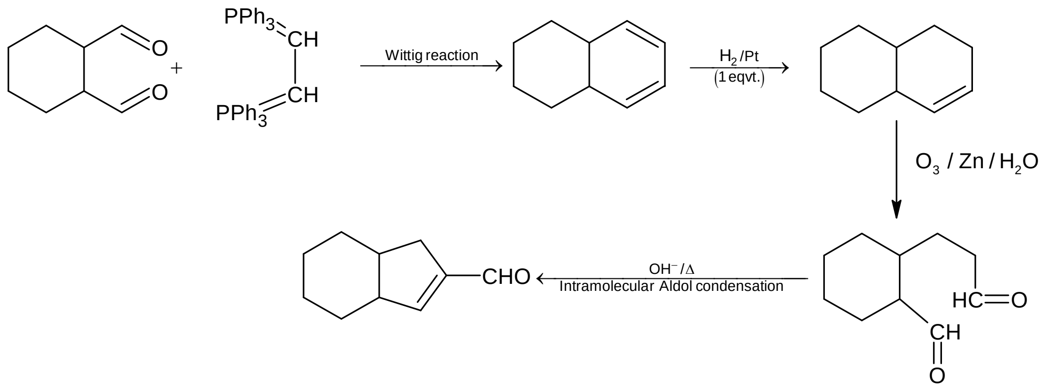
Citric acid

(C)



OH
OH
Conc. H2SO4, Δ
(Pinacol–Pinacolone rearrangement)
O

(D)


O
O
+
PPh3
CH
CH
PPh3
Wittig reaction
H2/Pt
(1 eqvt.)
O3 / Zn / H2O
HC=O
CH
O
OH⁻/Δ
Intramolecular Aldol condensation
CHO

21. A, B, D

Sol.

	$2ACl_3 \longrightarrow A_2O_5$	
at $t = 0$	1M	0
After time $= 10$ min	$(1-x)$	$\frac{x}{2}$

So, $(1-x)\times 2 = \frac{1}{4}\times 0.8\times 5$

$\therefore x = 0.5$ mole

So, $t_{1/2} = 10\,\text{min}$

Now, $k = \frac{1}{2\times t_{1/2}\times [A]_o} = \frac{1}{2\times 10\times 1} = 0.05\ \ell\text{mol}^{-1}\text{min}^{-1}$

Also, after t = 20 min,

$$20 = \frac{1}{2\times 0.05}\left[\frac{1}{[A]_t} - \frac{1}{[A]_o}\right]$$

$$2 = \frac{1}{[A]_t} - 1$$

$$\therefore [A]_t = \frac{1}{3}$$

So, % of ACl3 left unreacted after 20 min $= \frac{1}{3}\times 100 = 33.33\%$

22. A, B, C

Sol. (i)

	PO_4^{3-}	$+\ H^+ \longrightarrow$	HPO_4^{2-}
m.mol.	10	5	0
after neutralization	5	0	5

So, $pH = pK_{a_3} = 13$ (Buffer)

(ii)

	PO_4^{3-}	$+\ H^+ \longrightarrow$	HPO_4^{2-}
m.mol.	10	10	0
after neutralization	0	0	10

So, $pH = \frac{8+13}{2} = 10.5$ (Amphiprotic anion)

(iii)

	PO_4^{3-}	+ H^+	$\longrightarrow HPO_4^{2-}$
m.mol.	10	15	0
after neutralization	0	5	10

HPO_4^{2-}	+ H^+	$\longrightarrow H_2PO_4^-$
10	5	0
5	0	5

So, $pH = pK_{a_2} = 8$ (Buffer)

(iv)

	PO_4^{3-}	+ H^+	$\longrightarrow HPO_4^{2-}$
m.mol.	10	20	0
after neutralization	0	10	10

	HPO_4^{2-}	+ H^+	$\longrightarrow H_2PO_4^-$
m.mol.	10	10	0
after neutralization	0	0	10

So, $pH = pK_{a_3} = 5.5$ (Amphiprotic anion)

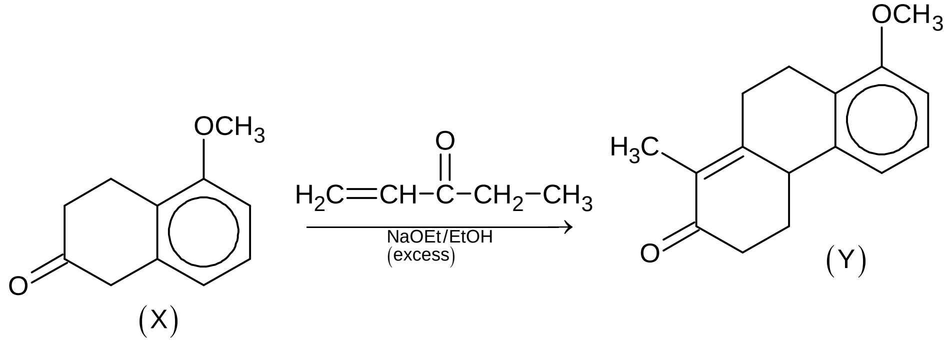
23. A, B, C

Sol. Mixing of gases is always accompanied with the increase in the entropy.

- At equilibrium, chemical potential is same in all phases of the system.
- Since in reversible adiabatic process, dS = 0, therefore these are isoentropic process.
- During expansion, work is maximum under reversible conditions.

24. B, C, D

Sol.



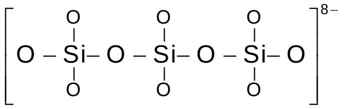
25. A, D

Sol. The order of volatility is IV < III < II < I

So, I = CH_3F, II = CH_2O, III = CH_3OH, IV = CH_3COOH

26. A, B, C

Sol. (A)



$$\left[O-\underset{O}{\overset{O}{Si}}-O-\underset{O}{\overset{O}{Si}}-O-\underset{O}{\overset{O}{Si}}-O \right]^{8-}$$

(B) HF reacts with glass, so it is used to make marking on the glass (etching).

(C) Since Fe^{3+} reacts with KCNS to produce red colour. So, it can be used as an indicator in the titration of Fe^{3+} with Sn^{2+}.

(D) $Pb_3O_4 + HCl \longrightarrow PbCl_2 + H_2O + \underset{\text{(Greenish yellow)}}{Cl_2} \uparrow$

27. D

Sol. (A) Spontaneity requires ΔG to be negative. Here ΔH is positive but nothing can be said about ΔS, so the process may or may not be spontaneous. Hence, option (A) is incorrect.

(B) Since, $\Delta S = 0$ so $\Delta G = \Delta H$ but $\Delta H = \Delta U + P\Delta V$, so this process can be spontaneous if ΔV is negative or zero or even small positive. But nothing is mentioned about ΔV, so the process may or may not be spontaneous. So, (B) is incorrect.

(C) For a reversible adiabatic process,
$\Delta S_{Syst} = \Delta S_{surr} = 0$ and for an irreversible adiabatic process, $\Delta S_{syst} > 0$ and $\Delta S_{surr} = 0$
So, (C) is incorrect.

28. B

Sol. An adiabatic process implies q = 0, and with volume not changing we have $\Delta V = 0$; therefore, W = 0 and thus $\Delta U = 0$. The constant 'U' and 'V' allows us to apply the strict entropy spontaneity test; if $\Delta S > 0$ the process is spontaneous. Since, we are given that ΔS is +ve, so the process must be spontaneous.

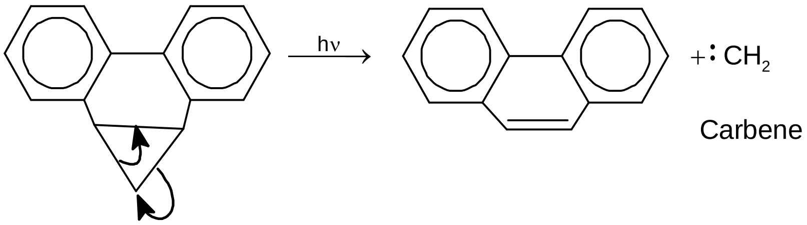
$\Delta G = \Delta H - T\Delta S$

Here, $\Delta H = \Delta U = 0,\ \Delta S = +ve$

So, ΔG must be negative.

29. B

Sol.



30. D

Sol. (A) Carbene is a diradical.
(B) It is Favorskii Rearrangement, where carbanion is formed as intermediate.
(C) It is Beckman's Rearrangement, where carbocation is the intermediate.

SECTION – C

31. 00006.50

Sol. All the above mentioned compounds except N_2 can react with PCl_5 to give $POCl_3$.

32. 00005.30

Sol. $\underset{(1\,bar)}{Pt;H_2(g)}\,|\,HA\,||\,AgCl(s), Cl^-\,|\,Ag(s)$

The cell reaction is

$$\frac{1}{2}H_2(g) + AgCl(s) \longrightarrow H^+ + Cl^- + Ag(s)$$

$E_{cell} = E^o_{cell} - 0.06\log_{10}[H^+][Cl^-]$

$= 0.20 - 0.06 \times \log[Cl^-] + 0.06 \times pH$

$E_{cell} = 0.26 + 0.06 \times pH$ … (1)

$0.56 = 0.26 + 0.06 \times pH_1$

$pH_1 = 5$

Similarly: $0.62 = 0.26 + 0.06 \times pH_2$

$pH_2 = 6$

Now, let there be initially x mol HA present and 20 mL NaOH containing 'y' mol of NaOH.

So, $pH_1 = 5 = pK_a + \log\frac{y}{x-y}$ … (2)

$pH_2 = 6 = pK_a + \log\frac{2.5y}{x-2.5y}$ … (3)

On solving Eqn. (1) and (2), we get

$x = 3y$

Now, substituting x = 3y in Eqn. (2)

We get $pK_a = 5.30$

33. 00000.75

Sol. I, II, V and VII will exist as anion at pH = 7, So, y = 4 and rest III, IV and VI will exist as cation at pH = 7. So, x = 3.

So, $\frac{x}{y} = 0.75$

34. 00004.50

Sol. x = 4 (I, II, III, VII)

y = 5 (I, II, III, IV, VII)

z = 2 (V, VI)

35. 00025.76

Sol. Meqvt. of Fe^{2+} taken = 50 × 0.16 = 8

- Meqvts. of Fe^{2+} ion left = 3.67 × 0.05 × 6 = 1.10
- Meqvts. of Cr^{+6} in solution = 8 – 1.10 = 6.90
- m. mol. of Cr^{+6} in solution = 6.90/3 = 2.30
- m. mol. of Chromite = 2.30/2 = 1.15

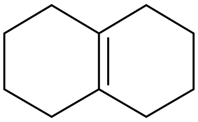
Mass of chromite in original sample $= \frac{1.15 \times 224}{1000} = 0.2576$ g

% of chromite in the original sample = 25.76%

36. 00001.20

Sol.

X =



So, x = 3, y = 5.

Mathematics PART – III

SECTION – A

37. A, B, C, D

Sol. $\frac{\left(1-\frac{b}{a}\right)\left(2-\frac{b}{a}\right)}{\left(1-\frac{b}{a}+\frac{c}{a}\right)}=\frac{\alpha}{\beta+1}+\frac{\beta}{\alpha+1}+2$. Let $0\le\alpha\le\beta\le1\Rightarrow\frac{\alpha}{\beta+1}+\frac{\beta}{\alpha+1}\le\frac{\alpha}{\alpha+1}+\frac{1}{\alpha+1}\le1$

Maximum value is 3, if $\alpha = 0$, $\beta = 1$ or $\alpha = 1$, $\beta = 1$ and minimum value = 2, if $\alpha = \beta = 0$

38. A, C, D

Sol. $a_{n+1}^2-a_n^2=1$. By Telescopic sum $a_n=\sqrt{n-1+a_1^2}$ now $a_{2n_0}=3a_{n_0}\Rightarrow 8a_1^2=8-7n_0\ge0\Rightarrow n_0=1$

$\Rightarrow a_1^2=\frac{1}{8}\Rightarrow a_n=\sqrt{n-\frac{7}{8}}$ and $\sqrt{\frac{8}{8a_n^2+7}}=\frac{1}{\sqrt{n}}$, $\sqrt{n+1}-\sqrt{n}<\frac{1}{2\sqrt{n}}<\sqrt{n}-\sqrt{n-1}$

$\Rightarrow\sqrt{50}-1<\frac{1}{2}\sum_{n=1}^{49}\sqrt{\frac{8}{8a_n^2+7}}<7$

39. A, B, D

Sol. (A) Number of ways so that the sum of a common edge is odd = $2\times4!\times4!$

(B) Number ways assigning numbers such that the sum of any two numbers with a common body diagonal even is $6\times(4!)^2$

40. A, D

Sol. $g(a,b)=\frac{a^2+b^2+ab}{\sqrt{3}}$

41. C, D

Sol. Total number of points will be 17 and number of squares joining these 16 point will be equal to $(3^2\times1+2^2\times2+1^2\times3)=20$

42. A, B

Sol. After 5 second bug can reach at (5, 0), (4, 1), (3, 2), (2, 3), (1, 4) and (0, 5) along 1, 5, 10, 10, 5, 1 different paths.

43. B, D

Sol. $r_1=s\tan\left(\frac{A}{2}\right)\Rightarrow\frac{r_1}{s}=\tan\left(\frac{A}{2}\right)$; $a>r_1\Rightarrow1>\frac{a}{s}>\tan\left(\frac{A}{2}\right)\Rightarrow$ A is acute and $r=(s-a)\tan\left(\frac{A}{2}\right)$

44. B, D

Sol. The point on S for which are of triangle with point B and C will be minimum, is $\left(\frac{5}{2},\frac{25}{4}\right)$

So, minimum area = $\frac{15}{4}$ unit^2 and $\sqrt{(\alpha-2)^2+\beta^2}=\sqrt{\left(\frac{5}{2}-2\right)^2+\left(\frac{25}{4}\right)^2}=\frac{\sqrt{629}}{4}$

45. C

46. B

Sol. **(for Q.45 to Q.46):**

P $\in$ B, Q $\in$ A, R $\in$ D, S $\in$ C and T $\in$ A, C, D; U $\in$ A, C, D

47. C

48. D

Sol. **(for Q.47 to 48):**

$$\lim_{x\to 0}\frac{f(x)}{g(x)}=1;\ \lim_{x\to\infty}\frac{f(x)}{g(x)}=\text{D.N.E.}\ \Rightarrow\ \lim_{x\to 0}\frac{f'(x)}{g'(x)}=1;\ \lim_{x\to\infty}\frac{f'(x)}{g'(x)}=0$$

$$\lim_{x\to 0}\frac{h(x)}{t(x)}=0;\ \lim_{x\to\infty}\frac{h(x)}{t(x)}=0\ \Rightarrow\ \lim_{x\to 0}\frac{h'(x)}{t'(x)}=\text{D.N.E.};\ \lim_{x\to\infty}\frac{h'(x)}{t'(x)}=0$$

SECTION – C

49. 00002.33

Sol. If both go to same bin, then probability = $\frac{1}{4}+\frac{1}{4^2}+\frac{1}{4^3}.....\infty=\frac{1}{3}$

So, required probability $(P)=\frac{1}{2}\left(1-\frac{1}{3}\right)=\frac{1}{3}$

50. 00007.00

Sol. Let z = (1 + ai)(1 + bi)(1 + ci) $\Rightarrow$ |z| = 3

|Re(z)| $\le$ |z| $\Rightarrow$ –2 $\le$ ab + bc + ca $\le$ 4

51. 00039.00

Sol. The integral will be at its maximum value if $380 - x - x^2 \ge 0$ $x \in [-20, 19]$

$\Rightarrow$ a = 20, b = 19

52. 00004.00

Sol. $f(x)=-\frac{x}{2},\ \forall x\in R,\ f(x)=-\frac{x}{3},\ \forall x\in R$

$$f(x)=\begin{cases}-\frac{x}{2} & ;\ x\ge 0\\ -\frac{x}{3} & ;\ x<0\end{cases},\quad f(x)=\begin{cases}-\frac{x}{3} & ;\ x\ge 0\\ -\frac{x}{2} & ;\ x<0\end{cases}$$

53. 00001.25

Sol. The exhaustive solution is $\left[0,\frac{\sqrt{5}-1}{2}\right)$

54. 02018.00

Sol. f(1) = 1 $\Rightarrow$ $f(x)+f\left(\frac{2020}{x}\right)=2f(x)$ $\Rightarrow$ $f^2(x) = 1$

$$f(x)=\begin{cases}1 & ;\ x>0\\ -1 & ;\ x<0\end{cases}$$

FIITJEE

ALL INDIA TEST SERIES

OPEN TEST

JEE (Main)-2020

TEST DATE: 09-02-2020

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 75 questions.
- Each subject (PCM) has 25 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only three sections: **Section-A**, **Section-B and Section-C**.

  Section-A (01 – 20, 26 – 45, 51 – 70) *contains 60 multiple choice questions which have **only one correct answer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.*

  Section-B (21 – 22, 46 – 47, 71 – 72) *contains 6 Numerical based questions with answer as numerical value from **0 to 9** and each question carries **+4 marks** for correct answer. There is no negative marking.*

  Section-C (23 – 25, 48 – 50, 73 – 75) *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries **+4 marks** for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A particle is projected with speed v at an angle α to the horizontal. If the magnitude of instantaneous velocity at time 't' is equal to the magnitude of average velocity from t = 0 to t = t. Find the time 't'.

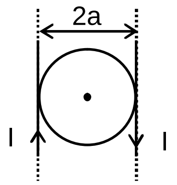
(A) $\frac{2v\sin\alpha}{3g}$

(B) $\frac{4v\sin\alpha}{3g}$

(C) $\frac{3v\sin\alpha}{4g}$

(D) $\frac{3v\sin\alpha}{2g}$

2. In the given figure two straight infinite conductors carry a current I. They are parallel and separated by a distance 2a. A circular conducting ring of radius 'a' in the plane of the parallel wires lies between the two straight conductors and is insulated from them. The mutual inductance between the circular ring and the straight conductors is



(A) $\mu_0 a$

(B) $2\mu_0 a$

(C) $\frac{\mu_0 a}{2}$

(D) $4\mu_0 a$

3. A sphere of radius r is at a potential V and is immersed in a conducting medium of conductivity σ. Find the current flowing from sphere to infinity.

(A) $2\pi\sigma rV$

(B) $4\pi\sigma rV$

(C) $\frac{\pi\sigma rV}{2}$

(D) $\frac{\pi\sigma rV}{4}$

4. A particle with charge q is travelling with a velocity v parallel to a wire with a uniform linear charge distribution λ per unit length. The wire also carries a current I. What should be the velocity of the charged particle to travel in a straight line parallel to the wire at a distance r from the wire? (c = speed of light)

(A) $\frac{2\lambda c^2}{I}$

(B) $\frac{\lambda c^2}{2I}$

(C) $\frac{\lambda c^2}{I}$

(D) $\frac{4\lambda c^2}{I}$

5. In an artificial medium, air pressure and volume are related as $P = \frac{K}{V^2}$, where K is a constant. Considering air as an ideal gas of density ρ, then the speed of sound in air is

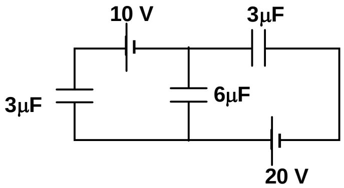
(A) $\sqrt{\frac{2P}{\rho}}$

(B) $\sqrt{\frac{P}{\rho}}$

(C) $\sqrt{\frac{P}{2\rho}}$

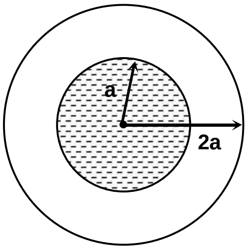
(D) $\sqrt{\frac{4P}{\rho}}$

6. In the given circuit, the charge on 6 μF capacitor in steady state is



(A) 7.5 μC
(B) 15 μC
(C) 30 μC
(D) 45 μC

7. Water is completely filled in the spherical cavity of radius 'a' of a thick spherical shell of inner and outer radii 'a' and '2a' respectively as shown. The initial temperature of water is 80°C and the surrounding temperature is θ_0 = 30°C. The thermal conductivity of the spherical shell varies as $k = \frac{\alpha}{r^2}$, where 'r' is the distance from the centre of shell and α is a constant. The time required to decrease the temperature of water from 80°C to 60°C is (ρ = density of water, S = specific heat of water)



(A) $\frac{\rho S a^4}{2\alpha} \ell n\left(\frac{5}{3}\right)$

(B) $\frac{\rho S a^4}{3\alpha} \ell n\left(\frac{5}{3}\right)$

(C) $\frac{\rho S a^4}{4\alpha} \ell n\left(\frac{5}{3}\right)$

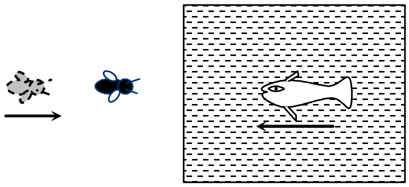
(D) $\frac{\rho S a^4}{5\alpha} \ell n\left(\frac{5}{3}\right)$

8. An ancient piece of wood shows an activity of 7.8 disintegration per second, per gram of ^{14}C. What is the age of piece of the wood if fresh ^{14}C, shows an activity of 31.2 disintegration per second per gram? Half life of ^{14}C is 5570 years.

(A) 16710 years
(B) 33420 years

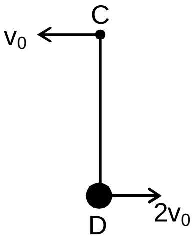
(C) 11140 years
(D) 22280 years

9. A fish in an aquarium approaching the left wall at 4 m/s observes a fly is approaching it at 8 m/s. If the refractive index of water is $\mu = \frac{4}{3}$. Find the actual velocity of the fly.



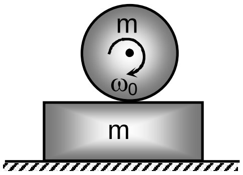
(A) 3 m/s
(B) 6 m/s
(C) 9 m/s
(D) 12 m/s

10. A small ball of mass 'm' is suspended from inextensible massless string of length l. At certain instant of time the velocity of point C is v_0 (in leftward direction) and of ball D is $2v_0$ (in rightward direction). The tension in the string at this instant of time is



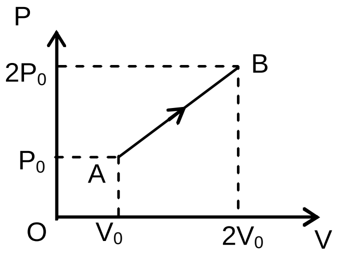
(A) $mg + \frac{4mv_0^2}{\ell}$
(B) $mg - \frac{9mv_0^2}{\ell}$
(C) $mg + \frac{mv_0^2}{\ell}$
(D) $mg + \frac{9mv_0^2}{\ell}$

11. A solid cylinder of mass m = 5 kg and radius R = 0.4 m is given an initial angular velocity ω_0 = 40 rad/s about a horizontal axis through its centre and gently placed on a plank of mass m = 5 kg. The coefficient of friction between the cylinder and plank is μ = 0.2. The plank rests on a smooth horizontal surface. The time after which pure rolling motion of cylinder will start relative to the plank is (Take g = 10 m/s^2)



(A) 2 sec
(B) 3 sec
(C) 4 sec
(D) 5 sec

12. An ideal diatomic gas is taken through a process AB as shown in the P-V diagram. The molar heat capacity of the gas in this process will be :



(A) 3R
(B) 4R
(C) $\frac{9R}{2}$
(D) $\frac{R}{2}$

13. The electric field strength produced by the radiations coming from 200 W bulb at a 5 m distance is E. The electric field strength produced by the radiations coming from 100 W bulb at the same distance 5m is

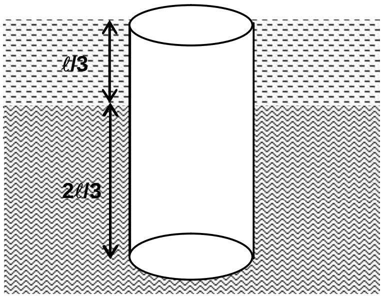
(A) $\frac{E}{2}$
(B) 2E

(C) $\frac{E}{\sqrt{2}}$
(D) $\sqrt{2}E$

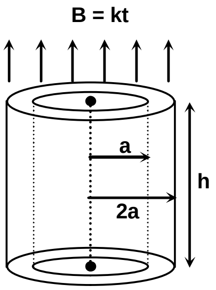
14. A particle ‘A’ of mass ‘m’ moving with an initial velocity ‘v’ collides elastically with a particle B of mass 2m which is initially at rest. The ratio of the de-Broglie wavelengths $\left(\frac{\lambda_A}{\lambda_B}\right)$ of the particles A and B after collision is
(A) 2
(B) 3
(C) 8
(D) 4

15. In YDSE of equal width slits, if the intensity at the center of the screen is I_0, then the intensity at a distance of $\frac{\beta}{4}$ from the central maxima is (β is fringe width, d is separation between the slits, λ is wavelength of light, D is separation between the plane of slits and the screen) (D>>d and d>>λ)
(A) I_0
(B) $\frac{I_0}{2}$
(C) $\frac{I_0}{3}$
(D) $\frac{I_0}{4}$

16. A cylinder of length ℓ floats with its entire length immersed in two liquids as shown in the figure. The upper liquid is water and lower liquid has density twice that of water. The two liquids are immiscible. The cylinder is in equilibrium. Find the specific gravity of the material of the cylinder.
(A) 2
(B) 5
(C) 4/3
(D) 5/3

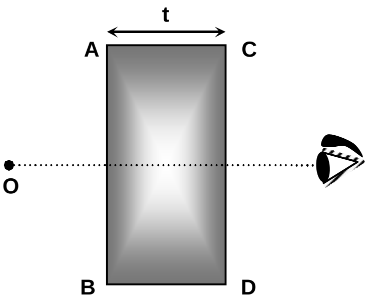


17. A ring of circular cross section is made of a material of resistivity ‘ρ’. The inner and outer radii of ring are a and 2a respectively and its thickness is ‘h’. The ring is placed in a time varying magnetic field B = kt (where k is a constant) which is parallel to the axis of the ring as shown in the figure. The induced current in the ring is

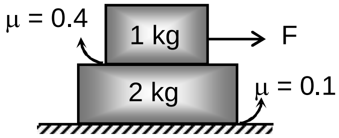


(A) $\frac{3kha^2}{4\rho}$
(B) $\frac{3kha^2}{2\rho}$
(C) $\frac{5kha^2}{4\rho}$
(D) $\frac{5kha^2}{2\rho}$

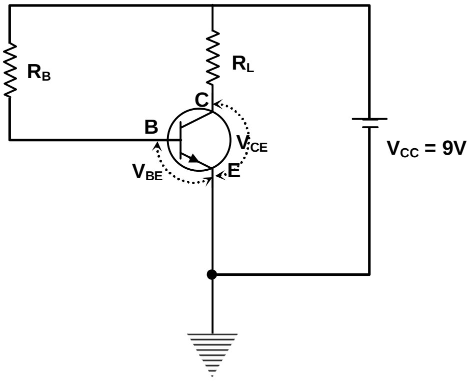
18. A glass slab is placed between an object O and observer. The refractive index of glass slab varies with distance x from the face AB as $\mu = \mu_0\left(1+\frac{x}{t}\right)$, where μ_0 = 1. How much closer (compared to original distance) the object appears to the observer. (Consider normal incidence only)
(A) t(1 + ℓn2)
(B) t(1 – ℓn2)
(C) t(2 + ℓn2)
(D) t(2 – ℓn2)



19. In the figure shown, the friction coefficient between the block of mass 1 kg and the plank of mass 2 kg is 0.4 while that between the plank and horizontal floor is 0.1. For what value of F will the block move with double the acceleration of that of the plank? (Take g = 10 m/s^2)
(A) 5 N
(B) 6 N
(C) 10 N
(D) 12.5 N



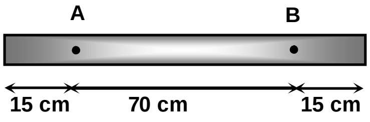
20. An n-p-n transistor is connected in common emitter mode as shown in the figure. The terminal of a 9 V battery is connected to the collector through a load resistance R_L = 1 kΩ and to the base through a resistance R_B. If the base-emitter voltage V_{BE} = 1.4 V, the collector-emitter voltage V_{CE} = 5 V and β = 100. Then the value of resistance R_B is
(A) 130 kΩ
(B) 160 kΩ
(C) 190 kΩ
(D) 220 kΩ



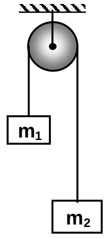
SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

21. A metallic rod of length 1 m is rigidly clamped at two points A and B as shown in the figure. Longitudinal stationary waves are setup in the rod. If the fundamental frequency of longitudinal vibration of the rod is (10 × n) kHz. Find the value of n. (Given Y = 1.6 × 10^{11} N/m^2, ρ = 2500 kg/m^3)



22. In an Atwood's machine setup as shown. Data is given by m_1 = (103.5 ± 0.2)g and m_2 = (43.5 ± 0.2)g and g = (9.80 ± 0.01) m/s^2 is acceleration due to gravity. Find the percentage error in the acceleration of the blocks.



SECTION – C
(Numerical Answer Type)

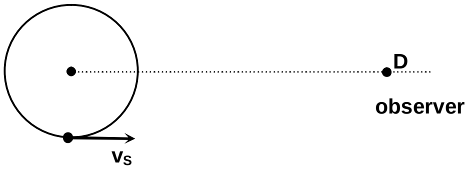
This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

23. A small ball of mass 1 kg and charge 8 μC is placed at the centre of a uniformly charged sphere of radius 2m and charge $\frac{1}{6}\text{mC}$. A narrow smooth groove is made in the sphere from centre to the surface of sphere and the sphere is made to rotate about its vertical diameter at a constant rate of $\frac{1}{4\pi}$ revolution per second. Find the speed (in m/s) with respect to ground with which the ball slides out from the groove. Ignore any magnetic force acting on the ball. (Take $\sqrt{2} = 1.41$)

24. The eyepiece of a compound microscope has a focal length of 2.5 cm and the objective has a focal length of 1 cm. Two lenses are separated by 26 cm. Microscope is used by a person with normal eye (near point at 25 cm). If the minimum magnification of the microscope is 100x. Find the value of x.

25. A source of sound is moving with a constant speed of 20 m/s in a circle. There is a stationary observer at some distance greater than the radius of the circle from the centre of circle as shown in the fiugre. Find the difference between the maximum and minimum frequency (in Hz) observed by the observer. (Assume speed of sound to be 340 m/s and frequency of the source is 360 Hz)



Chemistry

PART – II

SECTION – A

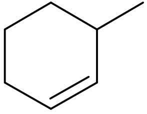
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

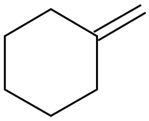
26. Which of the following is correct?
   - (A) The value of steric factor P (regarding Arrheneous equation) decreases as the complexity of reacting molecules decreases.
   - (B) During any individual reactive collision, the total energy of the colliding particles remain constant.
   - (C) During a free radical chain reaction, if chain termination is faster than chain branching and chain propagation, explosion occurs.
   - (D) In a termolecular elementary process : $O + O_2 + N_2 \longrightarrow O_3 + N_2$; N_2 serves as catalyst, while the order of reaction is two (2).

27. Which of the following is most stable?

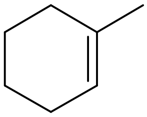
(A)



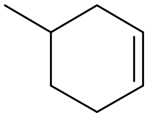
(B)



(C)



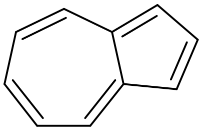
(D)



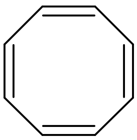
28. In which of the following M – F bond is strongest, among the given four compounds? (M = central atom)
   - (A) CF_4
   - (B) NF_3
   - (C) BF_3
   - (D) OF_2

29. Which of the following is aromatic?

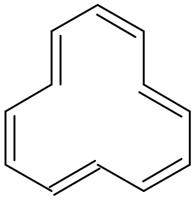
(A)



(B)



(C)



(D) A & B both

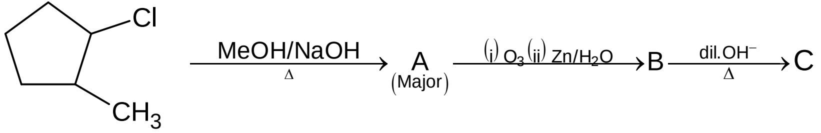
30. During extraction of sodium by Down's cell process $CaCl_2$ is mixed with NaCl, which lowers the fusion temperature, the main reason(s) for lowering the fusion temperature is:
(A) It is difficult to maintain 1081 K (fusion temperature of NaCl) during electrolysis and also at lower temperature the consumption of electricity is reduced.
(B) Both Na and Cl_2 exert corrosive nature/action on the vessel used for electrolysis at such high temperature (1081 K).
(C) At lower/reduced fusion temperature (850 K), the sodium is obtained at iron cathode in solid state.
(D) Both A and B are some of the reasons.

31. What is the pH of a saturated aqueous solution of AgOH? [Given $K_{SP}(AgOH) = 1.5 \times 10^{-8}$, $\log(1.225) = 0.088$; $\log(1.5) = 0.176$];
(A) 8.176
(B) 7.824
(C) 4.088
(D) 10.088

32. Which of the following is correct?
(A) Kjeldahal's method of estimation of nitrogen is not applicable to the compounds containing nitrogen in nitro groups, azo groups and nitrogen present in the ring.
(B) In Duma's method of estimation of nitrogen, the organic compound containing nitrogen is heated with Cu_2O in an atmosphere of CO_2, to yield H_2O, CO_2 and free N_2 gas along with free copper.
(C) During Carius method of estimation of halogen, a known mass of organic compound is heated with dil. HNO_3, in presence of $AgNO_3$.
(D) Phosphorous can not be detected by Lassaigne's test.

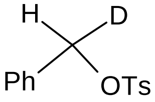
33. Which of the following is not the constituent of 'Acid Rain'?
(A) H_2CO_3
(B) H_2SO_4
(C) HNO_3
(D) H_3PO_4

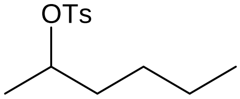
34. Analyse the following reaction sequence and select the correct statement, following the reaction?

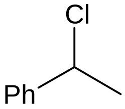


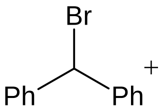
(A) 'A' has 1-degree of unsaturation.
(B) 'B' has 2-degree of unsaturation.
(C) 'C' is an a α, β-unsaturated ketone with 2-degree of unsaturation.
(D) All other three statements are incorrect.

35. In which of the following maximum stereochemical inversion is expected to occur?

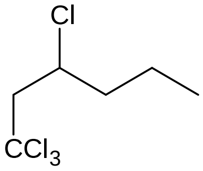
(A)  $+ \text{HCOOH} \longrightarrow S_N - \text{product}$

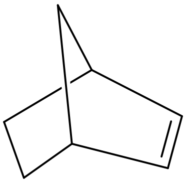
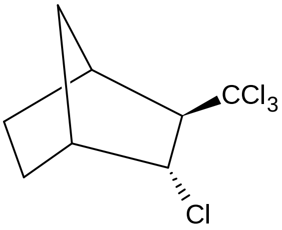
(B)  $+ CH_3COO^{-}NH_4^{+} \longrightarrow S_N - \text{product}$

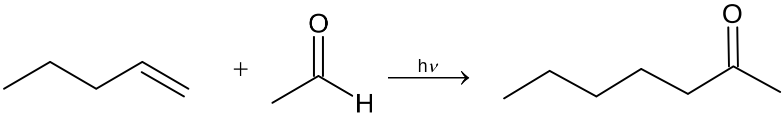
(C)  $+ CH_3COOK \xrightarrow[CH_3COOH]{} S_N - \text{product}$

(D)  $+ \text{dil. NaOH} \longrightarrow S_N - \text{product}$

36. In which of the following reaction, the given product is the major product of that reaction?

(A) $CCl_4 + CH_2 = CH - CH_2 - CH_2 - CH_3 \xrightarrow[\Delta]{(PhCO_2)_2}$  ;

(B) $CCl_4 +$  $\xrightarrow[\Delta]{(PhCO_2)_2}$  ;

(C) 

(D) In all the reactions, the given products are major products.

37. During extraction process of Sn which of the following is the common method of reduction?

(A) Self reduction
(B) Aluminium reduction
(C) Electrolytic reduction
(D) Carbon reduction

38. Which of the following show geometrical isomerism as well as ionization isomerism, and possesses spin only magnetic moment of 3.87 BM?

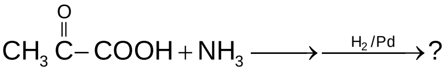
(A) $Co(NH_3)_4Br_2Cl$
(B) $Cr(CN)(CO)_4(NO_3)Cl$
(C) $Pd(NO_2)_2(NH_3)_2$
(D) $Co(CO)_5Br(SO_4)$

39. Which of the following give Glycine?

(A) $CH_3CH_2CH = CH - CH_2 - CH_3 \xrightarrow{O_3/H_2O} \xrightarrow[(ii)\,H_2O]{(i)\,Br_2/\text{red P}} \xrightarrow{NH_3(\text{excess})} \xrightarrow{H_2O} ?$

(B) $CH_3CH = CHCH_3 \xrightarrow{O_3/Zn} \xrightarrow[NaCN]{NH_4Cl} \xrightarrow{H_3O^+/\Delta} \xrightarrow{\text{Very dil.}OH^-} ?$

(C) $CH_3CH = CHCH_3 \xrightarrow{O_3/H_2O} \xrightarrow{Br_2/\text{red P}} \xrightarrow{NH_3(\text{excess})} \xrightarrow[H_2O]{} ?$

(D) 

$CH_3\overset{\overset{\large O}{\|}}{C}-COOH + NH_3 \longrightarrow \xrightarrow{H_2/Pd} ?$

40. Which one of the following statements is correct?
(Please ignore the balancing wherever is applicable)

(A) $Al + \text{dil. } H_2SO_4 \longrightarrow Al_2(SO_4)_3 + SO_2 + H_2O$.

(B) $Al + AlCl_3 \xrightarrow{\text{High temperature}} Al_2Cl_3$.

(C) $FeSO_4.(NH_4)_2SO_4.6H_2O$ is called Mohr's salt.

(D) AlCl is stable up to 800^oC.

41. Which of the following molecules is non linear?

(A) HCN

(B) CO_2

(C) $[AgCl_2]^-$

(D) $BaCl_2$

42. Which of the following is expected to be most acidic solution?

(A) Dilute aq. H_3BO_3 solution.

(B) Dilute aq. CH_3COOH solution.

(C) Dilute aq. HCOOH solution.

(D) Aq. $Be(OH)_2$ soluiton.

43. Which of the following process is expected to have the largest value of equilibrium constant, at room temperature?

(A) $H_3PO_2 \rightleftharpoons H^+ + HPO_2^-$; K_1

(B) $H_3PO_3 \rightleftharpoons H^+ + H_2PO_3^-$; K_2

(C) $H_3PO_4 \rightleftharpoons H^+ + H_2PO_4^-$; K_3

(D) $H_2PO_4^- \rightleftharpoons H^+ + HPO_4^{2-}$; K_4

44. Which of the following colloid combination is correctly classified?

(A) Rain cloud – Sol

(B) Soapsuds – Aerosol

(C) Silt in water – Sol

(D) Milk of magnesia – Foam

45. Cl_2 gas is passed into an aqueous solution of NaBr and NaI, followed by the addition of $CHCl_3$. What colour of $CHCl_3$ layer will be observed, ultimately?

(A) Blue

(B) Greenish yellow

(C) Reddish brown

(D) Violet

SECTION – B

(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

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46. If value of equilibrium constant for the following equilibria is 10^{+x}, then find the value of 'x'.

$$2Fe^{3+} + 2I^{-} \rightleftharpoons 2Fe^{2+} + I_2$$

Given: $E^{o}_{Fe^{3+}/Fe^{2+}} = 0.77\ V$

$E^{o}_{I_2/I^{-}} = 0.53\ V$

$\dfrac{2.303\ RT}{F} = 0.06$

47. 18 gm of glucose ($C_6H_{12}O_6$) is treated with sufficient amount of HIO_4, under requisite conditions. How much formaldehyde (in gm) is formed?

SECTION – C

(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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48. Excess of $NH_4HS(s)$ is heated at 300 K, in a closed container and at equilibrium the partial pressure of NH_3 is found to be 1.5 atm. Some amount of NH_3 is added to the reaction mixture so that at new equilibrium, under same conditions, the partial pressure of NH_3 becomes 2 atm, what is the ratio of total pressures before adding NH_3 and after addition of NH_3.

49. Calculate the heat of formation of $H_2O(g)$ by the following data and give its numerical value only (in kJ/mole).

$\in_{H-H} = 436\ kJ/mole;\ \in_{O=O} = 497\ kJ/mole;$

Average $\in_{H-O} = 492\ kJ/mole$

50. A metal (At. Mass = 65) has a fcc lattice with all the atoms at the lattice points. The edge length of the unit cell is 300 pm. What is its density. (in gm/cm^3) (Given: $N_A = 6.022 \times 10^{23}$)

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

51. $(p \Rightarrow q) \vee (q \Rightarrow r)$ is
   (A) a tautology
   (B) a contradiction
   (C) equivalent to $(\sim q \Rightarrow p) \wedge (\sim r \Rightarrow q)$
   (D) equivalent to $(p \vee q) \Rightarrow r$

52. Let $S = \{(x, y) : x^2 + y^2 - 4x - 2y + 4 = 0 \ \& \ x^2 + y^2 - 2y = 0\}$, Γ = set of circles which pass through all point(s) in S. Then the number of elements in Γ with unit radius that pass through all the point(s) in S and the origin is
   (A) 0
   (B) 1
   (C) 2
   (D) 3

53. The number of solution(s) of the equation $\tan^{-1}\left(x+\frac{2}{x}\right)-\tan^{-1}\frac{4}{x}-\tan^{-1}\left(x-\frac{2}{x}\right)=0$ is
   (A) 0
   (B) 1
   (C) 2
   (D) more than 2

54. For ΔABC, $\frac{a}{1+m^2n^2}=\frac{b}{m^2+n^2}=\frac{c}{(1-m^2)(1+n^2)}$, where $m, n \in R^+$. Given three statement(s):
   (I) $\angle BAC = 2\tan^{-1}\frac{m}{n}$, (II) $\angle ABC = 2\tan^{-1}mn$ and (III) area of $\Delta ABC = \frac{mnbc}{m^2+n^2}$.
   Which of the following options lists all the correct statements about ΔABC?
   (A) I only
   (B) II and III only
   (C) I and II only
   (D) I, II and III

55. A statue built on a 50m high pedestal subtends 45° at two points, A_1 and A_2, 50m apart on the ground. If the straight line joining A_1 and A_2 passes through the base of the pedestal, then what is the height of the statue (without the pedestal) (assume that the statue and pedestal are vertical)
   (A) $25\sqrt{2}$
   (B) 50
   (C) 150
   (D) 250

56. If tangents are drawn from a point P to the parabola $y^2 = 4x$ with focus (S) such that the lengths of the tangents are $\sqrt{5}$ and $\sqrt{10}$, then SP is equal to
   (A) $\frac{\sqrt{5}}{2}(1+\sqrt{2})$
   (B) $5\sqrt{2}$

(C) $\frac{2\sqrt{10}}{1+\sqrt{2}}$
(D) none of these

57. Let the tangents drawn to the ellipse $\frac{x^2}{4}+\frac{y^2}{9}=1$ from the endpoints (A_L and B_L) of a chord (L) passing through the point (1, 1) intersect at point C_L. As L varies C_L traces which of the following curves
(A) an ellipse
(B) a parabola
(C) a circle
(D) a straight line

58. Consider a chord to the hyperbola xy = 9 which has x-intercept 3 and y-intercept 15. The mid-point of this chord is
(A) $\left(\frac{15}{2},\frac{3}{2}\right)$
(B) $\left(\frac{3}{2},\frac{15}{2}\right)$
(C) (9, 12)
(D) (12, 9)

59. A chord of $x^2-\frac{y^2}{66}=1$ subtending 90° at the centre of the hyperbola can have the equation
(A) $5x+7y=5\sqrt{3}$
(B) $3x+7y=\sqrt{59}$
(C) $7x+2y=3\sqrt{6}$
(D) $7x+4y=\sqrt{66}$

60. If (3a + c)(2a + 3b + 6c) < 0, then the number of roots of $ax^2 + bx + c = 0$ in interval (–5, 5) is
(A) exactly zero
(B) at least one
(C) exactly two
(D) can not be determined

61. Let S be the set of points in the Argand plane satisfying $|z - 3 - 4i| \le 5$. If $z_1 \in S$ such that $|z_1 - 4 + 3i| \ge |z_1 - z_0|$ $\forall z_0 \in S$, then $\frac{10-(z_1+\bar{z}_1)}{20-i(z_1-\bar{z}_1)}$ is equal to
(A) 1
(B) $\frac{1}{2}$
(C) $\frac{1}{5}$
(D) $\frac{1}{7}$

62. If $\vec{c}$ is directed along the internal bisector of the angle between the vectors $\vec{a} = 7\hat{i} - 4\hat{j} - 4\hat{k}$ and $\vec{b} = -2\hat{i} - \hat{j} + 2\hat{k}$, with $|\vec{c}| = 5\sqrt{6}$, then $\vec{c}$ is

(A) $\frac{5}{3}(\hat{i} - 7\hat{j} + 2\hat{k})$

(B) $\frac{5}{3}(5\hat{i} + 5\hat{j} + 2\hat{k})$

(C) $\frac{5}{3}(\hat{i} + 7\hat{j} + 2\hat{k})$

(D) $\frac{5}{3}(-5\hat{i} + 5\hat{j} + 2\hat{k})$

63. If the area of the region bounded by the curves xy + x = 1, $y^2 = 12x$ and the x-axis is A, then

(A) A > 1

(B) A < ln 2

(C) $A^2 < \frac{1}{\sqrt{2}}$

(D) $A > \frac{1}{\sqrt{2}}$

64. $\lim\limits_{n\to\infty} \sum\limits_{i=1}^{n-1} \frac{n^2 i}{i^4 + n^4}$ is equal to

(A) ln 2

(B) $\frac{1}{2}\ln 2$

(C) $\frac{\pi}{4}$

(D) $\frac{\pi}{8}$

65. If $(z + 1)^{2n} + (z - 1)^{2n} = 0$, where z is a complex number and $n \in N$, then which of the following is always true?

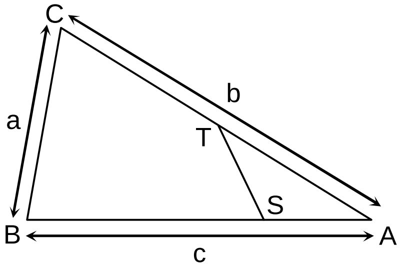
(A) $\overline{z} = z$

(B) $z = \overline{z}^2$

(C) $z + \overline{z} = 0$

(D) $z^2 + \overline{z}^2 = 1$

66. Given a triangular plot of land as per the figure, the owner wants to build a fence ST such that the plot is divided into 2 equal parts. The minimum length of fencing required is (where s is the semi-perimeter of ΔABC)



where $a \le b \le c$

(A) $\sqrt{2(s-b)(s-c)}$
(B) $\sqrt{s(s-a)}$
(C) $\sqrt{a(b+c)}$
(D) $\frac{s}{2}$

67. If $S_n = \frac{1}{1\cdot3\cdot4} + \frac{1}{2\cdot4\cdot5} + ... + \frac{1}{n(n+2)(n+3)}$, then $\lim\limits_{n\to\infty} S_n$ is equal to
(A) $\frac{1}{2}$
(B) $\frac{5}{36}$
(C) $\frac{5}{12}$
(D) $\frac{5}{6}$

68. If A, B $\in$ R such that the function $f(x) = \begin{cases} \frac{\pi}{2} & ; \text{ if } x \in [0, 4] \\ B\tan^{-1}\frac{2}{x-4} & ; \text{ if } x \in (4, 6) \\ \sin^{-1}(7-x) + A\frac{\pi}{4} & ; \text{ if } x \in [6, 8] \end{cases}$, is continuous in [0, 8], then $A^2 + B^2$ is equal to
(A) 1
(B) 2
(C) 3
(D) 4

69. If $f(x) = \begin{vmatrix} \cos x & x & 1 \\ 2\sin x & x^2 & 2x \\ \tan x & x & 1 \end{vmatrix}$, then $\lim\limits_{x\to0} \frac{f'(x)}{x}$ is equal to
(A) –2
(B) 0
(C) 1
(D) 2

70. If y = f(x) satisfies the differential equation $x\frac{dy}{dx} + y(2x+1) = xe^x$ and f(0) = 0, then the number of solution(s) of f(x) = $\frac{2}{x}$ is equal to
(A) 0
(B) 1
(C) 2
(D) more than 2

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

71. 5 boys (B_1, B_2, B_3, B_4 and B_5) and 5 girls (G_1, G_2, G_3, G_4 and G_5) are to be seated around a round table such that boy and girl sit alternately and B_i does not sit beside G_i $\forall$ i $\in$ {1, 2, 3, 4, 5}. If the number of such arrangements is N, then the sum of digits of N is equal to

72. A sample of 20 observations has mean of 50 and variance of 1, while a sample of 40 observations has mean of 50 and standard deviation 2. The 2 samples are combined to give complete set of 60 observations with variance σ^2, then $3\sigma^2$ is equal to

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

73. Let $f(x) = 27x^3 + 8x^2 + x + 1$, then $\lim\limits_{x\to\infty} \dfrac{x^{\frac{1}{3}}}{f^{-1}(27x) - f^{-1}(x)}$ is equal to

74. A plane (P) is parallel to the line $L \equiv \dfrac{x-1}{1} = \dfrac{y-2}{1} = \dfrac{z-3}{1}$. If the image of origin in P lies on the line L, then the square of distance of (3, 2, 1) from P is equal to

75. An aeroplane has 100 seats (numbered 1 to 100) and 100 passengers waiting to board each having a ticket with a number from 1 to 100. No number is on 2 tickets or on 2 seats. The rules of boarding are as below:
(i) Passengers board in the order of the number on their respective ticket,
(ii) The first passenger to board can sit on any seat, and
(iii) A passenger with ticket number i ($i \neq 1$) boards the plane and sits on seat numbered 'i' if it is empty, however if that seat is occupied he can sit on any empty seat.
If p is the probability that the 100th passenger sits in his assigned seat, then $p^2 + (1 - p)^2$ is equal to

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ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. B

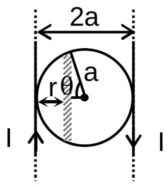
Sol. $\vec{v}_i = (v\cos\alpha)\hat{i} + (v\sin\alpha - gt)\hat{j}$

$< \vec{v} > = (v\cos\alpha)\hat{i} + (v\sin\alpha - \frac{gt}{2})\hat{j}$

$|\vec{v}_i| = |< \vec{v} >|$

$\Rightarrow\ t = \frac{4v\sin\alpha}{3g}$

2. B



Sol. r = a(1– cos θ) ⇒ dr = a sin θ dθ

Flux through the element is

$$d\phi = \frac{\mu_0 I}{2\pi a}\left[\frac{1}{(1-\cos\theta)} + \frac{1}{(1+\cos\theta)}\right]2a^2\sin^2\theta d\theta$$

$$\phi = \frac{\mu_0 I}{\pi}\int_0^{\pi}\frac{2a}{\sin^2\theta}\sin^2\theta d\theta = \frac{\mu_0 I}{\pi}2a\int_0^{\pi}d\theta$$

$\phi = 2\mu_0 Ia$

∴ mutual inductance

$M = \phi/I = 2\mu_0 a$

3. B

Sol. $V = \frac{Q}{k4\pi\varepsilon_0 r}$

$$\Rightarrow \frac{Q}{k\varepsilon_0} = 4\pi rv \quad \ldots(i)$$

$$I = \oint_S \vec{J}\cdot d\vec{s} = \sigma\oint_S \vec{E}\cdot d\vec{s} = \frac{\sigma Q}{k4\pi\varepsilon_0 r^2}4\pi r^2 = \frac{\sigma Q}{k\varepsilon_0} = 4\pi\sigma rv$$

4. C

Sol. $$\frac{q\lambda}{2\pi\varepsilon_0 r} - \frac{q\mu_0 I}{2\pi r}v = 0$$

$$v = \frac{\lambda}{\varepsilon_0\mu_0 I} = \frac{\lambda c^2}{I}$$

5. A

Sol. Speed of sound, $v = \sqrt{\frac{B}{\rho}}$

$PV^2 = K$

Bulk modulus, $B = -V\frac{dP}{dV} = \frac{2K}{V^2} = 2P$

$$v = \sqrt{\frac{2P}{\rho}}$$

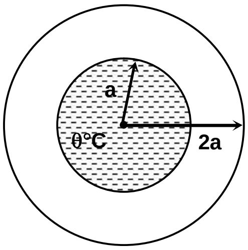
6. D

Sol. In steady state, potential difference across 6 μF capacitor = 7.5 V

∴ Charge on the 6μF capacitor, q = 6 × 7.5 = 45 μC

7. B

Sol. Thermal resistance of the spherical shell is



$$R = \int_a^{2a}\frac{dr}{K4\pi r^2} = \int_a^{2a}\frac{dr}{\frac{\alpha}{r^2}4\pi r^2} = \frac{a}{4\pi\alpha} \quad \ldots(i)$$

$$-\frac{msd\theta}{dt} = \frac{\theta-\theta_0}{R}$$

$$-mSR\int_{80}^{60}\frac{d\theta}{(\theta-\theta_0)} = \int_0^t dt$$

$$t = mSR\ell n\left(\frac{5}{3}\right)$$

$$t = \rho\frac{4}{3}\pi a^3 S\left(\frac{a}{4\pi\alpha}\right)\ell n\left(\frac{5}{3}\right)$$

$$t = \frac{\rho Sa^4}{3\alpha}\ell n\left(\frac{5}{3}\right)$$

8. C

Sol. $A = A_0 e^{-\lambda t}$

$$7.8 = 31.2e^{-\frac{\ell n2}{5570}t}$$

$\Rightarrow -2\ell n2 = -\frac{\ell n2}{5570}t$

Solving, t = 11140 years

9. A

Sol. Let v = actual velocity of fly towards right

$v_{approach} = 4 + \mu v$

$8 = 4 + \mu v$

$\therefore \quad v = 3$ m/s

10. D

Sol. $T - mg = \frac{m(3v_0)^2}{\ell}$

$T = mg + \frac{9mv_0^2}{\ell}$

11. A

Sol. $\tau_{CM} = I_{CM}\alpha$

$\mu mgR = \frac{mR^2}{2}\alpha$

$\alpha = \frac{2\mu g}{R}$

When pure rolling motion starts

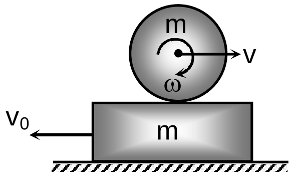
$\omega R - v = v_0$

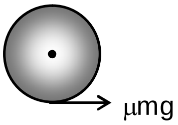
$(\omega_0 - \alpha t)R - \mu gt = \mu gt$

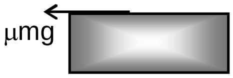
$\omega_0 R - 2\mu gt - \mu gt = \mu gt$

$\omega_0 R = 4\mu gt$

$\Rightarrow \; t = \frac{\omega_0 R}{4\mu g} = \frac{40 \times 0.4}{4 \times 0.2 \times 10} = 2\,\text{sec}$







12. A

Sol. The equation of process AB is

$P = \left(\frac{P_0}{V_0}\right)V \Rightarrow PV^{-1} = \frac{P_0}{V_0} = \text{constant}$

$\therefore$ This is a polytropic process with a polytropic constant, x = –1

$\therefore$ Molar heat capacity, $C = C_V + \frac{R}{(1-x)} = \frac{5R}{2} + \frac{R}{2} = 3R$

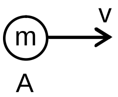
13. C

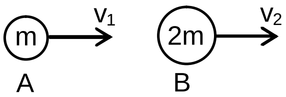
Sol. We know $E \propto \sqrt{P_{av}}$

$\frac{E_2}{E_1} = \sqrt{\frac{P_2}{P_1}} = \sqrt{\frac{100}{200}} = \frac{1}{\sqrt{2}}$

$\Rightarrow \qquad E_2 = \frac{E}{\sqrt{2}}$

14. D





Sol. From Conservation of momentum

$mv + 0 = mv_1 + 2mv_2$

$v = v_1 + 2v_2$ …(i)

coefficient of restitution;

$$e = \frac{v_2 - v_1}{v}$$

$v_2 - v_1 = v$ …(ii)

from (i) and (ii);

$$v_2 = \frac{2v}{3},\ v_1 = -\frac{v}{3}$$

$$\frac{\lambda_A}{\lambda_B} = \frac{2mv_2}{mv_1} = \frac{2v_2}{v_1} = 4$$

15. B

Sol. When $y = \frac{\beta}{4} = \frac{D\lambda}{4d}$

Path difference, $\Delta r = d\sin\theta = d\left(\frac{y}{D}\right) = d\left(\frac{\lambda}{4d}\right) = \frac{\lambda}{4}$ (for small ‘θ’)

$\therefore$ Phase difference, $\delta = \frac{2\pi}{\lambda} \times \Delta r = \frac{2\pi}{\lambda} \times \frac{\lambda}{4} = \frac{\pi}{2}$

$$I = I_0 \cos^2\left(\frac{\delta}{2}\right) = I_0 \cos^2\left(\frac{\pi}{4}\right) = \frac{I_0}{2}$$

16. D

Sol. $$A\left(\frac{2\ell}{3}\right)(2\rho)g + A\left(\frac{\ell}{3}\right)\rho g = A\ell\rho_0 g$$

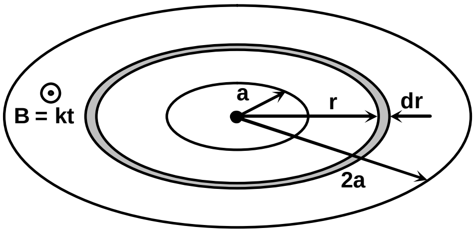
$$\frac{4\rho}{3} + \frac{\rho}{3} = \rho_0$$

$$\Rightarrow \rho_0 = \frac{5\rho}{3}$$

Specific gravity of the material of cylinder = $\rho_0/\rho = 5/3$

17. A

Sol. The emf induced in a thin circular ring of radius ‘r’ is



$$\varepsilon = \left|\frac{d\phi}{dt}\right|$$

$$\varepsilon = \frac{d}{dt}\left(kt\pi r^2\right) = k\pi r^2$$

$$\int dI = \int_a^{2a} \frac{k\pi r^2 h dr}{\rho 2\pi r}$$

$$I = \frac{kh}{2\rho}\left[\frac{r^2}{2}\right]_a^{2a} = \frac{3kha^2}{4\rho}$$

18. B

Sol. Shift, $dS = \left(1 - \frac{1}{\mu}\right)dx$

$$\int dS = \int_0^t \left(1 - \frac{t}{\mu_0 (t+x)}\right) dx$$

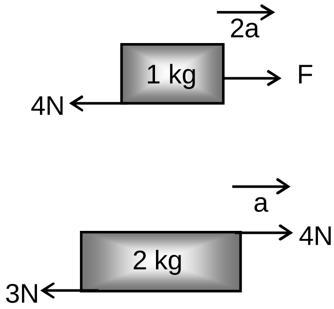
$$\Rightarrow\ t - t\left[\ell n(t+x)\right]_0^t = t - t\ell n2 = t(1 - \ell n2)$$

19. A

Sol. $F - 4 = 2a$ …(i)

$4 - 3 = 2a$ …(ii)

$\therefore F = 5N$



20. C

Sol. $I_C R_L + V_{CE} = V_{CC}$

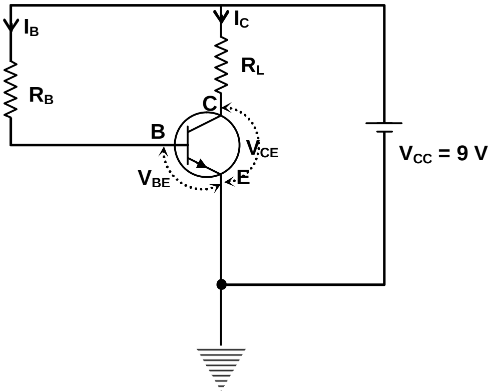
$I_C R_L = V_{CC} - V_{CE} = 9 - 5 = 4\ V$

$\therefore I_C = \frac{4}{R_L} = \frac{4}{10^3} = 4 \times 10^{-3}\ A$

$I_B = \frac{I_C}{\beta} = 4 \times 10^{-5}\ A$

$V_{CC} = I_B R_B + V_{BE}$

$$R_B = \frac{V_{CC} - V_{BE}}{I_B} = \frac{9 - 1.4}{4 \times 10^{-5}} = 1.9 \times 10^5\ \Omega = 190\ k\Omega$$



SECTION – B

21. 4

Sol. Velocity of longitudinal wave in a solid rod is

$$v = \sqrt{\frac{Y}{\rho}} = \sqrt{\frac{1.6 \times 10^{11}}{2500}} = \frac{4}{5} \times 10^4 = 8000\ \text{m/s}$$

Now, $n_1 : n_2 : n_3 = \ell_1 : \ell_2 : \ell_3$

$= 15 : 70 : 15$

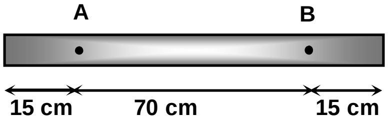
$= 1.5 : 7 : 1.5$

No. of loops formed in the fundamental mode of vibration $= 1.5 + 7 + 1.5 = 10$ loops

$\therefore 10(\lambda/2) = \ell$

$\Rightarrow \lambda = (2\ell)/10 = 0.2\ m$

$\therefore$ fundamental frequency, $f = \frac{v}{\lambda} = \frac{8 \times 10^3}{0.2} = 40\ kHz$



22. 1

Sol. $a = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) g$

$$\frac{\Delta a}{a} = \frac{\Delta g}{g} + \frac{\Delta(m_1+m_2)}{m_1-m_2} + \frac{\Delta(m_1+m_2)}{m_1+m_2}$$

$$\frac{\Delta a}{a} = \frac{0.01}{9.80} + \frac{0.4}{60} + \frac{0.4}{147} = 1\%$$

SECTION – C

23. 00002.82

Sol. $\omega = 2\pi n = 2\pi \times \frac{1}{4\pi} = 0.5$ rad/s

$$\frac{1}{2}mv_r^2 = \left(\frac{3}{2}\frac{KQq}{R} - \frac{KQq}{R}\right) + \int_0^R m\omega^2 r dr$$

$$\frac{1}{2}mv_r^2 = \frac{KQq}{2R} + \frac{m\omega^2R^2}{2} \Rightarrow v_r^2 = \frac{kQq}{R} + \omega^2R^2$$

$$v_r^2 = \frac{9\times10^9\times8}{2}\times\frac{1}{6}\times10^{-9} + 1 = 7 \Rightarrow v_r = \sqrt{7}\text{ m/s}$$

$$v_t = \omega R = 1\text{ m/s}$$

$$v = \sqrt{v_r^2 + v_t^2} = \sqrt{7+1} = \sqrt{8} = 2\sqrt{2} = 2 \times 1.41 = 2.82\text{ m/s}$$

24. 00002.25

Sol. $v + f_e = 26$ cm

$\Rightarrow v = 26 - 2.5 = 23.5$ cm

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f_0}$$

$$1 - \frac{v}{u} = \frac{v}{f_0} \Rightarrow \frac{v}{u} = 1 - \frac{v}{f_0} = 1 - \frac{23.5}{1} = -22.5\text{ cm}$$

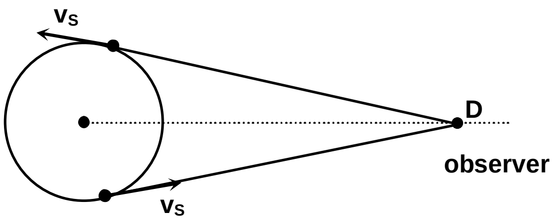
Angular magnification, $m = \frac{v}{u}\frac{D}{f_e} = -22.5 \times \frac{25}{2.5} = -225$

$|m| = 225$

$100x = 225 \Rightarrow x = 2.25$

25. 00042.50

Sol. $f_{max} = \left(\frac{v}{v - v_S}\right)f$



$$f_{max} = \frac{340}{320} \times 360\text{ Hz} = 382.5\text{ Hz}$$

$$f_{min} = \left(\frac{v}{v + v_S}\right)f$$

$$f_{min} = \frac{340}{360} \times 360\text{ Hz} = 340.0\text{ Hz}$$

$$\therefore\ f_{max} - f_{min} = 42.50\text{ Hz}$$

Chemistry

PART – II

SECTION – A

26. B

Sol. (A) The value of steric factor decreases as the complexity of reacting molecules increases.
(C) If chain termination is slower than chain branching and chain propagation, explosion occurs.
(D) N_2 is used to remove the excess energy as O_3 formed at lighter energy level can redissociate.

27. C

Sol. Stability order is
C > B > D > A

28. C

Sol. Due to highest electronegativity difference also due to bond order greater than 1 in BF_3 (only).

29. A

Sol. B & C are non aromatic as both are non planar.

30. D

Sol. Melting point of sodium (Na) is 371 K (approx), hence it is obtained in liquid state even at 850 K, the temperature of operation.

31. D

Sol. $\left[OH^-\right] = \sqrt{1.5\times10^{-8}}$ = 1.225 × 10^{-4}; pOH = 3.912;
Hence, pH = 10.088

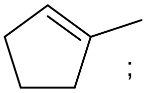
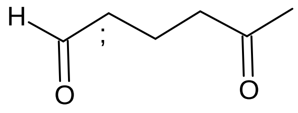
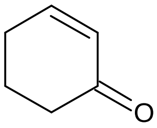
32. A

Sol. (B) Duma's method, the organic compound is heated with CuO, not with Cu_2O.
(C) Fuming HNO_3 is used in Carius method.
(D) N, S, X (halogen) and phosphorus present in an organic compound are detected by Lassaigne's test.

33. D

34. B

Sol.

A =  ; B =  ; C = 

35. B

Sol. In A, C and D – S_N1 runs in parallel.

36. D

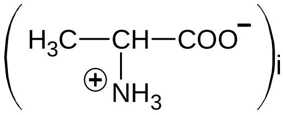
Sol. All are free radical reactions.

37. D

Sol. Carbon reduction is employed for extraction of Fe, Pb, Zn and Sn etc. generally.

38. B
Sol. Spin only magnetic moment of A, C and D are zero. 'C' cannot show ionization isomerism. While 'D' does not show geometrical isomerism.

39. C
Sol. By the processes defined in A, B and D, Alanine



$\left(H_3C - \underset{\overset{\oplus}{N}H_3}{\underset{|}{CH}} - COO^{-} \right)$

is formed.

40. C
Sol. (A) $Al + dil.\ H_2SO_4 \longrightarrow Al_2(SO_4)_3 + H_2 \uparrow$

(B) $Al + AlCl_3 \xrightarrow{\text{High temperature}} AlCl$

(D) AlCl disproportionates below 800^oC to give $AlCl_3$ and Al.

41. D
Sol. Shapes of MX_2 (M = alkali earth metals) change from linear to bent from top to bottom.

42. C
Sol. $Be(OH)_2$ solution is amphoteric.
- pK_a of CH_3COOH is 4.76.
- pK_a of CH_3COOH is 3.76.

43. A
Sol. The order of corresponding equilibrium constants is : $K_4 < K_3 < K_2 < K_1$.

44. C
Sol. (A) Rain cloud – Aerosol

(B) Soapsuds – Foam

(D) Milk of magnesia – Sol

45. D
Sol. Chlorine water oxidizes Br^- to Br_2 and I^- to I_2.
Also, Br_2 water oxidize I^- to I_2.

SECTION – B

46. 8
Sol. For the given reaction : n = 2.

$E^o_{cell} = 0.24$

Hence, $E^o = \frac{0.06}{2}\log K_{eq}$

$\frac{0.24 \times 2}{0.06} = \log K_{eq}$

$K_{eq} = 10^8$

Hence, x = 8.

47. 3

Sol. $\underset{(\text{Glucose})}{C_6H_{12}O_6} \xrightarrow{HIO_4} 5HCOOH + HCHO;$

1 mole $\equiv$ 180 gm glucose give 30 gm HCHO
Hence, 18 gm glucose give 3 gm of HCHO.

SECTION – C

48. 00000.96

Sol. $K_P = 1.5 \times 1.5 = 2.25 \text{ atm}^2$

At new equilibrium:

$2.25 = P'_{H_2S} \times 2$

$P'_{H_2S} = 1.125$

$P_{total} = 3.125$

Hence, the desired ratio is $\frac{3}{3.125} = 0.96$

49. 00299.50

Sol. $H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(g);$

$\Delta H_f(H_2O, g) = \in_{H-H} + \frac{1}{2}\in_{O=O} - 2\times \in_{O-H}$

= - 299.50 (kJ/mole)

50. 00015.99

Sol. $\text{Density} = \frac{ZM}{N.a^3}; Z = 4(\text{fcc})$

M = 65 gm/mole
a = 300 pm = 3 × 10^{-8} cm.
Hence, density = 15.99 gm/cm^3.

Mathematics PART – III

SECTION – A

51. A

Sol. (~p ∨ q) ∨ (~q ∨ r)

52. C

Sol. The circles touch each other at (1, 1)

53. C

Sol. $x = \pm\sqrt{2}$

54. D

Sol. Use half angle formulae and Heron's formula

55. D

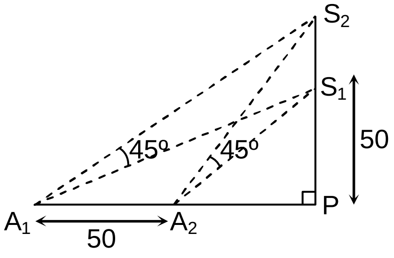
Sol. A_1, A_2, S_1 and S_2 are concyclic.

$\angle S_2A_1S_1 = \angle S_2A_2S_1 = 45°$ and $\angle S_1A_1A_2 = \angle S_1S_2A_2 = \alpha$

$\Rightarrow \angle A_1S_1A_2 = \angle A_1S_2A_2 = 45° - 2\alpha$

$$\frac{50}{\sin\left(\frac{\pi}{4} - 2\alpha\right)} = \frac{A_1S_1}{\sin\left(\frac{3\pi}{4} + \alpha\right)}$$, but $A_1S_1 = 50 \operatorname{cosec} \alpha$

$$\Rightarrow \tan\alpha = \frac{1}{3} \;\therefore\; S_1S_2 = \frac{A_1S_1}{\sin\left(\frac{\pi}{4} - \alpha\right)} \cdot \sin\frac{\pi}{4} = 250$$



56. B

Sol. Property, SP = Geometric mean of length of tangents

57. D

Sol. $\frac{x}{4} + \frac{y}{9} = 1$

58. B

Sol. Midpoint of segment between asymptotes is same as midpoint of chord

59. D

Sol. $x^2 - \frac{y^2}{66} = (\ell x + my)^2 \Rightarrow 1 - \ell^2 - \frac{1}{66} - m^2 = 0 \Rightarrow \ell^2 + m^2 = \frac{65}{66}$

60. B

Sol. $\int_{-3}^{3} f(x)dx \cdot \int_{0}^{1} f(x)dx < 0$, where $f(x) = ax^2 + bx + c$

61. D

Sol. z_1 lies on line joining 3 + 4i and 4 – 3i, which also contains the point 5 – 10i. So, expression is slope of perpendicular to this line

62. A

Sol. $\vec{c} = \lambda\left(\frac{\vec{a}}{|\vec{a}|} - + \frac{\vec{b}}{|\vec{b}|}\right)$

63. D

Sol. $A = \int_0^{\frac{1}{3}} \sqrt{12x}\,dx + \int_{\frac{1}{3}}^{1} \left(\frac{1}{x} - 1\right) dx$

64. D

Sol. $\lim_{n\to\infty} \frac{1}{n} \sum_{i=1}^{n-1} \frac{\frac{i}{n^2}}{1 + \frac{i^4}{n^2}} = \int_0^1 \frac{x}{1+x^4} = \frac{1}{2}\tan^{-1} x^2 \Big|_0^1 = \frac{\pi}{8}$

65. C

Sol. $\left(\frac{z+1}{z-1}\right)^{2n} = -1$

66. A

Sol. $ST^2 = AS^2 + AT^2 - 2AS\cdot AT\cdot \cos\alpha$ and $AS\cdot AT = \frac{1}{2}bc$

67. B

Sol. $t_n = \frac{1}{(n+1)(n+2)(n+3)} + \frac{1}{n(n+1)(n+2)(n+3)}$

68. B

Sol. A = –1, B = 1

69. A

Sol. $f(x) = x^2 (\tan x - \cos x)$

70. C

Sol. $xye^{2x} = \frac{xe^{3x}}{3} - \frac{e^{3x}}{9} + \frac{1}{9}$

SECTION – B

71. 6

Sol. $4!\cdot(2!\cdot 3 + 2 \times 2 + 3) = 312$

72. 9

Sol. $\sigma^2 = \frac{20 \times 1 + 40 \times 2^2}{60} = 3$ (Because mean of both samples is the same)

SECTION – C

73. 00001.50

Sol. $$\left.\begin{array}{l} f\left(x^{\frac{1}{3}}\right) > 27x > f\left(x^{\frac{1}{3}}-1\right) \\ f\left(\dfrac{x^{\frac{1}{3}}}{3}\right) > x > f\left(\dfrac{x^{\frac{1}{3}}}{3}-1\right) \end{array}\right\}$$ for large enough x, now use Sandwich Theorem.

74. 00004.50

Sol. Plane is –x + z = 1 $\Rightarrow$ $d = \frac{3}{\sqrt{2}}$

75. 00000.50

Sol. p = 0.5 as there is a bijection between the sequences where 100th passenger sits in his assigned seat and the sequences where he doesn't.

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VII

JEE (Advanced)-2020

PAPER – 1

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B.**

1. ***Section-A (01– 7, 19 – 25, 37 – 43)*** *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*

   Partial Marks **+1** for each correct option provided no incorrect option is selected.

   Section-A (08 – 13, 26 – 31, 44 – 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S). Each multiple choice question with 4 options has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section–B (14 – 18, 32 – 36, 50 – 54)*** *contains 15 Numerical based questions with answers as numerical value from 0 to 9 and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. Nucleus A decays to B with decay constant λ_1 and B decays constant λ_2. Initially at t = 0, number of nuclei of A and B are $2N_0$ and N_0 respectively. At $t = t_0$, number of nuclei of B stop changing. If at this instant number of nuclei of B are $\frac{3N_0}{2}$.

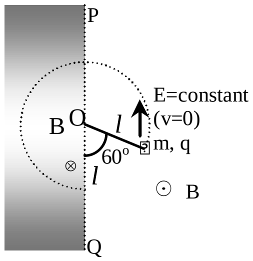
(A) The value of t_0 is $\frac{1}{\lambda_1}\ln\frac{4}{3}\frac{\lambda_1}{\lambda_2}$

(B) The value of t_0 is $\frac{1}{\lambda_2}\ln\frac{4}{3}\frac{\lambda_1}{\lambda_2}$

(C) The value of N_A at t_0 is $\frac{3N_0}{2}\frac{\lambda_2}{\lambda_1}$

(D) The value of N_A at t_0 is $\frac{2N_0}{3}\frac{\lambda_2}{\lambda_1}$

2. Consider a bob of mass m and having charge q attached with a light string of length l and pivoted at point O. It is released at rest at 60° with vertical. There are two regions– Region-I (left of line PQ) has a uniform and constant magnetic field B directed inside plane of paper. Region-II (right of line PQ) has a constant and uniform electric field E directed vertically up as shown. Consider no effect of gravity in both the regions.



(A) Time taken by particle to cross region-I for 1st time is $\pi\sqrt{\frac{2ml}{5qE}}$

(B) Time taken by particle to cross region-I for 2nd time is $\pi\sqrt{\frac{2ml}{13qE}}$

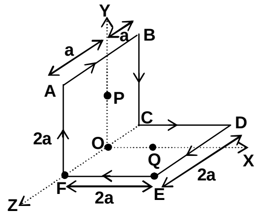
(C) Angular speed of 1st revolution in magnetic field is $\sqrt{\frac{5qE}{2ml}}$

(D) Angular speed of 2nd revolution in magnetic field is $\sqrt{\frac{13qE}{ml}}$

Space for Rough work

3. A binary stars system in which stars are considered as point mass having mass m and 2m are separated by a large distance ‘r’. Choose the correct statement(s)
(A) Radius of circular path of star of mass 2m is r/3.
(B) Kinetic energy of 2m mass star is one forth of that of lighter star.
(C) Time period of revolution of each star is same
(D) Angular momentum of lighter star is more.

4. A wire frame ABCDEF is kept as shown in figure. I am the current in the wire frame.



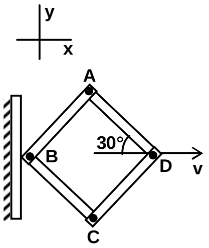
(A) The direction of magnetic field at ‘O’ due to the wire frame will be along $\left(\frac{-\hat{i}-\hat{j}}{\sqrt{2}}\right)$
(B) The direction of magnetic field at P (0, a, 0) due to wire CD and EF will be along $-\hat{j}$
(C) The direction of magnetic field at Q(a, 0, 0) due to wire EF and CD will be along $\left(-\hat{j}\right)$
(D) The direction of magnetic field at P(0, a, 0) due to wire AF and CB will be along $\left(-\hat{i}\right)$

5. Which of the following represents a progressive harmonic wave?
(A) A (ax – bt)
(B) A tan (ωt – kx)
(C) A cos (vt – x)
(D) A cos kx sinωt

6. A small ball of mass ‘m’& radius r is released from rest in a viscous liquid of coefficient of viscosity η and density half of that of ball. Choose the correct option(s)
(A) The ball will never attain constant velocity
(B) After time $t = \frac{m\ell n2}{6\pi\eta r}$ the velocity of ball will be half of the terminal velocity
(C) The instantaneous velocity of ball at a time t is given by $v = v_T\left(1 - e^{-\frac{6\pi\eta r}{m}t}\right)$
(D) The velocity of ball will remain constant

Space for Rough work

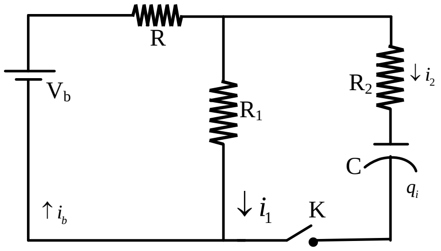
7. ABCD is a wire frame of identical wires in which point D is given velocity v as shown in figure. Choose the correct statement(s)
(A) Velocity of point A along x-axis will be v/2
(B) Speed of point A will be v
(C) Speed of point A along y-axis will v/2
(D) Velocity of point A will be equal to velocity of point C



(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions Q. 8, Q. 9 and Q. 10 by appropriately matching the information given in the three columns of the following table.



q_i is the initial charge on the capacitor. The key K is closed at t=0

Column 1		Column 2		Column 3	
(I)	$V_b=0V$	(i)	$R_1=R_2=5\Omega$ $R=10\Omega$	(P)	$C=5\mu F$ $q_i=0$
(II)	$V_b=30V$	(ii)	$R_1=5\Omega$ $R_2=10\Omega$ $R=10\Omega$	(Q)	$C=20\mu F$ $q_i=0$
(III)	$V_b=-30V$	(iii)	$R_1=10\Omega$ $R_2=5\Omega$ $R=10\Omega$	(R)	$C=5\mu F$ $q_i=100\mu C$
(IV)	$V_b=60V$	(iv)	$R_1=R_2=R=10\Omega$	(S)	$C=20\mu F$ $q_i=100\mu C$

Space for Rough work

8. In which of the following cases, will the current $i_1 = \frac{5}{3}\text{A}$, initially?

(A) (I) (i) (P)

(B) (II) (iv) (R)

(C) (II) (iv) (P)

(D) (I) (iii) (Q)

9. In which of the following cases will the net charge flowing through the capacitor be equal to 300 μC?

(A) (II) (i) (S)

(B) (I) (ii) (R)

(C) (IV) (i) (S)

(D) (III) (iii) (P)

10. In which case will the current through R decay exponentially to zero with a time constant of 0.2 ms?

(A) (IV) (ii) (Q)

(B) (I) (iii) (S)

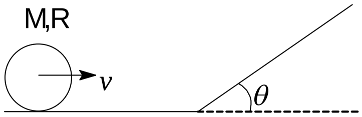
(C) (II) (i) (R)

(D) (I) (iii) (Q)

Space for Rough work

Answer questions Q. 11, Q. 12 and Q. 13 by appropriately matching the information given in the three columns of the following table.

An object of mass M and radius R is pure rolling on a horizontal surface. It smoothly climbs over an rough incline with sufficient friction to ensure no slipping. The following grid has 3-columns: Column- I represents the type of object. Column II represents the maximum height attained by the object and column III represents the time taken to reach the maximum height.



Column 1 (Object)		Column 2 (Height)		Column 3 (Time)	
(I)	Ring	(i)	$\frac{7v^2}{10g}$	(P)	$7v/5g\sin\theta$
(II)	Disc	(ii)	$\frac{3v^2}{4g}$	(Q)	$2v/g\sin\theta$
(III)	Hollow sphere	(iii)	v^2/g	(R)	$3v/2g\sin\theta$
(IV)	Solid sphere	(iv)	$\frac{5v^2}{6g}$	(S)	$5v/3g\sin\theta$

11. Pick the correct combination:-

(A) $(\mathrm{I})\ (\mathrm{i})\ (\mathrm{P})$

(B) $(\mathrm{III})\ (\mathrm{ii})\ (\mathrm{Q})$

(C) $(\mathrm{II})\ (\mathrm{ii})\ (\mathrm{R})$

(D) $(\mathrm{IV})\ (\mathrm{iv})\ (\mathrm{P})$

Space for Rough work

12. The combination where the total mechanical energy is maximum will be
(A) (I) (iii) (Q)
(B) (II) (ii) (R)
(C) (III) (iv) (P)
(D) (IV) (i) (S)

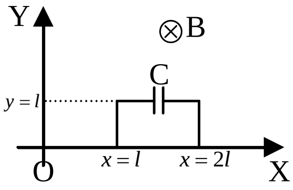
13. The combination for which maximum friction acts between the body and the incline is
(A) (I) (iii) (Q)
(B) (II) (ii) (R)
(C) (III) (iv) (S)
(D) (IV) (i) (P)

SECTION – B
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

14. A square frame of wire connected to a capacitor is kept in a magnetic field which varies with position as well as time and is given as $\vec{B} = \alpha xt\left(-\hat{k}\right)$ as shown in figure, where α is a constant. The charge on the capacitor at any time is $\frac{n}{2}C\alpha l^3$. Then find the value of 'n'.



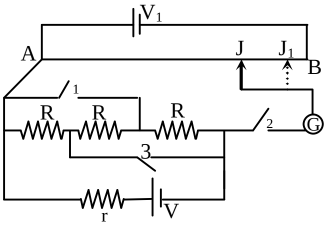
Space for Rough work

15. A large concave mirror with a radius of curvature of 0.5 m is placed on a horizontal plate. We pour a small amount of water into the mirror and place on it a plano-convex lens with a radius of curvature of 1.0 m whose plane side just covers the water. Then we place a point light source above this set-up at a height of 0.3 m. The distance (in metres) from the object where the final image is formed will be $\frac{x}{90}$. Find x given that the refractive index of water is $\frac{4}{3}$ and the refractive index of glass is 1.50.

16. A radioactive sample contains two nuclides A and B having decay constant λhr^{-1} and $2\lambda hr^{-1}$. Initially 25% of total decay comes from A. How long (in hr) will it take before 75% of total decay comes from A.
[Take $\lambda = \ln 3$]

17. An electron accelerated by a potential difference $V = 3.6\text{ V}$, first enters a region of uniform electric field of a parallel-plate capacitor whose plates extend over a length $l = 6\text{ cm}$ in the direction of initial velocity. The electric field is normal to the direction of initial velocity and its strength varies with time as $E = a \times t$ where $a = 3200\text{ Vm}^{-1}\text{s}^{-1}$. Then the electron enters a region of uniform magnetic field of induction $B = \pi \times 10^{-9}\text{ T}$. Direction of magnetic field is same as that of the electric field. Calculate the pitch (in mm) of helical path traced by the electron in the magnetic field. (Mass of electron, $m = 9 \times 10^{-31}\text{kg}, e = 1.6 \times 10^{-19}\text{C})$.
[Neglect the effect of induced magnetic field].

18. In the given circuit wire AB is of uniform resistance. On closing switch 2 with other two switches open, the balance length AJ is L_1. On closing all the switches, the balance length AJ_1 is L_2. The internal resistance of the battery V is $nR\Omega$.Find n. $\left(\frac{L_1}{L_2} = 3\right)$



Space for Rough work

Chemistry

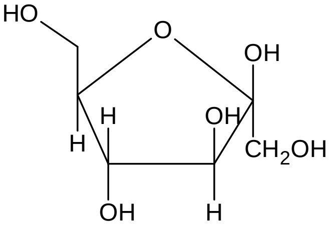
PART – II

SECTION – A

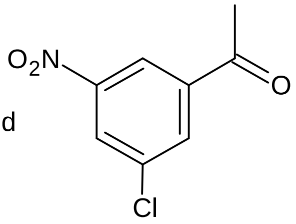
(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

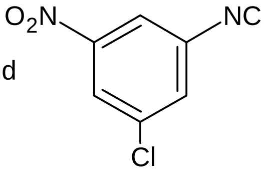
19. The correct statement regarding compound is:



(A) Can reduce Tollen’s reagent
(B) It is furanose compound
(C) It can show mutarotation
(D) Stable in basic condition

20. An oxime of compound 

whenever treated with H_2SO_4/Δ gives a compound P, which on hydrolysis produces Q and R. If Q is an aliphatic primary amine, then choose the correct option(s)?

(A) R is soluble in hot aqueous NaOH
(B) R gives brisk effervence of CO_2 with aqueous $NaHCO_3$
(C) Q can give foul smelling compound 

with $CHCl_3/NaOH$
(D) Q on Hofmann exhaustive methylation gives product which has very high solubility in water

Space for Rough work

21. $$\mathrm{Zn}\left(OH\right)_2\left(s\right) \rightleftharpoons Zn\left(OH\right)_2\left(aq.\right) \qquad K_1 = 10^{-6}\ M$$

$$\mathrm{Zn}\left(OH\right)_2\left(aq.\right) \rightleftharpoons Zn\left(OH\right)^{+} + OH^{-} \qquad K_2 = 10^{-7}\ M$$

$$\mathrm{Zn}\left(OH\right)^{+} \rightleftharpoons Zn^{2+} + OH^{-} \qquad K_3 = 10^{-4}\ M$$

$$\mathrm{Zn}\left(OH\right)_2\left(aq.\right) + OH^{-} \rightleftharpoons Zn\left(OH\right)_3^{-} \qquad K_4 = 10^{3}\ M^{-1}$$

$$\mathrm{Zn}\left(OH\right)_3^{-} + OH^{-} \rightleftharpoons Zn\left(OH\right)_4^{2-} \qquad K_5 = 10\ M^{-1}$$

Which of the following options are correct about solubility of zinc hydroxide at various pH.

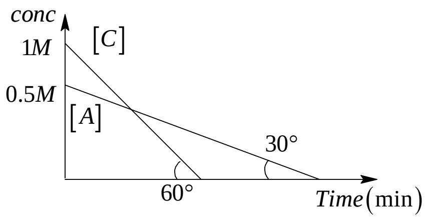
(A) $2\times10^{-4}\ M\ at\ pH = 13$

(B) $1.12\times10^{-6}\ M\ at\ pH = 9$

(C) $10\,M\ at\ pH = 5$

(D) $10^{-10}\ M\ at\ pH = 5$

22. For the two reactions $I : A \rightarrow B; II : C \rightarrow D$ following graph is obtained:



Which of the following statement is false?

(A) If $\left[B\right] = \left[A\right]$ then at that time $\left[D\right] = 0.75M$

(B) If $\left[C\right] = \left[A\right]$ then at that time $\left[B\right] > \left[D\right]$

(C) $\left(\mathrm{t}_{100\%}\right)_{\text{Reaction I}} = \left(\mathrm{t}_{100\%}\right)_{\text{Reaction II}}$

(D) $\left[A\right] = \left[C\right]\ \text{at}\ t = \dfrac{\sqrt{3}}{2}\min$

23. The ions for which all octahedral complexes are paramagnetic irrespective of ligand?

(A) Sc^{3+}, Ti^{3+}

(B) Cr^{3+}, Co^{3+}

(C) Ti^{3+}, V^{3+}

(D) Fe^{3+}, Ni^{3+}

Space for Rough work

24. In the reaction sequence given below A is an anionic Fe(II) complex

$$A \xrightarrow{aq.NO_2^-} \underset{\text{brown}}{B} \xrightarrow{aq.S^{-2}} \underset{\text{(Purple)}}{C}$$

Match the A,B, C with correct option.

	COLUMN – I		COLUMN-II
(1)	A	(P)	$Na_2[Fe(CN)_5NO]$
(2)	B	(Q)	$Na_4[Fe(CN)_6]$
(3)	C	(R)	$Na_4[Fe(CN)_5(NO)(SO_3)]$
		(S)	$Na_4[Fe(CN)_5NOS]$
		(T)	$[Fe(NO)(H_2O)_5]SO_4$
		(U)	Hybridisation of central metal atom is d^2sp^3
		(V)	Sodium penta cyano nitrosyl ferrate (II)

(A) 1-QU, 2-PSR, 3-SU
(B) 1-QU, 2-PUV, 3-PT
(C) 1-QV, 2-PUV, 3-SU
(D) 1-QU, 2-PUV, 3-SU

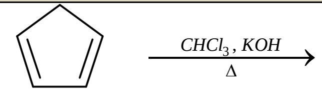
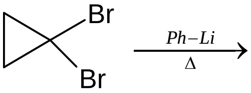
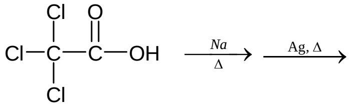
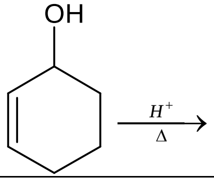
25. In a reaction $[Co(NH_3)_6]^{2+} \xrightarrow[\text{air}]{\text{bubble in}} [Co(NH_3)_6]^{3+}$, which of the following are correct about this reaction?
(A) Co^{3+} complex is more stable then Co^{2+} complex
(B) Charge transfer spectra is responsible for colour of both complexes
(C) Reduction by air
(D) Co^{3+} has high crystal field stabilization energy than Co^{2+}.

Space for Rough work

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions Q. 26, Q. 27 and Q. 28 by appropriately matching the information given in the three columns of the following table.

	Column 1 (Reaction)		**Column 2 (Intermediate)**		**Column 3 (Double bond equivalent in the Final product)**
(I)		(i)	Carbocation	(P)	0
(II)		(ii)	Carbanion	(Q)	4
(III)	 $CCl_3COOH \xrightarrow[\Delta]{Na} \xrightarrow{Ag,\ \Delta}$	(iii)	Free Radical	(R)	2
(IV)		(iv)	Carbene	(S)	3

26. Which of the following is correct combination if the given matrix?

(A) (II) (iv) (R)

(B) (I) (ii)(iv) (R)

(C) (II) (ii)(iv) (R)

(D) (III) (iii) (P)

Space for Rough work

27. Which of the following is correct combination if the given matrix?
(A) $(\mathrm{IV})(\mathrm{i})\ (\mathrm{R})$
(B) $(\mathrm{I})\ (\mathrm{iv})\ (\mathrm{R})$
(C) $(\mathrm{III})\ (\mathrm{iv})\ (\mathrm{P})$
(D) $(\mathrm{I})\ (\mathrm{ii})(\mathrm{iv})\ (Q)$

28. In which case the product is used for anesthetic purposes in old time
(A) $(\mathrm{IV})(\mathrm{i})\ (\mathrm{R})$
(B) $(\mathrm{IV})\ (\mathrm{i})\ (\mathrm{Q})$
(C) $(\mathrm{III})\ (\mathrm{ii})\ (\mathrm{R})$
(D) $(\mathrm{III})\ (\mathrm{iv})\ (\mathrm{Q})$

Answer questions Q. 29, Q. 30 and Q. 31 by appropriately matching the information given in the three columns of the following table.

Column-1 [Reactant-1]		Column-2 [Reactant-2]		Column-3 [Product]	
(I)	MnO_4^-	(i)	$H_2C_2O_4$	(P)	MnO_2
(II)	$K_2Cr_2O_7$	(ii)	$Na_2S_2O_3$ in H^+	(Q)	$MnSO_4$
(III)	I_2	(iii)	SO_2	(R)	CO_2
(IV)	CO	(iv)	Fe_2O_3	(S)	H_2SO_4

29. Which of the following combinations is not possible?
(A) $(\mathrm{I})\ (\mathrm{i})\ (\mathrm{R})$
(B) $(\mathrm{II})\ (\mathrm{iii})(\mathrm{S})$
(C) $(\mathrm{III})\ (\mathrm{ii})(\mathrm{S})$
(D) $(\mathrm{IV})\ (\mathrm{iv})\ (\mathrm{R})$

Space for Rough work

30. Which of the following is not possible in an acidic medium?

(A) (I) (iv) (P)

(B) (II) $(\mathrm{iii})(\mathrm{S})$

(C) (I) (iii) (Q)

(D) (II) (i) (R)

31. In which of the following combinations will the reactants react in 2:5 ratio.

(A) (II) (i) (R)

(B) (I) $(\mathrm{i})(\mathrm{Q})$

(C) (IV) $(\mathrm{iv})(\mathrm{R})$

(D) (I) (iii) (S)

SECTION – B
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

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32. Predict whether or not AgCl will be precipitated from a solution which is $0.02\mathrm{M}$ in NaCl and $0.1\mathrm{M}$ in $[\mathrm{Ag}(CN)_2]^-$. Given $K_{\text{dissociation of the complex ion}} = 4.0\times10^{-17}$ and K_{sp} $\mathrm{AgCl}=2.8\times10^{-10}$.

(i) mark 0, if ppt of $AgCl$ form
(ii) mark 1, if no ppt form
(iii) mark 2, if ppt of $NaCN$ form
(iv) mark 3, if ppt of KCN form

33. A $0.5\,mL$ sample of an aqueous solution containing $0.48\,\mu Ci$ per mL of Na^{22} is injected into the bloodstream of an animal. After allowing sufficient time for complete circulatory mixing a $0.1\,mL$ sample of blood is removed and found to have a net activity of 444 dpm of Na^{22} from this data, the blood volume of animal was found to be $60x$ mL. Find the value of x.

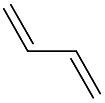
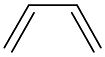
Space for Rough work

34. For the two parallel reaction $A \xrightarrow{k_1=2\sec^{-1}} B$ and $A \xrightarrow{k_2=4\sec^{-1}} C$, the activation energy E' for the disappearance of A is given in terms of activation energies E_1 and E_2 for the two path by

$E' = \frac{E_1 + 2E_2}{x}$. The value of x is………

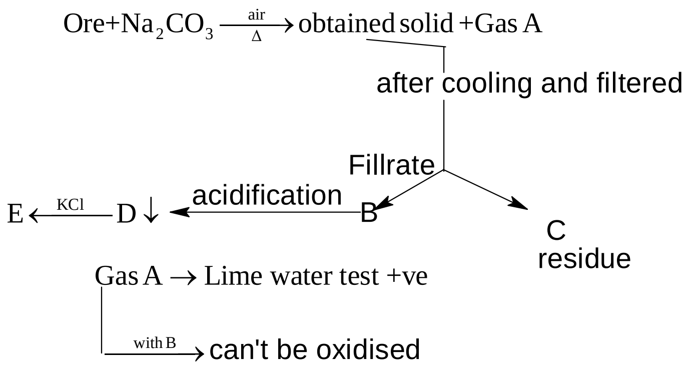
35. The correct statement(s) is/are $'x'$ then value of $\frac{x}{2.5}$ will be:

(a) In some cases, constitutional isomers are chiral
(b) In every cases, a pair of enantiomers have a mirror-image relationship
(c) Mirror-image molecules are in all cases enantiomers
(d) If a compound has an enantiomer it must be chiral
(e) Every chiral compound has a diastereomer
(f) If a compound has a diastereomer it must be chiral
(g) Every molecule containing one or more asymmetric carbons is chiral
(h) Any molecule containing a stereocentre must be chiral
(i) Any molecule with a stereocentre must show stereoisomerism
(j) Some diastereomers are mirror images to each other
(k) Any chiral compound with a single asymmetric carbon must have a positive optical rotation if the compound has the R configuration.
(l) If a structure has no plane of symmetry it is chiral
(m) All chiral molecules have no plane of symmetry
(n) All asymmetric carbons are stereocentre
(o) Gauche form of n-butane is chiral however anti form is achiral
(p) Molecules with two or more identically substituted stereocenters may exists as meso stereoisomers
(q) A stereocentre can be tetrahedral or trigonal planer

(r)  and  both are comformational diastereomers.

Space for Rough work

36.


Ore+Na₂CO₃ —air, Δ→ obtained solid +Gas A
after cooling and filtered
Fillrate
acidification
E
KCl
D↓
B
C
residue
Gas A → Lime water test +ve
with B
can't be oxidised

E is an oxidising agent and when a paper dipped in E solution comes in contact with SO_2 changes colour from orange to green.

Now, how many are correct about above flow diagram?

(A) Lime is added with Na_2CO_3, keeps the mass porous so that air becomes accessible to all parts reaction mixture and prevents fusion

(B) ‘C’ is mainly Fe_2O_3

(C) Filtrate is a yellow solution.

(D) During acidification a redox reaction is taking place.

(E) D contain 2 salts in solution and when fractional crystallisation occurs salt of lower molecular mass comes out first and is filtered off.

(F) Acidication gives two salts both hydrated. The one which has more water of hydration is less soluble

(G) When pH of solution is increased the colour of solution of E changes from orange to yellow

(H) The oxidising anions present in flow diagram can be distinguished by $AgNO_3$ One gives reddish-brown ppt and other gives brick red ppt.

Space for Rough work

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

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37. If the imaginary part of $\frac{z-3}{e^{1\theta}}+\frac{e^{i\theta}}{z-3}$ is zero, then z lies on

(A) A circle with unit radius
(B) A circle with radius 3 units
(C) A straight line through the point (3, 0)
(D) A parabola with the vertex (3, 0)

38. If $\frac{{}^{50}C_{5r}}{{}^{50}C_r}=29\times 43\times\frac{a}{b}$ where $a\in I^+$ is not a multiple of 47 and $b\in I^+$ then which of the following is true?

(A) r is a prime number
(B) r is a composite number
(C) r has two different integer values
(D) exponent of prime number 3 in $\frac{{}^{50}C_{5r}}{{}^{50}C_r}$ is 2

39. If $\lim\limits_{x\to 0}\frac{\sin\left(m^2+n^2\right)x}{\tan\frac{x}{\sqrt{3}}}=25$ where m, n $\in$ N

(A) m = 4, n = 3
(B) n = 3, m = 4
(C) m = 5, n = 1
(D) m = 1, n = 5

Space for Rough work

40. Tangents are drawn to the circle $x^2 + y^2 = 50$ from a point 'P' lying on the x-axis. These tangents meet the y-axis at points 'P_1' and 'P2'. Possible coordinates of 'P' so that area of triangle PP_1P_2 is minimum, are
(A) (10, 0)
(B) $(10\sqrt{2}, 0)$
(C) (-10, 0)
(D) $(-10\sqrt{2}, 0)$

41. The chord x+y=1 cuts the curve $y^2=12x$ in points A and B. The normals at A and B intersect at C. A third line from C cuts the $y^2=12x$ normally at D. Then which of the following is/are correct
(A) Sum of slopes of normals at A and B is 3
(B) Coordinates of D are (12,12)
(C) Tangent at D intersect y axis at (0,6)
(D) Coordinates of D are (12,–12)

42. The parametric angle θ, where $-\pi < \theta \le \pi$, of the point on the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2} = 1$ at which the tangent drawn cuts the intercept of minimum length on the co-ordinates axis, is/are:
(A) $\tan^{-1}\sqrt{\frac{b}{a}}$
(B) $-\tan^{-1}\sqrt{\frac{b}{a}}$
(C) $\pi - \tan^{-1}\sqrt{\frac{b}{a}}$
(D) $\pi + \tan^{-1}\sqrt{\frac{b}{a}}$

Space for Rough work

43. A chord AB, which is bisected at (1, 1) is drawn to the hyperbola $x^2+4xy-y^2-3=0$ with centre 'C' which intersects its asymptotes in E and F. Then

(A) Radius of the circum circle of Δ CEF is $\sqrt{2}$

(B) It e_k be the eccentricity of hyperbola $x^2+4xy-y^2-3k=0\ \forall k=1,\ 2,\ 3,\ldots..2014$, then $\prod_{k=1}^{2014} e_k = 2^{1007}$

(C) Slope of the line $\perp$ to the segment AE is $\frac{1}{3}$

(D) All A, B, C cannot be true simultaneously

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions Q. 44, Q. 45 and Q. 46 by appropriately matching the information given in the three columns of the following table.

Let $f(x)=\frac{(x-a)(x-b)}{(x-c)(x-d)}$ where $a<b<c<d$. Column-1: contains information about real roots of the equation; Column-2: contains information about limit of $f(x)$; column-3: contains information about increasing interval and decreasing interval of $f(x)$ *and* $f'(x)$ and information about local minimum value and local maximum value of $f(x)$

	Column 1		Column 2		Column 3
(I)	$f(x)=1$ has exactly one real root	(i)	$\lim_{x\to c^-} f(x)=-\infty$	(P)	$f(x)$ is increasing in the interval (b,c)
(II)	$f(x)=2$ has exactly two real root	(ii)	$\lim_{x\to d^+} f(x)=\infty$	(Q)	$f(x)$ is decreasing in the interval (d,∞)
(III)	$f(x)=-10$ has one real root	(iii)	$\lim_{x\to d^-} f(x)=-\infty$	(R)	$f'(x)$ is increasing in the interval (b,c)
(IV)	$f(x)=10$ has two real roots	(iv)	$\lim_{x\to\infty} f(x)=1$	(S)	Local minimum value of $f(x)$ is smaller than local maximum value of $f(x)$

Space for Rough work

44. Which of the following is the only **CORRECT** combination?
(A) (I) (ii) (S)
(B) (II) (iii) (Q)
(C) (III) (iv) (S)
(D) (IV) (iv) (S)

45. Which of the following is the only **INCORRECT** combination?
(A) (II) (ii) (P)
(B) (III) (i) (R)
(C) (IV) (iv) (P)
(D) (V) (iii) (Q)

46. Which of the following is the only **CORRECT** combination?
(A) (III) (iv) (P)
(B) (I) (ii) (R)
(C) (IV) (i) (S)
(D) (II) (iv) (S)

Space for Rough work

Answer questions Q. 47, Q. 48 and Q. 49 by appropriately matching the information given in the three columns of the following table.

Let $f\left(x\right)$ be a double differentiable function with continuous second derivative defined on the interval $\left[0,1\right]$ satisfying the equation $\int_0^x \sqrt{1-\left(f''(t)\right)^2}\,dt=\int_0^x f'\left(t\right)dt\ \forall x\in\left[0,1\right]$ *and* $f\left(0\right)=f'\left(0\right)=0$. Column-1; contains the information about interval of value of $f\left(x\right)$; Column-2; contains information about value of $f\left(x\right)$; Column-3: contains information about interval of value of definite integral of $f\left(x\right)$; Match the following Column(s)

	Column 1		Column 2		Column 3
(I)	$f\left(\frac{1}{2}\right)<\frac{1}{8}$	(i)	$f\left(\frac{1}{3}\right)=\frac{1}{18}$	(P)	$\int_0^1 f\left(x\right)dx>1$
(II)	$f\left(\frac{1}{2}\right)>\frac{1}{8}$	(ii)	$f\left(\frac{1}{4}\right)=\frac{1}{8}$	(Q)	$\int_0^1 f\left(x\right)dx>\frac{1}{6}$
(III)	$f\left(\frac{1}{3}\right)<\frac{1}{18}$	(iii)	$f\left(\frac{1}{6}\right)=2\sin^2\left(\frac{1}{12}\right)$	(R)	$\int_0^1 f\left(x\right)dx<\frac{1}{6}$
(IV)	$f\left(\frac{1}{4}\right)<\frac{1}{4}$	(iv)	$f\left(\frac{1}{8}\right)=-2\sin^2\left(\frac{1}{16}\right)$	(S)	$\int_0^1 f\left(x\right)dx<\frac{1}{4}$

47. Which of the following is the only **CORRECT** combination?

(A) (I) (ii) (Q)

(B) (II) (i) (S)

(C) (IV) (ii) (Q)

(D) (III) (iii) (R)

Space for Rough work

48. Which of the following is the only **CORRECT** combination?

(A) $(\text{I})\ (\text{iv})\ (\text{Q})$

(B) $(\text{II})\ (\text{iii})\ (\text{S})$

(C) $(\text{II})\ (\text{iv})\ (\text{P})$

(D) $(\text{IV})\ (\text{iii})\ (\text{S})$

49. Which of the following is the only **CORRECT** combination?

(A) $(\text{III})\ (\text{ii})\ (\text{Q})$

(B) $(\text{IV})\ (\text{ii})\ (\text{P})$

(C) $(\text{I})\ (\text{iii})\ (\text{R})$

(D) $(\text{III})\ (\text{ii})\ (\text{S})$

SECTION – B
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

50. If p, q, r and s are non – zero numbers such that 'r' and 's' are roots of $x^2 + px + q = 0$ and p, q are the roots of $x^2 + rx + s = 0$, then find the value of $(4p + q + 2r + s)$.

51. Value of $5^{\log_{1/5}(1/2)} + \log_{\sqrt{2}} \frac{4}{\sqrt{7}+\sqrt{3}} + \log_{1/2} \frac{1}{10+2\sqrt{21}}$

52. Let $1^P + 2^P + 3^P + ... + n^P = a_0 n^{P+1} + a_1 n^P + a_2 n^{P-1} .... + a_P n + a_{P+1}$, where $n, P \in N$. If $a_0 = \frac{1}{8}$, then P = ______

53. $y = f(x)$ is a particular solution of differential equation $\left(\left(\frac{dy}{dx}\right)^2 + y\frac{d^2y}{dx^2}\right) = e^x$ such that $f(0) = 1 = f'(0)$, then the value of $f^2(\ln 2)$ is ……………

54. The differential equation $\frac{dy}{dx} = \frac{(x+y+2)^2 - (y-1)^2}{(x+3)^2}$ determines a curve $y = f(x)$ & $f(0) = 1$ then f(3) is equal to …

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VII

JEE (Advanced)-2020

PAPER – 1

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. AC

Sol. $\frac{dN_B}{dt} = \lambda_1 N_A - \lambda_2 N_B$

at, $t = t_0, \frac{dN_B}{dt} = 0, N_B = \frac{3N_0}{2} \Rightarrow 2N_0\lambda_1 e^{-\lambda_1 t_0} - \lambda_0 \frac{3N_0}{2} = 0$

$t_0 = \frac{1}{\lambda_1} \ln \frac{4}{3}\frac{\lambda_1}{\lambda_2}$

2. ABC

Sol. Using work-energy theorem till string become taut

Work done by qE = Change in K.E.

$\Rightarrow qEl = \frac{1}{2}mv^2 - 0$

$\Rightarrow v = \sqrt{\frac{2qEl}{2m}}$

When string become taut an impulse is received and speed of the bob becomes

$v\cos 30^o = \sqrt{\frac{3qEl}{2m}}$

Further using work energy theorem speed of the bob becomes

$$v' = \sqrt{\frac{5qEl}{2m}}$$

$\therefore$ time period $= \dfrac{2\pi l}{v'} = 2\pi\sqrt{\dfrac{2ml}{5qE}}$

After 1st half revolution in magnetic field work done by *qE* =Change in K.E., from lowermost to uppermost point.

$$qE.2l = \frac{mv_1^2}{2} - \frac{m}{2}\frac{5qEl}{2m}$$

$$v_1 = \sqrt{\frac{13qEl}{2m}}$$

$\therefore$ Time period of 2nd revolution $= \dfrac{2\pi l}{v_1} = \pi\sqrt{\dfrac{2ml}{13qE}}$

$\therefore$ Angular speed of 1st revolution $= \sqrt{\dfrac{5qE}{2ml}}$

$\therefore$ Angular speed of 2nd revolution $= \sqrt{\dfrac{13qE}{2ml}}$

$\therefore$ ABC

3. ACD

Sol. Radius of $2m = \frac{r}{3}$, radius of $m = \frac{2r}{3}$. (because C.M of the system should be at rest)

Similarly, velocity of $2m = \frac{v}{3}$; velocity of $m = \frac{2v}{3}$.

$\therefore$ K.E of $2m = \frac{1}{2}m\left(\frac{v}{3}\right)^2$; K.E of $m = \frac{1}{2}m\left(\frac{2v}{3}\right)^2$

$\therefore$ K.E of $2m = \frac{mv^2}{9}$; K.E. of $m = \frac{2mv^2}{9}$.

Time period of $2m = \dfrac{2\pi(r/3)}{v/3}$; Time period of $m = \dfrac{2\pi\left(\frac{2\pi}{3}\right)}{2v/3}$

Time period of $2m = \frac{2\pi r}{v}$; Time period of $m = \frac{2\pi r}{v}$

Angular momentum of 2m = $2m\left(\frac{v}{3}\right)\left(\frac{r}{3}\right)$; angular momentum of $m = m\left(\frac{2v}{3}\right)\left(\frac{2r}{3}\right)$

Angular momentum of 2m = $\frac{2mvr}{9}$; angular momentum of $m = \frac{4mvr}{9}$.

4. ABCD

Sol. Direction of magnetic field at P due to $CD = \hat{i} \times \dfrac{(\hat{j}+\hat{k})}{\sqrt{2}} \Rightarrow \dfrac{k-\hat{j}}{\sqrt{2}}$

Direction of magnetic field at P due to $EF = -\hat{i} \times \frac{(\hat{j} - \hat{k})}{\sqrt{2}} \Rightarrow \frac{-k - \hat{j}}{\sqrt{2}}$

Hence direction will be along $-\hat{j}$

Direction of magnetic field at 'O' due to upper frame along $-\hat{i}$

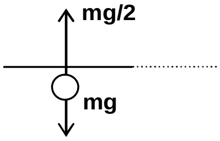
Direction of magnetic field at O due to horizontal frame will be along $-\hat{j}$

5. C

Sol. Travelling harmonic wave is sin or cos function of (ax ± bt)

6. B

Sol. $ma = mg - \frac{mg}{2} - 6\pi\eta rv$



$ma = 6\pi\eta rv_T - 6\pi\eta rv$

$\frac{dv}{dt} = \frac{6\pi\eta r}{m}(v_T - v)$

$\frac{dv}{v_T - v} = \frac{6\pi\eta r}{m}dt$

$\frac{v_T - v}{v_T} = e^{-\frac{6\pi\eta r}{m}t}$

$v = v_T\left(1 - e^{-\frac{6\pi\eta r}{m}t}\right)$

$v = v_T\left(1 - e^{-\frac{6\pi\eta r}{m}t}\right)$

$\frac{1}{2} = 1 - e^{-\frac{6\pi\eta r}{m}t}$

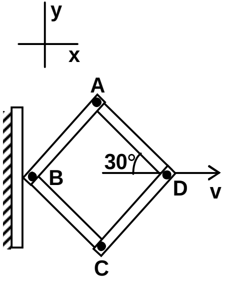
$\frac{6\pi\eta rt}{m} = \ell n2$

$t = \frac{m\ell n2}{6\pi\eta r}$

7. AB

Sol. $v_x = v/2$

$v_y = v_x \cot 30°$



$v_y = \frac{v}{2}\sqrt{3}$

$v_A = v$

8. B

9. C

10. B

Sol. (for Q.8 to 10)

$V_b = i_b R - i_1 R_1 = 0$

$-i_2 R_2 - q/C + +i_1 R_1 = 0$

With $i_2 = \frac{dq}{dt}$

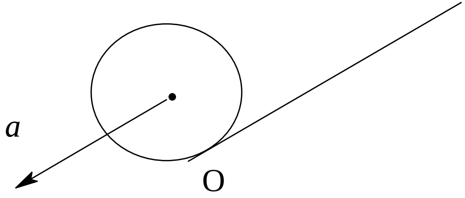
Substituting the given values, we get the result.

11. C

12. A

13. D

Sol. (for Q. 11 to 13)



Taking torques about $\text{ICR} \Rightarrow$

$\text{mg}\sin\theta \,.\, \text{R} = \left(\text{I}_{\text{CM}} + \text{mR}^2\right)\alpha$

$a = \alpha R \Rightarrow \frac{mg\sin\theta\, R^2}{\left(\text{I}_{\text{CM}} + \text{mR}^2\right)}$

Final $\text{V}_{\text{cm}} = 0 \therefore \text{t} = \frac{V}{a} = \frac{V\left(I_{CM} + mR^2\right)}{mg\sin\theta R^2}$

Also, Applying energy **conservation**:-

$\text{mg h} = \frac{1}{2}\left(\text{I}_{\text{CM}} + \text{mR}^2\right)\left(\frac{\text{V}}{\text{R}}\right)^2$

$\therefore h = \frac{1}{2}\left[\frac{I_{Cm}}{mR^2} + 1\right]\frac{V^2}{g}$

SECTION – B

14. 3

Sol. Flux of magnetic field at any time *t* is

$$\phi = \int_{l}^{2l} \alpha xtldx = \frac{3}{2}\alpha tl^3$$

$$\therefore |e| = \frac{3}{2}\alpha l^3$$

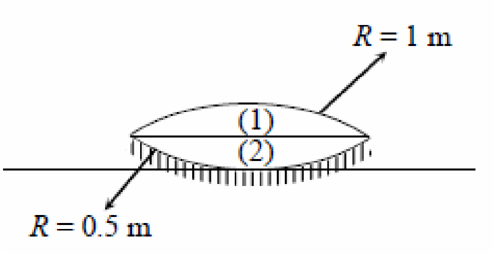
$\therefore$ Charge on capacitor $= \frac{3}{2}C\alpha l^3$

$\therefore \; n = 3$

15. 3

Sol. $\frac{1}{f_1} = (1.5-1)\left(\frac{1}{1}\right) = 0.5m^{-1}$

$\frac{1}{f_2} = \left(\frac{4}{3}-1\right)\left(\frac{1}{0.5}\right)$



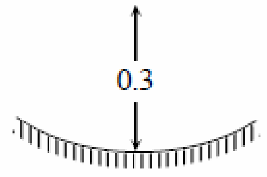
$= \frac{1}{3} \times \frac{1}{0.5} = \frac{2}{3}m^{-1}$

Power of the system

$P = 2P_1 + 2P_2 + P_m$

$= 2 \times 0.5 + 2 \times \frac{2}{3} + \frac{1}{0.25}$

$= 1 + \frac{4}{3} + 4 = \frac{3+4+12}{3} = \frac{19}{3}$



Focal length of equivalent mirror $= -\frac{3}{19}m$

$\frac{1}{v} + \frac{1}{-0.3} = \frac{1}{-3/19}$

$\frac{1}{v} = \frac{1}{0.3} - \frac{19}{3} = \frac{10}{3} - \frac{19}{3} = \frac{-9}{3} = -3$

$v = -\frac{1}{3}m$

$$\Rightarrow d = -\frac{3}{10}+\frac{1}{3}=\frac{1}{30}$$

$$\Rightarrow \frac{1}{30}=\frac{x}{90}\Rightarrow x = 3m$$

16. 2

Sol. Initially let number of molecules of $A = N_A$ and that of $B = N_B$

$$\frac{\lambda N_A}{\lambda N_A + 2\lambda N_B}=\frac{25}{100}$$

$$\therefore 100\lambda N_A = 25\lambda N_A + 50\lambda N_B \Rightarrow N_A = \frac{2}{3}N_B$$

Now, $N_A^{'} = N_A e^{-\lambda t} = \frac{2}{3}N_B e^{-\lambda t}$

$$N_B^{'} = N_B e^{-2\lambda t} = \frac{2}{3}N_B e^{-\lambda t}$$

$$\frac{\frac{2}{3}\lambda N_B e^{-\lambda t}}{\frac{2}{3}\lambda N_B e^{-\lambda t} + 2\lambda N_B e^{-2\lambda t}}=\frac{75}{100}=\frac{3}{4}$$

$$\Rightarrow \frac{1}{1+3e^{-\lambda t}}=\frac{3}{4}$$

$$\Rightarrow 1 = 9e^{-\lambda t}$$

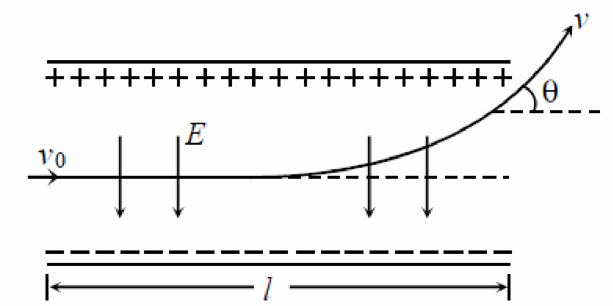
$$\Rightarrow e^{\lambda t} = 9$$

So, $t = \frac{\ln(9)}{\lambda}hr = \frac{2\ln(3)}{\ln(3)} = 2hr$

17. 9

Sol. Since, electron is accelerated through a potential difference *V*, its initial velocity v_0 is given by $\frac{1}{2}mv_0^2 = eV$

Or $v_0 = \sqrt{\frac{2eV}{m}}$ -------------- (1)



Since, initial velocity is parallel to plates or normal to the direction of electric field, component of velocity parallel to plates remains constant as v_0.

Hence, time taken by the electron to cross electric field is $t_0 = \frac{l}{v_0}$

Now consider motion of electron, normal to plates.

At some instant *t*, its acceleration = $= \frac{eE}{m} = \frac{eat}{m}$

Let velocity component normal to plates be v_y

$$\therefore \frac{d}{dt}v_y = \frac{eat}{m}$$

$$\therefore \int_0^{v_y} dv = \frac{ea}{m}\int_0^{t_0} t\,dt$$

$$or\ \ v_y = \frac{ea}{2m}t_0^2 = \frac{al^2}{4V}-----------(2)$$

If □is angular deviation of electron from its initial direction of motion,
then pitch of its helical path.

$$p = \frac{2\pi m}{eB}v\cos(90-\theta)$$

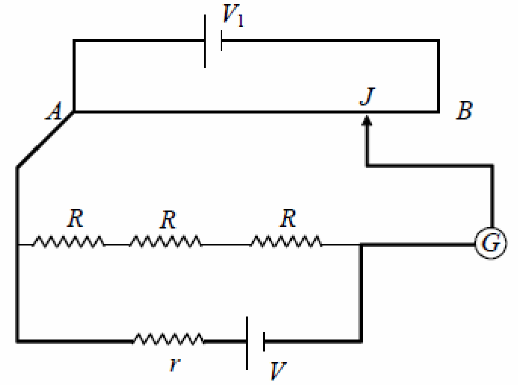
$$\therefore\ \ p = \frac{2\pi m}{eB}v\sin\theta = \frac{2\pi m}{eB}v_y$$

$$or\ p = \frac{\pi mal^2}{2eBV}$$

$$p = 9mm$$

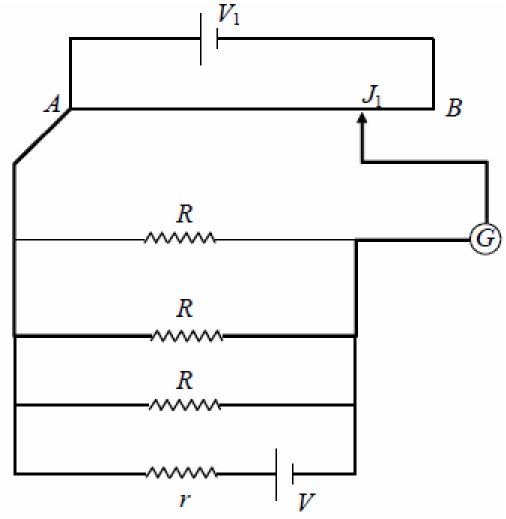
18. 1

Sol. When only switch 2 is closed



$$\frac{3RV}{r+3R} = \frac{V_1}{\lambda L}\lambda L_1------(i)\ \ (\lambda\text{-resistance per unit length})$$

When all switches are closed



$$\frac{V}{\frac{R}{3}+r}\times\frac{R}{3}=\frac{V_1}{\lambda L}\lambda L_2 \text{--------}(ii)$$

Dividing (i) and (ii)

$3R+9r=3r+9R$

$r=R$

$\therefore n=1$

Chemistry PART – II

SECTION – A

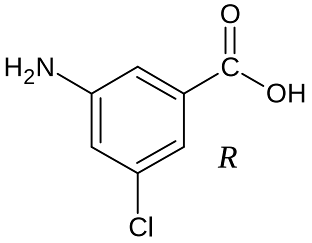
19. ABC

Sol. On opening the ring, it can convert in to fructose and thus giving Tollen's test.

20. ABD

Sol.

$CH_3-NH_2,$
Q



21. ABC

Sol. $s=\left[Zn(OH)_2\right]_{aq}+\left[Zn(OH)\right]^{+}+\left[Zn^{2+}\right]+\left[Zn(OH)_3\right]^{-}+\left[Zn(OH)_4\right]^{-}$

$$=K_1+\frac{K_2K_1}{\left[OH^-\right]}+\frac{K_1K_2K_3}{\left[OH^-\right]^2}+K_4\left[OH^-\right]K_1+K_1K_4K_5\left[OH^-\right]^2$$

22. BCD

Sol. $[A]=[A]_0-kt=[A]_0+(\tan 150)t=[A]_0-\frac{\sqrt{3}}{3}t=0.5\frac{-\sqrt{3}}{3}t$

Similarly $[C]=[C]_0-\sqrt{3}t.........(1)$

If $[B]=[A]\Rightarrow t=t_{1/2}=\frac{a}{2k}=\frac{0.5}{2\frac{\sqrt{3}}{3}}=0.25\sqrt{3}$

Now

$$[D]=[C]_0-[C]$$
$$=\sqrt{3}t \qquad by\ (1)$$
$$=\sqrt{3}\times 0.25\times\sqrt{3}=0.75$$

23. CD

Sol. $\left.\begin{array}{l} Ti^{3+}\rightarrow 3d^1 \\ V^{3+}\rightarrow 3d^2 \end{array}\right\}\text{always have unpaired e}^-$

24. D

Sol. $\left[Fe(CN)_6\right]^{4-}+NO_2^-+H_2O\longrightarrow\left[Fe(CN)_5NO\right]^{2-}+CN^-+2OH^-$

$\left[Fe(CN)_5NO\right]^{2-}+S^{2-}\longrightarrow\left[Fe(CN)_5NOS\right]^{4-}\text{(purple)}$

25. AD

Sol. More charge on central atom, more will be CFSE.

26. C

27. D

28. C

29. C

Sol. $I_2+Na_2S_2O_3 \longrightarrow I^-+Na_2S_4O_6$

30. A

Sol. In an acidic medium MnO_4^- reduces to Mn^{2+}

31. B

Sol. $2MnO_4^-+5H_2C_2O_4+2H^+ \longrightarrow 10CO_2+2MnO+6H_2O$

SECTION – B

32. 0

Sol. $Ag\left(CN\right)_2^- \longrightarrow Ag^+ + 2CN^-$

0.1 x 2x

$$4\times10^{-17} = \frac{4x^3}{0.1}$$

$x = 10^{-6}$

Ionic product $=\left[Ag^+\right]\left[Cl^-\right] = 10^{-6}\times0.02 = 2\times10^{-8}$

If $K_{sp} <$ Ionic product

So precipitation will take place.

33. 2

Sol. $0.48\ \mu Ci = 3.7\times10^4\times0.48\,\text{dPs}/m\ell$

For $0.5\,m\ell$ drop, it is $\frac{3.7\times10^4\times0.48}{2}dPs$

$$\frac{444}{60}\text{dPs}=\frac{3.7\times10^4\times0.24\times0.1}{V}\text{dPs}$$

$V = 120$

So $x = 2$

34. 3

Sol. $$E_a = \frac{k_1E_{a_1}+k_2E_{a_2}}{k_1+k_2} = \frac{2E_1+4E_2}{6} = \frac{E_1+2E_2}{3}$$

$x = 3$

35. 4
Sol. a,b,d,i,m,,n,o,p,q,r

36. 7
Sol. D is wrong other statements are correct
This ore is $FeCr_2O_4$ and it is the prep. Of $K_2Cr_2O_7$ in figure
$FeCr_2O_4 + O_2 + Na_2CO_3 \rightarrow Na_2CrO_4(yellow) + Fe_2O_3 + CO_2$ after acidification we have
$NaCr_2O_7.2H_2O$ and $Na_2SO_4.10H_2O$

Mathematics PART – III

SECTION – A

37. AC

Sol. Let $z - 3 = re^{i\theta}$

$\therefore \quad \frac{z-3}{e^{i\theta}} + \frac{e^{i\theta}}{z-3} = re^{i(\phi-\theta)} + \frac{1}{r}e^{i(\theta+\phi)}$

By solving for imaginary part

$\Rightarrow r - \frac{1}{r} = 0$ or $\sin(\phi - \theta) = 0$

r = 1

By putting the value we get

$\frac{x-3}{\cos\theta} = \frac{y}{\sin\theta} = r$

38. AD

Sol. $\frac{{}^{50}C_{5r}}{{}^{50}C_{r}} = 29 \times 43 \times \frac{a}{b}$

$\Rightarrow \frac{\underline{|r}\,\underline{|50-r}}{\underline{|5r}\,\underline{|50-5r}} = 29 \times 43 \times \frac{a}{b}$

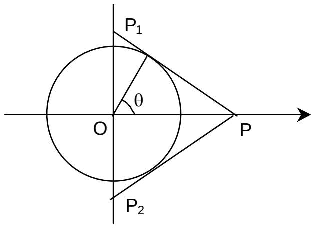
$\Rightarrow 43 \le 50 - r \le 46$ as 43 is present in the N_r and a $\notin$ 47 I.

Also $5r \le 25 \cap 50 - 5r \le 25$ as 29 is present in the D_r

$\Rightarrow r = 5$

39. AB

40. AC



Sol. OP = $5\sqrt{2}\sec\theta$

$OP_1 = 5\sqrt{2}\,\mathrm{cosec}\,\theta$

$\Delta\ PP_1P_2 = \frac{100}{\sin 2\theta}$

$(\Delta \mid PP_1P_2)_{\min} = 100 \Rightarrow \theta = \pi/4$

$\Rightarrow$ OP =10 $\Rightarrow$ P = (10, 0), (-10, 0) .

41. BC

Sol. Let $A = \left(3m_1^2, -6m_1\right), B = \left(3m_2^2 - 6m_2\right), D = \left(3m_3^2, -6m_3\right)$

A and B lies on x + y = 1

$\therefore\ 3m_1^2, -6m_1 = 0$ and $3m_2^2 - 6m_2 = 1$

$3m_1^2 - 3m_2^2 - 2(m_1 - m_2) = 0$

$m_1 + m_2 = 2 \Rightarrow -m_3 = 2$

$\therefore$ Coordinates of D are (12, 12)

42. ACD

Sol. Equation of tangent at θ

$$\frac{x\cos\theta}{a}+\frac{y\sin\theta}{b}=1 \quad\Rightarrow\quad \frac{x}{a\sec\theta}+\frac{y}{b\operatorname{cosec}\theta}=1$$

$\therefore$ Intercept $d=\sqrt{a^2\sec^2\theta+b^2\operatorname{cosec}^2\theta}$

$$\therefore\ d^2=a^2\sec^2\theta+b^2\operatorname{cosec}^2\theta \Rightarrow \frac{d\left(d^2\right)}{d\theta}=2a^2\frac{\sin\theta}{\cos^3\theta}-2b^2\frac{\cos\theta}{\sin^3\theta}=0$$

i.e $\dfrac{a^2\sin\theta}{\cos^3\theta}=\dfrac{b^2\cos\theta}{\sin^3\theta}$

$\therefore\ \tan^4\theta=\dfrac{b^2}{a^2}$ $\qquad\qquad$ $\therefore\ \tan\theta=\pm\sqrt{\dfrac{b}{a}}$

$$\theta=\tan^{-1}\sqrt{\frac{b}{a}},\ -\tan^{-1}\sqrt{\frac{b}{a}}\ \ \theta=\pi-\tan^{-1}\sqrt{\frac{b}{a}},-\pi+\tan^{-1}\sqrt{\frac{b}{a}}$$

43. ABC

Sol. The given hyperbola is a rectangular hyperbola so Δ CEF is right angle and eccentricity of the hyperbola is $\sqrt{2}$

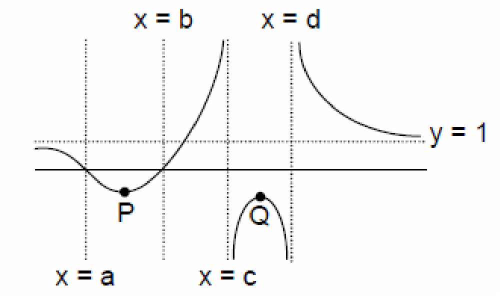
44. B

45. B

46. B

Sol. (for Q. 44 to 46)

We cannot be sure about the coordinates of P and Q as they depend on a, b, c and d



47. D

48. D

49. C

Sol. (for Q. 47 to 49)

$$\int_0^x\sqrt{1-\left(f''(t)\right)^2}\,dt=\int_0^x f'(t)\,dt\Rightarrow\sqrt{1-\left(f''(x)\right)^2}=f'(x)\Rightarrow f''(x)=\pm\sqrt{1-\left(f'(x)\right)^2}$$

$$\Rightarrow x=\pm\sin^{-1}f'(x)\Rightarrow f(x)=\pm(1-\cos x)=\pm2\sin^2\frac{x}{2}$$

$$f(x) \le |f(x)| = 2\sin^2\frac{x}{2} < 2\cdot\frac{x^2}{4} = \frac{x^2}{2}$$

$$\int_0^1 f(x)\,dx \le \int_0^1 |f(x)|\,dx = \int_0^1 2\sin^2\frac{x}{2}\,dx < \frac{1}{2}\int_0^1 x^2dx = \frac{1}{6}$$

SECTION – B

50. 2

Sol. $x^2+px+2=0 < \,^{r}{}_{s}$ and $x^2+rx+s=0 < \,^{p}{}_{q}$

$r+s=-p \quad (1)$

$rs=q \quad (2)$

$p+q=-r \quad (3)$

$pq=s \quad (4)$

$(2)\times(4) \Rightarrow pqrs=qs \Rightarrow pr=1 \quad (5)$

$(1)+(3) \Rightarrow p+q+r+s=-p-r$

$\Rightarrow 2(p+r)+q+s=0 \quad (6)$

Now p is a root of $x^2+rx+s=0 \Rightarrow p^2+rp+s=0$

And r is a root of $x^2+px+q=0 \Rightarrow r^2+pr+q=0$

Adding those two

$\Rightarrow (p+r)^2-2(p+r)=0 \Rightarrow p+r=0, p+r=2$

Also $pr=1 \Rightarrow p=1, r=1$

From $(4) pq=s \Rightarrow q=s$

$\therefore q+s=-2(p+r)$

$\Rightarrow q+s=-4 \Rightarrow q=s=-2$

$\therefore 4\times1-2+2-2=2$.

51. 6

Sol. $5^{\log_{1/5}(1/2)}+\log_{\sqrt{2}}\frac{4}{\sqrt{7}+\sqrt{3}}+\log_{1/2}\frac{1}{10+2\sqrt{21}}$

$=5^{\log_5 2}+2\log_2(\sqrt{7}-\sqrt{3})+\log_2(10+2\sqrt{21})$

$=6$

52. 7

Sol. $\sum_{r=1}^{n}\left[(r+1)^{P+1}-r^{P+1}\right]=(P+1)\sum_{r=1}^{n}r^P+\,^{P+1}C_2\sum_{r=1}^{n}r^{P-1}+.......+\sum_{r=1}^{n}(1)$

$a_0=\frac{1}{P+1}$

53. 3

Sol. $\because \frac{d}{dx}\left\{\frac{dy}{dx}.y\right\}=e^x$

$$\Rightarrow y\frac{dy}{dx} = e^x + c$$

$$\Rightarrow 1\times 1 = e^0 + c \Rightarrow c = 0$$

$$\Rightarrow tdy = e^x dx$$

$$\frac{1}{2}y^2 = e^x + c \therefore \frac{1}{2} = 1 - c \Rightarrow c = -\frac{1}{2}$$

$$y^2 = 2e^x - 1 \Rightarrow f^2(x) = 2e^x - 1$$

54. 7

Sol. Let $x+3 = X$ & $y-1 = Y$

$$\therefore \frac{dY}{dX} = \frac{(X+Y)^2 - Y^2}{X^2} = \frac{X^2 + 2XY}{X^2}$$

$$\Rightarrow \frac{dY}{dX} - \frac{2Y}{X} = 1$$

I.F. = $e^{\int -\frac{2}{X}dX} = e^{-2\ln X} = \frac{1}{X^2}$

$$\therefore \quad Y \times \frac{1}{X^2} = \int \frac{1}{X^2} \times 1\, dX + c$$

$$\Rightarrow \frac{(y-1)}{(x+3)^2} = -\frac{1}{(x+3)} + c \quad \Rightarrow (y-1) = c(x+3)^2 - (x+3)$$

$$\therefore 0 = 9c - 3$$

$$\Rightarrow c = \frac{1}{3}$$

$$y = 1 + \frac{1}{3}(x+3)^2 - (x+3)$$

$$y(3) = 1 + 12 - 6 = 7$$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VII

JEE (Advanced)-2020

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **One Section**: **Section-A.**

1. ***Section–A (01 – 07, 19 – 25, 37 – 43)*** *contains 21 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (08– 14, 26 – 32, 44 – 50) *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*

   Partial Marks **+1** for each correct option provided no incorrect option is selected.

   Section–A (15 – 18, 33 – 36, 51 – 54) *contains 6 paragraphs. Each paragraph is having 2 multiple choice questions having 4 options with* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A
(One Options Correct Type)

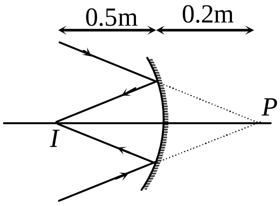
This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A body is projected up so that it can reach maximum height H. What is its height from ground when its velocity is half the maximum velocity?

(A) $\frac{H}{4}$ (B) $\frac{H}{2}$

(C) $\frac{3H}{4}$ (D) $\frac{3H}{8}$

2. A beam of convergent light converges to a point 0.5m in front of the mirror after reflection at convex mirror but in the absence of the mirror the beam converse to a point 0.2 m behind the mirror. The radius of the curvature of the mirror is



(A) 20 cm (B) 50 cm

(C) 66.67 cm (D) 28.5 cm

3. A circular loop of radius *r*, having *N* turns of a wire, in placed in a uniform and constant magnetic field *B*. The normal of the loop makes an angle θ with the magnetic field. Its normal rotates with angular velocity ω in such a way that it maintains the same angle θ with the field, the emf appearing in the loop is

(A) $\frac{\pi NB\omega r^2}{2}$ (B) $\frac{\pi NB\omega r^2}{2}\cos\theta$

(C) $\pi NB\omega r^2$ (D) Zero

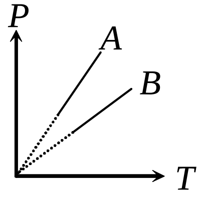
Space for Rough work

4. A point charge θ is located at the center of a hollow spherical conductor having inner radius as R_1 and outer radius R_2. The potential at the inner surface will be

(A) $KQ\left[\frac{1}{R_1}+\frac{1}{R_2}\right]$ (B) $KQ\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$

(C) $KQ\left[\frac{1}{R_2}-\frac{1}{R_1}\right]$ (D) $\frac{KQ}{R_2}$

5. The figure shows the P-T diagram of two different gasses *A* and *B* having same volume but different number of moles n_A and n_B respectively. Then



(A) $n_A > n_B$ (B) $n_A = n_B$

(C) $n_A < n_B$ (D) insufficient data

6. A rigid body of radius R, either hollow or solid, lies on a smooth horizontal surface. The body is pulled by horizontal force acting tangentially from the highest point. The distance travelled by the body in the time in which it makes one full rotation is the same that it will make in one full rotation during pure rolling. The rigid body will be:

(A) Solid sphere (B) Hollow sphere

(C) Circular disc (D) Hollow cylinder

7. A uniform rod of length L (in between the supports) and mass m is placed on two supports A and B. The rod breaks suddenly at length L/10 from the support B. Find the reaction at support A immediately after the rod breaks:

(A) $\frac{3}{20}\text{mg}$ (B) $\frac{19}{40}\text{mg}$

(C) $\frac{\text{mg}}{2}$ (D) $\frac{9}{20}\text{mg}$

Space for Rough work

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

8. A solid wooden stick is one fourth submerged in a liquid and is floating. A small mass of negligible valence is attached at the lower end of the stick. Now if the length of stick out of the liquid is one fourth. Then:
(A) For translational equilibrium of stick mass of attached object should be two times mass of stick.
(B) For translational equilibrium of stick mass of attached object should be equal to mass of stick.
(C) Rotational equilibrium of the stick is possible in this situation.
(D) Rotational equilibrium of the stick is not possible in this situation.

9. Potential energy of a system is given by $U(x)=(x+1)(x+2)$. Then:
(A) Point $x=-\frac{3}{2}$ corresponds to equilibrium position of the system.
(B) Point $x=-1$ and $x=-2$ corresponds to equilibrium position of the system
(C) System is in stable equilibrium position at the $x=-\frac{3}{2}$
(D) System is in unstable equilibrium position at $x=-\frac{3}{2}$

10. Choose the correct options regarding energy densities at different points of a harmonic travelling wave:
(A) Kinetic energy is maximum at crest
(B) Kinetic energy is minimum at trough
(C) Potential energy is maximum at crest
(D) Potential energy is minimum at trough

11. If the temperature of the bottom of lake of depth of depth $200\,\text{cm}$ is maintained at $4°\text{C}$ and the temperature surrounding remains -$2°\text{C}$ for many days. Then:
(A) The depth of ice formed is 120 cm
(B) The depth of ice formed is 80 cm
(C) The height of water is 80 cm
(D) The height of water is 80 cm

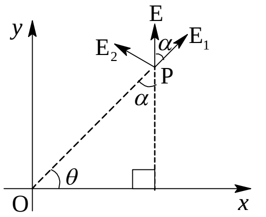
Space for Rough work

12. Which of the following numbers have three significant digits?

(A) 2.00 (B) 200

(C) 4.01 (D) 0.002

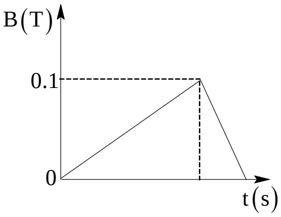
13. A point electric dipole is placed at the origin 'O' and is directed along the positive x-axis. At a point 'P' for away from the dipole, the electric field is parallel to the y-axis. The line 'OP' makes an angle 'θ' with the x-axis, then:



(A) $\tan\theta = \sqrt{3}$ (B) $\tan\theta = \sqrt{2}$

(C) $\tan\theta = \frac{1}{2}$ (D) $\tan\theta = \frac{1}{\sqrt{2}}$

14. A closed loop of cross-sectional area $10^{-2} m^2$ which has inductance of $10\,\text{mH}$ and negligible resistance is placed in a time varying magnetic field. Figure shows the variation of B with time for the internal 4 seconds. The field is perpendicular to the plane of the loop (Given t = 0, B = 0 and I = 0). The value of current in the loop has:



(A) Maximum value equal to $100\,\text{mA}$

(B) Maximum value equal to $200\,\text{mA}$

(C) Current increases as B increases

(D) Current decreases as B decreases

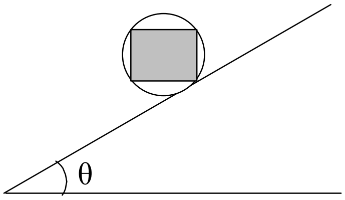
Space for Rough work

Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 15 and 16

Four identical rode's each of mass m are welded at ends to form a square and then welded to a ring of same mass m and radius R. If the system is allowed to roll down a rough incline plane of inclination θ, assuming no slipping. Then



15. The acceleration of the system is:

(A) g
(B) $\frac{15}{26} g \sin\theta$
(C) $\frac{2}{13} g \sin\theta$
(D) $\frac{2}{26} g \sin\theta$

16. The minimum coefficient of friction for no slipping is:

(A) $\frac{11}{26} \tan\theta$
(B) $\frac{11}{17} \tan\theta$
(C) $\frac{13}{17} \tan\theta$
(D) $\frac{19}{21} \tan\theta$

Space for Rough work

Paragraph for Question Nos. 17 and 18

A small object of mass 2kg is placed on the x-axis in a potential field which potential energy is define as $U = 16\left(x^2 - 2x\right)$ where position on x-axis x is in meter and potential energy U is in joule. If the object is released from origin i.e $x = 0$. Then answer the following questions.

17. Angular frequency of oscillations is:

(A) $2\,\text{rad/sec}$	(B) $4\,\text{rad/sec}$
(C) $8\,\text{rad/sec}$	(D) $12\,\text{rad/sec}$

18. Maximum kinetic energy during oscillations:

(A) $8\,\text{Joule}$	(B) $12\,\text{Joule}$
(C) $16\,\text{Joule}$	(D) $20\,\text{Joule}$

Space for Rough work

Chemistry

PART – II

SECTION – A

(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

19. A sample of certain mass of an ideal polyatomic gas is expanded against constant pressure of 1 atm adiabatically from volume 2L, pressure 6 atm and temperature 300 K to state where its final volume is 8L. Calculate entropy change (in J/K) in the process. (Neglect vibrational degrees of freedom)
[Take 1L atm = 100J, R=8.0 J/mol/K log 2=0.3, log 3=0.48 log e=2.3]
(A) –3.312 (B) –5.312
(C) –6.312 (D) –7.312

20. If the number of oxygen atom(s) present in hydrated (P) is:

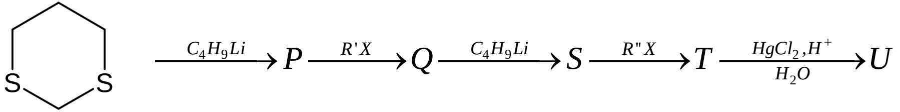
$$(P) \xrightarrow{H_2SO_4} (Q) + BaSO_4\downarrow + H_2O$$

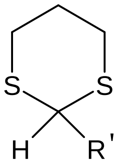
$$(Q) + H_2SO_4 + KI \longrightarrow K_2SO_4 + H_2O + (R)\downarrow$$

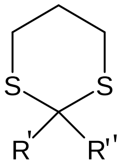
$$(R) \xrightarrow{\text{Starch}} \text{Blue colured}$$

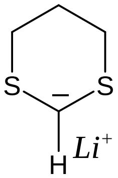
(A) 10 (B) 18
(C) 16 (D) 15

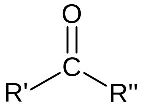
21. The final product U is:



(A) 

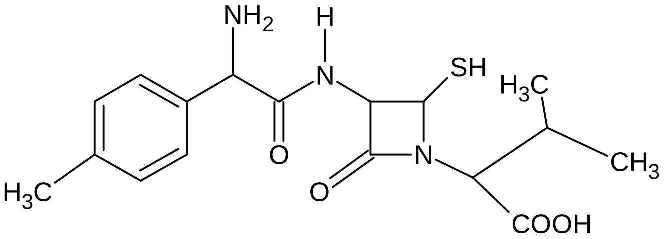
(B) 

(C) 

(D) 

Space for Rough work

22. Find out number of stereogenic center in following compound:

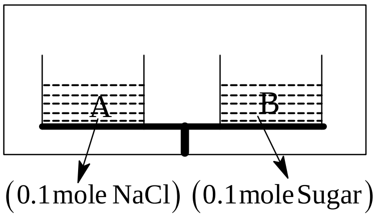


(A) 5 (B) 6
(C) 7 (D) 8

23. When $2.3\times10^{-5}\,g$ steric acid $(M=284)$ was placed on water as a surface film, the film could be compressed to an area of 100 sq cm as a monomolecular layer. Find the cross-section of the acid molecule. (cm^2)

(A) 2×10^{-15} (B) 2×10^{-17}
(C) 2×10^{-19} (D) 2×10^{-21}

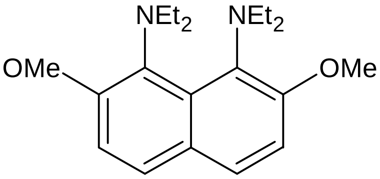
24. Two beakers $\mathrm{A}(0.1\,\mathrm{mole\,NaCl\,in\,1\,kg\,H_2O})$ & $\mathrm{B}(0.1\,\mathrm{mole\,sugar\,in\,1\,kg\,H_2O})$ is placed in a small sized closed container. The molality of solution of Beaker A changes to $\frac{'x'}{40}$. The value of 'x' will be: (Assume solutions to be dilute)



(A) 17.5×10^{-2} (B) 1.8×10^{-3}
(C) 7.5×10^{-2} (D) 1.8×10^{-4}

Space for Rough work

25. 1,8–Bis(diethyl amino)–2,7–dimethoxy naphthalene is extremely strong base with respect to N, N – Dimethyl aniline.



(A) Protonation relieves the strain operated by lone pair of electrons.
(B) Hydrogen bonding operated in conjugate base
(C) Attachment of +I and +M group with nitrogen and benzene ring.
(D) Both (A) and (B).

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

26. $2\mathrm{CaSO_4}(s) \rightarrow 2CaO(s) + 2SO_2(g) + O_2(g).\Delta H > 0$

Above equilibrium is established by taking sufficient amount of $\mathrm{CaSO_4(s)}$ in a closed container at 1600 K. Then which of the following may be correct option (Assume that $\mathrm{CaSO_4}$ is present in the container in each case)

(A) Moles of $\mathrm{CaO(s)}$ will increase with the increase in temperature.
(B) If the volume of the container is doubled at equilibrium then partial pressure of $\mathrm{SO_2(g)}$ will change at new equilibrium.
(C) If the volume of the container is halved partial pressure of $\mathrm{O_2(g)}$ at new equilibrium will remain same
(D) If two moles of the He gas is added at constant pressure then the moles of $\mathrm{CaO(s)}$ will increase

Space for Rough work

27. Which is / are **correct** statement?

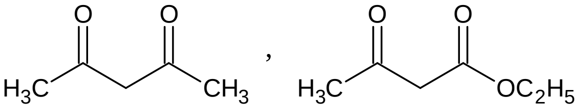
(A) $W_{\text{on the system, adiabatic}} > W_{\text{on the system, isothermally}}$ in an ideal gas compression from same initial state to same final volume

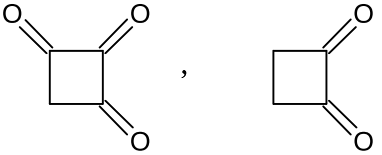
(B) The value of $\gamma \left(\gamma = \frac{C_p}{C_v}\right)$ remains constant for diatomic gas at all temperature

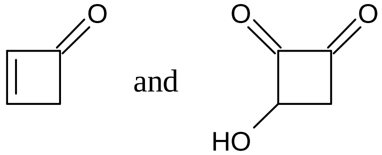
(C) Entropy increases when an ideal gas expanded isothermally.

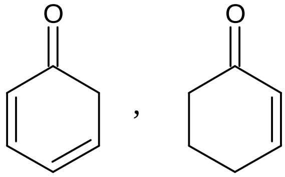
(D) $\Delta_r H$ & $\Delta_r S$ both are + ve for the decomposition of $MgCO_3(s)$.

28. In which of the following compounds, second has lesser enol content than first:

(A)


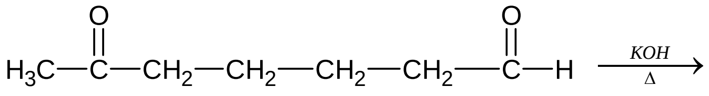
(B)


(C)


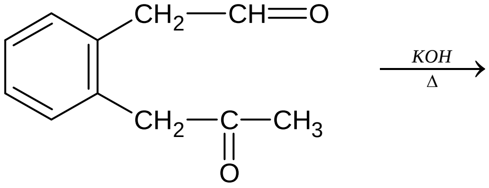
(D)


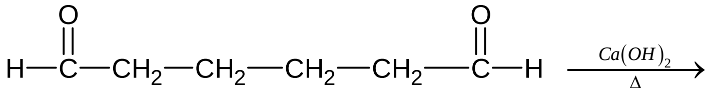
Space for Rough work

29. In which of the following intramolecular aldol condensation reaction more than two products (stereoisomers are not considered) are possible?

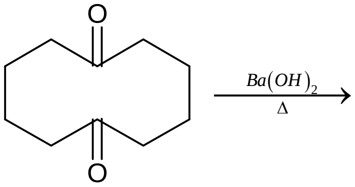
(A) 

$H_3C-\overset{\overset{O}{\|}}{C}-CH_2-CH_2-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-H \xrightarrow[\Delta]{KOH}$

(B) 

(C) 

$H-\overset{\overset{O}{\|}}{C}-CH_2-CH_2-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-H \xrightarrow[\Delta]{Ca(OH)_2}$

(D) 

30. Benzamide and aniline can be distinguished or reacted differently by:
(A) Ferric chloride test
(B) Carbyl amine test
(C) Dye azo test
(D) $NaOH/Br_2$

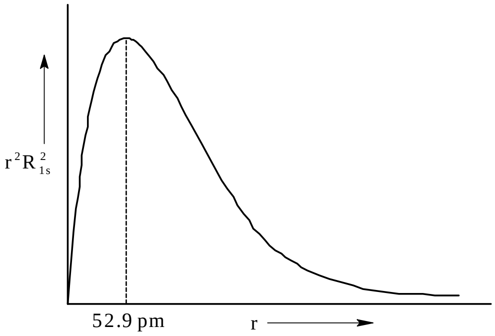
31. Select the correct statement:
(A) Lyophobic colloids are used to protect the lyophilic colloid
(B) Dehydration is used to coagulate the colloidal solution
(C) Rubber is obtained by coagulating the latex
(D) Sometimes heavy rainfall occurs when two oppositely charged clouds meets each other

Space for Rough work

32. Which of the following option is/are correct?

(A) Atomic orbitals are completely described as the regions where the probability of finding the electron is maximum.

(B)



The weighted average of large number of observations for measuring the radius of 1s orbital is greater than $52.9\,\text{pm}$ ($r^2R^2\,dr$ represents the total probability of finding the electron between r and r + dr).

(C) The energy of 4s is always lower than 3d for multi electronic atom/ ion.

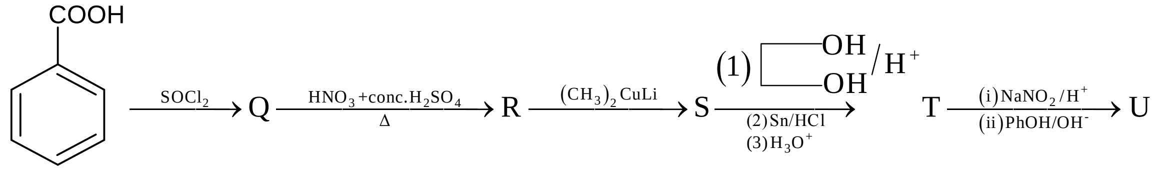
(D) Energy needed to excite an electron from $n=2$ to $n=4$ state is $\frac{25}{28}$ times the energy needed to excite an electron from n=2 to n=5 for a single electron atom / ion.

Space for Rough work

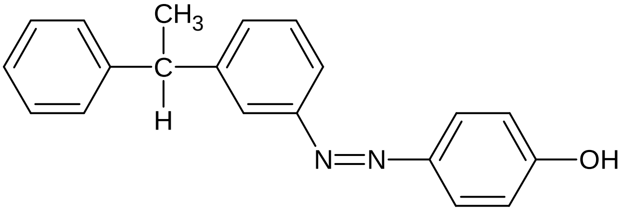
Paragraph Type (One Option Correct)

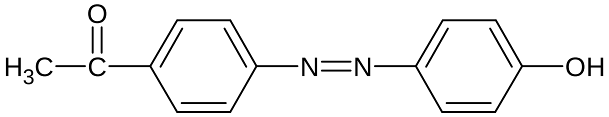
This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

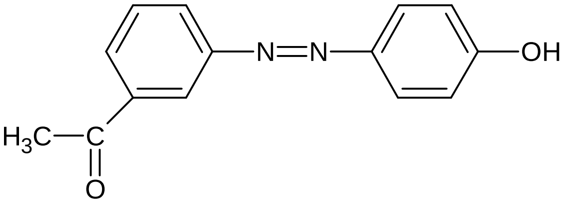
Paragraph for Question Nos. 33 and 34

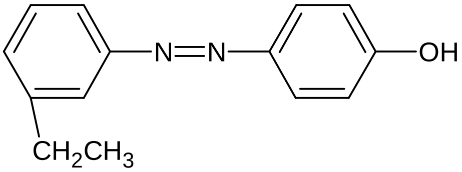

COOH
SOCl2
Q
HNO3+conc.H2SO4
Δ
R
(CH3)2CuLi
S
(1) OH OH /H+
(2)Sn/HCl
(3)H3O+
T
(i)NaNO2/H+
(ii)PhOH/OH-
U

33. The product U is:

(A)


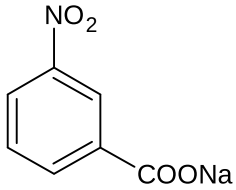
(B)


(C)


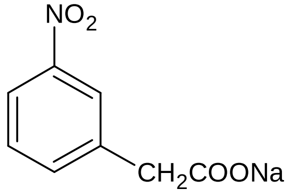
(D)


34. Which of the following will not be the product/s when "S" on reaction with $Cl_2/NaOH$ or on reaction with $Cl_2/NaOH$ followed by acidification:

(A)

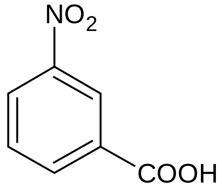


(B)



(C) $CHCl_3$

(D)



Paragraph for Question Nos. 35 and 36

Ligands are broadly classified into two classes classical and non-classical ligands, depending on their donor and acceptor ability. Classical ligands form classical complexes while non-classical ligands form non-classical complexes. Bonding mechanism in non-classical is called synergic bonding:

35. Synergic bonding is absent is:

(A) $\left[Mo(CO)_6\right]$

(B) $\left[Cr(CO)_3(B_3N_3H_6)\right]$

(C) $\left[Sc(CO)_6\right]^{3+}$

(D) $\left[Ni(CN)_4\right]^{4-}$

36. In compound $\left[M(CO)_n\right]^z$, the correct match for highest $'M-C'$ bond length for given M, n and z respectively:

	M	**n**	**z**
(A)	Cr	6	0
(B)	V	6	-1
(C)	Ti	6	-2
(D)	Mn	6	$+1$

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. If a complex number z satisfies $|z|^2 + \frac{4}{|z|^2} - 2\left(\frac{z}{\bar{z}} + \frac{\bar{z}}{z}\right) - 16 = 0$, then the maximum value of |z| is

(A) $\sqrt{6}+1$ (B) 4

(C) $2+\sqrt{6}$ (D) 6

38. Let S is the focus of parabola $y^2 = 4ax$ and X is the foot of the directrix, PP′ is a double ordinate of the curve and PX meets the curve again at Q. P′Q always passes through

(A) (a, 0) (B) $\left(\frac{a}{4}, 0\right)$

(C) $\left(\frac{2}{a}, 0\right)$ (D) $\left(\frac{a}{2}, \frac{a}{2}\right)$

39. If g(x) = $\frac{2h(x)+|h(x)|}{2h(x)-|h(x)|}$ where h(x) = sin x – $\sin^n x$, n $\in$ R^+, where R^+ is the set of positive real numbers, and f(x) = $\begin{cases} [g(x)], & x \in \left(0, \frac{\pi}{2}\right) \cup \left(\frac{\pi}{2}, \pi\right) \\ 3, & x = \frac{\pi}{2} \end{cases}$

Where [x] denotes the greatest integer function, then

(A) f(x) is continuous and differentiable at x = $\frac{\pi}{2}$, when 0 < n < 1

(B) f(x) is continuous and differentiable at x = $\frac{\pi}{2}$, when n > 1

(C) f(x) is continuous but not differentiable at x = $\frac{\pi}{2}$, when 0 < n < 1

(D) f(x) is continuous but not differentiable at x = $\frac{\pi}{2}$, when n > 1

Space for Rough work

40. The number of solution of the equation sinx sin2x sin 3x sin4x = $\frac{3}{4}$ is/are

(A) 1 (B) 2
(C) 3 (D) None of these

41. Let a, b ∈ [0, π], such that $2\cos\left(\frac{\pi}{7}\right)+6\cos a+7\cos b+9\cos\left(\frac{4\pi}{21}\right)=0$ and $2\sin\left(\frac{\pi}{7}\right)-6\sin a+7\sin b-9\sin\left(\frac{4\pi}{21}\right)=0$. Then the value of $\cos(a+b)$ is

(A) $\frac{3}{7}$ (B) $\frac{3}{14}$
(C) $\frac{1}{7}$ (D) None of these

42. If the expression, $2\cos 10°+\sin 100°+\sin 1000°+\sin 10000°$ is simplified, then it simplifies to

(A) $\cos 10°$ (B) $3\cos 10°$
(C) $4\cos 10°$ (D) $5\cos 10°$

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

43. Six balls of different colours are to be placed is 3 boxes of different sizes. Each box can hold all the six balls. Number of ways of placing the balls in the boxes so that no box remains empty, is

(A) $3^6-3.2^6+3$ (B) $6^3-6.5^3+{}^6C_2 4^3$
(C) 540 (D) $\left({}^6C_4+\frac{6!}{3!2!}+\frac{6!}{(2!)^3 3!}\right)3!$

Space for Rough work

44. Let $A=\begin{pmatrix} a & b & c \\ b & c & a \\ c & a & b \end{pmatrix}$ If trace $(A)=9$ and a, b, c are positive integers such that $ab+bc+ca=26$. Let A_1 denotes the adjoint of A; A_2 denote adjoint of A_1.......and so on. If value of $det\left(A_4\right)$ is M then

(A) $M=3^{48}$ (B) $M=3^{24}$

(C) Last two digits of M is 61 (D) $Det\left(A\right)=-27$

45. Let $f(x)=\frac{e^{-x}}{1+[x]}$, then

(A) Domain of definition of f(x) is $R-[-1,0)$

(B) Range of definition of f(x) is $\left(-\frac{1}{e},1\right]$

(C) f(x) is one-one in its domain

(D) Graph of f(x) is broken at infinitely many points

46. Set f(x) = ax^4 + bx^3 + cx^2 + dx + e, $a \neq 0$, is a function such that x = 1, x = 2 and x = 3 are normals to the curve y = f(x) such that f(2) is always greater than f(0), then which of the following are true for f(x)

(i) f(x) has 2 local maxima

(ii) There exist only one value of k such that Rolle's theorem is applicable to f(x) on the interval [0, k]

(iii) f(x) = 0 has two imaginary roots.

(A) Only (iii) and (i) are true (B) (ii) is true and (iii) is false

(C) Only (i) & (ii) are true (D) All are true

Space for Rough work

47. If $I_n = \int_0^{\pi/4} \tan^n x\ dx,\quad then$

(A) $I_n + I_{n-2} = \dfrac{1}{n-1}$

(B) $I_{n+1} + I_{n-1} = \dfrac{1}{n}$

(C) $\dfrac{1}{n+1} < 2I_n < \dfrac{1}{n-1}$, where $n > 1$ is a natural number

(D) $\left(I_{n+2} + I_n\right)\left(n+1\right) = 1$

48. $\displaystyle\int \frac{x^2 - 1}{x^3\sqrt{2x^4 - 2x^2 + 1}}\, dx$ is equal to

(A) $\dfrac{1}{x^2}\sqrt{2x^4 - 2x^2 + 1} + c$

(B) $\dfrac{1}{x^3}\sqrt{2x^4 - 2x^2 + 1} + c$

(C) $\dfrac{1}{x}\sqrt{2x^4 - 2x^2 + 1} + c$

(D) $\dfrac{1}{2x^2}\sqrt{2x^4 - 2x^2 + 1} + c$

49. A fair coin is tossed n times. Let $X=$ then number of times head occurs. If $P\left(X = 4\right), P\left(X = 5\right)$ and $P\left(X = 6\right)$ are in AP, then the value of n can be

(A) 7
(B) 10
(C) 12
(D) 14

50. Die A has 4 red and 2 white faces whereas die B has 2 red and 4 white faces. A coin is flipped once. If it shows a head, the game continues by throwing die A, if it shows tail, then die B is to be used. If the probability that die A is used is $32/33$. When it is given that red throws up every time in first n throws, then find the value of n?

(A) 4
(B) 5
(C) 6
(D) 7

Space for Rough work

Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 51 and 52

If $A_0 = \begin{bmatrix} 2 & -2 & -3 \\ -1 & 3 & 4 \\ 2 & -2 & -3 \end{bmatrix}$ and $B_0 = \begin{bmatrix} -4 & -3 & -3 \\ 1 & 0 & 1 \\ 4 & 4 & 3 \end{bmatrix}$ $B_n = adj\left(B_{n-1}\right),\ n \in N$ and I is an identity matrix of order 3. C_1, C_2, C_3 represent the column matrix of B_0 as shown, $C_1 = \begin{bmatrix} -4 \\ 1 \\ 4 \end{bmatrix}$, $C_2 = \begin{bmatrix} -3 \\ 0 \\ 4 \end{bmatrix}$ and $C_3 = \begin{bmatrix} -3 \\ 1 \\ 3 \end{bmatrix}$, then answer the following.

51. $\det\left(A_0 + A_0^2 B_0^2 + A_0^3 + A_0^4 B_0^4 + \text{......upto 10 terms}\right) =$

(A) 1000 (B) –800
(C) 0 (D) –8000

52. $B_1 + B_2 + \text{......} + B_{49} =$

(A) B_0 (B) $7B_0$
(C) $49B_0$ (D) 491

Space for Rough work

Paragraph for Question Nos. 53 and 54

Saina is to play with Sharapova in a three set match. For a particular set, the probability of Saina winning the set is y and if she wins probability of her winning the next set becomes $\sqrt{y}$ else the probability that she wins the next one becomes y^2. There is no possibility that a set is to be abandoned. R is probability that Saina wins the first set.

53. If R = $\frac{1}{2}$ then the probability that match will end in first two sets is nearly equal to

(A) 0.73
(B) 0.95
(C) 0.51
(D) 0.36

54. If R = $\frac{1}{2}$ and Saina wins the second set then probability that she has won first set as well is nearly equal to

(A) 0.74
(B) 0.46
(C) 0.26
(D) 0.54

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VII

JEE (Advanced)-2020

PAPER – 2

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. C

Sol. $\text{H}=\frac{u^2}{2g}.........(1)$

$$\frac{u^2}{4}=u^2-2gh \Rightarrow h=\frac{3u^2}{8g}=\frac{3\text{H}}{4}$$

2. C

Sol. $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$ $\frac{1}{-50}+\frac{1}{20}=\frac{1}{f}$ $f=\frac{100}{3}$ $R = 2f = 66.67$ cm

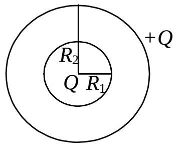
3. D

Sol. $\phi=\vec{B}.\vec{A}$ and $\varepsilon=-N\frac{d\phi}{dt}$ since angle between *B* and *A* is constant and magnitudes of *B* and A are also constant, so emf induced is zero.

4. D

Sol. Potential due to point charge and charge on the inner surface will cancel out each other, thus

$V=\frac{KQ}{R_2}$

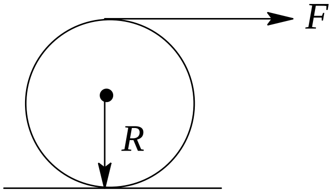


5. A

Sol. $PV = nRT \Rightarrow P = \left(\frac{nR}{V}\right)T \quad \therefore$ slope $\alpha\, n \;\therefore\quad n_A > n_B$

6. D

Sol. $\tau = F \times R = I\alpha$



In one full rotation, $\theta = 2\pi = \frac{1}{2}\alpha t^2 \Rightarrow t^2 = \frac{4\pi}{\alpha} = \frac{4\pi I}{FR}$

Linear acceleration, $a = F/M$

Distance travelled in one rotation = $2\pi R(given)$

$= \frac{1}{2}at^2 = \frac{1}{2}\frac{F}{M}.\frac{4\pi I}{FR} = \frac{2\pi I}{MR}$. It is a hollow cylinder.

7. A

Sol. Torque = $\tau = \frac{9}{10}mg\left(\frac{9}{20}L\right) = I\alpha = \frac{\left(\frac{9}{10}m\right)}{3}\left(\frac{9}{10}L\right)^2 \alpha \Rightarrow \alpha = \frac{5}{3}\frac{g}{L}$

Acceleration, $a_{CM} = \frac{9L}{10}\alpha$

Now, $\frac{9}{10}mg - N_A = ma_{CM} \Rightarrow N_A = \frac{3}{20}mg$

8. AC

Sol. For translation equilibrium

$$\frac{V}{4}\rho g = Mg ------(1)$$

$$\frac{3V}{4}\rho g = Mg + mg ------(2)$$

$m = 2M$

For rotational equilibrium centre of mass of the system should lie below centre of buoyancy.

As $\frac{3\ell}{8}(\text{position of centre of buoyancy from lower end of rod}) > \ell/6$ (position of centre of mass form lower end of rod). So rotational equilibrium is possible.

9. AC

Sol. $\frac{\mathrm{dU}}{\mathrm{dx}} = (x+1)(1) + (x+2)1 = 2x+3 = 0$

$x = -\frac{3}{2}$ is the equilibrium position

$\frac{\mathrm{d^2U}}{\mathrm{dx^2}} = 2 > 0$ so equilibrium stable

10. BD

Sol. $\frac{dK}{dx}=\frac{\mu V_p^2}{2}$ and $V_p=0$ at crest and trough

$\frac{dU}{dx}=\frac{I}{2}\left(\frac{\delta y}{\delta x}\right)^2$ and $\frac{\delta y}{dx}=0$ at crest and trough

11. AC

Sol. $\frac{KA(4-0)}{2-y}=\frac{3KA\{(0)-(-2)\}}{y}$

y=1.2m=120 cm

12. AC

13. D

Sol. $\tan\alpha=\frac{E_2}{E_1}=\frac{Kp\sin\theta/r^3}{2Kp\cos\theta/r^3}=\frac{1}{2}\tan\theta........(1)$

$\alpha+\theta=\frac{\pi}{2}.......(2)$

Solving (1) and (2) $\tan\theta=\frac{1}{\sqrt{2}}$

14. ACD

Sol. $\mathrm{A}\left(\frac{dB}{dt}\right)=\frac{L\,di}{dt}\Rightarrow\int_0^i di=\frac{A}{L}\int_0^B\frac{dB}{}\Rightarrow i=\frac{A}{L}B$

15. B

16. A

Sol. (for Q. 15 to 16)

$5mg\sin\theta-f=5ma............(1)$

$fR=I\alpha..................(2)$

$a=R\alpha..................(3)$

$I=\frac{4m\ell^2}{3}+mR^2...........(4)$ and $\ell^2=3R^2$

Solving above equation

$a=\frac{15}{26}g\sin\theta$

and

$\mu mg\cos\theta=f=\frac{5mg\sin\theta}{\frac{1+5mR^2}{I}}$

$\mu=\frac{11}{26}\tan\theta$

17. B

18. C

Sol. (for Q. 17 to 18)

$$ma = F = \frac{-dU}{dx} = -32\left(x-1\right)$$

$$a = -16\left(x-1\right) \Rightarrow \omega = 4\,\text{rad/second}$$

At mean position $a = 0 \Rightarrow x = 1\left(\text{mean position}\right)$

Applying conservation of mechanical energy

$$0 = -16 + K.\varepsilon_{\max} \Rightarrow K.\varepsilon_{\max} = 16\,\text{Joule}$$

Chemistry PART – II

SECTION – A

19. A

Sol.
$$\mathrm{n}=\frac{\mathrm{PV}}{\mathrm{RT}}=\frac{6\times 2}{0.08\times 300}=0.5\mathrm{mol}$$
$$\mathrm{q}=0$$
$$\Delta U=q+W$$
$$\mathrm{n}\times 3\mathrm{R}\times\left(T_2-T_1\right)=-P_{ext}\left(8-2\right)$$
$$0.5\times 3\times 0.08\left(T_2-300\right)=-1\mathrm{atm}\times 6\,\mathrm{L}$$
$$\left(T_2-300\right)=-50$$
$$T_2=250$$

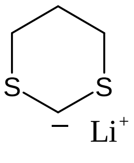
Now,
$$2L,300\,K\longrightarrow 8L,300K\longrightarrow 8L,250K$$
$$\begin{array}{ll}
\Delta s=nR\ln\frac{8}{2} & \Delta s=nC_V\ln\frac{250}{300}\\
\quad=0.5\times 8.0\times\ln 4 & \quad=0.5\times 3R\ln\frac{5}{6}\\
=8\ln 2 & =12\ln\frac{5}{6}\\
=8\times 2.3\times 0.3 & =12\left[\ln 10-\ln 3-\ln 4\right]\\
 & =12\times 2.3\left[\log 10-\log 3-\log 4\right]\\
=2.4\times 2.3 & =12\times 2.3\times\left[-0.08\right]\\
=5.52 & =-2.3\times 0.96\\
 & =-2.208 \qquad \Delta\mathrm{S}_{\mathrm{Total}}=-3.3
\end{array}$$

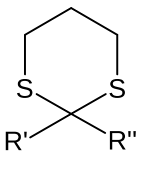
20. A

Sol.
$$BaO_2.8H_2O+H_2SO_4\longrightarrow BaSO_4\downarrow+H_2O_2+8H_2O$$
$$H_2O_2+H_2SO_4+2KI\longrightarrow K_2SO_4+2H_2O+I_2$$

21. D

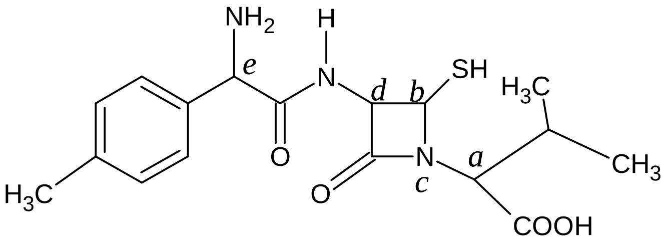
Sol.

P 

T= 

22. A

Sol. a, b, c, d, e are stereogenic centre.



23. A

Sol. $\frac{2.3\times10^{-15}}{284}\times \mathrm{N_A}$ cm number of molecules

Cross-section of acid molecule $=\frac{100\times284}{2.3\times10^{-5}\times N_A}$

$=2.05\times10^{-15}$

24. C

Sol. In equilibrium, vapour pressure of solution will remain same

$$\frac{\Delta p}{p*}=\left(\frac{n_{sugar}}{n_{sugar}+n_{H_2O}}\right)_{\text{Beaker B}}=\left[\frac{2\ n_{NaCl}}{2\ n_{NaCl}+n_{H_2O}}\right]_{\text{BeakerA}}$$

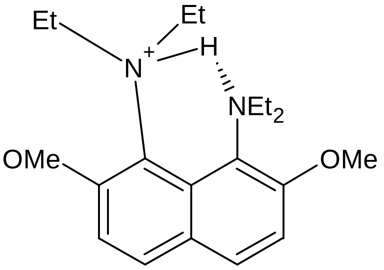
$$\frac{0.1}{0.1+\frac{(1-a)\times1000}{18}}=\frac{2\times0.1}{2\times0.1+\frac{(1+a)\times1000}{18}}$$

$\Rightarrow a=1/3$

So molarity of NaCl $=\frac{0.1}{\frac{4}{3}}=\frac{0.3}{4}=0.075$

25. A

Sol.



H-bonding

26. ACD

Sol. (A) As reaction is endothermic therefore it will go in the forward direction hence moles of CaO will increase.

(C) With the increase or decrease of volume particle pressure of the gases will remain same.

(D) Due to the addition of inset gas at constant pressure reaction will proceeded in the direct in which more number of gaseous are formed.

27. ACD

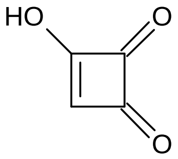
Sol. $W_{\text{on the system, adiabatic}} > W_{\text{on the system, isothermally}}$

$$MgCO_3(s) \longrightarrow MgO(s) + CO_2(g)$$

28. ABD

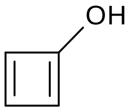
Sol. $A \rightarrow$ hydrogen of diketone is more acidic.

$B \rightarrow$



has some aromatic character

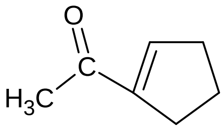
$C \rightarrow$



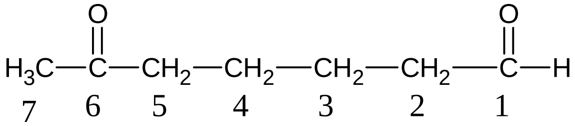
is antiaromatic

29. AB

Sol. (A)



Aldol



$$\underset{7}{H_3C}—\underset{6}{\overset{\overset{O}{||}}{C}}—\underset{5}{CH_2}—\underset{4}{CH_2}—\underset{3}{CH_2}—\underset{2}{CH_2}—\underset{1}{\overset{\overset{O}{||}}{C}}—H$$

Here C-2 and C-5 can form carbanion & leads to different product.

30. BCD

Sol. Aniline can show Carbylamine test, Diazo test, while Benzamide shows reaction with NaOH+Br$_2$.

31. BCD

Sol. Lyophilic colloids are used to protect lyophobic colloid.

32. BD

Sol. A.O. is a single e^- wave function

Area of the plot for r<52.9 pm is smaller than the area of the plot of r>52.9pm.

At higher atomic number every of $3d<4s$

$$\Delta E_{2\to5} = RhcZ^2\left[\frac{1}{2^2}-\frac{1}{5^2}\right] = RhcZ^2\left[\frac{21}{100}\right]$$

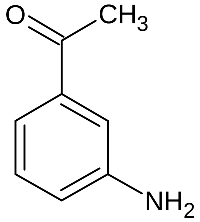
$$\Delta E_{2\to4} = RhcZ^2\left[\frac{1}{2^2}-\frac{1}{4^2}\right] = RhcZ^2\times\frac{3}{16}$$

$$\Delta E_{2\to5} = \frac{28}{25}\Delta E_{2\to4}$$

33. C

Sol.

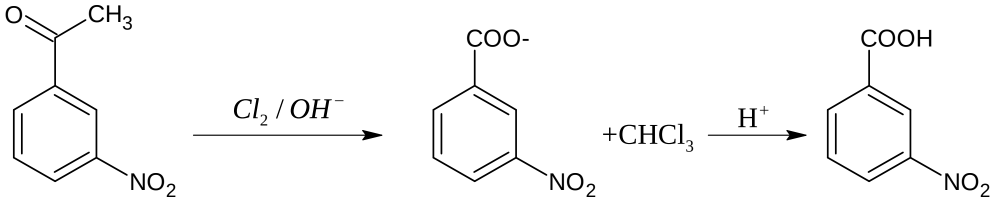
T →



34. B

Sol.

S →


O
CH3
NO2
Cl2 / OH−
COO-
NO2
+CHCl3
H+
COOH
NO2

35. C

Sol. $SC^{3+} \rightarrow 3d^{\circ}$ so no scope of $M \rightarrow L$ bonding

36. D

Sol. $\left[Mn\left(CO\right)_6\right]^{+} \Rightarrow 25-1+12=36=\text{EAN Rule}$

Mathematics PART – III

SECTION – A

37. C

Sol. Let $z = r(\cos\theta + i\sin\theta)$

Then the equation $r^2 + \frac{4}{r^2} - 2.2\cos 2\theta$ - 16 = 0

$r^4 - 4r^2(\cos 2\theta + 4) + 4 = 0$

By solving we get

For maximum value of r, $\cos 2\theta = 1$

$r = 2 + \sqrt{6}$

38. A

Sol. Equation of PX→$(1+t^2)y= 2t(x+a)$ …(1)

For point Q, m solving equation (1) & curve

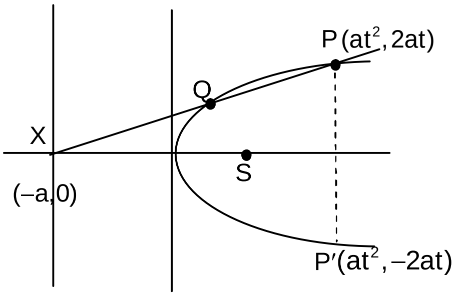
$t^2(x+a)^2 = ax(1+t^2)^2$

$(x–at^2)\ (xt^2–a)=0$

$x = \frac{a}{t^2} \Rightarrow \ \therefore\ Q = \left(\frac{a}{t^2}, \frac{2a}{t}\right)$

Equation of $P'Q \Rightarrow (x-a) + \left(\frac{t^2-1}{2t}\right)(y) = 0$

Will always passes through (a,0)



39. B

Sol. g(x) = $\frac{2\left(\sin x - \sin^n x\right) + \left|\sin x - \sin^n x\right|}{2\left(\sin x - \sin^n x\right) - \left|\sin x - \sin^n x\right|}$

for 0 < n < 1, sin x < $\sin^n$x, so g(x) = $\frac{1}{3}$ and for n > 1, sin x > $\sin^n$x, so g(x) = 3

∴ for n > 1, f(x) = 3, g(x) = 3

∴ f(x) is continuous and differentiable at x = $\frac{\pi}{2}$ and for 0 < n < 1

$$f(x) = \begin{cases} \left[\frac{1}{3}\right] = 0 & x \in \left(0, \frac{\pi}{2}\right) \cup \left(\frac{\pi}{2}, \pi\right) \\ 3, & = \frac{\pi}{2} \end{cases}$$

∴ f(x) is not continuous at x = $\frac{\pi}{2}$. Hence f(x) is also not differentiable at x = $\frac{\pi}{2}$.

40. D

Sol. Given relation can be written as

$\frac{1}{8}\left(2\cos^2 5x - \cos 2x + \cos 8x - \cos 4x + \cos 6x\right) < \frac{6}{8} < \frac{3}{4}$

Therefore, no solution

41. B

Sol: $2\cos\frac{\pi}{7} + 9\cos\left(\frac{4\pi}{21}\right) = -(6\cos a + 7\cos b)$

$2\sin\frac{\pi}{7} - 9\sin\frac{4\pi}{21} = 6\sin a - 7\sin b$

Squaring and adding, we get

$42\ \cos(a+b) = 9$

42. A

Sol. $2\cos 10^\circ + \sin 100^\circ + \sin 1000^\circ + \sin 10000^\circ$

$= 2\cos 10^\circ + \sin\left(90^\circ + 10^\circ\right) + \sin\left(3\times 360^\circ - 80^\circ\right) + \sin\left(27\times 360^\circ + 280^\circ\right)$

$= 2\cos 10^\circ + \cos 10^\circ - \cos 10^\circ - \cos 10^\circ$

$= \cos 10^\circ$

43. ACD

Sol. Placing 6 different colour balls into 3 different size boxes is as the number of onto function form 6 elements set to 3 element sets.

$\therefore$ Total number of ways $3^6 - 3.2^5 + 3.1^4$ (By inclusion – Exclusion principle)

Or

$\left({}^6C_4 + \frac{6!}{3!2!} + \frac{6!}{(2!)^3 3!}\right)3!$

44. ACD

Sol. $|A| = 3abc - a^3 - b^3 - c^3$

$a+b+c = 9.\&\, ab+bc+ca = 26$

So, $|A| = -27$

Hence $M = 3^{48}$

Now $3^{48} = 9^{24} = (10-1)^{24}$

Now last two digits are 61.

45. ACD

46. BC

Sol. Since x = 1, 2, 3 are normals

$\Rightarrow$ f'(x) = $4ax^3 + 3bx^2 + 2cx + d$

$\Rightarrow$ b = – 8a, C = 22a, d = –24a

Also f(2) > f(0)

$\therefore$ x =1 & 3 are point of local maxima

Also f(k) = f(0)

$\Rightarrow ak^4 + bk^3 + ck^2 + dk = 0$

$\Rightarrow ak(k-4)(k^2 - 4k + 6) = 0$

$\Rightarrow$ k = 4

47. ABCD

Sol. $I_n = \int_0^{\pi/4} \tan^n x\, dx$

$= \int_0^{\pi/4} \tan^{n-2} x\left(\sec^2 x - 1\right)dx$

$= \frac{1}{(n-1)} - I_{n-2}$

Or, $I_n + I_{n-2} = \frac{1}{(n-1)}$

48. D

Sol: $\int \frac{x^2-1}{x^3\sqrt{2x^4-2x^2+1}}\,dx = \int \frac{x^2-1}{x^5\sqrt{2-\frac{2}{x^2}+\frac{1}{x^4}}}\,dx = \int \frac{\frac{1}{x^3}-\frac{1}{x^5}}{\sqrt{2-\frac{2}{x^2}+\frac{1}{x^4}}}dx$

Let $2-\frac{2}{x^2}+\frac{1}{x^4} = t^2$

49. AD

Sol. $\therefore P(X=4), P(X=5)$ and $P(X=6)$ are in AP.

$\therefore 2P(X=5) = P(X=4) + P(X=6)$

$\Rightarrow \quad 2 = \frac{P(X=4)}{P(X=5)} + \frac{P(X=6)}{P(X=5)}$

$2 = \frac{{}^nC_4}{{}^nC_5} + \frac{{}^nC_6}{{}^nC_5}$

$\Rightarrow n^2 - 21n + 98 = 0 \quad \therefore n = 7, 14$

50. B

Sol. Let R be the event that a red face appears in each of the first n throws,

E_1: Die A is used when head has already fallen

E_2: Die B is used when tail has already fallen

$\therefore P\left(\frac{R}{E_1}\right) = \left(\frac{2}{3}\right)^n$ & $P\left(\frac{R}{E^2}\right) = \left(\frac{1}{3}\right)^n$

As per the given condition,

$$\frac{P(E_1).P\left(\frac{R}{E^1}\right)}{P(E_1).(PR/E^1) + P(E_2).\,P\left(\frac{R}{E_2}\right)} = \frac{32}{33}$$

$$\frac{\frac{1}{2}.\left(\frac{2}{3}\right)^n}{\frac{1}{2}\left(\frac{2}{3}\right)^n + \frac{1}{2}.\left(\frac{1}{3}\right)^n} = \frac{32}{33}$$

$n = 5$

51. C

Sol. $\det\left(A_0\right)\det\left(Al + A_0B_0^2 + A_0^2 + A_0^3B_0^4 + \text{.....up to 10 terms}\right) = 0\left(\because \det\left(A_0\right) = 0\right)$

52. C

Sol. $B_1 = adj\left(B_0\right) = B_0$

Hence $B_1 = B_2 = B_3 = ...B_{494} = B_0$

$\therefore B_1 + B_2 + ... + B_{49} = 49B_0$

53. A

Sol. Required probability $= \frac{1}{2} \times \frac{1}{\sqrt{2}} + \frac{1}{2}\left(1 - \frac{1}{4}\right) = 0.728$

54. A

Sol. $P\left(\frac{\text{I}}{\text{II}}\right) = \frac{P(\text{I}).P\left(\frac{\text{II}}{\text{I}}\right)}{P(\text{II})} = \frac{\frac{1}{2}.\frac{1}{\sqrt{2}}}{\frac{1}{2}.\frac{1}{\sqrt{2}+\frac{1}{8}}} = 0.74$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VII

JEE (Main)-2020

TEST DATE: 23-08-2020

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 75 questions.
- Each subject (PCM) has 25 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only three sections: **Section-A**, **Section-B and Section-C**.

  Section-A (01 – 20, 26 – 45, 51 – 70) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

  Section-B (21 – 22, 46 – 47, 71 – 72) *contains 6 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

  Section-C (23 – 25, 48 – 50, 73 – 75) *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

Physics

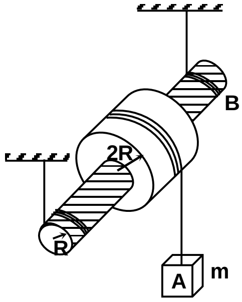
PART – I

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

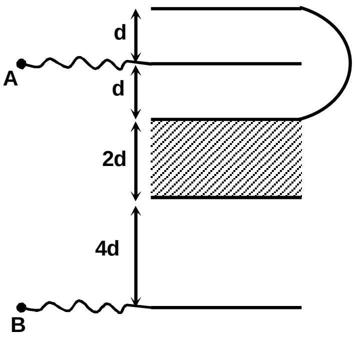
1. The volume charge density in a spherical region varies with the radial distance ‘r’ from its centre as $\rho = \frac{\alpha}{r}$ coulomb/m^3, where α is a constant. The electric field intensity in the spherical region varies as
(A) constant
(B) inversely proportional to ‘r’
(C) directly proportional to ‘r’
(D) inversely proportional to ‘r^{2}’

2. In the arrangement as shown, if the pulley accelerates in vertical downward direction with 2 m/s^2, then the acceleration of the block is (there is no slipping between the strings and the pulley)
(A) 2 m/s^2
(B) 4 m/s^2
(C) 6 m/s^2
(D) 8 m/s^2



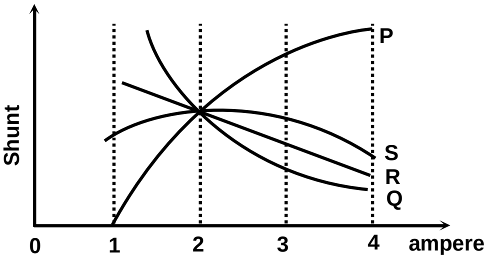
3. A ball is projected near the surface with speed u at an angle θ with the horizontal surface of an imaginary planet whose acceleration due to gravity on its surface is $g_p = 2g$ and wind blows with an acceleration of 2g along horizontal in the direction of throw. Find the range of the projectile. (g = acceleration due to gravity on the earth’s surface)
(A) $\frac{2u^2}{g}\sin\theta(\sin\theta+\cos\theta)$
(B) $\frac{u^2}{2g}\cos\theta(\sin\theta+\cos\theta)$
(C) $\frac{u^2}{g}\cos\theta(\sin\theta+\cos\theta)$
(D) $\frac{u^2}{g}\sin\theta(\sin\theta+\cos\theta)$

4. In the arrangement shown, a dielectric slab of dielectric constant k = 2 is completely filled in the shaded region. All the plates have same area S. Find the equivalent capacitance between A and B. (Given $\frac{\varepsilon_0 S}{d} = 1\mu F$)



(A) $\frac{2}{11}\mu f$
(B) $\frac{4}{11}\mu f$
(C) $\frac{7}{22}\mu f$
(D) $\frac{9}{22}\mu f$

5. The ammeter has a range of 1 ampere without shunt. The range can be varied by using different shunt resistance. The graph between the shunt resistance and the range will have the nature



(A) P
(B) Q
(C) R
(D) S

6. The Rutherford's calculation of electric potential at a distance 'r' from the centre of a spherical atom is

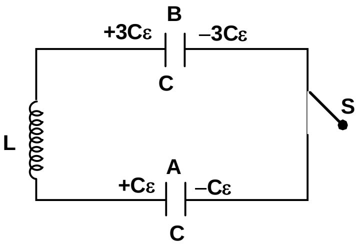
$V = \frac{Ze}{4\pi\varepsilon_0}\left(\frac{1}{r} - \frac{3}{2R} + \frac{r^2}{2R^3}\right)$; where R is the radius of spherical atom

The electric field intensity at a distance 'r' from the centre of spherical atom is

(A) $\frac{ze}{4\pi\varepsilon_0}\left(\frac{2r}{R^3} - \frac{1}{r^2}\right)$
(B) $\frac{ze}{4\pi\varepsilon_0}\left(\frac{1}{r^2} - \frac{2r}{3R^3}\right)$
(C) $\frac{ze}{4\pi\varepsilon_0}\left(\frac{1}{r^2} + \frac{2r}{3R^3}\right)$
(D) $\frac{ze}{4\pi\varepsilon_0}\left(\frac{1}{r^2} - \frac{r}{R^3}\right)$

7. The aperture diameter of a plano-convex lens is 6 cm and thickness 3 mm at its centre. If the speed of light in the material of lens is 2×10^8 m/s, the focal length of the lens is
(A) 15 cm
(B) 20 cm
(C) 30 cm
(D) 10 cm

8. In the circuit shown, initially charge on the two capacitors A and B are Cε and 3Cε respectively and connected through an inductor of inductance 'L' and having zero initial current. At t = 0, the switch 'S' is closed, then the maximum current through the inductor is



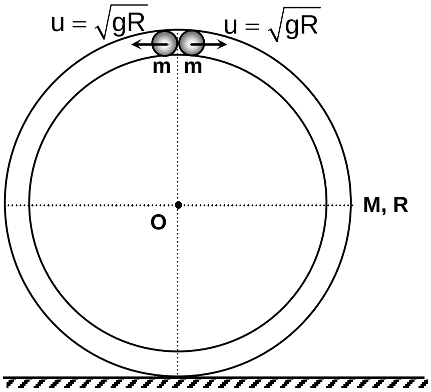
(A) $\varepsilon\sqrt{\frac{2C}{L}}$

(B) $\varepsilon\sqrt{\frac{C}{L}}$

(C) $\varepsilon\sqrt{\frac{C}{2L}}$

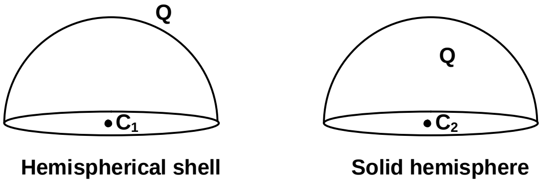
(D) $\varepsilon\sqrt{\frac{C}{3L}}$

9. A circular tube of mass 'M' and radius 'R' is placed vertically on a horizontal surface. Two identical small spheres each of mass m = 1 kg just fitting inside the tube are imparted equal and opposite initial horizontal velocity $u = \sqrt{gR}$ at the top of the tube as shown. If the tube loses contact with the horizontal surface when the radius vector of each ball makes an angle θ = 60° with the vertical, then the value of 'M' is



(A) 0.5 kg
(B) 1.5 kg
(C) 2.5 kg
(D) 4.5 kg

10. Charge Q each are distributed uniformly on a non-conducting hemispherical shell (on the surface) and in the volume of a non-conducting solid hemisphere. A point charge q is brought slowly at the centre C_1 of shell and at the centre C_2 of solid hemisphere from infinity.



If the work done in these two processes are W_1 and W_2 then, the ratio $\left(\frac{W_1}{W_2}\right)$ is

(A) $\frac{3}{4}$

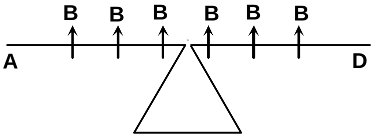
(B) $\frac{3}{2}$

(C) $\frac{4}{3}$

(D) $\frac{2}{3}$

11. The work function of a metallic surface is 3.8 eV. Photoelectrons are emitted when light of wavelength 2000 Å falls on it. The minimum potential difference required to stop the fastest photoelectron is
(A) 1.2 volts
(B) 2.4 volts
(C) 3.6 volts
(D) 4.8 volts

12. A conducting wire is bent into the shape of an equilateral triangular loop with each side of mass ‘m’ and length ‘ℓ’. The loop is suspended in a vertical plane from a horizontal axis ‘AD’ as shown. A uniform vertical upward magnetic field ‘B’ is existing in the region. If charge ‘Q’ is passed through the loop almost instantaneously, then the angular velocity acquired by the loop is



(A) $\frac{3\sqrt{3}BQ}{5m}$
(B) $\frac{2\sqrt{3}BQ}{5m}$
(C) $\frac{\sqrt{3}BQ}{5m}$
(D) $\frac{BQ}{5m}$

13. A transformer is used to light a 140 watt, 24 volt lamp from 240 V AC mains. The current in the main cable is 0.7 amp. The efficiency of the transformer is
(A) 48 %
(B) 63.8%
(C) 83.3 %
(D) 90%

14. The fundamental frequency of a sonometer wire increases by 6 Hz if its tension is increased by 44% keeping the length constant. The decrease in fundamental frequency (in Hz) of the sonometer wire when the length of the wire is increased by 20%, keeping the original tension in the wire, will be
(A) 2
(B) 4
(C) 5
(D) 10

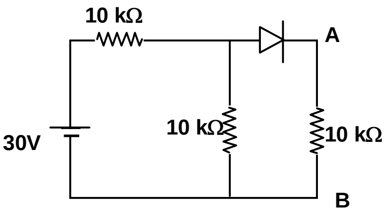
15. In Young’s double slit experiment, the central bright fringe of the interference pattern produced by light of wavelength 6000 Å is found to shift to the position of 4th bright fringe after a glass plate of refractive index 1.5 is placed in front of one slit. The thickness of the glass plate is
(A) 4.8 μm
(B) 8.23 μm
(C) 14.48 μm
(D) 3.78 μm

16. If gravitational force alone prevents a spherical rotating neutron star from disintegrating and it has a mean density of magnitude $\left(\frac{9\pi}{20}\right)\times 10^{11}$ kg/m^3, then the minimum time period of star is $\left(\text{Take}\quad G = \frac{20}{3}\times 10^{-11}\ \text{Nm}^2/\text{kg}^2\right)$
(A) 1 sec
(B) 1.5 sec
(C) 3 sec
(D) 5 sec

17. A small concentration of minority charge carriers is injected into a homogenous semiconductor crystal at one point. An electric field of 10 V/cm is applied across the crystal and this moves the minority carriers a distance of 1 cm in 20 μ sec. The mobility (in cm^2/V-sec) will be
(A) 1000
(B) 2000
(C) 5000
(D) 500000

18. An immersion rod is used to heat 10 kg of water. The resistance of rod is $10^3\ \Omega$. Find the time (in minutes) for which the current 0.1 ampere be passed so that water is heated from 10°C to 20°C. (Specific heat of water = 4.2 Joule/gm°C)
(A) 350 minutes
(B) 700 minutes
(C) 1400 minutes
(D) 2100 minutes

19. In the given figure potential difference between A and B is (assume ideal diode)
(A) 0
(B) 5V
(C) 10 V
(D) 15 V

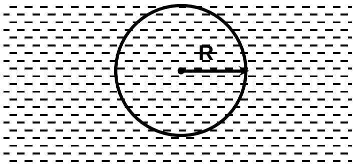


20. In a compound microscope, the objective has a focal length of 1.5 cm and the eyepiece has a focal length of 5 cm. If an object is placed at a distance of 2 cm from the objective then the magnification of the compound microscope for the adjustment for near point vision is (microscope is used by a person with near point at 25 cm).
(A) 15
(B) 18
(C) 24
(D) 30

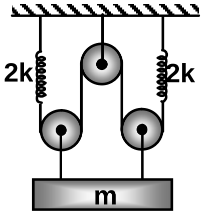
SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

21. A sphere is just immersed in a liquid. Find the ratio of hydrostatic force acting on the lower half and the upper half of the sphere. (Neglect atmospheric pressure)



22. In the arrangement as shown if the block is slightly displaced from its equilibrium position and then released, the frequency of small oscillation of the block is $\frac{n}{2\pi}\sqrt{\frac{k}{m}}$. Find the value of 'n'. (All the springs and pulleys are ideal)



SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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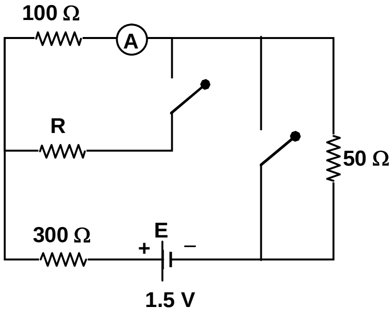
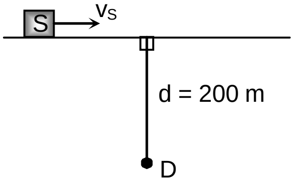
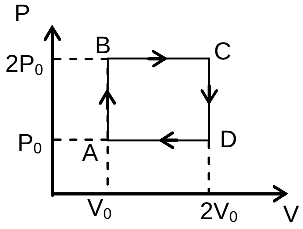
23. In the circuit shown, the reading of the ammeter (ideal) is the same with both switches open as with both switches closed. Find the value of resistance R in ohm.



24. A source emitting sound of frequency 600 Hz is moving along a straight horizontal road with a constant velocity 66 m/s. A stationary detector 'D' is located at a distance 200 m from the straight road. The velocity of sound in air is 330 m/s. Find the frequency (in Hz) of sound received by the detector when the source is closest to the detector.



25. The given figure shows the indicator diagram corresponding to n moles of an ideal monoatomic gas taken along the cyclic process ABCDA. Find the efficiency (in percentage) of the cycle.



Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

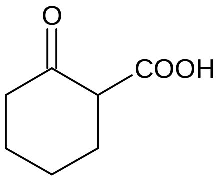
26.

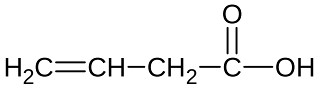
Column A	**Column B**
Name of Ore	Molecular formula
(a) Cassiterite	(i) Fe_3O_4
(b) Magnetite	(ii) SnO_2
(c) Pyrolusite	(iii) MnO_2
(d) Malachite	(iv) $CuCO_3.Cu(OH)_2$

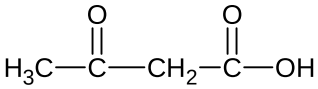
Select the correct combination:

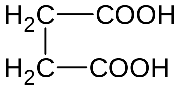
(A) (a) (i); b (ii); (c) (iii); d(iv)
(B) (a) (iii); b (i); (c) (ii); d(iv)
(C) (a) (ii); b (i); (c) (iii); d(iv)
(D) (a) (ii); b (i); (c) (iv); d(iii)

27. Which of the following molecules will not liberate CO_2 on heating?

(A)


(B)

$H_2C{=}CH{-}CH_2{-}\overset{\displaystyle O}{\overset{\|}{C}}{-}OH$

(C)

$H_3C{-}\overset{\displaystyle O}{\overset{\|}{C}}{-}CH_2{-}\overset{\displaystyle O}{\overset{\|}{C}}{-}OH$

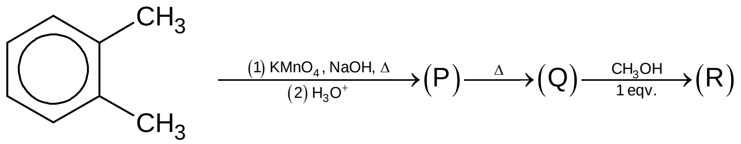
(D)

$$\begin{matrix} H_2C{-}COOH \\ | \\ H_2C{-}COOH \end{matrix}$$

28. A quantity of 212.0 g of an aqueous solution of solute (molar mass 50.0 g) having solute mole fraction to be 0.1 is reduced to 180.0 g on evaporation and simultaneously 14.0 g of solute crystallizes out. The molality of the saturated solution left over is:

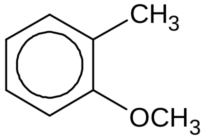
(A) 0.5
(B) 7.69
(C) 4.0
(D) 5.0

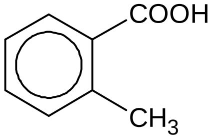
29. Which one of the following is not a common component of photochemical smog?

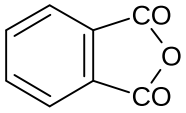
(A) Peroxyacyl nitrate
(B) Ozone
(C) Chlorofluoro carbons
(D) Acrolein

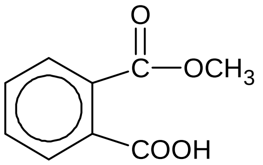
30. 

Considering the above sequence of reaction the product (R) is:

(A) 

(B) 

(C) 

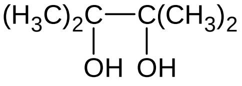
(D) 

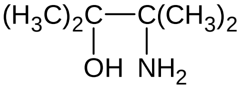
31. Which of the following statements regarding a hydrophilic sol is INCORRECT?
(A) Viscosity and surface tension are not very different from that of water.
(B) Coagulation is not very susceptible to addition of electrolytes.
(C) The charge on the sol particles depends on the pH value and it may be positive, negative or even zero.
(D) Stability towards coagulation is attributed to the electric charge on the sol particles as well as their hydration.

32. Compound ‘P’ (orange coloured solid) on heating gives compound ‘Q’ (green colour), ‘R’ (dry colourless gas) and water. ‘R’ on heating with Mg gives a compound ‘S’ (white solid) which on hydrolysis gives a colourless pungent smelling gas ‘T’. Gas ‘T’ gives white fumes with conc. HCl. Gas ‘R’ may be
(A) N_2
(B) NH_3
(C) NO_2
(D) NO

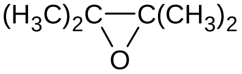
33. $$\left(CH_3\right)_2C=C\left(CH_3\right)_2 \xrightarrow{CF_3COOOH} (A) \xrightarrow[(2)\ H_2O]{(1)\ NaNH_2} (B) \xrightarrow{HNO_2} (C)$$

Considering the above sequence of reaction product ‘C’ is

(A) 
$(H_3C)_2C(OH)-C(OH)(CH_3)_2$

(B) 
$(H_3C)_2C(OH)-C(NH_2)(CH_3)_2$

(C) $(CH_3)_3CCOCH_3$

(D) 
$(H_3C)_2C-C(CH_3)_2$ (epoxide, O bridging)

34. 3.0 g of an ideal gas A, when placed in an evacuated vessel at 27°C, exerts a pressure of 1.5 atm, when a 9.0 g of another ideal gas B, non-reacting with A, is introduced in the same vessel pressure becomes 2.0 atm. What is the ratio between the average speeds of A and B at the same temperature?
(A) 1 : 3
(B) 1 : 4
(C) 4 : 1
(D) 3 : 1

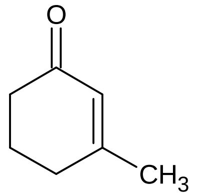
35. Which of the following statements is INCORRECT?
(A) At room temperature, ortho-hydrogen is more stable than para-hydrogen.
(B) The percentage of ortho-hydrogen increases with decrease in temperature.
(C) Ortho-hydrogen has proton of parallel spin.
(D) Ortho-hydrogen and para-hydrogen have different nuclear magnetic moment.

36. 0.3 M solutions each of acid HA($K_a = 1.0 \times 10^{-5}$) and HCl are neutralized separately with 0.3 M NaOH to the extent of 50%. The resulting solutions are subsequently diluted to 10 times of their current volumes. The pH values of the two solutions (final) respectively will be:
(A) 5.0 and 1.0
(B) 5.0 and 2.0
(C) 6.0 and 1.0
(D) 6.0 and 2.0

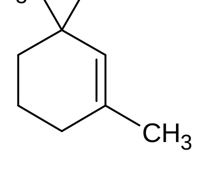
37. Which of the following statements is INCORRECT?
(A) Gypsum is added to cement to increase the setting time.
(B) Setting of cement is an exothermic process.
(C) Setting of plaster of paris is catalysed by borax.
(D) Setting of plaster of paris is catalysed by sodium chloride.

38. Which one of the following statements is INCORRECT?
(A) Aspartame is the artificial sweetner which is stable at lower temperature.
(B) Bithional is generally added to soaps as an antiseptic.
(C) Bithional is generally added as a softner to soaps.
(D) Alizarin with Al^{3+}, gives rose red colour.

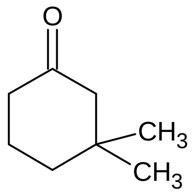
39. Which of the following alloy does not contain copper?
(A) Bell metal
(B) Type metal
(C) Monel metal
(D) Gun metal

40.


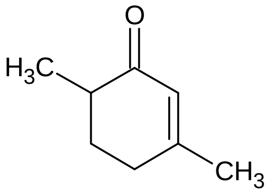
$\xrightarrow[(2)\,H_3O^+]{(1)(CH_3)_2CuLi}$ (P) Product (Major)

The product 'P' is:
(A)


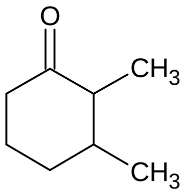
(B)



(C)

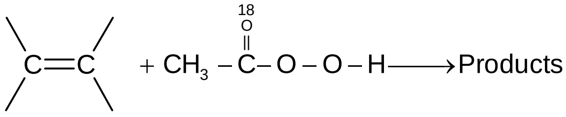


(D)



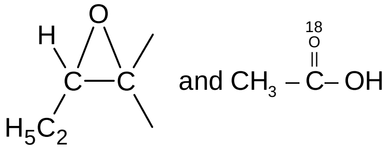
41. Which of the following molecules showing bridge bonding is planar ?
(A) B_2H_6
(B) I_2Cl_6
(C) Al_2Cl_6
(D) $Al_2(CH_3)_6$

42.

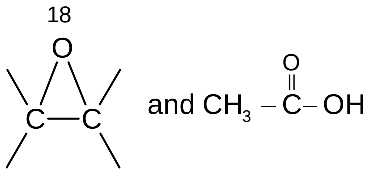


The product(s) are

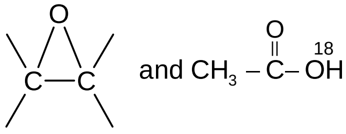
(A)



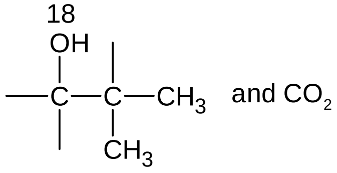
(B)



(C)



(D)



43. Which of the following statements is CORRECT?
    I. Passing of H_2S gas through nitric acid produces plastic sulphur.
    II. Passing of H_2S gas through nitric acid produces colloidal sulphur.
    III. Passing of H_2S gas through SO_2 produces colloidal sulphur.
    (A) Only I
    (B) I and III
    (C) II and III
    (D) I, II and III

44. Which of the following tests can be used to distinguish between glucose and fructose?
    (A) Tollen's test
    (B) Furfural test
    (C) Fehling's test
    (D) Molish's test

45. Which of the following is not an intensive property?
    (A) Dielectric constant
    (B) Heat capacity
    (C) Viscosity
    (D) Standard electrode potential

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

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46. Two isotopes 'X' and 'Y' of atomic mass 10 and 20 respectively are mixed in equal amounts by mass. After 30 days, their mass ratio is found to be 4 : 1. If isotope 'X' has half-life of 10 days. What is the half-life of 'Y' (in days)?

47. How many of the following are copolymers
    Polyurethrane ; Polymethylacrylate ; Glyptal ; Nylon-6,6 ; Teflon ; Dacron ; Bakelite ; BUNA-S ; Polyacrylonitrile.

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

48. An organic compound was analysed by Duma's method, 0.40 g of compound on combustion gave 50 ml of nitrogen at 27^oC and 756 mm of pressure. Calculate percentage of nitrogen in the compound.

49. The orbital angular momentum of an electron is $\sqrt{3}\frac{h}{\pi}$, if the minimum permissible value of total energy (eV) of this electron in unknown Bohr's orbit of Li^{2+} is – x eV, then the value of 'x' is :

50. $COCl_2(g)$ dissociates in the following manner
    $COCl_2(g) \rightleftharpoons CO(g) + Cl_2(g)$
    When $COCl_2(g)$ is heated to 750 K at 1.0 atm, density of the gas mixture was found to be 1.162 g/L. What is the value of K_P? [Take value of R = 0.082, and (assume the reaction is started taking 1 mole of $COCl_2$ initially)]

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

51. If 1 – i be one of the roots of $ax^2 - bx + c = 0$ where a, b, c are the sides of a triangle ABC, then which option is incorrect?
(A) Triangle is isosceles
(B) Greatest angle of the triangle is $\cos^{-1}\left(\frac{1}{4}\right)$
(C) Smallest angle of the triangle is $\cos^{-1}\left(\frac{7}{8}\right)$
(D) a, 2b, 3c are in Arithmetic Progression

52. The sum of all terms in 11th bracket of the series
$(1) + (2 + 2^2) + (2^3 + 2^4 + 2^5) + (2^6 + 2^7 + 2^8 + 2^9) + \dots$ is $2^p - 2^q$, then $\frac{2p+q}{2p-q}$ is
(A) 17 : 13
(B) 17 : 7
(C) 17 : 6
(D) none of these

53. If the number of quadrilaterals be just double of the number of triangles that can be formed by joining the vertices of a polygon. If the number of sides of polygon is n, then
(A) n is a multiple of 5
(B) n is a multiple of 3
(C) n is a multiple of 7
(D) n is a multiple of 11

54. If $A = \begin{bmatrix} \sqrt[3]{8} & 0 & 0 \\ 0 & \sqrt[3]{2} & 0 \\ 0 & 0 & \frac{1}{\sqrt[3]{4}} \end{bmatrix}$ and $|\text{Adj}(\text{Adj } A)| = \sqrt[3]{\lambda^{\lambda}}$, then $2\lambda - 1$ is
(A) 5
(B) 7
(C) 9
(D) 11

55. If p be the probability of arranging the word 'BANANA' in which A and B occur at the ends, then 3p is not equal to
(A) perpendicular distance of 3x – 4y – 1= 0 from origin
(B) eccentricity of conic $\frac{x^2}{25} + \frac{y^2}{24} = 1$
(C) $\lim_{x\to\infty} \frac{[x] - 5\ln x}{5(x - \{x\})}$
(where [.] & {.} denotes the greatest integer function and fractional part respectively)
(D) distance between 3x – 4y + 5 = 0 and 3x – 4y + 10 = 0

56. If $\theta \in [-2\pi, 2\pi]$, then number of solution of
$\sqrt{2\cos^2\theta - 4\cos\theta + 6} + \sqrt{19 - 6\cos\theta + 3\cos^2\theta} = 4 + \sin^2\theta + 2\cos\theta$
(A) 2
(B) 3
(C) 4
(D) 5

57. If cosec θ = cot θ + 1, then one of the roots of
$(a + 2b + 5c)x^2 - (3a - 5b + 4c)x + (2a - 7b - c) = 0$
(A) sin θ
(B) cos θ
(C) tan θ
(D) cot θ

58. If $\cos^{-1}\left(\frac{x}{2}\right) + \cos^{-1}\left(\frac{y}{3}\right) = \theta$ and $P = 9x^2 + 4y^2 - 12xy\cos\theta$, then which of the following is INCORRECT?
(A) $\frac{1}{18}\int_0^{\pi} P d\theta = \pi$
(B) $\int_0^{\pi/2} \frac{\sqrt{P}d\theta}{\sqrt{P} + \sqrt{36 - P}} = \frac{\pi}{4}$
(C) Minimum value of P is –36
(D) Maximum value of P is 36

59. If I be the incentre of ΔABC, P and Q are feet of perpendicular from A to BI, CI respectively. Then $\frac{AQ}{CI} + \frac{AP}{BI} = ?$
(A) $\cot\left(\frac{A+B}{2}\right)$
(B) $\cot\left(\frac{B+C}{2}\right)$
(C) $\cot\left(\frac{A+C}{2}\right)$
(D) $\tan\left(\frac{B+C}{2}\right)$

60. If f(x) is the derivative of $\tan^{-1}\left(\frac{x}{\sqrt{1+x^2} - 1}\right)$, then $\frac{1}{f(x)} + \frac{1}{f(x^2)}$ is
(A) polynomial of degree 4
(B) divisible by $(x^2 + 1)$
(C) divisible by $(2x^2 + 1)$
(D) zero

61. If tangent at any point $x^4 + y^4 = c$ $(c > 0)$ cuts intercept a and b respectively from both axes such that $a^{-\alpha} + b^{-2\beta} = c^{-\gamma}$, then
(A) α, β, γ are in Arithmetic Progression
(B) α, β, γ are in Geometric Progression
(C) α, β, γ are in Harmonic Progression
(D) $\beta, \alpha, 2\gamma$ are in Arithmetic Progression

62. If $\int \frac{\sum_{r=1}^{1011} x^{-(2r-1)}}{\sum_{r=0}^{1010} x^{2r}} dx = c - \frac{1}{k \cdot x^k}$, then the value of k is
(A) –2020
(B) 2020
(C) 2022
(D) –2022

63. $I_1 = \int_1^3 (x^2 + x + 3) f(x^3 - 2x^2 - 5x + 2020) dx$, $I_2 = \int_1^3 (4x^2 - 3x - 2) f(x^3 - 2x^2 - 5x + 2020) dx$, then
$2I_1 : 3I_2$
(A) $\in (1, 2)$
(B) $\in (0, 1)$
(C) $\in (-2, 0)$
(D) $\in (2, 3)$

64. The area bounded by the curve $y = e^{-x}$, $y = e^x$ and directrix of $y^2 - 4x - 4y + 12 = 0$ is
(A) $\sum_{r=1}^{\infty} \frac{1}{(2r)!}$
(B) $2\sum_{r=1}^{\infty} \frac{1}{(2r)!}$
(C) $\sum_{r=0}^{\infty} \frac{1}{(2r)!}$
(D) none of these

65. If $f''(x) = g''(x)$ and $f'(2019) = g'(2019)$ and $f(2018) = 3$ and $g(2018) = 2$, then $f(2020) - g(2020) = ?$
(A) 2020
(B) 2018
(C) 2019
(D) none of these

66. The curve represented by $2x + \sqrt{9 - 4xy + y^2 + 4x^2} = y + 1$ is
(A) straight line whose slope is 2
(B) parabola whose latus rectum is 2
(C) ellipse with eccentricity $\frac{1}{3}$
(D) hyperbola whose eccentricity is $\sqrt{2}$

67. The statement $\sim p \vee \sim q$ is equivalent to
(A) $\sim q \vee p$
(B) $-(p \wedge q)$
(C) $q \vee p$
(D) none of these

68. If the eccentricities of $\frac{x^2}{7}-\frac{y^2}{b^2}=1$ and $\frac{x^2}{16}+\frac{y^2}{9}=1$ are reciprocal to each other, then area bounded by the curve $\frac{x^2}{25}+\frac{y^2}{b^2}=1$ is

(A) 10π
(B) 15π
(C) 20π
(D) 25π

69. If the line $\frac{x-6}{3}=\frac{y-2}{5}=\frac{z+3}{2}$ meets the curve xy = a^2, z = 1, then the number of real value of a is

(A) 0
(B) 1
(C) 2
(D) more than 2

70. If $\vec{a}$ and $\vec{b}$ are two vectors satisfying $\vec{a}+\vec{b}=\vec{p}$ and $2\vec{a}+\vec{b}=\vec{q}$ where $\vec{p}=2\hat{i}-3\hat{j}$ & $\vec{q}=-\hat{i}-\hat{j}$.
Angle between $\vec{a}$ & $\vec{b}$ is θ such that $\cos\theta+\sqrt{\frac{\alpha}{\alpha+1}}=0$, then the value of α is

(A) 20
(B) 24
(C) 25
(D) 26

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

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71. If H(α, β), G(α_1, β_1) and C(α_2, β_2) be the orthocentre, centroid and circumcentre respectively of the triangle formed by the lines connected by 2xy = $x^2y + xy^2$. Then the value of
$5\alpha - 4\beta + 3\alpha_1 + 3\beta_1 - 2\alpha_2 - \beta_2$ is

72. $\underbrace{272727.....27}_{34-\text{digits}} = A\left(10^{34}-1\right)$, then the value of 11A is

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

73. Standard deviations of first 10 natural numbers is

74. Consider a point ‘P’ with abscissa n(n $\in$ I^+) on the curve $y^2 - x^2 = 1$. If d_n represents the shortest distance from the point P to the lie y = x, then $\lim\limits_{n\to\infty}\left(4n\cdot d_n\right)$ has the value

75. If N be the number of positive integral ordered pair of (a, b) such that 6, a, b are in Harmonic Progression, then the value of $\frac{8N}{3}$ is

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VII

JEE (Main)-2020

TEST DATE: 23-08-2020

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. A

Sol. Using Gauss's Law

$$E4\pi r^2 = \frac{1}{\varepsilon_0}\int_0^r \frac{\alpha}{r}4\pi r^2 dr$$

$$E4\pi r^2 = \frac{4\pi\alpha}{\varepsilon_0}\frac{r^2}{2} \Rightarrow E = \frac{\alpha}{2\varepsilon_0} = \text{constant}$$

2. C

Sol. Acceleration of pulley, $a_1 = 2\ m/s^2$

Acceleration of the block, $a_2 = a_1 + 2\alpha R$

$a_2 = a_1 + 2a_1 \quad [\because \alpha R = a_1]$

$a_2 = 3a_1$

$\Rightarrow a_2 = 3 \times 2 = 6\ m/s^2$

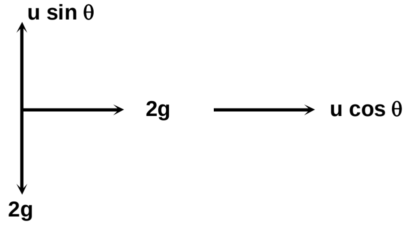
3. D

Sol. Time of flight, $T = \frac{2u\sin\theta}{2g} = \frac{u\sin\theta}{g}$

Horizontal range,

$$R = u\cos\theta\left(\frac{u\sin\theta}{g}\right) + \frac{1}{2}(2g)\left(\frac{u^2\sin^2\theta}{g^2}\right)$$

$$R = \frac{u^2\sin\theta\cos\theta}{g} + \frac{u^2\sin^2\theta}{g} = \frac{u^2}{g}\sin\theta(\cos\theta + \sin\theta)$$

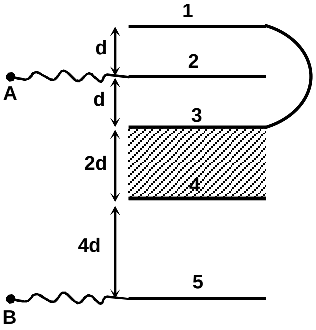


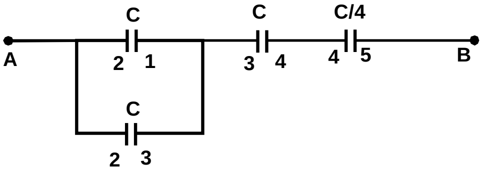
4. A

Sol. $C = \frac{\varepsilon_0 S}{d} = 1\mu F$

$$\frac{1}{C_{AB}} = \frac{1}{2} + 1 + \frac{4}{1} = \frac{11}{2}$$

$$\therefore\ C_{AB} = \frac{2}{11}\mu F$$

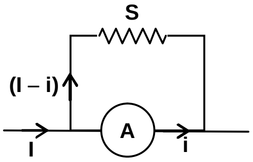




5. B

Sol. $(I - i)S = ir$

$$S = \frac{ir}{(I - i)}$$



6. D

Sol. $$E = -\frac{dV}{dr} = -\frac{ze}{4\pi \in_0}\left(-\frac{1}{r^2} + \frac{2r}{2R^3}\right) = \frac{ze}{4\pi\varepsilon_0}\left(\frac{1}{r^2} - \frac{r}{R^3}\right)$$

7. C

Sol. Refractive index of the lens material is

$$\mu = \frac{3\times10^8}{2\times10^8} = \frac{3}{2}$$

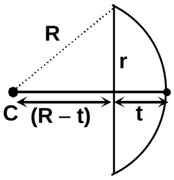
Now, $R^2 = r^2 + (R - t)^2$

$R^2 = r^2 + R^2 - 2Rt + t^2$

$R = \frac{r^2}{2t} = \frac{3\times3}{2\times0.3} = 15$ cm (as t^2 is very small, it can be neglected)

$$\frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \left(\frac{3}{2} - 1\right)\left(\frac{1}{15}\right)$$

f = 30 cm



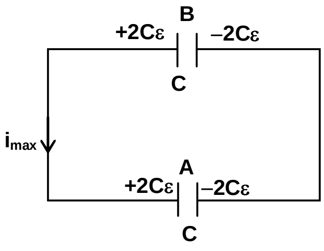
8. A

Sol. When the current through the inductor is maximum. The two capacitors will be in parallel.

Now, $\frac{(3C\varepsilon)^2}{2C} + \frac{(C\varepsilon)^2}{2C} = 2\times\frac{(2C\varepsilon)^2}{2C} + \frac{1}{2}Li_{max}^2$

$$\Rightarrow \frac{9C\varepsilon^2}{2} + \frac{C\varepsilon^2}{2} = 4C\varepsilon^2 + \frac{1}{2}Li_{max}^2$$

$$\Rightarrow i_{max} = \varepsilon\sqrt{\frac{2C}{L}}$$



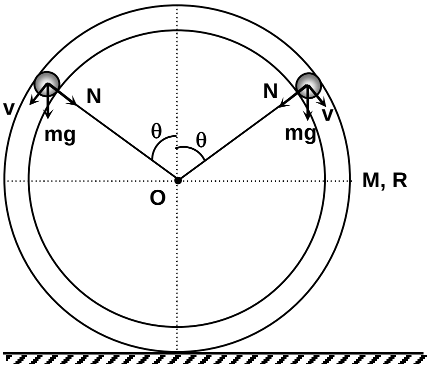
9. B

Sol. Since the tube loses contact with the horizontal surface when $\theta = 60°$

$2N\cos\theta = Mg$

$2N\cos 60° = Mg$

$N = Mg$ …(i)



Now, $mg\cos\theta + N = \frac{mv^2}{R}$

$\frac{mg}{2} + Mg = \frac{mv^2}{R}$ …(ii)

Using conservation of energy

$mgR(1-\cos\theta) = \frac{1}{2}m(v^2 - u^2)$

$\frac{mgR}{2} = \frac{m}{2}(v^2 - gR)$

$gR = v^2 - gR$

$v = \sqrt{2gR}$ ….(iii)

From (ii) and (iii)

$\frac{mg}{2} + Mg = 2mg$

$Mg = \frac{3mg}{2}$

$M = \frac{3m}{2} = 1.5\text{ kg}$

M = 1.5 kg

10. D

Sol. $$\frac{W_1}{W_2} = \frac{qV_1}{qV_2} = \frac{\frac{KQ}{R}}{\frac{3}{2}\frac{KQ}{R}} = \frac{2}{3}$$

11. B

Sol. Energy of each photon, $E = \frac{hc}{\lambda} = \frac{1240}{200} = 6.2\text{ eV}$

Now, $K_{max} = E - \phi = 6.2 - 3.8 = 2.4\text{ eV}$

Also, $eV_S = K_{max} = 2.4\text{ eV}$

$V_S = 2.4$ volt

12. C

Sol. Torque experienced by the loop is

$\tau = MB = \frac{\sqrt{3}}{4}\ell^2 IB$

Now, $\int \tau dt = \frac{5m\ell^2}{4}\omega$

$\frac{\sqrt{3}}{4}B\ell^2\int Idt = \frac{5m\ell^2}{4}\omega$

$\sqrt{3}BQ = 5m\omega$

$\omega = \frac{\sqrt{3}BQ}{5m}$

13. C

Sol. $\eta = \frac{E_2 I_2}{E_1 I_1} \times 100 = 83.3\%$

14. C

Sol. Fundamental frequency of a sonometer wire, $f = \frac{1}{2\ell}\sqrt{\frac{T}{\mu}}$

when tension is increased by 44%, then

$\Rightarrow \frac{f_1}{f} = \sqrt{\frac{1.44T}{T}} = 1.2$

$\therefore f_1 = 1.2f \Rightarrow f + 6 = 1.2f$

$\Rightarrow f = 30$ Hz

when the length is increased by 20%, then

$\frac{f_2}{f} = \frac{\ell}{\ell_2} = \frac{\ell}{1.2\ell}$

$f_2 = \frac{f}{1.2} = \frac{30}{1.2} = 25$ Hz

$\therefore$ decrease in the fundamental frequency = $f - f_2 = 5$ Hz

15. A

Sol. $t(\mu - 1) = 4\lambda$

$t = \frac{4\lambda}{(\mu - 1)} = 4.8\ \mu m$

16. A

Sol. To avoid disintegration

$\left(\frac{GM}{R^3}\right) r \geq \omega^2 r$

$\omega^2 \leq \frac{4\pi G\rho}{3}$

$\omega \leq \sqrt{\frac{4\pi G\rho}{3}}$

$\frac{2\pi}{T} \leq \sqrt{\frac{4\pi G\rho}{3}}$

$T \geq \sqrt{\frac{3\pi}{G\rho}}$

$T \geq \sqrt{\frac{3\pi}{\frac{20}{3} \times 10^{-11} \times \frac{9\pi}{20} \times 10^{11}}}$

$T \geq 1$ sec

17. C

Sol. Electric field 10 V/cm

Distance moved 1 cm

Time taken 20 μsec

$\therefore$ velocity of minority carrier = $\frac{1\,\text{cm}}{20 \times 10^{-6}\,\text{sec}} = 50{,}000$ cm/s

Drift velocity $v_d = \mu E$

$$\mu = \frac{V_d}{E} = \frac{50,000}{10} = 5000\ \text{cm}^2/\text{V-s}$$

18. B

Sol. $H = i^2Rt = ms\Delta\theta$

$(0.1)^2\ 10^3 t = 10 \times 10^3 \times 4.2 \times 10$

$$t = \frac{420}{0.01} = 42000\ \text{sec}$$

t = 700 minutes

19. C

Sol. Since diode is forward biased so it behaves as short circuit.

Equivalent resistance of circuit = 15 kΩ

Current through the cell = $\frac{30}{15} = 2\ \text{mA}$

Current between A and B = 1 mA

$V_{AB} = 10\ \text{k}\Omega \times 1\ \text{mA} = 10\ \text{V}$

20. B

Sol. $f_0 = 1.5$ cm, $f_e = 5$ cm

$$\frac{1}{v} - \frac{1}{-2} = \frac{1}{1.5}$$

$$\frac{1}{v} = \frac{1}{1.5} - \frac{1}{2}$$

v = +6 cm

Hence the magnification for the adjustment for near point vision is

$$m = \frac{v}{u}\left(1 + \frac{D}{f_e}\right) = \frac{-6}{2}\left(1 + \frac{25}{5}\right) = -18$$

$|m| = 18$

SECTION – B

21. 5

Sol. $F_1 = \rho\left(\pi R^3 - \frac{2}{3}\pi R^3\right)g = \frac{\rho\pi R^3}{3}g$, $F_2 = \rho\left(\pi R^3 + \frac{2}{3}\pi R^3\right)g = \frac{5\rho\pi R^3}{3}g$

$\therefore F_2/F_1 = 5$

22. 4

Sol. $m\frac{d^2x}{dt^2} = -16kx$

$$\frac{d^2x}{dt^2} = -\left(\frac{16k}{m}\right)x$$

$\therefore$ frequency of small oscillations $f = \frac{1}{2\pi}\sqrt{\frac{16k}{m}} = \frac{4}{2\pi}\sqrt{\frac{k}{m}}$

$\therefore n = 4$

SECTION – C

23. 00600.00

Sol. With both switches open: $I_A = \dfrac{E}{R_1 + R_2 + R_3}$

With both switches closed:
Current through E and R_2

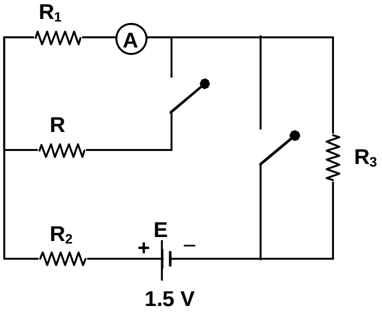
$$I' = \frac{E}{R_2 + \dfrac{RR_1}{R + R_1}}$$

Current through the ammeter

$$I'_A = \frac{RI'}{R + R_1}$$

$$I_A = I'_A$$

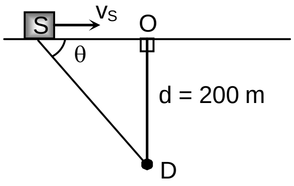
$$R = \frac{R_1R_2}{R_3} = 600\Omega$$



24. 00625.00

Sol. $\cos\theta = \dfrac{v_s t}{vt} = \dfrac{v_s}{v} = \dfrac{66}{330} = \dfrac{1}{5} = 0.2$

$$f = \left(\frac{v}{v - v_s\cos\theta}\right)f_0 = \frac{f_0}{\left(1 - \dfrac{1}{25}\right)} = \frac{25}{24}\times 600 = 625\,\text{Hz}$$



25. 00015.38

Sol. Total work done by gas per cycle, $\Delta W_{cycle} = P_0V_0$

During the process AB

$$\Delta Q_{AB} = nC_V\Delta T = n\frac{3R}{2}\Delta T = \frac{3}{2}V_0(2P_0 - P_0) = \frac{3}{2}P_0V_0$$

During the process BC

$$\Delta Q_{BC} = nC_P\Delta T = n\frac{5R}{2}\Delta T = \frac{5}{2}\times 2P_0(2V_0 - V_0) = 5P_0V_0$$

Efficiency of the cycle

$$\eta = \frac{\Delta W_{cycle}}{\Delta Q_{supplied}}\times 100 = \frac{P_0V_0}{\left(\dfrac{3P_0V_0}{2} + 5P_0V_0\right)}\times 100 = \frac{2}{13}\times 100 = 15.38\%$$

Chemistry

PART – II

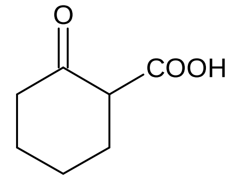
SECTION – A

26. C

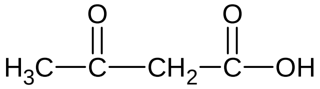
Sol. Cassiterite → SnO_2
Magnetite → Fe_3O_4
Pyrolusite → MnO_2
Malachite → $CuCO_3.Cu(OH)_2$

27. D

Sol.

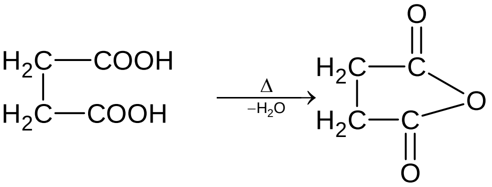


and



$$H_3C-\overset{\overset{O}{\|}}{C}-CH_2-\overset{\overset{O}{\|}}{C}-OH$$

are β-keto acid which undergo decarboxylation on heating.
β-γ unsaturated acid also decarboxylates on heating.



28. D

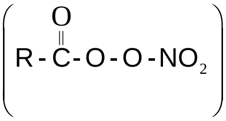
Sol. Let mass of solute = x g, mass of water = (212 – x) g

Then $\dfrac{x/50}{x/50+\left(\dfrac{212-x}{18}\right)}=0.1 \Rightarrow x=50\,g$

In solution left over, mass of the solute = 50 – 14 = 36.0 g
Mass of water = 180 – 36.0 = 144 g

Now molality (left over solution) $m=\dfrac{36}{50}\times\dfrac{1000}{144}=5.0$

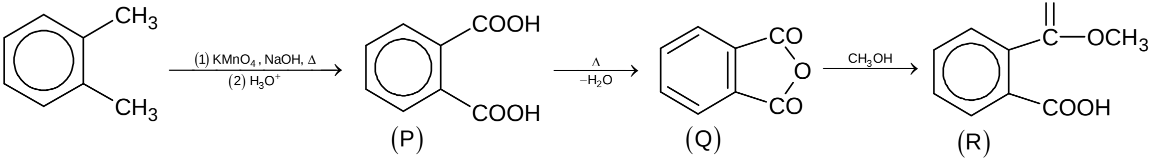
29. C



Sol. Peroxyacyl nitrate $\left(R\text{-}\overset{\overset{O}{\|}}{C}\text{-}O\text{-}O\text{-}NO_2\right)$, Acrolein CH_2 = CH – CHO and ozone are major components of photochemical smog.

30. D

Sol.

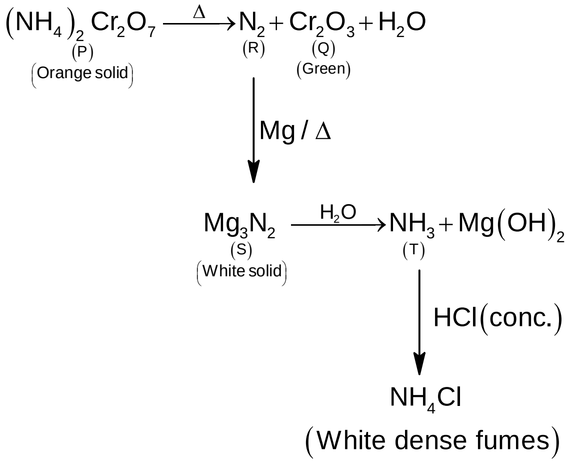


31. A

Sol. The viscosity of hydrophilic sol is much higher and surface tension is much lower than that of water.

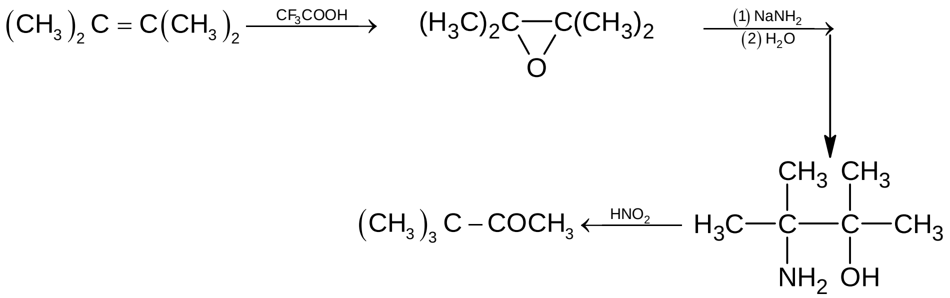
32. A

Sol.


$(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + Cr_2O_3 + H_2O$
(P)
(Orange solid)
(R)
(Q)
(Green)
Mg / Δ
$Mg_3N_2 \xrightarrow{H_2O} NH_3 + Mg(OH)_2$
(S)
(White solid)
(T)
HCl(conc.)
NH_4Cl
(White dense fumes)

33. C

Sol.


$(CH_3)_2C = C(CH_3)_2 \xrightarrow{CF_3COOH}$
$(H_3C)_2C—C(CH_3)_2$
O
(1) NaNH₂
(2) H₂O
CH₃ CH₃
H₃C—C—C—CH₃
NH₂ OH
HNO₂
$(CH_3)_3C - COCH_3$

34. D

Sol. $P_AV = \frac{3}{M_A}RT$ and $P_BV = \frac{9}{M_B}.RT$

But $P_B = 2.0 - 1.5 = 0.5$ atm

So, $\frac{P_A}{P_B} = \frac{1.5}{0.5} = \frac{3M_B}{9M_A}$

$\Rightarrow \frac{M_B}{M_A} = 9$

$\frac{V_A}{V_B} = \sqrt{\frac{M_B}{M_A}} = 3.$

35. B

Sol. Ortho-hydrogen has proton of parallel spin and magnetic moment of para form is zero, while ortho has twice that of proton.

Percentage of para-hydrogen increases with decrease in temperature and at room temperature ortho-hydrogen is more stable than para-hydrogen.

36. B

Sol. pH (HA solution) $= pK_a + \log\frac{[A^-]}{[HA]}$

$= -\log 1.0 \times 10^{-5} + \log\frac{0.15}{0.3-0.15}$

= 5.0

pH = 5.0 remains unaffected on dilution [Buffer solution].

For half neutralization of ‘V’ volume of the acids, V/2 volume of NaOH would be needed.

Hence, molarity of HCl solution after half-neutralisation

$= \frac{0.3\times V - 0.3\times V/2}{V+\frac{V}{2}} = \frac{(0.3-0.15)V}{1.5V} = 0.1$

= [H$^+$]

On 10 times dilution [H$^+$] $= \frac{0.1}{10} = 0.01 = 1\times10^{-2}$

pH = 2.

37. C

Sol. Setting of plaster of paris is retarded by addtition of borax.

38. C

39. B

Sol. Bell metal → Cu and Sn
Type metal → Pb, Sn, Sb
Monel metal → Cu, Ni, Fe
Gun metal → Cu, Zn, Sn

40. B

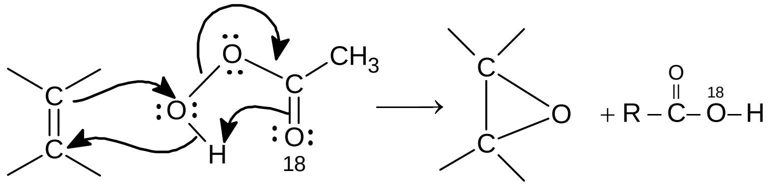
Sol. With Gilman’s reagent [$(CH_3)_2CuLi$] the 1-4 addtion product is the exclusively major product.

41. B

Sol. B_2H_6, Al_2Cl_6, $Al_2(CH_3)_6$ are non-planar.

42. C

Sol.



43. C

Sol. Passing of H_2S gas through a solution of an oxidizing agent like HNO_3, $KMnO_4$, SO_2 form colloidal sulphur.

$$2HNO_3 + H_2S \longrightarrow 2NO_2 + 2H_2O + \underset{\text{(Colloidal form)}}{S}$$

$$SO_2 + 2H_2S \longrightarrow 2H_2O + \underset{\text{(Colloidal form)}}{3S}$$

44. B

Sol. Furfural test → Fructose gives purple (violet) colour on addition of alcoholic α-Naphthol and conc. HCl, whereas glucose gives no colour.

45. B

Sol. Heat capacity is an extensive property as it depends upon amount of substance in the sample. Dielectric constant, viscosity and standard electrode potential are intensive property.

SECTION – B

46. 6

Sol. Let equal masses be m g.

Then amount of 'X' left out $= 10 \times \frac{m}{10} \times \left(\frac{1}{2}\right)^{30/10}$

$$= m\left(\frac{1}{2}\right)^3$$

and amount of 'Y' left out $= 20 \times \frac{m}{20} \times \left(\frac{1}{2}\right)^{30/t}$

$$= m\left(\frac{1}{2}\right)^{30/t}$$

Then $\frac{\text{mass of 'X'}}{\text{mass of 'Y'}} = \frac{m \times \left(\frac{1}{2}\right)^3}{m \times \left(\frac{1}{2}\right)^{30/t}}$

$$\frac{4}{1} = \frac{m \times \left(\frac{1}{2}\right)^3}{m \times \left(\frac{1}{2}\right)^{30/t}} \Rightarrow \frac{1}{4} \times \left(\frac{1}{2}\right)^3 = \left(\frac{1}{2}\right)^{30/t}$$

$$\Rightarrow \left(\frac{1}{2}\right)^5 = \left(\frac{1}{2}\right)^{30/t}$$

$\Rightarrow$ t = 6 days.

47. 6

Sol. Nylon-6,6 ; Glyptal ; Dacron ; Bakelite ; BUNA-S ; Polyurethrane are copolymers.

SECTION – C

48. 00014.14

Sol. Volume of N_2 at STP = $\frac{P_1V_1}{T_1} \times \frac{T_2}{P_2} = \frac{756}{300} \times 50 \times \frac{273}{760}$

= 45.26 ml

% of N_2 $\frac{28}{22400} \times \frac{45.26}{0.40} \times 100 = 14.14$

49. 00007.65

Sol. $\sqrt{\ell(\ell+1)}\frac{h}{2\pi} = \sqrt{3}\frac{h}{\pi}$

$\Rightarrow \ell = 3$, this means the electron belongs to n = 4(principal shell)

$$E_n = -13.6\frac{z^2}{n^2} = -13.6 \times \frac{3^2}{4^2} = -7.65 \text{ eV}$$

50. 00000.17

Sol. $COCl_2(g) \rightleftharpoons CO(g) + Cl_2(g)$

$$\begin{array}{lll} 1-\alpha & \alpha & \alpha \end{array}$$

Total number of moles at eq. $1 + \alpha$

$$M = \frac{dRT}{P} = \frac{1.162 \times 0.082 \times 750}{1.0} = 71.46$$

$$71.46 = \frac{99}{1+\alpha} \Rightarrow \alpha = 0.385$$

$$K_P = \frac{\alpha^2}{1-\alpha^2} = \frac{(0.385)^2}{1-(0.385)^2} = 0.17$$

Mathematics

PART – III

SECTION – A

51. D

Sol. Since a, b, c are the sides of a triangle $\therefore$ a, b, c are real $\Rightarrow$ 1 + i is the other root
Sum of the roots = 2 and product = 2 $\Rightarrow$ equation is $x^2 - 2x + 2 = 0$
On comparing with $ax^2 - bx + c = 0$, we have a = k, b = 2k, c = 2k
Hence, triangle is isosceles greatest angle is B or C

$$= \cos^{-1}\left(\frac{(2k)^2 + (k)^2 - (2k)^2}{2\cdot 2k\cdot k}\right) = \cos^{-1}\left(\frac{1}{4}\right)$$

Least angle is $A = \cos^{-1}\left(\frac{(2k)^2 + (2k)^2 - k^2}{2\cdot 2k\cdot 2k}\right) = \cos^{-1}\left(\frac{7}{8}\right)$

Also, a = k, 2b = 4k, 3c = 6k are not in Arithmetic Progression

52. B

Sol. 1st term of the successive brackets are $2^0, 2^1, 2^{1+2}, 2^{1+2+3}, \ldots$

$\therefore$ 1st term of 11th bracket is $2^{1+2+3+\ldots+10} = 2^{\frac{10\times 11}{2}} = 2^{55}$

Sum of all terms in 11th bracket is $2^{55} + 2^{56} + 2^{57} + \ldots$ to 11th terms $= \frac{2^{55}\left(2^{11}-1\right)}{2-1} = 2^{66} - 2^{55}$

$\therefore$ p : q = 66 : 55 = 6 : 5. Now, $\frac{2p+q}{2p-q} = \frac{2\left(\frac{p}{q}\right)+1}{2\left(\frac{p}{q}\right)-1} = \frac{2\times\frac{6}{5}+1}{2\times\frac{6}{5}-1} = \frac{17}{7}$

53. D

Sol. Let the number of sides be n, $\frac{{}^nC_4}{{}^nC_3} = \frac{2}{1}$

$$\Rightarrow \frac{n(n-1)(n-2)(n-3)\times 3!}{4!\times n(n-1)(n-2)} = \frac{2}{1} \Rightarrow \frac{n-3}{4} = 2 \Rightarrow n = 11$$

54. B

Sol. $|A| = \sqrt[3]{8\cdot 2\cdot \frac{1}{4}} = \sqrt[3]{4} = 4^{\frac{1}{3}}$ $\because$ $\left|\text{Adj}(\text{Adj } A)\right| = |A|^{(n-1)^2} = \left(4^{\frac{1}{3}}\right)^{(3-1)^2} = \left(4^{\frac{1}{3}}\right)^4 = \sqrt[3]{4^4} = \sqrt[3]{\lambda^\lambda} \Rightarrow \lambda = 4$

Hence, $2\lambda - 1 = 2\times 4 - 1 = 7$

55. D

Sol. $\because$ A and B occurs at the end in 2 ways (A ..... B or B ..... A) other 4 places can be filled by A, N, A, N in $\frac{4!}{2!\times 2!} = 6$ ways

$\therefore$ Number of ways in which A and B occurs at the ends = 2 × 6 = 12

$\therefore$ Required probability = $\frac{12}{\frac{6!}{2!\times 2!}} = \frac{1}{15} \Rightarrow 3p = \frac{1}{5}$

(A) Perpendicular distance of $3x - 4y - 1 = 0$ from origin $= \frac{|-1|}{\sqrt{3^2 + 4^2}} = \frac{1}{5}$

(B) $e = \sqrt{1-\frac{b^2}{a^2}} = \sqrt{1-\frac{24}{25}} = \sqrt{\frac{1}{25}} = \frac{1}{5}$

(C) $\lim\limits_{x\to\infty} \frac{[x]-5\ln x}{5(x-\{x\})} = \lim\limits_{x\to\infty} \frac{x-5\ln x}{5x} = \frac{1}{5} - \lim\limits_{x\to\infty} \frac{\ln x}{x}$ ($\because$ [x] = x when $x \to \infty$) = $\frac{1}{5} - 0 = \frac{1}{5}$

(D) Distance between 3x – 4y + 5 = 0 and 3x – 4y + 10 = 0 is = $\frac{|10-5|}{\sqrt{3^2+4^2}} = \frac{5}{5} = 1$

Hence, (D) is the correct option.

56. B

Sol. Let cos θ = x, $\sqrt{2x^2-4x+6} + \sqrt{19-6x+3x^2} = 5 - x^2 + 2x$

or $\sqrt{2(x^2-2x+1)+4} + \sqrt{3(x^2-2x+1)+16} = 6 - (x^2-2x+1)$

or $\sqrt{2(x-1)^2+4} + \sqrt{3(x-1)^2+16} = 6 - (x-1)^2$

L.H.S. ≥ 6 and R.H.S. ≤ 6. But L.H.S. = R.H.S.

Hence, $(x-1)^2 = 0$, x = 1, cos θ = 1, θ = 2nπ, θ = –2π, 0, 2π

Number of solution = 3

57. A

Sol. $\because$ cosec θ = cot θ + 1

$\therefore$ cosec θ – cot θ = 1 ..... (1)

But $\text{cosec}^2\theta - \cot^2\theta = 1$

$\Rightarrow$ cosec θ + cot θ = 1 ..... (2)

From equation (1) and (2), we get cosec θ = 1 $\Rightarrow$ sin θ = 1

x = 1 = sin θ is one of the roots of equation

58. C

Sol. $\cos^{-1}\left(\frac{xy}{2\cdot 3} - \sqrt{1-\frac{x^2}{4}}\cdot\sqrt{1-\frac{y^2}{9}}\right) = \theta \Rightarrow (xy - 6\cos\theta)^2 = (4-x^2)(9-y^2)$

$\Rightarrow 9x^2 + 4y^2 - 12xy\cos\theta = 36\sin^2\theta \Rightarrow P = 36\sin^2\theta$

(A) $\frac{1}{18}\int_0^{\pi} P d\theta = \int_0^{\pi} 2\sin^2\theta = \int_0^{\pi}(1-\cos 2\theta)d\theta = \left[\theta - \frac{\sin 2\theta}{2}\right]_0^{\pi} = \pi$

(B) $I = \int_0^{\pi/2} \frac{6\sin\theta}{6\sin\theta + \sqrt{36-36\sin^2\theta}} d\theta = \int_0^{\pi/2} \frac{\sin\theta d\theta}{\sin\theta + \cos\theta}$ ..... (1)

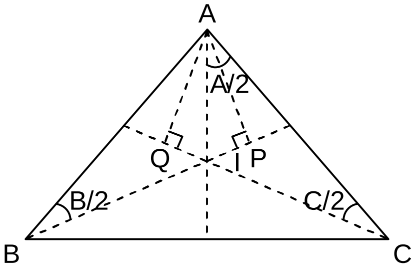
$I = \int_0^{\pi/2} \frac{\cos\theta d\theta}{\cos\theta + \sin\theta}$ (Using property) ..... (1)

Adding equation (1) and (2), we get $2I = \int_0^{\pi/2} d\theta = \frac{\pi}{2},\ I = \frac{\pi}{4}$

(C) $0 \le 36\sin^2\theta \le 1$ hence minimum value of P is zero

(D) Maximum value of P is 36. Hence, (C) is correct option

59. D



Sol. $\because \dfrac{AQ}{AC} = \sin\left(\dfrac{C}{2}\right) \Rightarrow AQ = AC\sin\left(\dfrac{C}{2}\right)$ ..... (1)

$\dfrac{CI}{\sin\dfrac{A}{2}} = \dfrac{AC}{\sin\left(\pi - \left(\dfrac{A}{2}+\dfrac{C}{2}\right)\right)}$ in ΔAIC

or $CI \equiv AC\cdot\dfrac{\sin\left(\dfrac{A}{2}\right)}{\sin\left(\dfrac{A+C}{2}\right)} = AC\dfrac{\sin\left(\dfrac{A}{2}\right)}{\cos\left(\dfrac{B}{2}\right)}$ ..... (2)

Dividing (1) by (2), we get $\dfrac{AQ}{CI} = \dfrac{\cos\dfrac{B}{2}\cdot\sin\dfrac{C}{2}}{\sin\dfrac{A}{2}}$. Similarly $\dfrac{AP}{BI} = \dfrac{\cos\dfrac{C}{2}\cdot\sin\dfrac{B}{2}}{\sin\dfrac{A}{2}}$

$$\frac{AQ}{CI}+\frac{AP}{BI} = \frac{\sin\left(\dfrac{B}{2}+\dfrac{C}{2}\right)}{\sin\dfrac{A}{2}} = \frac{\sin\left(\dfrac{B+C}{2}\right)}{\cos\left(\dfrac{B+C}{2}\right)} = \tan\left(\frac{B+C}{2}\right)$$

60. A

Sol. Let $g(x) = \tan^{-1}\left(\dfrac{x}{\sqrt{1+x^2}-1}\right)$, put x = tan θ

$= \tan^{-1}\left(\dfrac{\tan\theta}{\sec\theta-1}\right) = \tan^{-1}\left(\dfrac{\sin\theta}{1-\cos\theta}\right) = \tan^{-1}\left(\dfrac{2\sin\dfrac{\theta}{2}\cos\dfrac{\theta}{2}}{2\sin^2\dfrac{\theta}{2}}\right)$

$= \tan^{-1}\left(\cot\dfrac{\theta}{2}\right) = \tan^{-1}\left(\tan\left(\dfrac{\pi}{2}-\dfrac{\theta}{2}\right)\right) = \dfrac{\pi}{2}-\dfrac{\theta}{2} = \dfrac{\pi}{2}-\dfrac{1}{2}\tan^{-1}x$

$f(x) = g'(x) = -\dfrac{1}{2}\cdot\dfrac{1}{1+x^2}$, $f(x^2) = -\dfrac{1}{2(1+x^4)}$

$\therefore \dfrac{1}{f(x)}+\dfrac{1}{f(x^2)} = -2(1+x^2)-2(1+x^4) = -(2x^4+2x^2+4) = -2(x^4+x^2+2)$

61. B

Sol. Let P(x₁, y₁) on the curve $\dfrac{dy}{dx} = -\dfrac{x^3}{y^3} = -\dfrac{x_1^3}{y_1^3}$. Equation of tangent at P(x₁, y₁)

$y-y_1 = -\dfrac{x_1^3}{y_1^3}(x-x_1)$, $y_1^3\cdot y - y_1^4 = -x\cdot x_1^3 + x_1^4$, $y_1^3\cdot y + x\cdot x_1^3 = x_1^4+y_1^4 = c$

$\dfrac{y}{\dfrac{c}{y_1^3}}+\dfrac{x}{\dfrac{c}{x_1^3}} = 1$, $a = \dfrac{c}{x_1^3}$ and $b = \dfrac{c}{y_1^3}$, $x_1 = \left(\dfrac{c}{a}\right)^{\frac{1}{3}}$, $y_1 = \left(\dfrac{c}{b}\right)^{\frac{1}{3}}$, $x_1^4+y_1^4 = c$, $\left(\dfrac{c}{a}\right)^{\frac{4}{3}}+\left(\dfrac{c}{b}\right)^{\frac{4}{3}} = c$

$a^{-\frac{4}{3}}+b^{-\frac{4}{3}} = c^{-\frac{1}{3}}$

$\Rightarrow \alpha = \dfrac{4}{3}$, $\beta = \dfrac{2}{3}$, $\gamma = \dfrac{1}{3}$

$\Rightarrow$ α, β, γ are in Geometric Progression

62. B

Sol. $I = \int \frac{x^{-1} + x^{-3} + x^{5} + ... + x^{-2021}}{1 + x^2 + x^4 + ... + x^{2020}} dx = \int \frac{\frac{1}{x} + \frac{1}{x^3} + \frac{1}{x^5} + ... + \frac{1}{x^{2021}}}{1 + x^2 + x^4 + ... + x^{2020}} dx$

$= \int \frac{\frac{x^{2020} + x^{2018} + x^{2016} + ... 1}{x^{2021}}}{1 + x^2 + x^4 + ... + x^{2020}} dx = \int \frac{x^{-2021}\left(1 + x^2 + x^4 + ... + x^{2016} + x^{2018} + x^{2020}\right)}{1 + x^2 + x^4 + ... + x^{2020}} dx$

$= \int x^{-2021} dx = \frac{x^{-2021+1}}{-2021+1} + c = c - \frac{1}{2020x^{2020}} + c$. Hence k = 2020

63. B

Sol. $I_2 - I_1 = \int_1^3 \left(3x^2 - 4x - 5\right) f\left(x^3 - 2x^2 - 5x + 2020\right) dx$. Put $x^3 - 2x^2 - 5x + 2020 = z$

$(3x^2 - 4x - 5)dx = dz$, when x = 1, 1 – 2 – 5 + 2020 = z_{min}, $z_{min} = 2014$

When x = 3, 27 – 2 × 9 – 5 × 3 + 2020 = z_{max}, $z_{max} = 2014 \Rightarrow I_2 - I_1 = \int_{2014}^{2014} f(z) dz = 0$

$I_2 = I_1 \Rightarrow \frac{2I_1}{3I_2} = \frac{2}{3} \to (0, 1)$

64. B

Sol. $y^2 - 4x - 4y + 12 = 0 \Rightarrow y^2 - 4y + 4 = 4x - 8$

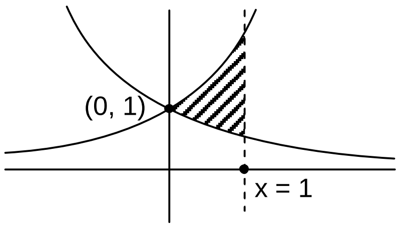
$\Rightarrow (y - 2)^2 = 4(x - 2)$ directrix of the above curve is

Required area

$= \int_0^1 \left(e^x - e^{-x}\right) dx = \left[e^x + e^{-x}\right]_0^1 = \left(e + e^{-1}\right) - 2$

$= \left(1 + \frac{1}{1!} + \frac{1}{2!} + \frac{1}{3!} + \frac{1}{4!} + \frac{1}{5!}.....\right) + \left(1 - \frac{1}{1!} + \frac{1}{2!} - \frac{1}{3!} + ...\right) - 2$

$= 2\left(\frac{1}{2!} + \frac{1}{4!} + \frac{1}{6!} + ...\right) = 2\sum_{r=1}^{\infty} \frac{1}{(2r)!}$



65. D

Sol. f″(x) = g″(x) ⇒ f′(x) = g′(x) + c ⇒ f′(2019) = g′(2019) + c ⇒ c = 0 ⇒ f′(x) = g′(x)

⇒ f(x) = g(x) + d ⇒ f(2018) = g(2018) + d ⇒ 3 = 2 + d ⇒ d = 1 ⇒ f(x) = g(x) + 1

⇒ f(2020) – g(2020) = 1

66. A

Sol. $\sqrt{9 + (2x - y)^2} = 1 - (2x - y) \Rightarrow 9 + (2x - y)^2 = 1 + (2x - y)^2 - 2(2x - y)$

$\Rightarrow 9 = 1 - 4x + 2y \Rightarrow y = 2x + 4$

67. B

Sol. Consider

p	q	~p	~q	~p ∨ ~q	~q ∨ p	(p ∧ q)	~(p ∧ q)	p ∧ ~q	q ∨ p
T	T	F	F	F	T	T	F	F	T
T	F	F	T	T	T	F	T	T	T
F	T	T	F	T	F	F	T	F	T
F	F	T	T	T	T	F	T	F	F

Therefore ~(p ∧ q) = ~p ∨ ~q

68. B

Sol. Let e_1 and e_2 be the eccentricities respectively $e_1 = \frac{1}{e_2}$

$\therefore\ 9 = 16\left(1 - e_2^2\right) \Rightarrow e_2^2 = \frac{7}{16} \Rightarrow e_1^2 = \frac{16}{7}$ also $b^2 = 7\left(e_1^2 - 1\right) = 7\left(\frac{16}{7} - 1\right) = 7 \times \left(\frac{16-7}{7}\right) = 9$

$\Rightarrow b = 3 \therefore$ area bounded by the curve $\frac{x^2}{25} + \frac{y^2}{b^2} = 1$ is $\pi(5) \times 3 = 15\pi$

69. C

Sol. Putting z = 1, $\frac{x-6}{3} = \frac{y-2}{5} = \frac{z+3}{2} \Rightarrow \frac{x-6}{3} = \frac{y-2}{5} = \frac{1+3}{2} \Rightarrow \frac{x-6}{3} = \frac{y-2}{5} = 2$

$\Rightarrow x = 12, y = 12$. One putting $x = 12$, $y = 12$ in $xy = a^2$, we get $a^2 = 144 \Rightarrow a = \pm 12$
Two real value of a

70. C

Sol. $\vec{a} + \vec{b} = \vec{p}$, $2\vec{a} + \vec{b} = \vec{q} \Rightarrow \vec{a} = -3\hat{i} + 2\hat{j}$, $\vec{b} = 5\hat{i} - 5\hat{j}$

$\therefore\ \cos\theta = \frac{a \cdot b}{|\vec{a}||\vec{b}|} = \frac{-15-10}{\sqrt{13}\cdot\sqrt{50}} = \frac{-25}{\sqrt{13} \times 5\sqrt{2}} = -\sqrt{\frac{25}{26}}$

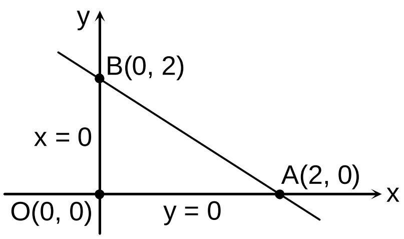
$\therefore\ \cos\theta + \sqrt{\frac{\alpha}{\alpha+1}} = 0 \Rightarrow -\sqrt{\frac{25}{26}} + \sqrt{\frac{\alpha}{\alpha+1}} = 0 \Rightarrow \alpha = 25$

SECTION – B

71. 1

Sol. $\because\ xy(2 - x - y) = 0$

$\Rightarrow$ 3 sides of the triangle are $x = 0$, $y = 0$ and $x + y = 2$
Clearly $H(\alpha, \beta)$ is at origin $\Rightarrow \alpha = 0, \beta = 0$
The triangle is right angled hence circumcentre
$C(\alpha_2, \beta_2) \equiv (1, 1) \Rightarrow \alpha_2 = \beta_2 = 1$.
Centroid $G(\alpha_1, \beta_1) = \left(\frac{2}{3}, \frac{2}{3}\right)$. Hence the value of



$5 \times 0 - 4 \times 0 + 3 \times \frac{2}{3} + 3 \times \frac{2}{3} - 2 \times 1 - 1 = 0 \Rightarrow 4 - 2 - 1 = 1$

72. 3

Sol. $A\left(10^{34} - 1\right) = \underbrace{272727.....27}_{34-\text{digits}} = 27 + 27 \times 10^2 + 27 \times 10^4 + ...$ 17 terms

$= \frac{27\left(\left(10^2\right)^{17} - 1\right)}{10^2 - 1} = \frac{27}{99}\left(10^{34} - 1\right) = \frac{3}{11}\left(10^{34} - 1\right) \Rightarrow A = \frac{3}{11} \Rightarrow 11A = 3$

SECTION – C

73. 00002.87

Sol. We know that standard deviation of first n natural numbers = $\sqrt{\frac{n^2 - 1}{12}}$

Put n = 10, we get standard deviation = $\sqrt{\frac{99}{12}} = \sqrt{8.25} = 2.87$

74. 00001.41

Sol. Let $P \equiv \left(n, \sqrt{n^2+1}\right)$, $d_n = \dfrac{\sqrt{n^2+1}-n}{\sqrt{2}}$ or $4n \cdot d_n = \dfrac{4n \cdot \left(\sqrt{n^2+1}-n\right)}{\sqrt{2}} = 2\sqrt{2}\,n\left(\sqrt{n^2+1}-n\right)$

$$\lim_{n\to\infty}\left(4n \cdot d_n\right) = \lim_{n\to\infty} 2\sqrt{2}\,n\left(\sqrt{n^2+1}-n\right) = \lim_{n\to\infty}\frac{2\sqrt{2}\,n\left(n^2+1-n^2\right)}{\sqrt{n^2+1}+n}$$

$$\lim_{n\to\infty}\frac{2\sqrt{2}\,n}{n\left(\sqrt{1+\frac{1}{n^2}}+1\right)} = \frac{2\sqrt{2}}{2} = \sqrt{2} = 1.414$$

75. 00018.66

Sol. 6, a, b are in Harmonic Progression $\Rightarrow \dfrac{1}{6}, \dfrac{1}{a}, \dfrac{1}{b}$ are in Arithmetic Progression

$\Rightarrow \dfrac{2}{a} = \dfrac{1}{6} + \dfrac{1}{b} \Rightarrow \dfrac{1}{b} = \dfrac{2}{a} - \dfrac{1}{6} \Rightarrow b = \dfrac{6a}{12-a} \Rightarrow a \in \{3, 4, 6, 8, 9, 10, 11\}$

Hence, the value of N is 7. So the value of $\dfrac{8N}{3} = \dfrac{8 \times 7}{3} = \dfrac{56}{3} = 18.6666$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VIII

JEE (Advanced)-2020

PAPER – 1

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section–A (01 – 04, 19 – 22, 37 – 40)*** *contains 12 multiple choice questions which out of 4 options have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (05 – 12, 23 – 30, 41 – 48) *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–1** In all other cases.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

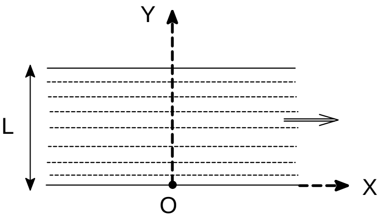
Physics

PART – I

SECTION – A
(One Options Correct Type)

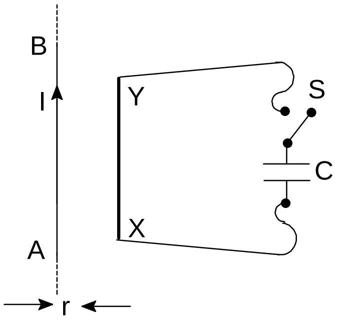
This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A river is flowing with a variable flow rate given by $v = (v_0 + \alpha x)$. A swimmer starts from origin having speed v with respect to water wants to cross the river in minimum time. Then drift of swimmer along x – axis would be (width of river is L)



(A) $\frac{v_0}{\alpha}\left[e^{\frac{L\alpha}{v}} - 1\right]$
(B) $\frac{v_0}{\alpha}e^{\frac{L\alpha}{v}}$
(C) $\ln\left(\frac{v_0}{\alpha}\frac{L}{v}\right)$
(D) $\frac{v_0 L\alpha}{v}$

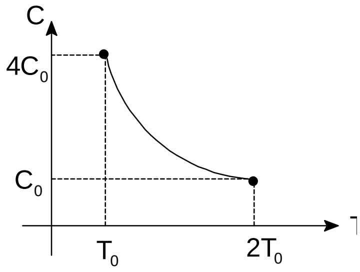
2. The figure shows a long fixed wire AB carrying constant current I. Another wire XY parallel to AB of mass per unit length λ is kept at a distance r from wire AB connected to a capacitor of capacitance C by flexible light wires through a switch. The capacitor is initially charged to voltage E_0. The switch is closed at t = 0 and the circuit has a negligible. The velocity of the wire XY, just after closing the switch will be



(A) $\frac{\mu_0 / CE_0}{4\pi r\lambda}$
(B) $\frac{\mu_0 / CE_0}{2\pi r\lambda + L\mu_0 / C}$
(C) $\frac{\mu_0 / CE_0}{2\pi r\lambda}$
(D) $\frac{\mu_0 / CE_0}{4\pi r + L\mu_0 / C}$

Space for Rough work

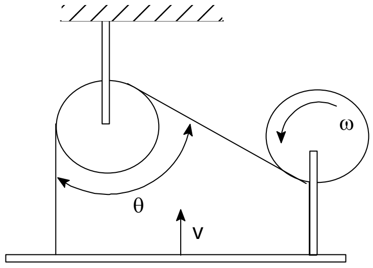
3. Find the heat energy required to raise the temperature of n motes of a gas from T_0 to $2T_0$ if its molar heat capacity varies as shown in the diagram. The equation of the curve is CT^x = constant



(A) $2nC_0T_0$ (B) nC_0T_0

(C) $\frac{nC_0T_0}{2}$ (D) $\frac{3}{2}nC_0T_0$

4. At the instant shown, the board is moving vertically upward with speed v. The drum of radius 'R' winds up at a rate $\omega(\text{rad}/\text{s})$. If the board always remains horizontal, springs taut. Find v.



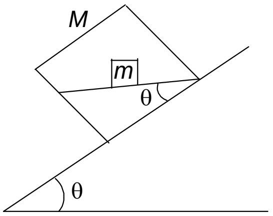
(A) ωR (B) $\frac{\omega R}{1+\cos\theta}$

(C) $\frac{\omega R}{\cos\theta}$ (D) $\frac{\omega R}{2+\cos\theta}$

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

5. A box of mass M is kept on a frictionless and inclined plane which is inclined at an angle θ with the horizontal. A box is having another frictionless inclined plane, inclined at same angle θ with the previously described inclined plane as shown in the figure. If a block of mass m is kept on this inclined plane inside the box, then



(A) the acceleration of the block with respect to the box is $\frac{(M+m)g\sin\theta\cos\theta}{M+m\sin^2\theta}$ towards the left side.

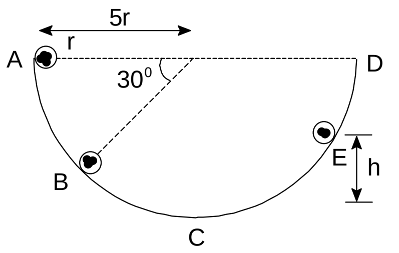
(B) the acceleration of the block with respect to the box is $\frac{(M+m)g\sin\theta\cos\theta}{M+m\sin^2\theta}$ towards the right side.

(C) the normal reaction between the box and the inclined plane is $\frac{M(M+m)g\cos\theta}{M+m\sin^2\theta}$.

(D) the normal reaction between the box and the block is $\frac{Mmg\cos^2\theta}{M+m\sin^2\theta}$

Space for Rough work

6. A solid sphere of radius r and mass m is released from point A on a vertical circular surface of radius 5r which has sufficient friction in part AB. Part BCD is smooth and h is the maximum height attained by the centre of the sphere from point C in part CD. The total energy and the kinetic energy at this height is T and K, respectively (assume that a lowest point C of the circular path as reference point for potential energy). Then



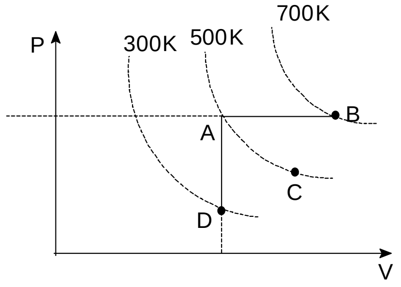
(A) $h = \left(\frac{31}{7}\right)r.$

(B) $T = 5mgr$

(C) $K = \left(\frac{4}{7}\right)mgr$

(D) The friction force on the sphere just before point B is $\frac{2\sqrt{3}mg}{5}$.

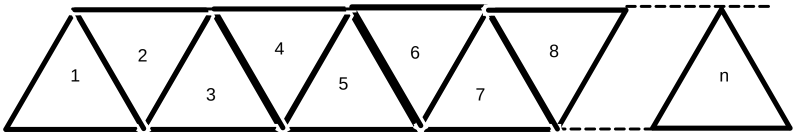
7. Figure shows three isotherms at temperatures 300K, 500K, and 700K, respectively, on PV diagram with broken lines. Three independent thermodynamic process (AB, AC and AD) are performed on 1 mole of monatomic ideal gas as shown in the figure. Then, choose the correct choice(s).



(A) In the process AC, first the temperature of the thermodynamic system increases and then decreases.
(B) In the process AC, the temperature of the thermodynamic system is always constant.
(C) In the process AD, average kinetic energy of molecules per unit volume decreases.
(D) None of these

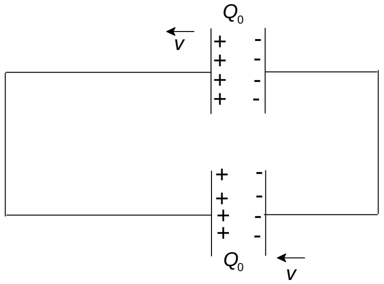
Space for Rough work

8. n number of identical equilateral prisms are kept in contact as shown in the figure. If the deviation through a single prism is δ, then (n, m are integers)



(A) if n = 2m, the deviation through the system of n prisms is zero.
(B) if n = 2m + 1, deviation through the system of n prisms is δ.
(C) if n = 2m, the deviation through the system of n prisms is δ.
(D) if n = 2m + 1 is deviation through the system of n prisms is zero.

9. Two identical capacitors are connected as shown and having initial charge Q_0. Separation between plates of capacitors is d_0. Suddenly the left plate of upper capacitor and right plate of lower capacitor start moving with speed v towards left while other plate of capacitor remains fixed.



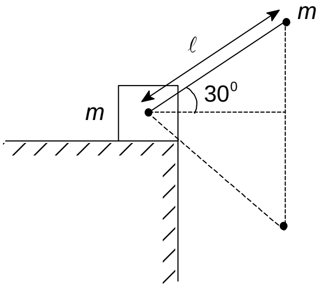
(A) The value of currents in the circuit be $\frac{Q_0 v}{d_0}$

(B) The value of current in the circuit be $\frac{Q_0 v}{2d_0}$

(C) The value of charge on lower capacitor at time t is $\frac{Q_0 v}{d_0}t$

(D) The value of charge on lower capacitor at time t is $\frac{Q_0\left(d_0 + vt\right)}{d_0}$

10. A block of mass m(= 1 kg) is placed on a smooth horizontal surface as shown. Its centre is tied to a string of length ℓ (= 10 m) and other end of the string is connected to ball of same mass. Ball is released from the position shown. It falls under gravity and then string becomes taut. The kinetic energy of block and ball just after string is taut are KE_b and KE_p respectively, then

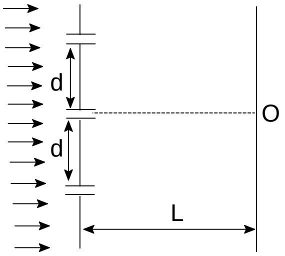


(A) $KE = 6\ J$ (B) $KE_p = 78\ J$
(C) $KE_b = 12\ J$ (D) $KE_p = 39\ J$

Space for Rough work

11. An atom has energy levels $E_n = -\frac{A}{n^2}$ where n is an integer and A is a constant. Among the spectral lines that atom can absorb at room temperature are two adjacent lines with wavelengths 97.5 nm and 102.8 nm. Select the correct alternative(s)
(A) $A = 54.4$ eV
(B) $A = 13.6$ eV
(C) The wavelength 97.5 nm corresponds to transition from n = 1 to n = 3
(D) The wavelength 102.8 nm corresponds to transition from n = 3 to n = 4

12. Suppose a monochromatic coherent, parallel beam of light, of wavelength λ passes three parallel slits each separated by a distance d from its neighbor. The distance of a point on the screen from the centre point O. at which a minima is formed $(L >> d)$



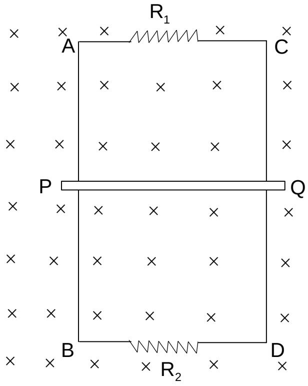
(A) $\frac{\lambda L}{3d}$ (B) $\frac{2\lambda L}{3d}$
(C) $\frac{4\lambda L}{3d}$ (D) $\frac{\lambda L}{d}$

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded ‑ off to the **second decimal place**; e.g. XXXXX.XX).

---

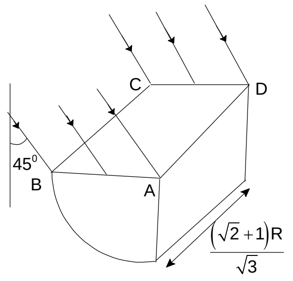
13. Two parallel vertical metallic rails AB and CD are separated by 1 m. They are connected at the two ends by resistances R_1 and R_2 as shown in the figure. A horizontal metallic bar PQ of mass 0.2 kg sides with out friction, vertically down the rails under the action of gravity. There is uniform horizontal magnetic field of 0.6 T, which is perpendicular to plane of the rails. It is observed that when the terminal velocity attained, the power dissipated in resistance R_1 and R_2 are 0.76 W and 1.2 W, respectively. Find the terminal velocity (in m/s) of the bar. (Take g = 9.8 m/s^2)



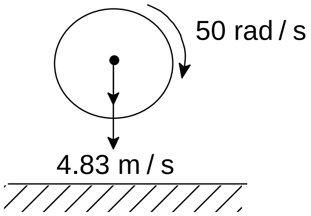
Space for Rough work

14. River stream velocity grows in proportion to the distance from the bank and reaches its maximum velocity 2 m/s in the middle. Near the bank, the velocity is zero. The speed of swimmer in still water is 5 m/s and directed perpendicular to the river stream. The width of the river is 100 m the drifting in swimmer is 5n metre. Find the value of n.

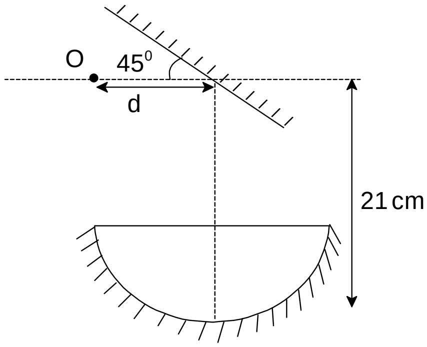
15. Light rays are falling on the flat surface ABCD of quarter of a cylinder of radius R = 3 m. Find the area (in m^2) on the flat surface on which falling light rays emit from the curved surface of the cylinder. Refractive index of the cylinder is $\sqrt{2}$.



16. A solid rubber ball of mass 2 kg and radius 3 cm collides with the horizontal ground with velocity 4.83 m/s and angular velocity 50 rad/s. The coefficient of friction and restitution are 2 and 0.5 respectively. Find the horizontal distance covered by the ball between the first and second impact of the ground in m.



17. A point object O is placed in front of a plane mirror and plano – convex lens (whose convex side is silvered) assembly, as shown. Find the distance d (in cm) of the object from the plane mirror so that the final image is created at the itself. Radius of curvature of the convex side of plano – convex lens is 42 cm and its refractive index is $\frac{3}{2}$.



18. Two candles A and B, each 30 cm long and requiring 4 and 6 hour respectively to burn out, stand vertically at a distance of 30 cm. The shadow of b falls on a vertical wall at a distance 3 m from b. Find the speed of the end of shadow (in decimeter/hour).

Space for Rough work

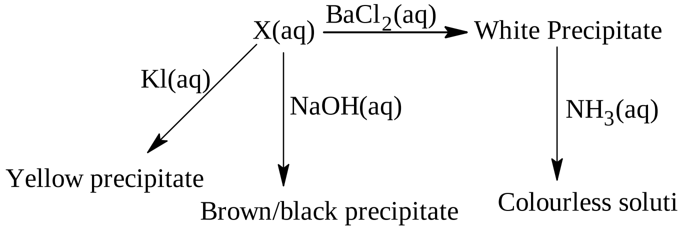
Chemistry

PART – II

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

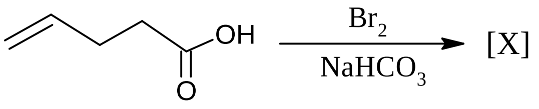
19. A compound 'X' reacts in the following ways


X(aq)
BaCl2(aq)
White Precipitate
Kl(aq)
NaOH(aq)
NH3(aq)
Yellow precipitate
Brown/black precipitate
Colourless solution

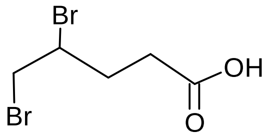
The compound 'X' is likely to be

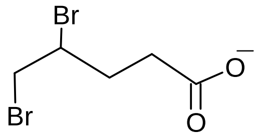
(A) $Pb(NO_3)_2$ (B) $CaCrO_4$
(C) $Hg(NO_3)_2$ (D) $AgNO_3$

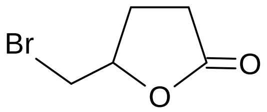
20.

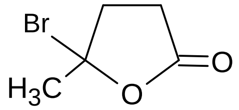

OH
O
Br2
NaHCO3
[X]

[X] is

(A)


(B)


(C)


(D)


21. $FeCl_3$ solution is treated with excess $NaOH$. A brown ppt. is formed. The ppt is filtered and dried finally heated with carbon monoxide at approximately 700^0C the products of the reaction is /are.

(A) $FeO+CO_2$ (B) $Fe_3O_4+CO_2$
(C) only *Fe* (D) $Fe+CO_2$

Space for Rough work

22. The following reaction was carried out in water:

$$Cl_2 + 2I^- \longrightarrow I_2 + 2Cl^-$$

The initial concentration of I^- was 0.25 mol L^{-1} and the concentration after 10 minutes was 0.23 mol L^{-1}. Then the rate of appearance of I_2 is:

(A) $1\times10^{-3}\, mol\, L^{-1}\min^{-1}$
(B) $0.002\, mol\, L^{-1}\min^{-1}$
(C) $1\times10^{-2}\, mol\, L^{-1}\min^{-1}$
(D) $0.02\, mol\, L^{-1}\min^{-1}$

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

---

23. Which of the following is true for 3-methyl-2-butanone?
(A) It may be prepared by CrO_3 oxidation of 2-methyl-2-butanol.
(B) Reaction with $NaBH_4$ gives a secondary alcohol.
(C) It may be prepared by acidic Hg^{2+} catalyzed hydration of 3-methyl-1-butyne.
(D) It forms a silver mirror on treatment with $Ag(NH_3)_2^+$.

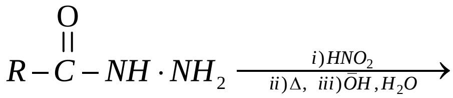
24. Which of the following statements is/are correct?
(A) The order of splitting energy is $PtCl_4^{2-} > PdCl_4^{2-} > NiCl_4^{2-}$
(B) $[Co(NH_3)_6]^{3+}$ is colourless whereas $[Ni(H_2O)_6]^{2+}$ is coloured.
(C) $[M(en)(gly)]^{n+}$ will represent geometrical isomerism.
(D) The magnetic moment of $K_3[Fe(CN)_6]$ is $\sqrt{3}$ B.M.

25. Which of the following statement is/are incorrect:
(A) K_2CO_3 is more covalent than Na_2CO_3
(B) Cyanogen $(CN)_2$ is inert towards NaOH
(C) N_3^- and CN^- are pseudohalides.
(D) Br_2 does not disproportionate in alkaline solution

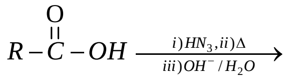
26. In Na_2O structure:
(A) O^{2-} ions constitute ccp.
(B) Na^+ ions occupy all the tetrahedral holes.
(C) Na^+ ions occupy all the octahedral holes.
(D) O^{2-} ions occupy half of octahedral holes.

Space for Rough work

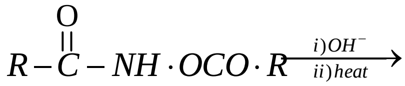
27. In which of the following reactions an isocyanate is expected as an intermediate?

(A) 

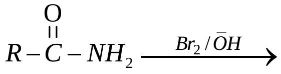
$$R-\overset{\overset{O}{||}}{C}-NH\cdot NH_2 \xrightarrow[ii)\Delta,\ iii)\bar{O}H, H_2O]{i)HNO_2}$$

(B) 

$$R-\overset{\overset{O}{||}}{C}-OH \xrightarrow[iii)OH^-/H_2O]{i)HN_3, ii)\Delta}$$

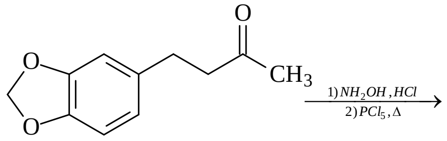
(C) 

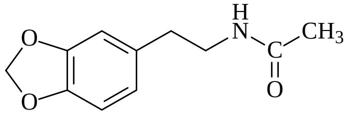
$$R-\overset{\overset{O}{||}}{C}-NH\cdot OCO\cdot R \xrightarrow[ii)heat]{i)OH^-}$$

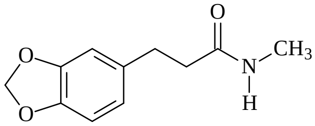
(D) 

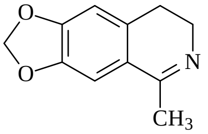
$$R-\overset{\overset{O}{||}}{C}-NH_2 \xrightarrow{Br_2/\bar{O}H}$$

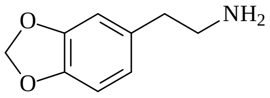
28. Which of the following will be obtained in the given reaction?



(A) 

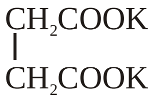
(B) 

(C) 

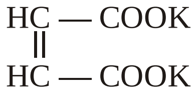
(D) 

29. Kolbe's electrolytic method can be applied on

(A) CH_3COONa

(B) 

$$\begin{array}{l} CH_2COOK \\ | \\ CH_2COOK \end{array}$$

(C) 

$$\begin{array}{l} HC — COOK \\ || \\ HC — COOK \end{array}$$

(D) C_6H_5COONa

30. For the given transition: C (graphite) $\longrightarrow$ C (diamond), correct options is/are

(A) C (diamond) is more thermodynamically stable then C (graphite) at 25^oC
(B) C (graphite) is more thermodynamically stable than C (diamond) at 25^oC
(C) diamond will provide more heat on complete combustion at 25^oC
(D) $\Delta G_{transition}$ of C (diamond) $\longrightarrow$ C(graphite) is -ve

Space for Rough work

SECTION – C

(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded - off to the **second decimal place**; e.g. XXXXX.XX).

---

31. A polyhydric alcohol is acylated by using ethanoyl chloride in presence of alkali. It was observed that molecular mass of alcohol is increased to 237% on acylation. If the molecular mass of polyhydric alcohol is 92, then the number of –OH groups present in polyhydric alcohol are

32. 80 mL sample solution of KI was electrolyzed for 3.0 minute, using a constant current. The I_2 produced required 0.25 M, 37.2 mL sodium thiosulphate solution and unreacted KI required 36.3 mL 0.02 M acidic solution of $KMnO_4$. Determine the current (in ampere) passed during the electrolysis.

33. Two organic liquids A and B have vapour pressure p_1^0 & p_2^0 at 80^0C in their pure states. A mixture of the two boils at 80^0C and shows ideal behaviour. It has mole fraction of A = 0.16. If $p_2^0 - p_1^0$ = 472 mm; then p_1^0 will be (in mm of Hg):

34. Among the following, in how many number of colloids, particles of D.P. move towards cathode during electro-osmosis?
Ferric hydroxide, methylene blue , Au, arsenius sulphide, Haemoglobin, Starch, silicic acid , congo red , gelatin

35. How many milligram of CaC_2O_4 will dissolve in one litre of saturated solution?
(K_{sp} of CaC_2O_4 is 2.5×10^{-9} mol^{-2})

36. 0.535 g mixture of ethanol and acetaldehyde when heated with Fehling solution gave 1.2 g of a red precipitate. What is the percentage of acetaldehyde in the mixture?

Space for Rough work

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. If a, b, c are three positive real number such that $2a+b+3c=1$ then maximum value of $\left(ab^2c^2\right)$

(A) $\frac{8}{9(5)^5}$
(B) $\frac{8}{9(5)^4}$
(C) $\frac{8}{9(3)^5}$
(D) $\frac{8}{9(5)^3}$

38. A bag contain three biased coins, odds in favour of tail when tossed are $3:1, 1:1, 4:1$ respectively. A coin is drawn at random and tossed results into a tail, then the probability that if the same coin is tossed again will result into tail is

(A) $\frac{315}{469}$
(B) $\frac{193}{295}$
(C) $\frac{253}{600}$
(D) $\frac{381}{620}$

39. If $\int \frac{\tan x}{1+\tan x+\tan^2 x}dx = x-\frac{K}{\sqrt{A}}\tan^{-1}\left(\frac{K\tan x+1}{\sqrt{A}}\right)+C$ (c is constant of integration). Then the ordered pair (K, A) is equal to

(A) (2, 3)
(B) (3, 2)
(C) (-2, 1)
(D) (-2, 3)

Space for Rough work

40. The integral $\int_a^b \frac{e^{\frac{x^2}{a^2}} - e^{\frac{b^2}{x^2}}}{x} dx$ is equal to

(A) 0 (B) $\sqrt{\frac{b}{a}}$

(C) $\sqrt{\frac{a}{b}}$ (D) None of these

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

---

41. If the equation $x^4 - (a+2)x^3 + 2x^2 + (a+2)x - 3 = 0$ has at least two distinct positive roots then

(A) $a \in [1, \infty)$ (B) $a \in [2, \infty)$

(C) $a \in [2, 4]$ (D) $a \in \left[\sqrt{3}-1, \infty\right)$

42. Two circles of radii r_1 *and* r_2 touch the x-axis at A and B respectively and the line $y = mx$ they intersect each other at $P(9, 6)$ *and* Q *also* $r_1 r_2 = 68,$ then

(A) $m = \frac{12\sqrt{221}}{49}$ (B) $m = \frac{-12\sqrt{221}}{49}$

(C) $m = \frac{221\sqrt{2}}{49}$ (D) None

Space for Rough work

43. All value of $x \in \left(0, \frac{\pi}{2}\right)$ such that $\frac{\sqrt{3}-1}{\sin x}+\frac{\sqrt{3}+1}{\cos x}=4\sqrt{2}$ is/are

(A) $\frac{\pi}{15}$ (B) $\frac{\pi}{12}$

(C) $\frac{3\pi}{10}$ (D) $\frac{11\pi}{36}$

44. If $\vec{a}$ *and* $\vec{b}$ are two vectors such that

$\left|\vec{a}+\vec{b}\right|=5\sqrt{2}$ *and* $\vec{a}\times\left(4\hat{i}+\lambda\hat{j}+2\hat{k}\right)=\left(4\hat{i}+\lambda\hat{j}+2\hat{k}\right)\times\vec{b}$ and

$\left(\vec{a}+\vec{b}\right)\cdot\left(-3\hat{i}+2\hat{j}+\lambda\hat{k}\right)=10$ then

(A) Sum of values of $\lambda=\frac{48}{7}$ (B) Product of value of $\lambda=\frac{84}{7}$

(C) No possible value of λ (D) Two possible value of λ

45. Let $f\left(\frac{x+y}{2}\right)=\frac{f(x)+f(y)}{2}$ for all real x and y. If $f'(o)$ exists and equal to -1 and $f(o)=1$ then

(A) $f(x)=1-x$ (B) $f(x)=1-x^2$

(C) $f(2)=-1$ (D) $f(2)=1$

46. The locus of a point whose chord of contact with respect to the ellipse $x^2+2y^2=1$ subtend a right angle at the centre of the ellipse is

(A) $x^2+4y^2=3$ (B) $y^2=4x$

(C) $2x^2+4y^2=3$ (D) $x^2=4y$

Space for Rough work

47. If $A = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix}$ then

(A) $A^3 - A^2 = A - I$

(B) $\det\left(A^{2010} - I\right) = 0$

(C) $A^{50} = \begin{bmatrix} 1 & 0 & 0 \\ 25 & 1 & 0 \\ 25 & 0 & 1 \end{bmatrix}$

(D) $A^{50} = \begin{bmatrix} 1 & 1 & 0 \\ 25 & 1 & 0 \\ 25 & 0 & 1 \end{bmatrix}$

48. If $\alpha,\ \beta,\ \gamma$ are roots of the equation $9x^3 - 7x + 6 = 0$ then the equation $x^3 + Ax^2 + Bx + C = 0$ has the roots $3\alpha + 2,\ 3\beta + 2,\ 3\gamma + 2$ then

(A) $A = 6$

(B) $B = -5$

(C) $C = 24$

(D) $A + B + C = 23$

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded - off to the **second decimal place**; e.g. XXXXX.XX).

---

49. Let $L_1 : \frac{x-6}{3} = \frac{y-7}{-1} = \frac{z-4}{1}$ *and* $L_2 : \frac{x}{-3} = \frac{y+9}{2} = \frac{z-2}{4}$. *If* L_1 *and* L_2 are skew lines such that P and Q are two points nearest to each other lying on lines L_1 *and* L_2 respectively. If image of P with respect to plane $3x + 3y - z = 11$ *is* $R(a,\ b,\ c)$ *then* $-a + b + \frac{c}{2}$ is

50. If x and y are the solution of the equation $12\sin x + 5\cos x = 2y^2 - 8y + 21$ then the value of $6\cot\left(\frac{xy}{2}\right)$ is

Space for Rough work

51. If $p(x) = x^4 + ax^3 + bx^2 + cx + d$ (where a, b, c, d∈R) and $p(1) = 10,\ p(2) = 20,\ p(3) = 30$

then the value of $\left(\frac{p(12) + p(-8) - 10}{10000}\right)$ equals to

52. If $\frac{\tan 8^\circ}{1 - 3\tan^2 8} + \frac{3\tan 24^\circ}{1 - 3\tan^2 24} + \frac{9\tan 72^\circ}{1 - 3\tan^2 72} + \frac{27\tan 216^\circ}{1 - 3\tan^2 216} = x\tan 108^\circ + y\tan 8^\circ$

then $(x^2 + y^2)$ is equal to

53. If $A = \lim\limits_{n\to\infty}\left({}^nC_0 \cdot {}^nC_1 \cdot {}^nC_2 \cdot {}^nC_3 \cdots {}^nC_n\right)^{\frac{1}{n(n+1)}}$ then A^2 is equal to

54. The Area bounded by the curve $y = \sin^{-1}|\sin x| + \cos^{-1}(\cos x)$ *and* $y = \cos x + \pi$ and the lines $x = 0 \quad x = 4\pi$ is

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VIII

JEE (Advanced)-2020

PAPER – 1

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. A

Sol. $\vec{V}_{sn} = (v_0 + \alpha x)\hat{i} + vj$

time taken, $t = \frac{L}{V}$

Now, $\frac{dx}{dt} = (v_0 + \alpha x) \Rightarrow \int_0^x \frac{dx}{v_0 + \alpha x} = \int_0^t dt$

$x = \frac{v_0}{\alpha}\left[e^{\frac{L\alpha}{v}} - 1\right]$

2. B

Sol. $V = \frac{\int F dt}{m} = \frac{\int iLB dt}{m}$

3. A

Sol. $4C_0T_0^x = C_0(2T_0)^x$

$\therefore x = 2$

Now, $CT^2 = 4C_0T_0^2$

$C = \frac{4C_0T_0^2}{T^2}$

$\int dq = \int_{T_0}^{2T_0} nCdT$

$q = 2nC_0T_0$

4. B

Sol. $V = \omega R - v\cos\theta$

$$V = \frac{\omega R}{1+\cos\theta}$$

5. B, C, D

Sol. Use concept of motion

6. A, B, C

Sol. From A to B,

$$mg(5r-r)\sin 30^0 = \frac{1}{2}mv_0^2 + \frac{1}{2}I\omega^2$$

$$\omega = \sqrt{\frac{20g}{7r}}$$

Apply energy equation between B and E

$$h = \frac{31r}{7}$$

7. A, C

Sol. For process AC;

$P = a - bv \quad [a, b = \text{constant}]$

$\therefore (a-bv)(v) = RT$

$$\therefore T = \frac{1}{R}\left(av - bv^2\right)$$

$$\therefore \frac{dT}{dv} = \frac{a}{R} - \frac{2bv}{R}$$

$$0 = \frac{a}{R} - \frac{2bv}{R} \Rightarrow v = \frac{a}{2b}$$

Also,

$$\left(\frac{d^2T}{dv^2}\right)_{\frac{a}{2b}} < 0$$

$\therefore$ For AC, T first increases and then decreases.

For AD, T $\downarrow$, $\therefore$ K.E $\downarrow$

8. A, B

Sol. Concept based

9. A, D

Sol. $q_1 + q_2 = 2Q_0 \qquad .....(i)$

$$C_1 = \frac{A\varepsilon_0}{d_0 + vt}, \; C_2 = \frac{A\varepsilon_0}{d_0 vt}$$

$$\therefore \frac{C_1}{C_2} = \frac{d_0 - vt}{d_0 + vt} = \frac{q_1}{q_2} \qquad ....(ii)$$

$\therefore$ from (i) and (ii),

$$q_2 = \frac{q_0\left(d_0 + vt\right)}{d_0}$$

and

$$I = \frac{dq_2}{dt} = \frac{q_0 v}{d_0}$$

10. A, B

Sol. Use momentum conservation and impulse momentum equation.

11. B, C, D

Sol. For $n_1 \to n_2$

$$\frac{1}{\lambda_1} = A\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \quad ......(i)$$

and For $n_2 \to (n_2 + 1)$

$$\frac{1}{\lambda_2} = A\left(\frac{1}{n^2} - \frac{1}{(n_2+1)^2}\right) \quad ....(ii)$$

and it is given that,

$\lambda_1 = 102.8$ nm

$\lambda_2 = 97.5$ nm

solving (i) and (ii)

$n_1 = 1$, then $n_2 = 3$ and $n_{2+1} = 4$

and $A = 2.174 \times 10^{-18} J = 13.6$ ev

12. A, B, C

Sol. Path difference (Δx) between two consecutive wave = $d\sin\theta = d\left(\frac{Y}{L}\right)$

For minimum, phase difference between two consecutive wave is $\frac{2\pi}{3}$ or $\frac{4\pi}{3}$.

Hence,

$$\Delta\phi = \frac{2\pi}{\lambda}\Delta x$$

$$\therefore y = \frac{\lambda L}{3d}, \frac{2\lambda L}{3d}, \frac{4\lambda L}{3d}..................$$

SECTION – C

13. 00001.00

Sol. Use the concept of motional emf.

14. 00004.00

Sol. Time taken to reach the middle of the river form the river bank, t = $\frac{50}{5} = 10$ second.

Now, $v_x = \left(\frac{2}{10}\right)t$

$$\int_0^x dx = \frac{1}{5}\int_0^{10} t\,dt$$

$x = 10$ m

Hence total difference = 10 × 2 = 20 m.

15. 00003.00

Sol. $1.\sin 45^0 = \sqrt{2}\,\sin r$

$r = 30^0$

Now,

At G,

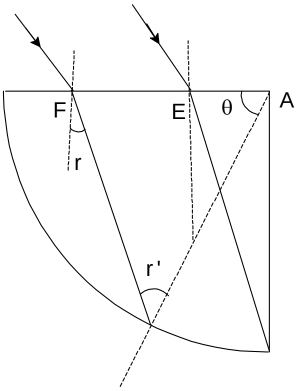
$r' = \left(120^0 - \theta\right)$

$\therefore$ For TIR,

$\sqrt{2}\sin\left(120^0 - \theta\right) = 1.\sin 90^0$

$\theta = 75^0$

Now



$AE = \dfrac{R}{\sqrt{3}},\ AF = \dfrac{\sqrt{2}R}{\sqrt{3}}$

$\therefore EF = \dfrac{\left(\sqrt{2}-1\right)R}{\sqrt{3}}$

Hence,

$\text{Area, } a = \dfrac{\left(\sqrt{2}-1\right)}{\sqrt{3}} \times \dfrac{\left(\sqrt{2}+1\right)R}{\sqrt{3}}$

$= \dfrac{1}{2}R^2 = \dfrac{9}{3} = 3$

16. 00007.00

Sol. $\int N dt = mev_0 - \left(-mv_0\right) \quad ....(i)$

$\int \mu n dt = mv \quad ......(ii)$

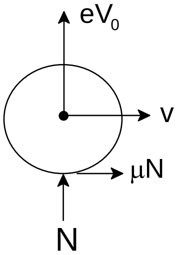
from (i) and (ii)

$v = v_0\left(1+e\right)\mu$

Now,

$t = \dfrac{2ev_0}{g}$

$\text{distance, } d = vt = 7$



17. 00007.00

Sol. $P_{eq} = 2P_L + P_m = \dfrac{2}{2R} + \dfrac{2}{R}$

$P_{eq} = \dfrac{3}{R}$

Now,

$-\dfrac{2}{R_{meq}} = \dfrac{3}{R}$

$\left|R_{meq}\right| = \dfrac{2R}{3}$

Hence, Image formed by the plane mirror is at a distance of $\frac{2R}{3} = 28$ cm.

$\therefore d + 21 = 28$

$d = 7$ cm

18. 00002.00

Sol. At time t,

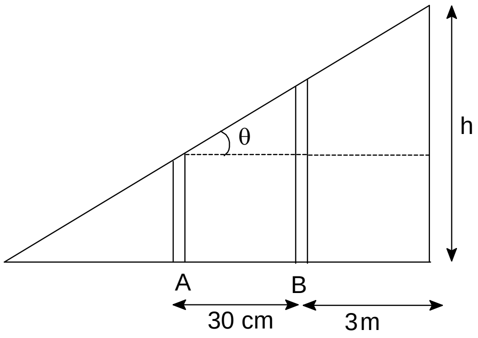
$h_A = 30 - \frac{30}{4}t,\ h_B = 30 - \frac{30}{6}t$

Now,

$\tan\theta = \frac{h_B - h_A}{30} = \frac{h}{330}$

$\therefore h = 30 - 20t$

$\therefore \frac{dh}{dt} = 20 \text{ cm/hr} = 2 \text{ decimeter/hr}$



Chemistry

PART – II

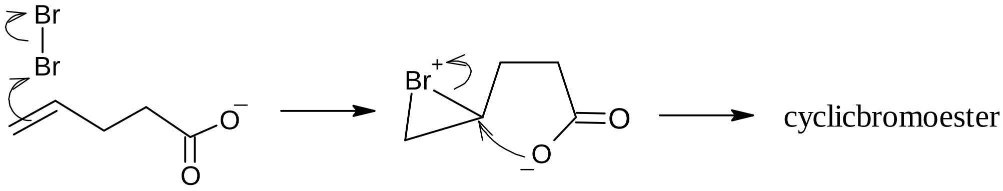
SECTION – A

19. D

Sol. White precipitate = AgCl
Yellow precipitate = AgI
Black precipitate = Ag_2O

20. C

Sol.



Intermolecular attack of bromide ion on the bromonium ion does not compete with the intramolecular cyclisation step.

21. D

Sol. The brown ppt. is $Fe(OH)_3$ on drying and heating it becomes Fe_2O_3 carbon monoxide will reduce it to iron metal.

$$Fe_2O_3 + 3CO \xrightarrow{700^0 c} 2Fe + 3CO_2$$

22. A

Sol.
$$\Delta[I^-] = [I^-]_{final} - [I^-]_{initial}$$
$$= 0.23 - 0.25 = -0.02 molL^{-1}.$$
$$\Delta t = 10 - 0 = 10 \min$$
$$-\frac{\Delta[I^-]}{\Delta t} = \frac{-(-0.02)}{10} = 0.002 molL^{-1}\min^{-1}$$

$\therefore$ Rate of appearance of $I_2 = -\frac{1}{2}\frac{\Delta[I^-]}{\Delta t} = \frac{0.002}{2} = 1\times10^{-3} mol\,L^{-1}\min^{-1}$

23. BC

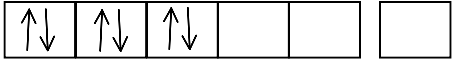
Sol. $3-\text{methyl}-1-\text{butyne} \xrightarrow[H_2SO_4]{Hg^{+2}} 3-\text{methyl}-2-\text{butanone} \xrightarrow{NaBH_4} 3-\text{methyl}-2-\text{butanol}$

24. ABD

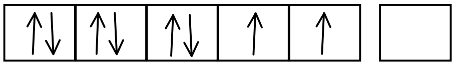
Sol. (A) The magnitude of splitting energy increases down the group. Thus
Pt^{2+} – $5d^8$, Pd^{2+} – $4d^8$ and Ni^{2+} – $3d^8$.

(B) NH_3 is a borderline ligand which forces pairing of electrons in Co^{3+}, whereas H_2O is a weak-field ligand and it can not force the pairing in Ni^{2+}.

Co^{3+} in $[Co(NH_3)_6]^{3+}$ – $3d^6, 4s^0$

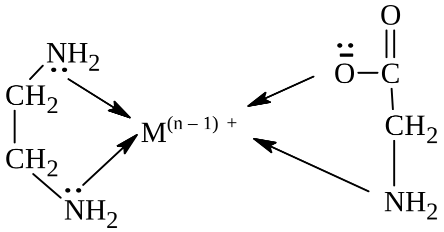


Ni^{2+} in $[Ni(H_2O)_6]^{2+}$ – $3d^8, 4s^0$



So, there is no unpaired electron in $[Co(NH_3)_6]^{3+}$ whereas there are unpaired electron in $[Ni(H_2O)_6]^{2+}$. Thus $[Co(NH_3)_6]^{3+}$ is colourless and $[Ni(H_2O)_6]^{2+}$ is coloured due to d–d transition.

(C)



As en is symmetrical ligand thus there is no geometrical isomerism.

(D) In $K_3[Fe(CN)_6]$, the oxidation state of Fe is +3.
$[Fe(CN)_6]^{3-}$ – $3d^5$, $4s^0$.

↑↓	↑↓	↑				

Number of unpaired electron = 1

$\therefore \mu = \sqrt{n(n+2)}$ B.M. = $\sqrt{1(1+2)}$ B.M. = $\sqrt{3}$ B.M.

25. ABD

Sol. $r_{K^+} > r_{Na^+}$
$\therefore$ K_2CO_3 is more ionic.
$(CN)_2 + NaOH \rightarrow NaCN + NaOCN + H_2O$
$Br_2 + OH^- \rightarrow Br^- + BrO^- + H_2O$.

26. AB

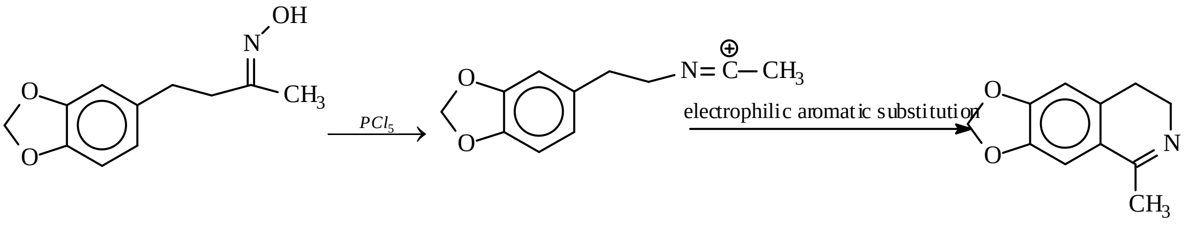
Sol. Na_2O has antifluorite structure, in which O^{-2} ions form ccp array and Na^+ ions occupy all tetrahedral voids.

27. ABCD

Sol. Alkyl isocyanate is $R-N=C=O$
(A) Curtius rearrangement
(B) Schmidt rearrangement
(C) Lossen rearrangement
(D) Hofmann rearrangement

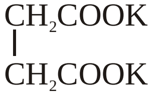
28. ABC

Sol. a and b are obtained by normal Beckmann rearrangement
mechanism for product ‘c’ is

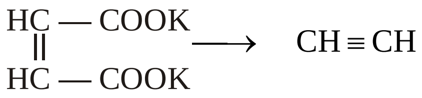


29. ABC

Sol. $CH_3COONa \longrightarrow C_2H_6$ (major)



$$\begin{array}{l} CH_2COOK \\ | \\ CH_2COOK \end{array} \longrightarrow CH_2 = CH_2$$



$$\begin{array}{l}\text{HC}-\text{COOK}\\ \;\,\|\\ \text{HC}-\text{COOK}\end{array}\longrightarrow \text{CH}\equiv\text{CH}$$

30. BCD

Sol. For $\text{C(graphite)}\xrightarrow[\text{high P}]{\text{high T}}\text{C(diamond)}$; $\Delta H = +\text{ve}$ and $\Delta S = -\text{ve}$

SECTION – C

31. 00003.00

Sol. $\text{ROH}\xrightarrow{CH_3COCl}\text{ROCOCH}_3$

Here H is replaced by $COCH_3$ i.e. one H of mass 1 is replaced by one $COCH_3$ of mass 43.

$\therefore$ Mass increased is 42.

$\therefore$ Mass of acylated product is = $92 \times \frac{237}{100} = 218$

$\therefore$ increase in mass = 218 – 92 = 126

$\therefore$ number of OH = 126/42 = 3

32. 00005.00

Sol. $2I^- \rightarrow I_2 + 2e^-$

$I_2 + 2S_2O_3^- \rightarrow 2I^- + S_4O_6^{-2}$

$2I^- + MnO_4^- \rightarrow I_2 + Mn^{+2}$

No. of eq. of KI electrolysed

= no. of eq. of I_2 produced

= no. of eq. of $Na_2S_2O_3$ = $0.25 \times 37.2 \times 1 \times 10^{-3}$

$= 9.3 \times 10^{-3}$

No. of eq.= $\frac{It}{96500} = \frac{I \times 3 \times 60}{96500} = 9.3 \times 10^{-3}$

$\Rightarrow$ I = 5 A

33. 00363.52

Sol. According to Raoult's law:

$P_T = p_1^0 x_1 + p_2^0 x_2$

$p_1 + p_2 = p_1^0(0.16) + p_2^0(0.84) = 760mm$

Also $p_1^0 - p_2^0 = 472mm$

$\therefore$ 760 = $p_1^0(0.16) + (p_1^0 - 472)(0.84)$

760 = $0.16p_1^0 + 0.84p_1^0 - 396.48$

$\therefore$ p_1^0 = 363.52 mm

34. 00000.00

Sol. no movement of D.P. towards any electrode in during electro-osmosis

35. 00006.40

Sol. $CaC_2O_4 \rightleftharpoons \underset{S}{Ca^{++}} + \underset{S}{C_2O_4^{--}}$

$K_{sp} = S \times S = S^2$

$s = \sqrt{K_{sp}}$ = $(2.5 \times 10^{-9})^{1/2} = 5 \times 10^{-5}$ mol litre^{-1} $\therefore \frac{w}{128} = 5 \times 10^{-5}$

$\therefore$ w = 6.4×10^{-3}g = 6.4 mg

36. 00069.16

Sol. Let the mass of acetaldehyde is *x* g, then mass of ethanol is (0.535 – *x*)g. When acetaldehyde is heated with Fehling solution, it gives 1.2 g of a red precipitate.

$CH_3CHO + 2CuO \rightarrow CH_3COO^- + \underset{\text{Re d ppt.}}{Cu_2O}$

$\because$143 g of Cu_2O is coming from = 44 g of CH_3CHO

$\therefore$1.2 g of Cu_2O is coming from $\frac{44}{143} \times 1.2$ = 0.37 g of CH_3CHO

% of CH_3CHO = $\frac{0.37}{0.535} \times 100$ = 69.16 %

Mathematics PART – III

SECTION – A

37. A

Sol. $$\frac{1\times(2a)+2\left(\frac{b}{2}\right)+2\left(\frac{3c}{2}\right)}{5}\ge\left((2a)\left(\frac{b}{2}\right)^2\left(\frac{3c}{2}\right)^2\right)^{1/5}$$

$$\frac{8}{9\times5^{-5}}\ge ab^2c^2$$

38. D

Sol. $$P(T)=\underbrace{\frac{1}{3}\cdot\frac{1}{4}}_{a}+\underbrace{\frac{1}{3}\cdot\frac{1}{2}}_{b}+\underbrace{\frac{1}{3}\cdot\frac{4}{5}}_{c}$$

So, required probability= $\frac{1}{a+b+c}\left(\frac{a\cdot1}{4}+\frac{b\cdot1}{2}+\frac{c\cdot4}{5}\right)=\frac{381}{620}$

39. A

Sol. $$I=\int\frac{\left(\tan x+1+\tan^2 x\right)-\left(1+\tan^2 x\right)}{\tan x+1+\tan^2 x}dx=x-\int\frac{1+\tan^2 x}{1+\tan x+\tan^2 x}dx$$

$z=\tan x \qquad dz=\sec^2 x dx$

$$I=x-\int\frac{dt}{\left(t+\frac{1}{2}\right)^2+\left(\frac{\sqrt{3}}{2}\right)^2}=x-\frac{2}{\sqrt{3}}\tan^{-1}\left(\frac{2\tan x+1}{\sqrt{3}}\right)+C$$

40. A

Sol. $$x=\frac{ab}{t}\Rightarrow dx=\frac{ab}{t^2}(-dt)$$

$$I=\int_b^a\frac{e^{\frac{b^2}{t^2}}-e^{\frac{t^2}{a^2}}}{\frac{ab}{t}}\left(-\frac{ab}{t^2}\right)dt=-I$$

$\therefore 2I=0 \qquad I=0$

41. BC

Sol. $\left(x^2-1\right)\left(x^2-(a+2)x+3\right)=0$

Since $x^2-(a+2)x+3=0$ must have at least one positive real roots.

$\because \alpha\,\beta=3$ both root must be positive

$\alpha+\beta=a+2>0\Rightarrow a>-2\ \&\ D\ge0\Rightarrow(a+2)^2-12\ge0 \qquad a\ge2\left(\sqrt{3}-1\right)$

42. AB

Sol. $m=\dfrac{2m_1}{1-m_1^2}$

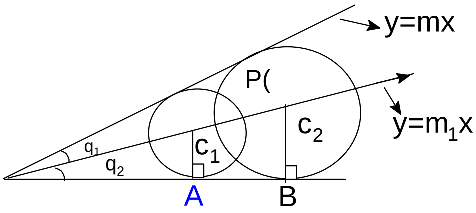
$O_1P^2=r_1^2=m_1^2\alpha^2$

$(9-\alpha)^2+(6-m_1\alpha)^2=m_1^2\alpha^2$

$\alpha^2-6(2m_1+3)\alpha+117=0$

$\alpha\beta=117 \qquad r_1r_2=m_1^2\alpha\beta=68$

$\therefore m=\pm\dfrac{12\sqrt{221}}{49}$



43. BD

Sol. $$\frac{\left(\frac{\sqrt{3}-1}{2\sqrt{2}}\right)}{\sin x}+\frac{\left(\frac{\sqrt{3}+1}{2\sqrt{2}}\right)}{\cos x}=2\Rightarrow\frac{\sin\left(\frac{\pi}{12}\right)}{\sin x}+\frac{\cos\left(\frac{\pi}{12}\right)}{\cos x}=2$$

44. AD

Sol. ∴ Given

$$\left(\vec{a}+\vec{b}\right)\times\left(4\hat{i}+\lambda\hat{j}+2\hat{k}\right)=0$$

$$\left|\vec{a}+\vec{b}\right|\left|-3\hat{i}+2\hat{j}+\lambda\hat{k}\right|\cos\theta=10$$

θ is the angle between $\left(4\hat{i}+\lambda\hat{j}+2\hat{k}\right)$ & $\left(-3\hat{i}+2\hat{j}+\lambda\hat{k}\right)$

$\therefore 7\lambda^2-48\lambda+52=0$

45. AC

Sol. $$f'(x)=\lim_{h\to0}\frac{f(x+h)-f(x)}{h}=\lim_{h\to0}\frac{f\left(\frac{2x+2h}{2}\right)-f(x)}{h}$$

$$=\lim_{h\to 0}\frac{f(2x)+f(2h)-2f(x)}{2h}$$

$$Let\ x=2x\ \&\ y=0 \qquad f(x)=\frac{f(2x)+f(0)}{2}=\frac{f(2x)+1}{2}$$

$$=\lim_{h\to 0}\frac{2f(x)-1+2f(2h)-2f(x)}{2h}=\lim_{h\to 0}\frac{f(2h)-1}{2h}$$

$$=\lim_{h\to 0}\frac{f(2h)-f(0)}{2h-0}=f'(0)=-1 \qquad \therefore f'(x)=-1$$

46. A

Sol. Use homogenization method

47. ABC

Sol. Use matrix property

48. ACD

Sol. $9x^3-7x+6=0$

$y=3x+2$

$x=\frac{y-2}{3}$

$9\left(\frac{y-2}{3}\right)^3-7\left(\frac{y-2}{3}\right)+6=0$

$(y-2)^3-7(y-2)+18=0$

$y^3-6y^2+5y+24=0$

SECTION – C

49. 00007.50

Sol. Direction ratio of PQ

$(-3r_2-3r_1-6,\ 2r_2+r_1+6,\ 4r_2-r_1-2)$

Now, $-3(-3r_2-3r_1-6)+2(2r_2+r_1-16)+4(4r_2-r_1-2)=0$

$\therefore 7r_1+29r_2=22 \qquad ---(1)$

$3(-3r_2-3r_1-6)-(2r_2+r_1-16)+(4r_2-r_1-2)=0$

$7r_2+11r_1=-4 \qquad ---(2) \qquad \therefore r_1=-1,\ r_2=1$

$a=-3,\ b=2,\ c=5$

$-a+b+\frac{c}{2}=3+2+25=7.5$

50. 00002.50

Sol. $12\sin x+5\cos x=2(y-2)^2+13$

$by\ LHS\le 13,\quad RHS\ge 13$

$\therefore y=2\ \therefore 12\sin x+5\cos x=13\ \cos(x-\alpha)=1\ x=2x\pi+\alpha$

51. 00001.98

Sol. $p(x) = (x-1)(x-2)(x-3)(x-\alpha) + 10x$

$\therefore p(12) + p(-8) = 19800 + 40$

$$\frac{p(12) + p(-8) - 10}{10000} = 1.98$$

52. 00102.53

Sol. Let $\frac{\tan 8^\circ}{1 - 3\tan^2 8} = \frac{1}{8}\left[\frac{8\tan 8^\circ}{1 - 3\tan^2 8} + \tan 8^\circ - \tan 8^\circ\right] = -\frac{1}{8}\tan 8^\circ + \frac{3}{8}\tan 24^\circ$

$\therefore$ Solving LHS

$$\frac{81}{8}\tan 108^\circ - \frac{1}{8}\tan 8^\circ = x^2 + y^2$$

$$x^2 + y^2 = \frac{(81)^2 + (1)^2}{64} = 102.53$$

53. 00000.50

Sol. $\overset{n}{\underset{K=0}{\pi}} \ {}^nC_K = \overset{n}{\underset{K=1}{\pi}} \frac{n!}{K!(n-K)!} = \frac{(n!)^{n+1}}{(1!2!...3!)^2}$

$$= \left(\overset{n}{\underset{K=1}{\pi}} (n+1-K)^{n+1-2K}\right)$$

$$= \overset{n}{\underset{K=1}{\pi}} \left(\frac{n+1-K}{n+1}\right)^{n+1-2K} \quad \sin ce \sum (n+1-2K) = 0$$

Taking log and limit we get

$$\frac{1}{n}\sum_{K=1}^{n}\left(1 - \frac{2K}{n+1}\right)\ln\left(1 - \frac{K}{n+1}\right)$$

$$= \int_0^1 (1-2x)\ln(1-x)\,dx = \frac{1}{2}$$

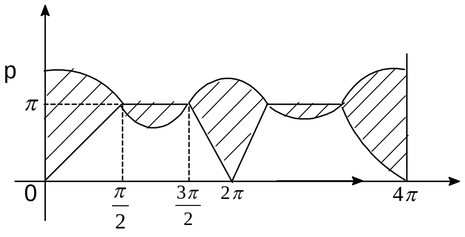
54. 00017.86

Sol. $f(x) = 2x;\ 0 \le x \le \frac{\pi}{2}$

$= \pi;\ \frac{\pi}{2} < x \le \frac{3\pi}{2}$

$= 4\pi - 2x;\ \frac{3\pi}{2} < x \le 2\pi$

Required Area



$$= 4\int_0^{\pi/2}\left(\pi + \cos x - 2x\right)dx + 2\int_{\pi/2}^{3\pi/2}\left(\pi - \left(\pi + \cos x\right)\right)dx$$

$$= \pi^2 + 8 = \left(3.14\right)^2 + 8 = 17.86$$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VIII

JEE (Advanced)-2020

PAPER – 2

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section-A (01 – 08, 19 – 26, 37 – 44)*** *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–1** In all other cases.*

   Section-A (09 – 12, 27 – 30, 45 – 48) *contains 6 List-Match sets with 12 questions (each set has 2 questions). Each question has 4 statements in LIST-I & 6 statements in LIST-II. The codes for Lists have choices (A), (B), (C), (D) out of which only one is correct.*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

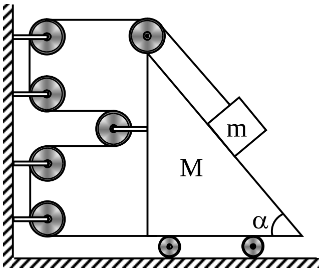
Physics

PART – I

SECTION – A
(One or More than one correct type)

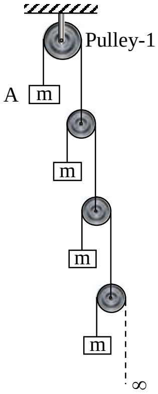
This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. If the acceleration of wedge in the figure shown is *a* m/s^2 towards left, then at this instant acceleration of the block (magnitude only) would be



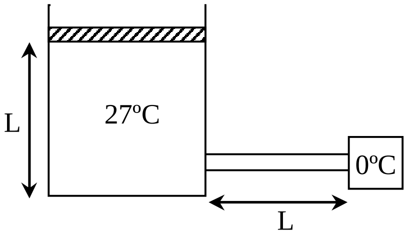
(A) $4a$ m/s^2
(B) $a\sqrt{17-8\cos\alpha}$ m/s^2
(C) $\sqrt{17a}$ m/s^2
(D) $\sqrt{17}\cos\frac{\alpha}{2}\times a$ m/s^2

2. System is released from rest. Only pulley 1 is fixed. Determine the acceleration of A



(A) $\frac{g}{2}$ downward
(B) $\frac{g}{2}$ upward
(C) $\frac{g}{4}$ downward
(D) $\frac{g}{4}$ upward

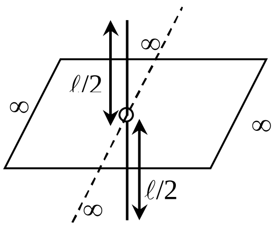
3. 0.5 mole of an ideal gas at constant temperature 27ºC kept inside a cylinder of length L and cross section area A closed by a mass less piston. The cylinder is attached with conducting rod length L cross section area $\left(\frac{1}{9}\right)m^2$ and thermal conductivity K, whose other end is maintained at 0ºC. If piston is moved such that rate of heat flow through the conducting rod is constant then velocity of piston when it is at height $\frac{L}{2}$ from the bottom of cylinder [neglect any kind of heat loss from system)



(A) $\frac{K}{R}m/s$
(B) $\frac{K}{10R}m/s$
(C) $\frac{K}{100R}m/s$
(D) $\frac{K}{1000R}m/s$

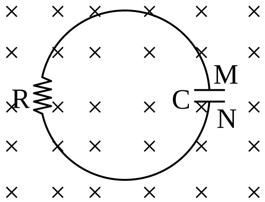
Space for Rough work

4. An infinite non conducting sheet having charge density σ and there is a small hole as shown in figure and there is rod of length λ having linear charge density λ and hinged in the hole as shown. If the mass of rod is m then time period of oscillation for small angular displacement



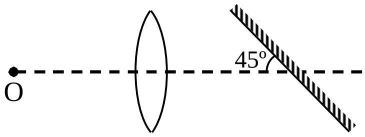
(A) $\pi\sqrt{\frac{m\in_0}{3\sigma\lambda}}$
(B) $2\pi\sqrt{\frac{2m\in_0}{3\sigma\lambda}}$
(C) $\frac{\pi}{2}\sqrt{\frac{m\in_0}{3\sigma\lambda}}$
(D) None of these

5. A uniform magnetic field decrease at a constant rate $\frac{dB}{dt} = -K$ where K is a positive constant. A circular loop of wire of radius 'a' containing a resistance R and a capacitance C is placed with its plane normal to the field



(A) maximum charge on the capacitor will be $\pi a^2 CK$
(B) maximum charge on the capacitor will be $2\pi a^2 CK$
(C) upper plate M, will be at higher potential when it is fully discharged
(D) lower plate N, will be at higher potential when it is fully discharged

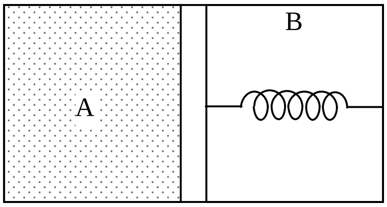
6. A convex lens of focal length $\frac{a}{2}$ and a plane mirror are arranged as shown. The plane mirror is inclined at an angle 45° with the axis and the distance between lens and mirror is equal to focal length of the lens.



A point source is placed at a distance 'a' from lens at its axis. The distance between the source and the image formed after reflection from the mirror will be

(A) $\frac{a}{2}$
(B) $\frac{\sqrt{5}a}{2}$
(C) $\frac{\sqrt{10}a}{2}$
(D) None of these

Space for Rough work



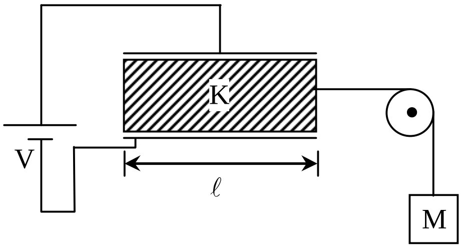
7. A thermally insulated chamber of volume $2V_0$ is divided by a frictionless piston of area *S* into two equal parts *A* and B. Part A has an ideal gas at pressure P_0 and temperature T_0 and in part B is vacuum. A massless spring of force constant *k* is connected with piston and the wall of the container as shown. Initially spring is unstretched. Gas in chamber A is allowed to expand. Let in equilibrium spring is compressed by x_0. Then -

(A) final pressure of the gas is $\frac{kx_0}{S}$

(B) work done by the gas is $\frac{1}{2}kx_0^2$

(C) change in internal energy of the gas is $\frac{1}{2}kx_0^2$

(D) temperature of the gas is decreased



8. A capacitor with air as dielectric has capacity C as shown in figure is completely filled with dielectric slab of mass M and is connected to a block of mass M. The system is released form rest at time t = 0 when the capacitor is completely filled with dielectric. Then:
(Dielectric constant of slab = K)

(A) Charge on the plate of the capacitor when it is half filled with air is $\frac{(K+1)CV}{2}$

(B) The kinetic energy of the block when the capacitor is half filled with dielectric is $\frac{mg\ell}{4} - \frac{CV^2(K-1)}{8}$

(C) The potential difference between the plates when the capacitor is half filled with air is V

(D) The energy stored in the capacitor when it is half filled with dielectric is $\frac{K}{2}CV^2$.

Space for Rough work

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

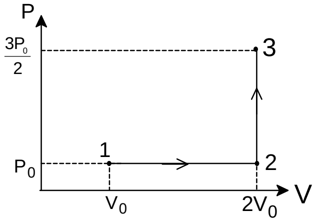
In a thermodynamic process on an ideal monatomic gas, the infinitesimal heat absorbed by the gas is given by $T\Delta X$, where T is temperature of the system and ΔX is the infinitesimal change in a thermodynamic quantity X of the system. For a mole of monatomic ideal gas $X = \frac{3}{2}R\ \ln\left(\frac{T}{T_A}\right) + R\ \ln\left(\frac{V}{V_A}\right)$.

Here, R is gas constant, V is volume of gas, T_A and V_A are constants.

The List-I below gives some quantities involved in a process and List-II gives some possible values of these quantities.

	List – I		List – II
(I)	Work done by the system in process 1 → 2 → 3	(P)	$\frac{1}{3}RT_0\ \ln 2$
(II)	Change in internal energy in process 1 → 2 → 3	(Q)	$\frac{1}{3}RT_0$
(III)	Heat absorbed by the system in process 1 → 2 → 3	(R)	RT_0
(IV)	Heat absorbed by the system in process 1 → 2	(S)	$\frac{4}{3}RT_0$
		(T)	$\frac{1}{3}RT_0\left(3+\ln 2\right)$
		(U)	$\frac{5}{6}RT_0$

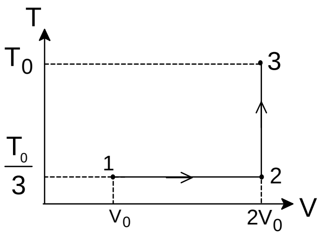
9. If the process carried out on one mole of monatomic ideal gas is as shown in figure in the PV diagram with $P_0V_0 = \frac{1}{3}RT_0$. The correct match is



(A) I – Q, II – S, III – R, IV – U
(B) I – S, II – R, III – Q, IV – T
(C) I – Q, II – R, III – P, IV – U
(D) I – Q, II – R, III – S, IV – U

Space for Rough work

10. If the process carried out on one mole of monatomic ideal gas is as shown in the TV – diagram with $P_0V_0 = \frac{1}{3}RT_0$. The correct match is



(A) $I-P, II-R, III-T, IV-P$
(B) $I-P, II-R, III-T, IV-S$
(C) $I-S, II-T, III-Q, IV-U$
(D) $I-P, II-T, III-Q, IV-T$

Answer the following by appropriately matching the list based on the information given in the paragraph.

A musical instrument is made using four different metal strings, 1, 2, 3 and 4 with mass per unit length μ, 2μ, 3μ and 4μ respectively. The instrument is played by vibrating the strings by varying the free length in between the range L_0 and $2L_0$. It is found that in string-1 (μ) at free length L_0 and tension T_0 the fundamental mode frequency is f_0.
List-I gives the above four strings while list-II lists the magnitude of some quantity.

	List – I		**List - II**
(I)	String – 1 (μ)	(P)	1
(II)	String – 2 (2μ)	(Q)	½
(III)	String – 3 (3μ)	(R)	$1/\sqrt{2}$
(IV)	String - 4 (4μ)	(S)	$1/\sqrt{3}$
		(T)	3/16
		(U)	1/16

11. If the tension in each string is T_0, the correct match for the highest fundamental frequency in f_0 units will be
(A) I – Q, II – S, III – R, IV – P
(B) I – P, II – R, III – S, IV – Q
(C) I – P, II – Q, III – T, IV – S
(D) I – Q, II – P, III – R, IV – T

Space for Rough work

12. The length of the strings 1,2,3 and 4 are kept fixed at L_0, $\frac{3L_0}{2}$, $\frac{5L_0}{4}$ and $\frac{7L_0}{4}$, respectively. Strings 1,2,3 and 4 are vibrated at their 1st, 3rd, 5th and 14th harmonics, respectively such that all the strings have same frequency. The correct match for the tension in the four strings in the units of T_0 will be

(A) I – P, II – R, III – T, IV– U
(B) I – P, II – Q, III – T, IV – U
(C) I – T, II – Q, III – R, IV – U
(D) I – P, II – Q, III – R, IV – T

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded - off to the **second decimal place**; e.g. XXXXX.XX).

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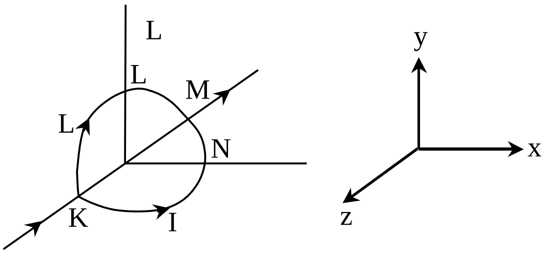
13. A circular loop of radius *R* is bent along a diameter and given a shape as shown in the figure. One of the semicircles (KNM) lies in the *x*-*z* plane and the other one (KLM) in the *y*-*z* plane with their centres at the origin. Current I is flowing through each of the semi circles as shown in figure.
A particle of charge *q* is released at the origin with a velocity $\vec{v} = v_0\hat{i}$.

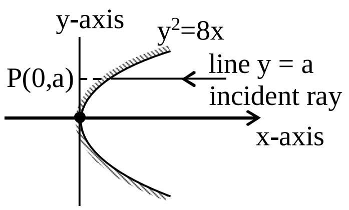


Find the magnitude of instantaneous force $\vec{F}$ on the particle if $\mu_0 q v_0 I = 8R$. Assume that space is gravity free.

14. The electric potential between a proton and an electron is given by, $V = V_0 \ln\left(\frac{r}{r_0}\right)$ where V_0 and r_0 are constants and *r* is the radius of the electron orbit around the proton. Assuming Bohr's model to be applicable, it is found that *r* is proportional to n^x, where *n* is the principal quantum number. Find the value of *x*.

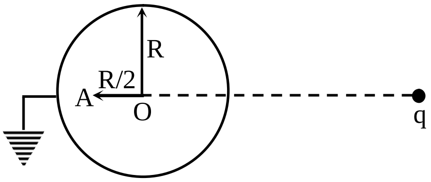
Space for Rough work

15. Figure shows a parabolic reflector in x-y plane given by $y^2 = 8x$. A ray of light traveling along the line y = a is incident on the reflector. Find where the ray intersects the x-axis after reflection.

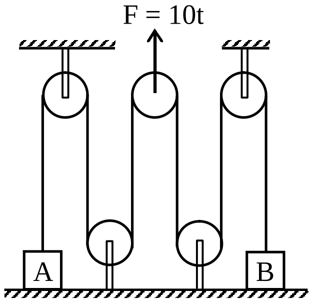


16. A hydrogen like atom (atomic number Z) is in a higher excited state of quantum number n. This excited atom can make a transition to the first excited state by successively emitting two photons of energies 10.20 eV and 17.00 eV respectively. Alternatively, the atom from the same excited state can make a transition to the second excited state by successively emitting two photons of energies 4.25 eV and 5.95 eV respectively. Determine the value of Z. (Ionisation energy of hydrogen atom is 13.6 eV).

17. A point charge q is placed at a distance 3R from the centre of a earthed conducting shell of radius R as shown in figure
Then find magnitude electric potential at point A, R/2 distance away centre, due to charge induce on the shell. If $q = 28\pi\varepsilon_0 R$.



18. In the arrangement shown $m_A = 1$ kg and $m_B = 2$ kg while all the pulleys & strings are massless & frictionless. At *t* = 0, a force *F* = 10 t starts acting over central pulley in vertical direction. When *B* loses contact with floor the velocity of *A* is (5n) m/sec. Find out the value of '*n*'.



Space for Rough work

Chemistry PART – II

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. For the reaction: $A + B \longrightarrow \text{Product}$; following data is given

Expt. No.	**[A]**	**[B]**	**Rate(M/sec)**
1	0.02 M	0.03 M	4×10^{-3}
2	0.04 M	0.06 M	1.6×10^{-2}
3	0.01 M	0.06 M	4×10^{-3}

Which of the following is correct?
(A) Given reaction may be elementary
(B) The value of rate constant is 6.67 $M^{-1}sec^{-1}$
(C) Given reaction may be complex
(D) If volume of container is doubled in first experiment, rate becomes 10^{-3} M/sec

20. Which of the following statement(s) is(are) correct regarding $H_4P_2O_6$?
(A) It contains P-P linkage
(B) It contains P-O-P linkage
(C) Its basicity may be 3
(D) The number of $p\pi - d\pi$ bonds = 2

21. Select the correct statement(s).
(A) The total number of Bravais lattice in 2-D crystal system is 5
(B) A cubic system contains 9 plane of symmetry
(C) For monoclinic system, $a \neq b \neq c$ and $\alpha \neq \beta \neq \gamma \neq 90^0$
(D) The packing fraction of BCC is 52%

22. A quantity of 720 gm water is added in 230 gm ethanol at a certain temperature to get 1 L of solution. Which of the following is/are correct regarding the solution formed?
(A) The density of solution is 950 kg/m^3
(B) The mole fraction of ethanol is 0.11
(C) The molarity of solution is 5 M
(D) The molality of solution is 6.94 m

Space for Rough work

23. The correct statement(s) for the following addition reaction is(are)

(i) $\text{Trans}-2-\text{butene}\xrightarrow{Br_2/CHCl_3}\text{M and N}$

(ii) $\text{Cis}-2-\text{butene}\xrightarrow{Br_2/CHCl_3}\text{O and P}$

(A) (**M** and **O**) and (**N** and **P**) are two pairs of enantiomers
(B) Bromination proceeds through trans-addition in both the reactions
(C) **O** and **P** are identical molecules
(D) (**M** and **O**) and (**N** and **P**) are two pairs of diastereomers

24. Which of the following are not redox reactions

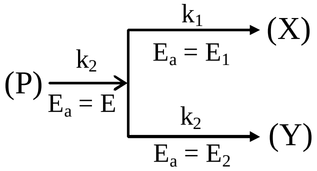
(A) $Mg + N_2 \longrightarrow Mg_3N_2$

(B) $K_4[Fe(CN)_6] + H_2SO_4 + H_2O \longrightarrow K_2SO_4 + CO + FeSO_4 + (NH_4)_2SO_4$

(C) $I_2 + 3Cl_2 \longrightarrow ICl_3$

(D) $CuSO_4 + NH_3 \longrightarrow [Cu(NH_3)_4]SO_4$

25. Consider a parallel reaction,



Which of the following statement(s) is/are true?

(A) When both the reactions are of 1st order, $\frac{k_1}{k_2}=\frac{[X]}{[Y]}$

(B) $\frac{k_1}{k_2}=\frac{[X]}{[Y]}$ is true for all parallel path reactions irrespective of their order.

(C) The overall energy of activation is given by $E=\frac{k_1E_1+k_2E_2}{E_1+E_2}$, if the two parallel reactions are of same order.

(D) For first order reaction, the plot of $\ln t_{1/2}$ vs $1/T$ is a straight line and slope of the line is equal to E/R (where R is gas constant).

26. By passing 1F of electricity

(A) 1 mol of Zn deposited
(B) 12 g of Mg deposited
(C) 1/3 mol of Al deposited
(D) 11.2 L of O_2 at NTP evolved

Space for Rough work

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

Match the solutions obtained by mixing different volumes of equimolar acid HA and base BOH given in list–I with the rise in temperature given in list–II if the solution obtained by mixing 10 ml each of the same acid and base shows an elevation in temperature of 5°C.

LIST - I		LIST - II (Rise in temperature)	
(I)	100 ml of HA + 100 ml of BOH	**P.**	5°C
(II)	10 ml of HA + 20 ml of BOH	**Q.**	4°C
(III)	20 ml of HA + 30 ml of BOH	**R.**	3.3°C
(IV)	50 ml of HA + 150 ml of BOH	**S.**	0.66°C
		T.	2.5°C
		U.	2.6°C

27. Which of following is correct combination.
(A) I – P & II – R
(B) II – P & III – R
(C) III – S & I – P
(D) IV – P & I – Q

28. Which of following is incorrect combination.
(A) I – P & III – Q
(B) I – P & II – R
(C) III – Q & IV – T
(D) III – S & IV – Q

Space for Rough work

Answer the following by appropriately matching the list based on the information given in the paragraph.

LIST - I	LIST - II
(I) $\underset{5\text{ ml }1\text{N}}{CH_3COOH} + \underset{5\text{ ml }1\text{N}}{NaOH}$	**P.** pH > 7
(II) $\underset{15\text{ ml }1\text{N}}{CH_3COOH} + \underset{10\text{ ml }1\text{N}}{NaOH}$	**Q.** pH < 7
(III) $\underset{5\text{ ml }1\text{N}}{HCl} + \underset{15\text{ ml }1\text{N}}{NH_4OH}$	**R.** Buffer
(IV) $\underset{1\text{ ml }1\text{N}}{HCl} + \underset{1\text{ ml }2\text{N}}{NaOH}$	**S.** Hydrolysis occurs
	T. pH < 8
	U. pH > 8

29. Which of following is correct combination
(A) I – P & II – Q, R
(B) II – P, R & III – Q
(C) III – S & I – P
(D) IV – P & I – Q

30. Which of following is incorrect combination.
(A) I – P & III – R
(B) I – P & II – R
(C) II – Q & III – Q
(D) I – P & IV – P

Space for Rough work

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded - off to the **second decimal place**; e.g. XXXXX.XX).

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31. 8 gm of methane is burnt with 4.48L of O_2 at STP. Find out the volume of CO_2 gas produced at STP and also the weight of CO_2 gas.

32. The pK_a of the carboxyl group in an amino acid valine, $(CH_3)_2CHCH(NH_2)(COOH)$ is 2.31 and the pK_a for the amino group of the same amino acid is 9.69. Compute the isolectric point (pH_i) for valine and draw the structure of this amino acid when the pH of the solution equals to pH_i. Also draw the structures of valine that predominate at pH=2 and pOH= 2.

33. The relative rate of abstraction per hydrogen atom of 3°H, 2°H and 1°H of alkane during photo chlorination is 5.0 : 3.8 : 1. The percentage of the major product formed in the chlorination of 2,2–dimethyl butane is x% then the value of x is

34. What is the percent by mass of iodine needed to reduce the freezing point of benzene to 3.5°C? The freezing point and cryoscopic constant of pure benzene are 5.5°C and 5.12 K/m respectively.

35. A diatomic molecule has a dipole moment of 1.2D. If its bond distance is 1.0Å. What fraction of an electronic charge exist on each atom?

36. Calculate the standard e.m.f. of the reaction$Fe^{3+} + 3e^- \rightarrow Fe_{(s)}$ $\varepsilon_3^0 = ?$

    Given $Fe^{3+} + e^- \rightarrow Fe^{2+}$ $\varepsilon_1^0 = 0.771V$ $Fe^{2+} + 2e^- \rightarrow Fe_{(s)}$ $\varepsilon_2^0 = -0.44V$

Space for Rough work

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. f(x) = $\cos\pi\left(|x|+[x]\right)$, then

(A) f is continuous at x = 1/2
(B) f is continuous at x = 0
(C) f is differentiable in (-1, 0)
(D) f is differentiable in (0, 1)

38. Tangent are drawn to the circle $x^2+y^2=50$ from a point 'P' lying on the x – axis. These tangents meet the y – axis at points 'P_1' and 'P_2'. Possible coordinates of 'P' so that area of triangle PP_1P_2 is minimum, is/are

(A) (10, 0)
(B) $\left(10\sqrt{2},0\right)$
(C) (-10, 0)
(D) $\left(-10\sqrt{2},0\right)$

39. Two particle start from the same point (2, -1), one moving 2 units along the line x + y = 1 and the other 5 units along x – 2y = 4. If the particles move towards increasing y, then their new position will be

(A) $\left(2-\sqrt{2},\sqrt{2}-1\right)$
(B) $\left(2\sqrt{5}+2,\sqrt{5}-1\right)$
(C) $\left(2+\sqrt{2},\sqrt{2}+1\right)$
(D) $\left(2\sqrt{5}-2,\sqrt{5}-1\right)$

40. If $\frac{x}{a}+\frac{y}{b}=1$ is a tangent to the curve x = 4t, $y=\frac{4}{t}$, $t\in R$ then

(A) $a>0, b>0$
(B) $a>0, b<0$
(C) $a<0, b>0$
(D) $a<0, b<0$

Space for Rough work

41. All values of $x \in \left(0, \frac{\pi}{2}\right)$ such that $\frac{\sqrt{3}-1}{\sin x}+\frac{\sqrt{3}+1}{\cos x}=4\sqrt{2}$ are

(A) $\frac{\pi}{15}$
(B) $\frac{\pi}{12}$
(C) $\frac{11\pi}{36}$
(D) $\frac{3\pi}{10}$

42. Let a, b, c be distinct complex numbers with $|a|=|b|=|c|=1$ and z_1, z_2 be the roots of the equation $az^2+bz+c=0$ with $|z_1|=1$. Also let P and Q represents the complex numbers z_1 and z_2 in the complex plane with $\angle POQ=\theta$ where O is the origin then

(A) $b^2=ac, \theta=\frac{2\pi}{3}$
(B) $\theta=\frac{2\pi}{3}, PQ=\sqrt{3}$
(C) $b^2=ac, PQ=2\sqrt{3}$
(D) $2b^2=ac, \theta=\frac{\pi}{3}$

43. If the sum of the first 100 terms of an AP is -1 and the sum of the even terms lying in the first 100 terms is 1, then

(A) common difference is $\frac{3}{50}$
(B) first term is $\frac{149}{50}$
(C) common difference is $\frac{7}{50}$
(D) first term is $-\frac{151}{50}$

44. A line segment is divided so that the lesser part is to the greater part is equal to the greater part is to the whole. If R is the ratio of the lesser part of the greater part, then

(A) $R^2+R-1=0$
(B) $R^2+R^{-1}=2$
(C) $R^{\left(R^2+R^{-1}\right)}+R^{-1}=2$
(D) $R^2+R+1=0$

Space for Rough work

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

List – I		**List - II**	
(I)	Two sides of traingle are given by the roots of the equation $x^2 - 5x + 3 = 0$. If the angle between these sides is $\pi/3$, then the product of inradius and circumradius of the triangle is	**(P)**	12
(II)	In a triangle ABC, if the radii of ex – circles r_1, r_2 and r_3 are given by $r_1 = 8$, $r_2 = 12$ and $r_3 = 24$, then value of the side a is	**(Q)**	15
(III)	Let a be a positive integer not exceeding 10, then the probability that the equation $x^2 - 2(a^2 - 1)x + 2a^2 - 7a + 3 = 0$ has one positive and one negative roots is	**(R)**	$\frac{3}{7}$
(IV)	Let (α, β) be a point from which two perpendicular tangents can be drawn to the ellipse $4x^2 + 5y^2 = 20$. If $F = 4\alpha + 3\beta$, then the maximum value of F	**(S)**	$\frac{1}{5}$
		(T)	$\frac{2}{3}$
		(U)	$\frac{1}{3}$

45. Which of following is correct combination
(A) I – T & II – P
(B) II – P & III – R
(C) III – S & I – P
(D) IV – P & I – Q

Space for Rough work

46. Which of following is incorrect combination.
(A) I – Q & III – Q
(B) I – P & II – R
(C) III – Q & IV – P
(D) III – S & IV – Q

Answer the following by appropriately matching the list based on the information given in the paragraph.

List – I		**List - II**	
(I)	The coefficient of two consecutive terms in the expansion of $(1 + x)^n$ will be equal, then n can be	**(P)**	9
(II)	If $15^n + 23^n$ is divided by 19, then n can be	**(Q)**	10
(III)	${}^{10}C_0\ {}^{20}C_{10} - {}^{10}C_1\ {}^{16}C_{10} - \ldots\ldots.$is divisible by 2^n, then n can be	**(R)**	11
(IV)	If the coefficient of T_r, T_{r+1}, T_{r+2} terms of $(1 + x)^{14}$ are in A.P., then r is less than	**(S)**	12
		(T)	14
		(U)	16

47. Which of following is correct combination
(A) I – P & II – Q, R
(B) II – P, R & III – Q
(C) III – S & I – P
(D) IV – P & I – Q

48. Which of following is incorrect combination.
(A) I – Q & III – Q
(B) I – P & II – R
(C) I – P & IV – T
(D) II – Q & III – Q

Space for Rough work

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded ‐ off to the **second decimal place**; e.g. XXXXX.XX).

---

49. Given (2 + 6 + 10 + 14 + ……+ 2a) + (2 + 6 + 10 + 14 + ……….+ 2b) = (2 + 6 + 10 + 14 + ………+ 2c), where a + b + c = 21 and a > 6. Then a – b is equal to ____________.

50. Seven digit numbers are formed using digits 1, 2, 3, 4, 5, 6, 7, 8, 9 without repetition. The probability of selecting a number such that product of any 5 consecutive digits is divisible by either 5 or 7 is p. Then 12p is equal to __________.

51. If a singular matrix $A = \left[a_{ij}\right]_{2\times 2}$ always commute with $B = \begin{bmatrix} 1 & 1 \\ 2 & 1 \end{bmatrix}$ such that $\frac{a_{11}}{a_{12}} = \sqrt{k},$ then k is equal to___________.

52. If the function $f(x) = 2x^3 - 9ax^2 + 12a^2x + 1$ has a local maximum at $x = x_1$ and a local minimum at $x = x_2$ such that $x_2 = x_1^2,$ then a is equal to ______________.

53. If positive numbers x, y, z are in A.P, then the minimum value of $\frac{x+y}{2y-x} + \frac{y+z}{2y-z}$ is equal to____.

54. The number of odd proper divisors of 24300 is N + 11, then N is equal to _______________.

Space for Rough work

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VIII

JEE (Advanced)-2020

PAPER – 2

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. B

Sol. $a_m = 4\ a_M$

if $a_M = a$

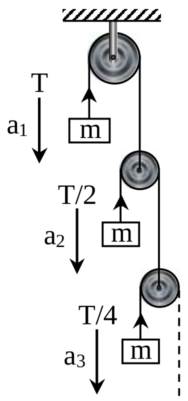
$a_m = 4\ a$

$= \sqrt{a^2 + (4a)^2 + 2(a)(4a)\cos(180 - \alpha)}$

$= a\sqrt{17 - 8\cos\alpha}$

2. B

Sol. Virtual power = 0



$-\ Ta_1 - \dfrac{T}{2}a_2 - \dfrac{T}{4}a_3 \ldots. = 0$

$a_1 + \dfrac{a_2}{2} + \dfrac{a_3}{4} + \ldots. = 0$

Newton second law

$mg - T = ma_1$

$a_1 = g - \dfrac{T}{m}$

$mg - \dfrac{T}{2} = ma_2$

$a_2 = g - \dfrac{T}{2m}$

$a_3 = g - \dfrac{T}{4m}$

put value of a_1a_2 ……. (1)

$$g + \frac{g}{2} + \frac{g}{4} + \ldots \infty = \frac{T}{m}\left[1 + \frac{1}{4} + \frac{1}{16} + \ldots\infty\right]$$

$$T = \frac{3mg}{2} \quad \therefore a_1 = g - 1.5\,g = -\frac{g}{2}$$

3. C

Sol. $\Delta Q = \frac{dh}{dt} = \left(\frac{27}{L}\right)K \times \frac{1}{9} = \frac{3K}{L}\,J/\sec$

First law of thermodynamic for the cylinder

$$\frac{dQ}{dt} = \frac{dW}{dt} + \frac{dU}{dt}$$

as T = constant, $\frac{dU}{dt} = 0$

$$\therefore \frac{3V}{L} = P\frac{dV}{dt}$$

$$P \times \frac{L}{2}A = 0.5 \times R \times 300$$

$$P = \frac{300R}{LA}$$

$$\frac{3K}{L} = \frac{300R}{L}9 \times \frac{dV}{dt}$$

$$\frac{3K}{L} = \frac{300R}{L} \times 9 \times A\frac{dL}{dt}$$

$$\frac{dL}{dt} = V = \frac{K}{100R}$$

4. B

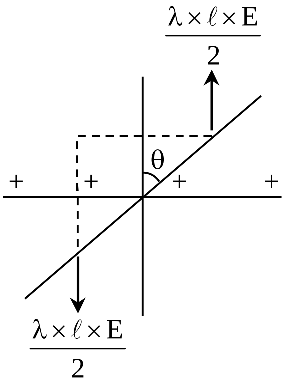
Sol. $\tau = I\alpha$

$$\frac{\lambda\ell \times E}{2} \times \frac{\ell}{2}\sin\theta = \frac{M\ell^2}{12} \times \alpha$$

$$\alpha = -\frac{3\lambda E}{M}\theta$$

$$\omega = \sqrt{\frac{3\lambda E}{m}}$$

$$T = \frac{2\pi\sqrt{m}}{\sqrt{3\lambda E}} = 2\pi\sqrt{\frac{m \times 2\epsilon_0}{3\lambda\sigma}}$$


$\frac{\lambda \times \ell \times E}{2}$
θ
+
+
+
+
$\frac{\lambda \times \ell \times E}{2}$

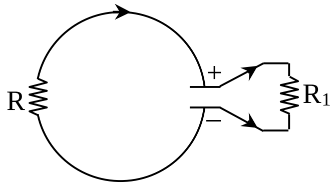
5. A

Sol. $e = -\pi a^2 \frac{dB}{dt} = \pi a^2 k$

$a = Ce = q\pi a^2 k$

B decreasing

∴ induced current is clockwise.

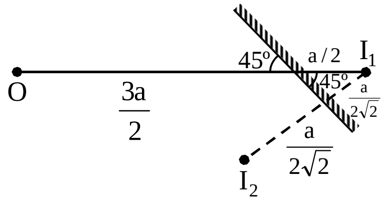


6. C

Sol. Through lens, the image of 'O' will be formed at distance a behind the lens on the principle axis itself and it will behave as virtual object for plane mirror and $\frac{a}{2}$ behind the mirror

So, the separation between O and I_2 is

$$\sqrt{\left(\frac{3a}{2}\right)^2+\left(\frac{a}{2}\right)^2}=\frac{\sqrt{10}a}{2}$$



7. ABCD

Sol. Equilibrium of piston gives

$PS = kx_0$ or $P = \frac{kx_0}{S}$

Since, the chamber is thermally insulated

$$\Delta Q = 0$$

$\therefore$ Elastic potential energy of spring

= work done by gas

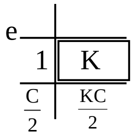
or work done by gas $= \frac{1}{2}kx_0^2$

This work is done in the expense of internal energy of the gas. Therefore, internal energy of the gas is decreased by $\frac{1}{2}kx_0^2$.

Internal energy of an ideal gas depends on its temperature only. Internal energy of the gas is decreasing. Therefore, temperature of the gas will decrease.

8. ABC

Sol. V remain same as capacitor is connected with battery charge on C = C'V



$C_{eq} = \frac{C}{2}+\frac{KC}{2}=\frac{(K+1)C}{2}$

Charge on C = $\frac{(K+1)}{2}CV$

energy stored in C when slab is

half filled = $\frac{1}{2}C'V^2 = \frac{1}{2}\frac{(K+1)C}{2}V^2$

Total work done = KE – 0

$W_{\text{by battery}} + T \times \frac{\ell}{2} + W \text{ by } F_{\text{electric}} = KE$

$W_{\text{by battery}} + T \times \frac{\ell}{2} - \left[\frac{1}{2}C'V^2 - \frac{1}{2}CV^2\right] = KE$

$W_{\text{by battery}} + T \times \frac{\ell}{2} - \frac{1}{2}V^2\left[\frac{(K+1)}{2}C - KC\right]$

$W_{\text{by battery}} + T \times \frac{\ell}{2} - \frac{1}{2}V^2\frac{[1-K]C}{2} = KE$

$W_{\text{by battery}} = (Q_t - Q_i) \times V$

$= \left[\frac{(K+1)CV}{2} - CV\right]V = \frac{[K-1]}{2}CV^2$

Mg – T = Ma

T = Ma

T = $\frac{mg}{2}$

$\frac{[1-K]CV^2}{2} - \frac{1}{4}CV^2[K-1] + \frac{mg\ell}{4} = KE$

$$KE = \frac{mg\ell}{4} - \frac{CV^2(K-1)}{8}$$

9. D

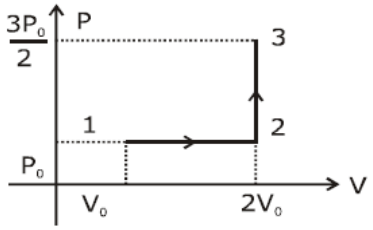
Sol. I→Q; II→R; III→S; IV→U

$$X = \frac{3}{2}R \ \ell n\frac{T}{T_A} + R\ell n\frac{V}{V_A}$$

$$dx = \frac{3}{2}R\frac{1}{T}dT + \frac{R}{V}dv$$

$$d\theta = Tdx$$

$$d\theta = \frac{3}{2}RdT + \frac{RT}{V}dv$$



$$\int dQ = \int \frac{3}{2}RdT + \int_{V_0}^{2V_0} \int \frac{RT}{V}dv$$

$$\text{(iv)} \ Q_{1\to 2} = \int \frac{3}{2}RdT + \int_{V_0}^{2V_0} \frac{RT}{V}dv$$

$$Q = \frac{3}{2}R\int_{\frac{2T_0}{3}}^{T_0} dT + \int pdv$$

$$Q = \frac{3}{2}R\frac{T_0}{3} + P_0V_0$$

$$Q_{1\to 2} = \frac{RT_0}{2} + \frac{RT_0}{3} = \frac{5}{6}RT_0 \quad \{\because P_0V_0 = \frac{RT_0}{3}$$

$$\text{(iii)} \ Q_{2\to 3} = \int_{\frac{2T_0}{3}}^{T_0} \frac{3}{2}RdT + 0$$

$$Q_{2\to 3} = \frac{RT_0}{2}$$

$$Q_{1\to 3} = \frac{5}{6}RT_0 + \frac{RT_0}{2} = \frac{4}{3}RT_0$$

$$\text{(ii)} \ \Delta u = \frac{f}{2}nR\Delta T = \frac{3}{2}R\frac{2T_0}{3} = RT_0$$

$$\text{(1)} \ dq = dw + du$$

$$dw = dq - du$$

$$w = \frac{4}{3}RT_0 - RT_0$$

$$W = \frac{RT_0}{3}$$

10. A

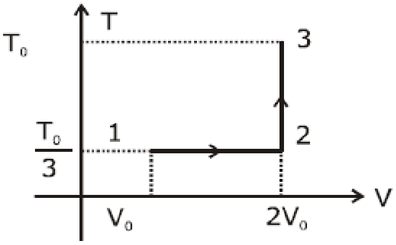
Sol. I→P; II→R; III→T; IV→P

$$X = \frac{3}{2}R \ \ell n\frac{T}{T_A} + R\ell n\frac{V}{V_A}$$

$$dx = \frac{3}{2}R\frac{1}{T}dt + \frac{R}{V}dv$$

$$dQ = Tdx$$

$$dQ = \frac{3}{2}RdT + \frac{RT}{V}dv$$



$$\text{(iv)} \ \int dQ = \int \frac{3}{2}Rdt + \int \frac{RT}{V}dv$$

$$Q = 0 + \frac{RT_0}{3}(\ell nv)_{v_0}^{2v_0}$$

$$Q_{1\to2} = \frac{RT_0}{3}\ell n2$$

$$\text{(iii)} \ Q_{2\to3} = \int_{\frac{T_0}{3}}^{T_0}\frac{3}{2}Rdt + 0 = \frac{3}{2}Rto\frac{2}{3} = RT_0$$

$$Q_{1\to3} = Q_{1\to2} + Q_{2\to3}$$

$$= \frac{RT_0}{3}(3 + \ell n2)$$

(ii) Change in internal energy

$$\Delta u = \frac{f}{2}nR\Delta t$$

$$\Delta u = \frac{3}{2}R\left(T_0 - \frac{T_0}{3}\right)$$

$$\Delta u = RT_0$$

$$\text{(i)} \ dq = dw + \Delta u$$

$$dw = dq - \Delta u$$

$$= \frac{1}{3}RT_0\ell n2$$

11. B

Sol. Fundamental frequency f_0 = $f_0 = \frac{1}{2L_0}\sqrt{\frac{T_0}{u}} \rightarrow (1)$

Ist string $f_1 = \frac{1}{2\ell_0}\sqrt{\frac{T_0}{\mu}}$

$f_1 = f_0$

IInd string $f_2 = \frac{1}{2L_0}\sqrt{\frac{T_0}{2\mu}}$

$f_2 = \frac{1}{\sqrt{2}}f_0$

IIIrd string

$f_3 = \frac{1}{2L_0}\sqrt{\frac{T_0}{3\mu}}$

$f_3 = \frac{1}{\sqrt{3}}f_0$

IVth string

$f_4 = \frac{1}{2L_0}\sqrt{\frac{T_0}{4\mu}}$

$f_4 = \frac{1}{2}f_0$

12. B

Sol. I→P; II→Q;III→T; IV→U

fundamental frequency

$f_0 = \frac{1}{2\ell}\sqrt{\frac{T_0}{\mu}}$

I^{st} string → 1 st harmonic

$f_1 = \frac{1`}{2\ell}\sqrt{\frac{T_0}{\mu}}$

$f_1 = f_0$

so $\Rightarrow T_1 = T_0$

II^{nd} string → IIIrd Harmonic

$\ell = \frac{3\ell_0}{2}$

$f_2 = 3\times\frac{1}{2\times\frac{3\ell_0}{2}}\sqrt{\frac{T_2}{2\mu}} = \frac{1}{\ell_0}\sqrt{\frac{T_2}{2\mu}}$

$\because f_2 = f_0$

So $T_2 = \frac{T_0}{2}$

IIIrd string

$\ell = \frac{5\ell_0}{4}$ → Fifth harmonic

$$f_3 = 5 \times \frac{1}{2 \times \frac{5\ell_0}{4}} \times \sqrt{\frac{T_3}{3\mu}}$$

$$f_3 = \frac{2}{\ell_0}\sqrt{\frac{T_3}{3\mu}}$$

$\because f_3 = f_0$

$$\frac{2}{\ell_0}\sqrt{\frac{T_3}{3\mu}} = \frac{1}{2}\sqrt{\frac{T_0}{\mu}}$$

$T_3 = \frac{3T_0}{16}$

IVth streing → IV harmonic

$$f_4 = 14 \times \frac{1}{\frac{2 \times 7\ell_0}{4}}\sqrt{\frac{T_4}{4\mu}}$$

$$f_4 = \frac{4}{\mu_0}\sqrt{\frac{T}{4\mu}}$$

$f_4 = f_0$

$T_4 = \frac{T_0}{16}$

SECTION – C

13. 00002.00

Sol. Magnetic field ($\vec{B}$) at the origin = Magnetic field due to semicircle KLM + magnetic field due to other semicircle KNM.

Therefore, $\vec{B} = \frac{\mu_0 I}{4R}(-\hat{i}) + \frac{\mu_0 I}{4R}(\hat{j})$

$$\Rightarrow \quad \vec{B} = \frac{\mu_0 I}{4R}\hat{i} + \frac{\mu_0 I}{4R}\hat{j} = \frac{\mu_0 I}{4R}(-\hat{i} + \hat{j})$$

[$\vec{B}$ due to a circular current carrying loop is $\frac{\mu_0 I}{2R}$

$\therefore$ For semicircle it is half]

Therefore, magnetic force acting on the particle.

$$\vec{F} = q(\vec{v}\times\vec{B}) = q\left\{(-v_0\hat{i})\times(-\hat{i}+\hat{j})\times\frac{\mu_0 I}{4R}\right\}$$

$$= \frac{-\mu_0 q v_0 I}{4R}\hat{k}$$

$$\therefore |\vec{F}| = \frac{\mu_0 q v_0 I}{4R} = \frac{8R}{4R} = 2 \text{ units}$$

14. 00001.00

Sol. $\mu = eV$

$$F = \frac{d\mu}{dr}$$

$$\Rightarrow \frac{d}{dr}\,(v_0)\log\left(\frac{r}{r_0}\right)$$

$$F = \frac{v_0}{r}\,.\,r_0 = \frac{mv^2}{r}$$

v = constant

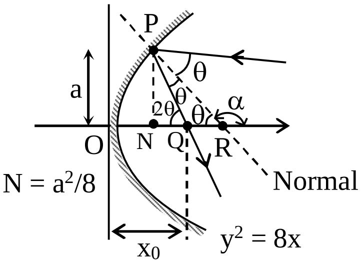
$$mvr = \frac{nh}{2\pi}$$

$r \propto n$

15. 00002.00

Sol. In ΔPNQ

$$\tan 2\theta = \frac{a}{\left(x_0 - \frac{a^2}{8}\right)} \qquad \ldots\text{(i)}$$



$y^2 = 8x$

$$\frac{dy}{dx} = \frac{4}{y}$$

at P $y = a$

$$\frac{dy}{dx} = \frac{4}{a} = \tan(90^o - \theta)$$

or $\boxed{\tan\theta = \frac{a}{4}}$ …(ii)

eq.(i) and (ii)

$x_0 = 2$

16. 00003.00

Sol. We have

$$E = 13.6\,Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \text{ (in eV)}$$

$$10.2 + 17 = 13.6\,Z^2\left(\frac{1}{2^2} - \frac{1}{n^2}\right) \quad \ldots\text{(i)}$$

and

$$4.25 + 5.95 = 13.6\,Z^2\left(\frac{1}{3^2} - \frac{1}{n^2}\right) \quad \ldots\text{(ii)}$$

from (i) & (ii)

$\boxed{n = 6}$ and $\boxed{Z = 3}$

17. 00002.00

Sol. At A

$V_A = 0$

Ie

$V_{\text{due to q}} + V_{\text{induced}} = 0$

$$\frac{1}{4\pi\varepsilon_0}\frac{q}{(3.5R)} + V_{induced} = 0$$

$$V_{induced} = \frac{28\pi\varepsilon_0 R}{14\pi\varepsilon_0 R} = 2$$

18. 00002.00

Sol. 10 t = 2T

T = 5t

Block A will lose the contact at $5t_1 = m_A g$,

$t_1 = 2$ sec.

Block B will lose the contact at $5t_2 = m_B g$

$t_2 = 4$ sec

For Block A between the two events,

$$5t - m_A g = m_A \frac{dv}{dt}$$

$$\int_2^4 (5t - 10)\,dt = \int_0^v dv$$

v = 10 m/sec

Chemistry

PART – II

SECTION – A

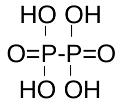
19. ABCD

Sol. Let, $r = k[A]^x[B]^y$

from the given data, $x = 1$ & $y = 1$

20. ACD

Sol. The structural formula of $H_4P_2O_6$(Hypophosphoric acid) is



$$\begin{array}{c} HO\ \ OH \\ |\quad\ | \\ O=P-P=O \\ |\quad\ | \\ HO\ \ OH \end{array}$$

21. AB

Sol. The five Bravais lattices in 2-D are: oblique (monoclinic), rectangular (orthorhombic), cantered rectangular (orthorhombic), hexagonal, square (tetragonal)

A cube has nine plane of symmetry. Three of the planes run parallel to the faces of the cube, and the other six run diagonally from one edge to the opposite edge.

For monoclinic system, $a \neq b \neq c$ and $\alpha = \gamma = 90^0, \beta \neq 120^0$

The packing fraction of BCC is 68%

22. ABCD

Sol. Apply the formula to get answers

23. BD

Sol. (i) $\text{Trans}-2-\text{butene} \xrightarrow{Br_2/CHCl_3} 2,3-\text{Dibromobutane(Meso compounds)}$

(ii) $\text{Cis}-2-\text{butene} \xrightarrow{Br_2/CHCl_3} 2,3-\text{Dibromobutane(Pair of enantiomers)}$

Bromination proceeds through trans – addition in both the reactions

24. BD

Sol. $K_4[Fe(CN)_6] + H_2SO_4 + H_2O \longrightarrow K_2SO_4 + CO + FeSO_4 + (NH_4)_2SO_4$

$CuSO_4 + NH_3 \longrightarrow [Cu(NH_3)_4]SO_4$

25. ACD

Sol. The ratio of $\frac{[X]}{[Y]}$ is a constant equal to $\frac{k_1}{k_2}$, only when order is same for both parallel reactions.

The overall energy of activation, $E = \frac{k_1E_1 + k_2E_2}{k_1 + k_2}$.

For parallel first order reaction, ln $t_{1/2} = \ln\left(\frac{0.693}{A}\right) + \frac{E}{R}\left(\frac{1}{T}\right)$.

26. BC

Sol. $Zn^{2+} + 2e^- \longrightarrow Zn(s)$ (1 F $\longrightarrow$ 65/2 g)

$Mg^{2+} + 2e^- \longrightarrow Mg(s)$ (1 F $\longrightarrow$ 24/2 g)

$Al^{3+} + 3e^- \longrightarrow Al(s)$ (1 F $\longrightarrow$ 27/3 g)

•• ••

$10H^- \longrightarrow H_2O + ½O_2 + Ze^-$ (1 F $\longrightarrow$ 8 g)

27. A

28. D

Sol. **(for Q. 27 & 28)**

$Q = mS\Delta T$

$$\Delta T \propto \frac{Q}{m}$$

$$\frac{\Delta T_1}{\Delta T_2} = \frac{(Q/m)_1}{(Q/m)_2}$$

$$HA + BOH \longrightarrow BA + H_2O$$

	HA	BOH
Milliequivalent	10	10
	–	–

When $\frac{Q}{m} = \frac{10\times10^{-3}\Delta Hneut}{20\times10^{-3}} = \frac{\Delta Hneut}{2}, \Delta T = 5°$ C

In (A) when $\frac{Q}{M} = \frac{100\Delta Hneu}{200} = \frac{\Delta Hneut}{2}, \Delta T = 5°$ C

In (B) $\frac{Q}{M} = \frac{10\Delta Hneut}{30} = \frac{\Delta Hneut}{3}$, $\Delta T' = ?$

$$\frac{\Delta T'}{5} = \frac{\frac{\Delta Hneut}{3}}{\frac{\Delta Hneut}{2}} = \frac{2}{3} \qquad \Delta T' = \frac{10}{3} = 3.3\,°C$$

In (C) $\frac{Q}{M} = \frac{20\Delta Hneu}{50} = \frac{2}{5}\Delta Hneu$ $\quad \Delta T'' = ?$ $\quad \frac{\Delta T''}{5} = \frac{\frac{2}{5}}{\frac{1}{2}} = \frac{4}{5}$ $\quad \Delta T'' = 4°C$

In (D) $\frac{\Delta T}{5} = \frac{\frac{50\times\Delta Hneu}{200}}{\Delta Hneu/2}$ $\quad \Delta T = 2.5°C$

[Ans:- (I) – P ; (II) – R ; (III) – Q ; (IV) – T]

29. A

30. C

Sol. **(for Q.29 & 30)**

In (A) $\quad pH = 7 + \frac{1}{2}pKa + \frac{1}{2}\log C = 7 + \frac{5}{2} + \frac{1}{2}\log\frac{5}{10} = 7 + 2.5 + \frac{1}{2}(-0.3010) = 9.34$

In (B) $\quad$ Since acid is left along with salt, we have a buffer $pH = 5 + \log\frac{10}{5} < 7$

In (C) $\quad pOH = 5 + \log\frac{5}{10} = 5 - 0.3010 = 4.699$

[Ans:- (I) – P, S ; (II) – Q, R ; (III) – P, R ; (IV) – P]

SECTION – C

31. 00004.40

Sol. The balanced chemical equation is

CH_4	+	$2O_2 \longrightarrow$	CO_2	+	$2H_2O$
1 mol		2 mol	1 mol		
16 gm		2 × 22.4 L	22.4 L		
			44 gm		

No. of moles of CH_4 = $\frac{8}{16} = 0.5\,\text{mol}$

No. of moles of O_2 = $\frac{4.48\text{L}}{22.4\text{L}} = 0.2\text{mol}$

Now since 1 mole of CH_4 requires 2 mol (i.e. 44.8 L) of O_2 for complete combustion. But the given moles of O_2 is only 0.2 mol. So, O_2 is the limiting reagent.

Again, since 2 moles of O_2 reacts with 1 mol of CH_4 to give 22.4 L of CO_2 at STP.

So 0.2 mole of O_2 will react with 0.1 mol of CH_4 to give 2.24 L of CO_2.

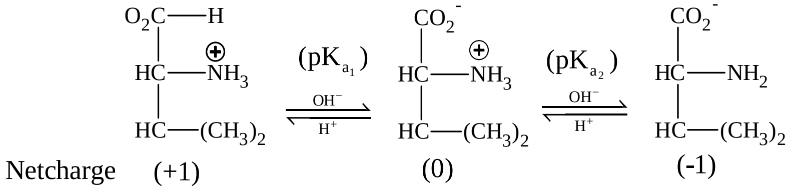
Wt. of CO_2 produced = 0.1 mol × 44 = 4.4 gms of CO_2

32. 00006.00

Sol. The isoelectric point (pH_i) is the pH at which the amino acid exists only as a dipolar ion with net charge zero.

At isoelectric point, for a neutral amino acid, $pH_i = \frac{\left(pK_{a_1} + pK_{a_2}\right)}{2}$

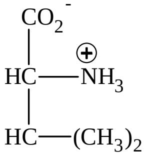
The dissociation of cationic form of valine can be represented as



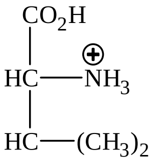
The species with zero net charge exists between species with (+1) and (–1) net charges.

$$pH_i = \frac{\left(pK_{a_1} + pK_{a_2}\right)}{2} = \frac{9.69 + 2.31}{2} = 6$$

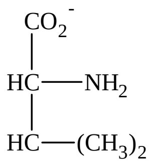
When the pH of the solution equals to pH_i, the structure of valine is



When the pH of the solution is two, the structure of valine is

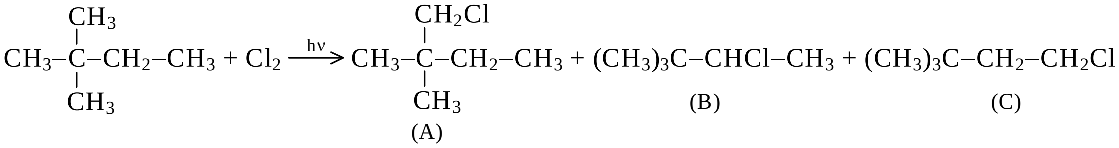


When the pH of the solution is 12, the structure of valine is



33. 00046.00

Sol. Photochlorination of 2,2–dimethylbutane gives three products as shown below



$$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-CH_2-CH_3 + Cl_2 \xrightarrow{h\nu} \underset{(A)}{CH_3-\underset{CH_3}{\overset{CH_2Cl}{C}}-CH_2-CH_3} + \underset{(B)}{(CH_3)_3C-CHCl-CH_3} + \underset{(C)}{(CH_3)_3C-CH_2-CH_2Cl}$$

	Reactivity factor		Probability factor		Number of parts
(A) :	1	×	9	=	9
(B) :	3.8	×	2	=	7.6
(C) :	1	×	3	=	3
			Total number of parts	=	19.6

The compound is the major product. Its percentage is given by

Percentage of (A) = $\frac{9 \times 100}{19.6}$ = 45.9 ≃ **46%**.

34. 00009.01

Sol. $\Delta T_f = T_f^0 - T_f = K\cdot m$

5.5°C – 3.5°C = 5.12 K/m × m

$$m = \frac{2}{5.12} = 0.39m$$

∴ Mass of iodine needed for 1000g of benzene = m × molecular mass of iodine I_2

= 0.39 mol/kg × 254 g/mol = 99.06 g/kg

∴ 1000g + 99.06g solution contains 99.06g I_2

100g solution contains $\frac{99.06g \times 100}{1099.06g} = 9.01\%$

35. 00000.25

Sol. Dipole moment for a diatomic molecule (μ) = e × d

∴ electronic charge = $\frac{\mu}{d} = \frac{1.2 \times 10^{-18}\,\text{esu.cm}}{1.0 \times 10^{-8}\,\text{cm}}$ = 1.2×10^{-10} esu

∴ fraction of electronic charge = $\frac{1.2 \times 10^{-10}}{4.8 \times 10^{-10}}$ = 0.25

36. 00000.03

Sol. With the help of calculation of free energy

$$\Delta G_1^0 = -nF\varepsilon^0 = -(1)(F)(0.771V) = -0.771V$$

$$\Delta G_2^0 = -(2)(F)(0.44) = 0.88FV$$

$$\Delta G_3^0 = -(3)(F)(\varepsilon^0) = -3Fe^0V$$

The free energy change for the unknown process can be obtained as

$$\Delta G_3^0 = \Delta G_1^0 + \Delta G_2^0$$

$$-3F\varepsilon^0 = -0.771F + 0.88F = 0.109F$$

or $\varepsilon^0 = -\frac{0.109}{3} = -0.036V$

Mathematics PART – III

SECTION – A

37. ACD

Sol. $f(x) = \cos\pi\left(|x| + [x]\right)$

$f(0) = 1. f(0-0) = \cos\pi(-1) = -1$

$f(1/2) = \cos\pi\left(\frac{1}{2}\right) = 0,\ f\left(\frac{1}{2}, 0\right)\cos\pi\left(\frac{1}{2}\right) = 0$

$f\left(\frac{1}{2} + 0\right) = \cos\frac{\pi}{2} = 0$

for $x \in (0, 1)\, f(x) = \cos\pi x$

for $x \in (-1, 0)\, f(x) = \cos\pi(-x-1) = -\cos\pi x$

38. AC

Sol. $OP = 5\sqrt{2}\ \sec\theta$

$OP_1 = 5\sqrt{2}\ \operatorname{cosec}\theta$

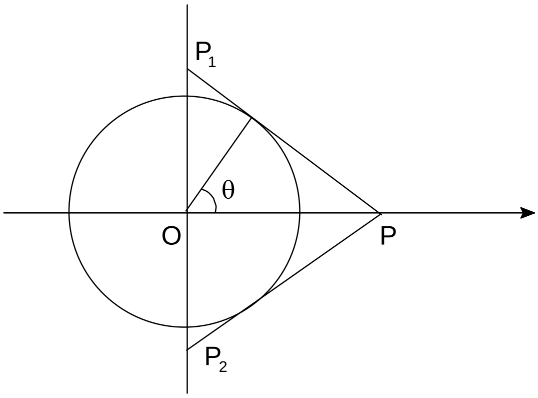
$\Delta PP_1P_2 = \frac{100}{\sin 2\theta}$

$(\Delta\, |\, PP_1P_2)_{\min} = 100$

$\Rightarrow \theta = \frac{\pi}{4}$

$\Rightarrow OP = 10$

$\Rightarrow P = (10, 0), (-10, 0)$



39. AB

Sol. Let P(2, -1) goes 2 units along x + y = 1 upto A and 5 units along x – 2y = 4 up to B

Slope of PA = -1 = tan 135^0, slope of PB = $\frac{1}{2} = \tan\theta$

$\therefore \sin\theta = \frac{1}{\sqrt{5}}, \cos\theta = \frac{2}{\sqrt{5}}$

$\therefore A \equiv \left(x_1 + r\cos 135^0,\ y_1 = r\sin 135^0\right) = \left(2 + 2x - \frac{1}{\sqrt{2}}, -1 + 2\times\frac{1}{\sqrt{2}}\right) = \left(2-\sqrt{2}, \sqrt{2}-1\right)$

$B \equiv \left(x_1 + r\cos\theta, {}_1 + r\sin\theta\right) = \left(2 + 5\times\frac{2}{\sqrt{5}},\ -1 + \frac{5}{\sqrt{5}}\right) = \left(2\sqrt{5} + 2,\ \sqrt{5} - 1\right)$

40. AD

Sol. Slope of tangent = $\frac{\frac{-1}{a}}{\frac{1}{b}} = -\frac{b}{a}$

$$\frac{dy}{dx} = \frac{\frac{dy}{dt}}{\frac{dx}{dt}} = \frac{\frac{-4}{t^2}}{4} = \frac{1}{t^2} < 0$$

So, $\frac{-b}{a} < 0 \Rightarrow \frac{b}{a} > 0$

41. BC

Sol. $\frac{\sin\frac{\pi}{12}}{\sin x} + \frac{\cos\frac{\pi}{12}}{\cos x} = 2$

42. AB

Sol. $|z_1| = |z_2| = 1; |z_1 + z_2| = 1$

$\Rightarrow (z_1 + z_2)(\bar{z}_1 + \bar{z}_2) = 1$

$|z_1 + z_2| = |z_1||1 + e^{i\theta}| = 1$

$|z_2 - z_1| = |z_1||e^{i\theta} - 1|$

43. AB

Sol. $\frac{100}{2}(x_1 + x_{100}) = -1$

$\frac{50}{2}(x_1 + d + x_{100}) = 1$

44. ABC

Sol. Let $y < x$

$\Rightarrow \frac{y}{x} = \frac{x}{x+y}$

$\Rightarrow R = \frac{1}{1+R}$

45. A

Sol. **I – T; II – P; III – S; IV– Q**.

(I) Let the sides a and b are the roots of $x^2 - 5x + 3 = 0$, then a + b = 5 and ab = 3

Alos, $\angle C = \frac{\pi}{3}$

$\therefore \frac{1}{2} = \frac{a^2 + b^2 - c^2}{2ab} \Rightarrow ab = (a+b)^2 - 2ab - c^2 \Rightarrow c = 4$

Now, $rR = \frac{abc}{2(a+b+c)} = \frac{3 \times 4}{2(5+4)} = \frac{2}{3}$

(II) We have $a = \frac{r_1(r_2 + r_3)}{\sqrt{r_1 r_2 + r_2 r_3 + r_3 r_1}} = \frac{8 \times 36}{24} = 12$

(III) Give $1 \le a \le 10$

Also, for roots of opposite sign $2a^2 - 7a + 3 < 0$

or $\frac{1}{2} < a < 3 \Rightarrow 1 \text{ or } 2$

$\therefore$Desired probability $= \frac{2}{10} = \frac{1}{5}$

(IV) (α, β) lies on the director circle of the ellipse i. e. on $x^2 + y^2 = 9$

So, we can assume $\alpha = 3\cos\theta, \beta = 3\sin\theta.$

Thus F = $12\cos\theta + 9\sin\theta = 3(4\cos\theta + 3\sin\theta)$

$\Rightarrow -15 \le F \le 15$

46. D

Sol. **I – T; II – P; III – S; IV– Q**.

(I) Let the sides a and b are the roots of $x^2 - 5x + 3 = 0$, then a + b = 5 and ab = 3

Alos, $\angle C = \frac{\pi}{3}$

$\therefore \frac{1}{2} = \frac{a^2 + b^2 - c^2}{2ab} \Rightarrow ab = (a+b)^2 - 2ab - c^2 \Rightarrow c = 4$

Now, $rR = \frac{abc}{2(a+b+c)} = \frac{3 \times 4}{2(5+4)} = \frac{2}{3}$

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Thus F = $12\cos\theta + 9\sin\theta = 3(4\cos\theta + 3\sin\theta)$

$\Rightarrow -15 \le F \le 15$

47. B

Sol. **I – P, R II – P, R; III – Q; IV- Q, R, S, T.**

(I) Let consecutive coefficient be ${}^nC_r$ and ${}^nC_{r+1}$. Then, $\frac{n!}{(n-r)!r!} = \frac{n!}{(n-r-1)!(r+1)!}$

$\Rightarrow \frac{1}{(n-r)(n-r-1)!r!} = \frac{1}{(n-r-1)!(r+1)r!}$

$\Rightarrow r1 = n - r$

$\Rightarrow n = 2r + 1$ hence, n is odd.

(II) $E = (19-4)^n + (19+4)^n$

$2\left[{}^nC_0 19^n + {}^nC_2 19^{n-2}.4^2 + ... + {}^nC_{n-1} 19.4^{n-1}\right]$ when n is even or

$2\left[{}^nC_0 19^n + {}^nC_2 .19^{n-2}.4^2 + ... + {}^nC_{n-1} 19.4^{n-1}\right]$ when n is odd

$\Rightarrow$ E is divisible by19 when n is odd

(III) $^{10}C_0\ {}^{20}C_{10} - {}^{10}C_1\ {}^{18}C_{10} + {}^{16}C_2\ {}^{16}C_{10} - ....$

$= \text{Coefficient of } x^{10} \text{ in}\left[{}^{10}C_0\left(1+x\right)^{20} - {}^{20}C_1 \times \left(1+x\right)^{18} + {}^{10}C_2\left(1+x\right)^{16} - ....\right]$

$= \text{Coefficient of } x^{10} \text{ in}\left[{}^{10}C_0\left(\left(1+x\right)^2\right)^{10} - {}^{10}C_1 \times \left(\left(1+x\right)^2\right)^9 + {}^{10}C_2\left(\left(1+x\right)^2\right)^8 - ....\right]$

$= \text{Coefficient of } x^{10} \text{ in}\left[\left(1+x\right)^2 - 1\right]^{10}$

$= \text{Coefficient of } x^{10} \text{ in}\left[2x + x^2\right]^{10}$

$= 2^{10}$

(IV) $T_r = {}^{14}Cr_{r-1}x^{r-1}; T_{r+1} = {}^{14}C_r x^r; T_{r+2} = {}^{14}C_{r+1}x^{r+1}$

By the given condition, $2\,{}^{14}C_r = {}^{14}C_{r-1} + {}^{14}C_{r+1}$

$\Rightarrow 2 = \dfrac{{}^{14}C_{r-1}}{{}^{14}C_r} + \dfrac{{}^{14}C_{r+1}}{{}^{14}C_r}$

$\Rightarrow 2 = \dfrac{r}{14-r+1} + \dfrac{14-\left(r+1\right)+1}{r+1}$

$\Rightarrow 2 = \dfrac{r}{15-r} + \dfrac{14-r}{r+1}$

$\Rightarrow r = 9$

48. C

Sol. **I – P, R; II – P, R; III – Q; IV- Q, R, S, T.**

(I) Let consecutive coefficient be ^nC_r and $^nC_{r+1}$. Then, $\dfrac{n!}{(n-r)!r!} = \dfrac{n!}{(n-r-1)!(r+1)!}$

$\Rightarrow \dfrac{1}{(n-r)(n-r-1)!r!} = \dfrac{1}{(n-r-1)!(r+1)r!}$

$\Rightarrow r1 = n - r$

$\Rightarrow n = 2r+1$ hence, n is odd.

(II) $E = \left(19-4\right)^n + \left(19+4\right)^n$

$2\left[{}^nC_0 19^n + {}^nC_2 19^{n-2}.4^2 + ... + {}^nC_{n-1}19.4^{n-1}\right]$ when n is even or

$2\left[{}^nC_0 19^n + {}^nC_2 .19^{n-2}.4^2 + ... + {}^nC_{n-1}19.4^{n-1}\right]$ when n is odd

$\Rightarrow$ E is divisible by19 when n is odd

(III) $^{10}C_0\ {}^{20}C_{10} - {}^{10}C_1\ {}^{18}C_{10} + {}^{16}C_2\ {}^{16}C_{10} - ....$

$= \text{Coefficient of } x^{10} \text{ in}\left[{}^{10}C_0\left(1+x\right)^{20} - {}^{20}C_1 \times \left(1+x\right)^{18} + {}^{10}C_2\left(1+x\right)^{16} - ....\right]$

$= \text{Coefficient of } x^{10} \text{ in}\left[{}^{10}C_0\left(\left(1+x\right)^2\right)^{10} - {}^{10}C_1 \times \left(\left(1+x\right)^2\right)^9 + {}^{10}C_2\left(\left(1+x\right)^2\right)^8 - ....\right]$

$= \text{Coefficient of } x^{10} \text{ in}\left[\left(1+x\right)^2 - 1\right]^{10}$

$= \text{Coefficient of } x^{10} \text{ in}\left[2x + x^2\right]^{10}$

$= 2^{10}$

(IV) $T_r = {}^{14}Cr_{r-1}x^{r-1}; T_{r+1} = {}^{14}C_r x^r; T_{r+2} = {}^{14}C_{r+1}x^{r+1}$

By the given condition, $2\,{}^{14}C_r = {}^{14}C_{r-1} + {}^{14}C_{r+1}$

$$\Rightarrow 2=\frac{{}^{14}C_{r-1}}{{}^{14}C_r}+\frac{{}^{14}C_{r+1}}{{}^{14}C_r}$$

$$\Rightarrow 2=\frac{r}{14-r+1}+\frac{14-(r+1)+1}{r+1}$$

$$\Rightarrow 2=\frac{r}{15-r}+\frac{14-r}{r+1}$$

$$\Rightarrow r=9$$

SECTION – C

49. 00002.00

Sol. $2(1+3+5+7+..........+a)+2(1+3+5+7+......+b)=2(1+3+5+7+.....+c)$

$$\Rightarrow\left[2+\left(\frac{a+1}{2}-1\right)2\right]\frac{a+1}{2}+\left[2+\left(\frac{b+1}{2}-1\right)2\right]\frac{b+1}{2}\left[2+\left(\frac{c+1}{2}-1\right)2\right]\frac{c+1}{2}$$

$$\Rightarrow (a+1)^2+(b+1)^2=(c+1)^2$$

$\because a>6$ and $a+b+c=21$

$\therefore a=7, b=5, c=9$

$\therefore a-b=2$

50. 00007.00

Sol. $p=\frac{{}^3C_1\times{}^8P_6+{}^3C_1\times{}^8P_6-{}^3P_2\times{}^7P_5}{2}=\frac{7}{12}$

51. 00002.00

Sol. $\begin{bmatrix}a_{11} & a_{12}\\ a_{21} & a_{22}\end{bmatrix}\begin{bmatrix}1 & 1\\ 2 & 1\end{bmatrix}=\begin{bmatrix}1 & 1\\ 2 & 1\end{bmatrix}\begin{bmatrix}a_{11} & a_{12}\\ a_{21} & a_{22}\end{bmatrix}$

$\Rightarrow a_{11}+2a_{12}=a_{11}+a_{21}$ .....(i)

$a_{11}+a_{12}=2a_{12}=a_{22}$ ....(ii)

$a_{21}+2a_{22}=2a_{11}+a_{21}$

$a_{21}+a_{22}=2a_{12}+a_{22}$

$\therefore$ From (ii), $a_{11}=a_{22}$

$a_{21}=2a_{12}$

$\because a_{11}a_{22}=a_{21}a_{21}\Rightarrow (a_{11})^2=2(a_{12})^2$

$\Rightarrow a_{11}=\sqrt{2}a_{12}$

52. 00002.00

Sol. $f''(x)=6x^2-18ax+12a^2=0\Rightarrow x=a,2a.$

Given $x_2=x_1^2$, so a cannot be negative. If $a>0$ then local minimum occurs at $x=2a$ and local maximum at $x=a$.

Thus $x_1=a$ and $x_2=2a$

$\Rightarrow 2a=a^2\Rightarrow a=2$(if $a=0, f(x)$ is always increasing)

53. 00004.00

Sol. Since x, y, z are in A.P., $x+z=2y$ and hence

$$\frac{x+y}{2y-x}+\frac{y+z}{2y-z}=\frac{x+y}{z}+\frac{y+z}{x}=\frac{y}{x}+\frac{y}{z}+\frac{z}{x}$$

$$=\frac{x}{z}+\frac{x+z}{2z}+\frac{z+z}{2x}+\frac{z}{x}=1+\frac{3}{2}\left(\frac{x}{z}+\frac{z}{x}\right)$$

$$\geq 1+3\left[\text{A.M} \geq \text{G.M}\right]$$

$\Rightarrow$ minimum value of the given expression is 4.

54. 00006.00

Sol. $24300=2^2 3^5 5^2$

Number of odd divisors = the number of terms in $\left(1+3+3^2+3^3+3^4+3^5\right)\left(1+5+5^2\right)$

$=6+6+6=18$

This also includes the factor 1. So the number of proper odd divisors = 17

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VIII

JEE (Main)-2020

TEST DATE: 27-08-2020

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 75 questions.
- Each subject (PCM) has 25 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only three sections: **Section-A**, **Section-B and Section-C**.

Section-A (01 – 20, 26 – 45, 51 – 70) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-B (21 – 22, 46 – 47, 71 – 72) *contains 6 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

Section-C (23 – 25, 48 – 50, 73 – 75) *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

Physics

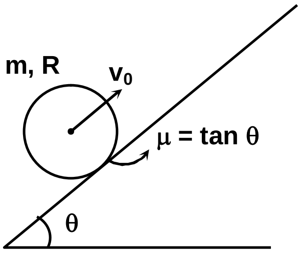
PART – I

SECTION – A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A solid sphere of mass 'm' and radius 'R' is placed on a rough inclined plane of inclination 'θ' and then imparted an initial velocity 'v_0' up the plane as shown in the figure. The coefficient of friction between the sphere and the inclined plane is $\mu = \tan\theta$. Then the time after which pure rolling motion of the sphere starts will be



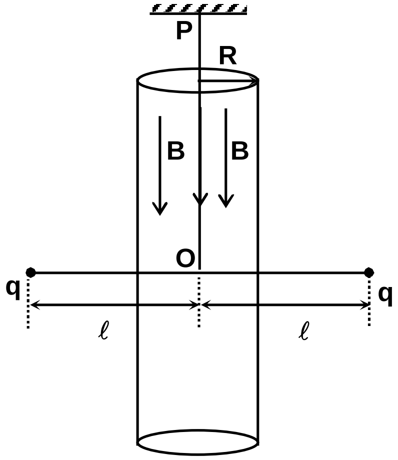
(A) $\dfrac{v_0}{9g\sin\theta}$

(B) $\dfrac{2v_0}{9g\sin\theta}$

(C) $\dfrac{v_0}{3g\sin\theta}$

(D) $\dfrac{2v_0}{3g\sin\theta}$

2. A uniform magnetic field 'B' is present in a cylindrical region of radius 'R' and parallel to the axis of the cylindrical region as shown in the figure. Two particles each having charge 'q' and mass 'm' are attached to the ends of the rod of length 2ℓ and mass m and this arrangement hangs with the help of a vertical rope PO as shown in the figure. At t = 0, the magnetic field is switched off, then the angular velocity acquired by the rod is (neglect twisting constant of rope)

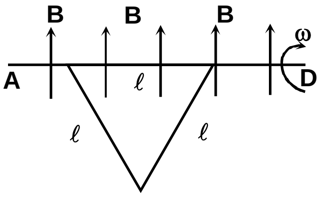


(A) $\dfrac{3qBR^2}{7m\ell^2}$

(B) $\dfrac{3qBR^2}{2m\ell^2}$

(C) $\dfrac{qBR^2}{5m\ell^2}$

(D) $\dfrac{qBR^2}{4m\ell^2}$



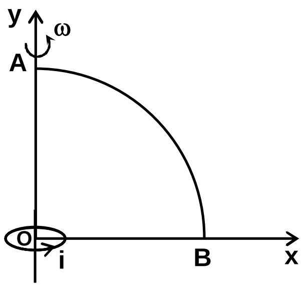
3. A conducting equilateral triangular loop having side length 'ℓ' and resistance 'R' is suspended in a vertical plane from a horizontal axis 'AD' coinciding with one side of the loop as shown in the figure. A uniform vertical upward magnetic field 'B' is existing in the region. If the triangular loop is rotated with a constant angular velocity 'ω' about the horizontal axis 'AD'. Then the average power developed in the loop is

(A) $\frac{3B^2\omega^2\ell^4}{32R}$

(B) $\frac{B^2\omega^2\ell^4}{16R}$

(C) $\frac{B^2\omega^2\ell^4}{32R}$

(D) $\frac{3B^2\omega^2\ell^4}{16R}$



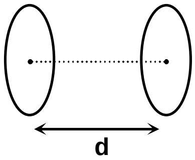
4. Consider a quarter circular conducting ring of large radius 'R' located in xy-plane with its centre at origin and a small circular loop of radius 'a' carrying current 'i' is placed in xz-plane with centre at origin as shown in the figure. If the quarter circular ring is rotated with a constant angular velocity 'ω' about the y-axis, then the emf induced between its ends A and B is

(A) $\frac{3\mu_0 a^2\omega i}{4R}$

(B) $\frac{\mu_0 a^2\omega i}{4R}$

(C) $\frac{\mu_0 a^2\omega i}{8R}$

(D) $\frac{3\mu_0 a^2\omega i}{8R}$



5. Two small circular current carrying loops each having radius 'R' and current 'I' in the same sense are placed coaxially at a distance 'd' apart. Then the force of attraction between the two current loops is
(assume d >>R)

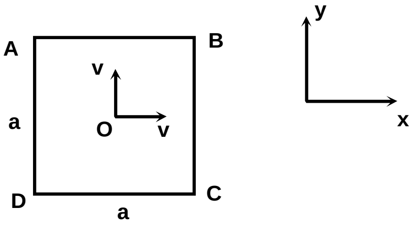
(A) $I\pi R^2\left(\frac{\mu_0 IR^2}{2d^4}\right)$

(B) $I\pi R^2\left(\frac{5\mu_0 IR^2}{2d^4}\right)$

(C) $I\pi R^2\left(\frac{3\mu_0 IR^2}{2d^4}\right)$

(D) $I\pi R^2\left(\frac{7\mu_0 IR^2}{2d^4}\right)$

6. A uniform square lamina with side 'a' is moving with a constant velocity $\left(v\hat{i} + v\hat{j}\right)$ with its plane lying on a smooth horizontal xy plane surface as shown in the figure. The angular velocity of the square lamina just after getting hinged at the vertex 'A' is



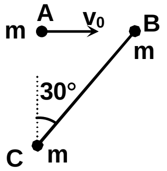
(A) $\frac{v}{2a}$

(B) $\frac{3v}{2a}$

(C) $\frac{5v}{2a}$

(D) $\frac{3v}{4a}$

7. Two identical balls B and C of same mass 'm' are connected by a massless inextensible string and placed on a smooth horizontal surface as shown in the figure. A third ball A of same mass 'm' moving with a velocity v_0 collides with the ball 'B' and after collision the ball A keeps moving in the same direction with a velocity $\frac{v_0}{5}$, then the impulse applied by the string on the ball C during collision is



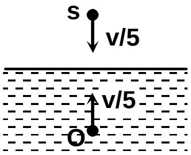
(A) mv_0

(B) $\frac{mv_0}{2}$

(C) $\frac{mv_0}{3}$

(D) $\frac{mv_0}{5}$

8. In the figure shown, a source 'S' is moving in air with a constant velocity $\frac{v}{5}$ and an observer 'O' is moving with a constant velocity $\frac{v}{5}$ in water. The source emits sound of frequency f. The velocity of sound in air is v and that in water 4v. Then the wavelength of sound received by the observer is



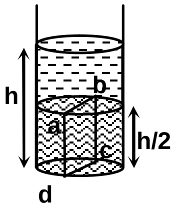
(A) $\frac{8v}{5f}$

(B) $\frac{16v}{5f}$

(C) $\frac{24v}{5f}$

(D) $\frac{32v}{5f}$

9. Liquid having density ‘ρ’ is filled in a beaker of radius R upto height h as shown in the figure. Then the force on the section abcd due to the liquid in the right side is



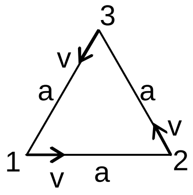
(A) $\left(P_0 + \rho g \frac{3h}{4}\right) 2R \times \frac{h}{3}$

(B) $\left(P_0 + \rho g \frac{3h}{4}\right) Rh$

(C) $\left(P_0 + \rho g \frac{3h}{4}\right) 2Rh$

(D) $\left(P_0 + \rho g \frac{3h}{4}\right) R \times \frac{h}{2}$

10. Three particles are located at the vertices of an equilateral triangle of side ‘a’. They all start moving simultaneously with the same constant speed ‘v’ with the 1st particle always heading for the 2nd, the 2nd particle always heading for the 3rd and 3rd is always heading for the 1st. Then the acceleration of each particle when the separation between the particles becomes ‘a/2’ will be



(A) $\frac{v^2}{2a}$

(B) $\frac{v^2}{a}$

(C) $\frac{\sqrt{3}v^2}{2a}$

(D) $\frac{\sqrt{3}v^2}{a}$

11. A fire cracker when bursted produces 80 dB sound at a distance of 10 cm. At what distance from the fire cracker should a person stand so that sound level heard by him is 40 dB? (assume sound energy is spreaded equally in all directions)

(A) 5 m
(B) 10 m
(C) 15 m
(D) 20 m

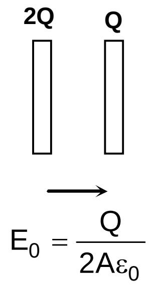
12. A cylindrical wire of copper having area of cross section 5 mm^2 is carrying a current of 1A. The wire is stretched so that its area of cross section becomes 2.5 mm^2. How does the mobility of charge carrier will change, if a current of 4A is passed through the wire.

(A) remain same
(B) increase
(C) decrease
(D) can’t say

13. A sonometer wire vibrating in first overtone has length of 17 cm. Tension in the wire is 289 N and mass per unit length is 10 gm/cm. When it is sounded together with a tuning fork, a beats frequency of 5 Hz is observed. If tension in the wire is slightly increased, no beats are heard. What is the possible frequency of the tuning fork?

(A) 50 Hz
(B) 75 Hz
(C) 90 Hz
(D) 105 HZ

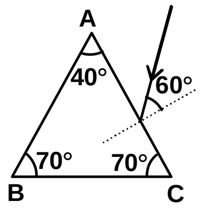
14. Two large parallel conducting plates of charges 2Q and Q are placed parallel to each other at a small separation 'd' in a uniform external electric field $E_0 = \frac{Q}{2A\varepsilon_0}$ perpendicular to the plates as shown. The surface area of each plate is A. The charge on the left surface of the left plate and right surface of the right plate are respectively.



(A) 2Q and Q
(B) 4Q and Q
(C) Q and 2Q
(D) 5Q and 2Q

15. An unpolarised light is passed through three polaroids 1, 2 and 3 respectively. Angle between the transmission axes of the polaroids 1 and 2 is 37°. Find the angle between the transmission axes of the polaroids 2 and 3, if the intensity of the emerging light is 8% of the original intensity of light.
(A) 30°
(B) 60°
(C) 75°
(D) 90°

16. A ray of light is incident on one face of a prism as shown. After refraction through this surface the ray is incident on the base of the prism. The refractive index of the prism is $\sqrt{3}$. The net deviation produced in the ray due to prism is $\left[\text{Take } \sin^{-1}\left(\frac{1}{\sqrt{3}}\right) = 35^\circ\right]$

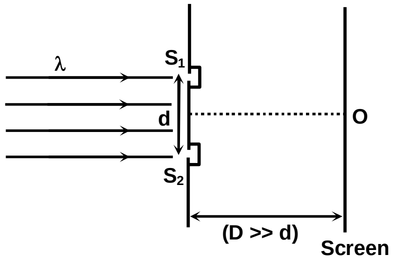


(A) 80° clockwise
(B) 160° clockwise
(C) 180° clockwise
(D) 240° clockwise

17. A speech signal of 5 kHz is used to modulate a carrier signal of frequency 1 MHz using amplitude modulation. The frequency of side bands will be
(A) 995 kHz, 1005 kHz
(B) 895 kHz, 5 kHz
(C) 695 kHz, 5 kHz
(D) 1995 kHz, 1005 kHz

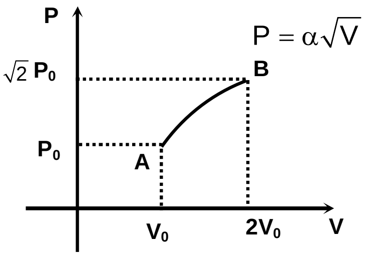
18. A wire of length $\ell = (5 \pm 0.05)$ cm, radius $r = (0.6 \pm 0.006)$cm and density $\rho = (0.4 \pm 0.004)$ gm/cm^3 is given. The maximum percentage error in the mass of the wire is
(A) 1
(B) 2
(C) 4
(D) 5

19. In young's double slit experiment, when the upper and lower slits are covered by two thin slabs of refractive indices 1.8 and 1.5 respectively and having same thickness, the central bright fringe is shifted to the third bright fringe of the interference pattern obtained on the screen by using a light of wavelength 5000 Å. Then the thickness of each slab is (D >>d)



(A) 1 μm
(B) 3 μm
(C) 5 μm
(D) 6 μm

20. An ideal diatomic gas is expanded from volume V_0 to $2V_0$ in the process $P = \alpha\sqrt{V}$ (where α is a constant) as shown. Then the molar heat capacity of the gas in the given process is



(A) $\frac{19R}{6}$

(B) $\frac{17R}{6}$

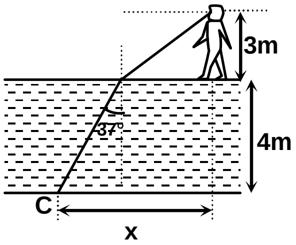
(C) $\frac{21R}{6}$

(D) $\frac{27R}{6}$

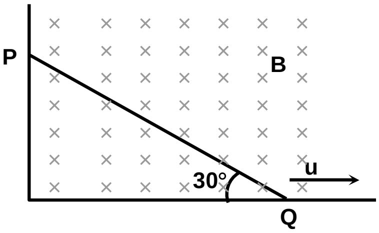
SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

21. A man is standing at the edge of 4 m deep swimming pool, completely filled with water of refractive index μ = (4/3). The eyes of the man are 3m above the edge of the swimming pool. A coin is located at the bottom of the pool. The ray coming from the coin 'C' at an angle 37° from the normal to the water-air interface reaches the eye of the man. Then find the horizontal distance in meter (represented by x in the figure) of the coin from the eye of the man is



22. A conducting rod PQ of length 'ℓ' is resting between a non-conducting wall and the horizontal floor as shown in the figure in the presence of a uniform magnetic field B. The lower end of the rod 'Q' has velocity u at the shown instant. If the potential difference between P and Q at that instant is $\frac{Bu\ell}{n}$. Find the value of n.

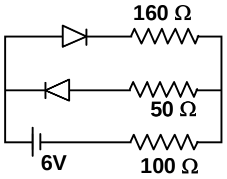


SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

23. The pitch of a screw gauge is 1 mm and its cap is divided into 100 divisions. There is no zero error in the screw gauge. When a wire is placed between its studs, the main scale reading is 3 mm and 25th division of circular scale coincides with the main scale. Find the diameter (in mm) of the wire.

24. The circuit shown in the figure contains 2 diodes each with a forward resistance of 40 ohms and with infinite backward resistance. If battery voltage is 6V, the current through the 100 ohm resistance (in milliampere) is



25. A uniform circular disc of radius 40 cm is suspended vertically from a point at a distance x from centre of the disc to oscillate under gravity. What should be the value of x (in cm) so that the time period of its small oscillation is minimum? (Take $\sqrt{2} = 1.41$)

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

26. Given the following value for the standard molar Gibbs free energy changes. ΔG°, at 25°C:

$$Ag^+(aq) + 2NH_3(\ell) \rightarrow Ag(NH_3)_2^+(aq);$$

$$\Delta G^\circ = -41.0\ kJ\ (mol\ Ag^+)^{-1}$$

$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s);$$

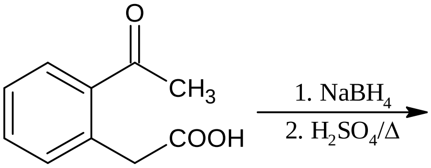
$$\Delta G^\circ = -55.6\ kJ\ (mol\ Ag^+)^{-1}$$

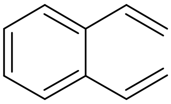
Calculate the value for the thermodynamic equilibrium constant, K, at 25°C for the reaction

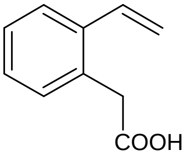
$$AgCl(s) + 2NH_3(l) \rightarrow Ag(NH_3)_2^+(aq) + Cl^-(aq)$$ (R = 8.3 J K^{-1} mol^{-1})

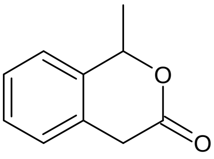
(A) 3.62×10^2
(B) 1.00
(C) 9.94×10^{-1}
(D) 2.76×10^{-3}

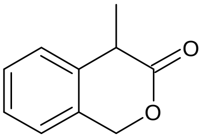
27. Predict the major product of the following reaction.



(A)


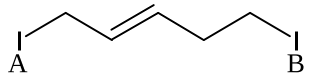
(B)


(C)


(D)


28. Calculate the density of NaCl type ionic solid AB (M_W = 60) in gm/cm^3 if shortest distance between two nearest neighbours is 100 pm & solid having 20% schottky defect ($N_A = 6 \times 10^{23}$)
(A) 10
(B) 20
(C) 30
(D) 40

29. Which one of the two iodine will be more reactive in the S_N1 and S_N2 reaction?



(A) A will be faster in S_N1 reaction but slower in S_N2.
(B) A will be faster both in S_N1 and S_N2 reaction
(C) A and B will be equally reactive
(D) B will be faster in S_N1 and S_N2 reactions

30. Bessemerization is carried out for
I: Fe II: Cu III: Al IV: silver
(A) I, II
(B) II, III
(C) III, IV
(D) I, III

31. The emf of a cell corresponding to the following reaction is 0.199 V at 298 K.

$$Zn(s)+2H^{+}(aq)\rightarrow Zn^{2+}(0.1M)+H_2(g)\quad\left(E^0_{Zn/zn^{+2}}=0.76V\right)$$

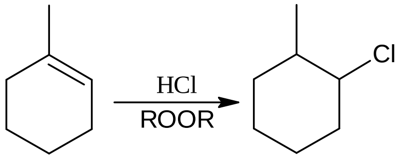
The approximate pH of the solution at the electrode where hydrogen is being produced is $\left(p_{H_2}=1\,atm\right)$
(A) 8
(B) 9
(C) 10
(D) 11

32. Consider the following reversible reaction:

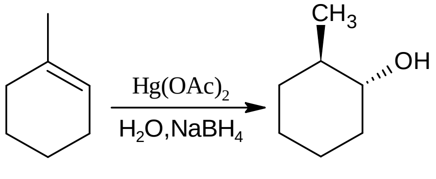
$$NO+NO_3 \rightleftharpoons 2NO_2$$

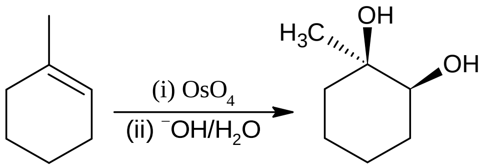
If 1.0 mol of NO is mixed with 3.0 mol of NO_3, 'x' mol of NO_2 is produced at equilibrium. If 2.0 mol of NO is added further. 'x' mole of NO_2 is further produced. What is the value of equilibrium constant?
(A) 1
(B) 2
(C) 3
(D) 4

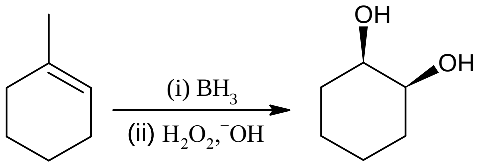
33. Which reaction below is correct?
(A)



(B)



(C)


(D)


34. Correct order of C–O bond length is:
(A) $CO^+ > C_2O_4^{2-} > CO$
(B) $CO^+ > CO > C_2O_4^{2-}$
(C) $C_2O_4^{2-} > CO^+ > CO$
(D) $C_2O_4^{2-} > CO > CO^+$

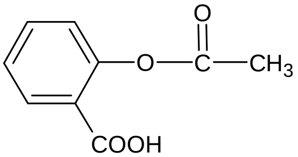
35. The mass of gas molecule Y is twice the mass of gas molecule 'Z'. The rms speed of 'Y' is twice the rms speed of 'Z' and their respective pressure is 'P_Y' and 'P_Z'. If two samples of 'Y' and "Z" contains same no. of molecules, what will be the ratio of respective pressure of two sample in separate container of equal volume ?
(A) 2
(B) 4
(C) 6
(D) 8

36. Which of the following will not give positive chromyl chloride test?
(A) $CaCl_2$
(B) $HgCl_2$
(C) $ZnCl_2$
(D) $C_6H_5NH_2.HCl$

37. Which of the following is not a disaccharide?
(A) Sucrose
(B) Mannose
(C) Lactose
(D) Maltose

38. Graph between $\log\frac{x}{m}$ and $\log P$ is a straight line inclined at an angle θ = 45°. When pressure is 0.5 atm and log *k* = 0.699, the amount of solution adsorbed per g of adsorbent will be:
(A) 2.5 g/g adsorbent
(B) 0.25 g/g adsorbent
(C) 1 g/g adsorbent
(D) 1.5 g/g adsorbent

39. The following compound is used as



(A) An anti-inflammatory compound
(B) Analgesic
(C) Hypnotic
(D) Antiseptic

40. Benzoic acid and carbolic acid can be distinguished by
(A) Aqueous $NaHCO_3$
(B) 2, 4-DNP test
(C) Aqueous NaOH
(D) Aqueous NH_3

41. Hydrolysis of one mole of peroxodi-sulphuric acid produces:
(A) two moles of sulphuric acid
(B) two moles of peroxomono-sulphuric acid
(C) one mole of sulphuric acid, one mole of peroxomono-sulphuric acid
(D) one mole of sulphuric acid, one mole of peroxomono-sulphuric acid and one mole of hydrogen peroxide.

42. Which of the following complex is paramagnetic?
(A) $K_2[Ni(CN)_4]$
(B) $K_4[Fe(CN)_6]$
(C) $[Co(NH_3)_6]Cl_3$
(D) $[Cr(H_2O)_6]SO_4$

43. Industrial preparation of nitric acid by Ostwald's process involves:
(A) Oxidation of NH_3
(B) Reduction of NH_3
(C) Hydrogenation of NH_3
(D) Hydrolysis of NH_3

44. Two samples A and B of an ideal gas, initially at same temperature and pressure, are compressed from volume V to V/2, isothermally for A and adiabatically for B. The final pressure of A will be:
(A) greater than that of B
(B) less than that of B
(C) twice that of B
(D) equal to that of B

45. The dipole moment of H_2O_2 is more than that of H_2O but H_2O_2 is not a good solvent because:
(A) It has a very high dielectric constant so that ionic compounds cannot be dissolved in it
(B) It does not act as an oxidising agent
(C) It acts only as a reducing agent
(D) It dissociates easily and acts as an oxidising agent in chemical reactions.

SECTION – B

(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

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46. How many geometrical isomers are possible in square planar complex, $[Pt(NH_3)\ (H_2O)\ (Py)\ (NO_2)]^+$

47. In borax molecule $Na_2(B_4O_5(OH)_x]\ .\ YH_2O$ what will be the value of 'x', If x molecules are part of its structural composition.

SECTION – C

(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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48. 3129 kJ of heat is liberated when 60 grams of ethane is completely burnt in oxygen. $\Delta H^0{}_f$ for CO_2 and $H_2O(\ell)$ are $-395kJ$ and $-286kJ$ respectively. The heat of formation of ethane is

49. At 18°C the molar conductivities at infinite dilution of NH_4Cl, NaOH& NaCl are 130, 220 & 100 Scm^2mol^{-1} respectively. If the molar conductivity of N/100 solution of NH_4OH is 10 Scm^2mol^{-1}, then find the pH of the NH_4OH solution. (log2 = 0.30)

50. If the osmotic pressure of 0.1M monobasic acid in a solution of pH value '2' at 25^0C is x atm, then what will be x?

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

51. The tangent at any point P(5, 2) on the parabola $y^2 = 2(x - 3)$ meets the directrix of this parabola at Q then if circumcentre of ΔSPQ where S is focus of parabola is (α, β), then $\alpha + 2\beta$ is equal to
(A) $\frac{13}{2}$
(B) $\frac{11}{2}$
(C) 7
(D) none of these

52. Let $f : R \to R$ be continuous function satisfying $f(x) + f(x + 1) = x^2 + 2x + 3$, then $\int_0^2 f(x)dx$ is equal to
(A) $\frac{38}{3}$
(B) $\frac{32}{3}$
(C) $\frac{13}{3}$
(D) $\frac{16}{3}$

53. From the digits 0, 1, 2, 3, 4, how may 4 digit number can be formed greater than 2100
(A) 250
(B) 249
(C) 350
(D) 349

54. $\lim\limits_{x\to\infty} \frac{30 + 3\sqrt{x} + x^{\frac{1}{3}}}{3 + \sqrt{9x - 5} + (27x - 4)^{\frac{1}{3}}}$ is equal to
(A) 2
(B) 3
(C) 4
(D) 1

55. For the function $f(x) = x \sin \pi x$, $x > 0$, then number of solution of $f'(x) = 0$ in [0, 2] is
(A) 2
(B) 3
(C) 4
(D) 1

56. If exhaustive values of x satisfying $|\cos^{-1} x| + |\sin^{-1} x| + |\tan^{-1} x| = |\pi - \cot^{-1} x|$ belongs to [a, b], then |a| + |b| is equal to
(A) 0
(B) 1
(C) 2
(D) 3

57. The number of solution of $\sin^2 2x = \cos^2 x$ in $[0, 2\pi]$ is
(A) 4
(B) 5
(C) 6
(D) 7

58. Let line 2x + y = 3 intersects a circle $x^2 + y^2 = 16$ at A and B. Now tangents are drawn to circle $x^2 + y^2 = 16$ at A and B which intersect at $P(\alpha, \beta)$, then $\alpha + \beta$ is equal to
(A) 8
(B) 12
(C) 16
(D) 18

59. Consider the cubic polynomial $f(x) = x^3 - ax^2 + bx + c$. If the equation f(x) = 0 has integral roots $\alpha, \beta, \gamma \in [0, 5]$ such that f(5) = 2, then integral value of a is
(A) 8
(B) 9
(C) 11
(D) 12

60. If the line x + y = 1 touches an ellipse $\frac{x^2}{4} + \frac{y^2}{3} = \frac{1}{12}$ at $P(x_1, y_1)$, then $\frac{1}{3x_1 + 8y_1}$ is equal to
(A) 1
(B) $\frac{1}{2}$
(C) $\frac{1}{3}$
(D) $\frac{1}{4}$

61. Exhaustive set of values of x satisfying equation [[x] + 2x] = 4 is (where [.] denote greatest integer function)
(A) (1, 2)
(B) $\left(\frac{3}{2}, 2\right]$
(C) $\left[\frac{3}{2}, 2\right)$
(D) $\left[\frac{3}{2}, 3\right)$

62. $f : R \to Y,\ f(x) = \dfrac{e^x - e^{|x|}}{10e^x + e^{|x|}}$ is onto function, then Y is
(A) $\left(-\dfrac{1}{10},\ 0\right]$
(B) $\left(-\dfrac{1}{10},\ \infty\right)$
(C) (–1, 0]
(D) (–1, 1]

63. The number of critical points of f(x) = max(|tan x|, cos |x|) in $(-\pi, \pi)$ is
(A) 3
(B) 4
(C) 5
(D) 2

64. A tangent at P(5, 5) to hyperbola $\dfrac{(x-1)^2}{4} - \dfrac{(y-2)^2}{3} = 1$ meets its asymptotes at Q and R. If C be the centre of hyperbola, then area of triangle CQR is equal to
(A) 12
(B) 6
(C) $2\sqrt{3}$
(D) $3\sqrt{2}$

65. If a – b = 1, b – c = 2, a, b, c $\in$ R, then value of $|a + bw + cw^2|^2$ where w is cube root of unity $(w \neq 1)$
(A) 5
(B) 7
(C) 9
(D) none of these

66. Two lines $\dfrac{x-1}{2} = \dfrac{y+1}{3} = \dfrac{z-1}{4}$ and $\dfrac{x-3}{1} = \dfrac{y-k}{2} = \dfrac{z}{1}$ intersect at a point $P(\alpha, \beta, \gamma)$, then $\alpha + \gamma - 2\beta$ is equal to
(A) 6
(B) 4
(C) 5
(D) 7

67. $\sim (p \vee q) \vee (\sim p \wedge q)$ is logically equivalent to
(A) ~p
(B) p
(C) q
(D) ~q

68. A pair of dice is rolled till a sum of 4 or 7 is obtained. The probability that 7 comes before 4 is

(A) $\frac{2}{7}$

(B) $\frac{2}{3}$

(C) $\frac{1}{3}$

(D) $\frac{3}{5}$

69. Let $\vec{a}$ and $\vec{b}$ be unit vectors, $\vec{a}\cdot\vec{b}=0$ and if $\alpha=\left[\vec{a}+\vec{a}\times\vec{b},\ \vec{b}+\left(\vec{a}\times\vec{b}\right),\ \vec{a}\times\vec{b}\right]$,

$\beta=\left(\vec{a}\times\vec{i}\right)\cdot\left(\vec{b}\times i\right)+\left(\vec{a}\times\vec{j}\right)\cdot\left(\vec{b}\times\vec{j}\right)+\left(\vec{a}\times\vec{k}\right)\cdot\left(\vec{b}\times\vec{k}\right)$, then $\alpha + \beta$ is equal to

(A) 0
(B) 1
(C) 2
(D) none of these

70. If number of solution of equation $z^2=\bar{z}$ where z = x + iy is n, then the coefficient x^{n+7} in expansion of $(2x^2 + x - 3)^6$ is

(A) 190
(B) 192
(C) 194
(D) 196

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

71. If y = f(x) passing through (4, 2) satisfies the differential equation y(1 + xy)dx – xdy = 0, then f(4) is equal to

72. If $\int\frac{5\sin x}{\sin x-2\cos x}dx=Ax+B\ln\left|\sin x-2\cos x\right|+c$, then 2A + B is equal to

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

73. In an experiment with 20 observations on x, the following results were available $\Sigma x^2=2530$, $\Sigma x=210$. On observation that 30 was found to be wrong and replaced by the correct value 40. Then the correct variance is

74. PQRS is a trapezium such that QR ⊥ RS. If ∠PSQ = 30°, $QR=3\sqrt{3}$, RS = 5, then PQ is equal to

75. If $x=1+\frac{1}{4}+\frac{1}{4^2}+.....\infty$, $y=1+\frac{1}{2}+\frac{1}{2^2}+\frac{1}{2^3}+.....\infty$, $z=1+\frac{1}{c}+\frac{1}{c^2}+\frac{1}{c^3}+.....\infty$. If x, y, z are in H.P. and |c| > 1, then c + 3 is equal to

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VIII

JEE (Main)-2020

TEST DATE: 27-08-2020

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. B

Sol. $a = \frac{mg\sin\theta + f_k}{m} = \frac{mg\sin\theta + mg\sin\theta}{m}$

$a = 2g\sin\theta$

$\tau_{CM} = I_{CM}\alpha$

$f_k R = \frac{2}{5}mR^2\alpha$

$\alpha = \frac{5g\sin\theta}{2R}$

When pure rolling motion starts

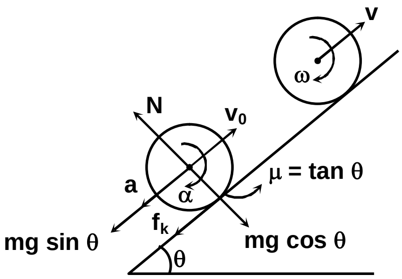
$v = \omega R$

$v_0 - at = \alpha t R$

$v_0 - 2g\sin\theta t = \frac{5g\sin\theta t}{2}$

$v_0 = \frac{9g\sin\theta t}{2}$

$t = \frac{2v_0}{9g\sin\theta}$



2. A

Sol. $\int \tau \cdot dt = I\omega$

$\int 2qE\ell dt = I\omega$

$$\int 2q\ell \frac{R^2}{2\ell}\frac{dB}{dt}\cdot dt = \left(\frac{4m\ell^2}{12} + m\ell^2 + m\ell^2\right)\omega$$

$$qR^2B = \frac{7m\ell^2}{3}\omega$$

$$\omega = \left(\frac{3qBR^2}{7m\ell^2}\right)$$

3. A

Sol. $$\phi = \frac{\sqrt{3}}{4}\ell^2 B\sin\omega t$$

$$|\varepsilon| = \frac{\sqrt{3}}{4}\ell^2\omega B\cos\omega t$$

$$I = \frac{\sqrt{3}\ell^2\omega B}{4R}\cos\omega t$$

$$P_{av} = \frac{\int_0^{2\pi/\omega} I^2 R dt}{\int_0^{2\pi/\omega} dt} = \left(\frac{\sqrt{3}\ell^2 B\omega}{4R}\right)^2 R\frac{\int_0^{\frac{2\pi}{\omega}}\cos^2\omega t dt}{\int_0^{2\pi/\omega} dt}$$

$$P_{av} = \left(\frac{\sqrt{3}\ell^2 B\omega}{4R}\right)^2 R\frac{1}{2} = \frac{3B^2\omega^2\ell^4}{32R}$$

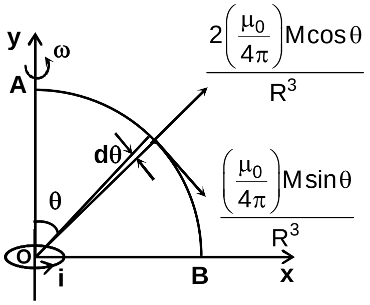
4. B

Sol. v = R sinθ·ω

$$\int_0^{\pi/2}\frac{2\mu_0}{4\pi R^3}M\cos\theta\cdot R\sin\theta\cdot\omega R d\theta$$

$$= \frac{\mu_0 M\omega}{2\pi\times 2R}\int_0^{\pi/2}\sin 2\theta\cdot d\theta = \frac{\mu_0 M\omega}{4\pi R}\left(-\frac{\cos 2\theta}{2}\right)_0^{\pi/2}$$

$$\frac{\mu_0 M\omega}{4\pi R}\left(\frac{1}{2}+\frac{1}{2}\right) = \frac{\mu_0 M\omega}{4\pi R} = \frac{\mu_0\omega i\pi a^2}{4\pi R} = \frac{\mu_0 a^2\omega i}{4R}$$


$\dfrac{2\left(\dfrac{\mu_0}{4\pi}\right)M\cos\theta}{R^3}$
y
ω
A
dθ
$\dfrac{\left(\dfrac{\mu_0}{4\pi}\right)M\sin\theta}{R^3}$
θ
O
i
B
x

5. C

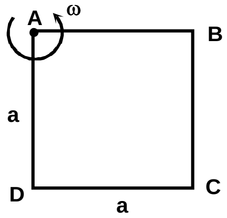
Sol. $$F = M\left|\frac{dB}{dr}\right| = \frac{\mu_0}{4\pi}\frac{6M^2}{d^4} = I\pi R^2\left(\frac{3\mu_0 IR^2}{2d^4}\right)$$

6. B

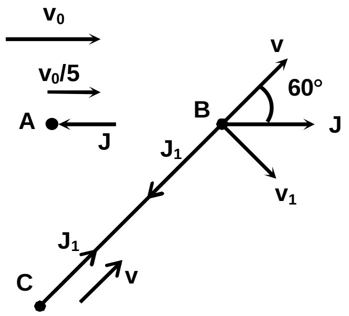
Sol. Using conservation of angular momentum about the vertical axis passing through vertex 'A'.

$$mv\frac{a}{2} + mv\frac{a}{2} = \frac{2}{3}ma^2\omega$$

$$\Rightarrow mva = \frac{2}{3}ma^2\omega \quad \Rightarrow \omega = \frac{3v}{2a}$$



7. D



Sol. $J = m\left(v_0 - \frac{v_0}{5}\right)$

$J = \frac{4mv_0}{5}$

$J \cos 60° = 2mv$

$\frac{2mv_0}{5} = 2mv$

$v = \frac{v_0}{5}$

Impulse due to string on the ball 'C' during collision is

$J_1 = mv$

$\Rightarrow\ J_1 = \frac{mv_0}{5}$

8. B

Sol. The wavelength of sound received by the observer is

$\lambda = \frac{4\left(v - \frac{v}{5}\right)}{f} = \frac{16v}{5f}$

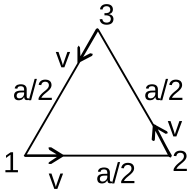
9. B

Sol. $F = \int_{h/2}^{h} (P_0 + \rho g y)2R\,dy = \left(P_0 + \rho g\frac{3h}{4}\right)Rh$

10. D

Sol. Acceleration of each particle

$a_0 = v\omega = v\frac{v\sin 60°}{a/2} = \frac{\sqrt{3}v^2}{a}$



11. B

Sol. $80 = 10\,\ell og\frac{I_1}{I_0}$ …(i)

$40 = 10\,\ell og\frac{I_2}{I_0}$ ….(ii)

From (i) and (ii)

$40 = 10\,\ell og\frac{I_1}{I_2}$

$4 = \ell og\left(\frac{r_2}{r_1}\right)^2$

$\frac{r_2}{r_1} = 10^2$

$r_2 = 10 \times 10^2$ cm = 10 m

12. A

Sol. mobility will remain same.

13. D

Sol. Frequency of the sonometer wire, $f = \frac{2}{2\ell}\sqrt{\frac{F}{\mu}} = \frac{1}{0.17}\sqrt{\frac{289}{1}} = 100$ Hz

Frequency of the tuning fork is $f_0 = f + 5 = 105$ Hz

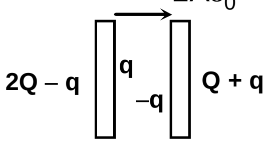
14. C

Sol. $\left(\frac{2Q - q}{2\varepsilon_0 A}\right) + \left(\frac{Q}{2\varepsilon_0 A}\right) = \left(\frac{Q + q}{2\varepsilon_0 A}\right)$

$(2Q - q) + Q = Q + q$

$q = Q$

$E_0 = \frac{Q}{2A\varepsilon_0}$



15. B

Sol. $I = \frac{I_0}{2}\cos^2 37° \times \cos^2\theta = \frac{I_0 8}{100}$

$\frac{I_0}{2} \times \frac{16}{25} \times \cos^2\theta = \frac{I_0 \times 4}{50}$

$\cos^2\theta = \frac{1}{4}$

$\cos\theta = \frac{1}{2}$

$\theta = 60°$

16. B

Sol. sin 60° = μ sin r

$\Rightarrow \frac{\sqrt{3}}{2} = \sqrt{3}$ sin r

r = 30°

The net deviation produced in the ray

δ = 30° + 100° + 30° = 160° clockwise

17. A

Sol. L.S.B. = (1000 – 5)kHz = 995 kHz

U.S.B. = (1000 + 5) kHz = 1005 kHz

18. C

Sol. $m = \rho\pi r^2\ell$

$100 \times \frac{\Delta m}{m} = \left(\frac{\Delta\rho}{\rho} + 2\frac{\Delta r}{r} + \frac{\Delta\ell}{\ell}\right) \times 100 = \left(\frac{0.004}{0.4} + 2 \times \frac{0.006}{0.6} + \frac{0.05}{5}\right) \times 100$

Maximum % error in the mass = (0.01 + 2 × 0.01 + 0.01) × 100 = 4%

19. C

Sol. $(\mu_1 - \mu_2)t = 3\lambda$

$t = \frac{3\lambda}{(\mu_1 - \mu_2)} = \frac{3 \times 5 \times 10^{-7}}{(1.8 - 1.5)} = 5\ \mu m$

20. A

Sol. The equation of process is $P = \alpha\sqrt{V}$

$PV^{-1/2} = \text{constant}$

This is a polytropic process with a polytropic constant, x = –(1/2)

∴ Molar heat capacity of the gas

$$C = C_V + \frac{R}{(1-x)} = \frac{5R}{2} + \frac{R}{\left(1+\frac{1}{2}\right)} = \frac{5R}{2} + \frac{2R}{3} = \frac{19R}{6}$$

SECTION – B

21. 7

Sol. $\frac{4}{3}\sin 37° = 1 \times \sin r$

r = 53°

So, x = 4 tan 37° + 3 cot 37° = 7 m

22. 2

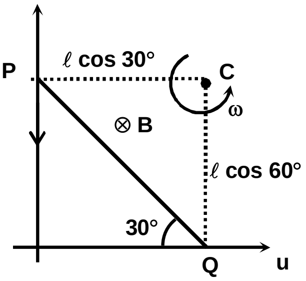
Sol. Angular velocity of the rod is

$\omega = \frac{u}{\ell \cos 60°} = \frac{2u}{\ell}$

Potential difference between P and Q

$= \frac{1}{2}B\omega\ell^2\left(\cos^2 30° - \cos^2 60°\right) = \frac{Bu\ell}{2}$

∴ n = 2



SECTION – C

23. 00003.25

Sol. Pitch of the screw gauge, P = 1mm

Least count, L.C. = $\frac{P}{N} = \frac{1}{100} = 0.01\text{mm}$

Diameter of the wire, d = 3 mm + 25 × L.C. = 3mm + 25 × 0.01 mm

∴ d = 3.25 mm

24. 00020.00

Sol. $I = \frac{6}{300} = 0.02$ ampere = 20 milliampere

25. 00028.20

Sol. $T = 2\pi\sqrt{\frac{\frac{mR^2}{2} + mx^2}{mgx}}$

T will be minimum for $x = \frac{R}{\sqrt{2}} = \frac{40}{\sqrt{2}} = 20\sqrt{2}$ = 28.2 cm

Chemistry

PART – II

SECTION – A

26. D

Sol. 2.76×10^{-3}

Subtraction of second equation from first will give the required equation. Hence

$$\Delta G=-41.0-(-55.6)$$

$$=14.6 \text{ kJ}=-2.303RT\ \log \text{K}$$

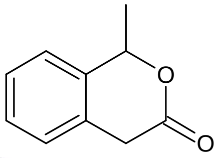
$$\Rightarrow\ \log_{10}\ \text{K}=-\frac{14.6\times1000}{8.3\times298\times2.303}$$

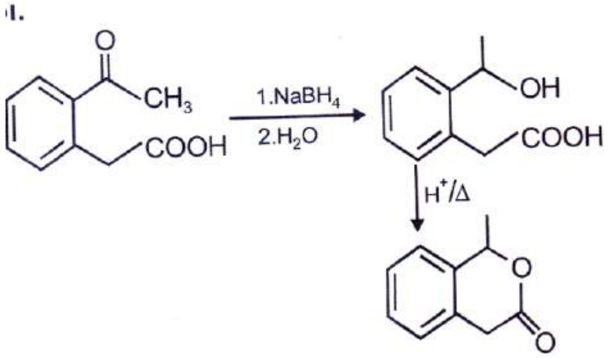
=–2.56

$$\Rightarrow\ \text{K}=2.7\times10^{-3}$$

27. C

Sol.





28. D

Sol. $Z=4\times0.8=3.2$

$$\frac{a}{2}=100$$

$$a=200\text{ pm}$$

$$d=\frac{Z\times M}{N_A\times a^3}=\frac{3.2\times60}{6\times10^{23}\times\left(2\times10^{-8}\right)^3}$$

29. B

Sol. A will be faster both in S_N1 and S_N2 reaction

Allylic halide gives both S_N1 and S_N2 reaction

30. A

Sol. I, II

31. C

Sol. At 298 K,

$$Zn(s)+2H^+(aq)\rightarrow Zn^{2+}(0.1M)+H_2(g);E^\circ=0.76V$$

EMF = 0.199 V

From Nernst equation,

$$E_{cell}=E^0_{Cell}+\frac{0.0591}{n}\log\frac{\left[H^+\right]^2}{\left[Zn^{2+}\right]}\left[n=2e^-\right]$$

$$0.199V-0.76V=\frac{0.0591}{2}\log\frac{\left[H^+\right]^2}{[0.1]}$$

$$H^+=10^{-10}M$$

$$\therefore\ \text{pH}=-\log H^+=-\log 10^{-10}$$

$$pH=10\log 10$$

$$pH=10$$

32. D

Sol.

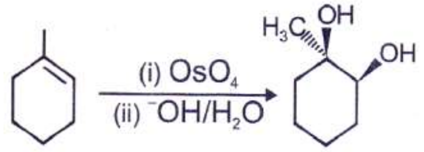
$$\begin{array}{lll} NO & +NO_3 & 2\text{NO}_2 \\ 1-\frac{x}{2} & 3-\frac{x}{2} & x \\ 3-x & 3-x & 2\text{x} \end{array}$$

$$K=\frac{x^2}{\left(1-\frac{x}{2}\right)\left(3-\frac{x}{2}\right)}=K=\frac{4x^2}{(3-x)^2}$$

Equating the two gives x = 3/2 then K = 4

33. C

Sol.



34. D

Sol. $C_2O_4^{2-}>CO>CO^+$

Bond order of C–O in $C_2O_4^{-2}$ is $\Rightarrow 1.5$

Bond order of C–O in CO is $\Rightarrow$ 3

Bond order of C–O in CO^+ is $\Rightarrow$ more than 3

35. D

Sol. Given $m_Y = 2m_Z$ . . . (i)

U_{rms} of 'Y' = 2 × U_{rms} of Z . . . (ii)

and no. of molecules of Y = No. of molecules of 'Z' . . . (iii)

$$\because\ P_YV_Y=\frac{1}{3}M_YU^2_{rms_Y}$$

$$P_ZV_Z=\frac{1}{3}M_ZU^2_{rms_Z}$$

$$\therefore \quad \frac{P_Y V_Y}{P_Z V_Z} = \frac{M_Y}{M_Z} \times \frac{U_Y^2}{U_Z^2} \qquad \text{. . . . . . (iv)}$$

∴ Given $V_Y = V_Z$ . . . . . . (v)

By equation 1, 2, 3, 4, 5,

$$\frac{P_Y}{P_Z} = 2 \times (2)^2 = 8$$

36. B

Sol. Mercuric chloride, $HgCl_2$.

Chromyl chloride test is used for the conformation of chloride ion. Formation of red vapour, yellow solution, yellow ppt.

[Chloride of $Sb^{+3}, Sn^{+4}, Ag^{+1}, Pb^{+2}, Hg^{+2}, Hg^{+}, Sb^{+5}$ does not give dissolve significantly in water]

37. B

Sol. Mannose

Mannose is a monosaccharide, a C–2 epimer of glucose.

38. A

Sol. 2.5 g/g adsorbent

$\frac{x}{m} = k.P^{l/n}$ since, log k = 0.699,

Hence , k = 5;

Slope = $\frac{1}{n} = \tan 45° = 1$

Thus, $\frac{x}{m} = 5 \times 0.5 g / g$ adsorbent

39. B

Sol. Analgesic

40. A

Sol. Phenol is also called carbolic acid, Benzoic acid is more acidic than phenol. So the acid reacts with $NaHCO_3$ to give $CO_2(g)$, while phenol does not react.

(B) Only carbonyl compound gives 2, 4-DNP test.

(C) Both acid and phenol react with aqueous NaOH to give their corresponding salts.

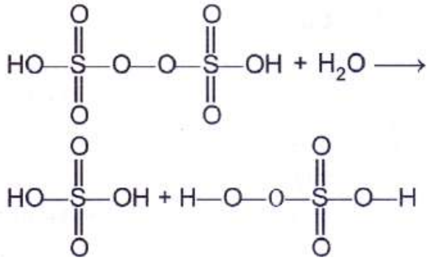
$$PhCOOH + NaOH \rightarrow PhCOONa$$

$$PhOH + NaOH \rightarrow PhONa$$

(D) Both acid and phenol react with NH_3. $PhCOOH + NH_3 \rightarrow PhNH_2$ (Aniline) + H_2O

41. C

Sol. one mole of sulphuric acid, one mole of peroxomono-sulphuric acid



42. D

Sol. The electronic configurations of Ni, Fe, CO and Cr in the given complexes are $\left(3d\right)^8$, $\left(3d\right)^6$,$\left(3d\right)^6$ and $\left(3d\right)^4$, respectively. These involves dsp², d²sp³, d²sp³ and sp³ d²-hybridizatin respectively. The complex $\left[Cr\left(H_2O\right)_6\right]SO_4$ will be paramagnetic as Cr contains four unpaired electrons.

43. A

Sol. Catalytic oxidation of NH_3 by O_2.

44. B

Sol. For gas A the temperature remains constant but in case of gas B the temperature increases so the pressure increases. Therefore, the final pressure of 'A' will be less than that of B.

45. D

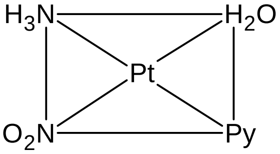
Sol. H_2O_2 is thermally unstable and it decomposes easily.

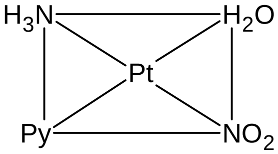
$H_2O_2\left(l\right)\rightarrow H_2O\left(l\right)+\frac{1}{2}O_2\left(g\right)$ Its decomposition is catalysed by alkali metals present in traces in the glass of the vessel.

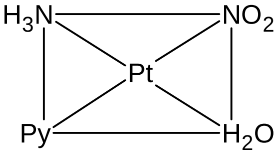
SECTION – B

46. 3

Sol.







47. 4

Sol. Borax molecule exists structurally as
$Na_2[B_4O_5(OH)_4].\ 8H_2O$
x = 4

SECTION – C

48. 00083.50

Sol. $2C_2H_6\left(g\right)+7O_2\left(g\right)\longrightarrow 4CO_2\left(g\right)+6H_2O\left(\ell\right)\ \Delta H=-3129KJ$

$$\Delta H=\sum\Delta H_{f\left(\text{Product}\right)}-\sum\Delta H_{f\left(\text{reactants}\right)}$$

$$-3129=\left[4\times\left(-395\right)+6\times-\left(286\right)\right]-\left[2\times\Delta H_f C_2H_6+7\times0\right]$$

$$\Delta H_{fC_2H_6}=-83.5KJ$$

49. 00010.60

Sol. $\Lambda_\infty NH_4Cl=\lambda NH_4^+ +\lambda Cl^- =130$ … (1)

$\Lambda_\infty NaOH=\lambda Na^+ +\lambda HO^- =220$ … (2)

$\Lambda_\infty NaCl=\lambda Na^+ +\lambda Cl^- =100$ … (3)

[(1) + (2)] – [(3)]

$$\lambda_\infty \mathrm{NH_4^+} + \lambda_\infty \mathrm{HO^-} = 250 = \Lambda_\infty \mathrm{NH_4OH}$$

$$'\alpha'\,\mathrm{of\, NH_4OH} = \frac{\Lambda_m^c}{\Lambda_\infty} = \frac{10}{250} = \frac{1}{25}$$

$$\left[HO^-\right] = C\alpha = \frac{1}{100}\times\frac{1}{25} \Rightarrow 4\times10^{-4}$$

$$pH = 10 + 2\log 2 = 10.6$$

50. 00002.69

Sol. $HA \rightleftharpoons H^+ + A^-$

$[H^+] = C\alpha = 10^{-2}$ $\therefore$ $\alpha = 0.1$

$i = 1 + \alpha = 1.1 \Rightarrow \pi = i(CRT)$

Thus $\pi = 0.1 \times 0.0821 \times 298 \times 1.1 = 2.69$ atm

Mathematics PART – III

SECTION – A

51. A

Sol. Directrix: $x-3=-\frac{1}{2},\ x=3-\frac{1}{2}=\frac{5}{2}$ ..... (1)

Slope of tangent at P(5, 2): $2y\frac{dy}{dx}=2,\ \frac{dy}{dx}=\frac{1}{2}$

Equation of tangent $y-2=\frac{1}{2}(x-5)$ ..... (2)

$y-2=\frac{1}{2}\left(\frac{5}{2}-5\right)=-\frac{5}{4},\ y=2-\frac{5}{4}=\frac{3}{4}$

$Q=\left(\frac{5}{2},\frac{3}{4}\right)$ circumcentre is mid-point of P and $Q\equiv\left(\frac{5+\frac{5}{2}}{2},\frac{2+\frac{3}{4}}{2}\right)=\left(\frac{15}{4},\frac{11}{8}\right)$

52. C

Sol. $\int_0^2 f(x)dx=\int_0^2 f(x)dx+\int_0^2 f(x)dx=\int_0^1 \left(f(x)+f(x+1)\right)dx$

$=\int_0^1 \left(x^2+2x+3\right)dx=\left.\frac{x^3}{3}+x^2+3x\right|_0^1=\frac{1}{3}+1+3=\frac{13}{3}$

53. D

Sol. Case 1: 1 × 4 × 5 × 5 = 100

Case 2: 2 × 5 × 5 × 5 = $\frac{250}{350}$

One number will be 2100

So required number of ways = 349

54. D

Sol. $$\lim_{x\to\infty}\frac{\frac{30}{x^{\frac{1}{2}}}+3+x^{-\frac{1}{6}}}{\frac{3}{\sqrt{x}}+\sqrt{9-\frac{5}{x}}+x^{-\frac{1}{6}}\left(27-\frac{4}{x}\right)^{\frac{1}{3}}}=\frac{0+3+0}{0+3+0}=1$$

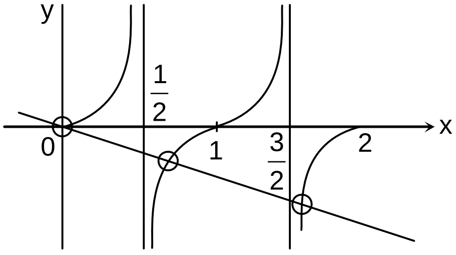
55. B

Sol. $f'(x)=\sin\pi x+\pi x\cos\pi x=0$

$\sin\pi x=-\pi x\cos\pi x$

$\tan\pi x=-\pi x$

3 solutions



56. B

Sol. $\cos^{-1} x + \sin^{-1} x + \tan^{-1} x = \pi - \cot^{-1} x$ for $x \in [0, 1]$

$\frac{\pi}{2} + \tan^{-1} x = \pi - \cot^{-1} x$, $\tan^{-1} x + \cot^{-1} x = \frac{\pi}{2}$

For $x \in [-1, 0)$, $\cos^{-1} x - \sin^{-1} x - \tan^{-1} x = \pi - \cos^{-1} x$ does not satisfy

So, $[a, b] = [0, 1]$, $a + b = 1$

57. C

Sol. $\frac{1-\cos 4x}{2} = \frac{1+\cos 2x}{2}$, $\cos 4x + \cos 2x = 0$, $2 \cos 3x \cos x = 0$

$x = (2n+1)\frac{\pi}{6}$, $\frac{\pi}{6}, \frac{\pi}{2}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{9\pi}{6}, \frac{11\pi}{6}$

58. C

Sol. Equation of AB as chord of contact T = 0

$x\alpha + y\beta - 16 = 0$ ….. (1)

Also, equation of AB $2x + y = 3$ ….. (2)

$\frac{\alpha}{2} = \frac{\beta}{1} = \frac{16}{3}$, $\alpha = \frac{32}{3}$, $\beta = \frac{16}{3}$, $\alpha + \beta = \frac{48}{3} = 16$

59. C

Sol. Let α, β, γ are roots then $f(x) = (x - \alpha)(x - \beta)(x - \gamma)$, $(5 - \alpha)(5 - \beta)(5 - \gamma) = 2$

$5 - \alpha = 1$, $5 - \beta = 1$, $5 - \gamma = 2$, $\alpha = 4$, $\beta = 4$, $\gamma = 3$, $a = 4 + 4 + 3 = 11$

60. C

Sol. $3x^2 + 4y^2 = 1$, Tangent at $P(x_1, y_1)$

$3xx_1 + 4yy_1 = 1$ ….. (1)

$x + y = 1$ ….. (2)

Comparing $\frac{3x_1}{1} = \frac{4y_1}{1} = 1$, $x_1 = \frac{1}{3}$, $y_1 = \frac{1}{4}$, $3x_1 + 8y_1 = 3$

61. C

Sol. $[x] + [2x] = 4$

Case-I: $[x] = 0$, $[2x] = 4$ not possible

Case-II: $[x] = 1$, $[2x] = 3$

$1 \le x < 2$ $3 \le 2x < 4$

$\frac{3}{2} \le x < 2$ possible

$[x] = 2$ $[2x] = 2$ not possible

62. C

Sol. $f(x) = \frac{e^x - e^x}{10e^x + e^x} = 0$ for $x \ge 0$

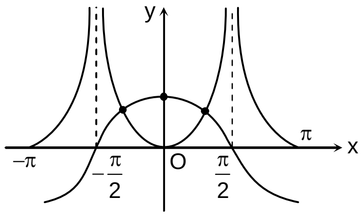
$= \frac{e^x - e^{-x}}{10e^x + e^{-x}} = \frac{e^{2x} - 1}{10e^{2x} + 1}$ for $x < 0$

For $x < 0$, $f(x) = \frac{2e^{2x} - 1}{10\left(e^{2x} + \frac{1}{10}\right)} = \frac{e^{2x} + \frac{1}{10} - \frac{11}{10}}{10\left(e^{2x} + \frac{1}{10}\right)} = \frac{1}{10}\left[1 - \frac{\frac{11}{10}}{e^{2x} + \frac{1}{10}}\right]$

$\frac{1}{10} < e^{2x} + \frac{1}{10} < \frac{1}{10} + 1$, $f(x) \in (-1, 0)$. Range of $f(x)$ is $(-1, 0]$

63. A

Sol. f(x) = max(|tan x|, cos |x|) is $(-\pi, \pi)$
3 critical points



64. C

Sol. Area of ΔCQR = constant = ab = $2\sqrt{3}$

65. B

Sol. $(a + bw + cw^2) = (a + bw + cw^2)(a + bw^2 + cw) = a^2 + b^2 + c^2 - ab - bc - ac$

$= \frac{(a-b)^2 + (b-c)^2 + (c-a)^2}{2} = \frac{1^2 + 2^2 + 3^2}{2} = 7$

66. B

Sol. Let $\frac{x-1}{2} = \frac{y+1}{3} = \frac{z-1}{4} = \lambda$, $x = 2\lambda + 1$, $y = 3\lambda - 1$, $z = 4\lambda + 1$ lies on 2nd line $\frac{x-3}{1} = \frac{y-k}{2} = \frac{z}{1}$

$\frac{2\lambda+1-3}{1} = \frac{3\lambda-1-k}{2} = \frac{4\lambda+1}{1}$. So, $2\lambda - 2 = 4\lambda + 1$, $2\lambda = -3 \Rightarrow \lambda = -\frac{3}{2}$

$\alpha = -2$, $\beta = -\frac{11}{2}$, $\gamma = -5$, $\alpha + \gamma - 2\beta = -2 - 5 + 11 = 4$

67. A

Sol. Shown in the table

p	q	$\sim(p \vee q)$	$\sim p \wedge q$	$\sim(p \vee q) \vee (\sim p \wedge q)$
T	T	F	F	F
T	F	F	F	F
F	T	F	T	T
F	F	T	F	T

68. B

Sol. Sum 4 = {(1, 3), (2, 2), (3, 1)}
Sum 7 = {(1, 6), (2, 5), (3, 4), (4, 3), (5, 2), (6, 1)}
n(E) = 6, n(S) = 9, $p(E) = \frac{6}{9} = \frac{2}{3}$

69. B

Sol. $\alpha = \vec{a} + \vec{a} \times \vec{b} \cdot \left(\vec{b} + \left(\vec{a} \times \vec{b}\right)\right) \times \left(\vec{a} \times \vec{b}\right) = \left(\vec{a} + \vec{a} \times \vec{b}\right) \cdot \left(\left(\vec{b} \cdot \vec{b}\right)\vec{a} - \left(\vec{b} \cdot \vec{a}\right)\vec{b}\right) = 1 - 0 + 0 + 0 = 1$

$$\beta = \begin{vmatrix} \vec{a} \cdot \vec{b} & \vec{a} \cdot i \\ \vec{b} \cdot \vec{c} & i \cdot \vec{i} \end{vmatrix} + \begin{vmatrix} \vec{a} \cdot \vec{b} & \vec{a} \cdot \vec{j} \\ \vec{b} \cdot \vec{j} & \vec{j} \cdot \vec{j} \end{vmatrix} + \begin{vmatrix} \vec{a} \cdot \vec{b} & \vec{a} \cdot \vec{k} \\ \vec{b} \cdot \vec{k} & \vec{k} \cdot \vec{k} \end{vmatrix} = 2\left(\vec{a} \cdot \vec{b}\right) = 0$$

70. B

Sol. $z^2 = \bar{z}$, $\Rightarrow \bar{z}^2 = z \Rightarrow z^4 = z \Rightarrow$ 4 solutions
So, coefficient of x^{11} in $(2x^2 + x - 3)^6$
= coefficient of x^{11} in $(x - 1)^6(2x + 3)^6$ = ${}^6C_0 \times {}^6C_1 2^5 \times 3 - {}^6C_1 \times {}^6C_0 2^6$
$= 3 \times 6 \times 2^5 - 6 \times 2^6 = 6 \times 2^5 (3 - 2) = 192$

SECTION – B

71. 2

Sol. $\frac{dy}{dx} = \frac{y(1+xy)}{x} = \frac{y}{x} + y^2 \Rightarrow \frac{1}{y^2}\frac{dy}{dx} - \frac{1}{xy} = 1$

Put $\frac{1}{y} = t$, $-\frac{1}{y^2}\frac{dy}{dx} = \frac{dt}{dx}$, $-\frac{dt}{dx} - \frac{1}{x}t = 1$, $\frac{dt}{dx} + \frac{t}{x} = -1$

If = $e^{\int \frac{1}{x}dx} = x$, $t \cdot x = \int -1 \cdot x\,dx$, $\frac{x}{y} = -\frac{x^2}{2} + c$, $\frac{4}{2} = -8 + c \Rightarrow c = 10$

$\frac{x}{y} = 10 - \frac{x^2}{2} \Rightarrow y = \frac{2x}{20 - x^2}$, $f(4) = \frac{8}{20-16} = 2$

72. 4

Sol. 5 sin x = ℓ(sin x – 2 cos x) + m(cos x + 2 sin x), ℓ + 2m = 5, m – 2ℓ = 0 $\therefore$ ℓ = 1, m = 2

So, $\int \frac{5\sin x}{\sin x - 2\cos x}dx = \int 1 \cdot dx + 2\int \frac{\cos x + 2\sin x}{\sin x - 2\cos x}dx$ = x + 2 ln |sin x – 2 cos x| + c

A = 1, B = 2, 2A + B = 4

SECTION – C

73. 00040.50

Sol. $\Sigma x = 210$, $\Sigma x^2 = 2530$

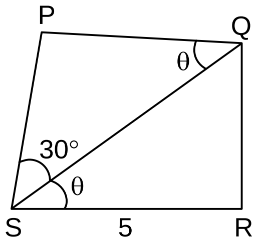
Increase in $\Sigma x = 10$ then $\Sigma x' = 220$

Increase in $\Sigma x^2 = 1600 - 900 = 700$

$\Sigma x'^2 = 2530 + 700 = 3230$

Variance = $\frac{1}{n}\Sigma x'^2 - \left(\frac{\Sigma x'}{n}\right)^2 = \frac{1}{20} \times 3230 - \left(\frac{220}{20}\right)^2 = \frac{323}{2} - 121 = \frac{323 - 242}{2} = \frac{81}{2} = 40.50$

74. 00003.71



Sol. $SQ = \sqrt{25 + 27} = \sqrt{52}$ and let ∠QSR = θ, then ∠PQS = θ

∠SPQ = 180° – 30° – θ = 150° – θ = π – θ – 30°

In ΔPQS, $\frac{SQ}{\sin(\pi - \theta - 30^\circ)} = \frac{PQ}{\sin 30^\circ}$, $\frac{\sqrt{52}}{\sin(\theta + 30^\circ)} = \frac{PQ}{\frac{1}{2}}$

$PQ = \frac{\sqrt{13}}{\sin\theta\cos 30^\circ + \sin 30^\circ \cos\theta}$

$= \frac{\sqrt{13}}{\frac{3\sqrt{3}}{\sqrt{52}} \times \frac{\sqrt{3}}{2} + \frac{1}{2} \times \frac{5}{\sqrt{52}}} = \frac{\sqrt{13} \times 2\sqrt{52}}{9 + 5}$

$= \frac{52}{14} = \frac{26}{7} = 3.714$

75. 00004.33

Sol. $x = \frac{1}{1 - \frac{1}{4}} = \frac{4}{3}$, $y = \frac{1}{1 - \frac{1}{2}} = 2$, $z = \frac{1}{1 - \frac{1}{c}}$, $\frac{2}{y} = \frac{1}{x} + \frac{1}{z}$, $1 = \frac{3}{4} + 1 - \frac{1}{c}$, $c = \frac{4}{3}$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – IX

JEE (Advanced)-2020

PAPER – 1

TEST DATE: 16-09-2020

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

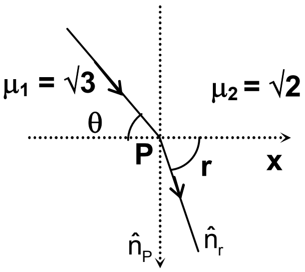
SECTION – A

1. C

Sol. Angle between normal x-axis and incident ray is

$\left(5\sqrt{2}\hat{i}-5\hat{j}-5\hat{k}\right).(\hat{i})=10\cdot 1\cdot \cos\theta$

$\cos\theta = \frac{1}{\sqrt{2}} \Rightarrow \theta = 45^\circ$



Applying snell's Law at P

$\mu_1 \sin\theta = \mu_2 \sin r$

$\sqrt{3}\cdot\frac{1}{\sqrt{2}}=\sqrt{2}\sin r$

$r = 60^\circ$

The unit vector along the refracted ray

$\hat{n}_r=\cos r\hat{i}+\sin r\hat{n}_P$

$\hat{n}_r=\cos 60^\circ\hat{i}+\sin 60^\circ\left(\frac{-\hat{j}-\hat{k}}{\sqrt{2}}\right)$

$\hat{n}_r=\frac{1}{2}\hat{i}+\frac{\sqrt{3}}{2\sqrt{2}}\left(-\hat{j}-\hat{k}\right)$

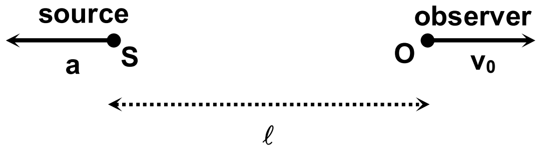
$\hat{n}_r=\frac{\sqrt{2}\hat{i}-\sqrt{3}\hat{j}-\sqrt{3}\hat{k}}{\sqrt{8}}$

2. B

Sol. Apparent wavelength

$$\lambda' = vT + \frac{1}{2}aT^2$$

Apparent frequency received by the observer

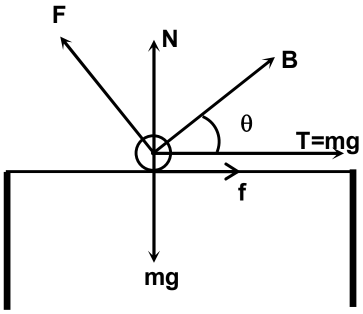


$$f' = \frac{v - v_0}{\lambda'} = \frac{(v - v_0)}{vT + \frac{1}{2}aT^2}$$

$$= \frac{(v - v_0)}{\frac{v}{f} + \frac{a}{2f^2}} = \frac{2(v - v_0)f^2}{(2vf + a)}$$

3. A

Sol. $F_{min} = \frac{\mu mg + mg}{\sqrt{1+\mu^2}}$



$$i\ell B_{min} = \frac{\mu mg + mg}{\sqrt{1+\mu^2}}$$

$B_{min} = 6$ Tesla

4. C

Sol. $v_0 = A\omega = A\sqrt{\frac{k}{m}} = 5\ell_0\sqrt{\frac{k}{m}}$

$A = 5\ell_0$

$x = A \sin \omega t$

$$3\ell_0 = 5\ell_0 \sin\left(\sqrt{\frac{k}{m}}t_1\right),\ t_1 = \left(\frac{37^\circ}{180^\circ}\pi\right)\sqrt{\frac{m}{k}}$$

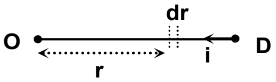
$$4\ell_0 = 5\ell_0 \sin\left(\sqrt{\frac{k}{m}}t_2\right),\ t_2 = \left(\frac{53^\circ}{180^\circ}\pi\right)\sqrt{\frac{m}{k}}$$

So, time period of oscillation

$$T = 2(t_1 + t_2) = 2\left(\frac{90^\circ}{180^\circ}\pi\sqrt{\frac{m}{k}}\right) = \left(\pi\sqrt{\frac{m}{k}}\right)$$

5. B, C, D

Sol. Taking torque about 'O' at time 't'



$$\tau = \int_0^{\ell}\left[\frac{\frac{1}{2}B\omega\ell^2}{R}\cdot dr \cdot B\right]r$$

$$\tau = \frac{B^2\omega\ell^4}{4R}$$

6. A, B, C, D

Sol. $\text{K.E.} = \frac{1}{2}mv^2 \propto \left(\frac{z}{n}\right)^2$

$\Rightarrow v \propto \frac{z}{n}$

$f = \frac{v}{2\pi r} \propto \frac{z^2}{n^3}$

$L = \frac{nh}{2\pi} \propto n$

7. A, B, C, D

Sol. (A) When S_1, S_2 both are open capacity of the system is C_1. Then C_1.

$$C_1 = \frac{\frac{4\pi\varepsilon_0(4R)(2R)}{(4R-2R)}(4\pi\varepsilon_0 6R)}{\frac{4\pi\varepsilon_0(4R)(2R)}{(4R-2R)} + 4\pi\varepsilon_0 6R}$$

$$C_1 = \frac{48\pi\varepsilon_0 R}{5}$$

(B) When S_1 is closed but S_2 is open capacity is C_2. Find C_2.

$$C_2 = \frac{(48\pi\varepsilon_0 R)(24\pi\varepsilon_0 R)}{(48\pi\varepsilon_0 R + 24\pi\varepsilon_0 R)} = 16\pi\varepsilon_0 R$$

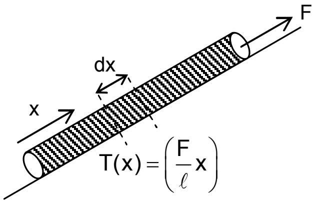
(C) When S_2 is closed but S_1 is opened capacity is C_3. Find C_3

$$C_3 = \frac{(24\pi\varepsilon_0 R)(24\pi\varepsilon_0 R)}{(24\pi\varepsilon_0 R + 24\pi\varepsilon_0 R)} = 12\pi\varepsilon_0 R$$

(D) when both S_1 and S_2 are closed. Capacity is C_4 is. Then C_4 is equal to
$C_4 = 24\ \pi\varepsilon_0 R$

8. A, B, C

Sol. Suppose $d\delta$ is increment in dx.



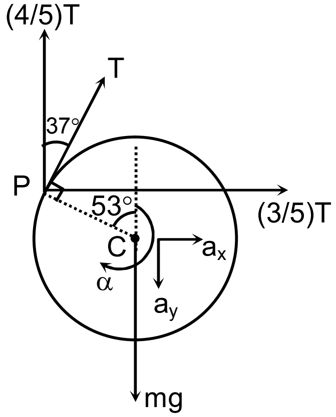
Then $\int d\delta = \frac{F}{YA\ell}\int_0^{\ell} x\,dx$

$\delta = \frac{F\ell}{2YA}$

$U = \frac{1}{2}kx^2 = \int \frac{1}{2}\left(\frac{YA}{dx}\right)\left(\frac{dx \cdot T}{YA}\right)^2 = \frac{1}{6}\left(\frac{F^2L}{YA}\right)$

9. A, B, C, D

Sol. $\frac{3}{5}T = ma_x$



$a_x = \frac{3T}{5m}$ …(i)

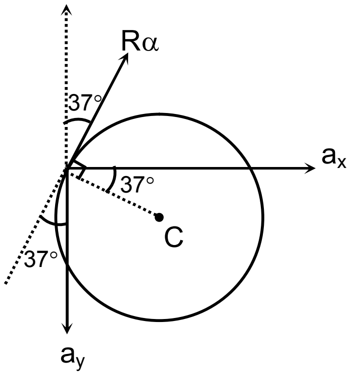
$mg - \frac{4}{5}T = ma_y$

$a_y = g - \frac{4T}{5m}$ …(ii)

$\tau_C \Rightarrow TR = \frac{2}{5}mR^2\alpha$

$R\alpha = \frac{5T}{2m}$ …(iii)

acceleration of point P along the string ‘S_1’ is zero



$R\alpha + a_x \sin 37° = a_y \cos 37°$

$R\alpha + \frac{3}{5}a_x = \frac{4}{5}a_y$ …(iv)

$\frac{5T}{2m} + \frac{3}{5}\left(\frac{3T}{5m}\right) = \frac{4}{5}\left(g - \frac{4T}{5m}\right)$

$T = \frac{8}{35}mg$

10. A, B, C, D

Sol. $C = C_v + \frac{P}{n}\left(\frac{dV}{dT}\right)$

$T = \left(\frac{T_0}{V_0}\right)V^2$

$\frac{dT}{dV} = \frac{T_0}{V_0^2}2V$

$= \frac{3}{2}R + \left(\frac{nRT}{V \cdot n}\right)\left(\frac{V_0^2}{2VT_0}\right)$

$= \frac{3}{2}R + \frac{RTV_0^2}{2T_0V^2}$

$= \frac{3}{2}R + \frac{R}{2} = \frac{4}{2}R = 2R$

$T_f = \left(\frac{T_0}{V_0^2}\right)(2V_0)^2 = 4T_0$

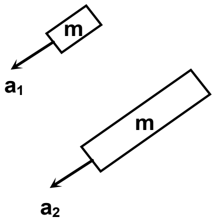
$\Delta Q = nC\Delta T = 1\,(2R)\,(4T_0 - T_0) = 6RT_0$

11. A, B, D

Sol. $\int_{P_1}^{P_5} \vec{B} \cdot \vec{d\ell} = \left(\frac{45°}{360°}\mu_0 I\right) + \left(\frac{45°}{360°}\mu_0 I\right) + \left(\frac{30°}{360°}\mu_0 I\right) - \left(\frac{15°}{360°}\mu_0 I\right) = \frac{7}{24}\mu_0 I$

12. A, B, C, D

Sol. a_1 and a_2 are acceleration of the block and the plank with respect to ground



$$a_1 = \frac{4}{5}g - \frac{1}{4}\left(\frac{3}{5}g\right) = \frac{13}{2}\ \text{m/s}^2$$

$$a_2 = \frac{4}{5}g + \frac{1}{4}\left(\frac{3}{5}g\right) - 2\left(\frac{1}{2}\right)\left(\frac{3}{5}g\right) = \frac{7}{2}\ \text{m/s}^2$$

$$a_{12} = a_1 - a_2 = \frac{13}{2} - \frac{7}{2} = 3\ \text{m/s}^2$$

$$\ell = ut + \frac{1}{2}at^2$$

$$1.8 = \frac{1}{2}(3)t^2$$

$$t = \sqrt{1.2}\ \text{sec}$$

$$d_1 = \frac{1}{2}a_1t^2 = \frac{1}{2}\times\frac{13}{2}\times 1.2 = 3.9\ \text{m}$$

SECTION – C

13. 00024.89

Sol. $$\text{Error} = \left(\frac{270^\circ}{360^\circ}\times 100\right)\times\frac{1\,\text{mm}}{100} = 0.75\,\text{mm}$$

Measured value = 24 + 0.26 –0.12 + 0.75 = 24.89 mm

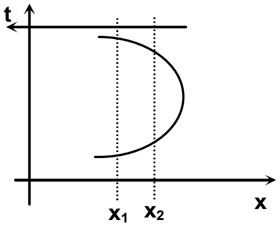
14. 00001.20

Sol. Charge particle lies at centroid of equilateral pyramid.

$$\phi = \frac{\left(\frac{q}{\varepsilon_0}\right)}{12} = \frac{q}{12\varepsilon_0}$$

15. 00005.10

Sol. $$a_0 = \frac{8(x_2 - x_1)}{(t_1^2 - t_2^2)} = \frac{8\times 7.65}{(16-4)} = 5.10$$



16. 00012.50

Sol. Impulse, $\int F dt = m\sqrt{2gh}$

$\int (i\ell B)dt = m\sqrt{2gh}$ …(i)

$\int i dt = \Delta q$ …(ii)

$$\Delta q = \frac{m\sqrt{2gh}}{B\ell} = \frac{20\sqrt{2\times 10\times 5}}{2\times 8} = 12.50\ \text{Coulomb}$$

17. 00000.80

Sol. $I_{C.B.F.} = K\left[A_1^2 + A_2^2 + 2A_1A_2\cos\phi\right] = I_0$

$KA^2 = \frac{I_0}{16}$, (A_1 = A, A_2 = 3A and ϕ = 0°)

$I_\theta = \frac{16}{25}K\left[A_1^2 + A_2^2 + 2A_1A_2\cos\phi\right] = I$

$\phi = \frac{2\pi}{\lambda}\Delta x = \frac{2\pi}{\lambda}\times d\sin\theta = \frac{2\pi}{\lambda}\times d\frac{3}{5}$

So, $\phi = \pi$

Hence, I = $\frac{I_0}{4}\times\frac{16}{25} = \frac{5\times 16}{100} = 0.80$ W/m^2

18. 00014.80

Sol. $\frac{dN}{dt} = r - \lambda N$

$$\int_{N_0}^{N}\frac{dN}{r-\lambda N} = \int_0^t dt$$

$\frac{dN}{dt} = r - \lambda N = (r - \lambda N_0)e^{-\lambda t}$

$= \left(10^4 - \frac{10^5}{20}\right)e^{-t/20} = \frac{5000}{7.4} = \left(\frac{10^4}{14.8}\right)$

Chemistry PART – II

SECTION – A

19. C

Sol. Thermal stability decreases with increase in bond length.

20. C

Sol. $\Delta T_b = \text{molality. } K_b$

$\Delta T_f = \text{molality. } K_f$

$\therefore \frac{\Delta T_b}{\Delta T_f} = \frac{K_b}{K_f}, \qquad \Delta T_f = \Delta T_b . \frac{K_f}{K_b}$

$\therefore \Delta T_f = 1.56 \times \frac{1.86}{0.52} = 5.58$

21. A

Sol. $\sqrt{\frac{8RT_1}{\pi M}} = \sqrt{\frac{2RT_2}{M}}$

$\therefore \frac{T_1}{T_2} = \frac{2\pi}{8} = \frac{3.14}{4} = 0.785$

22. D

Sol. $r = \frac{PA}{\sqrt{2\pi MRT}}$

$r_{He} : r_{N_2} : r_{O_2} = \frac{1}{\sqrt{4}} : \frac{1}{\sqrt{28}} : \frac{1}{\sqrt{32}}$

$\therefore P_{He} < P_{N_2} < P_{O_2}$

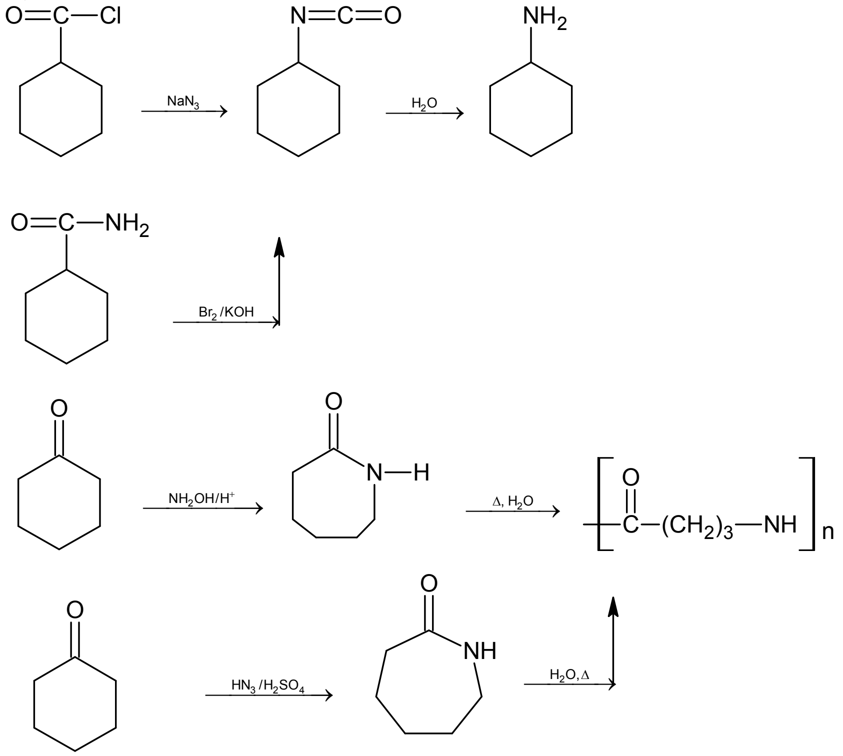
23. A, B, C

Sol. Facts.

24. C

25. B, C

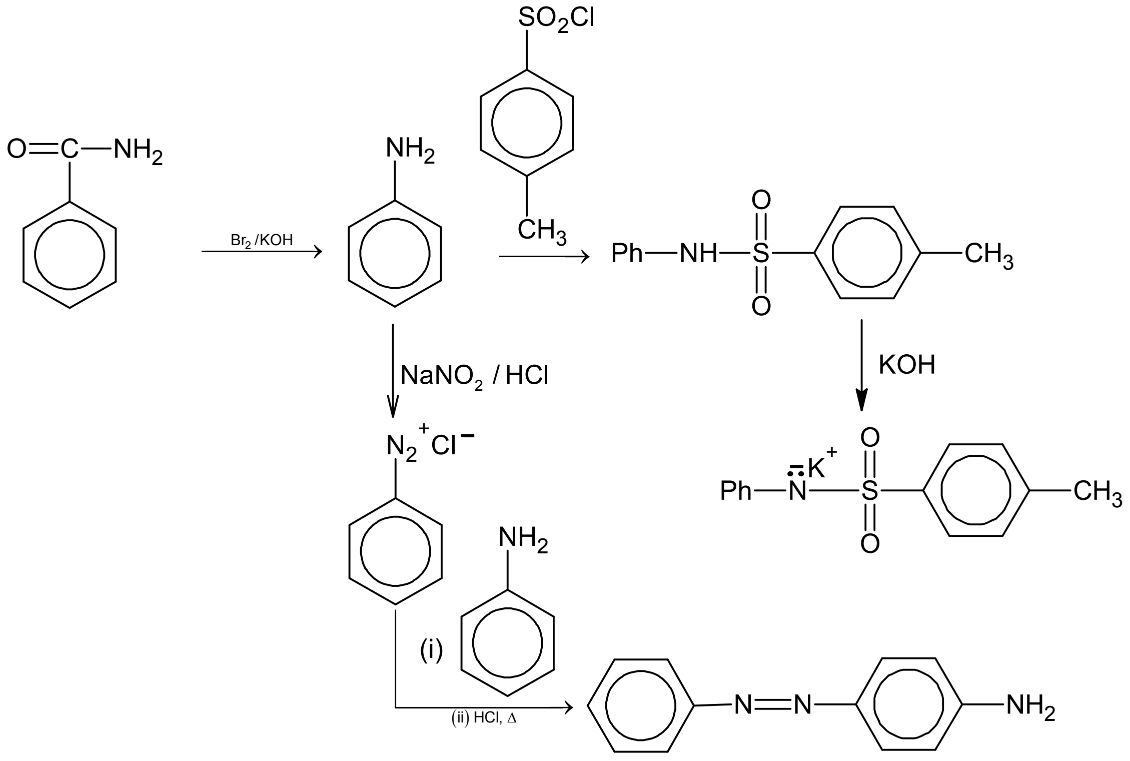
Sol.


NaN3
H2O
Br2 /KOH
NH2OH/H+
Δ, H2O
HN3 /H2SO4
H2O,Δ
O=C—Cl
N=C=O
NH2
O=C—NH2
N—H
NH
C—(CH2)3—NH
n

26. A, D

27. A, B, C, D

Sol.


O=C—NH2
Br2 /KOH
NH2
SO2Cl
CH3
Ph—NH—S—CH3
KOH
Ph—N̈—S—CH3
K+
NaNO2 / HCl
N2+Cl−
(i)
(ii) HCl, Δ
N=N—NH2

28. A, B, C

Sol. $2NH_3 + 2H_2O \rightleftharpoons 2NH_4^+ + 2\overset{-}{O}H$

$H_2S \rightleftharpoons 2H^+ + S^{2-}$

$2H^+ + 2\overset{-}{O}H \longrightarrow 2H_2O$

Hence, conc. Of S^{2-} is large.

$\therefore$ Both IInd and IV group cation will precipitate as S^{2-} salt.

29. A, B, D

Sol. Cinnabar → HgS

Galena → PbS

Chalcocite → Cu_2S

Bauxite → $Al_2O_3.2H_2O$

Sulphide ores can be concentrated by this method.

30. A, B, C, D

Sol. $BiCl_3 \xrightarrow{NaOH} Bi(OH)_3 + NaCl$

$$\underset{(P)}{Bi(OH)_3} \xrightarrow[\text{ii) KI}]{\text{i) conc. HCl}} \underset{\substack{\text{Black}\\(U)}}{BiI_3 \downarrow} \xrightarrow{KI} \underset{\substack{\text{Orange}\\(V)}}{K[BiI_4]}$$

$$\underset{(Q)}{NaCl} \xrightarrow[H_2SO_4]{K_2Cr_2O_7} \underset{\substack{\text{Red gas}\\(R)}}{CrO_2Cl_2 \uparrow} \xrightarrow{NaOH} \underset{\substack{\text{Yellow solution}\\(S)}}{Na_2CrO_4} \xrightarrow{AgNO_3} \underset{\substack{\text{Brick red ppt.}\\(T)}}{Ag_2CrO_4 \downarrow}$$

SECTION – C

31. 00060.25

Sol. $K_H = P_A/Y_A$

Partial pressure of O_2 = 0.21 atm = 21278.2 Pa.

$P_{N_2} = 0.79 \text{ atm} = 80046.8 \text{ Pa}$

$$X_{O_2} \text{ in dissolved water } = \frac{21278.2}{2.03 \times 10^8} = 10.4819 \times 10^{-5}$$

$$X_{N_2} \text{ dissolved in water } = \frac{80046.8}{5.07 \times 10^8} = 15.7883 \times 10^{-5}$$

$$\frac{X_{O_2}}{X_{N_2}} = 0.6639 = 0.66$$

$$\% \text{ of } O_2 = \frac{0.66}{1.66} \times 100 = 39.75$$

% of N_2 = 60.25

32. 00061.83

Sol. Mass of dissolved naphthalene = 0.624 gm

Mass of solvent (CCl_4) = 0.060 kg

$$\text{Molality} = = \frac{0.624 / 128.2}{0.060} = 0.08$$

$$\Delta T_b = K_b m$$

$$\therefore K_b = \frac{0.42}{0.08} = 5.25$$

For unknown solution

$$0.75 = 5.25 \times \frac{0.53}{M \times 0.06}$$

$$M = 61.8333 \approx 61.83$$

33. 00001.53

Sol. $M_{mix} = \frac{(2\times 28)+(3\times 4)}{5} = 13.6$

$\frac{r_{mix}}{r_{O_2}} = \frac{5}{5}\sqrt{\frac{32}{13.6}} = 1.5339 \approx 1.53$

34. 00023.00

Sol. $V_2 = \frac{P_1V_1}{P_2} = \frac{1\times 10}{1} = 10\ m^3$

$n = \frac{P_1V_1}{RT} = \frac{10\times 1\times 10^3}{(0.0821)(273.15)} = 445.9186$

≈ 445.92

$W = -\,2.303\ nRT\log\frac{P_1}{P_2}$

= - 2.303 × (445.82) (0.0821) (273.15)log10

= - 23002.018 J = - 23.00 kJ

35. 00001.15

Sol. $LiCl.3NH_3(s) \rightleftharpoons LiCl.NH_3(s) + 2NH_3(g)$

$LiCl.NH_3(s) + 2NH_3(g) \rightleftharpoons LiCl.3NH_3(s),\ K'_P = \frac{1}{16}\ atm^{-2}$

Initially	0.2	a	–
Finally	0	$a-0.4$	0.2

$K'_P == \frac{1}{P^2_{NH_3}} = \frac{1}{16}$

$\therefore P_{NH_3} = 4$ atm at equilibrium

PV = nRT

4 × 5 = n × 0.0821 × 323

n = 0.75419 ≈ 0.75 moles at equilibrium.

∴ Initial moles of NH_3 = 0.75 + 0.4 = 1.15.

36. 00209.18

Sol. $n = PV/RT = \frac{(1)(200\times 10^{-3})}{(0.0821)(273)} = 8.92\times 10^{-3}$

Number of Xe atom = $8.92 \times 10^{-3} \times 6.02 \times 10^{23}$

= 53.70×10^{20}

Volume occupied by atoms $= \left(\frac{4}{3}\pi r^3\right)\times 53.70\times 10^{20}$

= 418.36×10^{-7}

% of Volume occupied by He atoms = $= \frac{418.36\times 10^{-7}}{200}\times 100$

$= 209.18$

Mathematics PART – III

SECTION – A

37. C

Sol. Let A(0, a) and B(b, 2b)

Coordinate of P is $\left(\frac{2a}{5}, \frac{4a}{5}\right)$

Coordinate of Q is (0, 2b)

Equation of AB is $y - a - \left(2 - \frac{a}{b}\right)x = 0$

$\because$ It passes through (1, 3) hence $a = \frac{b}{b-1}$

Also equation of PQ is $y - 2b = \left(2 - \frac{5b}{a}\right)x$

i.e., y – 7x + b(x – 2) = 0

$\therefore$ Fixed point is $\left(\frac{2}{5}, \frac{14}{5}\right)$

38. B

Sol. $\int_0^{\pi/2} \frac{\sin 40x}{\sin 5x} = 2\int_0^{\pi/2} \left[\cos 5x + \cos 15x + \cos 25x + \cos 35x\right]dx = \frac{2}{5}\left(1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7}\right)$

39. C

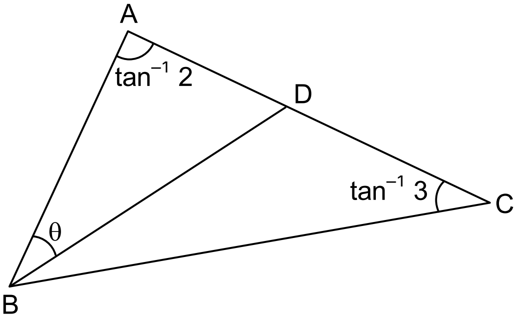
Sol. $e^{2x}f(x) = -\frac{1}{2}\tan x + e^{2x}\int_0^x e^{-2t}\tan t\,dt$

$$e^{2x}\left(f'(x) + 2f(x)\right) = -\frac{1}{2}\sec^2 x + e^{2x}e^{-2x}\tan x + 2\int_0^x e^{-2t}\tan t\,dt \cdot e^{2x}$$

$$\Rightarrow e^{2x}\left(f'(x) + 2f(x)\right) = -\frac{1}{2}\sec^2 x + \tan x + 2\left(e^{2x}f(x) + \frac{1}{2}\tan x\right)$$

$$\Rightarrow e^{2x}f'(x) = 2\tan x - \frac{1}{2}\sec^2 x \Rightarrow f'(x) = e^{-2x}\left(2\tan x - \frac{1}{2}\sec^2 x\right)$$

40. B



Sol. Let $\angle ABD = \theta$

$\because$ $\Delta ABD = \frac{9}{2}\Delta BCD$

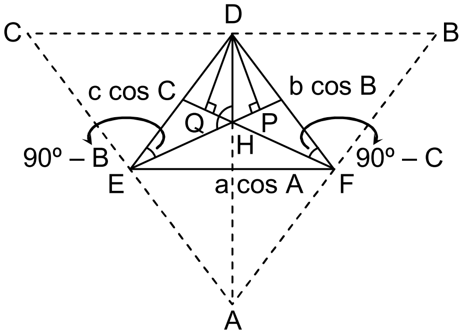
$\frac{1}{2}AB\,BD\sin\theta = \frac{9}{2}\cdot\frac{1}{2}BC\,BD\sin\left(\frac{\pi}{4} - \theta\right)$

$$\Rightarrow \frac{\sin\left(\tan^{-1}3\right)}{\sin\left(\tan^{-1}2\right)} = \frac{9}{2\sqrt{2}}\left(\frac{\cos\theta - \sin\theta}{\sin\theta}\right)$$

$$(\cot\theta - 1)\frac{9}{2\sqrt{2}} = \frac{3}{2\sqrt{2}}$$

$$\Rightarrow \cot\theta - 1 = \frac{1}{3} \Rightarrow \cot\theta = \frac{4}{3}$$

41. A, C



Sol. $\sin(90^\circ - B) = \frac{DP}{DE}$

$\Rightarrow$ DP = c cos C·cos B

Also applying sine rule in ΔDEH

$$\frac{c\cos C}{\sin(180^\circ - C)} = \frac{EH}{\sin(90^\circ - A)}$$

$$\Rightarrow EH = \frac{c\cos C\cos A}{\sin C}$$

$$\therefore \frac{DP}{EH} = \frac{\sin C\cos B}{\cos A}$$

Similarly $\frac{DQ}{FH} = \frac{\sin B\cos C}{\cos A}$ $\therefore \frac{DP}{EH} + \frac{DQ}{FH} = \tan A$

42. A, D

Sol. $$I_1 = \int_0^{\frac{\pi}{200}} \sin\left(2\pi\cos^2 100x\right)dx$$

$$I_1 = \int_0^{\frac{\pi}{200}} \sin\left(2\pi\sin^2 100x\right)dx$$

$$2I_1 = \int_0^{\frac{\pi}{200}} 2\sin\pi\cdot\cos(\pi\cos 200x)dx = 0$$

$$I_2 = \int_0^{\frac{\pi}{200}} \sin\left(\pi\sin^2 100x\right)dx = \int_0^{\frac{\pi}{200}} \sin\left(\pi\cos^2 100x\right)dx$$

$$2I_2 = \int_0^{\frac{\pi}{200}} 2\cos\left(\frac{\pi}{2}\cos 200x\right)dx$$

$$I_2 = 2\int_0^{\frac{\pi}{400}} \cos\left(\frac{\pi}{2}\cos 200x\right)dx$$

Let 2x = t, $\int_0^{\frac{\pi}{200}} \cos\left(\frac{\pi}{2}\cos 100t\right)dt = \int_0^{\frac{\pi}{200}} \sin\left(\pi\sin^2 50t\right)dt$

43. B, C

Sol.
$$f(x) = \begin{cases} 2\pi + 4\tan^{-1}\frac{x}{2} & ; \quad x < -2 \\ \pi & ; \quad -2 \le x < 0 \\ \pi - 4\tan^{-1}\frac{x}{2} & ; \quad 0 \le x \le 2 \\ 0 & ; \quad x > 2 \end{cases}$$

44. B, C, D

Sol. Image of P(10, 25, 35) about the plane x + y + z = 100 is S(30, 45, 55)

Here, equation of reflected ray is

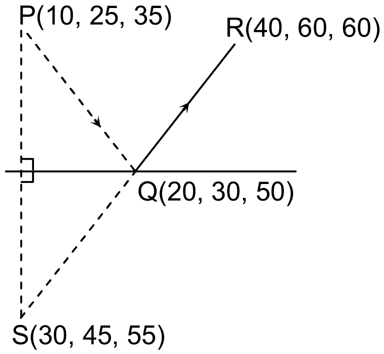
$$\frac{x-40}{2}=\frac{y-60}{3}=\frac{z-60}{1}=r$$

Also, point Q is (20, 30, 50)

$\therefore$ Equation of incident ray is $\frac{x-10}{2}=\frac{y-25}{1}=\frac{z-35}{3}$

Equation of plane containing the line PQ and RQ is

$$\begin{vmatrix} x-10 & y-25 & z-35 \\ 2 & 1 & 3 \\ 2 & 3 & 1 \end{vmatrix}=0 \text{ i.e., } 2x-y-z+40=0$$



45. A, C

Sol. $f'(C_1)=\frac{f(8)-f(0)}{8}=\frac{1}{2}$

$f(C_2)=\frac{f(4)+f(8)}{2}=3$

Let $g(x)=\int_0^{x^{3/2}} f(t)dt$

$\Rightarrow g'(x)=\frac{3}{2}\sqrt{x}\, f\left(x^{3/2}\right)$

$g'(\alpha)+g'(\beta)=\frac{g(4)-g(0)}{2}$

$\Rightarrow 3\left[\alpha f\left(\alpha\sqrt{\alpha}\right)+\beta f\left(\beta\sqrt{\beta}\right)\right]=\int_0^8 f(t)dt$

Let $g(x)=\int_0^{x^2} f(t)dt$

$g'(x) = 2xf(x^2)$

$g'(\alpha)=\frac{g(2)-g(0)}{2}$

$g'(\beta)=\frac{g(4)-g(2)}{2}$

$\Rightarrow g'(\alpha)+g'(\beta)=\frac{g(4)-g(0)}{2}$

46. A, B, C, D

Sol. $f(\alpha)=\frac{\alpha}{\sqrt{1-\alpha^2}}$

47. A, C, D

Sol. Let removed numbers are 2r – 1, 2r + 3, 2r + 7

$$\frac{n^2-3(2r+3)}{n-3}=\frac{105}{2}$$

$\Rightarrow r = \dfrac{2n^2 - 105n + 297}{12}$

$\because 1 \le \dfrac{2n^2 - 105n + 297}{12} \le n - 4$

$\Rightarrow 50 \le n \le 55$

Possible values of n are 51, 53, 55

For n = 51, r = 12 $\therefore$ Removed numbers are 23, 27, 31

48. A, B, C

Sol. $(A - 2I)^4 = 5A \Rightarrow \text{Det}(A - 2I)^4 = \text{Det}(5A) \Rightarrow \text{Det}(A - 2I) = \pm 5$

$\therefore$ Det B = 5. Also, $I - 2A^{-1} = A^{-1}B$, $\text{Det}(I - 2A^{-1}) = \text{Det}(A^{-1}B) = 1$

$\Rightarrow \text{Det}(\text{Adj}(I - 2A^{-1})) = 1$, $\text{Det}\left(\dfrac{B}{5}\right)^{-1} = \dfrac{1}{\text{Det}\left(\dfrac{B}{5}\right)} = 25$

$\Rightarrow \text{Det}\left(\text{Adj}\left(\dfrac{B}{5}\right)\right)^{-1} = 25^2 = 625$

Also, $I + 2B^{-1} = AB^{-1} \Rightarrow \text{Det}(I + 2B^{-1}) = 1$

SECTION – C

49. 00054.00

Sol. $\hat{p} = \dfrac{\hat{a} + \hat{b}}{\left|\hat{a} + \hat{b}\right|} = \dfrac{\hat{a} + \hat{b}}{\sqrt{3}}$

Similarly $\hat{q} = \dfrac{\hat{b} + \hat{c}}{\sqrt{3}}$ and $\hat{r} = \dfrac{\hat{c} + \hat{a}}{\sqrt{3}}$

Volume of regular tetrahedron = $\dfrac{\sqrt{3}}{2\sqrt{2}}$

$\left[\hat{p}\times\hat{q} \quad \hat{q}\times\hat{r} \quad \hat{r}\times\hat{p}\right] = \left[\hat{p} \ \hat{q} \ \hat{r}\right]$ = $\left[\dfrac{\hat{a}+\hat{b}}{\sqrt{3}} \ \dfrac{\hat{b}+\hat{c}}{\sqrt{3}} \ \dfrac{\hat{c}+\hat{a}}{\sqrt{3}}\right]^2$ = $\dfrac{4}{27}\times\left[\hat{a} \ \hat{b} \ \hat{c}\right]^2 = 2$

50. 01854.00

Sol. $a - 1 + ar^2 = 2ar$

$\Rightarrow (r - 1)^2 = \dfrac{1}{a} \Rightarrow r = 1 \pm \dfrac{1}{\sqrt{a}}$; $a = k^2$, $k \in I$

If a = 4, then $r = \dfrac{3}{2}, \dfrac{1}{2}$

$\therefore$ abc = 469 or 421

If a = 9, then $r = \dfrac{2}{3}, \dfrac{4}{3}$

$\therefore$ abc = 964; $r \ne \dfrac{4}{3}$

51. 00008.00

Sol. $\dfrac{a^{20}b + b^{20}a - (a + b)\left(a^{19}b + b^{19}a\right)}{a^{18}b + b^{18}a} = -ab$

52. 00005.00

Sol. $f(x) = \frac{10}{9}\frac{x^5}{1+x^4}$

$f(x) = \frac{5}{9}$ at x = 1

Required area $A = \frac{5}{9} - \int_0^1 \frac{10}{9}\frac{x^5}{1+x^4}dx = \frac{5\pi}{36}$

53. 00006.00

Sol. For f(x) to be continuous at x = 2 – k or 2 + k

$\frac{\sin\alpha}{4} + k^2 = \frac{\cos\alpha}{4} + k$ ..... (1)

$f'(2-k)^- = -1$, $f'(2-k)^+ = -2k$

∵ f(x) is differentiable

∴ $f'(2+k)^+ = f'(2+k)^- \Rightarrow k = \frac{1}{2}$

54. 00002.00

Sol. $20\left(1+x+x^2\right)^{20}(1+2x) = \sum_{k=1}^{40}\left(ka_k x^{k-1}\right)\left(1+x+x^2\right)$

Equating coefficient of x^{10} on both sides

$20\left[a_{10} + 2a_9\right] = 11a_{11} + 10a_{10} + 9a_9$

$\Rightarrow 11a_{11} = 10a_{10} + 31a_9$

$\Rightarrow \frac{\gamma - \alpha}{\beta} = 2$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – IX

JEE (Advanced)-2020

PAPER – 1

TEST DATE: 16-09-2020

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section–A (01 – 04, 19 – 22, 37 – 40)*** *contains 12 multiple choice questions which out of 4 options have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (05 – 12, 23 – 30, 41 – 48) *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–1** In all other cases.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A ray of light moving along vector $\left(5\sqrt{2}\hat{i}-5\hat{j}-5\hat{k}\right)$ undergoes refraction at an interface of two media, which is y-z plane. The refractive index for $x \le 0$ is $\sqrt{3}$ while for $x \ge 0$ it is $\sqrt{2}$. Then the unit vector along the refracted ray is

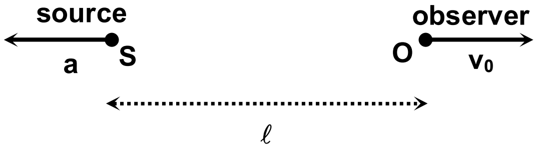
(A) $\dfrac{\sqrt{3}\hat{i}-\sqrt{2}\hat{j}-\sqrt{2}\hat{k}}{\sqrt{8}}$

(B) $\dfrac{\sqrt{3}\hat{i}-\sqrt{3}\hat{j}-\sqrt{2}\hat{k}}{\sqrt{8}}$

(C) $\dfrac{\sqrt{2}\hat{i}-\sqrt{3}\hat{j}-\sqrt{3}\hat{k}}{\sqrt{8}}$

(D) $\dfrac{\sqrt{2}\hat{i}+\sqrt{3}\hat{j}-\sqrt{3}\hat{k}}{\sqrt{8}}$

2. At t = 0, source starts accelerating with an acceleration a and observer starts moving with constant velocity v_0 as shown in the figure simultaneously. Source emits a frequency f and velocity of sound in the air is v. The frequency of the initial sound as detected by the observer is



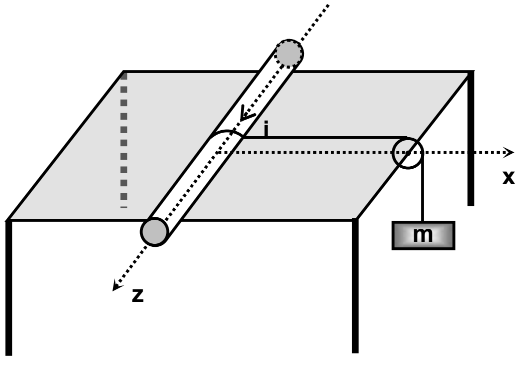
(A) $\dfrac{(v-v_0)f^2}{(2vf+a)}$

(B) $\dfrac{2(v-v_0)f^2}{(2vf+a)}$

(C) $\dfrac{(v-v_0)f^2}{(2vf-a)}$

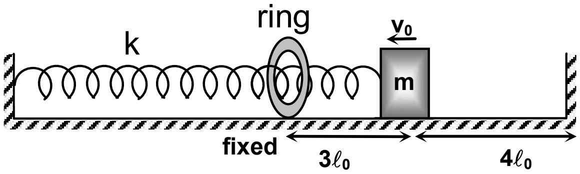
(D) $\dfrac{2(v-v_0)f^2}{(2vf-a)}$

3. A conducting rod of length 'ℓ' = $2\sqrt{5}$ meter and mass 'm' = 4 kg lies on the horizontal table and connected with a hanging block of mass 4 kg by an ideal string passing over the pulley as shown in the figure. Coefficient of friction between the rod and the table is 'μ' $=\left(\dfrac{1}{2}\right)$. If the current in the conductor is 2 ampere, then find the minimum magnitude of magnetic field strength (in Tesla) such that conducting rod just starts to translate along negative x-axis. (take g = 10 m/sec^2) [neglect the radius of rod]



(A) 6
(B) 2
(C) 4
(D) 8

4. Spring is in its natural length. Collision of the block with the ring fixed with the horizontal surface and wall is perfectly elastic. Find the time period of oscillation of block if at t = 0, a velocity $v_0 = 5\ell_0\sqrt{\frac{k}{m}}$ is given to the block.

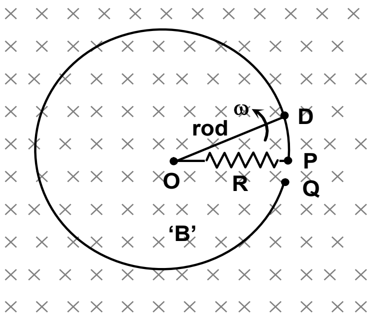


(A) $2\pi\sqrt{\frac{m}{k}}$
(B) $\frac{\pi}{2}\sqrt{\frac{m}{k}}$
(C) $\pi\sqrt{\frac{m}{k}}$
(D) $\frac{3\pi}{2}\sqrt{\frac{m}{k}}$

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

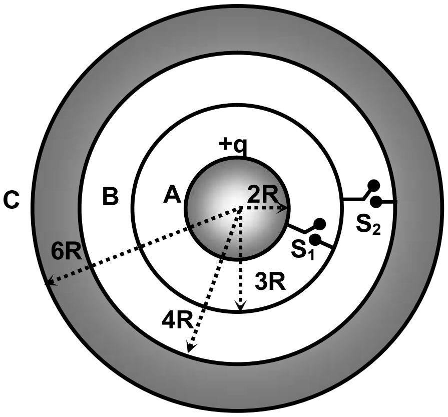
5. A conducting rod OD of mass m and length ℓ rotates about one end O, with its other end sliding smoothly on a circular conducting ring, as shown in the figure. A constant and uniform magnetic field 'B' acts into the plane of the ring and rod OD rotates with a constant angular velocity ω by applying some external force. Assume that the space is gravity free and that there is electrical contact between the ring and the rod at D. The ring and the rod have negligible resistance. There is a small gap in the ring between P and Q, so that the current flows along a unique path. Then,



(A) The torque due to external agent about O is $\frac{B^2\omega\ell^4}{2R}$
(B) The power delivered by the external agent is $\frac{B^2\omega^2\ell^4}{4R}$
(C) The rate of heat rejected by the resistor R is $\frac{B^2\omega^2\ell^4}{4R}$
(D) Work done by external agent for half revolution of rod is $\frac{\pi B^2\omega\ell^4}{4R}$

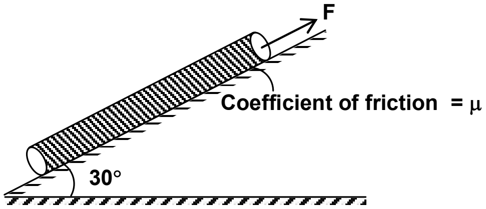
6. The magnitude of angular momentum, kinetic energy, velocity and frequency of an electron in a hydrogen atom corresponding to the quantum number n are L, K, V and f respectively. Then according to Bohr's theory of hydrogen atom:
   (A) $K^{-1}Lf$ is constant for the all orbits.
   (B) Kvf^{-1} is constant for the all orbits.
   (C) $K^{-1}Lv$ is proportional to n^2.
   (D) $K^{-1}f$ is proportional to $1/n$.

7. Three conducting bodies A(solid sphere), B(thin spherical shell) and C(hollow sphere with thickness 2R) are arranged as shown in the figure. A charge q is given to the inner sphere. Choose the correct option(s).



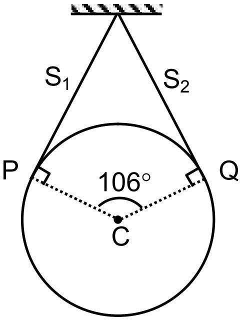
   (A) When S_1, S_2 both are open capacity of the system is C_1, then C_1 is $\frac{48\pi\varepsilon_0 R}{5}$
   (B) When S_1 is closed but S_2 is open capacity is C_2, then C_2 is $16\pi\varepsilon_0 R$
   (C) When S_2 is closed but S_1 is opened capacity is C_3, then C_3 is $12\pi\varepsilon_0 R$
   (D) When both S_1 and S_2 are closed. Capacity is C_4, then C_4 is $24\pi\varepsilon_0 R$

8. A uniform wire of mass m, length L and cross-sectional area 'A', made of a material of Young's modulus Y, is pulled by a constant force F on an inclined plane such that it move upto the inclined plane as shown in figure. Choose the correct option(s).



   (A) The extension in the wire is $\frac{F\ell}{2YA}$.
   (B) The tension in the rod at a distance $\frac{L}{4}$ from the lower end of the rod is $\frac{F}{4}$.
   (C) The elongation potential energy (elastic) in the rod is $\frac{1}{6}\frac{F^2L}{YA}$.
   (D) The elongation potential energy (elastic) in the rod is $\frac{1}{4}\frac{F^2L}{YA}$.

9. A solid sphere of mass 'm' and radius 'R' is held in equilibrium by two identical strings 'S_1' and 'S_2' of negligible mass as shown in the figure. Choose the correct option(s).



(A) Tension in the string S_2 when solid sphere is in equilibrium is $\frac{5}{8}mg$.

(B) Acceleration of point P just after cutting the string S_2 is $\frac{3}{5}g$.

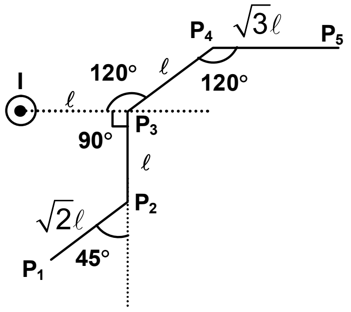
(C) Tension in the string 'S_1' immediately after cutting the string 'S_2' is $\frac{8mg}{35}$.

(D) Horizontal component of acceleration of centre of mass of solid sphere immediately after cutting the string 'S_2' is $\frac{24}{175}g$.

10. One mole of an ideal monoatomic gas undergoes a process T = $\left(\frac{T_0}{V_0^2}\right)V^2$, where T_0 and V_0 are the initial temperature and volume of the gas. If volume of gas changes from V_0 to $2V_0$. Then choose the correct option(s).

(A) The amount of heat transferred to the gas is $6RT_0$.
(B) The molar heat capacity of the gas is 2R.
(C) Final temperature of the gas is $4T_0$.
(D) The graph between the temperature and volume is parabolic.

11. A straight conducting wire of infinite length lies perpendicular to the plane of the paper and current of magnitude 'I' is flowing out to the paper as shown in figure. Then choose the correct option(s).



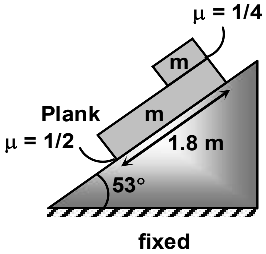
(A) The value of $\int_{P_1P_2} \vec{B}\cdot\vec{d\ell} = \frac{\mu_0 I}{8}$.

(B) The value of $\int_{P_1P_2} \vec{B}\cdot\vec{d\ell} = \int_{P_2P_3} \vec{B}\cdot\vec{d\ell}$.

(C) The value of $\int_{P_3P_4} \vec{B}\cdot\vec{d\ell} = 2\int_{P_4P_5} \vec{B}\cdot\vec{d\ell}$.

(D) The value of $\int_{P_1P_2P_3P_4P_5} \vec{B}\cdot\vec{d\ell} = \frac{7\mu_0 I}{24}$.

12. A plank of length 1.8 m and a small block of same mass initially at rest on a fixed large wedge as shown in the figure. The coefficient of friction between the plank and block is $\frac{1}{4}$ and between the plank and the wedge is $\frac{1}{2}$. Both block and plank are released from rest at t = 0. Then choose the correct option(s). (Take g = 10 m/s^2)



(A) Acceleration of the block with respect to ground is 6.5 m/s^2.
(B) Acceleration of the plank with respect to ground is 3.5 m/s^2.
(C) The time when the block just drops down from the plank is $\sqrt{1.2}$ sec.
(D) Displacement of the block with respect to the ground when the block just drops down from the plank is 3.9 m.

SECTION – C

(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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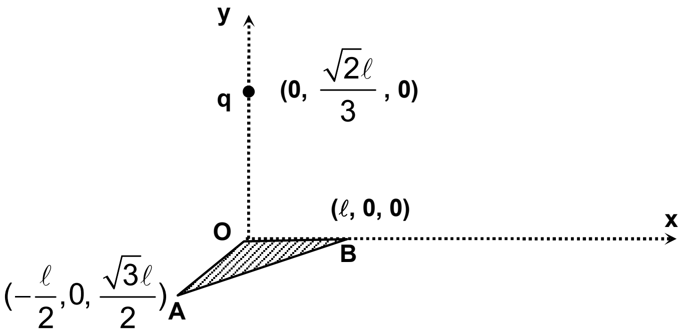
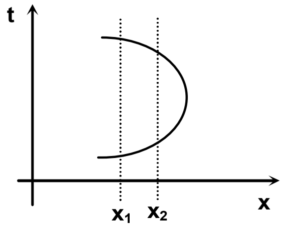
13. The pitch of a screw gauge is 1 mm and its circular scale is divided into 100 divisions. When nothing is put between the studs the zero of main scale is not seen, but when circular scale is rotated by 270° the zero of main scale is seen and the zero of main scale coincide with the 12th division of circular scale. When a glass plate is placed between the studs, the circular scale lies between 24th to 25th division of main scale and circular scale reads 26 divisions. Find the thickness of the glass plate in millimeter. (Assume value of one main scale division is same as pitch)

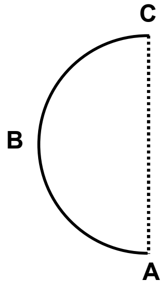
14. A point charge 'q' is placed at a distance $\frac{\sqrt{2}\ell}{3}$ (on the y-axis) vertically above the x-z plane. The flux of electric field passing through the triangular plate which lies in the x-z plane as shown in figure, is $\frac{q}{10m\varepsilon_0}$. Find the value of m.


y
q
$(0, \frac{\sqrt{2}\ell}{3}, 0)$
$(\ell, 0, 0)$
O
x
B
$(-\frac{\ell}{2}, 0, \frac{\sqrt{3}\ell}{2})$
A

15. The acceleration in a space is a_0 m/s^2 towards negative x-axis, where a_0 is a positive constant. A ball is projected and it passes through two given points x_1, x_2 in both the directions. If the time the ball takes to pass x_1 = 3.10m in both the directions is t_1 = 4 sec and time to pass x_2 = 10.75m in both the directions is t_2 = 2sec. Then find the magnitude of a_0.



16. A semicircular conducting ring ABC of mass m = 20 kg and radius R = 4m is placed on a horizontal surface and a uniform magnetic field B = 2 Tesla exists parallel to horizontal surface but perpendicular to the line AC. Almost instantaneously, a certain amount of charge is passed through it, then it is found to jump to a height h = 5m. Then, find the amount of charge passed through the conductor in coulomb. (take g = 10 m/s^2)



17. Suppose that one of the slits in YDSE is wider than the other, so the amplitude of the light reaching on screen from one slit, acting alone, is thrice that from the other slit, acting alone. The intensity for Central Bright Fringe is I_0 = 5 W/m^2. Then find the intensity I (W/m^2) on the screen for (angular position) θ = 37°. (Take $d/\lambda = 5/6$, where d is the separation between the slits and λ is the wavelength of the light)

18. A certain radio nuclide starts getting produced at a constant rate 10^4 sec^{-1} by some mechanism at a certain moment t = 0. At this moment there are already 10^5 number of radio nuclides present in the sample. The mean life of this radio-nuclide is 20 seconds. At t = 40 sec, the $\frac{dN}{dt}$ is $\frac{10^4}{K}$ (in sec^{-1}). Then find the value of K. (Take $e^2 = 7.4$)

Chemistry PART – II

SECTION – A

(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

19. The correct order of thermal stability of the following hydrides is:
(A) $H_2O < H_2S > H_2Se > H_2Te > H_2Po$
(B) $NH_3 < PH_3 < AsH_3 < SbH_3 > BiH_3$
(C) $H_2O > H_2S > H_2Se > H_2Te > H_2Po$
(D) $PH_3 < AsH_3 < SbH_3 < BiH_3 < NH_3$

20. Elevation in boiling point of an aqueous solution of a non-electrolyte solute is 1.56°, what is the depression in freezing point of this solution.
$K_f(H_2O) = 1.86^o\ mol^{-1}\ kg$
$K_b(H_2O) = 0.52^o\ mol^{-1}\ kg$
(A) 3.12
(B) 3.58
(C) 5.58
(D) 3.46

21. Average velocity at T_1 of CO is equal to most probable velocity at T_2. Thus, T_1/T_2 is
(A) 0.785
(B) 1.18
(C) 0.079
(D) 2.36

22. In a vessel 0.2 mole of each He, N_2 and O_2 was present. Pinhole of vessel opened in vacuum for a short time period. What will be the order of partial pressure of gases inside the vessel now?
(A) $P_{O_2} > P_{He} > P_{N_2}$
(B) $P_{N_2} > P_{O_2} > P_{He}$
(C) $P_{He} > P_{N_2} > P_{O_2}$
(D) $P_{He} < P_{N_2} < P_{O_2}$

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

23. Which of the following statement(s) is/are correct?
(A) $\overline{KE}_{molecule}$ of a triatomic linear molecule is $\frac{5}{2}KT$
(B) $\left(\frac{\partial G}{\partial T}\right)_P = -S$
(C) In adiabatic free expression of an ideal gas, temperature of gas also not changed.
(D) $\Delta S_{univ} = 0$ for irreversible adiabatic expansion.

24. Consider the following equilibrium?

$$N_2(g) + 3H_2(g) \xrightleftharpoons{200^{o}C} 2NH_3(g) \qquad \Delta H = -92\ kg/mol$$

Correct statement(s) is/are:

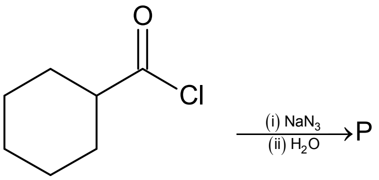
(A) On adding $N_2(g)$ in the equilibrium mixture. Equilibrium shift to forward direction due to increase in entropy in forward direction.

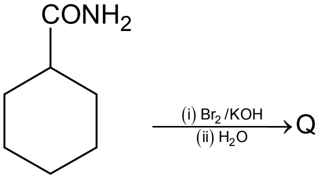
(B) At temp. < $200^{o}C$ reaction becomes faster.

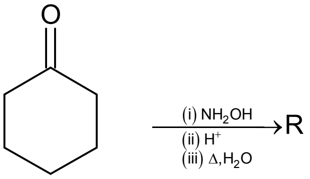
(C) On increasing the pressure yield of NH_3 increase.

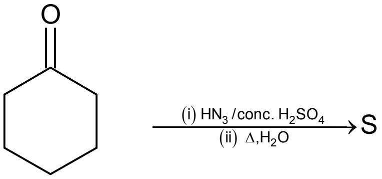
(D) No effect of introduction of inert gas at equilibrium mixture.

25. Which of the following products are identical?









(A) P, Q, R, S

(B) P, Q

(C) R, S

(D) Q, R

26. Correct reaction with products are:

(i) $NH_4NO_2 + NaOH + Zn\ powder / \Delta \longrightarrow NH_3 + Na_2ZnO_2$

(ii) $NH_4Cl + NaNO_3 \xrightarrow{\Delta} N_2O + NaCl + H_2O$

(iii) $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + 4H_2O + Cr_2O_3$

(iv) $NH_2CONH_2 \xrightarrow[HCl]{NaNO_2} NH_3 + CO_2 \uparrow + NaCl$

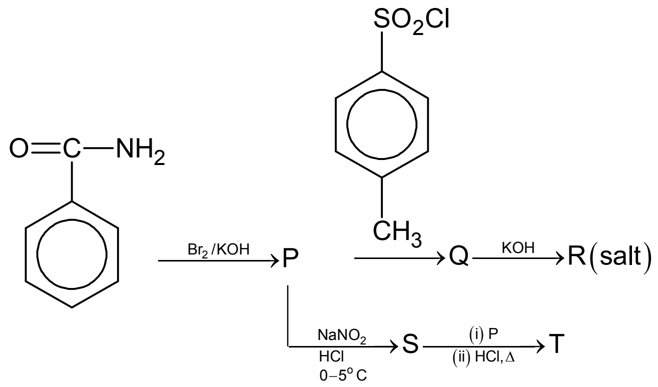
(A) ii, iii

(B) ii, iv

(C) i, iv

(D) i, iii

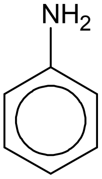
27.


O=C—NH2
Br2/KOH
P
SO2Cl
CH3
Q
KOH
R(salt)
NaNO2
HCl
0–5° C
S
(i) P
(ii) HCl, Δ
T

Which of the following is(are) correct?

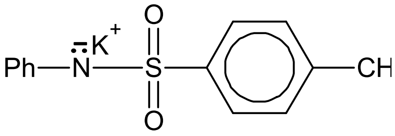
(A)

P =



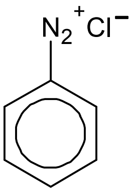
(B)

R is



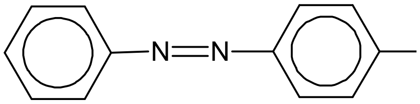
(C)

S is



(D)

T is



28. Which of the following give ppt. when H_2S is passed through the ammonical solution of their salts (in presence of NH_4Cl)
(A) Cu^{2+}
(B) Bi^{3+}
(C) Zn^{2+}
(D) Mg^{2+}

29. Which of the following ore(s) is/are concentrated by froth floatation method?
(A) Galena
(B) Chalcocite
(C) Bauxite
(D) Cinnabar

30. $\text{A salt's solution} \xrightarrow[\text{Excess}]{\text{NaOH}} \underset{\text{ppt.}}{P}\downarrow + Q_{\text{solution}}$

$$Q_{\text{solution}} \xrightarrow[H_2SO_4]{K_2Cr_2O_7} \underset{\text{Red gas}}{R}\uparrow \xrightarrow{\text{NaOH}} \underset{\text{Yellow soln.}}{S} \xrightarrow{AgNO_3} \underset{\text{Brick red}}{T}\downarrow$$

$$P \xrightarrow[\text{ii) KI}]{\text{i) conc. HCl}} \underset{\text{Black}}{U}\downarrow \xrightarrow[\text{Excess}]{\text{KI}} V_{\text{Soluble complex orange}}$$

Which of the following is/are correct according to the above reaction?

(A) R is CrO_2Cl_2

(B) T is Ag_2CrO_4

(C) U is BiI_3

(D) P is $Bi(OH)_3$

SECTION – C

(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

31. Henry's law constants for O_2 and N_2 dissolved in water at 273 K are 2.03×10^8 Pa and 5.07×10^8 Pa. respectively. A sample of water at a temperature just above 273 K was equilibrated with air (21% oxygen and 79% N_2) at 1 atm. The dissolved gas was separated from a sample of this water and then dried. Determine the composition of N_2 in percentage.

32. A solution containing 0.624 gm of naphthalene (molar mass 128.2 gm mol^{-1}) in 60 gm CCl_4. Yields a boiling point elevation of 0.42 K. While a solution of 0.53 gm of an unknown solute in the same mass of solvent gives a boiling point elevation of 0.75 K. Find the molar mass of the unknown solute.

33. Two containers A and B of identical volume. Container 'A' have 2 moles of N_2 and 3 mole of He. Container B has 5 mole of O_2. Both containers are at same temperature. Calculate the average rate of effusion of mixture of O_2.

34. Calculate the magnitude of work done (in kJ) in isothermal reversible expansion of 1 m^3 of He gas ($C_V = \frac{3}{2}R$) at 273.15 K and 10 atm to final pressure of 1 atm (in kJ)

35. For equilibrium

$LiCl.3NH_3(s) \rightleftharpoons LiCl.NH_3(s) + 2NH_3(g), K_P = 16\ atm^2$ at 50°C. A 5 litre vessel contains 0.2 mole of $LiCl.NH_3(s)$. How many moles of NH_3 should be added to the flask at this temperature to drive the backward reaction to completion: [R = 0.0821 litre atm mol^{-1} K^{-1}]

36. The radius of an He atom is 1.23×10^{-9} cm. A 200 cm^3 container is filled with Xe at a pressure of 1 atm and a temperature of 273 K. The % of volume that is occupied by He atom is $x \times 10^{-7}$, value of x is:

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. Let A and B be any two points on y-axis and the line y = 2x respectively. Also P and Q be the feet of perpendicular from A and B on the line y = 2x and y-axis respectively. If AB passes through the points (1, 3), then the line PQ passes through fixed point (x_1, y_1) such that $\frac{y_1}{x_1}$ is

(A) 5
(B) 6
(C) 7
(D) 8

38. The value of the integral $\int_0^{\pi/2} \frac{\sin 40x}{\sin 5x} dx$ is

(A) $\frac{1}{5}\left(1-\frac{1}{3}+\frac{1}{5}-\frac{1}{7}\right)$
(B) $\frac{2}{5}\left(1-\frac{1}{3}+\frac{1}{5}-\frac{1}{7}\right)$
(C) $\frac{1}{5}\left(1+\frac{1}{3}+\frac{1}{5}+\frac{1}{7}\right)$
(D) $\frac{2}{5}\left(1-\frac{1}{2}+\frac{1}{3}-\frac{1}{4}\right)$

39. Let f(x) be a differentiable function satisfying $e^{2x} f(x) = -\frac{1}{2}\tan x + \int_0^x e^{2t} \tan(x-t)\,dt$, then

(A) f(x) is increasing $\forall\ x \in \left[0, \frac{\pi}{8}\right]$
(B) f(x) is decreasing $\forall\ x \in \left[\frac{\pi}{6}, \frac{\pi}{3}\right]$
(C) f(x) is increasing $\forall\ x \in \left[\frac{\pi}{4}, \frac{\pi}{3}\right]$
(D) f(x) is decreasing $\forall\ x \in \left[\frac{\pi}{3}, \frac{\pi}{2}\right)$

40. In ΔABC, $\angle A = \tan^{-1} 2$, $\angle C = \tan^{-1} 3$. Let D be an interior point on side AC such that area of ΔABD is 4.5 times that of area of ΔBCD. If $\angle ABD = \theta$, then the value of $\sin 2\theta$ is

(A) $\frac{7}{24}$

(B) $\frac{24}{25}$

(C) $\frac{7}{25}$

(D) $\frac{3}{5}$

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

41. Let DEF be the triangle formed by joining the foot of altitudes from vertices A, B and C on sides BC, CA and AB respectively of ΔABC. If H be the orthocentre of ΔABC and P, Q be the foot of perpendicular from D on the altitudes BE and CF respectively, then

(A) $\frac{DP}{EH} + \frac{DQ}{FH} = \tan A$

(B) $\frac{DP}{EH} + \frac{DQ}{FH} = \cot A$

(C) $\frac{DP}{EH} + \frac{DQ}{FH} = \sqrt{2} + 1$, if $\angle A = \frac{3\pi}{8}$

(D) $\frac{DP}{EH} + \frac{DQ}{FH} = \sqrt{2} + 1$, if $\angle A = \frac{\pi}{8}$

42. Let $I_1 = \int_0^{\frac{\pi}{200}} \sin\left(2\pi\cos^2 100x\right)dx$, $I_2 = \int_0^{\frac{\pi}{200}} \sin\left(\pi\cos^2 100x\right)dx$, $I_3 = \int_0^{\frac{\pi}{200}} \sin\left(\pi\cos^2 50x\right)dx$, then

(A) $I_1 = 0$

(B) $I_2 = 0$

(C) $I_1 = I_2$

(D) $I_2 = I_3$

43. Let $f(x) = \sin^{-1}\left(\frac{4 - x^2}{4 + x^2}\right) + \cos^{-1}\left(\frac{4x}{4 + x^2}\right)$, then

(A) total number of local extremum of f(x) in (–4, 4) are 1

(B) total number of local maximum of f(x) in (–4, 4) are zero

(C) maximum value of f(x) in (–4, 4) is π

(D) range of f(x) in (–4, 4) is $\left(-\frac{\pi}{2}, \pi\right]$

44. Let a ray of light through P(10, 25, 35) is incident a point Q on the plane x + y + z = 100 and passes through the point R(40, 60, 60) after reflection, then
(A) coordinates of foot of perpendicular from P on the given plane is (20, 45, 35)
(B) equation of incident ray is $\frac{x-10}{2}=\frac{y-25}{1}=\frac{z-35}{3}$
(C) equation of reflected ray is $\frac{x-40}{2}=\frac{y-60}{3}=\frac{z-60}{1}$
(D) equation of plane containing incident ray and reflected ray 2x – y – z + 40 = 0

45. Let f: [0, 8] → R be a differentiable function such that f(0) = 0, f(4) = 2, f(8) = 4, then which of the following is/are correct?
(A) There exist some $C_1, C_2 \in (0, 8)$ such that $f'(C_1)f(C_2) = \frac{3}{2}$
(B) There exist some $C_1, C_2 \in (0, 8)$ such that $f'(C_1)f(C_2) = \frac{7}{2}$
(C) There exist some α, β ∈ (0, 4) such that $3\left(\sqrt{\alpha}f\left(\alpha\sqrt{\alpha}\right)+\sqrt{\beta}f\left(\beta\sqrt{\beta}\right)\right)=\int_0^8 f(t)dt$
(D) There exist some α, β ∈ (0, 4) such that $2\left(\alpha f\left(\alpha^2\right)+\beta f\left(\beta^2\right)\right)=\int_0^{16} f(t)dt$

46. Let α and f(α) be the eccentricity of the ellipse $\frac{x^2}{3b^2-2a^2}+\frac{y^2}{2b^2-a^2}=1$; ($b^2 > a^2$) and $\frac{x^2}{2b^2-a^2}+\frac{y^2}{b^2}=1$; then
(A) $f(\alpha)=\frac{\alpha}{\sqrt{1-\alpha^2}}$
(B) $\int_0^{1/2} ffff(\alpha)d\alpha=\frac{1}{4}$
(C) $\int e^{\alpha}\left(f(\alpha)-f''(\alpha)\right)d\alpha=e^{\alpha}\left[\frac{1}{\left(1-\alpha^2\right)^{3/2}}+\frac{\alpha}{\sqrt{1-\alpha^2}}\right]+c$
(D) $\underbrace{ffff.....f(\alpha)}_{2018\text{ times}}=\frac{\alpha}{\sqrt{1-2018\alpha^2}}$

47. Three alternate numbers a, b, c are removed from n numbers listed 1, 3, 5, 7, 9, ... If the arithmetic mean of the remaining numbers is $\frac{105}{2}$, then which of the following option(s) is/are correct?
(A) sum of the removed numbers is 81
(B) sum of the removed numbers is 61
(C) number of integral solutions of the equation xyz = n are 36
(D) number of positive integral solutions of the equation x + y + z = n :
(where x, y, z are odd) is 325

48. Let A be a square matrix of order 3 which satisfies the equation $A^4 - 8A^3 + 24A^2 - 37A + 16I = 0$ and $B = A - 2I$ be another matrix. If Det A = 5 and Det B > 0, A^{-1} represent inverse of matrix A, then

(A) $\text{Det}(\text{Adj}\,(I - 2A^{-1}))$ is equal to 1

(B) $\text{Det}\left(\text{Adj}\left(\frac{B}{5}\right)^{-1}\right)$ is equal to 625

(C) $\text{Det}(I + 2B^{-1})$ is equal to 1

(D) Det B = 25

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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49. Let OABC be a regular tetrahedron with $\overrightarrow{OA} = \vec{a}$, $\overrightarrow{OB} = \vec{b}$, $\overrightarrow{OC} = \vec{c}$ and having volume $\frac{\sqrt{3}}{2\sqrt{2}}$. If $\hat{p}, \hat{q}$ and $\hat{r}$ are unit vectors along bisectors of angle between pair of edges represented by $\overrightarrow{OA}$, $\overrightarrow{OB}$; $\overrightarrow{OB}$, $\overrightarrow{OC}$ and $\overrightarrow{OC}$, $\overrightarrow{OA}$ respectively, then the value of $27\left[\hat{p}\times\hat{q} \quad \hat{q}\times\hat{r} \quad \hat{r}\times\hat{p}\right]$ is

50. Let abc be a three digit number whose digits are in G.P. On subtracting 100 from the number, the digits of the three digit number obtained form an A.P. The sum of all such 3 digit numbers possible is equal to

51. Let a, b be the roots of the equation $x^2 - 10x - 8 = 0$. If $S_n = a^n b + b^n a$; $n \in N$, then the value of $\frac{S_{20} - 10S_{19}}{S_{18}}$ is equal to

52. A curve y = f(x) passing through origin satisfies the differential equation $\frac{9dy}{dx} + \frac{36x^3}{1+x^4}y = \frac{50x^4}{1+x^4}$. If the area enclosed by $y = f^{-1}(x)$, the x-axis and the ordinate $x = \frac{5}{9}$ in Ist quadrant is A, then the value of $\frac{36A}{\pi}$ is

53. Let $f(x) = \begin{cases} \frac{\sin\alpha}{4} + (x-2)^2 & ; \ |x-2| \le k \\ \frac{\cos\alpha}{4} + |x-2| & ; \ |x-2| > k \end{cases}$; k > 0. If f(x) is differentiable at x = 2 – k, 2 + k, then the number of values of $\alpha \in [0, 5\pi]$ is/are

54. Let $(1 + x + x^2)^{20} = \sum_{k=0}^{40} a_k x^k$. If $\alpha a_{11} = \beta a_{10} + \gamma a_9$, where $\alpha, \beta, \gamma \in N$, then the value of $\frac{\gamma - \alpha}{\beta}$ is

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – IX

JEE (Advanced)-2020

PAPER – 2

TEST DATE: 16-09-2020

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. A, C, D

Sol. Potential due to non conducting circular disc at a distance of x from its centre is

$$\frac{\sigma}{2\varepsilon_0}\left(\sqrt{R^2+x^2}-x\right)$$

So, potential at a distance of $\sqrt{3}R$ due to the given portion is

$$V_P=\frac{\sigma}{4\varepsilon_0}\left(\sqrt{R^2+3R^2}-\sqrt{3}R\right)+\frac{\sigma}{4\varepsilon_0}\left(\sqrt{4R^2+3R^2}-\sqrt{3}R\right)=\frac{\sigma R}{4\varepsilon_0}\left[2+\sqrt{7}-2\sqrt{3}\right]$$

Potential at the centre due to the given portion is

$$V_C=\left(\frac{\sigma\cdot 2R}{2\varepsilon_0}\right)\left(\frac{45^\circ}{360^\circ}\right)\times 4+\left(\frac{\sigma\cdot R}{2\varepsilon_0}\right)\left(\frac{45^\circ}{360^\circ}\right)\times 4=\frac{3}{4}\frac{\sigma R}{\varepsilon_0}$$

Work done by external agent = $\frac{3}{4}\frac{\sigma Rq}{\varepsilon_0}$

2. A, B, D

Sol. $$I_x=\frac{m(2\ell)^2}{12}+\frac{m\left(\frac{\ell}{4}\right)^2}{12}=\frac{65}{192}m\ell^2$$

$$I_y=\frac{m(2\ell)^2}{12}+m\left(\frac{\ell}{2}\right)^2+\frac{m\left(\frac{\ell}{4}\right)^2}{12}+m\left(\frac{\ell}{2}\right)^2=\frac{161}{192}m\ell^2$$

$$I_z=\frac{m(2\ell)^2}{6}+m\left(\frac{\ell}{2}\right)^2+m\left(\frac{\ell}{2}\right)^2=\frac{7}{6}m\ell^2$$

3. A, B, C

Sol. $V_{IP} = \left(\frac{f}{f-u}\right)^2 \times \frac{36}{\mu} = \left(\frac{-22.5}{-22.5+90}\right)^2 \times \left(\frac{36}{4/3}\right)$ = 3 cm/s

4. B, C, D

Sol. Let the acceleration of block is a downward and the tension in the string connected with the cylinder is T.

For the block

64mg – 16T = 64 ma …(i)

For the cylinder

T + f = 8ma …(ii)

Torque about contact point

$T\times 2R = \frac{3}{2}mR^2\alpha$

$R\alpha = 8a$ …(iii)

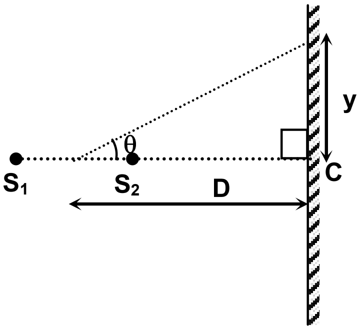
T = 6ma …(iv)

Solving (i), (ii), (iii) and (iv)

T = 48N, a = 4 m/s^2 and f = 16 N

5. A, B, C, D

Sol. $\Delta X_{max} = 2.5\,mm$



$n_{max} = \frac{2.5\times10^{-3}}{5000\times10^{-10}} = 5000$

For 3000th order bright fringe, n = 3000

d cos θ = (3000 λ)

$\cos\theta = \frac{3000\lambda}{5000\lambda} = \frac{3}{5}$

$\frac{D}{\sqrt{y^2+D^2}} = \frac{3}{5}$

Solving y = $\left(\frac{8}{3}\right)$m

For 5th bright fringe from 'C' n = 4996

5000 λ cos θ = 4996 λ

sin θ = 0.04

tan θ = y/D = 0.04

y = 8 × 10^{-2} m

For 2500th order bright fringe, n = 2500

cos θ = 1/2

$\frac{D}{\sqrt{y^2+D^2}} = \frac{1}{2}$

4D^2 = y^2 + D^2

$y = \sqrt{3}D$

y = $2\sqrt{3}$ m

6. A, C

Sol. ${}_{92}U^{238} \rightarrow {}_{90}Th^{234} + {}_2He^4$

$\frac{P^2}{2m_\alpha} + \frac{P^2}{2m_{Th}} = Q$

$$P = \left(\frac{2m_\alpha m_{Th} Q}{m_\alpha + m_{Th}}\right)^{1/2}$$

$$\frac{K.E_\alpha}{K.E_{Th}} = \frac{m_{Th}}{m_\alpha} = \frac{234}{4} = \frac{117}{2}$$

7. A, C

Sol. Torque about P_1P_2

$$i\ell^2 B \sin 60° = \frac{2}{3} m\ell^2 \alpha$$

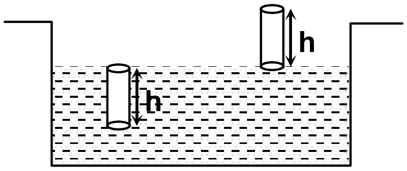
$$\alpha = \frac{3\sqrt{3}}{4}\frac{Bi}{m}$$

$$\frac{1}{2} I\omega^2 = U_i - U_f = -Bi\ell^2 \cos 60° - (-Bi\ell^2 \cos 0°)$$

$$\frac{1}{2} I\omega^2 = \frac{Bi\ell^2}{2}$$

$$\Rightarrow \omega = \sqrt{\frac{Bi\ell^2}{I}} = \sqrt{\frac{Bi\ell^2 \times 3}{2m\ell^2}} = \sqrt{\frac{3Bi}{2m}}$$

8. A, C, D



Sol. $$(Ah)(\rho_\ell)\left[g\frac{h}{2}\right] = (Ah)(\rho_S g)\left(\frac{h}{2} + \frac{h}{2}\right) + \frac{1}{2}(Ah)(\rho_S)v^2$$

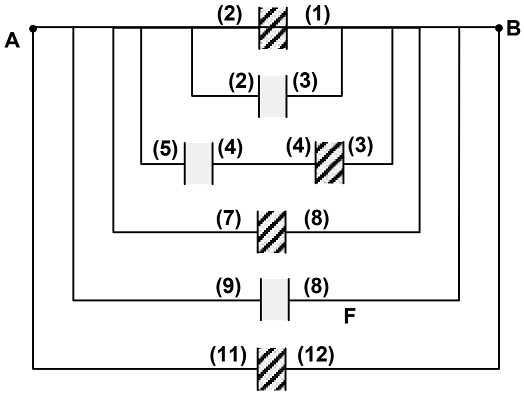
$$\frac{\rho_\ell gh}{2} = \rho_s gh + \frac{1}{2}\rho_s v^2$$

$$v = \sqrt{\frac{(\rho_\ell - 2\rho_s)gh}{\rho_s}}$$

9. D

10. A

Sol. Apply Kirchoff's Law on the equivalent circuit shown in the diagram.



11. C

12. B

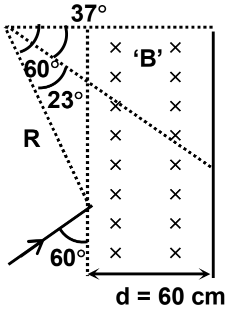
Sol. (for Q.11 – Q.12): Particle collides with the wall at its maximum height hence, the time after which the ball collides with the wall is $t = \frac{20\sqrt{2}\sin 45°}{10} = 2\,\text{sec}$

SECTION – C

13. 00000.25

Sol. $d = R\cos 37^\circ - R\cos 60^\circ$

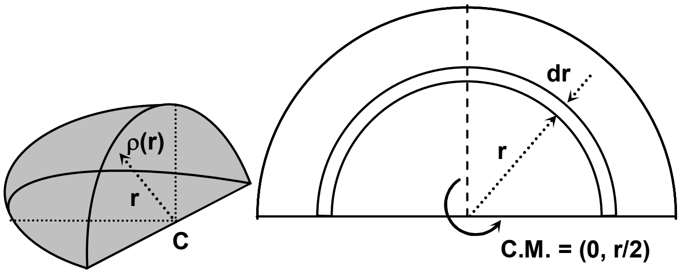
$R = 2$ m



14. 00003.50

Sol.
$$y_{cm} = \frac{\int_0^R \left[\rho_0\left(1-\frac{r^2}{R^2}\right)(2\pi r^2 dr)\right]\frac{r}{2}}{\int_0^R \rho_0\left(1-\frac{r^2}{R^2}\right)(2\pi r^2)dr} = \frac{5}{16}R$$

Position of CM, from C $= \left(\frac{5\sqrt{2}}{16}R\right)$



15. 00054.46

Sol. Change of resistance by 1 Ω = change of deflection by 4 + 6 = 10

Change in deflection by 1 division = change of resistance by 1/10 Ω

Change in deflection by 4 division = change of resistance by 4/10 Ω = 0.4 Ω

Here for null point R = 545 – 0.4 = 544.6 Ω

So, unknown resistance = $\frac{544.6 \times 10}{100} = 54.46\ \Omega$

16. 00002.80

Sol. $\vec{B} = \frac{\mu_0}{4\pi}\frac{q(\vec{v}\times\vec{r})}{r^3}$

$\vec{B} = \mu_0\varepsilon_0(\vec{v}\times\vec{E}) = \mu_0\varepsilon_0(-\hat{i}+\hat{j}-\hat{k})\times(\hat{i}+\hat{j}+\hat{k})$

$\vec{B} = 2(\hat{i}-\hat{k})\mu_0\varepsilon_0$

$B = 2\sqrt{2}\mu_0\varepsilon_0$

$K = 2\sqrt{2} = 2.80$

17. 00020.00

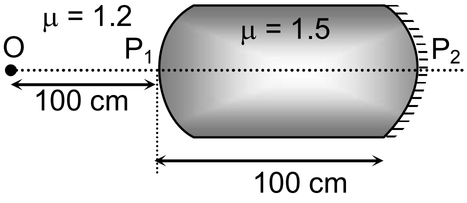
Sol. Refraction from P_1

$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$

$\frac{1.5}{v_1} - \frac{1.2}{-100} = \frac{1.5-1.2}{+20}$

$\Rightarrow v_1 = 500$ cm

Reflection from P_2



$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$$\frac{1}{-200} = \frac{1}{v_2} + \frac{1}{400}, \quad v_2 = \frac{-400}{3}\text{cm}$$

Again refraction from P_1

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}, \quad \frac{1.2}{v_3} - \frac{1.5}{100/3} = \frac{1.2-1.5}{-20}$$

$\Rightarrow v_3 = +20$ cm (left to P_1)

18. 00003.52

Sol. $8S = 10\,V$

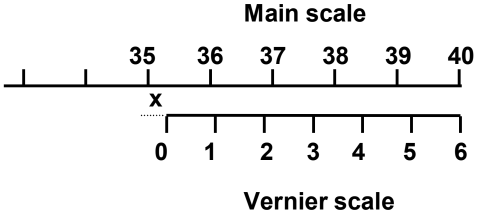
$V = 0.8$ mm

$6V = 0.8 \times 6 = 4.8$ mm

$40S = 35S + x + 6V$

$x = 0.2$ mm

Measured length = 3.52 cm



Chemistry

PART – II

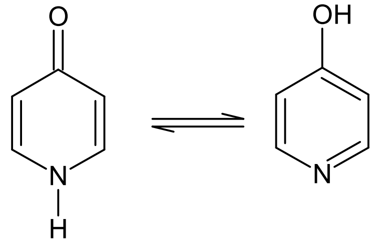
SECTION – A

19. B, C, D

Sol. Process is endothermic in forward direction.

20. A, C, D

Sol. $R_2CHCH = NH \rightleftharpoons R_2C = CH - NH_2$



$CH_3CH_2NO \rightleftharpoons CH_3CH = NOH$

21. A, B, C

Sol. Absence of POS and COS.

22. A, B, C, D

23. A, B, C, D

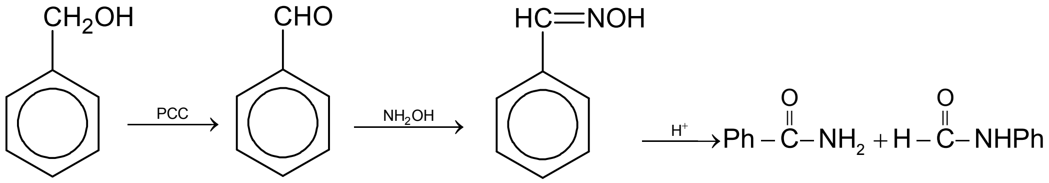
Sol. Facts

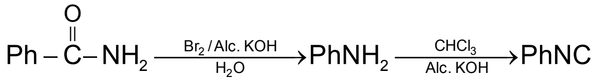
24. A, B, C, D

Sol. Facts.

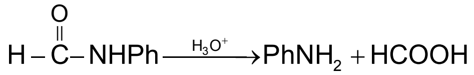
25. A, B, C, D

Sol.





$$Ph - \overset{O}{\overset{\|}{C}} - NH_2 \xrightarrow[H_2O]{Br_2/Alc.\,KOH} PhNH_2 \xrightarrow[Alc.\,KOH]{CHCl_3} PhNC$$



$$H - \overset{O}{\overset{\|}{C}} - NHPh \xrightarrow{H_3O^+} PhNH_2 + HCOOH$$

26. A, B, C

Sol. Facts

27. A

28. D

Sol. (for Q.27 – Q.28):

$$Pb^{2+} + KI \longrightarrow \underset{Yellow}{PbI_2} \downarrow \xrightarrow{KI} K_2PbI_4$$

$$Ag^{+} + KI \longrightarrow \underset{\text{Yellow}}{AgI} \downarrow$$

$$Cu^{2+} + KI \longrightarrow \underset{\text{White}}{Cu_2I_2} \downarrow$$

$$Cu^{2+} + K_4[Fe(CN)_6] \longrightarrow \underset{\text{Brown}}{Cu_2\left[Fe(CN)_6\right]} \downarrow$$

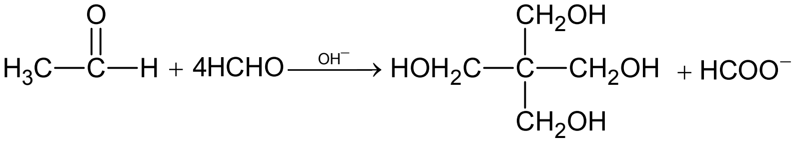
$$Cu^{2+} + KCN \longrightarrow \underset{\text{Yellow}}{Cu(CN)_2} \downarrow \longrightarrow \underset{\text{White}}{CuCN} \downarrow + (CN)_2$$

$$Bi^{3+} + KI \longrightarrow \underset{\text{Black}}{BiI_3} \downarrow \xrightarrow{KI} \underset{\text{Orange solution}}{KBiI_4}$$

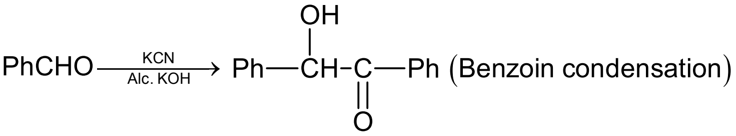
29. D

30. A

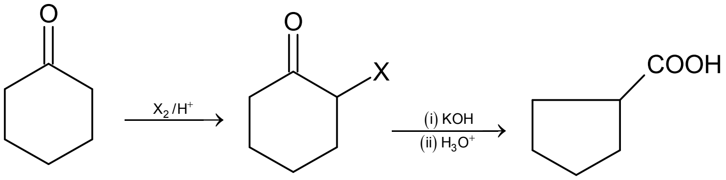
Sol. (for Q.29 – Q.30):

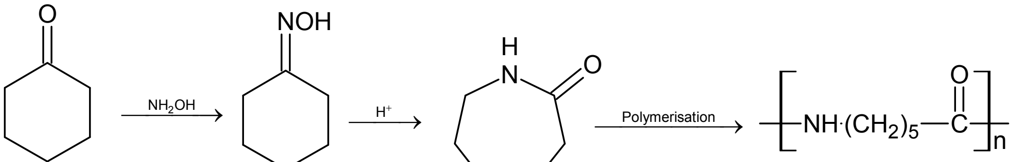


$$H_3C-\overset{O}{\overset{\|}{C}}-H + 4HCHO \xrightarrow{OH^-} HOH_2C-\underset{CH_2OH}{\overset{CH_2OH}{C}}-CH_2OH + HCOO^-$$

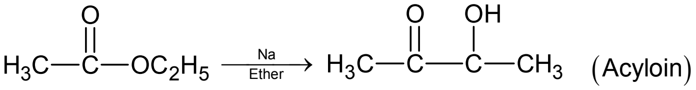


$$PhCHO \xrightarrow[\text{Alc. KOH}]{KCN} Ph-\overset{OH}{CH}-\underset{O}{\underset{\|}{C}}-Ph \text{ (Benzoin condensation)}$$

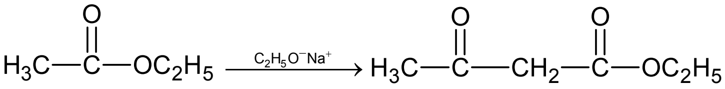




Nylon-6



$$H_3C-\overset{O}{\overset{\|}{C}}-OC_2H_5 \xrightarrow[\text{Ether}]{Na} H_3C-\overset{O}{\overset{\|}{C}}-\overset{OH}{C}-CH_3 \text{ (Acyloin)}$$



$$H_3C-\overset{O}{\overset{\|}{C}}-OC_2H_5 \xrightarrow{C_2H_5O^-Na^+} H_3C-\overset{O}{\overset{\|}{C}}-CH_2-\overset{O}{\overset{\|}{C}}-OC_2H_5$$

(Claisen condensation)

SECTION – C

31. 00030.00

Sol. Total possible are 30.00.

32. 00004.20

Sol. $i = 1 + (n-1)\alpha$ where $n = 5$

$= 1 + [5-1]0.8 = 4.2$

33. 00003.75

Sol. Removed 1 Zn^{2+} from tetrahedral void.

$\therefore$ Remaining occupied tetrahedral void = 3

Fraction $= \frac{3}{8} = 0.375$

$\therefore 10X = 3.75$

34. 00024.44

Sol. $W_{CO_2} = 1.44$ gm

$\therefore$ Moles of $CO_2 = \frac{1.44}{44} =$ moles of CO_3^{2-}

$\therefore W_{CO_3^{2-}} = \frac{1.44}{44} \times 60 = 1.9636$

Let two metal CO_3^{2-} are ACO_3 and BCO_3.

If A is 14.2%

% of B $= \frac{3.2 - [1.9636 + 0.4544]}{3.2} \times 100$

$= 24.437 \approx 24.44\%$

35. 00011.51

Sol. $\left[\overset{-}{O}H\right] = \frac{(80 \times 0.1) - (75 \times 0.1)}{155} = 0.0032258$

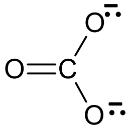
$= 3.23 \times 10^{-3}$

pOH = 2.49

$\therefore pH = 11.51$

36. 00001.33

Sol.



1.33

Mathematics

PART – III

SECTION – A

37. B, C

Sol. $Z = \sum_{r=1}^{100}(2r+3)(i)^r$ = $2\sum_{r=1}^{100} r\,i^r + 3\sum_{r=1}^{100} i^r$

Z = 100(1 – i)

38. A, B

Sol. $x^n - a^n$ is divisible by x – a if n is odd

39. A, B, D

Sol. Midpoint of PQ is $\left(\frac{7}{2}, \frac{9}{2}\right)$

$\therefore$ Slope of axis is $\frac{9}{7}$

Hence equation of directrix is 9y + 7x = 0

Equation of PQ is 11x – 3y – 25 = 0 and foot of perpendicular from origin on PQ is focus which is $\left(\frac{55}{26}, -\frac{15}{26}\right)$

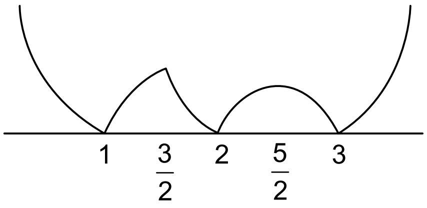
Foot of perpendicular from focus S on the line y – 2x = 0 is $\left(\frac{5}{26}, \frac{10}{26}\right)$

$\therefore$ Equation of tangent at vertex is $y - \frac{10}{26} = -\frac{7}{9}\left(x - \frac{5}{26}\right)$

i.e., 182x + 234y – 125 = 0

40. B, C

Sol. Use graph of f(x)



41. A, B, C

Sol. Let $\hat{x}\cdot\hat{y} = a$, $\hat{y}\cdot\hat{z} = b$, $\hat{x}\cdot\hat{z} = c$

$|\hat{x} + \hat{y} - \hat{z}| = |\vec{p}|$

$\Rightarrow$ 3 + 2(a – b – c) = 3

$\Rightarrow$ a – b – c = 0 ..... (1)

Also, $\hat{x}\times(\hat{y}\times\hat{z}) = \vec{q}$

$\Rightarrow c\hat{y} - a\hat{z} = \vec{q}$ ..... (2)

And $(\hat{x}\times\hat{y})\times\hat{z} = \vec{r}$

$\Rightarrow c\hat{y} - b\hat{x} = \vec{r}$ ..... (3)

From equation (2), c – ab = $\frac{3}{4}$

$\because\ \vec{q}\cdot\vec{y} = \frac{3}{4}$

Also, $\vec{p}\cdot\vec{x} = 1 + a - c \Rightarrow a - c = -1$

Using equation (1), b = –1 and $c + a = \frac{3}{4} \Rightarrow a = -\frac{1}{8}, c = \frac{7}{8}$

$\therefore\ \vec{r} = \frac{7}{8}\hat{y} + \hat{x}\ ;\ \vec{q} = \frac{7}{8}\hat{y} + \frac{\hat{z}}{8}$

$$|\vec{q}| = \left|\frac{7\hat{y} + \hat{z}}{8}\right| = \frac{\sqrt{49 + 1 + 14b}}{8} = \frac{3}{4}$$

42. A, B

Sol. $P(x) = x^4 + px^3 + qx^2 + rx - 48$

Let $Q(x) = x^3 - 2ax^2 + bx - 6$

$R(x) = x^3 + ax^2 - (3b + 1)x + 48$

Q(x) and R(x) must have 2 common roots (β, γ)

Which satisfy $3ax^2 - (4b + 1)x + 54 = 0$

$\Rightarrow \beta\gamma = \frac{18}{a}\ ;\ a \neq 0$

$\alpha\beta\gamma = 6$, $\beta\gamma\delta = -48$ and $\alpha = 1$

Also, $\alpha\beta\gamma\delta = -48 \Rightarrow \delta = -8$

$\therefore \beta\gamma = 6$

Hence, a = 3

Also, $\alpha + \beta + \gamma = 2a \Rightarrow \beta + \gamma = 5$

$\therefore \beta = 2, \gamma = 3$

$\therefore P(x) = (x - 1)(x - 2)(x - 3)(x + 8)$

a = 3, b = 11

43. A, C, D

Sol. $L_1 = \lim\limits_{x\to 0} \frac{3ax + (a-8)\sin x}{\left(\sin^{-1}x\right)^3} = \frac{(4a-8)x - \frac{1}{6}(a-8)^3 x^3 + ...}{\left(\sin^{-1}x\right)^3}$. If L_1 is finite then a = 2

$$L_2 = \lim_{x\to\infty} \frac{8 - \left(\frac{\operatorname{cosec}^{-1}x}{x}\right)^5}{\frac{4}{\pi}\sec^{-1}(kx-1) + \frac{k^3}{\pi}\left(\frac{\tan^{-1}\frac{\pi}{x^5}}{\frac{1}{x^5}}\right) + \frac{5k^2}{2}}$$. If k = 0 then $L_2 = \frac{8-0}{\frac{4}{\pi}\pi} = 2$

If $k \neq 0$ then $L_2 = \frac{8-0}{\frac{4}{\pi}\frac{\pi}{2} + k^3 + \frac{5k^2}{2}} = 2$

$\Rightarrow 2k^3 + 5k^2 - 4 = 0 \Rightarrow k = -2$

44. A, C, D

Sol. $4\alpha - \beta + 3\gamma = 4$ ..... (1)

$\alpha + 3\beta - 4\gamma = 2$ ..... (2)

$7\alpha + 8\beta - 9\gamma = 10$ ..... (3)

Given system of equations has infinite solution where $\alpha = \frac{14 - 5\gamma}{13}$, $\beta = \frac{4 + 19\gamma}{13}$

Moreover equation of plane is $3x + 4y + 5z + 44 = 0$

$\because$ P(α, β, γ) lies on the plane $\therefore \alpha = 3, \beta = -7, \gamma = -5$

45. A

46. D

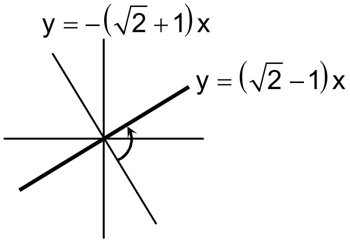
Sol. (for Q.45 – Q.46):

Re$((1 + i)Z^2) > 0$

$\Rightarrow x^2 - y^2 - 2xy > 0$

$\Rightarrow -\left(\sqrt{2}+1\right)x < y < \left(\sqrt{2}-1\right)x \ ; x \geq 0$

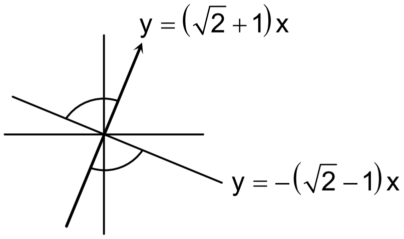
$\left(\sqrt{2}-1\right)x < y < -\left(\sqrt{2}+1\right)x \ ; x < 0$


$y = -\left(\sqrt{2}+1\right)x$
$y = \left(\sqrt{2}-1\right)x$

Im$((1 + i)Z^2) > 0 \ ; y < 0$

$\Rightarrow x^2 - y^2 + 2xy > 0$

$\Rightarrow -\left(\sqrt{2}-1\right)x < y < \left(\sqrt{2}+1\right)x$


$y = \left(\sqrt{2}+1\right)x$
$y = -\left(\sqrt{2}-1\right)x$

Im$(1 + i)Z^2 < 0 \ ; \ y \geq 0$

$\Rightarrow x^2 - y^2 + 2xy < 0$

$\Rightarrow \ y < -\left(\sqrt{2}-1\right)x$ or $y > \left(\sqrt{2}+1\right)x$

47. B

48. C

Sol. (for Q.47 – Q.48):

$$f(x) = \begin{cases} -2 & ; \ -1 \leq x < -\frac{1}{2} \\ -1 & ; \ -\frac{1}{2} \leq x < 0 \\ 0 & ; \ 0 \leq x < \frac{1}{2} \\ 1 & ; \ \frac{1}{2} \leq x < 1 \\ 2x & ; \ 1 \leq x \leq 2 \end{cases}$$

$$f(g(x)) = \begin{cases} -2 & ; \ x \in \left[\frac{7\pi}{6}, \frac{11\pi}{6}\right] - \left\{\frac{3\pi}{2}\right\} \\ -1 & ; \ x = \frac{3\pi}{2} \\ 1 & ; \ x \in \left(\frac{\pi}{6}, \frac{5\pi}{6}\right) \\ \text{cosec } x & ; \ x \in \left(0, \frac{\pi}{6}\right] \cup \left[\frac{5\pi}{6}, \pi\right) \end{cases}$$

$$f(f(x)) = \begin{cases} -2 & ; \ -\frac{1}{2} \leq x < 0 \\ 0 & ; \ 0 \leq x < \frac{1}{2} \\ 2 & ; \ \frac{1}{2} \leq x < 1 \\ 4 & ; \ x = 1 \end{cases}$$

$$g(f(x)) = \begin{cases} \frac{\text{cosec } 1}{2} & ; \ \frac{1}{2} \leq x < 1 \\ \frac{\text{cosec } 2x}{2} & ; \ 1 \leq x \leq 2 - \left\{\frac{\pi}{2}\right\} \end{cases}$$

$$f(2g(x)) = \begin{cases} -2 & ; \ x = \frac{3\pi}{2} \\ 2 \text{ cosec } x & ; \ x \in \left[\frac{\pi}{6}, \frac{5\pi}{6}\right] \end{cases}$$

SECTION – C

49. 00006.00

Sol. $\sin^2\frac{\pi}{n}+\sin^2\frac{2\pi}{n}=\sin^2\frac{3\pi}{n}$

$\Rightarrow \sin^2\frac{2\pi}{n}=\sin\frac{4\pi}{n}\cdot\sin\frac{2\pi}{n}$

$\Rightarrow \sin^2\frac{2\pi}{n}\left(2\cos\frac{2\pi}{n}-1\right)=0$

$\Rightarrow \cos\frac{2\pi}{n}=\frac{1}{2}$ $\Rightarrow$ n = 6

50. 00005.00

Sol. Required probability = $\dfrac{\frac{4}{5}\times\frac{1}{10}}{\frac{4}{5}\times\frac{1}{10}+\frac{1}{5}\times1}=\frac{2}{7}$

51. 00004.50

Sol. Equation reduces to $\sin\frac{4}{3}x+\cos\frac{16}{9}x=2$

$\Rightarrow \sin\frac{4}{3}x=1$ and $\cos\frac{16}{9}x=1$

$\Rightarrow x=(4n+1)\frac{3\pi}{8}$ and $x=\frac{9m\pi}{8}$

$\Rightarrow m=\frac{4n+1}{3}$ $\Rightarrow$ n = 3k + 2; k $\in$ **I**

$\therefore\ x=(4k+3)\frac{9\pi}{8}$; k has 4 values

52. 00001.50

Sol. f(x) = $\cos^{-1}x$ $\quad -\frac{1}{2}\le x<\frac{1}{2}$

$\sin^{-1}(1-x)$ $\quad \frac{1}{2}\le x<\frac{3}{2}$

$\cos^{-1}(x-2)$ $\quad \frac{3}{2}\le x<\frac{5}{2}$

$\sin^{-1}(3-x)$ $\quad \frac{5}{2}\le x<\frac{7}{2}$

f(x) is periodic with period 2

$$\int_{-\frac{1}{2}}^{\frac{23}{2}}f(x)dx=6\left[\int_{-\frac{1}{2}}^{\frac{1}{2}}\cos^{-1}x\,dx+\int_{\frac{1}{2}}^{\frac{3}{2}}\sin^{-1}(1-x)dx\right]=3\pi$$

53. 00009.00

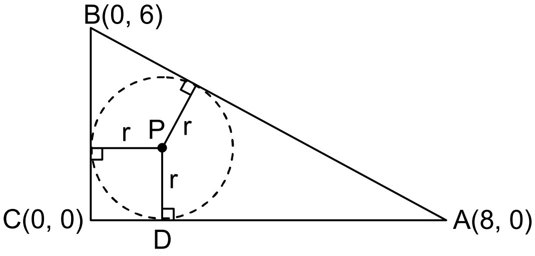
Sol. Let the centre be $(2\cos\theta, 3\sin\theta)$

$$\frac{x_1+x_2+x_3+x_4}{4}=\frac{2\cos\theta}{2} \text{ and } \frac{y_1+y_2+y_3+y_4}{4}=\frac{3\sin\theta}{2}$$

If (h, k) is the centroid of Δ then $x_4 = 4\cos\theta - 3h$, $y_4 = 6\sin\theta - 3k$

Hence, $\left(h-\frac{4}{3}\cos\theta\right)(k-2\sin\theta)=\frac{2}{9}$

54. 00003.25



Sol. $\frac{1}{2}(r+a)r=8$

$\Rightarrow r = 2$

AB = b + 2

$\because (b+2)^2 = b^2 + 6^2$

$\Rightarrow b = 8$

Let equation of required circle is

$(x-h)^2 + (y-3)^2 = h^2 + 9$

∵ Incircle and the required circle touch internally

$\therefore (h-2)^2+1=\left|\sqrt{h^2+9}-2\right|^2 \Rightarrow h=\frac{5}{4} \therefore r_1=\sqrt{h^2+9}=\sqrt{\frac{25}{16}+9}=\frac{13}{4}$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – IX

JEE (Advanced)-2020

PAPER – 2

TEST DATE: 16-09-2020

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section-A (01 – 08, 19 – 26, 37 – 44)*** *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–1** In all other cases.*

   Section-A (09 – 12, 27 – 30, 45 – 48) *contains 6 List-Match sets with 12 questions (each set has 2 questions). Each question has 4 statements in LIST-I & 4, 5 or 6 statements in LIST-II. The codes for Lists have choices (A), (B), (C), (D) out of which only one is correct.*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

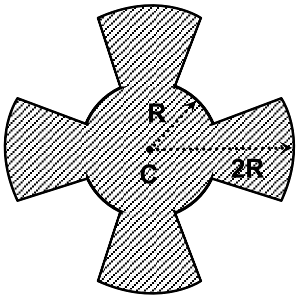
2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics PART – I

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A non-conducting portion of circular disc (as shown in figure) having positive charge density σ. Each cross section subtends an angle 45° on its center 'C'. A positive point charge q is slowly brought from infinity to the centre 'C'. Choose the correct option(s).



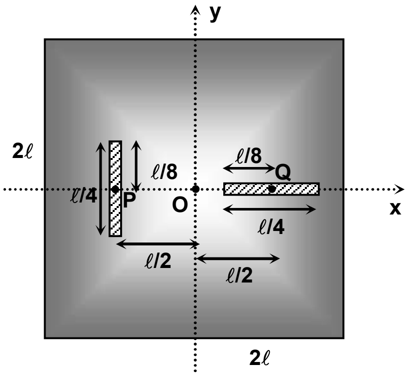
(A) The work done by the external agent is positive.

(B) The potential due to the non conducting portion at a distance of $\sqrt{3}R$ on its axis from centre C is $\frac{\sqrt{7}}{4}\frac{\sigma R}{\varepsilon_0}$.

(C) The potential due to the non conducting portion at a distance of $\sqrt{3}R$ on its axis from centre C is $\frac{\sigma R}{4\varepsilon_0}\left[2+\sqrt{7}-2\sqrt{3}\right]$.

(D) The magnitude of work done by the external agent to bring the charge particle slowly from infinity to the centre is $\frac{3}{4}\frac{\sigma Rq}{\varepsilon_0}$.

2. Two rods each of mass 'm' and length '$\ell/4$' are hinged on a larger square plate of same mass and edge length 2ℓ. Both rods can freely rotate about hinge points 'P' and 'Q' in the plane of square plate. Choose the correct option(s).



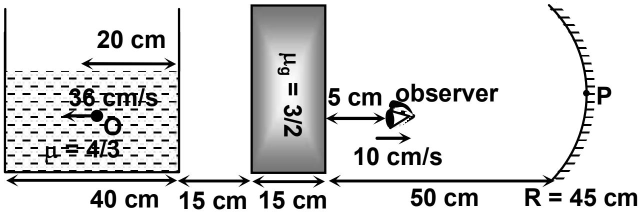
(A) The moment of inertia of the system about x-axis is $\frac{65}{192}m\ell^2$

(B) The moment of inertia of the system about y-axis is $\frac{161}{192}m\ell^2$

(C) The moment of inertia of the system about z-axis is $\frac{226}{192}m\ell^2$

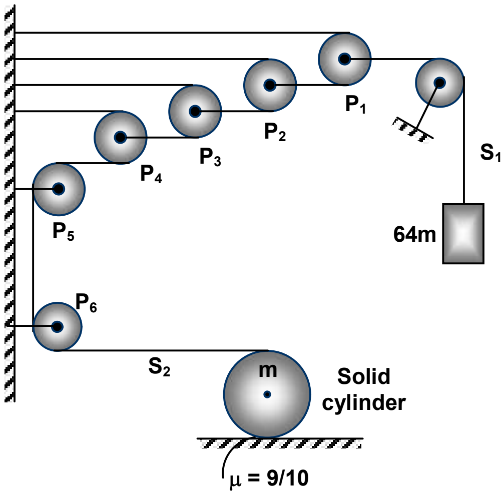
(D) The moment of inertia of the system about z-axis is $\frac{224}{192}m\ell^2$

3. A point object 'O' lies inside a transparent cuboidal container (of negligible thickness) having water as shown in the figure. An observer is situated between the glass slab and the concave mirror. At t = 0 observer starts moving with a velocity 10 cm/s towards right side and object 'O' also starts moving towards left side with a velocity 36 cm/s on the optic axis of concave mirror. Then choose the correct option(s).



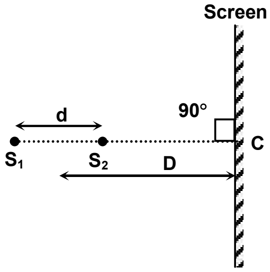
(A) Distance of image formed by the mirror from its pole is 30 cm left.
(B) Distance of object 'O' as seen by observer from the observer is 45 cm.
(C) The magnitude of velocity of the object 'O' with respect to observer when the observer directly sees the object is 37 cm/s.
(D) The magnitude of velocity of the image of object 'O' formed by the concave mirror with respect to observer is 13 cm/s.

4. All the pulleys and strings are massless. One end of the string S_1 is connected with a block and one end of the string S_2 is connected with a solid cylinder as shown in the figure. The coefficient of friction between the cylinder and the horizontal surface is $\mu = \frac{9}{10}$. Choose the correct option(s). (Take m = 2kg and g = 10 m/s^2)



(A) The tension in the string attached with the block '64m' is 48 Newton.
(B) The acceleration of block 64m is 4 m/s^2 downward.
(C) The acceleration of centre of mass of the solid cylinder is 32 m/s^2.
(D) Friction force between the cylinder and the horizontal surface is 16 N.

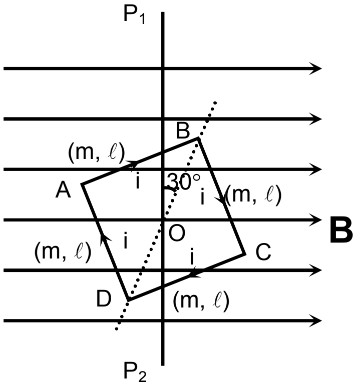
5. Two coherent sources are emitting light of wavelength λ = 5000Å. The separation between the sources is 2.5mm and the separation between the source and the screen is 2m. Then which of the following are correct.



(A) The position of 3000th order bright fringe from C is $\frac{8}{3}$ m.
(B) The position of 2500th order bright fringe from C is $2\sqrt{3}$ m.
(C) The position of 5th bright fringe from C is 0.08 m (include the bright fringe at C).
(D) The shape of fringes on the screen are circular.

6. In the α-decay of a U-238 nucleus the energy released in the decay is Q. The U-238 nucleus was initially stationary. Then which of the following is/are correct.
   (A) Ratio of kinetic energy of α-particle and thorium nucleus is 117 : 2
   (B) Ratio of momentum of α particle and thorium nucleus is 2 : 117
   (C) Momentum of α-particle is $\left(\frac{234Qm_\alpha}{119}\right)^{1/2}$
   (D) Recoil velocity of thorium nucleus is $\left(\frac{234Q}{13923\, m_{Th}}\right)^{1/2}$

7. Rod AB, BC, CD & DA for a square loop having current i, mass and length of each rod is m and ℓ respectively, is situated in a uniform magnetic field B which is parallel to the plane of paper as shown in the figure and it can rotate about fixed non conducting axis P_1P_2 perpendicular to $\vec{B}$ and rod AB, rod CD are attached with the axis, which lies in the plane of paper. At t = 0 the angle between the plane of the loop and the magnetic field is 30° and point C is above the plane of the paper (O is geometrical center of the loop). Then choose the correct option(s).



   (A) Angular acceleration of the square loop at t = 0 is $\frac{3\sqrt{3}}{4}\frac{Bi}{m}$.
   (B) Angular acceleration of the square loop at t = 0 is $\frac{3}{4}\frac{Bi}{m}$.
   (C) Angular velocity when square loop rotated by 60°, is $\sqrt{\frac{3Bi}{2m}}$.
   (D) Angular velocity when square loop rotated by 60°, is $\sqrt{\frac{\sqrt{3}Bi}{m}}$.

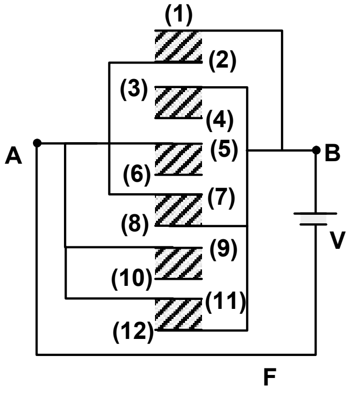
8. A uniform cylinder made of material of density ρ = 125 kg/m^3 pressed down and held at rest in a pool so that its upper circular surface is in level with the water surface. Length of the cylinder is ℓ = 5.40 m and radius is r = 10 cm. When released the cylinder jumps out of water. Water is calm while releasing, the axis of the cylinder is vertical, the cylinder comes out moving vertically. Then choose the correct option(s). (density of water is ρ_0 = 1000 kg/m^3 and acceleration due to gravity is g = 10 m/s^2)
   (A) The magnitude of velocity when the cylinder just leaves the water surface is 18 m/s.
   (B) The maximum height above the initial position attained by the cylinder after releasing is 16.2 m.
   (C) The maximum height above the initial position attained by the cylinder after releasing is 21.6 m.
   (D) The loss in potential energy of liquid when the cylinder comes out from the liquid, is 1458π Joule.

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

All identical capacitor plates each of area A are arranged such that adjacent plates are at d distance apart. Plates are connected to a source of emf V volts as shown in figure (dielectric constant in each shaded region is k = 2). Then



	List – I		List – II
(I)	Charge on plate 3 is $\frac{10\varepsilon_0 AV}{Kd}$. Then the value of K is	(P)	zero
(II)	The heat rejected by the system is $\frac{26\varepsilon_0 AV^2}{Kd}$. Then the value of K is	(Q)	3
(III)	Equivalent capacitance between AB is $\frac{26A\varepsilon_0}{Kd}$. Then the value of K is	(R)	$\frac{13}{5}$
(IV)	Potential difference between the plates 4 and 7 is $\frac{KV}{5}$. Then the value of K is	(S)	$\frac{26}{5}$
		(T)	6
		(U)	$\frac{10}{3}$

9. Which of the following is correct?

Options

(A) I → U, II → Q, III → P, IV → Q
(B) I → T, II → P, III → Q, IV → U
(C) I → U, II → T, III → Q, IV → P
(D) I → T, II → T, III → Q, IV → U

10. If the plates 4 and 5 are connected by a conducting wire. Then which of the following is correct.

Options

(A) I → U, II → S, III → R, IV → P

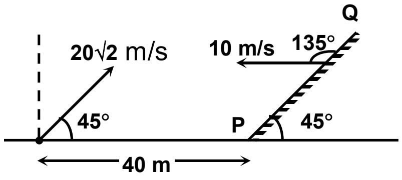
(B) I → T, II → S, III → R, IV → S

(C) I → S, II → R, III → U, IV → P

(D) I → P, II → U, III → R, IV → P

Answer the following by appropriately matching the list based on the information given in the paragraph.

A ball is projected with a velocity $20\sqrt{2}$ m/s at an angle of 45° with the horizontal as shown in the figure and a very large wall is also moving with a velocity 10 m/s horizontally maintaining its inclination 45° with the horizontal and the initial separation is 40m as shown in the figure . {Take $\tan^{-1}(2) = 63°$, $\tan^{-1}(1/3) = 18°$ and $g = 10\ m/s^2$}



	List – I		List – II (in S.I. unit)
(I)	Time after which the ball collides with the wall is	(P)	8
(II)	Magnitude of velocity of the ball after the collision is	(Q)	2
(III)	Maximum height attained by the ball from the ground is	(R)	$10\sqrt{10}$
(IV)	After the collision, ball moves at an angle of (2.25 × k)° with the inclined wall as observed by the observer which is fixed on the moving wall, then k is	(S)	40
		(T)	20
		(U)	65

11. If the collision between the wall and the ball is perfectly elastic. Then which of the following is correct?

Options

(A) I → Q, II → Q, III → P, IV → Q

(B) I → T, II → P, III → Q, IV → U

(C) I → Q, II → R, III → U, IV → T

(D) I → T, II → T, III → Q, IV → U

12. If coefficient of restitution between the ball and the wall is $\frac{1}{3}$. Then which of the following is correct?

Options

(A) I → U, II → S, III → R, IV → P

(B) I → Q, II → T, III → S, IV → P

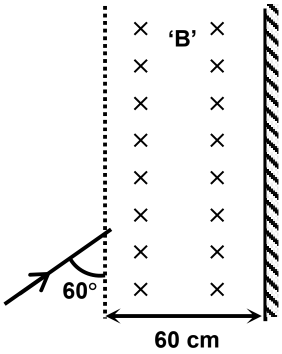
(C) I → Q, II → R, III → U, IV → P

(D) I → P, II → U, III → R, IV → P

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

13. A positive charged particle q and mass m enters and comes out from a uniform magnetic field B which exists with direction inside the paper in a finite space of width 60 cm after collision with the wall (collision is perfectly elastic) as shown in the figure. If time elapsed by the charge particle inside the magnetic field is $\left(\frac{23^\circ}{90^\circ}\right)\frac{\pi m}{qB}$. The radius of curvature of the charge particle is $\left(\frac{1}{2k}\right)$ meter when it is inside the magnetic field. Find the value of k.

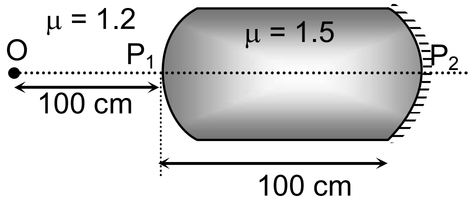


14. Find the position of centre of mass (in meter) of the quarter solid sphere from its geometrical centre in which mass per unit volume is given as $\rho(r) = \rho_0\left(1 - \frac{r^2}{R^2}\right)$, where r is radial distance from geometrical centre and R(= 8 m) is radius of solid quarter sphere. (Take $\sqrt{2} = 1.4$ and $\sqrt{3} = 1.7$)

15. In a PO box experiment it is found that for P : Q = 100 : 10, the deflection is to the left by 4 division when R is 545 Ω and to the right by 6 division when R is 544 Ω. Find the correct value of the unknown resistance (in Ω) in the fourth arm. (Assume that the deflection changes linearly with R near the balance point)

16. A charged particle is moving with a velocity $\vec{v} = -\hat{i} + \hat{j} - \hat{k}$ and the electric field produced by it at a distant point is $\vec{E} = \hat{i} + \hat{j} + \hat{k}$. The magnetic field produced at the same point due to the same charged particle is $K\mu_0\varepsilon_0$. Find the value of K. (All quantities are in S.I. units, take $\sqrt{2} = 1.4$ and $\sqrt{3} = 1.7$)

17. A luminous point object O is placed in front of spherical glass surface of radius R = 20 cm. The final real image is formed after refraction through the spherical surface, followed by reflection at the concave mirror of radius R = 400 cm and a second refraction through the spherical surface. Find the distance (in centimeter) of this final image from the pole P_1 of the spherical surface.



18. The main scale of a vernier calipers reads in millimeter and its vernier is divided into ten divisions which coincide with eight division of main scale. Further more when a cylinder is tightly placed along its length between two jaws, it is observed that the zero of vernier scale lies just right to 35th division of main scale and sixth division of vernier scale coincides with the main scale. Then find the measured value in centimeter. There is no zero error.

Chemistry

PART – II

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. For the following process

$\text{Ice} \xrightleftharpoons{0^{o}\text{C}} H_2O(\ell)$

Which of the following is/are true?

(A) $\Delta G > 0$

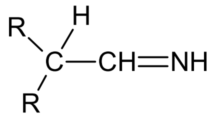
(B) $\Delta H > 0$

(C) $\Delta S > 0$

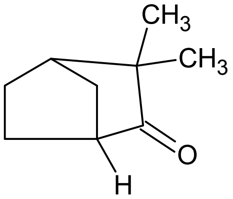
(D) $\Delta U > 0$

20. Tautomerism can be shown by the given molecule(s)

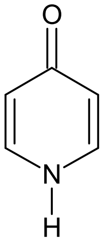
(A)



(B)



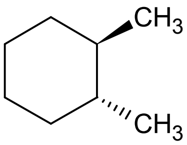
(C)



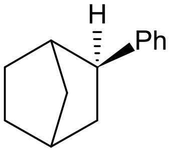
(D) CH_3CH_2NO

21. Optically active molecule(s) is/are

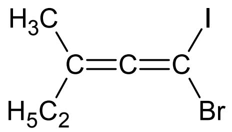
(A)



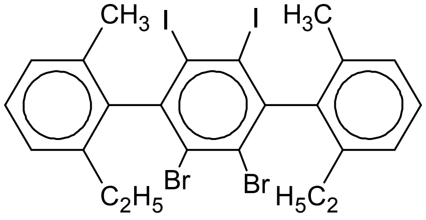
(B)



(C)

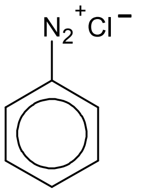


(D)



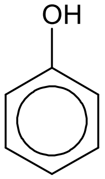
22. Which of the following method(s) is/are correct to get iodination product of aryl group?

(A)



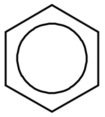
$+ \text{KI} \xrightarrow{\Delta}$

(B)



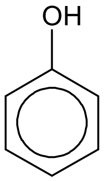
$+ I_2 \xrightarrow{\text{Base}}$

(C)



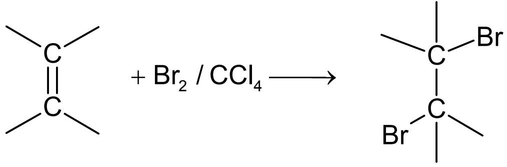
$+ \text{ICl} \xrightarrow{\text{AlCl}_3}$

(D)



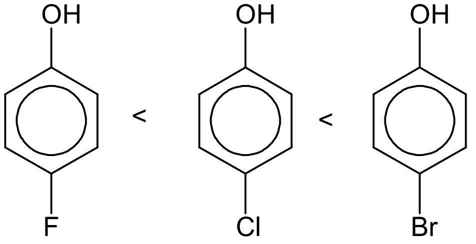
$+ \text{ICN} \longrightarrow$

23. Which of the following statement(s) is/are correct for the given reaction?



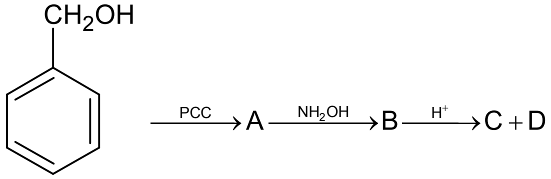
(A) Reaction will stop at high temperature.
(B) In reaction anti-addition of bromine takes place via ionic mechanism.
(C) Vacant d-orbital of Br_2 interacts with π bond of alkene
(D) Non-bonding electron pair of Br^- ion attacks on π^* orbital of alkene

24. Which of the following statement(s) is/are correct?
(A) order of rate of reaction for S_NAr mechanism in ArX is ArF > ArCl > ArBr > ArI
(B) Rate of reaction for benzyne mechanism in following Aryl Halides is ArBr > ArCl > ArF
(C) Acidic strength of substituted phenol are



(D) $CH_2=CH-CHO \xrightarrow[\text{reagent}]{\text{Jone's}} CH_2=CH-COOH$

25.

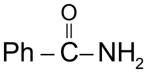


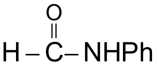
$$\xrightarrow{PCC} A \xrightarrow{NH_2OH} B \xrightarrow{H^+} C + D$$

$$C \xrightarrow[\text{(ii) } H_2O]{\text{(i) } Br_2/\text{alc.KOH}} E \xrightarrow[\text{alc. KOH}]{CHCl_3} F$$ bad smelling compound.

$$D \xrightarrow[\text{hydrolysis}]{H_3O^+} E + HCOOH$$

Which of the following is/are correct?

(A) C is 
$Ph-\overset{\overset{O}{\|}}{C}-NH_2$

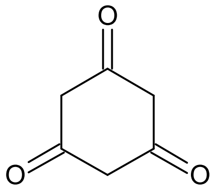
(B) D is 
$H-\overset{\overset{O}{\|}}{C}-NHPh$

(C) E is $PhNH_2$
(D) F is Ph – NC

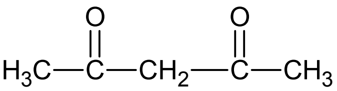
26. Haloform reaction is given by which of the following compound(s)

(A) CH_3-CH_2Cl

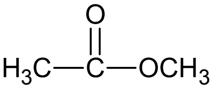
(B)



(C)


$H_3C-\overset{\overset{O}{\|}}{C}-CH_2-\overset{\overset{O}{\|}}{C}-CH_3$

(D)


$H_3C-\overset{\overset{O}{\|}}{C}-OCH_3$

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

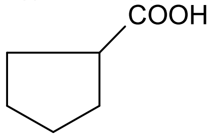
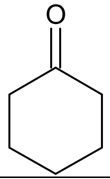
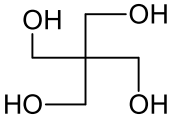
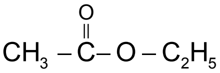
Answer the following by appropriately matching the list based on the information given in the paragraph.

List–I		**List–II**	
(I)	Pb^{2+}	(P)	White ppt. with KI
(II)	Ag^{+}	(Q)	Yellow ppt. with KI which dissolves in excess of KI
(III)	Cu^{2+}	(R)	Brick red ppt. with K_2CrO_4
(IV)	Bi^{3+}	(S)	Black ppt. with KI which dissolves in excess of KI to give orange solution
		(T)	Brown ppt. with $K_4[Fe(CN)_6]$
		(U)	Yellow ppt. with KCN which turns readily into white

27. Which of the following is correctly matched?
(A) (I), (Q)
(B) (I), (P)
(C) (III), (S)
(D) (III), (R)

28. Which of the following is not correct?
(A) (III), (U)
(B) (III), (T)
(C) (IV), (S)
(D) (II), (P)

Answer the following by appropriately matching the list based on the information given in the paragraph.

List–I		**List–II**	
(I)	CH_3CHO	(P)	On reaction with (i) X_2/H^+, (ii) KOH (iii) H_3O^+, gives 
(II)	PhCHO	(Q)	On acyloin condensation gives 'α' hydroxyl ketone
(III)		(R)	Gives  with excess of HCHO in basic medium
(IV)	 $CH_3-\overset{O}{\overset{\|}{C}}-O-C_2H_5$	(S)	On reaction with (i) NH_2OH (ii) H^+ (iii) polymerization gives Nylon-6
		(T)	Gives benzoin condensation with KCN/alc. KOH
		(U)	Gives Claisen condensation

29. Which of the following is INCORRECT?
    (A) (I), (R)
    (B) (II), (T)
    (C) (III), (P)
    (D) (IV), (S)

30. Which of the following is INCORRECT?
    (A) (II), (Q)
    (B) (III), (S)
    (C) (IV), (Q)
    (D) (IV), (U)

SECTION – C

(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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31. Total number of possible stereoisomers of the following co-ordinate compound
    Mabcdef where - a, b, c, d, e and f are mono dentate ligands.

32. $K_4[Fe(CN)_6]$, which dissociates 80% in aqueous solution. Calculate van't Hoff factor of $K_4[Fe(CN)_6]$.

33. If we remove all the ions along one body diagonal in zinc blende structure. The fraction of tetrahedral void remains occupied is X, then the value of 10X is:

34. A mixture of carbonates of two bivalent metals contains 14.2% of one metal. If 3.2 gm of the mixture liberates 1.44 g CO_2, what would be the % by weight of the other metal.

35. CH_3COOH (75 ml, 0.1 M) is titrated against 0.1 M NaOH solution. Calculate pH after the addition of 80 ml of NaOH. [log 0.23 = 0.6382]

36. What is the bond order of C – O bond in CO_3^{2-} ion?

Mathematics PART – III

SECTION – A

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. Let $Z = \sum_{r=1}^{100}(2r+3)\left\{\sum_{k=1}^{8}\left(\sin\frac{2k\pi}{9} - i\cos\frac{2k\pi}{9}\right)\right\}^r$, then which of the following option(s) is incorrect?
(A) $|Z| = 100\sqrt{2}$
(B) $\text{Arg}\left(Z^2\right) = \frac{7\pi}{4}$
(C) $|Z| = 50\sqrt{2}$
(D) $\text{Arg}\left(Z^2\right) = \frac{3\pi}{2}$

38. Let N = $2007^{2013} - 1974^{2013} - 1946^{2013} + 1913^{2013}$, then
(A) N is divisible by 61
(B) N is divisible by 2013
(C) N is divisible by 28
(D) all of these

39. Let a parabola touches the line y = 2x and 2y + x = 0 at P(5, 10) and Q(2, –1) respectively, then which of the following options is/are correct?
(A) equation of directrix is 9y + 7x = 0
(B) equation of tangent at vertex is 182x + 234y – 125 = 0
(C) focus is $\left(\frac{55}{26}, \frac{15}{26}\right)$
(D) length of latus rectum is $\frac{250}{13\sqrt{130}}$

40. Let f(x) = $|x^2 - 5x + 6| + |x^2 - 4x + 3| - ||x - 3|(|x - 1| - |x - 2|)|$; $x \in R$, then f(x) has a
(A) local extremum at x = $\frac{7}{2}$
(B) local maximum at x = $\frac{3}{2}$
(C) local minimum at x = 2
(D) local maximum at x = 1

41. Let $\hat{x}$, $\hat{y}$ and $\hat{z}$ be unit vectors such that $\hat{x} + \hat{y} - \hat{z} = \vec{p}$, $\hat{x} \times \left(\hat{y} \times \hat{z}\right) = \vec{q}$ and $\left(\hat{x} \times \hat{y}\right) \times \hat{z} = \vec{r}$.
If $|\vec{p}| = \sqrt{3}$, $\vec{q} \cdot \hat{y} = \frac{3}{4}$ and $\vec{p}$ is perpendicular to $\vec{x}$, then which of the following option(s) is/are correct?
(A) $\vec{r} \cdot \hat{y} = \frac{3}{4}$
(B) $\vec{q} \cdot \hat{x} = 0$
(C) $|\vec{q}| = \frac{3}{4}$

(D) $|\vec{r}| = \frac{3}{8}$

42. If the polynomial $x^4 + px^3 + qx^2 + rx - 48$ is divisible by the polynomials $x^3 - 2ax^2 + bx - 6$ and $x^3 + ax^2 - (3b + 1)x + 48$, then which of the following option is/are correct?

(A) $b - a = 8$

(B) $p = 2$

(C) $q = -7$

(D) $r = -82$

43. Let $L_1 = \lim\limits_{x \to 0} \frac{3ax + \sin((a-8)x)}{(\sin^{-1} x)^3}$; L_1 is finite,

$$L_2 = \lim_{x \to \infty} \frac{8x^5 - (\operatorname{cosec}^{-1} x)^5}{\frac{4}{\pi} x^5 \sec^{-1}(kx-1) + \frac{k^3 x^{10}}{\pi} \tan^{-1}\left(\frac{\pi}{x^5}\right) + \frac{5k^2 x^5}{2}}.$$

If L_2 is finite and equal to a, then which of the following option is/are correct?

(A) $\frac{L_1}{L_2} = 18$

(B) $\frac{L_1}{L_2} = 9$

(C) $k = -2$

(D) $a + k = 2$

44. Let α, β, γ be three real numbers satisfying $[\alpha \;\; \beta \;\; \gamma] \begin{bmatrix} 4 & 1 & 7 \\ -1 & 3 & 8 \\ 3 & -4 & -9 \end{bmatrix} = [4 \;\; 2 \;\; 10]$ ….. S. If the point P(α, β, γ) with reference to S, lies on a plane (π) containing the lines $L_1 : \frac{x+9}{1} = \frac{y+8}{-2} = \frac{z-3}{1}$ and $L_2 : \frac{x+9}{-4} = \frac{y+8}{3} = \frac{z-3}{0}$, then which of the following option(s) is/are correct?

(A) Distance of plane (π) from the point $(0, -11, 2\sqrt{2})$ is 2 units

(B) Line $L : \frac{x+10}{3} = \frac{y+6}{1} = \frac{z-2}{1}$ completely lies in plane (π)

(C) 6α + β + γ is equal to 6

(D) If plane (π) intersect the coordinate axes at points A, B and C respectively then volume of tetrahedron OABC, (O being origin) is $\frac{(44)^3}{360}$ cubic units

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

MM-I. Let z = x + iy be a complex number represented by the point P(x, y) in the argand plane. List-I contains information about the region S consisting of set of points satisfying a fixed condition. List-II contains information about possible arguments of complex number Z lying in region S

List-I		List-II	
(I)	$\text{Re}\left((1+i)Z^2\right) > 0\,;\text{Re}(Z) \ge 0$	(P)	$\frac{3\pi}{8} < \arg Z < \frac{7\pi}{8}$
(II)	$\text{Re}\left((1+i)Z^2\right) > 0\,;\text{Re}(Z) < 0$	(Q)	$-\frac{5\pi}{8} < \arg Z < \frac{-\pi}{8}$
(III)	$\text{Im}\left((1+i)Z^2\right) > 0\,;\text{Im}(Z) < 0$	(R)	$-\frac{3\pi}{8} < \arg Z < \frac{\pi}{8}$
(IV)	$\text{Im}\left((1+i)Z^2\right) < 0\,;\text{Im}(Z) \ge 0$	(S)	$\frac{\pi}{2} < \arg Z < \frac{3\pi}{4}$
		(T)	$-\frac{3\pi}{8} < \arg Z < \frac{5\pi}{8}$
		(U)	$-\frac{\pi}{8} < \arg Z < \frac{\pi}{8}$

45. Which of the following is the only CORRECT combination?
(A) (I), (R), (U)
(B) (II), (Q), (T)
(C) (I), (R), (S)
(D) (III), (R), (Q)

46. Which of the following is the only CORRECT combination?
(A) (I), (Q), (S)
(B) (II), (R), (T)
(C) (III), (S), (T)
(D) (IV), (P), (S)

Answer the following by appropriately matching the list based on the information given in the paragraph.

MM-II. Let $f(x) = \begin{matrix} [2x] & ; & -1 \le x < 1 \\ |2x| & ; & 1 \le x \le 2 \end{matrix}$, $g(x) = \dfrac{\text{cosec}\, x}{2}$; $x \in (0, 2\pi) - \{\pi\}$ (where [.] denotes the greatest integer function),

List-I: contains information about f(f(x)), f(g(x)), f(2g(x)), g(f(x))

List-II: contains information about the continuity and differentiability of ff(x), f(g(x)), f(2g(x)), gf(x)

	List-I		List-II
(I)	f(g(x)) = – 2 $\forall\ x \in \left[\frac{5\pi}{4}, \frac{5\pi}{3}\right] - \left\{\frac{3\pi}{2}\right\}$	(P)	discontinuous at x = 1
(II)	g(f(x)) = 1 for some x ∈ (1, 2)	(Q)	continuous at $x = \frac{\pi}{2}$
(III)	f(f(x)) = 0 for $\forall\ x \in \left[\frac{1}{4}, \frac{1}{3}\right]$	(R)	discontinuous at $x = \frac{5\pi}{6}$
(IV)	f(2g(x)) = 2 for some $x \in \left[\frac{\pi}{6}, \frac{5\pi}{6}\right]$	(S)	continuous at $x = \frac{\pi}{6}$
		(T)	differentiable at $x = \frac{\pi}{2}$
		(U)	differentiable at $x = \frac{\pi}{6}$

47. Which of the following is the only CORRECT combination?
    - (A) (I), (P), (T)
    - (B) (I), (R), (T)
    - (C) (II), (Q), (S)
    - (D) (II), (P), (Q)

48. Which of the following is the only CORRECT combination?
    - (A) (IV), (R), (T)
    - (B) (IV), (P), (S)
    - (C) (III), (P), (U)
    - (D) (II), (R), (T)

SECTION – C

(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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49. Let $A_1, A_2, \ldots, A_n$ be the vertices of n sided regular polygon having centre at origin. If $(A_1 A_2)^2 + (A_1 A_3)^2 = (A_1 A_4)^2$, then the value of n is

50. A teacher asks a puzzle to a student in a class but did not receive an answer. It is known that student fails to understand the puzzle one out of five times and the teacher fails to hear the reply one out of ten times. More over student would reply if he/she understood the puzzle. If the probability that student understood the puzzle is $\frac{a}{b}$ (a, b are coprime), then the value of b – a is

51. If the sum of all the solution(s) of the equation $\left(2\sec^2 x - \cos\frac{16}{9}x\right)\sec x - \left(\cos\frac{x}{3} + 2\tan x \sec x\right)\tan x = \sin\frac{x}{3}$; $x \in [-9\pi, 9\pi]$ is $k\pi$, then k is equal to

52. Let f be a real valued function defined as

$$f(x) = \begin{cases} \cos^{-1}\left(\left\{x+\frac{1}{2}\right\}-\frac{1}{2}\right); & \left[x+\frac{1}{2}\right] \text{ is even} \\ \sin^{-1}\left(\frac{1}{2}-\left\{x+\frac{1}{2}\right\}\right); & \left[x+\frac{1}{2}\right] \text{ is odd} \end{cases}$$

(where [x], {x} represents greatest integer function and fractional part function respectively).

If $\int_{-\frac{1}{2}}^{\frac{23}{2}} f(x)dx = 2k\pi$, then the value of k is

53. A circle having centre C(a, b) lying on the ellipse $\frac{x^2}{4}+\frac{y^2}{9}=1$ cuts the rectangular hyperbola xy = 2 in four points (x_i, y_i); i = 1, 2, 3, 4. If the locus of the centroid of triangle formed by any three points of intersection is $\left(x-\frac{2a}{3}\right)\left(y-\frac{2b}{3}\right)=k^2$, then the value of $\frac{2}{k^2}$ is

54. Let ABC be a triangle right angled at C, BC = 6. Also incircle of triangle touches side AC at D. If area of trapezium PDCB is 8 square units (P being the incentre of ΔABC), then the radius of the circle touching the incircle of triangle ΔABC and passing through the vertex B and C is _____

FIITJEE

ALL INDIA INTEGRATED TEST SERIES

HALF COURSE TEST – I

JEE (Main)-2020

TEST DATE: 30-12-2018

Time Allotted: 3 Hours **Maximum Marks: 360**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only one section: **Section-A**.

Section-A (01 – 30, 31 – 60, 61 – 90) *contains 90 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. The unit of Stefan-Boltzmann's constant (σ) is:

(A) $\dfrac{watt^4}{m \times K^4}$

(B) $\dfrac{calorie}{m^2 \times K^4}$

(C) $\dfrac{watt}{m^2 \times K^4}$

(D) $\dfrac{joule}{m^2 \times K^4}$

2. The equation of the stationary wave is:

$$y = 2A\sin\left(\frac{2\pi ct}{\lambda}\right)\cos\left(\frac{2\pi x}{\lambda}\right).$$

Which of the following statements is wrong?

(A) The unit of ct is same as that of λ

(B) The unit of x is same as that of λ

(C) The unit of $2\pi c/\lambda$ is same as that of $2\pi x/\lambda t$

(D) The unit of c/λ is same as that of x/λ

3. Given that: $y = a\cos\left(\dfrac{t}{p} - qx\right)$, where t represents time in second and x represents distance in metre. Which of the following statements is true?

(A) The unit of x is same as that of q

(B) The unit of x is same as that of p

(C) The unit of t is same as that of q

(D) The unit of t is same as that of p

4. A spherical body of mass m and radius r is allowed to fall in a medium of viscosity η. The time in which the velocity of the body increases from zero to 0.63 times, the terminal velocity (v) is called time constant (τ). Dimensionally τ can be represented by:

(A) $\dfrac{mr^2}{6\pi\eta}$

(B) $\sqrt{\left(\dfrac{6\pi mr\eta}{g^2}\right)}$

(C) $\dfrac{m}{6\pi\eta rv}$

(D) none of these

5. The pressure on a square plate is measured by measuring the force on the plate and the length of the sides of plate. If the maximum error in the measurement of force and length are respectively 4% and 2%, the maximum error in the measurement of pressure is:

(A) 1%
(B) 2%
(C) 6%
(D) 8%

6. If $Q = \dfrac{X^n}{Y^m}$ *and* ΔX is absolute error in the measurement of X, ΔY is absolute error in the measurement of Y, then absolute error ΔQ *in* Q is:

(A) $\Delta Q = \pm\left(n\dfrac{\Delta X}{X} + m\dfrac{\Delta Y}{Y}\right)$

(B) $\Delta Q = \pm\left(n\dfrac{\Delta X}{X} + m\dfrac{\Delta Y}{Y}\right)Q$

(C) $\Delta Q = \pm\left(n\dfrac{\Delta X}{X} - m\dfrac{\Delta Y}{Y}\right)Q$

(D) $\Delta Q = \pm\left(n\dfrac{\Delta X}{Y} - m\dfrac{\Delta Y}{X}\right)Q$

7. A particle of mass $= 5\,units$ is moving with a uniform speed $V = 3\sqrt{2}\,units$ in the XOY Plane along the line $Y = X + 4$. The magnitude of the angular momentum of the particle about the origin is:

(A) 60 unit
(B) $40\sqrt{2}\ unit$
(C) zero
(D) $7.5\,unit$

8. A particle of mass m is projected with a velocity V making an angle of 45^o with the horizontal. The magnitude of the angular momentum of the projectile about the point of projection when the particle is at its maximum height h is:

(A) zero

(B) $\dfrac{mV^2}{\sqrt{2}\ g}$

(C) $\dfrac{mV^2}{4\sqrt{2}g}$

(D) $m\sqrt{2gh^3}$

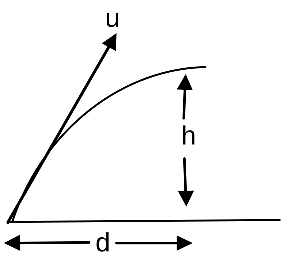
9. The displacement of a particle after time t is given by $x=(k/b^2)(1-e^{-bt}),\ where\ b$ is a constant. What is the acceleration of the particle?
(A) ke^{-bt}
(B) $-ke^{-bt}$
(C) $\frac{k}{b^2}e^{-bt}$
(D) $\frac{-k}{b^2}e^{-bt}$

10. The deceleration experienced by a moving motor boat, after its engine is cut-off is given by: $\frac{dv}{dt}=-kv^3,\ where\ k$ is constant. If v_0 is the magnitude of the velocity at cut-off, the magnitude of the velocity at a time t after the cut-off is:
(A) $v_0/2$
(B) v_0
(C) v_0e^{-kt}
(D) $\frac{v_0}{\sqrt{(2v_0^2kt+1)}}$

11. The displacement x of a particle varies with time t as $x=ae^{-\alpha t}+be^{\beta t}$, where a, b, α and β are positive constants. The velocity of the particle will:
(A) be independent of β
(B) drop to zero when $\alpha = \beta$
(C) go on decreasing with time
(D) go on increasing with time

12. The equation of motion of a projectile is:
$y=12x-\frac{5}{9}x^2$.
The horizontal component of velocity is $3\ ms^{-1}$. Given that $g=10\ ms^{-2}$, what is the range of the projectile?
(A) 12.4 m
(B) 21.6 m
(C) 30.6 m
(D) 36.0 m

13. If a stone is to hit at a point which is at a distance d away and at a height h above the point from where the stone starts, then what is the value of initial speed u if the stone is launched at an angle θ?



(A) $\frac{g}{\cos\theta}\sqrt{\frac{d}{2(d\ \tan\theta-h)}}$
(B) $\frac{d}{\cos\theta}\sqrt{\frac{g}{2(d\ \tan\theta-h)}}$

(C) $\sqrt{\dfrac{gd^2}{h\cos^2\theta}}$

(D) $\sqrt{\dfrac{gd^2}{(d-h)}}$

14. The speed of a projectile at its maximum height is $\dfrac{\sqrt{3}}{2}$ times its initial speed. If the range of the projectile is P times the maximum height attained by it, P is equal to:

(A) $\dfrac{4}{3}$

(B) $2\sqrt{3}$

(C) $4\sqrt{3}$

(D) $\dfrac{3}{4}$

15. The potential energy for a conservative system is given by:

$U = ax^2 - bx.$

Where a and b are positive constants. The law of the force governing the system is:

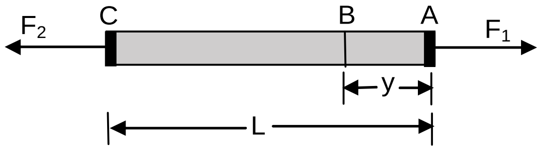
(A) $F = constt.$

(B) $F = bx - 2a$

(C) $F = b - 2ax$

(D) $F = 2ax$

16. A rod of length L and mass M is acted on by two unequal forces F_1 and F_2 $(< F_1)$ as shown in the following figure.



The tension in the rod at a distance y from the end A is given by:

(A) $F_1\left(1-\dfrac{y}{L}\right)+F_2\left(\dfrac{y}{L}\right)$

(B) $F_2\left(1-\dfrac{y}{L}\right)+F_1\left(\dfrac{y}{L}\right)$

(C) $(F_1 - F_2)\dfrac{y}{L}$

(D) none of these

17. A force acts on a 3.0 g particle in such a way that the position of the particle as a function of time is given by:

$x = 3t - 4t^2 + t^3.$

Where x is in metres and t is in seconds. The work done during the first 4 s is:

(A) 570 mJ
(B) 450 mJ
(C) 490 mJ
(D) 528 mJ

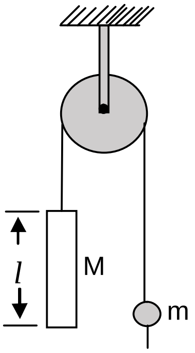
18. A bullet is fired from a gun. The force on the bullet is given by:

$F = 600 - 2\times10^5\ t.$

Where F is in newton and t in second. The force on the bullet becomes zero as soon as it leaves the barrel. What is the average impulse imparted to the bullet?

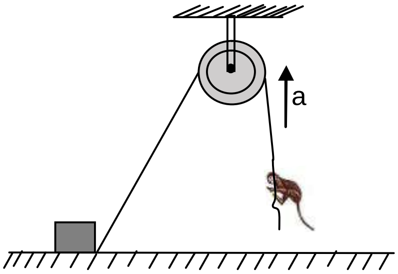
(A) $9\ N-s$
(B) $58.8\ kg/s$
(C) $0.9\ kg/s$
(D) $178.4\ kg/s$

19. Figure shows an arrangement of a rod of length l and mass M and a bead of mass m attached to a weightless string passing over a frictionless pulley. At $t = 0$, the bead is in level with the lower end of the rod. The bead slides down the string with considerable friction and is opposite to the other end of the rod after T second. Assuming friction between the bead and the string to be constant all through, the frictional force is:



(A) $\dfrac{2Mm}{(M-m)}\dfrac{l}{t^2}$
(B) $\dfrac{(M-m)}{2Mm}\dfrac{l}{t^2}$
(C) $\dfrac{2Mm}{(M+m)}\dfrac{l}{t^2}$
(D) $\dfrac{(M+m)}{2Mm}\dfrac{l}{t^2}$

20. A light string fixed at one end to a clamp on ground passes over a fixed pulley and hangs at the other side. It makes an angle of 30^o with the ground. A monkey of mass 5 kg climbs up the rope. The clamp can tolerate a vertical force of 40 N only. The maximum acceleration in upward direction with which the monkey can climb safely is: (neglect friction and take $g = 10m/s^2$)



(A) $2\ m/s^2$
(B) $4\ m/s^2$
(C) $6\ m/s^2$
(D) $8\ m/s^2$

21. An elevator accelerates upwards at a constant rate. A uniform string of length L and mass m supports a small block of mass M that hangs from the ceiling of the elevator. The tension at distance l from the ceiling is T. The acceleration of the elevator is:

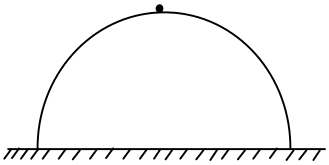
(A) $\dfrac{T}{M+m-\dfrac{ml}{L}}-g$

(B) $\dfrac{T}{2M+m-\dfrac{ml}{L}}+g$

(C) $\dfrac{T}{M+\dfrac{ml}{L}}-g$

(D) $\dfrac{T}{2M-m+\dfrac{ml}{L}}-g$

22. A hemisphere of radius *R* and of mass $4m$ is free to slide with its base on a smooth horizontal table. A particle of mass m is placed on the top of the hemisphere. The angular velocity of the particle relative to hemisphere at an angular displacement θ when velocity of hemisphere v is:



(A) $\dfrac{5v}{R\cos\theta}$

(B) $\dfrac{2v}{R\cos\theta}$

(C) $\dfrac{3v}{R\sin\theta}$

(D) $\dfrac{5v}{R\sin\theta}$

23. Three particles each of mass M are placed at the three corners of an equilateral triangle of side l. What is the force due to this system of particles on another particle of mass m placed at the mid -point of any side?

(A) $\dfrac{3GMm}{4l^2}$

(B) $\dfrac{4GMm}{3l^2}$

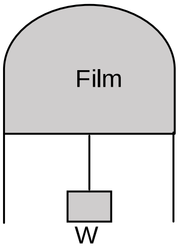
(C) $\dfrac{GMm}{4l^2}$

(D) $\dfrac{4GMm}{l^2}$

24. The two planets have radii $r_1 \; and \; r_2$ and their densities $p_1 \; and \; p_2$ respectively. The ratio of acceleration due to gravity on them will be:
(A) $r_1 p_1 : r_2 p_2$
(B) $r_1 p_1^2 : r_2 p_2^2$
(C) $r_1^2 p_1 : r_2^2 p_2$
(D) $r_1 p_2 : r_2 p_1$

25. If T is the surface tension of a liquid, the energy needed to break a liquid drop of radius R into 64 drops, is:
(A) $6\pi R^2 T$
(B) $\pi R^2 T$
(C) $12\pi R^2 T$
(D) $8\pi R^2 T$

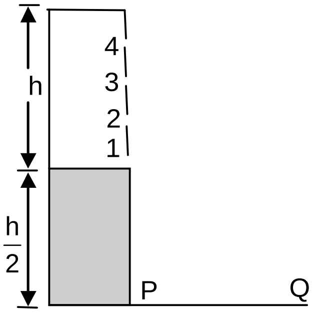
26. A thin liquid film formed between a U-shaped wire and a light slider supports a weight of $1.5\times10^{-2}\,N$ (see figure). The length of the slider is 30 cm and its weight are negligible. The surface tension of the liquid film is:



(A) $0.0125\; Nm^{-1}$
(B) $0.1\; Nm^{-1}$
(C) $0.05\; Nm^{-1}$
(D) $0.025\; Nm^{-1}$

27. A small metal sphere of radius a is falling with a velocity v through a vertical column of a viscous liquid. If the coefficient of viscosity of the liquid is η, then the sphere encounters an opposing force of:
(A) $6\pi\eta a^2 v$
(B) $\frac{6\eta v}{\pi a}$
(C) $6\pi\eta a v$
(D) $\frac{\pi\eta v}{6a^3}$

28. A cylinder of height h is filled with water and is kept on a block of height $h/2$. The level of water in the cylinder is kept constant. Four holes numbered 1, 2, 3 and 4 are at the side of the cylinder and at heights 0, $h/4,\; h/2 \; and \; 3h/4$ respectively. When all four holes are opened together, the hole from which water will reach farthest distance on the plane PQ is the hole number:



(A) 1
(B) 2
(C) 3
(D) 4

29. Assuming the sun to be a spherical body of radius R at a temperature of TK, evaluate the total radiant power, incident on the earth, at a distance r from the sun, is:

(Where r_0 is the radius of the earth and σ is Stefan's constant.)

(A) $\frac{R^2\sigma T^4}{r^2}$

(B) $\frac{4\pi r_0^2 R^2\sigma T^4}{r^2}$

(C) $\frac{\pi r_0^2 R^2\sigma T^4}{r^2}$

(D) $\frac{r_0^2 R^2\sigma T^4}{4\pi r^2}$

30. The length of an open organ pipe is twice the length of another closed organ pipe. The fundamental frequency of the open pipe is 100 Hz. The frequency of the third harmonic of the closed pipe is:

(A) 100 Hz
(B) 200 Hz
(C) 300 Hz
(D) 150 Hz

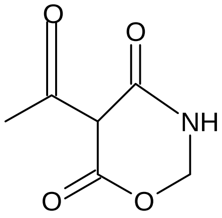
Chemistry

PART – II

SECTION – A
(One Options Correct Type)

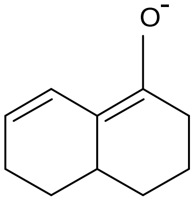
This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

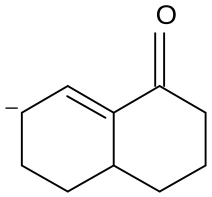
31. Identify which functional group is not present in following compound?

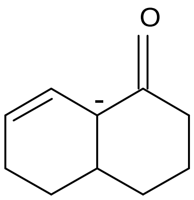


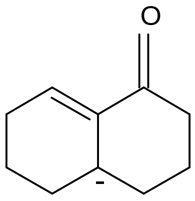
(A) Ketone
(B) Ester
(C) Amide
(D) Ether

32. Which of the following is not a resonating structure of others?

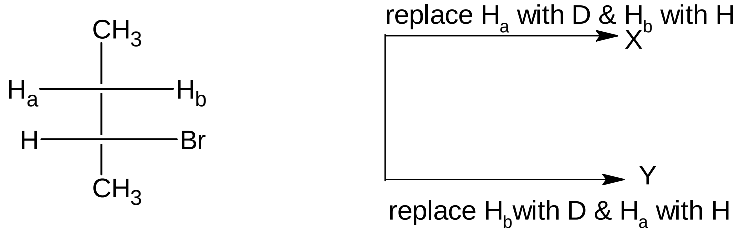
(A)


(B)


(C)


(D)


33.

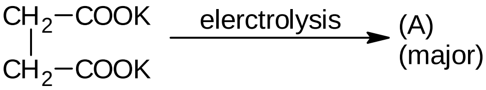

CH3
Ha
Hb
H
Br
CH3
replace Ha with D & Hb with H
X
Y
replace Hb with D & Ha with H

(X) & (Y) are

(A) Enantiomers
(B) Diastereomers
(C) E & Z isomer
(D) Constitutional isomer

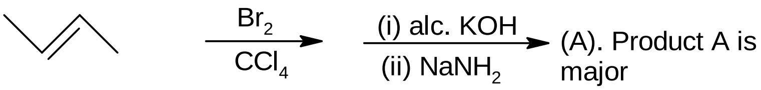
34. The separation of racemic mixture into pure enantiomers is termed as
(A) Racemization
(B) Isomerization
(C) Resolution
(D) Equilibration

35. Which of the following compounds can be best prepared by Wurtz reaction?
(A) Isobutane
(B) n – butane
(C) n – pentane
(D) Iso – pentane

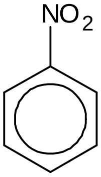
36.


$$\begin{matrix} CH_2-COOK \\ | \\ CH_2-COOK \end{matrix} \xrightarrow{\text{elerctrolysis}} \underset{\text{(major)}}{\text{(A)}}$$

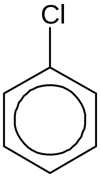
Product A is
(A) CH_3-CH_3
(B) $CH_2=CH_2$
(C) $CH_3-CH=CH_2$
(D) None

37.


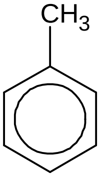
(A) $H_2C=CH-CH=CH_2$
(B) $CH_3-C\equiv C-CH_3$
(C) $CH_3-CH_2-C\equiv CH$
(D) $CH_3-CH=C=CH_2$

38.


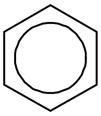
(A)



(B)



(C)


(D)

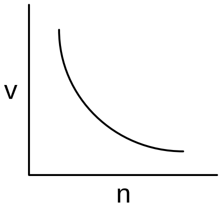
Correct order of rate of EAS (electrophilic aromatic substitution) is
(A) C > B > A > D
(B) C > D > A > B
(C) A > B > C > D
(D) C > D > B > A

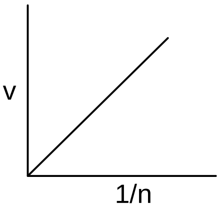
39. Which of the following is not a green house gas (GHG)?
(A) CO_2
(B) N_2O
(C) O_3
(D) NO

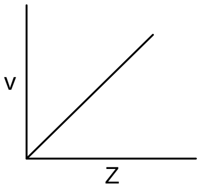
40. Rearrange the following (I to IV) in the order of increasing masses:
(I) 0.5 mole of O_3 (II) 0.5 gm atom of oxygen
(III) 3.011×10^{23} molecules of O_2 (IV) 5.6 litre of CO_2 at STP
(A) II < IV < III < I
(B) II < I < IV < III
(C) IV < II < III < I
(D) I < II < III < IV

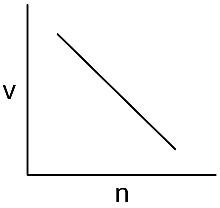
41. The number of neutrons in 5 g of D_2O (D is ${}_1^2H$) are
(A) 0.25 N_A
(B) 2.5 N_A
(C) 1.1 N_A
(D) None of these

42. Select the incorrect graph for velocity of e^- in an orbit vs. Z, $\frac{1}{n}$ and n

(A)


(B)


(C)


(D)


43. The orbital angular momentum of 3p electron is
(A) $\sqrt{3}$ h
(B) $\sqrt{6}$ h
(C) zero
(D) $\sqrt{2}\,\frac{h}{2\pi}$

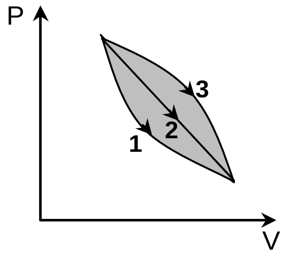
44. Air entering the lungs ends up in tiny sacs called alveoli. It is from the alveoli that oxygen diffuses into the blood. The average radius of the alveoli is 0.0050 cm and the air inside contains 14 per cent oxygen. Assuming that the pressure in the alveoli is 1.0 atm and the temperature is 37°C, calculate the number of oxygen molecules in one of the alveoli.
(A) 6×10^{13}
(B) 10^{24}
(C) 1.7×10^{22}
(D) 1.7×10^{12}

45. Starting out on a trip into the mountains, you inflate the tires on your automobile to a recommended pressure of 3.21×10^5 Pa on a day when the temperature is –5.0°C. You drive to the beach, where temperature is 28°C. Assume that the volume increased by 3%. What is the final pressure in the tires?
(A) 350 Pa
(B) 3500 Pa

(C) 3.5×10^5 Pa
(D) None of these

46. A sample of liquid in a thermally insulated container (a calorimeter) is stirred for 2 hr. by a mechanical linkage to a motor in the surrounding, for this process:
(A) $w < 0;\ q = 0;\ \Delta U = 0$
(B) $w > 0;\ q > 0;\ \Delta U > 0$
(C) $w < 0;\ q > 0;\ \Delta U = 0$
(D) $w > 0;\ q = 0;\ \Delta U > 0$

47. A given mass of gas expands from the state A to the state B by three paths 1, 2 and 3 as shown in the figure. If w_1, w_2 and w_3 respectively be the work done by the gas along three paths then:
(A) $w_1 > w_2 > w_3$
(B) $w_1 < w_2 < w_3$
(C) $w_1 = w_2 = w_3$
(D) $w_2 < w_3 < w_1$



48. Which of the following relations is correct for k_f and k_b in an equilibrium process that contains equal moles of reactants and products?
(A) $k_f = k_b$
(B) $k_f > k_b$
(C) $k_f < k_b$
(D) We cannot predict

49. When Mg_2C_3 is reacted with water, a compound X is formed which on heating with Na followed by treatment with C_2H_5Br gives another compound Y. Calculate the number of sigma bond in Y.
(A) 10
(B) 6
(C) 8
(D) 12

50. Given the following K_a values, determine which species is the strongest base,
$HSO_4^- = 1.2\times10^{-2}, H_2PO_4^- = 6.3\times10^{-8}, HCO_3^- = 4.7\times10^{-11}$
(A) CO_3^{2-}
(B) H_2SO_4
(C) SO_4^{2-}
(D) HPO_4^{2-}

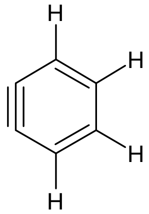
51. Given that K_w for water is 10^{-13} M^2 at 62°C, compute the sum of pOH and pH for a neutral aqueous solution at 62°C.
(A) 7.0
(B) 13.30
(C) 14.0
(D) 13.0

52. In the periodic table, metallic character of the elements shows which one of the following trends?
(A) Decreases down the group and increases across the period
(B) Increases down the group and decreases across the period
(C) Increase across the period and also down the group
(D) Decreases across the period and also down the group

53. Which of the following is arranged in decreasing order of size?
(A) $Mg^{2+} > Al^{3+} > O^{2-}$
(B) $O^{2-} > Mg^{2+} > Al^{3+}$
(C) $Al^{3+} > Mg^{2+} > O^{2-}$
(D) $Al^{3+} > O^{2-} > Mg^{2+}$

54. Correct statement regarding molecules SF_4, CF_4 and XeF_4 are
(A) 2, 0 and 1 lone pairs of central atom respectively
(B) 1, 0 and 1 lone pairs of central atom respectively
(C) 0, 0 and 2 lone pairs of central atom respectively
(D) 1, 0 and 2 lone pairs of central atom respectively

55. How many sp^2 and sp-hybridised carbon atoms are present respectively in the following compound?
(A) 4, 2
(B) 6, 0
(C) 3, 3
(D) 5, 1



56. For the alkali metals, which of the following increases with increasing atomic number?
(A) First ionization energy
(B) Electronegativity
(C) Hydration energy of the univalent ion
(D) Atomic radius

57. A solution of sodium in liquid ammonia is blue in colour due to:
(A) the presence of ions Na^+
(B) the presence of ammoniated electron
(C) the formation of $NaNH_2$
(D) the formation of sodium hydride

58. Colour of the bead in borax bead test is mainly due to the formation of
(A) metal oxides
(B) boron oxide
(C) metal metaborates
(D) elemental boron

59. PbI_4 does not exist because:
(A) iodine is not reactive
(B) Pb(IV) is oxidizing and I^- is strong reducing agent
(C) Pb(IV) is less stable than Pb (II)
(D) Pb^{4+} is not easily formed

60. The equilibrium constant K and reaction quotient Q are in ratio 0.33 : 1. It means that
(A) The reaction mixture will equilibrate to form more reactant species
(B) The reaction mixture will equilibrate to form more product species
(C) The equilibrium ratio of reactant to product concentrations will be 3
(D) The equilibrium ratio of reactant to product concentrations will be 0.33

Mathematics PART – III

SECTION – A

(One Options Correct Type)

This section contains **30 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

61. The coefficient of the term independent of x in the expansion of

$(1 + x + 2x^3)\left(\frac{3}{2}x^2 - \frac{1}{3x}\right)^9$ is

(A) 1/3
(B) 19/54
(C) 17/54
(D) 1/4

62. The sum to (n + 1) terms of the series $\frac{C_0}{2} - \frac{C_1}{3} + \frac{C_2}{4} - \frac{C_3}{5}$ + … is

(A) $\frac{1}{n+1}$
(B) $\frac{1}{n+2}$
(C) $\frac{1}{n(n+1)}$
(D) none of these

63. The number of integral values of λ for which $x^2 + y^2 + \lambda x + (1 - \lambda)y + 5 = 0$ is the equation of a circle whose radius cannot exceed 5, is

(A) 14
(B) 18
(C) 16
(D) None of these

64. The locus of the mid point of a chord of the circle $x^2 + y^2 = 4$ which subtends a right angle at the origin is

(A) $x + y = 2$
(B) $x^2 + y^2 = 1$
(C) $x^2 + y^2 = 2$
(D) $x + y = 1$

65. If α and β are the eccentric angles of the extremities of a focal chord of an ellipse, then the eccentricity of the ellipse is

(A) $\frac{\cos\alpha + \cos\beta}{\cos(\alpha - \beta)}$
(B) $\frac{\sin\alpha - \sin\beta}{\sin(\alpha - \beta)}$
(C) $\frac{\cos\alpha - \cos\beta}{\cos(\alpha - \beta)}$
(D) $\frac{\sin\alpha + \sin\beta}{\sin(\alpha + \beta)}$

66. The number of real tangents that can be drawn to the ellipse $3x^2 + 5y^2 = 32$ passing through (3, 5) is
(A) 0
(B) 1
(C) 2
(D) infinite

67. If F_1 and F_2 be the feet of the perpendicular from the foci S_1 and S_2 of an ellipse $\frac{x^2}{5}+\frac{y^2}{3} = 1$ on the tangent at any point P on the ellipse, then $(S_1 F_1)(S_2 F_2)$ is equal to
(A) 2
(B) 3
(C) 4
(D) 5

68. The normal to the rectangular hyperbola $xy = c^2$ at the point 't_1' meets the curve again at the point 't_2'. Then the value of $t_1^3 t_2$ is
(A) 1
(B) c
(C) –c
(D) –1

69. If PQ is a double ordinate of the hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2} = 1$ such that OPQ is an equilateral triangle, O being the center of the hyperbola. then the 'e' eccentricity of the hyperbola, satisfies
(A) $1 < e < \frac{2}{\sqrt{3}}$
(B) $e = \frac{2}{\sqrt{3}}$
(C) $e = \frac{\sqrt{3}}{2}$
(D) $e > \frac{2}{\sqrt{3}}$

70. The slope of the tangent of the circle $(x – 6)^2 + y^2 = 2$, which is passing through the focus of the parabola $y^2 = 16x$ is
(A) ±1
(B) ± 2
(C) –1/2, 2
(D) –2, 1/2

71. The condition that the parabolas $y^2 = 4ax$ and $y^2 = 4c(x – b)$ have a common normal other than x-axis (a, b, c being distinct positive real numbers) is
(A) $0 < \frac{b}{a-c} < 1$
(B) $\frac{b}{a-c} > 2$

(C) $\frac{b}{a-c} < 0$
(D) $1 < \frac{b}{a-c} < 2$

72. The number of ways in which 3 boys and 4 girls be seated around a circular table if no two boys sit together is
(A) 36
(B) 3!4!
(C) 7! – 3! × 4!
(D) 18

73. The number of positive integral solution of the equation xyz = 3000 are
(A) 200
(B) 300
(C) 3000
(D) 50

74. The sum of the divisors of $2^5.3^4.5^2$ is:
(A) $3^3.7^1.11^2$
(B) $3^2.7^1.11^2.31$
(C) 3.7.11.31
(D) none of these

75. The median AD of a triangle ABC is perpendicular to AB, Then value of tanA + 2tanB is
(A) 1
(B) 0
(C) 2
(D) 3

76. If in a triangle ABC, cosA cosB + sinA sinB sinC = 1, then *a* : *b* : *c* =
(A) $1:1:\sqrt{2}$
(B) 1:2:3
(C) 1:3: 4
(D) None of these

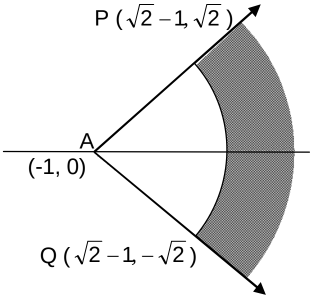
77. The value of $\cos\frac{\pi}{7}\cos\frac{2\pi}{7}\cos\frac{3\pi}{7}$ is
(A) 1/8
(B) –1/8
(C) 1
(D) 0

78. The minimum value of $\cos 2\theta + \cos\theta$ for real values of θ is
(A) –9/8
(B) 0
(C) –2
(D) none of these

79. For all complex numbers z_1, z_2 satisfying $|z_1| = 12$ and $|z_2 - 3 - 4i| = 5$, the minimum value of $|z_1 - z_2|$ is
(A) 0
(B) 2
(C) 7
(D) 17

80. If the line $y = \sqrt{3}x$ cuts the curve $x^3 + 3y^2 + 4x + 5y - 1 = 0$ at the points A, B, C then $OA \cdot OB \cdot OC$ is
(A) $\frac{4}{13}\left(3\sqrt{3} - 1\right)$
(B) $3\sqrt{3} + 1$
(C) $\frac{2}{\sqrt{3}} + 7$
(D) None of these

81. The locus of z which lies in shaded region is best represented by
(A) $z : |z+1| > 2, |arg(z+1)| < \pi/4$
(B) $z : |z-1| > 2, |arg(z-1)| < \pi/4$
(C) $z : |z+1| < 2, |arg(z+1)| < \pi/2$
(D) $z : |z-1| < 2, |arg(z-1)| < \pi/2$



82. If (b+c),(c+a),(a+b) are in H.P, then a^2, b^2, c^2 are in……
(A) A.P.
(B) G.P.
(C) H.P.
(D) None

83. Total number of integral solution of the equation xyz=24 is
(A) 30
(B) 120
(C) 85
(D) 60

84. The coefficient of the term independent of x in the expansion of $\left(\sqrt{\frac{x}{3}} + \frac{3}{2x^2}\right)^{10}$ is
(A) 5/4
(B) 7/4
(C) 9/4
(D) none of these

85. If a, b, c are in H.P., then the value of $\left(\frac{1}{b} + \frac{1}{c} - \frac{1}{a}\right)\left(\frac{1}{c} + \frac{1}{a} - \frac{1}{b}\right)$ is
(A) $\frac{2}{bc} - \frac{1}{b^2}$

(B) $\frac{1}{5}\left(\frac{3}{c^2}+\frac{2}{ca}-\frac{1}{a^2}\right)$
(C) $\frac{6}{b^2}-\frac{1}{ab}$
(D) none of these

86. The sum to n terms of the series $1^2 + (1^2 + 3^2) + (1^2 + 3^2 + 5^2) + \ldots$ is
(A) $\frac{1}{6}n(n+1)(2n^2+2n-1)$
(B) $\frac{1}{3}(n^4+2n^2)$
(C) $\frac{1}{3}(n^3+3n^2-n)$
(D) none of these

87. If $a_1, a_2, \ldots, a_n$ are positive real numbers whose product is a fixed number c, then the minimum value of $a_1 + a_2 + \ldots + a_{n-1} + 2a_n$ is
(A) $n(2c)^{1/n}$
(B) $(n + 1)c^{1/n}$
(C) $2nc^{1/n}$
(D) $(n + 1)(2c)^{1/n}$

88. The integral values of a for which the quadratic equation $(x - a)(x - 10) + 1 = 0$ has integral roots are
(A) (1, 6)
(B) (8, 12)
(C) (4, 6)
(D) (3, 15)

89. If $\sin\alpha, \cos\alpha$ are the roots of the equation $ax^2 + bx + c = 0$, $(c \neq 0)$ then
(A) $a^2 - b^2 + 2ac = 0$
(B) $(a + c)^2 = b^2 - c^2$
(C) $a^2 + b^2 - 2ac = 0$
(D) $(a - c)^2 = b^2 + c^2$

90. If the sum of the roots of the quadratic equation $ax^2 + bx + c = 0$, $(abc \neq 0)$ is equal to sum of the squares of their reciprocals, then a/c, b/a, c/b, are in
(A) arithmetic progression (A.P.)
(B) geometrical progression (G.P.)
(C) harmonic progression (H.P.)
(D) none of these

FIITJEE

ALL INDIA INTEGRATED TEST SERIES

HALF COURSE TEST – I

JEE (Main)-2020

TEST DATE: 30-12-2018

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. C

Sol. According to Stefan-Boltzmann's Law, energy radiated per sec per unit area is:

$E = e\sigma(T^4 - T_0^4)$

Hence, unit of $\sigma = \dfrac{joule/\text{sec}-m^2}{K^4} = \dfrac{watt}{m^2 \times K^4}$.

2. D

Sol. Here $(2\pi ct/\lambda)$ as well as $(2\pi x/\lambda)$ are dimensionless. So, unit of ct is same as that of λ.

Unit of x is same as that of λ.

Since, $\left[\dfrac{2\pi ct}{\lambda}\right] = \left[\dfrac{2\pi x}{\lambda}\right] = \left[M^0L^0T^0\right]$

Hence, $\dfrac{2\pi c}{\lambda} = \dfrac{2\pi x}{\lambda t}$

In the option $(d), \dfrac{x}{\lambda}$ is unitless. It is not the case with $\dfrac{c}{\lambda}$.

3. D

Sol. In $\cos\left(\dfrac{t}{p} - qx\right)$, the expression $\left(\dfrac{t}{p} - qx\right)$ is dimensionless. Hence, t/p is also dimensionless. This is possible when units of t are same as that of p.

4. D

Sol. $\left[\frac{mr^2}{6\pi\eta}\right] = \left[\frac{ML^2}{ML^{-1}\,T^{-1}}\right] = \left[L^3T\right]$

$[\eta] = \left[ML^{-1}T^{-1}\right]$

$\left[\left(\frac{6\pi mr\eta}{g^2}\right)^{1/2}\right] = \left[\left(\frac{MLML^{-1}T^{-1}}{L^2T^{-4}}\right)^{1/2}\right] = \left[ML^{-1}T^{3/2}\right]$

$\left[\frac{m}{6\pi\eta rv}\right] = \left[\frac{M}{ML^{-1}\,T^{-1}\,LLT^{-1}}\right] = \left[L^{-1}\,T^2\right]$

Thus, none of the given expression have the dimensions of time.

5. D

Sol. Maximum percentage error in the measurement of pressure,

$$\frac{\Delta P}{P}\times 100 = \frac{\Delta F}{F}\times 100 + 2\times\frac{\Delta r}{r}\times 100$$

$$= \frac{4}{100}\times 100 + 2\times\frac{2}{100}\times 100 = 8\%$$

6. B

Sol. Here, maximum fractional error is:

$$\frac{\Delta Q}{Q} = \pm\left(n\frac{\Delta X}{X} + m\frac{\Delta Y}{Y}\right)$$

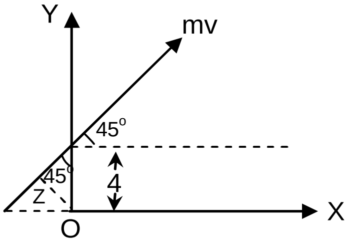
$\therefore$ Absolute error in Q, *i.e.*,

$$\Delta Q = \pm\left(n\frac{\Delta X}{X} + m\frac{\Delta Y}{Y}\right)Q$$

7. A

Sol. Momentum of the particle $= mass \times velocity$

$= (5)\times\left(3\sqrt{2}\right) = 15\sqrt{2}$



The direction of momentum in the XOY plane is given by:

$y = x + 4$

Slope of the line $= 1 = \tan\theta$

i.e., $\theta = 45^o$

Intercept of this st. line = 4

Length of the perpendicular z from the origin on the straight line:

$$= 4\sin 45^o = \frac{4}{\sqrt{2}} = 2\sqrt{2}$$

Angular momentum = momentum × perpendicular length = $15\sqrt{2}\times 2\sqrt{2} = 60\ unit$.

8. D

Sol. Momentum at the highest point

$$= mV\cos 45^o = \frac{mV}{\sqrt{2}}$$

Maximum height $= h$

$$h = \frac{V^2 \sin^2 45^o}{2g} = \frac{V^2}{4g}$$

Angular momentum $= L$

$$L = momentum \times height = \frac{mV}{\sqrt{2}} \times \frac{V^2}{4g} = \frac{mV^3}{4\sqrt{2}g}$$

But $\frac{V^2}{4g} = h \quad or \quad V = \sqrt{4gh}$

$$L = \frac{m}{4\sqrt{2}} \frac{(4gh)^{3/2}}{g} = m\sqrt{2gh^3}\ .$$

9. B

Sol. $x = \frac{k}{b^2}(1 - e^{-bt})$

$$\frac{dx}{dt} = \frac{k}{b}e^{-bt},\ \frac{d^2x}{dt^2} = -ke^{-bt}$$

10. D

Sol. Here, $\frac{dv}{dt} = -kv^3$

or $\frac{dv}{v^3} = -kdt \quad or \quad \int_{v_0}^{v} \frac{dv}{v^3} = \int_0^t -kdt$

$$\left[-\frac{1}{2v^2}\right]_{v_0}^{v} = -kt$$

or $\frac{1}{2v_0^2} - \frac{1}{2v^2} = -kt$

$\therefore \quad \frac{1}{2v^2} = \frac{1 + 2v_0^2 kt}{2v_0^2} \quad or \quad v^2 = \frac{v_0^2}{1 + 2v_0^2 kt}$

$\therefore \quad v = \frac{v_0}{\sqrt{(2v_0^2 kt + 1)}}$.

11. D

Sol. $x = ae^{-\alpha t} + be^{\beta t}$

$$\frac{dx}{dt} = a\alpha e^{-\alpha t} + b\beta e^{\beta t}$$

$$v = -a\alpha e^{-\alpha t} + b\beta e^{\beta t}$$

12. B

Sol. $y = 12x - \frac{3}{4}x^2$

$$\frac{dy}{dt} = 12\frac{dx}{dt} - \frac{3}{2}x\frac{dx}{dt}$$

At $x = 0$: $\frac{dy}{dt} = 12\frac{dx}{dt}$

If θ be the angle of projection, then

$$\frac{dy/dt}{dx/dt} = 12 = \tan\theta$$

Also, if u =initial velocity, then $u\cos\theta = 3$

Hence, $\tan\theta \times u\cos\theta = 36$ *or* $u\sin\theta = 36$

Range, $R = \frac{u^2\sin 2\theta}{g} = \frac{2u^2\sin\theta\cos\theta}{g}$

$$= \frac{2(u\sin\theta)(u\cos\theta)}{10} = \frac{2\times 36\times 3}{10} = 21.6\ m.$$

13. B

Sol. $h = (u\sin\theta)t - \frac{1}{2}gt^2$

$$d = (u\cos\theta)t$$

or $t = \frac{d}{u\cos\theta}$

$\therefore$ $h = u\sin\theta.\frac{d}{u\cos\theta} - \frac{1}{2}g.\frac{d^2}{u^2\cos^2\theta}$

$\therefore$ $u = \frac{d}{\cos\theta}\sqrt{\frac{g}{2(d\tan\theta - h)}}$.

14. C

Sol. Given: $\frac{\sqrt{3}u}{2} = u\cos\theta =$ speed at maximum height

$\therefore$ $\cos\theta = \frac{\sqrt{3}}{2}$

or $\theta = 30^o$

Given that; $pH_{\text{max.}} = R$

We know, $H_{\text{max.}} = \frac{R\tan\theta}{4}$

$\therefore$ $P = \frac{4}{\tan\theta} = \frac{4}{\tan 30^o} = 4\sqrt{3}$

15. C

Sol. In a conservative field, $F = -\frac{dU}{dr}$

$\therefore$ $F = -\frac{d}{dx}(ax^2 - bx) = b - 2ax$.

16. A

Sol. Net force on the rod = $F_1 - F_2 \quad (\because F_1 > F_2)$

As mass of the rod is M , hence acceleration of the rod is:

$$a = \frac{(F_1 - F_2)}{M} \qquad \text{....(i)}$$

If we now consider the motion of part AB of the rod [whose mass is equal to (M / L) y], then

$$F_1 - T = \frac{M}{L} y \times a$$

Where T is the tension in the rod at the point B.

Now, $$F_1 - T = \frac{M}{L} y \times \left(\frac{F_1 - F_2}{M}\right)$$

or $$T = F_1\left(1 - \frac{y}{L}\right) + F_2\left(\frac{y}{L}\right).$$

Alternative Method: Considering motion of the other part BC of the rod also, we can calculate tension at the point B. In this case,

$$T - F_2 = \frac{M}{L}(L - y) \times a$$

or $$T = F_2 + \frac{M}{L}(L - y) \times \frac{(F_1 - F_2)}{M}$$

$$= F_1\left(1 - \frac{y}{L}\right) + F_2\left(\frac{y}{L}\right).$$

17. D

Sol. $x = 3t - 4t^2 + t^3$

$$\frac{dx}{dt} = 3 - 8t + 3t^2 \text{ and } a = \frac{d^2x}{dt^2} = -8 + 6t$$

Now, $$W = \int F\, dx = \int ma\, dx = \int ma \frac{dx}{dt} dt$$

$$= \int_0^4 \frac{3}{1000} \times (-8 + 6t)(3 - 8t + 3t^2)dt$$

On integrating, we get; $W = 528\, mJ$.

18. C

Sol. When force on the bullet is zero, then

$$0 = 600 - 2 \times 10^5 t$$

or $$t = \frac{600}{2 \times 10^5} = 3 \times 10^{-3} s$$

Now, $$I = \int_0^t F\, dt = \int_0^{3\times10^{-3}} (600 - 2 \times 10^5 t)dt$$

$$= \left[600t - \frac{2 \times 10^5 \times t^2}{2}\right]_0^{3\times10^{-3}}$$

$$= \left[600 \times 3 \times 10^{-3} - 10^{5} \times 9 \times 10^{-6}\right]$$
$$= \left[18 \times 10^{-1} - 0.9\right] = \left[1.8 - 0.9\right] = 0.9\ N - s.$$

19. A

Sol. Let a_1 and a_2 be the accelerations of M and m respectively. Then

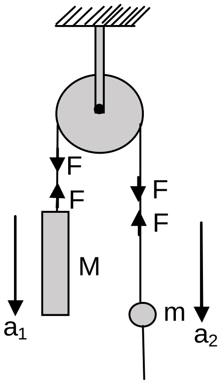
$$Mg - F = Ma_1 \qquad \text{....(i)}$$
$$mg - F = ma_2 \qquad \text{....(ii)}$$

Now, $1 + \frac{1}{2}a_2t^2 = \frac{1}{2}a_1t^2$

or $a_1 = \frac{2l}{t^2} + a_2$ ....(iii)

Solving equations (i), (ii) and (iii), we get;

$$F = \frac{2Mm}{(M-m)}\frac{l}{t^2}.$$



20. C

Sol. Let T be the tension in the string.

The upward force exerted on the clamp $= T\sin 30^o = \frac{T}{2}$

Given: $\frac{T}{2} = 40N$ or $T = 80N$ ....(i)

If a is the acceleration of monkey in upward direction,

$$a = \frac{T - mg}{m} = \frac{80 - 5\times 10}{5} = 6m/s^2.$$

21. A

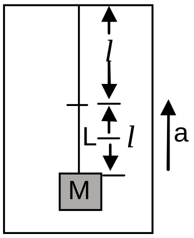
Sol. Let a be the acceleration of the lift.

Mass of lower portion of string

$$= \frac{m}{L}(L - l)$$

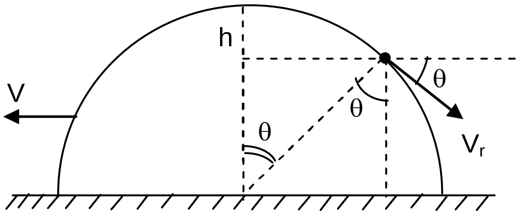
$$\therefore\ T - Mg - \frac{mg}{L}(L-l) = \left(M + \frac{m}{L}(L-1)\right)a$$

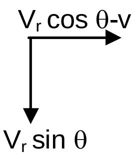
$$\therefore\ a = \frac{T}{M + m - \frac{ml}{L}} - g$$



22. A

Sol.





Let v_r be the velocity of particle relative to hemisphere and v be the linear velocity of hemisphere at this moment. Then from conservation of linear momentum, we have

$$4mv = m(v_r \cos\theta - v)$$

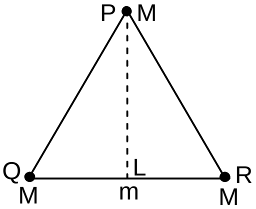
or $$5v = v_r \cos\theta$$

$$\therefore \quad v_r = \frac{5v}{\cos\theta}$$

$$\therefore \quad \omega = \frac{v_r}{R} = \frac{5v}{R\cos\theta}$$

23. B

Sol. Force on m due to masses at Q and R is zero. So, the net force is due to the mass at P.



Hence, $F = \dfrac{GMm}{(PL)^2}$

Now, $PL = l\sin 60^o = l\dfrac{\sqrt{3}}{2}$

$$\therefore \quad F = \frac{4GMm}{3l^2}.$$

24. A

Sol. $$g = \frac{GM}{r^2} = G.\frac{4}{3}\frac{\pi r^3 p}{r^2} = G.\frac{4}{3}\pi rp$$

$$\therefore \quad \frac{g_1}{g_2} = \frac{r_1 p_1}{r_2 p_2}.$$

25. C

Sol. Let r be the radius of each small droplets.

Then, volume of big drop $= 64\times$ volume of each small droplet

$$\frac{4}{3}\pi R^3 = 64\times\frac{4}{3}\pi r^3$$

$R = 4r$ ….(i)

Surface area of big drop $= 4\pi R^2$

Surface area of 64 small droplets $= 64\times 4\pi r^2$

$\therefore$ Increase in surface area $= 64\times 4\pi r^2 - 4\pi R^2$

$$= 4\pi\left[64r^2 - R^2\right]$$

$$= 4\pi\left[4R^2 - R^2\right]$$

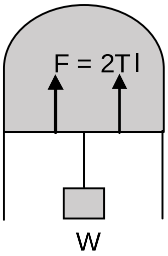
$$= 12\pi R^2$$

Energy needed $=$ surface tension $\times$ increase in surface area

$$= T\times 12\pi R^2 = 12\pi R^2 T.$$

26. D

Sol. The force of surface tension acting on the slider of length l in upward direction, balances the force due to the weight acting in downward direction.



$F = 2Tl = W$

$2T(0.3) = 1.5\times10^{-2}$

$\therefore\ T = \dfrac{1.5\times10^{-2}}{2\times0.3}$

$= 0.025\ N/m.$

27. C

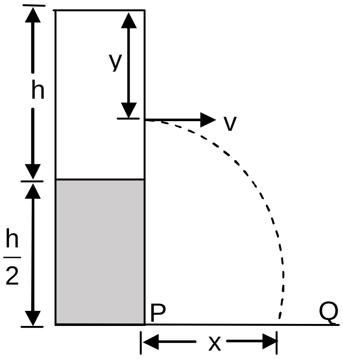
Sol. According to Stokes' law, the sphere encounters an opposing force F (or viscous force) when it falls through a viscous liquid of viscosity η with a velocity v and it is given by

$F = 6\pi\eta av$

Note : You can also see from the options, only **option (C)** has the dimensions of force.

28. B

Sol. Suppose there is a hole in the cylinder at depth y below water level.



Velocity of efflux $v = \sqrt{2gy}$

Time taken by water to reach on the plane PQ will be

$$t = \sqrt{\frac{2\left(\frac{h}{2}+(h-y)\right)}{g}} = \sqrt{\frac{3h-2y}{g}}$$

$\therefore$ Horizontal distance x travelled by the liquid is

$$x = vt = \sqrt{2gy}\sqrt{\frac{3h-2y}{g}},\quad x = \sqrt{2y(3h-2y)}$$

For x to be maximum, $\dfrac{dx}{dy} = 0$

$$\frac{1}{2\sqrt{2y(3h-2y)}}\times2(3h-4y) = 0$$

Or $3h-4y = 0;\ \therefore\ y = \dfrac{3h}{4}$

Hence, x will be maximum at $y = \dfrac{3h}{4} = \left(h-\dfrac{h}{4}\right)$

Where, hole number 2 is present.

29. C

Sol. Energy radiated per second by the sun,

$E = \sigma T^4 4\pi R^2$

This energy falls uniformly on the inner surface of spheres centred around the sun. If r is the distance of the earth from the sun, then energy falling per second on unit area of the sphere of radius r is,

$$\frac{2\pi R^2\sigma T^4}{2\pi r^2} = \frac{\sigma R^2T^4}{r^2}.$$

It is only from the front hemisphere of the sun that the energy is falling on the earth and it is only on the front half of the earth.

Therefore, $\dfrac{4\pi R^2}{2}$ and $\dfrac{4\pi r^2}{2}$ have to be used.

The radiant power incident on the earth is given by:

$$Q = \pi r_0^2 \times \frac{\sigma R^2 T^4}{r^2} = \frac{\pi r_0^2 R^2 \sigma T^4}{r^2}.$$

30. C

Sol. Let length of open organ pipe $= l_0$

Length of closed organ pipe $= l_C$

Also, $l_0 = 2l_C$

Fundamental frequency of the open pipe,

$v_0 = 100\text{ Hz}$

Also, $v_0 = \frac{v}{2l_0} = 100$, $\frac{v}{l_0} = 200; \frac{v}{2\,l_C} = 200$, $\frac{v}{l_C} = 400$

Fundamental frequency of closed organ pipe

$$v_C = \frac{v}{4\,l_C} = \frac{400}{4} = 100\text{ Hz}$$

So, the frequency of third harmonic of the closed organ pipe $= 3v_C = 300$ Hz.

Chemistry PART – II

SECTION – A

31. D
Sol. Information.

32. D
Sol. See resonating structures.

33. B
Sol. Stereomers are not mirror images.

34. C
Sol. Information.

35. B
Sol. Symmetrical alkane with single free radical intermediate.

36. B
Sol. Kolbe's method.

37. B
Sol. Bromination followed by dehydrohalogenation.

38. D
Sol. $-CH_3$ is activating group
$-NO_2$ is stongly deactivating group
$-Cl$ is weekly deactivating group

39. D

40. A
Sol. (a) (I) 0.5 mole O_3 = 24 g O_3
(II) 0.5 g atom of oxygen = 8 g
(III) $\frac{3.011\times10^{23}}{6.022\times10^{23}}\times32=16\text{ g }O_2$
(IV) $\frac{5.6}{22.4}\times44\text{ g }CO_2=11\text{ g }CO_2$

41. B
Sol. 10 g of $D_2O\equiv(2+8)N_A$ neutrons.

42. D
Sol. $v\propto\frac{Z}{n}$

43. D
Sol. Orbital angular momentum $=\sqrt{l(l+1)}\frac{h}{2\pi}; l=1$ for p - orbital.

44. D

Sol. $PV = n_{air}RT$

$$n_{oxygen} = \frac{14}{100}n_{air}$$

45. C

Sol. Because the number of moles is constant.

$$\frac{P_iV_i}{T_i} = \frac{P_fV_f}{T_f}; P_f = \frac{P_iV_iT_f}{V_fT_i}$$

$$P_f = \frac{P_iV_iT_f}{V_fT_i}$$

$$= 3.21\times10^5\ \text{Pa}\times\frac{V_i}{1.03V_i}\times\frac{(273+28.0)}{(273-5.00)}$$

$$= 3.50\times10^5\ \text{Pa}$$

46. D

Sol. $\Delta U = q + w,\ w > 0$ as work is done on the system.

47. B

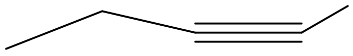
Sol. $|\text{Work done}|$ is area under the P-V curve.

48. D

Sol. $K_{eq} = \frac{k_f}{k_b} = \frac{\text{Conc. of proudcts as per rate law}}{\text{Conc. of reactants as per rate law}}$,stoichiometry of reaction is required.

49. D

Sol. $Mg_2C_3 \xrightarrow{4H_2O} 2Mg(OH)_2 + C_3H_4$

$C_3H_4 \xrightarrow[\text{ii) } C_2H_5Br]{\text{i) Na}}$ 

50. A

Sol. Weakest acid has strongest conjugate base and vice versa.

51. D

Sol. pH + pOH = pK_w

52. B

Sol. Information.

53. B

Sol. $\text{Size} \propto \frac{1}{z_{eff.}}$

54. D

Sol. SF_4: sp^3d hybridization
CF_4: sp^3 hybridization
XeF_4: sp^3d^2 hybridization

55. B

56. D

Sol. Atomic radius increases due to addition of extra shell.

57. B

Sol. $\text{Na} + (x+y)\text{NH}_3 \longrightarrow \text{Na}(\text{NH}_3)_x + \underset{\text{(blue)}}{e^-(\text{NH}_3)_y}$

58. C

Sol. Information (Borax bead: $NaBO_2 + B_2O_3$)

59. C

Sol. Inert pair effect makes +2 as more stable than +4 oxidation state.

60. A

Sol. If $Q > K$, equilibrium shifts backwards.

Mathematics

PART – III

SECTION – A

61. C

Sol. The $(r + 1)$th term in the expansion of $[(3/2)x^2 - (1/3x)]^9$ is given by

$$T_{r+1} = {}^9C_r \left(\frac{3}{2}x^2\right)^{9-r} \left(-\frac{1}{3x}\right)^r = {}^9C_r(-1)^r \frac{3^{9-2r}}{2^{9-r}} x^{18-3r} \qquad \ldots(1)$$

Since we are looking for the coefficient of the term independent of x in the expansion of

$$(1 + x + 2x^3)\left(\frac{3}{2}x^2 - \frac{1}{3x}\right)^9 \qquad \ldots(2)$$

we must get the coefficient of x^0, x^{-1} and x^{-3} in the expansion of $[(3/2)x^2 - (1/3x)]^9$. For x^0, r must be 6 in (1); for x^{-1}, there is no value of r ; and for x^{-3}, r must be 7 in (1). Therefore, the coefficient of the term independent of x in (2) is

$$1.{}^9C_6(-1)^6.\frac{3^{9-12}}{2^{9-6}} + 2.{}^9C_7(-1)^7.\frac{3^{9-14}}{2^{9-7}}$$

$$= \frac{9.8.7}{1.2.3}.\frac{3^{-3}}{2^3} + 2.\frac{9.8}{1.2}(-1).\frac{3^{-5}}{2^2} = \frac{7}{18} - \frac{2}{27} = \frac{17}{54}$$

62. D

Sol. We have

$$(1 - x)^n = C_0 - C_1x + C_2x^2 - C_3x^3 + \ldots$$

$$\Rightarrow \quad x(1 - x)^n = C_0x - C_1x^2 + C_2x^3 - C_3x^4 + \ldots$$

$$\int_0^1 x(1-x)^n\,dx = \int_0^1 x(1-x)^n\,dx = \int_1^0 (1-t)t^n(-1)dt \qquad [\text{Put } 1 - x = t]$$

$$= \int_0^1 \left(t^n - t^{n+1}\right)dt = \left|\frac{t^{n+1}}{n+1} - \frac{t^{n+2}}{n+2}\right|_0^1$$

$$= \frac{1}{n+1} - \frac{1}{n+2} = \frac{1}{(n+1)(n+2)}$$

Integrating R.H.S of (1) we get $\left(\frac{C_0x^2}{2} - \frac{C_1x^3}{3} + \frac{C_2x^4}{4} - \ldots\right)\Big|_0^1$

$$= \frac{C_0}{2} - \frac{C_1}{3} + \frac{C_2}{4} - \ldots$$

Thus $\frac{C_0}{2} - \frac{C_1}{3} + \frac{C_2}{4} - \ldots = \frac{1}{(n+1)(n+2)}$

63. C

Sol. Here, radius $\sqrt{\left(\frac{\lambda}{2}\right)^2 + \left(\frac{1-\lambda}{2}\right)^2 - 5} \le 5 \qquad \Rightarrow 2\lambda^2 - 2\lambda - 119 \le 0$

$$\therefore \frac{1-\sqrt{239}}{2} \le \lambda \le \frac{1+\sqrt{239}}{2} \Rightarrow -7.2 \le \lambda \le 8.2 \text{ (nearly)} \therefore \lambda = -7, -6, \ldots, 8$$

64. C

Sol. Let mid point be (h, k), then equation of chord is $hx + ky = h^2 + k^2$

Now on homoginising $x^2 + y^2 = 4$ with the help of this chord

$$x^2 + y^2 = 4\left(\frac{hx+ky}{h^2+k^2}\right)^2$$

Now as subtended angle is 90° $\Rightarrow$ Coeff. of x^2 + Coeff. of $y^2 = 0$

$$1 - \frac{4h^2}{\left(h^2+k^2\right)^2} + 1 - \frac{4k^2}{\left(h^2+k^2\right)^2} = 0,$$ represents a pair of straight lines passing through origin and intersection points of circle and chords.

$$2(x^2 + y^2)^2 = 4(x^2 + y^2) \Rightarrow x^2 + y^2 = 2$$

65. D

Sol. The equation of a chord joining points having eccentric angles α and β is given by

$$\frac{x}{a}\cos\left(\frac{\alpha+\beta}{2}\right) + \frac{y}{b}\sin\left(\frac{\alpha+\beta}{2}\right) = \cos\left(\frac{\alpha-\beta}{2}\right)$$

If it passes through $(ae, 0)$ then

$$e\cos\left(\frac{\alpha+\beta}{2}\right) = \cos\left(\frac{\alpha-\beta}{2}\right)$$

$$\Rightarrow \quad e = \frac{\cos\left(\frac{\alpha-\beta}{2}\right)}{\cos\left(\frac{\alpha+\beta}{2}\right)} \Rightarrow \frac{2\sin\left(\frac{\alpha+\beta}{2}\right)\cos\left(\frac{\alpha-\beta}{2}\right)}{2\sin\left(\frac{\alpha+\beta}{2}\right)\cos\left(\frac{\alpha+\beta}{2}\right)} \Rightarrow e = \frac{\sin\alpha+\sin\beta}{\sin\left(\alpha+\beta\right)}$$

66. C

Sol. Since $3(3)^2 + 5(5)^2 - 32 > 0$. So the given point lies outside the ellipse. Hence, two real tangents can be drawn from the point to the ellipse.

67. B

Sol. We know that the product of perpendiculars from two foci of an ellipse upon any tangent is equal to the square of the semi-minor axis.

$(S_1 F_1)(S_2 F_2) = 3$.

68. D

Sol. Normal at t_1 meets the curve again at t_2.

So normal passes through point $(ct_1, c/t_1)$ and $(ct_2, c/t_2)$.

Slope of normal $= \frac{c/t_2 - c/t_1}{ct_2 - ct_1} = -\frac{1}{t_1t_2}$

Slope of normal from equation of normal at $t_1 = t_1^2$

So $t_1^2 = -\frac{1}{t_1t_2} \Rightarrow t_1^3t_2 = -1$

69. D

Sol. Let the coordinates of P be (α, β)

Then, PQ = 2β and OP = $\sqrt{\alpha^2+\beta^2}$

Since OPQ is an equilateral triangle OP = PQ

$$\Rightarrow \quad \alpha^2 + \beta^2 = 4\beta^2 \Rightarrow \alpha^2 = 3\beta^2 \quad \Rightarrow \quad \alpha = \pm\sqrt{3}\,\beta$$

Also since (α, β) lies on the given hyperbola, $\frac{\alpha^2}{a^2} - \frac{\beta^2}{b^2} = 1$

$$\Rightarrow \quad \frac{3\beta^2}{a^2} - \frac{\beta^2}{b^2} = 1 \Rightarrow \frac{3}{a^2} - \frac{1}{b^2} = \frac{1}{\beta^2} > 0 \quad \Rightarrow \frac{b^2}{a^2} > \frac{1}{3} \quad \Rightarrow e^2 - 1 > \frac{1}{3}$$

$$\Rightarrow \quad e^2 > \frac{4}{3} \quad \Rightarrow e > \frac{2}{\sqrt{3}}$$

70. A

Sol. Equation of focal chord:
$y = m(x - 4)$

Thus $\frac{|0 - m(6-4)|}{\sqrt{1+m^2}} = \sqrt{2} \quad \Rightarrow \quad \frac{4m^2}{1+m^2} = 2 \quad \Rightarrow m = \pm 1$

71. B

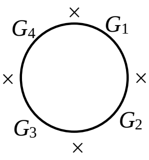
Sol. $y = mx - 2am - am^3$ (1)
$y = m(x - b) - 2cm - cm^3 \Rightarrow y = mx - (b + 2c)m - cm^3$ (2)
from (1) – (2) we gets, $0 = (b + 2c - 2a)m + (c - a)m^3$
$\Rightarrow \quad m\{(b + 2c - 2a) + (6 - a)m^2\} = 0$
Since common normal other than x–axis i.e., $m \neq 0$

$$\therefore \quad m^2 = \frac{2(a-c)-b}{(c-a)}$$

$$= -2 + \frac{b}{a-c} > 0 \Rightarrow \frac{b}{a-c} > 2$$

72. B

Sol. First make the 4 girls sit around a circular table.
This can be done in $(4 - 1)! = 3! = 6$.
After that '3' boys can occupy any three crosses.
This can be done in ${}^4P_3 = 4!$ ways.
Hence total no. of ways = 3! × 4!.



73. B

Sol. $xyz = 3 \times 2^3 \times 5^3$
Now the power of '3' is 1, then 3 can be distributed among three variables in '3' ways. Simmilarly the power of '2' is 2, hence 2 can be distribute among x, y and z in '10' ways and same is the case of 5^3.
Hence total ways = 3 × 10 × 10 = 300.

74. B

Sol. Any divisor of $2^5.3^4.5^2$ is of the form $2^a.3^b.5^c$ where $0 \leq a \leq 5$, $0 \leq b \leq 4$ and $0 \leq c \leq 2$.
Hence, the sum of the divisors

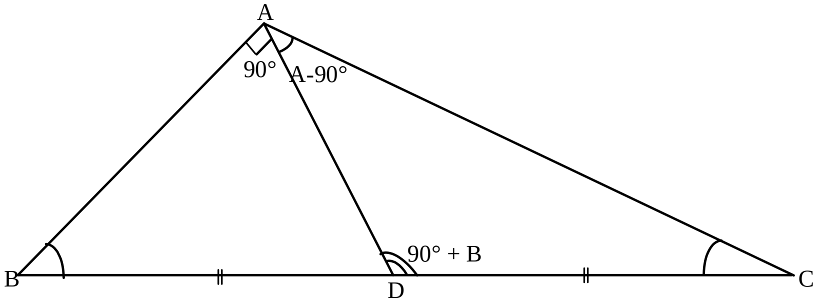
$$= \sum_{a=0}^{5}\sum_{b=0}^{4}\sum_{c=0}^{2} 2^a 3^b 5^c = (1 + 2 + \ldots + 2^5)(1 + 3 + \ldots + 3^4)(1 + 5 + 5^2)$$

$$= \left(\frac{2^6 - 1}{2-1}\right)\left(\frac{3^5 - 1}{3-1}\right)\left(\frac{5^3 - 1}{5-1}\right)$$

$= 63 \times 121 \times 31 = 3^2.7^1.11^2.31$

75. B

Sol. Since AD is the median



$\therefore$BD : DC = 1 : 1. From Figure, $\angle$ADC = 90° + B.

Now, applying m : n rule in triangle ABC, we get

$$(1 + 1)\ \cot(90° + B) = 1.\cot 90° - 1.\cot(A - 90°)$$

or, $-2\tan B = 0 - \cot[-(90° - A)]$

or, $-2\tan B = -[-\cot(90° - A)]$

or, $-2\tan B = \tan A$ $\quad\therefore\ \tan A + 2\tan B = 0$.

76. A

Sol. We have, cosA cosB + sinA sinB sinC = 1

from the given relation

$$\sin C = \frac{1-\cos A\cos B}{\sin A\sin B} \le 1 \qquad \ldots(i)$$

$\Rightarrow 1 \le \cos A\cos B + \sin A\sin B$

$\Rightarrow 1 \le \cos(A - B)$ $\qquad$ (as $\cos(A - B) \not> 1$)

$\Rightarrow 1 = \cos(A - B) \Rightarrow A - B = 0 \Rightarrow A = B$ $\qquad\ldots$(ii)

$\therefore$ from (i)

$$\sin C = \frac{1-\cos^2 A}{\sin^2 A} = 1$$

$\therefore$ $C = 90°$ and $A + B = 90°$

or A = B = 45° (by (ii))

By sine Law,

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$\frac{a}{\frac{1}{\sqrt{2}}} = \frac{b}{\frac{1}{\sqrt{2}}} = \frac{c}{1}$$

$a : b : c = 1 : 1 : \sqrt{2}$

77. A

Sol. $\cos\frac{\pi}{7}\cos\frac{2\pi}{7}\cos\frac{3\pi}{7} = \cos\frac{\pi}{7}\cos\frac{2\pi}{7}\cos\left(\pi - \frac{4\pi}{7}\right) = -\cos\frac{\pi}{7}\cos\frac{2\pi}{7}\cos\frac{4\pi}{7}$

$$= -\left[\frac{\sin\left(2^3.\frac{\pi}{7}\right)}{2^3\sin\frac{\pi}{7}}\right] = -\frac{\sin\frac{8\pi}{7}}{8\sin\frac{\pi}{7}} = \frac{1}{8}$$

78. A

Sol. Let S = cos2θ + cosθ

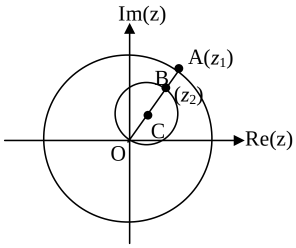
$= 2\cos^2\theta - 1 + \cos\theta = -1 + 2\left(\cos^2\theta + \frac{1}{2}\cos\theta + \frac{1}{16}\right) - \frac{1}{8}$

$= -\frac{9}{8} + 2\left(\cos\theta + \frac{1}{4}\right)^2 \geq -\frac{9}{8}$

So, the minimum value S = –9/8

79. B

Sol. Shortest distance = OA – OB = 12 – 10 = 2



80. D

Sol. Put x=rcosθ and y=rsinθ then find product of roots in cubic equation in r.

81. A

82. A

Sol. $(b+c)^{-1}$, $(c+a)^{-1}$, $(a+b)^{-1}$ are in A.P so by using properties of AP, we can show that $2b^2 = a^2+b^2$

83. B

Sol. Total number of +ve integral solution =30 and there are 4 cases to be +ve
i.e (+,+,+),(-,-,+)(+,-,-),(-,+,-)
Hence total no. of +ve integral solution= 120.

84. A

Sol. The (*r* + 1)th term in the expansion of $\left(\sqrt{\frac{x}{3}} + \frac{3}{2x^2}\right)^{10}$ is given by

$T_{r+1} = {}^{10}C_r \left(\sqrt{\frac{x}{3}}\right)^{10-r}\left(\frac{3}{2x^2}\right)^r = {}^{10}C_r \frac{x^{5-(r/2)}}{3^{5-(r/2)}}.\frac{3^r}{2^r x^{2r}}$

$= {}^{10}C_r \frac{3^{(3r/2)-5}}{2^r} x^{5\,-\,(5r/2)}$

For T_{r+1} to be independent of *x*, we must have 5 – (5*r*/2) = 0 or *r* = 2. Thus, the 3rd term is independent of *x* and its coefficient is given by

${}^{10}C_2 \frac{3^{3-5}}{2^2} = \frac{10 \times 9}{2} \times \frac{3^{-2}}{4} = \frac{5}{4}.$

85. A

Sol. As a, b, c are in H.P. 1/a, 1/b, 1/c are in A.P.

$\Rightarrow \quad \frac{1}{b} - \frac{1}{a} = \frac{1}{c} - \frac{1}{b}\ or\ \frac{2}{b} = \frac{1}{a} + \frac{1}{c} \quad ....(1)$

Therefore,

$$\left(\frac{1}{b}+\frac{1}{c}-\frac{1}{a}\right)\left(\frac{1}{c}+\frac{1}{a}-\frac{1}{b}\right)=\left(\frac{1}{b}+\frac{1}{c}+\frac{1}{c}-\frac{2}{b}\right)\left(\frac{1}{c}+\frac{1}{b}-\frac{1}{c}\right) \text{ [using (1)]}$$

$$= \left(\frac{2}{c}-\frac{1}{b}\right)\left(\frac{1}{b}\right)=\frac{2}{bc}-\frac{1}{b^2}.$$

86. A

Sol. We have

$t_r = 1^2 + 3^2 + 5^2 + \ldots + (2r - 1)^2$

$$= \sum_{k=1}^{r}(2k-1)^2 = \sum_{k=1}^{r}\left(4k^2-4k+1\right)$$

$$= 4\left\{\frac{1}{6}r(r+1)(2r+1)\right\}-\frac{4}{2}r(r+1)+r$$

$$= \frac{1}{6}r\left[4(r+1)(2r+1)-12(r+1)+6\right]$$

$$= \frac{1}{6}r\left[8r^2-2\right]=\frac{1}{3}\left(4r^3-r\right)$$

Thus, sum of n terms of the given series

$$\frac{4}{3}\sum_{r=1}^{n}r^3-\frac{1}{3}\sum_{r=1}^{n}r=\frac{4}{3}.\frac{1}{4}n^2(n+1)^2-\frac{1}{3}.\frac{1}{2}n(n+1)$$

$$= \frac{1}{6}n(n+1)[2n(n+1)-1]=\frac{1}{6}n(n+1)\left(2n^2+2n-1\right)$$

87. A

Sol. A.M. ≥ G.M.

$$\Rightarrow \frac{a_1+a_2+\ldots+a_{n-1}+2a_n}{n} \geq (a_1.a_2 \ldots a_{n-1}.2a_n)^{1/n}$$

$\Rightarrow a_1 + a_2 + \ldots + 2a_n \geq n(2c)^{1/n}$

88. B

Sol. Here the equation is $x^2 - (10 + a)x + 10a + 1 = 0$ (1)

Since integral roots will always be rational it means D should be a perfect square.

From (1) $D = a^2 - 20a + 96$

$\Rightarrow D = (a - 10)^2 - 4$

$\Rightarrow 4 = (a - 10)^2 - D$

If D is a perfect square it means we want difference of two perfect square as 4 which is possible only when $(a - 10)^2 = 4$ and $D = 0$

$\Rightarrow (a - 10) = \pm 2$

$\Rightarrow a = 12, 8$

89. A

Sol. Sum & product of the roots,

$\sin\alpha + \cos\alpha = -\frac{b}{a}$, $\sin\alpha\cos\alpha = \frac{c}{a}$

$\because 1 = \sin^2\alpha + \cos^2\alpha = (\sin\alpha + \cos\alpha)^2 - 2\sin\alpha\cos\alpha = \frac{b^2}{a^2} - \frac{2c}{a}$

$\Rightarrow \quad a^2 = b^2 - 2ac \Rightarrow a^2 - b^2 + 2\,ac = 0$
$\Rightarrow a^2 + c^2 + 2ac = b^2 + c^2 \quad \Rightarrow (a + c)^2 = b^2 + c^2$

90. C

Sol. $\alpha + \beta = \frac{1}{\alpha^2} + \frac{1}{\beta^2} = \frac{\alpha^2 + \beta^2}{\alpha^2\beta^2} = \frac{(\alpha+\beta)^2 - 2\alpha\beta}{\alpha^2\beta^2}$

$\Rightarrow -\frac{b}{a} = \frac{b^2/a^2 - 2c/a}{c^2/a^2} = \frac{b^2 - 2ac}{c^2} \Rightarrow \frac{2a}{c} = \frac{b^2}{c^2} + \frac{b}{a} = \frac{ab^2 + bc^2}{ac^2}$

$\Rightarrow 2a^2c = ab^2 + bc^2 \Rightarrow \frac{2a}{b} = \frac{b}{c} + \frac{c}{a}$ [dividing by abc] $\Rightarrow \frac{c}{a}, \frac{a}{b}, \frac{b}{c}$ are in A.P.

$\Rightarrow \frac{a}{c}, \frac{b}{a}, \frac{c}{b}$ are in H.P.

FIITJEE

ALL INDIA TEST SERIES

PART TEST – I

JEE (Advanced)-2020

PAPER – 1

TEST DATE: 10-11-2019

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section–A (01 – 04, 19 – 22, 37 – 40)*** *contains 12 multiple choice questions which out of 4 options have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*
Section-A (05 – 12, 23 – 30, 41 – 48) *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
*Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
*Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
*Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
*Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
*Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*

   *Negative Marks : **–1** In all other cases.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

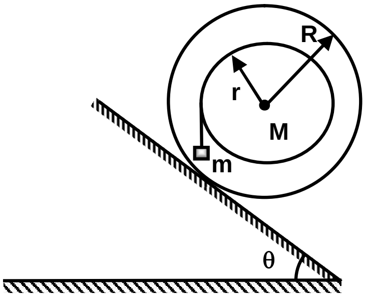
Physics

PART – I

SECTION – A
(One Options Correct Type)

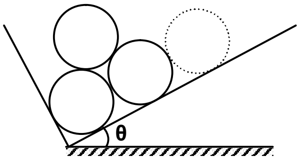
This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A bobbin of mass M = 3 kg consists of a central cylinder of radius r = 5 cm and two end plates of radius R = 6 cm. It is placed on a slotted incline on which it will roll but not slip, and a mass m = 4.5 kg is suspended from a cord wound around the bobbin, as shown in Figure. It is observed that the system is in static equilibrium. What is the angle of tilt θ of the incline?



(A) $\theta = 30°$
(B) $\theta = 45°$
(C) $\theta = 60°$
(D) $\theta = 75°$

2. Smooth, identical logs are piled in a stake truck. The truck is forced off the highway and comes to rest on an even keel lengthwise but with the bed at an angle θ with the horizontal, as shown in Figure. As the truck is unloaded, the removal of the log shown dotted leaves the remaining three in a condition where they are just ready to slide, that is, if θ were any smaller, the logs would fall down. Find θ.



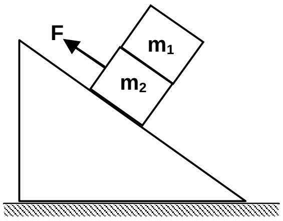
(A) $\theta = \tan^{-1}\left(\frac{1}{2\sqrt{3}}\right)$

(B) $\theta = \tan^{-1}\left(\frac{1}{3\sqrt{3}}\right)$

(C) $\theta = \tan^{-1}\left(\frac{1}{4\sqrt{3}}\right)$

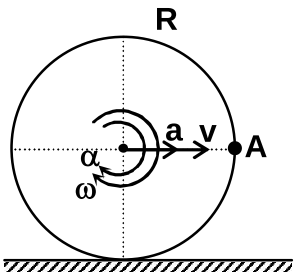
(D) $\theta = \tan^{-1}\left(\frac{1}{5\sqrt{3}}\right)$

3. In the arrangement shown in Figure, the inclined plane is 130 cm long and its upper end is 50 cm above the level of the lower end. The block m_2 rests on the plane, and has a mass of 60 kg. The block m_1 has a mass 200 kg. The coefficient of static friction between the two blocks is 0.50; the coefficient of sliding friction between the lower block and the plane is 0.33. A force F upward and parallel to the plane is applied to the lower block. What is the maximum value of F before the two blocks move with respect to each other?



(A) F = 2000N
(B) F = 2400N
(C) F = 2700N
(D) F = 3600N

4. A uniform circular disc of radius 'R' is rolling without slipping on a rough horizontal surface with a constant acceleration 'a'. Then the radius of curvature of trajectory of point 'A' of the disc relative to the ground at the given instant as shown in the figure is

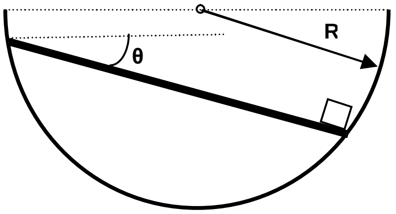


(A) 4R
(B) $2\sqrt{2}R$
(C) 2R
(D) $\sqrt{2R}$

(One or More than one correct type)

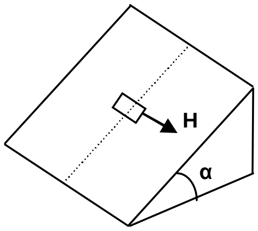
This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

5. A uniform plank of weight W and length $\sqrt{3}R$ lies in a smooth circular trough of radius R , as shown in Figure. At one end of the plank is a weight W/2. Find the possible values of angle θ at which the plank lies when it is in equilibrium.



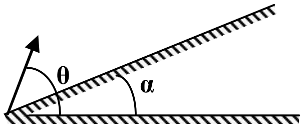
(A) $\theta = 30°$
(B) $\theta = 0°$
(C) $\theta = 25°$
(D) $\theta = 15°$

6. A particle of weight W rests on a rough inclined plane that makes an angle α with the horizontal, as shown in Figure . If the coefficient of static friction $\mu = 2 \tan \alpha$). A horizontal force H is acting transverse to the slope of the plane (see figure)



(A) If $H = 2\sqrt{3}\,W \sin \alpha$ the particle will move on the incline plane.
(B) If $H = 0.5W \sin \alpha$ the particle will move on the incline plane.
(C) If $H = \sqrt{3}\,W \sin \alpha$ the direction ϕ in which the block goes, relative to H is 30°.
(D) If $H = 0.5W \sin \alpha$ the direction ϕ in which the block goes, relative to H is 60°.

7. A perfectly elastic particle is projected with velocity v at an elevation θ. A smooth plane passes through the point of projection and is inclined at an angle α to the horizontal. The particle will return to the point of projection provided $\cot \alpha \cot(\theta - \alpha)$ is :

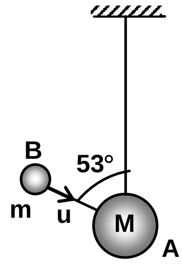


(A) 2
(B) 2.5
(C) 3
(D) 4

8. If a particle of mass m collides elastically with one of mass M at rest, and if the former is scattered at an angle θ and the latter moves at an angle ϕ with respect to the line of motion of the incident particle, then which of the following combinations are possible:
(A) $\theta = 30°$, $\phi = 0°$, m = 1kg, M = 1kg
(B) $\theta = 60°$, $\phi = 0°$, m = 3kg, M = 3kg
(C) $\theta = 45°$, $\phi = 45°$, m = 2kg, M = 2kg
(D) $\theta = 60°$, $\phi = 45°$, m = 1kg, M $=\sqrt{3}$kg

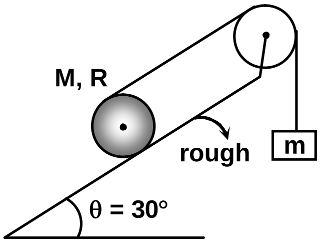
9. A locomotive engine, of mass M=1kg, has two pairs of wheels, of radius a = 0.25m, the moment of inertia of each pair about its axis being Mk^2; and the engine exerts a torque $L = \frac{33}{17}\text{Nm}$ on the forward axle. If both pairs of wheels commence to roll without sliding when the engine starts and F_μ is the friction between each of the front wheels and the line capable of being called into action. If k = 1, the values of F_μ (in newton) can be:
(A) 1
(B) 1.5
(C) 2.5
(D) 3

10. A ball ‘A’ of mass M = 4 kg is suspended by a vertical string. Another ball ‘B’ of mass m = 1 kg moving with a velocity u = 5.8 m/s at an angle $\theta = 53°$ from vertical collides elastically with the ball ‘A’ as shown. Then choose the correct option(s).



(A) The velocity of ball ‘A’ just after collision is 2 m/s
(B) The velocity of ball ‘B’ just after collision is 4.2 m/s
(C) The velocity of ball ‘B’ just after collision is 2.5 m/s
(D) The impulse on the ball ‘A’ due to tension in the string is 6 N-s

11. A block of mass m = 1 kg is attached to one end of an ideal string whose other end is wound over a solid cylinder of mass M = 8 kg and radius R = 10 cm as shown when the cylinder rolls without slipping down the rough inclined plane of inclination $\theta = 30°$, the block moves vertically upward. Then choose the correct option(s). ($g = 10\ m/s^2$)



(A) The acceleration of block is 2.5 m/s^2
(B) The acceleration of block is 5 m/s^2
(C) The tension in the string is 12.5 N
(D) The frictional force acting on the cylinder is 17.5 N

12. Consider a right solid cone, whose height is h and the radius of whose base is a.
(A) The moment of inertia of cone about its slant height is $\frac{3Ma^2\left(6h^2+a^2\right)}{20\left(h^2+a^2\right)}$
(B) The moment of inertia of cone about an axis passing through its centre of gravity and perpendicular to its axis. $\frac{3M\left(h^2+4a^2\right)}{80}$.

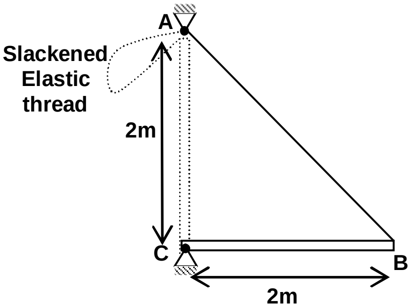
(C) The moment of inertia of cone about its axis is $\frac{3Ma^2}{10}$.

(D) The moment of inertia of cone about any axis passing through the centre of circular base and lying in the plane of the circle is same.

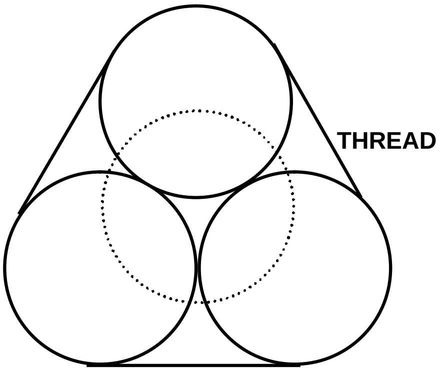
SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

13. A light elastic string of natural length 2m has one end, A, fixed and the other, B, attached to one end of a uniform rod BC of length 2m and mass $m = 3-2\sqrt{2}$ kg . This can turn freely in a vertical plane about its other end C, which is fixed at a distance 2m vertically below A. Initially the rod is vertical, and, on being slightly displaced, falls until it is horizontal, and then rises again. Find the elastic constant of string in N/m .(take $g = 10m/s^2$)

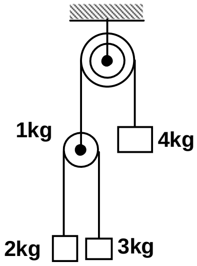


14. Three identical smooth spheres each of mass $m = \frac{3\sqrt{3}}{2}$kg on a smooth horizontal plane are in contact with one another, and are kept together by an endless string in the plane of their centers, just fitting them; when a fourth identical sphere is placed on them, the tension in the string is $\frac{k}{\sqrt{2}}$ newton, then find the value of k. (Take $g= 10m/s^2$).

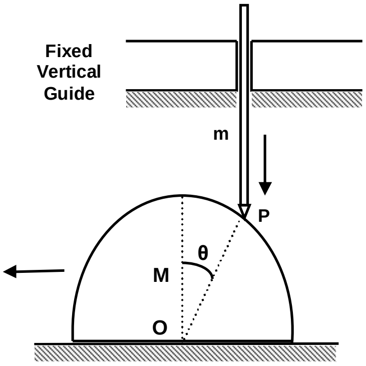


TOP VIEW

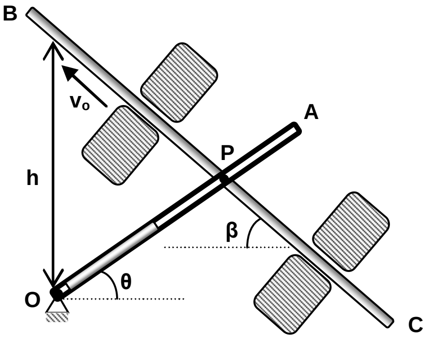
15. Over a smooth light pulley is passed a string supporting at one end a weight of mass 4 kg. At the other end of the string is a pulley of mass 1 kg. Two masses of 2 kg and 3 kg are suspended on either side of the 1kg pulley as shown in figure. The acceleration of the 4 kg mass is ng/49. Find n.



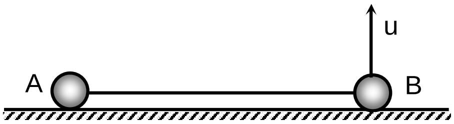
16. A smooth hemisphere, of mass M = 4kg and radius a = 2m, is placed with its plane base on a smooth table. A rod, of mass m = 2kg is constrained to move in a vertical line with one end P on the curved Surface of the hemisphere. Find the angular speed (in rad/s) of point P with respect to centre O of the hemisphere when OP makes an angle $\theta = 60°$ with the vertical. Initially the rod was at the topmost point of the hemisphere.



17. Pin P is attached to BC and slides freely in the slot of OA. Determine the rate of change $d\theta/dt$ (in rad/s) of the angle θ at the instant when h = 4 m, $\beta = 60^0$, and $\theta = 30^0$, knowing that BC moves at a constant speed $v_0 = 5$ m/s.



18. Two identical small balls A and B each of mass m connected by a light inextensible string of length ℓ = 67.5 cm are placed on a smooth horizontal surface. With what minimum velocity u (in m/s) should the ball B be projected vertically upwards so that the ball A leaves the horizontal surface? ($g = 10\ m/s^2$)



Chemistry

PART – II

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

19. In hydrogen atom during de-excitation of electron from an excited state to ground state 15 spectral lines are emitted. Find the longest wavelength of U.V. region during de-excitation.

(A) $\frac{4}{3R_H}$

(B) $\frac{36}{35R_H}$

(C) $\frac{25}{24R_H}$

(D) $\frac{16}{15R_H}$

20. 0.167 gram of $KBrO_3$ is reacted with excess of KI. And liberated I_2 requires 75 ml of $Na_2S_2O_3$. What is normality of $Na_2S_2O_3$ (where $KBrO_3$ is converted in KBr) (at. wt. of Br is = 80)

(A) 0.08
(B) 0.16
(C) 1.8
(D) 0.2

21. N_2 and H_2 are 1 : 3 molar ratio, allowed to react to form NH_3, at equilibrium 50% of N_2 and H_2 are reacted. If the total pressure of the system was 21 atm. Find partial pressure of NH_3 at equilibrium.

(A) 5 atm
(B) 7 atm
(C) 9 atm
(D) 11 atm

22. An alkaline earth metal whose sulphate is soluble and whose oxide is inert on heating. It forms insoluble hydroxide which is soluble in excess of NaOH. Find the metal

(A) Mg
(B) Ba
(C) Ca
(D) Be

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

23. Which of the following are correct?

(A) Number of wave made by an electron is two in an orbit where maximum magnetic quantum number is 2.
(B) Number of electrons in Ne having their orbital angular momentum equal to zero are four.
(C) Energy of 3d subshell will be more than 3p in hydrogen atom.

(D) The number of degenerated orbitals will be 9 in a orbit of hydrogen atom where energy is proportional to $\left(-\frac{R_H}{9}\right)$.

24. Hydrogen like species in ground state absorb n photons having same energy and during de-excitation emits exactly n photons. Then the energy of absorb photon would be
(A) 40.8 eV
(B) 91.8 eV
(C) 163.2 eV
(D) 57.2 eV

25. Which of the following is/are true regarding H_2 gas
(A) H_2 is more rapidly adsorbed on to the surface than D_2.
(B) H_2 reacts with Cl_2 13 times faster than D_2 with Cl_2.
(C) NaCl is more soluble in D_2O than H_2O.
(D) H_2 can be obtained from water gas by oxidation of CO into CO_2 which can be easily removed by dissolving in H_2O.

26. Which are true regarding H_2O_2?
(A) Decomposition of H_2O_2 can be catalysed by addition of MnO_2.
(B) H_2O_2 can be prepared by adding TiO_2 in dil. H_2SO_4.
(C) H_2O_2 can be prepared by adding H_3PO_4 in hydrated BaO_2.
(D) H_2O_2 decomposes on standing and on heating this can be retarded by using acetanilide or stannates.

27. Select the correct statement:
(A) F-Centre is responsible for imparting the colour to the crystal.
(B) Ionic compound having low co-ordination number shows Frenkel defect.
(C) Schottky defect is more common for crystal having high radius-ratio (cation to anion).
(D) Stoichiometry of crystal remains unaffected due to Schottky defect.

28. Select the CORRECT statements:
(A) Mixture of NaH_2PO_4 and Na_2HPO_4 act as a buffer solution.
(B) pH of a solution formed by mixing equimolar quantities of HCOOH and HCl will be less than that of a solution formed from equimolar quantities of HCOOH and HCOONa.
(C) When Na_3PO_4(aq) is titrated with HCl(aq), the pH of solution at second equivalent point is $\frac{1}{2}\left(pK_{a_1} + pK_{a_2}\right)$
(D) Phenolphthalein changes it's colour from pink to colourless at first equivalence point of titration of Na_2CO_3 with HCl.

29. Heating of lime stone given below

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2\uparrow$$

Equilibrium will shift in forward direction.
(A) addition of He gas at constant pressure
(B) By increasing the temperature
(C) Decreasing the volume of the vessel
(D) Addition of CaO

30. Which of the following statements regarding alkali metal are correct?
 (A) When alkali metal dissolve in liquid NH_3, as conc. of NH_3 increases paramagnetic character decreases.
 (B) Alkali metal in liquid NH_3 shows very strong oxidizing character.
 (C) Stability of superoxide of alkali metals increases with increase in size of metal cation.
 (D) All alkali metal carbonates decomposes on heating and gives CO_2 gas.

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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31. A unit cell has one atom on each corner of cube and two atoms at one of it's body diagonals if volume of unit cell is 5×10^{-24} cm^3 and density of element is 15 gram/cm^3. The number of atom present in 150 gram of element is $x \times 10^{24}$ find x. (Avogadro number = 6×10^{23})

32. $NH_2COONH_4(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$
 If at equilibrium some CO_2 at 1 atm is added at constant volume, 25% of original NH_3 and CO_2, solidified before equilibrium was re-established. Find total pressure at new equilibrium.

33. $3C_2H_2 \xrightarrow[\text{Cu tube}]{\text{Red hot}} C_6H_6$
 Find the degree of association of ethyne if observed molecular mass of mixture is 39.

34. $A(s) \rightleftharpoons B(s) + 2C(g)$
 K_P of above reaction is 9 atm^2, at 327°C
 A 10 litre vessel contains 1 mole of B. How many moles of C would be added to drive backward reaction to completion.

35. 50 ml of 0.1 M Na_3PO_4 was titrated with 50 ml of 0.2 M HCl. Find the pH of resulting mixture where pK_{a_1}, pK_{a_2} and pK_{a_3} of H_3PO_4 are 5, 8, 13.

36. A single electron species having atomic number Z make a transition from 2 to 1. The emitted photon is absorbed by excited electron of Li^{+2} in n_1 orbit and further excited to n_2. Find the value of $\frac{2n_1 + 3n_2 + 6Z}{10}$

Mathematics

PART – III

SECTION – A

(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. If $\int_0^1 \frac{\sin(\ln x)}{\ln x}dx$ is equal to

(A) $\frac{\pi}{4}$

(B) $\frac{11}{14}$

(C) $\frac{\pi}{4}-\frac{11}{14}$

(D) $\frac{22}{7}-\pi$

38. Number of continuous function(s) f: [0, 1] → R satisfying $\int_0^1 f(x)dx = \frac{1}{3}+\int_0^1 f^2(x^2)dx$ is/are

(A) 1
(B) 2
(C) 3
(D) 4

39. Let f, g : R → [1, ∞) are two differentiable function on the real line satisfying the differential equation $(f^2 + g^2)f' + (fg)g' = 0$, then
(A) f is bounded, but g not
(B) f is unbounded, but g is bounded
(C) both are unbounded
(D) both f and f·g are bounded

40. The area of the set of points (x, y) in the plane that satisfy that two inequalities $x^2 + y^2 \le 2$ and $x^4 + x^3y^3 \le xy + y^4$ is
(A) π
(B) $\frac{2\pi}{3}$
(C) $\frac{19\pi}{21}$
(D) none of these

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

41. Let f(x) be a real polynomial of degree 4 whose graph has two real inflection points. There are three regions bounded by the graph and the line passing through these inflection points, then
(A) Two of these regions have equal area

(B) Area of one of the region is equal to the sum of other two
(C) Area of one of the region is double the sum of areas of other two
(D) Area of one of the region is square of the sum of areas of other two

42. Let a curve passing through (1, 0) satisfies the differential equation
$\left(2xe^{y}+3y^{2}\right)\frac{dy}{dx}+\left(3x^{2}+2e^{y}\right)=0$, then
(A) $x^3 + 2xe^y + y^3 = 3$
(B) $x^3 - 2xe^{2y} + y^3 = -1$
(C) The slope of tangent to the curve at (1, 0) is $-\frac{5}{2}$
(D) The curve intersects x-axis at only one point

43. Let f be a function having a continuous derivative on [0, 1] and with the property that $0 < f'(x) \le 1$. Also, suppose that f(0) = 0, then $\frac{\left[\int_0^1 f(x)dx\right]^2}{\int_0^1 (f(x))^3 dx}$ is always greater than or equal to
(A) $\frac{2}{3}$
(B) $\frac{1}{2}$
(C) $\frac{1}{3}$
(D) 1

44. Let S be the set of points in the Cartesian plane that satisfy $|||x| - 2| - 1| + |||y| - 2| - 1| = 1$, if a model of S were built from wire of negligible thickness, then
(A) total length of wire required would be $64\sqrt{2}$
(B) total length of wire required would be $32\sqrt{2}$
(C) area enclosed by the wire is 50 sq. units
(D) area enclosed by the wire is 25 sq. units

45. Which of the following are CORRECT? (where [.] denotes the greatest integer function and {.} fractional part of x)
(A) Right hand derivative of $f(x) = |\sin x| \cos^{-1} \cos x$ at non-differentiable point is π
(B) Left hand derivative of $f(x) = [x] |\sin \pi x|$ at non-differentiable point is $(1 - k)\pi$, $k \in I$
(C) Left hand derivative of $f(x) = [x] \sin^2 \pi x$ at non- differentiable point is $(-1)^k\pi$
(D) Right hand derivative of $f(x) = |x - 1|\{x\}$: $x \in \left[\frac{1}{2}, \frac{3}{2}\right]$ at non- differentiable point is 0

46. The function f is defined by y = f(x) where $x = r(3 \cos t + 2|\cos t|)$
and $y = r(2 \sin t + |\sin t|)$: $t \in [0, \pi]$, then
(A) f(x) is continuous on [–r, 5r]
(B) f(x) is discontinuous at one point on [–r, 5r]
(C) f(x) is differentiable $\forall\, x \in [-r, 5r]$
(D) f(x) is not differentiation at 2 points on [–r, 5r]

47. $\int \frac{x^4+1}{x^6+1}dx$ is

(A) $\tan^{-1}x+\frac{1}{3}\tan^{-1}(x^3)+c$

(B) $\frac{1}{3}\tan^{-1}\left(\frac{3x-3x^5}{1-3x^2-3x^4+x^6}\right)+c$

(C) $\frac{1}{3}\tan^{-1}\left(\frac{2x-x^4}{1-2x^5-3x^2}\right)+c$

(D) $\frac{1}{2}\tan^{-1}\left(\frac{x-x^3-1}{1+x^2-3x^5}\right)+c$

48. Let f: [0, 1] → R be a double differentiable function with f(0) = f(1) = 0, and $f''(x) + 2f'(x) + f(x) \ge 0$ $\forall\, x \in (0, 1)$, then

(A) $f(x) \le 0\ \forall\, x \in [0, 1]$

(B) if $e^x f(x)$ assumes its minimum value in [0, 1] at $x=\frac{1}{\sqrt{2}}$, then $f(x) + f'(x) < 0$ $\forall\, x \in \left(0, \frac{1}{\sqrt{2}}\right)$

(C) if $g(x) = e^x f(x)$, then number of real solution of the equation g(g(g(x))) = 0 is 2

(D) $f(x) > 0\ \forall\, x \in [0, 1]$

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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49. Number of real solution(s) of the equation $6^x + 1 = 8^x - 27^{x-1}$ is equal to

50. Let A be the minimum value of the function f: R → R, $f(x)=\frac{(x^2-x+1)^3}{x^6-x^3+1}$, then $\frac{2+\sqrt{3}}{5\sqrt{3}}A$ is

51. If the equation $x^4 + ax^3 + 2x^2 + bx + 1 = 0$; ($a, b \in R$) has a real solution, then minimum value of $a^2 + b^2$ is

52. $\lim\limits_{n\to\infty}\frac{1+\frac{1}{2}+\frac{1}{3}+.....+\frac{1}{n^7}}{\ln n}$ is equal to

53. Let y = f(x) be a one-one function satisfying the differential equation $\frac{d^2y}{dx^2}+\frac{d^2x}{dy^2}=0$ and $f'(0) = 1$, f(1) = 2, then f(0) is

54. Number of continuously differentiable function f: R → R satisfying f(x) > 0 and $f'(x) = f(f(x))\ \forall\, x \in R$ is/are

FIITJEE

ALL INDIA TEST SERIES

PART TEST – I

JEE (Advanced)-2020

PAPER – 1

TEST DATE: 10-11-2019

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. A

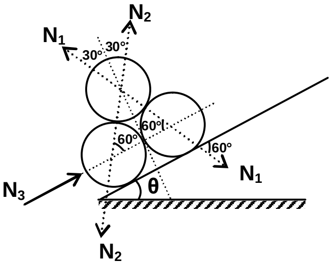
Sol. $mg(r - R\sin\theta) = MgR\sin\theta$

$mr = (M + m)R\sin\theta$

$$\sin\theta = \frac{mr}{(M+m)R} = \frac{1}{2}$$

$\therefore\ \theta = 30°$

2. B



Sol. $(N_1 + N_2)\cos 30° = mg\cos\theta$

$N_1 + N_2 = \frac{2}{\sqrt{3}}mg\cos\theta$ …(i)

$(N_2 - N_1)\cos 60° = mg\sin\theta$

$N_2 - N_1 = 2mg\sin\theta$ …(ii)

Solving (i) and (ii), we get

$N_2 = \frac{mg}{\sqrt{3}}(\cos\theta + \sqrt{3}\sin\theta)$ …(iii)

$N_1 = \frac{mg}{\sqrt{3}}(\cos\theta - \sqrt{3}\sin\theta)$ …(iv)

Also, $N_1\cos 60° = mg\sin\theta$

$N_1 = 2mg\sin\theta$ …(v)

From (iv) and (v),

$$2mg\sin\theta = \frac{mg}{\sqrt{3}}(\cos\theta - \sqrt{3}\sin\theta)$$

$$2\sqrt{3}\sin\theta = \cos\theta - \sqrt{3}\sin\theta$$

$$\Rightarrow\ 3\sqrt{3}\sin\theta = \cos\theta$$

$$\theta = \tan^{-1}\left(\frac{1}{3\sqrt{3}}\right)$$

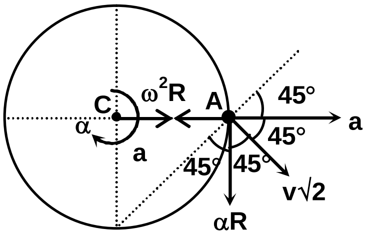
3. A

Sol. $a_{1(\max)} = g(\mu\cos\theta - \sin\theta) = \frac{10}{13}$ m/s^2 (where $\mu = 0.5$ and $\mu_0 = 0.33$)

$F - (m_1 + m_2)\, g(\sin\theta + \mu_0\cos\theta) = (m_1 + m_2)\, a_{1(\max)}$

$\Rightarrow F = 2000$ N

4. B



Sol. velocity of point 'A' $v_A = \sqrt{v^2 + \omega^2R^2} = v\sqrt{2}$

Normal acceleration of point A,

$$a_A(n) = \omega^2R\cos45^\circ + \alpha R\cos45^\circ - a\cos45^\circ$$

$$a_{A(n)} = \frac{\omega^2R}{\sqrt{2}} = \frac{v^2}{\sqrt{2}R}$$

$\therefore$ radius of curvature of trajectory of point 'A' relative to the ground is

$$r = \frac{(v_A)^2}{a_{A(n)}} = \frac{(v\sqrt{2})^2}{\frac{v^2}{\sqrt{2}R}} = 2\sqrt{2}R$$

5. A

Sol. $\theta = 30^\circ$

6. A, C

Sol. $f_{s(\max)} = \mu N = 2\tan\alpha \cdot W\cos\alpha = 2W\sin\alpha$

$$H_{\min} = \sqrt{(2W\sin\alpha)^2 - (W\sin\alpha)^2} = \sqrt{3}W\sin\alpha$$

$H_{\min} = \sqrt{3}W\sin\alpha$, $\phi = 30^\circ$

7. A, C, D

Sol. The velocity parallel to the plane is unaltered by the impacts, so that the distance described parallel to the plane will be zero at the end of a time t given by :

$$0 = vt\cos(\theta - \alpha) - \frac{(g\sin\alpha)t^2}{2}$$

$$\Rightarrow \qquad t = \frac{2v\cos(\theta - \alpha)}{g\sin\alpha}$$

Also, since the elasticity is perfect, the velocity perpendicular to the plane is just reversed at each impact. The time of flight for each trajectory is thus twice the time in which the velocity vsin $(\theta - \alpha)$ is destroyed by g cos α, and thus t = $\frac{2v\sin(\theta-\alpha)}{g\cos\alpha}$

Clearly the particle will return to the point of projection if the first of these is some multiple, n, of the second, i.e. if

$$\frac{2v\cos(\theta-\alpha)}{g\sin\alpha} = n\frac{2v\sin(\theta-\alpha)}{\cos\alpha}$$

i.e. if cot α . cot $(\theta - \alpha)$ is an integer.

8. C, D

Sol. $\frac{m}{M} = \frac{\sin(2\phi+\theta)}{\sin\theta}$

9. C, D

Sol. F_μ must be not less than $\frac{L(k^2+a^2)}{2a(2k^2+a^2)}$ =2 N

Let F be the friction on each of the front wheel in the forward direction, and F_1 the friction backward , on each of the hind wheel . Then :

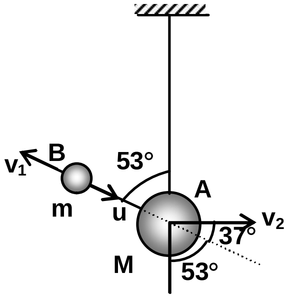
$$Mk^2\frac{d^2\theta}{dt^2} = L - 2Fa \ ; \ Mk^2\frac{d^2\theta}{dt^2} = 2F_1a \text{ and } Ma\frac{d^2\theta}{dt^2} = 2F - 2F_1$$

Solving we get, F = $\frac{L(k^2+a^2)}{2a(2k^2+a^2)}$ = 2N

F_μ must be not less than $\frac{L(k^2+a^2)}{2a(2k^2+a^2)}$ =2N

10. A, B, D

Sol. Using conservation of momentum along horizontal direction



mu sin 53° = –mv_1 sin 53° + Mv_2

$$\frac{4}{5}u = -v_1\frac{4}{5} + 4v_2$$

$5v_2 - v_1 = u$ …(i)

$$\frac{v_2\cos37^\circ + v_1}{u} = e = 1$$

$0.8\ v_2 + v_1 = u$ …(ii)

Solving (i) and (ii), we get

$5.8\ v_2 = 2u$

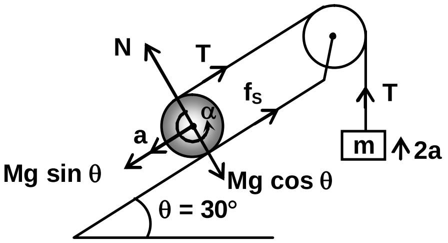
$$\Rightarrow v_2 = \frac{2u}{5.8} = 2 \text{ m/s}$$

$\therefore v_1 = 5v_2 - u = 5 \times 2 - 5.8 = 4.2$ m/s

$$\int N dt = m(v_1 + u) = 10 \text{ N} - \text{s}$$

$$\int T dt = \int N\cos53^\circ dt = \frac{3}{5}\int N dt = \frac{3}{5}\times 10 = 6 \text{ N-s}$$

11. A, C, D



Sol. $Mg\sin\theta - T - f_S = Ma$ …(i)

$f_S R - TR = \frac{MR^2}{2}\alpha$

$f_s - T = \frac{Ma}{2}$ …(ii)

$T - mg = 2ma$

$2T - 2mg = 4ma$ …(iii)

Adding (i), (ii) and (iii), we get

$$Mg\sin\theta - 2mg = \left(\frac{3M}{2} + 4m\right)a$$

$$\Rightarrow a = \left(\frac{M\sin\theta - 2m}{\frac{3M}{2} + 4m}\right)g = \frac{20}{16} = \frac{5}{4}\ \text{m/s}^2$$

$\therefore$ T = m(g + 2a) = 1(10 + 5/2) = 12.5 N

$\therefore f_S = T + \frac{Ma}{2} = 12.5 + \frac{8}{2}\times\frac{5}{4}$

$\Rightarrow f_S = 17.5$ N

12. A, B, C, D

Sol. Use the definition of moment of Inertia.

SECTION – C

13. 00005.00

Sol. Apply work energy theorem

$$mg - \frac{k}{2}\left(2\sqrt{2} - 2\right)^2 = 0 \text{ => } k=5$$

14. 00005.00

Sol. Draw the F.B.D. of the sphere at the top.

15. 00009.00

Sol. Let f_1 be the acceleration upwards of the 4 kg and therefore of the 1 kg. pulley downwards. Let f_2 and f_3 be the accelerations of the 2 and 3 kg (both measured downwards). Let T, T_1 be the tensions of the upper and lower strings. Then

$T - 4g = 4f_1$

$2T_1 - T + g = 1.f_1$

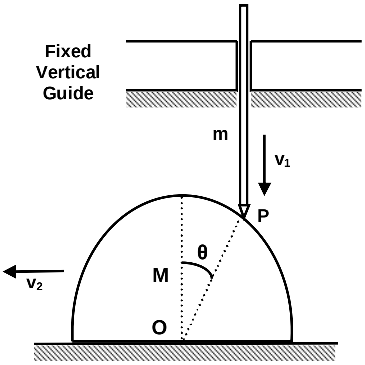
$2g - T_1 = 2f_2$

$3g - T_1 = 3f_3$

$f_2 + f_3 = 2f_1$

From the above equations => $f_1 = \frac{9g}{49}$

16. 00002.00



Sol. $v_1 \cos\theta = v_2 \sin\theta$

$v_1 = v_2 \tan\theta$

$v_1 = v_2\sqrt{3}$ (given $\theta = 60°$)

Now using conservation of energy

$$mga(1-\cos\theta) = \frac{1}{2}mv_1^2 + \frac{1}{2}Mv_2^2$$

$$\Rightarrow \quad 2ga = 2v_1^2 + 4v_2^2$$

$$40 = 6v_2^2 + 4v_2^2$$

$$\Rightarrow \quad 10v_2^2 = 40$$

$$\Rightarrow \quad v_2 = 2 \text{ m/s}$$

$$\therefore \quad v_1 = 2\sqrt{3} \text{ m/s}$$

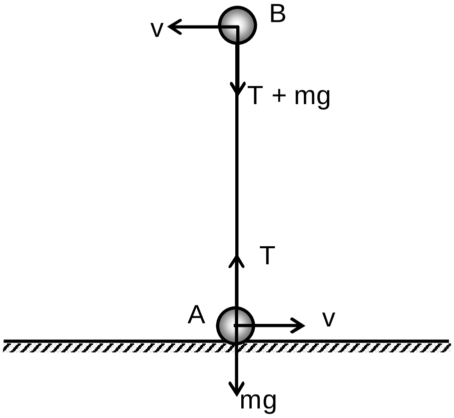
$$\omega = \frac{v_1 \sin\theta + v_2\cos\theta}{a} = 2 \text{ rad/s}$$

17. 00002.50

Sol. $v_0 = \omega h \sin\theta$

$$\Rightarrow \omega = \frac{v_0}{h\sin\theta} = \frac{2v_0}{h} = 2.50 \text{ rad/s}$$

18. 00004.50



Sol. When the ball A leaves the horizontal surface

$T = mg$ ....(i)

$$T + mg = \frac{m(2v)^2}{\ell}$$

$$2mg = \frac{4mv^2}{\ell}$$

$$v = \sqrt{\frac{g\ell}{2}} \quad \text{...(ii)}$$

Now, using Conservation of Energy

$$\frac{1}{2}mu^2 = 2\times\frac{1}{2}mv^2 + mg\ell$$

$$u^2 = 2v^2 + 2g\ell$$

$$u^2 = g\ell + 2g\ell$$

$$\Rightarrow u_{min} = \sqrt{3g\ell} = \sqrt{3\times10\times0.675} = 4.50 \text{ m/s}$$

Chemistry

PART – II

SECTION – A

19. A

Sol. $\frac{1}{\lambda} = R_H\left[\frac{1}{1^2} - \frac{1}{2^2}\right] = R_H\left[\frac{3}{4}\right]$

20. A

Sol. $BrO_3^- + I^- \longrightarrow I_2 + Br^-$

$I_2 + S_2O_3^{-2} \longrightarrow I^- + S_4O_6^{-2}$

Meq. of $KBrO_3$ = Meq. of $Na_2S_2O_3$

$$\frac{0.167 \times 1000}{\frac{167}{6}} = 75 \times N \times 1$$

6 = 75 N

$$N = \frac{6}{75} = \frac{2}{25} = 0.08$$

21. B

Sol.

	N_2	+ $3H_2$ $\rightleftharpoons$	$2NH_3$
$t = 0$	1	3	0
$t = t$	$1 - 0.5$	$3 - 1.5$	2×0.5

$$P_{NH_3} = \frac{1}{3} \times 21 = 7 \text{ atm}$$

22. D

Sol. $Be(OH)_2 + NaOH \longrightarrow NaBeO_2$

23. B, D

Sol. (A) m = 2, $\ell = 2$, n = 3

(B) Ne = $1s^2\ 2s^2\ 2p^6$

(C) 3d = 3p

(D) $E \propto \frac{1}{n^2}$

n = 3

Third shell in hydrogen atom 3s = 3p = 3d

Ans. 9 orbitals.

24. A, B, C

Sol. It means electron would move into first excited state.

$$E_2 - E_1 = 13.6Z^2\left[\frac{1}{1^2} - \frac{1}{2^2}\right] = 10.2Z^2$$

Z may be 1, 2, 3……..

25. A, B, D

26. A, C, D

27. A, B, C, D

28. A, B, C, D

29. A, B

30. A, C

SECTION – C

31. 00006.00

Sol. Number of atoms in unit cell = 1 + 2 = 3

15 = density = $\dfrac{3 \times \text{at.wt.}}{5 \times 10^{-24} \times 6 \times 10^{23}}$

At. Wt. = $5 \times 5 \times 6 \times 10^{-1}$

= 15

15 gram has 6×10^{23} atoms

150 gram " $\quad$ " $= \dfrac{150}{15} \times 6 \times 10^{23}$

$= 60 \times 10^{23}$

= 6 × 10^{24}

x = 6

32. 00003.19

Sol.

$$NH_2COONH_4(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$$

$$\qquad\qquad\qquad 2P \qquad\qquad P$$

$K_p = 4P^3$

$$NH_2COONH_4(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$$

$$\qquad\qquad\qquad 2P - 0.5P \qquad P + 1 - 0.25\,P$$

$$\qquad\qquad\qquad 1.5P \qquad\qquad 0.75P + 1$$

$K_P = (1.5P)^2(0.75P + 1) = 4P^3$

$2.25(0.75P + 1) = 4P$

$\dfrac{9}{4}\left(\dfrac{3}{4}P + 1\right) = 4P$

$$\frac{27P+36}{16}=4P$$
$$27P+36=64P$$
$$36=37P, \qquad P=\frac{36}{37}$$
$$P_T=1.5P+0.75P+1$$
$$=2.25P+1$$
$$=2.25\times\frac{36}{37}+1=3.19$$

33. 00000.50

Sol. $M\propto\frac{1}{x}$

$$3C_2H_2 \longrightarrow C_6H_6$$
$$\begin{array}{ll} 1 & 0 \\ 1-\alpha & \frac{\alpha}{3} \end{array}$$
$$\frac{M_1}{M_2}=\frac{n_2}{n_1}$$
$$\frac{26}{39}=1-\frac{2\alpha}{3}$$
$$\frac{2\alpha}{3}=\frac{1}{3} \qquad \alpha=\frac{1}{2}$$

34. 00002.60

Sol. $A(s) \rightleftharpoons B(s)+2C(g)$

$$K_P=9=(P_C)^2$$
$$P_C=3$$
$$\begin{array}{lll} A(s) \rightleftharpoons & B(s) + & 2C(g) \\ & 1 & a\ \text{mol} \\ & & a-1\times 2 \end{array}$$

PV = nRT

$$3\times10=(a-2)0.0821\times600$$
$$(a-2)=\frac{3\times10}{0.0821\times600}=\frac{1}{0.0821\times20}$$

a = 2.60

35. 00006.50

Sol. $pH=\frac{5+8}{2}=6.5$

PO_4^{-3}	$+\ H^+$	$\longrightarrow HPO_4^{-2}$
5 mm	10 mm	0
0	5 mm	5 mm

HPO_4^{-2}	$+\ H^+$	$\longrightarrow H_2PO_4^-$
5 mm	5 mm	0
0	0	5 mm

$H_2PO_4^-$ is a amphoteric ion whose, pH = $\frac{1}{2}\left(pK_{a_1}+pK_{a_2}\right)=\frac{1}{2}\left(5+8\right)=6.5$

36. 00003.00

Sol. $13.6Z^2\left[\frac{1}{1^2}-\frac{1}{2^2}\right]=13.6\times 3^2\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]$

$Z^2\times\frac{3}{4}=9\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]$

$\frac{Z^2}{12}=\frac{1}{n_1^2}-\frac{1}{n_2^2}$

Z = 1, n_1 = 3, n_2 = 6

Hence $=\frac{2n_1+3n_2+6Z}{10}$ = 3

Mathematics

PART – III

SECTION – A

37. A

Sol. Let $I(t)=\int_0^1 \frac{\sin(\ln x\, t)}{\ln x}dx$

$I'(t)=\int_0^1 \frac{\ln x}{\ln x}\cos(t\ln x)dx = \int_0^1 \mathrm{Re}\left(e^{it\ln|x|}\right)dx$

$I'(t)=\mathrm{Re}\left(\frac{1-it}{1+t^2}\right)=\frac{1}{1+t^2}$

$\int_0^1 I'(t)dt=\frac{\pi}{4}$

38. A

Sol. $\int_0^1\left[f^2(x^2)-2xf(x^2)+x\right]dx=0$

$\Rightarrow \int_0^1 \left(f(x^2)-x\right)^2 dx=0$

So, $f(x^2) = x$

i.e., $f(x)=\sqrt{x}$

39. D

Sol. $(f^3 + g^2)f' + f^2gg' = 0$

$\Rightarrow \left(\frac{1}{4}f^4+\frac{1}{2}f^2g^2\right)'=0$

$\Rightarrow f^4 + 2f^2g^2 = c$

40. A

Sol. $y^4 + xy - x^4 - x^3y^3 \geq 0$

$(y^3 + x)(y - x^3) \geq 0$

Thus the two curves partition the circle $x^2 + y^2 \leq 2$ into 4 regions of equal area and the inequality is satisfied by the two regions the cover the y-axis. So, the area of the set is half the area of the circle.

41. A, B

Sol. By scaling and translating, we may assume that the two inflection points are located at $x = -1$ and $x = 1$

So, $f(x) = (x^4 - 6x^2 + 5) + bx + c$ where $2b = f(1) - f(-1)$; $2c = f(1) + f(-1)$ the line passing through inflection points is $g(x) = bx + c$

So, other intersection points = $\pm\sqrt{5}$

So, $\left|\int_{-\sqrt{5}}^{-1}(x^4-6x^2+5)dx\right| = \left|\int_{1}^{\sqrt{5}}(x^4-6x^2+5)dx\right| = \frac{16}{5}$ and $\int_{-1}^{1}(x^4-6x^2+5)dx = \frac{32}{5}$

42. A, B, C, D

Sol. Let M = $3x^2 + 2e^y$, N = $2xe^y + 3y^2$ solution of the differential equation is

$\int(3x^2+2e^x)dx + \int(3y^2)dy = c$

$\Rightarrow x^3 + 2xe^y + y^3 = c$

43. A, B, C, D

Sol. Let $F(t) = \left[\int_0^t f(x)dx\right]^2 - \int_0^t (f(x))^3 dx \;\; \forall\, t \in [0, 1]$

$F'(t) = f(t)\left[2\int_0^t f(x)dx - f^2(t)\right]$

Let $G(t) = 2\int_0^t f(x)dx - f^2(t)$

$G'(t) = 2f(t)(1 - f'(t))$

So, $F'(t) \geq 0 \;\forall\, t \in [0, 1]$

So, if $1 \geq t \geq 0$

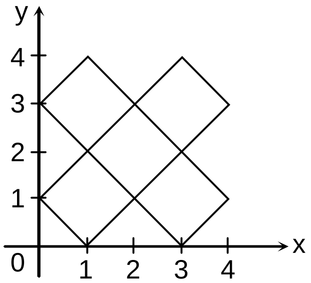
$F(1) \geq F(t) \geq F(0)$

$\left[\int_0^1 f(x)dx\right]^2 - \int_0^1 (f(x))^3 dx \geq 0$

If f(x) = x, x ∈ [0, 1], then equality holds and in many more such example

44. A, C

Sol. Draw the graph in first quadrant



45. A, B, D

Sol. $f(x) = |\sin x| \cos^{-1}(\cos x)$

Points of non-differentiability $x = (2n + 1)\pi$

LHD = $-\pi$, RHD = 2π

$f(x) = [x]|\sin \pi x|$. Points of non-differentiability x = integers

LHD = $(1 - k)\pi$, RHD = $k\pi$

$f(x) = [x]\sin^2(\pi x)$ differentiable $\forall\, x \in R$

$f(x) = |x - 1|\{x\}$: points of non-differentiability x = 1

46. A, D

Sol. Clearly f(x) is continuous on [r, 5r] and not differentiable at x = –r, 5r
Because there is vertical tangent at x = –r, 5r

47. A, B

Sol. $\int \frac{x^4+1}{x^6+1}dx = \int \frac{x^4-x^2+1}{x^6+1}dx + \int \frac{x^2}{x^6+1}dx$

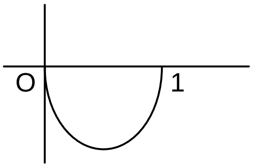
$= \int \frac{(x^4-x^2+1)}{(x^2+1)(x^4-x^2+1)}dx + \int \frac{x^2}{(x^3)^2+1}dx$

$= \tan^{-1}x + \frac{1}{3}\tan^{-1}x^3$

$= \frac{1}{3}\tan^{-1}\left(\frac{3x-3x^5}{1-3x^2-3x^4+x^6}\right)+c$

48. A, B, C

Sol. $(f(x)e^x)'' \geq 0$
So, f(x) e^x is convex
So, f(x) $e^x \leq$ max [f(0), f(1)] = 0
$\therefore$ $f(x) \leq 0 \ \forall \ x \in [0, 1]$



SECTION – C

49. 00002.00

Sol. Let a = 2^x, b = -3^{x-1} and c = –1
So, $2^x = 3^{x-1}$
$\Rightarrow 3^{x-1} - 2^{x-1} = 2^{x-1} - 1$
Let $f(t) = t^{x-1}$
So, $f'(t_1) = f'(t_2)$ from LMVT on (1, 2) and (2, 3) and $t_1 \in (1, 2)$, $t_2 \in (2, 3)$
$(x-1)t_1^{x-2} = (x-1)t_2^{x-2}$
Clearly, there are only 2 solutions x = 1 and x = 2

50. 00000.20

Sol. $f(x) = \frac{\left(x+\frac{1}{x}-1\right)^3}{x^3+\frac{1}{x^3}-1}$

Let $x+\frac{1}{x}=t$

$g(t) = 1+\frac{6t-3t^2}{t^3-3t-1}$

After g′(t), we get CP: $t = 1, 1, 1 \pm \sqrt{3}$

So, $g(1+\sqrt{3}) = \frac{\sqrt{3}}{2+\sqrt{3}}$

51. 00008.00

Sol. $f(x) = \left(x^2 + \frac{a}{2}x\right)^2 + \left(1 + \frac{b}{2}x\right)^2 + \frac{1}{4}\left(8 - a^2 - b^2\right)x^2 \ge 0 \;\; \forall\, x \in R$

f(x) is strictly positive unless $a^2 + b^2 \ge 8$

52. 00007.00

Sol. $1 + \frac{1}{2} + \frac{1}{3} + ... + \frac{1}{n^7} > \int\limits_1^{n^7} \frac{dx}{x} > \frac{1}{2} + \frac{1}{3} + ... + \frac{1}{n^7}$

$\ln^7 - 1 > 1 + \frac{1}{2} + \frac{1}{3} + ... + \frac{1}{n^3} > \ln n^7$

So, $\lim\limits_{n\to\infty} \dfrac{1 + \frac{1}{2} + \frac{1}{3} + ... + \frac{1}{n^7}}{\ln n} = 7$

53. 00001.00

Sol. $\because \; \dfrac{dx}{dy} = \dfrac{1}{\frac{dy}{dx}}$

$$\frac{d^2x}{dy^2} = \frac{d}{dy}\left(\frac{1}{\frac{dy}{dx}}\right) = \frac{d}{dx}\left(\frac{1}{\frac{dy}{dx}}\right)\cdot\frac{dx}{dy} = \frac{-1}{\left(\frac{dy}{dx}\right)^2}\cdot\frac{d^2y}{dx^2}\cdot\frac{dx}{dy} = \frac{-1}{\left(\frac{dy}{dx}\right)^3}\cdot\frac{d^2y}{dx^2}$$

From the given is $\dfrac{d^2y}{dx^2}\left(1 - \dfrac{1}{\left(\frac{dy}{dx}\right)^3}\right) = 0$

$\Rightarrow \dfrac{d^2y}{dx^2} = 0$ or $\dfrac{dy}{dx} = 1 \Rightarrow y = ax + b : a \ne 0$

54. 00000.00

Sol. Assume that such a function exists

$\because$ f′(x) = f(f(x)) > 0

$\Rightarrow f \uparrow$

f′(x) = f(f(x)) > f(0) $\forall\, x \in R$

$\int\limits_x^0 f'(x)dx > \int\limits_x^0 f(0)dx \;\; ; x < 0$

$\Rightarrow$ f(x) < (x + 1)f(0)

Clearly for $x \le -1$, $f(x) \le 0$

Contradicting the hypothesis that f(x) > 0 $\forall$ x

No such function exist

FIITJEE

ALL INDIA TEST SERIES

PART TEST – I

JEE (Advanced)-2020

PAPER – 2

TEST DATE: 10-11-2019

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section-A (01 – 08, 19 – 26, 37 – 44)*** *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*

*Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
*Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
*Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
*Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
*Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
*Negative Marks : **–1** In all other cases.*

Section-A (09 – 12, 27 – 30, 45 – 48) *contains 6 List-Match sets with 12 questions (each set has 2 questions). Each question has 4 statements in LIST-I & 5 or 6 statements in LIST-II. The codes for Lists have choices (A), (B), (C), (D) out of which only one is correct.*
Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

Physics PART – I

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1 A force F(x, y, z) = $F_x\hat{i}+F_y\hat{j}+F_z\hat{k}$ is conservative if, and only if, the following relations are satisfied:

(A) $\frac{\partial F_x}{\partial y}=\frac{\partial F_y}{\partial x}$

(B) $\frac{\partial F_y}{\partial z}=\frac{\partial F_z}{\partial y}$

(C) $\frac{\partial F_z}{\partial x}=\frac{\partial F_x}{\partial z}$

(D) Work done by the force on any closed path is zero.

2. The two endpoints of an 8 m long weightless thread are fixed at the same height at a distance of 4 m. An object of mass 10 kg is hung onto the thread and can move without friction. A horizontal force of magnitude F is exerted on the object to keep it at rest on the thread exactly below one of the endpoints of the thread? If F is removed, the object has an initial acceleration 'a' and eventually acquires a maximum speed v_{max}.

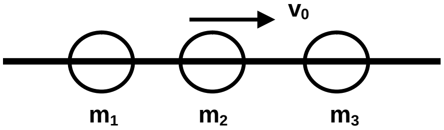
(A) F = 50N

(B) a = 4m/s^2

(C) $v_{max}=\sqrt{20\left(2\sqrt{3}-3\right)}$ m/s

(D) The radius of curvature of path traced by the particle after removal of F will first decrease and then increase.

3. Three balls of mass m_1, m_2 and m_3 can slide without friction along a horizontal rod. (There are holes in the balls.) At a certain moment the middle ball is given an initial speed of v_0 = 5 m/s towards the right. If all collisions are totally elastic pick the correct statement/s .



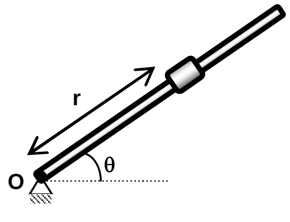
(A) For any value of m_1, m_2 and m_3 there can be at most 2 collisions.

(B) If m_1 = 4m, m_2 = m and m_3 = 3m then for any value of v_0 there will be 2 collisions.

(C) If m_1 = 4m, m_2 = m and m_3 = 3m then the final speed of m_3 will be 2.5 m/s.

(D) If m_1 = 4m, m_2 = m and m_3 = 3m then the final speed of m_2 will be 1.5 m/s.

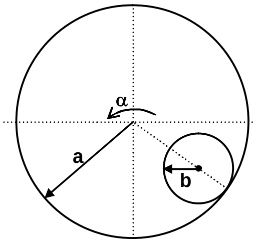
4. The rotation of rod OA about O is defined by the relation $\theta=\pi\left(4t^2-8t\right)$, where θ and t are expressed in radians and seconds, respectively. Collar B slides along the rod so that its distance from O is r = 10 + 6 sinπt , where r and t are expressed in metres and seconds, respectively. When t = 1 s,



(A) The speed of the collar in radial direction is 6π m/s.

(B) The speed of the collar in tangential direction is 80π m/s
(C) The speed of the collar in radial direction is zero.
(D) The speed of the collar in tangential direction is zero.

5. A perfectly rough cylindrical grindstone, of radius a = 1m, is rotating with a uniform angular acceleration about its axis, which is horizontal. If a sphere in contact with its edge can remain with its centre at rest, The angular acceleration of the grindstone (in rad/s^2) can be (take g = 10m/s^2) (There is no slipping between the sphere and the cylindrical grindstone)



(A) 15
(B) 20
(C) 25
(D) 30

6. A train is travelling at a speed of v_0. Then it decelerates uniformly during a time of t to finally stop. In one of the wagons there is a small object on the floor. The wagon long enough, so that the object does not collide with any of the walls of the wagon. ℓ is the distance covered by the object on the floor (with respect to train) , μ is the coefficient of friction between the floor of the wagon and the object.

(A) If $\frac{v_0}{t} < \mu g, \ell = 0$

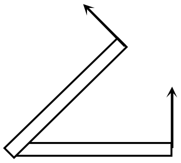
(B) If $\frac{v_0}{t} > \mu g, \ell = \frac{v_0^2}{4\mu g} - \frac{\mu g t^2}{4}$

(C) If $\frac{v_0}{t} > \mu g, \ell = 0$

(D) If $\frac{v_0}{t} > \mu g, \ell = \frac{v_0^2}{2\mu g} - \frac{v_0 t}{2}$

7. A particle is projected from a given point with a given velocity v = 10 m/s and after hitting a smooth vertical wall returns to the point from which it started. The distance of the initial point from the wall can be: (Take g = 10m/s^2) :
(A) 3 m
(B) 4 m
(C) 4.5 m
(D) 6 m

8. A long thin uniform rod lies flat on the table as shown. One end of the rod is slowly pulled up by a force that remains perpendicular to the rod at all times. The rod is to be brought to the vertical position without any slipping of the bottom end? The coefficient of static friction between rod and ground can be:



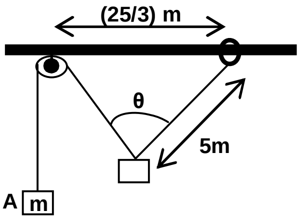
(A) 0.2
(B) 0.3
(C) 0.4
(D) 0.5

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

A mass of 1 kg is supported by a cord 5 m long fastened to a massless ring free to move on a horizontal rod , as shown in Figure. The coefficient of static friction between the ring and the rod is 0.75. A second cord is fastened to the weight and passes over a pulley fastened to the rod (25/3) m to the left of the ring. Block A of mass m is attached to the other end of this cord.



	List-I		List-II
(I)	Tension in the sting connected to block A in Newton .	(P)	6
(II)	Tension in the 5m cord in Newton.	(Q)	8
(III)	The value of θ is π/k radians , what can be the possible value/s of k.	(R)	2
(IV)	Acceleration of block A(in m/s^2).	(S)	0
		(T)	4
		(U)	12

9. If mass m is such that the ring just begins to slip. The correct match will be,

Options

(A) I → P, II → Q, III → R, IV → S

(B) I → Q, II → P, III → T, IV → S

(C) I → T, II → Q, III → R, IV → S

(D) I → U, II → Q, III → R, IV → S

10. The value of m was initially chosen so that the ring just began to slide. Now , the ring is welded to the rod and mass of block A is increased to 5m , holding the 1kg mass . Immediately after the system is realeased then the correct match will be,

Options

(A) I → P, II → Q, III → R, IV → T

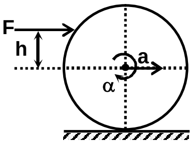
(B) I → Q, II → P, III → T, IV → U

(C) I → T, II → U, III → R, IV → Q

(D) I → U, II → Q, III → R, IV → P

Answer the following by appropriately matching the list based on the information given in the paragraph.

A solid body of mass m and radius 'R' is placed on a rough horizontal surface. When a horizontal force 'F' is applied to the body at a height 'h' above the centre level, the body starts rolling without slipping on the horizontal surface as shown.



List –I gives the four different shapes of the given solid body and corresponding values of F and h while List –II gives the magnitude of some quantities.

	List-I		List-II
(I)	For a ring, F = 2mg, $h = \frac{R}{2}$	(P)	1
(II)	For a disc, F = mg, $h = \frac{3R}{4}$	(Q)	$\frac{1}{3}$
(III)	For a hollow sphere, $F = \frac{5mg}{8}$, $h = \frac{R}{3}$	(R)	$\frac{7}{9}$
(IV)	For a solid sphere, $F = \frac{mg}{2}$, $h = \frac{3R}{5}$	(S)	$\frac{8}{21}$
		(T)	$\frac{1}{4}$
		(U)	$\frac{1}{7}$

11. If acceleration of the ring is 'a_0' then the acceleration of the different shapes of the body in a_0 units will be

Options
(A) I → P, II → R, III → Q, IV → S
(B) I → Q, II → P, III → S, IV → U
(C) I → P, II → T, III → R, IV → S
(D) I → T, II → Q, III → R, IV → U

12. If frictional force acting on the ring is 'f_0' then the frictional force acting on the different shapes of the body in 'f_0' units will be

Options
(A) I → P, II → Q, III → R, IV → S
(B) I → Q, II → P, III → S, IV → U
(C) I → P, II → Q, III → T, IV → U
(D) I → T, II → Q, III → R, IV → U

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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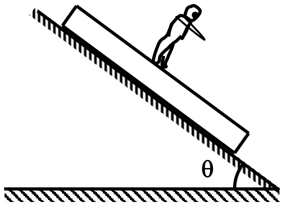
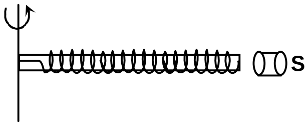
13. A mass of m = 1kg moves initially with a velocity of $v_0 = 10\sqrt{15}$ m/s. A constant power P = 1000 Watt is applied so as to increase its velocity. Find the time (in sec) that elapses before the acceleration is reduced to half of its original value.

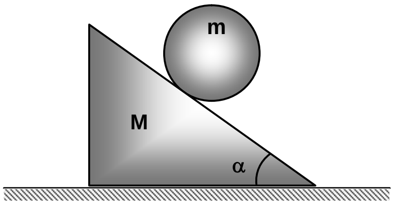
14. A plank, of mass M = 1kg and length ℓ = 7.2 m, is initially at rest along a line of greatest slope of a smooth plane inclined at an angle $\theta = 30°$ to the horizontal, and a man, of mass M_0 = 1kg, starting from the upper end walks down the plank so that it does not move. Find the time(in seconds) in which he gets to the other end of the plank .



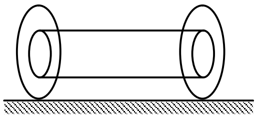
15. A rod of length $\ell = 2$m is maintained to rotate with a constant angular velocity $\omega = 1$ rad/s about a vertical axis passing through one end (fig). There is a spring of spring constant k = 1 N/m which just encloses rod inside it in natural length. One end of the spring is attached to axis of rotation. S is a sleeve of mass m = 0.4kg which can just fit on the rod. All surfaces are smooth. With what minimum kinetic energy (in J) sleeve should be projected so that it enters on the rod without impulse and completely compresses the spring.

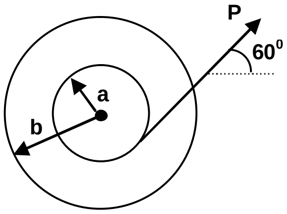


16. A wedge of mass M = 10 kg and inclination $\alpha = 30°$ is free to move on a smooth horizontal plane. A uniform solid cylinder of mass m = 20 kg is placed on the rough inclined face of the wedge. Find the acceleration (in m/s^2) of the centre of the cylinder relative to the wedge down the face. There is no slipping between the cylinder and the wedge.



17. Rope is coiled round a drum of radius a = 1.5 m. Two wheels each of radius b = 2 m are fitted to the ends of the drum, and the wheels and drum form a rigid body having a common axis. The system stands on the rough horizontal surface and a free end of the rope, after passing under the drum, is inclined at an angle of 60^o to the horizontal. If a force P = 10 N be applied to the rope, find the magnitude of acceleration (in m/s^2) of centre of drum. Where mass of the system is 0.25 kg and its radius of gyration about the axis is k = 2 m.


Front view



Side view

18. At what speed (in m/s) must a pebble be thrown from a height of h = 3.6m, and at an angle of 30^o, measured from the horizontal, if it is to hit the ground at an angle of 45^o. (Air drag can be neglected.) (Take g = 10 m/s^2)

Chemistry

PART – II

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. Which is/are correct regarding alkali metals:
(A) Conductivities of alkali metal chloride in aqueous solution follows order
LiCl < NaCl < KCl < RbCl
(B) All alkali metal dissolved in liquid NH_3 their solubility follows order Li < Na < K
(C) In the electrolysis of NaCl (aq) during formation of NaOH. Cl_2 (g) at cathode and H_2 (g) at anode are liberated
(D) Negative value of ΔH_f^o (standard enthalpy of formation) LiF > NaF > KF > RbF > CsF

20. Correct statement are
(A) In $[ICl_4]^-$ molecular ion, $Cl-I-Cl$ bond angle is 90^o.
(B) Bond dissociation energy follows order
H – H > Cl – Cl > Br – Br
(C) Extent of overlap follows order
p – p > p – s > s – s
(D) When ether is added to the mixture of LiCl, NaCl, KCl, it is KCl which will be extracted to the ether solution.

21. Which of the following is/are true?
(A) Titration of H_3BO_3 with NaOH require *cis*-polyhydroxy alcohol to move the reaction in forward direction.
(B) Aqueous solution of Borax will act as buffer solution.
(C) Elemental B can be obtained by reducing the B_2O_3 with carbon.
(D) $(BN)_x$ is obtained when NH_4Cl and $Na_2B_4O_7$ is reacted at red hot temperature.

22. Select the correct statement(s):
(A) $4\pi r^2\psi^2$ vs r plotted for a H-orbital curve contains 3 maxima and 2 angular node then orbital will be 5d.
(B) There will be 13 electrons in Cu atom having magnetic quantum number is equal to zero.
(C) There will be minimum four atoms of hydrogen atom require during de-excitation from 4th shell to 1st shell to cover all distinct spectral line.
(D) The value of $(n+\ell+m)$ of last electron in Mg atom is 5.

23. $N_2O_4 \rightleftharpoons 2NO_2$
In above equilibrium mixture of N_2O_4 and NO_2 at 425 K, contains N_2O_4 at 4 atm and NO_2 at 8 atm. Now volume of vessel becomes double at the same temperature.
(A) New pressure of N_2O_4 is 1.53 atm
(B) New pressure NO_2 is 4.945 atm
(C) Mole percentage of N_2O_4 is 23.63%
(D) New pressure of NO_2 is 7.26 atm

24. Which of the following statements is/are correct?
(A) Diamond is a covalent solid and co-ordination number of each carbon atom is 4.

(B) The CCP and HCP structure of a given element would have same co-ordination number and same packing fraction.
(C) On decreasing the pressure, coordination number of CsCl decreases to that of NaCl.
(D) In fluorite structure of CaF_2, Ca^{+2} ion occupy tetrahedral void and F^- ion at CCP point.

25. Which among the following statements are not correct?
(A) CaC_2 and Mg_2C_3 on hydrolysis gives alkyne.
(B) Be_2C and Al_4C_3 on hydrolysis gives alkene.
(C) Linear silicones are formed by hydrolysis of monoalkyl chloro silane.
(D) In pyrosilicate two oxygen atoms is shared between two $\left[SiO_4^{4-}\right]$ unit.

26. Which of the following are not true?
(A) A mixture of 2 mole of CH_3COONa and 1 mol of HCl will act as buffer solution.
(B) 200 ml of $\frac{M}{3}$ solution of H_3PO_2 is completely neutralized by 100 ml of 1M $Ca(OH)_2$ solution.
(C) pH of 0.5 M NaH_2PO_2 solution is 7.45 where pK_a of H_3PO_2 is 1.2.
(D) NaH_2PO_2 is a amphoteric salt.

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Match the following List-I with List-II:

LIST–I		LIST–II	
(I)	NaCl type (AB)	(P)	Co-ordination number 6 : 6
(II)	Antifluorite – (A_2B)	(Q)	Co-ordination number 4 : 8
(III)	Fluorite (AB_2)	(R)	Co-ordination number 8 : 4
(IV)	Diamond	(S)	Effective atom/ions in unit cell 8
		(T)	Effective atom/ions in unit cell 4
		(U)	Packing fraction 34%

27. Which of the following options has the correct combination considering List-I and List-II?
Options
(A) (IV), (S)
(B) (III), (Q)
(C) (II), (R)
(D) (I), (T)

Match the following List-I with List-II:

LIST–I		LIST–II	
(I)	NaCl type (AB)	(P)	Co-ordination 6 : 6
(II)	Antifluorite – (A_2B)	(Q)	Co-ordination 4 : 8
(III)	Fluorite (AB_2)	(R)	Co-ordination 8 : 4
(IV)	Diamond	(S)	Effective atom/ions in unit cell 8
		(T)	Effective atom/ions in unit cell 4
		(U)	Packing fraction 34%

28. Which of the following options has the correct combination considering List-I and List-II?

Options

(A) (II), (S)
(B) (I), (S)
(C) (IV), (Q)
(D) (III), (P)

Match the following List-I with List-II:

LIST–I		**LIST–II**	
(I)	KO_2	(P)	Paramagnetic
(II)	K_2O_2	(Q)	Diamagnetic
(III)	K_2O	(R)	Aqueous alkaline solution
(IV)	KO_3	(S)	CO_2 absorber and O_2 releaser
		(T)	Coloured
		(U)	Used as breathing mask in submarine

29. Which of the following options has the correct combination considering List-I and List-II?

Options

(A) (I), (Q)
(B) (II), (P)
(C) (I), (U)
(D) (IV), (S)

Match the following List-I with List-II:

LIST–I		**LIST–II**	
(I)	KO_2	(P)	Paramagnetic
(II)	K_2O_2	(Q)	Diamagnetic
(III)	K_2O	(R)	Aqueous alkaline solution
(IV)	KO_3	(S)	CO_2 absorber and O_2 releaser
		(T)	Coloured
		(U)	Used as breathing mask in submarine

30. Which of the following options has the correct combination considering List-I and List-II?

Options

(A) (IV), (Q)
(B) (I), (T)
(C) (III), (S)
(D) (III), (P)

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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31. Balance the chemical reaction given below:

$$xMn\left(NO_3\right)_2 + yKOH + S \longrightarrow K_2MnO_4 + K_2SO_4 + NO + zH_2O$$

Find $\dfrac{x+y+z}{10}$

32. An inorganic mixture containing 0.5 mole of PCl_3 and 0.5 mol of PCl_5 was dissolved in excess of water. Find the number of moles of NaOH required to neutralized this solution.

33. RH_2 (ion exchange resin) can replace Ca^{+2} in water. If 1 litre of water is passed in ion exchange resin and pH of solution found to be 5.
Find hardness of water in ppm scale in term of Ca^{+2}.

34. One millimole of CO_2 is absorbed in 200 ml of 0.1 M NaOH. If the resulting solution is titrated with HCl using phenolphthalein as indicator, find millimole of HCl required when indicator changes it's colour.

35. For the reaction

$$A(g) \rightleftharpoons B(g) + C(g)$$

Average vapour density of mixture is 83.33. If molar mass of A, B and C are 100, 60 and 40 g. Find the number of moles of B formed at equilibrium starting with one mole of A.

36. 49 gram of a sample of oleum containing 20% free SO_3 was neutralized by $\frac{M}{10}$ NaOH. The volume of NaOH in litre require for neutralization is

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. Let f be a continuous function on [0, 1] such that $\int_x^1 f(t)dt \geq \frac{1-x^2}{2}$ $\forall$ x $\in$ [0, 1], then $\int_0^1 f^2(t)dt$ is always greater than or equal to

(A) $\frac{1}{3}$

(B) $\frac{1}{4}$

(C) $\frac{4}{19}$

(D) $\frac{3}{10}$

38. The number of function(s) f: [0, 1] → R such that $\int_0^1 \left(f\left(x^{1/k}\right)\right)^{n-k} dx = \frac{k}{n}$ $\forall$ k $\in$ {1, 2, 3, ..., n – 1}, where n is an odd integer greater than 1, is

(A) 1
(B) 2
(C) 5
(D) 7

39. Let f: R → R be a thrice differentiable function such that f(x), f′(x), f″(x) and f‴(x) are positive $\forall$ x $\in$ R. Moreover, f‴(x) < f(x) $\forall$ x $\in$ R, then

(A) $f'(x) < 2f(x)$ $\forall$ x $\in$ R

(B) $f'(x) < \left(\frac{3}{2}\right)^{\frac{1}{3}} f(x)$ $\forall$ x $\in$ R

(C) $f'(x) < \frac{5}{2} f(x)$ $\forall$ x $\in$ R

(D) $f'(x) < 3f(x)$ $\forall$ x $\in$ R

40. If y(x) be the solution of the differential equation $y \cdot y'' = 2x(y')^2$ given $y'(0) = -4$, $y(0) = 1$, then

(A) $y(1) = e^4$
(B) $y(2) = e^{8/3}$
(C) $y(x) \in (0, \infty) - \{e^2\}$
(D) $y(x) \in (0, \infty) - \{e^3\}$

41. Let f: [0, 1] → R be continuously differentiable function and

$\left|\frac{f(0)+f(1)}{2} - \int_0^1 f(x)dx\right| \leq \alpha \max_{x \in [0,1]} |f'(x)|$, then α can be

(A) $\frac{1}{4}$

(B) $\frac{1}{2}$

(C) $\frac{3}{10}$

(D) 1

42. If $\frac{e^x + e^{-x}}{2} \le e^{cx^2}$ $\forall$ x $\in$ R, then c can be

(A) $\frac{1}{2}$

(B) $\frac{1}{\sqrt{2}}$

(C) $\frac{1}{e}$

(D) 1

43. Which of the following are INCORRECT?

(A) f(x) = {sin x} cos x $(\cos^{-1}\cos x)^3$ is not differentiable at $2n\pi$, $\left(2n\pi + \frac{\pi}{2}\right)$ and $(2n + 1)\pi$, n $\in$ Z (where {.} represents fractional part function)

(B) f(x) = |(x – 1)(x – 2)(x – 3)||sin πx| is not differentiable at 3 points in x $\in$ [0, 4]

(C) f(x) = ||x – 2| – |x – 8|| – 3$|x - 5|^3$ + 8x + 1 + cos(|x – 8|) not differentiable at 3 points

(D) f(x) = $(x^2 - 3x + 2)^{3/5}\sin(x^2 - 2x)$ is not differentiable at x = 1

44. Let f: [0, 1] → R be a continuous function, differentiable on (0, 1) such that $\int_0^a f(x)dx = 0$ for some a $\in$ (0, 1), then

(A) $\left|\int_0^a f(x)dx\right| \le \frac{1-a}{2} \max\limits_{0<x<1}|f'(x)|$

(B) $\left|\int_0^1 f(x)dx\right| > \frac{1-a}{2} \max\limits_{0<x<1}|f'(x)|$

(C) $\left|\int_0^1 f(x)dx\right| = \frac{1-a}{2} \max\limits_{0<x<1}|f'(x)|$ for some function f(x)

(D) none of the other options is correct

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

MM-I. Let $f_1(x) = \lim\limits_{n\to\infty}(x-1)\frac{(x^{4n}-1)}{(x^{4n}+1)}$;

$f_2(x) = \{x\}\cos^2\left(\frac{2x-1}{2}\right)\pi$; (where {.} denotes fractional part function x);

$$f_3(x) = \begin{cases} x^2 - x\sqrt{3} & ; \quad x \text{ is irrational} \\ 0 & ; \quad x \text{ is rational} \end{cases};$$

$$f_4(x) = \begin{cases} 0 & ; \quad x \text{ is irrational} \\ \dfrac{1}{n} & ; \quad x \text{ is rational number of the form } x = \dfrac{m}{n} \text{ in lowest terms with } m, n > 0 \end{cases}$$

LIST–I		LIST–II	
(I)	$f_1(x)$ is discontinuous at	(P)	–1
(II)	$f_2(x)$ is discontinuous at	(Q)	0
(III)	$f_3(x)$ is discontinuous at	(R)	1
(IV)	$f_4(x)$ is discontinuous at	(S)	2
		(T)	$\sqrt{2}$
		(U)	$\sqrt{3}$

45. Which of the following is the only INCORRECT combination?
(A) (I), (P)
(B) (IV), (S)
(C) (IV), (R)
(D) (IV), (T)

46. Which of the following is the only CORRECT combination?
(A) (II), (P)
(B) (III), (T)
(C) (III), (Q)
(D) (IV), (U)

MM-II. List-I represents equations and List-II represents number of positive real roots of the corresponding equations

LIST–I		LIST–II	
(I)	$(x^3 - x + 1)^3 - x^3 + x = 0$	(P)	0
(II)	$x^6 - x^4 + 2x^3 - x^2 + 1 = 0$	(Q)	1
(III)	$\frac{1}{x-1} + \frac{1}{x-2} + \frac{1}{x-3} - x^{\frac{3}{5}} = 0$	(R)	2
(IV)	$x^4 - 2^x = 0$	(S)	3
		(T)	4
		(U)	5

47. Which of the following is the only CORRECT combination?
(A) (I), (P)
(B) (I), (T)
(C) (III), (T)
(D) (III), (R)

48. Which of the following is the only CORRECT combination?
(A) (IV), (R)
(B) (IV), (Q)
(C) (II), (Q)
(D) (II), (R)

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

49. Let f(x) be a differentiable function with a continuous derivative $\forall$ x $\in$ R. If f(1) = 2 and f(2) = 5 and $f'(x)$ takes only rational values, then $f(3) + f'(0)$ is equal to

50. If f(x) is a function with a continuous third derivative on [0, 2] such that
$f(0) = f'(0) = f''(0) = f'(2) = f''(2) = 0$ and f(2) = 2, then minimum number of value(s) of c $\in$ [0, 2] such that $f'''(c) \geq 6$ is

51. Let f: $(0, \infty) \to R$ be a twice differentiable function such that $|f''(x) + 2xf'(x) + (x^2 + 1)f(x)| \leq 2$
$\forall$ x $\in$ R and $\lim_{x\to\infty}(xf(x) + f'(x)) = 5$, then $\lim_{x\to\infty} f(x)$ is equal to

52. Let f: R $\to$ R be a continuous function $\forall$ x $\in$ R such that $f(x) = f\left(x^2 + \frac{1}{4}\right)$ and $f'(0) = 0$, then $f'\left(\frac{1}{4}\right)$ is equal to

53. Let f(x) be a three times differentiable function (defined on R) such that f(x) has at least five distinct real zeroes, then number of distinct real zeroes of $f(x) + 6f'(x) + 12f''(x) + 8f'''(x)$ is/are

54. $\lim_{n\to\infty} \sum_{k=1}^{n} \left(\frac{k}{n^2}\right)^{\frac{k}{n^2}+1}$ is equal to

FIITJEE

ALL INDIA TEST SERIES

PART TEST – I

JEE (Advanced)-2020

PAPER – 2

TEST DATE: 10-11-2019

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. A, B, C, D

Sol. By definition

2. A, C

Sol. To find F draw the F.B.D. of the mass. Then apply work energy theorem to get maximum speed.

3. B, C, D

Sol. The number of collisions will be dependent on the masses of the three objects. If $m_1 = 4m$, $m_2 = m$ and $m_3 = 3m$ then m_1 finally moves to left with 1 m/s, m_2 with speed 1.5 m/s and m_3 to right side with speed 2.5 m/s.

4. A, D

Sol. Write the co-ordinates of the collar and differentiate w.r.t. time to get velocity of collar.

5. A, B, C

Sol. Let the line joining the centres of sphere and grindstone be inclined at ϕ to the vertical, and let R, F be the normal reaction and friction. The sphere remains at rest if:
$R = Mg\cos\phi$ and $F = Mg\sin\phi$

Also : $\frac{2Mb^2}{5}\frac{d^2\theta}{dt^2} = Fb = Mgb\sin\phi \Rightarrow \frac{bd^2\theta}{dt^2} = \frac{5g\sin\phi}{2}$

and $bd^2\theta/dt^2$ = acceleration of point of contact = $a\alpha$, therefore $\alpha = \frac{5g\sin\phi}{2a}$, so that α must not exceed 5g/2a.

6. A, D

Sol. If $a = \frac{v_0}{t} > \mu g$, then the distance covered by the object relative to train

$$\ell = \frac{1}{2}(a-\mu g)t^2 + \frac{(a-\mu g)^2 t^2}{2\mu g}$$

$$= \frac{v_0 t}{2} - \frac{1}{2}\mu g t^2 + \frac{(v_0-\mu g t)^2}{2\mu g}$$

$$= \frac{v_0^2}{2\mu g} - \frac{v_0 t}{2}$$

If the wagon long enough, distance moved by the small body relative to train is $\ell = \frac{v_0^2}{2\mu g} - \frac{v_0 t}{2}$

7. A, B, C

Sol. Let θ be the inclination of the direction of projection to the horizontal, and x the distance from the wall to the point of projection, so that the time to the wall = x/vcosθ. After the impact the horizontal velocity is evcosθ, so that the particle will be vertically over the starting point again in time x/evcosθ from the impact .(e is the coefficient of restitution)
The vertical velocity is unaltered by the impact, so that the particle will be on the same vertical level as the point of projection in time 2Vsinθ/g .
The particle will therefore return to the point of projection if

$$\frac{2v\sin\theta}{g} = \frac{x}{v\cos\theta} + \frac{x}{ev\cos\theta}$$

$$\Rightarrow \quad x = \left(\frac{e}{1+e}\right)\frac{v^2\sin 2\theta}{g}$$

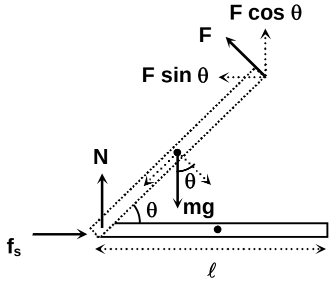
Now the greatest value of sin 2θ is unity, so that the greatest value of x is $\frac{v^2 e}{g(e+1)}$, where e is the coefficient of restitution. Since $0 \le e \le 1 \Rightarrow x \le 5$

8. C, D

Sol. Since the rod is raised slowly (quasi-statically), the entire system remains in equilibrium at any moment of time. Thus, the torque about the point of rotation of the rod is zero about any axis, and the net external forces are 0.

$$\tau = -F\ell + \frac{mg\ell\cos\theta}{2} = 0 \Rightarrow F = \frac{mg\cos\theta}{2}$$

$N = mg - F\cos\theta$, $f_s = F\sin\theta$



The F sin θ force causes the rod's bottom end to slip in one direction. The friction force counters this force to stop the slipping, $f_s \le \mu_s N$

$\mu_s N \ge F \sin\theta$. Hence,

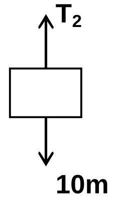
$$\mu_s \ge \frac{F\sin\theta}{mg - F\cos\theta} = \frac{\sin\theta\cos\theta}{2-\cos^2\theta}$$

Maximum of μs can be found by setting its derivative with respect to theta equal to zero:

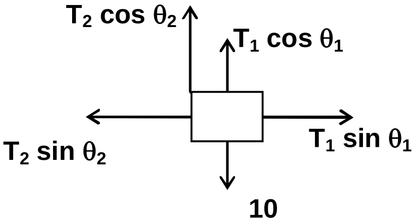
$$\frac{d\mu}{d\theta} = \frac{\left(2-\cos^2\theta\right)\left(2\cos^2\theta-1\right)-2\cos^2\theta\left(1-\cos^2\theta\right)}{\left(2-\cos^2\theta\right)^2} = 0 \text{ This gives } \sin\theta = \frac{1}{\sqrt{3}} \text{ and } \mu_{\min} = \frac{\sqrt{2}}{4}$$

9. A

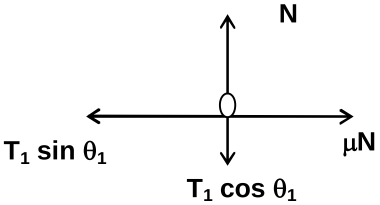
Sol.



F.B.D. of m



F.B.D. of 1 kg



F.B.D of ring

For ring

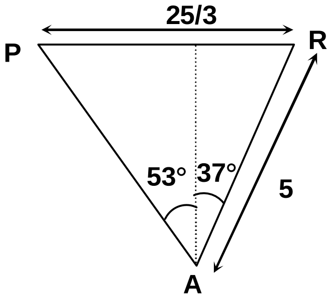
$N = T_1 \cos\theta_1$

$\frac{3}{4}N = T_1 \sin\theta_1$

$\tan\theta_1 = 3/4 \Rightarrow \theta_1 = 37°$

from geometry of triangle $\theta_2 = 53°$

$\Rightarrow \theta = 90°$



For 1 kg block

$T_1 \sin\theta_1 = T_2 \sin\theta_2 \Rightarrow 3T_1 = 4T_2$

$T_2 \cos\theta_2 + T_1 \cos\theta_1 = 10$

$\Rightarrow T_2 = 6\text{ N}, T_1 = 8\text{ N}$

For m

$T_2 = 10\,m = 6$

$m = \frac{6}{10}\text{kg} = 0.6\text{ kg}$

10. D

Sol. For 1 kg block

$T_1 = 8$ N

$T_2 - 6 = a$ ….(i)

For Block A

$5mg - T_2 = 5ma$

$30 - T_2 = 3a$ …(ii)

Solving (i) and (ii), we get

$a = 6\text{ m/s}^2$

$\therefore T_2 = 6 + a = 6 + 6 = 12$ N

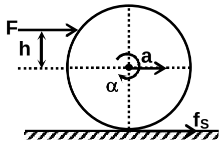
11. A

12. C

Sol. (for Q.11-12)

If $h > h_0$ $\left(\text{where } h_0 = \frac{I_{CM}}{mR}\right)$

$F + f_S = ma$ …(i)



$Fh - f_S R = I_{CM}\alpha$

$$\frac{Fh}{R} - f_s = \frac{I_{cm}a}{R^2} \qquad \ldots(ii)$$

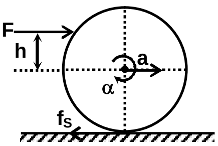
From (i) and (ii)

$$F\left(1+\frac{h}{R}\right) = ma\left(1+\frac{I_{CM}}{mR^2}\right)$$

$$a = \frac{F\left(1+\frac{h}{R}\right)}{m\left(1+\frac{I_{CM}}{mR^2}\right)}$$

$f_S = ma - F$

If h < h₀



$$F - f_S = ma \qquad \ldots(i)$$

$Fh + f_S R = I_{CM}\alpha$

$$\frac{Fh}{R} + f_s = \frac{I_{cm}a}{R^2} \qquad \ldots(ii)$$

From (i) and (ii)

$$F\left(1+\frac{h}{R}\right) = ma\left(1+\frac{I_{CM}}{mR^2}\right)$$

$$a = \frac{F\left(1+\frac{h}{R}\right)}{m\left(1+\frac{I_{CM}}{mR^2}\right)}$$

$f_S = F - ma$

For a ring,

$F = 2mg$, $h = R/2$

$$a_0 = \frac{3g}{2},\ f_0 = f_S = F - ma = \frac{mg}{2}$$

$$a_0 = \frac{3g}{2},\ \ f_0 = \frac{mg}{2}$$

For a disc,

$F = mg$, $h = 3R/4$

$$a = \frac{mg\left(1+\frac{3}{4}\right)}{m\frac{3}{2}} = \frac{7g}{4}\times\frac{2}{3} = \frac{7g}{6}$$

$$f_S = ma - F = \frac{7mg}{6} - mg = \frac{mg}{6}$$

$$a = \frac{7a_0}{9},\ \ f_S = \frac{f_0}{3}$$

For a hollow sphere,

$$F = \frac{5mg}{8},\ h = \frac{R}{3}$$

$$a = \frac{\frac{5mg}{8}\times\frac{4}{3}}{\frac{5}{3}m} = \frac{g}{2} \quad \therefore\ a = a_0/3$$

$f_S = F - ma = \dfrac{5mg}{8} - \dfrac{mg}{2} = \dfrac{mg}{8} = \dfrac{f_0}{4}$

$f_S = f_0/4$

For a solid sphere

$F = mg/2$, $h = 3R/5$

$$a = \frac{\frac{mg}{2} \times \frac{8}{5}}{m\frac{7}{5}} = \frac{4g}{7} = \frac{8}{21}a_0$$

$f_S = ma - F$

$$f_S = \frac{4mg}{7} - \frac{mg}{2} = \frac{mg}{14}$$

$$a = \frac{8a_0}{21},\ \ f_S = \frac{f_0}{7}$$

SECTION – C

13. 00002.25

Sol. $m\dfrac{dv}{dt}v = P$ = constant

When acceleration reduces to half value its speed becomes doubled i.e. $v = 2v_0$

$$Pt = \frac{1}{2}m\left(v^2 - v_0^2\right)$$

$$Pt = \frac{1}{2}m\left(4v_0^2 - v_0^2\right)$$

$$\Rightarrow t = \frac{3mv_0^2}{2P} = \frac{3 \times 1 \times 100 \times 15}{2 \times 1000} = 2.25 \text{ sec.}$$

14. 00001.20

Sol. $M_0 g \sin\theta + f_s = M_0 a$ …(i)

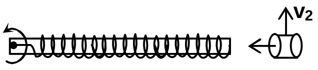
$f_s = Mg \sin\theta$ …(ii)

$$a = \frac{(M_0 + M)g\sin\theta}{M_0}$$

The time in which he gets to the other end of the plank is $\sqrt{\dfrac{2M_0\ell}{(M + M_0)g\sin\theta}}$

15. 00003.60

Sol. For entering without jerk $v_2 = \ell\omega = 2$ m/s



Top View

Using work energy theorem on sleeve after entering in the frame of rod.

$W_{spring} + W_{centrifugal} = \Delta K$

$$-\frac{1}{2}k\ell^2 - \frac{1}{2}m\omega^2\ell^2 = 0 - \frac{1}{2}mv_1^2$$

$$\Rightarrow\ \frac{1}{2}mv_1^2 = \frac{1}{2}k\ell^2 + \frac{1}{2}m\omega^2\ell^2$$

Now $K = \frac{1}{2}m\left(v_1^2 + v_2^2\right) = \frac{1}{2}k\ell^2 + \frac{1}{2}m\omega^2\ell^2 + \frac{1}{2}m\omega^2\ell^2$

= 2 + 1.6 = 3.6 Joule

16. 00005.00

Sol. When the wedge has moved through a distance y, let the point of contact of cylinder have moved down the plane through x (with respect to wedge). Let F be the friction between the cylinder and the plane.

Since there is no horizontal force on (wedge + cylinder system)

$$M\frac{d^2y}{dt^2} + m\left(\frac{d^2y}{dt^2} - \cos\alpha\frac{d^2x}{dt^2}\right) = 0 \qquad \ldots(1)$$

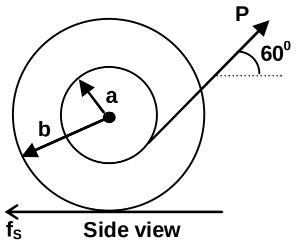
Also, $m\left(\frac{d^2y}{dt^2}\cos\alpha - \frac{d^2x}{dt^2}\right) = F - mg\sin\alpha$ and $\frac{ma}{2}\frac{d^2x}{dt^2} = \frac{ma^2}{2}\frac{d^2\theta}{dt^2} = Fa$, so that

$$2\frac{d^2y}{dt^2}\cos\alpha - 3\left(\frac{d^2x}{dt^2}\right) = -2g\sin\alpha \qquad \ldots(2)$$

Equation (1) and (2) implies acceleration of the centre of the cylinder down the face, and relative to the wedge, is $\frac{2g\sin\alpha(M+m)}{3M+m+2m\sin^2\alpha}$ = 5 m/s^2.

17. 00005.00

Sol. Assume that the drum rolls away from the force P, so that the friction F is away from P. Then :



$$Mk^2\frac{d^2\theta}{dt^2} = Pa - Fb \text{ and } Mb\frac{d^2\theta}{dt^2} = M\frac{d^2x}{dt^2} = F - P\cos 60°$$

$$M\left(k^2 + b^2\right)\frac{d^2\theta}{dt^2} = P\left[a - \frac{b}{2}\right]$$

$$\Rightarrow 0.25 \times 8\frac{d^2\theta}{dt^2} = 10(1.5 - 1)$$

$$\Rightarrow \frac{d^2\theta}{dt^2} = 2.5 \text{ rad/s}^2$$

And the required acceleration = $b\frac{d^2\theta}{dt^2}$ = 2 × 2.5 = 5 m/s^2

18. 00012.00

Sol. $v_0\cos 30° = v\cos 45°$

$$\Rightarrow v = v_0\sqrt{\frac{3}{2}}$$

Now using conservation of energy

$$\frac{1}{2}m(v^2 - v_0^2) = mgh$$

$$\frac{3v_0^2}{2} - v_0^2 = 2gh \qquad \Rightarrow \frac{v_0^2}{2} = 2gh$$

$$\Rightarrow v_0 = \sqrt{4gh} = \sqrt{4 \times 10 \times 3.6} = 12 \text{ m/s}$$

Chemistry

PART – II

SECTION – A

19. A, B, D

Sol. Cathode : H_2, Anode : Cl_2

20. A, B, C

Sol. (D) : LiCl

21. A, B, D

22. A, B, C

Sol. $Mg = [Ne]3s^2$

3 + 0 + 0 = 3

23. A, B, C

Sol.

$$N_2O_4 \rightleftharpoons 2NO_2$$

4 8

$$K_P = \frac{8 \times 8}{4} = 16 \text{ atm}$$

On doubling the volume

$$N_2O_4 \rightleftharpoons 2NO_2$$

$$\frac{4}{2} - x \qquad \frac{8}{2} + 2x$$

$$16 = \frac{(4+2x)^2}{(2-x)}$$

x = 0.4725

24. A, B, C

25. B, C, D

Sol. (A) $CaC_2/Mg_2C_3 + H_2O \rightarrow C_2H_2 / C_3H_4$

(B) $Be_2C / Al_4C_3 + H_2O \longrightarrow CH_4$

(C) R_2SiCl_2

(D) In pyrosilicate one oxygen atom is shared.

26. B, D

Sol. n-Factor of H_3PO_2 is one

$$200\times\frac{1}{3}\times1\neq100\times1\times2$$

$$\text{pH}=7+\frac{1}{2}\times1.2+\frac{1}{2}\log\frac{1}{2}=7.45$$

27. A

28. B

29. C

30. B

SECTION – C

31. 00001.50

Sol.

$$S\longrightarrow K_2SO_4+6e^- \qquad \ldots(1)$$

$$Mn(NO_3)_2+2e^-\longrightarrow K_2MnO_4+2NO \qquad \ldots(2)$$

$$3Mn(NO_3)_2+S\longrightarrow K_2SO_4+3K_2MnO_4+6NO$$

Now balance K by adding 8 KOH on left side.

$$3Mn(NO_3)_2+S+8KOH\longrightarrow K_2SO_4+3K_2MnO_4+6NO+4H_2O$$

$$=\frac{x+y+z}{10}=\frac{3+8+4}{10}=1.5$$

32. 00006.50

Sol.

$$PCl_3+3H_2O\longrightarrow H_3PO_3+3HCl$$

$$0.5 \qquad\qquad 0.5 \qquad 3\times0.5$$

No. of mole of NaOH = 0.5 × 2 + 3 × 0.5 × 1

= 2.5

$$PCl_5+4H_2O\longrightarrow H_3PO_4+5HCl$$

$$0.5 \qquad\qquad 0.5 \qquad 0.5\times5$$

Number of moles of NaOH required = 0.5 × 3 + 0.5 × 5 × 1

= 4

Hence, total mole of NaOH = 2.5 + 4

= 6.5 mol

33. 00000.20

Sol. pH = 5

$[H^+] = 10^{-5}$

$$RH_2 + Ca^{+2}\longrightarrow RCa+2H^+$$

$$\frac{1}{2}\times10^{-5} \qquad\qquad 10^{-5}$$

Wt. of Ca^{+2} in one litre $=\frac{1}{2}\times10^{-5}\times40=2\times10^{-4}$ gram = 0.2 mg

Hence, hardness will be 0.2 ppm.

34. 00019.00

Sol. $2NaOH + CO_2 \longrightarrow Na_2CO_3$

$20\,mm \quad 1\,mm \quad 0$

$18\,mm \quad 0 \quad 1\,mm$

meq. of $NaOH + \frac{1}{2}$ meq. of Na_2CO_3 = meq. of HCl

$18 \times 1 + \frac{1}{2} \times 1 \times 2 = x \times 1,$

x = 19

35. 00000.20

Sol. $A \rightleftharpoons B + C$

$$\alpha = \frac{D - d}{d}$$

$$= \frac{50 - 41.67}{41.67} = 0.2$$

$A \rightleftharpoons B \quad + \quad C$

$1 \quad 0 \quad 0$

$(1-\alpha) \quad 1 \times \alpha \quad 1 \times \alpha$

Hence number of mole of

$= 1 \times 0.2 = 0.2$

36. 00010.45

Sol. $$\frac{49 \times \frac{1}{5} \times 1000}{40} + \frac{49 \times \frac{4}{5} \times 1000}{49} = V \times \frac{1}{10}$$

$V = 10450\text{ ml} = 10.45\text{ litre}$

Mathematics

PART – III

SECTION – A

37. A, B, C, D

Sol. $\because\ 0 \le \int_0^1 (f(x)-x)^2\,dx = \int_0^1 f^2(x)dx - 2\int_0^1 xf(x)dx + \int_0^1 x^2dx$

So, $\int_0^1 f^2(x)dx \ge 2\int_0^1 xf(x)dx - \int_0^1 x^2dx = 2\int_0^1 xf(x)dx - \frac{1}{3}$

$\because\ \int_0^1\left(\int_x^1 f(t)dt\right)dx \ge \int_0^1\left(\frac{1-x^2}{2}\right)dx$

$\Rightarrow \int_0^1 tf(t)dt \ge \frac{1}{3}$

So, $\int_0^1 f^2(x)dt \ge \frac{1}{3}$

38. A

Sol. Putting $x^{\frac{1}{k}} = t$ gives $\int_0^1 (f(t))^{n-k}\ t^{k-1}\ dt = \frac{1}{n}\ \ \forall\ k \in \{1, 2, 3, \ldots.., n-1\}$

So, $\int_0^1 (f(t)-t)^{n-1}dt = \int_0^1\sum_{k=0}^{n-1} {}^{n-1}C_k\,(-1)^k\,(f(t))^{n-1-k}t^k\ dt$

$= \int_0^1\sum_{k=1}^{n} {}^{n-1}C_{k-1}(-1)^{k-1}(f(t))^{n-k}t^{k-1}\ dt$

$= \sum_{k=1}^{n}(-1)^{k-1}\left({}^{n-1}C_{k-1}\right)\int_0^1 (f(t))^{n-k}\cdot t^{k-1}dt$

$= \sum_{k=1}^{n}(-1)^{k-1}\left({}^{n-1}C_{k-1}\right)\frac{1}{n} = \frac{1}{n}(1-1)^{n-1} = 0$

But $(f(t) - t)^{n-1} \ge 0$ as n – 1 is an even positive integer

$\therefore$ f(t) = t $\forall$ t $\in$ [0, 1]

39. A, B, C, D

Sol. $f''(x)\,f'''(x) \le f''(x)\,f(x) < f''(x)\,f(x) + (f'(x))^2\ \forall\ x \in R$

$\Rightarrow \frac{1}{2}(f''(x))^2 < f(x)f'(x)\ \ \forall\ x \in R\ \left(\because \lim_{x\to-\infty}\frac{1}{2}(f''(x))^2 - f(x)f'(x) = 0\right)$

$\frac{1}{2}(f''(x))^2 + \frac{1}{2}f'(x)f'''(x) < f(x)\cdot f'(x) + \frac{1}{2}f'(x)f'''(x) < f(x)\cdot f'(x) + \frac{1}{2}f'(x)f(x)$

$\frac{1}{2}f'(x)f''(x) < \frac{3}{4}f^2(x)\ \ \forall\ x \in R \Rightarrow \frac{1}{2}(f'(x))^2 f''(x) < \frac{3}{4}f^2(x)f'(x)\ \ \forall\ x \in R$

$\Rightarrow \frac{1}{6}f'^3(x) < \frac{1}{4}f^3(x)\ \ \forall\ x \in R \Rightarrow f'(x) < \left(\frac{3}{2}\right)^{\frac{1}{3}} f(x)\ \ \forall\ x \in R$

40. A, B, C

Sol. $\frac{y\cdot y''-(y')^2}{(y')^2}=\frac{(2x-1)(y')^2}{(y')^2}$; $-\int d\left(\frac{y}{y'}\right)=\int(2x-1)dx$

$y=e^{\frac{4x}{2x-1}}$

41. A, B, C, D

Sol. $\int_0^1\left(x-\frac{1}{2}\right)f'(x)dx=\frac{f(1)+f(0)}{2}-\int_0^1 f(x)dx$

Since, $\left|\int_0^1\left(x-\frac{1}{2}\right)f'(x)dx\right|\le\max_{0\le x\le 1}|f'(x)|\int_0^1\left|x-\frac{1}{2}\right|dx\le\frac{1}{4}\max_{0\le x\le 1}|f'(x)|$

42. A, B, D

Sol. $\frac{e^x+e^{-x}}{2}=\sum_{n=0}^{\infty}\frac{x^{2n}}{\lfloor\underline{2n}}\le\sum_{n=0}^{\infty}\frac{x^{2n}}{2^n\lfloor\underline{n}}=e^{\frac{x^2}{2}}\le e^{cx^2}\ \ \forall x\in R\Rightarrow c\ge\frac{1}{2}$

For $c=\frac{1}{e}$, inequality does not hold for x = 1

43. A, B

Sol. (A) Clearly function is differentiable at some of these points
(B) Differentiable $\forall x\in[0,4]$
(C) Not differentiable at x = 2, 5, 8
(D) f(x) is not differentiable at 1

44. A, C

Sol. $\because\ \int_0^a f(x)dx=0$

Put x = at, we get $\int_0^1 f(at)dt=0$

Let $M=\max_{0<x<1}|f'(x)|$

Using LMVT on [a, ax], |f(x) – f(ax)| ≤ (1 – a)xM

Now, $\left|\int_0^1 f(x)dx\right|=\left|\int_0^1(f(x)-f(ax))dx\right|\le(1-a)M\int_0^1 xdx\le\frac{1}{2}(1-a)M$

Equality holds if $f(x)=\pm M\left(x-\frac{a}{2}\right)$

45. D

46. B

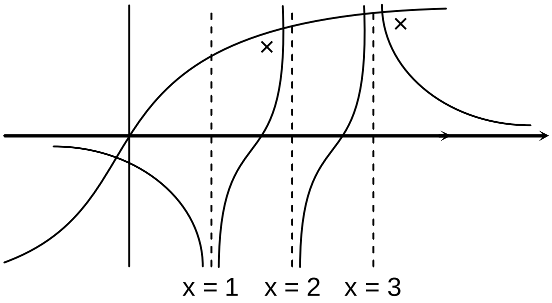
Sol. (45.-46.)
$f_1(x)$ is discontinuous at x = –1 only

$f_2(x)$ is continuous $\forall\ x \in R$
$f_3(x)$ is continuous at $x = 0, \sqrt{3}$ only
$f_4(x)$ is continuous at each irrational number

47. A

48. A

Sol. (47.-48.)
(I) $(x^3 - x + 1)^3 - x^3 + x = 0$
$\Rightarrow f(f(x)) = 0$, where $f(x) = x^3 - x + 1$
which has only one negative solution
(II) $f(x) = x^6 - x^4 + 2x^3 - x^2 + 1$
$= (x^2 - 1)^2(x^2 + 1) + 2x^3 > 0\ \forall\ x > 0$
(III) $\frac{1}{x-1} + \frac{1}{x-2} + \frac{1}{x-3} = x^{\frac{3}{5}}$ has three positive solutions
(IV) $2^x = x^4$, has two positive solutions



SECTION – C

49. 00011.00

Sol. $f(3) = 8$ and $f'(0) = 3$

50. 00001.00

Sol. $f(x) = f(0) + f'(0)x + \frac{f''(0)}{2!}x^2 + \frac{f'''(\alpha)}{3!}x^3$ where $0 \le \alpha \le x$ and

$f(x) = f(2) + f'(2)(x-2) + \frac{f''(2)}{2!}(x-2)^2 + \frac{f'''(\beta)}{3!}(x-2)^3$ where $x \le \beta \le 2$

$\frac{f'''(\alpha)}{6}x^3 = \frac{f'''(\beta)}{6}(x-2)^3 + 2$

Put $x = 1$; $f'''(\alpha) + f'''(\beta) = 12$

So, at least one of $f'''(\alpha)$ and $f'''(\beta)$ is ≥ 6

51. 00000.00

Sol. $\lim\limits_{x\to\infty} f(x) = \frac{f(x)\cdot e^{\frac{x^2}{2}}}{e^{\frac{x^2}{2}}} = \lim\limits_{x\to\infty} \frac{f''(x) + 2xf'(x) + (x^2+1)f(x)}{(x^2+1)}$

So, $\lim\limits_{x\to\infty} f(x) = 0$

52. 00000.00

Sol. Put $g(x) = x^2 + \frac{1}{4}$

$x \in \left[-\frac{1}{2}, \frac{1}{2}\right]$, then $x \le g(x) \le \frac{1}{2}$

Let $x_0 \in \left[-\frac{1}{2}, \frac{1}{2}\right]$ and $x_{n+1} = g(x_n)$ $\forall$ n ≥ 0. The sequence x_n is increasing and bounded above so its limit exists and this limit is $\frac{1}{2}$ (by solving g(l) = l)

By continuity, the constant sequence $\langle f(x_n)\rangle$ tends to $f\left(\frac{1}{2}\right)$ $\Rightarrow$ f is constant over $\left[-\frac{1}{2}, \frac{1}{2}\right]$

53. 00002.00

Sol. Let g(x) = $e^{x/2}$ f(x)
Using Rolle's Theorem, g', g'', g''' have at least 4, 3, 2 distinct real zeroes respectively

54. 00000.50

Sol.
$$\lim_{n\to\infty} \frac{\left(\frac{k}{n^2}\right)^{\frac{k}{n^2}+1}}{\frac{k}{n^2}} = 1 \ \forall\ k \in N \Rightarrow \lim_{n\to\infty} \frac{\sum_{k=1}^{n}\left(\frac{k}{n^2}\right)^{\frac{k}{n^2}+1}}{\sum_{k=1}^{n}\frac{k}{n^2}} = 1 \Rightarrow \lim_{n\to\infty} \sum_{k=1}^{n}\left(\frac{k}{n^2}\right)^{\frac{k}{n^2}+1} = \lim_{n\to\infty} \sum_{k=1}^{n}\frac{k}{n^2} = \frac{1}{2}$$

FIITJEE

ALL INDIA TEST SERIES

PART TEST – I

JEE (Main)-2019-20

TEST DATE: 9-11-2019

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 75 questions.
- Each subject (PCM) has 25 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only three sections: **Section-A**, **Section-B and Section-C**.

  Section-A (01 – 20, 26 – 45, 51 – 70) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

  Section-B (21 – 22, 46 – 47, 71 – 72) *contains 6 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

  Section-C (23 – 25, 48 – 50, 73 – 75) *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. For a particle projected with initial velocity $\vec{u} = 6\hat{i} + 8\hat{j} + 20\hat{k}$, find angular velocity of the particle about the point of projection, at t = 2 sec. (Given $\vec{g} = -10\hat{k}$)

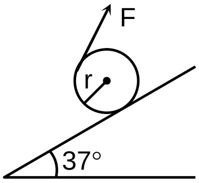
(A) $\frac{1}{5}\hat{i} - \frac{3}{20}\hat{j}$

(B) $-\frac{1}{5}\hat{i} + \frac{3}{20}\hat{j}$

(C) $\frac{\sqrt{2}}{5}\hat{i} - \frac{3\sqrt{2}}{20}\hat{j}$

(D) $\frac{\sqrt{2}}{5}\hat{i} + \frac{3\sqrt{2}}{20}\hat{j}$

2. A solid cylinder of mass 'm' is kept stationary on a fixed incline of 37°, by applying a force tangentially as shown in the figure. Calculate the minimum coefficient of friction that the surface must have in order to achieve equilibrium of the cylinder by applying a force of minimum magnitude.



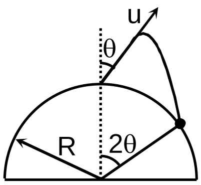
(A) $\frac{3}{4}$

(B) $\frac{3}{8}$

(C) $\frac{3}{16}$

(D) none of these

3. For what value of initial speed u, a projectile launched at θ (from the vertical) from the top point of a hemisphere will land at 2θ angular position(from the vertical) on the hemisphere as shown in the figure.



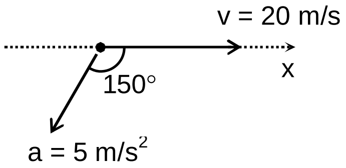
(A) $\sqrt{gR}\cot\theta$

(B) $\sqrt{gR}\frac{\cos^2\theta}{\sin\theta}$

(C) $\sqrt{gR}\cos\theta$

(D) Not possible

4. A particle moving in space with a velocity 20 m/s along positive x-axis starts experiencing a constant acceleration at t = 0 as shown in the figure. The minimum value of the ratio $\frac{R_{min}}{R_{max}}$, where R_{min}/R_{max} is the minimum and maximum radius of curvature of the particle's trajectory for any t > 0 is



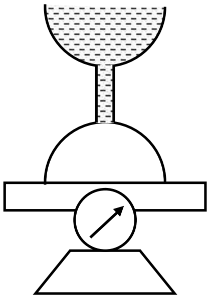
(A) $\frac{1}{8}$

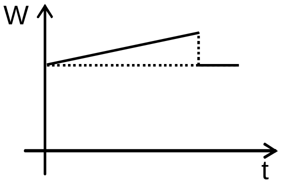
(B) $\frac{1}{6}$

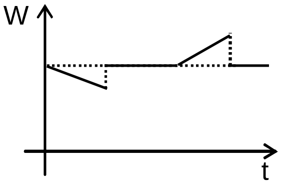
(C) $\frac{1}{5}$

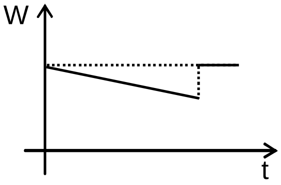
(D) none of these

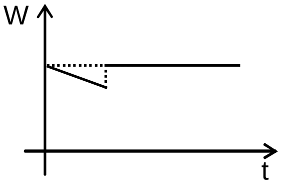
5. An hour glass containing sand is kept on a weighing scale. At t = 0, sand starts falling from upper compartment to lower compartment at constant rate. How will the reading of scale look like when plotted against time.



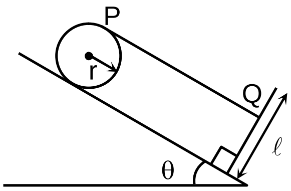
(A)


(B)


(C)


(D)


6. A rod of length 'ℓ' and cylinder of radius 'r' is kept on an incline plane as shown in the figure. The rod is pivoted, while the cylinder can roll without slipping. A light string PQ attaches top of cylinder to some point on the rod such that it is parallel to the incline. The minimum value of radius of cylinder to ensure that the string is taut when the system is released from rest is



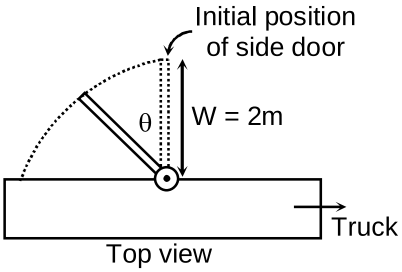
(A) $\frac{2}{5}\ell$

(B) $\frac{21}{50}\ell$

(C) $\frac{4}{9}\ell$

(D) none of these

7. A truck has its side door initially open as shown. The dimension of the door is 2m × 3m (W × ℓ) and its mass is M = 5 kg. At t = 0, the truck starts moving with uniform acceleration a = 5 m/sec^2 as shown in figure (top view). At any time t, if the door makes angle θ with its initial position, then the component of force exerted by hinge on the door along its width is



(A) $\frac{125}{2}\sin\theta$

(B) 250 sin θ

(C) 75 sin θ

(D) none of these

8. For a particle moving in space with velocity $\vec{v}$, which of the following is incorrect.

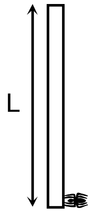
(A) $\left|\frac{d\vec{v}}{dt}\right| \ge \frac{d|\vec{v}|}{dt}$

(B) $\int_0^t |\vec{v}| dt \ge \left|\int_0^t \vec{v} \cdot dt\right|$

(C) $|\Delta\vec{v}| \le \int_{t_1}^{t_2} |\vec{a}|\, dt$

(D) $\frac{d|\vec{v}|}{dt} = \frac{d\vec{v}}{dt} \cdot \left(\frac{\vec{v}}{v}\right)$

9. A stick of length L is dropped from rest. At same instant, an insect starts moving up the stick with a constant speed u relative to the stick. The maximum height attained by the insect from its initial position with respect to the ground is



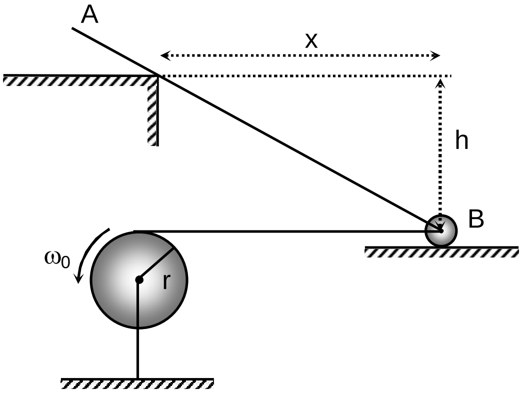
(A) $\frac{u^2}{2g}$

(B) $\frac{u^2}{g}$

(C) $\frac{2u^2}{g}$

(D) none

10. In the arrangement shown, a bar AB is connected through a rotating drum via a massless string which is attached to the end B of the bar. The portion of the rod near end A rests on a horizontal surface. The drum rotates with a uniform angular speed ω_0. The angular speed of bar AB at given position is



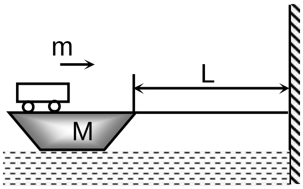
(A) $\frac{\omega_0 rx}{\sqrt{x^2+h^2}}$

(B) $\frac{\omega_0 rh}{(x^2+h^2)}$

(C) $\frac{\omega_0 rh}{\sqrt{x^2+h^2}}$

(D) $\frac{\omega_0 rx}{(x^2+h^2)}$

11. A car of mass m is initially at rest on a boat of mass M and is tied to the shore as shown. The car starts accelerating from rest at t = 0 and acquires a velocity v_0 in time t_0. At $t = t_0$, the car applies brake and comes to rest relative to the boat in no time. Neglect friction between the boat and the water. The time 't' in which the boat strikes the wall is



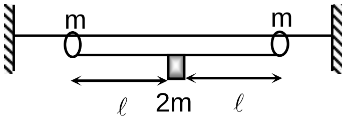
(A) $t_0+\frac{1}{v_0}$

(B) $t_0+\frac{L(M+m)}{mv_0}$

(C) $\frac{LM}{mv_0}$

(D) none of these

12. Two small rings of mass 'm' each are contained to move on smooth wire. The rings are connected to a block of mass '2m' via massless strings of length 'ℓ' each. Initially, the system is held at rest as shown. The velocity of block when string makes 60° with the vertical is



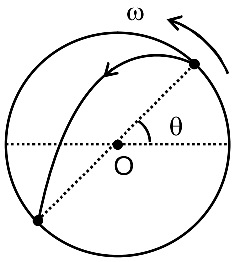
(A) $\sqrt{2g\ell}$

(B) $\sqrt{\frac{3g\ell}{5}}$

(C) $\sqrt{\frac{g\ell}{5}}$

(D) $\sqrt{\frac{3g\ell}{4}}$

13. A spinning drum of radius 'R' with its axis parallel to the ground, carries dust particles deposited on its inner surface. Find minimum angular speed with which drum be rotated so that a dust particle separating from the drum may fall at its diametrical opposite position in space. Assume, sufficient friction present to prevent any relative slipping of dust particle on the drum.



(A) $\sqrt{\frac{g}{2R}}$

(B) $\sqrt{\frac{g}{\sqrt{2}R}}$

(C) $\sqrt{\frac{g}{4R}}$

(D) None of these

14. A particle moves in xy plane. The position vector of particle at any time t is $\vec{r} = \left\{(2t)\hat{i} + (2t^2)\hat{j}\right\}$ m.

The rate of change of θ at t = 2 sec, where θ is the angle made by the velocity vector from the positive x-axis, is

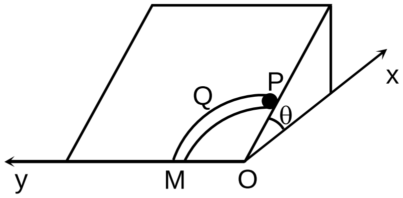
(A) $\frac{1}{14}$ rad/sec

(B) $\frac{2}{17}$ rad/sec

(C) $\frac{4}{7}$ rad/sec

(D) $\frac{6}{5}$ rad/sec

15. A circular groove PQM of radius R is cut in an inclined plane as shown. A small ball of mass m is released form P. The magnitude of the displacement of wedge by the time ball reaches M is (θ = 60°, R = 1m, m = 2kg, M = 3kg)



(A) $\sqrt{5}$ m

(B) $\sqrt{\frac{1}{5}}$ m

(C) $\sqrt{\frac{17}{5}}$ m

(D) none of these

16. A man is rotating a stone of mass 10 kg tied at the end of a light rope in a circle of radius 1m. To do this, he continuously moves his hand in a circle of radius 0.6 m. Assume, both circular motions to be occurring in the same horizontal plane. What is the maximum speed with which he can throw the stone, if he can exert a pull not exceeding 1250 N on the string.

(A) $10\sqrt{2}$ m/s

(B) $5\sqrt{5}$ m/s

(C) 10 m/s

(D) 20 m/s

17. A man of mass m while jumping up in the air applies a force F = F_0 cos ωt on the ground. Assume, that he remains in contact with the ground from t = 0 to t = $\frac{\pi}{2\omega}$ sec.

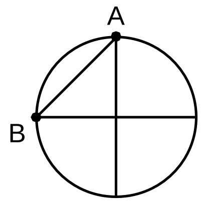
(A) Velocity of man during take off $\left(t = \frac{\pi}{2\omega}\right)$ is less than $\frac{F_0}{m\omega}$

(B) Man is producing peak power at the instant of take off.

(C) The average power produced by man is zero.

(D) The ratio of power produced at t = $\frac{\pi}{8\omega}$ and $t = \frac{3\pi}{8\omega}$ is more than 1.

18. Two beads A and B of equal mass 'm' are connected by a light string. The beads are positioned to move on a smooth ring in a vertical plane as shown in the figure. The tension in the string just after release is



(A) $\sqrt{2}$ mg

(B) $\frac{mg}{2}$

(C) $\frac{mg}{4}$

(D) $\frac{mg}{\sqrt{2}}$

19. A particle A is fixed at the origin of a fixed coordinate system. B is another particle that experiences a force $\vec{F} = \left(-\frac{2\alpha}{r^3} + \frac{\beta}{r^2}\right)\hat{r}$ due to particle A, where $\vec{r}$ is the position vector of B with respect to A. Find the work done in moving particle B slowly from $P_1\left(\sqrt{2}r_0, \sqrt{2}r_0\right)$ to point $P_2\left(\frac{r_0}{\sqrt{2}}, \frac{r_0}{\sqrt{2}}\right)$ by an external agent, where r_0 is the equilibrium position of the particle.

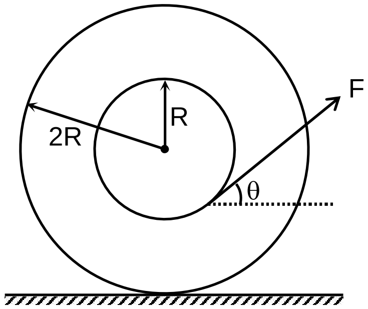
(A) $\frac{9\beta^2}{64\alpha}$

(B) $\frac{\beta^2}{16\alpha}$

(C) $-\frac{\beta^2}{16\alpha}$

(D) $-\frac{9\beta^2}{64\alpha}$

20. A spool of mass 'm' has inner and outer radius R and 2R respectively. A thread is wound on the inner disc and its free end is pulled with a force F at an angle θ with the horizontal in the direction as shown in the figure. Assume no slipping condition for thread and the spool and $I_{cm} = 2mR^2$, then



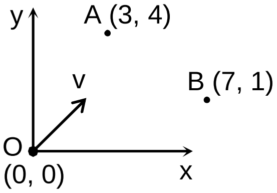
(A) For $0 \le \theta \le 90°$, frictional force acts leftward only.
(B) For $0 \le \theta \le 60°$, it acts leftward and for $60° \le \theta \le 90°$ it acts rightward.
(C) For a certain θ between 0° and 90° friction becomes zero.
(D) none of these

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

21. Two men A and B of mass M and 2M are standing 120° apart on a circular platform of mass 4M and radius R. The platform is free to rotate about its centre, while men are standing at periphery. Now men interchange their position with respect to disc by walking along periphery only. If Δθ represents magnitude of angle rotated by platform with respect to the ground, find the ratio $\frac{\Delta\theta_{max}}{\Delta\theta \min}$.

22. A(3 m, 4 m) and B(7 m, 1 m) are two coins on a carrom board. The striker is placed at origin O. If the striker can be shot with a speed of 5 m/sec, then find the minimum time (in sec) taken by striker to become collinear with coin A and B.

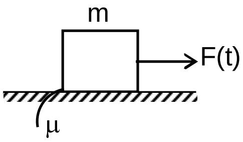


SECTION – C
(Numerical Answer Type)

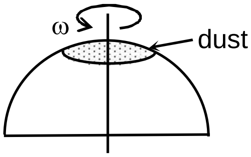
This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

23. The resultant of two vectors $\vec{A} = 5\hat{i}$ and $\vec{B}$ is $\vec{R}$. The direction of $\vec{R}$ is such that it makes an angle $\frac{\pi}{6}$ with the positive x-axis in anticlockwise sense. Find the magnitude of $\vec{R}$ when $\vec{B}$ has minimum magnitude. (Take $\sqrt{3} = 1.732$)

24. A block of mass m = 4 kg is kept on a rough surface of $\mu = 0.25$. At t = 0, an external force F(t) that varies linearly with time starts acting on the block. The force acts for a duration of 8 sec only and F(t = 8) = 0 N. If the block starts moving at t = 2 sec and finally stops at t = 11 sec, then find the time (in sec) instant when velocity acquired by the block is maximum.



25. A hemisphere of radius R = 0.5 m is rotated with a uniform angular speed $\omega = \sqrt{10}$ rad/sec for some time. The hemisphere is then stopped and it was found that only 20% of its top surface area remained covered with dust particles. Find the coefficient of friction between the particles and the hemisphere.



Chemistry

PART – II

SECTION – A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

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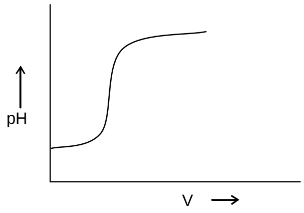
26. The geometry around each iodine in dinuclear anion $\left[I_2(OH)_2O_8\right]^{4-}$ is:
    (A) Octahedral
    (B) Monocapped octahedral
    (C) Square pyramidal
    (D) Pentagonal bipyramidal

27. Amongst Zn, Ga, Ge and As the element with the lowest first I.E. is:
    (A) As
    (B) Zn
    (C) Ga
    (D) Ge

28. The magnetic property of which molecule changes if we assume s – p mixing is not operational for all given molecules:
    (A) N_2
    (B) F_2
    (C) O_2
    (D) C_2

29. Consider the following reversible reaction; $A(g) + 2B(g) \rightleftharpoons AB_2(g) \quad K_c = \frac{1}{2}$.
    The above equilibrium is established in a 1 L flask and at equilibrium 2 moles of each A and B are present. If 2.0 moles of B are added further how many moles of AB_2 should be added so that moles of A does not change?
    (A) 6
    (B) 8
    (C) 10
    (D) 12

30. During titration of acetic acid with aq. NaOH solution, the neutralization graph has a vertical line. This line indicates:



    (A) Neutral nature at equivalence point
    (B) Acidic nature at equivalence point
    (C) Depends on experimental proceedings
    (D) Alkaline nature at equivalence point

31. Which is the poorest reducing agent?
(A) Nascent hydrogen
(B) Atomic hydrogen
(C) Dihydrogen
(D) All have same reducing strength

32. For which of the following reactions, the degree of dissociation cannot be calculated from the V.D. data:
I. $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$
II. $2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$
III. $2NO(g) \rightleftharpoons N_2(g) + O_2(g)$
IV. $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
(A) I and III
(B) II and IV
(C) I and II
(D) III and IV

33. On dissolving moderate amount of sodium metal in liquid NH_3 at low temperature, which of the following does not occur?
(A) Blue coloured solution is obtained.
(B) Na^+ ions reformed in the solution.
(C) Liquid ammonia solution becomes good conductor of electricity.
(D) Liquid ammonia solution becomes diamagnetic.

34. Consider the following statements about carbon suboxide
I. It is a linear molecule.

II. It is an optically active cumulene.

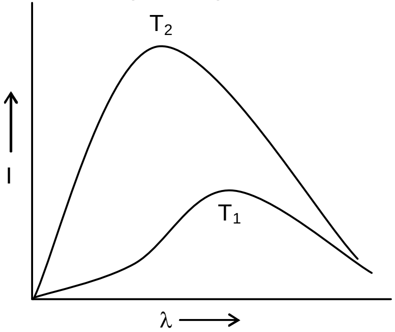
III. The total number of σ bonds, π bonds and lone pair in the compound are 12.
The correct statement is/are:
(A) I and II
(B) II and III
(C) I and III
(D) All of the above

35. In the compound M – O – H, the M – O bond will be broken if:
(A) ΔE.N. of M and O < ΔE.N. of O and H
(B) ΔE.N. of M and O = ΔE.N. of O and H
(C) ΔE.N. of M and O > ΔE.N. of O and H
(D) Cannot be predicted by ΔE.N. data

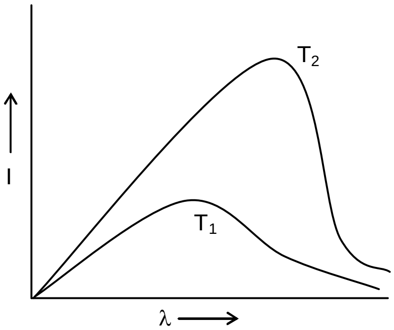
36. Choose the INCORRECT statement:
(A) Amorphous solids are short range orders
(B) Amorphous solids are anisotropic in nature
(C) Crystalline solids have definite heat of fusion
(D) Crystalline solids are true solids

37. The correct observed curve for a backbody at different temperature representing intensity wavelength relation is: ($T_2 > T_1$)

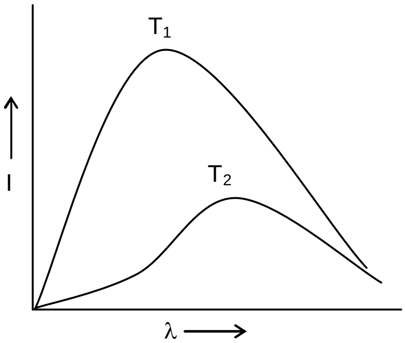
(A)



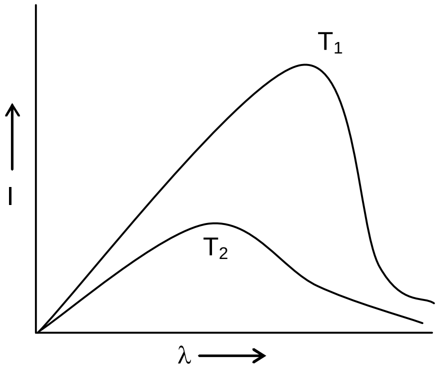
(B)



(C)

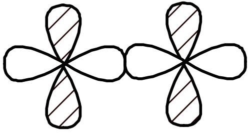


(D)



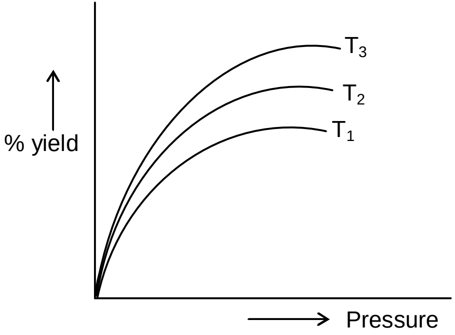
38. The oxidation state of sulphur in the product/(s) of the reaction of S_8 in basic medium is/are:
(A) +2 and +6
(B) - 2 and +6
(C) - 2 and +2
(D) - 2 only.

39. The orbital overlapping in the figure results in:



(A) d – d π antibonding
(B) d – d σ bonding
(C) d – d σ antibonding
(D) d – d π bonding

40. The preparation of SO_3(g) by reaction $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$ is an exothermic reaction following temperature – pressure relationship for its % yield, for temperatures (T_1, T_2 and T_3) the correct option is:



(A) $T_3 > T_2 > T_1$
(B) $T_1 = T_2 = T_3$
(C) $T_1 > T_2 > T_3$
(D) Not enough information.

41. The existence of a solid compound in more than one modification is known as:
(A) Isomorphism
(B) Allotropy
(C) Amorphism
(D) Polymorphism

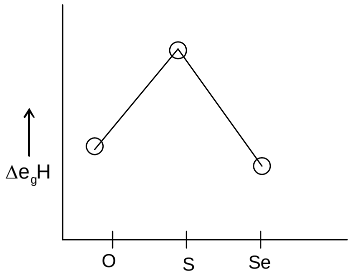
42. The INCORRECT statement amongst the following is:
(A) Boron has unusually high melting point due to strong crystalline lattice.
(B) In group 13, the compound with +1 O.S. are more ionic than with +3.
(C) Aluminium dissolves in dil. HCl to liberate H_2 whereas H_2 is not liberated when it reacts with NaOH.
(D) Aluminium chloride in acidified aqueous solution forms $\left[Al(H_2O)_6\right]^{+3}$ ion.

43. Pick out the correct statement:
(A) $\frac{r^+Cs^+}{r^+Cl^-} = 0.536$.
(B) High temperature increases coordination number.
(C) Presence of excess Li^+ in LiCl develops violet colouration.
(D) Greater is the number of F-centres, greater is the intensity of colour developed.

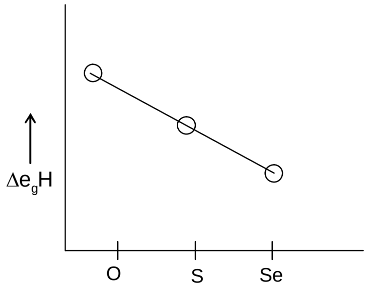
44. The INCORRECT order is:
    (A) Covalent character: $PbCl_2 > CaCl_2 > SrCl_2 > BaCl_2$
    (B) Thermal stability: $PbF_4 > PbCl_4 > PbBr_4 > PbI_4$
    (C) Melting point: KF > KCl > KBr > KI
    (D) Boiling point: $CHCl_3 > CH_3Cl > CCl_4$

45. The correct graph representing the electron gain enthalpy of chalcogens is: ($\Delta e_g H$ is released energy)

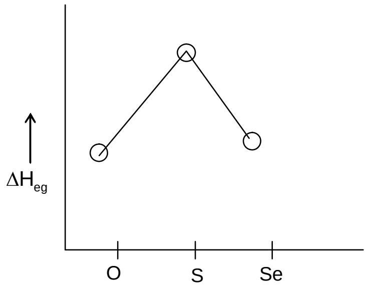
(A)



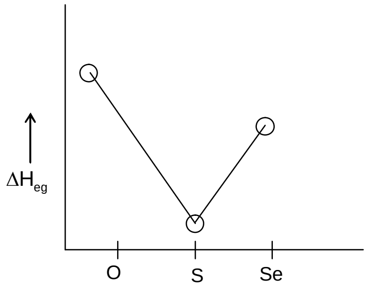
(B)



(C)



(D)



SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

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46. The radial distribution curve of the orbital with double dumbshell shape in the fourth principal shell consists of 'n' nodes, n is:

47. After balancing the given reaction:

$$Ca_5(PO_4)_3F + SiO_2 + C \longrightarrow aP_4 + bCaF_2 + cCaSiO_3 + dCO$$

The value of [d – (a + b + c)] is:

SECTION – C

(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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48. Equal volumes of 0.02 M $AgNO_3$ and 0.02 M HCN were mixed. If $[Ag^+]$ at equilibrium is $x \times 10^{-5}$, calculate x. Take $K_a(HCN) = 9 \times 10^{-10}$ and $K_{sp}(AgCN) = 4 \times 10^{-16}$.

49. The ratio of distances of nearest neighbours in BCC lattice by next to next nearest in FCC lattice is:

50. The concentration of oxalic acid is ‘X’ mol L^{-1}. 40 ml of this solution react with 16 mL of 0.05 M acidified $KMnO_4$. What is the pH of ‘X’ M solution? Assume oxalic acid dissociates completely: (log2 = 0.3010).

Mathematics PART – III

SECTION – A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

51. Let $\lambda = \int_0^1 \frac{dx}{1+x^3}$, $\beta = \lim_{n\to\infty}\left[\frac{\prod_{r=1}^{n}\left(n^3+r^3\right)}{n^{3n}}\right]^{\frac{1}{n}}$, then log β is equal to

(A) $\log 2 - 1 + \lambda$
(B) $\log 2 - 3 + 3\lambda$
(C) $2\log 2 - \lambda$
(D) $\log 4 - 3 + 3\lambda$

52. $\int \frac{x\cos\alpha + 1}{\left(x^2+2x\cos\alpha+1\right)^{\frac{3}{2}}}dx$ is equal to

(A) $\frac{x}{\sqrt{x^2+2x\cos\alpha+1}}+c$
(B) $\frac{-x\cos\alpha}{\sqrt{x^2+2x\cos\alpha+1}}+c$
(C) $\frac{2x}{\sqrt{x^2+2x\cos\alpha+1}}+c$
(D) $\frac{2x\cos\alpha}{\sqrt{x^2+2x\cos\alpha+1}}+c$

53. $f(x)=\frac{[x]+1}{\{x\}+1}$ for $f:\left[0,\frac{5}{2}\right)\to\left(\frac{1}{2},3\right]$ (where [.] denotes the greatest integer function and {.} represents fractional part of x), then which of the following is true?

(A) f(x) is many-one discontinuous function
(B) $\min\left(\lim_{x\to1^-} f(x), \lim_{x\to1^+} f(x)\right) = f(1)$
(C) f(x) is surjective differentiable function every where
(D) f(x) is injective function

54. Let f(x) be a decreasing function defined on (0, ∞). If $f(2a^2+a+1) < f(3a^2-4a+1)$, then the range of a is

(A) $a > 1$ or $a < \frac{1}{3}$
(B) $a \in (0, 5)$
(C) $a > \frac{1}{3}$
(D) $a \in \left(0,\frac{1}{3}\right)\cup(1, 5)$

55. Let f: R → R be a function such that f(0) = 1 and for $x, y \in R$, $f(xy + 1) = f(x)\cdot f(y) - f(y) - x + 2$ holds (where [.] denotes the greatest integer function). Then which is the correct option?

(A) $\lim\limits_{x\to 1^+} [f(x)] = 1$

(B) $\lim\limits_{x\to 2^+} [f(x)] = 2$

(C) $\lim\limits_{x\to 0^-} [f(x)] = 0$

(D) $\lim\limits_{x\to 0^-} [f(x)] = 1$

56. Tangent are drawn to the curve y = cos x from the origin. Then the point of contact lies on the curve $x^2 - y^2 = ax^2y^2$. This value of 'a' is equal to

(A) –1

(B) $\frac{1}{2}$

(C) 1

(D) 2

57. If the curve $y = x^2 + ax + b$ and $y = cx - x^2$ touch each other at (1, 0). Then the area bounded by the curve $y = x^2 + ax + b$ with x-axis is

(A) $\frac{2}{3}$

(B) $\frac{5}{6}$

(C) $\frac{1}{3}$

(D) $\frac{1}{6}$

58. Number of solutions of $\int\limits_0^x \frac{dt}{\sqrt{4-t^2-t^3}} = x$ in (0, 1) is/are

(A) 1

(B) 2

(C) 3

(D) none of these

59. It is given that there are two sets of real numbers $A = \{a_1, a_2, ..., a_{100}\}$ and $B = \{b_1, b_2, ..., b_{50}\}$. Total number of onto functions 'f' from A to B such that $f(a_1) \le f(a_2) \le f(a_3) \le ..... \le f(a_{100})$ is/are

(A) ${}^{100}C_{50}$

(B) ${}^{99}C_{50}$

(C) ${}^{100}C_{49}$

(D) ${}^{99}C_{51}$

60. $\lim\limits_{x\to 0^+} \left(\left(x^{x^x}\right) - x^x\right)$ is equal to

(A) 0

(B) 1

(C) –1

(D) does not exist

61. If for all x, y the function f is defined by $f(x) + f(y) + f(x) \cdot f(y) = 1$ and $f(x) > 0$, f(x) is differential everywhere, then
(A) $f'(0) > f'(1)$
(B) $f'(x) = 0$ for all x
(C) $f'(0) < f'(1)$
(D) none of these

62. If $f(x) = 1 + \sum_{n=1}^{\infty} \frac{x^n}{n!}(\log a)^n$, then at x = 0, f(x)
(A) has no limit
(B) is discontinuous
(C) is continuous but not differentiable
(D) is differentiable

63. $\lim_{n\to\infty} \cos\left(\pi\sqrt{n^2+n}\right)$, $n \in Z$ is equal to
(A) 0
(B) 1
(C) –1
(D) does not exist

64. n/m means that n is a factor of m, then the relation ‘ / ’ is
(A) reflexive and symmetric
(B) transitive and reflexive
(C) transitive and symmetric
(D) equivalence

65. If f: R → R is a continuous function satisfying f(0) = 1 and $f(3x) - f(x) = x \ \forall \ x \in R$ and $\lim_{n\to\infty} f(x) - f\left(\frac{x}{3^n}\right) = P(x)$, then which of the following is correct?
(A) $P(\pi) = \pi$
(B) $P(e) = \frac{3e}{2}$
(C) P(5) = 10
(D) P(11) = 5.5

66. The value of $\int_0^{\infty} \frac{dx}{(1+x^3)(1+x^2)}$ is equal to
(A) $\frac{\pi}{3}$
(B) $\frac{\pi}{2}$
(C) $\frac{\pi}{6}$
(D) $\frac{\pi}{4}$

67. Let f(x) be a real valued differentiable function defined for all $x \geq 1$ such that $f'(x) = \frac{1}{x^2 + f(x)^4}$ and f(1) = 1, then

(A) $\lim\limits_{x\to\infty} f(x) < 1+\frac{\pi}{4}$

(B) $\lim\limits_{\lambda\to\infty} f(x) > 1+\frac{\pi}{4}$

(C) $\lim\limits_{x\to 0} f(x) > 1-\frac{\pi}{4}$

(D) we can't say

68. If α and β the roots of the equation $x^2 + t^2x - 2t = 0$, $I(t) = \int\limits_{-1}^{2}\left[\left(x+\frac{1}{\alpha^2}\right)\left(x+\frac{1}{\beta^2}\right)+\frac{1}{\alpha\beta}\right]dx$, then

(A) $I(t) = \frac{3t^2}{8}+\frac{3}{4t^2}+3$

(B) $I(t) = \frac{3t^2}{8}-\frac{3}{4t^2}+3$

(C) $I(t) = -\frac{3t^2}{8}+\frac{3}{4t^2}-3$

(D) $I(t) = -\frac{3t^2}{8}+\frac{3}{4t^2}+3$

69. Let $\lim\limits_{x\to 0^+} f(x) = 24$ and $\lim\limits_{x\to 0^-} f(x) = 3$. If $\lim\limits_{x\to 0} f(2x^2 - x^3) = \lambda \lim\limits_{x\to 0} f(x^6 - x^2)$, then λ is equal to

(A) 27
(B) 21
(C) 12
(D) none of these

70. Let f: (0, ∞) → (0, ∞) be a differentiable surjective function and F(x) is the anti-derivative of f(x) such that $2(F(x) - f(x)) = f^2(x)$ for $\forall\ x \in R^+$, then

(A) $\lim\limits_{x\to\infty} \frac{f(x)}{x} = 2$

(B) $\lim\limits_{x\to\infty} \frac{f(x)}{x} = 1$

(C) f(x) is strictly decreasing function

(D) can't say

SECTION – B

(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

71. Let $M_n = \{0.a_1a_2 \ldots\ldots a_n$, such that $a_i = 0, 1$, for $1 \le i \le n - 1$, $a_n = 1\}$, be a set of decimal fractions, T_n and S_n be the number and sum of the elements of M_n respectively, then $\lim\limits_{n\to\infty} \frac{54S_n}{T_n}$ is equal to

72. Let area bounded by the parabola $y^2 + 4y = 4x$ and $y = mx + m - 2$ is 9 sq. units, then value of $|9m|$ is equal to

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. xxxxx.xx).

---

73. The number of non-zero integral values of 'a' for which the function $f(x) = x^4 + ax^3 + \frac{27x^2}{2} + 1$ is concave upward for $\forall\ x \in R$

74. Let f(x) = ax + cos 2x + sin x + cos x is defined for $\forall\ x \in R$ and $a \in R$, f(x) is strictly increasing function the range of a is $\left[\frac{\alpha}{2}, \infty\right)$, then α is

75. Let $\int_0^1 \left(2x^2 - 3f(x)\right)f(x)dx = \frac{1}{15}$ and $\int_0^1 f(x)dx = \frac{1}{k}$, then k is equal to

FIITJEE

ALL INDIA TEST SERIES

PART TEST – I

JEE (Main)-2019-20

TEST DATE: 9-11-2019

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

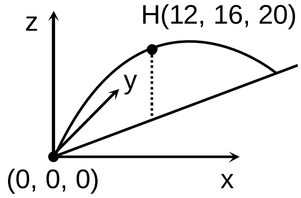
1. B

Sol. Particle will be at H_{max} at t = 2

$$H_{max} = \frac{20 \times 20}{2 \times 10} = 20\text{m}$$

$$\vec{r}_H = 12\hat{i} + 16\hat{j} + 20\hat{k};\ |\vec{r}| = 20\sqrt{2}$$

$$\vec{v}_H = 6\hat{i} + 8\hat{j}$$



$$\vec{\omega} = \frac{\vec{r} \times \vec{v}}{|\vec{r}|^2} = \frac{-160\hat{i} + 120\hat{j}}{\left(20\sqrt{2}\right)^2} = -\frac{1}{5}\hat{i} + \frac{3}{20}\hat{j}$$

2. B

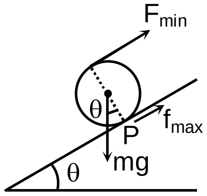
Sol. Force when applied parallel to plane will have minimum magnitude.
Torque about P;

F(2r) = mg sinθ × r

$$\therefore\ F_{min} = \frac{mg\sin\theta}{2} \qquad \text{....(i)}$$

Also, F + f_{max} = mg sin θ ....(ii)

$$\therefore\ \mu = \frac{\tan\theta}{2} = \frac{3}{8}$$



3. C

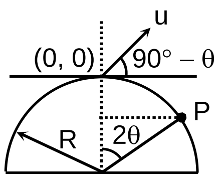
Sol. Coordinates of P [(R sin 2 θ, – R (1 – cos 2θ)]

$$y = x\tan(90-\theta) - \frac{1}{2}g\frac{x^2}{\left[u\cos(90-\theta)\right]^2}$$

$$-R\left[1-\cos 2\theta\right] = R\sin 2\theta\frac{\cos\theta}{\sin\theta} - \frac{1}{2}g\frac{R^2\sin^2 2\theta}{u^2\sin^2\theta}$$

$$-2\sin^2\theta = 2\cos^2\theta - \frac{1}{2}g\frac{R4\sin^2\theta\cos^2\theta}{u^2\sin^2\theta}$$

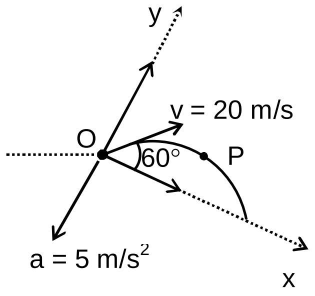
$$\frac{2gR\cos^2\theta}{u^2} = 2 \Rightarrow u = \sqrt{gR}\cos\theta$$



4. D

Sol. Particle will describe a parabolic path as shown
After long time $R_{max} \to \infty$

$$\therefore \frac{R_{min}}{R_{max}} = 0.$$



5. B

Sol. Till first sand particle touches lower compartment of hourglass, weight will decrease, then it becomes constant, when last sand particle leave upper compartment it increases.

6. C

Sol. $a_Q > a_P$

$$\frac{3g\sin\theta r}{\ell} > \frac{4}{3}g\sin\theta$$

$$\Rightarrow r > \frac{4\ell}{9}$$

7. A

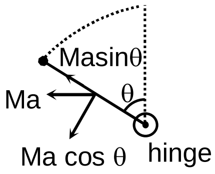
Sol. MI of door about hinge : $\frac{Mw^2}{3}$

Using : $\tau = I\alpha$

$$Ma\left(\frac{w}{2}\right)\cos\theta = \frac{Mw^2}{3}\alpha$$

$$\alpha = \frac{3}{2}\frac{a}{w}\cos\theta$$

$$\omega\frac{d\omega}{d\theta} = \frac{3}{2}\frac{a}{w}\cos\theta$$



$$\Rightarrow \omega^2 = \frac{3a}{w}\sin\theta$$

For circular motion of CM of door;

$$R_H - Ma\sin\theta = M\omega^2\left(\frac{w}{2}\right)$$

$$\therefore R_H = Ma\sin\theta + \frac{3}{2}Ma\sin\theta = \frac{5}{2}Ma\sin\theta = \frac{125}{2}\sin\theta$$

8. C

Sol. Use the definition of kinematics variables.

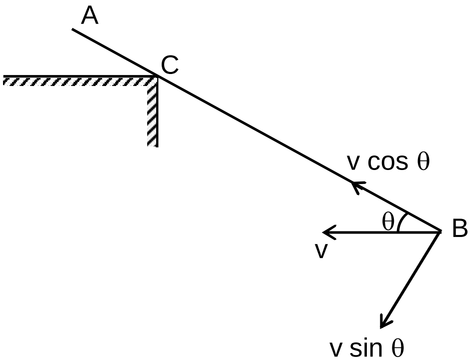
9. A

Sol. $\vec{v}_{\text{insect}} = (u - gt)\hat{j}$, $v = 0$ at $t = \frac{u}{g}$

$$\therefore\ y_{\text{max}^2} = \int_0^{u/g} v\,dt = \int_0^{u/g} (u - gt)\,dt = \frac{u^2}{2g}$$

10. B

Sol. $\omega_{A/B} = \omega_{C/B} = \frac{v\sin\theta}{CB} = \frac{\omega_0 rh}{(x^2 + h^2)}$



11. B

Sol. $mv_0 = (M + m)v'$

$$v' = \frac{mv_0}{M + m}$$

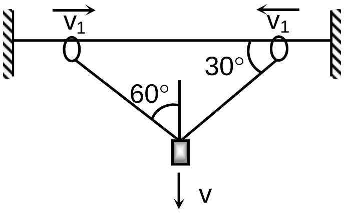
$$t = t_0 + \frac{L(M + m)}{mv_0}$$

12. D

Sol. $2mg\frac{\ell}{2} = \frac{1}{2}(2m)v^2 + 2 \times \frac{1}{2}mv_1^2$ …(i)

$v_1 \cos 30° = v \cos 60°$ …(ii)

Solving $v = \sqrt{\frac{3g\ell}{4}}$



13. B

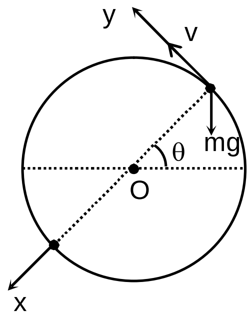
Sol. $v = \omega R$ …(i)

$mg \sin\theta = \frac{mv^2}{R}$ …(ii)

for motion after separation

$T = \frac{2V}{g\cos\theta}$ …(iii)

$2R = \frac{1}{2} g\sin\theta\left(\frac{2V}{g\cos\theta}\right)^2$ …(iv)



$gR\frac{\cos^2\theta}{\sin\theta} = Rg\sin\theta \Rightarrow \theta = 45°$

$\therefore \omega^2 R = \frac{g}{\sqrt{2}}$ or $\omega=\sqrt{\frac{g}{\sqrt{2}R}}$

14. B

Sol. $\vec{v}(t) = 2\hat{i} + (4t)\hat{j}$

$\therefore \tan\theta = 2t$

$\frac{d\theta}{dt} = \frac{2}{\sec^2\theta} = \frac{2}{17}\text{rad / sec} \ \ (\text{at } t = 2\,\text{sec})$

15. B

Sol. Centre of mass of wedge and ball will not shift in x-y plane

Let wedge displacement be $x\hat{i} + y\hat{j}$

$\vec{S}_r = (-R\cos\theta)\hat{i} + R\hat{j}$

$\therefore\ m\left[(x - R\cos\theta)\hat{i} + (y + R)\hat{j} + M(x\hat{i} + y\hat{j})\right] = 0$

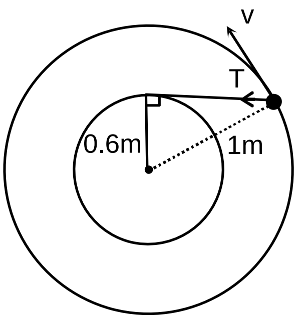
$x = \frac{mR\cos\theta}{m+M}$; $y = -\frac{mR}{m+M}$

$\vec{S}_w = \frac{1}{5}\hat{i} - \frac{2}{5}\hat{j}$

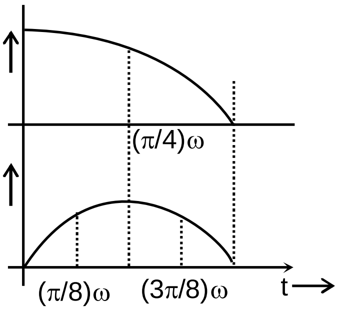
16. C

Sol. $T\cos\theta = \frac{mv^2}{R}$

$\Rightarrow\ v = \sqrt{\frac{TR\cos\theta}{m}} = 10\text{ m/s}$



17. A



Sol. $a = \frac{F_0}{m}\cos\omega t$

$v = \frac{F_0}{m\omega}\sin\omega t$

$\therefore$ peak power at $t = \frac{\pi}{4\omega}$.

Ratio of power is 1

Also $\int_0^{\pi/2\omega}(F - mg)dt = mv$

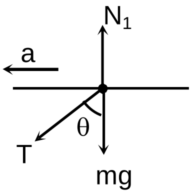
$v = \frac{F_0}{m\omega} - \frac{g\pi}{2\omega}$

18. D

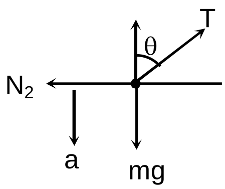
Sol. $T\sin\theta = ma$ …(i)

$mg - T\cos\theta = ma$

$T = \frac{mg}{\sin\theta + \cos\theta} = \frac{mg}{\sqrt{2}}$ $(\theta = 45^o)$



Bead A



Bead B

19. B

Sol. $W_{ext} = \int \vec{F}_{ext} d\vec{r} = \int_{r_i}^{r_f}\left(\frac{2\alpha}{r^3} - \frac{\beta}{r^2}\right)dr$

$= \left[-\frac{\alpha}{r^2} + \frac{\beta}{r}\right]_{2r_0}^{r_0}$

$W_{ext} = -\frac{3\alpha}{4r_0^2} + \frac{\beta}{2r_0}$

Also, at equilibrium; F = 0 $\Rightarrow r_0 = \frac{2\alpha}{\beta}$

$\therefore W_{ext} = \frac{\beta^2}{4\alpha} - \frac{3\alpha\beta^2}{4\times 4^{a^2}} = \frac{\beta^2}{16\alpha}$

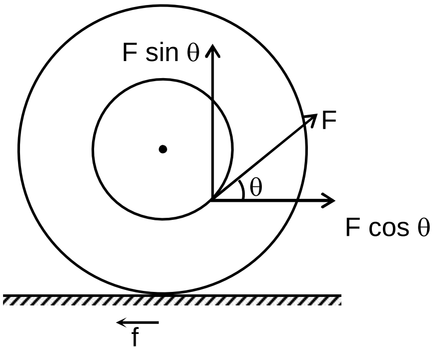
20. A

Sol. $F\cos\theta - f = ma_C$ …(ii)

$f(2R) - FR = 2mR^2\alpha$ …(ii)

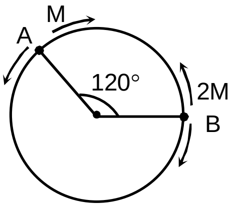
$a_C = \alpha 2R$ …(iii)

$\therefore f = \frac{F}{3}(1 + \cos\theta) \Rightarrow$ always leftward.



SECTION – B

21. 5



Sol. A and B can swipe their position by walking clockwise / anticlockwise
For $\Delta\theta_{max}$: A should turn 120° (clockwise) while B should turn 240°(clockwise)
Conserving angular momentum about C:

$$MR^2(120° - \theta) + 2MR^2(240° - \theta) + \frac{4MR^2}{2}(-\theta) = 0$$

$\Rightarrow \theta = 120°$

For $\Delta\theta_{min}$: A should turn 120° clockwise, B should turn 120° anticlockwise

$$\theta_{min} = \frac{120°}{5}$$

$$\therefore \frac{\theta_{max}}{\theta_{min}} = 5$$

22. 1

Sol. For t_{min}, striker should be shot perpendicular to line AB

$$AB = \sqrt{(3-7)^2 + (4-1)^2} = 5 \text{ m}$$

$$\therefore \frac{1}{2} \times h \times AB = \frac{1}{2}|\overrightarrow{OA} \times \overrightarrow{OB}|$$

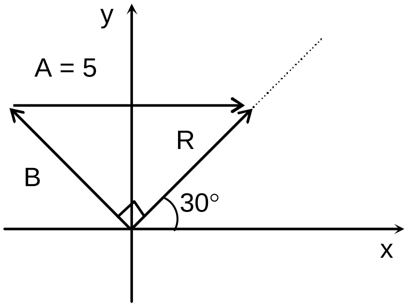
$$\frac{5h}{2} = \frac{1}{2}\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 4 & 0 \\ 7 & 1 & 0 \end{vmatrix}$$

$\Rightarrow$ h = 5 m

$\therefore t_{min}$ = 5/5 = 1 sec

SECTION – C

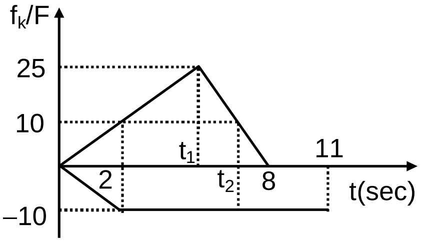
23. 00004.33



Sol. From triangle;

R = 5 cos 30° = $\frac{5\sqrt{3}}{2}$

24. 00006.80



Sol. $f_{max} = 0.25 \times 4 \times 10 = 10$ N

Net impulse is zero in 11 sec

$\Rightarrow I_f = I_F$

$\Rightarrow \frac{1}{2} \times 8 \times F_{max} = 100$

$F_{max} = 25$N

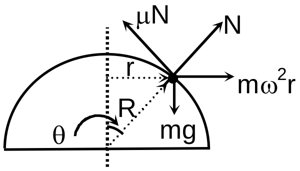
From similar triangle

$$\frac{25}{t_1} = \frac{10}{2} \Rightarrow t_1 = 5\,\text{sec}$$

Block will acquire V_{max} at t = t_2 where

$$\frac{25}{3} = \frac{10}{(8 - t_2)} \Rightarrow t_2 = 6.8\,\text{sec}$$

25. 00001.35



Sol. Given : $\frac{2\pi}{2\pi}(1 - \cos\theta) = 0.2$

$\Rightarrow \cos\theta = 0.8$

From FBD of dust particle:

$N = mg\cos\theta - m\omega^2 r\sin\theta$ …(i)

$\mu N = mg\sin\theta + m\omega^2 r\cos\theta$ …(ii)

$$\therefore\ \mu = \frac{g\sin\theta + \omega^2 r\cos\theta}{g\cos\theta - \omega^2 r\sin\theta} = 1.35$$

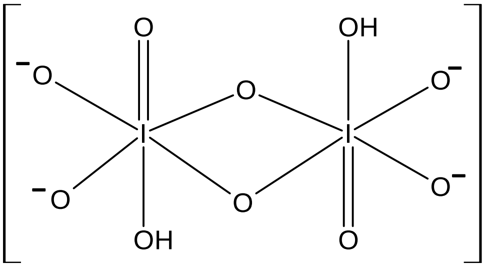
Chemistry

PART – II

SECTION – A

26. A

Sol.



27. C

Sol. $Zn = 906 \text{ kJ mol}^{-1}$

$Ga = 579 \text{ kJ mol}^{-1}$

$Ge = 761 \text{ kJ mol}^{-1}$

$As = 947 \text{ kJ mol}^{-1}$

28. D

Sol. $C_2(12) \rightarrow \text{actual} \rightarrow \sigma1s^2\sigma^*1s^2\sigma2s^2\sigma^*2s^2\pi2p_x^2 = \pi2p_y^2$

Diamagnetic

If s – p is not operational.

$\sigma1s^2\sigma^*1s^2\sigma2s^2\sigma^*2s^2\sigma2p_z^2\pi2p_x^1 = \pi2p_y^1$

paramagnetic

29. D

Sol. $A(g) + 2B(g) \rightleftharpoons AB_2(g)$

$$K_c = \frac{1}{2} = \frac{[AB_2]}{[A][B]^2}$$

$$\Rightarrow \frac{1}{2} = \frac{[AB_2]}{2(2)^2} \Rightarrow AB_2 = 4 \text{ moles}$$

Now, B = 4 moles

Let y moles of AB_2 is added.

$$\frac{1}{2} = \frac{(4+y)}{2\times(4)^2}$$

$\therefore y = 12$

30. D

31. C

Sol. $\frac{1}{2}H_2 \longrightarrow H^+ + e^-$
Takes B.E. for dissociation to H and then oxidizes slow.
Fact by NCERT.

32. A

Sol. $\Delta n_g = 0$ in I and III.
$\therefore$ Same moles at equilibrium as before.

33. D

Sol. $$\underset{(x+y)}{Na + \text{Liq. } NH_3} \longrightarrow \left[Na(NH_3)_x\right]^+ + \left[e(NH_3)_x\right]^-$$
Blue coloured and paramagnetic in nature.

34. C

Sol. O = C = C = C = O
→ Linear
→ Optically inactive
→ $4\sigma, 4\pi$ and 4 lone pair.

35. C

Sol. ΔE.N. , more polarity.

36. B

37. A

Sol. If $T_2 > T_1$
$\therefore$ At high E → Intensity increases and λ decreases.
(Reference – NCERT)

38. C

Sol. $$S_8(s) + 12\overset{-}{O}H(aq) \longrightarrow \underset{(-2)}{4S^{-2}}(aq) + \underset{(+2)}{2S_2O_3^{-2}}(aq) + 6H_2O(\ell)$$

39. B

Sol. Both d-orbitals have axial overlapping in same phase forming σ bonds.

40. C

Sol. For exothermic reaction, increase in temperature decreases yield.

41. D

42. C

Sol. Al reacts with both acid and base to liberate H_2.

43. D

Sol. (A) $\frac{r^+Cs^+}{r^+Cl^-} = 0.732$.

(B) High temperature decreases coordination temperature.

(C) LiCl has pink colour.

44. D

45. C

Sol. $\Delta e_g H \to O \to -141$

$S \to -200$

$Se \to -195$

$\therefore S > Se > O$

SECTION – B

46. 1

Sol. Double dumb shell confirms the graph touches x-axis only once.
$\therefore$ 1 node.

47. 7

Sol. $4Ca_5\left(PO_4\right)_3F + 18SiO_2 + 30C \longrightarrow 3P_4 + 2CaF_2 + 18CaSiO_3 + 30CO$

SECTION – C

48. 00006.67

Sol. After mixing [AgCN] = 0.01 M, [HCN] = 0.01 M

$HCN \rightleftharpoons H^+ + CN^- \qquad K_a$

$\underline{Ag^+ + CN^- \rightleftharpoons AgCN(s)} \qquad 1/K_{sp}$

$Ag^+ + HCN \rightleftharpoons H^+ + AgCN(s) \qquad K = \frac{K_a}{K_{sp}} = 2.25 \times 10^6$

$0.01 \quad 0.01 \quad - \quad -$

$x \quad x \quad 0.01 - x \quad 0.01 - x$

$K = \frac{0.01 - x}{x^2}$ since x is small w.r.t. 0.01

$$K = \frac{0.01}{x^2}$$

$$\therefore x = 6.6 \times 10^{-5}\ M = \left[Ag^+\right]$$

49. 00000.71

Sol. Nearest in BCC $\frac{\sqrt{3}a}{2}$; Next to next nearest $= \sqrt{\frac{3}{2}}a$ in FCC

$$\therefore \text{Ratio } = \frac{\sqrt{3}a \times \sqrt{2}}{2 \times \sqrt{3}a} = \frac{1}{\sqrt{2}} = 0.71$$

50. 00001.30

Sol. (Oxalic) $N_1V_1 = N_2V_2$ ($KMnO_4$)
M × 40 × 2 = 0.05 × 16 × 5

$$M = \frac{0.05 \times 16 \times 5}{40 \times 2} = 0.05$$

pH = - log (0.05)
=1.3

Mathematics PART – III

SECTION – A

51. B

Sol. $\log\beta = \int_0^1 \log(1+x^3)\,dx = \log 2 - 3 + \int_0^1 \frac{3}{1+x^3}\,dx = \log 2 - 3 + 3\lambda$

52. A

Sol. Put x + cos α = sin α tan θ

$$\int \frac{x\cos\alpha + 1}{(x^2 + 2x\cos\alpha + 1)^{\frac{3}{2}}}\,dx = \int(\cot\alpha\sin\theta + \cos\theta)\,d\theta = -\cot\alpha\cos\theta + \sin\theta + c$$

$$= \frac{x}{\sqrt{x^2 + 2x\cos\alpha + 1}} + c$$

53. D

Sol. $f(x) = \begin{cases} \frac{1}{x+1} & ; \quad 0 \le x < 1 \\ \frac{2}{x} & ; \quad 1 \le x < 2 \\ \frac{3}{x-1} & ; \quad 2 \le x < \frac{5}{2} \end{cases}$ f(x) is discontinuous and bijective function

$\lim_{x\to 1^-} f(x) = \frac{1}{2}; \ \lim_{x\to 1^+} f(x) = 2$ and f(1) = 2

54. D

Sol. $f(2a^2 + a + 1) < f(3a^2 - 4a + 1)$

$\Rightarrow 2a^2 + a + 1 > 3a^2 - 4a + 1$

$\Rightarrow a \in (0, 5)$

Also, $2a^2 + a + 1 > 0$ and $3a^2 - 4a + 1 > 0$, we get $a < \frac{1}{3}$ or $a > 1$

So, $a \in \left(0, \frac{1}{3}\right) \cup (1, 5)$

55. C

Sol. f(xy + 1) = f(x) f(y) – f(y) – x + 2 ..... (1)

f(xy + 1) = f(x) f(y) – f(x) y + 2 ..... (2)

Thus, f(x) + y = f(y) + x

Put y = 0, we get f(x) = x + 1

56. C

Sol. Let the point of contact be (α, cos α), then $\frac{y - \cos\alpha}{x - \alpha} = -\sin\alpha$

$\Rightarrow$ –cot α = α, then, we get a = 1

57. D

Sol. $1 + a + b = 0$

$c - 1 = 0 \Rightarrow c = 1$

Also, $\frac{dy}{dx} = c - 2x\Big|_{x=1} = -1$

$\frac{dy}{dx} = 2x + a\Big|_{x=1} = -1$

$\Rightarrow a = -3;\ b = 2$

Area bounded by $y = x^2 + ax + b$ with x-axis

$$\Rightarrow \left|\int_1^2 (x^2 - 3x + 2)dx\right| = \left|\left(\frac{x^3}{3} - \frac{3x^2}{2} + 2x\right)\right|_1^2 = \frac{1}{6}$$

58. D

Sol. Let $f(x) = \int_0^x \frac{dt}{\sqrt{4 - t^2 - t^3}} - x$

$f'(x) = \frac{1}{\sqrt{4 - x^2 - x^3}} - 1 < 0 \quad \forall\ x \in (0, 1)$

$\Rightarrow$ f(x) is decreasing in (0, 1)

Also, $f(0) = 0$

$\Rightarrow f(x) < 0\ \forall\ x \in (0, 1)$

$\Rightarrow$ No solution

59. B

Sol. Let first x_1 elements of set A maps with b_1 and next x_2 elements maps with b_2 and so on last x_{50} elements maps with b_{50}

$\Rightarrow x_1 + x_2 + ... + x_{50} = 100$

Number of positive integral solutions = ${}^{99}C_{49}$

60. C

Sol. $\lim_{x \to 0^+} x^x = 1$

61. B

Sol. Put y = x, we get $2f(x) + (f(x))^2 = 1$

Differentiate w.r.t to x, we get $2f'(x) + 2f(x)f'(x) = 0$

$\Rightarrow f'(x)\,(1 + f(x)) = 0$

$\Rightarrow f'(x) = 0$, because $f(x) > 0$

62. D

Sol. $f(x) = \sum_{n=0}^{\infty} \frac{(x\log a)^n}{n!} = e^{x\log a} = a^x$

$f(x) = a^x$ always continuous and differentiable

63. A

Sol. $\cos\pi\sqrt{n^2+n} = (-1)^n \cos\left(n\pi - \pi\sqrt{n^2+n}\right)$

$\lim\limits_{n\to\infty} n - \sqrt{n^2+n} \Rightarrow -\frac{1}{2}$

$\lim\limits_{n\to\infty} \cos\left(\pi\sqrt{n^2+n}\right) = (-1)^n \cos\frac{\pi}{2} = 0$

64. B

Sol. ‘ / ‘ is reflexive since every natural number is a factor of itself
‘ / ‘ is transitive. If n is a factor of m and m is a factor of P, then surely n is a factor of P
‘ / ‘ is not symmetric, for example 2 is a factor of 4 but 4 is not a factor of 2

65. D

Sol. f(3x) – f(x) = x

$\Rightarrow$ Replace x by $\frac{x}{3}$, we get

$f(x) - f\left(\frac{x}{3}\right) = \frac{x}{3}$

$f\left(\frac{x}{3}\right) - f\left(\frac{x}{9}\right) = \frac{x}{9}$

....

....

$f\left(\frac{x}{3^{n-1}}\right) - f\left(\frac{x}{3^n}\right) = \frac{x}{3^n}$

Adding, we get $f(x) - f\left(\frac{x}{3^n}\right) = x\left(\frac{1}{3} + \frac{1}{9} + \frac{1}{27}.....\right)$

$\lim\limits_{n\to\infty} f(x) - f\left(\frac{x}{3^n}\right) = \frac{x}{2}$

$P(x) = \frac{x}{2}$

66. D

Sol. $I = \int_0^\infty \frac{dx}{(1+x^3)(1+x^2)}$ ..... (1)

Put x = $\frac{1}{t}$

$I = \int_0^\infty \frac{x^3}{(1+x^3)(1+x^2)}dx$ ..... (2)

Adding equation (1) and (2), we get

$2I = \int_0^\infty \frac{dx}{1+x^2} = \frac{\pi}{2}$

$I = \frac{\pi}{4}$

67. A

Sol. $f'(x) = \frac{1}{x^2 + f(x)^4} < \frac{1}{x^2+1}$

$\Rightarrow \int_1^x f'(x) < \int_1^x \frac{dx}{1+x^2}$

$\Rightarrow f(x) < \tan^{-1} x - \frac{\pi}{4} + f(1)$

$\Rightarrow f(x) < \tan^{-1} x + 1 - \frac{\pi}{4}$

68. A

Sol. $I(t) = \int_{-1}^{2} \left[x^2 + \left(\frac{t^2}{4} + \frac{1}{t} \right) x + \left(\frac{1}{4t^2} - \frac{1}{2t} \right) \right] dx = \frac{3t^2}{8} + \frac{3}{4t^2} + 3$

69. D

Sol. $\lim_{x\to 0} f\left(2x^3 - x^2\right) = \lim_{x\to 0^+} f(x) = 24$

$\lim_{x\to 0} f\left(x^6 - x^2\right) = \lim_{x\to 0^-} f(x) = 3$

$\Rightarrow \lambda = 8$

70. B

Sol. $2(F(x) - f(x)) = f^2(x)$

and $\frac{dF}{dx} = f(x)$

$F'(x) = f'(x)(1+f(x))$

$\Rightarrow f'(x) = \frac{f(x)}{1+f(x)}$

$\lim_{x\to\infty} f(x) \to \infty$

As f(x) is increasing surjective function

$\lim_{x\to\infty} \frac{f(x)}{x} = 1$

SECTION – B

71. 3

Sol. The frequency of $a_i = 1$ is the same as that of $a_i = 0$ for $1 \le i \le n - 1$ and $a_n = 1$, then

$S_n = \frac{1}{2} \times 2^{n-1} \times \left(\frac{1}{10} + \frac{1}{10^2} + ... + \frac{1}{10^{n-1}} \right) + 2^{n-1} \times \frac{1}{10^n}$

$\lim_{n\to\infty} \frac{S_n}{T_n} = \lim_{n\to\infty} \left[\frac{1}{18}\left(1 - \frac{1}{10^{n-1}}\right) + \frac{1}{10^n} \right] = \frac{1}{18}$

72. 6

Sol. Area bounded by $y^2 = 4x$ and $y = mx$ is $\frac{8}{3m^3}$

$\Rightarrow \left|\frac{8}{3m^3}\right| = 9 \Rightarrow m = \pm\frac{2}{3}$

SECTION – C

73. 00012.00

Sol. $f''(x) = 12x^2 + 6ax + 27 \geq 0$
$\Rightarrow a \in [-6, 6]$

74. 00004.25

Sol. $f'(x) = a - 2\sin 2x + \cos x - \sin x = a + 2(\cos x - \sin x)^2 + (\cos x - \sin x) - 2$

Minimum values of $2(\cos x - \sin x)^2 + (\cos x - \sin x) - 2$ is $-\frac{17}{8}$

So, $a - \frac{17}{8} \geq 0$ for increasing function

$\therefore\ a \geq \frac{17}{8}$

75. 00009.00

Sol. $\int_0^1 \left\{\frac{x^4}{9} - \left(\frac{x^2}{3} - f(x)\right)^2\right\} dx = \frac{1}{45}$

$\Rightarrow f(x) = \frac{x^2}{3} \Rightarrow \int_0^1 f(x)\,dx = \frac{1}{9}$

FIITJEE

ALL INDIA TEST SERIES

PART TEST – II

JEE (Advanced)-2020

PAPER – 1

TEST DATE: 17-11-2019

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B.**

1. ***Section-A (01– 7, 19 – 25, 37 – 43)*** *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect option is selected.

   Section-A (08 – 13, 26 – 31, 44 – 49) *contains 18 questions. Each of 2 Tables with 3 Columns and 4 Rows has three questions. Column 1 will be with 4 rows designated (I), (II), (III) and (IV). Column 2 will be with 4 rows designated (i), (ii), (iii) and (iv). Column 3 will be with 4 rows designated (P), (Q), (R) and (S). Each multiple choice question with 4 options has* ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section–B (14 – 18, 32 – 36, 50 – 54)*** *contains 15 Numerical based questions with answers as numerical value from 0 to 9 and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

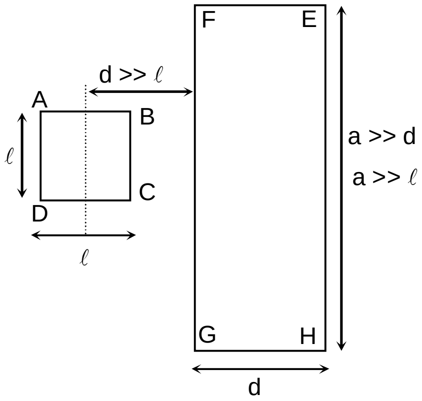
Physics

PART – I

SECTION – A
(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A square conducting loop ABCD and a rectangular conducting loop EFGH are placed on the same plane as shown in the figure. The loop ABCD is placed symmetrically with respect to EFGH such that its central line is at a distance d from the loop EFGH. Side length 'ℓ' of small loop ABCD is much smaller than the length 'a' and width 'd' of the bigger loop EFGH. A source is applied on loop ABCD, such that it sets up a current I = kt in it. Here k is a positive constant and t is time. Then choose the correct option(s).



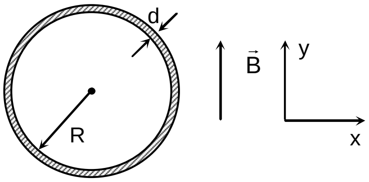
(A) If the current in the loop ABCD is in clockwise sense then the induced current in the loop EFGH due to this current is in anticlockwise sense.

(B) If the current in the loop ABCD is in clockwise sense then the induced current in the loop EFGH due to this current is in clockwise sense.

(C) emf induced in the loop EFGH due to current in the loop ABCD is $\frac{\mu_0 \ell^2 k}{4\pi d}$.

(D) emf induced in the loop EFGH due to current in the loop ABCD is $\frac{3\mu_0 \ell^2 k}{4\pi d}$.

2. A thin walled non-magnetic spherical shell with wall thickness d and radius R (R >> d) is placed in a uniform magnetic field $\vec{B} = B_0\hat{j}$, which slowly changes as $\frac{dB_0}{dt} = \alpha$, where α is a positive constant. Electrical resistivity of the material of the shell is ρ.
Then choose the correct option(s).



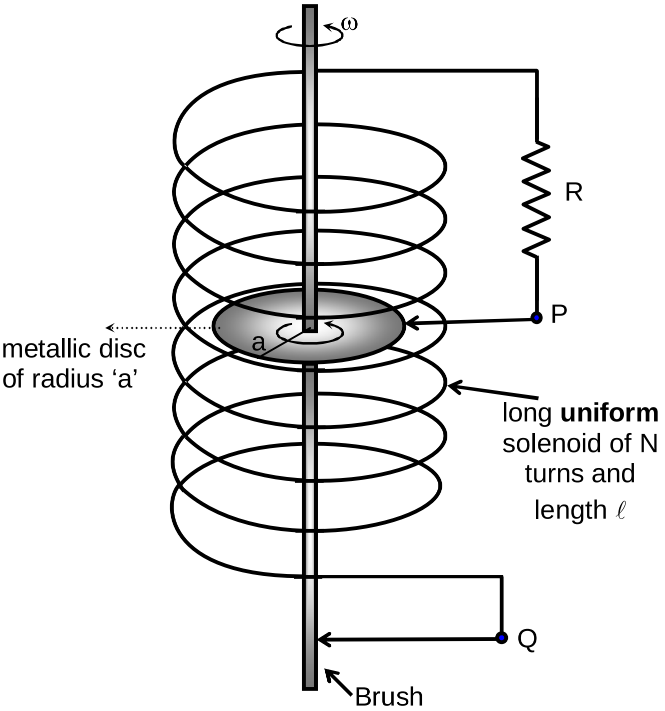
(A) Induced magnetic moment of the shell is towards $+\hat{j}$ direction

(B) Induced magnetic moment of the shell is towards $-\hat{j}$ direction

(C) Induced magnetic moment of the shell is $\frac{3\pi}{2\rho}dR^4\alpha$

(D) Induced magnetic moment of the shell is $\frac{2\pi}{3\rho}dR^4\alpha$

3. A metallic disc of radius 'a' mounted on a rigid axle is rotating with a constant angular velocity ω inside a long solenoid of inductance L whose two ends are connected to the rotating disc by two brush contacts as shown. The total resistance of the whole circuit is R. Then


ω
R
P
a
metallic disc of radius 'a'
long **uniform** solenoid of N turns and length ℓ
Q
Brush

(A) The induced emf between terminals P and Q is $\frac{\mu_0 N i \omega a^2}{2\ell}$, when current in the coil is i.

(B) Current in the coil can increase or decrease with time depending upon the value of ω.

(C) ω_{min} for increasing the current in the coil always is $\frac{\ell R}{2\mu_0 N a^2}$

(D) ω_{min} for increasing the current in the coil always is $\frac{2\ell R}{\mu_0 N a^2}$

4. A solenoid of radius r is made of thin metallic wire rings with resistance of each ring R. The rings have been put in a uniform way on a very long glass cylinder which has vacuum inside it. The solenoid and glass cylinder are glued to each other. The number of rings per unit length is n and the planes containing the rings are perpendicular to the symmetry axis of the cylinder. At a moment the cylinder starts rotating around its symmetry axis with an angular acceleration α. The magnetic field B at the centre of the cylinder (after a long time) is ($\frac{e}{m}$ is specific charge of electron).

(A) $\frac{\mu_0 n m r^2 \alpha}{eR}$

(B) $\frac{\pi \mu_0 n m r^2 \alpha}{eR}$

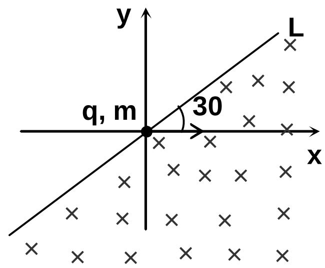
(C) $\frac{2\pi \mu_0 n m r^2 \alpha}{eR}$

(D) $\frac{4\pi \mu_0 n m r^2 \alpha}{eR}$

5. During the melting of a slab of ice at 273 K at the atmospheric pressure.
   (A) Positive work is done by the ice-water system on the atmosphere.
   (B) Positive work is done on the ice-water system by the atmosphere.
   (C) The internal energy of the ice-water system increases.
   (D) The internal energy of the ice-water system decreases.

6. An electric dipole having dipole moment $\vec{P} = \left(3\hat{i} + 4\hat{j}\right) \times 10^{-9}\,\text{Cm}$ is placed in a uniform electric field $\vec{E} = \left(-60\hat{i} - 80\hat{j}\right)$ N/C.
   (A) Electric field applies zero net force on the dipole
   (B) Electric field energy of the dipole in the electric field is -5×10^{-7} J.
   (C) The dipole is in stable equilibrium in the electric field.
   (D) The dipole is in unstable equilibrium in the electric field.

7. A charged particle of charge q and mass m is entering at origin with a velocity $v\hat{i}$ in a uniform magnetic field $-B\hat{k}$ which is extended upto infinite at right of the line L. Select the correct option(s)
   Given that $\frac{mv}{qB} = 1$ meter. and v = 1 m/s.

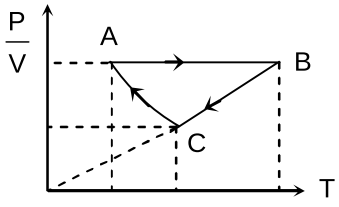


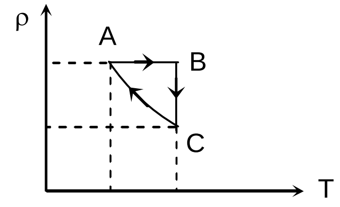
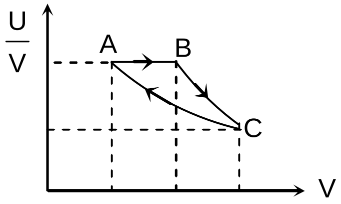
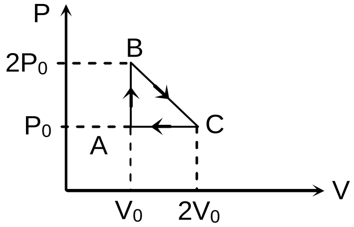
   (A) Velocity of the particle makes an angle 60° with x-axis while it is coming out of the magnetic field.
   (B) The co-ordinates of point of exit is $\left(\frac{1}{2}\text{m}, \frac{\sqrt{3}}{2}\text{m}\right)$
   (C) The co-ordinates of point of exit is $\left(\frac{\sqrt{3}}{2}\text{m}, \frac{1}{2}\text{m}\right)$.
   (D) Time spent by the particle in the magnetic field is $\frac{\pi}{3}$ sec.

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer questions 8, 9 and 10 by appropriately matching the information given in the three columns of the following table.

<table>
<tr><td colspan="6">Here P, V, T ρ, U have usual meaning of pressure, volume, temperature, density and Internal energy of gas.</td></tr>
<tr><th colspan="2">Column – 1</th><th colspan="2">Column – 2</th><th colspan="2">Column – 3</th></tr>
<tr><td>(I)</td><td>
CA – Rectangular Hyperbola</td><td>(i)</td><td>$W_{AB} > 0$</td><td>(P)</td><td>$\Delta U_{AB} > 0$</td></tr>
</table>

(II)	 CA – Rectangular Hyperbola	(ii)	$W_{AB} < 0$	(Q)	$\Delta U_{BC} = 0$
(III)	 CA – Rectangular Hyperbola	(iii)	$W_{BC} > 0$	(R)	$\Delta U_{AB} < 0$
(IV)		(iv)	$W_{CA} < 0$	(S)	$\Delta U_{CA} < 0$

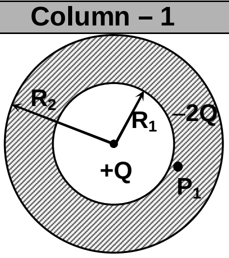
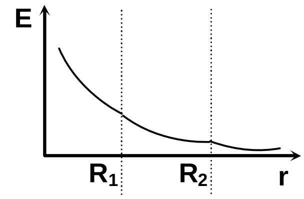
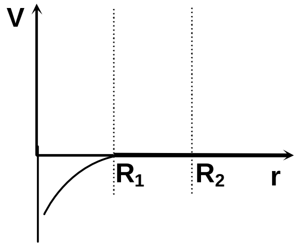
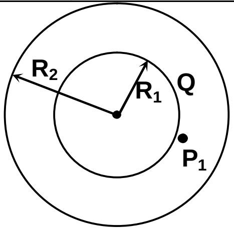
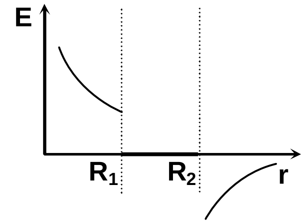
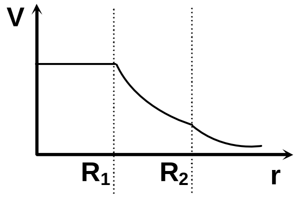
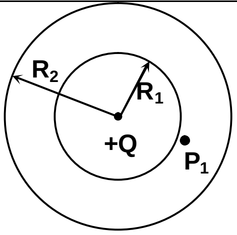
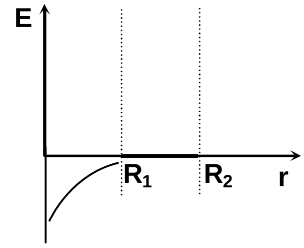
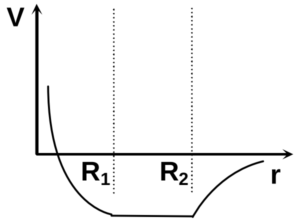
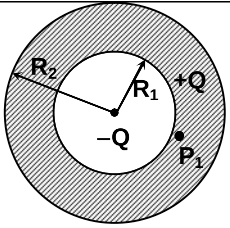
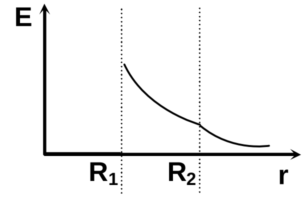
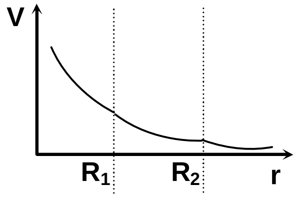
8. In a cyclic process W_{AB} and ΔU_{AB} are both non zero values and have same sign.
(A) (I) (ii) (R)
(B) (II) (i) (P)
(C) (III) (i) (P)
(D) (IV) (ii) (R)

9. In a cyclic process ΔQ_{BC} must be positive.
(A) (I) (iii) (Q)
(B) (II) (iii) (Q)
(C) (III) (iii) (Q)
(D) (IV) (iii) (Q)

10. In a cyclic process, $\Delta W_{\text{any path}} + \Delta U_{\text{any path}} < 0$ (any path means any of AB or BC or CA)
(A) (I) (ii) (R)
(B) (II) (iv) (S)
(C) (III) (iv) (S)
(D) (IV) (i) (R)

Answer questions 11, 12 and 13 by appropriately matching the information given in the three columns of the following table.

Column –1 is having charged systems, Column –2 is having variation of electric field for any charged system of column –1 and Column –3 is having variation of electric potential (taking potential at infinity to be zero) for any charged system of column –1

Column – 1		**Column – 2**		**Column – 3**	
(I)	 Point charge at center = Q and charge on thick conducting shell = –2Q	(i)		(P)	
(II)	 Two thin conducting shell, out of which inner shell is having charge Q and outer shell is uncharged	(ii)		(Q)	
(III)	 Two thin uncharged conducting shell and Point charge at centre = Q	(iii)		(R)	
(IV)	 Point charge at center = –Q, Charge on thick conducting shell = +Q	(iv)		(S)	

In each charged system Q = 1 μC, R_1 = 10 cm, R_2 = 20 cm. Each of the shells or spheres are conducting. Variation of electric field and potential is given as a function of radial distance r. point P_1 in each figure is at distance $r = R_1 + \delta$ (where $\delta \to 0$)

11. Electric field at point P_1 is $900\frac{KV}{m}$ for a charged system. Choose the correct option for that charged system.
(A) (III) (i) (Q)
(B) (III) (iv) (S)
(C) (II) (iv) (Q)
(D) (II) (i) (P)

12. Electric potential of a conducting shell (thin or thick) is –45 KV for a charged system. Choose the correct option for that charged system.
(A) (I) (ii) (R)
(B) (I) (ii) (P)
(C) (III) (i) (R)
(D) (III) (i) (P)

13. Electrical potential energy stored in outside space (from $r = R_2$ to $(r \to \infty)$ is 2.25×10^{-2}J
(A) (I) (ii) (Q)
(B) (II) (iv) (S)
(C) (III) (i) (P)
(D) (III) (i) (S)

SECTION – B
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

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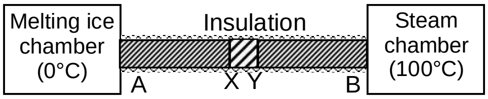
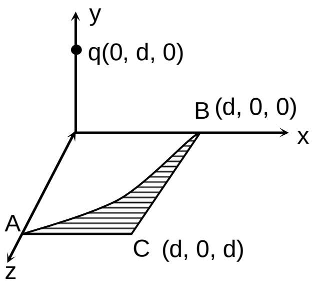
14. A conducting rod is initially at 0°C temperature. Now one end A is kept at melting ice chamber (0°C) and the other end B is kept at steam chamber (100°C). The surface of the rod is well insulated from the outer environment so that heat is only flowing along the length of the rod as shown is the figure.



The cross-sectional area of the rod is 1 cm^2 and length of the rod is 1 m. Thermal conductivity of the rod is 500 W/m-K. Density of the rod is 8000 kg/m^3. Specific heat capacity of the rod is 500 J/kg-K. A small cylindrical element xy (of length 1 cm and cross-sectional area same as that of rod) is examined. It is observed that temperature gradient of the end X is 5°C/m and average temperature of xy part of the rod is rising at 0.05°C/sec. What is the temperature gradient (in °C/m) of end Y of the element?

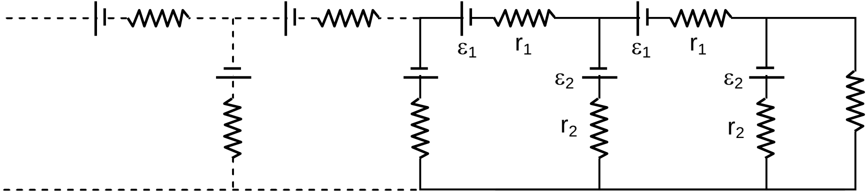
15. A point charge $q = 8.85 \times 10^{-9}$ C is placed at (0, d, 0) where d = 1m. An insulating surface ABCA is on the x-z plane, which is bounded by a quarter circle AB and two equal length straight line BC and CA as shown in the figure. Electric flux through the surface ABCA in Nm^2/C is (nearest integer)

Take $\varepsilon_0 = 8.85 \times 10^{-12} \frac{C^2}{Nm^2}$

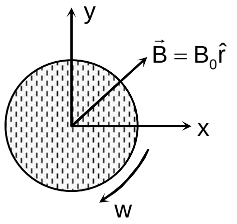


16. Chandrayan-1, the lunar mission launched by India in 2008, had all gold wiring. A particular instrument on board the mission, was operating at the same temperature as the space surrounding the Chandrayan at 3 K. Instrument specifications demanded that no wire in the instrument should offer a resistance more than 7 mΩ. All the instruments on Chandrayan were fabricated in ISRO lab at room temperature of 30°C. If the radius of all wires in the instrument was 0.1 mm (as measured in ISRO lab). If the maximum allowable length (as measured in ISRO lab) of any wire is approximately ℓ meter then find $\frac{1}{\ell}$. $\left(\text{Take } \pi = \frac{22}{7}\right)$. (Assume that resistivity and length of gold wire change linearly with temperature)
You can use these properties of gold.
- Resistivity at room temperature $\rho = 2.2 \times 10^{-8}$ Ωm
- Temperature coefficient of resistivity $\beta = 0.0032\ K^{-1}$
- Linear thermal expansion coefficient $\alpha = 1.5 \times 10^{-5}\ K^{-1}$.

17. The network shown consists of an infinite number of cells of emf ε_1 and ε_2 with corresponding internal resistances r_1 and r_2 respectively A resistor R = 1Ω is connected to the end of the network. If the values of the emfs and internal resistances are $\varepsilon_1 = 1.0$ V, $\varepsilon_2 = 2.0$ V, $r_1 = 4Ω$ and $r_2 = 6Ω$. If the current flowing through the resistor R is I ampere, then find 10 I.



18. A thin non conducting disc of mass M = 2 kg, charge Q = 2×10^{-2}C and radius $R = \frac{1}{6}$m is placed on a frictionless horizontal plane with its centre at the origin of the coordinate system. A non uniform, radial magnetic field $\vec{B} = B_0\hat{r}$ exists in space, where $B_0 = 10$ T and the disc is rotated with an angular velocity $\omega = x \times 10^2$ rad/sec about an axis passing through its centre and perpendicular to its plane, as shown in the figure. At what value of x the disc will lift off from the surface.



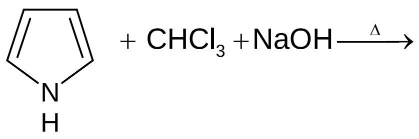
Chemistry

PART – II

SECTION – A
(More Than One Correct Type)

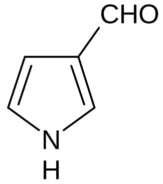
This section contains **7 multiple** choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

19.

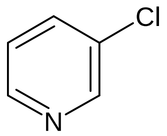

N
H
$+ CHCl_3 + NaOH \xrightarrow{\Delta}$

Product (s) formed is/are

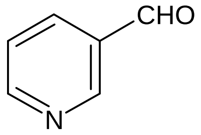
(A)



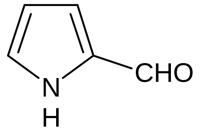
(B)



(C)



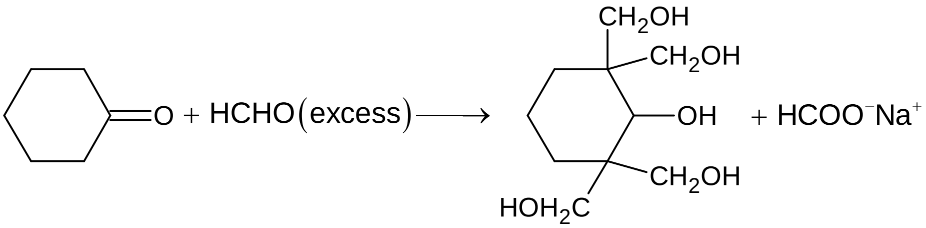
(D)



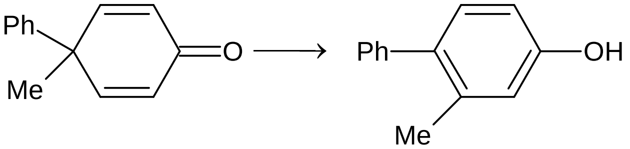
20. Which of the following statement is/are correct?
(A) Cellulose nitrate is a natural polymer.
(B) Vulcanization increases rigidity by restricting the movement of the polymer chains.
(C) HDPE is a linear polymer whereas LDPE is a branched polymer.
(D) Cellulose is an example of an unbranched polysaccharide.

21. Which of the following transformation(s) is/are possible by aq. NaOH in presence or absence of heating

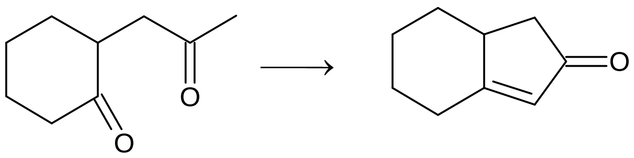
(A)


O + HCHO(excess) ⟶
CH$_2$OH
CH$_2$OH
OH
CH$_2$OH
HOH$_2$C
+ HCOO$^-$Na$^+$

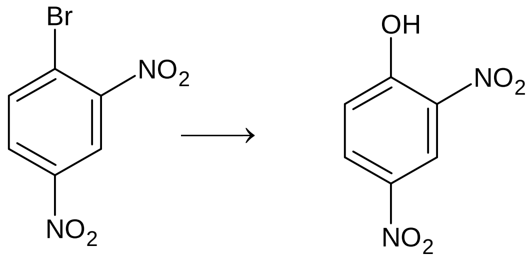
(B)


Ph
Me
O ⟶
Ph
OH
Me

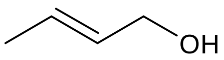
(C)



(D)



22.



Which of the following is/are correct about the above drawn compound?

(A) It gives positive Br_2 – water test.
(B) It gives positive Na-metal test.
(C) It gives negative iodoform test.
(D) It does not give turbidity with Lucas reagent at room temperature.

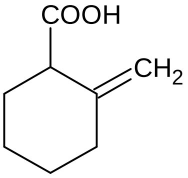
23. $H_2C = CH_2 \xrightarrow{SCl_2} P$

Which of the following statement(s) is/are correct regarding 'P'?

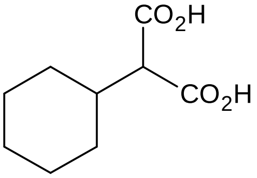
(A) P on treatment with sodium ethoxide produces divinyl sulphide.
(B) It is a chemical warfare agent.
(C) Rate of hydrolysis of P is much more than its corresponding ether analogue.
(D) On complete hydrolysis it produces HCl and diol.

24. Which of the following acids undergo decarboxylation just on heating?

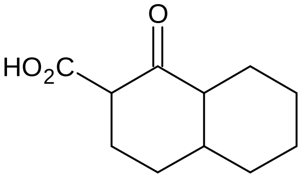
(A)



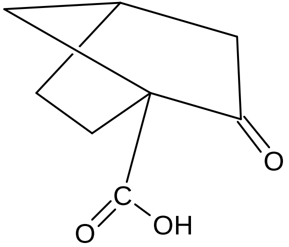
(B)



(C)



(D)



25. How many of the following statements is/are correct?
   (A) α-D-(+)-glucopyranose and β-D-(+)-glucopyranose are diastereomers
   (B) D-Glucose and D-Mannose are diastereomers
   (C) Maleic acid and Fumaric acid are diastereomers
   (D) Dextro' form and 'Meso' form of tartaric acid (2,3-dihydroxybutanedioic acid) are diastereromers.

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer Q. 26, Q. 27 and Q. 28 by appropriately matching the information given in the three columns of the following table.

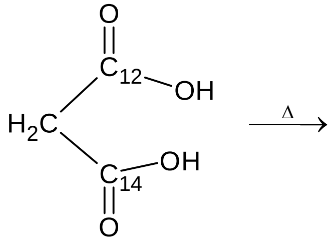
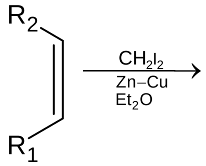
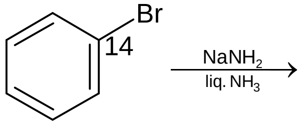
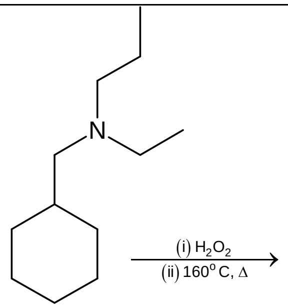
Column 1		**Column 2**		**Column 3**	
(I)	Orlon	(i)	High impact resistance and mechanical toughness	(P)	Elastometer
(II)	Buna-N	(ii)	Have good resistance to stains, chemicals	(Q)	Homopolymer
(III)	Dacron	(iii)	Resistant to the action of petrol, lubricating oil	(R)	Terpolymer
(IV)	ABS	(iv)	Crease resistant	(S)	Thermoplastic or thermoset depend on the chemical structure

26. Which of the following is only correct combination?
   (A) (I) (iv) (S)
   (B) (II) (iii) (P)
   (C) (IV) (i) (P)
   (D) (I) (iv) (S)

27. Which of the following is only correct combination?
   (A) (IV) (i) (R)
   (B) (II) (ii) (Q)
   (C) (III) (iv) (Q)
   (D) (I) (ii) (P)

28. Which of the following is only correct combination?
   (A) (II) (ii) (S)
   (B) (III) (ii) (R)
   (C) (IV) (i) (P)
   (D) (I) (ii) (Q)

Answer Q. 29, Q. 30 and Q. 31 by appropriately matching the information given in the three columns of the following table.

Column 1		**Column 2**		**Column 3**	
(I)		(i)	E_{1CB} involved during the reaction	(P)	One product
(II)		(ii)	Proceeds via six membered cyclic TS	(Q)	Three products
(III)		(iii)	Proceeds via five membered cyclic TS	(R)	Four products
(IV)	 Product(s) (not containing N)	(iv)	Butterfly type transition state	(S)	Two products

29. Which of the following is only correct combination?
(A) (III) (ii) (R)
(B) (II) (iv) (S)
(C) (IV) (i) (P)
(D) (I) (iii) (S)

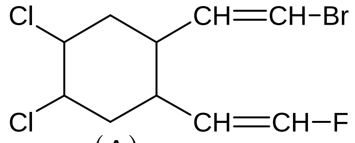
30. Which of the following is only correct combination?
(A) (III) (i) (S)
(B) (II) (i) (P)
(C) (IV) (ii) (P)
(D) (I) (iii) (R)

31. Which of the following is only correct combination?
(A) (III) (iv) (S)
(B) (IV) (iii) (Q)
(C) (IV) (ii) (S)
(D) (I) (ii) (P)

SECTION – B
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

32.



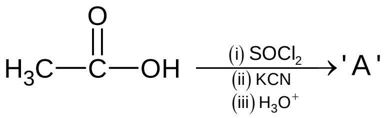
(A)

$HO_2C\text{—}(CHOH)_3\text{—}CO_2H$

(B)

If number of stereoisomers for (A) is 2^x, and if number of stereoisomers are possible for (B) is 2^y. Then value of x/y would be?

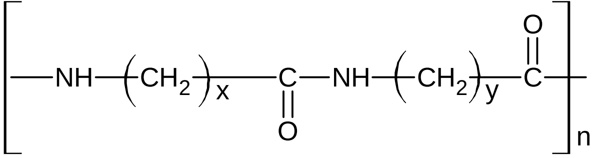
33.



$$H_3C\text{—}\overset{\overset{\displaystyle O}{\|}}{C}\text{—}OH \xrightarrow[\text{(ii) KCN}\ \text{(iii) } H_3O^+]{\text{(i) } SOCl_2} \text{'A'}$$

How many of the following statements is/are correct about 'A'?
(1) It forms oxime with hydroxylamine
(2) It can be prepared by the oxidation of propylene glycol by $KMnO_4$.
(3) It is stronger acid than propanoic acid
(4) It forms phenyl hydrazone with phenyl hydrazine
(5) It can be prepared by hydrolysis of α, α-dibrompropanoic acid
(6) When it is heated with dil. H_2SO_4 in a sealed tube, decarboxylation takes place
(7) When it is heated with conc. H_2SO_4, decarbonylation takes place
(8) It gives positive result in the iodoform reaction
(9) It decolourises bromine water and $KMnO_4$ solution.

34. Nylon-2-nylon-6 is a biodegradable step growth polymer. It can be expressed as

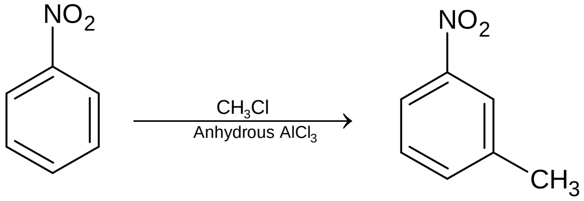


$$\left[\text{—}NH\text{—}(CH_2)_x\text{—}\underset{\underset{\displaystyle O}{\|}}{C}\text{—}NH\text{—}(CH_2)_y\text{—}\overset{\overset{\displaystyle O}{\|}}{C}\text{—}\right]_n$$

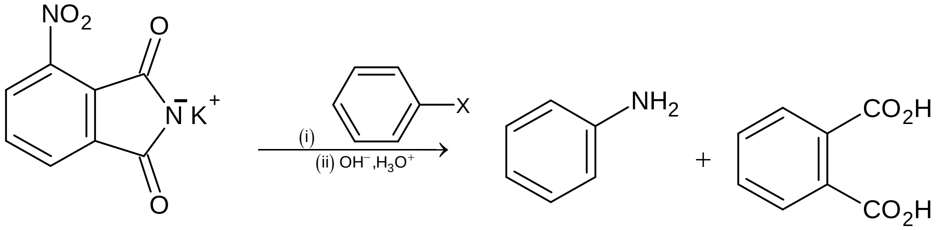
Value of y + x would be?

35. How many of the following reaction is not possible or produce very poor yield?

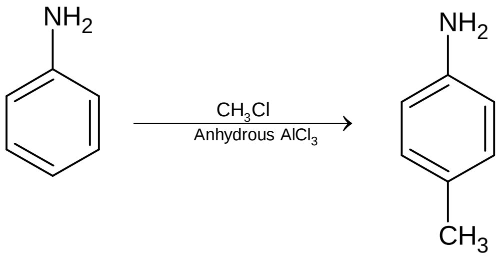
(i)



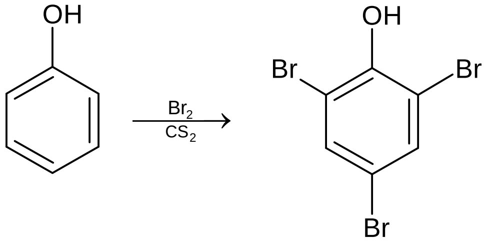
(ii)



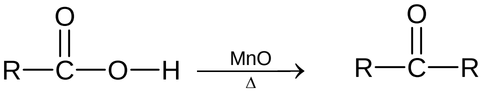
(iii)


NH$_2$
CH$_3$Cl
Anhydrous AlCl$_3$
NH$_2$
CH$_3$

(iv)

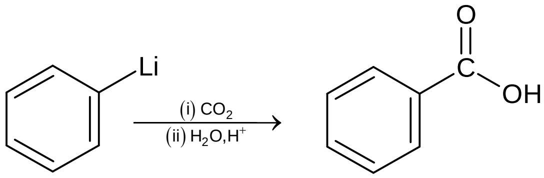

OH
Br$_2$
CS$_2$
OH
Br
Br
Br

(v)

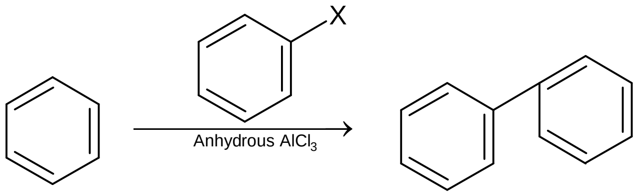

O
R—C—O—H
MnO
Δ
O
R—C—R

$$R-\overset{\overset{\large O}{\|}}{C}-O-H \xrightarrow[\Delta]{MnO} R-\overset{\overset{\large O}{\|}}{C}-R$$

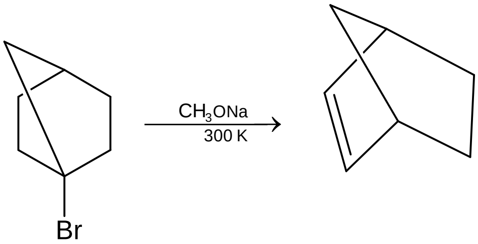
(vi)


Li
(i) CO$_2$
(ii) H$_2$O,H$^+$
O
C
OH

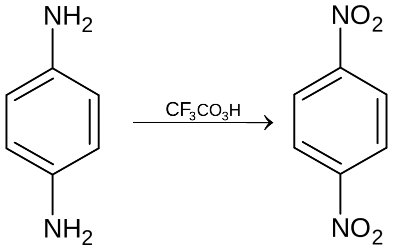
(vii)


X
Anhydrous AlCl$_3$

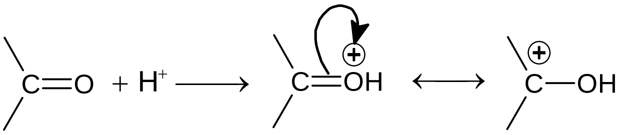
(viii)


Br
CH$_3$ONa
300 K

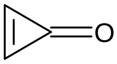
(ix)

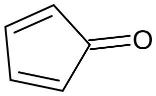

NH$_2$
NH$_2$
CF$_3$CO$_3$H
NO$_2$
NO$_2$

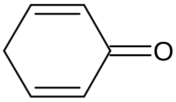
36. Protonation of carbonyl group forms a cation with significant charge on the carbon atom

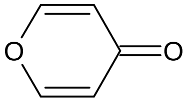


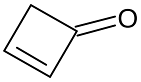
How many of the following carbonyl compounds form an aromatic cation on protonation?

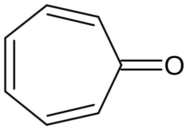
1.


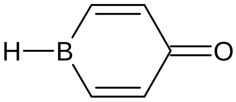
2.


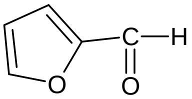
3.


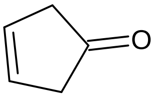
4.


5.


6.


7.


8.


9.


Mathematics

PART – III

SECTION – A
One OR More Than One Choice Type

This section contains **07 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which only **ONE OR MORE THAN ONE** is/are correct

37. Let the ordered pair of integers (x_i, y_i) where i = 1, 2, ..., n satisfy the equation $\tan^{-1} x + \tan^{-1} 8 = \tan^{-1} y + \frac{\pi}{2}$. For the polygon so formed in xy plane which of the following is/are true?
(A) It is a rectangle
(B) It is not cyclic
(C) It is symmetric about line $y = x$
(D) It is symmetric about line $x + y = 0$

38. Let A = {xy = c| c $\in$ R – {0}}. Let $E_C = 0$ represent locus of point P_c such that sum of slopes of normals drawn from it to xy = c is equal to sum of ordinates of feet of normals. Let F be the set of points of intersection of $E_c = 0$ with xy = c (for parameter 'c'), then
(A) (1, 1) is an element of F
(B) (2, 1) is not an element of F
(C) (0, 0) is an element of $E_c \cap F \ \forall \ c \in R - \{0\}$
(D) F is a set of hyperbolas

39. Which of the following is/are correct with respect to angle bisectors of pair of lines $3x^2 - 4y^2 - xy - 12x + 16y = 0$
(A) Angle bisector containing point (2, 1) is the obtuse angle bisector
(B) Equation of acute angle bisector is $(3\sqrt{2}+5)x - (4\sqrt{2}-5)y - 20 = 0$
(C) Equation of obtuse angle bisector is $(3\sqrt{2}+5)x - (4\sqrt{2}-5)y - 20 = 0$
(D) Angle bisectors are perpendicular with respect to each other

40. For the curves $2x^2 + y^2 = 2$ and $y^2 - x^2 = -2$ which of the following is/are true?
(A) Equation of a pair of common tangents is $4x^2 + y^2 - 4xy - 6 = 0$
(B) Equation of a pair of common tangents is $4x^2 + y^2 + 4xy - 6 = 0$
(C) Length of common tangent is $\sqrt{\frac{5}{3}}$
(D) Length of common tangent is $\sqrt{\frac{10}{3}}$

41. Let $E_1 : \frac{x^2}{4} + \frac{y^2}{3} = 1$ and $E_2 : \frac{(x-4)^2}{4} + \frac{y^2}{3} = 1$. If E_2 rolls on E_1, without slipping, then which of the following is/are true?
(A) Locus of centre of E_2 is a polynomial of fourth degree
(B) Locus of one of the focus of E_2 is polynomial of third degree
(C) Locus of centre of E_2 is a closed curve
(D) Locus of one of the focus of E_2 is a closed curve

42. Let O be circumcenter of ΔABC and AO, BO, CO meet circumcircle of ΔABC in D, E, F respectively. If areas of ΔABC, ΔDBC, ΔEAC, ΔFAB are Δ, Δ_1, Δ_2, Δ_3 and radius of their circumcircle are R, R_1, R_2, R_3 respectively, then (where A, B, C and a, b, c have usual meaning)
(A) $\Delta_1 + \Delta_2 + \Delta_3 = \Delta$
(B) $\Delta_1 + \Delta_2 + \Delta_3 = 2R^2 \sin A \sin B \sin C$
(C) $\frac{a}{R_1} + \frac{b}{R_2} + \frac{c}{R_3} = \frac{4\Delta}{R^2}$
(D) $\frac{a}{R_1} + \frac{b}{R_2} + \frac{c}{R_3} = \frac{abc}{R^2}$

43. $\prod_{i=1}^{n} P_i^{a_i \cos^2 a_i} = 2019$ where P_i represents the i^{th} prime number
(i.e., for example $P_1 = 2$, $P_2 = 3$, $P_3 = 5$ .....) such that $P_n < 2019$ and $a_i \in R$. If elements of set A be solution of the equation represented by ordered n-tuple (a_1, a_2, a_3 ....., a_n), then
(A) number of elements in set A is finite
(B) if $a_i \le 9\ \forall\ i = 1, 2, \ldots, n$, then number of element in set A is 25
(C) if $a_i \le 0\ \forall\ i = 1, 2, \ldots, n$, then A is null set
(D) if $a_i \le 9\ \forall\ i = 1, 2, \ldots, n$, then A is singleton set

(Matching type - Single Correct Option)

This section contains **SIX** questions of matching type. The section contains **TWO** tables (each having 3 columns and 4 rows). Based on each table, there are **THREE** questions. Each question has **FOUR** options (A), (B), (C), and (D). **ONLY ONE** of these four options is correct.

Answer Q.44, Q.45 and Q.46 by appropriately matching the information given in the three columns of the following table.

Let $P_1 P_2 P_3$ form an equilateral triangle. Let P_{n+3} be mid-point of P_n and P_{n+1} $\forall$ $n \in N$. Match the ratios of areas of triangle given in Column-1 and ratio of angles of triangle given in Column-2 to their respective values in Column-3

Column–1	Column–2	Column–3
(I) $\frac{\Delta P_{2017} P_{2018} P_{2019}}{\Delta P_{2019} P_{2020} P_{2021}}$	(i) $\frac{\angle P_{2021} P_{2022} P_{2023}}{\angle P_{2020} P_{2019} P_{2018}}$	(P) 1
(II) $\frac{\Delta P_{2017} P_{2018} P_{2019}}{\Delta P_{2020} P_{2021} P_{2022}}$	(ii) $\frac{\angle P_{2001} P_{2002} P_{2003}}{\angle P_{2020} P_{2018} P_{2021}}$	(Q) 2
(III) $\frac{\Delta P_{2017} P_{2019} P_{2020}}{\Delta P_{2018} P_{2019} P_{2020}}$	(iii) $\frac{\angle P_{2004} P_{2005} P_{2003}}{\angle P_{2002} P_{2003} P_{2004}}$	(R) 4
(IV) $\frac{\Delta P_{2021} P_{2022} P_{2023}}{\Delta P_{2021} P_{2023} P_{2025}}$	(iv) $\frac{\angle P_{2017} P_{2018} P_{2019}}{\angle P_{2018} P_{2019} P_{2020}}$	(S) 8

44. Which of the following combination is only CORRECT?
(A) (I) (i) (Q)
(B) (II) (iii) (P)
(C) (I) (iii) (R)
(D) (II) (i) (S)

45. Which of the following combination is only CORRECT?
    (A) (III) (ii) (P)
    (B) (IV) (i) (R)
    (C) (III) (i) (P)
    (D) (IV) (iv) (R)

46. Which of the following combination is only CORRECT?
    (A) (II) (iv) (P)
    (B) (IV) (i) (Q)
    (C) (II) (ii) (R)
    (D) (IV) (iv) (P)

Answer Q.47, Q.48 and Q.49 by appropriately matching the information given in the three columns of the following table.

Let inverse trigonometric functions be defined as follows: $\sin^{-1}x:[-1, 1]\to\left[\frac{\pi}{2}, \frac{3\pi}{2}\right]$; $\cos^{-1}x:[-1, 1]\to[0, \pi]$; $\tan^{-1}x:R\to\left(\frac{\pi}{2}, \frac{3\pi}{2}\right)$; $\text{cosec}^{-1}x:(-\infty, -1]\cup[1, \infty)\to\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]-\{0\}$; $\cot^{-1}x:R\to(\pi, 2\pi)$; $\sec^{-1}x:(-\infty, -1]\cup[1, \infty)\to[0, \pi]-\left\{\frac{\pi}{2}\right\}$. Match maximum value of expression in Column-1 and minimum value of expression in Column-2 to corresponding values given in Column-3.

Column–1	Column–2	Column–3
(I) $\sin^{-1}x+\cos^{-1}x$	(i) $\tan^{-1}x+\cot^{-1}x$	(P) 0
(II) $\sin^{-1}(-x)+\sin^{-1}x$	(ii) $\tan^{-1}x+\tan^{-1}(-x)$	(Q) $\frac{\pi}{2}$
(III) $\cot^{-1}x+\cot^{-1}(-x)-\frac{5\pi}{2}$	(iii) $\sec^{-1}\left(\frac{1}{x}\right)+\cos^{-1}(x)$	(R) 2π
(IV) $\text{cosec}^{-1}\left(\frac{1}{x}\right)+\sin^{-1}x-\pi$	(iv) $\sec^{-1}x+\text{cosec}^{-1}x$	(S) $\frac{5\pi}{2}$

47. Which of the following combination is **CORRECT?**
    (A) (I) (i) (P)
    (B) (I) (ii) (R)
    (C) (I) (i) (S)
    (D) (II) (i) (R)

48. Which of the following combination is **CORRECT?**
    (A) (II) (ii) (R)
    (B) (III) (iii) (S)
    (C) (IV) (iv) (P)
    (D) (I) (i) (Q)

49. Which of the following combination is **CORRECT?**
    (A) (III) (iv) (Q)
    (B) (IV) (ii) (P)
    (C) (II) (iv) (P)
    (D) (I) (ii) (Q)

SECTION – B
(Single digit integer type)

This section contains **FIVE** questions. The answer to each question is a single Digit integer ranging from 0 to 9, both inclusive.

---

50. If length of smallest path that can be traced from (0, 0) to $\left(\sqrt{2}+1, -1\right)$ without traversing inside the curve $x^2 + y^2 - 2\sqrt{2}x + 1 = 0$ is of the form $\frac{a\pi}{16} - b$; a, b $\in$ I, then value of a + b is equal to.

51. Let $f(a, b) = \sqrt{\left(\sqrt{25-a^2} - b\right)^2 + \left(a - \frac{1}{3}\sqrt{144-16b^2}\right)^2}$. If maximum and minimum value of f(a, b) is c and d respectively $\forall$ a, b $\in$ R, then c – d equals.

52. If there are only two points on the curve $2x^2 - 2y^2 - 4x + 21 = 0$ such that tangents drawn to $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ (a, b $\in$ N) are perpendicular, then a + b equals.

53. Number of solutions of the equation $\text{cosec}^2 x - \sec^2 x - \tan^2 x - \cot^2 x - \sin^2 x - \cos^2 x + 3 = 0$ $\forall$ x $\in$ [–2π, 2π] is.

54. If maximum value of $\tan^{-1}x + 2\sin^{-1}x + 3\sec^{-1}x$ is $\frac{p\pi}{q}$ where p, q are coprime integers, then p – q equals.

FIITJEE

ALL INDIA TEST SERIES

PART TEST – II

JEE (Advanced)-2020

PAPER – 1

TEST DATE: 17-11-2019

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. B, C

Sol. Magnetic flux through the smaller loop due to current in the bigger loop = $\left(\frac{\mu_0 I}{2\pi d} - \frac{\mu_0 I}{2\pi(2d)}\right)\ell^2$

$= \frac{\mu_0 I \ell^2}{4\pi d}$

So mutual inductance = $\frac{\mu_0 \ell^2}{4\pi d}$

$\therefore$ So emf induced in the bigger loop = $\frac{d}{dt}\left[\frac{\mu_0 \ell^2}{4\pi d}kt\right]$

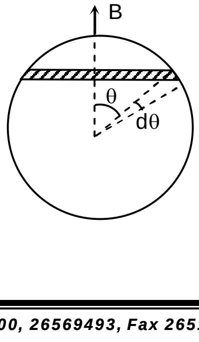
$= \frac{\mu_0 \ell^2 k}{4\pi d}$

2. B, D

Sol. $\varepsilon = \pi R^2 \sin^2\theta\alpha$

So current $di = \frac{\varepsilon}{dr} = \frac{1}{2\rho}dR^2\alpha\sin\theta d\theta$

So $\int d\mu = \int_0^{\pi}\frac{\pi dR^4\alpha\sin^3\theta d\theta}{2\rho} = \frac{2\pi}{3\rho}dR^4\alpha$.



3. A, B, D

Sol. Loop equation gives

$$L\frac{di}{di}+iR=\frac{\mu_0 Na^2\omega}{2\ell}i$$

So $\frac{di}{dt}=\frac{1}{L}\left(\frac{\mu_0 Na^2\omega}{2\ell}-R\right)i$

So to grow current always, $\frac{\mu_0 Na^2\omega}{2\ell}-R>0$

$$\Rightarrow \omega > \frac{2\ell R}{\mu_0 Na^2}$$

4. C

Sol. eE = mrα $\Rightarrow$ $E=\frac{mr\alpha}{e}$

So $I=\frac{2\pi rE}{R}=\frac{2\pi mr^2\alpha}{eR}$

and $B=\mu_0 nI$

$$=\frac{2\pi\mu_0 nmr^2\alpha}{eR}$$

5. B, C

Sol. During melting of ice, its volume decreases.

6. A, D

Sol. Dipole is in uniform field, so net electric force is zero.

Electric potential energy of a dipole $U=-\vec{P}.\vec{E}$. For stable equilibrium potential energy should be minimum.

7. A, C, D

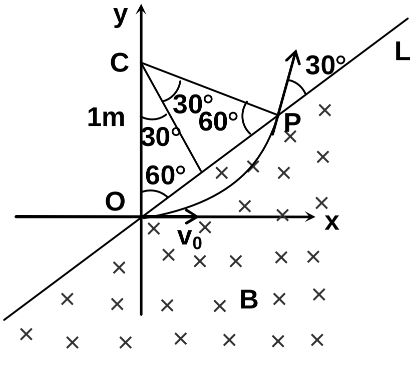
Sol. OB = 1 m

and time period

$T=\frac{2\pi m}{qB}=2\pi$ sec

Time spent by the particle in the magnetic field is

$t=\frac{\pi}{3\omega}=\frac{\pi m}{3qB}=\frac{\pi}{3}$ sec



8. C

9. D

10. B

Sol. (for Q.8-10)

Cyclic process	Work Done	ΔU
(I)	$W_{AB} > 0$ $W_{BC} = 0$ $W_{CA} < 0$	$\Delta U_{AB} > 0$ $\Delta U_{BC} < 0$ $\Delta U_{CA} < 0$
(II)	$W_{AB} = 0$ $W_{BC} > 0$ $W_{CA} < 0$	$\Delta U_{AB} > 0$ $\Delta U_{BC} = 0$ $\Delta U_{CA} < 0$
(III)	$W_{AB} > 0$ $W_{BC} > 0$ $W_{CA} < 0$	$\Delta U_{AB} > 0$ $\Delta U_{BC} < 0$ $\Delta U_{CA} = 0$
(IV)	$W_{AB} = 0$ $W_{BC} > 0$ $W_{CA} < 0$	$\Delta U_{AB} > 0$ $\Delta U_{BC} = 0$ $\Delta U_{CA} < 0$

11. C

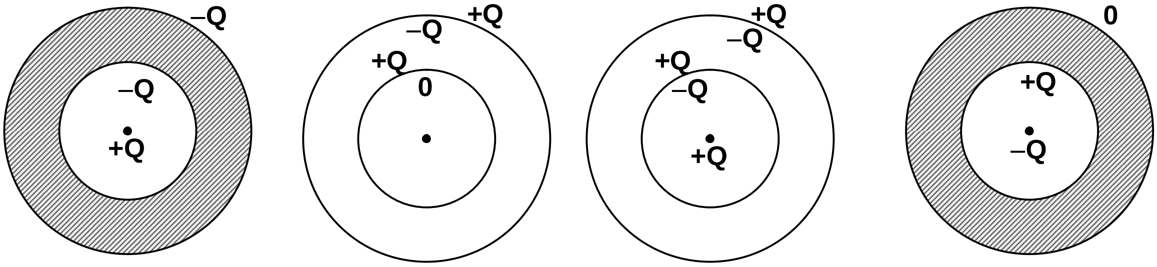
12. A

13. D

Sol. (for Q. 11-13)

Final charge distributions are as follows

Electric field at P_1 = $\frac{\left(9\times10^{9}\right)\left(10^{-6}\right)}{\left(10^{-1}\right)^{2}} = 900\frac{KV}{m}$



Electric potential of conductor = $-\frac{\left(9\times10^{9}\right)\left(10^{-6}\right)}{2\times10^{-1}} = -45KV$

Electric potential energy in the outside space = $\frac{\left(9\times10^{9}\right)\left(10^{-6}\right)^{2}}{2\times2\times10^{-1}} = 2.25\times10^{-2}J$

SECTION – B

14. 9

Sol. $KA\left.\frac{dT}{dx}\right|_{Y} - KA\left.\frac{dT}{dx}\right|_{X} = ms\frac{dT}{dt} = \left(10^{-6}\times8\times10^{3}\right)\left(500\right)\left(0.05\right)$

$$\therefore \quad \left.\frac{dT}{dx}\right|_Y = \left.\frac{dT}{dx}\right|_X + \frac{10^{-6}\times 8\times 10^3\times 500\times 0.05}{500\times 10^{-4}} = 9$$

15. 5

Sol. $\phi = \frac{q}{24\varepsilon_0} - \frac{q}{\varepsilon_0 4\pi}\frac{2\pi\left(1-\frac{1}{\sqrt{2}}\right)}{4}$

$= \frac{q}{24\varepsilon_0} - \frac{q}{8\varepsilon_0} + \frac{q}{8\sqrt{2}\varepsilon_0} = \frac{q}{8\sqrt{2}\varepsilon_0} - \frac{q}{12\varepsilon_0}$

$\approx 5\ \frac{Nm^2}{c}$.

16. 4

Sol. $R_S = 7\times 10^{-3} = \frac{\rho_S \ell_S}{\pi r_S^2}$ (X_S is the physical quantity in space)

So $7\times 10^{-3} = \frac{\rho_\ell (1-\beta 300)\ell_\ell (1-\alpha 300)}{\pi r_\ell^2 (1-\alpha 300)^2}$

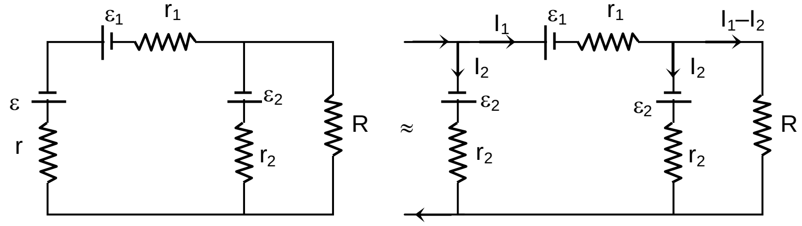
Where (X_ℓ is the physical quantity in ISRO lab)

Putting all the values

$\ell_\ell \approx \frac{1}{4}m$

17. 5

Sol. For the cell network equivalent emf is ε and equivalent resistance is r, then the equivalent circuit is



So loop equations is the left loop is

$-1-4I_1+2-6I_2+6I_2-2=0$

So $I_1 = -\frac{1}{4}A$

Another loop equation is the right loop is

$-(I_1-I_2)+6I_2-2=0$

So $7I_2 = 2-\frac{1}{4}$ So $I_2 = \frac{1}{4}A$

So $I_1 - I_2 = -\frac{1}{2}A$

18. 9

Sol. $F = \int_0^R \frac{Q}{\pi R^2}2\pi r dr\ \omega r B_0 \Rightarrow \frac{2}{3}Q\omega B_0 R = mg$

$\omega = 9\times 10^2\ rad/s$

Chemistry

PART – II

SECTION – A

19. B, D

Sol. Pyrrole is π-excessive heterocyclic compound, so can take part in Reimer-Tiemann reaction.

20. B, C, D

Sol. Cellulose nitrate is a semi-synthetic polymer.

21. A, C, D

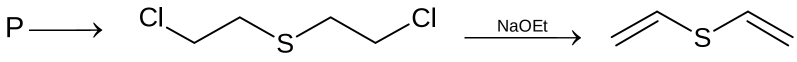
Sol. Conceptual

22. A, B, C

Sol. Allyl and benzyl 1^{o} alcohol give turbidity with Lucas reagent instantly.

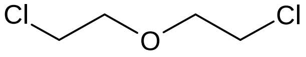
23. A, B, C, D

Sol.



(Mustard gas)

Rate of hydrolysis is more than corresponding ether analogue



due to NGP.

24. A, B, C

Sol. Bridgehead β-keto carboxylic acids do not decarboxylate as it would require formation of a double bond at bridgehead carbon which would be highly strained.

25. A, B, C, D

Sol. Epimers, Anomers and geometrical isomers – all are examples of diastereomers.

26. B

27. A

28. D

Sol. (for the Q. No. 26 to 28)
Factual.

29. B

30. A

31. B

Sol. (for the Q. No. 29 to 31)
Conceptual.

SECTION – B

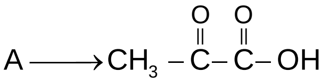
32. 3

Sol. For A $\Rightarrow 2^6$

For B $\Rightarrow 2^2$

33. 9

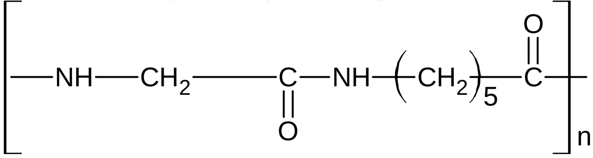
Sol.



$$A \longrightarrow CH_3-\overset{\overset{O}{\|}}{C}-\overset{\overset{O}{\|}}{C}-OH$$

34. 6

Sol. Structure of Nylon-2-nylon-6 is given below:



$$\left[-NH-CH_2-\underset{\underset{O}{\|}}{C}-NH-(CH_2)_5-\overset{\overset{O}{\|}}{C}-\right]_n$$

35. 6

Sol. Nitrobenzene is highly deactivating towards EAS reactions, cannot take part in Friedel-Crafts alkylation.

Aryl 1° amine cannot be prepared by Gabriel's phthalimide synthesis.

Aniline give very poor yield in Friedel-Crafts alkylation.

Phenol on treatment with bromine water gives tri-substituted product.

36. 4

Sol. Conceptual.

Mathematics

PART – III

SECTION – A

37. B, D

Sol. $\tan^{-1} x - \tan^{-1} y = \tan^{-1}\frac{1}{8}$

Case-I: $x, y > 0 \Rightarrow \frac{x-y}{1+xy} = \frac{1}{8} \Rightarrow x = \frac{8y+1}{8-y} \Rightarrow (5, 3)$ and $(57, 7)$

Case-II: $x > 0, y < 0 \Rightarrow \frac{x+p}{1-xp} = \frac{1}{8}$ $(p = -y) \Rightarrow x = \frac{1-8p}{8+p} < 0 \;\; \forall\, p > 0 \Rightarrow$ no solution

Case-III: $x < 0, y < 0 \Rightarrow \tan^{-1} p - \tan^{-1} q = \tan^{-1}\frac{1}{8}$ $(p = -y, q = -x) \Rightarrow (-3, -5), (-7, -57)$

38. A, B, C

Sol. $E_c : x^2 = cy$
$F : (y^2 - x)(y^2 + x) = 0$

39. A, C, D

Sol. Bisectors are given by $\frac{3x-4y}{5} = \pm\left(\frac{x+y-4}{\sqrt{2}}\right)$. Bisector containing (2, 1) is given by '–' sign which is also obtuse angle bisector

40. A, B, D

Sol. Tangent for ellipse : $y = mx \pm \sqrt{m^2+2}$

Tangent for hyperbola : $y = mx \pm \sqrt{2m^2-2}$

$\Rightarrow m^2 = 4$ or $m = \pm 2$

Point of tangency for ellipse $\left(\frac{-2}{\sqrt{6}}, \frac{2}{\sqrt{6}}\right)$ and for $\left(\frac{-4}{\sqrt{6}}, \frac{-2}{\sqrt{6}}\right)$

41. A, C, D

Sol. The two ellipses will be reflection of each other in common tangent
So, locus of centre of E_2 can be obtained by finding locus of centre of E_1 in variable tangent to E_1.
If (h, k) be the reflection of centre, then $\frac{h-0}{m} = \frac{k-0}{-1} = -2\left(\frac{\sqrt{4m^2+3}}{m^2+1}\right)$
Eliminating 'm', we get $(x^2 + y^2)^2 = 4(4x^2 + 3y^2)$ which is fourth degree polynomial closed curve
Similar procedure can be adopted for focus

42. A, B

Sol. $\Delta_1 = 2R^2 \sin A \cos B \cos C$
$\Delta_2 = 2R^2 \cos A \sin B \cos C$
$\Delta_3 = 2R^2 \cos A \cos B \sin C$
$\Delta_1 + \Delta_2 + \Delta_3 = 2R^2(\sin(A + B + C) + \sin A \sin B \sin C) = 2R^2 \sin A \sin B \sin C = \Delta$
$R_1 = R_2 = R_3 = R$

43. B, C

Sol. $2019 = 3 \times 673$

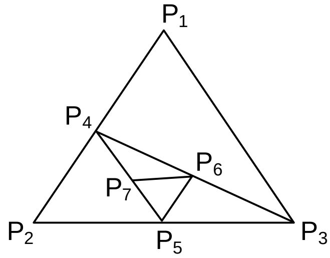
$2^{a_1 \cos^2 a_1}\, 3^{a_2 \cos^2 a_2}\, 5^{a_3 \cos^2 a_3} \ldots\ldots = 3 \times 673$

$\Rightarrow a_1 = a_3 ..... = 0,\ a_2 \cos^2 a_2 = 1$ and $a_{122} \cos^2 a_{122} = 1$ ($a_{122} = 673$)
$x \cos^2 x = 1$ has 5 solutions in $(-\infty, 9]$, infinite solutions in $(-\infty, \infty)$, no solution in $(-\infty, 0]$

44. C

45. A

46. B
Sol. (for Q. 44.-46.)
If $P_1 P_2 P_3$ is equilateral then $P_5 P_6 P_7$ is also equilateral



47. C

48. A

49. A
Sol. (for Q. 47.-49.)

The identities are $\sin^{-1} x - \cos^{-1} x = \frac{\pi}{2}\ \forall\ x \in [-1, 1]$

$\cot^{-1} x + \tan^{-1} x = \frac{5\pi}{2}\ \forall\ x$

$\sec^{-1} x + \text{cosec}^{-1} x = \frac{\pi}{2}\ \forall\ x \in R - (-1, 1)$

$\sin^{-1} x + \sin^{-1}(-x) = 2\pi\ \forall\ x \in [-1, 1]$

$\tan^{-1}(-x) + \tan^{-1} x = 2\pi\ \forall\ x \in R$

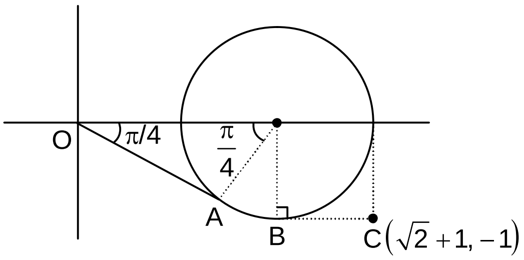
$\cot^{-1}(-x) + \cot^{-1} x = 3\pi\ \forall\ x \in R$

$\text{cosec}^{-1}\left(\frac{1}{x}\right) = \pi - \sin^{-1} x\ \forall\ x \in [-1, 1] - \{0\}$

SECTION – B

50. 2

Sol. Length of path OABC is $\frac{\pi}{4} + 2$



51. 8
Sol. f(a, b) represent distance between the curves $16x^2 + 9y^2 = 144$ and $x^2 + y^2 = 25$.
So, c = 9 and d = 1

52. 4

Sol. Director circle of $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ is $x^2 + y^2 = a^2 + b^2$. It intersects $(x - 1)^2 - y^2 + \frac{19}{2}=0$ at only two points. Solving the two equations simultaneously $2x^2 - 2x + \frac{21}{2} - (a^2 + b^2) = 0$

$\Rightarrow 4-8\left(\frac{21}{2}-(a^2+b^2)\right)=0 \Rightarrow a^2 + b^2 = 10 \Rightarrow a + b = 4$

53. 8

Sol. $\text{cosec}^2 x - \cot^2 x - (1 + \tan^2 x) - \tan^2 x - 1 + 3 = 0$

$\Rightarrow \tan^2 x = 1 \Rightarrow \tan x = \pm1$

54. 3

Sol. Domain of expression $f(x) = \tan^{-1} x + 2\sin^{-1} x + 3\sec^{-1} x$ is $\{-1, 1\}$

$f(-1) = -\frac{\pi}{4} + 2\left(-\frac{\pi}{2}\right) + 3\pi = \frac{7\pi}{4}$

$f(1) = \frac{\pi}{4} + 2\left(\frac{\pi}{2}\right) + 3.0 = \frac{5\pi}{4}$

FIITJEE

ALL INDIA TEST SERIES

PART TEST – II

JEE (Advanced)-2020

PAPER – 2

TEST DATE: 17-11-2019

Time Allotted: 3 Hours **Maximum Marks: 183**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **One Section**: **Section-A.**

1. ***Section–A (01 – 07, 19 – 25, 37 – 43)*** *contains 21 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

   Section-A (08– 14, 26 – 32, 44 – 50) *contains 21 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for correct answer and* ***–2 marks*** *for wrong answer*
   Partial Marks **+1** for each correct option provided no incorrect option is selected.

   Section–A (15 – 18, 33 – 36, 51 – 54) *contains 6 paragraphs. Each paragraph is having 2 multiple choice questions having 4 options with* ***only one correct answer****. Each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

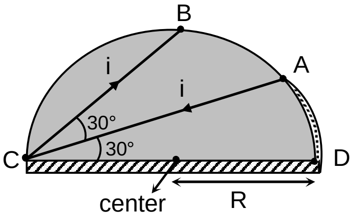
Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. A current carrying wire is placed in the grooves of an insulating semicircular disc of radius R as shown in the figure. The current enters at point A and leaves from point B. The magnetic field at point D is



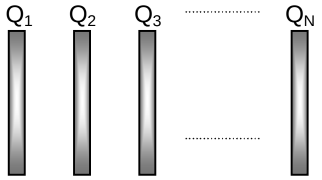
(A) $\frac{\mu_0 i}{4\sqrt{3}\pi R}$

(B) $\frac{\mu_0 i}{8\sqrt{3}\pi R}$

(C) $\frac{\mu_0 i}{2\sqrt{3}\pi R}$

(D) Zero

2. N large square metallic plates are separated by a small distance and arranged parallel to its nearby plates as shown in the figure. Each of the plates are imparted charges Q_1, Q_2 ………….. Q_N respectively.
Choose the correct answer(s) from the options.



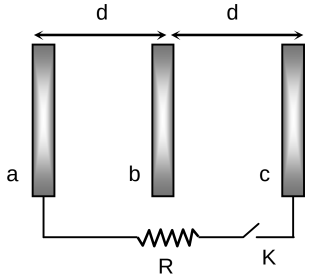
(A) Charges on the outermost surfaces of the plate system are equal and opposite.

(B) If the plate 1 is earthed, then charge flown to the earth is Q_1.

(C) If the plate 3 is earthed, then charge flown to the earth is $\frac{\sum_{i=1}^{N} Q_i}{N}$

(D) If the plate 4 is earthed, the charge flown to the earth is $\sum_{i=1}^{N} Q_i$.

3. Three identical large metal plates each of area 'A' are placed parallel to each other at equal distance d as shown. Initially metal plate 'a' is uncharged, while metal plates b and c have respective charges $+q_0$ and $-q_0$ initially as shown. Metal plates a and c are connected by switch K through resistor of resistance R. The key K is closed at time t = 0. Then the magnitude of current through the resistor at any time t is



(A) $\frac{q_0 d}{RA\varepsilon_0} e^{\frac{-dt}{RA\varepsilon_0}}$

(B) $\frac{q_0 d}{RA\varepsilon_0} e^{\frac{-2dt}{RA\varepsilon_0}}$

(C) $\frac{q_0 d}{2RA\varepsilon_0} e^{\frac{-dt}{RA\varepsilon_0}}$

(D) $\frac{q_0 d}{2RA\varepsilon_0} e^{\frac{-2dt}{RA\varepsilon_0}}$

4. A spherical black body has a radius R and steady surface temperature T, heat sources ensure the heat evolution at a constant rate and distributed uniformly over its volume. What should be the new steady state surface temperature of the object if the radius is decreased by half? Assume surrounding to be at absolute zero and heat evolution rate through unit volume remain same.

(A) $(2)^{\frac{1}{4}}T$

(B) $\sqrt{2}T$

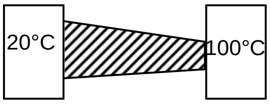
(C) $\frac{T}{(2)^{\frac{1}{4}}}$

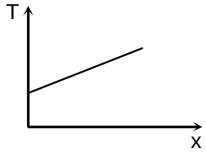
(D) $\frac{T}{\sqrt{2}}$

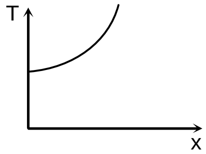
5. Three charged conducting metal spheres of radius R_1, R_2 and R_3 are connected together by very thin wires and they are separated by large distances from each other. If $R_1 < R_2 < R_3$, at equilibrium, which of the following sets of relations involving the electric field strength E generated by a sphere at a point just outside the surface, its potential V and its charge Q must hold between the spheres.

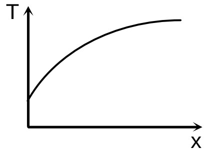
(A) $V_1 = V_2 = V_3$, $E_1 < E_2 < E_3$, $Q_1 < Q_2 < Q_3$
(B) $V_1 = V_2 = V_3$, $E_1 > E_2 > E_3$, $Q_1 < Q_2 < Q_3$
(C) $V_1 < V_2 < V_3$, $E_1 < E_2 < E_3$, $Q_1 = Q_2 = Q_3$
(D) $V_1 > V_2 > V_3$, $E_1 < E_2 < E_3$, $Q_1 > Q_2 > Q_3$

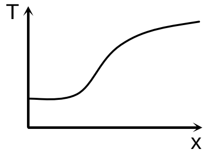
6. A conical metal beam is placed between two constant temperature surface. The surfaces are at 20°C and 100°C as shown in the figure. Which one of the following graphs best represents the temperature along the axis of the beam at a distance 'x' from the left end in steady state?



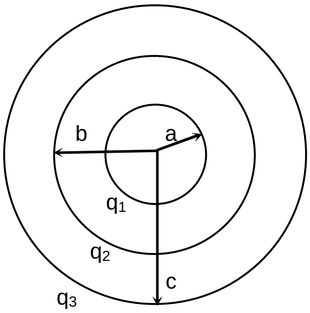
(A)


(B)


(C)


(D)


7. Three concentric thin shells are shown carrying charges q_1, q_2 and q_3 and of radii a, b and c respectively. If the middle shell expands from radius b to b′ (b′ < c). The work done by the electric field in the process is



(A) $\frac{1}{4\pi\varepsilon_0}\left(\frac{q_2^2}{2b'}-\frac{q_2^2}{2b}+\frac{q_1q_2}{b'}-\frac{q_1q_2}{b}\right)$

(B) $\frac{1}{4\pi\varepsilon_0}\left(\frac{q_2^2}{2b}-\frac{q_2^2}{2b'}+\frac{q_1q_2}{b}-\frac{q_1q_2}{b'}\right)$

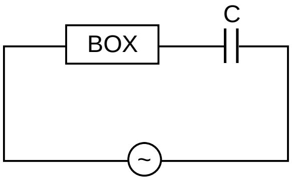
(C) $\frac{1}{4\pi\varepsilon_0}\left(\frac{q_2^2}{2b'}-\frac{q_2^2}{2b}\right)$

(D) $\frac{1}{4\pi\varepsilon_0}\left(\frac{q_1q_2}{b}-\frac{q_1q_2}{b'}\right)$

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

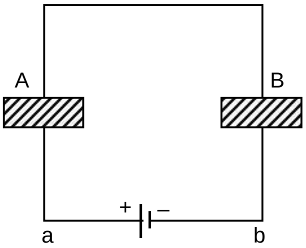
8. A box has a large electric circuit inside it. When it was connected to an AC generator, it was found that it was putting a lot of load on the generator and the power factor of the box was $\frac{1}{\sqrt{2}}$. Now a capacitor of capacitance C was connected in series with the box and the power factor of the circuit becomes equal to 1. Then



AC generator of angular frequency ω

(A) The impedance of the box must be resistive and capacitive.
(B) The impedance of the box must be resistive and inductive.
(C) The impedance of the box is $\frac{\sqrt{2}}{\omega C}$
(D) The impedance of the box is $\frac{1}{\sqrt{2}\,\omega C}$

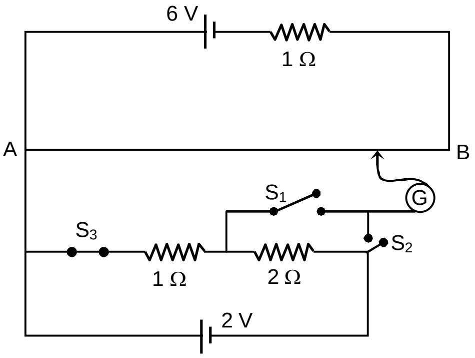
9. Consider two identical dielectric slabs that are inserted into two identical capacitors A and B connected to the battery as shown in the figure. Now the dielectric slab of capacitor B is pulled out slowly from it with the battery still remaining connected. Then during the process of removing the dielectric slab, we observe the following statement(s) to be correct.



(A) Positive charge flows from a to b.
(B) Final charge on capacitor B will be less than that on capacitor A.
(C) Work is done by the external force F appears completely as heat in the circuit.
(D) Internal energy of the battery increases.

10. The relation between internal energy U, pressure P and Volume V of a gas in an adiabatic process U = a + b PV, where a and b are positive constants. Then
    (A) Equation for the process is $PV^{\frac{b+2}{b}}$ = constant
    (B) Equation for the process is $PV^{\frac{b+1}{b}}$ = constant
    (C) The gas must be monoatomic
    (D) The gas must be diatomic

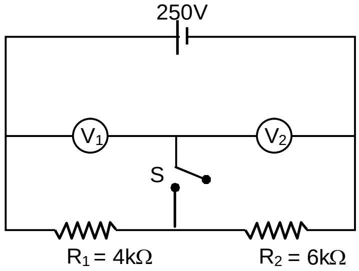
11. Figure shows a potentiometer circuit. The length of potentiometer wire AB is 120 cm and its resistance is 2 Ω. The internal resistance of 2V cell is negligible and the internal resistance of 6V cell is 1 Ω initially the switches S_1 and S_2 are open and S_3 is closed.



    (A) When only S_2 is open, balanced length $\ell = 20\,\text{cm}$
    (B) When only S_1 is open, balanced length $\ell = 60\,\text{cm}$
    (C) When all three switches are closed, balanced length is 60 cm
    (D) When S_3 is open, S_2 is also open but S_1 is closed, balance length is 60 cm

12. Two identical objects A and B are at temperatures T_A and T_B respectively. Both objects are placed in a room with perfectly absorbing walls maintained at a temperature. $T(T_A > T > T_B)$. The objects A and B attain the temperature T eventually. Select the correct statements from the following
    (A) A only emits radiation, while B only absorbs it until both attain the final temperature T.
    (B) A loses more heat by radiation than it absorbs, while B absorbs more radiation than it emits, until they attain the temperature T.
    (C) Both A and B only absorbs radiation, but do not emit it, until they attain the temperature T.
    (D) Each object continues to emit and absorb radiation even after attaining the temperature T.

13. In the circuit shown in figure, V_1 and V_2 are two voltmeters having resistances 6 KΩ and 4 KΩ respectively. The emf of the battery is 250 V, having negligible internal resistance. The resistances R_1 = 4 KΩ and R_2 = 6 KΩ are also connected in the circuit as shown. Choose the correct option(s).



    (A) When switch S is open, then readings of voltmeters are V_1 = 100 V and V_2 = 150 V.
    (B) When switch S is open, then readings of voltmeters are V_1 = 150 V and V_2 = 100 V.
    (C) When switch S is closed, then readings of voltmeter are V_1 = 100 V and V_2 = 150 V.
    (D) When switch S is closed, then readings of voltmeters are V_1 = 125 V and V_2 = 125 V.

14. A charged particle ‘P’ leaves the origin with speed $v = v_0$ at some inclination with the x-axis. There is a uniform magnetic field B along the x-axis. The particle ‘P’ strikes a fixed target ‘T’ on the x-axis for a minimum value of $B = B_0$. The particle ‘P’ will also strike the target T, if
(A) $B = 2B_0, v = 2v_0$
(B) $B = 2B_0, v = v_0$
(C) $B = B_0, v = 2v_0$
(D) $B = \frac{B_0}{2}, v = 2v_0$

Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

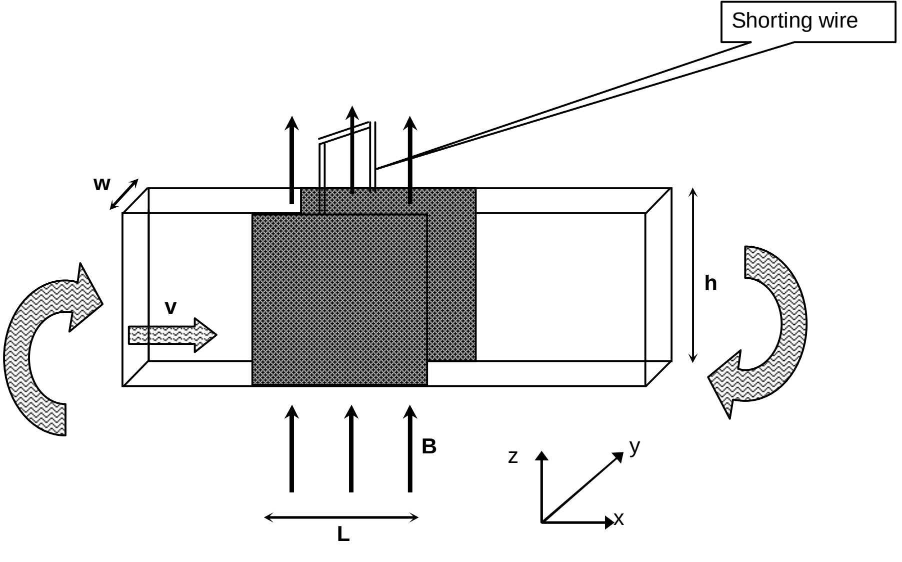
Paragraph for Question Nos. 15 and 16

The production of electrical power through the use of a conducting fluid moving through a magnetic field is referred to as a MAGNETO HYDRODYNAMIC (MHD) GENERATOR. A simplistic way of functioning of MHD is shown in the figure. In the figure shown, a horizontal rectangular plastic pipe of width w and height h is filled with mercury of electrical conductivity σ. A pressure difference ΔP is produced by a turbine which drives this fluid with a constant speed V_0. The two opposite vertical walls of a section of the pipe with length L are made of copper.

To simplify the situation we assume the following.

- Although the fluid is viscous, its speed is uniform over the entire cross-section.
- The speed of the fluid is always proportional to the net external force acting upon it.
- The fluid is incompressible.

These conducting walls are electrically shorted with an external wire as shown in the figure. The steady state velocity of the fluid after application of magnetic field is v.



15. The current flowing in the shorting wire in the steady state is
(A) $BLh\sigma v$
(B) $BLw\sigma v$
(C) $\frac{BL^2h\sigma v}{w}$
(D) $Bvh\sigma w$

16. Taking the assumption taken in the MHD working that speed of the fluid is always proportional to the net external force acting upon it, the expression of steady state velocity v after application of magnetic field is

(A) $\frac{\Delta P}{B^2 L\sigma}$

(B) $\frac{\Delta P v_0}{\Delta P + B^2 L\sigma v_0}$

(C) $\frac{\Delta P h v_0}{\Delta P h + B^2 L w\sigma v_0}$

(D) $\frac{\Delta P v_0}{\Delta P + B^2 w\sigma v_0}$

Paragraph for Question Nos. 17 and 18

A nonlinear circuit element can be made out of a parallel plate capacitor and small balls, each of mass m, that can move between the plates. The balls collide inelastically with the plates, dissipate all kinetic energy as thermal energy and immediately release all the charge they are carrying to the plate. Almost instantaneously, the balls then pick up a small charge of magnitude q from the plate, the balls are then repelled directly towards the other plate under electrostatic forces only. Another collision happens, kinetic energy is dissipated, the balls give up the charge, collect a new charge and the cycle repeats. There are n_0 balls per unit surface area of the plates. The capacitor has a capacitance C, the separation ‘d’ between the plates is much larger than the radius r of the balls. A battery is connected to the plates in order to maintain a constant potential difference V. Neglect edge effects and assume magnetic and gravitational forces to be negligible. (ε_0 is permittivity of free space)

17. The current between the plates in terms of any or all of the given parameters ε_0, m, n_0, c, q and V is

(A) $\frac{2Cn_0 q}{\varepsilon_0}\sqrt{\frac{qV}{m}}$

(B) $\frac{Cn_0 q}{\varepsilon_0}\sqrt{\frac{2qV}{m}}$

(C) $\frac{Cn_0 q}{\varepsilon_0}\sqrt{\frac{qV}{m}}$

(D) $\frac{Cn_0 q}{\varepsilon_0}\sqrt{\frac{qV}{2m}}$

18. The effective resistance of the device in terms of any or all of the given parameters ε_0, m, n_0, c, q and V is

(A) $\frac{\varepsilon_0}{Cn_0 q}\sqrt{\frac{mV}{q}}$

(B) $\frac{\varepsilon_0}{Cn_0 q}\sqrt{\frac{2mV}{q}}$

(C) $\frac{\varepsilon_0}{Cn_0 q}\sqrt{\frac{mV}{2q}}$

(D) $\frac{2\varepsilon_0}{Cn_0 q}\sqrt{\frac{mV}{q}}$

Chemistry

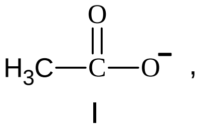
PART – II

SECTION – A

(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

19. The order of increasing nucleophilicity of the anions (in polar protic solvent)

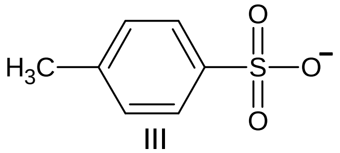


$H_3C-\overset{\overset{O}{\|}}{C}-O^-$,

I

$\bar{C}N$

II



III

, $C_2H_5O^-$,

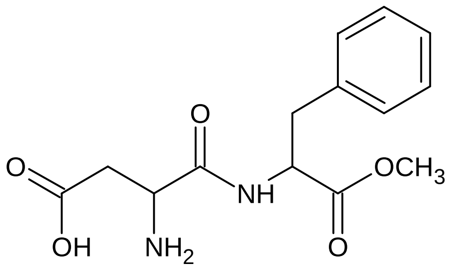
IV

$CH_3-CH_2-\bar{S}$

V

(A) V < I < III < II < IV
(B) III < I < IV < II < V
(C) III < II < I < IV < V
(D) II < III < I < V < IV

20. Aspartame is an artificial non-saccharide sweetner 200 times sweeter than sucrose and is commonly used as a sugar substitute in foods and beverages. Structure of Aspartame is given below:



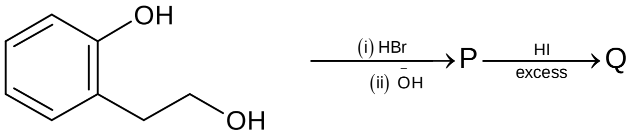
Which of the following is correct about aspartame?
(A) It contains 4 functional groups and on hydrolysis produce 2 essential amino acids
(B) It contains 5 functional groups and on hydrolysis produce one essential and one non essential amino acids
(C) It contains 4 functional group and on hydrolysis produce 2 non essential amino acids.
(D) It contains a 4 functional groups and on hydrolysis produce 1 essential and 1 non essential amino acids.

21. When trans-2 methyl cyclopentanol is treated with tosyl chloride and the product with potassium tert-butoxide; then the final product would be
(A) Methyl-cyclopentene
(B) 3-methyl cyclopentene
(C) Mixture of A and B
(D) t-butoxy cyclopentane

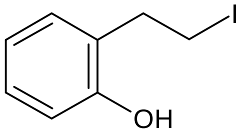
22. Correct increasing order of acidic strength among
Formic acid (I), Acetic acid (II), Oxalic acid (III) and Malonic acid (IV) would be:
(A) II < I < IV < III
(B) II < IV < I < III
(C) I < II < IV < III
(D) III < IV < II < I

23. Upon treatment with sulphuric acid, a mixture of tert-butyl alcohol and ethyl alcohol at room temperature gives mainly
(A) diethyl ether
(B) iso butane
(C) Di-t-butyl ether
(D) Tert-butyl ethyl ether

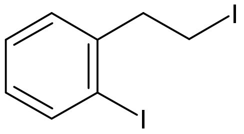
24.


OH
OH
(i) HBr
(ii) $\overset{-}{O}H$
P
HI
excess
Q

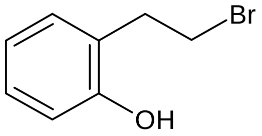
(A)



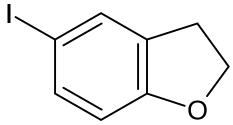
(B)



(C)

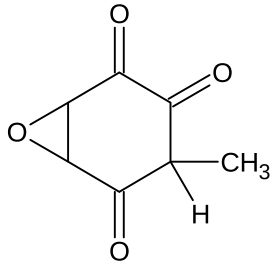


(D)

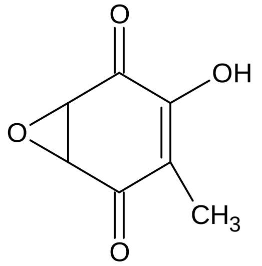


25. Terreic acids ($C_7H_6O_4$) is a naturally occurring antibiotic substance. Which of the following structure is most stable form of terreic acid

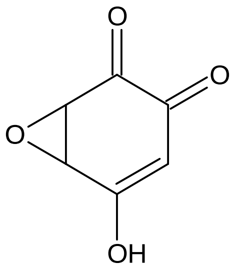
(A)



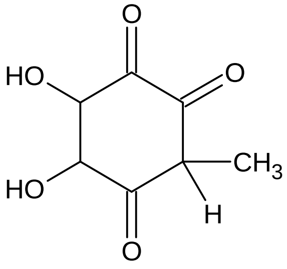
(B)



(C)



(D)


O
HO
O
CH3
HO
H
O

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

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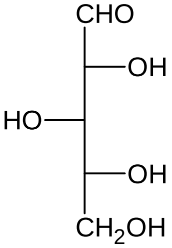
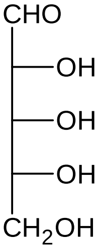
26. Which of the following compound/s is/are a D-sugar that gives an optically active pentitol on reduction?

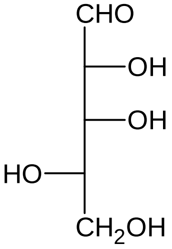
(A)


CHO
OH
HO
OH
CH2OH

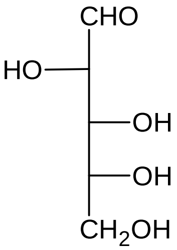
(B)


CHO
OH
OH
OH
CH2OH

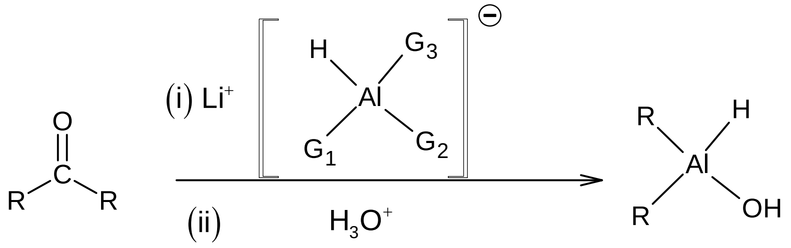
(C)


CHO
OH
OH
HO
CH2OH

(D)



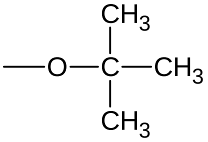
27.



Which of the following statement(s) is/are correct about the above reaction

(A) Rate of reaction decreases as the size of R increases

(B) Reaction rate is more when $G_1 = G_2 = G_3 = H$ (LAH) than When $G_1 = G_2 = G_3 =$

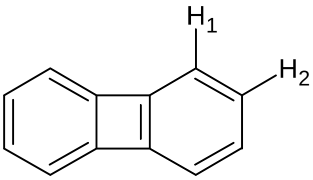


$-O-C(CH_3)_2-CH_3$ (LTBA)

(C) LTBA is much more sterically hindered compared to LAH and therefore, have difficulty in transferring hydride ions.

(D) LTBA is used to selectively reduce aldehydes and ketones in the presence of esters.

28.



Biphenylene

Which of the following statement(s) is/are correct about Biphenylene?

(A) It is a dimer of reactive intermediate benzyne

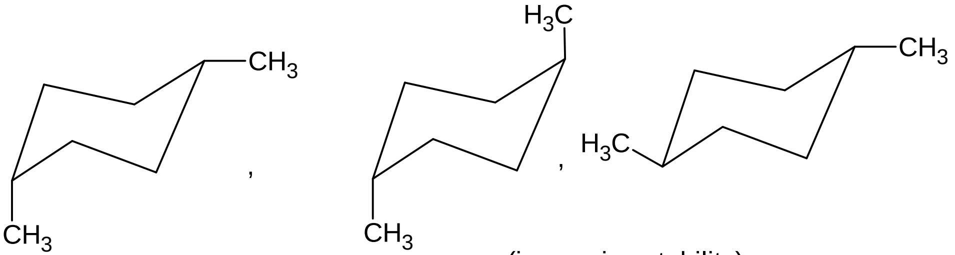
(B) All C – C bonds have equal length

(C) H_1 is more acidic than H_2

(D) Due to the influence of central ring it has lesser degree of aromaticity.

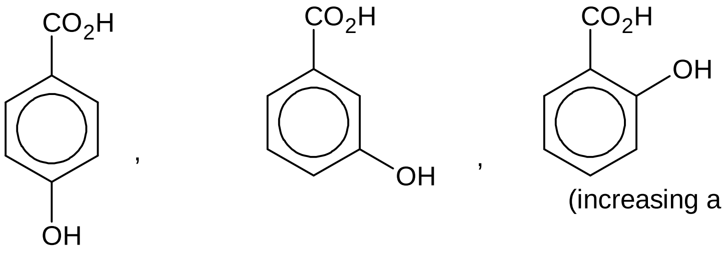
29. Which of the following is/are arranged in correct mentioned order

(A)



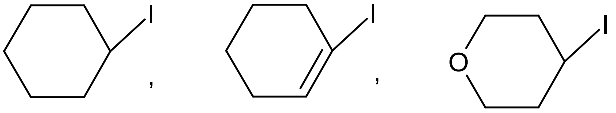
(increasing stability)

(B)


CO2H
OH
,
CO2H
OH
,
CO2H
OH

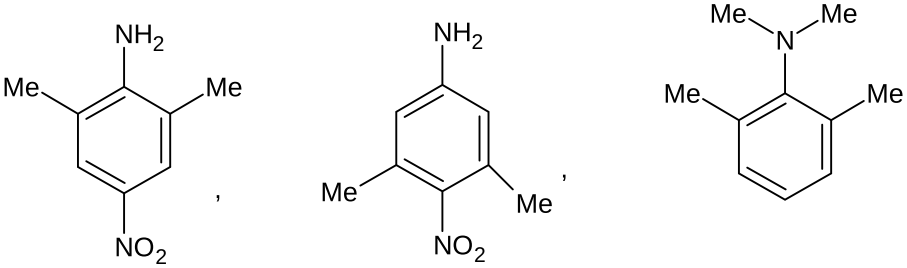
(increasing acid strength)

(C)



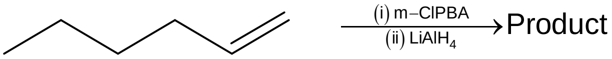
(increasing rate of solvolysis)

(D)


NH2
Me
Me
NO2
,
NH2
Me
Me
NO2
,
Me
N
Me
Me
Me

(increasing basic strength)

30.


(i) m–ClPBA
(ii) LiAlH4
Product

Which of the following is/are correct about product?

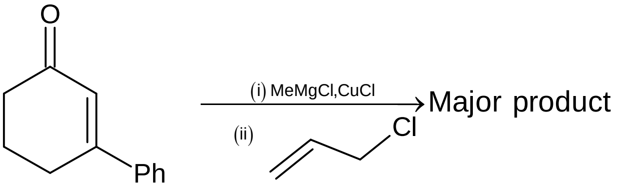
(A) It is racemic mixture

(B) Product is a hydrocarbon which can not decolourise Br_2 – water

(C) Product can give positive iodoform test

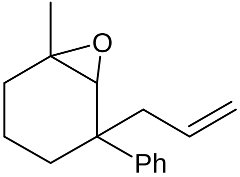
(D) Product is also obtained from the alkene by HBO (hydroboration – oxidation) process

31.

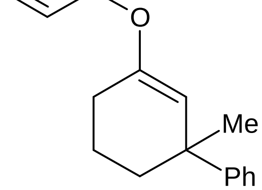

O
Ph
(i) MeMgCl,CuCl
(ii)
Cl
Major product

Which of the following options can not be the major product?

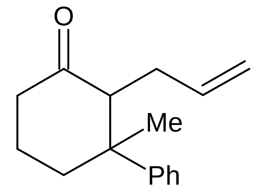
(A)



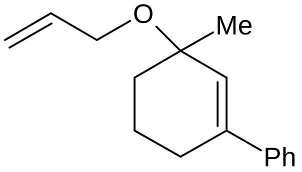
(B)



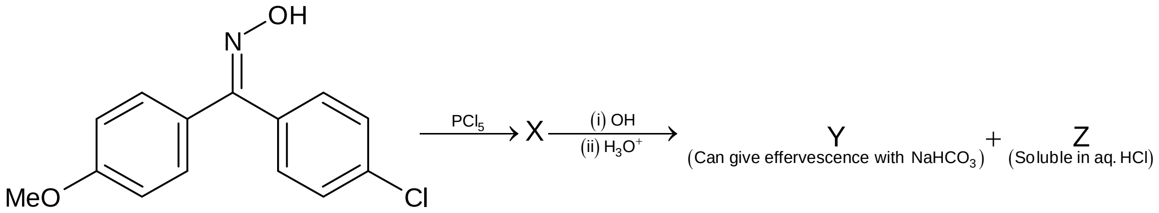
(C)



(D)



32.


OH
N
MeO
Cl
PCl5
X
(i) OH
(ii) H3O+
Y
(Can give effervescence with NaHCO3)
+
Z
(Soluble in aq. HCl)

Identity the correct statements:

(A) (Y) is more acidic than benzoic acid

(B) (Z) is weaker base than aniline

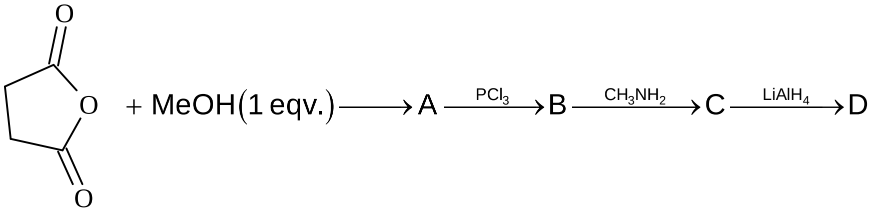
(C) In (X) both the benzene rings are activated towards EAS

(D) Z reacts at much faster rate towards electrophile than Y.

Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 33 and 34


O
O
O
+ MeOH(1 eqv.)
A
PCl3
B
CH3NH2
C
LiAlH4
D

33. What would be correct choice for 'D' from the following statements:

(A) On heating with $CHCl_3$ along with aq. KOH produce foul smelling compound.

(B) Produce blue colour in Victor Meyor test.

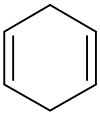
(C) On treatment with HNO_2 produces yellow oily compound.

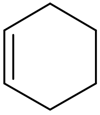
(D) It can produce substituted ammonium nitrite salt on treatment with HNO_2.

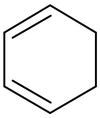
34. $D \xrightarrow[\text{(ii) AgOH,}\Delta]{\text{(i) }CH_3I\text{ excess}} E \xrightarrow[\text{(ii) AgOH,}\Delta]{\text{(i) }CH_3I\text{ excess}} F + G(C_3H_9N)$

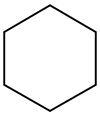
$F \xrightarrow{CH_2=CH_2,\ \Delta} H$

Structure of H would be:

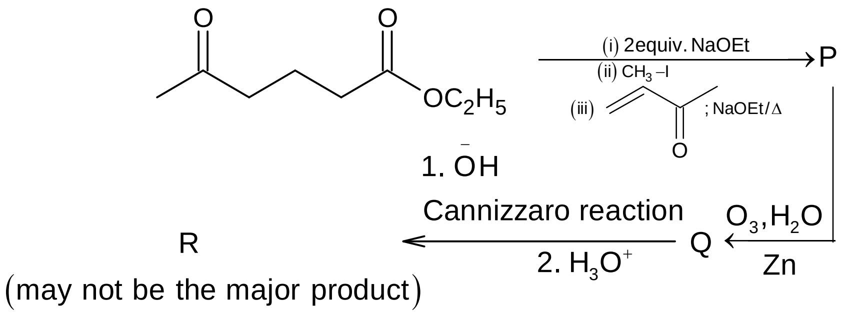
(A)


(B)


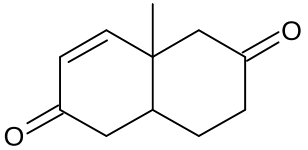
(C)


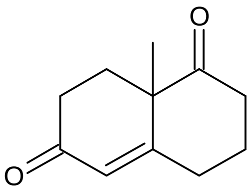
(D)


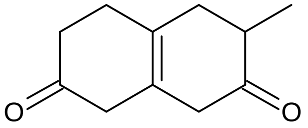
Paragraph for Question Nos. 35 to 36

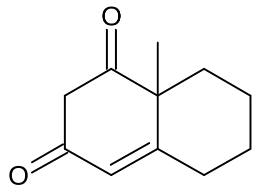

O
O
OC2H5
(i) 2equiv. NaOEt
(ii) CH3–I
(iii) ; NaOEt/Δ
O
P
O3, H2O
Zn
Q
1. OH⁻
Cannizzaro reaction
2. H3O+
R
(may not be the major product)

35. The correct structure of P, would be

(A)


(B)


(C)


(D) 

36. INCORRECT statement about R is:
- (A) It produces effervescence on addition of $NaHCO_3$.
- (B) It give positive iodoform test.
- (C) It give coloured compound with 2, 4 DNPH.
- (D) It gives reddish brown colouration with freshly prepared $FeCl_3$ solution.

Mathematics

PART – III

SECTION – A

(One Options Correct Type)

This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. Let $f(x) = \left[2019^{\sin^2 x} + 2019^{\cos^2 x}\right]$ (where [.] denotes the greatest integer function), then number of integers in range of f(x) is
(A) 1930
(B) 1931
(C) 1932
(D) none of these

38. Circle $x^2 + y^2 - 2x - 3 = 0$ intersects parabola $y^2 = 4x$ at points A and B. Let tangents to the parabola at A and B intersect at point C. If radius of circle increases at a rate of 1 m/s, the speed of point C after 2019 seconds is (in m/s)
(A) 1
(B) $\frac{2019}{2}$
(C) 2019
(D) none of these

39. Let S_1 and S_2 be two externally tangent circles having the same radius ‘r’. Let L be a direct common tangent to S_1 and S_2. If S_n be circle such that it touches S_{n-1} and S_1 externally and line L, $\forall\, n \geq 3$, $n \in N$, then radius of S_{2020} is
(A) r
(B) $\frac{r}{2019}$
(C) $\frac{r}{(2019)^2}$
(D) $\frac{r}{(2019)^3}$

40. In a scalene ΔABC, E and F are points on the sides AC and AB respectively such that BE and CF are internal angle bisectors of the triangle. If BE and CF intersect at I and IE = IF, then $\angle CAB$ can be equal to
(A) $\frac{\pi}{3}$
(B) $\frac{\pi}{2}$
(C) $\frac{2\pi}{3}$
(D) $\frac{3\pi}{4}$

41. Let A = {x | x $\in$ N, x $\le$ 105, x is coprime with 105} value of $\sum_{r\in A}\cos\left(\frac{2\pi r}{105}\right)$ is equal to

(A) –3
(B) –1
(C) 0
(D) none of these

42. The trigonometric equation $\sum_{r=1}^{6} r^3\sin(r\pi x) = 441$ (x $\in$ R) has

(A) no solution
(B) unique solution
(C) infinite solutions
(D) finite number of solutions

43. Value of $\sqrt{2+\sqrt{2+\sqrt{2+\sqrt{2+2\cos 1360^\circ}}}}$ is equal to

(A) 2 cos 5°
(B) 2 cos 25°
(C) 2 cos 65°
(D) 2 cos 85°

(One or More than one correct type)

This section contains **07** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

44. Let $f(x) = \sum_{r=0}^{n}(r+2)x^{2r}$ and g(x) = $ax^2 + \cos^2 b + \sin b$ where n $\in$ N ; a, b $\in$ R. If d(n, a, b) represents shortest distance between curves y = f(x) and y = g(x) for given values of n, a, b ; then

(A) d(2019, 2020, b) = $\frac{3}{4}$ $\forall$ b $\in$ R
(B) d(n, –2018, b) = $\frac{3}{4}$ $\forall$ b $\in$ R, n $\in$ N
(C) d(n, a, b) = $\frac{3}{4}$ $\forall$ n $\in$ N, a, b $\in$ R
(D) d(2020, a, b) = $\frac{3}{4}$ $\forall$ a, b $\in$ R

45. For the hyperbola $2x^2 + 12xy - 7y^2 - 16x + 2y - 3 = 0$, which of the following is/are true?

(A) Equation of its conjugate hyperbola is $2x^2 + 12xy - 7y^2 - 16x + 2y + 17 = 0$
(B) Its asymptotes are given by $2x^2 + 12xy - 7y^2 - 16x + 2y + 7 = 0$
(C) Its principal axes are given by $2x^2 - 2y^2 - x + 7y - 3xy - 3 = 0$
(D) Orthocentre of triangle formed by any three points on the hyperbola lies on the hyperbola itself

46. Let P be a point on the parabola $y^2 = 4x$ such that normal chord drawn at P to parabola has shortest length. If tangent and normal at P intersects axis of parabola at A and B respectively, then

(A) Slope of normal at P is ± 2
(B) Slope of tangent at P is $\pm\frac{1}{\sqrt{2}}$
(C) Area of ΔPAB is $12\sqrt{2}$ sq. units
(D) Circumcenter of ΔPAB is (1, 0)

47. A particle starts from origin and moves at a constant speed of 4 unit/s towards positive x-axis. The particle changes its direction by angle 'θ' (clockwise or anticlockwise at random) with respect to its previous direction after every 2 seconds, then

(A) For $\theta = \frac{\pi}{2}$, particle can pass through the point (2019, 0)

(B) For $\theta = \pi$, particle will trace a line segment

(C) For $\theta = \frac{\pi}{3}$, particle may lie on the line $y + \sqrt{3}x = 0$

(D) For $\theta = \frac{\pi}{6}$, after 2019 seconds, particle may lie on the line $x - \sqrt{3}y - 8 = 0$

48. Let $A = \left\{x \,|\, 1 + 4^{\sin x - \cos x} = \sec^2 x, x > 0\right\}$, then

(A) elements of set A form an Arithmetic Progression
(B) number of elements of set A which are less than $n\pi$ is n + 1
(C) the sum of smallest four elements is 3π
(D) set A contains only irrational elements

49. A square is formed such that its opposite sides are tangential to the hyperbola $x^2 - y^2 = 1$. Determine which of the following is/are true?

(A) Side length of largest possible square is 2
(B) Side length of largest possible square is $2\sqrt{2}$
(C) Side length of smallest possible square is $2^{\frac{3}{4}}$
(D) Side length of smallest possible square is $2^{\frac{5}{4}}$

50. For given pair of lines $f(x, y) = ax^2 + by^2 + 2hxy + 2gx + 2fy + c = 0$, which of the following is/are **NOT** true?

(A) If $h^2 > ab$, then f(x, y) = 0 always represents distinct real lines
(B) If $h^2 = ab$, then f(x, y) = 0 always represents coincident real lines
(C) If $h^2 = ab$, then f(x, y) = 0 always represents distinct real lines
(D) If $h^2 \geq ab$, then f(x, y) = 0 always represents real lines

Paragraph Type (One Option Correct)

This section contains **02 paragraph** each describing theory, experiment, data etc. **Four questions** relate to the paragraph. Each question of a paragraph has **Only One correct** answer among the four choices (A), (B), (C) and (D).

Paragraph for Question Nos. 51 to 52

Read the following write up carefully and answer the following questions:
Consider the lines x = 0, y = 0 and 3x + 4y = 12. Let S_1, S_2, S_3, S_4 be four distinct circles with each of them touching the three lines. Let S_1 be the smallest of the four circles. Let A_i and C_i represent the area and the centre respectively of circle S_i for i = 1, 2, 3, 4.

51. Which of the following is true for A_1, A_2, A_3, A_4?

(A) Their Arithmetic mean is 25π
(B) Their Geometric mean is 6π
(C) Their Harmonic mean is 2π
(D) None of these

52. Let circles S_5, S_6, S_7 be drawn with C_2C_3, C_3C_4 and C_4C_2 as diameters, then radical centre of the circles S_5, S_6, S_7 is
(A) (1, 1)
(B) (0, 0)
(C) $\left(2, \frac{3}{2}\right)$
(D) $\left(\frac{4}{3}, 1\right)$

Paragraph for Question Nos. 53 to 54

Read the following write up carefully and answer the following questions:
Let ABC be a triangle such that $\angle ABC = 75°$, $\angle BCA = 60°$, $\angle CAB = 45°$ and AB = 1 unit. Let D, E, F be points on sides AB, BC, AC respectively such that perimeter of ΔDEF is minimum

53. Perimeter of ΔDEF is
(A) $\frac{3}{2}$
(B) $\frac{\sqrt{3}-1}{2}$
(C) $\frac{\sqrt{3}+1}{2}$
(D) none of these

54. Radius of circumcircle of ΔDEF is equal to
(A) $\sqrt{3}-1$
(B) $\frac{1}{2\sqrt{3}}$
(C) $\frac{1}{\sqrt{3}}$
(D) none of these

FIITJEE

ALL INDIA TEST SERIES

PART TEST – II

JEE (Advanced)-2020

PAPER – 2

TEST DATE: 17-11-2019

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. A

Sol. $$B_{net} = \frac{\mu_0 i}{4\pi R}\left(\frac{\sqrt{3}}{2}\right) - \frac{\mu_0 i}{4\pi R\sqrt{3}}\left(\frac{1}{2}\right)$$

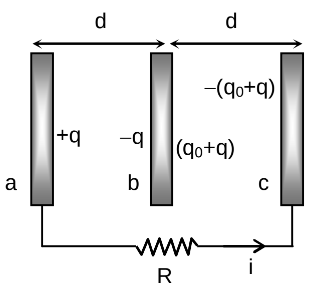
$$= \frac{\mu_0 i}{4\sqrt{3}\pi R}$$

2. D

Sol. Total charge (finally) = 0

So charge flown to the earth = $\sum_{i=1}^{N} Q_i$

3. B



Sol. $$\frac{q}{C} + \frac{q_0 + q}{C} = iR \qquad \left(\text{where } C = \frac{\varepsilon_0 A}{d}\right)$$

$$\Rightarrow i = \frac{q_0 + 2q}{RC} \qquad \Rightarrow -\frac{dq}{dt} = \frac{q_0 + 2q}{RC}$$

$$\Rightarrow -\int_0^q \frac{dq}{q_0 + 2q} = \int_0^t \frac{dt}{RC}$$

$$i = \frac{q_0 d}{R\varepsilon_0 A} e^{\frac{-2dt}{R\varepsilon_0 A}}$$

4. C

Sol. $(P)\left(\frac{4}{3}\pi r^3\right) = \sigma\left(4\pi r^2\right)T^4$

So $T = cr^{1/4}$ (where c is a constant)

5. B

Sol. All the spheres are at same potential so, $V_1 = V_2 = V_3$ and $Q_1 : Q_2 : Q_3 = R_1 : R_2 : R_3$ and $E_1 : E_2 : E_3 = \frac{1}{R_1} : \frac{1}{R_2} : \frac{1}{R_3}$.

6. B

Sol. $\frac{dQ}{dt} = kA\frac{dT}{dx}$

7. B

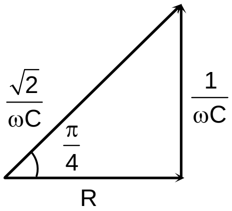
Sol. $W_{elect} = U_i - U_f$

$$U_i = \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1^2}{2a} + \frac{q_2^2}{2b} + \frac{q_3^2}{2c} + \frac{q_1q_3}{c} + \frac{q_1q_2}{b} + \frac{q_2q_3}{c}\right)$$

$$U_f = \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1^2}{2a} + \frac{q_2^2}{2b'} + \frac{q_3^2}{2c} + \frac{q_1q_3}{c} + \frac{q_1q_2}{b'} + \frac{q_2q_3}{c}\right)$$

8. B, C

Sol. From the Phasor diagram



9. A, D

Sol. Capacitors are connected in series, so charges on the capacitors remain same. During removal of the slab anticlockwise current flows through the circuit, so battery is being charged.

10. B

Sol. 0 = dU + PdV = d(a + bPV) + PdV

After solving

$PV^{\frac{b+1}{b}} = $ constant

11. A, B, C, D

Sol. When only S_2 is open

$\frac{2}{3} = \left(\frac{4}{120}\right)\ell \Rightarrow \ell = 20$ cm

When only S_1 is open

$2 = \left(\frac{4}{120}\right)\ell \Rightarrow \ell = 60$ cm

When all three are closed

$2 = \frac{4}{120}\times\ell \Rightarrow \ell = 60$ cm

When only S_1 is closed

$2 = \frac{4}{120}\times\ell \Rightarrow \ell = 60$ cm

12. B, D

Sol. Every body radiates and absorbs radiation simultaneously at any non zero temperature T.

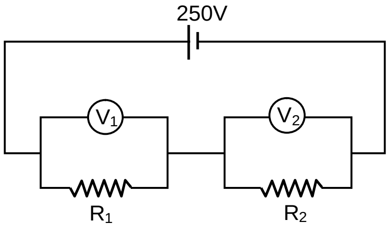
13. B, D

Sol. When switch S is open

$$V_1 = \frac{250}{10000}(6000) = 150\,V$$

$$V_2 = \frac{250}{10000}(4000) = 100\,V$$

When switch S is closed circuit reduces to shown in the figure.



So both the voltmeters show readings $V_1 = V_2 = \frac{250}{2} = 125\,V$

14. A, B

Sol. Distance of the target x = (n) $\frac{2\pi m}{qB} v\cos\theta$, where n is an integer

$$\frac{nv}{B} = \frac{v_0}{B_0}$$

15. A

16. B

Sol. (for Q.15-16)

Emf induced between the plates = Bwv

So $I = \frac{Bwv(Lh)\sigma}{w} = BLh\sigma v$

So $F_B = BIw = B^2Lh\sigma wv$

So net external force = $\Delta Phw - B^2Lh\sigma wv = kv$

(at steady state)

In the absence of magnetic field, $\Delta Phw = kv_0$

So $\Delta Phw - B^2 Lh\sigma wv = \frac{\Delta Phw}{v_0}v$

So $v = \frac{\Delta Pv_0}{\Delta P + B^2L\sigma v_0}$

17. D

18. B

Sol. (for Q. 17-18)

Acceleration of ball, a = $\frac{qV}{md}$

So time of motion, $\Delta t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2md^2}{qV}}$

So $I = \frac{\Delta Q}{\Delta t} = \frac{n_0qA}{\sqrt{\frac{2md^2}{qV}}} = \frac{C}{\varepsilon_0}n_0q\sqrt{\frac{qV}{2m}}$

So $R = \frac{V}{I} = \frac{\varepsilon_0 V}{Cn_0q}\sqrt{\frac{2m}{qV}} = \frac{\varepsilon_0}{Cn_0q}\sqrt{\frac{2mV}{q}}$

Chemistry PART – II

SECTION – A

(One Options Correct Type)

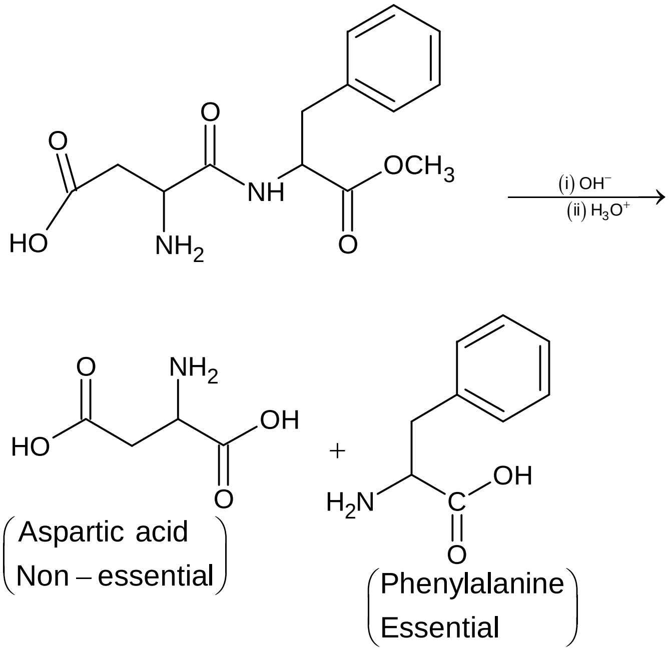
This section contains **07 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

19. B

Sol. Down the group nucleophilicity generally increases in polar protic solvent, and if attacking atom is same stronger the base, stronger the nucleophile.

20. D

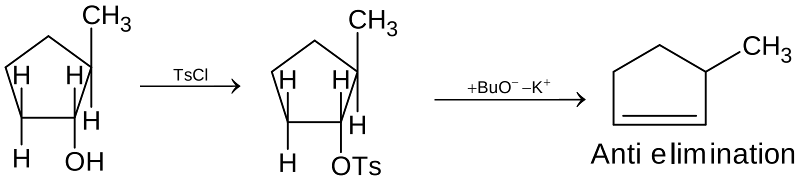
Sol.



O
O
OCH3
NH
HO
NH2
O
(i) OH⁻
(ii) H3O⁺
O
NH2
OH
HO
O
+
OH
H2N
C
O
Aspartic acid
Non – essential
Phenylalanine
Essential

21. B

Sol.



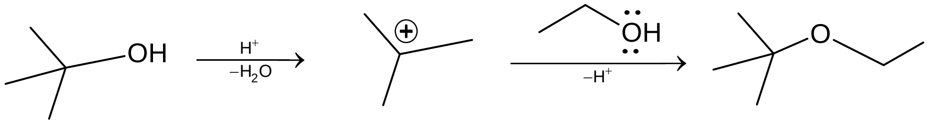
CH3
H
H
H
H
OH
TsCl
CH3
H
H
H
H
OTs
+BuO⁻–K⁺
CH3
Anti elimination

22. A

Sol. The – COOH group is electron-withdrawing, acid strengthening compared to – H or – CH_3.

23. D

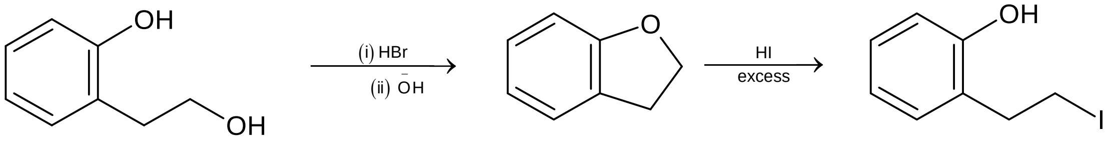
Sol.



OH
H⁺
–H2O
OH
–H⁺
O

24. A

Sol.


OH
OH
(i) HBr
(ii) $\bar{O}$H
O
HI
excess
OH
I

25. B

Sol. db is conjugated by two carbonyl groups.

26. D

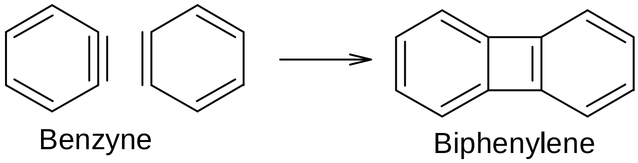
Sol. Conceptual.

27. A, B, C, D

Sol. Conceptual.

28. A, C, D

Sol.


Benzyne
Biphenylene

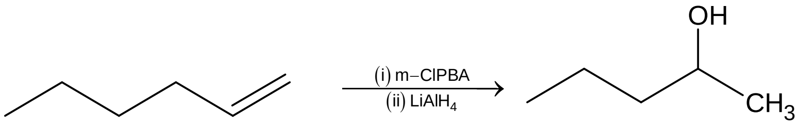
All C – C bonds are not equal in biphenylene. Central ring is antiaromatic.

29. B, D

Sol. Conceptual.

30. A, C

Sol.


(i) m−ClPBA
(ii) LiAlH$_4$
OH
CH$_3$

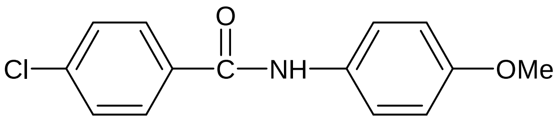
31. A, B, D

Sol. Conceptual.

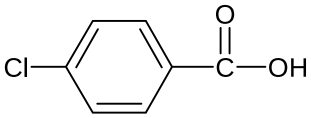
32. A, D

Sol.

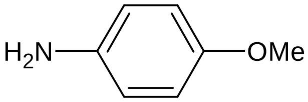
X →



Y →



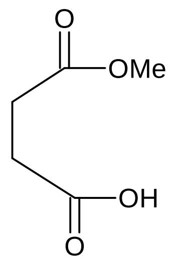
Z →



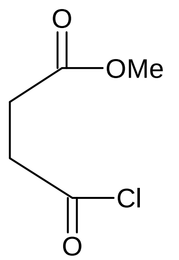
33. D

Sol.

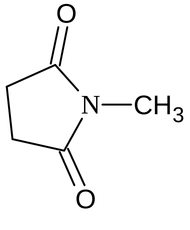
(A) →



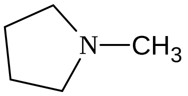
(B) →



(C) →



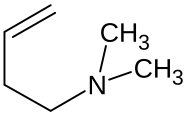
(D) →



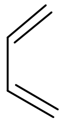
34. B

Sol.

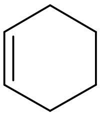
(E) →



(F) →



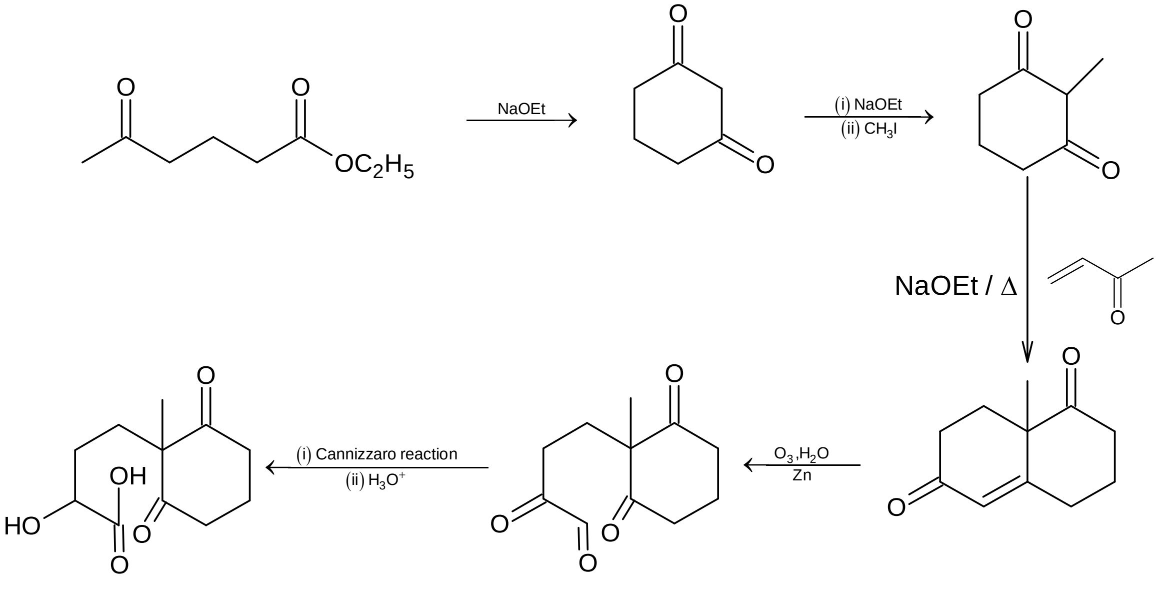
(H) →



35. B

36. B

Sol. (for Q. No. 35 and 36)



NaOEt
(i) NaOEt
(ii) CH_3I
NaOEt / Δ
O_3,H_2O
Zn
(i) Cannizzaro reaction
(ii) H_3O^+
OC₂H₅
OH
HO

Mathematics

PART – III

SECTION – A

37. C

Sol. $2020 \geq f(x) \geq 2\sqrt{2019}$

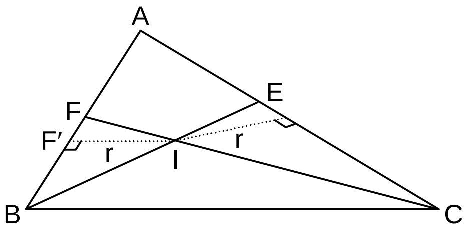
38. A

Sol. C always lies on circle

39. C

Sol. $\frac{1}{\sqrt{r_n}} = \frac{1}{\sqrt{r_1}} + \frac{1}{\sqrt{r_{n-1}}} \Rightarrow r_{2020} = \frac{r}{(2019)^2}$

40. C



Sol. $\text{IF} = r\,\text{cosec}\left(B + \frac{C}{2}\right)$

$\text{IE} = r\,\text{cosec}\left(C + \frac{B}{2}\right)$

$\text{IE} = \text{IF} \Rightarrow \sin\left(B + \frac{C}{2}\right) = \sin\left(C + \frac{B}{2}\right)$

$\Rightarrow 2\sin\left(\frac{B}{4} - \frac{C}{4}\right)\cos\left(\frac{3B}{4} + \frac{3C}{4}\right) = 0$

$\Rightarrow \frac{3}{4}(B + C) = (2n+1)\frac{\pi}{2},\ n \in I$

41. B

Sol. Let B_n be set of natural numbers less than or equal to 105 which are multiples of ‘n’, then

$A = B_1 - B_2 \cup B_5 \cup B_7$ ($\because$ $105 = 3 \times 5 \times 7$)

$\Rightarrow \sum_{r \in A} \cos\left(\frac{2\pi r}{105}\right) = \sum_{r=1}^{105} \cos\left(\frac{2\pi r}{105}\right) - \sum_{r \in B_3 \cup B_5 \cup B_7} \cos\left(\frac{2\pi r}{105}\right)$

Using sum of ‘n’ n^{th} roots of unity is 0, we get $\sum_{r \in A} \cos\left(\frac{2\pi r}{105}\right) = -1$

42. A

Sol. $\sum_{r=1}^{6} r^3 = 441$ if equation has a solution then $\sin(r\pi x)$ should be equal to 1 for r = 1, 2, ..., 6, which is not possible

43. A

Sol. Use $\cos 2\theta = 2\cos^2\theta - 1$

44. A, B

Sol. $g(x) = ax^2 + \frac{5}{4} - \left(\sin b - \frac{1}{2}\right)^2$

45. A, B, C

Sol. Let equation of asymptotes be A : $2x^2 + 12xy - 7y^2 - 16x + 2y + d = 0$ where ‘d’ is given by $\Delta = 0$

Angle bisectors of asymptotes give principal axis

46. B, D

Sol. Length of chord joining P(t_1) and Q(t_2) is $|t_1-t_2|\sqrt{(t_1+t_2)^2+4}$

As PQ is normal at P $\Rightarrow$ $t_2=\frac{-2}{t_1}-t_1$. Length is minimum for $t_1^2=2$ i.e., $t_1=\pm\sqrt{2}$

$\Rightarrow$ P is $(2, 2\sqrt{2})$ or $(2, -2\sqrt{2})$, A is (–2, 0) and B is (4, 0)

Area of ΔPAB is $6\sqrt{2}$ sq. units and circumcenter is focus

47. A, B, C, D

Sol. For $\theta=\frac{\pi}{2}$, particle can pass through all point on coordinate axes

For $\theta=\frac{\pi}{6}$, if particle always changes its direction anticlockwise, then if will lie on $x-\sqrt{3}y-8=0$ after 2019 seconds

48. A, D

Sol. $2^{\sin x-\cos x}=\pm\tan x \Rightarrow 2^{\sin x-\cos x}=\tan x \Rightarrow x=n\pi+\frac{\pi}{4}$, $n\in W$

49. A, C

Sol. Let tangent of slope m be $y=mx\pm\sqrt{m^2-1}$, then side length will be $2\sqrt{\frac{m^2-1}{m^2+1}}$

Also, length of diagonal of square should be greater than or equal to distance between points of tangency

$\Rightarrow 2\sqrt{2}\sqrt{\frac{m^2-1}{m^2+1}}\ge 2\sqrt{\frac{m^2+1}{m^2-1}} \Rightarrow m^2\ge\left(\sqrt{2}+1\right)^2$

Side length = $2\sqrt{\frac{m^2-1}{m^2+1}}$ (for smallest square) = $2\sqrt{\frac{2+2\sqrt{2}}{4+2\sqrt{2}}}=2^{\frac{3}{4}}$

Side length of largest possible square is 2 (as $m\to\infty$)

50. A, B, C

Sol. For distinct real lines $h^2 > ab$ and $g^2 > ac$
For coincident lines $h^2 = ab$ and $g^2 = ac$
For distinct parallel lines $h^2 > ab$, $g^2 > ac$

51. B

Sol. $A_1=\pi$, $A_2=4\pi$, $A_3=9\pi$, $A_4=36\pi$

52. A

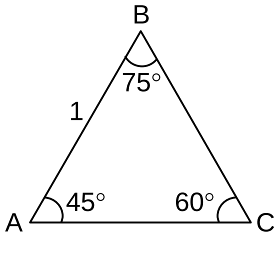
Sol. Radical centre is incenter of the triangle formed by three lines

53. C

Sol. Minimum perimeter is for orthic triangle whose sides are
a cos A, b cos B, c cos C

$a=\sqrt{\frac{2}{3}}$, b = 1, $c=\frac{\sqrt{3}+1}{\sqrt{6}}$ (Using sine rule)

So, sides of ΔDEF are $\frac{1}{2}$, $\frac{1}{\sqrt{3}}$ and $\frac{1}{2\sqrt{3}}$



54. B

Sol. Radius of circumcircle of ΔDEF = half of circumradius of ΔABC = $\frac{1}{2}\cdot\frac{1}{2\sin 60^\circ}=\frac{1}{2\sqrt{3}}$

FIITJEE

ALL INDIA TEST SERIES

PART TEST – II

JEE (Main)-2020

TEST DATE: 16-11-2019

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 75 questions.
- Each subject (PCM) has 25 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only three sections: **Section-A**, **Section-B and Section-C**.

  Section-A (01 – 20, 26 – 45, 51 – 70) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

  Section-B (21 – 22, 46 – 47, 71 – 72) *contains 6 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

  Section-C (23 – 25, 48 – 50, 73 – 75) *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

Physics

PART – I

SECTION – A

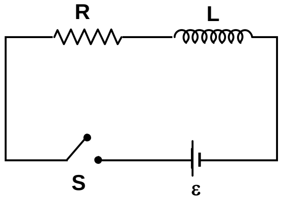
(One Options Correct Type)

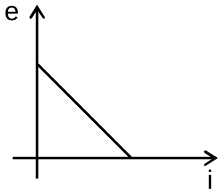
This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

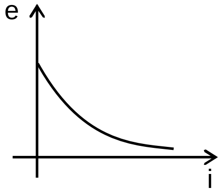
1. A sphere of radius 3.5 cm and mass 250 gm floats in a liquid at 20°C. As the temperature is raised, the sphere just begins to sink at a temperature of 35°C. If the density of liquid at 0°C is 1.527 gm/cm^3, find the coefficient of cubical expansion of the liquid. Neglect expansion of the sphere.
(A) 1.30×10^{-3} C^{-1}
(B) 5.61×10^{-3} C^{-1}
(C) 2.75×10^{-3} C^{-1}
(D) 8.68×10^{-5} C^{-1}

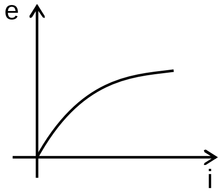
2. In a certain region of outer space there are only 100 molecules per cm^3 on an average. The temperature there is about 3K. What is the average pressure of this very dilute gas?
(A) 4.14×10^{-15} Pa
(B) 1.14×10^{-15} Pa
(C) 8.28×10^{-14} Pa
(D) 9.50×10^{-14} Pa

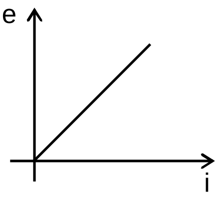
3. In an L-R circuit connected to a battery of constant emf ε, switch S is closed at time t = 0. If e denotes the induced emf across inductor and i the current in the circuit at any time t. Then which of the following graphs shows the variation of e with i?



(A)


(B)


(C)


(D) 

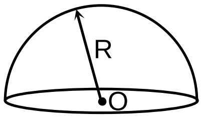
4. A parallel beam of nitrogen molecules moving with velocity v = 400 m/s impinges on a wall at an angle $\theta = 30^\circ$ to its normal. The concentration of molecule in the beam $n_0 = 0.9 \times 10^{19}\ \text{cm}^{-3}$. Find the pressure exerted by the beam on the wall assuming the collisions of molecules with the wall are perfectly elastic.

(A) 10^6 Pa
(B) 10^7 Pa
(C) 10^4 Pa
(D) 10^5 Pa

5. A beam of fast moving electrons having cross section area A falls normally on flat surface. The electrons are absorbed by the surface and the average pressure exerted by the electrons on this surface is found to be P. If the electrons are moving with a speed v, then the effective current through any cross section of the electrons beam is

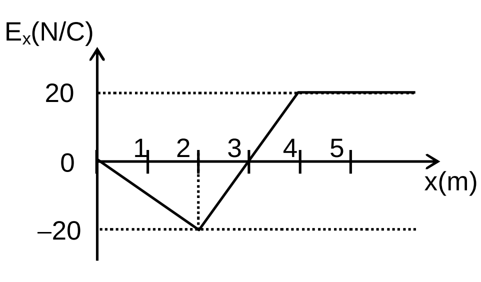
(A) $\frac{APe}{(mv)}$
(B) $\frac{APe}{(mv^2)}$
(C) $\frac{2APe}{(mv)}$
(D) $\frac{APm}{(ev)}$

6. Charge Q coulombs is uniformly distributed through out the volume of a solid hemisphere of radius R meters. Then find the potential at centre O of the hemisphere in volts.



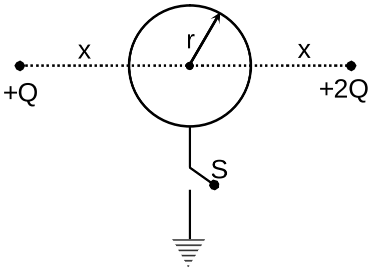
(A) $\frac{1}{4\pi\varepsilon_0}\frac{3Q}{2R}$
(B) $\frac{1}{4\pi\varepsilon_0}\frac{3Q}{4R}$
(C) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{4R}$
(D) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{8R}$

7. A graph of the X component of the electric field as a function of x in a region of space is shown. The Y and Z components of the electric field are zero in this region. If the electric potential is 10V at the origin, then find the potential at x = 2.0 m.



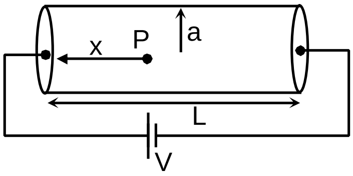
(A) 10 V
(B) 40 V
(C) –10 V
(D) 30 V

8. Two particles having positive charges +Q and +2Q are fixed at equal distance x from the centre of a conducting sphere having zero net charge and radius r as shown. Initially the switch S is open. After the switch S is closed, then find the net charge following out of sphere.



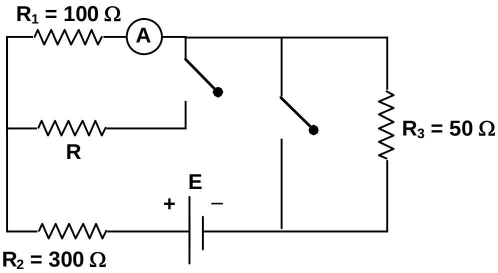
(A) $\frac{Qr}{x}$
(B) $-\frac{Qr}{x}$
(C) $\frac{3Qr}{x}$
(D) $-\frac{3Qr}{x}$

9. A cylindrical solid rod of length L and radius 'a' is connected across a source of emf V and negligible internal resistance as shown in the figure. The resistivity of the rod at point P at a distance 'x' from left end is given by $\rho = bx$ (where b is a positive constant). Find the electric field at point P.



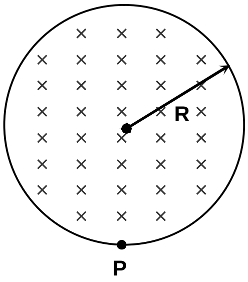
(A) $\frac{2V}{L^2}x$
(B) $\frac{V}{L^2}x$
(C) $\frac{4V}{L^2}x$
(D) $\frac{8V}{L^2}x$

10. In the circuit shown, the reading of the ammeter (ideal) is the same with both switches open as with both closed. Find the value of resistance R in Ω.



(A) 600
(B) 800
(C) 400
(D) 300

11. A uniform magnetic field of induction B is confined to cylindrical region of radius R. The magnetic field is increasing at a constant rate of $\frac{dB}{dt}(TS^{-1})$. An electron of charge –e, placed at the point P on the periphery of the field experiences an acceleration.



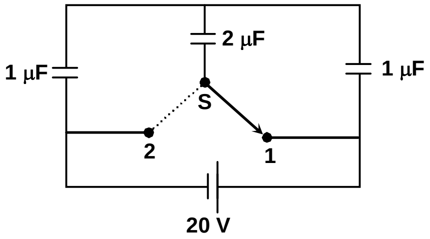
(A) $\frac{1}{2}\frac{eR}{m}\frac{dB}{dt}$ towards left

(B) $\frac{1}{2}\frac{eR}{m}\frac{dB}{dt}$ towards right

(C) $\frac{eR}{m}\frac{dB}{dt}$ towards left

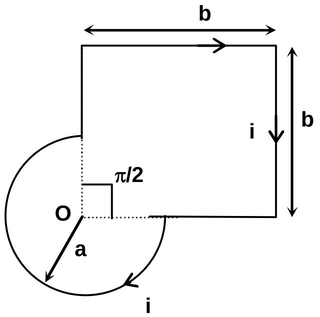
(D) zero

12. The amount of heat liberated when the switch S is shifted from position 1 to 2 is



(A) 180 μJ
(B) 200 μJ
(C) 220 μJ
(D) 210 μJ

13. Find the magnitude of magnetic field at O (centre of the circular part) of the current carrying coil as shown.



(A) $\frac{\mu_0 i}{4\pi}\left(\frac{3\pi}{a}+\frac{\sqrt{2}}{b}\right)$

(B) $\frac{\mu_0 i}{2\pi}\left(\frac{3\pi}{2a}+\frac{\sqrt{2}}{b}\right)$

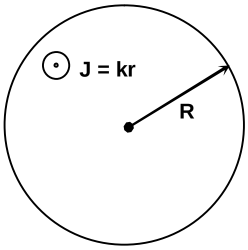
(C) $\frac{\mu_0 i}{2\pi}\left(\frac{\pi}{3a}+\frac{3}{\sqrt{2}b}\right)$

(D) $\frac{\mu_0 i}{4\pi}\left(\frac{3\pi}{2a}+\frac{\sqrt{2}}{b}\right)$

14. If a charged particle goes un accelerated in a region containing electric and magnetic fields, then which of the following is true?
    (A) $\vec{E}$ must be parallel to $\vec{B}$
    (B) $\vec{V}$ must be perpendicular to $\vec{E}$.
    (C) $\vec{E}$ must be equal to $\vec{B}$
    (D) $\vec{V}$ must be perpendicular to $\vec{B}$.

15. A nonconducting spherical shell of radius 'R' and uniformly charged on its surface with charge 'Q' is rotating about its diametrical axis with a constant angular velocity 'ω'. Find the magnetic moment of the sphere.
    (A) $\frac{QR^2\omega}{2}$
    (B) $\frac{QR^2\omega}{3}$
    (C) $\frac{QR^2\omega}{4}$
    (D) none of these

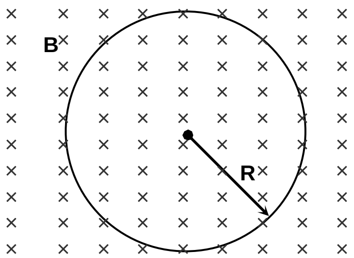
16. The current density (current per unit area) in a solid cylinder of radius R varies with distance r from its axis as J = kr, where k is a constant. Find the magnetic field at a point P where r > R.



    (A) $\frac{\mu_0 kR^2}{r}$
    (B) $\frac{\mu_0 kR^3}{r}$
    (C) $\frac{\mu_0 kR^3}{2r}$
    (D) $\frac{\mu_0 kR^3}{3r}$

17. An equilateral triangular loop of wire of side ℓ carries a current i. The magnetic field produced at the circum centre of the loop is
    (A) $\frac{\mu_0}{4\pi}\frac{3\sqrt{3}i}{\ell}$
    (B) $\frac{\mu_0}{4\pi}\frac{9i}{\ell}$
    (C) $\frac{\mu_0}{4\pi}\frac{18i}{\ell}$
    (D) $\frac{\mu_0}{4\pi}\frac{6i}{\ell}$

18. A conducting loop of radius R is present in a uniform magnetic field B perpendicular to the plane of the ring. If radius R varies as a function of time 't' as $R = R_0 + t$, the emf induced in the loop is

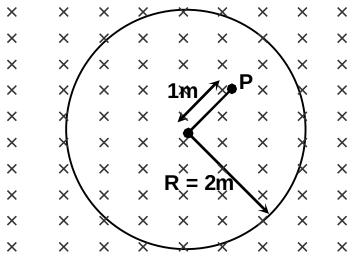


(A) $4\pi(R_0 + t)B$
(B) $\pi(R_0 + t)B$ clockwise
(C) $2\pi(R_0 + t)B$ anticlockwise
(D) zero

19. The magnetic flux through a conducting loop with resistance R varies during interval of time T as $\phi = at(T - t)$. The heat generated during this time, neglecting the inductance of loop will be

(A) $\frac{a^2T^3}{3R}$
(B) $\frac{a^2T^2}{3R}$
(C) $\frac{a^2T}{3R}$
(D) $\frac{a^2T^3}{R}$

20. The magnetic field in a certain cylindrical region is changing with time according to the law $B = (16 - 4t^2)$ Tesla. The induced electric field at point P at time t = 2sec.



(A) 8 Volt/m
(B) 6 Volt/m
(C) 4 Volt/m
(D) none of these

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

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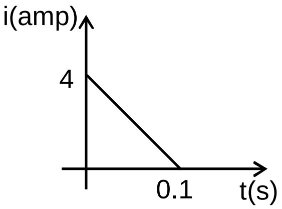
21. When magnetic flux through a coil is changed, the variation of induced current in the coil with time is as shown in graph. If resistance of coil is 10Ω, then the total change in flux (in Weber) of coil will be



22. The potential at a point P due to a point electric dipole is 1.8×0^5 V. If P is at a distance of 50 cm from the centre O of the dipole and if vector $\overrightarrow{OP}$ makes an angle 60° with the positive side of the axial line of the dipole, the dipole moment of the dipole is 10^{-n} C-m. Find the value of n.

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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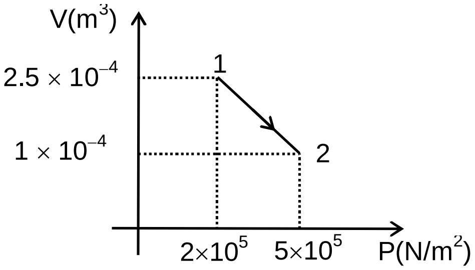
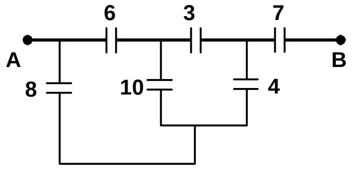
23. A gas is taken from State-1 to State-2 along the path shown in the figure. If 70 cal of heat is rejected by the gas in the process. Find the magnitude of change in internal energy (in Joule) of the system.



24. In the circuit diagram shown, all the capacitors are in μF. The equivalent capacitance between points A and B is (in μF)



25. 15 gm of nitrogen is enclosed in a container of constant volume at temperature T = 300 K. Find the amount of heat (in Joule) required to double the root mean square velocity of these molecules.

Chemistry

PART – II

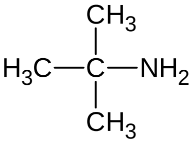
SECTION – A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

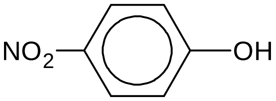
26. What is the degree of unsaturation of the compound formed by the reaction of formaldehyde with excess of ammonia?
(A) 6
(B) 4
(C) 3
(D) 5

27. Which of the amines can not be prepared by Gabriel's phthalimide synthesis?
(A) $CH_3-CH_2-CH_2-NH_2$
(B) $CH_3-CH_2-NH_2$
(C) CH_3-NH_2
(D)

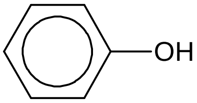


$H_3C-\overset{CH_3}{\underset{CH_3}{C}}-NH_2$

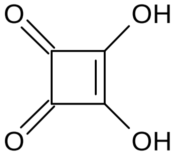
28. Which of the following acid is the strongest acid?
(A)



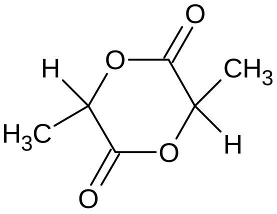
(B)



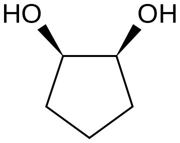
(C) CH_3-CH_2COOH
(D)



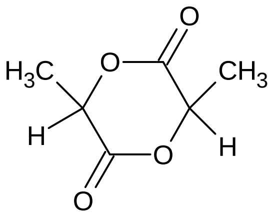
29. Which of the following molecule is chiral?
(A)



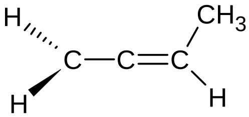
(B)



(C)

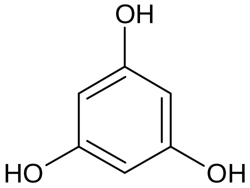


(D)

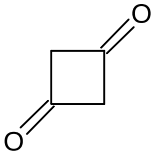


30. Which of the compound has most stable enol form?

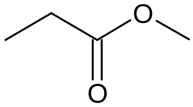
(A)



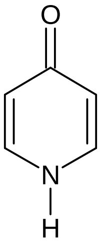
(B)



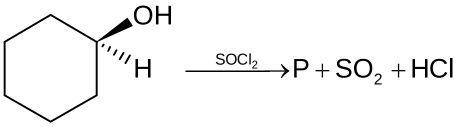
(C)



(D)

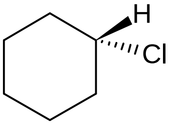


31.

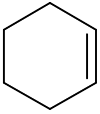


The structure of P is:

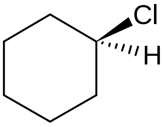
(A)



(B)

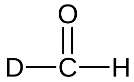


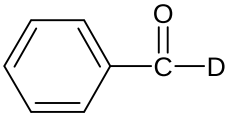
(C)

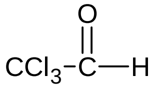


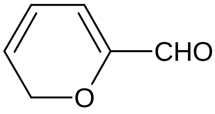
(D) Both A and C are in equal ratio

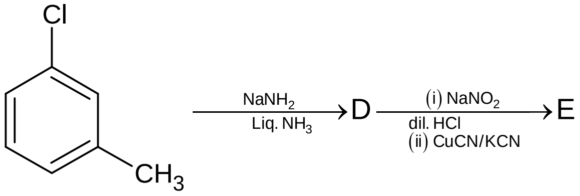
32. Which of the following compounds does not undergo Cannizzaro reaction?

(A)

$D-\overset{\overset{\displaystyle O}{\|}}{C}-H$

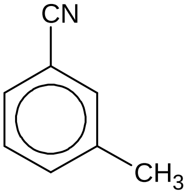
(B)


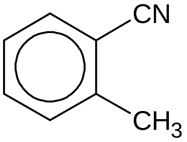
(C)

$CCl_3-\overset{\overset{\displaystyle O}{\|}}{C}-H$

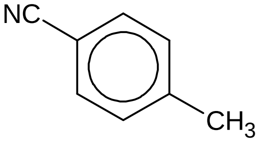
(D)


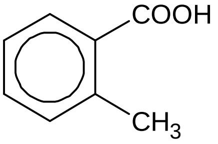
33.

Cl
CH3
NaNH2
Liq. NH3
D
(i) NaNO2
dil. HCl
(ii) CuCN/KCN
E

Find out the product E.

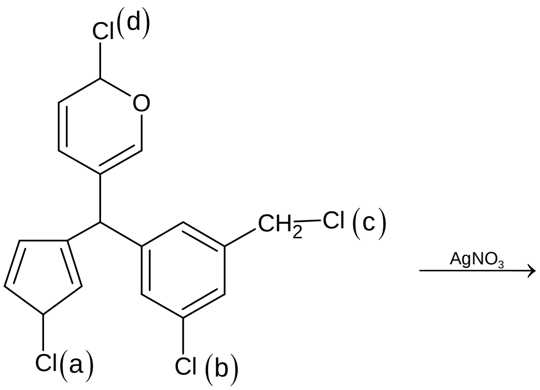
(A)


(B)


(C)


(D)


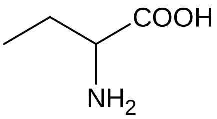
34.

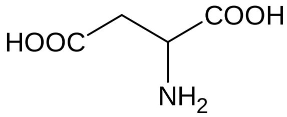

Cl(d)
O
CH2—Cl (c)
AgNO3
Cl(a)
Cl (b)

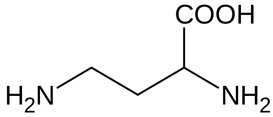
Which of the Cl is removed in fastest rate?
(A) Cl (a)
(B) Cl (b)
(C) Cl (c)
(D) Cl (d)

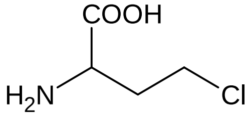
35. D-glucose and D-fructose can be distinguished by
(A) Fehling's Test
(B) Tollen's Test
(C) Br_2/H_2O
(D) Osazone formation

36. Which of the amino acids is a basic amino acid?

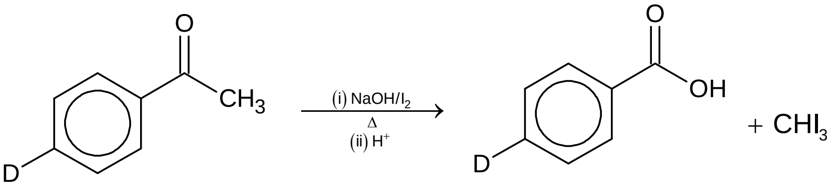
(A)


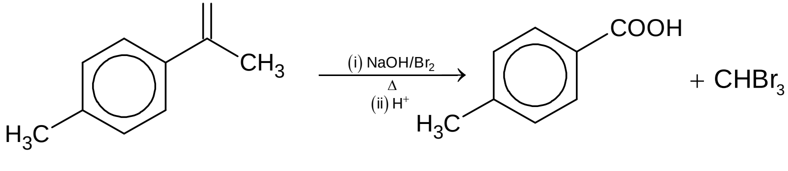
(B)

HOOC
COOH
NH2

(C)

COOH
H2N
NH2

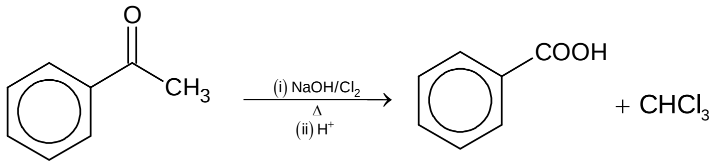
(D)


37. Which of the reaction takes place in fastest rate?

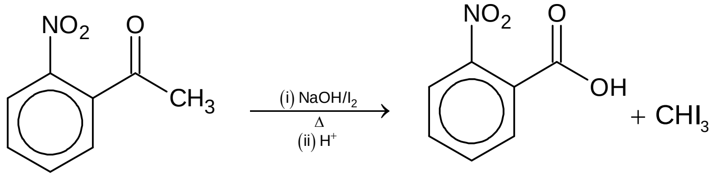
(A)

O
CH3
D
(i) NaOH/I2
Δ
(ii) H+
O
OH
D
+ CHI3

(B)

O
CH3
H3C
(i) NaOH/Br2
Δ
(ii) H+
COOH
H3C
+ CHBr3

(C)


O
CH3
(i) NaOH/Cl2
Δ
(ii) H+
COOH
+ CHCl3

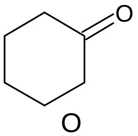
(D)


NO2
O
CH3
(i) NaOH/I2
Δ
(ii) H+
NO2
O
OH
+ CHI3

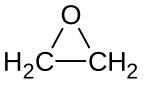
38. Which of the following compound produces primary alcohol on reaction with CH_3MgBr?

(A) $CH_3 - CH = O$

(B)



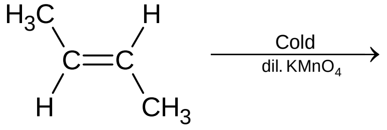
(C)



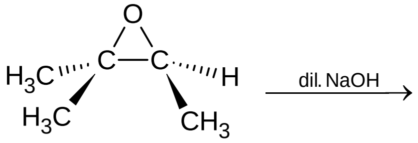
(D) $CH_3 - C \equiv N$

39. Which of the following reactions results meso compound as the product?

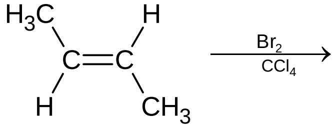
(A)


H3C
H
C=C
H
CH3
Cold
dil. KMnO4

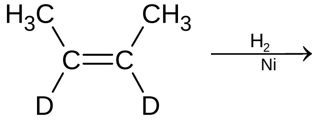
(B)


O
H3C
C
C
H
H3C
CH3
dil. NaOH

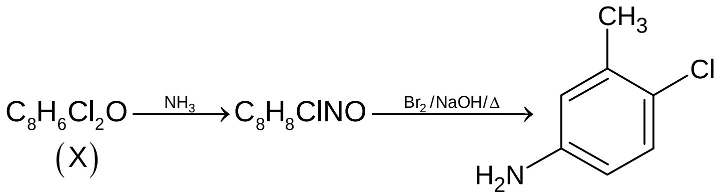
(C)


H3C
H
C=C
H
CH3
Br2
CCl4

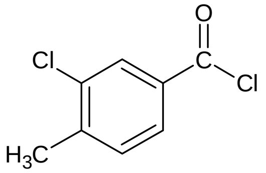
(D)


H3C
CH3
C=C
D
D
H2
Ni

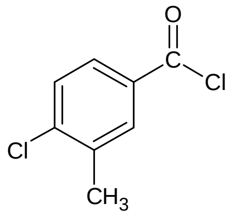
40. Identify ‘X’ in the following sequence of reaction


C8H6Cl2O
(X)
NH3
C8H8ClNO
Br2/NaOH/Δ
CH3
Cl
H2N

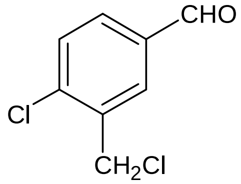
(A)



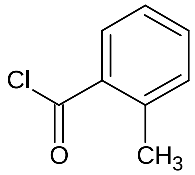
(B)



(C)

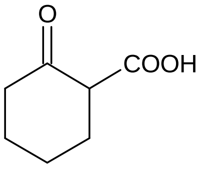


(D)

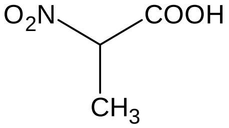


41. Which of the following compounds is most difficult to decarboxylate?

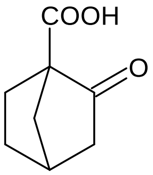
(A)



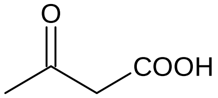
(B)



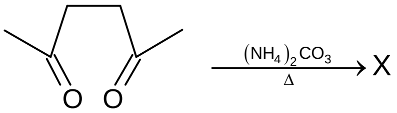
(C)



(D)



42.

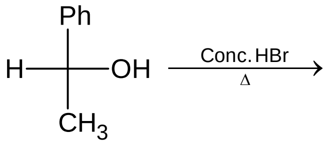


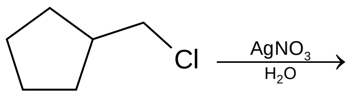
Which of the following statement is INCORRECT?

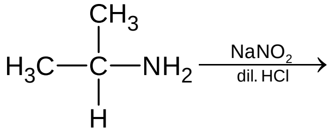
(A) The product X has a five membered ring.
(B) The product X is aromatic.
(C) The degree of unsaturation of the product X is 3.
(D) The product X has a six membered ring.

43. Which of the following reactions does not proceed through the formation of a carbocation?

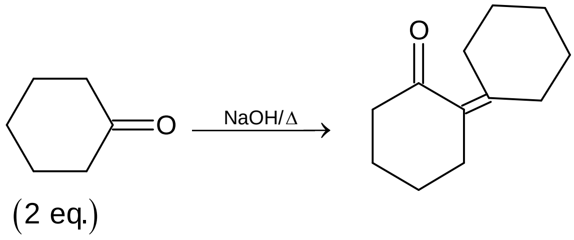
(A)



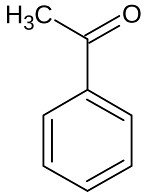
(B) 

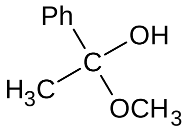
(C) 

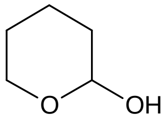
$$H_3C-\overset{\overset{\large CH_3}{|}}{\underset{\underset{\large H}{|}}{C}}-NH_2 \xrightarrow[\text{dil. HCl}]{NaNO_2}$$

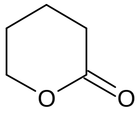
(D) 

44. Which of the compounds can respond in Fehling's test?

(A) 

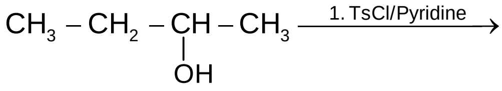
(B) 

(C) 

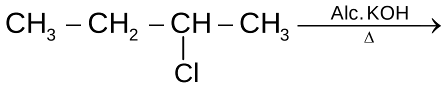
(D) 

45. Which of the following reaction leads to the Hoffmann's product?

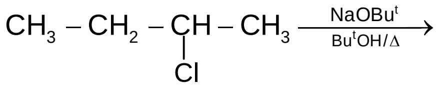
(A) $CH_3-CH_2-CH_2-CH_2-OH \xrightarrow[\Delta]{\text{Conc.} H_2SO_4}$

(B) 

$$CH_3-CH_2-\underset{\underset{\large OH}{|}}{CH}-CH_3 \xrightarrow{\text{1. TsCl/Pyridine}}$$

(C) 

$$CH_3-CH_2-\underset{\underset{\large Cl}{|}}{CH}-CH_3 \xrightarrow[\Delta]{\text{Alc. KOH}}$$

(D) 

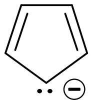
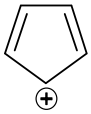
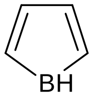
$$CH_3-CH_2-\underset{\underset{\large Cl}{|}}{CH}-CH_3 \xrightarrow[Bu^tOH/\Delta]{NaOBu^t}$$

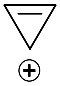
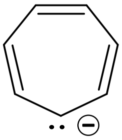
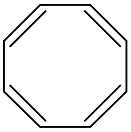
SECTION – B

(Single digit integer type)

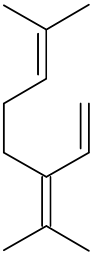
This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

46. Find out the number of species which are destabilized through conjugation?

47. Find out the number of different products obtained on the ozonolysis of the following compounds:



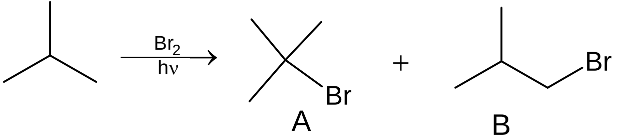
SECTION – C

(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

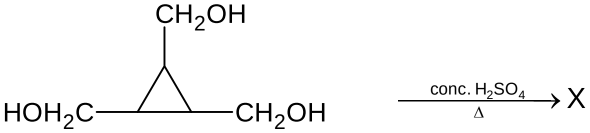
48. Optically pure (S) (+) 2-bromo octane ($\alpha = 36^o$) reacts with aqueous NaOH in acetone to give optically pure (R) (–) 2 octanol, (α = - 10.3^o). With partially racemised bromo compound whose ($\alpha = 30^o$). Specific rotation of alcohol is – 6.0^o. What is the optical purity of partially racemised product?

49. The relative reactivity of 1^{o}H, 2^{o}H, & 3^{o}H in bromination reaction if found to be 1 : 82 : 1600 respectively



What is the % yield of A?

50.



If the molecular wt. of X is M, then $\frac{M}{5} = ?$

Mathematics

PART – III

SECTION – A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

51. The least value of n for which $(n - 2)x^2 + 8x + (n + 4) > \sin^{-1}(\sin 12) + \cos^{-1}(\cos 12)\ \forall\ x \in R\ (n \in N)$ is
(A) 4
(B) 5
(C) 6
(D) 7

52. In a triangle ABC, $\sum_{r=0}^{n} {}^{n}C_r a^r b^{n-r} \cos(rB - (n-r)A)$ is equal to (where a, b, c represents the sides and A, B, C represents the angles of ΔABC)
(A) a^n
(B) b^n
(C) c^n
(D) none of these

53. The radius of the circle touching the pair of lines $7x^2 - 18xy + 7y^2 = 0$ and the circle $x^2 + y^2 - 8x - 8y = 0$ and is contained in the given circle is
(A) $\sqrt{10}$
(B) 3
(C) $2\sqrt{2}$
(D) $\sqrt{7}$

54. A parabola having directrix $x + y + 2 = 0$ touches a line $2x + y - 5 = 0$ at (2, 1). Then the semi latus rectum of the parabola is
(A) $\frac{8}{\sqrt{2}}$
(B) $\frac{9}{\sqrt{2}}$
(C) $\frac{10}{\sqrt{2}}$
(D) $\frac{11}{\sqrt{2}}$

55. Number of points from which pair of perpendicular tangents can be drawn to hyperbola $x^2 \operatorname{cosec}^2 \alpha - y^2 \sec^2 \alpha = 1$, is $\alpha \in \left(0, \frac{\pi}{4}\right)$
(A) 0
(B) 1
(C) 2
(D) infinite

56. Let AB be the chord of contact of the point (5, –5) w.r.t the circle $x^2 + y^2 = 5$, then the locus of the orthocentre of ΔPAB where P is any point moving on the circle is
(A) $(x - 1)^2 + (y + 1)^2 = 5$
(B) $(x - 1)^2 + (y + 1)^2 = \frac{5}{2}$
(C) $(x + 1)^2 + (y - 1)^2 = 5$
(D) $(x + 1)^2 + (y - 1)^2 = \frac{5}{2}$

57. A parabola $y = ax^2 + bx + c$ crosses the x-axis at $(\alpha, 0)$, $(\beta, 0)$ both to the right of the origin. A circle also passes through these 2 points. The length of tangent from the origin to the circle is
(A) $\sqrt{\frac{bc}{a}}$
(B) ac^2
(C) $\frac{b}{a}$
(D) $\sqrt{\frac{c}{a}}$

58. If e_1 and e_2 are the roots of the equation $x^2 - ax + 2 = 0$ where e_1 and e_2 are the eccentricities of an ellipse and hyperbola respectively, then a belongs to
(A) $(3, \infty)$
(B) $(2, \infty)$
(C) $(1, \infty)$
(D) $(-\infty, 1) \cup (1, 2)$

59. If the locus of a point, whose chord of contact with respect to the circle $x^2 + y^2 = 4$ is a tangent to the curve $xy = 1$ is $xy = c^2$, then the value of c^2 is
(A) 2
(B) 4
(C) $\frac{1}{2}$
(D) $\frac{1}{4}$

60. Let $f(x) = \sin x + \cos x + \tan x + \sin^{-1} x + \tan^{-1} x + \cos^{-1} x$. If M and m are maximum and minimum values of f(x), then its sum is
(A) $\pi + 2\cos 1$
(B) $\pi + 2\sin 1$
(C) $\frac{\pi}{2} + 2\tan 1$
(D) $\pi + \tan 1 + \sin 1$

61. Consider an obtuse angled triangle with sides 8 cm, 15 cm and x cm (largest side being 15 cm). If x is an integer, then number of possible triangles are
(A) 4
(B) 6
(C) 7
(D) 5

62. In a right angled triangle, the smallest angle is θ. A triangle which is taking the reciprocal of sides is also a right angled triangle, then $\sin\theta$ is equal to
(A) $\frac{\sqrt{5}+1}{4}$
(B) $\frac{\sqrt{5}-1}{2}$
(C) $\frac{\sqrt{5}-1}{4}$
(D) $\frac{\sqrt{2}-1}{2}$

63. If the equation of pair of straight lines passing through (1, 1), one making an angle θ with the positive direction of x-axis and other making the same angle with positive direction of y-axis is $x^2 - (a + 2)xy + y^2 + a(x + y - 1) = 0$, $a \neq -2$, then $\sin 2\theta$ is
(A) $(a - 2)$
(B) $a + 2$
(C) $\frac{2}{a+2}$
(D) $\frac{2}{a}$

64. If the chords of the hyperbola $x^2 - y^2 = 16$ touches the parabola $y^2 = 16x$, then the locus of the middle points of these chords is a curve
(A) $y^2(x + 4) = x^3$
(B) $y^2(x - 4) = x^3$
(C) $y^2(x + 8) = 3x^3$
(D) $y^2(x - 8) = 2x^3$

65. If the number of radical axis of a system of circles is same as number of radical centres, then number of circles in that particular system is
(A) 4
(B) 6
(C) 10
(D) 5

66. The vertices of a ΔABC lie on a rectangular hyperbola such that the orthocentre of the triangle is (3, 2) and the asymptotes of the rectangular hyperbola are parallel to coordinate axes. If the two perpendicular tangents of the hyperbola intersect at (1, 1), then equation of the rectangular hyperbola is
(A) $xy = 2x + y - 2$
(B) $2xy = x + 2y + 5$
(C) $xy = x + y + 1$
(D) none of these

67. The locus of the centre of a variable circle touching two circles of radius r_1 and r_2 externally which also touch each other externally is a conic. The eccentricity of the conic, if $\frac{r_1}{r_2} = 3 + 2\sqrt{2}$ is
(A) 1
(B) $\sqrt{2}$
(C) $\frac{1}{2}$
(D) $2\sqrt{2}$

68. AB is any chord of the circle $x^2 + y^2 - 6x - 8y - 11 = 0$ which subtends an angle of $\frac{\pi}{2}$ at (1, 2). If locus of mid-point of AB is $x^2 + y^2 - 2ax - 2by - c = 0$, then a + b + c is
(A) 8
(B) 10
(C) 6
(D) 12

69. $\lim\limits_{n\to\infty} \sum\limits_{r=1}^{n} \cot^{-1}\left(\frac{r^3 - r + \frac{1}{r}}{2}\right)$ is equal to
(A) 0
(B) π
(C) $\frac{\pi}{2}$
(D) $\frac{\pi}{4}$

70. Let $f(\theta) = \frac{1}{1+(\cot\theta)^x}$, then the value of $2\sum\limits_{\theta=1^\circ}^{89^\circ} f(\theta)$ is
(A) 44
(B) 89
(C) 65
(D) 178

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

---

71. The value of cot 76° cot 44° + cot 16° cot 44° – cot 76° cot 16° is

72. In a triangle ABC if $r_1 + r_3 + r = r_2$, then the value of $(\sec^2 A + \cos^2 B - \cot^2 C)$ is

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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73. Let ABC be a right angled triangle at C. If the inscribed circle touches the side AB at D and (AD)·(BD) = 11, then area of triangle is

74. If the reflection of the ellipse $\frac{(x-4)^2}{16} + \frac{(y-3)^2}{9} = 1$ in the line mirror $x - y - 2 = 0$ is $k_1x^2 + k_2y^2 - 160x - 36y + 292 = 0$, then $k_1 + k_2$ is equal to

75. A chord is drawn passing through P(2, 2) on the ellipse $\frac{x^2}{25} + \frac{y^2}{16} = 1$ such that it intersects the ellipse at A and B, then the maximum value of PA·PB is

FIITJEE

ALL INDIA TEST SERIES

PART TEST – II

JEE (Main)-2020

TEST DATE: 16-11-2019

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A

1. C

Sol. It is given that at 20°C, sphere is floating in liquid but at 35°C it begins to sink as on increasing temperature, liquid expands and its density decreases. At 35°C its density becomes equal to that of the sphere and then the buoyancy force on sphere is just equal to the weight of sphere and its is fully submerged in the liquid.

Given that density of sphere is

$$\rho_S = \frac{m}{\frac{4}{3}\pi r^3} = \frac{250}{\frac{4}{3}\times 3.14\times(3.5)^3} = 1.393\ \text{gm/cm}^3$$

It is given that density of liquid at 0°C is ρ_0 = 1.527 gm/cm^3 if γ is the coefficient of cubical expansion of liquid, then its density at 35°C is given as

$$\rho_{35} = \frac{\rho_0}{1+\gamma(35)}$$

At 35°C, as sphere begins to sink, we have density of sphere = density of liquid

$$1.393 = \frac{1.527}{1+\gamma(35)}$$

(As sphere does not expand, its density remains constant)

$$\gamma = \left(\frac{1.527}{1.393}-1\right)\times\frac{1}{35} = 2.75\times10^{-3}\ \text{C}^{-1}$$

2. A

Sol. We know that the gas pressure is given as

$$P = \frac{1}{3}\rho v_{rms}^2$$

Now we can write the density of gas as $\rho = m_0N$, where m_0 is the mass of the gas molecule and N is the number of molecules in 1 m^3 of the gas.
In the present case, $N = 100 \times 10^6$

$$\text{Or } P = \frac{1}{3}(100\times10^6)m_0v_{rms}^2$$

As we know rms velocity of gas molecules is given as

$$v_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3kT}{m_0}} \quad \left[\text{As } M = m_0N_{av} \text{ and } \frac{R}{N_{Av}} = k\right]$$

So we have

$$P = \frac{1}{3}\times(100\times10^6)\times3kT \text{ (as T = 3k)}$$

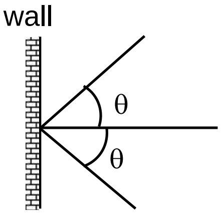
$$P = 4.14 \times 10^{-15}\text{ Pa}$$

3. A

Sol. The induced emf across the inductor is $e = \varepsilon - iR$. Hence the plot of e versus i is a straight line with negative slope.

4. D

Sol. Figure shows a beam of molecules in cylindrical form striking the wall. According to elastic collision, each molecule is reflected from the wall at the same angle of incidence as shown with same speed. If m_0 is the mass of each nitrogen molecule, momentum of each molecule is



$P_0 = m_0v$

During collision, change in momentum of each molecule is

$\Delta P_0 = 2m_0v\cos\theta$

If S is the cross section area of beam and v be the velocity of molecules in the beam then number of molecules incident on wall per second are

$N = n_0vS$ (n_0 = molecule density)

Thus total momentum imparted to the wall per second by the beam and the force exerted on the wall is

$$F = \frac{\Delta P_0}{\Delta t} = 2m_0v\cos\theta\times n_0vS$$

This equation gives total momentum imparted to the wall per second. This is the net fore exerted by beam on the wall.

Thus the pressure on the wall by beam is

$$P = \frac{F\cos\theta}{S} = 2m_0v^2\cos^2\theta\cdot n_0$$

$$= 2\times\frac{28\times10^{-3}}{6.023\times10^{23}}\times9\times10^{24}\times(400)^2\times\cos^2(30^\circ) = 10^5\text{ Pa}$$

5. A

Sol. Let n be the average number of electrons per unit volume, present in the beam of electrons, then impulse momentum theorem gives

$(nAv)(mv) = F$

$P = F/A$

$$n = \frac{P}{(mv^2)}$$

$$\therefore \text{ current } I = nAev = \left(\frac{P}{mv^2}\right)Aev = \frac{PAe}{mv}$$

6. A

Sol. The potential at centre of sphere in which q charge is uniformly distributed through the volume is

$$V_C = \frac{1}{4\pi\varepsilon_0}\frac{3q}{2R}$$

By symmetry, the potential at centre due to half sphere will be half of the complete sphere.

$$V_0 = \frac{V_C}{2} = \frac{1}{4\pi\varepsilon_0}\frac{3q/2}{2R} = \frac{1}{4\pi\varepsilon_0}\frac{3Q}{2R} \text{ (since, q/2 = Q)}$$

7. D

Sol. $V_B - V_A = -\int E_x dx = -(\text{area under } E_x - x \text{ curve})$

$$V_B - 10 = -\frac{1}{2}\times 2\times(-20) = 20$$

$V_B = 30$ V

8. C

Sol. After the sphere is grounded, potential at centre becomes zero. Let the net charge on the sphere finally be q.

$$\frac{kq}{r} + \frac{k3Q}{x} = 0$$

$$q = -\frac{3Qr}{x}$$

The charge following out of sphere is $\frac{3Qr}{x}$

9. A

Sol. $$R = \int\frac{\rho dx}{A} = \frac{\int_0^{\ell} bxdx}{A} = \frac{b\ell^2}{2A}$$

$$I = \frac{V}{R} = \frac{2VA}{b\ell^2}$$

$$\therefore\ j = \frac{I}{A} = \frac{2V}{b\ell^2}$$

$\Rightarrow j = \sigma E$

$$E = \rho j = \frac{bx2V}{b\ell^2} = \frac{2V}{L^2}x$$

10. A

Sol. With both switches open, $I_A = \frac{E}{R_1 + R_2 + R_3}$

With both switches closed, there will be no current through R_3,
the current through E and R_2 is

$$I' = \frac{E}{R_2 + \frac{RR_1}{R + R_1}}$$

Current through the ammeter is

$$I'_A = \frac{RI'}{R + R_1} = \frac{RE}{(R + R_1)R_2 + RR_1}$$

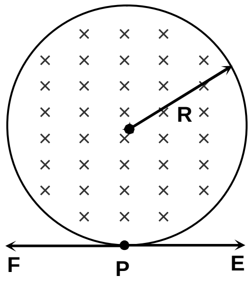
$$= \frac{E}{R_1 + R_2 + \frac{R_2R_1}{R}}$$

As $I_A = I'_A$

$$R = \frac{R_1R_2}{R_3} = \frac{100 \times 300}{50} = 600\ \Omega$$

11. A

Sol. If we consider the cylindrical surface to be a ring of radius R, there will be an induced electric field due to time varying magnetic field.



$$\oint \vec{E} \cdot d\vec{\ell} = -\frac{d\phi}{dt} = \frac{AdB}{dt}$$

$$\Rightarrow E(2\pi R) = A\frac{dB}{dt} = \pi R^2 \frac{dB}{dt}$$

$$E = \frac{R}{2}\frac{dB}{dt}$$

So, force on the electron

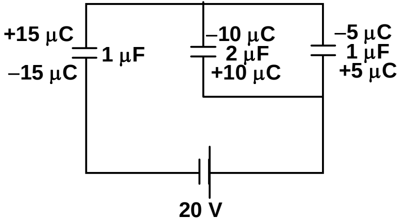
$$F = -Ee = -\frac{eR}{2}\frac{dB}{dt}$$

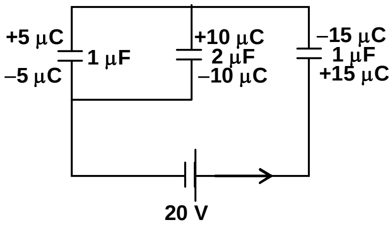
Acceleration = $\frac{1}{2}\frac{eR}{m}\frac{dB}{dt}$

Force will be towards left on electron.

12. B

Sol. Charge supplied by battery, $\Delta Q = 10\ \mu C$





Work done by battery

$\Delta W_B = (10\ \mu C)\ (20v) = 200\ \mu J$

Change in potential energy

Stored by capacitors

$\Delta U = U_f - U_i = 0$

Heat loss = $\Delta W_B - \Delta U$

$= 200\ \mu J$

13. D

Sol. Magnetic field due to circular segment = $\frac{3}{4}\frac{\mu_0 i}{2a}$

Due to one straight wire segment $= \frac{\mu_0 i}{4\pi b}(\sin 45° + \sin 0°) = \frac{\mu_0 i}{4\sqrt{2}\pi b}$

Net field $= \frac{3\mu_0 i}{8a} + 2 \times \frac{\mu_0 i}{4\sqrt{2}\pi b}$

$= \frac{\mu_0 i}{4\pi}\left(\frac{3\pi}{2a} + \frac{\sqrt{2}}{b}\right)$

14. B

Sol. $q\vec{E} = -q(\vec{v} \times \vec{B})$

$\vec{E} = -(\vec{v} \times \vec{B})$

$\Rightarrow \vec{E} \perp \vec{v}$ and $\vec{E} \perp \vec{B}$

15. B

Sol. $\frac{M}{L} = \frac{Q}{2m}$

$M = \frac{Q}{2m} \times \frac{2}{3} mR^2\omega$

$M = \frac{QR^2\omega}{3}$

16. D

Sol. We take the ampeiran loop of radius r > R.

Since the loop is outside the cylinder, the current through the loop is

$$I = \int_0^R kr \times (2\pi r dr) = 2\pi k \int_0^R r^2 dr = \frac{2\pi k R^3}{3}$$

$$\Rightarrow B \times 2\pi r = \mu_0 I = \frac{2\pi k R^3 \mu_0}{3}$$

$$B = \frac{\mu_0 k R^3}{3r}$$

17. C

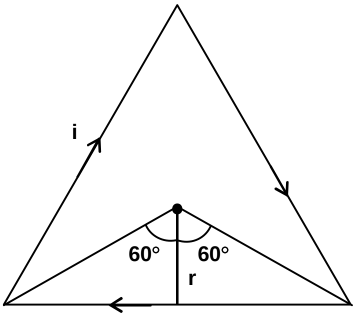
Sol. Due to a wire

$$B = \frac{\mu_0}{4\pi} \frac{i}{(\ell / 2\sqrt{3})} (\sin 60° + \sin 60°)$$

$$= \frac{\mu_0 i}{4\pi\ell} 2\left(\frac{\sqrt{3}}{2}\right) \times 2\sqrt{3} = \frac{6\mu_0 i}{4\pi\ell}$$

Magnetic field due to three sides

$$B_{net} = 3B = \frac{\mu_0}{4\pi} \frac{18i}{\ell}$$



$r = \frac{\ell}{2\sqrt{3}}$

18. C

Sol. $\phi = BS = B\pi R^2$

$= B\pi(R_0 + t)^2$

$e_{ind} = -\frac{d\phi}{dt} = -2\pi(R_0 + t)B$

Since flux is increasing e_{ind} is anticlockwise

19. A

Sol. $\phi = at(T - t) = aTt - at^2$

$e_{ind} = -\frac{d\phi}{dt}$

$e_{ind} = -a(T - 2t)$

$$i_{end} = \frac{e_{ind}}{R} = \frac{(2at - aT)}{R}$$

$$H = \int_0^T i^2 R dt = \int_0^T \frac{(2at - aT)^2}{R} dt$$

$$= \frac{\int_0^T (4a^2t^2 + a^2T^2 - 4a^2Tt)dt}{R} = \frac{1}{R}\left(\frac{4a^2T^3}{3} + a^2T^3 - \frac{4a^2T^3}{2}\right)$$

$$H = \frac{a^2T^3}{3R}$$

20. A

Sol. $\phi = B\pi r^2 = (16 - 4t^2)\pi r^2$

$$e_{ind} = -\frac{d\phi}{dt} = 8\pi r^2 t$$

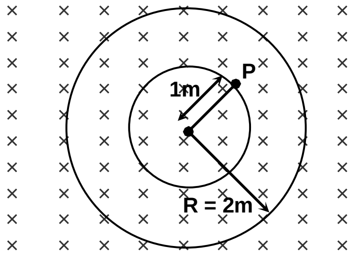
$$e_{ind} = \int E \cdot d\ell$$

$$8\pi r^2 t = E 2\pi r$$

$$\Rightarrow E = \frac{8rt}{2} = 4rt$$

at t = 2 sec

E = 8 Volt/m



SECTION – B

21. 2

Sol. $q = \frac{\Delta\phi}{R}$

$\Rightarrow$ $\Delta\phi$ = qR = area of i-t graph × R

$= \frac{1}{2}(4)(0.1) \times 10 = 0.2 \times 10 = 2$ Weber

22. 5

Sol. $V = \frac{1}{4\pi\varepsilon_0}\frac{p\cos\theta}{r^2}$

Here $V = 1.8 \times 10^5$ V, $\theta = 60°$

$r = 50 \times 10^{-2} = 0.5$ m

$\Rightarrow 1.8 \times 10^5 = 9 \times 10^9 \times \frac{p\cos 60°}{(0.5)^2}$

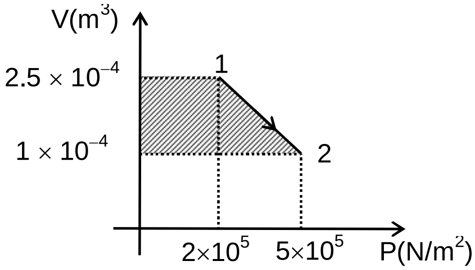
Dipole moment, $p = \frac{1.8 \times 10^5 \times 0.25 \times 2}{9 \times 10^9} = 10^{-5}$ C-m

SECTION – C

23. 00241.50

Sol. We know work done by a gas is given by the area under PV curve or the area between PV-curve and the volume axis. Generally we take in this process volume of gas decreases thus work is done on the gas and it is given as

$$\Delta W = -\frac{1}{2}\times 1.5\times 10^{-4}\times(2+5)\times 10^5 = -52.5 \text{ Joule}$$



It is given that heat rejected in the process is 70 cal. Thus

$\Delta Q = -70$ cal = 70 × 4.2 J = –294 J

Now from first law of thermodynamics, we have

$\Delta Q = \Delta W + \Delta U$

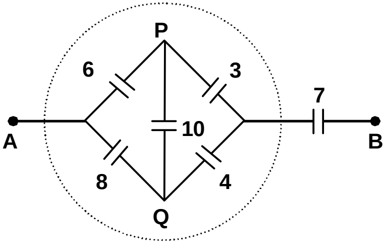
$\Delta U = \Delta Q - \Delta W$

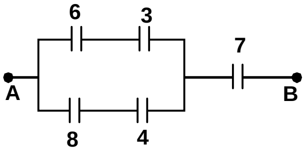
= (–294) – (–52.5) = –241.5 J

Thus in the process, internal energy of gas decreases by 241.5 J

24. 00002.80

Sol. Balanced Wheat stone Bridge





$$C_{eq} = \frac{14}{5}\,\mu F = 2.80\,\mu F$$

25. 10021.34

Sol. We know rms velocity of gas molecules is given as

$$v_{rms} = \sqrt{\frac{3RT}{M}}$$

As v_{rms} is directly proportional to $\sqrt{T}$, to double rms speed temperature must be raised to four times, T_f = 1200 k. As the gas is enclosed in a container of constant volume, the heat required is

$\Delta Q = \Delta U$

$= nC_V\Delta T$

$= n\frac{5}{2}R\Delta T = \frac{15}{28}\times\frac{5}{2}\times 8.314\times 900$

= 10021.34 Joule

Chemistry

PART – II

SECTION – A

26. C

Sol. $6HCHO + 4NH_3 \longrightarrow (CH_2)_6N_4$

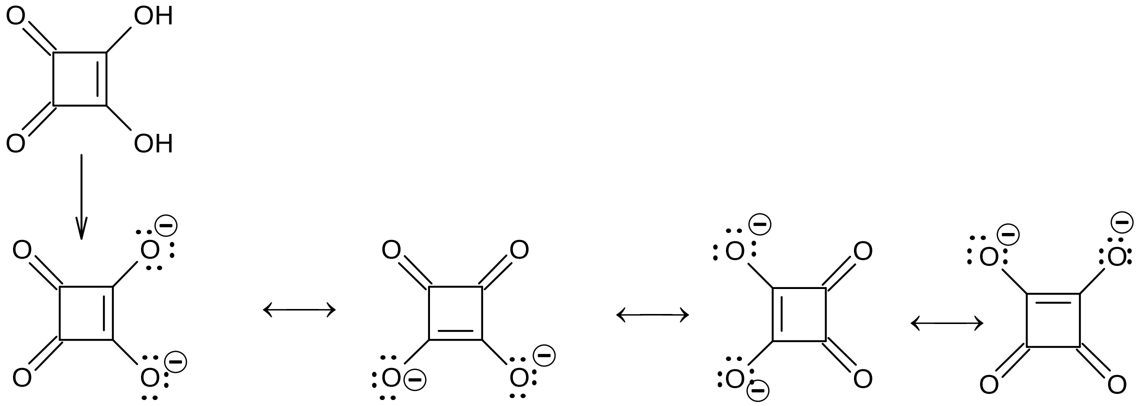
Degree of unsaturation of $(CH_2)_6N_4 = 3$.

27. D

Sol. Gabriel's phthalimide synthesis involves S_N2 reaction, thus 3^o butyl amine cannot be prepared through this method.

28. D

Sol. Conjugate base is stabilized through four equivalent resonating structures.

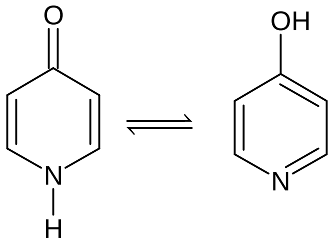


29. C

Sol. As it has no plane of symmetry and point of symmetry.

30. D

Sol.



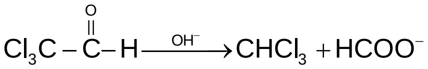
Enol form is aromatic.

31. C

Sol. S_Ni reaction involves retention in configuration.

32. C

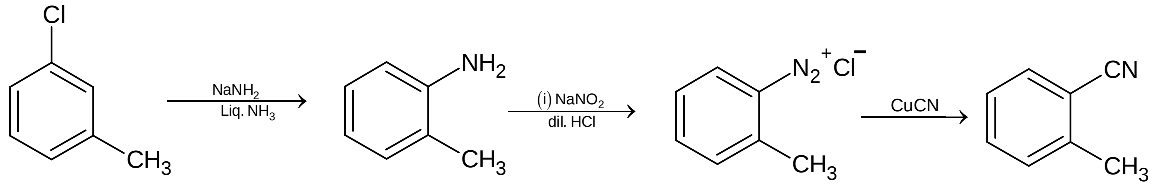
Sol.



$$Cl_3C-\overset{\overset{O}{||}}{C}-H \xrightarrow{OH^-} CHCl_3 + HCOO^-$$

33. B

Sol.


Cl
CH3
NaNH2
Liq. NH3
NH2
CH3
(i) NaNO2
dil. HCl
N2+Cl−
CH3
CuCN
CN
CH3

34. D

Sol. As after removal the carbocation becomes aromatic.

35. C

Sol. Glucose can be oxidized by Br_2/H_2O but fructose does not respond in the reaction, as it is a ketose.

36. C

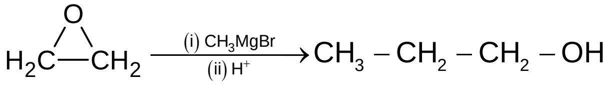
Sol. Due to presence of two amino groups.

37. D

Sol. Extracted of H is the rate determining step in haloform reaction.

38. C

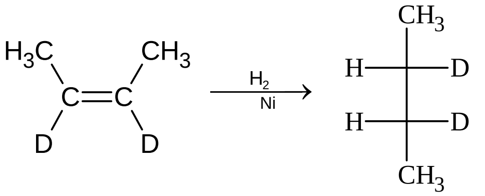
Sol.


O
H2C—CH2
(i) CH3MgBr
(ii) H+

$$\xrightarrow[\text{(ii) } H^+]{\text{(i) } CH_3MgBr} CH_3-CH_2-CH_2-OH$$

39. D

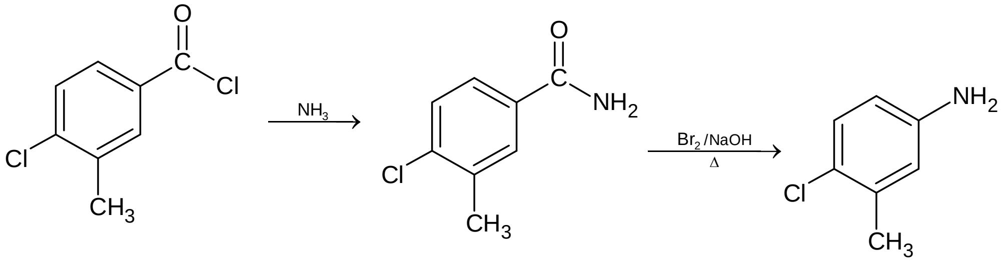
Sol.


H3C
CH3
C=C
D
D
H2
Ni
CH3
H
D
H
D
CH3

If the substrate has 'cis' configuration, on syn addition, a 'meso' compound is generated.

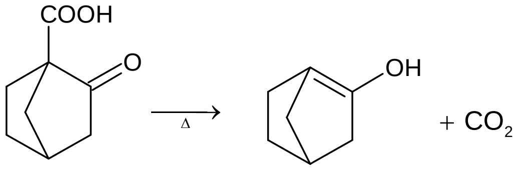
40. B

Sol.


O
C
Cl
Cl
CH3
NH3
O
C
NH2
Cl
CH3
Br2/NaOH
Δ
NH2
Cl
CH3

41. C

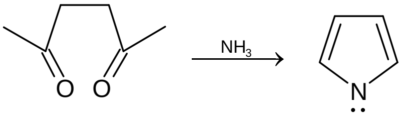
Sol.


COOH
O
Δ
OH
+ CO2

After decarboxylation, double bond appears at bridgehead position.

42. D

Sol. $(NH_4)_2CO_3 \longrightarrow 2NH_3 + CO_2 + 2H_2O$



Option (D) is incorrect.

43. D

Sol. Aldol condensation takes place through the formation of enolate anion.

44. C

Sol. A hemiacetal can respond in Fehling's test.

45. D

Sol. A large base always extracts less substituted H.

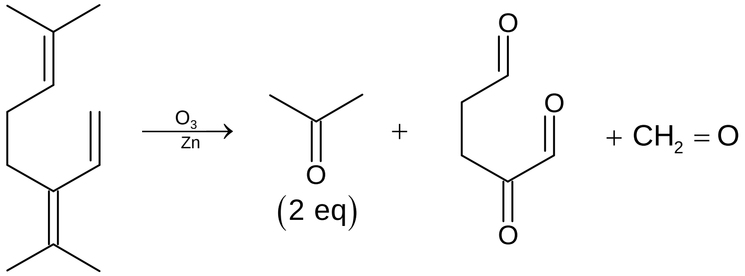
SECTION – B

46. 3

Sol. All are antiaromatic.

47. 3

Sol.



SECTION – C

48. 00083.00

49. 00099.40

50. 00014.40

Mathematics

PART – III

SECTION – A

51. B

Sol. $\sin^{-1}(\sin 12) + \cos^{-1}(\cos 12) = 0$

52. C

Sol. $\cos(rB - (n - r)A)$ is real part of $e^{i[rB-(n-r)A]}$

53. C

Sol. Centre lies on the line y = x. Let it be (h, h) and radius be r, $r^2 = \frac{4h^2}{\sqrt{4\cdot 9^2}}$

54. B

Sol. Find foot of perpendicular from (2, 1) on the directrix say (α, β)
Now, image of (α, β) abt tangent is focus
On solving $(\alpha, \beta) = \left(-\frac{1}{2}, -\frac{3}{2}\right)$; focus $\left(\frac{11}{2}, \frac{3}{2}\right)$

55. A

Sol. $x^2 - y^2 = -\cos 2\alpha$ is the director circle which does not exist

56. A

Sol. Let the orthocentre be (h, k), image w.r.t AB will lie on the circle, so $(x - 1)^2 + (y + 1)^2 = 5$

57. D

Sol. $OT^2 = OA\cdot OB = \alpha\beta = \frac{c}{a} \Rightarrow \sqrt{\frac{c}{a}}$

58. A

Sol. $e_1 < 1 < e_2$; $f(1) < 0$; $a > 3$

59. B

Sol. Locus is xy = 4

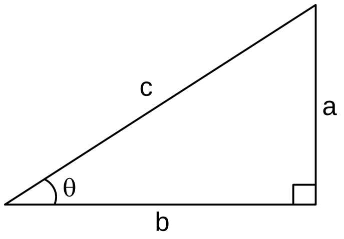
60. A

Sol. Domain [–1, 1] ; $f'(x) > 0 \uparrow$
Range is [f(–1), f(1)]

61. D

Sol. $\cos\theta = \frac{x^2 + 8^2 - 15^2}{16x}$, $-1 < \cos\theta < 0$
on solving $7 < x < 13$, $x \in \{8, 9, 10, 11, 12\}$

62. B



Sol. $\frac{1}{a} > \frac{1}{b} > \frac{1}{c}$; $a^2 + b^2 = c^2$, $\frac{1}{b^2} + \frac{1}{c^2} = \frac{1}{a^2}$

Solving, we get $1 = \frac{c^2}{a^2} - 2 + \frac{a^2}{c^2}$

Let $t = \frac{a}{c}$; $t^2 + \frac{1}{t^2} - 3 = 0$

$\Rightarrow t = \frac{\sqrt{5}-1}{2} = \frac{a}{c} = \sin\theta$

63. C

Sol. Lines are $y - 1 = \tan\theta(x - 1)$ and $(y - 1) = \cot\theta(x - 1)$ multiply and compare $\sin 2\theta = \frac{2}{a+2}$

64. B

Sol. $y = mx + \frac{4}{m}$ and $hx - ky = h^2 - k^2$ represents same line

65. D

Sol. ${}^nC_2 = {}^nC_3 \Rightarrow n = 5$

66. C

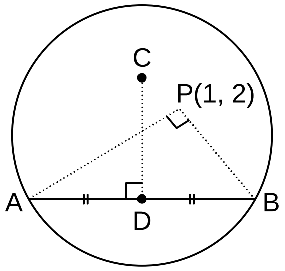
Sol. Equation of asymptotes are $x - 1 = 0$ and $y - 1 = 0$ hyperbola passes through (3, 2)
Equation of hyperbola is $xy = x + y + 1$

67. B

Sol. Curve is hyperbola and $e = \frac{r_1 + r_2}{r_1 - r_2} = \sqrt{2}$

68. A

Sol. Shown in the figure
AD = BD = PD



69. C

Sol. $\lim\limits_{n\to\infty} \sum_{r=1}^{n} \tan^{-1}(r^2 + r) - \tan^{-1}(r^2 - r) = \tan^{-1}\infty - \tan^{-1}0 = \frac{\pi}{2}$

70. B

Sol. $f(\theta) + f\left(\frac{\pi}{2} - \theta\right) = 1$

SECTION – B

71. 3

Sol. cot 120° = cot (76° + 44°) = $-\frac{1}{\sqrt{3}}$

cot 76° cot 44° = $1-\frac{1}{\sqrt{3}}$(cot 76° + cot 44°)

72. 1

Sol. $r_1 + r_3 = r_2 - r \Rightarrow \frac{\Delta}{s-a}+\frac{\Delta}{s-c}=\frac{\Delta}{s-b}-\frac{\Delta}{s}$

On solving $\angle B=\frac{\pi}{2}$ and ∠A + ∠C = 90°

$\sec^2(90° - C) + \cos^2 90° - \cot^2 C = \text{cosec}^2 C - \cot^2 C = 1$

SECTION – C

73. 00011.00

Sol. (s – a)(s – b) = 11 gives ab = 22 $\Rightarrow \Delta=\frac{1}{2}(22)=11$

74. 00025.00

Sol. Take the image of (4 + 4 cos θ, 3 + 3 sin θ) and then eliminate θ

75. 00014.75

Sol. Use parametric form and satisfy in the ellipse, product of roots = $\left|\frac{236}{16+9\sin^2\theta}\right|=\frac{236}{16}$

FIITJEE

ALL INDIA TEST SERIES

PART TEST – III

JEE (Advanced)-2020

PAPER – 1

TEST DATE: 15-12-2019

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section–A (01 – 04, 19 – 22, 37 – 40)*** *contains 12 multiple choice questions which out of 4 options have **only one correct answer**. Each question carries **+3 marks** for correct answer and **–1 mark** for wrong answer.*

   Section-A (05 – 12, 23 – 30, 41 – 48) *contains 24 multiple choice questions which have **one or more than one correct** answer. Each question carries **+4 marks** for all correct answer.*
   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*

   *Negative Marks : **–1** In all other cases.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries **+3 marks** for correct answer. There is no negative marking.*

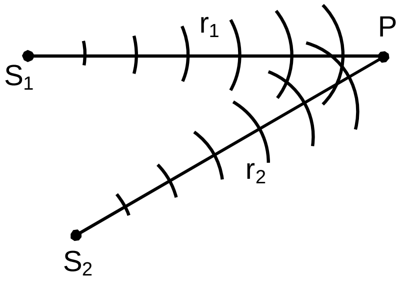
Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

1. Consider two point sources S_1 and S_2 which emit waves of the same frequency and amplitude A. The waves start in the same phase, and this phase relation at the sources is maintained through out the time. Consider point P at which r_1 is nearly equal to r_2 also it is given that r_1 and r_2 are sufficiently large as compared to A. After superposition of these two waves amplitude at the position P (approximately) is given by :



(Where r = $\frac{r_1+r_2}{2} \simeq r_1 \simeq r_2$, k is angular wave number)

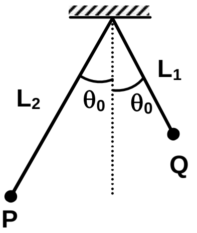
(A) $\frac{2C}{r}\cos\frac{k}{2}(r_1-r_2)$

(B) $\frac{C}{r}\cos\frac{k}{2}(r_1-r_2)$

(C) $\frac{2C}{r}\cos k(r_1-r_2)$

(D) $\frac{C}{r}\cos k(r_1-r_2)$

2. Two simple pendulum of length L_1 and L_2 are released from their extreme position in vertical plane. The angular amplitude of both the pendulums are equal. It is given that $L_1 = L_0$ and $L_2 = 25\ L_0$. The time after which the two strings become parallel to each other for the first time is



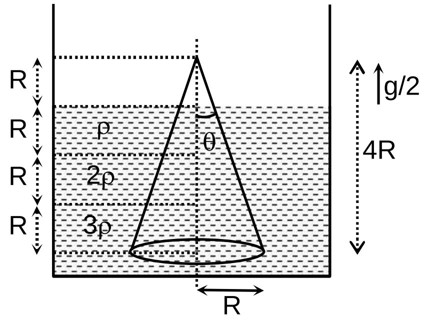
(A) $\frac{5\pi}{4}\sqrt{\frac{L_0}{g}}$

(B) $\frac{5\pi}{12}\sqrt{\frac{L_0}{g}}$

(C) $\frac{5\pi}{6}\sqrt{\frac{L_0}{g}}$

(D) $\frac{5\pi}{2}\sqrt{\frac{L_0}{g}}$

3. A solid cone is kept in three immiscible liquids of density ρ, 2ρ and 3ρ inside a container. The radius of cone is 'R' and it's height is 4R. Container is accelerated with a constant acceleration g/2 in vertically upward direction as shown. If cone is in equilibrium relative to the frame of container then density of the cone is



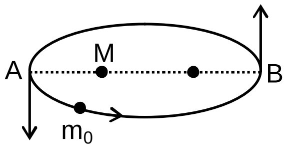
(A) $\frac{73}{24}\rho$

(B) $\frac{146}{25}\rho$

(C) $\frac{39}{16}\rho$

(D) $\frac{146}{37}\rho$

4. A satellite of mass m_0 is moving in an elliptical orbit around a planet of mass M. Planet is fixed at one of the foci of elliptical orbit. The eccentricity of elliptical orbit is e. Points A and B are called perihelion and aphelion respectively. The ratio of radius of curvature of elliptical orbit at perihelion to aphelion is



(A) e

(B) $\frac{1-e}{1+e}$

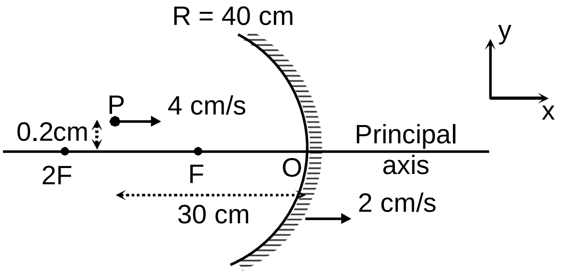
(C) $\frac{1}{e}$

(D) 1

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

5. A spherical concave mirror of radius of curvature 40 cm is moving with a constant velocity 2 cm/s along positive x-axis as shown. A point object 'P' located at a distance 30 cm left to the pole of the concave mirror is also moving with a velocity of 4 cm/s along positive x-axis at a height of 0.2 cm above the principal axis as shown in figure. Then choose the correct option(s).



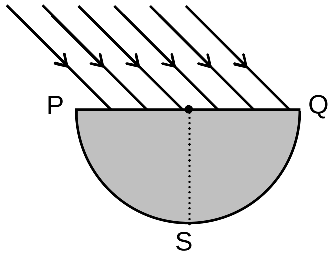
(A) The velocity of image along negative x-axis is 8 cm/s.

(B) The velocity of image along negative x-axis is 6 cm/s.

(C) The velocity of image along negative y-axis is zero.

(D) The velocity of image along negative y-axis is $\frac{2}{25}$ cm/s.

6. A parallel beam of light rays are incident on the flat surface of half cylinder made of glass as shown in the figure. The refractive index of the material of glass is $\sqrt{2}$. The angle of incidence is 45°. 'R' and 'L' are the radius and length of cylinder respectively. Choose the correct option(s).



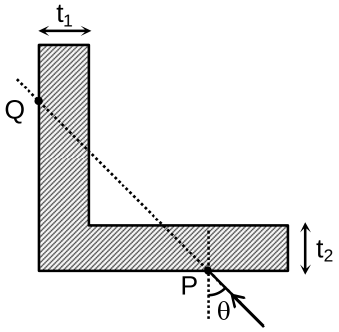
(A) Laws of refraction are valid for plane surface and spherical surface only.

(B) Surface area of cylinder from which the rays emerging out is $\frac{\pi}{2}RL$

(C) Surface area of cylinder from which the rays emerging out is $\frac{\pi}{6}RL$

(D) Let A_1 is the area of portion PS from which rays are emerging out and A_2 is from QS. Then $\frac{A_1}{A_2} = \frac{1}{5}$

7. Two glass slabs of thickness t_1 and t_2 are joined to make L shape as shown in the figure. The refractive indices of both glass slabs are same. A light ray is incident at point 'P' with an angle of incidence 'θ' as shown in the figure. It is assumed that refraction takes place from both the glass slabs. Then choose the correct option(s).



(A) emergent ray passes from Q if $t_1 = 2t_2$, $\theta = 30°$.
(B) emergent ray passes from Q if $t_1 = 2t_2$, $\theta = 45°$.
(C) emergent ray passes above the 'Q' if $t_2 > t_1$, $\theta = 45°$.
(D) emergent ray passes below the 'Q' if $t_2 < t_1$, $\theta = 45°$.

8. A He^+ ion and Li^{2+} ion both are in second excited state. Let a_{He} and a_{Li} are the acceleration of electron in their orbits and T_{He} and T_{Li} are the time periods of electron in their respective orbits. Then choose the correct option(s).

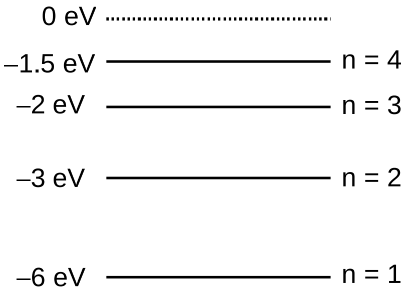
(A) $a_{Li} > a_{He}$

(B) $a_{Li} < a_{He}$

(C) $T_{Li} > T_{He}$

(D) $T_{Li} < T_{He}$

9. Consider a hypothetical atom, the energy level of atoms are given in the figure. Choose the correct option(s). (Given hc = 1240 eV-nm)



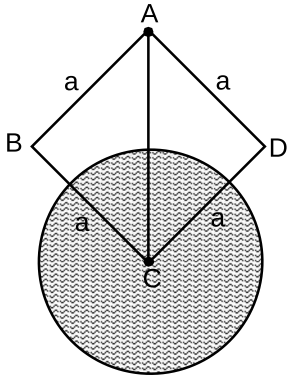
(A) An atom in the ground state gets excited by a photon and during de-excitation it emits photons, one of them has wavelength 1240 nm, then the incident photon may have wavelength of 310 nm.

(B) An atom in the ground state gets excited by a photon and during de-excitation it emits photons, one of them has wavelength 1240 nm, then the incident photon may have wavelength of 1240 nm.

(C) An atom in the ground state gets excited by a collision with an electron and during de-excitation it emits photons, one of them has wavelength 1240 nm, then incident electron must have an energy of 4eV.

(D) An atom in the ground state gets excited by a photon of 8eV then as a result an ionized atom and an electron of 2eV is obtained.

10. A square plate ABCD of mass m and side ‘a’ is suspended from point A in vertical plane. Another disc of same mass and $\sqrt{2}$a diameter is attached at point C as shown in the figure. Disc can freely rotate about point C. Now square plate is slightly displaced from its equilibrium position such that axis of rotation is perpendicular to the plane of paper. Friction is absent everywhere. Choose the correct option(s).



(A) The moment of inertia of system about an axis passing through A and perpendicular to the plane of paper is $\frac{19}{6}ma^2$

(B) The moment of inertia of system about an axis passing through A and perpendicular to the plane of paper is $\frac{8}{3}ma^2$

(C) The time period of small oscillation is $2\pi\sqrt{\frac{8\sqrt{2}}{9}\frac{a}{g}}$.

(D) The time period of small oscillation is $2\pi\sqrt{\frac{19\sqrt{2}}{18}\frac{a}{g}}$.

11. Choose the correct option(s).

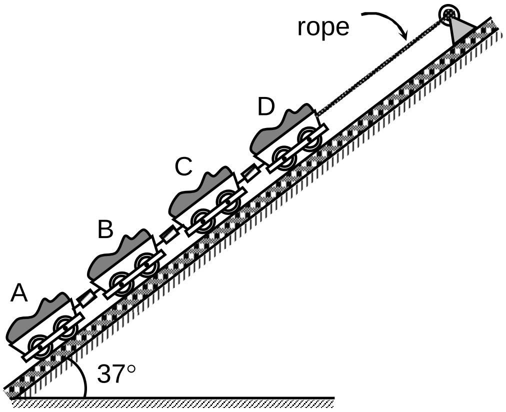
(A) If Q value of an exothermic nuclear reaction is +15.76 MeV and the kinetic energy of products of reaction is 18.24 MeV then kinetic energy of incident particles is 2.48 MeV.

(B) In a nuclear reaction, during α-decay energy released is shared between alpha particle and daughter nucleus is in the form of kinetic energy and its value for α-particle has more than that of daughter nucleus.

(C) In a decay process of a radioactive element, the activity of the sample at any instant is directly proportional to the number of undecayed nuclei present in the sample at that time.

(D) Photo electric effect supports quantum nature of light because there is a minimum frequency of light below which no photoelectrons are emitted.

12. Four ore wagon cars are held at rest on a frictionless inclined of 37° with the help of an extensible rope as shown in the figure. Any two cars are connected with an inextensible coupling. The extension in the rope is 20 cm in equilibrium and mass of each ore wagon car is 1000 kg. Now if middle coupling is break due to some problem then choose the correct options. ($g = 10\ m/s^2$)



(A) The acceleration of cars ‘A’ and ‘B’ is $6\ m/s^2$

(B) The frequency of cars ‘C’ and ‘D’ is $\frac{\sqrt{60}}{2\pi}$ Hz.

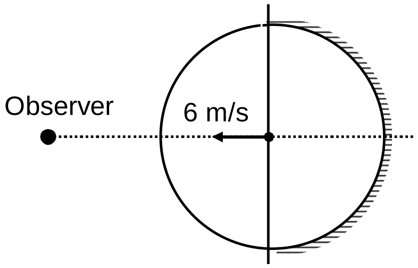
(C) The amplitude of oscillations of cars C and D is 10 cm.

(D) The amplitude of oscillations of cars C and D is 20 cm.

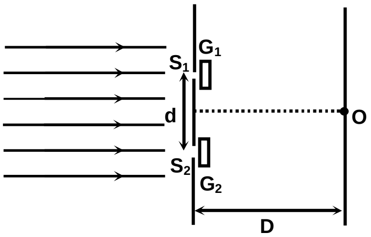
SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

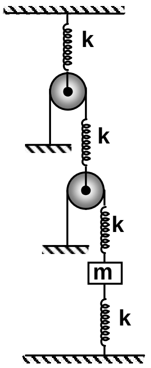
13. A spherical aquarium of radius 10 cm filled with water of refractive index 4/3 is kept as shown. One half of aquarium is silvered and other half is smooth. The thickness of aquarium is negligible. A fish is moving towards left with a velocity 6 m/s. An observer detects two images of the fish. Find the relative velocity (in m/s) between the two images of the fish as seen by the observer.



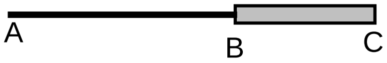
14. A parallel beam of monochromatic light of wavelength 4500 Å is incident on YDSE. Let I_0 is the intensity of incident light. Now two glass slabs G_1 and G_2 are kept infront of both slits S_1 and S_2. The refractive index of G_1 is 1.9 and for G_2 it is 1.6. The thickness of each glass slab is 15μm. It is observed that glass G_1 transmits $\frac{1}{16}$th and G_2 transmits $\frac{1}{25}$th of incident energy. If $I_0 = 8$ Watt/m^2, then find the intensity (in W/m^2) observed at point ‘O’ on the screen.



15. Four identical massless springs, two massless pulleys and a block of mass m are connected as shown and system is kept in vertical plane. Initially the system is in equilibrium. Now the block is slightly displaced from equilibrium position along a vertical line and then released. Find the time period (in sec) of small oscillation of the block if m = 6.6 kg and k = 70 N/m. (take $\pi = 3.14$)

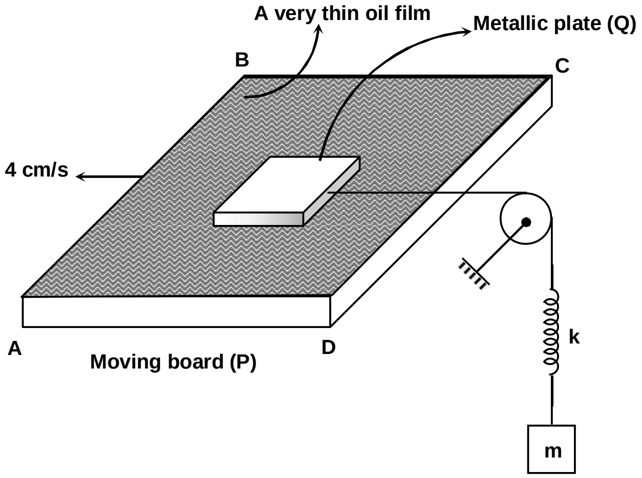


16. Two strings AB and BC of length 1 meter and 1/2 meter respectively are joined together at end B as shown. Point B is the junction of both strings. The mass per unit length of string AB and BC are 0.16 kg/m and 0.25 kg/m respectively. A tension of 100 N is maintained in both the strings. A sinusoidal wave pulse of amplitude 2mm is produced at end 'A'. It is partly reflected and partly transmitted at joint B. Find the ratio of amplitudes of transmitted and reflected waves.



17. A rod PQ is suspended in a vertical plane. When the rod is suspended from end 'P' and slightly rotated from its equilibrium position and then released, its time period is 6 sec and now if it is suspended from end 'Q' and slightly rotated from its equilibrium position and then released, its time period is 10 sec. The moment of inertia of the rod about the axes passing through ends 'P' and 'Q' and perpendicular to the plane of oscillation are 16 kg-m^2 and 25 kg-m^2 respectively. The length of the rod PQ is 20 cm. Find the distance (in cm) between the end 'P' and the centre of mass of rod.

18. A board ABCD is moved by an external force with a constant velocity of 4 cm/sec. A thin layer of oil separates the moving board and a metallic plate (Q). The dimensions of metallic plate is 10 cm × 20 cm and thickness of oil layer is 2 mm. The metallic plate is at rest in equilibrium. A block of mass m is connected with the metallic plate by a spring of spring constant 80 N/m as shown in the figure. The coefficient of viscosity of oil is 50 poise. Find the elongation (in cm) in the spring.



Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

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19. A constant current was passed for 193 sec. through KI solution oxidizing I^- ions to I_2. At the end of the experiment the liberated I_2, required 60 ml of 0.2 M solution of $Na_2S_2O_3$ for complete titration. The current passed through the solution of KI in ampere is
(A) 6 amp
(B) 8 amp
(C) 3 amp
(D) 12 amp

20. The rate constant for the reaction
$2N_2O_5 \longrightarrow 4NO_2 + O_2$
is 2×10^{-5} sec^{-1} at a given temperature. If the reaction is started with 10 mole per litre of N_2O_5, then the rate of formation of NO_2 at the moment of the reaction when concentration of O_2 is 2 mol $litre^{-1}$ is:
(A) $8 \times 10^{-5}\ molL^{-1}\,sec^{-1}$
(B) $4.8 \times 10^{-4}\ molL^{-1}\,sec^{-1}$
(C) $9.6 \times 10^{-4}\ molL^{-1}\,sec^{-1}$
(D) $2.4 \times 10^{-4}\ molL^{-1}\,sec^{-1}$

21. The final temperature of a monoatomic ideal gas $\left(\gamma = \frac{5}{3}\right)$ that is compressed reversibly and adiabatically from 40 L to 5 L at 300 K is
(A) 1200 K
(B) 800 K
(C) 600 K
(D) 400 K

22. The mass of nonvolatile solute urea need to be dissolved in 90 g water in order to decrease the vapour pressure of water by 20% is
(A) 100 g
(B) 75 g
(C) 60 g
(D) 80 g

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

---

23. The complex ion(s) in which the central atom is sp^3 hybridised is/are
(A) $\left[Ni(CN)_4\right]^{2-}$
(B) $\left[NiCl_4\right]^{2-}$

(C) $\left[MnCl_4\right]^{2-}$

(D) $\left[Cu\left(NH_3\right)_4\right]^{2+}$

24. Acidic oxide(s) among the following oxides is/are:
(A) CrO_3
(B) N_2O
(C) B_2O_3
(D) P_4O_{10}

25. The correct statement(s) among the following statements is/are:
(A) ClO_2 molecule is paramagnetic and dimerise to form Cl_2O_4
(B) Cl_2O_6 reacts with water to form chloric acid and perchloric acid
(C) I_2O_5 oxidises CO to CO_2
(D) Liquid IF_5 conducts electricity

26. Which of the following pairs of ions can be separated by using dil. HCl?
(A) Fe^{3+}, Ag^{+}
(B) Hg_2^{2+}, Ag^{+}
(C) Hg_2^{2+}, Cd^{2+}
(D) Ag^{+}, Cu^{2+}

27. Incorrect statement(s) among the following statements is/are:
(A) $Ba(N_3)_2$ on thermal decomposition produces pure N_2
(B) $Pb(NO_3)_2$ on thermal decomposition produces N_2O_3
(C) NO_2 reacts with NaOH solution to form $NaNO_2$ and $NaNO_3$
(D) PH_3 reacts with $HgCl_2$ solution to form PCl_3

28. Which of the following reaction(s) is/are correct?
(A) $XeF_6 + 6H_2O \longrightarrow XeO_3 + 6HF$
(B) $2XeF_6 + SiO_2 \longrightarrow XeOF_4 + SiF_4$
(C) $XeO_3 + 2XeF_6 \longrightarrow 3XeOF_4$
(D) $XeF_4 + Pt \longrightarrow Xe + PtF_4$

29. Which of the following precipitate(s) is/are insoluble in yellow ammonium sulphide?
(A) HgS
(B) SnS
(C) Bi_2S_3
(D) CuS

30. The correct statement(s) among the following statements is/are
(A) In Froth Floatation process for the concentration of Galena NaCN is used as depressant for ZnS.
(B) In Goldschmidt aluminothermic process Al_2O_3 is reduced by chromium.
(C) In Mac-Arthur Forrest cyanide process silver is recovered from $Na[Ag(CN)_2]$ by adding Zn.
(D) In the Van-Arkel process impure Ti is purified by reacting impure Ti with CO.

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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31. 0.2 g of a non-volatile and non-electrolytic substance is present in 300 ml of a solution and the solution shows an osmotic pressure of 38 cm of Hg at $27^{o}C$. The molecular weight of the substance is (R = 0.0821 litre atm k^{-1} mol^{-1})

32. 50 ml of 1 M solution of $CuBr_2$ was electrolysed with a current of 0.965 ampere for one hour. If the volume of the solution remains constant during the electrolysis, then the normality (in N) of the remaining $CuBr_2$ solution is

33. The standard enthalpy of combustion of C_2H_6 (g) is – 1564.25 kJ mol^{-1}. Standard heat of formation of $CO_2(g)$ and $H_2O(\ell)$ are – 395 kJ mol^{-1} and – 286 kJ mol^{-1} respectively. The heat liberated in kJ mole $^{-1}$ for the formation of 1 mole of $C_2H_6(g)$ from its constituent elements in standard state is

34. The half-life of first order decomposition of $NH_4NO_2(aq) \xrightarrow{\Delta} N_2(g) + 2H_2O(\ell)$ is 13.86 minute at 293 K.
If 10 g of NH_4NO_2 is allowed to decompose then the time in minute required to decompose 90% of NH_4NO_2 is

35. 8g of a mixture of Na_2CO_3 and Na_2SO_4 is dissolved in water and the volume of the solution made up to 250 ml. 25 ml of this solution required 20 ml of $\frac{N}{10}H_2SO_4$ solution for neutralization. The percentage of Na_2CO_3 in the mixture is

36. At 300 K temperature and 8 atm pressure the compressibility factor for a real gas is 0.8. The volume (in litre) of 10 mole of the gas at same temperature and pressure is

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **04 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

37. If $r \in (0, 1)$, $m \in W$ and $P = (2m + 1)r^m (1 - r)$ also $Q = 1 - r^{2m+1}$, then
(A) $P < Q$
(B) $P > Q$
(C) $P = Q$
(D) none of these

38. If α and β are the roots of equation $x^2 - a(x + 1) - b = 0$, then $\frac{\alpha^2 + 2\alpha + 1}{\alpha^2 + 2\alpha + b} + \frac{\beta^2 + 2\beta + 1}{\beta^2 + 2\beta + b}$ is/are
(A) 1
(B) $\frac{a+1}{b} + \frac{b+1}{a}$
(C) $a + \frac{1}{a} + b + \frac{1}{b}$
(D) none of these

39. Let $y = \sum_{r=1}^{n-1} \frac{2r^2 - r(n-2) + 1}{(n-r)\,{}^nC_r}$; $n \in N$, then
(A) $y = n + \frac{1}{n}$
(B) $y \geq 2$
(C) $y = n - \frac{1}{n}$
(D) $y = 2n$

40. If $x, y, z > 0$ are such that $\left(\frac{4x^2}{1+4x^2} - y\right)^2 + \left(\frac{4y^2}{1+4y^2} - z\right)^2 + \left(\frac{4z^2}{1+4z^2} - x\right)^2 = 0$, then
(A) $x + y = z$
(B) $x = y$
(C) $x < y < z$
(D) $x > y > z$

(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

41. Let $|a|, |b| < 1$, where a and b are complex number, then
(A) $\left|\frac{a-b}{1-\bar{a}b}\right| < 1$
(B) $\left|\frac{a-b}{1-\bar{a}b}\right| > 1$

(C) $\left|\dfrac{a-b}{1-a\bar{b}}\right| < 1$

(D) $\left|\dfrac{a-b}{1-a\bar{b}}\right| > 1$

42. If between two real numbers x and y an even number of arithmetic mean are inserted, such that sum of these means exceed their number by unity, then

(A) x + y can be $\dfrac{24}{11}$

(B) x + y can be $\dfrac{25}{12}$

(C) x + y can be $\dfrac{37}{2}$

(D) x + y can be $\dfrac{13}{6}$

43. From the first ($675n^6 + 2$) natural number, if five consecutive numbers are chosen, E be event that sum of the numbers is cube of natural number and sum of middle three is a square of a natural number, then

(A) $P(E) = \dfrac{2}{673}$, if n = 1

(B) $P(E) = \dfrac{3}{673}$, if n = 1

(C) $P(E) = \dfrac{2n+1}{675n^2-2}$, for $n \in N$

(D) $P(E) = \dfrac{n+1}{675n^2-2}$, for $n \in N$

44. If a, b, c x, y, z $\in$ R and $\vec{r}_1 = a\hat{i} + b\hat{j} + c\hat{k}$, $\vec{r}_2 = x\hat{i} + y\hat{j} + z\hat{k}$ are two vectors such that $|\vec{r}_1| = 5$, $|\vec{r}_2| = 6$ and $\vec{r}_1 \cdot \vec{r}_2 = 30$, then

(A) $\dfrac{x}{a} = \dfrac{y}{b}$

(B) $\dfrac{x}{a} = \dfrac{z}{c}$

(C) x = y = z = a = b = c

(D) $\dfrac{a+b+c}{x+y+z} = \dfrac{5}{6}$

45. If max{$x^2 + \cos x - 1, 1 - x^2 - \cos x$} = max{$\cos x + x^2 - 1, x^2 - 1 - \cos x$}, $x \in \left(\dfrac{\pi}{2}, \dfrac{5\pi}{2}\right)$, then the value of x that satisfy the equation is/are

(A) number of integer values of x is 3

(B) let $x = \dfrac{k\pi}{2}$, $k \in I$ then k = 1, 2, 3

(C) let $x = \dfrac{k\pi}{2}$, $k \in I$ then n(k) = 7

(D) $x \in \left[2\pi, \dfrac{5\pi}{2}\right)$

46. If $x^4 - (a + 1)x^3 + x^2 + (a + 1)x - 2 = 0$, $a \in R$ have atleast two positive real roots, then **'a'** can be in the interval

(A) $a \in \left(-\infty, -1-2\sqrt{2}\right]$

(B) $a \in \left[2\sqrt{2}-1, \infty\right)$

(C) $a \in \left[-15, -1-2\sqrt{2}\right]$

(D) $a \in \left[2\sqrt{2}-1, 15\right]$

47. Let the roots of the equation $x^3 + ax + a = 0$, $a \in R - \{0\}$ be α, β and γ such that $\frac{\alpha^2}{\beta}+\frac{\beta^2}{\gamma}+\frac{\gamma^2}{\alpha}+8=0$ and $\alpha < \beta < \gamma$, then

(A) $\alpha = -1-\sqrt{5}$

(B) $\beta = 1-\sqrt{5}$

(C) $\gamma = 1+\sqrt{5}$

(D) $a = -8$

48. If 7, g_1, g_2, g_3, g_4, –7 are in G.P. and the roots of equation $x^2 + (g_1 + g_3)x + g_2g_4 = 0$ are α_1, β_1 and $x^2 + (g_2 + g_4)x + g_1g_3 = 0$ are α_2, β_2, then which of the following are correct?

(A) $g_1 + 2g_2 + 2g_3 + g_4 = 0$

(B) $g_1g_2 = g_3g_4$

(C) $\alpha_1 = 7$

(D) $\beta_2 = -7$

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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49. A line L in the Argand plane is a mean line for the points $w_1, w_2, w_3, \ldots\ldots, w_n$ if there are points $z_1, z_2, z_3, \ldots\ldots z_n$ on L such that $\sum_{r=1}^{n}(w_r - z_r) = 0$. The slope of a mean line for the points $32 + 170i$, $-7 + 64i$, $-9 + 200i$, $1 + 27i$, $-14 + 43i$ which passes through the point $3i$ is/are

50. A particle moves in a sequence of unit steps. Each step along North, South, East or West with equal probability. It starts at the origin, let p be the probability that it will reach (2, 2) in less than 7 steps, then 16p is equal to

51. Let 'n' be the number of the numbers of the form 9^x where $0 \le x \le 4000$, have left most digit 9, given that 9^{4000} has 3817 digits and that its leftmost digit is 9 then n is equal to

52. Let f(x, y) is defined for $x, y \in N$ and satisfy $f(x, x) = x$,

$f(x, x + y) = \left(1+\frac{x}{y}\right)\cdot f(x, y)$,

$f(x, y) = f(y, x)$. Then f(52, 14) is

53. A is the region of the complex plane defined by p(z) such that complex numbers $\frac{z}{40}$ and $\frac{40}{\bar{z}}$ have real and imaginary parts in (0, 1), then the area of region A is (Take $\pi = 3.142$)

54. Starting at the origin a particle makes 40 moves, the nth move is of a distance of $\frac{n^2}{2}$ unit along a straight line. Its moves are in order of due east, then north, then west and then south and continues the order till 40 moves. The particle will be at a distance of ______ from origin?

FIITJEE

ALL INDIA TEST SERIES

PART TEST – III

JEE (Advanced)-2020

PAPER – 1

TEST DATE: 15-12-2019

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. A

Sol. Amplitude of two waves at point ‘P’ is $\frac{C}{r_1}$ & $\frac{C}{r_2}$ respectively, where ‘C’ is a constant

Let, $y_1 = \frac{C}{r_1}\sin(kr_1 - \omega t)$

$y_2 = \frac{C}{r_2}\sin(kr_2 - \omega t)$

$y = y_1 + y_2$

$= \frac{C}{r}\left[\sin(kr_1 - \omega t) + \sin(kr_2 - \omega t)\right]$

$= \frac{2C}{r}\cos\frac{k}{2}(r_1 - r_2).\sin(kr - \omega t)$

2. C

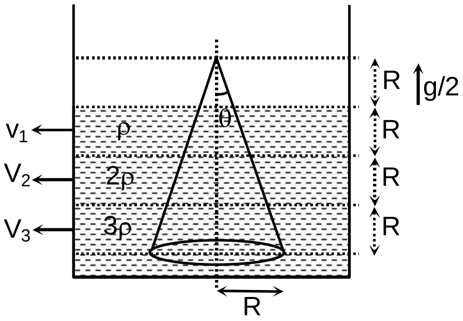
Sol. $\theta_1 = \theta_0 \sin(\omega_1 t + \pi/2)$
$\theta_2 = \theta_0 \sin(\omega_2 t + 3\pi/2)$
For $\theta_1 = \theta_2$
$\cos \omega_1 t = -\cos \omega_2 t$
$\cos(\omega_1 t) = \cos(\pi - \omega_2 t)$
$(\omega_1 + \omega_2)t = \pi$
$2\left(\frac{1}{T_1} + \frac{1}{T_2}\right)t = 1$

Where $T_1 = 2\pi\sqrt{\frac{L_0}{g}}$, $T_2 = 2\pi\sqrt{\frac{25L_0}{g}}$

$$t = \frac{5\pi}{6}\sqrt{\frac{L_0}{g}}$$

3. C

Sol. $\text{Tan}\,\theta = \frac{1}{4}$



$$v_1 = \frac{\pi}{3}\left[x_2^2.2R - x_1^2.R\right] = \frac{7\pi}{48}R^3$$

$$v_2 = \frac{\pi}{3}\left[x_3^2.3R - x_2^2.2R\right] = \frac{19\pi}{48}R^3$$

$$v_3 = \frac{\pi}{3}\left[R^2.4R - x_3^2.3R\right] = \frac{37\pi}{48}R^3$$

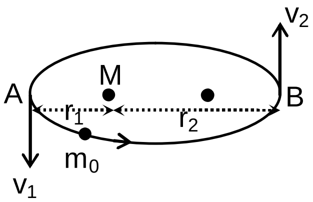
So, $m = v_1\rho + v_2(2\rho) + v_3(3\rho)$

$$\rho_0\frac{\pi R^2}{3}\times 4R\left(\frac{3g}{2}\right) = \rho\frac{\pi R^3}{48}(156)\left(\frac{3g}{2}\right)$$

Density of cone, $\rho_0 = \frac{39}{16}\rho$

4. D

Sol. $v_1r_1 = v_2r_2$ …(1)



$$\frac{GMm_0}{r_1^2} = \frac{m_0v_1^2}{R_1}$$

$$\frac{GMm_0}{r_2^2} = \frac{m_0v_2^2}{R_2}$$

So, $\frac{R_1}{R_2} = \frac{v_1^2}{v_2^2}\frac{r_1^2}{r_2^2} = 1$

5. B, D

Sol. $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$$\frac{dv}{dt} = -\frac{v^2}{u^2}\frac{du}{dt} = -8 \text{ m/s}$$

$$m_T = -\frac{v}{u} = \frac{f}{f-u}$$

$$h_i = \frac{f}{f-u}h_0$$

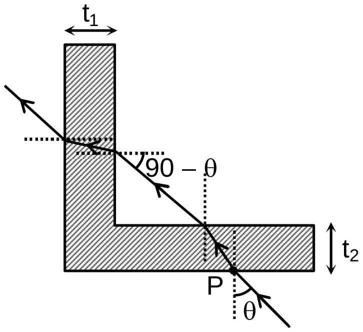
$$\frac{dh_i}{dt} = \frac{fh_0}{(f-u)^2}\frac{du}{dt} = \frac{-20\times 0.2\times 2}{100} = \frac{-2}{25} \text{ cm/s}$$

6. B, D

Sol. Use the concepts of refraction and TIR.

7. C, D

Sol.



8. A, D

Sol. $a \propto \frac{z^3}{n^4}$

$T \propto \frac{n^3}{z^2}$

9. A, D

Sol. $\Delta E = \frac{hc}{\lambda}$

$\Delta E = \frac{hc}{\lambda(\text{in nm})}(\text{in eV})$

10. B, C

Sol. $I = \frac{ma^2}{6} + m\left(\frac{a}{\sqrt{2}}\right)^2 + m(\sqrt{2}a)^2 = \frac{8}{3}ma^2$

$d = \frac{a}{\sqrt{2}} + \frac{a}{2\sqrt{2}} = \frac{3a}{2\sqrt{2}}$

$T = 2\pi\sqrt{\frac{I}{2mgd}} = 2\pi\sqrt{\frac{8\sqrt{2}}{9}\frac{a}{g}}$

11. A, B, C, D

Sol. Q = ΔK

and use basic concept

12. A, B, C

Sol. In equilibrium

4 mg sin θ = kx_0

k = 120,000 N/m

$f = \frac{1}{2\pi}\sqrt{\frac{k}{2m}} = \frac{\sqrt{60}}{2\pi}$ Hz

New amplitude = 20/2 = 10 cm

SECTION – C

13. 00016.00

Sol. For refraction only

$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R} \qquad \ldots(i)$$

v = –10 cm

Differentiate equation (i) w.r.t. time

$$-\frac{\mu_2}{v^2}\frac{dv}{dt} + \frac{\mu_1}{u^2}\frac{du}{dt} = 0$$

$$\frac{dv}{dt} = \frac{\mu_1}{\mu_2}\frac{v^2}{u^2}\frac{du}{dt} = \frac{4}{1\times 3}\times 1\times 6 = 8 \text{ m/s (towards left)}$$

The velocity of image formed after refraction is 8 m/s (towards left)

The velocity of image formed after reflection and then refraction = 8 m/s (towards right).

The relative velocity between two images formed = 16 m/s

14. 00001.62

Sol. Path difference at 'O' = $(\mu_1 - \mu_2)t = 4.5 \times 10^{-6}$ m

Hence phase difference $\phi = \frac{2\pi}{\lambda}\cdot\Delta r = 20\pi$

Now, $I_1 = \frac{I_0}{16}$ and $I_2 = \frac{I_0}{25}$

So, $I = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$

= 1.62 W/m^2

15. 00001.88

Sol. Let 'x' is the displacement of block from its equilibrium position.

$$m\frac{d^2x}{dt^2} = -kx - \frac{kx}{21}$$

$$\frac{d^2x}{dt^2} = -\left(\frac{22k}{21m}\right)x$$

$$T = 2\pi\sqrt{\frac{21m}{22k}} = 1.88 \text{ sec}$$

16. 00008.00

Sol. $v_1 = \sqrt{\frac{F}{\mu_1}} = 25$ m/s

$$v_2 = \sqrt{\frac{F}{\mu_2}} = 20 \text{ m/s}$$

$$A_r = \left(\frac{|v_2 - v_1|}{v_2 + v_1}\right)A_i = \frac{2}{9} \text{ mm}$$

$$A_t = \left(\frac{2v_2}{v_2 + v_1}\right)A_i = \frac{16}{9} \text{ mm}$$

$$\therefore \frac{A_t}{A_r} = 8$$

17. 00012.80

Sol. $T = 2\pi\sqrt{\frac{I}{mgd}}$

So $\frac{T_P}{T_q} = \sqrt{\frac{I_P}{d_P} \cdot \frac{d_q}{I_q}}$

$\frac{6}{10} = \sqrt{\frac{16}{25} \cdot \frac{d_q}{d_p}}$

$\frac{d_q}{d_p} = \frac{9}{16}$ …(1)

$d_q + d_p = 20$ …(2)

$\Rightarrow d_p = \frac{64}{5} = 12.80$

18. 00002.50

Sol. $\eta A\frac{dv}{dy} = kx = mg$

$5 \times 2 \times 10^{-2} \times \frac{4 \times 10^{-2}}{2 \times 10^{-3}} = 80x$

$x = \frac{2}{80}m = 2.50\,cm$

Chemistry

PART – II

SECTION – A

19. A

Sol. Meq of I_2 = meq of $Na_2S_2O_3$ = 60 × 0.2 = 12

Wt. of I_2 liberated $= \frac{12 \times E}{1000}$

Also, $W = \frac{EIt}{96500}$

$$\therefore \frac{EIt}{96500} = \frac{12 \times E}{1000}$$

$$= \frac{I \times 193}{96500} = \frac{12}{1000}$$

I = 6 amp.

20. B

Sol.

$$\begin{array}{llll} & 2N_2O_5 \longrightarrow & 4NO_2 & + \ O_2 \\ t = 0 & 10 & 0 & 0 \\ t & 6 & 8 & 2 \end{array}$$

$[N_2O_5]$ left = 6 M.

Rate of reaction = $2 \times 10^{-5} \times 6 = 12 \times 10^{-5}$ M sec^{-1}

Rate of formation of NO_2 = $4 \times 12 \times 10^{-5} = 4.8 \times 10^{-4}$ M sec^{-1}

21. A

Sol. $$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma - 1}$$

$$\frac{T_2}{300} = \left(\frac{40}{5}\right)^{\frac{5}{3} - 1}$$

$$T_2 = 300 \times (8)^{2/3}$$

$$T_2 = 300 \times \left(2^3\right)^{2/3}$$

T_2 = 1200 K.

22. B

Sol. $$\frac{P^o - P^S}{P^o} = \frac{n_B}{n_B + n_A}$$

$$= \frac{100 - 80}{100} = \frac{n_B}{n_B + n_A}$$

$$= \frac{20}{100} = \frac{\frac{W_B}{60}}{\frac{W_B}{60} + \frac{90}{18}}$$

$W_B = 75$ g

23. B, C

Sol. $[NiCl_4]^{2-}$ and $[MnCl_4]^{2-}$ are tetrahedral complexes.

24. A, C, D

Sol. N_2O is a neutral oxide.

25. B, C, D

Sol. ClO_2 does not dimerise.

$$Cl_2O_6 + H_2O \longrightarrow HClO_3 + HClO_4$$

$$I_2O_5 + 5CO \longrightarrow 5CO_2 + I_2$$

Liquid IF_5 self ionizes and therefore conducts electricity.

$$2IF_5 \rightleftharpoons IF_4^+ + IF_6^-$$

26. A, C, D

Sol. Hg_2^{2+} and Ag^+ give white ppt. with dil. HCl.

27. B, D

Sol. $$2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2 + O_2$$

$$2PH_3 + 3HgCl_2 \longrightarrow Hg_3P_2 + 6HCl$$

28. A, B, C, D

Sol. All the reactions are correct. XeF_4 fluorinate Pt.

29. A, C, D

Sol. SnS is soluble in yellow ammonium sulphide.

30. A, C

Sol. In aluminothermic process Cr_2O_3 is reduced by Al.

In Van-Arkel process impure Ti is purified by reacting with I_2.

SECTION – C

31. 00032.84

Sol. $\pi V = \frac{W}{M}RT \qquad \pi = \frac{38}{76} = 0.5$ atm

$$M = \frac{W\ RT}{\pi\ V}$$

$$= \frac{0.2 \times 0.0821 \times 300 \times 1000}{300 \times 0.5}$$

= 32.84

32. 00001.28

Sol. Initial meq. of Cu^{2+} = 50 × 1 × 2 = 100

Electricity passed = 0.965 × 3600 = 3474 C

No of meq of Cu^{2+} discharged $= \frac{3474 \times 1000}{96500}$ = 36

$\therefore$ Meq of Cu^{2+} remained = 100 – 36 = 64

$$\therefore N = \frac{64}{50} = 1.28$$

33. 00083.75

Sol. $C_2H_6(g)+\frac{7}{2}O_2(g)\longrightarrow 2CO_2(g)+3H_2O(\ell)$

$\Delta H_r^o=\sum\Delta H_f^o(\text{Products})-\sum\Delta H_f^o(\text{Reactants})$

$-1564.25=\left[2\times(-395)+3\times(-286)\right]-\left[\Delta H_f^o C_2H_6\right]$

$\Delta H_f^o C_2H_6=-83.75\text{ kJ mol}^{-1}$

34. 00046.06

Sol. $k=\frac{0.693}{13.86}$

$t=\frac{2.303}{k}\log\frac{10}{1}$

$=\frac{2.303\times 13.86}{0.693}$

= 46.06

35. 00013.25

Sol. Meq of Na_2CO_3 in 25 ml = meq of H_2SO_4 $=20\times\frac{1}{10}=2$

Meq of Na_2CO_3 in 250 ml = 20

$\therefore$ wt of Na_2CO_3 $=\frac{20\times 53}{1000}=1.06$ g

% of Na_2CO_3 $=\frac{1.06}{8}\times 100=13.25$

36. 00024.63

Sol. $Z=\frac{PV}{nRT}$

$\frac{V}{n}=\frac{ZRT}{P}=\frac{0.8\times 0.0821\times 300}{8}$

= 2.463 litre/mole

$\therefore$ Volume of 10 mol of the gas = 24.63 litre.

Mathematics PART – III

SECTION – A

37. A

Sol. $1, r, r^2, \ldots, r^{2m}$ are in G.P.
$1 + r^{2m} > 2.r^m$
$r + r^{2m-1} > 2.r^m$
$r^2 + r^{2m-2} > 2.r^m$
$r^3 + r^{2m-3} > 2.r^m$
.
.
.
Hence $1 + r + r^2 + \ldots + r^{2m} > 2(r^m + r^m + \ldots \text{ m times}) + r^m$
$\left(\frac{1-r^{2m+1}}{1-r}\right) > 2m.r^m + r^m = (2m + 1).r^m$
$(2m + 1)r^m.(1 - r) < 1 - r^{2m+1}$.

38. A

Sol. $\alpha + \beta = a, \alpha\beta = -(a + b) \Rightarrow (1 + \alpha)(1 + \beta) = (\alpha + \beta) + \alpha\beta + 1 = -(a + b) + a + 1 = (1 - b)$

$$\Rightarrow \frac{\alpha^2+2\alpha+1}{\alpha^2+2\alpha+b} + \frac{\beta^2+2\beta+1}{\beta^2+2\beta+b} = \frac{(\alpha+1)^2}{(\alpha+1)^2+(b-1)} + \frac{(\beta+1)^2}{(\beta+1)^2+(b-1)}$$

$$= \frac{(\alpha+1)^2}{(\alpha+1)(\alpha+1-1-\beta)} + \frac{(\beta+1)^2}{(\beta+1)(\beta+1-1-\alpha)} = \frac{\alpha+1}{\alpha-\beta} + \frac{\beta+1}{\beta-\alpha} = \frac{\alpha-\beta}{\alpha-\beta} = 1$$

39. C

Sol. $$y = \sum_{r=1}^{n-1} \frac{(r+1)^2 - r(n-r)}{(n-r)\,{}^nC_r} = \sum_{r=1}^{n-1}\left(\frac{(r+1)}{\frac{n-r}{r+1}\,{}^nC_r} - \frac{r}{{}^nC_r}\right) = \sum_{r=1}^{n-1}\left(\frac{r+1}{{}^nC_{r+1}} - \frac{r}{{}^nC_r}\right) = \frac{n}{{}^nC_n} - \frac{1}{{}^nC_1} = n - \frac{1}{n}$$

40. B

Sol. $\frac{4x^2}{1+4x^2} = y \Rightarrow \frac{y}{x} = \frac{4x}{1+4x^2}$ and $1 + 4x^2 \ge 4x \Rightarrow \frac{y}{x} \le 1 \Rightarrow y \le x$
Similarly, $x \le z$ and $z \le y$. Hence, $x = y = z$

41. A, C

Sol. $$|a-b|^2 - |1-\bar{a}b|^2 = \left(|a|^2 + |b|^2 - 2\text{Re}(\bar{a}b)\right) - \left(1 + |a|^2|b|^2 - 2\text{Re}(\bar{a}\bar{b})\right) = -\left(1-|a|^2\right)\left(1-|b|^2\right) < 0$$

Hence, $|a - b| < |1-\bar{a}b| \Rightarrow \left|\frac{a-b}{1-\bar{a}b}\right| < 1$

42. B, D

Sol. $x, a_1, a_2, \ldots, a_{2n}, y$ are in A.P.
$d = \left(\frac{y-x}{2n+1}\right)$
$(2n + 1) = \sum_{r=1}^{2n} a_r = \sum_{r=1}^{2n}(x + rd)$
$= 2nx + n(2n + 1)d = n(2x + y - x)$

$(2n + 1) = (x + y)n \Rightarrow n = \left(\dfrac{1}{x+y-2}\right)$

$\Rightarrow x + y - 2 = \dfrac{1}{n};\ x + y = \left(\dfrac{1+2n}{n}\right)$

43. A, D

Sol. $n(s) = (675n^6 - 2)$

Let k be the middle number

$\therefore$ numbers are $k - 2, k - 1, k, k + 1, k + 2$

$\therefore 3k = \beta^2$ or $k = 3\lambda^2$

also $5k = q^3$

$15\lambda^2 = q^3 \quad \therefore \lambda = 15\mu^3$

$15.15^2.\mu^6 = q^3 \therefore k = 3.225\mu^6 \Rightarrow k = 675\mu^6$

$\Rightarrow k \in \{675, 675.1^6, 675.2^6, \ldots, 675.n^6\}$

$\Rightarrow n(E) = (n + 1) \Rightarrow P(E) = \left(\dfrac{n+1}{675n^6 - 2}\right)$

44. A, B, D

Sol. $\vec{r}_1 \cdot \vec{r}_2 = |\vec{r}_1| \cdot |\vec{r}_2| \cos\theta \Rightarrow \cos\theta = 1$. Hence, $\vec{r}_1$ and $\vec{r}_2$ are collinear vectors $\Rightarrow \dfrac{x}{a} = \dfrac{y}{b} = \dfrac{z}{c} = \dfrac{6}{5}$

45. A, D

Sol. When $\cos x < 0$, $x^2 + \cos x - 1 = x^2 - 1 - \cos x \Rightarrow \cos x = 0 \Rightarrow x = \dfrac{3\pi}{2}$

When $x \in \left(\dfrac{3\pi}{2}, \dfrac{5\pi}{2}\right)$, $\cos x > 0$, $x^2 + \cos x - 1 = x^2 - 1 + \cos x \Rightarrow \forall\ x \in \left(\dfrac{3\pi}{2}, \dfrac{5\pi}{2}\right)$

$\Rightarrow x \in \left[\dfrac{3\pi}{2}, \dfrac{5\pi}{2}\right)$

46. B, D

Sol. $(x^4 + x^2 - 2) - (a + 1)x(x^2 - 1) = 0$,

$(x^2 + 2)(x^2 - 1) - (a + 1)x(x^2 - 1) = 0$

$(x^2 - 1)(x^2 - (a + 1)x + 2) = 0$

$\Rightarrow x^2 - (a + 1)x + 2 = 0$ have atleast one positive real root

$D \geq 0 \Rightarrow (a + 1)^2 - 8 \geq 0$

$\Rightarrow a \in \left(-\infty, -1 - 2\sqrt{2}\right] \cup \left[2\sqrt{2} - 1, \infty\right)$ and since $\alpha\beta = 2$

Hence, both root, should be positive $\Rightarrow (a + 1) > 0 \Rightarrow a > -1 \Rightarrow a \in \left[2\sqrt{2} - 1, \infty\right)$

47. B, C, D

Sol. α, β, γ are roots of equation $x^3 + ax + a = 0 \Rightarrow \alpha + \beta + \gamma = 0$, $\alpha\beta + \beta\gamma + \alpha\gamma = a$, $\alpha\beta\gamma = -a$

Also, $\alpha^3 = -a(\alpha + 1)$, $\beta^3 = -a(\beta + 1)$, $\gamma^3 = -a(r + 1)$ $\therefore \dfrac{\alpha^2}{\beta} + \dfrac{\beta^2}{\gamma} + \dfrac{\gamma^2}{\alpha} = -8$

$\Rightarrow \alpha^3\gamma + \beta^3\alpha + \gamma^3\beta + 8\alpha\beta\gamma = 0$, $-a(\alpha + 1)\gamma - a(\beta + 1)\alpha - a(\gamma + 1)\beta - 8a = 0$

$-a(\alpha\gamma + \gamma + \beta\alpha + \alpha + \gamma\beta + \beta + 8) = 0$, $a \neq 0 \Rightarrow \alpha\beta + \beta\gamma + \gamma\alpha + (\alpha + \beta + \gamma) + 8 = 0$

$a + 8 = 0 \Rightarrow a = -8 \therefore x^3 - 8x - 8 = 0 \Rightarrow x = -2, 1 \pm \sqrt{5}$

48. A, B, C, D

Sol. $7, g_1, g_2, g_3, g_4, -7$ are in G.P. $\Rightarrow -7 = 7 \cdot r^5 \Rightarrow r = -1 \Rightarrow g_2 = g_4 = 7$ and $g_1 = g_3 = -7$

Hence, equation are $x^2 - 14x + 49 = 0 \Rightarrow (x - 7)^2 = 0$ and $x^2 + 14x + 49 = 0 \Rightarrow (x + 7)^2 = 0$

$\Rightarrow x = \pm 7$ are roots.

SECTION – C

49. 00163.00

Sol. $\Sigma w_r = \Sigma z_r = 3 + 504i$, let $z_r = 3i + k_r(a + ib)$

$\Rightarrow \sum_{r=1}^{5} z_r = 15i + k(a+ib)$ when $k = \Sigma k_r$.

$\Rightarrow b/a = 163$ is the slope of the line L

50. 00000.75

Sol. Will reach at A(2, 2) either in four steps of different combination EENN

$= \frac{4!}{2!2!} = \frac{4\times3\times2}{2\times2} = 6$ ways

(or) in 6 steps:

EEENNW (or) EENNNS

Where (EENN in any order cannot come in 1st four steps since that it is at point A)

$\therefore$ Number of ways = $2\left(\frac{6!}{3!2!} - \frac{4!}{2!2!}\times2\right) = 2\left(\frac{6\times5\times4}{2} - 6\times2\right) = 96$

$\therefore$ Probability = $\frac{6}{4^4} + \frac{96}{4^6} = \frac{3}{64}$

51. 00184.00

Sol. If 9^x has leftmost digit as 9 and number of digit is m then 9^{x-1} i.e. ($9x \div 9$) will have leftmost digit 1 and number of digits remain same m.

Where as if 9^x has leftmost digit other than 9, then and number of digits is m then on division by 9 i.e. in 9^{x-1} number of digit changes to (m – 1).

$\Rightarrow$ every time number of digits increases by 1 by multiplying by 9 then the number was not having left most digit as 9.

Now $9' = 9$ (1 digit number)

9^{4000} has leftmost digit is 9 and number of digits is 3817

$\therefore$ number of digit increases from 1 to 3817

Hence 3816 numbers are not starting with 9 (i.e. leftmost digit is not 9)

and rest 4000 – 3816 = 184 number are which have left most digit as 9

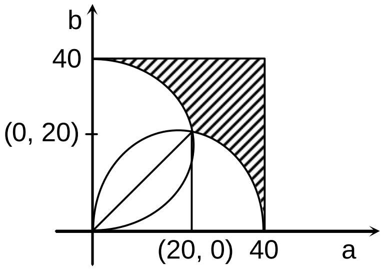
52. 00364.00

Sol. $f(52, 14) = f(14, 52) = \left(1+\frac{14}{24}\right).f(14, 38)$

$= \frac{26}{19}\left(1+\frac{14}{24}\right)f(14,24) = \frac{26}{19}\cdot\frac{19}{12}\left(1+\frac{14}{10}\right)f(14,10) = 364$

53. 00571.60

Sol. Let $z = a + ib$



$\Rightarrow 0 < \text{Re}\left(\frac{z}{40}\right) < 1,\ 0 < \text{Im}\left(\frac{z}{40}\right) < 1,$

$0 < \text{Re}\left(\frac{40}{\bar{z}}\right) < 1,\ 0 < \text{Im}\left(\frac{40}{\bar{z}}\right) < 1$

$\Rightarrow 0 < a, b < 40$ and $0 < 40a < a^2 + b^2$ and $0 < 40b < a^2 + b^2$

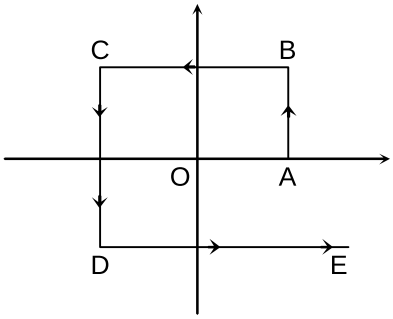
$\Rightarrow (a – 20)^2 + b^2 > 20^2$ and $a^2 + (b – 20)^2 > 20$

Required area = $40 \times 40 – \pi(20)^2 – 2\left(\frac{1}{4}\times\pi(20)^2 - \frac{1}{2}\times20\times20\right)$

$= 1600 – 400\pi + 200\pi – 400$

$= 1200 – 200\pi = 200(6 – \pi) = 571.6$

54. 00580.00



Sol. From origin all distance parallel to x-axis are

$\bar{x} = \frac{1^2}{2} - \frac{3^2}{2} + \frac{5^2}{2} - \frac{7^2}{2} + ... + \frac{37^2}{2} - \frac{39^2}{2}$

$= \frac{1}{2}$ ((–2) (4) + (–2) (12) + (–2) (20) + ….. + (–2) (76))

= –4(1 + 3 + 5 + …..+19) = –4(100) = –400

$y = \frac{1}{2}$ $(2^2 - 4^2 + 6^2 - 8^2 + 10^2 - 12^2 + ….. + 38^2 - 40^2)$

$= \frac{1}{2}$ ((–2) (6) + (–2) (14) + (–2) (22) + ….. + (–2) (78))

= –2(3 + 7 + 11 + 15 + ….. + 39)

$= -2\left(\frac{10}{2}(3+39)\right) = -420$

Point will be (–400, –420) its distinct from origin

$d = \sqrt{(400)^2 + (420)^2} = 10\sqrt{1600+1764}$

$= 10\sqrt{3364}$ = 580 units

FIITJEE

ALL INDIA TEST SERIES

PART TEST – III

JEE (Advanced)-2020

PAPER – 2

TEST DATE: 15-12-2019

Time Allotted: 3 Hours **Maximum Marks: 186**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-C.**

1. ***Section-A (01 – 08, 19 – 26, 37 – 44)*** *contains 24 multiple choice questions which have* ***one or more than one correct*** *answer. Each question carries* ***+4 marks*** *for all correct answer.*
   *Full Marks : **+4** If only (all) the four option(s) is (are) chosen.*
   *Partial Marks : **+3** If all the four options are correct but ONLY three options are chosen.*
   *Partial Marks : **+2** If three or more options are correct but ONLY two options are chosen and both of which are correct options.*
   *Partial Marks : **+1** If two or more options are correct but ONLY one option is chosen and it is a correct option.*
   *Zero Marks : **0** If none of the options is chosen (i.e. the question is unanswered).*
   *Negative Marks : **–1** In all other cases.*

   Section-A (09 – 12, 27 – 30, 45 – 48) *contains 6 List-Match sets with 12 questions (each set has 2 questions). Each question has 4 statements in LIST-I & 5 or 6 statements in LIST-II. The codes for Lists have choices (A), (B), (C), (D) out of which only one is correct.*
   Each question has ***only one correct*** *answer and carries* ***+3 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

2. ***Section-C (13 – 18, 31 – 36, 49 – 54)*** *contains 18 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+3 marks*** *for correct answer. There is no negative marking.*

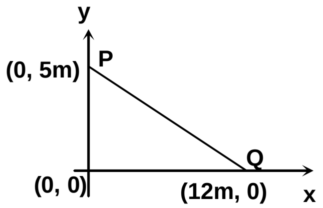
Physics

PART – I

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A particle is executing simple harmonic motion along a line 12y + 5x = 60 only in between the extreme points 'P' and 'Q'. At t = 0, the particle starts its motion from the extreme point 'P'. The time period of simple harmonic motion executed by the particle is 8 sec. Then choose the correct option(s).



(A) The position vector of the particle at time t is given by $\vec{r} = \left[12\sin^2\left(\frac{\pi t}{8}\right)\hat{i} + 5\cos^2\left(\frac{\pi t}{8}\right)\hat{j}\right]$m.

(B) The position vector of the particle at time t is given by $\vec{r} = \left[12\cos^2\left(\frac{\pi t}{8}\right)\hat{i} + 5\sin^2\left(\frac{\pi t}{8}\right)\hat{j}\right]$m.

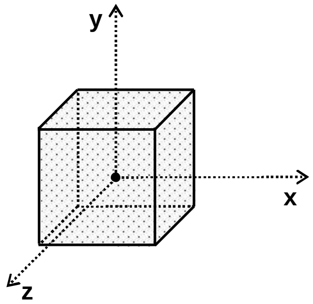
(C) The velocity vector of the particle at time t is given by $\vec{v} = \left[\frac{3\pi}{2}\sin\left(\frac{\pi t}{4}\right)\hat{i} - \frac{5\pi}{8}\sin\left(\frac{\pi t}{4}\right)\hat{j}\right]$ m/s.

(D) The amplitude of simple harmonic motion executed by the particle is $\frac{13}{2}$ m.

2. Choose the incorrect option(s)

(A) The buoyant force on a submerged rigid body can be considered to be acting at the centre of mass of the rigid body.
(B) Steady fluid flow in a tube of flow of variable cross-section is non-accelerated.
(C) Viscosity of a liquid increases with rise in temperature.
(D) The angle of contact of liquid in a capillary tube and surface tension of liquid decrease with increase in temperature.

3. A rubber ball is kept at rest at the centre of a cube filled with liquid. The density of liquid is ρ and rubber ball is ρ/3. At t = 0, the cube is accelerated with an acceleration $\vec{a} = \left(\frac{5}{\sqrt{2}}\hat{i} - \frac{15}{2}\hat{j} + \frac{5}{2}\hat{k}\right)$ m/s^2 and the ball is released from origin as shown in the figure. The acceleration due to gravity is along negative y-axis. At t = 0, choose the correct option(s). (Take g = 10 m/s^2)



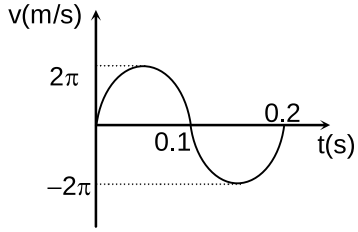
(A) Angle made by acceleration of ball with x-axis is $\frac{\pi}{4}$ as seen from the cube.

(B) Angle made by acceleration of ball with y-axis is $\frac{\pi}{3}$ as seen from the cube.

(C) Angle made by acceleration of ball with z-axis is $\frac{\pi}{3}$ as seen from the cube.

(D) If density of rubber ball is considered as ρ/2 then angle made by acceleration vector of ball with x, y and z-axis is changed as seen from the cube.

4. A spring block system performs simple harmonic motion about its equilibrium position along x-axis. The spring constant of used spring is 200 N/m and equilibrium position of block is origin. The velocity time graph of the particle is given in the figure. Choose the correct option(s). (Take $\pi^2 = 10$)

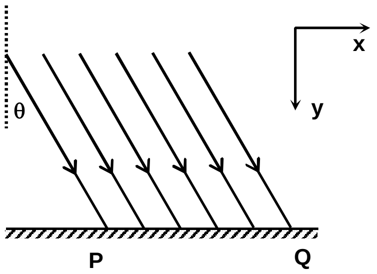


(A) The mass of the block is 0.2 kg.
(B) The displacement of the particle from equilibrium position at t = 0 is 0.1 meter.
(C) The acceleration of block at t = 0.1 second is -200 m/s^2.
(D) The maximum kinetic energy of the block is 4.0 Joule.

5. An imaginary particle has a charge equal to the charge of electron but mass of imaginary particle is 50 times the mass of electron. Now, consider that imaginary particle moves in circular orbit around a nucleus. The charge of nucleus is +4e, and nucleus is assumed to be at rest. Assume mass of nucleus is very large as compared to the mass of imaginary particle moving around it. Choose the correct option(s).

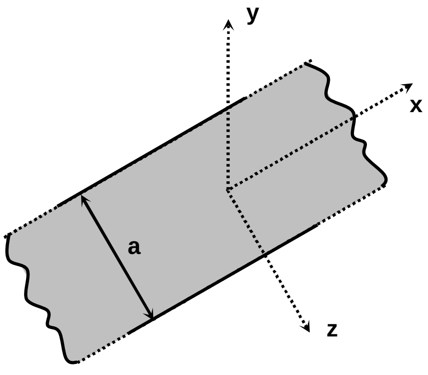
(A) The radius of nth orbit is $\frac{n^2h^2\varepsilon_0}{200\pi me^2}$, where m is mass of electron, h is Planck constant, e is charge of electron.
(B) If all atoms are at 16th excited state then during de-excitation till 10th excited state the total maximum number of possible wavelengths emitted is 21.
(C) The wavelength of photon emitted when transition takes place from third excited state to ground state is 1.21 Å.
(D) Since mass of imaginary particle is different from the mass of electron so the velocity of imaginary particle and the electron in nth orbit will be different.

6. A reflecting surface PQ is fixed and a parallel beam of light is incident on it. The intensity of light is 600 W/m^2 and it makes an angle 53° with the vertical line. The area of surface PQ is 2.0 m^2. It is observed that 40% incident energy is reflected by the reflecting surface PQ. Now choose the correct option(s).



(A) Due to incident beam force along the x-axis on the surface is 1.152×10^{-6} N.
(B) Due to incident beam force along the y-axis on the surface is 2.016×10^{-6} N.
(C) Due to incident energy radiation pressure on the surface is 0.576×10^{-6} N/m^2.
(D) Due to incident energy radiation pressure on the surface is 1.008×10^{-6} N/m^2.

7. A thin metallic plate of uniform mass density is kept along x-axis symmetrically. The length of plate along x-axis is very large as compared to its width 'a' along z-axis. It is given that 'σ' is mass per unit area. Then choose the correct option(s)



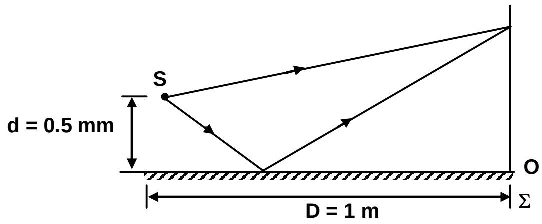
(A) The gravitational field at $\left(0,\frac{\sqrt{3}a}{2},0\right)$ is $\frac{2G\sigma\pi}{3}$.

(B) The gravitational field at $\left(0,\frac{a}{2},0\right)$ is $G\sigma\pi$.

(C) The ratio of gravitational field at $\left(0,\frac{a}{2\sqrt{3}},0\right)$ and $\left(0,\frac{\sqrt{3}a}{2},0\right)$ is 2.

(D) The ratio of gravitational field at $\left(0,\frac{a}{2\sqrt{3}},0\right)$ and $\left(0,\frac{a}{2},0\right)$ is $\frac{4}{3}$.

8. A narrow slit S transmitting light of wavelength λ is placed a distance d above a large plane mirror as shown in the figure. The light coming directly form the slit and that coming after reflection from the plane mirror interfere on a screen Σ placed at a distance D from the slit. Assume that the mirror is 100% reflecting. (Given D = 1m, d = 0.5 mm and λ = 500 nm)



(A) Distance from O, where first interference maximum is formed on the screen is $\frac{1}{4}$mm.

(B) Distance from O, where closest interference minimum is formed on the screen is zero.

(C) Fringe width of the interference pattern formed on the screen is $\frac{1}{2}$mm.

(D) Closest point to O on the screen where waves interfere with a phase difference of $\frac{\pi}{2}$ is $\frac{1}{8}$mm.

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO (02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

Two point sound sources of same frequency 'f' amplitude 2A and 4A are situated at x = 0 and x = 20 λ respectively (λ = wavelength of wave) on the x-axis. These sources are vibrating in same phase. Four observers A, B, C and D are situated at $x_A = 4\lambda$, $x_B = 8\lambda$, $x_C = 12\lambda$ and $x_D = 16\lambda$ respectively. The value of intensity observed by another observer O situated exactly at midpoint of location of two sources is I_0. Observers A, B, C and D are tabulated in first List and in second List some quantities are given. (Given $I_0 = \frac{36A^2k}{100}$)

List –I gives the above four observers while List –II lists the magnitude of some quantity.

	List-I		List-II
(I)	Observer A	(P)	$\frac{9}{16}$

(II)	Observer B	(Q)	$\frac{49}{144}$
(III)	Observer C	(R)	$\frac{4}{9}$
(IV)	Observer D	(S)	$\frac{5}{16}$
		(T)	$\frac{81}{64}$
		(U)	$\frac{10}{36}$

9. List –I contains observers and List-II contains the values of intensity observed by respective observers in unit of kA^2. Pick the correct option.

Options

(A) I → Q, II → R, III → S, IV → P
(B) I → P, II → Q, III → R, IV → T
(C) I → P, II → Q, III → T, IV → S
(D) I → Q, II → P, III → R, IV → T

10. In separate experiment location of sources are interchanged. The values of intensity observed by the observers now in units of kA^2 are given in List-II. Match respective intensities observed by the observers.

Options

(A) I → T, II → R, III → S, IV → Q
(B) I → Q, II → S, III → R, IV → P
(C) I → P, II → Q, III → T, IV → S
(D) I → T, II → R, III → Q, IV → P

Answer the following by appropriately matching the list based on the information given in the paragraph.

A uniform candle of length 10 cm is glued with an aluminium cylinder of same radius and length 1 cm. Composite system is submerged in the water and it floats stably in vertical orientation. Density of wax is 0.8 g/cm^3, density of aluminium is 2.7 g/cm^3 and density of water is 1.0 g/cm^3. At t = 0 candle is lit and assume that it consumes wax at a constant rate of 0.1 cm/min. List –I gives four different instant of time while List-II lists magnitude of some quantity.

	List-I		**List-II**
(I)	t = 5 minutes	(P)	$\sqrt{\frac{103}{107}}$
(II)	t = 10 minutes	(Q)	9.3
(III)	t = 15 minutes	(R)	8.9
(IV)	t = 20 minutes	(S)	$\sqrt{\frac{99}{107}}$
		(T)	8.5
		(U)	$\sqrt{\frac{95}{107}}$

11. The correct match for time and length of the candle inside the water (in cm) will be:

Options

(A) I → Q, II → R, III → T, IV → T

(B) I → Q, II → S, III → P, IV → R
(C) I → P, II → S, III → Q, IV → T
(D) I → P, II → P, III → S, IV → T

12. If candle is extinguished at different times i.e. at t = 5 minute, t = 10 minute, t = 15 minute and at t = 20 minutes and slightly displaced from mean position in each case. The correct match for time period of small oscillation in each case will be (in units of T_0 where T_0 is time period at t = 0)

Options

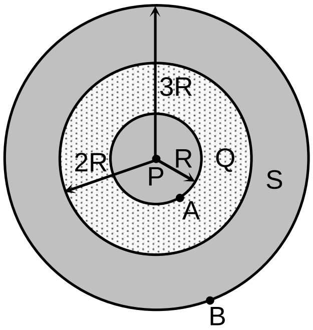
(A) I → P, II → P, III → U, IV → U
(B) I → Q, II → U, III → T, IV → T
(C) I → Q, II → P, III → S, IV → S
(D) I → P, II → S, III → U, IV → U

SECTION – C
(Numerical Answer Type)

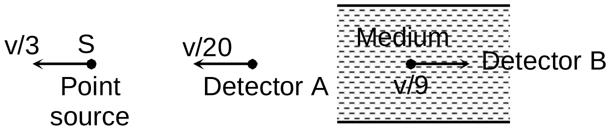
This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

13. The sound from a trumpet is emitted uniformly in all directions at 20°C. At point 'P' in space the sound intensity level is 30 dB. The density of air in the medium is 1.5 kg/m^3, the velocity of sound at 20°C is 300 m/sec. Find the displacement amplitude (in Å) at point 'P'. The frequency of sound wave in the medium is 600 Hz. (Take $\pi^2 = 10$)

14. A solid sphere P and two hollow sphere Q and S are concentrically placed as shown in the figure. The radius of P. Q and S are R, 2R and 3R respectively. The density of P, Q and S are ρ_1, ρ_2 and ρ_3 respectively. It is given that the density of middle sphere is the arithmetic mean of the densities of other two spheres. If the gravitational fields at points A and B are equal then find the ratio of $\frac{\rho_3}{\rho_1}$.

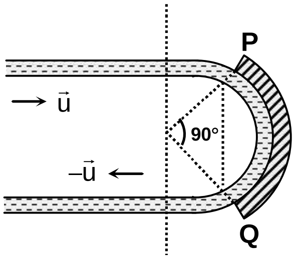


15. A point source 'S' is moving in air towards left with a constant velocity $\frac{v}{3}$, where v is the speed of sound in air. There are two detectors A and B. A is moving in air with a velocity $\frac{v}{20}$ towards left and B is moving in a medium with a velocity $\frac{v}{9}$ towards right as shown in the figure. The velocity of sound in the medium is 4V and frequency of sound emitted by the point source is f. Let λ_A is the wavelength detected by the detector A and λ_B the wavelength detected by the detector B. If $\lambda_B - \lambda_A = k\left(\frac{v}{3f}\right)$, then find the value of k.

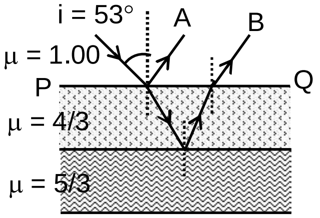


16. A small cube of negligible mass is floating on the surface of lake. The side of the cube is 30 cm and depth of lake is 2m. The cube is pushed very slowly under the water, down to the bottom of the lake. The density of water is 10^3 kg/m^3 and acceleration due to gravity is 9.8 m/s^2. Find the work done (in Joule) by external pushing force in the process.

17. PQ is a stationary circular curved surface blade. A stream line water impinges on the curved surface of the blade. The speed of stream line water is $5\sqrt{2}$ m/s before and after it strikes the curved surface blade. The mass flow rate of water per unit time is 112 gm/sec. Find the force (in newton) exerted by the stream line water on the blade.



18. A light wave of wavelength λ = 650 nm is incident on the surface PQ at an angle of incidence i = 53° as shown. If the phase difference between the two reflected rays A and B is π. Find the thickness (in nanometer) of the thin film of refractive index $\frac{4}{3}$.



Chemistry PART – II

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

19. The correct statement(s) among the following is/are
(A) The complexes $\left[Co\left(NH_3\right)_6\right]^{3+}$ and $\left[Fe\left(NH_3\right)_6\right]^{2+}$ have same geometry
(B) The complexes $\left[Co\left(NH_3\right)_6\right]^{3+}$ and $\left[Fe\left(NH_3\right)_6\right]^{2+}$ differ in their magnetic properties
(C) The complexes $\left[Pt\left(CN\right)_4\right]^{2-}$ and $\left[CuCl_4\right]^{2-}$ differ in their geometry
(D) The complexes $\left[Ni\left(NH_3\right)_6\right]^{2+}$ and $\left[Cr\left(NH_3\right)_6\right]^{3+}$ differ in their primary valency

20. The correct statement(s) among the following is/are
(A) In 3d-series enthalpy of atomization of Zn is lowest.
(B) Cu^{2+}(aq) is more stable than Cu^{+} (aq)
(C) Sc does not exhibit variable oxidation state
(D) MnO_4^- is coloured due to d – d transition of electron.

21. Which of the following order given below is/are incorrect for the property indicated against it?
(A) $OCl^- < ClO_2^- < ClO_3^- < ClO_4^-$ (Cl – O bond distance)
(B) $HClO_4 < HBrO_4 < HIO_4$ (Acidity)
(C) Cl > F > Br > I (Electron gain enthalpy)
(D) H – F < H – Cl < H – Br < H – I (Bond energy)

22. The correct statement(s) among the following is/are
(A) Cu^{2+} (aq) ions react with $K_4[Fe(CN)_6]$ to form chocolate brown precipitate.
(B) Cu^{2+} (aq) ions react with $K_3[Fe(CN)_6]$ to form green precipitate.
(C) Hg_2Cl_2 when treated with NH_4OH gives a black residue.
(D) NH_4Cl solution when treated with Nessler's reagent gives green precipitate.

23. The incorrect statement(s) among the following is/are
(A) Red phosphorous is more reactive than white phosphorous
(B) P_2H_4 is more stable than N_2H_4
(C) Bond angle in PH_3 is higher than that in PH_4^+
(D) In the solid state PBr_5 exists as $\left[PBr_4\right]^+\left[PBr_6\right]^-$

24. Which of the following ore(s) is/are concentrated by froth floatation process
(A) Galena
(B) Copper pyrite
(C) Zinc blende
(D) Bauxite

25. Which of the following molecule(s) have cyclic structure?
(A) $N_3P_3Cl_6$
(B) C_3N_{12}
(C) N_4S_4
(D) $P_3N_2Cl_9$

26. Which of the following statement(s) is/are correct about azeotropic mixture?
(A) Azeotropic mixture are non ideal solution
(B) Solution with large negative deviation from Raoult's law forms maximum boiling azeotropes
(C) The components of azeotropic mixture cannot be separated completely by fractional distillation
(D) Azeotropes obey Raoult's law

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

List-I includes the complex ions and List-II includes the hybridization of central atom in the complex ions and magnetic property of the complex ions:

LIST–I		LIST–II	
(I)	$\left[CoF_6\right]^{3-}$	(P)	sp^3
(II)	$\left[Fe\left(CN\right)_6\right]^{4-}$	(Q)	dsp^2
(III)	$\left[Co\left(NH_3\right)_6\right]^{3+}$	(R)	sp^3d^2 (outer orbital complex)
(IV)	$\left[CuCl_4\right]^{2-}$	(S)	d^2sp^3 (inner orbital complex)
		(T)	Paramagnetic
		(U)	Diamagnetic

27. Which of the following options has the correct combination considering List-I and List-II:
(A) (I), (U), (S)
(B) (III), (S), (U)
(C) (II), (T), (S)
(D) (IV), (Q), (T)

List-I includes the complex ions and List-II includes the hybridization of central atom in the complex ions and magnetic property of the complex ions:

LIST–I		LIST–II	
(I)	$\left[CoF_6\right]^{3-}$	(P)	sp^3
(II)	$\left[Fe\left(CN\right)_6\right]^{4-}$	(Q)	dsp^2
(III)	$\left[Co\left(NH_3\right)_6\right]^{3+}$	(R)	sp^3d^2 (outer orbital complex)
(IV)	$\left[CuCl_4\right]^{2-}$	(S)	d^2sp^3 (inner orbital complex)
		(T)	Paramagnetic
		(U)	Diamagnetic

28. Which of the following options has the correct combination considering List-I and List-II:
(A) (I), (R), (T)
(B) (III), (Q), (T)
(C) (II), (R), (T)
(D) (IV), (P), (U)

Answer the following by appropriately matching the lists based on the information given in the paragraph.

List-I includes the oxides of nitrogen and List-II includes the properties of the oxides of nitrogen.

LIST–I		LIST–II	
(I)	N_2O_5	(P)	Colourless gas
(II)	N_2O	(Q)	Brown coloured gas
(III)	NO	(R)	Acidic oxide
(IV)	NO_2	(S)	Neutral oxide
		(T)	Blue coloured solid
		(U)	Paramagnetic

29. Which of the following options has the correct combination considering List-I and List-II
(A) (IV), (R), (U), (Q)
(B) (III), (T), (S), (U)
(C) (II), (Q), (U), (S)
(D) (I), (P), (R), (U)

Answer the following by appropriately matching the list based on the information given in the paragraph.

List-I includes the oxides of nitrogen and List-II includes the properties of the oxides of nitrogen.

List–I		List–II	
(I)	N_2O_5	(P)	Colourless gas
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(III)	NO	(R)	Acidic oxide
(IV)	NO_2	(S)	Neutral oxide
		(T)	Blue coloured solid
		(U)	Paramagnetic

30 Which of the following options has the correct combination considering List-I and List-II
(A) (II), (T), (U), (S)
(B) (I), (Q), (U), (S)
(C) (III), (P), (S), (U)
(D) (IV), (P), (U), (R)

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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31. The rate constant for the forward reaction $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ is $92.12 \times 10^{-2}\ \text{min}^{-1}$. The time (in sec) required for the molar ratio of NO_2 (g) to N_2O_4 (g) in the reaction mixture to become 2 : 1 is [log 2 = 0.3010]

32. $NH_3\left(g\right)$ reacts with CuO (s) according to the following reaction

$3CuO\left(s\right)+2NH_3\left(g\right)\longrightarrow 3Cu\left(s\right)+N_2\left(g\right)+3H_2O\left(\ell\right)$

Standard enthalpies of formation of $NH_3\left(g\right), CuO\left(s\right)$ and $H_2O\left(\ell\right)$ are -46, - 155 and – 285 kJ/mole respectively. The heat liberated (in kJ) when 2.72 g of NH_3(g) is reacted completely with CuO(s) according to the reaction given above when all the reactants and products are in their standard state is

33. At higher altitude, boiling point of water is 95°C. The mass in gram of NaCl $\left(\alpha = 0.8\right)$ added to 100 g of water (K_b = 0.52 K kg mol^{-1}) in order to raise the boiling point to 100°C is (MW of NaCl = 58.5)

34. 3 g of an oxide of a metal is converted completely to 5 g chloride of the same metal. Equivalent weight of metal is

35. The density of a certain gaseous oxide at 3.2 bar pressure and 47°C is same as that of O_2 at 27°C and 4.2 bar pressure. The molar mass of the gaseous oxide is

36. The specific conductivity of a saturated solution of AgCl is 3.38×10^{-6} ohm^{-1} cm^{-1} at 25°C. If $\lambda^o_{Ag^+} = 62.3$ $ohm^{-1}\,cm^2\,mol^{-1}$ and $\lambda^o_{Cl^-} = 67.7$ $ohm^{-1}\,cm^2$ mol^{-1}, then the solubility of AgCl at 25°C is $y\times10^{-5}$ M. The value of y is

Mathematics PART – III

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

37. If the equation $x^4 + px^3 + qx^2 + rx + 5 = 0$ has four positive real roots, then
   (A) p can be –10
   (B) r can be –20
   (C) $pr \geq 80$
   (D) none of these

38. If a, b $\in$ R and $a + b \geq 0$, let $P = (a^2 + b^2)^3$ and $Q = 32(a^3 + b^3)(ab - a - b)$, then
   (A) $P < Q \ \forall$ a, b
   (B) $P \leq Q \ \forall$ a, b
   (C) $P \geq Q \ \forall$ a, b
   (D) none of the above

39. If $y = \sum_{r=1}^{n} (-1)^{r-1} \left(\frac{r^2 + 3r + 1}{r^3 + 2r^2 + r}\right) {}^nC_r$, then which of the following is correct?
   (A) $y < \frac{n+1}{n}$
   (B) $y = \frac{n+1}{n}$
   (C) $y \geq \sum_{r=1}^{n} \left(\frac{n+1}{n}\right)\left(\frac{1}{r}\right)$
   (D) $y \leq \sum_{r=1}^{n} \left(\frac{n}{n+1}\right)\left(\frac{1}{r}\right)$

40. If $|z + 2| - |z - 2| = 2$ and $\frac{z - a}{z + a} = ik$, where k is a real parameter, a $\in$ R has exactly two solutions, then
   (A) $a < -1$
   (B) $a > 1$
   (C) a = 1 only
   (D) a = –1 only

41. A line L with direction cosines l, m, n meets each of the lines $y = x \tan\alpha$, $z = c$;
   $y = -x \tan\alpha$, $z + c = 0$, then the shortest distance between the line L and the z-axis is
   (A) $\left|\frac{c \tan\alpha (m^2 - l^2)}{n\sqrt{m^2 + l^2}}\right|$
   (B) $\left|\frac{c (m^2 \cot\alpha - l^2 \tan\alpha)}{n\sqrt{m^2 + l^2}}\right|$
   (C) $\left|\frac{c (m^2 \tan^2\alpha - l^2 \cot^2\alpha)}{n\sqrt{m^2 + l^2}}\right|$

(D) $\left|\frac{c\left(m^2-l^2\right)}{n\sqrt{m^2+l^2}}\right|$ for $\alpha = \frac{\pi}{4}$

42. Let the line L on the plane x + y + z = 1, such that a plane perpendicular to x + y + z = 1 contains the line L and $\frac{x-1}{2}=\frac{y-1}{1}=\frac{z-1}{1}$, then
(A) line L passes through the point (1, –1, 1)
(B) line L passes through the point $\left(\frac{1}{3},\frac{1}{3},\frac{1}{3}\right)$
(C) one of the direction ratio of line L is (1, –1, –1)
(D) one of the direction ratio of line L is (2, –1, –1)

43. Let a, b, c, d can be arranged at 'n' places such that a occurs exactly even number of times, then the number of such arrangements are
(A) 28 for n = 3
(B) $2^{n-1}(2^n - 1)$ for $n \in N$
(C) 36 for n = 3
(D) $2^{n-1}(2^n + 1)$ for $n \in N$

44. If the determinant $A = \begin{vmatrix} a & b & a\alpha+b \\ b & c & b\alpha+c \\ a\alpha+b & b\alpha+c & 0 \end{vmatrix} = 0$, then
(A) a, b, c are in Arithmetic Progression
(B) a, b, c are in Geometric Progression
(C) α is root of equation $ax^2 + bx + c = 0$
(D) α is root of equation $ax^2 + 2bx + c = 0$

(Matching List Type)

This section contains **TWO (02)** List-Match Sets. Each List-Match set has **TWO(02)** Multiple Choice Questions. Each List-Match set has two lists: **List-I** and **List-II**. **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Six** entries (P), (Q), (R), (S), (T) and (U). **FOUR** options are given in each Multiple Choice Question based On **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

Answer the following by appropriately matching the list based on the information given in the paragraph.

MM-I. Let $x_i = \frac{a_i}{30}$ $\forall$ i = 1, 2, 3, ..., n is a rational number in its lowest form and $S_{(k,r)} = \sum_{i=1}^{n} x_i$, $k < x_i < r$

LIST–I		LIST–II	
(I)	$S_{(0,1)}$ is equal to	(P)	2
(II)	$S_{(0,2)}$ is equal to	(Q)	4
(III)	$S_{(n,2n)}$ is equal to	(R)	14
(IV)	$S_{(0,n)}$ is equal to	(S)	$2n^2$
		(T)	$4n^2$
		(U)	$14n^2$

45. Which of the following is the only CORRECT combination?
(A) (I), (P)
(B) (I), (Q)
(C) (II), (Q)
(D) (II), (R)

46. Which of the following is the only CORRECT combination?
(A) (III), (S)
(B) (III), (U)
(C) (IV), (T)
(D) (IV), (U)

Answer the following by appropriately matching the list based on the information given in the paragraph.

MM-II. Let position vectors of the point A, B, C are $\bar{a} = \hat{i} + \hat{j} + \hat{k}$, $\bar{b} = 2\hat{i} + 2\hat{j} + \hat{k}$, $\bar{c} = 5\hat{i} + \hat{j} - \hat{k}$ respectively, and let position vector of a variable point R be $\bar{r}$

LIST–I		**LIST–II**	
(I)	locus of point $R(\bar{r})$ such that $\bar{r}\cdot\bar{a} = 5$	(P)	pair of lines
(II)	locus of point $R(\bar{r})$ such that $\lvert\bar{r}-\bar{b}\rvert + \lvert\bar{r}-\bar{c}\rvert = 4$	(Q)	circle
(III)	locus of point $R(\bar{r})$ such that $\bar{r}\cdot\bar{a} = 5$ and $\lvert\bar{r}-\bar{b}\rvert + \lvert\bar{r}-\bar{c}\rvert = 4$	(R)	ellipse
(IV)	area of the region formed by point $R(\bar{r})$ such that $\bar{r}\cdot\bar{a} = 5$ and $\lvert\bar{r}-\bar{b}\rvert + \lvert\bar{r}-\bar{c}\rvert = 4$	(S)	π
		(T)	$\sqrt{2}\pi$
		(U)	2π

47. Which of the following is the only CORRECT combination?
(A) (I), (Q)
(B) (I), (R)
(C) (III), (R)
(D) (III), (Q)

48. Which of the following is the only CORRECT combination?
(A) (II), (Q)
(B) (II), (P)
(C) (IV), (U)
(D) (IV), (T)

SECTION – C
(Numerical Answer Type)

This section contains **06** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

49. Let $n = 2^{31}.3^{19}$, then number of factors of n^2 less than n and does not divide n are

50. A person A was issued a 10 digit mobile phone number having his 6 digit birth date (DDMMYY format) in it. Let E be the event that his birth was in first 9 days of a month, then the probability of the occurrence of the event E is

51. Let $y = \sum_{r=1}^{\infty} \frac{1.3.5.....(2r-1)}{r!}\left(\frac{2}{5}\right)^r$, then $\frac{(y+1)^2}{2}$ is

52. Number of ordered pair(s) (x, y) that satisfies the inequation $y - |x| \geq 1 + \sqrt{x^2 + y^2 - 1}$ is/are

53. If $a(n) = x^n + y^n$, where $x, y \in [-1, 1]$ and $x^2 + y^2 = 1$, then maximum value of $\frac{a(n) - a(n+2)}{a(n-2)}$ is

54. If a plane passes through the intersection of $5x + b_1y + c_1z = d_1$ and $4x + b_2y + c_2z = d_2$ and contains the x-axis, then $d_1 : d_2$ is

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ANSWERS, HINTS & SOLUTIONS

Physics PART – I

SECTION – A
(One or More than one correct type)

This section contains **08** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four options is(are) correct.

1. A, C, D

Sol. Amplitude = $\frac{13}{2}$m, $\omega = \frac{2\pi}{T} = \frac{\pi}{4}\,s^{-1}$

$$\vec{r} = \frac{13}{2}(1-\cos\omega t)\frac{12}{13}\hat{i} + \left[5 - \frac{13}{2}(1-\cos\omega t)\frac{5}{13}\right]\hat{j}$$

$$\vec{r} = 12\sin^2\left(\frac{\pi t}{8}\right)\hat{i} + 5\cos^2\left(\frac{\pi t}{8}\right)\hat{j}$$

$$\therefore\ \vec{v} = \left[\frac{3\pi}{2}\sin\left(\frac{\pi t}{4}\right)\hat{i} - \frac{5\pi}{8}\sin\left(\frac{\pi t}{4}\right)\hat{j}\right] \text{m/s}$$

2. A, B, C

Sol. By using basic concept of fluid mechanics.

3. A, B, C

Sol. Let acceleration of ball relative to the cube is $\vec{a}_{b,c} = a'_x\hat{i} + a'_y\hat{j} + a'_z\hat{k}$

Now, $a'_x = \left(\dfrac{\rho - \dfrac{\rho}{3}}{\dfrac{\rho}{3}}\right) a_x = 2a_x = 2 \times \dfrac{5}{\sqrt{2}} = 5\sqrt{2}\ \text{m/s}^2$

$$a'_y = \left(\dfrac{\rho - \dfrac{\rho}{3}}{\dfrac{\rho}{3}}\right)(g + a_y) = 2(g + a_y) = 2\left(10 - \dfrac{15}{2}\right) = 5\ \text{m/s}^2$$

$$a'_z = \left(\dfrac{\rho - \dfrac{\rho}{3}}{\dfrac{\rho}{3}}\right) a_z = 2a_z = 2 \times \dfrac{5}{2} = 5\ \text{m/s}^2$$

∴ Acceleration of ball relative to the cube is $\vec{a}_{b,c} = (5\sqrt{2}\hat{i} + 5\hat{j} + 5\hat{k})\ \text{m/s}^2$

4. A, C, D

Sol. T = 0.2 = $2\pi\sqrt{\dfrac{m}{k}}$

$\Rightarrow$ m = 0.2 kg

At t = 0, particle is at extreme position and moving towards +ve x-axis

$K_{max} = \dfrac{1}{2}m\left(v_{max}\right)^2 = 4.0\ \text{J}$

5. A, B, C

Sol. $\dfrac{m_0 v^2}{r_n} = \dfrac{1}{4\pi\varepsilon_0}\dfrac{ze^2}{r_n^2}$ (Where $m_0 = 50m$) …(i)

$m_0 v r_n = \dfrac{n}{2}\dfrac{h}{\pi}$ …(ii)

$$r_n = \frac{n^2 h^2 \varepsilon_0}{200\pi m e^2}$$

$$E_n = \frac{-13.6z^2}{n^2} \times 50\ \text{eV}$$

$E_4 = -680$ eV

$E_1 = -10880$ eV

$\Delta E = E_4 - E_1 = 10{,}200$ eV

$\lambda = \dfrac{1240}{\Delta E} = 1.21\,\text{Å}$

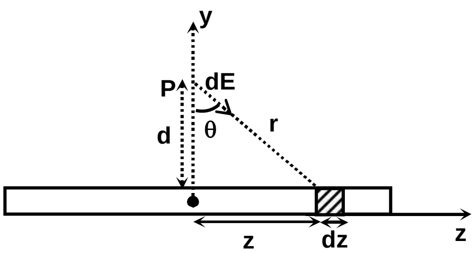
6. A, B, D

Sol. $F_x = \dfrac{IA\cos\theta\sin\theta}{C}(1 - r) = 1.152 \times 10^{-6}\text{N}$

$$F_y = \frac{IA\cos^2\theta}{C}(1 + r) = 2.016 \times 10^{-6}\text{N}$$

$$p_r = \frac{I\cos^2\theta}{C}(1 + r) = 1.008 \times 10^{-6}\ \text{N/m}^2$$

7. A, B, C, D



Sol. Gravitational field due to a long wire,

$$dE = \frac{2G\lambda}{r} = \frac{2G\sigma dz}{r}$$

$$E_P = \int dE.\cos\theta = \int \frac{2G\sigma dz}{r}\frac{d}{r} = 2G\sigma d\int_{-\frac{a}{2}}^{+\frac{a}{2}}\left(\frac{dz}{d^2+z^2}\right)$$

$$E_P = 4G\sigma\tan^{-1}\left(\frac{a}{2d}\right)$$

8. A, B, C, D

Sol. For the first interference maximum

$$2d\sin\theta = \frac{\lambda}{2}$$

$$\Rightarrow \sin\theta = \frac{\lambda}{4d} = \frac{10^{-3}}{4}$$

$$\frac{y}{D} = \frac{10^{-3}}{4}$$

$$y = \frac{1}{4}\text{mm}$$

Fringe width, $\omega = \frac{\lambda D}{2d} = 0.5\text{ mm}$

$$2d\sin\theta = \frac{\lambda}{4}$$

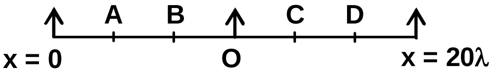
$$\Rightarrow \sin\theta = \frac{\lambda}{8d}$$

$$\therefore y = \frac{\lambda D}{8d} = \frac{1}{8}\text{mm}$$

9. B

10. D

Sol. **(for Q. 9-10):** Path difference = integral multiple of λ in all cases i.e. interference is constructive.



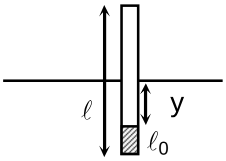
$I_0 = \frac{36}{100}kA^2$, $I_A = \frac{9}{16}kA^2$, $I_B = \frac{49}{144}kA^2$, $I_C = \frac{4}{9}kA^2$ and $I_D = \frac{81}{64}kA^2$

For second case

$I_A = \frac{81}{64}kA^2$, $I_B = \frac{4}{9}kA^2$, $I_C = \frac{49}{144}kA^2$ and $I_D = \frac{9}{16}kA^2$

11. A

12. D



Sol. **(for Q. 11-12)**

$\ell_0 A \times 2.7 + \ell A \times 0.8 = (\ell_0 + y)A$

$\ell_0(2.7 - 1) + 0.8\,\ell = y$

$y = 1.7\,\ell_0 + 0.8\ell$

$y = 1.7 + 0.8\,\ell$

at t = 5 minute; $\ell = 9.5$ cm $y = 9.3$

at t = 10 minute; $\ell = 9$ cm $y = 8.9$

at t = 15 minute; $\ell = 8.5$ cm $y = 8.5$

at t = 20 minute; $\ell = 8$ cm $y = 8.1$ which is not possible $\Rightarrow y = 8.5$

$$T = 2\pi\sqrt{\frac{m}{A\rho g}}$$

$m_0 = k(2.7 + 8) = 10.7\,k$
$m_5 = k(2.7 + 7.6) = 10.3\,k$
$m_{10} = k(2.7 + 7.2) = 9.9\,k$
$m_{15} = k(2.7 + 6.8) = 9.5\,k$
$m_{20} = k(2.7 + 6.8) = 9.5\,k$

$$T_0 \propto \sqrt{10.7}$$

$$T_5 \propto \sqrt{10.3} \Rightarrow \sqrt{\frac{103}{107}}T_0$$

$$T_{10} = \sqrt{\frac{99}{107}}T_0$$

$$T_{15} = \sqrt{\frac{95}{107}}T_0$$

$$T_{20} = \sqrt{\frac{95}{107}}T_0$$

SECTION – C

13. 00005.55

Sol. $\beta = 10 \log \dfrac{I}{I_0}$

$$3 = \log\frac{I}{10^{-12}}$$

$\Rightarrow I = 10^{-9}\ \text{W/m}^2$

$$\text{Now, } I = \frac{(\Delta P_0)^2 v}{2B} = \frac{(BAK)^2 v}{2B} = \frac{B\omega^2 A^2}{2v} = \frac{BA^2 4\pi^2 f^2}{2v}$$

$$A = \sqrt{\frac{Iv}{B2\pi^2 f^2}} = \sqrt{\frac{I}{\rho v 2\pi^2 f^2}} = 5.55\ \text{Å}$$

14. 00000.20

Sol. Let mass of P, Q and S are m_1, m_2 and m_3 respectively

$$\frac{Gm_1}{R^2} = \frac{G(m_1 + m_2 + m_3)}{9R^2}$$

$8m_1 = m_2 + m_3$

$$8\rho_1\frac{4}{3}\pi R^3 = \frac{4}{3}\pi R^3(7\rho_2+19\rho_3)$$

On solving

$$\frac{\rho_3}{\rho_1} = 0.2$$

15. 00012.00

Sol. $\lambda_A = \lambda_0 + v_sT = vT + \frac{v}{3}T = \frac{4}{3}\frac{v}{f}$

$$\lambda_B = \frac{\frac{4}{3}\frac{v}{f}}{\frac{1}{4}} = \frac{16}{3}\frac{v}{f}$$

16. 00489.51

Sol. $\Delta W_{ex}\left(\int_0^a \rho a^2 xgdx\right) + \rho a^3 g(h-a) = \rho a^3 g\left(h-\frac{a}{2}\right)$ = 00489.51

17. 00001.12

Sol. $\vec{F} = \frac{d\vec{P}}{dt} = \frac{\Delta\vec{P}}{dt}$

$$\left|\vec{F}\right| = \sqrt{2}\cdot u\frac{dm}{dt} = \sqrt{2}\times 5\sqrt{2}\times 0.112 = 1.12 \text{ newton}$$

18. 00097.50

Sol. $\sin i = \frac{4}{3}\sin r$

$\therefore$ r = 37°

Now, $2\mu t \sec r = \lambda/2$

$$\Rightarrow t = \frac{\lambda}{4\mu\sec r} = 97.50 \text{ nm}$$

Chemistry PART – II

SECTION – A

19. A, B, C, D

Sol. $\left[Co(NH_3)_6\right]^{3+}$ - Octahedral and diamagnetic $\left[Fe(NH_3)_6\right]^{2+}$ - Octahedral and paramagnetic.

$\left[Pt(CN)_4\right]^{2-}$ - Square planar, $\left[CuCl_4\right]^{2-}$ - Tetrahedral

$\left[Ni(NH_3)_6\right]^{2+}$ - Primary valency = 2

$\left[Cr(NH_3)_6\right]^{3+}$ - Primary valency = 3

20. A, B, C

Sol. MnO_4^- is coloured due to charge transfer phenomena.

21. A, B, D

Sol. $OCl^- > ClO_2^- > ClO_3^- > ClO_4^-$ (Cl – O bond distance)

$HClO_4 > HBrO_4 > HIO_4$ (Acidity)

H – F > H – Cl > H – Br > H – I (Bond energy)

22. A, B, C

Sol. $$2Cu^{2+} + K_4\left[Fe(CN)_6\right] \longrightarrow \underset{\text{Chocolate brown ppt.}}{Cu_2\left[Fe(CN)_6\right]}\downarrow$$

$$3Cu^{2+} + 2K_3\left[Fe(CN)_6\right] \longrightarrow \underset{\text{Green ppt.}}{Cu_3\left[Fe(CN)_6\right]_2}\downarrow$$

$$Hg_2Cl_2 + 2NH_4OH \longrightarrow \underbrace{Hg + Hg(NH_2)Cl}_{\text{Black residue}} + NH_4Cl + 2H_2O$$

23. A, B, C, D

Sol. (i) White phosphorous is more reactive than red phosphorous.

(ii) P_2H_4 is less stable than N_2H_4

(iii) Bond angle in PH_4^+ is higher than that in PH_3

(iv) In the solid state PBr_5 exists as $\left[PBr_4\right]^+ Br^-$

24. A, B, C

Sol. Sulphide ores are concentrated by froth floatation process.

25. A, B, C

Sol. $N_3P_3Cl_6$, C_3N_{12} and N_4S_4 have cyclic structure.

26. A, B, C

Sol. Azeotropes do not obey Raoult's law.

27. B

Sol. $\left[Co(NH_3)_6\right]^{3+}$ is an inner orbital complex ion. Hybridisation of central atom is d^2sp^3.

28. A

Sol. $\left[COF_6\right]^{3-}$ is an outer orbital complex ion. Hybridization of the central atom is sp^3d^2.

29. A

Sol. NO_2 is a brown coloured gas, acidic oxide and paramagnetic.

30. C

Sol. NO is a colourless gas, neutral oxide and paramagnetic.

SECTION – C

31. 00045.15

Sol.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

$$\begin{array}{ll} a & 0 \\ a-x & 2x \end{array}$$

$$\frac{2x}{a-x} = 2,\ x = \frac{a}{2}$$

$$t = \frac{2.303}{92.12\times10^{-2}}\log\frac{a}{a-x}$$

$$t = \frac{2.303}{92.12\times10^{-2}}\log 2$$

$$t = \frac{2.303\times0.3010}{92.12\times10^{-2}}$$

$$t = 0.7525 \text{ min} = 45.15 \text{ sec}.$$

32. 00023.84

Sol. $3CuO(s) + 2NH_3(g) \longrightarrow 3Cu(s) + N_2(g) + 3H_2O(\ell)$

$$\Delta rH^o = \sum \Delta H_f^o(\text{Products}) - \sum \Delta H_f^o(\text{Reactants})$$

= [3 × (- 285)] – [3 × (- 155) + 2 × (- 46)]

= - 298 kJ

Heat liberated $= \frac{298\times2.72}{2\times17} = 23.84$ kJ

33. 00031.25

Sol. $\Delta T = iK_b\ m$

$$5 = 1.8\times0.52\times\frac{1000}{100}\times\frac{W}{58.5}$$

$$W = \frac{5\times58.5}{1.8\times0.52}$$

$$W = 31.25 \text{ g}$$

34. 00033.25

Sol. $\frac{3}{M+8} = \frac{5}{M+35.5}$

$M = 33.25$ (M = EW of metal)

35. 00044.80

Sol. $P_{O_2} = P_{oxide}$

$$\frac{P_1M_1}{RT_1} = \frac{P_2M_2}{RT_2}$$

$$\frac{4.2\times32}{300} = \frac{3.2\times M_2}{320}$$

$M_2 = 44.80$

36. 00002.60

Sol. $\lambda^o_{AgCl} = \lambda^o_{Ag^+} + \lambda^o_{Cl^-}$

$= 62.3 + 67.7 = 130$

$$\lambda^o_{AgCl} = K\times\frac{1000}{M}$$

$$130 = 3.38\times10^{-6}\times\frac{1000}{M}$$

$$M = \frac{3.38\times10^{-6}\times1000}{130}$$

$M = 2.6\times10^{-5}\ M$

$\therefore y = 2.60$

Mathematics

PART – III

SECTION – A

37. A, B, C

Sol. Let $\alpha, \beta, \gamma, \delta$ be the roots $\Rightarrow \alpha + \beta + \gamma + \delta = -p,\ p < 0$

$\Sigma\alpha\beta = q,\ q > 0,\ \Sigma\alpha\beta\gamma = -r,\ r < 0,\ \alpha\beta\gamma\delta = 5$, AM $\geq$ G.M.

$$\Rightarrow \frac{\Sigma\alpha}{4} \geq (\alpha\beta\gamma\delta)^{\frac{1}{4}} = 5^{\frac{1}{4}},\ -p \geq 4\cdot 5^{\frac{1}{4}}$$

Also, $\dfrac{\Sigma\alpha\beta\gamma}{4} \geq (\alpha\beta\gamma\delta)^{\frac{3}{4}} = 5^{\frac{3}{4}} \Rightarrow -r \geq 4\cdot 5^{\frac{3}{4}} \Rightarrow pr \geq 16.5 = 80$

38. C

Sol. $(a^2 + b^2)^3 + 32(a^3 + b^3)(a + b) \geq 32(a^3 + b^3)\,ab$

hold true if $ab < 0$

Let $a.b \geq 0 \Rightarrow a, b \geq 0$

Using A.M $\geq$ G.M

$(a^2 + b^2)^3 + 32(a^3 + b^3)(a + b) \geq 2((a^2 + b^2)^3\, 32(a^3 + b^3)(a + b))^{1/2}$

$$= 8\sqrt{2\left(a^2 - ab + b^2 + ab\right)^3\left(a^3 + b^3\right)(a + b)} \geq 8\sqrt{2\left(2\sqrt{\left(a^2 - ab + b^2\right)(ab)}\right)^3\left(a^3 + b^3\right)(a + b)}$$

$$= 32\sqrt{\left(a^3 + b^3\right)^2\sqrt{\left(a^2 - ab + b^2\right)a^3b^3}} \geq 32\sqrt{\left(a^3 + b^3\right)^2\sqrt{aba^3b^3}} = 32(a^3 + b^3)ab$$

39. C

Sol. L.H.S. $= \displaystyle\sum_{r=1}^{n}(-1)^{r-1}\left(\frac{1}{r} + \frac{1}{(r+1)^2}\right){}^nC_r$, $(1-x)^n = {}^nC_0 - {}^nC_1x + {}^nC_2x^2 - {}^nC_3x^3 + ... + (-1)^n\,{}^nC_nx^n$

$$\int_0^1 \frac{1-(1-x)^n}{x}dx = \int_0^1\left({}^nC_1 - {}^nC_2x + {}^nC_3x^2 + ... + (-1)^{n-1}\,{}^nC_nx^{n-1}\right)dx$$

$$1 + \frac{1}{2} + \frac{1}{3} + ... + \frac{1}{n} = \sum_{r=1}^{n}(-1)^{r-1}\left(\frac{{}^nC_r}{r}\right)$$

Similarly, $\displaystyle\int_0^1 \frac{1-(1-x)^{n+1}}{x(n+1)}dx = \int_0^1\left(\frac{{}^{n+1}C_0}{1} - \frac{{}^{n+1}C_1}{2}x + \frac{{}^{n+1}C_2}{3}x^2 + ... + (-1)^{n+1}\frac{{}^{n+1}C_n}{n+1}x^{n+1}\right)dx$

$$\Rightarrow \left(\frac{1}{n+1}\right)\left(1 + \frac{1}{2} + \frac{1}{3} + ... + \frac{1}{n+1}\right) = 1 - \frac{{}^nC_1}{2^2} + \frac{{}^nC_2}{3^2} + ... + (-1)^n\frac{{}^nC_n}{(n+1)^2} = \sum_{r=1}^{n}(-1)^{r-1}\frac{{}^nC_r}{(r+1)^2}$$

$$\therefore\ y = \left(\frac{n}{n+1}\right)\left(1 + \frac{1}{2} + \frac{1}{3} + ... + \frac{1}{n}\right),\ \frac{n+1}{n} \leq \frac{1}{1} + \frac{1}{2} + \frac{1}{3} + ... + \frac{1}{n} \leq \frac{n+1}{1}$$

40. A, B

Sol. Intersection of branch of hyperbola with the circle.

41. B, D

Sol. Equation of plane containing the line with direction cosines (l, m, n) and the line $\dfrac{x}{1} = \dfrac{y}{\tan\alpha} = \dfrac{z-c}{0}$

is $\begin{vmatrix} x & y & z-c \\ 1 & \tan\alpha & 0 \\ l & m & n \end{vmatrix} = 0$

$\Rightarrow (n\tan\alpha)x - ny + (m - l\tan\alpha)(z - c) = 0$ ..... (1)

Equation of plane containing the line with direction cosines (l, m, n) and the line $\frac{x}{1} = \frac{y}{-\tan\alpha} = \frac{z+c}{0}$ is $\begin{vmatrix} x & y & z+c \\ 1 & -\tan\alpha & 0 \\ l & m & n \end{vmatrix} = 0$

$\Rightarrow$ $(-n \tan\alpha)x - ny + (m + l \tan\alpha)(z + c) = 0$ ..... (2)

$\therefore$ Plane through (1) and (2) is

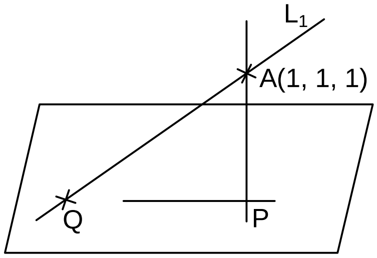
$(n \tan\alpha\, x - ny + (m - l \tan\alpha)(z - c)) + \lambda(n \tan\alpha x + ny - (m + l \tan\alpha)(t + c)) = 0$ is parallel to z-axis

Hence, $(m - l \tan\alpha) - \lambda(m + l \tan\alpha) = 0 \Rightarrow \lambda = \left(\frac{m - l\tan\alpha}{m + l\tan\alpha}\right)$

$\therefore$ Shortest distance is = $\left|\frac{c\left(m^2 \cot\alpha - l^2 \tan\alpha\right)}{n\sqrt{m^2 + l^2}}\right|$.

42. B, D

Sol. Any point on line $L_1 : \frac{x-1}{2} = \frac{y-1}{1} = \frac{z-1}{1}$ is $(2r + 1, r + 1, r + 1)$



Put in equation of plane $x + y + z = 1 \Rightarrow r = -\frac{1}{2}$

$\therefore\ Q = \left(0, \frac{1}{2}, \frac{1}{2}\right)$. For point P equation of AP

$\frac{x-1}{1} = \frac{y-1}{1} = \frac{z-1}{1} = t$ $\therefore$ Any point on line (t + 1, t + 1, t + 1) lie to plane P

$\Rightarrow\ t = -\frac{2}{3} \Rightarrow$ Point P = $\left(\frac{1}{3}, \frac{1}{3}, \frac{1}{3}\right)$

$\therefore$ Equation of QP $\frac{x - \frac{1}{3}}{\frac{1}{3}} = \frac{y - \frac{1}{3}}{-\frac{1}{6}} = \frac{z - \frac{1}{3}}{-\frac{1}{6}}$

$\Rightarrow\ \frac{x - \frac{1}{3}}{2} = \frac{y - \frac{1}{3}}{-1} = \frac{z - \frac{1}{3}}{-1}$

43. C, D

Sol. $2^{n-1}(2^n + 1)$

Let $a_n \Rightarrow$ the number of arrangements at n places such that **'a'** occurs even number of times and $b_n \Rightarrow$ the number of arrangements at n places such that **'a'** occurs odd number of times

$\Rightarrow a_n = b_{n-1} + 3a_{n-1} = 4^{n-1} + 2a_{n-1}$

$\Rightarrow a_n - 2a_{n-1} = 4^{n-1}$

Let $a_n = 2^n t_n \Rightarrow 2^n(t_n - t_{n-1}) = 2^{2n-2} \Rightarrow t_n - t_{n-1} = 2^{n-2}$

$$\Rightarrow \begin{array}{l} t_2 - t_1 = 2^0 \\ t_3 - t_2 = 2^1 \\ t_4 - t_3 = 2^2 \\ \vdots \\ t_n - t_{n-1} = 2^{n-2} \\ \hline t_n - t_1 = \left(2^{n-1} - 1\right) \end{array} \quad \text{where } t_1 = \frac{3}{2}$$

$\therefore a_n = 2^{n-1}(2^n + 1)$

44. B, D

Sol. $A = \begin{vmatrix} a & b & a\alpha + b \\ b & c & b\alpha + c \\ a\alpha + b & b\alpha + c & 0 \end{vmatrix} = 0$, $R_3 \to R_3 - \alpha R_1 - R_2$

$A = \begin{vmatrix} a & b & 0 \\ b & c & 0 \\ a\alpha + b & b\alpha + c & a\alpha^2 + 2b\alpha + c \end{vmatrix} = 0 \Rightarrow (a\alpha^2 + 2b\alpha + c)(ac - b^2) = 0$

$\Rightarrow$ Either $b^2 = ac$ (or) $a\alpha^2 + 2b\alpha + c = 0$

45. B

46. C

Sol. (for Q. 45.-46.)

$0 < x_i < 1 \Rightarrow x_i \Rightarrow \frac{1}{30}, \frac{7}{30}, \frac{11}{30}, \frac{13}{30}, \frac{17}{30}, \frac{19}{30}, \frac{23}{30}, \frac{29}{30} \Rightarrow \Sigma x_i = 4$

for $1 < x_i < 2$ $x_i : \frac{1}{30} + 1, \frac{7}{30} + 1, \frac{11}{30} + 1, ..., \frac{29}{30} + 1 \Rightarrow \Sigma x_i = 12$

Similarly for $4 < x_i < 5$ $\frac{1}{30} + 4, \frac{7}{30} + 4, \frac{11}{30} + 4, ..., \frac{29}{30} + 4$

Hence $\sum_{i=1} x_i = 4 + 12 + 20 + ...$ upto n term

$= \frac{n}{2}(8 + (n - 1)\,8) = \frac{n}{2}\,.\,8n = 4n^2$

47. C

48. D

Sol. $|\vec{r} - \vec{b}| + |\vec{r} - \vec{c}| = 4$ represent, an ellipsoid in 3D space with a = 2 and $|\vec{b} - \vec{c}| = 2ae$

$\Rightarrow b = \frac{1}{\sqrt{2}}$, $\vec{r} \cdot \vec{a} = 5$ is plane passing through $\vec{b}$, $\vec{c}$

Hence, area B area of ellipse = πab = $\pi \cdot \frac{2}{\sqrt{2}} = \sqrt{2}\,\pi$ square unit

SECTION – C

49. 00589.00

Sol. Let $n^2 = 2^{62}.3^{38}$

Let F is a factor or $n^2 \Rightarrow 2^{\alpha}\, 3^{\beta}$, $0 \le \alpha < 62$; $0 \le \beta \le 38$

$\Rightarrow n(F) = 63 \times 39 = 2457$

Let a, b are two factor, of n^2 such that $a.b = n^2$ when a, b $\ne$ n

if a < n then b > n will exist in pairs

$\therefore$ number of factors less than n = 1228

Similarly if x and y are factors of n such that

x.y = n and x and y are also factors of n^2

$\Rightarrow$ number of such factors = $(32 \times 20 - 1) = 639$

$\therefore$ req. number of factors = 1228 – 639 = 589

50. 00000.72

Sol. $n(E) = 4 \times 9 \times 10^3 = 36000$

n(S) = 50,000

$\Rightarrow$ P(E) = 0.72

51. 00002.50

Sol. Let $y = x + \frac{1.3}{2!}x^2 + \frac{1.3.5}{3!}x^3 + ...$

$\frac{dy}{dx} = 1 + \frac{1.3}{1!}x^1 + \frac{1.3.5}{2!}x^2 + ...$

$x\frac{dy}{dx} = x + \frac{1.3}{1!}x^2 + \frac{1.3.5}{2!}x^3 + ...$

and $y - \frac{dy}{dx} = -1 + \left(1 - \frac{3}{1!}\right)x + \frac{1.3}{2!}(1-5)x^2$ ....

$y - \frac{dy}{dx} = -1 - 2(x\frac{dy}{dx})$

$\int\frac{dy}{1+y} + \int\frac{dx}{2x-1} = 0$

$\sqrt{1-2x}(1+y) = 1$ put x = 2/5 hence $y = \sqrt{5} - 1$

52. 00001.00

Sol. R.H.S. $\geq 1 \Rightarrow$ L.H.S. ≥ 1

$\Rightarrow y > |x| \geq 0 \Rightarrow y^2 + x^2 - 2|x|y \geq x^2 + y^2 + 2\sqrt{x^2 + y^2 - 1}$

$-|x|y \geq \sqrt{x^2 + y^2 - 1}$, L.H.S. ≤ 0 and R.H.S. ≥ 0.

Hence, L.H.S. = R.H.S. = 0

$\Rightarrow |x|y = 0$ and $x^2 + y^2 - 1 = 0$, $y > 0$

$\Rightarrow x = 0$ and $y^2 = 1 \Rightarrow y = \pm1$. Since $y > 0 \Rightarrow y = 1$

Hence, any one order pair of (x, y) = (0, 1)

53. 00000.25

Sol. $a(n) = (x^n + y^n)(x^2 + y^2) = x^{n+2} + y^{n+2} + x^2y^n + y^2x^n$

$a(n) = a(n + 2) = x^2y^2(x^{n-2} + y^{n-2})$, $\frac{a(n) - a(n+2)}{a(n-2)} \leq x^2y^2 = x^2(1 - x^2)$

$= x^2 - x^4 = \frac{1}{4} - \left(\frac{1}{2} - x^2\right)^2 \leq \frac{1}{4} \Rightarrow \frac{a(n) - a(n+2)}{a(n-2)} \leq \frac{1}{4}$

54. 00001.25

Sol. Line of intersection of two planes and x-axis must be coplanar i.e., (x, 0, 0) must satisfy both the planes

$\Rightarrow 5x = d_1$ and $4x = d_2$, $\frac{d_1}{d_2} = \frac{5}{4} = 1.25$

FIITJEE

ALL INDIA TEST SERIES

PART TEST – III

JEE (Main)-2020

TEST DATE: 08-12-2019

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 75 questions.
- Each subject (PCM) has 25 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each part has only three sections: **Section-A**, **Section-B and Section-C**.

  Section-A (01 – 20, 26 – 45, 51 – 70) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

  Section-B (21 – 22, 46 – 47, 71 – 72) *contains 6 Numerical based questions with answer as numerical value from* ***0 to 9*** *and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

  Section-C (23 – 25, 48 – 50, 73 – 75) *contains 9 Numerical answer type questions with answer XXXXX.XX and each question carries* ***+4 marks*** *for correct answer. There is no negative marking.*

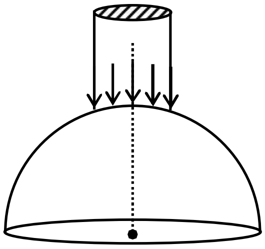
Physics

PART – I

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

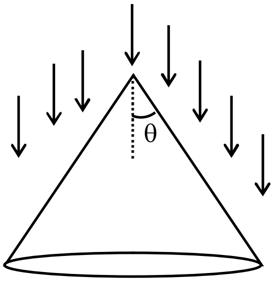
1. A cylindrical beam of diameter (d = R) is incident on a glass hemisphere of radius R and refractive index $\left(\mu = \sqrt{2}\right)$ on the curved surface symmetrically as shown in the figure. The radius of circular bright spot formed on the flat surface of the hemisphere is:



(A) $\frac{R}{4\sqrt{2}}\left[2\sqrt{2}-\sqrt{7}+\sqrt{3}\right]$
(B) $\frac{R}{2\sqrt{2}}\left[2\sqrt{2}-\sqrt{7}+\sqrt{3}\right]$
(C) $\frac{R}{4\sqrt{2}}\left[2\sqrt{2}+\sqrt{7}-\sqrt{3}\right]$
(D) $\frac{R}{10}\left[\sqrt{21}-1\right]$

2. A silicon diode requires minimum current of 2mA to be above its knee point of its (V-I) characteristics. Assuming voltage across diode is constant above its knee point. The value of maximum resistance that should be connected in series with diode and battery of 10 V such that diode operates above its knee point. (Assume resistance of diode to be zero)
(A) 5 kΩ
(B) 5.35 kΩ
(C) 4.65 kΩ
(D) 9.30 kΩ

3. Light of intensity I falls parallel to the axis on the curved surface of a perfectly reflecting right circular cone having semi vertical angle θ and base radius R as shown in figure. The value of force acting on the cone due to light is (where c is speed of light in vacuum)



(A) $\frac{\pi R^2 I}{c}(1-\cos\theta)$
(B) $\frac{\pi R^2 I}{2c}$
(C) $\frac{2\pi R^2 I}{c}$
(D) $\frac{\pi R^2 I}{c}(1-\cos 2\theta)$

4. Consider a plane progressive wave propagating along negative x-direction whose frequency is f. At t = t_0 the displacement associated with the wave is given by the following equation:
$y(x, t = t_0) = A \cos kx$
Displacement associated with the wave as a function of x at t = $2t_0$ can be represented by equation.
(A) $A \cos (kx + 2\pi f t_0)$
(B) $A \sin (kx + 2\pi f t_0)$
(C) $A \cos (kx - 2\pi f t_0)$
(D) $A \cos (kx + 4\pi f t_0)$

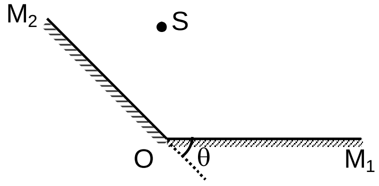
5. A sample contains two radioactive materials A and B with half life 5 hours and 2 hours respectively. The nucleus A decays into B and B decays into stable nucleus C. At t = 0 activities of both samples were equal. The ratio of activity of A to the activity of B when activity of B is maximum, is
(A) 1
(B) $\frac{5}{2}$
(C) $\frac{2}{5}$
(D) $\frac{4}{25}$

6. Water is flowing in a circular pipe of radius r and thickness t with constant speed. A valve installed in the pipe is closed almost instantaneously resulting in an abrupt rise in water pressure. What should be the value of maximum speed of the flow of water such that pipe does not crack due to abrupt rise in pressure. Given density of water ρ, speed of sound in water v and tensile strength of steel is σ.
(A) $\frac{\sigma t}{\rho v r}$
(B) $\frac{\sigma t}{2\rho v r}$
(C) $\frac{\sigma^2 t}{\rho v r^2}$
(D) $\frac{2\sigma t}{\rho v r}$

7. In a nuclear reaction $p + {}^{15}N \rightarrow {}^{15}O + n$

If proton were to collide with ${}^{15}N$ at rest and initiate above reaction. The minimum value of Kinetic energy of proton for which above reaction can take place is
Given: m(p) = 1.007825 amu, m(n) = 1.008665 amu
m(${}^{15}O$) = 15.0031 amu, m(${}^{15}N$)= 15.000 amu (Take 1 amu = 931.5 MeV/c^2)
(A) 3.67 MeV
(B) 3.91 MeV
(C) 3.30 MeV
(D) 3.00 MeV

8. In the arrangement shown in figure, S is a point source, M_1 and M_2 are two plane fixed mirrors inclined at an angle θ with each other. If OS = b, then the value of distance between two images formed.



(A) b sin 2θ
(B) 2b sin θ
(C) 2b sin 2θ
(D) b sin θ

9. Two optical medium of refractive index μ and 3/2 contains 3 and 2 waves of same monochromatic radiation in thickness t and 2t. The value of μ is
(A) 3
(B) 4.5
(C) 2.5
(D) 2

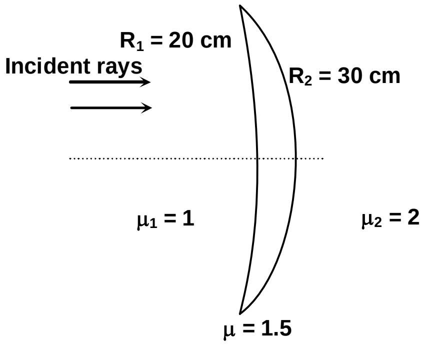
10. The electrons of kinetic energy 75 eV each are diffracted from a metal foil having lattice spacing d = 30Å. If the first maxima occurs when incident at an angle θ from the atomic layer, then the value of sin θ is
(A) 0.023
(B) 0.253
(C) 0.707
(D) 0.047

11. A plane progressive electromagnetic wave travelling in vacuum along +z direction has a wavelength of 6 mm. The variation in the electric field occurs in x-direction with amplitude 50 Vm^{-1}. The equation of electric field and magnetic field as a function of position and time are given by:
(A) $(50\ Vm^{-1})\cos(2\pi \times 10^{11}\ s^{-1})\left(t-\frac{x}{c}\right)\hat{i}$, $(\frac{5}{3} \times 10^{-6}\ T)\cos(2\pi \times 10^{11}\ s^{-1})\left(t-\frac{x}{c}\right)\hat{j}$
(B) $(50\ Vm^{-1})\sin(\pi \times 10^{11}\ s^{-1})\left(t-\frac{z}{c}\right)\hat{i}$, $(\frac{5}{3} \times 10^{-7}\ T)\sin(\pi \times 10^{11}\ s^{-1})\left(t-\frac{z}{c}\right)\hat{j}$
(C) $(50\ Vm^{-1})\sin(\pi \times 10^{11}\ s^{-1})\left(t-\frac{x}{c}\right)\hat{i}$, $(6 \times 10^{6}\ T)\sin(\pi \times 10^{11}\ s^{-1})\left(t-\frac{y}{c}\right)\hat{j}$
(D) $(50\ Vm^{-1})\cos(\pi \times 10^{11}\ s^{-1})\left(t+\frac{z}{c}\right)\hat{i}$, $(6 \times 10^{6}\ T)\sin(\pi \times 10^{8}\ s^{-1})\left(t+\frac{z}{c}\right)\hat{j}$

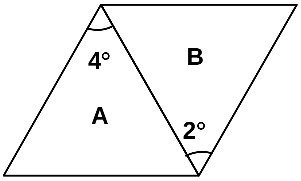
12. If x, v and a denote the displacement, velocity and acceleration of a particle executing S.H.M. of time period T and frequency ν. Then which of the following quantities does not change with time?
(A) $\frac{aT}{x}$
(B) $a^2T + 4\pi\nu^2$
(C) $\frac{aT}{\nu}$
(D) none of these

13. An equilateral prism produces an angle of deviation 60° when the angle of incidence is 60°. The angle of deviation produced when the ray is incident normal to the surface is
(A) 30°
(B) 45°
(C) 60°
(D) can't be determined

14. Magnitude of focal length of the lens shown in the figure is
(A) 240 cm
(B) 60 cm
(C) 48 cm
(D) 30 cm



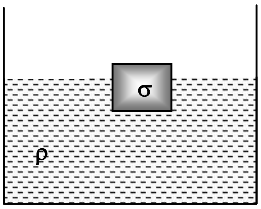
15. Two thin prisms are combined as shown in the figure. Find the total angular dispersion suffered by a white light after it is passed through the combination of two prisms. The refractive indices of prisms A and B for different lights are listed in the table below.



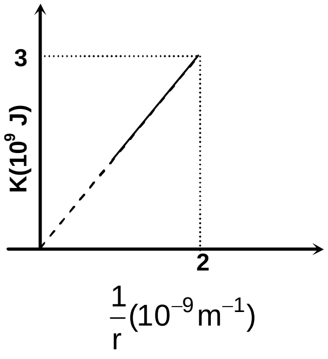
Color	Prism A	Prism B
Violet	1.5	1.7
Yellow	1.45	1.6
Red	1.4	1.5

(A) 0.8°
(B) 0°
(C) 3.0°
(D) 0.6°

16. A cubical block of side a, density σ is floating in a liquid of density $\rho(>\sigma)$ in equilibrium. Block is pushed down very slowly until it is completely getting inside the water. Work done by the pushing force in the process is (assume that area of cross section of container in which liquid is kept is very large as compared to a^2)
(A) $a^4 g\sigma$
(B) $a^4 g\left(\rho - \frac{\rho^2}{\sigma}\right)$
(C) $a^4 g\left(\frac{\rho}{2} - \sigma + \frac{\sigma^2}{2\rho}\right)$
(D) $a^4 g\left(\sigma - \frac{\sigma^2}{\rho}\right)$



17. A graph of kinetic energy K of an asteroid versus $\frac{1}{r}$ (where r is the distance from the centre of the planet A) is shown in the figure. Asteroid falls directly towards the centre of the planet A. What is the value of mass of the asteroid? (M is mass of planet A, G is universal gravitational constant in SI units)
(A) $\frac{3}{2MG} \times 10^{18}$ Kg
(B) $\frac{450}{MG} \times 10^{18}$ Kg



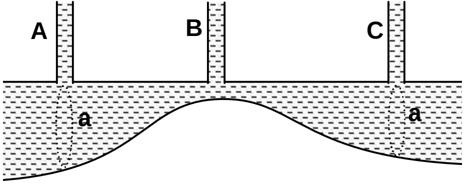
(C) $\frac{2}{MG}\times10^{18}Kg$

(D) $\frac{600}{MG}\times10^{18}Kg$

18. Time period of a particle executing linear S.H.M. is T = 4π sec. There is a point P at a distance x = 2 cm from the mean position O. When the particle passes through the point P towards O it has speed v = 1 cm/sec. The minimum time after which it will again return to point P is
(A) (π/4) sec
(B) 3π sec
(C) (3π/4) sec
(D) 2π sec

19. A small air bubble of radius r is found to be formed at a depth of H from open surface of liquid contained in a beaker. If T is surface tension, ρ is density of the liquid and p_0 is atmospheric pressure then pressure inside the bubble is (r = radius of bubble)
(A) $P_0+\frac{4T}{r}-\rho gH$
(B) $P_0-\rho gH+\frac{2T}{r}$
(C) $P_0+\rho gH+\frac{2T}{r}$
(D) $P_0+\frac{4T}{r}+\rho gH$

20. An ideal fluid is flowing through a horizontal pipe as shown in the figure. Three tubes A, B and C are connected to the pipe. Radii of the tubes A, B and C at junction are 2r, r and 2r respectively. It can be said that (a = cross section area of tube)

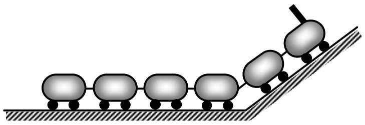


(A) Height of liquid in the tube B is maximum.
(B) Height of liquid in the tubes A and B are same.
(C) Height of liquid in all the three tubes are same.
(D) Height of liquid in the tubes A and C are same.

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

21. A train of length ℓ = 125 m running on a horizontal surface with its engine switched off starts climbing an inclined track of inclination θ = 30° as shown in the figure. Total time spent by train or any part of train on inclination is 5πk sec. The value of k is (g = 10 m/s^2, assume no loss of energy)



22. We would like to find a relation between mass of black hole and the area of its event horizon A. This area depends on the mass of black hole, speed of light and universal gravitational constant. We write it as $A = G^{\alpha}c^{\beta}m^{\gamma}$. Then the value of $|\alpha + \beta - \gamma|$ is

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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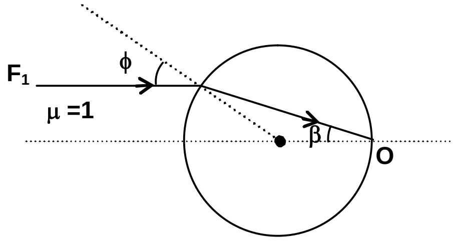
23. A ray of light enters a spherical drop of refractive index $\left(\mu = \frac{5}{4}\right)$ as shown in the figure. The value of 100 cosβ is (where ϕ is the angle for which the ray after refraction passes through the point O as shown in the figure.



24. There is a U-tube of different cross sectional area A = 2.5 cm^2 and 4A of limbs fitted with the frictionless pistons each of mass m = 1 kg. An ideal liquid of density ρ = 2000 kg/m^3 is filled in the tube and the tube is accelerated in horizontal direction with a constant acceleration 'a'. Find the value of acceleration 'a' (in m/s^2) for which both pistons stay in the same horizontal level. The length of horizontal section of U-tube is ℓ = 1m. (Take g = 10 m/s^2)

25. A solid sphere is initially kept in open air, pressure exerted by air on it is 10^5 N/m^2. The sphere is lowered into ocean to a depth where pressure is 100 times atmospheric pressure. The fractional change in the volume of the sphere is (Bulk modulus of sphere, B = 4.95×10^8 N/m^2)

Chemistry PART – II

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

26. Which of the following statement is correct for the following reaction?

$$CrO_5 + H_2SO_4 \longrightarrow Cr_2(SO_4)_3 + H_2O + O_2$$

(A) It is not a redox reaction.
(B) One mole of CrO_5 will liberate7/4 moles of O_2.
(C) Oxidation number of Cr decreases from +10 to +3 during the reaction.
(D) None of these.

27. A sample of liquid H_2O of mass 18.0 g is injected into an evacuated 7.6 L flask maintained at 27^oC. If vapour pressure of water at 27^oC is 24.63 mm Hg, what weight percentage of the water will be vapourised when the system comes to equilibrium? Assume water vapour behaves as an ideal gas and the volume occupied by water is negligible compared to the volume of the container:

(A) 1%
(B) 10%
(C) 18%
(D) 20%

28. If x is the specific resistance (in S^{-1} cm) of the electrolyte solution and y is the molarity of the solution, then Λ_m (in S cm^2 mol^{-1}) is given by

(A) $\frac{1000x}{y}$
(B) $\frac{1000y}{x}$
(C) $\frac{1000}{xy}$
(D) $\frac{xy}{1000}$

29. Boiling point of which set of aqueous solutions given below will not be identical?

(A) 1 mole NaCl in 1 L water, 2 mole CH_3OH in 1 L water.
(B) 18.4 M H_2SO_4 $\left(d = 1.84\frac{g}{mL} \text{ and } 98\% \ H_2SO_4 \text{ by mass}\right)$,
500 m H_2SO_4 $\left(d = 1.84\frac{g}{mL} \text{ and } 98\% \ H_2SO_4 \text{ by mass}\right)$
(C) 0.1 M urea, 0.1 M glucose
(D) 0.11 % by moles (R) – 2-butanol in water, 0.11 % by moles (S) – 2 – butanol in water.

30. Which of the following is a mismatch:

(A) Lyophilic colloids – reversible sols
(B) Associated colloids – micelles
(C) Tyndall effect – Scattering of light by colloidal particles.
(D) Electrophoresis – movement of dispersion medium under the influence of electric field.

31. Which of the following statements is incorrect?
(A) Transition elements exhibit higher enthalpies of atomization as they have stronger interatomic interaction.
(B) IE_2 of $_{23}V < {}_{24}Cr > {}_{25}Mn$ and $_{28}Ni < {}_{29}Cu > {}_{30}Zn$
(C) Ni(II) compounds are more stable than Pt(II) where as Pt(IV) compounds are more stable than Ni(IV).
(D) The elements which give the greatest number of oxidation state does not occur in or near the middle of the transition series.

32. An aqueous solution of a substance gives a white precipitate on treatment with dilute hydrochloric acid, which dissolves on heating. When hydrogen sulphide is passed through the hot acidic solution, a black precipitate is obtained. The substance is a:
(A) Hg_2^{+2} salt
(B) Cu^{+2} salt
(C) Ag^{+} salt
(D) Pb^{+2} salt

33. Which of the following compounds does not liberate NH_3 on heating?
(A) $(NH_4)_2SO_4$
(B) $(NH_4)_2CO_3$
(C) NH_4Cl
(D) NH_4NO_3

34. For a certain reaction
$A \xrightarrow{\quad} \text{Products}$, the $t_{1/2}$ as a function of $[A]_0$ is given as below:

$[A]_0$:	0.1	0.025
$t_{1/2}$ (min.) :	100	50

(A) The order is 2.
(B) $t_{1/2}$ would be $100\sqrt{10}$ min. for $[A]_0$ = 1 M.
(C) The order is 1.
(D) $t_{1/2}$ would be 100 min. for $[A]_0$ = 1 M.

35. Which of the following is not an ore of copper?
(A) Azurite
(B) Siderite
(C) Cuprite
(D) Malachite

36. Which of the following pairs of ions is expected to show colour in aqueous solutions?
(A) La^{+3}, Ce^{+3}
(B) La^{+3}, Lu^{+3}
(C) Ce^{+3}, Sm^{+3}
(D) Lu^{+3}, Sm^{+3}

37. The density of steam at 27°C and 8.314×10^4 pascal is 0.8 kg m^{-3}. The compressibility factor would be:
(A) 0.75
(B) 1
(C) 0.88
(D) 1.1

38. The RMS speed of the molecule of diatomic gas is U. When the temperature is doubled, the molecule dissociates into two atoms. The new RMS speed of the atom is:
(A) $\sqrt{2}U$
(B) U
(C) 2U
(D) 4U

39. For a perfectly crystalline solid, $C_{P,m} = aT^3$, where a is constant. If $C_{P,m}$ is 0.84 J K^{-1} mol^{-1} at 10 K, molar entropy at 10 K is:
(A) 0.42 J K^{-1} mol^{-1}
(B) 0.28 J K^{-1} mol^{-1}
(C) 4.2 J K^{-1} mol^{-1}
(D) 2.8 J K^{-1} mol^{-1}

40. The ratio of number of σ bond and π bond in Bithionol, which is added to soaps to impart antiseptic properties:
(A) $\frac{26}{3}$
(B) $\frac{13}{3}$
(C) $\frac{19}{3}$
(D) $\frac{22}{3}$

41. How many grams of sulphuric acid is to be dissolved to prepare 200 mL aqueous solution having concentration of H_3O^+ ions = 1 M at 25°C.
(A) 4.9 g
(B) 19.6 g
(C) 9.8 g
(D) 0.98 g

42. Out of Cu^{+2}, Ni^{+2}, Co^{+2} and Mn^{+2}, which ion is precipitated when H_2S is passed through it in the presence of dilute HCl?
(A) Cu^{+2}
(B) Ni^{+2}
(C) Co^{+2}
(D) Mn^{+2}

43. Amongst the following compounds, which one is not responsible for the depletion of ozone layer?
(A) CH_4
(B) $CFCl_3$
(C) NO
(D) Both (A) and (B)

44. 100 mL of 0.05 M $CuSO_4$ (aq.) solution was electrolysed using inert electrodes by passing current till the pH of the resulting solution was 2. The solution after electrolysis was neutralized and then treated with excess KI and formed I_2 was titrated with 0.04 M $Na_2S_2O_3$. Calculate the required volume (in mL) of $Na_2S_2O_3$.
(A) 112.5 mL
(B) 100 mL
(C) 125 mL
(D) 150 mL

45. When an excess of a very dilute aqueous solution of KI is added to a very dilute aqueous solution of $AgNO_3$, the colloidal particles of AgI are associated with which of the following Helmholtz double layer

(A) $AgI \vdots Ag^{+} \vdots I^{-}$

(B) $AgI \vdots K^{+} \vdots NO_3^{-}$

(C) $AgI \vdots I^{-} \vdots K^{+}$

(D) $AgI \vdots NO_3^{-} \vdots Ag^{+}$

SECTION – B
(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

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46. Among the elements of lanthanoid series $\left({}_{58}Ce - {}_{71}Lu\right)$, the total number of elements which have odd number of electrons in f-orbitals in their ground state configuration.

47. Sucrolose is *x* times sweet in comparison to cane sugar while Aspartame is *y* time sweet in comparison to cane sugar. The ratio $\frac{x}{y}$ is:

SECTION – C
(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

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48. For first order gaseous reaction, $\log_{10}K$ when plotted against $\frac{1}{T}$ gives a straight line with a slope of – 8000. Calculate the activation energy of the reaction (in Kcal) (Take R = 2 cal k^{-1} mol^{-1})

49. Calculate the concentration of $Na_2S_2O_3.5H_2O$ solution in grams per litre, 10 mL of which just decolourised 15 mL of $\frac{N}{20}$ iodine solution.

50. A fuel cell develops an electrical potential from the combustion of butane at 1 bar at 298 K.

$$C_4H_{10}(g) + 6.5O_2(g) \longrightarrow 4CO_2(g) + 5H_2O(\ell), \quad \Delta_r G^0 = -2746 \text{ kJ/mol}$$

What is E^o of the cell (in volt)?

Mathematics PART – III

SECTION – A
(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

51. Unit vector perpendicular to the vectors $\hat{i}+2\hat{j}-\hat{k}$ and $2\hat{i}+3\hat{j}+\hat{k}$ is

(A) $\frac{1}{\sqrt{35}}\left(5\hat{i}-3\hat{j}-\hat{k}\right)$

(B) $\frac{1}{\sqrt{35}}\left(3\hat{i}-5\hat{j}+\hat{k}\right)$

(C) $\frac{1}{\sqrt{35}}\left(\hat{i}+5\hat{j}-3\hat{k}\right)$

(D) none of these

52. For any three vectors $\vec{a}$, $\vec{b}$, $\vec{c}$ (non-zero), $\left(\vec{a}-\vec{b}\right)\cdot\left[\left(\vec{b}-\vec{c}\right)\times\left(\vec{c}-\vec{a}\right)\right]$ is

(A) $2|\vec{c}|$

(B) $3|\vec{b}-\vec{c}|$

(C) $3|\vec{b}-\vec{c}+\vec{a}|$

(D) zero

53. The projection of the line segment P(1, 2, 3) and Q(–1, 4, 2) on the line having direction ratios 2, 3, –6 is

(A) $\frac{7}{8}$

(B) $\frac{6}{7}$

(C) $\frac{8}{7}$

(D) $\frac{9}{2}$

54. Image of the point P(3, 5, 7) in the plane 2x + y + z = 0 is

(A) (9, –1, –1)

(B) (–9, 1, –1)

(C) (–9, –1, 1)

(D) none of these

55. The number of distinct terms in the expansion of $\left(2x+3+\frac{1}{5x}\right)^n$, $n \in N$ is

(A) 3n

(B) 3n + 1

(C) 2n

(D) 2n + 1

56. $\frac{1}{{}^{2n+1}C_5}+\frac{1}{{}^{2n+1}C_6}=\frac{2n+2}{2n+1}\frac{1}{{}^{2n}C_\alpha}$, then α is
(A) 4
(B) 5
(C) 6
(D) none of these

57. Let α, β, γ be distinct complex numbers such that $\frac{\alpha}{1-\beta}=\frac{\beta}{1-\gamma}=\frac{\gamma}{1-\alpha}=\lambda$, then λ is
(A) ω
(B) ω^2
(C) $-\omega^2$
(D) none of these

58. The product of the real part of the roots of $z^2 - z = 5 - 5i$ is
(A) –25
(B) –6
(C) –5
(D) 25

59. The probability that a man can hit a target is $\frac{3}{4}$, he tries 5 times. The probability that he will hit the target at least three times is
(A) $\frac{291}{364}$
(B) $\frac{371}{464}$
(C) $\frac{471}{502}$
(D) $\frac{459}{512}$

60. Let E and F be two independent events such that P(E) > P(F). The probability that both E and F happened is $\frac{1}{12}$ and the probability that neither E nor F happens is $\frac{1}{2}$, then
(A) $P(E)=\frac{1}{3}, P(F)=\frac{1}{4}$
(B) $P(E)=\frac{1}{2}, P(F)=\frac{1}{6}$
(C) $P(E)=\frac{1}{2}, P(F)=\frac{1}{8}$
(D) none of these

61. If a, b, c are all different from zero and $\begin{vmatrix}1+a & 1 & 1\\ 1 & 1+b & 1\\ 1 & 1 & 1+c\end{vmatrix}=0$, then $\frac{1}{a}+\frac{1}{b}+\frac{1}{c}$ is
(A) abc
(B) $\frac{1}{abc}$

(C) –a – b – c
(D) –1

62. If, $k \in R^+$, then Det(Adj(λI_4)) is
(A) λ^3
(B) λ^{12}
(C) λ^4
(D) λ

63. A and B are two given matrices such that the order of A is 3 × 4, if A′B and BA′ are both defined, then
(A) order of B′ is 3 × 4
(B) order of B′A is 4 × 4
(C) order of B′A is 3 × 3
(D) B′A is not defined

64. The sum of integral values of α for which the equation $(x + \alpha)(x + 1991) + 1 = 0$ has integral roots is/are
(A) 1989
(B) 1997
(C) 3982
(D) none of these

65. If for an A.P. $a_1, a_2, a_3, \ldots, a_n$; $a_1 + a_3 + a_5 = -12$ and $a_1a_2a_3 = 8$, then $a_2 + a_4 + a_6$ is
(A) –12
(B) –16
(C) –18
(D) –2

66. The number of arrangements of the word 'PARABOLA' under the condition that consonants and vowels alternate is
(A) 48
(B) 24
(C) 192
(D) 216

67. The number of ways in which can three people divide among themselves six identical apples, one orange, one lemon, one banana, one pear, one plum and one apricot is
(A) ${}^8C_3$
(B) $(3)^6$
(C) ${}^8C_4 \times (3)^6$
(D) none

68. The mean of 10 numbers is 12.5, the mean of first six numbers is 15 and mean of last five is 10, then sixth number is
(A) 15
(B) 12
(C) 18
(D) 12.5

69. Standard deviation of the first 2n + 1 natural numbers is

(A) $\sqrt{\frac{n(n+1)}{4}}$

(B) $\sqrt{\frac{n(n+1)(2n+1)}{3}}$

(C) $\sqrt{\frac{n(n+1)}{3}}$

(D) $\sqrt{\frac{n(n+1)}{2}}$

70. The coefficients of 3 consecutive terms in the expansion of $(1 + x)^n$ are in the ratio 1 : 7 : 35, then value of 'n' is

(A) 35
(B) 46
(C) 23
(D) none of these

SECTION – B

(Single digit integer type)

This section contains **02** questions. The answer to each question is a **single Digit integer** ranging from **0 to 9, both inclusive**.

---

71. Let $A = \begin{bmatrix} 2 & 1 \\ 0 & 3 \end{bmatrix}$ be a matrix such that $A^{10} = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$, then the number of factors of a + b + c + d is 'n' where (n – 15) is

72. The equation $x^2 + bx + c = 0$ has distinct roots. If 2 is subtracted from each root, then the result is the reciprocal of original root, then $b^2 + c^2$ is

SECTION – C

(Numerical Answer Type)

This section contains **03** questions. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. XXXXX.XX).

---

73. At a dance function there are 12 boys and 15 girls. The number of ways in which they can form four couples consisting of different genders is N, then $\frac{N}{10^3}$ is

74. If z is any complex number satisfying $|z - 4 - 3i| = 2$ in argand plane. The maximum and minimum values of $|z|$ are α and β respectively, then $\frac{\alpha+\beta}{4}$ is

75. A purse contains 4 copper and 3 silver coins & another purse contains 6 copper & 2 silver coins. One coin is drawn from any one of these purses. The probability that it is a copper coin is $\frac{\alpha}{\beta}$ (α, β $\in$ N & are coprime), then $\frac{\alpha}{\beta+18}$ is

FIITJEE

ALL INDIA TEST SERIES

PART TEST – III

JEE (Main)-2020

TEST DATE: 08-12-2019

ANSWERS, HINTS & SOLUTIONS

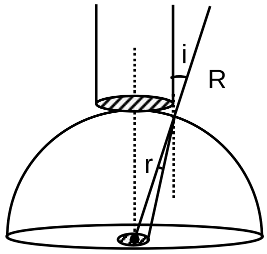
Physics

PART – I

SECTION – A

1. D

Sol. Using Snell's law:



$$\sin i = \frac{R}{2R} \Rightarrow i = 30^\circ$$

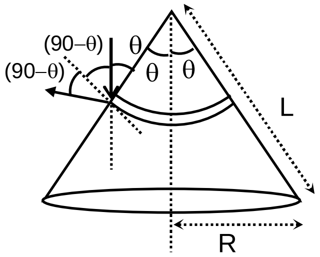
$$\sin i = \mu \sin r$$

$$\sin r = \frac{1}{2\sqrt{2}}$$

2. C

Sol. $$\frac{10-0.7}{2\times 10^{-3}} = 4.65\,\text{k}\Omega$$

3. D



Sol. $$F = \int \frac{2I ds \sin^2\theta}{c}\sin\theta$$

$$= = \frac{2I\sin^2\theta}{c}\sin\theta\int ds = \frac{2I\sin^2\theta}{c}\pi RL\sin\theta$$

$$= \frac{I\pi R^2}{c}(1-\cos 2\theta)$$

4. A

Sol. $y(x, t = t_0) = A \cos kx$

$\therefore\ y(x, t) = A \cos k[x + v(t - t_0)]$

$y(x, t) = A \cos [kx + \omega t - \omega t_0)]$

at $t = 2t_0$

$y(x, t = 2t_0) = A \cos [kx + \omega t_0)]$

$y(x, t = 2t_0) = A \cos [kx + 2\pi f t_0]$

5. A

Sol. $A \xrightarrow{\lambda_1} B \xrightarrow{\lambda_2} C$

$$\frac{dN_B}{dt} = \lambda_1 N_A - \lambda_2 N_B = 0$$

$$\Rightarrow \frac{N_A}{N_B} = \frac{\lambda_2}{\lambda_1} \Rightarrow \frac{\lambda_1 N_A}{\lambda_2 N_B} = 1$$

6. A

Sol. impulse momentum theorem

$\rho v v_1 A\Delta t = \Delta p A \Delta t$

$\Rightarrow \Delta p = \rho v v_1$

Also $\Delta p.(2r)\ell = \sigma.(2t)\ell$

$\Rightarrow \Delta pr = \sigma t$

$\Rightarrow \rho v v_1 r = \sigma t$

$$v_1 = \frac{\sigma t}{\rho v r}$$

7. B

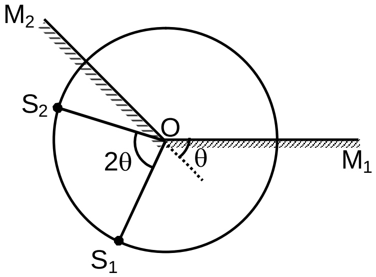
Sol. $|Q| = 0.00394 \times 931.5 = 3.67$ MeV

threshold Kinetic energy

$$= \left(\frac{m_1 + m_2}{m_2}\right)|Q| = \left(1 + \frac{m_P}{m_N}\right)|Q| = 3.91\,\text{MeV}$$

8. B

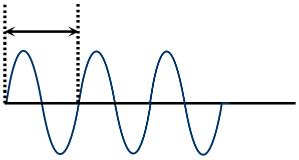
Sol. If mirror rotates by angle θ image of object rotates by angle 2θ.



9. B

Sol. Optical path = μ geometrical path

$$\frac{\left(\frac{3\lambda}{\mu_1}\right)}{\left(\frac{2\lambda}{\mu_2}\right)} = \frac{1}{2} \Rightarrow \frac{3\mu_2}{2\mu_1} = \frac{1}{2} \Rightarrow \mu_1 = 9/2$$



10. A

Sol. $\lambda = \frac{h}{\sqrt{2mK}}$

$\lambda = \sqrt{\frac{150}{75}} \Rightarrow \lambda = 1.414\ \text{Å}$

For the first maxima

$2d\sin\theta = \lambda$

$\Rightarrow \sin\theta = \frac{\lambda}{2d} = \frac{1.414}{2\times 30} = 0.023$

11. B

Sol. The direction of ($\vec{E}\times\vec{B}$) gives the direction of propagation of wave

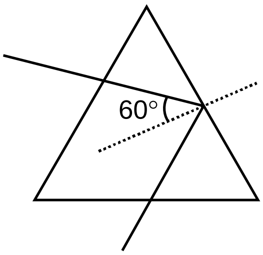
$\hat{i}\times\hat{j}\rightarrow\hat{k}$

12. A

Sol. $\frac{\omega^2 xT}{x} = \omega^2 T$

13. C

Sol. TIR will take place



14. C

Sol. $\frac{3}{2v_1} - \frac{1}{\infty} = \frac{(0.5)}{-20}$

$\frac{2}{f} - \frac{3}{2v_1} = \frac{0.5}{-30}$

$\frac{2}{f} = -\frac{1}{2}\left(\frac{1}{20}+\frac{1}{30}\right)$

$f = -\frac{4\times 20\times 30}{50} = -48\,\text{cm}$

15. B

Sol. Total angular dispersion = $(\mu_v - \mu_r)A - (\mu'_v - \mu'_r)A' = 0$

16. C

Sol. In equilibrium

$\sigma a^3 g = \rho a^2 x_0 g$

$x_0 = \frac{\sigma a}{\rho}$

The work done by the applied force,

$$\Delta W = \int F dx = \int_0^{a-x_0} \rho a^2 x g dx$$

$$= \frac{\rho a^2 g}{2}(a - x_0)^2 = \frac{\rho a^2 g}{2}\left[a - \left(\frac{\sigma a}{\rho}\right)\right]^2$$

$$= a^4 g\left(\frac{\rho}{2} - \sigma + \frac{\sigma^2}{2\rho}\right)$$

17. A

Sol. Using conservation of energy, $K - \frac{GMm}{r} = 0$

$$K = \frac{GMm}{r} \Rightarrow K = (GMm)\frac{1}{r}$$

$$GMm = \frac{3}{2} \times 10^{18}$$

$$m = \frac{3}{2MG} \times 10^{18} \text{Kg}$$

18. B

Sol. $t = \frac{T}{2\pi}(2\pi - 2\phi) = \frac{T}{\pi}(\pi - \phi)$

$$\phi = \tan^{-1}\left(\frac{vT}{2\pi x}\right) = \tan^{-1}\left(\frac{4\pi}{2\pi \cdot 2}\right)$$

$$\phi = \pi/4$$

$$t = 4 \times \frac{3\pi}{4} = 3\pi \sec$$

19. C

Sol. $\Delta P = \frac{2T}{r}$

$$\therefore\ P = P_0 + \rho g H + \frac{2T}{r}$$

20. D

Sol. Bernoulli's theorem

SECTION – B

21. 1

Sol. $ma = -\left(\frac{m}{\ell} \cdot x\right) g \sin\theta$

$$a = -\left(\frac{g\sin\theta}{\ell}\right)x$$

$$\Rightarrow \quad \frac{d^2x}{dt^2} = -\left(\frac{g\sin\theta}{\ell}\right)x$$

$$T = 2\pi\sqrt{\frac{\ell}{g\sin\theta}} = 2\pi\sqrt{\frac{125}{10\times\frac{1}{2}}} = 2\pi\times5 = 10\pi \text{ sec}$$

Time spent on the inclined track is $t_0 = \frac{T}{2} = \frac{10\pi}{2} = 5\pi$ sec

22. 4

Sol. $L^2 = [M^{-1}L^3T^{-2}]^{\alpha}[LT^{-1}]^{\beta}[M]^{\gamma}$

$-\alpha + \gamma = 0$

$-2\alpha - \beta = 0$

$3\alpha + \beta = 2$

$\Rightarrow \alpha = 2, \beta = -4, \gamma = 2$

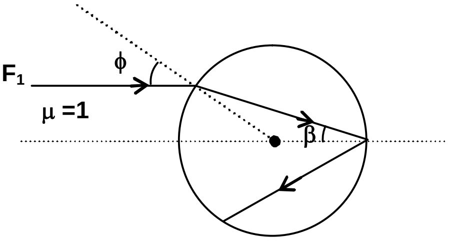
SECTION – C

23. 00062.50

Sol. $\sin\phi = \mu\sin\beta$

$\cos\beta = \mu/2 = 5/8$ (since $\phi/2 = \beta$)

$\therefore\ 100\cos\beta = 100\times\frac{5}{8} = 62.50$



24. 00015.00

Sol. $\Delta p = \frac{mg}{A} - \frac{mg}{4A}$

$\Rightarrow \quad \rho a\ell = \frac{3mg}{4A}$

$a = \frac{3mg}{4A\rho\ell} = \frac{3\times1\times10}{4\times2.5\times10^{-4}\times2\times10^3\times1} = 15 \text{ m/s}^2$

25. 00000.02

Sol. $\left|\frac{\Delta V}{V}\right| = \frac{\Delta P}{B} = \frac{99\times10^5}{4.95\times10^8} = 0.02$

Chemistry

PART – II

SECTION – A

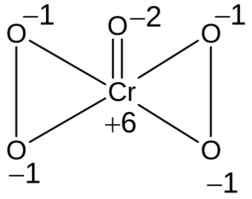
26. B

Sol. Balanced reaction is

$$2CrO_5 + 3H_2SO_4 \longrightarrow Cr_2\left(SO_4\right)_3 + 3H_2O + \frac{7}{2}O_2$$

So, 1 mole CrO_5 liberates $\frac{7}{4}$ moles of O_2.

It is a redox reaction because oxidation number of Cr decreases and oxidation number of O increases.



27. A

Sol. Initial weight of $H_2O(\ell) = 18$ g

$$n_{H_2O}(g) = \frac{PV}{RT}$$

$$= \frac{\left(\frac{24.63}{760}\right)\times 7.6}{0.0821\times 300} = 0.01\,\text{mole}$$

% wt. of H_2O vapourised $= \frac{0.01\times 18}{18}\times 100$

= 1%

28. C

Sol. $\Lambda_m = \frac{\kappa \times 1000}{M}$

or $\Lambda_m = \frac{1}{\rho}\times\frac{1}{M}\times 1000$ [κ = specific conductance, ρ = specific resistance]

or $\Lambda_m = \frac{1000}{xy}$

29. A

Sol. NaCl is non-volatile but CH_3OH is volatile. So, these solutions would have different boiling points. Raoult's law can not be applied to CH_3OH solution since it does not form an ideal solution with H_2O.

30. D

Sol. Electrophoresis means movement of colloidal particles (particles of dispersed phase) under the influence of electric field.

31. D

Sol. (A) Stronger the inter-atomic interaction, higher the enthalpy of atomization.

(B) Cr^+ has half-filled valence shell electronic configuration ($3d^5$), so it has higher second ionization energy. Similarly, Cu^+ has completely filled valence shell electronic configuration $3d^{10}$, so it has higher second ionization energy.

(C) Sum of first two ionization energies ($IE_1 + IE_2$) of Ni(II) is less than that of Pt(II), while sum of first four ionization energies ($IE_1 + IE_2 + IE_3 + IE_4$) of Pt (IV) is less than that of Ni(IV).

(D) Occurs in the middle, e.g. Mn has +7 oxidation state.

32. D

Sol. White precipitates of Hg_2Cl_2 and AgCl are water insoluble (even in hot water). Copper salts do not give white precipitate with dilute HCl as $CuCl_2$ is water soluble (at room temperature)

$$Pb^{+2} + 2Cl^- \longrightarrow \underset{\begin{pmatrix}\text{white precipitate}\\ \text{soluble in hot water}\end{pmatrix}}{PbCl_2}$$

$$Pb^{+2} + S^{-2} \longrightarrow \underset{(\text{Black})}{PbS}$$

33. D

Sol. $NH_4NO_3 \xrightarrow{\Delta} N_2O + 2H_2O$

34. B

Sol. $t_{1/2} \propto [A]_0^{1-n}$

$100 \propto (0.1)^{1-n}$

$50 \propto (0.025)^{1-n}$

On dividing

$2 = 4^{1-n}$

$2 = (2^2)^{1-n}$

$2^1 = 2^{2-2n}$

$\therefore 2 - 2n = 1$

or 2n = 1

or $n = \frac{1}{2}$

$100 \propto (0.1)^{1/2}$

$t_{1/2} \propto (1)^{1/2}$

Divide

$$\frac{t_{1/2}}{100} = \left(\frac{1}{0.1}\right)^{\frac{1}{2}}$$

$\therefore t_{1/2} = 100\sqrt{10}$ minutes.

35. B

Sol. Siderite is an ore of iron ($FeCO_3$).

36. C

Sol. Colour is attributed to the presence of unpaired f-electrons.

$$Ce^{+3} = 4f^1,\ Sm^{+3} = 4f^5$$

$$La^{+3} = 4f^0,\ Lu^{+3} = 4f^{14}$$

37. A

Sol. $$Z = \frac{PV}{nRT} = \frac{PV}{\frac{w}{M} \times RT} = \frac{PM}{dRT}$$

$$Z = \frac{8.314 \times 10^4 \times 18 \times 10^{-3}}{0.8 \times 8.314 \times 300} = \frac{18 \times 10}{300 \times 0.8}$$

$$Z = \frac{3}{4} = 0.75$$

38. C

Sol. $$U = \sqrt{\frac{3RT}{M}}$$

Let new rms speed be U_2.

$$U_2 = \sqrt{\frac{3R \times 2T}{\frac{M}{2}}} = 2 \times \sqrt{\frac{3RT}{M}}$$

$$\therefore U_2 = 2U$$

39. B

Sol. $C_{P,m} = aT^3$

$$a = \frac{C_{P,m}}{T^3} = \frac{0.84}{(10)^3} = 0.84 \times 10^{-3}$$

$$S_m = \int_{0K}^{10K} \frac{C_{P,m}}{T}.dT$$

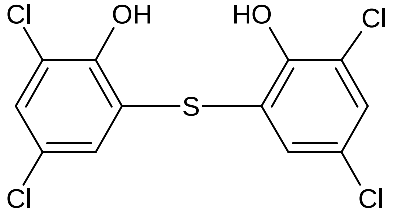
$$S_m = \int_{0K}^{10K} \frac{aT^3}{T}.dT = \int_{0K}^{10K} aT^2.dT$$

$$S_m = \frac{a}{3}\left[10^3 - 0\right] = \frac{a}{3} \times 10^3$$

$$S_m = \frac{0.84 \times 10^{-3} \times 10^3}{3} = 0.28$$

40. B

Sol.



Bithionol

There are 26 σ bonds and 6π bonds. So, ratio is $\frac{26}{6}=\frac{13}{3}$

41. C

Sol. In order to get $\left[H_3O^+\right]=1M$, H_2SO_4 concentration should be = 0.5 M.

$$\underset{(H_2SO_4)}{M}=\frac{W(\text{in g})}{\text{Molar mass}\times V\text{ in L}}$$

$$0.5=\frac{W(\text{in g})}{98\times 0.2}$$

Wt. of H_2SO_4 = 9.8 g

42. A

Sol. Cu^{+2} is member of II group cations while Ni^{+2}, Co^{+2} and Mn^{+2} are members of IV group cations. When H_2S is passed in presence of dilute HCl, only II group cation (Cu^{+2}) is precipitated.

43. A

Sol. Following reactions are responsible for the depletion of ozone layer

$$NO+O_3\longrightarrow NO_2+O_2$$

$$CFCl_3\xrightarrow{h\nu}\dot{C}F_2Cl+Cl^{\bullet}$$

$$Cl^{\bullet}+O_3\longrightarrow ClO^{\bullet}+O_2$$

$$ClO^{\bullet}+O\longrightarrow \dot{C}l+O_2$$

CH_4 is not responsible for ozone layer depletion.

44. A

Sol. $\left[H^+\right]=10^{-2}$

m moles of $H^+=10^{-2}\times 100=1$

During electrolysis, following reactions take place.

At cathode

$$Cu^{+2}(aq.)+2e^-\longrightarrow Cu(s)$$

At anode

$$H_2O(\ell)\longrightarrow\frac{1}{2}O_2(g)+2H^+(aq.)+2e^-$$

From above reactions, it is clear that for 1 m mole of H^+ produced at anode, 0.5 m mole of Cu^{+2} is reduced at cathode.

Initial m mole of Cu^{+2} = 100 mL × 0.05
= 5 m mole

After electrolysis

Cu^{+2} remaining in solution = 5 – 0.5 = 4.5 m moles

$$2Cu^{+2}+4I^-\longrightarrow Cu_2I_2+I_2$$

So, according to above reaction

4.5 m mole Cu^{+2} will liberate $\frac{4.5}{2}$ m moles of I_2.

$$I_2+2Na_2S_2O_3\longrightarrow Na_2S_4O_6+2NaI$$

According to above reaction $\frac{4.5}{2}$ m moles of I_2 requires 4.5 m moles of $Na_2S_2O_3$.

$$M = \frac{\text{m moles}}{\text{V in mL}}$$

$$V(\text{in mL}) = \frac{4.5}{0.04} = \frac{450}{4}$$

V = 112.5 mL

45. C

Sol. Excess of KI is added, I^- ions are adsorbed on AgI forming a fixed layer and give – ve charge on colloid particles. It then attracts K^+ ions from the medium forming second diffused (mobile) layer.

SECTION – B

46. 8

Sol. Total 8 f-Block elements in 4f-series have odd electrons in f-orbitals in their ground state configuration.

${}_{58}Ce$, ${}_{59}Pr$, ${}_{61}Pm$, ${}_{63}Eu$, ${}_{64}Gd$, ${}_{65}Tb$, ${}_{67}Ho$, ${}_{69}Tm$

47. 6

Sol. Sucrolose is 600 times sweet in comparison to cane sugar and Aspartame is 100 times sweet in comparison to cane sugar.

So, $\frac{x}{y} = \frac{600}{100}$

= 6

SECTION – C

48. 00036.85

Sol. $\log_{10} K = \log_{10} A - \frac{Ea}{2.303RT}$

$$\text{Slope} = -\frac{Ea}{2.303R}$$

$$-8000 = -\frac{Ea}{2.303 \times 2}$$

$$Ea = 8000 \times 2 \times 2.303 = 36848 \text{ calorie}$$

$$Ea = 36.85 \text{ Kcal}$$

49. 00018.60

Sol. $2Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + 2NaI$

n-factor of I_2 = 2

Therefore, number of m moles of I_2 = $15 \times \frac{M}{40} = \frac{15}{40}$

Number of m moles of $Na_2S_2O_3 = \frac{15}{40} \times 2 = \frac{15}{20}$ in 10 mL solution.

Weight of $Na_2S_2O_3.5H_2O(\text{in g})$ in 10 mL solution $= \frac{15}{20} \times 10^{-3} \times 248 = 0.186 \text{ g}$

Therefore, concentration of $Na_2S_2O_3.5H_2O$ = 18.6 (in g/L)

50. 00001.09

Sol. $\Delta G^o = -nFE^o_{cell}$

$$E^o_{cell} = \frac{-2746 \times 1000}{-26 \times 96500} = 1.09 \text{ V}$$

Mathematics

PART – III

SECTION – A

51. A

Sol. Vector $(\vec{v}) = \frac{\vec{a}\times\vec{b}}{|\vec{a}\times\vec{b}|} = \frac{1}{\sqrt{35}}\left(5\hat{i}-3\hat{j}-\hat{k}\right)$

52. D

Sol. $\left(\vec{a}-\vec{b}\right)\cdot\left[\left(\vec{b}-\vec{c}\right)\times\left(\vec{c}-\vec{a}\right)\right] = \left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right]-\left[\vec{b}\ \ \vec{c}\ \ \vec{a}\right]=0$

53. C

Sol. Required projection is $\frac{2}{7}(-1-1)+\frac{3}{7}(4-2)-\frac{6}{7}(2-3)=\frac{8}{7}$

54. C

Sol. D.R. of normal $\equiv$ (2, 1, 1). Let, Q be the image of point P in the plane and PQ meet in R
R $\equiv$ (2r + 3, r + 5, r + 7), $\therefore$ 2(2r + 3) + r + 5 + r + 7 = 0, $\therefore$ r = –3
$\therefore$ Using section formula Q $\equiv$ (–9, –1, 1)

55. D

Sol. The number of terms is same as $(1 + x + x^2)^n$ which is 2n + 1

56. B

Sol. $\frac{1}{{}^{2n+1}C_r}+\frac{1}{{}^{2n+1}C_{r+1}}=\frac{{}^{2n+2}C_{r+1}}{{}^{2n+1}C_r\cdot{}^{2n+1}C_{r+1}}=\frac{2n+1}{2n+1}\times\frac{1}{{}^{2n}C_r}$

57. C

Sol. $\alpha = \lambda(1-\beta) = \lambda-\lambda(\lambda-\lambda c)$
Also, $(1+\lambda^3)\beta = \lambda-\lambda^2+\lambda^3$, $(1+\lambda^3)\gamma = \lambda-\lambda^2+\lambda^3$
$\therefore$ $(1+\lambda^3)\alpha = (1+\lambda^3)\beta = (1+\lambda^3)\gamma$, $\therefore$ $\lambda^3 = -1$, $\therefore$ $\lambda = -1, -\omega, -\omega^2$

58. B

Sol. Roots are 3 – i and –2 + i, $\therefore$ product is –6

59. D

Sol. $p=\frac{3}{4}$, $q=\frac{1}{4}$, n = 5

Probability = ${}^5C_3\left(\frac{3}{4}\right)^3\left(\frac{1}{4}\right)^2 + {}^5C_4\left(\frac{3}{4}\right)^4\left(\frac{1}{4}\right) + {}^5C_5\left(\frac{3}{4}\right)^5 = \frac{459}{512}$

60. A

Sol. $P(E\cap F) = P(E)\cdot P(F) = \frac{1}{12}$, $P(E'\cap F')=\frac{1}{2}$, $(1-P(E))(1-P(F))=\frac{1}{2}$

61. D

Sol. $C_1 \to C_1 - C_2$, $C_2 \to C_2 - C_3$, open by R_1, ab + abc + ac + bc = 0
$\therefore$ $\frac{1}{a}+\frac{1}{b}+\frac{1}{c}=-1$

62. B

Sol. $\left|\text{Adj}\left(\lambda I_n\right)\right| = \lambda^{n(n-1)}$

63. B

Sol. Order of B′ → 4 × 3, order of B′A → (4 × 3) × (3 × 4) ⇒ 4 × 4

64. C

Sol. $(x + \alpha) = 1$ and $x + 1999 = -1 \Rightarrow \alpha = 1993$
$x + \alpha = -1$ and $x + 1991 = 1$, $\alpha = 1989$
Sum = 1993 + 1989

65. D

Sol. Let term be a – 2d, a – d, a, a + d, a + 2d
$\therefore$ 3a = –12 ⇒ a = –4, (a – 2a)(a – d)(a) = 8
$\therefore$ d = –3
$\therefore$ $a_2 + a_4 + a_6 = -21$

66. C

Sol. Required value is $2\times\underline{|4}\times\frac{\underline{|4}}{\underline{|3}}=192$

67. D

Sol. Number of ways is ${}^{8}C_2\times(3)^6$

68. A

Sol. Let numbers be $a_1, a_2, \ldots, a_{10}$. $\sum_{i=1}^{10} a_i = 125$, $\sum_{i=1}^{6} a_i = 90$, $\sum_{i=6}^{10} a_i = 50$
$\therefore$ $a_6 + 125 = 90 + 50$ $\therefore$ $a_6 = 15$

69. C

Sol. $\bar{x}=\frac{1+2+3+.....+2n+1}{2n+1}=n+1,\ \sigma^2=\frac{1}{2n+1}\times\sum_{r=0}^{2n}\left((1+r)-(1+n)\right)^2=\frac{n(n+1)}{3}$
$\therefore\ \sigma^2=\sqrt{\frac{n(n+1)}{3}}$

70. C

Sol. ${}^{n}C_r : {}^{n}C_{r+1} : {}^{n}C_{r+2} \equiv 1 : 7 : 35$
$\Rightarrow \frac{r+1}{n-r}=\frac{1}{7}$ ⇒ 8r = n – 7 and $\frac{r+2}{n-(1+r)}=\frac{1}{5}$
$\therefore$ n = 23

SECTION – B

71. 7

Sol. $A^2=\begin{bmatrix}2^2 & 3^2-2^2\\ 0 & 3^2\end{bmatrix},\ A^{10}=\begin{bmatrix}2^{10} & 3^{10}-2^{10}\\ 0 & 3^{10}\end{bmatrix}$ $\therefore$ $a + b + c + d = 2^1\cdot 3^{10}$
$\therefore$ Number of factors = 2 × 11 = 22

72. 5

Sol. Let r_1 and r_2 be the roots $r - 2 = \frac{1}{r} \Rightarrow r^2 - 2r - 1 = 0 \therefore b^2 + c^2 = 5$

SECTION – C

73. 16216.20

Sol. $\frac{{}^{12}C_4 \times {}^{15}C_4 \times \underline{|4}}{10^3} = 16216.20$

74. 00002.50

Sol. $|(x - 4) + i(y - 3)| = 2$; centre $\equiv (4, 3)$, radius = 2
$\therefore \alpha = 7$ and $\beta = 3$

75. 00000.50

Sol. $p = \frac{1}{2} \times \frac{4}{7} + \frac{1}{2} \times \frac{6}{8} = \frac{37}{56}$

FIITJEE Computer Based All India Test Series for JEE Main & JEE Advanced 2023

with Live Online Concept Strengthening Classroom Program (CSCP)

Schedule

S.No.	TEST / Live Online CSCP	Test Dates & Timings
1	PART TEST - I (Main)	November 12, 2022 (3:00 PM to 6:00 PM)
	Live Online CSCP by FIITJEE Delhi	November 15, 2022 (10:30 AM to 5:30 PM)
2	**PART TEST - I (Advanced)**	November 20, 2022 (Paper 1- 9:00 AM to 12:00 PM Paper 2- 2:30 PM to 5:30 PM)
	Live Online CSCP by FIITJEE Delhi	November 22, 2022 (10:30 AM to 5:30 PM)
3	PART TEST - II (Main)	December 3, 2022 (3:00 PM to 6:00 PM)
	Live Online CSCP by FIITJEE Delhi	December 6, 2022 (12:45 PM to 7:45 PM)
4	**PART TEST - II (Advanced)**	December 11, 2022 (Paper 1-9:00 AM to 12:00 PM Paper 2-2:30 PM to 5:30 PM)
	Live Online CSCP by FIITJEE Delhi	December 13, 2022 (12:45 PM to 7:45 PM)
5	PART TEST - III (Main)	December 17, 2022 (3:00 PM to 6:00 PM)
	Live Online CSCP by FIITJEE Delhi	December 20, 2022 (12:45 PM to 7:45 PM)
6	**PART TEST - III (Advanced)**	December 25, 2022 (Paper 1-9:00 AM to 12:00 PM Paper 2-2:30 PM to 5:30 PM)
	Live Online CSCP by FIITJEE Delhi	December 27, 2022 (12:45 PM to 7:45 PM)
7*, 8*	FULL TEST - I (Main) & **Full Test -I (Advanced)**	December 28, 2022 *(Tests will be live for 7 days at fiitjee.glorifire.com)*
9	FULL TEST - II (Main)	January 7, 2023 (3:00 PM to 6:00 PM)
	Live Online CSCP by FIITJEE Delhi	January 10, 2023 (12:45 PM to 7:45 PM)
10	FULL TEST - III (Main)	January 11, 2023 (3:00 PM to 6:00 PM)
	Live Online CSCP by FIITJEE Delhi	January 13, 2023 (12:45 PM to 7:45 PM)
11	OPEN TEST (Main)	January 15, 2023 (9:00 AM to 12:00 PM)
	Live Online CSCP by FIITJEE Delhi	January 17, 2023, 12:45 PM onwards
12*	FULL TEST V (Main)	January 18, 2023 *(Tests will be live for 7 days at fiitjee.glorifire.com)*
13	FULL TEST - VI (Main)	January 19, 2023 (9:00 AM to 12:00 PM)
14*, 15*	CONCEPT RECAPITULATION TEST – I, II (Main)	January 20, 2023 *(Tests will be live for 7 days at fiitjee.glorifire.com)*
16	**OPEN TEST I (Advanced)**	February 5, 2023 (Paper 1-9:00 AM to 12:00 PM Paper 2-2:30 PM to 5:30 PM)
	Live Online CSCP by FIITJEE Delhi	February 7, 2023 (12:45 PM to 7:45 PM)
17*, 18*, 19*	**FULL TEST III, IV & V (Advanced)**	February 8, 2023 *(Tests will be live for 7 days at fiitjee.glorifire.com)*
20	FULL TEST - VII (Main)	March 22, 2023 (9:00 AM to 12:00 PM)
	Live Online CSCP by FIITJEE Delhi	March 24, 2023 (12:45 PM to 7:45 PM)
21	FULL TEST - VIII (Main)	March 25, 2023 (3:00 PM to 6:00 PM)
	Live Online CSCP by FIITJEE Delhi	March 26, 2023 (12:45 PM to 7:45 PM)
22*,23*	CONCEPT RECAPITULATION TEST PAPERS – SET III, IV (Main)	March 27, 2023 (Test will be live for 7 days at fiitjee.glorifire.com)
24	FULL TEST - IX (Main)	March 28, 2023 (9:00 AM to 12:00 PM)
	Live Online CSCP by FIITJEE Delhi	March 29, 2023 (12:45 PM to 7:45 PM)
25	FULL TEST - X (Main)	March 31, 2023 (3:00 PM to 6:00 PM)
	Live Online CSCP by FIITJEE Delhi	April 1, 2023 (12:45 PM to 7:45 PM)
26	FULL TEST - XI (Main)	April 2, 2023 (9:00 AM to 12:00 PM)
27	**OPEN TEST II (Advanced)**	April 16, 2023 (Paper 1-9:00 AM to 12:00 PM Paper 2-2:30 PM to 5:30 PM)
	Live Online CSCP by FIITJEE Delhi	April 18, 2023 (10:30 AM to 5:30 PM)
28	**FULL TEST - VII (Advanced)**	April 23, 2023 (Paper 1-9:00 AM to 12:00 PM Paper 2-2:30 PM to 5:30 PM)
	Live Online CSCP by FIITJEE Delhi	April 25, 2023 (10:30 AM to 5:30 PM)
29*,30*, 31*,32*	**CONCEPT RECAPITULATION TEST PAPERS - SET I, II, III & IV (Advanced)**	April 26, 2023 (Test will be live for 7 days at fiitjee.glorifire.com)
33	**FULL TEST - VIII (Advanced)**	April 30, 2023 (Paper 1-9:00 AM to 12:00 PM Paper 2-2:30 PM to 5:30 PM)
	Live Online CSCP by FIITJEE Delhi	May 2, 2023 (10:30 AM to 5:30 PM)
34	**FULL TEST - IX (Advanced)**	May 7, 2023 (Paper 1-9:00 AM to 12:00 PM Paper 2-2:30 PM to 5:30 PM)
	Live Online CSCP by FIITJEE Delhi	May 9, 2023 (10:30 AM to 5:30 PM)
35	**FULL TEST - X (Advanced)**	May 14, 2023 (Paper 1-9:00 AM to 12:00 PM Paper 2-2:30 PM to 5:30 PM)
	Live Online CSCP by FIITJEE Delhi	May 16, 2023 (10:30 AM to 5:30 PM)
36	**FULL TEST - XI (Advanced)**	May 21, 2023 (Paper 1-9:00 AM to 12:00 PM Paper 2-2:30 PM to 5:30 PM)
	Live Online CSCP by FIITJEE Delhi	May 23, 2023 (10:30 AM to 5:30 PM)

1. Tests can be taken from CBT Centers located at cities namely Ahmedabad, Allahabad, Amritsar, Bangalore, Bhilai, Bhopal, Bhubaneswar, Bokaro, Chandigarh, Chennai, Cuttack, Delhi (Dwarka), Delhi (East), Delhi (North-West), Delhi (South), Delhi NCR (Faridabad), Delhi NCR (Ghaziabad), Delhi NCR (Gurugram), Delhi NCR (Noida), Dhanbad, Durgapur, Gorakhpur, Gwalior, Hyderabad, Indore, Jaipur, Jamshedpur, Jodhpur, Kanpur, Kharagpur, Kolkata, Kota, Lucknow, Meerut, Mumbai, Nagpur, Patna, Pune, Raipur, Ranchi, Vadodara, Varanasi, Vijayawada, Visakhapatnam.
2. Tests can also be taken from home on one's own computer.
3. * marked Tests can be taken only at https://fiitjee.glorifire.com. Tests will be live for 7 days from the given date.
4. Link for Live Online CSCP will be sent by WhatsApp to your registered mobile number one/ two days before the session.

FIITJEE Computer Based All India Test Series for JEE Main, 2023

Syllabus

Part Test - I

CHEMISTRY	Atomic Structure, Chemical Kinetics, Chemical Equilibrium, Balancing of Redox Reaction, Ionic Equilibrium,Chemical Bonding, s-Block and Hydrogen, Boron and Carbon Family, Periodic Properties
MATHEMATICS	Sets, Relations and Functions, Limits, Continuity and Differentiability, Application of Derivatives, Indefinite Integration, Definite Integrals and their Properties, Area, Differential Equations, Volume & Surface
PHYSICS	Units and Measurement, Kinematics (Motion in One Dimension), Vectors, Kinematics (Motion in Two and Three Dimensions), Relative motion, Laws of Motion, Work, Energy and Power, Center of mass, Conservation of momentum Collisions, Circular motion, Rotational Motion

Part Test -II

CHEMISTRY	Organic Chemistry (Including GOC), Practical Organic Chemistry, Biomolecules, Polymers
MATHEMATICS	Trigonometric Ratios and Identities, Trigonometric Equations, Heights and distance, Solution of triangle,Straight Lines, Circles, Parabola, Ellipse, Hyperbola
PHYSICS	Kinetic theory of gases, Heat and Thermodynamics (second law+reversible and irreversible process, carnot engine+thermal expansion + calorimetry), Transfer of Heat + convection, Electrostatics, Current Electricity (color code of resistors), Thermal Effects of Current, Magnetic Effects of Current, Pure magnetism (current loop as magnetic dipole and its moment), bar magnet, magnetic field lines, earth magnetism, para-dia-ferro), Magnets, susceptibility and permeability, hysteresis, eleectromagnets and permanent magnets, Magnetostatics, Electromagnetics Induction and Alternating Currents (ac generator and transformer, watless current, quality factor)

Part Test - III

CHEMISTRY	Group V to VIII, Transition Elements & Coordination Compounds, f-Block elements, Ores and Metallurgy, Liquid Solution, Surface Chemistry, Electrochemistry, Thermodynamics & Thermochemistry, Stoichiometry, Gaseous State, Qualitative Analysis, Solid State, Environmental Chemistry, Chemistry in Everyday Life
MATHEMATICS	Progression and Series, Quadratic Equations and Expressions, Complex Numbers, Binomial Theorem, Matrices, Determinants, Permutation and Combination, Statistics (Measures of Dispersion) and Probability, Probability Distribution, Binomial Distribution, Vector, Three Dimensional Geometry
PHYSICS	Oscillations (forced and damped oscillations), Wave & Sound, Ray Optics (microscope and astronomical telescope), Wave Optics (diffraction (single slit), resolving power of microscope and astronomical telescope, polarisation, brewesters law, uses of polaroids and polarised light), Electromagnetic Waves, Dual Nature of Matter & Radiation, Atoms, Molecules and Nuclei, Electronic Devices & Communication Systems, Experimental Skills in Physics, Gravitation, Properties of Solids and Fluids + streamline flow, turbulent flow, reynolds number, Geometrical Optics, Semi Conductor Devices

Note : Full Tests syllabi will be same as that of Part Test - I, II & III combined.

FIITJEE Computer Based All India Test Series for JEE Advanced, 2023

Syllabus

Part Test - I

CHEMISTRY	Atomic Structure, Chemical Kinetics, Chemical Equilibrium, Balancing of Redox Reaction, Ionic Equilibrium, Chemical Bonding, s-Block and Hydrogen, Boron and Carbon Family
MATHEMATICS	Functions, Limits, Continuity and Differentiability, Application of Derivatives, Indefinite Integration, Definite Integrals and their properties, Area, Differential Equations
PHYSICS	Kinematics, Laws of Motion, Work, Energy and Power, Conservation of Momentum, Rotation

Part Test - II

CHEMISTRY	Organic Chemistry (Including GOC), Practical Organic Chemistry, Biomolecules, Polymers
MATHEMATICS	Trigonometric ratios and Identities, Trigonometric equations, Solution of triangles, Straight Lines,Circles, Parabola, Ellipse, Hyperbola
PHYSICS	Heat and Thermodynamics, Electrostatics, Current Electricity, Magnetics, Electromagnetic Induction, A.C. Circuit

Part Test - III

CHEMISTRY	Group V to VIII, Transition Elements & Coordination Compounds, Ores and Metallurgy, Liquid Solution, Electrochemistry, Thermodynamics & Thermochemistry, Stoichiometry, Gaseous State,Qualitative Analysis, Solid State
MATHEMATICS	Progression and Series, Quadratic Equation s and Expressions, Complex Numbers, BinomialTheorem, Matrices, Determinants, Permutation and Combination, Probability, Vector, Three Dimensional Geometry
PHYSICS	Gravitation, Fluids, Simple Harmonic Motion, Waves & Sound, Optics, Modern Physics, Error Analysis

Note : Full Tests syllabi will be same as that of Part Test - I, II & III combined.

FIITJEE

ALL INDIA TEST SERIES

PART TEST – I

JEE (Main)-2023

TEST DATE: 12-11-2022

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is Mathematics.
- Each part has only two sections: **Section-A and Section-B**.
- **Section – A** : Attempt all questions.
- **Section – B :** Do any five questions out of 10 questions.

Section-A (01 – 20, 31 – 50, 61 – 80) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-B (21 – 30, 51 – 60, 81 – 90) *contains 30 Numerical based questions. The answer to each question is rounded off to the nearest integer value. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

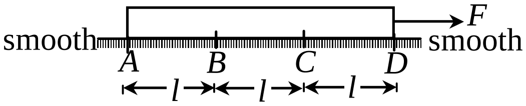
PART – A

SECTION – A

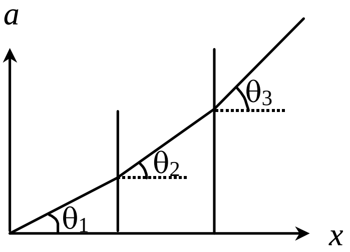
(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. In the diagram, the variation of coefficient of friction of the surface is shown. The external force *F* applied on board is equal to $2\mu Mg$. Now the board is gently pulled so it starts moving. The variation of acceleration of board with respect to displacement has been shown. The ratio $\tan\theta_1 : \tan\theta_2 : \tan\theta_3$ is



Coefficient of friction for
A to *B* = 3μ, *B* to *C* = 2μ, *C* to *D* = μ

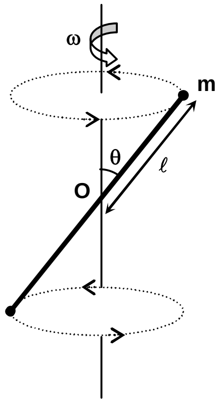


(A) 3 : 2 : 1
(B) 3 : 4 : 1
(C) 3 : 4 : 5
(D) 1 : 2 : 3

2. In terms of the basic units of mass *M*, length *L*, time *T* and charge *Q*, the dimensions of magnetic permeability of vacuum μ_0 are

(A) $[MLQ^{-2}]$
(B) $[ML^2T^{-1}Q^{-2}]$
(C) $[LTQ^{-1}]$
(D) $[LT^{-1}Q^{-1}]$

3. A thin massless rod of length 2ℓ has equal point masses *m* attached at its ends as shown in the figure. The rod is rotating about an axis passing through its centre and making angle θ with it. The magnitude of net torque about O is



(A) $2m\ell^2\omega^2\sin\theta\cos\theta$
(B) $2m\ell^2\omega^2\sin\theta$
(C) $2m\ell^2\omega^2\sin^2\theta$
(D) $2m\ell^2\omega^2\cos^2\theta$

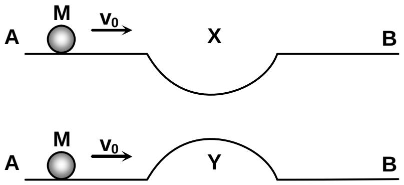
4. A rain drop falling vertically under gravity gathers moisture from the atmosphere at a rate given by $\frac{dm}{dt} = kt^2$, where m is the instantaneous mass, t is time and k is a constant. The equation of motion of the rain drop is $m\frac{dv}{dt} + v\frac{dm}{dt} = mg$

If the drop starts falling at t = 0, with zero initall velocity and initial mass m_0(m_0 = 2 gm, k = 12 gm/s^3 and g = 1000 cm/s^2), the velocity v of the drop after one second is

(A) 250 cm/s
(B) 500 cm/s
(C) 750 cm/s
(D) 1000 cm/s

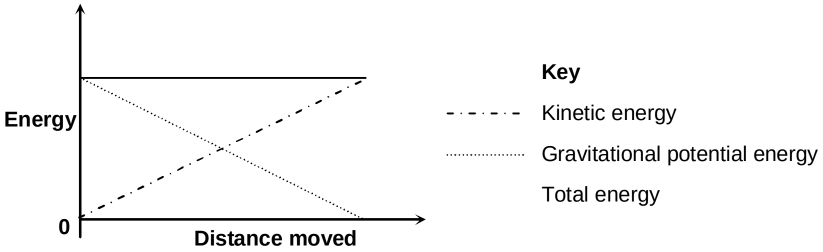
5. A particle is released at x = 1 in a force field $\vec{F}(x) = \left(\frac{2}{x^2} - \frac{x^2}{2}\right)\hat{x},\ x \geq 0.$ Which one of the following statement is FALSE?
(A) $\vec{F}(x)$ is conservative
(B) The angular momentum of the particle about the origin is constant
(C) The particle moves towards $x = \sqrt{2}$
(D) The particle moves towards the origin

6. A small mass *M*, is given an initial velocity v_0, and it slides from A to B via two possible paths; either down the shallow dip X or over the hump Y, both of which are the same shape but inverted. Friction is to be ignored. Along which path does the mass take the shortest time to slide from A to B?



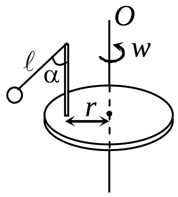
(A) Via X (B) Via Y
(C) You cannot say (D) Same time taken

7. The graph below represents the kinetic energy, gravitational potential energy, and total energy of a moving block. Which best describes the motion of the block?



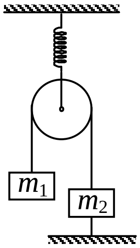
(A) Sliding down an incline with constant friction
(B) Falling at a constant velocity
(C) Acceleration on a flat horizontal surface
(D) Falling freely under gravity

8. A ball of mass *m* is attached to the end of a thread fastened to the top of a vertical rod which is fitted to a horizontally revolving round table as shown. If the thread forms an angle α with the vertical, the angular velocity ω of table is



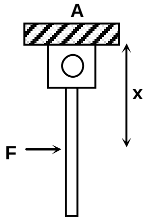
(A) $\sqrt{\frac{g}{\ell\cos\alpha}}$ (B) $\sqrt{\frac{r}{g\tan\alpha}}$
(C) $\sqrt{\frac{g\tan\alpha}{r+\ell\sin\alpha}}$ (D) $\sqrt{\frac{g\tan\alpha}{r}}$

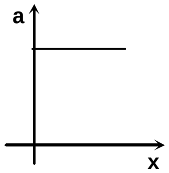
9. In the figure shown, pulley and spring are ideal. If *k* is spring constant of spring, the potential energy stored in it at equilibrium is ($m_1 > m_2$)

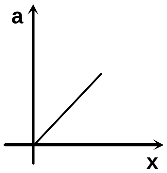


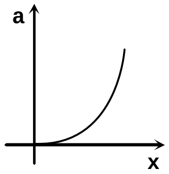
(A) $\frac{2m_1^2g^2}{k}$ (B) $\frac{2m_2^2g^2}{k}$
(C) $\frac{(m_1+m_2)^2g^2}{k}$ (D) $\frac{1}{2}\frac{(m_1-m_2)^2g^2}{k}$

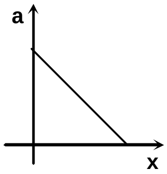
10. A rod of mass m and length ℓ is hinged at one of its end A as shown in the figure. A force F is applied at a distance ‘x’ from A. The acceleration of centre of mass ‘a’ varies with ‘x’ as



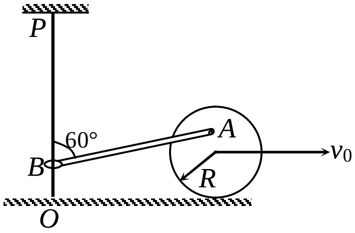
(A)


(B)


(C)


(D)


11. A smooth rod *OP* is fixed vertically. A disc of mass *m* and radius *R* is rolling without slipping on a rough horizontal surface as shown. Velocity of centre of mass of disc is v_0. A rod *AB* of length *L* is connected with disc at *A*, *R*/2 distance vertically up from centre of disc with pin joint (about which it can rotate freely), other end of the rod is attached to a small smooth ring *B*, which can move freely over rod *OP*. At an instant rod *AB* makes an angle 60° with the vertical. The velocity of ring on the vertical rod at this instant is



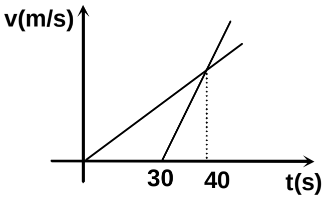
(A) $\frac{3\sqrt{3}}{2}v_0$ (B) $\frac{3}{2}v_0$

(C) v_0 (D) $\frac{v_0}{2}$

12. The police is chasing a thief and both move on same straight road. After passing a particular point, their velocity v vary with time t as shown in the figure. When will the police catch the thief?

(A) 90 sec (B) 80 sec

(C) 60 sec (D) 120 sec

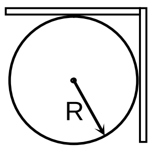


13. Last mango in the mango tree is located at 30 m horizontal and 40 m vertical from a boy. The speed and angle with horizontal with which the boy should throw a stone so as to hit the last mango?

(A) 50 m/s, $\tan^{-1}(2)$ (B) 30 m/s, $\tan^{-1}(3)$

(C) 30 m/s, $\tan^{-1}(2)$ (D) 20 m/s, $\tan^{-1}(3)$

14. A plate bent at right angles along its centre line, is placed onto a horizontal fixed cylinder of radius *R* as shown. The minimum co-efficient of friction between the cylinder and the plate so that plate does not slip off the cylinder will be (Assume mass of plate and cylinder to be same)

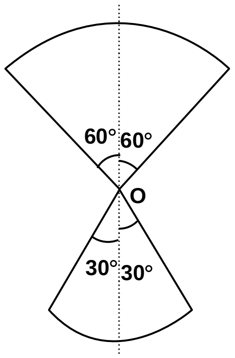


Side view

(A) $\frac{1}{\sqrt{2}}$ (B) $\sqrt{2}$

(C) $\sqrt{2}-1$ (D) $1-\frac{1}{\sqrt{2}}$

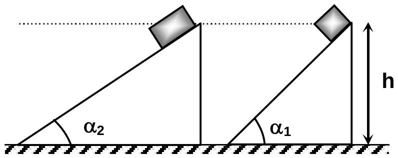
15. Two sectors made of same material and same radius R but angle 120° and 60° are arranged as shown with centre as origin. Find the location of centre of mass?



(A) $\frac{2R(\sqrt{3}-1)}{3}$ (B) $\frac{R(\sqrt{3}-1)}{3}$

(C) $\frac{3R(\sqrt{3}-1)}{3}$ (D) $\frac{4R(\sqrt{3}-1)}{3}$

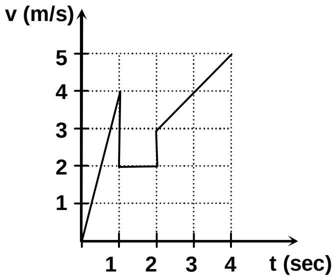
16. Two object of the same mass slide down on two different smooth fixed incline plane of same height but of different angles. When they reach the bottom then I_1 and I_2 are the impulse of the weight of first and second object. Choose the correct option.



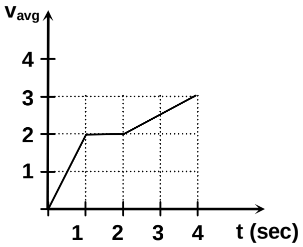
(A) $\frac{I_1}{I_2}=\frac{\sin\alpha_1}{\sin\alpha_2}$ (B) $\frac{I_1}{I_2}=\frac{\sin\alpha_2}{\sin\alpha_1}$

(C) $\frac{I_1}{I_2}=\frac{\tan\alpha_1}{\tan\alpha_2}$ (D) $\frac{I_1}{I_2}=\frac{\tan\alpha_2}{\tan\alpha_1}$

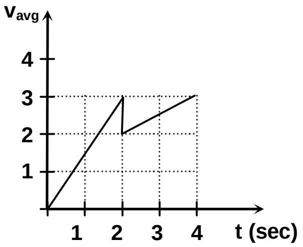
17. The instantaneous velocity of a body moving in a straight line changes with time as shown in the figure. Choose the correct average velocity versus time depicting the same motion?



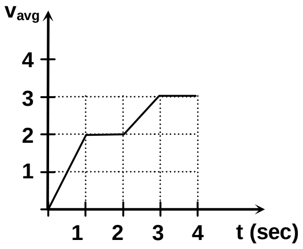
(A)



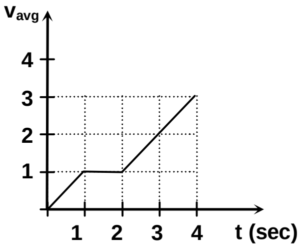
(B)



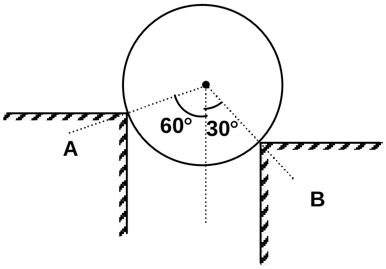
(C)



(D)



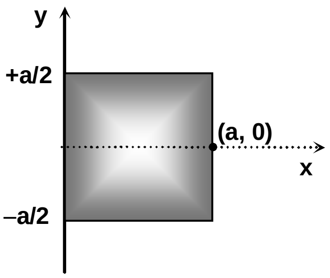
18. A cylinder of mass M and radius R is resting on two corner edges A and B as shown in the figure. The normal reaction at the edges A and B are: (Neglect friction)



(A) $N_A = \sqrt{2}N_B$ (B) $N_B = \sqrt{2}N_A$

(C) $N_A = \frac{Mg}{2}$ (D) $N_B = \frac{2\sqrt{3}Mg}{5}$

19. A square laminar sheet with side a and mass M, has mass per unit area given by $\sigma(x) = \sigma_0\left[1 - \frac{x}{a}\right]$. Moment of inertia of the sheet about y axis is



(A) $\frac{Ma^2}{2}$ (B) $\frac{Ma^2}{4}$

(C) $\frac{Ma^2}{6}$ (D) $\frac{Ma^2}{12}$

20. A spring is compressed between two toy carts of masses m_1 and m_2. When the toy carts are released, the spring exerts on each toy cart equal and opposite forces for the same time t. If the coefficients of friction μ between the ground and the toy carts are equal, then the displacements of the toy carts are in the ratio

(A) $\frac{s_1}{s_2} = \frac{m_2}{m_1}$ (B) $\frac{s_1}{s_2} = \frac{m_1}{m_2}$

(C) $\frac{s_1}{s_2} = \left(\frac{m_2}{m_1}\right)^2$ (D) $\frac{s_1}{s_2} = \left(\frac{m_1}{m_2}\right)^2$

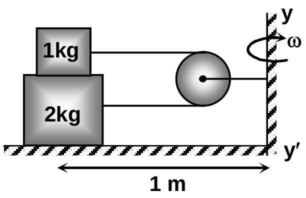
SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

21. A shell if fired at an angle θ with horizontal up a plane inclined at an angle $\frac{\pi}{6}$. The value of θ for maximum range is $\frac{\pi}{k}$. Fid the value of k.

22. Two blocks A and B 1 kg and 2 kg respectively are kept on a turn table 1 m away from axis yy′ as shown in the figure. Consider μ = 0.5 between all contact surfaces and pulley to be massless and frictionless. The angular speed of the turn table for which the blocks just begin to slide is $\sqrt{5k}$. Find k. (Take g = 10 m/s^2)

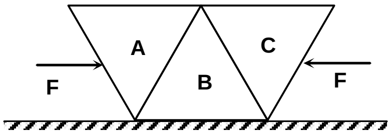


23. Two objects of masses *m* and 2*m* are moving at speeds of *v* and *v* / 2, respectively. After undergoing a completely inelastic collision, they move together with a speed of *v* / 3. The angle between the initial velocity of the two objects is K°. Find the value of k.

24. If there is a positive error of 50% in the measurement of velocity of a body, then the error in the measurement of kinetic energy is k%. Find the value of k.

25. The motion of a point A on the rim of a wheel rolling uniformly along a horizontal path has the form
$x = 2(5t - \sin 5t)$
$y = 2(1 - \cos 5t)$
The distance which it traverses between two successive contacts with the roadbed is k meter. Find the value of k.

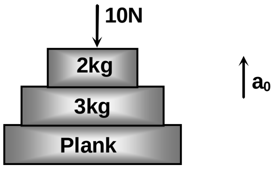
26. Three identical equilateral prisms A, B and C are arranged as shown in the figure. Mass of each prism is $M = \sqrt{3}$ kg. Two horizontal forces of equal magnitude (F) are applied on A and C as shown in the figure. Find the minimum value of F in newton so that A and C loose contact with the floor. (Ignore friction and take $g = 10\ m/s^2$)



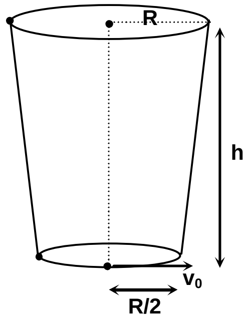
27. A modern machine gun fires 3600 bullets per minute with 600 km/hr. If each bullet weights 200 gm then the power of the gun is $\frac{500}{m}$ kilowatt. Find the value of m.

28. A solid cylinder rolls down an incline plane of angle θ. The least value of coefficient of friction so that the cylinder rolls without slipping is $\frac{\tan\theta}{k}$. Find the value of k.

29. Two blocks of masses 2 kg and 3 kg are placed on a plank. An external force of 10 N is acting on 2 kg block and the whole system including the plank is moving vertically up with a constant acceleration $a_0 = 2\ m/s^2$. The normal reaction force between the 3 kg block and Plank is α N. Find the value of $\frac{\alpha}{10}$. ($g = 10\ m/s^2$)



30. A smooth cylindrical glass lies on the ground. A small particle of mass m lies on the bottom surface touching circumference as shown in the figure. The minimum value of v_0 (along the circumference) such that particle just reaches at the top of glass is $\sqrt{\frac{Kgh}{3}}$. Find the value of K.



Chemistry

PART – B

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

31. The CORRECT order of electron gain enthalpy of B, Be, N and C is (consider magnitude only)
(A) Be < B < C < N
(B) Be < N < B < C
(C) N < Be < C < B
(D) N < C < B < Be

32. Which of the following properties is INCORRECTLY matched?
(A) $F_2 > Cl_2 > Br_2 > I_2$ (Oxidising character)
(B) $K > Mg > Al > B$ (Metallic character)
(C) $C > Be > B > Li$ (1^{st} Ionisation enthalpy)
(D) $Li > Na > K > Rb$ (Chemical reactivity)

33. The minimum uncertainty in the velocity of a particle of mass 1.1×10^{-28} kg will be if its uncertainty in position is 3×10^{-10} cm $\left(h = 6.62 \times 10^{-34}\ Js\right)$.
(A) $1.6 \times 10^{6}\ ms^{-1}$
(B) $2.6 \times 10^{5}\ ms^{-1}$
(C) $3.6 \times 10^{5}\ ms^{-1}$
(D) $1.6 \times 10^{5}\ ms^{-1}$

34. The coefficients of $BaCrO_4$, KI, $CrCl_3$ and KCl in the balanced equation of the following reaction are respectively

$$BaCrO_4 + KI + HCl \longrightarrow BaCl_2 + I_2 + KCl + CrCl_3 + H_2O$$

	$BaCrO_4$	KI	$CrCl_3$	KCl
(A)	2	6	2	6
(B)	6	2	6	6
(C)	2	2	6	6
(D)	6	6	2	2

35. At a given temperature, the rate constant for the decomposition of HI on a metal surface is $0.06\ Ms^{-1}$

$$2HI(g) \longrightarrow H_2(g) + I_2(g)$$

The time taken for the concentration of HI to fall from 1.50 M to 0.30 M is
(A) 10 s
(B) 20 s
(C) 15 s
(D) 8 s

36. The increasing order of bond angles in OF_2, OCl_2, ClO_2 and H_2O is…….
(A) $OF_2 < H_2O < OCl_2 < ClO_2$
(B) $H_2O < F_2O < Cl_2O < ClO_2$
(C) $OF_2 < Cl_2O < H_2O < ClO_2$
(D) $ClO_2 < Cl_2O < OF_2 < H_2O$

37. Consider the following reactions in equilibrium

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \qquad (K_1)$$

$$N_2 + O_2 \rightleftharpoons 2NO \qquad (K_2)$$

$$H_2 + \frac{1}{2}O_2 \rightleftharpoons H_2O \qquad (K_3)$$

Then the equilibrium constant for the reaction

$$2NH_3 + \frac{5}{2}O_2 \rightleftharpoons 2NO + 3H_2O$$

(All the above reactions are in homogeneous equilibrium)
(A) $\frac{K_2K_3}{K_1}$
(B) $\frac{K_2K_1^3}{K_3}$
(C) $\frac{K_2K_3^3}{K_1}$
(D) $\frac{K_2K_1}{K_3}$

38. The pH of pure water at 25^oC and 35^oC are 7 and 6 respectively. The heat of formation of $H^+(aq)$ and $OH^-(aq)$ ions in $Kcalmol^{-1}$ is
(A) –84.5
(B) + 84.5
(C) –94.5
(D) + 94.5

39. A hypothetical small particle of mass ‘m’ moves in such a way that its potential energy $= -\frac{1}{2}mkr^4$. Where k is a constant and r is its distance from the nucleus (origin). Assuming Bohr’s model r is directly proportional to
(A) n^2
(B) n
(C) $\sqrt{n}$
(D) $\sqrt[3]{n}$

40. Consider the reaction in equilibrium

$$SnO_2(s) + 2H_2(g) \rightleftharpoons 2H_2O(g) + Sn(\ell)$$

at 300 K, the equilibrium mixture was found to contain 40% by volume of $H_2(g)$. The K_P for the reaction is

(A) 1.15
(B) 10.9
(C) 7.75
(D) 2.25

41. The three reactions are given below

$A(g) + B(g) \rightleftharpoons C(g) + D(g)$ … (I)

$A(g) \rightleftharpoons C(g) + D(g)$ … (II)

$A(g) + B(g) \rightleftharpoons D(g)$ … (III)

Which of the following statement is INCORRECT?

(A) Increase in pressure shifts the equilibrium (II)nd to the left
(B) Decrease in volume shifts the (III)rd equilibrium to right
(C) Addition of He at constant volume shifts the (II)nd equilibrium to left
(D) Addition of He at constant pressure shifts the (III)rd equilibrium to left

42. At high temperature and at a pressure of around 2 atm, nitrogen gas is bubbled over calcium carbide, the major product obtained is

(A) Calcium cyanide
(B) Calcium cyanamide
(C) Calcium nitride
(D) Calcium

43. Which of the following statement is NOT correct?

(A) Stability of peroxides and superoxides of alkali metals increases with increase in the size of metal ion.
(B) Sodium hydroxide does not absorb water from atmosphere.
(C) Lithium fluoride is less soluble in water due to its high lattice enthalpy.
(D) Caesium iodide is less soluble in water due to low hydration enthalpy.

44. In solid state, beryllium chloride has

(A) Three centre-four electron bonds.
(B) Three centre-three electron bonds.
(C) Two centre-three electron bonds.
(D) Two centre-two electron bonds.

45. Consider the following silicates

I. Pyro silicates II. Cyclic silicates
III. Double chain silicates IV. Single chain silicates
V. 3D-silicates VI. Sheet silicates

The silicates in which **only two** corners **per tetrahedron** are shared

(A) I, II, IV
(B) IV, VI
(C) I, VI
(D) II, IV

46. Select the CORRECT sequence of geometry of the given molecules/ions

Borazon, Borazole, $B_3O_6^{---}, Al_2Cl_6$

(A) Non planar, non planar, non planar, planar
(B) Planar, planar, non planar, non planar
(C) Non planar, non planar, non planar, planar
(D) Non planar, planar, planar, non planar

47. Consider the following species

$NO_2, \overset{+}{N}O_2, \overset{-}{N}O_2, \overset{-}{N}O_3$

Select the INCORRECT statement for the above molecule/ions?

(A) NO_2 is paramagnetic
(B) $\overset{+}{N}O_2$ is linear, $\overset{-}{N}O_2$ is bent having bond angle more than 120^o
(C) $\overset{-}{N}O_3$ has bond order 1.33
(D) NO_2 has bond angle more than 120^o

48. Consider the compounds LiH, NaH, Li_2CO_3 and Na_2CO_3. Select the compound (s) which decomposes on heating around 400 – 500^{o}C.

(A) LiH, Li_2CO_3
(B) NaH, Na_2CO_3
(C) LiH, NaH
(D) NaH, Li_2CO_3

49. Which of the following statement(s) is(are) NOT correct?

I. Bond length order is $H_2^- = H_2^+ > H_2$.
II. O_2^+, NO, N_2^- have bond order 2.5.
III. Bond order varies from 0 to 4.
IV. In NO_3^- and BO_3^- the bond order is same between central atom and side atom.

(A) I, II
(B) II, III
(C) I, IV
(D) I, III

50. Select the INCORRECT statement regarding Diborane (B_2H_6)

(A) Maximum 6 H-atoms lie in a plane
(B) Maximum 6 atoms lie in a plane
(C) There is hindered rotation between two boron atoms
(D) Terminal H – B – H bond angle is greater than bridge H – B – H bond angle

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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51. A sample of solid AgCl was treated with 5.00 mL of 1.5 M Na_2CO_3 solution to give Ag_2CO_3. The remaining Cl^- ion concentration was found to be 0.0026 g L^{-1}. The solubility product of AgCl is given by $x \times 10^{-y}$. Then the value of (x + y) is………(Rounded off to nearest integer).

$\left(K_{SP} \text{ of } Ag_2CO_3 = 8.2 \times 10^{-12}\right)$

52. A tiny particle moving with a velocity $\frac{1}{60}$th times the velocity of light. If uncertainty in the position is $\frac{6.62}{3.14} \times 10^{-12}$ m, then the minimum uncertainty in kinetic energy is $x \times 10^{-y}$ J, then the value of xy is…….

53. Potassium permanganate reacts with sulfur dioxide in acidic medium to produce a product containing bisulphate ion(s) and same other product(s). The sum total of coefficients of potassium permanganate and the product containing bisulphate ions in the balanced equation is…….

54. For a reaction which following first order kinetics the half life is 693 s and the values of pre exponential factor and activation energy are 4×10^{13} Hz and 98.6 kJ mol^{-1} respectively, then the temperature in Kelvin when half life is 693 s, is…… (log2 = 0.30)

55. An equilibrium mixture at 300 K contains N_2O_4 and NO_2 at 0.28 and 1.1 atm respectively. If the volume of container get doubled, the equilibrium pressure of $NO_2(g)$ is $x \times 10^{-2}$ atm, then the value of x is………

56. Total number of species having used all three P-orbitals for hybridisation of central atom and are non-polar also is…..

XeO_2F_2, $SnCl_2$, IF_5, I_3^+, XeO_4, $[XeF_7]^+$, SO_2

57. The number of correct order(s) in the following is……..
1. $CH_4 < CCl_4 < CF_4$ (Electronegativity of carbon)
2. $Mg^{++} < K^+ < S^{--} < Se^{--}$ (Ionic radius order)
3. $LiF > NaF > KF > RbF$ (Lattice energy order)
4. $Li^+ < Mg^{++} < Al^{3+}$ (Hydration energy order)
5. $Cl_2 > F_2 > Br_2 > I_2$ (Bond energy order)

58.
$$\begin{tikzcd}
Na_2O_2 \arrow[r, "H_2O"', "\text{(Ice cold)}"] \arrow[d, "H_2O"', "\text{(Room temperature)}"] & P + Q \\
P + R \uparrow &
\end{tikzcd}$$

If molar mass of (Q) and (R) are M_1 and M_2 respectively then the value of $\left(\frac{M_1 + M_2}{2}\right)$ is......

59. A 1.025 g sample containing a weak acid HA (MW = 82) is dissolved in 60 mL of water and titrated with 0.25 M NaOH. When half of the acid was neutralized, the pH was found to be 5.0 and at the equivalence point the pH is 9.0. The mass percent of weak acid HX in the sample is…….%.

60. The pH of the resultant solution of 25 mL of 0.1 M HCl, 50 mL of 0.2 M HNO_3 and 25 mL of 0.1 M NaOH is……

Mathematics

PART – C

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

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61. Let f be a differentiable function satisfying $\int_0^x (x-p+1)f(p)\,dp = x^4 + x^2\ \forall\ x \in [-2, \infty)$, then value of $\int_{-2}^{2}(f'(x)+f(x))dx$ is

(A) 0 (B) 36
(C) 72 (D) 18

62. Let P = $\lim\limits_{x\to 0}\dfrac{1-(\cos 2x\cos 4x\cos 6x\cos 8x\cos 10x)^3}{(\tan^2 x)}$, then the value of $\left(\dfrac{P}{10}\right)$ is

(A) 66 (B) 33
(C) 22 (D) 11

63. If A = $\lim\limits_{n\to\infty}\sum\limits_{r=1}^{n}\sin\left(\dfrac{r}{n^2}\right)$ and B = $\lim\limits_{n\to\infty}\dfrac{1}{n}\sum\limits_{r=1}^{n}\sin\left(\dfrac{\pi r}{n}\right)$, then value of 2A + B is

(A) $1+\dfrac{2}{\pi}$ (B) $\dfrac{2}{\pi}$

(C) $\dfrac{\pi-1}{2}$ (D) $\dfrac{\pi}{2}-1$

64. Let f(x) = $\dfrac{1}{\sin^2 x-(x-a)^2}$, x ∈ (0, 1), then which of the following is **INCORRECT** ?

(A) f(x) is always increasing in (0, 1) (B) f(x) is always decreasing in (0, 1)
(C) f(x) is increasing if a ∈ (2, 3) (D) f(x) is decreasing if a ∈ (2, 3)

65. If $A=\int_0^1\left(1-x^{2023}\right)^{\frac{1}{2022}}dx$ and $B=\int_0^1\left(1-x^{2022}\right)^{\frac{1}{2023}}dx$, then find the value of $\left(\dfrac{A^3-B^3}{B^3}\right)+\left(\dfrac{A^4+B^4}{B^4}\right)$ is

(A) 0 (B) 1
(C) 2 (D) none of these

66. The exhaustive set of domain of the function f(x) = $\operatorname{sgn}\left(\dfrac{x^2+x+4}{x^2+x+3}\right)+\tan\left(\left[\dfrac{x^2+x+3}{x^2+x+4}\right]\right)$, (where [.] is G.I.F.) is

(A) (–∞, 0) (B) $\left(\dfrac{1}{3},3\right)$

(C) $\left[\dfrac{1}{3},3\right]$ (D) (–∞, ∞)

67. If the area bounded between the curves y = tanx, y = sinx, x = 0 and x = $\frac{\pi}{4}$ is A, the A is equal to

(A) $\frac{1}{2}\ln 2+\frac{1}{\sqrt{2}}$ (B) $\frac{1}{2}\ln 2$

(C) $\frac{1}{\sqrt{2}}$ (D) none of these

68. Let f(x) be a function, such that f(x) = x + sinx and $I_1=\int_0^{\pi} f(x)dx, I_2=\int_0^{\pi} f^{-1}(x)dx$ and $I_3=\int_0^{1} e^{-x^2}dx$, then which of the following is true ?

(A) $I_1 > I_2 > I_3$ (B) $I_3 > I_2 > I_1$

(C) $I_1 > I_3 > I_2$ (D) $I_3 > I_1 > I_2$

69. If $f(x)=\int_0^{x}(\ln t)^2\,dt$ and $g(x)=\int_0^{x}(\ln t)\,dt$, then area bounded between the curve y = f'(x) and y = g'(x) between x = 1 to x = e is

(A) e – 3 (B) 3

(C) e (D) 3 – e

70. Let $L_1=\lim\limits_{x\to\infty}\sec^{-1}x, L_2=\lim\limits_{x\to-\infty}\sec^{-1}x$, then the value of $\int_{L_1}^{L_2}\frac{x^3+1}{x^2+1}dx$

(A) π (B) $\frac{\pi}{2}$

(C) $\frac{\pi}{4}$ (D) 0

71. $\lim\limits_{x\to 1}\left(\sum_{n=1}^{12}\frac{x}{n(n+1)x^2+3(2n+1)x+9}\right)$ is equal to

(A) $\frac{11}{60}$ (B) $\frac{3}{16}$

(C) $\frac{13}{64}$ (D) $\frac{9}{44}$

72. Water is being filled at the rate of 100 litre/min in a conical vessel (vertex downwards) with axis vertical. Its semi vertical angle is $\tan^{-1}\left(\frac{5}{12}\right)$. The rate (in square meter per minute) at which the wet curved surface area of the tank is increasing, when the depth of water in tank is 3 meters is

(A) $\frac{13}{75}$ (B) $\frac{13}{25}$

(C) $\frac{1}{5}$ (D) $\frac{3}{11}$

73. The area of the region bounded by A = {(x, y) : $x^2 - 4 \le y \le \min\{2x + 11, 9, 12 - 6x\}$} is

(A) $\frac{511}{12}$ (B) $\frac{947}{12}$

(C) $\frac{437}{8}$ (D) $\frac{240}{7}$

74. Let $f(t)=\int_0^t e^{x^2}\left(\dfrac{x^5}{\left(x^4+2x^2+2\right)^2}\right)dx$, then f(1) + f′(1) is equal to

(A) $\dfrac{3e}{10}-\dfrac{1}{4}$ (B) $\dfrac{7e}{50}-\dfrac{1}{4}$

(C) $\dfrac{7e}{50}-\dfrac{1}{2}$ (D) $\dfrac{2e}{5}-\dfrac{1}{2}$

75. $\lim\limits_{x\to\infty}\left(\sqrt{x^4+kx^3+3x^2+mx+2}-\sqrt{x^4+2x^3-nx^2+3x-p}\right)$ = 4 then k + n is equal to

(A) 3 (B) 7

(C) 5 (D) 0

76. If $I=\int_0^{\sqrt{2\pi}}\dfrac{x^3\sin^{2022}x^2}{\cos^{2022}x^2+\sin^{2022}x^2}$ dx is equal to

(A) $\dfrac{\pi^2}{2}$ (B) $2\pi^2$

(C) π^2 (D) 0

77. If the solution curve of the differential equation $\dfrac{dy}{dx}=\dfrac{x+y-4}{x-y}$ passes through the point (3, 2) and (p + 2, 3), p > 0, then

(A) $2\tan^{-1}\left(\dfrac{1}{p}\right)=\log_e\left(p^2+1\right)$ (B) $\tan^{-1}\left(\dfrac{1}{p}\right)=\log_e\left(p^2+1\right)$

(C) $2\tan^{-1}\left(\dfrac{1}{p+1}\right)=\log_e\left(p^2+2p+2\right)$ (D) $2\tan^{-1}\left(\dfrac{1}{p}\right)=\log_e\left(\dfrac{p^2+1}{p}\right)$

78. Let f : [–4, 2] → R be given as $f(x)=\begin{cases}\min\{(x+6),x^2\} & -4\le x\le 0\\ \max\{\sqrt{x},x^2\} & 0\le x\le 2\end{cases}$

If the area bounded by y = f(x) and x-axis in A then the value of 3A is equal to

(A) 19 (B) 35

(C) 37 (D) 32

79. If $f(t)=\int_1^t\dfrac{\log_{10}x}{1+x}dx$, t > 0, then $f(e^4)+f(e^{-4})$ is equal to

(A) 8 (B) $\dfrac{16}{\log_e 10}$

(C) $\dfrac{8}{\log_e 10}$ (D) $\dfrac{e^4-1}{2\log_e 10}$

80. Let f(x) = $\begin{cases}x^3-2x^2+3x-9 & x\le 2\\ -3x+\log_3\left(k^2-5\right) & x>2\end{cases}$, then the set of all values of k for which f(x) has maximum value at x = 2 is

(A) $\left[-4\sqrt{2},4\sqrt{2}\right]$ (B) $\left(-\sqrt{5},4\sqrt{2}\right)$

(C) $\left[-4\sqrt{2},-\sqrt{5}\right)\cup\left(\sqrt{5},4\sqrt{2}\right]$ (D) $\left(\sqrt{5},2\sqrt{2}\right]$

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

---

81. The number of solution of the equation $\sin^{-1}(x) = \left[\frac{x^2+x+2}{x^2+x+1}\right] = 0$, [.] is G.I.F.

82. The area bounded between the curves y = $\sin^{-1}(\sin x)$ and $y = \sqrt{\frac{\pi^2}{4} - \left(\pi - \frac{\pi}{2}\right)^2}$ is 'A', then the value of $\left[\frac{8A}{\pi^2}\right]$ (where [.] is G.I.F) is

83. Let f(x) be a function defined as $f(x) = \begin{vmatrix} 0 & -x & -x^2 \\ x & 0 & x+1 \\ x^2 & -x-1 & 0 \end{vmatrix} + \left[\left|\frac{x}{2}\right|\right]\sin x + \sqrt{3\left(4-x^2\right)}$, then the number of integers in the range of f(x) is (where [.] is G.I.F)

84. The number of points where the function f : R → R, $f(x) = |x-2|\cos|x^2-3x|\sin|x-2| + (x-1)|x^3-8x^2+7x|$ is non differentiable is

85. Let m = $\begin{bmatrix} a & 0 & 1 \\ a & b & -b \\ 0 & 1 & c \end{bmatrix}$ and det(m) = 37, if a, b, c are positive integers, then least value of trace(m) is

86. If y = y(x) is an implicit function of x such that $\log_e(x+y) = 6xy$, then $\frac{d^2y}{dx^2}$ at x = 0 is equal to ____

87. If the value of $\lim\limits_{x\to 0}\left(3 - 2\cos x\sqrt{\cos 2x}\right)^{\left(\frac{x+3}{x^2}\right)}$ is equal to e^a, then a is equal to

88. If the tangent to the curve $y = x^3 - 2x^2 + 4x + 4$, at the point (a, b) (where a > 0) is also tangent to the curve $y = 3x^2 + 2x - 1$ at (1, 4), then a + b is equal to

89. If f(x) = $\int \frac{12x^{15} + 5x^{18}}{\left(2x^3 + 3 - 7x^8\right)^3}dx$ and 16f(1) – 1 = 0 and f(–1) = $\frac{1}{k}$, then |k| =

90. Let $I_n = \int_1^e x^{23}\left(\log|x|\right)^n dx$ where n ∈ N, if $24I_{15} = \alpha I_{14} + BI_{13}$, then α + β is equal to

FIITJEE

ALL INDIA TEST SERIES

PART TEST – I

JEE (Main)-2023

TEST DATE: 12-11-2022

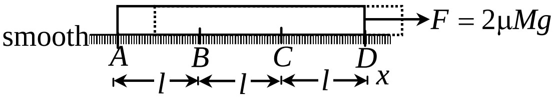
ANSWERS, HINTS & SOLUTIONS

Physics

PART – A

SECTION – A

1. A



Sol. If the block has moved by distance *x*,

$$Ma = 2\mu Mg - \left[\frac{\mu Mg}{3} + \frac{2\mu Mg}{3} + \frac{3\mu Mg}{3l}(l - x)\right]$$

$$a = 2\mu g - \left(\frac{\mu g}{3} + \frac{2\mu g}{3} + \frac{3\mu g}{3l}(l - x)\right)$$

$\frac{da_1}{dx} = \frac{3\mu g}{3l}$ [for 2nd and 3rd cells similarly]

$\tan\theta_1 : \tan\theta_2 : \tan\theta_3 = 3 : 2 : 1$

2. A

Sol. $\vec{F} = I\int \overrightarrow{d\ell} \times \vec{B},\ B \approx \frac{\mu_0 I}{d} \Rightarrow F \propto I^2\mu_0$

$\Rightarrow [MLT^{-2}] = \left(\frac{Q}{T}\right)^2 \mu_0$

$\Rightarrow \mu_0 = [MLQ^{-2}]$

3. A

Sol. $L = m\left[\vec{r} \times (\vec{\omega} \times \vec{r})\right] + m\left[\vec{r} \times (\vec{\omega} \times \vec{r})\right] = 2m\left[\vec{r} \times \ell\omega\sin\theta\right] = 2m\omega\ell^2\sin\theta$

Torque = $\frac{dL}{dt} = \vec{\omega} \times \vec{J} = 2m\omega\ell^2\sin(90 - \theta)\sin\theta = 2m\omega\ell^2\cos\theta\sin\theta$

4. B

Sol. $\frac{dm}{dt} = kt^2 \Rightarrow m = \frac{kt^3}{3} + 2$

$m\frac{dv}{dt} + v\frac{dm}{dt} = mg \Rightarrow m\frac{dv}{dt} + vkt^2 = mg$

$\frac{dv}{dt} + \frac{kt^2}{m}v = g \Rightarrow \frac{dv}{dt} + \frac{3kt^2}{kt^3+6}v = g$ which is linear differential equation

$v(kt^3+6) = \int g(kt^3+6)dt + c$, t = 0, v = 0 $\Rightarrow$ c = 0

$v = \frac{g(kt^4+24t)}{4(kt^3+6)}$

Put 2 gm, k = 12 gm/s^3 and g = 100 cm/s^2) and t = 1

$v = \frac{1000(12+24)}{4(12+6)} = 500$ cm/sec

5. C

Sol. $\vec{F}(x) = \left(\frac{2}{x^2} - \frac{x^2}{2}\right)\hat{e}_x,\ x \ge 0$

Work done in a cycle is zero so conservative

$\vec{r} \times \vec{F} = 0$, so angular momentum is conserved

For equilibrium point F = 0 $\Rightarrow F = \left(\frac{2}{x^2} - \frac{x^2}{2}\right) = 0 \Rightarrow x = -\sqrt{2}, \sqrt{2}$ x > 0 so equilibrium point is $\sqrt{2}$

To check stable and unstable equilibrium point $\frac{dF}{dx} = 0 \Rightarrow \frac{-4}{x^3} - \frac{2x}{2} = 0$

At $x = \sqrt{2},\ \frac{dF}{dx} = 0 \Rightarrow \frac{-4}{x^3} - \frac{2x}{2} = -\frac{4}{2\sqrt{2}} - \sqrt{2}$ = –ve

So, it is unstable point so particle moves away from point x = $\sqrt{2}$

So, it is obvious that it will moves towards origin.

6. A

Sol. Speed is never less than v_0 in x whereas in y it is less than v_0 first and then increases t v_0 so, y take more time.

7. D

Sol. Friction will produce heat energy and so the total energy will not be PE + KE (or all of the PE will not turn into KE). At a constant velocity there is no gain of KE. On a horizontal surface there is no change of PE. Falling freely, the PE turns solely into KE.

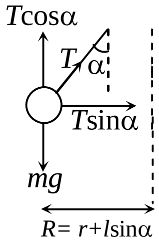
8. C

Sol. $T\sin\alpha = m\omega^2 R$

$T\cos\alpha = mg$

$\tan\alpha = \frac{\omega^2 R}{g}$

$\omega = \sqrt{\frac{g\tan\alpha}{R}} = \sqrt{\frac{g\tan\alpha}{r + \ell\sin\alpha}}$



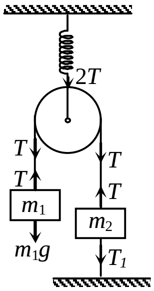
9. A

Sol. $T = m_1 g$

$kx = 2T = 2m_1 g$

$x = \frac{2m_1 g}{k}$

Energy stored = $\frac{1}{2}kx^2 = \frac{1}{2}k\frac{4m_1^2 g^2}{k^2} = \frac{2m_1^2 g^2}{k}$



10. B

Sol. The rod will rotate about point A with angular acceleration:

$$\alpha = \frac{\tau}{I} = \frac{Fx}{\frac{m\ell^2}{3}} = \frac{3Fx}{m\ell^2}$$

$$\therefore\ a = \frac{\ell}{2}\alpha = \frac{3}{2}\frac{Fx}{m\ell} \text{ or } a \propto x$$

i.e., a-x graph is a straigth line passing through origin.

11. A

Sol. $v\cos 60° = \frac{3v_0}{2}\cos 30°$, $v = \frac{3\sqrt{3}}{2}v_0$

12. C

Sol. $v_1 = \frac{v_0 t}{40}$, $S_1 = \frac{v_0}{40}\frac{t^2}{2}\Big|_{30}^{t}$

$v_2 = \frac{v_0 t}{10} - 3v_0$, $S_2 = \frac{v_0 t^2}{20} - 3v_0 t\Big|_{30}^{t}$

$S_1 = S_2$

$\Rightarrow t = 60$ sec

13. B

Sol. $v_{min} = \sqrt{g(y + \sqrt{x^2 + y^2})} = 30$ m/s

$\tan\theta = \frac{v^2}{gx} = 3$

14. C

Sol. $N_1 + f_2 = 2mg$ …(i)

$N_2 = f_1$ …(ii)

$f_1 = \mu N_1$ …(iii)

$f_2 = \mu N_2$ …(iv)

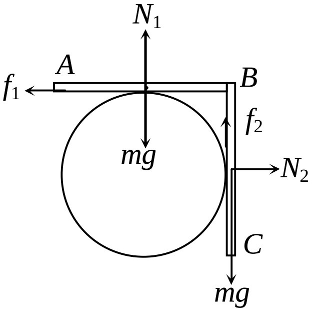
Taking moment about corner *B* of plate

$(mg + N_2)R = N_1 R$

$mg + N_2 = N_1$ …(v)

From (i), (ii) & (v),

$f_1 + f_2 = mg$ …(vi)



From (iii), (iv) & (vi), $\mu^2 + 2\mu - 1 = 0$ or

$\mu = \sqrt{2} - 1$

15. A

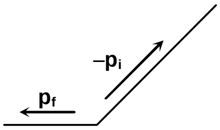
Sol. Centre of mass of arc is $\frac{2R\sin\alpha}{3\alpha}$

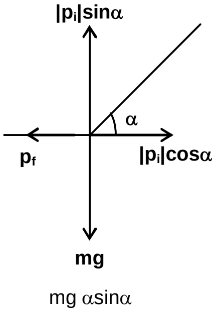
$m_1 = 2m$, $m_2 = m$

$$\text{centre of mass} = \frac{\dfrac{2m\left(2R\sin\left(\frac{\pi}{3}\right)\right)}{\left(3\frac{\pi}{3}\right)} + m\left(\dfrac{-2R\sin\left(\frac{\pi}{6}\right)}{2\left(\frac{\pi}{6}\right)}\right)}{3m} = \frac{2R(\sqrt{3}-1)}{3}$$

16. A

Sol. impulse $= \vec{p}_f - \vec{p}_i$





17. A

Sol. t = 0 to t = 1 sec

v = 4t m/s

s = 2t^2 m

s(t = 0) = 0 m, s(t=1) = 2m

$v_{average} = \frac{\Delta s}{\Delta t} = 2$ m/s

t = 1 to t = 2 sec

v = 2 m/s

s = 2t m

s (t = 1) = 2m, s(t = 2) = 4m

$v_{average}$ = 2 m/s

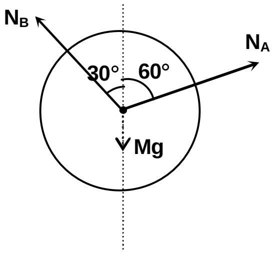
18. C

Sol. A cylinder of mass M

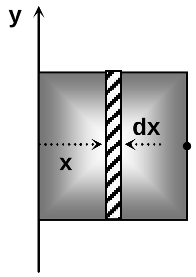
For equilibrium $N_A \cos 60° + N_B \cos 30° = Mg$

and $N_A \sin 60° = N_B \sin 30°$

On solving $N_B = \sqrt{3}N_A$; $N_A = \frac{Mg}{2}$



19. C



Sol. $dM = \sigma_0\left(1-\frac{x}{a}\right)dx$

$M = \frac{\sigma_0 a}{2}$

$\Rightarrow d(MOI) = dmx^2$

$MOI = \int dMx^2 = \frac{Ma^2}{6}$

20. C

Sol. Minimum stopping distance = *s*

Force of friction $= \mu mg$

Work done against the friction $W = \mu mgs$

Initial kinetic energy of the toy cart $= \left(p^2 / 2m\right)$

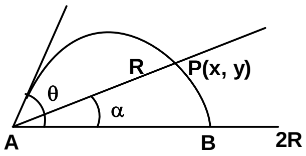
$\therefore \quad \mu mgs = \left(p^2 / 2m\right)$

$$\frac{s_1}{s_2} = \left(\frac{m_2}{m_1}\right)^2$$

SECTION – B

21. 3

Sol. Let the shell hit the plane at p(x, y), the range being AP = R, as shown in the figure. The equation for the projectile's motion is



$y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$ …(i)

Now y = R sin α …(ii)

x = R cos α …(iii)

Using equation (ii) and equation (iii) in equation (i) and simplifying

$$R = \frac{2u^2\cos\theta\sin(\theta-\alpha)}{g\cos^2\alpha}$$

The maximum range is obtained by setting $\frac{dR}{d\theta} = 0$, holding u, α and g constant. This gives

$\cos(2\theta-\alpha) = 0$ or $2\theta - \alpha = \frac{\pi}{2}$

22. 5

Sol. for block A

$T = \mu m_A g + m_A\omega^2 R$

For block B

$T + \mu(m_A + m_B)g + \mu m_A g = m_B\omega^2 R$

$$\omega = \sqrt{\frac{\mu g(3m_A + m_B)}{R(m_B - m_A)}}$$

23. 120

Sol. As $\Delta p_x = 0$, $\Delta p_y = 0$

For x direction,

$$\Rightarrow 2m \times \frac{v}{2}\frac{\cos\theta}{2} + mv\frac{\cos\theta}{2} = 3m \times \frac{v}{3}$$

$$\Rightarrow 2mv\frac{\cos\theta}{2} = mv \Rightarrow \frac{\cos\theta}{2} = \frac{1}{3} = \cos 60^\circ$$

$$\frac{\theta}{2} = 60^\circ \Rightarrow \theta = 120^\circ$$

24. 125

Sol. Kinetic energy $E = \frac{1}{2}mv^2$

$$\therefore \frac{\Delta E}{E} \times 100 = \frac{v'^2 - v^2}{v^2} \times 100 = \left[(1.5)^2 - 1\right] \times 100$$

$$\frac{\Delta E}{E} \times 100 = 125\%$$

25. 16

Sol. $v = \sqrt{v_x^2 + v_y^2}$

$v_x = 10 - 10 \cos 5t$, $v_y = +10 \sin 5t$

$$v = 20\sin\left(\frac{5t}{2}\right)$$

$$S = \int_0^t 20\sin\left(\frac{5t}{2}\right)dt \text{ , } \omega t = 2\pi$$

So, S = 16 m

26. 30

Sol. A begins to climb B if $F \cos 60^\circ \geq Mg \sin 60^\circ$

$F \geq \sqrt{3}\ Mg$

$F \geq 30$ N

27. 3

Sol. $\text{Power} = \text{K.E./ time} = \dfrac{n\frac{1}{2}mv^2}{t} = \dfrac{3600}{60}\left(\dfrac{1}{2}\right)(0.2)\left(\dfrac{500}{3}\right)^2$

$$= \left(\frac{500}{3}\right) \times 10^3 \text{ watt}$$

28. 3

Sol. $a = g(\sin\theta - \mu\cos\theta)$

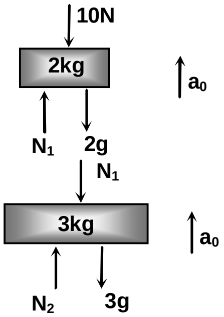
Also, $a = R\alpha$, $\dfrac{Rz}{I} = \dfrac{R(\mu mg\cos\theta R)}{\frac{1}{2}mR^2} = 2\mu g\cos\theta$

$\therefore g(\sin\theta - r\cos\theta) = 2\mu g\cos\theta$

$$\mu = \frac{\tan\theta}{3}$$

29. 7

Sol. $2a_0 = N_1 - 10 - 2g$



$N_1 = 34$ N

$3a_0 = N_2 - N_1 - 3g$

$N_2 = 70$ N

30. 8

Sol. By the conservation of energy

$$\frac{1}{2}mv_0^2 = mgh + \frac{1}{2}mv^2 \quad \dots(i)$$

By conservation of angular momentum

$$\frac{mv_0R}{2} = mvR$$

From equation (i) and equation (ii)

$$v_0 = \sqrt{\frac{8gh}{3}}$$

$\Rightarrow k = 8$

Chemistry

PART – B

SECTION – A

31. B

Sol.

Be	B	C	N
$2s^2$	$2s^2p^1$	$2s^2p^2$	$2s^2p^3$

Be and N have stable configurations, so do not accept electron easily, hence for these elements the process is Endothermic.
So, correct order is Be < N < B < C

32. D

Sol. On moving down the group the IE_1 of Gr(1) elements decreases continuously hence reactivity increases.

33. D

Sol. $\Delta v \times \Delta x = \frac{h}{4\pi m}$ (Using uncertainty principle)

$$\Rightarrow \Delta v = \frac{6.62 \times 10^{-34}}{4 \times 3.14 \times 1.1 \times 10^{-28} \times 3 \times 10^{-12}}$$

$$\Rightarrow \Delta v = 1.597 \times 10^5 \sim 1.6 \times 10^5 \text{ ms}^{-1}$$

34. A

Sol. The ionic equation is

$$\underset{(+6)}{CrO_4^{--}} + \underset{(-1)}{I^-} + HCl \xrightarrow[\text{medium}]{\text{Acidic}} \underset{(+3)}{Cr^{+++}} + \underset{(0)}{I_2}$$

$$\Rightarrow 2CrO_4^{--} + 6I^- + 16H^+ \longrightarrow 2Cr^{+++} + 3I_2 + 8H_2O$$

or

$$\underline{2}BaCrO_4 + \underline{6}KI + 16HCl \longrightarrow \underline{2}CrCl_3 + 3I_2 + 8H_2O + \underline{6}KCl + 2BaCl_2$$

35. A

Sol. $2HI(g) \longrightarrow H_2(g) + I_2(g)$ (follows zero order kinetics)

$$-\frac{1}{2}\frac{d[R]}{dt} = k[R]^o$$

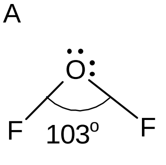
$$\Rightarrow t = \frac{[R_o] - [R]}{2k}$$

$$\Rightarrow t = \frac{1.50 - 0.30}{2 \times 0.06}$$

$$\Rightarrow t = \frac{1.20}{0.12} = 10 \text{ s}$$

36. A

Sol.



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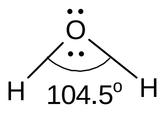

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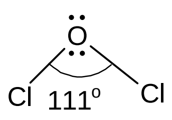

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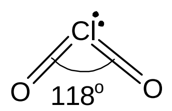


H_2O has larger bp – bp repulsion than OF_2 and OCl_2 has larger steric repulsion between two large Cl atoms while in ClO_2 the bond angle is 118^o $\left(\text{close to } 120^o\right)$.

37. C

Sol. $2NH_3 \rightleftharpoons N_2 + 3H_2 \quad \left(\frac{1}{K_1}\right)$ … (1)

$N_2 + O_2 \rightleftharpoons 2NO \quad \left(K_2\right)$ … (2)

$3H_2 + \frac{3}{2}O_2 \rightleftharpoons 3H_2O \quad \left(K_3^3\right)$ … (3)

Adding (1), (2) and (3)

$2NH_3 + \frac{5}{2}O_2 \rightleftharpoons 2NO + 3H_2O \quad \left(K_{eq}\right)$

$\Rightarrow K_{eq} = \frac{K_2K_3^3}{K_1}$

38. B

Sol. $H_2O(\ell) \rightleftharpoons H^+(aq) + OH^-(aq)$

At 25^oC, $\left[H^+\right] = \left[OH^-\right] = 10^{-7}$ M

$\Rightarrow K_{W_1} = 10^{-14}$

At 35^oC, $\left[H^+\right] = \left[OH^-\right] = 10^{-6}$ M

$\Rightarrow K_{W_2} = 10^{-12}$

Now, $2.303 \log\frac{K_{W_2}}{K_{W_1}} = \frac{\Delta H}{R}\left[\frac{T_2 - T_1}{T_1T_2}\right]$

$\Rightarrow 2.303\log\frac{10^{-12}}{10^{-14}} = \frac{\Delta H}{2}\left(\frac{308 - 298}{308 \times \times 298}\right)$

$\Rightarrow 2.303 \times 2 = \frac{\Delta H}{2} \times \frac{10}{308 \times 298}$

$\Rightarrow \Delta H = 84.551\,\text{Kcal mol}^{-1}$

Since, $84.551\,\text{Kcal mol}^{-1}$ is the enthalpy change for the reaction

39. D

Sol. $KE = -\frac{1}{2}(PE) = -\frac{1}{2}\left(-\frac{1}{2}mkr^4\right)$

$KE = \frac{1}{4}mkr^4 = \frac{1}{2}mv^2$

$\Rightarrow v^2 = \frac{mkr^4.2}{4.m} = \frac{1}{2}kr^4$ … (1)

Since, $mvr = \frac{nh}{2\pi} \Rightarrow v^2 = \frac{n^2h^2}{4\pi^2m^2r^2}$ … (2)

From (1) and (2)

$\frac{1}{2}kr^4 = \frac{n^2h^2}{4\pi^2m^2r^2}$

$\Rightarrow r^6 \propto n^2 \Rightarrow r \propto \sqrt[3]{n}$

40. D

Sol. $K_P = \dfrac{P^2_{H_2O(g)}}{P^2_{H_2(g)}}$ … (1)

$P_{H_2} = \dfrac{40}{40+60} \times P_T = 0.4P_T$

$P_{H_2O} = \dfrac{60}{40+60} \times P_T = 0.6P_T$

$\Rightarrow \dfrac{P_{H_2O}}{P_{H_2}} = \dfrac{0.6P_T}{0.4P_T} = \dfrac{3}{2} = 1.5$

$\therefore$ From Eq. (1) $K_P = (1.5)^2 = 2.25$

41. C

Sol. (A) $\Rightarrow \Delta n_g > 0, \uparrow$ in P shifts the equilibrium $\leftarrow$

(B) $\downarrow$ in volume in (III)rd equilibrium shifts the equilibrium $\rightarrow (\Delta n_g < 0)$

(C) At constant volume no effect of addition of He

(D) At constant pressure, addition of He shifts the equilibrium $\leftarrow (\Delta n_g < 0)$

42. B

Sol. $CaC_2 + N_2 \xrightarrow[\text{high temp.}]{\text{2 atm}} \underset{\text{Calcium cyanamide}}{CaCN_2} + C$

43. B

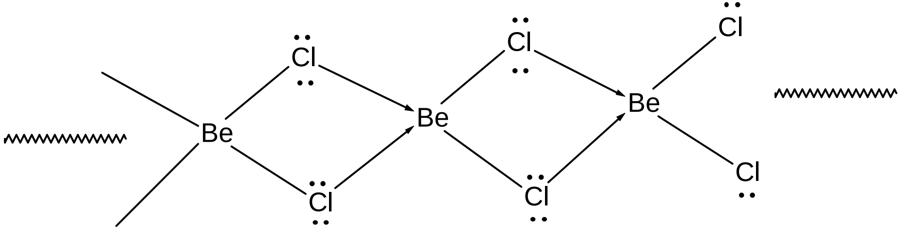
Sol. (A) On moving down the group, the size of metal ion increases, so stability of peroxides/superoxides increases.
i.e. Large cation – Lagre anion interactions increases.

(B) NaOH is hygroscopic in nature.

(C), (D) Fact based on $\Delta_{lattice} H^{\ominus}$ and $\Delta_{hyd} H^{\ominus}$.

44. A

Sol. In solid state, $BeCl_2$ exists as a polymer.



(four electrons are shared between three atoms, so 3c-4e type of bonds are present)

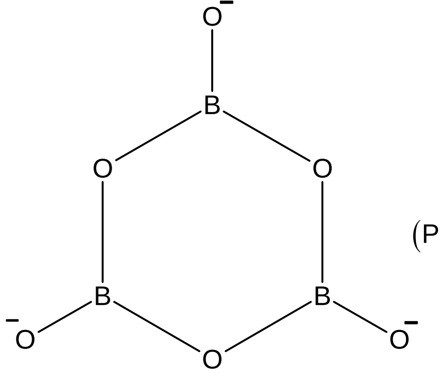
45. D

Sol. I. – 1 corner shared
II. – 2 corners shared
III. – One unit shares 2 corners while one unit shares 3-corners.
IV. – 2 corners shared
V. – 4 corners shared
VI – 3 corners shared

46. D

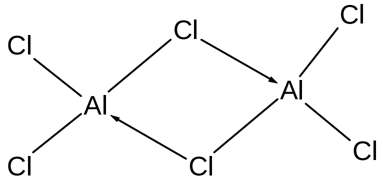
Sol. Borazon → Diamond like structure (Non-planar)
Borazole → Inorganic benzene (Planar)

$B_3O_6^{---} \Longrightarrow$



(Planar)

$Al_2Cl_6 \Longrightarrow$



(Non-planar)

47. B

Sol. $NO_2 \rightarrow$ odd electron species
$\rightarrow$ Paramagnetic

$\overset{+}{N}O_2$ is linear while $\overset{-}{N}O_2$ and NO_2 are bent.

$\overset{-}{N}O_2 \rightarrow$ lp – bp repulsion

$NO_2 \rightarrow$ bond angle is around 134°

Bond order of $\overset{-}{N}O_3$ is $\frac{4}{3} = 1.33$

Bond angles, $\overset{-}{N}O_2\left(115^o\right), \overset{+}{N}O_2\left(180^o\right), NO_2\left(134^o\right)$

48. D

Sol. LiH → Stable
NaH → Unstable
$Li_2CO_3 \rightarrow$ Unstable
$Na_2CO_3 \rightarrow$ Stable
(Around 400 – 500°C)

49. C

Sol. I. → Bond length order is $H_2^- > H_2^+ > H_2$

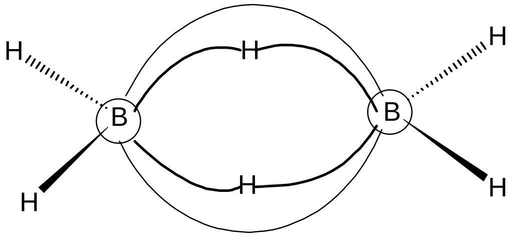
II.→ Isoelectronic species, so identical bond order.

III. → Fact.

IV → NO_3^- (Resonance), BO_3^- (no resonance).

50. A

Sol.



Maximum 4 – H atoms lie in a plane.
Maximum 6 – atoms (4H + 2B) lie in a plane.
Bridge (B – H) is stronger than terminal (B – H)
Terminal (H – B – H) bond angle > Bridge (H – B – H) bond angle.

SECTION – B

51. 12

Sol. $Ag_2CO_3(s) \rightleftharpoons 2Ag^+(aq) + CO_3^{--}(aq)$

$K_{SP} = \left[Ag^+\right]^2\left[CO_3^{--}\right]$

$\Rightarrow \left[Ag^+\right]^2 = \left[\frac{8.2\times10^{-12}}{7.5/5}\right]$

$\Rightarrow \left[Ag^+\right]^2 = \left[\frac{82}{15}\times10^{-12}\right]$

$\Rightarrow \left[Ag^+\right] = 2.34\times10^{-6}$ M

Now $K_{SP}(AgCl) = \left[Ag^+\right]\left[Cl^-\right]$

$K_{SP} = 2.34\times10^{-6}\times\left(\frac{0.0026}{35.5}\right)$

$K_{SP} = 1.71\times10^{-10}$

$\Rightarrow x = 1.71, \quad y = 10$

$\Rightarrow x + y = 1.71 + 10 = 11.71 \sim 12$

52. 20

Sol. $KE = \frac{1}{2}mv^2$

$\Rightarrow d(KE) = d\left(\frac{1}{2}mv^2\right)$

$\Rightarrow d(KE) = mv(dv)$ … (1)

Since, $dv \times dx = \frac{h}{4\pi m}$

$\Rightarrow dv = \frac{h}{4\pi m(dx)}$ … (2)

From (1) and (2)

$d(KE) = mv.\frac{h}{4\pi m.(dx)}$

$$\Rightarrow d(KE) = \frac{1}{60} \times \frac{3\times10^{8}\times6.62\times10^{-34}}{4\times3.14\times\frac{6.62}{3.14}\times10^{-12}}$$

$$\Rightarrow d(KE) = \frac{1}{80}\times10^{-14} = 1.25\times10^{-16}\,J$$

$$\Rightarrow x = 1.25,\ y = 16$$

$$\Rightarrow xy = 1.25\times16 = 20$$

53. 7

Sol. The ionic equation involved is

$$MnO_4^-(aq) + SO_2(g) + H^+(aq) \longrightarrow Mn^{++}(aq) + HSO_4^-(aq)$$

The balanced equation is

$$2MnO_4^-(aq) + 5SO_2(g) + 2H_2O(\ell) + H^+(aq) \longrightarrow 2Mn^{++}(aq) + 5HSO_4^-(aq)$$

$\therefore$ Sum total of coefficient(s) = 2 + 5 = 7.

54. 310

Sol. $k = Ae^{-E_a/RT}$

$$\log K = \log A - \frac{E_a}{2.303RT}$$

$$\Rightarrow \log\left(\frac{0.693}{693}\right) = \log\left(4\times10^{13}\right) - \frac{98.6\times1000}{2.303\times8.314\times T}$$

or

$$\Rightarrow \log\frac{4\times10^{13}}{10^{-3}} = \frac{98.6\times1000}{2.303\times8.314\times T}$$

$$\Rightarrow T = 310.1\,K \sim 310K$$

55. 64

Sol. $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

0.28 1.1

$$K_P = \frac{\left(P_{NO_2}\right)^2}{\left(P_{N_2O_4}\right)} = \frac{(1.1)^2}{0.28} = 4.32$$

Now, volume is doubled, so pressure will become half and reaction proceeds in forward direction

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

$$\left(\frac{0.28}{2} - P\right) \qquad \left(\frac{1.1}{2} + 2P\right)$$

$$\Rightarrow K_P = \frac{(0.55 + 2P)^2}{(0.14 - P)}$$

$$\Rightarrow 4.32 = \frac{(0.55)^2 + 2(0.55)(2P)}{0.14 - P}$$

$$= \frac{0.3025 + 2.20P}{0.14 - P}$$

(Ignoring P^2 terms)

$$\Rightarrow P = 0.046\ \text{atm}$$

$$\therefore P_{NO_2} = 0.55 + 2\times0.046 \cong 0.642$$

$= 64.2 \times 10^{-2}$ atm

$\Rightarrow x = 64.2 \sim 64$

56. 2

Sol. $XeO_2F_2 \Rightarrow AB_4L \Rightarrow sp^3d \Rightarrow \text{Polar}$ $(\times)$

$SnCl_2 \Rightarrow AB_2L \Rightarrow sp^2 \Rightarrow \text{Polar}$ $(\times)$

$IF_5 \Rightarrow AB_5L \Rightarrow sp^3d^2 \Rightarrow \text{Polar}$ $(\times)$

$I_3^+ \Rightarrow AB_2L_2 \Rightarrow sp^3 \Rightarrow \text{Polar}$ $(\times)$

$XeO_4 \Rightarrow AB_4 \Rightarrow sp^3 \Rightarrow \text{Non-Polar}$ $(\surd)$

$[XeF_7]^+ \Rightarrow AB_7 \Rightarrow sp^3d^3 \Rightarrow \text{Non-Polar}$ $(\surd)$

$SO_2 \Rightarrow AB_2L \Rightarrow sp^2 \Rightarrow \text{Polar}$ $(\times)$

57. 4

Sol.
1. Correct as EN of side atom increases, EN of carbon increases.
2. Correct, $Mg^{++} \Rightarrow 3^{rd}$ period
   $K^+ / S^{--} \Rightarrow 4^{th}$ period and isoelectronic
   $Se^{--} \Rightarrow 5^{th}$ period
3. Correct as moving down the group cationic size increases so lattice energy decreases
4. Correct as Hydration energy $\propto \dfrac{1}{\text{Size of cation}}$
5. Incorrect as the bond energy order among halogens is
   $Cl_2 > Br_2 > F_2 > I_2$

58. 33

Sol. $$Na_2O_2 + 2H_2O \xrightarrow[\text{(Ice cold)}]{H_2O} \underset{(P)}{2NaOH} + \underset{(Q)}{H_2O_2}$$

$$2Na_2O_2 + 2H_2O \xrightarrow[\text{temperature}]{\text{Room}} \underset{(P)}{4NaOH} + \underset{(R)}{O_2} \uparrow$$

Hence, $\dfrac{M_1 + M_2}{2} = \dfrac{34 + 32}{2} = 33$

59. 80

Sol. At half neutralization $|S| = |A|$

$$pH = pK_a + \log\frac{|S|}{|A|}$$

$\Rightarrow pH = pK_a \Rightarrow pK_a = 5.0$

Now, at equivalence point,

$$PH = \frac{1}{2}(pK_W + pK_a + \log C)$$

$$9 = \frac{1}{2}(14 + 5 + \log C)$$

$\Rightarrow C = 0.1\,M$

Let, V mL of NaOH is used

$\text{Meq.}(\text{NaOH}) \Rightarrow \dfrac{0.25 \times \text{V}}{60 + \text{V}} = 0.1$ = Meq. (salt)

$\therefore$ Volume (V) = 40 mL

Meq. of acid = millimoles of acid = 0.25 × 40 = 10

Mass of acid (HX) = $10 \times 10^{-3} \times 82$ = 0.829

$\text{Mass\%} = \dfrac{0.82}{1.025} \times 100 = 80\%$

60. 1

Sol. $\left[\text{H}^{+}\right]_{\text{total}} = 25 \times 0.1 + 50 \times 0.2 = 12.5 \text{ milimoles}$

$\left[\text{OH}^{-}\right]_{\text{total}} = 25 \times 0.1 = 2.5 \text{ milimoles}$

$\therefore \left[\text{H}^{+}\right]_{\text{final}} = \dfrac{12.5 - 2.5}{25 + 50 + 25}$

$\left[\text{H}^{+}\right]_{\text{final}} = \dfrac{10}{100}\text{M} = \dfrac{1}{10}\text{M}$

$\therefore \text{pH} = -\log\left[\text{H}^{+}\right]_{\text{final}}$

$\text{pH} = -\log\left(\dfrac{1}{10}\right) = 1.00$

Mathematics

PART – C

SECTION – A

61. C

Sol. $f'(x) + f(x) = 12x^2 + 2$

62. B

Sol. Use expansion and collect the coefficient of x^2

$\Rightarrow \quad P = 330$

63. A

Sol. For A $\quad x - \frac{x^3}{6} < \sin x < x$ and for B use limit as a sum

$\Rightarrow A = \frac{1}{2}, B = \frac{2}{\pi}$

64. D

Sol. $f'(x) = \frac{-1}{\left(\sin^2 x - (x-a)^2\right)^2}\left(\sin 2x - 2(x-a)\right) < 0 \quad \forall\, x \in (0, 1)$ and $a \in (2, 3)$

65. C

Sol. $A - B = \int_0^1 f(x)\,dx + \int_{f(0)}^{f(1)} f^{-1}(x)\,dx = 0$, and also A = B.

66. D

Sol. Domain is R.

67. D

Sol. $A = \int_0^{\pi/4} (\tan x - \sin x)\,dx = \left(\frac{1}{2}\ln 2 + \frac{1}{\sqrt{2}} - 1\right)$

68. A

Sol. $I_1 = \frac{\pi^2}{2} + 2, I_2 = \frac{\pi^2}{2} - 2, I_3 < 1$

69. D

Sol. $f'(x) = (\ln x)^2$, $g'(x) = (\ln x)$, so area = $\int_1^e \left(\ln x - (\ln x)^2\right)dx = 3 - e$

70. D

Sol. $L_1 = L_2 = \frac{\pi}{2}$

71. B

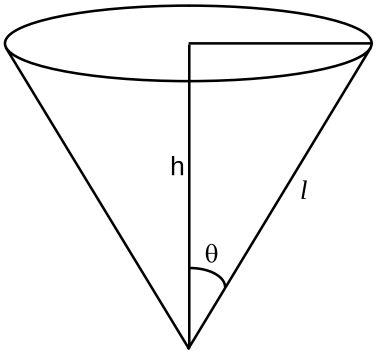
Sol. $T_n = \frac{\left((n+1)x+3\right) - (nx+3)}{\left((n+1)x+3\right)(nx+3)} = \frac{1}{nx+3} - \frac{1}{(n+1)x+3}$

$S_{12} = V_1 - V_2 + V_2 - V_3 + \ldots\ldots V_{12} - V_{13} = V_1 - V_{13}$

$$= \frac{1}{x+3} - \frac{1}{13x+3}$$

$$\lim_{x\to 1} \frac{1}{4} - \frac{1}{16} = \frac{3}{16}$$

72. A



Sol. $\tan\theta = \frac{5}{12} = \frac{r}{h} \Rightarrow r = \frac{5h}{12}$

$\frac{dv}{dt} = 0.1\ m^3/min$

$v = \frac{1}{3}\pi r^2 h = \frac{\pi 25h^3}{432}$

$\Rightarrow \frac{dv}{dt} = \frac{25\pi h^2}{144}\frac{dh}{dt} \Rightarrow 0.1 = \frac{25}{144}\times\pi\times 3\times 3\times\frac{dh}{dt}$

$\Rightarrow \frac{16}{250}\pi = \frac{dh}{dt}$

Now $s = \pi rl = \pi r\sqrt{h^2+r^2} = \frac{65\pi h^2}{144}$

$\frac{ds}{dt} = \frac{65\pi}{144}\times 2h\times\frac{dh}{dt} = \frac{65\pi}{144}\times 2\times 3\times\frac{16}{250\pi} = \frac{13}{75}\ m^2/min$

73. A

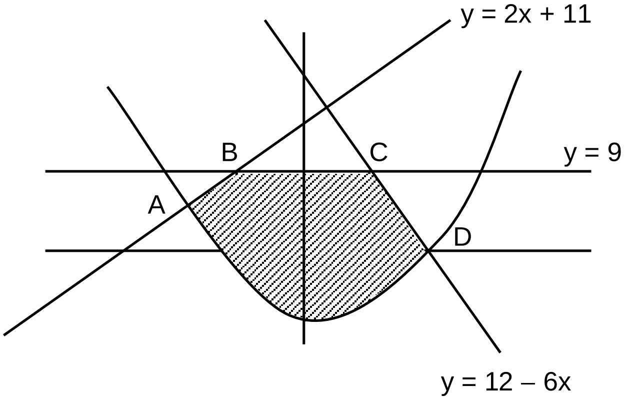
Sol. $x^2 - 4 = 2x + 11$

$x = -3, 5 \therefore A(-3, 5)$

$2x + 11 = 9$

$x = 1 \therefore B(-1, 9)$

$C\left(\frac{1}{2}, 9\right)$ and $D(2, 0)$



Required area $\int_{-3}^{-1}(2x+11)-(x^2-4)dx + \int_{-1}^{1/2} 9-(x^2-4)dx + \int_{1/2}^{2} 12-6x-(x^2-4)dx$

$= \int_{-3}^{-1}(2x-x^2+15)dx + \int_{-1}^{1/2} 13-x^2dx + \int_{1/2}^{2}(16-6x-x^2)dx$

$= x^2 - \frac{x^3}{3} + 15x\Big|_{-3}^{-1} + 13x - \frac{x^3}{3}\Big|_{-1}^{1/2} + 16x - 3x^2 - \frac{x^3}{3}\Big|_{1/2}^{2}$

$= \frac{40}{3} + \frac{153}{8} + \frac{81}{8} = \frac{511}{12}$

74. B

Sol. $f'(t) = \frac{e^{t^2}t^5}{\left(t^4+2t^2+2\right)^2} \Rightarrow f'(1) = \frac{e}{25}$

Let $x^2 = v \Rightarrow \dfrac{dv}{dx} = 2x \Rightarrow \dfrac{1}{2}\int \dfrac{e^v v^2}{\left(v^2+2v+2\right)^2}dv$

$$\Rightarrow \quad \frac{1}{2}\int e^v\left(\frac{1}{v^2+2v+2} - \frac{2v+2}{\left(v^2+2v+2\right)^2}\right) = \frac{1}{2}\frac{e^v}{v^2+2v+2}$$

$$= \frac{1}{2}\frac{e^{x^2}}{x^4+2x^2+2}$$

$$\therefore \quad f(t) = \frac{1}{2}\frac{e^{x^2}}{x^4+2x^2+2}\Bigg|_0^t = \left(\frac{e^{t^2}}{t^4+2t^2+2} - \frac{1}{2}\right)\frac{1}{2}$$

$$\therefore \quad f(1) = \frac{e}{10} - \frac{1}{4}$$

$$\therefore \quad f(1) + f'(1) = \frac{e}{10} + \frac{e}{25} - \frac{1}{4} = \frac{7e}{50} - \frac{1}{4}$$

75. B

Sol. $\lim\limits_{x\to\infty} \dfrac{(k-2)x^3 + (3+n)x^2 + (m-3)x + (2-p)}{\sqrt{x^4 + kx^3 + 3x^2 + mx + 2} + \sqrt{x^4 + 2x^3 - nx^2 + 3x - p}}$

k – 2 has to be 0 else limit wont be finite

$\Rightarrow$ k = 2

Now dividing Num. & Den by x^2

$$\lim_{x\to\infty} \frac{(3+n) + \dfrac{m-3}{x} + \dfrac{(2-b)}{x^2}}{\sqrt{1+\dfrac{a}{x}+\dfrac{3}{x^2}+\dfrac{b}{x^3}+\dfrac{2}{x^4}} + \sqrt{1+\dfrac{2}{x}-\dfrac{c}{x^2}+\dfrac{3}{x^3}-\dfrac{d}{x^4}}}$$

$= \dfrac{3+n}{2} \Rightarrow \dfrac{3+n}{2} = 4 \Rightarrow n = 5.$

76. A

Sol. Let $x^2 = t \Rightarrow \dfrac{dt}{dx} = 2x \Rightarrow I = \dfrac{1}{2}\displaystyle\int_0^{2\pi} \dfrac{t\sin^{2022} t\, dt}{\cos^{2022} t + \sin^{2022} t}$

$$\Rightarrow \quad I = \frac{1}{2}\int_0^{2\pi} \frac{(2\pi - t)\sin^{2022} t}{\cos^{2022} t + \sin^{2022} t} \Rightarrow 2I = \int_0^{2\pi} \frac{\pi\sin^{2022} t}{\cos^{2022} t + \sin^{2022} t}$$

$$\Rightarrow \quad 2I = 4\int_0^{\frac{\pi}{2}} \frac{\pi\sin^{2022} t}{\cos^{2022} t + \sin^{2022} t}$$

$$\Rightarrow \quad 2I = 4\int_0^{\frac{\pi}{2}} \frac{\pi\cos^{2022} t}{\cos^{2022} t + \sin^{2022} t}$$

$$\Rightarrow \quad 4I = 4\int_0^{\frac{\pi}{2}} \pi\, dt \Rightarrow I = \frac{\pi^2}{2}.$$

77. A

Sol. $\frac{dy}{dx} = \frac{(x-2)+(y-2)}{(x-2)-(y-2)}$

put x – 2 = h, y – 2 = k

$\frac{dk}{dh} = \frac{h+k}{h-k}$ put k = vh

$\Rightarrow \quad v + h\frac{dv}{dh} = \frac{1+v}{1-v}$

$\Rightarrow \quad \int \frac{1-v}{1+v^2}dv = \int \frac{dh}{h} \quad \Rightarrow \tan^{-1}v = \frac{1}{2}\ln\left(1+v^2\right) + \ln h + c$

$\Rightarrow \quad \tan^{-1}\left(\frac{y-2}{x-2}\right) = \frac{1}{2}\ln\left(1+\frac{(y-2)^2}{(x-2)^2}\right) + \ln(x-2) + c$

$\because$ it passes through (3, 2)

$\Rightarrow \quad \tan^{-1}0 = \frac{1}{2}\ln 1 + \ln 1 + c \Rightarrow c = 0$

$\because$ it also passes through (p + 2, 3)

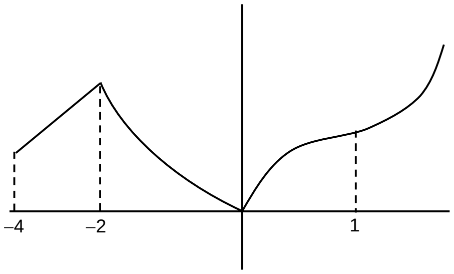
$\tan^{-1}\left(\frac{1}{p}\right) = \frac{1}{2}\ln\left(1+\frac{1}{p^2}\right) + \ln p$

$\Rightarrow \quad 2\tan^{-1}\left(\frac{1}{p}\right) = \ln\left(1+p^2\right)$

78. B

Sol. $A = \int_{-4}^{-2}(x+6) + \int_{-2}^{0} x^2 dx + \int_{0}^{1}\sqrt{x}dx + \int_{1}^{2} x^2 dx$

$= 6 + \frac{8}{3} + \frac{2}{3} + \frac{7}{3} = \frac{35}{3}$



79. C

Sol. $f\left(e^4\right) = \int_{1}^{e^4} \frac{\log_{10} x}{1+x}dx$ …(1)

Let x = $\frac{1}{v} \Rightarrow \frac{dx}{dv} = \frac{-1}{v^2}$

$\Rightarrow \quad f(t) = \int_{1}^{1/t} \frac{\log_{10}(1/v)}{1+\frac{1}{v}} - \frac{1}{v^2}dv = \int_{1}^{1/t} \frac{\log_{10} v}{v(v+1)}dv$

$\Rightarrow \quad f(t) = \int_{1}^{1/t} \frac{\log_{10} v}{v(v+1)} \Rightarrow f\left(e^{-4}\right) = \int_{1}^{e^4} \frac{\log_{10} v}{v(v+1)}dv = \int_{1}^{e^4} \frac{\log_{10} x}{x(x+1)}dx$ …(2)

Add (1) and (2)

$f(e^{-4}) + f(e^4) = \frac{1}{\ln 10}\int_{1}^{e^4} \frac{\ln x}{(1+x)}\left(1+\frac{1}{x}\right)dx$

$$= \frac{1}{\ln 10}\int_1^{e^4}\frac{\ln x}{x} = \frac{1}{\ln 10}\frac{(\ln x)^2}{2}\Bigg|_1^{e^4}$$

$$= \frac{1}{2\ln 10}16 = \frac{8}{\ln 10}$$

80. C

Sol. Let $g(x) = x^3 - 2x^2 + 3x - 9$
$g'(x) = 3x^2 - 4x + 3 > 0 \quad \forall x \in R$
$\Rightarrow$ g(x) is always increasing
$\therefore$ $g(2) = 8 - 8 + 6 - 9 = -3$ is maximum value for $x \le 2$
If $-3x + \log^3(k^2 - 5) \le -3$ for $x > 2$
then we have maximum at x = 2
$\Rightarrow -6 + \log_3(k^2 - 5) \le -3 \Rightarrow \log^3(k^2 - 5) \le 3$
$\Rightarrow k^2 - 5 \le 27 \Rightarrow \left(k - 4\sqrt{2}\right)\left(k + 4\sqrt{2}\right) \le 0$
$k \in \left[-4\sqrt{2}, 4\sqrt{2}\right]$ and $k^2 - 5 > 0$
$\Rightarrow k \in \left(-\infty, -\sqrt{5}\right) \cup \left(\sqrt{5}, \infty\right)$
$\therefore k \in \left[-4\sqrt{2}, -\sqrt{5}\right) \cup \left(\sqrt{5}, 4\sqrt{2}\right]$

SECTION – B

81. 1

Sol. $\left[\frac{x^2 + x + 2}{x^2 + x + 1}\right] = 1$

82. 1

Sol. $A = \frac{\pi^3}{8} - \frac{\pi^2}{4}$

83. 4

Sol. $D_f = [-2, 2]$ as $f(x) = \sqrt{3}\left(\sqrt{4 - x^2}\right)$

$R_f = \in \left[0, 2\sqrt{3}\right]$

84. 2

Sol. $f(x) = \cos(x^2 - 3x)\,|x - 2|\,\sin|x - 2| + (x - 1)\,|x|\,|x - 1|\,|x - 7|$
$\therefore$ f(x) non differentiable at x = 0 and 7 only.

85. 12

Sol. a = 1, b = 6, c = 5

86. 96

Sol. Put x = 0 we get y = 1
$\ln(x + y) = 6xy$
Differentiate w.r.t. x
$\frac{1}{x + y}\left(1 + \frac{dy}{dx}\right) = 6\left(\frac{xdy}{dx} + y\right)$

at x = 0, y = 1 $\Rightarrow \frac{dy}{dx} = 5$

$\Rightarrow \quad 1+\frac{dy}{dx} = 6\left(x+y\right)\left(x\frac{dy}{dx}+y\right)$

Differentiate w.r.t. x both side

$\Rightarrow \quad \frac{d^2y}{dx^2} = 6\left((x+y)\left(\frac{xd^2y}{dx^2}+\frac{dy}{dx}+\frac{dy}{dx}\right)+\left(\frac{xdy}{dx}+y\right)\left(1+\frac{dy}{dx}\right)\right)$

$= 6(1(0 + 5 + 5) + 1(6)) = 96$

87. 9

Sol. $\because \lim\limits_{x\to 0}\left(3-2\cos x\sqrt{\cos 2x}\right)^{\left(\frac{x+3}{x^2}\right)}$ is of the form 1^{∞}

$\therefore$ it is equal to $e^{\lim\limits_{x\to 0}\left(\frac{2-2\cos x\sqrt{\cos 2x}}{x^2}\right)\times(x+3)}$

Now, $\lim\limits_{x\to 0}\frac{2-2\cos x\sqrt{\cos 2x}}{x^2}$

$= \lim\limits_{x\to 0}\frac{\frac{-2\cos x}{2\sqrt{\cos 2x}}\times -\sin 2x\times 2-\sqrt{\cos 2x}\left(-\sin x\right)}{2x}$

$= \lim\limits_{x\to 0}\frac{\frac{2\cos x\sin 2x}{\sqrt{\cos 2x}}+2\sin x\sqrt{\cos 2x}}{2x}$

$= 2 + 1 = 3$

$\therefore \; e^{\lim\limits_{x\to 0}\left(\frac{2-2\cos x\sqrt{\cos 2x}}{x^2}\right)(x+3)}$

$= e^{3\times 3} = e^{9} \;\; \therefore$ a = 9

88. 14

Sol. $\frac{dy}{dx}$ = 3x^2 – 4x + 4 $\Rightarrow \left(\frac{dy}{dx}\right)_{(a,b)}$ = 3a^2 – 4a + 4

$\frac{dy}{dx}$ = 6x + 2 $\Rightarrow \left(\frac{dy}{dx}\right)_{(1,4)}$ = 8

$\Rightarrow$ 3a^2 – 4a + 4 = 8 $\Rightarrow$ a = 2, $-\frac{2}{3}$

$\therefore$ b = 8 – 8 + 8 + 4 = 12

89. 144

Sol. $\int\frac{12x^{15}+5x^{18}}{x^{24}\left(-7+3x^{-8}+2x^{-5}\right)^3}dx = \int\frac{12x^{-9}+5x^{-6}}{\left(-7+3x^{-8}+2x^{-5}\right)^3}$

Let –7 + 3x^{-8} + 2x^{-5} = t $\Rightarrow \frac{dt}{dx}$ = –24x^{-9} – 10x^{-6}

$= -\frac{1}{2}\int\frac{1}{t^3}dt = -\frac{1}{2}\frac{t^{-2}}{-2}+c = \frac{1}{4\left(-7+3x^{-8}+2x^{-5}\right)^2}+c$

$\because f\left(1\right) = \frac{1}{16} \;\Rightarrow\; \frac{1}{16} = \frac{1}{4\left(-7+3+2\right)^2}+c \;\Rightarrow\;$ c = 0

$$\therefore f(x) = \frac{1}{4\left(-7+3x^{-8}+2x^{-5}\right)^2} \quad \therefore f(-1) = \frac{1}{4(-6)^2} = \frac{1}{144}$$

90. 23

Sol. $I_n = \int_1^e \underset{\text{II}}{\underset{\downarrow}{x^{23}}}\left(\underset{\text{I}}{\underset{\downarrow}{\log x}}\right)^n dx$

$\Rightarrow I_n = (\ln x)^n \frac{x^{24}}{24}\Big|_1^e - \int_1^e n\frac{(\ln x)^{n-1}}{x}\frac{x^{24}}{24}dx$

$\Rightarrow I_n = \frac{e^{24}}{24} - \frac{nI_{n-1}}{24} \Rightarrow 24I_n = e^{24} - nI_{n-1}$

Put n = 15 $24I_{15} = e^{24} - 15I_{14}$ …(1)

Put n = 14 $24I_{14} = e^{24} - 14I_{13}$ …(2)

$24I_{15} - 24I_{14} = 14I_{13} - 15I_{14}$

$24I_{15} = 9I_{14} + 14I_{13}$

FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
PART TEST – I
PAPER –1
TEST DATE: 20-11-2022

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B**.

Section – A *(01 –06, 19 – 24, 37 – 42):* This section contains **EIGHTEEN (18)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – A *(07 – 10, 25 – 28, 43 – 46):* This section contains **TWELVE (12)** Matching List Type Questions. Each question has **FOUR** statements in **List-I** entries (I), (II), (III) and (IV) and **FIVE** statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which, **ONLY ONE** of these four options is correct answer.

Section – B *(11 – 18, 29 – 36, 47 – 54):* This section contains **TWENTY FOUR (24)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.

MARKING SCHEME

Section – A (One or More than One Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4	If only (all) the correct option(s) is (are) chosen;
Partial Marks	:	+3	If all the four options are correct but ONLY three options are chosen;
Partial marks	:	+2	if three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks	:	+1	If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–2	In all other cases.

Section – A (Single Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+3	If ONLY the correct option is chosen.
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–1	In all other cases.

Section – B: Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+3	If ONLY the correct numerical value is entered at the designated place;
Zero Marks	:	0	In all other cases.

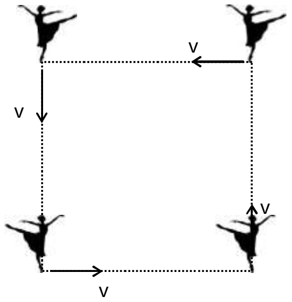
Physics

PART – I

Section – A (Maximum Marks: 24)

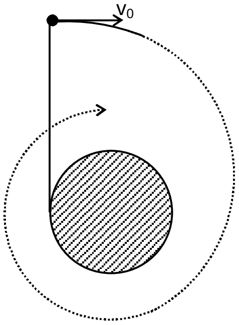
This section contains ***SIX (06)*** *questions. Each question has* ***FOUR*** *options (A), (B), (C) and (D).* ***ONE OR MOER THAN ONE*** *of these four option(s) is (are) correct answer(s).*

1. Four dancers start their dance by forming a square with side ℓ = 9m. After that, they always move anticlockwise towards their neighbour with variable velocity $v = k\sqrt{x}$ where k = 0.1 $m^{1/2}sec^{-1}$ and x is the distance of the closest neighbour in meter. Then choose the correct option(s).



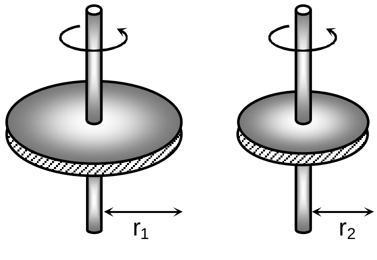
(A) All the dancers will meet with each other at t = 60 sec after they start their dance.
(B) Angular velocity of the line joining the adjacent dancers increases with time.
(C) All the dancers will meet with each other at t = 63 sec after they start their dance.
(D) Magnitude of acceleration of each dancer is remains constant with time.

2. A point object of mass m = 2kg is connected to a cylinder of radius R = 1m via a massless inextensible rope. At time t = 0 the object is moving with an initial velocity v_0 = 5 m/s perpendicular to the rope as shown in the figure. The rope has initial length L_0 = 10 m and having non zero tension. Figure shows the top view and the motion of the object is taking place on the horizontal smooth surface and the cylinder is always fixed. The point object moves such that the rope wraps up around the cylinder. The rope will break when the tension in the rope exceeds 100 N. Then choose the correct option(s).
(A) Kinetic energy of the object at the instant when the rope breaks is 25 J.



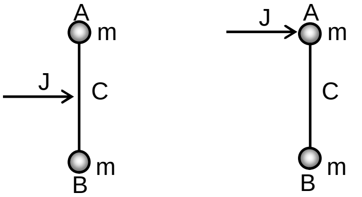
(B) Angular momentum of the object about the axis of the cylinder at the instant when the rope breaks is less than 5 kg-m^2/sec.
(C) Angular momentum of the object about the axis of the cylinder at the instant when the rope breaks is equal to 5 kg-m^2/sec.
(D) Angular momentum of the object about the axis of the cylinder at the instant when the rope breaks is greater than to 5 kg-m^2/sec.

3. Two discs are mounted on thin, lightweight rods oriented through their centres and normal to the discs. These axles are constrained to be vertical at all times, and the discs can pivot frictionlessly on the rods. The discs have identical thickness and are made up of the same material, but having different radii r_1 and r_2. The discs are given angular velocities ω_1 and ω_2, respectively, and L_1 and L_2 represents angular momentum of the discs along their rotational axis respectively. Now they are brought into contact at the edges. After the discs interact via friction it is found that both discs come exactly to a halt. Which of the following(s) must hold? Ignore effects associated with the vertical rods.



(A) $\omega_1 r_1^4 = \omega_2 r_2^4$
(B) $\omega_1 r_1^3 = \omega_2 r_2^3$
(C) $\dfrac{L_1}{L_2} = \dfrac{r_1}{r_2}$
(D) $\dfrac{L_1}{L_2} = \dfrac{\omega_1 r_1^2}{\omega_2 r_2^2}$

4. A dumbbell is formed by connecting two identical particles each of mass m with a massless rod. The system is placed on a horizontal smooth surface and impulse J is applied in two ways as shown in the figure as situation-(i) and situation-(ii). Then just after the application of impulse, choose the correct option(s).



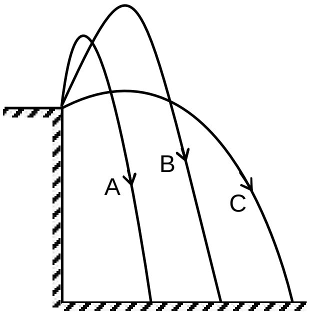
Situation-(i) Situation-(ii)

(A) Velocity of centre of mass with respect to ground frame in situation-(i) and situation-(ii) are same.
(B) Kinetic energy of the dumbbell with respect to centre of mass frame in situation-(i) and situation-(ii) are same.
(C) Angular momentum of the dumbbell with respect to centre of mass frame in situation-(i) and situation-(ii) are different.
(D) Velocity of particle A in situation-(ii) is double of velocity of particle A in situation-(i) just after the application of impulse.

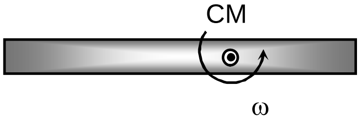
5. Three particles A, B and C are simultaneously thrown from a cliff and their trajectories are shown in the given figure. Neglect air resistance and take gravity to be uniform during the motion. If u_A^y, u_B^y and u_C^y denotes the initial vertical components of velocity of particles A, B and C respectively and the times t_A, t_B and t_C, they take to hit the ground respectively. Then

(A) $u_B^y > u_C^y > u_A^y$ (B) $u_B^y > u_A^y > u_C^y$

(C) $t_A < t_C < t_B$ (D) $t_C < t_A < t_B$



6. A thin rod has an unknown non-uniform density. It is mounted on an axle passing perpendicular to it, through its centre of mass as shown and is then rotated about the axle. The axle divides the rod into two parts, one on each side of it. Which of the following must be true, no matter how the mass in the rod is distributed?



(A) The two part must have the same mass.
(B) The magnitudes of the linear momentum of the two parts must be equal.
(C) The magnitudes of the angular momentum of the two parts about the centre of mass must be equal.
(D) The kinetic energies of two parts must be equal.

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (I), (II), (III) and (IV) and FIVE statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

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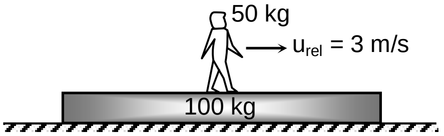
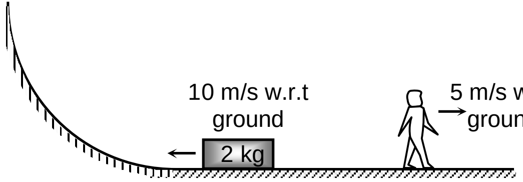
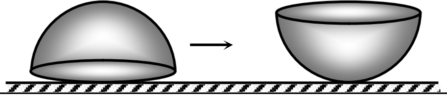
7. List –I describes for systems and List-II gives possible value of work done in Joules.

List –I		**List -II**	
(I)	A plank of mass 100 kg is placed on a smooth horizontal surface at rest along with a man. Now man starts moving on the plank with relative velocity of 3 m/s with respect to plank. The work done by man is 	(P)	+100J
(II)	A block of mass 2 kg is placed on a smooth track and imparted a velocity of 10 m/s to the left and observed by an observer moving with 5 m/s as shown in the figure. Work done by the normal force applied by the track on the block upto the instant when the block reaches the highest point on the track in the frame of observer. Assume that block never loose contact with the track. (take g = 10 m/s^2) 	(Q)	–100J
(III)	A particle of mass 1 kg is projected from an unstable equilibrium point N towards a stable equilibrium point S with negligible velocity in a conservative force field having potential energy function $U = -\left(\frac{1}{100}\,J/m^4\right)\left[x-10\right]^2\left[x-30\right]^2$, where x is in meters. Then work done by conservative force during the displacement from N to S is	(R)	+150J
(IV)	A solid hemisphere of mass 4 kg and radius 10 m is slowly turned as shown in the figure. Then work done by external force in turning is (Take g = 10 m/s^2) 	(S)	–150J
		(T)	Zero

Which one of the following options is correct ?

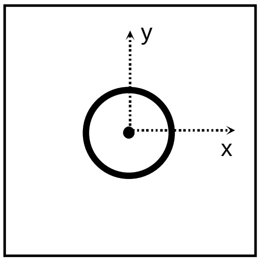
(A) I → R, II → T, III → P, IV → P

(B) I → S, II → T, III → Q, IV → P

(C) I → R, II → Q, III → P, IV → P

(D) I → T, II → Q, III → Q, IV → P

8. A disc placed on a frictionless horizontal plank is rotating with a constant angualr velocity $\vec{\omega}$ about its vertical axis. Now the plank is made to move with a constant acceleration $\vec{a}$ on a straight path. Initially the centre of the disc is at the origin of xyz space which is fixed with the plank and xy plane is on the plank. List-I gives some possible $\vec{a}$, $\vec{\omega}$ and List-II gives trajectories of instantaneous centre of rotation of the disc.



List –I		List -II	
(I)	$\vec{a} = -2\hat{j}$ m/s^2, $\vec{\omega} = 4\hat{k}$ rad/s	(P)	y = 4
(II)	$\vec{a} = -2\hat{j}$ m/s^2, $\vec{\omega} = -4\hat{k}$ rad/s	(Q)	$y = 4x^2$ $(x \le 0)$
(III)	$\vec{a} = -2\hat{i}$ m/s^2, $\vec{\omega} = 4\hat{k}$ rad/s	(R)	$y = 4x^2$ $(x \ge 0)$
(IV)	$\vec{a} = -2\hat{i}$ m/s^2, $\vec{\omega} = -4\hat{k}$ rad/s	(S)	$x = 4y^2$ $(y \ge 0)$
		(T)	$x = 4y^2$ $(y \le 0)$

Which one of the following options is correct ?

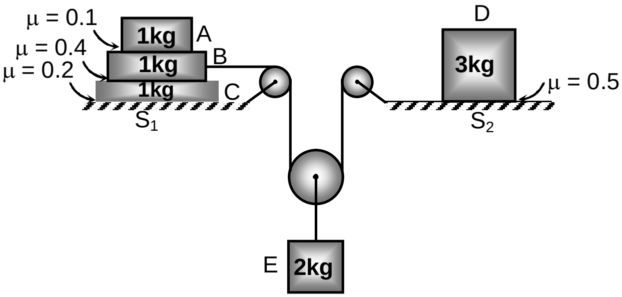
(A) I → P, II → Q, III → T, IV → S

(B) I → Q, II → R, III → S, IV → T

(C) I → Q, II → S, III → T, IV → R

(D) I → R, II → Q, III → S, IV → T

9. Figure shows a system of multiple blocks placed over each other and connected through an inextensible string. All the pulleys are ideal and frictionless. List-I shows the surfaces between which the friction is asked and List-II gives the value of friction acting between the surfaces. (Take $g = 10$ m/s^2)



List –I		List –II	
(I)	Between A and B	(P)	15 N
(II)	Between B and C	(Q)	9.4 N
(III)	Between C and S_1	(R)	7.2 N
(IV)	Between D and S_2	(S)	6 N
		(T)	1 N

Which one of the following options is correct ?

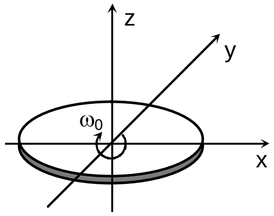
(A) I → T, II → R, III → S, IV → Q

(B) I → T, II → R, III → S, IV → P

(C) I → T, II → S, III → R, IV → Q

(D) I → T, II → Q, III → R, IV → P

10. A disc of mass m is placed over a horizontal smooth surface (xy plane) such that the centre of the disc is at the origin of the xyz space, as shown in the figure. Radius of the disc is R = 1m and is rotating with an angular velocity $\vec{\omega}_0 = -6\hat{k}$ rad/s and having zero velocity of centre of mass. A particle of same mass m hits the disc with a speed $|\vec{v}|$ = 8 m/s in each case of list-I. List-I gives the trajectory and velocity direction of the particle before hitting the disc and the coefficient of restitutions (e) of the collision. List-II gives the angular velocity of the disc just after the collision (in rad/s)



List –I		List -II	
(I)	x = 0, y = R and $\hat{v} = -\hat{k}$, e = 0	(P)	3
(II)	$y = \frac{x}{\sqrt{3}}$, z = 0 and $\hat{v} = \frac{\sqrt{3}}{2}\hat{i} + \frac{1}{2}\hat{j}$, e = 1	(Q)	5
(III)	y = R, z = 0 and $\hat{v} = \hat{i}$, e = 0	(R)	6
(IV)	$y = \frac{R}{2}$, z = 0 and $\hat{v} = \hat{i}$, e = 0	(S)	7
		(T)	8

Which one of the following options is correct ?

(A) I → P, II → Q, III → R, IV → T

(B) I → S, II → Q, III → P, IV → R

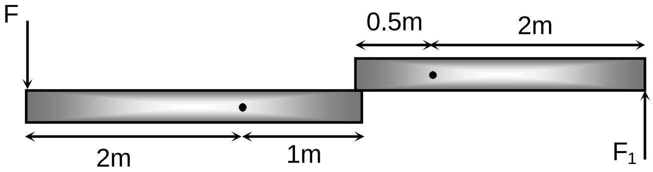
(C) I → P, II → R, III → S, IV → Q

(D) I → S, II → P, III → Q, IV → T

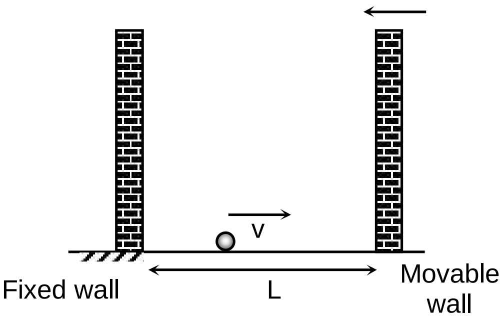
Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

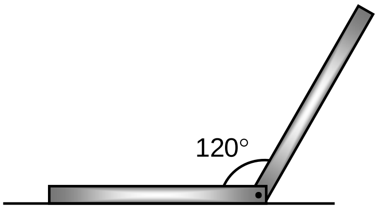
11. Two massless rods are attached to frictionless pivots, with their ends touching. The distances between the pivot points and the endpoints of the rods are shown in the figure. Neglect friction force between the rods, if a force F = 9N is applied at the left end of the left rod, what force F_1 (in newton) must be applied at the right end of the right rod to keep the system in equilibrium.



12. A small sphere slides with a speed v = 60 m/s on a frictionless horizontal surface between two parallel massive walls. One of which is fixed and the other can be moved. Initial distance between walls is L. The sphere bounces between the walls perfectly elastically. Now the right wall is moved towards the left walls by a distance 0.01 L with speed 0.0001v. Then what is the final speed of the sphere after the said movement of the wall in m/s.

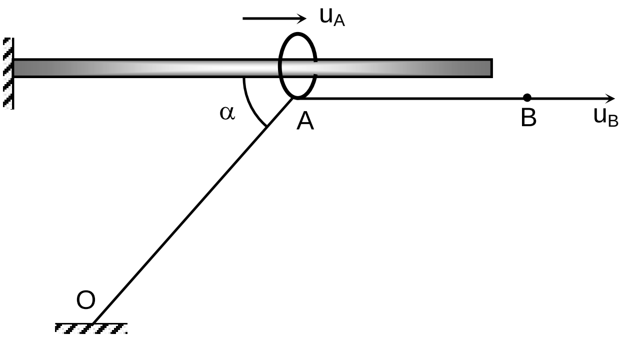


13. Figure shows a laptop made of two identical uniform plates, each of mass m = 1 kg connected by a hinge and placed on a rough horizontal surface as shown. The hinge is locked when the screen makes an angle of 120° from the keypad of the laptop. Assume that the laptop does not slide on the horizontal surface, then what is the minimum force (in newton) that can be applied on the top of the laptop, in the plane of the page to cause the bottom of the laptop to lift off the ground? (Take g = 10 m/s^2)

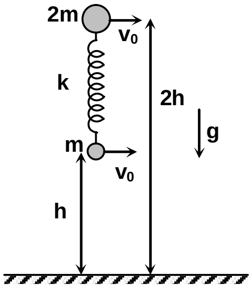


14. A block of mass m = 1 kg is dropped vertically onto a fixed ramp from a height of h = 2.5 m with angle θ = 37° with horizontal and having coefficient of static friction and kinetic friction μ= 0.5. The block is dropped in such a way that it does not rotate after colliding with the ramp. Through this problem assume that the time of the collision is negligible. The block slides down the ramp immediately after impact. What it the speed (in m/s) of the block right after the collision? (Take g = 10 m/s^2)

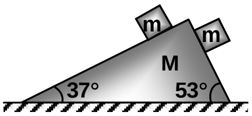
15. One end of the non stretchable rope is tied to a fixed knob O, while other end B of the rope is moving horizontally with a constant velocity u_B = 1 m/s. That rope goes through a small ring A, which can move freely along a horizontal straight rod as shown in the figure. Determine velocity u_A of the ring (in m/s), when inclined section of the rope makes an angle α = 30° with the rod.



16. Two small bodies with masses m and 2m are attached to a spring of negligible mass. Initially the compressed spring form a straight vertical line, when both objects are launched with same velocities v_0 = 1 m/s in the horizontal direction as shown in the figure. Initial height of the lower body is h = 1 m from the ground, while distance of heavier body is 2h = 2m. After t = 0.1 sec from the launch, lower body hits the ground. Determine height H (in m) of the upper body from the ground at that moment of time. (assume no air drag and g = 10 m/s^2)



17. A right triangular wooden block of mass M = 4 kg is at rest on a smooth table as shown in the figure. Two smaller wooden cubes both of mass m = 2 kg, initially at rest on the two sides of the larger block start sliding down. What is the normal force (in newton) applied by the system on the table? (take $g = 9.8\ m/s^2$)



18. The 'wall of death' ride consists of a drum with diameter d = 10m which rotates at an angular velocity ω as shown in the figure-(a). Passengers stand against the inside vertical rough wall and as the ride speeds up to angular velocity ω, they are held against the wall and can not slide down due to friction with the wall. The rotating drum is now tilted so that its axis of rotation is $\theta = 37°$ above the horizontal as shown in the figure-(b). If the coefficient of friction between the wall and the passenger is $\mu = 0.5$, then find the minimum angular velocity ω_0 (in rad/s) of the drum so that passengers are held against the wall at the highest point. (Take $g = 10\ m/s^2$)

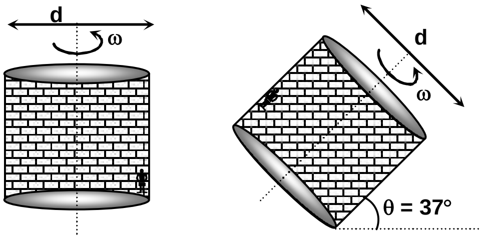


Figure-(a) Figure-(b)

Chemistry

PART – II

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

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19. Which of the following species are polar as well as non-planar?
(A) XeF_4
(B) H_2O_2
(C) $XeF_5^{\ominus}$
(D) $XeF_5^{\oplus}$

20. All bonds are equivalent in
(A) $Cr_2O_7^{2-}$
(B) HCO_3^-
(C) XeO_6^{4-}
(D) SF_6

21. The radial part $R(r) = \frac{1}{9\sqrt{\sigma a_o^{3/2}}}\left(\frac{6r}{a^o} - \frac{r^2}{a_o^2}\right)e^{-r/3a^o}$ represent for an orbital. (a_o is Bohr's radius of H-atom)
Choose the correct statement about the orbital
(A) this orbital may have one nodal plane in yz plane
(B) it is 3p orbital
(C) one node will be found at the $r = 6a^o$ distance from nucleus
(D) this orbital can accommodate maximum 6 electrons

22. Which of the following geometry is most likely form from sp^3d – hybridisation?
(A) Linear
(B) Tetrahedral
(C) Bent T-shaped
(D) See-Saw

23. Find the incorrect statement
(A) Iodine exists as I_8^{2-} ion in Cs_2I_8
(B) Oxidation state of Cr in CrO_5 and CrO_8^{3-} is +6
(C) $FeCl_2$ is more ionic than $FeCl_3$
(D) LiO_2 and NaO_2 are yellow coloured compound but KO_2 is colourless

24. Consider the following options and choose the correct one
(A) In the given equilibrium $2SO_2 + O_2 \rightleftharpoons 2SO_3$
If O_2 is added and the volume of the reaction vessel is reduced the equilibrium is shift in product side.
(B) If we add CrO_4^{2-} ion in saturated solution of Ag_2CrO_4 it will decreases $\left[Ag^+\right]$.

(C) Three sparingly soluble salt A_2B, AB and AB_3 are given. If all the three having same value of solubility product (K_{SP}). In the saturated solution the correct order of their solubilities is $AB > A_2B > AB_3$.

(D) If in option (A) inert gas is added at constant pressure and temperature. Partial pressure of SO_3 will be remain same.

Section – A (Maximum Marks: 12)

This section contains ***FOUR (04)*** *Matching List Type Questions. Each question has FOUR statements in* ***List-I*** *entries (I), (II), (III) and (IV) and FIVE statements in* ***List-II*** *entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which* ***ONLY ONE*** *of these four options is correct answer.*

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25. If t_x represents time required for a fraction x of a reactant to be reacted during a reaction involving only one reactant. Then match List – I with List – II.

List – I		**List – II**	
(I)	Zero order reaction	(P)	$\frac{t_{3/4}}{t_{1/2}} = 3$
(II)	First order reaction	(Q)	$\frac{t_{1/4}}{t_{1/8}} = 2$
(III)	Second order reaction	(R)	$\frac{t_{7/8}}{t_{3/4}} = \frac{3}{2}$
(IV)	Order of reaction $\geq$ 1	(S)	$\alpha = \left(1 - e^{-kt}\right)$
		(T)	$\frac{t_{100\%}}{t_{50\%}} = 2$

($\alpha \rightarrow$ degree of dissociation, k $\rightarrow$ rate constant)

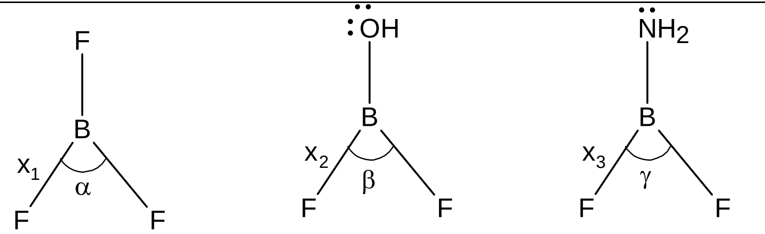
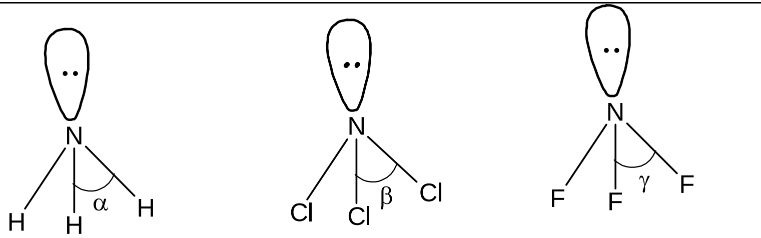
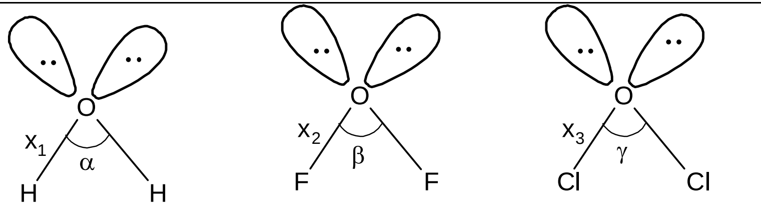
(A) I→Q, T; II→R, S; III→P; IV→P, R, S
(B) I→Q; II→R, T; III→P; IV→P, R
(C) I→ T; II→P; III→R, S; IV→Q, T
(D) I→R, T; II→Q; III→ P; IV→P, Q

26. List – I contains properties and List – II contains moles or ions

List – I		**List – II**	
(I)	2 lone pair on central atom	(P)	XeF_5^-
(II)	Zero dipole moment	(Q)	NF_3
(III)	Planar	(R)	ICl_3
(IV)	All adjacent bond angle are equal	(S)	XeF_4
		(T)	PCl_3F_2

(A) I→P, R, S; II→S, T; III→P, Q,R, S; IV→P, Q, R, S, T
(B) I→P, R, S; II→P, S, T; III→P, R, S; IV→P, Q,R, S
(C) I→P, R, T; II→R, S, T; III→R, S; IV→S, T
(D) I→P,S, T; II→P, R, S; III→P, Q,R, S, T; IV→P, R, S

27. List – I contains compounds with bond parameter and List – II contains bond parameter decreasing order (x_1, x_2, x_3 are bond length while α, β, γ are bond angle)

	List – I		List – II
(I)	 F B x_1 α F F OH B x_2 β F F NH_2 B x_3 γ F F	(P)	$x_1 > x_3 > x_2$
(II)	 N H H α H N Cl Cl β Cl N F F γ F	(Q)	$\gamma > \alpha > \beta$
(III)	 O x_1 α H H O x_2 β F F O x_3 γ Cl Cl	(R)	$\alpha > \beta > \gamma$
(IV)	S_8 S_2F_2 S_2Cl_2 (S – S bond length) x_1 x_2 x_3	(S)	$x_3 > x_2 > x_1$
		(T)	$\gamma > \beta > \alpha$

(A) I→S,T; II→R; III→Q,S; IV→S
(B) I→R, S; II→Q; III→S, T; IV→P
(C) I→R,S; II→R; III→Q, S; IV→P
(D) I→R,S; II→T; III→S,T; IV→S

28. List – I contains elements and compounds in respective properties and List – II contains decreasing order of properties.

	List – I						List – II
(I)	B 1	Al 2	Ga 3	In 4	(Atomic size)	(P)	4 > 3 > 2 > 1
(II)	NaOH 1	KOH 2	RbOH 3	CsOH 4	(Thermal stability)	(Q)	4 > 2 > 3 > 1
(III)	SiO_2 1	CO_2 2	CaO 3	Cs_2O 4	(Basic strength)	(R)	1 > 2 > 3 > 4
(IV)	BeF_2 1	BaF_2 2	CaF_2 3	MgF_2 4	(Water solubility)	(S)	4 > 3 > 1 > 2
						(T)	2 > 3 > 4 > 1

(A) I→Q; II→S; III→P; IV→T
(B) I→Q; II→P; III→S; IV→T
(C) I→P; II→Q; III→S; IV→R
(D) I→Q; II→P; III→S; IV→R

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

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29. Fauzosite, a zeolite has formula

$Na_x\left[(AlO_2)_y\,(SiO_2)_{136}\right].250H_2O$

The value of $\frac{x}{y}$ is.....

30. Calculate the pH at equilibrium point when a solution of 0.6 M CH_3COOH is titrated with a solution of 0.20 M NaOH (K_a of CH_3COOH 10^{-5} at 25^oC (log2 = 0.30, log3 = 0.48)

31. In cyanuric triazide $\left[C_3N_3(N_3)_3\right]$. The number of sp^2 hybridised centre atoms is/are 'x' and number of π bond that can lies in same plane is/are 'y'. Calculate the value of $\frac{x}{y}$...?

32. For reaction $I^- + ClO_3^- + H_2SO_4 \longrightarrow Cl^- + HSO_4^- + I_2$

If stoichiometric coefficient of HSO_4^- is 'x' and total number of electron gain in the balance reduction half reaction is 'y'. Calculate the value of $\frac{x+z}{y}$......?

(z – Stoichiometric coefficient of I_2).

33. 2 mole of $NH_4HS(s)$ is taken in close container of volume 2 litre. If 1 mole NH_4HS (s) taken part in reaction to attain the equilibrium state and at equilibrium moles of $H_2(g)$ is 0.75.

$NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$ $\qquad K_{C_1} = x$

$NH_3(g) \rightleftharpoons \frac{1}{2}N_2(g) + \frac{3}{2}H_2(g)$ $\qquad K_{C_2} = y$

At equilibrium $[NH_3]$ = a M

$[N_2]$ = b M calculate the value of $\frac{y_1}{x_1(a+b)}$ is...?

34. The mechanism of the reaction

$X + 2Y \xrightarrow{K,Ea,A} P$ is

Step 1. $X + Y \underset{K_2,E_{a_2},A_2}{\overset{K_1,Ea_1,A_1}{\rightleftharpoons}} I$ (Fast)

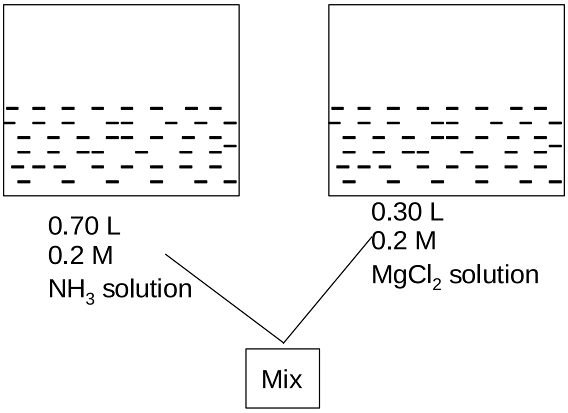
Step 2. $I + Y \xrightarrow{K_3,Ea_3,A_3} P$ (Slow)

If the value of $K_1, K_2, K_3, E_{a_1}, E_{a_2}, E_{a_3}, A_1, A_2$ and A_3 are given below

K_1	K_2	K_3	A_1	A_2	A_3	E_{a_1}	E_{a_2}	E_{a_3}
10^{-3}	10^{-4}	10^{-5}	2×10^8	2×10^9	2×10^6	20	40	35

Rate constant unit and pre-exponential factors for the reaction is in sec^{-1} and activation energy is in kJ. Calculate the value of $\frac{K\times A}{E_a}$ is.....?

35.



What mass (in g) of $(NH_4)_2SO_4$ should be added to the above mixture cause the $Mg(OH)_2$ to re-dissolve? $\left(K_{SP} \text{ for } Mg(OH)_2 = 6.0 \times 10^{-12} \text{ and } K_b \text{ for } NH_3 = 2 \times 10^{-5}\right)$

36. In a elementary chemical reaction $A(aq) \xrightarrow{t_{1/2}=10\text{ min}} 2B(aq) + C(aq)$

Reaction mixture react with another reactant T and n-factor of A, B and C react with T in the ratio 2 : 1 : 2 respectively.

If volume of 'T' used at 10 min is 40 ml. Calculated volume of T used at t = 0 is x ml, at t = 20 min, is y ml at $t = \infty$ is z ml.

Find out the value of $\frac{y+z}{x}$ is.......?

Mathematics

PART – III

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

37. If maximum value of $f(x) = \frac{3\sqrt{2x^2+x}}{2x^2+x+2\sin^2\theta}$ (where x > 0) is $\frac{3}{\sqrt{2}}$, then θ may lie in

(A) $\left(-\frac{\pi}{6}, \frac{\pi}{6}\right)$ (B) $\left(-\frac{\pi}{4}, \frac{\pi}{4}\right)$

(C) $\left(-\frac{\pi}{3}, \frac{\pi}{3}\right)$ (D) $(-\pi, \pi)$

38. If $\int_0^x f(t)dt = e^x - ae^{2x}\int_0^1 f(t)e^{-t}dt$, then

(A) $a = \frac{1}{3-2e}$ (B) $f(x) = e^x - 2e^{2x}$

(C) $a = \frac{1}{e}$ (D) $f(x) = e^x - e^{-x}$

39. If a function satisfies $(x - y) f(x + y) - (x + y) f(x - y) = 2(x^2y - y^3)$ $\forall$ x, y $\in$ R and f(1) = 2, then

(A) |f(x)| is non differentiable at two points (B) |f(x)| is continuous everywhere

(C) f(–4) = 12 (D) f(4) = 18

40. The value(s) 'a' for which the area of the triangle included between the axes and any tangent to the curve $x^ay = \lambda^a$ is constant is/are

(A) $-\frac{1}{2}$ (B) –1

(C) $\frac{1}{2}$ (D) 1

41. Let f(x) be non-positive continuous function and F(x) = $\int_0^x f(t)dt$ $\forall$ x $\geq$ 0 and f(x) $\geq$ c F(x) where c > 0 and let g : [0, ∞) $\to$ R be a function such that $\frac{d(g(x))}{dx} < g(x)$ $\forall$ x > 0 and g(0) = 0, then

(A) the total number of roots of the equation f(x) = g(x) is 1

(B) the total number of roots of the equation f(x) = g(x) is 0

(C) the number of solution of equation $|x^2 + x - 6| = f(x) + g(x)$ is 1

(D) the number of solution of equation $|x^2 + x - 6| = f(x) + g(x)$ is 0

42. If y(sin 2x + y cos x) + $\sin x\frac{dy}{dx}(\sin x + 2y) = \sin x(1 + 2\cos x)$ and $\left(\frac{\pi}{2}, 0\right)$ is a point on the curve, then which of the following is a point on the curve also

(A) $\left(\frac{3\pi}{2}, -1\right)$ (B) $\left(\frac{3\pi}{2}, 0\right)$

(C) $\left(\frac{\pi}{2}, -1\right)$ (D) none of these

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (I), (II), (III) and (IV) and FIVE statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

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43. Match the following List-I with List-II

List-I		**List-II**	
(I)	If function f satisfies $\int_0^1 \left(f^4(x) - 8x^2 f^2(x)\right)dx + \frac{16}{5} = 0$, then the value of $f^2(1)$ is	(P)	0
(II)	If the point of inflection for the curve $y = \int_0^x \sqrt{1-t^4}\,dt$ is (α, β), then $\alpha + \beta$ is equal to	(Q)	1
(III)	Let f be continuous and function g is defined as $g(x) = \int_0^x \left(t^2 \cdot \int_1^x f(u)du\right)dt$ also f(1) = 3, and $g'(1) + g''(1)$ is equal to $n_1 + \frac{f'(1)}{n_2}$ (where $n_1, n_2 \in N$), then $n_1 - n_2$ is	(R)	2
(IV)	Let $I_1 = \int_0^1 \frac{e^x}{1+x}dx$ and $I_2 = \int_0^1 \frac{x^2}{e^{x^3}\left(2-x^3\right)}dx$, then $\frac{I_1}{eI_2}$ is	(S)	3
		(T)	4

The correct option is:
(A) (I) → (T); (II) → (P); (III) → (R); (IV) → (S)
(B) (I) → (T); (II) → (P); (III) → (Q); (IV) → (R)
(C) (I) → (P); (II) → (Q); (III) → (R); (IV) → (S)
(D) (I) → (T); (II) → (P); (III) → (T); (IV) → (S)

44. Match the following List-I with List-II

List-I		**List-II**	
(I)	Number of points of discontinuity of $f(x) = \left[\frac{2x}{\pi}\right] + \{\sin x\}$ in $x \in [0, \pi]$ is/are (where [.] and {.} represents greatest integer function and fractional part function)	(P)	0
(II)	If the area included between the curve $y^2 = x^3$, tangent to it at point (1, 1) and x-axis is A, then [A + 1] (where [.] represents greatest integer function)	(Q)	1
(III)	If the area bounded by $f : [1, \infty) \to [1, \infty)$ given by $f(x) = x^2 - 2x + 2$ and its inverse is A, then 3A is equal to	(R)	2
(IV)	Let $I_n = \int_0^1 x^n\sqrt{1-x^2}\,dx$, then $\lim_{n\to\infty} \frac{I_n}{I_{n-2}}$ is equal to	(S)	3
		(T)	4

The correct option is:
(A) (I) → (R); (II) → (Q); (III) → (S); (IV) → (T)
(B) (I) → (T); (II) → (P); (III) → (Q); (IV) → (R)
(C) (I) → (R); (II) → (Q); (III) → (Q); (IV) → (Q)
(D) (I) → (T); (II) → (P); (III) → (S); (IV) → (R)

45. Match the following List-I with List-II

List-I		List-II	
(I)	Let $f(x) = x^3 - \frac{3}{2}x^2 + x + \frac{1}{4}$, then the value of $\int_{1/4}^{3/4} f(f(x))dx$ is	(P)	5
(II)	Let f : R → R, f(x) = 2x – x^2 and g : R → R, g(x) = x^n, n ∈ N. If area between f(x) and g(x) in first quadrant is $\frac{1}{2}$, then n is	(Q)	$\frac{11}{2}$
(III)	If $f(x) = \frac{1}{1+e^x}$ and S = f(5) + f(4) + f(3) + ... + f(–3) + f(–4) + f(–5), then the value of S is	(R)	$\frac{13}{2}$
(IV)	If $f(x) = \left(4\cos^4 x - 2\cos 2x - \frac{1}{2}\cos 4x - x^7\right)^{\frac{1}{7}}$, then f(f(4))	(S)	$\frac{1}{4}$
		(T)	4

The correct option is:
(A) (I) → (T); (II) → (P); (III) → (R); (IV) → (S)
(B) (I) → (S); (II) → (P); (III) → (Q); (IV) → (T)
(C) (I) → (S); (II) → (P); (III) → (T); (IV) → (Q)
(D) (I) → (T); (II) → (P); (III) → (S); (IV) → (S)

46. Match the following List-I with List-II

List-I		List-II	
(I)	If f : R → R be differentiable function such that f(x + 2y) = f(x) + f(2y) + 4xy ∀ x, y ∈ R, then f′(1) – f′(0) is equal to	(P)	1
(II)	If $\lim_{x\to\infty} f(x)$ exist and is finite and non-zero and $\lim_{x\to\infty}\left(f(x) + \frac{3f(x)-1}{f^2(x)}\right) = 3$, then value of $\lim_{x\to\infty} f(x)$ is	(Q)	2
(III)	Let f(x) = 1 + 2 cos x + 3 sin x. If real number a, b, c are such that af(x) + bf(x + c) = 1 holds for any x ∈ R, then $\left\lvert\frac{b\cos c}{a}\right\rvert$ is	(R)	3
(IV)	Define f : R → R, such that f(x + y) = 3^y f(x) + 2^xf(y) ∀ x, y ∈ R and f(1) = 1, then f(2) is	(S)	4
		(T)	5

The correct option is:
(A) (I) → (Q); (II) → (P); (III) → (T); (IV) → (P)
(B) (I) → (T); (II) → (P); (III) → (Q); (IV) → (R)
(C) (I) → (P); (II) → (Q); (III) → (R); (IV) → (S)
(D) (I) → (Q); (II) → (P); (III) → (P); (IV) → (T)

Section – B (Maximum Marks: 24)

This section contains ***EIGHT (08)*** *numerical based questions. The answer to each question is a* ***NUMERICAL VALUE.*** *If the numerical value has more than two decimal places, truncate/round-off the value to* ***TWO*** *decimal places.*

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47. Function f : $R^+ \to R$ is differentiable and satisfies the condition f(x) – f(y) ≥ $\ln\left(\frac{x}{y}\right) + x - y$, for all x, y ∈ R^+. If g denote the derivative of f, then the value of the $g\left(\frac{1}{2022}\right)$

48. Consider a function $f(x) = \prod_{r=1}^{\infty}\left(\frac{1+2\cos\left(\frac{2x}{3^r}\right)}{3}\right)$. Then two number of points where |x f(x)| + ||x – 2| – 1| is non differentiable on interval (0, 3π)

49. If the value of definite integral $I = \int_0^2 (3x^2 - 3x + 1)\cos(x^3 - 3x^2 + 4x - 2)dx$ can be expressed in the form of α(sin β), where α, β ∈ N, then the value of $\frac{\alpha^2 + \beta^2 + 1}{2}$

50. If $S = \sum_{r=1}^{502}\left[\frac{305r}{503}\right]$, then $\frac{S}{10,000}$ is (where [.] represents greatest integer function)

51. The value of $I = \frac{2^{2022}\int_0^1 x^{1010}(1-x)^{1010}\,dx}{\int_0^1 x^{1010}(1-x^{2022})^{1010}\,dx}$ is

52. Let f be a differentiable function satisfying the functional equation f(xy) = $f(x) + f(y) + \frac{x+y-1}{xy}$ ∀ x, y > 0 and f′(1) = 2, then the value of $\left[f(e^{200})\right]$ is equal to (where [.] represents greatest integer function)

53. Consider the following area:
    A_1 = Area of region common to y ≤ f(x) and y ≥ g(x)
    A_2 = Area of region common to y ≥ f(x) and y ≤ g(x)
    A = Area of region bounded by y = f(x), y = g(x) and x = ±π
    where f(x) = |cos |x||, g(x) = |sin |x|| for x ∈ [–π, π]. Then the value of $(\sqrt{2}+1)(A_1 + A_2 + A_3)$ is

54. If $I = \int_0^{\pi/2} \sin x \log_e(\sin x)dx$ and A is area of the region bounded by the set $\left\{(x, y) : 0 \le y \le \min\left\{3 - x, x + \frac{1}{x}\right\}\right\}$, then the value of A – I is

FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
PART TEST – I
PAPER –2
TEST DATE: 20-11-2022

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B**.

Section – A *(01 – 04, 19 – 22, 37 – 40)*: This section contains **TWELVE (12)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.

Section – A *(05 –10, 23 – 28, 41 – 46)*: This section contains **EIGHTEEN (18)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – B *(11 – 18, 29 – 36, 47 – 54)*: This section contains **TWENTY FOUR (24)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.**

MARKING SCHEME

Section – A (Single Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct option is chosen.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –1 In all other cases.

Section – A (One or More than One Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If only (all) the correct option(s) is (are) chosen;
Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;
Partial marks : +2 if three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –2 In all other cases.

Section – B: Answer to each question will be evaluated according to the following marking scheme:

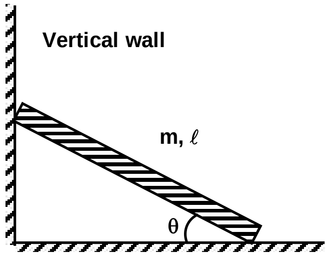
Full Marks : +3 If ONLY the correct integer is entered;
Zero Marks : 0 Question is unanswered;
Negative Marks : –1 In all other cases.

Physics PART – I

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

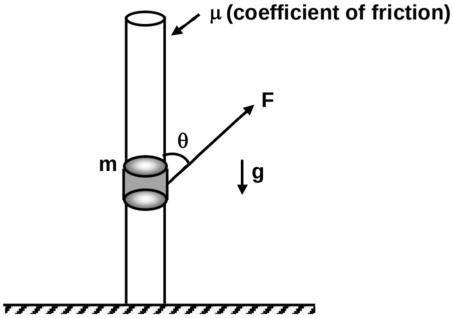
1. A uniform rod of mass m and length ℓ is released from the position shown in the diagram. If all the surfaces are smooth then find the Normal reaction applied by ground on the rod just after the release. $\left(\sin\theta = \frac{3}{5}\right)$.



(A) $\frac{9mg}{25}$ (B) $\frac{12mg}{25}$

(C) $\frac{16mg}{25}$ (D) $\frac{13mg}{25}$

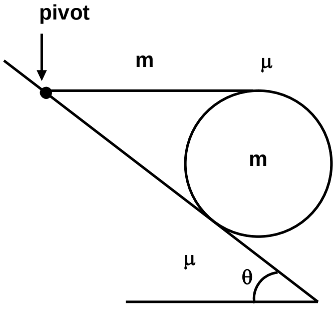
2. A collar of mass m is to be moved along a long fixed rough straight vertical rod by applying a force F which is constant in magnitude and whose direction is continuously changing such that θ is increased from 0° to 90° linearly with time. Initially the collar is at rest at ground and again comes to rest when the force becomes horizontal then



(A) $F = \frac{mg\pi}{2(1-\mu)}$ (B) $F = \frac{mg\pi}{(1-\mu)}$

(C) $F = \frac{3mg\pi}{2(1-\mu)}$ (D) $F = \frac{2mg\pi}{(1-\mu)}$

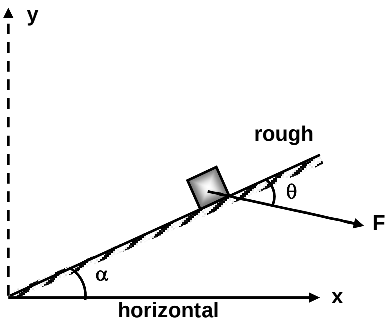
3. A horizontal stick of mass m has its left end attached to a pivot on the inclined plane while its right end rests on the top of a cylinder of same mass m as shown. The coefficient of friction between the cylinder and both the stick and plane is μ. Then the smallest value of μ for which the system doesn't slip anywhere is



(A) $\frac{\sin\theta}{2+\cos\theta}$ (B) $\frac{3\sin\theta}{1+\cos\theta}$

(C) $\frac{\sin\theta}{1+\cos\theta}$ (D) $\frac{3\sin\theta}{2+\cos\theta}$

4. A block is placed on a fixed rough inclined plane $\left(\mu = \frac{1}{\sqrt{3}}\right)$ as shown. A force F is applied on the block in the direction shown. Find the range of θ so that any value of the force F is not able to slide the block along the inclined plane. (Assuming that $\vec{F}$ always lies in x-y plane). (Also Given $\alpha < 30°$).

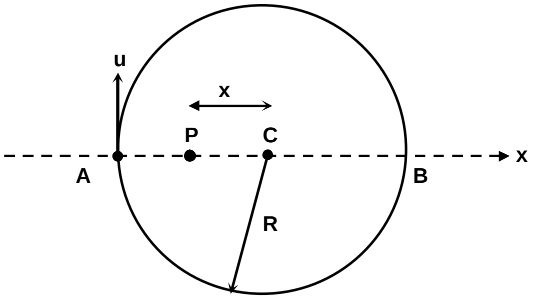


(A) [60°, 120°] (B) [30°, 120°]
(C) [30°, 90°] (D) [60°, 90°]

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

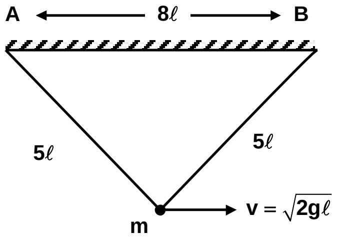
5. A bead of mass m is given a velocity u from point A along a fixed smooth circular wire of radius R which passes inside the bead as shown in gravity free space. A force F (constant in magnitude) always acting on bead towards a fixed point P. If u_0 is the minimum value of u so that bead completes the entire circle and if $\frac{u}{u_0} = \alpha$ and $\frac{x}{R} = \beta$ and $\vec{N}$ is the normal reaction experienced by bead at point B. Then choose the correct option(s).



(A) If $\alpha = \sqrt{2}, \beta = \frac{1}{8}$ then $\vec{N} = \frac{F}{2}\hat{i}$ (B) If $\alpha = \sqrt{2}, \beta = \frac{1}{3}$ then $\vec{N} = -\frac{F}{3}\hat{i}$

(C) If $\alpha = \sqrt{3}, \beta = \frac{1}{8}$ then $\vec{N} = \frac{5F}{2}\hat{i}$ (D) If $\alpha = \sqrt{3}, \beta = \frac{1}{3}$ then $\vec{N} = \frac{-5F}{3}\hat{i}$

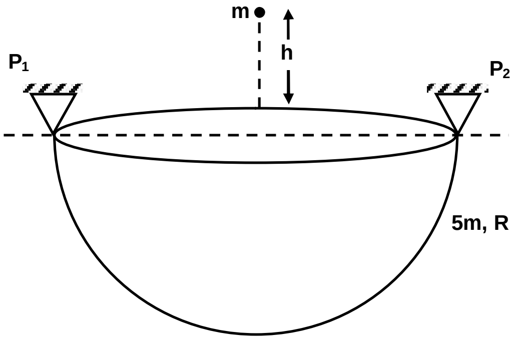
6. An ideal smooth massless inextensible string passes through the bead as shown whose ends are fixed at A and B. Initially the system is in equilibrium, now bead is given a velocity $\sqrt{2gl}$ in horizontal direction and in the plane of the string as shown. Let T_0 be the tension in the string and r_0 be the radius of curvature of particle just after the velocity is given. Then choose the correct option(s).



(A) $T_0 = \frac{31\,mg}{30}$ (B) $r_0 = \frac{35\ell}{3}$

(C) $T_0 = \frac{41\,mg}{40}$ (D) $r_0 = \frac{25\ell}{3}$

7. A small particle of mass m is dropped from height h from the flat surface of a uniform solid hemisphere of mass 5m and radius R which is held at rest with the help of two frictionless pivots on diametrically opposite points and the hemisphere is free to rotate about the axis passing through the pivots. The particle strikes on a point on circumference which is equidistant from the pivots and sticks to it. After the collision, the flat surface of hemisphere just able to reach in vertical plane. Then choose the correct option(s)



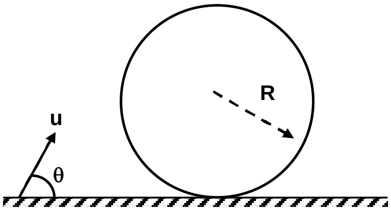
(A) $h = \frac{21R}{8}$

(B) h = 3R

(C) Angular velocity of the system just after collision is $\sqrt{\frac{7g}{12R}}$

(D) Angular velocity of the system just after collision is $\sqrt{\frac{8g}{12R}}$

8. A particle is thrown from ground with speed u at an angle θ with horizontal as shown. If u_0 is the minimum value of u so that the particle will cross the horizontal cylinder just grazing at two points on it and θ_0 is the corresponding angle of projection. Then choose the correct option(s).



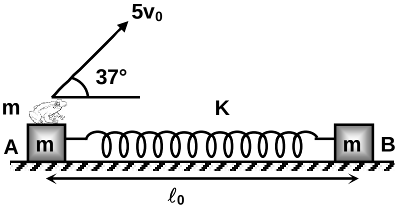
(A) $u_0^2 = Rg\left[2+2\sqrt{2}\right]$

(B) $\tan^2\theta_0 = [3+2\sqrt{3}]$

(C) $u_0^2 = Rg\left[2+2\sqrt{3}\right]$

(D) $\tan^2\theta_0 = [3+2\sqrt{2}]$

9. The system of two blocks and a frog (each having mass m) is placed on a smooth horizontal surface as shown. Initially the spring is in natural length (ℓ_0) and all are at rest. Now the frog jumps with velocity 5 v_0 at an angle of 37° with horizontal w.r.t. the block A and lands directly on block B. If R is the horizontal Range of frog in ground frame during the jump. If stiffness of the spring is $K = \frac{\pi^2 mg^2}{288 v_0^2}$, then choose the correct option(s).



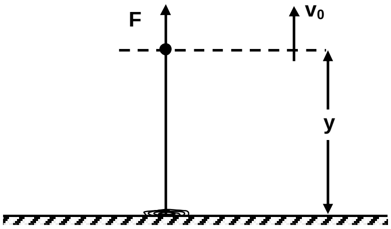
(A) $R = \frac{12v_0^2}{g}$

(B) $R = \frac{24v_0^2}{g}$

(C) $\ell_0 = \frac{12v_0^2}{g}\left[1+\frac{2}{\pi}\right]$

(D) $\ell_0 = \frac{6v_0^2}{g}\left[3-\frac{2}{\pi}\right]$

10. A uniform rope of linear mass density λ is coiled on a smooth horizontal table as shown. One end is pulled up with constant speed v_0. Then choose the correct option(s)



(A) Force exerted (F) on the end of the rope is $\lambda yg + \frac{\lambda v_0^2}{2}$

(B) Force exerted (F) on the end of the rope is $\lambda yg + \lambda v_0^2$

(C) Heat loss per unit time is $\frac{\lambda v_0^3}{2}$

(D) Heat loss per unit time is λv_0^3

Section – B (Maximum Marks: 24)

This section contains ***EIGHT (08)*** *numerical based questions. The answer to each question is a* ***Single Digit Integer, ranging from 0 to 9 both inclusive.***

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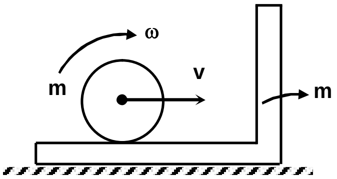
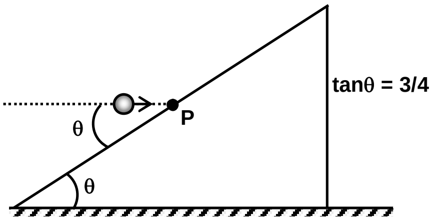
11. An L shaped wedge of mass m having long horizontal base is placed on smooth horizontal surface as shown. A thin Ring of mass m and Radius R is set in motion on the rough horizontal part of the wedge with a linear velocity v and angular velocity ω such that $v = \omega R$. Ring collides with the smooth vertical part of wedge such that collision is perfectly elastic. After a sufficiently long time, the final velocity of wedge is $\frac{v}{K}$. Find the value of K. (Assume wedge does not topple due to collision)



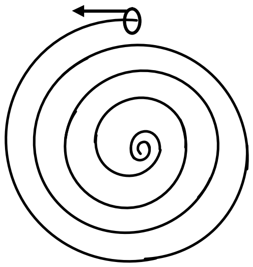
12. A projectile is thrown from ground with velocity 8 m/s. When it is moving with 6 m/s, it is at maximum separation from the point of projection corresponding to the speed 6 m/s. Then this maximum separation corresponding to speed 6 m/s is k meter. Find the value of k. (Take g = 10 ms^{-2})

13. A small elastic ball moving horizontally with 40 m/s collides with the smooth stationary wedge (e = 1) at point P which is placed on smooth horizontal surface as shown. After that it again strikes on the wedge at same point P after t_0 seconds. Find the value of t_0. (Take g = 10 ms^{-2})

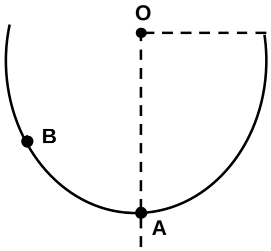


14. Bob of mass m of simple pendulum is given a velocity from the lower most position in horizontal direction in uniform vertical gravitational field (g) such that $\frac{T_{max}}{T_{min}} = 2$ during the subsequent motion. Then the tension in the string when it becomes horizontal is K mg. Find the value of K. (T represents tension in the string)

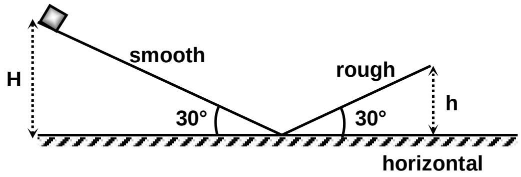
15. A bead of mass m is given a velocity along a smooth rigid spiral wire (mass M = 2m and outer radius R) such that bead slides along the wire. When bead will reach the center of spiral and sticks to it, at that moment velocity of bead is v and angular velocity of spiral is ω. (Assume that the center of mass of loop lies at its centre and given that its moment of Inertia about an axis passing through centre and perpendicular to its plane is $I = \frac{MR^2}{2}$). Find $\frac{\omega R}{v}$ (Neglect gravity)



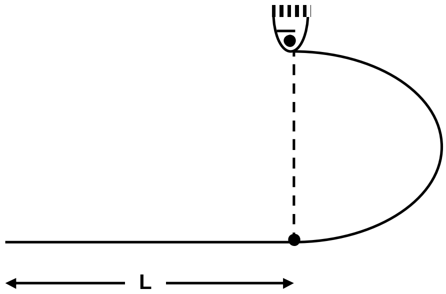
16. In a fixed hemispherical smooth bowl of Radius R, a particle is dropped at point B somewhere else other than point A. Collision with the bowl is perfectly elastic. For second collision to take place at point A, the maximum value of $\angle BOA$ is $\frac{\pi}{K}$ radian. Find the value of K.



17. A particle is released from the top of a fixed smooth inclined surface as shown from height H from the ground. The particle will reach upto height h from the ground on a rough fixed inclined plane which is directly connected to the smooth inclined plane. If coefficient of friction for rough inclined plane is $\frac{1}{2\sqrt{3}}$ the find $\frac{H}{4h}$. (Assume that particle does not jump.)



18. A uniform rod of length L is rigidly attached with a uniform semi-circular ring of same density as of rod to form a rigid body in a plane. The system is hanged in vertical plane in equilibrium with the help of hinge as shown such that rod is in horizontal position. Then the distance of centre of mass of the system from hinge is $\frac{L}{2}\left[\frac{\pi+\alpha}{\pi+\beta}\right]$. Find the value of $\alpha\beta$.



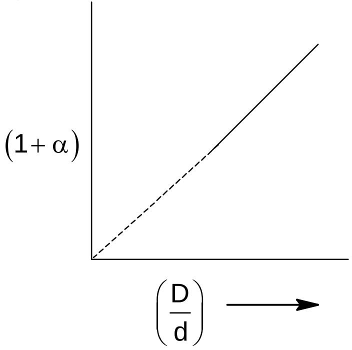
Chemistry PART – II

Section – A (Maximum Marks: 12)

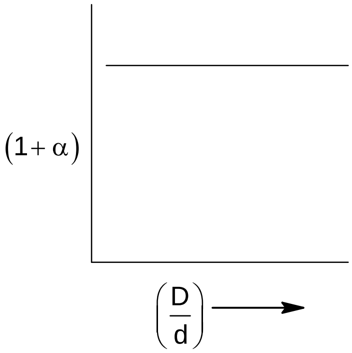
*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

19. For the dissociation of $PCl_5(g)$ the variation of $(1+\alpha)$ against (D/d) is represented as
(D → Vapour density at t = 0, d → Vapour density at equilibrium)

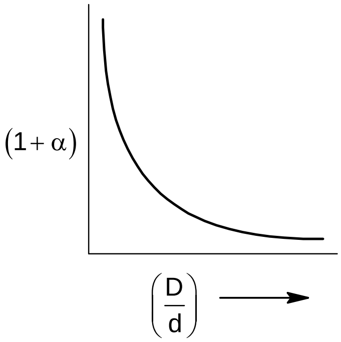
(A)



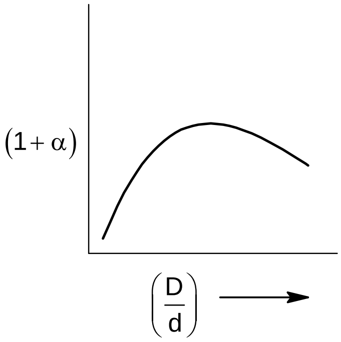
(B)



(C)



(D)



20. For an reaction $2-\text{pentyne} \rightleftharpoons 1-\text{pentyne}$. The temperature dependence of equilibrium constant is given by $\ell nK = 8.0 - \frac{8000}{T}$. The value of ΔS^o at 300 K. is….

(A) 4R
(B) 8R
(C) 8000R
(D) $\frac{R}{8}$

21. An electron in an atom jumps in such a way that its kinetic energy changes from x to $\frac{x}{8}$. The change in its potential energy will be?

(A) $+\frac{7}{8}x$
(B) $+\frac{7}{4}x$
(C) $-\frac{7}{4}x$
(D) $\left(-\frac{9x}{4}\right)$

22. The time required for 50% completion of a first order reaction at 298 K is equal to that required for 75% completion of a reaction at 308 K. If the pre-exponential factor for the reaction is 3.5×10^6 sec^{-1} in the given temperature range. Find the ratio of K_{298} to K_{308}.

(A) 0.5
(B) 2
(C) $\frac{3}{4}$
(D) $\frac{3}{2}$

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

23. In the emission spectrum of H-atom from energy level 'n' to ground state in one or more step and no line belongs to the Breckett series is observed. The wave length of lines belonging to Balmer series may be (R = Rydberg constant)

(A) $\frac{36}{5R}$
(B) $\frac{16}{3R}$
(C) $\frac{R}{3R}$
(D) $\frac{35}{3R}$

24. For the reaction started with 1 mol $A_2B_4(g)$ is

$A_2B_4(g) \longrightarrow A_2(g) + 2B_2(g)$

The vapour densities are measured at various time of dissociation and observed value are

(i)	at time t = 0 min	VD = 50
(ii)	at time t = 10 min	VD = 25
(iii)	at time t = 20 min	VD = 20

If $\frac{\text{V.D.}(A_2B_4)}{\text{V.D.}(A_2)} = 5$ and $t_{100\%}$ is 40 min.

Choose the correct option(s)

(A) The ratio of atomic mass of 'A' and atomic mass of 'B is 1 : 2

(B) Mole% of B_2 at time t = 10 min is 50%

(C) Assuming uniform dissociation the ratio of rate of disappearance of A_2B_4 and rate of appearance of A_2 (g) between t = 10 min to t = 20 min is 1 : 1

(D) Mole % of A_2 at t = 10 min is 50%

25. A closed rigid container of volume 1 litre, initially contains 4 mole of HI (g) and 4.25 moles of $N_2(g)$ at 27^oC. When the mixture is heated to 127^oC two reversible reactions takes place till equilibrium is established.

$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$ K_{C_1}

$2N_2(g) + 6H_2(g) \rightleftharpoons 4NH_3(g)$ K_{C_2}

At equilibrium the concentration of I_2 and NH_3 are 1.0 M and 0.5 M respectively. Choose the correct option

(A) $K_{C_1} = \frac{5}{32}$

(B) $K_{C_2} = \frac{16}{125}$

(C) $K_{C_1} \times \sqrt{K_{C_2}} = \frac{1}{25}$

(D) Conc. of N_2 at equilibrium = 4.0 mol/litre

26. How many of the following compounds has more than one $p\pi - d\pi$ bond

(A) SO_2

(B) SO_3

(C) XeO_4

(D) ClO_3^-

27. Which of the following statement(s) is/are true for $CH_2 = CH_2$ and $CH_2 = SF_4$ (Methyl sulphur tetrafloride)?

(A) In ethylene nodal plane lies in molecular plane

(B) In methyl sulphur tetrafloride nodal plane lies in axial plane

(C) In methyl sulphur tetrafloride nodal plane lies in equatorial plane

(D) If the nodal plane lies in equatorial plane its stability will be less than if its lies in axial plane

28. How many of the following compounds has more than two (3C – 2e) bond.

(A) $(AlCl_3)_n$

(B) B_2H_6

(C) $Al(BH_4)_3$

(D) $Be(BH_4)_2$

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.***

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29. Not considering the electronic spin the degeneracy of the second excited state of H-atom is 'x' degeneracy of the second excited state of H^- is 'y'. And number of angular node in $d_{x^2-y^2}$ orbital is 'z'. Calculate the value of $\frac{x}{y}+z$?

30. The given reaction how many of them can give sp^2 hybridised boron centre. In case of the product(s)

(i) $\text{Borax} \xrightarrow{\Delta}$

(ii) $\text{Borax} + NH_4Cl \xrightarrow{\Delta}$

(iii) $\text{Borax} \xrightarrow{HCl}$

(iv) $\text{Borax} \xrightarrow{H_2O}$

(v) $B_2H_6 + NH_3 \xrightarrow{\Delta}$

(vi) $B_3N_3H_3Cl_3 + LiBH_4 \xrightarrow{THF}$

(vii) $LiH + B_2H_6 \longrightarrow$

(viii) $K_3\left[AlF_6\right] + BF_3 \longrightarrow$

31. (i) If the sum of the number of lone pairs of electrons on each central atom in the given species is/are 'x'

$\left[TeBr_6\right]^{2-}, \left[IF_2\right]^{+}, SNF_3$ and $\left[XeF_3\right]^{-}$

(ii) and among the following species the number of diamagnetic spin is/are 'y'

B_2, Li_2, C_2, C_2^-, O_2^{2-}, O_2^+, He_2^+, Be_2, KO_2, K_2O, N_2O_4, $B_3N_3H_6$

(Atomic number of Te = 52, Br = 35, Xe = 54, K = 39, I = 127).

Calculate the value of $\frac{x+y}{2}$?

32. Equilibrium constant of $SO_3(g)$ decomposition and formations was calculated by following two methods

Method (1)

$$\boxed{2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)}$$

I

at t = 0, 10 moles of SO_3 is added $5(\ell)$ in container. If at equilibrium mixture is titrated with 0.2 M acidic $KMnO_4$ its volume 4 litre. K_C for the reaction is 'x' (mol/litre)

Method (2)

$$\boxed{2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)}$$

II

Initially 2 : 1 molar ratio SO_2 and O_2 is added respectively. At the equilibrium total pressure of mixture 20 atm. Mole % of O_2 at equilibrium is 25%. K_P for the reaction is 'y' atm^{-1}.

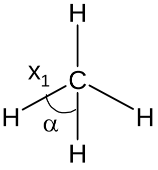
The value of $\frac{y}{x}$ is?

33. Consider the following combination of atomic orbitals

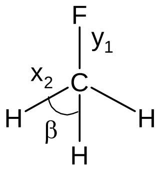
Sr. No.	Combining orbitals	Internuclear axis
i.	$s + p_x$	**(x)**
ii.	$d_{xy} + d_{xy}$	**(x)**
iii.	$d_{yz} + p_z$	**(z)**
iv.	$p_y + p_y$	**(y)**
v.	$d_{yz} + d_{yz}$	**(x)**
vi.	$s + s$	**(z)**
vii.	$d_{z^2} + d_{z^2}$	**(z)**
viii.	$d_{xy} + d_{xy}$	**(z)**
ix.	$p_x + p_x$	**(y)**
x.	$s + p_z$	**(x)**

Calculate the value of $\frac{a^2 + b^2 + 2d}{4}$ (Where $a = \sigma$, M.O. $b = \pi$. M.O. $d = \text{non} - \text{bonding}$ M.O.)

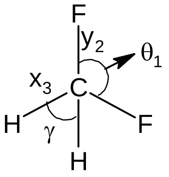
34. In the given compounds bond angle and bond length are defined



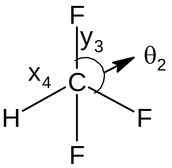
I


F
y1
x2
C
H
β
H
H

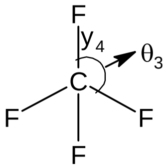
II


F
y2
θ1
x3
C
H
γ
F
H

III


F
y3
θ2
x4
C
H
F
F

IV



V

Order of bond parameter is/are given

(I) $\gamma > \beta > \alpha$

(II) $y_1 > y_2 > y_3 > y_4$

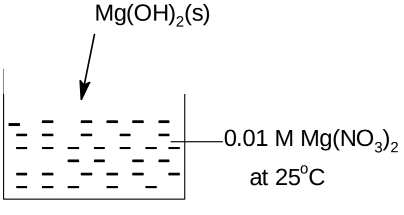
(III) $\theta_3 > \theta_2 > \theta_1$

(IV) $x_1 > x_2 > x_3 > x_4$

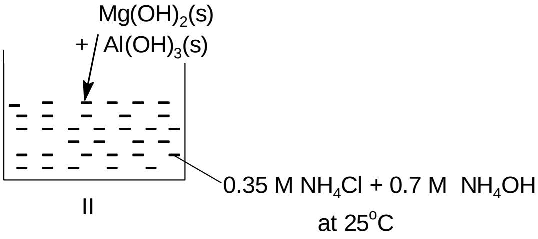
(V) Dipole moment IV > II > III > I = V

If the number of correct order(s) is 'x' and incorrect order (s) is 'y' about molecules I, II, III, IV and V. Calculate the value of (2x + y) …. Is?

35. The solubility of $Mg(OH)_2$ in pure water is 5.8×10^{-4} g/litre at 25°C.


Mg(OH)2(s)
0.01 M Mg(NO3)2
at 25°C

I


Mg(OH)2(s)
+ Al(OH)3(s)
0.35 M NH4Cl + 0.7 M NH4OH
at 25°C

II

K_b for $NH_4OH = 1.0 \times 10^{-5}$

K_{SP} $Al(OH)_3 = 1.6 \times 10^{-20}$

If the $\left[Mg^{+2}\right]$ in container (I) is 'x M' and concentration of $\left[Mg^{+2}\right]$ and $\left[Al^{3+}\right]$. In container II is 'y M' and 'z M' respectively. Calculate the value of $\frac{yz}{25x} =$ ......? (log2 = 0.30)

36. Choose the correct and incorrect statement in the following given statements

1. Hydrogen peroxide. In the pure state is non-planar and almost colourless.
2. $S_8(s) + aOH^-(aq.) \longrightarrow bS^{2-}(aq.) + cS_2O_3^{2-}(aq) + dH_2O(\ell)$
   The value of a + b is 16.
3. Hydrogen peroxide. In its reaction with KIO_4 and NH_2OH respectively is acting reducing agent and oxidizing agent.
4. $MgCl_2.6H_2O$ on heating give anhydrous $MgCl_2$.
5. H_3BO_3 is mono basic weak Lewis acid.
6. According to MOT B_2 and C_2 both do not have $\sigma-$bond.
7. 'Be' cannot be qualitatively confirmed by the flame test.
8. Correct order of density of alkali metals is Li < K < Na < Rb < Cs.
9. The silicates in which three oxygen atoms of $[SiO_4]^{4-}$ are shared known as sheet silicate.
10. Pb^{+4} compounds are stronger oxidizing agent than Sn^{+4} compounds.
11. Graphite is better lubricant on the earth than on moon.
12. The hydrolysis of trialkylchlorosilane R_3SiCl yields trialkylchlorosilanol.

If the correct number of statement(s) is/are x and incorrect statement(s) is/are y. Value of $\frac{3x+y}{6}$ is….

Mathematics PART – III

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

37. If f(x) is a function such that $f(x+y)+\frac{f(x)\cdot f(y)}{1+y^2}+\frac{\tan^{-1}x\cdot\tan^{-1}y}{1+y^2}=0\ \forall$ x, y $\in$ R and f′(0) = 1, then the function f(x) is

(A) $1-\tan^{-1}x-2e^{-\tan^{-1}x}$ (B) –(1 + $\tan^{-1}$ x)

(C) $e^{1-\tan^{-1}x}$ (D) $1-\tan^{-1}x-e^{-\tan^{-1}x}$

38. A function f(x) is such that the area enclosed by |y| = f(x) between x = 1 and x = a (a > 1) is given by g(a) = a^4 + $6a^2$ – 16a + 9, then the area formed by the curve $k(x)=\frac{f(x)}{g(x)+5}$ between the lines x = 2 and x = 3 with the x-axis is

(A) $\frac{1}{2}\ln\left(\frac{101}{22}\right)$ (B) $\frac{1}{2}\ln\left(\frac{131}{22}\right)$

(C) $\frac{1}{2}\ln\left(\frac{141}{12}\right)$ (D) $\frac{1}{2}\ln\left(\frac{101}{12}\right)$

39. The value of $\int e^{x^2}(2x-\cot x)(x^2-\ln(\sin x))(\operatorname{cosec} x)dx$ is equal to

(A) $e^{x^2}(2x-\ln(\sin x)+1)(\operatorname{cosec}\ x)+c$ (B) $e^{x^2}(2x-\ln(\sin x)-1)(\operatorname{cosec}\ x)+c$

(C) $e^{x^2}(x^2-\ln(\sin x)+1)(\operatorname{cosec}\ x)+c$ (D) $e^{x^2}(x^2-\ln(\sin x)-1)(\operatorname{cosec}\ x)+c$

40. Let C be a curve f(x, y) = 0 passing through (1, 1) such that it is orthogonal to the family of circles x^2 + y^2 – ax = 0, where ‘a’ being parameter, then the shortest distance between the curve C and the parabola x^2 = 2y + 1 is

(A) $\sqrt{2}+1$ (B) $\sqrt{2}-1$

(C) $\sqrt{3}+1$ (D) $\sqrt{3}-1$

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

41. Let f(x) = ($\cos^2$ x)·($e^{\tan x}$), $x\in\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$, then which of the following options is/are true?

(A) f‴(x) = 0 has atleast one root in $x\in\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$

(B) y = f′(x) has a point of local maxima in $x\in\left(-\frac{\pi}{4},0\right)$

(C) f″(x) = 0 has exactly one root in $x\in\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$

(D) $\lim\limits_{x\to\alpha}\frac{x^3-6x^2+11x-6}{x^2-3x+2}=-1$

where ‘α’ is the total number of points of maxima and minima of y = f′(x)

42. Let f(x) be a function satisfying $f'(x) > 0$, $f''(x) > 0\ \forall\ x \in (0, 1)$ and $f(0) = 0$, $f(1) = 1$, then which of the following options is/are true?

(A) $f\left(\frac{1}{2}\right)\cdot f\left(\frac{1}{3}\right) < 1$

(B) $f^{-1}\left(\frac{1}{2}\right)\cdot f^{-1}\left(\frac{1}{3}\right) > 1$

(C) $f\left(\frac{1}{3}\right)\cdot f^{-1}\left(\frac{1}{3}\right) < \frac{1}{3}$

(D) $f\left(\frac{1}{2}\right)\cdot f^{-1}\left(\frac{1}{2}\right) > \frac{1}{2}$

43. In a question, a student was given to find the derivative of the product of two functions 'f' and 'g'. The student by mistake thought $(fg)' = f'\cdot g'$ for his question $f(x) = \sqrt{\frac{x-1}{x-3}}$ and he got the correct answer. Given that g(1) = e. Which of the following options is/are correct?

(A) g(x) is discontinuous at one point

(B) $\lim\limits_{x\to\infty} g(x) = 1$

(C) $\lim\limits_{x\to\alpha} \frac{x^3-8}{x-2} = 12$ where α is the number of points of discontinuity of g(x)

(D) g(x) is discontinuous at two points

44. Let $f(x) = \cos^{-1}\left\{\frac{1-x^2}{1+x^2}\right\}$ and g(x) = {f(x)} $\forall\ x \in R$ (where {x} denotes fractional part function of x), then which of the following options is/are true?

(A) Total number of points where f(x) is not continuous is 2

(B) Total number of points where g(x) is not continuous is 7

(C) $f'(1) = f'(-1) = 1$ and g(x) is not differentiable at x = 0

(D) Total number of points where f(x) is not continuous is 3

45. Let f(x) be a function defined by $f(x) = \int_0^{3\pi/4} \left|x\cos t - 3\sin t + \sqrt{2}x\right|\left(\frac{1+\sqrt{2}\cos t}{(\cos t+\sqrt{2})^3}\right)dt$ where x is any real number, then which of the following options is/are true?

(A) f(x) is continuous and differentiable everywhere

(B) f(x) is continuous for all x but non-differentiable at two values of x

(C) Minimum value of f(x) is $\frac{3}{2}$ for $x \in R$

(D) Minimum value of f(x) is $\frac{3}{4}$ for $x \in R$

46. Let the function $f : (-\infty, \infty) \to \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$ be given by $f(x) = \sin^{-1}\left(\log_3\left(\frac{x^2-x+1}{x^2+x+1}\right)\right)$, then which of the following options is/are true for f(x)?

(A) f(x) is injective function

(B) f(x) is surjective function

(C) $f\left(\frac{1}{x}\right) = -f(-x)$

(D) The equation f(x) = x – 1 has two distinct roots

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.***

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47. If f(x) is a function satisfying $3f^2(x) - 4xf(x) + 2 = 0$ and the value of integral $\int \frac{(6x-2)f(x)-4x^2}{(3f(x)-2x)(x^2-f(x))^2}dx$ is equal to $\frac{ax+bf(x)}{3x^2f(x)-4x^3+2}+c$ (where a, b, c are constants), then the value of (a + b) is

48. If the area bounded between the curves |x| + y = 4 and $\sqrt{|x|}+\sqrt{y}=2$ is $\frac{16\lambda}{3}$ sq. units, then the value of λ is

49. The value of $\lim\limits_{n\to\infty}\left(\lim\limits_{m\to\infty}\left(\sum_{r=1}^{n}\left(\sum_{k=1}^{mr}\frac{mn^2}{(m^2n^2+k^2)(n^2+r^2)}\right)\right)\right)$ is $\frac{\lambda\pi^2}{160}$, then the value of λ is

50. Consider $f(x)=\frac{(x^2-1)(x^2-9)}{g(x)}$, $x \in R - \{a, b\}$, where g(x) is a polynomial of degree ≤ 4.

    f(x) has a removable type of discontinuity at x = a and x = b. The following three informations are also known

    (i) $\lim\limits_{x\to\pm\infty} f(x)=\infty$ (ii) $\lim\limits_{x\to1} f(x)=-4$

    (iii) $\lim\limits_{x\to-3} f(x)=a$ non-zero finite number

    Let L and M denotes the number of points of discontinuity and the number of points of non-differentiability of y = |f(|x|)| respectively in R (the set of all real numbers), then the value of (L + M) is

51. If $\int_0^{4\pi}\frac{dx}{2+\sin 4x}=\lambda\int_0^{3\pi/8}\frac{dx}{7+\cos\left(\frac{8x}{3}\right)}$, then the value of $\frac{3\lambda}{16}$ is

52. Let f(x) be a polynomial of degree 6 such that f(2) = 85 and attains its local minimum value 4 at points x = –1, x = 1 and x = 5. The local maximum value of f(x) lies at x = α and x = β.

    If $\lim\limits_{x\to(\alpha+\beta)}\left(\frac{x^2-9}{x^2-5x+6}\right)=\lambda$, then the value of [$\lambda$] is (where [.] represents greatest integer function)

53. If the value of $\lim\limits_{x\to0}\left(\frac{1}{x^{2022}}\int_{x^{2023}}^{x^{2022}}\frac{(1+t)^{\frac{1}{2021}}-1}{t}dt\right)=\frac{1}{\lambda}$, then the number of positive divisors of λ is

54. If the area bounded by the curves $x^2 = y$, $x^2 = -y$ and $y^2 = 4x - 3$ is $\frac{m}{n}$, where m and n are relatively prime positive integer, then |m – n| is

FIITJEE
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JEE (Advanced)-2023
PART TEST – I
PAPER –1
TEST DATE: 20-11-2022

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

Section – A

1. A, B, D

Sol. $-\frac{dx}{dt} = 0.1\sqrt{x}$

$\int_9^0 \frac{dx}{\sqrt{x}} = -0.1\int_0^\tau dt \Rightarrow \tau = 60$ sec

$\omega = \frac{0.1\sqrt{x}}{x} = \frac{0.1}{\sqrt{x}}$ rad/s

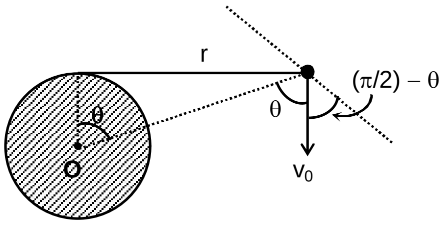
$a = v\omega = 0.1\sqrt{x}\,\frac{0.1}{\sqrt{x}} = 0.01$ m/s^2

2. A, C

Sol. Speed of the object will remain constant because tension is always perpendicular to the velocity.

So angular momentum about O = $mv_0 \sin\theta \frac{r}{\sin\theta} = mv_0 r$

$\frac{mv_0 mv_0^2}{T_{max}} = 5$ kg-m^2/sec



3. B, C

Sol. For the bigger disc $C\omega_1 r_1^4 - \int f dt r_1 = 0$

For the smaller disc $C\omega_2 r_2^4 - \int f dt r_2 = 0$

So, $\omega_1 r_1^3 = \omega_2 r_2^3$ and $\frac{L_1}{L_2} = \frac{r_1}{r_2}$

4. A, C, D

Sol. In both situations $v_C = \frac{J}{m}$

In situation-(ii), $\omega = \frac{J}{m\ell}$

5. B, D

Sol. $H_B^{max} > H_A^{max} > H_C^{max}$ (as shown clearly)

So, $u_B^y > u_A^y > u_C^y$

Vertical component of initial velocity of each particle will decide the time taken.

So, $t_C < t_A < t_B$

6. B

Sol. For COM position, $m_1x_1 = m_2x_2$

Where m_1 and m_2 are masses of left and right part of the rod and x_1, x_2 are their respective position of centre of mass.

Simultaneously, $m_1x_1\omega = m_2x_2\omega$

and $I_1\omega \neq I_2\omega$

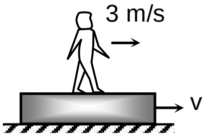
and $\frac{1}{2}I_1\omega^2 \neq \frac{1}{2}I_2\omega^2$

7. C

Sol. (I) $0 = 100v + 50(v + 3)$ (COLM)

$v = -1$ m/s

So, work done by man = $\frac{1}{2}(100)(1)^2 + \frac{1}{2}(50)(2)^2 = 150$ J



(II) $W_N + W_{mg} = \Delta$ K.E. (WET)

$W_N - \frac{1}{2}(2)(10)^2 = \frac{1}{2}(2)\left[(5)^2 - (15)^2\right]$

$W_N = -100$ J

(III) Unstable equilibrium points are x = 10 m, 30 m

Stable equilibrium point is x = 20 m

So, $U_i = 0$, and $U_f = -\frac{1}{100}(10)^4 = -100$ J

$W_{\text{conservative force}} = U_i - U_f = 100$ J

(IV) $W_{ext} = U_f - U_i = mg\left(\frac{5R}{8} - \frac{3R}{8}\right) = \frac{mgR}{4} = 100$ J

8. B

Sol. **In case-(I)**

$at = \omega x$

$y = \frac{1}{2}at^2$

$y = \frac{1}{2}a\frac{\omega^2x^2}{a^2}$

$y = \frac{\omega^2x^2}{2a}$

9. A

Sol. 3 kg block will be at rest. (so friction between S_2 and D = tension in the string connect to block D)
Considering A + B + C in a system
$T - 6 = 3a$, $20 - 2T = 2a_1$ and $a = 2a_1$
So, $a = \frac{8}{7}$ m/s^2
So, there will be slipping between blocks A and B.
Now consider (B + C) in a system
$T' - 6 - 1 = 2a'$
$20 - 2T' = 2a_2$ and $a' = 2a_2$
So, $T' - 7 = 4a_2$
$20 - 2T' = 2a_2$
So, $a' = 1.2$ m/s^2

10. C

Sol. **Case –I :** $\frac{mR^2}{2}\omega_0 = \left(\frac{mR^2}{2} + \frac{mR^2}{4} + \frac{mR^2}{4}\right)\omega$

$\omega = \frac{\omega_0}{2} = 3$ rad/s

Case –II: $\omega = \omega_0 = 6$ rad/s

Case –III: $\frac{mR^2}{2}\omega_0 + mv\frac{R}{2} = (mR^2)\omega$

So, $3 + \frac{8}{2} = \omega = 7$ rad/s

Case –IV: $\frac{mR^2}{2}\omega_0 + mv\frac{R}{2}\left(\frac{1}{2}\right) = mR^2\omega$

$3 + \frac{8}{4} = \omega = 5$ rad/s

Section – B

11. 4.50 (range 4.40 to 4.60)

Sol. (F) (2) = (N) (1) ⇒ N = 2F (N is normal between rods)
and $(N)\left(\frac{1}{2}\right) = (F_1)(2)$
So, $F_1 = \frac{F}{2}$

12. 60.60 (range 60.00 to 61.00)

Sol. Total time taken = $\frac{0.01L}{0.0001v} = \frac{100L}{v}$

Total number of collision with moving wall in the said movement $= \frac{100L}{v\left(\frac{2L}{v}\right)} = 50$

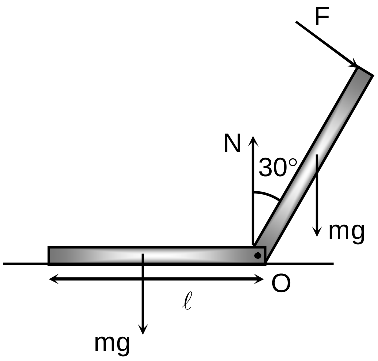
In each collision with the movable wall speed of the sphere increases by 0.0002 v.
So, final speed of sphere = v + 50 × 0.0002v = 1.01 v = 60.60 m/s

13. 2.50 (range 2.40 to 2.60)

Sol. from torque equilibrium about O

$$F\ell + mg\frac{\ell}{2}\frac{1}{2} = mg\frac{\ell}{2}$$

$$F = \frac{mg}{4}$$



14. 1.41 (range 1.35 to 1.45)

Sol. $\int N dt = mv\cos\theta \quad (v = \sqrt{2gh})$

So, $v_f = \dfrac{mv\sin\theta - \mu mv\cos\theta}{m} = \sqrt{2gh}\left(\dfrac{3}{5} - \dfrac{1}{2}\dfrac{4}{5}\right) = \dfrac{\sqrt{50}}{5} = \sqrt{2}$ m/s

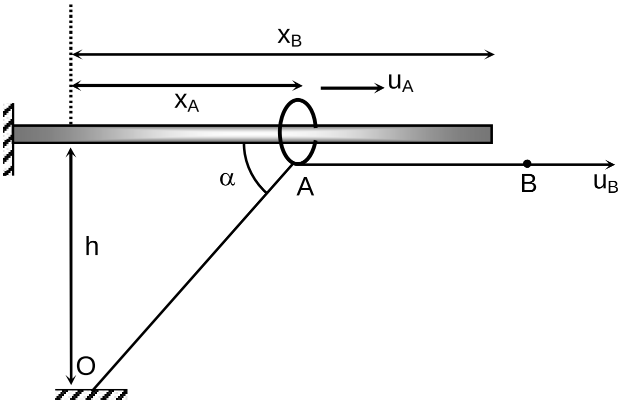
15. 7.46 (range 7.40 to 7.50)

Sol. $x_B - x_A + \sqrt{x_A^2 + h^2} = L$

$$\frac{dx_B}{dt} - \frac{dx_A}{dt} + \frac{x_A}{\sqrt{x_A^2 + h^2}}\frac{dx_A}{dt} = 0$$

So, $u_A = \dfrac{u_B}{1 - \cos\alpha} = \dfrac{1}{1 - \dfrac{\sqrt{3}}{2}} = \dfrac{2}{2 - \sqrt{3}}$

$\Rightarrow u_A = 7.46$ m/s



16. 2.43 (range 2.35 to 2.55)

Sol. $\Delta y_{CM} = \dfrac{1}{2}(10)\left(\dfrac{1}{10}\right)^2 = 0.05$ m

So, $h_{CM} = 1 + \dfrac{2}{3} - 0.05 = 1.62$ m

So, $y_{2m} = \dfrac{1.62 \times 3}{2} = 2.43$ m

17. 58.80 (range 57.00 to 59.00)

Sol. Assume the bloc M at rest, we see that both smaller cubes are applying net zero resultant horizontal force on the larger block.

So, $N = Mg + mg(\cos^2 37° + \cos^2 53°) = Mg + mg$

18. 2.00 (range 1.95 to 2.05)

Sol. $mg\cos 53^\circ = 0.5\,N$

$mg\sin 53^\circ + N = m\omega^2 r$

So, $mg(0.8) + \frac{mg(0.6)}{0.5} = m\omega^2 r$

So, $g\left(\frac{8}{10} + \frac{6}{5}\right) = \omega^2 r$

So, $10 \times 2 = \omega^2 r$

So, $\omega = \sqrt{\frac{20}{5}} = 2.00$ rad/s

Chemistry

PART – II

Section – A

19. B, D

Sol. $XeF_4 \rightarrow sp^3d^2 \rightarrow$ Square planar and nonplanar

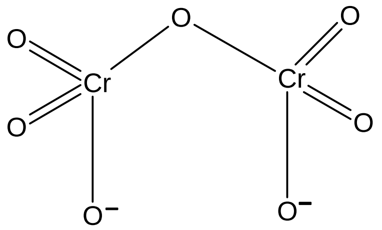
$H_2O_2 \rightarrow sp^3 \rightarrow$ open book structure. Nonplanar and polar

$XeF_5^{\ominus} \rightarrow$ Pentagonal planar and non – polar

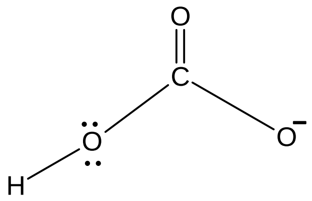
$XeF_5^{\oplus} \rightarrow$ Square pyramidal non – planar polar

20. C, D

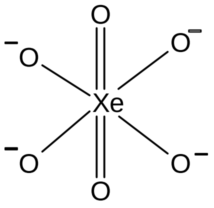
Sol.



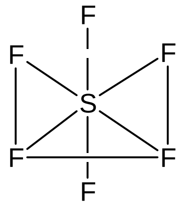
All Cr - O bonds are not equivalent



All C - O bonds are not equivalent



All Xe - O bonds are equivalent due to resonance



sp^3d^2 hybridisation

21. A, B, C

Sol. r = 0, R(r) = 0 so its true for p-orbital, Azimuthal quantum number is 1.

$$R(r) = 0, \frac{6r}{a^o} - \frac{r^2}{a_0^2} = 0$$

One radial node is observed at $r = 6a^o$ distance.

So, its true for 3p-orbital.

In P_x orbital nodal plane is in yz plane and p-orbital accommodate only 2-electron.

22. A, C, D

Sol. Tetrahedral will be formed by sp^3-hybridisation. Other three can be formed by distorted sp^3d hybridisation. i.e.

XeF_2 and I_3^- are sp^3d but linear shape.

BrF_3 is sp^3d but bent T-shaped.

SF_4 is sp^3d but see-saw shaped.

23. A, C

Sol. In CrO_8^{3-} Cr has +5 oxidation state.

KO_2 is also colorful.

24. A, B, C

Sol. In option (D) if we add inert gas at constant pressure and temperature. Equilibrium will get disturbed and more in backward direction.

25. A

Sol. For reaction $A \xrightarrow{\quad} \text{Product}$

Using the given formula we can solve all the options

For zero order reaction $t = \frac{[A]_o - [A]_t}{k}$

For first order reaction $t = \frac{1}{k} \ell n \frac{[A]_o}{[A]_t}$

For second order reaction $t = \frac{1}{k}\left[\frac{1}{[A]_t} - \frac{1}{[A]_o}\right]$

26. B

Sol. Correct answer is I→P, R, S; II→P, S, T; III→P, R, S; IV→P, Q,R, S

27. C

Sol. Correct order is I→R,S; II→R; III→Q, S; IV→P

28. D

Sol. Correct answer is I→Q; II→P; III→S; IV→R

Section – B

29. 1.00

Sol. SiO_2 is neutral and Na has unit +ve charge AlO_2 should have unit – ve charge to balance the charge of molecule.

$x(1) + y(-1) + 136(0) + 250(0) = 0$

$x = y$

$\frac{x}{y} = 1.00$

30. 9.09

Sol.

$$\begin{array}{llll} CH_3COOH & + \; NaOH & \xrightarrow{\quad} & CH_3COONa + H_2O \\ 0.60\ V & 0.20 \times 3V & & 0.60V \end{array}$$

$[CH_3COONa] = \frac{0.60V}{4V} = \frac{3}{20} M$

pH at 25^{o}C for salt of WA + SB is

$pH = 7 + \frac{1}{2}\left(pK_a + \log(\text{salt})\right)$

$pH = 7 + \frac{1}{2}\left(5 + \log\frac{3}{20}\right)$

$= 7 + \frac{1}{2}(5 - 0.82)$

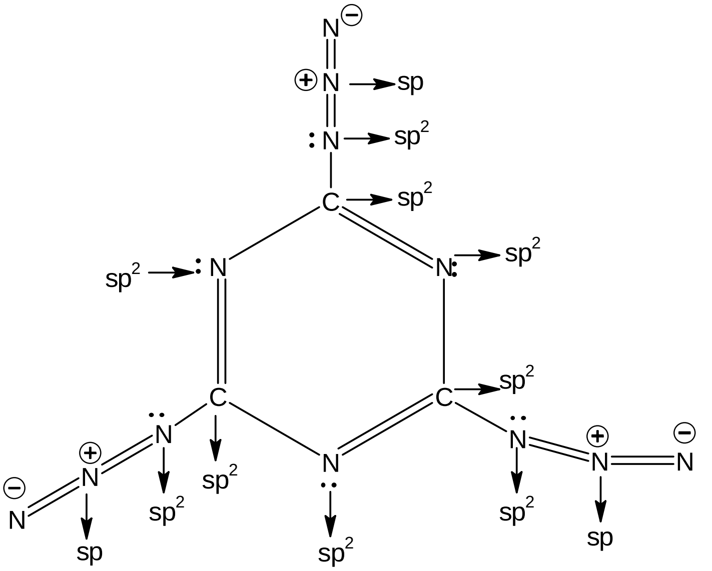
$= 7 + \frac{1}{2}(4.18)$

$= 7 + 2.09$

= 9.09

31. 1.50

Sol.



Maximum 6π bond can lies in same plane and sp^2 centre are 9.

$x = 9,\ y = 6$

$$\Rightarrow \frac{x}{y} = \frac{9}{6} = 1.50$$

32. 1.50

Sol. Balance reaction is

$$ClO_3^- + 6I^- + 6H_2SO_4 \longrightarrow 3I_2 + Cl^- + 6HSO_4^- + 3H_2O$$

x = 6, y = 6, z = 3

33. 6.93

Sol.

$$NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$$

$$\begin{array}{lll} 2-x & x-y & x \end{array}$$

$$NH_3(g) \rightleftharpoons \frac{1}{2}N_2(g) + \frac{3}{2}H_2(g)$$

$$\begin{array}{lll} x-y & \frac{y}{2} & \frac{3y}{2} \end{array}$$

Given,

$2 - x = 1$ $\qquad$ $\frac{3y}{2} = 0.75$

$x = 1$ $\qquad$ $y = \left(\frac{1}{2}\right)$

$$x_1 = K_{C_1}\left(\frac{1}{2}\right).\left(\frac{1}{4}\right) = \left(\frac{1}{8}\right)$$

$$y_1 = K_{C_2} = \frac{\left(\frac{3}{8}\right)^{\frac{3}{2}}\left(\frac{1}{8}\right)^{\frac{1}{2}}}{\left(\frac{1}{4}\right)} = \left(\frac{3\sqrt{3}}{16}\right)$$

$a=[NH_3]=\frac{1}{4}M$

$[H_2S]=\frac{1}{2}M$

$b=[N_2]=\frac{1}{8}M$

$[H_2]=\frac{3}{8}M$

$\frac{y_1}{x_1(a+b)}=\frac{3\sqrt{3}}{16}\times\frac{8}{1}\times\frac{8}{3}=4\sqrt{3}$
$=4\times1.732$
= 6.928
= 6.93

34. 1.33

Sol. $K(\text{overall})=\frac{K_1K_3}{K_2}=10^{-4}\ \text{sec}^{-1}$

$A(\text{overall})=\frac{A_1A_3}{A_2}=2\times10^{5}\ \text{sec}^{-1}$

$E_a(\text{overall})=E_{a_1}+E_{a_3}-E_{a_2}=15\text{ kJ}$

$\frac{K.A}{E_a}=\frac{2\times10^{-4}\times10^{5}}{15}=1.33$

35. 18.48

Sol. $MgCl_2+2NH_3+2H_2O\longrightarrow Mg(OH)_2(s)\downarrow+2NH_4Cl$

$Mg(OH)_2(s)\rightleftharpoons Mg^{2+}+2OH^-$

$(NH_4)_2SO_4$ is acidic so it will dissolved $Mg(OH)_2$ solid which is formed in mix. When all $Mg(OH)_2$ will re-dissolve the conc. of Mg^{2+} ions in the final solution will become equal to its initial conc.

$[NH_3]$ in mix initially $=\frac{0.70\times0.2}{1.0}=0.14\text{ M}$

$[Mg^{2+}]$ in mix initially $=\frac{0.30\times0.2}{1.0}=0.06\text{ M}$

When $[Mg^{2+}]=0.06$

$[OH^-]=\sqrt{\frac{K_{SP}}{[Mg^{2+}]}}=\sqrt{\frac{6\times10^{-12}}{0.06}}=10^{-5}\text{ M}$

For NH_3 $K_b=\frac{[NH_4^+][OH^-]}{[NH_3]}\Rightarrow[NH_4^+]=\frac{K_b[NH_3]}{[OH^-]}$

$[NH_4^+]=\frac{2\times10^{-5}\times0.14}{10^{-5}}=0.28\text{ M}$

Mole of $[NH_4^+]=0.28$

Mole of $[NH_4]_2\,SO_4$ needed $= \dfrac{0.28}{2} = 0.14$

Mass of $[NH_4]_2\,SO_4 = 132 \times 0.14$

= 18.48 g.

36. 37.50

Sol.

$$A(aq) \longrightarrow 2B(aq) + C(aq)$$

$t = 0$	a	0	0
$t = 10$ min	$a - \dfrac{a}{2}$	a	$\dfrac{a}{2}$
$t = 20$ min	$a - \dfrac{3a}{4}$	$\dfrac{3a}{2}$	$\dfrac{3a}{4}$
$t = \infty$	0	$2a$	a

Let the normality of ‘T’ is N and initial volume of ‘T’ is used x ml

At t = 0 Meq. of A = Meq. of T

$$a \times 2n = N \times x \qquad \dots (1)$$

At t = 10 min Meq. of (A + B + C) = Meq. of T

$$\frac{a}{2} \times 2n + a \times n + \frac{a}{2} \times 2n = 40 \times N \qquad \dots (2)$$

At t = 20 min Meq. of (A + B + C) = Meq. of T

$$\frac{a}{4} \times 2n + \frac{3a}{2} \times n + \frac{3a}{4} \times 2n = N \times y \qquad \dots (3)$$

At t = ∞ min Meq. of (B + C) = Meq. of T

$$2a \times n + a \times 2n = N \times z \qquad \dots (4)$$

Solving these equilibrium $x = \dfrac{80}{3}\,\text{ml}, y = \dfrac{140}{3}\,\text{ml}, z = \dfrac{160}{3}\,\text{ml}$

Value of $\dfrac{y+z}{x} = 37.5$.

Mathematics

PART – III

Section – A

37. B, C, D

Sol. $f(x)=\dfrac{3}{\sqrt{2x^2+x}+\left(\dfrac{2\sin^2\theta}{\sqrt{2x^2+x}}\right)}$

Using AM ≥ GM

$\Rightarrow \dfrac{\sqrt{2x^2+x}+\dfrac{2\sin^2\theta}{\sqrt{2x^2+x}}}{2}\ge\left(2\sin^2\theta\right)^{\frac{1}{2}} \Rightarrow \dfrac{3}{2f(x)}\ge 2^{\frac{1}{2}}\left|\sin\theta\right| \Rightarrow f(x)\le\dfrac{3}{2^{\frac{3}{2}}}\left|\operatorname{cosec}\theta\right|$

$\because\ f(x)\le\dfrac{3}{\sqrt{2}} \Rightarrow |\operatorname{cosec}\theta| = 2 \Rightarrow |\sin\theta| = \dfrac{1}{2}$

38. A, B

Sol. Put x = 0 $\Rightarrow \int_0^1 f(t)e^{-t}dt=\dfrac{1}{a}$

$\Rightarrow \int_0^x f(t)dt=e^x-ae^{2x}\times\dfrac{1}{a}=e^x-2^{2x}$, differentiating we get, $f(x)=e^x-2e^{2x}$

39. A, B, C

Sol. (x – y) f(x + y) – (x + y) f(x – y)= 2y(x – y)(x + y)

Let x – y = u, x + y = v ⇒ uf(v) – v(f(u) = (v – u)uv $\Rightarrow \dfrac{f(v)}{v}-v=\dfrac{f(u)}{u}-u=k$

⇒ f(x) = kx + x^2 ∵ f(1) = 2 ⇒ k = 1 ⇒ f(x) = x^2 + x

40. D

Sol. $x^a y=\lambda^a$, on differentiating $ax^{a-1}y+x^a\dfrac{dy}{dx}=0 \Rightarrow \dfrac{dy}{dx}=-\dfrac{ay}{x}$

Tangent at point (x_1, y_1) is $y-y_1=-\dfrac{ay_1}{x_1}\left(x-x_1\right)$

Area = $\dfrac{1}{2}\lambda^a\cdot\dfrac{(a+1)^2}{a}\left(x_1\right)^{1-a}$ ⇒ area is constant if a = 1

41. A, D

Sol. f(x) ≤ 0, F′(x) = f(x) as f(x) ≥ c F(x) ⇒ F′(x) – c F(x) ≥ 0

$\Rightarrow e^{-cx}\cdot F'(x)-c\cdot e^{-cx}F(x)\ge 0 \Rightarrow \dfrac{d}{dx}\left(e^{-cx}\cdot F(x)\right)\ge 0$

$\Rightarrow e^{-cx}\cdot F(x)$ is an increasing function

$\Rightarrow e^{-cx}\cdot F(x)\ge e^{-c(0)}\cdot f(0)$ ⇒ F(x) ≥ 0 ⇒ f(x) ≥ 0 ⇒ f(x) = 0

Also, $\dfrac{d}{dx}\left(e^{-x}g(x)\right)<0 \Rightarrow e^{x}g(x)$ is a decreasing function

⇒ e^{-x}g(x) < $e^{-(0)}$g(0) ⇒ g(x) < 0 (as g(0) = 0)

Thus, f(x) = g(x) has one solution x = 0 also, |x^2 + x – 6| = f(x) + g(x) = g(x) ⇒ no solution

42. B, C

Sol. Solution of differential equation is $\left(\sin^2 x\right)y+\left(\sin x\right)y^2+\left(\cos x+\cos^2 x\right)=0$

43. D

Sol. (I) $\int\limits_0^1\left(f^4(x)-8x^2\cdot f^2(x)+16x^4\right)dx \Rightarrow \int\limits_0^1\left(f^2(x)-4x^2\right)^2=0 \Rightarrow f^2(x) = 4x^2$

(II) $f''(x)=-\dfrac{4x^3}{2\sqrt{1-x^4}} \Rightarrow f''(x) = 0$ at $x = 0$ and $f''(x)$ changes sign around it

(III) $g'(x)=x^2\left(\int\limits_1^x f(u)\,du\right)+f(x)\cdot\left(\int\limits_0^x t^2 dt\right)$ and $g'(1) = 1 \Rightarrow g''(1)=6+\dfrac{f'(1)}{3}$

(IV) $I_2=-\dfrac{1}{3}\int\limits_0^{-1}\dfrac{dt}{e^{-t}(2+t)}=-\dfrac{1}{3}\int\limits_1^0\dfrac{e^{t-1}}{1+t}dt=\dfrac{1}{3e}I_1$ (Let $-x^3 = t$)

44. C

Sol. (I) f(x) is discontinuous at $x=\dfrac{\pi}{2},\pi$

(II) $A=\int\limits_0^1\left(x^{3/2}-\left(\dfrac{3x-1}{2}\right)\right)dx=\dfrac{3}{20}$

(III) Required area = $2\left|\int\limits_1^2 x\,dx-\int\limits_1^2\left(x^2-2x+2\right)dx\right|=\dfrac{1}{3}$

(IV) $I_n=\int\limits_0^1 x^n\sqrt{1-x^2}\,dx=\int\limits_0^1 x^{n-1}\cdot x\sqrt{1-x^2}\,dx=0+\dfrac{n-1}{3}\int\limits_0^1 x^{n-2}\left(1-x^2\right)\sqrt{1-x^2}\,dx$

$=\dfrac{n-1}{3}I_{n-2}-\dfrac{n-1}{3}I_n \Rightarrow \dfrac{I_n}{I_{n-2}}=\dfrac{n-1}{n+2}$

45. B

Sol. (I) For $f(x)=x^3-\dfrac{3}{2}x^2+x+\dfrac{1}{4} \Rightarrow f(x)+f(1-x)=1 \Rightarrow f(f(x))+f(1-f(x))=1$

$\Rightarrow I=\int\limits_{1/4}^{3/4} f\left(f(x)\right)dx$ ..... (1)

$I=\int\limits_{1/4}^{3/4} f\left(f(1-x)\right)dx$ ..... (2)

Adding equation (1) and (2), we get $2I=\int\limits_{1/4}^{3/4} f\left(f(x)\right)+f\left(1-f(x)\right)=\dfrac{1}{2}\ \therefore\ I=\dfrac{1}{4}$

(II) Area $(A)=\int\limits_0^1\left(2x-x^2-x^n\right)dx=\dfrac{1}{2} \Rightarrow n = 5$

(III) $f(x)+f(-x)=1 \Rightarrow S=\dfrac{11}{2}$

(IV) $f(x)=\left(\dfrac{3}{2}-x^7\right)^{1/7}$ and $f(f(x)) = x$

46. D

Sol. (I) Put 2y = y $\Rightarrow$ f(x + y) = f(x) + f(y) + 2xy partially differentiate with respect to x
$f'(x + y) = f'(x) + 2y$ put x = 1, y = –1 $\Rightarrow f'(1) - f'(0) = 2$

(II) Let $\lim\limits_{x\to\infty} f(x) = \alpha$, then $\alpha + \frac{3\alpha - 1}{\alpha^2} = 3 \Rightarrow \alpha = 1$

(III) $f(x) + f(x + \pi) = 2 \therefore \frac{1}{2}f(x) + \frac{1}{2}f(x+\pi) = 1$ also af(x) + bf(x + c) = 1

On comparing a = b = $\frac{1}{2}$, c = π

(IV) $f(x + y) = 3^y f(x) + 2^x f(y)$ ..... (1)
Put x = 1 in equation (1) $f(1 + y) = 3^y f(1) + 2f(y)$
$y \to x \Rightarrow f(1 + x) = 3^x f(1) + 2f(x)$ ..... (2)
Now, put y = 1 in equation (1)
$f(1 + x) = 3f(x) + 2^x f(1)$ ..... (3)
From equation (2) and (3), we get $f(x) = 3^x - 2^x$

Section – B

47. 2023.00

Sol. $f(x) - f(y) \ge \ln x - \ln y + x - y$ ..... (1)
$x \to y$ and $y \to x$
$f(y) - f(x) \ge \ln y - \ln x + y - x$
$\Rightarrow f(x) - f(y) \le \ln x - \ln y + x - y$ ..... (2)
From equation (1) and (2), f(x) – f(y) = (ln x + x) – (ln y + y)
$\Rightarrow f(x) = \ln x + x \Rightarrow g(x) = 1 + \frac{1}{x} \Rightarrow g\left(\frac{1}{2022}\right) = 2023$

48. 5.00

Sol. $\sin 3\theta = 3\sin\theta - 4\sin^3\theta = \sin\theta(1 + 2\cos 2\theta) \Rightarrow \sin x = \sin\frac{x}{3}\left(1 + 2\cos\frac{2x}{3}\right)$

$\sin\frac{x}{3} = \sin\left(\frac{x}{3^2}\right)\left(1 + 2\cos\frac{2x}{3^2}\right)$ and so on multiplying all

$$\sin x = \sin\left(\frac{x}{3^n}\right)\prod_{r=1}^{n}\left(1 + 2\cos\frac{2x}{3^r}\right) \Rightarrow \frac{\sin x}{x} = \lim_{n\to\infty}\frac{\sin\left(\frac{x}{3^n}\right)}{\left(\frac{x}{3^n}\right)}\cdot\prod_{r=1}^{n}\frac{\left(1 + 2\cos\frac{2x}{3^r}\right)}{3} \Rightarrow f(x) = \frac{\sin x}{x}$$

Thus |x f(x)| + ||x – 2| – 1| = |sin x| + ||x – 2| – 1| is not differentiable at 5 points in (0, 3π)

49. 4.50

Sol. $$I = \int_0^2 (3x^2 - 6x + 4)\cos(x^3 - 3x^2 + 4x - 2)dx + \int_0^2 (3x - 3)\cos(x^3 - 3x^2 + 4x - 2)dx$$

Let I = $I_1 + I_2$

$I_1 = \int_{-2}^{2}(\cos t)dt = 2\sin 2$ (where $t = x^3 - 3x^2 + 4x - 2$)

$I_2 = 3\int_{-1}^{1} u\cos(u^3 + u)du = 0$ (where u = x – 1)

50. 7.63

Sol. If each of two positive real number x, y is not integer but x + y is an integer,
then [x] + [y] = x + y – 1

$(\because \{x\}+\{y\}=1)$

Since, $\frac{305k}{503}+\frac{305(503-k)}{503}=305$ for $1 \le k \le 502$

$\Rightarrow S=\left[\frac{305}{503}\right]+\left[\frac{305\cdot 2}{503}\right]+.....+\left[\frac{305\cdot 502}{503}\right]$ = 304.251 = 76304

51. 4044.00

Sol. $I_2=\int_0^1 x^{1010}(1-x^{2022})^{1010}\,dx$ let $x^{1011}=t$

$\Rightarrow I_2=\frac{1}{1011}\int_0^1 (1-t^2)^{1010}\,dt = \frac{1}{1011}\int_0^1 (1-(1-t^2))^{1010}\,dt = \frac{1}{1011}\int_0^1 t^{1010}(2-t)^{1010}\,dt$

Put t = 2y

$I_2=\frac{2^{2021}}{1011}\int_0^{1/2} y^{1010}(1-y)^{1010}\,dy$ and $I_1=\int_0^1 x^{1010}(1-x)^{1010}\,dx = 2\int_0^{1/2} x^{1010}(1-x)^{1010}\,dx$

$\Rightarrow I=2^{2022}\frac{I_1}{I_2}=4044$

52. 199.00

Sol. $f(x)=\ln x-\frac{1}{x} \Rightarrow f(e^{200})=200-\frac{1}{e^{200}}$

53. 16.00

Sol. $A_1=4\int_0^{\pi/4}(\cos x-\sin x)\,dx=4(\sqrt{2}-1)$ also $A_1=A_2=\frac{A}{2}$

54. 4.75

Sol. $I=\frac{1}{2}\int_0^{\pi/2}\sin x(\ln(\sin^2 x))\,dx$, put cos x = t

$I=\frac{1}{2}\int_0^1 \ln(1-t^2)\,dt = \frac{1}{2}\int_0^1\left(-t^2-\frac{(-t^2)^2}{2}+\frac{(-t^2)^3}{3}+.....\right)dt = -\frac{1}{2}\left[\frac{1}{3}+\frac{1}{10}+\frac{1}{21}+.....\right]$

$= -\left[\frac{1}{6}+\frac{1}{20}+\frac{1}{42}+.....\right]=-\left[\left(\frac{1}{2}-\frac{1}{3}\right)+\left(\frac{1}{4}-\frac{1}{5}\right)+.....\right] = \log_e 2-1$

and $A=\frac{15}{4}+\ln 2$

FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
PART TEST – I
PAPER –2
TEST DATE: 20-11-2022

ANSWERS, HINTS & SOLUTIONS

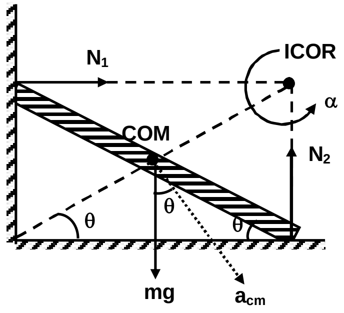
Physics

PART – I

Section – A

1. D

Sol. $\tau = I\alpha$ (about ICOR)



$$mg\left(\frac{\ell 4}{5}\right)\frac{1}{2} = \left(\frac{m\ell^2}{12} + m\left(\frac{\ell}{2}\right)^2\right)\alpha$$

$$\alpha = \frac{6g}{5\ell}$$

$$\therefore \quad a_{cm} = \frac{\ell}{2}\alpha = \frac{3g}{5}$$

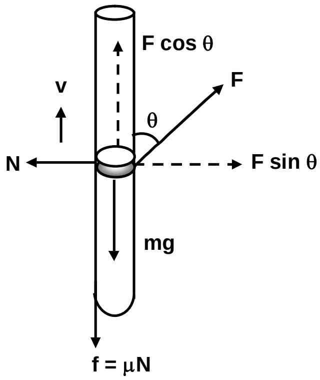
$$mg - N_2 = (ma_{CM})\cos\theta$$

$$mg - N_2 = \frac{3mg}{5}\left(\frac{4}{5}\right)$$

$$\Rightarrow \quad N_2 = \frac{13mg}{25}$$

2. A

Sol. $\theta = \omega t(\omega = \text{constant})$



$N = F \sin \omega t$

$$\frac{mdv}{dt} = (F\cos\omega t - \mu N - mg)$$

$$\int_0^0 mdv = \int_0^T \left(F(\cos\omega t - \mu\sin\omega t) - mg\right)dt$$

$$\frac{F}{\omega}[\sin\omega t + \mu\cos\omega t]_0^T = mgT$$

$$\therefore \quad \text{Also } \omega T = \frac{\pi}{2}$$

$$\therefore \quad F\left[\sin\frac{\pi}{2}+\mu\cos\frac{\pi}{2}-\mu\right]=mg\omega T$$

$$F[1-\mu]=mg\frac{\pi}{2}$$

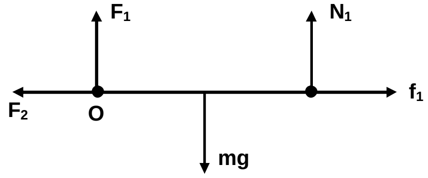
$$\therefore \quad F=\frac{mg\pi}{2(1-\mu)}.$$

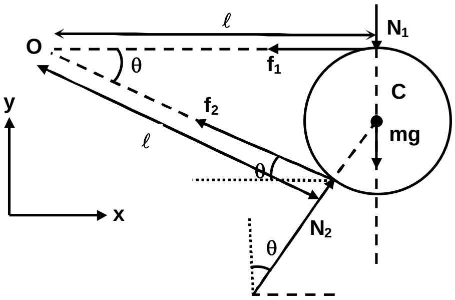
3. B

Sol. F.B.D. of rod

$\vec{\tau}_0 = 0$ (about pivot)

$\Rightarrow \quad N_1=\dfrac{mg}{2}$ …(i)





F.B.D. of cylinder

$\vec{\tau}_C = 0$

$\Rightarrow \quad f_1R = f_2R$

$f_1 = f_2$ …(ii)

(say f)

Also $\vec{\tau}_0 = 0$

$(N_1+mg)\ell = N_2\ell \ \Rightarrow N_2 = N_1 + mg$

$N_2=\dfrac{3mg}{2}$ …(iii)

$\sum F_x = 0$ (on the cylinder)

$f(1+\cos\theta)=N_2\sin\theta$

$\therefore \quad f=\dfrac{3mg\sin\theta}{2(1+\cos\theta)}$

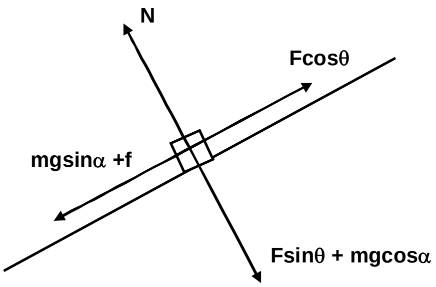
Also $f_{1\max} < f_{2\max}\ (\because N_1 < N_2)$

$\therefore \quad f \le \mu N_1 \ \Rightarrow \ \dfrac{3mg\sin\theta}{2(1+\cos\theta)} \le \mu\dfrac{mg}{2}$

$\mu \ge \dfrac{3\sin\theta}{1+\cos\theta}$

4. A

Sol. F.B.D. of block is as shown ($\theta \le 90°$)



$N = F\sin\theta + mg\cos\alpha$

$f = F\cos\theta - mg\sin\alpha$

for No sliding $f \le \mu N$

$F\cos\theta - mg\sin\alpha \le \dfrac{1}{\sqrt{3}}(F\sin\theta + mg\cos\alpha)$

$\cos\theta - \dfrac{\sin\theta}{\sqrt{3}} \le \dfrac{mg}{F}\left[\sin\alpha + \dfrac{\cos\alpha}{\sqrt{3}}\right]$

$\cos\theta - \dfrac{\sin\theta}{\sqrt{3}} \le 0$ ($\because$ no sliding even when $F \to \infty$)

$\tan\theta \ge \sqrt{3} \Rightarrow \theta \ge 60°$

For $\theta > 90°$

$N = F\sin\theta + mg\cos\alpha$

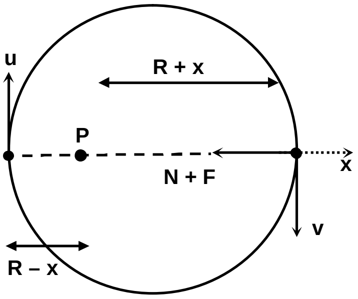
$f = mg\sin\alpha - F\cos\theta$

$f \le \mu N \Rightarrow \theta \le 120°$

$\therefore$ Range $\Rightarrow$ $\theta \in [60°, 120°]$

5. A, B, D

Sol. Applying WET on bead from A to B $W_N + W_F = \Delta K$



$$O + \underbrace{F\left[(R-x)-(R+x)\right]}_{\text{conservative}} = \frac{m}{2}\left[v^2 - u^2\right]$$

$$v^2 = u^2 - \frac{4Fx}{m} \Rightarrow u_0 = 2\sqrt{\frac{Fx}{m}}$$

$$\text{Also} \quad N + F = \frac{mv^2}{R}$$

$$N = \frac{m}{R}\left[u^2 - \frac{4Fx}{m}\right] - F = \frac{m}{R}\left[u^2 - u_0^2\right] - F$$

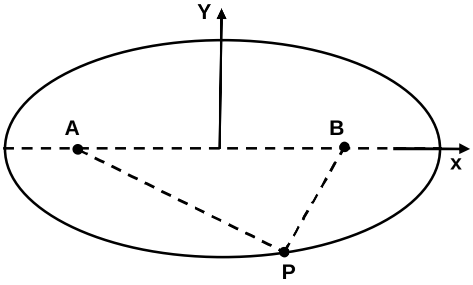
$$N = \frac{m}{R}\left[\alpha^2 - 1\right]u_0^2 - F = \frac{m}{R}\left[\alpha^2 - 1\right]\frac{4Fx}{m} - F$$

$$N = F\left[4\beta\left(\alpha^2 - 1\right) - 1\right]$$

$$\vec{N} = F\left[1 + 4\beta\left(1 - \alpha^2\right)\right]\hat{i}$$

6. A, D

Sol. As PA + PB = 10 ℓ = Constant



The bead will move along the elliptical path in vertical plane.

Such that $2a = 10\ell$ and $2ae = 8\ell \Rightarrow a = 5\ell,\ b = 3\ell$

$\therefore$ Equation of ellipse is

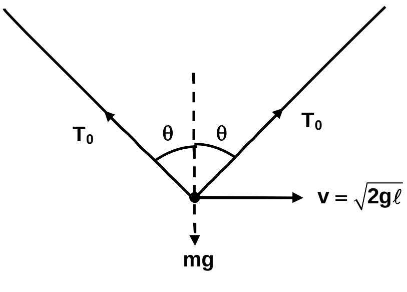
$$\frac{x^2}{(5\ell)^2} + \frac{y^2}{(3\ell)^2} = 1$$

$$r_0 = \frac{\left[1 + (y')^2\right]^{3/2}}{|y''|} \text{ at } (0, -3\ell) \qquad (\because y' = 0,\ y'' = \frac{3}{25\ell})$$

$$\therefore \quad r_0 = \frac{25\ell}{3}$$

$$2T_0\cos\theta - mg = \frac{m}{r_0}\left(\sqrt{2g\ell}\right)^2 \qquad \left(\because \cos\theta = \frac{3}{5}\right)$$

$$T_0 = \frac{31\,mg}{30}.$$



7. A, C

Sol. Angular momentum of system is conserved about the axis passing through the pivots

$\vec{L}_i$ (Just before collision) = $\vec{L}_f$ (Just after collision)

$$mv_0R = \left(mR^2 + \frac{2}{5}(5m)R^2\right)\omega$$

$$\Rightarrow \quad \omega = \frac{v_0}{3R}$$

Now, applying conservation of mechanical energy after the collision

$$\frac{1}{2}\left[mR^2 + \frac{2}{5}(5m)R^2\right]\omega^2 + mgR = 5mg\frac{3R}{8}$$

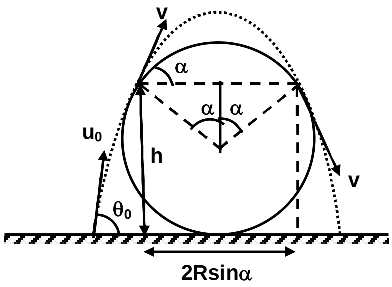
$$\frac{mR^2}{2}(3)\frac{v_0^2}{9R^2} = \frac{7mgR}{8}$$

Also $v_0 = \sqrt{2gh} \Rightarrow h = \frac{21R}{8} \Rightarrow \omega = \sqrt{\frac{7g}{12R}}$

8. A, D

Sol. For u to be minimum, it just grazes the cylinder at two points as shown.

From COME



$$\frac{mu^2}{2} = \frac{mv^2}{2} + mgh$$

$$u^2 = v^2 + 2gh$$

$$u^2 = v^2 + 2gR(1+\cos\alpha)$$

Also $2R\sin\alpha = v^2\frac{\sin 2\alpha}{g} \Rightarrow v^2 = \frac{Rg}{\cos\alpha}$ …(2)

From (1) and (2)

$$u^2 = Rg\left[2 + 2\cos\alpha + \frac{1}{\cos\alpha}\right]$$

For u → min. $\frac{d}{d\alpha}(u^2) = 0 \Rightarrow \cos\alpha = \frac{1}{\sqrt{2}} \Rightarrow \alpha = 45°$

$$u_0^2 = Rg\left[2 + 2\sqrt{2}\right]$$

Also $u\cos\theta = v\cos\alpha$

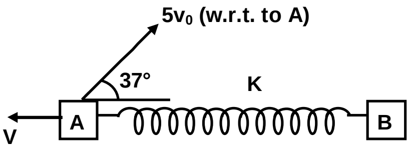
$$\tan^2\theta_0 = [3 + 2\sqrt{2}]$$

9. A, D

Sol. Just after the jump by the frog.

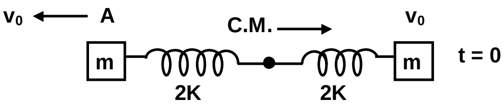
According to COLM of (A + frog)

$(4v_0 - v)\,m - mv = 0 \qquad v = 2v_0$



Now consider the motion of blocks in their COM frame.

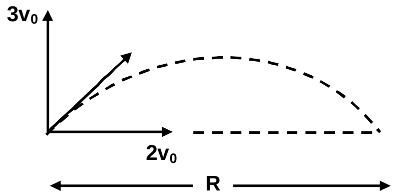
At any time t



$$v_{BC} = v_B - v_{CM} = v_0\cos(\omega t),\ \omega = \sqrt{\frac{2k}{m}}$$

$$v_B = v_{CM} + v_0\cos\omega t$$

$$v_B = -v_0 + v_0\cos\omega t$$



Also the frog is in projectile motion from ground frame

$$R = 2\left(\frac{3v_0}{g}\right)\frac{2v_0}{g} = \frac{12v_0^2}{g} \qquad \left(T = \frac{6v_0}{g}\right)$$

Also frog land on B

Then $\ell_0 + \int_0^T v_B dt = R$

$$\ell_0 = R - \int_0^T v_0\left(\cos\omega t - 1\right)dt$$

$$\ell_0 = R + v_0 T - \frac{v_0}{\omega}\sin\omega T$$

$$\therefore \quad \ell_0 = \frac{12v_0^2}{g} + \frac{6v_0^2}{g} - v_0\sqrt{\frac{m}{2K}}\sin\left(\sqrt{\frac{2K}{m}}\frac{6v_0}{g}\right)$$

$$\therefore \quad \ell_0 = \frac{6v_0^2}{g}\left[3 - \frac{2}{\pi}\right].$$

10. B, C

Sol. $F = mg + v_0\frac{dm}{dt}$ also $m = \lambda y$

$$F = \lambda yg + v_0\lambda\frac{dy}{dt}$$

$$= \lambda yg + \lambda v_0^2$$

Heat loss per unit time = $Fv_0 - \frac{dE}{dt}$

$$= \left(\lambda yg + \lambda v_0^2\right)v_0 - \frac{d}{dt}\left[\frac{1}{2}(\lambda y)v_0^2 + \lambda yg\frac{y}{2}\right]$$

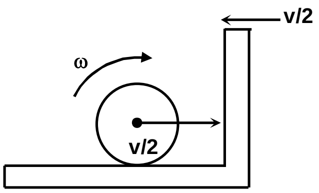
$$\lambda ygv_0 + \lambda v_0^3 - \frac{\lambda v_0^3}{2} - \lambda ygv_0$$

$$= \frac{\lambda v_0^3}{2}.$$

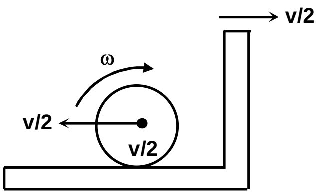
Section – B

11. 2

Sol. Observing the motion in COM frame. Then system will look like



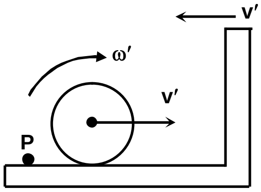
Just before the collision



Just after the collision

After the collision, ring starts sliding and then starts pure rolling on wedge as shown.

$\omega' R = 2v'$ (pure rolling)



Applying COAM of ring in centre of mass frame (after the collision) about point P on wedge

$$mR^2\omega+\left(-mR\frac{v}{2}\right)=mRv'+mR^2\omega'$$

$$mR\frac{v}{2}=3mRv'\Rightarrow v'=\frac{v}{6}$$

Therefore the velocity of wedge is $\frac{v}{6}$ (in centre of mass frame) when pure rolling starts after the first collision. Then they again collides and ring again starts pure rolling on wedge and velocity of wedge is $\frac{v}{18}$ (in centre of mass frame) after 2nd collision.

The process goes on and there will be infinite collisions and finally wedge comes at rest in centre of mass frame.

$\therefore$ Velocity of wedge = $\frac{v}{2}$ (in ground frame)

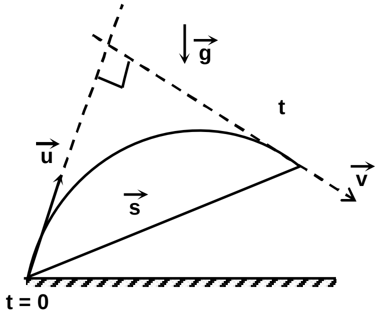
12. 5

Sol. $\vec{v}=\vec{u}+\vec{g}t$

also $\vec{s}=(\vec{v}_{ave})t=\left(\frac{\vec{v}+\vec{u}}{2}\right)t$

$\therefore$ $\vec{v}-\vec{u}=\vec{g}t$ …(i)

$\vec{v}+\vec{u}=\frac{2\vec{s}}{t}$ …(ii)



Squaring and multiplying

$$(\vec{v}.\vec{v}+\vec{u}.\vec{u}+2\vec{u}.\vec{v})(\vec{v}.\vec{v}+\vec{u}.\vec{u}-2\vec{u}.\vec{v})=4g^2s^2$$

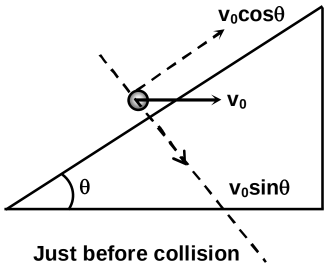
$$s^2=\frac{(100+2\vec{u}.\vec{v})(100-2\vec{u}.\vec{v})}{4g^2}$$

s is max. when $\vec{u}.\vec{v}=0\Rightarrow\vec{u}\perp\vec{v}$

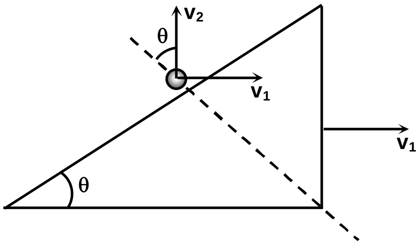
$\therefore$ $s_{max}=\frac{100}{2(10)}=5m$

13. 6

Sol. If it strike again at same point, then the horizontal component of their velocities are same after the first collision.



Just before collision



Just after collision

As e = 1

$v_{sep}=v_{app}$

$v_2\cos\theta=v_0\sin\theta$

$\therefore \quad v_2 = v_0 \tan\theta = (40)\frac{3}{4}$ = 30 m/s

$t_0 = \frac{2v_2}{g}$ = 6 sec.

14. 9

Sol. $T_{max} = T_1$

$T_{min} = T_2$

$T_1 - mg = \frac{mu^2}{l}$ …(1)

$T_2 + mg = \frac{mv^2}{l}$ …(2)

From COME (of pendulum + earth system)

$\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + mg(2l)$

$\therefore \quad u^2 = v^2 + 4gl$ …(3)

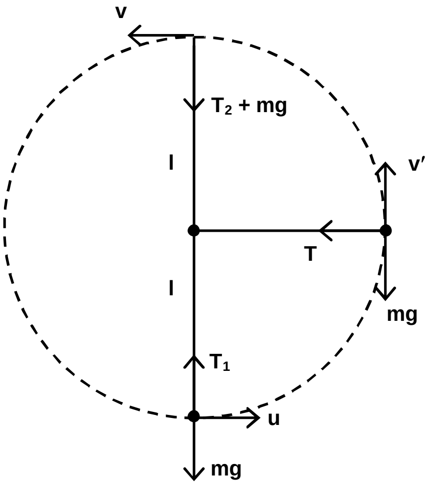
also $\frac{T_1}{T_2} = 2$ …(4)

from (1), (2) (3) and (4)

$u = \sqrt{11gl}, \quad v = \sqrt{7gl}$

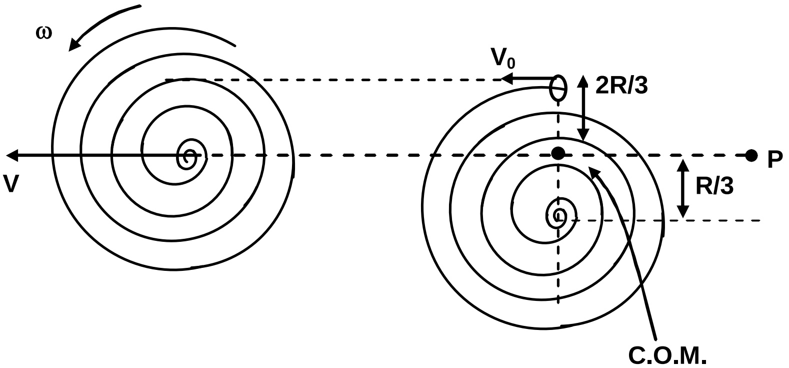
$\therefore \quad v' = \sqrt{9gl}$,

$T = \frac{mv'^2}{l} = 9mg$ K = 9



15. 2

Sol.



Applying COLM

$mv_0 = (m + 2m)v \quad v = \frac{v_0}{3}$

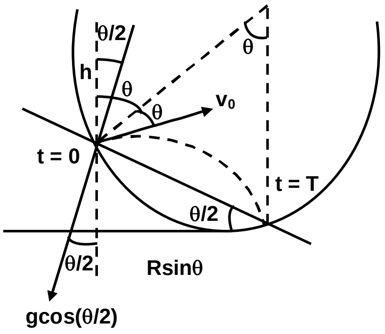
Applying COAM about point P

$mv_0\frac{2R}{3} = \left(\frac{MR^2}{2}\right)\omega \Rightarrow 2m\frac{v_0R}{3} = mR^2\omega$

$\therefore \quad \omega R = \frac{2v_0}{3}$

$\therefore \quad \frac{\omega R}{v} = 2$

16. 3



Sol.
$$T=\frac{2v_0\cos\left(\frac{3\theta}{2}\right)}{g\cos\left(\frac{\theta}{2}\right)}$$

$$=\frac{2v_0}{g}\left[4\cos^2\left(\frac{\theta}{2}\right)-3\right]$$

Also $R\sin\theta = V_0\sin2\theta T$

$$R\sin\theta=\frac{2v_0^2}{g}(2\sin\theta\cos\theta)\left[2(1+\cos\theta)-3\right]$$

As $v_0^2=2gh$

$$\therefore\quad h=\frac{R}{8\left[\cos\theta\left[2\cos\theta-1\right]\right]}$$

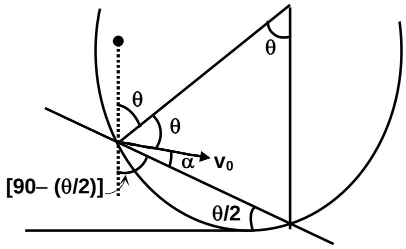
$h\ge0\ 2\cos^2\theta-\cos\theta\ge0$

$\cos\theta(2\cos\theta-1)\ge0$

$$\cos\theta\ge\frac{1}{2}$$

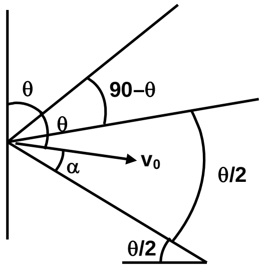
$\theta\le\frac{\pi}{3}$ K = 3.

2nd Method:



$$2\theta+\alpha+\left(90-\frac{\theta}{2}\right)=180^\circ$$

$$\alpha=90-\frac{3\theta}{2}$$



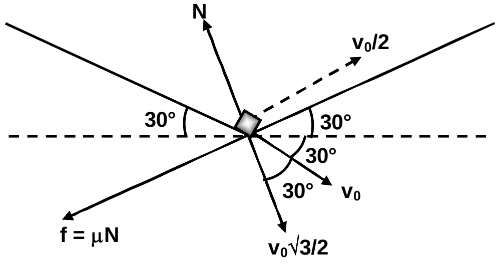
Now $\alpha > 0$

$\theta < 60^\circ$

$\theta_{max}=\frac{\pi}{3}$ radian

17. 6

Sol. Applying impulse momentum theorem.



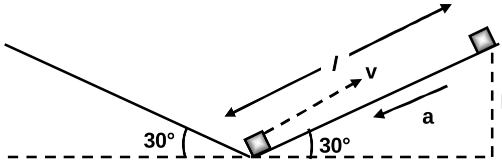
Just before the impact

$$\int Ndt=mv_0\frac{\sqrt{3}}{2}$$

$$\int\mu Ndt=m\left(\frac{v_0}{2}-v\right)$$

$$\therefore\quad v=\frac{v_0}{2}\left(1-\sqrt{3}\mu\right)$$

Also $v_0^2=2gH$ and



Just after the impact
a = g/2 [1 + √3 μ]

$$\therefore \quad 2gh\left(1+\sqrt{3}\mu\right) = \frac{2gH}{4}\left(1-\sqrt{3}\mu\right)^2$$

Also $\mu = \frac{1}{2\sqrt{3}}$

$$h\left(1+\frac{1}{2}\right) = \frac{H}{4}\left(1-\frac{1}{2}\right)^2$$

$$\Rightarrow \quad \frac{H}{4h} = 6$$

18. 8

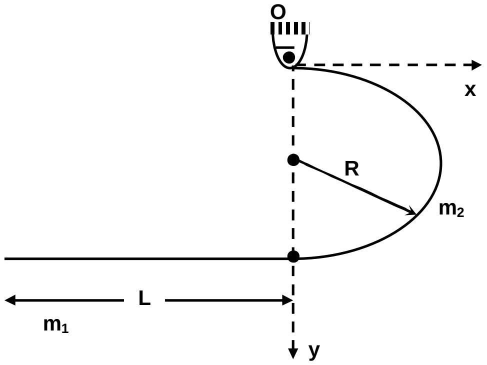
Sol. In equilibrium, the centre of mass of the system must lies on the vertical line passing through hinge.

$\therefore \quad X_{CM} = 0$

$$-m_1\frac{L}{2} + m_2\left(\frac{2R}{\pi}\right) = 0$$

$$\frac{\lambda L^2}{2} = \lambda(\pi R)\frac{2R}{\pi}$$

$\therefore \quad L = 2R$



$$Y_{CM} = \frac{m_1(2R) + m_2 R}{m_1 + m_2}$$

$$= \frac{\lambda L^2 + \lambda\pi R^2}{\lambda L + \lambda\pi R} = \left(\frac{\pi+4}{\pi+2}\right)\frac{L}{2} \Rightarrow \alpha = 4, \beta = 2$$

$\therefore \quad \alpha\beta = 8.$

Chemistry

PART – II

Section – A

19. A

Sol. $PCl_5 \rightleftharpoons PCl_3(g) + Cl_2(g)$

$\alpha = \dfrac{D-d}{(n-1)d}$, n = 2

$(1+\alpha) = \left(\dfrac{D}{d}\right)$

Thus, $(1+\alpha)$ will linearly increases with increase of $\left(\dfrac{D}{d}\right)$.

20. A

Sol. $\ell nK = \dfrac{\Delta S^o}{R} - \dfrac{\Delta H^o}{R}$

$\Delta S^o = 8R$

21. B

Sol. Change in potential energy $= -\dfrac{2x}{8} - (-2x) = -\dfrac{2x}{8} + 2x = \dfrac{-2x+16x}{8}$

$= +\dfrac{14x}{8} = +\dfrac{7x}{4}$

22. A

Sol. $K_{298} = \dfrac{2.303}{t_{1/2}} \log\dfrac{100}{50}$

$K_{308} = \dfrac{2.303}{t_{1/2}} \log\dfrac{100}{25}$

$\dfrac{K_{298}}{K_{308}} = \dfrac{\log 2}{\log 4} = \dfrac{1}{2} = 0.5$

23. A, B

Sol. Possible transition $3 \rightarrow 2$ and $4 \rightarrow 2$

$\lambda_{3\rightarrow 2} \Rightarrow \dfrac{36}{5R}$

$\lambda_{4\rightarrow 2} \Rightarrow \dfrac{16}{3R}$

24. A, B, C

Sol. Molecular mass of $A_2B_4 = 100$

$2A + 4B = 100,\ \dfrac{2A+4B}{2A} = 5(\text{given})$

$A = 10, B = 20, \dfrac{A}{B} = \dfrac{10}{20} = 1:2$

$$A_2B_4(g) \longrightarrow A_2(g) + 2B_2(g)$$

$1-\alpha \qquad \alpha \qquad 2\alpha$

At 10 min. V.D. = 25

Molecular mass = 50

$$50 = \frac{100}{1+2\alpha}$$

$$\alpha = \frac{1}{2} \quad \%B_2(\text{by mole}) = \frac{1}{2}\times 100 = 50\%$$

$$\%A_2(\text{by mole}) = \frac{1}{4}\times 100 = 25\%$$

At t = 20 min.

$$40 = \frac{100}{1+2\alpha}$$

$$\alpha = 0.75$$

$$-\frac{d(A_2B_4)}{dt} = \frac{0.5-0.25}{10} = \frac{0.25}{10}$$

$$+\frac{d(A_2)}{dt} = \frac{0.75-0.50}{10} = \frac{0.25}{10}$$

Ratio of rate = 1 : 1

25. A, C, D

Sol.

$$2HI \rightleftharpoons H_2 + I_2$$

At equilibrium $4-2x \qquad x-3y \qquad x$

$$2N_2 + 6H_2 \rightleftharpoons 4NH_3$$

At equilibrium $4.25-2y \qquad x-3y \qquad 4y$

Given x = 1.0 M

4y = 0.5 M

Using these value $K_{C_1} = \frac{5}{32}$

$$K_{C_2} = \frac{4^5}{5^6}$$

$$\sqrt{K_{C_2}} = \left(\frac{32}{125}\right)$$

26. B, C, D

Sol.

$$SO_2 \rightarrow 1(p\pi - p\pi)$$
$$1(p\pi - d\pi)$$

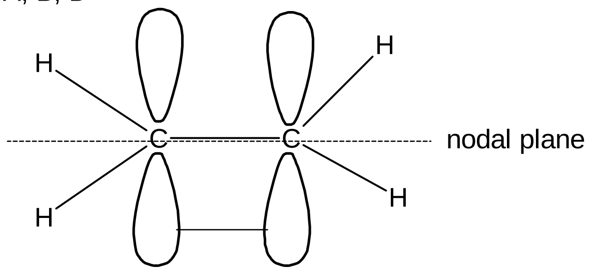
$$SO_3 \rightarrow 1(p\pi - p\pi)$$
$$2(p\pi - d\pi)$$

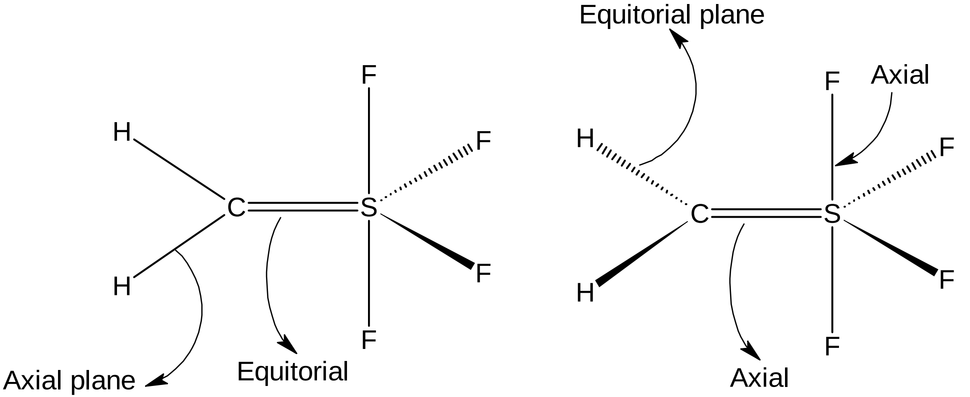
$$XeO_4 \rightarrow 4(p\pi - d\pi)$$

$$ClO_3^- \rightarrow 2(p\pi - d\pi)$$

27. A, B, D

Sol.


H
H
H
H
C
C
nodal plane


Equitorial plane
Axial
F
F
F
F
H
H
C
S
Axial plane

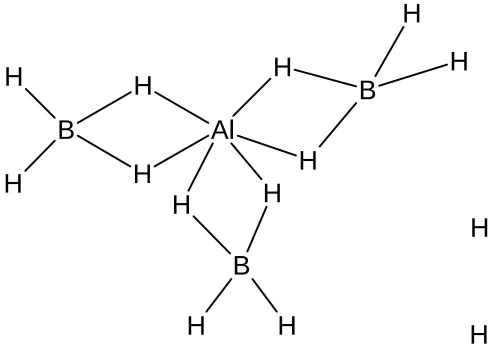
Equitorial
More stable form due to bent rule. nodal plane lies in axial.

Axial
Less stable due to more repulsion. Its nodal plane lies in equitorial

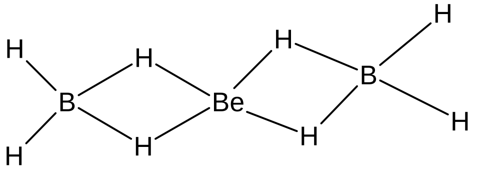
28. C, D

Sol. $\left(AlCl_3\right)_n \rightarrow$ has (3C – 4e) bond not (3C – 2e)

$\left(B_2H_6\right) \rightarrow$ Two (3C – 2e) bond



6-(3C-2e) bond



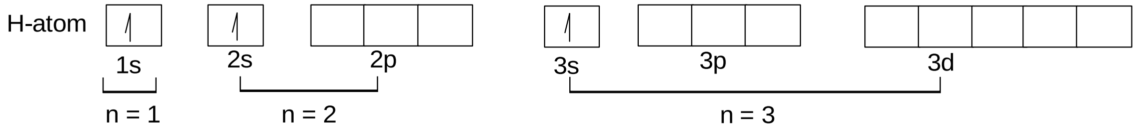
4-(3C-2e) bond

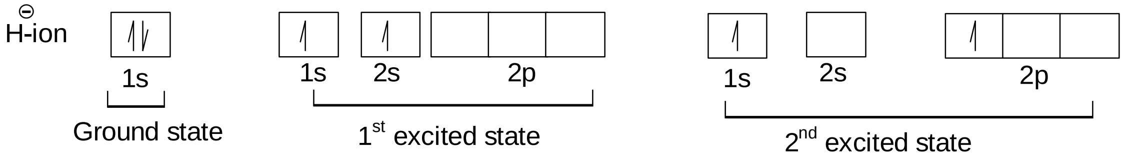
Section – B

29. 5

Sol. x = 9, y = 3, z = 2

In one electron system all orbitals of a shell are degenerate (same energy level). In case of many electron system different orbitals of a shell are non-degenarate. Hence, in second excited state only three p-orbitals (2p) are degenerate.


H-atom
1s
2s
2p
3s
3p
3d
n = 1
n = 2
n = 3



30. 6

Sol. (i) $\text{Borax} \xrightarrow{\Delta} NaBO_2 + B_2O_3$

(ii) $\text{Borax} + NH_4Cl \xrightarrow{\Delta} BN + B_2O_3 + NaCl + H_2O$

(iii) $\text{Borax} + HCl \longrightarrow H_3BO_3$

(iv) $\text{Borax} + H_2O \longrightarrow Na\left[B(OH)_4\right] + H_3BO_3$

(v) $3B_2H_6 + 6NH_3 \xrightarrow{\Delta} 2B_3N_3H_6 + 12H_2$

(vi) $B_3N_3H_3Cl_3 + 3LiBH_4 \xrightarrow{THF} B_3N_3H_6 + 3LiCl + 3BH_3$

(vii) $LiH + B_2H_6 \longrightarrow \underset{\substack{\downarrow \\ sp^3}}{2LiBH_4}$

(viii) $K_3\left[AlF_6\right] + BF_3 \longrightarrow \underset{\substack{\downarrow \\ sp^3}}{3KBF_4} + AlF_3$

Except (vii) and (viii) all options can give sp^2 hybridised Boron centre as one of the product.

31. 6

Sol. Lone pair in $\left[TeBr_6\right]^{2-}$, $\left[IF_2\right]^{+}$, SNF_3 and $\left[XeF\right]_3^{-}$ are 1, 2, 0 and 3 respectively. Hence, x = 6.

Diamagnetic species are Li_2, C_2, O_2^{2-}, K_2O, N_2O_4, $B_3N_3H_6$.

Note: Be_2 does not exist so we can't say it is paramagnetic or diamagnetic species.

Hence, y = 6.

$$\frac{x+y}{2} = 6.$$

32. 4

Sol. **In container (I)**

$KMnO_4$ will oxidized only SO_2

$$\frac{\text{Moles of O.A.}}{2} = \frac{\text{Moles of R.A.}}{5}$$

$$\frac{0.2 \times 4}{2} = \frac{\text{Moles of } SO_2}{5}$$

$$\text{Mole of } \left[SO_2\right]_{\text{equilibrium}} = 2$$

$$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$$

$10 - 2x_1 \quad 2x_1 \quad x_1$

$2x_1 = 2$

$x_1 = 1.0$

In container (II)

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

$2x_1 \quad x_1 \quad 0$

$2x_1 - 2a \quad x_1 - a \quad 2a$

Total moles $n_T = (3x_1 - a)$

Given $\frac{x_1 - a}{3x_1 - a} = \frac{1}{4}$ $\quad a = \frac{x_1}{3}$

$$y = K_P = \frac{\left(\frac{2a}{n_T} \times 20\right)^2}{\left(\frac{2x_1 - 2a}{n_T} \times 20\right)^2 \left(\frac{x_1 - a}{n_T} \times 20\right)} = \left(\frac{1}{20}\right) \text{atm}^{-1}$$

$$x = K_C \frac{\left(\frac{2}{5}\right)^2\left(\frac{1}{5}\right)}{\left(\frac{8}{5}\right)^2} = \frac{1}{80}(\text{mol}/\ell)$$

Value of $\frac{y}{x} = \frac{80}{20} = 4$

33. 6

Sol. a = 4 → i, iv, vi, vii
b = 2 → ii, ix
v and viii forms δ M.O.
d = 2 → iii, x
$\frac{a^2 + b^2 + 2d}{4} = \frac{24}{4} = 6$

34. 9

Sol. I, II, III and IV are correct due to bent rule and V is incorrect. Correct order in case of V is II > III > IV > I = V.
x = 4
y = 1
2x + y = 9

35. 8

Sol. K_{SP} of $Mg(OH)_2$ is $= \left(\frac{5.8}{58} \times 10^{-3}\right)^3 .4 = 4 \times 10^{-12}$

$$Mg(OH)_2(s) \rightleftharpoons \underset{x+0.01}{Mg^{2+}} + \underset{2x}{2OH^-}$$

$(x + 0.01)(4x^2) = 4 \times 10^{-12}$

$4x^2 \times 0.01 = 4 \times 10^{-12}$

$x = 10^{-5}$ mole / ℓ

$[Mg^{+2}]$ in container II $= 1.0 \times 10^{-5}$

For basic buffer $pOH = pK_b + \log\frac{[NH_4^+]}{[NH_4OH]}$

$pOH = 5 + \log 5$

= 5.70

$OH^- = 2 \times 10^{-6}$

$[Mg^{+2}] = \frac{4 \times 10^{-12}}{4 \times 10^{-12}} = 1.0$ M

$[Al^{3+}] = \frac{1.6 \times 10^{-20}}{8 \times 10^{-18}} = 2 \times 10^{-3}$ M

$x = 10^{-5}$

$y = 1.0$

$z = 2 \times 10^{-3}$

Value of $\frac{yz}{25x} = \frac{200}{25} = 8$.

36. 5

Sol. Statement 4, 11 and 12 are incorrect and other statements are correct.
x = 9, y = 3.

Mathematics PART – III

Section – A

37. A

Sol. By differentiating, $f'(x)+\frac{1}{1+x^2}f(x)+\frac{\tan^{-1}x}{1+x^2}=0$

$f(x)=1-\tan^{-1}x-2e^{-\tan^{-1}x}$

38. A

Sol. $\int_1^a \left(f(x)+|f(x)|\right)dx=g(a)$; $f(x) = 2x^3 + 6x - 8$

$\int_2^3 \left|\frac{f(x)}{g(x)+5}\right|dx=\frac{1}{2}\ln\left(\frac{101}{22}\right)$

39. D

Sol. $\int e^{x^2}\left(\frac{2x-\cot x}{\sin x}\right)\cdot\ln\left(\frac{e^{x^2}}{\sin x}\right)dx$

Let $\frac{e^{x^2}}{\sin x}=t \Rightarrow \int \ln(t)\,dt=t(\ln t-1)+c$

40. B

Sol. $x^2 + y^2 - ax = 0 \Rightarrow x^2 + 2xy\cdot y' - y^2 = 0$

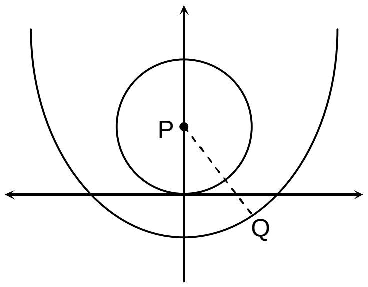
Orthogonal curve : $x^2-\frac{2xy}{y'}-y^2=0$; $y'=\frac{2xy}{x^2-y^2}$

By solving, $x^2+y^2=\frac{y}{c}$

Passing through (1, 1) so $x^2 + y^2 = 2y$

For shortest distance, Q = (1, 0)

D = PQ – r = $\sqrt{2}-1$



41. A, B, D

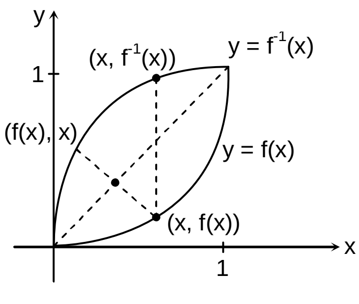
Sol. $f''(x) = f(x)\cdot(\tan x - 1)(\tan^3 x - \tan^2 x + 3\tan x + 1)$

$g(x) = \tan^3 x - \tan^2 x + 3\tan x + 1 = 0$ has exactly one root in $x\in\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$ which lies in $x\in\left(-\frac{\pi}{4},0\right)$

So, $f''(x) = 0$ at $x=\frac{\pi}{4}$ and k where $k\in\left(-\frac{\pi}{4},0\right)$

42. A, C

Sol. $f(x)\cdot f^{-1}(x)<x$



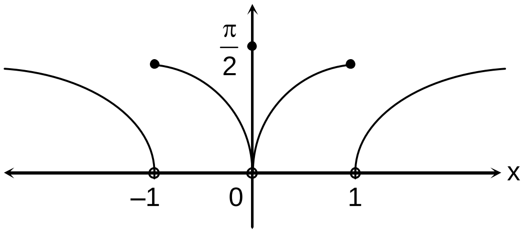
43. A, B

Sol. $f'g' = f'g + fg'$ by solving $g(x) = e^{-\frac{1}{x-2}}$

g(x) is discontinuous at one point at x = 2

44. B, D

Sol. Graph of y = f(x)



45. A, D

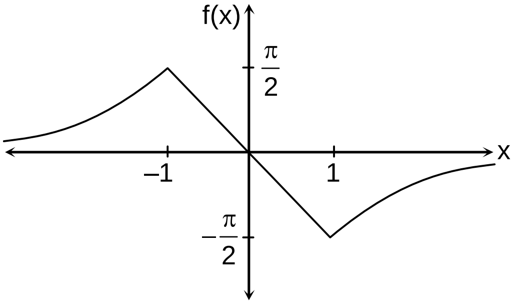
Sol. $f(x) = \int_0^{3\pi/4} \left| x - \frac{3\sin t}{\cos t + \sqrt{2}} \right| \left(\frac{1+\sqrt{2}\cos t}{\left(\cos t + \sqrt{2}\right)^2} \right) dt$

$$f(x) = \int_0^1 |x - 3u|\,du \Rightarrow f(x) = \begin{cases} \frac{3}{2} - x & ; \quad x \le 0 \\ \frac{x^2}{3} - x + \frac{3}{2} & ; \quad 0 \le x \le 3 \\ x - \frac{3}{2} & ; \quad x \ge 3 \end{cases}$$

46. B, C

Sol. $\frac{x^2 - x + 1}{x^2 + x + 1} \in \left[\frac{1}{3}, 3\right] \ \forall\ x \in R$

Maxima at x = –1 and minima at x = 1



Section – B

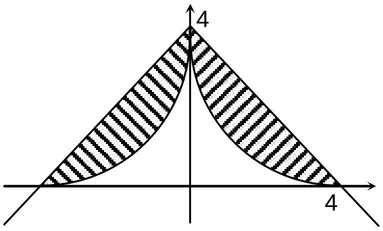
47. 1

Sol. $\int \frac{\left(6x f(x) - 4x^2\right) - 2f(x)}{\left(3f(x) - 2x\right)\left(x^2 - f(x)\right)^2} dx = \int \frac{2x}{\left(x^2 - f(x)\right)^2} dx - \int \frac{f'(x)}{\left(x^2 - f(x)\right)^2} dx = -\frac{1}{x^2 - f(x)} + c$

Substitute $f(x) = \frac{2}{4x - 3f(x)}$

48. 2

Sol. $\frac{16\lambda}{3} = 2\left[8 - \int_0^4 \left(x - 4\sqrt{x} + 4\right) dx\right]$



49. 5

Sol. $$\lim_{n\to\infty}\left(\sum_{r=1}^{n}\left(\frac{n^2}{n^2+r^2}\left(\lim_{m\to\infty}\sum_{k=1}^{mr}\left(\frac{1}{n^2+\frac{k^2}{m^2}}\right)\frac{1}{m}\right)\right)\right) = \lim_{n\to\infty}\left(\sum_{r=1}^{n}\frac{n^2}{n^2+r^2}\int_0^r\frac{1}{n^2+x^2}dx\right)$$

$$= \lim_{n\to\infty}\left(\sum_{r=1}^{n}\frac{n}{n^2+r^2}\tan^{-1}\left(\frac{r}{n}\right)\right) = \int_0^1\frac{\tan^{-1}x}{1+x^2}dx = \frac{\pi^2}{32}$$

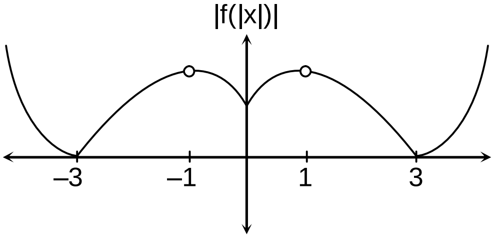
50. 7

Sol. $f(x) = \frac{(x^2-1)(x^2-9)}{(x-1)(x+3)}$ $x \in R - \{-3, 1\}$

Graph of y = |f(|x|)|

Discontinuity at x = ± 1

Non-differentiable at x = 0, ±1, ±3



51. 8

Sol. $$I = \int_0^{4\pi}\frac{dx}{2+\sin 4x} = \int_0^{4\pi}\frac{dx}{2-\sin 4x} \Rightarrow I = 2\int_0^{4\pi}\frac{1}{4-\sin^2 4x}dx = 64\int_0^{\pi/8}\frac{1}{4-\sin^2 4x}dx$$

$$I = 64\int_0^{\pi/8}\frac{2}{7+\cos 8x}dx \text{ ; } 3x = t \Rightarrow I = \frac{128}{3}\int_0^{3\pi/8}\frac{1}{7+\cos\left(\frac{8t}{3}\right)}dt$$

52. 4

Sol. $f(x) = k(x+1)^2(x-1)^2(x-5)^2 + 4 \Rightarrow f(2) = 81k + 4 = 85 \Rightarrow k = 1$

$f(x) = (x+1)^2(x-1)^2(x-5)^2 + 4 \Rightarrow f'(x) = 2(x+1)(x-1)(x-5)(3x^2 - 10x - 1)$

$$\alpha + \beta = \frac{10}{3} \Rightarrow \lim_{x\to\frac{10}{3}}\left(\frac{x^2-9}{x^2-5x+6}\right) = \frac{19}{4}$$

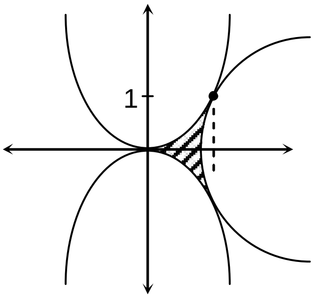
53. 4

Sol. $$\lim_{x\to 0}\frac{\frac{2022\left((1+x^{2022})^{\frac{1}{2021}}-1\right)}{x} - \frac{2023\left((1+x^{2023})^{\frac{1}{2021}}-1\right)}{x}}{2022x^{2021}} = \frac{1}{2021}$$

λ = 2021 = 43 × 47 number of divisors = 2 × 2 = 4

54. 2

Sol. Area = $2\int\left(\frac{y^2+3}{4} - \sqrt{y}\right)dy = \frac{1}{3}$



FIITJEE

ALL INDIA TEST SERIES

PART TEST – II

JEE (Main)-2023

TEST DATE: 03-12-2022

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is Mathematics.
- Each part has only two sections: **Section-A and Section-B**.
- **Section – A** : Attempt all questions.
- **Section – B :** Do any five questions out of 10 questions.

Section-A (01 – 20, 31 – 50, 61 – 80) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-B (21 – 30, 51 – 60, 81 – 90) *contains 30 Numerical based questions. The answer to each question is rounded off to the nearest integer value. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

PART – A

SECTION – A

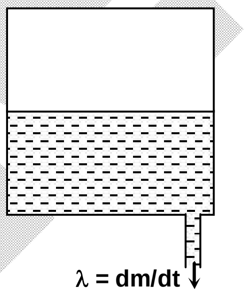
(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. A metal vessel of negligible heat capacity contains 0.5 kg of water (of specific heat capacity 4200 $\text{Jkg}^{-1}\text{K}^{-1}$). It is heated from 15°C to 85°C by 750 W immersion heater in 4 minutes. The average loss of heat in watts to the surroundings from the vessel during this time is nearly:

(A) 70 (B) 123
(C) 138 (D) 212

2. A well insulated box contains water (specific heat = C and very large conductivity) of mass m_0 and temperature T_0 at time t = 0. If heat is being added to it uniformly at a constant rate $\frac{dQ}{dt} = R$ and water is leaking from it at a constant rate $\frac{dm}{dt} = \lambda$, then the temperature of the water at time t $\left(t < \frac{m_0}{\lambda}\right)$ will be:

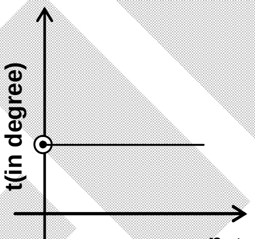


(A) $T = \frac{R}{2\lambda C}\ell n\left(\frac{m_0}{m_0 - \lambda t}\right) + T_0$ (B) $T = \frac{R}{\lambda C}\ell n\left(\frac{m_0}{m_0 - \lambda t}\right) + T_0$

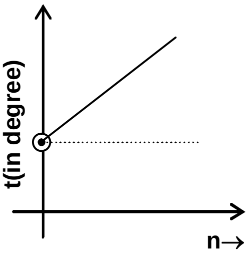
(C) $T = \frac{R}{\lambda C}e^{(m_0 - \lambda t)}$ (D) $T = \frac{R}{2\lambda C}e^{(m_0 - \lambda t)}$

3. A slab X of thickness 't' thermal conductivity 'k' and area of cross-section 'A' is placed in thermal contact with another slab Y which is $2n^2$ times thicker, 4n times conductive and having n times larger cross-section area. If the outside face of X is maintained at 100°C, the outside face of Y at 0°C, then the temperature of the junction is represented by the graph (n > 0) :

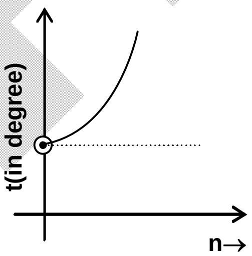
(A)



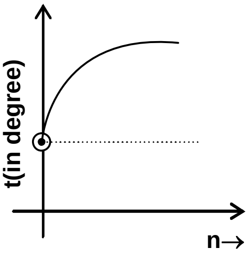
(B)



(C)



(D)



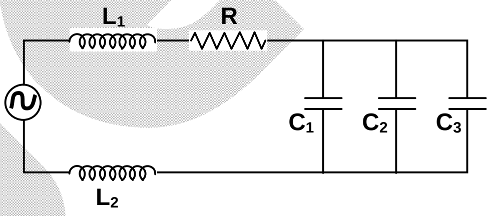
4. Two identical metallic sheets each behaves like a black body are kept parallel to each other with small separation between them in vacuum. Thermal energy is generated at a constant rate P in one of the sheets by passing electricity through it. In steady state, temperature of the other sheet is found to be constant at 300K. Find the value of P in kilo-watt. (given area of plates = $A = \frac{10^3}{17 \times 27} m^2$ and $\sigma = \frac{17}{3} \times 10^{-8}$ W/m^{2}K^4)

(A) 3 (B) 4
(C) 5 (D) 6

5. A copper sphere is suspended in an evacuated chamber maintained at 300K. The sphere is maintained at a constant temperature of 500K by heating it electrically. A total of 300W of electric power is needed to do it. When half of the surface of the copper sphere is completely blackened 600W is needed to maintain the same temperature of the sphere. Calculate the emissivity of copper.

(A) $e = \frac{1}{3}$ (B) $e = \frac{2}{3}$
(C) $e = \frac{1}{2}$ (D) $e = \frac{1}{6}$

6. A generator with an adjustable frequency of oscillation is connected to resistance, R = 100 Ω, inductances, L_1 = 1.7 mH and L_2 = 2.3 mH and capacitances, C_1 = 4 μF, C_2 = 2.5 μF and C_3 = 3.5 μF. The resonant angular frequency of the circuit is

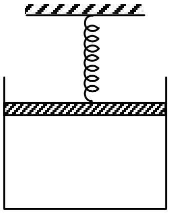


(A) 0.5 rad/s
(B) 0.5×10^4 rad/s
(C) 2 rad/s
(D) 2×10^{-4} rad/s

7. Power factor of an L-R series circuit is 0.6 and that of a C-R series circuit is 0.5. If the elements (L, C and R) of the two circuit are joined in series the power factor of this circuit is found to be 1. The ratio of the resistance is L-R circuit to the resistance in the C-R circuit is

(A) $\frac{6}{5}$ (B) $\frac{5}{6}$
(C) $\frac{4}{3\sqrt{3}}$ (D) $\frac{3\sqrt{3}}{4}$

8. One mole of an ideal gas is kept enclosed under a light and frictionless piston (area = 10^{-4} m^2) connected by a compressed spring (spring constant 100 N/m). The volume of gas is 0.83 m^2 and its temperature is 100 K. The gas is heated so that it compresses the spring further by 0.1 m. The work done by the gas in the process is X joules. Find the value of X. (Take R = 8.3 J-mol^{-1}K^{-1} and there is no atmosphere)



(A) $\frac{1}{2}$ (B) $\frac{3}{2}$
(C) $\frac{5}{2}$ (D) $\frac{3}{4}$

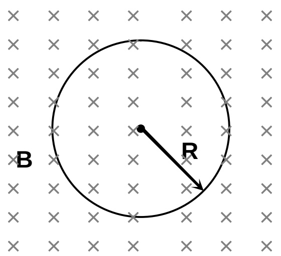
9. A charged particle of specific charge α is released from origin at t = 0 with velocity $\vec{v} = v_0\hat{i} + v_0\hat{j}$ in magnetic field $\vec{B}_0 = B_0\hat{i}$. The coordinate of the particle at time $t = \frac{\pi}{B_0\alpha}$ are (specific charge α = q/m)

(A) $\left(\frac{v_0}{2B_0\alpha}, \frac{\sqrt{2}v_0}{\alpha B_0}, \frac{-v_0}{B_0\alpha}\right)$
(B) $\left(\frac{-v_0}{2B_0\alpha}, 0, 0\right)$
(C) $\left(0, \frac{2v_0}{\alpha B_0}, \frac{v_0\pi}{2B_0\alpha}\right)$
(D) $\left(\frac{v_0\pi}{B_0\alpha}, 0, \frac{-2v_0}{B_0\alpha}\right)$

10. An electron is released from the origin at a place where a uniform electric field $\vec{E}$ and uniform magnetic field $\vec{B}$ exists along the negative y-axis and negative z-axis respectively. Then which of the following are INCORRECT.

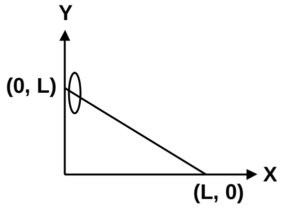
(A) At time t the y-component of velocity of the electron becomes $v_y = \frac{E}{B}\sin\omega t$, where $\omega = \frac{eB}{m}$
(B) At $t = \frac{\pi m}{eB}$ the electron will have only x-component of velocity.
(C) At $t = \frac{2\pi m}{3eB}$, the y-component of velocity becomes zero.
(D) The displacement along y-axis is $\frac{2Em}{eB^2}$, when the velocity of electron becomes perpendicular to the y-axis.

11. A conducting loop of radius R is present in a uniform magnetic field B perpendicular to the plane of the ring. If the radius R varies as a function of time 't', as $R = R_0 + t$, the emf induced in the loop is



(A) $2\pi(R_0 + t)B$ clockwise
(B) $\pi(R_0 + t)B$ clockwise
(C) $2\pi(R_0 + t)B$ anticlockwise
(D) zero

12. Electric field given by the vector $\vec{E} = x\hat{i} + y\hat{j}$ present in the XY plane. A small ring carrying charge +Q, which can freely slide on smooth non-conducting rod, is projected along the rod from the point (0, L) such that it can reach the other end of the rod. What minimum velocity should be given to the ring? (Assume z-axis is the vertical axis)



(A) $\left(\frac{QL^2}{m}\right)^{1/2}$
(B) $2\left(\frac{QL^2}{m}\right)^{1/2}$
(C) $4\left(\frac{QL^2}{m}\right)^{1/2}$
(D) $\left(\frac{QL^2}{2m}\right)^{1/2}$

13. Current density in a cylindrical wire of radius R is given as

$$J = \begin{cases} J_0\left(\dfrac{x}{R}-1\right) & \text{for} \quad 0 \le x < \dfrac{R}{2} \\ J_0\left(\dfrac{x}{R}\right) & \text{for} \quad \dfrac{R}{2} \le x \le R \end{cases}$$

The current flowing in the wire is

(A) $\frac{7}{24}\pi J_0R^2$ (B) $\frac{1}{6}\pi J_0R^2$

(C) $\frac{7}{12}\pi J_0R^2$ (D) $\frac{5}{12}\pi J_0R^2$

14. A container encloses 32 g of O_2 at 127°C and of pressure P_0. A small hole is made in the container and the gas leaks out. At a certain state, pressure of gas becomes $\frac{P_0}{2}$ and its temperature 27°C. Mass of the gas that has leaked out till this stage is nearly:

(A) 6.3g (B) 7.4g

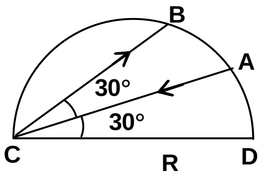
(C) 16.3g (D) 10.7g

15. A long straight wire along the z-axis carries I in the negative z-direction. The magnetic vector field B at a point having coordinates (x, y) in the z = 0 plane is

(A) $\frac{\mu_0 I(y\hat{i}-x\hat{j})}{2\pi(x^2+y^2)}$ (B) $\frac{\mu_0 I(y\hat{i}+x\hat{j})}{2\pi(x^2+y^2)}$

(C) $\frac{\mu_0 I(x\hat{i}-y\hat{j})}{2\pi(x^2+y^2)}$ (D) $\frac{\mu_0 I(x\hat{i}+y\hat{j})}{2\pi(x^2+y^2)}$

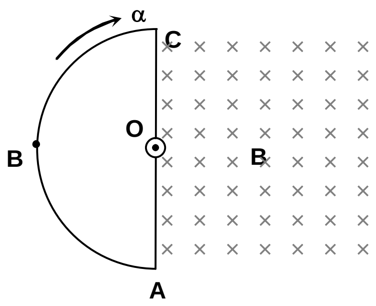
16. A current carrying wire is placed in the grooves of an insulating semi-circular disc of radius R, a shown. The current enters at point A and leaves from point B. The magnetic field at point D, has magnitude:



(A) $\frac{\mu_0 I}{8\pi R\sqrt{3}}$ (B) $\frac{\mu_0 I}{4\pi R\sqrt{3}}$

(C) $\frac{\sqrt{3}\mu_0 I}{4\pi R}$ (D) $\frac{\sqrt{3}\mu_0 I}{2\pi R}$

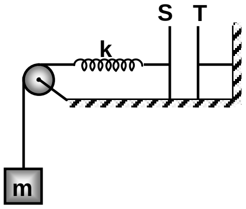
17. What is the emf induced in the loop OABCO (radius = a) at time t placed in uniform magnetic field B as shown when its angular acceleration is β? n = number of half revolutions of the loop in a given time t.



(A) $\frac{Ba^2\beta t}{2}$ (B) $\frac{(-1)^n Ba^2\beta t}{2}$

(C) $\frac{(-1)^n Ba^2\beta t}{4}$ (D) $(-1)^n Ba\beta t$

18. The plate S and T of an uncharged parallel plate capacitor are connected across a battery. The battery is then disconnected and the charged plates are now connected in a system as shown in the figure. The system shown is in equilibrium. All the strings are massless. The magnitude of charge on one of the capacitor plate is: (consider the area of plates to be A)



(A) $\sqrt{2mgA\varepsilon_0}$ (B) $\sqrt{\dfrac{4mgA\varepsilon_0}{k}}$

(C) $\sqrt{mgA\varepsilon_0}$ (D) $\sqrt{\dfrac{2mgA\varepsilon_0}{k}}$

19. Power radiated by a black body is P_0 and the wavelength corresponding to maximum energy is around λ_0. On changing the temperature of the black body, it was observed that the power radiated becomes $\dfrac{256P_0}{81}$. The shift in wavelength corresponding to the maximum energy will be

(A) $\dfrac{\lambda_0}{4}$ (B) $\dfrac{\lambda_0}{2}$

(C) $-\dfrac{\lambda_0}{4}$ (D) $-\dfrac{\lambda_0}{2}$

20. One mole of an ideal gas contained in a cylinder undergoes a thermodynamic process during which pressure relates to volume as $P = \dfrac{A}{1+\left(\dfrac{B}{V}\right)^2}$, where A and B are constants. As the volume of the gas is changed from V = B to V = 2B, its change of temperature can be expressed as:

(A) $\dfrac{6AB}{5R}$ (B) $\dfrac{AB}{2R}$

(C) $\dfrac{-3AB}{5R}$ (D) $\dfrac{11AB}{10R}$

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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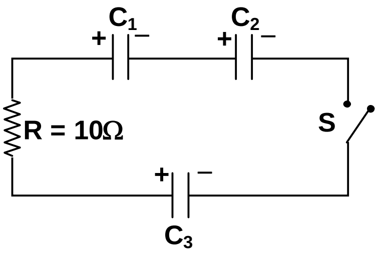
21. A moving coil galvanometer 'A' has 100 turns and resistance 50 Ω. Another moving coil galvanometer 'B' has number of turns 500 and resistance 200 Ω. The other quantities are same in both cases. They are connected to a battery through a resistance of 50Ω. The ratio of deflection of B to A is ……….

22. Three concentric thin spherical shells of radii R, 2R and 3R are given 2Q, Q and –Q respectively. The innermost and the outermost shells are earthed. The final charge on the inner most sphere is $\left(-\dfrac{Q}{n}\right)$. Find the value of n.

23. A galvanometer having a resistance of 50Ω, gives a full scale deflection for a current of 0.05 A. Find the length (in meter) of a resistance wire of area of cross-section 2.97×10^{-2} cm^2 that can be used to convert the galvanometer into an ammeter which can read a maximum of 5A current. (specific resistance of the wire = 5×10^{-7} Ω-m)

24. Three charged capacitors C_1, C_2 and C_3 of capacitances 3 μF, 6 μF and 6 μF respectively and having charge 30 μC each are connected with a resistor of resistance R = 10Ω through a switch as shown in the figure. The switch S is closed at t = 0. Find the total heat (in μJ) dissipated through the resistor.



25. Two identical containers A and B with frictionless pistons contain the same ideal gas at the same temperature and the same volume V. The mass of the gas in A is m_A and that in B is m_B. The gas in each cylinder is now allowed to expand isothermally to the same final volume 2V. The change in pressure in A and B are found to be ΔP and 1.5ΔP respectively. If $\frac{m_A}{m_B} = \frac{2}{\lambda}$ then find the value of λ.

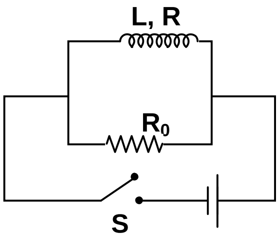
26. An ideal gas has a molar heat capacity $C = \frac{9R}{2}$ in the process PT = constant. Find the degree of freedom of the gas molecule. (R = ideal gas constant)

27. When an ideal diatomic gas is heated at constant pressure, during a process. If during the given process, the ratio $\frac{\Delta Q}{\Delta W} = \frac{n}{2}$. Find the value of n. (where ΔQ = Heat supplied to the gas during the process, ΔW = work done by the gas during the process)

28. If P-V diagram of a diatomic gas during a process is plotted, it is a straight line (when extended it passes through the origin). If molar heat capacity of the gas in the process is nR. Find the value of n. (where R = ideal gas constant)

29. In a region of space, the magnetic field is changing at a constant rate $\frac{dB}{dt}$. A given mass 'm' of copper of resistivity ρ and density d drawn into a wire of radius r and formed into a circular loop of radius R_1 which is placed perpendicular to the given magnetic field region. If the current induced in the loop in the terms of given quantities is $\frac{nm}{4\pi\rho d}\frac{dB}{dt}$. Find n.

30. A coil of inductance L = 2μH and R = 1Ω is connected to a source of constant emf, ε = 3V. A resistance R_0 = 2Ω is connected in parallel with the coil. The heat generated in the coil after the switch S is disconnected after a long time is $P \times 10^{-6}$ J. The internal resistance of the source is negligible. Find the value of P.



Chemistry

PART – B

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

31. Molecular formula of P and Q is C_2H_4O and C_3H_6O. If P and Q both give (+ve) $NaHSO_3$ test and only P gives haloform test. Choose the INCORRECT option:

$P + Q \xrightarrow[2.\ \Delta]{1.\ NaOH} \text{Product}$

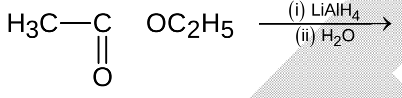
(A) Total 4 products will be obtained excluding stereoisomers.
(B) Total 4 products will be obtained including stereoisomers.
(C) Reaction is known as cross-Aldol condensation.
(D) All products obtained will give (+ve) Tollen's test as well as Fehling test.

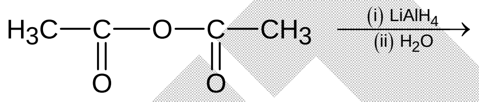
32. If Q is benzal chloride, then choose the INCORRECT statement about this commercial method

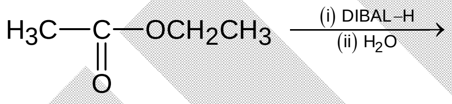
$P \xrightarrow[h\nu]{Cl_2} Q \xrightarrow[373\ K]{H_2O} R$

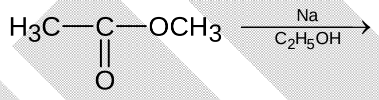
(A) R will give (–ve) Fehling test.
(B) Total 10 benzenoid structural isomers for Q are possible.
(C) (P) can have molecular formula C_7H_8.
(D) Free radical addition involves in conversion of P to Q.

33. The reaction in which two moles of (same or different) alcohol is not obtained as a product is

(A) 
$H_3C-\underset{\underset{O}{\|}}{C}\quad OC_2H_5 \xrightarrow[(ii)\ H_2O]{(i)\ LiAlH_4}$

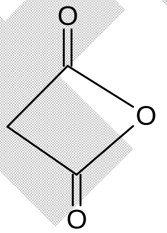
(B) 
$H_3C-\underset{\underset{O}{\|}}{C}-O-\underset{\underset{O}{\|}}{C}-CH_3 \xrightarrow[(ii)\ H_2O]{(i)\ LiAlH_4}$

(C) 
$H_3C-\underset{\underset{O}{\|}}{C}-OCH_2CH_3 \xrightarrow[(ii)\ H_2O]{(i)\ DIBAL-H}$

(D) 
$H_3C-\underset{\underset{O}{\|}}{C}-OCH_3 \xrightarrow[C_2H_5OH]{Na}$

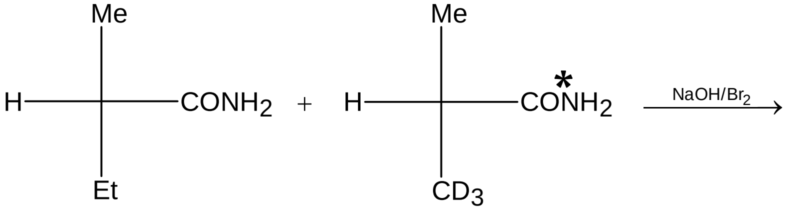
34. The product obtained on reaction of Malonic acid with P_2O_5 / Δ is

(A) $CH_3 - COOH$

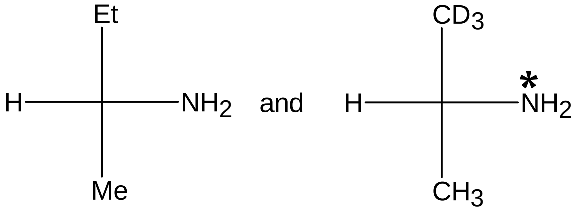
(B) 

(C) $O = C = C = C = O$
(D) $O = C = C = O$

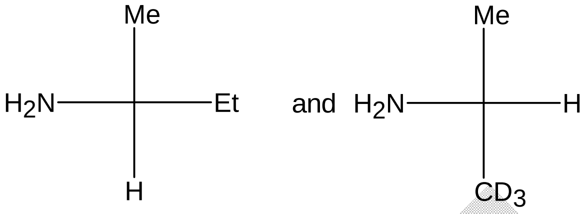
35. The product of the following reaction is:


Me
H
CONH2
+
Et
Me
H
*
CONH2
CD3
NaOH/Br2

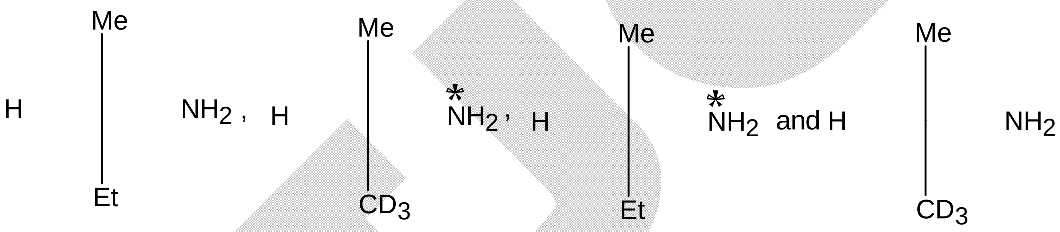
(A)


Et
H
NH2
and
Me
CD3
H
*
NH2
CH3

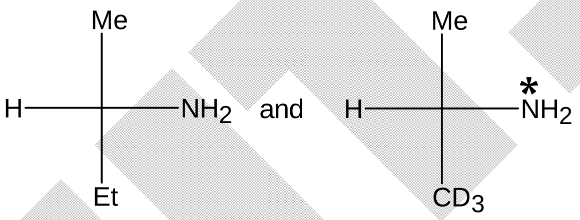
(B)


Me
H2N
Et
H
and
Me
H2N
H
CD3

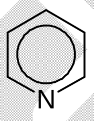
(C)


Me
H
NH2 ,
Et
Me
H
*
NH2 ,
CD3
Me
H
*
NH2
Et
and H
Me
NH2
CD3

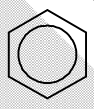
(D)


Me
H
NH2
and
Et
Me
H
*
NH2
CD3

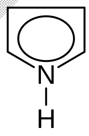
36. The correct order of rate of electrophilic aromatic substitution is



(I)



(II)

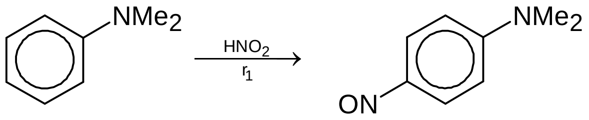


(III)

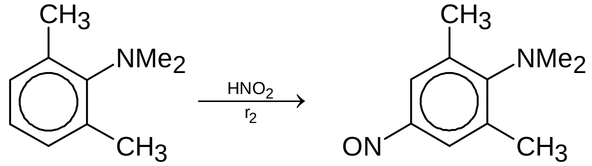
(A) I > II > III
(B) I < II < III
(C) II > I > III
(D) III > I > II

37. Consider the following reaction

Reaction - I


NMe2
HNO2
r1
NMe2
ON

Reaction - II


CH3
NMe2
CH3
HNO2
r2
CH3
NMe2
ON
CH3

Which of the following is a CORRECT comparison of rate of reaction?

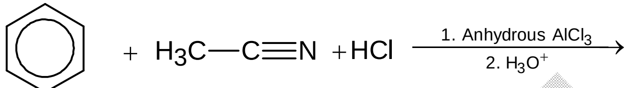
(A) $r_1 > r_2$

(B) $r_2 > r_1$

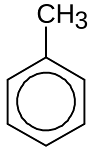
(C) $r_1 = r_2$

(D) Reactions are not possible

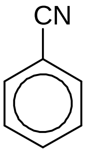
38. The final product of the following reaction is


+ H3C—C≡N +HCl
1. Anhydrous AlCl3
2. H3O+

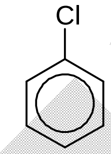
(A)



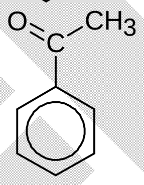
(B)



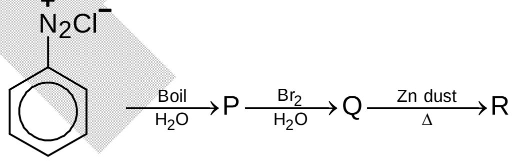
(C)



(D)



39. The dipole moment of final organic product obtained in the following reaction is:


N2Cl
Boil
H2O
P
Br2
H2O
Q
Zn dust
Δ
R

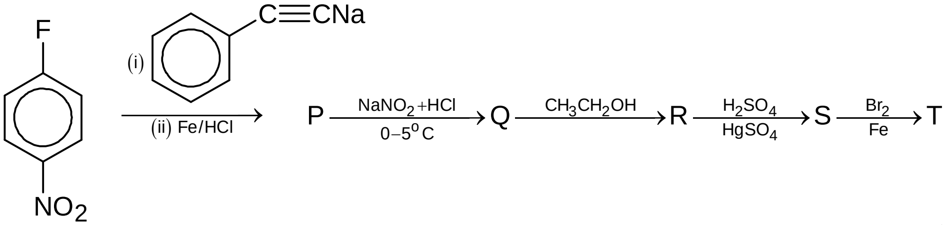
(A) $\mu_R \neq 0$

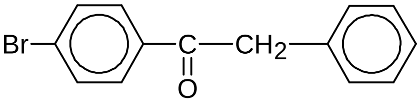
(B) $\mu_Q = 0$

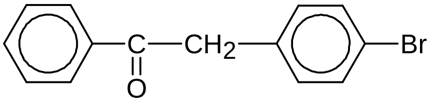
(C) $\mu_R < \mu_Q$

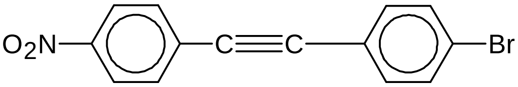
(D) $\mu_R > \mu_Q$

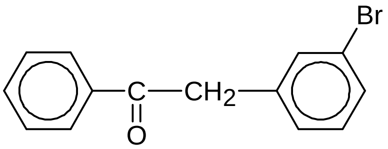
40. The final product 'T' in the following reaction sequence is


F
NO2
(i) C≡CNa
(ii) Fe/HCl
P
NaNO2+HCl
0–5° C
Q
CH3CH2OH
R
H2SO4
HgSO4
S
Br2
Fe
T

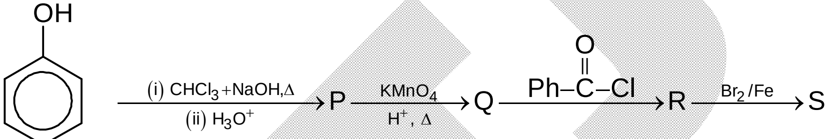
(A)


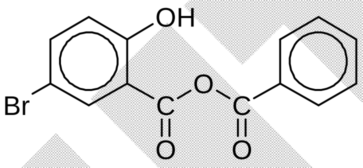
(B)


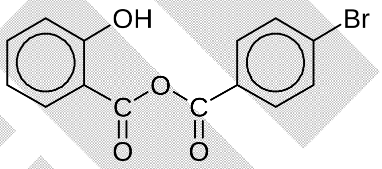
(C)


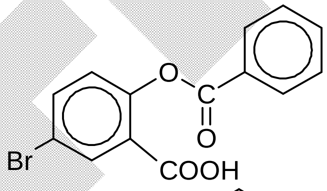
(D)


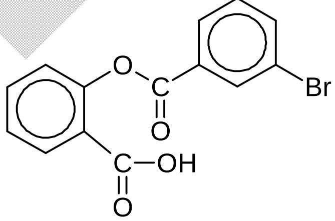
41. The major product 'S' obtained in the following reaction is


OH
(i) CHCl3+NaOH,Δ
(ii) H3O+
P
KMnO4
H+, Δ
Q
O
Ph–C–Cl
R
Br2/Fe
S

(A)


(B)


(C)


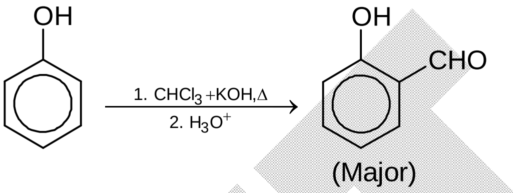
(D)


42. Compare van't Hoff factor for compounds CH_3CH_2OH (A) and Ph_3COH (B) in cold conc. H_2SO_4 determined from measurement of freezing point.
(A) $i_A > i_B$
(B) $i_B > i_A$
(C) $i_A = i_B$
(D) $i_A < i_B < 1$

43. 896 mL vapour of a hydrocarbon 'P' having carbon 87.80% and hydrogen 12.19% weighs 3.28 g at STP. Hydrogenation of 'P' gives 2-methyl pentane. Also 'P' on hydration in the presence of $H_2SO_4 / HgSO_4$ gives a ketone 'Q' having molecular formula $C_6H_{12}O$. The ketone 'Q' gives a positive iodoform test. The INCORRECT statement is:
(A) P gives white ppt. with Ammonical $AgNO_3$.
(B) Q gives orange colour with 2,4-DNP.
(C) Q gives crystalline compound with $NaHSO_3$.
(D) P gives red colour of Cu_2O with Ammonical Cu_2Cl_2.

44. Phenol and formaldehyde undergo condensation to give a polymer (P) which on heating with formaldehyde gives a thermosetting polymer (Q). The polymer (P) is:
(A) Novolac
(B) Bakelite
(C) Glyptal
(D) Polyster

45. Consider the following reaction



The intermediate formed in above reaction is
(A) Singlet dichloro carbene
(B) $\overset{-}{C}Cl_3$
(C) Chloronium ion
(D) $\overset{\oplus}{C}Cl_2$

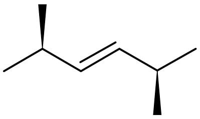
46. The basic strength order of the following in H_2O is

$MeNH_2$,	Me_2NH ,	Me_3N
(I)	(II)	(III)

(A) I > II > III
(B) II > I > III
(C) III > II > I
(D) I > III > II

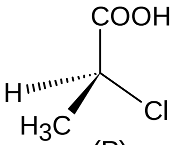
47. Most acidic compound among the following is
(A) Picric acid
(B) Squaric acid
(C) Carbonic acid
(D) Carbolic acid

48. The total number of stereoisomers of following compound 'X' is

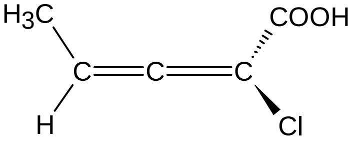


(A) 2
(B) 6
(C) 4
(D) 8

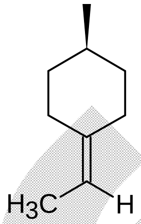
49. Asymmetric compound among the following is



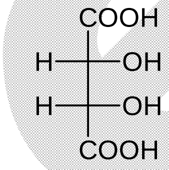
(P)



(Q)

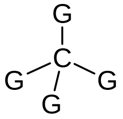


(R)



(S)

(A) P, Q, R, S
(B) P, Q, S
(C) P, Q, R
(D) Q, S, R

50. A compound  $C(G)_4$ contain $\frac{\sigma}{\pi}$ ratio 1 : 1, if G is

(A) CHO
(B) CN
(C) COOH
(D) $C \equiv CH$

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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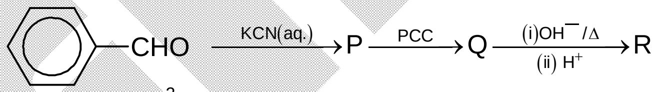
51. 

How many sp^2 hybridised carbons are present in [R]?

52. In soda lime decarboxylation, soda lime is made of x mole of NaOH and y moles of CaO, then $\frac{x}{y}$ is….

53. 0.5 g of an organic compound having molecular formula $C_{12}H_{24}N_x$ was analysed for nitrogen using Duma's method. The nitrogen evolved was collected over water and found to be 110 mL at 300 K and 802 mm Hg pressure. If aqueous tension of H_2O at 300 K is 42 mm Hg, the value of x is…..

54. In the qualitative analysis of sulphide ions $\left(S^{-2}\right)$, the following reaction is used

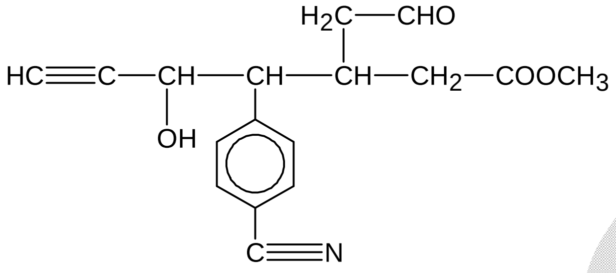
$S^{-2} + \text{Compound}(X) \longrightarrow Na_4\left[Fe(CN)_5(NOS)\right]$

What is magnetic moment (in B. M.) for compound 'X'?

55. How many alcoholic structural isomers of molecular formula $C_6H_{14}O$ are possible which on oxidation with PCC give aldehyde product?

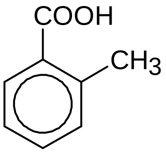
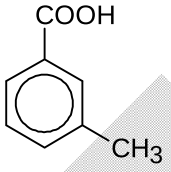
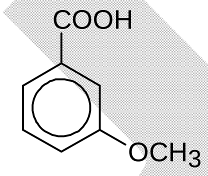
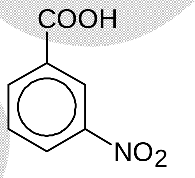
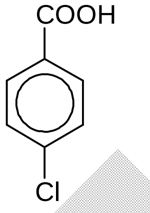
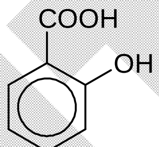
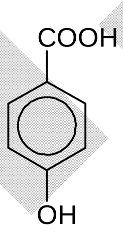
56. Number of moles of CH_3MgBr which will react with one mole of compound 'Y':

Y =



57. An organic compound 'A' having molecular formula $C_5H_{10}O_6$ on acetylation forms a compound having molecular weight 334. Number of hydroxyl groups (–OH) in the compound 'A' is:

58. Among the following compounds, which are more acidic than benzoic acid

59. Total number of alkenes of molecular formula C_6H_{12} which will show geometrical isomerism

60. Total number of meso structures in $CH_3\left(CHOH\right)_5CH_3$ is

Mathematics

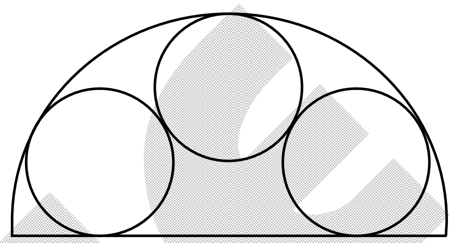
PART – C

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

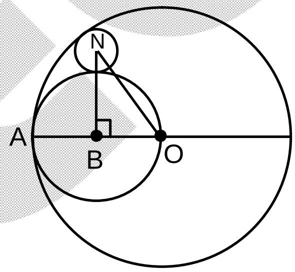
61. Three identical circles, each of radius a, are drawn as shown in figure and tangent to a semi-circle of radius r, express a in terms of r ?



(A) $\frac{r}{4}$ (B) $\frac{r}{2}$

(C) $\frac{r}{3}$ (D) $\frac{2r}{3}$

62. In the figure below is a circle with centre O, and another circle with centre at the midpoint B of the radius OA and passing through O. A small circle is drawn as shown, tangent to both the larger circles, such that its centre N is directly above B (that is, BN $\perp$ AB). If the perimeter of the triangle NBA is 8 cm, find the value (in cm) of the radius of the small circle



(A) $\frac{2}{3}$ (B) 2

(C) 1 (D) $\sqrt{2}$

63. In a ΔABC

$$3\sin A + 4\cos B = 6$$

and $4\sin B + 3\cos A = 1$

then angle C is equal to

(A) $\frac{\pi}{6}$ (B) $\frac{\pi}{3}$

(C) $\frac{\pi}{4}$ (D) $\frac{2\pi}{3}$

64. Let $f_k(x) = \frac{1}{k}(\sin^k x + \cos^k x)$, then $f_4(x) - f_6(x) = \frac{\lambda}{24}$, then λ is

(A) 1 (B) 2

(C) –2 (D) –1

65. In a triangle ABC, $\frac{a}{b} = 2 + \sqrt{3}$ and $\angle C = 60°$, then

(A) $\angle A = 15°$ (B) $\angle A = 105°$

(C) $\angle B = 105°$ (D) $\angle B = 30°$

66. Let A(α, 2), B(α, –2) and C(β, 2) be the vertices of a triangle ABC. If the circumcentre is origin and orthocentre is (3, γ), then which of the following is **NOT CORRECT** about ΔABC

(A) area is 12 (B) perimeter is $10 + 2\sqrt{13}$

(C) inradius is $\frac{5 - \sqrt{13}}{2}$ (D) circum radius is $2\sqrt{13}$

67. Let PQ be a chord of length 8 of the circle $4x^2 + 4y^2 + 24x - 32y - 189 = 0$. If tangents drawn to the circle at point P and Q intersect at the point R, then perpendicular distance of R from chord PQ is

(A) $\frac{15}{2}$ (B) $\frac{32}{15}$

(C) $\frac{68}{15}$ (D) $\frac{36}{17}$

68. Let P_1 be a parabola with vertex (1, 8) and focus (3, –1) and P_2 is the mirror image of P_1 with respect to the line $3x - y + 10 = 0$. If the focus of P_2 is (α, β) and directrix of P_2 is $7x + 6y = \gamma$, then $\alpha + \beta + \gamma$ is equal to

(A) 125 (B) 137

(C) 52 (D) 119

69. If two tangents can be drawn to the different branches of hyperbola $x^2 - 9y^2 = 9$ from the point (α, β) then (α, β) can be

(A) $\left(2, \frac{4}{9}\right)$ (B) $\left(-1, \frac{1}{4}\right)$

(C) $\left(1, \frac{1}{2}\right)$ (D) (5, 1)

70. Let the line $y = mx$ and the ellipse $4x^2 + 9y^2 = 1$ intersect at point P in the first quadrant. If the normal to the ellipse at P meets the coordinate axes at $A(\alpha, 0)$ and $B\left(0, -\frac{5}{8\sqrt{3}}\right)$, then area of triangle OAB is equal to (where O is origin)

(A) $\frac{1}{16\sqrt{3}}$ (B) $\frac{25}{576\sqrt{3}}$

(C) $\frac{9}{144\sqrt{3}}$ (D) $\frac{25}{288\sqrt{3}}$

71. Consider the circle $x^2 + y^2 = 25$ and $y^2 = 24x$. They intersect at P and Q in the first and fourth quadrant. Tangents at P and Q to the circle intersect the x-axis at R and tangent at P and Q to the parabola intersect x-axis at S, then radius of circumcircle of ΔPRS is

(A) $20\sqrt{7}$ (B) $5\sqrt{7}$

(C) $2\sqrt{7}$ (D) $7\sqrt{3}$

72. Perpendicular tangents are drawn from the point P to an ellipse (whose axes are parallel to coordinate axes). The locus of point P is $x^2 + y^2 - 4x - 6y - 5 = 0$ and if the product of length of perpendicular from foci upon any one of these tangents is 6, then eccentricity is

(A) $\frac{1}{\sqrt{6}}$ (B) $\frac{1}{\sqrt{3}}$

(C) $\frac{1}{2}$ (D) $\frac{1}{\sqrt{2}}$

73. If the directrix of hyperbola (having positive x intercept) $xy = 8 + x$ is the tangent to the hyperbola $x^2 - ky^2 = 30$, then k is equal to

(A) $\sqrt{5}$ (B) 6

(C) $\sqrt{6}$ (D) $\sqrt{15}$

74. Given points P, Q on an ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ (a > b > 0) satisfying OP $\perp$ OQ, the minimum of |OP| × |OQ| is

(A) $\frac{2a^2b^2}{a^2+b^2}$ (B) $\frac{2a^2b^2}{a^2-b^2}$

(C) $\frac{4a^2b^2}{a^2-b^2}$ (D) $\frac{4a^2b^2}{a^2+b^2}$

75. The straight line $\frac{x}{4}+\frac{y}{3}=1$ intersect the ellipse $\frac{x^2}{16}+\frac{y^2}{9}=1$ at two points A and B, there is a point P on the ellipse such that the area of ΔPAB is equal to 3. Then the number of possible point P is/are

(A) 1 (B) 2

(C) 4 (D) 3

76. Suppose points F_1, F_2 are the focii of ellipse $\frac{x^2}{9}+\frac{y^2}{4}=1$, P is a point on the ellipse such that $\frac{|PF_1|}{|PF_2|}=\frac{2}{1}$, then the area of ΔPF_1F_2 is equal to

(A) 16 (B) 20

(C) 4 (D) 32

77. The curve represented by the equation $\frac{x^2}{\sin\sqrt{2}-\sin\sqrt{3}}+\frac{y^2}{\cos\sqrt{2}-\cos\sqrt{3}}=1$ is

(A) an ellipse with the focii on x-axis (B) an ellipse with the focii on y-axis

(C) an hyperbola with focii on x-axis (D) an hyperbola with focii on y-axis

78. If one side of square ABCD is on the line y = 2x − 17 and the other two vertices lies on the parabola $y = x^2$, then the minimum area of the square is

(A) 160 (B) 1200

(C) 80 (D) 60

79. Let a line with the inclination of 60° from positive x-axis be drawn through the focus F of the parabola $y^2 = 8(x + 2)$. If the two intersection points of the line and the parabola are A and B and the perpendicular bisector of the chord AB intersect the x-axis at the point P, then the length of segment PF is

(A) $\frac{16}{3}$ (B) $\frac{8}{3}$

(C) $\frac{16\sqrt{3}}{3}$ (D) $8\sqrt{3}$

80. ΔABC is inscribed in a unit circle. The three bisectors of the angles A, B, C are extended to intersect the circle at A_1, B_1, C_1 respectively, then the value of $\frac{AA_1\cos\frac{A}{2}+BB_1\cos\frac{B}{2}+CC_1\cos\frac{C}{2}}{\sin A+\sin B+\sin C}$ is

(A) 2 (B) 4

(C) 6 (D) 8

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

81. Let $x_0 = 2022$ and let $x_{n+1} = \frac{1+x_n}{1-x_n}$ for $n \geq 1$, find x_{2024}

82. Let $x + y + z = 1$, $x, y, z \in R^+$ then determine the least value of $\frac{1}{x}+\frac{4}{y}+\frac{9}{z}$.

83. The value of (1 – cot23°) (1 – cot22°) is equal to

84. The number of values of x in the interval $\left(0, \frac{\pi}{2}\right)$ such that $\frac{\sqrt{3}-1}{\sin x}+\frac{\sqrt{3}+1}{\cos x} = 4\sqrt{2}$ is

85. If $\alpha = \frac{\pi}{2023}$, then value of $\cos\alpha.\cos2\alpha.\cos3\alpha.\cos4\alpha \ldots\ldots \cos(1011\alpha) = 2^{-\lambda}$, then λ is

86. A horizontal park is in the shape of a rectangle ABCD with AB = 30m. A vertical lamp post BP is created at the point B such that $\angle PCB = 30°$ and $\angle PDB = \tan^{-1}\left(\frac{8}{17\sqrt{3}}\right)$. If height of the lamp post is h, then [h] is equal to (where [.] denotes G.I.F.)

87. If the asymptotes of the hyperbola $9x^2 - 4y^2 - 18x - 24y - 63 = 0$ are tangents to the circle $13x^2 + 13y^2 - 26x + k = 0$ at point $A(\alpha_1, \beta_1)$ and $B(\alpha_2, \beta_2)$ then $|\alpha_1 + \alpha_2 + k|$ is equal to

88. Let α and β be real numbers in the interval $\left[0, \frac{\pi}{2}\right]$, then of $\sin^6\alpha + 3\sin^2\alpha\cos^2\beta + \cos^6\beta = 1$, then $\frac{\alpha}{\beta}$ is equal to

89. The points (0, 0), (a, 11) and (b, 37) are the vertices of an equilateral triangle, then ab is equal to

90. Let P is a point, lies on circle $(x + 5)^2 + (y - 12)^2 = 196$, then the minimum value of sum of squares of abscissa and ordinate of point P is

FIITJEE

ALL INDIA TEST SERIES

PART TEST – II

JEE (Main)-2023

TEST DATE: 03-12-2022

ANSWERS, HINTS & SOLUTIONS

Physics

PART – A

SECTION – A

1. C

Sol. $Pt = Q_{system} + Q_{lost}$

$750 \times 4 \times 60 = 0.5 \times 4200 \times 70 + Q_{lost}$

$\therefore\ P_{lost} = \frac{Q_{lost}}{time}$

2. B

Sol. $(m_0 - \lambda t)\, CdT = Rdt$

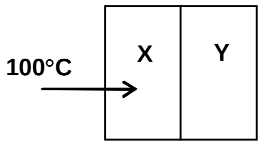
3. A

Sol. At steady state

Let the temperature at the junction be T

$\therefore\ \frac{kA}{\ell}(T - 100) = \frac{4nknA}{2n^2\ell}(0 - T)$

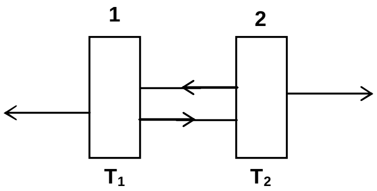
$\therefore$ T is independent of n.



4. A

Sol. $P_1 = 2\sigma AT_1^4 - \sigma AT_2^4$

$\sigma AT_1^4 = 2\sigma AT_2^4$



5. A

Sol. $$\frac{300}{600}=\frac{2(2\pi R^2)\sigma e(500^4-300^4)}{2\pi R^2\sigma e\left[500^4-300^4\right]+2\pi R^2\sigma\left[500^4-300^4\right]}$$

6. B

Sol. $$\omega^2=\frac{1}{LC}$$

7. D

Sol. $\cos\phi_1=0.6$ $\cos\phi_2=0.5$ $\cos\phi_3=1$

$\tan\phi_1=\frac{X_L}{R_1}$ $\tan\phi_2=\frac{X_C}{R_2}$ $\therefore\ X_L=X_C$

$R_1\tan\phi_1=R_2\tan\phi_2$

8. B

Sol. The force exerted by gas on the piston when spring has compression x is

$F=P_0A+kx$

$$W=\int_0^{\ell}Fdx$$

9. D

Sol. Pitch (along x-axis) = V_0t

Magnetic force is towards negative z-axis

$\therefore\ \theta=\omega t=\pi$

$\therefore$ at this instant y = 0 and z = –2radius

10. C

Sol. $\vec{u}=u_x\hat{i}+u_y\hat{j}$

$\vec{E}=-E\hat{j}$

$\vec{B}=-B\hat{k}$

$\vec{F}=-e\left[\vec{E}+\vec{u}\times\vec{B}\right]=-e\left[-E\hat{j}+\left(u_x\hat{i}+u_y\hat{j}\right)\times\left(-B\hat{k}\right)\right]$

$F_x=eu_yB,\ F_y=e\left(E-u_xB\right)$

$\therefore\quad a_x=\frac{eB}{m}u_y$

$a_y=\frac{e}{m}\left[E-u_xB\right]$

$\therefore\quad u_y=A\sin\left(\omega t+\delta\right),\ a_y=A\omega\cos\left(\omega t+\delta\right)$

At t = 0, $u_y=0$ $\therefore\ \delta=0$

$a_y=\frac{F_y}{m}=\frac{eE}{m}$

$\therefore\quad A=\frac{eE}{m\omega}=\frac{E}{B}$

$\therefore\quad u_y=\frac{E}{B}\sin\omega t$

The velocity is along x-axis implies final velocity along y-axis is zero.

$$u_y = \frac{dy}{dt} \Rightarrow \int dy = \int_0^{\pi/\omega} u_y dt\,.$$

11. C

Sol. $\varepsilon = -\frac{d\phi}{dt}$

12. D

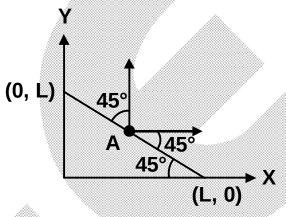
Sol. At point A, E along the rod = 0

x cos 45° = y sin 45°

$\Rightarrow$ x = y

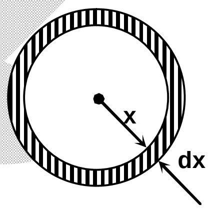
If the particle just reaches point A with velocity tending toward zero, then it will be able to reach the other end.

Apply work energy theorem



13. D

Sol. $$\int_0^i di = \int_0^{R/2} J_0\left(\frac{x}{R}-1\right)2\pi x dx + \int_{R/2}^{R} J_0 \frac{x}{R}(2\pi x)dx$$



14. D

Sol. Apply PV = nRT

$$\frac{P}{nT} = \frac{R}{V}$$

15. A

Sol. Magnetic field is along the tangent

16. B

Sol. $$\vec{B} = \frac{\mu_0 I[\sin 60^\circ](+\hat{k})}{4\pi(2R\sin 30^\circ)} + \frac{\mu_0 I[\sin 30^\circ](-\hat{k})}{4\pi(2R\sin 60^\circ)}$$

17. B

Sol. $\theta = \frac{1}{2}\beta t^2$

$$\varepsilon = -\frac{d\left(B\theta a^2/2\right)}{dt}$$

18. A

Sol. mg = kx

and $kx = \frac{q^2}{2\varepsilon_0 A}$

19. C

Sol. $T_0 \propto \frac{1}{\lambda_0}$

$P_0 \propto T_0^4$

$\therefore\ P_0 \propto \frac{1}{\lambda_0^4}$ and $\frac{256P_0}{81} \propto \frac{1}{\lambda^4}$

$\therefore\ \frac{P_0}{\frac{256P_0}{81}} = \frac{\lambda^4}{\lambda_0^4}$

20. D

Sol. PV = RT

and $P = \frac{A}{1+\frac{B^2}{V^2}}$;

$\frac{RT}{V} = \frac{A}{1+\frac{B^2}{V^2}}$

$T = \frac{VA}{R\left(1+\frac{B^2}{V^2}\right)}$

SECTION – B

21. 2

Sol. V = I_1R_1 and V = I_2R_2

NIAB = $k\theta$

$I_1 = \frac{k\theta_1}{N_1AB}$

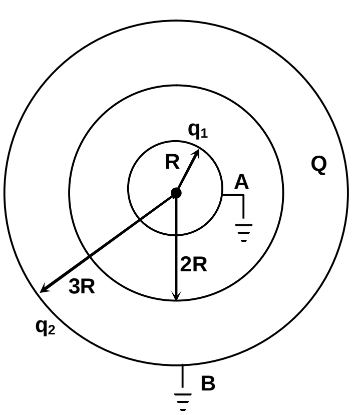
$\therefore\ I_2 = \frac{k\theta_2}{N_2AB}$

$V = \frac{k\theta_1R_1}{N_1AB} = \frac{k\theta_2R_2}{N_2AB}$

22. 4

Sol. $V_A = 0 = \frac{kq_1}{R} + \frac{kQ}{2R} + \frac{k(q_2)}{3R}$

$V_B = 0 = \frac{k(q_1+Q+q_2)}{3R}$



23. 3

Sol. $S = \frac{I_g G}{I - I_g} = \frac{\rho\ell}{A}$

24. 75

Sol. $\Delta H = \frac{(30)^2}{2}\left(\frac{1}{3}+\frac{1}{6}+\frac{1}{6}\right) - \left[\frac{(15)^2}{2}\left(\frac{1}{3}+\frac{1}{6}\right) + \frac{(45)^2}{2\times 6}\right] = 75\ \mu J$

25. 3

Sol. $\Delta P = \frac{n_A RT}{2V} - \frac{n_A RT}{V}$ …(i)

$1.5\Delta P = \frac{n_B RT}{2V} - \frac{n_B RT}{V}$ …(ii)

Solve equation (i) and (ii)

26. 5

Sol. PT = constant

$PV^{1/2}$ = constant

$x = \frac{1}{2}$

$C = C_v + \frac{R}{1-x}$

$\frac{9R}{2} = \frac{fR}{2} + 2R$

$\therefore$ f = 5

27. 7

Sol. $\Delta Q = nC_P\Delta T$

$\Delta Q = \frac{7}{2}nR\Delta T$

$\Delta W = P\Delta V = nR\Delta T$

$\frac{\Delta Q}{\Delta W} = \frac{7}{2}$

28. 3

Sol. $P \propto V$

PV^{-1} = constant

$\Rightarrow$ x = –1

$C = C_v + \frac{R}{1-x}$

$= \frac{5R}{2} + \frac{R}{2} = \frac{6R}{2} = 3R$

29. 1

Sol. Resistance, $R = \frac{\rho 2\pi R_1}{\pi r^2}$

$m = d(\pi r^2)2\pi R_1$

$R = \rho(2\pi R_1)^2 \frac{d}{m}$

Induced current in the loop, $I = \frac{dB}{dt}\frac{\pi R_1^2}{R}$

30. 3

Sol. $I = \frac{\varepsilon}{R} = 3\,A$

$H = \frac{1}{2}LI^2 = \frac{1}{2}\times 2\times 10^{-6}\times (3)^2 = 9\,\mu J$

$H_1 = \frac{H}{3} = \frac{9}{3} = 3\,\mu J$

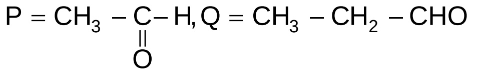
Chemistry

PART – B

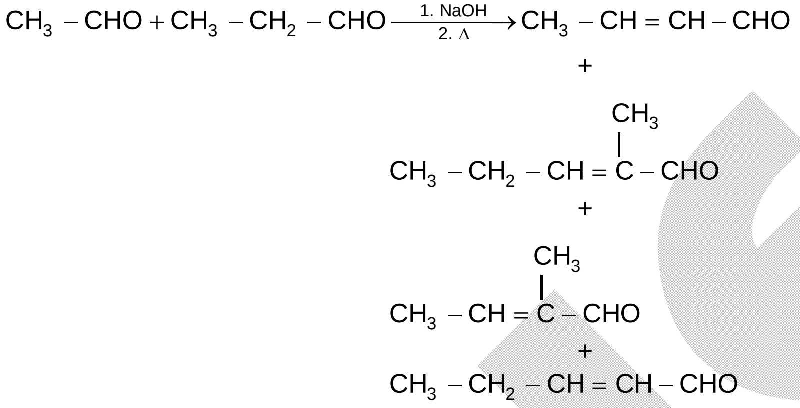
SECTION – A

31. B

Sol. $P(C_2H_4O)$ and $Q(C_3H_6O)$ must be carbonyl compounds as they both show +ve $NaHSO_3$ test. P must be ethanal as it gives haloform test.



$$P = CH_3-\underset{\underset{O}{||}}{C}-H, Q = CH_3-CH_2-CHO$$

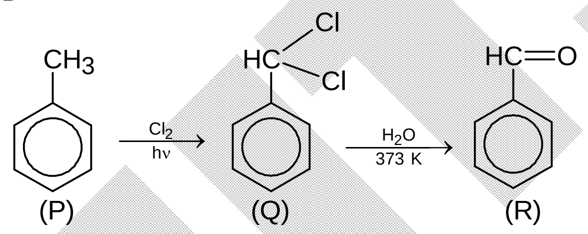


$$CH_3-CHO + CH_3-CH_2-CHO \xrightarrow[2.\ \Delta]{1.\ NaOH} CH_3-CH=CH-CHO$$
$$+$$
$$CH_3-CH_2-CH=\overset{\overset{CH_3}{|}}{C}-CHO$$
$$+$$
$$CH_3-CH=\overset{\overset{CH_3}{|}}{C}-CHO$$
$$+$$
$$CH_3-CH_2-CH=CH-CHO$$

Total 4 products obtained if we exclude stereoisomerism.

32. D

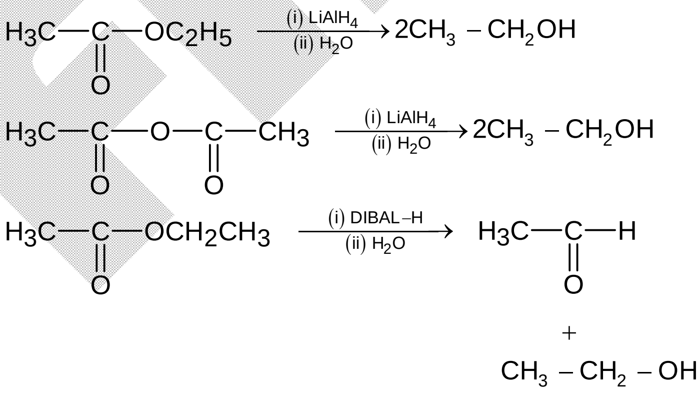
Sol.



Free-radical substitution is involved in conversion of P to Q.

33. C

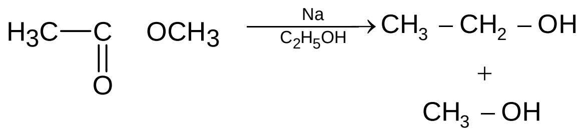
Sol.



$$H_3C-\underset{\underset{O}{||}}{C}-OC_2H_5 \xrightarrow[(ii)\ H_2O]{(i)\ LiAlH_4} 2CH_3-CH_2OH$$

$$H_3C-\underset{\underset{O}{||}}{C}-O-\underset{\underset{O}{||}}{C}-CH_3 \xrightarrow[(ii)\ H_2O]{(i)\ LiAlH_4} 2CH_3-CH_2OH$$

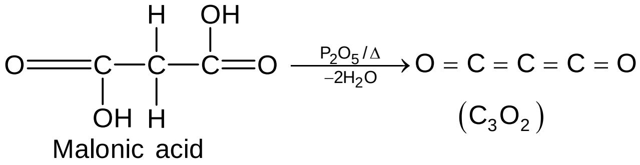
$$H_3C-\underset{\underset{O}{||}}{C}-OCH_2CH_3 \xrightarrow[(ii)\ H_2O]{(i)\ DIBAL-H} H_3C-\underset{\underset{O}{||}}{C}-H + CH_3-CH_2-OH$$



$$H_3C-\overset{\overset{}{}}{\underset{\underset{O}{\|}}{C}}\ OCH_3 \xrightarrow[C_2H_5OH]{Na} CH_3-CH_2-OH + CH_3-OH$$

34. C

Sol.

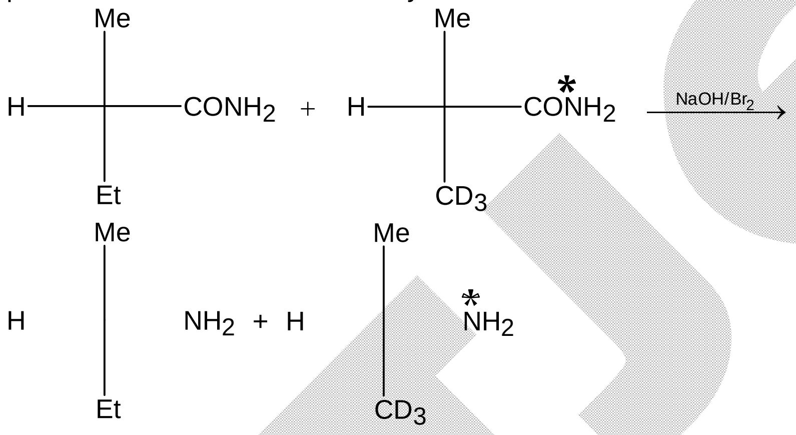


$$O=\underset{\underset{OH}{|}}{C}-\overset{\overset{H}{|}}{\underset{\underset{H}{|}}{C}}-\overset{\overset{OH}{|}}{C}=O \xrightarrow[-2H_2O]{P_2O_5/\Delta} O=C=C=C=O \ (C_3O_2)$$

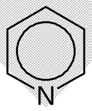
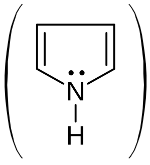
Malonic acid

35. D

Sol. This is Hoffmann bromamide reaction which involved intramolecular migration. No cross-over product is formed. Stereochemistry is retained.



36. B

Sol. The lone pair on N-atom in pyridine  is localised but – I effect of N-atom deactivates benzene ring. On the other hand, the lone pair on N-atom in pyrrole  is de-localized and hence activates the ring towards EAS.

$\therefore$ Order of reactivity is : III > II > I.

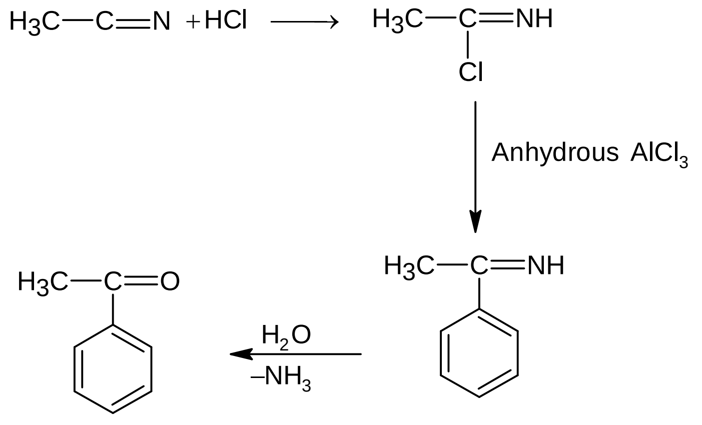
37. A

Sol. In the first reaction, the lone pair on nitrogen atom takes part in resonance with benzene ring and hence activates benzene ring towards EAS. But in second reaction, the lone pair on nitrogen atom does not take part in resonance with benzene ring due to SIR-effect and hence does not activate benzene ring.

$\therefore r_1 > r_2$.

38. D

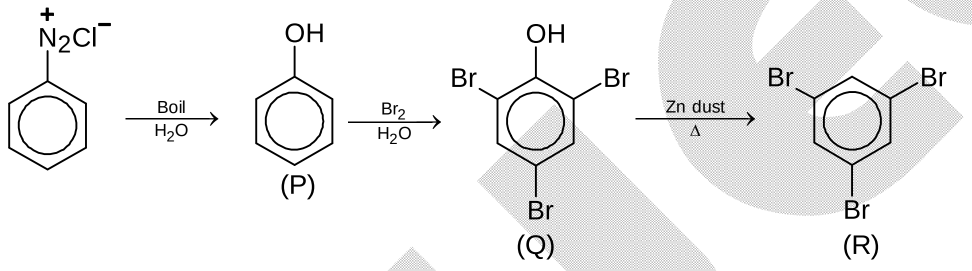
Sol.



$H_3C-C{\equiv}N$ + HCl
$H_3C-C(Cl)=NH$
Anhydrous $AlCl_3$
$H_3C-C=NH$
H_2O
$-NH_3$
$H_3C-C=O$

39. C

Sol.



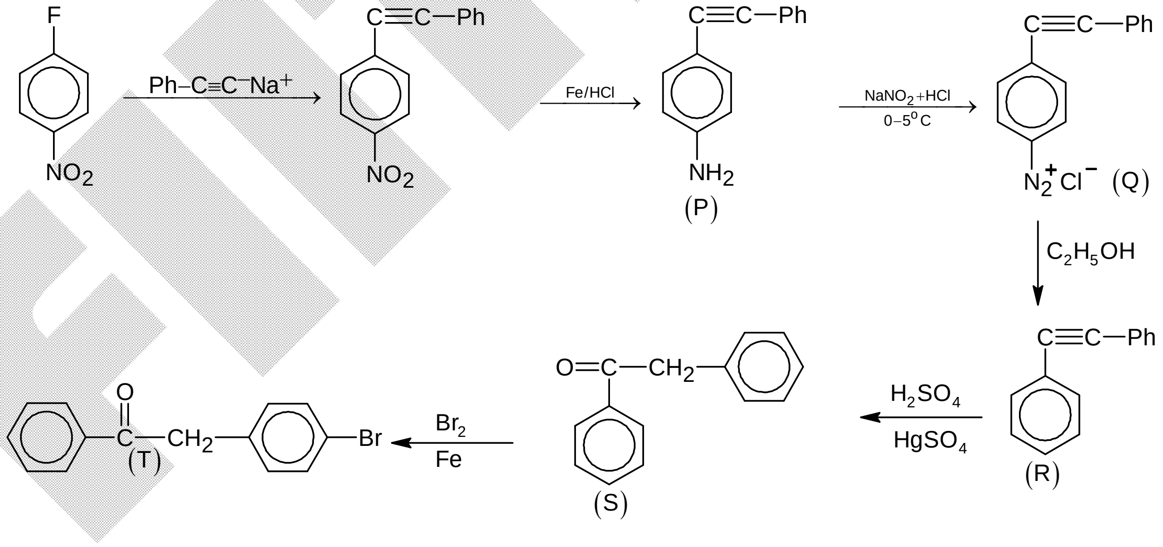
$\overset{+}{N}_2Cl^-$
Boil
H_2O
OH
(P)
Br_2
H_2O
Br
(Q)
Zn dust
Δ
(R)

Q is polar while R is non-polar.

$\therefore \mu_Q > \mu_R$.

40. B

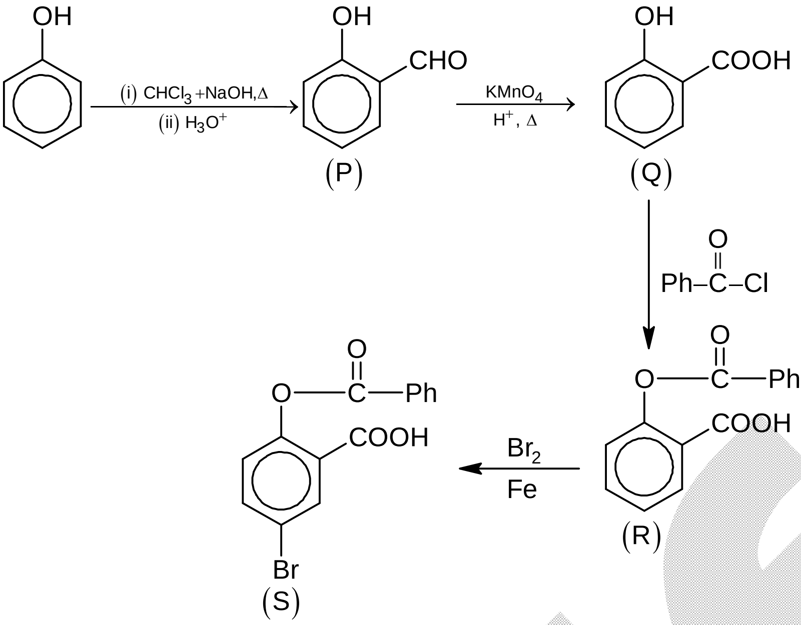
Sol.



F
NO_2
$Ph-C{\equiv}C^-Na^+$
$C{\equiv}C-Ph$
Fe/HCl
NH_2
(P)
$NaNO_2+HCl$
$0-5^0C$
$\overset{+}{N}_2Cl^-$ (Q)
C_2H_5OH
(R)
H_2SO_4
$HgSO_4$
$O=C-CH_2$
(S)
Br_2
Fe
Br
O
$C-CH_2$
(T)

41. C

Sol.


OH
CHO
COOH
(i) CHCl3 +NaOH,Δ
(ii) H3O+
KMnO4
H+, Δ
(P)
(Q)
Ph–C–Cl
O
C
Ph
Br2
Fe
Br
(R)
(S)

42. B

Sol. $CH_3CH_2OH \xrightarrow[H_2SO_4]{\text{Cold conc.}} \left[CH_3 - CH_2 - \overset{+}{O}H_2\right]HSO_4^-$

Oxonium salt

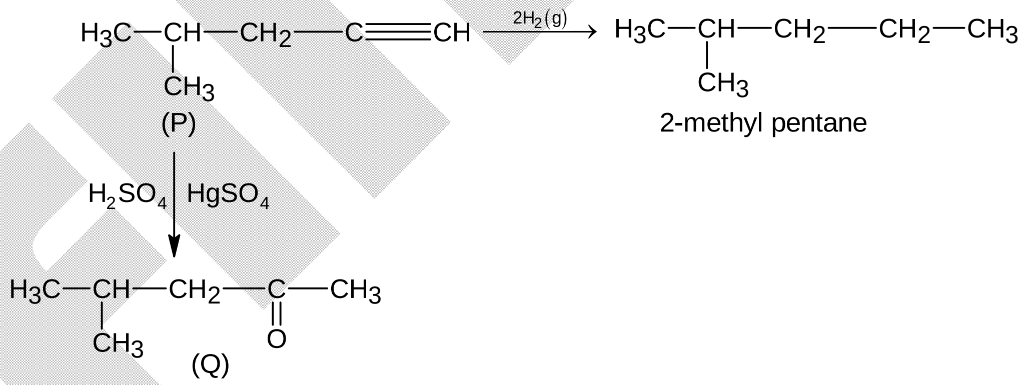
$(i \simeq 2)$

$Ph_3C - OH \xrightarrow[H_2SO_4]{\text{Cold conc.}} Ph_3C^+ + H_3O^+ + 2HSO_4^-$

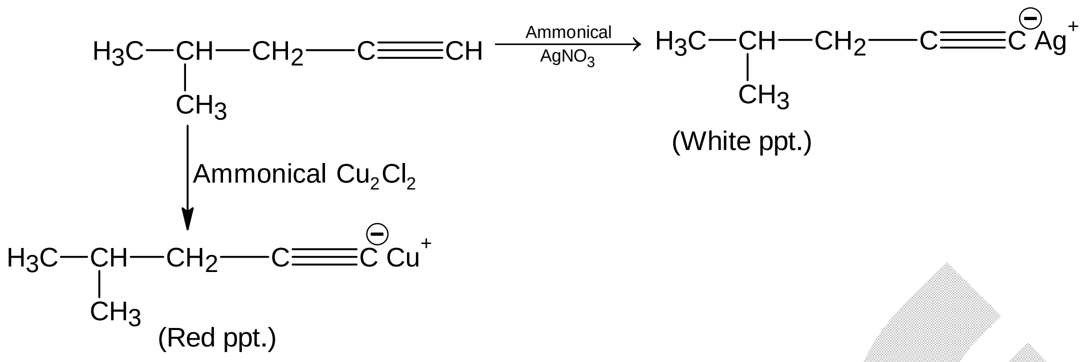
$(i \simeq 4)$

43. D

Sol.


H3C—CH—CH2—C≡CH
CH3
(P)
2H2(g)
H3C—CH—CH2—CH2—CH3
CH3
2-methyl pentane
H2SO4 | HgSO4
H3C—CH—CH2—C—CH3
CH3
O
(Q)

The ketone (Q) gives positive Iodoform test and shows 2,4-DNP test. It also forms white crystalline product with $NaHSO_3$.



44. A

Sol. $\text{Phenol} + \text{H}-\text{CHO} \xrightarrow{\Delta} \text{Novolac}(\text{P}) \xrightarrow[\text{H-CHO}]{\Delta} \text{Bakelite}(\text{Q})$

45. A

Sol. It's a Reimer-Teimann reaction. Dichloro carbene (Singlet) is formed as an intermediate in this reaction.

46. B

Sol. Order of basic strength in aqueous medium is

$$\underset{(\text{II})}{Me_2NH} > \underset{(\text{I})}{MeNH_2} > \underset{(\text{III})}{Me_3N}$$

47. A

Sol.

Picric acid	$pK_a = 0.4$
Squaric acid	$pK_{a_1} = 1.5$
Phenol (Carbolic acid)	$pK_a = 9.98$
Carbonic acid	$pK_{a_1} = 6.37$

48. A

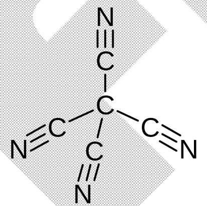
Sol. There is only geometrical isomerism in the given molecule around C = C. There are two geometrical isomers possible for the given molecule.

49. C

Sol. Assymetric compounds are P, Q and R as these do not contain POS (Plane of Symmetry).

50. B

Sol.



No. of σ bonds $= 8$

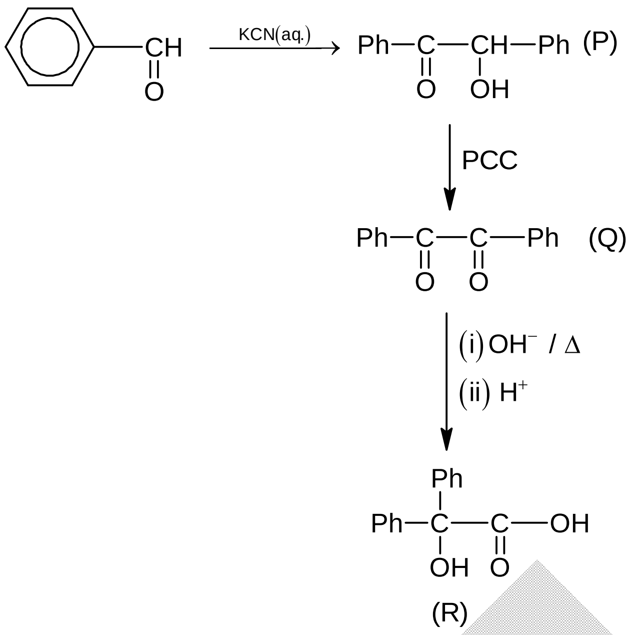
No. of π bonds $= 8$

$\therefore \frac{\sigma}{\pi} = 1:1$.

SECTION – B

51. 13

Sol.



Number of sp^2 hybridised carbons in R = 13.

52. 3

Sol. Soda lime is a mixture of 3 moles of NaOH and 1 mole of CaO.

53. 4

Sol. Pressure = 802 – 42 = 760 mm Hg

= 1 atmosphere

Volume = 110 mL = 0.11 L

$$n = \frac{PV}{RT} = \frac{1\times 0.11}{0.0821\times 300} = 4.47\times 10^{-3}\ \text{moles}$$

Weight of $N_2 = n\times 28$

$= 4.47\times 10^{-3}\times 28 = 0.125\ g$

$$\%\ \text{of nitrogen} = \frac{\text{Wt. of nitrogen}}{\text{Wt. of organic compound}}\times 100$$

$$= \frac{0.125}{0.5}\times 100 = 25\%$$

Molecular formula $= C_{12}H_{24}N_x$

Molecular weight = 168 + 14x

$$\%\ \text{of nitrogen} = \frac{14x}{168+14x}\times 100 = 25$$

x = 4

$\therefore$ Molecular formula = $C_{12}H_{24}N_4$

54. 0

Sol. $S^{-2} + Na_2\left[Fe(CN)_5(NO)\right] \longrightarrow Na_4\left[Fe(CN)_5(NOS)\right]$

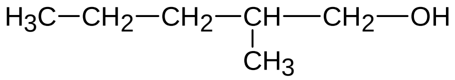
('X') Violet colour

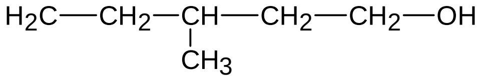
Compound 'X' is sodium nitroprusside and its magnetic moment is (0.0 B.M.)

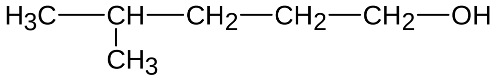
55. 8

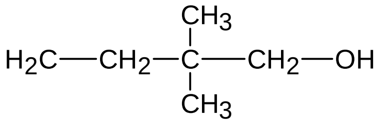
Sol. Only primary alcohols give aldehydes on oxidation with PCC. 8 structural isomers are possible for such alcohol.

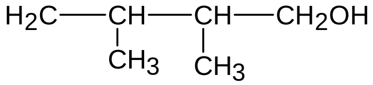
1. $CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-OH$

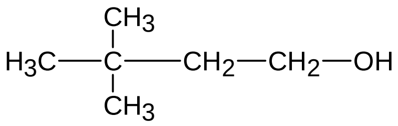
2. 
$H_3C-CH_2-CH_2-\underset{CH_3}{CH}-CH_2-OH$

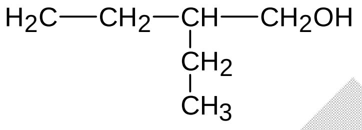
3. 
$H_2C-CH_2-\underset{CH_3}{CH}-CH_2-CH_2-OH$

4. 
$H_3C-\underset{CH_3}{CH}-CH_2-CH_2-CH_2-OH$

5. 
$H_2C-CH_2-\underset{CH_3}{\overset{CH_3}{C}}-CH_2-OH$

6. 
$H_2C-\underset{CH_3}{CH}-\underset{CH_3}{CH}-CH_2OH$

7. 
$H_3C-\underset{CH_3}{\overset{CH_3}{C}}-CH_2-CH_2-OH$

8. 
$H_2C-CH_2-\underset{\underset{CH_3}{CH_2}}{CH}-CH_2OH$

56. 6

Sol. With $C \equiv CH \rightarrow$ 1 mole G.R. reacts

With $-OH \rightarrow$ 1 mole G.R. reacts

With $CN \rightarrow$ 1 mole G.R. reacts

With $CHO \rightarrow$ 1 mole G.R. reacts

With $COOCH_3 \rightarrow$ 2 mole of G.R. reacts

Thus, total 6 moles of G.R. are consumed

57. 4

Sol. On acetylation, –OH group gets converted into $-OCOCH_3$ per –OH group. It means that molecular weight increases by 42.

Molecular weight of ‘A’ = 166

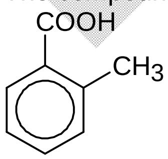
Molecular weight after acetylation = 334

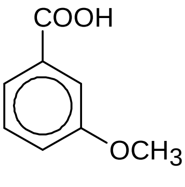
Increase in molecular weight = 168

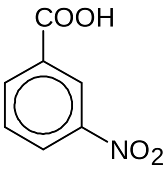
$\therefore$ Number of OH group $= \dfrac{168}{42} = 4$

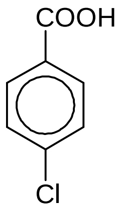
58. 5

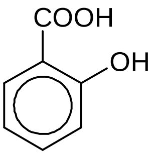
Sol. The compounds which are more acidic than benzoic acid are







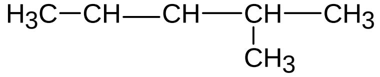




59. 4

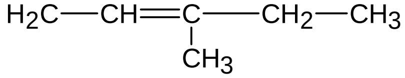
Sol. 1. $CH_3-CH=CH-CH_2-CH_2-CH_3$

2.



$H_3C-CH-CH-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_3$

3.



$H_2C-CH=\underset{\displaystyle CH_3}{\underset{|}{C}}-CH_2-CH_3$

4. $H_2C-CH_2-CH=CH-CH_2-CH_3$

60. 4

Sol. Number of meso-isomers for a symmetrical molecule having odd number of chiral carbon

$=2^{\left(\frac{n-1}{2}\right)}$, where n = number of chiral carbon

$\therefore$ Number of meso isomers $=2^{\left(\frac{5-1}{2}\right)}=2^2=4$.

Mathematics

PART – C

SECTION – A

61. C

Sol. From the diagram, $\angle AOB = \angle BOC = \angle COD = 60°$

$\Rightarrow \quad \angle YOD = \frac{\pi}{6}$

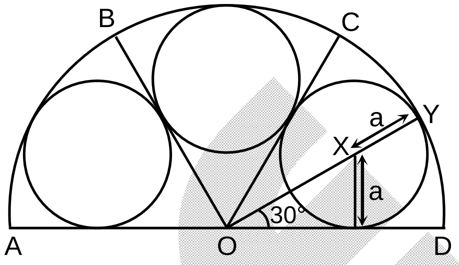
$\Rightarrow$ Let X be the centre of right hand circle, $OX\sin 30° = a$

$\Rightarrow \quad OX = 2a$

Now

$r = OY = 2a + a$

$a = \frac{r}{3}$



62. A

Sol. Let AB = BO = R and radius of smallest circle is r, OA = 2R, ON = 2R – r and BN = R + r

In ΔOBN

$BN^2 + OB^2 = ON^2$

$(R + r)^2 + R^2 = (2R - r)^2$

$2R^2 - 6Rr = 0$

$R(R - 3r) = 0$

Considering ΔOBN, perimeter

$OB + BN + NO = R + (R + r) + (2R - r) = 8$

$\Rightarrow \quad R = 2$

$r = \frac{1}{3}R = \frac{2}{3}$

63. A

Sol. Square and add

$24(\sin A \cos B + \cos A \sin B) = 12$

$\Rightarrow \quad \sin(A + B) = \sin(\pi - C) = \frac{1}{2}$

$\Rightarrow \quad \sin C = \frac{1}{2}$

$\Rightarrow \quad C = \frac{\pi}{6}$ or $\frac{5\pi}{6}$

but if $C = \frac{5\pi}{6}$, then $A < \frac{\pi}{6}$ so $3\sin A + 4\cos B = \frac{3}{2} + 4 < 6$

$\Rightarrow \quad C = \frac{\pi}{6}$ only.

64. B

Sol. $\frac{1}{4}(\sin^4 x + \cos^4 x) - \frac{1}{6}(\sin^6 x + \cos^6 x)$

$\Rightarrow \quad \frac{1}{12}[3(\sin^4 x + \cos^4 x) - 2(\sin^6 x + \cos^6 x)]$

$\Rightarrow \quad \frac{1}{12}[3((\sin^2 x + \cos^2 x)^2 - 2\sin^2 x\cos^2 x) - 2\{(\sin^2 x + \cos^2 x)(1 - 3\sin^2 x\cos^2 x)\}]$

$$\Rightarrow \quad \frac{1}{12}\{3 - 6\sin^2 x\cos^2 x - 2(1 - 3\sin^2 x\cos^2 x)\}$$

$$\Rightarrow \quad \frac{1}{12} = \frac{2}{24}$$

65. B

Sol. $\dfrac{\frac{a}{b}-1}{\frac{a}{b}+1} = \tan\left(\dfrac{A-B}{2}\right)\tan\dfrac{C}{2}$

$$\Rightarrow \quad \frac{1+\sqrt{3}}{\sqrt{3}+3} = \tan\left(\frac{A-B}{2}\right)\tan\frac{C}{2} = \tan\left(\frac{A-B}{2}\right)\frac{1}{\sqrt{3}}$$

$$\Rightarrow \quad \tan\left(\frac{A-B}{2}\right) = 1$$

$$\Rightarrow \quad A - B = \frac{\pi}{2} \text{ and } A + B = \frac{2\pi}{3}$$

$$\Rightarrow \quad A = 105°,\ B = 15°$$

66. D

Sol. $AO^2 = OB^2 = OC^2$

$\alpha^2 + 4 = \beta^2 + 4 \Rightarrow \alpha = \pm\beta$

$\Rightarrow \alpha = -\beta$ (if $\alpha = \beta$ then no triangle is formed)

ABC is right angled triangle at A

$\therefore$ $(\alpha, 2)$ is orthocentre $\therefore$ $\alpha = 3$, $\gamma = 2$

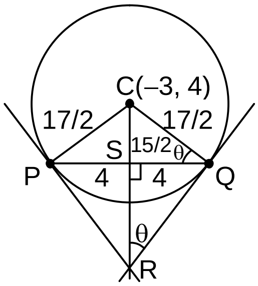
$\therefore$ vertices are (3, 2), (3, –2) and (–3, 2).

67. B

Sol. $\tan\theta = \dfrac{15/2}{4} = \dfrac{15}{8}$

In ΔRSQ $\tan\theta = \dfrac{4}{RS}$

$$\Rightarrow \quad \frac{15}{8} = \frac{4}{RS} \quad \Rightarrow \quad RS = \frac{32}{15}$$



68. D

Sol. Image of vertex of P_1 in $3x - y + 10 = 0$ will be vertex of P_2

$$\frac{x_2 - 1}{3} = \frac{y_2 - 3}{-1} = \frac{-2(3 - 8 + 10)}{10}$$

$\therefore$ vertex of $P_2 = (-2, 9)$

Similarly focus of P_2 is $(-9, 3)$ $\therefore$ $\alpha = -9$ and $\beta = 3$

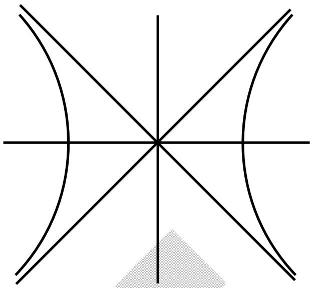
Slope of directrix $= -\dfrac{7}{6}$

Equation of directrix $y - 15 = -\dfrac{7}{6}(x - 5)$

$7x + 6y = 125$ $\therefore$ $\gamma = 125$.

69. C

Sol. Equation of asymptotes x – 3y = 0 and x + 3y = 0
If tangents to different branches are drawn then
$(\alpha^2 - 9\beta^2 - 9) < 0$ and $(\alpha - 3\beta)(\alpha + 3\beta) < 0$
i.e. $\alpha^2 < 9\beta^2 + 9$ and $\alpha^2 < 9\beta^2$.



70. B

Sol. $a^2 = \frac{1}{4}$, $b^2 = \frac{1}{9}$ let P be (x_1, y_1)

Equation of normal $\frac{1x}{4x_1} - \frac{1y}{9y_1} = \frac{5}{36}$

It cuts y-axis at $\left(0, -\frac{5y_1}{4}\right) \Rightarrow \frac{-5y_1}{4} = \frac{-5}{8\sqrt{3}} \Rightarrow y_1 = \frac{1}{2\sqrt{3}}$ $\therefore x_1 = \frac{1}{4}$

Thus $\alpha = \frac{5}{36}$

Area of $\Delta OAB = \frac{1}{2} \times \frac{5}{36} \times \frac{5}{8\sqrt{3}} = \frac{25}{576\sqrt{3}}$

71. B

Sol. $x^2 + 24x = 25 \Rightarrow x = -25, 1$
$\therefore$ $P\left(1, 2\sqrt{6}\right)$ and $Q\left(1, -2\sqrt{6}\right)$
Equation of tangent at P and Q to the circle
$x + 2\sqrt{6}y = 25$ and $x - 2\sqrt{6}y = 25$
$\therefore$ R is (25, 0)
Equation of tangent at P and Q to the parabola
$2\sqrt{6}y = 12(x+1)$ and $-2\sqrt{6}y = 12(x+1)$
$\therefore$ S is (–1, 0)

Area of $\Delta PRS = \frac{1}{2} \times 2\sqrt{6} \times 26 = 26\sqrt{6}$

$$R = \frac{abc}{4\Delta} = \frac{26 \times 2\sqrt{7} \times 10\sqrt{6}}{4 \times 26\sqrt{6}} = 5\sqrt{7}$$

72. D

Sol. $a^2 + b^2 = 18$ and $b^2 = 6$

$\Rightarrow a^2 = 12 \Rightarrow 6 = 12(1 - e^2) \Rightarrow e = \frac{1}{\sqrt{2}}$

73. B

Sol. $x(y - 1) = 8$
Equation of directrix $x + (y - 1) = 2\sqrt{2} \times \sqrt{2}$
$\Rightarrow x + y = 5 \Rightarrow y = -x + 5$ touches
$\frac{x^2}{30} - \frac{y^2}{30/k} = 1$ $\therefore 25 = 30 \times 1 - \frac{30}{k}$ $\Rightarrow k = 6$.

74. A

Sol. $P \equiv (|OP| \cos\theta, |OP| \sin\theta)$

$Q \equiv \left(|OQ| \left(\cos\left(\theta \pm \frac{\pi}{2}\right), \sin\left(\theta \pm \frac{\pi}{2}\right)\right)\right)$

$\Rightarrow \quad \frac{1}{|OP|^2} = \frac{\sin^2\theta}{b^2} + \frac{\cos^2\theta}{a^2}$

$\Rightarrow \quad \frac{1}{|OQ|^2} = \frac{\sin^2\theta}{a^2} + \frac{\cos^2\theta}{b^2}$

$\Rightarrow \quad \frac{1}{|OP|^2} + \frac{1}{|OQ|^2} = \frac{1}{a^2} + \frac{1}{b^2}$

$\Rightarrow$ $|OP \times |OQ|$ reaches $\frac{2a^2b^2}{a^2+b^2}$

75. B

Sol. Suppose there is a point P(4cosθ, 3sinθ) on the ellipse, then distance of P to AB is

$= \left|\frac{3(4\cos\theta) + 4(3\sin\theta) - 12}{5}\right|$

$= \frac{12}{5}(\cos\theta + \sin\theta - 1)$

$\le \frac{12}{5}\left(\sqrt{2} - 1\right) \le \frac{6}{5}$

But AB = 5 so $\Delta APB \le \frac{1}{2} \times 5 \times \frac{6}{5} = 3$

So exactly two points.

76. C

Sol. $PF_1 + PF_2 = 2a = 6$

$\frac{PF_1}{PF_2} = \frac{2}{1}$; $PF_1 = 4$ and $PF_2 = 2$

$F_1F_2 = 2\sqrt{5}$

there $PF_1^2 + PF_2^2 = (F_1F_2)^2$

$16 + 4 = \left(2\sqrt{5}\right)^2$

So ΔPF_1F_2 is right angle triangle

area = $\frac{1}{2} \times PF_1 \times PF_2 = \frac{1}{2} \times 4 \times 2 = 4$

77. B

Sol. Since $\sqrt{2} + \sqrt{3} > \pi, \frac{\pi}{2} - \sqrt{2} < \sqrt{3} - \frac{\pi}{2} < \frac{\pi}{2}$

$\Rightarrow \quad \cos\left(\frac{\pi}{2} - \sqrt{2}\right) > \cos\left(\sqrt{3} - \frac{\pi}{2}\right)$

$\Rightarrow \quad \sin\left(\sqrt{2}\right) > \sin\left(\sqrt{3}\right)$

again $\cos\left(\sqrt{2}\right) > 0$ and $\cos\left(\sqrt{3}\right) < 0$

$\cos\sqrt{2} - \cos\sqrt{3} > 0$

$\Rightarrow$ given curve will be ellipse

Now $\left(\sin\sqrt{2}-\sin\sqrt{3}\right)-\left(\cos\sqrt{2}-\cos\sqrt{3}\right)$

$= 2\sqrt{2}\sin\left(\frac{\sqrt{2}-\sqrt{3}}{2}\right)\sin\left(\frac{\sqrt{2}+\sqrt{3}}{2}+\frac{\pi}{4}\right)$

and $-\frac{\pi}{2} < \frac{\sqrt{2}-\sqrt{3}}{2} < 0$

$\Rightarrow$ $\sin\left(\frac{\sqrt{2}-\sqrt{3}}{2}\right) < 0$ and $\frac{\pi}{2} < \frac{\sqrt{2}+\sqrt{3}}{2} < \frac{3\pi}{4}$

$\Rightarrow$ $\sin\left(\frac{\sqrt{2}+\sqrt{3}}{2}+\frac{\pi}{4}\right) > 0$

$\Rightarrow$ $2\sqrt{2}\sin\left(\frac{\sqrt{2}-\sqrt{3}}{2}\right)\sin\left(\frac{\sqrt{2}+\sqrt{3}}{2}+\frac{\pi}{4}\right) < 0$

$\Rightarrow$ ellipse is vertical ellipse.

78. C

Sol. Assume AB is on the line $y = 2x - 17$ and coordinate of other two are on parabola are $C(x_1, y_1)$ and $D(x_2, y_2)$, then CD is on the line L whose equation is $y - 2x = b$

by solving with curve we get

$x^2 - 2x - b = 0 \Rightarrow x_1, x_2 = 1 \pm \sqrt{b+1}$

assume length of one side of square is a

$\Rightarrow$ $a^2 = (x_1 - x_2)^2 + (y_1 - y_2)^2$

$= 5(x_1 - x_2)^2 = 20(b + 1)$ …(1)

Now $a = \left|\frac{17+b}{\sqrt{5}}\right|$ …(2)

$\Rightarrow$ $b = 3$ or $63 \Rightarrow a^2 = 80$ or 1280.

79. A

Sol. Equation of AB $\Rightarrow y = \sqrt{3}x$ by solving with parabola $y^2 = 8(x + 2)$

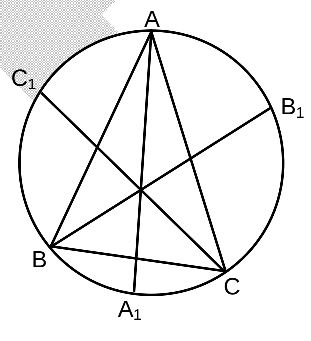
$3x^2 - 8x - 16 = 0$

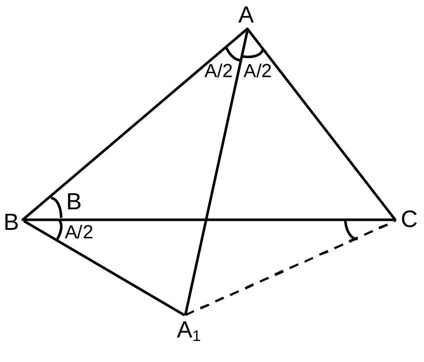
E is mid point of AB then x coordinate of E is $\frac{4}{3}$, then

$|FE| = \frac{1}{\cos 60^\circ} \times \frac{4}{3} = \frac{8}{3}$, $|PF| = 2 \times |FE| = \frac{16}{3}$ where F is focus

80. A

Sol. In ΔABC





$$\angle B = \angle ABC + \frac{A}{2}$$

$$\frac{AA_1}{\sin\left(B+\frac{A}{2}\right)} = 2R = 2$$

$$AA_1 = 2\sin\left(B+\frac{A}{2}\right) = 2\cos\left(\frac{B}{2}-\frac{C}{2}\right)$$

$$\Rightarrow \quad AA_1\cos\frac{A}{2} = 2\cos\left(\frac{B-C}{2}\right)\cos\left(\frac{A}{2}\right)$$

$$= \cos\left(\frac{\pi}{2}-C\right)+\cos\left(\frac{\pi}{2}-B\right) = \sin B+\sin C$$

$$\Rightarrow \quad \text{similarly } BB_1\cos\frac{B}{2} = \sin A+\sin C$$

$$CC_1\cos\frac{C}{2} = \sin A+\sin B$$

SECTION – B

81. 2022

Sol. Let $x_n = \tan a_n$

$$\Rightarrow \quad \tan a_{n+1} = \frac{1+\tan a_n}{1-\tan a_n} = \tan\left(\frac{\pi}{4}+a_n\right)$$

$$\Rightarrow \quad \tan a_{n+1} = \tan\left(\frac{\pi}{4}+a_n\right)$$

$$\Rightarrow \quad a_{n+1} = a_n + \frac{\pi}{4} + n\pi$$

$\Rightarrow$ $a_{n+4} = a_n + k.\pi$; $k \in I$

$\Rightarrow$ $x_{n+4} = \tan a_{n+4} = \tan a_n = x_n$

$\Rightarrow$ x_n is periodic for period 4

$\Rightarrow$ $x_{2024} = x_0 = 2022$

82. 36

Sol. Let assume $x = \cos^2\alpha\cos^2\beta$, $y = \cos^2\alpha\sin^2\beta$, $z = \sin^2\alpha$

Now $x + y + z = 1$

$\Rightarrow$ $P = \sec^2\alpha\sec^2\beta + 4\sec^2\alpha\operatorname{cosec}^2\beta + 9\operatorname{cosec}^2\alpha$

$\Rightarrow$ $P = (\tan^2\alpha + 1)(\tan^2\beta + 1) + 4(\tan^2\alpha + 1)(\cot^2\beta + 1) + 9(\cot^2\alpha + 1)$

$= 14 + 5\tan^2\alpha + 9\cot^2\alpha + (\tan^2\beta + 4\cot^2\beta)(1 + \tan^2\alpha)$

$\geq 14 + 5\tan^2\alpha + 9\cot^2\alpha + 2\tan\beta.2\cot\beta(1 + \tan^2\alpha)$

$= 18 + 9(\tan^2\alpha + \cot^2\alpha) \geq 18 + 9.2\tan\alpha\cot\alpha = 36$

Equality hold when $\cos^2\alpha = \frac{1}{2}$, $\cos^2\beta = \frac{1}{3}$

$$\Rightarrow \quad x = \frac{1}{6}, y = \frac{1}{3}, z = \frac{1}{2}$$

83. 2

Sol. $(1 - \cot 22°)(1 - \cot 23°)$

$$\Rightarrow \quad \left(1-\frac{\cos 22°}{\sin 22°}\right)\left(1-\frac{\cos 23°}{\sin 23°}\right)$$

$$\Rightarrow \quad \left(\frac{\sin 22^\circ-\cos 22^\circ}{\sin 22^\circ}\right)\left(\frac{\sin 23^\circ-\cos 23^\circ}{\sin 23^\circ}\right)$$

$$\Rightarrow \quad \frac{\sqrt{2}\left(\sin\left(22^\circ-45^\circ\right)\right)\sqrt{2}\sin\left(23^\circ-45^\circ\right)}{\left(\sin 22^\circ \sin 23^\circ\right)}$$

$$\Rightarrow \quad \frac{2\sin\left(-22^\circ\right)\sin\left(-23^\circ\right)}{\left(\sin 22^\circ\right)\left(\sin 23^\circ\right)}=2$$

84. 2

Sol. $$\frac{\frac{\sqrt{3}-1}{4}}{\sin x}+\frac{\frac{\sqrt{3}+1}{4}}{\cos x}=\sqrt{2}$$

$$\Rightarrow \quad \frac{\sin\left(\frac{\pi}{12}\right)}{\sin x}+\frac{\cos\left(\frac{\pi}{12}\right)}{\cos x}=2$$

$$\Rightarrow \quad \sin\left(\frac{\pi}{12}\right)\cos x+\cos\left(\frac{\pi}{12}\right)\sin x=2\sin x\cos x$$

$$\Rightarrow \quad \sin\left(\frac{\pi}{12}+x\right)=\sin 2x$$

$$\Rightarrow \quad \frac{\pi}{12}+x=2x \quad \text{or} \quad \frac{\pi}{12}+x=\pi-2x$$

$$\Rightarrow \quad x=\frac{\pi}{12} \quad \text{or} \quad x=\frac{11\pi}{36}$$

85. 1011

Sol. Let P denote the desired product and Q = $\sin\alpha.\sin2\alpha.\sin3\alpha$ …… $\sin(1011\alpha)$

then $2^{1011}PQ = \sin2\alpha.\sin4\alpha.\sin6\alpha$ ….. $\sin(2022)\alpha$

= $(\sin2\alpha.\sin4\alpha$ ….. $\sin(1010\alpha)$ $(\sin(\pi-1012\alpha))$ …. $(\sin(\pi-2020\alpha)$ $(\sin(\pi-2022)\alpha)$

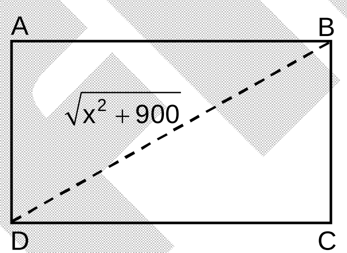
$\Rightarrow$ $2^{1011}PQ = \sin\alpha.\sin2\alpha.\sin3\alpha$ ….. $\sin(1011\alpha) = Q$

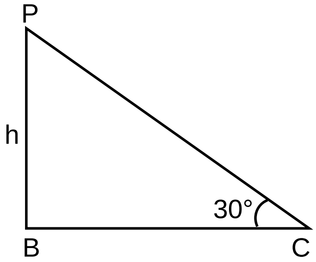
$\Rightarrow$ $2^{1011}PQ = Q$

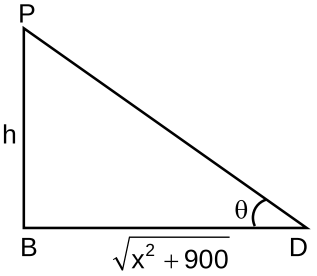
$$P=\frac{1}{2^{1011}}$$

86. 9

Sol.







$$\tan30^\circ=\frac{h}{x}\Rightarrow x=h\sqrt{3}$$

$$\tan\theta=\frac{h}{\sqrt{x^2+900}}=\frac{8}{17\sqrt{3}}$$

$$\frac{h}{\sqrt{3h^2+900}}=\frac{8}{17\sqrt{3}}$$

$289 \times 3 \times h^2 = 192h^2 + 64 \times 900$
$675h^2 = 64 \times 900$
$\Rightarrow h = \frac{16}{\sqrt{3}}$

87. 21
Sol. Asymptotes $3(x - 1) - 2(y + 3) = 0$ and $3(x - 1) + 2(y + 3) = 0$
$3x - 2y - 9 = 0$ and $3x + 2y + 3 = 0$
It touches $x^2 + y^2 - 2x + k/13 = 0$
$\therefore$ $A\left(-\frac{5}{13}, -\frac{12}{13}\right)$ and $B\left(\frac{31}{13}, -\frac{12}{13}\right)$
$\therefore$ $k = -23$

88. 1
Sol. $(\sin^2\alpha)^3 + (\cos^2\beta)^3 + (-1)^3 - 3\sin^2\alpha\cos^2\beta(-1) = 0$
$\Rightarrow$ $\sin^2\alpha + \cos^2\beta - 1 = 0$ or $\underbrace{\sin^2\alpha = \cos^2\beta = -1}_{\text{not possible}}$
$\Rightarrow$ $\sin^2\alpha = 1 - \cos^2\beta$
$\Rightarrow$ $\sin^2\alpha = \sin^2\beta$
$\alpha = \beta$

89. 315
Sol. Let M is mid point of AB, $M = \left(\frac{a+b}{2}, 24\right)$
$OM \perp MA$, $|OM| = \sqrt{3}\,MA$
$\Rightarrow$ $\frac{a+b}{2} = 13\sqrt{3}, \frac{a-b}{2} = 8\sqrt{3}$
$\Rightarrow$ $a = 21\sqrt{3}$ and $b = 5\sqrt{3}$

90. 1
Sol. $P(x, y) = (14\cos\theta - 5, 14\sin\theta + 12)$
minimum value of $g(\theta)$ where
$g(\theta) = (14\cos\theta - 5)^2 + (14\sin\theta + 12)^2$
$= 365 + 28(12\sin\theta - 5\cos\theta)$
$g(\theta) \geq 1$

FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
PART TEST – II
PAPER –1
TEST DATE: 11-12-2022

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B**.

Section – A *(01 –06, 19 – 24, 37 – 42):* This section contains **EIGHTEEN (18)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – A *(07 – 10, 25 – 28, 43 – 46):* This section contains **TWELVE (12)** Matching List Type Questions. Each question has **FOUR** statements in **List-I** entries (I), (II), (III) and (IV) and **FIVE** statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which, **ONLY ONE** of these four options is correct answer.

Section – B *(11 – 18, 29 – 36, 47 – 54):* This section contains **TWENTY FOUR (24)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.

MARKING SCHEME

Section – A (One or More than One Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4	If only (all) the correct option(s) is (are) chosen;
Partial Marks	:	+3	If all the four options are correct but ONLY three options are chosen;
Partial marks	:	+2	if three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks	:	+1	If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–2	In all other cases.

Section – A (Single Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+3	If ONLY the correct option is chosen.
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–1	In all other cases.

Section – B: Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+3	If ONLY the correct numerical value is entered at the designated place;
Zero Marks	:	0	In all other cases.

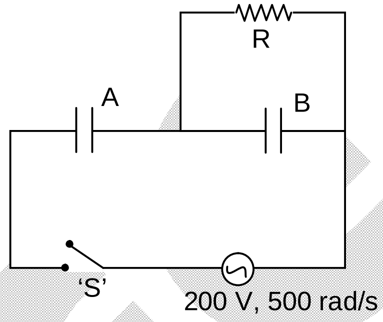
Physics

PART – I

Section – A (Maximum Marks: 24)

This section contains ***SIX (06)*** *questions. Each question has* ***FOUR*** *options (A), (B), (C) and (D).* ***ONE OR MOER THAN ONE*** *of these four option(s) is (are) correct answer(s).*

1. A resistor 'R' of resistance 2000 Ω and two similar capacitor 'A' and 'B' of capacitance 1 μC each are connected with an A.C. source of 200 Volt and 500 rad/s. Now switch is closed at t = 0, then choose the correct option(s).



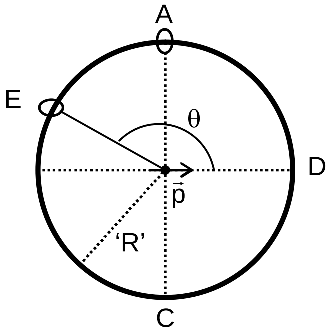
(A) The phase difference between applied voltage and voltage across the capacitor A is $\tan^{-1}\left(\frac{1}{3}\right)$

(B) The phase difference between current supplied by source and current in the capacitor 'B' is zero.

(C) The current in the capacitor 'A' is $\frac{1}{5\sqrt{20}}$ ampere.

(D) Power dissipated through resistor is 4 watt.

2. A ring of radius R is fixed and kept in a vertical plane. A small dipole of dipole moment $\vec{p}$ is fixed at the centre of ring. A small bead of mass 'm' and charge q is released from point A. Bead can slide on the ring. The inner diameter of bead and thickness of ring are nearly equal. Ring is insulating and frictionless. Ignore effect of gravity. Now choose the correct option(s).



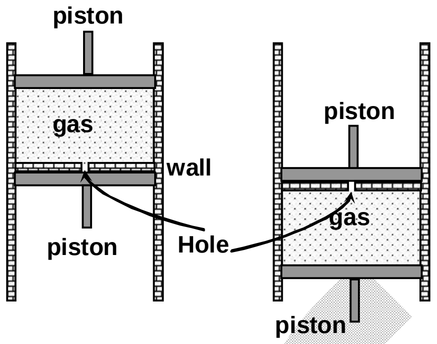
(A) Bead will never reach at point D.

(B) The normal force between bead and ring at 'E' is directly proportional to the charge on the bead.

(C) The motion of bead is periodic.

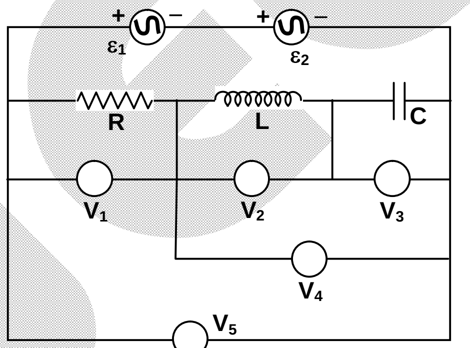
(D) Speed of bead at point 'E' is given by $\sqrt{\frac{-p(\cos\theta)q}{2\pi\varepsilon_0 mr^2}}$

3. There is a fixed long vertical cylinder of good heat insulator with open ends, is separated from its surroundings by two insulated identical, frictionless pistons. An insulated separating wall is fixed between pistons. A very small hole is made at the middle of separating wall. An ideal gas is enclosed between the pistons at temperature of surrounding. Initially the lower piston is held up against the separating wall, when lower piston is released, it moves downward very slowly. Now choose the correct option(s).



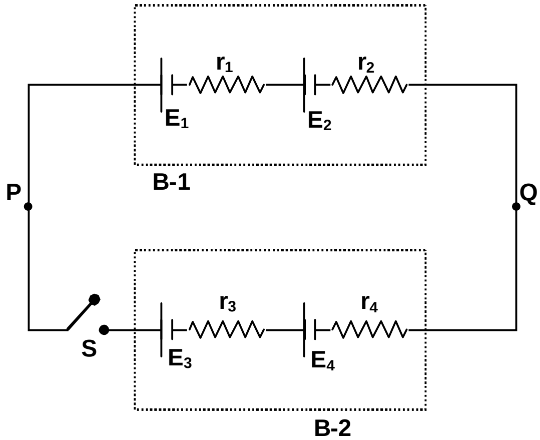
(A) During the process the pressure of gas above the separating wall remains constant.
(B) During the process the pressure of gas below the separating wall remains constant.
(C) Initial and final temperature of gas remain same.
(D) Initial and final temperature of gas is different.

4. A resistor R = 500 Ω, an ideal inductor L = 0.9 H and a capacitor C = 2.5 μF are connected with two alternating source $e_1 = 100\sin(1000t)$ and $e_2 = 100\sqrt{3}\cos(1000t)$. V_1, V_2, V_3, V_4 and V_5 are five ideal voltmeters and connected in the circuit as shown in the figure. Choose the correct option(s).



(A) Phase difference between voltage of V_3 and V_5 is $\frac{\pi}{2}+\tan^{-1}\left(\frac{9}{5}\right)$
(B) Reading of V_4 is 180 volt
(C) Difference between reading of V_2 and V_1 is 80 volt.
(D) Ratio of reading of V_4 and V_5 is $\frac{1}{\sqrt{2}}$

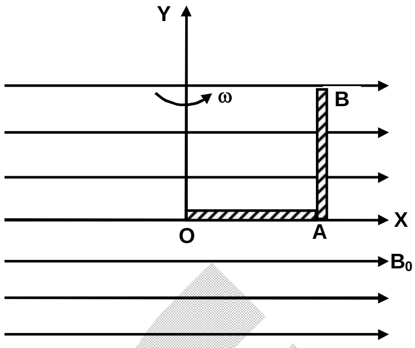
5. A battery B-1 is made by using two cells of emf E_1 and E_2 and internal resistance r_1 and r_2 respectively. Another battery B-2 is made by using different cells of emf E_3 and E_4 and internal resistance r_3 and r_4 respectively. Now they are connected with points P and Q as shown in the figure. All cells are rechargeable. Now switch is closed at t = 0, then choose the correct option(s).



(A) The potential difference across both the battery will be equal.
(B) Rate of heat dissipation in both batteries is equal.
(C) One battery will charge the other battery.
(D) Rate of loss in chemical energy of one battery is more than the rate of gain in chemical energy of the other.

6. A L-shaped conducting rod OAB is rotating in a constant magnetic field of B_0 = 100 Tesla acting along x-axis. The length of rod OA = 20 cm and AB = 20 cm. If rod is rotating about y-axis with constant angular velocity of 5 rad/second then at a given instant.

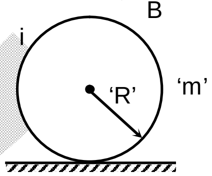
(A) Potential difference across OA is 10 Volt
(B) Potential difference across OA is zero Volt
(C) Potential difference across AB is 20 Volt
(D) Potential difference across OB is 10 Volt



Section – A (Maximum Marks: 12)

This section contains ***FOUR (04)*** *Matching List Type Questions. Each question has FOUR statements in* ***List-I*** *entries (I), (II), (III) and (IV) and FIVE statements in* ***List-II*** *entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which* ***ONLY ONE*** *of these four options is correct answer.*

7. A ring of mass m = 10 kg and radius R = 5 cm is kept at rest on a smooth horizontal surface in vertical plane as shown in the figure. The ring carries a current i = 7 ampere. A constant horizontal magnetic field B = 100 mT is switched on at t = 0.



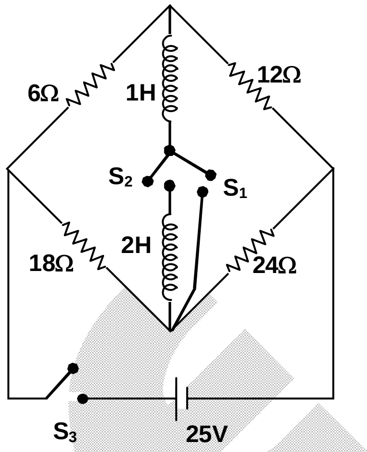
List –I describes the statement regarding ring and List-II gives their respective values.

	List –I		List –II
(I)	The magnetic moment of loop in S.I. units	(P)	0.0880
(II)	Torque acting on loop due to magnetic field in S.I. units at t = 0	(Q)	0.0044
(III)	Angular acceleration of loop in S.I. units at t = 0	(R)	0.0055
(IV)	Kinetic energy of ring when it has rotated through 90°	(S)	0.4400
		(T)	0.0550

Which one of the following options is correct ?

(A) I → T, II → R, III → S, IV → R
(B) I → P, II → Q, III → R, IV → S
(C) I → S, II → T, III → P, IV → Q
(D) I → T, II → S, III → P, IV → R

8. Four resistors 6Ω, 12Ω, 18Ω and 24Ω, two ideal inductors 1H and 2H and a battery of 25 V are arranged in the given circuit with the help of three switches S_1, S_2 and S_3 as shown in the figure. ($e^{-1} = 0.37$).



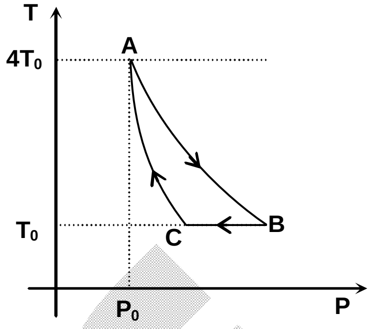
List –I describes statement regarding the given circuit and List-II gives their values. (either exactly or as a close approximation).

List –I		List -II	
(I)	When switch S_1 and S_3 closed simultaneity and S_2 remain opened. Then time constant of circuit in second.	(P)	1.35
(II)	When switch S_1 and S_3 remain closed for long time and S_2 remain opened then current through inductor in ampere at one time constant.	(Q)	0.07
(III)	When switch S_1 and S_3 remain closed for long time and S_2 remain opened then current in 12Ω resistance at one time constant.	(R)	0.056
(IV)	If S_1 and S_3 remain closed for long time and then S_1 is opened, S_2 is closed and S_3 remain closed then find current in the branch of inductor immediately after switching.	(S)	0.105
		(T)	0.167

Which one of the following options is correct ?

(A) I → Q, II → T, III → S, IV → R
(B) I → Q, II → S, III → P, IV → R
(C) I → R, II → P, III → Q, IV → S
(D) I → R, II → Q, III → T, IV → S

9. One mole of an ideal diatomic gas undergoes a cyclic process as shown in Temperature-Pressure graph. Temperature and pressure of gas at 'A' is $4T_0$ and P_0 respectively and temperature in process BC is T_0. The process AB is given by TP^2 = constant and the process CA is given by TP^4 = constant.



List –I describe the name of thermodynamics process involve in the cyclic process and List-II gives work done by gas in the process, charge in internal energy of the gas in the process and heat given to the gas in the process.

	List –I		List –II
(I)	In the thermodynamics process $A \to B$	(P)	Work done by gas and heat given to gas is negative
(II)	In the thermodynamics process $B \to C$	(Q)	Work done by gas is negative but heat given to gas is positive
(III)	In the thermodynamics process $C \to A$	(R)	Work done by gas is positive but heat given to gas negative
(IV)	In the cyclic process	(S)	Work done by gas and heat given to gas is positive
		(T)	Work done by gas is positive and change in internal energy of gas is negative

Which one of the following options is correct ?

(A) $I \to P,\ II \to T,\ III \to S,\ IV \to Q$

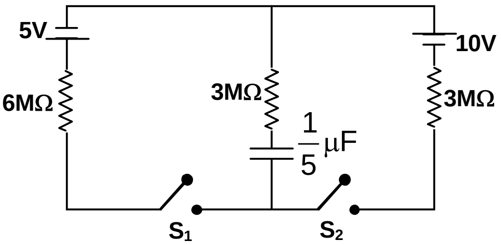
(B) $I \to S,\ II \to P,\ III \to Q,\ IV \to R$

(C) $I \to P,\ II \to S,\ III \to S,\ IV \to P$

(D) $I \to Q,\ II \to R,\ III \to S,\ IV \to T$

FIITJEE

10. Three resistors of resistance 6MΩ, 3MΩ and 3MΩ, one capacitor of capacitance $\frac{1}{5}\mu F$, two cells of potential difference 5V and 10V and two switches are connected in the circuit as shown in the figure. Both switches is closed simultaneously at t = 0. ($e^{-1} = 0.37$)



List-I describe the charges and currents in the circuit at a particular time and List-II gives possible values of charges and current.

List –I		List -II	
(I)	The maximum charge on the capacitor in μC	(P)	0.63
(II)	Charge on capacitor at t = 1 sec in μC	(Q)	1.54
(III)	Current in the branch of capacitor at t = 1 sec in μA	(R)	2.06
(IV)	Current passing through battery of 5V at t = 1 sec in μA	(S)	1.00
		(T)	0.37

Which one of the following options is correct ?

(A) I → P, II → T, III → R, IV → S

(B) I → T, II → P, III → Q, IV → R

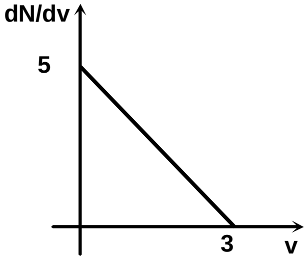
(C) I → P, II → R, III → T, IV → Q

(D) I → S, II → P, III → T, IV → Q

Section – B (Maximum Marks: 24)

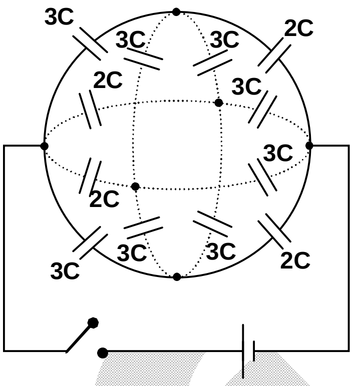
*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

11. Consider a gas kept in a closed container. 'N' is the no of molecules present in the container and v is the speed of molecules. Molecular speed distribution graph is shown in the figure with suitable S.I. units of $\frac{dN}{dv}$ and v. Find v_{rms}^2 of molecules in S.I. units.

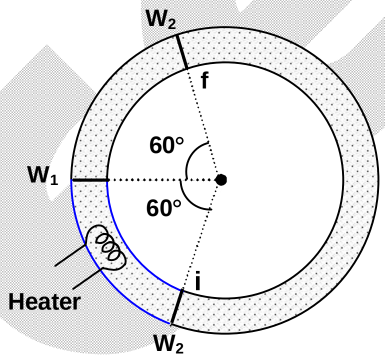


12. A semi-cylindrical shell (A) of diameter 15 cm and length $\frac{70}{22}$ meter is kept in another semi-cylindrical shell (B) of diameter 30 cm and same length such that the axis of both cylinder coincide with each other. A liquid of resistivity 100 Ω m is filled in the space between them. The lower surface of smaller cylinder A is maintained at higher potential than the larger cylinder B. Find the electrical resistance between the surface of cylinder in Ω.

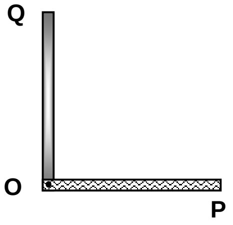
13. 12 capacitors are connected with a battery of potential difference V_0 as shown in the figure. Initially switch is open. Find total heat (in μJ) generated in the system after the switch is closed. (Given $C = \frac{1}{340}\mu F$, V_0 = 17 volt)



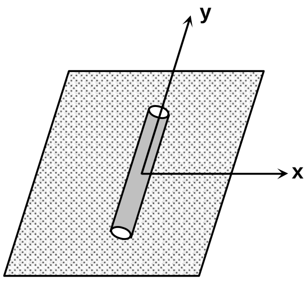
14. An insulated thin tube is fixed on horizontal surface. The total volume of tube is V_0. Inside the tube, W_1 is fixed adiabatic wall and W_2 is movable adiabatic wall. An ideal gas of adiabatic coefficient $\gamma = \frac{3}{2}$ is filled to entire volume of tube in both chambers. The initial pressure in both chamber is P_0 and number of moles of gas in both chamber are same. A heater is fixed which supplies heat very slowly such that wall W_2 is moved from position i to f, at this position wall W_2 stays in equilibrium position even the heater is switched off. Neglect friction and any loss of heat to the surrounding. The total heat supplied by heater is $\mu P_0 V_0$. Find the value of μ. ($\sqrt{5} = 2.23$)



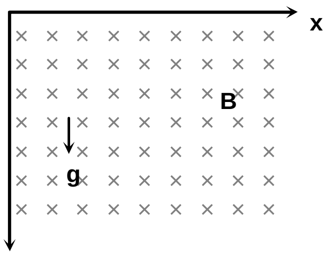
15. A L-shaped rod is made by using two different rods PO and QO. The length of rods PO and QO is 6.0 cm and 4.0 cm respectively and their coefficient of linear expansion is 1.2×10^{-5} /°C and 3.0×10^{-5} /°C respectively. The coefficient of linear expansion of the rod to be joined between point P and Q is $\lambda \times 10^5$ /°C. Find the value of λ so that no bending takes place anywhere.



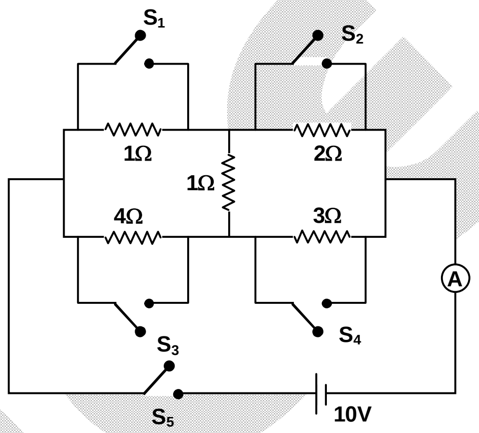
16. A uniform magnetic field B = 4 Tesla exist in the horizontal direction along x-axis. A conducting wire of mass 600 gm and length 5 cm is kept along y-axis on a rough horizontal surface. Conducting wire is carrying a current of magnitude 5 amp along y-axis. The minimum force required along x-axis to move the wire is F_1. Now the direction of current in the wire is reversed then minimum force required along x-axis to move the wire is F_2. Find the ratio of $\frac{F_1}{F_2}$.



17. A constant horizontal uniform magnetic field $B = 5 \times 10^6$ Tesla exist in a uniform vertical gravitational field $g = 10$ m/s^2. Both fields are perpendicular to each other. A particle of mass m = 50 gm and charge q = 2 μC is released in the space. Find the displacement (in cm) of particle along y-axis when velocity of particle is along x-axis first time.



18. Five resistors of resistance 1 Ω, 1Ω, 2Ω, 3Ω and 4Ω, a battery of voltage 10V, an ideal ammeter and five switches S_1, S_2, S_3, S_4 and S_5 are connected in a circuit as shown in the figure. When S_3 and S_5 are closed and S_1, S_2 and S_4 remain opened then current read by ammeter is i_1. When S_1, S_3 and S_5 are closed and S_2, S_4 remain opened then current read by ammeter is i_2. The ratio of current $\frac{i_1}{i_2}$ is given by 11λ. Find the value of λ.



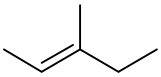
Chemistry

PART – II

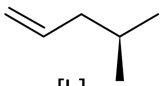
Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

19. Choose the INCORRECT statement(s) about the following alkenes is/are



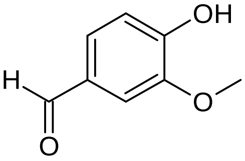
[K]



[L]

(A) Alkene [K] is more stable than alkene [L].
(B) Hydrogenation of achiral alkene [K] will give chiral product.
(C) Hydrogenation of achiral alkene [L] will give chiral product.
(D) The two alkenes [K] and [L] are structural isomers.

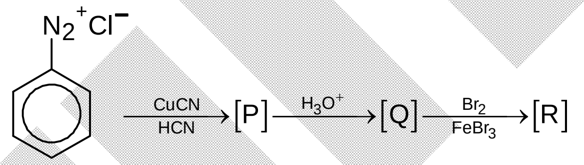
20. Choose the CORRECT statement (s) regarding Vanilin



Vanilin [P]

(A) [P] can be obtained as a major product when 3,4-dihydroxy benzaldehyde is treated with one equivalent of NaOH and one equivalent of MeBr.
(B) [P] can be obtained as a one of the product when 2-methoxy phenol is treated with chloroform and aq. KOH.
(C) Position isomer of [P] can be obtained when 3,4-dihydroxy benzaldehyde is treated with one equivalent of NaOH and one equivalent of MeBr.
(D) [P] can be obtained when 3,4-dihydroxy benzaldehyde is treated with two equivalent of NaOH and one equivalent of MeBr followed by acidic work up.

21. In the following reaction sequence:

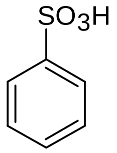


Choose the 'FALSE' statement(s):
(A) [R] is more acidic than [Q].
(B) [R] is more reactive towards electrophilic aromatic substitution than [Q].
(C) [Q] is more reactive towards electrophilic substitution than benzene.
(D) [R] on reaction with sodalime form a compound which can undergo phenol formation with aq. NaOH treatment under the normal condition of pressure and temperature.

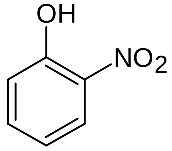
22. Which of the following compounds are soluble in $NaHCO_3$?

(A) Picric acid

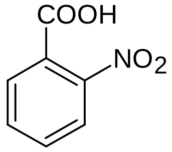
(B)



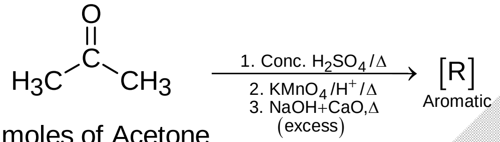
(C)



(D)



23.


O
H_3C
CH_3
1. Conc. H_2SO_4/Δ
2. $KMnO_4$/H^+/Δ
3. NaOH+CaO,Δ (excess)
[R]
Aromatic

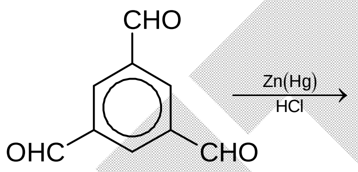
$$\underset{\text{3 moles of Acetone}}{H_3C\overset{\overset{O}{||}}{C}CH_3} \xrightarrow[\substack{2.\ KMnO_4/H^+/\Delta \\ 3.\ NaOH+CaO,\Delta \\ (excess)}]{1.\ Conc.\ H_2SO_4/\Delta} \underset{\text{Aromatic}}{[R]}$$

Out of the given reactions, which can give major product [R]?

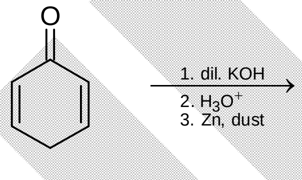
(A) $HC\equiv CH \xrightarrow[\text{Fe tube}]{\text{Red hot}}$

(B) $\text{n – hexane} \xrightarrow[\text{773 K, 10–20 atm}]{Cr_2O_3-Al_2O_3}$

(C)


CHO
OHC
CHO
Zn(Hg)
HCl

(D)


O
1. dil. KOH
2. H_3O^+
3. Zn, dust

24. Choose the correct statements regarding the given scheme

$$\underset{\text{Optically inactive}}{\underset{C_5H_{12}O}{[R]}} \xleftarrow{H_2/Pd-C} \underset{\text{Optically active}}{\underset{C_5H_6O}{[P]}} \xrightarrow[\text{Lindlar catalyst}]{H_2} \underset{\text{Optically inactive}}{\underset{C_5H_8O}{[Q]}}$$

(A) [R] can be oxidized with PCC into optically active carbonyl compound.
(B) Oxidised product of [Q] with PCC can show tautomerism.
(C) [P] contains triple bond at 4th carbon (as per IUPAC)
(D) [Q] can give white turbidity immediately with Lucas test.

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (I), (II), (III) and (IV) and FIVE statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

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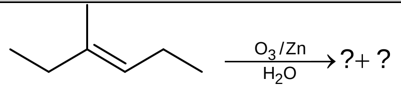
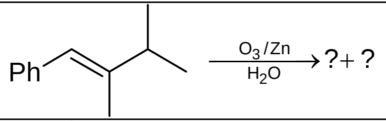
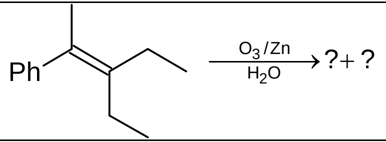
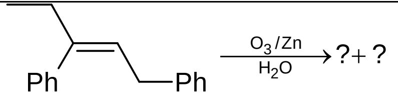
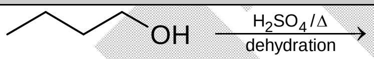
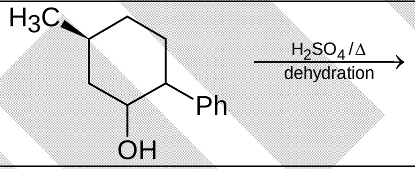
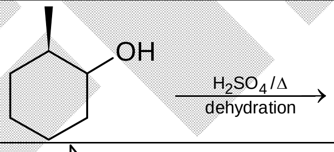
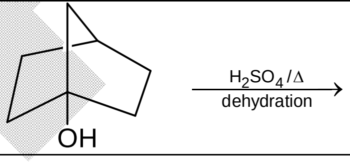
25. Match each species in List – I with their properties in List-II and choose correct option

List – I		List – II (Products can be distinguished)	
(I)		(P)	Fehling's test
(II)		(Q)	Tollen's test
(III)		(R)	Iodoform test
(IV)	 Ph Ph O_3/Zn H_2O ?+ ?	(S)	Schiff's test
		(T)	Benedict's test

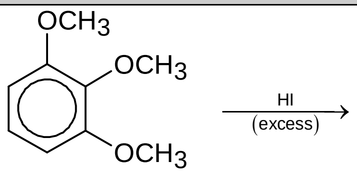
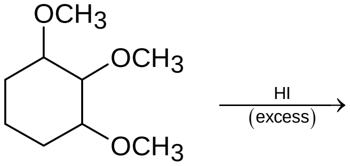
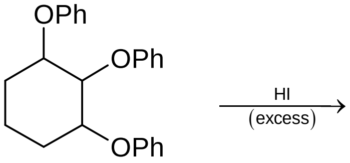
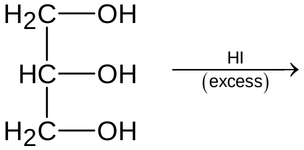
(A) I→P,Q, R, S; II→P, Q, R; III→R,S; IV→P, Q, S, T
(B) I→P, Q, R, S, T; II→Q, R, S; III→R; IV→P, Q, S, T
(C) I→Q, R, S, T; II→Q, R; III→ S; IV→P, Q, S
(D) I→R, S, T; II→P, R; III→Q,S; IV→ Q, S, T

26. Match each species in List – I with appropriate statement (s) of List – II and choose correct option

List – I		List – II	
(I)	 OH H_2SO_4/Δ dehydration	(P)	At least one of the product shows optical isomerism.
(II)	 H_3C Ph OH H_2SO_4/Δ dehydration	(Q)	Major product contains even number of α – hydrogens (Hydrogens which can involve in hyperconjugation).
(III)	 OH H_2SO_4/Δ dehydration	(R)	One of the product shows geometrical isomerism.
(IV)	 OH H_2SO_4/Δ dehydration	(S)	Reactant can turn acidified dichromate to green.
		(T)	Will not undergo dehydration.

(A) I→Q, R; II→Q, S, T; III→P, S; IV→T
(B) I→Q, R, S; II→Q, R,S; III→P, Q; IV→R,S
(C) I→P, Q,R, S; II→Q, R, S; III→P, R; IV→Q
(D) I→Q,R, S; II→P, Q, R, S; III→P,S; IV→T

27. Match each species in List – I with appropriate statement(s) in List – II and choose correct options:

List – I		List – II	
(I)		(P)	More than 4 moles of HI will be consumed.
(II)		(Q)	Product will react with Na/dry ether.
(III)		(R)	Product formed contains 2^o halide.
(IV)	 $\begin{array}{l}H_2C-OH\\ \mid\\ HC-OH\\ \mid\\ H_2C-OH\end{array} \xrightarrow[\text{(excess)}]{HI}$	(S)	CH_3I is one of the product.
		(T)	2-Iodopropane is a major product.

(A) I→Q, R; II→P, Q, R; III→P,Q,R; IV→Q, S, T
(B) I→P, T; II→Q, R,S; III→P, Q, R, T; IV→P, Q, R
(C) I→P,Q; II→Q,S, T; III→P. Q, R; IV→Q, R, T
(D) I→Q,S; II→P, Q, R, S; III→P, Q,R; IV→P, Q, R, T

28. Match each species in List – I with List – II and choose correct option

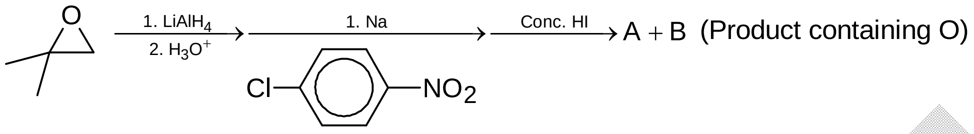
List – I		List – II	
(I)	A carbohydrate which yields only glucose on hydrolysis	(P)	Sucrose
(II)	A carbohydrate which yields glucose and fructose on hydrolysis	(Q)	Lactose
(III)	A carbohydrate which yields glucose and galactose on hydrolysis	(R)	Amylose
(IV)	A carbohydrate which can reduce Fehling's solution	(S)	Mannose
		(T)	Cellulose

(A) I→R, T; II→Q; III→P; IV→Q, S
(B) I→T; II→Q; III→Q; IV→Q
(C) I→R; II→P; III→Q; IV→P
(D) I→R, T; II→P; III→Q; IV→Q, S

Section – B (Maximum Marks: 24)

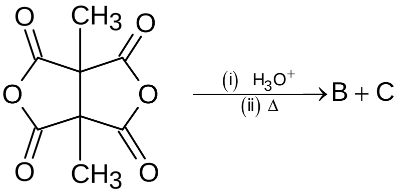
*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

29.



In the above reaction, the ratio of number of atoms of O to C in the molecular formula of B is

30.



[A]

0.1 mol of (A) was reacted according to above reaction. 'C' is the gas produced which turns lime water milky. The amount of 'C' formed in gram is x. The value of $\frac{x}{2}$ is

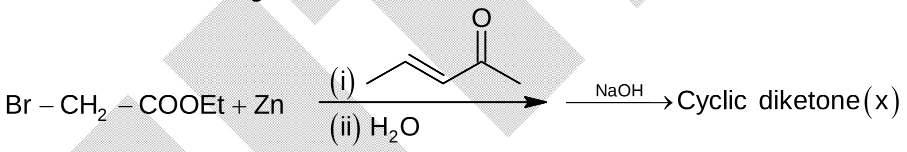
31. 'A' is an optically active hydrocarbon with minimum molecular weight ('A' does not have any isotopic atoms like D and C^{14}).

If (a) Number of carbon atoms in A = x.

(b) Degree of unsaturation = y.

Calculate $\frac{x+y}{2}$

32. Consider the following reaction:



If (x) is finally treated with excess of $NaBH_4$ followed by acid work-up, the number of diols formed (including stereoisomers) is (y). Then, calculate the value of 10y.

33. How many chloroethenes (including stereoisomers) are possible for molecular formula $C_2H_{4-n}Br_n$ (where 'n' can be an integer from 1 to 4) which can possess geometrical isomerism.

34. The number of co-polymer(s) in the below list is/are X:

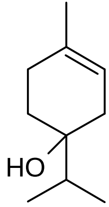
(Nylon-6,6, Buna-N, Dacron, Buna-S, Teflon, PHBV)

The number of carbohydrate (s) which show mutarotation in the below list is/are Y:

$$\left(\begin{array}{l}\alpha-\text{D}-\text{Glucopyranose, }\beta-\text{D}-\text{Glucopyranose, Lactose,}\\ \alpha-\text{D}-\text{Fructofuranose, }\beta-\text{D}-\text{Fructofuranose, Sucrose,}\\ \text{Maltose}\end{array}\right)$$

The value of $\frac{Y}{X}$?

35. Terpinen-4-ol is an active ingredient in tea tree oil has following structure



Which of the following statement(s) is/are correct about above compound?

1. It can rotate the plane polarized light.
2. It reacts with Baeyer's reagent to form triol.
3. On reaction with excess of NaBr and dilute H_2SO_4, it can form a dibromo compound.
   (Note: Write your answer in three digits)

i.e. If only statement-1 is correct, then 0.01 is correct answer.
If only statement-2 is correct, then 0.02 is correct answer.
If only statement-3 is correct, then 0.03 is correct answer.
If statement-1 and 2 both are correct, then 0.12 is correct answer.
If statement-1 and 3 both are correct, then 0.13 is correct answer.
If statement-1, 2 and 3 are correct, then 1.23 is correct answer.

36. In Duma's method of estimation of nitrogen, 0.1840 g of an organic compound gave 30 ml of nitrogen collected over water at 287 K and 758 mm of Hg pressure. The percentage composition of nitrogen in the compound is………[Given : aqueous tension at 287 K = 14 mm of Hg] [R = 0.0821 L atm mol^{-1} K^{-1}]

FIITJEE

Mathematics PART – III

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

37. To the parabola $x^2 = 4ay$, tangent is drawn at any point (x_1, y_1) other than the vertex. If tangents are drawn to the circle $x^2 + y^2 = 4a^2$ from any point on this tangent such that all the corresponding chords of contact pass through a fixed point (x_2, y_2), then

(A) y_1, 2a, y_2 are in Geometric Progression

(B) $-4, \frac{x_1}{x_2}, \frac{y_1}{y_2}$ are in Geometric Progression

(C) $\frac{x_1}{2}$, 2a, x_2 are in Geometric Progression

(D) $x_1x_2 + y_1y_2 = 4a^2$

38. Two ellipse with same centre and same length of major axis are such that the foci of one are on the other. If their eccentricities are e_1 and e_2, then

(A) the angle θ between their axes is given by $\theta = \sin^{-1}\left(\frac{\sqrt{(e_1^2-1)(e_2^2-1)}}{e_1e_2}\right)$

(B) quadrilateral formed by joining the foci is a parallelogram

(C) for $\theta = \frac{\pi}{4}$, $e_1^2 = \frac{2e_2^2+1}{e_2^2-2}$

(D) none of these

39. Normal to the circle $x^2 + y^2 = 9$ divides the circle having centre at $\left(3\sqrt{2}, \frac{3}{2}\right)$ and radius 3 in the areas of ratio $\left(2\pi - 3\sqrt{3}\right) : \left(10\pi + 3\sqrt{3}\right)$. Then the normal can be

(A) $\sqrt{2}y = x$

(B) $y = \sqrt{2}x$

(C) $5y + \sqrt{2}x = 0$

(D) $\sqrt{2}y + x = 0$

40. If $\alpha = p\cos^3\theta \cdot \sin^2\theta$, $\beta = p\sin^3\theta \cdot \cos^2\theta$ and $\frac{\left(\alpha^2+\beta^2\right)^a}{(\alpha\beta)^b}$ (a, b $\in$ N) is independent of θ, then (a, b) is equal to

(A) (4, 5)

(B) (8, 10)

(C) (5, 4)

(D) (10, 8)

41. If one of the lines represented by $4x^2 + pxy + 6y^2 = 0$ is perpendicular to one of the lines given by $4x^2 + qxy - 6y^2 = 0$ and the other lines represented by them are coincident, then the value of p – 2q is

(A) –6

(B) –8

(C) 8

(D) 6

42. The expression $\frac{x^3}{2}\text{cosec}^2\left(\tan^{-1}\left(\frac{x}{y}\right)\right) + \frac{y^3}{2}\sec^2\left(\tan^{-1}\left(\frac{y}{x}\right)\right)$ is divisible by

(A) $x + y$

(B) $x^2 + y^2$

(C) $x^3 + y^3$

(D) $x^2 - y^2$

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (I), (II), (III) and (IV) and FIVE statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

---

43. Match the following List-I with List-II

List-I		**List-II**	
(I)	The number of solutions of $x^4 - 2x^2\sin^2\frac{\pi x}{2} + 1 = 0$ is	(P)	4
(II)	The number of solutions of $16(x^2 + 1) + \pi^2 = \lvert\tan x\rvert + 8\pi x$, $x \in \left(-\frac{\pi}{2}, \frac{3\pi}{2}\right)$, $x \neq \frac{\pi}{2}$ is	(Q)	2
(III)	The numbers of pairs (x, y) satisfying the equation $\sin x + \sin y = \sin(x + y)$ and $\lvert x\rvert + \lvert y\rvert = 1$ is	(R)	1
(IV)	The number of integral values of x in [0, 6] satisfying $\sin x + \frac{1}{2}\sin 2x + \frac{1}{3}\sin 3x > 0$ is	(S)	3
		(T)	6

The correct option is:
(A) (I) → (T); (II) → (P); (III) → (S); (IV) → (Q)
(B) (I) → (S); (II) → (P); (III) → (R); (IV) → (Q)
(C) (I) → (Q); (II) → (P); (III) → (T); (IV) → (S)
(D) (I) → (R); (II) → (T); (III) → (P); (IV) → (S)

44. Let $t_{10} = (\sin^{-1}x)^{\sin^{-1}x} 0$, $t_2 = (\sin^{-1}x)^{\cos^{-1}x}$, $t_3 = (\cos^{-1}x)^{\sin^{-1}x}$, $t_4 = (\cos^{-1}x)^{\cos^{-1}x}$ match the following List-I with List-II

List-I		**List-II**	
(I)	$x \in (0, \cos 1)$	(P)	$t_1 > t_2 > t_4 > t_3$
(II)	$x \in \left(\cos 1, \frac{1}{\sqrt{2}}\right)$	(Q)	$t_4 > t_3 > t_1 > t_2$
(III)	$x \in \left(\frac{1}{\sqrt{2}}, \sin 1\right)$	(R)	$t_4 > t_1 > t_2 > t_3$
(IV)	$x \in (\sin 1, 1)$	(S)	$t_2 > t_1 > t_4 > t_3$
		(T)	$t_3 > t_4 > t_1 > t_2$

The correct option is:
(A) (I) → (T); (II) → (S); (III) → (Q); (IV) → (R)
(B) (I) → (Q); (II) → (T); (III) → (S); (IV) → (P)
(C) (I) → (R); (II) → (Q); (III) → (S); (IV) → (T)
(D) (I) → (P); (II) → (Q); (III) → (R); (IV) → (S)

45. Match the following List-I with List-II

List-I		List-II	
(I)	The shortest distance between the parabola $2y^2 = 2x - 1$ and $2x^2 = 2y - 1$ is	(P)	$\frac{2\sqrt{2}}{3}$
(II)	The triangle formed by the tangent to the parabola $y = x^2$ at the point whose abscissa is x_0 ($x_0 \in [1, 2]$), the y-axis and the straight line $y = x_0^2$ has the greatest area if x_0 is equal to	(Q)	$\frac{1}{4}$
(III)	An ellipse is inscribed in a circle and a point within the circle is chosen at random. If the probability that this point lies outside the ellipse is $\frac{2}{3}$, then the eccentricity of the ellipse is	(R)	$\frac{1}{2\sqrt{2}}$
(IV)	If $f(x) = x^3 + ax^2 + bx + c$, (a, b, c are rational numbers) and 2 roots of f(x) = 0 are eccentricities of a parabola and a rectangular hyperbola, then $\frac{1}{abc}$ equals	(S)	$\frac{1}{\sqrt{2}}$
		(T)	2

The correct option is:
(A) (I) → (S); (II) → (T); (III) → (Q); (IV) → (R)
(B) (I) → (P); (II) → (Q); (III) → (S); (IV) → (T)
(C) (I) → (Q); (II) → (S); (III) → (R); (IV) → (T)
(D) (I) → (R); (II) → (T); (III) → (P); (IV) → (Q)

46. Match the following List-I with List-II

List-I		List-II	
(I)	If the angle between lines belonging to the family of lines $(3x + y - 7) + \lambda(x + y - 3) = 0$ and $(x + 3y - 7) + \mu(x + 4y - 3) = 0$ which are farthest from origin (λ and μ are real parameters), is $\tan^{-1}\left(\frac{a}{b}\right)$ where a, b are coprime natural numbers, then b – a is	(P)	11
(II)	If the roots of the equation $px^2 + qx + 10 = 0$ are not real and distinct where $p, q \in R$ and α and β are the values of p and q respectively for which 5p + q is minimum, then the family of lines $\alpha(4x + 5\alpha y + 3) + \beta(4x + \beta y - 4) = 0$ are concurrent at (a, b). (a – b) is	(Q)	7
(III)	A circle is inscribed into a rhombus PQRS with one angle 120°. The distance from the centre of the circle to the nearest vertex is equal to 1. If A is any point on the circle, then $\lvert AP\rvert^2 + \lvert AQ\rvert^2 + \lvert AR\rvert^2 + \lvert AS\rvert^2$ is	(R)	3
(IV)	If the area bounded by the circles $x^2 + y^2 = r^2$, r = 1, 2 and the rays given by $2x^2 - 3xy - 2y^2 = 0$, y > 0 is $\frac{\lambda\pi}{4}$ sq. units. Then the value of λ is	(S)	1
		(T)	5

The correct option is:
(A) (I) → (P); (II) → (R); (III) → (S); (IV) → (Q)
(B) (I) → (Q); (II) → (S); (III) → (P); (IV) → (R)
(C) (I) → (T); (II) → (P); (III) → (S); (IV) → (R)
(D) (I) → (S); (II) → (P); (III) → (T); (IV) → (Q)

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

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47. If $\sin^{-1}\alpha + \sin^{-1}\beta + \sin^{-1}\gamma = \pi$, then $\dfrac{\alpha\sqrt{1-\alpha^2} + \beta\sqrt{1-\beta^2} + \gamma\sqrt{1-\gamma^2}}{\alpha\beta\gamma}$ is equal to

48. If $b^2 + c^2 = 2023a^2$, where a, b, c are the side lengths of ΔABC for usual notation, then $\dfrac{\cot A}{\cot B + \cot C}$ is equal to

49. For the hyperbola $\dfrac{x^2}{25} - \dfrac{y^2}{45} = 1$, the chord $x \cos \theta + y \sin \theta = \lambda$ subtends a right angle at the centre. Then the length of tangent to the circle, concentric with this hyperbola, to which the given chord is a tangent, from the point $P\left(5, 5\sqrt{2}\right)$ is

50. Two circles S and S′ pass through both the points P(1, –2) and Q(2, 3) such that the line $x - 3y + 9 = 0$ is a common tangent touching them at A and B respectively. If the possible coordinates of a point R are (α, β) such that PARB is a parallelogram and $\alpha = \dfrac{a}{b}$, $\beta = \dfrac{c}{d}$ (both in lowest forms) with a, b, c d $\in$ I, then |abcd| is

51. For real numbers x and y satisfying $x^2 + 4y^2 - 6x + 4y + 9 = 0$. Then the absolute difference between the maximum and minimum values of $(8x - 12y)$ is

52. There are two families of lines in a plane $y = x + i$, $y = -x + i$, where $i = \{0, 1, 2, 3, 4, 5\}$. The number of squares having diagonal lengths of odd units, formed by these lines is

53. Points P, Q, R lie on the parabola $y^2 = 4ax$. Tangents to the parabola at these points taken in pairs, intersect at A, B, C. The ratio of the areas of ΔABC and ΔPQR is

54. The sum of all possible values of α (in degrees) such that $\cos^3 3\alpha + \cos^3 5\alpha = 8 \cos^3 4\alpha \cos^3 \alpha$ where α is measured in degrees and $\alpha \in (100°, 200°)$, is

FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
PART TEST – II
PAPER –2
TEST DATE: 11-12-2022

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B**.

Section – A ***(01 – 04, 19 – 22, 37 – 40)*:** This section contains **TWELVE (12)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.

Section – A ***(05 –10, 23 – 28, 41 – 46)*:** This section contains **EIGHTEEN (18)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – B ***(11 – 18, 29 – 36, 47 – 54)*:** This section contains **TWENTY FOUR (24)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.**

MARKING SCHEME

Section – A (Single Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+3	If ONLY the correct option is chosen.
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–1	In all other cases.

Section – A (One or More than One Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4	If only (all) the correct option(s) is (are) chosen;
Partial Marks	:	+3	If all the four options are correct but ONLY three options are chosen;
Partial marks	:	+2	if three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks	:	+1	If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–2	In all other cases.

Section – B: Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+3	If ONLY the correct integer is entered;
Zero Marks	:	0	Question is unanswered;
Negative Marks	:	–1	In all other cases.

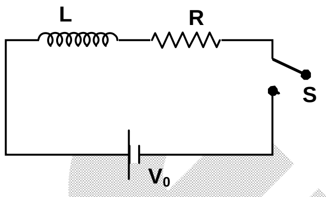
Physics

PART – I

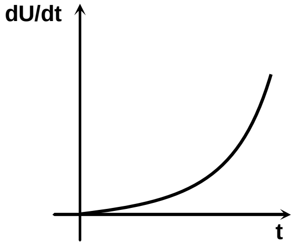
Section – A (Maximum Marks: 12)

This section contains ***FOUR (04)*** *questions. Each question has* ***FOUR*** *options.* ***ONLY ONE*** *of these four options is the correct answer.*

1. An ideal inductor and a resistor are connected in series with a battery of pontential difference V_0 through a switch 'S'. The switch is closed at t = 0. The potential energy stored in inductor at time 't' is given by U. The rate of change of potential energy in inductor with time is best represented by



(A)



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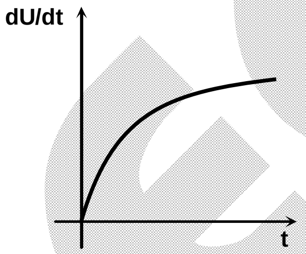
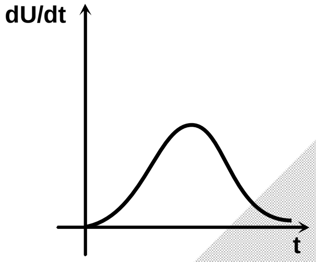
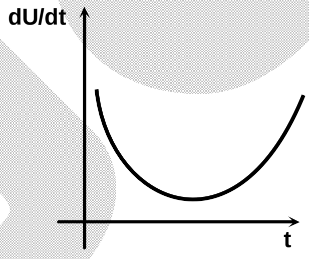


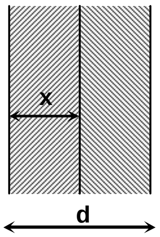
(C)



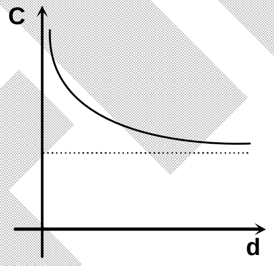
(D)



2. A dielectric is completely filled between the space of a parallel plate capacitor. The separation between plates of capacitor is 'd' and dielectric constant is given by $k = k_0 e^{\lambda x}$, where 'k_0' and 'λ' are positive constants and x is distance from one plate of capacitor. If distance between plate (d) increases slowly then graph between capacitance of capacitor and distance between plate is given by



(A)



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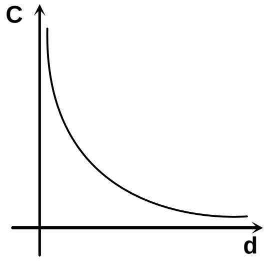

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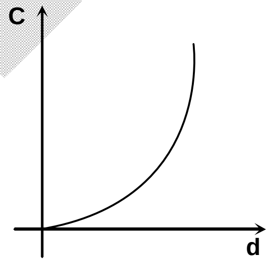

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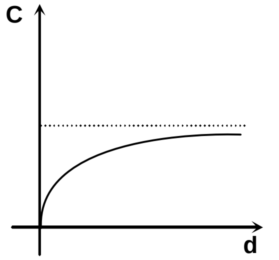
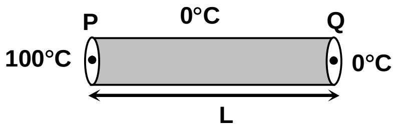
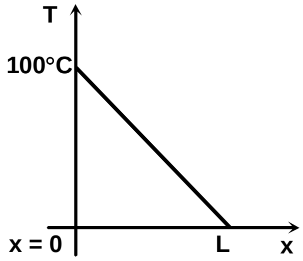


3. A conducting rod of length 'L' cross-sectional area 'A' and thermal conductivity 'k' is kept in the surrounding at 0°C. The end P is maintained at 100°C and Q at 0°C. The graph between temperature (T) of the rod and distance (x) from the end 'P' is best represented by



(A)



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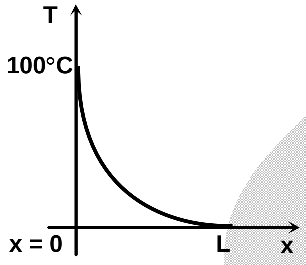
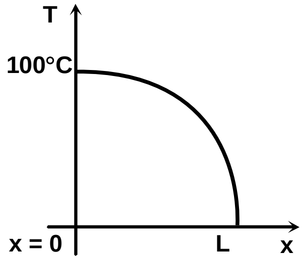
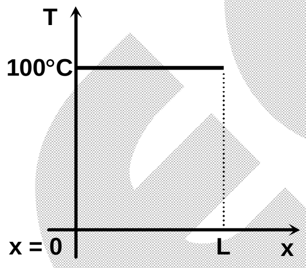


(C)

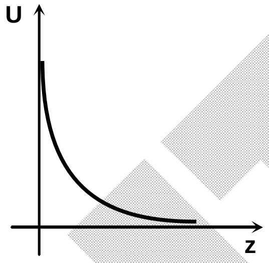


(D)

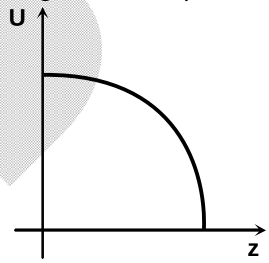


4. Four point charges 2q, 2q, –q and –q are kept at (a, –a, 0), (–a, +a, 0), (a, a, 0) and (–a, –a, 0) and fixed at their position. Another point charge q_0 is kept at origin and slightly displaced along positive z-axis. The graph of potential energy of the charge is best represented by

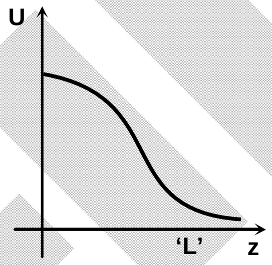
(A)



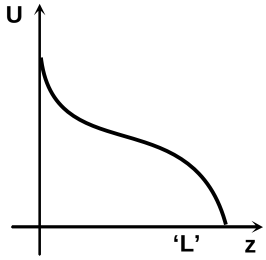
(B)



(C)



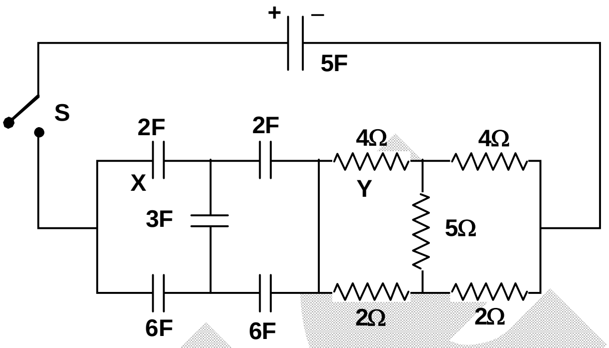
(D)



Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

5. A capacitor of capacity 5F is charged by a battery of 2 volt and then connected with 5 uncharged capacitors and 5 resistors with the help of a switch 'S' as shown in the figure. At t = 0, switch is closed. Choose the correct option(s).



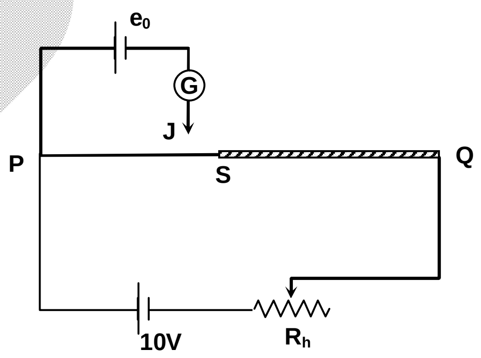
(A) Charge on capacitor X at time t is given by $\frac{10}{9}\left(1-e^{-\frac{27}{160}t}\right)$

(B) Current in resistor Y at time t is given by $\frac{1}{4}\left(e^{-\frac{27}{160}t}\right)$

(C) Total energy dissipated in the circuit is $\frac{50}{9}$J

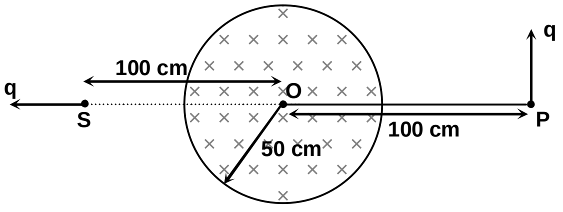
(D) Total energy dissipated in the circuit is $\frac{40}{9}$J

6. A potentiometer wire PQ is made by using two wires of different cross sectional area A and 2A. The material of wire PS and SQ is same and their lengths are 5m each. A source battery of 10V and rheostat R_h are connected in the circuit as shown in the figure. Choose the correct option(s) regarding the balance point.



(A) If a cell of emf e_0 = 5V is used then balance point from the end P is at 7.5 m
(B) If a cell of emf e_0 = 5V is used then balance point from the end P is at 3.75 m
(C) If a cell of emf e_0 = 8V is used then balance point from the end P is at 7 m
(D) If a cell of emf e_0 = 8V is used then balance point from the end P is at 8.5 m

7. A cylindrical vertical magnetic field exist in a gravity free space. Magnetic field is increasing at a rate of 700 T/sec. The radius of cylindrical magnetic field is 50 cm. A point charge q = 50 μC is moved very slowly by an external agent from two point 'P' and 'S' then

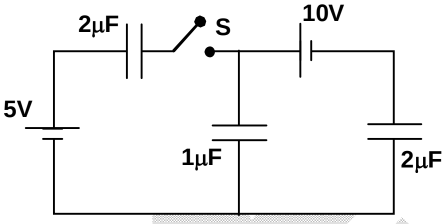


(A) Work done by external agent is zero if charge particle is moved from point 'S' upto infinity along the line OS.
(B) Work done by external agent is zero if charge particle is moved from point 'P' upto infinity perpendicular to the line OP.

(C) Work done by external agent is $\frac{55}{8}$mJ if charge particle is moved from point ‘P’ upto infinity perpendicular to the line OP.

(D) Work done by external agent to move a charge particle from any point to infinity is path independent.

8. Three capacitors of capacity 2 μF, 2 μF, 1μF and two ideal cells of potential difference 10V and 5V are connected in a circuit through a switch ‘S’. Initially switch is opened for a long time and then it is closed. Choose the correct option(s) after switch is closed.



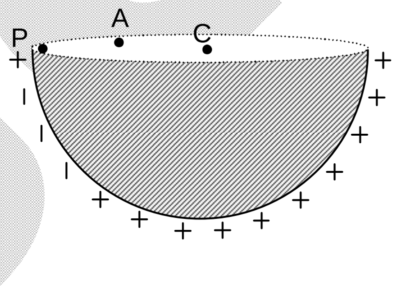
(A) Charge passing through 10V cell is $\frac{4}{3}$μC

(B) Work done by 5V battery is 10μJ

(C) Charge on 1μF capacitor is 6μC

(D) Total heat dissipated in the circuit after switching is $\frac{5}{3}$μJ

9. A non conducting hemispherical shell of radius ‘R’ has uniform surface charge density σ. Point ‘C’ is center of hemispherical shell. Point ‘A’ and point ‘P’ lie on the flat surface of the shell. The distance between C and A is R/2 and between C and P is R. Choose the correct option(s).



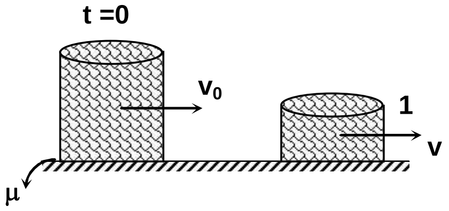
(A) The potential at point P is $\frac{\sigma R}{2\varepsilon_0}$

(B) The potential at point A is $\frac{\sigma R}{4\varepsilon_0}$

(C) Word done by electrostatic force if a charge ‘q_0’ is moved from P to A is $\frac{-q_0\sigma R}{4\varepsilon_0}$

(D) Word done by electrostatic force if a charge ‘q_0’ is moved from P to A is $\frac{q_0\sigma R}{4\varepsilon_0}$

10. An ice in the shape of cylinder is kept on a rough horizontal surface as shown in the figure. An initial velocity v_0 is imparted to cylindrical ice. The initial mass of ice is m_0 and coefficient of friction between ice and horizontal surface is ‘μ’. The initial temperature of ice 0°C and its latent heat of fusion is L. Choose the correct option(s).



(A) The velocity of cylindrical ice at time ‘t’ is given by ($v_0 + \mu gt$)

(B) The velocity of cylindrical ice at time ‘t’ is given by ($v_0 - \mu gt$)

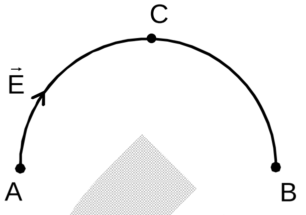
(C) The mass of cylindrical ice at time ‘t’ is given by $m_0 e^{-\frac{\mu g}{L}\left(v_0 t-\frac{\mu g L^2}{2}\right)}$

(D) The mass of cylindrical ice at time ‘t’ is given by $m_0 e^{-\frac{\mu g}{L}\left(\frac{v_0 t}{2}-\frac{\mu g L^2}{2}\right)}$

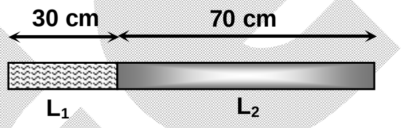
Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.***

11. Semicircular electric field line is present in a space. The magnitude of electric field is constant at each point of electric field lines. A point charge is constrained to move along the filed lines. The particle starts from rest and initially it is at point A. The magnitude of acceleration of the particle at C is a_1 and it is a_2 when reaches at B. The ratio of a_1 and a_2 is given by $\sqrt{\frac{1+k_1}{1+k_2}}$. Find the value of $\frac{k_2}{k_1}$.

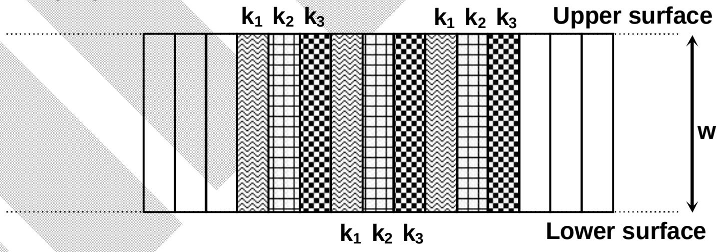


12. Two rods L_1 and L_2 of different materials are used to make a single composite rod as shown in the figure. The cross sectional are of both rods is same. At 25°C, the total length of combined rod is 1m, in which the length of L_1 is 30 cm. When temperature of combined rod is increased, at 125°C, the total length of combined rod increased by 1.91 mm. The coefficient of linear expansion of L_1 is 1.7×10^{-5}/°C and that of the L_2 is $k\times10^{-5}$/°C. Find the value of k.

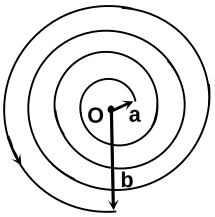


13. A particle of mass m = $\sqrt{227}$ gm and charge q = 7μC is projected in a space where magnetic field is given by $\vec{B} = y^2\hat{i} + z^2\hat{j} + x^2\hat{k}$. The initial velocity of projection of particle is $\vec{v} = \hat{i} - 2\hat{j} + 3\hat{k}$ from (1, 2, 1). Find radius of curvature of particle at t = 0 in kilometer.

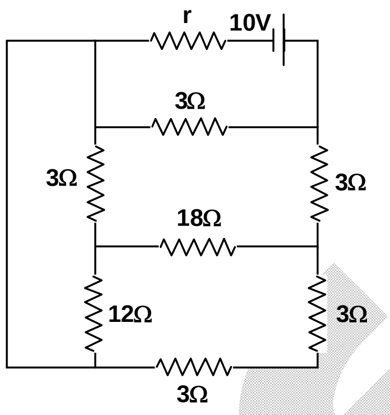
14. Three different type of glasses are used to make a large glass slab. The thermal conductivity of glass slabs are k_1, k_2 and k_3. The width of each glass slab is 'ω' and cross-sectional area is A. The glass slabs are kept in a pattern as shown in the figure. The upper surface of glass slab is maintained at temperature T_1 and lower surface at T_2. It is given that k_1 = 1.10 W/mK, k_2 = 2.82 W/mK, k_3 = 2.08 W/mK, w = 10 cm, A = 1.3 m^2, T_1 = 100°C, T_2 = 0°C. Find equivalent thermal conductivity of large glass slab in W/mK.



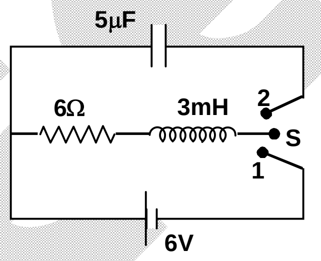
15. A conducting spiral of inner radius a = 20 cm and outer radius b = 40 cm is kept on a frictionless horizontal surface. The total number of turns is equal to 1000 which are wound tightly and insulated to each other. There exist a vertical magnetic field which is changing at a rate of $\frac{50}{\pi}$ mT/sec. If the resistance of conducting spiral is $\frac{14}{9}\Omega$, then find induced current in ampere.



16. A battery of potential difference 10 V and internal resistance ‘r’ is connected to seven resistors as shown in the figure. If battery delivers maximum power to the circuit with internal resistance $r = \frac{4}{13}\lambda$, then find the value of λ.

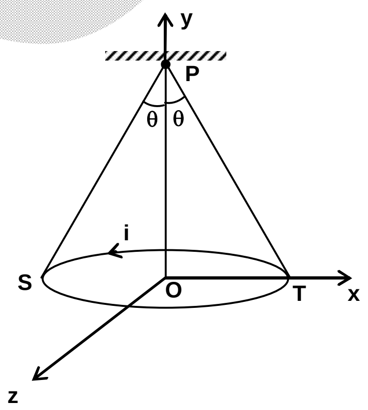


17. A capacitor (5μF), a resistor (6Ω), an inductor (3mH), a cell (6V) and a switch are connected in a circuit as shown in the figure. Initially switch is kept at position-1 for a long time. The potential difference (in volt) across the ends of inductor immediately after the switch is shifted from position-1 to position-2 is



18. A ring of uniform mass density (m = 100 gm) and radius (R = 50 cm) is suspended by two strings PS and PT from the point P on y-axis in vertical plane. The ring is kept parallel to horizontal surface on x-z plane. Ring carries a current $\left(i = \frac{7}{22}\text{amp}\right)$ as shown in the figure. There exist a magnetic field (B = 1 Tesla) along negative x-axis. The tension in the string PS is T_1 and in the string PT is T_2. Find the ratio $\frac{T_1}{T_2}$.

(It is given that $\theta = 60°$)



Chemistry PART – II

Section – A (Maximum Marks: 12)

This section contains ***FOUR (04)*** *questions. Each question has* ***FOUR*** *options.* ***ONLY ONE*** *of these four options is the correct answer.*

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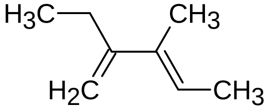
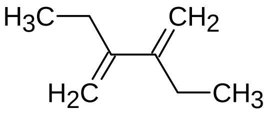
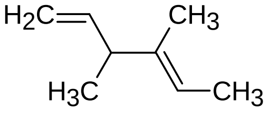
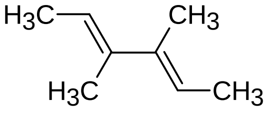
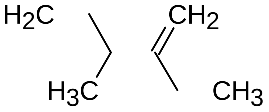
19. Which of the following is NOT the chain isomer of


H3C
CH3
H2C
CH3

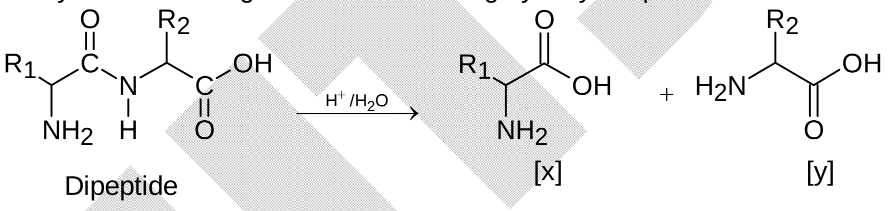
(A) 
H3C
CH2
H2C
CH3

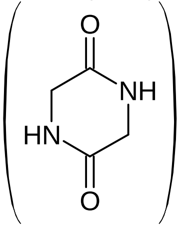
(B) 
H2C
CH3
H3C
CH3

(C) 
H3C
CH3
H3C
CH3

(D) 
H2C
CH2
H3C
CH3

20. Analyse the following data of the following hydrolyzed products and choose the correct option:


O
R2
R1
C
N
H
C
OH
O
NH2
Dipeptide
H+/H2O
R1
O
OH
NH2
[x]
+
H2N
R2
OH
O
[y]

If the dipeptide is first treated with HNO_2 and then hydrolysis is carried out, we got lactic acid and [y]. [y] on heating gives 2,5-diketopiperazine 

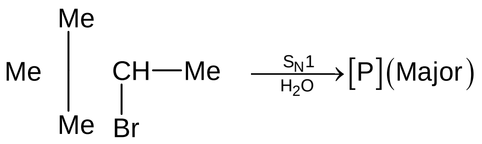
(A) $R_1 = H$ and $R_2 = CH_3$

(B) $R_1 = CH_3$ and $R_2 = CH_3$

(C) $R_1 = CH_3$ and $R_2 = H$

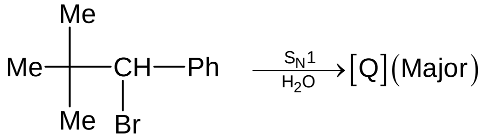
(D) $R_1 = H$ and $R_2 = H$

21. (I)



$$\mathrm{Me{-}\overset{\displaystyle Me}{\underset{\displaystyle Me}{C}}{-}\underset{\displaystyle Br}{CH}{-}Me} \xrightarrow[H_2O]{S_N1} [P](\text{Major})$$

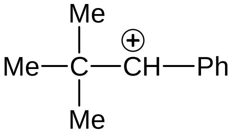
(II)



$$\mathrm{Me{-}\overset{\displaystyle Me}{\underset{\displaystyle Me}{C}}{-}\underset{\displaystyle Br}{CH}{-}Ph} \xrightarrow[H_2O]{S_N1} [Q](\text{Major})$$

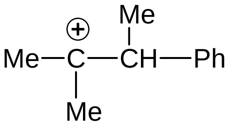
Identify the INCORRECT intermediate carbocation, which does NOT form during the reaction (I) and (II)?

(A)



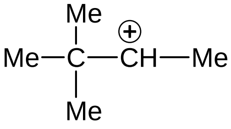
$$\mathrm{Me{-}\overset{\displaystyle Me}{\underset{\displaystyle Me}{C}}{-}\overset{\oplus}{C}H{-}Ph}$$

(B)



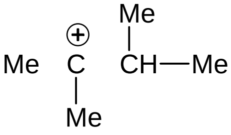
$$\mathrm{Me{-}\overset{\oplus}{\underset{\displaystyle Me}{C}}{-}\overset{\displaystyle Me}{CH}{-}Ph}$$

(C)



$$\mathrm{Me{-}\overset{\displaystyle Me}{\underset{\displaystyle Me}{C}}{-}\overset{\oplus}{C}H{-}Me}$$

(D)



$$\mathrm{Me\quad \overset{\oplus}{\underset{\displaystyle Me}{C}}\quad \overset{\displaystyle Me}{CH}{-}Me}$$

22. Identify which test are positive (+) or negative (–) for $\beta-\mathrm{D}-$glucopyranose?

[Note: Here positive means respond to test and negative means not respond to test)

1. 2, 4-DNP
2. NH_2OH/H^+
3. Tollen's test
4. $NaHSO_3$

(A)

1	2	3	4
+	+	+	−

(B)

1	2	3	4
+	+	−	−

(C)

1	2	3	4
−	+	+	−

(D)

1	2	3	4
–	–	−	−

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

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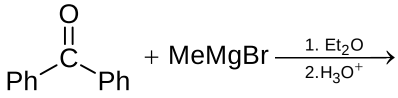
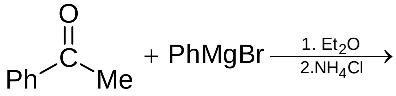
23. Which of the following reaction(s) will provide a synthesis of 1,1-diphenylethanol as a major product?

(A)



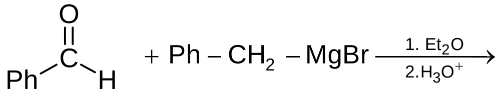
$PhCOPh + MeMgBr \xrightarrow[2.H_3O^+]{1.\ Et_2O}$

(B)



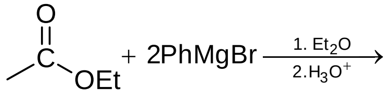
$PhCOMe + PhMgBr \xrightarrow[2.NH_4Cl]{1.\ Et_2O}$

(C)



$PhCHO + Ph-CH_2-MgBr \xrightarrow[2.H_3O^+]{1.\ Et_2O}$

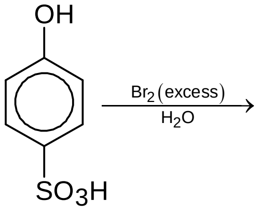
(D)



$CH_3COOEt + 2PhMgBr \xrightarrow[2.H_3O^+]{1.\ Et_2O}$

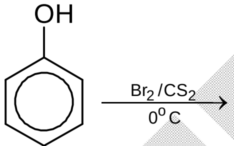
24. Which among the given reactions can yield the 2, 4,6-tribromo phenol as a major product?

(A)



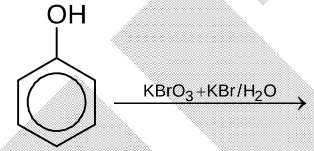
OH
Br_2(excess)
H_2O
SO_3H

(B)



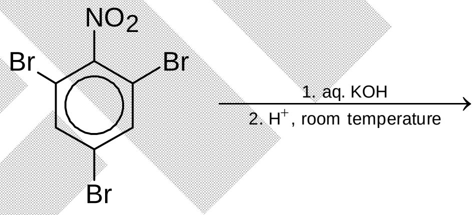
OH
Br_2/CS_2
0^oC

(C)



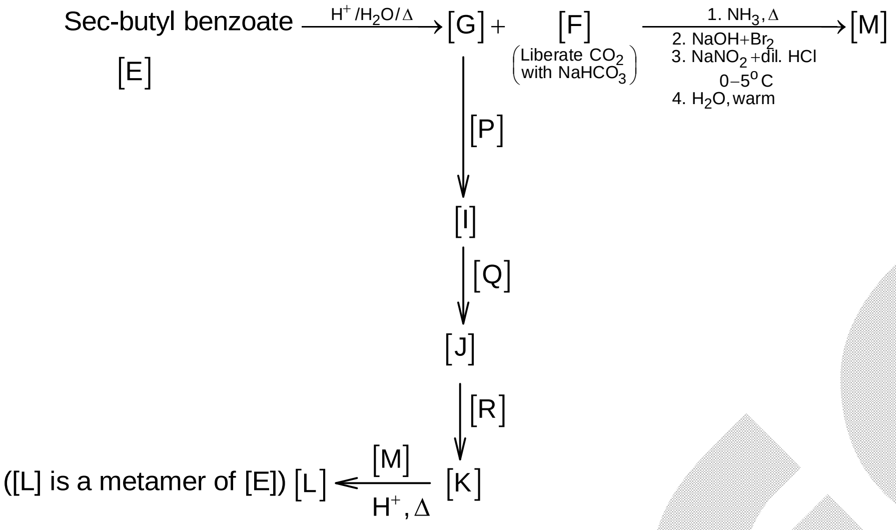
OH
$KBrO_3+KBr/H_2O$

(D)



NO_2
Br
Br
Br
1. aq. KOH
2. H^+, room temperature

25. Choose the correct options regarding the given scheme?


Sec-butyl benzoate
[E]
H⁺/H₂O/Δ
[G] +
[F]
(Liberate CO₂ with NaHCO₃)
1. NH₃, Δ
2. NaOH+Br₂
3. NaNO₂+dil. HCl 0–5°C
4. H₂O, warm
[M]
[P]
[I]
[Q]
[J]
[R]
[K]
[M]
H⁺, Δ
[L]
([L] is a metamer of [E])

(A) $[P] = SOCl_2$ $[Q] = Mg / dry\ ether$ $[R] = 1.\ HCHO \quad 2.\ H^+$

(B) $[P] = KBr + H_2SO_4$ $[Q] = AgCN / DMF$ $[R] = H_3O^+ / \Delta$

(C) $[P] = PBr_3$ $[Q] = Mg / dry\ ether$ $[R] = 1.\ CO_2 \quad 2.\ H^+$

(D) $[P] = HBr$ $[Q] = NaCN / DMF$ $[R] = H_3O^+ / \Delta$

26. Choose the INCORRECT statement(s) for the given reaction scheme

$$\underset{C_4H_4O_2}{[P]} \xrightarrow[2.\ H^+ (\text{work up})]{1.\ NaOH} \underset{C_4H_6O_3}{[Q]} \xrightarrow[-CO_2]{\Delta} \underset{\text{gives iodoform test}}{[R]} \xrightarrow{NaOH/\Delta} \underset{C_6H_{10}O}{[S]}$$

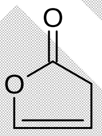
Unsaturated

Lactone

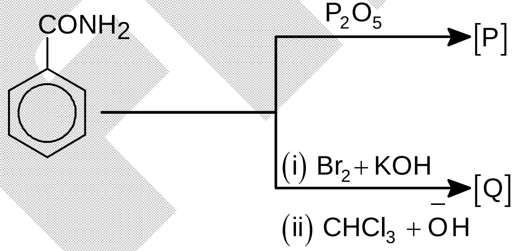
(A) [S] is an $\alpha,\beta-$unsaturated aldehyde.

(B) Four stereoisomers are possible for [S].

(C) Two structural isomers of [P] can satisfy the above reaction scheme.

(D) [P] is 

27.


CONH₂
P₂O₅
[P]
(i) Br₂ + KOH
(ii) CHCl₃ + O̅H
[Q]

Which statement(s) is/are CORRECT?

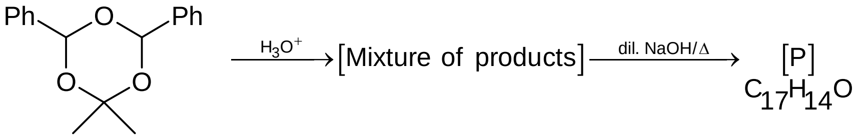
(A) Reduced product of P and Q will be metamers to each other. (Consider $LiAlH_4$ as a reducing agent)

(B) By dry distillation of hydrolysed product of P with $Ca(OH)_2$ gives benzophenone.

(C) One of the hydrolysis product of Q reacts with $NaNO_2$ + HCl followed by reaction with phenol in mild basic medium gives orange red dye.

(D) Electrophile involved in the formation of Q is dichlorocarbene.

28. Choose the correct statement(s)


Ph
O
Ph
O
O
$\xrightarrow{H_3O^+}$ [Mixture of products] $\xrightarrow{\text{dil. NaOH}/\Delta}$ [P]
$C_{17}H_{14}O$

(A) In mixture, one of the product shows positive iodoform test.
(B) In mixture, one of the product shows positive Tollen's test and negative Fehling's test.
(C) [P] on reaction with hydroxyl amine gives oxime that can have 4 stereoisomers.
(D) Number of double bonds in [P] is 10.

Section – B (Maximum Marks: 24)

This section contains ***EIGHT (08)*** *numerical based questions. The answer to each question is a* ***Single Digit Integer, ranging from 0 to 9 both inclusive.***

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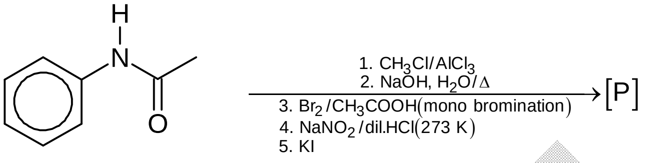
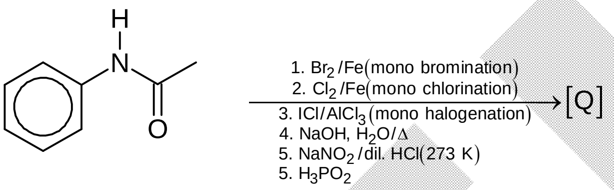
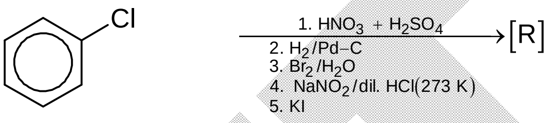
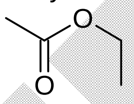
29. Consider the major organic product in each case and calculate the Sum of number of halogen atoms in [P], [Q] and [R]

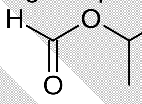

H
N
O
1. $CH_3Cl/AlCl_3$
2. NaOH, H_2O/Δ
3. Br_2/CH_3COOH(mono bromination)
4. $NaNO_2$/dil.HCl(273 K)
5. KI
[P]

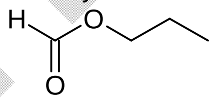

H
N
O
1. Br_2/Fe(mono bromination)
2. Cl_2/Fe(mono chlorination)
3. $ICl/AlCl_3$(mono halogenation)
4. NaOH, H_2O/Δ
5. $NaNO_2$/dil. HCl(273 K)
5. H_3PO_2
[Q]

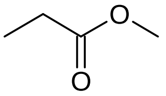

Cl
1. $HNO_3 + H_2SO_4$
2. H_2/Pd–C
3. Br_2/H_2O
4. $NaNO_2$/dil. HCl(273 K)
5. KI
[R]

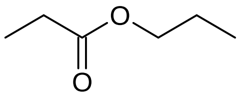
30. An organic compound reacts with excess of MeMgBr followed by hydrolysis to give two organic products of which one reacts with NaOI to give yellow precipitate and OTHER DOES NOT. How many of the following compounds can satisfy these conditions?

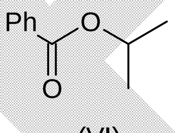

(I)

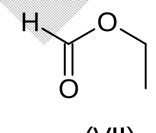

(II)

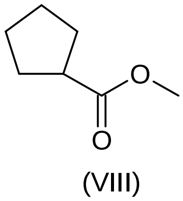

(III)

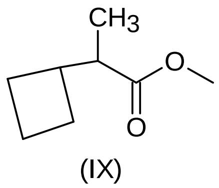

(IV)


(V)


(VI)


(VII)


(VIII)


(IX)

31. Consider all possible isomeric ketones including stereoisomers of MW = 100. All these isomers are independently reacted with CH_3MgBr (Note : Stereoisomers are also reacted separately and consider no racemisation of alpha carbon of the carbonyl group during the reaction). The total number of ketones that gives a racemic product is/are

32. $\text{D – Glucose} \xrightarrow[H_2O]{Br_2} P$

Number of chiral centre in compound P is

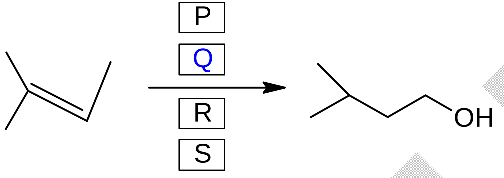
33. Number of correct statement(s) is/are

1. Chlorofluorocarbons are responsible for ozone layer depletion.
2. Green house effect is responsible for global warming.
3. Ozone layer does not permit infrared radiation from sun to reach the earth.
4. Acid rain is mostly because of oxides of nitrogen and sulphur.
5. Classical smog occurs in cool humid climate.
6. Classical smog is a mixture of smoke, fog and sulphur dioxide.
7. Classical smog is also called reducing smog.
8. Classical smog is also called oxidizing smog.
9. Ozone absorbs infrared radiations.
10. Ozone absorbs the intense ultraviolet radiations of the sun.

34. Choose the appropriate reagent sequence from the given reagent pool to complete the synthetic conversion. Make sure to use strictly four reagents, not more not less.

Note: You can simply mention the numerical values corresponding to the reagent in the boxes P, Q, R, S respectively and also consider major organic product in each step.

What is the value of [P + R + S – Q].

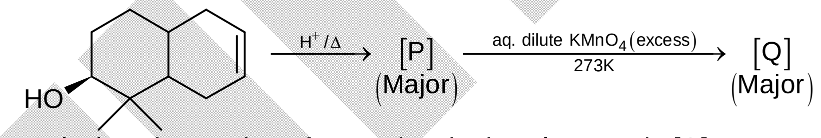


1. HBr
2. H^+ / H_2O
3. $Hg(OAc)_2 / H_2O$
4. $BH_3.THF$
5. EtONa / EtOH / Δ
6. HBr / ROOR / Δ
7. conc. H_2SO_4 / Δ
8. $NaBH_4$
9. H_2O_2, aq. NaOH
10. t – BuOK / Δ

35. [A] is a monomer of natural rubber, on reaction with HBr (1 eq)/CCl_4 at 298 K, it forms major product [B].

The number of allylic hydrogen of [A] is x and that of [B] is y, the value of (y – x)?

36.



Calculate the number of secondary hydroxyl groups in [Q]

Mathematics

PART – III

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

37. In a triangle ABC let a, b, c denote the length of the sides BC, AC and AB respectively, if $8(b^2 + c^2) = 65a^2$, then the value of $\frac{\cot A}{\cot B + \cot C}$ is equal to

(A) $\frac{57}{16}$
(B) $\frac{53}{8}$
(C) $\frac{57}{8}$
(D) $\frac{59}{16}$

38. Three circles C_1, C_2, C_3 with radii r_1, r_2, r_3 ($r_1 < r_2 < r_3$) respectively are given as $r_1 = 4$ and $r_3 = 9$. They are placed such that C_2 lies to the right of C_1 and touches it externally, C_3 lies to the right of C_2 and touches it externally. There exists two straight lines each of which is a direct common tangent simultaneously to all three circles, then r_2 is equal to

(A) $\frac{13}{2}$
(B) 6
(C) $\frac{72}{13}$
(D) 7

39. Consider the ellipse $E = 9x^2 + 25y^2 = 225$ with foci S and S_1 where S lies on positive x-axis. Let the locus of the image of S with respect to any tangent to the ellipse be the curve C.
If the line $ky - 2x + 22 = 0$ touches the curve C, then k is equal to

(A) ± 1
(B) $\pm\sqrt{3}$
(C) $\pm\sqrt{5}$
(D) $\pm 4\sqrt{2}$

40. Let A and B be two distinct points on the parabola $y^2 = 8x$ such that a circle with AB as diameter passes through the vertex of the parabola. Tangents at A and B to the parabola intersect at point C. Another pair of tangents are drawn from point C to the parabola $y^2 = kx$. If angle between these tangents is 90°, then k is equal to

(A) 1
(B) 2
(C) 32
(D) 16

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

41. Let $f(n) = \sum_{k=1}^{n} \cos\left(\frac{2k\pi}{7}\right)$ and $g(m) = \sum_{k=1}^{m} \cos\left(\frac{2^k \pi}{7}\right)$, then which of the following is/are CORRECT?

(A) f(3) = g(3)
(B) 2f(3) = f(6)
(C) 2g(3) = g(6)
(D) f(8) = g(8)

42. Consider a circle whose radius is 2 and centre is origin. Tangents are drawn from a point $P(\alpha, 2)$ which touches the circle at $A(a_1, a_2)$ and $B(b_1, b_2)$. Another pair of tangents are drawn from the point $Q(\beta, -2)$ which touches the circle at $A(a_1, a_2)$ and $C(c_1, c_2)$. Then which of the following is/are CORRECT? ($\alpha, \beta > 0$)

(A) $b_1 + b_2 + c_1 + c_2 = 0$
(B) $\alpha\beta = 4$
(C) If $\alpha = 4$, then $4a_2 + 3a_1 = 0$
(D) If $\alpha = \beta$, then $a_2 = 0$

43. Consider a parabola P : $x^2 = 4ky$ and a circle C : $x^2 + y^2 - 2\alpha x + 6y + 9 = 0$ (where $\alpha > 0$). The line of shortest distance between them cuts the parabola P at the end point of latus rectum in first quadrant, then which of the following is/are TRUE?

(A) If $k = 1$, then $\alpha = 6$
(B) If $k = 1$, then $\alpha = -6$
(C) If $k = 2$, then $\alpha = 12$
(D) If $\alpha = 20$, then $k = \frac{17}{3}$

44. In a ΔPQR, let p, q, r denote the length of the sides opposite to angles P, Q and R respectively, let s be the semiperimeter. If $s - p = \frac{s-q}{4} = \frac{s-r}{6}$ and area of the circumcircle of the triangle PQR is $\frac{175}{4\sqrt{66}}$, then which of the following is/are CORRECT?

(A) Area of triangle PQR is $4\sqrt{66}$
(B) Radius of incircle of triangle PQR is $2\sqrt{\frac{6}{11}}$
(C) $\sin\frac{P}{2}\sin\frac{Q}{2}\sin\frac{R}{2} = \frac{12}{175}$
(D) Radius of the excircle opposite to vertex P is $\frac{\sqrt{66}}{5}$

45. Define the collections $\{E_1, E_2, E_3, ...\}$ of ellipse and $\{R_1, R_2, R_3, ...\}$ of rectangles as follows:
$E_1 : x^2 + 4y^2 = 32$
R_1 : rectangle of largest area with sides parallel to the axes, inscribed in E_1
E_n : ellipse $\frac{x^2}{a_n^2} + \frac{y^2}{b_n^2} = 1$ of largest area inscribed in R_{n-1}, $n > 1$
R_n : rectangle of largest area with sides parallel to axes, inscribed in E_n, $n > 1$.
Then which of the following options is/are CORRECT?

(A) $\sum_{n=1}^{N}\left(\text{area of } R_n\right) < 64$ for each positive integer N
(B) The ratio of eccentricities of E_{10} and E_{12} is 1 : 4
(C) The length of major axis of E_6 is 2
(D) The length of diagonal of R_6 is $\frac{\sqrt{5}}{2}$

46. Let the vertex P of ΔPQR move on the curve $xy = 4$. If the perpendicular bisectors of side PQ and PR are given by $y = 0$ and $x - y = 0$, then which of the following is/are CORRECT?

(A) Locus of centroid of ΔPQR is $9xy = 18y^2 + 4$
(B) Locus of centroid ΔPQR is $9xy = 18x^2 + 4$
(C) Locus of orthocentre of ΔPQR is $xy = 2y^2 + 4$
(D) Circumcentre of ΔPQR is origin

Section – B (Maximum Marks: 24)

This section contains ***EIGHT (08)*** *numerical based questions. The answer to each question is a* ***Single Digit Integer, ranging from 0 to 9 both inclusive.***

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47. $f(\theta) = \sin^3\theta + \frac{1}{3}\sin^3(3\theta) + \frac{1}{9}\sin^3 9\theta + \frac{1}{27}\sin^3 27\theta + ...$ upto 10 terms, then

$4f(\theta) = k\sin\theta - \frac{\sin 3^m\theta}{3^n}$, then k + n – m is

48. Consider the ellipse $E: \frac{x^2}{25} + \frac{y^2}{9} = 1$. Tangents are drawn at the ends points of a double ordinate passing through (c, 0) (where $5 < c < 5$). The tangents intersect at G. If $\Delta(c)$ = area of ΔEFG, then for $1 \le c \le 3$ if minimum value of $\Delta(c)$ is k, then $\frac{5k}{8}$ is equal to

49. In a triangle PQR, $\angle P = 54°$, $\angle R = 18°$. If S is a point on PR such that area of triangle PSQ is $\left(\sqrt{5} - 1\right)$ times the area of triangle RSQ, then ratio of angle $\angle PQS : \angle RQS$ is

50. A circle with centre (6, 12) and of variable radius cuts the hyperbola $x^2 - y^2 = 144$ at the points A, B, C and D. If the locus of the centroid of the ΔABC is $(x - \alpha)^2 - (y - \beta)^2 = \gamma^2$, then $|\alpha + \beta - \gamma|$ is equal to

51. Consider the parabola $y^2 = 4x$ and hyperbola $\frac{x^2}{9} - \frac{y^2}{16} = 1$. Tangents are drawn from a point P to the parabola $y^2 = 4x$, the chord of contact of these tangents touches the hyperbola $\frac{x^2}{9} - \frac{y^2}{16} = 1$. The locus of point P is a conic whose eccentricity is e, then $4e^2$ is equal to

52. An equilateral triangle ABC is inscribed in the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$. If the eccentric angles of the vertices of triangle ABC are α, β, γ respectively and the circumcentre of triangle ABC lies on the ellipse $\frac{9x^2}{7a^2} + \frac{9y^2}{7b^2} = 1$, then the value of

$\cos\alpha\cos\beta + \cos\beta\cos\gamma + \cos\gamma\cos\alpha + \sin\alpha\sin\beta + \sin\beta\sin\gamma + \sin\gamma\sin\alpha$ is equal to

53. Let the director circle of the hyperbola $H: \frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ be denoted by C_1 and let director circle of the ellipse $E: \frac{x^2}{a^2} + \frac{y^2}{b^2} = \frac{1}{3}$ be denoted C_2. If the circle C_2 is also the director circle of C_1 and let e_1 and e_2 be the eccentricities of the ellipse E and hyperbola H, then $\frac{e_2^2}{e_1^2}$ is equal to (a > b)

54. Let a, b, c denote the lengths of the sides opposite to A, B and C in triangle ABC.
If $2a^2 + 4b^2 + 9c^2 = 4ab + 6ac$, then $\cos B = \frac{p}{k}$ (where p and k are coprime), then p – k is equal to

FIITJEE
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JEE (Advanced)-2023
PART TEST – II
PAPER –1
TEST DATE: 11-12-2022

ANSWERS, HINTS & SOLUTIONS

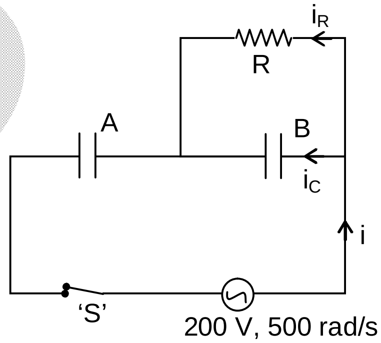
Physics

PART – I

Section – A

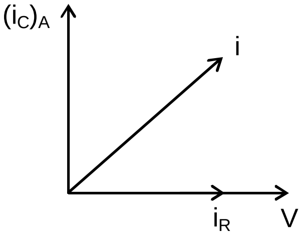
1. A, C, D

Sol. $x_C = \frac{1}{\omega_C} = 2000\Omega$ …(i)



$i^2 = \left(i_C\right)_A^2 + \left(i_R\right)^2$

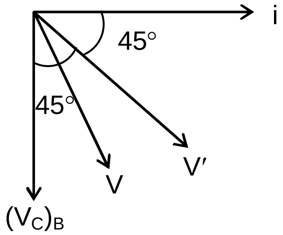
$z' = 1000\sqrt{2}$ …(ii)



$V^2 = (V_C)_B^2 + (V')^2 + 2V_C \cdot V' \cos 45°$

$z = \sqrt{10} \cdot (10)^3$ …(iii)

$i = \frac{200}{\sqrt{10} \times 10^3} = \frac{1}{5\sqrt{10}}$



$i_R = i\cos 45°$

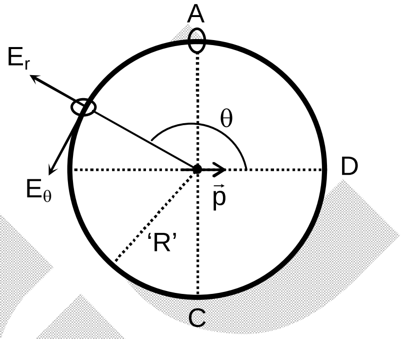
$(i_C)_A = i\cos 45°$

$$\tan\alpha = \frac{V'\sin 45^\circ}{(V_C)_B + V'\cos 45^\circ} = \frac{1}{3} \qquad \ldots\text{(iv)}$$

$$\text{Power} = i^2R = \left(\frac{1}{5\sqrt{20}}\right)^2 \cdot 2000 = 4\ \text{W}$$

2. A, C, D

Sol.



$$E_r = \frac{2kp\cos\theta}{r^3}$$

$$E_\theta = \frac{kp\sin\theta}{r^3}$$

From conservation of energy at A and E.

$$0 + 0 = \frac{1}{2}mv^2 + \frac{(kp\cos\theta)q}{r^2}$$

$$v = \sqrt{\frac{-2kp(\cos\theta)q}{mr^2}} = \sqrt{\frac{-p(\cos\theta)q}{2\pi\varepsilon_0 mr^2}}$$

3. A, B, C

Sol. Since piston more very slowly so they are at equilibrium at each instant

Above separately wall $P_1 = P_0 + \frac{mg}{A}$

Below separately wall $P_2 = P_0 - \frac{mg}{A}$

$\Delta Q = 0$

$W + \Delta U = 0$

$W = -\Delta U = -nC_V\Delta T$

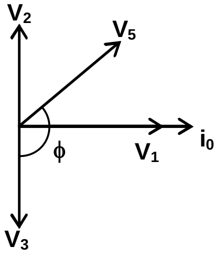
$$P_2V_2 - P_1V_1 = -n\frac{f}{2}R(T_2 - T_1) = \frac{f}{2}\left[nRT_1 - nRT_2\right] = \frac{f}{2}\left[P_1V_1 - P_2V_2\right]$$

$$\left(1 + \frac{f}{2}\right)P_2V_2 = \left(1 + \frac{f}{2}\right)P_1V_1$$

$P_1V_1 = P_2V_2$, So, $T_1 = T_2$

4. A, C, D

Sol.



$$e = e_1 + e_2 = 200\sin\left(\omega t + \frac{\pi}{2}\right)$$

e_0 = 200 volt

$$v_5 = \frac{200}{\sqrt{2}} = 100\sqrt{2}$$

$$z = \sqrt{(500)^2 + (500)^2} = 500\sqrt{2}$$

$$i_{rms} = \frac{100\sqrt{2}}{500\sqrt{2}} = \frac{1}{5}$$

$$V_1 = 500 \times \frac{1}{5} = 100\ \text{volt}$$

$$V_2 = 900 \times \frac{1}{5} = 180\ \text{volt}$$

$$V_3 = 400 \times \frac{1}{5} = 80\text{ volt}$$

$$V_4 = V_2 - V_3 = 100\text{ volt}$$

$$\phi = \frac{\pi}{2} + \tan^{-1}\left(\frac{9}{5}\right)$$

5. A, C, D

Sol. $i = \dfrac{|E_1 + E_2 - E_3 - E_4|}{r_1 + r_2 + r_3 + r_4}$

6. B, C

Sol. $dV = \left(\vec{v} \times \vec{B}\right).d\vec{\ell}$

So potential difference across OA is zero

$\Rightarrow$ Potential difference across OB = $\frac{1}{2}B_0\omega\left(\sqrt{2}OA\right)^2 = \frac{1}{2}(100)(5)2(0.2)^2$ = 20 Volt.

So potential difference across AB is also 20 Volt.

7. A

Sol. μ = iA = 0.0550

$\tau = \vec{\mu} \times \vec{B} = 0.0055$

$|\tau|$ = Iα

α = 0.0440

From conservation of energy

$U_i + K_i = U_f + K_f$

$K_f = -U_f = 0.4400$

8. B

Sol. $\tau = \dfrac{1}{\dfrac{6 \times 12}{6 + 12} + \dfrac{18 \times 24}{18 + 24}} = 0.07$

$\Rightarrow$ At steady state

$$R_{eq} = \frac{25}{2}$$

Current through battery = 2 ampere

Current through inductor = 1/6 ampere

$\Rightarrow$ At one time constant

Current through inductor = $0.63 \times \frac{1}{6} = 0.105$ ampere

From KVL, current through 12Ω = 1.353 ampere

$\Rightarrow$ For part (iv) after switching

$\frac{1}{6}L = i_L(L + 2L)$

$i_L = \frac{1}{18} = 0.056$ ampere

9. C

Sol. A → B

TP^2 = constant

$PV^{1/3}$ = constant

$$W_{A\to B} = \frac{P_1V_1 - P_2V_2}{x-1} = \frac{nR(T_1 - T_2)}{x-1} = -\frac{9}{2}nRT_0$$

$$\Delta U_{A\to B} = -3nRT_0$$

$$\Delta Q_{A\to B} = -\frac{15}{2}nRT_0$$

$C \to A$

$TP^4 = \text{constant}$

$PV^{1/5} = \text{constant}$

$$W_{C\to A} = \frac{nR(T_1 - T_2)}{x-1} = \frac{15}{4}nRT_0$$

$\Delta U_{C\to A} = nR(T_A - T_C) > 0$

$\Delta Q_{C\to A} > 0$

$B \to C$

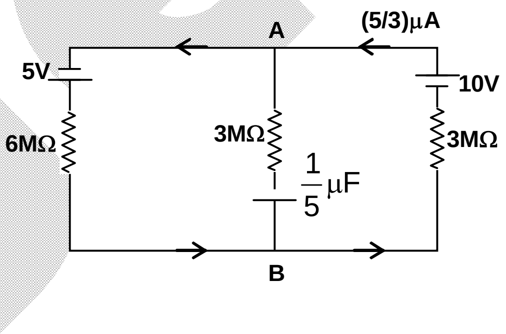
$\Delta U = 0$

$W_{B\to C} > 0$

$\Delta Q_{B\to C} > 0$

10. D

Sol. For τ:



$$R_{eq} = \frac{6\times 3}{6+3} + 3 = 5\ M\Omega$$

$$\tau = 5\times\frac{1}{5} = 1\text{ sec}$$

$\Rightarrow$ For q_{max} at steady state

Current passing through 10 V battery = $\frac{5}{3}\mu A$

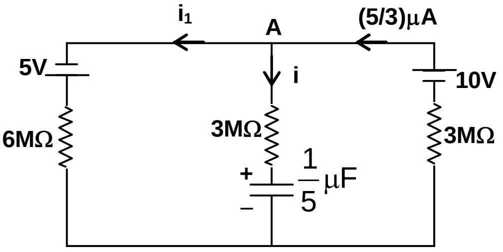
$$V_A + 5 - \frac{5}{3}\times 6 = V_B$$

$V_A - V_B = 5V$

$q_{max} = 1\mu C$

$\Rightarrow$ At time t = 1sec

$q = 1\left(1 - e^{-t}\right) = 0.63\ \mu C$



$$i = \frac{dq}{dt} = e^{-t} = 0.31\ \mu amp$$

From KVL

$$\frac{0.63}{1/5} + (0.37)3 + 5 - i_1(6) = 0$$

μ = 1.54 μA

Section – B

11. 1.50

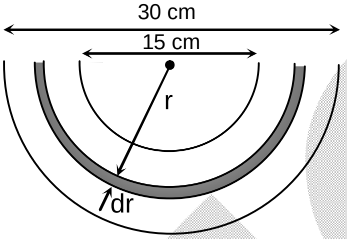
Sol. $$v_{rms}^2 = \frac{\int v^2 dN}{\int dN} = \frac{\int v^2 \frac{dN}{dv}dv}{\int \frac{dN}{dv}dv}$$

$$= \frac{\int_0^3 v^2\left(-\frac{5}{3}v+5\right)dv}{\int_0^3\left(-\frac{5}{3}v+5\right)dv} = 1.50$$

12. 6.93

Sol. $dR = \frac{\rho dr}{\pi r \ell}$

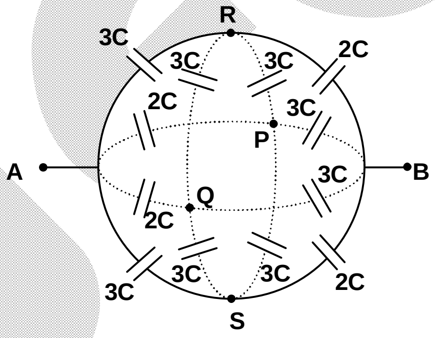
$$R = \frac{\rho}{\pi\ell}\int\frac{dr}{r} = \frac{\rho}{\pi\ell}\ell n2 = 6.93\,\Omega$$



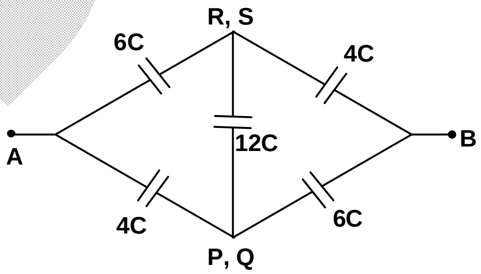
13. 2.10

Sol. P& Q and R & S are equipotential

$$C_{AB} = \frac{2(6C)(4C)+(6C)(12C)+(4C)(12C)}{6C+4C+2(12C)} = \frac{84}{17}C$$



Heat generated = $\frac{1}{2}(C_{AB})V_0^2 = 2.10\ \mu J$



14. 20.30

Sol. Let final pressure on both side of W_2 is P'

$$P'\left(\frac{V_0}{6}\right)^{\gamma} = P_0\left(\frac{5V_0}{6}\right)^{\gamma}$$

$$P' = 5\sqrt{5}P_0$$

$$\text{Work done by gas} = \frac{5\sqrt{5}P_0\left(\frac{V_0}{6}\right) - P_0\left(\frac{5V_0}{6}\right)}{\gamma-1} = \frac{5P_0V_0}{3}(\sqrt{5}-1)$$

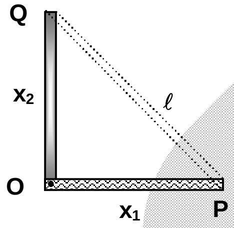
$$\Delta U = nC_V\Delta T = n\left(\frac{R}{\gamma-1}\right)\Delta T = 2nR\Delta T$$

$$= 2\left(P'\frac{5V_0}{6} - P_0\frac{V_0}{6}\right) = 2\left(\frac{5\sqrt{5}P_0 5V_0}{6} - \frac{P_0V_0}{6}\right)$$

$$= \frac{P_0V_0}{3}(25\sqrt{5}-1)$$

$$\Delta Q = \Delta U + W = 2P_0V_9(5\sqrt{5}-1) = 20.3\ P_0V_0$$

15. 1.75



Sol. $\ell^2 = x_1^2 + x_2^2$

$$2\ell\frac{d\ell}{dt} = 2x_1\frac{dx_1}{dt} + 2x_2\frac{dx_2}{dt}$$

$$\ell^2\left[\frac{1}{\ell}\frac{d\ell}{dt}\right] = x_1^2\left(\frac{1}{x_1}\frac{dx_1}{dt}\right) + x_2^2\left(\frac{1}{x_2}\frac{dx_2}{dt}\right)$$

$$\ell^2(\alpha_{PQ}) = x_1^2(\alpha_{PO}) + x_2^2(\alpha_{QO})$$

$$\alpha_{PQ} = \frac{\alpha_{PO}x_1^2 + \alpha_{QO}x_2^2}{x_1^2 + x_2^2} = 1.7538\times10^{-5}\ /°C$$

16. 1.40

Sol. In first case

$N = mg + iB\ell$

$F_1 = \mu(mg + iB\ell)$

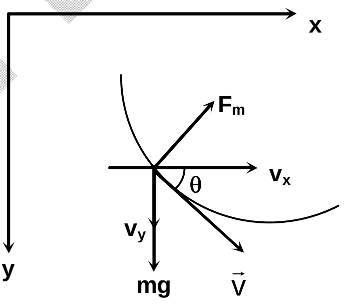
In second case

$N = mg - iB\ell$

$F_2 = \mu(mg - iB\ell)$

$$\frac{F_1}{F_2} = 1.40$$

17. 0.05



Sol. $mg - qBv_x = m\frac{dv_y}{dt}$

$$qBv_y = m\frac{dv_x}{dt}$$

Differentiate equation (i) with respect to time

$$0 - qB\frac{dv_x}{dt} = m\frac{d^2v_y}{dt^2}$$

$$\frac{d^2v_y}{dt^2} = -\frac{q^2B^2}{m^2}v_y = -\omega^2v_y$$

Solution of equation

$v_y = (v_y)_0\sin\omega t$

$$\frac{dv_y}{dt} = (v_y)_0\,\omega\cos\omega t$$

at t = 0, $\frac{dv_y}{dt} = g$, so $(v_y)_0 = \frac{g}{\omega}$

Now form equation (i)

$$v_x = \frac{mg}{qB}(1-\cos\omega t)$$

So, $v_y = 0$, at $\omega t = \pi$, $t = \frac{\pi}{\omega}$

$$v_x = \frac{mg}{qB}\left[1-(-1)\right] = \frac{2mg}{qB}$$

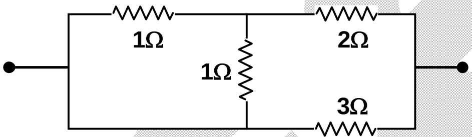
From work energy theorem

$$mgy = \frac{1}{2}mv_x^2$$

$$y = \frac{2m^2g}{q^2B^2} = 0.05 \text{ meter}$$

18. 0.08

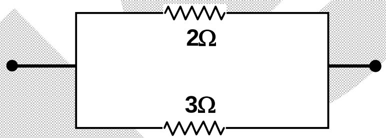
Sol. In first case



$$R_{eq} = \frac{\frac{5}{2}\times 3}{\frac{5}{2}+3} = \frac{15}{11}\Omega$$

$$i_1 = \frac{V_0}{15/11} = \frac{11}{15}V_0$$

In second case



$$R_{eq} = \frac{2\times 3}{2+3} = \frac{6}{5}\Omega$$

$$i_2 = \frac{V_0}{6/5} = \frac{5}{6}V_0$$

$$\frac{i_1}{i_2} = \frac{22}{25}$$

Chemistry

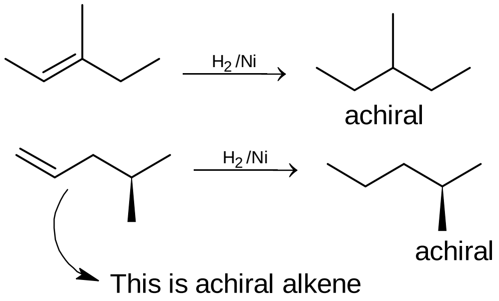
PART – II

Section – A

19. B, C

Sol. Alkene [K] has $8\alpha-$Hydrogens.

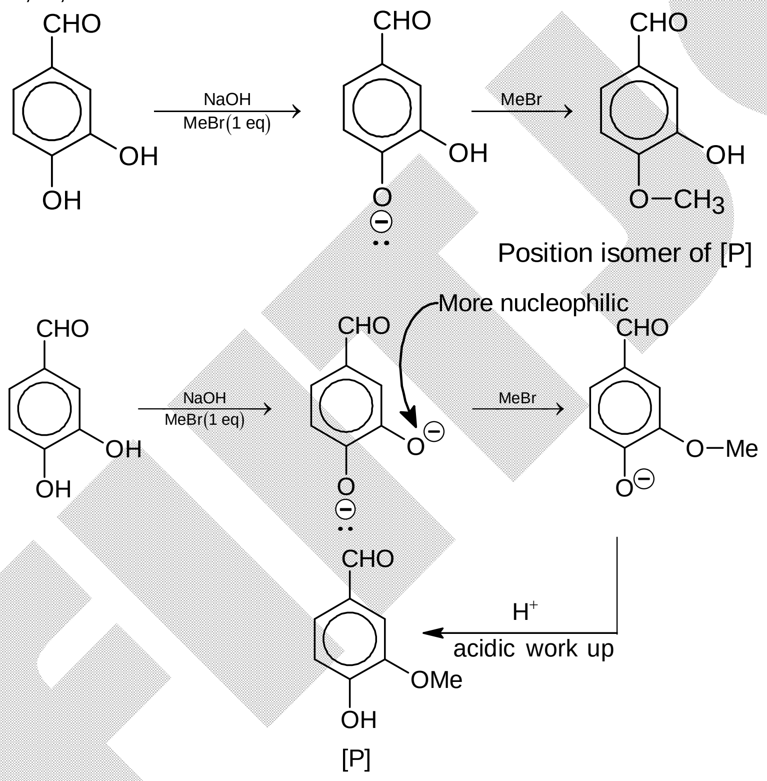
Alkene [L] has $2\alpha-$Hydrogens.



H_2/Ni
achiral
H_2/Ni
achiral
This is achiral alkene

20. B, C, D

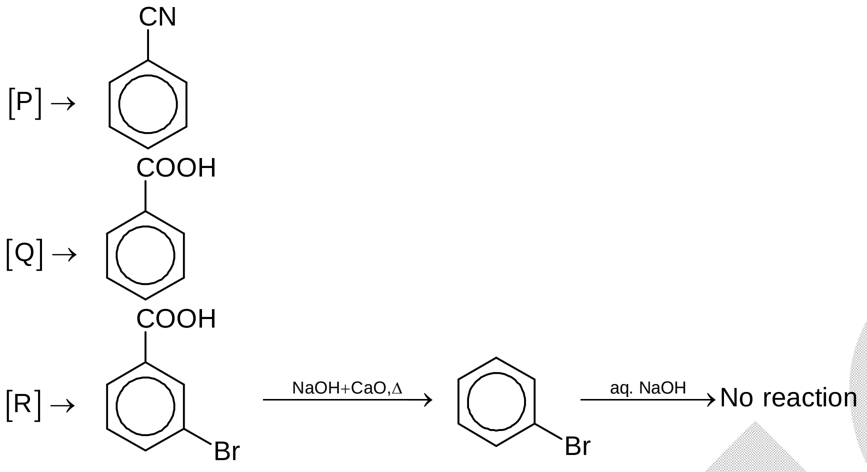
Sol.



CHO
OH
OH
NaOH
MeBr(1 eq)
CHO
OH
O
MeBr
CHO
OH
O–CH$_3$
Position isomer of [P]
More nucleophilic
CHO
OH
OH
NaOH
MeBr(1 eq)
CHO
O
O
MeBr
CHO
O–Me
O
H$^+$
acidic work up
CHO
OMe
OH
[P]

21. B, C, D

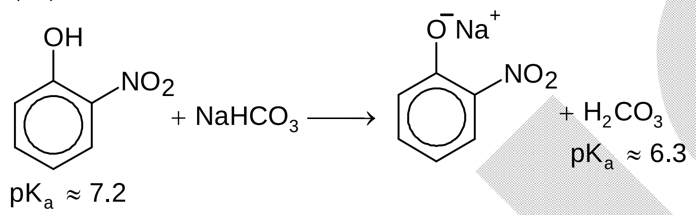
Sol.



[P] →
CN
[Q] →
COOH
[R] →
COOH
Br
NaOH+CaO,Δ
Br
aq. NaOH
No reaction

22. A, B, D

Sol.

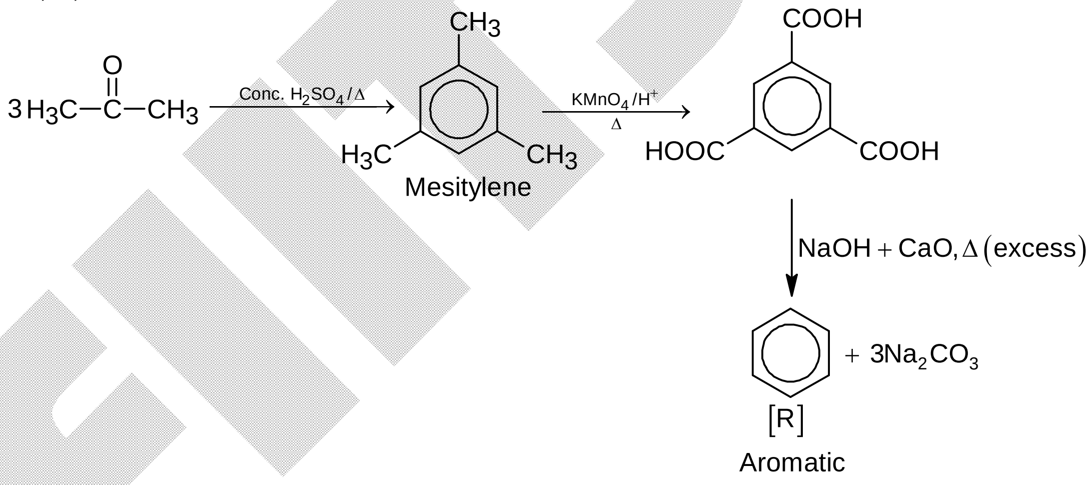


OH
NO2
+ NaHCO3
O⁻Na⁺
NO2
+ H2CO3
pKa ≈ 6.3
pKa ≈ 7.2

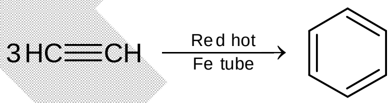
As H_2CO_3 is more acidic than o-nitrophenol, so forward reaction is not possible.

23. A, B, D

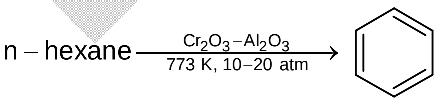
Sol.



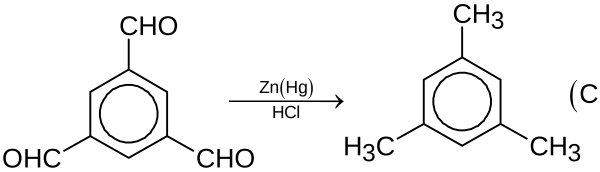
3 H3C—C(=O)—CH3
Conc. H2SO4/Δ
CH3
H3C
CH3
Mesitylene
KMnO4/H+
Δ
COOH
HOOC
COOH
NaOH + CaO, Δ (excess)
+ 3Na2CO3
[R]
Aromatic



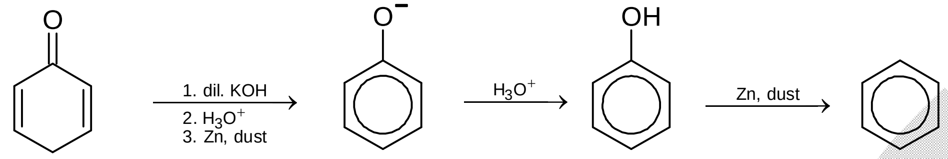
3 HC≡CH
Red hot
Fe tube



n – hexane
Cr2O3–Al2O3
773 K, 10–20 atm

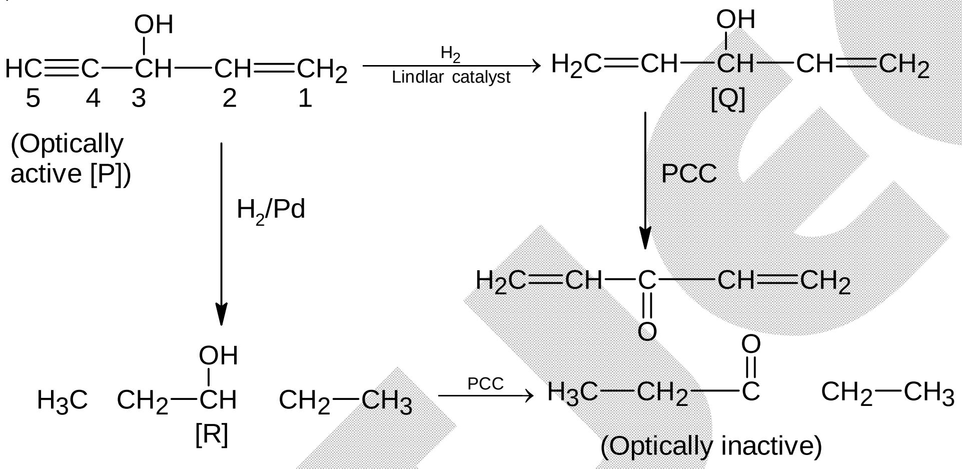

CHO
OHC
CHO
Zn(Hg)
HCl
CH3
H3C
CH3

(Clemmensen reduction)


O
1. dil. KOH
2. H3O+
3. Zn, dust
O−
H3O+
OH
Zn, dust

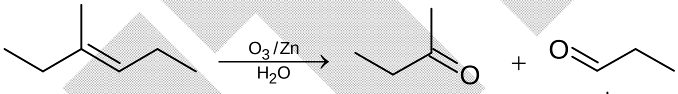
24. C, D

Sol.

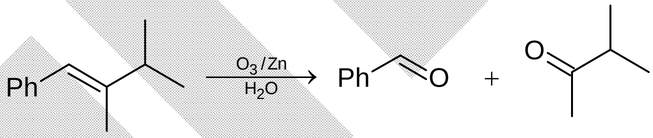

OH
HC≡C—CH—CH=CH2
5 4 3 2 1
(Optically active [P])
H2
Lindlar catalyst
OH
H2C=CH—CH—CH=CH2
[Q]
PCC
H2/Pd
H2C=CH—C—CH=CH2
O
OH
H3C CH2—CH CH2—CH3
[R]
PCC
O
H3C—CH2—C CH2—CH3
(Optically inactive)

25. B

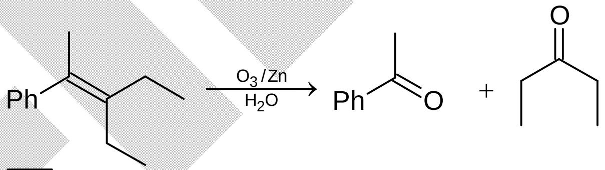
Sol. (I)



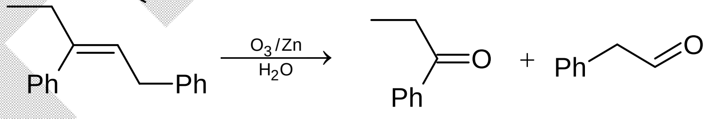
(II)


Ph
O3/Zn
H2O
Ph
O
+
O

(III)

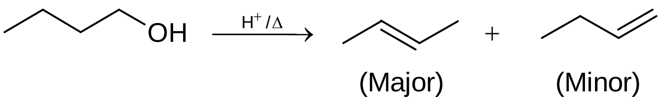

Ph
O3/Zn
H2O
Ph
O
+
O

(IV)

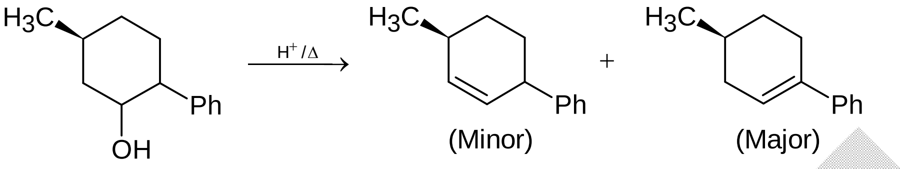

Ph
Ph
O3/Zn
H2O
O
Ph
+
Ph
O

26. D

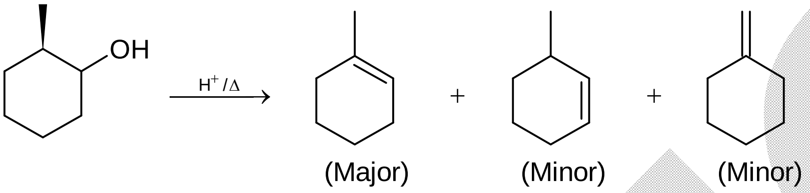
Sol. (I)


OH
H+ / Δ
(Major)
(Minor)

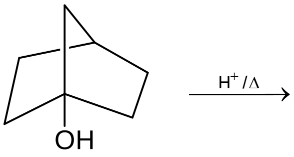
(II)


H3C
Ph
OH
H+ / Δ
H3C
Ph
(Minor)
H3C
Ph
(Major)

(III)


OH
H+ / Δ
(Major)
(Minor)
(Minor)

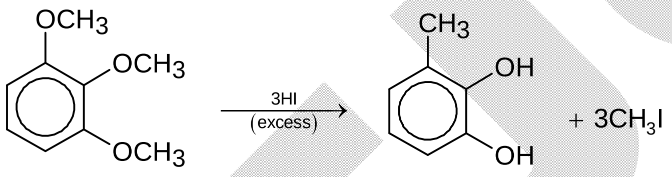
(IV)



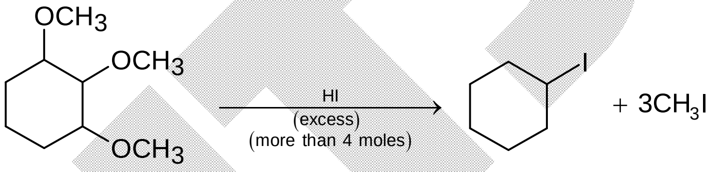
cannot undergo dehydration as bridge head C-atom can never be sp^2-hybridised.

27. D

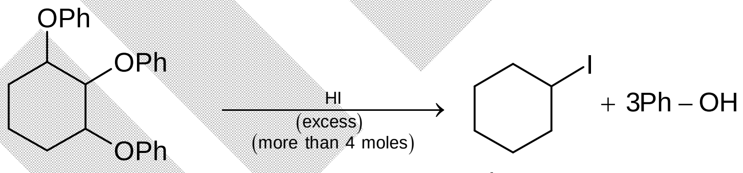
Sol. (I)


OCH3
OCH3
OCH3
3HI
(excess)
CH3
OH
OH
+ 3CH3I

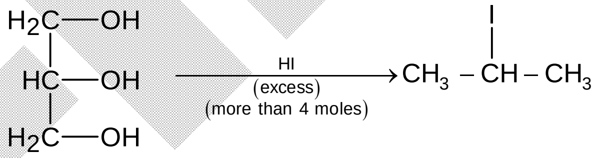
(II)


OCH3
OCH3
OCH3
HI
(excess)
(more than 4 moles)
I
+ 3CH3I

(III)


OPh
OPh
OPh
HI
(excess)
(more than 4 moles)
I
+ 3Ph – OH

(IV)


H2C—OH
HC—OH
H2C—OH
HI
(excess)
(more than 4 moles)
I
CH3 – CH – CH3

28. D

Sol. Sucrose $\xrightarrow{\text{Hydrolysis}}$ α – D – glucose + β-D-fructose

Lactose $\xrightarrow{\text{Hydrolysis}}$ β – D – glucose + β-D-galactose

Amylose $\xrightarrow{\text{Hydrolysis}}$ α – D – glucose + α-D-glucose+.....

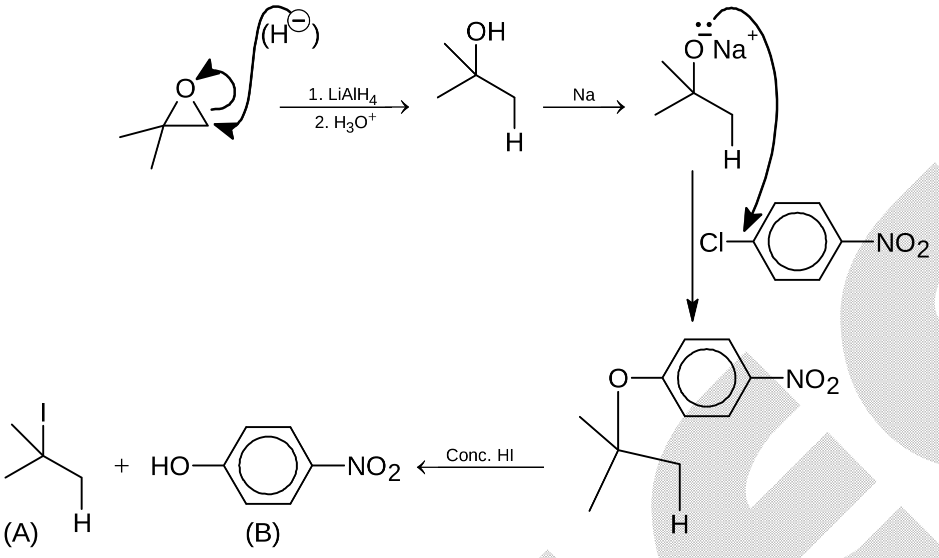
Mannose cannot be hydrolysed.

Lactose and mannose can reduce Fehling's solution due to presence of hemiacetal and aldehyde group.

Section – B

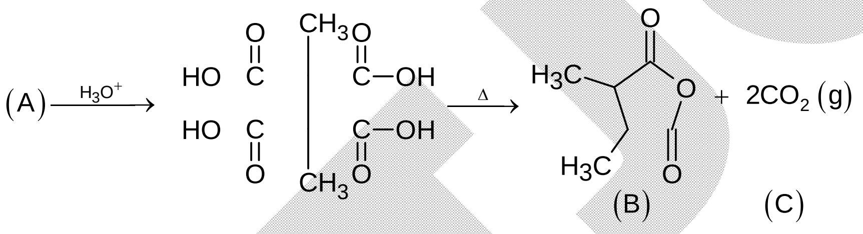
29. 0.50

Sol.


$(H^{\ominus})$
1. $LiAlH_4$
2. H_3O^+
OH
H
Na
$O^-\,Na^+$
H
Cl
NO_2
O
NO_2
H
Conc. HI
I
H
+ HO
NO_2
(A)
(B)

30. 4.40

Sol.


(A)
H_3O^+
HO
HO
O
C
C
O
CH_3
CH_3
O
C—OH
C—OH
O
Δ
H_3C
O
O
H_3C
O
+ $2CO_2(g)$
(B)
(C)

$0.1\,\text{mol A} \rightarrow 0.2\text{ mol C}$

$n_C = 0.2$

$w_C = 0.2 \times 44\,(g) = 8.8\,(g) = x$

$\frac{x}{2} = 4.40$ grams.

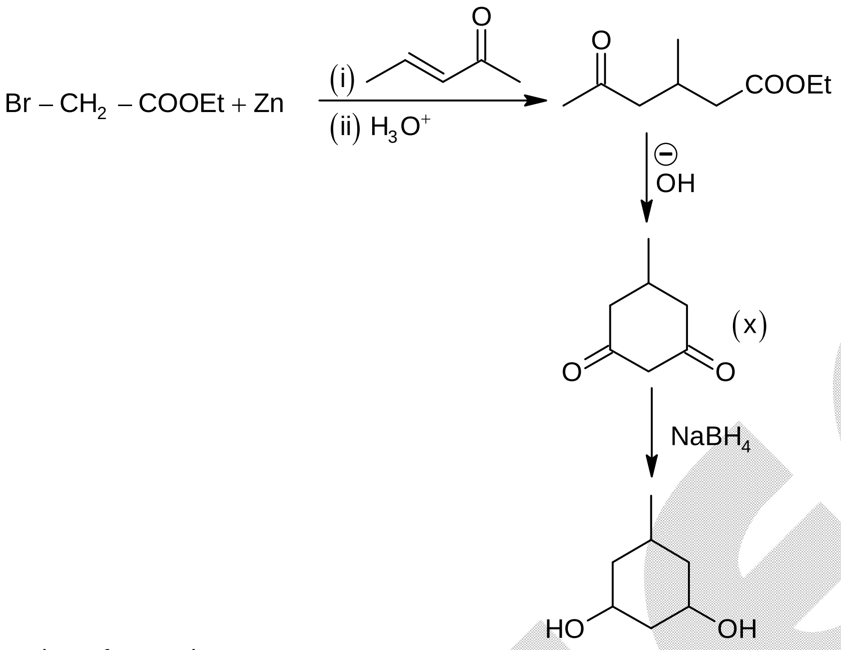
31. 3.50

Sol. 'A' is $CH_3-CH=C=CH-CH_3$, optically active with minimum weight.

$\therefore x = 5,\ y = 2$.

32. 40.00

Sol.



Number of stereoisomers = 4.

33. 2.00

Sol.

$n = 1$, $C_2H_3Br_1$ (No stereoisomer)

$n = 2$, $C_2H_2Br_2$ (Two geometrical isomers)

$n = 3$, C_3HBr_3 (No stereoisomer)

$n = 4$, C_2Br_4 (No stereoisomer)

34. 1.20

Sol. Co-polymer are Nylon-6,6, Buna-N, Dacron, Buna-S, PHBV. So, X = 5.

Mutarotation is shown by $\alpha - D - G$, $\beta - D - G$, Lactose, $\alpha - D - F$, $\beta - D - F$, Maltose .

So, Y = 6.

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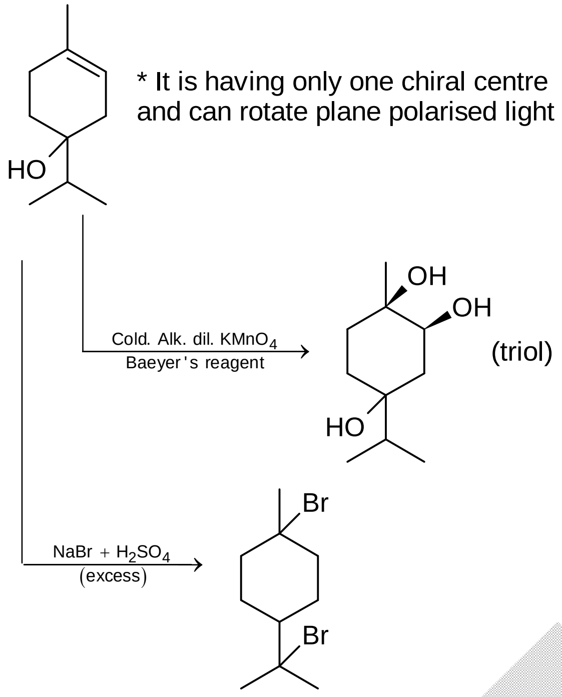
35. 1.23

Sol.


HO
Cold. Alk. dil. KMnO$_4$
Baeyer's reagent
OH
OH
HO
(triol)
NaBr + H$_2$SO$_4$
(excess)
Br
Br

* It is having only one chiral centre and can rotate plane polarised light

36. [18.95 – 18.99]

Sol. Aqueous tension at 287 K = 14 mm of Hg.

Hence, actual pressure = (758 – 14) = 744 mm of Hg.

$$\text{Number of moles of } N_2 = \frac{744 \times 30 \times 10^{-2}}{760 \times 0.0821 \times 287}$$

$$= 1.246 \times 10^{-3} \text{ mol}$$

$$\text{Mass of } N_2 = 1.246 \times 10^{-3} \times 28$$

$$= 34.888 \times 10^{-3} \text{ g}$$

$$\% \text{ mass } = \frac{34.888 \times 10^{-3}}{0.184} \times 100$$

= 18.96%

Mathematics PART – III

Section – A

37. C, D

Sol. Consider $(x_1, y_1) \equiv (2at, at^2) \Rightarrow$ Equation of tangent $\equiv tx = y + at^2$

$\Rightarrow$ COC w.r.t $(\lambda, t\lambda - at^2)$ is $\lambda(x + ty) - (at^2y + 4a^2) = 0$

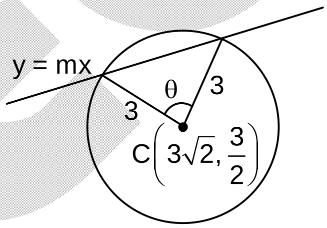
$\Rightarrow (x_2, y_2) \equiv \left(\frac{4a}{t}, -\frac{4a}{t^2}\right)$

38. A, B

Sol. Here, $\cos\theta = \sqrt{\frac{1}{e_1^2} + \frac{1}{e_2^2} - \frac{1}{e_1^2e_2^2}}$

39. B, C

Sol. $$\Rightarrow \frac{\left(\frac{\pi(3)^2}{2\pi}\cdot\theta - \frac{1}{2}(3)^2\sin\theta\right)}{\pi(3)^2 - \left(\frac{\pi(3)^2}{2\pi}\cdot\theta - \frac{1}{2}(3)^2\sin\theta\right)} = \frac{\left(2\pi - 3\sqrt{3}\right)}{\left(10\pi + 3\sqrt{3}\right)}$$



$\theta = \frac{\pi}{3}$ satisfies this $\Rightarrow m = -\frac{\sqrt{2}}{5}$ or $\sqrt{2}$

40. C, D

Sol. Here, $\frac{\left(\alpha^2 + \beta^2\right)^a}{(\alpha\beta)^b}$ is independent of θ if 4a = 5b

41. A, D

Sol. Consider $4x^2 + pxy + 6y^2 = (y - m_1x)(y - m_2x)$, then $4x^2 + qxy - 6y^2 = \left(y + \frac{1}{m_1}x\right)(y - m_2x)$

Comparing, p = –10, q = –2 or p = 10, q = 2

42. A, B

Sol. Given expression = $\frac{(x + y)\left(x^2 + y^2\right)}{2}$

43. C

Sol. (I) Here, $x^2 = \sin^2\frac{\pi x}{2} = 1$

(II) $|\tan x| = (4x - \pi)^2 + 16$

(III) $x + y = 0$ or $x = 0 \Rightarrow (x, y) = \left(\pm\frac{1}{2}, \mp\frac{1}{2}\right)$, (0, ±1), (±1, 0)

(IV) The given equation becomes, $\frac{(\sin x)\left[(1+\cos x) + (1+\cos x)^2 + 3\cos^2 x\right]}{3} > 0$

$\Rightarrow x \in (0, \pi)$

44. B

Sol. (I) $\cos^{-1} x > 1 > \sin^{-1} x$
(II) $1 > \cos^{-1} x > \sin^{-1} x$
(III) $1 > \sin^{-1} x > \cos^{-1} x$
(IV) $\sin^{-1} x > 1 > \cos^{-1} x$

45. D

Sol. (I) The given parabolas are symmetric about the line y = x
(II) Area of the given triangle = x_0^3
(III) Probability (required) = $\frac{\pi a^2 - \pi ab}{\pi a^2} = \frac{2}{3} \Rightarrow a = 3b$
(IV) Here, roots are $1, \sqrt{2}, -\sqrt{2}$

46. B

Sol. (I) The two given families pass through A(2, 1) and B(19, –4) respectively
$\Rightarrow m_{OA} = \frac{1}{2}$, $m_{OB} = -\frac{4}{19} \Rightarrow$ Slope of $\perp$ lines are –2 and $\frac{19}{4} \Rightarrow \theta = \tan^{-1}\left(\frac{27}{34}\right)$
(II) Given family is always concurrent at $\left(-\frac{1}{6}, -\frac{7}{6}\right)$
(III) $AP^2 + AQ^2 + AR^2 + AS^2 = \frac{7}{4} + \frac{7}{4} + \frac{3}{4} + \frac{27}{4} = 11$
(IV) Given rays are $y = \frac{x}{2}$ and y = –2x ($\perp$) $\Rightarrow$ Required area = $\frac{4\pi - \pi}{4} = \frac{3\pi}{4}$

Section – B

47. 2.00

Sol. If A + B + C = π, then sin 2A + sin 2B + sin 2C = 4 sin A sin B sin C

48. 1011.00

Sol. $\frac{\cot A}{\cot B + \cot C} = \frac{\cos A \cdot \sin B \cdot \sin C}{\sin^2 A}$

49. 4.33

Sol. By the concept of homogenization, $\lambda = \frac{15}{2}$

50. 34937.00

Sol. Here, R(α, β) lies on PQ and midpoint of PR lies on AB
$\Rightarrow \alpha = \frac{23}{7}$, $\beta = \frac{31}{7}$

51. 20.00

Sol. The given ellipse is $(x-3)^2 + \frac{\left(y + \frac{1}{2}\right)^2}{\frac{1}{4}} = 1$

$\Rightarrow x = 3 + \cos\theta, y = -\frac{1}{2} + \frac{1}{2}\sin\theta \Rightarrow 8x - 12y \in [20, 40]$

52. 35.00

Sol. Required number of squares = $5^2 + 3^2 + 1^2 = 35$

53. 0.50

Sol. For $P(t_1)$, $Q(t_2)$, $R(t_3)$. Area of $\Delta PQR = |a^2(t_1 - t_2)(t_2 - t_3)(t_3 - t_1)|$

And area of $\Delta ABC = \frac{a^2}{2}\left|(t_1 - t_3)(t_2 - t_1)(t_2 - t_3)\right|$

54. 906.00

Sol. Here, cos x = 0, cos 3x = 0, cos 4x = 0, cos 5x = 0

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ALL INDIA TEST SERIES
JEE (Advanced)-2023
PART TEST – II
PAPER –2
TEST DATE: 11-12-2022

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

Section – A

1. C

Sol. $i = i_0\left(1 - e^{-t/\tau}\right)$

$$\frac{di}{dt} = \frac{i}{\tau}e^{-t/\tau}$$

$$U = \frac{1}{2}Li^2$$

$$\frac{dU}{dt} = \frac{1}{2}L\left(2i\frac{di}{dt}\right) = ke^{-t}(1 - e^{-t})$$

at t = 0, $\frac{dU}{dt} = 0$

$t \to \infty,\ \frac{du}{dt} = 0$

2. A

Sol. $dC = \frac{k\varepsilon_0 A}{dx}$

$$\frac{1}{C_{eV}} = \int \frac{1}{dC} = \int \frac{1}{k\varepsilon_0 A}dx$$

$$= \int_0^d \frac{1}{k_0 e^{\lambda x}\varepsilon_0 A}dx$$

$$C_{eq} = \frac{\lambda k_0 \varepsilon_0 A}{1 - e^{-\lambda d}}$$

3. B

Sol. $H = -kA\frac{d\theta}{dx}$

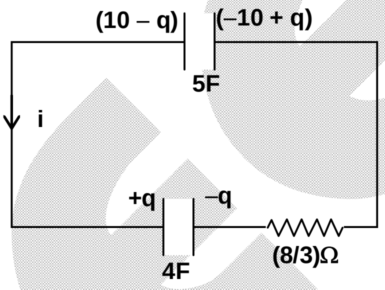
The heat current decreases from the end P and Q through the rod hence slope of (T-x) graph also decreases.

4. C

Sol. $U = \frac{kq_0(2q)}{\sqrt{z^2+2a^2}}$

5. A, B, D

Sol. At time 't'



$$-\frac{q}{4} - i\times\frac{8}{3} + \frac{10-q}{5} = 0$$

$$\int_0^q \frac{dq}{2-\frac{9}{20}q} = \int_0^t \frac{3}{8}dt$$

$$q = \frac{40}{9}\left[1-e^{-\frac{27}{160}t}\right],$$

$$\frac{dq}{dt} = i = \frac{3}{4}e^{-\frac{27}{160}t}$$

$$U_i = \frac{(10)^2}{2\times 5}$$

$$U_f = \frac{(40/9)^2}{2\times 4} + \frac{(50/9)^2}{2\times 5}$$

$$\Delta U = U_i - U_f = \frac{40}{9}J$$

6. B, C

Sol. Current in the circuit

$$i = \frac{5}{R+\frac{R}{2}} = \frac{20}{3R}$$

$\Rightarrow$ Potential drop across PS = iR = $\frac{20}{3}$V

Potential drop across SQ = $i\left(\frac{R}{2}\right)$ = $\frac{10}{3}$V

$\Rightarrow$ Potential q radiant for PS = $\frac{20/3}{5} = \frac{4}{3}$V/m

Potential q radiant for SQ = $\frac{10/3}{5} = \frac{2}{3}$V/m

$\Rightarrow$ Length required for 5V = $\frac{5}{4/3}$V= 3.75 m

Length required for 8V = $5 + \frac{8-\frac{20}{3}}{2/3} = 7\,m$

7. A, C

Sol. When charge particle is moved from ‘S’ to infinity then induced electric field is perpendicular to the displacement hence work done by external agent is zero.

From P to infinity

Work done = q(change in potential difference)

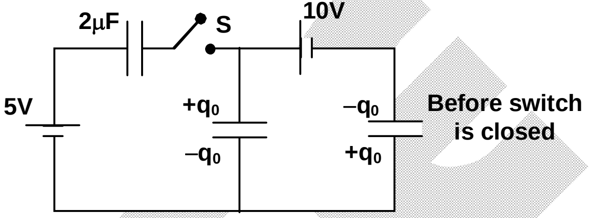
$$= q = \frac{\pi r^2}{4}\frac{dB}{dt} = \frac{55}{8}\mu J$$

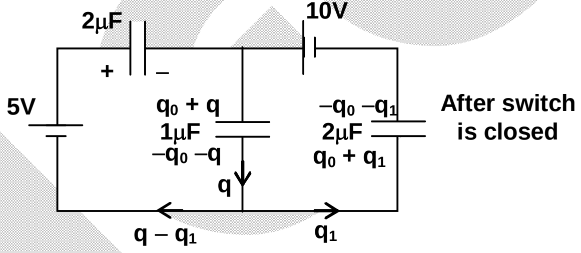
8. A, C, D

Sol. Before switch is closed

$$10 - q_0 - \frac{q_0}{2} = 0$$

$$q_0 = \frac{20}{3}\mu C$$





After switch is closed

From KVL,

$$5 - \frac{q - q_1}{2} - \frac{q_0 + q}{1} = 0$$

$$10 - \frac{q_0 + q}{1} - \frac{q_0 + q}{2} = 0$$

On solving,

$$q = -\frac{2}{3}\mu C,\ q_1 = \frac{4}{3}\mu C$$

$$U_i = \frac{1}{2}\frac{(20/3)^2}{1} + \frac{1}{2}\frac{(20/3)^2}{2} = \frac{100}{3}\mu J$$

$$U_f = \frac{1}{2}\frac{(6)^2}{1} + \frac{1}{2}\frac{(8)^2}{2} + \frac{1}{2}\frac{(2)^2}{2} = 35\ \mu J$$

$$W_B = 5(-2) + 10 \times \frac{4}{3} = \frac{10}{3}\mu J$$

So, heat required = $\frac{5}{3}\mu J$

9. A

Sol. Potential at ‘C’ = $\frac{kQ}{R} = \frac{\sigma R}{2\varepsilon_0}$

Flat surface of hemispherical shell is on equipotential surface.

10. B, C

Sol. $f_f = \mu mg$

$a = \mu g$

$$\int_{v_0}^{v} dv = \int_0^t -\mu g\ dt$$

$$v - v_0 = -\mu gt$$

$$v = v_0 - \mu gt$$

$$\Rightarrow\quad L\left(-\frac{dm}{dt}\right) = f_f v = \mu mg(v_0 - \mu gt)$$

$$\int_{m_0}^{m}\left(-\frac{dm}{m}\right)=\int_{0}^{t}-\frac{\mu g}{L}(v_0-\mu g t)dt$$

$$\ell n\frac{m}{m_0}=-\frac{\mu g}{L}\left(v_0 t-\frac{\mu g t^2}{2}\right)$$

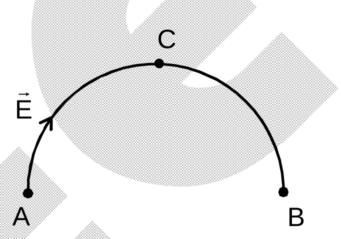
$$m=m_0 e^{-\frac{\mu g}{L}\left(v_0 t-\frac{\mu g t^2}{2}\right)}$$

Section – B

11. 4

Sol. $\frac{1}{2}mv_C^2 = qE\cdot\frac{\pi R}{2}$ …(i)

$\frac{1}{2}mv_B^2 = qE\cdot\pi R$ …(ii)



At C, $a_C = \frac{v_C^2}{R} = \frac{qE\pi}{m}$

At B, $a_C = \frac{v_B^2}{R} = \frac{2qE\pi}{m}$

$$a_1 = \sqrt{\left(\frac{qE}{m}\right)^2 + \left(\frac{qE\pi}{m}\right)^2}$$

$$a_2 = \sqrt{\left(\frac{qE}{m}\right)^2 + \left(\frac{2qE\pi}{m}\right)^2}$$

$$\frac{a_1}{a_2} = \sqrt{\frac{1+\pi^2}{1+4\pi^2}}$$

12. 2

Sol. $\Delta\ell_1 = L_1\alpha_1\Delta T = \frac{30}{100}(1.7\times10^{-5})\times100 = 0.51\,\text{mm}$

$\Delta\ell_2 = (1.91-0.51) = 1.4\ \text{mm}$

So, $\Delta\ell_2 = L_2\alpha_2\Delta T$

$\alpha_2 = 2\times10^{-5}\,/^\circ C$

13. 2

Sol. $\vec{B} = 4\hat{i}+\hat{j}+\hat{k}$

$\vec{v} = \hat{i}-2\hat{j}+3\hat{k}$

So, $\vec{F} = q(\vec{v}\times\vec{B}) = q(-5\hat{i}+11\hat{j}+9\hat{k})$

$|F| = q\sqrt{227}$

$R = \frac{|v|^2}{a_C} = 2\times10^3\text{m} = 2\ \text{km}$

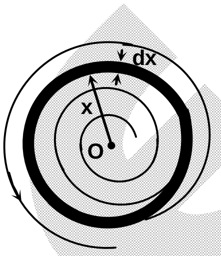
14. 2

Sol. $$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$k_{eq}A = k_1A_1 + k_2A_2 + k_3A_3$$

$$k_{eq} = \frac{k_1 + k_2 + k_3}{3} = 2 \text{ W/mK}$$

15. 3



Sol. $$\text{emf} = \frac{d\phi}{dt} = \pi x^2 \frac{dB}{dt}(dN)$$

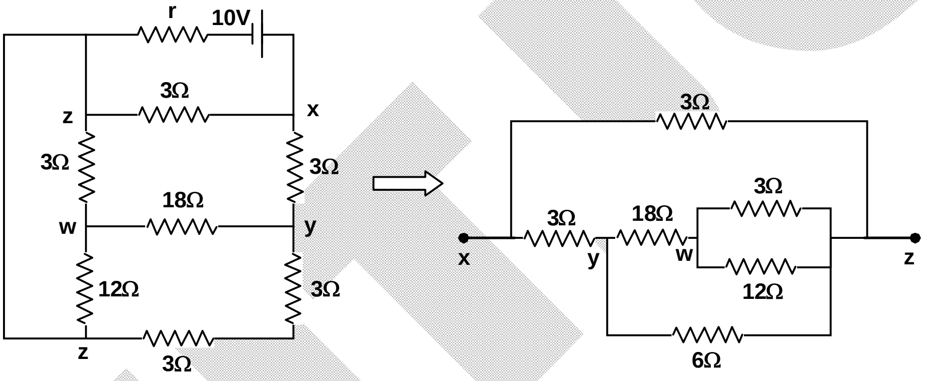
$$= \frac{N}{b-a}\pi\left(\frac{dB}{dt}\right)\int_a^b x^2 dx = \frac{14}{3} \text{ volt}$$

$$i = \frac{\text{emf}}{R} = 3 \text{ A}$$

16. 7

Sol. R_{eq} between points x and z

$$R_{eq} = \frac{28}{13}\Omega$$



r
10V
3Ω
z
x
3Ω
3Ω
18Ω
w
y
12Ω
3Ω
z
3Ω
3Ω
3Ω
18Ω
3Ω
x
y
w
z
12Ω
6Ω

17. 6

Sol. Immediately after the switching, current in the branch of inductor will not change and charge on capacitor will be zero.

18. 3

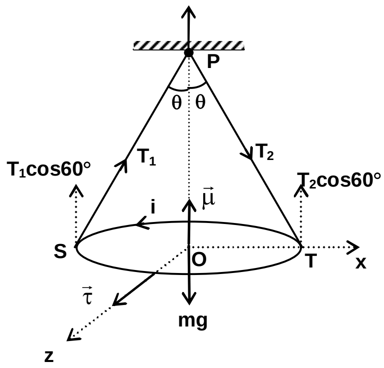
Sol. $T_1\cos 60° + T_2\cos 60° = mg$

$T_1 + T_2 = 2mG$ …(i)

Taking torque about 'O'

$(T_2\cos 60°)R + |\vec{\mu} \times \vec{B}| = (T_1\cos 60°)R$ …(ii)

On solving $\frac{T_1}{T_2} = 3$



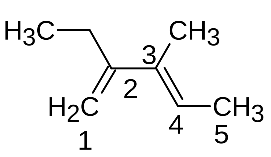
P
θ θ
T₁
T₂
T₁cos60°
T₂cos60°
i
μ⃗
S
O
T
x
τ⃗
mg
z

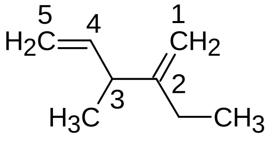
Chemistry PART – II

Section – A

19. D

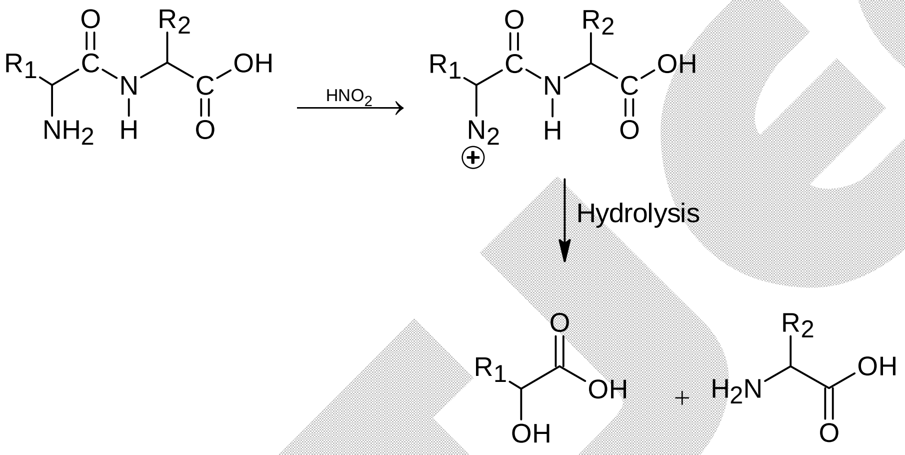
Sol. Option (D) has longest chain of 5C-atom which is same as in the compound given


H3C
CH3
3
2
H2C
1
4
CH3
5


5
4
1
H2C
CH2
2
3
H3C
CH3

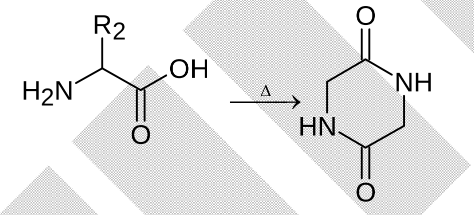
20. C

Sol.


O
R2
R1
C
N
C
OH
NH2
H
O
HNO2
N2
Hydrolysis
OH
+
H2N

Lactic acid
($R_1 = CH_3$)

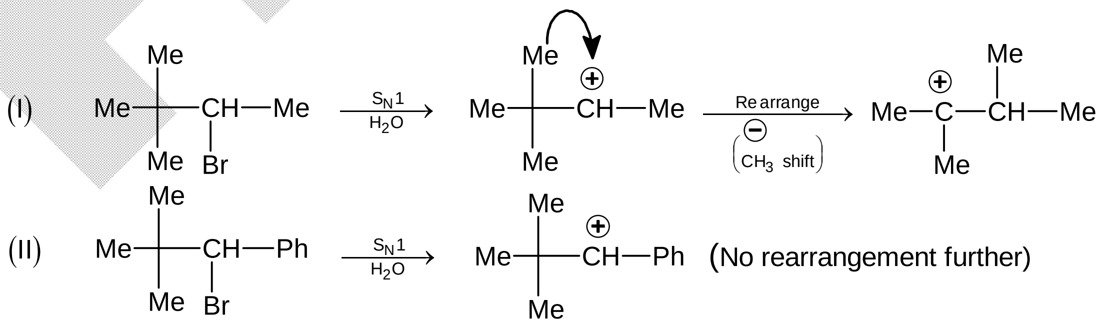
[y]


R2
H2N
OH
O
Δ
NH
HN

2,5-diketopiperazine($R_2 = H$)

21. B

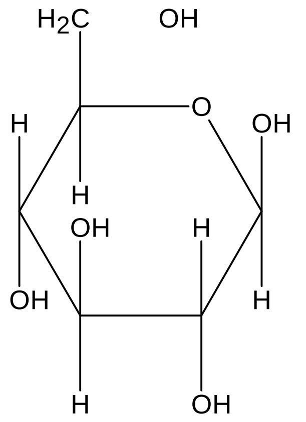
Sol.


(I)
Me
CH
Br
SN1
H2O
Rearrange
CH3 shift
(II)
Ph

(No rearrangement further)

22. C

Sol.

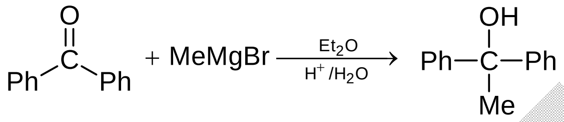


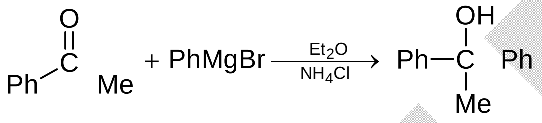
β – D – Glucopyranose

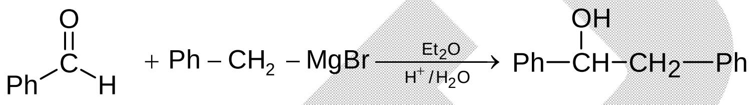
gives positive Tollen's test and NH_2OH/H^+ due to presence of Hemiacetal linkage.

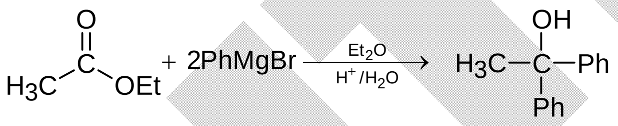
23. A, B, D

Sol.



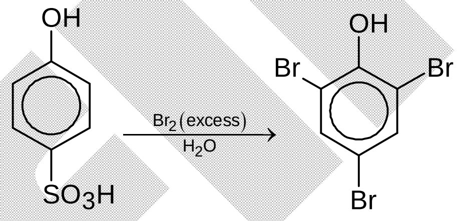




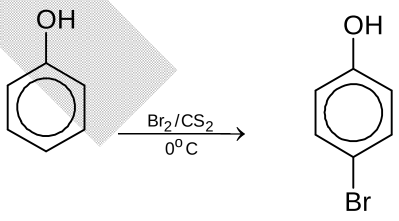


24. A, C

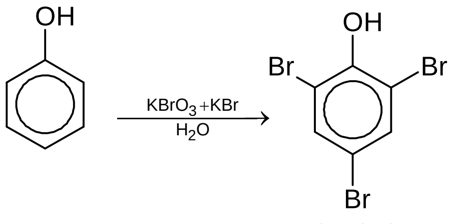
Sol.



(Major)

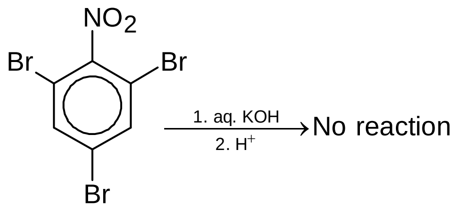


(Major)


OH
$KBrO_3$+KBr
H_2O
OH
Br
Br
Br

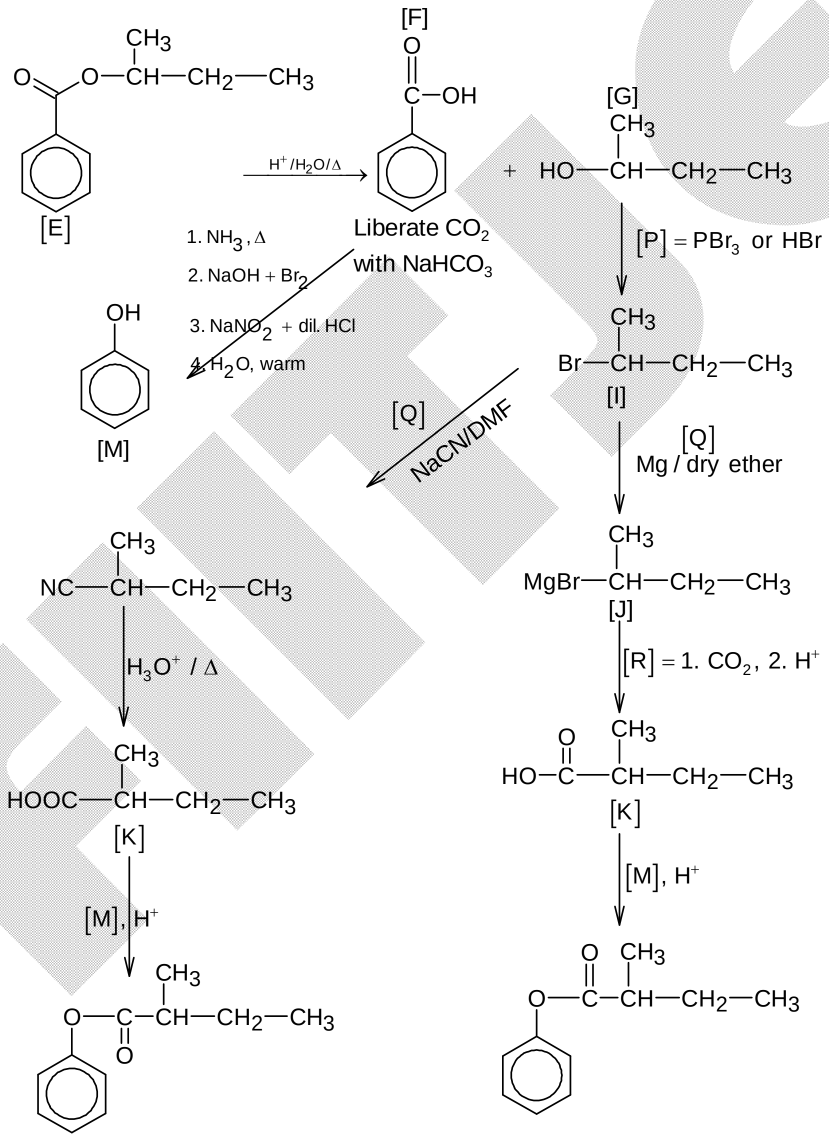
(Major)

$$\left(KBrO_3 + KBr + H_2O \longrightarrow Br_2\right)$$


NO_2
Br
Br
Br
1. aq. KOH
2. H^+
No reaction

25. C, D

Sol.

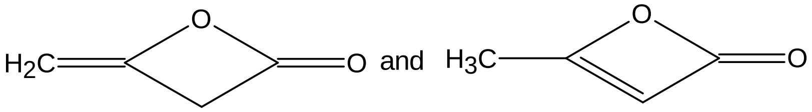

CH_3
O
O—CH—CH_2—CH_3
[E]
$H^+/H_2O/\Delta$
[F]
O
C—OH
Liberate CO_2 with $NaHCO_3$
+
[G]
CH_3
HO—CH—CH_2—CH_3
$[P] = PBr_3$ or HBr
1. NH_3, Δ
2. NaOH + Br_2
3. $NaNO_2$ + dil. HCl
4. H_2O, warm
OH
[M]
CH_3
Br—CH—CH_2—CH_3
[I]
[Q]
NaCN/DMF
[Q]
Mg / dry ether
CH_3
NC—CH—CH_2—CH_3
H_3O^+ / Δ
CH_3
MgBr—CH—CH_2—CH_3
[J]
$[R]$ = 1. CO_2, 2. H^+
CH_3
HOOC—CH—CH_2—CH_3
[K]
O
CH_3
HO—C—CH—CH_2—CH_3
[K]
[M], H^+
[M], H^+
CH_3
O—C—CH—CH_2—CH_3
O
O CH_3
O—C—CH—CH_2—CH_3

[L] is metamer of [E]

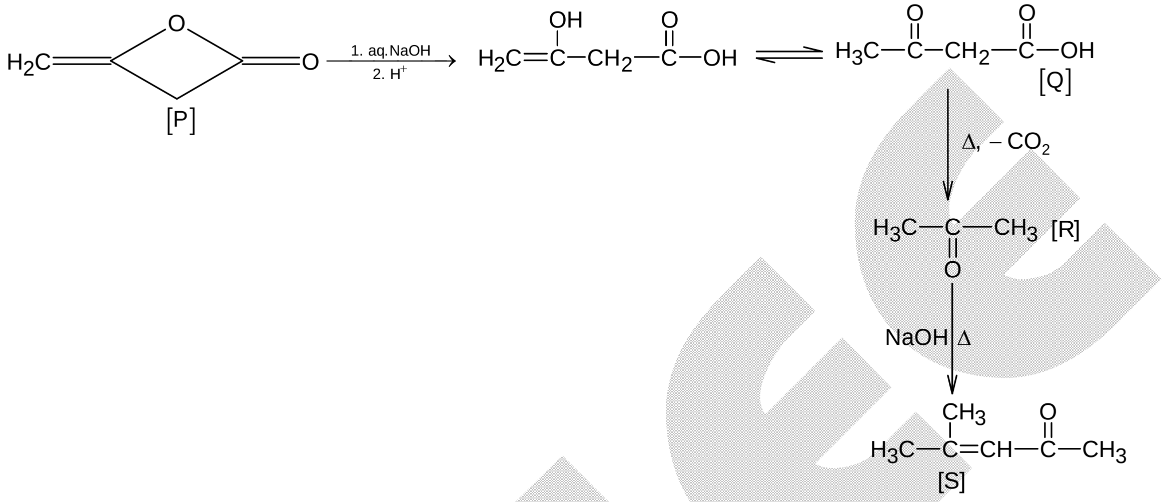
26. A, B, D

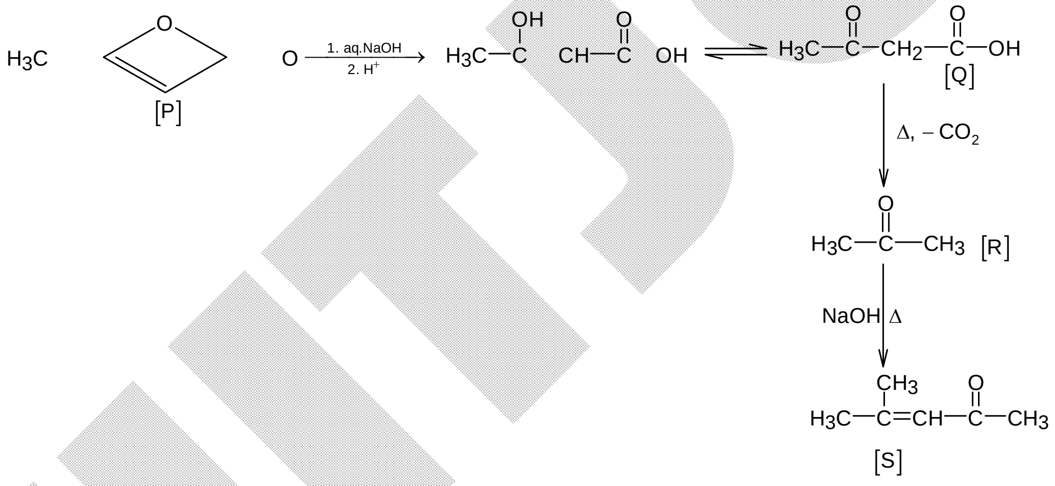
Sol.

[P] can be


H2C
O
O
and
H3C
O
O

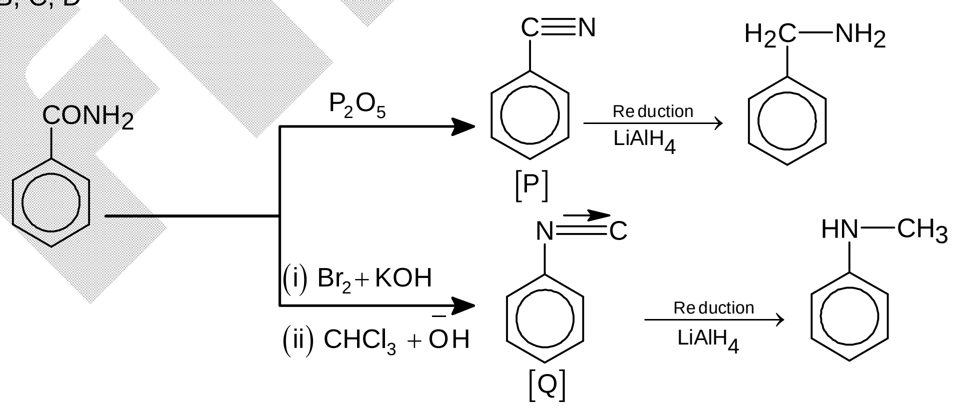
(Two structural isomers)

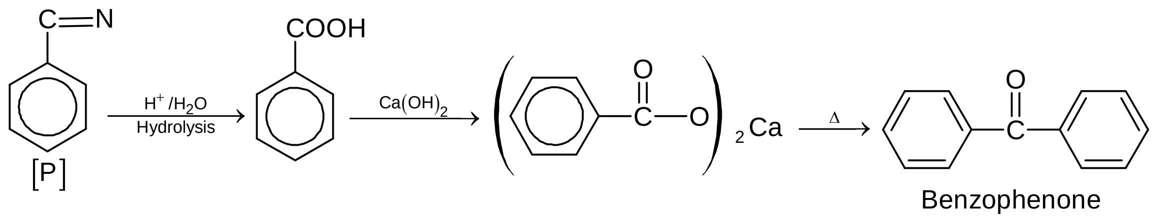

H2C
O
O
[P]
1. aq.NaOH
2. H+
OH
O
H2C=C–CH2–C–OH
O
O
H3C–C–CH2–C–OH
[Q]
Δ, – CO2
H3C–C–CH3 [R]
O
NaOH Δ
CH3
O
H3C–C=CH–C–CH3
[S]

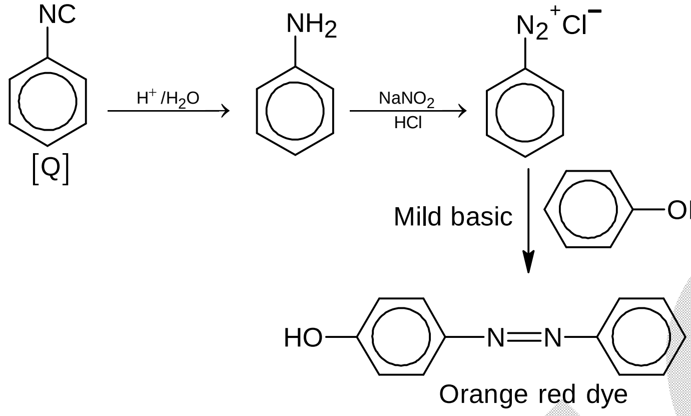

H3C
O
O
[P]
1. aq.NaOH
2. H+
OH
O
H3C–C CH–C OH
O
O
H3C–C–CH2–C–OH
[Q]
Δ, – CO2
O
H3C–C–CH3 [R]
NaOH Δ
CH3
O
H3C–C=CH–C–CH3
[S]

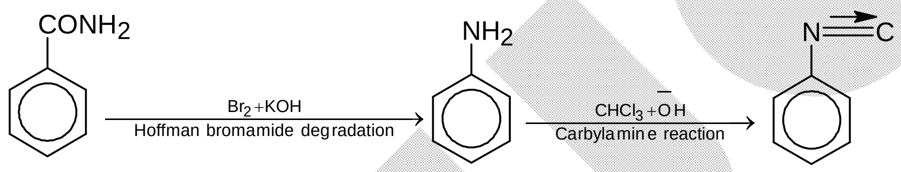
27. B, C, D

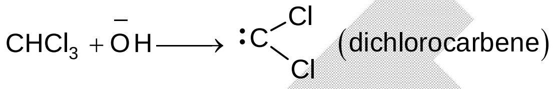
Sol.


CONH2
P2O5
C≡N
[P]
Reduction
LiAlH4
H2C–NH2
(i) Br2 + KOH
(ii) CHCl3 + OH⁻
N≡C
[Q]
Reduction
LiAlH4
HN–CH3


C≡N
[P]
H⁺/H₂O
Hydrolysis
COOH
Ca(OH)₂
O
C—O
₂Ca
Δ
O
C
Benzophenone

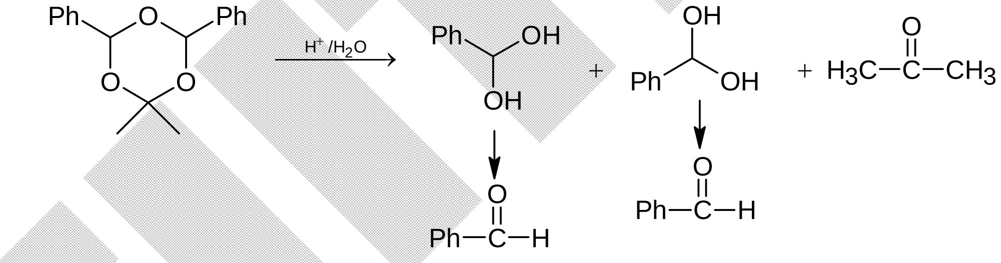

NC
[Q]
H⁺/H₂O
NH₂
NaNO₂
HCl
N₂⁺Cl⁻
Mild basic
OH
HO
N=N
Orange red dye

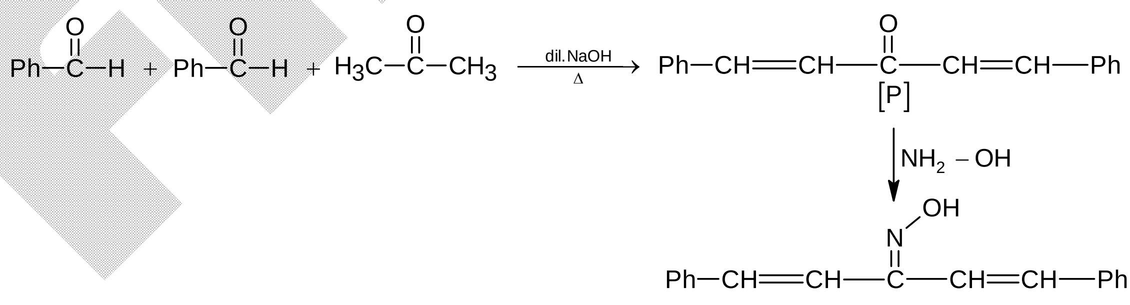

CONH₂
Br₂+KOH
Hoffman bromamide degradation
NH₂
CHCl₃+OH⁻
Carbylamine reaction
N≡C


$$CHCl_3 + \bar{O}H \longrightarrow :CCl_2 \ (\text{dichlorocarbene})$$

28. A, B, C

Sol.


Ph
O
Ph
O
O
H⁺/H₂O
Ph
OH
OH
+
OH
Ph
OH
+ H₃C—C(=O)—CH₃
Ph—C(=O)—H
Ph—C(=O)—H

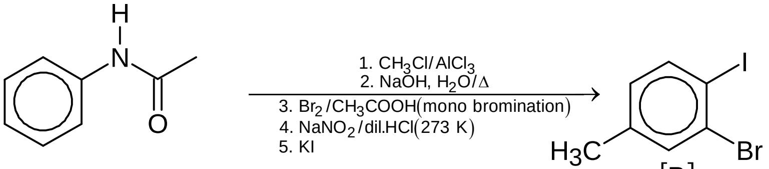

Ph—C(=O)—H + Ph—C(=O)—H + H₃C—C(=O)—CH₃
dil.NaOH
Δ
Ph—CH=CH—C(=O)—CH=CH—Ph
[P]
NH₂ – OH
OH
N
Ph—CH=CH—C—CH=CH—Ph

(Number of stereoisomers = 4)

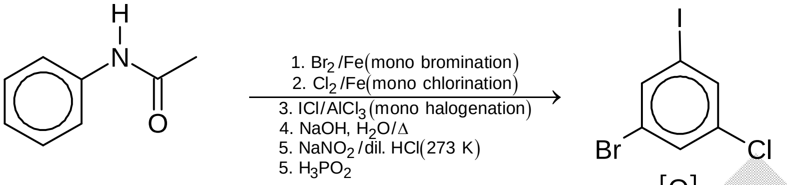
Section – B

29. 9

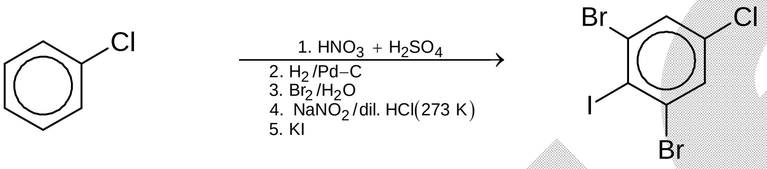
Sol.


H
N
O
1. $CH_3Cl/AlCl_3$
2. NaOH, H_2O/Δ
3. Br_2/CH_3COOH(mono bromination)
4. $NaNO_2$/dil.HCl(273 K)
5. KI
I
H_3C
Br

[P]


H
N
O
1. Br_2/Fe(mono bromination)
2. Cl_2/Fe(mono chlorination)
3. $ICl/AlCl_3$(mono halogenation)
4. NaOH, H_2O/Δ
5. $NaNO_2$/dil. HCl(273 K)
5. H_3PO_2
I
Br
Cl

[Q]


Cl
1. $HNO_3 + H_2SO_4$
2. H_2/Pd–C
3. Br_2/H_2O
4. $NaNO_2$/dil. HCl(273 K)
5. KI
Br
Cl
I
Br

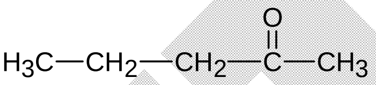
[R]

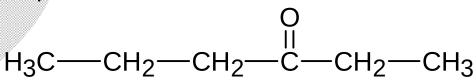
30. 3

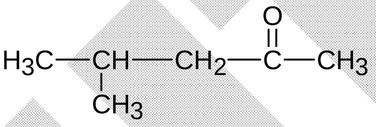
Sol. I, III and VI compounds satisfy the conditions

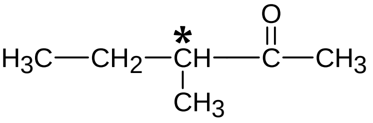
31. 2

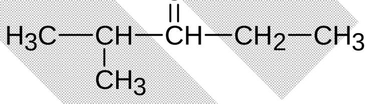
Sol. General formula of isomeric ketone of MW = 100 is $C_6H_{12}O$ possible structures:

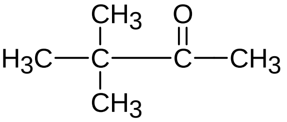
(A)

$$H_3C-CH_2-CH_2-\overset{O}{\overset{||}{C}}-CH_3$$

(B)

$$H_3C-CH_2-CH_2-\overset{O}{\overset{||}{C}}-CH_2-CH_3$$

(C)

$$H_3C-\underset{CH_3}{\underset{|}{CH}}-CH_2-\overset{O}{\overset{||}{C}}-CH_3$$

(D)

$$H_3C-CH_2-\underset{CH_3}{\underset{|}{\overset{*}{C}H}}-\overset{O}{\overset{||}{C}}-CH_3$$

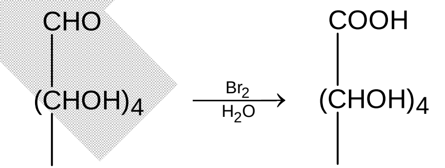
(E)

$$H_3C-\underset{CH_3}{\underset{|}{CH}}-\overset{O}{\overset{||}{CH}}-CH_2-CH_3$$

(F)

$$H_3C-\underset{CH_3}{\underset{|}{\overset{CH_3}{\overset{|}{C}}}}-\overset{O}{\overset{||}{C}}-CH_3$$

Compound B and E will give racemic mixture.

32. 4

Sol.


CHO
$(CHOH)_4$
H_2C—OH
Br_2
H_2O
COOH
$(CHOH)_4$
H_2C—OH

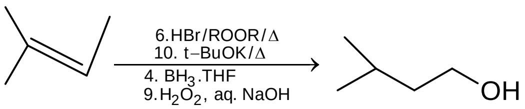
D-Glucose Gluconic acid

33. 7

Sol. Statements 1, 2, 4, 5, 6, 7 and 10 are correct.

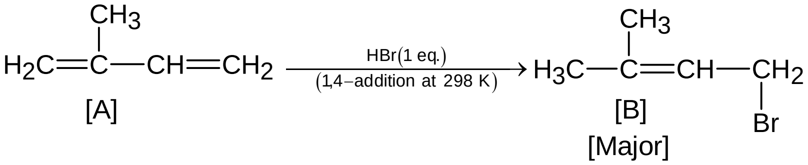
34. 9

Sol.


6.HBr/ROOR/Δ
10. t–BuOK/Δ
4. BH3.THF
9.H2O2, aq. NaOH
OH

35. 5

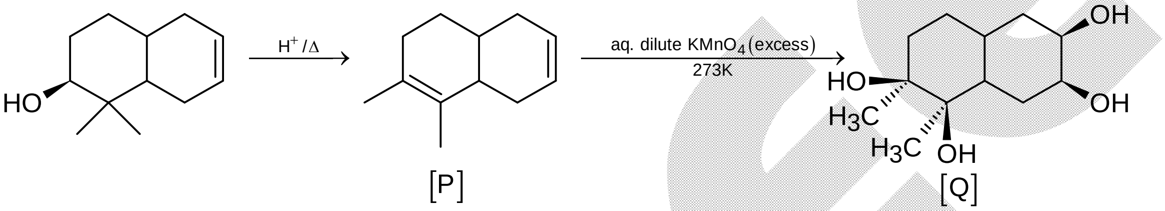
Sol.


HBr(1 eq.)
(1,4–addition at 298 K)
[A]
[B]
[Major]

$$\underset{[A]}{H_2C=\overset{\overset{\displaystyle CH_3}{|}}{C}-CH=CH_2} \xrightarrow[\text{(1,4–addition at 298 K)}]{\text{HBr(1 eq.)}} \underset{\substack{[B]\\ [Major]}}{H_3C-\overset{\overset{\displaystyle CH_3}{|}}{C}=CH-\underset{\underset{\displaystyle Br}{|}}{CH_2}}$$

36. 2

Sol.


HO
H+/Δ
[P]
aq. dilute KMnO4(excess)
273K
HO
H3C
H3C
OH
OH
OH
[Q]

Mathematics

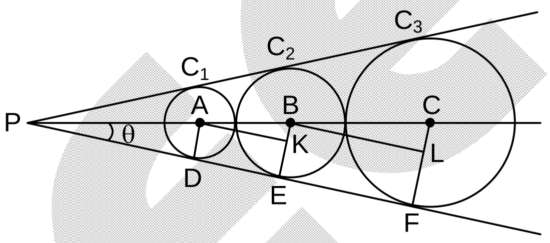
PART – III

Section – A

37. A

Sol. $$\frac{\frac{\cos A}{\sin A}}{\frac{(\cos B\sin C+\sin B\cos C)}{\sin B\sin C}}=\frac{\cos A\sin B\sin C}{\sin^2 A}=\frac{\left(\frac{b^2+c^2-a^2}{2bc}\right)\frac{b}{2R}\times\frac{c}{2R}}{\frac{a^2}{4R^2}}=\frac{57a^2}{8\times 2bc}\times\frac{bc}{a^2}=\frac{57}{16}$$

38. B



Sol. $DE = AK = \sqrt{(r_1+r_2)^2-(r_2-r_1)^2} = 2\sqrt{r_1r_2}$

Similarly, BL = EF = $2\sqrt{r_2r_3}$

Let $\angle APD = \theta$ and PD = x, then

$\tan\theta = \frac{AD}{PD} = \frac{BE}{PE} = \frac{CF}{PF}$

$\Rightarrow \frac{r_1}{x} = \frac{r_2}{x+2\sqrt{r_1r_2}} = \frac{r_3}{x+2\sqrt{r_1r_2}+2\sqrt{r_2r_3}}$ = k (say)

$r_1 = kx, r_2 = kx+2k\sqrt{r_1r_2}$, $r_3 = kx+2k\sqrt{r_1r_2}+2k\sqrt{r_2r_3}$; $\frac{r_2-r_1}{2\sqrt{r_1r_2}} = \frac{r_3-r_2}{2\sqrt{r_2r_3}} \Rightarrow r_2 = \sqrt{r_1r_3} = \sqrt{4\times 9} = 6$

39. C

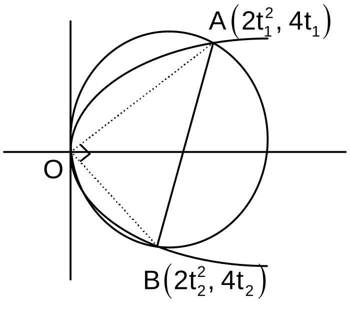
Sol. $\frac{x^2}{25}+\frac{y^2}{9}=1 \therefore$ S is (4, 0)

Let image of S in any tangent be P(h, k),
Midpoint of SP will lie on auxiliary circle
($\because$ foot of perpendicular from focus on any tangent lies on auxiliary circle)

$\therefore \left(\frac{h+4}{2}, \frac{k}{2}\right)$ lies on $x^2 + y^2 = 25$ $\therefore$ locus of image is $(x+4)^2 + y^2 = 100$

It touches ky – 2x + 22 = 0 $\therefore \frac{|0+8+22|}{\sqrt{k^2+4}} = 10 \Rightarrow k^2 + 4 = 9 \Rightarrow k = \pm\sqrt{5}$

40. C



Sol. $\angle AOB = 90°$ (as AB is diameter)

$\therefore$ Slope of OA × Slope of OB = –1

$\frac{2}{t_1}\times\frac{2}{t_2} = -1 \Rightarrow t_1t_2 = -4$

Point of intersection of tangent at A and B is
$C(2t_1t_2, 2(t_1+t_2)) = C(-8, 2(t_1+t_2))$
If perpendicular tangents are drawn from C to
$y^2 = kx$, then C must be on its directrix $\therefore$ k = 32

41. A, B, C

Sol. $f(3) = \cos\frac{2\pi}{7}+\cos\frac{4\pi}{7}+\cos\frac{6\pi}{7}$ and $g(3) = \cos\frac{2\pi}{7}+\cos\frac{4\pi}{7}+\cos\frac{8\pi}{7}$

$\because\ \cos\frac{6\pi}{7}=\cos\frac{8\pi}{7}\ \therefore$ f(3) = g(3)

$$f(6)=\cos\frac{2\pi}{7}+\cos\frac{4\pi}{7}+\cos\frac{6\pi}{7}+\cos\frac{8\pi}{7}+\cos\frac{10\pi}{7}+\cos\frac{12\pi}{7}=$$

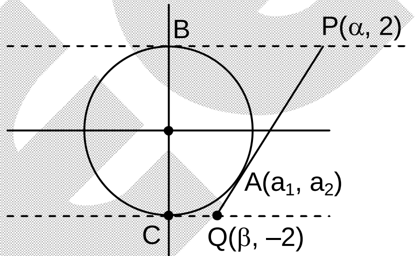
$$2\left(\cos\frac{2\pi}{7}+\cos\frac{4\pi}{7}+\cos\frac{6\pi}{7}\right)=2f(3)$$

($\because$ cos θ = cos(2π – θ))

$$g(6)=\cos\frac{2\pi}{7}+\cos\frac{4\pi}{7}+\cos\frac{8\pi}{7}+\cos\frac{16\pi}{7}+\cos\frac{32\pi}{7}+\cos\frac{64\pi}{7}$$

$\left(\because\cos\frac{64\pi}{7}=\cos\frac{8\pi}{7},\cos\frac{32\pi}{7}=\cos\frac{4\pi}{7},\cos\frac{16\pi}{7}=\cos\frac{2\pi}{7}\right)\ \therefore$ g(6) = 2g(3)

42. A, B, C, D



Sol. B(0, 2) and C is (0, –2). Slope of PQ = $\frac{4}{\alpha-\beta}$

Equation of PQ $y-2=\frac{4}{\alpha-\beta}(x-\alpha)$

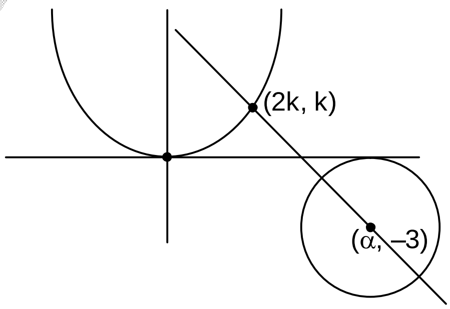
$y(\alpha-\beta)-2(\alpha-\beta)=4x-4\alpha$

$4x-y(\alpha-\beta)-2(\alpha+\beta)=0$

$\because$ it touches $x^2+y^2=4\ \therefore\ \frac{|0-0-2(\alpha+\beta)|}{\sqrt{16+(\alpha-\beta)^2}}=2$

$\Rightarrow \alpha\beta=4 \Rightarrow$ If α = 4 slope of $PQ=\frac{4}{3}\ \therefore$ Slope of $OA=-\frac{3}{4}\Rightarrow\frac{a_2}{a_1}=-\frac{3}{4}$

43. A, D



Sol. $X^2=4ky\Rightarrow 2x=4k\frac{dy}{dx}\Rightarrow\frac{dy}{dx}=\frac{x}{2k}\Rightarrow\left(\frac{dy}{dx}\right)_{(2k,k)}=1$

$\therefore$ Slope of normal at (2k, k) = –1

$\therefore$ Equation of normal y – k = –1(x – 2k) ⇒ x + y = 3k

If k = 1, equation of normal x + y = 3

$\because$ Shortest distance lies along the common normal

$\therefore$ It passes through (α, –3) ; α – 3 = 3 ⇒ α = 6

⇒ If k = 2, x + y = 6 passes through (α, –3) $\therefore$ α = 9

⇒ If α = 20 $\therefore$ x + y = 3k passes through (20, –3)

$\therefore\ k=\frac{17}{3}$

44. B, C

Sol. $s-p=\frac{s-q}{4}=\frac{s-r}{6}=k\ (\text{say})\ \because\ s=\frac{p+q+r}{2}$ ⇒ q + r – p = 2k ; p + r – q = 8k ; p + q – r = 12 k

⇒ p = 10k, r = 5k, q = 7k $\therefore$ S = 11k $\because\ \Delta=\sqrt{s(s-p)(s-q)(s-r)}$

$\Rightarrow\ \Delta=\sqrt{11k\times k\times 4k\times 6k}=2\sqrt{66}\,k^2$; Circumradius = $\frac{pqr}{4\Delta}\Rightarrow\frac{175}{4\sqrt{66}}=\frac{5k\times 7k\times 10k}{4\times 2\sqrt{66}\,k^2}$ ⇒ k = 1

$\therefore$ Area = $2\sqrt{66}$ inradius = 4(Circumradius) $\sin\frac{P}{2}\sin\frac{Q}{2}\sin\frac{R}{2}$

$$\Rightarrow\ 2\sqrt{\frac{6}{11}}=4\times\frac{175}{4\sqrt{66}}\times\sin\frac{P}{2}\sin\frac{Q}{2}\sin\frac{R}{2}$$

45. A, C, D

Sol. Area of inscribed rectangle

$= 2a\cos\theta \times 2a\sin\theta = 2ab\sin 2\theta$

(Here, $a = 4\sqrt{2}; b = 2\sqrt{2}$)

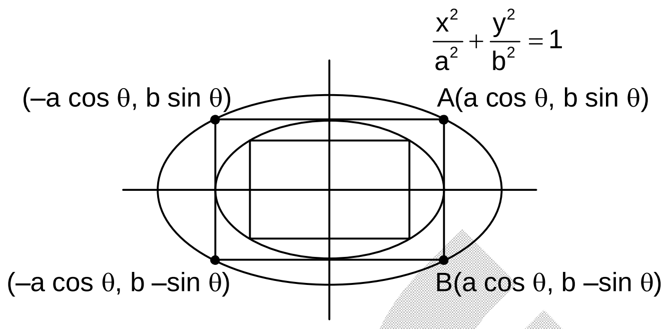
Maximum value = 2ab when $\theta = 45°$

$\therefore$ Area of $R_1 = 2ab$

and sides of r_1 are $a\sqrt{2}; b\sqrt{2}$

Let major axis and minor axis of E_2 be $2a_2, 2b_2$

$\therefore\ 2a_2 = a\sqrt{2} \Rightarrow a_2 = \frac{a}{\sqrt{2}}; b_2 = \frac{b}{\sqrt{2}}$


$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$
$(-a\cos\theta, b\sin\theta)$
$A(a\cos\theta, b\sin\theta)$
$(-a\cos\theta, b -\sin\theta)$
$B(a\cos\theta, b -\sin\theta)$

$\therefore$ Area of $R_2 = 2\times\frac{a}{\sqrt{2}}\times\frac{b}{\sqrt{2}} = ab$ and sides are of R_2 are a and b

⋮

Similarly area of $R_n = \frac{2ab}{2^{n-1}}$ and sides of R_n are $\frac{\sqrt{2}a}{(\sqrt{2})^{n-1}}; \frac{\sqrt{2}b}{(\sqrt{2})^{n-1}}$

Similarly major axis and minor axis of E_n are $\frac{2a}{(\sqrt{2})^{n-1}}; \frac{2b}{(\sqrt{2})^{n-1}}$

$\therefore$ Sum of areas of rectangles R_1, R_2, R_3 ..... is $2ab + ab + \frac{ab}{2}+\frac{ab}{4}+..... = \frac{2ab}{1-\frac{1}{2}} = 4ab$

$\therefore$ Sum of areas is always less than $4\times 4\sqrt{2}\times 2\sqrt{2} = 64$

Eccentricities does not change $\therefore E_{10} = E_{12}$

46. A, C, D

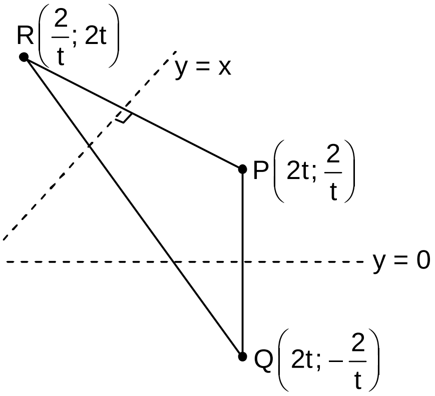
Sol. Centroid : $\left(\frac{4t+\frac{2}{t}}{3}; \frac{2t}{3}\right)$; $h = \frac{4t+\frac{2}{t}}{3}; k = \frac{2t}{3}$

$\Rightarrow t = \frac{3k}{2}\ \therefore\ 3h = 6k + \frac{4}{3k} \Rightarrow 9hk = 18k^2 + 4$

Circumcentre is (0, 0)

$\therefore$ Orthocentre : $\left(4t+\frac{2}{t}; 2t\right)$

$\therefore$ Locus $hk = 2k^2 + 4$


$R\left(\frac{2}{t}; 2t\right)$
y = x
$P\left(2t; \frac{2}{t}\right)$
y = 0
$Q\left(2t; -\frac{2}{t}\right)$

Section – B

47. 2

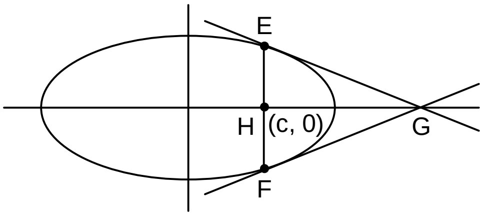
Sol. $T_r = \frac{1}{3^{r-1}}\sin^3\left(3^{r-1}\theta\right) = \frac{1}{4\times 3^{r-1}}\left(3\sin 3^{r-1}\theta - \sin 3^r\theta\right) = \frac{1}{4}\left(\frac{\sin 3^{r-1}\theta}{3^{r-2}} - \frac{\sin 3^r\theta}{3^{r-1}}\right) = \frac{1}{4}\left(V_r - V_{r+1}\right)$

$\therefore\ S_{10} = \frac{1}{4}\left(V_1 - V_2 + V_2 - V_3 + ...\ V_{10} - V_{11}\right) = \frac{1}{4}\left(V_1 - V_{11}\right) \Rightarrow f(\theta) = \frac{1}{4}\left(3\sin\theta - \frac{\sin 3^{10}\theta}{3^9}\right)$

48. 8

Sol. Let E be (5 cos θ, 3 sin θ) ⇒ 5 cos θ

$\Rightarrow c \Rightarrow \cos\theta = \frac{c}{5}$ F is (5 cos θ, –3 sin θ)



Tangent at E : $\frac{x\cos\theta}{5} + \frac{y\sin\theta}{3} = 1$

Tangent at F : $\frac{x\cos\theta}{5} - \frac{y\sin\theta}{3} = 1$ ∴ G is $\left(\frac{5}{\cos\theta}, 0\right)$

Area of ΔEFG = $\frac{1}{2} \times GH \times EF = \frac{1}{2} \times \left(\frac{5}{\cos\theta} - 5\cos\theta\right) \times 6\sin\theta$

$= \frac{1}{2} \times \left(\frac{25}{c} - c\right) \times 6\left(\sqrt{1 - \frac{c^2}{25}} = \frac{3}{5c}(25 - c^2)^{3/2}\right) \Rightarrow \Delta'(c) = \frac{3}{5}\left(\frac{c\frac{3}{2}(25 - c^2)^{1/2} \times (-2c) - (25 - c^2)^{3/2}}{c^2}\right)$

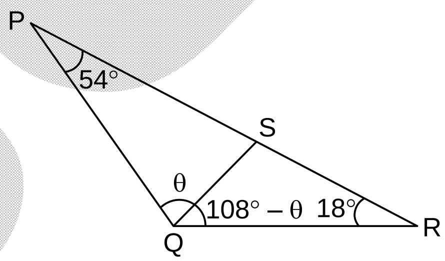
Which is always negative (–ve) ∴ Δ(c) is always decreasing

If 1 ≤ c ≤ 3, then minimum value of Δ(c) is at c = 3

$\Delta(3) = \frac{3}{5 \times 3}(16)^{3/2} = \frac{3}{5 \times 3} \times 2^6 = \frac{64}{5}$

49. 5

Sol. ∵ Area of ΔPSQ = $(\sqrt{5} - 1)$ area of ΔRSQ



$\frac{1}{2} \times PQ \times QS \times \sin\theta = (\sqrt{5} - 1) \times \frac{1}{2} QR \times QS \times \sin(108 - \theta)$

∵ $\frac{PQ}{\sin 18^\circ} = \frac{QR}{\sin 54^\circ}$

∴ $\sin\theta \sin 18^\circ = (\sqrt{5} - 1)\sin 54^\circ \sin(108^\circ - \theta)$

∴ $\sin\theta \frac{\sqrt{5} - 1}{4} = (\sqrt{5} - 1) \times \frac{\sqrt{5} + 1}{4} \times \sin(108^\circ - \theta) \Rightarrow \frac{\sin(108^\circ - \theta)}{\sin\theta} = \frac{1}{\sqrt{5} + 1} = \frac{\sqrt{5} - 1}{4}$

sin 108° cot θ – cos 108° = $\frac{\sqrt{5} - 1}{4}$ ⇒ cot θ = 0 ⇒ θ = 90°

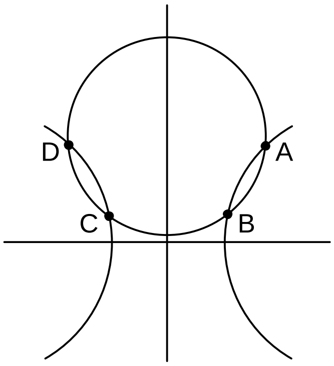
50. 8

Sol. Let A be (12 sec θ_1, 12 tan θ_1)

B be (12 sec θ_2, 12 tan θ_2)

C be (12 sec θ_3, 12 tan θ_3) and

D be (12 sec θ_4, 12 tan θ_4)



Let centroid of ABC be (h, k)

⇒ h = 4 sec θ_1 + 4 sec θ_2 + 4 sec θ_3 and

K = 4 tan θ_1 + 4 tan θ_2 + 4 tan θ_3

$$\frac{12\sec\theta_1 + 12\sec\theta_2 + 12\sec\theta_3 + 12\sec\theta_4}{4} = \frac{6 + 0}{2}$$

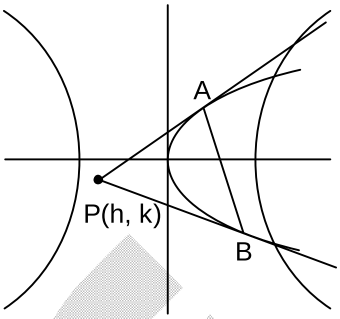
$3h + 12\sec\theta_4 = 12 \Rightarrow 4\sec\theta_4 = 4 - h$

$$\frac{12\tan\theta_1 + 12\tan\theta_2 + 12\tan\theta_3 + 12\tan\theta_4}{4} = \frac{12 + 0}{2}$$

3k + 12 tan θ_4 = 24 ⇒ 4 tan θ_4 = 8 – k ⇒ $(h - 4)^2 - (k - 8)^2 = 16$ ⇒ α = 4, β = 8, γ = 4

51. 3

Sol. Equation of chord of contact AB ky = 2(x + h)



$y = \frac{2x}{k} + \frac{2h}{k}$ $\because$ it touches $\frac{x^2}{9} - \frac{y^2}{16} = 1$

$\frac{4h^2}{k^2} = \frac{9 \times 4}{k^2} - 16$; $h^2 + 4k^2 = 9$

$\Rightarrow$ locus is $\frac{x^2}{9} + \frac{y^2}{9/4} = 1$

$\frac{9}{4} = 9(1 - e^2) \Rightarrow e = \frac{\sqrt{3}}{2}$

52. 2

Sol. $\because$ It is equilateral Δ $\therefore$ $x_1 = \frac{a}{3}(\cos\alpha + \cos\beta + \cos\gamma)$; $y_1 = \frac{b}{3}(\sin\alpha + \sin\beta + \sin\gamma)$

$\frac{9x_1^2}{a^2} + \frac{9y_1^2}{b^2} = (\cos\alpha + \cos\beta + \cos\gamma)^2 + (\sin\alpha + \sin\beta + \sin\gamma)^2$

$= 3 + 2(\cos\alpha\cos\beta + \cos\beta\cos\gamma + \cos\gamma\cos\alpha + \sin\alpha\sin\beta + \sin\beta\sin\alpha + \sin\gamma\sin\alpha)$

53. 6

Sol. $\therefore C_1 : x^2 + y^2 = a^2 - b^2 \Rightarrow C_2 : x^2 + y^2 = \frac{a^2 + b^2}{3}$

Director circle of C_1 is $x^2 + y^2 = 2(a^2 - b^2) \Rightarrow 2(a^2 - b^2) = \frac{a^2 + b^2}{3}$

$\Rightarrow 6a^2 - 6b^2 = a^2 + b^2 \Rightarrow 5a^2 = 7b^2$

$5a^2 = 7a^2(1 - e_1^2) \Rightarrow e_1^2 = \frac{2}{7}$ and $5a^2 = 7a^2(e_2^2 - 1) \Rightarrow e_2^2 = \frac{12}{7}$

54. 7

Sol. $(a - 2b)^2 + (a - 3c)^2 = 0 \Rightarrow a = 2b, a = 3c \Rightarrow b = \frac{a}{2}, c = \frac{a}{3}$

$\cos B = \frac{a^2 + c^2 - b^2}{2ac} \Rightarrow \cos B = \frac{a^2 + \frac{a^2}{9} - \frac{a^2}{4}}{2 \times a \times \frac{a}{3}} = \frac{31}{24}$

FIITJEE

ALL INDIA TEST SERIES

PART TEST – III

JEE (Main)-2023

TEST DATE: 17-12-2022

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is Mathematics.
- Each part has only two sections: **Section-A and Section-B**.
- **Section – A** : Attempt all questions.
- **Section – B :** Do any five questions out of 10 questions.

Section-A (01 – 20, 31 – 50, 61 – 80) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-B (21 – 30, 51 – 60, 81 – 90) *contains 30 Numerical based questions. The answer to each question is rounded off to the nearest integer value. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

PART – A

SECTION – A

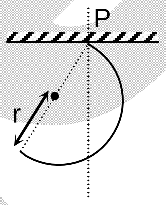
(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. The wave length of light incident on a metal surface is reduced from 300 nm to 200 nm (both are less than threshold wavelength). What is the change in the stopping potential for photoelectrons emitted from the surface (take $h = 6.6 \times 10^{-34}$ J-sec)

(A) 0.0625 V
(B) 1.0625 V
(C) 2.0625 V
(D) 3.0625 V

2. A uniform semicircular ring having mass m and radius r is hanging at one of its end (P) freely as shown in the given figure. The ring is slightly disturbed so that it oscillates in its own plane. The time period of oscillation of the ring is



(A) $2\pi\sqrt{\dfrac{r}{g\left(1+\dfrac{1}{\pi^2}\right)}}$
(B) $2\pi\sqrt{\dfrac{r}{g\left(1-\dfrac{4}{\pi^2}\right)^{1/2}}}$
(C) $2\pi\sqrt{\dfrac{r}{g\left(1-\dfrac{2}{\pi^2}\right)^{1/2}}}$
(D) $2\pi\sqrt{\dfrac{2r}{g\left(1+\dfrac{4}{\pi^2}\right)^{1/2}}}$

3. A number of little droplets of a liquid of surface tension T, density ρ, all of same radius r, combine to form a single drop of radius R. If the total energy released in this process is converted into kinetic energy of the bigger drop, velocity of the bigger drop is

(A) $\sqrt{\dfrac{3T(R-r)}{Rr\rho}}$
(B) $\sqrt{\dfrac{6T(R-r)}{Rr\rho}}$
(C) $\sqrt{\dfrac{T(R-r)}{Rr}}$
(D) $\sqrt{\dfrac{2T(R-r)\rho}{R}}$

4. In a screw gauge, 5 complete rotations of the screw cause it to move a linear distance of 0.25 cm and each rotation corresponds to one main scale division. There are 100 circular scale divisions. The thickness of a wire measured by this screw gauge gives a reading of 4 main scale divisions and 30 circular scale divisions. Assuming negligible zero error, what is the thickness (in mm) of the wire?

(A) 2.15
(B) 3.15
(C) 1.25
(D) 2.25

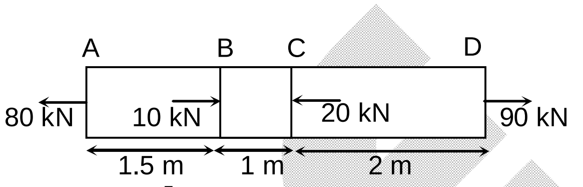
5. The refracting angle of a prism is A and the refractive index of the material of the prism is $\cot\left(\dfrac{A}{2}\right)$. The angle of minimum deviation is

(A) 180° – 3A
(B) 180° + 2A
(C) 90° – A
(D) 180° – 2A

6. In a hypothetical system, a particle of mass m and charge –3q is moving around a very heavy particle having charge q. Assume that Bohr's model is applicable to this system, then velocity of mass m in the first orbit is

(A) $\frac{3q^2}{2\varepsilon_0 h}$
(B) $\frac{3q^2}{4\varepsilon_0 h}$
(C) $\frac{3q}{2\pi\varepsilon_0 h}$
(D) $\frac{3q}{4\pi\varepsilon_0 h}$

7. A steel rod of cross sectional area 1 m^2 is acted upon by forces shown in figure. The elongation of the length BC of the rod is ($Y = 2.0 \times 10^{11}$ N/m^2)

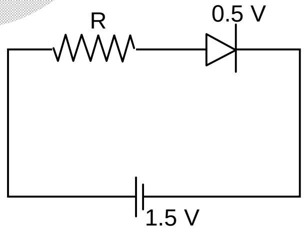


(A) 13×10^{-7} m
(B) 4.5×10^{-7} m
(C) 5×10^{-7} m
(D) 3.5×10^{-7} m

8. A body executes SHM of period 20 seconds. Its velocity is 5 cm/s, 2 seconds after it has passed the mean position. Find the amplitude (in cm) of the bob. (cos 36° = 0.809 and $\pi = \frac{22}{7}$)

(A) 15.67
(B) 17.67
(C) 19.67
(D) 21.67

9. The diode used in the circuit shown in figure has a constant voltage drop of 0.5 V at all currents and a maximum power rating of 100 mW. What should be the value of the resistance R, connected in series with diode for obtaining maximum current?



(A) 5Ω
(B) 5.6Ω
(C) 6.7Ω
(D) 20Ω

10. A ray enters a glass slab at an angle θ from air and the refractive index varies along the slab as $\mu = \mu_0 - kt^2$, where t is the distance measured along the normal. μ_0 and k are positive constants. If the glass slab is sufficiently thick, how far along the normal will the ray go before it reflects back?

(A) $\frac{\mu_0 - \sin\theta}{k}$
(B) $\frac{\mu_0 + \sin\theta}{k}$
(C) $\sqrt{\frac{\mu_0 - \sin\theta}{k}}$
(D) $\sqrt{\frac{\mu_0 + \sin\theta}{k}}$

11. The electric field part of an electromagnetic wave in a medium is represented by
$E_x = 0$
$E_y = 2.5 \text{ N/C} \cos\left[\left(2\pi \times 10^6 \text{ rad/s}\right)t - \left(\pi \times 10^{-2} \text{ rad/m}\right)x\right]$
and $E_z = 0$
Then the wave is
(A) moving along x direction with frequency 10^6 Hz and wavelength 100 m
(B) moving along x direction with frequency 10^6 Hz and wavelength 200 m
(C) moving along –x direction with frequency 10^6 Hz and wavelength 200 m
(D) moving along y direction with a frequency $2\pi \times 10^6$ Hz and wavelength 200 m.

12. In a Fraunhofer diffraction experiment at a single slit using a light of wavelength 400 nm, the first minimum is formed at an angle 30°. The direction θ of the first secondary maximum is given by:

(A) $\sin^{-1}\left(\frac{2}{3}\right)$ (B) $\sin^{-1}\left(\frac{3}{4}\right)$

(C) $\sin^{-1}\left(\frac{1}{4}\right)$ (D) $\sin^{-1}\left(\frac{2}{5}\right)$

13. A cylindrical vessel filled with water upto a height h weighs w and is resting on a horizontal plane. The side of wall of the vessel has a plugged circular hole touching the bottom. The coefficient of friction between the bottom of the vessel and the plane is μ. The minimum diameter of the hole so that the vessel just begins to move on the floor after the removal of the plug is:

(A) $\sqrt{\frac{\pi\mu w}{\rho h g}}$ (B) $\sqrt{\frac{\mu w}{2\pi\rho h g}}$

(C) $\sqrt{\frac{\mu w}{\pi\rho h g}}$ (D) $\sqrt{\frac{2\mu w}{\pi\rho h g}}$

14. The transverse displacement y(x, t) of a wave on a string is given by y(x, t) = $e^{-(ax^2+bt^2+2\sqrt{ab}xt)}$. This represents a ……….

(A) wave moving along +x-axis with speed $\sqrt{\frac{a}{b}}$

(B) wave moving along –x-axis with speed $\sqrt{\frac{b}{a}}$

(C) standing wave of frequency $\sqrt{b}$

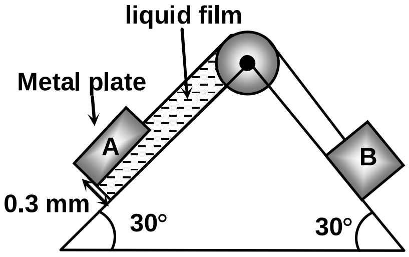
(D) standing wave of frequency $\frac{1}{\sqrt{b}}$

15. A body is fired with a velocity of magnitude $\sqrt{gR} < v < \sqrt{2gR}$ at an angle of 30° with the radius vector of the earth. If at the highest point, the speed of the body is $\frac{v}{4}$, the maximum height attained by the body is equal to (R = radius of earth and use the appropriate assumptions)

(A) $\frac{v^2}{8g}$ (B) R

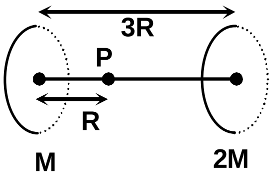
(C) $R\sqrt{2}$ (D) 2R

16. A metal plate of area 0.10 m^2 is connected to a 0.04 kg mass via a string that passes over an ideal pulley (considered massless and frictionless). A liquid with a film of thickness of 0.3 mm is placed between the plate and the table. When the system is released the plate moves up with constant speed of 0.085 m/s. Find the approximate value of coefficient of viscosity of the liquid. (mass of metal plate is 0.02 kg, g = 9.8 m/s^2)



(A) 3.46×10^{-3} Pa sec (B) 3.46×10^{-4} Pa sec
(C) 6.90×10^{-3} Pa sec (D) 6.90×10^{-4} Pa sec

17. Two rings having masses M and 2M, respectively, having the same radius are placed coaxially as shown in the figure. If the mass distribution on both the rings is non-uniform, then the gravitational potential at point P is



(A) $-\frac{GM}{R}\left[\frac{1}{\sqrt{2}}+\frac{2}{\sqrt{5}}\right]$

(B) $-\frac{GM}{R}\left[1+\frac{1}{\sqrt{2}}\right]$

(C) zero

(D) cannot be determined from the given information

18. A heavenly body is receding from earth such that the fractional change in λ is 1, then its velocity is

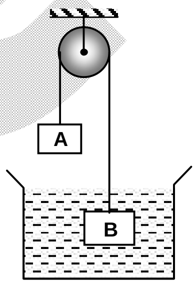
(A) c

(B) $\frac{3c}{5}$

(C) $\frac{c}{5}$

(D) $\frac{2c}{5}$

19. In the given figure $m_B = 3m$, density of liquid is ρ and density of block B is 2ρ. The system is released from rest so that block B moves up when in liquid and moves down when out of liquid with the same acceleration. Find the mass of block A.



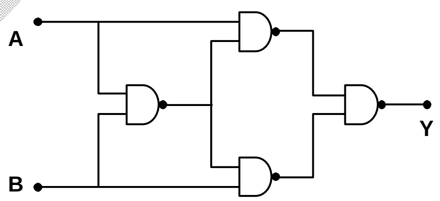
(A) $\frac{7}{4}m$

(B) 2m

(C) $\frac{9}{7}m$

(D) $\frac{9}{4}m$

20. Truth table for a system of four NAND gates as shown is



(A)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

(B)

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	1

(C)

A	B	Y
0	0	1
0	1	1
1	0	0
1	1	0

(D)

A	B	Y
0	0	1
0	1	0
1	1	0
1	1	1

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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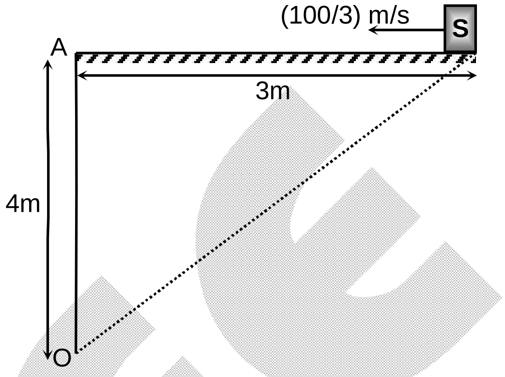
21. A source of sound S is travelling at $\frac{100}{3}$ m/s along a road towards a point A. A person standing at point O on a road perpendicular to AS hears a sound of frequency f′ corresponding to the sound emitted at the instant when the source is 3m away from A. The distance of O from A is 4m. If the original frequency is 640 Hz, then find the value of f′ in Hz. (velocity of sound is 340 m/s)



22. A metallic sphere of radius 21 cm is kept in the path of a parallel beam of light of large aperture of intensity $\frac{1}{110}$ W/m^2. The force exerted by beam on the sphere is $k \times 10^{-13}\text{N}$. Find k. ($\pi = \frac{22}{7}$ and light is completely absorbed by sphere)

23. An astronomical telescope has objective and eyepiece of focal length 40 cm and 4 cm respectively. To view an object 200 cm away from the objective, at what distance the lenses must be separated (in cm)?

24. Cobalt-57 is radioactive, emitting β-particles. The half life for this is 270 days. If 100 mg of this is kept in an open container, then what mass (in mg) of Cobalt-57 will remain after 540 days.

25. A clear sheet of polaroid is placed on the top of similar sheet so that their axes make an angle $\sin^{-1}\left(\frac{3}{5}\right)$ with each other. The ratio of intensity of the emergent light to that of unpolarised incident light is $\frac{k}{25}$. Find k.

26. A narrow parallel beam of light is incident on a transparent sphere of refractive index $\frac{4}{n}$. If the beam finally gets focused at a point situated at a distance = 2 × (radius of sphere) from the centre of the sphere, then find n.

27. A hydrogen like atom of atomic number Z is in excited state of quantum number 2n. It can emit a maximum energy photon of 204 eV. If it makes a transition to the quantum state n, a photon of energy 40.8 eV is emitted. Calculate the atomic number Z. Ground state energy of hydrogen atom is –13.6 eV.

28. Image of an object approaching convex mirror of radius of curvature 20 m along its optical axis is observed to move from $\frac{25}{3}$ m to $\frac{50}{7}$ m in 30 sec. If the object is moving uniformly, then it's speed is n km/h. Find the value of n.

29. An open pipe is suddenly closed at one end with the result that the frequency of third harmonic of the closed pipe is found to be higher by 100 Hz than the fundamental frequency of the open pipe. Find the fundamental frequency of the open pipe in Hz.

30. In a double slit arrangement fringes are produced using light of wavelength 4800 Å. One slit is covered by a thin plate of glass of refractive index 1.4 and the other with another glass plate of same thickness but of refractive index 1.7. By doing so the central bright shifts to original fifth bright fringe from centre. Thickness of glass plate is k μm. Find the value of k.

FIITJEE

Chemistry

PART – B

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

31. The products obtained when I_2 reacts with hot and concentrated aqueous NaOH are
(A) IO^- and IO_3^-
(B) IO_2^- and IO_3^-
(C) I^- and IO^-
(D) I^- and IO_3^-

32. Which of the following product is not produced during the hydrolysis of XeF_4 ?
(A) XeO_3
(B) O_2
(C) XeO_2F_2
(D) Xe

33. Four successive members of first row transition element are listed below. Which one of them unexpectedly have highest $E^o_{M^{3+}/M^{2+}}$ value?
(A) Mn (Z = 25)
(B) Fe (Z = 26)
(C) V (Z = 23)
(D) Cr (Z = 24)

34. In context of actinoids, which of the following statements is not correct?
(A) The actinoids are radioactive elements which make their study more difficult.
(B) There is a gradual decrease in the radii of the members with increasing atomic number in the series.
(C) The magnetic properties of actinoids can not be explained easily, as they are more complex.
(D) As compare to lanthanoid compounds, actinoid compounds are less basic.

35. Which of the following has a square planar geometry?
(A) $[FeI_4]^{2-}$
(B) $[PdCl_4]^{2-}$
(C) $[NiCl_4]^{2-}$
(D) $[CoI_4]^{2-}$

36. Which of the following statements is correct?
(A) NO_2 is a reddish-orange gas and it does not play any role in photochemical smog.
(B) SO_2 does not affect the formation of chlorophyll in plants.
(C) CO combines with haemoglobin to form carboxyhaemoglobin which is more stable than oxyhaemoglobin.
(D) SO_2 is more harmful than SO_3.

37. The reaction that is involved in the ozone layer depletion mechanism in the stratosphere is

(A) $NO + \frac{1}{2}O_2 \xrightarrow{h\nu} NO_2$

(B) $CH_4 + O_2 \longrightarrow CH_2O + H_2O$

(C) $Cl^{\bullet} + CH_4 \longrightarrow \overset{\bullet}{C}H_3 + HCl$

(D) $ClO^{\bullet} + O \longrightarrow Cl^{\bullet} + O_2$

38. Which of the following chromates is not yellow in colour?

(A) $PbCrO_4$

(B) $SrCrO_4$

(C) Ag_2CrO_4

(D) $BaCrO_4$

39. Which of the following statements is correct?

(A) Dettol is a mixture of chloroxylenol and bithionol.

(B) 2-3% solution of chloroform in alcohol-water is known as tincture of iodine.

(C) Boric acid in concentrated aqueous solution is weak antiseptic for eyes.

(D) 0.2% solution of phenol is an antiseptic while 1% solution of phenol is disinfectant.

40. Which of the following antibiotic is baceteriostatic?

(A) Penicillin

(B) Tetracyclin

(C) Aminoglycosides

(D) Ofloxacin

41. Multimolecular colloid is present in

(A) Sol of starch

(B) Soap solution

(C) Sol of sulphur

(D) Sol of protein

42. 100 ml of 0.6 M acetic acid is shaken with 4 g activated carbon. The final concentration of the solution after adsorption is 0.4 M. The amount of acetic acid (in g) adsorbed per gram of carbon is……..?

(A) 0.6

(B) 0.3

(C) 1.2

(D) 0.9

43. Which of the following statements is incorrect?

(A) Average translational kinetic energy of a molecule in a gas at given temperature does not depend on its molecular mass.

(B) Root mean square speed of a molecule in a gas at a give temperature is halved when its molar mass is increased four times.

(C) Average translational kinetic energy of a molecule in a gas at a given temperature is doubled when its molar mass is increased twice.

(D) Root mean square speed of a molecule in a gas is doubled when its temperature is increased four times.

44. When 100 ml of 1.0 M HCl was mixed with 100 ml of 1.0 M NaOH in an insulated beaker at constant pressure, a temperature increase of 5.8°C was measured for the beaker and its constants. If the enthalpy of neutralization of a strong acid with a strong base is -58.0 kJ mol^{-1}, the calorimeter constant in $\left(\text{kJ k}^{-1}\right)$ is…………

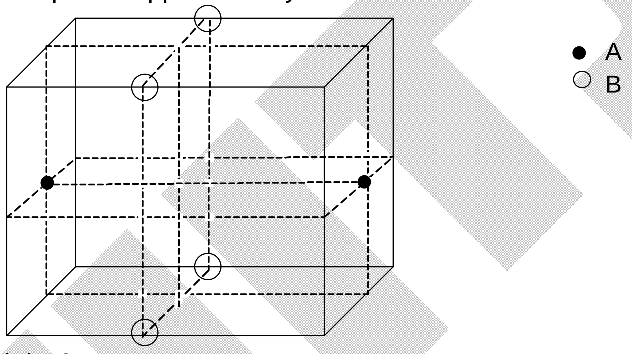
(Given: Heat capacity of solution is $4.2\ \text{J g}^{-1}\text{k}^{-1}$ and density of solution is $1\ \text{g mL}^{-1}$)

(A) 0.84
(B) 1
(C) 0.42
(D) 0.16

45. Which of the following ores has carbonate anion?
(A) Diaspore
(B) Calamine
(C) Willemite
(D) Argentite

46. Extraction of aluminium from bauxite does not involve which of the following steps:
(A) Crushing followed by concentration of the ore is done by Leaching process.
(B) Extraction of aluminium from concentrated ore is done by Hall Heroult process.
(C) Extraction of aluminium from concentrated ore is done by carbon.
(D) In reduction process CaF_2 is mixed with concentrated ore to reduce the melting point of the mixture and brings conductivity.

47. The cubic unit cell structure of compound containing cation A and anion B is shown below. The size of cation is smaller than anion and anion-anions are in contact. The packing efficiency of compound approximately is



(A) 73
(B) 55
(C) 85
(D) 25

48. The increase in the molar conductivity of HCl with dilution is due to
(A) Increase in the self ionization of water.
(B) Hydrolysis of HCl with dilution.
(C) Decrease in the self ionization of water.
(D) Decrease in the interionic forces by dilution.

49. The moles of $K_2Cr_2O_7$ are required to react completely with 2.4 mol of CuS in hot acidic medium
(A) 1.8
(B) 3.2
(C) 1.6
(D) 6.4

50. The value of n in the molecular formula $Be_nAl_2Si_6O_{18}$ is
(A) 2
(B) 5
(C) 4
(D) 3

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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51. The reaction of white phosphorous and excess of dry chlorine gas gives a compound Q. The number of moles of HCl produced by the complete hydrolysis of 1 mole of Q is________

52. An aqueous solution is prepared by dissolving 0.2 mole of an ionic salt in 1.86 kg of water at 27°C. The salt is only 80% dissociated in the solution. The freezing point of the solution is -0.52^oC. The number of ions present per formula unit of ionic salt is________(Given molal depression constant of water (K_f) is 1.86 K kg mol^{-1} and freezing point of water is 0°C).

53. The electrode potential of the following cell is – x at 300 K.
$Pt(s)\,|\,H_2\,(g)(4\text{ atm})\,/\,CH_3COOH(aq)\left(10^{-1}\text{ M}\right)||\,NaOH(aq)\left(10^{-3}\text{ M}\right)/\,H_2\,(g)(1\text{ atm})\,/\,Pt(s)$.
The value 1000x is_______
[Given: $\frac{2.303\ RT}{F}$ at 300 K = 0.06, log2 = 0.3, K_a for acetic acid is 10^{-5}]

54. A crystalline solid of a pure substance X has body centred cubic structure with a cell edge of 800 pm. The number of atoms present in 512 g of crystal X is $N \times 10^{22}$ if the density of the substance in the crystal is 8 g cm^{-3}. The value of N is______

55. Reaction of aqueous solution of KI with ozone produced a paramagnetic product Y. The spin only magnetic moment (in B.M.) of Y in nearest integer is________

56. 60 ml of x M $AgNO_3$ required for complete precipitation of Br^- ions present in 15 ml of 0.02 M solution of $\left[Co(NH_3)_5\,Br\right]Br_2$ as silver bromide. The value 100x is_______

57. The enthalpy change (ΔH) for the following reaction at temperature 25°C is -2573 kJ mol^{-1}.
$2C_2H_2\,(g) + 5O_2\,(g) \longrightarrow 4CO_2\,(g) + 2H_2O(g)$
The average bond enthalpy of C – H bond is x kJ mol^{-1}, if the average bond enthalpy of $C \equiv C$, $O = O$, $C = O$ and O – H bonds are 814, 499, 724 and 640 kJ mol^{-1} respectively at temperature 25°C. The x is….

58. On heating acidified NaCl with orange solid gives orange-red vapours. On passing these orange red vapours through NaOH solution turns it into yellow solution. This yellow solution gives yellow precipitate when the solution of acetic acid and lead acetate is added to this solution. The oxidation state of the element which has highest oxidation state in yellow precipitate is_______

59. In the chemical reaction between stoichiometric quantities of $KMnO_4$ and $MnSO_4$ in weakly alkaline solution, the number of moles of MnO_2 formed is Y. If 4.2 moles of $KMnO_4$ are consumed. The value of 2Y is…….

60. Ammonia is formed by reaction of ammonium chloride and calcium hydroxide. What is the volume of ammonia gas in litres (L) produced at 600 K and 0.82 atm pressure when 10.7 g of ammonium chloride and 10 ml of 5.0 M calcium hydroxide are mixed together for the reaction? (Given atomic mass in $g\,mol^{-1}$ H, N, Cl are respectively 1, 14 and 35.5 respectively, R = 0.082 atm L mol^{-1} K^{-1})

FIITJEE

Mathematics

PART – C

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

61. A function f is defined on the complex number by f(z) = (a + ib)z, where a and b are positive number. This function has the property that the image of each point in the complex plane is equidistant from that point and the origin. If |a + ib| = 8, then b^2 is

(A) $\frac{255}{4}$ (B) $\frac{245}{4}$
(C) $\frac{235}{4}$ (D) $\frac{225}{4}$

62. The smallest prime that is the fifth term of an increasing arithmetic sequence all four preceding terms also a prime is

(A) 31 (B) 29
(C) 37 (D) not possible

63. The largest two digit prime factor of ${}^{200}C_{100}$ is

(A) 61 (B) 59
(C) 17 (D) 60

64. The sum of all positive integers n for which $n^2 - 19n + 99$ is a perfect square is

(A) 36 (B) 37
(C) 39 (D) 38

65. Initially A, B and C had a total of 444 peanuts. C had the most peanuts and A had the least. The numbers of peanuts that each person had formed a G.P. A eats 5 of his peanuts, B eats 9 of its peanuts and C eats 25. Now the three numbers of peanuts each has forms an A.P. Find the number of peanuts A had initially

(A) 108 (B) 106
(C) 300 (D) 144

66. There is a 40% chance of rain on Saturday and a 30% chance of rain on Sunday. However, it is twice as likely to rain on Sunday if it rains on Saturday than if it does not rain on Saturday. The probability that it rains at least one day this weekend is

(A) $\frac{3}{10}$ (B) $\frac{3}{14}$
(C) $\frac{37}{70}$ (D) $\frac{33}{70}$

67. For polynomial $P(x) = 1 - \frac{1}{3}x + \frac{1}{6}x^2$, define $Q(x) = P(x).P(x^3).P(x^5).P(x^7).P(x^9) = \sum_{i=0}^{50} a_i x^i$, then $\sum_{i=0}^{50} |a_i| =$

(A) $\frac{275}{37}$ (B) $\frac{243}{32}$
(C) $\frac{243}{39}$ (D) $\frac{245}{37}$

68. Let x, y and z be real numbers satisfying the system

$\log_2(xyz - 3 + \log_5 x) = 5$
$\log_3(xyz - 3 + \log_5 y) = 4$
$\log_4(xyz - 3 + \log_5 z) = 4$

then the value of $|\log_5 x| + |\log_5 y| + |\log_5 z|$ is

(A) 376 (B) 378
(C) 380 (D) 382

69. Let a and b be positive integers satisfy $\frac{ab+1}{a+b} < \frac{3}{2}$, then the maximum possible value of $\frac{a^3b^3+1}{a^3+b^3}$ is

(A) $\frac{31}{9}$ (B) $\frac{65}{9}$
(C) $\frac{65}{16}$ (D) $\frac{31}{5}$

70. In three dimensional space f(x, y, z) = xy + xz, then locus of all points which satisfy the equation f(x, y, z) = 0 is

(A) pair of perpendicular lines
(B) pair of perpendicular planes
(C) pair of a line and a plane which are perpendicular to each other
(D) pair of line and plane which are parallel to each other

71. Out of all possible 8 digit numbers formed using all the digits 0, 0, 1, 1, 2, 3, 4, 4 a number is randomly selected, probability that the selected number is odd is

(A) $\frac{5}{7}$ (B) $\frac{5}{9}$
(C) $\frac{5}{11}$ (D) $\frac{5}{14}$

72. If α, β, γ are the roots of $x^3 - 3x + 1 = 0$, then the equation whose roots are $\alpha - \frac{1}{\beta\gamma}, \beta - \frac{1}{\gamma\alpha}, \gamma - \frac{1}{\alpha\beta}$ is

(A) $x^3 - 3x + 8 = 0$ (B) $x^3 - 6x + 8 = 0$
(C) $x^3 - 9x + 8 = 0$ (D) $x^3 - 12x + 8 = 0$

73. Three Arithmetic mean, three Geometric mean and three Harmonic mean are inserted between 1 and 5. The cubic equation whose roots are 3rd A.M, 2nd G.M, and 1st H.M is

(A) $x^3 - \frac{1}{4}\left(21 + 4\sqrt{5}\right)x^2 + 5x - 5\sqrt{5} = 0$

(B) $x^3 - \frac{1}{4}\left(21 + 4\sqrt{5}\right)x^2 + \left(5 + \frac{21}{4}\sqrt{5}\right)x - 5\sqrt{5} = 0$

(C) $4x^3 - \left(21 + 4\sqrt{5}\right)x^2 + \left(15 + 21\sqrt{5}\right)x - 20\sqrt{5} = 0$

(D) $4x^3 - \left(21 + 4\sqrt{5}\right)x^2 + \left(15 + 21\sqrt{5}\right)x - 5\sqrt{5} = 0$

74. If lines $\frac{x-1}{2} = \frac{y-2}{x_1} = \frac{z-3}{x_2}$ and $\frac{x-2}{3} = \frac{y-3}{4} = \frac{z-4}{5}$ lies in the same plane then for equation $x_1t^2 + (x_2 + 2)t + a = 0$

(A) $2x_1 - x_2 = 1$ (B) sum of roots of above equation = – 2
(C) $2x_1 + x_2 = -4$ (D) sum of root is 0

75. Let $\vec{a}$ and $\vec{b}$ are two perpendicular unit vectors. If $\vec{c}$ is another unit vector equally inclined at angle θ to the vectors $\vec{a}$ and $\vec{b}$, then the set of exhaustive values of θ is

(A) $\left(0, \frac{\pi}{2}\right)$ (B) $\left[0, \frac{\pi}{4}\right]$

(C) $\left(\frac{\pi}{2}, \frac{3\pi}{4}\right)$ (D) $\left[\frac{\pi}{4}, \frac{3\pi}{4}\right]$

76. If x + y + z = 1 and $0 \le x, y, z \le 1$, then the maximum value of expression 27(xy + yz + zx – 2xyz) is equal to

(A) 7 (B) 10

(C) 8 (D) 9

77. Matrix A is given by $A = \begin{bmatrix} 6 & 11 \\ 2 & 4 \end{bmatrix}$, then the determinant of $A^{2005} - 6A^{2004}$ is

(A) 2^{2006} (B) $(-11)\, 2^{2005}$

(C) $-2^{2005} \cdot 7$ (D) $(-9)\, 2^{2004}$

78. Let a, b, c be distinct cube roots of unity and $\Delta = \begin{vmatrix} a^2+b^2 & c^2 & c^2 \\ a^2 & b^2+c^2 & a^2 \\ b^2 & b^2 & c^2+a^2 \end{vmatrix}$, then

(A) Re(Δ) = 0 (B) Im(Δ) = 0

(C) Re(Δ) + Im(Δ) = 0 (D) Re(Δ)Im(Δ) = 4

79. An urn contains 4 green balls and 6 blue balls. A second urn contains 16 green balls and N blue balls. A single ball is drawn at random from each urn. The probability that both balls are of the same colour is 0.58, then (N – 140) is

(A) 5 (B) 4

(C) 6 (D) 7

80. A and B are two square matrix (all the entries of A and B are real such that $A^2B = BA$ and if $(AB)^{10} = A^k.B^{10}$ is true for all square matrices of same order for the value of k, then value of k – 1020 is

(A) 5 (B) 4

(C) 3 (D) 2

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

81. Let $f(x) = x^4 + ax^3 + bx^2 + cx + d$ be a polynomial whose roots are all negative integer, if a + b + c + d = 2009, then d is

82. If x and y are real numbers such that $\frac{(x-4)^2}{4} + \frac{y^2}{9} = 1$, then the largest possible value of $\frac{x^2}{4} + \frac{y^2}{9}$ is

83. Let p(x) be the polynomial of degree 4 with roots 1, 2, 3, 4 and leading coefficient 1. Let q(x) be the polynomial of degree 4 with roots 1, $\frac{1}{2}, \frac{1}{3}$ and $\frac{1}{4}$ and leading coefficient 1, then $\lim\limits_{x\to1}\frac{p(x)}{q(x)}$ is equal to k, then |k| is

84. Kiran is deciding whether to visit Russia or Ukrain for the holidays. She makes her decision by rolling a regular 6-sided die. If she gets 1 or 2 she goes to Ukrain, if she rolls a 3, 4 or 5 she goes to Russia. If she rolls a 6 she rolls again, the probability that she goes to Ukrain is p, then 5p is

85. There are real numbers a, b, c and d such that –20 is a root of $x^3 + ax + b = 0$ and –21 is a root of $x^3 + cx^2 + d = 0$. These two polynomials share a complex root $m + i\sqrt{n}$, where m, n are positive integers and $i = \sqrt{-1}$, then $\frac{n}{4m}$ is

86. If $A = \begin{bmatrix} a & 2 & 3 \\ 3 & 1 & 2 \\ 2 & 1 & b \end{bmatrix}$, $B = \begin{bmatrix} 2 & -5 & d \\ -8 & -2 & 7 \\ c & 3 & -5 \end{bmatrix}$ and B = adj A and |B| =

87. If the plane containing x-axis and the point (1, 1, 1) is parallel to the line $\frac{x+1}{2k} = \frac{y-1}{k} = \frac{z}{-3}$, then the value of |k| is

88. The number of ways of arranging the letters of the word **ALGEBRA** in which either vowels or consonants, but not both appear in alphabelical order is

89. If three successive terms of a G.P. with common ratio r(r > 1) form the sides of a ΔABC and [r] denotes G.I.F., then [r] + [–r] + 5 is

90. Let a three term strictly increasing arithmetic sequence of integers are one such that the sum of the squares of the three terms equals the product of the middle term and the square of the common difference, then the sum of third term of such sequence is p, then (p – 25) is

FIITJEE

ALL INDIA TEST SERIES

PART TEST – III

JEE (Main)-2023

TEST DATE: 17-12-2022

ANSWERS, HINTS & SOLUTIONS

Physics

PART – A

SECTION – A

1. C

Sol. $eV_1 = \frac{hC}{\lambda_1} - \phi$

$eV_2 = \frac{hC}{\lambda_2} - \phi$

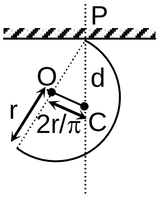
$e(V_2 - V_1) = hc\left(\frac{1}{\lambda_2} - \frac{1}{\lambda_1}\right)$

$\Rightarrow (V_2 - V_1) = \frac{hc}{e}\left(\frac{\lambda_1 - \lambda_2}{\lambda_1\lambda_2}\right)$

$= \frac{6.6\times10^{-34}\times3\times10^{8}}{1.6\times10^{-19}}\times\frac{100}{6\times10^{-5}} = 2.0625 \text{ volt}$

2. D

Sol. Use $T = 2\pi\sqrt{\frac{I_P}{mgd}}$



Where $d = \sqrt{r^2 + \left(\frac{2r}{\pi}\right)^2}$ …(i)

$I_0 = mr^2 = I_C + m\left(\frac{2r}{\pi}\right)^2$ …(ii) and $I_P = I_C + md^2$

$$I_P = I_C + m\left\{r^2 + \left(\frac{2r}{\pi}\right)^2\right\} \qquad \text{…(iii)}$$

From (ii) and (iii)

$I_P = 2mr^2$

$$T = 2\pi\sqrt{\frac{2mr^2}{mgr\left(1+\frac{4}{\pi^2}\right)^{1/2}}}$$

$$T = 2\pi\sqrt{\frac{2r}{g\left(1+\frac{4}{\pi^2}\right)^{1/2}}}$$

3. B

Sol. $R^3 = Nr^3$

$$\Rightarrow N = \frac{R^3}{r^3}$$

Energy released = $T \times 4\pi\left(Nr^2 - R^2\right)$

$$= 4\pi T\left(\frac{R^3}{r^3}r^2 - R^2\right) = 4\pi TR^2\left(\frac{R-r}{r}\right)$$

So, $\frac{1}{2}mv^2 = 4\pi TR^2\left(\frac{R-r}{r}\right)$

$$\frac{1}{2}\times\frac{4}{3}\pi R^3\rho v^2 = 4\pi TR^2\left(\frac{R-r}{r}\right)$$

$$v = \sqrt{\frac{6T(R-r)}{Rr\rho}}$$

4. A

Sol. Least count = $\frac{0.25}{5\times100}\text{cm} = 5\times10^{-4}$ cm

Reading = 4 × 0.05 cm + 30 × 5 × 10^{-4} cm
= 2.15 mm

5. D

Sol. Since, $\mu = \dfrac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

$$\cot\left(\frac{A}{2}\right) = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

$$\cos\left(\frac{A}{2}\right) = \sin\left(\frac{A+\delta_m}{2}\right)$$

$$\sin\left(\frac{\pi}{2}-\frac{A}{2}\right)=\sin\left(\frac{A+\delta_m}{2}\right)$$

$\Rightarrow \delta_m = \pi - 2A$

6. A

Sol. $\frac{mv^2}{r}=\frac{3q^2}{4\pi\varepsilon_0 r^2}\Rightarrow mvr=\frac{3q^2}{4\pi\varepsilon_0 v}$ …(i)

and $\frac{nh}{2\pi}=mvr$ …(ii)

using (i) and (ii) and putting n = 1

$$\frac{h}{2\pi}=\frac{3q^2}{4\pi\varepsilon_0 v}\Rightarrow v=\frac{3q^2}{2\varepsilon_0 h}$$

7. D

Sol. The bar is at equilibrium. The net force from right or left of a section of BC is 70 KN.

$$\Delta\ell=\frac{F\ell}{AY}=\frac{(70\times10^3)\times1}{1\times2\times10^{11}}$$

$\Delta\ell = 3.5\times10^{-7}$ m

8. C

Sol. T = 20 sec

at t = 2, v = 5 cm/s

$v = A\omega\cos\omega t$

$$v=A\times(2\pi f)\cos\left(\frac{2\pi}{T}t\right)$$

$$5=A\times\left(\frac{2\pi}{20}\right)\cos\left(\frac{2\pi}{20}t\right)$$

$$\Rightarrow \frac{A\pi}{10}\cos36^\circ=5$$

9. A

Sol. The current through circuit $i=\frac{P}{V}=\frac{100\times10^{-3}}{0.5}=0.2$ A

Voltage drop across resistance = 1.5 − 0.5 = 1 V

$$\Rightarrow R=\frac{1}{0.2}=5\Omega$$

10. C

Sol. As t is increasing μ is decreasing, so refraction is taking place from denser to rarer medium as light is proceeding in the medium. Using continuous varying refractive index, let the ray reflect back after travelling $t = t_0$ along the normal, then at this location, angle of refraction is $\frac{\pi}{2}$.

So, $1\times\sin\theta=\left(\mu_0-kt_0^2\right)\sin\left(\frac{\pi}{2}\right)$

$$\Rightarrow t_0=\sqrt{\frac{\mu_0-\sin\theta}{k}}$$

11. B

Sol. Compare the given equation with standard equation

$E_y = E_0\cos(\omega t - kx)$

$\therefore\ \omega = 2\pi \times 10^6$

$2\pi\nu = 2\pi \times 10^6$

$\Rightarrow \nu = 10^6$ Hz

$k = \pi \times 10^{-2}$

or $\dfrac{2\pi}{\lambda} = \pi \times 10^{-2}$

or $\lambda = 200$ m

12. B

Sol. For first diffraction minimum

$a\sin\theta = \lambda$

$\Rightarrow a = \dfrac{\lambda}{\sin\theta}$

For first secondary maximum, we use

$a\sin\theta' = \dfrac{3\lambda}{2}$

$\sin\theta' = \dfrac{3\lambda}{2} \times \dfrac{1}{a} = \dfrac{3\lambda}{2} \times \dfrac{\sin\theta}{\lambda}$

$= \dfrac{3}{2} \times \sin 30° = \dfrac{3}{4}$

$\theta' = \sin^{-1}\left(\dfrac{3}{4}\right)$

13. D

Sol. u = velocity of water through the hole= $\sqrt{2gh}$

R = rate of mass flow = $\rho A u$ [A = area of the hole]

F = reaction force on the wall

$= R(u - 0) = \rho A u^2$

For cylinder to just move

$\mu w = \rho A u^2 = \dfrac{\rho\pi d^2}{4}\left(\sqrt{2gh}\right)^2$

$\therefore\ d = \sqrt{\dfrac{2\mu w}{\pi\rho h g}}$

14. B

Sol. General equation of travelling wave is

$y = f(ax \pm bt) = f(x \pm vt)$

$\therefore\ y = e^{-(ax^2 + bt^2 + 2\sqrt{ab}xt)}$

$= e^{-(\sqrt{a}x + \sqrt{b}t)^2}$

So, the wave will be travelling along –x axis with speed $\sqrt{\dfrac{b}{a}}$

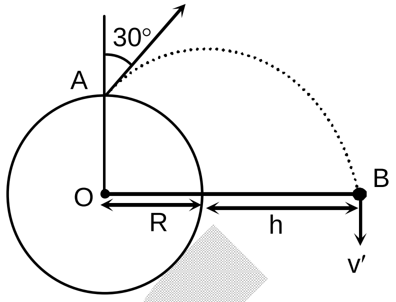
15. B

Sol. By conservation of angular momentum of the body about O

$$(mv\sin 30^\circ)R = mv'(R+h)$$

$$\frac{vR}{2} = \frac{v}{4}(R+h)$$

$\Rightarrow h = R$



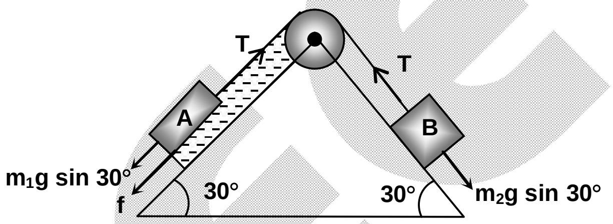
16. A

Sol. $T = m_2 g\sin 30^\circ$ …(i)

$T = m_1 g\sin 30^\circ + \dfrac{\eta A v}{\ell}$ …(ii)

From (i) and (ii)

$$\eta = \frac{(m_2 - m_1)g\ell\sin 30^\circ}{vA} = 3.46\times 10^{-3}\text{ Pa sec}$$



17. A

Sol. As all the points on the periphery of either ring are at the same distance from point P, the potential at point P due to the whole ring can be calculated as $V = -\dfrac{GM}{\sqrt{R^2+x^2}}$, where x is the axial distance from the centre of the ring. This expression is independent of the fact whether the distribution of mass is uniform or non-uniform

So, at P, $V = -\dfrac{GM}{R\sqrt{2}} - \dfrac{G2M}{R\sqrt{5}} = -\dfrac{GM}{R}\left[\dfrac{1}{\sqrt{2}} + \dfrac{2}{\sqrt{5}}\right]$

18. A

Sol. $\dfrac{\Delta\lambda}{\lambda} = \dfrac{v}{c}$

$1 = \dfrac{v}{c}$

$v = c$

19. D

Sol. Acceleration when block B is in the liquid

$$a_1 = \frac{m_A g - (m_B g - \text{upthrust})}{m_A + 3m}$$

$$= \frac{m_A g - \left(3mg - \frac{3m}{2\rho}\rho g\right)}{(m_A + 3m)}\uparrow$$

Acceleration when block B is outside of the liquid.

$$a_2 = \frac{3mg - m_A g}{m_A + 3m}$$

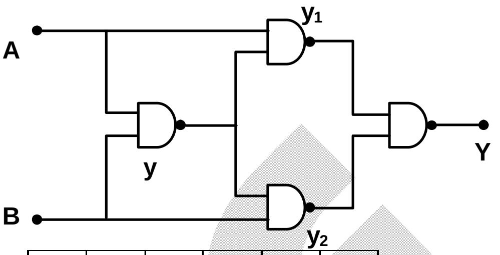
Given $a_1 = a_2$

$$\Rightarrow m_A g - \frac{3}{2}mg = 3mg - m_A g$$

$$m_A = \frac{9}{4}m$$

20. A

Sol. Output of the gates are marked as y, y_1 and y_2.



A NAND gate gives low output when both the inputs are high, otherwise it gives a high output. Now the truth table.

A	B	y	y_1	y_2	Y
0	0	1	1	1	0
0	1	1	1	0	1
1	0	1	0	1	1
1	1	0	1	1	0

SECTION – B

21. 680

Sol. $$f' = f\left(\frac{v}{v - v_s\cos\theta}\right)$$

$$f' = 640\left(\frac{340}{340 - \frac{100}{3}\cos\theta}\right)$$

$$f' = 640\left(\frac{340}{340 - \frac{100}{3}\times\frac{3}{5}}\right)$$

$\Rightarrow$ f′ = 680 Hz

22. 42

Sol. $$F = (\text{Area})\frac{I}{C}$$

Effective area = πR^2

$$F = (\pi R^2)\frac{I}{C}$$

$$F = \frac{22}{7}\times(21\times10^{-2})^2\times\frac{1}{110}\times\frac{1}{3\times10^8}$$

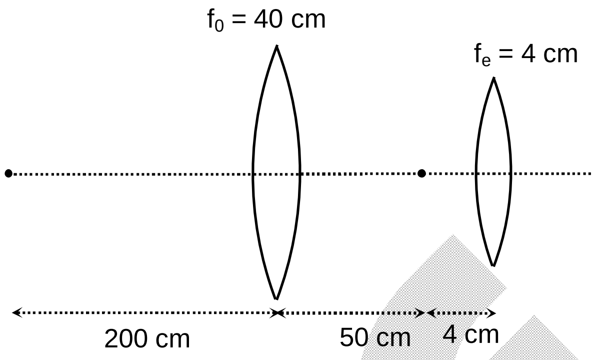
$$F = 42\times10^{-13}\text{N}$$

23. 54

Sol. $\frac{1}{v} - \frac{1}{-200} = \frac{1}{40}$

v = 50 cm

d = 50 + 4 = 54 cm



24. 25

Sol. Here $T_{1/2} = 270$ days

After 540 days, it means two half lives have been completed n = 2

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$$

$$\frac{m}{m_0} = \left(\frac{1}{2}\right)^n$$

$$\Rightarrow \frac{m}{100} = \frac{1}{4}$$

$\Rightarrow$ m = 25 mg

25. 8

Sol. If I is the intensity of the incident unpolarised light, the intensity transmitted by the first is I/2. This is the intensity of incident light on the second polaroid. Intensity transmitted by the second polaroid is $\frac{I}{2}\cos^2\theta$, where θ is the angle between the axes.

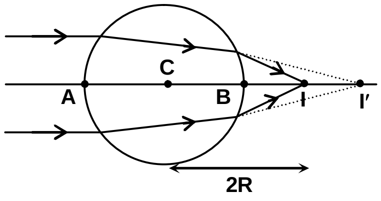
Here sin θ = 3/5 therefore cos θ = 4/5

$$\frac{I}{2}\cos^2\theta = \frac{I}{2}\left(\frac{4}{5}\right)^2 = \frac{8}{25}I$$

$\therefore \frac{8}{25}$ is the required ratio.

26. 3

Sol. from first refraction



$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$$

$$\frac{n}{v} - \frac{1}{\infty} = \frac{n-1}{R}$$

$$\frac{n}{v} = \frac{n-1}{R}$$

$$AI' = v = \frac{nR}{n-1}$$

for 2nd refraction

$$u = BI' = AI' - 2R$$

$$= \frac{nR}{n-1} - 2R$$

$= \frac{(2-n)R}{(n-1)}$

and v = R

For second surface

$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$

$\frac{1}{v} - \frac{n}{u} = \frac{1-n}{-R}$

$\frac{1}{R} - \frac{n(n-1)}{(2-n)R} = \frac{n-1}{R}$

(2 –n) – n(n –1) = (n –1) (n –2)

n = 4/3

27. 4

Sol. Let ground state energy (in eV) be E,

Then from given condition,

$E_{2n} - E_1 = 204$ eV

$\frac{E_1}{4n^2} - E_1 = 204$ eV

$E_1\left(\frac{1}{4n^2} - 1\right) = 204$ eV …(i)

and $E_{2n} - E_n = 40.8$ eV

$\frac{E_1}{4n^2} - \frac{E_1}{n^2} = 40.8$ eV

$\Rightarrow E_1 \times -\frac{3}{4n^2} = 40.8$ eV …(ii)

From (i) and (ii)

$\frac{1-\frac{1}{4n^2}}{\frac{3}{4n^2}} = 5$

n = 2

Now from equation (ii)

$E_1 = -\frac{4}{3}n^2(40.8)$

Or $E_1 = -217.6$ eV

and $E_1 = -13.6\,Z^2$

Therefore

$Z^2 = \frac{E_1}{-13.6} = \frac{-217.6}{-13.6} = 16$

Z = 4

28. 3

Sol. $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$\frac{3}{25} + \frac{1}{u} = \frac{1}{10}$

$\Rightarrow u = -50$ m

and for final position of the object

$\frac{7}{50}+\frac{1}{u}=\frac{1}{10}$

$\Rightarrow u = -25$ m

Therefore, the shift in object = 50 – 25 = 25 m

Speed = $\frac{25}{30}$ m/s = 3 km/hr

29. 200

Sol. Fundamental frequency of open pipe $f_0 = \frac{v}{2\ell}$

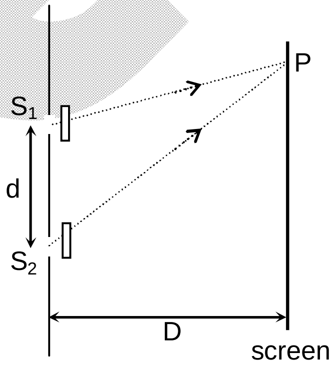
Third harmonic of the closed pipe $f_C = 3\left(\frac{v}{4}\right)$

Given $3\left(\frac{v}{4\ell}\right) = \frac{v}{2\ell}+100$

Or $\frac{v}{2\ell} = 200$ Hz

30. 8

Sol. Shift $\Delta x = \frac{\beta}{\lambda}(\mu-1)t$



Shift due to one plate = $\Delta x_1 = \frac{\beta}{\lambda}(\mu_1-1)$

Shift due to another plate = $\Delta x_2 = \frac{\beta}{\lambda}(\mu_2-1)t$

Net shift $\Delta x = (\Delta x_2 - \Delta x_1)$

$\Delta x = \frac{\beta}{\lambda}(\mu_2-\mu_1)t$ …(i)

and also $\Delta x = 5\beta$ …(ii)

Hence $5\beta = \frac{\beta}{\lambda}(\mu_2-\mu_1)t$

$\Rightarrow t = \frac{5\lambda}{(\mu_2-\mu_1)} = 8\times10^{-6}$m

$t = 8\ \mu$m

Chemistry PART – B

SECTION – A

31. D

Sol. $I_2 + \underset{(\text{hot and conc.})}{\text{NaOH}} \longrightarrow \text{NaI} + \text{NaIO}_3$

32. C

Sol. $6XeF_4 + 12H_2O \longrightarrow 4Xe + 2XeO_3 + 24HF + 3O_2$

33. A

Sol. Because half filled electronic configuration is achieved in Mn^{2+}.

34. D

Sol. Actinoid compounds are more basic than lanthanoid compounds.

35. B

Sol. $[PdCl_4]^{2-}$ has square planar geometry.

36. C

Sol. SO_3 is more harmful than SO_2. SO_2 affects the formation of chlorophyll.

37. D

Sol. $ClO^{\bullet} + O \longrightarrow Cl^{\bullet} + O_2$ reaction is involved in ozone layer depletion.

38. C

Sol. Ag_2CrO_4 is red in colour.

39. D

Sol. Dilute boric acid solution is weak antiseptic for eyes.

40. B

Sol. Bactericidal – Penicillin, Aminoglycosides and ofloxacin.
Bacteriostatic – Tetracyclin.

41. C

Sol. Multimolecular : Sol of sulphur
Macromolecular : Sol of protein, Sol of starch.

42. B

Sol. Moles of acetic acid adsorbed $= (0.6 \times 100 - 0.4 \times 100) \times 10^{-3}$

$= 20 \times 10^{-3}$

Mass of acetic acid adsorbed (W) = $20 \times 10^{-3} \times 60$ g

Mass of acetic acid adsorbed per gram activated charcoal $= \frac{1.2}{4}$

= 0.3 g.

43. C

Sol. $KE = \frac{3}{2}RT \qquad KE \propto T$

$$u_{rms} = \sqrt{\frac{3RT}{M}} \qquad u_{rms} \propto \sqrt{T}$$

$$u_{rms} \propto \frac{1}{\sqrt{M}}$$

44. D

Sol. $+5.8 = C \times 5.8 + \frac{200 \times 4.2 \times 5.8}{1000}$

1 = C + 0.84

C = 0.16 kJ/K

45. B

Sol. Calamine : $ZnCO_3$ Argentite : Ag_2S

Willemite : Zn_2SiO_4 Diaspore : $Al_2O_3.H_2O$

46. C

Sol. Extraction of aluminium from concentrated solution is not done by coke.

47. D

Sol. $PE = \frac{\frac{4}{3}\pi r_+^3 + \frac{4}{3}\pi r_-^3}{(2r_-)^3} \times 100$

$= \frac{4 \times \pi}{3 \times 8} \times 100\left[\left(\frac{r_+}{r_-}\right)^3 + 1\right]$

$= \frac{\pi}{6} \times 100\left[(0.732)^3 + 1\right]$

$= \frac{\pi}{6} \times 100 \times 1.4$

= 72.8

≈ 73

48. D

Sol. Due to decrease in the interionic forces.

49. B

Sol. $(n \times nf)_{K_2Cr_2O_7} = (n \times nf)_{CuS}$

$n \times 6 = 2.4 \times 8$

$n = \frac{2.4 \times 8}{6} = 3.2$

50. D

Sol. $n \times 2 + 2 \times 3 + 4 \times 6 - 18 \times 2 = 0$

$n = 3$

SECTION – B

51. 5

Sol. $P_4 + 10Cl_2 \longrightarrow 4PCl_5$

$PCl_5 + 4H_2O(\text{excess}) \longrightarrow H_3PO_4 + 5HCl$

52. 3

Sol. $\Delta T_f = iK_f,m$

$0.52 = i \times 1.86 \times \frac{0.2}{1.86}$

$i = 2.6$

$\alpha = \frac{i-1}{n-1}$

$(n-1) = \frac{i-1}{\alpha} = \frac{2.6-1}{0.8} = \frac{1.6}{0.8} = 2$

$n - 1 = 2$

$n = 3$

53. 462

Sol. $H_2\,(4\text{ atm}) \longrightarrow 2H^+\,(C_1) + 2e^-$

$\underline{2H^+\,(C_2) + 2e^- \longrightarrow H_2\,(1\text{ atm})}$

$H_2\,(4\text{ atm}) + 2H^+\,(C_2) \longrightarrow 2H^+\,(C_1) + H_2$

For acetic acid

$\alpha = \sqrt{\frac{K_a}{C}} = \sqrt{\frac{10^{-5}}{10^{-1}}} = 10^{-2}$

$\left[H^+\right](C_1) = C\alpha = 10^{-1} \times 10^{-2} = 10^{-3}$

From NaOH $\left[H^+\right](C_2) = 10^{-11}$

$E = \frac{0.06}{2}\log\frac{C_2^2 \times 4}{C_1^2 \times 1}$

$= 0.03\log\left(\frac{10^{-22} \times 4}{10^{-6} \times 1}\right)$

$= 0.03\left(\log 4 \times 10^{-16}\right)$

$= 0.03[-16 + 0.6]$

$= -0.03 \times 15.4$

$= -0.462$

54. 25

Sol. $d = \frac{Z \times M}{a^3 \times N}$

$N = \frac{Z \times M}{d \times a^3} = \frac{2 \times 512}{8 \times \left(8 \times 10^{-8}\right)^3} = \frac{2 \times 512 \times 10^{24}}{8 \times (8)^3}$

$= 0.25 \times 10^{24} = 25 \times 10^{22}$

55. 3

Sol. $2KI + H_2O + O_3 \longrightarrow 2KOH + I_2 + \underset{'Y"}{O_2}$

Number of unpaired electrons in O_2 = 2

$\mu = \sqrt{n(n+2)}$ B.M.

$= \sqrt{2(2+2)}$ B.M.

$= \sqrt{8}$ B.M.

= 2.83

≈ 3

56. 1

Sol. $60 \times x = 15 \times 0.02 \times 2$

$x = 0.01\,\text{M}$

57. 414

Sol. $-2573 = [2 \times 814 + 4 \times H_{C-H}] + [5 \times 499] - [8 \times 724 + 4 \times 640]$

$-2573 = [1628 + 4 \times H_{C-H} + 2495] - [5792 + 2560]$

$H_{C-H} = 414$

58. 6

Sol. $NaCl + K_2Cr_2O_7 + H_2SO_4 \longrightarrow \underset{\text{(Orange red vapours)}}{CrO_2Cl_2} + K_2SO_4 + H_2O$

$CrO_2Cl_2 + NaOH \longrightarrow \underset{\text{(Yellow solution)}}{Na_2CrO_4} + NaCl$

$Na_2CrO_4 + Pb(CH_3COOH)_2 \longrightarrow \underset{\text{(Yellow ppt.)}}{PbCrO_4} + CH_3COONa$

59. 21

Sol. $MnO_4^- + Mn^{2+} \longrightarrow MnO_2 + H_2O$

$n_f(MnO_2) = \frac{6}{5},\ n_f(MnO_4^-) = 3$

$(n_f \times n)_{MnO_2} = (n_f \times n)_{KMnO_4}$

$\frac{6}{5} \times n = 3 \times 4.2$

$n = 2.1 \times 5$

$n = 10.5$

$2Y = 2 \times 10.5 = 21$.

60. 6

Sol. $2NH_4Cl + Ca(OH)_2 \longrightarrow 2NH_3 + CaCl_2 + H_2O$

$n_{NH_4Cl} = \frac{10.7}{53.5} = 0.2$

$n_{Ca(OH)_2} = \frac{M \times V}{1000} = \frac{5 \times 10}{1000} = 0.05$

Limiting reagent is $Ca(OH)_2$

$n_{NH_3} = 0.05 \times 2 = 0.1$

PV = nRT

$0.82 \times V = 0.1 \times 0.082 \times 600$

V = 6 L

Mathematics PART – C

SECTION – A

61. A

Sol. $z = 1, f(1) = a + ib$

$\Rightarrow$ a + ib must fall on the line $\text{Re}(z) = a = \frac{1}{2}$ (By equidistant rule)

$\Rightarrow |a + ib| = 8 \Rightarrow b^2 = \frac{255}{4}$

62. B

Sol. Conceptual

63. A

Sol. If p is a prime such that $100 > p > \frac{200}{3}$, then p and 2p but not 3p belong to [1, 2, …, 200].

While just p belongs to (1, 2, …, 100), so p does not divide ${}^{200}C_{100}$ but consider 61 the largest prime < $\frac{200}{3}$

61^3 divides 200! but only 61 divides 100!
Hence 61 divides ${}^{200}C_{100}$.

64. D

Sol. If $n^2 - 19n + 99 = x^2$
$\Rightarrow n^2 - 19n + 99 - x^2 = 0$
$n = \frac{19 \pm \sqrt{4x^2 - 35}}{2}$
$4x^2 - 35 = q^2$
$(2x + 9)(2x - 9) = 35 = 7 \times 5$
$\Rightarrow x = 3$ or 9
n = 1, 9, 10 or 18

65. A

Sol. We have
$ar - 9 - (a - 5) = a(r - 1) - 4 = ar^2 - 25 - (ar - 9)$
$\Rightarrow$ $ar(r - 1) - 16$
We now have $ar^2 + (-2ar) + a = 12$
$\Rightarrow$ $3ar = 432$, $ar = 144$
$\Rightarrow$ $r = \frac{4}{3} = 108$.

66. C

Sol. Let x be the probability that it rains on Sunday given that it does not rain on Saturday.

We then have $\frac{3}{5}x + \frac{2}{x}2x = \frac{3}{10} \Rightarrow x = \frac{3}{14}$

So probability that it does not rain on either day = $\left(1 - \frac{3}{14}\right) \cdot \frac{3}{5} = \frac{33}{70}$

So the probability that rains on at least one of the day is $1 - \frac{33}{70} = \frac{37}{70}$

67. B

Sol. All the coefficient of odd powered terms is an odd number of odd degree terms multiplied together and all coefficient of even powered terms has an even number of odd degree terms multiplied together. Since every odd degree term is negative and every even degree is positive so we sum is just Q(–1) = P(–1)^5 = $\frac{243}{32}$.

68. B

Sol. $xyz - 3 + \log_5 x = 32$ …(i)
$xyz - 3 + \log_5 y = 81$ …(ii)
$xyz - 3 + \log_5 z = 256$ …(iii)
Add (i), (ii) and (iii) we have
$xyz = 125$
$\Rightarrow$ $\log_5 x = -90$
$\log_4 y = -41$
$\log_4 z = 134$

69. D

Sol. $\frac{ab+1}{a+b} < \frac{3}{2}$
$\Rightarrow$ $2ab + 2 < 3a + 3b$
$\Rightarrow$ $(2a - 3)(2b - 3) < 5$
So (2a – 3) and (2b – 3) each cannot be even or else a and b will not be integer
(2a – 3) (2b – 3) = (1, 1), (1, 3), (3, 1)
(a, b) = (2, 2), (2, 3), (3, 2)
$\frac{a^3b^3+1}{a+b} = \frac{65}{16}$ or $\frac{31}{5}$. So Ans is $\frac{31}{5}$.

70. B

Sol. x(y + z) = 0
$\Rightarrow$ x = 0, y + z = 0 pair of perpendicular plane.

71. D

Sol. Total number = ${}^7C_2 \cdot \frac{6!}{2!2!}$

Unit digit 3, ${}^6C_2 \cdot \frac{5!}{2!2!}$

Unit digit 1, ${}^6C_2 \cdot \frac{5!}{2!}$

Probability = $\frac{5}{14}$

72. D

Sol. $\alpha - \frac{1}{\beta\gamma} \Rightarrow \alpha\left(1 - \frac{1}{\alpha\beta\gamma}\right) = 2\alpha$

So, equation whose roots are 2α, 2β, 2γ are

$\left(\frac{x}{2}\right)^3 - 3\left(\frac{x}{2}\right) + 1 = 0$

$x^3 - 12x + 8 = 0$

73. B

Sol. $A_3 = 4$

$G_2 = \sqrt{5}$

$H_1 = \frac{5}{4}$

So equation is $(x - A_3)(x - G_2)(x - H_1) = 0$

74. B

Sol. Lines are coplanar if $\begin{vmatrix} 1 & 1 & 1 \\ 2 & x_1 & x_2 \\ 3 & 4 & 5 \end{vmatrix} = 0$

$\Rightarrow 2x_1 - x_2 = 2$

Also sum of roots = $\frac{-(x_2 + 2)}{x_1} = \frac{-2x_1}{x_1} = -2$.

75. D

Sol. Let $\vec{c} = \lambda\vec{a} + \mu\vec{b} + \nu(\vec{a} \times \vec{b})$, then

$\vec{a} \cdot \vec{c} = \lambda \Rightarrow \lambda = \cos\theta$.

Similarly $\mu = \cos\theta$.

also, $|\vec{c}|^2 = \lambda^2 + \mu^2 + \nu^2 |\vec{a} \times \vec{b}|^2$

$\Rightarrow 1 = 2\lambda^2 + \nu^2\left[|\vec{a}|^2|\vec{b}|^2 - (\vec{a} \cdot \vec{b})^2\right] = 2\lambda^2 + \nu^2 \qquad [\because \lambda = \mu]$

$\therefore \nu^2 = 1 - 2\lambda^2 = 1 - 2\cos^2\theta = -\cos 2\theta$.

Now $\nu^2 \geq 0 \Rightarrow \cos 2\theta \leq 0 \Rightarrow \frac{\pi}{4} \leq \theta \leq \frac{3\pi}{4}$.

76. A

Sol. $(1 - 2x)(1 - 2y)(1 - 2z) = 1 - 2\sum x + 4\sum xy - 8xyz$

$= 4\sum xy - 8xyz - 1$

$\therefore \sum xy - 2xyz = \frac{1 + (1-2x)(1-2y)(1-2z)}{4}$

$\frac{\sum(1-2x)}{3} \geq \{(1-2x)(1-2y)(1-2z)\}^{1/3}$.

$\Rightarrow (1 - 2x)(1 - 2y)(1 - 2z) \leq \frac{1}{27}$

$\Rightarrow xy + yz + zx - 2xyz \leq \frac{7}{27}$.

Equality holds for $x = y = z = \frac{1}{3}$

$\therefore$ maximum value = $\frac{7}{27}$.

77. B

Sol. $|A^{2005} - 6A^{2004}| = |A|^{2004}\,|A - 6I|$

$= 2^{2004} \cdot \begin{vmatrix} 0 & 11 \\ 2 & -2 \end{vmatrix} = (-22)\,2^{2004} = (-)\,2 \times 11 \times 2^{2004} = (-11)(2)^{2005}$.

78. B

Sol. $$\Delta = \begin{vmatrix} 0 & -2b^2 & -2a^2 \\ a^2 & b^2+c^2 & a^2 \\ b^2 & b^2 & c^2+a^2 \end{vmatrix} \quad (R_1 \to R_1 - R_2 - R_3)$$

$$= -2\begin{vmatrix} 0 & b^2 & a^2 \\ a^2 & b^2+c^2 & a^2 \\ b^2 & b^2 & c^2+a^2 \end{vmatrix}$$

$$= -2\begin{vmatrix} 0 & b^2 & a^2 \\ a^2 & c^2 & 0 \\ b^2 & 0 & c^2 \end{vmatrix} \quad (R_1 \to R_2 - R_1 \text{ and } R_3 \to R_3 - R_1)$$

$= 4a^2b^2c^2 = 4$ [as a, b, c are cube roots of unity].

79. B

Sol. First find the probability both are green, then the probability both are blue and add the two probability. The sum should be equal to 0.58.

$$\Rightarrow \quad \frac{4}{10}\times\frac{16}{16+N}+\frac{6}{10}\cdot\frac{N}{16+N}=\frac{29}{50}$$

$\Rightarrow$ N = 144

80. C

Sol. $(AB)^2 = AB.AB = A^3B^2$

$(AB)^3 = (AB)^2.AB = A^3B^2.AB = A^7.B^3$

$(AB)^4 = (AB)^3.AB = A^7.B^3.AB = A^{15}.B^4$

$\Rightarrow \quad (AB)^{10} = A^{1023}.B^{10}$

SECTION – B

81. 528

Sol. Let roots are $-x_1, -x_2, -x_3, -x_4$

$f(x) = (x + x_1)(x + x_2)(x + x_3)(x + x_4)$

$f(1) = (1 + x_1)(1 + x_2)(1 + x_3)(1 + x_4) = 1 + a + b + c + d = 2010$

Since 2010 = 2.3.5.6.7

So d is the product of 4 roots = (–1) (–2) (–4) (–66) = 528

82. 9

Sol. Take

$x = 4 + 2\cos\theta$

$y = 3\sin\theta$

83. 24

Sol. Let $f(x) = x^4 q\left(\frac{1}{x}\right)$ it has same root as 1, 2, 3, 4 as p(x), but has same coefficient as q(x). Just in reverse order, it leading coefficient is $q(0) = \frac{1}{24}$, limit will be –24.

84. 2

Sol. On each roll, the probability that Kiran decides to go to Russia is $\frac{3}{2}$ times the probability she decides to go to Ukrain, so the total probability that she goes to Russia is $\frac{3}{2}$ times the totoal probability that she goes to Ukrain. Since the total probability is 1 (they are the only two eventual outcomes) Kiran goes to Ukrain with probability $\frac{2}{5}$ and Russia with probability $\frac{3}{5}$.

85. 8

Sol. Let $z = m + \sqrt{n}\,i$

$\bar{z} = m - \sqrt{n}\,i$

i.e. $x^3 + ax + b$ has roots -20, z, $\bar{z}$ and $x^3 + cx^2 + b$ has roots -21, z, $\bar{z}$

$\Rightarrow$ $-20 + z + \bar{z} = 0$

$m = 10$

$-21z - 21\bar{z} + z\bar{z} = 0$

$-21(z + \bar{z}) + z\bar{z} = 0$

$\Rightarrow$ $n = 320$

86. 121

Sol. A.B = |A|.I

$\Rightarrow$ $|A| = -11 \therefore |B| = |A|^2 = 121$

87. 3

Sol. The plane is $y - z = 0$

$a_1b_1 + a_2b_2 + a_3b_3 = 0 \Rightarrow k = -3$

88. 943

Sol. ${}^7P_4 \times 1 + \frac{{}^7P_3}{2} + 1 - 2 = 943$

89. 4

Sol. a, ar, ar^2 in G.P. $\Rightarrow ar^2 - ar < 1 \Rightarrow r^2 - r < 1 \Rightarrow r^2 - r - 1 < 0$

$r = \frac{\sqrt{5}+1}{2}$, $[r] = 1$, $[-r] = -2$

90. 6

Sol. Let x – d, x, x + d one the sequence

So, it is given that $(x - d)^2 + x^2 + (x + d)^2 = xd^2 \Rightarrow 3x^2 + 2d^2 - xd^2 = 0 \Rightarrow 3x^2 - xd^2 + 2d^2 = 0$

$\Rightarrow x = \frac{d^2 \pm \sqrt{d^4 - 24d^2}}{6} = \frac{d^2 \pm d\sqrt{d^2 - 24}}{6}$

So, d = 5 and d = 7 are the only (+ve) integers value of d in possible, so that $\sqrt{d^2 - 24}$ a positive integer.

At d = 5, x = 5 and $x = \frac{10}{3}$, d = 7, x = 14 so, (5 + 5) + (7 + 14) = 31

FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
PART TEST – III
PAPER –1
TEST DATE: 25-12-2022

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B**.

Section – A *(01 –06, 19 – 24, 37 – 42):* This section contains **EIGHTEEN (18)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – A *(07 – 10, 25 – 28, 43 – 46):* This section contains **TWELVE (12)** Matching List Type Questions. Each question has **FOUR** statements in **List-I** entries (I), (II), (III) and (IV) and **FIVE** statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which, **ONLY ONE** of these four options is correct answer.

Section – B *(11 – 18, 29 – 36, 47 – 54):* This section contains **TWENTY FOUR (24)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.

MARKING SCHEME

Section – A (One or More than One Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If only (all) the correct option(s) is (are) chosen;
Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;
Partial marks : +2 if three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –2 In all other cases.

Section – A (Single Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct option is chosen.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –1 In all other cases.

Section – B: Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct numerical value is entered at the designated place;
Zero Marks : 0 In all other cases.

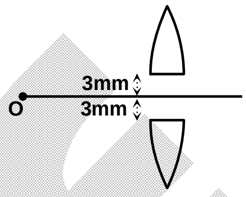
Physics

PART – I

Section – A (Maximum Marks: 24)

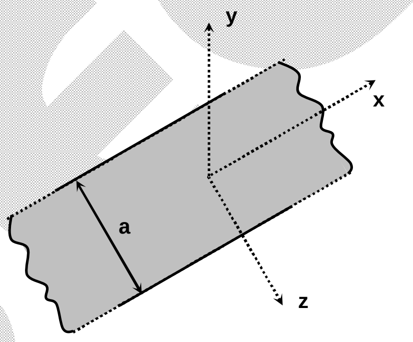
*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

1. A point object is placed at a distance of 0.4 meters from a convex lens of focal length 0.2 m. The lens is cut into two equal parts each of which is displaced vertically by 3 mm away from the optic axis as shown in figure. Mark the correct statements.



(A) Image is formed at a distance of 0.4 meter from the lens
(B) Number of images formed are 2
(C) Separation between images is 12 mm
(D) Separation between images is 6 mm

2. A thin metallic plate of uniform mass density is kept along x-axis symmetrically. The length of plate along x-axis is very large as compared to its width ‘a’ along z-axis. It is given that ‘σ’ is mass per unit area. Then choose the correct option(s)



(A) The gravitational field at $\left(0,\frac{\sqrt{3}a}{2},0\right)$ is $\frac{2G\sigma\pi}{3}$.

(B) The gravitational field at $\left(0,\frac{a}{2},0\right)$ is $G\sigma\pi$.

(C) The ratio of gravitational field at $\left(0,\frac{a}{2\sqrt{3}},0\right)$ and $\left(0,\frac{\sqrt{3}a}{2},0\right)$ is 2.

(D) The ratio of gravitational field at $\left(0,\frac{a}{2\sqrt{3}},0\right)$ and $\left(0,\frac{a}{2},0\right)$ is $\frac{4}{3}$.

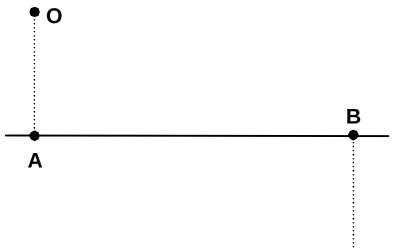
3. Choose the correct option(s).

(A) If Q value of an exothermic nuclear reaction is +15.76 MeV and the kinetic energy of products of reaction is 18.24 MeV then kinetic energy of incident particles is 2.48 MeV.
(B) In a nuclear reaction, during α-decay from a nucleus at rest, energy released is shared between alpha particle and daughter nucleus is in the form of kinetic energy and its value for α-particle has more than that of daughter nucleus.
(C) In a decay process of a radioactive element, the activity of the sample at any instant is directly proportional to the number of undecayed nuclei present in the sample at that time.
(D) Photo electric effect supports quantum nature of light because there is a minimum frequency of light below which no photoelectrons are emitted.

4. In a resonance tube experiment, a closed organ pipe of length 125 cm resonates when tuned with a tuning fork of frequency 340 Hz. If water is poured in the pipe then (Given v_{air} = 340 m/s)

(A) Minimum length of water column to have the resonance is 50 cm
(B) The distance between two successive nodes is 50 cm
(C) Maximum length of water column to create the resonance in 100 cm
(D) Maximum length of water column to create the resonance in 105 cm

5. A luminous point object is placed at O, whose image is formed at I as shown in figure. Line AB is the optical axis. Which of the following statement is/are correct?



(A) If a lens is used to obtain the image, then it must be a converging lens and its optical center will be the intersection point of line AB and OI.
(B) If a lens is used to obtain the image, then it must be a diverging lens and its optical center will be the intersection point of line AB and OI.
(C) If a mirror is used to obtain the image then the mirror must be concave and object and image subtend equal angles at the pole of the mirror.
(D) I is a real Image.

6. Point A (0, 0.1 cm) and B (12 cm, 0.5 cm) are object image pair (one of the point acts as object and the other point as image) x-axis is the principal axis of the mirror. Then this object image pair is:
(A) Due to a convex mirror of focal length 2.5 cm
(B) Due to a concave mirror having its pole at (2cm, 0)
(C) Real virtual pair
(D) Data is insufficient for (A) and (B)

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (I), (II), (III) and (IV) and FIVE statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

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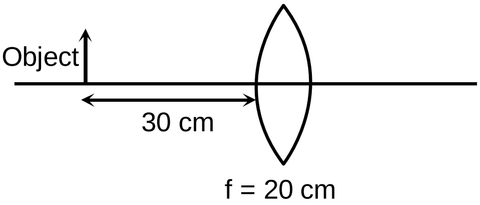
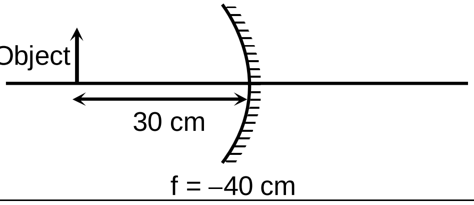
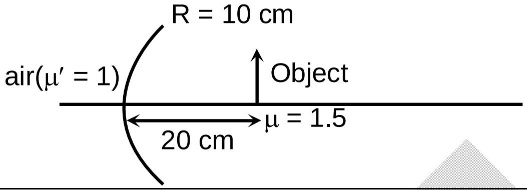
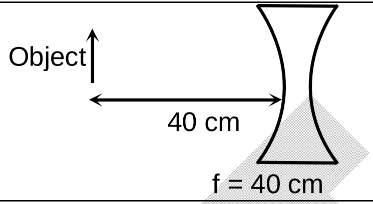
7. List –I describes physical quantities and List-II gives their dimensions.

List –I		**List -II**	
(I)	Magnetic flux	(P)	$MLT^{-3}A^{-1}$
(II)	Electrical conductivity	(Q)	$M^{-1}L^{-3}T^{3}A^{2}$
(III)	Electric field	(R)	$M^{-1}L^{-2}T^{4}A^{2}$
(IV)	Capacitance	(S)	$ML^{2}T^{-2}A^{-1}$
		(T)	$M^{2}L^{2}T^{-2}A^{-1}$

Which one of the following options is correct ?
(A) I → R, II → T, III → P, IV → P
(B) I → S, II → T, III → P, IV → P
(C) I → R, II → Q, III → Q, IV → P
(D) I → S, II → Q, III → P, IV → R

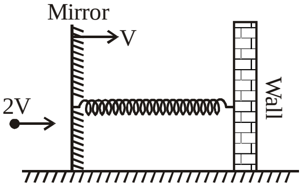
8. List –I shows the object and optical device, List-II shows nature of the image formed for paraxial approximation. Match the List-I with nature of image in List-II.

List –I		List -II	
(I)		(P)	Erect image
(II)		(Q)	Inverted image
(III)		(R)	Magnified image
(IV)		(S)	Diminished image
		(T)	Real image

Which one of the following options is correct ?

(A) I $\rightarrow$ Q,R,T II $\rightarrow$ P,S III $\rightarrow$ P,R IV $\rightarrow$ Q,R,T
(B) I $\rightarrow$ P,S II $\rightarrow$ Q,R,T III $\rightarrow$ P,S IV $\rightarrow$ P,R
(C) I $\rightarrow$ P,S II $\rightarrow$ P,R III $\rightarrow$ Q,R,T IV $\rightarrow$ P,S
(D) I $\rightarrow$ Q,R,T II $\rightarrow$ P,R III $\rightarrow$ P,R IV $\rightarrow$ P,S

9. A plane mirror is tied to the free end of an ideal spring. The other end of the spring is attached to a wall. The spring with mirror is held vertically to the floor, can slide along it smoothly. When the spring is at its natural length, the mirror is found to be moving at a speed of V with respect to ground frame. An object is moving towards the mirror with speed 2V with respect to ground frame. Then, Match the following :

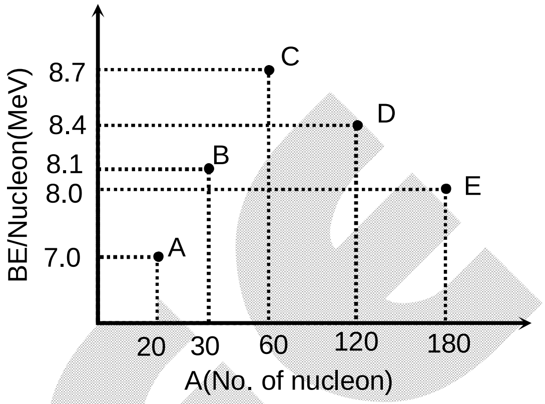


List –I		List –II	
(I)	Speed of image with respect to ground frame when spring is at natural length	(P)	V
(II)	Speed of image with respect to mirror when spring is at natural length	(Q)	O
(III)	Speed of image with respect to object when spring is at natural length	(R)	2V
(IV)	Speed of image with respect to ground frame when spring is at maximum compressed state	(S)	3V
		(T)	4V

Which one of the following options is correct ?

(A) I → Q, II → R, III → P, IV → S
(B) I → T, II → R, III → S, IV → P
(C) I → Q, II → P, III → R, IV → R
(D) I → T, II → Q, III → R, IV → P

10. Consider the position of different nuclei on the binding energy per nucleon graph as shown :



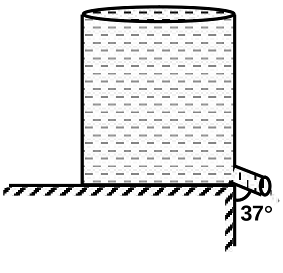
List –I (Reactions)		List –II [Q-values(MeV)]	
(I)	$2B \rightarrow C$	(P)	Zero
(II)	$2B + C \rightarrow D$	(Q)	102
(III)	$E \rightarrow C + D$	(R)	Non-zero
(IV)	$3A \rightarrow C$	(S)	36
		(T)	90

Which one of the following options is correct ?
(A) I → P,S II → P III → R,T IV → Q,R
(B) I → R,S II → P III → P,T IV → Q,R
(C) I → S,T II → P,R III → R,T IV → Q,R
(D) I → R,S II → P III → R,T IV → Q,R

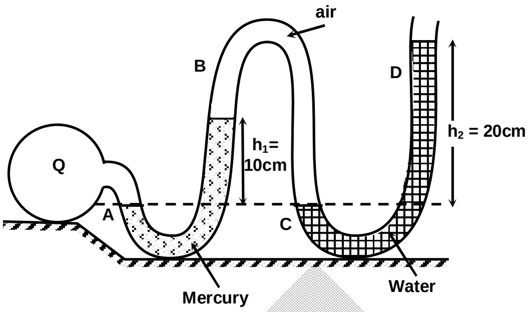
Section – B (Maximum Marks: 24)

This section contains ***EIGHT (08)*** *numerical based questions. The answer to each question is a* ***NUMERICAL VALUE.*** *If the numerical value has more than two decimal places, truncate/round-off the value to* ***TWO*** *decimal places.*

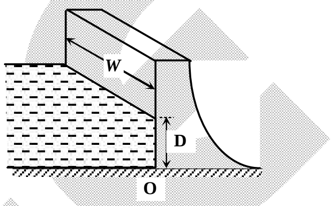
11. A cylindrical tank of cross-sectional area A filled with water upto certain height is placed on a rough horizontal surface having coefficient of friction $\mu = 0.5$. Water comes out of the tank through a small tube of cross-sectional area 'a' inclined at an angle $\theta = 37°$ with the wall of the tank as shown in the figure. Assuming Bernoulli's theorem to be applicable here, find the minimum ratio of a/A so, that the frictional force between tank and horizontal surface is limiting. Neglect the mass of the tank.



12. A bulb Q is filled with air. A tube is connected to the bulb filled with mercury and water. A column of air is trapped between mercury and water as shown in the figure. The heights of mercury and water are shown in the figure. Find the pressure inside the bulb Q(in mega N/m^2) assuming one end of tube opens to open atmosphere. Assume density of air to be small. (Take g = 10 m/s^2 and atmospheric pressure 10^5 N/m^2)



13. Water stands upto depth D, behind the vertical face of dam of width W. Given that it exerts a resultant horizontal force = 3000 kN and torque about O tending to overturn is 10000 kN-m. Find the width (in m). (Taking density of water = 1000 kg/m^3, g = 10 m/s^2)



14. A solid cylindrical piece of wood of length L = 0.5 m, cross-sectional area A = 1×10^{-2} m^2 and density ρ = 600 kg/m^3 is floating with its axis vertical in a liquid of density ρ_0 = 1200 kg/m^3. The wood is pressed down slowly into the liquid from its equilibrium position. Find the work done (in J) by the force pressing it until it is just immersed completely.

15. The resistance of a metal is given by R = V/I, where V is potential difference and I is the current. In a circuit the potential difference across resistance is V = (12±0.4)V and current in resistance I = (2±0.2)A. What is the maximum percentage error in measurement of resistance?

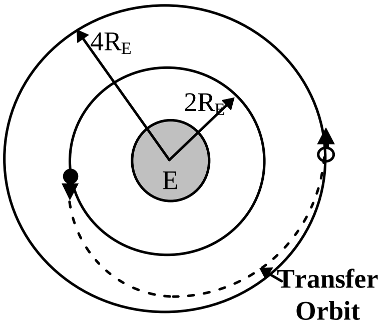
16. In a screw gauge, the graduation in the circular scale consists of 100 equal divisions and 10 complete rotation of the cap is equivalent to 5 mm on the main scale. While measuring diameter of a wire with screw gauge, a particular observation gives initial circular cap reading as 57 and after completing 3 complete rotation the final circular cap reading as 63. It is observed that while proceeding from initial reading to final reading the cap reading increases. Calculate the diameter of the wire (in mm) from the above data.

17. In the measurement of the focal length of a convex lens using the u-v method the following values were obtained:

u	35 cm	40 cm	50 cm	60 cm
v	46.2 cm	40.5 cm	33 cm	30.5 cm

Find the value of focal length by taking the average of the measurements. If the errors in u and v are 0.4 cm respectively, estimate the error in the measurement of focal length in a typical measurement (in cm).

18. An artificial satellite of mass m orbiting the earth in a circular orbit of radius twice the earth's radius R. It is to be taken in another circular orbit of radius 4R. The transfer is accomplished through an elliptical orbit as shown in the figure. The energy needed to complete the job is calculated to be equal to $\frac{1}{k}\left(\frac{GMm}{R}\right)$, where M is the mass of the earth. Find the value of k.



Chemistry PART – II

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

19. 500 ml aqueous solution is made by dissolving a certain amount of Na_2CO_3 and NaOH mixture. 100 ml of this solution require 40 ml, 0.1 M HCl solution for the colour change when phenolphthalein is used as indicator, while 60 ml 0.1 N HCl require for the colour change when methyl orange is used as indicator in a separate titration. The correct option(s) is/are
(A) Weight % of NaOH in the mixture is 27.4.
(B) Weight of NaOH in the mixture is 0.08 gm.
(C) Weight of Na_2CO_3 in the mixture is 1.06 gm.
(D) Total weight of mixture is 0.292 gm.

20. The possible product(s) obtained by the hydrolysis (partial or complete) of XeF_6 is/are
(A) XeO_3
(B) $XeOF_4$
(C) XeO_3F_2
(D) XeO_2F_2

21. The INCORRECT statement(s) among the following is/are
(A) Multilayer adsorption of any gas on a solid surface is physisorption.
(B) The plot of log(x/m) vs. log(P) in the Freundlich adsorption isotherm is straight line with negative slope.
(C) High pressure and high temperature is favourable condition for physisorption.
(D) The magnitude for heat of adsorption of chemisorption is lower than physisorption.

22. Which of the following is correct?
(A) van Arkel method is used for the purification of Ti.
(B) Poling is used for purification of Cu.
(C) Mond's process is used for the purification of Au.
(D) Cupellation is used for the purification of Ag.

23. A gaseous mixture of 1 : 2 molar ratio of CH_4 and He diffuses two times slower than a gas 'X' under identical condition. Which of the following statement(s) is/are true about the gas 'X"?
(A) The gas "X' is O_2.
(B) The gas 'X' diffuse $\sqrt{2}$ times faster than He gas under identical condition.
(C) The gas 'X' is lightest known molecule.
(D) The gas 'X' diffuses 4 times slower than H_2 gas under identical condition.

24. A compound has two isomeric liquid 'A' and 'B' with pure vapour pressure $P_A^o = 100$ torr and $P_B^o = 80$ torr at 298 K. The binary solution of liquid A and B is in equilibrium with its vapour. The molar ratio of A and B in its liquid form is found to be 1 : 2 at room temperature. Which of the following options are correct?
(A) Mass ratio of A and B in vapour phase is 5 : 8.
(B) Mole ratio of A and B in vapour phase is 1 : 2.
(C) Mole ratio of A and B in vapour phase is 5 : 8.
(D) Total vapour pressure of the solution is $\frac{260}{3}$ torr.

Section – A (Maximum Marks: 12)

This section contains ***FOUR (04)*** *Matching List Type Questions. Each question has FOUR statements in* ***List-I*** *entries (I), (II), (III) and (IV) and FIVE statements in* ***List-II*** *entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which* ***ONLY ONE*** *of these four options is correct answer.*

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25. List-I contains processes List-II contains metal or their compound used as catalyst

List – I		**List – II**	
(I)	Ziglar-Natta catalyst	(P)	V_2O_5
(II)	Ostwald process	(Q)	$TiCl_4$
(III)	Contact process	(R)	Fe
(IV)	Haber-Bosch process	(S)	Pt
		(T)	$Al(C_2H_5)_3$

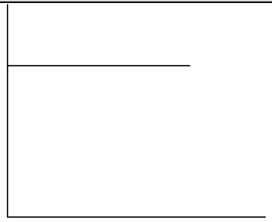
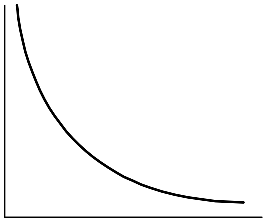
(A) I→Q; II→P; III→T; IV→R
(B) I→T; II→Q; III→R; IV→S
(C) I→Q,T; II→R; III→P; IV→S
(D) I→Q,T; II→S; III→P; IV→R

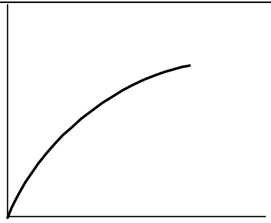
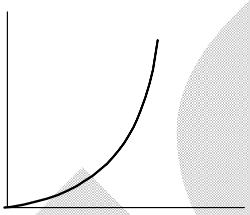
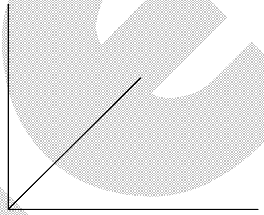
26. Match the List-I with List-II

List – I		**List – II**	
(I)	The process is mainly applicable for sulphide ore	(P)	Froth floatation
(II)	The process is mainly applicable for carbonates	(Q)	Calcination
(III)	Physical method of separation	(R)	Roasting
(IV)	Chemical method of separation	(S)	Leaching
		(T)	Concentration of the ore

(A) I→S; II→P; III→P,S; IV→Q
(B) I→P, R; II→Q; III→P; IV→S
(C) I→Q,R; II→P; III→T; IV→P
(D) I→R; II→T; III→Q; IV→S, R

27. Match the correct graph, if the process is taken place at constant temperature for the fixed amount of ideal gas

List – I		**List – II**	
(I)	P vs. $\frac{1}{V^2}$	(P)	
(II)	P vs. $\frac{1}{V}$	(Q)	

(III)	$\frac{1}{P^2}$ vs. V	(R)	
(IV)	PV vs. V	(S)	
		(T)	

(A) I→R; II→S; III→Q; IV→P
(B) I→S; II→T; III→R; IV→P
(C) I→S; II→Q; III→P; IV→R
(D) I→S; II→P; III→R; IV→R

28. List-I contains metal complexes and List-II contains their properties

List – I		**List – II**	
(I)	$\left[Cr\left(H_2O\right)_6\right]^{3+}$	(P)	Central atom is sp^3d^2 hybridisation
(II)	$\left[Co\left(CN\right)_6\right]^{3-}$	(Q)	Central atom is d^2sp^3 hybridized
(III)	$[CuF_6]^{4-}$	(R)	t_{2g} orbital contains 6 electron
(IV)	$[MnF_6]^{3-}$	(S)	Unsymmetrical e_g orbitation electronic configuration
		(T)	3-unpaired electron present

[Given atomic number of Cr = 24, Co = 27, Ni = 28, Mn = 25]
(A) I→Q,T; II→Q, R; III→Q,R; IV→P, S
(B) I→P,T; II→Q, R; III→R, S; IV→P,S
(C) I→Q,S, T; II→Q,R; III→P, R, S; IV→P, T
(D) I→Q,T; II→Q, R; III→P,S; IV→P, S

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

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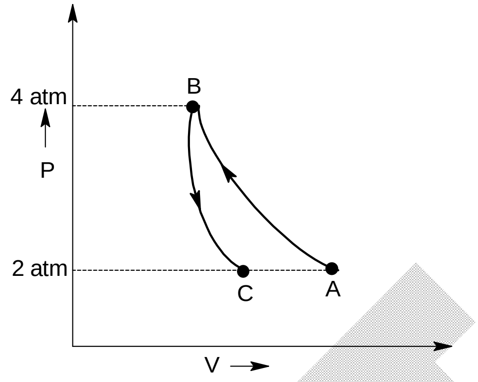
29. The EMF of the cell at 298 K
$Ag \mid AgBr(s), KBr(1\ M) \| AgNO_3(0.1\ M)/Ag(s)$ is 0.591 V. If in aq. solution $AgNO_3$ dissociate 80% and KBr dissociate 75%, the solubility of AgBr found to be $x \times 10^{-12}$ mol/litre. The value of x is

30. One mole of an ideal gas $\left(C_{p,m} = \frac{5}{2}R\right)$ at 500 K follows path $A \to B$ (Reversible isothermal) and then $B \to C$ (Reversible adiabatic) as shown in graph. What will be the volume of gas (in litre) at point C?
[Given $R = 0.082$, $2^{3/5} = 1.52$]

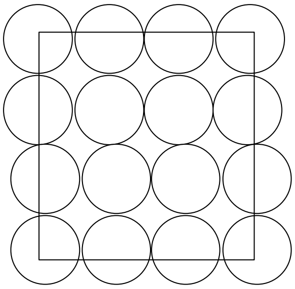


31. AgX crystallizes in rock salt like structure in which X^- occupy FCC lattice site. The density of AgX crystal found to be $\frac{40}{6.022}\ g/cm^3$ and the edge length of the unit cell is 600 pm. What will be the mass of 1 mole unit cell if all the atoms along one body diagonal of each unit cell have been removed. [Given : Atomic weight of = 108 g/mol, $N_A = 6.022 \times 10^{23}$]

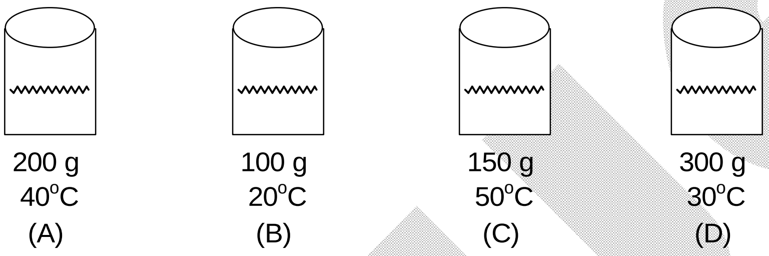
32. An excess amount of $CaCO_3$ is treated with 600 ml, 0.1 N HCl solution. The obtained $CaCl_2$ is used for the preparation of plaster of paris. The maximum amount of plaster of paris (in gram) that could be obtained is? [At. wt. of Ca = 40, S = 32, O = 16, C = 12, H = 1]

33. An aqueous solution of 0.2 M CH_3COOH is placed between parallel electrodes separated 1 cm apart with cross sectional area 1 cm^2. The resistance of solution is found to be $50\,\Omega$. What will be the osmotic pressure of same acetic acid solution at 300 K in atm?
[Given $\lambda_M^o\ CH_3COO^- = 50\ S\ cm^2\ mol^{-1}$, $\lambda_M^o\ H^+ = 350\ S\ cm^2\ mol^{-1}$, $R = \frac{1}{12}\ lit\ atm\ K^{-1}\ mol^{-1}$

34. The % packing efficiency of two dimensional square close packed unit cell shown below is $(\pi = 3.14)$



35. All four identical beakers containing $H_2O(\ell)$ (shown below) is heated separately to reach temperature 90°C, for this purpose w, x, y, and z Joule energy is required. If the magnitude of thermal energy required is w < x < y < z then what is the value of $\frac{x}{y}$. (Assuming there is no loss of $H_2O(\ell)$ during heating)



36. 45 gram of anhydrous oxalic acid is present in 500 ml solution. If 50 ml of this solution is shaken with 0.2 gram of wood charcoal, the concentration of oxalic acid become 0.6 molar. The amount of (in gm) oxalic acid adsorbed per gram of charcoal is [M.Wt. of C = 12, O = 16, H = 1).
[Assuming volume of solution remains same after adsorption]

Mathematics

PART – III

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

37. Starting at (–3, –3) a bug moves in the co-ordinate plane via a sequence of steps, each of length one, each step is left, right, up or down all four being equally likely, if P_n is the probability that object reaches (–1, –1) first time in 'n' steps, then which of the following is/are CORRECT?

(A) $P_4 = \frac{3}{128}$
(B) $P_5 + P_6 = \frac{3}{128}$
(C) $P_4 + P_6 = \frac{3}{64}$
(D) $P_4 + P_5 = \frac{3}{64}$

38. Let $\vec{a}$ and $\vec{b}$ be two vectors such that $|\vec{a}| = 4$, $|\vec{b}| = 3$ & $\vec{a}\cdot\vec{b} = 6\sqrt{3}$ and let $\vec{P}_1$ and $\vec{P}_2$ be two vectors such that $\vec{P}_1 = (\vec{a}\cdot\hat{b})\hat{b} - |\vec{a}|(\hat{a}\cdot\hat{b})^2\,\hat{a}$, $\vec{P}_2 = \vec{a} - (\vec{a}\cdot\hat{b})\hat{b} + \vec{P}_1$ and vector $\vec{P}_3$ is parallel to vector $\vec{a}\times\vec{b}$ such that $|\vec{P}_3| = 6$, then which of the following is/are CORRECT?

(A) $|\vec{P}_1| + |\vec{P}_2| = 1 + \sqrt{3}$
(B) $|\vec{P}_3\cdot(\vec{P}_1\times\vec{P}_2)| = 18\sqrt{3}$
(C) $|\vec{P}_1| + |\vec{P}_2| = 4 + \sqrt{3}$
(D) $|\vec{P}_3\cdot(\vec{P}_1\times\vec{P}_2)| = 6\sqrt{3}$

39. If $\sum_{r=0}^{1000}\frac{\left({}^{1000}C_r\right)}{\left({}^{2019}C_r\right)} = \frac{m}{n}$ (where m and n are relatively prime positive integers) and $N = \left[\frac{m}{n}\right] + \left[\frac{2m}{n}\right] + \ldots.. + \left[\frac{(n-1)m}{n}\right]$ (where [.] represents greatest integer function), then which of the following is/are CORRECT?

(A) m + n = 100
(B) N is divisible by 3
(C) N is divisible by 5
(D) m – n = 50

40. If all the complex number z = x + iy, x, y ∈ R, $i = \sqrt{-1}$, such that points of complex coordinates z, z^2, z^3, z^4 in this given order, are the vertices of a cyclic quadrilateral (z ≠ 0 + i0, 1 + i0), then

(A) $\arg z \in \left(0, \frac{2\pi}{3}\right)$
(B) $\arg z \in \left(\frac{2\pi}{3}, \frac{4\pi}{3}\right)$
(C) $\frac{1+z+z^2}{z}$ is purely real
(D) $\arg z \in \left(\frac{4\pi}{3}, 2\pi\right)$

41. Let M_1, M_2 be two matrices of order 3 × 3, all the elements of both the matrices are real numbers and $(M_1)^2 + (M_2)^2 = O$ (where O is null matrix), then which of the following statements is/are CORRECT?

(A) $\det(M_1) + \det(M_2) = 0$
(B) There exist a non-null matrix M of order 3 × 3, such $(MM_1 + MM_2)$ is invertible matrix
(C) There exist infinitely many ordered pair of (a, b), a, b ∈ R, such that $\det((aM_1) + (bM_2)) = 0$
(D) There exist infinitely many matrix M of order 3 × 3 such that $M(M_1 + M_2)$ is non-invertible matrix

42. Let z_1, z_2, z_3 be three complex numbers of unit modulus such that $z_1 + z_2 + z_3 \neq 0$ and $z_1^2 + z_2^2 + z_3^2 = 0$, then which of the following is/are CORRECT?

(A) $\left|z_1^3 + z_2^3 + z_3^3\right| = 1$

(B) $\left|z_1^{2021} + z_2^{2021} + z_3^{2021}\right| = 2$

(C) z_1^2, z_2^2, z_3^2 are collinear

(D) $\left|z_1^{2023} + z_2^{2023} + z_3^{2023}\right| = 0$

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (I), (II), (III) and (IV) and FIVE statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

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43. For any finite set S, let n(S) denote the number of elements in S, suppose A and B are two subset of {1, 2, 3, 4, 5} that satisfy $n(A)\cdot n(B) = n(A \cap B)\cdot n(A \cup B)$ and P(E) is the probability of occurrence of event E, then (where n(A) is number of elements in the set A)

List-I		**List-II**	
(I)	$P(n(A) > n(B))$	(P)	$\frac{32}{211}$
(II)	$P(n(A) \le n(B))$	(Q)	$\frac{211}{454}$
(III)	$P\left((n(A) = n(B)) \big/ (n(A) \ge n(B))\right)$	(R)	$\frac{32}{454}$
(IV)	$P(n(A) = n(B))$	(S)	$\frac{243}{454}$
		(T)	$\frac{32}{243}$

The correct option is:

(A) (I) → (P); (II) → (S); (III) → (T); (IV) → (Q)

(B) (I) → (Q); (II) → (S); (III) → (T); (IV) → (R)

(C) (I) → (T); (II) → (R); (III) → (P); (IV) → (Q)

(D) (I) → (Q); (II) → (T); (III) → (P); (IV) → (R)

44. Consider the matrices $M = \begin{bmatrix} a & b & c \\ c & a & b \\ b & c & a \end{bmatrix}$ such that det(M) = 1, a, b, c $\in$R, then

List-I		**List-II**	
(I)	There is only one matrix M	(P)	$a \in \{-1, 0, 1\}$, $b \in \{-2, -1, 0\}$, $c \in \{1, 2, 3\}$
(II)	There are two distinct matrices M	(Q)	$a \in \{-1, 0, 1\}$, $b \in \{-2, 0, 1\}$, $c \in \{-2, -1, 0\}$
(III)	There are more than 2, but finitely many matrices M	(R)	a, b, c $\in$ {0, 1, 2}
(IV)	There are infinitely many matrices M	(S)	a, b, c all are negative integers
		(T)	a, b, c $\in$ Q

The correct option is:

(A) (I) → (P); (II) → (T); (III) → (R); (IV) → (S)

(B) (I) → (S); (II) → (Q); (III) → (R); (IV) → (T)

(C) (I) → (P); (II) → (R); (III) → (T); (IV) → (S)

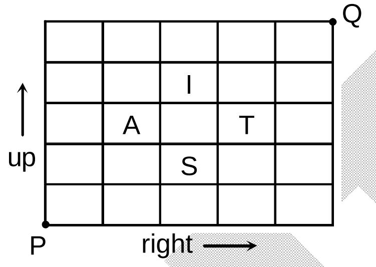
(D) (I) → (P); (II) → (Q); (III) → (R); (IV) → (T)

45. If $z_1, z_2, ..., z_8$ are the roots of the equation $(z^2 - 4z + 4)^4 = (9)^4$, such that $\arg z_1 < \arg z_2 < ... < \arg z_8$. (where $\arg z \in [0, 2\pi)$). Let z_k is a complex number satisfying the equation $|z_k - z_4| = |z_8 - z_k|$, and let
$L = |(z_k - z_2)(z_k - z_3)(z_k - z_4)(z_k - z_5)|$, then

List-I		List-II	
(I)	$z_k = 3 + i$	(P)	$L = 3^4$
(II)	$z_k = 5 + 3i$	(Q)	$L = \sqrt{\left(\frac{3\sqrt{2}-3}{3\sqrt{2}+3}\right)(3^8 \cdot 2^4 - 3^8)}$
(III)	$z_k = 2 + i0$	(R)	$L = \sqrt{\frac{1}{5}\cdot(3^8 - 2^8)}$
(IV)	$Z_k = 0 + i0$	(S)	$L = \sqrt{\left(\frac{3-\sqrt{2}}{3+\sqrt{2}}\right)(3^8 - 2^4)}$
		(T)	$L = 2^4$

The correct option is:
(A) (I) → (T); (II) → (P); (III) → (S); (IV) → (R)
(B) (I) → (S); (II) → (Q); (III) → (P); (IV) → (T)
(C) (I) → (T); (II) → (P); (III) → (R); (IV) → (S)
(D) (I) → (S); (II) → (Q); (III) → (P); (IV) → (R)

46. A square of 5 × 5 unit^2 area is shown is the diagram, contain 25 square of 1 × 1 unit^2 area. A person can move on this grid (on the sides of small squares) either right or up, then



List-I		List-II	
(I)	Number of such paths from point P to point Q which do not touch the boundary of squares (1 × 1 unit^2 area) contain alphabets A, I, T and S	(P)	73
(II)	Number of such paths from point P to point Q which do not crosses the diagonal PQ at any moment	(Q)	84
(III)	How many rectangles can be formed by joining small (1 × 1 unit^2 area) so that none of rectangles contain alphabets A, I, T and S	(R)	218
(IV)	Number of such paths from P to Q, which always pass through the boundaries of the square which contain either (A and I) or (T and S)	(S)	144
		(T)	4

The correct option is:
(A) (I) → (T); (II) → (P); (III) → (Q); (IV) → (R)
(B) (I) → (P); (II) → (Q); (III) → (T); (IV) → (S)
(C) (I) → (T); (II) → (Q); (III) → (P); (IV) → (R)
(D) (I) → (Q); (II) → (R); (III) → (P); (IV) → (T)

Section – B (Maximum Marks: 24)

This section contains ***EIGHT (08)*** *numerical based questions. The answer to each question is a* ***NUMERICAL VALUE.*** *If the numerical value has more than two decimal places, truncate/round-off the value to* ***TWO*** *decimal places.*

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47. Each unit square of a 3 by 3 unit grid is to be cloured either green or blue for each square, either colour is equally likely. If the probability of obtaining a grid that does not have any 2 by 2 green square is $\frac{p}{q}$, where p, q $\in$ N and p, q are coprime, then the value of |p – q|

48. A person can take one step or two steps or three steps at a time. If "P" is the number of distinct ways he can cover 8 steps, then value of P is

49. Consider a polynomial $f(x) = a_1x^3 + a_2x^2 + a_3x + a_4$ such that $a_1, a_2, a_3, a_4 \in \{0, 1, 2, \ldots, 8, 9\}$, how many such polynomial of degree three or less than three such that $a_1 - a_2 + a_3 - a_4 + 9 = 0$

50. If $A = \begin{bmatrix} a & c \\ b & d \end{bmatrix}$, a, b, c, d $\in$ R such that det(A) + Tr(A) = 2, then minimum value of det(A^2 + det(A)A + Tr(A)·I_2) is (where Tr(A) is trace of A and I_2 is identity matrix of order 2 × 2)

51. Let f(x) be a least degree unique polynomial with rational coefficients such that, when f(x) divided by ($x^2 + x + 1$), the remainder is x + 2 and when f(x) divided by ($x^2 + 1$), the remainder is 2x + 1, then find the sum of squares of coefficients of the polynomial f(x) is

52. In a tetrahedron OPQR, $\vec{p}, \vec{q}, \vec{r}$ are position vector of vertices P, Q and R respectively and O is origin. If OP = QR = α, OQ = PR = β, OR = PQ = γ and G_1 and G_2 are centroid of ΔPQR and ΔPOR respectively such that $OG_1 \perp QG_2$, then the value of $\frac{\alpha^2 + \gamma^2}{\beta^2}$ is

53. If $x^2 + px + q = 0$ has two distinct real roots and $(x^2 + 2x - 1)^2 + p(x^2 + 2x - 1) + q = 0$ has four distinct real roots $\alpha, \beta, \gamma, \delta$ such that $\alpha < \beta < \gamma < \delta$ and $\alpha, \beta, \gamma, \delta$ form an arithmetic sequence, then maximum values of (p – q) is

54. If $m = e^{i\frac{\pi}{6}}$ and $n = e^{i\frac{2\pi}{3}}$, where $i = \sqrt{-1}$ two complex numbers, then number of ordered pair of (p, q), p, q $\in$ integers and $1 \le$ p, q ≤ 100 which satisfy the equation $(n)^q = i(m)^p$, is

FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
PART TEST – III
PAPER –2
TEST DATE: 25-12-2022

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B**.

Section – A *(01 – 04, 19 – 22, 37 – 40)*: This section contains **TWELVE (12)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.

Section – A *(05 –10, 23 – 28, 41 – 46)*: This section contains **EIGHTEEN (18)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – B *(11 – 18, 29 – 36, 47 – 54)*: This section contains **TWENTY FOUR (24)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.**

MARKING SCHEME

Section – A (Single Correct): Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +3 If ONLY the correct option is chosen.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –1 In all other cases.

Section – A (One or More than One Correct): Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +4 If only (all) the correct option(s) is (are) chosen;
Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;
Partial marks : +2 if three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –2 In all other cases.

Section – B: Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +3 If ONLY the correct integer is entered;
Zero Marks : 0 Question is unanswered;
Negative Marks : –1 In all other cases.

Physics

PART – I

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

1. The refracting angle of a prism is 60º. What should be the minimum value of the refractive index of the material from which the prism is to be made so that light cannot emerge from the second refracting surface.

(A) $\frac{\sqrt{3}}{2}$ (B) 2

(C) 1.5 (D) $\frac{2}{\sqrt{3}}$

2. The de-Broglie wavelength of Helium atom of mass 'm' having energy corresponding to the mean thermal energy at a temperature of 'T' Kelvin (k_B is Boltzmann constant) is

(A) $\frac{h}{\sqrt{6mk_BT}}$ (B) $\frac{h}{\sqrt{3mk_BT}}$

(C) $\frac{h}{\sqrt{2mk_BT}}$ (D) $\frac{h}{\sqrt{mk_BT}}$.

3. If K_α radiation of copper Cu(Z=29) has a wavelength of 1.52 Å, the wavelength of the corresponding radiation of molybdenum $\text{Mo}(Z = 42)$ is

(A) 0.71 Å (B) 1.71 Å

(C) 0.50 Å (D) 1.5 Å.

4. The atomic ratio between the uranium isotopes ^{238}U and ^{234}U in a mineral is 1.8×10^4. The activity of both the isotopes at the given moment is same. The half life of ^{238}U is $T_{1/2}(^{238}U) = 4.5\times10^9\,\text{yr}$, the half life of ^{234}U is

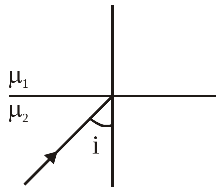
(A) 4.05×10^{13} yr (B) 2.5×10^5 yr

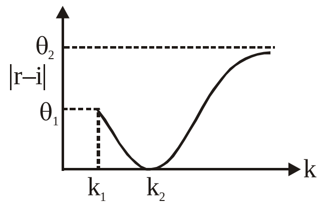
(C) 2.00×10^{13} yr (D) 8.1×10^{13} yr.

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

5. The figure shown a ray of light incident at an angle i = π/3. For different values of μ_1 and μ_2 angle of refraction is difference. The plot drawn shows the variation of |r – i| versus $\frac{\mu_1}{\mu_2} = k$, (r = angle of refraction).



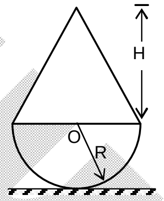


(A) The value of k_1 is $\frac{2}{\sqrt{3}}$ (B) The value of $\theta_1 = \pi/6$

(C) The value of $\theta_2 = \pi/3$ (D) The value of k_2 is 1

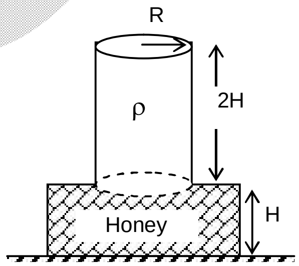
6. Two plane mirrors at an angle such that a ray incident on a mirror undergoes a total deviation of 240º after two reflections.
   (A) The angle between the mirrors is 60º.
   (B) The number of images formed by this system will be 5, if an object is placed symmetrically between the mirrors.
   (C) The number of images will be 5 if an object is kept un-symmetrically between the mirrors.
   (D) A ray will retrace its path after 2 successive reflections, if the angle of incidence with one mirror is 60º.

7. It is desired to construct a toy by attaching a solid cone of height H on the top of solid hemisphere as shown in the figure. The radius of the hemisphere and the base of cone is R. The whole system is kept on a rough horizontal surface. If the toy is slightly disturbed from the given equilibrium position it oscillates simple harmonically. Then mark the correct statements. (Given that both the cone and hemisphere are made of same material)



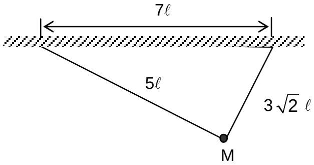
   (A) $H < \sqrt{3}R$
   (B) $H > \sqrt{3}R$
   (C) $\sqrt{3}R < H < 2R$
   (D) centre of mass of the combined system must not be above O.

8. A bottle is kept on the ground as shown in the figure. The bottle can be modelled as having two cylindrical zones. The lower zone of the bottle has a cross-sectional radius of $R\sqrt{2}$ and is filled with honey of density 2ρ. The upper zone of the bottle is filled with the water of density ρ and has a cross-sectional radius R. The height of the lower zone is H while that of the upper zone is 2H. If now the honey and the water parts are mixed together to form a homogeneous solution (Assume that total volume does not change)



   (A) The pressure inside the bottle at the base will remain unaltered.
   (B) The normal reaction on the bottle from the ground will remain unaltered.
   (C) The pressure inside the bottle at the base will increase by an amount $(1/2)\rho gH$
   (D) The pressure inside the bottle at the base will decrease by an amount $(1/4)\rho gH$

9. A particle is suspended by two ideal strings as shown in the figure. Now mass m is given a small displacement perpendicular to the plane of triangle formed. Choose the correct statement(s).



   (A) The period of oscillation of the system is $2\pi\sqrt{\frac{3\sqrt{3}\ell}{g}}$.
   (B) The period of oscillation of the system is $2\pi\sqrt{\frac{3\ell}{g}}$.
   (C) The period of oscillation of the system is independent of M.
   (D) If the distance between the suspension points was kept constant and the lengths of the strings were quadrupled then the period of the system will double.

10. Two spherical bodies, each of mass M, are kept with their centres at a distance 2L apart. A particle of mass m is projected from the mid-point of the line joining their centres, perpendicular to the line. The gravitational constant is G. Which of the following statements is/are true?
(A) The minimum initial velocity of the mass m to escape the gravitational field of the two bodies is $4\sqrt{\frac{GM}{L}}$
(B) The minimum initial velocity of the mass m to escape the gravitational field of the two bodies is $2\sqrt{\frac{GM}{L}}$
(C) The minimum initial velocity of the mass m to escape the gravitational field of the two bodies is $\sqrt{\frac{2GM}{L}}$
(D) The total mechanical energy of the mass m remains constant.

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.***

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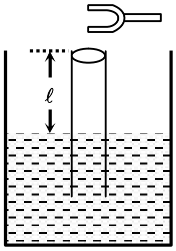
11. A man is looking down a 9 m deep tank filled with a transparent liquid of refractive index √3. The line of sight of the man makes an angle of 30° with the horizontal. What is the apparent depth of the tank (in meter) as seen by the man?

12. A tuning fork of known frequency is held at the open end of a long tube, which is dipped into water as shown in the figure. The tuning fork of frequency 165 Hz resonates in first and second harmonic when air columns have lengths ℓ_1 = 50 ±0.5 cm and ℓ_2 = 150 ± 0.1 cm. Find the maximum possible error in measurement of speed of sound(in m/s) in air.



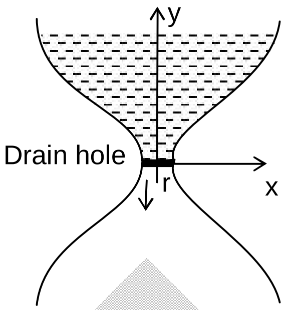
13. A standing wave exists in a string of length 150cm and is fixed at both ends. The displacement amplitude of a point at a distance of 10cm from one of the ends is $5\sqrt{3}$ mm. The distance between the two nearest points, within the same loop and having displacement amplitude equal to $5\sqrt{3}$ mm, is 10cm. Find the mode of vibration of the string i.e. the harmonic produced.

14. A uniform inextensible string of length L= 6m and linear density μ is suspended vertically and a transverse pulse is produced at the lower end. At the same time a point object is released from rest from the top of the string and falls freely. How far (in meter) from the top does the object passes the pulse?

15. A person standing between two parallel hills, fires a gun. He hears the first echo after 1.5sec and the second after 2.5 sec. The speed of sound is 332 m/s. When will he hear the third echo?

16. A point source of power 50π watts is producing sound waves. The velocity of sound is 330m/s, density of air is 1.0 kgm^{-3}. Then find the pressure amplitude (in Nm^{-2}) at a distance r = $\sqrt{330}$m from the point source.

17. The shape of an ancient water clock jar is such that the water level descends at a constant rate at all times. The water level falls by λ m/s and the shape of the jar is given by $y \propto x^n$. Find the value of n if the radius r of the drain hole can be assumed to be very small.



18. During Searle's experiment, the zero of a vernier scale lies between 3.20×10^{-2} m and 3.25×10^{-2} m of the main scale divisions. The 20th division of the vernier scale exactly coincides with one of the main scale divisions. When an additional load of 2 kg is applied to the wire, the zero of the vernier scale still lies between 3.20×10^{-2} m and 3.25×10^{-2} m of the main scale but now the 45th division of the vernier scale coincides with one of the main scale divisions. The length of the thin metallic wire is 2 m and its cross-sectional area is 8.0×10^{-7} m^2.The least count of the vernier scale is 1.0×10^{-5} m. Find the maximum percentage error in the Young modulus of the wire.

FIITJEE

Chemistry

PART – II

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

19. The colourless inter halogen compound among the following is
(A) IF_3
(B) IBr
(C) ICl
(D) IF_7

20. What will be the value of entropy of mixing for 44 gm CO_2 gas, 28 g N_2 gas and 2 mole of Ar gas at 400 K. Considering ideal behaviour of gases.
(A) $6R\ell n\frac{1}{2}$
(B) $\frac{3}{200}\ell n2$
(C) $6R\ell n2$
(D) $2400R\ell n2$

21. If the concentration (C) of a strong electrolyte is diluted 16 times. The magnitude of change in molar conductivity will be? (b is Debye, Huckel Onsagar constant)
(A) $\frac{4}{3}b\sqrt{C}$
(B) $\frac{b}{4}\sqrt{C}$
(C) 0
(D) $\frac{3}{4}b\sqrt{C}$

22. Which of the following is correct electronic configuration of ${}_{64}Gd^{2+}$ ion?
(A) $[Xe]4f^8 5d^o 6s^2$
(B) $[Xe]4f^7 5d^o 6s^1$
(C) $[Xe]4f^5 5d^1 6s^2$
(D) $[Xe]4f^7 5d^1 6s^0$

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

23. The correct option(s) is/are
(A) In 1 equivalent of H_2SO_4, 2 equivalent of H-atom is present.
(B) Volume strength of $\frac{1}{5}N\ H_2O_2$ solution is 1.12.
(C) 14 gm of ethene required, 48 gm of oxygen gas for complete combustion.
(D) Number of moles of oxygen atom in 276 gm of N_2O_4 is 6.

24. Which of the following solution(s) is/are isotonic with 0.2 M NaCl $(\alpha = 1)$ solution at identical temperature. (α = degree of dissociation)
(A) 0.2 M $MgCl_2$ $(\alpha = 0.5)$ solution.
(B) 18 g of glucose present in 250 ml solution.
(C) 0.5 mole of $Al(NO_3)_3$ $(\alpha = 0.4)$ present in 4 litre solution.
(D) 1 mole $AlCl_3$ $(\alpha = 0.2)$ present in 4 litre solution.

25. The C – O bond length in $BH_3.CO$, $\left[Mn(CO)_6\right]^+$, $\left[V(CO)_6\right]^-$ and $\left[Ti(CO)_6\right]^{2-}$ are w, x, y and z $\overset{o}{A}$ respectively. The correct option is/are
(A) x > w
(B) y < z
(C) z < x
(D) y > w

26. For 1 mole of an ideal gas

$$\left(\frac{dP}{dT}\right)_V \cdot \left(\frac{dV}{dT}\right)_P =$$

(A) $\frac{R}{T}$ (B) $\frac{1}{T}$
(C) $\frac{R^2}{PV}$ (D) $\frac{R^2}{P^2}$

27. Which of the following statement(s) is/are true about PH_3?
(A) It is a toxic gas.
(B) It can be prepared by hydrolysis of white phosphorous with NaOH solution.
(C) It is more basic than NH_3.
(D) The P – H bond in PH_3 is stronger than N – H bond in NH_3.

28. The correct statement(s) is/are
(A) NH_4^+ and Mg^{2+} cations (basic radical) belongs to zero group.
(B) Chloride of Hg(I) and Hg(II) do not respond to chromyl chloride test.
(C) In the brown ring test of NO_2^-, the $FeSO_4$ solution must be freshly prepared.
(D) Hg^{+2} ion on reaction with excess KI produce yellow coloured HgI_2 precipitate.

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.***

29. How many of the following cations (basic radicals) do not belong to group-V.
Ni^{+2}, Mg^{+2}, Sr^{+2}, Zn^{+2}, K^+, Fe^{+3}, Ca^{+2}, Mn^{+2}, Pb^{+2}

30. The number of white coloured compounds among the following
Ag_2CO_3, Ag_2SO_3, $AgNO_2$, Ag_2S, AgI, Ag_2CrO_4, PbS, ZnS, FeS, $Fe(OH)_3$, $BaCO_3$.

31. In crystal structure of Fe_3O_4 metal ions occupy void (Tetrahedral and octahedral) space. While O^{2-} ion present at FCC lattice. What will be total number of unpaired electron present in metal ion occupying tetrahedral voids per unit cell.

32. How many of the following ores contains CO_3^{2-} ion.
Cerrusite, Azurite, Calamine, Zincite, Siderite, Magnetite, Magnesite, Dolomite, Bauxite.

33. How many of the following species are coloured due to charge transfer
$\left[Co(H_2O)_6\right]^{2+}$, $Fe_4\left[Fe(CN)_6\right]_3$, V_2O_5, $\left[Ti(H_2O)_6\right]^{3+}$, $K_2Cr_2O_7$, MnO_4^-, $\left[Mn(H_2O)_6\right]^{2+}$

34. Total number of correct statements among the following is
1. Pressure and density are intensive properties.
2. Every isolated system is closed system and vice-versa.
3. Entropy change for adiabatic reversible process is zero.
4. A reaction is non-spontaneous at any temperature when enthalpy change is positive and entropy change is negative.
5. For cyclic process internal energy change is zero.
6. For isobaric process, volume (for fixed amount of an ideal gas) get doubled when temperature increases from $100^\circ C$ to $200^\circ C$.
7. The dissolution of NaCl in H_2O is endothermic though it is spontaneous process.
8. Heat of combustion of ethane is – 341.1 kcal/mole and heat of combustion of ethyne is – 310 kcal/mole means ethane is a better fuel.

35. Total number of geometrical isomers for complex
$\left[Fe(en)(F)(Cl)(Br)(I)\right]^{2-}$ is (en = 1, 2-ethylenediamine).

36. How many of the following Antibiotics has inhibitory effect on microbes
Peniciline, Ertythromycin, Ofloxacin, Tetracyclin, Amonoglucosides, Chloramphenical.

FIITJEE

Mathematics PART – III

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

37. A real number a is chosen randomly and uniformly from the interval [–20, 18] the probability that the roots of the polynomial $x^4 + 2ax^3 + (2a - 2)x^2 + (-4a + 3)x - 2$ are all real is

(A) $\frac{17}{19}$ (B) $\frac{13}{19}$

(C) $\frac{21}{19}$ (D) $\frac{18}{19}$

38. Find the number of permutations x_1, x_2, x_3, x_4, x_5 of numbers 1, 2, 3, 4, 5 such that the sum of five products $x_1x_2x_3 + x_2x_3x_4 + x_3x_4x_5 + x_4x_5x_1 + x_5x_1x_2$ is divisible by 3

(A) 16 (B) 80

(C) 32 (D) 48

39. In the complex plane, let A be the set of solutions to $z^3 - 8 = 0$ and let B be the set of solution to $z^3 - 8z^2 - 8z + 64 = 0$, then the maximum distance between a point of A and a point of B is

(A) $\sqrt{21}$ (B) $3\sqrt{21}$

(C) $4\sqrt{21}$ (D) $2\sqrt{21}$

40. Let $f(x) = \{x\}[x]$; $g(x) = ax^2$ the sum of all real solutions of equation satisfying f(x) = g(x) is 420. (Where a is (+ve) rational number), then a is equal to
(Where [.] and {.} represents greatest integer function and fractional part function respectively)

(A) $\frac{28}{900}$ (B) $\frac{29}{900}$

(C) $\frac{31}{900}$ (D) $\frac{37}{900}$

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

41. Let $P(x) = ax^2 + bx + c$ where a, b, c are real numbers and $a \neq 0$, the polynomial $P(x^2 + 4x - 7)$ has x = 1 as a root and at least one repeated roots, then the roots of polynomial $P(x^2 + 4x - 7)$ can be

(A) x = 1 (B) x = –5

(C) x = –2 (D) x = 2

42. If $b_n = \sum_{r=0}^{n} \frac{1}{{}^nC_r}$, n ≥1, then b_n can be written as

(A) $b_n = \frac{1}{n} \cdot \sum_{r=0}^{n-1} \frac{r+1}{{}^{n-1}C_r} + 1$ (B) $b_n = \frac{1}{n} \cdot \sum_{r=0}^{n-1} \frac{r+1}{{}^{n-1}C_r}$

(C) $b_n = \frac{n+1}{2n} \cdot b_{n-1} + 1$ (D) $b_n = \frac{n-1}{2n} \cdot b_{n-1} + 1$

43. Equation of two lines passes through point A and B whose position vectors are $\vec{a}$ and $\vec{b}$ is $\vec{r} = \vec{a} + \lambda\vec{\alpha}$ and $\vec{r} = \vec{b} + \mu\vec{\beta}$. The position vector of R and S will be, where RS is the shortest distance between the given lines is

(A) $\vec{a} + \dfrac{\left[(\vec{a}-\vec{b})\cdot(\vec{\beta}\cdot(\vec{\beta}\times\vec{\alpha}))\right]\cdot\vec{\alpha}}{|\alpha\times\beta|^2}$

(B) $\vec{a} + \dfrac{\left[(\vec{a}-\vec{b})\cdot(\vec{\beta}\times(\vec{\beta}\times\vec{\alpha}))\right]\vec{\alpha}}{|(\alpha\times\beta)|^2}$

(C) $\vec{b} + \dfrac{\left[(\vec{a}\times\vec{b})\cdot(\vec{\alpha}\times(\vec{\beta}\times\vec{\alpha}))\right]\vec{\beta}}{|\alpha\times\beta|^2}$

(D) $\vec{b} + \dfrac{(\vec{a}-\vec{b})\cdot(\vec{\alpha}\times(\vec{\beta}\times\vec{\alpha}))\vec{\beta}}{|\alpha\times\beta|^2}$

44. A and B are two events defined as follows:
A : It rains today with probability P(A) = 40%. **B :** It rains tomorrow with probability P(B) = 50%
Also, probability P (It rains today and tomorrow) = 30%. Also, $E_1 : P\left(\dfrac{(A\cap B)}{(A\cup B)}\right)$,

$E_2 : P\left(\dfrac{\{(A\cap\bar{B}) \text{ or } B\cup\bar{A}\}}{A\cup B}\right)$, then which of the following is/are TRUE?

(A) A and B are independent

(B) $P\left(\dfrac{A}{B}\right) < P\left(\dfrac{B}{A}\right)$

(C) E_1 and E_2 are equiprobable

(D) $P\left(\dfrac{A}{A\cup B}\right) = P\left(\dfrac{B}{A\cup B}\right)$

45. Let A_n be an n × n matrix in which diagonal elements are 1, 2, 3, 4, ... n
(i.e., $a_{11} = 1$, $a_{22} = 2$, $a_{33} = 3$, ... $a_{nn} = n$) and all other elements are equal to n
(A) A_n is singular for all n
(B) A_n is non-singular for all n
(C) det $A_n = (-1)^n \cdot n!$
(D) det $A_n = (-1)^{n+1} \cdot n!$

46. If $C_r = {}^nC_r$, then sum of the series $S = C_0^2 + \dfrac{C_1^2}{2} + \dfrac{C_2^2}{3} + ...$ upto (n + 1) terms, which of the following options is/are TRUE?

(A) $\dfrac{1}{(n+1)} \cdot {}^{2n+1}C_{n+1}$

(B) $\dfrac{1}{2(n+1)} \cdot {}^{2n+2}C_{n+1}$

(C) $\dfrac{1}{(n+1)} \cdot {}^{2n+1}C_n$

(D) $\dfrac{(2n+1)!}{((n+1)!)^2}$

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.***

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47. Let $x_1 < x_2 < x_3$ be the three real roots of the equation $\sqrt{2014}\, x^3 - 4029x^2 + 2 = 0$, then $x_2(x_1 + x_3)$ is

48. There exists a unique strictly increasing sequence of non-negative integers $a_1 < a_2 < ..... < a_k$ such that $\dfrac{2^{289}+1}{2^{17}+1} = 2^{a_1} + 2^{a_2} + ... + 2^{a_k}$, then (k – 130) is

49. 10 chairs are arranged in a circle. Then the number of subset of this set of chairs that contain at least three adjacent chairs is N, then (N – 580) is

50. Let a_n and b_n are real number such that $(2+i)^n = a_n + b_n i$ for all integers $n \geq 0$ where $i = \sqrt{-1}$, if $\sum_{n=0}^{\infty} \frac{a_n b_n}{7^n}$ is k, then 16k is equal to

51. Let the sequence is 4, 7, 1, 8, 9, 7, 6, ... for n > 2 the nth term of the sequence is the units digit of the sum of the two previous terms. Let S_n denote the sum of the first n terms of this sequence. The smallest value of n for which $S_n > 10{,}000$ is p, then (p – 1990) is

52. Let ω and z be complex numbers such that $|\omega| = 1$ and $|z| = 10$. Let $\theta = \arg\left(\frac{\omega - z}{z}\right)$. Let $\frac{1}{m}$ is the maximum possible value of $\tan^2 \theta$, then (m – 95) is

53. The number of rational number r, 0 < r <1, such that when r is written as a fraction in lowest terms the numerator and denominator have a sum of 1000 is N, then (N – 197) is

54. Let A_n and B_n be square matrices of order 3, which are defined as $A_n = \left[a_{ij}\right]$ and $B_n = \left[b_{ij}\right]$ where $a_{ij} = \frac{2i+j}{3^{2n}}$ and $b_{ij} = \frac{3i-j}{2^{2n}}$ $\forall$ i and j, $1 \leq i, j \leq 3$, if $\ell = \lim_{n\to\infty} T_r\left(3A_1 + 3^2 A_2 + 3^3 A_3 ..... + 3^n A_n\right)$ and $m = \lim_{n\to\infty} T_r\left(3B_1 + 2^2 B_2 + 2^3 B_3 ..... + 2^n B_n\right)$, then the value of $\frac{\ell + m}{3}$, where T_r (A) represent trace of matrix A

FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
PART TEST – III
PAPER –1
TEST DATE: 25-12-2022

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

Section – A

1. A, B, C

Sol. Rays passing through optical centres passes unreflected. Two images are formed at I_1 and I_2
For a convex lens,

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$$

u = –0.4m f = 0.2m

$$= \frac{1}{v}-\frac{1}{u}=\frac{1}{f} \Rightarrow \frac{1}{v}+\frac{1}{0.4}=\frac{1}{0.2}$$

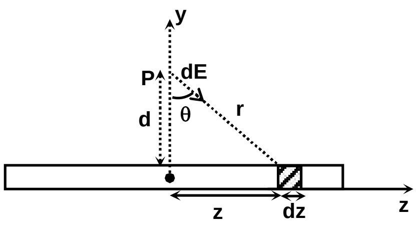
$$\Rightarrow \frac{1}{v}-\frac{1}{0.2}=\frac{1}{0.4}$$

$$\Rightarrow \frac{1}{v}=\frac{1}{0.4}$$

(A) v = 0.4 meter.
(B) Number of images formed = 2
(C) Separation between images is $2\left(3+3\times\frac{0.4}{0.4}\right)$ = 12 mm

2. A, B, C, D

Sol. Gravitational field due to a long wire, $dE = \frac{2G\lambda}{r} = \frac{2G\sigma dz}{r}$



$$E_P = \int dE.\cos\theta = \int \frac{2G\sigma dz}{r}\frac{d}{r} = 2G\sigma d\int_{-\frac{a}{2}}^{+\frac{a}{2}}\left(\frac{dz}{d^2+z^2}\right)$$

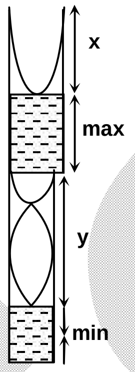
$$E_P = 4G\sigma\tan^{-1}\left(\frac{a}{2d}\right)$$

3. A, B, C, D

Sol. $Q = \Delta K$
and use basic concept

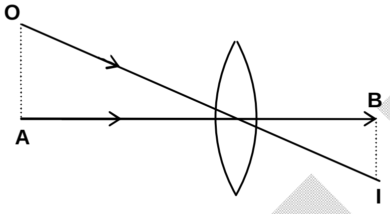
4. A, B, C

Sol. $\lambda = 1\text{m}$
$\lambda/4 = x$
So, $x = 25$ cm
Max = 125 – 25
Max = 100 cm
$y = 3\lambda/4 = 75$ cm
MIN = 125 – 75 = 50 cm
$\lambda/2$ = distance between nodes = 50 cm

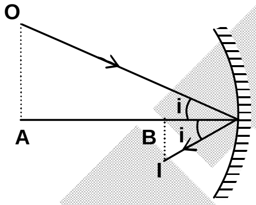


5. A, C, D

Sol. (A)



(C)



(D) Image is inverted ⇒ It should be real

6. A, B, C

Sol. Due to a convex mirror of focal length 2.5 cm and due to a concave mirror having its pole at (2cm, 0) real virtual pair

7. D

Sol. Use basic formulae for the given physical quantities to derive the dimensions.

8. D

Sol. $F = +20\,\text{cm}$

$u = -30\,\text{cm}$

$$v = \frac{uF}{u+F} = \frac{(-30)(20)}{-30+20} = \frac{+600}{-10} = +60\,\text{cm}$$

$$m = \frac{v}{u} = \frac{60}{-30} = -2$$

Real, inverted and magnified

$F = -40\,\text{cm}$

$u = -30\,\text{cm}$

$$v = \frac{(-30)(-40)}{-30+40} = 120\,\text{cm}$$

$$m = -\left[\frac{v}{u}\right] = -\left[\frac{120}{-30}\right] = +4$$

virtual, erect and magnified

(R) $\frac{u_2}{v} - \frac{u_1}{u} = \frac{u_2 - u_1}{R}$

$$\frac{1}{v} - \frac{3/2}{-20} = \frac{1-3/2}{-10}$$

$$\frac{1}{v} + \frac{3}{40} = \frac{1}{20}$$

$$\frac{1}{v} = \frac{1}{20} - \frac{3}{40} = \frac{2-3}{40} = -\frac{1}{40} \Rightarrow v = -40$$

$$m = +\frac{u_i}{u_r}\frac{v}{u} = \frac{+3/2}{1} \times \left[\frac{-40}{-20}\right] = +3$$

Virtual, erect, magnified

(S)$v = \frac{uF}{u+F} = \frac{(-40)(-40)}{-40-40} = \frac{1600}{-80} = -20$

$$m = \frac{v}{u} = \frac{-20}{-40} = +\frac{1}{2}$$

Virtual, erect, diminished.

9. C

Sol. Use momentum conservation during collision. In case of a plane mirror image and object will be equidistant from the mirror

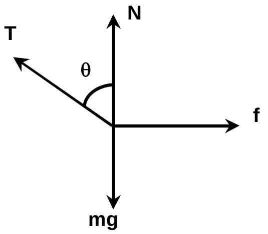
10. D

Sol. $Q = (\Sigma B\cdot E)_{\text{Product}} - (\Sigma B\cdot E)_{\text{Reactant}}$ **Q**

Section – B

11. 0.24

Sol. Thrust of the ejected water on the tank $T = \rho a u^2$ where u is the speed of the ejected water from tank



$$u = \sqrt{\frac{2gh}{1-(a/A)^2}}$$

Now for the tank to slide, $T\sin\theta \ \geq\ \mu(mg - T\cos\theta)$

$$\Rightarrow T \geq \frac{\mu mg}{\sin\theta + \mu\cos\theta}$$

$$\Rightarrow \rho a u^2 \geq \frac{\mu A h \rho g}{\sin\theta + \mu\cos\theta} \qquad \Rightarrow \frac{2(a/A)}{1-(a/A)^2} \geq \frac{\mu}{\sin\theta + \mu\cos\theta}$$

$$\Rightarrow \frac{2x}{1-x^2} \geq m \text{ where } x = \frac{a}{A} \text{ and } m = \frac{\mu}{\sin\theta + \mu\cos\theta}$$

$$\Rightarrow x \geq \frac{\sqrt{1+m^2}-1}{m} \text{ for } \theta = 37^\circ \text{ and } \mu = 0.5$$

$$m = 0.5 \text{ and } x \geq \frac{\sqrt{1+0.25}-1}{0.5}$$

Hence $x_{min} = 0.236$

12. 0.12

Sol. $P_C = P_D + \rho_2 g h_2 = P_0 + \rho_2 g h_2$

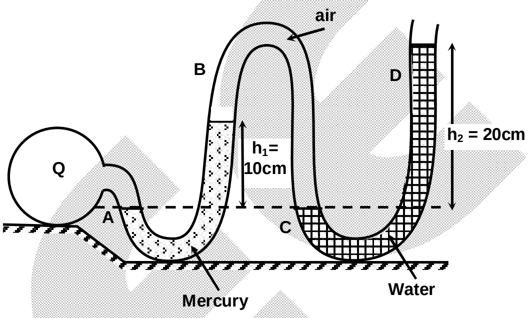
$P_A = P_B + \rho_1 g h_1$

and $P_B = P_C$ (neglecting the density of air as compared to water or mercury)

$\therefore\ P_A = P_0 + \rho_2 g h_2 + \rho_1 g h_1$

$= 10^5 + 10(13.8 \times 0.1 + 1 \times 0.2) \times 10^3$

$= 10^5 + 10^4(1.38 + 0.2) = 1.16 \times 10^5\ \text{N/m}^2$



13. 6.00

Sol. Area of element = wdy

dF = ρwgydy

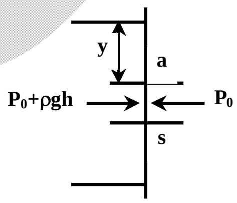
Net force = $\frac{\rho w g D^2}{2}$ . . .(1)

dτ = ρwgydy(D – y)

$\tau = \frac{\rho w g D^3}{6}$ . . .(2)

Putting the value of F and τ in equation (1) and (2)

D = 10 m and W = 6 m



14. 3.75

Sol. Let V be the total volume of the piece of wood and V′ be its volume inside the liquid. Since the wood piece is in equilibrium

Weight of the wood piece = buoyant force

$\Rightarrow V\rho g = V'\rho_0 g$

$\Rightarrow AL\rho g = AL'\rho_0 g$

- Now if the wood piece is pressed by distance x below the fluid.
  Buoyant force = $A(L'+x)\rho_0 g$
  Net force = $A(L'+x)\rho_0 g - AL\rho g$
  $= AL'\rho_0 g + Ax\rho_0 g - AL\rho g$
  $= Ax\rho_0 g$ in the vertically upward direction (Since $AL'\rho_0 g = AL\rho g$)
- Therefore the pressing force = $Ax\rho_0 g$ in the vertically downward direction.
  The work done by the pressing force for a small displacement dx
  $dW = Fdx = Ax\rho_0 g\,dx$
  Total work done by the pressing force
- $W = \int dW = A\rho_0 g \int_0^{L/2} x\,dx$

$$= \frac{A\rho_0 g L^2}{8} = \frac{10^{-2} \times 1200 \times 10 \times (0.5)^2}{8} = 3.75\ \text{J}$$

15. 13.33

Sol. R = V/I = 12/2 = 6 Ω

Error, $\frac{\Delta R}{R}\times 100 = \left(\frac{\Delta V}{V}+\frac{\Delta I}{I}\right)\times 100$

$= \left(\frac{0.4}{12}+\frac{0.2}{2}\right)\times 100$

= 13.33%

∴ Resistance = (6±13.33%)Ω

16. 1.53

Sol. Pitch of the Screw gauge = 5/10 mm = 0.5 mm

Least count = $\frac{\text{Pitch}}{100} = \frac{0.5}{100} = 0.005\,\text{mm}$

Pitch scale reading = Pitch×N = 0.5×3 = 1.5 mm

Difference of the cap reading = F~I = 6

Circular scale reading = Difference × L.C = 0.03 mm

Diameter = P.S.R. + C.S.R. = (1.5+0.03)mm = 1.53 mm

17. 0.20

Sol. The focal length of the lens is given by

$$\frac{1}{f} = \frac{1}{|v|}+\frac{1}{|u|}$$

substituting the values, we get,

f = 19.9 cm, 20.1 cm, 19.9 cm, 20.2

The average focal length ≅ 20.0 cm

The error in a typical measurement:

$$\frac{\delta f}{f^2} = \frac{\delta u}{u^2}+\frac{\delta v}{v^2}$$

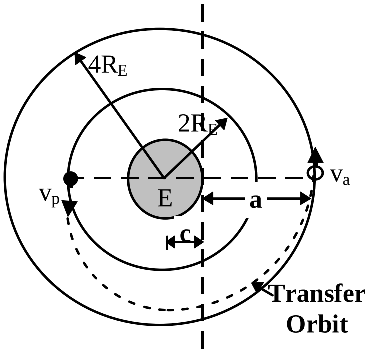
$$\frac{\delta f}{f} = \left(\frac{0.4}{40^2}+\frac{0.4}{(40.5)^2}\right)\times 20 \cong 0.01$$

δf = 0.01 × 20 = 0.2 cm

18. 8.00

Sol. Initial orbital speed $v_1 = \sqrt{\frac{GM}{2R}}$ …(i)

Final orbital speed $v_2 = \sqrt{\frac{GM}{4R}}$ …(ii)



For elliptical orbit

From COAM

$v_1' \times 2R = v_2' \times 4R$

$\Rightarrow \quad v_2' = \frac{v'}{2}$ …(iii)

From COE $\frac{1}{2}mv_1'^2 - \frac{GMm}{2R} = \frac{1}{2}mv_2'^2 - \frac{GMm}{4R}$

$\Rightarrow \quad v_1' = \sqrt{\frac{2GM}{3R}}$

So, energy required = $\frac{1}{2}m\left[\frac{2GM}{3R}-\frac{GM}{2R}\right]+\frac{1}{2}m\left[\frac{GM}{4R}-\frac{1}{4}\frac{2GM}{3R}\right] = \frac{GMm}{8R}$

Chemistry

PART – II

Section – A

19. A, C

Sol. Suppose meq. of NaOH and Na_2CO_3 in the mixture are x and y respectively.
When phenolphthalein is used as indicator

$$x + \frac{y}{2} = 40 \times 0.1 = 4 \quad \dots \text{(i)}$$

When methyl orange is used as indicator

$$x + y = 60 \times 0.1 = 6 \quad \dots \text{(ii)}$$

Solving Eq. (i) and Eq. (ii), we get

$x = 2$ meq. and $y = 4$ meq.

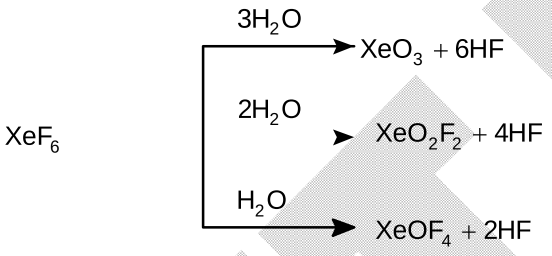
$\therefore$ Weight of NaOH in the mixture $= \left(2 \times 10^{-3} \times 40\right) \times 5 = 0.4$ g.

Weight of Na_2CO_3 in mixture $= \left(4 \times 10^{-3} \times 53\right) \times 5 = 1.06$ g

Weight % of NaOH in the mixture $= \dfrac{0.4}{0.4 + 1.06} \times 100 = 27.4\%$

20. A, B, D

Sol.

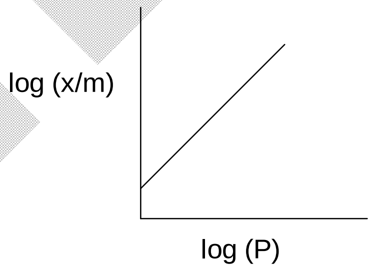


21. B, C, D

Sol. Physisorption is multilayer

log (x/m) vs. log (P)

Slope is +ve.



Physisorption favour at low temperature and high pressure.

$$\left|\Delta H_{\text{physisorption}}\right| < \left|\Delta H_{\text{chemisorption}}\right|$$

22. A, B, D

Sol. Mond's process is used for the purification of Ni.

23. B, C

Sol. $M_{mix} = \dfrac{1 \times 16 + 2 \times 4}{1 + 2} = 8$

$$\frac{r_x}{r_{mix}} = \sqrt{\frac{M_{mix}}{M_x}}$$

$$\Rightarrow 2 = \sqrt{\frac{8}{M_x}} \qquad \therefore M_x = 2$$

$\therefore$ Gas is H_2 gas.

$$\frac{r_{H_2}}{r_{He}} = \sqrt{\frac{4}{2}} = \sqrt{2} \quad \therefore r_x = \sqrt{2}\ r_{He}$$

$\therefore$ (B) and (C) are correct statement.

24. A, C, D

Sol. From given data

$$X_A = \frac{1}{3} \qquad X_B = \frac{2}{3}$$

Where, X_A and X_B are mole fraction of A and B in liquid phase.

If the Y_A and Y_B are mole fraction of And B in vapour phase.

$$\frac{Y_A}{Y_B} = \frac{P_A^o X_A\ /P_{total}}{P_B^o X_B\ /P_{total}} = \frac{P_A^o X_A}{P_B^o X_B} = \frac{100 \times \frac{1}{3}}{80 \times \frac{2}{3}} = \frac{5}{8}$$

$$\frac{Y_A}{Y_B} = \frac{n_A}{n_B} = \frac{W_A\ /M_A}{W_B\ /M_B} = \frac{W_A}{W_B} (\because \text{ A and B are isomer})$$

$$\therefore \text{Mass ratio of A and B} = \frac{5}{8}.$$

$$P_{Total} = P_A^o X_A + P_B^o X_B = 100 \times \frac{1}{3} + 80 \times \frac{2}{3}$$

$$= \frac{260}{3} \text{torr}$$

25. D

Sol. Ziglar Natta $\rightarrow TiCl_4 + Al(C_2H_5)_3$

Ostwald process $\rightarrow$ Pt

Contact process $\rightarrow V_2O_5$

Haber process $\rightarrow$ Fe

26. B

Sol. Conceptual

27. B

Sol. Application of Boyle's Law.

28. D

Sol. $\left[Cr(H_2O)_6\right]^{3+} \rightarrow d^2sp^3 \rightarrow Cr^{+3} \rightarrow d^3 \rightarrow t_{2g}^3 e_g^o$

$\left[Co(CN)_6\right]^{3-} \rightarrow d^2sp^3 \rightarrow Co^{+3} \rightarrow d^6 \rightarrow t_{2g}^6 e_g^o$

$[CuF_6]^{4-} \rightarrow sp^3d^2 \rightarrow Cu^{2+} \rightarrow d^9 \rightarrow t_{2g}^6 e_g^3$

$[MnF_6]^{3-} \rightarrow sp^3d^2 \rightarrow Mn^{+3} \rightarrow d^4 \rightarrow t_{2g}^3 e_g^1$

Section – B

29. 8.00

Sol. $\left[Ag^+\right]_{Anode} = \frac{K_{SP}}{\left[Br^-\right]} = \frac{K_{SP}}{1\times 0.75}M$

$\left[Ag^+\right]_{Cathode} = 0.1\times 0.8 = 0.08\ M$

$E_{cell} = 0.0591\log\frac{\left[Ag^+\right]_{Cathode}}{\left[Ag^+\right]_{Anode}}$

$0.591 = 0.0591\log\left[\frac{0.08}{K_{SP}/0.75}\right]$

$10 = \log\frac{0.75\times 0.08}{K_{SP}}$

$\therefore 10^{+10} = \frac{0.75\times 0.08}{K_{SP}}$

$\therefore K_{SP} = \frac{0.08\times 0.75}{10^{10}} = 6\times 10^{-12}$

$\text{Solubility} = \frac{K_{SP}}{\left[Br^-\right]} = \frac{6\times 10^{-12}}{0.75}\ \text{mol / lit.}$

$x\times 10^{-12} = 8\times 10^{-12}$

$\therefore x = 8$

30. 15.58

Sol. $V_A = \frac{RT}{P_A} = \frac{0.082\times 500}{2} = 20.5\ \text{lit}$

$A\to B$ is isothermal path

$\therefore V_B = \frac{P_A V_A}{P_B} = \frac{21.5\times 2}{4} = 10.25\ \text{litre}$

$B\to C$ is adiabatic path

$\frac{P_B}{P_C} = \left(\frac{V_C}{V_B}\right)^{\gamma}$ $\quad\because C_P = \frac{5}{2}R$

$\frac{4}{2} = \left(\frac{V_C}{V_B}\right)^{\frac{5}{3}}$ $\quad\therefore C_V = \frac{3}{2}R$

$\log 2 = \frac{5}{3}\log\frac{V_C}{V_B}$ $\quad\gamma = \frac{5}{3}$

$\Rightarrow \log\frac{V_C}{V_B} = \log 2^{3/5}$

$\frac{V_C}{V_B} = 2^{3/5} = 1.52$

$\therefore V_C = 1.52\times 10.25$

= 15.58 litre

31. 729.00

Sol. $M_{AgX} = \dfrac{\rho \times N_A \times a^3}{4} = \dfrac{\dfrac{40}{6.022} \times 6.022 \times 10^{23} \times \left(6 \times 10^{-8}\right)^3}{4}$

$= 216 \text{ g / mole}$

$\therefore M_X = 216 - 108 = 108 \text{ g / mole}$

If all atoms along one body diagonal have been removed, the formula of unit cell

$= Ag_{4-1}X_{4-\frac{1}{4}} = Ag_3X_{\frac{15}{4}}$

$\therefore$ Mass of 1 mole of these unit cell $= 108 \times 3 + 108 \times \dfrac{15}{4} = 729.00$

32. 4.35

Sol. Number of equivalent of HCl used = Number equivalent of $CaCl_2$ obtained = Number of equivalent of plaster of paris can form $= \dfrac{600 \times 0.1}{1000} = 0.06$

Equivalent weight of plaster of paris $\left(CaSO_4.\dfrac{1}{2}H_2O\right) = \dfrac{\text{Mol.wt.}}{2} = \dfrac{145}{2}$

$\therefore$ Maximum weight of $CaSO_4.\dfrac{1}{2}H_2O$ that can be obtained $= 0.06 \times \dfrac{145}{2} = 4.35$ g .

33. 6.25

Sol. $\kappa = \dfrac{1}{R} \times \dfrac{\ell}{A} = \dfrac{1}{50} \times \dfrac{1}{1} = \dfrac{1}{50} \text{ S cm}^{-1}$

$\Lambda_m = \dfrac{\dfrac{1}{50} \times 1000}{0.2} = 100 \text{ S cm}^2 \text{ mol}^{-1}$

$\alpha = \dfrac{\Lambda_m}{\Lambda_m^o} = \dfrac{100}{\lambda^o_{H^+} + \lambda^o_{CH_3COO^-}} = \dfrac{100}{50 + 350} = \dfrac{1}{4}$

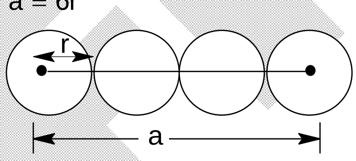
Van't Hoff factor $i = 1 + \alpha = 1.25$

$\pi = i.C.R.T.$

$\pi = 1.25 \times 0.2 \times 300 \times \dfrac{1}{12} = 6.25 \text{ atm}$.

34. 78.50

Sol. a = 6r



Effective number of atom in one unit cell $= 4 \times \dfrac{1}{4} + 8 \times \dfrac{1}{2} + 4 = 9$

$\therefore \%P.E. = \dfrac{9 \times \pi r^2}{a^2} \times 100$

$= \dfrac{9 \times 3.14 \times r^2}{(6r)^2} \times 100$

$$= \frac{9 \times 314r^2}{36r^2} = \frac{314}{4}$$

= 78.5%

35. 0.70

Sol. Amount of thermal energy required $= w \times C_S \times \Delta T$

Amount of thermal energy in beaker A $= 200 \times C_S \times (90 - 40) = 10000\ C_S$

Amount of thermal energy in beaker B $= 100 \times C_S \times (90 - 20) = 7000\ C_S$

Amount of thermal energy in beaker C $= 150 \times C_S \times (90 - 50) = 6000\ C_S$

Amount of thermal energy in beaker D $= 300 \times C_S \times (90 - 30) = 18000\ C_S$

$\therefore w = 6000\ C_S,\ x = 7000\ C_S,\ y = 10000\ C_S,\ z = 18000\ C_S$

$$\therefore \frac{x}{y} = \frac{7000\ C_S}{10000\ C_S} = 0.7$$

36. 9.00

Sol. Weight of oxalic acid in 50 ml solution before adsorption $= \frac{45}{500} \times 50 = 4.5\ \text{gm}$

Weight of oxalic acid in 50 ml solution after adsorption $= 0.6 \times \frac{50}{1000} \times 90 = 2.7\ \text{gm}$

$\therefore$ Weight of oxalic acid adsorbed by 0.2 gm of charcoal = 4.5 – 2.7 = 1.8 g

$\therefore$ Weight adsorbed per gram $= 1.8 \times \frac{1}{0.2} = 9\ \text{gm}$.

FIITJEE

Mathematics PART – III

Section – A

37. A, B, C

Sol. $P_4 = \dfrac{{}^4C_2}{4^4}$, $P_5 = 0$, $P_6 = \dfrac{2(60-12)}{4^6} = \dfrac{96}{4^6}$

38. A, D

Sol. $|\vec{P}_1| = \sqrt{3}$, $|\vec{P}_2| = 1$ and $\vec{P}_1 \cdot \vec{P}_2 = 0 \Rightarrow |\vec{P}_3 \cdot \vec{P}_1 \times \vec{P}_2| = |\vec{P}_3|\,|\vec{P}_1|\,|\vec{P}_2|$

39. C, D

Sol. $\dfrac{m}{n} = \dfrac{101}{51}$, $N = \dfrac{(m-1)(n-1)}{2}$

40. A, C, D

Sol. $\dfrac{(z^3 - z^2)}{(z - z^2)} \cdot \dfrac{(z - z^4)}{(z^3 - z^4)} \in R \Rightarrow (z - \bar{z})(z\bar{z} - 1) = 0$ for given order z, z^2, z^3, z^4

$\Rightarrow \arg z \in \left(0, \dfrac{2\pi}{3}\right) \cup \left(\dfrac{4\pi}{3}, 2\pi\right)$

41. A, C, D

Sol. $\det(M_1) = \det(M_2) = 0 \Rightarrow \det(aM_1 + bM_2) = 0\ \forall\ a, b \in R$

42. A, B

Sol. z_1, z_2, z_3 are the roots of the equation $z^3 - 2\lambda z^2 + 2\lambda^2 z - \lambda^3 = 0$

43. B

Sol. $n(A) > n(B) \rightarrow$ Total number of cases 211

$n(A) = n(B) \rightarrow$ Total number of 32 cases

44. D

Sol. $(a + b + c)((a - b)^2 + (b - c)^2 + (c - a)^2) = 2$

If $a, b, c \in Z \Rightarrow (1, 0, 0), (0, 1, 0), (0, 0, 1)$ are solutions

If $t \in \theta \Rightarrow a = c$, $2a + b = \dfrac{1}{t^2}$, $a - b = t \Rightarrow$ infinite possibility

45. D

Sol. $|((z - 2)^8 - 3^8| = |(z - z_1)(z - z_2)(z - z_3) \ldots\ldots (z - z_8)|$

46. C

Sol.
(I) There are 4 distinct path

(II) There are $\dfrac{1}{3}\left({}^{10}C_5\right)$ distinct path

(III) Count rectangle of all possible dimension = 73

(IV) There are 218 distinct path

Section – B

47. 95.00

Sol. Let θ_i be the event that i is the upper left corner of required square

$$\Rightarrow P\left(\theta_i \cup \theta_2 \cup \theta_3 \cup \theta_4\right) = \frac{95}{512} \Rightarrow P\left(\theta_1^c \cap \theta_2^c \cap \theta_3^c \cap \theta_4^c\right) = \frac{417}{512}$$

48. 81.00

Sol. Suppose there are T_n ways to cover n steps

$T_n = T_{n-1} + T_{n-2} + T_{n-3}$, $T_1 = 1$, $T_2 = 2$

49. 220.00

Sol. Let $p = 9 - a$, $q = 9 - a_3 \Rightarrow p + a_2 + q + a_4 = 9 \Rightarrow {}^{12}C_3 = 220$

50. 4.00

Sol. $|A^2 + |A|A + Tr(A)\cdot I_2| = 4(2(|A| - 1)^2 + 1)$

51. 23.00

Sol. $P(x) = x^3 + 2x^2 + 3x + 3$

52. 3.00

Sol. $\left(\frac{\vec{p}+\vec{q}+\vec{r}}{3}\right)\cdot\left(\frac{\vec{p}+\vec{r}}{3} - \vec{q}\right) = 0 \Rightarrow |\vec{p}|^2 + |\vec{q}|^2 = 3|\vec{r}|^2$

53. 2.78

Sol. Let $\alpha = u$, $\beta = u + v$, $\gamma = u + 2v$, $\delta = u + 3v \Rightarrow p - q = -\frac{1}{9}(u+1)^2\left(u^2 + 2u - 9\right)$

54. 834.00

Sol. Let $im = n \rightarrow 9 \times 34$ cases

$im^5 = n^2 \rightarrow 8 \times 33$ cases

$im^9 = n^3 \rightarrow 8 \times 33$ cases

FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
PART TEST – III
PAPER –2
TEST DATE: 25-12-2022

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

Section – A

1. B

Sol. If $A > 2\theta_C$ then light does not emerge.

$A = 60^o$

θ_C should be less than 30º

$$\sin 30^\circ = \frac{1}{\mu}$$

$\Rightarrow \quad \mu = 2$

minimum value of μ is 2.

2. B

Sol. $\lambda = \frac{h}{mv}$

$$\frac{1}{2}m\bar{v}^2 = \frac{3}{2}k_BT$$

$$v_{rms} = \sqrt{\bar{v}^2} = \sqrt{\frac{3k_BT}{m}}$$

$$\lambda = \frac{h}{mv_{rms}} = \frac{h}{\sqrt{3mk_BT}}$$

3. A

Sol. From Moseley's law,

$$\frac{1}{\lambda_{K_\alpha}} \propto (Z-1)^2$$

$$\frac{\lambda_{M_0}}{\lambda_{Cu}} = \frac{(Z_{Cu}-1)^2}{(Z_{M_0}-1)^2} = \frac{(28)^2}{(41)^2}$$

$$\lambda_{M_0} = \lambda_{Cu} \times \frac{(28)^2}{(41)^2} = 0.71\text{Å}.$$

4. B

Sol. $N_{238}\lambda_{238} = N_{234}\lambda_{234}$

$$\frac{N_{238}}{T_{1/2}(^{238}U)} = \frac{N_{234}}{T_{1/2}(^{234}U)}$$

$$T_{1/2}(^{234}U) = \frac{N_{234}}{N_{238}} \times T_{1/2}(^{238}U)$$

$$= \frac{1}{1.8\times10^4}\times 4.5\times10^9\,y = 2.5\times10^5\,yr$$

5. B, C, D

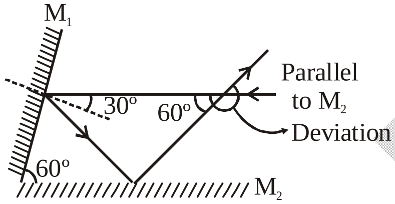
Sol. For the critical ray at the interface,

$\mu_2 \sin i = \mu_1 \sin 90^o$

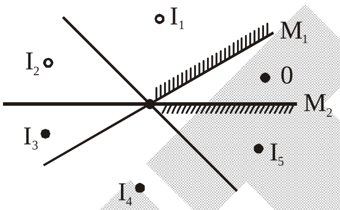
$\theta_1 = (90^o - i) \equiv \frac{\pi}{2} - \frac{\pi}{3} = \frac{\pi}{6}$.

6. A, B, C, D

Sol. (A)

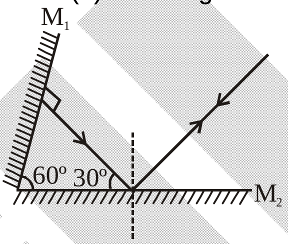


(B)



(C) same as (b) – 5 images.

(D)



7. A, D

Sol. For equilibrium, the system must be in a local minima of potential energy. This is possible only if the centre of mass of the system lies below O i.e. the centre of the hemisphere. In the critical case, the centre of mass of the system can coincide with O.

Now taking O as the origin, say H is the maximum principle height of the cone then:

$$\left(-\frac{3R}{8}\right)\cdot\frac{2}{3}\pi R^3 + \left(\frac{H}{4}\right)\cdot\frac{1}{3}\pi R^2 H = 0$$

$$\Rightarrow\quad -\frac{R^2}{4} + \frac{H^2}{12} = 0 \quad \text{or} \quad H = \sqrt{3}R$$

8. B, C

Sol. Initial pressure at the bottom = $\rho g \times 2H + 2\rho \times g \times H = 4\rho gH$.

Final density of the homogenous mixture:

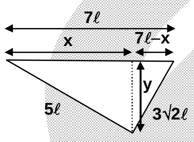
$$= \frac{\rho \times A \times 2H + 2\rho \times 2A \times H}{A \times 2H + 2A \times H} = \frac{3}{2}\rho$$

Final pressure $= \frac{3}{2}\rho \times g \times 3H = \frac{9}{2}\rho gH$.

9. B, C

Sol. $y^2 = (5\ell)^2 - x^2 = (3\sqrt{2}\ell)^2 - (7\ell - x)^2$

$\Rightarrow\ x = 4\ell \Rightarrow y = 3\ell \Rightarrow T = 2\pi\sqrt{\frac{3\ell}{g}}$



10. B, D

Sol. $\frac{1}{2}mv^2 + \left(-\frac{2GMm}{L}\right) = 0$

$\Rightarrow v = 2\sqrt{\frac{GM}{L}}$

Gravitational field is conservative, in which total mechanical energy (KE + PE) remains conserved. Hence, the kinetic energy imparted to the mass m is gradually reduced and gets converted into its potential energy, so that at every point of its flight the total mechanical energy remains constant.

Section – B

11. 1

Sol. $H_{app} = \frac{H}{\mu}\left(\frac{\cos i}{\cos r}\right)^3 = \frac{9}{\sqrt{3}} \times \left(\frac{1}{\sqrt{3}}\right)^3 = 1m$

12. 2

Sol. Let be λ is wavelength of sound in air

$\ell_1 = \frac{\lambda}{4}$ and $\ell_2 = \frac{3\lambda}{4}$

$\lambda = 2(\ell_2 - \ell_1)$

$v = f\lambda = 165 \times 2(150 - 50) \times 10^{-2} = 330$ m/s

$\frac{dv}{v} = \frac{|d\ell_2| + |d\ell_1|}{\ell_2 - \ell_1}$

$dv = \frac{0.5 + 0.1}{150 - 50} \times 330 = 1.98$ m/s

$v = (330 \pm 2)$ m/s, it is speed of sound in air.

13. 5

Sol. Let equation of the wave be

$y = A \sin kx \cos \omega t$

$\because\ 5\sqrt{3} = A\sin(k \times 10)$ . . . (1)

and $5\sqrt{3} = A\sin(k\times 20)$ . . . (2)

From (1) and (2), and the given conditions,

$20k = \pi - 10k \quad \Rightarrow \quad k = \frac{\pi}{30}$

$5\sqrt{3} = A\sin\left(\frac{\pi}{30}\times 10\right)$ using equation (1)

$\Rightarrow$ A = 10mm

$\because \; k = \frac{2\pi}{\lambda} = \frac{\pi}{30}$,

$\Rightarrow \lambda = 60$cm.

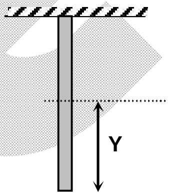
$\because \; L = n\frac{\lambda}{2}$

$\Rightarrow n = \frac{2L}{\lambda} = \frac{2\times 150}{60} = 5$

As the number of loops is 5, the string vibrates in the 4th overtone 5th harmonic.

14. 4

Sol. Tension in the string at a height y from the lower end = Weight of the lower part (having y length) = μyg



Wave speed at this point $V = \sqrt{\frac{T}{\mu}}$

$\Rightarrow V = \sqrt{\frac{\mu yg}{\mu}} = \sqrt{yg}$

$\Rightarrow \frac{dy}{dt} = \sqrt{yg}$

On integration we get,

$y = \frac{gt^2}{4}$

- Distance travelled by the body in time $t = \frac{1}{2}gt^2$

  When the pulse & the body are at same level

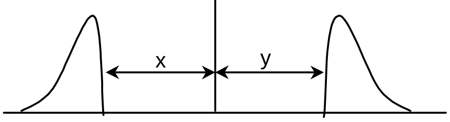
  $\frac{gt^2}{4} + \frac{1}{2}gt^2 = L$

  $\Rightarrow t = \sqrt{\frac{4L}{3g}}$

Therefore, distance from the top

$= \frac{1}{2}gt^2 = \frac{2L}{3}$

15. 4



Sol. $t_1 = \frac{2x}{v}$ & $t_2 = \frac{2y}{v}$

$\therefore \; x + y = \frac{v}{2}(t_1 + t_2) = \frac{332}{2}[1.5 + 2.5] = 664$ m.

third echo will be heard after

$t_3 = t_1 + t_2 = 1.5 + 2.5 = 4$ sec.

16. 5

Sol. $\frac{P_0^2}{2\rho V} = I = \frac{\text{Power}}{4\pi r^2}$

Put the values to get the answer.

17. 4

Sol. $(\pi r^2)\sqrt{2gy} = \pi x^2\left(-\frac{dy}{dt}\right)$

$\Rightarrow (r^2)\sqrt{2gy} = x^2\lambda$

$\Rightarrow y \alpha x^4$

18. 4

Sol. $Y = \frac{FL}{A\ell}$

Here measurement is for ℓ only,

So, $\frac{\Delta Y}{Y} = \frac{\Delta \ell}{\ell}$

From observation, ℓ_1 = MS + 20(LC), and ℓ_2 = MS + 45(LC)

Change in length = $\ell_2 - \ell_1$ = 25 × LC, and the maximum permissible error in measurement of elongation in one LC.

$\frac{\Delta Y}{Y} \times 100\% = \frac{1}{25}\frac{LC}{(LC)} \times 100\% = 4\%$

FIITJEE

Chemistry

PART – II

Section – A

19. D

Sol. $IF_3 \rightarrow$ Yellow powder

$IBr \rightarrow$ Black solid

$ICl \rightarrow$ Red solid

$IF_7 \rightarrow$ Colourless gas

20. C

Sol. $\Delta S_{mix} = -n_{total}R\sum x_i \ell n x_i$

$n_{CO_2} = 1 \qquad n_{N_2} = 1 \qquad n_{Ar} = 2$

$\therefore \chi_{CO_2} = \frac{1}{4} \qquad \chi_{N_2} = \frac{1}{4} \qquad \chi_{Ar} = \frac{1}{2}$

$$\Delta S_{mix} = -4R\left\{\frac{1}{4}\ell n\frac{1}{4} + \frac{1}{4}\ell n\frac{1}{4} + \frac{1}{2}\ell n\frac{1}{2}\right\}$$

$$= -4R\left\{\frac{1}{2}\ell n\frac{1}{4} + \frac{1}{2}\ell n\frac{1}{2}\right\}$$

$$= -4R \times \frac{3}{2}\ell n\frac{1}{2}$$

$$= -6R\ell n\frac{1}{2} = 6R\ell n2$$

21. D

Sol. $\Lambda_m = \Lambda_m^o - b\sqrt{C}$ … (i)

When it is diluted $C' = \frac{C}{16}$

$\Lambda'_m = \Lambda_m^o - b\sqrt{\frac{C}{16}}$ … (ii)

$$\therefore \left|\Lambda_m - \Lambda'_m\right| = \left|-b\sqrt{C} + \frac{b\sqrt{C}}{4}\right|$$

$$= \frac{3b\sqrt{C}}{4}$$

22. D

Sol. ${}_{64}Gd \rightarrow [Xe]4f^7 5d^1 6s^2$

${}_{64}Gd^{+2} \rightarrow [Xe]4f^7 5d^1 6s^0$

23. B, C

Sol. 1 equivalent of H_2SO_4 = 1 equivalent of H – atom

$V_{H_2O_2} = 5.6 \times \text{Normality} = 5.6 \times \frac{1}{5} = 1.12$

$C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$

$\therefore$ Moles of O_2 required $= \dfrac{14}{28} \times 3 = \dfrac{3}{2}$

$\therefore$ Weight of O_2 $= \dfrac{3}{2} \times 32 = 48$ g

Moles of 'O' atom in 276 gm of N_2O_4 $= \dfrac{276}{92} \times 4 = 12$ mole.

24. A, B, D

Sol. For isotonic solution, osmotic pressure (π) should be same.

$\pi = \text{i.CRT}$

i.C for 0.2 M $NaCl(\alpha = 1)$

$= \left[1 + (x + y - 1)\alpha\right]C$

$= \left[1 + (1 + 1 - 1)1\right]0.2 = 0.4$

i.C for 0.2 M $MgCl_2\ (\alpha = 0.5)$

$= \left\{1 + (1 + 2 - 1) \times 0.5\right\} \times 0.2$

= 0.4

i.C for 18 g glucose in 250 ml solution $= 1 \times \dfrac{18/180}{250/1000} = 0.4$

i.C for 0.5 mole of $Al(NO_3)_3$ in 4 litre $(\alpha = 0.4)$ $= \left\{1 + (1 + 3 - 1)0.4\right\}\dfrac{0.5}{4} = 0.275$

i.C for 1 mole of $AlCl_3\ (\alpha = 0.2)$ in 4 litre solution $= \left\{1 + (1 + 3 - 1)0.2\right\} \times \dfrac{1}{4} = 0.4$

$\therefore$ A, B and D are isotonic solution with 0.2 M NaCl $(\alpha = 1)$.

25. A, B, D

Sol. Strength of M – C back bonding α electronic density of metal
α M – C bond order
α C – O bond length

M – C back bonding order

$\left[Ti(CO)_6\right]^{2-} > \left[V(CO)_6\right]^{-} > \left[Mn(CO)_6\right]^{+} > BH_3.CO$

$\therefore$ Bond length order z > y > x > w.

26. A, C

Sol.
$$\left(\frac{dP}{dT}\right)_V = \frac{d}{dT}\left(\frac{RT}{V}\right)_V = \frac{R}{V}$$
$$\left(\frac{dV}{dT}\right)_P = \frac{d}{dT}\left(\frac{RT}{P}\right)_P = \frac{R}{P}$$
$$\therefore \left(\frac{dP}{dT}\right)_V \times \left(\frac{dV}{dT}\right)_P = \frac{R}{V} \times \frac{R}{P} = \frac{R^2}{PV} = \frac{R^2}{RT} = \frac{R}{T}$$

27. A, B

Sol. PH_3 – Toxic

$P_4 + 3NaOH + 3H_2O \longrightarrow PH_3 + 3NaH_2PO_2$

$\ddot{N}H_3$ is more basic than PH_3

N – H bond energy (389 kJ/mol) > P – H bond energy (318 kJ/mol)

28. B, C

Sol. Mg^{2+} belongs to Group-VI.

$Hg^{+2} + KI \longrightarrow K_2[HgI_4]$

Option (A) and (D) are wrong.

Section – B

29. 7

Sol. Group – V cations are $Ca^{+2}, Sr^{+2}, Ba^{+2}$.

30. 5

Sol. White → Ag_2CO_3, Ag_2SO_3, $AgNO_2$, ZnS, $BaCO_3$

Black → Ag_2S, FeS, PbS

Yellow → AgI

Reddish brown → $Fe(OH)_3$

31. 5

Sol. Fe_3O_4 is an example of inverse spinel, in which one Fe^{+3} ion present at tetrahedral void and one Fe^{+3} as well as one Fe^{+2} ion present at octahedral voids per unit cell.

∴ 1 Fe^{+3} ion is present at tetrahedral voids.

$Fe^{+3}(d^5) \rightarrow e^2t_2^3$

∴ Total 5 unpaired electrons.

32. 6

Sol. Cerrusite → $PbCO_3$

Azurite → $Cu(OH)_2.2CuCO_3$

Calamine → $ZnCO_3$

Zincite → ZnO

Siderite → $FeCO_3$

Magnetite → Fe_3O_4

Magnesite → $MgCO_3$

Dolomite → $MgCO_3$, $CaCO_3$

Bauxite → $Al_2O_3.2H_2O$

33. 4

Sol. $Fe_4[Fe(CN)_6]_3$, $K_2Cr_2O_7$, MnO_4^-, V_2O_5 are coloured due to charge transfer.

34. 5

Sol.
1. Pressure and density are intensive property as it does not depends on amount.
2. Every close system is not isolated system.
3. $\Delta S = 0$ for adiabatic reversible process.
4. ΔG should be – ve for a spontaneous processs.
5. For cyclic process $\Delta U = 0$.
6. $\frac{V_2}{V_1} = \frac{T_2}{T_1} = \frac{573}{473}$.

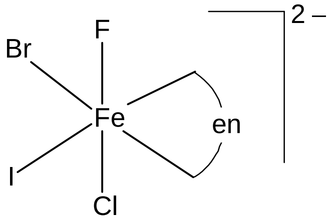
7. Calorific value of $C_2H_6 = \frac{341.1}{30} = 11.37$ kcal / g . Calorific value of $C_2H_2 = \frac{310}{26} = 11.92$ kcal / g .

$\therefore$ Ethyne is a better fuel.

1, 3, 4, 5 and 7 are correct statement.

35. 6

Sol.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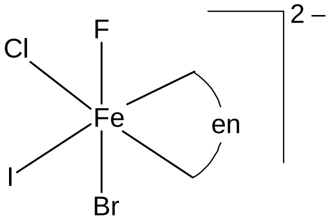
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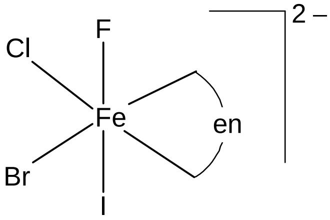
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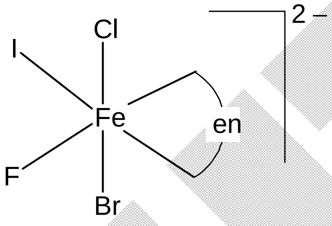
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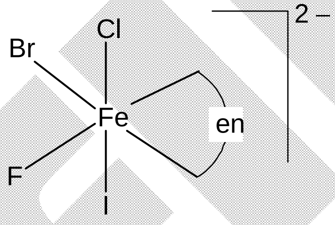
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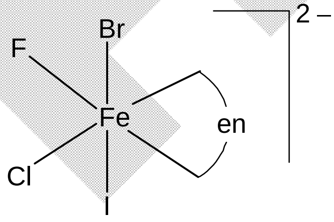
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36. 3

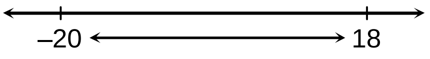
Sol. Erythromycin, Tetracyclin and Chloramphenical has inhibitory effect on microbes.

Mathematics PART – III

Section – A

37. D

Sol. By rational root theorem turn the given polynomial into a degree = 2 polynomial with rational root
x = 1, –1, 2, –2 are all possible root
So, x = –2, x = 1. Polynomial is equal to 0
So, polynomial becomes $(x - 1)(x + 2)(x^2 + (2a - 1)x + 1)$
So, we only need to focus on the quadratic
$(2a - 1)^2 - 4 \geq 0 \Rightarrow n(S) = 38$; $n(E) = 36$ $\therefore$ Probability $= \frac{36}{38} = \frac{18}{19}$



38. B

Sol. Let $x_3 = 3$, then $x_1x_2x_3 + x_2x_3x_4 + x_3x_4x_5 + x_4x_5x_1 + x_5x_1x_2 = 3(x_1x_2 + x_2x_4 + x_4x_5) + x_5x_1(x_2 + x_4)$
So, the sum is divisible by 3 if $x_2 + x_4$ is divisible by 3, the possible sums of $(x_2 + x_4)$ can be (1, 2), (2, 1), (1, 5), (5, 1), (2, 4), (4, 2), (4, 5) or (5, 4) are we have 2 ways to designate x_1 and x_5 for a total of $8 \times 2 = 16$
So, desired = $16 \times 5 = 80$

39. D

Sol. $z^3 - 8 = 0 \Rightarrow (z - 2)(z^2 + 2z + 4) = 0 \Rightarrow z = 2$ and $z^2 + 2z + 4 = 0 \Rightarrow z = -1 \pm \sqrt{3}\, i$
and $z^3 - 8z^2 - 8z + 64 = 0 \Rightarrow (z^2 - 8)(z - 8) = 0 \Rightarrow z = \left(2\sqrt{2}, -2\sqrt{2}, 8\right)$
Maximum distance is from 8 and $-1 \pm \sqrt{3}\, i$ i.e. $2\sqrt{21}$

40. B

Sol. $[x]\{x\} = ax^2$
Case-I: $[x]\cdot\{x\} < 0$ where $x < 0$ while $ax^2 \geq 0\ \forall\ x \in R$ and $x = 0$ is one solution but that does not affect the sum of the solution
Thus we need to look at (+ve) solutions for $n \leq x < n + 1$
$[x] = n$, $\{x\} = x - n$ equation is $nx - n^2 = ax^2$
$ax^2 - nx + n^2 = 0 \Rightarrow x = \frac{n \pm \sqrt{n^2 - 4an^2}}{2a} = n\left(\frac{1 \pm \sqrt{1 - 4a}}{2a}\right)$
For (+ve) roots we consider $x = \frac{n}{2a}\left(1 - \sqrt{1 - 4a}\right)$
Since, sum of all solutions is 420
$\Rightarrow \sum \frac{n}{2a}\left(1 - \sqrt{1 - 4a}\right) = 420 \Rightarrow \left(\frac{1 - \sqrt{1 - 4a}}{2a}\right)\cdot \sum n = 420$
$\Rightarrow \left(\frac{1 - \sqrt{1 - 4a}}{2a}\right)\left(\frac{n(n+1)}{2}\right) = 420 \Rightarrow \left(\frac{1 - \sqrt{1 - 4a}}{2a}\right)\cdot 406 = 420$
(Considering n is 28 i.e. $\frac{n(n+1)}{2} = 406$ at n = 28 which is nearer to 420)
$\Rightarrow a = \frac{29}{900}$

41. A, B, C

Sol. Let $Q(x) = P(x^2 + 4x - 7) \Rightarrow Q(1) = P(-2) = 0 \Rightarrow P(x) = a(x + 2)(x - \alpha)$
Now, $Q(x) = P(x^2 + 4x - 7) = a(x^2 + 4x - 5)(x^2 + 4x - 7 - \alpha)$

$\Rightarrow Q(x) = a(x - 1)(x + 5)(x^2 + 4x - (7 + \alpha))$
As Q(x) has at least one repeated root, this must be $x = 1$ or $x = -5$
$Q(x) = a((x - 1)(x + 5))^2$ or $x^2 + 4x - (7 + \alpha) = 0$ has double roots if D = 0, $\alpha = -11$
$Q(x) = a(x - 1)(x + 5)(x + 2)^2$

42. A, C

Sol. $b_n = \sum_{r=0}^{n}\frac{1}{{}^nC_r} = \sum_{r=0}^{n-1}\frac{1}{{}^nC_r} + \frac{1}{{}^nC_n} = \sum_{r=0}^{n-1}\frac{(n-r)!r!}{n!}+1 = \sum_{r=0}^{n-1}\left(\frac{(n-r)}{n}\right)\left(\frac{((n-1)-r)!r!}{(n-1)!}\right)+1$

$\Rightarrow \frac{1}{n}\cdot\sum_{r=0}^{n-1}\frac{(n-r)}{{}^{n-1}C_r}+1$ ..... (1)

$\Rightarrow \frac{1}{n}\cdot\sum_{r=0}^{n-1}\frac{n-(n-1-r)}{{}^{n-1}C_{n-1-r}}+1$

$\Rightarrow \frac{1}{n}\cdot\sum_{r=0}^{n-1}\frac{r+1}{{}^{n-1}C_r}+1$ ..... (2)

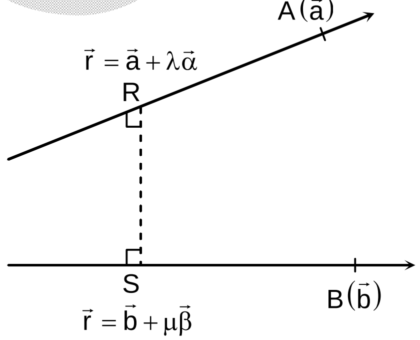
Adding equation (1) and (2), we get $2b_n = \frac{1}{n}\cdot\sum_{r=0}^{n-1}\frac{n-r+r+1}{{}^{n-1}C_r}+2$

$\Rightarrow \frac{n+1}{2n}\cdot\sum_{r=0}^{n-1}\frac{1}{{}^{n-1}C_r}+1 \Rightarrow \frac{n+1}{2n}\cdot b_{n-1}+1$

43. B, D

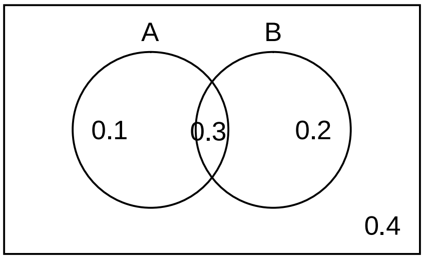
Sol. Let position vector R is $\vec{a}+\lambda\vec{\alpha}$ and position vector of S is $\vec{b}+\mu\vec{\beta}$

Vector $\overrightarrow{RS} = (\vec{a}-\vec{b})+\lambda\vec{\alpha}-\mu\vec{\beta}$ taking dot product of $\overrightarrow{RS}$ with $\vec{\alpha}$ and $\vec{\beta}$ we will get λ or μ and then the position vector R and S


$A(\vec{a})$
$\vec{r} = \vec{a}+\lambda\vec{\alpha}$
R
S
$B(\vec{b})$
$\vec{r} = \vec{b}+\mu\vec{\beta}$

44. B, D

Sol. $P(A) = 0.4$, $P(A \cup B) = P(A) + P(B) - P(A \cap B) = 0.6$
$P(B) = 0.5$, $P(A \cap B) = 0.3$



$P(E_1) = \frac{P(A\cap B)}{P(A\cup B)} = \frac{0.3}{0.6} = \frac{1}{2}$

$P(E_2) = \frac{P(A\cap\bar{B})+P(\bar{A}\cap B)}{P(A\cup B)} = \frac{0.1+0.2}{0.6} = \frac{1}{2}$

$P\left(\frac{A}{B}\right) = \frac{P(A\cap B)}{P(B)} = \frac{0.3}{0.5} = \frac{3}{5}$; $P\left(\frac{B}{A}\right) = \frac{0.3}{0.4} = \frac{3}{4}$

$P\left(\frac{A}{A\cup B}\right) = \frac{P(A)}{P(A\cup B)} = \frac{0.4}{0.6} = \frac{2}{3}$; $\frac{P(B)}{P(A\cup B)} = \frac{0.5}{0.6} = \frac{5}{6}$

45. B, D

Sol. A_n is non-singular for all n and det $A_n = (-1)^{n+1}\cdot n!$

46. A, B, C, D

Sol. For $r \geq 0$, $\frac{1}{r+1} \cdot C_2^2 = \frac{1}{(r+1)} \cdot \frac{n!}{r!(n-r)!} \cdot C_r = \frac{1}{(n+1)} \cdot \frac{((n+1)!)}{(r+1)!(n-r)!} \cdot C_r = \frac{1}{(n+1)} \cdot {}^{(n+1)}C_{r+1} \cdot {}^{n}C_r$

Thus, $S = \frac{1}{(n+1)} \cdot S_1$ where $S_1 = \sum_{r=0}^{n} {}^{n+1}C_{r+1} \cdot {}^{n}C_r = \frac{(2n+1)!}{n!(n+1)!}$

$\therefore\ S = \frac{1}{n+1} \cdot \frac{(2n+1)!}{n!(n+1)!} = \frac{(2n+1)!}{((n+1)!)^2} = \frac{1}{(2n+2)} \cdot {}^{2n+2}C_{n+1}$

Section – B

47. 2

Sol. Let $x = \frac{y}{\sqrt{2014}}$ i.e. is $\frac{y^3}{2014} - \frac{4029y^2}{2014} + 2 = 0 \Rightarrow y^3 - 4029y^2 + 4028 = 0$

$\Rightarrow (y - 1)(y^2 - 4028y - 4028) = 0$ it is observed as $y = 1$, is middle root

Therefore, $x_2(x_1 + x_3) = \frac{1}{\sqrt{2014}} \times \frac{4028}{\sqrt{2014}} = 2$

48. 7

Sol. Let $2^{17} = x$ given equation is $\frac{x^{17}+1}{x+1} = x^{16} - x^{15} + x^{14} + \ldots.. - x^1 + x^0$

Now, consider $(x^{16} - x^{15}) = x^{15}(x - 1) = x^{15}(2^{17} - 1)$

Since, $2^{17} - 1 = 2^{16} + 2^{15} + \ldots.. + 1 \Rightarrow$ Total 17 terms

So, there are 8 such pair like $x^{14} - x^{13}$ and so on

So, total is $17 \times 8 + 1 = 137$, 1 is for x^0

49. 1

Sol. As a subset with less than 3 chairs cannot contain 3 adjacent chair, these are only 10 sets of 3 chairs so that they are all 3 adjacent there are 10 subsets of 4 chairs where all r adjacent and $10 \times 5 = 50$, where there are only 3

If there are 5 chairs, 10 have all 5 adjacent $10 \times 4 = 40$ have 4 adjacent and $10 \times {}^{5}C_2 = 100$ have 3 adjacent with 6 chairs in the subset

10 have all 6 adjacent, $10 \times 3 = 30$ have 5 adjacent, $10 \times {}^{4}C_2 = 60$ have 4 adjacent

$\frac{10 \times 3}{2} = 15$ have 2 groups of 3 adjacent chairs and $10 \times \left({}^{5}C_2 - 3\right) = 70$ have 1 group of 3 adjacent chairs. All possible subsets with more than 6 chairs have at least 1 group of 3 adjacent.

So adding all it is total = 581

50. 7

Sol. **First Solution:**

$(2+i)^n = (a_n + b_n)^i$ square the given equality $(3+4i)^n = (a_n + b_n i)^2 = (a_n^2 - b_n^2) + 2a_n b_n i$

So, $a_n b_n = \frac{1}{2}\text{Im}(3+4i)^n \Rightarrow \sum_{n=0}^{\infty} \frac{a_n b_n}{7^n} = \sum \frac{1}{2} \frac{\text{Im}(3+4i)^n}{7^n} = \frac{1}{2}\text{Im}\left(\frac{1}{1 - \frac{3+4i}{7}}\right) = \frac{7}{16}$

Second Solution:

$2 + i = \sqrt{5}\left(\frac{2}{\sqrt{2}} + \frac{1}{\sqrt{5}} i\right) = \sqrt{5}(\cos\theta + i\sin\theta) \Rightarrow \theta = \tan^{-1}\frac{1}{2}$

$(2+i)^n = (\sqrt{5})^n (\cos\theta + i\sin n\theta) \Rightarrow \sum_{n=0}^{\infty} \frac{a_n b_n}{7^n} = \sum_{n=0}^{\infty} \frac{\cos n\theta \cdot \sin n\theta \cdot 5^n}{7^n}$

$$= \frac{1}{2}\sum\left(\frac{5}{7}\right)^n \cdot \sin 2n\theta = \frac{1}{2}\text{Im}\sum\left(\frac{5}{7}\right)^n \cdot e^{i2n\theta} = \frac{1}{2}\text{Im}\left[\sum_{n=0}^{\infty}\left(\frac{5}{7}\right)^n \left(e^{i2\theta}\right)^n\right] \text{ is a Geometric Progression}$$

$$\Rightarrow \frac{1}{2}\text{Im}\left[\frac{1}{1-\frac{5}{7}\cdot e^{2\theta i}}\right] \Rightarrow \frac{1}{2}\text{Im}\left(\frac{1}{1-\frac{5}{7}(\cos 2\theta + i\sin 2\theta)}\right) = \frac{1}{2}\text{Im}\left(\frac{7}{8}+\frac{7}{8}i\right) = \frac{1}{2}-\frac{7}{8} = \frac{7}{16}$$

51. 9

Sol. The given sequence 4, 7, 1, 8, 9, 7, 6, 3, 9, 2, 1, 3, 4, 7, 1 .....
So, after 12th terms the separation of numbers starts and the sum of 12th terms is
4 + 7 + ... + 1 + 3 = 60

Since, $S_n > 10{,}000 \Rightarrow \frac{10{,}000}{60} = 166$ and 166 × 12 = 1992

So, $S_{1992} = 60 \times 166 = 9960 \Rightarrow 9960 + 4 + 7 + 1 + 8 + 9 + 7 = 9996 + 6 = 10{,}000$

$\therefore S_{1999} > 10{,}000$

52. 4

Sol. Let $\omega = \cos\alpha + i\sin\alpha$; $z = 10(\cos\beta + i\sin\beta)$

$\Rightarrow \frac{\omega - z}{z} = \frac{1}{10}\cos(\alpha-\beta) + \frac{1}{10}i\sin(\alpha-\beta) - 1$. Let $x = \alpha - \beta$

$\tan\theta = \frac{\sin x}{\cos x - 10}$, maximum occurs at $\cos x = \frac{1}{10}$, $\sin x = \pm\frac{\sqrt{99}}{10}$

$\therefore \tan^2\theta = \frac{1}{99}$

53. 3

Sol. Set of these rational numbers in from $\frac{1}{999}$ to $\frac{499}{501}$

There are 499 numbers between 501 and 999 ⇒ 249 numbers are divisible by 2
⇒ 99 numbers are divisible by 5 ⇒ 49 numbers are divisible by 10
So, by inclusion/exclusion 499 – 249 – 99 + 49 = 200

54. 7

Sol. $\ell = \lim_{n\to\infty} 18\left(\frac{3}{3^2}+\frac{3^2}{4^4}+\frac{3^3}{3^6}+.....\right) = 18 \times \frac{1}{3\left(1-\frac{1}{3}\right)} = 9$

$m = \lim_{n\to\infty} 12\left(\frac{2}{2^2}+\frac{2^2}{2^4}+.....\right) = 12 \times \frac{1}{2\left(1-\frac{1}{2}\right)} = 12 \Rightarrow A_n = \frac{9+12}{3} = 7$

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – I

JEE (Main)-2023

TEST DATE: 28-12-2022

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is Mathematics.
- Each part has only two sections: **Section-A and Section-B**.
- **Section – A** : Attempt all questions.
- **Section – B :** Do any five questions out of 10 questions.

Section-A (01 – 20, 31 – 50, 61 – 80) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-B (21 – 30, 51 – 60, 81 – 90) *contains 30 Numerical based questions. The answer to each question is rounded off to the nearest integer value. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

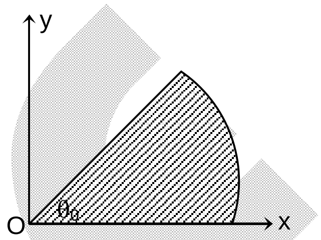
PART – A

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. Co-ordinates of the centre of mass of a sector of uniform circular disc of radius R and of mass m and subtends an angle θ_0 at it's centre as shown in figure are



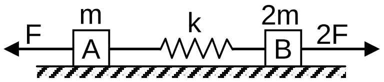
(A) $\left[\frac{2R}{3}\frac{\sin\frac{\theta_0}{2}}{\frac{\theta_0}{2}},\frac{2R}{3}\left(\frac{1-\cos\frac{\theta_0}{2}}{\frac{\theta_0}{2}}\right),0\right]$

(B) $\left[\frac{2R}{3}\frac{\sin\theta_0}{\theta_0},\frac{2R}{3}\left(\frac{1-\cos\theta_0}{\theta_0}\right),0\right]$

(C) $\left[\frac{4R}{3}\frac{\sin\theta_0}{\theta_0},\frac{4R}{3}\frac{\cos\theta_0}{\theta_0},0\right]$

(D) $\left[\frac{4R}{3}\frac{\sin\theta_0}{\theta_0},\frac{2R}{3}\left(\frac{1-\cos\theta_0}{\theta_0}\right),0\right]$

2. Two blocks A & B of mass 'm' & 2m respectively are joined to the ends of an under formed massless spring of spring constant 'k'. They can move on a horizontal smooth surface. Initially A & B has velocities 'u' towards left and '2u' towards right respectively. Constant forces of magnitudes F and 2 F are always acting on A and B respectively in the directions shown. The maximum extension in the spring during the motion is



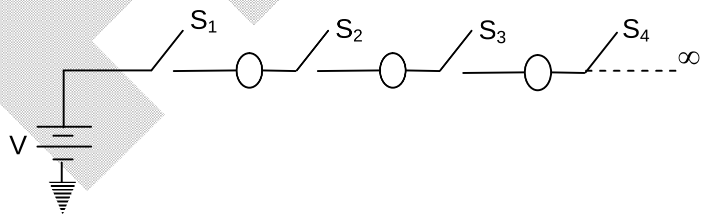
(A) $x_{max}=\frac{4F-\sqrt{16F^2+54mu^2k}}{3k}$

(B) $x_{max}=\frac{4F+\sqrt{16F^2+54mu^2k}}{3k}$

(C) $x_{max}=\frac{4F+\sqrt{16F^2-54mu^2k}}{3k}$

(D) $x_{max}=\frac{4F-\sqrt{16F^2-54mu^2k}}{3k}$

3. All spheres are identical of radius R and initially uncharged, S_1 is closed at t = 0, leaving all other switches open. After sufficiently long time S_1 opened and S_2 is closed. The process is done till S_{n-1} is opened and S_n is closed. Net loss of energy of system after t = 0 if process is done for infinite number of spheres, is



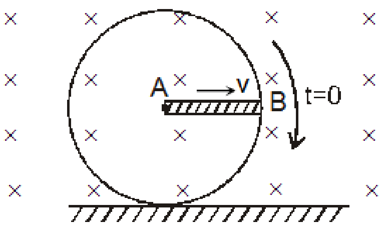
(A) $\frac{20}{6}\pi\varepsilon_0RV^2$

(B) $2\pi\varepsilon_0RV^2$

(C) $\frac{8}{3}\pi\varepsilon_0RV^2$

(D) Zero

4. As shown in figure a conducting rod AB is attached to wooden disc of radius R and disc is in pure rolling with linear velocity v, find net emf developed across rod of length r as a function of time. Initial position of rod is shown in figure. Magnetic field is B and is directed into the plane.



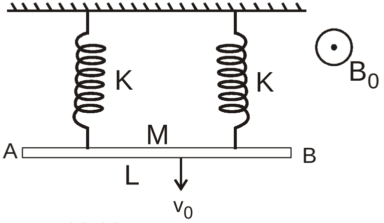
(A) $2BvR\left(1+\sin\frac{v}{R}t\right)$

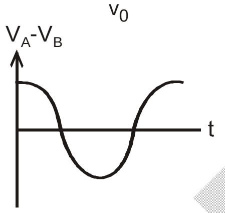
(B) zero

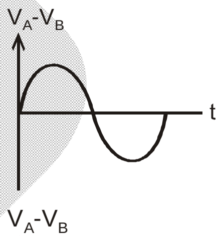
(C) $\frac{BvR}{2}\left(1+2\cos\frac{v}{R}t\right)$

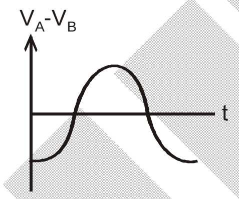
(D) $\frac{BvR}{2}\left(1-2\sin\frac{v}{R}t\right)$

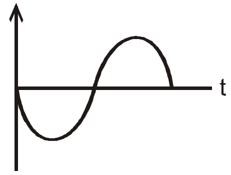
5. A horizontal conducting rod is kept in vertical plane is supported by two non-conducting springs as shown. A uniform magnetic field is directed outward rod initially at rest in equilibrium position and t=0 it is given velocity v_0 in downward direction. Which of the following graphs represent potential difference across to ends of the rod.



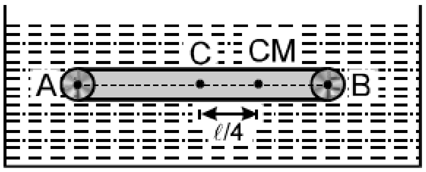
(A)


(B)


(C)


(D)


6. A non uniform cylinder of mass m, length ℓ and radius r is having its centre of mass at a distance ℓ/4 from the centre and lying on the axis of the cylinder. The cylinder is kept in a liquid of uniform density ρ. The moment of inertia of the rod about the centre of mass is I. The angular acceleration of point A relative to point B just after the rod is released from the position shown in figure is



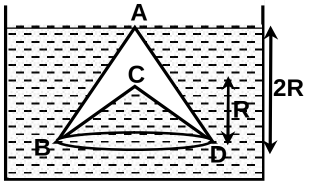
(A) $\frac{\pi\rho g\ell^2r^2}{I}$

(B) $\frac{\pi\rho g\ell^2r^2}{4I}$

(C) $\frac{\pi\rho g\ell^2r^2}{2I}$

(D) $\frac{3\pi\rho g\ell^2r^2}{4I}$

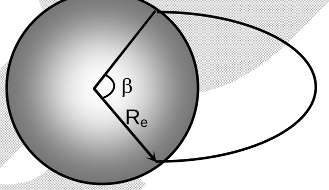
7. A solid cone of uniform density and height 2R and the base radius R has a conical portion scooped out from its base with the same base radius but height R as shown in the figure. The solid cone is floating in a liquid of density r with vertex A touching the fluids surface. If atmospheric pressure is P_0, the force acting on the surface BCD due to liquid is



(A) $\frac{\pi R^3 \rho g}{3}\left(2+\frac{2P_0}{R\rho g}\right)$ (B) $\frac{\pi R^3 \rho g}{3}\left[5+\frac{3P_0}{R\rho g}\right]$

(C) $\frac{\pi R^3 \rho g}{3}\left[1+\frac{3P_0}{R\rho g}\right]$ (D) $\frac{\pi R^3 \rho g}{3}\left[4+\frac{3P_0}{R\rho g}\right]$

8. A particle is projected from the surface of the earth (of radius R_e and mass M_e) with speed equal to $\sqrt{\frac{GM_e}{R_e}}$, at certain angle from local horizontal as shown in the figure such that the angle subtended by arc between launching & landing site at earth's centre is β = 90°. Calculate the maximum separation of the particle from the centre of the earth. Consider earth to be uniformly dense and air resistance to be absent.



(A) $R_e\sqrt{2}$ (B) $R_e(\sqrt{2}+1)$

(C) $R_e \frac{(\sqrt{2}+1)}{\sqrt{2}}$ (D) $R_e \frac{(\sqrt{2}+1)}{(\sqrt{2}-1)}$

9. A satellite is moved from one circular orbit around the earth, to another of lesser radius. Which of the following statement is true?

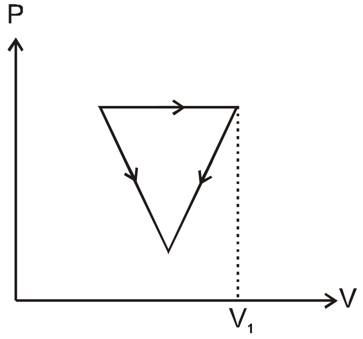
(A) The kinetic energy of satellite increases and the gravitational potential energy of satellite-earth system increases;

(B) The kinetic energy of satellite increases and the gravitational potential energy of satellite-earth system decreases;

(C) The kinetic energy of satellite decreases and the gravitational potential energy of satellite-earth system decreases;

(D) The kinetic energy of satellite decreases and the gravitational potential energy of satellite-earth system increases.

10. The diagram shows an equilateral cyclic process on a PV diagram. The ratio of maximum pressure to minimum pressure is 2. The maximum temperature in the process is T_1. The work done by the two moles of ideal gas in the cyclic process is equal to



(A) $\frac{R^2T_1^2}{\sqrt{3}V_1^2}$ (B) $\frac{R^2T_1^2}{V_1^2}$

(C) $\frac{3R^2T_1^2}{V_1^2}$ (D) $\frac{3}{2}\frac{R^2T_1^2}{V_1^2}$

11. The surface temp of a small planet having a circular orbit round the sun with time period T assuming sun and the planet to be black bodies. Take radius of sun = R mass of sun = M, surface temp of the sun Q_0 is :

(A) $\sqrt{\frac{R}{2r}}\theta_0$ (B) $\sqrt{\frac{R+r}{2}}\theta_0$

(C) $\sqrt{\frac{R-r}{2}}\theta_0$ (D) $\sqrt{\frac{R}{r}}\theta_0$

12. In a sample of rock, the ratio of ^{206}Pb to ^{238}U nuclei is found to be 0.5. The age of the rock is. (Assume that all the Pb nuclides in the rock was produced due to the decay of Uranium nuclides and $T_{1/2}(^{238}U) = 4.5\times10^9$ year).

(A) 2.25×10^9 year (B) $4.5 \times 10^9 \ln 3$ year

(C) $4.5 \times 10^9 \frac{\ln\left(\frac{3}{2}\right)}{\ln 2}$ year (D) $2.25 \times 10^9 \ln\left(\frac{3}{2}\right)$ year

13. A body of mass m_0 is placed on a smooth horizontal surface. The mass of the body is decreasing exponentially with disintegration constant λ. Assuming that the mass is ejected backwards with relative velocity u. initially the body was at rest. The velocity of it after time t :

(A) $u\,\lambda t$ (B) $u\,e^{-\lambda t}$

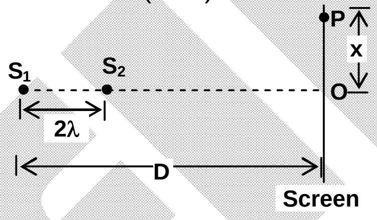
(C) $u\,e^{\lambda t}$ (D) none of these

14. A point object is moving with a velocity, $\vec{v}_0 = 2\hat{i} - 3\hat{j} + 4\hat{k}$; in front of a moving plane mirror whose normal is along x-axis. The mirror is moving with a velocity $\hat{i} - 4\hat{j} + 3\hat{k}$. The velocity vector of the image is given by

(A) $15\hat{j} + 3\hat{k}$ (B) $-3\hat{j} + 4\hat{k}$

(C) $\hat{j} + 2\hat{k}$ (D) $2\hat{i} + 3\hat{j} - 2\hat{k}$

15. Two coherent narrow slits emitting light of wavelength λ in the same phase are placed parallel to each other at a small separation of 2λ. The light is collected on screen which is placed at a distance D (>> λ) from the slit S_1 as shown in figure.



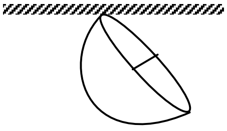
(A) The finite distance x such that the intensity at P is equal to the intensity at O is $\sqrt{3}D$

(B) The finite distance x such that the intensity at P is equal to the intensity at O is $\sqrt{\frac{3}{2}}D$

(C) There is no point on the screen at which the intensity at P is equal to intensity at O

(D) The finite distance x such that the intensity at P is equal to the intensity at O is $\sqrt{2}D$

16. Time period of small oscillations of a uniform hemispherical shell of radius R and mass m is



(A) $2\pi\sqrt{\frac{2\sqrt{5}R}{3g}}$ (B) $2\pi\sqrt{\frac{2\sqrt{5}R}{g}}$

(C) $2\pi\sqrt{\frac{\sqrt{5}R}{2g}}$ (D) $2\pi\sqrt{\frac{\sqrt{5}R}{3g}}$

17. A siren is placed at a railway platform is emitting sound of frequency 10 KHz. A passenger sitting in a moving train A records frequency of 11 kHz, while the train approaches the siren. During his return journey in a different train B he records a frequency of 12 KHz while approaching the same siren. Ratio of velocity of train B to that of train A is

(A) 2 (B) $\frac{242}{252}$

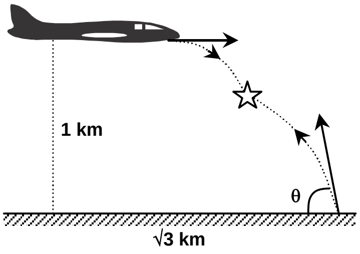
(C) $\frac{6}{5}$ (D) $\frac{11}{6}$

18. The pressure of an ideal gas varies according to the law $P = P_0 - AV^2$ where P_0 and A are positive constants. The highest temperature that can be attained by the gas is

(A) $\frac{P_0}{nR}\sqrt{\frac{P_0}{3A}}$ (B) $\frac{2P_0}{nR}\sqrt{\frac{P_0}{3A}}$

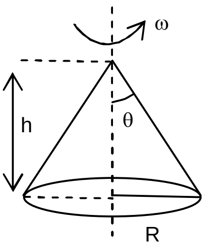
(C) $\frac{2P_0}{3nR}\sqrt{\frac{P_0}{3A}}$ (D) $\frac{2P_0}{3nR}\sqrt{\frac{P_0}{A}}$

19. An aircraft is flying horizontally with a constant velocity = 200 m/s, at a height = 1 km above the ground. At the moment shown, a bomb is released from the aircraft and the cannon-gun below fires a shell with initial speed = 200 m/s, at some angle θ. For what value of 'θ' will the projectile shell destroy the bomb in mid air?



(A) θ = 15° (B) θ = 30°
(C) θ = 45° (D) θ = 60°

20. 'Q' charge is uniformly distributed over the surface of a right circular cone of semi-vertical angle θ and height h. The cone is uniformly rotated about its axis at angular velocity ω. Magnetic moment associated with the cone is found to be



(A) $\frac{Q\omega h^2 \tan^2\theta}{2}$ (B) $Q\omega h^2 \tan^2\theta$

(C) $\frac{Q\omega h^2 \tan^2\theta}{4}$ (D) $\frac{Q\omega h \tan\theta}{2}$

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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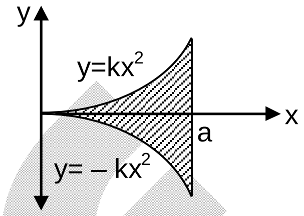
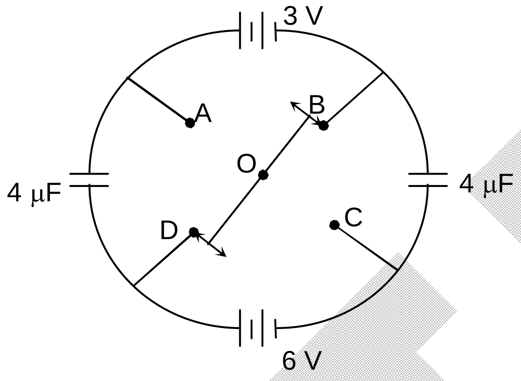
21. A thin sheet of metal of uniform thickness is cut into the shape bounded by the line x = a and $y = \pm kx^2$, as shown.

If the x-coordinate of the centre of mass is $\frac{na}{12}$ then find n.



22. In figure there is four way key at the middle. If key is thrown from situation BD to AC, then charge flowing through point is q_0. Value of $\frac{q_0}{12}$ is ………

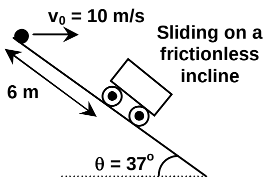


23. A fixed container of height ‘H’ with large cross-sectional area ‘A’ is completely filled with water. Two small orifices of cross-sectional area ‘a’ are made, one at the bottom and the other on the vertical side of the container at a distance H/2 from the top of the container. The time taken by the water level to reach a height of H/2 from the bottom of the container is $\frac{XA}{3\alpha}\left(\sqrt{2}-1\right)\sqrt{\frac{H}{g}}$. Find the value of X.

24. A wire forming a loop is dipped into soap solution and taken out, so that a film of soap solution is formed. A loop of 6.28 cm long thread is gently put on the film is pricked with a needle inside the loop. The thread loop takes the shape of a circle. Find the tension in the thread in (10^{-4} N). Surface tension of soap solution = 0.03 N/m.

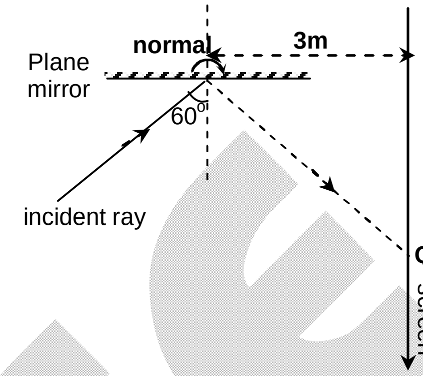
25. A solid copper sphere (density ρ and specific heat C) of radius r at an initial temperature 200 K is suspended inside a chamber whose walls are almost at 0 k. the time required for the temperature of sphere to drop to 100 K is found to be $\frac{x}{72}\frac{r\rho c}{\sigma}\times 10^{-6}\text{ sec}$. The value of *x* is.

26. A ball is projected horizontally from an incline so as to strike a cart sliding on the incline. Neglect height of cart and point of projection of ball above incline. At the instance the ball is thrown, the speed of cart is ‘v’ (in m/s). Find ‘v’ so that the ball strikes the cart.

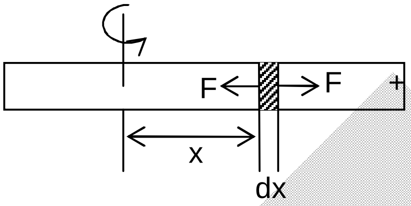


27. If the frequency of k_α x – ray emitted from the element with atomic number 31 is f, if the frequency of k_α X- ray emitted from the element with atomic number 51 is given by $\frac{25}{x}f$ then x will be ?

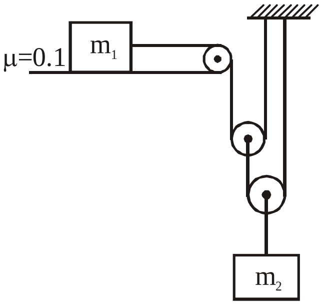
28. In the given figure, a ray is incident on the plane mirror as shown. The reflected ray strike the screen at Q. the mirror now starts, rotating about axis passing through P and perpendicular to plane of paper with angular speed $\pi/180$ rad/second. If the speed of point at which reflected ray strike the screen is $\frac{k\pi}{15}$ m/second at time t = 15 second, find the value of k.



29. A horizontally oriented copper rod of length l is rotated about a vertical axis passing through its middle. Frequency at which the rod ruptures when rotated at $\frac{1}{2\pi}\sqrt{\frac{X\sigma}{\rho l^2}}$. Breaking or breaking force of copper takes as σ and density of copper ρ. Find X.



30. In the figure, find the velocity of m_1 in ms^{-1} when m_2 falls by 9m.
Given $m_1 = m$
$m_2 = 2m$
(take $g = 10\ ms^{-2}$)



Chemistry

PART – B

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

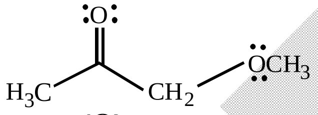
31. The conductivity measurement of a coordination compound of Cobalt (III) shows that it dissociates into 3 ions in solution. The compound is
(A) Hexaamminecobalt(III) chloride
(B) Pentaamminesulphatocobalt(III) chloride
(C) Pentaamminechloridocobalt(III) sulphate
(D) Pentaamminechloridocobalt(III) chloride

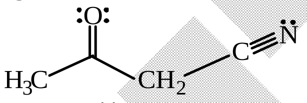
32. Which is the major product obtained by hydrolysis of compound formed by reaction between formaldehyde and ethyl magnesium bromide?
(A) Ethan-1-ol
(B) Propan-2-ol
(C) Propan-1-ol
(D) 2-Methyl-propan-2-ol

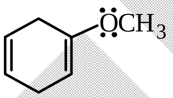
33. The total number of isomeric linear dipeptide which can be synthesized from racemic alanine is
(A) 1
(B) 2
(C) 3
(D) 4

34. The charge carried by 1 millimole of M^{n+} ions is 193 coulombs. The value of n is
(A) 1
(B) 2
(C) 3
(D) 4

35. The molecule/molecules that has/have delocalised lone pair(s) of electrons is/are

(I) 

(II) 

(III) 

(IV) $CH_3CH = CHCH_2CH_3$
(A) I, II and III
(B) I, II and IV
(C) I and III
(D) only III

36. Which one of the following electronic arrangements is absurd?
(A) n = 3, ℓ = 1, m = –1
(B) n = 3, ℓ = 0, m = 0
(C) n = 2, ℓ = 0, m = –1
(D) n = 2, ℓ = 1, m = 0

37. In order to oxidise a mixture one mole of each of FeC_2O_4, $Fe_2(C_2O_4)_3$, $FeSO_4$ and $Fe_2(SO_4)_3$ in acidic medium , the number of moles of $KMnO_4$ required is -
(A) 3
(B) 2
(C) 1
(D) 1.5

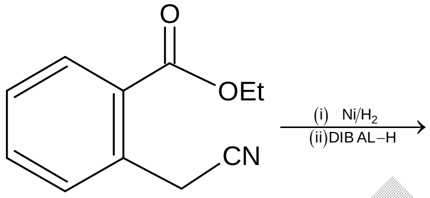
38. Which one of the following is likely to give a precipitate with $AgNO_3$ solution ?
(A) $(CH_3)_3CCl$
(B) $CHCl_3$
(C) $CH_2 = CH – Cl$
(D) CCl_4

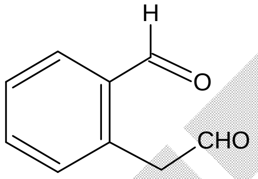
39. 1 g of non-volatile non-electrolyte solute is dissolved in 100g of two different solvents A and B whose ebullioscopic constants are in the ratio of 1 : 5. The ratio of the elevation in their boiling points, is :
(A) 5 : 1 (B) 10 : 1
(C) 1 : 5 (D) 1 : 0.2

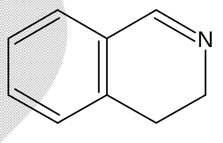
40. Among the following, the INCORRECT statement about colloids is :
(A) They can scatter light.
(B) They are large molecules and have high molar mass.
(C) The range of diameters of colloidal particles is between 1 and 1000 nm.
(D) The osmotic pressure of a colloidal solution is of higher order than the true solution for same weight of solute per litre solution.

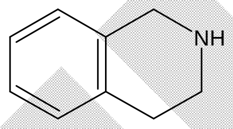
41. The radius of the largest sphere which fits properly at the centre of the edge of body centred cubic unit cell is :
(Edge length is represented by 'a') :-
(A) 0.134 a (B) 0.027 a
(C) 0.067 a (D) 0.047 a

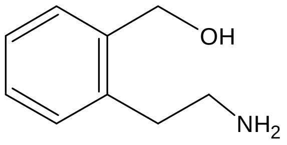
42. The major product of the following reaction is:



(A)


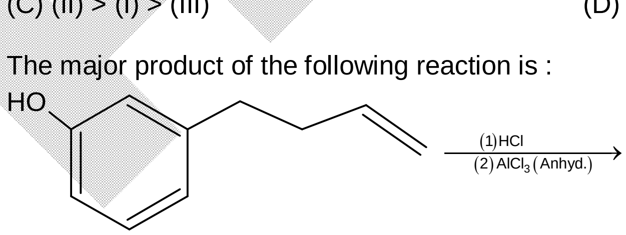
(B)


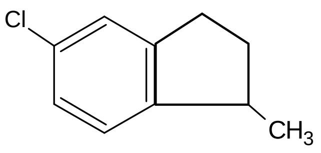
(C)


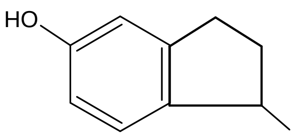
(D)


43. Three complexes, $[CoCl(NH_3)_5]^{2+}$ (I),
$[Co(NH_3)_5H_2O]_3$+ (II) and $[Co(NH_3)_6]^{3+}$ (III)
absorb light in the visible region. The correct order of the wavelength of light absorbed by them is:
(A) (III) > (I) > (II) (B) (I) > (II) > (III)
(C) (II) > (I) > (III) (D) (III) > (II) > (I)

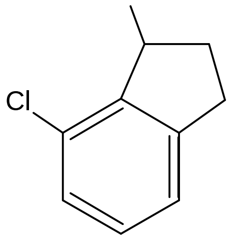
44. The major product of the following reaction is :



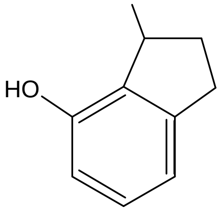
(A)


(B)


(C)



(D)



45. The primary pollutant that leads to photochemical smog is :
(A) Sulphur dioxide (B) Acrolein
(C) Ozone (D) Nitrogen oxides

46. NaH is an example of :
(A) Electron-rich hydride (B) Molecular hydride
(C) Saline hydride (D) Metallic hydride

47. For the reaction of H_2 with I_2, the rate constant is $2.5 \times 10^{-4} dm^3\ mol^{-1}\ s^{-1}$ at 327°C and $1.0\ dm^3\ mol^{-1}\ s^{-1}$ at 527°C. The activation energy for the reaction, in $kJ\ mol^{-1}$ is:
($R = 8.314\ J\ K^{-1}\ mol^{-1}$)
(A) 72 (B) 166
(C) 150 (D) 59

48. Which of the following order is incorrect :
(A) Ionic character – $MCl > MCl_2 > MCl_3$
(B) Polarizability – $F^- < Cl^- < Br^- < I^-$
(C) Polarising power– $Na^+ < K^+ < Mg^{+2} < Al^{+3}$
(D) Polarising power – $Li^+ < Be^{+2} < B^{+3}$

49. $(CH_3)_2CHBr \xrightarrow[\text{(ii) CuI}]{\text{(i) Li}} A \xrightarrow{(CH_3)_2CHCH_2Br} B$
'B' is -
(A) $(CH_3)_2CHCH_2CH_3$
(B) $(CH_3)_2CHCH(CH_3)_2$
(C) $(CH_3)_2CHCH_2CH(CH_3)_2$
(D) $(CH_3)_2CHCH_2CH_2CH(CH_3)_2$

50. Calculate the potential of an indicator electrode versus the standard hydrogen electrode, which originally contained 0.1 M MnO_4^- and 1.72 M H^+ and which was treated with Fe^{2+} necessary to reduce 90% of $KMnO_4$ to Mn^{2+}

$$E^0_{MnO_4^-/Mn^{2+}} = 1.51V$$

(A) 1.4 V (B) 1.5 V
(C) 1.6 V (D) 1.3 V

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

51. An adiabatic container fitted with a movable adiabatic piston (operating at 1 atm) is filled with 2 litre of 2M H_2O_2(aq) solution at 300 K. If H_2O_2 dissociates following first order decay with a half life of 10min then value of [Magnitude of change in internal energy (in cal) ÷ 100] in first 20 min will be

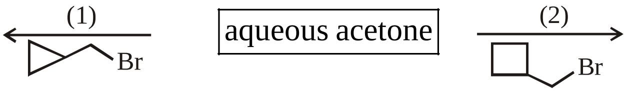
52. Number of compounds which are planar ?
XeF_2, ClF_3, H_2O, $[XeF_5]^-$, I_3^-, BCl_3, XeF_4, SF_4, PCl_5, SF_6, IF_7.

53. In how many reactions the 1st reaction is faster than 2nd reaction?

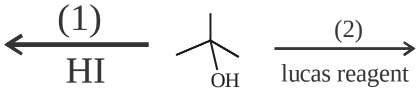
$$(P)\xleftarrow[(1)]{CF_3CH_2O^{\Theta}}\boxed{CH_3-CH_2-Br}\xrightarrow[(2)]{CH_3CH_2O^{\Theta}}$$

(Q) (Alkene) $\xleftarrow[(CH_3)_3CBr/\Delta]{(1)}\boxed{C_2H_5O^{\Theta}}\xrightarrow[(CH_3)_2CHCH_2Br/\Delta]{(2)}$ (Alkene)

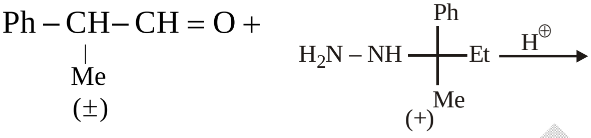
(R)



(S)



54. The number of stereoisomers of the product obtained in the following reaction is :



55. Na_2SO_3, NaCl, $Na_2C_2O_4$, Na_2HPO_4, Na_2CrO_4, $NaNO_2$, CH_3COONa are separately treated with $AgNO_3$ solution. In how many cases white ppt. is/are obtained?

56. A sample consisting of choclate-brown powder of PbO_2 is allowed to react with excess of KI and iodine liberated is reacted with N_2H_4 in another container. The volume of gas liberated from this second container at STP was measured out to be 1.12 litre. Find out volume of decimolar NaOH (in litre) required to dissolve PbO_2 completely. (Assume all reactions are 100% complete)

57. The ionization energy of the Be^{3+} ion with the electron in its ground state is 2.10×10^{A} kJ/mol. Find the value of A.

58. By how many times the absolute temperature of a gas when U_{rms} of a gas in a container of fixed volume is increased from 5×10^4 cm/sec to 10×10^4 cm/sec

59. A sample of HI(g) is placed in flask at a pressure of 0.2 atm. At equilibrium, the partial pressure of HI(g) is 0.04 atm. What is K_P for the given equilibrium ? $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$

60. In 100 ml sample of hard water, 100 ml of (N/50) Na_2CO_3 was added and the mixture was boiled and filtered. The filtrate was neutralized with 60 ml of (N/50) HCl. Calculate the permanent hardness of water (in ppm).
(sp. gr. of hard water = 1).

Mathematics PART – C

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

61. A triangle is formed by the lines whose combined equation is given by $(x+y-4)(xy-2x-y+2)=0$ The equation of its circumcircle is

(A) $x^2+y^2-5x-3y+8=0$
(B) $x^2+y^2-3x-5y+8=0$
(C) $x^2+y^2-3x-5y-8=0$
(D) None of these

62. Two circles, each of radius 5, have a common tangent at (1,1) whose equation is 3x + 4y – 7 = 0. Then their centres are

(A) (4, -5), (-2, 3)
(B) (4, -3), (-2, 5)
(C) (4, 5), (-2, -3)
(D) None of these

63. If *p* and *q* be the longest distance and the shortest distance respectively of the point (-7, 2) from any point (α, β) on the curve whose equation is $x^2+y^2-10x-14y-51=0$, then G.M. of *p* and *q* is equal to

(A) $2\sqrt{11}$
(B) $5\sqrt{5}$
(C) 13
(D) None of these

64. Through the point (13, 31) a straight line is drawn to meet the axes of *X* and *Y* at Q and S respectively. If the rectangle OQRS is completed, the co-ordinates of R satisfy the equation.

(A) $\frac{13}{x}+\frac{31}{y}=1$
(B) $\frac{31}{x}+\frac{13}{y}=1$
(C) $\frac{13}{x}-\frac{31}{y}=1$
(D) $\frac{31}{x}-\frac{13}{y}=1.$

65. The normal chord of parabola, which sub-stends right angle at vertex is inclined at an angle α to the axis of parabola. Find the value of α ?

(A) $\tan^{-1}\left(\frac{1}{\sqrt{2}}\right)$
(B) $\tan^{-1}(\sqrt{7})$
(C) $\frac{\pi}{3}$
(D) $\tan^{-1}(\sqrt{2})$

66. A ray of light travelling along the line y = k from the positive direction of x-axis strikes a concave mirror, whose intersection with xy plane is parabola $y^2 = 4ax$. Find the equation of line along which the reflected ray will travel. Assume ‘a’ and ‘k’ are positive.

(A) $(k^2-4a^2)y=4ak(x-a)$
(B) $(k^2-4a^2)y=4ak(x+a)$
(C) $x=a$
(D) $x=2a$

67. TP and TQ are tangents drawn to a parabola from the point T and P_1, P_2 and P_3 are the lengths of perpendicular from P, T and Q respectively on any tangent to the curve. Then

(A) P_1, P_2, P_3 are in A.P
(B) P_1, P_2, P_3 are in G.P
(C) P_1, P_2, P_3 are in H.P
(D) $\frac{1}{P_1}+\frac{1}{P_2}=\frac{a}{P_2}$ (4a is latus rectum)

68. Any point P on the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ is joined to its centre O. The locus of mid-point of OP is

(A) $\frac{x^2}{a^2}+\frac{y^2}{b^2}=\frac{1}{2}$
(B) $\frac{x^2}{a^2}+\frac{y^2}{b^2}=\frac{1}{4}$
(C) $\frac{x^2}{a^2}+\frac{y^2}{b^2}=2$
(D) $\frac{a^2}{x^2}+\frac{b^2}{y^2}=1$

69. If the normal at any point P on an ellipse of eccentricity 'e' meets the major axis and minor axis at T and G respectively, then PT : PG is equal to

(A) e
(B) 1 : e
(C) $(1 - e^2) : 1$
(D) $(1 - e^2) : e$

70. For a certain value of c, $\lim\limits_{x\to-\infty}\left[\left(x^5+7x^4+2\right)^C - x\right]$ is finite & non zero. The value of c and the value of the limit is

(A) 1/5, 7/5
(B) 0, 1
(C) 1, 7/5
(D) none of these

71. If $\int\left(x^3-2x^2+5\right)e^{3x}dx = e^{3x}\left(Ax^3+Bx^2+Cx+D\right)$ then the statement which is incorrect is

(A) C + 3D = 5
(B) A + B + 2/3 = 0
(C) 3C + 2B = 0
(D) A + B + C = 0

72. Let $I_1 = \int\limits_0^{\pi/2} e^{-x^2}\sin(x)dx$; $I_2 = \int\limits_0^{\pi/2} e^{-x^2}dx$; $I_3 = \int\limits_0^{\pi/2} e^{-x^2}(1+x)dx$

and consider the statements

I $I_1 < I_2$ **II** $I_2 < I_3$ **III** $I_1 = I_3$

Which of the following is(are) true?

(A) I only
(B) II only
(C) Neither I nor II nor III
(D) Both I and II

73. If the function f(x) = 2 tan x + (2a + 1)ln |sec x| + (a –2)x is increasing in $\left(0, \frac{\pi}{2}\right)$ then range of 'a' equal to

(A) $(-\infty, 0]$
(B) $[0, 1]$
(C) $[0, 3]$
(D) $[0, \infty)$

74. The maximum value of $\sec^{-1}\left(\frac{7-5\left(x^2+3\right)}{2\left(x^2+2\right)}\right)$ is:

(A) $\frac{5\pi}{6}$
(B) $\frac{5\pi}{12}$
(C) $\frac{7\pi}{12}$
(D) $\frac{2\pi}{3}$

75. Suppose p, q, r $\neq$ 0 and system of equations
$(p+a)x+by+cz=0$
$ax+(q+b)y+cz=0$
$ax+by+(r+c)z=0$
has a non-trivial solution, then value of $\frac{a}{p}+\frac{b}{q}+\frac{c}{r}$ is
(A) -1 (B) 0
(C) 1 (D) 2

76. If the system of equations $ax + hy + g = 0$, $hx + by + f = 0$ and $ax^2 + 2hxy + by^2 + 2gx + 2fy + c + t = 0$ has a unique solution, then
(A) t = 1 (B) t = 0
(C) $t=\frac{abc+2fgh-af^2-bg^2-ch^2}{h^2-ab}$ (D) $t=\frac{1}{h^2-ab}$

77. Let $\vec{p}$ and $\vec{q}$ be the position vectors of P and Q respectively, with respect to O and $|\vec{p}|=p$, $|\vec{q}|=q$. The points R and S divide PQ internally and externally in the ratio 2 : 3 respectively. If $\overrightarrow{OR}$ and $\overrightarrow{OS}$ are perpendicular, then
(A) $9p^2 = 4q^2$ (B) $4p^2 = 9q^2$
(C) 9p = 4q (D) 4p = 9q

78. If $\vec{d}=\lambda(\vec{a}\times\vec{b})+\mu(\vec{b}\times\vec{c})+\gamma(\vec{c}\times\vec{a})$ and $[\vec{a},\vec{b},\vec{c}]=1$
Then $\lambda+\mu+\gamma$ is equal to
(A) $\vec{d}.(\vec{a}+\vec{b}+\vec{c})$ (B) $\vec{a}+\vec{b}+\vec{c}$
(C) 1 (D) none of these

79. Area of the region bounded by the curve $y=\frac{16-x^2}{4}$ and y = $\sec^{-1}$ [– $\sin^2$ x] (where [.] denotes the greatest integer function) is
(A) $\frac{1}{3}(4-\pi)^{3/2}$ (B) $8(4-\pi)^{3/2}$
(C) $\frac{8}{3}(4-\pi)^{3/2}$ (D) $\frac{8}{3}(4-\pi)^{1/2}$

80. A contest consists of predicting the results (win, draw or defeat) of 10 football matches. The probability that one entry contains at least 5 correct answers is
(A) $\frac{12585}{3^{10}}$ (B) $\frac{12385}{3^{10}}$
(C) $\frac{9385}{3^{10}}$ (D) none of these

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

81. If sinx + cosx + tanx + cot x + secx + cosecx = 7 and sin2x = a – b$\sqrt{7}$, where a, b are rational , then $\frac{a+b}{10}$ is

82. If tanx – tan^{2}x = 1, then the value of tan^{4}x – 2tan^{3}x – tan^{2}x + 2tanx + 1 is

83. The hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ passes through (4, 2) and length of latus rectum is $\frac{4}{3}$, the angle between asymptotes is θ then $\frac{6}{\pi}\theta$ is

84. Co-ordinates of points common to hyperbola 25x^2 – 9y^2 = 225 and 25x + 12y = 45 is (x_1, y_1) then $3\left|(x_1+y_1)\right|$ is

85. For x satisfying $\log_{1/\sqrt{5}}(6^{x+1}-36^x) \geq -2$, $x \in (-\infty, a] \cup [\log_b c, \infty)$ then a + b + c is

86. S.D of a data is 6. When each observation is increased by 1, then the S.D of new data is

87. Let u = $\int_0^1 \frac{\ln(x+1)}{x^2+1}dx$ and v = $\int_0^{\pi/2} \ln(\sin 2x)dx$ then 4u + v =

88. Let f(x) = Max. (cos x, x, 2x –1) where x ≥ 0. Then number of points of non-differentiability of f(x), is equal to

89. If a_1 is the value of a for which function f(x) = $x^2+\frac{a}{x}$ has a local minimum at x = 2 and a_2 is the value of a for which f(x) has a point of inflection at x = 1, then $\left(\frac{a_1+a_2}{3}\right)$ is equal to

90. If n positive integers are taken at random and multiplied together, then the probability that the last digit of the product is 2, 4, 6 or 8 is $\frac{a^n-b^n}{C^n}$ then a + b + c is equal to

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – I

JEE (Main)-2023

TEST DATE: 28-12-2022

ANSWERS, HINTS & SOLUTIONS

Physics

PART – A

SECTION – A

1. B

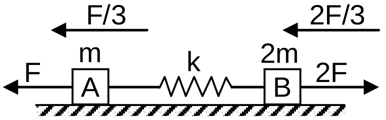
Sol. Centre of mass will be on angle bisector and distance is $\frac{2}{3}R\frac{\sin\frac{\theta_0}{2}}{\frac{\theta_0}{2}}$

x-coordinate = $\left(\frac{2}{3}R\frac{\sin\frac{\theta_0}{2}}{\frac{\theta_0}{2}}\right)\cos\frac{\theta_0}{2}$

y-coordinate = $\left(\frac{2}{3}R\frac{\sin\frac{\theta_0}{2}}{\frac{\theta_0}{2}}\right)\sin\frac{\theta_0}{2}$

2. B

Sol. In frame of centre of mass → $a_{cm} = \frac{F}{3m}$



Work energy theorem in centre of mass frame →

$$\frac{4F}{3}x_1 + \frac{4F}{3}x_2 = \frac{1}{2}k(x_1 + x_2)^2 - \frac{1}{2}m(2u)^2 - \frac{1}{2}(2m)u^2$$

3. B

Sol. $$\Delta H_1 = \frac{Q^2}{2}\left(\frac{1}{C} - \frac{1}{2C}\right)$$

$$\Delta H_2 = \frac{Q^2}{2}\left(\frac{1}{2C} - \frac{1}{3C}\right)$$

....

....

$$\Delta H_n = \frac{Q^2}{2}\left(\frac{1}{nC} - \frac{1}{(n+1)C}\right)$$

$$\Delta H = \Delta H_1 + \Delta H_2 + ... = \frac{Q^2}{2C} = \frac{C^2V^2}{2C} = \frac{CV^2}{2}$$

$$= 2\pi\varepsilon_0 RV^2$$

4. D

Sol. Add linear and Angular

EMF $\frac{B\omega L^2}{2} = \frac{BvR}{2}$

$BvR\sin\omega t = B$

5. A

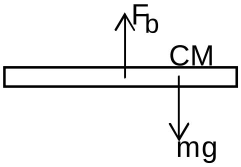
Sol. Velocity will be sinusoidal function of time.

6. B

Sol. Torque about CM;

$$F_b \frac{\ell}{4} = I\alpha$$

$$\alpha = \frac{\pi r^2 \ell^2 g\rho}{4I}$$



7. B

Sol. Upthrust on the complete solid cone $\Rightarrow B = \frac{\pi}{3}(2R)R^2\rho g$

$$\Rightarrow F_{Base} - F_{C\,surface} = \frac{2\pi R^2\rho g}{3}$$

$$\Rightarrow F_1 = F_{C\,surface} = \left[\rho_0 + \rho g(2R)\right]\pi R^2 - \frac{2}{3}\pi R^2\rho g \text{ ....(1)}$$

For remaining cone

F_2 = B.F• $+F_1$

$$= \left[\frac{\pi}{3}R^2 \times 2R - \frac{\pi}{3}R^3R\right]\rho g + P_0\left(\pi R^2\right) + \frac{4}{3}\pi R^3\rho g$$

$$F_1 = \frac{\pi}{3}R^3\rho g\left[5 + \frac{3P_0}{R\rho g}\right]$$

8. C

Sol. Let length of semi major axis is a and eccentricity is e.

$$-\frac{GMm}{R_e}+\frac{1}{2}m\left(\sqrt{\frac{GM_e}{R_e}}\right)^2=-\frac{GM_em}{2a}\Rightarrow a = R_e$$

As the separation between ends of semi minor axis and focus is equal to length of semi major axis we can say that launching and landing sites are ends of semi minor axis.

$\Rightarrow R_e \cos45^\circ = ae \Rightarrow e = 1/\sqrt{2}$

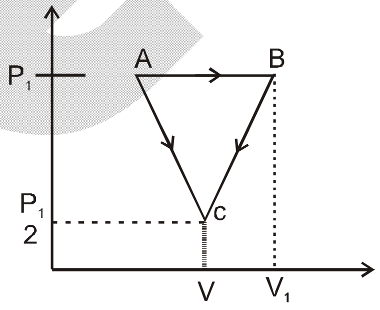
Then maximum separation will be a + ae = $R_e\frac{\left(\sqrt{2}+1\right)}{\sqrt{2}}$

9. B

Sol. In the circular motion around the Earth, the centripetal force on the satellite is a gravitational force. Therefore, v^2 = GM /R, where M is the mass of the Earth, R is the radius of the orbit of satellite and G is the universal gravitational constant. Therefore, the kinetic energy increases with the decrease in the radius of the orbit. The gravitational potential energy is negative and decreases with the decrease in radius.

10. A

Sol. In equilateral DABC given that $P_A = 2\,P_C = P_1$



$$\tan 60^0 = \frac{P_1/2}{v_1-v}$$

$$v_1 - v = \frac{p_1}{2\sqrt{3}}$$

Work done = area of triangle = $\frac{1}{2}2x\left(v_1-v\right)x\frac{P_1}{2}=\frac{P_1^2}{4\sqrt{3}}$

By ideal gas equation

$$p_1v_1 = nRT_1$$

$$p_1 = \frac{nRT_1}{V_1}$$

$$w = \frac{\left(nRT_1\right)^2}{4\sqrt{3}v_1^2}=\frac{n^2R^2T_1^2}{4\sqrt{3}v_1^2}$$

N = 2 moles

Work done = $\frac{R^3T_1^2}{\sqrt{3}v_1^2}$

11. A

Sol. For circular orbit,

$\frac{GMm}{r^2} = mw^2r$ (r = radius of planet’s orbit)

$$w^2 = \frac{GM}{r^3} = \left(\frac{2\pi}{T}\right)^2 \text{ Þ } r = \left(\frac{GMT}{4\pi^2}\right)^{3/2}$$

Energy radiated by the sun per second = $s(4pR^2)q_0{}^4$

Energy received by the planet persecond = $s(4pR^2)q_4{}^4\left(\frac{\pi R_P^2}{4\pi r^2}\right)$

In thermal equilibrium

$$\sigma.\left(4\pi R^2\right)\theta_0^4\left(\frac{\pi R_P^2}{4\pi r^2}\right) = \sigma.\left(4pR_P^2\right)\theta^4$$

–

Energy received by planet

Energy radiated by planet

$$\left(\theta = \sqrt{\frac{R}{2R}}\theta_0\right)$$

12. C

Sol. Let N_o be initial number of active nuclides of ^{238}U

Given $\frac{N(Pb)}{N(U)} = \frac{1}{2} \Rightarrow \frac{N_o - N_o e^{-\lambda t}}{N_o e^{-\lambda t}} = \frac{1}{2} \Rightarrow e^{-\lambda t} - 1 = \frac{1}{2}$

$$\Rightarrow\ t = \frac{T_{1/2}\ln(1.5)}{\ln 2} = 4.5\times10^9\frac{\ln\left(\frac{3}{2}\right)}{\ln 2}\text{ year}$$

13. A

Sol. $m = m_0 e^{-\lambda t}$

Thrust force on the body is

$$F = u_r\left(-\frac{dm}{dt}\right) = m\left(\frac{dv}{dt}\right)$$

14. B

Sol. Along common normal $\nu_{l/o} = -2\hat{i}$

$\vec{\nu}_{l/o} = \nu_{l/g} - \nu_{o/g} = 0$ along C.N.

Hence (B) is correct

15. A

Sol. $S_1P - S_2P = 2\lambda\cos\theta = \lambda$, $\therefore \cos\theta = ½ \Rightarrow \tan\theta = x/D \Rightarrow x = D\tan60^o$

$x = D\sqrt{3}$

16. A

Sol. $r = \frac{R}{2}$

Using parallel axis theorem

$I_x = I_{cm} + mr^2$ twice

17. A

Sol. $11 = 10\,\frac{V+V_A}{V}$

$12 = 10\,\frac{V+V_B}{V}$

Solve for ratio

$$\left(\frac{V_B}{V_A}\right)$$

FIITJEE

18. C

Sol. PV = nRT

$P = P_0 - AV^2$

$\Rightarrow (P_0 - AV^2)V = nRT$

$\Rightarrow P_0 - 3\,AV^2 = nR\left(\frac{dT}{dV}\right)$

For $T_{max}\ \frac{dT}{dV} = 0$

$\Rightarrow V = \sqrt{\frac{P_0}{3A}} \Rightarrow P = P_0 - A\left(\sqrt{\frac{P_0}{3A}}\right)^2$

$\Rightarrow T_{max} = \frac{2P_0}{3nR}\sqrt{\frac{P_0}{3A}}$

PV = nRT

$T = \frac{PV}{nR} = \frac{2P_0}{3nR}\sqrt{\frac{P_0}{3A}}$

19. D

Sol. $v_b = 200\,\hat{i}$

$v_s = \left[-200\cos\theta\,\hat{i} + 200\sin\theta\right]$

$v_{bs} = (200 + 200\cos\theta)\,\hat{i} - 200\sin\theta\,\hat{j}$

$+200\sin\theta = \frac{1}{\sqrt{3}}$

$(200 + 200\cos\theta)$

20. C

Sol. $d\mu = \int dq\left(\frac{\omega}{2\pi}\right)\pi r^2$

SECTION – B

21. 9

Sol. $x_{cm} = \frac{\int dm \times x}{\int dm} = \frac{\int_0^a\left(\sigma \times 2kx^2\right)dx \times x}{\sigma \times \frac{2}{3}ka^3} = \frac{3}{4}a = \frac{9}{12}a$

22. 6

Sol. $Q_0 = C(\varepsilon_1 + \varepsilon_2) \times 2$

$Q_0 = 72\mu F$

$\frac{Q_0}{12} = \frac{72}{12} = 6\ \mu C$

23. 2

24. 3

Sol. For a small arc subtending angle $d\theta$ at the centre the inward force due to tension in thread is balanced by outward force due to surface tension

$$2T\sin\left(\frac{d\theta}{2}\right) = SRd\theta$$

$$\Rightarrow Td\theta = SRd\theta$$

T = SR

25. 7

Sol. $$\frac{dQ}{dt} = mc\left(-\frac{dT}{dt}\right)$$

$$E = \sigma AT^4$$

$$mc\left(-\frac{dT}{dt}\right) = \sigma A\left(T^4 - 0^4\right) = \sigma AT^4$$

$$\frac{dT}{T^4} = \frac{-\sigma A}{mc}dt$$

$$\int_{200}^{100} T^{-4}dT = -\frac{\sigma A}{mc}\int_0^t dt$$

$$\left|\frac{T^{-3}}{-3}\right|_{200}^{100} = -\frac{\sigma A}{mc}t$$

$$t = \frac{mc}{3\sigma A}\left[\frac{1}{T^3}\right]_{200}^{100}$$

$$= \frac{\left(\frac{4}{3}\pi r^3\rho\right)c}{3\sigma \times 4\pi r^2}\left[\frac{1}{100^3} - \frac{1}{200^3}\right]$$

$$= \frac{7}{72}\frac{r\rho c}{\sigma}\times 10^{-6}\text{ sec.}$$

26. 4

Sol. $$T = \frac{2v_0\sin 37^o}{g\cos 37^o} = \frac{3}{2}\text{sec}$$

$$V_0\cos 37^o \times \frac{3}{2} + \frac{1}{2}g\sin 37^o \times \left(\frac{3}{2}\right)^2 = 6 + V\times\frac{3}{2} + \frac{1}{2}g\sin 37^o\left(\frac{3}{2}\right)^2$$

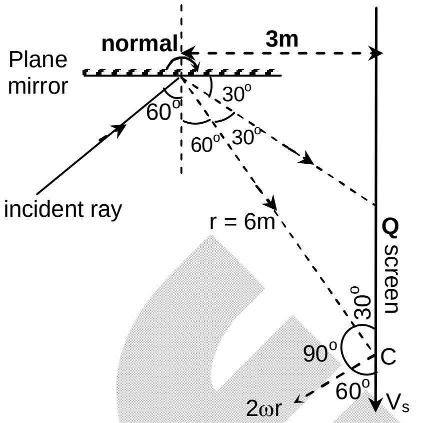
V = 4

27. 9

Sol. $\sqrt{f} = a(Z-1)$

28. 2

Sol. When incident ray is fixed the angular velocity of reflected ray becomes twice in the same sense as that of reflected ray. After t = 15 sec, the mirror rotates 15° then reflected ray rotates 30° in the same sense.



In ΔABC, $\cos 60° = \frac{3}{r}$

Where $\omega = \frac{\pi}{180}\text{rad/sec}.r = 6\text{m}$

Then, there are two components of velocity of spot on the screen.

(a) radial component which increase the length of r i.e.,

$$V_s \sin 60° = \frac{dr}{dt}$$

(b) perpendicular component

$$V_s \cos 60° \qquad \Rightarrow V_s \times \frac{1}{2} = 2 \times \frac{\pi}{180} \times 6 \Rightarrow V_s = \left(\frac{2\pi}{15}\text{m/s}\right)$$

29. 8

Sol. The stresses are zero at the free end and maximum at the axis. Therefore, the rod will ruptures at the middle.

Let us consider the element of rod at a distance x from the axis, the mass of element

$$dm = \rho A dx$$

Applying Newton's second law,

$$F - (F + dF) = (\rho A dx)\omega^2 x$$

Where ω is the rotation speed.

$$F = -\int dF = -\rho A\omega^2 \frac{x^2}{2} + C$$

Rupture of rod will occur when $f = \sigma$

$$\therefore \frac{\rho\omega^2 l^2}{8} = \sigma$$

$$\Rightarrow \omega = \sqrt{\frac{8\sigma}{\rho l^2}} \Rightarrow n = \frac{1}{2\pi}\sqrt{\frac{8\sigma}{\rho l^2}}$$

30. 4

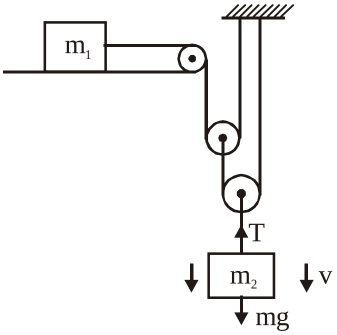
Sol. Applying work energy theorem

$K_f - K_i = w$

$$\frac{1}{2}m_2 v^2 + \frac{1}{2}m_1(4v)^2$$

$$= m_2 g \times y - \mu m_1 g(4y)$$

v = 4 m/s.



Chemistry

PART – B

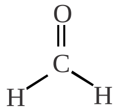
SECTION – A

31. D

Sol. Pentaammine chloride cobalt (III) chloride
$[Co(NH_3)_5Cl]Cl_2$ $[Co(NH_3)5Cl^-]^{+2} + 2Cl^-$
Gives 3 ions in aqueous solution.

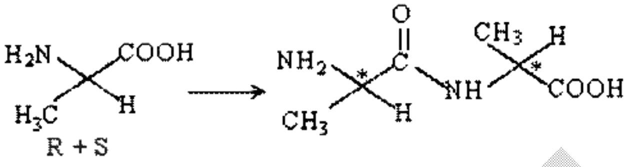
32. C

Sol.


$\xrightarrow{I_2C_2H_5MgBr}$ C_2H_5–CH–OH

33. D

Sol.



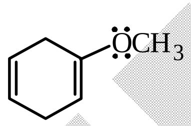
34. B

Sol. Charge on 1 milimole M^{n+} ions = 193 cb

$$= \frac{n \times 96500}{1000}$$

$$n = \frac{193 \times 1000}{96500} = 2$$

35. D

Sol. In  the lone pair of oxygen

get delocalised on the π bond located on the next carbon.

36. C

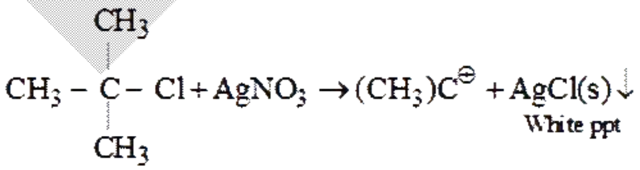
Sol. Quantum number set n = 2, ℓ = 0, m = –1 it is not possible (not valid).

37. B

Sol. neq. KMnO4
= neq.$[FeC_2O_4 + Fe_2(C_2O_4)_3 + FeSO_4]$
or n × 5 = 1 × 3 + 1 × 6 + 1 × 1
$\therefore$ n = 2

38. A

Sol.



$$CH_3 - \underset{CH_3}{\overset{CH_3}{C}} - Cl + AgNO_3 \rightarrow (CH_3)C^{\oplus} + \underset{\text{White ppt}}{AgCl(s)\downarrow}$$

Reason : Due to most stable carbocation formation tert-butyl chloride given the ppt immediately.

39. C

Sol. $\Delta Tb = Kb \times m$

$$\therefore \quad \frac{\Delta T_{b\,(A)}}{\Delta T_{b\,(B)}} = \frac{K_{b\,(A)}}{K_{b\,(B)}} \text{ as } m_A = m_B$$

$$\therefore \quad \frac{\Delta T_{b\,(A)}}{\Delta T_{b\,(B)}} = \frac{1}{5}$$

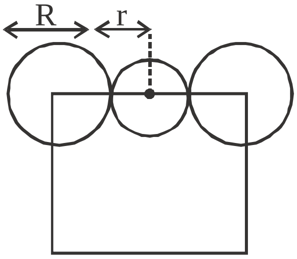
40. D

Sol. Colligative properties of colloidal solution are smaller than true solution.

41. C

Sol. $a = 2\,(R + r)$

$$\frac{a}{2} = (R + r) \;...(1)$$



$$a\sqrt{3} = 4R \;...(2)$$

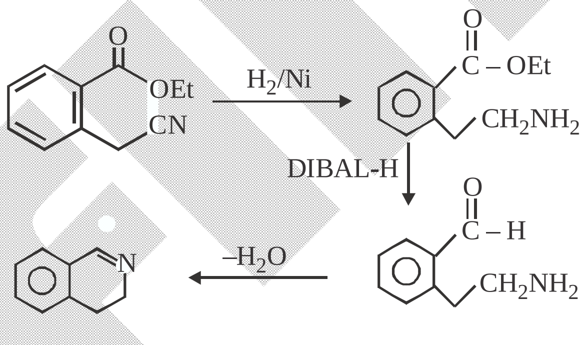
Using (1) & (2)

$$\frac{a}{2} - \frac{a\sqrt{3}}{4} = r \quad ; \; a\left(\frac{2-\sqrt{3}}{4}\right) = r$$

$$r = 0.067\,a$$

42. B

Sol.



43. B

Sol. A complex having strong field ligand has tendency to absorb light of highest energy. Among the three complexes $[Co(NH_3)_6]^{+3}$ will absorb radiation of highest energy and least wavelength. $[Co(NH_3)_5H_2O]^{3+}$ has field weaker than the above compound and therefore absorb radiation of lesser energy and more wavelength.

$[CoCl(NH_3)_5]^{2+}$ has the weakest field and therefore will absorb light of least energy and highest wavelength.

Strength of ligand $NH_3 > H_2O > Cl$.

44. B

Sol. Reagent based

45. D

Sol. Nitrogen oxides and hydrocarbons (unburnt fuel) are primary pollutant that leads to photochemical smog.

46. C

Sol. NaH is an example of ionic hydride which is also known as saline hydride.

47. B

Sol. $H_2(g) + I_2(g) \rightarrow 2HI\ (g)$

Apply Arrhenius equation

$$\log\frac{K_2}{K_1} = \frac{E_a}{2.303R}\left(\frac{1}{600} - \frac{1}{800}\right)$$

$$\log\frac{1}{2.5\times10^{-4}} = \frac{E_a}{2.303\times8.31}\left(\frac{200}{600\times800}\right)$$

$\therefore \quad E_a \approx 166$ kJ/mol

48. C

Sol. Polarisation power $\propto$ + ve charge

$\propto$ 1 / Size of ion

49. C

Sol. $$(CH_3)_2CHBr \xrightarrow[\text{(ii) CuI}]{\text{(i) Li}} [(CH_3)_2CH]_2CuLi$$

$$\xrightarrow{(CH_3)_2CHCH_2Br} (CH_3)_2CH–CH_2–CH(CH_3)_2$$

50. B

Sol. $MnO_4^- + Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + Fe^{3+}$

0.1M 1.72M

0.01 M 1.0M 0.09 M

$$E^0_{RP\,(MnO_4^-/Mn^{2+})} > E^0_{RP\,(H^+/H_2)}$$

Permangnate electrode behave as cathode

$E°_{cell} = 1.51$ V

Using Nernsts equation : (n = 5)

$$E^0_{MnO_4^-/Mn^{2+}} = 1.51 + \frac{0.059}{5}\log\frac{[MnO_4^-][H^+]^8}{[Mn^{2+}]}$$

$= 1.51 – 0.011 = 1.499 \approx 1.5$V

SECTION – B

51. 9

Sol. Initial moles of $H_2O_2 = 2 \times 2 = 4$

Moles of H_2O_2 left after 20 min.

$= 4 \times \frac{1}{2^2} = 1$ (2 half lives)

Moles of H_2O_2 decomposed 20 min.

$= 4 - 1 = 3$

$H_2O_2 \rightarrow H_2O + \frac{1}{2} O_2$

Moles of O_2 formed during 20 min. = 3/2

Volume change = $\frac{\frac{3}{2} \times R \times T}{P}$

$q = 0$; $\Delta U = W$

$W = -P_{ext} (V_2 - V_1) = - P_{ext} \Delta V$

$= - \frac{3}{2} \times 2 \times 300 = - 900$ Cal.

52. 7

Sol. (i) Planar molecules :

XeF_2, ClF_3, H_2O, $[XeF_5]^-$, I_3^-, BCl_3, XeF_4.

(ii) SF_4 – See- Saw shape

PCl_5 – Trigonal bipyramidal

SF_6 – Square bipyramidal

IF_7 – Pentagonal bipyramidal

53. 3

Sol. $(P) \xleftarrow[(1)]{CF_3CH_2O^{\Theta}} \boxed{CH_3 - CH_2 - Br} \xrightarrow[(2)]{CH_3CH_2O^{\Theta}}$

In reaction 2nd Nucleophile is stronger.

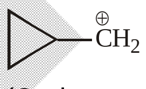
(Q) (Alkene) $\xleftarrow[(CH_3)_3CBr/\Delta]{(1)} \boxed{C_2H_5O^{\Theta}}$

$\xrightarrow[(CH_3)_2CHCH_2Br/\Delta]{(2)}$ (Alkene)

In reaction 1st 3° alkyl halide

$1 > 2$

(R) In reaction 1st stable carbocation is formed



(Cyclopropyl methyl C^+)

$1 > 2$

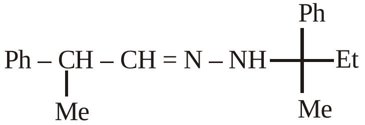
(S) In reaction 1st reagent in HI.

HI is more ionised, gives sufficient concentration of H^+ ion and I^+ is a good Nucleophile also.

> 2

54. 4

Sol. The product is



$Ph-\underset{Me}{CH}-CH=N-NH-\overset{Ph}{\underset{Me}{C}}-Et$

I = (+, +) (E)
II = (+, +) (Z)
III = (–, +) (E)
IV = (–, +) (Z)

55. 5

Sol. $Na_2SO_3 \xrightarrow{AgNO_3} Ag_2SO_3 \leftarrow$white ppt.

$NaCl \xrightarrow{AgNO_3} AgCl \leftarrow$white ppt.

$Na_2C_2O_4 \xrightarrow{AgNO_3} Ag_2C_2O_4 \leftarrow$white ppt.

$Na_2HPO_4 \xrightarrow{AgNO_3} Ag_3PO_4 \leftarrow$yellow ppt.

$Na_2CrO_4 \xrightarrow{AgNO_3} Ag_2CrO_4 \leftarrow$red ppt.

$NaNO_2 \xrightarrow{AgNO_3} AgNO_2 \leftarrow$white ppt.

$CH_3COONa \xrightarrow{AgNO_3} CH_3COOAg \leftarrow$white ppt.

56. 2

Sol. $PbO_2 + 4KI \longrightarrow PbI_2 + I_2 + 2K_2O$

$N_2H_4 + 2I_2 \longrightarrow N_2 + 4HI$

moles of N_2 liberated $= \frac{1.12}{22.4} = 5\times10^{-2}$ mole

sol mole of I_2 reacted $=5\times10^{-2} \times 2 = 10^{-1}$ mole

$PbO_2 + 2H_2O \longrightarrow Pb(OH)_4$

$Pb(OH)_4 + 2NaOH \longrightarrow Na_2[Pb(OH)_6]$

Na_2PbO_2 mole of NaOH required = $10^{-1}\times 2$

$$V\times\frac{1}{10}\times10^3 = 2\times10^{-1}$$

$$V = \frac{2}{10^{-3}} = 2000 \text{ mili litre } = 2 \text{ litre}$$

57. 4

Sol. The Be^{3+} ion has one electron in the 1s orbital (n = 1) in its ground state. Since beryllium has four protons in its nucleus (Z = 4), the energy of the electron in the 1s orbital of Be^{3+} can be calculated.

$$E = -\left(\frac{Z^2}{n^2}\right)(1310)\ \text{kJ / mole}$$

$$= -\left(\frac{4^2}{1^2}\right)(1310)\ \text{kJ / mole}$$

$= 2.10 \times 10^4$ kJ/mol

58. 4

Sol. U_{rms} at temp T_1 = $\sqrt{\frac{3RT_1}{M}}$

U_{rms} at temp T_2 = $\sqrt{\frac{3RT_2}{M}}$

$$\therefore \quad \frac{U_{rms}\ \text{at temp.}\ T_2}{U_{rms}\ \text{at temp.}\ T_1} = \sqrt{\frac{T_2}{T_1}}$$

$$\text{or} \quad \frac{10 \times 10^4}{5 \times 10^4} = \sqrt{\frac{T_2}{T_1}} \quad \text{or} \quad \sqrt{\frac{T_2}{T_1}} = \frac{4}{1}$$

$\therefore$ Temperature is to be increased 4 times.

59. 4

Sol. We can write, $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$

Initial pressure : 0.2 atm 0 0

Equilibrium partial pressure :

0.04 atm $\frac{(0.2 - 0.04)}{2}$ $\frac{(0.2 - 0.04)}{2}$

= 0.08 = 0.08

Then, $K_p = \frac{[H_2][I_2]}{[HI]^2} = \frac{0.08 \times 0.08}{(0.04)^2} = 4.0$

60. 400

Sol. Equivalents of Na_2CO_3 used

$= (100 - 60) \times 10^{-3} \times \frac{1}{50}$

Equivalent of Na_2CO_3 used = equivalent of Ca^{2+} or Mg^{2+} present in 100 ml of hard water

= equivalent of Ca^{2+} or Mg^{2+}

present in 100 ml of hard water.

The amount of $CaCO_3$ in 10^3 g of hard water = $\frac{40 \times 10^{-3} \times 10 \times 1 \times 50}{50} = 400 \times 10^{-3}$ g

The amount of $CaCO_3$ in 10^6 g of hard water

= 400 g.

Permanent hardness of water = 400 ppm.

Mathematics PART – C

SECTION – A

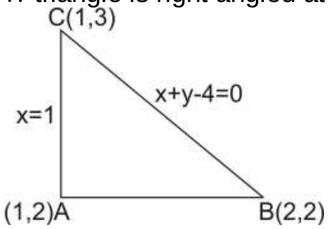
61. B

Sol. $(x+y-4)(xy-2x-y+2)=0$

$\Rightarrow (x+y-4)(x-1)(y-2)=0$

$\therefore$ sides of the triangle are $x+y-4=0, x=1, y=2$

$\therefore$ triangle is right angled at (1, 2).



Hypotenuse is x + y = 4, whose ends are (1, 3), (2, 2).

$\therefore$ circumcentre is $\left(\frac{2+1}{2}, \frac{2+3}{2}\right)$ i.e. $\left(\frac{3}{2}, \frac{5}{2}\right)$.

circumradius $= \frac{1}{2}\sqrt{(1-2)^2+(3-2)^2} = \frac{1}{\sqrt{2}}$

$\therefore$ circumcircle is $\left(x-\frac{3}{2}\right)^2 + \left(y-\frac{5}{2}\right)^2 = \frac{1}{2}$

$\Rightarrow x^2+y^2-3x-5y+\frac{9}{4}+\frac{25}{4}-\frac{1}{2}=0$

$\Rightarrow \qquad x^2+y^2-3x-5y+8=0$

62. C

Sol. Clearly (c) is the right choice.

$\therefore$ length of the $\perp$ from (4, 5) upon 3x + 4y – 7 = 0 is

$$\frac{12+20-7}{\sqrt{9+16}} = \frac{25}{5} = 5$$

Also for (-2, -3).

63. A

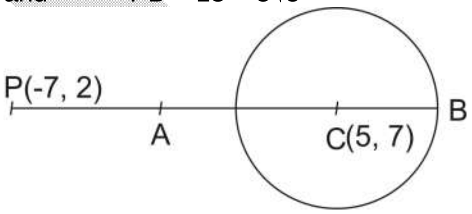
Sol. The centre C of the circle is (5, 7)

and radius = $\sqrt{5^2+7^2+51} = 5\sqrt{5}$

PC = $\sqrt{(5+7)^2+(7-2)^2} = 13$

$\therefore$ PA = 13 - 5√5

and PB = 13 + 5√5



$\therefore \quad p = 13 + 5\sqrt{5}$

$q = 13 - 5\sqrt{5}$

G.M. of $p, q = \sqrt{pq} = \sqrt{169 - 125} = \sqrt{44} = 2\sqrt{11}.$

64. A

Sol. Equation of any line through the given pt. (13, 31) is $y - 31 = m\,(x - 13)$.

It meets the x – axis at Q $\left(13 - \frac{31}{m}, 0\right)$ and y – axis at S $(0, 31 - 13m)$

$\therefore$ the co – ordinates of R are (h, k), where $h = 13 - \frac{31}{m}, k = 31 - 3m$

$\therefore (h - 13)(k - 31) = 31 \times 13$

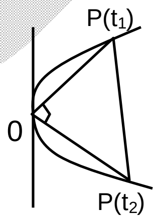
$\Rightarrow hk = 31h + 13k \quad \Rightarrow \frac{13}{h} + \frac{31}{k} = 1$

Hence R satisfies $\frac{13}{x} + \frac{31}{y} = 1.$

65. D

Sol. $t_2 = -t_1 - \frac{2}{t_1}$ slope of $OP = \frac{2}{t_1} = M$

slope of $OQ = \frac{2}{t_2} = N$



$\frac{2}{t_1} \times \frac{2}{t_2} = -1$

So, $t_1 = \pm\sqrt{2}$

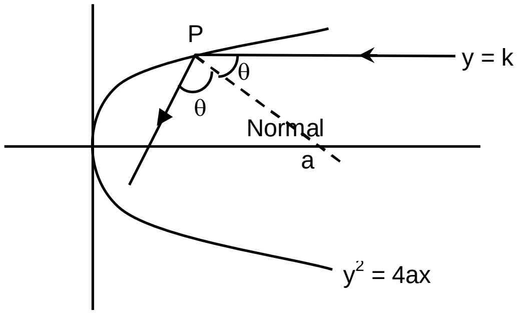
66. A

Sol. The line y = k intersects parabola $y^2 = 4ax$ at point $P\left(\frac{k^2}{4a}, k\right)$

Slope of normal at P is $m = \frac{-k}{2a}$

Slope of incident ray is O.

At slope of reflected ray is m,



$$\frac{-k}{2a} = \frac{m_1 - \left(\frac{-k}{2a}\right)}{1 + m_1\left(-\frac{k}{2a}\right)} \Rightarrow m_1 = \frac{4ak}{k^2 - 4a^2}$$

Equation of reflected ray is $(k^2 - 4a^2)y = 4ak(x - a)$.

67. B

Sol. $P(t_1)$ $Q(t_2)$ $T(at_1t_2, a(t_1 + t_2))$

Let equation of tangent be x = 0

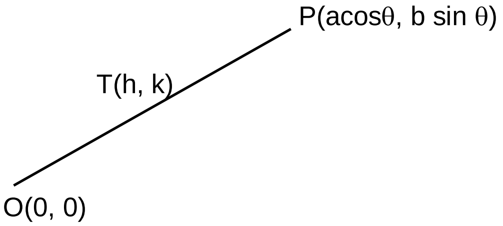
Hence

$P_1 = at_1^2 \qquad P_2 = at_1t_2 \qquad P_3 = at_2^2$

$P_1P_3 = P_2^2.$

68. B

Sol.



$$2h = a\cos\theta \quad \Rightarrow \quad \cos^2\theta = \left(\frac{2h}{a}\right)^2$$

$$2k = b\sin\theta \quad \Rightarrow \quad \sin^2\theta = \left(\frac{2k}{b}\right)^2$$

$$\frac{4h^2}{a^2} + \frac{4k^2}{b^2} = 1$$

$$\boxed{\frac{x^2}{a^2} + \frac{y^2}{b^2} = \frac{1}{4}}$$

69. C

Sol. A normal at P(a cos θ, b sin θ) is

$a\,x\sec\theta - by\,\text{cosec}\,\theta = a^2 - b^2$

$$T\left(\frac{a^2-b^2}{a}\cos\theta,\, 0\right) \qquad G\left(0,\, \frac{a^2-b^2}{a}\sin\theta\right)$$

$$PT^2 = \frac{b^2}{a^2}\left(a^2\sin^2\theta + b^2\cos^2\theta\right)$$

$$PG^2 = \frac{a^2}{b^2}\left(a^2\sin^2\theta + b^2\cos^2\theta\right)$$

$$PT : PG = \frac{b^2}{a^2} = 1 - e^2$$

70. A

Sol. $$\lim_{x\to-\infty}\left(x^{5c}\left(1+\frac{7}{x}+\frac{2}{x^5}\right)^c - x\right) = \lim_{x\to-\infty} x\left(x^{5c-1}\left(1+\frac{7}{x}+\frac{2}{x^5}\right)^c - 1\right)$$

This will be of the form ∞ × 0 only if

5c – 1 = 0 c = 1/ 5 substituting c = 1/5 , I becomes

Hence $I = \lim\limits_{x\to-\infty} x\left[(1+x)^{1/5} - 1\right]$ *where* $X = \frac{7}{x} + \frac{2}{x^5}$

$$= \lim_{x\to-\infty} x\left[1 + \frac{x}{5} + ... - 1\right] \quad \lim_{x\to-\infty} x\left(\frac{7}{x}+\frac{2}{x^5}\right).\frac{1}{5} = \frac{7}{5}$$

Hence $c = \frac{1}{5}$ *and* $I = \frac{7}{5}$

71. C

Sol. [Hint: $A = \frac{1}{3}, B = -1, C = \frac{2}{3}; D = \frac{13}{9}$]

72. D

Sol. [Sol. since 0 < sin x < 1 and 1 + x > 1 in (0, π/2)

hence $I_3 > I_2 > I_1$

⇒ A and B are correct ⇒ (D)]

73. D

Sol. Let f(x) = 2 tan x + (2a + 1) ln |sec x| + (a – 2)x

$\Rightarrow f'(x) = 2\sec^2 x + (2a + 1)\tan x + (a - 2) = 2\tan^2 x + (2a + 1)\tan x + a$

For f(x) to be increasing, $f'(x) \geq 0 \ \forall \ x \in \left(0, \frac{\pi}{2}\right)$

$\Rightarrow \quad 2\tan^2 x + (2a+1)\tan x + a \geq 0 \forall x \in \left(0, \frac{\pi}{2}\right)$

$\Rightarrow \quad (1+2\tan x)(\tan x + a) \geq 0 \forall x \in \left(0, \frac{\pi}{2}\right)$

Hence $a \geq 0$. Ans

74. D

Sol. Find maximum of $\left(\frac{7-5(x^2+3)}{2(x^2+2)}\right)$

75. A

Sol. Since given system of equation has a non – trivial solution.

$$\therefore \begin{vmatrix} p+a & b & c \\ a & q+b & c \\ a & b & r+c \end{vmatrix} = 0$$

Operate $R_1 - R_2$ and $R_2 - R_3$, we get $\begin{vmatrix} p & -q & 0 \\ 0 & q & -r \\ a & b & r+c \end{vmatrix} = 0$

$\Rightarrow p\begin{vmatrix} q & -r \\ b & r+c \end{vmatrix} + a\begin{vmatrix} -q & 0 \\ q & -r \end{vmatrix} = 0 \qquad \Rightarrow p(qr+qc+br) + a(qr) = 0$

$\Rightarrow 1 + \frac{c}{r} + \frac{b}{q} + \frac{a}{p} = 0 \qquad \Rightarrow \frac{a}{p} + \frac{b}{q} + \frac{c}{r} = -1.$

76. C

Sol. Clearly $ab - h^2 \neq 0$ [$\because$ first two equations are solvable for *x, y*]

Third equation can be written as

$x(ax + hy + g) + y(hx + by + f) + gx + fy + c + t = 0$

Since any solution of first two must be sol. of the third equation.

$\therefore$ given system of equations can be written as

$ax + hy + g = 0$

$hx + by + f = 0$

$gx + fy + c + t = 0$

Since the above system of equations are consistent

$$\therefore \begin{vmatrix} a & h & g \\ h & b & f \\ g & f & c+t \end{vmatrix} = 0 \quad \Rightarrow \begin{vmatrix} a & h & g \\ h & b & f \\ g & f & c \end{vmatrix} + \begin{vmatrix} a & h & 0 \\ h & b & 0 \\ g & f & t \end{vmatrix} = 0$$

$$\Rightarrow \left(abc + 2fgh - af^2 - bg^2 - ch^2\right) + t\left(ab - h^2\right) = 0$$

$$\Rightarrow t = \frac{abc + 2fgh - af^2 - bg^2 - ch^2}{(h^2 - ab)}$$

77. A

Sol. $\overline{OR} = \frac{2\vec{q} + 3\vec{p}}{2+3} = \frac{2\vec{q} + 3\vec{p}}{5}$

$\overline{OS} = \frac{2\vec{q} - 3\vec{p}}{2-3} = \frac{2\vec{q} - 3\vec{p}}{-1}$

Since $\overrightarrow{OR} \perp \overrightarrow{OS} \therefore \overrightarrow{OR}.\overrightarrow{OS} = 0$

$$\therefore \frac{2\vec{q} + 3\vec{p}}{5} . \frac{2\vec{q} - 3\vec{p}}{-1} = 0$$

$$\Rightarrow \quad \frac{4|\vec{q}|^2 - 9|\vec{p}|^2}{-5} = 0 \quad \Rightarrow 4q^2 - 9p^2 = 0 \Rightarrow \quad 9p^2 = 4q^2$$

78. A

Sol. Now $\vec{d}\,.\,(\vec{a} + \vec{b} + \vec{c}) = \vec{d}\,.\vec{a} + \vec{d}\,.\vec{b} + \vec{d}\,.\vec{c}$

$$= \mu(\vec{b} \times \vec{c}\,.\vec{a}) + \gamma(\vec{c} \times \vec{a}\,.\vec{b}) + \lambda(\vec{a} \times \vec{b}\,.\vec{c})$$

$$= \lambda + \mu + \gamma \qquad [\because (\vec{a}, \vec{b}, \vec{c}) = 1]$$

Hence $\lambda + \mu + v = \vec{d}\,.\,(\vec{a} + \vec{b} + \vec{c})$

79. C

Sol. $0 \le \sin^2 x \le 1 \Rightarrow [-\sin^2 x] = 0$ or -1

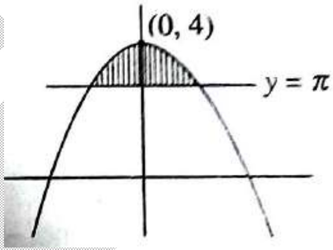
But $\sec^{-1}$ (0) is not defined

$\Rightarrow y = \sec^{-1} [-\sin^2 x] = \sec^{-1} (-1) = \pi$

Solving with $y = \dfrac{16 - x^2}{4}$, $16 - x^2 = 4\pi$

$\therefore \qquad x = \pm 2\sqrt{4 - \pi}$

Required area $= \displaystyle\int_{-2\sqrt{4-\pi}}^{2\sqrt{4-\pi}} \left(\frac{16 - x^2}{4} - \pi\right) dx = \frac{8}{3}(4 - \pi)^{3/2}$



80. A

Sol. The total no. of ways of predicting the result is 3^{10}. The no. of ways in which exactly K results are correct is ${}^{10}C_K \,.\, 2^{10-K}$

$\therefore$ the no. of favourable ways is

${}^{10}C_5 \,.\, 2^5 + {}^{10}C_6 \,.\, 2^4 + {}^{10}C_7 \,.\, 2^3 + {}^{10}C_8 \,.\, 2^2 + {}^{10}C_9 \,.\, 2 + {}^{10}C_{10} = 12585.$

Hence reqd . prob. $= \dfrac{12585}{3^{10}}$

SECTION – B

81. 3

Sol. sinx + cosx + tanx + cotx + secx + cosecx = 7

$$\Rightarrow (\sin x + \cos x) + \left(\frac{1}{\sin x \cos x}\right) + \frac{(\sin x + \cos x)}{\sin x . \cos x} = 7$$

$$\Rightarrow (\sin x + \cos x)\left(1 + \frac{2}{\sin 2x}\right) = \left(7 - \frac{2}{\sin 2x}\right)$$

$$\Rightarrow (1 + \sin 2x)\left(1 + \frac{4}{\sin^2 2x} + \frac{4}{\sin 2x}\right) = 49 + \frac{4}{\sin^2 2x} - \frac{28}{\sin 2x} \text{ (squaring both sides)}$$

$\Rightarrow \sin^3 2x - 44 \sin^2 2x + 36 \sin 2x = 0$

$\Rightarrow \sin 2x = 22 - 8\sqrt{7}$.

82. 4

Sol. $\tan^4 x - 2\tan^3 x - \tan^2 x + 2\tan x + 1$
$\tan^4 x + \tan^2 x - 2\tan^3 x + 2\tan x - 2\tan^2 x + 1$
$= (\tan^2 - \tan x)^2 + 2(\tan x - \tan^2 x) + 1 = 4.$

83. 2

Sol. Use angle between asymptotes as $\theta = \tan^{-1}\dfrac{2ab}{b^2 - a^2}$ & Latusrectum $= \dfrac{2b^2}{a}$

84. 5

Sol. It is point of contact of tangent

85. 11

Sol. $x \in (-\infty, 0] \cup [\log_6 5, \infty)$

86. 6

Sol. S.D (and variance) of a data is not changed when each observation is increased (or decreased) by the same constant.

87. 0

Sol. $[u = \int_0^1 \frac{ln(x+1)}{x^2+1}dx \qquad put\ x = \tan\theta$

$$= \int_0^{\pi/4} \ln(1+\tan\theta)d\theta == \int_0^{\pi/4} \ln\left(1+\frac{1-\tan\theta}{1+\tan\theta}\right)d\theta == \int_0^{\pi/4} \ln\left(\frac{2}{1+\tan\theta}\right)d\theta = \frac{\pi}{4}\ln 2 - u$$

$$\therefore \qquad u = \frac{\pi}{8}\ln 2 \qquad \Rightarrow 4u = \frac{\pi}{2}\ln 2 \qquad ....(1)$$

Again $v = \int_0^{\pi/2} \ln(\sin 2x)dx \qquad (put\ 2x = t); v = \frac{1}{2}\int_0^{\pi} \ln(\sin t)dt = \int_0^{\pi/2} \ln(\sin t)dx$

$$v = -\frac{\pi}{2}\ln 2 \qquad ...(2)$$

$(1)+(2) \Rightarrow \qquad 4u + v = 0 \qquad \Rightarrow (C)]$

88. 2

Sol. Using Graph number of points of non differentiability = 2 Ans.

89. 5

Sol. $f'(x) = 2x - \dfrac{a}{x^2}$

$$f'(2) = 4 - \frac{a}{4} = 0 \Rightarrow a = 16 \Rightarrow a_1 = 16$$

Also, $f''(x) = 2 + \dfrac{2a}{x^3}$

$$\therefore\ f''(1) = 2 + 2a = 0 \Rightarrow a = -1 \Rightarrow a_2 = -1$$

Hence $\left(\dfrac{a_1 + a_2}{3}\right) = \dfrac{15}{3} = 5$ Ans.

90. 11

Sol. The last digit of the product will be 1, 2, 3, 4, 6, 7, 8 or 9 iff each of the n positive integer ends in any of these digits. Now the probability of an integer ending in 1, 2, 3, 4, 6, 7, 8 or 9 is $\frac{8}{10} = \frac{4}{5}$

$\therefore$ The prob. that the last digit of the product of n integers is 1, 2, 3, 4, 6, 7, 8 or 9 = $\left(\frac{4}{5}\right)^n$.

Next, the last digit of the product will be 1, 3, 7 or 9 iff each of the n + ve integers ends in 1, 3, 7 or 9 is $\frac{4}{10} = \frac{2}{5}$

$\therefore$ The prob. for the product of n + ve integer to end in 1, 3, 7 or 9 is $\left(\frac{2}{5}\right)^n$

Hence the prob. of the reqd. event = $\left(\frac{4}{5}\right)^n - \left(\frac{2}{5}\right)^n = \frac{4^n - 2^n}{5^n}$

FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
FULL TEST – I
PAPER –1
TEST DATE: 28-12-2022

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B**.

Section – A *(01 –06, 19 – 24, 37 – 42):* This section contains **EIGHTEEN (18)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – A *(07 – 10, 25 – 28, 43 – 46):* This section contains **TWELVE (12)** Matching List Type Questions. Each question has **FOUR** statements in **List-I** entries (I), (II), (III) and (IV) and **FOUR/FIVE** statements in **List-II** entries (P), (Q), (R), (S) OR (T). The codes for lists have choices (A), (B), (C), (D) out of which, **ONLY ONE** of these four options is correct answer.

Section – B *(11 – 18, 29 – 36, 47 – 54):* This section contains **TWENTY FOUR (24)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.

MARKING SCHEME

Section – A (One or More than One Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4	If only (all) the correct option(s) is (are) chosen;
Partial Marks	:	+3	If all the four options are correct but ONLY three options are chosen;
Partial marks	:	+2	if three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks	:	+1	If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–2	In all other cases.

Section – A (Single Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+3	If ONLY the correct option is chosen.
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–1	In all other cases.

Section – B: Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+3	If ONLY the correct numerical value is entered at the designated place;
Zero Marks	:	0	In all other cases.

Physics

PART – I

Section – A (Maximum Marks: 24)

This section contains ***SIX (06)*** *questions. Each question has* ***FOUR*** *options (A), (B), (C) and (D).* ***ONE OR MORE THAN ONE*** *of these four option(s) is (are) correct answer(s).*

1. A large insulating thick sheet of thickness 2d is charged with a uniform volume charge density ρ. A particle of mass m, carrying a charge q having a sign opposite to that of the sheet, is released from the surface of the sheet. The sheet does not offer any mechanical resistance to the motion of the particle. Find the oscillation frequency v of the particle inside the sheet:

(A) $\text{v}=\frac{1}{2\pi}\sqrt{\frac{q\rho}{m\varepsilon_0}}$ (B) $\text{v}=\frac{1}{2\pi}\sqrt{\frac{2q\rho}{m\varepsilon_0}}$

(C) $\text{v}=\frac{1}{4\pi}\sqrt{\frac{q\rho}{m\varepsilon_0}}$ (D) $\omega=\frac{1}{2\pi}\sqrt{\frac{q\rho}{m\varepsilon_0}}$

2. A charged particles with velocity $\vec{v}=x\hat{i}+y\hat{j}$ moves in a magnetic field $\vec{B}=y\hat{i}+x\hat{j}$. The magnitude of magnetic force acting on the particle is F. Which one of the following statement(s) is/are correct?

(A) No force will act on particle if $x=y$ (B) $F\propto\left(x^2-y^2\right)if\ \ x>y$

(C) The force will act along z-axis if $x>y$ (D) The force will act along y-axis if $x>y$

3. In a photoelectric effect experiment. If f is the frequency of radiations incident on the metal surface and I is the intensity of incident radiations, then which of the following is/are correct.

(A) If ‘f’ is increased keeping ‘I’ and work function constant, stopping potential and maximum kinetic energy of photoelectron increases.
(B) If distance between cathode and anode is increased, stopping potential remains same.
(C) If ‘I’ is increased keeping ‘f’ and work function constant, saturation current increases and stopping potential remains same.
(D) If the work function is decreased keeping ‘f’ and ‘I’ constant then stopping potential will increase and maximum kinetic energy of photoelectrons also increases.

4. $y(x,t)=\frac{0.6}{(2x-5t)^2+5}$ is equation of moving pulse, where x and y are in meter t is in second, then:

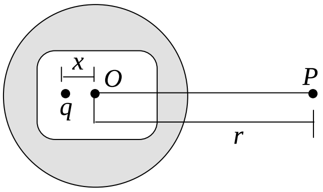
(A) Pulse is moving in +x direction (B) It is a symmetric pulse

(C) Its maximum displacement is $0.8\,\text{m}$ (D) In 1 second it will travel a distance of 2.5 m

5. The speed (v) of a particle moving along a straight line, when it is at a distance (x) from a fixed point on the line, is given by $v^2=144-9x^2$. Select the correct option:

(A) Displacement of the particle $\le$ distance moved by it
(B) The magnitude of acceleration at a distance 3 units from the fixed point is 27 units
(C) The motion is simple harmonic with $\text{T}=\frac{\pi}{3}$ units
(D) The maximum displacement from the fixed point is 4 units

6. A point charge q is placed within the cavity of an electrically neutral conducting shell whose outer surface has spherical shape figure. Then:



(A) The potential V at point P lying outside the shell at a distance r from the centre O of the outer surface depends upon the value of x.
(B) Potential at P does not depend upon the value of x.
(C) A total charge q will be induced on the outer surface of the shell which will be distributed uniformly on the outer surface.
(D) A total charge $-q$ will be induced on the inner surface of the shell, which will be distributed non-uniformly on the inner surface.

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (I), (II), (III) and (IV) and FOUR/FIVE statements in **List-II** entries (P), (Q), (R), (S) OR (T). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

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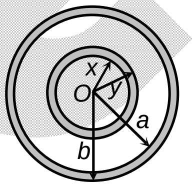
7. In the figure shown a conducting spherical shell of inner radius *x* and outer radius *y* is concentric with a larger conducting spherical shell of inner radius *a* and outer radius *b*. The inner shell has a total charge +3*Q* and the outer shell has a total charge +5*Q*. Let *r* be the distance of any point from the common centre *O*. Match List –I and List–II.

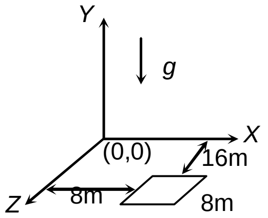


List-I		**List-II**	
(I)	Electric field strength is zero	(P)	On outer surface of the larger spherical shell
(II)	Electric field strength is non-zero	(Q)	On inner surface of the larger spherical shell
(III)	Magnitude of charge is 3*Q*	(R)	On outer surface of the smaller spherical shell
(IV)	Charge is + 8*Q*	(S)	For *a* < *r* < *b*

Which one of the following options is correct?

(A) $\mathrm{I} \to \mathrm{P},\ \mathrm{II} \to \mathrm{Q,R},\ \mathrm{III} \to \mathrm{Q,R},\ \mathrm{IV} \to \mathrm{R,S}$
(B) $\mathrm{I} \to \mathrm{S},\ \mathrm{II} \to \mathrm{P,Q},\ \mathrm{III} \to \mathrm{P,S},\ \mathrm{IV} \to \mathrm{R,Q}$
(C) $\mathrm{I} \to \mathrm{S},\ \mathrm{II} \to \mathrm{P,Q,R},\ \mathrm{III} \to \mathrm{Q,R},\ \mathrm{IV} \to \mathrm{P}$
(D) $\mathrm{I} \to \mathrm{Q},\ \mathrm{II} \to \mathrm{P},\ \mathrm{III} \to \mathrm{Q,S},\ \mathrm{IV} \to \mathrm{P,Q,R}$

8. A square platform of side length 8 m is situated in *x*-*z* plane such that it is at 16 m from the *x*-axis and 8 m from the *z*-axis as shown in figure. A particle is projected with velocity $\vec{v} = (v_2\hat{i} + 25\hat{j})\text{m/s}$ relative to wind from origin and at the same instant the platform starts with acceleration $\vec{a} = (2\hat{i} + 2.5\hat{j})\text{m/s}^2$. Wind is blowing with velocity $v_1\hat{k}$. (g = 10 m/s^2)



List-I		List-II	
(I)	Possible values of v_2 (in m/s) so that particle hits the platform is/are	(P)	4
(II)	Possible value of v_1 (in m/s) so that particle hits the platform is/are	(Q)	6
(III)	Possible time of flight (in second) of the particle is/are	(R)	8
(IV)	Possible value of displacement/s (in m) of the particle in *y*-direction when v_2 has its minimum possible value is/are (till particle hit the platform)	(S)	20

Which one of the following options is correct?

(A) $\text{I} \rightarrow \text{Q, R, II} \rightarrow \text{P,Q, III} \rightarrow \text{P, IV} \rightarrow \text{S}$

(B) $\text{I} \rightarrow \text{Q, II} \rightarrow \text{Q, III} \rightarrow \text{P, IV} \rightarrow \text{S}$

(C) $\text{I} \rightarrow \text{S, II} \rightarrow \text{P,Q, III} \rightarrow \text{Q, R, IV} \rightarrow \text{P, S}$

(D) $\text{I} \rightarrow \text{Q, R, II} \rightarrow \text{P, III} \rightarrow \text{Q,S, IV} \rightarrow \text{P,Q,R}$

9. Match the statements in List–I with the results in List–II.

List-I		List-II	
(I)	A thin uniform spherical shell of surface area *S* has an initial temperature more than its surrounding atmosphere. Then magnitude of rate of change of its temperature with time	(P)	is independent of *S*
(II)	A soap bubble initially in equilibrium is given a charge *Q*, which distributes uniformly over its surface. The centre of the bubble is always fixed. For the duration the bubble having surface area *S* expands, the magnitude of electric potential at a fixed point always lying outside the bubble.	(Q)	depends on *S*
(III)	A container with open top and filled with ideal liquid is placed at rest on a smooth horizontal table. A small hole of area *S* is drilled at the bottom of a side wall of container. The magnitude of force exerted by escaping liquid on the container.	(R)	remains constant
(IV)	An infinitely long straight current carrying wire lies along the axis of a closed cylindrical surface of total surface area *S* in space. As the magnitude of current in the wire is continuously increased, the magnitude of the magnetic flux through the surface of this cylinder.	(S)	decreases with time

Which one of the following options is correct?

(A) $\text{I} \rightarrow \text{S, II} \rightarrow \text{P,Q, III} \rightarrow \text{R,S, IV} \rightarrow \text{P, R}$

(B) $\text{I} \rightarrow \text{P,S, II} \rightarrow \text{P,R, III} \rightarrow \text{Q,S, IV} \rightarrow \text{P,R}$

(C) $\text{I} \rightarrow \text{S,R, II} \rightarrow \text{R, III} \rightarrow \text{Q,S, IV} \rightarrow \text{R,S}$

(D) $\text{I} \rightarrow \text{S, II} \rightarrow \text{P,R, III} \rightarrow \text{P,Q, IV} \rightarrow \text{Q,R}$

10. Related to photoelectric effect, in List-I, some physical quantities change while in List-II effects of these changes are given. Match the entries of List-I with the entries of List-II.

List-I		List-II	
(I)	Intensity of incident light changes	(P)	$K_{\max}$ of emitted photoelectrons changes
(II)	Frequency of incident light changes	(Q)	Stopping potential changes
(III)	Target material changes	(R)	Saturation current changes
(IV)	Potential difference between the emitter and collector changes	(S)	Time delay in emission of photoelectrons changes

Which one of the following options is correct?

(A) $\text{I} \rightarrow \text{R, II} \rightarrow \text{P, III} \rightarrow \text{Q,S, IV} \rightarrow \text{S}$

(B) $\text{I} \rightarrow \text{S, II} \rightarrow \text{Q,S, III} \rightarrow \text{P,Q, IV} \rightarrow \text{S}$

(C) $\text{I} \rightarrow \text{R, II} \rightarrow \text{P,Q, III} \rightarrow \text{P,Q, IV} \rightarrow \text{S}$

(D) $\text{I} \rightarrow \text{S, II} \rightarrow \text{P,Q, III} \rightarrow \text{Q,S, IV} \rightarrow \text{R}$

Section – B (Maximum Marks: 24)

This section contains ***EIGHT (08)*** *numerical based questions. The answer to each question is a* ***NUMERICAL VALUE.*** *If the numerical value has more than two decimal places, truncate/round-off the value to* ***TWO*** *decimal places.*

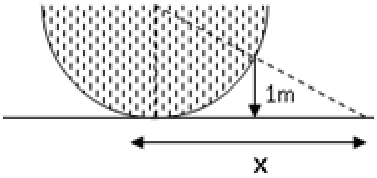
11. If resistance R_1 in resistance box is 300Ω , then the balanced length is found to be $75.0\,\text{cm}$ from end A. The diameter of unknown wire is 1 mm and length of the unknown wire is $31.4\,\text{cm}$. Find the specific resistance of the unknown wire $(\mu\Omega\text{-m})$

12. A slab of glass of thickness 6cm and index 1.5 is placed somewhere in between a concave mirror and a point object, perpendicular to the mirror's optical axis. The radius of curvature of the mirror is 40 cm. If the reflected final image coincides with the object, then find the distance of the object from the mirror (in cm).

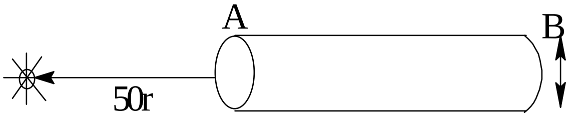
13. A terrorist places a bomb at a horizontal distance of 6m from the foot of building of height 8m. When the bomb explodes its fragments fly in all directions with a velocity upto 30 m/s. Find how long (in seconds) a man on the top of the building will be in danger. (g=10 ms^{-2})

14. A string is attached 10a horizontal cylinder of radius r = 4cm around which it passes several times. The free end hangs vertically and supports a particle. The vertical portion is equal to $l_0 = 28cm$. The particle is given' a horizontal velocity u perpendicular to the axis of the cylinder and in such a sense as to wind up the string around the cylinder. What is the value of u (in m/sec) so that the string does not slacken in the subsequent motion?

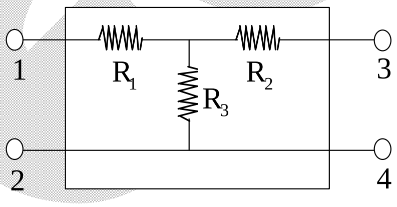
15. A hemispherical tank of diameter 4m is filled with water. A very 'small hole is punched at 1m above the bottom as shown in figure. Find x (in m) (distance at which water strikes the surface).



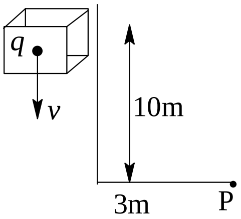
16. A cylindrical rod of length 64 cm and cross-section radius $r=\left(2/\sqrt{\pi}\right)\text{cm}$ is placed at a distance $50\,r$ from a infrared point source S of power 1.25 kW as shown in the figure. The lateral surface of the rod is perfectly insulated from the surroundings. The cross-section A absorbs 80% of the incident energy, has temperature T_A in steady state. The surface B is radiating energy into space and the wavelength emitted by it with maximum energy density is $100,000\ \text{Å}$. Find the value of T_A (temperature of end A in Kelvin) if conductivity varies with temp as $\text{K}=\frac{\text{T}}{\text{T}_\text{A}}$. Assume that the rate of flow of heat through the rod is steady.
(Wein's constant $=0.003\,\text{K}$)



17. A concealed circuit (a black box) consisting of resistors has four terminals. If a voltage is applied between clamps 1 and 2 when clamps 3 and 4 are open, the power liberated is $P_1=40\text{ W}$ and when clamps 3 and 4 are closed, the power liberated is $P_2=80\text{ W}$. If the same source is connected to the clamps 3 and 4, the power liberated in the circuit when clamps 1 and 2 are open is $P_3=20\text{ W}$. Determine the power P_4 (in Watt) consumed in the circuit when the clamps 1 and 2 are connected and the same voltage is applied between the clamps 3 and 4.



18. An elevator carrying a charge of 0.2 C, is moving down with a velocity of $4\times10^3\text{ m/s}$. The elevator is 10 m from the bottom and 3 m horizontally from P as shown. What magnetic field (in μT) does it produces at point P



Chemistry PART – II

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

19. Which of the following statement (s) is/are correct?
(A) Fe^{3+} and Mn^{2+} have equal paramagnetic character
(B) Cu_2Cl_2 and $CuCl_2$ are coloured.
(C) MnO_4^- is purple in colour because of unpair d electrons
(D) The magnetic moment of Fe^{2+} and Co^{3+} both are equal to $2\sqrt{6}$ B. M.

20. Which of the following statements are correct?
(A) The total spectral lines obtained from a single line during Zeeman effect is (2*l* + 1).
(B) In the Lyman series as the energy liberated during transition increases then the distance between the spectral lines goes on decreasing.
(C) The highest probability of finding an electron in 1s orbital is in the vicinity of the circumference.
(D) The highest probability of finding an electron in 1s orbital is exactly at the middle between nucleus and circumference.

21. Which of the following is/are correct?
(A) Ammonium salts are more soluble than sodium salts
(B) $SnCl_2$ is more ionic than $SnCl_4$
(C) Calcium fluoride is more ionic than calcium chloride
(D) The formal charge on S atom in SO_2 is four

22. Which of the following statements are true for a gas -
(A) The mean free path is inversely proportional to the pressure of the gas at constant temperature
(B) The mean free path is proportional to temperature at constant pressure
(C) The collision frequency among the molecules of gas is proportional to temperature
(D) The velocity possessed by the largest fraction of molecules at a given temperature is known as root mean square velocity

23. Which of the following statements is/are false -
(A) Endothermic reactions are never spontaneous, at any temperature
(B) Exothermic reactions are always spontaneous at any temperature
(C) Exothermic reactions in which the entropy change for the system is negative are spontaneous at any temperature
(D) Reactions in which the entropy change for the system is negative are never spontaneous at any temperature

24. An aqueous solution contains either Hg_2^{2+} or Hg^{2+} the given solution gives green ppt with KI solution but no precipitate with H_2S. About the given aqueous solution which of following is correct -
(A) It contains Hg_2^{2+}
(B) It contains Hg^{2+}
(C) With NH_3 solution it gives black precipitate
(D) None of these

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (I), (II), (III) and (IV) and FOUR/FIVE statements in **List-II** entries (P), (Q), (R), (S) OR (T). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

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25. Match the following:

List-I		**List-II**	
(I)	O < Te < Se < S	(P)	Acidic character of oxides
(II)	$Be^+ < C^+ < B^+ < N^+ < F^+ < O^+ < Li^+$	(Q)	Electron Affinity
(III)	$Fe^{2+} < Fe^{3+} < Fe^{6+}$	(R)	Atomic radius
(IV)	N < P < As < Sb	(S)	Ionisation energy

Which one of the following options is correct?

(A) $I \rightarrow P,\ II \rightarrow R,\ III \rightarrow S,\ IV \rightarrow R$

(B) $I \rightarrow Q,\ II \rightarrow S,\ III \rightarrow P,Q,S,\ IV \rightarrow R,Q$

(C) $I \rightarrow S,\ II \rightarrow P,\ III \rightarrow Q,R,\ IV \rightarrow P,S$

(D) $I \rightarrow Q,\ II \rightarrow P,\ III \rightarrow Q,S,\ IV \rightarrow P,Q,R$

26. Match the following:

List-I		**List-II**	
(I)	$XeOF_4$	(P)	no lone pairs of electron
(II)	XeO_4	(Q)	one lone pair of electrons.
(III)	XeF_4	(R)	more than one lone pairs of electrons
(IV)	IF_5	(S)	non planar

(A) $I \rightarrow Q,S,\ II \rightarrow P,S,\ III \rightarrow R,\ IV \rightarrow Q,S$

(B) $I \rightarrow Q,\ II \rightarrow S,\ III \rightarrow P,Q,S,\ IV \rightarrow R,Q$

(C) $I \rightarrow S,\ II \rightarrow P,\ III \rightarrow Q,R,\ IV \rightarrow P,S$

(D) $I \rightarrow Q,\ II \rightarrow P,\ III \rightarrow Q,S,\ IV \rightarrow P,Q,R$

27. Match the following:

List-I		**List-II**	
(I)	$\left[CoCl_3(NH_3)_3\right]$	(P)	show facial form
(II)	$\left[Cr(Ox)_3\right]^{3-}$	(Q)	cis form is optically active
(III)	$\left[CrCl_2(Ox)_2\right]$	(R)	Transform is optically inactive
(IV)	$\left[RhCl_3(Py)_3\right]$	(S)	show meridian form

(A) $I \rightarrow Q,S,\ II \rightarrow P,S,\ III \rightarrow R,\ IV \rightarrow Q,S$

(B) $I \rightarrow Q,\ II \rightarrow S,\ III \rightarrow P,Q,S,\ IV \rightarrow R,Q$

(C) $I \rightarrow S,\ II \rightarrow P,\ III \rightarrow Q,R,S,\ IV \rightarrow P,S$

(D) $I \rightarrow P,S,\ II \rightarrow Q,\ III \rightarrow Q,R,\ IV \rightarrow P,S$

28. Match the following:

List-I		List-II	
(I)	Paramagnetic	(P)	N_2O_3
(II)	Dark blue liquid in liquid or solid state	(Q)	NO_2
(III)	Unstable gas due to auto decomposition.	(R)	NO
(IV)	Brown gas	(S)	N_2O_5

(A) $I \rightarrow Q,S,\ II \rightarrow P,\ S,\ III \rightarrow R,\ IV \rightarrow Q,S$

(B) $I \rightarrow Q,\ II \rightarrow S,\ III \rightarrow P,Q,S,\ IV \rightarrow P,S$

(C) $I \rightarrow Q,R,\ II \rightarrow P,\ III \rightarrow P,S,\ IV \rightarrow Q$

(D) $I \rightarrow P,S,\ II \rightarrow Q,\ III \rightarrow Q,R,\ IV \rightarrow P,S$

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

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29. A mixture of CH_4 and C_2H_2 occupied a certain volume at a total pressure equal to 63 torr. The same gas mixture was burnt to CO_2 and H_2O (ℓ). The CO_2 (g) alone was collected in the same volume and at the same temperature, the pressure was found to be 69 torr. What was the mole fraction of CH_4 in the original gas mixture?

30. N_2 gas is assumed to behave ideally. A given volume of N_2 originally at 373 K and 0.1013 MPa pressure is adiabatically compressed due to which its temperature rises to 673 K. What is final pressure (in MPa) of gas?

31. A saturated solution of iodine in water is 1.25×10^{-3} (M). In any saturated solution of I_2 concentration of I_2 is 1.25×10^{-3} (M). In 1 L of 0.1 (M) solution I^-, it is seen 51.25×10^{-3} mole of I_2 can be maximum dissolved. In the aqueous solution of I^-(aq), I_2 (ag) undergoes complex formation, $I_2\text{ (aq)} + I^- \underset{}{\overset{K_C}{\rightleftharpoons}} I_3^-\text{ (aq)}$.
What is the value of K_C?

32. The reaction, $N_2O_5\text{ (g)} \rightleftharpoons 2\,NO_2\text{ (g)} + \frac{1}{2}\,O_2\text{ (g)}$, is started with initial pressure of N_2O_5 (g) equal to 600 torr. What fraction of N_2O_5 (g) decomposed when total pressure of the system is 960 torr ?

33. At 298 K, the conductivity of a saturated solution of AgCl in water is 2.6×10^{-6} ohm^{-1} cm^{-1}. Given, λ_m^{∞} (Ag^+) = 63 ohm^{-1} cm^2 mol^{-1} & λ_m^{∞} (Cl^-) = 67 ohm^{-1} cm^2 mol^{-1}
The solubility product of AgCl is $x \times 10^{-10}$, then value of 'x' is ____.

34. For a certain reaction of order n, the time for half change, $t_{1/2}$, is given by $t_{1/2} = \frac{[2-\sqrt{2}]}{k} \times C_0^{1/2}$ where k is the rate constant and C_0 is the initial concentration what is n ____.

35. The density of solid argon (Ar = 40 g/mol) is 1.68 g/mL at 40 K. If the argon atom is assumed to be a sphere of radius = 1.50×10^{-8} cm, what % of solid Ar is apparently empty space?

36. Two liquids X and Y form are ideal solution. At 300 K, vapour pressure of the solution containing 1 mole of X and 3 moles of Y is 550 mm Hg. At the same temperature, if 1 mole of Y is further added to this solution, vapour pressure of the solution increases by 10 mm Hg. What is the sum of vapour pressure (in mm Hg) of X and Y in their pure states?

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Mathematics PART – III

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

37. Let $A\, and\, B$ are commutative square matrices of order three such that A is symmetric and B is skew symmetric, if $C=(A+B)^T(A+B)(A-B)^{-1}$ (where $X^T\ and\ |x|$ denotes transpose and determinant value of x respectively), then

(A) $A+B-C=0$
(B) $A-B-C=0$
(C) $|B|=0$
(D) $2A-C=C^T$

38. If $\lim\limits_{n\to\infty}\left(\frac{1}{1^2}+\frac{1}{2^2}+......+\frac{1}{n^2}\right)=\frac{\pi^2}{6}\ and\ S=\lim\limits_{n\to\infty}\left(\frac{1}{1^3\cdot 2^3}+\frac{1}{2^3\cdot 3^3}+\frac{1}{3^3\cdot 4^3}+....\frac{1}{n^3\cdot(n+1)^3}\right)$, then $S+\pi^2$ is equal to

(A) A non-integral number
(B) An rational number
(C) A transcendental number
(D) An integer

39. $f(x)$ is a differentiable function such that $f(x)=x^2+\int_0^x e^{-t}f(x-t)dt$, then

(A) $f(x)=\frac{x^3}{3}+x$
(B) $f(x)=\frac{x^3}{3}+x^2$
(C) $f'(x)=x^2+2x$
(D) $\int_{-2}^{2}\left(f(x)-x^2\right)dx=0$

40. Mr. A randomly picks 3 distinct numbers from the set $\{1,2,3,.....,9\}$ and arranges them in descending order to form a three digit number. Mr. B randomly picks 3 distinct numbers from the set $\{1,2,3,....,8\}$ and also arranges them in descending order to form 3 digit numbers.

(A) Probability that Mr. A's 3 digit number is always greater then Mr. B's 3 digit number is $\frac{1}{3}$

(B) Probability that Mr. A and Mr. B has the same 3 digit numbers is $\frac{1}{84}$

(C) Probability that Mr. A's 3 digit number is greater then Mr.B's 3 digit number is $\frac{37}{56}$

(D) Probability that Mr. A's 3 digit number is greater then Mr.B's 3 digit number is $\frac{1}{3}$

41. Let $H: \frac{(x-1)^2}{9} - \frac{(y+2)^2}{4} = 1$ be the hyperbola with centre at C. Now if from any point 'Q' on the asymptotes a straight line be drawn perpendicular to the transverse axis to meet the hyperbola at P and P'. Again a tangent is drawn to the hyperbola at P which meet the asymptotes at L and G, then

(A) $PQ.QP' = 4$
(B) $PQ.QP' = 9$
(C) area of $\Delta CLG = 6$
(D) area of $\Delta CLG = 8$

42. If $I_1 = \int_0^{\frac{\pi}{2}} \frac{\sin(\sin x)}{\sin x} dx; I_2 = \int_0^{\frac{\pi}{2}} \frac{\sin x}{x} dx; I_3 = \int_0^{\frac{\pi}{2}} \frac{\sin(\tan x)}{\tan x} dx$, then which of the following is true

(A) $I_1 > I_3$
(B) $I_2 > I_3$
(C) $I_1 > I_2$
(D) $I_1 < I_2$

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (I), (II), (III) and (IV) and FOUR/FIVE statements in **List-II** entries (P), (Q), (R), (S) OR (T). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

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43. Let $f(x) = \begin{cases} (15-3b)\{x\} - (b^2-4b-5)\operatorname{sgn}(x+1), & \frac{-\pi}{2} < x < 0 \\ k([x]+[-x]), & 0 \le x \le \pi \\ \frac{(a+2\cos x)(1+\tan x)}{\ln(1+\pi^2-2\pi x+x^2)}, & \pi < x < \frac{3\pi}{2} \end{cases}$

Where $[y]$, $\{y\}$ and $\operatorname{sgn}(y)$ denote greatest integer function, fractional part function and signum function of y respectively.

List-I		List-II	
(I)	If f is continuous in $\left(\frac{-\pi}{2}, 0\right)$, then the value of b is	(P)	0
(II)	If f is continuous at $x = \pi$, then value of $(a+k)$ is	(Q)	1
(III)	If f is continuous in $\left(\frac{-\pi}{2}, \pi\right)$, then value of $(b+k)$ is	(R)	5
(IV)	If f has exactly four points of discontinuity in $\left(\frac{-\pi}{2}, \frac{3\pi}{2}\right)$, then $(a+b+k)$ is equal to	(S)	6

Which one of the following options is correct?

(A) I → R, II → Q, III → R, IV → S
(B) I → P, II → Q, III → R, IV → S
(C) I → S, II → P, III → Q,R, IV → P
(D) I → Q, II → P, III → Q,S, IV → P

44. Match the following:

	List-I		List-II
(I)	The number of solution(s) of the equation $\sin^{-1}\left(\frac{1}{1+x^2}\right)=\text{sgn}\left(x^2+1\right)$, is (are)	(P)	4
(II)	If the range of the function $f\left(x\right)=\cos^{-1}\left(\frac{x^2}{1+x^2}\right)$ is $\left(a,b\right]$, then $\left[a+b\right]$ is equal to	(Q)	1
(III)	If α and β are the roots of the $2x^2-3x-2=0$, then $\frac{12}{17}\left(\tan^2\left(\sin^{-1}\frac{\alpha}{\sqrt{1+\alpha^2}}\right)+\tan^2\left(\cos^{-1}\frac{1}{\sqrt{1+\beta^2}}\right)\right)$ is	(R)	2
(IV)	If $f\left(x\right)=\sin\left(\cos^{-1}\left(\sin\left(\cos^{-1}x\right)\right)+\sin^{-1}\left(\cos\left(\sin^{-1}x\right)\right)\right)$, then the value of $\sum_{x=1}^{4}f\left(\frac{3x}{16}\right)$ is equal to	(S)	3

Which one of the following options is correct?

(A) $\text{I}\rightarrow\text{P, II}\rightarrow\text{R, III}\rightarrow\text{S, IV}\rightarrow\text{R}$

(B) $\text{I}\rightarrow\text{R, II}\rightarrow\text{Q, III}\rightarrow\text{S, IV}\rightarrow\text{P}$

(C) $\text{I}\rightarrow\text{S, II}\rightarrow\text{P, III}\rightarrow\text{R, IV}\rightarrow\text{P}$

(D) $\text{I}\rightarrow\text{Q, II}\rightarrow\text{P, III}\rightarrow\text{Q, IV}\rightarrow\text{R}$

45. Consider a system of linear equation $3x+y-z=0,\ x-\frac{py}{4}+z=2$ and $2x-y+2z=q$ where $p,q\in I$ and $p,\ q\in\left[1,10\right]$, then identify the correct statement(s).

	List-I		List-II
(I)	Number of ordered pairs $\left(p,q\right)$ for which system of equation has unique solution is	(P)	1
(II)	Number of ordered pairs $\left(p,q\right)$ for which system of equation has no solution is	(Q)	9
(III)	Number of ordered pairs $\left(p,q\right)$ for which system of equation has infinite solution is	(R)	91
(IV)	Number of ordered pairs $\left(p,q\right)$ for which system of equation has atleast one solution is	(S)	90

Which one of the following options is correct?

(A) $\text{I}\rightarrow\text{P, II}\rightarrow\text{R, III}\rightarrow\text{S, IV}\rightarrow\text{R}$

(B) $\text{I}\rightarrow\text{Q, II}\rightarrow\text{S, III}\rightarrow\text{P, IV}\rightarrow\text{R}$

(C) $\text{I}\rightarrow\text{S, II}\rightarrow\text{Q, III}\rightarrow\text{P, IV}\rightarrow\text{R}$

(D) $\text{I}\rightarrow\text{Q, II}\rightarrow\text{P, III}\rightarrow\text{S, IV}\rightarrow\text{P}$

46. March the following:

List-I		**List-II**	
(I)	If $\int \frac{\cos x-\sin x+1-x}{e^x+\sin x+x}dx=\ln\left(h(x)\right)+g(x)+c$, where *c* is arbitrary constant and $f(x)=h(x)+g(x)$, then	(P)	$f'(0)=3$
(II)	If $f(x)$ is a quadratic polynomial such that $f(0)=1$ and $\int \frac{f(x)}{x^2(x+1)^3}dx$ is a rational function, then	(Q)	$f'(0)=2$
(III)	If $\int \frac{\cos x(1+4\cos 2x)}{\sin x+4\sin x\cos^2 x}dx=\frac{1}{2}\ln\lvert h(x)\rvert+\frac{1}{2}\ln\lvert f(x)\rvert+c$, then	(R)	$f(x)$ is neither even nor odd function
(IV)	If $\int \frac{x^4+1}{x\left(x^2+1\right)^2}dx=A\ln\lvert x\rvert+\frac{B}{1+x^2}+c$, where *c* is arbitrary constant and $f(x)=Ax^2+2Bx$, then	(S)	$f(0)=0$

Which one of the following options is correct?

(A) $\text{I}\to\text{P,R, II}\to\text{Q, III}\to\text{R, IV}\to\text{S}$

(B) $\text{I}\to\text{Q, II}\to\text{S, III}\to\text{P,Q, IV}\to\text{R,S}$

(C) $\text{I}\to\text{S, II}\to\text{Q,R,S III}\to\text{P, IV}\to\text{P,S}$

(D) $\text{I}\to\text{Q,R, II}\to\text{P, Q, III}\to\text{S, IV}\to\text{Q,R,S}$

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

---

47. A triangle is so placed that the midpoints of its sides one placed on the co-ordinate axes, if a, b and c are the sides of the triangle, then the equation of the triangle is $\frac{x}{x_1}+\frac{y}{y_1}+\frac{z}{z_1}=1$ where $a^2+b^2+c^2=k\left(x_1^2+y_1^2+z_1^2\right)$, then the value of k is______

48. Let f be real function defined on R (the set of real numbers) such that $\text{f}'(\text{x})=100\ (\text{x}-1)(\text{x}-2)^2(x-3)^3.......(x-100)^{100}$, for all $x\in R$. If g is a function defined on R such that $\int_a^x e^{f(t)}dt=\int_0^x g(x-t)dt+2x+3$, If some of the all the values of x for which g(x) has a local extremum be λ then find $\frac{\lambda}{3}$

49. If $\lim_{x\to1}\frac{100}{1-x^{100}}-\frac{50}{1-x^{50}}=5\text{A}$; find the value of A.

50. If S_1, S_2, S_3 denote the sums of first twenty terms of three non constant sequence in A.P., whose first terms are unity and common differences are in H.P. Then $\frac{2S_3S_1 - S_1S_2 - S_2S_3}{S_1 - 2S_2 + S_3}$ is equal to___

51. If P is a point $(2,4)$ on the parabola $y^2 = 8x$ and PQ is a focal chord, the coordinate of the mirror image of Q with respect to tangent at P are given by (α,β) then $(\beta - \alpha)$ is_____

52. If sum of the roots of the equation $\sqrt{2}\sin\left(x+\frac{\pi}{4}\right)\left(\sec^2 x - \left(1+\sqrt{3}\right)\tan x + 2 + \sqrt{3}\right)$ $= \sqrt{9+18\sin x.\cos x}$ in $[0, 2\pi]$ is $\frac{p}{q}\pi$ where $p, q \in N$, then find the least value of $|p-q|$

53. Let S be infinite sum of the series $2 + 3\cos x + 4\cos^2 x + 5\cos^3 x + ...\infty$, where x satisfies the equation $|5\cos x + 4| + |5\cos x - 2| = 6$. If the least value of S is equal to $\left(\frac{a}{b}\right)$ where a and b are co-prime numbers, then the value of $(a+b)$ is:

54. If the coefficient of x^8 in the expansion of $\left(2 + 9x^3 + 6x^4 + x^5\right)^{10}$ is $5.2^p.3^q$ where $p, q \in N$, then find the value of $(p+q)$

FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
FULL TEST – I
PAPER –2
TEST DATE: 28-12-2022

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B**.

Section – A *(01 – 04, 19 – 22, 37 – 40)*: This section contains **TWELVE (12)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.

Section – A *(05 –10, 23 – 28, 41 – 46)*: This section contains **EIGHTEEN (18)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – B *(11 – 18, 29 – 36, 47 – 54)*: This section contains **TWENTY FOUR (24)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.**

MARKING SCHEME

Section – A (Single Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct option is chosen.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –1 In all other cases.

Section – A (One or More than One Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If only (all) the correct option(s) is (are) chosen;
Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;
Partial marks : +2 if three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –2 In all other cases.

Section – B: Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct integer is entered;
Zero Marks : 0 Question is unanswered;
Negative Marks : –1 In all other cases.

Physics

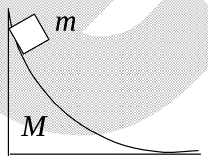
PART – I

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

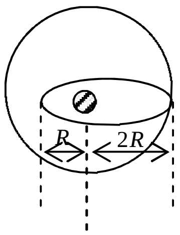
1. In a process on a system, the initial pressure and volume are equal to the final pressure and volume:
   (A) The initial temperature must be equal to the final temperature
   (B) The net heat given to the system in the process must be zero
   (C) The net work done by the system in the process must be zero
   (D) None of these

2. Block placed on wedge of mass M is released. All surface are smooth, then which of following is/are correct:
   (A) C.M. of mass will remain at rest
   (B) Acceleration of centre of mass is in downward direction



   (C) Normal force exerted by floor on wedge will be equal to wedge of weight at some point of its motion.
   (D) Normal force exerted by floor on wedge is always less than combined weight of block and wedge.

3. A spaceship (which has negligible mass) is in an elliptical orbit about a planet. The minimum distance between the spaceship and the planet is R. At the point of maximum distance, spaceship is travelling at a speed v_0,. It then fires his thrusters so that it enters a circular orbit of radius 2R. What is its new speed:



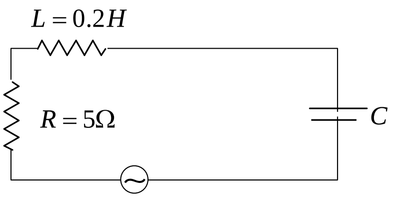
   (A) $v_0 \frac{\sqrt{3}}{2}$ (B) $v_0\sqrt{5}$
   (C) $v_0 \frac{\sqrt{3}}{5}$ (D) $v_0\sqrt{2}$

4. A nucleus is kept at rest. It breaks into two parts which fly off with velocity in the ratio $27:8$. Then the ratio of radii of the parts is
   (A) 27 : 8 (B) 8 : 27
   (C) 2 : 3 (D) 3 : 2

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

5. An alternating voltage $E = 6\sin 20t + 8\cos 20t$ is applied to series resonant circuit as shown. The correct statements is:
   (A) The capacitance is $12.5mF$
   (B) The resonant current in the circuit is $2A$
   (C) Power dissipated in the circuit is 10 watt
   (D) Power dissipated in the circuit is 20 watt



6. Two non-conducting solid spheres of radii R and 2R, having uniform volume charge densities ρ_1 and ρ_2 respectively are touching each other. The net electric field at a distance 2R from the centre of the smaller sphere, along the line joining the centres of the spheres, is zero then the ratio $\frac{\rho_1}{\rho_2}$ can be:

(A) -4

(B) $-\frac{32}{25}$

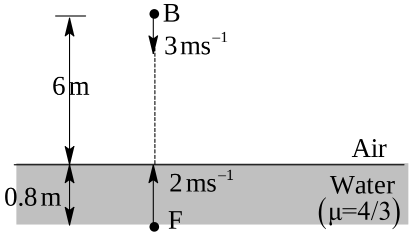
(C) $+\frac{32}{25}$

(D) 4

7. If one of the slits of a standard Young's double-slit experiment is covered by a thin parallel sided glass slab so that it transmits only one-half the light intensity of the other, then:
(A) The fringe pattern will get shifted toward the covered slit
(B) The fringe pattern will get shifted away from the covered slit
(C) The bright fringes will become less bright and the dark ones will become more bright.
(D) The fringe width will reaming unchanged.

8. According to Bohr's theory of the hydrogen atom, for the electron in the nth allowed orbit:
(A) The linear momentum is proportional to $(1/n)$
(B) The radius is proportional to n
(C) The kinetic energy is proportional to $(1/n^2)$
(D) The angular momentum is proportional to n

9. A fish F, in the pond is at a depth of 0.8 m from the water surface and is moving vertically upward with velocity $2\,ms^{-1}$. At the same instant, a bird B is at a height of 6 m from the water surface and is moving downward with velocity $3\,ms^{-1}$. At this instant, both are on the same vertical line as shown in figure. Which of the following statements are correct?



(A) Height of B, observed by F (from itself), is equal to 5.30 m
(B) Depth of F, observed by B (from itself), is equal to 6.60 m
(C) Velocity of B, observed by F (relative to itself), is equal to $5.50\,ms^{-1}$
(D) Velocity of F, observed by B (relative to itself), is equal to $4.50\,ms^{-1}$

10. n moles of an ideal monatomic gas undergo a process in which the temperature changes with volume as $T=KV^2$. If the temperature of the gas changes from T_0 to $4T_0$ then:

(A) Work done by the gas is $3nRT_0$

(B) Heat supplied to the gas is $6nRT_0$

(C) Work done by the gas is $\frac{3}{2}nRT_0$

(D) Heat supplied to the gas is $\frac{3}{2}nRT_0$

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.***

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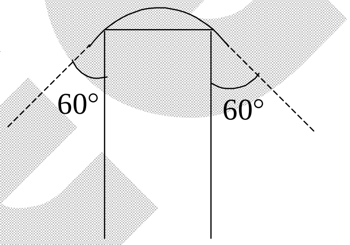
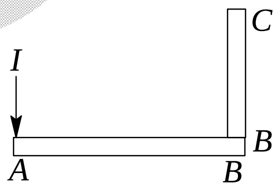
11. Sound of frequency $1000Hz$ from a stationary source is reflected from an object approaching the source at $30\,m/s$, back to stationary observer located at the source. The speed of sound in air is $330\,m/s$. The frequency of the sound heard by the observe is $K\times 400Hz$. Determine $'K'$

12. At an instant, the ratio of the amounts of radioactive substances is $2:1$. If their half lives be 12 & 16 hours respectively, then after 2 days the ratio of amounts of substances left over will be $1:x$ find x:

13. A soap bubble is being blown on a tube of radius 1 cm. The surface tension of the soap solution is $0.05\,Nm^{-1}$ and the bubble makes 60° with the tube as shown in the figure. The excess of pressure over the atmosphere pressure in the tube is 2β Pa. Find the value of β ____.

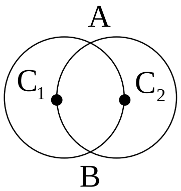


14. A uniform rod AB of mass M is placed in contact with a second rod BC of mass $m=M/2$ on a horizontal smooth table at right angles to each other as shown in figure. Impulse I is imparted to A kinetic energy generated in BC is $\frac{nI^2}{3m}$. Find the value of $'n'$ ___ .



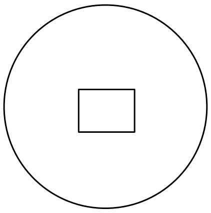
15. A ray of light is incident at an angle of 60° on one face of a prism which has refracting angle of 30°. The ray emerging out of the prism makes an angle of 30° with the incident ray. If the refractive index of the material of the prism is $\mu=\sqrt{a}$, find the value of a ____.

16. Two circular rings of identical radii and resistance of 36Ω each are placed in such a way that they cross each other's centre C$_1$ and C$_2$ as shown in figure. Conducting joints are made at intersection point A and B of the rings. An ideal cell of emf 20 V is connected across A and B. Find the power delivered by the cell (in $10^2\mathrm{W}$) ____.



17. A cubical block of mass M vibrates horizontally with amplitude of 4.0 cm and a frequency of 2.0 Hz. A small block of mass m is placed on the bigger block. In order that the smaller block does not slide on the bigger block, the minimum value of the coefficient of static friction between the two blocks is $(0.16x)$. Find the value of x. (Take $\pi^2=10$ and $\mathrm{g}=10\,\mathrm{m/s^2}$)

18. Consider the two loops with common centre and on the same plane as shown in the figure. The large circular loop has radius R = 10 cm and the small square loop has side $a=1cm$. There is a current circulating in the large loop given by $i(t)=i_0t/\tau$ with $i_0=\frac{2}{\pi}\times 100A,\ \tau=2\times 10^{-2}\sec$. Emf (in micro volts) induced in the small loop is ____.

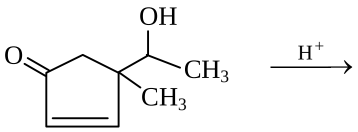


Chemistry

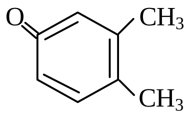
PART – II

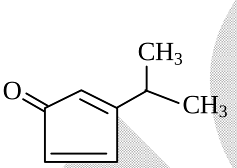
Section – A (Maximum Marks: 12)

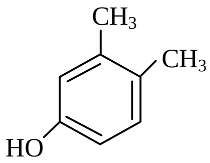
*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

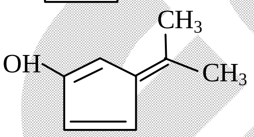
19. 

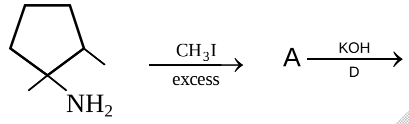
major product is -

(A) 

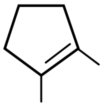
(B) 

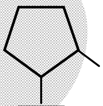
(C) 

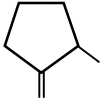
(D) 

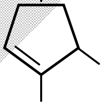
20. 

B then B will be-

(A) 

(B) 

(C) 

(D) 

21. If on a strand of DNA the base sequence is ATTGACGCAT then the sequence transcription on RNA would be -
(A) UAACUGCGUA
(B) AUUCUGCGUA
(C) UAACTGCGUA
(D) TAACTGCGTA

22. The structure of a crystalline lattice AB is rock salt type where B atoms are occupying all the CCP positions but A atoms are occupying all the octahedral voids -
(A) If atoms lying on one tetrad axis of symmetry are removed then molecular formula of the compound become AB
(B) If atoms lying on one triad axis of symmetry are removed then molecular formula of the compound become A_4B_5
(C) If atoms lying on one diad axis of symmetry are removed then molecular formula of the compound become A_5B_8
(D) All of the above molecular formula are correct corresponding to the defects mentioned

Section – A (Maximum Marks: 24)

This section contains ***SIX (06)*** *questions. Each question has* ***FOUR*** *options (A), (B), (C) and (D).* ***ONE OR MORE THAN ONE*** *of these four option(s) is (are) correct answer(s).*

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23. Identify the correct statement (s) regarding the oxidation of $N_2H_5^+$ by $Cr_2O_7^{2-}$ in acid medium.

(A) 10 ml 0.2 M dicromate is required for the complete oxidation of 12 ml 0.25 M $N_2H_5^+$

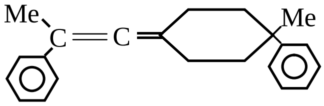
(B) 10 ml 0.2 M dicromate is required for the complete oxidation of 10 ml 0.6 N $N_2H_5^+$

(C) Number of moles of N_2 liberated per mole of dichromate is 1.5

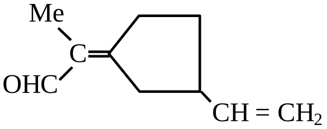
(D) One mole of $N_2H_5^+$ is 3 equivalents

24. Which is resolvable ?

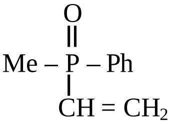
(A)



(B)


Me
C
OHC
CH = CH2

(C)

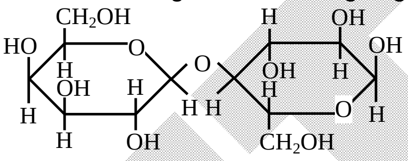


$Me-\overset{\overset{O}{\parallel}}{\underset{\underset{CH=CH_2}{|}}{P}}-Ph$

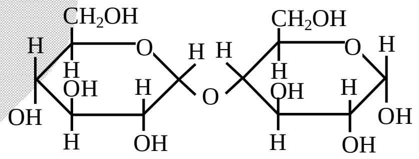
(D) Ethylmethylphenyl amine at pH=2

25. Which of the following is/are reducing sugars -

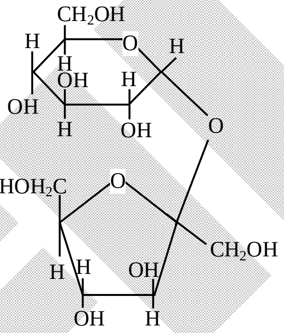
(A)


CH2OH
HO
O
H
OH
H
H
H
OH
O
H H
H
OH
OH
OH
H
H
O
H
CH2OH

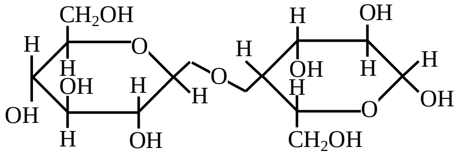
(B)


CH2OH
H
O
H
OH
H
OH
H
OH
H H
O
CH2OH
O
H
H
OH
H
OH
H
OH

(C)


CH2OH
H
O
H
H
OH
H
OH
H
OH
O
HOH2C
O
CH2OH
H
H
OH
OH
H

(D)


CH2OH
H
O
H
OH
H
OH
H
OH
H
O
H
H
OH
OH
H
H
H
O
OH
CH2OH

26. Which of the following statements is/are correct?

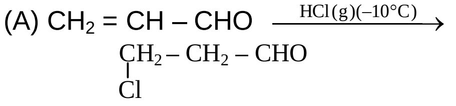
(A) B_2H_6 reacts with excess NH_3 at low temperature to produce an ionic compound

(B) B_2H_6 reacts with excess of NH_3 at higher temperature to form boron nitride solid

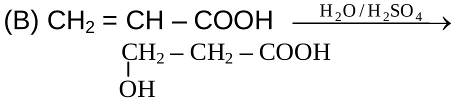
(C) Boron nitride has polymeric layer structure

(D) In borazine there are –ve and +ve charges on B and N respectively

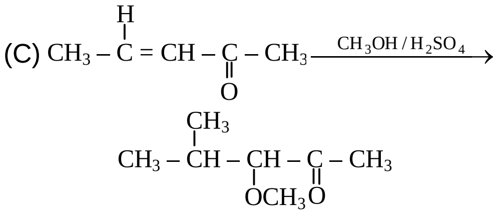
27. The correct products have been reported in reactions –



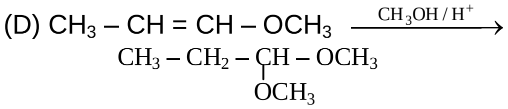
(A) $CH_2 = CH - CHO \xrightarrow{HCl(g)(-10°C)} \underset{\substack{|\\Cl}}{CH_2} - CH_2 - CHO$



(B) $CH_2 = CH - COOH \xrightarrow{H_2O/H_2SO_4} \underset{\substack{|\\OH}}{CH_2} - CH_2 - COOH$



(C) $CH_3 - \overset{\substack{H\\|}}{C} = CH - \underset{\substack{\|\\O}}{C} - CH_3 \xrightarrow{CH_3OH/H_2SO_4} CH_3 - \overset{\substack{CH_3\\|}}{CH} - \underset{\substack{|\\OCH_3}}{CH} - \underset{\substack{\|\\O}}{C} - CH_3$

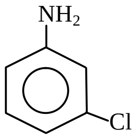


(D) $CH_3 - CH = CH - OCH_3 \xrightarrow{CH_3OH/H^+} CH_3 - CH_2 - \underset{\substack{|\\OCH_3}}{CH} - OCH_3$

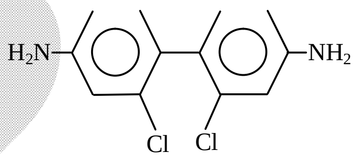
28. $C_6H_6 \xrightarrow[H_2SO_4]{HNO3} \xrightarrow[Fe]{Cl_2} [X] \xrightarrow[NaOH]{Sn} [Y] \xrightarrow[\Delta]{HCl} \xrightarrow{OH^-} [Z] \xrightarrow[H_3PO_2]{HNO_2} [P]$

The current statement(s) are/is -

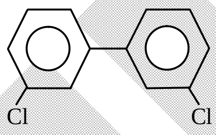
(A) Y =



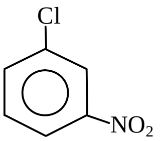
(B) Z =



(C) P =



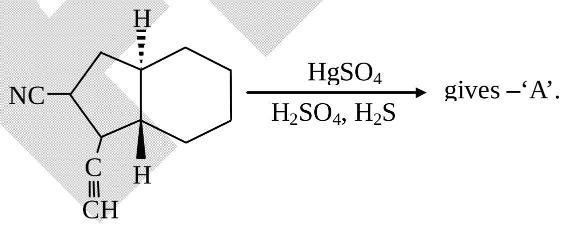
(D) X =



Section – B (Maximum Marks: 24)

This section contains ***EIGHT (08)*** *numerical based questions. The answer to each question is a* ***Single Digit Integer, ranging from 0 to 9 both inclusive.***

29.

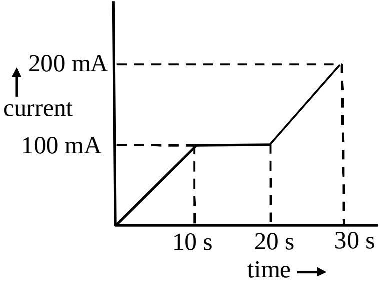


The degree of unsaturation of compound 'A' is?

30. What is the minimum pH required to prevent the precipitation of ZnS in a solution that is 0.01 M $ZnCl_2$ and saturated with $0.10\,M\ H_2S$?

[Given $K_{sp} = 10^{-21}$, $K_{a_1} \times K_{a_2} = 10^{-20}$]

31. In a Cu-voltameter , mass deposited in 30s is m gm. If the time-current graph is shown in the following figure



The electrochemical equivalent of Cu is $\frac{m}{x}$. Then find the value of $'x'$ is ___.

32. For a certain reaction the variation of rate constant with temperature is given by the equation

$\ell n\, k_t = \ell n k_0 + \frac{(\ell n3)t}{10}$ (t ≥ 0°C)

The value of temperature coefficient of the reaction is ____.

33. A compound MX_2 has observed and normal molar masses 65.6 and 164 respectively. The apparent degree of ionization of MX_2 is $15x\%$. Then find the value of 'x' is ____.

34. What is the highest oxidation state of nickel in the given complexes of Ni metal?

(i) $Ni(CO)_4$

(ii) K_2NiF_6

(iii) $[Ni(NH_3)_6](BF_4)_2$

(iv) $K_4[Ni(CN)_6]$

35. Benitoite is represented as $BaTi[Si_3O_n]$, the value of n is ……..

36. In order to prepare a buffer of pH= 8.26, the amount of $(NH_4)_2SO_4$ required to be mixed with one litre of 0.1(M) NH_3 (aq) is $0.25x$ mole. The value of 'x' is ____.

(Given:- pK_b of $NH_4OH = 4.74$)

Mathematics **PART – III**

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

37. Maximum value of function $f(x) = \left(\sin^{-1}(\sin x)\right)^2 - \sin^{-1}(\sin x)$ is:

(A) $\frac{\pi}{4}(\pi + 2)$
(B) $\frac{\pi}{4}(\pi - 2)$
(C) $\frac{\pi}{4}$
(D) None of these

38. For a parabola $x^2 - 4xy + 4y^2 - 32x + 4y + 16 = 0$, focus is:

(A) $(2,1)$
(B) $(-2,1)$
(C) $(-2,-1)$
(D) $(2,-1)$

39. Given three non – zero, non – coplanar vectors, and $\vec{a}, \vec{b}$ and $\vec{c}$ and $\vec{r}_1 = p\vec{a} + q\vec{b} + \vec{c}$ and $\vec{r}_2 = \vec{a} + p\vec{b} + q\vec{c}$ if the vectors $\vec{r}_1 + 2\vec{r}_2$ and $2\vec{r}_1 + \vec{r}_2$ are collinear then (p, q) is

(A) (0, 0)
(B) (1, –1)
(C) (–1, 1)
(D) (1, 1)

40. Solution of differential equation $f'(x) f'''(x) = 3\left(f''(x)\right)^2, \left(y = f(x)\right)$ is:

(A) $x = k_1 y^2 + k_2 y + k_3$
(B) $y = k_1 x^2 + k_2 + k_3$
(C) $x = \sin y$
(D) None of these

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

41. Let

$$f(x) = \begin{cases} \lim\limits_{n\to\infty}\left(\dfrac{px}{n}\sum\limits_{r=1}^{n}\dfrac{\left[r^2 - e^{-x} + r - 1\right]}{r(r+1)}\right) + \lambda, & x > 0 \\ q, & x = 0 \\ \lim\limits_{n\to\infty}\sum\limits_{r=1}^{n}\dfrac{\left\{r^2 + r + e^{x} - 1\right\}}{r(r+1)}, & x < 0 \end{cases}$$

Is differentiable in $\mathbb{R}$:

$\left([.]\text{ is G.I.F. and } \{.\} \text{ is F.P. of x}\right)$ Then:

(A) p=1
(B) q=1
(C) p+q+λ=3
(D) if g is inverse of F then $g'(1/2) = 2$

42. Consider $f\left(x\right)=4x^4-24x^3+31x^2+6x-8$ be a polynomial function and $\alpha,\beta,\gamma,\sigma$ are the roots. $\left(\alpha<\beta<\gamma<\sigma\right)$. So:

(A) $\sigma^{\beta}+\dfrac{1}{\sigma^{\alpha}}+\sigma^{\gamma}+\gamma^{\sigma}=36$
(B) $\sigma^{\beta}+\dfrac{1}{\sigma^{\alpha}}+\sigma^{\gamma}+\gamma^{\sigma}=18$
(C) $\displaystyle\int_{2\alpha}^{2\beta}\frac{x^{\sigma+1}-5x^{\gamma+1}+2\beta\left|x\right|+1}{x^2+4\beta\left|x\right|+1}dx=2\ln 2$
(D) $\displaystyle\int_{2\alpha}^{2\beta}\frac{x^{\sigma+1}-5x^{\gamma+1}+2\beta\left|x\right|+1}{x^2+4\beta\left|x\right|+1}dx=\ln 2$

43. Consider the equation $z^2-\left(3+i\right)z+\left(m+2i\right)=0\left(m\in R\right)$. If the equation has exactly one real and one-non-real complex root, then which of the following hold(s) good:
(A) Modulus of the non-real complex root is 2
(B) The value of m is 3
(C) Additive inverse of non-real root is $\left(-1-i\right)$
(D) Product of real root and imaginary part of non-real complex root is 2

44. $\displaystyle\sum_{m=1}^{\infty}\sum_{n=1}^{\infty}\frac{m^2n}{\left(n.3^m+m.3^n\right)}=\frac{p}{q}$ (Where $p\,\&\,q$ are coprime) then:

(A) $p+q=41$
(B) $p<q$
(C) p is perfect square
(D) q is perfect square

45. Let $p\left(x\right)=4\sin^3x-\sin x+2\left(\sin\dfrac{x}{2}-\cos\dfrac{x}{2}\right)^2$, then which of the following is/are correct?

(A) Range of $\mathrm{p(x)\,is}\left[1,3\right]$
(B) Range of $\mathrm{p(x)\,is}\left[0,4\right]$
(C) Number of solution of $\mathrm{p(x)=1\,in}\left[0,\pi\right]\mathrm{is}\,2$
(D) Number of solution of $\mathrm{p(x)=1\,in}\left[0,2\pi\right]\mathrm{is}\,4$

46. Let m,n be real numbers satisfying the relation:

$$\log_2\left(m^2+n^2+1\right)+\log_3\left(\frac{1+2\sin^2\left(\frac{2\pi}{7}\right)}{2-\cos\left(\frac{4\pi}{7}\right)}\right)=\log_2 n+\log_2\left(2m+2-n\right)$$

Identify which of the following statement(s) is/are correct?
(A) $m+n=2$
(B) $\left|\left|m\right|-\left|n\right|\right|=4$
(C) Area of the figure enclosed by $\left|x\right|+\left|y\right|=\left|m\right|+\left|n\right|$ is 8 square units.
(D) Area of the figure enclosed by $\left|x\right|+\left|y\right|=\left|m\right|+\left|n\right|$ is 16 square units.

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.***

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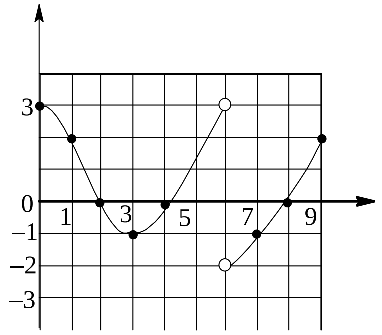
47. A and B are two square matrices such that $A^2B = BA$ and if $(AB)^{10} = A^k B^{10}$ then the value of $k - 1020$ is....

48. The graph of the derivative f of a continous function f is shown with f(0) = 0



If $f(x)$ has local minima at $x = x_1$ and $x = x_2$; f has inflection point at $x = k$; number of critical points of $y = f(x)$ is w then $x_1 + x_2 - k - w$ is.....

49. Number of values of $x \in [0, \pi]$ where $f(x) = [4\sin x - 7]$ is non derivable is ($[.]$ is G. I. F)

50. If the equation on reflection of $\frac{(x-4)^2}{16} + \frac{(y-3)^2}{9} = 1$ about the line $x - y - 2 = 0$ is $16x^2 + 9y^2 + k_1x - 36y + k_2 = 0$ then $\frac{k_1 + k_2}{22}$ is

51. If $0 < \alpha < 30°$, then find the value of $\log_2\left(\frac{8\cos(30° - 2\alpha) - \frac{8}{\cot\alpha + \cot(30° - \alpha)}}{\sqrt{3}}\right)$

52. Find the value of $\log_{\sqrt{5}}\left(\frac{\sqrt{(5\sqrt{5}+5)\sqrt{(5\sqrt{5}+5)^2\sqrt{(5\sqrt{5}+5)^3\sqrt{....}}}}}{(6+2\sqrt{5})\sqrt[3]{215-18\sqrt[3]{215-18\sqrt[3]{215-18\sqrt[3]{....}}}}}\right)$

53. Three circles C_1, C_2, C_3 with radii r_1, r_2, r_3 ($r_1 < r_2 < r_3$) respectively are given as $r_1 = 2$, and $r_3 = 8$ they are placed such that C_2 lies to the right of C_1 and touches it externally, C_3 lies to the right of C_2 and touches it externally. There exist two straight lines each of which is a direct common tangent simultaneously to all the three circles then r_2 is equal to __.

54. If K^{th} term is the greatest term in the square $a_n = \frac{n}{70 + n^2}, n \in N,$ then k is____

FIITJEE

ALL INDIA TEST SERIES

JEE (Advanced)-2023

FULL TEST – I

PAPER –1

TEST DATE: 28-12-2022

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

Section – A

1. AD

2. ABC

3. ABCD

Sol. $\Delta E = \frac{hc}{\lambda}$

$\Delta E = \frac{hc}{\lambda(\text{in nm})}(\text{in eV})$

4. AD

5. BCD

6. BCD

7. C

8. A

9. B

10. C

Section – B

11. 250.00

12. 42.00

13. 2.96

Sol. Let b be the velocity and α the angle of projection for a fragment reaching the man. According to the questions the greatest value of u can be 20 m/s. If t be the time taken by this fragment to reach the man, then considering the horizontal and vertical motions of the fragment

$$8+\frac{1}{2}gt^2 = u\sin\alpha t$$

$$g^2t^4 - 4\left(u^2 - g\times 8\right)t^2 + 4\times 100 = 0$$

The period in which the man will be in danger on account of this fragment

$$= t_1 - t_2 = \sqrt{\left(t_1^2+t_2^2\right)-2t_1t_2} = \frac{2}{g}\left\{u^2 - 8g - 10g\right\}^{1/2}$$

14. 3.21

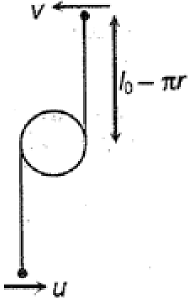
Sol. Using WET

$$\frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

$$= -mg\left(l_0 + l_0 - \pi r\right) \text{............ (i)}$$

At highest point $v = \sqrt{\left(l_0 - \pi R\right)g}$

Substituting in equation (i)



$$v = \sqrt{5gl_0 - 4r\pi g} \cong 3.21 m/\sec$$

15. 2.81

Sol. Velocity of watre coming out from hole

$$v = \sqrt{2gh} = \sqrt{2g1}$$

$$y = u_y t + \frac{1}{2}a_y t^2$$

$$1 = \sqrt{2gt}\sin 30^\circ + \frac{1}{2}\times 10t^2$$

$$1 = \sqrt{2g}\,\frac{t}{2} + 5t^2$$

$$t = \frac{-2.24 \pm \sqrt{(2.24)^2 + 20}}{10} = 0.28\sec.$$

$$x_1 = v_x t = \sqrt{2g}\cos 30^\circ \times 0.28 = 1.08m$$

$$x = x_1 + x_2 = 1.08 + 1.73 = 2.81m$$

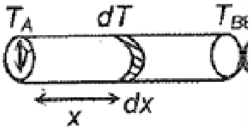
16. 500.00

Sol. Intensity of the source at the cross-section A

$$\Rightarrow l = \frac{P}{4\pi\left(50r\right)^2} = \frac{1.25\times10^3}{4\pi\left(50r\right)^2}$$

Power absorbed by the end A

$$T_B = \frac{0.003}{100000\times10^{-10}} = 300K$$



$$\int_0^j \frac{0.1T_A.dx}{4\times10^{-4}} = -\int_{T_A}^{T_B} TdT$$

$$\Rightarrow T_A = 500K$$

17. 40.00

Sol. When (1) and (2) are connected and (3) and (4) are open

$$P_1 = \frac{v^2}{R_1+R_2} \qquad .....(i)$$

When (3) and (4) are closed and (1) and (2) are connected

$$P_2 = \frac{v^2}{R_2+\left(\frac{R_2R_3}{R_2+R_3}\right)} \qquad .....(ii)$$

When (3) and (4) are connected and (1) and (2) are open

$$P_3 = \frac{v^2}{R_2+R_3} \qquad ......(iii)$$

When (3) and (4) are connected and (1) and (2) are closed

$$P_4 = \frac{v^2}{R+\left(\frac{R_1R_3}{R_1+R_3}\right)} \qquad ......(iv)$$

From (i) to (iv)

$$\frac{P_1}{P_3} = \frac{P_2}{P_4} \Rightarrow P_4 = 40W$$

18. 21.00

Sol. Accroding to Biot-Savert law,

$$\text{B}=\frac{\mu_0}{4\pi}\frac{qv\sin\theta}{r^2}$$

$$\text{B}=\frac{10^{-7}\times0.2\times4\times10^3\times3}{109\times\sqrt{109}} = 21\mu T$$

Chemistry PART – II

Section – A

19. AD

Sol. Both Fe^{3+} & Mn^{2+} have 5 unpair electrons
Cu_2Cl_2 is colourless because Cu^+ has no unpair electrons

20. ABC

Sol. (A) The total lines obtained due to the splitting of a spectral line in the presence of magnetic effect is (2l + 1) as the presence of orbitals which have specific orientation in the presence of external field take up certain new orientation. The number of orbitals are equal to (2l + 1) and for each orbital one splitting takes place.

(B) As we move away from the nucleus the difference in the energy levels become lesser and lesser hence.

For 1st line of Lyman $\Delta E = E_1\left[\frac{1}{n_1^2}-\frac{1}{n_n^2}\right]$

$\Delta E_1 = E_1\left[\frac{3}{4}\right]$ – 1st line; $\Delta E_2 = E_1\left[\frac{8}{9}\right]$–2nd line

$\Delta E_3 = E_1\left[\frac{15}{16}\right]$–34rd line ; $\Delta E_4 = E_1\left[\frac{24}{25}\right]$ – 4th line;

$\Delta E_5 = E_1\left[\frac{35}{36}\right]$ – 5th line;

$$\Delta E_2 - \Delta E_1 = E_1\left[\frac{8}{9}-\frac{3}{4}\right] = E_1\left[\frac{5}{36}\right]$$

$$\Delta E_3 - \Delta E_2 = E_1\left[\frac{15}{16}-\frac{8}{9}\right] =$$

$$E_1\left[\frac{135-128}{144}\right] = E_1\left[\frac{7}{144}\right]$$

$$\Delta E_4 - \Delta E_3 = E_1\left[\frac{24}{25}-\frac{15}{16}\right]$$

$$= E_1\left[\frac{16\times 24-15\times 25}{25\times 16}\right] = E_1\left[\frac{9}{400}\right]$$

We find that $(\Delta E_2 - \Delta E_1) > (\Delta E_3 - \Delta E_2) > (\Delta E_4 - \Delta E_3)$
Hence the distance also become lesser and lesser.

(C) The distance from the nucleus for maximum probability of finding electrons is 0.53 Å. This is not on the circumference of the orbital but is in the vicinity of the circumference.

21. ABC

Sol. Because of the H–bonding NH_4^+ is more extensively solvated than Na^+, hence NH_4^+ salts is more soluble than Na^+ salts.
The polarising power of Sn^{4+} is greater than Sn^{2+} , hence $SnCl_4$ is more covalent
The polarisibility of Cl^- is greater than F^- because of greater size.
Formal charge

$$= \begin{pmatrix} \text{no. of valence} \\ \text{electrons of the} \\ \text{atom} \end{pmatrix} - \begin{pmatrix} \text{no.of} \\ \text{nonbonded} \\ \text{electrons} \end{pmatrix} - \frac{1}{2}\begin{pmatrix} \text{no. of} \\ \text{bonded} \\ \text{electrons} \end{pmatrix}$$

In SO_2 , formal charge of S = $6 - 2 - \frac{1}{2} \times 4 = 2$

22. AB

23. ABCD

24. AC

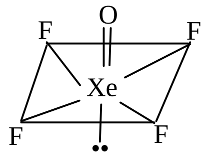
Sol. $Hg_2^{2+} + 2I^- \rightarrow Hg_2I_2$(green ppt) ;
$Hg_2^{2+} + H_2S \rightarrow$ no ppt

25. B

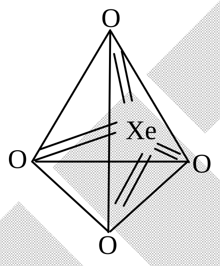
26. A

Sol.

(I) $XeOF_4$:

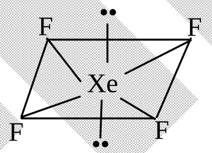


one ℓ p of electrons ; sp^3d^2 hybridisation ; square pyramidal
(I) → (Q,S)
(II) XeO_4 : tetrahedral and no ℓ p of electrons



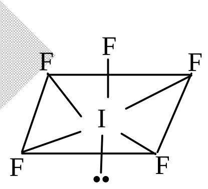
(II) → (P, S)

(III) XeF_4 :



sp^3d^2 hybridisation ; planar ; two ℓ ps of electrons
(III) → R

(IV) IF_5 :



sp^3d^2 hybridisation ; one ℓ p. of electrons
(IV) → (Q,S)

27. D

28. C

Section – B

29. 0.90

Sol. Let no. of moles of CH_4 present = n_1 mol.

Let no. of moles of C_2H_2 present = n_2 mol.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

n_1 $\quad$ n_1

$$C_2H_2 + \frac{5}{2}O_2 \longrightarrow 2CO_2 + H_2O$$

n_2 $\quad$ $2n_2$

Total no. of moles at initial = $n_1 + n_2$

Total no. of moles at final = $n_1 + 2n_2$

At constant V & T,

$$\frac{P_1}{P_2} = \frac{\text{No. of moles at initial}}{\text{No. of moles at final}}$$

$$\frac{63}{69} = \frac{n_1+n_2}{n_1+2n_2} \Rightarrow \frac{21}{23} = \frac{n_1+n_2}{n_1+2n_2}$$

$$\Rightarrow \frac{n_2}{n_1} = \frac{2}{19} \Rightarrow \frac{n_1+n_2}{n_1} = \frac{21}{19}$$

$$\therefore \frac{n_1}{n_1+n_2} = \frac{19}{21}$$

30. 0.39

Sol. $$\Delta u = Q + W = 0 + \int -P_{ext.}dV = -P_{ext}(V_2 - V_1)$$

$$\Rightarrow C_V(T_2 - T_1) = -P_{ext.}\left(\frac{RT_2}{P_2} - \frac{RT_1}{P_1}\right);$$

Here $P_{ext} = P_2$

$$\Rightarrow \frac{5}{2}R(673\text{–}373) = -673R + \left(\frac{373R}{0.1013}\right)P_2$$

$$\Rightarrow P_2 = 0.3865 \text{ M Pa}$$

31. 800.00

Sol.

	I_2 +	I^- $\xrightleftharpoons{KC}$	I_3^-
	51.25×10^{-3}	0.1	
At Equilibrium	1.25×10^{-3}(M)	50×10^{-3}(M)	50×10^{-3}(M)

$$K_C = \frac{50\times10^{-3}}{50\times10^{-3}\times1.25\times10^{-3}} = \frac{1000}{1.25} = 800$$

32. 0.40

Sol. $$N_2O_5(g) \rightleftharpoons 2NO_2(g) + \frac{1}{2}O_2(g)$$

Initially : 600 torr — —

At equilibrium: $(600 - p)$ torr $2p$ torr $\frac{p}{2}$ torr

Total press is $\left(600 + \frac{3p}{2}\right)$ torr

$\therefore\ 600 + \frac{3p}{2} = 960$

or $\frac{3p}{2} = 360$

or $p = 240$ torr

$\therefore$ fraction of N_2O_5 (g) decomposed = $\frac{240}{600} = 0.4$

33. 4.00

Sol. $s = \frac{10^3 \times \kappa}{\lambda_m^{\infty}(\text{AgCl})} = \frac{10^3 \times 2.6 \times 10^{-6}}{(63+67)}$

$= 2 \times 10^{-5}$ (M)

$\therefore\ K_{sp} = (2 \times 10^{-5})^2 = 4 \times 10^{-10}$.

34. 0.50

35. 64.36

Sol. Vol. of all atoms in 1.68 gm

argon $= \frac{1.68}{40} \times N_A \times \frac{4}{3} \times \pi \times (1.5 \times 10^{-8})^3 = 0.3564$

vol. of solid argon = 1 cm^3

% empty space = $(1 - 0.3564) \times 100 = 64.36$

36. 1000.00

Sol. Initially $P_m = P^o_X.X_X + P^o_Y.X_Y$

$550 = P^o_X\left(\frac{1}{1+3}\right) + P^o_Y\left(\frac{3}{1+3}\right)$

or $P^\circ_X + 3P^\circ_Y = 2200$ ...(i)

When 1 mole of Y is further added to it

$P_m = P^o_X.X_X + P^o_Y.X_Y$

$560 = P^o_X\left(\frac{1}{1+4}\right) + P^o_Y\left(\frac{4}{1+4}\right)$

$\therefore\ P^\circ_X + 4P^\circ_Y = 2800$ ...(ii)

By eqs. (i) and (ii)

$P^o_X = 400$ mm and $P^\circ_Y = 600$ mm.

Mathematics

PART – III

Section – A

37. ACD

Sol. $\because (A+B)(A-B) = (A-B)(A+B)$

Now $C = \left(A^T + B^T\right)(A+B)(A-B)^{-1}$

$$= (A-B)(A+B)(A-B)^{-1}$$

$$= (A+B)(A-B)(A-B)^{-1}$$

$$= A+B$$

Now $C^T = A^T + B^T = A - B$

$$C + C^T = 2A$$

38. BD

Sol. Let $t_r = \left(\dfrac{1}{r(r+1)}\right)^3 = \left(\dfrac{1}{r} - \dfrac{1}{r+1}\right)^3 = \dfrac{1}{r^3} - \dfrac{1}{(r+1)^3} - \dfrac{3}{r(r+1)}\left(\dfrac{1}{r(r+1)}\right)$

$$= \frac{1}{r^3} - \frac{1}{(r+1)^3} - 3\left(\frac{(r+1)-r}{r(r+1)}\right)^2$$

$$t_r = \frac{1}{r^3} - \frac{1}{(r+1)^3} - 3\left(\frac{1}{r^2} + \frac{1}{(r+1)^2}\right) + 6\left(\frac{1}{r} - \frac{1}{r+1}\right)$$

$$\sum_{r=1}^{n} t_r = \left(1 - \frac{1}{(n+1)^3}\right) - 3\left(\frac{\pi^2}{6} + \frac{\pi^2}{6} - 1\right) + 6\left(1 - \frac{1}{n+1}\right)$$

$$\lim_{x\to\infty} \sum t_r = 10 - \pi^2$$

39. BCD

Sol. $f(x) = x^2 + \displaystyle\int_0^x e^{-t} f(x-t)\,dt$

$$= x^2 + \int_0^x e^{-(x-t)}.f(x(x-t))\,dt$$

$$= x^2 + e^{-x}.\int_0^x e^{t}.f(t)\,dt$$

$$\therefore e^x.f(x) = x^2.e^x + \int_0^x e^t.f(t)\,dt$$

Differentiate with respect to x, we get $f'(x) = x^2 + 2x$

$$\Rightarrow f\left(x\right)=\frac{x^3}{3}+x^2+x, also\ f\left(0\right)=0$$

$$\Rightarrow c=0$$

$$\Rightarrow f\left(x\right)=\frac{x^3}{3}+x^2$$

40. ABC

Sol. When 9 is not included $=\frac{{}^8C_3.{}^8C_3-{}^8C_3}{2}$

and required probability is $=\frac{1}{3}+=\frac{{}^8C_3.{}^8C_3-{}^8C_3}{2.{}^9C_3.{}^8C_3}=\frac{37}{56}$

41. AB

Sol. By property: $PQ\cdot P'Q=b^2$ and area of $\Delta CLG=ab$

42. ABC

Sol. $0<x<\frac{\pi}{2}\Rightarrow\frac{\sin x}{x}$ is decreasing and $\sin x<x<\tan x$

$$\Rightarrow\frac{\sin\left(\sin x\right)}{\sin x}>\frac{\sin x}{x}>\frac{\sin\left(\tan x\right)}{\tan x}$$

$$\Rightarrow I_1>I_2>I_3$$

43. A

44. B

Sol. (I) clearly, number of solutions is 2.

(II) $f\left(x\right)=\cos^{-1}\left(\frac{x^2}{1+x^2}\right)=\cos^{-1}\left(1-\frac{1}{1+x^2}\right)$

$$t=1-\frac{1}{1+x^2}\Rightarrow\ t\in\left[0,1\right)$$

$$\therefore\cos^{-1}t\in\left(0,\frac{\pi}{2}\right]=\left(a,b\right]\Rightarrow\left[a+b\right]=1$$

(III) $12\left(\tan^2\left(\tan^{-1}\alpha\right)+\tan^2\left(\tan^{-1}\beta\right)\right)=12\left(\alpha^2+\beta^2\right)$

$$=12\left(\left(\alpha+\beta\right)^2-2\alpha\beta\right)$$

$$=12\left(\frac{9}{4}-2.1\right)=3$$

(IV) $\sin\left(\cos^{-1}x\right)=\sin\left(\frac{\pi}{2}-\sin^{-1}x\right)=\cos\left(\sin^{-1}x\right)=t$

$$f\left(x\right)=\sin\left(\cos^{-1}t+\sin^{-1}t\right)=\sin\frac{\pi}{2}=1$$

$$\sum_{x=1}^{4} f\left(\frac{3x}{16}\right)=1+1+1+1=4$$

45. C

Sol. (a) $3x+y-z=0 \quad .....(1)$

$$x-\frac{py}{4}+z=0 \quad ......(2)$$

$$2x-y+2z=q \quad ....(3)$$

Eqn. (2) × (2) – eqn. (3)

$$\Rightarrow\left(1-\frac{p}{2}\right)y=4-q$$

For unique solution, $p\neq 2,\ q\in N \Rightarrow$ number of ordered pairs (p,q) in $[1, 10]$ are 90.

For infinite solution, $p=2$ and $q=4 \Rightarrow$ exactly one ordered pair

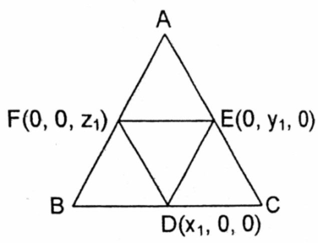
For no solution, $p=2$ and $q\neq 4 \Rightarrow$ number of ordered pairs (p,q) in $[1, 10]$ are 9

46. D

Section – B

47. 8.00

Sol. Let the intercept of plane on the axes be $(x_1,0,0),(0,y_1,0),(0,0,z_1)$



So, equation is $\frac{x}{x_1}+\frac{y}{y_1}+\frac{z}{z_1}=1$

$$\because EF \| BC \text{ and } EF=\frac{1}{2}BC=4\left(y_1^2+z_1^2\right)=a^2$$

Similarly $4\left(x_1^2+y_1^2\right)=c^2 \text{ and } 4\left(z_1^2+x_1^2\right)=b^2$

$$\Rightarrow a^2+b^2+c^2=8\left(x_1^2+y_1^2+z_1^2\right)$$

$$\Rightarrow k=8$$

48. 833.33

Sol. $\because \int_a^x e^{f(t)}dt=\int_0^x g(x-t)dt+2x+3$

$$\Rightarrow \int_a^x e^{f(t)}dt=\int_0^x g(t)dt+2x+3$$ (Using King Property)

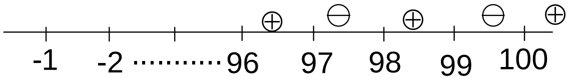
Differential both sides, we get

$$e^{f(x)}=g(x)+2$$

$$\Rightarrow g(x)=e^{f(x)}-2$$

$$\Rightarrow g'(x)=e^{f(x)}.f'(x)$$

$\because e^{f(x)}$ is always greater than zero.
$\therefore$ Sign of g'(x) is same as sign of $f'(x)$.
$\therefore$ Sign of g'(x)



Clearly, local extreme (maximum or minimum) will occur at x=99,97,95,….,3,1

$\therefore$ Sum of all the values=1+3+5+…+99=$\frac{50}{2}[2\times1+(50-1)\times2]=2500$

49. 5.00

Sol. $\lim\limits_{y\to1}\frac{100y^{100}}{y^{100}-1}-\frac{50.y^{50}}{y^{50}-1}$

$\lim\limits_{y\to1}100-50-\left(\frac{100}{1-y^{100}}-\frac{50}{1-y^{50}}\right)$

L=50-L $\therefore$ L=$\frac{50}{2}=25$

50. 20.00

Sol. $S_i=\frac{20}{2}(2+19di)$

$$\frac{2S_3S_1-(S_1+S_3)}{S_1+S_3-2S_2}=\frac{200(2+19d_1)(2+19d_3)-100(2+19d_2)(4+19(d_1+d_3))}{10(4+19(d_1+d_3)-4-38d_2)}$$

$$=10\left(\frac{8+76(d_1+d_3)+722d_1d_3-8-38(d_1+d_3+2d_2)-361d_2(d_1+d_3)}{19(d_1+d_3-2d_2)}\right)$$

$$=10\left(\frac{38(d_1+d_3-2d_2)+361(2d_1d_3-d_2\,d_1+d_3)}{19(d_1+d_3-2d_2)}\right)$$

$=20$

51. 10.00

52. 25.00

Sol. $(\sin x+\cos x)\left(\tan^2x-\left(1+\sqrt{3}\right)\tan x+3+\sqrt{3}\right)=3|\sin x+\cos x|$

Case – 1: $\sin x+\cos x\ge0$

$$(\sin x+\cos x)\left(\tan^2x-\left(1+\sqrt{3}\right)\tan x+\sqrt{3}\right)=0$$

$$\tan x=-1,\ 1,\ \sqrt{3}$$

$\Rightarrow \quad x=\frac{3\pi}{4},\frac{\pi}{4},\frac{\pi}{3},\frac{7\pi}{4}$

Case- 2 : $\sin x+\cos x\le0$

$\tan x=-1$

$$\therefore \text{Sum} = \frac{37\pi}{12}$$

53. 151.00

Sol. $S = 2 + 3\cos x + 4\cos^2 x + ...\infty$

$$\underline{S.\cos x = \qquad 2\cos x + 3\cos^2 x + ...\infty}$$

$$S(1-\cos x) = 2 + \cos x + \cos^2 x..............\infty$$

$$= 1 + \frac{1}{1-\cos x}$$

$$S = \frac{1}{1-\cos x} + \frac{1}{(1-\cos x)^2}$$

$$|5\cos x + 4| + |5\cos x - 2| = 6$$

$$\Rightarrow \cos x \in \left[-\frac{4}{5}, \frac{2}{5}\right]$$

For the least value of S, $\cos x = -4/5$

$\therefore a + b = 151$

54. 14.00

Sol. $\left(2 + x^3(3+x)^2\right)^{10}$

$$\downarrow$$

$${}^{10}C_r.2^{10-r}.x^{3r}(3+x)^{2r}$$

$$\downarrow$$

$${}^{2r}C_k.3^{2r-k}.x^k$$

$3r + k = 8 \Rightarrow k = 2,\ r = 2$

$\therefore$ Coefficient of $x^8 = {}^{10}C_2.2^8.{}^4C_2.3^2 = 5.2^9.3^5$

FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
FULL TEST – I
PAPER –2
TEST DATE: 28-12-2022

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

Section – A

1. A

2. C
Sol. No horizontal force is on block C therefore is will have vertical path from ground frame when all surface are smooth.

3. A
Sol. By conservation of energy

$$\frac{-GMm}{R}+\frac{1}{2}mv'^2=\frac{-GMm}{2R}+\frac{1}{2}mv_0{}^2 ......(i)$$

By conservation of angular momentum

$$mv_0 2R = mv'R$$

$$\Rightarrow v' = 2v_0 \qquad (ii)$$

$$\Rightarrow v_0 = \sqrt{\frac{GM}{3R}} \qquad (\text{using}\,(i)\,\&\,(ii))$$

For circular orbit

$$\frac{mv''^2}{2R}=\frac{GMm}{(2R)^2}\Rightarrow v''=\sqrt{\frac{GM}{2R}}$$

$$v''=\sqrt{\frac{3}{2}}v_0$$

4. C
Sol. $\frac{v_1}{v_2}=\frac{27}{8}$

So, $\frac{m_1}{m_2}=\frac{8}{27}$ (from conservation of momentum)

$r \propto A^{1/3}$

$\frac{r_1}{r_2} = \left(\frac{8}{27}\right)^{1/3} = \frac{2}{3}$

5. AC

Sol. $E = 10\sin\left(20t + \phi\right) \quad \omega = 20$

$20 = \frac{1}{\sqrt{0.2 \times C}} \Rightarrow C = \frac{1}{400 \times 0.2} = \frac{1}{80}$

$\cos\phi = \frac{6}{\omega} = \frac{3}{5}$

$= 12.5\,Amf$

6. BD

7. ACD

8. ACD

9. BD

10. BC

Section – B

11. 3

12. 1

13. 5

14. 5

15. 3

16. 1

17. 4

18. 2

FIITJEE

Chemistry

PART – II

Section – A

19. C

20. C

21. A
Sol. Thynine base of DNA is replaced by uracil in RNA

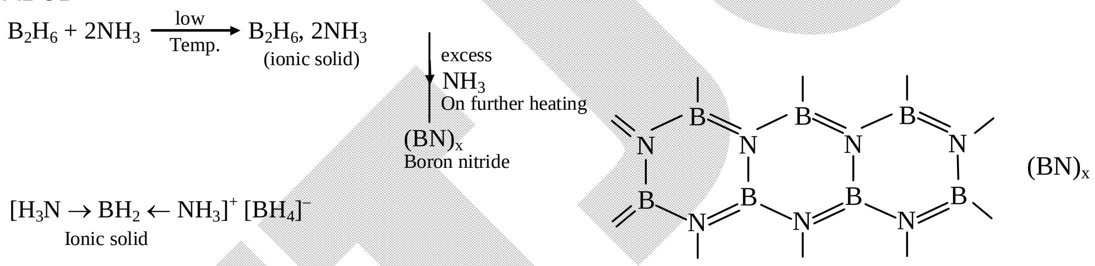
22. D

23. AC
Sol. $3N_2H_5^+ + 2Cr_2O_7^{2-} + 13H^+ \longrightarrow 3N_2 + 4Cr^{3+} + 14\,H_2O$

24. BCD

25. ABD
Sol. Sucrose with anomeric–OH groups in glycosidic linkage & thus non-Reducing

26. ABCD
Sol.


B2H6 + 2NH3 —low Temp.→ B2H6, 2NH3
(ionic solid)
excess NH3
On further heating
(BN)x
Boron nitride
[H3N → BH2 ← NH3]+ [BH4]–
Ionic solid
B
N
(BN)x

27. ABD

28. CD

Section – B

29. 5

30. 1
Sol. $K_{sp} = [Zn^{2+}][S^{2-}]$

$$[S^{2-}] = \frac{10^{-21}}{0.01} = 10^{-19}$$

$$\text{for } K_{a_1}\,.\,K_{a_2} = \frac{[H^+]^2[S^{2-}]}{[H_2S]}$$

$$10^{-20} = \frac{[H^+]^2 \times 10^{-19}}{0.1} \; □ \; [H^+] = 0.1 \text{ or pH} = 1$$

31. 3
Sol. Total current passed in 30 sec.

$$= \frac{1}{2} \times 100 \times 10 + 100 \times 10 + 100 \times 10 + \frac{1}{2}$$

$\times 100 \times 10$

$= 3 \times 100 \times 10$ mA × s

$= 3000 \times 10^{-3}$ amp s = 3 C

$W = \frac{EQ}{F}$ or $\frac{W}{Q} = \frac{E}{F} = Z = \frac{m}{3}$

32. 3

Sol. $\frac{k_t}{k_0} = \mu^{\frac{t-0}{10}}$

$\log_e k_t - \log_e k_0 = \frac{t}{10} \log(\mu)$

$\ell n\, k_t = \ell n\, k_0 + \left(\frac{\ell n(\mu)}{10}\right) t$

$\therefore \mu = 3$

33. 5

Sol. $i = \frac{\text{Theo. Mw.}}{\text{exp. Mw}}$

$= \frac{164}{65.6} = 2.5$

$a = \frac{1-i}{n-1}$

$= \frac{2.5-1}{3-1} = 0.75$

a = 75 %

34. 4

35. 9

36. 2

Sol. $pOH = pK_b + \log \frac{[NH_4^+]}{[NH_3]}$

$5.74 = 4.74 + \log \frac{[NH_4^+]}{0.1}$

or $\log \frac{[NH_4^+]}{0.1} = 1$

or $\frac{[NH_4^+]}{0.1} = 10$

or $[NH_4^+] = 1$ (M)

$\therefore$ $(NH_4^+)_2SO_4$ required = 0.5 mole

Mathematics PART – III

Section – A

37. A

Sol. $\left(\sin^{-1}\sin x - 1/2\right)^2 - 1/4$

38. D

Sol. $(x-2y-4)^2 = 12(2x+y)$

39. D

40. A

Sol. $$\frac{3f''(x)}{f'(x)} = \frac{f'''(x)}{f''(x)}$$

$$\Rightarrow 3\ln f'(x) = \ln f''(x) + k$$

$$\Rightarrow \frac{d^2x}{dy^2} = c$$

41. ABCD

Sol. $$f(x) = \begin{cases} px+\lambda, x>0 \\ q, x=0 \\ e^x, x<0 \end{cases}$$

42. AC

Sol. $f(x) = (2x-1)(2x+1)(x-2)(x-4)$

$\alpha = -\frac{1}{2}$

$\beta = \frac{1}{2}$

$\gamma = 2$

$\sigma = 4$

43. CD

Sol. If α is real root then $\alpha = 2, m = \pm 2,$ non-real root = $1+i$

44. ABC

Sol. $$2S = \sum_{m=1}^{\infty}\sum_{n=1}^{\infty}\left(\frac{m.n}{m.3^n + n.3^n}\right)\left(\frac{n}{3^m} + \frac{m}{3^n}\right)$$

45. AC

46. AC

Section – B

47. 3

48. 1

Sol. $x_1 = 4, x_2 = 8,\ k = 3,\ w = 4$

49. 7

50. 6

51. 2

52. 2

53. 4

54. 8

Sol. Let $f(x) = \dfrac{x}{70+x^2};\ f'(x) = \dfrac{70-x^2}{\left(70+x^2\right)^2}$

So $f(x)$ increase in $\left(0, \sqrt{70}\right)$ and $f(x)$ decrease in $\left(\sqrt{70}, \infty\right)$

So, greater term may be $a_8\ or\ a_9$

But $\dfrac{a_8}{a_9} > 1$

$\Rightarrow k = 8$

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ALL INDIA TEST SERIES

FULL TEST – II

JEE (Main)-2023

TEST DATE: 07-01-2023

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is Mathematics.
- Each part has only two sections: **Section-A and Section-B**.
- **Section – A** : Attempt all questions.
- **Section – B :** Do any five questions out of 10 questions.

Section-A (01 – 20, 31 – 50, 61 – 80) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-B (21 – 30, 51 – 60, 81 – 90) *contains 30 Numerical based questions. The answer to each question is rounded off to the nearest integer value. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

PART – A

SECTION – A

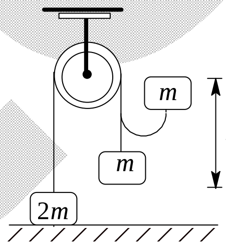
(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. In a two slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance from the plane of slits. If the screen is moved by 5×10^{-2} m towards the slits, the change in fringe width is 3×10^{-5} cm. If the distance between the slits is 10^{-3} m, calculate the wavelength of the light used.

(A) 4500 Å (B) 3000 Å
(C) 9000 Å (D) 6000 Å

2. A mass 2m rests on a horizontal table. It is attached to a light inextensible string which passes over a smooth pulley and carries a mass m at the other end. If the mass m is raised vertically through a distance h and is then dropped, then the speed with which the mass 2m begins to rise is:



(A) $\sqrt{2gh}$ (B) $\frac{\sqrt{2gh}}{3}$
(C) $\frac{\sqrt{gh}}{2}$ (D) $\sqrt{gh}$

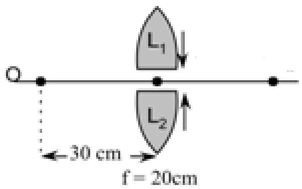
3. A particle starts moving with initial velocity from the origin of co-ordinates at time t = 0 and moves in the xy plane with a constant acceleration α in the y-direction. Its equation of motion is $y = \beta x^2$. Its velocity component in the x-direction is:

(A) α / β (B) $\sqrt{2\alpha / \beta}$
(C) $\alpha / 2\beta$ (D) $\sqrt{\alpha / 2\beta}$

4. By what percent the energy of a satellite has to be increased to shift if from an orbit of radius r to $\frac{3}{2}r$?

(A) 66.7% (B) 33.3%
(C) 15% (D) 20.3%

5. A point object O is placed at a distance of 0.3 m from a convex lens (focal length 0.2 m) cut into two halves each to which is displacement by 0.005 m thus making separation between them of 2×0.005 as shown in fig. Find the position of the image. Find the distance between the images.



(A) 0.003 m (B) 0.002 m
(C) 0.004 m (D) 0.001 m

6. The relation between U, p and V for an ideal gas in an adiabatic process is given by relation $U = a + bpV$. Find the value of adiabatic exponent (γ) of this gas:

(A) $\frac{b+1}{b}$ (B) $\frac{b+1}{a}$

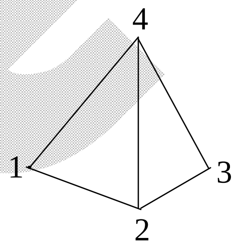
(C) $\frac{a+1}{b}$ (D) $\frac{a}{a+b}$

7. A metal disc of radius a rotates with a constant angular velocity ω about is axis. The potential difference between the centre and the rim of the disc is ($m = mass$ of electron, $e =$ charge on electron):

(A) $\frac{m\omega^2a^2}{e}$ (B) $\frac{1}{2}\frac{m\omega^2a^2}{e}$

(C) $\frac{e\omega^2a^2}{2m}$ (D) $\frac{e\omega^2a^2}{m}$

8. Six wires each of resistance r form a tetrahedron. The equivalent resistance between corners 1-2 and 1-3 are respectively:



(A) $\frac{r}{2}, \frac{r}{2}$ (B) r, r

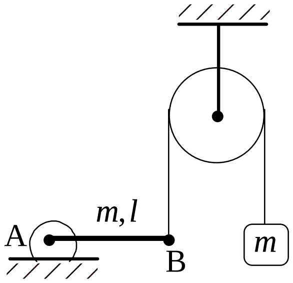
(C) $\frac{r}{2}, r$ (D) $r, \frac{r}{2}$

9. The ionization potential of Li^{++} ion is 122.4 V. Find the value of its first excitation potential.

(A) 91.8v (B) 45.9 V

(C) 122.4V (D) 28.4 V

10. Uniform rod AB is hinged at the end A in a horizontal position as shown in the figure. The other end of the rod is connected to a block through a massless string as shown. The pulley is smooth and massless. Masses of the block and the rod are same and are equal to 'm'. Acceleration due to gravity is g. The tension in the thread and angular acceleration of the rod just after release of block from this position are:



(A) $\frac{3mg}{8}, \frac{g}{8l}$ (B) $\frac{5mg}{8}, \frac{3g}{8l}$

(C) $\frac{mg}{8}, \frac{5g}{8l}$ (D) $\frac{7mg}{8}, \frac{7g}{8l}$

11. A radioactive sample has 6.0×10^{18} active nuclei at a certain instant. How many of these nuclei will still be in the same active state after two half-lives?

(A) 3×10^{18} (B) 1.5×10^{18}

(C) 0.75×10^{18} (D) 6×10^{18}

12. A particle performs SHM of amplitude A along a straight line. When it is at a distance $\sqrt{3}/2$ A from mean position, its kinetic energy gets increased by an amount $1/2m\omega^2A^2$ due to an impulsive force. Then its new amplitude becomes:

(A) $\frac{\sqrt{5}}{2}A$ (B) $\frac{\sqrt{3}}{2}A$

(C) $\sqrt{2}A$ (D) $\sqrt{5}A$

13. Find the constant b in Moseley's equation $\sqrt{\nu}$ = a (Z – b) from the following data.

Element	Z	Wavelength of K_aX-ray
Mo	42	71 pm
Co	27	178.5 pm

(A) 1.43 (B) 1.11

(C) 1 (D) 1.37

14. A 70 cm long sonometer wire is in unison with a tuning fork. If the length of the wire is decreased by 1.0 cm, it produces 4 beats per sec. with the same tuning fork. Find the frequency of the tuning fork -

(A) 276 $\sec^{-1}$ (B) 272 $\sec^{-1}$

(C) 269 $\sec^{-1}$ (D) 280 $\sec^{-1}$

15. Mr. Sanjay wants to calculate the current and power dissipated in an LCR series circuit. He connected 100W resistance to an AC source of 200 V and angular frequency 300 radian/sec. When he removed only the capacitance, the current was found to be lagging behind the voltage by 60°. While on removing the inductance he found, the current leading the voltage by 60°. Find the value of current and the power dissipated obtained by him

(A) 200 Watt (B) 100 Watt

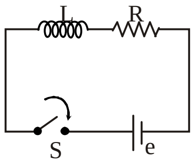
(C) 400 Watt (D) 300 Watt

16. The length of a wire between the two ends of a sonometer is 105 cm. Where the two bridges should be placed so that the fundamental frequencies of the three segments are in the ratio of 1:3:15.

(A) 75 cm, 25 cm, (B) 25 cm, 75 cm,

(C) 75 cm, 100 cm, (D) None of these

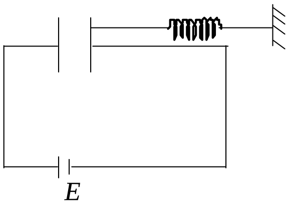
17. In an LR circuit as shown in fig. when the switch is closed how much time will it take the current to grow a value $\frac{\eta\varepsilon}{R}$ (where η < 1)



(A) (L/R) ln $\left|\frac{1}{\eta}\right|$ (B) (L/R) ln $\left|\frac{1}{1-\eta}\right|$

(C) (2L/R) ln $\left|\frac{1}{\eta}\right|$ (D) None of these

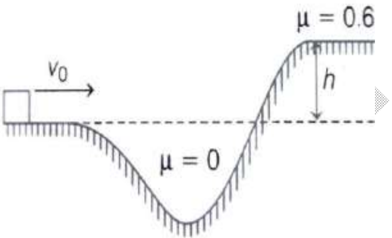
18. One plate of a capacitor is connected to a spring as shown in figure. Area of both the plates is A. In steady state, separation between the plates is $0.8d$ (spring was unstretched and the distance between the plates was d when the capacitor was uncharged). The force constant of the spring is approximately:



(A) $\frac{4\varepsilon_0 AE^2}{d^3}$ (B) $\frac{2\varepsilon_0 AE}{d^2}$

(C) $\frac{6\varepsilon_0 E^2}{Ad^3}$ (D) $\frac{\varepsilon_0 AE^3}{2d^3}$

19. In the figure, a block slides along a track from one level to a higher level, by moving through an intermediate valley. The track is frictionless until the block reaches the higher level. There a frictional force stops the block in a distance d. The block's initial speed v_0 in $6\,\text{m/s}$, the height difference h is 1.1m and the coefficient of kinetic fraction μ is 0.6. The value of d is (g = 10 m/s^2)

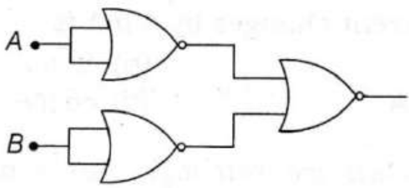


(A) 1.17m (B) 1.71m

(C) 3.41m (D) 2.81m

20. The combination of the gates shown in the figure produces:

(A) NOR gate
(B) OR gate
(C) AND gate
(D) XOR gate

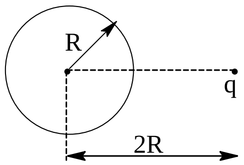


SECTION – B

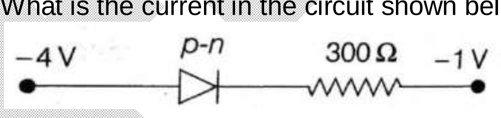
(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

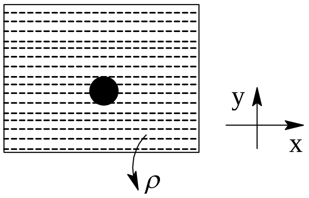
21. A point charge is placed outside a spherical shell as shown in the figure. Find the electric potential (in kilo volt) on the surface of shell (Take: $q=1\mu c$ and $R=50\text{cm}$)



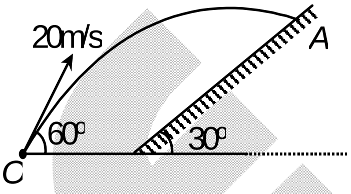
22. What is the current in the circuit shown below?



23. The pressure and volume of an ideal gas are related as $P=\frac{a}{1+\left(\frac{V}{b}\right)^3}$, where 'a' and 'b' are constants. The translational kinetic energy due to the thermal motion of the gas sample at volume $V=b$, (given that $ab=12\,\text{kJ}$) is $n\,\text{kJ}$. Find n.



24. A small spherical ball of density same as that of liquid is released from rest in a vessel filled completely with a liquid and accelerating with acceleration $5\hat{i}+5\hat{j}\,m/s$ as shown in the figure. Find the initial acceleration of ball just after the release with respect to vessel.



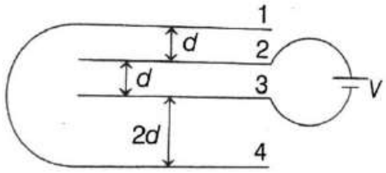
25. A ball is projected from the point *O* with velocity 20 m/s at an angle of $60°$ with horizontal as shown in figure. At highest point of its trajectory it strikes a smooth plane of inclination $30°$ at point *A*. The collision is perfectly inelastic. The maximum height from the ground attained by the ball is $\frac{75}{k}\text{meter}$. Find the value of k? (*g* = 10 m/s^2)

26. The potential energy of a particle is determined by the expression $U=\alpha\left(x^2+y^2\right)$, where α is a positive constant. The particle begins to move from a point with the co-ordinates $(3, 3)$ only under the action of potential fields force. When it reaches the point $(1, 1)$ its kinetic energy is $4K\alpha$. Find the value of K.

27. An ambulance blowing a siren of frequency 700Hz is travelling slowly towards vertical reflecting wall with a speed of 2 m/s. The speed of sound is 350 m/s. How many beast are heard per sec to the driver of the ambulance?

28. In *YDSE*, when a glass plate of refractive index 1.5 of thickness *t* is placed in the path of one of the interfering beams of wavelength λ, intensity at the position where central maximum occurred previously remain unchanged. If the minimum thickness of the glass plate is $k\lambda$. Find the value of k….

29. If the ionization potential of hydrogen atom is 13.6eV, the energy required to remove from the third orbit of hydrogen atom is $k/2\text{eV}$. Find the value of k…..



30. Four identical metal plates are arranged as shown. Plates 1 and 4 are connected by a connecting wire. A battery of emf V volts is connected between plates 2 and 3. The electric field between plates 3 and 4 is $\frac{2V}{Kd}$. Find the value of K ______.

Chemistry

PART – B

SECTION – A

(Single Choice Answer Type)

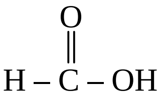
This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

31. Which of the following molecule has highest bond angle?
(A) NH_3 (B) H_2O
(C) Cl_2O (D) CH_4

32. Identify the least stable ion amongst the following
(A) Li^- (B) Be^-
(C) B^- (D) C^-

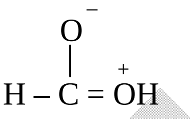
33. When sulphur is dissolved in oleum, a deep blue solution containing polyatomic sulphur cation is obtained. The formula of the cation present is
(A) S_4^{2+} (B) S_8^{2+}
(C) S_{19}^{2+} (D) S_{16}^{+2}

34.



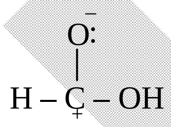
$H-\overset{\overset{O}{\|}}{C}-OH$

I



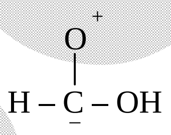
$H-\overset{\overset{O^-}{|}}{C}=\overset{+}{O}H$

II



$H-\underset{+}{\overset{\overset{\bar{O}:}{|}}{C}}-OH$

III

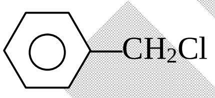


$H-\underset{-}{\overset{\overset{O^+}{|}}{C}}-OH$

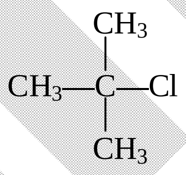
IV

Increasing order of stability is
(A) I < III < II < IV (B) IV < III < II < I
(C) III < IV < II < I (D) II < IV < III < I

35. There is formation of precipitate almost instantly when alcoholic $AgNO_3$ reacts with

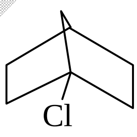


(I)



$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-Cl$

(II)



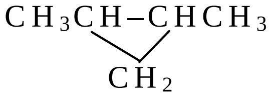
(III)

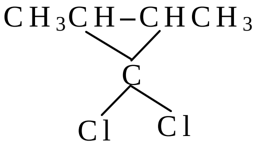
(A) I, II and III (B) I and II
(C) II and III (D) I and III

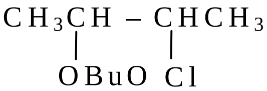
36. In the detection of nitrogen, blue/green colour is due to formation of Prussian blue. It is:
(A) $Fe_4^{III}\left[Fe^{II}(CN)_6\right]$ (B) $NaFe^{II}\left[Fe^{III}(CN)_6\right]$
(C) $Na_4\left[Fe(CN)_6\right]$ (D) $Na_3\left[Fe(CN)_6\right]$

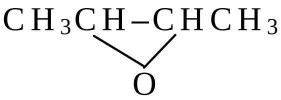
37. An alkane with the formula C_6H_{14} can be prepared by the hydrogenation of only two alkenes (C_6H_{12}). IUPAC name of the alkane is:
(A) 2, 2-dimethylbutane (B) 2, 3-dimethylbutane
(C) 2-methyl-pentane (D) *n*-hexane

38. $CH_3CH{=}CHCH_3 + CHCl_3 + t-BuOK \rightarrow A$. A is:

(A) 

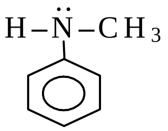
(B) 

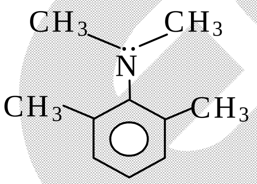
(C) 
$\underset{\text{OBuO}}{CH_3CH} - \underset{\text{Cl}}{CHCH_3}$

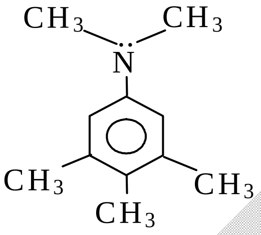
(D) 

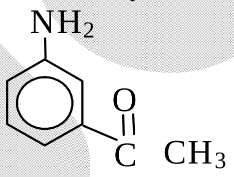
39. Glucose is added to 1 litre water to such an extent that $\Delta T_f / K_f$ becomes equal to 1/1000, the wt. of glucose added is
(A) 180 g
(B) 18 g
(C) 1.8 g
(D) 0.18 g

40. Which of the following is most basic?

(A) 

(B) 

(C) 

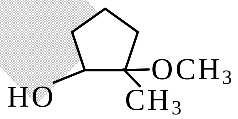
(D) 

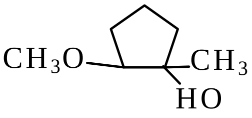
41. Cellulose on hydrolysis with dil. H_2SO_4 gives -
(A) $\alpha - \text{D} - \text{glucose}$
(B) $\beta - \text{D} - \text{glucose}$
(C) $\text{D} - \text{fructose}$
(D) none of these

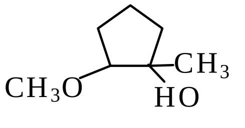
42. Which of the following is the example of condensation polymer
(A) Polystyrene
(B) Terylene
(C) Polyethene
(D) Polypropene

43. Tin reacts with-
(A) Hot conc. HCl
(B) Conc. HNO_3
(C) $HgCl_2$ on heating
(D) All of these

44. If the starting material is 1-methyl-1, 2-epoxy-cyclopentane, of absolute configuration, decide which one compound correctly represent the product of its reaction with sodium methoxide in methanol.

(A) 

(B) 

(C) 

(D) all of these

45. Pick out the incorrect statement for XeF_6–
(A) XeF_6 is hydrolysed partially to form $XeOF_4$
(B) It reacts with SiO_2 to from XeF_4
(C) On complete hydrolysis, it forms XeO_3
(D) It acts as F^- acceptor when treated with alkali metal fluoride, but cannot act as F^- donor to form complexes.

46. An inorganic compound gives a white ppt. with a solution of $AgNO_3$, a white ppt. with dil. H_2SO_4 and impart green colour to flame. The probable compound is
(A) $CuCl_2$ (B) $BaCl_2$
(C) $Cu(NO_3)_2$ (D) $PbCl_2$

47. When $CH_2 = CH–COOH$ is reduced with $LiAlH_4$, the compound obtained will be
(A) $CH_3–CH_2–COOH$ (B) $CH_2 = CH–CH_2OH$
(C) $CH_3–CH_2–CH_2OH$ (D) $CH_3–CH_2–CHO$

48. In the electronic configuration of nitrogen has $1s^7$, it would have energy lower than that of the normal ground state configuration $1s^22s^22p^3$ because the electrons would be closer to the nucleus. Yet $1s^7$ is not observed because it violates
(A) Heisenberg uncertainty principle (B) Hund's rule
(C) Pauli's exclusion principle (D) Bohr postulates of stationary orbits

49. A mixture of calcium ethanoate and calcium methanoate is heated strongly. The expected product is
(A) acetaldehyde (B) Ethyl methyl ketone
(C) diethyl ketone (D) Propyl ketone

50. Among the following complexes which one will show co-ordination isomerism?
(A) $[Cr(NH_3)_6]\,[CoCl_6]$ (B) $[Cr(NH_3)_6]Cl_2$
(C) $[Co(en)_2Cl_2]Cl$ (D) $[Cr(en)_2Cl_2]^+$

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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51. A large irregularly–shaped closed tank is first evacuated and then connected to a 55 litre cylinder containing compressed nitrogen gas. The gas pressure in the cylinder, originally at 21.4 atm, falls to 1.5 atm after it is connected to the evacuated tank. Volume of the tank in litres is $x\times10$, then the value of $'x'$ is_____.

52. Number of neutrons in 18 mL of water (density of water = 1 gm/mL) is $x\times10^{23}$. The value of $'x'$ is _____. (where, $N_A = 6\times10^{23}$)

53. A solution containing H^+ and D^+ ions is in equilibrium with a mixture of H_2 and D_2 gases at 25ºC. If partial pressure of both the gases are 1.0 atm, then $\log\frac{[D^+]}{[H^+]}$ is $x\times10^{-2}$. The value of $'x'$ is (approximate value to nearest integer) _____. [$E^o(D^+/D_2) = –0.003V$]

54. The solubility product of AgI at 25ºC is 1.0 × 10^{-16} mol^2 L^{-2}. The solubility of AgI in 10^{-x} N solution of KI at 25ºC is approximately (in mol L^{-1}) is 1×10^{-12} mol/L. Find the value of 'x'.

55. 0.7 g of Na_2CO_3. x H_2O is dissolved in 100 ml, 20 ml of which required 19.8 ml of 0.1 N HCl. The value of x is ____.

56. *k* for a zero order reaction is 2 × 10^{-2} mol 1^{-1}s^{-1}. If the concentration of the reactant after 25 s is 0.5 M, the initial concentration must have been

57. The temperature of 5 ml of a strong acid increases by 5K when 5 ml of a strong base is added to it. If 10 ml of each is mixed, temperature should increase by ....K

58. The coagulation of 10 cm^3 of gold sol is completely prevented by addition of 0.025g of starch to it. The gold number of starch is_____ (when 1ml 10% NaCl solution is added in the gold solution)

59. One mole of N_2O_4(g) at 300K is kept in a closed container under one atmosphere. It is heated to 600K the resultant pressure is 2.4 atm at equilibrium. Find out % decomposition of N_2O_5 (g)

60. In cubic ZnS lattice, if the radii of Zn^{2+} and S^{2-} ions are 0.83 Å and 1.74 Å, the lattice parameter (edge length, a) of cubic ZnS is (in nearest integer)

FIITJEE

Mathematics

PART – C

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

61. A function $f : R \to R$ is defined as $f\left(x\right) = 3x^2 + 1$. Then $f^{-1}\left(x\right)$ is

(A) $\frac{\sqrt{x-1}}{3}$ (B) $\frac{1}{3}\sqrt{x-1}$

(C) f^{-1} does not exist (D) $\sqrt{\frac{x-1}{3}}$

62. $\lim\limits_{x \to \frac{\pi}{3}} \frac{\sin\left(\frac{\pi}{3} - x\right)}{2\cos x - 1}$ is equal to:

(A) $\frac{2}{\sqrt{3}}$ (B) $\frac{1}{\sqrt{3}}$

(C) $\sqrt{3}$ (D) $\frac{1}{2}$

63. Let $f\left(x\right) = \int e^x\left(x-1\right)\left(x-2\right)dx$. Then $f\left(x\right)$ decreases in the interval?

(A) $\left(2, \infty\right)$ (B) $\left(-2, -1\right)$

(C) $\left(1, 2\right)$ (D) $\left(-\infty, 1\right) \cup \left(2, \infty\right)$

64. If $I = \int \frac{x^2 - 1}{x^3\sqrt{2x^4 - 2x^2 + 1}}$ is equal to:

(A) $\frac{\sqrt{2x^4 - 2x^2 + 1}}{x^2} + \text{C}$ (B) $\frac{\sqrt{2x^4 - 2x^2 + 1}}{x} + \text{C}$

(C) $\frac{\sqrt{2x^4 - 2x^2 + 1}}{2x^2} + \text{C}$ (D) None of these

65. The area enclosed between the curves $y = ax^2 \; and \; x = ay^2 \left(a > 0\right)$ is $1 \, sq.unit$, then the value of a is:

(A) $\frac{1}{\sqrt{3}}$ (B) $\frac{1}{2}$

(C) 1 (D) $\frac{1}{3}$

66. The solution of the differential equation $\frac{dy}{dx} = \left(4x + y + 1\right)^2$ is:

(A) $4x + y + 1 = 2\tan\left(2x + y + C\right)$
(B) $4x + y + 1 = 2\tan\left(x + 2y + C\right)$
(C) $4x + y + 1 = 2\tan\left(2y + C\right)$
(D) $4x + y + 1 = 2\tan\left(2x + C\right)$

67. For $x \in R$, the expression $\frac{x^2 + 2x + c}{x^2 + 4x + 3c}$ can take all real values if $c \in$:

(A) $\left(1, 2\right)$
(B) $\left[-1, 1\right]$
(C) $\left(0, 1\right)$
(D) $\left(-1, 0\right)$

68. The third term of a G.P. is 2. Then the product of the first five terms is:

(A) 2^3
(B) 2^4
(C) 2^5
(D) None of these

69. If the system of linear equations

$x + 2ay + az = 0$

$x + 3by + bz = 0$

$x + 4cy + cz = 0$

Has a non-zero solution, then $a,\ b,\ c$:

(A) are in A.P.
(B) are in G.P.
(C) are in H.P.
(D) satisfy $a + 2b + 3c = 0$

70. The number of points of intersection of the curves represented by

$$\arg\left(z - 2 - 7i\right) = \cot^{-1}\left(2\right) \text{and} \arg\left(\frac{z - 5i}{z + 2 - i}\right) = \pm\frac{\pi}{2}$$

(A) 0
(B) 1
(C) 2
(D) None of these

71. If all the roots of $z^3 + az^2 + bz + c = 0$ are of unit modulus, then:

(A) $\left|a\right| \le 3$
(B) $\left|b\right| \le 3$
(C) $\left|c\right| = 1$
(D) All of these

72. If M be a square matrix of order 3 such that $\left|\mathrm{M}\right| = 2,$ then $\left|\mathrm{adj}\left(\frac{\mathrm{M}}{2}\right)\right|$ equals to:

(A) $\frac{1}{2}$
(B) $\frac{1}{4}$
(C) $\frac{1}{8}$
(D) $\frac{1}{16}$

73. How many ways are there to arrange the letters of the word ''GARDEN'' with the vowels in alphabetical order?

(A) 120
(B) 480
(C) 360
(D) 240

74. If $\left(1+x+x^2\right)^n = \sum_{r=0}^{2n} a_r x^r$, then $a_r - {}^nC_1 \cdot a_{r-1} + {}^nC_2 \cdot a_{r-2} - {}^nC_3 \cdot a_{r-3} + ... + (-1)^r\ {}^nC_r \cdot a_o$ is equal to: (r is not multiple of 3)

(A) 0
(B) ${}^nC_r$
(C) a_r
(D) 1

75. If $(1+x)^{2010} = C_0 + C_1x + C_2x^2 + ... + C_{2010}x^{2010}$ than the sum of series $C_2 + C_5 + C_8 + ... + C_{2009}$ equal to:

(A) $\frac{1}{2}\left(2^{2010}-1\right)$
(B) $\frac{1}{3}\left(2^{2010}-1\right)$
(C) $\frac{1}{2}\left(2^{2009}-1\right)$
(D) $\frac{1}{3}\left(2^{2009}-1\right)$

76. The boy comes from a family of two children. What is the probability that the other child is his sister?

(A) $\frac{1}{2}$
(B) $\frac{1}{3}$
(C) $\frac{2}{3}$
(D) $\frac{1}{4}$

77. If A be any event in sample space then the maximum value of $3\sqrt{P(A)} + 4\sqrt{P(A)}$ is:

(A) 4
(B) 2
(C) 5
(D) Cannot be determined

78. Least positive integral value of $'a'$ for which $\log_{\left(x+\frac{1}{x}\right)}\left(a^2-3a+3\right) > 0; (x>0)$:

(A) 1
(B) 2
(C) 3
(D) 4

79. The minimum value of $x^2+y^2+z^2$ if $ax+by+cz=p,$ is:

(A) $\left(\frac{p}{a+b+c}\right)^2$
(B) $\frac{p^2}{a^2+b^2+c^2}$
(C) $\frac{a^2+b^2+c^2}{p^2}$
(D) 0

80. The scalar triple product $\left[\vec{a}+\vec{b}-\vec{c}\ \ \vec{b}+\vec{c}-\vec{a}\ \ \vec{c}+\vec{a}-\vec{b}\right]$ is equal to:

(A) 0
(B) $\left[\vec{a}\,\vec{b}\,\vec{c}\right]$
(C) $2\left[\vec{a}\,\vec{b}\,\vec{c}\right]$
(D) $4\left[\vec{a}\,\vec{b}\,\vec{c}\right]$

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

81. Find the number of integers in the domain of $f\left(x\right)=\dfrac{1}{\sqrt{\ln\cos^{-1}x}}$.

82. If $x=\cos\theta$ and $y=\sin^3\theta,$ then $\left|\dfrac{yd^2y}{dx^2}+\left(\dfrac{dy}{dx}\right)^2\right|$ at $\theta=\dfrac{\pi}{2}$ is:

83. For a positive integer n, let $\mathrm{I}_{\mathrm{n}}=\int\limits_{-\pi}^{\pi}\left(\dfrac{\pi}{2}-|x|\right)\cos nx\,dx$. Find the value of $\left[\mathrm{I}_1+\mathrm{I}_2+\mathrm{I}_3+\mathrm{I}_4\right]$ where $[.]$ denotes greatest integer function.

84. Find the number of positive integral values of k for which $kx^2+\left(k-3\right)x+1<0$ for atleast one positive x.

85. The value of $\sum\limits_{r=1}^{\infty}\dfrac{8r}{4r^4+1}$ is equal to:

86. The sum of all digits of n for which $\sum\limits_{r=1}^{n}r\,2^r=2+2^{n+10}$ is:

87. For a unique value of $\mu\,\&\,\lambda,$ the system of equations given by

$x+y+z=6$

$x+2y+3z=14$

$2x+5y+\lambda z=\mu$

Has infinitely many solutions, then $\dfrac{\mu-\lambda}{4}$ is equal to:

88. A and B are two square matrices. Such that $A^2B=BA$ and if $\left(AB\right)^{10}=A^k\,.B^{10}$. Find the value of $k-1020$.

89. The remainder when $\left(\sum\limits_{k=1}^{5}{}^{20}C_{2k-1}\right)^6$ is divided by 11, is:

90. If $\log_{16}\left(\log_{\sqrt[4]{3}}\left(\log_{\sqrt[3]{5}}\left(x\right)\right)\right)=\dfrac{1}{2}$; find x.

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – II

JEE (Main)-2023

TEST DATE: 07-01-2023

ANSWERS, HINTS & SOLUTIONS

Physics

PART – A

SECTION – A

1. D

Sol. The fringe–width β is given by

$$\beta = \frac{\lambda D}{2d} \text{ and } \beta' = \frac{\lambda D'}{2d}$$

Where λ is the wavelength of light used, D is the distance of the screen from the two slits and 2 d is the separation between two slits.

Now $$\beta - \beta' = \frac{\lambda(D - D')}{2d}$$

$$\Rightarrow \quad \lambda = \frac{(\beta - \beta')2d}{D - D'}$$

$$\lambda = \frac{(3\times10^{-5})(10^{-3})}{5\times10^{-2}}$$

$$= 0.6 \times 10^{-6} \text{ m} = 6000 \text{ Å}$$

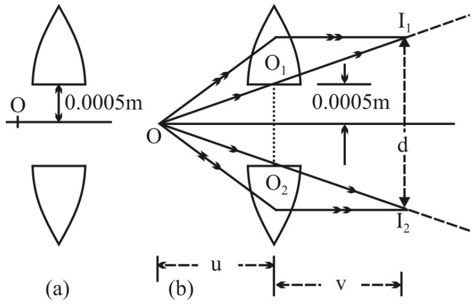
2. B

3. D

4. B

5. A

Sol. The image formation is shown in fig.



The rays through optical centres O_1 and O_2 pass undeflected. The image of O are formed at I_1 and I_2 due to upper and lower lenses respectively.

The number of images formed = two

For a convex lens, $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

Here u = – 0.3 m and f = 0.2 m

$\therefore \quad \frac{1}{v} = \frac{1}{u} + \frac{1}{f} = -\frac{1}{0.3} + \frac{1}{0.2} = \frac{1}{0.6}$

u = **0.6 m**

Let d be the distance between the two images I_1 and I_2. From ΔOO_1O_2 and ΔII_1I_2, we have

$$\frac{d}{O_1O_2} = \frac{u+v}{u}$$

or $\frac{d}{0.0005+0.0005} = \frac{0.3+0.6}{0.3}$

Solving we get d = 0.003 m

6. A

7. B

8. A

9. A

Sol. According to given data, ionization energy of Li^{++} ion is 122.4 eV

$\therefore$ Excitation energy of this ion

$= 122.4\left[\frac{1}{1^2} - \frac{1}{2^2}\right]$

$= 122.4\left[1 - \frac{1}{4}\right]$

$= 122.4 \times \frac{3}{4}$ eV

$\therefore$ $E_{ex} = 91.8$ eV

Hence, the value of the first excitation potential
= 91.8 V

10. B

11. B

Sol. In one half-life the number of active nuclei reduces to half the original number. Thus, in two half-lives the number is reduced to $\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)$ of the original number. The number of remaining active nuclei is, therefore, $6.0 \times 10^{18} \times \left(\frac{1}{2}\right) \times \left(\frac{1}{2}\right) = 1.5 \times 10^{18}$

12. C

13. D

Sol. Moseley's equation is

$$\sqrt{\nu} = a(Z - b).$$

Thus $\sqrt{\frac{c}{\lambda_1}} = a(Z_1 - b)$ ...(i)

and $\sqrt{\frac{c}{\lambda_2}} = a(Z_2 - b)$ ...(ii)

Using equations (i) and (ii), we get

$$\sqrt{c}\left(\frac{1}{\sqrt{\lambda_1}} - \frac{1}{\sqrt{\lambda_2}}\right) = a(Z_1 - Z_2)$$

$$\Rightarrow a = \frac{\sqrt{c}}{(Z_1 - Z_2)}\left(\frac{1}{\sqrt{\lambda_1}} - \frac{1}{\sqrt{\lambda_2}}\right)$$

Putting given values

$a = 5.06 \times 10^7$ Hz

Dividing equation (i) by (ii), we get

$$\sqrt{\frac{\lambda_2}{\lambda_1}} = \frac{Z_1 - b}{Z_2 - b}$$

$$\Rightarrow \sqrt{\frac{178.5}{71}} = \frac{42 - b}{27 - b}$$

$\Rightarrow$ b = 1.37

14. A

Sol. Let the frequency of the fork be n. In the first case, the length of the wire is 70 cm (0.70 m). Therefore,

$$n = \frac{1}{2 \times 0.70}\sqrt{\frac{T}{m}} \quad ...(1)$$

On decreasing the length of the wire, its frequency will increase. Hence in the second case when the length is 69 cm = 0.69 m, then

$$n + 4 = \frac{1}{2 \times 0.69}\sqrt{\frac{T}{m}} \quad ...(2)$$

dividing equation (1) by (2), we get

$$\Rightarrow \frac{n}{n+4} = \frac{0.69}{0.70}$$

$\Rightarrow n \times 0.70 = (n + 4) \times 0.69$

$$\Rightarrow n = \frac{4 \times 0.69}{0.01} = 276 \text{ sec}^{-1}$$

15. A

Sol. tan 60º = $\frac{\omega L}{R}$, tan 60º = $\frac{1/\omega C}{R}$.

$\therefore \omega L = \frac{1}{\omega C}$.

$\therefore$ impedance of the circuit,

$$Z = \left[R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2\right]^{\frac{1}{2}} = R.$$

Current in the circuit,

$$i_0 = \frac{V_0}{Z} = \frac{V_0}{R} = \frac{200}{100} = 2 \text{ ampere.}$$

Average power, $\overline{P} = \frac{1}{2} V_0\, i_0 \cos\phi$.

But tan $\phi = \frac{\omega L - 1/\omega C}{R} = 0$, $\quad \therefore \cos\phi = 1$.

$$\therefore \overline{P} = \frac{1}{2} \times 200 \times 2 \times 1 = 200$$

16. C

Sol. From the law of length of stretched string, we have $n_1\ell_1 = n_2\ell_2 = n_3\ell_3$

Here $n_1 : n_2 : n_3 = 1 : 3 : 15$

$$\therefore \frac{\ell_1}{\ell_2} = \frac{n_1}{n_2} = \frac{3}{1} \text{ and } \frac{\ell_1}{\ell_3} = \frac{n_3}{n_1} = 15/1$$

$$\ell_2 = \frac{\ell_1}{3} \text{ and } \ell_3 = \frac{\ell_1}{15}$$

The total length of the wire is 105 cm.

Therefore $\ell_1 + \ell_2 + \ell_3 = 105$

or $\ell_1 + \frac{\ell_1}{3} + \frac{\ell_1}{15} = 105$ or $\frac{21\ell_1}{15} = 105$

$$\ell_1 = \frac{105 \times 15}{21} = 75 \text{ cm.}$$

$$\therefore \ell_2 = \frac{\ell_1}{3} = \frac{75}{3} = 25 \text{ cm}$$

$$\ell_3 = \frac{\ell_1}{15} = \frac{75}{15} = 5 \text{ cm}$$

Hence the bridge should be placed at 75 cm and (75 + 25) = 100 cm from one end.

17. B

Sol. We know that

$$i = \frac{\varepsilon}{R}\left(1 - e^{t/\tau}\right)$$

$$i = \eta \frac{\varepsilon}{R} \text{ (given)}$$

$$n\frac{\varepsilon}{R} = \frac{\varepsilon}{R}\left(1 - e^{-t/\tau}\right)$$

or $e^{-t/\tau} = 1 - \eta$

or $t = \tau \ \ln \left|\frac{1}{1-\eta}\right|$

18. A

19. A

20. C

SECTION – B

21. 9
Sol. Field inside the shell is zero, so potential is uniform

$$V=\frac{kq}{2R}=9\,\text{kilo volts}$$

22. 0

23. 9

24. 0

25. 4

26. 4

27. 8

28. 2
Sol. $t(\mu-1)=\lambda \quad \Rightarrow \quad t(1.5-1)=\lambda \quad \Rightarrow t = 2\lambda$

29. 3
Sol. Energy required removing the electron from the third orbit

$$=\frac{13.6}{3^2}\,\text{eV}=1.5\ \text{eV} = 1.5 \times 1.6 \times 10^{-19}\text{J} = 3\ \text{eV}$$

30. 6

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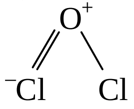
Chemistry PART – B

SECTION – A

31. C

Sol. Due to back bonding between lone pair of oxygen atom and vacant d-orbital of Cl atom, hybridization of oxygen atom changes from sp^3 to sp^2, so the bond angle increases.



32. B

Sol. Be atom has it's configuration $1s^2.2s^2$ so, B^- has it's configuration $1s^2$, $2s^2$, $2p^1$ and therefore it will be most destabilized.

33. B

34. B

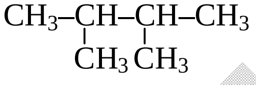
Sol. Stability order is I > II > III > IV, because I is neutral, while in II all atoms with complete octet system while III is more stable than IV because in case of IV oxygen is positive with incomplete octet system.

35. B

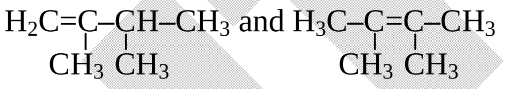
Sol. In (III) carbocation cannot be formed because of the bridge head.

36. A

37. B

Sol. 

$CH_3–\underset{CH_3}{CH}–\underset{CH_3}{CH}–CH_3$ It can be prepared by the hydrogenation of only two alkenes.

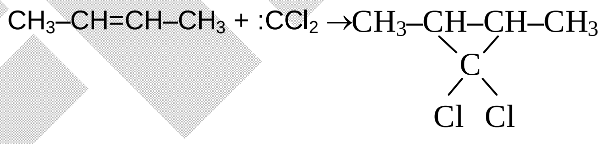


$H_2C=\underset{CH_3}{C}–\underset{CH_3}{CH}–CH_3$ and $H_3C–\underset{CH_3}{C}=\underset{CH_3}{C}–CH_3$

38. B

Sol. $CHCl_3 + t–BuO^-k^+ \rightarrow t–BuOH + CCl_3^-$

$CCl_3^- \rightarrow :CCl_2 + Cl^-$



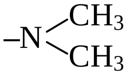
39. D

Sol. $\Delta T_f = k_f \times \text{Molality}$

$$\therefore \quad \frac{\Delta T_f}{k_f} = \text{molality} = \frac{\text{number of moles of glucose}}{\text{mass of water (in kg)}} = \frac{1}{1000} = \frac{\text{weight of glucose (in g)}}{180 \times 1}$$

$\therefore$ weight of glucose (in g) = 0.18 g

40. B

Sol. Steric hinderence of two $–CH_3$ groups makes  $–N(CH_3)_2$ group out of plane of benzene ring. So, lone pair on nitrogen atom is not involved in resonance, therefore, this amine is most basic.

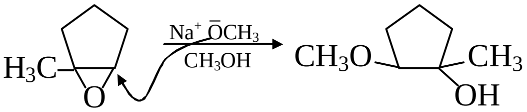
41. B

42. B

43. D

44. B

Sol.



45. D

46. B

47. B

48. C

49. A

Sol. $(CH_3–COO)_2Ca + (H–COO)_2Ca \xrightarrow{\Delta} 2CH_3–CHO + 2CaCO_3$

50. A

SECTION – B

51. 73

Sol. Let the volume of the tank be *V* litres.

As the number of moles of N_2 before and after connecting it to the tank will be same,

$$\frac{21.4\times 55}{RT} = \frac{1.5\times(55+V)}{RT} \qquad \left[n = \frac{PV}{RT}\right]$$

(moles of N_2 before connection) (moles of N_2 after connection)

∴ V = 726 litres.

52. 48

Sol. 18mL water ≡ 18g water = 1 mole water

= N_A water molecules

∵ One water molecule contains 8 neutrons

∴ total number of neutrons in the given sample = $8N_A$.

53. 5

Sol. At equilibrium, $E_{cell} = 0$, Cell reaction is $\frac{1}{2}D_2(g) + H^+ \rightarrow D^+ + \frac{1}{2}H_2(g)$

∴ $E^o_{cell} = 0.0591 \log \frac{[D^+]}{[H^+]} = 0.003$

$$\therefore \qquad \log\frac{[D^+]}{[H^+]} = \frac{E^o_{cell}}{0.0591} = \frac{0.003}{0.0591} \cong 0.05$$

54. 4

Sol. k_{sp} of AgI = $[Ag^+]$ $[4g^+]$ × $[I^-]$

$1.0 \times 10^{-16} = [Ag^+] \times 10^{-4}$

$\therefore \quad [Ag^+] = 1.0 \times 10^{-12}$

So, solubility of AgI = $[Ag^+] = 1 \times 10^{-12}$ mol/L

55. 2

Sol. Total number of equivalents of $Na_2CO_3.xH_2O$ = $\frac{\text{weight (in g)}}{\text{Equivalent weight}} = \frac{0.7}{53+9x}$

(n factor of $Na_2CO_3.xH_2O$ = 2)

Total number of equivalents of HCl required for complete neutralization

$$= \left(\frac{0.1\times 19.8}{1000}\right)\times 5$$

so, $\frac{0.7}{53+9x} = \frac{0.1\times 19.8\times 5}{1000}$

$\Rightarrow \quad x = 2$

56. 1

Sol. For a zero order reaction,

$C_0 - C_t = Kt$

$\therefore \quad C_0 = C_t + Kt = 0.5 + 2 \times 10^{-2} \times 25 = 1.0$ M

57. 5

58. 25

59. 20

Sol. $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

at 300k, 1mole 0 mole P = 1 atm

at 600k, 1–0.2 = 0.8 moles 0.4 moles P = ?

total number of moles at 600k = 1.2 moles

$\because \quad P \propto nT$

$\therefore \quad \frac{P_1}{P_2} = \frac{n_1T_1}{n_2T_2}$ were n is number of moles and T is the temperature in 'K'.

$\therefore \quad \frac{1}{P_2} = \frac{1\times 300}{1.2\times 600}$ $\therefore$ P_2 = 2.4 atm

60. 6

Sol. In ZnS lattice, S^{2-} ions are present as FCC with Zn^{2+} ions occupying alternate tetrahedral voids.

$$\therefore \frac{\sqrt{3}\ a}{4} = \left(r_{Zn^{2+}} + r_{S^{2-}}\right)$$

a = $\frac{4}{\sqrt{3}}$ (0.83 + 1.74) = 5.94 A° $\approx$ 6

Mathematics PART – C

SECTION – A

61. C

Sol. Function is many one so inverse does not exist.

62. B

Sol. Let $x-\pi/3=t,\ x\to\pi/3\Rightarrow t\to 0$

$$\lim_{t\to 0}\frac{\sin(-t)}{2\cos(t+\pi/3)-1}$$

63. C

Sol. $f(x)$ is decreasing, so $\Rightarrow f'(x)<0$

64. C

Sol. $=\int\frac{\frac{1}{x^3}-\frac{1}{x^5}}{\sqrt{2-\frac{2}{x^2}+\frac{1}{x^4}}}dx,$ let $t=2-\frac{2}{x^2}+\frac{1}{x^4}$

65. D

66. D

67. C

Sol. $y=\frac{x^2+2x+c}{x^2+4x+3c}$, apply nature of roots

68. C

Sol. Let terms a, ar, ar^2, ar^3, ar^4 given that $ar^2=2$, product of five terms

$=a.ar.\ ar^2.\ ar^3.\ ar^4=\left(ar^2\right)^5=2^5$

69. C

70. A

71. D

72. D

73. C

74. A

75. B

Sol. Put $x=1, x=\omega\ \&\ x=\omega^2$

76. A

77. C

78. C

Sol. $x+\frac{1}{x}>2$

$$\left.\begin{array}{l} a^2-3a+3>1 \\ a^2-3a+3>0 \end{array}\right\}\cap$$

79. B

80. D

Sol. $\left[\vec{a}\,\vec{b}\,\vec{c}\right]=\vec{a}.\left(\vec{b}\times\vec{c}\right)$

SECTION – B

81. 2

Sol. $\ln\cos^{-1}x>0$

$-1\le x\le 1$

82. 3

83. 4

84. 0

Sol. $k<0,\ \& D<0$

85. 2

Sol. $$\sum_{r=1}^{\infty}\frac{2.\left\{\left(2r^2+2r+1\right)-\left(2r^2+1-2r\right)\right\}}{\left(2r^2+2r+1\right).\left(2r^2+1-2r\right)}$$

86. 9

87. 7

Sol. $\Delta=0$, also $\Delta_x=\Delta_y=\Delta_z=0$ and atleast one co-factor of $\Delta\neq 0$

88. 3

89. 4

90. 5

Sol. $\log_b a=x\Rightarrow a=b^x$

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ALL INDIA TEST SERIES

FULL TEST – III

JEE (Main)-2023

TEST DATE: 11-01-2023

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is Mathematics.
- Each part has only two sections: **Section-A and Section-B**.
- **Section – A** : Attempt all questions.
- **Section – B :** Do any five questions out of 10 questions.

Section-A (01 – 20, 31 – 50, 61 – 80) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-B (21 – 30, 51 – 60, 81 – 90) *contains 30 Numerical based questions. The answer to each question is rounded off to the nearest integer value. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

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Physics

PART – A

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

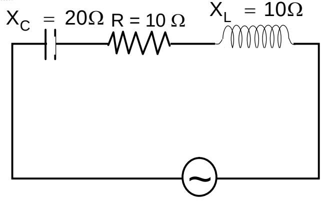
1. A uniform solid brass sphere is rotating with angular speed ω_0 about a diameter. If its temperature is now increased by 100^0C. What will be its new angular speed (Given $\alpha_{brass} = 2.0 \times 10^{-5} \text{per}^0\text{C}$)

(A) 1.1 ω_0 (B) 1.01 ω_0

(C) 0.996 ω_0 (D) 0.824 ω_0

2. When a positively charged conductor is connected to earth,
(A) electrons flow from the earth to the conductor
(B) protons flow from the conductor to the earth
(C) electrons flow from the conductor to the earth
(D) any of (A) or (C) may happen

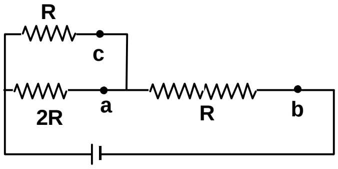
3. In LCR circuit shown in figure, then choose incorrect option
(A) Current will lead the voltage
(B) rms value of current is 20 A
(C) Power factor of the circuit is $\frac{1}{\sqrt{2}}$
(D) Voltage drop across resistance = voltage drop across inductor



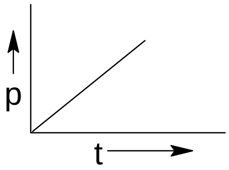
4. The mass of a body is measured as 10.1 kg. The possible percentage error in the measurement is

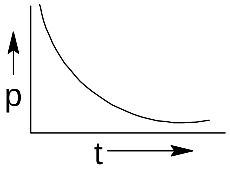
(A) ± 1% (B) ± 0.1%
(C) ± 10% (D) ± 0.01%

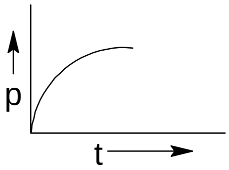
5. Referring to the shown circuit, the current will be minimum in
(A) a
(B) b
(C) c
(D) same in all the branches

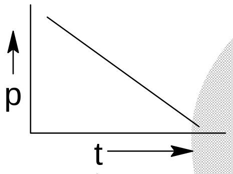


6. A soap bubble is blown slowly at the end of a tube by a pump supplying air at a constant rate. Which one of the following graphs represents the correct variation of the excess of pressure inside the bubble with time?

(A)


(B)


(C)


(D)


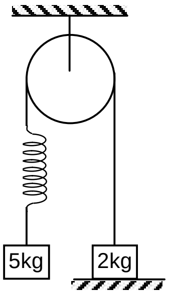
7. There is a 90^0 bend in a pipe line in which water is flowing at speed v. The cross sectional area of pipe is A. The force exerted by pipe walls on water at bend is

(A) $\sqrt{3}\,A v^2\rho$
(B) $\sqrt{2}\,Av^2\rho$
(C) $Av^2\rho$
(D) $\sqrt{5}\,Av\rho$

8. A uniform solid hemisphere of radius r is joined to uniform solid right circular cone of base of radius r. Both have same density. The centre of mass of the composite solid lies on the common face. The height (h) of the cone is

(A) 2r
(B) $\sqrt{3}\,r$
(C) 3r
(D) $r\sqrt{6}$

9. System shown in figure is released from rest pulley and spring is massless and friction is absent everywhere. The speed of 5 kg block when 2 kg block leaves the contact with ground is (K = 40 N/m & g = 10 m/s^2)

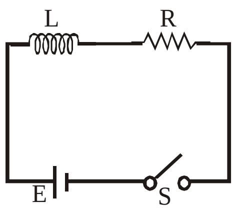


(A) $\sqrt{2}$ m/s
(B) $2\sqrt{2}$ m/s
(C) 2 m/s
(D) $4\sqrt{2}$ m/s

10. One half mole of a monoatomic ideal gas absorbs 1200 J of heat energy while performing 2196 J of work. The temperature of the gas increases by

(A) 160^0C
(B) 80^0C
(C) 40^0C
(D) -160^0C

11. In the LR circuit as shown in figure, the switch is closed at t = 0. Mark the incorrect statement of the following:



(A)The current increases with time

(B)The current increases with a decreasing rate

(C)The voltage drop across the inductor increases

(D)The voltage drop across the resistor increases

12. A charged particle of unit mass and unit charge moves with velocity of $\vec{v} = \left(8\hat{i} + 6\hat{j}\right)\text{m/s}$ in a magnetic field of $\vec{B} = 2\hat{k}T$. Choose the correct alternative

(A) The path of the particle may be $x^2 + y^2 - 4x - 21 = 0$

(B) The path of the particle may be $x^2 + y^2 - 4x - 5 = 0$

(C) The path of the particle may be $x^2 + y^2 + 2x - 8 = 0$

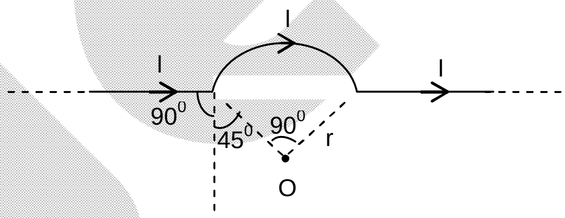
(D) The path of the particle may be $x^2 + y^2 - 2x - 15 = 0$

13. A source of sound is moving towards a stationary observer with a speed of 50 m/s. The observer measures the frequency of the source as 1000 Hz. The speed of sound is 350 m/s. The apparent frequency measured by the observer when the source is moving away after crossing the observer is

(A) 750 Hz (B) 850 Hz

(C) 1150 Hz (D) 1250 Hz

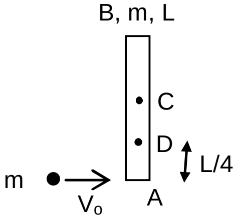
14. The magnetic field at the centre O of the arc in figure is (r is the radius of circular arc)



(A) $\frac{\mu_0 I}{4\pi \times r}\left[\sqrt{2} + \pi\right]$ (B) $\frac{\mu_0 I}{2\pi r}\left[\frac{\pi}{4} + 1\left(\sqrt{2} - 1\right)\right]$

(C) $\frac{\mu_0}{4\pi} \times \frac{I}{r}\left[\sqrt{2} + r\right]$ (D) $\frac{\mu_0}{4\pi} \times \frac{I}{r}\left[\sqrt{2} + \frac{\pi}{4}\right]$

15. A thin, uniform rod of mass M and length L is at rest on a smooth horizontal surface. A particle of same mass M collides with the rod at one end perpendicular to its length with velocity V_o and sticks to it. C is the middle point of the rod and D is a point at a distance of L/4 from end A. The time taken by the rod to turn through 90^o after collision is



(A) $\frac{L}{V_o}$ (B) $\frac{\pi L}{V_o}$

(C) $\frac{3\pi L}{5V_o}$ (D) $\frac{5\pi L}{12V_o}$

16. A string of length 1m and linear mass density 0.01 kg m^{-1} is stretched to a tension of 100 N. When both ends of the string are fixed, the three lowest frequencies for standing wave are f_1, f_2 and f_3. When only one end of the string is fixed, the three lowest frequencies for standing wave are n_1, n_2 and n_3. Then

(A) $n_3 = 5n_1 = f_3 = 125$ Hz (B) $f_3 = 5f_1 = n_2 = 125$ Hz

(C) $f_3 = n_2 = 3f_1 = 150$ Hz (D) $n_2 = \frac{f_1 + f_2}{2} = 75$ Hz

17. A simple pendulum is suspended from the ceiling of the lift. When the lift is at rest, its time period is T. With what acceleration should lift be acceleration upwards in order to reduce its time period to T/2?

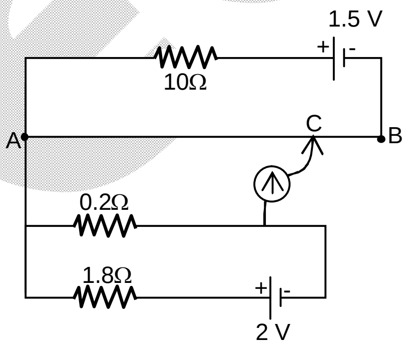
(A) 9g (B) g
(C) 2g (D) 3g

18. A tunnel is dug along diameter inside the surface of earth and a particle is projected from the centre of tunnel. The minimum velocity of particle such that it escape out from the earth's gravitation field is (Radius of earth = R_e)

(A) $\sqrt{2gR_e}$ (B) $\sqrt{\frac{3}{2}gR_e}$
(C) $\sqrt{3gR_e}$ (D) $\sqrt{\frac{5}{2}gR_e}$

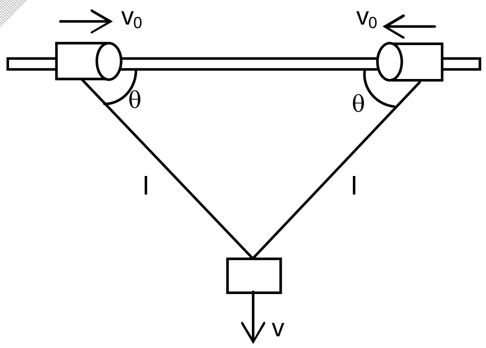
19. In the figure, AB is a uniform wire of length 100 cm whose resistance is 5 Ω. If galvanometer reads zero, then AC =

(A) 10cm (B) 20cm
(C) 40cm (D) 80cm



20. In the shown figure two identical beads slide along a smooth horizontal rod as shown in figure. The relation between v and v_0 in the shown position will be

(A) $v = v_0 \cot\theta$
(B) $v = v_0 \sin\theta$
(C) $v = v_0 \tan\theta$
(D) $v = v_0 \cos\theta$



SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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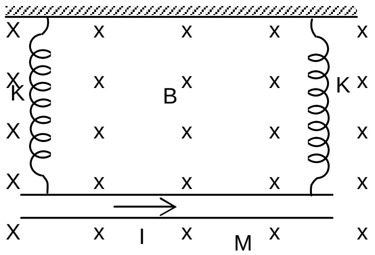
21. K_α wavelength emitted by an atom of atomic number Z = 11 is λ. Find the atomic number for an atom that emits K_α radiation with wavelength 4λ.

22. A metal rod of mass 10gm and length 25 cm is suspended on two springs as shown in figure. The springs are extended by 4 cm. When a 20 ampere current passes through the rod it rises by 1 cm. The magnetic field is x × 10^{-2} T (g = 10 m/s^2). Find the value of 10x.



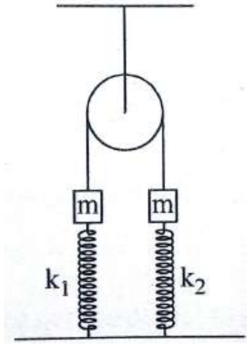
23. In a certain hypothetical radioactive decay process, species A decays into species B and species B decays into species C according to the reactions

$$A \longrightarrow 2B + \text{particles} + \text{energy}$$
$$B \longrightarrow 3C + \text{particles} + \text{energy}$$

The decay constant for species A is $\lambda_1 = 1\,\text{sec}^{-1}$ and that for species B is $\lambda_2 = 100\ \text{sec}^{-1}$. Initially 10^4 moles of species of A were present while there was none of B and C. It was found that species B reaches its maximum number at a time t_0 = 2 ln(10)sec. If maximum number of moles of B is N, then 10 N is:

24. In YDSE experiment if the screen is shifted by a distance of 0.5 m away from the slit, 3rd maxima is shifted by 3 × 10^{-4} m. The slit width is 2 × 10^{-3}m. If the wavelength (in nm) used in the experiment is 'k', find the value of 'k'.

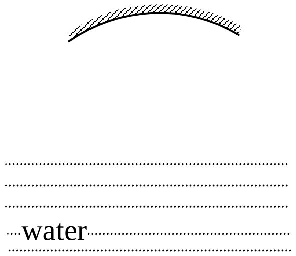
25. On the diagram, two blocks of equal mass are connected by an ideal string. The values of m = 1 kg and k_2 = 100 N/m are given. Initially, both springs are relaxed. Then the left block is slowly pulled down a distance 0.1 m and released. The maximum possible value of k_1 (in N/m) for which both blocks will have same magnitude of acceleration just after releasing, is k. Both spring have natural length of 2m. Then find the value of k..



26. In YDSE distance between the slits plane and screen is 1m and distance between two slits is 5 mm. If slabs of thickness 2mm and 1.5mm having refractive index 1.5 and 1.4 are placed in front of two slits, find the shift (in mm) of central maxima

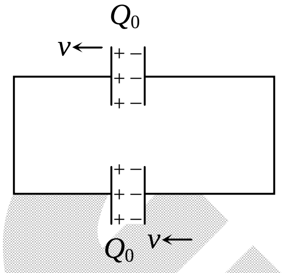
27. Suppose potential energy between electron and proton at separation r is given by U = k ln r, where k is constant. For such hypothetical hydrogen atom, find the ratio of energy difference between energy levels (n = 1 and n = 2) and (n = 2 and n = 4) is

28. A concave mirror of focal length 15 cm is placed in air at a height of 45 cm above the water surface as shown. The axis of the mirror is vertical and the reflecting surface faces the water surface. A point object is placed on the axis of concave mirror at a distance 35 cm above the water surface. Find the position of image formed after two successive processes- first reflection from the concave mirror and then first refraction from the water (reflective Index of water 4/3). The distance of image from water surface (in cm) is



29. A point mass of 1 kg collides elastically with a stationary point mass of 5 kg. After their ~~collision, the 1~~ kg mass reverses its direction and moves with a speed of 2 ms^{-1}. Find the kinetic energy (in mJ) of a particle of mass 6 kg moving with same velocity as that of centre of mass of the above two particles of mass 1 kg and 5 kg.

30. Two identical capacitor connected as shown and having initial charge Q_0. Separation between plates of capacitor is d_0. Suddenly the left plate of upper capacitor and right plate of lower capacitor start moving with speed v towards left while other plate of capacitor remains fixed. (given $\frac{Q_0 v}{2d}=1$ amp). Find the value of current (in amp) in the circuit.



FIITJEE

Chemistry

PART – B

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

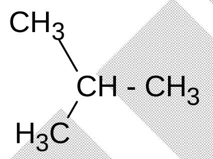
31. Molar heat capacity of an ideal gas at constant volume is given by $C_v = 2 \times 10^{-2}$ J (in Joule). If 3.5 mole of this ideal gas are heated at constant volume from 300 K to 400 K the change in internal energy will be
(A) 7 (B) 4
(C) 8 (D) 6

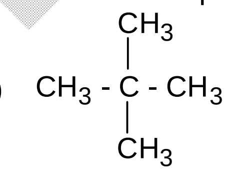
32. The compound X – CH_2COOH will be the strongest acid if X is:
(A) CH_3 (B) NO_2
(C) F (D) OH

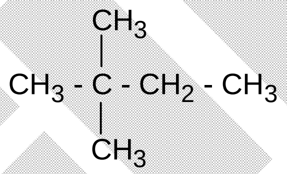
33. $BCl_3 + H_2 + C \xrightarrow{1700\text{–}1800^{0}C} \text{Product}(s)$
The product(s) of above reaction is/are
(A) $CCl_4 + B_2H_6$ (B) $B_4C + HCl$
(C) $B + Cl_2 + CH_4$ (D) $B_2H_6 + CHCl_3$

34. Atomic radii of Ti, Zr and Hf vary
(A) Ti > Zr > Hf (B) Ti < Zr < Hf
(C) Ti < Hf < Zr (D) Ti < Zr = Hf

35. Which of the following hydrocarbon can form one monochloro product with Cl_2/light?

(A)


(B)

$CH_3-C(CH_3)_2-CH_3$

(C)

$CH_3-C(CH_3)_2-CH_2-CH_3$

(D) $CH_3CH_2CH_3$

36. Dehydration of alcohols produces
(A) alkanes (B) alkenes
(C) alkynes (D) aldehydes

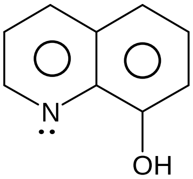
37. The shape of $[Co(NH_3)_6]^{3+}$ is:
(A) Tetrahedral (B) Trigonal bipyramidal
(C) Octahedral (D) Square planar

38. $AgNO_3$ solution will not give white precipitate with:
(A) $[Co(NH_3)_3Cl_3]$ (B) $[Co(NH_3)_4Cl_2]Cl$
(C) $[Co(NH_3)_5Cl]Cl_2$ (D) $[Co(NH_3)_6]Cl_3$

39. Which of the following compound exhibits tautomerism?
(A) chloroethane (B) ethanol
(C) ethoxyethane (D) nitroethane

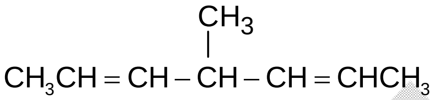
40. Which of the following two reagents form silicates when react with silica (SiO_2)?
(A) NaCl and Na_2S (B) NaOH and Na_2CO_3
(C) Na_2SO_4 and $NaNO_3$ (D) NaBr and $NaHSO_4$

41. In which combinations, all the ligands are ambient in nature?
(A) $NO_2, \overline{S}CN$ and $\overline{C}N$ (B) EDTA, $\overline{S}CN$
(C) H_2O,



(D) All of these

42.

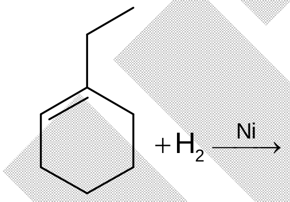


$$CH_3CH=CH-\underset{}{\overset{CH_3}{\overset{|}{C}}}H-CH=CHCH_3$$

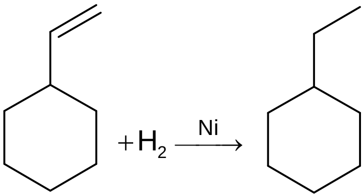
How many stereoisomer(s) is/are possible for the above compound?
(A) 2 (B) 3
(C) 4 (D) 6

43. Which of the following reaction produces maximum heat?

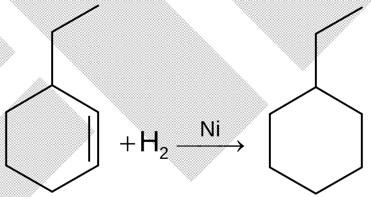
(A)



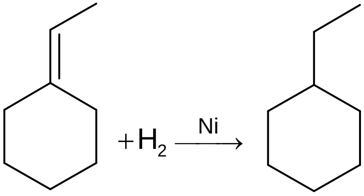
(B)



(C)

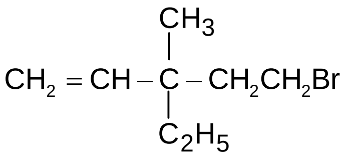


(D)



44. Which of the following substance can decrease the ionization of CH_3COOH in water?
$$CH_3COOH(l) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$$
(A) NaOH (B) NH_4Cl
(C) K_2CO_3 (D) NaCl

45.



$$CH_2=CH-\underset{C_2H_5}{\overset{CH_3}{C}}-CH_2CH_2Br$$

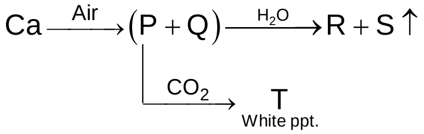
Which of the following substance converts the above optically active compound to optically inactive compound?

(A) HBr
(B) Br_2/CCl_4
(C) HBr/R_2O_2
(D) Br_2/H_2O

46. Which substance is used for refining of Nickel in Mond's process?

(A) I_2
(B) CO
(C) CO_2
(D) MnO

47.



$$Ca\xrightarrow{Air}(P+Q)\xrightarrow{H_2O}R+S\uparrow$$

$$(P+Q)\xrightarrow{CO_2}\underset{\text{White ppt.}}{T}$$

$S\uparrow+CO_2\longrightarrow U+H_2O$

Which of the following is 'U'?

(A) CH_3COONH_4
(B) NH_2CONH_2
(C) NH_2COONH_4
(D) NH_2COOH

48. Which of the following orbital has the maximum number of radial nodes?

(A) 4s
(B) 4p
(C) 4d
(D) 4f

49. In which case bond length of C – O bond is maximum

(A) Carboxylate ion
(B) Phenoxide ion
(C) p-nitro phenoxide ion
(D) 2, 4 di-nitro phenoxide ion

50. Which of the following overlap forms the strongest sigma bond?

(A) 2s – 2s
(B) $2p_x - 2p_x$
(C) $3p_y - 3p_y$
(D) $2p_x - 3p_x$

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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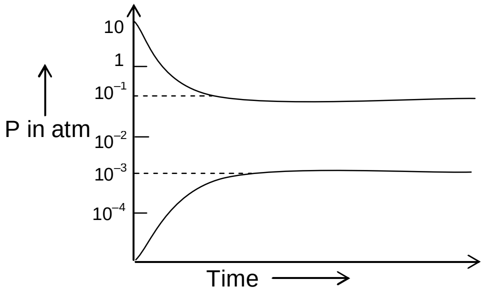
51. The energy of an electron of hydrogen atom is -13.6 eV when it is 0.53 $\overset{o}{A}$ away from the nucleus. When the hydrogen atom is supplied with 12.75 eV energy the electron moves to a higher orbit. If the distance of that orbit from the nucleus in is expressed as $\frac{x}{100}\overset{o}{A}$. What is the value of x?

52. 56.7 g anhydrous oxalic acid ($H_2C_2O_4$) completely decolourises 200 mL of acidified $KMnO_4$ solution. If the molarity of the $KMnO_4$ solution is expressed as $\left(\frac{20+x}{100}\right)$M. What is the value of x?

53. A large number of structural isomers are possible with formula $C_4H_{11}N$
If x = Number of primary amines,
y = Number of secondary amines and
z = number of tertiary amines, then
What is (x + y + z)

54. The temperature of a sample of diatomic ideal gas is increased by 4.5 times of its initial value. At this temperature the molecules are completely dissociated into atoms. How many times will the gas velocity increase from initial value due to the change?

55.



The plot of partial pressure of the product and reactant is given above. What is the value of ΔG^o in L atm unit at temperature 'T'?
[Assume 2.303 RT = 4 L atm mol^{-1}]

56. AB_2 is 10% dissociated in water to A^{2+} and B^-. The boiling point of a 10.0 molal aqueous solution of AB_2 is _____^{o}C.(Round off to the nearest integer). [Given: Molal elevation constant of water K_b= 0.5 K kg mol^{-1} boiling point of pure water = 100^{o}C]

57. At 363 K, the vapour pressure of A is 21 kPa and that of B is 18 kPa. One mole of A and 2 moles of B are mixed. Assuming that this solution is ideal, the vapour pressures of mixture is ____kPa.(Round off to the nearest integer)

58. A certain element crystallises in a bcc lattice of unit cell edge length 27/AA. If the same element under the same conditions crystallizes in the fcc lattice, the edge length of the unit cell in \AA will be ______(Round off to the nearest integer)
[Assume each lattice point as a single atom]
[Assume $\sqrt{3} = 1.73$, $\sqrt{2} = 1.41$]

59. When light of wavelength 248 nm falls on a metal of threshold energy 3.0 eV, the de-Broglie wavelength of emitted electrons is _________\A.
(Round off to the nearest integer)
[Use: $\sqrt{3}$ = 1.73, h = 6.63 × 10^{-34} Js, M_e = 9.1 × 10^{-31} kg, c = 3.0 × 10^8 ms^{-1}, leV = 1.6 ×10^{-19}J]

60. A certain orbital as n = 4 and m_ℓ = -3. The number of radial nodes in this orbital is _________(Round off to the nearest integer)

Mathematics

PART – C

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

61. The area bounded by the x – axis, part of the curve $y = 1 + x^{-2}$ and the ordinates x = 1 and x = 2 is divided into equal parts by the ordinate at $x = a$ such that $a = \frac{3+\sqrt{p}}{8}$, then the value of p is

(A) 70 (B) 71
(C) 72 (D) 73

62. $\underset{y\to\infty}{\text{Lt}} \frac{\sqrt{1+\sqrt{1+y^4}} - \sqrt{2}}{y^4} =$

(A) $4\sqrt{2}$ (B) $\frac{1}{4\sqrt{2}}$
(C) $\sqrt{2}$ (D) 0

63. If the parabola $y = ax^2 + bx + c$ has vertex at (4, 2) and $\lambda \in [1, 3]$, and the maximum value of product abc is λ, then $\frac{|\lambda|}{24}$ is

(A) 2 (B) 4
(C) 6 (D) 8

64. Let P be a point on the line segment joining $A(5\cos\alpha, 5\sin\alpha)$ and $B(5\cos\beta, 5\sin\beta)$ such that $3PA = 2PB$ then the locus of P is if $|\alpha - \beta| = \frac{\pi}{3}$

(A) $x^2 + y^2 = 13$ (B) $x^2 + y^2 = 19$
(C) $x^2 + y^2 = 1$ (D) $x^2 + y^2 = 25$

65. Let z_1, z_2 and z_3 are three complex numbers such that $|z_1| = |z_2| = |z_3| = 1$ and

$$\frac{z_1}{z_2 z_3} + \frac{z_2}{z_3 z_1} + \frac{z_3}{z_1 z_2} = -1$$

then the number of possible integral values of $|z_1 + z_2 + z_3|$ is

(A) 3 (B) 2
(C) 1 (D) 4

66. Let P be any point on the line $x - y + 3 = 0$ and A be a fixed point (3, 4). If the family of lines given by the equations $\left(3\sec\theta + 5\,\text{coesc}\,\theta\right)x + \left(7\sec\theta - 3\,\text{cos ec}\,\theta\right)y + 11\left(\sec\theta - \text{cos ec}\,\theta\right) = 0$ are concurrent at a point B for all permissible value of θ, then maximum value of $|PA - PB|$ is

(A) 3 (B) $2\sqrt{10}$

(C) $2\sqrt{34}$ (D) 5

67. Let $P(x)$ be a quadratic polynomial such that $P(1) = -1$, if $\int \frac{p(x)dx}{(2x-3)^2(3x-2)^2} = \frac{1}{5}\ell n|f(x)| + C$ where C is constant of integration and $f(x)$ is a rational function such that $\lim_{x\to\infty} f(x) = \frac{4}{3}$, then value of $|f(1)|$ is

(A) 1 (B) 2

(C) 3 (D) 4

68. Let f be a function defined by $f(x) = \begin{cases} (x-r)^2, & r-1 \le x < r+1 \\ 1, & r+1 \le x \le r+2 \end{cases}$

Where r = 3k, k ∈ I. Find the value of $\sqrt{\int_0^{45} f(x)dx}$

(A) 1 (B) 3

(C) 5 (D) 7

69. If $f(x)$ is an even function which is also periodic with the period T and $\int\limits_0^a f(x)dx = 3$ and $\int\limits_{-T/2}^{3T/2} f(x)dx = 18$, then $\int\limits_{-a}^{a+5T} f(x)dx$ is equal to

(A) 31 (B) 43

(C) 51 (D) 71

70. Let $f(x) = 2\tan^{-1}x$ and $g(x)$ be a differentiable function satisfying $g\left(\frac{x+2y}{3}\right) = \frac{g(x)+2g(y)}{3}\ \forall x, y \in R$ and $g'(0) = 1$ and $g(0) = 2$. The number of integers 'x' satisfying $f^2(g(x)) - 5f(g(x)) + 4 > 0$ where $x \in (-10, 20)$ is greater than or equal to

(A) 5 (B) 6

(C) 7 (D) 8

71. Area bounded by the straight lines $x^2y - y^3 - x^2 + 5y^2 - 8y + 4 = 0$ is equal to (in sq. units)

(A) 1 (B) 3

(C) 5 (D) 7

72. If $\left(2xy - y^2 - y\right)dx = \left(2xy + x - x^2\right)dy$ and $y(1) = 1$, then the value of $12\left|y(-1)\right|$ is

(A) 12
(B) 13
(C) 15
(D) 17

73. The point (2, 1) is translated parallel to the line $L : x - y = 4$ by $2\sqrt{3}$ units. If the new point Q lies in the third quadrant, then the equation of the line passing through Q and perpendicular to L is

(A) $x + y = 2 - \sqrt{6}$
(B) $x + y = 3 - 3\sqrt{6}$
(C) $x + y = 3 - 2\sqrt{6}$
(D) $2x + 3y = 1 - \sqrt{6}$

74. A circle C touches the line $x = 2y$ at the point (2, 1) and intersects the circle $C_1 : x^2 + y^2 + 2y - 5 = 0$ at two points P and Q such that PQ is a diameter of C_1. Then the length of diameter of C is:

(A) $7\sqrt{5}$
(B) 15
(C) $\sqrt{285}$
(D) $4\sqrt{15}$

75. Three circles of radii a, b, c (a < b < c) touch each other externally. If they have x – axis as a common tangent, then

(A) a, b, c are in A.P.
(B) $\frac{1}{\sqrt{b}} = \frac{1}{\sqrt{a}} + \frac{1}{\sqrt{c}}$
(C) $\frac{1}{\sqrt{a}} = \frac{1}{\sqrt{b}} + \frac{1}{\sqrt{c}}$
(D) $\sqrt{a}, \sqrt{b}, \sqrt{c}$ are in A.P.

76. If pair of variable straight lines $x^2 + 4y^2 + \alpha xy = 0$ (α is real parameter) cuts the ellipse $x^2 + 4y^2 = 4$ at two points A and B, then the locus of point of intersection of tangents at A and B of ellipse

(A) $x^2 - 4y^2 = 0$
(B) $4x^2 - y^2 = 0$
(C) $x^2 - xy + 4y^2$
(D) $x^2 - xy - 4y^2 = 0$

77. If $\arg\frac{\left(z - (10 + 6i)\right)}{\left(z - (4 + 2i)\right)} = \frac{\pi}{4}$ then the perimeter of locus of z is:

(A) $\sqrt{13}\left(\frac{\pi}{4}\right)$
(B) $3\sqrt{13}\,\pi$
(C) $3\sqrt{13}\left(\frac{\pi}{4}\right)$
(D) $3\sqrt{26}\left(\frac{\pi}{2}\right)$

78. The sum of all values of $\theta \in \left(0, \dfrac{\pi}{2}\right)$ satisfy $\sin^2 2\theta + \cos^4 2\theta = \dfrac{3}{4}$ is

(A) $\dfrac{\pi}{2}$ (B) π

(C) $\dfrac{3\pi}{8}$ (D) $\dfrac{5\pi}{4}$

79. The value of $\dfrac{1}{3^2+1} + \dfrac{1}{4^2+2} + \dfrac{1}{5^2+3} + \text{..........to } \infty$ is?

(A) $\dfrac{31}{13}$ (B) $\dfrac{13}{36}$

(C) $\dfrac{31}{36}$ (D) $\dfrac{1}{36}$

80. Let $x = \sin 1^o$, then the value of the expression

$\dfrac{1}{\cos 0^o \cos 1^o} + \dfrac{1}{\cos 1^o \cos 2^o} + \dfrac{1}{\cos 2^o \cos 3^o} + ... + \dfrac{1}{\cos 44^o \cos 45^o}$ is equal to

(A) x (B) $\dfrac{1}{x}$

(C) $\dfrac{\sqrt{2}}{x}$ (D) $\dfrac{x}{\sqrt{2}}$

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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81. If $\left({}^{40}C_0\right) + \left({}^{41}C_1\right) + \left({}^{42}C_2\right) + ... + \left({}^{60}C_{20}\right) = \dfrac{m}{n}\, {}^{60}C_{20}$, m and n are coprime, then maximum value of '$m+n$'is equal to

82. Let $P(A \cap B) = \dfrac{1}{4}$ and $P(B) = \dfrac{1}{3}$, where $P\left(\dfrac{(A \cap B)}{(A \cup \overline{B})}\right) = \dfrac{k}{22}$, then 'k' is equal to

83. The line which contains all points (x, y, z) which are of the form $(x, y, z) = (2, -3, 4) + \lambda(1, 2, -3)$ intersects the plane $2x + 3y - z = 13$ at the point P and intersects the yz – plane at Q. If the distance between P and Q is $a\sqrt{b}$, where $a, b \in N$ and $a > 3$, then $\dfrac{a+b}{3}$ equals

84. Let S be the set (2, 3, 5, 7, 11). Suppose A and B are two matrices of order 2 each with distinct elements belonging to set S. The probability that the matrix AB has at least one odd entry is

85. If $\cos^{-1}\sqrt{p}+\cos^{-1}\sqrt{1-p}+\cos^{-1}\sqrt{1-q}=\frac{3\pi}{4}$ then q =

86. Let $\sum_{i=0}^{100}\sum_{j=0}^{100}\left(C_i^2+C_j^2+C_iC_j\right)=a.{}^{2n}C_n+2^b$, where a, b, n are even natural numbers and C_r, represent the coefficient of x^r in the expansion of $(1+x)^{100}$ then a + b + n = C_r represent

87. If maximum value of quadratic equation $y=ax^2+bx+c$ is $\frac{1}{2}$ at $x=-2,$ then $2c-8a+5$ is

88. The sum of possible value(s) of p for which at least one root of equation $x^4-8x^3+22x^2-24x+p=0$ is of multiplicity 2, is

89. The sum of the following infinite series

$$1+\left(\frac{\sqrt{2}-1}{2\sqrt{2}}\right)+\left(\frac{3-2\sqrt{2}}{8}\right)+\left(\frac{5\sqrt{2}-7}{16\sqrt{2}}\right)+\frac{17-12\sqrt{2}}{64}+.....\infty \text{ is}$$

90. If $2\tan^2x-5\sec x-1=0$ has 7 different roots in $\left[0,\frac{n\pi}{2}\right]$, $n\in N$, then greatest value of n is

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – III

JEE (Main)-2023

TEST DATE: 11-01-2023

ANSWERS, HINTS & SOLUTIONS

Physics

PART – A

SECTION – A

1. C

Sol. Variation of moment of inertia with temperature

$I = I_o(1 + 2\alpha\,\Delta T)$

C.O.A.M:

$I_i\omega_i = I_f\,\omega_f$

2. D

Sol. Upon earthing, final potential of conductor becomes zero. Final charge may or may not be zero.

3. B

Sol. $\tan\theta = \dfrac{X_c - X_L}{X_R}$

and $\cos\theta$ = power factor.

4. A

Sol. $\Delta m = 0.1$ kg ; $\dfrac{\Delta m}{m} = \dfrac{0.1}{10}$

$\therefore$ Error $= \pm\dfrac{\Delta m}{m}\times 100 = \pm 1\%$.

5. A

Sol. $I_a = \frac{3V}{15R}, I_b = \frac{3V}{5R}$; $I_c = \frac{6V}{15R}$.

6. C

Sol. At first the pressure will increase rapidly and then it will become constant.

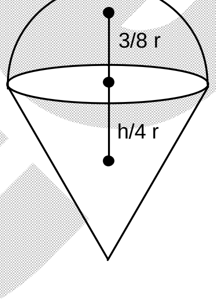
7. B

Sol. $F = \frac{dp}{dt} = \left(\sqrt{2}\,V\right)\frac{dm}{dt} = \left(\sqrt{2}\,V\rho\right)\frac{d(\text{volume})}{dt} = \left(\sqrt{2}\,V\rho\right)(AV)$

8. B

Sol. $\frac{3}{8}r \cdot \rho\frac{2}{3}\pi r^3 = \frac{h}{4}\cdot\rho\frac{1}{3}\pi r^2 h$

$\Rightarrow \quad h = \sqrt{3}\,r$



9. B

Sol. Kx = 2 × g = 20, $x = \frac{1}{2}$m

$5\,gx - \frac{1}{2}Kx^2 = \frac{1}{2}5V^2$

$V = 2\sqrt{2}$ m/s

10. D

Sol. $\Delta q = \Delta u + \Delta w$

$\Rightarrow \quad \Delta U = -996\text{ J} = \frac{nR}{\gamma - 1}\Delta T$

$\gamma = \frac{5}{3}$ for mono-atomic gas.

11. C

Sol. $i = \frac{E}{R}\left(1 - e^{-\frac{tR}{L}}\right)$

12. A

Sol. $r = \frac{mv}{qB} = \frac{1\times10}{1\times2} = 5\text{m}$ And motion of particle will be in x – y plane.

13. A

Sol. $1000 = \left(\frac{350}{350-50}\right)f \quad \ldots(i)$

$$f_1 = \left(\frac{350}{350+50}\right)f \qquad \ldots(ii)$$

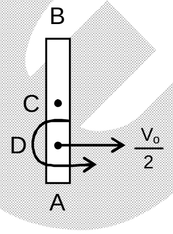
f_1 = 750 Hz

14. B

Sol. $$B = 2\left[\frac{\mu_0 I}{4\pi r \cos 45^0}\right]\left(\sin 90^0 - \sin 45^0\right) + \frac{\mu_0 I}{4\pi r}\left(\frac{\pi}{2}\right)$$

15. D

Sol. By COAM about point D (ie about new centre of mass)



$$MV_o\frac{L}{4} = \left[\frac{ML^2}{12} + \frac{ML^2}{16} + \frac{ML^2}{16}\right]\omega$$

or, $w = \frac{6v_o}{5L}$

Now, $t = \frac{\theta}{w} = \frac{(\pi/2)}{w} = \frac{5\pi L}{12v_o}$

16. D

Sol. $f = \frac{m}{2\ell}\sqrt{\frac{T}{\mu}}$; $n = \frac{2m+1}{4\ell}\sqrt{\frac{T}{\mu}}$

17. D

Sol. $T = 2\pi\sqrt{\frac{\ell}{g_{eff}}} = 2\pi\sqrt{\frac{\ell}{g+a}}$

18. C

Sol. Potential energy of particle at the centre of earth is $U = -\frac{3}{2}\frac{GMm}{R_e}$

So, $V_e = \sqrt{\frac{3GM}{R_e}} = \sqrt{3gR_e}$

19. C

Sol. $V_{AC} = 2\times\left(\frac{0.2}{1.8+0.2}\right) \qquad \ldots(i)$

Also, $V_{AC} = (1.5)\left(\frac{5}{15}\right)\left(\frac{\ell}{100}\right) \qquad \ldots(ii)$

20. A

Sol. $V_o \cos\theta = V\sin\theta$

SECTION – B

21. 6

Sol. $\sqrt{f_1} = \sqrt{\frac{v}{\lambda_1}} = a(11-1)$ and $\sqrt{f_2} = \sqrt{\frac{v}{\lambda_2}} = a(Z-1)$

By dividing, $\sqrt{\frac{\lambda_2}{\lambda_1}} = \frac{10}{Z-1} \Rightarrow \sqrt{\frac{4}{1}} = \frac{10}{Z-1}$

$\Rightarrow$ Z = 6.

22. 15

Sol. Initially the rod will be in equilibrium if

$2T_o = Mg$ with $T_o = kx_o$ …(i)

when the current I is passed through the rod, it will experience a force

F = BIL vertically up,

In equilibriums

2T + BIL = Mg with T = kx …(ii)

from (i) & (ii)

$\frac{T}{T_o} = \frac{Mg - BIL}{Mg}$ i.e. $\frac{x}{x_o} = 1 - \frac{BIL}{Mg}$

or, $B = \frac{Mg(x_o - x)}{I\ \ L\ \ x_0}$

Putting the values we get $B = 1.5 \times 10^{-2}\,T$.

23. 20

Sol. $\frac{dN_A}{dt} = -\lambda_1 N_A$, $\frac{dN_B}{dt} = 2\lambda_1 N_A - \lambda_2 N_B$,

N_B = maximum $\Rightarrow \frac{dN_B}{dt} = 0$

$\Rightarrow \quad 2\lambda_1 N_A = \lambda_2 N_{B_{max}}$

$\Rightarrow \quad N_{B_{max}} = \frac{2\lambda_1}{\lambda_2} N_A$

$\Rightarrow \quad N_{B_{max}} = \frac{2\lambda_1}{\lambda_2} N_0 e^{-\lambda_1 t}$ = 2.

24. 400

Sol. Here 3rd maxima is shifted by 3 × 10^{-4} m. It indicates fringe width increases by 1 × 10^{-4} m.

Hence $\beta = \frac{\lambda(D+0.5)}{d} = \frac{\lambda D}{d} + 1 \times 10^{-4}$

or $\frac{0.5\lambda}{d} = 1 \times 10^{-4}$ m or $\lambda = \frac{2 \times 10^{-3} \times 1 \times 10^{-4}}{0.5} = 4 \times 10^{-7}$ m = 400 nm

25. 300

Sol. Let T be the tension in the ideal string and ‘a’ be the acceleration of the blocks at the instant of release. For the block on the left, the upward acceleration may be found from

$T + k_1x - mg = ma$

For the block on the right, the downward acceleration may be found from

$k_2x + mg - T = ma$

Adding the equations gives the acceleration of the blocks as

$a = (k_1 + k_2)x/(2m)$

However, subtracting the equations gives

$T = mg - (k_1 - k_2)x/2$

for maximum value of k_1T will be zero.

$mg = \left(\frac{k_1 - k_2}{2}\right)x$; $k_1 = 300$.

26. 80

Sol. $D = 1m,\ d = 5 \times 10^{-3} m$

shift = $\frac{D}{d}\left[t_1(\mu_1 - 1) - t_2(\mu_2 - 1)\right]$

$= \frac{1}{5 \times 10^{-3}}\left[2(1.5 - 1) - 1.5(1.4 - 1)\right] \times 10^{-3} = \frac{0.4}{5} = 0.08m$

27. 1

Sol. F = $-\frac{dU}{dr} = -\frac{k}{r},\ \frac{k}{r} = \frac{mv^2}{r}$ ..... (i)

$E_n = \frac{1}{2}mv^2 + k\ln r$ ..... (ii)

mvr = $\frac{nh}{2\pi}$ ..... (iii)

Solving these $E_n = \frac{k}{2}\left(1 + \ln\left(\frac{n^2h^2}{4\pi^2 mk}\right)\right)$

required ratio = $\frac{E_2 - E_1}{E_4 - E_2} = 1$.

28. 100

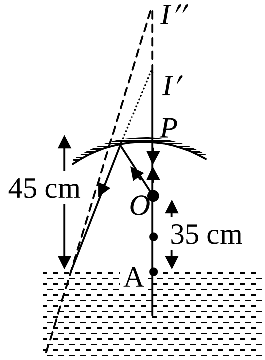
Sol. For the reflection at the concave mirror,

$u = -10$ cm; v = ?; $f = -15$ cm

From the mirror formula, we have

$$v = \frac{uf}{u - f} = \frac{(-10) \times (-15)}{-10 + 15} = \frac{150}{5} = +30 \text{ cm}$$

The positive sign indicates that the image is formed on the other side of the concave mirror,



Now, the image formed by the concave mirror serves as a virtual object for refraction at water surface which takes placed from air to water. So,

$$\mu = \frac{\text{Apparent height}}{\text{Real height}}$$

$\therefore$ AI'' = Apparent height = μ × real height $= \frac{4}{3}\times 75$ = 100 cm.

29. 750

Sol. $e = \frac{v_2 - v_1}{u_1 - u_2}$

$1 = \frac{v_2 - (-2)}{u_1}$

$u_1 = v_2 + 2$

$u_1 = 1(-2) + 5(u_1 - 2)$

$u_1 = -2 + 5u_1 - 10$

$u_1 = \frac{12}{4} = 3\text{m/s}$

$v_2 = 1\text{ m/s}$

Kinetic energy of the centre of mass = $\frac{1}{2}\times(1+5)\times\left(\frac{3}{1+5}\right)^2 = \frac{3}{4}$ J

30. 2

Sol. $\frac{q_1}{C_1} = \frac{q_2}{C_2}$ **;** $q_1 + q_2 = 2Q_0$

$C_1 = \frac{\varepsilon_0 A}{d_0 + vt}$; $C_2 = \frac{\varepsilon_0 A}{d_0 - vt}$

$\frac{q_1}{q_2} = \frac{d_0 - vt}{d_0 + vt}$

$q_2\left(\frac{d_0 - vt}{d_0 + vt}\right) + q_2 = 2Q_0$

$q_2\left[\frac{2d_0}{d_0 + vt}\right] = 2Q_0$

$q_2 = \frac{2Q_0}{2d_0}(d_0 + vt)$

$I = \frac{dq_2}{dt} = \frac{Q_0 v}{d_0}$ = 2 amp

Chemistry PART – B

SECTION – A

31. A
Sol. Using
$\Delta U = nC_V \times \Delta T$
$\Delta T = 100$ $n = 3.5$
$C_V = 2 \times 10^{-2}$
$\Delta U = 7$

32. B
Sol. NO_2 is the strongest electron withdrawing group among the given groups or atoms.

33. B
Sol. $4BCl_3 + 6H_2 + C \longrightarrow B_4C + 12HCl$
The reaction takes place in the preparation of bullet proof fabric B_4C.

34. D
Sol. This is due to lanthanoid contraction on 6th period.

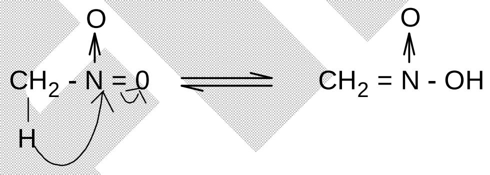
35. B
Sol. It is most symmetrical.

36. B
Sol. $RCH_2CH_2OH \xrightarrow[\Delta]{Conc.H_2SO_4} R-CH=CH_2 + H_2O$

37. C
Sol. Octahedral complex with C.N number 6.

38. A
Sol. No free Cl^- in the ionisation sphere.

39. D
Sol.



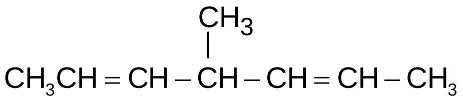
$$\underset{H}{CH_2} - \overset{O}{\overset{\uparrow}{N}} = O \rightleftharpoons CH_2 = \overset{O}{\overset{\uparrow}{N}} - OH$$

40. B
Sol. $SiO_2 + 2NaOH \longrightarrow Na_2SiO_3 + H_2O$
$SiO_2 + Na_2CO_3 \longrightarrow Na_2SiO_3 + CO_2$

41. A
Sol. Having two possible donating site but donate from one only.

42. C

Sol. Due to double bond, the geometrical isomers are:



$$CH_3CH=CH-\overset{CH_3}{\overset{|}{C}H}-CH=CH-CH_3$$

Cis	Cis	
Trans	Trans	
Cis	Trans	Identical
Trans	Cis	

When the double bonds are Cis and trans, the molecule becomes optically active.

$\therefore$ For trans Cis(two optical isomers are possible)

$\therefore$ Total no. of stereoisomers are:

Geometrical (2) + Optical (2) = 4

43. B

Sol. It is least substituted alkene. Hence it is unstable.

44. B

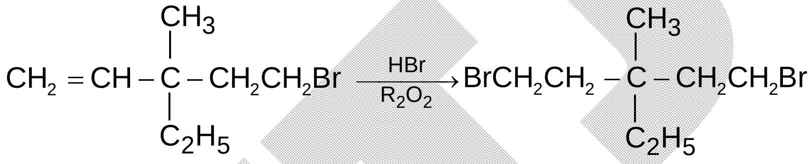
Sol. $NH_4Cl \longrightarrow NH_4^+ + Cl^-$

$NH_4^+ + H_2O \longrightarrow NH_4OH + H^+$

H^+ shift the ionization reaction toward backward direction due to common ion effect.

45. C

Sol.



$$CH_2=CH-\underset{C_2H_5}{\underset{|}{\overset{CH_3}{\overset{|}{C}}}}-CH_2CH_2Br \xrightarrow[R_2O_2]{HBr} BrCH_2CH_2-\underset{C_2H_5}{\underset{|}{\overset{CH_3}{\overset{|}{C}}}}-CH_2CH_2Br$$

Optically inactive

46. B

Sol. $Ni(impure) + 4CO \longrightarrow Ni(CO_4) \xrightarrow{\Delta} Ni(pure) + 4CO$

47. B

Sol. P = CaO, Q = Ca_3N_2, R = $Ca(OH)_2$, S = NH_3, T = $CaCO_3$, U = NH_2CONH_2

48. A

Sol. No. of radial nodes = (n – l – 1)

For 4s orbital, it is 3

For 4p orbital, it is 2

For 4d orbital, it is 1

For 4f orbital, it is 0

49. B

Sol. More double bond character, smaller bond length

50. B

Sol. Small size atomic orbitals undergo better overlap than larger atomic orbitals.

SECTION – B

51. 848

Sol. $E_n - E_1 = 12.75$

or $\frac{-E_1}{n^2} - E_1 = 12.75$ [E_1 = -13.6 eV(given)]

$\therefore$ n = 4

$r_n = \frac{n^2}{Z} a_0 = \frac{16}{1}(0.53) = 8.48\,\overset{o}{A}$

$\therefore \frac{x}{100} = 8.48$, x = 848

52. 106

Sol. M_{eq} of $KMnO_4$ = M_{eq} of $H_2C_2O_4$

$(V) \times (M)(n) = \frac{W}{E} \times 1000$

Or, $(200)(M)(5) = \frac{56.7}{90/2} \times 1000$

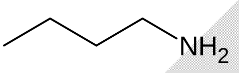
$\therefore$ M = 1.26

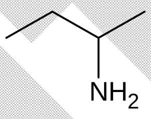
$\therefore \frac{20 + x}{100} = 1.26 \Rightarrow x = 106$

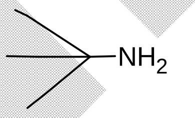
53. 7

Sol. x = 3, y = 3, z = 1

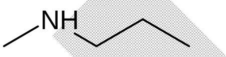
Primary amines are

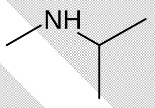


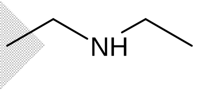




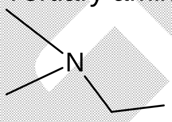
Secondary amines are







Tertiary amine is



54. 3

Sol. $C_i = \sqrt{\frac{3RT}{M}}$

$C_f = \sqrt{\frac{3R(4.5)T}{\frac{M}{2}}} = 3\sqrt{\frac{3RT}{M}} = 3C_i$

You can take any velocity.

55. 8

Sol. $K_P = \frac{10^{-3}}{10^{-1}} = 10^{-2}$

ΔG^o = -2.303 RTlogK_P

= -2.303 RTlog10^{-2} = (-4)(2 log10) = 8

56. 106

Sol. $AB_2 \longrightarrow A^{2+} + 2B^-$

t = 0 a 0 0

t = t a - aα aα 2 aα

nT = a - aα + aα + 2 aα

= a(1 + 2aα)

So, i = 1 + 2α

Now ΔT_b = i × m × K_b

ΔT_b =(1 + 2α) × m × K_b

α = 0.1, m = 10, K_b = 0.5

ΔT_b = 1.2 × 10 × 0.5 = 6

So boiling point = 106

57. 19

Sol. According to Roult's law: P T = X A P A ◦ + X B P B ◦ P T = 1 3 × 21 + 2 3 × 18 = 7 + 12 P T = 19 kPa.

58. 33

Sol. For BCC $\sqrt{3}a = 4r$

so, $r = \frac{\sqrt{3}}{4} \times 27$

for FCC $a = 2\sqrt{2}r$

$= 2 \times \sqrt{2} \times \frac{\sqrt{3}}{4} \times 27$

$= \frac{\sqrt{3}}{\sqrt{2}} \times 27 = 33$

59. 9

Sol. $\underset{\text{photon}}{\text{Incident energy of}} = \underset{\text{metal}}{\text{Work function}} + \underset{\text{photoelectron}}{\text{K.E. of}}$

$h\nu = h\nu_0 + KE$

$$\frac{6.63 \times 10^{-34}\,Js \times 3 \times 10^{8}\,ms^{-1}}{248 \times 10^{-9}\,m \times 1.6 \times 10^{-19}\,JeV^{-1}} = 3.0 + K.E.$$

$K.E. = 2.0\ eV$

$$\lambda = \frac{h}{\sqrt{2mK.E.}} = \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 2 \times 10^{-19} \times 1.6}}$$

$= 8.68 \times 10^{-10}\,m = 9A^{\circ}$

60. 0

Sol. $n = 4$ and $m_\ell = -3$

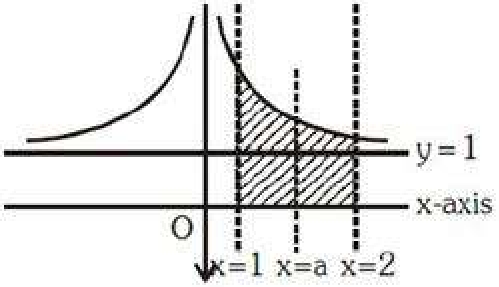
Hence, ℓ value must be 3. Now number of radial nodes $= n - \ell - 1$

$= 4 – 3 – 1 = 0$

Mathematics PART – C

SECTION – A

61. D



Sol. $\Rightarrow x - \frac{1}{x}\Big|_1^a = x - \frac{1}{x}\Big|_0^2$

$\Rightarrow 2\left(a - \frac{1}{a}\right) = \frac{3}{2}$

$\Rightarrow 4a^2 - 3a - 4 = 0$

$\Rightarrow a = \frac{3+\sqrt{73}}{8}$

62. B

Sol. $\lim\limits_{y\to 0} \frac{\sqrt{1+\sqrt{1+y^4}} - \sqrt{2}}{y^4}$

$= \lim\limits_{y\to 0} \frac{1+\sqrt{1+y^4} - 2}{y^4\left(\sqrt{1+\sqrt{1+4y^4}} + \sqrt{2}\right)}$

$= \lim\limits_{y\to 0} \frac{\left(\sqrt{1+y^4} - 1\right)\left(\sqrt{1+y^4} + 1\right)}{y^4\sqrt{\left(1+\sqrt{1+y^4} + \sqrt{2}\right)}\left(\sqrt{1+y^4} + 1\right)}$

$= \lim\limits_{y\to 0} \frac{1+y^4 - 1}{y^4\left(\sqrt{1+\sqrt{1+y^4}} + \sqrt{2}\right)\left(\sqrt{1+y^4} + 1\right)}$

$= \lim\limits_{y\to 0} \frac{1}{\left(\sqrt{1+\sqrt{1+y^4}} + \sqrt{2}\right)\left(\sqrt{1+y^4} + 1\right)} = \frac{1}{4\sqrt{2}}$

63. C

Sol. As given $-\frac{b}{2a} = 4$ and $-\frac{D}{4a} = 2$

Hence, $E = abc = -16\left(a^2 + 8a^3\right)$

$\frac{dE}{da} < 0$ for $a \in [1, 3]$

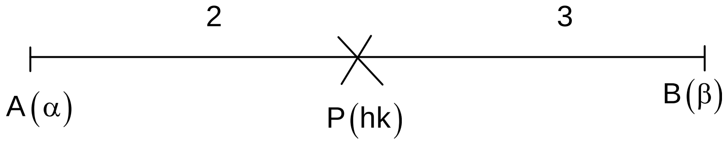
$E_{max} = -16\left(1^2 + 8.1^3\right) = -144$

$\Rightarrow |\lambda| = 144$

$\frac{|\lambda|}{24} = 6$

64. B

Sol. $\frac{PA}{PB} = \frac{2}{3}$



$$h = \frac{10\cos\beta + 15\cos\alpha}{5} = 2\cos\beta + 3\cos\alpha$$
$$k = 2\sin\beta + 3\sin\beta$$
$$h^2 + k^2 = 13 + 12\cos(\alpha - \beta)$$
$$x^2 + y^2 = 13 + 12\cos(\alpha - \beta)$$

65. B

Sol. On solving, we have $z_1^3 + z_2^3 + z_3^3 + z_1z_2z_3 = 0$

$$\Rightarrow (z_1 + z_2 + z_3)\left((z_1 + z_2 + z_3)^2 - 3z_1z_2 - 3z_2z_3 - 3z_3z_1\right) = -4z_1z_2z_3$$
$$\Rightarrow (z_1 + z_2 + z_3)^3 = z_1z_2z_3\left(3(z_1 + z_2 + z_3)\left(\frac{1}{z_1} + \frac{1}{z_2} + \frac{1}{z_3}\right) - 4\right)$$
$$\Rightarrow |z_1 + z_2 + z_3|^3 = \left|3(z_1 + z_2 + z_3)\left(\bar{z}_1 + \bar{z}_2 + \bar{z}_3\right) - 4\right|$$
$$\Rightarrow x^3 = \left|3x^2 - 4\right| \Rightarrow x = 1, 2$$

66. B

Sol. $(3\sec\theta + 5\operatorname{cosec}\theta)x + (7\sec\theta - 3\operatorname{cosec}\theta)y + 11(\sec\theta - \operatorname{cosec}\theta) = 0$

$\sec\theta(3x + 7y + 11) + \operatorname{cosec}\theta(5x - 3y - 11) = 0$

Hence point B is (1, –2)

Now proceed.

67. B

Sol. $$\frac{p(x)}{(2x-3)^2(3x-2)^2} = \frac{A}{2x-3} + \frac{B}{(2x-3)^2} + \frac{C}{3x-2} + \frac{D}{(3x-2)^2}$$

$f(x)$ is rational function

B = D = 0 and $P(x) = \lambda(2x-3)(3x-2)$

$P(1) = -\lambda = -1 \Rightarrow \lambda = 1$

$$\int \frac{dx}{(2x-3)(3x-2)} = \int \left[\frac{2}{2x-3} - \frac{3}{3x-2}\right]\frac{dx}{5}$$
$$= \frac{1}{5}\ell n\left|\frac{2x-3}{3x-2}\right| + C = \frac{1}{5}\ell n\left|\frac{4x-6}{3x-2}\right| + C'$$

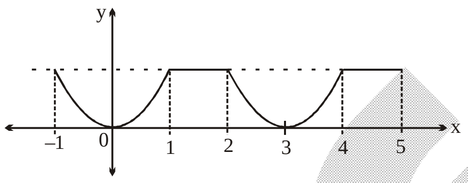
$$\because \lim_{x\to\infty} f(x) = \frac{4}{3} \Rightarrow f(x) = \frac{4x-6}{3x-2}$$

$$= \left|f(1)\right| = 2$$

68. C

Sol.

$$f(x) = \begin{cases} \left.\begin{array}{ll} x^2 & -1 \le x < 1 \\ 1 & 1 \le x \le 2 \end{array}\right\} \text{for } r = 0 \\ \left.\begin{array}{ll} (x-3)^2 & 2 < x < 4 \\ 1 & 4 \le x \le 5 \end{array}\right\} \text{for } r = 3 \\ \left.\begin{array}{ll} (x-6)^2 & 5 < x < 7 \\ 1 & 7 \le x \le 8 \end{array}\right\} \text{for } r = 6 \end{cases}$$



From the graph of f(x), it is clear that f(x) is periodic with period 3.

$$\text{Now } \sqrt{\int_0^{45} f(x)dx} = \sqrt{15\int_0^{3} f(x)dx} = \sqrt{15\int_{-1}^{2} f(x)dx} = \sqrt{15\left[\int_{-1}^{1} x^2\,dx + \int_1^2 1\cdot dx\right]} = \sqrt{15\left(\frac{2}{3}+1\right)} = \sqrt{25} = 5$$

69. C

Sol. $$\int_{-T/2}^{3T/2} f(x)dx = 18 \Rightarrow \int_0^{2T} f(x)dx = 18 \Rightarrow \int_0^{T} f(x)dx = 9$$

$$\int_{-a}^{a+5T} f(x)dx = \int_{-a}^{a} f(x)dx + \int_{a}^{a+5T} f(x)dx$$

$$= 2\int_0^{a} f(x)dx + 5\int_0^{T} f(x)dx = 2\times 3 + 5\times 9 = 51$$

70. D

Sol. $$g\left(\frac{x+2y}{3}\right) = \frac{2f(y)+f(x)}{3}$$

$\Rightarrow g(x)$ is linear

$g(x) = mx + c$

$g'(x) = m = 1$

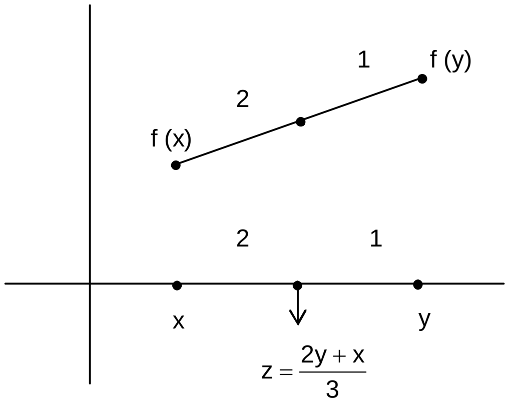
$g(x) = c = 2$

$\Rightarrow g(x) = x + 2$

$f(g(x)) = 2\tan^{-1}(x+2)$

$f^2(g(x)) - 5f(g(x)) + 4 > 0$

$(f(g(x)-1))(g(x)-4) > 0$



71. A

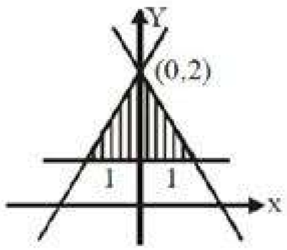
Sol. $x^2y - x^2 - y^3 + y^2 + 4y^2 - 4y - 4y + 4 = 0$

$\Rightarrow x^2(y-1) - y^2(y-1) + 4y(y-1) - 4(y-1) = 0$

$\Rightarrow (y-1)\left(x^2 - y^2 + 4y - 4\right) = 0$

$\Rightarrow y = 1$ or $x^2 = (y-2)^2$

$\Rightarrow y = 1,\ x = y - 2$ or $x = 2 - y$



Shaded area $= \dfrac{1}{2} \times 2 \times 1 = 1$ sq. units.

72. A

Sol. $d\left(x^2y\right) = d(xy) + d\left(xy^2\right)$

$\Rightarrow x^2y = xy + xy^2 + c$

at x = 1, y = 1 $\Rightarrow c = -1$

$\Rightarrow x^2y = xy + xy^2 - 1 \Rightarrow y = -y - y^2 - 1$

$\Rightarrow y^2 + 2y + 1 = 0 \Rightarrow y = -1$

$\therefore 12\left|y(-1)\right| = 12$

73. C

Sol. $x - y = 4$

To find equation of R

Slope of L = 0 is 1

$\Rightarrow$ Slope of QR = –1

Let QR is y = mx + c

$y = -x + c$

$x + y - c = 0$ distance of QR from

(2, 1) is $2\sqrt{3}$

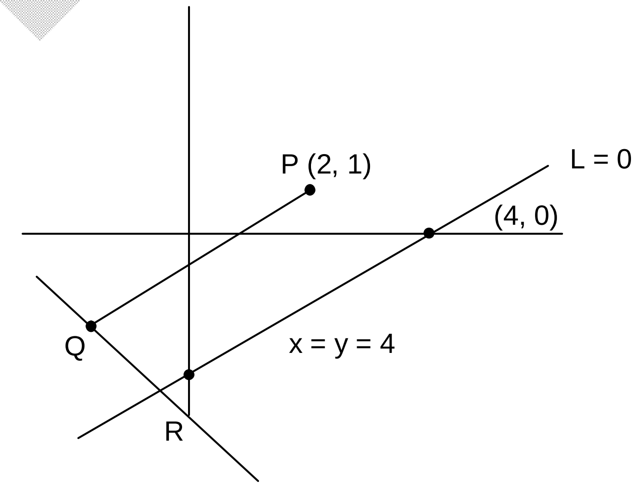
$2\sqrt{3} = \dfrac{|2+1-c|}{\sqrt{2}}$

$2\sqrt{6} = |3 - c|$

$c - 3 = \pm 2\sqrt{6} c = 3 \pm 2\sqrt{6}$

Line can be $x + y = 3 \pm 2\sqrt{6}$

$x + y = 3 - 2\sqrt{6}$



74. A

Sol. $\left(x-2\right)^2+\left(y-1\right)^2+\lambda\left(x-2y\right)=0$

$C: x^2+y^2+x\left(\lambda-4\right)+y\left(-2-2\lambda\right)+5=0$

$C_1: x^2+y^2+2y-5=0$

$S_1-S_2=0$

(Equation of PQ)

$\left(\lambda-4\right)x-\left(2\lambda+4\right)y+10=0$

Press through (0, –1)

$\Rightarrow \lambda=-7$

$C: x^2+y^2-11x+12y+5=0$

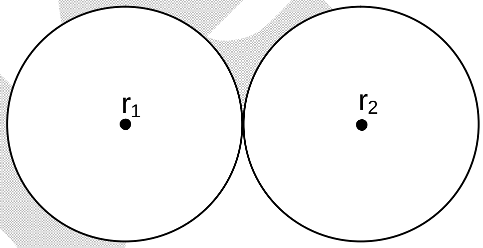
$=\frac{\sqrt{245}}{4}$

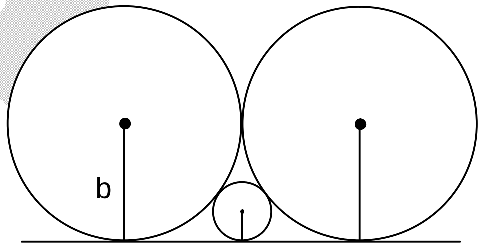
Diameter $=7\sqrt{5}$

75. C

Sol. Length of common tangent

$\Rightarrow \sqrt{\left(r_1+r_2\right)^2-\left(r_1-r_2\right)^2}$





$\sqrt{\left(a+b\right)^2+\left(a-b\right)^2}+\sqrt{\left(a+c\right)^2-\left(a-c\right)^2}$

$=\sqrt{\left(b+c\right)^2-\left(b-c\right)^2}$

$\sqrt{ab}+\sqrt{ac}=\sqrt{bc}$

$\frac{1}{\sqrt{c}}+\frac{1}{\sqrt{b}}=\frac{1}{\sqrt{a}}$

76. A

Sol. Equation of AB is $\frac{xb}{4}+ky=1$

Centroid equation of as OB = 4

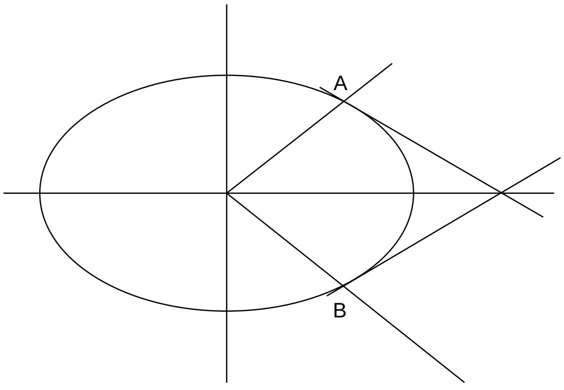
$x^2+4y^2-4\left(\frac{xb}{4}+\frac{xy}{1}\right)^2=0$ ………..(i)

$x^2+4y^2+\alpha xy=0$ ………..(ii)

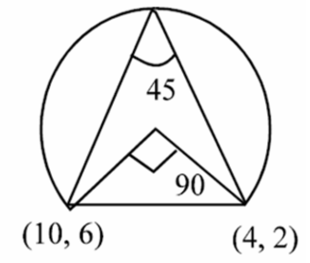
$\frac{h^2-4}{16}=\frac{k^2-4}{4}=\frac{br}{2h}$

$\left(h^2-4\right)=4\left(k^1-1\right)$

Locus is $x^2-4y^2=0$



77. D



Sol. $\sqrt{2}r = \sqrt{(10-4)^2+(6-2)^2}$

$= \sqrt{36+16} = 2\sqrt{13}$

$r = \sqrt{26}$

Perimeter $= \frac{3}{4}\times 2\pi r = \frac{3}{2}\pi\sqrt{26}$

78. A

Sol. $\sin^2 2\theta + \cos^4 2\theta = \frac{3}{4},\ \theta \in \left(0, \frac{\pi}{2}\right)$

$\Rightarrow 1-\cos^2 2\theta + \cos^4 2\theta = \frac{3}{4}$

$\Rightarrow 4\cos^4 2\theta - 4\cos^2 2\theta + 1 = 0$

$\Rightarrow \left(2\cos^2 2\theta - 1\right)^2 = 0$

$\Rightarrow \cos^2 2\theta = \frac{1}{2} = \cos^2 \frac{\pi}{4}$

$\Rightarrow 2\theta = n\pi \pm \frac{\pi}{4},\ n \in I$

$\Rightarrow \theta = \frac{n\pi}{2} + \frac{\pi}{8}$

$\Rightarrow \theta = \frac{\pi}{8}, \frac{\pi}{2} - \frac{\pi}{8}$

79. B

Sol. $Sn = \sum_{n=3}^{\infty} \frac{1}{n^2+n-2};\ = \sum \frac{1}{(n+2)(n-1)}$

$= \sum \frac{1}{3}\left(\frac{1}{n-1} - \frac{1}{n+2}\right)$

$= \frac{1}{3}\left[\left(\frac{1}{2}-\frac{1}{5}\right)+\left(\frac{1}{3}-\frac{1}{6}\right)+\left(\frac{1}{4}-\frac{1}{7}\right)+\left(\frac{1}{5}-\frac{1}{8}\right)+\left(\frac{1}{6}-\frac{1}{9}\right)+...\right]$

$= \frac{1}{3}\left[\frac{1}{2}+\frac{1}{3}+\frac{1}{4}\right] = \frac{13}{36}$

80. B

Sol. $\frac{1}{\sin 1}\left[\frac{\sin(1-0)}{\cos 0 \cos 1} + \frac{\sin(2-1)}{\cos 2 \cos 2} + ... + \frac{\sin(45-44)}{\cos 44 \cos 45}\right]$

$= \frac{1}{\sin 1}\left[\tan 1 - \tan 0 + \tan 2 - \tan 2 + \tan 3 - \tan 2 + ... + \tan 45 - \tan 44\right]$

$= \frac{1}{\sin 1}.[1-0]$

$= \dfrac{1}{\sin 1}$

$= \dfrac{1}{x}$.

SECTION – B

81. 101

Sol. $^{41}C_0 + {}^{41}C_1 + {}^{42}C_2 + \ldots\ldots\ldots + {}^{60}C_{20}$

$^{42}C_1 + {}^{42}C_2 + \ldots\ldots\ldots + {}^{60}C_{20}$

$\dfrac{61}{41}.\,{}^{60}C_{20} = \dfrac{m}{n}.\,{}^{60}C_{20}$

82. 6

Sol. Let $P = P\left(\dfrac{(A \cap B)}{(A \cup \bar{B})}\right) = \dfrac{P(A \cap B)}{P(A \cup \bar{B})}$

$\because\ A \cap B \subset A \cap \bar{B}$

$\Rightarrow p = \dfrac{P(A \cap B)}{1 - (P(B) - PA \cap B)}$

$= \dfrac{\frac{1}{4}}{1 - \frac{1}{3} + \frac{1}{4}}$

$= \dfrac{3}{11} \Rightarrow k = 6$

83. 6

Sol. Here equation of line is $\dfrac{x-2}{1} = \dfrac{y+3}{2} = \dfrac{z-4}{-3} = \lambda$ say ……(i)

Hence any point on the line (i) will be $p(\lambda + 2,\ \lambda - 3,\ -3\lambda + 4)$

Given line (i) intersect the given plane

$2x + 3y - z = 13$ at the point P

$\Rightarrow \lambda = 2$

$\therefore P = (4, 1, -2)$

also equation (i) intersects the YZ – plane at Q i.e. $x = 0$

$\therefore \lambda + 2 = 0 \qquad \Rightarrow \qquad \lambda = -2$

$\therefore Q = (0, -7, 10)$

84. 1

Sol. Total ways in which A and B can be chosen $= \left({}^{5}C_{4}\,4!\right)^2 = (5!)^2$

Required probability = 1 – P (A and B does not contain 2)

$$=1-\frac{(4!)^2}{(5!)^2}=1-\frac{1}{25}=\frac{24}{25}=0.96$$

85. 0

Sol. Given, $\cos^{-1}\sqrt{p}+\cos^{-1}\sqrt{(1-p)}+\cos^{-1}\sqrt{(1-q)}=\frac{3\pi}{4}$

$$\Rightarrow \cos^{-1}\sqrt{p}+\cos^{-1}\sqrt{\left(1-\left(\sqrt{p}\right)^2\right)}+\cos^{-1}\sqrt{\left(1-\left(\sqrt{q}\right)^2\right)}=\frac{3\pi}{4}$$

$$\Rightarrow \cos^{-1}\sqrt{p}+\sin^{-1}\sqrt{p}+\cos^{-1}\sqrt{(1-q)}=\frac{3\pi}{4}$$

$$\frac{\pi}{2}+\cos^{-1}\sqrt{(1-q)}=\frac{3\pi}{4}$$

$$\therefore q=\frac{1}{2}$$

86. 502

Sol. $\sum_{i=0}^{100}\sum_{j=0}^{100}\left(C_i^2+C_j^2+C_iC_j\right)$

$$\sum_{i=0}^{100}\left(101\,C_i^{\,2}+{}^{200}C_{100}+C_i2^{100}\right)$$

$$=a\ {}^{2n}C_n+2^b$$

$$\Rightarrow a=202\ \ n=100,\ b=200$$

87. 6

Sol. $y=ax^2+bx+c$

y is max. at x = 2

$$\Rightarrow -\frac{b}{2a}=-2\Rightarrow b-4a$$

max value $=\frac{-D}{4a}$

$$\frac{\left(b^2-4ac\right)}{4a}=\frac{1}{2}$$

$$4ac-b^2-2a$$

$$4ac-16a^2-2a$$

$$2c-8a-1$$

$$\Rightarrow 2c-8a+5=6$$

88. 17

Sol. Let α be a double root of $f(x)=0$

$$f'(x)=4(x-1)(x-2)(x-3)$$

If $x=1$ is double root, then $f(1)=0\Rightarrow p=9$

If x = 2 is double root, then $f(2) = 0 \Rightarrow p = 8$

If x = 3 is double root, then $f(3) = 0 \Rightarrow p = 9$

$\therefore$ Sum of all possible values of p = 17

89. 2

Sol. The given series is in the form $1 + a + a^2 + a^3 ....$ to ∞ where $a = \left(\frac{\sqrt{2}-1}{2\sqrt{2}}\right)$

$$S_n = \frac{1}{1-a}$$

$$= \frac{1}{1-\left(\frac{\sqrt{2}-1}{2\sqrt{2}}\right)}$$

$$= \frac{2\sqrt{2}}{2\sqrt{2}-\sqrt{2}+1}$$

$$= \frac{2\sqrt{2}}{\sqrt{2}+1}$$

$$= 2\sqrt{2}\left(\sqrt{2}-1\right)$$

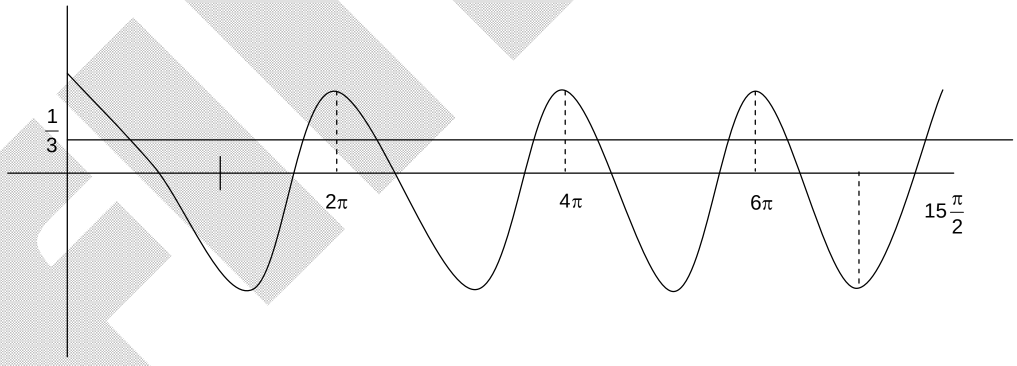
90. 15

Sol. $2\sec^2 x - 5\sec x - 3 = 0$

$(2\sec x + 1)(\sec x - 3) = 0$

$\Rightarrow \sec x = 3$

$$\cos x = \frac{1}{3}$$



FIITJEE

ALL INDIA TEST SERIES

OPEN TEST

JEE (Main)-2023

TEST DATE: 15-01-2023

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is Mathematics.
- Each part has only two sections: **Section-A and Section-B**.
- **Section – A** : Attempt all questions.
- **Section – B :** Do any five questions out of 10 questions.

Section-A (01 – 20, 31 – 50, 61 – 80) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-B (21 – 30, 51 – 60, 81 – 90) *contains 30 Numerical based questions. The answer to each question is rounded off to the nearest integer value. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

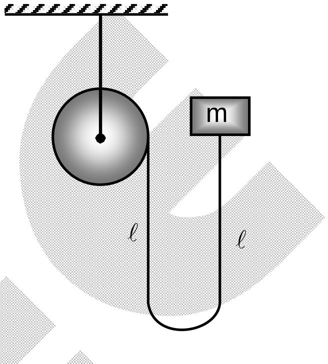
Physics

PART – A

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**



1. A block of mass m is attached to one end of a light string which is wrapped on a disc of mass 2m and radius R which if free to rotate about the horizontal axis passing through its centre of mass. The total length of the slack portion of the string is ℓ. The block is released from rest as shown. The velocity of the block just after the string becomes taut is (no slipping between disc and string)

(A) $\sqrt{g\ell}$ (B) $\sqrt{\frac{g\ell}{2}}$
(C) $\sqrt{\frac{2g\ell}{3}}$ (D) $\sqrt{\frac{3g\ell}{2}}$

2. A potential of 2 V is applied across the faces of a pure germanium plate of area 4×10^{-4} m^2 and of thickness 2×10^{-3} m. Concentration of carriers in germanium at room temperature is 1.0×10^6 m^{-3}, Mobility of electrons and holes are 0.7 m^{2}V^{-1}s^{-1} and 0.3 m^{2}V^{-1}s^{-1} respectively. The current produced in germanium plate at room temperature, is

(A) 1.40×10^{-10} A (B) 1.40×10^{-9} A
(C) 9.6×10^{-10} A (D) 6.4×10^{-14} A

3. The wavelength of the waves associated with a proton and a photon are the same. Therefore, the two have equal.

(A) mass (B) velocity
(C) momentum (D) kinetic energy

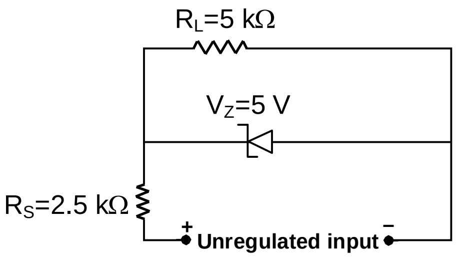
4. One mole of an ideal diatomic gas undergoes a thermodynamic process, in which its molar heat capacity varies directly proportional to temperature as C = αT, where α is a positive constant. Work done by the gas when it is heated from initial temperature T_0 to a final temperature $3T_0$ will be

(A) $4\alpha T_0^2$ (B) $(\alpha T_0 - R)\frac{3T_0}{2}$
(C) $(4\alpha T_0 - 5R)T_0$ (D) $(3\alpha T_0 - 5R)\frac{T_0}{2}$

5. When a sample of atoms is irradiated by neutrons, radioactive atoms are produced at a constant rate R, which decay with decay constant λ. The number of radioactive atoms accumulated after an irradiation time t is given by

(A) $N(t) = Rte^{-\lambda t}$ (B) $N(t) = \frac{R}{\lambda}e^{-\lambda t}$
(C) $N(t) = \frac{R}{\lambda}(1 - e^{-\lambda t})$ (D) $N(t) = Rt(1 - e^{-\lambda t})$

6. In the DC voltage regulator circuit shown, the zener breakdown voltage V_Z = 5 V. If the unregulated input varies between 11 V to 15 V, maximum zener current (in mA) is



(A) 1 (B) 2
(C) 3 (D) 4

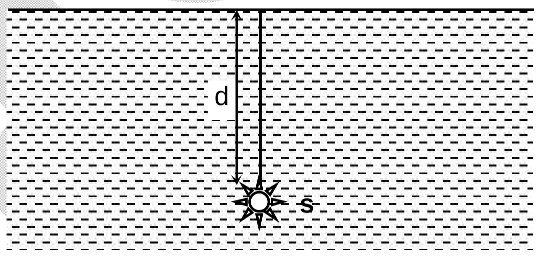
7. Radius of $^{x}_{32}$Ge (germanium) nucleus is measured to be twice the radius of $^{9}_{4}$Be nucleus. Number of neutrons in Ge are

(A) 38 (B) 40
(C) 42 (D) 44

8. A SONAR system fixed in a submarine operates at a frequency 40 kHz. An enemy submarine moves towards the SONAR with a speed of 360 km/h. The frequency of sound is reflected by submarine is (Speed of sound in water = 1400 m/s)

(A) $\frac{300}{7}$ kHz (B) $\frac{600}{13}$ kHz
(C) $\frac{560}{13}$ kHz (D) 40 kHz

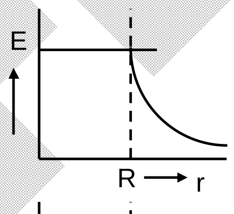
9. A point source S of light is placed at a depth d below the surface of water in a large and deep lake. Maximum fraction of light that escapes in space above directly from water (refractive index = μ) surface is given by



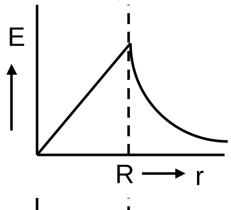
(A) $\frac{1}{2}-\sqrt{\frac{\mu^2-1}{\mu}}$ (B) $\sqrt{\frac{\mu^2-1}{\mu}}$
(C) $\frac{1}{2}-\frac{\sqrt{\mu^2-1}}{2\mu}$ (D) $\frac{1}{2}-\frac{\sqrt{\mu^2-1}}{\mu^2}$

10. In a sphere of radius R, the volume charge density ρ varies as $\rho \propto r$ (r is distance from centre). Variation of electric field E with r (For all values of r : $r \le R$ and $r > R$) is best represented by

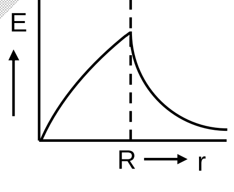
(A)



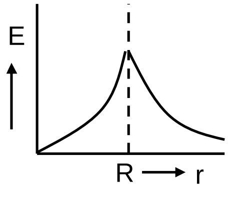
(B)



(C)



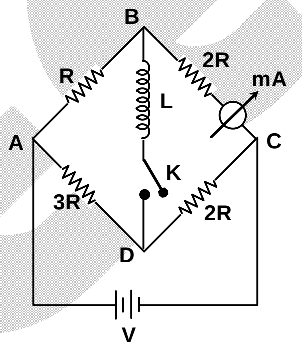
(D)



11. Binding energy per nucleon of Helium and deuterium nuclei are 7 MeV and 1.1 MeV, respectively. When two deuterium nuclei undergo fusion to form helium nucleus, energy released in the process is
(A) 23.6 J
(B) 37.76×10^{-13} MeV
(C) 23.6 eV
(D) 37.76×10^{-13} J

12. Current I flows through a long thin walled metallic cylinder of radius R with a thin longitudinal slit of width d_0(d_0 << R) running parallel to the axis of the cylinder. The magnetic induction B produced at any point on the axis of the cylinder is approximately
(A) B = zero
(B) $B = \frac{\mu_0 I}{2\pi R^2}$
(C) $B = \frac{\mu_0 I d_0}{4\pi^2 R^2}$
(D) $B = \frac{\mu_0 I d_0}{2\pi R^2}$

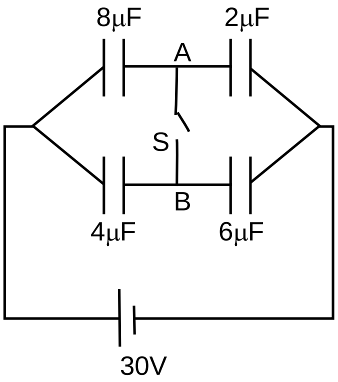
13. The reading of the ammeter, used in the electrical network shown below, is 20 mA, a long time after the key K is closed. The reading of the same ammeter, immediately after the key was closed was
(A) zero
(B) 16 mA
(C) 25 mA
(D) $\frac{70}{3}$ mA



14. Consider the diffraction pattern due to a single slit. The first maximum for a certain monochromatic light coincides with the first minimum for red light of wavelength 660 nm. The wavelength of the monochromatic light is
(A) 660 nm
(B) 550 nm
(C) 440 nm
(D) 330 nm

15. The energy of the characteristic X-ray photon in Coolidge tube comes from
(A) the kinetic energy of striking electron.
(B) the kinetic energy of the free electrons of the target.
(C) the kinetic energy of the ions of the target.
(D) the electronic transition of the target atom.

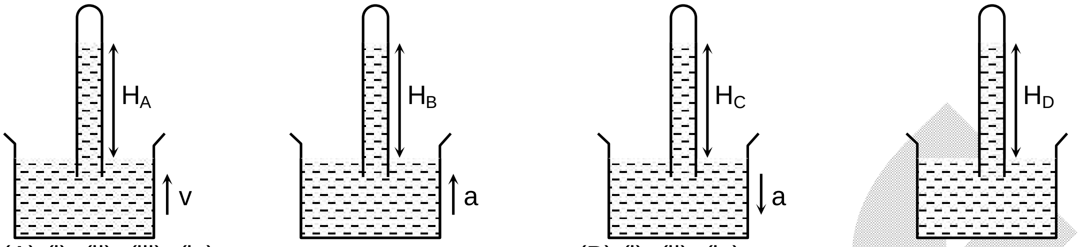
16. A system of capacitors $C_1 = 8\mu F, C_2 = 2\mu F, C_3 = 4\mu F$ and $C_4 = 6\mu F$ connected across a battery of emf E = 30 V is shown in figure. The charge that will flow, through the switch S, when it is closed is
(A) 60 μC A to B
(B) 48 μC A to B
(C) 24 μC B to A
(D) 36 μC B to A



17. Four barometer A, B, C and D are shown in the figure. A is moving up with constant velocity, B is accelerated up, C is accelerated down and D is at rest. Atmospheric pressure is represented by 76 cm of mercury column.

(i) $H_A = 76$ cm, (ii) $H_B < 76$ cm, (iii) $H_C = 76$ cm, (iv) $H_D = 76$ cm

Mark the correct answer.



(A) (i), (ii), (iii), (iv)
(B) (i), (ii), (iv)
(C) (i), (iii), (iv)
(D) (ii), (iii), (iv)

18. A total charge Q is uniformly distributed over a non-conducting ring of radius r. There is a time varying magnetic field perpendicular to its plane and changing at the uniform rate of $\frac{dB}{dt}$. The magnitude of torque experienced by the ring is

(A) $Qr^2\left(\frac{dB}{dt}\right)$
(B) $Qr^3\left(\frac{dB}{dt}\right)$
(C) $\frac{1}{2}Qr^2\left(\frac{dB}{dt}\right)$
(D) $\frac{1}{2}Qr^3\left(\frac{dB}{dt}\right)$

19. A circular loop of radius r is placed inside another circular loop of radius R (R >> r). The loops are coplanar and concentric. The mutual inductance (M) of the system is proportional to

(A) $\frac{\mu_0 \pi r}{R}$
(B) $\frac{\mu_0 \pi r^2}{R}$
(C) $\frac{\mu_0 \pi R^2}{r}$
(D) $\frac{\mu_0 \pi r^2}{R^2}$

20. A sphere and cube have equal surface area are made of the same material. The two are heated to the same temperature and kept in identical surrounding. The ratio of their initial rates of cooling is

(A) 1 : 1
(B) $\sqrt{\frac{\pi}{2}}:1$
(C) $\sqrt{\frac{\pi}{3}}:1$
(D) $\sqrt{\frac{\pi}{6}}:1$

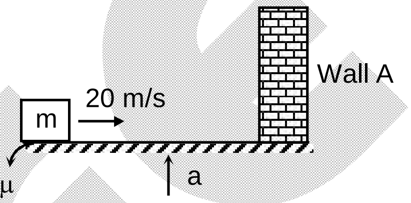
SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

21. In a young's double slit experiment distance between the slits is d = 1 mm, Wavelength of light used is 600 nm and distance of screen from the plane of slits is D = 1 m. The minimum distance between two points is $\frac{k}{10}$ mm on the screen, where intensity is maximum. Find the value of k. (Assume both sources of equal power).

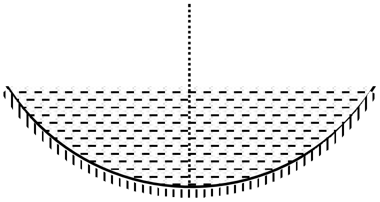
22. A block of mass m is projected from a point A with velocity 20 m/s on the rough surface having coefficient of friction μ to hit the wall B with velocity 10 m/s. With what velocity same mass m should be projected to hit the wall B with same velocity 10 m/s if the surface is moving now upward with an acceleration of a = 4g as shwon in the figure.



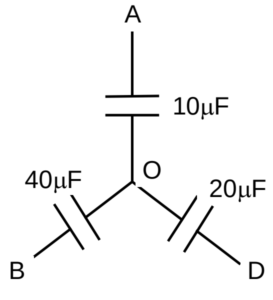
23. A sound source of constant frequency resonates with an open end organ pipe of length 30 cm and a close end organ pipe of length 23 cm (both of same diameter). Both pipes are sounding their first overtone. If velocity of sound is 340 ms^{-1}, then find the end correction in cm.

24. In an electromagnetic wave the amplitude of magnetic field is 3×10^{-8} T. If the frequency of wave is 10^{12} Hz, then find the amplitude of associated electric field in S.I. unit.

25. A concave mirror when placed in air has a focal length f = 20 cm. The mirror is now placed horizontally and filled with a thin layer of water having refractive index $\frac{4}{3}$. The object is placed at principal axis at a distance d from the mirror such that a real, inverted image coincides with the object. Find the value of d in cm.



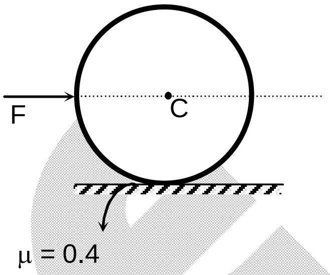
26. Three uncharged capacitors of capacitances C_1 = 10μF, C_2 = 40μF and C_3 = 20μF are connected as shown in figure to one another at O and to points A, B and D at potentials V_A = 100 V, V_B = 50 V and V_D = 200 V respectively. Calculate charge in 40 μF capacitor in μC.



27. The rate of flow of a certain liquid of viscosity η through a horizontal capillary of length ℓ and radius r is Q when the pressure difference between the inlet and outlet is equal to the atmospheric pressure. The rate of flow of the same liquid through another capillary of length 2ℓ and radius 2r when the pressure difference between inlet and outlet is 3 times the atmospheric pressure is kQ. Find the value of k.

28. A ball is projected from horizontal ground. It attains a maximum height H on its projectile path and there after strikes a stationary smooth vertical wall and falls on ground vertically below the point of maximum height. Assume the collision with wall to be perfectly elastic, the height of the point on the wall where the ball strikes is $\frac{3H}{k}$. Find the value of k.

29. A solid cylinder of mass m = 10 kg is rolling without slipping on a rough horizontal surface, under the action of a horizontal force F = 48 N such that the line of action of F passes through centre C of the cylinder. Coefficient of friction between cylinder and surface is $\mu = 0.4$. Calculate the frictional force (in newton) acting on the cylinder.



30. Two small solid balls of masses m and 8 m made up of same material and same density are tied at the two ends of a thin weightless thread. They are dropped from a balloon in air. The tension T of thread during fall, after the motion of balls has reached the steady state is T = k mg. Find the value of k.

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Chemistry

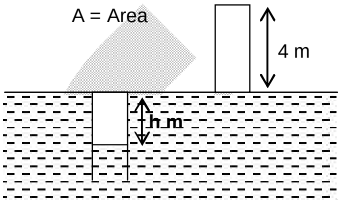
PART – B

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

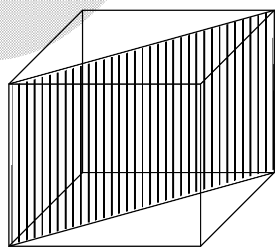
31. A 4 m long tube closed at one end is lowered vertically into water until the closed end is flushed with water surface (See figure). Calculate the water level height in the tube, h. [Barometric pressure = 1 atm = 10 m of hydrostatic water head; $T = 25^{o}C$, $d_{H_2O} = 1\ g/mL$. Neglect water vapour pressure]



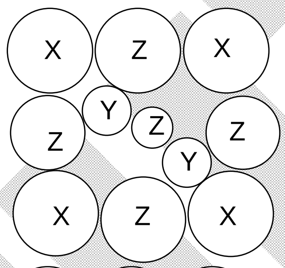
(A) 1.71 m
(B) 3.06 m
(C) 1.53 m
(D) 0.855 m

32. The oxidation state of sulphur in the dithionous and dithionic acids, respectively are:
(A) +4, +6
(B) +4, +5
(C) +3, +5
(D) +3, +6

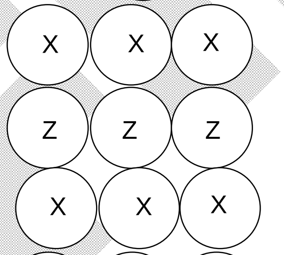
33. In a hypothetical solid, x atoms form CCP lattice. ‘Y’ atoms occupy all tetrahedral voids and ‘Z’ atoms occupy all octahedral voids. If a unit cell of crystal is cut by a plane shown in the figure, then the cross section of the plane looks like:



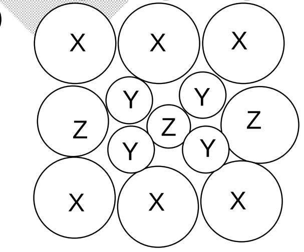
(A)

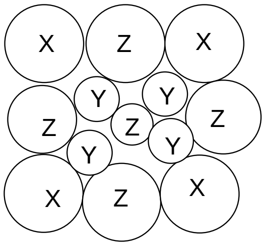


(B)

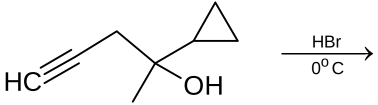


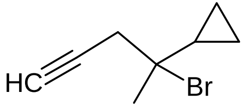
(C)

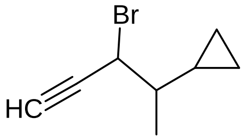


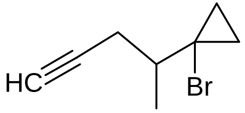
(D)


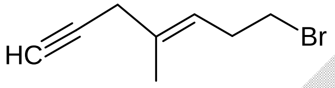
34. The major product formed in the following reaction is:



(A)


(B)


(C)


(D)


35. In the synthesis of polydimethyl siloxane, the chain forming, branching and terminating agent respectively, are

(A) Me_2SiCl_2, Me_3SiCl and $MeSiCl_3$

(B) Me_2SiCl_2, $MeSiCl_3$ and Me_3SiCl

(C) $MeSiCl_3$, Me_2SiCl_2 and Me_3SiCl

(D) Me_2SiCl_2, $MeSiCl_3$ and Me_4Si

36. Choose the correct statement(s) among the following

(I) LiF is more soluble than $LiClO_4$ in water.

(II) The standard reduction potential $\left[E^o\right]$ of Li is more negative than that of Na.

(III) The heat of hydration of $Li^+(g)$ is greater than that of $Na^+(g)$.

(A) I and II
(B) I and III
(C) II and III
(D) III only

37. The two main pollutants which are released when fossil fuels are burnt are

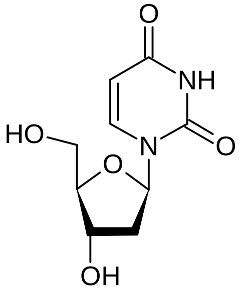
(A) O_3 and hydrocarbon

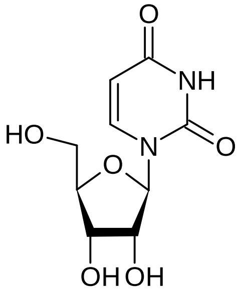
(B) NO_2 and O_3

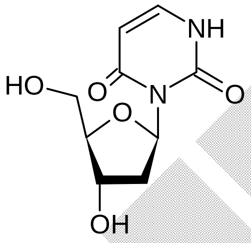
(C) NO and NO_2

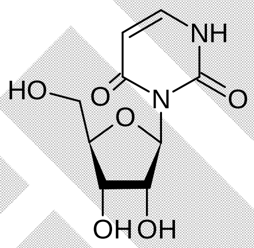
(D) NO_2 and hydrocarbon

38. The role of BF_3 as an industrial polymerization catalyst is to generate
(A) Carbanion
(B) Carbocation
(C) Organic radical
(D) Carbon radical

39. The correct structure of ribonucleoside uridine is:
(A)

O
NH
HO
N
O
O
OH

(B)

O
NH
HO
N
O
O
OH OH

(C)

NH
HO
O
N
O
O
OH

(D)

NH
HO
O
N
O
O
OH OH

40. The number of degenerate spatial orbitals of a hydrogen like atom with principal quantum number n = 5 is
(A) 25
(B) 5
(C) 50
(D) 10

41. Consider the entropy changes in a system undergoing transformation, as depicted in the diagram below

$$\begin{tikzcd} 20^{o}\,C \arrow[r, "\Delta S_1"] \arrow[rr, bend right, "\Delta S"'] & 40^{o}\,C \arrow[r, "\Delta S_2"] & 60^{o}\,C \end{tikzcd}$$

The correct statement among the following is

(A) $\Delta S_1 = \Delta S_2$ and $\Delta S = \Delta S_1 + \Delta S_2$

(B) $\Delta S_1 > \Delta S_2$ and $\Delta S \neq \Delta S_1 + \Delta S_2$

(C) $\Delta S_1 < \Delta S_2$ and $\Delta S \neq \Delta S_1 + \Delta S_2$

(D) $\Delta S_1 > \Delta S_2$ and $\Delta S = \Delta S_1 + \Delta S_2$

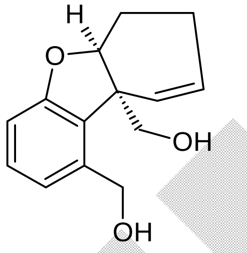
42. For the following complexes, the increasing order of magnetic moment (spin only value) is

(a) $\left[TiF_6\right]^{-3}$ (b) $\left[CrF_6\right]^{-3}$ (c) $\left[MnF_6\right]^{-3}$ (d) $\left[CoF_6\right]^{-3}$

(A) d < a < b < c
(B) c < a < d < b
(C) b $\approx$ a < d < c
(D) a < b < c $\approx$ d

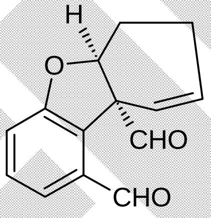
43. The stability of lyophobic colloids is a consequence of the
(A) Electric double layer at the surface of the particle
(B) van der Waal forces between the particles
(C) Small size of particles
(D) Shape of particles

44.

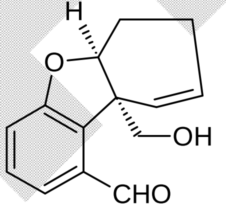


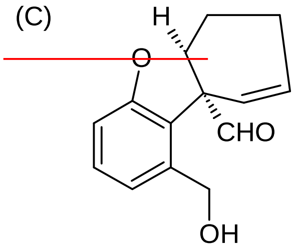
$\xrightarrow[\text{Acetone}]{MnO_2}$ The major product is?

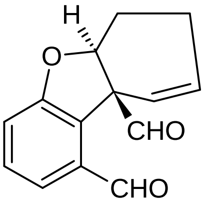
(A)



(B)



(C)


(D)


45. The rate constant of a second order reaction $A \longrightarrow B$ is k_2. If the initial concentration of the reactant is x_o and the concentration of the product at time t is a, then a linear function of t with the slope k_2x_o is :

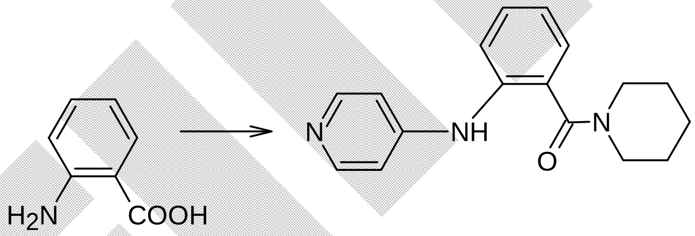
(A) $\ell n\left(\frac{a}{x_o - a}\right)$

(B) $\left(\frac{a}{x_o(x_o - a)}\right)$

(C) $\left(\frac{a}{x_o - a}\right)$

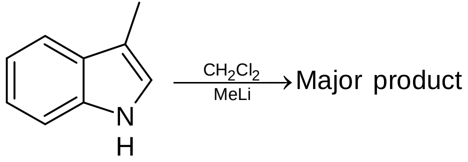
(D) $\ell n\left(\frac{a}{x_o(x_o - a)}\right)$

46. Correct sequence of reagent (i) to (iii) required for the conversion of A to B is:

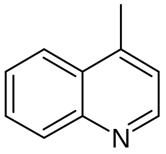


(i) Thionyl chloride
(ii) 4-chloropyridine
(iii) Piperidine
(A) i, ii and iii
(B) i, iii and ii
(C) ii, i and iii
(D) iii, i and ii

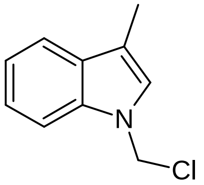
47. The major product formed in the following reaction is


N
H
CH2Cl2
MeLi
Major product

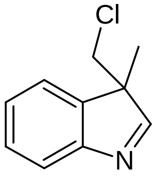
(A)



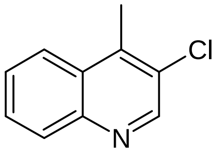
(B)



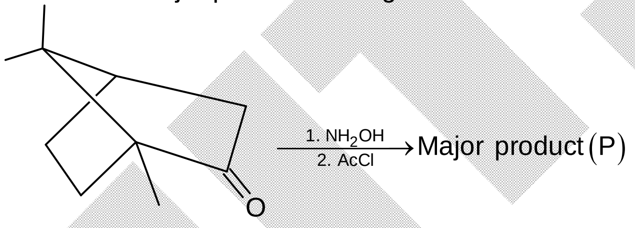
(C)



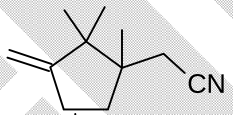
(D)



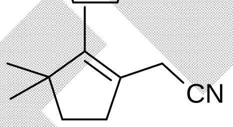
48. Predict the major product in the given reaction:


O
1. NH2OH
2. AcCl
Major product (P)

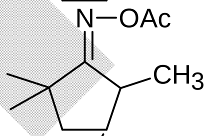
(A)



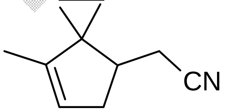
(B)



(C)



(D)



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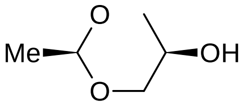
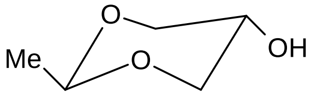
49. Among the structures given below, the one that corresponds to the most stable conformation of compound (X) be:

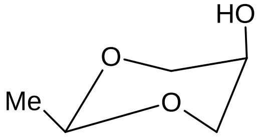


(X)

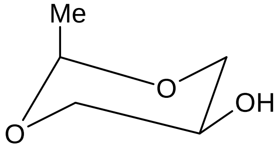
(A)



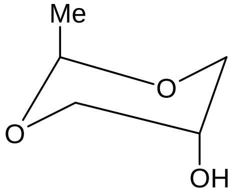
(B)



(C)



(D)



50. Allred – Rochow electronegativity of an element is:

I. Directly proportional to the effective nuclear charge.
II. Directly proportional to the covalent radius.
III. Inversely proportional to the square of the covalent radius.
IV. Directly proportional to the square of the effective nuclear charge.

The correct answer is:

(A) I and II
(B) I and III
(C) II and III
(D) I and IV

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

51. The degree of unsaturation in the product formed by heating mellitic acid $\left(C_6\left(COOH\right)_6\right)$ is:

52. XH_2 (ion exchange resin) can replace Ca^{+2} ions in hard water as $XH_2 + Ca^{+2} \longrightarrow XCa + 2H^+$. If 1 L hard water after passing through XH_2 has a pH = 4 then hardness in parts per million of Ca^{+2} is

53. The theoretical efficiency of a hypothetical cell is about 84% which involves the following reaction

$A(s) + B^{+2}(aq) \longrightarrow A^{+2}(aq) + B(s) \qquad \Delta H = -285 \text{ kJ}$

then, the standard EMF of the cell is:

54. An amount of 0.1 millimole of $CdSO_4$ is present in 10 mL acid solution of 0.08 M HCl. Now, H_2S is passed to precipitate all the Cd^{+2} ions. What would be the pH of solution after filtering off precipitate, boiling off H_2S and making the solution 100 mL by adding water?

55. The freezing point of an aqueous solution of KCN containing 0.2 mole/kg water was -0.8^oC. On addition of 0.1 mole of $Hg(CN)_2$ in the solution containing 1 Kg of water, the freezing point of the solution was -0.6^oC. Assuming that the complex is formed according to the following equation: $Hg(CN)_2 + mCN^- \longrightarrow Hg(CN)_{m+2}^{-m}$ and $Hg(CN)_2$ is the limiting reagent, the value of 4 m is:

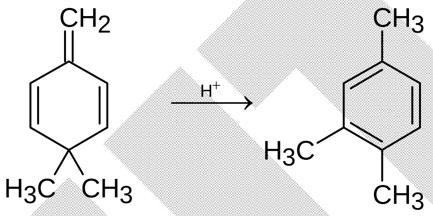
56. For the following molecules; if x is the total number of p-orbitals used in hybridisation of each central atom, then what is the value of $\frac{\sum x}{6}$?
XeO_2F_2, B_2H_6, $[NiCl_4]^{-2}$, $[PtCl_4]^{-2}$, $N(SiH_3)_3$, H_3BO_3

57. The number of optically active stereoisomer possible for X are:
$X : CH_3 - CH(OH) - CH(OH) - CH(OH) - CH_3$

58. The number of bridging carbonyls in $[Mn_2(CO)_{10}]$ are:

59. The total number of black coloured sulphides in the following are:
PbS, CuS, HgS, MnS, Ag_2S, NiS, CoS, SnS_2, CdS

60. The sum of reaction numbers for which the major product is/are correctly mentioned is:

1.


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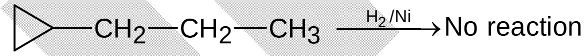

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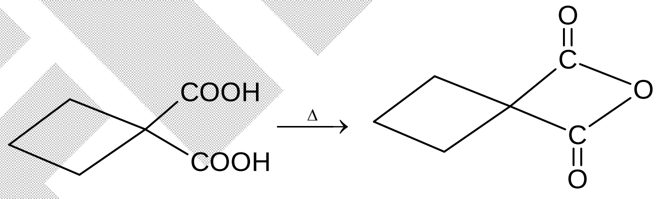
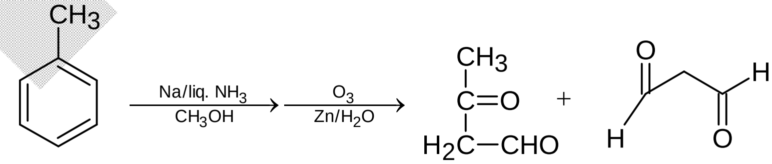


4. $2CH_3 - CH_2 - COOH \xrightarrow{\Delta} 2CH_3 - CH_3$

5.


Mathematics PART – C

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

61. Let $A = \{x : x^2 \le x + 20,000 ; x \in N\}$
$B = \{x = 3k + 2 ; k \in N\}$
$C = \{x = 4k ; k \in N\}$
The sum of the elements of the set $A \cap (B - C)$ is
(A) 2443 (B) 2447
(C) 2450 (D) 2453

62. The number of integral values of a for which the equation $x^4 - (a + 2)x^3 + 2ax^2 + 4(a - 2)x - 16 = 0$ has at least two positive roots; $a \in [-10, 10]$ is/are
(A) 5 (B) 6
(C) 7 (D) 16

63. Let $(1 + x + x^2)^{30} = \sum_{r=0}^{60} a_r x^r$. If $\alpha a_{21} = \beta a_{20} + \gamma a_{19}$, $(\alpha, \beta, \gamma \in N)$ then the value of $\alpha + \beta + \gamma$ can be
(A) 62 (B) 72
(C) 82 (D) 74

64. $\int e^{\frac{1}{2}\left(x^2+\frac{1}{x^2}\right)}\left(\frac{x^4+x^2-1}{x^2}\right)dx = f(x) + c$, then $\left(f\left(\sqrt{2}\right)\right)^4$ is
(A) e^5 (B) $2e^5$
(C) $4e^5$ (D) $\sqrt{2}e^5$

65. If $1(50)^{49} + 2(51)^1(50)^{48} + 3(51)^2(50)^{47} + \ldots.. (50)(51)^{49} = k(50)^{49}$ then the number of factor of k of the form 4m + 1, $(m \in W)$ is/are
(A) 3 (B) 4
(C) 5 (D) 7

66. If the pair of perpendicular lines $4x^2 + by^2 + 2\cos\theta\, xy + 12x + 2\sin^2\theta y + c = 0$, $\theta \in \left(\frac{3\pi}{2}, 2\pi\right)$ intersect on x-axis then the area of triangle formed by the given pair of lines and y = 2 is
(A) $\sqrt{65}$ (B) $\frac{\sqrt{65}}{2}$
(C) $\frac{\sqrt{65}}{4}$ (D) $2\sqrt{65}$

67. Consider two circles
$C_1 : (x - 1)^2 + (y - 4)^2 - 16 = 0$ and $C_2 : (x - 13)^2 + (y - 9)^2 - 81 = 0$
If a circle of radius r touches x-axis and C_1 and C_2 externally, then r is equal to
(A) 1.44 (B) 1.48
(C) 1.52 (D) 1.6

68. A line $y = m(x - 4)$ meets x-axis at P and the parabola $x^2 = 32y$ at $Q(x_1, y_1)$. The tangent to the parabola at $Q(x_1, y_1)$ meets x-axis at $R(x_2, 0)$ $0 < x_2 < 6$. If the area of triangle PQR assumes a local maximum, then the value of m is

(A) $\frac{1}{3}$ (B) $\frac{2}{3}$

(C) $\frac{1}{2}$ (D) $\frac{3}{4}$

69. Consider three curves
$H : (x + a)y = \lambda;\ \lambda < 0,\ a > 0$
$C : x^2 + y^2 - 21y + 109 = 0$
$P : y^2 = bx;\ b > 0$
Let the line $2x - y + 8 = 0$ touches the curve H, C and P at L, M & N respectively such that LM = MN = $\sqrt{45}$, then the value of $8\lambda + b + a$ is

(A) 0 (B) 1

(C) – 1 (D) 2

70. A line $L = 2x - y + 5 = 0$ is a tangent to the hyperbola $H \equiv \frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ such that foot of perpendicular from the foci of hyperbola on line L is $\left(\frac{\sqrt{3} - 2\sqrt{5}}{\sqrt{5}}, \frac{2\sqrt{3} + \sqrt{5}}{\sqrt{5}}\right)$. If the hyperbola intersects an ellipse $E \equiv \frac{x^2}{25} + \frac{y^2}{\lambda^2} = 1$ orthogonally, then eccentricity of the ellipse is

(A) $\sqrt{\frac{1}{5}}$ (B) $\sqrt{\frac{3}{5}}$

(C) $\frac{1}{5}$ (D) $\sqrt{\frac{2}{3}}$

71. Let y = y(x) be a solution curve of the differential equation $\frac{dy}{dx} + \frac{y\cos x}{\sin x + \cos x} = \frac{2\tan^2 x + \tan x + 2}{\sqrt{\sin x + \cos x}}$.
If $y\left(\frac{\pi}{4}\right) = 2^{3/4}$, then $y^2\left(\frac{7\pi}{12}\right)$ is

(A) $7\sqrt{6} + 4\sqrt{2}$ (B) $7\sqrt{2} + 4\sqrt{6}$

(C) $3\sqrt{6} + 7\sqrt{2}$ (D) $28\sqrt{2} + 16\sqrt{6}$

72. Let P(z), R(z^4) and Q(z^2) be three points in Argand plane such that PR + RQ = PQ; ($z \neq 0, 1$) then z lies on

(A) a circle centred at $\left(-\frac{1}{2}, 0\right)$ (B) a line segment having length $2\sqrt{3}$

(C) a line having slope $-\frac{1}{2}$ (D) a line parallel to y-axis

73. Let $\begin{vmatrix} a & \sqrt{5} & \sqrt{7} \\ \sqrt{3} & b & \sqrt{7} \\ \sqrt{3} & \sqrt{5} & c \end{vmatrix} = 0$, $\left(a \neq \sqrt{3}, b \neq \sqrt{5}, c \neq \sqrt{7}\right)$ and $\frac{a}{a - \sqrt{3}} + \frac{b}{b - \sqrt{5}} + \frac{c}{c - \sqrt{7}} = \lambda$, if $a = 2\sqrt{3}$ then the point (b^2, c^2) may lie on the line

(A) $5y - 21x = 0$ (B) $5y - 24x = 0$

(C) $5y - 63x = 0$ (D) $21y - 5x = 0$

74. In ΔABC, $\angle A = \tan^{-1}7$, $\angle C = \tan^{-1}\frac{4}{3}$. Let D be an interior point on side AC such that area of ABD is twice that of area of ΔBCD. If $\angle ABD = \theta$, then the value of $\tan 2\theta$ is

(A) $\frac{12}{5}$ (B) $\frac{5}{12}$

(C) $\frac{36}{77}$ (D) $\frac{77}{36}$

75. There are two townships A and B in a city containing 40% and 60% of the population respectively. 15% of the total population suffer from heart disease.
P(person suffering from heart disease who lives in A) = 6 P(person suffering from heart disease who lives in B) where P(E) denotes the probability of a event E.
A person randomly diagnosed turns out to be free from heart disease, then the probability that he lives in B township is

(A) $\frac{28}{85}$ (B) $\frac{38}{85}$

(C) $\frac{57}{85}$ (D) $\frac{47}{85}$

76. Consider the following frequency distribution

Class :	0 – 10	10 – 20	20 – 30	30 – 40	40 – 50	50 – 60
Frequency :	3	a	b	11	8	4

If the mean is $\frac{277}{9}$ and median is $\frac{335}{11}$, then the value of 4a + b is

(A) 40 (B) 38
(C) 50 (D) 48

77. Consider the following statements
P : Sachin is a topper
Q : Sachin is sincere
R : Sachin is not demotivated
The negation of the statement.
If Sachin is a sincere and he is not demotivated, then he is a topper

(A) $P \rightarrow (Q \vee R)$ (B) $(\sim P) \wedge (Q \wedge R)$
(C) $P \rightarrow ((\sim Q) \vee (\sim R))$ (D) $P \rightarrow (Q \wedge R)$

78. The upper four-fifth portion of a vertical tower subtends an angle $\tan^{-1}\frac{8}{21}$ at a point A in the horizontal plane through its foot and at a distance 50m from the foot. If the angle subtended by the lower one fifth of tower at point A is β, then the height of the tower can be

(A) 25 (B) 50
(C) 13 (D) 75

79. Let N be the number of four digits even numbers such that if 3 is one of the digit, then 5 is the succeeding digit. If N can be resolved as $P_1^{\alpha}P_2^{\beta}P_3^{\gamma}$ (P_1, P_2, P_3 are primes and α, β, γ are natural numbers then $P_1 + P_2 + P_3$ is

(A) 11 (B) 31
(C) 29 (D) 9

80. Let $S_1 = \{z \in c : |z - 2| \le |\text{Re}Z + 2|\}$
$S_2 = \{z \in c : z(1 + i) + \bar{z}(1 - i) - 12 \le 0\}$
$S_3 = \{z \in c : \text{Re}Z \ge 0,\ \text{Im}Z \ge 0\}$
and $S = S_1 \cap S_2 \cap S_3$, then the maximum value of $|z - 20i|^2$; $z \in S$
(A) 436
(B) 446
(C) 456
(D) 384

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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81. If the sum of values of θ in $(-3\pi, 3\pi)$ satisfying

$$\sum_{m=1}^{15} \sec\left(\theta + (m-1)\frac{\pi}{18}\right)\sec\left(\theta + m\frac{\pi}{18}\right) = \left(4 + 2\sqrt{3}\right)\operatorname{cosec}\frac{\pi}{18} \text{ is } \frac{k\pi}{10}$$

then the value of k is _______

82. If $\begin{matrix} 2\left(\sin A - \sin^3 A\right) = \cos B \\ 2\left(\cos A + \cos^3 A\right) = \sin B \end{matrix}$; $0 < A, B < \pi/2$, then the value of $\cos B = \sqrt{\frac{m}{n}}$, m & n are co-prime where m + n is _______

83. Let $\frac{5}{6}\cos^{-1}\sqrt{\frac{3}{3+\pi^2}} + \frac{1}{3}\sin^{-1}\frac{2\sqrt{3}\pi}{3+\pi^2} + \frac{1}{6}\tan^{-1}\frac{\sqrt{3}}{\pi} = a$

and $\cos^{-1}\left[\frac{13}{40}\cos\left(\cot^{-1}\frac{5}{12}\right) + \frac{13}{32}\sin\cos^{-1}\left(\frac{5}{13}\right)\right] = b$

then cosec $\left(\int_b^a \left[\frac{\tan x}{\sqrt{3}}\right] dx\right)$ is ([.] represents greatest integer function)

84. Let $A = \begin{bmatrix} 1 & 0 & 0 \\ \sqrt{a} & 1 & 0 \\ a\sqrt{a} & \sqrt{b} & 1 \end{bmatrix}$; $a, b \in R^+$. If for some $n \in N$, $A^n = \begin{bmatrix} 1 & 0 & 0 \\ 72 & 1 & 0 \\ 3600 & 72 & 1 \end{bmatrix}$ then number of triangles formed by joining the vertices of n sided polygon having no side common with the polygon are

85. Consider the curves

$$\left.\begin{matrix} C_1 : y^2 - x = 0 \\ C_2 : y - x^2 = 0 \end{matrix}\right\} ;\ 0 \le x \le \frac{\sqrt{3}}{2}$$

$$C_3 : y = f(x) \qquad ;\ f(x) < 0 \quad \forall x \in \left(0, \frac{\sqrt{3}}{2}\right)$$

From any point P on C_2, lines are drawn parallel to the coordinate axes so as to intersect C_1 at Q and C_3 at R. If area of region OPRO is twice of the area of region OPQO; (O being origin) then the value of $\left|32f\left(\frac{1}{2}\right)\right|$ is

86. Let f be a differentiable function satisfying (f(x) – 1) (f(y) – 1) = f(x + y) –1 $\forall$ x, y $\in$ R ; f(0) $\neq$ 1, f'(0) = ln4. If $\lim\limits_{x\to 1}\dfrac{\sin\left(f(x)-5\right)+2-2^x}{x^3-7x^2+ax+b}$ = ln8, then the value of a – b is

87. Let f(x) = $\begin{cases} 6a\left(\ln 2\right)^2\tan^{-1}\left(\dfrac{b+x}{3}\right) & ; \quad -1 < x < 0 \\ \dfrac{\ln 4}{3} & ; \quad x = 0 \\ \dfrac{2^{\frac{cx}{3}}-1}{x} & ; \quad 0 < x < 1 \end{cases}$

If f(x) is differentiable at x = 0, then the value of $\dfrac{b^2+9}{a}$ is

88. Let f : R $\to$ R, g : R $\to$ R and h : R $\to$ R be differentiable function such that f(x) = x^5 + $2x^3$ + 3x + 3 g(f(x) = x and h(g(g(x))) = x $\forall$ x $\in$ R, then h'(0) is

89. If L_1 is the line of intersection of the planes x + y + z – 6 = 0, 2x + 3y + z – 5 = 0 and line L_2 is $\dfrac{(x-14)}{3}=\dfrac{y+6}{0}=\dfrac{z-2}{1}$. If P is the plane containing lines L_1 and L_2 which intersects the coordinate axes at A, B, C respectively, then volume of tetrahedron OABC (O is origin) is V. The value of 90V is

90. Let $\hat{x}, \hat{y}$ and $\hat{z}$ be unit vectors such that $\hat{x}+\hat{y}-\hat{z}=\vec{p}, \hat{x}\times\left(\hat{y}\times\hat{z}\right)=\hat{q}$ and $\left(\hat{x}\times\hat{y}\right)\times\hat{z}=\vec{r}$. If $\left|\vec{p}\right|=\sqrt{7}, \vec{q}\cdot\hat{y}=5$ and $\vec{p}$ is perpendicular to $\hat{x}$, then the number of positive integral solutions(s) of the equation $x_1x_2x_3$ = $\left(\left(\hat{x}\cdot\hat{y}\right)\left(\hat{y}\cdot\hat{z}\right)\left(\hat{z}\cdot\hat{x}\right)\right)^4$ is

FIITJEE

ALL INDIA TEST SERIES

OPEN TEST

JEE (Main)-2023

TEST DATE: 15-01-2023

ANSWERS, HINTS & SOLUTIONS

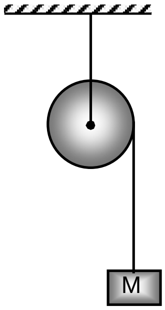
Physics

PART – A

SECTION – A

1. B

Sol. Applying conservation of angular momentum of system about centre of mass of disc



$$mvR = mv'R + \frac{2mR^2}{2}\omega$$

$$v' = R\omega$$

$$mvR = mv'R + mv'R$$

$$v' = \frac{v}{2} = \frac{\sqrt{2g\ell}}{2} = \sqrt{\frac{g\ell}{2}}$$

2. D

Sol. $I = neA(\mu_e + \mu_h)E$

$$= 1.0\times10^{6}\times1.6\times10^{-19}\times4\times10^{-4}(1.0)\times\frac{2}{2\times10^{-3}} = 6.4\times10^{-14}\text{ A}$$

3. C

Sol. Basic concepts

4. C

Sol. $C = C_V + \dfrac{dW}{ndT}$

$$\int dW = \int_{T_0}^{3T_0}\alpha T dT - \int_{T_0}^{3T_0}\frac{5R}{2}dT \text{ for one mole}$$

$$W = (4\alpha T_0 - 5R)T_0$$

FIITJEE

5. C

Sol. $\frac{dN}{dt} = R - \lambda N$

So $\int_0^N \frac{dN}{R-\lambda N} = \int_0^t dt \Rightarrow \ln(R-\lambda N)\Big|_0^N = -\lambda t$

So $\ln\frac{R-\lambda N}{R} = -\lambda t$

So $1 - \frac{\lambda N}{R} = e^{-\lambda t} \Rightarrow N = \frac{R}{\lambda}\left(1-e^{-\lambda t}\right)$

6. C

Sol. Zener current will be maximum, when V = 15V

$15 - (i \times 2.5k) = 5$

$i = 4$ mA

$i_z = 3$ mA

7. B

Sol. $\frac{R_{Ge}}{R_{Be}} = \left(\frac{X}{9}\right)^{1/3}$

X = 72

Number of neutron = 72 – 32 = 40

8. B

Sol. frequency received by submarine

$n_1 = \left(\frac{1400+100}{1400}\right) \times 40 \times 10^3 = \left(\frac{15}{14}\right) \times 40 \times 10^3$

Frequency reflected by submarine

$n_2 = \left(\frac{1400}{1400-100}\right) n_1 = \left(\frac{15}{13}\right) \times 40 \times 10^3 \text{ Hz} = \frac{600}{13}\text{kHz}$

9. C

Sol. $f = \frac{2\pi(1-\cos\theta_C)}{4\pi}$

$f = \frac{2\pi}{4\pi}\left[1 - \sqrt{1-\frac{1}{\mu^2}}\right] = \frac{1}{2}\left[1 - \sqrt{1-\frac{1}{\mu^2}}\right]$

10. D

Sol. For $(r \le R)$

$E \times 4\pi r^2 = \int_0^r cx 4\pi x^2 dx / \varepsilon_0$

So $E \propto r^2$

and For $(r \ge R)$

$E \propto \frac{1}{r^2}$

11. D

Sol. ${}_1^2H + {}_1^2H = {}_2^4He$

$BE_H = 1.1$ MeV

$BE_{He} = 7$ MeV

Q_{value} = Binding energy of product – Binding energy of reactants
$= (4 \times 7 - 4 \times 1.1)$ MeV = 23.6 MeV
$= 23.6 \times 1.6 \times 10^{-19} \times 10^{6} = 37.76 \times 10^{-23}$

12. C

Sol. $B = \frac{\mu_0 dI}{2\pi R} = \frac{\mu_0 I d_0}{(2\pi R)(2\pi R)} = \frac{\mu_0 I d_0}{4\pi^2 R^2}$

13. D

Sol. After long time,

$I_A = \frac{2V}{7R} = 20$ mA …(i)

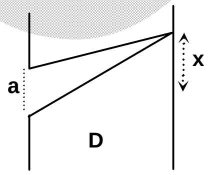
Immediately after the key is closed,

$I = \frac{V}{3R} = \frac{70}{3}$ mA

14. C

Sol. For 1st secondary minima $\frac{ax}{D} = \lambda_1$

For 1st secondary maxima $\frac{ax}{D} = \frac{3\lambda_2}{2}$



$\lambda_1 = \frac{3}{2}\lambda_2$

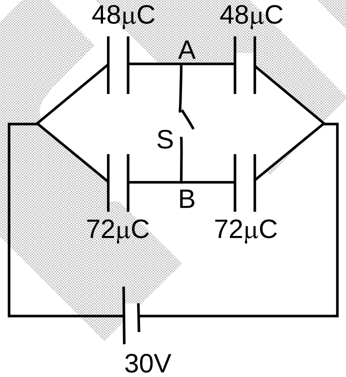
$\lambda = 440$ Å

15. D

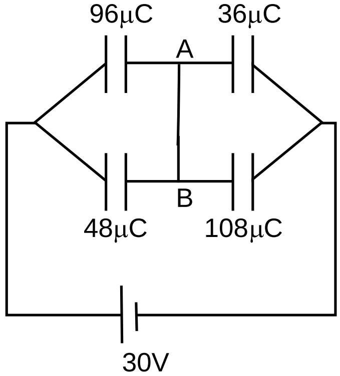
Sol. Basic Concepts

16. A

Sol. When S is open



When S is closed



So charge flown = 60 μC
From A to B

17. B

Sol. Basic concept

18. C

Sol. $E2\pi r = \frac{d}{dt}(B\pi r^2)$

$E = \frac{r}{2}\frac{dB}{dt}$

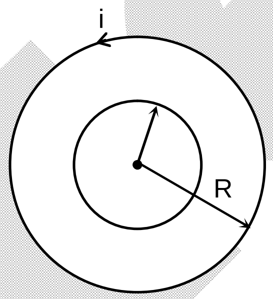
$\tau = QEr = \frac{Qr^2}{2}\frac{dB}{dt}$

19. B

Sol. $B = \frac{\mu_0 i}{2R}$

$\phi = B\pi r^2 = \frac{\mu_0 i\pi r^2}{2R}$

Mutual inductance, $M = \frac{\phi}{i} = \frac{\mu_0\pi r^2}{2R}$



20. D

Sol. Rate of cooling

$-\frac{dT}{dt} = \frac{\varepsilon\sigma A(T^4 - T_s^4)}{mC} = r$

$\frac{r_{sphere}}{r_{cube}} = \frac{m_{cube}}{m_{sphere}} = \frac{\rho a^3}{\rho\frac{4}{3}\pi r^3}$

given, $4\pi r^2 = 6a^2$

$\frac{r_{sphere}}{r_{cube}} = \frac{3\left(\frac{4\pi}{6}\right)^{3/2} r^3}{4\pi r^3} = \sqrt{\frac{\pi}{6}}$

SECTION – B

21. 6

Sol. Separation between two maxima $\beta = \frac{\lambda D}{d}$

22. 40

Sol. $v_0^2 = 4v_0^2 - (2)(\mu g)(d) \Rightarrow 2\mu gd = 3v_0^2$

$v_0^2 = v^2 - (2)(5\mu g)(d) \Rightarrow v^2 = v_0^2 + 15V_0^2$

So $v = 4v_0$

23. 1

Sol. $\frac{2v}{2(\ell_0 + 1.2d)} = \frac{3v}{4(\ell_c + e)}$

So $4(23+e)=3(30+2e)$

So e = 1 cm

24. 9

Sol. $E_0 = CB_0$

$= 3\times10^{8}\times3\times10^{-8}$ = 9 V/m

25. 30

Sol. $\frac{1}{f_e}=-2\frac{1}{f_\ell}+\frac{1}{f_m}$,

Where $\frac{1}{f_\ell}=\left(\frac{4}{3}-1\right)\left(\frac{1}{40}\right)=\frac{1}{120}$

So $\frac{1}{f_e}=-2\frac{1}{120}-\frac{1}{20}=-\frac{1}{15}\text{cm}$

So R = 30 cm

26. 2000

Sol. $(100-v)10+(200-v)20+(50-v)40=0$

So v = 100 volt

Q = 40 × 50 = 2000 μC

27. 24

Sol. $\frac{dV}{dt}=\frac{\pi\Delta pr^4}{8\eta\ell}$

$Q=\frac{\pi P_0 r^4}{8\eta\ell}$

Now, $Q'=\frac{\pi3P_0(2r)^4}{8\eta\times2\ell}=\frac{3\pi P_0 r^4}{\eta\ell}=24Q$

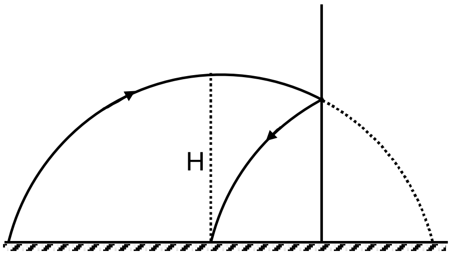
28. 4

Sol. $y=x\tan\theta\left(1-\frac{x}{R}\right)\Rightarrow H=\frac{R}{2}\tan\theta\left(1-\frac{1}{2}\right)$

$\Rightarrow\ H=\frac{R\tan\theta}{4}$

$y=\frac{3R}{4}\tan\theta\left(1-\frac{3R}{4R}\right)$

$=\frac{3R}{16}\tan\theta=\frac{3R}{16}\frac{4H}{R}=\frac{3H}{4}$



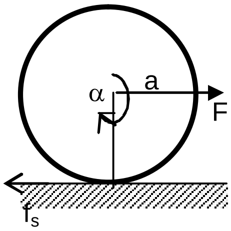
29. 16

Sol. $a=\alpha R$

$F-f_S=ma$ …(i)

$f_S R=\frac{mR^2\alpha}{2}$

$f_S=\frac{ma}{2}$ ..(ii)



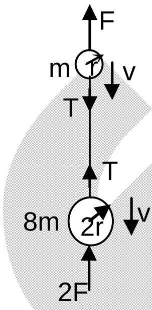
FIITJEE

$$F = \frac{3ma}{2}$$

$$\Rightarrow a = \frac{2F}{3m} \Rightarrow f_S = \frac{ma}{2} = \frac{F}{3}$$

30. 2

Sol. In steady state, v = constant



$9\,mg = 3F$

$\Rightarrow F = 3\,mg$ … (i)

$T + mg = F$

$T = F - mg = 3mg - mg = 2mg$

$T = 2mg$

FIITJEE

Chemistry

PART – B

SECTION – A

31. B

Sol. $P_1V_1 = P_2V_2$

$10\text{m} \times (4) \times A = (10 + h)\text{m} \times h \times A$

$h = 3.06$ m

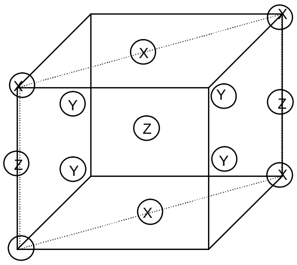
32. C

Sol. Dithionous acid → $H_2S_2O_4$ $S = +3$

Dithionic acid → $H_2S_2O_6$ $S = +5$

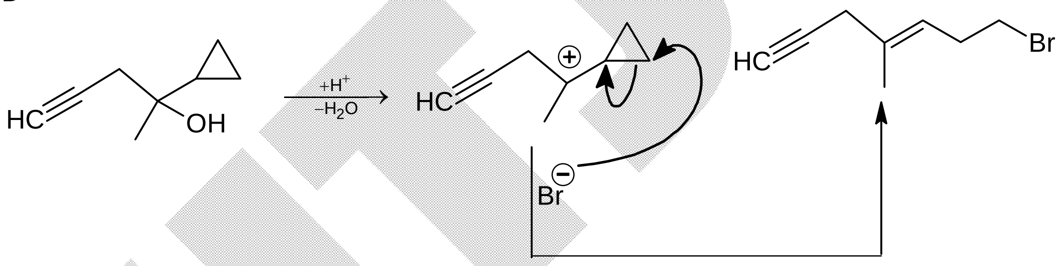
33. C

Sol.



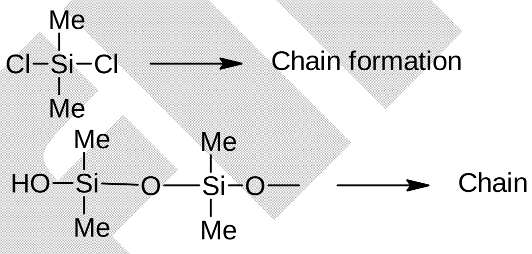
34. D

Sol.



35. B

Sol.



$$\text{Cl}-\overset{\text{Me}}{\underset{\text{Me}}{\text{Si}}}-\text{Cl} \longrightarrow \text{Chain formation}$$

$$\text{HO}-\overset{\text{Me}}{\underset{\text{Me}}{\text{Si}}}-\text{O}-\overset{\text{Me}}{\underset{\text{Me}}{\text{Si}}}-\text{O}- \longrightarrow \text{Chain}$$

36. C

Sol. $LiClO_4$ is more soluble than LiF.

37. D

Sol. Factual

38. B

Sol. BF_3 is electron deficient and is used to generate electrophile in F.C. reactions. Therefore, acts as catalyst in industrial processes.

39. B

Sol. Uridine is glycosylated pyrimidine-containing uracil attached to ribose ring.

$\text{Ribose}(\text{sugar}) + \text{Uracil}(\text{base}) \longrightarrow \text{Nucleoside}$

40. A

Sol. Degenerate orbitals $= n^2$

$= (5)^2 = 25$

41. D

Sol. $\Delta S \rightarrow$ State function $\quad \Delta S = \Delta S_1 + \Delta S_2$

$\Delta S = \dfrac{q}{T}$ since q = same; smaller temperature, higher entropy.

42. D

Sol. $Ti^{+3} \longrightarrow 3d^1 \longrightarrow t_{2g}^1$

$Cr^{+3} \longrightarrow 3d^3 \longrightarrow t_{2g}^3$

$Mn^{+3} \longrightarrow 3d^4 \longrightarrow t_{2g}^3 eg^1$

$Co^{+3} \longrightarrow 3d^6 \longrightarrow t_{2g}^4 eg^2$

43. A

Sol. Factual

44. B

Sol. MnO_2 oxidises unhindered primary allylic and benzylic alcohols to aldehyde.

45. C

Sol. $\dfrac{1}{x_o - a} - \dfrac{1}{x_o} = k_2 t$

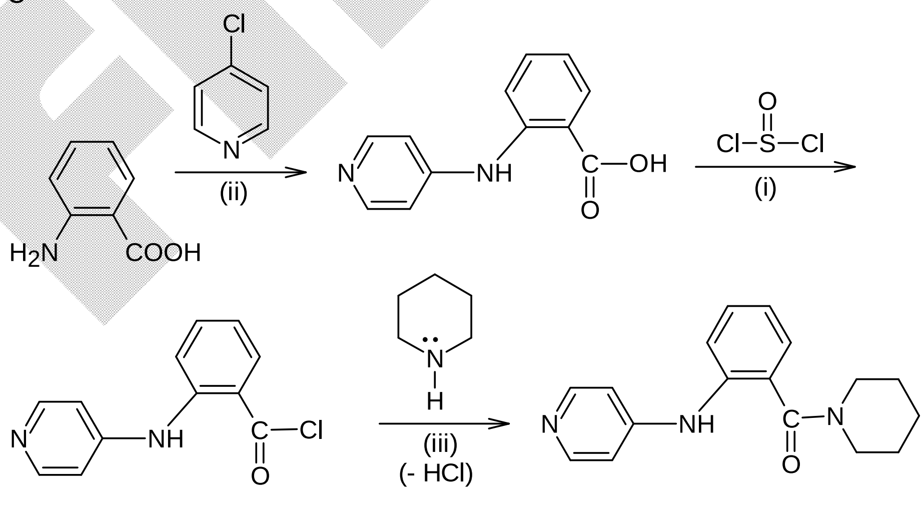
Rearranging

$\dfrac{a}{x_o - a} = x_o k_2 t$

$\therefore \dfrac{a}{x_o - a}$ vs. t gives $x_o k_2$ as slope.

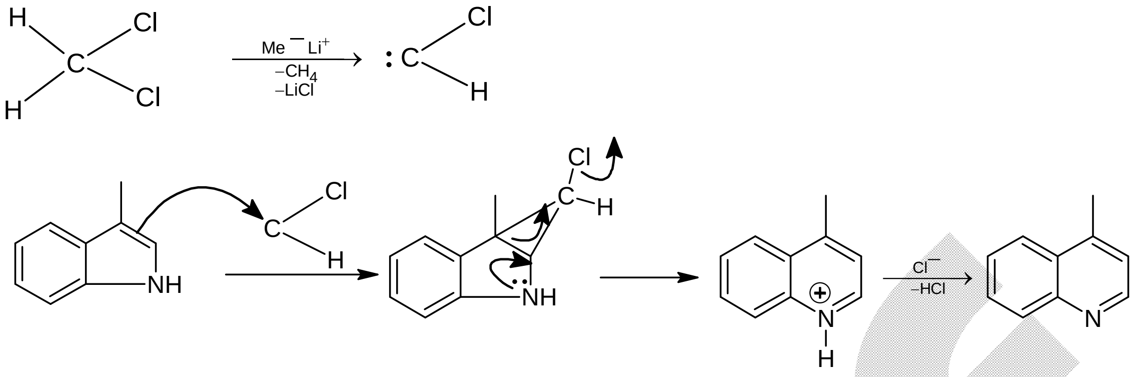
46. C

Sol.



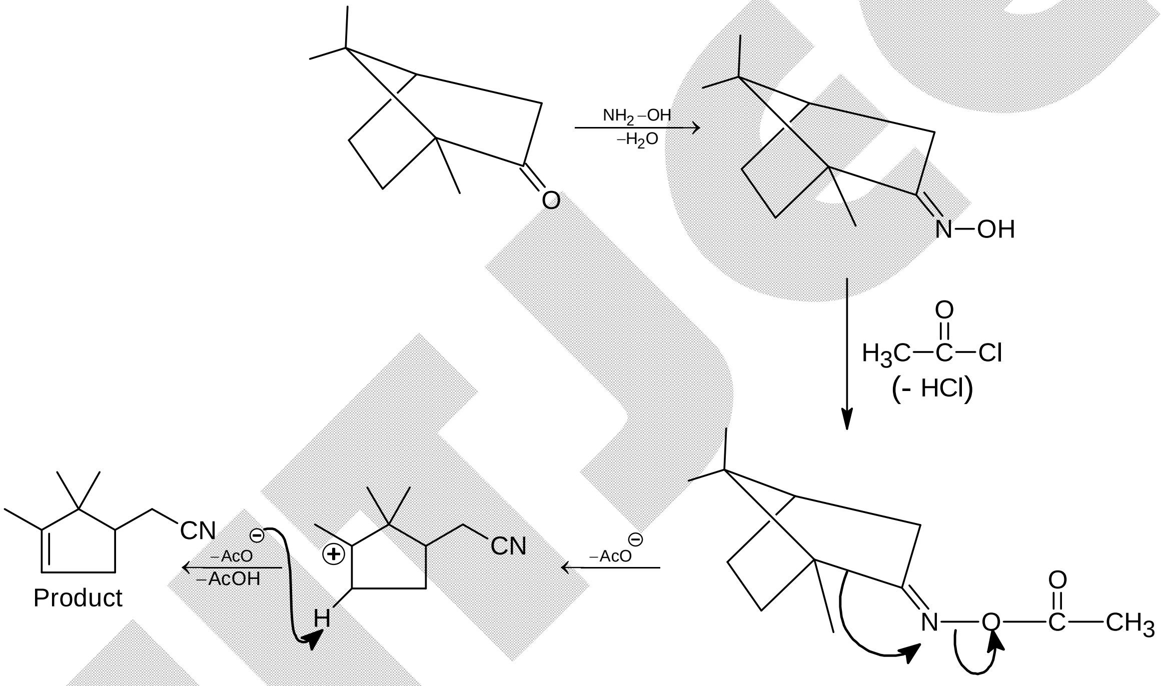
47. A

Sol.

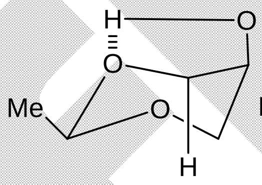

H
Cl
C
H
Cl
Me⁻ Li⁺
−CH4
−LiCl
:C
Cl
H
NH
Cl
C
H
Cl
C
H
NH
N
H
Cl⁻
−HCl
N

48. D

Sol.


O
NH2−OH
−H2O
N−OH
H3C−C(=O)−Cl
(- HCl)
N
O
C
O
CH3
−AcO⁻
CN
H
−AcO
−AcOH
CN
Product

49. B



Sol. Hydrogen bonding and as 1-3 dihedral interaction between methyl and hydrogen.

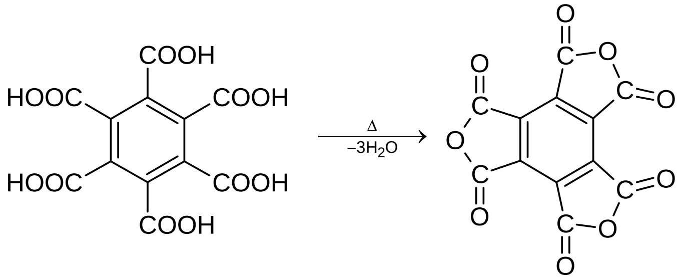
50. B

Sol. $x_A = \frac{0.744 + 0.359Z_{eff}}{r_A^2} \leftarrow \text{Alfred} - \text{Rochow scale}$

SECTION – B

51. 13

Sol.



DOU = 13

52. 2

Sol. $\left[H^{+}\right] = 10^{-4}$

$\therefore \left[Ca^{+2}\right] = \dfrac{10^{-4}}{2} M$

Weight of Ca^{+2} $= 20 \times 10^{-4}$ g in 1 L

$\therefore$ Weight of Ca^{+2} ion in 10^6 mL $H_2O = \dfrac{20 \times 10^{-4} \times 10^{6}}{10^{3}} = 2$

$\therefore$ Hardness = 2 ppm.

53. 1

Sol. Theoretical efficiency $= \dfrac{-\Delta G^{o}}{-\Delta H^{o}}$

$0.84 = \dfrac{-\Delta G^{o}}{285}$

$\Delta G^{o} = -0.84 \times 285 \text{ kJ} = -nFE^{o}_{cell}$

$E^{o}_{cell} = 1.24 \text{ V}$

54. 2

Sol.

$$Cd^{+2} + H_2S \rightleftharpoons Cd(s) + 2H^{+}$$

Initial 0.1×10^{-3} moles $\quad 0.08 \times 10 \times 10^{-3}$ moles

final $-$ $\quad 0.8 \times 10^{-3} + 0.2 \times 10^{-3}$

$= 10^{-3}$ moles

$\therefore \left[H^{+}\right]_{final} = \dfrac{10^{-3}}{100} \times 1000 = 0.01 \text{ M} = 10^{-2} \text{ M}$

pH = 2.0

55. 8

Sol. For KCN: $\Delta T_f = i.K_f.m \Rightarrow 0.8 = K_f.0.2 \times 2$

$K_f = 2$ … (i)

$$Hg(CN)_2 + mCN^{-} \longrightarrow Hg(CN)_{m+2}^{-m}$$

Initial 0.1 $\quad$ 0.2 $\quad$ –

Final $(0.2 - 0.1\,m)$ $\quad$ 0.1

Final effective molality = (0.2 – 0.1 m) + 0.1 + 0.2

= 0.5 – 0.1 m

New: $\Delta T_f = K_f.m$

$0.6 = 2 \times (0.5 - 0.1\,m)$

m = 2

4m = 8

56. 3

Sol. $XeO_2F_2 \longrightarrow sp^3d \quad \rightarrow x = 3$

$B_2H_6 \longrightarrow sp^3 \quad \rightarrow x = 6$

$[NiCl_4]^{-2} \longrightarrow sp^3 \quad \rightarrow x = 3$

$[PtCl_4]^{-2} \longrightarrow dsp^2 \quad \rightarrow x = 2$

$N(SiH_3)_3 \longrightarrow sp^2 \quad \rightarrow x = 2$

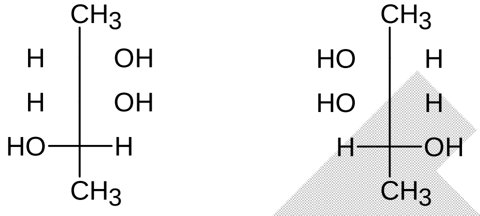
$H_3BO_3 \longrightarrow sp^2 \quad \rightarrow x = 2$

$\sum x = 3 + 6 + 3 + 2 + 2 + 2 = 18$

$\therefore \frac{\sum x}{6} = 3$

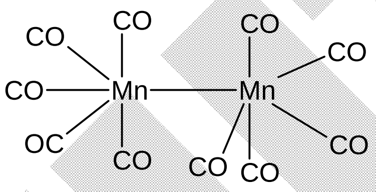
57. 2

Sol.


CH3
H
OH
H
OH
HO
H
CH3
CH3
HO
H
HO
H
H
OH
CH3

58. 0

Sol.


CO
CO
CO
Mn
OC
CO
CO
CO
Mn
CO
CO
CO

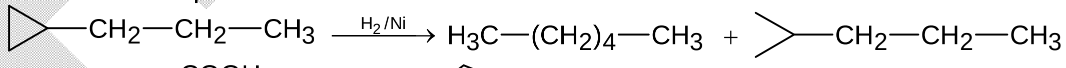
59. 6

Sol. Black coloured : PbS, CuS, HgS, Ag_2S, NiS and CoS.

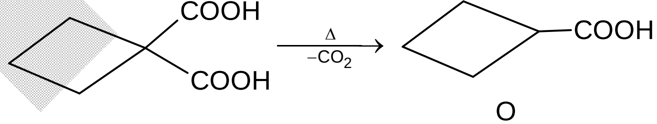
60. 6

Sol. 1 and 5 have correct products.

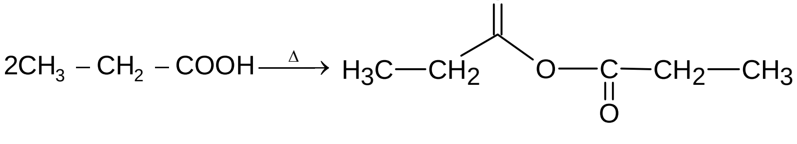
2.


CH2—CH2—CH3
H2/Ni
H3C—(CH2)4—CH3
+
CH2—CH2—CH3

3.


COOH
COOH
Δ
−CO2
COOH

4.



$$2CH_3 - CH_2 - COOH \xrightarrow{\Delta} H_3C-CH_2-\overset{O}{\overset{\|}{C}}-O-\underset{O}{\underset{\|}{C}}-CH_2-CH_3$$

Mathematics PART – C

SECTION – A

61. B

Sol. $A = \{1, 2, 3, \ldots\ldots, 141\}$
$A \cap (B - C) = \{5, 11, 14, 17, 23, 26, 29, \ldots\ldots 134, 137\}$
Sum of elements = $(5 + 11 + 17 + \ldots\ldots 137) + (14 + 26 + 38 + \ldots\ldots 134)$

62. C

Sol. $x^2 - ax + 4 = 0$ must have atleast one positive root
$\because \quad \alpha\beta > 0$
$\therefore$ both roots must be positive
$\Rightarrow \quad a \geq 4$

63. B

Sol. $30(1 + x + x^2)^{30}(1 + 2x) = \sum_{r=0}^{60} r a_r x^{r-1}(1 + x + x^2)$
Equating coefficient of x^{20} on both sides we have,
$30(a_{20} + 2a_{19}) = 21a_{21} + 20a_{20} + 19a_{19}$
$\Rightarrow 21a_{21} = 10a_{20} + 41a_{19}$

64. C

Sol. Use $\int\left(xg'(x) + g(x)\right)dx = xg(x) + C_1$

65. C

Sol. $k = 2500 = 2^2.5^4$
$\therefore$ number of factor = 5

66. B

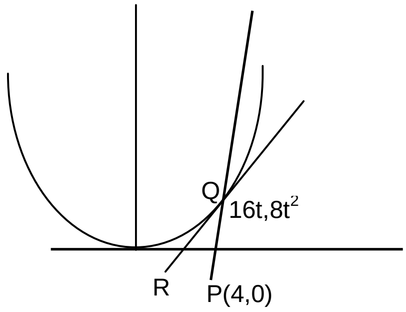
Sol. $b = -4,\ c = 9$
$2\sin^2\theta = 3\cos\theta$
$\Rightarrow 2\cos^2\theta + 3\cos\theta - 2 = 0$
$\cos\theta = \frac{1}{2}\ \therefore \sin^2\theta = \frac{3}{4}$
$\therefore 4x^2 - 4y^2 + xy + 12x + \frac{3}{2}y + 9 = 0$

67. A

Sol. $r = \frac{r_1 r_2}{r_1 + r_2 + 2\sqrt{r_1 r_2}}$

68. B

Sol. $A = \frac{1}{2}(4 - 8t)8t^2 = 16(t^2 - 2t^3)$
$\frac{dA}{dt} = 16(2t - 6t^2) = 0 \Rightarrow t = 0, \frac{1}{3}$
$\frac{d^2A}{dt^2} = 16(2 - 12t) < 0$ at $t = \frac{1}{3} \Rightarrow$ A is maximum
$\therefore Q\left(\frac{16}{3}, \frac{8}{9}\right)$ lies on the line $\therefore m = \frac{2}{3}$



69. A

Sol. M is (1, 10)

$\therefore$ N is (4, 16)

L is (–2, 4)

Equation of tangent to $(x + a)y = \lambda$ is

$$y = 2x + \frac{\lambda}{t} + 2(a - t);\ \lambda = -2t^2$$

$\therefore$ $2a - 4t = +8 \Rightarrow a - 2t = 4$

and $(a - 2)4 = \lambda = -2t^2$

$\therefore$ $(t + 2)^2 = 0$

$\Rightarrow$ $t = -2$

$\therefore$ $\lambda = -8$ & $a = 0$

70. B

Sol. $4a^2 - b^2 = 25$

Equation of auxiliary circle is $x^2 + y^2 = 8$

$\Rightarrow$ $a^2 = 8,\ b^2 = 7$

Also $a^2 + b^2 = A^2 - \lambda^2$

$\Rightarrow$ $\lambda^2 = 25 - 15 = 10$

$\therefore$ eccentricity of ellipse $e = \sqrt{1 - \frac{10}{25}} = \sqrt{\frac{3}{5}}$.

71. D

Sol. IF = $e^{x/2}\sqrt{\sin x + \cos x}$

$\therefore$ solution is $ye^{x/2}\sqrt{\sin x + \cos x} = \int e^{x/2}\left(\tan x + 2\sec^2 x\right)dx$

$ye^{x/2}\sqrt{\sin x + \cos x} = 2e^{x/2}\tan x + c$

$\because y\left(\frac{\pi}{4}\right) = 2^{3/4}$ $\therefore$ c = 0

$$y = \frac{2\tan x}{\sqrt{\sin x + \cos x}}$$

72. D

Sol. $\text{Arg}\left(\frac{z^4 - z}{z^2 - z}\right) = 0$

$\Rightarrow \text{Arg}\left(\frac{z(z-1)(z^2+z+1)}{z(z-1)}\right) = 0$; $z \neq 0, 1$

$\Rightarrow z^2 + z + 1$ is positive real number $(x + iy)^2 + x + iy + 1 > 0$

$\Rightarrow x^2 - y^2 + x + 1 > 0$ and $y(1 + 2x) = 0$

(i) $y = 0,\ x^2 + x + 1 > 0 \Rightarrow x \in R$

(ii) $x = -\frac{1}{2},\ y^2 < \frac{3}{4} \Rightarrow y \in \left(-\frac{\sqrt{3}}{2}, \frac{\sqrt{3}}{2}\right)$.

73. C

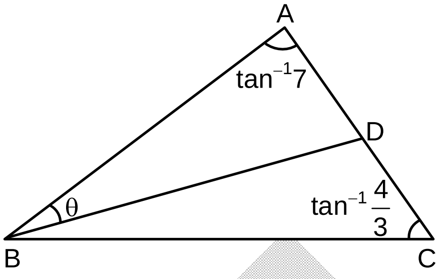
Sol. $\frac{a}{a-\sqrt{3}} + \frac{b}{b-\sqrt{5}} + \frac{c}{c-\sqrt{7}} = 2$

If $a = 2\sqrt{3}$, then $\frac{b}{b-\sqrt{5}} + \frac{c}{c-\sqrt{7}} = 0$

Possible value of $b = \frac{2\sqrt{5}}{3}$, c = $2\sqrt{7}$.

FIITJEE

74. D



Sol. $$\frac{\frac{1}{2}\sin\left(\tan^{-1}\frac{4}{3}\right)BD\sin\theta}{\frac{1}{2}\sin\left(\tan^{-1}7\right)BD\sin\left(\frac{\pi}{4}-\theta\right)}=2$$

$$\Rightarrow \frac{\frac{4}{5}\sin\theta}{\frac{7}{5\sqrt{2}}\left(\frac{\cos\theta-\sin\theta}{\sqrt{2}}\right)}=2 \Rightarrow \cot\theta=\frac{11}{7}$$

75. C

Sol. $P(A)=\frac{2}{5}$, $P(B)=\frac{3}{5}$

$P(D)=\frac{3}{20}$

$$6\times\frac{2}{5}x+\frac{3}{5}\times x=\frac{3}{20}\Rightarrow x=\frac{1}{20}$$

$$P\left(\frac{B}{D^C}\right)=\frac{P\left(B\cap D^C\right)}{P(D^C)}=\frac{\frac{3}{5}\times\frac{19}{20}}{\frac{85}{100}}=\frac{57}{85}$$

76. A

Sol. $$\frac{\sum_{i=1}^{n}x_if_i}{\sum_{i=1}^{n}f_i}=\frac{15a+25b+980}{26+a+b}=\frac{277}{9} \qquad \ldots(1)$$

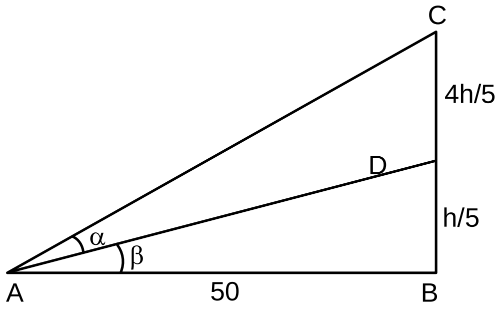
Also $$30+\frac{\frac{26+a+b}{2}-(a+b+3)}{11}\times10=\frac{335}{11}$$

$\Rightarrow$ a + b = 19 …(2)

From (1) and (2) a = 7, b = 12.

77. B

78. A



Sol. $\tan(\alpha+\beta)=\frac{h}{50}$

$$\Rightarrow \frac{h}{50}=\frac{\frac{8}{21}+\frac{h}{250}}{1-\frac{8}{21}\times\frac{h}{250}}=\frac{2000+21h}{5250-8h}$$

h = 25

79. B

Sol. $\boxed{3}\,\boxed{5}$ …… $= 9 \times 5 = 45$

$\_\_$ $\boxed{3}\,\boxed{5}$ $\_\_\_\_$ $= 8 \times 5 = 40$

……………. $= 8 \times 9 \times 9 \times 5 = 3240$

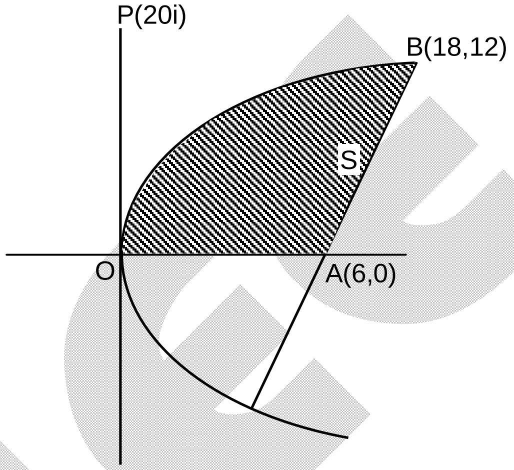
N = 3325

80. A

Sol. $PB = \sqrt{324+64} = \sqrt{388}$

$PA = \sqrt{36+400} = \sqrt{436}$

OP = 20



SECTION – B

81. 5

Sol. $$\sum_{m=1}^{15} \frac{\sin\left(\theta + m\frac{\pi}{18} - \left(\theta + (m-1)\frac{\pi}{18}\right)\right)}{\cos\left(\theta + m\frac{\pi}{18}\right)\cos\left(\theta + (m-1)\frac{\pi}{18}\right)}$$

$$= \sum_{m=1}^{15} \tan\left(\theta + m\frac{\pi}{18}\right) - \tan\left(\theta + (m-1)\frac{\pi}{18}\right)$$

$$\Rightarrow \quad \tan\left(\theta + \frac{5\pi}{6}\right) - \tan\theta = 4 + 2\sqrt{3}$$

$$\Rightarrow \quad \cos\left(2\theta + \frac{5\pi}{6}\right) = 1$$

$$\Rightarrow \quad \theta = n\pi - \frac{5\pi}{12};\ n \in I.$$

82. 59

Sol. Squaring and adding

$1 + \sin^6 A + \cos^6 A + 2(\cos^4 A - \sin^4 A) = 1/4$

$\Rightarrow$ $2 + 1 - 3\sin^2 A \cos^2 A + 2\cos 2A = 1/4$

$2 - 3/4 \sin^2 2A + 2\cos 2A = 1/4$

$\Rightarrow$ $3\cos^2 2A + 8\cos 2A + 4 = 0$

$\cos 2A = -2/3$

$$\sin A = \sqrt{\frac{5}{6}}$$

$$\therefore \quad \cos B = 2\left(\sqrt{\frac{5}{6}} - \frac{5}{6}\sqrt{\frac{5}{6}}\right) = \sqrt{\frac{5}{54}}.$$

83. 13

Sol. $a = \frac{5\pi}{12}, b = \frac{\pi}{3}$

$$\int_{\pi/3}^{5\pi/12}\left[\frac{\tan x}{\sqrt{3}}\right]dx$$

$$= \int_{\pi/3}^{\tan^{-1}2\sqrt{3}} 1 + \int_{\tan^{-1}2\sqrt{3}}^{5\pi/12} 2dx = \cot^{-1}2\sqrt{3} = \operatorname{cosec}^{-1}13.$$

84. 546

Sol. Let A = I + B where B = $\begin{bmatrix} 0 & 0 & 0 \\ \sqrt{a} & 0 & 0 \\ a\sqrt{a} & \sqrt{b} & 0 \end{bmatrix}$, $B^2 = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ \sqrt{ab} & 0 & 0 \end{bmatrix}$, $B^3 = 0$ (Null)

$\therefore A^n = I + {}^nC_1B + {}^nC_2B^2$

$$\Rightarrow A^n = \begin{bmatrix} 1 & 0 & 0 \\ n\sqrt{a} & 1 & 0 \\ na\sqrt{a} + \frac{n(n-1)}{2}\sqrt{ab} & n\sqrt{b} & 1 \end{bmatrix}$$

$\Rightarrow n\sqrt{a} = n\sqrt{b} = 72 \Rightarrow$ a = b and $72a + 36\left(72 - \sqrt{a}\right) = 3600$

$\Rightarrow \sqrt{a} = 4 \Rightarrow a = 16$ and n = 18.

85. 20

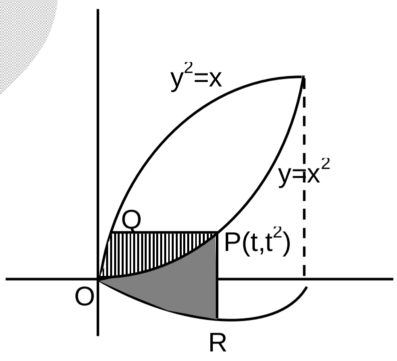
Sol. Let $P(t, t^2)$, $Q(t^4, t^2)$

$$\int_0^t \left(x^2 - f(x)\right)dx = 2\int_0^{t^2}\left(\sqrt{y} - y^2\right)dy$$

$\Rightarrow t^2 - f(t) = 2(t - t^4)2t$

$\Rightarrow f(t) = 4t^5 - 3t^2$

$f\left(\frac{1}{2}\right) = \frac{4}{32} - \frac{3}{4} = -\frac{20}{32}$.



86. 20

Sol. $f(x) = 1 + 4^x$

$$\lim_{x\to 1}\frac{\sin(4^x - 4) + 2 - 2^x}{x^3 - 7x^2 + ax + b} = \ln 8$$

For $\left(\frac{0}{0}\right)$ form a + b = 6

Also $\lim_{x\to 1}\frac{\left(\cos(4^x - 4)\right)4^x\ln 4 - 2^x\ln 2}{3x^2 - 14x + a} = \ln 8$

$\Rightarrow \frac{6\ln 2}{a - 11} = 3\ln 2$

$\Rightarrow a - 11 = 2 \Rightarrow a = 13, b = -7$

87. 81

Sol. For continuity at x = 0

$$\lim_{x\to 0}\frac{2^{\frac{cx}{3}}-1}{\frac{cx}{3}}\cdot\frac{c}{3}=\frac{\ln 4}{3}\Rightarrow c = 2$$

For differentiability at x = 0

$$\lim_{x\to 0^-}\frac{6a(\ln 2)^2}{1+\left(\frac{b+x}{3}\right)^2}\cdot\frac{1}{3}=\lim_{x\to 0}\frac{\frac{2^{\frac{cx}{3}}-1}{x}-\frac{\ln 4}{3}}{x}$$

$$\Rightarrow \frac{6a(\ln 2)^2}{3\left(1+\frac{b^2}{9}\right)}=\lim_{x\to 0}\frac{3(2^{\frac{cx}{3}}-1)-x\ln 4}{3x^2}$$

$$= 2\frac{(\ln 2)^2}{9}=\lim_{x\to 0}\frac{3\left(2^{\frac{cx}{3}}\ln 2\times\frac{c}{3}\right)-\ln 4}{6x}=\frac{2(\ln 2)^2}{9}$$

$$= \frac{6a}{3}\frac{(\ln 2)^2\times 9}{b^2+9}=\frac{2(\ln 2)^2}{9} = \frac{b^2+9}{a}=81$$

88. 1386

Sol. h(g(g(x))) = x

h'(g(g(x)).g'(g(x).g'(x) = 1 ; g(x) = $f^{-1}(x)$

h'(0) $\Rightarrow$ g(g(x)) = 0 $\Rightarrow$ g(x) = f(0) = 3 $\Rightarrow$ x = f(3) = 309

Also g'(f(x)) = $\frac{1}{f(x)}$

g'(3) = $\frac{1}{f'(0)}=\frac{1}{3}$

g'(309) = $\frac{1}{f'(3)}=\frac{1}{462}$

$\Rightarrow$ h'(0) = $\frac{1}{g'(3)g'(309)}$

89. 10648

Sol. L_1 is parallel to vector $2\hat{i}-\hat{j}-\hat{k}$ and it passes through point (13, –7, 0).

Equation of plane P is x + 5y – 3z + 22 = 0

$$V = \frac{1}{6}\begin{vmatrix}-22 & 0 & 0\\ 0 & -\frac{22}{5} & 0\\ 0 & 0 & \frac{22}{3}\end{vmatrix}=\frac{(22)^3}{90}.$$

90. 225

Sol. Let $\hat{x}\cdot\hat{y} = a$, $\hat{y}\cdot\hat{z} = b$, $\hat{x}\cdot\hat{z} = c$

$\left|\hat{x}+\hat{y}-\hat{z}\right| = \left|\vec{p}\right| \Rightarrow a - b - c = 2$ …(1)

Also $c\hat{y} - a\hat{z} = q$ …(2)

and $c\hat{y} - b\hat{x} = r$ …(3)

$\because\ \vec{q}\cdot\hat{y} = 5 \quad \therefore\ c - ab = 5$ …(4)

and $c - a = 1$ …(5)

Hence a = 1, b = –3, c = 2

FIITJEE

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – V

JEE (Main)-2023

TEST DATE: 18-01-2023

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is Mathematics.
- Each part has only two sections: **Section-A and Section-B**.
- **Section – A** : Attempt all questions.
- **Section – B :** Do any five questions out of 10 questions.

Section-A (01 – 20, 31 – 50, 61 – 80) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-B (21 – 30, 51 – 60, 81 – 90) *contains 30 Numerical based questions. The answer to each question is rounded off to the nearest integer value. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

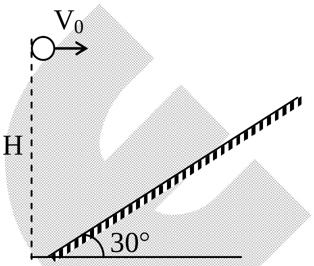
PART – A

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. In the given figure, the angle of inclination of the inclined plane is 30°. A particle is projected horizontally from a height H above the foot of the inclined plane. Find the horizontal velocity V_0 so that the particle will retrace the path after hitting the inclined plane. Collision is perfectly elastic.

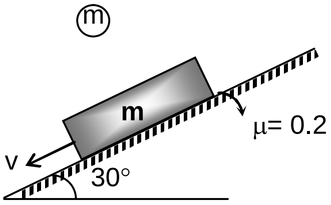


(A) $v_0 = \sqrt{\frac{2gH}{5}}$ (B) $v_0 = \sqrt{\frac{2gH}{7}}$

(C) $v_0 = \sqrt{\frac{gH}{5}}$ (D) $v_0 = \sqrt{\frac{gH}{7}}$

2. A signal of frequency 25 KHz and peak voltage 20 V is used to modulate a carrier wave of frequency 1.5 MHz and peak voltage 50 V. Choose the correct statement.
(A) Modulation index is 0.4, side frequency bands are 1475 KHz and 1525 KHz
(B) Modulation index is 0.4, side frequency bands are 2950 KHz and 3150 KHz
(C) Modulation index is 2.5, side frequency bands are 1475 KHz and 1575 KHz
(D) Modulation index is 2.5, side frequency bands are 2950 KHz and 3150 KHz

3. A ball of mass m falls vertically from a height h = $\frac{20}{3}$m and collides with a block of equal mass m moving down an inclined plane with a velocity v as shown in the figure. The coefficient of kinetic friction between the block and the surface is 0.2, while the coefficient of restitution (e) between the ball and the block is 0.5. Three is no friction acting between the ball and the block. The velocity of the block decreases by



(A) 5 m/s (B) 0
(C) 1 m/s (D) 3 m/s

4. Air column in an open organ pipe of length ℓ = 30 cm resonates with a sonic source emitting wave of frequency f = $1100H_Z$. If maximum pressure variation in the pipe over the atmospheric pressure due to standing wave is 0.1 P_0, where P_0 is the atmospheric pressure. Find the difference of the maximum and minimum pressure in the tube at a distance 5 cm from the open end. Take speed of sound in air equal to 330 m/s and ignore the end correction.

(A) $\frac{\sqrt{3}}{20}P_0$ (B) $\frac{\sqrt{3}}{10}P_0$

(C) $\sqrt{3}P_0$ (D) $2P_0$

5. At time t = 0, a horizontal disc starts rotating with angular acceleration 1 rad/sec^2 about an axis perpendicular to its plane and passing though its center. A small block is lying on this disc at a distance 0.5 m from center, coefficient of friction between surface of block and disc is 0.255. The block will start slipping on the disc at time t, is approximately equal to

(A) $2\sqrt{3}$ s (B) $2\sqrt{2}$ s

(C) 6 s (D) $\sqrt{5}$ s

6. A thin spherical conducting shell of radius R has a charge q. Another charge Q is placed at the centre of the shell. Calculate electrostatic potential at a point P a distance R/2 from the centre of the shell.

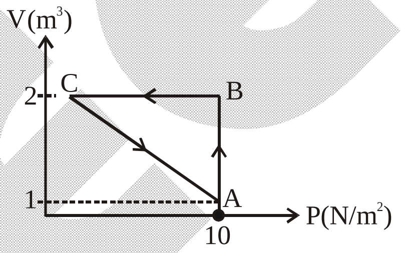
(A) $\frac{2Q}{2\pi\varepsilon_0 R}-\frac{2q}{4\pi\varepsilon_0 R}$ (B) $\frac{Q}{2\pi\varepsilon_0 R}+\frac{q}{4\pi\varepsilon_0 R}$

(C) $\frac{(q+Q)}{2\pi\varepsilon_0}\frac{2}{R}$ (D) $\frac{2Q}{2\pi\varepsilon_0 R}$

7. An ammeter reads upto 1 ampere. Its internal resistance is 0.81 ohm. To increase the range to 10A the value of the required shunt is –

(A) 0.3 Ω (B) 0.9 Ω
(C) 0.09 Ω (D) 0.30 Ω

8. An ideal gas is taken through a cycle A → B → C → A as shown in figure. If the heat supplied in the cycle is 5J, then work done on the gas in the process C → A is in joules is



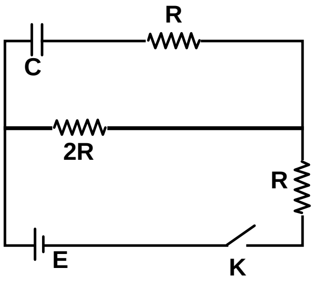
(A) –5J (B) –10J
(C) –15J (D) –20J

9. A space vehicle approaching a planet has a speed v, when it is very far from the planet. At that moment tangent of its trajectory would miss the centre of the planet by distance R. If the planet has mass M and radius r, what is the value of R in order that the resulting orbit of the space vehicle will just miss the surface of the planet ?

(A) $R=\frac{r}{v}\left[v^2+\frac{2GM}{r}\right]^{1/2}$ (B) $R=vr\left[1+\frac{2GM}{r}\right]$

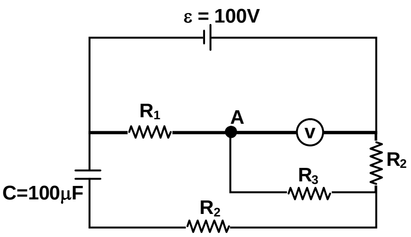
(C) $R=\frac{r}{v}\left[v^2+\frac{2GM}{r}\right]$ (D) $R=\frac{2GMv}{r}$

10. In the given circuit, the capacitor of capacitance C is charged by closing key K at t = 0. Find the time required to charge the capacitor up to maximum charge for the given circuit, if it were to be charged with the constant initial charging rate at t = 0 in the given circuit.



(A) RC/3 (B) 2RC/3
(C) 2RC/3 (D) 5RC/3

11. In the circuit shown in figure E is a battery of emf 100 V. Resistance R_1 = 100Ω, R_2 = 200Ω, R_3 = 200Ω. The voltmeter resistance is 200Ω. What reading will the voltmeter show in steady state ?



(A) 50/3 V (B) 400/7 V
(C) 100/3 V (D) 50 V

12. A ray of light travelling in a medium of refractive index μ is incident at an angle θ on a composite transparent plate consisting of 50 plates of refractive indices 1.01μ, 1.02μ, 1.03μ.....1.50μ. The ray emerges from the composite plate into a medium of refractive index 1.6μ at angle x. Then

(A) $\sin x = \left(\frac{1.01}{1.5}\right)^{50} \sin\theta$ (B) $\sin x = \frac{5}{8}\sin\theta$

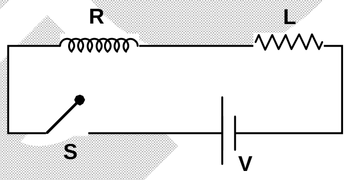
(C) $\sin x = \frac{8}{5}\sin\theta$ (D) $\sin x = \left(\frac{1.5}{1.01}\right)^{50} \sin\theta$

13. The binding energy per nucleon of deuteron $\left({}_{1}^{2}H\right)$ and helium nucleus $\left({}_{2}^{4}He\right)$ is 1.1 MeV and 7 MeV respectively. If two deuteron nuclei react to form a single helium nucleus, then the energy released is–

(A) 23.6 MeV (B) 26.9 MeV

(C) 13.9 MeV (D) 19.2 MeV

14. An inductor of inductance $L = \frac{\tau R}{2}$ and a resistor of resistance R is connected to a battery of emf V as shown in the figure. The potential difference across the resistance at a time, $t = \tau \ln 2$ after the switch S is closed is (τ is constant)



(A) $\frac{V}{4}$ (B) $\frac{3V}{4}$

(C) $\frac{V}{2}$ (D) $\frac{2V}{3}$

15. A resistance R draws P power when connected to an AC source. If an inductance is now placed in series with the resistance, such that the impedance of the circuit becomes Z, the power drawn will be

(A) $P\left(\frac{R}{Z}\right)^2$ (B) $P\left(\frac{R}{Z}\right)$

(C) $P\sqrt{\frac{R}{Z}}$ (D) P

16. At STP 44.8 liter of helium gas is confined in a cylindrical vessel by a movable piston. The gas is thermally insulated from surrounding, however, heat is supplied to the gas very slowly by an electric heater consequently piston moves slowly. In this process find the heat supplied to the gas by the heater to increase its temperature by 20°C. Ignore any dissipative force on the piston. (R is universal gas constant)

(A) 200 R (B) 100 R

(C) 60 R (D) 140 R

17. Wavelength of K_α X-ray of an element A is λ_1 and wavelength of K_α X-ray element B is λ_2. $\frac{\lambda_1}{\lambda_2}$ is equal to $\frac{1}{4}$ and Z_1 and Z_2 are the atomic numbers of element A and B respectively. Then relation between Z_1 and Z_2 are given by

(A) $2Z_2 - Z_1 = 1$ (B) $Z_2 - 2Z_1 = 1$

(C) $\frac{Z_2}{Z_1} = 4$ (D) $\frac{Z_1}{Z_2} = 4$

18. A radioactive element undergoes two different types of radioactive disintegration, one with disintegration constant λ_1 and the other with λ_2 .The half-life of the element is

(A) $\frac{0.693}{\lambda_1+\lambda_2}$
(B) $\frac{0.693}{(\lambda_1+\lambda_2)/2}$
(C) $0.693\frac{\lambda_1\lambda_2}{\lambda_1+\lambda_2}$
(D) $\frac{0.693}{2}\frac{\lambda_1\lambda_2}{\lambda_1+\lambda_2}$.

19. A photon collides with a stationary hydrogen atom in ground state inelastically. Energy of the colliding photon is 10.2 eV. Almost instantaneously, another photon collides with same hydrogen atom inelastically with an energy of 15 eV. What will be observed by the detector ?
(A) two photons of energy 10.2 eV
(B) two photons of energy 1.4 eV
(C) one photon of energy 10.2 eV and an electron of energy 1.4 eV
(D) one electron having kinetic energy nearly 11.6 eV

20. A uniform string of mass m = 200 g and lengths l = 5m is stretched along x-axis. One end at x = 0 is attached to a harmonic oscillator and the other end is fixed to a rigid support. Tension in the string is T = 1600 N. At the time t = 0, the oscillator starts producing transverse harmonic waves in the string. The y-coordinate of a particle in the string near the source varies with time as y = 0.5 cm sin (100π t), where t is the time in second. Find the y-co-ordinate of the mid point on the string at the instant when first disturbance emitted by the source reaches the fixed end.

(A) $\frac{1}{2\sqrt{2}}$ cm
(B) $-\frac{1}{2\sqrt{2}}$ cm
(C) $\frac{1}{\sqrt{2}}$ cm
(D) $\frac{1}{2}$ cm

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

---

21. An electric lamp designed for operation on 110V AC is connected to a 220 V AC supply, through a choke coil of inductance 2H, for proper operation. The angular frequency of the AC is 100$\sqrt{10}$ rad/s. If a capacitor is to be used in place of the choke coil, its capacitance must be (in μF)

22. A cylindrical block of mass m = 200 gm is suspended from a fixed support by a light spring of stiffness k = 90 N/m. The block is slightly pulled down from its equilibrium and then the pulling force is removed. Consequently, the block performs oscillatory motion. If damping constant of air is 40 g/s, the time (in sec) after which displacement amplitude reduces to the half of the initial value is nearly

23. An object is projected with a speed 10 m/s at an angle of 30º with the horizontal. The object breaks down into n equal fragments during its motion. One fragment is found to strike the ground at a distance of $\sqrt{3}$ m from the point of projection in the same azimuthal plane, in which the object is projected. If the centre of mass of the remaining fragments strikes the ground at distance of 7$\sqrt{3}$ m from the point of projection, then the value of n is

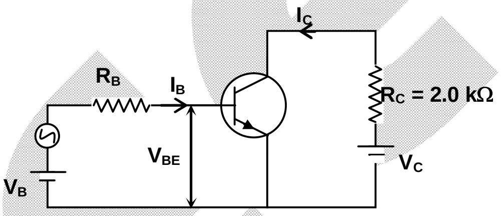
24. A beam of light converges at a point P. A converging lens of focal length 25 cm is placed in the path of the beam before converging it at P at a distance of 20 cm from the point P. Now locate the point where beam will converge. Find the distance from the position of the lens.

25. All atoms in a sample of helium gas are in the first excited state. Photons emitted from these atoms due to de-excitation are incident on the surface of a metal having work function $\phi = 2.8$ eV. Find the stopping potential of the photoelectrons ejected from metal surface. The ionization energy of hydrogen atom is 13.6 eV.

26. The half life of the radioactive nuclei ${}^{60}_{26}\text{Co}$ is 5.3 year. The activity of a sample containing ${}^{60}_{26}\text{Co}$ nuclei is observed to be 8.0 mCi. Find the amount of ${}^{60}_{26}\text{Co}$ in the sample in microgram. (Given: $1\text{Ci} = 3.7 \times 10^{10}$ dPS)

27. When forward biasing across a p-n junction diode is increased from 0.65 V to 0.70 V, the diode current increases by 5mA. Find the dynamic resistance of the diode.

28. Circuit diagram of a common emitter amplifier is shown in the figure. The audio signal voltage across the collector resistance $R_C = 2.0\ \text{k}\Omega$ is 2V. The current amplification factor of the transistor is 100. Find the value of R_B (in kΩ) in the series with v_B supply of 2V. given that DC base current is 10 times the signal current and $V_{BE} = 0.6$ V.



29. A 200 m long antenna is fixed on a 500 m tall tower. This antenna can transmit waves of wavelength nearly equal to?

30. A parallel beam of monochromatic light passes through a narrow slit of width d = 0.2 mm. The angular width of the central maximum is found to be 4×10^{-3} rad. Find the wavelength of the light in Å.

Chemistry

PART – B

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

31. Substance which tends to decompose at their sublimation temperature can preferably purified by sublimation under the following pressure condition
(A) increased pressure
(B) reduced pressure
(C) pressure has no effect on the sublimation temperature of a substance
(D) at atmospheric pressure

32. Liquid A and liquid B form ideal solution. The ratio of the pure vapour pressure of A and B, respectively at 298 K is 1 : 4. Also, the ratio of their masses in liquid phase is 2 : 1. What will be the ratio of their masses in vapour phase?
(A) 1 : 2 (B) 1 : 8
(C) 8 : 1 (D) 2 : 1

33. In which of the following conditions, the electrical conductivity decreases?
(A) ZnO is heated in Zn vapour
(B) NaCl is heated in Na vapour
(C) Silicon is doped with arsenic
(D) Heating metallic conductor

34. Which of the following order is INCORRECT?
(A) $Li < Be < B < C$ (magnitude of effective nuclear charge)
(B) $Li^+ > Na^+ < K^+ < Rb^+$ (ionic radius in aqueous medium)
(C) $N^{3-} > Ne > Mg^{2+} > Al^{3+}$ (ionic radius)
(D) $B > Al < Ga > In$ (first ionization energy)

35. Which of the following orders of given character in the following oxides is CORRECT?
(A) $V_2O_3 < V_2O_4 < V_2O_5$ (basic character)
(B) $CrO < Cr_2O_3 < CrO_3$ (acidic character)
(C) $CO_2 > SO_3 > Cl_2O_7$ (acidic character)
(D) $MgO < CaO > BaO$ (basic character)

36. Which of the following statement about hydrogen peroxide is INCORRECT?
(A) The gas phase bond angles in H_2O_2 is less than that in crystalline phase.
(B) H_2O_2 can be prepared by adding ice-cold dilute $H_2SO_4\ (20\%)$ on Na_2O_2.
(C) The gas phase O – H bond length is greater than that of in crystalline phase.
(D) The dihedral angle in H_2O_2 in its gas phase is larger than that of bond angle.

37. Electrons in a group of degenerate orbitals can have five Z-components of angular momentum. Which sub-shell does this group of orbitals belong to:
(A) s (B) p
(C) d (D) s + d

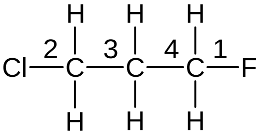
38. Two containers containing N_2 and O_2 gases respectively, are present in the same compartment of a train which is moving with 120 km/hr. The volume of first container is twice the size of second one. Find the ratio of the mean square speeds of N_2 gas and O_2 gas, respectively

(A) $\frac{8}{7}$	(B) $\frac{7}{8}$
(C) $\frac{1}{2}$	(D) $\frac{2}{1}$

39. He gas and N_2 gas both initially at the same temperature and pressure are compressed adiabatically and reversibly from a volume of V to $\frac{V}{3}$ (Assuming ideal behaviour of both the gases). Which gas will be at higher temperature?

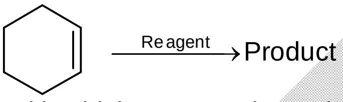
(A) He
(B) N_2
(C) Both remain at same temperature
(D) None of these

40. Which of the following highlighted bond most likely break through homolytic bond cleavage?



$$\mathrm{Cl}\overset{2}{-}\underset{H}{\overset{H}{C}}\overset{3}{-}\underset{H}{\overset{H}{C}}\overset{4}{-}\underset{H}{\overset{H}{C}}\overset{1}{-}\mathrm{F}$$

(A) 1	(B) 2
(C) 3	(D) 4

41. 

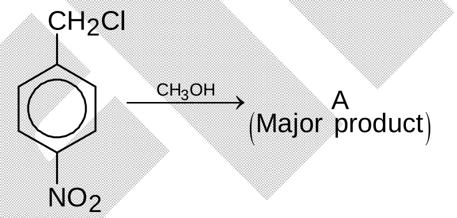
With which reagent, the major product will not be syn addition product?

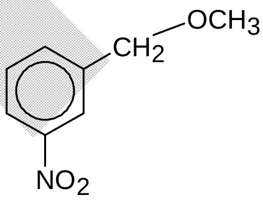
(A) (1) OsO_4, (2) Na_2SO_3, H_2O

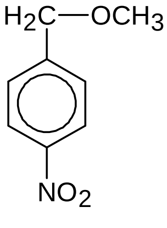
(B) (1) $KMnO_4, H_2O / OH^-$ (cold)

(C) (1) HBr, $(C_6H_5COO)_2$

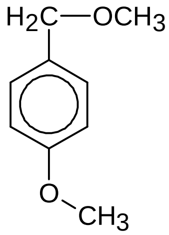
(D) (1) B_2H_6 / THF, (2) H_2O_2 / NaOH

42. 

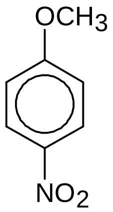
(A) 

(B) 

(C)



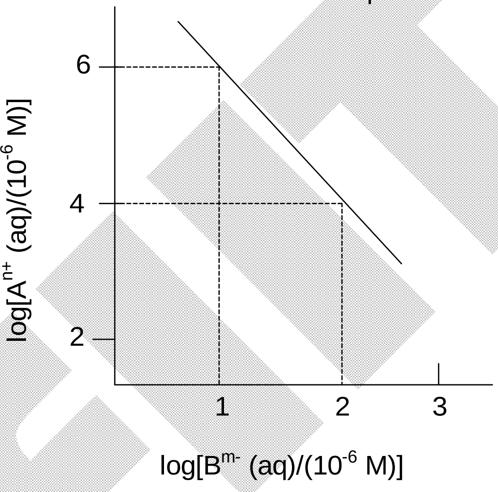
(D)



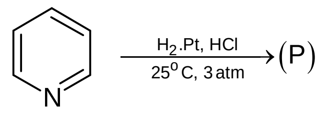
43. Which of the following is CORRECT?
(A) In case of association, value of van't Hoff factor is more than unity while for dissociation it is less than unity.
(B) Solid CO_2 directly sublimes upon heating at atmospheric pressure but it will first liquefy if this heating is done at sufficiently higher pressure.
(C) Even at high pressure solid CO_2 always sublimes upon heating.
(D) When placed in saline water (concentration < 0.9% m/V) blood cells (internal concentration = 0.9% m/V) shrink.

44. In which of the following reactions, the catalyst has been incorrectly marked?
(A) $N_2(g) + 3H_2(g) \xrightarrow{Fe(s)} 2NH_3(g)$ (Haber's process)
(B) $4NH_3(g) + 5O_2(g) \xrightarrow{Pt(s)} 4NO(g) + 6H_2O(g)$ (Ostwald's process)
(C) $2KClO_3 \xrightarrow{MnO_2(s)} 2KCl + 3O_2$
(D) $CH_3COOCH_3(aq) + H_2O(\ell) \xrightarrow{NaOH} CH_3COOH(aq) + CH_3OH(aq)$

45. A sparingly soluble salt A_mB_n shows following relation in its saturated aqueous solution. Find the possible formula unit of this compound



(A) AB
(B) AB_2
(C) A_2B
(D) A_3B

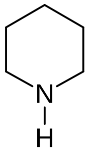
46. 

Pyridine [Q]

Which of the following statement is correct?

(A) Q and P both are aromatic

(B)

P is 

(C) P is acyclic amine compound

(D) Q is more basic than P

47. Arrange the following coordination compounds in increasing order of wavelength of light that they absorbed

$\left[CrCl_6\right]^{3-}$, $\left[Cr(H_2O)_6\right]^{3+}$, $\left[Cr(NH_3)_6\right]^{3+}$, $\left[Cr(CN)_6\right]^{3-}$

(I) (II) (III) (IV)

(A) I > II > III > IV (B) IV > II > III > I

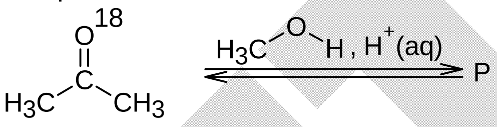
(C) I > III > II > IV (D) IV > III > II > I

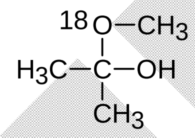
48. Order of octahedral ionic radii of M^{2+} for the first row transition elements

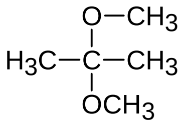
(A) Ca < V < Mn > Zn (B) V < Mn > Ni < Zn

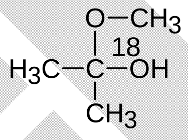
(C) V < Mn < Ni > Zn (D) Fe < Co < Ni > Zn

49. The product or intermediate which can not be synthesized from the given reaction



(A) 
$$H_3C-\overset{{}^{18}O-CH_3}{\underset{CH_3}{C}}-OH$$

(B) 
$$H_3C-\overset{O-CH_3}{\underset{OCH_3}{C}}-CH_3$$

(C) 
$$H_3C-\overset{O-CH_3}{\underset{CH_3}{C}}-{}^{18}OH$$

(D) None of these

50. Compound A upon strong heating produces a salt B and a colourless gas C. The gas C is also produced by heating hydrogen peroxide. Aqueous solution of salt B produces white precipitate when aqueous $AgNO_3$ solution is mixed into it. When gas D is passed through hot and concentrated solution of potassium hydroxide, then compound A is formed. In presence of moisture, gas D acts as an oxidizing agent.

Correct option is:

(A) $A = KNO_3$

(B) $A = KClO_3$

(C) $D = O_2$

(D) $B = NaI$

SECTION – B

(Numerical Answer Type)

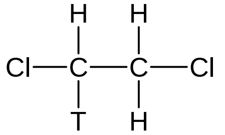
This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

51. Find the total number of bonds in which there is involvement of hybridized orbitals in the following molecules/ions.

CH_4, ClF_3, C_2H_4, C_2H_2, NO_2^+

52. 20 mL of '10 volume' hydrogen peroxide solution upon heating releases that much amount of oxygen at STP which is just sufficient to completely burn 'x mg' of ethene. Find the value of x (to the nearest integer).

53. The total loss in mass (in g) when mixture of 1 mole Li_2CO_3 and 2 moles $Na_2CO_3.10H_2O$ is heated.

54. 

$Cl-\overset{H}{\underset{T}{C}}-\overset{H}{\underset{H}{C}}-Cl \xrightarrow[\text{Ether}]{\text{Na}} \text{Product}(s)$

(Product should not have more than 4 carbons)

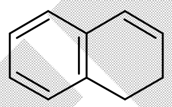
From all the possible products, how many of them will be chiral?

55. During rusting of iron, iron converted to ferricoxide it has been found that 3.2 kg of iron rust has been formed. How many mole(s) of electrons does iron has given up to form this much rust? (Atomic mass : Fe = 56 u, O = 16 u)

56. 2 Moles of radioactive substance X undergo radioactive decay as shown below at 298 K temperature in a closed container of volume V lit. Half life period of X is 16 hrs. After 32 hr, 75% of X has been disintegrated and the pressure developed inside the container is 18.32 atm. Find the value of V to the nearest integer. $\left[R = 0.082 \text{ atm lit mol}^{-1} \text{ K}^{-1}\right]$

$${}_{Z}^{A}X(s) \longrightarrow {}_{Z-4}Y(s) + {}_{2}^{4}He(g)$$

57. Find the number of π electrons (which are in conjugation) because of which the following compound is aromatic?



58. The sum of the total number of lone pair electrons in the Lewis structure of I_3^- ion.

59. The CFCs which are generally called by the trade name Freons, lead to ozone layer depletion. Freon-12 has a percentage abundance of 4×10^{-4} % in troposphere. Find its partial pressure at sea level (in microbar). [Answer should be reported to nearest integer]

60. Acid catalysed hydrolysis of 0.2 mole of sucrose yields D(+) glucose and D (–) fructose. If the percentage dissociation of sucrose and the percentage yield of this reaction are 60% and 80%, respectively. Find the mass of fructose (in gram) that has been produced. [Answer should be reported to nearest integer]

Mathematics PART – C

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

61. For a data set having 100 observations, mean, median, mode are 50, 60, 70 respectively. If the largest 50 observations are increased by 10, then sum of new mean, median, mode equals

(A) 180 (B) 190
(C) 200 (D) 210

62. Maximum number of compound propositions out of

$$p \wedge q \wedge r,\quad p \wedge \sim q \wedge r,\quad p \wedge q \wedge \sim r$$
$$\sim p \wedge q \wedge s,\quad \sim p \wedge \sim q \wedge s,\quad \sim p \wedge \sim q \wedge \sim s$$
$$q \wedge r \wedge s,\quad q \wedge \sim r \wedge s,\quad \sim q \wedge \sim r \wedge \sim s$$

that can be made simultaneously false by an assignment of the truth values to p, q, r and s, is equal to

(A) 6 (B) 7
(C) 8 (D) 9

63. Let $f(x) = \begin{vmatrix} \cos x & \cos^2 x & \cos^4 x \\ \cos 3x & \cos^2 3x & \cos^4 3x \\ \cos 5x & \cos^2 5x & \cos^4 5x \end{vmatrix}$, then $\int_0^{\pi} f(x)dx$ equals

(A) 9 (B) 18
(C) 27 (D) none of these

64. Let R be a relation defined on first twenty natural numbers such that R = {(a, b) : $\frac{a}{b}$ is a prime number}. Consider the following statements :

(I) R is reflexive and symmetric but not transitive
(II) Range of R^{-1} has 20 elements
(III) Domain of R^{-1} has 10 elements

which of the statements are true ?

(A) I, II, III (B) II, III
(C) II (D) III

65. Value of sin32° sin88° sin152° equals

(A) sin6° (B) $\frac{\sin 6°}{4}$
(C) cos6° (D) $\frac{\cos 6°}{4}$

66. Let α, β be roots of the equation $x^2 - 3x - \sqrt{7} = 0$ and $\alpha^2 + \frac{1}{\beta}$, $\beta^2 + \frac{1}{\alpha}$ be the roots of the equation $x^2 + px + q = 0$, then for the equation $x^2 + p^2q^2x - (11q + p) = 0$, roots are

(A) positive (B) negative
(C) one positive and other negative (D) none of these

67. Let A = $\sum_{i=0}^{2023}\sum_{j=0}^{2023}\min\left\{{}^{2023}C_i,\ {}^{2023}C_j\right\}$, B = $\sum_{i=0}^{2023}\sum_{j=0}^{2023}\max\left\{{}^{2023}C_i,\ {}^{2023}C_j\right\}$, then A + B equal

(A) 2024.2^{2023}
(B) 2023.2^{2023}
(C) $2024(2^{2023} - 1)$
(D) $2023(2^{2023} - 1)$

68. Let H_L and H_R be two branches of a hyperbola having A, B as endpoints of latus-rectum on H_L. If C be any point on H_R such that $\angle ACB$ is never obtuse, then maximum possible eccentricity of hyperbola is

(A) $\sqrt{2}$
(B) $\sqrt{3}$
(C) 2
(D) 3

69. If chord of contact of pair of tangents from points P and Q on $\frac{x^2}{9}+\frac{y^2}{16}=1$ to the ellipse $\frac{x^2}{3}+\frac{y^2}{4}=1$ is normal to the curve $2x^2 + 2y^2 - 4x - 4y + 1 = 0$, then sum of eccentric angles of P and Q is

(A) $\frac{\pi}{2}$
(B) π
(C) 2π
(D) none of these

70. A rectangular hyperbola and ellipse have coincident end points of latus-rectum, then eccentricity of ellipse equals

(A) $\frac{1}{2\sqrt{2}}$
(B) $\frac{1}{\sqrt{2}}$
(C) $\frac{1}{2}$
(D) none of these

71. If $\lim\limits_{x\to 0}\frac{\sin x\sin 2x\sin 3x......\sin nx - x^n}{x\tan\left((1+x)(1+2x)(1+3x).....(1+2023x)\right)}$ exists and is non-zero, then 'n' equals

(A) 2022
(B) 2023
(C) 2024
(D) no such value of n exists

72. Let $A_k = [a_{ij}]$ be square matrix of order 3 such that $a_{ij} = (i - j)^k$ for all i, j = 1, 2, 3. Then determinant value of $|A_1 + A_3 + A_5 + ... + A_{2023}|$ equals

(A) 3^{4046}
(B) 3^{6069}
(C) $3^{6069} - 3^{4046}$
(D) none of these

73. Which of the following functions is differentiable at x = 0 ?

(A) $\left|\tan|x| - \cos|x|\right|$
(B) $\left|\sin|x| - \tan|x|\right|$
(C) $\left|\cos|x| - \sin|x|\right|$
(D) all of these

74. Water is being filled at rate of π cm^3/s in right circular conical vessel (vertex upwards) of height 5cm and diameter 8cm. When the height of water level is 3cm, the rate (in cm^2/s) at which the wet conical surface area of the vessel increases is

(A) $\frac{2\pi}{3}$
(B) $\frac{\sqrt{41}}{12}\pi$
(C) $\frac{\sqrt{41}}{18}\pi$
(D) none of these

75. Let $f(x) = x^7(x^3 + 2x^2 - x - 2) + (x^3 - x)(x + 3) + 2(x^2 - 1)$, then which of the following is **NOT** true?
(A) $y = f(x)$ has 7 critical points
(B) there are exactly 2 points in $(-1, 1)$ where $f'(x) = 0$
(C) $y = f(x)$ does not have an extrema at $x \in I$
(D) $y = f(x)$ has exactly 2 stationary point in $(-2, 1)$

76. Value of $\int_0^1 x^6 \left(x^3 - 1\right)^{2022} dx$ is
(A) $\dfrac{3^{2022}(2022)!}{10.13.16.....6073}$
(B) $\dfrac{3^{2022}(2022)!}{7.10.13.....6073}$
(C) $\dfrac{3^{2022}(2022)!}{4.7.10.....6073}$
(D) none of these

77. If area bounded by an ellipse with its auxiliary circle equals area bounded by its auxiliary circle and director circle, then eccentricity of ellipse equals
(A) $\sqrt{2\sin 18^\circ}$
(B) $\sqrt{2\cos 18^\circ}$
(C) $\sqrt{2\sin 36^\circ}$
(D) $\sqrt{2\cos 36^\circ}$

78. Ajay has to take medicine having 100 mg paracetamol at a gap of every 12 hours. The amount of paracetamol (salt) in Ajay's bloodstream decreases at a rate that is proportional at any time to the amount of salt in bloodstream at that time. If the amount of salt in bloodstream is halved in every 5 hours, then amount of salt in Ajay's bloodstream 15 hours after taking the medicine first time is (in mg)
(A) $100\left(\frac{1}{2}\right)^3$
(B) $100\left(\left(\frac{1}{2}\right)^3 + 1\right)$
(C) $100\left(\left(\frac{1}{2}\right)^3 + \left(\frac{1}{2}\right)^{12/5}\right)$
(D) $100\left(\left(\frac{1}{2}\right)^3 + \left(\frac{1}{2}\right)^{3/5}\right)$

79. Equation of plane passing through the line $\frac{x-1}{2} = \frac{y-2}{3} = \frac{z-3}{4}$ at minimum possible distance from the point $(-1, -3, 1)$ is
(A) $7x - 2y - 2z + 3 = 0$
(B) $x + 3y + 10 = 0$
(C) $3x + y - z = 2$
(D) none of these

80. $\left[\left(\vec{a} \times \vec{b}\right) \times \left(\vec{b} \times \vec{c}\right)\right] \times \left(\vec{c} \times \vec{a}\right) \cdot \vec{b}$ equal (where $\vec{a}, \vec{b}, \vec{c}$ are non-coplanar vectors)
(A) $\left[\vec{a}\,\vec{b}\,\vec{c}\right]^2 \left|\vec{b}\right|^2$
(B) $\left[\vec{a}\,\vec{b}\,\vec{c}\right]^2 \left(\vec{b} \cdot \vec{c}\right)$
(C) $\left[\vec{a}\,\vec{b}\,\vec{c}\right]^2 \left(\vec{b} \cdot \vec{a}\right)\left(\vec{c} \cdot \vec{b}\right)$
(D) none of these

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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81. Let z_1, z_2, z_3 be represented by A, B, C on Argand plane such that $z_1 = 3 + 3i$, $z_2 = 9 - 6\sqrt{2} + \left(6\sqrt{2} - 3\right)i$ and ΔABC is right angled at C. If minimum and maximum possible value of Argument of z_3 is a, b respectively (Argument of $z_3 \in (-\pi, \pi]$, then b – a is $\frac{\pi}{k}$ where k equals

82. Number of ordered pairs (x, y) satisfying $\frac{4^{\sin x}16^{\sin y}}{\left(1+16^{\sin x}\right)\left(1+256^{\sin y}\right)} = \frac{1}{4}$, $3^{1+\sqrt{\cos^2 x}} + 3^{1+\cos y} = 10$; x, y $\in [0, 2\pi]$ is

83. Two families each having 4 members are to be seated around a circular table having alternate red and blue chairs. If probability that members of same family are seated together is p, then 35p equals

84. Number of 5-digit natural numbers such that the product of their digits equals number of ways to create a necklace out of 6 beads from 10 distinct beads is

85. Remainder when $(2022)^{2023}$ is divided by 11 is

86. Let $\{a_1, a_2, \ldots, a_n\}$ be a sequence such that $a_1 = 0$, $a_2 = 1$, $a_3 = 2$ and $a_{n+3} = a_{n+2} + a_n - a_{n+1}$ $\forall$ $n \geq 1$, then value of $15\sum_{n=1}^{\infty}\frac{a_n}{2^n}$ equals

87. Let A(0, 0), B(x_1, y_1) and C(x_2, y_2) form a triangle having circumcentre at $(3^{1/4}, 3^{1/4})$. If area of ΔABC lies in (a, b], then 2(a + b) equals

88. If difference of distances of A(1, 1) and B(–3, 13) from any point R on x + 2y – 1 = 0 is minimum, then absolute value of five times sum of abscissa and ordinate of R equals

89. Sum of all solutions of the equation $\sin^{-1}[x] = \cos^{-1}\{x\}$ is (where [.] represents greatest integer function and { } represents fractional part function)

90. Number of skew symmetric matrices of order 3 with integer entries such that their squares equals identity matrix is

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – V

JEE (Main)-2023

TEST DATE: 18-01-2023

ANSWERS, HINTS & SOLUTIONS

Physics

PART – A

SECTION – A

1. A

Sol. x-axis along the inclined plane
y-axis perpendicular to the inclined plane.

$$v_{0x} = v_0\cos 30^\circ = v_0\frac{\sqrt{3}}{2}, \quad a_x = -g\sin 30^\circ = -\frac{g}{2}$$

$$v_{0y} = v_0\sin 30^\circ = -\frac{v_0}{2}, \quad a_y = -g\cos 30^\circ = -g\frac{\sqrt{3}}{2}$$

$$x_0 = 0, \quad y_0 = H\sin 30^\circ = H\frac{\sqrt{3}}{2}$$

When particle reaches the inclined plane, y = 0

$$\Rightarrow 0 = \frac{H\sqrt{3}}{2} - \frac{v_0}{2}t - \frac{1}{2}\frac{g\sqrt{3}}{2}t^2 \qquad \ldots(i)$$

If particle hits the inclined plane at 90°. It will retrace the path for this $v_x = 0$

$$\Rightarrow 0 = \frac{v_0\sqrt{3}}{2} - \frac{g}{2}t$$

$$\Rightarrow t = \frac{v_0\sqrt{3}}{g} \qquad \ldots(ii)$$

$$0 = \frac{H\sqrt{3}}{2} - \frac{v_0}{2}\times\frac{v_0\sqrt{3}}{g} - \frac{1}{2}\times\frac{g\sqrt{3}}{2}\times\frac{v_0^2\times 3}{g^2}$$

$$\Rightarrow \quad v_0 = \sqrt{\frac{2gH}{5}}$$

2. A

Sol. Modulation index = $\frac{A_m}{A_C} = \frac{20}{50} = 0.4$

Side frequency band is $f_C - f_m$ and $f_C + f_m$

3. D

Sol. For the ball along perpendicular to the inclined plane

$\int N dt = mv_0(e+1)$ …(i) (v_0 = 10 m/s)

For the block along the surface of the inclined plane

$-\int \mu N dt = m(v_f - v_i)$ …(ii)

$\Rightarrow -\mu \times mv_0(e+1) = m\Delta v$

$\Rightarrow \Delta v = -0.2 \times v_0 \times 1.5 = -3$ m/s

4. B

Sol. $\because \quad f = n\frac{v}{2\ell}$

$\Rightarrow \quad 1100 = n \times \frac{330}{2 \times 30 x 10^{-2}}$

This shows that air column vibrates in 2nd harmonic. This implies that wavelength $\lambda = \ell$ = 30 cm.

$\because \quad \Delta P = 0.1 P_0 \sin kx \cos wt.$

x is measured from open end.

At x =5 cm, i.e., at $x = \frac{\lambda}{6}$

$\Delta P = 0.1 P_0 \sin\left(\frac{2\pi}{\lambda} \cdot \frac{\lambda}{6}\right) \cos wt$

$\Rightarrow P_{max} - P_{min} = 2 \times 0.1 P_0 \cdot \frac{\sqrt{3}}{2}$

$= \sqrt{3} \times 10^4 \text{ N/m}^2$

5. D

Sol. $f_T = m\alpha r$

$f_R = m\omega^2 r = m\alpha^2 t^2 r$

Since $\sqrt{f_T^2 + f_R^2} = \mu mg$

$\Rightarrow m\alpha r\sqrt{1+\alpha^2 t^4} = \mu mg$

$\Rightarrow t = \frac{1}{\sqrt{\alpha}}\left[\left(\frac{\mu g}{\alpha r}\right)^2 - 1\right]^{1/4} = \frac{\left[\left(\frac{0.255 \times 10}{1 \times 0.5}\right)^2 - 1\right]^{1/4}}{\sqrt{\alpha}} = \sqrt{5}$ s

6. B

Sol. $V = \frac{kQ}{\frac{R}{2}} + \frac{kQ}{R} = \frac{Q}{2\pi\varepsilon_0 R} + \frac{Q}{4\pi\varepsilon_0 R}$

7. C

Sol. $1A \times 0.081\ \Omega = 9A \times R$

$\Rightarrow R = 0.09\ \Omega$

8. A

Sol. $\Delta Q_{AB} = \Delta W_{AB} + \Delta U_{AB}$

$$= 10 \times + nC_V \frac{10}{nR} = 10 + \frac{10C_V}{R}$$

$$\Delta Q_{BC} = \Delta W_{BC} + \Delta U_{BC} = 0 + \left(\frac{2P_C - 20}{R}\right)C_V$$

$$\Delta Q_{CA} = \Delta W_{CA} + \Delta U_{CA} = \Delta W_{CA} + \left(\frac{10 - 2P_C}{R}\right)C_V$$

$$\Delta Q = \Delta Q_{AB} + \Delta Q_{BC} + \Delta Q_{CA} = 5J$$

$$\Rightarrow 10 + \frac{10C_V}{R} + \left(\frac{2P_C - 20}{R}\right)C_V + \Delta W_{CA} + \left(\frac{10 - 2P_C}{R}\right)C_V = 5\ J$$

$$\Rightarrow \Delta W_{CA} = -5J$$

9. A

Sol. $mvR = mv'r$ …(i)

and $\frac{1}{2}mv^2 = -\frac{GMm}{r} + \frac{1}{2}mv'^2$

$$\Rightarrow v'^2 = v^2 + \frac{2GM}{r}$$

$$\Rightarrow \frac{v^2R^2}{r^2} = v^2 + \frac{2GM}{r}$$

$$R = \frac{r}{v}\left[v^2 + \frac{2GM}{r}\right]^{1/2}$$

10. D

Sol. $q_{max} = \frac{2EC}{3}$

In the beginning current through the cell

$$I_0 = \frac{3E}{5R}$$

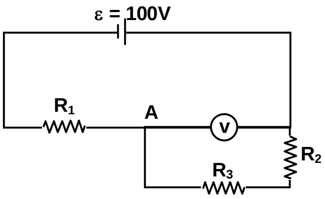
Therefore, $\frac{dq}{dt} = \frac{2}{3}I_0 = \frac{2E}{5R}$

Since, $\left(\frac{2E}{5R}\right) \times t = \frac{2EC}{3}$

$$\Rightarrow t\ \frac{5RC}{3}$$

11. B

Sol. In the steady state current in the branch having capacitor is zero. The effective circuit is shown in the figure.



Current through the cell

$$I = \frac{3}{7}A$$

Therefore current through the voltmeter is $I' = \frac{2}{3}I = \frac{2}{7}A$

Therefore, voltmeter reading is $= I'R_V = \frac{400}{7}V$

12. B

Sol. From snell's law

$\mu\sin\theta = 16\mu \sin x$

$\Rightarrow \sin x = \frac{5}{8}\sin\theta$

13. A

Sol. $Q = A_{He}.BE_{He}$ (per nucleon) – $2A_H(BE_H$ per nuclear)

= 28 MeV – 4.4 MeV = 23.6 MeV

14. B

Sol. $V_R = V\left(1 - e^{-\frac{tR}{L}}\right)$, at $t = \tau\ \ell n2$

$$V_R = \frac{3V}{4}$$

15. A

Sol. Initially, $P = \frac{v_{rms}^2}{R} \Rightarrow v_{rms} = \sqrt{PR}$

Finally, $P' = I_{rms}^2 R = \frac{v_{rms}^2}{z^2}R = \frac{PR}{z^2} \times R = P\left(\frac{R}{z}\right)^2$

16. B

Sol. The gas expands isobarically, therefore, $\Delta Q = nC_p\Delta T$

At STP. 1 mole of a gas occupies the volume 22.4 liter. This implies that in the vessel 2 mole helium is present

$\Rightarrow \Delta Q = 2 \times \frac{5R}{2} \times 20J = 100R$.

17. A

Sol. $\frac{\lambda_2}{\lambda_1} = \frac{(z_1 - 1)^2}{(z_2 - 1)^2} = 4$

$\Rightarrow 2z_2 - z_1 = 1$

18. A

Sol. The effective decay constant

$\lambda = \lambda_1 + \lambda_2$

Therefore effective half life

$$T_{1/2}=\frac{\ell n2}{\lambda}=\frac{0.693}{\lambda_1+\lambda_2}$$

19. D

Sol. Collective energy of both photons is 11.6 eV more than the ionization energy of a hydrogen atom.

20. B

Sol. $\because \quad y(x,t)=0.5\text{cm}\sin\left\{100\pi\left(t-\frac{x}{v}\right)\right\}$

Here, $v=\sqrt{\frac{T}{\mu}}=\sqrt{\frac{1600}{40\times10^{-3}}}=200\text{m}/\text{s}$

and $t=\frac{5}{200}\text{s}$

$x=\frac{5}{2}\text{m}$

$y\left(x=\frac{5}{2},t=\frac{5}{200}\text{s}\right)=0.5\text{cm}\sin\left\{100\pi\left(\frac{5}{200}-\frac{5}{400}\right)\right\}$

$=-\frac{0.5}{\sqrt{2}}\text{cm}$

SECTION – B

21. 5

Sol. Let the resistance be R,

Therefore, $I_{rms}=\frac{110}{R}\text{A}$

With L, $I_{rms}=\frac{220}{\sqrt{R^2+\omega^2L^2}}=\frac{110}{R}$

$\Rightarrow R^2=\frac{4}{3}\times10^5\,\Omega^2$

With C, $I_{rms}=\frac{220}{\sqrt{R^2+\left(\frac{1}{\omega C}\right)^2}}=\frac{110}{R}$

$\Rightarrow C = 5\mu F$

22. 7

Sol. $\because \quad A=A_0e^{\frac{-bt}{2m}}$

Where, A_0 = initial amplitude
b = damping constant
M = mass of the block

$\Rightarrow \frac{A_0}{2}=A_0e^{\frac{-bt}{2m}}$

$\Rightarrow \quad t=\frac{\ell n2}{b/2m}$

$=\frac{0.693}{40\,\text{g}/\text{s}}\times2\times200\,\text{g}=7\text{ s}$

23. 3

Sol. $R_{cm} = \dfrac{u^2 \sin 2\theta}{g} = 5\sqrt{3}$ m

Let M be the mass of each fragment

$\Rightarrow \dfrac{M\sqrt{3} + (n-1)M \times 7\sqrt{3}}{nM} = 5\sqrt{3}$

$\Rightarrow$ n = 3

24. 11

Sol. The point P acts like a virtual object for the lens.

Since, $\dfrac{1}{f} = \dfrac{1}{v} - \dfrac{1}{u}$

$\Rightarrow \dfrac{1}{25} = \dfrac{1}{v} - \dfrac{1}{20}$

$\Rightarrow \dfrac{1}{v} = \dfrac{1}{25} + \dfrac{1}{20} = \dfrac{9}{100}$

$\Rightarrow$ v = 11.11 cm $\approx$ 11 cm

25. 38

Sol. Energy of the incident photon

$E = E_0 z^2 \times \dfrac{3}{4} = 40.8$ eV

Stopping potential, $v_0 = \dfrac{E - \phi}{e} = 38\,V$

26. 7

Sol. Since, $\lambda = \dfrac{\ell n2}{T_{1/2}} = 4.14 \times 10^{-9}$ s

Activity, $\dfrac{dN}{dt} = \lambda N$

$\Rightarrow N = \dfrac{\left(\dfrac{dN}{dt}\right)}{\lambda} = \dfrac{8 \times 3.7 \times 10^{7}}{4.14 \times 10^{-9}} = 7.133 \times 10^{10}$

Therefore mass, $M = \dfrac{7.133 \times 10^{6}}{6.023 \times 10^{23}} \times 60 = 7.12 \times 10^{-6}\,g \approx 7\mu g$

27. 10

Sol. Since, $\dfrac{\Delta V}{\Delta I} = \dfrac{0.05V}{5 \times 10^{-3}\,A} = 10\Omega$

28. 14

Sol. The output AC voltage is 2.0 V. Therefore AC collector current, $I_C = \dfrac{2.0}{2000\Omega} = 10^{-3}\,A$

Since, amplification factor, $\beta = \dfrac{I_C}{I_B} = 100$

$\Rightarrow I_B = \dfrac{I_C}{100} = 10^{-5}\,A$

DC base current is $10 \times 10^{-5}\,A = 10^{-4}\,A$

From the circuit, $V_B = I_B R_B + V_{BE}$

$\Rightarrow R_B = \frac{V_B - V_{BE}}{I_{B(DC)}} = \frac{2-0.6}{10^{-4}} = 14\ k\Omega$

29. 800

Sol. Length of the antenna, $\ell = \frac{\lambda}{4}$

$\Rightarrow \lambda = 4\ell = 800$ m

30. 4000

Sol. Let θ be the angular diffraction.

$\Rightarrow \sin\theta = \frac{n\lambda}{d}$

For small θ, $\sin\theta = \theta = \frac{n\lambda}{d}$

For 1st minima, n = 1

$\Rightarrow \theta$ for first minima = $\frac{\lambda}{d}$

Since, angular width of the central maximum is $2\theta = \frac{2\lambda}{d} = 4\times10^{-3}$ rad

$\Rightarrow \lambda = d \times 2 \times 10^{-3}$ m $= 4 \times 10^{-7}$ m = 4000 Å

Chemistry PART – B

SECTION – A

31. B

Sol. Decreasing pressure usually decreases the sublimation temperature of the substance and thus preventing it from decomposition.

32. A

Sol. $\frac{Y_A}{Y_B} = \frac{X_A}{X_B}\frac{p_A^o}{p_B^o}$

$\frac{Y_A}{Y_B} = \left(\frac{m_A}{m_B}\right) \times \frac{M_B}{M_A}$; M_A = molar mass of A

M_B = molar mass of B

$\frac{m_A}{m_B}$ = ratio of their masses in vapour phase.

Similarly, $\frac{X_A}{X_B} = \left(\frac{m'_A}{m'_B}\right) \times \frac{M_B}{M_A}$

$\frac{m'_A}{m'_B}$ = (Ratio of their masses in liquid phase)

33. D

Sol. Defect usually increases the conductivity, while heating metallic conductor decreases its conductivity due to increase in the vibration of metal ions which consequently increases the resistance.

34. B

Sol. In aqueous medium,
Size of ion is in the order of
$Li^+ > Na^+ > K^+ > Rb^+$

35. B

Sol. In a particular group, lower member have high basic character of their oxide. For same element with different oxides (having different oxidation states), the oxides having high oxidation state of element have high acidic characer.

36. C

Sol. (Structure of H_2O_2, NCERT)

37. C

Sol. Z-components of angular momentum of an electron in an atomic orbital is governed by magnetic quantum number. For, d sub-shell, there are 5 Z-components possible.

38. A

Sol. Root mean square speed of any gas $= \left(\frac{3RT}{M}\right)^{\frac{1}{2}}$

Mean square speed $= \left(\frac{3RT}{M}\right)$

Both the gases are in same compartment, the temperature is same for both the gases.

Required ratio $= \frac{3RT}{28} \times \frac{32}{3RT} = \frac{32}{28} = \frac{8}{7}$

39. A

Sol. $T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$ (for adiabatical change)

$$\left(\frac{T_2}{T_1}\right) = \left(\frac{V_1}{V_2}\right)^{\gamma-1} = 3^{\gamma-1}$$

As γ is more for monoatomic gas He. Hence, temperature will also be more for it.

40. C

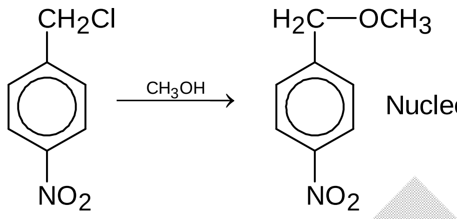
Sol. $\mathrm{C}\overset{3}{-}\mathrm{C}$ bond has lowest electronegativity difference. For homolytic bond cleavage a bond should have low electronegative difference.

41. C

Sol. With HBr along with peroxide, the product can both have syn as well as anti addition.

42. B

Sol.



Nucleophilic substitution at benzylic carbon.

43. B

Sol. Value of van't Hoff factor is more than unity during dissociation. Solid CO_2 first liquefies upon heating at high pressure. Blood cells present in hypotonic solution will swell.

44. D

Sol. $CH_3COOCH_3(aq) + H_2O(\ell) \xrightarrow{NaOH} CH_3COO^-(aq) + CH_3OH(aq)$

45. B

Sol. $AB_2(s) \rightleftharpoons A^{2+}(aq) + 2B^-(aq)$

$K_{SP} = \left[A^{2+}(aq)\right]\left[B^-(aq)\right]^2$

i.e. $\left[A^{2+}(aq)\right]\left[B^-(aq)\right]^2 = \text{Constant}(C)$

$C = K_{SP}$

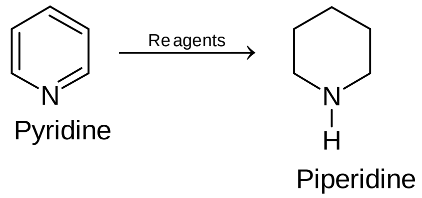
$\log\left[A^{2+}\right] + 2\log\left[B^-\right] = \log C$

$\log\left[A^{2+}\right] = \log C - 2\log\left[B^-\right]$

$y = C - mx \qquad (m = 2)$

46. B

Sol.


Reagents
N
Pyridine
N
H
Piperidine

47. A

Sol. $\xrightarrow[\text{Strong ligands}]{Cl^- < H_2O < NH_3 < CN^-}$

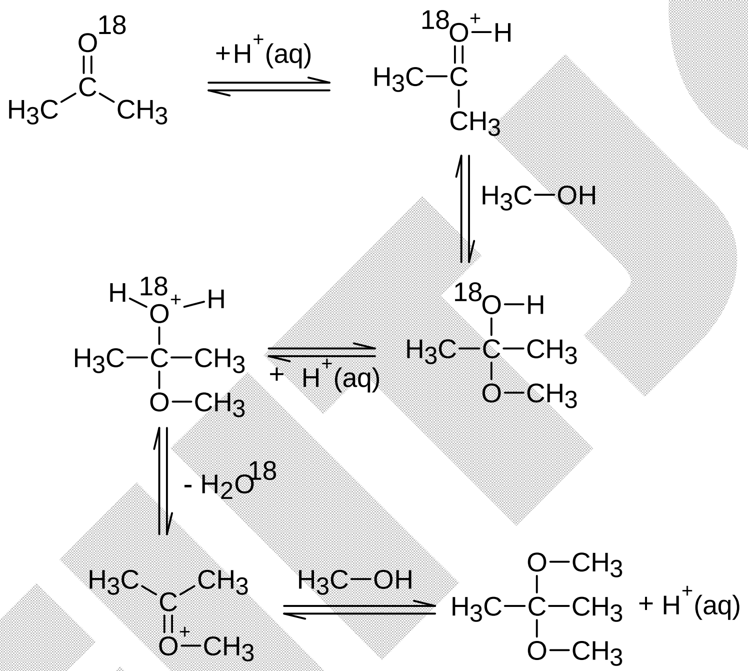
Stronger the ligand, greater will be the splitting and hence the compound will absorbs light of high frequency (or low wavelength).

48. B

Sol. Octahedral ionic radii of these elements in M^{2+} state is related with its stabilization due to CFSE.

49. A

Sol.


O18
H3C C CH3
+H+(aq)
18O+ H
H3C C
CH3
H3C OH
18O H
H3C C CH3
O CH3
+ H+(aq)
H 18O+ H
H3C C CH3
O CH3
- H2O18
H3C C CH3
O+ CH3
H3C OH
O CH3
H3C C CH3
O CH3
+ H+(aq)

50. B

Sol. $KClO_3 \xrightarrow{\Delta} KCl + O_2(g)$

(A) (B) (C)

$KCl(aq) + AgNO_3 \longrightarrow AgCl\downarrow$

(B)

$KOH + Cl_2(g) \longrightarrow KCl + KClO_3 + H_2O$

(D)

SECTION – B

51. 17

Sol. Hybridisation is involved in sigma bond. Hybridisation and number of corresponding bonds, respectively are given as

$CH_4\left(sp^3\right) \to 4$

$ClF_3\left(sp^3d\right) \to 3$

$C_2H_4\left(sp^2\right) \to 5$

$C_2H_2\left(sp\right) \to 3$

$NO_2^+\left(sp\right) \to 2$

52. 83

Sol. 20 mL of '10 volume' H_2O_2 solution produces 200 ml of O_2 at STP (or $\frac{200}{22400}$ mole of O_2)

$C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$

$\frac{200}{22400}$ mole of O_2 will burn $\left(\frac{1}{3} \times \frac{200}{22400} \times 28\right)$g of C_2H_4

Required answer = 83 mg.

53. 404

Sol. $Li_2CO_3\left(s\right) \xrightarrow{\Delta} Li_2O\left(s\right) + CO_2 \uparrow$

1 mole

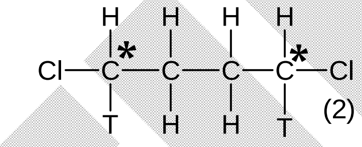
$Na_2CO_3.10H_2O\left(s\right) \xrightarrow{\Delta} Na_2CO_3\left(s\right) + 10H_2O \uparrow$

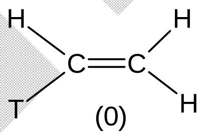
2 moles

Required answer = 44 + 180 × 2
= 44 + 360
= 404 g.

54. 10

Sol.


(2)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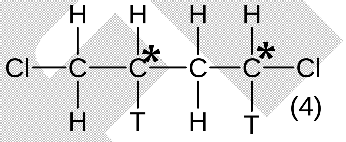
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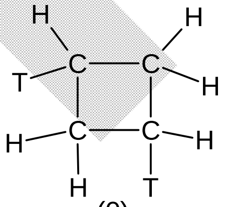
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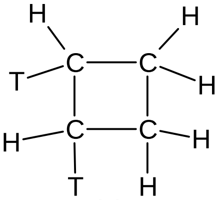
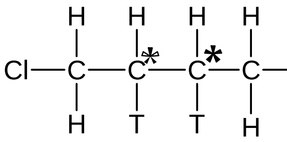

(2)

(trans)



$Cl-CH_2-\overset{*}{C}HT-\overset{*}{C}HT-CH_2-Cl$

(2)

55. 120

Sol. $4Fe(s)+3O_2(g)\longrightarrow 2Fe_2O_3(s)$

40 moles 20 moles

So, 40 moles of Fe will give up 120 moles of electrons to form 20 moles of Fe_2O_3.

56. 4

Sol. ${}^{A}_{Z}X(s)\longrightarrow {}_{Z-4}Y(s)+{}^{4}_{2}He(g)$

2 moles (75% disintegration) → 3 moles of He(g)

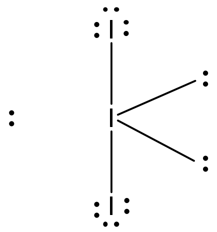
$$V=\frac{3\times 0.082\times 298}{18.32}=4 \text{ Lit.}$$

57. 6

Sol. Because of the π electrons in benzene ring which are in conjugation, the compound is aromatic.

58. 18

Sol.



59. 4

Sol. At sea level

Atmospheric pressure = 1.013 bar

Partial pressure $=4\times 10^{-6}\times 1.013$ bar

$=4.032\times 10^{-6}$ bar

60. 17

Sol. $C_{12}H_{22}O_{11}+H_2O\xrightarrow{H_3O^+}C_6H_{12}O_6 + C_6H_{12}O_6$

Sucrose Glucose Fructose

(0.2 mole)

Required mass of glucose $=0.2\times\frac{60}{100}\times\frac{80}{100}\times 180$

= 17.28 g

Mathematics PART – C

SECTION – A

61. C
Sol. 55 + 65 + 80 = 200

62. D
Sol. $p \to T,\ q \to F,\ r \to F,\ s \to T$

63. D
Sol. $\frac{1}{2}\int_0^{\pi} f(x)+f(\pi-x)\,dx = 0$

64. D
Sol. R is symmetric but neither reflexive nor transitive. Domain and range of R has 19 and 10 elements respectively.

65. D
Sol. $\sin 32^\circ \sin 88^\circ \sin 28^\circ = \frac{1}{4}\sin 84^\circ = \frac{\cos 6^\circ}{4}$

66. C
Sol. $-p = (\alpha + \beta)^2 - 2\alpha\beta + \frac{\alpha+\beta}{\alpha\beta} = 9 - \frac{11}{\sqrt{7}}$

$q = \alpha^2\beta^2 + \alpha + \beta + \frac{1}{\alpha\beta} = 10 - \frac{1}{\sqrt{7}}$

67. A
Sol. $A + B = 2024({}^{2023}C_0 + {}^{2023}C_1 + \ldots\ldots + {}^{2023}C_{2023}) = 2024.2^{2023}$

68. C
Sol. $\frac{b^2}{a} \le a + ae \Rightarrow e^2 - 1 \le 1 + e$

$\Rightarrow e \in (1, 2]$

69. A
Sol. $\cos\theta + \sin\theta = 1 \Rightarrow \theta = 0, \frac{\pi}{2}$

70. B
Sol. $ae = AE,\ \frac{b^2}{a} = \frac{B^2}{A} \Rightarrow eE = 1 \Rightarrow e = \frac{1}{\sqrt{2}}$

71. D
Sol. Limit equals 0 for $n \ge 1$ and does not exist for $n < 1$

72. D
Sol. $A_1 + A_3 + \ldots.. + A_{2023}$ is skew symmetric matrix of order 3 so its determinant equals 0.

73. B

Sol. Check RHD and LHD at x = 0

74. B

Sol. $\frac{dv}{dt} = -\pi r^2 \cot\theta \frac{dr}{dt}, \frac{ds}{dt} = -2\pi r \frac{dr}{dt} \operatorname{cosec}\theta$

$\Rightarrow \frac{ds}{dt} = \frac{\sqrt{41}}{12}\pi$

75. D

Sol. $f(x) = (x + 2)(x + 1)(x - 1)(x^7 + x + 1)$

There are 3 stationary points in (–2, 1)

76. B

Sol. Let $I_n = \int_0^1 x^6 \left(x^3 - 1\right)^n dx$

$= \left| \frac{x^7}{7}\left(x^3 - 1\right)^n \right|_0^1 - \frac{3n}{7}\int_0^1 x^9 \left(x^3 - 1\right)^{n-1} dx$

$= -\frac{3n}{7}\left(I_n + I_{n-1}\right) \quad \Rightarrow I_n = -\frac{3n}{3n+7} I_{n-1}$

$I_{n-1} = -\frac{3(n-1)}{3n+4} I_{n-2}$

…

…

…

$I_2 = -\frac{3.2}{13} I_1$ where $I_1 = -\frac{3}{70}$

77. A

Sol. $\pi(a^2 - ab) = \pi(a^2 + b^2 - a^2) \Rightarrow \frac{b}{a} = \frac{\sqrt{5} - 1}{2}$

$\Rightarrow e = \sqrt{\frac{2\sqrt{5} - 2}{4}} = \sqrt{2\sin 18^\circ}$

78. D

Sol. Let amount of salt in bloodstream a time t = x

$\Rightarrow \frac{dx}{dt} = -kx \Rightarrow x = ce^{-kt}$

where c = 100 and $k = \frac{\ln 2}{5}$

$\Rightarrow x = 100e^{-\frac{\ln 2}{5}t}$ (for first 12 hours)

At $t = 12^+$ hrs, initial amount is $100\left(1 + e^{-\frac{12}{5}\ln 2}\right)$

At t = 15 hrs, $x = 100\left(1 + e^{-\frac{12}{5}\ln 2}\right)e^{-\frac{3\ln 2}{5}}$

79. A

Sol. Plane contains (1, 2, 3) and (–1, –3, 1) and parallel to $2\hat{i}+3\hat{j}+4\hat{k}$

80. D

Sol. $\left[\left(\vec{a}\times\vec{b}\right)\times\left(\vec{b}\times\vec{c}\right)\right]\times\left(\vec{c}\times\vec{a}\right)\cdot\vec{b}=\left[\vec{a}\;\vec{b}\;\vec{c}\right]\vec{b}\times\left(\vec{c}\times\vec{a}\right)\cdot\vec{b}$

$= \left[\vec{a}\;\vec{b}\;\vec{c}\right]\left(\left(\vec{b}\cdot\vec{a}\right)c-\left(\vec{b}\cdot\vec{c}\right)\vec{a}\right)\cdot\vec{b}=0$

SECTION – B

81. 4

Sol. $b=\frac{\pi}{2}, a=\frac{\pi}{4}$

82. 3

Sol. $(4^{\sin x} + 4^{-\sin x})(16^{\sin y} + 16^{-\sin y}) = 4$

$\Rightarrow \sin x = \sin y = 0$ (by A.M - G.M)

$3^{|\cos x|} + 3^{\cos y} = \frac{10}{3} \Rightarrow 3^{\cos y} = \frac{1}{3} \Rightarrow \cos y = -1$

$y = \pi$, $x = 0, \pi, 2\pi$

83. 2

Sol. $p = \frac{2}{35}$

84. 60

Sol. $x_1x_2x_3x_4x_5 = 9 \times 8 \times 7 \times 5 \times 5$

$\Rightarrow$ total numbers $= \frac{5!}{2} = 60$

85. 3

Sol. Using Binomial expansion remainder comes out to be 3.

86. 9

Sol. $S=\frac{1}{4}+\frac{2}{8}+\frac{1}{2}\left[S-\frac{1}{4}\right]+\frac{S}{8}-\frac{1}{4}S$

$\Rightarrow S = \frac{3}{5} \Rightarrow 15S = 9$

87. 9

Sol. Maximum area of $\Delta ABC = \frac{3\sqrt{3}}{4}\cdot 2\sqrt{3}=\frac{9}{2}$

$\Rightarrow \Delta ABC \in \left(0, \frac{9}{2}\right]$

88. 18

Sol. R lies on the line $\frac{y-7}{x+1}=\frac{1}{3}$ and on the line $x + 2y - 1 = 0$

$\Rightarrow$ R is $\left(-\frac{41}{5},\frac{23}{5}\right)$

89. 1

Sol. If $[x] = 0 \Rightarrow 0 = \cos^{-1}x \Rightarrow x = 1$ (not possible)

If $[x] = 1 \Rightarrow \frac{\pi}{2} = \cos^{-1}\{x\} \Rightarrow \{x\} = 0 \Rightarrow x = 1$

If $[x] = -1 \Rightarrow -\frac{\pi}{2} = \cos^{-1}\{x\}$ not possible

90. 0

Sol. Let $A = \begin{bmatrix} 0 & a & b \\ -a & 0 & c \\ -b & -c & 0 \end{bmatrix} \Rightarrow A^2 = \begin{bmatrix} -a^2 - b^2 & -bc & -ac \\ -bc & -a^2 - c^2 & -ab \\ -ac & -ab & -b^2 - c^2 \end{bmatrix} \neq I \ \forall a, b, c \in I$

FIITJEE

FIITJEE

ALL INDIA TEST SERIES

FULL TEST – VI

JEE (Main)-2023

TEST DATE: 19-01-2023

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is Mathematics.
- Each part has only two sections: **Section-A and Section-B**.
- **Section – A** : Attempt all questions.
- **Section – B :** Do any five questions out of 10 questions.

Section-A (01 – 20, 31 – 50, 61 – 80) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-B (21 – 30, 51 – 60, 81 – 90) *contains 30 Numerical based questions. The answer to each question is rounded off to the nearest integer value. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

PART – A

SECTION – A

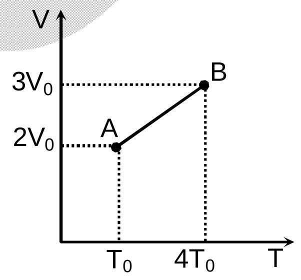
(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. An ice block at 0°C is dropped from height 'h' above the ground. What should be the value of 'h' so that it melts completely by the time it reaches the bottom assuming the loss of whole gravitational potential energy is used as heat by the ice? [Given: $L_f = 80$ cal/gm and $g = 10$ m/s^2]
(A) 33.6 m (B) 33.6 km
(C) 8 m (D) 8 km

2. A Solid floats with 2/3 of its volume immersed in a liquid and with 3/4 of its volume immersed in another liquid. What fraction of its volume will be immersed if it floats in a homogenous mixture formed of equal volumes of the liquids?
(A) $\frac{6}{11}$ (B) $\frac{8}{11}$
(C) $\frac{11}{16}$ (D) $\frac{12}{17}$

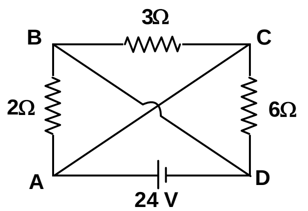
3. One mole of ideal gas undergoes an expansion from state A to state B as shown in the V-T diagram. The pressure of gas:
(A) remains constant during the process.
(B) increases from A to B, $\frac{8}{3}$ times
(C) is same at A and B, but increases in between
(D) decreases from A to B, $\frac{3}{8}$ times



4. To increase the resonant frequency in series L-C-R circuit,
(A) source frequency should be increased
(B) another resistance should be added in series with the first resistance
(C) another capacitor should be added in series with the first capacitor
(D) the source frequency should be decreased

5. Time taken by light to travel in two different materials A and B of refractive indices μ_A and μ_B of same thickness is t_1 and t_2, respectively. If $t_2 - t_1 = 5 \times 10^{-10}$ s and the ratio of μ_A to μ_B is 1:2. Then, the thickness of material in metre is (Given, V_A and V_B are velocities of light in A and B materials, respectively.)
(A) $(5 \times 10^{-10} \times v_A)$ m (B) (5×10^{-10}) m
(C) (1.5×10^{-10}) m (D) $(5 \times 10^{-10} \times v_B)$ m

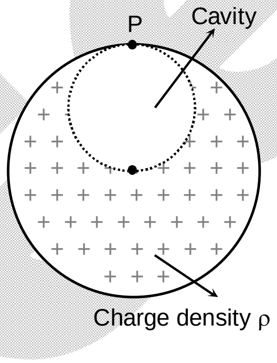
6. Current flowing between points A and C is
(A) zero (B) 4A
(C) 8A (D) 12A



7. If frequency of incident light in a photoelectric cell is doubled, then stopping potential increases by
(A) 50%
(B) 100%
(C) more than 100%
(D) any amount depending on work function of metal

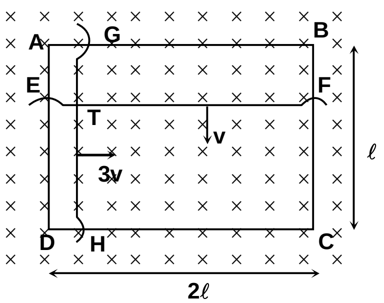
8. A charged particle enters in a region of a uniform magnetic field making 45° with direction of field. If P and R represent pitch and radius of helical path followed by particle, then $\frac{P}{R}$ equals to
(A) π
(B) 2π
(C) 1
(D) $\sqrt{\pi^2+1}$

9. A sphere of diameter d is removed from a uniform non-conducting sphere of charge density p and radius R thereby creating a cavity as shown. An electron (of charge - e and mass m) is released at top point P of this cavity. Time after which the electron strikes the surface of the cavity is (Take, d = R and gravity is absent)



(A) $\sqrt{\frac{12\varepsilon_0 m}{\rho e}}$
(B) $\frac{1}{2}\sqrt{\frac{\rho e}{3\varepsilon_0 m}}$
(C) $\sqrt{\frac{2\varepsilon_0 m}{\rho e}}$
(D) $\sqrt{\frac{\varepsilon_0 m}{2\rho e}}$

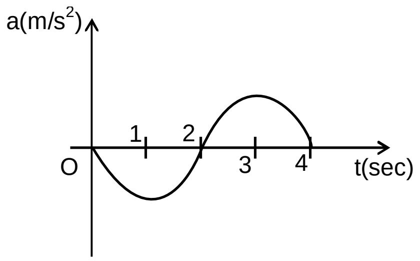
10. The figure here shows a fixed rectangular conducting frame ABCD of side ℓ and 2ℓ in a region of transverse uniform magnetic field B_0. Two straight conducting sliders EF and GH are moving with respective speeds v and 3v as shown in figure. Initially, EF and GH are located very near to sides AB and AD respectively. Intersection contact of the sliders is represented by T. Emf induced in the loop ETHD when it is a square, is



(A) $2B_0v\ell$
(B) $1.5B_0v\ell$
(C) $B_0v\ell$
(D) $0.5\,B_0v\ell$

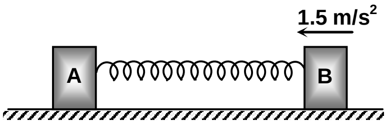
11. A particle experiences a force $\vec{F} = Ar^2\hat{r}$, where $\hat{r}$ is the unit vector along position vector $\vec{r}$. The dimensional formula of A is:
(A) $[MLT^{-2}]$
(B) $[ML^{-2}T^{-2}]$
(C) $[ML^{-2}T^{-1}]$
(D) $[ML^{-1}T^{-2}]$

12. Acceleration (a)-time (t) graph for a particle starting from rest at t = 0 is as given aside. The particle has maximum speed at:



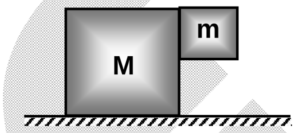
(A) 1s
(B) 2 s
(C) 3 s
(D) 4 s

13. Two blocks A and B with mass 4 kg and 6 kg respectively are connected by a stretched spring of negligible mass as shown in figure. When the two blocks are released simultaneously the initial acceleration of B is 1.5 m/s^2 westward. The acceleration of A is



(A) 1 m/s^2 westward
(B) 2.25 m/s^2 eastward
(C) 1 m/s^2 eastward
(D) 2.75 m/s^2 westward

14. With what minimum acceleration, mass M must be moved on frictionless surface so that m remains stick to it as shown? The coefficient of friction between M and m is μ.



(A) μg (B) $\frac{g}{\mu}$

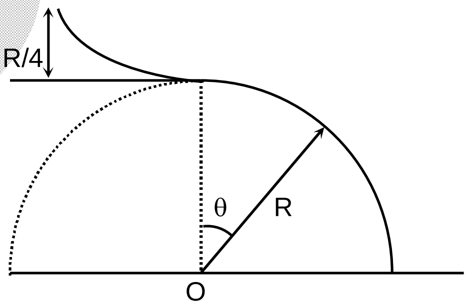
(C) $\frac{\mu mg}{M+m}$ (D) $\frac{\mu mg}{M}$

15. In a circular motion of a particle, the tangential acceleration of the particle is given by $a_t = 9$ m/s^2. The radius of the circle is 4 m. The particle was initially at rest. Time after which total acceleration of the particle makes an angle of 45° with the radial acceleration is

(A) $\frac{1}{3}$ sec (B) $\frac{2}{3}$ sec

(C) 1 sec (D) $\frac{4}{3}$ sec

16. A skier plans to ski a smooth fixed hemisphere of radius R. He starts from rest from a curved smooth surface of height (R/4). The angle θ at which he leaves the hemisphere is:



(A) $\cos^{-1}\left(\frac{2}{3}\right)$

(B) $\cos^{-1}\left(\frac{5}{\sqrt{3}}\right)$

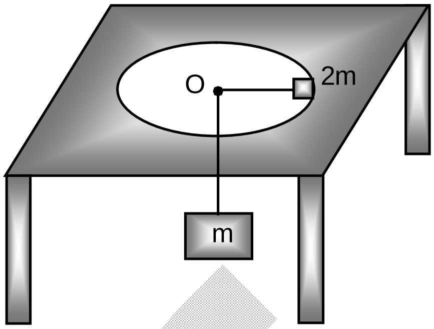
(C) $\cos^{-1}\left(\frac{5}{6}\right)$

(D) $\cos^{-1}\left(\frac{5}{2\sqrt{3}}\right)$

17. Sachin (55 kg) and Kapil (65 kg) are sitting at the two ends of a boat at rest in still water. The boat weighs 100 kg and is 3.0 m long. Sachin walks down to Kapil and shakes hand. The boat gets displaced by:

(A) zero m (B) 0.75 m
(C) 3.0 m (D) 2.3 mm

18. A mass 2m rotating freely in a horizontal circle of radius 1m on a frictionless smooth table supports a stationary mass m, attached to the other end of the string passing through smooth hole O in table, hanging vertically. Find the angular velocity of rotation. (Given g = 10 m/s^2)



(A) $\sqrt{5}$ rad/s
(B) $2\sqrt{5}$ rad/s
(C) $\sqrt{10}$ rad/s
(D) $\frac{\sqrt{5}}{2}$ rad/s

19. A bowling ball of mass m, which can be treated as a uniform rigid sphere, is rolling without slipping on a horizontal surface. The coefficient of static friction between the ball and the surface is μ_S, the coefficient of kinetic friction is μ_K, and the acceleration due to gravity is g. What is the force of friction acting on the ball?

(A) zero
(B) $\mu_S mg$
(C) $\mu_k mg$
(D) $\frac{2}{5}\mu_S mg$

20. A disc of radius R and mass M is pivoted at the rim and is set for small oscillations in vertical plane (in its plane). If simple pendulum has to have the same period as that of the disc, the length of the simple pendulum should be :

(A) $\left(\frac{5}{4}\right)R$
(B) $\left(\frac{2}{3}\right)R$
(C) $\left(\frac{3}{4}\right)R$
(D) $\left(\frac{3}{2}\right)R$

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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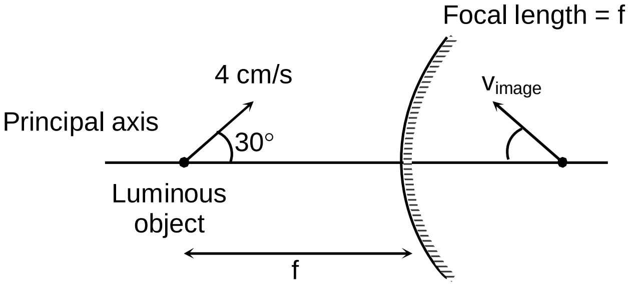
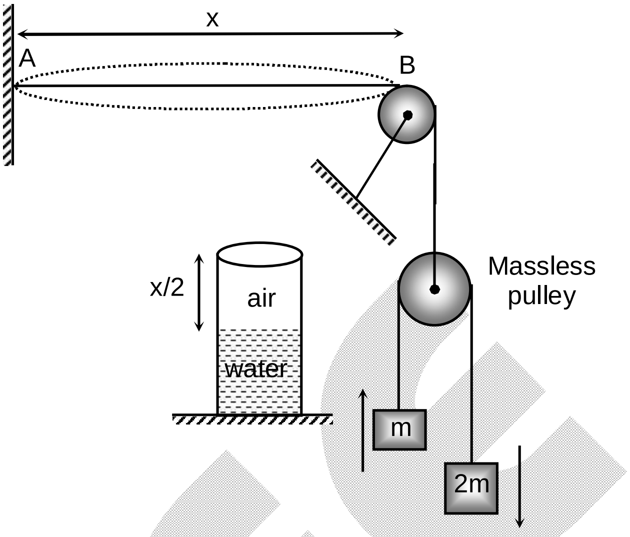
21. A point charge of $\frac{1}{4\pi}$ coulomb is placed in front of an infinite imaginary plane. Electric flux through the plane is 4.5×10^b N-m^2/C. Find b.

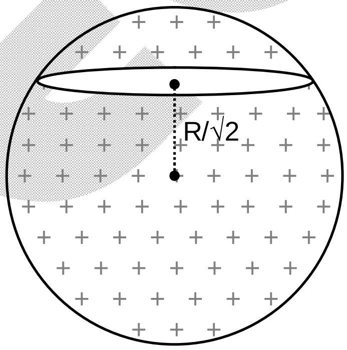
22. The speed of image of the object moving on axis of the mirror as shown is $\frac{\sqrt{7}}{k}$ cm/s. Find the value of k.



23. Consider the arrangement shown in the figure. A uniform wire (linear mass density 0.2 g/m) vibrating in its fundamental mode is in resonance with air column in a resonance tube vibrating in 1st overtone. The value of m is $\frac{54}{k}$ kg. Find the value of k. (Given that speed of sound in air is 400 m/s and g =10 m/s^2)



24. Consider the shown section at a perpendicular distance $\frac{R}{\sqrt{2}}$ from centre of the shown uniform solid sphere. Electric flux through the section is $\frac{Q}{k\sqrt{2}\varepsilon_0}$. Find the value of k.



Uniform solid sphere
(Total charge = Q, Radius = R)

25. Average life time of a hydrogen atom excited to n = 2 state is 10^{-8} s. The number of revolutions made by the electron on the average before it jumps to ground state is close to 8×10^x. Find x. (Take radius of first Bohr's orbit r_0 = 0.53 Å and speed of electron in first Bohr's orbit 2.2×10^6 m/s)

26. If percentage errors in measurement of length of pendulum and time period of pendulum in an experiment to measure g are 1% and 2% respectively, then find maximum possible percentage error in measurement of g.

27. A vibration magnetometer has two identical bar magnets placed over each other such that they are mutually perpendicular and bisect each other. Time period of combination is $\sqrt[4]{32}$ s. Now if one of the magnet is removed, find time period of the remaining magnet in second.

28. 20 divisions on a vernier scale coincides with 19 divisions of main scale. If least count of the instrument is 0.05 mm, find the length of one Main Scale Division (MSD) in mm.

29. Two identical thin equiconvex lenses of focal length 15 cm and refractive index 1.5 are in contact with each other. The space between the lenses is filled with a liquid of refractive index 1.25. Find the focal length of the combination in cm.

30. In a potentiometer arrangement, a cell gives a balancing point at 75 cm length of wire. This cell is now replaced by another cell of unknown emf. If the ratio of the emf's of two cells, is 3: 2, the difference in the balancing length of the potentiometer wire in above two cases will be x cm. Find x.

Chemistry

PART – B

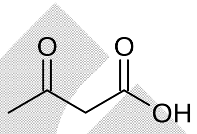
SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

31. The correct order of decreasing acidity for following compound is

O_2NCH_2COOH, CCl_3COOH, $(F_3C)_3\ COH$,



1 2 3 4

(A) 1 > 3 > 2 > 4
(B) 3 > 1 > 2 > 4
(C) 2 > 1 > 4 > 3
(D) 3 > 1 > 4 > 2

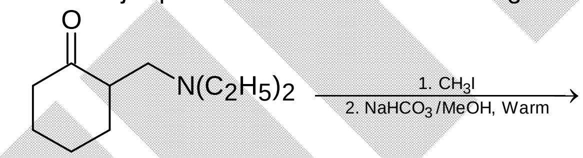
32. The major product obtained in the following reaction, is

$$H-C\equiv C-CH_2OH \xrightarrow[\substack{\text{2. } C_2H_5Br(1\text{ equiv.}) \\ \text{3. } H_3O^+}]{\text{1. } LiNH_2(2\text{ equiv.})/\text{liq. } NH_3}$$

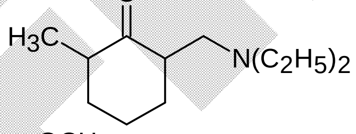
(A) $CH_3CH_2-C\equiv C-CH_2OH$
(B) $H-C\equiv C-CH_2OCH_2CH_3$
(C) $CH_3CH_2-C\equiv C-CH_2NH_2$
(D) $H-C=C-CH_2NH-CH_2CH_3$

33. The reaction of P_2O_5 with HNO_3 and $HClO_4$, respectively, gives
(A) NO_2 and ClO_2
(B) N_2O_5 and Cl_2O_6
(C) N_2O_3 and Cl_2O_7
(D) N_2O_5 and Cl_2O_7

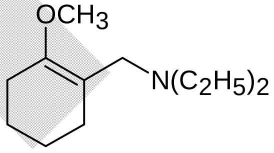
34. The major product formed in the following reaction, is



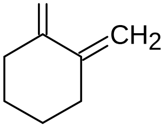
(A)



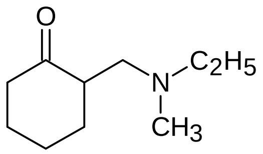
(B)



(C)



(D)



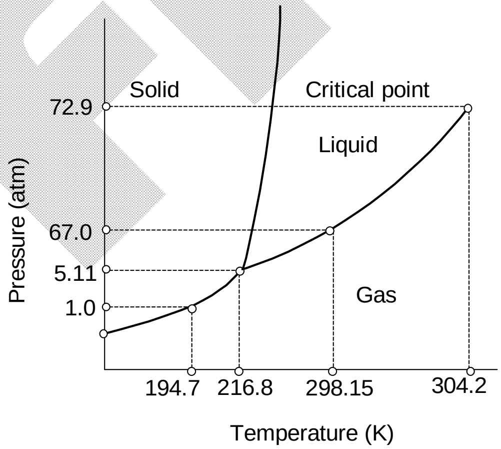
35. Select the correct statement(s) about drugs:
(A) Chlordiazepoxide is suitable for relieving tension.
(B) Barbiturates are sleep producing agents.
(C) Cimetidine prevent the interaction of histamine with the receptors present in stomach wall.
(D) All of the above are correct statements.

36. The correct electronic configuration and spin only magnetic moment Gd^{3+} (at. no. 64) are
(A) $[Xe]4f^7$ and 7.9 BM
(B) $[Xe]4f^7$ and 8.9 BM
(C) $[Xe]4f^6 5d^1$ and 7.9 BM
(D) $[Rn]5f^7$ and 7.9 BM

37. Among the following octahedral complexes, the one that has the highest enthalpy of hydration is
(A) $\left[Ca(H_2O)_6\right]^{2+}$
(B) $\left[Mn(H_2O)_6\right]^{2+}$
(C) $\left[V(H_2O)_6\right]^{2+}$
(D) $\left[Cr(H_2O)_6\right]^{2+}$

38. The Lewis acidity of BF_3 is less than BCl_3 even though fluorine is more electronegative than chlorine. It is due to
(A) stronger 2p(B)-2p(F) σ – bonding
(B) stronger 2p(B)-2p(F) π – bonding
(C) stronger 2p(B)-3p(Cl) σ – bonding
(D) stronger 2p(B)-3p(Cl) π – bonding

39. Consider the following phase diagram of CO_2 (not to scale). At equilibrium, the INCORRECT statement is:



(A) At 200 K, on increasing the pressure from 1 to 50 atm, CO_2 gas condenses to liquid.
(B) It is not possible to obtain liquid CO_2 from gaseous CO_2 below 5.11 atm.
(C) Both liquid and gas phase CO_2 coexist at 29.15 K and 67 atm.
(D) With increasing pressure, the melting point of solid CO_2 increases.

40. Among the following species, the one that has pentagonal shape is:
(Given: atomic numbers of O, F, S, I and Xe are 8, 9, 16, 53 and 54, respectively)

(A) $XeOF_4$	(B) IF_5
(C) $[SF_5]^-$	(D) $[XeF_5]^-$

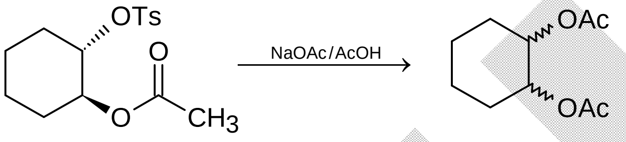
41. Which of the following is a viable particulate

(A) Smoke	(B) Algae
(C) Mists	(D) Dust

42. The number of unit cells in 117 g of NaCl is approximately

(A) 6×10^{20}	(B) 3×10^{23}
(C) 6×10^{23}	(D) 0.5×10^{24}

43. The product obtained in the following solvolysis reaction is



enantiomerically
pure compound

(A) a racemic mixture of *trans* 1,2-diacetoxycyclohexane
(B) enantiomerically pure *trans* 1,2-diacetoxycyclohexane
(C) racemic *cis* 1,2-diacetoxycyclohexane
(D) a mixture of *cis* and *trans* 1,2-diacetoxycyclohexane

44. A 0.1 M solution of $\left[Cu(NH_3)_4\right]^+$ is stirred with an excess of potassium cyanide sufficient to convert all the ammonium complex to the corresponding cuprocyanide complex $\left[Cu(CN)_4\right]^{-3}$ and in addition to provide the solution with an excess of CN^- equal to 0.2 M. Calculate the maximum pH of the solution when the final solution is treated with hydrogen sulphide to maintain $[H_2S] = 0.1\text{ M}$ and the precipitation of cuprous sulphide is prevented. The instability constant for $\left[Cu(CN)_4\right]^{-3}$ is 6.4×10^{-15}, $K_{a,\text{ overall}}$ of $H_2S = 1.6\times10^{-21}$, K_{sp} of $Cu_2S = 2.56\times10^{-27}$.

(A) 4.0	(B) 10.0
(C) 10.8	(D) 3.2

45. The compound which don't liberate coloured gas with conc. H_2SO_4 is

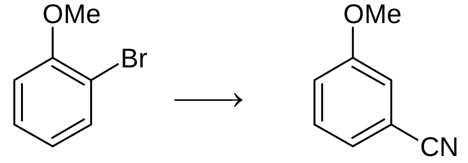
(A) $KCl + K_2Cr_2O_7$	(B) KCl
(C) KNO_2	(D) KBr

46. Suppose the mass of electron is decreased by 25%. How will it affect the Rydberg constant?
(A) It remains unchanged.
(B) It becomes one-fourth.
(C) It reduces to 75% of its original value.
(D) It is doubled.

47. At moderate pressure, the compressibility factor for a gas is given as $Z = 1 + 0.35P - \frac{168}{T}.P$, where P is in bar and T is in Kelvin. What is the Boyle's temperature of the gas?
(A) 168 K
(B) 480 K
(C) 58.8 K
(D) 575 K

48. Graph between $\log\left(\frac{x}{m}\right)$ and log P is a straight line at an angle 45^o with intercept on y-axis, 0.3010. The amount (in g) of the gas absorbed per g of the adsorbent when pressure is 0.2 atm is (assume that the adsorption obey Freundlich isotherm)
(A) 0.4
(B) 0.6
(C) 0.8
(D) 0.2

49. The correct set of reagents for the following conversion is



(A) (i) $NaNH_2$ / liq. NH_3; (ii) $NaNO_2$ / dil. HCl; (iii) CuCN, heat
(B) (i) HNO_3 / H_2SO_4; (ii) ZnHCl; (iii) $NaNO_2$ / dil. HCl; (iv) CuCN, heat
(C) (i) Mg / ether, H_2O^+; (ii) $(EtO)_2$ CO; (iii) NH_4OH; (iv) PCl_5
(D) (i) Mg / ether, H_2O^+; (ii) HNO_3 / H_2SO_4; (iii) $NaNO_2$ / dil. HCl; (iv) CuCN, heat

50. Phenol on reacting with Hinsberg's reagent gives:
(A) Sulphone
(B) Sulphanilic
(C) Sulphonic ester
(D) Sulphonal

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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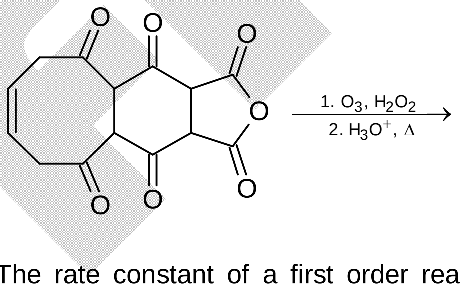
51. Number of carbonyl groups present in the final product of the following reaction sequence is...............



52. The rate constant of a first order reaction, $X \to Y$, is 1.6×10^{-3} s^{-1} at 300 K. Given that the activation energy of the reaction is 28 kJ mol^{-1} and assuming Arrhenius behaviour for the temperature dependence, the total time required to obtain 90% of Y at 350 K is ____________s. (Use R = 8.31 J K^{-1} mol^{-1})

53. The Latimer diagram of oxygen is given below. The value of 100x is________V.

$$\begin{tikzcd}
O_2 \arrow[r, "+0.70\ V"] \arrow[rr, bend right, "xV"'] & H_2O_2 \arrow[r, "+1.76\ V"] & H_2O
\end{tikzcd}$$

54. On heating a sample of 25 g hydrated compound (molecular weight = 250 g/mol) in thermogravimetric analysis, 16 g of dehydrated compound remains. The number of water molecules lost per molecule of hydrated compound is________.

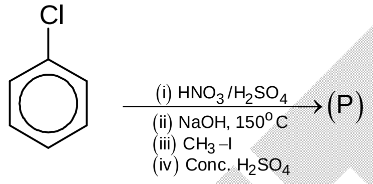
55. The entropy change for the melting of 'x' moles of ice (heat of fusion is 80 cal g^{-1}) at 273 K and 1 atm pressure is 28.80 cal K^{-1}. The value of '50x' is__________
(Molecular weight of water = 8 g/mol)

56. At 10^oC, the osmotic pressure of urea solution is 500 mm. The solution diluted and the temperature is raised to 100^oC, when the osmotic pressure is found to be 94 mm. The extent of dilution (ratio of final to initial volume of solution) is

57. Among the following ores
Bauxite, Kaolinite, Malachite, Sphalerite, Calamine, Siderite, Magnetite, the number of principal ores of copper and zinc are______

58. The number of nitrogen atoms present in the adenine is_____

59. In the given reaction



The number of π bonds present in compound (P) is____________

60. How many different secondary halide names can be assigned to compounds with molecular formula $C_5H_{11}Cl$ (excluding stereoisomers)?

Mathematics PART – C

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

61. If P is any point on ellipse with foci S_1 and S_2 and eccentricity is $\frac{1}{2}$ such that $\angle PS_1S_2 = \alpha$, $\angle PS_2S_1 = \beta$, $\angle S_1PS_2 = \gamma$, then $\cot\left(\frac{\alpha}{2}\right), \cot\left(\frac{\gamma}{2}\right), \cot\left(\frac{\beta}{2}\right)$ are in

(A) A.P. (B) G.P.
(C) H.P. (D) not A.P., G.P. and H.P.

62. For each positive integer n, consider the point P with abscissa n on the curve $y^2 - x^2 = 1$. If d_n represents the shortest distance from the point P to the line y = x, then $\lim\limits_{n\to\infty}(n \cdot d_n)$ is

(A) $\frac{1}{2\sqrt{2}}$ (B) $\frac{1}{2}$
(C) $\frac{1}{\sqrt{2}}$ (D) 0

63. Latus-rectum of the conic satisfying the differential equation xdy + ydx = 0 and passing through the point (2, 8) is

(A) $4\sqrt{2}$ (B) 8
(C) $8\sqrt{2}$ (D) 16

64. Let a and b be real numbers and let $f(x) = a\sin x + b\sqrt[3]{x} + 4$, $\forall\ x \in R$. If $f(\log_{10}(\log_3 10)) = 5$, then $f(\log_{10}(\log_{10} 3))$ is

(A) 2 (B) 1
(C) 3 (D) 4

65. Suppose f is an even periodic function with period 2, and that f(x) = x for all x in the interval [0, 1]. The value of f(3.14) is

(A) 3.14 (B) 0.86
(C) 1.57 (D) 1.3

66. $\int \left(x^2+1\right)\left((x+1)e^x\right)^2 dx = A\left(f(x)\right)^2 + C$ where C is constant of integration and $f(-1) = \frac{2}{e}$, then 2A + f(0) is

(A) 3 (B) 2
(C) 1 (D) 0

67. If $\sum\limits_{i=1}^{6}\left(\sin^{-1}(x_i) + \cos^{-1}(y_i)\right) = 9\pi$, then $\int\limits_{\sum_{i=1}^{6} x_i}^{\sum_{i=1}^{6} y_i} x\ln\left(1+x^2\right)\left(\frac{e^x}{1+e^{2x}}\right)dx$ is equal to

(A) 0 (B) $e^6 + e^{-6}$
(C) $\ln\left(\frac{37}{12}\right)$ (D) $e^6 - e^{-6}$

68. Area bounded by $y=\frac{1}{x^2-2x+2}$ and x-axis is

(A) 2π sq. units (B) $\frac{\pi}{2}$ sq. units

(C) 2 sq. units (D) π sq. units

69. Let f(x) = $\frac{\sin\left(\pi x^4\right)+\left(x+2\right)^n\frac{\tan\left(\pi x\right)}{\left(x+1\right)}}{1+\left(x+2\right)^n-x^4}$, then $\lim\limits_{x\to-1}f\left(x\right)$ is

(A) π (B) $\frac{22}{7}$

(C) 1 (D) $-\pi$

70. If $f\left(x\right)=\frac{\sqrt{x^2+kx+1}}{x^2-k}$, the interval(s) of all possible values of k for which f is continuous for every $x \in R$, is

(A) $(-\infty, -2]$ (B) $[-2, 0)$

(C) $R - (-2, 2)$ (D) $(-2, 2)$

71. Number of complex numbers satisfying the relation $\left|z+\bar{z}\right|+\left|z-\bar{z}\right|=2$ and $|z + i| + |z - i| = 2$ is

(A) 1 (B) 2

(C) 3 (D) 4

72. If A = $\begin{bmatrix}1 & 1\\1 & 1\end{bmatrix}$ and $\det(A^n - I) = 1 - \lambda^n$, $n \in N$, then the value of λ is

(A) 2 (B) -2

(C) 3 (D) 4

73. The matrix A = $\begin{bmatrix}1 & 2 & 2\\2 & 1 & 1\\2 & 2 & 1\end{bmatrix}$ be a zero divisor of the polynomial $f(x) = x^2 - 4x - 5$, then the trace of matrix A^3, is

(A) 213 (B) 123

(C) 203 (D) 201

74. The relation R = {(1, 1), (2, 2), (3, 3), (1, 2), (2, 3), (1, 3)} on the set A = {1, 2, 3} is

(A) reflexive but not symmetric (B) reflexive but not transitive

(C) symmetric and transitive (D) neither symmetric nor transitive

75. A tower subtends angles d, 2α, 3α respectively at points A, B and C all lying on a horizontal line through the foot of the tower, then $\frac{AB}{BC}$ is equal to

(A) $\frac{\sin\left(3\alpha\right)}{\sin\left(2\alpha\right)}$ (B) $1 + 2\cos(2\alpha)$

(C) $2\cos(2\alpha)$ (D) $\frac{\sin\left(2\alpha\right)}{\sin\alpha}$

76. The sum of squares of deviations for 10 observations taken from mean 50 is 250. The coefficient of variation is
(A) 10% (B) 40%
(C) 50% (D) none of these

77. If p and q be two statements, then $(\sim p \vee q) \wedge (\sim p \wedge \sim q)$ is a
(A) tautology (B) contradiction
(C) neither tautology nor contradiction (D) either tautology or contradiction

78. Let $y = \tan^{-1}\left(\frac{4x}{1+5x^2}\right) + \tan^{-1}\left(\frac{2+3x}{3-2x}\right)$ where $x \in \left(0, \frac{2}{3}\right)$. If $\frac{dy}{dx} = \frac{\alpha}{1+25x^2}$, then the value of α is
(A) 3 (B) 4
(C) 5 (D) 6

79. $I = \int_{e^{\pi/6}}^{e^{\pi/2}} \frac{\sin(\ln(\sin(\ln x)))\cdot\cos(\ln x)}{x\sin(\ln x)}dx$, then $\cos^{-1}(I + 1)$ is
(A) $\frac{\pi}{2}$ (B) $\frac{\pi}{3}$
(C) ln2 (D) 2ln2

80. The largest value of $\frac{y}{x}$, where (x, y) is real number pair satisfying $(x - 3)^2 + (y - 3)^2 = 6$, is
(A) $2\sqrt{3}$ (B) $2+\sqrt{3}$
(C) $3+2\sqrt{2}$ (D) $6+2\sqrt{3}$

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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81. If $f(\theta) = \frac{1}{1+(\cot\theta)^x}$ and $s = \sum_{\theta=1^\circ}^{89^\circ} f(\theta)$, then [s] is (where [.] denotes G.I.F)

82. Let $\vec{v}_1$ and $\vec{v}_2$ are two vectors such that $\vec{v}_1 = 2(\sin\alpha + \cos\alpha)\,\hat{i} + \hat{j}$ and $\vec{v}_2 = (\sin\beta)\hat{i} + (\cos\beta)\hat{j}$ where α and β satisfy the reaction $2(\sin\alpha + \cos\alpha)\sin\beta = 3 - \cos\beta$, then the value of $3\tan^2\alpha + 4\tan^2\beta$ is

83. The line which contains all points (x, y, z) which are of the form $(x, y, z) = (2, -2, 5) + \lambda(1, -3, 2)$ intersects the plane $2x - 3y + 4z = 163$ at P and intersects the YZ plane at Q. If the distance PQ is $a\sqrt{b}$, where $a, b \in N$ and $a > 3$ then $(a + b)$ is

84. If A and B are two events with P(A) = 0.5 and $P(A \cup B) = 0.8$. If P(B) = p and A and B are mutually exclusive and P(B) = q, if A and B are independent then $\left|\frac{q}{p}\right|$ is

85. If x > 0 and y > 0 and $x^2y^3 = 6$. If m be the least value of 3x + 4y, then m is

86. If the point P(h, k) lies on the line 2x + 3y = 5 such that |PA − PB| is maximum where A(2, 3) and B(1, 2), then 3h + 2k is

87. If x, y, z be positive numbers such that $x + y + z = 10$. If maximum value of $x^2y^3z^5$ is N, then number of odd divisors is

88. The remainder, when $15^{23} + 23^{23}$ is divided by 19 is m, then m is

89. Let x, y be real variables satisfying $x^2 + y^2 + 8x - 10y + 40 = 0$. Let $a = \max\{(x + 2)^2 + (y - 3)^2\}$ and $b = \min\{(x + 2)^2 + (y - 3)^2\}$, then ab is

90. If $\cos^{-1}x + \cos^{-1}y + \cos^{-1}z = 3\pi$, then $(x + y - z)^{2022}$ is

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ALL INDIA TEST SERIES

FULL TEST – VI

JEE (Main)-2023

TEST DATE: 19-01-2023

ANSWERS, HINTS & SOLUTIONS

Physics

PART – A

SECTION – A

1. B

Sol. Applying energy conservation:

$mgh = mL_f$

$$h = \frac{L_f}{g} = \frac{80\ \text{cal/gm}}{10\ \text{m/s}^2}$$

$$= \frac{80\times 42\times 1000\ \text{J/kg}}{10\ \text{m/s}^2} = \left(\frac{336\times 10^3}{10}\right)\frac{\text{N}-\text{s}^2}{\text{kg}} = 33.6\ \text{km}$$

2. D

Sol. $$\frac{2}{3}v\rho_1 g = v\rho g$$

$$\frac{3}{4}v\rho_2 g = v\rho g$$

$$v\rho_1 + v\rho_2 = 2v\rho_m$$

$$\frac{\rho_1+\rho_2}{2} = \rho_m$$

$$v'\left(\frac{\rho_1+\rho_2}{2}\right)g = v\rho g$$

$$\frac{v'}{2}\left(\frac{3\rho g}{2} + \frac{4\rho g}{3}\right) = v\rho g$$

$$v' = \frac{12}{17}v$$

3. B

Sol. As $P = nR\frac{T}{V}$ so $P_A = nR\frac{T_0}{2V_0}$

and $P_B = nR\frac{4T_0}{3V_0}$

$\Rightarrow \frac{P_B}{P_A} = \frac{8}{3}$

4. C

Sol. Resonant frequency of an L-C-R circuit is given by

$$\omega_r = \frac{1}{\sqrt{LC}}$$

So, resonance frequency does not depend on resistance of circuit and frequency of supply. To increase resonance frequency, we have to reduce inductance or capacitance of circuit. As capacitance reduces when capacitors are connected in series

(i.e. $\frac{1}{C_{series}} = \frac{1}{C_1} + \frac{1}{C_2}$), another capacitor in series to increase resonant frequency.

5. A

Sol. As, refractive index,

$$\mu = \frac{\text{speed of light in air}}{\text{speed of light in medium}}$$

So, speed of light in a medium

$$v = \frac{c}{\mu}$$

Hence, for medium A and B,

$v_A = \frac{c}{\mu_A}$ and $v_B = \frac{c}{\mu_B}$

Time taken by light to cross some thickness x is $\left(\text{speed} = \frac{\text{distance}}{\text{time}}\right)$

$t_1 = \frac{x}{(c/\mu_A)}$ and $t_2 = \frac{x}{(c/\mu_B)}$

Hence, $t_2 - t_1 = \frac{\mu_B \cdot x}{c} - \frac{\mu_A \cdot x}{c}$

$\Rightarrow t_2 - t_1 = \frac{x}{c}(\mu_B - \mu_A)$

Now, given, $\frac{\mu_A}{\mu_B} = \frac{1}{2}$

$\Rightarrow \mu_B = 2\mu_A$

and $t_2 - t_1 = 5 \times 10^{-10}$ s

substituting these values, we get

$$5 \times 10^{-10} = \frac{x}{c}(2\mu_A - \mu_A)$$

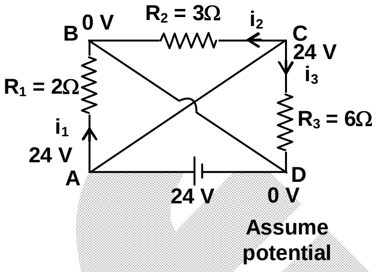
$$\Rightarrow x = 5 \times 10^{-10} \times \frac{c}{\mu_A}$$

But $\frac{c}{\mu_A} = v_A$

$\therefore\ x = (5 \times 10^{-10} \times v_A)\,m$

6. D

Sol. Assume potential at point D is equal to zero. As we know potential of all points on a plane wire are equal, so potential at B will also be equal to 0 V. Also potential difference across cell is 24 V, so potential at A will be 24 V. Similarly, potential at C is also 24V.



Using Ohm's law for branch AB,

$$i_1 = \frac{V_A - V_B}{R_1} = \frac{24-0}{2} = 12\text{ A}$$

For branch CB,

$$i_2 = \frac{V_C - V_B}{R_2} = \frac{24-0}{3} = 8\text{A}$$

For branch CD,

$$i_3 = \frac{V_C - V_D}{R_3} = \frac{24-0}{6} = 4\text{A}$$

By KCL for junction C,

$$i = i_2 + i_3 = 8 + 4 = 12\text{ A}$$

7. C

Sol. As per Einstein's photoelectric equation

$$V_S = \frac{hf}{e} - \frac{\phi}{e} \qquad \text{...(i)}$$

If f is doubled, new stopping potential,

$$V_S' = \frac{2hf}{e} - \frac{\phi}{e}$$

$$= 2\left(\frac{hf}{e} - \frac{\phi}{e}\right) + \frac{\phi}{e} = 2V_S + \frac{\phi}{e} \qquad \text{[from equation (i)]}$$

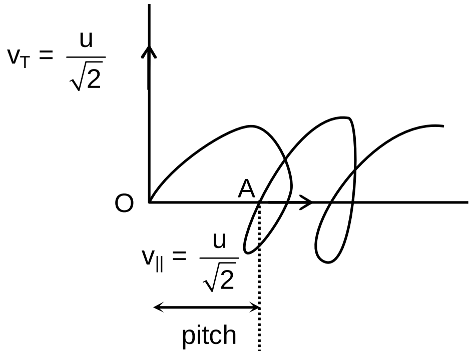
Which is more than double or an increase of more than 100%

8. B

Sol. When a charged particle enters a region of a uniform magnetic field, such that the angle it makes with the direction of B ≠ 90°, then it follows a helical path as shown below

Radius of helix,

$$R = \frac{mv_\perp}{qB} = \frac{mu}{\sqrt{2}qB} \qquad \text{...(i)}$$



Where, $v_\perp$ = Component of velocity perpendicular to field.

Also, pitch, P = Displacement along field in one revolution (OA)

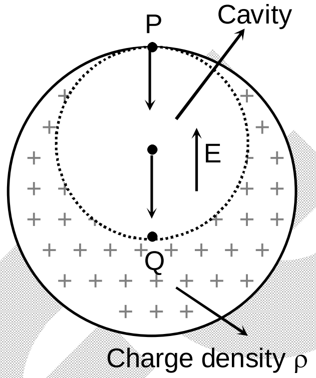
$$= v_{||} \times T = \frac{u}{\sqrt{2}} \times \frac{2\pi m}{qB} \qquad \text{(ii)}$$

Dividing equation (ii) by equation (i), $\frac{P}{R} = 2\pi$

9. A

Sol. Field inside spherical cavity in a sphere = $\frac{\rho a}{3\varepsilon_0}$

Where a = distance between centres of sphere and cavity. Direction of field is along line joining centres as shown in figure.



So, field inside cavity will be $E = \frac{\rho\left(\frac{R}{2}\right)}{3\varepsilon_0} = \frac{\rho R}{6\varepsilon_0}$ (as shown)

Under influence of field, electron will accelerate down with acceleration,

$$a = \frac{eE}{m} = \frac{\rho Re}{6\varepsilon_0 m} \qquad \text{...(i)}$$

As electrons move from P to Q, striking the cavity at Q, its displacement will be equal to PQ = R= s ...(ii)

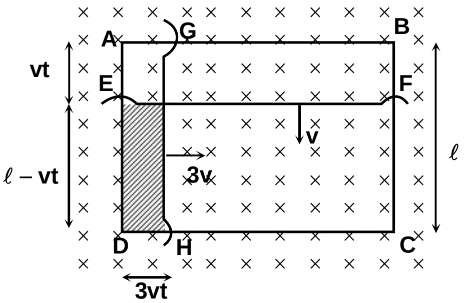
So, by using, $s = ut + \frac{1}{2}at^2$, we get

$$R = 0 + \frac{1}{2}\frac{\rho Re}{6\varepsilon_0 m}t^2 \qquad \text{[using equation (i) and (ii)]}$$

$$\Rightarrow t = \sqrt{\frac{12\varepsilon_0 m}{\rho e}}$$

10. B

Sol. At time t, distances moved by sliders GH and EF will be 3vt and vt respectively as shown.



Therefore, area of loop ETHD will be

$A = 3vt(\ell - vt) = 3v\ell t - 3v^2t^2$

$$\Rightarrow \frac{dA}{dt} = 3v\ell - 6v^2t \qquad \text{...(i)}$$

At the instant, the loop is square, its two sides will be equal. Therefore,

$$3vt = \ell - vt \Rightarrow t = \frac{\ell}{4v}$$

...(ii)

By Faraday's law, emf induced in the loop

$$\varepsilon = \frac{d\phi}{dt} = \frac{d(B_0 \cdot A)}{dt} = B_0\frac{dA}{dt}$$

$= B_0(3v\ell - 6v^2t)$ using equation (i)

$= B_0\left[3v\ell - 6v^2\left(\frac{\ell}{4v}\right)\right]$ using equation (ii)

$$= \frac{3B_0v\ell}{2} = 1.5\ B_0v\ell$$

11. D

Sol. $[\vec{F}] = [Ar^2\hat{r}] = [Ar^2]$

$$[A] = \frac{[\vec{F}]}{[r^2]} = \frac{MLT^{-2}}{L^2} = [ML^{-1}T^{-2}]$$

12. B

Sol. Between t = 0 and t = 2, acceleration has same sign which increases speed. At t = 2 sec. Direction of acceleration is reversed and speed starts decreasing.

13. B

Sol. $T = M_B \times a_B$ but T is also equal to M_Aa_A

$\therefore M_Ba_B = M_Aa_A$

$\Rightarrow 6 \times 1.5 = 4 \times a_A$

$\Rightarrow a_A = 2.25\ m/s^2$

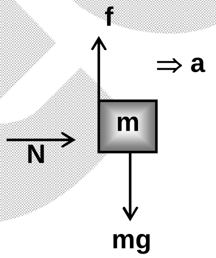
14. B

Sol. f = mg and N = mA

So, $\mu N = mg$

$\mu mA = mg$ (For A_{min}, f is max)

$\Rightarrow A = \frac{g}{\mu}$



15. B

Sol. At 45°, $a_t = a_r = 9$

$$\frac{v^2}{r} = \frac{v^2}{4} = 9$$

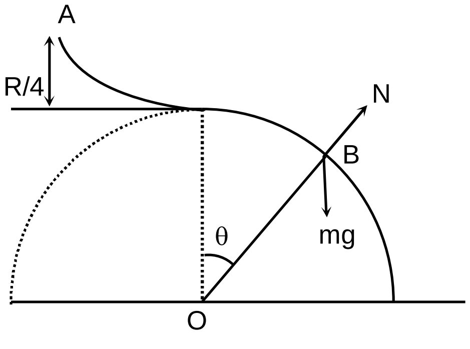
v = 6 m/s

Now, 6 = 0 + 9t

$t = \frac{2}{3}$ sec

16. C

Sol. Conserving energy between points A and B,



$$mg\left[\frac{R}{4} + R(1-\cos\theta)\right] = \frac{1}{2}mv^2$$

Also at point B, N = 0

$$\text{So, } mg\cos\theta = \frac{mv^2}{R}$$

$$\frac{1}{4} + (1-\cos\theta) = \frac{1}{2}\cos\theta$$

$$\frac{5}{4} = \frac{3}{2}\cos\theta$$

$$\cos\theta = \frac{5}{6}$$

17. B

Sol. Kapil and the boat can be considered as one body of mass m_b = (65 + 100) = 165 kg. Note that the centre of mass of the system remains unchanged since no external force acts on the system. Let m_S be the mass of Sachin and Δx_b and Δx_S be the displacements of the combined body of mass m_b and Sachin respectively with reference to the centre of mass. Then use the equation $m_S\Delta x_S + m_b\Delta x_b = 0$, to get the answer.

18. A

Sol. $T = (2m)\ell\omega^2 = mg$

$$\omega = \sqrt{\frac{g}{2}} = \sqrt{5}\text{ rad/s}$$

19. A

Sol. If friction acts backwards then ω will increase and v_{cm} will decrease hence violating pure rolling condition and if friction acts in forward direction the ω will decrease and v_{cm} will increase again violating pure rolling condition hence no friction acts.

20. D

Sol. $$2\pi\sqrt{\frac{\frac{3}{2}MR^2}{MgR}} = 2\pi\sqrt{\frac{\ell}{g}}$$

SECTION – B

21. 9

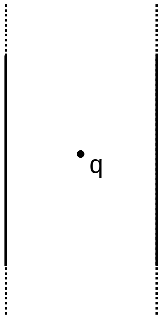
Sol. To find through infinite plane-1, let us construct an infinite plane-2 at same distance from q on other side. If electric flux through plane-1 is ϕ, then flux through plane-2 will be also ϕ.

By Gauss's Law

$$\phi_{total} = 2\phi = \frac{q}{\varepsilon_0}$$

$$\phi = \frac{q}{2\varepsilon_0} = \frac{1}{8\pi\varepsilon_0} = \frac{9\times10^9}{2} = 4.5\times10^9$$

b = 9



22. 2

Sol. Magnification of the object

$$m = \frac{f}{f-u} = \frac{f}{f-(-f)} = \frac{1}{2}$$

As velocity component of image along axis is given by

$$v_i = -m^2v_0$$

$$\Rightarrow v_i = -\left(\frac{1}{2}\right)^2 4\cos30° = -\frac{\sqrt{3}}{2}\text{ cm/s}$$

Also velocity component of image perpendicular to axis is given by

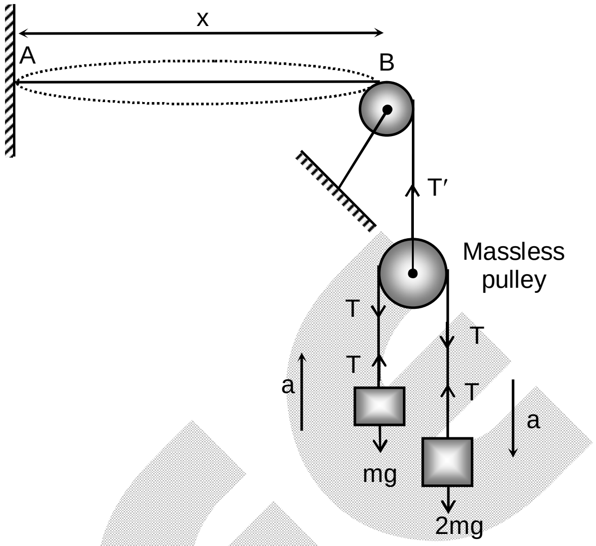
$$v_i' = mv_0 = \frac{1}{2}\cdot4\sin30° = 1\text{ cm/s}$$

Therefore, net velocity of image is

$$v_{net}' = \sqrt{v_i^2 + v_i'^2} = \sqrt{\frac{3}{4}+1} = \frac{\sqrt{7}}{2}\text{ cm/s}$$

23. 5

Sol. Consider FBD of blocks.



For mass m, using F = ma, we get

$T - mg = ma$ …(i)

Similarly for mass 2m, we get

$2mg - T = 2ma$ ...(ii)

From Equation (i) and (ii),

$T = \frac{4mg}{3}$ …(iii)

From FBD of pulley,

$T' = 2T = \frac{8mg}{3}$

Therefore, frequency of vibration of wire in fundamental mode,

$$f_1 = \frac{1}{2\ell}\sqrt{\frac{T'}{\mu}} = \frac{1}{2x}\sqrt{\frac{8mg}{3\mu}}$$

Also, frequency of vibration of air in 1st overtone (3rd harmonic)

$$f_2 = \frac{3v}{4\ell} = \frac{3v}{\frac{4x}{2}} = \frac{3v}{2x}$$

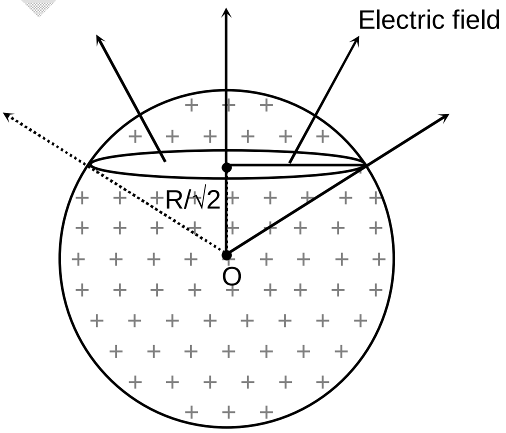
As, resonance implies frequencies are equal

i.e., $f_1 = f_2 \Rightarrow \frac{1}{2x}\sqrt{\frac{8mg}{3\mu}} = \frac{3v}{2x}$ [using Eq. (v) and (vi)]

$$\Rightarrow m = \frac{27\mu v^2}{8g} = \frac{27(0.2\times10^{-3})(400)^2}{8\times10} = \frac{54}{5}\text{ kg}$$

24. 8

Sol. Lets construct a cone as shown. By field picture, ϕ through lateral surface is zero.



$$\Rightarrow \phi_{\text{section}} = \phi_{\text{cone}} = \frac{q_{\text{inside}}}{\varepsilon_0}$$

$$= \frac{\rho\cdot\frac{1}{3}\pi\left(\frac{R}{\sqrt{2}}\right)^2\left(\frac{R}{\sqrt{2}}\right)}{\varepsilon_0}$$

$$= \frac{\left(\frac{Q}{\frac{4}{3}\pi R^3}\right)\cdot\left(\frac{1}{3}\pi\frac{R^3}{2\sqrt{2}}\right)}{\varepsilon_0} = \frac{Q}{8\sqrt{2}\varepsilon_0}$$

25. 6

Sol. Frequency of revolution of electron,

$$f = \frac{v}{2\pi r} = \frac{v_0\frac{Z}{n}}{2\pi r_0\frac{n^2}{z}} = \frac{v_0 z^2}{2\pi r_0 n^3}$$

Number of revolutions in time t will be

$$N = ft = \frac{v_0 z^2 t}{2\pi r_0 n^3}$$

As we know, Bohr's radius

$r_0 = 0.53$ Å $= 0.53 \times 10^{-10}$ m

v_0 = Bohr's speed = 2.2×10^6 m/s

Putting these values in Eq. (ii), we get

$$N = \frac{2.2\times10^6 \times 1^2 \times 10^{-8}}{2\times3.14\times0.53\times10^{-10}\times2^3} \approx 8\times10^6$$

Comparing with given value, we get x = 6

26. 5

Sol. Time period of a pendulum is given by

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

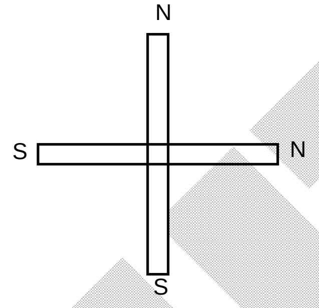
$$\Rightarrow\ g = \frac{4\pi^2\ell}{T^2}$$

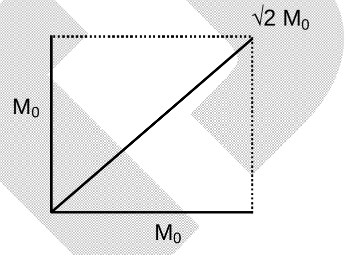
$$\Rightarrow \left(\frac{\Delta g}{g}\times100\right)_{\max} = \frac{\Delta\ell}{\ell}\times100 + 2\frac{\Delta T}{T}\times100 = 1 + 2\times2 = 5\%$$

27. 2

Sol. For two perpendicular magnets of magnetic moment M_0 and moment of inertial each, equivalent magnetic moment,

$M = \sqrt{2}M_0$ …(i)





and total moment of inertia

$I = 2I_0$ ...(ii)

Also, time period of oscillation of magnet in magnetic field is given by

$T = 2\pi\sqrt{\frac{I}{MB}}$ ... (iii)

Time period of the system, using

Equations (i), (ii) and (iii), we get

$T = 2\pi\sqrt{\frac{2I_0}{\sqrt{2}M_0B}} = 2\pi\sqrt{\frac{\sqrt{2}I_0}{M_0B}}$ ...(iv)

Also, using Equation (iii) time period of single magnet,

$T' = 2\pi\sqrt{\frac{I_0}{M_0B}}$ …(v)

Dividing Equation (v) by Equation (iv), we get

$$\frac{T'}{T} = \frac{1}{2^{1/4}} \quad \Rightarrow\ T' = \frac{T}{2^{1/4}} = \frac{32^{1/4}}{2^{1/4}} = 16^{1/4} = 2\text{s}$$

28. 1

Sol. LC = 1 MSD –1 VSD

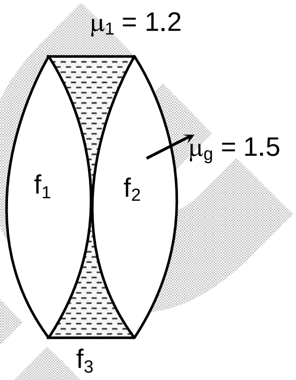
$\Rightarrow$ LC = 1 MSD – $\frac{19}{20}$ MSD = $\frac{MSD}{20}$

$\Rightarrow$ MSD = 20 $\times$ LC = 20 $\times$ 0.05 = 1 mm

29. 10

Sol. Given, focal length of two thin biconvex lens, $f_1 = f_2 = f = 15$ cm

Using lens Maker's formula for first lens,



$$\frac{1}{f_1} = (\mu_g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\Rightarrow \frac{1}{15} = (1.5 - 1)\left(\frac{1}{R} - \frac{1}{-R}\right) \quad \Rightarrow \frac{1}{15} = \frac{1}{R}$$

$\Rightarrow$ R = 15 cm

$\therefore$ Focal length of combination is given as

$$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3} \qquad \ldots(i)$$

Where, $f_1 = f_2 = f = 15$ cm

and $\frac{1}{f_3} = (\mu_1 - 1)\left(\frac{1}{-R} - \frac{1}{R}\right) = (1.25 - 1)\left(\frac{-2}{R}\right) = -\frac{1}{30}$

$\Rightarrow f_3 = -30$ cm

Hence, from Equation (i), we get

$$\frac{1}{f_{eq}} = \frac{1}{15} + \frac{1}{15} - \frac{1}{30} = \frac{3}{30} = \frac{1}{10}$$

$\Rightarrow f_{eq} = 10$ cm

30. 25

Sol. Comparison of emfs of two cells using the experiment of potentiometer is given as

$$\frac{e_1}{e_2} = \frac{l_1}{l_2}$$

Where, l_1 and l_2 are their corresponding balancing length.

$\therefore \frac{3}{2} = \frac{75}{l_2}$ (since, $l_1 = 75$ cm given)

$\Rightarrow l_2 = 50$ cm

$\therefore$ difference in balancing length

$= l_1 - l_2 = 75 - 50 = 25$ cm

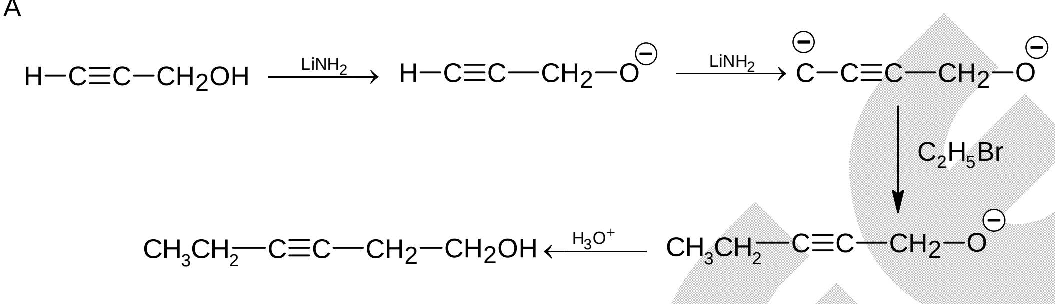
Chemistry

PART – B

SECTION – A

31. C
Sol. Carboxylic acids are more acidic than alcohol. Electronic effects also influence acidity.

32. A
Sol.

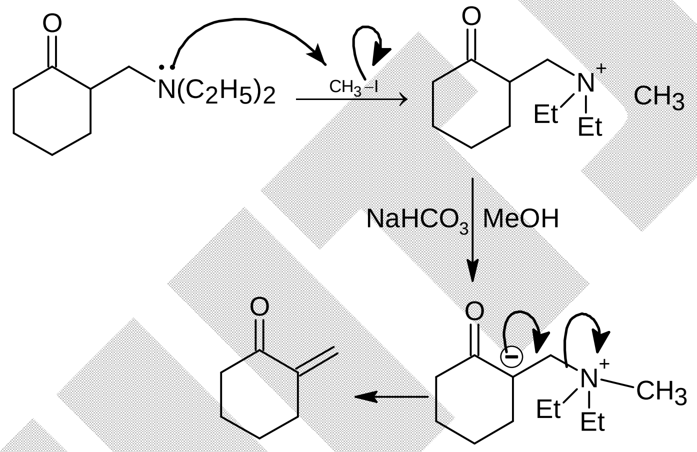


H−C≡C−CH2OH
LiNH2
H−C≡C−CH2−O⊖
LiNH2
⊖C−C≡C−CH2−O⊖
C2H5Br
CH3CH2−C≡C−CH2−O⊖
H3O+
CH3CH2−C≡C−CH2−CH2OH

33. D
Sol. $P_2O_5 + 2HNO_3 \longrightarrow N_2O_5 + 2HPO_3$

$P_2O_5 + 2HClO_4 \longrightarrow Cl_2O_7 + 2HPO_3$

34. C
Sol.



O
N(C2H5)2
CH3−I
O
N+
Et
Et
CH3
NaHCO3 MeOH
O
⊖
N+
CH3
Et
Et
O

35. D
Sol. Fact

36. A
Sol. $Gd = [Xe]4f^7 5d^1 6s^2$

$Gd^{3+} = [Xe]4f^7$

$\mu = \sqrt{n(n+2)} = \sqrt{7(7+2)} = 7.9$ BM

37. C
Sol. Highest the CFSE of compound, highest is the enthalpy of hydration.

38. B
Sol. Smaller the size of orbital extent of back bonding is more.

39. A

Sol. On increasing pressure CO_2 gas condeses to liquid.

40. D

Sol. $\left[XeF_5\right]^-$ is sp^3d^3 hybridized.

41. B

Sol. Viable particualte are minute living organisms that are dispersed in the atmosphere.

42. B

Sol. Molar mass of NaCl = 58.5 g

Moles of NaCl $\frac{117}{58.5} = 2$

In a unit cell = 4 NaCl

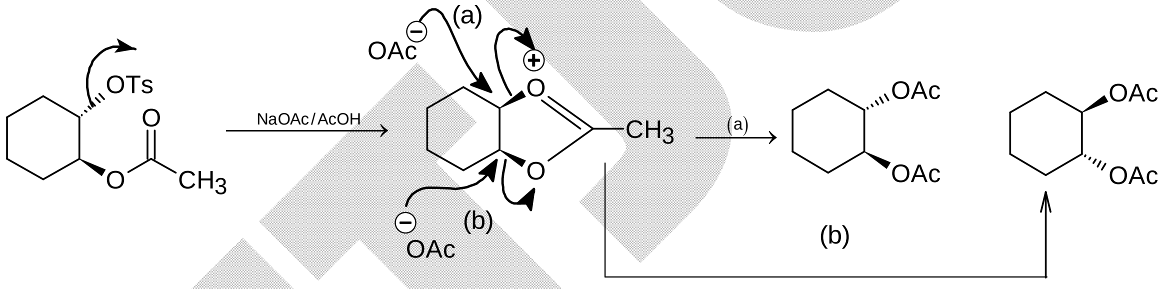
Total number unit cell $= \frac{1}{4} \times \text{Number of NaCl}$

$= \frac{1}{4} \times 2 \times 6.02 \times 10^{23}$

$= 3 \times 10^{23}$

43. A

Sol.



44. B

Sol. From the question,

$\left[Cu(CN)_4^{3-}\right] = 0.1\text{ M and }\left[\left[CN^-\right]\right] = 0.2\text{ M}$

$$\therefore \left[Cu^+\right] = \frac{K_{instab} \cdot \left[Cu(CN)_4^{3-}\right]}{\left[CN^-\right]^4} = \frac{6.4 \times 10^{-15} \times 0.1}{(0.2)^4}$$

$= 4 \times 10^{-13}$ M

$$\text{Now, } \left[S^{2-}\right] = \frac{K_{SP}\left(Cu_2S\right)}{\left[Cu^+\right]^2} = \frac{2.56 \times 10^{-27}}{\left(4 \times 10^{-13}\right)^2}$$

$= 1.6 \times 10^{-2}$ M

$$\therefore \left[H^+\right] = \sqrt{\frac{K_a \times [H_2S]}{\left[S^{2-}\right]}} = \sqrt{\frac{1.6 \times 10^{-21} \times 0.1}{1.6 \times 10^{-2}}} = 10^{-10}\text{ M}$$

and pH = 10.0.

45. B

Sol. $Cl^- + H_2SO_4 \longrightarrow HCl \uparrow (\text{Colourless}) + HSO_4^-$

46. C

Sol. $R = \dfrac{2\pi^2 me^4}{(4\pi\varepsilon_0)^2 h^3 c}$

$\Rightarrow R \propto m$

Here, m becomes $\left(m - \dfrac{m}{4} = \dfrac{3m}{4}\right)$, then R becomes $\dfrac{3}{4}R$.

47. B

Sol. At Boyle's temperature, $\dfrac{dz}{dp} = 0 \Rightarrow T = \dfrac{168}{0.35} = 480\ K$.

48. A

Sol. $\dfrac{x}{m} = K.P^{\frac{1}{n}} \Rightarrow \log\dfrac{x}{m} = \log K + \dfrac{1}{n}.\log P$

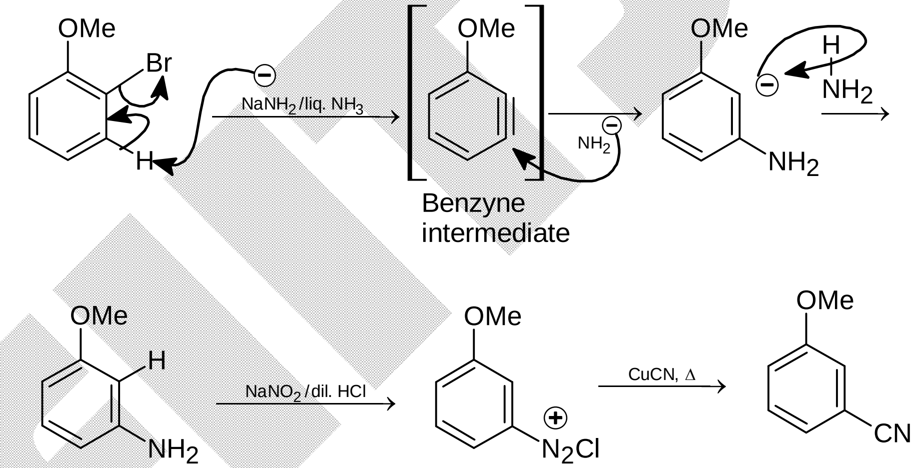
From question, $\log K = 0.3010 = \log 2 \Rightarrow K = 2$

And $\dfrac{1}{n} = \tan 45^o = 1 \Rightarrow n = 1$

$\therefore \dfrac{x}{m} = 2 \times P = 2 \times 0.2 = 0.4$

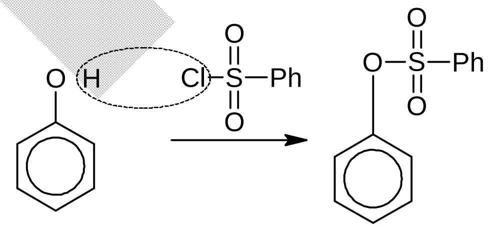
49. A

Sol.


OMe
Br
H
NaNH2/liq. NH3
OMe
Benzyne intermediate
NH2
OMe
H
NH2
NH2
OMe
H
NH2
NaNO2/dil. HCl
OMe
N2Cl
CuCN, Δ
OMe
CN

50. C

Sol. Benzene sulphonyl chloride $(Ph - SO_2Cl)$ is known as Hinsberg reagent.

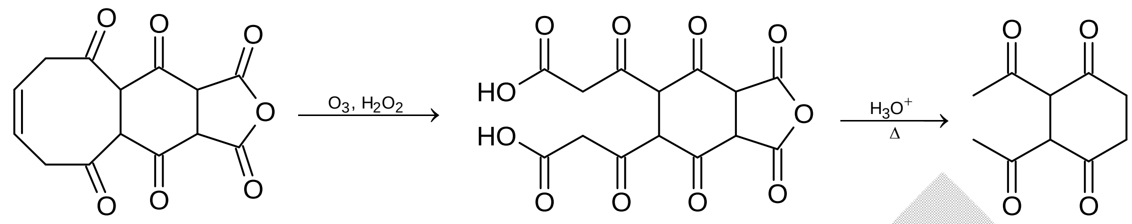

O H
Cl
O
S
Ph
O
O
O
S
Ph
O

Sulphonic ester

SECTION – B

51. 4

Sol.



52. 289

Sol. $\log\frac{K_2}{K_1} = \frac{E_a}{2.303R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

$T_1 = 300$ K $\quad K_1 = 1.6 \times 10^{-3}$, $\quad T_2 = 350$ K

$t_{90\%} = \frac{2.303}{K_2}\log\frac{100}{10}$

= 289 s.

53. 123

Sol. $2H^+ + O_2 + 2e^- \longrightarrow H_2O_2 \qquad \Delta G_1^o$

$2e^- + 2H^+ + H_2O_2 \longrightarrow 2H_2O \qquad \Delta G_2^o$

$4H^+ + O_2 + 4e^- \longrightarrow 2H_2O \qquad \Delta G_3^o$

$\Delta G_1^o + \Delta G_2^o = \Delta G_3^o$

$(-2 \times 0.70) + (-2 \times 1.76) = -4 \times x$

$E_3^o = 1.23$

100x = 100 × 1.23 = 123

54. 5

Sol. $A.xH_2O \longrightarrow A + xH_2O$

$\frac{25}{250} \qquad \frac{16}{M}$

$\frac{25}{250} = \frac{16}{M}$

M = 160

x = 5.

55. 273

Sol. $\Delta S_{fusion} = \frac{\Delta H_{fusion}}{T} = \frac{80 \times 18 \times x}{273}$

x = 5.46 mole

50x = 273

56. 7

Sol. $\frac{V_1}{V_2} = \frac{C_1}{C_2} = \frac{\pi_1 / T_1}{\pi_2 / T_2} = \frac{500/283}{94/373} = 7$

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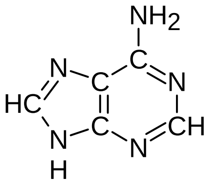
57. 3

Sol. Malachite, Sphalerite and Calamine are the principal ores of copper and zinc.

58. 5

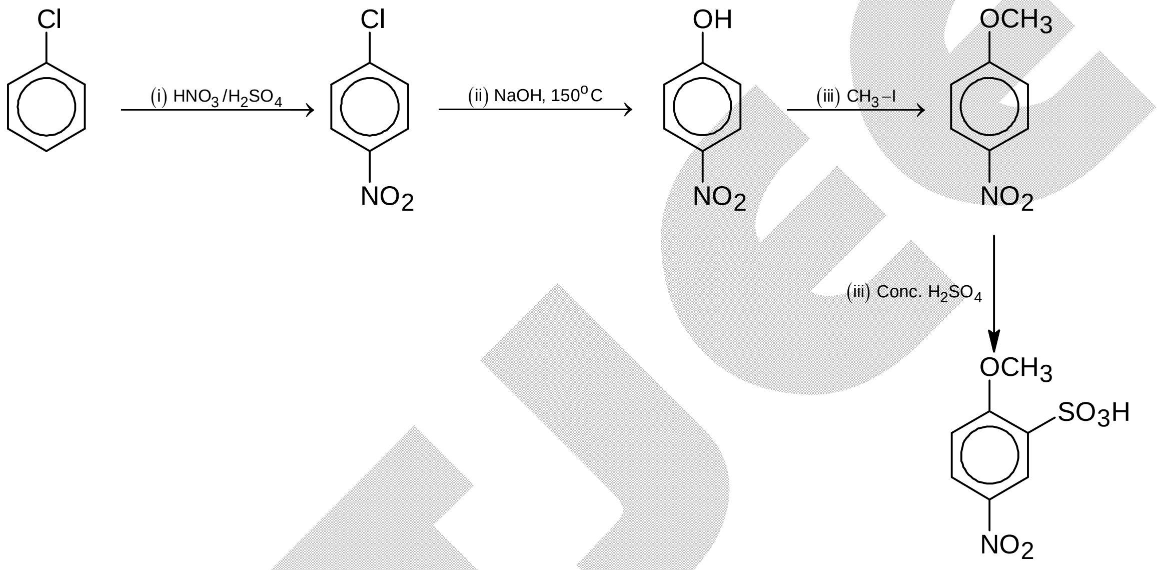
Sol.



Adenine

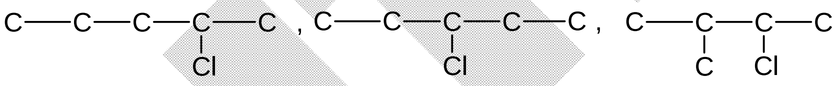
59. 6

Sol.


Cl
(i) HNO3/H2SO4
Cl
NO2
(ii) NaOH, 150°C
OH
NO2
(iii) CH3–I
OCH3
NO2
(iii) Conc. H2SO4
OCH3
SO3H
NO2

60. 3

Sol.



$$\underset{}{C-C-C-\underset{\mid}{\overset{}{C}}-C}\ \ \ \ $$

$$C-C-C-\underset{\underset{Cl}{|}}{C}-C,\quad C-C-\underset{\underset{Cl}{|}}{C}-C-C,\quad C-\underset{\underset{C}{|}}{C}-\underset{\underset{Cl}{|}}{C}-C$$

Mathematics

PART – C

SECTION – A

61. A

Sol. $\frac{2ae}{\sin(\alpha+\beta)} = \frac{S_1P}{\sin\beta} = \frac{S_2P}{\sin\alpha} = \frac{2a}{\sin\alpha+\sin\beta}$

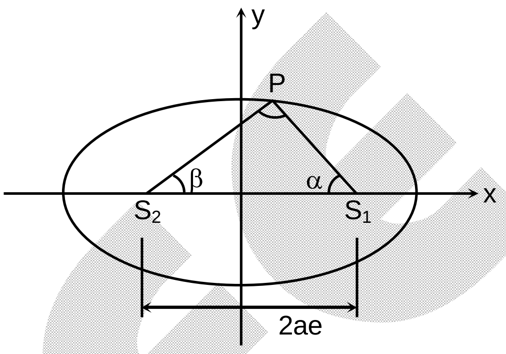
$e = \frac{\sin(\alpha+\beta)}{\sin\alpha+\sin\beta}$

$\frac{1-e}{1+e} = \tan\left(\frac{\alpha}{2}\right)\tan\left(\frac{\beta}{2}\right) = \frac{1-\frac{1}{2}}{1+\frac{1}{2}} = \frac{1}{3}$

Also $\cot\left(\frac{\alpha}{2}\right)+\cot\left(\frac{\beta}{2}\right)+\cot\left(\frac{\gamma}{2}\right)$

$= \cot\left(\frac{\alpha}{2}\right)\cot\left(\frac{\beta}{2}\right)\cot\left(\frac{\gamma}{2}\right) = 3\cot\left(\frac{\gamma}{2}\right)$

$\cot\left(\frac{\alpha}{2}\right)+\cot\left(\frac{\beta}{2}\right) = 2\cot\left(\frac{\gamma}{2}\right)$



62. A

Sol. $d_n = \left|\frac{n-\sqrt{n^2+1}}{\sqrt{2}}\right|$

$\lim_{n\to\infty}(n\cdot d_n) = \frac{n}{\sqrt{2}\left(n+\sqrt{n^2+1}\right)} = \frac{1}{2\sqrt{2}}$

63. C

Sol. $\frac{dy}{y}+\frac{dx}{x} = 0 \Rightarrow xy = c$

c = 16

xy = 16

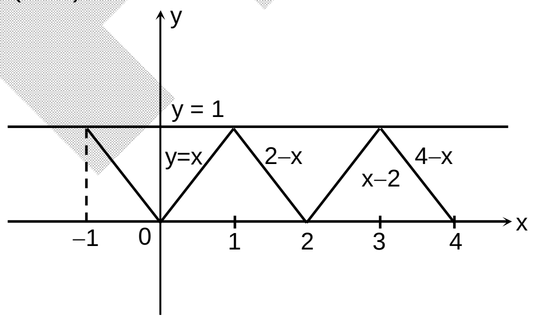
L.R. = $8\sqrt{2}$

64. C

Sol. f(x) + f(–x) = 8

65. B

Sol. f(3.14) = 4 – 3.14 = 0.86



66. B

Sol. $(x^2 + 1)\, e^x = y \Rightarrow (x + 1)^2\, e^x dx = dy$

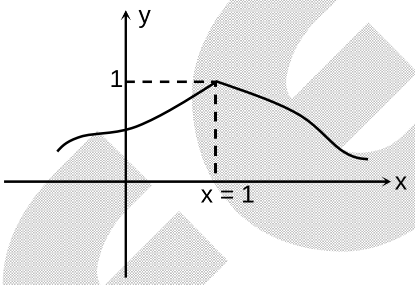
67. A

Sol. $x_i = 1 \Rightarrow \sum_{i=1}^{6} x_i = 6$

$y_i = -1 \Rightarrow \sum_{i=1}^{6} y_i = -6$

68. D

Sol. Req. area = $2\int_1^{\infty} \frac{dx}{(x-1)^2+1} = \pi$ sq. units



69. A

Sol. $\lim_{x\to -1} f(x) = \pi$

70. B

Sol. $x^2 - k \neq 0$
$k < 0$
$x^2 + x + 1 \geq 0$

71. B

Sol. Number of solutions 2

72. A

Sol. $A^n = \begin{bmatrix} 2^{n-1} & 2^{n-1} \\ 2^{n-1} & 2^{n-1} \end{bmatrix}$

$\det(A^n - I) = (2^{n-1} - 1)^2 - (2^{n-1})^2 = 1 - 2^n$

73. B

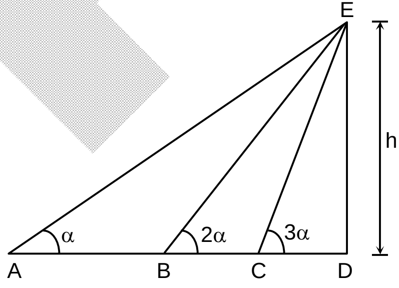
Sol. Trace $(A^3) = 123$

74. A

Sol. Reflexive, transitive but not symmetric

75. B

Sol.



76. A

Sol. $\sum\left(x_i-\bar{x}\right)^2=250$

$\sigma^2=\frac{250}{10}=25$

Co-efficient of variation is = $\frac{6}{\bar{x}}\times100=\frac{5}{50}\times100=10\%$

77. C

78. C

Sol. $y = (\tan^{-1}(5x) - \tan^{-1}(x)) + (\tan^{-1}x + \tan^{-1}(2/3))$

$\frac{dy}{dx}=\frac{5}{1+25x^2}$

79. C

Sol. $I = \int_{-\ln 2}^{0}\sin t\,dt=\cos(\ln 2)-1$

80. C

Sol. $y = mx$

$\left|\frac{3m-3}{\sqrt{m^2+1}}\right|=\sqrt{6}$

$m = 3\pm2\sqrt{2}$

SECTION – B

81. 44

Sol. $f(\theta) = \frac{(\sin\theta)^x}{(\sin\theta)^x+(\cos\theta)^x}$

$\sum_{\theta=1^\circ}^{89^\circ}f(\theta)=\frac{89}{2}$

82. 35

Sol. $\vec{v}_1\cdot\vec{v}_2=3 \Rightarrow \cos^2\theta = \frac{9}{5+\sin2\alpha}\le1$

$\alpha = \frac{\pi}{4}$

$\theta = 0$

$\Rightarrow \vec{v}_1$ and $\vec{v}_2$ are collinear

$\therefore \frac{2(\sin\alpha+\cos\alpha)}{\sin\beta}=\frac{1}{\cos\beta}$

$\tan\beta = 2\sqrt{2}$

$3\tan^2\alpha + 4\tan^2\beta = 3 + 4(8) = 35$

83. 23

Sol. $(\lambda + 2, -(3\lambda + 2), 2\lambda + 5)$ lies on $2x - 3y + 4z = 16 \Rightarrow \lambda = 7$

$P = (9, -23, 19)$

For Q : $x = 0$

$\lambda + 2 = 0$

$\therefore Q = (0, 4, 1)$

$PQ = 9\sqrt{14}$

84. 2

Sol. $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$0.8 = 0.5 + p - 0 \Rightarrow p = 0.3 = \frac{3}{10}$

$P(A \cap B) = P(A).P(B)$

$0.8 = 0.5 + 9 - 0.59$

$0.3 = 0.5q \Rightarrow q = \frac{3}{5}$

$\frac{q}{p} = 2$

85. 10

Sol. $3x + 4y = \frac{3x}{2} + \frac{3x}{2} + \frac{4y}{3} + \frac{4y}{3} + \frac{4y}{3}$

$AM \geq GM$

$\Rightarrow \frac{3x+4y}{5} \geq 2$

86. 4

Sol. $|PA - PB| \leq AB$

$|PA - PB|$ to be maximum, P must be the intersection of line joining A and B and $2x + 3y = 5$

$\therefore h = \frac{2}{5}$

$k = \frac{7}{5}$

$3h + 2k = \frac{6+14}{5} = 4.$

87. 24

Sol. $$\frac{2\left(\frac{x}{2}\right) + 3\left(\frac{y}{3}\right) + 5\left(\frac{z}{5}\right)}{10} \geq \left(\frac{x^2}{2^2} \cdot \frac{y^3}{3^3} \cdot \frac{z^5}{5^5}\right)^{\frac{1}{10}}$$

$\Rightarrow x^2y^3z^5 \leq 2^2.3^3.5^5$

$N = 2^2.3^3.5^5$

Number of odd divisors = (3 + 1) (5 + 1) = 24

88. 0

Sol. $15^{23} + 23^{23}$

$= (19 - 4)^{23} + (19 + 4)^{23}$

$= 2[(19)^{23} + {}^{23}C_2(19)^{21}(4)^2 + \ldots.. + {}^{23}C_{22}.19(4)^{22}]$

89. 49

Sol. $(x + 4)^2 + (y - 5)^2 = 1$

$(-4 + \cos\theta, 5 + \sin\theta)$

$(x + 2)^2 + (y - 3)^2$

$= (\cos\theta - 2)^2 + (\sin\theta + 2)^2$

$= 9 + 4(\sin\theta - \cos\theta)$

$a = 9 + 4\sqrt{2}$

$b = 9 - 4\sqrt{2}$

90. 1

Sol. $x = y = z = -1$

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – I

JEE (Main)-2023

TEST DATE: 20-01-2023

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is Mathematics.
- Each part has only two sections: **Section-A and Section-B**.
- **Section – A** : Attempt all questions.
- **Section – B :** Do any five questions out of 10 questions.

Section-A (01 – 20, 31 – 50, 61 – 80) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-B (21 – 30, 51 – 60, 81 – 90) *contains 30 Numerical based questions. The answer to each question is rounded off to the nearest integer value. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

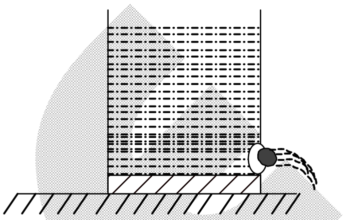
PART – A

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

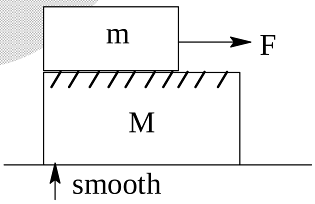
1. Liquid of density ρ is filled in the container of negligible mass having area A. Area of hole 'a' is very small (a << A). Co-efficient of friction between container and surface is equal to $\left(\frac{a}{A}\right)$. As liquid is coming out of vessel, instantaneous acceleration of the container.



(A) $\left(\frac{A}{a}g\right)$ (B) $\frac{3g}{2}$

(C) $\left(\frac{ag}{A}\right)$ (D) zero

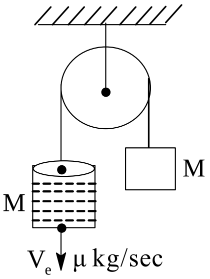
2. A plank having mass M is placed on smooth horizontal surface. Block of mass m is placed on it coefficient of friction between block and plank is $\mu_0 + kx$, where k is constant and x is relative displacement between block and plank. A force F is applied on block where F = at, where a = 10; t is in second. Find t_0 when relative motion will occur between block and plank



(A) $\mu_0 M + \frac{\mu_0 M^2}{m}$ (B) $\mu_0 m + \frac{\mu_0 M^2}{m}$

(C) $\mu_0 m + \frac{\mu_0 m^2}{M}$ (D) $\mu_0 M + \frac{\mu_0 m^2}{M}$

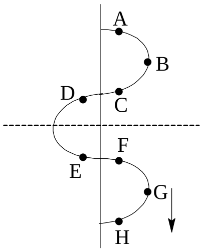
3. Velocity of water flow in downward direction relative to cylindrical tank is V_e acceleration at any time t will be



(A) $\frac{\mu(v_e + gt)}{(2M - \mu t)}$ (B) $\frac{\mu v_e}{(2M - \mu t)}$

(C) $\frac{\mu g t}{(2M - \mu t)}$ (D) None of these

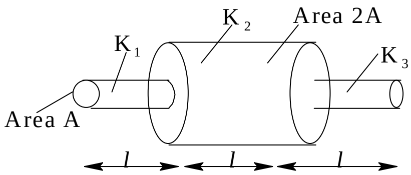
4. A transverse wave travelling along negative y-axis its snap shot is given at any instant of time t. Points which is having velocity in negative x-direction.



(A) A,E,F (B) C,D,H

(C) B,G,H (D) A,H

5. Equivalent thermal conductivity of figure given below will be? Given that length of each cylinder is l and area of cylinder having thermal conductivity $K_1 \& K_3$ is A while middle cylinder is having K_2.



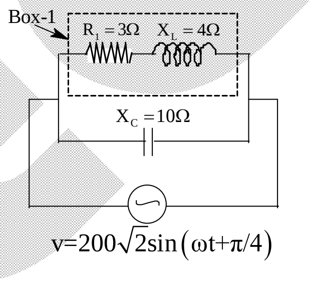
(A) $\dfrac{5}{2\left[\dfrac{1}{K_1}+\dfrac{1}{2K_2}+\dfrac{1}{K_3}\right]}$

(B) $\dfrac{1}{\left(\dfrac{1}{K_1}+\dfrac{1}{2K_2}+\dfrac{1}{K_3}\right)}$

(C) $\dfrac{2}{5\left[\dfrac{1}{K_1}+\dfrac{1}{2K_2}+\dfrac{1}{K_3}\right]}$

(D) None of these

6. As shown in figure , Instantaneous current in branch having capacitor C will be :(given $\tan^{-1}$ (4/3) = 53°)



(A) $20\sqrt{2}\sin\left(\omega t + 3\pi/4\right)$

(B) $40\sqrt{2}\sin\left(\omega t + \pi/4\right)$

(C) $60\sqrt{2}\sin\left(\omega t - \pi/4\right)$

(D) None of above

7. A thermodynamic process obeys the following relation $2dQ = dU + 2dW$ where dQ, dU, dW has usual meaning. Then heat capacity for the process is:
[Given di-atomic gas; R = gas constant]

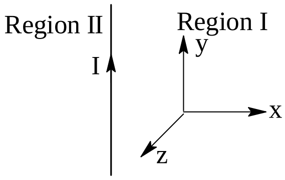
(A) $\dfrac{5R}{2}$

(B) $\dfrac{7R}{2}$

(C) $\dfrac{3R}{5}$

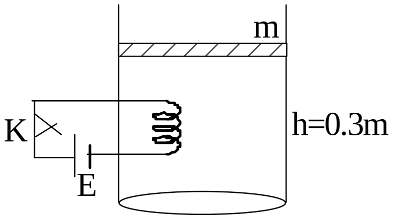
(D) infinite

8. A infinite length current carrying wire is placed in x, y plane parallel to y axis as shown in figure. (All charges are projected in region I)



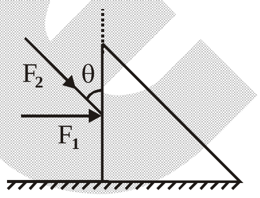
(A) A positively charged particle projected along y axis will get deflected along z axis
(B) A positively charged particle projected along x axis will get deflected along y axis
(C) A negatively charged particle is projected along x axis will get deflected along +y axis
(D) A negatively charge particle is projected along x axis will get deflected along +z axis

9. An insulated cylinder contains nitrogen gas which is sealed on the top by a heavy metal piston of mass m. Piston is free to move with negligible friction. Initial height of the piston is 0.3 m at temperature 27°C when it is given some heat with the help of an electrical circuit piston slowly rises to height 0.5 m above the bottom of the cylinder. During expansion of the gas, net heat absorbed by the nitrogen gas:



(A) Equal to work done by nitrogen gas on the piston
(B) Greater to work done by nitrogen gas on the piston
(C) Less to work done by nitrogen gas on the piston
(D) Will be always twice of the work done by the gas on the piston

10. A wedge of mass m, lying on a rough horizontal plane, is acted upon by a horizontal force F_1 and another force F_2, inclined at an angle θ to the vertical. The block is in equilibrium, then minimum coefficient of friction between it and the surface is



(A) $(F_2\sin\theta)/(mg+F_2\cos\theta)$
(B) $(F_1\cos\theta+F_2)/(mg-F_2\sin\theta)$
(C) $(F_1+F_2\sin\theta)/(mg+F_2\cos\theta)$
(D) $(F_1\sin\theta-F_2)/(mg-F_2\cos\theta)$

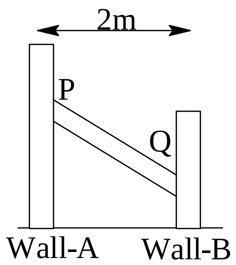
11. A charge particle is projected in a region of magnetic field and electric field. If mass of charged particle is m and its speed changes from V_0 to $2V_0$ [W_E = work done by electric field; W_B = work done by magnetic field]. Which statement is incorrect?

(A) $W_B = \frac{1}{2}mv_0^2$
(B) $W_B + W_E = \frac{3}{2}mv_0^2$
(C) $W_E = \frac{3}{2}mv_0^2$
(D) $W_E - W_B = \frac{3}{2}mv_0^2$

12. De-Broglie wavelength of the particle increases by 75% then kinetic energy of particle becomes

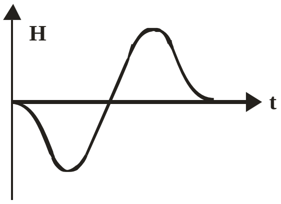
(A) $\frac{16}{49}$ times
(B) $\frac{9}{16}$ times
(C) $\frac{16}{25}$ times
(D) $\frac{4}{9}$ times

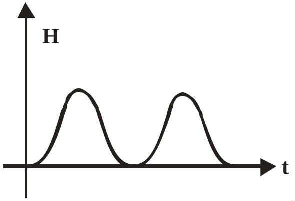
13. Two vertical walls are separated by a distance of 2 metres. Wall 'A' is smooth while wall B is rough with a coefficient of friction $\mu = 0.5$. A uniform rod is propped between them. The length of the longest rod that can be probed between the walls is equal to :

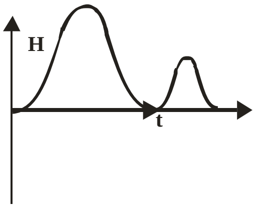


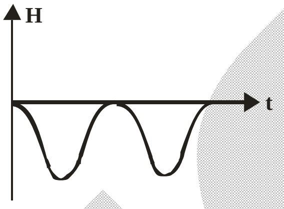
(A) 2 metres
(B) $2\sqrt{2}$ metres
(C) $\sqrt{5}$ metres
(D) $\frac{\sqrt{17}}{2}$ metres

14. A bar magnet is pulled along axis of a coil with uniform velocity with South Pole entering into the coil. The sketch of Joule's heat with time is represented by:

(A)


(B)


(C)


(D)


15. A parent radioactive nucleus A (decay constant λ_a) converts into a radio-active nucleus B of decay constant λ_b, initially, number of atoms of B is zero. At any time N_a, N_b are number of atoms of nuclei A and B respectively then maximum value of N_b.

(A) $\frac{\lambda_a N_a}{\lambda_b}$
(B) $\frac{\lambda_b N_a}{\lambda_a}$
(C) $\frac{(\lambda_a + \lambda_b) N_a}{\lambda_b}$
(D) $\frac{\lambda_b}{(\lambda_a + \lambda_b)} N_a$

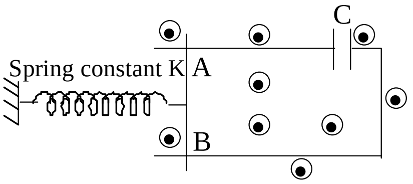
16. Fundamental note of a closed pipe of length l is f_0 at 0°C. First overtone of the same pipe at 273°C is (assume there is no effect of temperature on the dimension of the pipe).

(A) $3f_0$
(B) f_0
(C) $\left(3\sqrt{2}\right)f_0$
(D) $3/\sqrt{2}\,f_0$

17. A satellite is revolving round the earth at a height (R/2) from surface of earth in circular orbit. The change in speed required for the satellite to escape to infinity for the satellite to escape to infinity is: [Take R as radius of earth; and M as mass of earth]

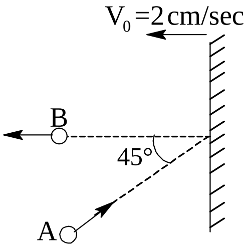
(A) $\sqrt{\frac{2GM}{3R}}$
(B) $\sqrt{\frac{GM}{3R}}\left(2-\sqrt{2}\right)$
(C) $\sqrt{\frac{GM}{3R}}\left(\sqrt{2}-1\right)$
(D) $\sqrt{\frac{4GM}{3R}}$

18. In the arrangement shown in the figure, uniform magnetic field B is upward to the plane of paper. Connecter AB is smooth and conducting, having mass m and length l. Initially spring has extension X_0. Spring is non-conducting (neglect induction in spring). Connector is released at t = 0. Maximum charge on the capacitor is:



(A) $X_0\sqrt{\frac{KC}{1+\frac{B^2l^2C}{m}}}$
(B) $X_0\sqrt{\frac{KC}{1+\frac{m}{B^2l^2C}}}$
(C) $\sqrt{\frac{KC}{2+\frac{B^2l^2C}{m}}}$
(D) $\sqrt{\frac{4KC}{1+\frac{B^2l^2C}{2m}}}$

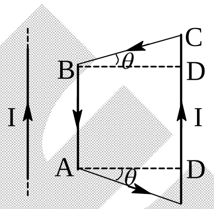
19. Mirror is moving towards the particle with speed 2 cm/sec. Speed of A and B are $10\sqrt{2}$ and 5 cm/sec respectively in the direction shown in figure. Magnitude of velocity of image of the particle B with respect to image of A.



(A) $\sqrt{325}\,\text{cm/sec}$ (B) $15\,\text{cm/sec}$

(C) $13\,\text{cm/sec}$ (D) $\sqrt{269}\,\text{cm/sec}$

20. Loop ABCD and long straight wire are in the same plane. Side CD = 2AB. Distance between long straight wire and AB is equal to distance BD. Net force on the loop is:



(A) Towards the long straight wire
(B) Away from the long straight wire
(C) Parallel to the long straight wire
(D) Net force on the loop will be zero

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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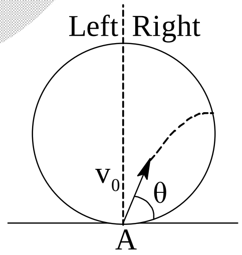
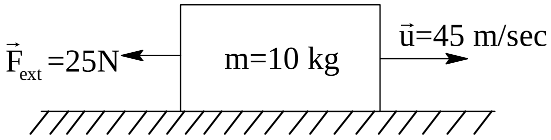
21. A hollow sphere of mass m and radius R is placed on smooth ground. A particle of mass m is projected with velocity v_0 and angle θ from lowest point A inside the sphere as shown in diagram. If particle strikes the sphere at a point which is on horizontal level of centre and at that moment particle is at highest point. The collision between particle and sphere is elastic. The value of v_0 is $\frac{\sqrt{kRg}}{\sin\theta}$. Find the value of 'k'

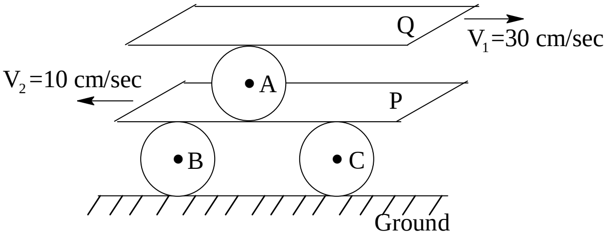


22. Initial velocity of the block $\vec{u} = 45\hat{i}$ while external force on it is $\vec{F} = 25(-\hat{i})$. It coefficient of static and kinetic friction are 0.3 and 0.2 respectively then distance traveled by the block in 12 second is $25x\,\text{m}$, then find the value of 'x' (g = 10 m/s^2) :

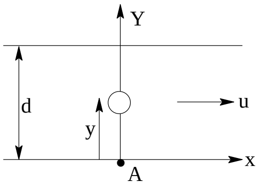


23. Calculate the time (in hrs) in which a layer of ice of thickness 10 cm will increase by 5 cm on the surface of a pond when temperature of the surrounding is –10°C. Coefficient of thermal conductivity of ice $K = 0.005\left(\frac{\text{Cal}}{\text{cm}-\text{sec}-^{\circ}\text{C}}\right)$ and density $\rho = 0.9\,\text{gram/cm}^3$. (L = 80 cal/g)

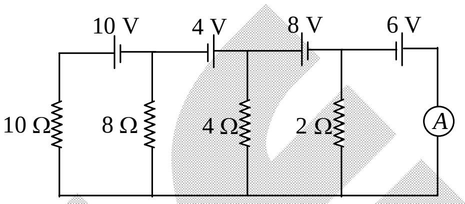
24. All three spheres are identical having radius 10 cm. There is no slipping at any point of contact. Plank P and Q are moving in opposite direction with speed 10 and 30 cm/sec. Find the height of instantaneous axis of rotation of sphere A from the ground (in cm) :



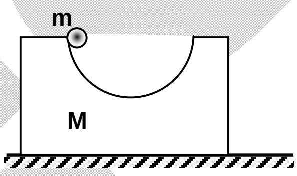
25. A river of width d is flowing with a velocity u. A person starts from point A. He always try to keep himself along y axis. Speed of man w.r.t. to river at any position is given by $v = k\sqrt{y}$ (k → +ve constant). Time taken by man to cross the river is $\frac{x\sqrt{d}}{4k}$, then find the value of ____.
(Assume that at t = 0, y = 0)



26. If the reading of the ideal ammeter connected in the given circuit is $n\left(\frac{13}{20}\right)$ ampere, find the value of n. Assume that the cells have negligible internal resistance.

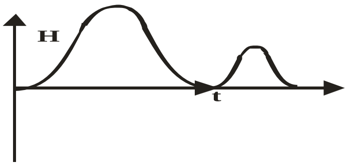


27. A semi-cylinder is cut out of a block and the block is kept on the horizontal surface. A small body of mass m is released at the top of the cylinder shaped hole. (Friction is negligible.)
If the block is able to move on the horizontal surface without friction, then the force exerted on the block by the small body at the lowest point is 7mg/2. Find the ratio of M/m?

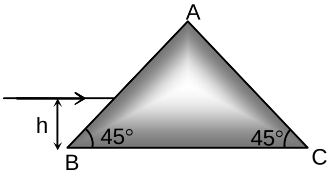


28. At what speed (in m/s) must a pebble be thrown from a height of h = 3.6m, and at an angle of 30°, measured from the horizontal, if it is to hit the ground at an angle of 45°. (Air drag can be neglected.) (Take g = 10 m/s^2)

29. A sphere is just immersed in a liquid. Find the ratio of hydrostatic force acting on the lower half and the upper half of the sphere. (Neglect atmospheric pressure)



30. A ray of light is incident parallel to BC at a height h = 3.0 cm from BC. Find the height (in cm) above BC at which the emergent ray leaves the surface AC. It is given that $\mu = \sqrt{2}$ and length BC = 20 cm. Take tan 15° = 0.25.



Chemistry

PART – B

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

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31. In the following statement, which combination of true (T) and false (F) options in correct?

(A) Ionic mobility is highest for I^- in water as compared to other halides.

(B) IF_5 is square pyramidal and IF_7 is pentagonal bipyramidal in shape

(C) Reactivity order is $F_2 < Cl_2 < Br_2 < I_2$

(D) Oxidising power order is $F_2 < Cl_2 < Br_2 < I_2$

(A) TFTF (B) TTFT
(C) TTTT (D) TTFF

32. According to VSEPR model, the shape of $\left[XeOF_5\right]^-$ is

(A) Octahedral (B) Triagonal bipyramidal
(C) Square pyramidal (D) Pentagonal monopyramidal

33. Identify the statement(s) which is not correct with respect to surface phenomenon.

(A) If on adding electrolyte in an emulsion, the conductivity increases then it will be oil in water type emulsion.
(B) Tyndall effect is observed when refractive indices of dispersed phase and dispersion medium differ largely.
(C) Macromolecular colloids are generally lyophobic in nature
(D) Gases which can react with adsorbents are generally chemisorbed

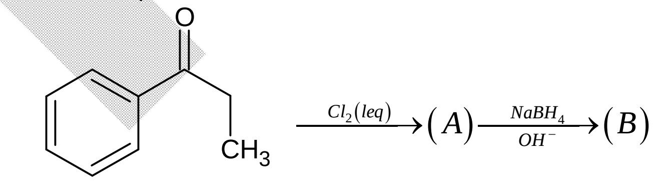
34. Xenon fluorides are very good oxidising and fluorinating agents. They also act as F^- donors and acceptors. When XeF_4 donates its fluoride to SbF_5, then the states of hybridisation of central atom of cationic part and anionic part of product are:

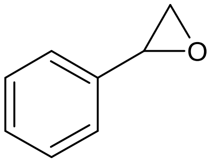
(A) sp^3d, sp^3d^2 (B) sp^3d^2, sp^3d
(C) sp^3d^2, sp^3d^2 (D) dsp^2, sp^3

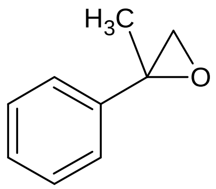
35. Correct order of bond angle is

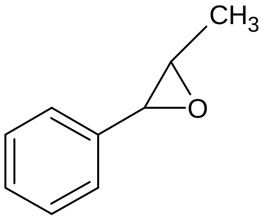
(A) $(\bullet CH_3) > (\bullet CF_3)$ (B) $CH_3^- > CH_3^+$
(C) $CH_4 > CF_4$ (D) $CH_4 > (\bullet CH_3)$

36. The end product of the reaction is:



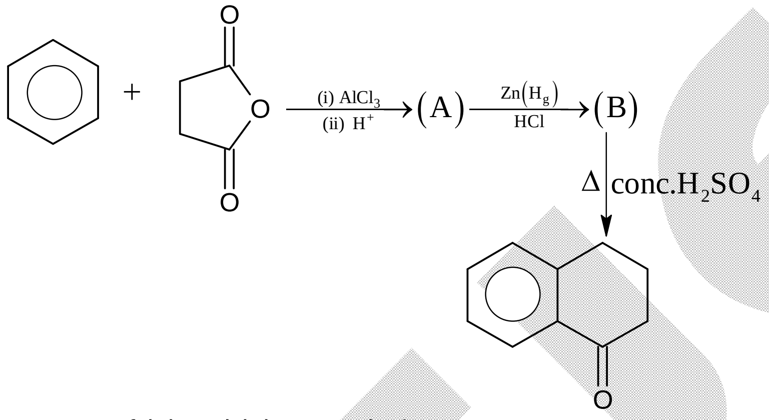
(A) 

(B) 

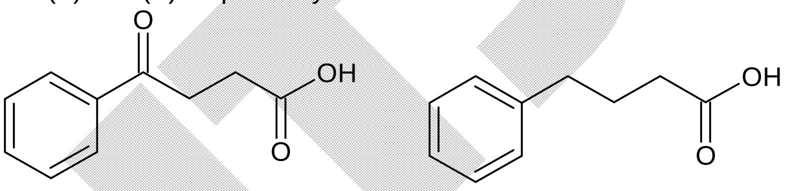
(C) 

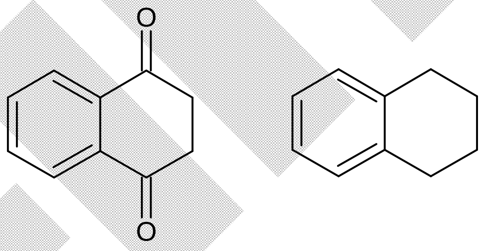
(D) None of these

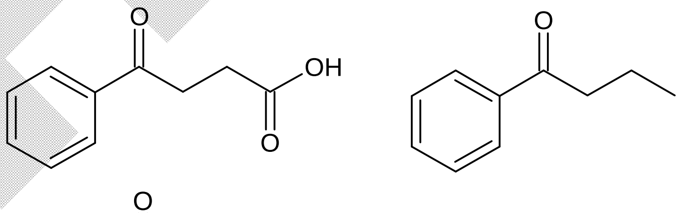
37.

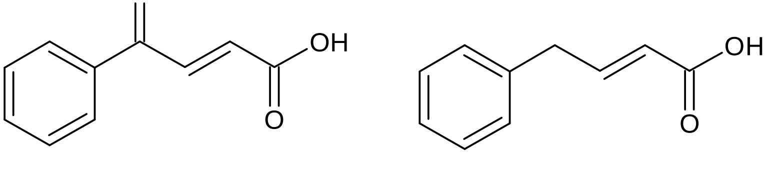

O
O
O
+
(i) AlCl3
(ii) H+
(A)
Zn(Hg)
HCl
(B)
Δ conc.H2SO4
O

Structure of (A) and (B) respectively are:

(A) 

(B) 

(C) 

(D) 

38. An aqueous solution of a metal ion (A) on reaction with KI gives a black brownish ppt (B) and this aqueous suspension on treatment with excess KI gives orange yellowish solution. Then A is

(A) pb^{2+} (B) Bi^{3+}

(C) Hg_2^{2+} (D) Hg^{2+}

39. Which of the following compounds consist of a P – P linkage?

(A) Hypo phosphoric acid (B) Pyrophosphorous acid

(C) Dipolyphosphoric acid (D) Metaphosphoric acid

40. Which of the following elements of lanthanide series have highest tendency to show $+2$ oxidation state?

(A) Eu (B) Gd

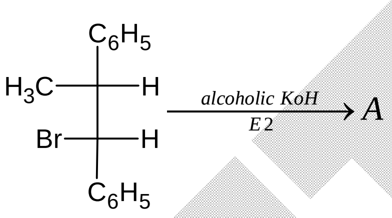
(C) Tb (D) None of these

41. The specific conductance of a saturated solution of silver bromide is $K\ Scm^{-1}$. The limiting ionic conductivity of Ag^+ and Br^- ions are $x\ and\ y$ respectively. The solubility of silver bromide in g / L is (molar mass of $AgBr = 188$)

(A) $\frac{K \times 1000}{x - y}$ (B) $\frac{K}{x + y} \times 188$

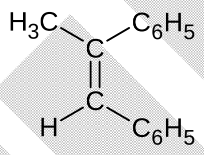
(C) $\frac{K \times 1000 \times 188}{x + y}$ (D) $\frac{x + y}{k} \times \frac{1000}{188}$

42.

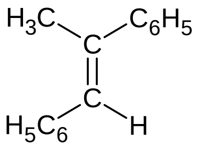


A is

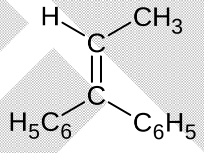
(A)



(B)

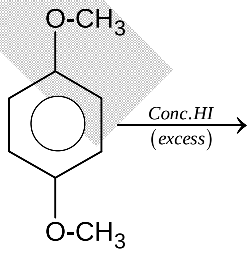


(C)

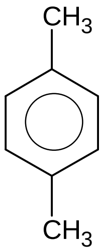


(D) None of these

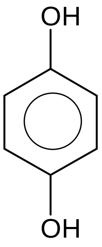
43.



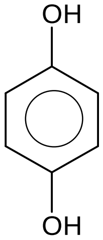
Products,Products of reaction are

(A)


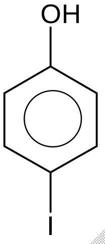
$+2CH_3I$

(B)


$+2CH_3OH$

(C)


$+2CH_3I$

(D)


$+2CH_3I$

44. The activation energies of two reactions are E_1 & E_2 with $E_1 > E_2$. If temperature of reacting system is increased from T_1(rate constant are k_1 and k_2) to T_2 (rate constant are k_1^1 and k_2^1) predict which of the following alternative is correct.

(A) $\frac{k_1^1}{k_1} = \frac{k_2^1}{k_2}$ (B) $\frac{k_1^1}{k_1} > \frac{k_2^1}{k_2}$

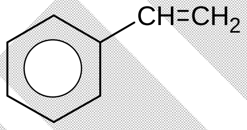
(C) $\frac{k_1^1}{k_1} < \frac{k_2^1}{k_2}$ (D) $k_1^1 < k_2^1$

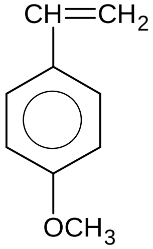
45. The wavelength of the first Lyman lines of hydrogen, He^+ and Li^{2+} ions and λ_1, λ_2 & λ_3. The ration of these wavelengths is

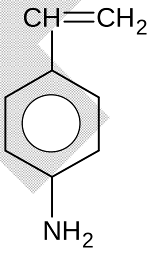
(A) $1:4:9$ (B) $9:4:1$

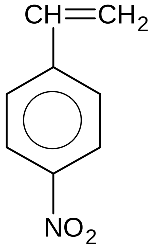
(C) $36:9:4$ (D) $6:3:2$

46. Which of the following monomers has greatest ability to undergo cationic polymerisation?

(A)


(B)


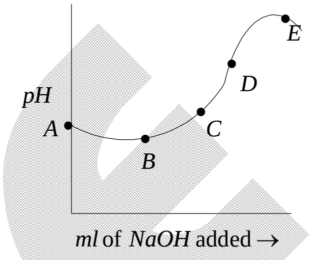
(C)


(D)


47. Two system $PCl_5\left(g\right) \rightleftharpoons PCl_3\left(g\right)+Cl_2\left(g\right) and\, COCl\left(g\right) \rightleftharpoons CO\left(g\right)+Cl_2\left(g\right)$ are simultaneously in equilibrium in a vessel at constant volume. If some CO is introduced in the vessel, then at new equilibrium, the modes of

(A) PCl_5 increase
(B) PCl_5 remain unchanged
(C) PCl_5 decrease
(D) Cl_2 increase

48. The curve in the figure shows the variation of pH during the course of titration of weak acid HA with a strong base NaOH. At which point in the titration curve is the concentration of acid equal to that of its conjugate base.



(A) Point D
(B) Point E
(C) Point C
(D) Point B

49. The minimum mass of NaBr which should be added in 200 ml of 0.0004 $M - AgNO_3$ solution just to start precipitation of $AgBr.K_{sp}\ of\ AgBr = 4\times10^{-13}$. (Br = 80)

(A) $1.0\times10^{-9}\,g$
(B) $2\times10^{-10}\,g$
(C) $2.06\times10^{-8}\,g$
(D) $1.03\times10^{-7}\,g$

50. In which of the following cases is the value of x maximum?

(A) $CaSO_4 \bullet xH_2O$
(B) $BaSO_4 \bullet xH_2O$
(C) $MgSO_4 \bullet xH_2O$
(D) All have same values of x as all metal ions belong to same group

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

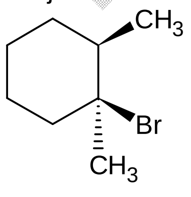
---

51. The number of incorrect statements of the following statements is:

(i) H^+ is the smallest size cation in the periodic table
(ii) Van der Waals radius of chlorine is more than covalent radius
(iii) Ionic mobility of hydrated Li^+ is greater than that of hydrated Na^+
(iv) He atom has the highest ionisation enthalpy in the periodic table

52. How many dichloride cyclopentanes (including stereoisomers) are obtained when cyclopentane reacts with excess chlorine at high temperature?

53. The number of alpha hydrogen's present in major product obtained when following substrate is subjected to $E2$ reaction will be:



54. The number of paramagnetic complexes from given compounds:
(i) $\left(Ni\left(CN\right)_4\right)^{2-}$
(ii) $\left(NiCl_4\right)^{2-}$
(iii) $\left(CoCl_4\right)^{2-}$
(iv) $\left(CoF_6\right)^{2-}$

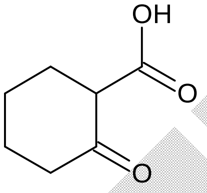
55. A certain amount of reducing agent reduces x mole of $KMnO_4$ & y mole of $K_2Cr_2O_7$ in different experiments in acidic medium. If the change in oxidation state of reducing agent is same in both experiments then $\left(x-y\right)$ is__ .

56. Number of electrons having $m_1 = 0$ for sodium atom is ____.

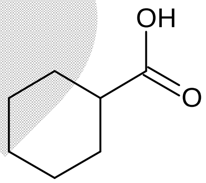
57. The number of non polar molecules from the given molecules?
(i) XeF_4
(ii) BF_3
(iii) C_2F_4
(iv) PCl_2F_3

58. The number of following compounds which loses $\mathrm{CO_2}$ on heating to $100°\mathrm{C}$

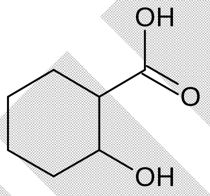
(A)



(B)



(C)



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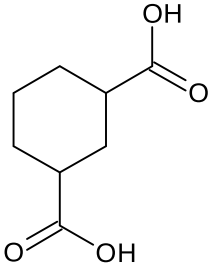
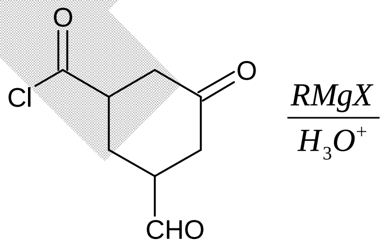
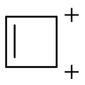
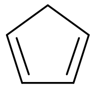


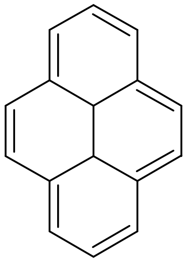
59. How many molecules of RMgX are consumed in the below reaction

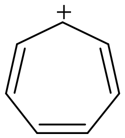


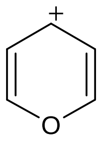
60. Amongst the following, total no of aromatic compounds are

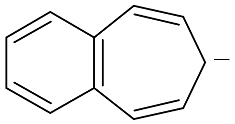












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Mathematics PART – C

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

61. If $a\alpha^2+b\alpha+c=3\alpha^2-4\alpha+1, a\beta^2+b\beta+c=3\beta^2-4\beta+1$ and $a\gamma^2+b\gamma+c=3\gamma^2-4\gamma+1$ (where $\alpha,\beta,\gamma\in R$ and distinct) these sum of root of the equation $3ax^2+9bx+7c=0$.

(A) 1
(B) 2
(C) 3
(D) 4

62. If k denotes the sum of the imaginary parts of the roots of the equation $z^2-8(1-i)z+63-16i=0$ then k is

(A) 6
(B) -6
(C) 8
(D) -8

63. The sum $\sum_{k=0}^{49}(-1)^k\ {}^{99}C_{2k}$ equals

(A) -2^{98}
(B) 2^{98}
(C) -2^{49}
(D) 2^{49}

64. For differential equation $\left(x^4y^2-y\right)dx+\left(x^2y^4-x\right)dy=0$

(A) $\left(x^3-y^3\right)+\dfrac{3}{xy}=c$
(B) $x^3-y^3+\dfrac{1}{xy}=c$
(C) $x^3+y^3+\dfrac{3}{xy}=c$
(D) $x^3+y^3+\dfrac{1}{xy}=c$

65. Sum of roots of the equation $2^{333x-2}+2^{111x+1}=2^{222x+2}+1$ is.

(A) $\dfrac{111}{2}$
(B) $\dfrac{2}{111}$
(C) 2
(D) 111

66. $\displaystyle\int\frac{e^{\tan^{-1}x}}{\left(1+x^2\right)}\left(\left(\sec^{-1}\sqrt{1+x}\right)^2+\cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)\right)dx$ is $(x>0)$

(A) $e^{\tan^{-1}x}\cdot\tan^{-1}x+c$
(B) $e^{\tan^{-1}x}\cdot\dfrac{\left(\tan^{-1}x\right)^2}{2}+c$
(C) $e^{\tan^{-1}x}\left(\sec^{-1}\sqrt{1+x^2}\right)^2+c$
(D) $e^{\tan^{-1}x}\left(\cos ec^{-1}\sqrt{1+x^2}\right)^2+c$

67. If $\left(x-2y-4\right)^2 = 24x+12y$ then length of latus rectum is

(A) $\frac{5}{\sqrt{12}}$ (B) $\frac{\sqrt{5}}{12}$

(C) $\frac{12}{\sqrt{5}}$ (D) None of these

68. IF $P\left(a\sec\theta, b\tan\theta\right), Q\left(a\sec\phi, b\tan\phi\right)$ are the ends of a focal chord of $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ then $\tan\frac{\theta}{2}\tan\frac{\phi}{2}$ can be

(A) $\frac{e-1}{e+1}$ (B) $\frac{e+1}{e-1}$

(C) $\frac{1+e}{1-e}$ (D) None of thee

69. Consider the function $f\left(x\right)=\frac{\sqrt{1+\cos x}+\sqrt{1-\cos x}}{\sqrt{1+\cos x}-\sqrt{1-\cos x}}\left(x\in\left(x,2\pi\right)\right)$ then $f\left(x\right)$ is

(A) $\cot\left(\frac{\pi}{4}+\frac{x}{2}\right)$ (B) $\tan\left(\frac{\pi}{4}+\frac{x}{2}\right)$

(C) $\cot\left(\frac{\pi}{4}-\frac{x}{2}\right)$ (D) None of these

70. In $\left[-\frac{\pi}{2},\frac{\pi}{2}\right]$ the equation $\log_{\sin\theta}\cos 2\theta = 2$ has

(A) No solution (B) One solution

(C) 2 solutions (D) None of these

71. Let $f\left(x\right)=\cos x, g\left(x\right)=\left[\begin{array}{ll}\min\left\{f\left(t\right):0\le t\le x\right\} & x\in\left[0,\pi\right]\\ \sin x-1 & x>\pi\end{array}\right.$ then

(A) $g\left(x\right)$ is discontinuous at $x=\pi$ (B) $g\left(x\right)$ is continuous for $x\in\left[0,\infty\right)$

(C) $g\left(x\right)$ is differentiable at $x=\pi$ (D) $g\left(x\right)$ differentiable for $x\ge 0$

72. If $f\left(x\right) and\ g\left(x\right)$ are two functions such that $f\left(x\right)=\left[x\right]+\left[-x\right] and\ g\left(x\right)=\left\{x\right\}\forall x\in R\ and$ $h\left(x\right)=f\left(g\left(x\right)\right)$ these incorrect statement is($[.]$ is G.I.F and $\{.\}$ is F Part of x)

(A) $f\left(x\right) and\ g\left(x\right)$ are identical function (B) $f\left(x\right)=g\left(x\right)$ has no solution

(C) $f\left(x\right)+h\left(x\right)>0$ has no solution (D) $f\left(x\right)-h\left(x\right)$ is periodic function

73. Let $f\left(x\right)$ be a polynomial $f:R\to R$ such that $f\left(2x\right)=f'\left(2x\right)f''\left(x\right)$ these $f\left(x\right)$ is

(A) One – One onto (B) One – One into

(C) Many One – Onto (D) Many – One into

74. Consider three planes $2x+py+6z=8, x+2y+qz=5\, and\; x+y+3z=4$ then 3 planes intersect at a point if

(A) $p=2, q\neq 3$ (B) $p\neq 2, q\neq 3$

(C) $p\neq 2, q=3$ (D) None of these

75. If a^2, b^2, c^2 are in AP then $\cot A, \cot B\, and\, \cot C$ in

(A) GP (B) AP

(C) HP (D) None of these

76. R is relation over the set of integers and it is given by $(x,y)\in R \Leftrightarrow |x-y|\leq 1$. Then R is

(A) Reflective and transitive (B) Reflective and symmetric

(C) Symmetric and transitive (D) An equivalence relation

77. If $A=\begin{bmatrix} a & b & c \\ c & a & b \\ b & c & a \end{bmatrix}$ and a, b, c are roots of the equation $x^3+x^2-4=0$ then $A\ A^T$ is

(A) I (B) $I+A$

(C) A^2 (D) $A-I$

78. If $a>b>c$ and the system of equations $ax+by+cz=0, bx+cy+az=0, cx+ay+bz=0$ has a non-trivial solution these both the roots of equation $at^2+bt+c=0$ are

(A) Cereal (B) Negative

(C) Positive (D) None of these

79. If A and B are non-zero square metrics of order 3 there incorrect statement is

(A) $adj(AB)=adjA.adjB$ (B) $(AB)^{-1}=B^{-1}.A^{-1}$

(C) $(AB)^T=B^T A^T$ (D) $AB=0\Rightarrow |A|=0\ and\ |B|=0$

80. The only statement among the following that is tautology is

(A) $A\cap(A\cup B)$ (B) $A\cup(A\cap B)$

(C) $[A\cap(A\to B)]\to B$ (D) $B\to[A\cap(A\to B)]$

SECTION – B

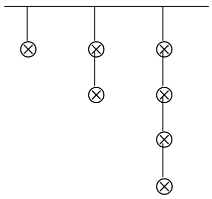
(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

---

81. $\int_0^{\frac{\pi}{2}} \frac{1-\sin 2x}{(1+\sin 2x)^2}dx=\frac{a}{b}$ (a & b are coprime) these $a+b+ab$ is ____.

82. 7 clay balls (shown as $\otimes$). If N be the number of different ways these can be shot (lone at a time). If no ball can be shot unit the ball (s) below it, have been shot, then N is _____.



83. A regular pyramid on a square base has an edge 150m long and the length of the side of its base is 200m. Then height of pyramid is _____

84. 20 teachers of a school either teach maths or physics 12 of them teach maths while 4 teach both the subjects then the no. of teachers teaching only physics is _____

85. If $a_r = \left(\cos 2r\pi + \sin 2r\pi\right)^{1/9}$ then $\Delta = \begin{vmatrix} a_1 & a_2 & a_3 \\ a_4 & a_5 & a_6 \\ a_7 & a_8 & a_9 \end{vmatrix}$ is ____.

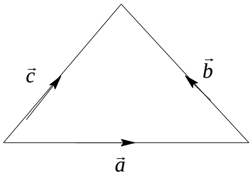
86. $\left[\sqrt{1}\right]+\left[\sqrt{2}\right]+\left[\sqrt{3}\right]+\left[\sqrt{4}\right]+\left[\sqrt{5}\right]+.......+\left[\sqrt{224}\right]-1112$,is ([.] is G.I.F)

87. $2\tan^{-1}x+\sin^{-1}\frac{2x}{1+x^2}\left(x>1\right)$ is equal to $\text{k}\pi$ then find k is ____.

88. $\int_{-1}^{3}\left(\tan^{-1}\left(\frac{x}{1+x^2}\right)+\tan^{-1}\left(\frac{x^2+1}{x}\right)\right)dx$ is equal to $\text{k}\pi$ then find k is ____.

89. Number of integral values of k for which the equation $4\cos^{-1}\left(-|x|\right)=k$ has exactly two solutions, is _____.

90. If
$\vec{a} = \lambda x\hat{i} + y\hat{j} + 4z\hat{k}, \vec{b} = y\hat{i} + x\hat{j} + (3y)\hat{k}, \vec{c} = -z\hat{j} - 2z\hat{j} - (\lambda+1)x\hat{k}$
are sides of triangle then the value of α is λ is (where x, y, z are not all zero).



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ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – I

JEE (Main)-2023

TEST DATE: 20-01-2023

ANSWERS, HINTS & SOLUTIONS

Physics

PART – A

SECTION – A

1. C

Sol. At any time

$$F_{thrust} - F_{friction} = ma$$

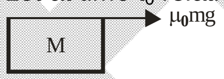
$$\rho a v^2 - \mu m g = ma$$

$$\rho a(2gh) - \left(\frac{a}{A}\right)(\rho A h)g = (\rho A h)a'$$

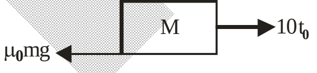
$$2\rho a g h - \rho a g h = \rho A h a' \; ; \; \frac{a}{A}g = a'$$

2. C

Sol. Let at time t_0 relative motion will occur



$$\mu_0 mg = Ma \quad \text{….. (1)}$$



$$10\,t_0 - \mu_0 mg = ma \quad \text{….. (2)}$$

From (1) and (2) ;

$$t_0 = \mu_0 m + \frac{\mu_0 m^2}{M}$$

3. A

Sol. $Mg - T = M\dfrac{dv}{dt}$ ….. (1)

$T + \mu v_e - (M_0 - \mu t)g = \left(M_0 - \mu t\right)\dfrac{dV}{dt}$ ….. (2)

From (1) and (2), we get

$Mg + \mu V_e - (M - \mu t)g = (2M - \mu t)\dfrac{dv}{dt}$ ….. (3)

$\left(\mu v_e + \mu g t\right) = \left(2M - \mu t\right)\dfrac{dv}{dt}$ ….. (4)

$$\frac{dv}{dt} = \frac{\mu(v_e + gt)}{(2M - \mu t)}$$

$$\therefore \quad \frac{dv}{dt} = \frac{\mu(v_e + gt)}{(2M - \mu t)}$$

So, correct answer is (A)

4. A

5. A

Sol. $\dfrac{l}{K_1A} + \dfrac{l}{2K_2A} + \dfrac{l}{K_3A} = \dfrac{l}{KA} + \dfrac{l}{2K_A} + \dfrac{l}{KA}$

$$\frac{5}{2K} = \left(\frac{1}{K_1} + \frac{1}{2K_2} + \frac{1}{K_3}\right)$$

$$K_{eq} = \frac{5}{2\left(\dfrac{1}{K_1} + \dfrac{1}{2K_2} + \dfrac{1}{K_3}\right)}$$

6. A

Sol. Voltage across capacitor will lag current by 90° ;

$$\therefore \quad i_C = \frac{200\sqrt{2}}{10}\sin\left(\omega t + \frac{\pi}{4} + \frac{\pi}{2}\right)$$

$$i = 20\sqrt{2}\sin\left(\omega t + \frac{3\pi}{4}\right)$$

$\therefore$ Correct answer is (A)

7. D

Sol. 2dQ = dU + 2dW

dQ = dU + dW

dQ = dW

$\Rightarrow$ dU = 0

Process is isothermal.

8. B

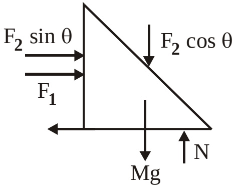
Sol. F = q v × B

$= q v_0 i \times B(-k) = q v_0 B j$

9. B

10. C

Sol. f = μN ; ($F_1 + F_2 \sin\theta$) = μ (mg + $F_2 \cos\theta$)



$$\mu = \frac{F_1 + F_2 \sin\theta}{mg + F_2 \cos\theta}$$

11. C

Sol. $W_B = 0$

$W_E = \Delta KE$; $W_B + W_E = \Delta KE$

12. A

Sol. K.E. = $p^2 / 2m$ and $p = h/\lambda$

13. D

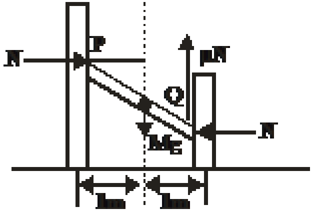
Sol. Drawing F.B.D. of rod PQ

$\Sigma Fx = 0$

$\Sigma Fy = 0 \Rightarrow \mu N = mg$ ….. (1)

$\Sigma\tau$ about centre of mass = 0

$$\left[N \times \frac{l}{2}\sin\theta\right][2] = \mu N \times \frac{l}{2}\cos\theta \Rightarrow \tan\theta = \frac{\mu}{2}$$



Hence $\sec\theta = \left(\sqrt{\mu^2 + 4}\right)/2$

Thus, $\left(\frac{l/2}{1}\right) = \frac{\sqrt{\mu^2 + 4}}{2} \Rightarrow l = \sqrt{\mu^2 + 4}$

$\Rightarrow\ l = \sqrt{0.25 + 4} = \frac{\sqrt{17}}{2}$ metres

14. B

Sol. $e = -\frac{d\phi}{dt}$

$i = \frac{e}{R}$ where R is resistance

$H = i^2 Rt$

The emf will induce from zero to some maximum value and then from maximum to zero.

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15. A

Sol. N_b reaches maximum when activity of A will be equal to activity of B.

i.e., $\lambda_a N_a = \lambda_b N_b \Rightarrow N_b = \dfrac{\lambda_a N_a}{\lambda_b}$

16. C

Sol. $f_0 = \dfrac{c}{\lambda} = \dfrac{c}{4(l+e)}$ and $\dfrac{c}{c_0} = \sqrt{\dfrac{273+\theta}{273}}$

$\therefore\ f_0' = \dfrac{c_0}{4(l+e)}\sqrt{1+\dfrac{\theta}{273}}$

If temperature is same, first overtone will be $3f_0$

$\therefore$ at 273°C first overtone is $3\sqrt{2}\,f_0$.

17. B

Sol. $V_0 = \sqrt{\dfrac{GM}{3R/2}} = \sqrt{\dfrac{2GM}{3R}}$

In order to escape to infinity let $(V - V_0)$ is the speed change required. Thus,

$$\frac{-GMm}{(3R/2)} + \frac{1}{2}m(v)^2 = 0$$

Thus, $v = \sqrt{\dfrac{4GM}{3R}}$

Thus speed change required = $v - v_0$

$$\Delta V = \sqrt{\frac{4GM}{3R}} - \sqrt{\frac{2GM}{3R}}\ ;\ \Delta V = \sqrt{\frac{GM}{3R}}\left(2-\sqrt{2}\right)$$

18. B

Sol. At any time

$Kx - IlB = ma$ ….. (1)

$\dfrac{q}{C} = Bvl$

$I = BlCa$ ….. (2)

From (1) and (2)

$kx = a(B^2l^2C + m)$

$a = \left(\dfrac{K}{B^2l^2C+m}\right)x$ ….. (3)

Since motion of connector will be opposite to the displacement from equilibrium. Therefore equation (3) represents S.H.M.

$$\omega = \sqrt{\frac{K}{B^2l^2C+m}}$$

$$V_{max} = X_0\omega$$

$\therefore\ q_{max} = BlCV_{max}$

$$q_{max} = BlCX_0\omega$$

$$X_0\sqrt{\begin{matrix}KC\\ 1+\frac{m}{B^2l^2C}\end{matrix}}$$

19. A

Sol. Velocity of image of particle B

$$\bar{v}_B = 5(\hat{i}) + 4(-\hat{i}) = \hat{i}$$

velocity of image of particle A

$$v_A = 10(-\hat{i}) + 4(-\hat{i}) - 10\hat{j}$$

$$= 14(-\hat{i}) - 10\,j$$

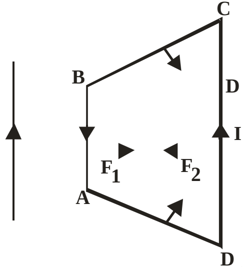
Relative velocity of image

$$\bar{V}_{BA} = \bar{V}_B - \bar{V}_A \;= \hat{i} - \left[14(-\hat{i}) - 10\hat{j}\right] \;= 15\hat{i} + 10\,\hat{j}$$

$$|\,\bar{V}_{BA}\,| = \sqrt{325}\,\text{cm/sec}$$

20. B

Sol. Magnitude of force on AB (F_1) and magnitude of force on CD (F_2) will be equal in magnitude and opposite in direction.



Hence $\bar{F}_1 + \bar{F}_2 = 0$ resultant of $\bar{F}_3 + \bar{F}_4$ will be away from the long straight wire.

SECTION – B

21. 2

Sol. Conservation of energy

$$\frac{1}{2}mv_0^2 = mgR + \frac{1}{2}mv^2, v = v_0\cos\theta$$

$$\frac{1}{2}v_0^2 = gR + \frac{v_0^2\cos^2\theta}{2}$$

$$v_0^2\left[1-\cos^2\theta\right] = gR$$

$$v_0 = \frac{\sqrt{2gR}}{\sin\theta}$$

22. 9

Sol. Net retardation $a = \frac{F_{ext} + \mu_k mg}{m} = 4.5$

If body stop at time t, then

$$V = u + at$$

$0 = 45 - 4.5t \quad \Rightarrow t = 10\,\text{sec}$

When block stops, F_{ext} will try to bring the block back ward while frictional force will oppose its motion, since block is stationary therefore at this moment, frictional force will be static. Whose maximum value will be $\mu_s mg = 30\text{N}$. Since static frictional force is self adjusting therefore it will be 25 N and block will not move after t = 10 sec.

$$S = \frac{u^2}{2a} = 225\,\text{m}$$

23. 25

Sol. Time taken by the layer of ice to increase its thickness by $x = x_2 - x_1$

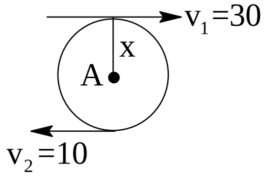
$$t = \frac{\rho L}{2K\theta}(x_2^2 - x_1^2) = \frac{.9 \times 80}{2 \times .005 \times 10}\left[(15)^2 - (10)^2\right]$$

$t = 9 \times 10^4\,\text{sec}$; t = 25 Hours

24. 25

Sol. Let x be the distance of axis of rotation from the top of sphere A (downward). Since angular velocity of the top and bottom point of sphere A will be same, therefore,

$$\omega = \frac{30}{x} = \frac{10}{(2R - x)}$$



$$\frac{30}{x} = \frac{10}{20 - x}$$

$\Rightarrow$ x = 15

$\therefore$ Distance from ground

= 2R + (2R – x)

= 20 + 5 = 25 cm

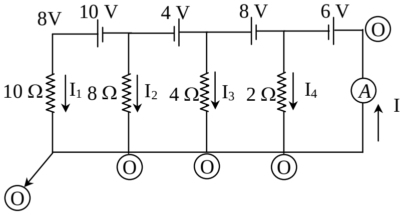
25. 8

Sol. $t = \int \frac{dy}{V_y} = \int_0^d \frac{dy}{Ky^{1/2}} = \frac{2\sqrt{d}}{k}$.

26. 3

Sol. $I = I_1 + I_2 + I_3 + I_4 = \frac{8}{10} - \frac{2}{8} + \frac{2}{4} - \frac{6}{2}$

$$\frac{32 - 10 + 20 - 120}{40} = \frac{-78}{40}\text{Amp}$$



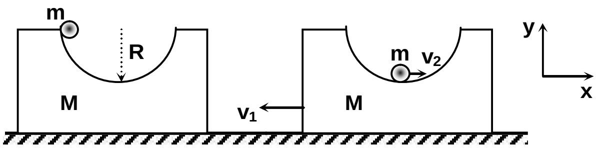
27. 4

Sol. Momentum conservation along x

$0 = mv_2 - Mv_1$

Work energy theorem

$$mgR = \frac{1}{2}mv_2^2 + \frac{1}{2}Mv_1^2$$



from (i) and (ii)

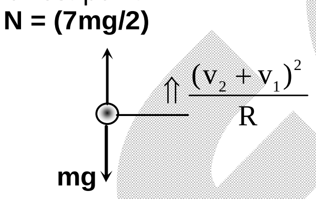
$$\Rightarrow 2mgR = mv_2^2 + \frac{m^2}{M}v_2^2$$

$$\sqrt{\frac{2gRM}{M+m}} = v_2 \text{ and } v_1 = \frac{m}{M}\sqrt{\frac{2gRM}{M+m}}$$

Making FBD of particle with respect wedge at lowest point

$$\frac{7mg}{2} - mg = \frac{m(v_1+v_2)^2}{R}$$

Substituting the values, we get : $\frac{M}{m} = 4$



28. 12

Sol. $v_0\cos 30° = v \cos 45°$

$$\Rightarrow v = v_0\sqrt{\frac{3}{2}}$$

Now using conservation of energy

$$\frac{1}{2}m\left(v^2 - v_0^2\right) = mgh$$

$$\frac{3v_0^2}{2} - v_0^2 = 2gh \quad \Rightarrow \frac{v_0^2}{2} = 2gh$$

$$\Rightarrow v = \sqrt{4gh} = \sqrt{4\times10\times3.6} = 12\,m/s$$

29. 5

Sol. $F_1 = \rho\left(\pi R^3 - \frac{2}{3}\pi R^3\right)g = \frac{\rho\pi R^3}{3}g$, $F_2 = \rho\left(\pi R^3 + \frac{2}{3}\pi R^3\right)g = \frac{5\rho\pi R^3}{3}g$

$\therefore$ $F_2/F_1 = 5$

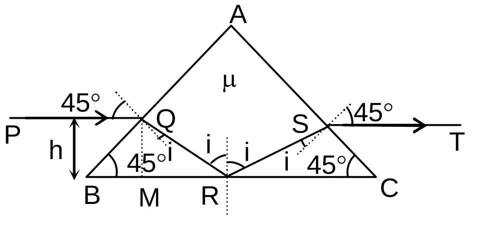
30. 1

Sol. $\sin 45° = \mu \sin r \Rightarrow r = 30°$

From ΔBQR and ΔCSR

$$\frac{BQ}{SC} = \frac{BR}{RC}$$

$$\therefore\ h' = 3\left(\frac{RC}{BR}\right)$$



$i = 45° + r = 75°$

So, $\frac{QM}{MR} = \tan 15°$, so MR = 12 cm

So, BR = 15 cm and RC = 5 cm

So, h′ = 1cm

Chemistry

PART – B

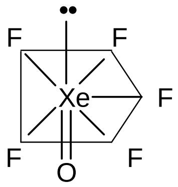
SECTION – A

31. D

Sol. Fluorine is most reactive amongst halides and has highest oxidising power

32. D

Sol.



Hybridisation $-sp^3d^3$

Shape – pentagonal monopyramidal

33. C

Sol. Macromolecular colloids like starch, gelatin are generally lyophilic.

34. A

Sol.

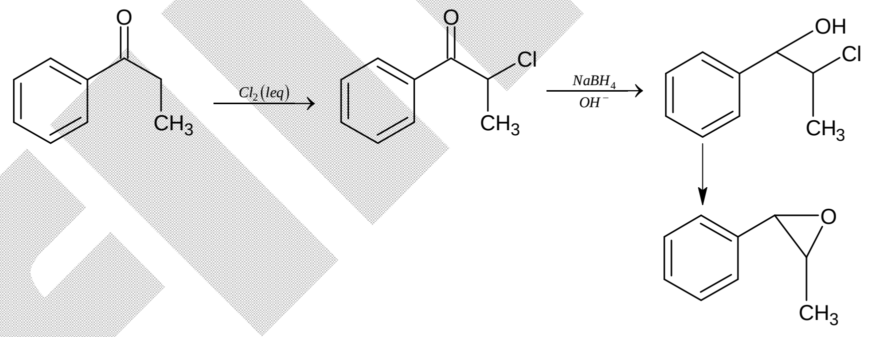
$$\underset{sp^3d}{\underset{\downarrow}{\left[XeF_3\right]^+}}\ \underset{sp^3d^2}{\underset{\downarrow}{\left[SbF_6\right]^-}}$$

35. A

Sol. In $(\bullet CF_3)$, % p-character because of which bond angle decreases

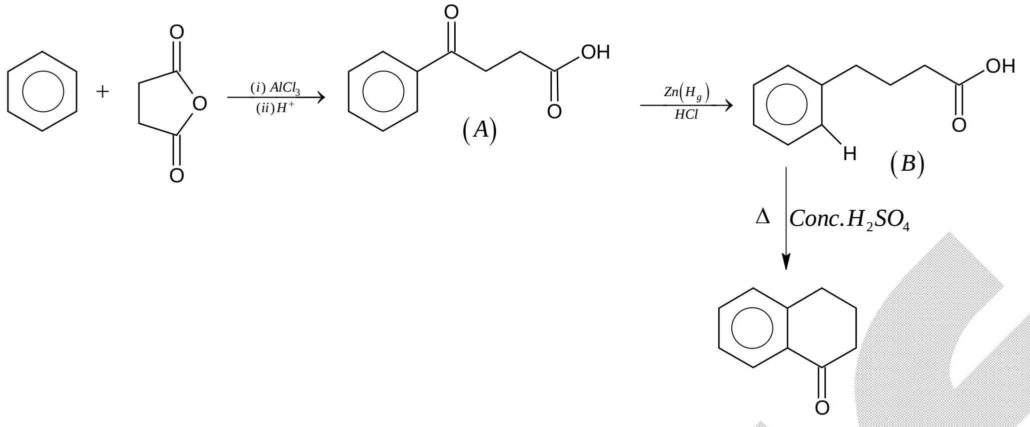
36. C

Sol.



37. A

Sol.


(i) AlCl3
(ii) H+
(A)
OH
Zn(Hg)
HCl
(B)
H
Δ Conc. H2SO4
O

38. B

Sol.

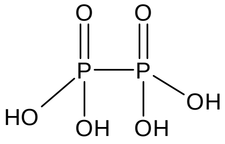
$$Bi^{3+} \xrightarrow{KI} BiI_3 \xrightarrow[KI]{excess} \left[BiI_4\right]^-$$

(A) (B)

Black ppt yellow brown solution

39. A

Sol.


O
O
P
P
HO
OH
OH
OH

$H_4P_2O_6$

40. A

Sol. Because of stability of half filled f-subshell configuration.

41. C

Sol. $AgBr = x + y$

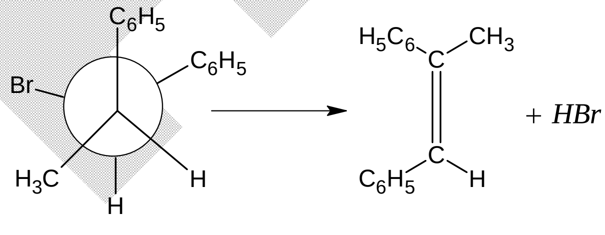
$$AgBr = \frac{K \times 1000}{M}$$

M – molarity of $AgBr$ solution

8 (solubility in g/L) = $\frac{K \times 1000}{\left(x+y\right)} \times 188$

42. A

Sol.


C6H5
C6H5
Br
H3C
H
H
H5C6
CH3
C
C
C6H5
H
+ HBr

43. C

Sol. $-OH$ group of phenol cannot be replaced by iodine as it does not undergo nucleophilic substitution reaction under normal conditions.

44. B

Sol. Greater the activation energy of a reaction, greater is the temperature dependence of rate constant of reaction.

45. C

Sol. $\frac{1}{\lambda} = RZ^2\left(1-\frac{1}{4}\right)$ for lyman line

46. C

Sol. Methoxy group stabilises the cationic intermediate by $+M$ effect

47. C

Sol. Cl_2 is present simultaneously in two equilibria. Decrease in its concentration shift both equilibria forward.

48. D

Sol. Point B represents exactly half neutralisation of acid. At this point concentration acid left and its conjugate base are equal.

49. C

Sol. $\left[Br^-\right] = \frac{4\times10^{-13}}{4\times10^{-4}} = 10^{-9}M$

Mass of $NaBr$ added of $200\,ml = 103\times\frac{10^{-9}}{1000}\times200$

$= 2.06\times10^{-8}g$

50. C

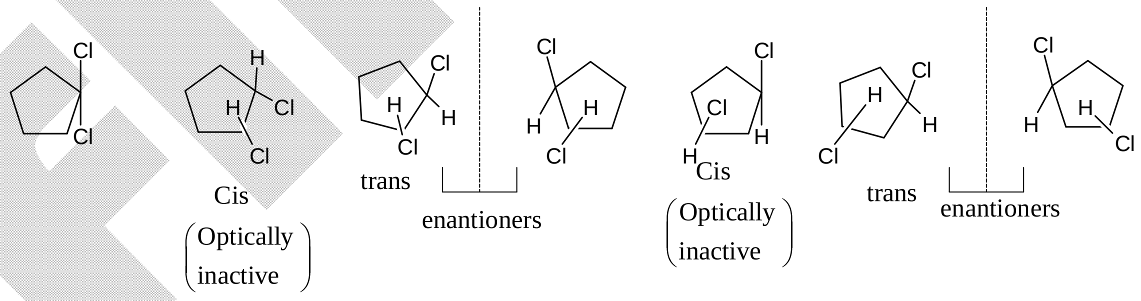
Sol. Greater the charge density, greater is hydration.

SECTION – B

51. 1

52. 7

Sol.


Cl
Cl
H
H
Cl
Cl
Cis
(Optically inactive)
Cl
H
H
Cl
trans
Cl
H
H
Cl
enantioners
Cl
Cl
H
H
Cis
(Optically inactive)
Cl
H
H
Cl
trans
Cl
H
H
Cl
enantioners

Total isomers = 7

53. 10

54. 3

Sol. $\left(\mathrm{Ni}\left(\mathrm{CN}\right)_4\right)^{2-}$ is dsp^2 hybridised and diamagnetic

55. 1

Sol. Equivalents of $KMnO_4 = 5x$

Equivalents of $K_2Cr_2O_7 = 6y$

Equivalents of oxidising agent must be same $5x = 6y$

$x - y = 6 - 5 \Rightarrow 1$

56. 7

Sol.

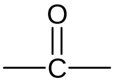
$$\begin{array}{lllll} Na-1s^2 & 2s^2 & 2p^6 & & 3s^1 \\ \boxed{\uparrow\downarrow} & \boxed{\uparrow\downarrow} & \boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow}\boxed{\uparrow\downarrow} & & \boxed{\uparrow\downarrow} \\ m_l - 0 & 0 & +1\ \ 0\ -1 & & 0 \end{array}$$

57. 3

Sol. In PCl_2F_3, net dipole moment does not cancel out.

58. 1

Sol.



$$-\overset{\overset{\displaystyle O}{\|}}{C}-$$

Group stabilise the carbanion character on $\alpha-$carbon

59. 4

Sol. 2 molecules of $RMgX$ are consumed by acid chloride group as it undergoes addition elimination first and then addition. The other aldehydic & ketonic group consume one $RMgX$ molecule each.

60. 4

Sol. Structure containing a ring of $(4n+2)\pi e^{-}s$ is aromatic

Mathematics PART – C

SECTION – A

61. D
Sol. $a = 3, b = -4, c = 1$

62. D

63. C
Sol. Put $x = i$ and equate the real part

64. C
Sol. $x^2dx + y^2dy = \frac{d(xy)}{(xy)^2}$

65. B
Sol. Let $x = \frac{\log_2 y}{111}$ these $y^3 - 16y^2 + 8y - 4 = 0$

66. C
Sol. $\sec^{-1}\sqrt{1+x^2} = \tan^{-1}x, \cos^{-1}\frac{1-x^2}{1+x^2} = 2\tan^{-1}x$

67. C
Sol. $\left(\frac{x-2y-4}{\sqrt{5}}\right)^2 = \frac{12}{\sqrt{5}}\left(\frac{2x+y}{\sqrt{5}}\right)$ (if is parabola)

68. C
Sol. $\tan\frac{\theta}{2}\tan\frac{\theta}{2} = \frac{1+e}{1-e}$ if focus is $(-ae, \theta)$

69. D
Sol. $f(x) = \tan\left(\frac{\pi}{4} - \frac{x}{2}\right)$

70. B

71. B

72. D

73. C

74. B

75. B
Sol. $b^2 + c^2 - a^2, c^2 + a^2 - b^2, a^2 + b^2 - c^2$ are in AP.

76. B

77. A

78. D
Sol, Both the roots opposite in sign

79. A
Sol. $adj\left(AB\right)=adjB.adjA$

80. C

SECTION – B

81. 7
Sol. $\int_0^{\frac{\pi}{2}}\frac{\left(1-\tan x\right)^2}{\left(1+\tan x\right)^4}\sec^2 x\,dx=\frac{1}{3}$

82. 105
Sol. $\frac{\lfloor 7}{\lfloor 4\ \lfloor 2}=105$

83. 50
Sol. $OM=\sqrt{\left(50\sqrt{5}\right)^2-\left(100\right)^2}=50m$

84. 8

85. 0
Sol. $\Delta=0$

86. 1023
Sol. $3+5+7+....\text{upto}\,32\text{nd terms}=1023$

87. 1
Sol. $\sin^{-1}\frac{\frac{2}{x}}{1+\left(\frac{1}{x}\right)^2}=2\tan^{-1}\frac{1}{x}$

88. 2
Sol. $\int_1^3\left(\tan^{-1}\left(\frac{x}{1+x^2}\right)+\tan^{-1}\left(\frac{x^2+1}{x}\right)\right)dx=2\pi$

89. 6

90. 0
Sol. $\vec{a}+\vec{b}=\vec{c}$

FIITJEE

ALL INDIA TEST SERIES

CONCEPT RECAPITULATION TEST – II

JEE (Main)-2023

TEST DATE: 20-01-2023

Time Allotted: 3 Hours **Maximum Marks: 300**

General Instructions:

- The test consists of total 90 questions.
- Each subject (PCM) has 30 questions.
- This question paper contains **Three Parts.**
- **Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is Mathematics.
- Each part has only two sections: **Section-A and Section-B**.
- **Section – A** : Attempt all questions.
- **Section – B :** Do any five questions out of 10 questions.

Section-A (01 – 20, 31 – 50, 61 – 80) *contains 60 multiple choice questions which have* ***only one correct answer****. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Section-B (21 – 30, 51 – 60, 81 – 90) *contains 30 Numerical based questions. The answer to each question is rounded off to the nearest integer value. Each question carries* ***+4 marks*** *for correct answer and* ***–1 mark*** *for wrong answer.*

Physics

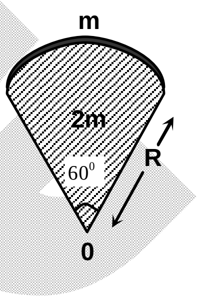
PART – A

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. What is the distance of centre of mass of the combined system as shown in figure from 'O'. System consists of a uniform sector of mass 2m and radius R, fixed with a uniform arc of mass m and radius R along the edge of the sector. (System is making an angle $\theta = 60^0$ at their common centre)



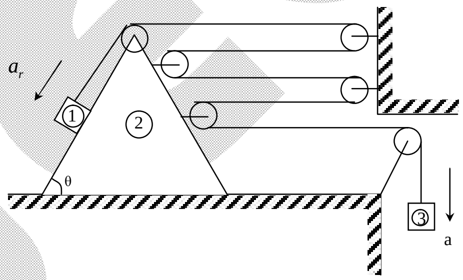
(A) $\frac{5R}{3\pi}$

(B) $\frac{4R}{3\pi}$

(C) $\frac{7R}{3\pi}$

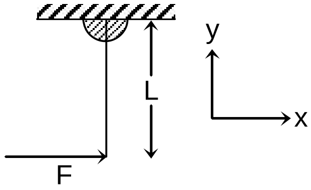
(D) none of these

2. In the figure shown, all the three bodies 1, 2, 3 can move. If acceleration of body 1 w.r.t 2 is $a_r = 6\,m/s^2$ and acceleration of 3 w.r.t ground is $a = 4\,m/s^2$, then magnitude of acceleration wedge 2 w.r.t. ground is



(A) 2 m/s^2
(B) 0.8 m/s^2
(C) 0.4 m/s^2
(D) 1 m/s^2

3. A rod of mass m, length L is kept in a vertical plane such that upper end is fixed. A force F is applied at bottom as shown. The hinge reaction in the given position will be :



(A) $F(+\hat{i}) + mg(+\hat{j})$

(B) $mg(+\hat{j})$

(C) $\frac{F}{2}\hat{i} + mg(+\hat{j})$

(D) $\frac{9F}{7}\hat{i} + mg(+\hat{j})$

4. From a circle of radius *a*, an isosceles right angled triangle with the hypotenuse as the diameter of the circle is removed. The distance of the centre of mass of the remaining part from the centre of the circle is

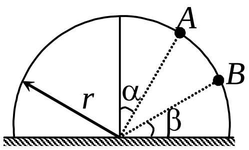
(A) $3(\pi - 1)a$

(B) $\frac{(\pi - 1)a}{6}$

(C) $\frac{a}{3(\pi - 1)}$

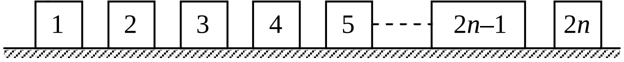
(D) $\frac{a}{3(\pi + 1)}$

5. A particle moves from rest at *A* on the surface of a smooth circular cylinder of radius r as shown. At *B* it leaves the cylinder. The equation relating α and β is



(A) $3\sin\alpha = 2\cos\beta$
(B) $2\sin\alpha = 3\cos\beta$
(C) $3\sin\beta = 2\cos\alpha$
(D) $2\sin\beta = 3\cos\alpha$

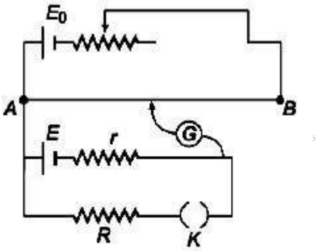
6. $2n$ identical cubical blocks are kept in a straight line on a horizontal smooth surface. The distance between the consecutive blocks is same. The blocks 1, 3, 5, …, $(2n – 1)$ are given velocity v to the right whereas blocks 2, 4, 6, …, $2n$ are given velocity to the left. All collisions between blocks are perfect elastic. The total number of collisions that will take place is



(A) n (B) $n + 1$

(C) $\frac{n(n+1)}{2}$ (D) $n(n+1)$

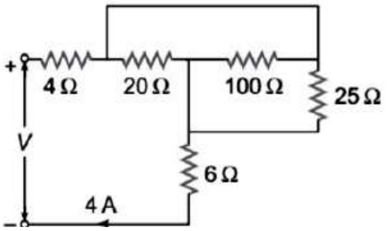
7. The given figure represents an arrangement of potentiometer for the calculation of internal resistance (r) of the unknown battery (E). The balance length is 70.0 cm with the key opened and 60.0 cm with the key closed. R is 132.40Ω. The internal resistance (r) of the unknown cell will be



(A) 22.1 Ω (B) 113.5 Ω

(C) 154.5 Ω (D) 10 Ω

8. In the circuit shown in figure, V must be



(A) 50 V (B) 80 V

(C) 100 V (D) 1290 V

9. A galvanometer of resistance 50 Ω is connected to a battery of 3 V along with resistance of 2950 Ω in series. A full scale deflection of 30 divisions is obtained in the galvanometer. In order to reduce this deflection to 20 divisions, the above series resistance should be

(A) 4450 Ω (B) 5050 Ω

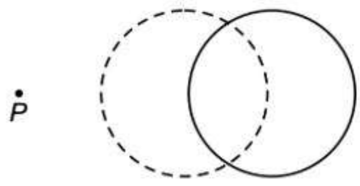
(C) 5550 Ω (D) 6050 Ω

10. Two identical coaxial rings each of radius R are separated by a distance of $\sqrt{3}$ R. They are uniformly charged with charges +Q and –Q respectively. The minimum kinetic energy with which a charged particle (charge +q) should be projected from the centre of the negatively charged ring along the axis of the rings such that it reaches the centre of the positively charged ring is

(A) $\frac{Qq}{4\pi\varepsilon_0 R}$ (B) $\frac{3Qq}{2\pi\varepsilon_0 R}$

(C) $\frac{Qq}{2\pi\varepsilon_0 R}$ (D) $\frac{3Qq}{4\pi\varepsilon_0 R}$

11. Figure shows a closed dotted surface which intersects a conducting uncharged sphere. If a positive charge is placed at the point P, the flux of the electric field through the closed surface



(A) will remain zero

(B) will become positive

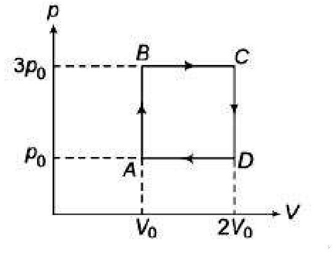
(C) will become negative

(D) data insufficient

12. A gas is found to be obeyed the law p^2V = constant. The initial temperature and volume are T_0 and V_0. If the gas expands to a volume $3V_0$, then the final temperature becomes

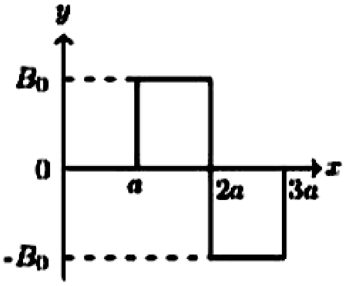
(A) $\sqrt{3}T_0$
(B) $\sqrt{2}T_0$
(C) $\frac{T_0}{\sqrt{3}}$
(D) $\frac{T_0}{\sqrt{2}}$

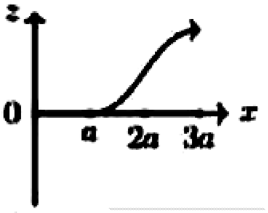
13. An ideal monoatomic gas is carried around the cycle ABCDA as shown in the figure. The efficiency of the gas cycle is

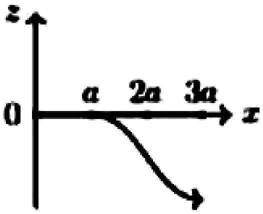


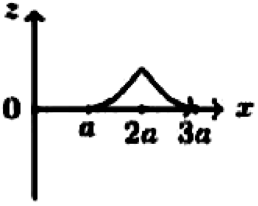
(A) $\frac{4}{21}$
(B) $\frac{2}{21}$
(C) $\frac{4}{31}$
(D) $\frac{2}{31}$

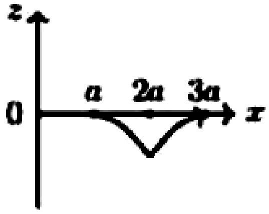
14. A magnetic field vector $\vec{B} = B_0\hat{j}$ exists in the region a < x < 2a and vector $\vec{B} = -B_0\hat{j}$, in the region 2a < x < 3a, where B_0 is a positive constant. A positive point charge moving with a velocity vector $\vec{v} = v_0\hat{i}$, where v_0 is a positive constant, enters the magnetic field at x = a. The trajectory of the charge in this region can be like



(A)


(B)


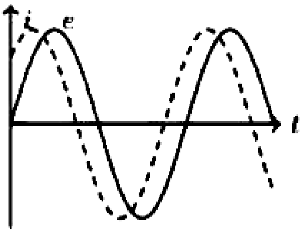
(C)


(D)


15. Two identical circular loops of metal wire are lying on a table without touching each other. Loop A carries a current which increases with time. In response, the loop B

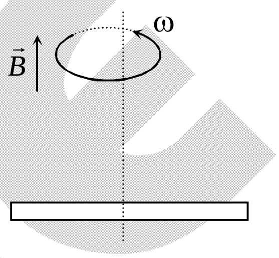
(A) remains stationary
(B) is attracted by the loop A.
(C) is repelled by the loop A.
(D) rotates about its CM, with CM fixed.

16. When an AC source of emf e = $e_0\sin(100t)$ is connected across a circuit, the phase difference between the emf e and the current i in the circuit is observed to be $\pi/4$, as shown in the diagram. If the circuit consists possibly R-C or R-L or L-C in series, find the relationship between the two elements.



(A) R = 1 kΩ, C = 10 μF
(B) R = 1 kΩ, C = 1 μF
(C) R = 1 kΩ, L = 10 H
(D) R = 1 kΩ, L = 1 H

17. A conducting rod of length 2*l* is rotating with constant angular speed ω about its perpendicular bisector. A uniform magnetic field $\vec{B}$ exists parallel to the axis of rotation. The emf induced between two ends of the rod is



(A) $B\omega l^2$
(B) $\frac{1}{2}B\omega l^2$
(C) $\frac{1}{8}B\omega l^2$
(D) zero

18. The energy that should be added to an electron, to reduce its de-Broglie wavelengths from 10^{-10}m to 0.5×10^{-10} m, will be
(A) four times the initial energy
(B) thrice the initial energy
(C) equal to the initial energy
(D) twice the initial energy

19. The wavelength of a certain line in the x-ray spectrum for tungsten ($Z = 74$) is 200 Å. What would be the wavelength of the same line for platinum ($Z = 78$)? The screening constant *a* is unity.
(A) 179.76 Å
(B) 189.76 Å
(C) 289.76 Å
(D) 379.76 Å

20. Two radioactive substances *X* and *Y* initially contain equal number of nuclei. *X* has a half life of 1 hour and *Y* has half life of 2 hours. After two hours the ratio of the activity of *X* to the activity of *Y* will be
(A) 1 : 4
(B) 1 : 2
(C) 1 : 1
(D) 2 : 1

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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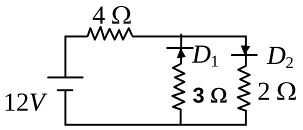
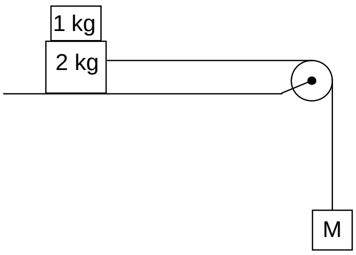
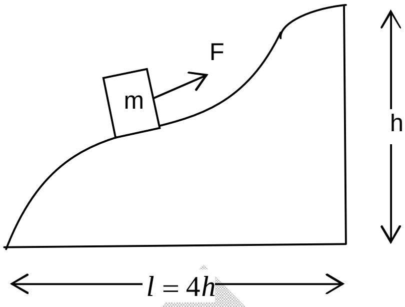
21. The circuit has two oppositely connected ideal diodes in parallel. What is the current flowing in the circuit?



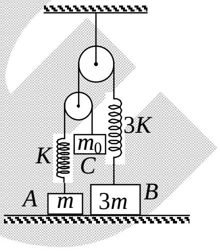
22. Find minimum value of mass suspended M for which 1 kg block start toppling. Assume 1 kg block does not slip over smooth 2 kg block. Length of 1 kg block is 4 cm and height is 8 cm. (ground is smooth).



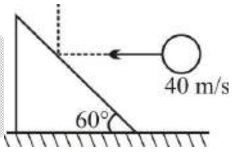
23. A body of mass 'm' is slowly hauled up a hill by an external force which is always acting along the surface as shown. The coefficient of friction between the body and the surface is $\mu = 0.5$. If work done by friction and gravity on the body are ΔW_{fr} and ΔW_g respectively during the process. Find the ratio $\frac{\Delta W_{fr}}{\Delta W_g}$



24. A spring mass system arrangement in vertical plane is as shown. Initially springs are in natural length and blocks *A* & *B* are resting on the ground. Determine the minimum mass (in kg) of block *C* so that block *A* leaves contact with the ground after releasing block *C*. (Take *m* = 10 kg)



25. Inclined surface of a smooth wedge of mass 6 kg makes an angle of 60° with horizontal as shown. A ball hits the wedge horizontally and elastically with a velocity of 40 m/s and moves vertically with respect to ground after the collision. Find the mass (in kg) of the ball if the wedge can also move on the smooth floor.



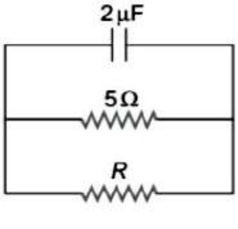
26. The peak power consumed by a resistive coil when connected to an AC source is 80 W. Find the energy consumed by the coil is 100 seconds which is many times larger than the time period of the source. (in kJ)

27. In YDSE experiment if the screen is shifted by a distance of 0.5 m away from the slit, 3rd maxima is shifted by 3×10^{-4} m. If the slit width is 2×10^{-4}m, find the wavelength used in the experiment (in nm).

28. When the voltage applied to an *X*-ray tube is increased from 10 kV to 20 kV the wavelength interval between the K_α line and the short wave cut off of the continuous *X*-ray spectrum increases by a factor 3. Find the atomic number of element of which the tube anti-cathode is made. (Rydberg's constant = 10^7 m^{-1})

29. A bus is moving towards a huge wall with a velocity of 5 m/s. the driver sounds a horn of frequency 200 Hz. What is the frequency of beats heards by a passenger of the bus, if the speed of sound in air is 330 m/s.

30. A capacitor of capacitance 2 μF is charged to a potential difference of 5 V. Now, the charging battery is disconnected and the capacitor is connected in parallel to a resistor of 5 Ω and another unknown resistor of resistance R as shown in figure. If the total heat proudced in 5 Ω resistance is 10 μJ, then the unkonwn resistance R is equal to 10/n. Find the value of n.



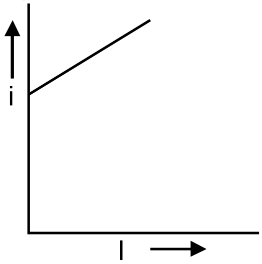
Chemistry PART – B

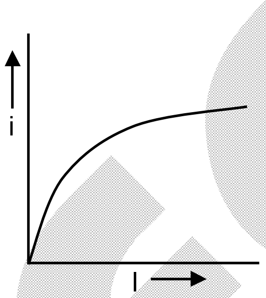
SECTION – A

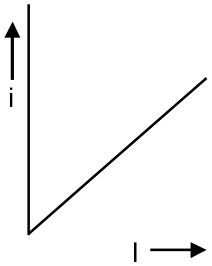
(Single Choice Answer Type)

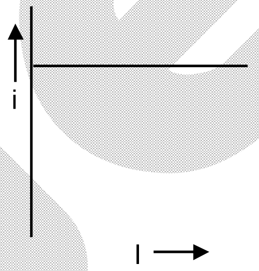
This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

31. Which of the following graphs depicts correctly the variation of photoelectric current *i*, with the intensity, *I*, of incident radiation?

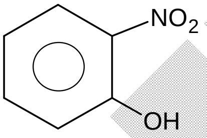
(A)


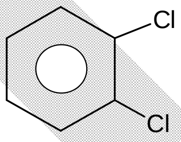
(B)


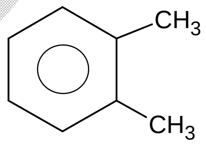
(C)


(D)


32. Which is the correct order of dipole moments of the compounds

(I)


(II)


(III)


(A) I > II > III (B) II > I > III
(C) III > I > II (D) III > II > I

33. The compressibility factor of helium as a real gas is

(A) unity (B) $1-\frac{a}{RTV}$
(C) $1+\frac{Pb}{RT}$ (D) $\frac{RTV}{1-a}$

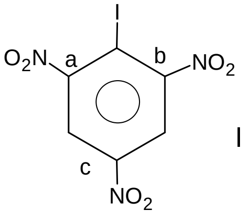
34. 20 ml of a solution containing Na_2CO_3 and $NaHCO_3$ requires 10 ml of 0.1 N H_2SO_4 for neutralization using phenolphthalein as an indicator. Methyl orange is then added when a further 10 ml of 0.2 N H_2SO_4 is required. Molar concentration of Na_2CO_3 and $NaHCO_3$ in the solution respectively are

(A) 0.05 M and 0.05 M (B) 0.1 M and 0.05 M
(C) 0.05 M and 0.10 M (D) 0.1 Mj and 0.1 M

35. Time required for 99.9% completion of a first order reaction is nearly

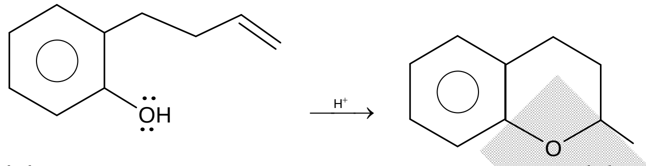
(A) 10 times that required for 25% of the reaction
(B) 10 times that required for 50% of the reaction
(C) 20 times that required for 50% of the reaction
(D) 100 times that required for 90% of the reaction

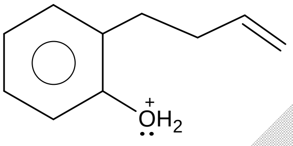
36. A 1.0 M with respect to each of metal halides AX_3, BX_2, CX_3 and DX_2 is electrolysed using platinum electrodes. If $E^\circ_{A^{3+}/A} = 1.50\,V, E^\circ_{B^{2+}/B} = +0.34, E^\circ_{C^{3+}/C} = -0.74\,V \quad E^\circ_{D^{2+}/D} = -2.37\,V$, the correct sequence in which the various metals are deposited at the cathode, is:
(A) A, B, C, D (B) D, C, B, A
(C) A, B, C (D) C, B, A

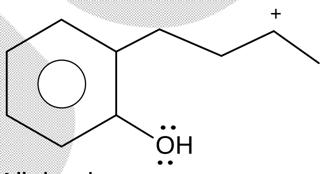


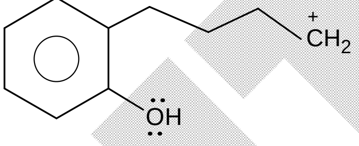
37. 2, 4, 6– Trinitroiodobenzene has three C–N bonds labelled as a, b and c. The correct bond length of three bonds is
(A) a = b = c (B) a > b > c
(C) a = b > c (D) a = b < c

38. Which of the following ion is formed in the following reaction?

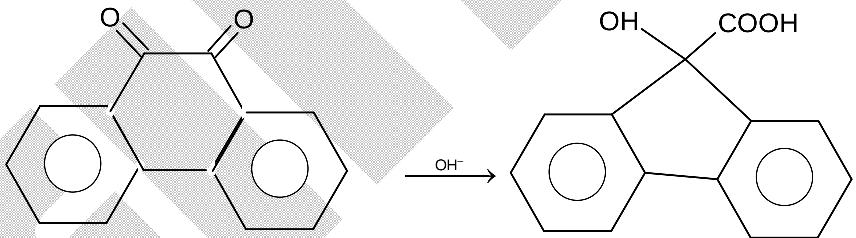


(A)


(B)


(C)


(D) All the three

39.


The above reaction is an example of
(A) Baeyer – Villiger rearrangement (B) Benzilic acid rearrangement
(C) Cannizzaro reaction (D) Pinacol – pinacolone rearrangement

40. Oxide which can not be a reducing agent is
(A) NO_2 (B) CO_2
(C) ClO_2 (D) SO_2

41. The number of S – S bonds in sulphur trioxide trimer (S_3O_9) is
(A) 3 (B) 2
(C) 1 (D) 0

42. The number of geometrical isomers for octahedral $[Co(NH_3)_2Cl_4]^-$,square planar $AuCl_2Br_2^-$ and $[Co(No_2)\ (NH_3)_5]^{2+}$ are

(A) 2, 2, 2 (B) 2, 2, no isomerism
(C) 3, 2, 2 (D) 2, 3, no isomerism

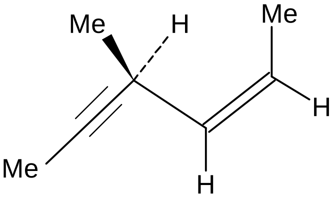
43. For the correct assignment of electronic configuration of a complex, the valence bond theory often requires the measurement of

(A) molar conductance (B) optical activity
(C) magnetic moment (D) dipole moment

44. Which of the following pairs can be distinguished by Fehling's solution?

(A) Glucose and fructose (B) Glucose and sucrose
(C) Methanal and ethanal (D) Hydroxypropanone and benzaldehyde

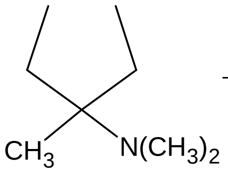
45.



Hydrogenation of the above compound in the presence of poisoned palladium catalyst gives

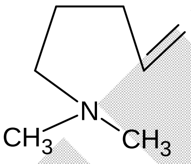
(A) an optically active compound (B) an optically inactive compound
(C) a racemic mixture (D) a diastereomeric mixture

46.

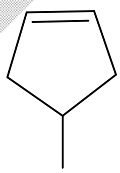


$\xrightarrow[\text{(ii)Heat}]{\text{(i)}H_2O_2}$ Pr oduct P is

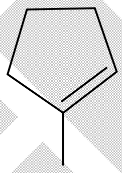
(A)



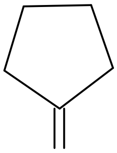
(B)



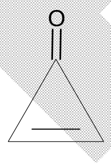
(C)



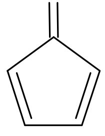
(D)



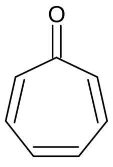
47. Which of the following is least stable?



I



II



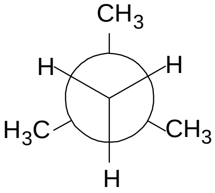
III

(A) I (B) II
(C) III (D) All are equally stable

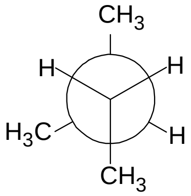
48. A mixture of CH_4, N_2 and O_2 is enclosed in a container of 1 litre capacity at 0ºC. Total pressure of gaseous mixture is 2660 mm Hg. If the ratio of partial pressure of the gases is 1 : 4 : 2 respectively, the number of moles of oxygen present in the vessel is:

(A) $\frac{1}{22.4}$ (B) 1.0
(C) 0.1 (D) None of these

49.



(I)



(II)

(A) Conformational isomers (B) Stereoisomers
(C) Constitutional isomers (D) Identical

50. In zone refining method the molten zone
(A) moves to either side
(B) contains the purified metal only
(C) contains more impurity than the original metal
(D) consists of impurities only

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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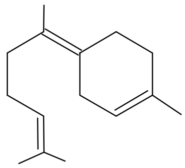
51. Consider the reaction: $AB_{2(g)} \rightleftharpoons AB_{(g)} + B_{(g)}$. If the initial pressure of AB_2 is 500 torr and equilibrium pressure is 600 torr, equilibrium constant K_p in terms of torr is

52. Reductive ozonolysis of a terpenoid of following structure



gives how many different products

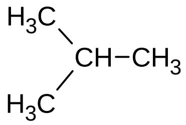
53. For H_2SO_4, K_{al} = infinite and $K_{a2} = 1.2 \times 10^{-2}$. The molarity of H_2SO_4 solution of pH 2.0 is 'xM'. The value of '1000000x' is

54. In how many of the following compound 'd' orbital (which contains no nodal plane) is used in hybridisation of central atom/ions?

$Fe(CO)_5$, MnO_4^- $Co(C_2O_4)_3^{-3}$

$NiCl_2(PPh_3)$ $PtCl_4^{2-}$ $Ni(CN)_4^{-2}$

$Ni(CN)_4^{-4}$

55. The number of monohalogenated alkanes formed by the reaction of  with Cl_2 in presence of light is

56. Iron forms a series of compounds of the type $Fe_x(CO)_y$. In air, they are oxidised to Fe_2O_3 and CO_2 gas. After heating a 0.142 g sample in air, you isolate the CO_2 in a 1.50 L flask at 25ºC. The pressure of the gas is 44.9 mm Hg. What will be the value of $\frac{y}{x}$ in the simplest empirical.

57. The edge length of the unit of LiCl (NaCl like structure) is 520 pm. Assuming that the lithium ion is small enough that the chloride ions are in contact, the ionic radius of chloride ion (in pm) is $\left(\frac{1}{\sqrt{2}} = 0.7\right)$

58. A certain metal 'M' forms an insoluble oxalate complex $M_4O_3(C_2O_4)_3 . 12H_2O$. If 3.2 g of the complex is formed from 1 g of oxalic acid, what is the atomic mass of M?

59. For the reaction $R - X + OH^- \rightarrow R - OH + X^-$ the rate of reaction is given as, rate = 4.7×10^{-5} $[R–X][OH^-] + 0.24 \times 10^{-5}$ [RX] what percentage of R – X react by S_N2 mechanism when $[OH^-]$ = 0.001 molar.

60. Find the sum of optically active isomers of both $[Pt(gly)_2Cl_2]$ and $[Co(en)_2Cl_2]$.

Mathematics PART – C

SECTION – A

(Single Choice Answer Type)

This section contains **20 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

61. The angle between the line $\frac{x-2}{2}=\frac{y+1}{-1}=\frac{z-3}{2}$ and the plane 3x + 6y – 2z + 5 = 0 is

(A) $\cos^{-1}\left(\frac{4}{21}\right)$ (B) $\sin^{-1}\left(-\frac{4}{21}\right)$
(C) $\sin^{-1}\left(\frac{6}{21}\right)$ (D) $\sin^{-1}\left(\frac{4}{21}\right)$

62. The slope of the tangent to the curve $y=\int_x^{x^2}\cos^{-1}t^2dt$ at $x=\frac{1}{(2)^{1/4}}$ is

(A) 0 (B) $\pi/2$
(C) $\left(\frac{(8)^{1/4}}{3}-\frac{1}{4}\right)\pi$ (D) $\left(\frac{(8)^{1/4}}{6}-\frac{1}{4}\right)\pi$

63. Area bounded by f(x) = max.{sinx, cosx}; $0 \le x \le \pi/2$, $x = \pi/2$ and the coordinate axes is equal to

(A) $\sqrt{2}$ sq. units (B) 2 sq. units
(C) $\frac{1}{\sqrt{2}}$ sq. units (D) None of these

64. The co-efficient of x^7 in the expansion of $(1-x^4)(1+x)^9$ is

(A) 27 (B) –24
(C) 48 (D) –48

65. The chords of contact of the pair of tangents drawn from each point on the line 2x + y = 4 to the circle $x^2 + y^2 = 1$ pass through fixed point

(A) (2 , 4) (B) $\left(-\frac{1}{2}, -\frac{1}{4}\right)$
(C) $\left(\frac{1}{2}, \frac{1}{4}\right)$ (D) (-2, -4)

66. The equation of the line through the intersection of the lines 2x + 3y + 4 = 0 and 6x – 3y + 12 = 0 and normal to the circle $x^2 + y^2 - 4x - 12 = 0$, is

(A) x = y (B) x = 0
(C) y = 0 (D) None of these

67. The solution of the differential equation $x\frac{dy}{dx}=-\frac{y}{2}-\frac{\sin 2x}{2y}$ is given by

(A) $xy^2 = \cos^2 x + c$ (B) $xy^2 = \sin^2 x + c$
(C) $yx^2 = \cos^2 x + c$ (D) None of these

68. If a, b, c > 0 and x, y, z $\in$ R, then the determinant $\begin{vmatrix} (a^x + a^{-x})^2 & (a^x - a^{-x})^2 & 1 \\ (b^y + b^{-y})^2 & (b^y - b^{-y})^2 & 1 \\ (c^z + c^{-z})^2 & (c^z - c^{-z})^2 & 1 \end{vmatrix}$ is equal to

(A) $a^x + b^y + c^z$
(B) $a^{-x}\ b^{-y}\ c^{-z}$
(C) $a^{2x}\ b^{2y}\ c^{2z}$
(D) 0

69. $\int_0^\infty \left[\frac{3}{x^2+1}\right]dx$ is equal to ([.] denotes the greatest integer function)

(A) $\sqrt{2}$
(B) $\sqrt{2} + 1$
(C) $3/\sqrt{2}$
(D) infinite

70. The value of $\int \frac{\ln x}{(1+\ln x)^2}dx$ is

(A) $\frac{x}{1-\ln x} + c$
(B) $\frac{x \ln x}{1+\ln x} + c$
(C) $\frac{x}{(1+\ln x)} + c$
(D) $\frac{\ln x}{x(1+\ln x)} + c$

71. Domain of $\log_{1/2}\log_4\log_3[(x-4)^2]$ is, [.] denotes the integer function .

(A) $(-\infty, 2] \cup [6, \infty)$
(B) $(-\infty, 2] \cup [6, 8)$
(C) (2, 6)
(D) [2, 6]

72. PQ is a vertical pole with end P on level ground. R is the mid–point of PQ. At a point A on the level ground, the portion QR subtends an angle α at A. If AP = nPQ, then $\tan\alpha$ =

(A) $\frac{n}{2n^2+1}$
(B) $\frac{n}{n^2-1}$
(C) $\frac{n}{n^2+1}$
(D) None of these

73. The line lx + my + n = 0 will be a normal to the hyperbola $b^2x^2 - a^2y^2 = a^2b^2$ if

(A) $\frac{a^2}{l^2} + \frac{b^2}{m^2} = \frac{(a^2+b^2)^2}{n^2}$
(B) $\frac{a^2}{l^2} - \frac{b^2}{m^2} = \frac{(a^2-b^2)^2}{n^2}$
(C) $\frac{a^2}{l^2} - \frac{b^2}{m^2} = \frac{(a^2+b^2)^2}{n^2}$
(D) None of these

74. The coordinates of the point on the parabola $y = x^2 + 7x + 2$, which is nearest to the straight line $y = 3x - 3$ are

(A) (-2, -8)
(B) (1, 10)
(C) (2, 20)
(D) (-1, -4)

75. If AFB is a focal chord of the parabola $y^2 = 4ax$ and AF = 4, FB = 5, then the latus-rectum of the parabola is equal to

(A) $\frac{80}{9}$ (B) $\frac{9}{80}$

(C) 9 (D) 80

76. $\sum_{n=1}^{\infty} \frac{n}{4n^4 + 1}$ equals to

(A) 2 (B) 1

(C) ∞ (D) 1/4

77. If S denote the sum to infinity and S_n the sum of n terms of the series $1 + \frac{1}{3} + \frac{1}{9} + \frac{1}{27} + \ldots$ such that $S - S_n < \frac{1}{300}$, then the least value of n is

(A) 4 (B) 5

(C) 6 (D) 7

78. The set of values of 'a' for which the equation $x^3 - 3x + a$ has three distinct real roots, is

(A) $(-\infty, \infty)$ (B) (-2, 2)

(C) (-1, 1) (D) none of these

79. If the line $y = \sqrt{3}\,x$ cuts the curve $x^4 + ax^2y + bxy + cx + dy + 6 = 0$ at A, B, C and D, then OA.OB.OC.OD (where O is the origin) is

(A) a – 2b +c (B) $2c^2d$

(C) 96 (D) 6

80. The equation of plane perpendicular to 2x + 6y + 6z – 1 = 0 and passing through the points (2, 2, 1) and (9, 3, 6) is

(A) 3x + 4y + 5z + 9 = 0 (B) 3x + 4y – 5z + 9 = 0

(C) 3x + 4y – 5z – 9 = 0 (D) 3x + 4y + 5z – 9 = 0

SECTION – B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

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81. Shortest distance between lines $\frac{x-6}{1} = \frac{y-2}{-2} = \frac{z-2}{2}$ and $\frac{x+4}{3} = \frac{y}{-2} = \frac{z+1}{-2}$ is

82. The number of solutions of the equation $x^3 + 2x^2 + 5x + 2\cos x = 0$ in $[0, 2\pi]$ is

83. If the second, third and fourth terms in the expansion of $(a+ b)^n$ are 135, 30 and 10/3 respectively, then n =

84. If the equation $|z - z_1|^2 + |z - z_2|^2 = k$ represents the equation of a circle, where $z_1 \equiv 2+ 3i$, $z_2 \equiv 4 + 3i$ are the extremities of a diameter, then the value of k is

85. The sum of the distances of any point on the ellipse $3x^2 + 4y^2 = 12$ from its directrix is

86. Given that g(x) is a function satisfying g(x + y) = g(x) g(y) $\forall$ x, y $\in$ N and g(1) = 3, the value of $\sum_{x=1}^{4} g(x)$ is equal to

87. Given a function f(x) continuous $\forall$ x $\in$R such that $\lim_{x\to 0}\left[f(x)+\log\left(1-\frac{1}{e^{f(x)}}\right)-\log(f(x))\right]$ = 0, then f(0) is

88. Let S be the set of 6-digit numbers $a_1a_2a_3a_4a_5a_6$ (all digits distinct) where $a_1 > a_2 > a_3 > a_4 < a_5 < a_6$. Then n(S) is equal to

89. Six identical coins are arranged in a row. The number of ways in which the number of tails is equal to number of heads is

90. Entries of a 2 × 2 determinant are chosen from the set {−1, 1}. The probability that determinant has zero value is $\frac{1}{\lambda}$ then λ is

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CONCEPT RECAPITULATION TEST – II

JEE (Main)-2023

TEST DATE: 20-01-2023

ANSWERS, HINTS & SOLUTIONS

Physics

PART – A

SECTION – A

1. C

Sol. For the sector, $y_{cm} = \frac{4R}{3}\frac{\sin(\phi/2)}{\phi} = \frac{2R}{\pi} \quad \left(\because \phi = \frac{\pi}{3}\right)$

For the arc, $y_{cm} = \frac{2R\sin(\phi/2)}{\phi} = \frac{3R}{\pi}$

2. A

Sol. If acceleration of block 2 is a_2 to the right, then

$$5a_2 = a_r + a = 6 + 4$$

$$\boxed{a_2 = 2m/s^2}$$

3. C

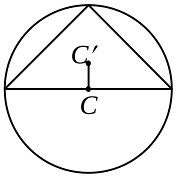
Sol. $\alpha = \frac{\tau}{I} = \frac{FL}{\frac{mL^2}{3}} = \frac{3F}{m\ell} \quad \Rightarrow \quad a_{cm} = \frac{\ell}{2}\alpha = \frac{3F}{2m}$

$$\Sigma F_x = ma_{cm}$$

$$N_x + F = \frac{3F}{2} \quad \Rightarrow N_x = \frac{F}{2}$$

$$N_y = Mg$$

4. C



Sol. C.M. of triangle is at $\frac{a}{3}$ from centre of circular plate

$$m_{\text{triangle}} = \frac{m_{\text{circle}}}{\pi}$$

$$y_{CM} = \frac{M_y - m_y}{M - m}$$

On solving, $\frac{a}{3(\pi - 1)}$

5. C

Sol. $-\Delta U = \Delta k_e$

$$-[U_B - U_A] = \frac{1}{2}mv^2$$

Ball will leave when normal at B = 0

$$\therefore\ mg\sin\beta - N_B = \frac{mv_B^2}{R} \Rightarrow 0 \quad \text{at} \quad B \quad \Rightarrow\ mg\sin\beta = \frac{mv_B^2}{R}$$

6. D

Sol. Block number 1 and 2*n* will suffer one collision each, block number 2 and 2*n* – 1 will suffer two collision each similarly block number *n* and *n* + 1 will suffer *n* collision each. So total number of collisions will be 2(1 + 2 + … + *n*) = *n* (*n* + 1)

7. A

Sol. $r = R\left(\frac{\ell_1}{\ell_2} - 1\right) = 132.4\left(\frac{70}{60} - 1\right) \approx 22.1\,\Omega$

8. B

Sol. 100 Ω, 25 Ω and 20 Ω are in parallel.

Their, net resistance is 10 Ω

$\therefore$ $R_{net} = 4\,\Omega + 10\Omega + 6\Omega = 20\,\Omega$

$V = i\,R_{net} = 80$ V

9. A

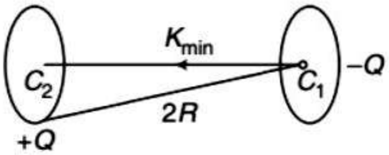
Sol. Current decreases $\frac{20}{30}$ times or $\frac{2}{3}$ times. Therefore, net resistance should become $\frac{2}{3}$ times.

$$\therefore\ R + 50 = \frac{3}{2}(2950 + 50)$$

Solving we get, R = 4450 Ω

10. A

Sol.



$$k_{C_1} + U_{C_1} = k_{C_2} + U_{C_2}$$

$$k_{min} + qV_{C_1} = 0 + qV_{C_2} \qquad \text{...(i)}$$

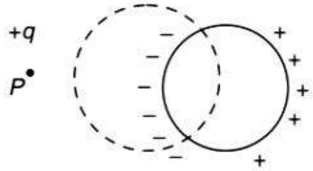
$$V_{C_1} = \frac{1}{4\pi\varepsilon_0}\left(\frac{Q}{2R} - \frac{Q}{R}\right)$$

$$V_{C_2} = \frac{1}{4\pi\varepsilon_0}\left(\frac{Q}{2} - \frac{Q}{2R}\right)$$

Substituting these values in Eq. (i), we can find K_{min}.

11. C

Sol.



The induced charges on conducting sphere due to +q charge at P are as shown in figure.
Now, net charge inside the closed dotted surface is negative. Hence, according to Gauss's theorem net flux is negative.

12. A

Sol. p^2V = constant

$$\therefore \left(\frac{nRT}{V}\right)^2 V = \text{ constant}$$

$\therefore \quad T^2 \propto V$

or $\quad T \propto \sqrt{V}$

V is made three times. So, T will becomes $\sqrt{3}$ times.

13. A

Sol. $W_{net} = 2p_0V_0$

$Q_{+ve} = Q_{ABC} = W_{ABC} + \Delta U_{ABC}$

= area under the graph + $nC_V\Delta T$

$$= (3p_0V_0) + n\left(\frac{3}{2}R\right)(T_C - T_A)$$

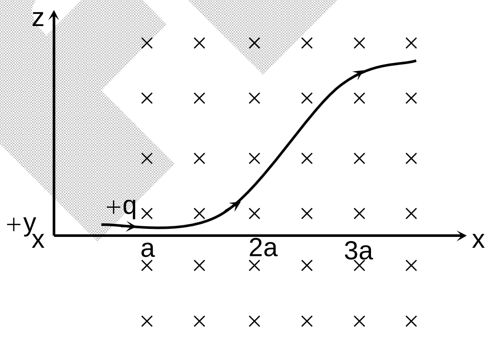
$$= (3p_0V_0) + \frac{3}{2}(p_CV_C - p_AV_A)$$

$= 10.5\ p_0V_0$

$$\eta = \frac{W_{net}}{Q_{+ve}} = \frac{4}{21}$$

14. A

Sol.



15. C

Sol. Conceptual

16. A

Sol. $\tan\phi = \frac{X_C}{R}$ $\frac{1}{\omega C} = R$

$\tan\frac{\pi}{4} = \frac{X_C}{R}$ $\frac{1}{\omega R} = C$

$X_C = R$

i leads emf $\therefore$ circuit is LC

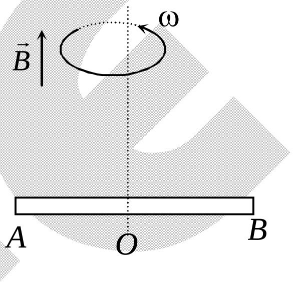
17. D

Sol. Potential difference between

O and *A* is $V_A - V_O = \frac{1}{2}Bl^2\omega$

O and *B* is $V_B - V_O = \frac{1}{2}Bl^2\omega$

So $V_A - V_B = 0$



18. B

Sol. $\lambda = \frac{h}{\sqrt{2mE}}$ $\Rightarrow$ $\lambda \propto \frac{1}{\sqrt{E}}$

$\Rightarrow$ $\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{E_2}{E_1}}$ $\Rightarrow$ $\frac{10^{-10}}{0.5\times10^{-10}} = \sqrt{\frac{E_2}{E_1}}$

$\Rightarrow$ $E_2 = 4E_1$

Hence added energy = $E_2 - E_1 = 3E_1$

19. A

Sol. Using Moseley's law, we get

$$\frac{\lambda_2}{\lambda_1} = \frac{(Z_1 - a)^2}{(Z_2 - a)^2}$$

$$\lambda_2 = \frac{200\times(74-1)^2}{(78-1)^2} = 179.76\ \text{Å}$$

20. C

Sol. ${}^{x}\lambda = \frac{\ln 2}{t_{1/2}}$

${}^{y}\lambda = \frac{\ln 2}{t_{1/2}}$

$\frac{{}^{x}A}{{}^{y}A} = \frac{{}^{x}\lambda\,{}^{x}N_0 e^{-{}^{x}\lambda t}}{{}^{y}\lambda\,{}^{y}N_0 e^{-{}^{2}\lambda t}}$

$e^{\ln 2} = 2$

SECTION – B

21. 2

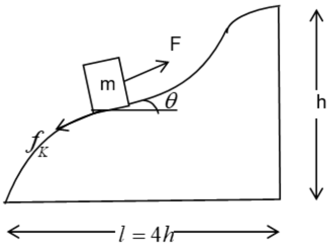
Sol. D_1 is reverse biased therefore it will act like an open circuit.

$i = \frac{12}{6} = 2.00A$

22. 3

Sol. Psueodo force and friction will make a force couple. Normal reaction and Mg will make a force couple.
When block is about the topple normal reaction will shift to edge.

23. 2



Sol. $\Delta W_f = -\int \mu mg \cos\theta ds$

$= -\mu mg \int_0^l dx$

$= -\mu mgl = 0.5mg\,4h = -2mgh$

$\Delta W_g = -mgh$

$\therefore \Delta W_{fr} / \Delta W_g = 2$

24. 5

Sol. $mg = kx$ (for m to leave the ground)

$m_0 gx = \frac{1}{2}kx^2$ or $m_0 = \frac{m}{2}$ = 5 kg

25. 4

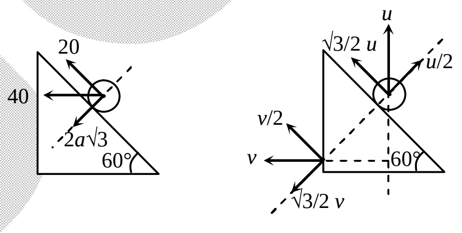
Sol. Conservation of momentum along horizontal

$m40 = 6 \times v$ …(i)

Newton's law of restitution

$\frac{u}{2} + \frac{\sqrt{3}}{2}v = 20\sqrt{3}$ …(ii)

Linear momentum of ball will remain conserved along inclined



Before Collision

$\frac{\sqrt{3}}{2}u = 20$

$u = \frac{40}{\sqrt{3}}$ …(iii)

From (i), (ii) and (iii)

m = 4 kg

26. 4

Sol. $P_{avg} = \frac{\varepsilon_{10} i_0}{2} = \frac{80}{2} = 40$

$P_{avg} = \frac{\text{Energy}}{\text{Time}}$

27. 40

Sol. Here 3rd maxima is shifted by 3 × 10^{-4} m. It indicates fringe width increases by 1 × 10^{-4} m.

Hence $\beta = \frac{\lambda(D+0.5)}{d} = \frac{\lambda D}{d} + 1\times10^{-4}$

or $\frac{0.5\lambda}{d} = 1\times10^{-4}$ m or $\lambda = \frac{2\times10^{-3}\times1\times10^{-4}}{0.5} = 4\times10^{-7}$ m = 40 nm

28. 30

Sol. $\lambda_{C_1} = \frac{hc}{eV} = \frac{12375}{10\times10^3} A^\circ$ = 1.2375 A° … (1)

λ_{C_2} = 0.61875 A° … (2)

$$\frac{1}{\lambda_{K_\alpha}} = (Z-1)^2 \left\{\frac{1}{1} - \frac{1}{4}\right\} \times 10^7 \quad \text{… (3)}$$

It is given

$3 \times (\lambda_{k\alpha} - 1.2375) = \lambda_{k\alpha} - 0.61875$

$\therefore$ $\lambda_{k\alpha}$ = 1.54338 A° … (4)

Putting this value in (3)

$Z - 1 = 29$

Z = 30

29. 6

Sol. As source (horn of bus) is approaching stationary wall (say, listener), therefore, apparent frequency striking the wall is

$$v' = \frac{\upsilon\, v}{\upsilon - \upsilon_s} \quad \text{…(1)}$$

Sound of this frequency will be reflected by the wall (now, source). The passenger is the listener moving towards source. Therefore, frequency heard by the listener $v'' = \frac{(\upsilon + \upsilon_L)v'}{\upsilon}$

using (1)

$$v'' = \frac{\upsilon + \upsilon_L}{\upsilon} \times \frac{\upsilon v}{\upsilon - \upsilon_s} = \frac{(\upsilon + \upsilon_L)v}{\upsilon - \upsilon_s}$$

$$= \frac{(330+5)\times 200}{330-5} = \frac{335}{325} \times 200$$

$v'' = 206$Hz

$\therefore$ Beat frequency = $(v'' - v)$

$= 206 - 200 = 6$ Hz

30. 3

Sol. Total heat product $= \frac{1}{2}CV^2$

$= \frac{1}{2}(2\mu F)(5)^2$

$= 25\ \mu J$

Now, this should distribute in inverse ratio of resistors, as they are in parallel.

$\therefore$ $\frac{H_{5\Omega}}{H_R} = \frac{R}{5}$

or $H_{5\Omega} = \left(\frac{R}{R+5}\right)$ (Total heat)

or $10 = \left(\frac{R}{R+5}\right)(25)$

Solving this equation, we get

$R = \left(\frac{10}{3}\right)\Omega$

Chemistry

PART – B

SECTION – A

31. C

Sol. Intensity of incident radiations depends on no. of photons in the incident light and simultaneously no. of photoelectrons increases and photoelectric current increases

32. A

Sol. In all the three options groups are arranged at ortho position. So after that the value of dipole moment will depend on the electro negativity difference.

33. C

Sol. For helium is a very light gas for which attraction is ignored and do not have vanderwall constant 'a' in the equation of compressibility factor and for helium Z > 1.

34. A

Sol. $Na_2CO_3 \longrightarrow NaHCO_3$ x

$NaHCO_3 \longrightarrow H_2CO_3$ x

$NaHCO_3 \longrightarrow H_2CO_3$ y

With phenolphthalein as indication 10 mL × 1N × 2
2 mill g. equation = x
with methyl orange as indicator
10mL × 0.2N × 4 milli gram equation = x + y
y = 2 mili gram eq.

Normality = $\frac{2\text{mill gram eq.}}{20\,\text{mL}} = 0.1\text{N}$

N = nf × molarity M = 0.05 M

35. D

Sol. For first order reaction, $t = \frac{2.303}{k}\log\frac{a}{a-x}$ $t_{99.9} = \frac{2.303}{k}\log\frac{100}{100-99.9} = \frac{2.303}{k}\times 3$

$t_{50} = \frac{2.303}{k}\log\frac{2.303}{k}\log 2 = \frac{2.303}{k}\times 0.301\, t_{99.9/t50} = 10\,\text{approx.}$

36. C

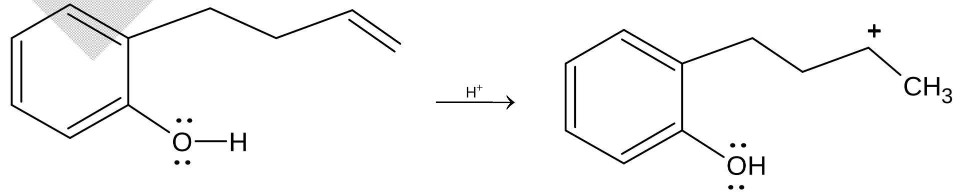
Sol. The cations will be liberated in the sequence of decreasing reduction potentials. Cations having E°value < –0.83 (reduction potential of water) will not be liberated from aqueous solutions

37. C

Sol. Iodine is a bulky group due to ortho effect mesomeric effect stops at ortho position & hence a and b will be longer than C bond

38. B

Sol.



More stable carbocation forms at this position

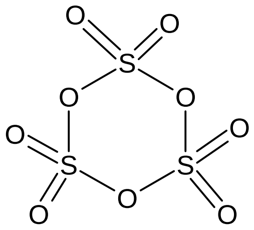
39. B

Sol. Benzilic acid involves transformation of α–diketones to α–hydroxyl acid by means of OH^-

40. C

Sol. CO_2, in CO_2 carbon is already in it's maximum oxidation state and cannot be oxidised further. While N, Cl, S are not in their maximum oxidation state.

41. D

Sol. Structure  no S – S bonds

42. B

Sol. $[Co(NH_3)_2Cl_4]^-$ = cis and trans isomerism
$AuCl_2Br_2^-$ square planar cis and trans isomersim
$[Co(NO_2)\,[NH_3]^{2+}$ = No isomerism

43. C

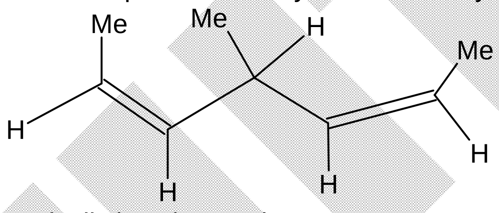
Sol. VBT is based on measurement of magnetic moment measurement. Based on that structure is being predicted.

44. B

Sol. Fehlings solution can separate reducing and non-reducing sugars.
Glucose – Reducing sugar
Sucrose – non-reducing sugar.

45. B

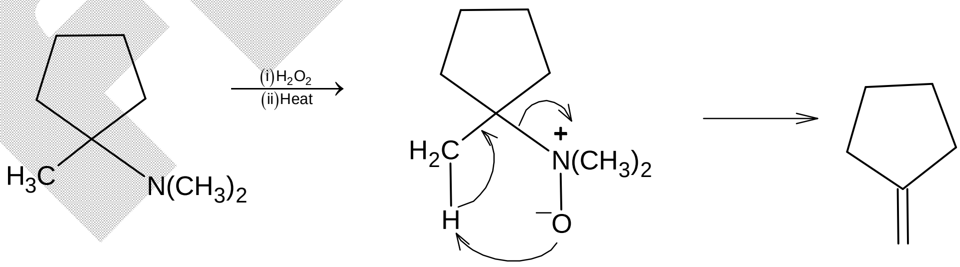
Sol. Poisoned palladius catalyst reduces Alkyne to cis-Alkene.



Optically inactive product

46. D

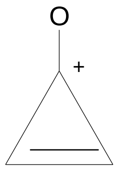
Sol.



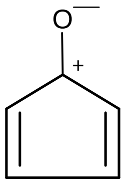
Less stable alkene is the major product

47. B

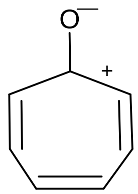
Sol.



Aromatic



Anti-aromatic



Aromatic

Anti-aromatic is the least stable

48. A

Sol. Partial pressure of O_2 = $\frac{2}{7} \times 2660$ mm

Thus 1 L of O_2 is present at 0ºC and 760 mm

So no. of O_2 molecules = $\frac{0.02 \times 10^{23}}{22.4}$

PV = nRT

No. of moles of O_2 = $\frac{1\text{atm} \times 1\text{L}}{0.0821^{-1}\text{atm}} \times 273\text{k} = \frac{1}{22.4}$

49. C

Sol. They have different bond connectivity. Hence constitutional isomers.

50. C

Sol. Zone refining is based on the principal that impurities are more soluble in molten state than solid state.

Hence molten zone contains more impurities than the original metal.

SECTION – B

51. 25

Sol.

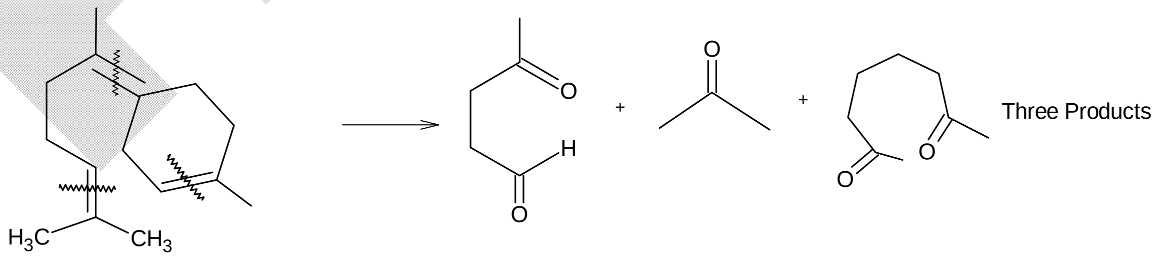
$$\begin{array}{ccccc} AB_2 & \rightleftharpoons & AB(g) & + & B(g) \\ 500 & & - & & - \\ 500 - x & & x & & x \end{array}$$

Require = 600 torr = 500 – x + x + x, x = 100 torr

$K_p = \frac{P_{AB} \cdot P_B}{P_{AB_2}} = \frac{100 \times 100}{400}$ = 25 torr

52. 3

Sol.



53. 6470

Sol.
$$\begin{array}{cccc} H_2SO_4 & \rightleftharpoons & H^+ & + \quad HSO_4 \\ x & & - & - \\ x-y & & y+Z & y-Z \end{array}$$

$$\begin{array}{cccc} H_2SO_4^- & \rightleftharpoons & H^+ & + \quad SO_1^{a-} \\ y-Z & & Z+y & Z \end{array}$$

$$K_{G_1} = \frac{(y-Z)(y+Z)}{x-y} \qquad k_q \qquad \frac{Z(Z+y)}{y-Z}$$

$k_{a_1} = \infty,\ \therefore x = y$

$$1.2\times10^{-2} = \frac{2\times10^{-2}}{y-Z}$$

1.2 (y) – 1.22 = Z

1.2 y = 2.2Z

Y = 1.833Z

Y + z = 0.01

2.8332 = 0.01

Z = 0.0025

Y = 0.0064705 = x

$\therefore$ 6470.546

54. 2

Sol. d_{z^2} orbital has no mola plane.

$Fe(CO)_5 = dsp^2 = dz^2$

$MnO_4^- = d^3sw = d_{xy}, d_{yz}, d_{x2}$

$Co(C_2O_4)_3^{3-} = sp^3d^2 \quad d_{x^2-y^2}$ and d_{z^2}

$NiCl_2(PPh_3)_2 = dsp^2 = d_{x^2-y^2}$

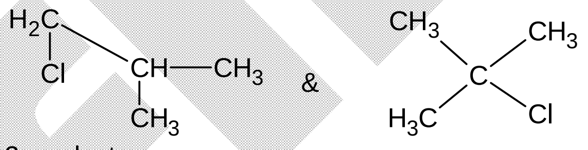
$PtCl_4^2 = dsp^2 = d_{x^2-y^2}$

$Ni(CN)_4^2 = dps^2 = d_{x^2-y^2}$

$Ni(CN)_4^{4-} = sp^3$

55. 2

Sol.



2 products

56. 5

Sol. $Fe_x(CO)_y \xrightarrow{\Delta} \frac{x}{2}Fe_2O_3 + yCO_2$

$$Fe_x(CO)_y + \left(\frac{3x}{4}+y\right)O_2 \longrightarrow \frac{x}{2}Fe_2O_3 + y\ CO_2$$

0.0026 mole

1-50 L at 25ºC, P = 44.9 mm Hg

PV = nRT

$$\frac{44.9}{760}\times1.50L = n\times0.0821\times298$$

$$= n = 0.036 \text{ mole}$$

$0.142 = 56\,x + 0.0036 \times 28$

$$x = \frac{0.0412}{56} = 0.00073$$

$$\frac{y}{x} = 4.9 \simeq 5$$

57. 182

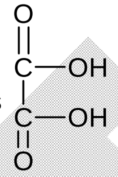
Sol. Fcc like structure has edge length
$2r_+ + 2r_- = 520$ ppm
From radius ration

$$\frac{r^+}{r^-} = 0.414$$

$2\,(0.414\,r^-) + 2r^- = 520$ pm
$2.85\,r^- = 520$
$r^- = 182$ pm

58. 84

Sol. Given wt. of complex = 3.2 gm
Molecular wt. of complex = 4 M + 48 + 264
= 4 M + 528 + 216

Molar mass of oxalic acid is  is 90 gm

$$\begin{matrix} O \\ \| \\ C-OH \\ | \\ C-OH \\ \| \\ O \end{matrix}$$

$$\frac{3.2g}{4M+528}\times = \frac{1g}{90}$$

M = 84 g/ mol

59. 2

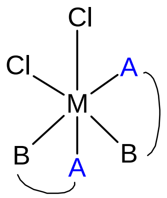
Sol. Rate = $\underbrace{\left[4.7\times10^{-5}\right][R-x]\left[OH^-\right]}_{\substack{\downarrow\\ S_N2}} + \underbrace{0.24\times10^{-5}[RX]}_{\substack{\downarrow\\ S_N1}}$

% of SN^2 = $\dfrac{4.7\times10^{-5}[RX]\times10^{-3}M}{0.24\times10^{-5}[RX]+4.7\times10^{-5}[RX]}\times100$

on solving answer = 2

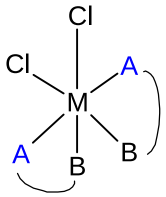
60. 8

Sol. $\left[Pt(gly)_2Cl_2\right] = \left[Pt(AB)_2Cl_2\right]$

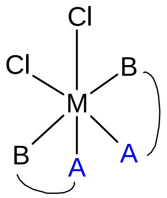


complete cis

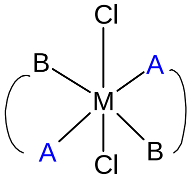
optically active = 2



optically active = 2



optically actice = 2



optically inactice & Cis – [co (en)$_2$ Cl$_2$] is optically active isomers = 2 while trans – [Co(en)Cl$_2$] is optically inactive

FIITJEE

Mathematics

PART – C

SECTION – A

61. D

Sol. $\sin^{-1}\dfrac{|2\times 3+(-1)\times 6+2\times(-2)|}{\sqrt{2^2+(-1)^2+2^2}\cdot\sqrt{3^2+6^2+(-2)^2}}$

62. C

Sol. $\dfrac{dy}{dx}=\cos^{-1}x^4x^2$

$= - \cos^{-1}x^2$

$= \dfrac{2\pi}{3}\times\dfrac{1}{2^{1/4}}-\dfrac{\pi}{4}$

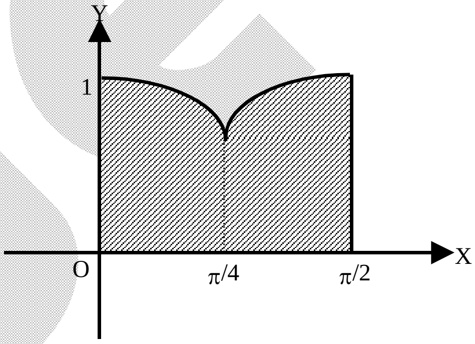
63. A

Sol. $f(x) = \cos x$ for $0 \le x \le \pi/4$

$= \sin x$ for $\pi/4 < x \le \pi/2$

Required $= 2\displaystyle\int_0^{\pi/4}\cos x\,dx = 2\sin x\Big|_0^{\pi/4}$

$= \sqrt{2}$ sq. units.



64. D

Sol. $(1 - x^4)(1 + {}^9C_1 x + {}^9C_2 x^2 + {}^9C_3 x^3 \ldots\ldots\ldots\ldots {}^9C_9x^9)$

Coefficient of $x^7 = {}^9C_7 - {}^9C_3 = -48$

65. C

Sol. The chord of contact of tangents from (α, β) is

$\alpha x + \beta y = 1$ ..... (1)

Also, (α, β) lies on $2x + y = 4$, so that $2\alpha + \beta = 4$

$\Rightarrow \dfrac{\alpha}{2}+\dfrac{\beta}{4}=1$

Hence, (1) passes through $\left(\dfrac{1}{2},\ \dfrac{1}{4}\right)$.

66. C

Sol. Equation of line is $(2x + 3y + 4) + \lambda(6x - 3y + 12) = 0$ …(1)

(1) is normal to circle, therefore (1) passes through (2, 0)

$\Rightarrow \lambda = \dfrac{-1}{3}$ and required equation is $y = 0$.

67. A

Sol. $\Rightarrow 2y\dfrac{dy}{dx}x=-y^2-\sin 2x$ $\Rightarrow y^2+2yx\dfrac{dy}{dx}=-\sin 2x$

$\Rightarrow \frac{d}{dx}(xy^2) = \frac{d}{dx}(\cos^2 x)$ $\Rightarrow xy^2 = \cos^2 x + c$

68. D

Sol. $$\begin{vmatrix} (a^x + a^{-x})^2 & (a^x - a^{-x})^2 & 1 \\ (b^y + b^{-y})^2 & (b^y - b^{-y})^2 & 1 \\ (c^z + c^{-z})^2 & (c^z - c^{-z})^2 & 1 \end{vmatrix}$$

Operating $C_1 \rightarrow C_1 - C_2$

$$\begin{vmatrix} 4a^x a^{-x} & (a^x - a^{-x})^2 & 1 \\ 4b^y b^{-y} & (b^y - b^{-y})^2 & 1 \\ 4c^z c^{-z} & (c^z - c^{-z})^2 & 1 \end{vmatrix} = 4\begin{vmatrix} 1 & (a^x - a^{-x})^2 & 1 \\ 1 & (b^y - b^{-y})^2 & 1 \\ 1 & (c^z - c^{-z})^2 & 1 \end{vmatrix} = 0.$$

69. C

Sol. $0 < \frac{3}{x^2+1} \le 3$, $\frac{3}{x^2+1} = 2 \Rightarrow x = \frac{1}{\sqrt{2}}$ and $\frac{3}{x^2+1} = 1 \Rightarrow x = \sqrt{2}$

$$I = \int_0^{1/\sqrt{2}} 2dx + \int_{1/\sqrt{2}}^{\sqrt{2}} 1.dx + \int_{\sqrt{2}}^{\infty} 0\,dx = \sqrt{2} + \sqrt{2} - \frac{1}{\sqrt{2}} = 2\sqrt{2} - \frac{1}{\sqrt{2}} = \frac{3}{\sqrt{2}}.$$

70. C

Sol. $$\int \frac{\ln x}{(1+\ln x)^2}dx$$

Let $\ln x = t \Rightarrow dx = e^t\,dt$

$$\int \frac{te^t}{(1+t)^2}dt = \int \frac{e^t(t+1-1)}{(1+t)^2}dt$$

$$= \int \frac{e^t(t+1-1)}{(1+t)^2}dt$$

$$= \int e^t\left\{\frac{1}{t+1} - \frac{1}{(1+t)^2}\right\}dt$$

$$= \frac{e^t}{t+1} + c \qquad \text{since } \int e^x(f(x) + f'(x))dx = e^x f(x) + c$$

$$= \frac{e^{\ln x}}{1+\ln x} + c = \frac{x}{1+\ln x} + c.$$

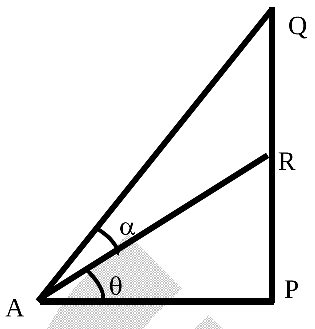
71. A

Sol. $f(x) = \log_{1/2}\log_4\log_3[(x-4)^2] \Rightarrow \log_4(\log_3[x-4)^2]) > 0 \Rightarrow \log_3[(x-4)^2] > 1$

$\Rightarrow [(x-4)^2] \ge 4 \Rightarrow (x-4)^2 - 4 \ge 0 \Rightarrow (x-2)(x-6) \ge 0$

$\Rightarrow x \in (-\infty, 2] \cup [6, \infty)$.

72. A



Sol. $\tan(\theta + \alpha) = \frac{PQ}{AP} = \frac{1}{n}$

$\tan\theta = \frac{PR}{AP} = \frac{(1/2)PQ}{AP} = \frac{1}{2n}$

$\alpha = (\theta + \alpha) - \theta$

$\Rightarrow \tan\alpha = \frac{\tan(\theta+\alpha) - \tan\theta}{1 + \tan(\theta+\alpha)\tan\theta}$

$= \frac{\frac{1}{n} - \frac{1}{2n}}{1 + \frac{1}{n}.\frac{1}{2n}} = \frac{n}{2n^2+1}$.

73. C

Sol. Normal to hyperbola will be

$ax\cos\theta + by\cot\theta = a^2 + b^2$

If this is same as $lx + my + n = 0$, comparing the coefficients,

$\frac{a\cos\theta}{l} = \frac{b\cot\theta}{m} = \frac{a^2+b^2}{-n}$

$\sec\theta = -\frac{an}{l(a^2+b^2)}$, $\tan\theta = \frac{-bn}{m(a^2+b^2)}$

$\sec^2\theta - \tan^2\theta = 1$

$\Rightarrow \frac{a^2}{l^2} - \frac{b^2}{m^2} = \frac{(a^2+b^2)^2}{n^2}$.

74. A

Sol. Any point on the parabola is $(x, x^2 + 7x + 2)$

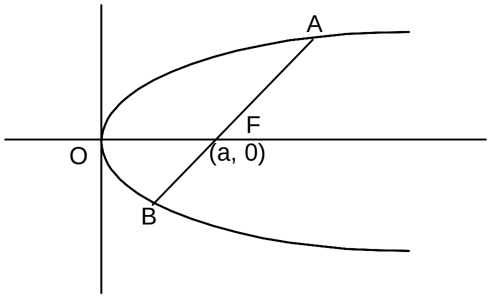
Its distance from the line $y = 3x - 3$ is given by

$P = \left|\frac{3x - (x^2+7x+2) - 3}{\sqrt{9+1}}\right| = \left|\frac{x^2+4x+5}{\sqrt{10}}\right| = \frac{x^2+4x+5}{\sqrt{10}}$ (as $x^2 + 4x + 5 > 0$ for all $x \in R$)

$\frac{dP}{dx} = 0 \Rightarrow x = -2$

The required point $\equiv (-2, -8)$.

75. A



Sol. FA = 4, FB = 5

We know that $\frac{1}{a} = \frac{1}{AF} + \frac{1}{FB}$

$\Rightarrow a = \frac{20}{9} \Rightarrow 4a = \frac{80}{9}$.

76. D

Sol. $\frac{n}{4n^4+1} = \frac{1}{4}\left[\frac{1}{2n^2-2n+1} - \frac{1}{2n^2+2n+1}\right]$

Hence $\sum_{n=1}^{k}\frac{n}{4n^4+1} = \frac{1}{4}\left[1 - \frac{1}{2k^2+2k+1}\right] = \frac{1}{4}$ as $k \to \infty$

77. C

Sol. $S - S_n < \frac{1}{300}$

$\Rightarrow \frac{1}{1-\frac{1}{3}} - \frac{1-\frac{1}{3^n}}{1-\frac{1}{3}} < \frac{1}{300} \Rightarrow \frac{3}{2}\left[1-1+\frac{1}{3^n}\right] < \frac{1}{300}$

$\Rightarrow \frac{1}{3^n} < \frac{1}{300}\times\frac{2}{3} \Rightarrow \frac{1}{3^n} < \frac{1}{450} \Rightarrow 3^n > 450$

$\therefore$ least value of n = 6

78. B

Sol. Let $f(x) = x^3 - 3x + a$

$f'(x) = 3x^2 - 3$.

For three distinct real roots (i) $f'(x) = 0$ should have two distinct real roots α and β and (ii) $f(\alpha)\,f(\beta) < 0$

Here $\alpha = 1$, $\beta = -1$.

Now $f(\alpha)\,f(\beta) < 0$

$\Rightarrow (1 - 3 + a)\,(-1 + 3 + a) < 0 \Rightarrow (a - 2)\,(a + 2) < 0$

$\Rightarrow -2 < a < 2$.

79. C

Sol. The line $y = \sqrt{3}x$ can be written as $x = \frac{r}{2}$, $y = \frac{r\sqrt{3}}{2}$.

If this line cuts the given curve, then

$\frac{r^4}{16} + \frac{ar^3\sqrt{3}}{8} + \frac{br^2\sqrt{3}}{4} + \frac{cr}{2} + \frac{dr\sqrt{3}}{2} + 6 = 0$.

Therefore OA. OB.OC.OD = $|r_1|\,|r_2|\,|r_3|\,|r_4| = |r_1\,r_2\,r_3\,r_4| = 96$

80. C

Sol. Plane passing through (2, 2, 1) is $a(x - 2) + b(y - 2) + c(z - 1) = 0$

It passes through (9, 3, 6)

$\Rightarrow 7a + b + 5c = 0$ …. (1)

It is $\perp$ to $2x + 6y + 6z - 1 = 0$

$\Rightarrow 2a + 6b + 6c = 0$ …. (2)

(1) and (2) $\Rightarrow \frac{a}{-24} = \frac{b}{-32} = \frac{c}{40}$

$\Rightarrow \frac{a}{3} = \frac{b}{4} = \frac{c}{-5}$

$\Rightarrow$ The required plane is

$3(x - 2) + 4(y - 2) - 5(z - 1) = 0$

$\Rightarrow 3x + 4y - 5z - 9 = 0$.

SECTION – B

81. 9

Sol. $$\text{S. D} = \frac{\begin{vmatrix} 10 & 2 & 3 \\ 1 & -2 & 2 \\ 3 & -2 & -2 \end{vmatrix}}{\sqrt{8^2+8^2+4^2}} = \frac{108}{12} = 9$$

82. 0

Sol. Let $f(x) = x^3 + 2x^2 + 5x + 2\cos x$

$\Rightarrow f'(x) = 3x^2 + 4x + 5 - 2\sin x$

$$= 3\left(x+\frac{2}{3}\right)^2 + \frac{11}{3} - 2\sin x$$

Now $\frac{11}{3} - 2\sin x > 0\ \forall\ x$ (as $-1 \le \sin x \le 1$)

$\Rightarrow f'(x) > 0\ \forall\ x \Rightarrow f(x)$ is an increasing function.

Now $f(0) = 2$

$\Rightarrow f(x) = 0$ has no solution in $[0, 2\pi]$.

83. 5

Sol. $T_2 = {}^nC_1\, ab^{n-1} = 135$ .....(1)

$T_3 = {}^nC_2\, a^2\, b^{n-2} = 30$ .....(2)

$T_4 = {}^nC_3\, a^3 b^{n-3} = 10/3$ .....(3)

Dividing (1) by (2)

$$\frac{{}^nC_1 ab^{n-1}}{{}^nC_2 a^2 b^{n-2}} = \frac{135}{30}$$

$$\frac{n}{\frac{n}{2}(n-1)}\frac{b}{a} = \frac{9}{2}$$

$$\frac{b}{a} = \frac{9}{4}(n-1) \quad \text{.... (5)}$$

Dividing (2) by (3)

$$\frac{\frac{n(n-1)}{2}}{\frac{n(n-1)(n-2)}{3.2}}\cdot\frac{b}{a} = 9$$

$$\therefore\ \frac{b}{a} = 3(n-2) \quad \text{....(6)}$$

Eliminating a and b from (5) and (6)

$\Rightarrow n = 5$

84. 4

Sol. $k = |z - z_1|^2 + |z - z_2|^2 = |z_1 - z_2|^2$ $\Rightarrow k = 4$

85. 8

Sol. $\frac{x^2}{4}+\frac{y^2}{3}=1 \Rightarrow$ a = 2, b = $\sqrt{3}$ and e = $\frac{1}{2}$

Sum of distances = $\frac{2a}{e}$ = $\frac{4}{1/2}=8$.

86. 120

Sol. g(x) = g(x – 1 + 1) = g(x – 1) g(1)

= g(x – 2) $[g(1)]^2$ = …. = $[g(1)]^x = 3^x$

$\Rightarrow \sum_{x=1}^{4} 3^x = 3^1 + 3^2 + 3^3 + 3^4 = 120$

87. 0

Sol. $\lim\limits_{x\to 0}\left[f(x)+\log\left(1-\frac{1}{e^{f(x)}}\right)-\log(f(x))\right]$

$= \lim\limits_{x\to 0}\left[\log\left(e^{f(x)}\right)+\log\left(\frac{1-\frac{1}{e^{f(x)}}}{f(x)}\right)\right]$

$\Rightarrow \lim\limits_{x\to 0}\log\left(\frac{e^{f(x)}-1}{f(x)}\right) = 0 \Rightarrow \lim\limits_{x\to 0}\left(\frac{e^{f(x)}-1}{f(x)}\right) = 1$

$\Rightarrow \lim\limits_{x\to 0} f(x)=0 \Rightarrow f(0) = 0$ (as f(x) is a continuous function) .

88. 2100

Sol. First, 6 distinct digits can be selected in ${}^{10}C_6$ ways. Now the position of smallest digit in them is fixed i.e. position 4. Of the remaining 5 digits, two digits can be selected in ${}^{5}C_2$ ways. These two digits can be placed to the right of 4th position in one way only. The remaining three digits to the left of 4th position are in the required order automatically.

So n(S) = ${}^{10}C_6 \times {}^{5}C_2 = 210 \times 10 = 2100$.

89. 20

Sol. Required number of ways = $\frac{6!}{3!3!}=\frac{720}{6\times 6}=20$

90. 2

Sol. $\begin{vmatrix} a & b \\ c & d \end{vmatrix}$ = ad – bc = 0 $\Rightarrow$ whether ad = 1, bc = 1 or ad = – 1, bc = – 1

which occur in eight ways. Total number of 2 × 2 determinants from {–1, 1} is 16. Thus required probability is $\frac{8}{16}=\frac{1}{2}$.

FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
OPEN TEST – I
PAPER –1
TEST DATE: 05-02-2023

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B**.

Section – A *(01 –06, 19 – 24, 37 – 42):* This section contains **EIGHTEEN (18)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – A *(07 – 10, 25 – 28, 43 – 46):* This section contains **TWELVE (12)** Matching List Type Questions. Each question has **FOUR** statements in **List-I** entries (I), (II), (III) and (IV) and **FIVE** statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which, **ONLY ONE** of these four options is correct answer.

Section – B *(11 – 18, 29 – 36, 47 – 54):* This section contains **TWENTY FOUR (24)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.

MARKING SCHEME

Section – A (One or More than One Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4	If only (all) the correct option(s) is (are) chosen;
Partial Marks	:	+3	If all the four options are correct but ONLY three options are chosen;
Partial marks	:	+2	if three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks	:	+1	If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–2	In all other cases.

Section – A (Single Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+3	If ONLY the correct option is chosen.
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–1	In all other cases.

Section – B: Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+3	If ONLY the correct numerical value is entered at the designated place;
Zero Marks	:	0	In all other cases.

Physics

PART – I

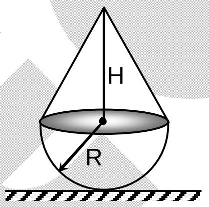
Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

1. Two infinite long thin wire have linear charge density $-\lambda$ and $+\lambda$. They are parallel to z-axis passing through x-axis at point x = –a and x = +a respectively. The equipotential surface having potential $\frac{\lambda \ell n(2)}{4\pi\varepsilon_0}$ is

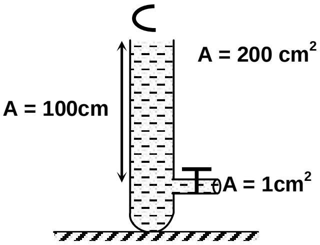
(A) a sphere
(B) A cylinder
(C) having radius of $\sqrt{2}a$
(D) having radius $2\sqrt{2}a$

2. In the shown figure a solid hemisphere of radius R and a cone of radius height H is welded. The object formed is placed on rough horizontal surface. Density of material is same for hemisphere and cone. If it is slightly displaced from its equilibrium position. The correct statements are/is



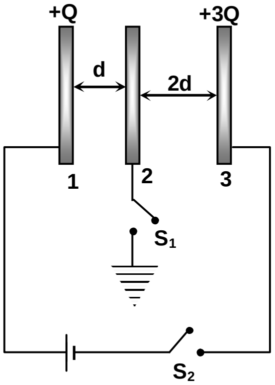
(A) It will oscillate if H = R
(B) It will have finite time period of H = 2R
(C) It will have finite time period if $H \le R\sqrt{3}$
(D) It will not oscillate if H = $R\sqrt{2}$

3. A tuning fork of frequency 1000 Hz is sounded over Resonance tube as shown in the figure. Speed of sound is v = 320 m/s and area of cross-section of tube is 200 cm^2 at the level of 100 cm a water outlet is attached. The water outlet has area of cross-section a = 1 cm^2 water outlet is opened at time t = 0. Neglect the end effect of resonance tube.



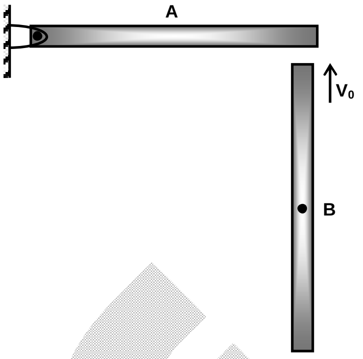
(A) First resonance will occur when water level goes down by 8 cm from open end of tube.
(B) First resonance will occur when water level is 16 cm below open end of tube
(C) The time after which resonance occurs first time is nearly half minutes.
(D) The time between first two resonances is nearly 3 minutes.

4. Three conducting sheets 1, 2 and 3 are placed parallel to each other such that separation between them is negligible. Sheet-1 and sheet-3 are given charges +Q and +3Q respectively. Cell of emf 1 V is to be connected between sheet 1 and 3. (Take $\frac{\varepsilon_0 A}{d} = 30$ mF and Q = 3 mC) where A is area of sheets. First switch S_1 is closed and then switch S_2 is closed.



(A) When switch S_1 is closed charge flow through S_1 is zero.
(B) When switch S_1 is closed charge flow through S_1 is 12 mC.
(C) When S_2 is closed charge flown through S_2 is 2 mC.
(D) When S_2 is closed charge flown through S_2 is 15 mC.

5. In figure shown rod A of mass 2m and length 2ℓ is kept on a horizontal frictional surface and hinged at point O such that it can rotate about vertical axis passing through O. Another identical rod B moving with a constant velocity v_0 collides with rod A at its end and stickes to it (both rods are perpendicular to each other)



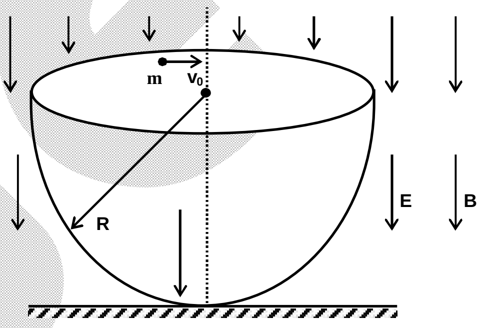
(A) angular velocity of system just after collision is $\frac{3v_0}{10\ell}$

(B) Velocity of centre of mass at system just after collision is $9v_0\sqrt{\frac{2}{5}}$

(C) Centre of mass of system is at a distance of $\sqrt{\frac{5}{2}}\ell$ from O.

(D) Kinetic energy of system just after collision is $\frac{3mv_0^2}{5}$

6. A particle of mass m, charge q is given horizontal velocity v_0 at the rim of smooth, fixed hemispherical shell. The particle moves down and always is in contact with the inner surface of shell uniform electric field E_0 and magnetic field B_0 is present in vertical direction. The correct statements are.



(A) The particle moves down and then it starts moving upwards.

(B) Conservation of energy can be applied.

(C) Angular momentum of the particle along the vertical axis passing through centre of shall is conserved

(D) Due to presence of torque. Angular momentum is not conserved

Section – A (Maximum Marks: 12)

This section contains ***FOUR (04)*** *Matching List Type Questions. Each question has FOUR statements in* ***List-I*** *entries (I), (II), (III) and (IV) and FIVE statements in* ***List-II*** *entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which* ***ONLY ONE*** *of these four options is correct answer.*

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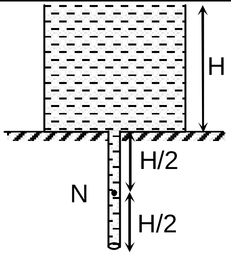
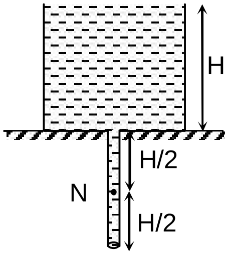
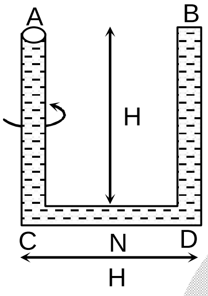
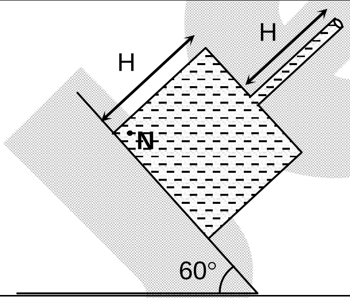
7. In List-I liquid of uniform density is filled in container and in the List-II gauge pressure at point N is given

	List –I			**List -II**
(I)	Wide container of height H and a pipe of length H is shown in the figure. The end of the pipe is closed		(P)	ρgH

(II)	Wide container of height H is connected with a pipe of small area of cross section. Liquid is allowed to flow out from pipe. Assume Bernoulli's theorem is valid		(Q)	$\frac{5}{4}\rho gH$
(III)	ABCD is U shape tube in which liquid is filled fully and end B is closed with help of cap, while end A is open. It is rotated about AC with angular speed $\omega = \sqrt{\frac{2g}{H}}$. Point N is at mid point of horizontal part of the tube.		(R)	$\frac{-\rho gH}{2}$
(IV)	A thin pipe of height H, connected with a wide vessel of height H filled with liquid is released from rest on smooth inclined plane. Point N is at the edge point of bottom of vessel.		(S)	$\frac{\rho gH}{2}$
			(T)	$\frac{3}{2}\rho gH$

Which one of the following options is correct ?

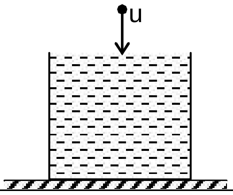
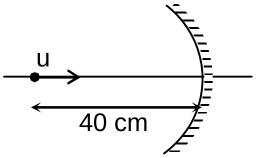
(A) I → Q, II → P, III → S, IV → T

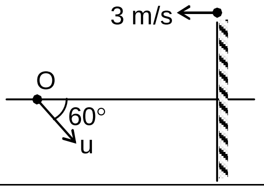
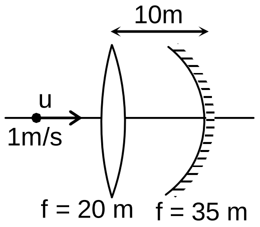
(B) I → T, II →R, III → Q, IV → P

(C) I → Q, II → P, III → S, IV → R

(D) I → T, II → Q, III → P, IV → R

8. In List-I motion of a particle is shown and in List-II relative speed between object and its image is given.

List –I				List -II
(I)	Object is moving towards water with velocity 3 m/s. Refractive index of water is 4/3		(P)	10 m/s
(II)	Object O is moving towards concave mirror focal length 10 cm with velocity u= 9 m/s		(Q)	1 m/s

(III)	Object is moving towards plane mirror with velocity u = 2 m/s and mirror is also moving with velocity 3 m/s as shown in the figure.		(R)	0
(IV)	Observer O is moving toward lens with speed 1 m/s, which is at 15 m away from it. The separation between lens (f = 20 m) and mirror (f = 35 m) is 10 m.		(S)	8 m/s
			(T)	15 m

Which one of the following options is correct ?

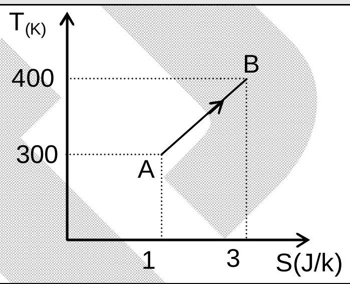
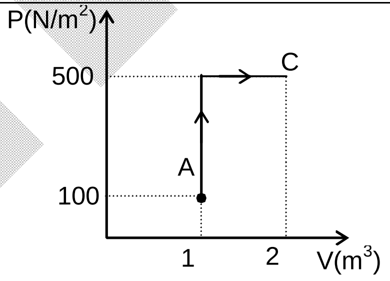
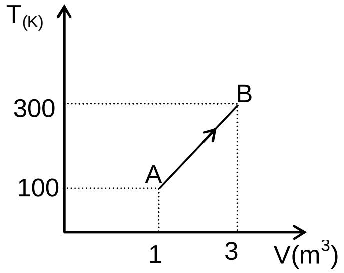
(A) I → Q, II → P, III → Q, IV → S

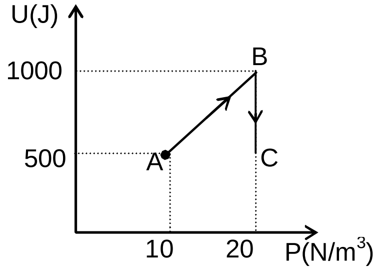
(B) I → Q, II → P, III → S, IV → R

(C) I → P, II → Q, III → S, IV → T

(D) I → P, II → S, III → T, IV → R

9. In List-I, difference thermodynamics process are given and in List-II magnitude of possible heat exchange between system and surrounding are given due the process.

List –I				List -II
(I)	2 mole monoatomic ideal gas is taken through process A → B which is shown in temperature (T) and entropy(s) diagram		(P)	1850J
(II)	2 mole ideal monoatomic gas is taken through process A→ B→ C as shown in P-V diagram		(Q)	8314J
(III)	Two mole monoatomic ideal gas is taken through the process A→B as shown in the T-V diagram		(R)	333J

(IV)	One mole monoatomic ideal gas is taken through the process ABC as shown in the figure, with the help of internal energy U and pressure P of the gas		(S)	400J
			(T)	700J

Which one of the following options is correct ?

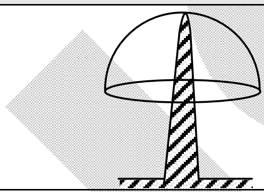
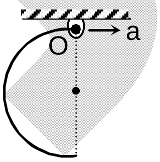
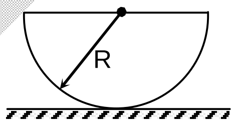
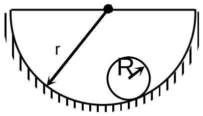
(A) I $\rightarrow$ T, II $\rightarrow$ P, III $\rightarrow$ R, IV $\rightarrow$ Q

(B) I $\rightarrow$ T, II $\rightarrow$ R, III $\rightarrow$ P, IV $\rightarrow$ Q

(C) I $\rightarrow$ T, II $\rightarrow$ P, III $\rightarrow$ Q, IV $\rightarrow$ R

(D) I $\rightarrow$ Q, II $\rightarrow$ P, III $\rightarrow$ Q, IV $\rightarrow$ S

10. In List-I a body is given which can oscillate if slightly disturbed from its equilibrium position. In List-II time period of oscillation is given.

List –I				**List -II**
(I)	A thin hemispherical shell of radius R is supported on the end of thin fixed vertical rod		(P)	$2\pi\sqrt{\frac{26R}{15g}}$
(II)	A thin semicircular ring of radius R is hanging from point O which is accelerating in horizontal direction with some acceleration so that the line joining two ends of the semicircular ring is vertical.		(Q)	$2\pi\sqrt{\frac{R}{g\sqrt{\left(1+\frac{4}{\pi^2}\right)}}}$
(III)	Solid hemisphere of radius R is placed on rough sufficiently rough horizontal surface to support rolling.		(R)	$2\pi\sqrt{\frac{2R}{g\left(1+\frac{4}{\pi^2}\right)}}$
(IV)	A solid sphere of radius R is placed in side a fixed concave surface of radius r = 6R friction is large between sphere and concave surface to support rolling.		(S)	$2\pi\sqrt{\frac{4R}{3g}}$
			(T)	$2\pi\sqrt{\frac{7R}{g}}$

Which one of the following options is correct ?

(A) I $\rightarrow$ T, II $\rightarrow$ Q, III $\rightarrow$ R, IV $\rightarrow$ P

(B) I $\rightarrow$ S, II $\rightarrow$ P, III $\rightarrow$ R, IV $\rightarrow$ Q

(C) I $\rightarrow$ S, II $\rightarrow$ R, III $\rightarrow$ T, IV $\rightarrow$ P

(D) I $\rightarrow$ S, II $\rightarrow$ R, III $\rightarrow$ P, IV $\rightarrow$ T

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

---

11. A circular metal disc has some moment of inertia about it tangent passing in its plane as shown in figure-A. Now half of the disc is folded over the other half as shown in the figure. B. Find the fractional change in moment of inertia about the same axis rotation (use value of $\pi = 3.14$)

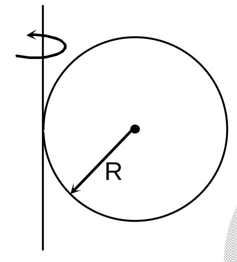


Fig-A

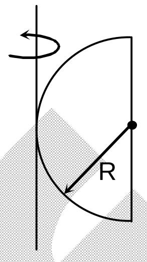
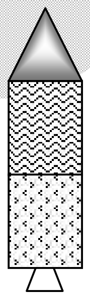
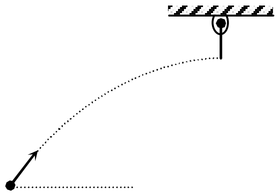


Fig-B

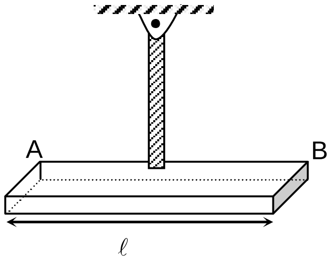
12. In year 2050 humans on earth as mastered in fusion reactor technology and due to atomic war possibility some of the people with all genetic material go on space journey for safer planet. Total mass of rocket system is 300000 kg thrust force is provided by radiation coming out of rocket system. Find the minimum rate of fuel consumption (in kg/s) so that rocket system can leave the earth. (Assume all radiation is coming out of nozzle of the rocket and it is in the form of parallel beam)



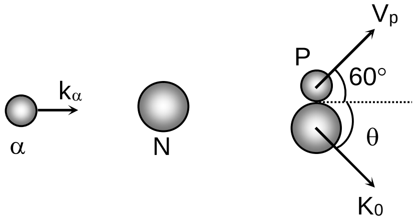
13. A thin rod of mass m = 1kg length ℓ = 20 cm is hanging from a high point. The point of suspension is capable of bearing only 10 N force. A particle of mass m′ = 1 kg is thrown from ground with velocity v_0 = 20 m/s at angle θ = 45° from horizontal. It collides with rod at its lowest point and sticks to it. The collision takes place when particle was moving horizontally. Find the number of rotation completed by rod before it falls on the ground. (Take value of $g = 10\ m/s^2$ and π = 3.14)



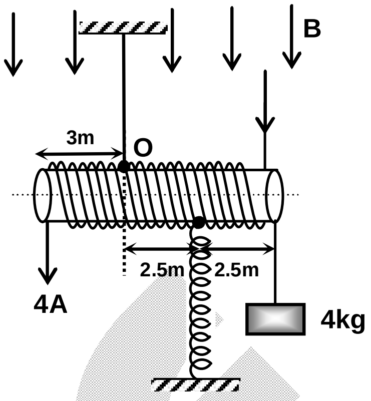
14. A bar AB of mass m = 10 kg and length ℓ = 10m is glued with a massless rod of length L = 20 m. The rod is free to rotate in vertical plane about horizontal axis passing at end O. An insect of mass m = 0.02 kg lands smoothly on the bar at end A and runs towards end B such that the rod remains vertical. Find the time taken by insect to reach at end B in seconds.



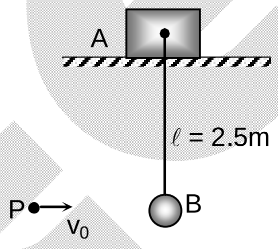
15. Consider the nuclear reaction, in which α particle collides with stationary nitrogen nucleus
$\alpha^4 + N^{14} \rightarrow O^{17} + P^1$
in which incoming α-particle has kinetic energy k_α = 4.0 MeV and outgoing proton going at angle 60° from incoming direction of α-particle has kinetic energy k_P = 2.09 MeV. The Q value of the reaction in MeV is



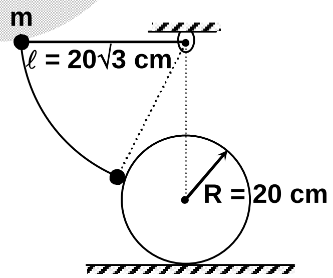
16. The figure shows a massless rod having current carrying coil of cross section area 10^{-2} m^2, current I= 4A and 20 turns. A spring of force constant k = 100 N/m is connected to rod at 2.5 m from point O. The other end of spring is connected to ground. Initially the spring is in relaxed state. At the end of rod a block of mass 4 kg is attached. When magnetic field of 5T is switched on. The spring is extended. Find extension in the spring in steady state in meter (for small angle $\sin\theta \approx \theta$).



17. A block with horizontal nail has total mass 5 kg, can move on smooth horizontal surface. A small sphere B of mass 4 kg is hanging from the nail with the help of thin, mass less string of length ℓ = 2.5 m. A small particle of mass m = 1kg moving horizontal with velocity v_0, hits the block B and get stuck with it. The minimum value of v_0 (in m/s) such that block B can complete circular motion about nail in vertical plane is $N \times 10^2 m/s$.The value of N is



18. A pendulum of mass m connected with string of length $\ell = 20\sqrt{3}$ cm. It is suspended above the centre of a sphere of radius 20 cm and mass m, at a distance 40 cm above centre of sphere. After collision pendulum stops. All surfaces are smooth. The coefficient of restitution is



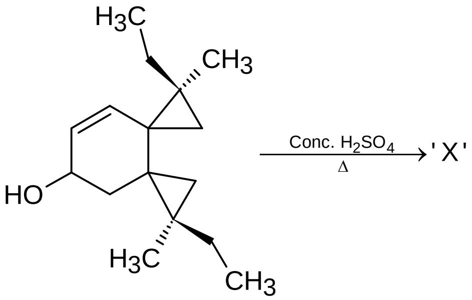
Chemistry

PART – II

Section – A (Maximum Marks: 24)

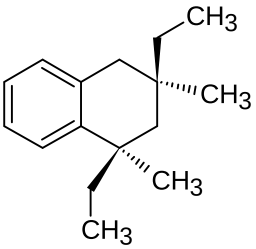
*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

19. Consider the following reaction:

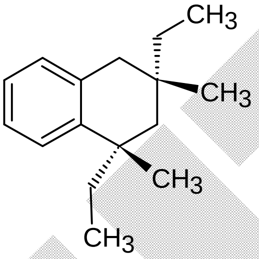

H3C
CH3
HO
H3C
CH3
Conc. H2SO4
Δ
'X'

The structure of the product can be:

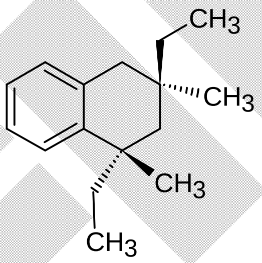
(A)


CH3
CH3
CH3
CH3

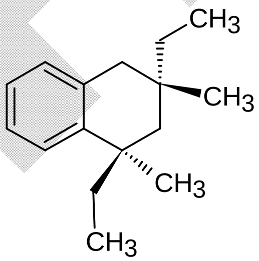
(B)


CH3
CH3
CH3
CH3

(C)


CH3
CH3
CH3
CH3

(D)


CH3
CH3
CH3
CH3

20. Which of the following reaction(s) can take place?

(A) $CH_3Br + 2Li \xrightarrow{Et_2O} LiCH_3 + LiBr$

(B) $MgCl_2 + LiC_2H_5 \xrightarrow{Et_2O} C_2H_5MgCl + LiCl$

(C) $C_2H_5Li + C_6H_6 \xrightarrow{Et_2O} C_6H_5Li + C_2H_6$

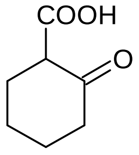
(D) $Li_3N + 2H_2 \xrightarrow{Et_2O} LiNH_2 + 2LiH$

21. What happens when beryllium oxide is added to baryta water solution?

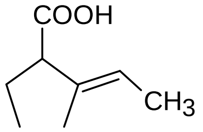
(A) BeO is insoluble in baryta water.
(B) BeO dissolves in baryta water.
(C) Basic character of the solution increases as the concentration of basic substance increases.
(D) pH of the solution decreases.

22. Which of the following compound(s) lose(s) CO_2 just on heating?

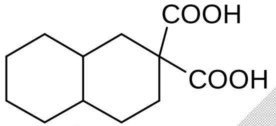
(A)



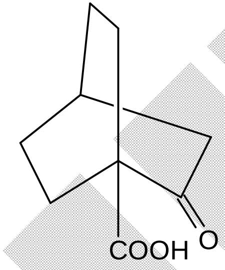
(B)



(C)



(D)

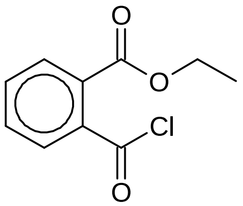


23. Which of the following statement(s) is/are correct?

(A) Eight Cs^+ ions occupy the second nearest neighbour locations of a Cs^+ ion in CsCl crystal.
(B) Each sphere is surrounded by six voids in two dimensional hexagonal close packed layers.
(C) If the radius of cation and the anion are $0.3\ \overset{o}{A}$ and $0.4\ \overset{o}{A}$ respectively, then coordination number of the cation of crystal is 6.
(D) In AgCl, the silver ion is displaced from its lattice positions to an interstitial positions, such a defect is called Frankel defect.

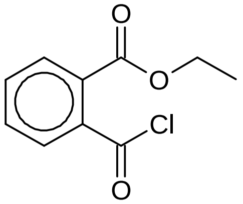
24. Which of the following is/are correct matched structure and IUPAC name?

(A)



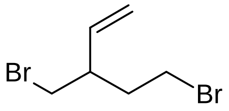
: 2-Carboxyethyl benzoyl chloride

(B)



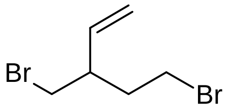
: Ethyl-2-(chloro-carbonyl) benzoate

(C)



: 5-Bromo-3-(bromomethyl) pent-1-ene

(D)



: 1, 4-dibromo-3-ethyl butane

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (I), (II), (III) and (IV) and FIVE statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

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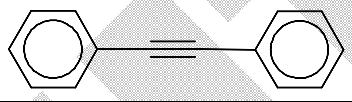
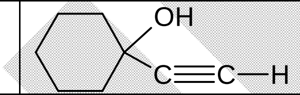
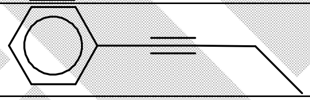
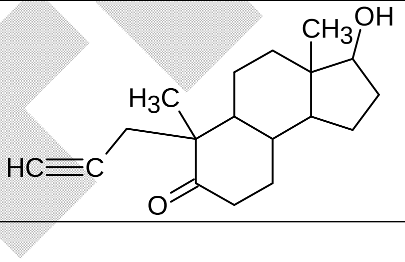
25. Match the compounds in List-I with their characteristics in List-II and choose the answer from the codes given below:

List – I		List – II	
(I)		(P)	Reacts with Lindlar's catalyst $(H_2 / Pd - BaSO_4)$.
(II)		(Q)	Trans alkene will form, when reacts with $Na / liq.\ NH_3$.
(III)		(R)	Produces hydrogen gas by means of sodium suspended in n-hexane.
(IV)		(S)	Degree of unsaturation is greater than two.
		(T)	Gives a white precipitate on reaction with $\left[Ag(NH_3)_2\right]NO_3$.

(A) I→P, Q, S; II→P, Q, S, T; III→P,S, T; IV→Q, R, S, T
(B) I→P, Q, S; II→P, R, S, T; III→P, Q, S; IV→P,R, S, T
(C) I→P, Q, S, T; II→Q,R, S, T; III→P, Q, S; IV→Q, S, T
(D) I→P,Q, S; II→P, R, S, T; III→Q, R, S; IV→P, R, S, T

26. Match the compounds given in List-I with their corresponding characteristics in List-II and choose the correct option from the codes given below:

	List – I		List – II
(I)	$AlCl_3$	(P)	Lewis acid
(II)	BCl_3	(Q)	Forms acidic solution in water
(III)	B_2H_6	(R)	Sublimes on heating
(IV)	Alum	(S)	Swells on heating
		(T)	Empty orbital is involved in hybridisation

(A) I→P, Q; II→P, Q; III→P, Q, T; IV→Q, S
(B) I→P, Q, R; II→P, Q, T; III→P, Q, T; IV→Q, S, T
(C) I→Q,R, T; II→P, Q, T; III→P, Q; IV→Q, S
(D) I→P, Q, R; II→P, Q; III→P, Q, T; IV→Q, S

27. Consider the following galvanic cell at 25^{o}C.

$$Pt(s)/\underset{(1\,bar)}{H_2(g)}\,|\left(\underset{(100\text{ mL, }0.2\text{ M})}{H_3PO_4} + \underset{(100\text{ mL, }0.1\text{ M})}{Na_3PO_4}\right)\Bigg\|\left(\underset{(100\text{ mL, }0.1\text{ M})}{CH_3COOH}\,|\,\underset{(1\,bar)}{H_2(g)}/Pt(s)\right)$$

For $H_3PO_4 : K_{a_1} = 10^{-4},\ K_{a_2} = 10^{-8},\ K_{a_3} = 10^{-12}$ at 25^oC

For $CH_3COOH : K_a = 1\times10^{-5}$ at 25^oC

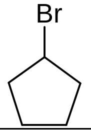
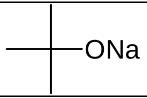
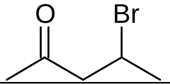
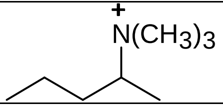
Now, some electrolyte is added in one of the compartment of the given cell in List-I and corresponding cell potential is given in List – II. Choose the correct option(s) from the codes given below:

[Take $\dfrac{2.303\ RT}{F} = 0.06\ V, \log 2 = 0.3$]

	List – I		List – II
(I)	If no electrolyte is added in either of the compartment of cell, then	(P)	$E_{cell} = 0.06\ V$
(II)	If 100 mL, 0.1 M NaOH solution is added in the anode compartment of the original cell, then	(Q)	$E_{cell} = 0.282\ V$
(III)	If 50 mL, 0.1 M NaOH solution is added in the cathode compartment of original cell, then	(R)	$E_{cell} = 0.18\ V$
(IV)	If 100 mL, 0.1 M HCl solution is added in the anode compartment of original cell, then	(S)	$E_{cell} = 0.078\ V$
		(T)	E_{cell} decreases after addition with respect to its initial value.

(A) I→R; II→Q; III→P, T; IV→S
(B) I→Q; II→R, T; III→P; IV→S, T
(C) I→R; II→Q; III→P, T; IV→S, T
(D) I→P; II→Q, T; III→R, T; IV→S

28. Match the reactions given List-I with their corresponding characteristics in List-II and select the correct option from the codes given below:

List – I		List – II	
(I)	 $+ C_2H_5ONa \xrightarrow{\Delta}$	(P)	Major product is formed via E1cb mechanism
(II)	 $+ CH_3I \xrightarrow{\Delta}$	(Q)	Major product is formed via E_2 or E_2' mechanism
(III)	 $+ KOH(alc.) \xrightarrow{\Delta}$	(R)	Reaction proceeds with the formation of transition state
(IV)	 $+ KOH(alc.) \xrightarrow{\Delta}$	(S)	Carbanion is formed as intermediate
		(T)	Major product is formed via S_N2 mechanism

(A) I→Q, R; II→R, T; III→P, S; IV→Q, S
(B) I→Q, R; II→R, T; III→P, S; IV→P,S
(C) I→R, T; II→Q, T; III→P, T; IV→P, S
(D) I→Q, R; II→R, T; III→P, S; IV→Q, R

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

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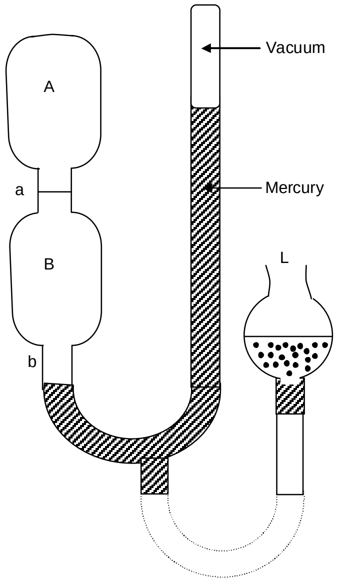
29. Consider the following statements:
(i) There are a maximum of 5 plane of symmetry in a molecule of SF_6.
(ii) Paracetamol gives positive $FeCl_3$ test.
(iii) Asprin is used as an antipyretic as well as analgesic.
(iv) About 60% of the solar energy reaching the earth is absorbed by earth surface, which increases its temperature.
(v) Methane is one of the gas responsible for global warming.
(vi) SO_2 and NO_2 are major contributors of acid rain.
(vii) Clean water would have biochemical oxygen demand (BOD) value less than 5 ppm.
(viii) Water sample having nitrate content of 40 ppm is good for drinking purpose.
(ix) Azurite is a mineral of copper metal.

Of the above statements, the ratio of number of correct statements to the number of incorrect statements is:

30. Helium is contained at $30.2^{o}C$ in the system as shown in the figure.



Figure

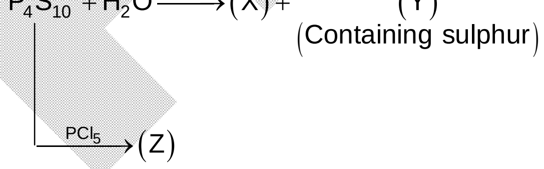
The leveling bulb (L) can be raised so as to fill the lower bulb with mercury and force the gas into the upper part of the device. The volume of bulb ‘A’ to the mark ‘a’ is 100.5 cm^3 and volume of bulb ‘B’ between the marks ‘a’ and ‘b’ is 110 cm^3. The pressure exerted by helium is measured by the difference between the mercury levels in the device and in evacuated arm of the manometer. When mercury level is at ‘b’, the pressure is 20.14 mm Hg. If the mass of helium in the container be $x \times 10^{-4}$ g (scientific notation) $\left(R = 0.082 \text{ L atm mol}^{-1} \text{ K}^{-1}\right)$, then the value of ‘x’ is……

31. Two moles of an ideal gas at 1 bar and 298 K are compressed at constant temperature by use of constant pressure of 5 bar. If the compression is driven by a 100 kg mass, how far (in ‘metres’) will it fall in the earth’s gravitational field? $\left(g = 10 \text{ m / s}^2\right)$.

32. The iodine content of a solution was determined by titration with cerium (IV) sulphate in the presence of HCl, in which I^- is converted to ICl. A 200 mL sample of the solution required 15 mL of 0.05 N Ce^{4+} solution, calculate the iodine concentration in original solution in g/L?

33. Ratio of the total number of isomers of Benzene hexachloride to that of $K\left[Co\left(NH_3\right)_2\left(F\right)_2\left(Cl\right)_2\right]$ is:

34. Consider the following reactions



$$P_4S_{10} + H_2O \longrightarrow (X) + \underset{\text{(Containing sulphur)}}{(Y)}$$

$$P_4S_{10} \xrightarrow{PCl_5} (Z)$$

Let, the sum of all atoms in one molecule each of ‘X’ and ‘Y’ be x, and total number of atoms in a molecule (Z) = y, then calculate the value of $\frac{x}{y}$

35. Let, the maximum number of electrons present in palladium atom (Z = 46) satisfying the condition $\ell + m_\ell > 0$ be 'x' and the total number of plane of symmetry in $\sigma^*_{2p_z}$ orbital be 'y', then the value of $\frac{x}{y}$ will be……

36. Ratio of the total number of triangular faces to that of octagonal faces in a truncated solid cube is

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Mathematics PART – III

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

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37. Which of the following is/are CORRECT statement(s)?

(A) The number of ways of arranging 5 boys and 5 girls in a queue if infront of each girl number of girls are more than or equal to the number of boys is k, then $\frac{k}{(5!)^2}$ is 42

(B) Let $z_1, z_2, \ldots\ldots z_n$ be complex number such that $|z_1| = |z_2| = \ldots\ldots = |z_n|$ and $\text{Re}\left(\sum_{j=1}^{n}\sum_{k=1}^{n}\frac{z_j}{z_k}\right) = 0$ if and only if $\sum_{k=1}^{n} z_k = 0$

(C) The number of ways of arranging 5 boys and 5 girls in a queue if infront of each girl number of girls are more than or equal to the number of boys is k, then $\frac{k}{(5!)^2}$ is 45

(D) Let a, b, c, x, y, z > 0 and ax + by + cz < d, then maximum value of xyz (d – ax – by – cz) is $\frac{d^4}{4^4 abc}$

38. Let $S_n = \sum_{r=1}^{n} t_r$ where $t_1 = 1$ and $t_r \geq 0$, $n \in N$. If $S_n = \frac{1}{2}\left(t_n + \frac{1}{t_n}\right)$, then

(Where [.] represents greatest integer function)

(A) $S_{100} = 10$

(B) $\lim_{n\to\infty}(S_n t_n) = \frac{1}{2}$

(C) $\left[\sum_{n=1}^{100}\frac{1}{S_n}\right] = 18$

(D) $\lim_{n\to\infty}(S_n t_n) = 1$

39. $\sum_{r=0}^{10}\frac{{}^{10}C_r}{{}^{30}C_{10+r}}$ is equal to

(A) $\frac{1}{{}^{30}C_{20}\cdot{}^{20}C_{10}}\sum_{r=0}^{10}{}^{10+r}C_r\cdot{}^{20+r}C_{10}$

(B) $\frac{1}{{}^{30}C_{20}\cdot{}^{20}C_{10}}\sum_{r=0}^{10}{}^{10+r}C_r\cdot{}^{20-r}C_{10}$

(C) $\frac{{}^{31}C_{10}}{{}^{30}C_{20}\cdot{}^{20}C_{10}}$

(D) $\frac{{}^{40}C_{10}}{{}^{30}C_{20}\cdot{}^{20}C_{10}}$

40. Let $f(x) = \lim_{m\to\infty}\frac{\ln(3+x^2) - x^{2m}\sin(x^2)}{1+x^{2m}}$, then which of the following is/are CORRECT?

(A) f(x) is discontinuous at two points

(B) There exists α such that $f(\alpha) = 1$

(C) The equation f(x) = 0 has atleast one root in $(1, \infty)$

(D) Minimum value of f(x) is equal to (–sin 1)

41. Let F(x) be a six degree polynomial with leading coefficient k. If y = F(x) touches, f(x) = x + α at x = 1, 2, and 3, then which of the following is/are CORRECT?

(A) If $\int_1^3 (F(x) - f(x))dx = \frac{32}{105}$, then k = 2 (B) F(x) – f(x) is divisible by $(x-1)^2(x-2)^2$

(C) If $\int_1^3 (F(x) - f(x))dx = \frac{32}{105}$, then k = 1 (D) F(x) – f(x) is divisible by $(x-2)(x-3)^2$

42. Consider the 3 planes $\vec{r}\cdot\vec{n}_1 = a$, $\vec{r}\cdot\vec{n}_2 = b$ and $\vec{r}\cdot\vec{n}_3 = c$ where abc $\neq$ 0, then which of the following is/are CORRECT?

(A) If the above 3 planes have common line of intersection, then $a(\vec{n}_2\times\vec{n}_3)+b(\vec{n}_3\times\vec{n}_1)+c(\vec{n}_1\times\vec{n}_2)=0$

(B) If the above 3 planes have a common line of intersection, then $a(\vec{n}_2\times\vec{n}_3)+b(\vec{n}_3\times\vec{n}_1)+c(\vec{n}_1\times\vec{n}_2)\neq 0$

(C) If $[\vec{n}_1\ \vec{n}_2\ \vec{n}_3]\neq 0$, then the above 3 planes will intersect at a point

(D) If $\vec{n}_1, \vec{n}_2, \vec{n}_3$ are non coplanar vectors, then the above 3 planes will intersect at point with position vector = $\frac{1}{[\vec{n}_2\ \vec{n}_2\ \vec{n}_3]}\left\{c(\vec{n}_1\times\vec{n}_2)+a(\vec{n}_2\times\vec{n}_3)+b(\vec{n}_3\times\vec{n}_1)\right\}$

Section – A (Maximum Marks: 12)

This section contains ***FOUR (04)*** *Matching List Type Questions. Each question has FOUR statements in* ***List-I*** *entries (I), (II), (III) and (IV) and FIVE statements in* ***List-II*** *entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which* ***ONLY ONE*** *of these four options is correct answer.*

43. Let $f(x) = \begin{cases} \sqrt{1-x^2} & ; \quad -1 \le x \le 0 \\ 1+x^2 & ; \quad 0 < x \le 1 \\ 1+x^3 & ; \quad x > 1 \end{cases}$ and g(x) is a function such that g(f(x)) = x, $\forall$ x $\geq$ –1 and f(g(x)) = x, $\forall$ x $\geq$ 0, then match the following List-I with List-II

List-I		List-II	
(I)	The range of y = g(x) is	(P)	[–2, ∞)
(II)	The domain of y = g(x) is	(Q)	[–1, ∞)
(III)	The range of y = f(f(f(g(x)))) is	(R)	[0, ∞)
(IV)	The domain of y = g(g(g(f(x)))) is	(S)	[1, ∞)
		(T)	[2, ∞)

The correct option is:
(A) (I) → (Q); (II) → (R); (III) → (T); (IV) → (S)
(B) (I) → (R); (II) → (Q); (III) → (T); (IV) → (S)
(C) (I) → (Q); (II) → (R); (III) → (S); (IV) → (T)
(D) (I) → (Q); (II) → (T); (III) → (R); (IV) → (S)

44. Match the following List-I with List-II

List-I		**List-II**	
(I)	The distance between the point A(–1, –5, –10) and point of intersection of $\frac{x-2}{3}=\frac{y+1}{4}=\frac{z-2}{12}$ with the plane $x + 5y + z + 1 = 0$ is	(P)	$\frac{1}{3}$
(II)	The distance of the point P(–2, 3, –4) from the line $\frac{x+2}{3}=\frac{2y+3}{4}=\frac{3z+4}{5}$ measured parallel to the plane $4x + 12y – 3z + 1 = 0$ is	(Q)	2
(III)	In ΔABC let P and Q be points on AB and BC respectively, such that $\frac{AP}{BP}=\frac{1}{3}$ and $\frac{CQ}{BQ}=\frac{3}{1}$. Let R be the point of intersection of AQ and CP, then area of ΔABC is (given area of ΔBRC is 1 square unit)	(R)	$\frac{13}{9}$
(IV)	If $f(x)=\int_{x}^{x+\frac{\pi}{3}}\lvert\sin t\rvert\,dt$, $0 \le x \le \pi$ has local maximum at x = k, then $\frac{k}{\pi}$ is	(S)	13
		(T)	$\frac{17}{2}$

The correct option is:
(A) (I) → (S); (II) → (T); (III) → (P); (IV) → (R)
(B) (I) → (S); (II) → (R); (III) → (T); (IV) → (P)
(C) (I) → (S); (II) → (P); (III) → (R); (IV) → (T)
(D) (I) → (S); (II) → (T); (III) → (R); (IV) → (P)

45. Let a double differentiable function g(x), satisfies the relation $g(x)\,g''(x) = (g'(x))^2 + g(x)\,g'(x)$, $g(0) = g'(0) = 1$, then match the following List-I with List-II

List-I		**List-II**	
(I)	The number of solution of the equation $g(x) = e^x$ is	(P)	1
(II)	$\lim\limits_{x\to-\infty}(3e)g(x)$ is	(Q)	5
(III)	$\lim\limits_{x\to 0}\frac{4(g(x)-1)}{x}$ is	(R)	4
(IV)	The number of real roots of the equation g(x) = x	(S)	3
		(T)	0

The correct option is:
(A) (I) → (P); (II) → (T); (III) → (R); (IV) → (S)
(B) (I) → (P); (II) → (S); (III) → (R); (IV) → (T)
(C) (I) → (P); (II) → (S); (III) → (T); (IV) → (R)
(D) (I) → (P); (II) → (R); (III) → (S); (IV) → (T)

46. Match the following List-I with List-II

List-I		List-II	
(I)	Let $2g(x)=\int_0^x (x-t)^2 f(t)dt$ and $\int_0^1 f(t)dt=3$, then g″(1) is	(P)	8
(II)	Let g(x) = e^x + x + 1, then $\int_2^{e+2} g^{-1}(x)dx$ is	(Q)	$\frac{1}{2}$
(III)	Let g: R → R be a differentiable function such that $g\left(\frac{x+y}{2}\right)=\frac{g(x)+g(y)}{2}$ ∀ x, y ∈ R. If g(0) = 1, g′(0) = 1, then area bounded by y = g(x) and co-ordinate axes is	(R)	4
(IV)	If the area bounded by |x| ≤ 2, |y| ≤ 2, 2xy ≤ x + y ≤ $x^2 + y^2$ is A, then $A+\frac{\pi}{2}-\frac{1}{2}\ln 15$ is	(S)	3
		(T)	$\frac{3}{2}$

The correct option is:
(A) (I) → (S); (II) → (Q); (III) → (P); (IV) → (T)
(B) (I) → (S); (II) → (T); (III) → (P); (IV) → (Q)
(C) (I) → (S); (II) → (T); (III) → (Q); (IV) → (P)
(D) (I) → (S); (II) → (T); (III) → (Q); (IV) → (R)

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

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47. The number of polynomials P(x) with integral coefficient such that P(a) = b, P(b) = c and P(c) = a is (Where a, b and c are distinct integers)

48. Let a tangent to the parabola with focus S(1, 2), is x + y = 1 at A. If tangent intersects directrix and tangent at vertex at B and C respectively, then the value of AC·BC is equal to

49. Let AB and CD be the direct common tangents to $x^2 + y^2 = 4$ and $(x – 3)^2 + (y – 4)^2 = 9$. Let both the circles intersect at the point P. Let the Circumradius of the ΔCPD be r, then [r] is
(Where [.] represents greatest integer function)

50. The variable chords of the ellipse $\frac{x^2}{4}+y^2=1$ which subtends right angle at $\left(\sqrt{2},\frac{1}{\sqrt{2}}\right)$ pass through a fixed point P, the length of the tangent drawn from P to $x^2+y^2=\frac{1}{4}$ is $\sqrt{\frac{p}{q}}$, then p + q is equal to
(Where HCF of (p, q) is 1)

51. The value of $1+\sum_{k=1}^{8}\frac{\cos k\theta}{\cos^k\theta}$ for θ = 30° is p, then $\frac{\sin 9\theta}{p\sin\frac{\pi}{6}\left(\cos\frac{\pi}{6}\right)^8}$ is equal to

52. Let P and Q be invertible matrices of order 3 × 3 with real entries such that $P^{-1}+Q^{-1}=(P+Q)^{-1}$. If |P| = 5, then |Q| is equal to

53. Two persons A and B fire at the target. A fires 9 times and B fires 10 times. If probability of their success is $\frac{1}{2}$, then the probability that number of successful hit of B is more than that of A is

54. Let $N=\prod_{r=1}^{45}\sin\left((2r-1)^{\circ}\right)$, then $\sqrt{2}\,2^{45}N$ is equal to

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ALL INDIA TEST SERIES

JEE (Advanced)-2023

OPEN TEST – I

PAPER –2

TEST DATE: 05-02-2023

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B**.

Section – A ***(01 – 04, 19 – 22, 37 – 40)*****:** This section contains **TWELVE (12)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.

Section – A ***(05 –10, 23 – 28, 41 – 46)*****:** This section contains **EIGHTEEN (18)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – B ***(11 – 18, 29 – 36, 47 – 54)*****:** This section contains **TWENTY FOUR (24)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.**

MARKING SCHEME

Section – A (Single Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+3	If ONLY the correct option is chosen.
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–1	In all other cases.

Section – A (One or More than One Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4	If only (all) the correct option(s) is (are) chosen;
Partial Marks	:	+3	If all the four options are correct but ONLY three options are chosen;
Partial marks	:	+2	if three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks	:	+1	If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–2	In all other cases.

Section – B: Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+3	If ONLY the correct integer is entered;
Zero Marks	:	0	Question is unanswered;
Negative Marks	:	–1	In all other cases.

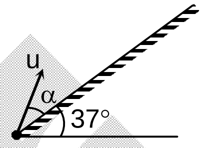
Physics

PART – I

Section – A (Maximum Marks: 12)

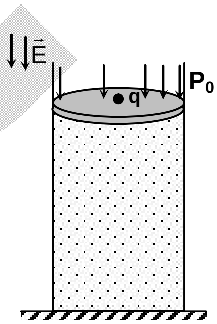
*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

1. A particle is projected from the foot of smooth, fixed inclined plane, which is at an angle of 37° from horizontal. After its elastic collision with the plane it moves in vertical direction. Its initial velocity is $u = \sqrt{388}$ m/s. (g = 10 m/s^2)



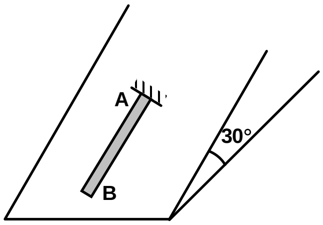
(A) The time after which particle returns to its initial position is 6s
(B) The time after which particle returns to its initial position is 4s
(C) The angle of initial velocity with incline plane is $\tan^{-1}\left(\frac{3}{4}\right)$
(D) The angle of initial velocity with incline plane is $\tan^{-1}\left(\frac{5}{9}\right)$

2. Below shown is heat insulating piston cylinder arrangement having ideal gas of adiabatic exponent γ enclosed. A point charge q having negligible mass is attached to centre of freely movable piston of mass M. The system is kept in uniform electric field $\vec{E}$ as shown. Atmospheric pressure is P_0 and when the piston is in equilibrium volume is V_0. On disturbing the piston from equilibrium position (Assume system to have cross-sectional area as A)



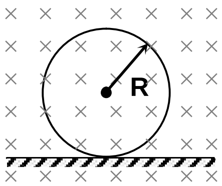
(A) The system executes S.H.M. with time period T= $2\pi\sqrt{\dfrac{M V_0}{\left(\dfrac{qE+Mg}{A}+P_0\right)\gamma A^2}}$
(B) The system does not executes S.H.M.
(C) The system will not execute S.H.M. if magnitude of charge is increased.
(D) The system executes S.H.M. with time period T= $2\pi\sqrt{\dfrac{M V_0}{P_0\gamma A^2}}$

3. In the shown figure, A thin rod AB of length ℓ is placed on smooth inclined plane having angle 30° with horizontal. It is hinged at end A such that it is free to move parallel to the plane. Its linear mass density increases linearly as $\frac{dm}{dx} \propto x$, where x is distance from end A. It is slightly displaced from its equilibrium position then it oscillates about an axis passing through A and perpendicular to inclined plane. The time period of oscillations is



(A) $2\pi\sqrt{\dfrac{3\ell}{2g}}$
(B) $2\pi\sqrt{\dfrac{3\ell}{4g}}$
(C) $2\pi\sqrt{\dfrac{2\ell}{3g}}$
(D) $2\pi\sqrt{\dfrac{\ell}{2g}}$

4. A uniform non-conducting sphere of mass m, radius R is placed on rough horizontal surface. Uniform horizontal magnetic field is present in circular region co-centric with centre of the sphere. Sphere is uniformly charged with total charge Q on its surface. Magnetic field is suddenly switched off. The sphere starts moving on the surface and finally it starts pure rolling with velocity.



(A) $\frac{QBR}{m}$ (B) $\frac{QBR}{6m}$

(C) $\frac{5QBR}{21m}$ (D) $\frac{QBR}{2m}$

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

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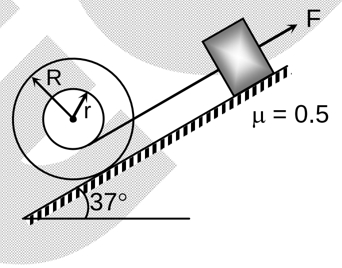
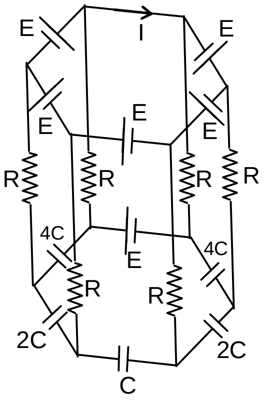
5. In the shown figure a spool of mass 10 kg of outer and inner radius R=2m and r=1m respectively , moment of inertia about its axis 10 kg-m^2 is placed on rough inclined surface where coefficient of friction is $\mu = 0.5$. A block of mass 4 kg is attached with a string which is wrapped on the spool. Force F = 106 N is applied up the inclined plane as shown in the figure. The correct statements are (no slipping between spool and string) [take g = 10 m/s^2]

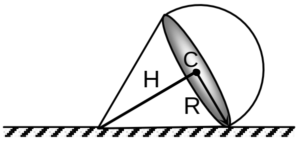


(A) Acceleration spool is 2 m/s^2 down the plane
(B) Acceleration spool is 2 m/s^2 up the plane
(C) Acceleration of the block is 1 m/s^2 up the plane
(D) Acceleration of the block is 1 m/s^2 down the plane

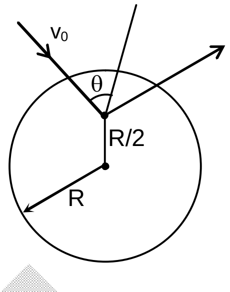
6. Hexagonal prism wire frame is made in which 6 sources of equal emf $\varepsilon = 5V$ with equal internal resistance $r = 1\Omega$. Six equal resistance each equal to $R = 2\Omega$ and four capacitors of capacitance as shown in the figure. Value of capacitance $C = 2\mu F$ then the correct statement(s) is/are
(A) Value of current I = 6A
(B) Value of current I = 5A
(C) Value of charge on capacitor 4C = 16μc
(D) The value of charge on capacitor C = 0



7. A right circular cone of height $H = R\sqrt{3}$ is glued with hemisphere of radius R. Both are made from same material of uniform density. The object made is rolled on rough horizontal surface such that speed of centre of hemisphere is v_0. The correct statements are

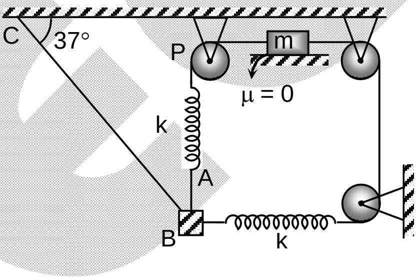


(A) The ratio of time period of top about cones axis to the vertical axis is 2 : 3
(B) The ratio of time period of top about cones axis to the vertical axis is 1 : 2
(C) The frictional force acting on this top is $\frac{5}{2}\frac{mv_0^2}{R}$ where m is mass of the top.
(D) The frictional force acting on this top is $\frac{2}{3}\frac{mv_0^2}{R}$, where m is mass of the top.



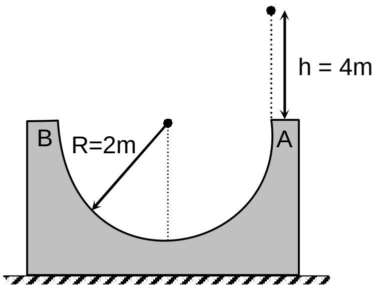
8. A disc of radius R = 20 cm and mass m is lying (in X-Y plane) on smooth horizontal surface. A particle of mass m moving with velocity $\vec{v}_0 = (5\hat{i} - 10\hat{j})$ m/s collides with the disc at a distance $\frac{R}{2}$ from centre of the disc. The coefficient of restitution e = 1 and coefficient of friction between particle and disc is $\mu = 0.2$. Assume slipping during collision and the vertical plane in which particle is moving is at distance R/2 from centre of disc. The correct statements are ($g = 10\ m/s^2$)

(A) Angular velocity of disc after collision is 20 rad/s
(B) Linear velocity of the centre of disc is 4 m/s
(C) The ratio of time of flight of particle after collision and time period of disc is $\frac{20}{\pi}$
(D) The ratio of time of flight of particle after collision to time period of disc is $\frac{\pi}{20}$



9. In the shown figure a block of mass $m = \frac{1}{2}$kg is suspended in equilibrium with the help of ideal string and two ideal spring of force constant k = 100 N/m. Now string AP is cut. Pullies are massless, frictionless, AP is vertical and other spring is horizontal. Just after cutting the string ($g = 10\ m/s^2$)

(A) Tension in string BC is 3N
(B) Tension in string BC is $\frac{37}{7}$N
(C) Acceleration of the suspended block is $\frac{32}{7}\ m/s^2$.
(D) Acceleration of the suspended block is $8\ m/s^2$.

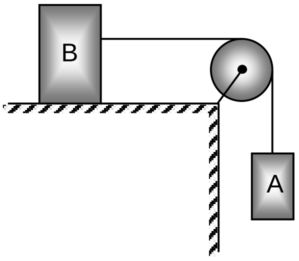


10. In the shown figure a block of mass 10 kg is placed on smooth horizontal surface. It has smooth hemispherical surface of radius R = 2m. A particle of mass 5 kg is released from rest from height of 4m above point A, such that it smoothly lands on spherical surface at point A. Neglect air drag .The correct option(s) are ($g = 10\ m/s^2$)

(A) Particle will move up from end B upto height 4m
(B) Particle will move up from end B upto height less then 4m
(C) maximum vertical acceleration of the particle is $90\ m/s^2$
(D) maximum vertical acceleration of particle is $40\ m/s^2$

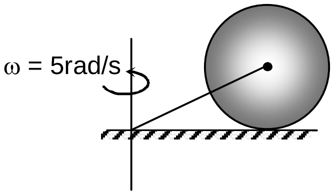
Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.***

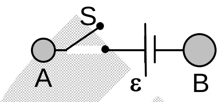


11. A block B of mass $M_B = \frac{\pi}{e}$kg placed on rough horizontal surface is connected with block A with the help of string (ideal). The string passes over fixed horizontal cylinder. The coefficient of friction between block B and ground as well as between string and cylinder is $\mu = \frac{7}{11}$. Find the minimum mass of block A in kg so that block B starts sliding. (Take value of $\pi = \frac{22}{7}$ and e = 2.72)

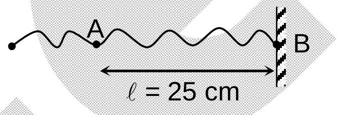
12. A sphere of mass 1.8 kg and radius 40 cm is radially pierced by a massless stick up to its centre. Length of stick is 2m. The free end of stick is pivoted on smooth ground and sphere is given velocity so that it slides on the ground such that its centre moves in a circle around pivot with angular velocity ω = 5 rad/s. The normal force acting on sphere due to ground in newton is 9P. Find the value of P. (g = 10 m/s^2)



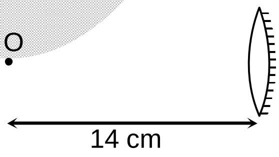
13. Two spherical conductors A and B of radius 9m and 18m respectively are placed at large distance. They are connected to each other through a cell of emf ε = 300 volt as shown in the figure. Initially they are chargeless. The loss of electric energy when switch is ON is 10P μJ. The value of P is



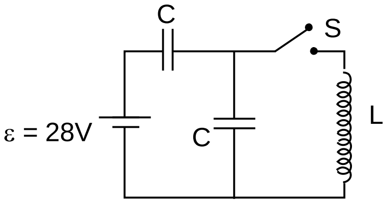
14. A wave $y = 10\sin\left(200\pi t - \frac{4\pi}{100}x\right)$ (where x and y are in cm and t is in second) is travelling in string in which tension is 100 N. The wave is reflected from a fixed support and stationary wave is produced . Assuming no loss of energy due to reflection and air drag, the energy in 25 cm length of string is $k\pi^2$ Joules. Find the value of k.



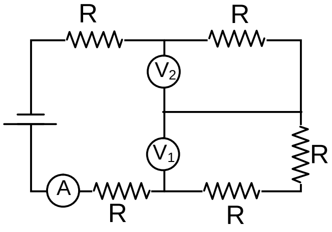
15. Object O is placed at a distance of 14 cm from an equi-convex lens of refractive index $\mu = \frac{3}{2}$ and radius of curvature of lens surface is 32 cm. One of its surface is silvered another convex lens of focal length 24 cm is placed between object and silvered lens such that the final image coincides with the object. The distance between object and the lens in cm is …………..



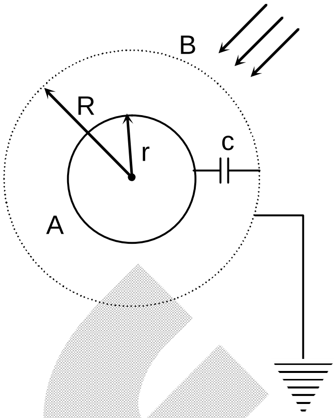
16. In the shown figure two uncharged capacitors each of equal capacitance C = 2mF are connect to cell of emf 28V. The circuit was in this state from long time. Now switch S is closed with inductor with inductance L = 16mH. The maximum current in inductor in ampere will be



17. In the figure two identical voltmeter having their reading V_1 = 15 V and V_2 = 10V. The reading of ideal ammeter is I = 3A. All the five resistance have equal resistance R. The value of R is Ω is



18. A conducting solid sphere of radius r = 2 cm is surrounding by a conducting shell which is made up of fine wire mesh with radius R = 4 cm are shown in the figure. The shell and sphere are joined by a capacitor of capacitance C = 2μF. Work function of the material of shell A and B is 1eV and 4eV respectively. Light falls on this system have frequency $\nu = 7.27 \times 10^{14}$ Hz. The energy stored in the capacitor C in steady condition (in μJ) is



FIITJEE

Chemistry

PART – II

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

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19. In a $AB_xL_y\left(sp^3d \text{ hybridisation of } 'A'\right)$ have linear shape. What will be the shape of molecule if 'A' forms AB_yL_x type molecule?

(B = Bond pair of electron, L = Lone pair of electrons and A = Central atom).

(A) T-shape
(B) See – saw
(C) Trigonal bipyramidal
(D) Linear

20. If only gases remain after 12 g carbon is treated with 49.26 litre of air at 300 K and 2 atm pressure (Assume 20% by volume of O_2, 79% by volume of N_2 and 1% by volume of CO_2 is present in air). Total amount of heat released in this reaction is……

$\left(\Delta H_f \text{ for CO and } CO_2 \text{ are } -26 \text{ kcal mol}^{-1} \text{ and } -94 \text{ kcal mol}^{-1}\right)$

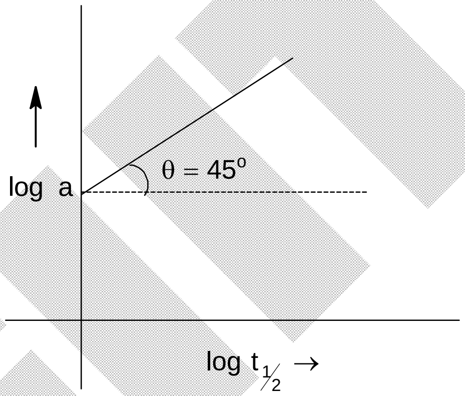
(No reactants are left unreacted after the reaction)

(A) –96.8 kcal
(B) –66.8 kcal
(C) –23.4 kcal
(D) –33.4 kcal

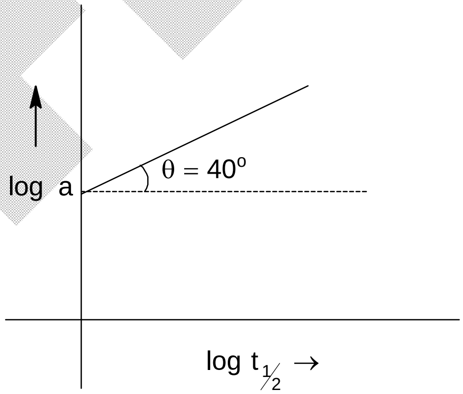
21. Which of the following is correct graph for the reaction given below (where 'a' represents initial conc. of reactant and $t_{1/2}$ represents its half-life time) [Assume the rate constant of the reaction to be greater than unity]

$N_2O(g) \xrightarrow[\Delta]{Pt} N_2(g) + \frac{1}{2}O_2(g)$

(A)



(B)



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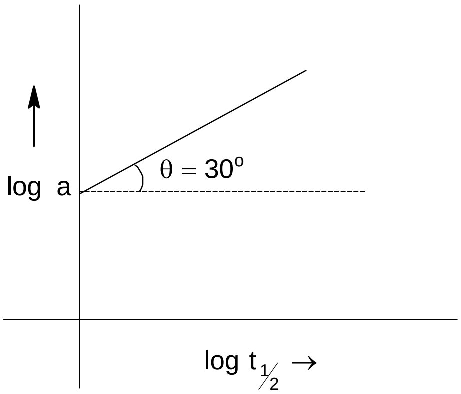
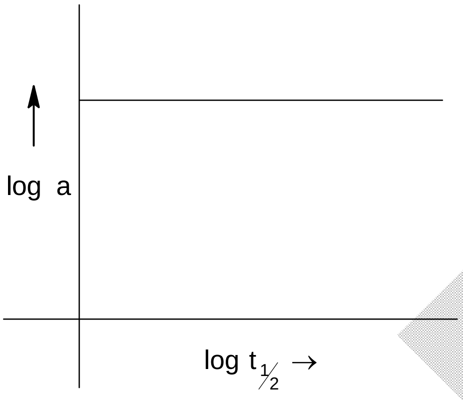


(D)



22. Fructose has a specific rotation of (-92.4^o). An aqueous solution of fructose has an observed angle of rotation of (-27.7^o) when placed in a polarimeter tube 10 cm long. How much amount of fructose is dissolved in 100 ml of aqueous solution?
(A) 0.299 g (B) 3.33 g
(C) 2.99 g (D) 29.97 g

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

23. A metal sulphide crystallizes with cubic close packed array of S^{2-} ions. Cations are Zn^{2+} and Al^{3+} ions. Only half of the octahedral voids and $\left(\frac{1}{8}\right)^{th}$ of the tetrahedral voids are occupied by cations. The correct conclusion regarding this solid is/are:
(A) Empirical formula of the solid is $ZnAl_2S_4$.
(B) Empirical formula of the solid is $Zn_5Al_2S_8$.
(C) Co-ordination number of Zn^{2+} ions is 4.
(D) Co-ordination number of Al^{3+} ions is 6.

24. A solution is 0.01 M in $(NH_4)_2SO_4$ and 0.02 M in $NH_4OH\left(K_b = 2\times10^{-5}\right)$. Which of the following is/are true about this solution?
(A) The solution has buffer property.
(B) pH of this solution is (9 + 2 log2)
(C) pH of this solution is (9 + log2)
(D) Adding water to this solution increases pH.

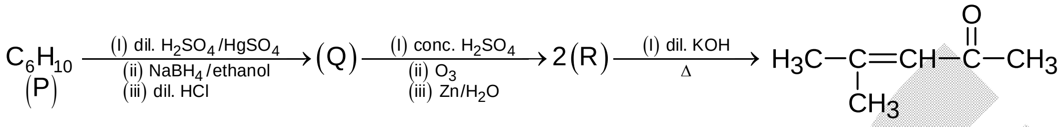
25. Which of the following option(s) is/are correct regarding XeF_6 ?

(A) It acts as Lewis acid when it reacts with RbF.

(B) It undergoes complete hydrolysis to give XeO_3.

(C) It fluorinates silica (SiO_2) to give $XeOF_4$.

(D) When it reacts with HCl, gives HF, $XeCl_2$ and F_2.

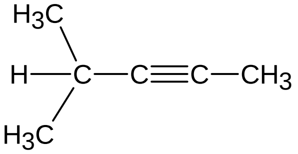
26. 

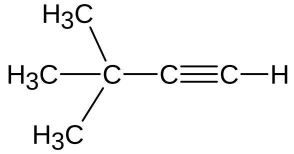
$$\underset{(P)}{C_6H_{10}} \xrightarrow[\text{(ii) NaBH}_4\text{/ethanol, (iii) dil. HCl}]{\text{(I) dil. } H_2SO_4/HgSO_4} (Q) \xrightarrow[\text{(ii) } O_3\text{, (iii) Zn/}H_2O]{\text{(I) conc. } H_2SO_4} 2(R) \xrightarrow[\Delta]{\text{(I) dil. KOH}} H_3C-\underset{CH_3}{\underset{|}{C}}=CH-\overset{O}{\overset{||}{C}}-CH_3$$

Which of the following is/are NOT the possible structure of (P)?

(A) $CH_3CH_2CH_2CH_2-C\equiv C-H$

(B) $CH_3CH_2-C\equiv C-CH_2CH_3$

(C) 

(D) 

27. For the reaction:

$A \longrightarrow B$

The rate expression is given below:

$$\text{rate} = \frac{2[A]}{3+[A]}$$

Where [A] is the concentration (mol/L) of reactant left at any time 't (in minutes)' and $[A]_o$ represents initial concentration of the reactant 'A' $(\ell n2 = 0.7)$

Now, identify the correct statement(s) regarding the above reaction:

(A) Plot of half-life time (Y-axis) versus $[A]_o$ (X-axis) is a straight line with slope 0.25 and intercept 1.05 on Y-axis.

(B) If initial concentration of A is 8 M, then it takes 5.1 minutes to reduce its concentration to 2 M.

(C) The reaction follows first order kinetics if concentration of 'A' is very small as compared to 3.

(D) If concentration of A is much greater than 3, then the plot of $t_{1/2}$ (Y-axis) versus $[A]_o$ (X-axis) is a straight line passing through origin.

28. Cyclohexene on heating with conc. H_2SO_4 gives a major product (A) and a minor product (B) having greater number of $\alpha-$hydrogen atoms as compared to the other minor product (B'). (A) on reductive ozonolysis gives (C) while (B) on reductive ozonolysis gives (D). (C) on heating with dil. KOH gives (E) while (D) on heating with dil. Alkali gives (F).

Now, choose the correct option(s) from the following:

(A) (E) on reductive ozonolysis gives (C) and new product which on heating with conc. NaOH followed by acidification gives hydroxy cyclopentanecarboxylic acid.

(B) Degree of unsaturation of (F) is 4.

(C) Ratio of degree of unsaturation of (D) to that of (C) is 1.5.

(D) (F) consists of two rings and both rings are of same size.

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.***

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29. If total number of plane of symmetry in a molecule of TEREPHTHALIC ACID be 'x' and total number of elements of symmetry (excluding axis of symmetry) in a molecule of MESO-2,3-dichlorocyclobutane be 'y' and total number of stereocentres in pent-3-en-2-ol be 'z', then the value of (x + y + z) will be……….

30. Consider the following set of reactions:

(i) $Ag_2S + NaCN \longrightarrow \left[Ag(CN)_x\right]^{-n}$

(ii) $Au + NaCN + O_2 \xrightarrow{H_2O} \left[Au(CN)_y\right]^{-n}$

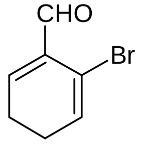
(iii) $\left[Ag(CN)_x\right]^{\pm n} \xrightarrow{Zn} Ag\downarrow + \left[Zn(CN)_z\right]^{-m}$

(iv) $\left[Au(CN)_y\right]^{\pm n} \xrightarrow{Zn} Au\downarrow + \left[Zn(CN)_z\right]^{-m}$

(Where m, n, x, y and z, all are positive integers.)
What is the value of (x + y + z – 2n + m)?

31. 'P' gram of urea is dissolved in 500 g of water. If the difference in boiling point and freezing point of the solution is 100.46 K, then what is the value of (P)?
[For water, $K_b = 0.5$ K kg mol^{-1} and $K_f = 1.8$ K kg mol^{-1}]

32. How many of the following molecules have locant-2 for bromine atom [Locant = Figure to indicate the position of bromine atom] as per IUPAC nomenclature?



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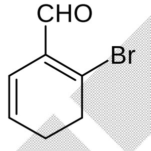

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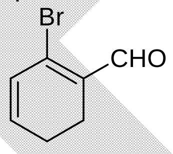

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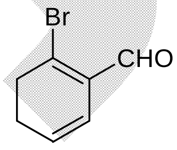

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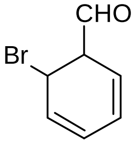
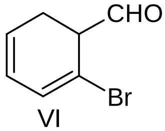


V



VI

33. How many of the following statement(s) is/are correct?
(i) Sodium amalgam is better reducing agent than hydrogen.
(ii) Sodium carbonate can be decomposed to its oxides on gentle heating.
(iii) On adding excess of NaOH to salt solution of $ZnCl_2$, soluble product is formed.
(iv) Copper sulphate on treatment aq. Na_2CO_3 solution gives basic copper carbonate.
(v) In case of alkali metals, for performing flame test, chlorides are preferred over carbonates.

34. Volume strength of H_2O_2 solution is 22.4. 5 mL of this H_2O_2 solution is just sufficient to react with 0.40 gm impure sample of H_2S. If the mass % of pure H_2S in the impure sample is 17x, then find the value of 'x'. [Assume impurities are inert]

35. in how many of the following reactions 'BORON' is formed?

(i) $NH_4Cl + Na_2B_4O_7 \xrightarrow{\text{red hot}} ?$

(ii) $BCl_3 + NH_4Cl \xrightarrow{140^{o}C} ? \xrightarrow{NaBH_4} ?$

(iii) $KBF_4 + K \xrightarrow{\Delta} ?$

(iv) $B_2O_3 + Cr_2(SO_4)_3 \xrightarrow{\Delta} ?$

(v) $B_2H_6 \xrightarrow[\Delta]{CH_3NH_2} ?$

(vi) $B_2H_6 \xrightarrow[\Delta]{(CH_3)_3N} ?$

36. 6.0 g of He^4 having average velocity 4×10^2 m / s is mixed with 12 g of Ne^{20} having same average velocity. If the average kinetic energy per mole of the mixture is 'x' kJ, then find the value of 10x?

FIITJEE

Mathematics PART – III

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

37. Consider the 12 face diagonals of a cube. If two diagonals are selected at random, then the probability that they are skew lines is

(A) $\frac{3}{11}$ (B) $\frac{6}{11}$

(C) $\frac{1}{2}$ (D) $\frac{5}{11}$

38. A new sequence is obtained from the sequence of the positive integers 1, 2, 3, ... by deleting all the perfect squares. Then the 2023rd term of the new sequence is

(A) 2066 (B) 2067

(C) 2068 (D) 2069

39. Let $x \in \left[-\frac{5\pi}{12}, -\frac{\pi}{3}\right]$. Then the maximum value of $y = \tan\left(x+\frac{2\pi}{3}\right) - \tan\left(x+\frac{\pi}{6}\right) + \cos\left(x+\frac{\pi}{6}\right)$ is

(A) $\frac{12\sqrt{2}}{5}$ (B) $\frac{11\sqrt{2}}{6}$

(C) $\frac{11\sqrt{3}}{6}$ (D) $\frac{11\sqrt{3}}{5}$

40. If $x^a = y^b = z^c$, where a, b, c are unequal positive numbers and x, y, z are in Geometric Progression, then $a^3 + c^3$ is

(A) $> 2b^3$ (B) $> 2c^3$

(C) $< 2b^3$ (D) $< 2c^3$

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

41. Let A, B and C be the points (4, 1), (–1, –6) and (–3, 2) respectively. The point (x, y) in inside triangle ABC or on its perimeter, then

(A) maximum value of 4x – 3y is 14 (B) maximum value of 4x – 3y is 18

(C) minimum value of 4x – 3y is –14 (D) minimum value of 4x – 3y is –18

42. A variable point z_1 in the complex plane moves according to the equation $|z_1 - z_0| = |z_1|$, where z_0 is a fixed point ($z_0 \neq 0$). A second variable point z moves according to the equation $z_1 z = -1$. Then the locus of point z is

(A) a circle with centre $\frac{-1}{z_0}$ (B) a circle with centre $\frac{1}{z_0}$

(C) a circle with radius $\frac{1}{|z_0|}$ (D) a circle with radius $\frac{2}{|z_0|}$

43. Let 4x – y = 0 and y = 0 be two lines and C(6, 4) be a point in the xy plane. A variable line through C intersect the given lines at A and B respectively. P be the point of intersection of the given lines, then

(A) if area of ΔPAB is minimum, then A is $\left(\frac{3}{2}, 6\right)$

(B) if area of ΔPAB is minimum, then A is (2, 8)

(C) if PA + PB is minimum, then B is $\left(\frac{15}{2}, 0\right)$

(D) if PA + PB is minimum, then B is (10, 0)

44. The solution set of the inequality $\sqrt{\log_2 x - 1} + \frac{1}{2}\log_{\frac{1}{2}} x^3 + 2 > 0$ may be

(A) [2, 3) (B) (2, 3]
(C) [2, 4) (D) (2, 4]

45. Let f : z → R be defined as f(x + 2) = f(x) + 2(x + 1) if x is even and f(x + 2) = f(x) + 1 if x is odd and f(1) = 1, f(2) = 5, then
(A) f(6) = f(41) (B) f(7) < f(8)
(C) f(x) is increasing (D) f(10) + f(11) = 59

46. Consider the equation $3\cot^2 x + \lambda \cot x + 3 = 0$, $x \in (0, 2\pi) - \{\pi\}$. Which of the following options is/are CORRECT?
(A) Sum of the solutions of the equation = 3π if λ = 7
(B) Sum of the solutions of the equation = 3π if λ = –8
(C) Sum of the solutions of the equation = 5π if λ = 9
(D) Sum of the solutions of the equation = 5π if λ = –10

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.***

---

47. The number of real solution of the equation $\left(x^{2024}+1\right)\left(1+x^2+x^4+.....+x^{2022}\right) = 2024x^{2023}$ is

48. The complex numbers z_1 and z_2 satisfy $|z_1| = |z_1 + z_2| = 3$ and $|z_1 - z_2| = 3\sqrt{3}$. If the value of $\log_3\left|\left(z_1\bar{z}_2\right)^{2023} + \left(\bar{z}_1 z_2\right)^{2023}\right|$ is 578k, then the value of k is

49. The maximum value of $f(x) = \sqrt{x^4 - 3x^2 - 6x + 13} - \sqrt{x^4 - x^2 + 1}$ is k, then [k] is
(where [.] represents greatest integer function)

50. Let P be any point on the hyperbola $\frac{x^2}{9} - \frac{y^2}{4} = 1$. If F_1 and F_2 be the foci of the hyperbola and I be the in-centre of the ΔPF_1F_2. If locus of I is $\lambda y^2 + 2x + \mu = 0$, then the value of $|\lambda + \mu|$ is equal to

51. Let $\vec{a}, \vec{b}, \vec{c}$ be three vectors such that $|\vec{a}| = 1, |\vec{b}| = 2$, and $|\vec{c}| = 4$. If $|\vec{a} - \vec{b}|^2 + |\vec{b} - \vec{c}|^2 + |\vec{c} - \vec{a}|^2 = 62$, then the value of $|2\vec{a} + 3\vec{b} + 4\vec{c}|$ is equal to

52. Let $f(x) = \int_x^1 \ln\left(1 - t^2\right)dt$, $x \in (0, 1)$ and $\alpha = \int_0^1 f(x)dx$, then the value of $4\alpha + 5$ is equal to

53. Let tangent at (α_1, β_1) on the curve $y = x^4 - 2x^2 - x$ touch the curve again at (α_2, β_2), then the value of $|\alpha_1| + |\alpha_2| + |\beta_1| + |\beta_2|$ is equal to

54. Let A and C be two points on the line $\frac{x-1}{3} = \frac{y-2}{2} = \frac{z-3}{1}$ and B & D be two point on the line $\frac{x-2}{5} = \frac{y-1}{2} = \frac{z-2}{3}$ such that AB is perpendicular to both the given lines and the length of CD is $3\sqrt{3}$. If V is the maximum volume of the tetrahedron ABCD, then [V] is equal to
(where [.] represents greatest integer function)

FIITJEE

ALL INDIA TEST SERIES

JEE (Advanced)-2023

OPEN TEST – I

PAPER –1

TEST DATE: 05-02-2023

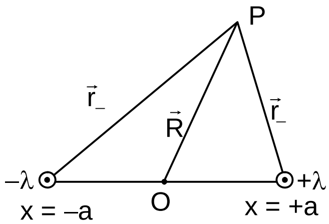
ANSWERS, HINTS & SOLUTIONS

Physics PART – I

Section – A

1. B, D

Sol. $E = \frac{2k\lambda}{}$



$$\Rightarrow \int_0^V dV = -\int_{r_0}^{r} E dr$$

$$\Rightarrow V = -2k\lambda(\ell nr - \ell nr_0)$$

$$V = -2k\lambda\ell n(r) + C$$

$$V_P = V_{-\lambda} + V_{+\lambda} = 2k\lambda\ell n(r_-) - 2k\lambda\ell n(r_+) = 2k\lambda\ell n\left(\frac{r_-}{r_+}\right)$$

$$\vec{r}_- = (x+a)\hat{i} + y\hat{j}$$

$$\vec{r}_+ = (x-a)\hat{i} + y\hat{j}$$

$$V_P = 2k\lambda\ell n\sqrt{\frac{(x+a)^2+y^2}{(x-a)^2+y^2}}$$

$$\text{for } v_P = \frac{\lambda}{4\pi\varepsilon_0}\text{In}2$$

$$\Rightarrow \frac{(n+a)^2+y^2}{(x-a)^2+y^2} = 2$$

$$(x+a)^2 + y^2 = 2(x-a)^2 + 2y^2$$

$$(x-3a)^2 + y^2 = 8a^2$$

$\Rightarrow$ Equipotential surface is cylinder with radius $2\sqrt{2}a$

2. A, C

Sol. For oscillation to occur it must be in the stable equilibrium i.e. centre of mass of the system must be below the centre of hemisphere.

3. A, C, D

Sol. $1000 = \frac{320}{4\ell_1} \Rightarrow \ell_1 = 8$ cm

$1000 = \frac{3 \times 320}{4\ell_2} \Rightarrow \ell_2 = 24$ cm

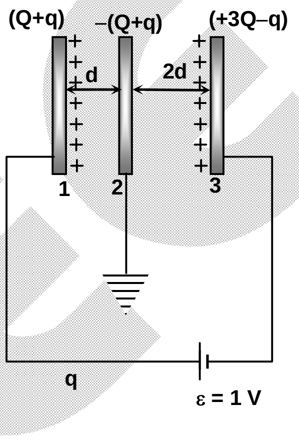
$-A\frac{dh}{dv} = 2\sqrt{2gh} \Rightarrow -\int \frac{dh}{\sqrt{h}} = \frac{a}{A}\sqrt{2g}\int dt$

4. B, D

Sol. Charge flown through S_1 is Q + 3Q = 12 mC

$0 + \frac{(Q+q)}{\varepsilon_0 A}d - \varepsilon - \frac{(3Q-q)2d}{\varepsilon_0 A} = 0$

By solving q = 15 mC



5. A, C, D

Sol. Conserve angular momentum about O. $2mv_0 2\ell = I\omega$

Where $I = \frac{40m\ell^2}{3}$

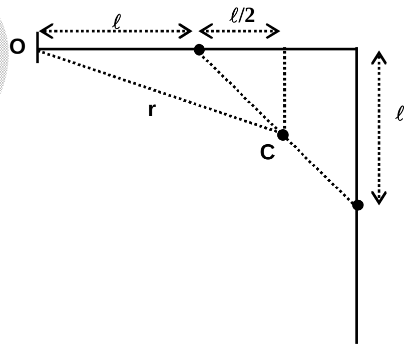
$\therefore \omega = \frac{3v_0}{10\ell}$

$r = \sqrt{\frac{\ell^2}{4} + \left(\ell + \frac{\ell}{2}\right)^2}$

$r = \sqrt{\frac{5}{2}}\ell$

$v_c = r_c\omega = \sqrt{\frac{5}{2}}\ell \times \frac{3v_0}{10\ell} = \frac{3}{2\sqrt{10}}v_0$

K.E. = $\frac{1}{2}I\omega^2 = \frac{3}{5}mv_0^2$



6. A, B, C, D

Sol. Torque along vertical axis is zero

7. B

Sol. (I) $P_N = P_0 + \rho g\left(\frac{3H}{2}\right)$

$P_N - P_0 = 3\rho g\frac{H}{2}$

(II) $V = \sqrt{2g(2H)} = 2\sqrt{gH}$

$$P_0 + \rho gH = P_N - \rho g\frac{H}{2} + \frac{1}{2}\rho(4gH)$$

$$P_N - P_0 = \rho gH + \frac{\rho gH}{2} - 2\rho gH = -\frac{\rho gH}{2}$$

(III) $P_N = P_0 + \rho gh + \frac{1}{2}\rho\omega^2\left(\frac{H}{2}\right)^2$

$$P_N - P_0 = \rho gH + \frac{1}{8}\rho\omega^2 H^2$$

$$\omega^2 H = 2g$$

$$\therefore \; P_N - P_0 = \frac{5}{4}\rho gH$$

(IV) $P_N = P_0 + \rho(g\cos 60°)2H$

$$P_N - P_0 = \rho gH$$

8. B

Sol. (I) $v_I = \frac{4}{3} \times 3 = 4$

$v_r = 4 - 3 = 1$ m/s

(II) $\frac{dv}{dt} = -\left(\frac{v}{u}\right)^2 \frac{du}{dt}$

$\Rightarrow v_I = 1$ m/s and $v_r = 10$ m/s

(III) $v_{I,m} = 4$

$\Rightarrow v_{I,\,g} = 7 \Rightarrow v_r = 8$ m/s

(IV) final image is at the position of object hence magnification is 1

$\Rightarrow v_I = v_0 = 1$m/s

$\Rightarrow v_r = 0$

9. C

Sol. (I) $Q = \int T ds$ = Area between T-s diagram = 700 J

(II) $\Delta Q = n\frac{3}{2}R\left(T_f - T_i\right) + n\frac{5}{2}R(T_f - T_i)$

$= \frac{3}{2}(nRT_f - nRT_i) + \frac{5}{2}(nRT_f - nRT_i)$

$= \frac{3}{2}(500 - 100) + \frac{5}{2}(1000 - 500) = 1850$ J

(III) Process is T = 100 V $\Rightarrow \frac{T}{V}$ = constant i.e. pressure = constant

$\therefore Q = nC_P\Delta T = 2\frac{5}{2}R(300-100) = 1000R$

(IV) A → B is V = constant and B → C, P = constant

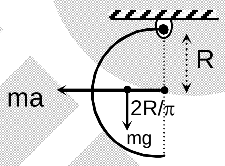
$\Delta Q = n\frac{3}{2}R(T_B - T_A) + n\frac{5}{2}R(T_C - T_B) = (1000-500) + \frac{5}{3}(500-1000)$

10. D

Sol. (I) $-mg\frac{R}{2}\theta = \frac{2}{3}mR^2\alpha \Rightarrow \alpha = -\left(\frac{3g}{4R}\right)\theta$

$T = 2\pi\sqrt{\frac{4R}{3g}}$

(II) $maR = mg\frac{2R}{\pi}$



$a = \frac{2g}{\pi}$

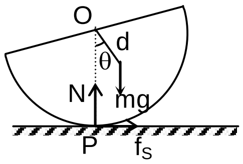
$-mg_{eff}\sqrt{R^2 + \frac{4R^2}{\pi^2}}\sin\theta = 2mR^2\alpha$

$g_{eff} = \sqrt{a^2 + g^2} = g\sqrt{1 + \frac{4}{\pi^2}}$

$\therefore \alpha = -\left[\frac{g}{2R}\left(1 + \frac{4}{\pi^2}\right)\right]\theta \Rightarrow T = 2\pi\sqrt{\frac{2R}{g\left(1 + \frac{4}{\pi^2}\right)}}$

(III) $\tau_P = I_P\alpha$

$-mgd\sin\theta = I_P\theta$

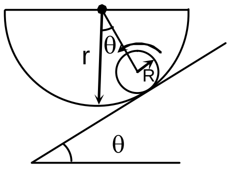


$d = \frac{3R}{8}$, $I_P = \frac{13}{20}mR^2$

$\alpha = -\left(\frac{mgd}{I_P}\right)\theta$

$T = 2\pi\sqrt{\frac{I_P}{mgd}} \Rightarrow T = 2\pi\sqrt{\frac{26R}{15g}}$

(IV) $a = \frac{g\sin\theta}{1 + \frac{I_C}{mR^2}}$

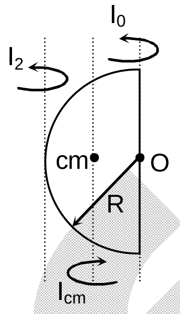


$a = -\frac{5g}{7} = -\frac{5g}{7}\frac{x}{r-R} = -\frac{g}{7R}x$

$T = 2\pi\sqrt{\frac{7R}{g}}$

Section – B

11. 0.68



Sol. $I_1 = \frac{MR^2}{4} + MR^2$ …(i)

$I_2 = I_{cm} + M\left(R - \frac{4R}{3\pi}\right)^2$ …(ii)

$I_0 = I_{cm} + M\left(\frac{4R}{3\pi}\right)^2$

$I_0 = \frac{MR^4}{4}$

Solving the equations

$\left|\frac{I_2 - I_1}{I_1}\right| = 0.68$

12. 0.01

Sol. $F = n\frac{h}{\lambda}$

and F = mg

$\therefore$ Power P = $n\frac{hc}{\lambda}$

$\therefore\ mg = \frac{P}{c}$

P = mgc

Also, $P = \frac{dm}{dt}c^2$

$\therefore\ \frac{dm}{dt} = \frac{mg}{c} = 0.01$ kg/s

13. 19.11

Sol. $mv_0\cos\theta = 2mv_C$

$\Rightarrow\ v_C = \frac{v_0\cos\theta}{2}$

Conservation of angular momentum

$mv_0\cos\theta\frac{\ell}{4} = \left(\frac{m\ell^2}{16} + \frac{m\ell^2}{12} + \frac{m\ell^2}{16}\right)\omega$

$\omega = \frac{6v_0\cos\theta}{5\ell}$

$\theta = \omega t$ and $N = \frac{\theta}{2\pi} = \frac{3v_0^2\sin 2\theta}{10\pi g\ell}$

14. 3.14

Sol. $f_S = ma$

$N = mg$

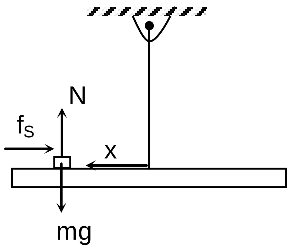
$\tau_0 = 0$

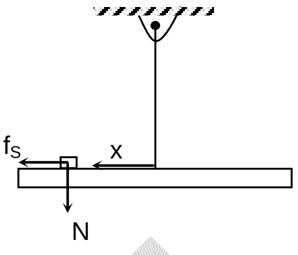
$Nx - f_S \ell = 0$

$$f_s = \frac{mgx}{\ell}$$

$$a = -\frac{g}{\ell}x$$

$$\text{Time} = \pi\sqrt{\frac{\ell}{g}} = \pi \text{ sec}$$





15. 1.19

Sol. $\sqrt{2\times 4k_\alpha} = \sqrt{2\times 1\times k_p}\cos 60^\circ + \sqrt{2\times 17k_0}\cos\theta$

$\sqrt{2\times 1\times k_P}\sin 60^\circ = \sqrt{2\times 17\times k_0}\sin\theta$

Solving $k_0 = 0.71$ MeV

$\therefore$ $Q = (k_\alpha - k_P - k_0) = 1.19$ MeV

16. 0.80

Range (0.79 to 0.82)

Sol. For rotation equilibrium net torque is zero

$- NIAB + 4g \times 5 \times 10^{-2} + (100x) \times 2.5 \times 10^{-2} = 0$

$x = 0.8$ m

17. 0.75

Sol. Minimum speed of sphere w.r.t. block at highest point is v_{min}=5m/s.

Conservation of momentum

$1v_0 = (1+4)v = 5v_1 + 5(v_1 - 5)$

Conservation of energy

$$\frac{1}{2}\times 5v^2 = 5g(2\times 2.5) + \frac{1}{2}5v_1^2 + \frac{1}{2}5(v_1-5)^2$$

18. 0.75

Sol. Velocity of pendulum before collision

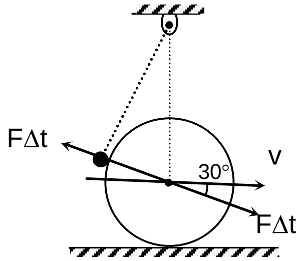
$v_0 = \sqrt{2g\ell\cos 30^\circ} = \sqrt{6}$ m/s

$F\Delta t = mv_0$

$F\Delta t \cos 30^\circ = mv$

$$\therefore\ mv_0\frac{\sqrt{3}}{2} = mv \Rightarrow v = \frac{v_0\sqrt{3}}{2}$$

$$e = \frac{v\frac{\sqrt{3}}{2}}{v_0} = \frac{3}{4}$$



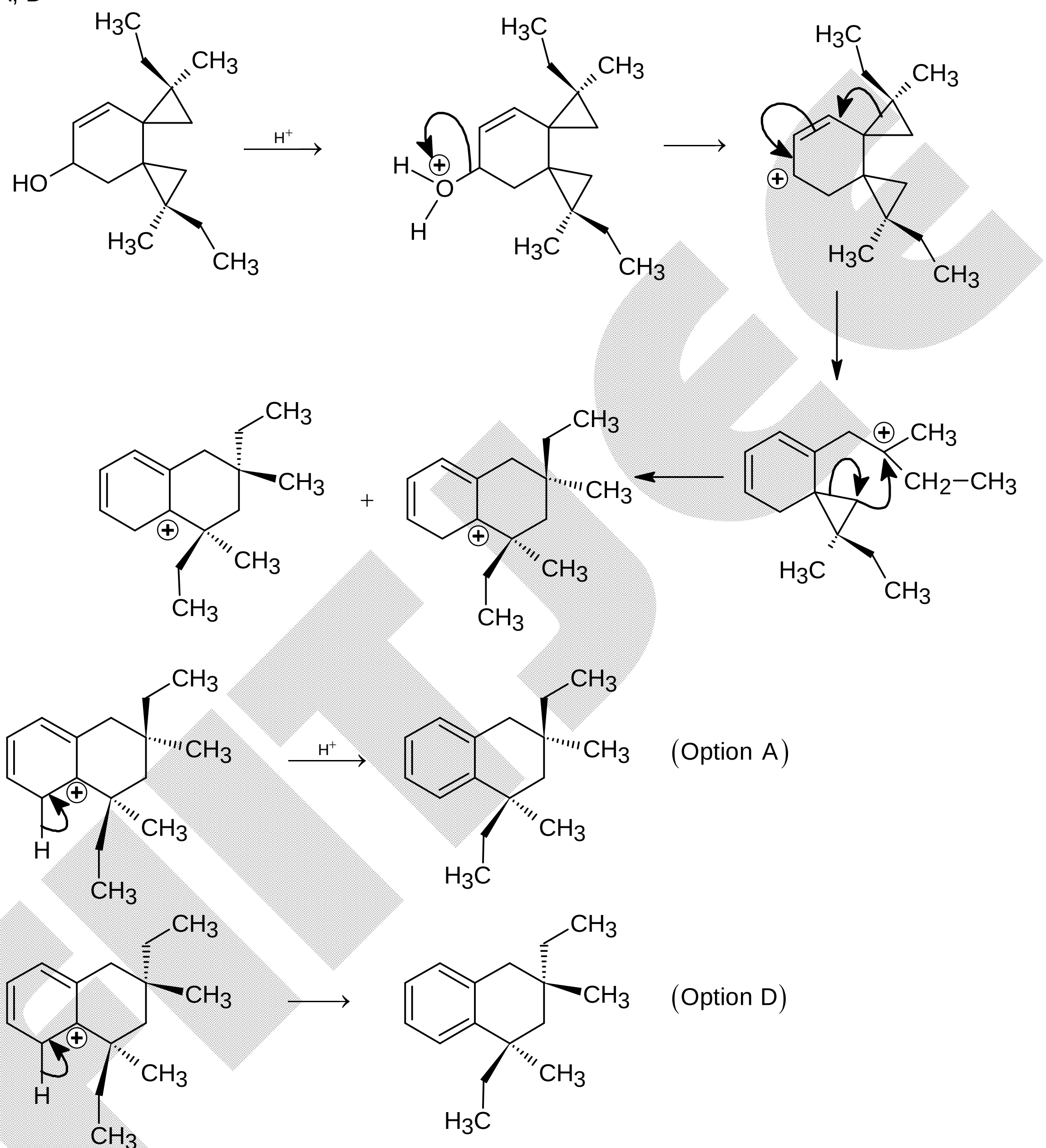
Chemistry

PART – II

Section – A

19. A, D

Sol.



20. A, B, C, D

Sol. The driving force behind these reactions (A and B) is the formation of LiCl or LiBr (very large lattice energy and insoluble in organic solvents in which the reaction is performed)

- Benzene is more acidic than C_2H_6, so the reaction (C) can occur.
- Li_3N converts into amides and hydrides by reaction with hydrogen.

21. B, D

Sol. $\underset{\text{(Amphoteric oxide)}}{\text{BeO}} + \underset{\underset{\text{(basic)}}{\text{(Baryta water)}}}{\text{Ba(OH)}_2} \longrightarrow \text{Ba}\left[\text{Be(OH)}_4\right]$

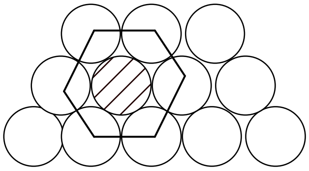
22. A, B, C

Sol. $\beta-$keto acids, gem-dioic acids and $\beta,\gamma-$unsaturated acids decarboxylates on simple heating. (D) is however a $\beta-$keto acid but in transition state, there will be a double bond at bridge head position which is not stable. So, (D) will not decarboxylate on heating.

23. B, D

Sol. (A) Second nearest neighbours of Cs^+ are 6 and not 8 (in CsCl crystal).

(B)

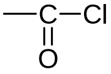


There are 6 triangular voids around a sphere in two dimensional hcp layer.

(C) $\frac{r_+}{r_-} = \frac{0.3}{0.4} = 0.75$ which indicates that cations are present in cubic void of a simple cubic unit cell, so its coordination number is 8 and not 6.

(D) Definition of Frenkel defect.

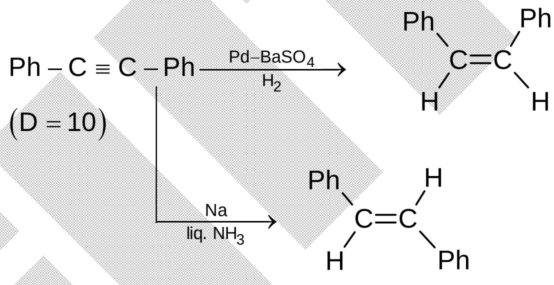
24. B, C

Sol. 
$-\underset{\underset{\text{O}}{\|}}{\text{C}}-\text{Cl}$ has less priority than ester, so, (A) is wrong but (B) is correct.

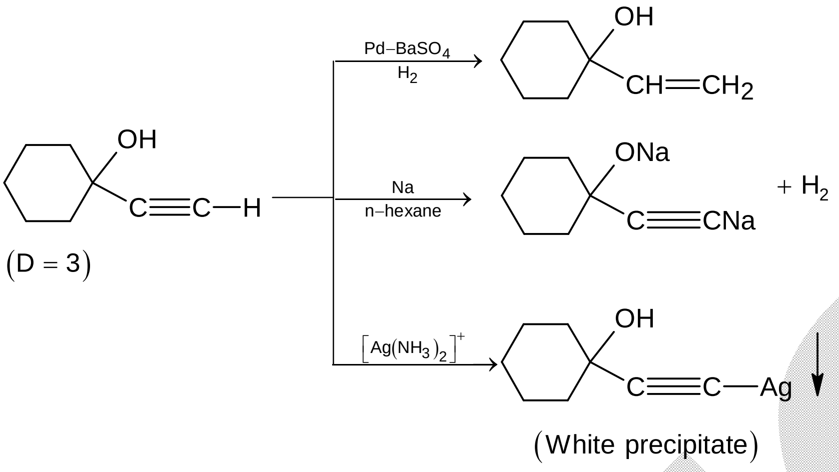
Double bond has more priority than 'Br'.

25. B

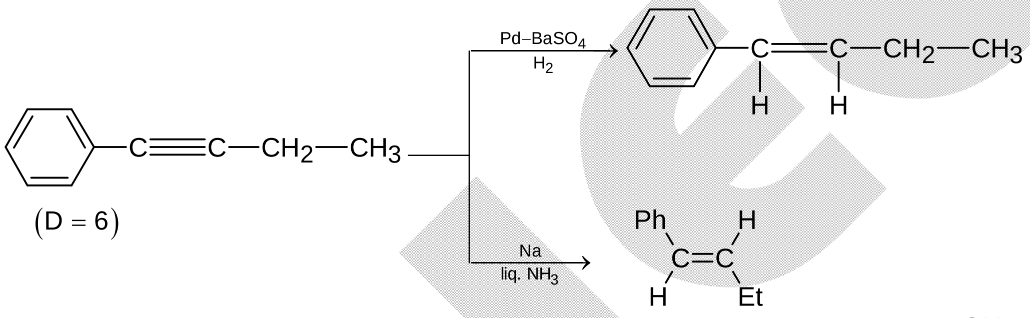
Sol. (I)



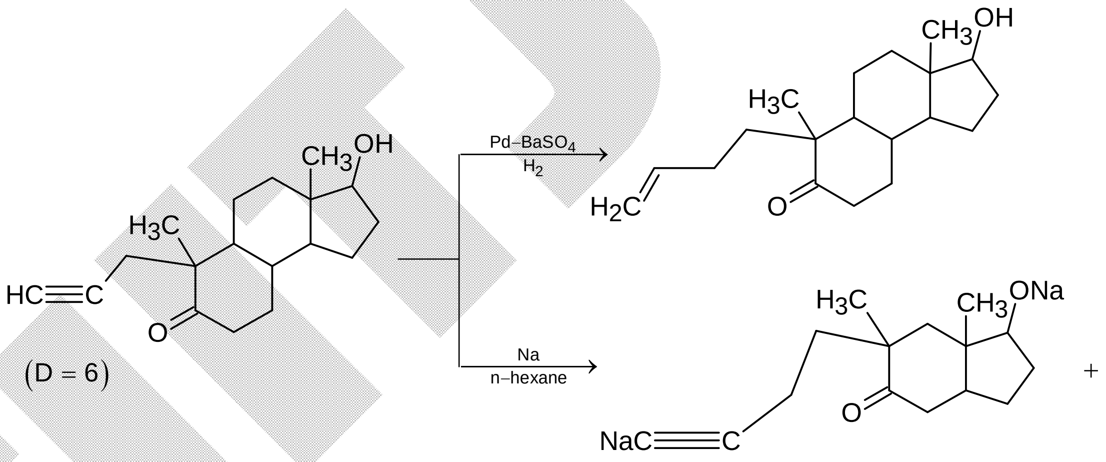
(II)


OH
C≡C—H
(D = 3)
Pd–BaSO4 / H2
OH
CH=CH2
Na / n–hexane
ONa
C≡CNa
+ H2
[Ag(NH3)2]+
OH
C≡C—Ag
(White precipitate)

(III)


C≡C—CH2—CH3
(D = 6)
Pd–BaSO4 / H2
C=C—CH2—CH3
H
H
Na / liq. NH3
Ph
H
C=C
H
Et

(IV)


CH3
OH
H3C
HC≡C
O
(D = 6)
Pd–BaSO4 / H2
H3C
CH3
OH
H2C
O
Na / n–hexane
H3C
CH3
ONa
O
NaC≡C
+

26. D

Sol. $AlCl_3 + H_2O \longrightarrow \left[Al(H_2O)_6\right]^{3+} \longrightarrow \left[Al(H_2O)_5(OH)\right]^{2+} + H^+$

$BCl_3 + 3H_2O \longrightarrow H_3BO_3 + 3HCl$

$B_2H_6 + H_2O \longrightarrow \underset{(Acid)}{H_3BO_3} + H_2$

Alums contains Al^{3+} or Cr^{3+} or Fe^{3+} ions whose aqueous solution is strongly acidic.

Also, in B_2H_6, there is 3c-2e bond formation in which vacant 2p-orbital of 'B' is also involved in sp^3-hybridisation.

27. C

Sol. $$\underset{(1\,\text{bar})}{Pt(s)/H_2(g)}\,|\left(\underset{(100\text{ mL, }0.2\text{ M})}{H_3PO_4}+\underset{(100\text{ mL, }0.1\text{ M})}{Na_3PO_4}\right)\Bigg\|\left(\underset{(100\text{ mL, }0.1\text{ M})}{CH_3COOH}\,|\,\underset{(1\,\text{bar})}{H_2}(g)/Pt(s)\right)$$

From Nernst Equation

$$E_{cell}=-0.06\times\log\frac{\left[H^+\right]_a}{\left[H^+\right]_c}$$

or $E_{cell}=\left[(pH)_a-(pH)_c\right]\times 0.06$ … (1)

(I)

$$\begin{array}{llll} H_3PO_4+ & PO_4^{3-}\longrightarrow & H_2PO_4^- & +HPO_4^{2-} \\ 20 & 10 & 0 & 0 \\ 10 & 0 & 10 & 10 \end{array}$$

Again,

$$\begin{array}{lll} H_3PO_4+ & HPO_4^{2-}\longrightarrow & 2H_2PO_4^- \\ 10 & 10 & 10 \\ 0 & 0 & 30 \end{array}$$

$$\therefore (pH)_a=\frac{pK_{a_1}+pK_{a_2}}{2}=\frac{4+8}{2}=6$$

Also, at cathode

$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$

$$\alpha=\sqrt{\frac{K_a}{C}}=\sqrt{\frac{10^{-5}}{0.1}}=10^{-2}, \qquad \left[H^+\right]_c=10^{-3}$$

$$\therefore (pH)_c=3$$

$$E_{cell}=0.06[6-3]=0.18\text{ V}$$

(II) If 100 mL, 0.1 M NaOH is added in anode compartments

$$\begin{array}{lll} H_3PO_4, & PO_4^{3-}, & NaOH \\ 20\text{ m.mol} & 10\text{ m.mol} & 10\text{ m.mol} \end{array}$$

$$\begin{array}{lll} H_3PO_4+ & OH^-\longrightarrow & H_2PO_4^-+H_2O \\ 20 & 10 & 0 \\ 10 & 0 & 10 \end{array}$$

Also,

$$\begin{array}{llll} H_3PO_4+ & PO_4^{3-}\longrightarrow & H_2PO_4^- & +HPO_4^{2-} \\ 10 & 10 & 10 & 0 \\ 0 & 0 & 20 & 10 \end{array}$$

So, it is a buffer.

$$(pH)_a=pK_{a_2}+\log\frac{\left[HPO_4^{2-}\right]}{\left[H_2PO_4^{2-}\right]}=8+\log\frac{10}{20}$$

$$\therefore (pH)_a=7.7$$

$$E_{cell}=0.06[7.7-3]=0.282\text{ V}$$

(III) 50 mL, 0.1 M NaOH is added in cathode compartment

$$\begin{array}{llll} CH_3COOH + & OH^- \longrightarrow & CH_3COO^- + H_2O \\ 10 & 5 & 0 \\ 5 & 0 & 5 \end{array}$$

$\therefore$ P it is also a buffer.

$$(pH)_c = 5 + \log\frac{5}{5} = 5$$

$$\therefore E_{cell} = 0.06[6-5] = 0.06\ V$$

(IV) 100 mL, 0.1 M HCl is added in anode compartment

$$\begin{array}{lll} PO_4^{3-} + & H^+ \longrightarrow & HPO_4^{2-} \\ 10 & 10 & 0 \\ 0 & 0 & 10 \end{array}$$

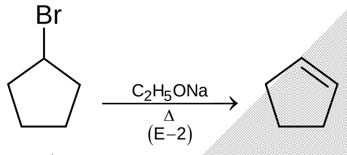
$$\begin{array}{lll} H_3PO_4 + & HPO_4^{2-} \longrightarrow & 2H_2PO_4^- \\ 20 & 10 & 0 \\ 10 & 0 & 20 \end{array}$$

$$\therefore (pH)_a = 4 + \log 2 = 4.3$$

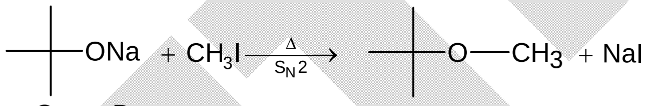
$$E_{cell} = 0.06[4.3-3] = 0.06 \times 1.3 = 0.078\ V$$

28. D

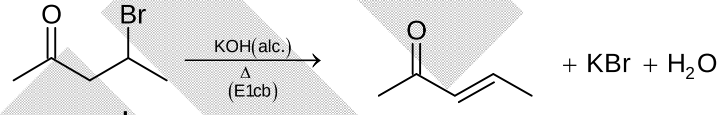
Sol. (I)



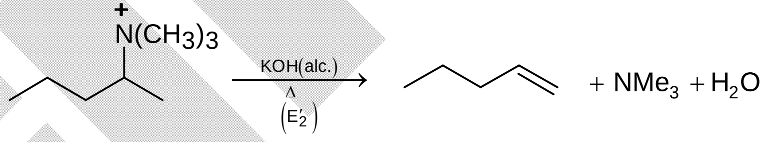
(II)



(III)



(IV)



Section – B

29. 3.50

Sol. Except statements (i) and (iv), all other statements are correct.

(i) SF_6 molecule has a maximum of 9 planes of symmetry (and not 5).

(iv) About **75%** (and not 60%) of the solar energy reaching the earth is absorbed by earth surface which increases its temperature.

30. 8.97

[Range :8.96 – 8.98]

Sol. PV = nRT

$$PV = \left(\frac{W_{He}}{4}\right) \times R \times T$$

$$\frac{20.14}{760} \times \frac{(110 + 100.5)}{1000} = \frac{W_{He}}{4} \times 0.082 \times (273 + 30.2)$$

$$W_{He} = 8.97 \times 10^{-4} \text{ g} = x \times 10^{-4} \text{ g}$$

$$\therefore x = 8.97$$

31. 19.82

[Range : 19.81 – 19.83]

Sol. $W = -P_2(V_2 - V_1)$

$$= -P_2\left(\frac{nRT}{P_2} - \frac{nRT}{P_1}\right)$$

$$= -nRT\left(1 - \frac{P_2}{P_1}\right)$$

$$= -2 \times 8.314 \times 298\left(1 - \frac{5}{1}\right)$$

$$W = 19820.576 \text{ J}$$

Now, $|W| = mgh$

$$h = \frac{W}{mg}$$

$$h = \frac{19820.576}{100 \times 10} = 19.82 \text{ 'm'}$$

32. 0.24

[Range : 0.23 – 0.25]

Sol. meq. of iodine in 200 mL solution = meq. of $Ce^{4+} = 15 \times 0.05$

= 0.75

$\therefore$ Normality of iodine $= \frac{0.75}{200}$

Eq. weight of $I^{-} = \frac{127}{2}$

Iodide ion concentration $= \frac{0.75}{200} \times \frac{127}{2}$ = 0.238 g/L

33. 1.50

Sol. Total number of isomers of B.H.C. = 9

Total number of isomers of $K\left[Co(NH_3)_2(F)_2(Cl)_2\right]$ = 6

34. 2.20

Sol. $X = H_3PO_4$, $Y = H_2S$, $Z = PSCl_3$

$x = 8 + 3 = 11$

$y = 5$

$$\frac{x}{y} = \frac{11}{5} = 2.20$$

$$P_4S_{10} + 16H_2O \longrightarrow 4\underset{(X)}{H_3PO_4} + 10\underset{(Y)}{H_2S}$$

$$P_4S_{10} + 6PCl_5 \longrightarrow 10\underset{(Z)}{PSCl_3}$$

35. 9.33
[Range : 9.33 – 9.34]

Sol.

$$\text{Pd}(46): 1s^2\ 2s^2\ \underset{\substack{\downarrow\\ 4}}{2p^6}\ 3s^2\ \underset{\substack{\downarrow\\ 4}}{3p^6}\ \underset{\substack{\downarrow\\ 8}}{3d^{10}}\ 4s^2\ \underset{\substack{\downarrow\\ 4}}{4p^6}\ \underset{\substack{\downarrow\\ 8}}{4d^{10}}\ 5s^0$$

So, x = 28
y = 3

36. 1.33
[1.33 – 1.34]

Sol. Number of triangular faces in truncated cube = 8
Number of octagonal faces in truncated cube = 6
Each corner of the cube will become a triangular face and each square face will become an octahedral face in a truncated solid cube.

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Mathematics

PART – III

Section – A

37. A, B, D

Sol. Apply AM ≥ GM
$d - ax - by - cz > 0$
$ax, by, cz, d - ax - by - cz$
Apply AM ≥ GM

38. A, B, C

Sol. $S_n^2 = S_{n-1}^2 + 1 \Rightarrow S_n = \sqrt{n}$

39. B, C

Sol. $\sum_{r=0}^{10} \frac{{}^{10}C_r}{{}^{30}C_{10+r}} = \frac{1}{{}^{30}C_{20} \cdot {}^{20}C_{10}} \sum_{r=0}^{10} {}^{10+r}C_r \cdot {}^{20-r}C_{10}$ = coefficient of x^{10} is $(1 - x)^{-22}$

40. A, B, C

Sol.
$$f(x) = \begin{cases} -\sin x^2 & ; \quad x < -1 \\ \frac{\ln 4 - \sin 1}{2} & ; \quad x = -1 \\ \ln(3 + x^2) & ; \quad -1 < x < 1 \\ \frac{\ln 4 - \sin 1}{2} & ; \quad x = 1 \\ -\sin(x^2) & ; \quad x > 1 \end{cases}$$

41. A, B, D

Sol. $F(x) - f(x) = k(x - 1)^2(x - 2)^2(x - 3)^2$

42. A, C, D

Sol. The plane $(\vec{r} \cdot \vec{n}_1 - a) + \lambda(\vec{r} \cdot \vec{n}_2 - b) = 0$ is identical with $\vec{r} \cdot \vec{n}_3 = c$

43. A

Sol. Domain of g(x) is $[0, \infty)$ and range of g(x) is $[-1, \infty)$

44. D

Sol. (I) The point of intersection is (2, –1, 2)

(II) Line drawn from P intersects the line $\frac{x+2}{3} = \frac{2y+3}{4} = \frac{3z+4}{5}$ measured parallel to the plane $4x + 12y - 3z + 1 = 0$ at $\left(4, \frac{5}{2}, 2\right)$

(III) $\frac{AR}{RQ} = \frac{4}{9}$

(IV) $f'(x) = \left|\sin\left(x + \frac{\pi}{3}\right)\right| - |\sin x| = 0 \Rightarrow x = \frac{\pi}{3}$ or $\frac{5\pi}{6}$ at $x = \frac{\pi}{3}$ local maxima exists

45. B

Sol. $\frac{d}{dx}\left(\frac{g(x)}{g'(x)}\right)=\frac{-g(x)}{g'(x)} \Rightarrow g(x)=\frac{1}{e}\cdot e^{e^x}$

46. C

Sol. (I) Expand the square

(II) $\int_0^1 g(x)dx+\int_{g(0)}^{g(1)} g^{-1}(x)dx=1\cdot g(1)-0\cdot g(0)$

$$\int_0^1 (e^x+x+1)dx+\int_2^{e+2} g^{-1}(x)dx=(e+2)\times 1-0\times 2$$

$$\int_2^{e+2} g^{-1}(x)dx=(e+2)-\left|e^x+\frac{x^2}{2}+x\right|_0^1 = (e+2)-\left\{\left(e+\frac{1}{2}+1\right)-e^0\right\} = e+2-e-\frac{1}{2}=\frac{3}{2}$$

(III) g(x) = ax + b

(IV) Area bounded = $\frac{1}{2}\times 4\times 4 \quad -\int_{\frac{2}{3}}^{2}\left(2-\frac{x}{2x-1}\right)dx-\pi\left(\frac{1}{2}\right)^2$

Section – B

47. 0.00

Sol. P(a) = b, P(b) = c and P(c) = a

$\Rightarrow \frac{b-c}{a-b}=l_1$, $\frac{c-a}{b-c}=l_2$ and $\frac{a-b}{c-a}=l_3$

48. 2.00

Sol. $AC\cdot BC = CS^2$

49. 2.00

Sol. Circle touches each other externally

50. 33.00

Sol. $P\left(\frac{3\sqrt{2}}{5},\frac{-3}{5\sqrt{2}}\right) \Rightarrow \ell=\sqrt{\frac{36}{50}+\frac{9}{50}-\frac{1}{4}}=\sqrt{\frac{9}{10}-\frac{1}{4}}=\sqrt{\frac{36-10}{40}}=\sqrt{\frac{13}{20}}$

51. 1.00

Sol. Let $z=\frac{\cos\theta+i\sin\theta}{\cos\theta}$; $z^k=\frac{\cos k\theta+i\sin k\theta}{\cos^k\theta}$

$$\sum_{k=0}^{n-1} z^k=\frac{1-z^n}{1-z}=\frac{1-\frac{\cos n\theta+i\sin n\theta}{\cos^n\theta}}{1-\frac{\cos\theta+i\sin\theta}{\cos\theta}} = \frac{\sin n\theta}{\sin\theta\cos^{n-1}\theta}+i\frac{\cos^n\theta-\cos n\theta}{\sin\theta\cos^{n-1}\theta}$$

So, $\text{Re}\left(\sum_{k=0}^{n-1} z^k\right)=\frac{\sin n\theta}{\sin\theta\cos^{n-1}\theta}=\frac{\sin n\frac{\pi}{6}}{\sin\frac{\pi}{6}\left(\cos\frac{\pi}{6}\right)^{n-1}}$

52. 5.00

Sol. $P^{-1}+Q^{-1}=(P+Q)^{-1} \Rightarrow (P^{-1}+Q^{-1})(P+Q)=I \Rightarrow I+P^{-1}Q+Q^{-1}P+I=I$

Let $P^{-1}Q=A$, then $A+A^{-1}+I=0 \Rightarrow A^2+A+I=0$

$A^3 = I \Rightarrow |A| = 1$

$|P^{-1}Q|=1 \Rightarrow |P^{-1}||Q|=1 \Rightarrow \frac{1}{|P|}\times|Q|=1 \therefore |Q| = 5$

53. 0.50

Sol. The person B will score more if

Case-I: In first 9 chances A and B have same score and B is successful in 10th chance

Case-IIL In first 9 chances B has more score.

54. 2.00

Sol. Multiply and divide by sin 2° sin 4° sin 6° ..... sin 88°

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ALL INDIA TEST SERIES
JEE (Advanced)-2023
OPEN TEST – I
PAPER –2
TEST DATE: 05-02-2023

ANSWERS, HINTS & SOLUTIONS

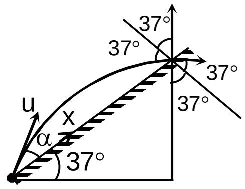
Physics

PART – I

Section – A

1. A

Sol. At t = T



$$Y = 0 \Rightarrow T = \frac{2u\sin\alpha}{g\cos 37^\circ}$$

$$\Rightarrow T = \frac{u\sin\alpha}{4}$$

Also at t = T, v is at 37° with normal on the plane i.e.

$$\tan 37^\circ = \frac{V_x}{-V_y}$$

$$\frac{3}{4} = \frac{u\cos\alpha - \frac{3}{5}gT}{-\left(u\sin\alpha - \frac{4}{5}gT\right)}$$

By solving $\tan\alpha = \frac{4}{9}$

Also, $T = \frac{1}{4}\sqrt{388}\sin\alpha = \sqrt{\frac{388}{4}} \times \frac{4}{\sqrt{97}} = 2\text{ sec}$

Velocity of particle just before it collides

$$v_y = u_y + a_yT = -8$$

$$v_x = u_x + a_xT = 6$$

$$\therefore\ v = \sqrt{8^2 + 6^2} = 10\text{ m/s}$$

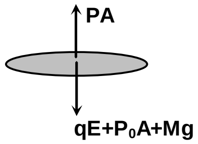
Velocity after collision = 10 m/s

$$\therefore\ T' = \frac{2 \times 10}{g} = 2\text{ sec}$$

Total times in returning is 2 + 2 + 2 = 6 sec

2. A

Sol. PA = qE + P_0A + Mg



$PV_0^{\gamma} = \text{constant}$

After displacing piston through small distance x in downward directions pressure changes. Let new pressure be P′

So, $PV_0^{\gamma} = P'(V_0 - AX)^{\gamma}$

$$PV_0^{\gamma} = P'V_0^{\gamma}\left(1 - \frac{\gamma AX}{V_0}\right)$$

$$\Rightarrow P = P'\left(1 - \frac{\gamma AX}{V_0}\right)$$

$$Mg + \frac{qE}{A} + P_0 = P'\left(1 - \frac{\gamma AX}{V_0}\right)$$

$$\omega = \sqrt{\frac{\left(\frac{qE + Mg}{A} + P_0\right)\gamma A^2}{MV_0}}$$

3. A

Sol. $\frac{dm}{dx} = kx$

$$\Rightarrow \int_0^m dm = k\int_0^{\ell} x dx \Rightarrow k = \frac{2m}{\ell^2}$$

$$dI = x^2 dm = x^2 \frac{2m}{\ell^2} x dx$$

$$I = \frac{2m}{\ell^2}\int_0^{\ell} x^3 dx = \frac{m\ell^2}{2}$$

$$X_{cm} = \int x dm = \frac{2\ell}{3}$$

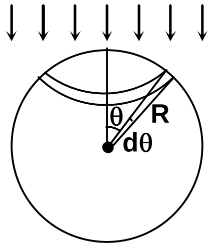
$$-(mg\sin 30^\circ)\ \frac{2\ell}{3}\theta = \frac{m\ell^2}{2}\alpha$$

$$\Rightarrow \alpha = -\frac{2g}{3\ell}\theta$$

$$T = 2\pi\sqrt{\frac{3\ell}{2g}}$$

4. C

Sol. $E.2\pi r = \pi r^2 \frac{dB}{dt}$



$$\Rightarrow E = \frac{r}{2}\frac{dB}{dt}$$

$$rdq \cdot E = \frac{r^2}{2} dq \frac{dB}{dt}$$

$$d\tau = \frac{dB}{dt}\frac{r^2}{2} dq$$

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$$\int d\tau = -\frac{dB}{dt}\int_0^{\pi^2}\frac{1}{2}R^2\sin^2\theta\cdot 2\pi R\sin\theta R d\theta\sigma \qquad (\because\ r = R\sin\theta)$$

$$\tau = \frac{dB}{dt}\frac{4}{3}\sigma\pi R^4$$

$$\int \tau dt = \frac{4\sigma\pi R^4}{3}\int_B^0 dB$$

$$I\omega - 0 = \frac{4}{3}B\sigma\pi R^4$$

Conservation of angular momentum

$$I\omega = I\frac{v}{R} + mvR$$

$$\Rightarrow\ v = \frac{I\omega R}{I + mR^2} = \frac{5QBR}{21m}$$

5. A, D

Sol. $F - T - \mu mg\cos\theta - mg\sin\theta = ma_1$

$\Rightarrow 106 - T - 40 = 4a_1$ …(i)

$10g\sin\theta - T - f_S = 10a_C$

$\Rightarrow 60 - T - f_S = 10\ a_C$ …(ii)

$f_S R + rT = I\alpha$

$\Rightarrow 2f_S + T = 10\alpha$ …(iii)

$r\alpha - a_C = a_1$ …(iv)

and $a_C = R\alpha$ …(v)

Solving the equations $a_C = 2\ m/s^2$, $a_1 = -1\ m/s^2$

6. A, C, D

Sol. $\varepsilon - i_1 r + \varepsilon - i_1 r + \varepsilon - i_1 r + \varepsilon - i_1 r + \varepsilon - i_1 r = 0$

$$\Rightarrow\ i_1 = \frac{\varepsilon}{r} = 5A$$

$$\varepsilon - i_2 r - i_2 R - i_2 R = 0 \Rightarrow\ i_2 = \frac{\varepsilon}{r + 2R} = 1A$$

$I = I_1 + I_2 = 6A$

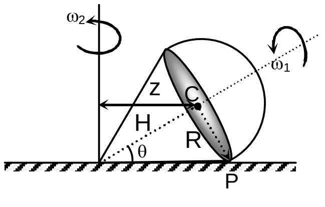
Charges on capacitors 2C, C is zero since current in resistance R is zero

$$\therefore\ \varepsilon - i_2 R = \frac{q}{4C}$$

$q = 16\mu c$

7. B, D

Sol. Velocity of point P is $\omega_2 \times 2R - \omega_1 R = 0$



$$\frac{T_1}{T_2} = \frac{\omega_2}{\omega_1} = \frac{1}{2}$$

$$f_S = \frac{mv_0^2}{z} = \frac{2}{3}\frac{mv_0^2}{R}$$

8. A, B, C

Sol. Velocity of particle after collision in vertical direction is 10 m/s

$\mu N\Delta t = \mu \times 20\ m$

For disc, $\mu N\Delta t = mv_C$

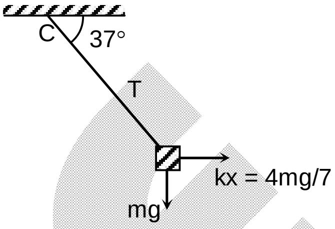
$\therefore v_C = 4$ m/s

$\mu N \Delta t \frac{R}{2} = \frac{MR^2}{2}(\omega - 0)$

$\Rightarrow \omega = 20$ rad/s

9. B, C

Sol. Initial tension in spring $kx = \frac{4mg}{7}$



FBD of block just after string is cut

Since, v = 0

$\therefore$ acceleration along string is zero

$T = k\cos 37° + mg\sin 37° = \frac{37}{7}N$

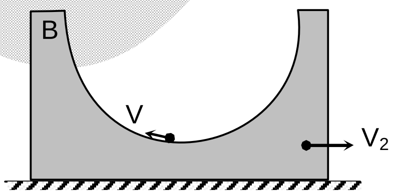
Acceleration is only perpendicular to spring

ma = mg cos 37° – kx sin 37°

$\Rightarrow a = \frac{32}{7}$ m/s^2

10. A, C

Sol. Using conservation of energy and momentum when particle leaves end B, velocity of the block will be zero.



At lower most point vertical acceleration is $\frac{v^2}{R}$

$\therefore 5v_1 = 10v$

and $5 \times g \times 6 = \frac{1}{2} \times 5v_1^2 + \frac{1}{2} \times 10 \times v_2^2$

Solving equations $v_1 = \sqrt{80}$, $v_2 = \sqrt{20}$

$v_{P,B} = \sqrt{80} + \sqrt{20}$

$a_{P,B} = \frac{v_{P,B}^2}{R} = \frac{(\sqrt{80} + \sqrt{20})^2}{2}$

$\vec{a}_{P,g} = \vec{a}_{P,B} + \vec{a}_{B,g}$

$\vec{a}_{B,g} = 0$ (when particle is at lowest position)

$\therefore \vec{a}_{P,g} = \vec{a}_{P,B} = 90$ m/s^2

Section – B

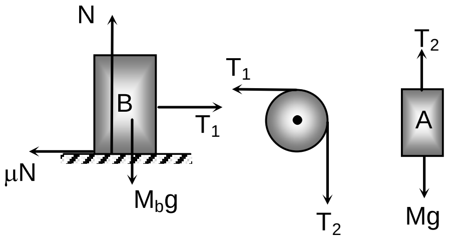
11. 2

Sol. $T_1 = \mu M_B g$

$T_2 = mg$

due to friction on pull

in limiting case ,when block B is about to slide



$T_2 = T_1 e^{\mu \frac{\pi}{2}}$

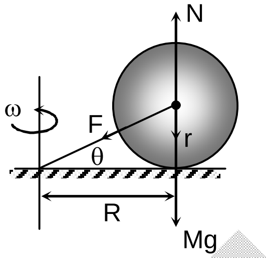
Solving equation m = 2kg

12. 4

Sol. $F\cos\theta = m\omega^2 R$

$F\sin\theta + mg = N$

$\therefore\ N = mg + m\omega^2 r = 36\text{ N}$



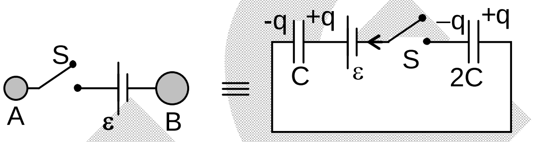
13. 3

Sol. $$\frac{q}{C} - \varepsilon + \frac{q}{2C} = 0$$

$$q = \frac{2}{3}C\varepsilon$$

Loss energy $H = q\varepsilon - \Delta U$

$= \dfrac{3}{4}\dfrac{q^2}{C}$, where $C = 4\pi\varepsilon_0 \times 9 = 30\ \mu J$



14. 4

Sol. Standing wave $y = 2A\sin kx \cos\omega t$

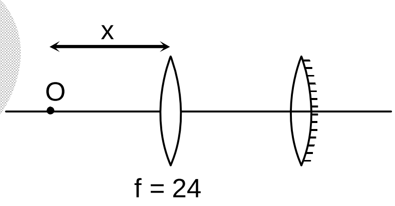
Has energy $E = \mu\omega^2 A^2 \ell$

15. 6

Sol. $$\frac{1}{v} - \frac{1}{-x} = \frac{1}{24}$$

$$\Rightarrow \frac{1}{v} = \frac{1}{24} - \frac{1}{x}$$

$$\frac{1}{v} = -\frac{1}{\left(\frac{24-x}{24x}\right)}$$



Object distance for silvered lens is $(14-x) + \dfrac{24x}{(24-x)}$ for image to be on object O, this distance must be equal to equivalent radius of mirror.

For (Reflecting lens is effectively mirror)

$$-\frac{2}{R_{eq}} = 2\left(\frac{3}{2}-1\right)\left(\frac{1}{32} - \frac{1}{-32}\right) - \frac{3}{-32}$$

$\Rightarrow R_{eq} = -16$ cm

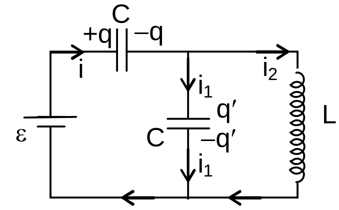
$$\therefore\ 16 = (14-x) + \frac{24x}{(24-x)}$$

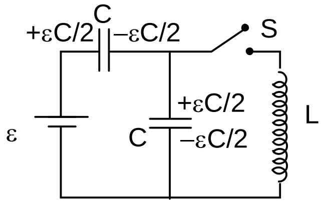
$\Rightarrow x = 6$ cm

16. 7

Sol. Using Kirchhoff's Law

$$\varepsilon - \frac{q}{C} - \frac{q'}{C} = 0 \qquad \ldots\text{(i)}$$





$$-\frac{q}{C}+L\frac{di_2}{dt}=0 \qquad \ldots(ii)$$

$$\varepsilon-\frac{q}{C}-L\frac{di_2}{dt}=0 \qquad \ldots(iii)$$

Solving these equations and at t = 0, $i_2 = 0$ and $i_2=\varepsilon\sqrt{\frac{C}{2L}}\sin\omega t$

$$\therefore\ i_{2(\max)}=\varepsilon\sqrt{\frac{C}{2L}}=7A$$

17. 5

Sol. Consider some resistance to the voltmeter and applying Kirchhoff's law

18. 4

Sol. $K_{e\max}=h\nu-\phi=\frac{6.6\times10^{-34}\times7.27\times10^{14}}{1.6\times10^{-19}}-1=2\text{ eV}$

Maximum potential difference is 2V

$$U=\frac{1}{2}CV^2$$

Chemistry PART – II

Section – A

19. A

Sol. AB_2L_3 has linear shape but AB_3L_2 has T-shape.

20. B

Sol. Total moles of air $= \frac{PV}{RT} = \frac{2\times 49.26}{0.0821\times 300} = 4$ mole

$\therefore n_{O_2} = 4\times 0.2 = 0.8$ mole

Moles of 'C' = 1

$$\underset{1\text{ mole}}{C} + \underset{0.8\text{ mole}}{O_2} \longrightarrow \underset{x\text{ mole}}{CO} + \underset{y\text{ mole}}{CO_2}$$

Apply POAC for C-atom

$1\times 1 = x\times 1 + y\times 1$ or $x + y = 1$ … (1)

Also, apply POAC for O-atoms,

$0.8\times 2 = x\times 1 + y\times 2$ or $x + 2y = 1.6$ … (2)

On solving Equation (1) and (2), we get

$y = 0.6$ and $x = 0.4$

So, total amount of heat produced

$= -0.4\times(26) - 0.6\times(94)$

$= -10.4 - 56.4$

$= -66.8$ kcal

21. A

Sol. Since, decomposition of N_2O on hot platinum surface follows ZERO order kinetics:

So, $t_{1/2} = \frac{a}{2k_o}$

or $a = (2k_o)\times t_{1/2}$

$\log a = \log(2k_o) + \log t_{1/2}$

$y = C + mx$

$m = 1$ or $\tan\theta = 1$ or $\theta = 45^o$

$C = \log 2k_o = +ve$

22. D

Sol. $\alpha = \frac{\theta}{\ell(dm)\times C(g/ml.)}$

$-92.4^o = \frac{-27.7^o}{(1\ dm)\times C}$

$C = \frac{27.7}{1\times 92.4} = 0.2997\ g/ml$

So, mass of fructose dissolved in 100 mL solution

$= 0.2997\times 100$

= 29.97 g.

23. A, C, D

Sol. Since, the crystal should be electrically neutral. So, empirical formula of the solid should be:

$$\left(Al^{3+}\right)_{4\times\frac{1}{2}}\left(Zn^{2+}\right)_{8\times\frac{1}{8}}\left(S^{2-}\right)_{4} \Rightarrow ZnAl_2S_4$$

Since, Zn^{2+} ions are present in tetrahedral void, so, its coordination number = 4.
Also, Al^{3+} ions are present in octahedral void, so, its coordination number = 6.

24. A, C

Sol. Since, the solution contains a weak base (NH_4OH) and salt of this weak base with strong acid, i.e. $(NH_4)_2SO_4$. So, it is a basic buffer.

By Henderson's Equation:

$$pOH = pK_b + \log\frac{2\times 0.01}{0.02} = pK_b$$

$$\therefore pH = 14 - pOH$$

$$pH = 14 - (5 - \log 2) = 9 + \log 2$$

Since, it's a buffer, so dilution does not affect the pH.

25. A, B, C

Sol. (A) $XeF_6 + RbF \longrightarrow Rb^+ + XeF_7^-$

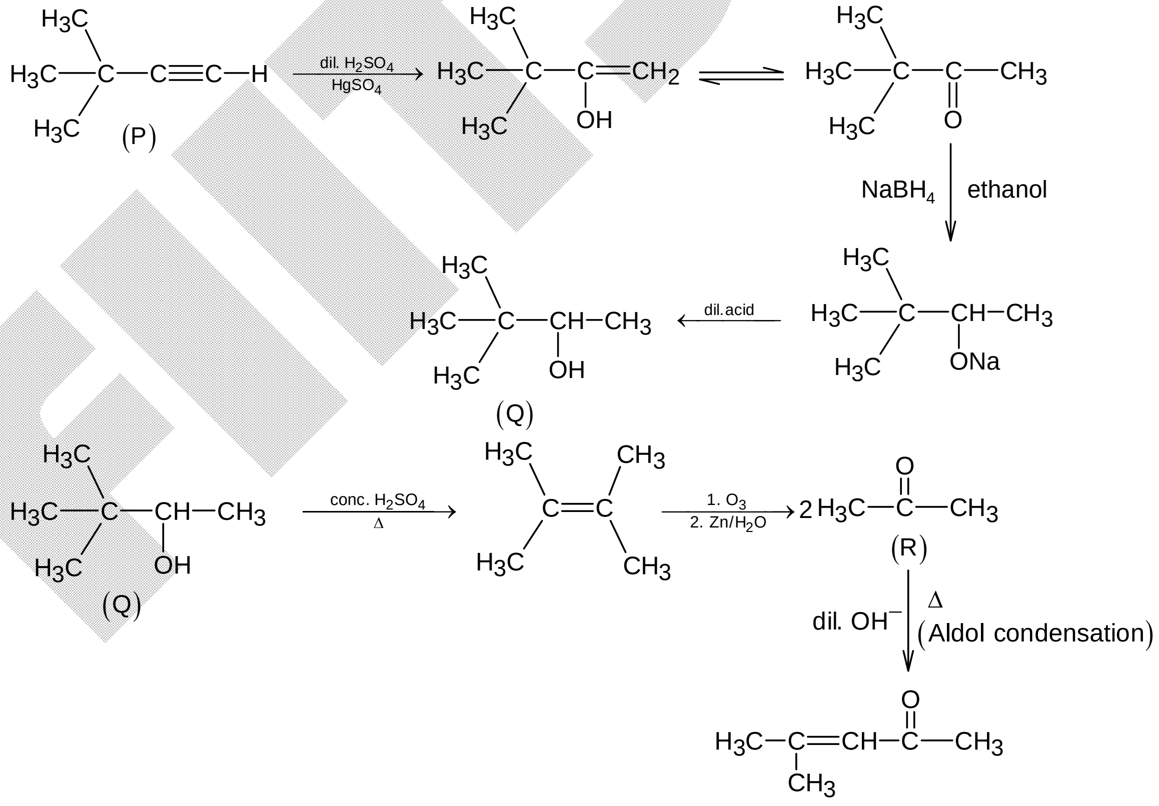
(B) $XeF_6 + 3H_2O \longrightarrow XeO_3 + 6HF$

(C) $2XeF_6 + SiO_2 \longrightarrow 2XeOF_4 + SiF_4$

(D) $XeF_6 + 6HCl \longrightarrow 6HF + Xe + 3Cl_2$

26. A, B, C

Sol.



27. A, B, C, D

Sol. $r = \dfrac{2[A]}{3+[A]}$

So, integrated rate equation of the above reaction is

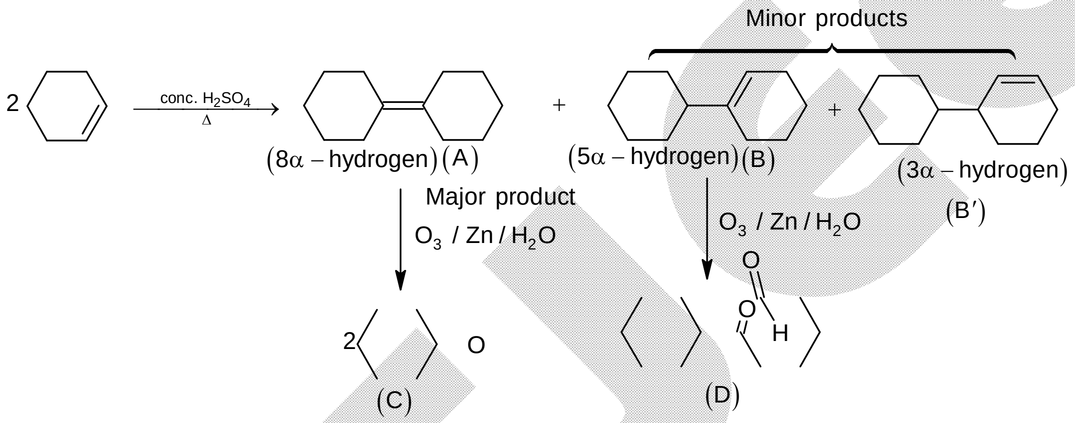
$$t = \frac{1}{2}\left[[A]_o - [A] + 3\ell n\frac{[A]_o}{[A]}\right]$$

So, $t_{1/2} = \dfrac{1}{4}[A]_o + \dfrac{3}{2}\ell n2$

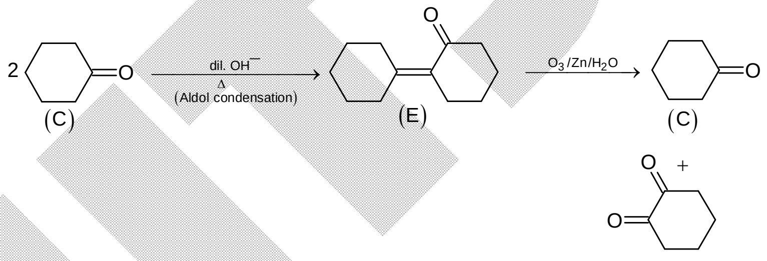
$$t_{3/4} = \frac{3[A]_o}{8} + 3\ell n2 = \frac{3}{8}\times 8 + 3\times 0.7 = 5.1 \text{ minutes}$$

28. A, B, C

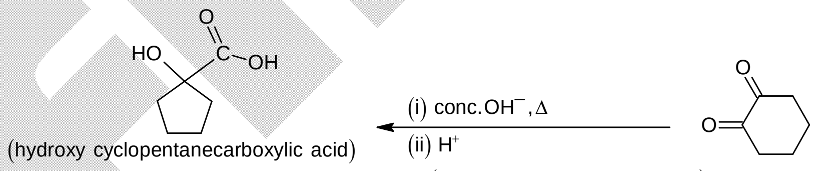
Sol.



Minor products
2
conc. H_2SO_4
Δ
+
+
(8α – hydrogen) (A)
(5α – hydrogen) (B)
(3α – hydrogen)
(B′)
Major product
O_3 / Zn / H_2O
O_3 / Zn / H_2O
2
O
(C)
O
O
H
(D)

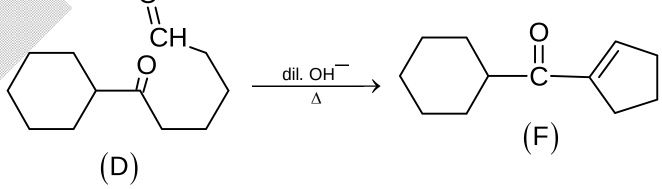


2
O
(C)
dil. OH^-
Δ
(Aldol condensation)
O
(E)
$O_3/Zn/H_2O$
O
(C)
O +
O



O
HO
C
OH
(hydroxy cyclopentanecarboxylic acid)
(i) conc.OH^-, Δ
(ii) H^+
(Benzillic acid rearrangement)
O
O

Also,

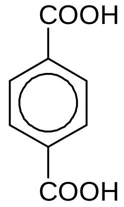


O
CH
O
(D)
dil. OH^-
Δ
O
C
(F)

Section – B

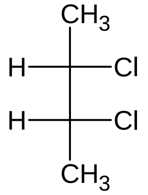
29. 8

Sol.



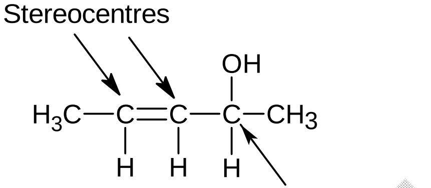
has 3 planes of symmetry, i.e. x = 3

(Terephthalic acid)


CH3
H
Cl
H
Cl
CH3

It has one plane of symmetry and one centre of symmetry. So, y = 2.

(Meso-2,3-dichlorobutane)


Stereocentres
OH
H3C
C
C
C
CH3
H
H
H
Stereocentres

$H_3C-\underset{H}{C}=\underset{H}{C}-\overset{OH}{\underset{H}{C}}-CH_3$

(Pent-3-en-2-ol)

So, z = 3.

30. 8

Sol. x= 2, y = 2, z = 4.
n = 1, m = 2

31. 6

Sol. Freezing point in Kelvin $= (-1.8\ m + 273)$ K

Boiling point in Kelvin $= (373 + 0.5\ m)$ K

Difference of boiling point and freezing point = 100 + 2.3 m = 100.46

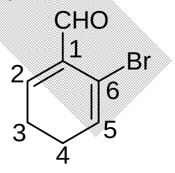
$\therefore M = 0.2$

Now, $0.2 = \dfrac{P \times 1000}{60 \times 500}$

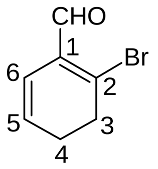
$\therefore P = 6$ gram

32. 4

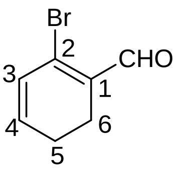
Sol.


CHO
1
Br
2
6
3
5
4

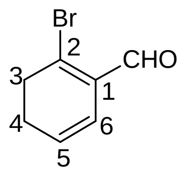
I


CHO
1
Br
6
2
5
3
4

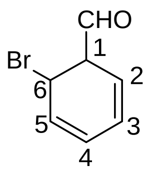
II


Br
2
CHO
3
1
4
6
5

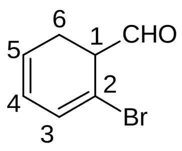
III


Br
2
CHO
3
1
4
6
5

IV


CHO
1
Br
6
2
5
3
4

V


6
1
CHO
5
2
4
Br
3

VI

33. 4

Sol. (i) $Na-Hg+H_2O\longrightarrow NaOH+Hg+\frac{1}{2}H_2$

(ii) $Na_2CO_3\xrightarrow{\Delta}X$

(iii) $4NaOH+ZnCl_2\longrightarrow Na_2ZnO_2+2NaCl+2H_2O$

(iv) $CuSO_4+Na_2CO_3+H_2O\longrightarrow \underbrace{CuCO_3.Cu(OH)_2}_{\text{basic copper carbonate}}$

(v) In case of alkali metals, for performing flame test, chlorides are preferred over carbonates as chlorides are more volatile.

34. 5

Sol. $N_{H_2O_2}=\frac{22.4}{5.6}=4$

Let, mass of pure H_2S present in impure sample = 'w' gm

Then $4\times5\times10^{-3}=\frac{w}{\left(\frac{34}{2}\right)}\Rightarrow w=0.34\text{ gm}$

So, % of pure H_2S in impure sample $=\frac{0.34}{0.40}\times100=85\%$

$\therefore 17x=85$
$\therefore x=5$

35. 1

Sol. (i) $NH_4Cl+Na_2B_4O_7\xrightarrow{\text{red hot}}(BN)_x+NaCl+H_2O$

(ii) $BCl_3+NH_4Cl\xrightarrow{140^0C}B_3N_3H_3Cl_3\xrightarrow{NaBH_4}B_3N_3H_6$

(iii) $KBF_4+K\xrightarrow{\Delta}B+KF$

(iv) $B_2O_3+Cr_2(SO_4)_3\xrightarrow{\Delta}Cr(BO_2)_3$

(v) $B_2H_6\xrightarrow[\Delta]{CH_3NH_2}\left[BH_2(CH_3NH_2)_2\right]^+\left[BH_4\right]^-$

(vi) $B_2H_6\xrightarrow[\Delta]{(CH_3)_3N}2BH_3.(CH_3)_3N$

36. 8

Sol. Average velocity $=\sqrt{\frac{8RT}{\pi M}}=4\times10^2$

$\therefore RT=2\pi M\times10^4$

Total kinetic energy of 'He' $=\frac{3}{2}nRT=\frac{3}{2}\times\frac{6}{4}\times RT=\frac{9RT}{4}$

Total kinetic energy of 'He' $=\frac{9}{4}\times2\pi M\times10^4$

$=\frac{9}{4}\times2\pi\times\left(4\times10^{-3}\right)\times10^4$

$=180\pi$ Joule

Total kinetic energy of $'Ne^{20}'=\frac{3}{2}nRT=\frac{3}{2}\times\frac{12}{20}\times RT$

$= \frac{9}{10} \times 2\pi M \times 10^4$

$= \frac{9}{10} \times 2\pi \times \left(20 \times 10^{-3}\right) \times 10^4$

$= 360\pi$ Joule

Average kinetic energy of mixture per mole $= \frac{360\pi + 180\pi}{1.5 + 0.6}$

$= \frac{540}{2.1} \times 3.14$

$= 807.42$ J

$= 0.80742$ kJ

So, x = 0.8

$\therefore 10x = 8$.

Mathematics PART – III

Section – A

37. D

Sol. Favorable cases: For first diagonal we have 12 choices them for the second to be skew we have 5 choices. So number of favorable choices is $\frac{12\times 5}{2}=30$

Required probability = $\frac{30}{{}^{12}C_2}=\frac{5}{11}$

38. C

Sol. Since $\left\lfloor\sqrt{2066}\right\rfloor=\left\lfloor\sqrt{2067}\right\rfloor=\left\lfloor\sqrt{2068}\right\rfloor=\left\lfloor\sqrt{2069}\right\rfloor=45$ and 2023 + 45 = 2068

39. C

Sol. Let $z=-x-\frac{\pi}{6}$, then $z\in\left[\frac{\pi}{6},\frac{\pi}{4}\right]$ and $2z\in\left(\frac{\pi}{3},\frac{\pi}{2}\right)$

Then, $y=\cot z+\tan z+\cos z=\frac{2}{\sin 2z}+\cos z$

Since, both $\frac{2}{\sin 2z}$ and cos z are monotonic decreasing in this case

Then $y_{\max}=\frac{2}{\sin\frac{\pi}{3}}+\cos\frac{\pi}{6}=\frac{11\sqrt{3}}{6}$

40. A

Sol. $x^a=y^b=z^c=\lambda$, now x, y, z are in Geometric Progression

$\Rightarrow \frac{2}{b}=\frac{1}{a}+\frac{1}{c}$ therefore a, b, c are in Harmonic Progression

By G.M. > H.M.; $\sqrt{ac}>b$ for a^3, b^3, c^3

A.M. > G.M.; $\frac{a^3+c^3}{2}>\left(\sqrt{ac}\right)^3>b^3$

41. A, D

Sol. Draw variable lines of slope 4x – 3y that passes through the points on or inside the triangle

42. A, C

Sol. $\left|\frac{1}{z}+z_0\right|=\frac{1}{|z|}$ multiply both side by $\left|\frac{z}{z_0}\right|$, we have $\left|z-\left(-\frac{1}{z_0}\right)\right|=\frac{1}{|z_0|}$

Circle with centre $\frac{-1}{z_0}$ and radius $\frac{1}{|z_0|}$, however we have to exclude the point z = 0 from the locus

43. B, D

Sol. If PA + PB is minimum ⇒ Area of ΔPAB is minimum
⇒ C is mid-point of AB ⇒ Equation of AB is x + y = 10

44. A, B, C

Sol. Since, $\log_2 x - 1 \ge 0$; Let $\sqrt{\log_2 x - 1} = t$, we have $t - \frac{3}{2}t^2 + \frac{1}{2} > 0$ and $t \ge 0$

Solution of the above inequality is $0 \le t < 1 \Rightarrow 0 \le \log_2 x - 1 < 1 \Rightarrow 2 \le x < 4$

45. A, B, D

Sol. $f(x) = \frac{x^2}{2} + 3$ if x is even and $f(x) = \frac{x+1}{2}$ is x is odd

46. B, C

Sol. If $\lambda \ge 6$, then sum of solutions = 5π and if $\lambda \le -6$, then sum of solutions = 3π

Section – B

47. 1

Sol. $\left(x + \frac{1}{x^{2023}}\right)(1 + x^2 + x^4 + ... + x^{2022}) = 2024$

$\Rightarrow (x + x^3 + x^5 + ... + x^{2023}) + \left(\frac{1}{x^{2023}} + \frac{1}{x^{2021}} + ... + \frac{1}{x}\right) = 2024$

$\Rightarrow$ By A.M., G.M. inequality, we get

$(x + x^3 + x^5 + ... + x^{2023}) + \left(\frac{1}{x} + \frac{1}{x^3} + ... + \frac{1}{x^{2023}}\right) \ge 2 \times 1012 = 2024$

Where the equality holds if and only if $x = \frac{1}{x}$, $x^3 = \frac{1}{x^3}$, ..., $x^{2023} = \frac{1}{x^{2023}}$ $\Rightarrow x = 1$

48. 7

Sol. $|z_1| = |z_2| = 3$ and $z_1\bar{z}_2 + \bar{z}_1 z_2 = -9 \Rightarrow |z_1\bar{z}_2| = 9$

Let $z_1\bar{z}_2 = 9(\cos\theta + i\sin\theta)$, then $\bar{z}_1 z_2 = 9(\cos\theta - i\sin\theta)$

$\Rightarrow 18\cos\theta = -9 \Rightarrow \cos\theta = -\frac{1}{2}$

$z_1\bar{z}_2 = -9\omega$ and $\bar{z}_1 z_2 = -9\omega^2$ where ω is cube root of unity other than 1

$\log_3\left|(z_1\bar{z}_2)^{2023} + (\bar{z}_1 z_2)^{2023}\right| = 2 \times 2023 = 4046$

49. 3

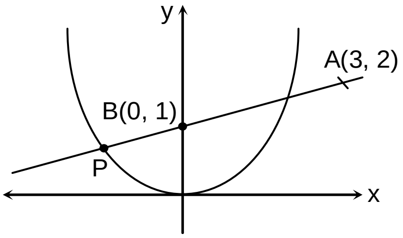
Sol. $f(x) = \sqrt{(x-3)^2 + (x^2-2)^2} - \sqrt{x^2 + (x^2-1)^2}$

Let P be any point on the parabola $y = x^2$ and A(3, 2), B(0, 1)

By Δ inequality $|PA - PB| \le AB$

$|PA - PB| \le \sqrt{10}$

$\therefore k = \sqrt{10}$



50. 6

Sol. Locus of I is the tangent at the vertex $\Rightarrow$ Locus is $x = \pm 3$

51. 8

Sol. $|\vec{a} - \vec{b}|^2 + |\vec{b} - \vec{c}|^2 + |\vec{c} - \vec{a}|^2 = 62 \Rightarrow \vec{a}\cdot\vec{b} + \vec{b}\cdot\vec{c} + \vec{c}\cdot\vec{a} = -10 \Rightarrow \vec{c} = -4\vec{a} = -2\vec{b}$

52. 3

Sol. $\ln\left(1-t^2\right) = \sum_{r=1}^{\infty}\left(-\frac{t^{2r}}{r}\right) \Rightarrow \int_0^1 f(x)\,dx = \sum_{r=1}^{\infty}\frac{-1}{2r(r+1)} = -\frac{1}{2}$

53. 4

Sol. Let y = mx + c be the tangent $\Rightarrow x^4 - 2x^2 - x - (mx + c) = (x^2 + ax + b)^2$

$\Rightarrow$ a = 0, b = –1, m = –1, c = –1

$\Rightarrow$ x + y + 1 = 0 is tangent to the curve at (–1, 0) and (1, –2)

$\Rightarrow |\alpha_1| + |\alpha_2| + |\beta_1| + |\beta_2| = 4$

54. 3

Sol. A and B are (1, 2 3) and (2, 1, 2) respectively

If AC = d_1 and BC = d_2, then volume of tetrahedron = $\frac{1}{6}\cdot AB d_1 d_2 = \frac{\sqrt{3}}{6} d_1 d_2$

Also, $CD^2 = d_1^2 + d_2^2 + 3 \Rightarrow d_1^2 + d_2^2 = 24$

Using AM, GM, $\frac{d_1^2 + d_2^2}{2} \geq d_1 d_2 \Rightarrow d_1 d_2 \leq 12 \Rightarrow V = 2\sqrt{3}$

FIITJEE

FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
FULL TEST – III
PAPER –1
TEST DATE: 08-02-2023

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B**.

Section – A *(01 –06, 19 – 24, 37 – 42):* This section contains **EIGHTEEN (18)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – A *(07 – 10, 25 – 28, 43 – 46):* This section contains **TWELVE (12)** Matching List Type Questions. Each question has **FOUR** statements in **List-I** entries (I), (II), (III) and (IV) and **FIVE** statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which, **ONLY ONE** of these four options is correct answer.

Section – B *(11 – 18, 29 – 36, 47 – 54):* This section contains **TWENTY FOUR (24)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.

MARKING SCHEME

Section – A (One or More than One Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4	If only (all) the correct option(s) is (are) chosen;
Partial Marks	:	+3	If all the four options are correct but ONLY three options are chosen;
Partial marks	:	+2	if three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks	:	+1	If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–2	In all other cases.

Section – A (Single Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+3	If ONLY the correct option is chosen.
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–1	In all other cases.

Section – B: Answer to each question will be evaluated according to the following marking scheme:

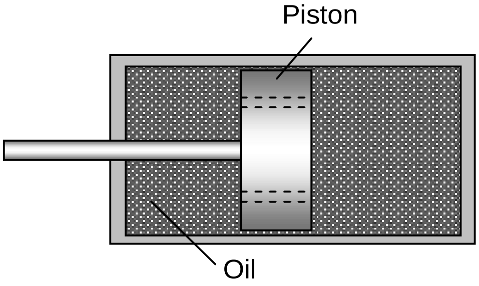
Full Marks	:	+3	If ONLY the correct numerical value is entered at the designated place;
Zero Marks	:	0	In all other cases.

Physics PART – I

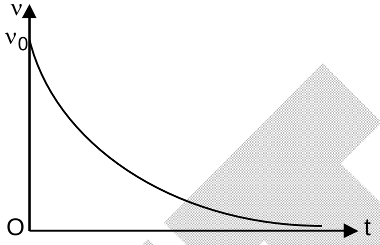
Section – A (Maximum Marks: 24)

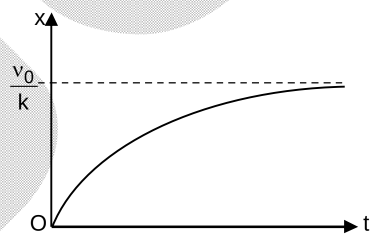
*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

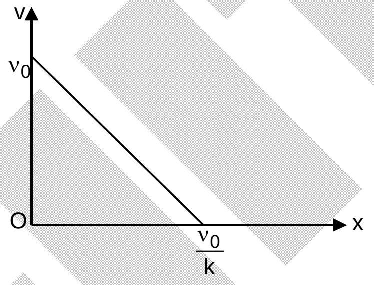
1. The brake mechanism used to reduce recoil in certain types of guns consist essentially of a piston attached to the barrel and moving in a fixed cylinder filled with oil. As the barrel recoils with an initial velocity υ_0, the piston moves and oil is forced through orifices in the piston, causing the piston and the barrel to decelerate at a rate proportional to their velocity; that is, $a = -k\upsilon$, (k > 0), where v and x are the velocity and position of barrel at time t.

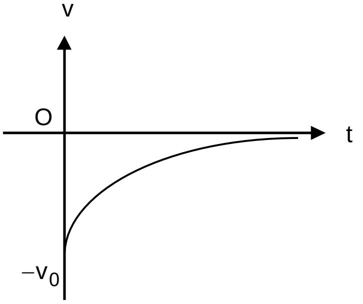


Choose correct graph(s):

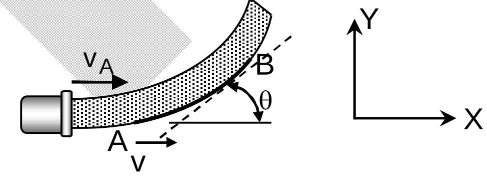
(A)


(B)


(C)


(D)


2. A nozzle discharges a stream of water of cross – sectional area A with a velocity v_A. The stream is deflected by a single blade which moves to the right with a constant velocity V. Assuming that the water moves along the blade at constant speed, Choose the correct option(s);



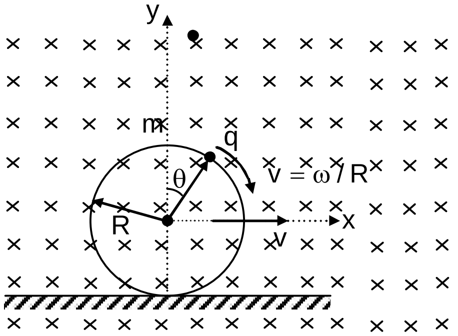
(A) The Y component of the force exerted by the blade on the steam is $A\rho(V_A - V)^2 \sin\theta$.

(B) The X component of the force exerted by the blade on the steam is $A\rho(V_A - V)^2(1 - \cos\theta)$

(C) The X component of the force exerted by the blade on the steam is $A\rho(V_A - V)^2 \cos\theta$

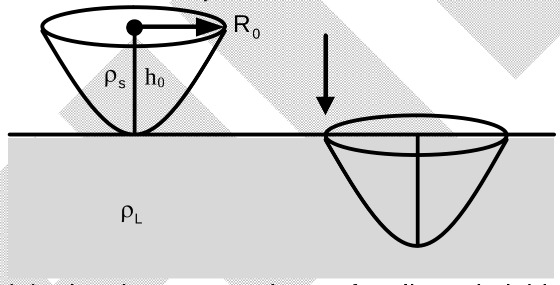
(D) The velocity V for which maximum power is developed is $V = \frac{V_A}{3}$

3. A ring of mass m and radius R is set into pure rolling on horizontal rough surface, in a uniform magnetic field of strength B-as shown in the figure. A point charge(q) of negligible mass is attached to rolling ring. Friction is sufficient so that it does not slip at any point of its motion. (θ is measured in clockwise from positive y-axis)



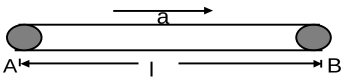
(A) Ring will continue to move with constant velocity.
(B) The value of friction acting on ring is Bqv cos θ.
(C) The value of friction acting on ring is Bqv $\sin\theta$.
(D) Ring will lose contact with ground if v is greater than $\left(\frac{mg}{2qB}\right)$

4. A solid paraboloid of base radius R_0 and height h_0 is having uniform volume mass density of ρ_s is Inverted and placed just above the surface as shown, of a liquid having volume mass density of ρ_L. When paraboloid is released from rest it has been observed that when it becomes completely submerged in the liquid the paraboloid comes to the rest again. There exist uniform gravity of g. Assume that the liquid body is very large so that liquid level is not changing as the paraboloid enters into the liquid.

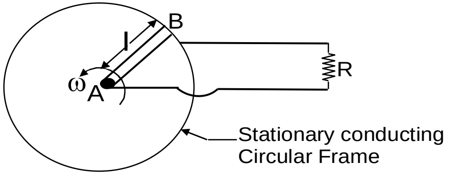


(A) The phenomenon is true for all paraboloids irrespective of their dimensions as long as density ratio is maintained.
(B) The phenomenon is not true for all paraboloids irrespective of their dimensions as long as density ratio is maintained.
(C) The ratio of $\frac{\rho_L}{\rho_s}$ is 2.
(D) The ratio of $\frac{\rho_L}{\rho_s}$ is 3.

5. consider a metal rod of length L that is given a uniform acceleration as shown in figure (a) and an identical rod rotating with constant angular velocity in figure (b).



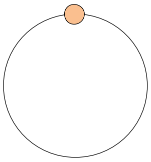
(a)



(b)

(A) If V_A and V_B are potentials of end A and B respectively, then $V_A < V_B$ in figure (a)
(B) If V_A and V_B are potentials of end A and B respectively, then $V_A > V_B$ in figure (b)
(C) Electric field inside rod has magnitude $\frac{ma}{e}$ in figure (a)
(D) Electric field inside rod has magnitude $\frac{m\omega^2 r}{e}$ in figure (b)

6. A bead is fixed on a rigid ring of radius r and negligible mass as compared to that of the bead. Assembly thus formed is held motionless on a horizontal floor with the plane of the ring vertical and the bead on the top. Coefficient of friction between the ring and the floor is μ. Now the assembly is given a slight push so that the ring starts rolling Acceleration of free fall is g. Choose the correct statements.



(A) The angle rotated by the ring before it begins to slide is $\tan^{-1}(\mu)$
(B) The speed of centre of the ring before it begins to slide is $\mu\sqrt{gR}$
(C) The angle rotated by the ring before it begins to slide is $2\tan^{-1}(\mu)$
(D) The speed of the centre of the ring before it begins to slide is $\mu\sqrt{2gR}$

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (I), (II), (III) and (IV) and FIVE statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

---

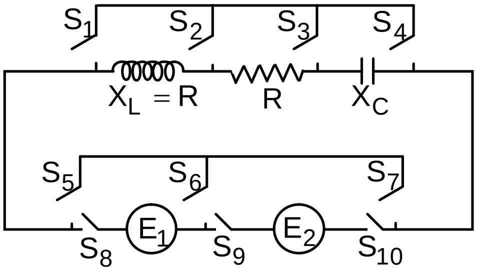
7. The ground state energy of hydrogen atom is -13.6 eV. A sample of hydrogen atoms in its ground state is irradiated with photons of energy 10.2 eV. The radiations from the above sample is then incident on two sample containing excited He^+ ions and excited Li^{2+} ions respectively. Both the samples absorb the radiations. (use $hc = 12400\ \text{eV}\ \overset{o}{A}$)

List-I		List-II	
(I)	No. of spectral lines obtained in the Spectra of Li^{2+}	(P)	6
(II)	No. of spectral lines obtained in the Spectra of He^+	(Q)	15
(III)	Smallest wavelength in spectra of He^+ is $(48.8)X\ \overset{o}{A}$ then X (Approx.) is	(R)	5
(IV)	Smallest wavelength in spectra of Li^{2+} is $(10.4)Y\ \overset{o}{A}$ then Y (Approx.) is	(S)	10
		(T)	18

Codes:

	I	II	III	IV
(A)	R	P	P	T
(B)	Q	P	P	Q
(C)	Q	P	R	S
(D)	T	P	R	Q

8. Consider a given series LCR circuit as shown in figure. There are 10 switches. In list-I switches which are closed, is given and corresponding value is asked. In list-II these values are given. Choose the proper value from list-II to list-I using the codes given below.



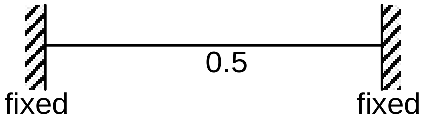
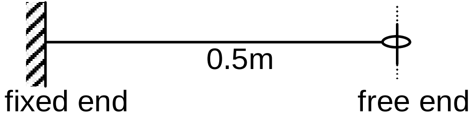
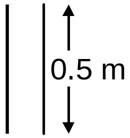
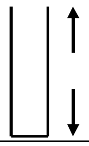
$E_1 = E_0 \sin\omega t \qquad E_2 = E_0 \sin(\omega t + \phi)$

List-I		**List-II**	
(I)	It is observed that effective current in the circuit in case if either S_8, S_6 and S_7 or if S_5, S_6, S_9, S_{10} or if S_8, S_9 and S_{10} are closed (Rest open) remains same.	(P)	$\frac{2\pi}{5}$
(II)	Switch S_8, S_9 & S_{10} are closed. Now its observed if rest switches are opened or switches S_3, S_4 are closed (rest opened) effective value of current in the circuit is same, value of $\frac{4\pi X_C}{5R}$ is	(Q)	$\frac{\pi}{2}$
(III)	Switch S_8, S_6, S_7 are closed. Now effective current if S_1, S_2 closed (Rest opened) is I_1 and If S_3, S_4 closed (Rest opened) is I_2, value of $\pi\left(\frac{I_1}{I_2}\right)^2$ is	(R)	$\frac{2\pi}{3}$
(IV)	Switch S_5, S_6, S_9 and S_{10} are closed. Peak value current if rest are opened is I_3 and if S_2, S_3 closed (Rest opened) is I_4. Value of $\pi\left(\frac{I_3}{I_4}\right)^2$ is	(S)	$\frac{8\pi}{5}$
		(T)	$\frac{\pi}{3}$

Codes:

	I	II	III	IV
(A)	Q	S	P	T
(B)	Q	T	P	S
(C)	R	P	T	Q
(D)	R	S	P	Q

9. In each of the four situations of List I, a stretched string or an organ pipe is given along with the required data. In case of strings the tension in strings is $T = 102.4$ N and the mass per unit length of string is 1 g/m. Speed of sound in air is 320 m/s. Neglect end corrections. The frequencies of resonance are given in List II. Match each situation in List I with the possible resonance frequencies given in List II.

List-I		**List-II**	
(I)	String fixed at both ends 	(P)	320 Hz
(II)	String fixed at one end and free at other end 	(Q)	480 Hz
(III)	Open organ pipe 	(R)	640 Hz
(IV)	Closed organ pipe 	(S)	
		(T)	1280 Hz

Codes:

	I	II	III	IV
(A)	P	R	Q	S
(B)	P	S	R	Q
(C)	R	Q	S	P
(D)	Q	S	P	R

10. There exists a uniform electric field in space. Potential of few points in space is given below

Coordinates	(0, 0, 0)	(a, 0, 0)	(0, b, 0)	(0, 0, c)
Potential	1 V	2 V	3 V	4 V

Match the points in List I with their potential in List II

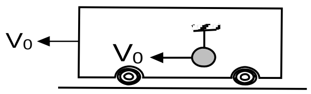
List-I		**List-II**	
(I)	(a, b, 0)	(P)	4V
(II)	(a, b, c)	(Q)	7V
(III)	(-a, -b, -c)	(R)	0V
(IV)	(0, b, c)	(S)	6V
		(T)	–5V

Codes:

	I	II	III	IV
(A)	R	T	Q	S
(B)	P	Q	T	S
(C)	S	Q	P	R
(D)	T	P	Q	R

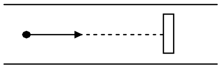
Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*



11. A pendulum with massless string of length l and bob of mass m is attached inside a railway carriage which is moving with speed v_0 as shown. Carriage is brought to rest uniformly by applying brakes. When carriage comes to rest pendulum string is horizontal.
Minimum magnitude of retardation of carriage such that bob completes vertical circular motion is (in ms^{-2}).
(g = 10 ms^{-2})

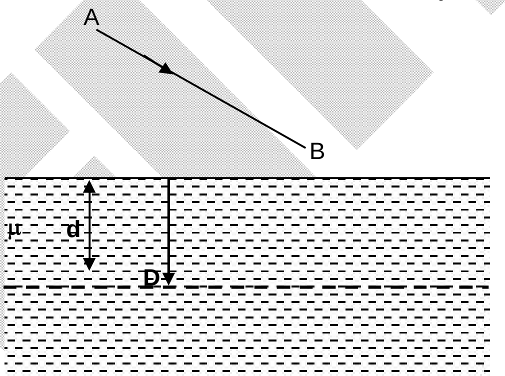
12. A small boat is travelling downstream with velocity 5 m/s relative to river flowing with speed 7/3 m/s. it encounters a log floating in the river at some distance from itself. It turns by an angle of 37^o and just crosses the edge of the log after 8 sec. Find time (in seconds) taken by boat to just cross the edge of log if log is kept fixed.



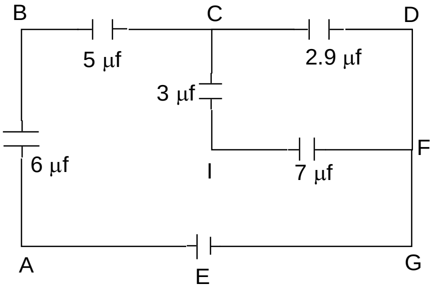
13. In YDSE, if sources are incoherent, the intensity on screen is 13*I$_0$*. When these sources are coherent then minimum intensity on screen is *I$_0$*. The maximum intensity produced by these coherent sources on screen is___W/m^2 $\left[\text{given } I_0 = 1W/m^2\right]$

14. The electrostatic flux through a rectangular area of $\frac{7}{188}m^2$ lying in a plane $2x+3y+6z=10$ due to an electric field $\left(8\hat{i}+6\hat{j}+10\hat{k}\right)V/m$ will be in (V – m)

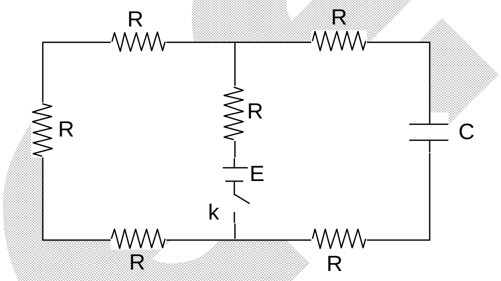
15. A diver D is still under water $\left(\mu = \frac{4}{3}\right)$ at a depth d = 10m. A bird is diving along line AB at a constant velocity in air. When the bird is exactly above the diver he sees it at a height of 50 m from himself and velocity of the bird appears to be inclined at 45^0 to the horizontal. At what distance from the diver, the bird actually hits the water surface. (in meter)



16. Consider the circuit shown. If in steady state $V_A - V_C = 1$ volt, find $11(V_I - V_G)$ in steady state.



17. In the given circuit initially the capacitor is uncharged. At t = 0 the key k is closed. The time constant of circuit is n times of RC. Find the value of 'n'.



18. The pitch of a screw gauge is 1 mm and its cap is divided into 100 divisions. When nothing is placed between its studs, the zero of the circular scale lies 6 divisions below the reference line. When a wire is placed between its studs, the main scale reading is 4 mm and 56th division of circular scale coincides with the reference line. The length of the wire is 4.20 cm. Find the curved surface area (*in cm*^{2}) of the wire in true significant figures.

FIITJEE

Chemistry PART – II

Section – A (Maximum Marks: 24)

This section contains ***SIX (06)*** *questions. Each question has* ***FOUR*** *options (A), (B), (C) and (D).* ***ONE OR MORE THAN ONE*** *of these four option(s) is (are) correct answer(s).*

19. The radial wave equation for hydrogen atom is:

$$\psi = \frac{1}{16\sqrt{4}}\left(\frac{1}{a_0}\right)^{3/2}\left[(x-1)\left(x^2-8x+12\right)\right]e^{-x/2}$$

where $x = 2r/a_0$, $a_0 =$ radius of first Bohr's orbit.

Select the correct statement(s)

(A) minimum position of node will be $0.5a_0$

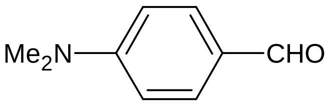
(B) maximum position of node will be $3a_0$

(C) There will be 3 radial nodes

(D) There will be 2 radial nodes

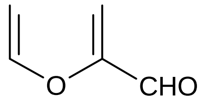
20. How many of the following will give Cannizzaro reaction?

(A)

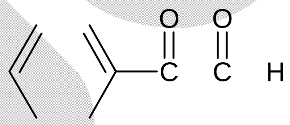


(B) Me_2CHCHO

(C)



(D)



21. On the basis of MO theory, which is correct?

(A) The bond order for C_2 molecule is two and both bond are π bond

(B) The bond order for C_2 molecule is two and one bond is π and one is σ

(C) The bond order for C_2 molecule is two and both bond are σ bond

(D) Total bonding e^- in C_2 is 8

22. Which of the following statement(s) is (are) correct about slag?

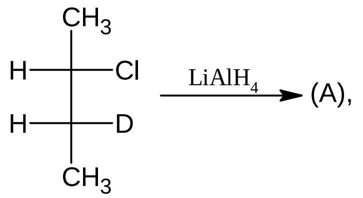
(A) The calcium silicate, $CaSiO_3$ is obtained in slag formation zone in the extraction of iron from haematite ore.

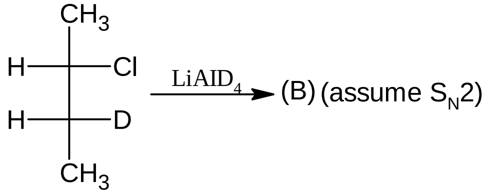
(B) The chemical composition of "slag" formed during the smelting process in the extraction of copper is $FeSiO_3$

(C) In blast furnace/Bessemer converter, the upper layer of molten liquid (i.e. molten metal) is of slag.

(D) The slag is fusible matter.

23.





Select the correct is/are statement(s)

(A) A is optically active

(B) B is optically active

(C) A is optically active, but B is optically inactive

(D) A is optically inactive, B is optically active

24. Which of the following orders is/are correct?

(A) $SbH_3 > NH_3 > AsH_3 > PH_3$ – Boiling point

(B) $NH_3 > PH_3 > AsH_3 > SbH_3$ – Thermal stability

(C) $NH_3 > PH_3 > AsH_3 > SbH_3$ – Basic character

(D) $NH_3 > PH_3 > AsH_3 > SbH_3$ – Bond Angle

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (I), (II), (III) and (IV) and FIVE statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

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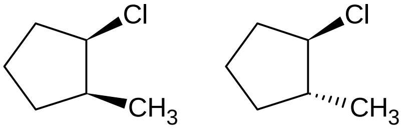
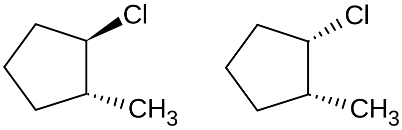
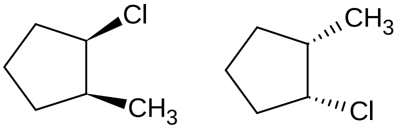
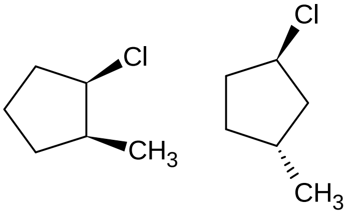
25. Consider the following list:

List - I			**List - II**		
	Electrode			**Anode**	**Cathode**
(I)	Fused NaCl	Graphite & mercury	(P)	$O_{2(g)}$	$Na(g)$
(II)	Conc. NaCl	Pt	(Q)	$O_{2(g)}$	$H_2(g)$
(III)	Dil. NaCl	Pt	(R)	$Cl_{2(g)}$	$H_2(g)$
(IV)	Dil. $NaCl_{(aq)}$	Mercury	(S)	$Cl_{2(g)}$	$Na_{(s)}$
			(T)	$O_{2(g)}$	$Cl_{2(g)}$

Codes:

	I	II	III	IV
(A)	S	R	Q	P
(B)	T	R	Q	P
(C)	S	T	Q	P
(D)	S	R	T	P

26. Match List-I with List-II:

List – I (Molecules)		**List – II (Relationship)**	
(I)		(P)	Identical
(II)		(Q)	Enantiomer
(III)		(R)	Diastereomer
(IV)		(S)	Structural isomerism
		(T)	Homomers

Codes:

	I	II	III	IV
(A)	R	T	P	S
(B)	R	R	T	S
(C)	R	R	P	T
(D)	R	R	P	S

27. Consider the following lists:

List - I		**List - II**	
(I)	$CH_2=CH-CHO \xrightarrow{NaBH_4,alc}$	(P)	Acetal
(II)	$C_6H_5CHO + Ph-NH_2 \xrightarrow{pH(4-5)}$	(Q)	Schiff's base
(III)	$C_6H_5COCH_3 + CH_3-CH_2-NH-CH_3 \xrightarrow{pH(4-5)}$	(R)	Unsaturated alcohol
(IV)	$RCHO + 2RCH_2OH \xrightarrow{H^+}$	(S)	Enamine
		(T)	Imine

Which one is correct?

Codes:

	I	II	III	IV
(A)	R	Q	S	P
(B)	T	Q	S	P
(C)	R	T	S	P
(D)	R	Q	T	P

28. Consider the following lists:

List - I		**List - II**	
(I)	$Me_3C-Cl+EtO^-Na^+$	(P)	Me_3C-OEt
(II)	$EtCl+Me_3CO^-Na^+$	(Q)	Alcohol
(III)	$PhCl+MeO^-Na^+$	(R)	Anisole
(IV)	PhO^-Na^++MeCl	(S)	No result
		(T)	$Ph-O-Ph$

Which one is correct?

Codes:

	I	II	III	IV
(A)	P	Q	S	R
(B)	S	P	Q	R
(C)	Q	P	S	R
(D)	Q	P	T	R

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

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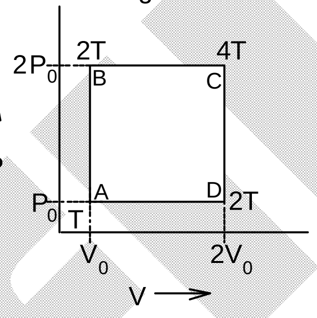
29. With strong oxidizing agent, the oxidation product of $K_4\left[Fe(CN)_6\right]$ is K_2O, Fe_2O_3, NO_3^- and CO_3^{2-}, then what will be the 'n' factor of $K_4\left[Fe(CN)_6\right]$.

30. For the acid indicator (HIn) thymol blue, pH is 2.176 when 60% of the indicator is in ionized form. Find the % indicator in unionized form in the solution with $\left[H^+\right]=3.33\times10^{-3}M$.

31. Find out the efficiency (in %) of the following cyclic process $A\rightarrow B\rightarrow C\rightarrow D\rightarrow A$ for 1-mole mono-atomic gas.



32. A solution having a vapour pressure of 520 mm of Hg contains o-nitrophenol and p-nitrophenol with mole fraction of 0.6 and 0.4 respectively. One of the above has $P^\circ = 400$ mm of Hg. The vapour pressure of o-nitrophenol is

33. A hydrogen like species with atomic number 'Z' is in excited state 'n' and emits photons of energy 25.7 and 8.7 eV when makes a transitions to 1st and 2nd excited state respectively. Ionisation energy (eV) of specie is

34. What should be the relative humidity below which $CuSO_4.5H_2O$ would efflorescent at $25°C$? For the reaction

$$CuSO_4.5H_2O_{(s)} \rightleftharpoons CuSO_4.3H_2O_{(s)} + 2H_2O_{(g)}$$

at $25°C$ Kp is $1.0 \times 10^{-4} atm^2$ and vapour pressure of water is 30.4 torr. (Given: Relative humidity is the ratio of amount moisture in air to the maximum amount of moisture that could exist in air at specific temperature)

35. Potassium has a bcc structure with nearest neighbours distance 4.52 A. Its atomic weight is 39. Its density (in kg m^{-3}) will be:

36. Two moles of an ideal triatomic gas $\left(\gamma = \frac{4}{3}\right)$ at 16 bar and 300 K are expanded reversibly upto a final pressure of 1 bar. How much work (in J (magnitude)) is done by the gas?

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Mathematics PART – III

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

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37. If $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$ are roots of equation $x^5 - 5x^4 - 1 = 0$, then

(A) $\sum_{r=1}^{r=5} \frac{1}{\alpha_r^4} = -\frac{1}{20}$ (B) $\sum_{r=1}^{r=5} \frac{1}{\alpha_r^4} = -20$

(C) $\prod_{r=1}^{r=5}\left(\frac{1}{\alpha_r^4} + 5\right)^5 = 1$ (D) $\prod_{r=1}^{r=5}\left(\frac{1}{\alpha_r^4} + 5\right)^3 = \frac{1}{5}$

38. If three non-zero and non-collinear vectors $\hat{i} + a\hat{j} - \hat{k}$, $2\hat{i} - \hat{j} + 3\hat{k}$ and $a\hat{i} - \hat{j} + 3\hat{k}$ are coplanar, then 'a' is/are

(A) $\frac{1}{3}$ (B) 2

(C) $-\frac{1}{3}$ (D) –2

39. If $3f(x) + 4f(3-x) = 3x^2 - 8$ and $\int_\alpha^\beta f(x)dx \le 0$, where $\alpha, \beta\ (\alpha < \beta)$ are roots of $x^2 - 3x + a = 0$, then 'a' can be

(A) $\frac{-1}{101}$ (B) $\frac{1}{101}$

(C) $\frac{2}{301}$ (D) $\frac{401}{301}$

40. If the curves $y = \lambda x^2 + \lambda x + \frac{1}{24}$ and $x = \lambda y^2 + \lambda y + \frac{1}{24}$ are tangent to each other, then λ can be

(A) $\frac{2}{3}$ (B) $\frac{3}{2}$

(C) $\frac{13 + \sqrt{601}}{12}$ (D) $\frac{-13 + \sqrt{601}}{12}$

41. $\lim\limits_{n \to \infty} \frac{1}{n^2}\left[(n+1)\left(n + \frac{1}{2}\right)\left(n + \frac{1}{2^2}\right)........\left(n + \frac{1}{2^{n-1}}\right)\right]^n$ is 'a', then

(A) $[a] = 5$ (B) $[a] = 7$

(C) $(a) = 6$ (D) $(a) = 8$

Here (.) represents least integer part and [.] represents greatest integer part.

42. a, b, c are distinct complex numbers with $|a| = |b| = |c| = 1$ and z_1, z_2 be the roots of the equation $az^2 + bz + c = 0$ with $|z_1| = 1$. Also, let P and Q represents the complex numbers z_1 and z_2 in the complex plane with $\angle POQ = \theta$, where O is origin. Then,

(A) $b^2 = ac,\ \theta = \frac{2\pi}{3}$
(B) $\theta = \frac{2\pi}{3},\ PQ = \sqrt{3}$
(C) $b^2 = ac,\ PQ = 2\sqrt{3}$
(D) $2b^2 = ac,\ \theta = \frac{\pi}{3}$

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (I), (II), (III) and (IV) and FIVE statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

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43. Let N be the number of words which can be formed using all the letters of the word "DARJEELING" so that there are at least two consonants between any two vowels. Then match List I with List II:

	List - I		**List - II**
(I)	If N is divisible by 2^n $(n \in N)$, then n can be	(P)	1
(II)	If N is divisible by 6^P $(P \in N)$, then P must be less than	(Q)	2
(III)	Number of odd divisors of N is greater than	(R)	3
(IV)	Number of zeroes at the end of N is less than	(S)	4
		(T)	5

Codes:

	I	II	III	IV
(A)	PQR	QRST	PQRST	PST
(B)	QRT	PQT	PQRS	PQRST
(C)	PQRST	ST	PQRST	QRST
(D)	PQST	PQRST	PQRT	PQR

44. Given $y = ax^2 + bx + c$ is a quadratic expression for $x \in$ [0, 2], y falls completely in [0, 1] and $-\frac{b}{2a} \notin$ (0, 2). Then, for $a \neq 0$, match the following:

	List - I		**List - II**
(I)	The value of *c* may be	(P)	0
(II)	The value of $\lvert 2a + b \rvert$ may be	(Q)	1
(III)	If $\frac{\lambda}{a}$ is a root of $ax^2 + bx + c = 0$, then λ may be	(R)	$\frac{1}{2}$
(IV)	The sum of roots of $ax^2 + bx + c = 0$ is $\left(p^2 + p + 3\right)$ for $p \in R$, then the value of $\lvert a \rvert$ can't be	(S)	$\frac{4}{3}$
		(T)	2

Codes:

	I	II	III	IV
(A)	PQ	R	PR	QST
(B)	PQR	PR	T	ST
(C)	ST	Q	PQ	RS
(D)	R	ST	QST	PQ

45. Match the equations in List I to solution in List II:

List - I		List - II	
(I)	$\frac{2}{\pi}\tan\left(\frac{\pi x}{2}\right)+\frac{1}{2x}=\left(\frac{\pi+2}{\pi}\right)e^{-k}$ for $0 < x < 1$	(P)	Only one solution for $k \in (0, 1/e)$
(II)	$\ln x = kx$ has	(Q)	Only one solution for $k \in \left(-\frac{1}{e}, 0\right)$
(III)	$xe^{x} = k$ has	(R)	Two solutions for $k \in \left(\frac{-1}{e}, 0\right)$
(IV)	$x\ln x = k$ has	(S)	Two distinct solutions for $k \in \left(0, \frac{1}{e}\right)$
		(T)	No solution for $k \in \left(0, \frac{1}{e}\right)$

Codes:

	I	II	III	IV
(A)	PQ	T	S	PR
(B)	T	PT	PR	QS
(C)	QS	Q	PT	R
(D)	RT	QS	PR	PR

46. Match the locus of 'z' in List I from List II:

List - I		List - II	
(I)	Straight line	(P)	If $z^2 z + +z^2 z = (z + z)$; then z lies on
(II)	Circle	(Q)	If $\left\| \|z-3\| - \|z+3\| \right\| \le 6$, then z lies on
(III)	Parabola	(R)	If $z^3 z + zz^3 - 2\left(z^2 + z^2 - 4\left(\|z\|^2 - 2\right)\right)$, then z lies on
(IV)	Hyperbola	(S)	$\left(z^2 + \bar{z}^2\right) - 4\ \mathrm{Re}\ (z) \times \left(\left(z - \bar{z}\right)^2 - \left(z + \bar{z}\right)\right) = 0$, then z lies on
		(T)	$z^2 + \bar{z}^2 = z\bar{z}$, then z lies on

Codes:

	I	II	III	IV
(A)	PQ	PR	S	QR
(B)	Q	PR	QS	T
(C)	QR	QR	S	P
(D)	P	T	Q	S

Section – B (Maximum Marks: 24)

This section contains ***EIGHT (08)*** *numerical based questions. The answer to each question is a* ***NUMERICAL VALUE.*** *If the numerical value has more than two decimal places, truncate/round-off the value to* ***TWO*** *decimal places.*

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47. If $\cos^{-1}(2-x^2)+\sin^{-1}(2-x^2)+\tan^{-1}x \ge \frac{2\pi}{3}$. Given the solution set, $\alpha \le x \le \beta$, then $\left(\alpha + \frac{1}{\beta^2}\right)$ is equal to

48. If $y = \cfrac{x}{x^2 + \cfrac{x}{x^2 + \ldots\infty}}$, then $\int \frac{\left(y - x^2\right)dx}{\left(x^2+y\right)\left(x+y^2\right)} = f(y)$. Then, $f'(4)$ is equal to

49. If $(9\sin x + 4\operatorname{cosec} x) = 2k + 4$ has only three solutions, then $k =$

50. If $\sqrt{5}x - 2y + 5 = 0$ is a tangent at any point P on the parabola whose focus is $\equiv\left(-\sqrt{5}, 2\right)$ & length of latus rectum is 4 units; intersect axis at A & normal at point P intersect axis at B, then the circum radius of ΔPAB is

51. If $\frac{1}{e-1}\sum_{n=1}^{50}\frac{1}{(n+1)!}\int_{-n}^{n} e^{\{|x|\}}\frac{dx}{1+e^{\sin x}} = 1 - \frac{1}{(ab)!}$
where a and b are prime, then $|a-b|$ is equals to

52. Let $f(x) = x^3 - x^2 - x + 1, g(x) = a^2 - 2$ (where a is real parameter) and $f(x) = g(x)$ has three real and distinct roots, then $f(x) = [a^2]$ has real root having the integral part (where [.] is G.I.F) equal to

53. If $\frac{3x^2+1}{\sqrt{x^4+x^2}} \geq \max f(x)$, where $f(x)$ is constant for $0 < x \leq \sqrt{2}$, then minimum value of
$\int_0^{\sqrt{2}} \frac{3x^2+1}{\sqrt{x^4+x^2}}dx$ is

54. Let x, y, z are selected from the set of natural numbers. If the probability that $x^2 + y^2 + z^2$ is divisible by 5 is $\frac{p}{q}$ (where p, q are coprime), then p + q is equal to

FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
FULL TEST – III
PAPER –2
TEST DATE: 08-02-2023

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B**.

Section – A ***(01 – 04, 19 – 22, 37 – 40)*:** This section contains **TWELVE (12)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.

Section – A ***(05 –10, 23 – 28, 41 – 46)*:** This section contains **EIGHTEEN (18)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – B ***(11 – 18, 29 – 36, 47 – 54)*:** This section contains **TWENTY FOUR (24)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.**

MARKING SCHEME

Section – A (Single Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct option is chosen.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –1 In all other cases.

Section – A (One or More than One Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If only (all) the correct option(s) is (are) chosen;
Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;
Partial marks : +2 if three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –2 In all other cases.

Section – B: Answer to each question will be evaluated according to the following marking scheme:

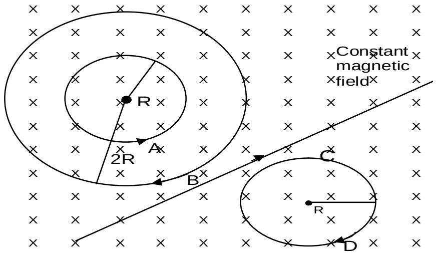
Full Marks : +3 If ONLY the correct integer is entered;
Zero Marks : 0 Question is unanswered;
Negative Marks : –1 In all other cases.

Physics PART – I

Section – A (Maximum Marks: 12)

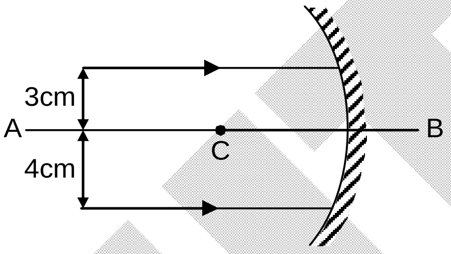
*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

1. Four particles A, B, C and D of masses m_A, m_B, m_C and m_D respectively, follow the paths shown in the figure, in a uniform magnetic field. Each particle moving with same speed. Q_A, Q_B, Q_C and Q_D are the specific charge of particles A,B,C and D respectively :



(A) $Q_A < Q_B < Q_C < Q_D$
(B) $Q_D < Q_B < Q_C < Q_A$
(C) Charge on the particle B and particle D is of different nature
(D) Work done by magnetic force on the particle C is minimum as compared to other particle

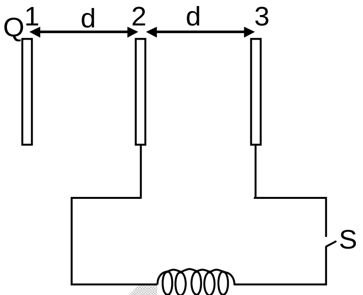
2. Two rays are incident on a spherical concave mirror of radius $R = 5$ cm and rays are parallel to a line AB which passes through the centre C. The rays are at perpendicular distances 3 cm and 4 cm from AB respectively as shown. Find the distance between the points at which these rays intersect the line AB after reflection –



(A) $\frac{25}{24}$cm
(B) $\frac{24}{25}$cm
(C) zero
(D) $\frac{1}{3}$cm

3. A neutron collides head-on with a stationary hydrogen atom $\left({}_1H^1\right)$ in ground state, then choose the correct statement: (Assume that mass of neutron and mass of ${}_1H^1$ atom is same)
(A) If kinetic energy of the neutron is less than 13.6 eV, collision must be elastic
(B) If kinetic energy of the neutron is less than 13.6 eV, collision may be inelastic
(C) Inelastic collision may take place only when initial kinetic energy of neutron is less than 13.6 eV
(D) None of these

4. Three identical large plates are fixed at separation of d from each other as shown. The area of each plate is A. Plate 1 is given charge +Q while plates 2 and 3 are neutral and are connected to each other through coil of inductances L and switch S. If resistance of all connected wires is neglected the maximum current flow through coil after closing the switch is $\left(C = \varepsilon_0 A / d\right)$ (neglect fringe effect)

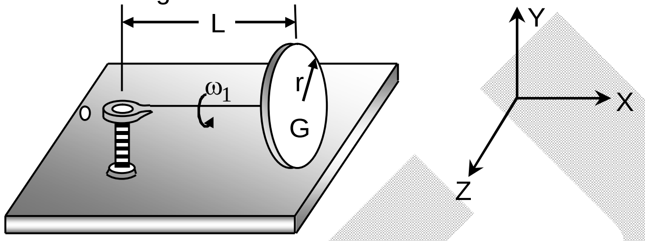


(A) $\frac{Q_0}{\sqrt{LC}}$
(B) $\frac{Q_0}{\sqrt{2LC}}$
(C) $\frac{2Q_0}{\sqrt{LC}}$
(D) $\frac{Q_0}{2\sqrt{LC}}$

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

5. A homogeneous disk of radius r and mass m is mounted on an axle OG of length L and negligible mass. The axle is pivoted at the fixed point O, and the disk is constrained to roll on a horizontal floor. Knowing that the 'disk' rotates counterclockwise at the rate ω_1 about the axle OG,



Choose the correct option(s)

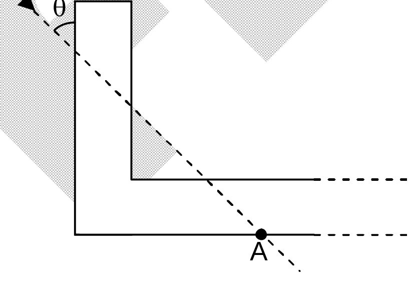
(A) The angular velocity of the disk $\omega_1\hat{i} - \frac{\omega_1 r}{L}\hat{j}$

(B) The angular velocity of the disc $-\left(\frac{\omega_1 r}{L}\right)\hat{j}$

(C) The X component of angular momentum of disc about 'O' is $\frac{1}{2}mr^2\omega_1$

(D) The Z component of angular momentum of disc about 'O' is zero

6. Two glass slabs of same thickness and same refractive index are joined to form an 'L' shape as shown. A ray is incident on the combination as shown (in the plane of paper)., Choose correct option(s):



(A) Total deviation will zero for all values of θ.
(B) Total deviation will be zero for $\theta = 45°$ only.
(C) The ray will emerge from point A for all values of θ.
(D) The ray will emerge from point A for $\theta = 45°$ only.

7. If the two slits of double slit experiment were moved symmetrically apart with small relative velocity v and the distance between screen and mid-point of slits is fixed and equal to D. Consider a point P on the screen at a distance x from central maxima then (x<<<D):

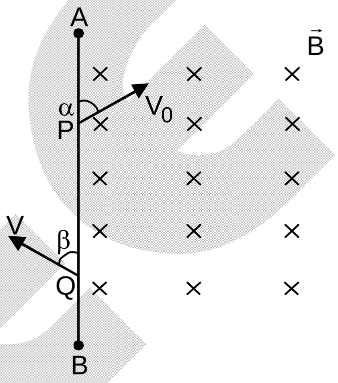
(A) Rate of change of number of fringes between central maxima and point P changes with respect to time is $\frac{xv}{\lambda D}$

(B) Number of fringes contained between central maxima and point P increases with time

(C) Fringe width decreases as time passes

(D) Fringe width increases as time passes

8. There exists a uniform magnetic field perpendicular to piane of the paper (inward) right side of the line AB. A particle of charge –q and mass m enters uniform magnetic field B (perpendicular to paper inward) at P with a velocity V_0 at an angle α and leaves the field at Q with velocity V at angle β as shown in figure.



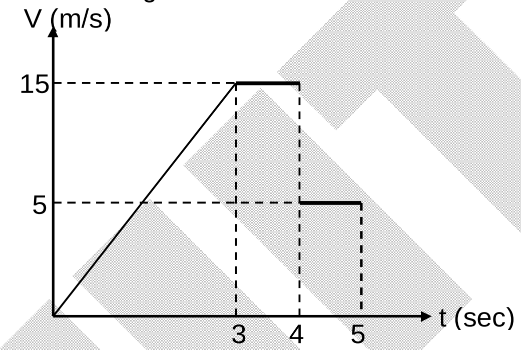
(A) $\alpha = \beta$

(B) $V = V_0$

(C) $PQ = \frac{2mV_0 \sin\alpha}{Bq}$

(D) The particle remains in the field for time $t = \frac{2m(\pi - \alpha)}{Bq}$

9. The figure shows the velocity as a function of the time for an object with mass 10 kg being pushed along a frictionless horizontal surface by external horizontal force. At $t = 3$ s, the force stops pushing and the object moves freely. It then collides head on and sticks to another object of mass 25 kg.



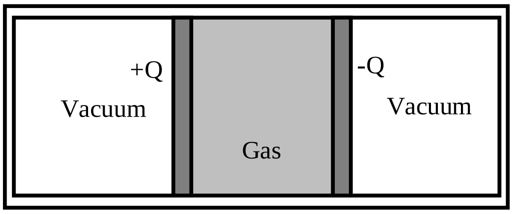
(A) External force acting on the block of mass 10 kg is 50 N from $t = 0$ to $t = 3$ sec.

(B) Speed of the 2^{nd} particle just before the collision is 1 m/s.

(C) Before collision both bodies are moving in the same direction.

(D) Before collision, bodies are moving in opposite direction.

10. A ideal gas having **f** degrees of freedom is kept inside a thermally insulated vessel, the vessel has two large pistons each with charge of +Q and -Q. Assume charges are uniformly distributed. Pistons can move without friction inside the vessel. At an instant the charge of pistons is increased **k** times with the help of an external agent. Then which of the following statements are correct



(A) The Ratio of final to initial temperature of gas in equilibrium is $\frac{K^2+f}{2+f}$.

(B) The Ratio of final to initial temperature of gas in equilibrium is $\frac{2K^2+f}{2+f}$.

(C) Work done by the agent in the process is $(K^2-1)nRT_1$ where T_1 is initial temperature.

(D) Work done by the agent in the process is $\left(K^2-1\right)\frac{Q^2L_1}{A\varepsilon_0}$ where L_1 is initial separation between pistons.

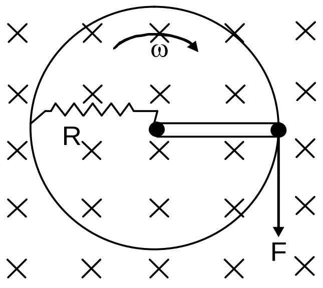
Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.***

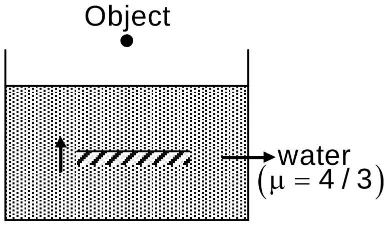
11. A thin spherical soap bubble has surface tension S. Its surface is uniformly charged with charge Q, its volume is V. It is found that when $Q^2 = 16n\pi\varepsilon_0 SV$, the excess pressure inside the bubble becomes zero. Find n.

12. A circular disc of diameter d lies horizontally inside a metallic hemispherical bowl of radius a. The disc is just visible to an eye looking over the edge. The bowl is now filled with a liquid of refractive index $\mu = \sqrt{3}$. Now, the whole of the disc is just visible to the eye in the same position, if $\frac{d}{a}$ is equal to:

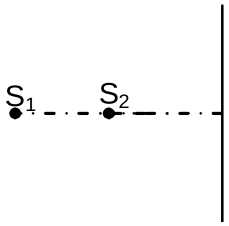
13. A metallic ring of mass 2 kg and radius 1m with a uniform metallic spoke of same mass 2kg and length 1 m is rotated about its axis with angular velocity 1 rev/sec. in a perpendicular uniform magnetic field B of magnitude 10T as shown in figure. If the central end of the spoke is connected to the rim of the wheel through a resistor R magnitude $\pi\Omega$ as shown. The resistor does not rotate, its one end is always at the center of the ring and other end is always in contact with the ring. A force F as shown is needed to maintain constant angular velocity of the spoke then, fill $\frac{F}{25}$ (The ring and the spoke has zero resistance)



14. Mirror in the arrangement shown in figure is moving up with speed 8 cm/sec. Speed of final image (in cm/sec) is 4x, calculate x.



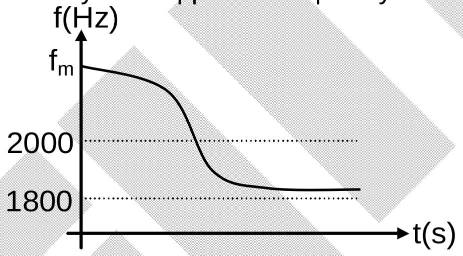
15. Two coherent monochromatic point sources S_1 and S_2 are placed in front of an infinite screen as shown in figure. Wavelength of the light emitted by both the sources is λ. Initial phase difference between the source is zero.



Initially $S_1S_2 = 2.5\lambda$ and the number of bright circular rings on the screen in n_1. If the distance S_1S_2 is increased and made 5.7λ the number of bright circular rings becomes n_2. The difference $n_2 - n_1$ is:

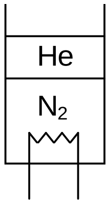
16. If the frequency of k_α x-ray emitted from the element with atomic number 31 is f, if the frequency of k_α x-ray emitted from the element with atomic number 51, is given by $\frac{25}{x}f$, then x is (assume that screening constant for K_α is 1)

17. A stationary observer receives a sound from a source of frequency 2000 Hz moving with constant velocity. The apparent frequency varies with time as shown in the figure.



The value of f_m is (2300 – 10x)Hz. Find the value of x. (Take speed of sound = 300 m/s and neglect the time taken by sound to reach the stationary observer).

18. 5 moles of Nitrogen gas are enclosed in an adiabatic cylindrical vessel. The piston itself is a rigid light cylindrical container containing 3 moles of Helium gas. There is a heater which gives out a power 100 cal/second to the nitrogen gas. A power of 30 cal/sec is transferred to Helium through the bottom surface of the piston. The rate of increment of temperature of the nitrogen gas (in kelvin/sec) is (assuming that the piston moves slowly):



Chemistry

PART – II

Section – A (Maximum Marks: 12)

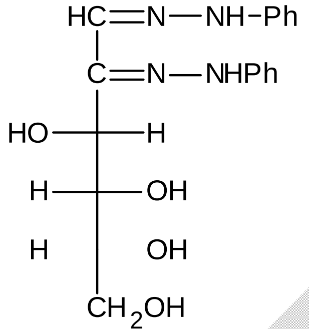
This section contains ***FOUR (04)*** *questions. Each question has* ***FOUR*** *options.* ***ONLY ONE*** *of these four options is the correct answer.*

19. The magnetic moment of $\left[Mn(CN)_6\right]^{3-}$ is 2.8 BM while the magnetic moment of $\left[MnBr_4\right]^{2-}$ is 5.9 BM. The geometries of the complex ions respectively are:

(A) Tetrahedral, tetrahedral
(B) Octahedral, octahedral
(C) Octahedral, tetrahedral
(D) Tetrahedral, octahedral

20. D-glucose on treatment with x mol of $PhNHNH_2$ gives 1 mol of (A), 1 mol of $PhNH_2$ and 1 mol of NH_3. (A) and x are:

A **x**

(A)

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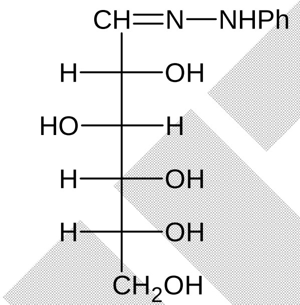
(B)

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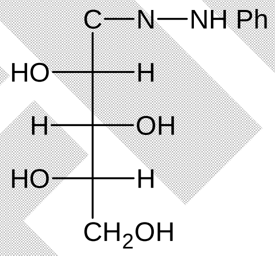
(C)

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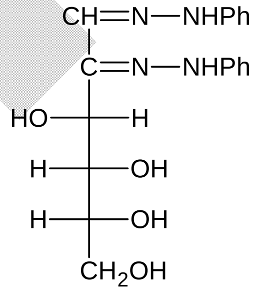
(D)

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21. Initially 3 moles of 'A' was taken in a 1L container. What would be the approx. moles of A left in the container when the following equilibrium is established.

$3A \rightleftharpoons B; \quad K_C = 8\times10^{15}$

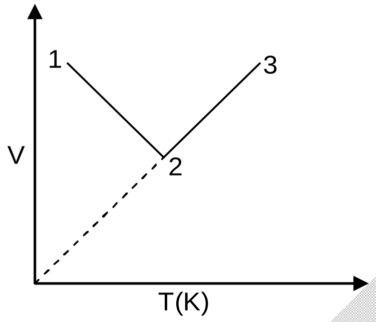
(A) 1.67×10^{-4} (B) 3.33×10^{-8}
(C) 1.25×10^{-10} (D) 5×10^{-6}

22. Which of the following cationic detergents?
(A) Sodium lauryl sulphate (B) Cetyl trimethyl ammonium bromide.
(C) Sodium dodecylbenzene sulphonate (D) Glyceryl oleate

Section – A (Maximum Marks: 24)

This section contains ***SIX (06)*** *questions. Each question has* ***FOUR*** *options (A), (B), (C) and (D).* ***ONE OR MORE THAN ONE*** *of these four option(s) is (are) correct answer(s).*

23. Following graph is constructed for the fixed amount of the gas. Which of the following is/are correct?

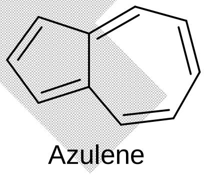


(A) From $1\rightarrow2$ pressure will increase
(B) From $2\rightarrow3$ pressure remains constant
(C) Gas pressure at (3) is greater at state (1)
(D) For pressure the correct order is $P(3) > P(2) > P(1)$

24. The compound(s) which (have) peroxo linkage is (are):
(A) $H_2S_2O_3$ (B) H_2SO_5
(C) $H_2S_2O_7$ (D) $H_2S_2O_8$

25. Which one is classified as addition polymer?
(A) Acrylonitrile (B) Dacron
(C) Neoprene (D) Teflon

26. Which of the following is /are true about azulene?



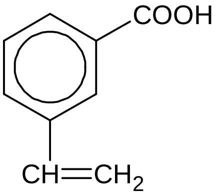
Azulene

(A) Both rings are aromatic in nature
(B) It is soluble in polar solvents
(C) Attack of electrophile occurs at five membered ring
(D) Attack of nucleophile occurs at seven membered ring

27. Which one of the following statements about acidic/ basic strength is/are correct?
(A) $HCOOH$ is more acidic than $Ph-COOH$
(B) Acidic strength odder is as $CH_3OH > H_2O > C_2H_5-OH$
(C) Fumaric acid is stronger acid than Maleic acid
(D) Pyridine is more basic than pyrrole

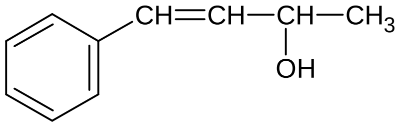
28. Compound 'P' $(C_{10}H_{12}O)$ evolves H_2 gas with Na metal. It reacts with Br_2/CCl_4 to give 'Q' $(C_{10}H_{12}Br_2O)$. With I_2/NaOH it forms iodoforms and an acid 'R' $(C_9H_8O_2)$. 'P' has geometrical and optical isomers. The structure of 'P' and 'R' should be

(A)

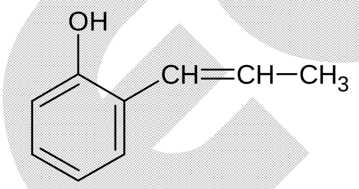


(B) $PH-CH=CH-COOH$

(C)



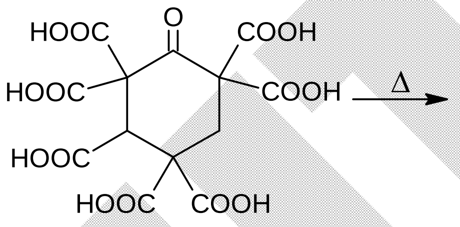
(D)



Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.***

29. The number of moles of CO_2 that will be evolved in the following is



30. How many of the reagents from the lists below would give effeverence when treated with propyne?
NaOH (I) CH_3CH_2ONa (II)
CH_3CH_2MgBr (III) NaH (IV)
$NaNH_2$ (V) Na (VI)
$NaHCO_3$ (VII) $\{(CH_3)CH\}_2NLi$ (VIII)
CH_3CH_2Li (IX)

31. How many of the following are reducing sugars?
Glucose Fructose Mannose Sucrose Maltose Cellobriose
Lactose Cellulose Starch

32. The formation constant of complex HgI_4^{2-} is $1.0 \times 10^{(n \times 5)}$
Given: $E^{\circ}_{\left(Hg^{2+}/Hg\right)} = 0.85$ and $E^{\circ}_{\left(HgI_4^{2-}/Hg,\, I^{-}\right)} = -0.05$ V.
The value of 'n' is

33. 30 ml of 0.2 M NaOH is added to 50 ml 0.2 M CH_3COOH is give 80 ml of the solution. $\frac{10}{x}$ mL of 0.2 M NaOH required to make the pH of the solution 5.00. The value of 'x' is
Given: The ionization constant of $CH_3COOH = 2 \times 10^{-5}$.

34. Iron exists as BCC at 10°C while exist as FCC at 910°C. What would be the percentage decrease in volume of iron at 910°C from 10°C?

35. Among the following how many of the molecule is linear?
CO_2, NO_2^-, SO_2, N_3^-, C_2H_2, I_3^-, XeF_2, $BeCl_2$, CS_2

36. For the reaction: $3A_{(g)} \longrightarrow 2B_{(g)}$, the rate of formation of 'B' at 298 K is represented as $\ln\left(\frac{d[B]}{dt}\right) = -0.04 + 2\ln[A]$. The order of reaction is

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Mathematics PART – III

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

37. If $(\alpha-\beta)$, $(\alpha+\beta)$, $\left(\frac{1}{\alpha}+\frac{1}{\beta}\right)$ are in A.P. for $\alpha>0>\beta$ and $|\alpha|>|\beta|$, then for quadratic equation $ax^2+bx-1=0$

(A) $a\in(-2,\ \infty)$
(B) $a\in(-\infty,\ 2)$
(C) $a\in(-\infty,\ 0)$
(D) $a\in(0,\ \infty)$

38. $\lim\limits_{n\to\infty}\sum\limits_{r=3}^{n}\frac{(r^3-8)}{(r^3+8)}=$

(A) $\frac{1}{3}$
(B) $\frac{2}{5}$
(C) $\frac{3}{8}$
(D) $\frac{2}{7}$

39. Let P be a point (not origin) lying on the parabola $x^2=y$. The normal line to the parabola at P will intersect the parabola at another point Q. The minimum possible value for area bounded by the line PQ and the parabola is

(A) $\frac{2}{3}$
(B) $\frac{3}{4}$
(C) $\frac{4}{3}$
(D) $\frac{3}{5}$

40. If $\frac{(\tan^2 x)}{\left(1+\tan x-\sqrt{1+\tan x}\right)^2}<\frac{\sec^2 x+3\tan x+17}{(1+\tan x)^3}$ for $-\frac{\pi}{2}<x<\frac{\pi}{2}$, then number of solutions of $\tan x+x^2=1$ is/are

(A) 0
(B) 1
(C) 2
(D) Infinite

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

41. Which is/are correct?

(A) $\int_0^{\pi}\frac{\sin^3 x dx}{(1+x)}=3\int_0^{\pi}\sin 2x.(x+1)\left\{\ln\left(\frac{x+1}{e}\right)\right\}dx$
(B) $\int_0^{\pi}\frac{\sin^3 x dx}{2x-\pi}=\int_0^{\pi/2}\frac{\cos^3 x}{x}dx$
(C) $\int_0^{\pi}\frac{\sin^3 x dx}{(1+x)}+\int_0^{\pi}\frac{\cos^3 x}{x}dx=0$
(D) $\int_0^{\pi}\frac{\sin^3 x dx}{(1+x)}=3\int_0^{\pi}\sin 2x(x+1)\ln(x+1)dx$

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42. If α, β are roots of $x^2 - x - 1 = 0$, then quadratic whose roots are either $\left(\dfrac{\alpha^6 - 1}{\alpha^3}\right)$ or $\left(\dfrac{\beta^6 - \beta^3 - 1}{\beta^3}\right)$ is/are

(A) $x^2 - 5x + 4 = 0$
(B) $x^2 - 7x + 12 = 0$
(C) $x^2 - 5x + 6 = 0$
(D) $x^2 - 9x + 14 = 0$

43. If $f(n) = \sum_{k=1}^{k=n} \int_{k}^{k+1} \dfrac{(k+1)dx}{x(x+1)}$ and $g(x) = (x+1)\ln\left(\dfrac{x+2}{x+1}\right) + f(x)$, then

(A) $g'(0) = 2$
(B) $g''(0) = -1$
(C) $g'(1) = \dfrac{1}{2}$
(D) $\lim_{n\to\infty} \sum_{r=1}^{r=n} \left(\dfrac{1}{2.e^{g(r)} - 1 + n}\right) = \log_e 2$

44. If P moves on a circle which touches both the axis and angle bisector of $\angle APB$ for two different positions of P in the same segment are given by $x + y = 3$ and $x - y = 1$, then radius of circle can be _______ (AB is given chord)

(A) 1
(B) 3
(C) 4
(D) 5

45. Let $f : R \to (0,\ 1)$ be a continuous function, then which of the following pair of vectors are linearly dependent for some $x \in (0,\ 1)$?

(A) $\vec{a} = (f(x))\hat{i} + 2\hat{j},\ \vec{b} = x^2\hat{i} + 3\hat{j}$
(B) $\vec{a} = (f(x))\hat{i} + 3\hat{j},\ \vec{b} = x^2\hat{i} + 2\hat{j}$
(C) $\vec{a} = \left(\int_0^{1-x} f(t)dt\right)\hat{i} + 3\hat{j},\ \vec{b} = x\hat{i} + 2\hat{j}$
(D) $\vec{a} = \left(\int_0^{1-x} f(t)dt\right)\hat{i} + 2\hat{j},\ \vec{b} = x\hat{i} + 3\hat{j}$

46. Matrices of order 2×2 are formed by using the elements of the set $A = \{-2,\ -1,\ 0,\ 1,\ 2\}$. Then, probability that matrix is either symmetric or skew-symmetric, is greater than

(A) $\dfrac{1}{10}$
(B) $\dfrac{2}{15}$
(C) $\dfrac{3}{5}$
(D) $\dfrac{3}{10}$

Section – B (Maximum Marks: 24)

This section contains EIGHT (08) numerical based questions. The answer to each question is a Single Digit Integer, ranging from 0 to 9 both inclusive.

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47. Number of integral values of a for which $\dfrac{2x^2 + ax + 2}{x^2 + x + 1} = \dfrac{e^y}{[y+1]}$ is true $\forall x \in R$ and $y \geq 0$ (where [.] denotes G.I.F), is

48. If det (A) = $\begin{vmatrix} \alpha & 0 \\ 2 & \bar{\alpha} \end{vmatrix}$, where α is complex number, $\bar{\alpha}$ is its conjugate and $\det(2A^2 - 2A) = 144$, then tr(A) is either m or n, then (m + n) = ________.

49. If $f(x) = \dfrac{\alpha x + 1}{x - \beta}$ $\forall x \in R - \{\beta\}$ & $\alpha\beta \neq 1$ & $\alpha \neq 1$ is a self-inverse function such that $\dfrac{f(4)}{4} = \dfrac{f(12)}{12} = f\left(\dfrac{1+\beta}{1-\alpha}\right)$, then "$\beta$" is equal to

50. If $f(x) = x+1$ & $g^{-1}(x) = x^3 + x + 1$, let $gof(x) = h(x)$, then $\lim\limits_{x\to 1}\frac{h^{-1}(x)-h^{-1}(1)}{x-1} =$

51. Let α be a complex number satisfying $i\alpha^3 + \alpha^2 - \alpha + i = 0$ and β be a complex number satisfying $|\beta - 1| = 4$, then maximum value of $|\alpha + \beta|$ is

52. Let A be a square matrix of order 3 such that transpose of inverse of A is A itself, then $|\text{adj}(\text{adj}A)|$ is equal to

53. If $p = \sin^4\alpha + \cos^4\alpha + 1$ and $q = \cos^6\beta + \sin^6\beta + 1$ $(\alpha, \beta \in R)$, then the value of $\left[(p+q)_{\max}\right] + \left[(p+q)_{\min}\right]$ is (where [.] is G.I.F)

54. Let $n = x_1x_2x_3\ldots\ldots x_9$ is formed using the digit $1, 2\ldots 9$. Each digit is being used once only. If n_1 is number of possible n for which $1 < |x_3 - x_4| < 5$ and n_2 is number of possible n for which $|x_3 - x_4| = 1$, then $\left[\frac{n_1}{n_2}\right]$ is equal to (where [.] is G.I.F)

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JEE (Advanced)-2023
FULL TEST – III
PAPER –1
TEST DATE: 08-02-2023

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

Section – A

1. ABC

Sol. $-k\upsilon = \frac{d\upsilon}{dt}$, $\int \frac{d\upsilon}{\upsilon} = -k\ dt\ \int_t^t dt$

$\ln \frac{\upsilon}{\upsilon_0} = -kt$ $\upsilon = \upsilon_0 e^{-kt}$

$\upsilon_0 e^{-kt} = \frac{dx}{dt}$

$\int_0^x dx = \upsilon_0 \int_0^t e^{-kt} dt$

$x = \frac{\upsilon_0}{k}\left[e^{-kt}\right]_0^t = -\frac{\upsilon_0}{k}\left(e^{-kt} - 1\right)$, $x = \frac{\upsilon_0}{k}\left(1 - e^{-kt}\right)$

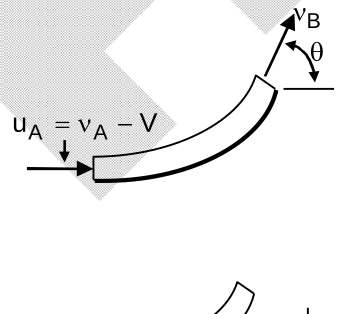
$-k\upsilon = \upsilon\frac{d\upsilon}{dx}$, $d\upsilon = -k\ dx$

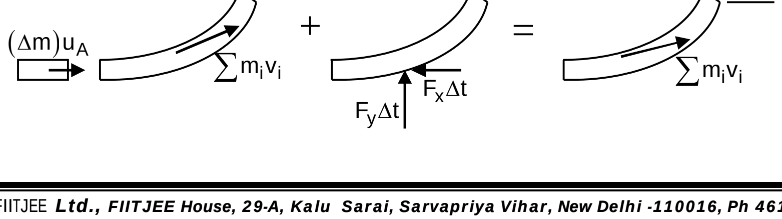
$\int_{\upsilon_0}^{\upsilon} d\upsilon = -k\int_0^x dx$

$\upsilon - \upsilon_0 = -kx$, $\upsilon = \upsilon_0 - kx$

2. ABD

Sol.





$\xrightarrow{+}$ x components: $(\Delta m)u - F_x\Delta t = (\Delta m)u\cos\theta$

$+\uparrow$ y components: $+F_y\Delta t = (\Delta m)u\sin\alpha$

Substituting $\Delta m = A\rho(\upsilon_A - V)\Delta t$ and $u = \upsilon_A - V$, we obtain

$F_x = A\rho(\upsilon_A - V)^2(1-\cos\theta) \leftarrow$ and $F_y = A\rho(\upsilon A - V)^2\sin\theta\uparrow$

$\text{Power} = F_xV = A\rho(\upsilon_A - V)^2(1-\cos\theta)V$

$$\frac{d(\text{power})}{dV} = A\rho\left(\upsilon_A^2 - 4\upsilon_AV + 3V^2\right)(1-\cos\theta) = 0$$

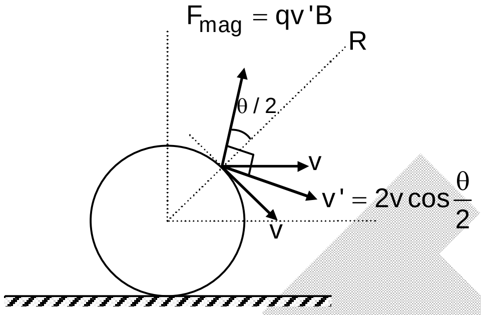
$V = \upsilon_A$ $\quad V = \frac{V_A}{3}$ For maximum power $V = \frac{V_A}{3}$

3. ACD

Sol. $f = qv'B\ \sin\frac{\theta}{2} = q\left\{2v\cos\left(\frac{\theta}{2}\right)\right\}B\sin\frac{\theta}{2} = Bqv\sin\theta$

Since, speed at topmost point is maximum

$\therefore\ N = mg - 2Bqv$



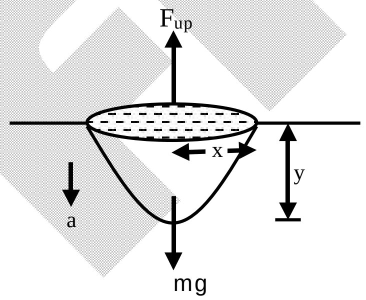
$\Rightarrow$ To loose the contact, $N = 0$

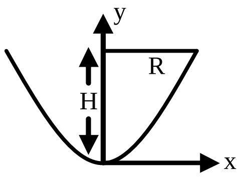
$\Rightarrow v = \frac{mg}{2qB}$

4. AD

Sol. Let $Y = ax^2$ (A parabola)

$Y = \frac{H}{R^2}x^2$ (from given data)





$v = \frac{dy}{dt}$

$$mg - \rho_L \cdot \frac{1}{2}\pi x^2 y \cdot g = m \cdot \frac{dv}{dt}$$

$$\frac{dv}{dt} = g - \frac{\pi x^2 y g \rho_L}{2\rho_s \frac{\pi R^2 H}{2}} g \Rightarrow g - \frac{\rho_L}{\rho_s}\frac{x^2}{R^2} \times \frac{yg}{H}$$

$$v \cdot \frac{dv}{dy} = g - \frac{\rho_L}{\rho_s}\frac{gy^2}{H^2}$$

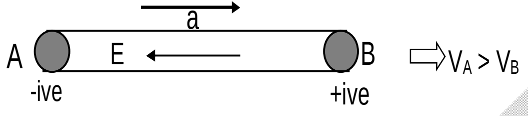
$$\int_0^0 vdv = \int_0^H (g - \frac{\rho_L}{\rho_s}\frac{gy^2}{H^2})\, dy$$

$$o = gH - \frac{g\rho_L}{3\rho_s} H$$

$$\frac{\rho_L}{\rho_s} = 3$$

5. ABCD

Sol. Due to pseudo force, electrons move from B to A.

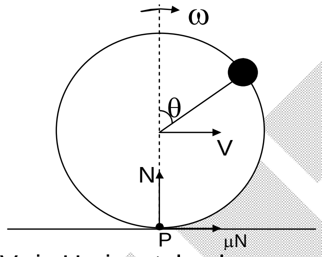


In figure (b) electron moves from A to B

Region I Region II

6. BC

Sol.



V_C is Horizontal only.

$\overrightarrow{V_P} = \overrightarrow{V_{PC}} + \overrightarrow{V_C}$

$V_P = 0$

Mechanical energy conservation,

$mgR(1 - \cos\theta) = \frac{1}{2} mV_{bead}^2$ $\quad V_{Bead} = 2v\cos\theta/2$

$gR \times 2\sin^2\theta/2 = 2v^2\cos^2\theta/2$

$V = \sqrt{gR}\tan\theta/2$

$\overrightarrow{\tau_{em}} = I_{cm} \propto = 0 \quad$ As $I_{cm} = 0$

$NR\sin\theta = \mu N(R + R\cos\theta)$

$\tan\theta/2 = \mu$

$\theta = 2\tan^{-1}(\mu)$

7. C

Sol. For He^+ absorption occur from level $(2 \to 4)$

For Li^{2+} absorption occur from level $(3 \to 6)$

8. D

Sol. (I) If 1st case $E = E_1 = E_0 \sin\omega t$

If 2nd case $E = E_2 = E_0 \sin(\omega t + \phi)$

If 3rd case $E = E_1 + E_2 = E_0' \sin(\omega t + \delta)$

All three cases effective value is same $\Rightarrow$ $E_0' = E_0$

$$\Rightarrow \qquad \phi = \frac{2\pi}{3}$$

(II) Case : (2) When S_3, S_4 closed $Z_1 = \sqrt{2}R$

Case : (2) When all opened $Z_2 = \sqrt{R^2 + (X_C - X_L)^2}$

$$\Rightarrow \qquad X_C - X_L = R \Rightarrow X_C = 2R \Rightarrow \frac{X_C}{R} = 2$$

$$\Rightarrow \qquad \frac{4\pi}{5}\frac{X_C}{R} = \frac{8\pi}{5}$$

(III) When S_1, S_2 closed $Z_1 = \sqrt{5}R$

When S_3, S_4 closed $Z_2 = \sqrt{2}R$

$$\frac{I_1}{I_2} = \sqrt{\frac{2}{5}} \Rightarrow \pi\left(\frac{I_1}{I_2}\right) = \frac{2\pi}{5}$$

(IV) When all opened $Z_1 = \sqrt{2}R$

When S_2, S_3 Closed $Z_2 = R$

$$\frac{I_3}{I_4} = \frac{1}{\sqrt{2}} \Rightarrow \pi\left(\frac{I_3}{I_4}\right)^2 = \frac{\pi}{2}$$

9. B

Sol. (I) The fundamental frequency in the string.

$$f_0 = \frac{\sqrt{T/\mu}}{2\ell} = \sqrt{\frac{102.4}{1\times10^{-3}}} \times \frac{1}{2\times0.5}\text{Hz} = 320 \text{ Hz.}$$

Other possible resonance frequencies are f_A and $f_0 = 320$ Hz, 640 Hz, 960 Hz.

(II) The fundamental frequency in the string.

$$f_0 = \frac{\sqrt{T/\mu}}{4\ell} = \frac{320}{4\times0.5} = 160 \text{ Hz.}$$

Other possible resonance frequencies are

$f_B = 160$ Hz, 480 Hz, 800 Hz.

(III) The fundamental frequency in both ends open organ pipe is

$$f_0 = \frac{v}{2\ell} = \frac{320}{2\times0.5} = 320 \text{ Hz.}$$

Other possible resonance frequencies are

$f_c = 320$ Hz, 640 Hz, 960 Hz

(IV) The fundamental frequency in one end open organ pipe is

$$f_0 = \frac{v}{4\ell} = \frac{320}{4\times0.5} = 160 \text{ Hz.}$$

Other possible resonance frequencies are

$f_D = 160$ Hz, 480 Hz, 800 Hz.

10. B

Sol. $E_x = \frac{-1}{a}$ $E_y = \frac{-2V}{b}$ $E_z = \frac{-3V}{c}$

$\Delta V = -\vec{E}.\vec{d}$

Section – B

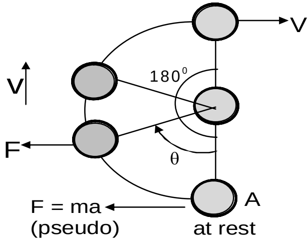
11. 25.00

Sol. Acceleration of train = $a \longrightarrow$

Motion of bob w.r.t. train:

Initially $\vec{V}_{\text{bob/train}} = O$

From $A \xrightarrow{\quad} B$, pseudo force F = ma $\longleftarrow$ acts on bob. Let bob turns through 180^o and has speed v' at highest position



W/E theorem $A \to B$:

FR = $\frac{1}{2}mv^2 + mgh$

$\frac{mv^2}{R} = 2(ma - mg)$ …….(i)

$B \xrightarrow{\quad} C$: Now train has stopped, a = 0,

No pseudo force acts on bob.

Conservation of Energy

mgR + $\frac{1}{2}mv'^2 = \frac{1}{2}mv^2$

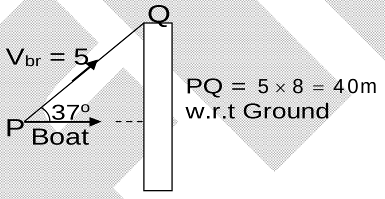
$\frac{mv'^2}{R} = \frac{mv^2}{R} - 2mg$

T + mg = 2 (ma – mg) – 2mg [From eq. (i)]

On solving $a \geq 25 m/s^2$

12. 6.00

Sol.

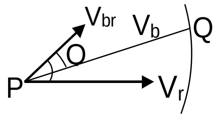


$\overrightarrow{V_b} = \overrightarrow{V_{br}} + \overrightarrow{V_r}$

Velocity must be along PQ

$v_{br} \sin\theta = v_r \sin 37$

$\sin\theta = 7/25$



$$t = \frac{40}{v_{br}\cos\theta + v_r\cos 37^{o}} = 6 \text{ sec.}$$

13. 25.00

Sol. $I_1 + I_2 = 13I_0$

$\left(\sqrt{I_2} - \sqrt{I_2}\right)^2 = I_0$

$I_1 + I_2 - 2\sqrt{I_1}\sqrt{I_2} = I_0$

$2\sqrt{I_1}\sqrt{I_2} = 12I_0$

$I_{max} = 13I_0 + 12I_0 = 25I_0 = (5)^2 I_0$

14. 0.50

Sol. $\phi = \left[\vec{E}.\vec{n}\right]A = \left[\frac{8\times 2 + (6\times 3) + (10\times 6)}{\sqrt{2^2 + 3^2 + 6^2}}\right]\frac{7}{47}$

15. 41.23

Sol. $\tan\alpha = \frac{v_y}{v_x}$

16. 1.80

Sol. $V_I - \frac{q_1}{7} - V_G = 0$

$V_{IG} = \frac{1.80}{11}$

17. 2.75

Sol. Equivalent resistance across capacitor (after shorting the battery) $= \frac{11R}{4}$

Voltage across capacitor in steady state $= \frac{3E}{4}$

$q = \frac{CE}{4}\left(1 - e^{\frac{-4t}{1RC}}\right)$

18. 5.94

Sol. Least count $= \frac{P}{N} = \frac{1mm}{100} = 0.01\,mm$

Diameter of the wire is

$d = 4mm + 56\times L.C - 6\times L.C$

$d = 4mm + 50\times L.C$

$d = 4mm + 50\times 0.01mm$

$d = 4.50\,mm$

$d = 0.450$ cm

The curved surface area of the wire is

$S = \pi dl$

$S = \frac{22}{7}\times 0.450\times 4.2 = 5.94\,cm^2$

Chemistry PART – II

Section – A

19. ABC

Sol. $(x-1)\left(x^2-8x+12\right)=0$

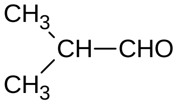
$x = 1, 2, 6$

$x = \frac{2r}{a_0}\Big|\, r = \frac{a_0}{2}, a_0, 3a_0$

Minimum position	maximum position
0.5 a_0	$3a_0$

20. BCD

Sol. It will give Cannizzaro because it fails to give self aldol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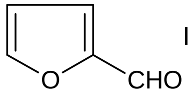
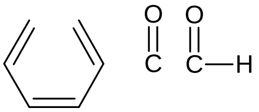

IV


VI

These will give Cannizzaro reaction.

21. AD

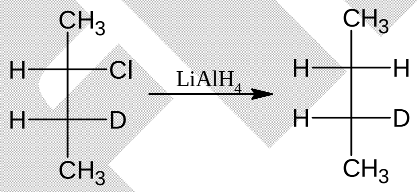
Sol. $C_2 = \sigma 1s^2\, \overset{*}{\sigma} 1s^2\, \sigma 2s^2\, \overset{*}{\sigma} 2s^2\, \underbrace{\pi 2p_x^2 \pi 2p_y^2}_{\text{forms } \pi \text{ bond}}$

22. BCD

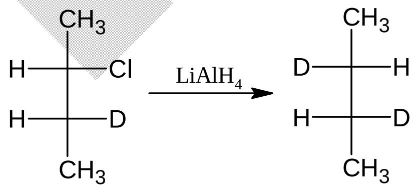
Sol. Fact

23. AB

Sol.


A

Optically active


A

Optically active

24. ABCD

Sol. (A) NH_3 has higher boiling point than AsH_3 and PH_3 on account H-bonding. SbH_3 has highest boiling point on account of highest molecular weight.

(B) As the size of element increases, the strength of M-H bond decreases and thus stability decreases.

(C) Basicity decreases down the group. (Drago rule).

(D) (Drago rule). HEH angle $(^\circ): NH_3 = 107.8; PH_3 = 93.6, AsH_3 = 91.8; SbH_3 = 91.3.$

25. A

Sol. Electrolysis of NaCl

(I) Fused NaCl

(II) Conc. $NaCl_{(aq)}$

(III) Dil. $NaCl_{(aq)}$

(IV) NaCl (mercury electrode)

(I) Fused NaCl:

At cathode:

$$Na^+ + e^- \longrightarrow Na_{(s)} \qquad ;E^\circ = -2.71V$$

At anode:

$$2Cl^- \longrightarrow Cl_{2(g)} + 2e^- \quad ;E^\circ = \text{-}1.36V$$

Voltage $= -2.71 - 1.36 = -4.07V$

(II) Conc. $NaCl_{(aq)}$

At cathode:

$$2H^+ - 2e^- \longrightarrow H_{2(g)} \qquad ;E^\circ = 0.00V$$

$$2H_2O + 2e^- \longrightarrow H_{2(g)} + 20H^- \quad ;E^\circ = -0.828V$$

$$Na^+ + e^- \longrightarrow Na \qquad ;E^\circ = -2.71V$$

At anode:

$$40H^- \longrightarrow O_2 + 2H_2O + 4e^- \quad ;E^\circ = -0.401V$$

$$2H_2O \longrightarrow O_2 + 4H^+ + 4e^- \quad ;E^\circ = -1.229V$$

$$T,K\ 2Cl^- \longrightarrow Cl_2 + 2e^- \quad ;E^\circ = -1.36V$$

(due to over voltage and high conc. of Cl^-)

At cathode: $H_{2(g)}$

At anode: $Cl_{2(g)}$, [O_2 also but percentage may be low]

To increase the kinetics of reactions a higher voltage (as from required) is provided, due to this Cl^- start to oxidized at the anode, So

Cl_2 – higher voltage

O_2 – lower voltage

(III) Dil. $NaCl_{(aq)}$

At cathode:

$$2H_2O + 2e^- \longrightarrow H_{2(g)} + 20H^- \quad ;E^\circ = -0.828V$$

At anode:

$$2H_2O \longrightarrow O_{2(g)} + 4H^+ + 4e^- \quad ;E^\circ = -1.229V$$

At cathode: $H_{2(g)}$

At anode: $O_{2(g)}$

(IV) $NaCl_{(aq)}$ (Mercury electrode):

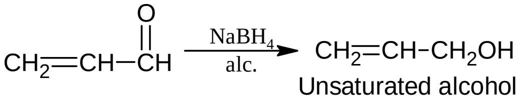
As Na makes an amalgam with Hg so the kinetics favoured the occurrence of Na rather than $H_{2(g)}$.

26. D

Sol. Fact

27. A

Sol.

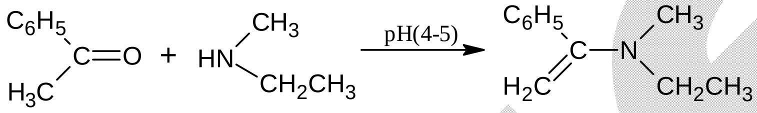
(I) 

$$CH_2{=}CH{-}\overset{\overset{O}{\|}}{C}H \xrightarrow[\text{alc.}]{NaBH_4} CH_2{=}CH{-}CH_2OH$$

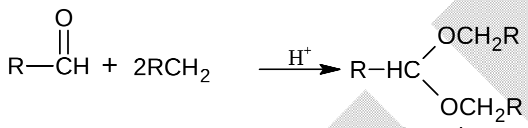
Unsaturated alcohol

(II) $C_6H_5CH{=}O + H_2N{-}Ph \xrightarrow{pH(4\text{-}5)} C_6H_5CH{=}N{-}Ph$

Schiff's base

(III) 

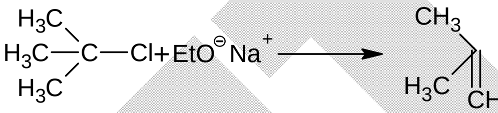
Enamine

(IV) 

Acetal

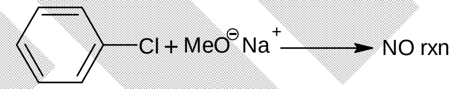
28. C

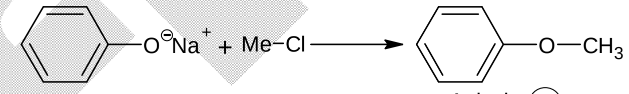
Sol.

(I) 

+ EtOH Alcohol Q

(II) $CH_3CH_2Cl + Me_3CO^{\ominus}Na^{\oplus} \longrightarrow \underset{P}{CH_3CH_2{-}O{-}C(Me)_3} + CH_2{=}CH_2$

(III) 

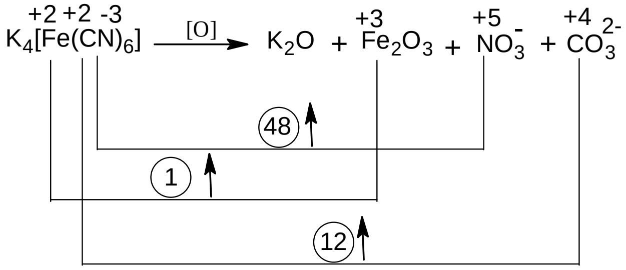
(IV) 

Anisole Ⓡ

Section – B

29. 61.00

Sol.



$$\overset{+2}{K_4}[\overset{+2}{Fe}(\overset{-3}{CN})_6] \xrightarrow{[O]} K_2O + \overset{+3}{Fe_2O_3} + \overset{+5}{NO_3^-} + \overset{+4}{CO_3^{2-}}$$

Total ↑ in oxidation number $= 48 + 12 + 1 = 61$

So ‘n’ factor $= 61$

30. 25.00

Sol. $\underset{1-0.6}{HIn} \rightleftharpoons H^+ + \underset{0.6}{In^-}$

$= 0.4$

$$pH = pK_{In} + \log\frac{[In^-]}{[HIn]}$$

$$2.176 = pK_{In} + \log\frac{0.6}{0.4}$$

$$pK_{In} = 2 \Rightarrow K_{In} = 10^{-2}$$

$\underset{1-0.6}{HIn} \rightleftharpoons H^+ + \underset{0.6}{In^-}$

$= 0.4$

now $\underset{C(1-\alpha)}{HIn} \rightleftharpoons \underset{3.33\times10^{-3}}{H^+} + \underset{C\alpha}{In^-}$

$$\frac{3.33\times10^{-3}\times C\alpha}{C(1-\alpha)} = 10^{-2}$$

$$\frac{\alpha}{1-\alpha} = 3 \quad \Rightarrow \alpha = 3 - 3\alpha$$

$$\Rightarrow \alpha = 0.75$$

So $[HIn] = 1 - 0.75 = 0.25$

$\%[HIn] = 25\%$

31. 15.38

Sol. Total work done in the cyclic process

$=$ Area under PV

$= P_0V_0$

Now,

$$A \xrightarrow[\text{Heat taken}]{} B \xrightarrow[\text{Heat taken}]{} C \xrightarrow[\text{Heat rejected}]{} D \xrightarrow[\text{Heat rejected}]{} A$$

$$= \begin{array}{c|c|} 1\times\frac{3R}{2}(2T - T) & = 1\times\frac{3R}{2}(4T - 2T) \\ \text{at constant volume} & \text{at constant pressure} \end{array}$$

$= \frac{3}{2}RT \qquad \frac{5}{2}\times 2RT$

$= 1.5RT \qquad 5RT$

$= 1.5P_0V_0 \qquad 5P_0V_0 \quad \left| \begin{array}{l} \text{At point A} \\ P_0V_0 = 1RT \end{array} \right.$

Total Heat taken

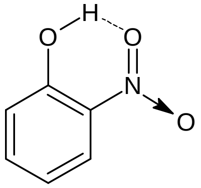
$= 6.5\ P_0V_0$

$$\eta = \frac{\text{work done}}{\text{Heat taken}} = \frac{P_0V_0}{6.5P_0V_0} = 0.1538 \qquad \text{i.e. } 15.38\%.$$

32. 600.00

Sol. o-nitrophenol p-nitrophenol

Note:



Due to intramolecular H Bonding $V\cdot P$ of O nitrophenol will be higher. If one have $V\cdot P = 400$ & the $V\cdot P$ of mixture is 520 mm of Hg, i.e. the $V\cdot P$ of other will be higher than 400, so if P is the $V\cdot P$ then it will of O nitrophenol

O nitrophenol	P nitrophenol
P	400

$520 = P\times 0.6 + 400\times 0.4$

$$P = \frac{520-160}{0.6} = \frac{360}{0.6} = 600 \text{ mm of Hg.}$$

33. 122.40

Sol. $25.7 = 13.6\ z^2\left[\frac{1}{2^2}-\frac{1}{n^2}\right]$ .....(i)

$8.7 = 13.6\ z^2\left[\frac{1}{3^2}-\frac{1}{n^2}\right]$ .....(ii)

Now (i) ÷ (ii)

$$\frac{25.7}{8.7} = \frac{\left(n^2-4\right)9n^2}{4n^2\left(n^2-9\right)}$$

$$\frac{25.7}{8.7} = \frac{9n^2-36}{4n^2-36}$$

$2.95\times 4n^2 - 2.95\times 36 = 9n^2 - 36$

$n^2\left(11.816-9\right) = 36\times 1.95$

$n^2 = 25 \qquad \Rightarrow \quad n = 5$

Now,

$$25.7 = 13.6z^2\left[\frac{1}{4}-\frac{1}{25}\right]$$

$z = 3$

Ionisation energy $= 13.6\times 3^2 = 122.4$ eV

34. 25.00

Sol. $$CuSO_2 \cdot 5H_2O \rightleftharpoons CuSO_4 \cdot 3H_2O_{(s)} + \underset{p}{2H_2O_{(g)}}$$

$kp = p^2$

$10^{-4} = p^2$

$p = 10^{-2}$ atm

$= 10^{-2} \times 760 = 7.6$ mm of Hg

Relative humidity $= \frac{7.6}{30.4} \times 100 = 25\%$

35. 915.00

Sol. In BCC nearest neighbor distance

$$= \frac{\sqrt{3}a}{2}$$

$$\frac{\sqrt{3}a}{2} = 4.52$$

$$a = \left(\frac{2 \times 4.52}{\sqrt{3}}\right) A°$$

$$d = \frac{ZM}{NV} = \frac{2 \times 39}{6 \times 10^{23} \times \left(\frac{2 \times 4.52}{\sqrt{3}}\right)^3 \times 10^{-24}} = \frac{2 \times 39}{6 \times 14.2} = 0.915 \text{ g/cc}$$

$$= 915 \text{ kg/m}^3$$

36. 7482.60

Sol. Given: $P_1 = 16$ bar, $T_1 = 300$ K, $P_2 = 1$ bar, $T_2 = ?$

To calculate T_2 use:

$$TP^{\left(\frac{1-\gamma}{\gamma}\right)} = \text{cons t}$$

$$T_1P_1^{\left(\frac{1-\gamma}{\gamma}\right)} = T_2P_2^{\left(\frac{1-\gamma}{\gamma}\right)}$$

$$300 \times 16^{\left(\frac{1-\gamma}{\gamma}\right)} = T_2 \times 1^{\left(\frac{1-\gamma}{\gamma}\right)}$$

$$T_2 = 300 \times 16^{\left(\frac{3}{4}-1\right)}$$

$$T_2 = \frac{300}{2} = 150 \text{ K}$$

$$W_{rev.adia} = nC_V(T_2 - T_1)$$

$$= 2 \times 3R(150 - 300)$$

$$= -7482.6 \text{ J}$$

Mathematics PART – III

Section – A

37. BC

Sol. $x^4(x-5)=1$

$\Rightarrow x-5=\dfrac{1}{x^4}$

$\therefore \sum \dfrac{1}{\alpha_r^4}=\sum \alpha_r-25=5-25=-20$

Similarly, $\left(\dfrac{1}{\alpha_r^4}+5\right)=\alpha_r$

38. A

Sol. $\because \begin{vmatrix} 1 & a & -1 \\ 2 & -1 & 3 \\ a & -1 & 3 \end{vmatrix}=0$

$\Rightarrow a=\dfrac{1}{3}$ or 2

But for a = 2, two vectors are parallel.

39. D

Sol. $\because I=\int_{\alpha}^{\beta} f(x)dx$

$\Rightarrow I=\int_{\alpha}^{\beta} f(\alpha+\beta-x)dx=\int_{\alpha}^{\beta} f(3-x)dx$

So, $7I=\int_{\alpha}^{\beta}(3x^2-8)dx$

$=\beta^3-\alpha^3-8(\beta-\alpha)$

$=(\beta-\alpha)\{\beta^2+\alpha^2+\beta\alpha-8\}$

$=\sqrt{9-4a}\{9-\alpha\beta-8\}=\sqrt{9-4a}(1-a)\le 0$

$\Rightarrow 1\le a\le \dfrac{9}{4}$

40. AB

Sol. If $\lambda x^2+(\lambda-1)x+\dfrac{1}{24}=0$ has equal and real roots,

$\Rightarrow (\lambda-1)^2=4.\lambda.\dfrac{1}{24}$

$\Rightarrow 6\lambda^2-13\lambda+6=0$

$\therefore \lambda=\dfrac{13\pm\sqrt{169-144}}{2\times 6}=\dfrac{2}{3}$ or $\dfrac{3}{2}$

41. BD

Sol. $$\lim_{n\to\infty}\left(\frac{1}{n^n}\right)^n.\left(n^n\right)^n\left[\left(1+\frac{1}{n}\right)\left(1+\frac{1}{2n}\right)\left(1+\frac{1}{2^2n}\right)........\right]^n$$

$$= e^1.e^{\frac{1}{2}}.e^{\frac{1}{2^2}}..........\infty$$

$$= e^{1+\frac{1}{2}+\frac{1}{2^2}+.......} = e^{\frac{1}{1-\frac{1}{2}}} = e^2 \simeq 7.3441$$

42. AB

Sol. $|z_1| = |z_2| = 1$ & $|z_1 + z_2| = 1$

$\therefore |z_1 + z_2| = |z_1||1 + e^{i\theta}| = 1$

$|z_1 - z_2| = |z_1||1 - e^{i\theta}| = 1$

$\because z_2 = z_1\omega$

$\therefore z_1 + z_2 = z_1(1+\omega) = \frac{-b}{a}$

& $z_1z_2 = z_1^2\omega = \frac{c}{a}$

$\Rightarrow \left(\frac{b^2}{a^2}\right) = \frac{c}{a} \Rightarrow b^2 = ac$

$1+\cos^2\theta + 2\cos\theta + \sin^2\theta = 1$

$2 + 2\cos\theta = 1$

$\cos\theta = \frac{-1}{2} \Rightarrow \theta = \frac{2\pi}{3}$

43. C

Sol. AEEI (4 vowels) and DRJLNG (6 consonants)

$\therefore N = \frac{\lfloor 4}{\lfloor 2} \times \lfloor 6 = 12 \times 720$

$= 2^6 \times 3^3 \times 5^1$

44. A

Sol. Either increasing or decreasing part lie in [0, 2] → [0, 1]

Then $y(0) = c = 1$ or 0

and $y = x(ax+b)+c \Rightarrow y(2) = 2(2a+b)+c = 1$ or 0

$\therefore |2a+b| = \frac{1}{2}$

If $\frac{\lambda}{a}$ is root, $a\times\frac{\lambda^2}{a^2} + b\times\frac{\lambda}{a} + c = 0 \Rightarrow \frac{\lambda^2}{a} + \frac{b\lambda}{a} + 1 = 0$ ……. (i)

$\because 4a + 2b + 1 = 0$

$1 + \frac{b}{2a} + \frac{1}{4a} = 0$ …….. (ii)

From (i) and (ii), $\lambda = \frac{1}{2}$

Sum of roots = $-\frac{b}{a} = \left(\frac{2a+\frac{1}{2}}{a}\right) = p^2 + p + 3 \geq \frac{11}{4}$

$\because 4a + 2b + 1 = 0$ $\qquad \Rightarrow 2 + \frac{1}{2a} \geq \frac{11}{4}$

$-b = \left(2a + \frac{1}{2}\right)$ $\qquad$ For $a > 0$, $\frac{1}{2a} \geq \frac{3}{4} \Rightarrow a \leq \frac{2}{3}$

For $a < 0$, $a \geq \frac{2}{3} \Rightarrow |a| \leq \frac{2}{3}$

$|a| \leq 0.66$

45. D

Sol. $\because f(x) = \frac{2}{\pi}\tan\left(\frac{\pi x}{2}\right) + \frac{1}{2x}$ has point of minima at $x = \frac{1}{2}$

So, range $\in \left[\frac{\pi+2}{\pi}, \infty\right)$

$\therefore e^{-k} \geq 1$

$\Rightarrow e^k \leq 1 \quad \Rightarrow k \leq 0$

So, for $k \in \left(-\frac{1}{e}, 0\right)$, we have two solutions.

In the same manner use graphs.

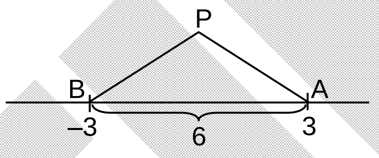
46. A

Sol. $\because z^2\bar{z} + \bar{z}^2 z = (z + \bar{z})$

$\Rightarrow z\bar{z}(z + \bar{z}) = (z + \bar{z})$

$\Rightarrow x^2 + y^2 = 1$ or $x = 0$

circle $\qquad$ straight line



$|PA - PB| = 6$

means, P lies on straight line

& $|PA - PB| < 6$ shows it is hyperbola.

Section – B

47. 1.33

Sol. $\because \quad 1 \leq |x| \leq \sqrt{3} \qquad \& \qquad \tan^{-1} \geq \frac{2\pi}{3} - \frac{\pi}{2} = \frac{\pi}{6}$

$\Rightarrow x \geq \frac{1}{\sqrt{3}} \quad \therefore \quad \frac{1}{3} \leq x \leq \sqrt{3}.$

$\therefore \quad \alpha + \frac{1}{\beta^2} = 1 + \frac{1}{3} = \frac{4}{3}.$

48. 0.25

Sol. $\because\ y = \frac{x}{x^2+y} \qquad \Rightarrow y^2 + x^2y - x = 0$

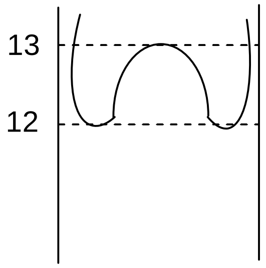
$$\therefore\ \frac{dy}{dx} = \frac{-(2xy-1)}{(x^2+2y)} \Rightarrow \frac{dy}{dx} = \frac{-\left(2x.\frac{x}{x^2+y}-1\right)}{(x^2+y+y)} = -\frac{-(2x^2-x^2-y)/x^yy}{\left(\frac{x}{y}+y\right)}$$

$$= \frac{-y(x^2-y)}{(x^2+y)(x+y^2)} \Rightarrow \frac{1}{y}\frac{dy}{dx} = \frac{(y-x^2)}{(x^2+y)(x+y^2)}$$

$$= \frac{d}{dx}(\ln y) = \frac{(y-x^2)}{(x^2+y)(x+y^2)} \Rightarrow \ln y + c = \int \frac{(y-x^2)dx}{(x^2+y)(x+y^2)}$$

49. 4.50

Sol. Graph of $(9\sin x + 4\operatorname{cosec} x)$ is



$\because 12 < 2k + 4 \le 13$

$\Rightarrow 8 < 2k \le 9$

$4 < k \le \frac{9}{2}$

$\therefore k = \frac{9}{2}$

50. 1.78

Sol. (distance from focus)^2 = (Circumradius) $\times \frac{1}{4}(\text{L.R.}).\left(\frac{4}{3}\right)^2 = R \times \frac{1}{4} \times 4 \Rightarrow R = \frac{16}{9}$

51. 14.00

Sol. $\int_{-n}^{n} e^{\{|x|\}} \frac{dx}{1+e^{\sin x}}$

$= \int_0^n e^{\{|x|\}} dx.$

$= n\int_0^1 e^{x-[x]} = n(e-1)$

$\sum_1^{50} \frac{n}{(n+1)!} = 1 - \frac{1}{(3\times 17)!}$

So $|a-b| = 14$

52. 1.00

Sol. $x^3 - x^2 - x + 1 = (x+1)(x-1)^2$, $f(x) = g(x)$ have 3 real and distinct roots

$\Rightarrow 0 < a^2 - 2 < 1$

$\Rightarrow [a^2] = 2$

Now $x^3 - x^2 - x + 1 = 2$
has solution in (1, 2)
$\Rightarrow$ the integral part of root is 1.

53. 4.00

Sol. $\frac{3x^2+1}{\sqrt{(x^4+x^2)}} = \frac{(3x^2+1)}{\sqrt{x^2(x^2+1)}}$

$= \frac{2x^2+(x^2+1)}{x\sqrt{x^2+1}}$

$= \frac{2x}{\sqrt{x^2+1}} + \frac{\sqrt{x^2+1}}{x}$

$\geq 2\sqrt{2}$

Equality for $2x^2 = x^2 + 1$
$x^2 = 1$
$x = 1$

$\therefore \int_0^{\sqrt{2}} \frac{3x^2+1}{\sqrt{x^4+x^2}} dx \geq 2\sqrt{2}\left(\sqrt{2}-0\right) = 4$

54. 147.00

Sol. Required probability = $\frac{176}{10\times10\times10} = \frac{22}{125}$

So, $p + q = 147$

FIITJEE

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ALL INDIA TEST SERIES
JEE (Advanced)-2023
FULL TEST – III
PAPER –2
TEST DATE: 08-02-2023

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

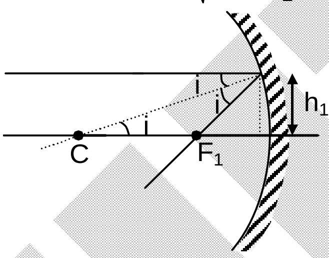
Section – A

1. B

Sol. Since B & revolve in opposite since, thus they are oppositely charged. From direction of motion of the charges $Q_A = +$ ve Q_B & $Q_D \to$ -ve $Q_C \to$ neutral

2. A

Sol. $CF_1 = \frac{R}{2\cos i} = \frac{R^2}{2\sqrt{R^2 - h_1^2}}$ and $(h_1 = 3\text{ cm})$



$CF_2 = \frac{R^2}{2\sqrt{R^2 - h_2^2}}$ and $(h_2 = 4\text{ cm})$ $\Rightarrow$ $CF_2 - CF_1 = \frac{25}{24}$ cm

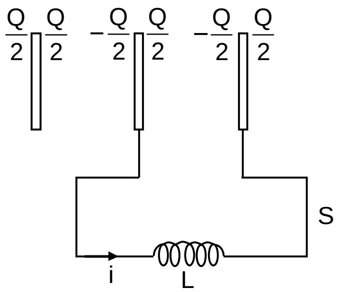
3. A

Sol. If maximum loss in kinetic energy is greater than first excitation energy inelastic collision may take place.

4. D

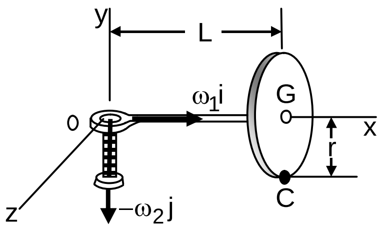
Sol. $\frac{\left(\frac{Q}{2}\right)^2}{2C} = \frac{1}{2}Li_0^2$

$\Rightarrow I_0 = \frac{Q}{2\sqrt{LC}}$


$\frac{Q}{2}$ $\frac{Q}{2}$
$-\frac{Q}{2}$ $\frac{Q}{2}$
$-\frac{Q}{2}$ $\frac{Q}{2}$
S
i
L

5. ACD

Sol. $\omega = \omega_1 i - \omega_2 j$



$v_C = \omega \times r_C = 0$

$(\omega_1 i - \omega_2 j) \times (Li - r\,j) = 0$

$(L\omega_2 - r\omega_1)k = 0$ $\qquad \omega_2 = \omega_1 i / L$

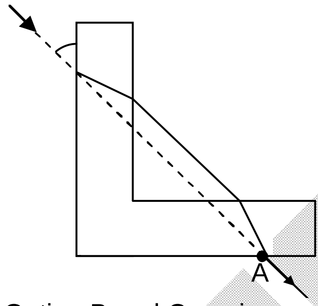
$\omega = \omega_1 i - (r\omega_1 / L)\,j$

$H_x = I_x \omega_x = \left(\frac{1}{2}mr^2\right)\omega_1$

$H_z = I_z \omega_z = \left(mL^2 + \frac{1}{4}mr^2\right)0 = 0$

6. AD

Sol.



Option B and C are incorrect.

7. ABC

Sol. Let N be the number of fringes within the length x, then we have,

$\beta N = x \;\Rightarrow\; \frac{D\lambda}{d}N = x \;\Rightarrow\; N = \frac{xd}{\lambda D}$

At any time t

$$N = \frac{x}{\lambda D}(d + vt)$$

$$\frac{dN}{dt} = \frac{xv}{\lambda D}.$$

8. ABCD

Sol. $r = \frac{mV_0}{qB}$, and $PQ = 2r\,\sin\alpha = \frac{2mV_0}{qB}\sin\alpha$

$\alpha = \beta$

Time taken $(t) = \frac{2\pi r}{V}$

9. ABC

Sol. From graph in time from $t = 0$ to $t = 3$ sec.

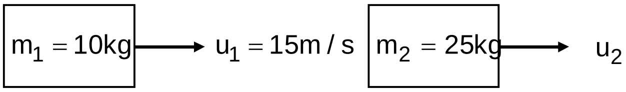
Acceleration of object of mass $m_1 = 10$ kg is

$$a = \frac{15 - 0}{3} = 5 \text{ m/s}^2$$

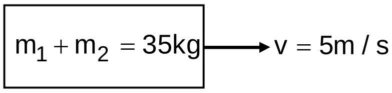
$\therefore$ Force on object of mass m_1 from $t = 0$ to $t = 3$ sec. ...(i)

$$= 10 \times 5 = 50 \text{ N}$$

Before and after collision at $t = 4$ sec, the velocities of blocks are as shown.



Before collision



After collision

$\therefore$ Initial momentum of system

$$= m_1u_1 + m_2u_2 = 150 + 25\ u_2$$

Final momentum of system

$$= (m_1 + m_2)v = 35 \times 5 = 175$$

From conservation momentum

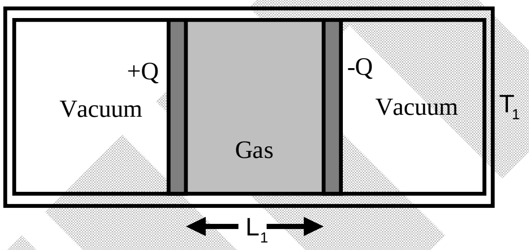
$\therefore$ $150 + 25\ u_2 = 175$

or $u_2 = +1$ m/s

$\therefore$ speed of second particle just before collision is 1 m/s and before collision both blocks move in same direction.

10. BCD

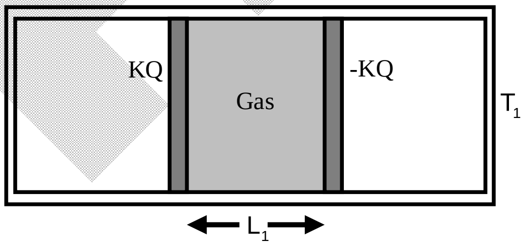
Sol. Stage 1



$P_1AL_1 = nRT_1$ $\quad \frac{Q^2}{2A\varepsilon_0} = P_1A = \frac{nRT_1}{L_1}$ (Force Balancing)

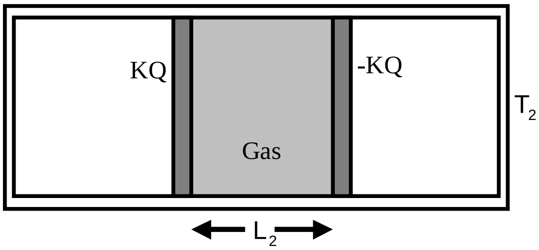
Stage 2

Charge is suddenly changed



System is not in equilibrium

Stage 3



L_2CL_1

Finally system in equilibrium

$P_2AL_2 = nRT_2 \quad \frac{K^2Q^2}{2A\varepsilon_0} = P_2A = \frac{nRT_2}{L_2}$

Energy of the system is conserved between stage 2 and 3.

$\Rightarrow \frac{1}{2}\varepsilon_0 E_2^2 AL_1 + \frac{f}{2}nRT_1 = \frac{1}{2}\varepsilon_0 E_2^2 AL_2 + \frac{f}{2}nRT_2$

On solving all the above equation

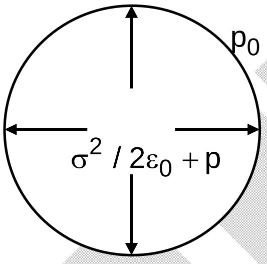
$\frac{T_2}{T_1} = \frac{2K^2+f}{2+f} \quad w_{ext} = (K^2-1)\frac{Q^2L_1}{2A\varepsilon_0} = (K^2-1)nRT_1$

Section – B

11. 6

Sol. $V = \frac{4}{3}\pi r^3$ .... (1)

$\sigma = \frac{Q}{4\pi r^2}$ ....(2)



$\frac{\sigma^2}{2\epsilon_0} + p - p_0 = \frac{4s}{r}$ .... (3)

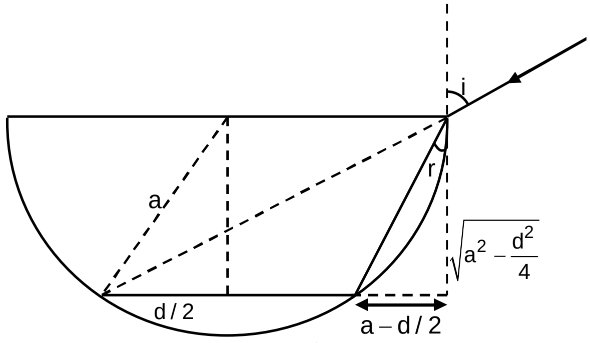
$p - p_0 = 0$ .... (4)

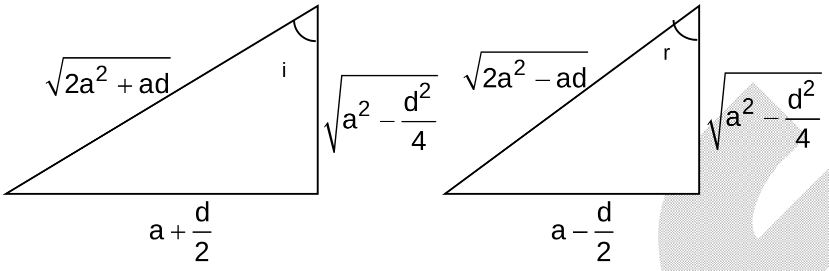
$\Rightarrow \quad \frac{1}{2\varepsilon_0} \cdot \frac{Q^2}{16\pi^2 r^4} = \frac{4s}{r}$

$\Rightarrow \quad n = 6$

12. 1

Sol.


i
r
a
$\sqrt{a^2 - \frac{d^2}{4}}$
d / 2
a − d / 2


$\sqrt{2a^2 + ad}$
i
$\sqrt{a^2 - \frac{d^2}{4}}$
$a + \frac{d}{2}$
$\sqrt{2a^2 - ad}$
r
$\sqrt{a^2 - \frac{d^2}{4}}$
$a - \frac{d}{2}$

$\sin i = \mu \sin r$

$\Rightarrow \quad \frac{d}{a} = 1$

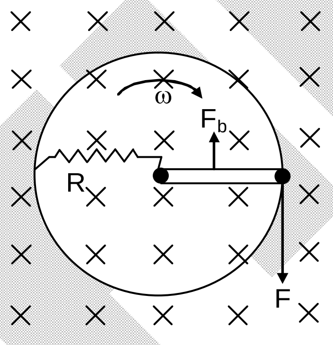
13. 2

Sol. $F_b = BIL$, ($\therefore L = r = 1\text{m}$)

Induced current: $I = \frac{\left(B\omega r^2 / 2\right)}{R}$

$\therefore \quad F_b = B\left(\frac{B\omega r^2}{2R}\right)r = \frac{B^2\omega r^3}{2R}$

To maintain constant angular velocity:

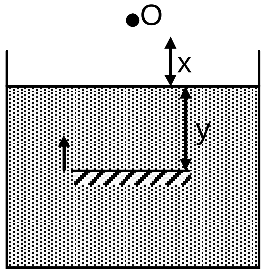


$F(r) = F_B\left(r/2\right)$

$\Rightarrow \quad F = \frac{F_B}{2} = \frac{B^2\omega r^3}{4R} = \frac{(10)^2 \times 2\pi \times (1)^3}{4 \times \pi} = 50\text{N}$

14. 3

Sol. Apparent distance of mirror from O



$= x + \frac{y}{\mu}$

Distance of final image from O

$= 2\left(x + \frac{y}{\mu}\right)$

Velocity of image

$= 2\left(\frac{dx}{dt} + \frac{1}{\mu}\frac{dy}{dt}\right) = \frac{2}{\mu} \times 8 = \frac{2}{4/3} \times 8 = 12 \text{ cm/s}$

15. 3

Sol. For $S_1S_2 = 2.5\lambda$ max path different $= 2.5\lambda$

Min path different $= 0$

Between 2.5λ and 0 lie 2λ and $\lambda \Rightarrow$ two circular bright fringes

$n_1 = 2$

For $S_1S_2 = 5.7\lambda$, max. path different $= 5.7\lambda$

Min path different $= 0$

Between 5.7λ and 0 lie 5λ, 4λ, 3λ, 2λ, $\lambda \Rightarrow$ Five circular bright fringes.

$\Rightarrow n_2 = 5$

$\therefore n_2 - n_1 = 5 - 2 = 3$

16. 9

Sol. $\sqrt{f} = a(Z-1)$

$\sqrt{f} = a(31-1)$

$\sqrt{\frac{25f}{x}} = a(51-1)$

$x = 9$

17. 5

Sol. $f_m = \frac{v}{(v - v_s\cos\theta)_{min}} \times f$

$1800 = \frac{v}{(v + v_s\cos\theta)_{max}} \times f$

On solving,

$f_m = 2250 \text{ Hz}$

$= 2300 - 50$

18. 2

Sol. Net power given to N_2 gas $= 100 - 30 = 70$ cal/s

The nitrogen gas expands isobarically

$\therefore \ \frac{dq}{dt} = n\ Cp\ \frac{dT}{dt}$ or $70 = 5 \times \frac{7}{2}\ R\ \frac{dT}{dt}$

$\therefore \ \frac{dT}{dt} = 2k / sec$

FIITJEE

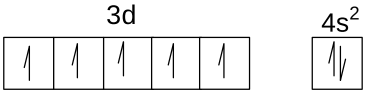
Chemistry

PART – II

Section – A

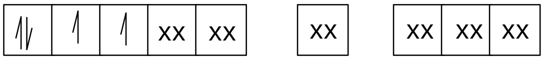
19. C

Sol. Mn



$\overset{+3}{[Mn(CN)_6]^{3-}}$ $\mu = 2.8$ so $\underset{\text{unpaired}}{n = 2}$

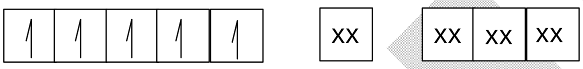
for $\overset{3+}{[Mn(CN)_6]^{3-}}$


xx
xx
xx
xx
xx
xx

Octahedral

$\overset{2+}{[MnBr_4]^{2-}}$ $\mu = 5.5$ so $n = 5$

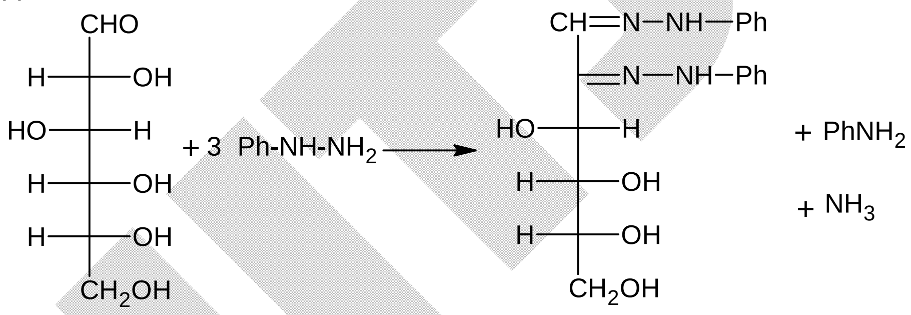
so,



Tetrahedral

20. A

Sol.


CHO
H
OH
HO
H
H
OH
H
OH
CH2OH
+ 3 Ph-NH-NH2
CH=N–NH–Ph
=N–NH–Ph
HO
H
H
OH
H
OH
CH2OH
+ PhNH2
+ NH3

21. D

Sol. $3A \rightleftharpoons B$ $K_C = 8\times10^{15}$

Initially	3	0
Assume	3-3	1
	$=0$	1
Actually	3x	1-x
		$\simeq 1$

So $\frac{1}{(3x)^3} = 8\times10^{15}$

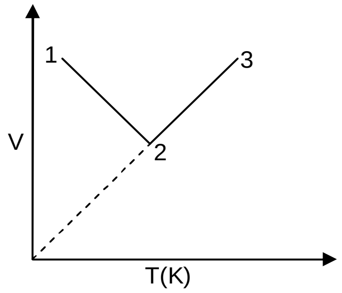
$$(3x)^3 = \frac{1}{8\times10^{15}}$$

$$3x = \frac{1}{2}\times10^{-5}$$

$[A] = 3x = 5\times10^{-6}$

22. B
Sol. Fact.

23. ABC
Sol.

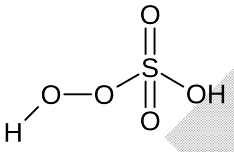


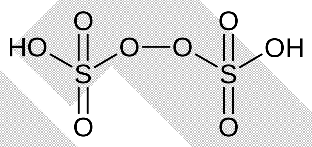
(A) for $1 \to 2$
$V\downarrow$ & $T\uparrow$ so
By $PV = nRT$

$$P = \frac{nRT}{V}$$

P will $\uparrow$
(B) for $2 \to 3$
$V \propto T$
So P will be constant
(C) at 1 & 3, T is higher at 3 so
$P_{(3)} > P_{(1)}$

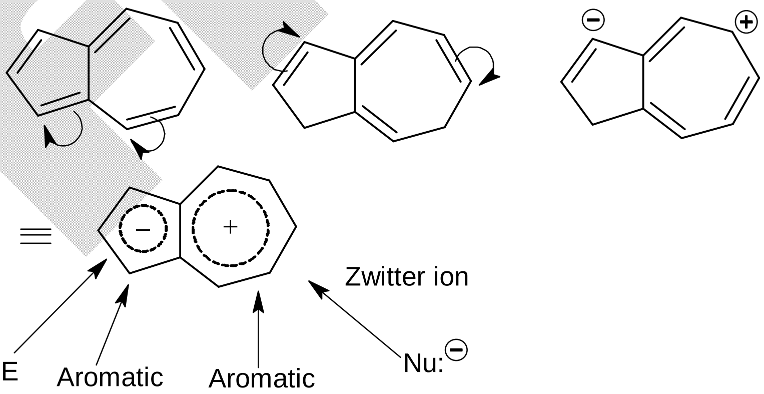
24. BD
Sol.


(B)


(D)

25. ACD
Sol. Dacron is a condensation polymer. Teflon, neoprene and acrylonitrile are addition polymers. Hence option (A, C and D) is the answer.

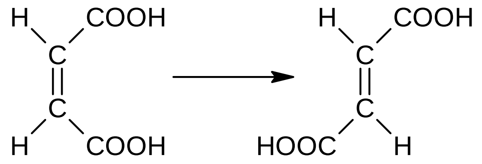
26. ABCD
Sol.



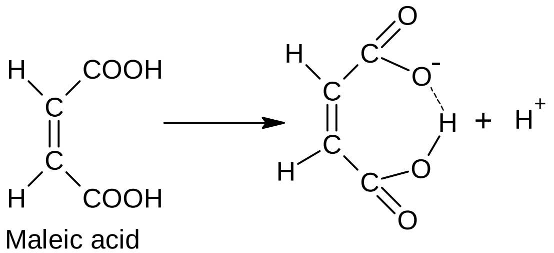
27. ABD

Sol. Maleic acid is stronger acid than fumaric acid

Maleic acid form cyclic ring after ionization while fumaric acid cannot do so that's why maleic acid $\left(pK_{a1} = 1.9,\ pK_{a1} = 6.1\right)$ is more stringer acid than fumaric acid $\left(pK_{a1} = 3.0,\ pK_{a1} = 4.4\right)$.



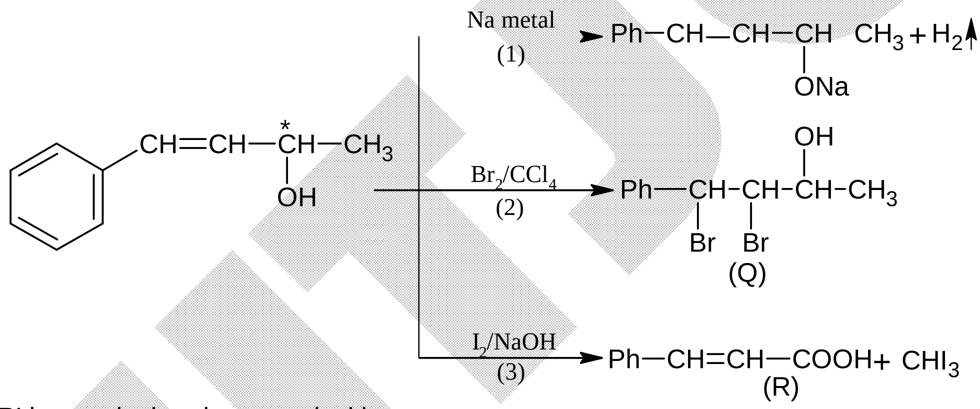
Maleic acid Fumaric acid



Maleic acid

28. BC

Sol.

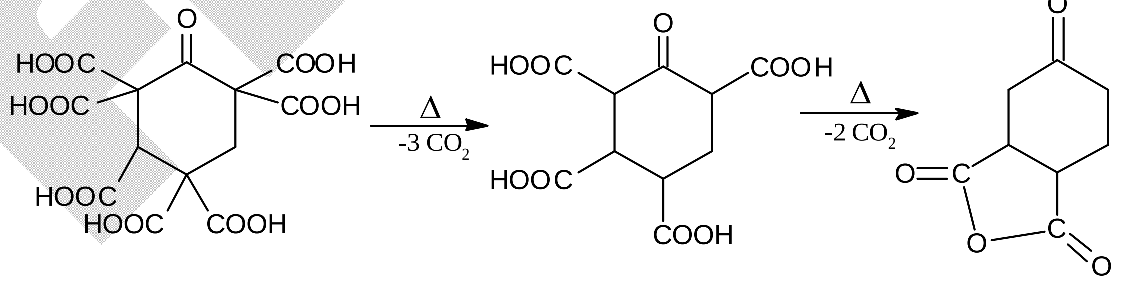

Na metal
(1)
Ph–CH–CH–CH CH$_3$ + H$_2$↑
ONa
Br$_2$/CCl$_4$
(2)
Ph–CH-CH-CH-CH$_3$
OH
Br Br
(Q)
I$_2$/NaOH
(3)
Ph–CH=CH–COOH+ CHI$_3$
(R)

'P' has optical and geometrical isomers.

Section – B

29. 5

Sol.


Δ
-3 CO$_2$
Δ
-2 CO$_2$

5 mole CO$_2$

30. 6

Sol. The following will release H_2 gas with propyne

CH_3CH_2MgBr (III), NaH (IV), $NaNH_2$ (V), Na (VI), $\{(CH_3)CH\}_2NLi$(VIII), CH_3CH_2Li(IX)

31. 6

Sol. Glucose Fructose Mannose Maltose Cellobiose Lactose

32. 6

Sol.

$$Hg^{2+} + 2e^- \longrightarrow Hg \qquad \Delta G_1^o = -2F(0.85)$$

$$Hg + 4I^- \longrightarrow HgI_4^{2-} + 2e^- \qquad \Delta G_2^o = -2F(0.05)$$

So

$$Hg^{2+} + 4I^- \longrightarrow HgI_4^{2-} \qquad \Delta G^o = -2F(0.90)$$

$$0.90 = \frac{0.06}{2}\log K_f$$

$$K_f = 1.0\times10^{30}$$

33. 3

Sol. m.m. of $NaOH = 30\times0.2 = 6$ m.m

m.m. of $CH_3COOH = 50\times0.2 = 10$ m.m

Now:

$$\begin{array}{llll} CH_3COOH & +\,NaOH & \longrightarrow CH_3COONa & +\,H_2O \\ \quad 10 & \quad 6 & \quad 0 & \\ 10-6=4 & 6-6=0 & \quad 6 & \end{array}$$

$$pH = -\log\left(2\times10^{-5}\right) + \log\frac{6}{4}$$

$$= 4.87$$

Suppose 'v' mL of NaOH is added then

m.m of $CH_3COONa = (6 + v\times0.2)$

m.m of $CH_3COOH = (4 - v\times0.2)$

$$5 = -\log\left(2\times10^{-5}\right) + \log\left(\frac{6+0.2v}{4-0.2v}\right)$$

$$0.3010 = \log\left(\frac{6+0.2v}{4-0.2v}\right)$$

$$\text{So } \left(\frac{6+0.2v}{4-0.2v}\right) = 2 \Rightarrow v = 3.33\text{mL}$$

34. 8

Sol.

$$\%\text{ decrease in vol} = \frac{V_{bcc} - V_{fcc}}{V_{bcc}}\times100$$

$$= \frac{\frac{1}{d_{bcc}} - \frac{1}{d_{fcc}}}{\frac{1}{d_{bcc}}}\times100$$

$$= \frac{\frac{N_A(4r)^3}{2\times 56\times 3\sqrt{3}} - \frac{N_A(4r)^3}{4\times 56\times 2\sqrt{2}}}{\frac{N_A(4r)^3}{2\times 56\times 3\sqrt{3}}}$$

$$= \frac{\frac{1}{3\sqrt{3}} - \frac{1}{2\times 2\sqrt{2}}}{\frac{1}{3\sqrt{3}}}$$

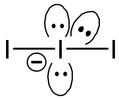
$$= \frac{0.46}{5.65}\times 100 \approx 8\%$$

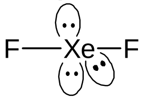
35. 7

Sol. $O = C = O$

$N \equiv \overset{+1}{N} - \overset{-2}{N}$

$H - C \equiv C - H$





$Cl - Be - Cl$

$S = C = S$

are linear

36. 2

Sol. $+\frac{1}{2}\frac{d[B]}{dt} = k[A]^n$

Taking ln on both side

$$\ln\left(\frac{1}{2}\right) + \ln\left(\frac{d[B]}{dt}\right) = \ln k + n\ \ln[A]$$

$$\ln\left(\frac{d[B]}{dt}\right) = \left(\ln k - \ln\left(\frac{1}{2}\right)\right) + n\ \ln[A]$$

So $\quad n = 2$

Mathematics PART – III

Section – A

37. D

Sol. $\because 2(\alpha+\beta) = (\alpha-\beta) + \left(\frac{1}{\alpha}+\frac{1}{\beta}\right)$

$\Rightarrow \left(2-\frac{1}{\alpha\beta}\right) = \frac{\alpha-\beta}{\alpha+\beta}$

$\Rightarrow (2+a) = \frac{\alpha-\beta}{\alpha+\beta} > 0 \Rightarrow a+2>0 \Rightarrow a>-2$

But $\alpha\beta<0 \Rightarrow \frac{a}{-1}<0 \Rightarrow a>0$

38. D

Sol. $\because \frac{(3^3-8)}{(3^3+8)}\times\frac{(4^3-8)}{(4^3+8)}\times\frac{(5^3-8)}{(5^3+8)}\times........\times\frac{(n^3-8)}{(n^3+8)}$

Use: $n^3-8=(n-2)(n^2+2n+4)$

and $n^3+8=(n+2)(n^2-2n+4)$

We get, product $=\frac{1.2.3.4.(n^3-3)(n^2+2n+4)}{(n-1)n.(n+1)(n+2).7.12}$

For $n\to\infty$, its value $=\frac{1.2.3.4}{7.12}=\frac{2}{7}$

39. C

Sol. Let P $(t,\ t^2)$ and Q $(s,\ s^2)$.

So, equation of normal at P is $x+2+y=t+2t^3$

$\therefore$ Area $=\int_s^t\left(t^2+\frac{1}{2}-\frac{x}{2t}-x^2\right)dx=\frac{4}{3}\left(t+\frac{1}{4t}\right)^3\geq\frac{4}{3}$ $(\text{AM}\geq\text{GM})$

(Here, take t > 0)

40. B

Sol. Let $1+\tan x=t^2$

$\frac{(t^2-1)^2}{(t^2-t)^2}<\frac{t^4+t^2+16}{t^4}$

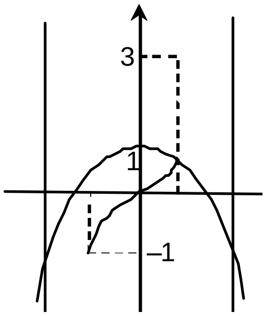
$\Rightarrow t^3<8\Rightarrow t<2$

But t > 0 and $t\neq1$

$\Rightarrow \tan x\in(-1,\ 0)\cup(0,\ 3)$

$\Rightarrow -\frac{\pi}{4}<x<0$ or $0<x<\tan^{-1}3$

Only one solution on graph.



41. AC

Sol. $$\int_0^{\pi}\frac{\sin^3 x dx}{x+1}=\int_0^{\pi}\underset{(I)}{\sin^3 x}\,\underset{(II)}{\frac{1}{(1+x)}}dx$$

$$=0-3\int_0^{\pi}\underset{(I)}{\sin^2 x}.\underset{(II)}{\ln(x+1)}dx$$

$$=-3\left[0-\int_0^{\pi}\sin 2x.(x+1)\{\ln(x+1)-1\}dx\right]$$

$$\&\ \int_0^{\pi}\frac{\sin^3 x dx}{2x-\pi}=2\int_0^{\pi/2}\frac{\sin^3 x}{2x-\pi}dx=2\int_0^{\pi/2}\frac{\cos^3 x}{\pi-2x-\pi}dx$$

$$=-\int_0^{\pi/2}\frac{\cos^3 x}{x}dx$$

42. ABC

Sol. $\because \alpha^2-\alpha-1=0 \Rightarrow \alpha^6-\alpha^3-1=3.\alpha^3$

$\Rightarrow \alpha^6-1=4\alpha^3$

$\Rightarrow \dfrac{\alpha^6-1}{\alpha^3}=4$

Similarly,

$\beta^2-\beta-1=0$

$\beta^6-\beta^3-1=3.\beta^3$

$\dfrac{\beta^6-\beta^3-1}{\beta^3}=3$

43. BCD

Sol. $\because f(n)=(n+1)\ln\left(\dfrac{n+1}{n+2}\right)+\ln\left(\dfrac{n+1}{2}\right)$

$\Rightarrow g(n)=\ln\left(\dfrac{n+1}{2}\right)\Rightarrow g(x)=\log_e\left(\dfrac{x+1}{2}\right)$

$\Rightarrow g'(x)=\dfrac{2}{x+1}.\dfrac{1}{2}\Rightarrow g'(0)=0$

$g''(x)=-\dfrac{1}{(x+1)^2}\Rightarrow g''(0)=-1$

$$\&\ \lim_{n\to\infty}\sum_{r=1}^{r=n}\left(\frac{1}{2.e^{\log_e\left(\frac{r+1}{2}\right)}-1+n}\right)=\sum_{r=1}^{r=n}\frac{1}{r+1-1+n}=\sum_{r=1}^{r=n}\frac{1}{n}\frac{1}{\left(\frac{r}{n}+1\right)}$$

44. AD

Sol. $\because$ (2, 1) lies on circle

$\therefore (2-r)^2+(1-r)^2=r^2$ for touching circles on axis.

$\Rightarrow r^2-6r+5=0$

$\Rightarrow r=1$ or 5

45. BCD

Sol. (A) $\frac{f(x)}{x^2} = \frac{2}{3} \Rightarrow g(x) = 3f(x) - 2x^2$

$g(0) > 0$ & $g(1) > 0$ or < 0

So, can't say.

(B) $g(x) = 2f(x) = 3x^2$

$\therefore g(0) > 0$ & $g(1) < 0$

Similarly, (C) and (D).

46. AB

Sol. Probability $= \frac{5^3 + 5 - 1}{5^4} = 0.203$

Section – B

47. 5

Sol. $y \geq 0$

$\Rightarrow \frac{e^y}{[y+1]} \leq 1$

$\Rightarrow \frac{2x^2 + ax + 2}{x^2 + x + 1} \geq 0$

$\Rightarrow x^2 + x(a-1) + 1 \geq 0 \forall x \in R$

$\Rightarrow -1 \leq a \leq 3$

So, no. of integer a = 5

48. 7

Sol. $\because |A| = \alpha.\bar{\alpha} = |\alpha|^2$ and $|A - I| = \begin{vmatrix} \alpha - 1 & 0 \\ 2 & \bar{\alpha} - 1 \end{vmatrix}$

$|A - I| = \alpha\bar{\alpha} - \alpha - \bar{\alpha} + 1 = |\alpha - 1|^2$

$\Rightarrow |A - I| = |\alpha|^2 - tr(A) + 1$

Given, $|2A^2 - 2A| = 144$

$\Rightarrow |A^2 - A| = 36$

$|A||A - I| = 36$

$\Rightarrow |\alpha|^2 |\alpha - 1|^2 = 36$

$|\alpha(\alpha - 1)| = 6$ or -6

$\alpha^2 - \alpha = 6$ or -6

$\alpha = 3$ or –2 or $\alpha = \frac{+1 \pm i\sqrt{2}.3}{2 \times 1}$

$\bar{\alpha} = 3$ or –2 or $\bar{\alpha} = \frac{+1 \mp i\sqrt{2}.3}{2 \times 1}$

$\alpha + \bar{\alpha} = 6$ or –4 or 1

49. 8

Sol. $\because \quad \beta = \dfrac{f(4)+f(12)}{2}$

$= \dfrac{4+12}{2} = 8$

50. 4

Sol. $f^{-1}(x) = x-1$ then $h^{-1}(x) = \left(g\cdot f(x)\right)^{-1}$

$\therefore \dfrac{d}{dx}\left(h^{-1}(x)\right) = 3x^2+1 \qquad = f^{-1}\cdot g^{-1}(x)$ (reversal law)

$= f^{-1}\left(x^3+x^3+x+1\right)$

$= x^3+x$

$\left(h^{-1}(1)\right)' = 3+1 = 4$

51. 6

Sol. $|\alpha+\beta| \;\le\; |\alpha|+|\beta|$

Now,

$i\alpha^3+\alpha^2-\alpha^2-\alpha+i = 0$

$\Rightarrow \alpha^2\left(i\alpha+1\right)+i\left(i\alpha+1\right) = 0$

$\Rightarrow |\alpha| = 1$

so $|\alpha+\beta| \le 1+5 \le 6$

52. 1

Sol. Given that $A^{-1}, T = A = (A^T)^{-1} = AA^T = I$

$\Rightarrow |A| = \pm 1$

Now, $|\text{adj}(\text{adj}A)| \;=\; |A|^{2^2} = 1$

53. 4

Sol. $p \in \left[\dfrac{3}{2}, 2\right], q \in \left[\dfrac{1}{4}, 1\right]$

$\Rightarrow \dfrac{7}{4} \le p+q \le 3$

$\Rightarrow \left[(p+q)_{\text{max}}\right]+\left[(p+q)_{\text{min}}\right]$

$= 3+1 = 4$

54. 2

Sol. $n_1 = 2(7+6+5)\left(7!\right) = 36(7!)$

$n_2 = 16(7!)$

$\left[\dfrac{n_1}{n_2}\right] = \left[\dfrac{36}{16}\right] = 2$

FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
FULL TEST – IV
PAPER –1
TEST DATE: 08-02-2023

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B**.

Section – A *(01 –06, 19 – 24, 37 – 42):* This section contains **EIGHTEEN (18)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – A *(07 – 10, 25 – 28, 43 – 46):* This section contains **TWELVE (12)** Matching List Type Questions. Each question has **FOUR** statements in **List-I** entries (I), (II), (III) and (IV) and **FIVE** statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which, **ONLY ONE** of these four options is correct answer.

Section – B *(11 – 18, 29 – 36, 47 – 54):* This section contains **TWENTY FOUR (24)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.

MARKING SCHEME

Section – A (One or More than One Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4	If only (all) the correct option(s) is (are) chosen;
Partial Marks	:	+3	If all the four options are correct but ONLY three options are chosen;
Partial marks	:	+2	if three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks	:	+1	If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–2	In all other cases.

Section – A (Single Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+3	If ONLY the correct option is chosen.
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–1	In all other cases.

Section – B: Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+3	If ONLY the correct numerical value is entered at the designated place;
Zero Marks	:	0	In all other cases.

Physics

PART – I

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

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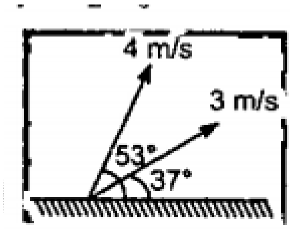
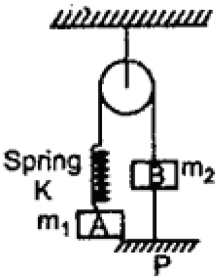
1. Two particles are projected with sped 4 m/s and 3 m/s simultaneously from same point as shown in the figure. Then:



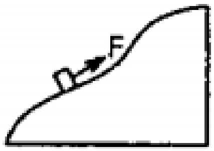
(A) Their relative velocity is along vertical direction.
(B) Their relative acceleration is non-zero and it is along vertical direction.
(C) They will hit the surface simultaneously.
(D) Their relative velocity is constant and has magnitude 1.4 m/s.

2. In the system shown in figure $m_1 > m_2$. system is held at rest by thread BP. Just after the thread BP is burnt:



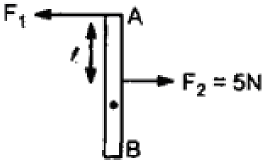
(A) Magnitude of acceleration of both blocks will be equal to $\left(\dfrac{m_1 - m_2}{m_1 + 2m_2}\right)g$
(B) Acceleration of m_1 will be equal to zero.
(C) Acceleration of m_2 will be upwards
(D) Magnitudes of acceleration of two blocks will be non-zero and unequal.

3. A body of mass m was slowly hauled up the rough hill by a force which at each point was directed along tangent to the hill. Work done by the force

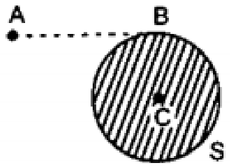


(A) Is independent of shape of trajectory
(B) Depends upon vertical component of displacement but independent of horizontal component.
(C) Depends upon both the components of displacement.
(D) Does not depend upon coefficient of friction.

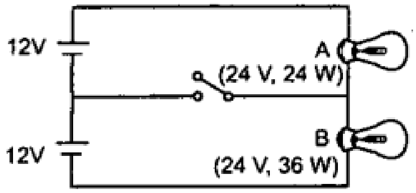
4. A thin uniform rod AB of mass 1 kg move translationally with acceleration a = 2m/s^2 due to two antiparallel force as shown. If ℓ = 20 cm then:



(A) F_1 = 3N
(B) F_1 = 5N
(C) Length of rod is 1 m
(D) Length of rod is 80 cm



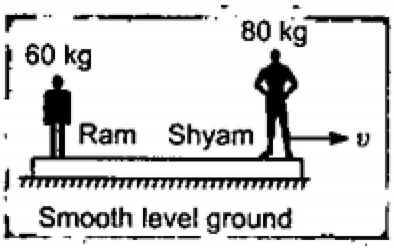
5. S is solid neutral conducting sphere. A point charge q of 1×10^{-6} C is placed at point A. Point C is the centre of sphere and AB is a tangent. BC = 3m and AB = 4m:
(A) The electric potential of the conductor is 1.8 kV.
(B) The electric potential of the conductor is 2.25 kV.
(C) The electric potential at B due to induced charges on the sphere is –0.45 kV.
(D) The electric potential at B due to induced charges on the sphere is 0.45 kV.



6. Two light bulbs shown in the circuit have ratings A(24 V, 24 W) and B(24 V and 36 W) as shown. When the switch is closed:
(A) the intensity of light in bulb A increases.
(B) the intensity of light in bulb A decreases.
(C) the intensity of light in bulb B increases.
(D) the intensity of light in bulb B decreases.

Section – A (Maximum Marks: 12)

This section contains ***FOUR (04)*** *Matching List Type Questions. Each question has FOUR statements in* ***List-I*** *entries (I), (II), (III) and (IV) and FIVE statements in* ***List-II*** *entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which* ***ONLY ONE*** *of these four options is correct answer.*



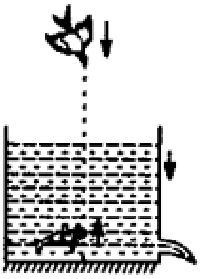
7. Two men of mass 60 kg and 80 kg stand on a plank of mass 20 kg. Both of them can jump with a velocity of 1 m/s relative to the plank. In each event shown in List-I, find the velocity of plank after the event.

Sign of right direction is (+ve) and (–ve) for left direction.

List-I		**List-II**	
(I)	Ram alone jumps to the left	(P)	$-\frac{17}{40}$ m/s
(II)	Shyam alone jumps to the right	(Q)	$-\frac{1}{2}$ m/s
(III)	Ram jumps to left and Shyam jumps to right simultaneously	(R)	$\frac{3}{8}$ m/s
(IV)	Ram jumps to left and after that Shyam jumps to right.	(S)	$-\frac{1}{8}$ m/s
		(T)	$\frac{1}{3}$ m/s

The correct option is:
(A) I → R, II → Q, III → S, IV → P
(B) I → R, II → Q, III → P, IV → S
(C) I → P, II → Q, III → T, IV → P
(D) I → S, II → T, III → P, IV → Q

8. A bird in air is diving vertically over a tank with speed 6 cm/s. Base of tank is silvered. A fish in the tank is rising upward along the same line with speed 4 cm/s. Water level is falling at rate of 2 cm/s. (take: μ water = 4/3)

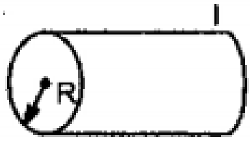


List-I		List-II	
(I)	Speed of the image of fish as seen by the bird directly (Apparent)	(P)	12
(II)	Speed of the image of fish formed after reflection fro the mirror as seen by the bird.	(Q)	4
(III)	Speed of image of bird relative to the fish looking upwards	(R)	9
(IV)	Speed of image of bird relative to the fish looking downwards in the mirror	(S)	3
		(T)	5

The correct option is:

(A) I $\rightarrow$R, II$\rightarrow$Q, III$\rightarrow$T, IV$\rightarrow$P (B) I$\rightarrow$R, II$\rightarrow$S, III$\rightarrow$P, IV$\rightarrow$Q (C) I$\rightarrow$P, II$\rightarrow$ Q, III$\rightarrow$T, IV$\rightarrow$P (D) I$\rightarrow$T, II$\rightarrow$S, III$\rightarrow$P, IV$\rightarrow$Q

9. A long straight conductor of radius R carries a current I as shown. The current density j varies as a function of radius according to j = br where b is a constant. Match the quantities in List-I with those in List-II.

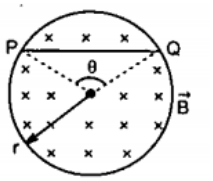
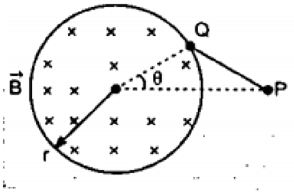
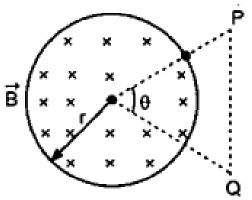
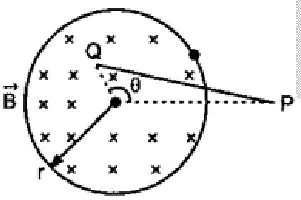


List-I		List-II	
(I)	B_{inside}	(P)	Maximum
(II)	$B_{surface}$	(Q)	$\frac{\mu_0 br^2}{3}$
(III)	$B_{outside}$	(R)	$\frac{2\pi br^3}{3}$
(IV)	I (total current inside wire)	(S)	$\frac{\mu_0 bR^3}{3r}$
		(T)	$\frac{\mu_0 br^2}{3}$

The correct option is:

(A) I $\rightarrow$ R, II $\rightarrow$ Q, III $\rightarrow$ T, IV $\rightarrow$ P
(B) I $\rightarrow$ R, II $\rightarrow$ S, III $\rightarrow$ P, IV $\rightarrow$ Q
(C) I $\rightarrow$ P, II $\rightarrow$ Q, III $\rightarrow$ R, IV $\rightarrow$ S
(D) I $\rightarrow$ Q, II $\rightarrow$ PT, III $\rightarrow$ S, IV $\rightarrow$ R

10. List–I shows the cylindrical region of radius r where a downward magnetic field $\vec{B}$ exists, and $\vec{B}$ is increasing at the rate of $\frac{dB}{dt}$, A rod PQ is placed in different situation as shown. Match the list–I with the correct statement in list–II regarding the induced e.m.f. in rod.

List-I		List-II	
(I)		(P)	Induced e.m.f. in rod PQ is $\frac{1}{2}r^2\theta\frac{dB}{dt}$
(II)		(Q)	Induced e.m.f. in rod PQ is less than $\frac{1}{2}r^2\theta\frac{dB}{dt}$
(III)		(R)	End P is positive with respect to point Q
(IV)		(S)	End Q is positive with respect to point P
		(T)	End P and Q are at same potential

The correct option is:

(A) I → RS, II → T, III → TP, IV → PS

(B) I → RQ, II → S, III → PT, IV → QP

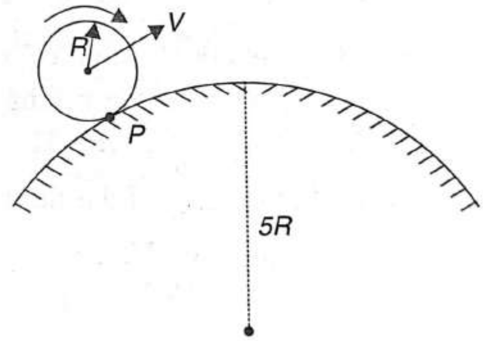
(C) I → QS, II → PR, III → SP, IV → QR

(D) I → QR, II → PS, III → RP, IV → QS

Section – B (Maximum Marks: 24)

This section contains ***EIGHT (08)*** *numerical based questions. The answer to each question is a* ***NUMERICAL VALUE.*** *If the numerical value has more than two decimal places, truncate/round-off the value to* ***TWO*** *decimal places.*

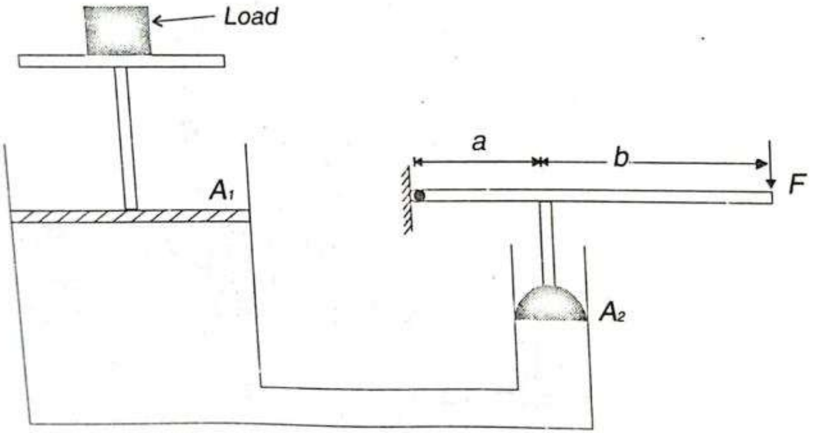
11. A convex surface has a uniform radius of curvature equal to 5R. A wheel of radius R is rolling without sliding on it with a constant speed V. Find the acceleration of the point (P) of the wheel which is in contact with the convex surface.



(V = 6 meter/second, R = 4 meter)

12. A man can jump up to a height of $h_0 = 1$ m on the surface of the earth. What should be the radius of a spherical planet (in km) so that the man makes a jump on its surface and escapes out of its gravity? Assume that the man jumps with same speed as on earth and the density of plant is same as that of earth. Take escape speed on the surface of the earth to be 11.2 km/s and radius of earth to be 6400 km. ($g = 10$ m/sec^2)

13. The figure shows a schematic layout of a hydraulic jack. The load to be raised weighs 20,000 N. The area of cross section of the two pistons are $A_1 = 50$ cm^2 and $A_2 = 10$ cm^2. The force (F) is applied at the end of a light lever bar as shown in the figure. Lengths a and b are 4 cm and 36 cm respectively. Find the force (F) required to raise the load slowly.

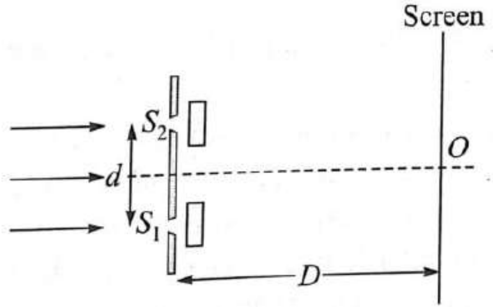


14. Consider the β-decay

$^{198}\text{Au} \rightarrow {}^{198}\text{Hg} + \beta^- + \nu^-$

where ^{198}Hg represents a mercury nucleus in an excited state of energy 1.088 MeV above the ground state. What can be maximum kinetic energy of the electron emitted (in kilo electron volt). The atomic mass of ^{198}Au is 197.968233 u and that of ^{198}Hg is 197.966760 u. 1 u = 931 MeV/c^2.

15. Two circular aperture S_1 and S_2 of radii 1 mm and 2 mm. A parallel beam of light of intensity $\frac{7}{22}\text{Wm}^{-2}$ and wavelength 600 nm is incident normally as shown in the figure. A transparent film of thickness 200 nm having refractive index $\mu_1 = 2$ is placed in front of S_1, and other transparent film of thickness 200 nm and refractive index 1.5 is placed in front of other slit. Find the resultant intensity (in μW) at the centre of screen.



16. A vessel of volume 0.2 m^3 contains hydrogen gas at temperature 300 K and pressure 1 bar. Find the heat (in Kcal) required to raise the temperature to 400 K. The molar heat capacity of hydrogen at constant volume is 5 cal/mol K. (R = 8.31)

17. Steel wire of length 'L' at 40°C is suspended from the ceiling and then a mass 'm' is hung from its free end. The wire is cooled down from 40°C to 30°C to regain its original length 'L'.
The coefficient of linear thermal expansion of the steel is 10^{-5} / ^{0}C. Young's modulus of steel is 10^{11} N/m^2 and radius of the wire is 1 mm. Assume that L >> diameter of the wire. Then the value of 'm' in kg is nearly. (g = 10 m/sec^2)

18. A tuning fork of frequency 200 Hz is in unison with a sonometer wire. How many beats are heard in 30 s if the tension is increased by 1%.

Chemistry PART – II

Section – A (Maximum Marks: 24)

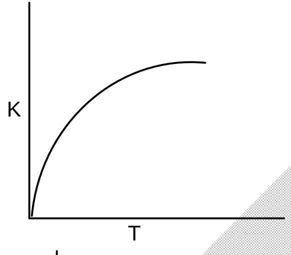
*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

19. Silicate having one monovalent corner oxygen atom in each tetrahedron unit is
(A) Sheet silicate (B) Cyclic silicate
(C) Single chain silicate (D) Double chain silicate

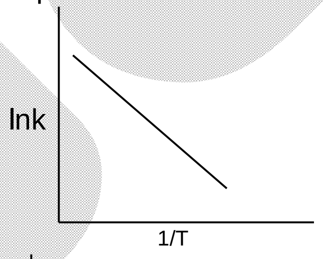
20. Given $\Delta H_f^0(C_2H_6, g) = -85\,kJ/mole$,
$\Delta H_f^0(C_3H_8, g) = -104\,kJ/mole$,
$\Delta H_{sub}^0(C, s) = 718\,kJ/mole$ & B.E. of $(H-H) = 436$ kJ/mole.
Then, in kJ/mole, the
(A) C – C bond enthalpy is 218 (B) C – H bond enthalpy is 414
(C) C – C bond enthalpy is 345 (D) C – H bond enthalpy is 448

21. Which of the following plots of rate constant vs temperature is correct?

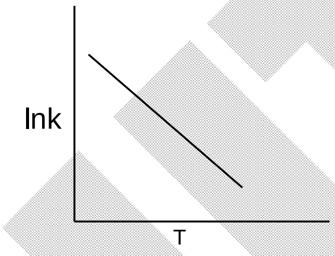
(A)



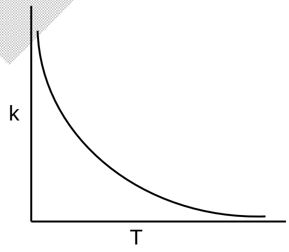
(B)



(C)



(D)



22. The correct statement regarding Ytterbium is/are
(A) it contains no unpaired electrons
(B) Yb^{2+} contains a full-filled electronic configuration
(C) it produces H_2 gas when reacts with HCl
(D) radius of Yb^{3+} is larger than Yb^{2+} ion

23. Which of the following carbide(s) form CH_4 when react(s) with water?
(A) Be_2C (B) CaC_2
(C) Mg_2C_3 (D) Al_4C_3

24. Which of the following statement(s) is/are false?

(A) All adiabatic processes are isoentropic (or isentropic) process

(B) The heat of vaporization of water at 100^0C is 40.6 kJ/mole. When 9g of water vapour condenses to liquid at 100^0C of 1 atm, then $\Delta S_{\text{system}} = 54.42\,J/K$

(C) When $\left(\Delta G_{\text{system}}\right)_{T,P} < 0$; the reaction must be exothermic

(D) dG = Vdp – S dT is applicable for closed system, both PV and non – PV work

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (I), (II), (III) and (IV) and FIVE statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

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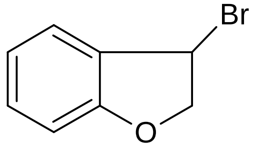
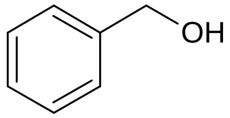
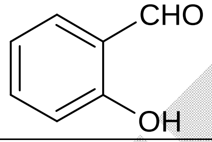
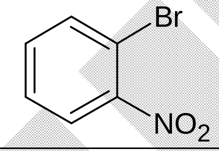
25. Answer the following by appropriately matching the lists

List – I		**List – II**	
(I)		(P)	Nucleophilic substitution
(II)		(Q)	Elimination
(III)		(R)	Nucleophilic addition
(IV)		(S)	Esterification with acetic anhydride
		(T)	Dehydrogenation

Which of the following is the correct combination?

(A) I → PQT, II → PST, III → RS, IV → P

(B) I → PST, II → PQT, III → PRS, IV → PS

(C) I → QT, II → QR, III → T, IV → S

(D) I → SU, II → PQR, III → ST, IV → ST

26. Answer the following by appropriately matching the lists

List – I		**List – II**	
(I)	Work done in isobaric process	(P)	$-P_{ext} \times \Delta V$
(II)	Work done during free expansion	(Q)	$nRT\ell n\frac{P_1}{P_2}$
(III)	Work done in reversible adiabatic process	(R)	$nRT\ell n\frac{V_1}{V_2}$
(IV)	Work done in adiabatic irreversible process	(S)	$-nR(T_{final} - T_{initial})$
		(T)	Zero

Which of the following is the correct combination?

(A) I→ PS, II→ T, III→ P, IV → PS
(B) I→ T, II→ PQ, III→ P, IV → Q
(C) I → R, II→ S, III→ PS, IV → QR
(D) I → P, II→ QT, III → QR, IV → ST

27. Match the following list-I with list-II.

List – I (Electronic configuration)		**List - II (Corresponding elements)**	
(I)	$[Xe]4f^{14}5d^{10}6s^2$	(P)	s-block elements
(II)	$[Rn]5f^{14}6d^1 7s^2$	(Q)	Transition elements
(III)	$[Xe]4f^{14}5d^{10}6s^2 6p^6 7s^2$	(R)	d-block elements
(IV)	$[Xe]4f^{14}5d^2 6s^2$	(S)	Representative elements
			Inner transition elements

(A) I→ T, II→ R, III→ QS, IV → PR
(B) I→ RS, II→ RS, III→ P, IV → Q
(C) I → R, II → T, III→ PS, IV → QR
(D) I → P, II→ QT, III→ QR, IV → ST

28. Answer the following by appropriately matching the lists

List – I		**List - II**	
(I)	Gas evolved by the action of dilute H_2SO_4 on a sulphite	(P)	Colour of acidified $KMnO_4$ is discharged
(II)	Gas evolved by the action of dilute H_2SO_4 carbonate	(Q)	Acidified dichromate solution is turned green
(III)	Gas evolved by heating an ammonium salt with NaOH	(R)	Nessler's reagent gives a brown precipitate
(IV)	Gas evolved by the action of dilute H_2SO_4 on a sulphide	(S)	Bartya water turns milky
		(T)	Alkaline nitroprusside turns violet

(A) I→ PS, II → ST, III→ RS, IV → PQ
(B) I→ PQS, II → S, III→ R, IV → PQT
(C) I→ PQ, II → RS, III→ PQ, IV → PQT
(D) I→ ST, II → QRS, III→ QR, IV → ST

Section – B (Maximum Marks: 24)

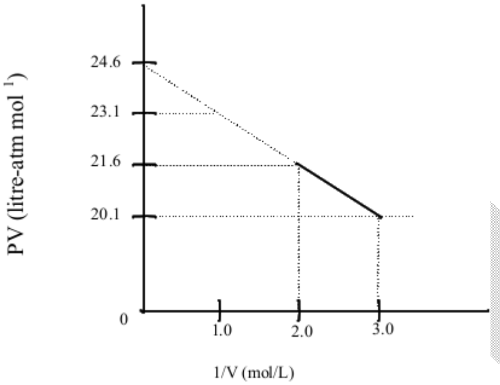
*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

29. A sample of camphor used in a method for determining of molar mass had melting point of 450 K. The melting point of a solution containing 0.5 gm camphor and 0.04 gm of an unknown non-volatile non-electrolyte compound was 430 K. The molar mass of camphor is 152 and its $\Delta H_{fusion} = 1.52\ \text{Kcal mol}^{-1}$. The molar mass of unknown compound in gm/mole is………
$\left(R = 2\ \text{cal mol}^{-1}\ \text{K}^{-1}\right)$.

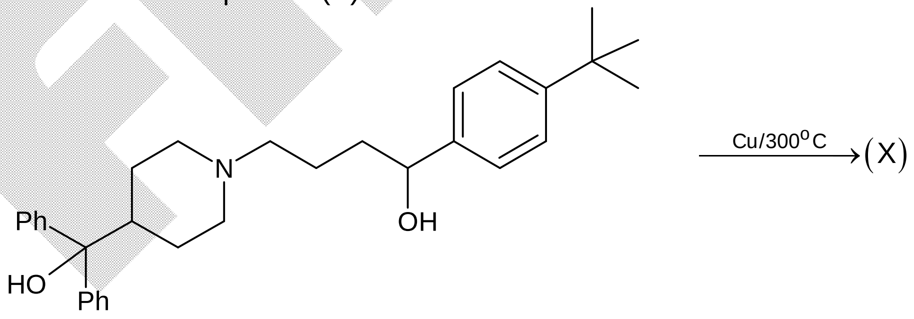
30. What volume of 0.001 M HCl solution be added into 100 mL of 0.001 NaOH to change the pH by one unit?

31. The molar conductance at infinite dilution of $CaCl_2$, $Ca(CH_3COO)_2$ and HCl are respectively 271.6, 200.8 and 425.95 S cm^2 mol^{-1}. What will be the molar conductance of CH_3COOH in S cm^2 mol^{-1} unit?

32. For one mole of a vander Waals gas when b = 0 and T = 300 K, the PV vs 1/V plot is shown below. The value of the van der Waals constant a (atm. litre^2 mol^{-2}) is



33. Seldane contains a chemical named terfenadine. Reaction of this chemical with Cu/300°C forms product(X).



How many pi-bond(s) is/are present in (X)?

34. How much gram of Fe^{2+} ions can be completely oxidized into Fe^{3+} ions by 104.3 litre of acidified $KMnO_4$ solution of 0.1 M concentration, according to the following reaction.

$$MnO_4^- + Fe^{2+} + H^+ \longrightarrow Mn^{2+} + Fe^{3+} + H_2O$$

35. What is the percentage of ferric ion in the non-stoichiometric solid having formula $Fe_{0.96}O$.

36. Aluminium crystallises in a cubic system with unit cell edge length equal to $4.0\,\overset{o}{A}$. It its density is $\frac{45}{16}$ g/cm^3, then the atomic radius of Al atom in $\overset{o}{A}$ is

FIITJEE

Mathematics

PART – III

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

37. Let V be the volume of the parallelogpiped formed by the vectors $\vec{a} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$, $\vec{a} = b_1\hat{i} + b_2\hat{j} + b_3\hat{k}, \vec{c} = c_1\hat{i} + c_2\hat{j} + c_3\hat{k}$, If a_r, b_r, c_r where r = 1,2,3 are non – negative real numbers and $\sum_{r=1}^{3}\left(a_r + b_r + c_r\right) = 3L$, then which of the following may hold

(A) $L^3 > V$
(B) $L^3 < V$
(C) $L^3 = V$
(D) Nothing can be said

38. The real parameters m and n are such that the graph of the function $f(x) = \sqrt[3]{8x^3 + mx^2} - nx$ has the horizontal asymptote y = 1 then

(A) $|m+n| = 10$
(B) $|m+n| = 14$
(C) $|m-n| = 10$
(D) $|m-n| = 2$

39. If $\int \frac{x^4+1}{x^6+1}dx = \alpha \arctan\frac{P(x)}{Q(x)} + C, \alpha \in \mathbb{Q}, .$

(A) $\alpha = \frac{1}{3}$
(B) $P(1) = 0$
(C) $P(-1) = 0$
(D) $Q(1) = -4$

40. Let a and b be positive real numbers and $f(a, b) = \int_a^b \frac{e^{\frac{x}{a}} - e^{\frac{b}{x}}}{x}dx$, then

(A) $f(1,2) = 0$
(B) $f(3, 1) = 2$
(C) $f(2,1) = 0$
(D) $f(1, 3) = 2$

41. $$\frac{1}{\cot 9^o - 3\tan 9^o} + \frac{3}{\cot 27^o - 3\tan 27^o} + \frac{9}{\cot 81^o - 3\tan 81^o} + \frac{27}{\cot 243^o - 3\tan 243^o} =$$

(A) $10\tan 9^o$
(B) $10\cot 81^o$
(C) $10\cot 9^o$
(D) $10\tan 81^o$

42. Point M moved on the circle $(x-4)^2+(y-8)^2=20$. Then it broke away from it and moving along a tangent to the circle, cuts the x – axis at the point (–2, 0). The coordinates of a point on the circle at which the moving point broke away is:

(A) $\left(-\frac{3}{5},\frac{46}{5}\right)$ (B) $\left(-\frac{2}{5},\frac{44}{5}\right)$

(C) (6, 4) (D) (3, 5)

Section – A (Maximum Marks: 12)

This section contains ***FOUR (04)*** *Matching List Type Questions. Each question has FOUR statements in* ***List-I*** *entries (I), (II), (III) and (IV) and FIVE statements in* ***List-II*** *entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which* ***ONLY ONE*** *of these four options is correct answer.*

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43. Match the following list-I with list-II.

List– I		List- II	
(I)	Let $f(x)=\begin{cases} x^{3/5} & \text{if } x\le 1 \\ -(x-2)^3 & \text{if } x>1\end{cases}$ then the number of critical points on the graph of the function is	(P)	5
(II)	Number of real solution of the equation, $\log_2^2 x+(x-1)\log_2 x=6-2x$, is		4
(III)	The number of values of c such that the straight line $3x+4y=c$ touches the curve $\frac{x^4}{2}=x+y$ is	(R)	3
(IV)	If $f(x)=\int_x^{x^2}(t-1)\,dt,\ 1\le x\le 2,$ then global maximum value of $f(x)$ is	(S)	2
		(T)	1

Which is correct option?

(A) I→ Q (B) II→S

(C) III→P (D) IV →T

44. Match the following list-I with list-II.

List– I		**List- II**	
(I)	If $\lim\limits_{x\to 0}\left(\frac{\sin x}{x}\right)^{\frac{1}{1-\cos x}}$ is L then ln (L) equals k. The value of $\frac{1}{k^2}$ is equal to	(P)	0
(II)	The value of $\lim\limits_{n\to\infty}\left(\frac{n^2}{n-1}\right)^{\tan\frac{1}{\sqrt{n}}}$ is	(Q)	1
(III)	Number of solution of the equation $8\sin^4 x+8\cos^4 x=5$ in the interval $0<x<2\pi$ is	(R)	3
(IV)	Let $f(x)$ be a non – constant polynomial function and $g(x)=\left\|x(x-1)(x-2)f(x)\right\|$. If $g(x)$ is differentiable $\forall\ x\in R,$ then minimum number of distinct roots of $f(x)=0$ is	(S)	8
		(T)	9

Which is correct option?

(A) I→ Q
(B) II→S
(C) III→P
(D) IV →R

45. The number of 10 letter permutations comprising $4a's$, $3b's$ and $3c's$ such that

List– I		**List- II**	
(I)	a' s are separated and all b' s are together is equal to	(P)	18
(II)	a' s are separated and exactly two b' s are together is equal to	(Q)	20
(III)	no two adjacent letters are identical is equal to	(R)	150
(IV)	no two b's are together, no two c' s are together and all 'a' s are	(S)	180
		(T)	248

Which is correct option?

(A) I→ Q
(B) II→T
(C) III→P
(D) IV →Q

46. In a tournament, there are twelve players $S_1, S_2, ..., S_{12}$ and divided into six pairs at random. From each game a winner is decided on the basis of a game played between the two players of the pair. Assuming all the players are of equal strength, then

List– I		**List- II**	
(I)	Probability that S_2 is among the losers is	(P)	$\frac{5}{22}$
(II)	Probability that exactly one of S_3 and S_4 is among the losers is	(Q)	$\frac{1}{2}$
(III)	Probability that both S_2 and S_4 are among the winners is	(R)	$\frac{6}{11}$
(IV)	Probability that S_4 and S_5 not playing against each other is	(S)	$\frac{10}{11}$
		(T)	$\frac{3}{11}$

Which is correct option?

(A) I→ P (B) II→Q

(C) III→R (D) IV →S

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

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47. Let N be the integer next above $\left(\sqrt{3}+1\right)^{2018}$. The greatest integer ‘p’ such that $(16)^P$ divides N is equal to

48. The coefficient of $x^{\frac{n^2+n-14}{2}}$ in $(x-1)\left(x^2-2\right)\left(x^3-3\right)\left(x^4-4\right)...\left(x^n-n\right), n \geq 30$ is equal to

49. If α, β, γ are such that $\alpha+\beta+\gamma=2,\ \alpha^2+\beta^2+\gamma^2=6,\ \alpha^3+\beta^3+\gamma^3=8,$ then $\alpha^4+\beta^4+\gamma^4$ is

50. Find the global minimum of the function

$$f:\mathbb{R}^2 \to \mathbb{R},\ f(x,y)=x^4+6x^2y^2+y^4-\frac{9}{4}x-\frac{7}{4}y$$

51. Let $f:\mathbb{R}\to\mathbb{R}$ be a differentiable function such that f’ is continuous on $\mathbb{R}$ with $f'(3)=18$. Define $g_n(x)=n\left\{f\left(x+\frac{5}{n}\right)-f\left(x-\frac{2}{n}\right)\right\}$. Then $\lim\limits_{n\to\infty} g_n(3)$ equals ____

52. Find the area of the region bounded by the curves $y = x^2$, $y = \left|2 - x^2\right|$ and $y = 2$, which lies to the right of the line $x = 1$.

53. Find the maximum value of $S = (1 - x_1)(1 - y_1) + (1 - x_2)(1 - y_2)$ if $x_1^2 + x_2^2 = y_1^2 + y_2^2 = 8$

54. Let $[x] =$ greatest integer less than or equal to x. If all the values of x such that the product $\left[x - \frac{1}{2}\right]\left[x + \frac{1}{2}\right]$ is prime, belongs to the set $[x_1, x_2) \cup [x_2, x_4)$, find the value of $x_1^2 + x_2^2 + x_3^2 + x_4^2$

FIITJEE

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ALL INDIA TEST SERIES
JEE (Advanced)-2023
FULL TEST – IV
PAPER –2
TEST DATE: 08-02-2023

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B**.

Section – A ***(01 – 04, 19 – 22, 37 – 40)*****:** This section contains **TWELVE (12)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.

Section – A ***(05 –10, 23 – 28, 41 – 46)*****:** This section contains **EIGHTEEN (18)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – B ***(11 – 18, 29 – 36, 47 – 54)*****:** This section contains **TWENTY FOUR (24)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.**

MARKING SCHEME

Section – A (Single Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct option is chosen.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –1 In all other cases.

Section – A (One or More than One Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If only (all) the correct option(s) is (are) chosen;
Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;
Partial marks : +2 if three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –2 In all other cases.

Section – B: Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If ONLY the correct integer is entered;
Zero Marks : 0 Question is unanswered;
Negative Marks : –1 In all other cases.

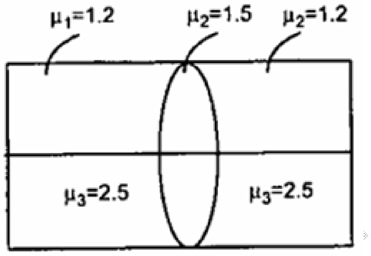
Physics

PART – I

Section – A (Maximum Marks: 12)

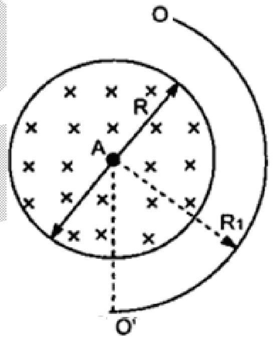
*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

1. A thin lens of refractive index 1.5, and focal length in air 20 cm is placed inside, a large container containing two immiscible liquids as shown. If an object is placed at an infinite distance close to principle axis (common intersection line of the layers), the distance between images



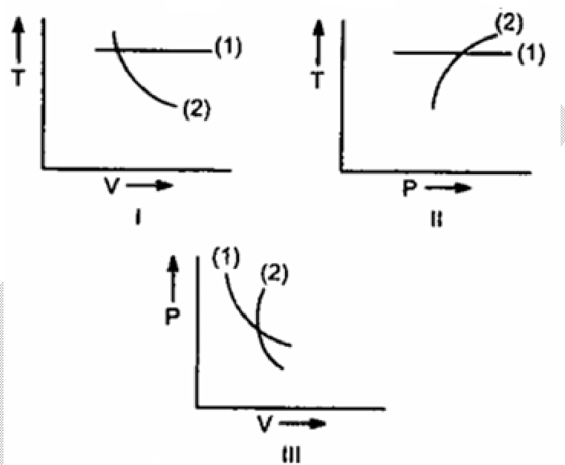
(A) 25 cm (B) 45 cm
(C) 65 cm (D) 85 cm

2. There is a uniform magnetic field B in circular region of radius R as shown in figure, whose magnitude changes at the rate of dB/dt. The e.m.f. induced across the ends of a circular concentric conducting arc of radius R_1 having an angle θ as shown ($\angle OAO'$) is:



(A) $\frac{\theta}{2\pi}R_1^2\frac{dB}{dt}$ (B) $\frac{\theta}{2}R^2\frac{dB}{dt}$
(C) $\frac{\theta}{2\pi}R^2\frac{dB}{dt}$ (D) none of these

3.



If (I) represents isothermal and (II) represents adiabatic, which of the graphs given above in respect of an ideal gas are correct?

(A) I and II (B) II and III
(C) I and III (D) I, II and III

4. A travelling wave is given by

$$y = \frac{0.8}{3x^2 + 12xt + 12t^2 + 4}$$

Where x and y are in m and t is in sec, then velocity and amplitude of wave will be

(A) 2 m/s, 0.2 m
(B) 4 m/s, 0.2 m
(C) 2 m/s, 0.4 m
(D) none of these

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

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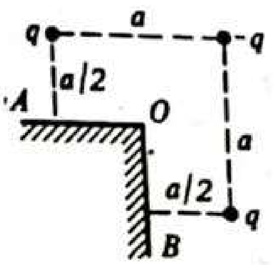
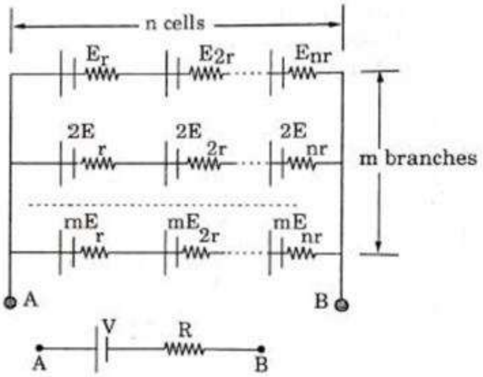
5. Three unlike point charges are arranged as shown in given figure, where AOB is the right angle formed by two conducting half-planes. The magnitude of each of the charges is | q | and the distances between them are shown in the figure. Total charge induced on the conducting half-planes and the force acting on the charge –q is



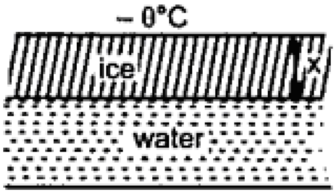
(A) charge = –q
(B) charge = –3q
(C) $\text{Force} = \left(\frac{2\sqrt{2}-1}{4\pi\varepsilon_0}\right)\frac{q^2}{2a^2}$
(D) $\text{Force} = \left(\frac{4\sqrt{2}+1}{4\pi\varepsilon_0}\right)\frac{q^2}{2a^2}$

6. Consider an arrangement of cells shown in the figure. There are m-branches and in each branch there are n-cells. Suppose this combination of cells can be replaced by a single battery of emf V and internal resistance R, then V and R.



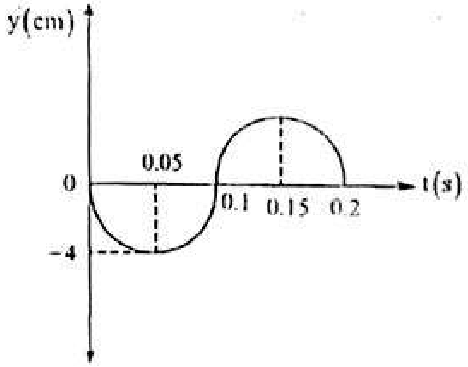
(A) $V = \frac{n(m+1)E}{2}$
(B) $V = \frac{m(n+1)E}{2}$
(C) $R = \frac{n(n+1)r}{2m}$
(D) $R = \frac{m(m+1)r}{2n}$

7. Consider the shown case of a freezing lake due to negative environmental temperature ($-\theta^0$C). Thickness (x) of ice layer is small in comparison to depth of lake. Rate of increase in x will be greater:



(A) if environmental temperature increases.
(B) for larger thickness of ice layer.
(C) if environmental temperature decreases.
(D) for smaller thickness of ice layer.

8. For a certain transverse standing wave on a long string, an antinode is formed at x = 0 and next to it, a node is formed at x = 0.10 meter, the displacement y(t) of the sting particle at x = 0 is shown in figure.



(A) Transverse displacement of the particle at x = 0.05 m and t = 0.05 sec is $-2\sqrt{2}$ cm

(B) Transverse displacement of the particle at x = 0.04 m and t = 0.025 sec is $-2\sqrt{2}$ cm

(C) Speed of travelling wave that interfere to produce this standing wave is 2 m/s.

(D) The transverse velocity of the string particle at $x = \frac{1}{15}$m and t = 0.1 sec is 20π cm/sec.

9. A particle performing simple harmonic motion undergoes initial displacement of A/2 (where A is the amplitude of simple harmonic motion) in 1s At t = 0, the particle may be at the extreme position or mean position. The time period of the simple harmonic motion can be

(A) 6 s
(B) 2.4 s
(C) 12 s
(D) 1.2 s

10. A sky lab of mass m is first launched from the surface of earth (radius R) in a circular orbit of radius 2R (from centre of earth) and then it is shifted from this circular orbit to another circular orbit of radius 3R.

(A) Minimum energy required to place the lab in first orbit is equal to $\frac{3}{4}$mgR.

(B) Minimum energy required to shift lab from first orbit to second orbit is $\frac{mgR}{12}$.

(C) Energy of sky lab in second orbit is greater than its energy in firsts orbit.

(D) Energy of sky lab in second orbit is less than its energy in first orbit.

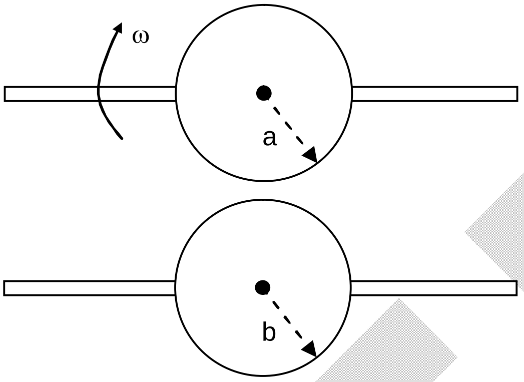
Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.***

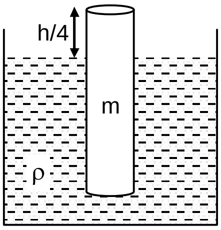
11. A glass of refractive index 1.5 is coated with a thin layer of thickness t, of refractive index 1.8. Light of wavelength λ travelling in air is incident normally on the layer. It is partly reflected at the upper and at the lower surfaces of the layer. The two reflected rays interfere. If λ = 648 nm, obtain the least value of t (in 10^{-8} m) for which the rays interfere constructively.

12. A Bohr hydrogen atom undergoes a transition n = 5 to n = 4 and emits a photon of frequency f. Frequency of circular motion of electron in n = 4 orbit is f_4. The ratio $\frac{f}{f_4}$ is found to be $\frac{18}{5m}$. State the value of m.

13. Two uniform spheres shown in given figure rotate separately on two parallel horizontal axis passing though their centres. The upper sphere has an angular speed ω_0 and the lower sphere is at rest. Now the two spheres are moved together so that their surfaces touch. After a short time the two spheres, now in contact, are rotating without slipping. Find the final rate of rotation of upper sphere in rad/s [given moment of inertia of the upper sphere $I_l = 4$ kg m^2, moment of inertia of lower sphere $I_2 = 2$ kg m^2, radius of upper sphere a = 2 m, radius of lower sphere b = 1 m, $\omega_0 = 12$ rad/s].



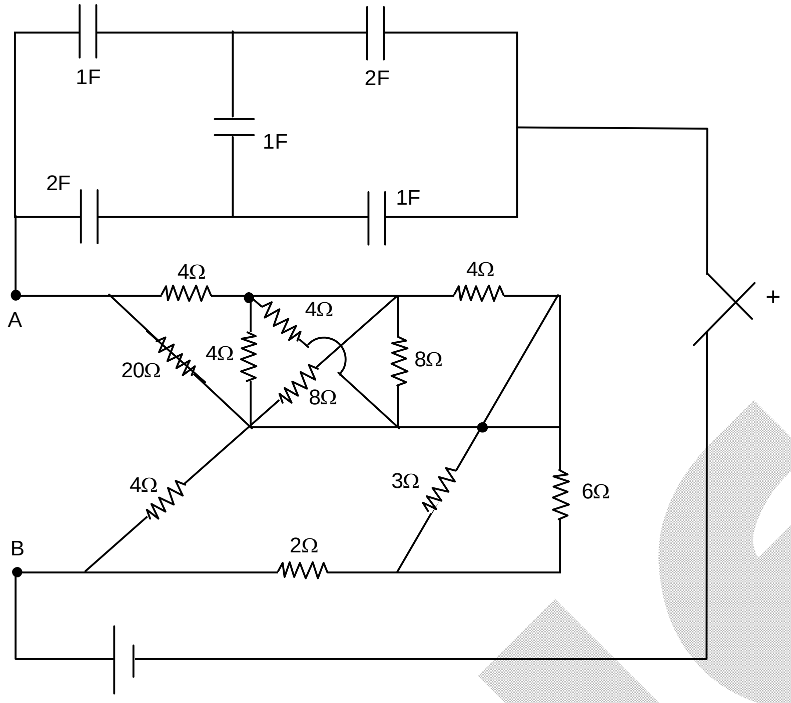
14. A solid cylinder of height h and mass m is floating in a liquid of density ρ as shown in the figure. Find the acceleration of the vessel (in m/s^2) containing liquid for which the relative downward acceleration of the completely immersed cylinder w.r.t. vessel becomes equal to one-third of that of the vessel acceleration in magnitude. (Take g = 10 m/s^2)



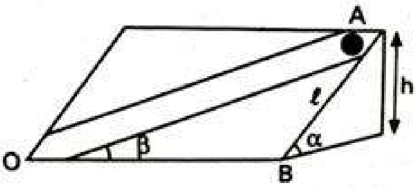
15. A barometer contains two uniform capillaries of radii 1.44×10^{-3} m and 7.2×10^{-4} m. If the height of liquid in narrow tube is 0.2 m more than that in wide tube. The true pressure difference is 310 × N. Then the value of 'N' is ______.
Density of liquid = 10^3 kg/m^3, surface tension = 72×10^{-3} N/m and g = 9.8 m/s^2. (Angle of contact = 0)

16. Two electrode each of radius $a = \frac{1}{\pi}$ are embedded a large distance apart in a homogeneous conducting medium of resistivity ρ = 1. Resistance between the electrodes is $\frac{4}{n}$. Then the value of 'n' is ______ .

17. Time constant in given network. $\tau = 2.1 \times n$. Then the value of 'n' is ______ .



18. Plane of height h = 1.6 meter and inclination $\alpha = 30°$ to the horizontal has a smooth groove cut in it inclined at an angle $\beta = 45°$ to the line of greatest slope as shown in figure. Time that a particle would take to move top point A to bottom point O in groove, starting from rest at the top is $\frac{3.2}{k}$. Then value of 'k' is ($g = 10\ m/sec^2$)



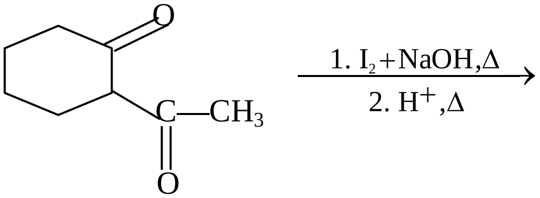
Chemistry

PART – II

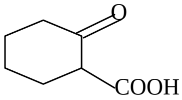
Section – A (Maximum Marks: 12)

This section contains ***FOUR (04)*** *questions. Each question has* ***FOUR*** *options.* ***ONLY ONE*** *of these four options is the correct answer.*

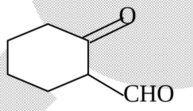
19. End product of the following sequence of reaction is



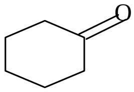
(A) Yellow ppt. of CHI_3,



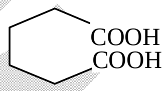
(B) Yellow ppt. of CHI_3,



(C) Yellow ppt. of CHI_3,



(D) Yellow ppt. of CHI_3,



20. The following reactions takes place in stratosphere

$$O_2 \xrightarrow{\text{U.V radiation}} O + O$$

$$O + O_2 + M \longrightarrow O_3 + M(\text{exothermic})$$

What is the role of 'M' in above reaction?

(A) It is used as a catalyst

(B) It absorbs some heat energy and prevents decomposition of O_3

(C) It converts ground state O_2 to excited O_2^*

(D) It reduces the reactivity of nascent oxygen

21. The temperature of a definite amount of an ideal monoatomic gas becomes four times in an isoentropic process. Which of the following is correct relation between the final and initial parameters of gas?

(A) $V_f = 8V_i$ (B) $V_f = 16 V_i$

(C) $P_f = 32 P_i$ (D) $P_f = P_i$

22. 0.1 M acetic acid solution is titrated against 0.1 M NaOH solution. What would be the difference in pH between ¼ and ¾ stages of neutralization of acid.

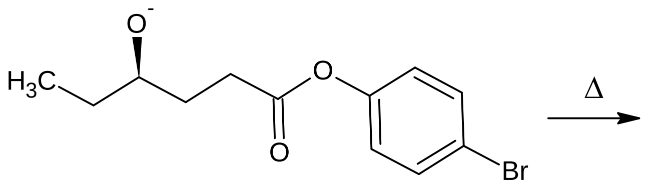
(A) 2 log 3/4 (B) 2 log ¼

(C) log 1/3 (D) 2 log 3

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

23.



Which of the statements regarding the product formed in the above reaction is correct?
(A) If Br is replaced with NO_2 rate of reaction increases
(B) Inversion of configuration takes place.
(C) Nucleophillic acyl substitution takes place.
(D) Configuration at chiral carbon does not change

24. Which of the following statements is/are true about an azeotropic mixture?
(A) An azeotropic mixture boils at constant temperature
(B) The composition of an azeotropic mixture changes on distillation
(C) An azeotropic solution of two liquids has a boiling point lower than that of either of them when it shows positive deviation from the Raoult's law
(D) An azeotropic solution of two liquids has a boiling point higher than that of either of them if it shows positive deviation from Raoult's law

25. The following data are given for the reaction

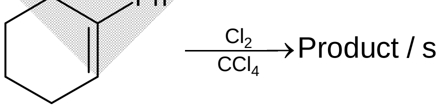
$$X(g) + Y(g) \longrightarrow \text{Product}$$

No. of expt.	Initial concentration of 'X' in 'M'	Initial concentration of 'Y' in 'M'	Rate of reaction in M s^{-1} unit
1.	0.1	0.1	2×10^{-8}
2.	0.2	0.2	4×10^{-8}
3.	0.4	0.2	8×10^{-8}

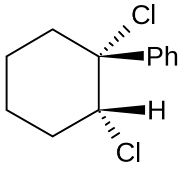
Choose the correct statement(s) from the following
(A) The order of reaction with respect to X is one
(B) The overall order of reaction is one
(C) The rate constant of the reaction is 2×10^{-7} s^{-1}
(D) The half-life of 'Y' does not depend on its concentration

26. Which of the following substance(s) produce(s) gases when treated with water?
(A) CaC_2 (B) Mg_3N_2
(C) Na_2S (D) KNO_3

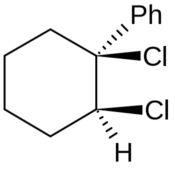
27. What is/are the product of reaction?

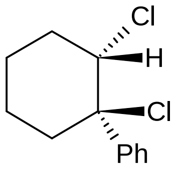


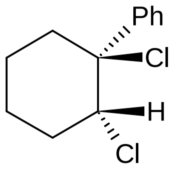
(A)



(B)



(C) 

(D) 

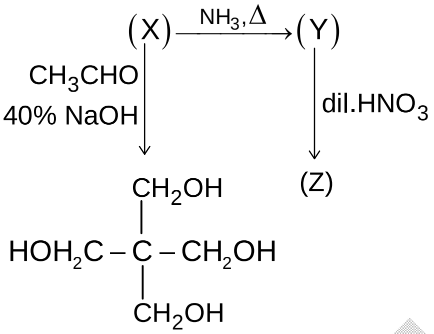
28. Which of the following complex(es) show(s) geometrical isomerism?

(A) $[Cr(H_2O)_5Cl]Cl_2.H_2O$ (B) $[Pt(NH_2CH_2COO)_2]$

(C) $[PtCl_2P(C_2H_5)_3]_2$ (D) $K_2[Fe(CN)_4(NH_3)_2]$

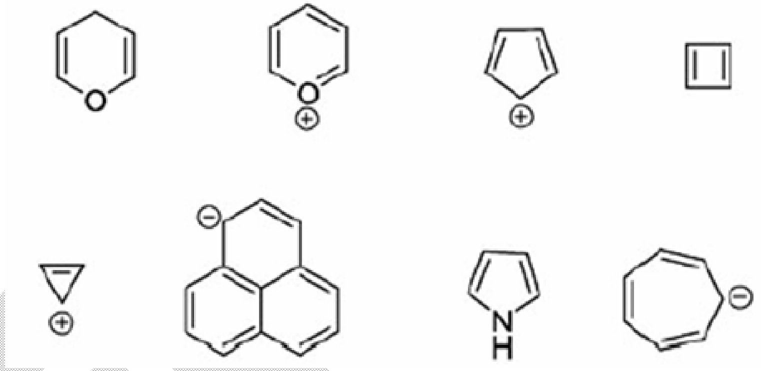
Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.***

29. 

Total how many sp^2 hybridised N are present in (Z)

30. Among the following



The total number of aromatic species is

31. The Mo–Mo bond order in $[(\eta^5\text{-}C_5H_5)Mo(CO)_2]_2$ which obeys the 18-electron rule is__.

32. $X(s)\xrightarrow{HCl}Y\uparrow\xrightarrow[NaOH]{Na_2[Fe(CN)_5NO]}$Purple solution gas

Y has been allowed to react with following species in neutral/acidic medium

(a) $FeCl_3$ (b) $CuSO_4$ (c) $BaCl_2$ (d) SO_2 (e) $Cr_2O_7^{2-}$ (f) CH_3COONa (g) Hg^{2+}

The calculate the value of P + Q – R

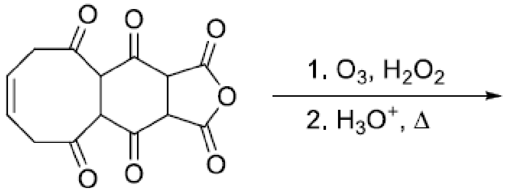
P : Number of species which undergoes redox reaction with gas Y

Q: Number of species with which gas Y undergoes precipitation

R: Number of species with which gas Y produce no observable change

33. On heating a sample of 25 mg hydrated compound(molecular weight = 250 g/mol) in thermogravimetric analysis, 16 mg of dehydrated compound remains. The number of water molecules lost per molecule of hydrated compound is _________
(Molecular weight of water = 18 g/mol)

34. Number of carbonyl groups present in the final product of the following reaction sequence is



35. A tetrapeptide, made up of natural amino acids, has alanine as the N-terminal residue which is coupled to a chiral amino acid. Upon complete hydrolysis, the tetrapeptide gives glycine, alanine, phenylalanine and leucine. The number of possible sequences of the tetrapeptide is

36. The number of possible stereoisomers for cyclononene is ______

FIITJEE

Mathematics PART – III

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

37. Let A and B be 2 × 2 matrices with real entries satisfying $(AB - BA)^n = I_2$ for some positive integer n, then n is

(A) even
(B) odd
(C) prime
(D) any integer

38. Let A & B be two n × n matrices that do not commute and for which there exist non zero real numbers p, q, r such that $pAB + qBA = I_n$ and $A^2 = rB^2$ then

(A) $p + q = 0$
(B) $p - q = 0$
(C) $p^2 + q = 0$
(D) $p = 2q$

39. The solution of the differential equation $\frac{d^2y}{dx^2} = \sin 3x + e^x + x^2$ when $y_1(0) = 1$ and $y(0) = 0$ is

(A) $\frac{-\sin 3x}{9} + e^x + \frac{x^4}{12} + \frac{1}{3}x - 1$
(B) $\frac{-\sin 3x}{9} + e^x + \frac{x^4}{12} + \frac{1}{3}x$
(C) $\frac{-\cos 3x}{3} + e^x + \frac{x^4}{12} + \frac{1}{3}x + 1$
(D) none of these

40. Consider a circle of diameter AB and center O, and the tangent t at B. A variable tangent to the circle with contact point M intersects t at P. The locus of the point Q where the line OM intersects the parallel through P to the line AB is

(A) straight line
(B) parabola
(C) ellipse
(D) hyperbola

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

41. Variable circle is described to pass through point (1, 0) and tangent to the curve $y = \tan(\tan^{-1} x)$. The locus of the centre of the circle is a parabola whose:

(A) length of the latus rectum is $2\sqrt{2}$
(B) axis of symmetry has the equation $x + y = 1$
(C) vertex has the co – ordinates $\left(\frac{3}{4}, \frac{1}{4}\right)$
(D) none of these

42. Line through P(a, 2) meets the ellipse $\frac{x^2}{9}+\frac{y^2}{4}=1$ at A and D and meets the coordinate axes at B and C so that PA, PB, PC, PD are in G.P., then possible values of a can be:

(A) 5 (B) 8

(C) 10 (D) –7

43. Let α be a real number, then the integral, $(n \in I)$

$$I(\alpha)=\int_{-1}^{1}\frac{\sin\alpha\,dx}{1-2x\cos\alpha+x^2}=$$

(A) $\frac{\pi}{2}$ if $\alpha \in \left[2n\pi, (2n+1)\pi\right]$ (B) $\frac{\pi}{2}$ if $\alpha \in \left((2n+1)\pi, (2n+2)\pi\right)$

(C) $\frac{-\pi}{2}$ if $\alpha \in \left((2n+1)\pi, (2n+2)\pi\right)$ (D) $\frac{\pi}{2}$ if $\alpha \in \left(2n\pi, (2n+1)\pi\right)$

44. Let $u = ax + by + a\sqrt[3]{b} = 0$, $v = bx - ay + b\sqrt[3]{a} = 0$, where $a,b \in R$ be two straight lines. The equations of the bisectors of the angles formed by $k_1u - k_2v = 0$ and $k_1u + k_2v = 0$ for non zero real k_1 and k_2 are:

(A) $u = 0$ (B) $k_2u + k_1v = 0$

(C) $k_2u - k_1v = 0$ (D) $v = 0$

45. If $f:\mathbb{R}\to\mathbb{R}$, such that $f(x)=\frac{\left(x^2-x+1\right)^3}{x^6-x^3+1}$, then

(A) minimum value of $f(x)$ is 1 (B) minimum value of $f(x)$ is $\frac{\sqrt{3}}{1+\sqrt{3}}$

(C) maximum value of $f(x)$ is 1 (D) maximum value of $f(x)$ is 9

46. Let z, iz and z + iz represent three vertices of a triangle then,

(A) area of Δ is given by, Area $=\frac{1}{2}|z|^2$ (B) area of Δ is given by, Area $=|z|^2$

(C) orthocentre of Δ is given by $z+iz$ (D) None of these

Section – B (Maximum Marks: 24)

This section contains ***EIGHT (08)*** *numerical based questions. The answer to each question is a* ***Single Digit Integer, ranging from 0 to 9 both inclusive.***

47. Tangent are drawn from any point on the hyperbola $\frac{x^2}{9}-\frac{y^2}{4}=1$ to the circle $x^2+y^2=9$. If the locus of the mid – point of the chord of contact is $a\left(x^2+y^2\right)^2=bx^2-cy^2$, then the value of $a^2+b^2+c^2-7870$ is equal to

48. Let $\vec{b} = 4i + 3j$ and $\vec{c}$ be two vectors perpendicular to each other in the xy – plane. If $\vec{r}_i,\ i = 1, 2, \ldots n$ are the vectors in the same plane having projection 1 and 2 along $\vec{b}$ and $\vec{c}$ respectively $\sum_{i=1}^{n}\left|\vec{r}_i\right|^2$ is equal to k then $\frac{k}{4}$ equals to

49. If the value of greater of $\sin x + \tan x$ and $2x\left(0 < x < \frac{\pi}{2}\right)$ at $\frac{\pi}{4}$ is $g\left(\frac{\pi}{4}\right)$ then $g\left(\frac{\pi}{4}\right) - \frac{1}{\sqrt{2}}$ is equal to

50. Let A & B be 2 × 2 matrices with integer entries such that A, A + B, A + 2B, A + 3B and A + 4B are all invertible matrices whose inverse have integer entries, then find I det (A + 5B) I

51. Let $< a_n >$ be an arithmetic sequence such that arithmetic mean of $a_1, a_3, a_5, \ldots.. a_{97}, a_{99}$ is 1. Find the value of $\left|\sum_{r=1}^{50}(-1)^{\frac{r(r+1)}{2}}.a_{2r-1}\right|$

52. Let $f(x) = ax^2 + bx + c,$ where $a \neq 0,\ a, b, c$ are integers and $f(1) = 1,\ 6 < f(3) < 8$ and $18 < f(5) < 22$. Then the number of solutions of equation $f(x) = e^x$ is ______

53. If z_1, z_2 are complex numbers, then the maximum value of $\frac{z_1\bar{z}_2 + \bar{z}_1 z_2 + z_1 z_2 + \bar{z}_1\bar{z}_2}{\left|z_1 z_2\right|}$ is equal to ____________.

54. Let $f(x) = ax^2 + bx + c,\ (a < b)$ and $f(x) \geq 0\ \forall\ x \in R$. If the minimum value of $\frac{a + b + c}{b - a}$ is k then value of k is

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FULL TEST – IV
PAPER –1
TEST DATE: 08-02-2023

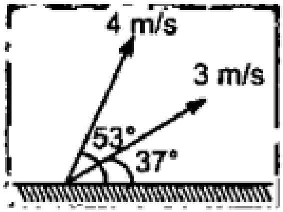
ANSWERS, HINTS & SOLUTIONS

Physics PART – I

Section – A

1. AD

Sol. So, velocity of first particle



$= 3\cos 37°\,\hat{i} + 3\sin 37°\,\hat{j}$

$= \frac{12}{5}\hat{i} + \frac{9}{5}\hat{j}$

Velocity of second particle

$= 4\cos 53^o\,\hat{i} + 4\sin 53^o\,\hat{j}$

$= \frac{12}{5}\hat{i} + \frac{16}{5}\hat{j}$

So, relative horizontal velocity is zero. So their relative velocity is in vertical direction only. Since, both particles are moving under gravity, so their relative acceleration is zero.

Their relative velocity = $\frac{16}{5} - \frac{9}{5} = \frac{7}{5}$ = 1.4 m/s

2. BC

Sol. Just after BP is cut.

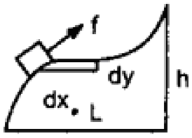
For block A no force has changed.

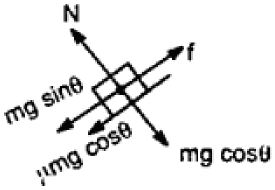
$\therefore$ acceleration of $m_1 = 0$

for m_2 downward force is being reduced

$\therefore$ m_2 will move upwards.

3. AC





Sol. $dw = \vec{f}\cdot\vec{d}s$

Since, body is hauled slowly, so

$f = mg\sin\theta + \mu mg\cos\theta$

$W = \int(mg\sin\theta + \mu mg\cos\theta)ds$

$= \int mgds\sin\theta + \int \mu mgds\cos\theta$

$= \int mgdy + \int \mu mgdx$

$= mgh + \mu mgL$

4. AC

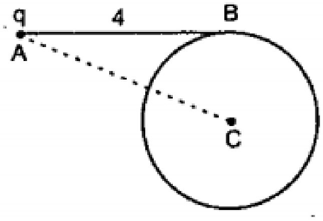
Sol. $5 - F_1 = 1 \times 2 \Rightarrow F_1 = 3$ N

Taking torque about CM:

$5x = 3(\ell + x) \Rightarrow 2x = 3 \times 20 \Rightarrow x = 30$ cm

Length of rod $= 2 \times (\ell + x) = 100$ cm $= 1$ m

5. AC



Sol. AC = 5 m

$$V = \frac{kq}{AC} = \frac{9\times10^{9}\times1\times10^{-6}}{5}$$

$= 1.8 \times 10^{3} = 1.8$ kV

$V_B = (V_B)_{\text{due to q}} + (V_B)_i$

$(V_B)_i = -0.45$ kV

So, (A) and (C) are correct.

6. BC

Sol. For a bulb $R = \dfrac{V^2}{W}$

$\Rightarrow R_B \le R_A$

when switch is open $I_A = I_B$

$P_A = R_A I_A^2$

$P_B = R_B I_B^2$

$\Rightarrow P_B < P_A$ and $V_A > V_B$

$\Rightarrow V_A > 12V$ and $V_B < 12V$

After closing the switch

$V_A = V_B = 12$ V

7. A

Sol. (I)

$$P_i = P_f \Rightarrow 60(1-V) = 100\,V$$

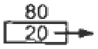
$\Rightarrow \quad V = \frac{3}{8}$ opposite to velocity of Ram i.e. $\frac{3}{8}$ m/s towards right.

(II) $80\,V = 80\,(1 - V)$

$\Rightarrow \quad V = \frac{1}{2}\text{m/sec}$ left.

(III) $80(1 + V) + 60(-1 + V) + 20V = 0$

$V = -\frac{1}{8}\text{m/s}$

(IV) After jump of Ram  3/8

Now $(80 + 20)\frac{3}{8} = 80(1 + V) + 20\,V$

$$V = -\frac{17}{40}\text{m/s}$$

8. B

Sol. (I) Velocity of fish in air = $4 \times \frac{3}{4} = 3\uparrow$

Velocity of fish w.r.t. bird = 3 + 6 = 9↑

(II) Velocity of image of fish after reflection from mirror in air = $4 \times \frac{3}{4} = 3\downarrow$

w.r.t. bird = –3 + 6 = 3↑

(III) Velocity of bird in water = $6 \times \frac{4}{3} = 8\downarrow$

w.r.t. fish = 8 + 4 = 12↓

(IV) Velocity of bird in water after reflection from mirror = 8↑
w.r.t. fish = 8 – 4 = 4↑

9. D

Sol. $I = \int_0^r 2\pi r dr br = \frac{2\pi b r^3}{3}$

Use ampere law for B.

10. C

Sol. $\oint \overline{B} \cdot \overline{d\ell} = -A\left(\frac{dB}{dt}\right)$

Section – B

11. 7.50

Sol. The centre of the wheel is moving with constant speed on a circular path of radius 6R. Hence, it has a centripetal acceleration of $a_c = \frac{V^2}{6R}$ directed towards the centre of curvature of the convex surface.

With respect to the centre of the wheel, the contact point has acceleration equal to $\frac{V^2}{R}$ directed towards the centre of the wheel.

∴ Acceleration of the contact point in reference frame of ground is

$$a_P = \frac{V^2}{R} - \frac{V^2}{6R} = \frac{5V^2}{6R}.$$

12. 2.56

Sol. For a jump of h_0 = 1 m on the earth, speed required is given by

$$\frac{1}{2}mV^2 = mgh_0 \quad \Rightarrow \quad V = \sqrt{20}\ \text{m/s}$$

Escape speed on the surface of a planet is

$$V_{esc} = \sqrt{\frac{2GM}{R}} = \sqrt{\frac{8\pi GR^2\rho}{3}}$$

$$\therefore \quad \frac{V_{esc-planet}}{V_{esc-earth}} = \frac{R_{planet}}{R_{earth}}$$

We want $V_{esc}^{planet} = \sqrt{20}\ \text{m/s}$

And it is given that V_{esc}^{planet} = 11.2 km/s

$$R_{planet} = \frac{\sqrt{20} \times (6400\ \text{km})}{11200} = 2.56\ \text{km}$$

13. 400.00

Sol. If force exerted on piston of area A_2 is F_2 then, the force acting on the other piston will be

$= \frac{F_2}{A_2} \cdot A_1$ [Pascal's law]

$= 5F_2$ $\because \left[\frac{A_1}{A_2} = 5\right]$

To raise the load $5F_2 = 20000$ ⇒ $F_2 = 4000$ N

Since lever bar is light, net torque on it (about the hinge) must be zero.

∴ $F_2a = F(a + b)$

$$\therefore \quad F = \frac{F_2 a}{a+b} = \frac{4000 \times 4}{4+36} = 400\ \text{N}$$

14. 283.40

Sol. The product nucleus ^{198}Hg is in excited state and possesses extra 1.088 MeV energy. If ^{198}Hg would had been in ground state, the kinetic energy available to electron and antineutrino must have

$Q = (m_{Au} - m_{Hg})\ 931$ MeV

$= (197.968233 - 197.966760)\ 931\ \text{MeV}$

$= 1.3714\ \text{MeV}$

Since ^{198}Hg is in excited state, actual kinetic energy available to electron and antineutrino is

$K = (1.3714 - 1.088)\ \text{MeV}$

$= 0.2834\ \text{MeV}$

As β-ray and antineutrino has continuous spectrum starting from zero value, therefore, this is also the maximum kinetic energy of the electron emitted.

15. 7.00

Sol. $\Delta x = (\mu_1 - 1)t_1 - (\mu_2 - 1)t_2$

$= (2 - 1)200 - (1.5 - 1)200$

$= 200 - 100 = 100\ \text{nm}$

$$\therefore\ \phi = \frac{2\pi}{\lambda}\Delta x = \frac{2\pi}{600}\times 100 = \frac{\pi}{3}$$

$$\therefore\ P = P_1 + P_2 + 2\sqrt{P_1P_2}\cos\theta$$

$$= I_0\pi r_1^2 + I_0\pi r_2^2 + 2\sqrt{I_0\pi r_1^2 \times I_0\pi r_2^2}\cos\frac{\pi}{3}$$

$= 7\ \mu\text{W}$

16. 4.01

Sol. As here volume of gas remains constant,

$(\Delta Q)_v = \mu C_V \Delta T$, Here $C_v = 5$ cal/mol K

And $\Delta T = (400 - 300) = 100$ K

And so for ideal gas $PV = \mu RT$,

$$\mu = \frac{(10)^5 \times (0.2)}{8.31 \times 300} = 8.0224$$

$(\Delta Q)_v = \mu \times 5 \times 100 = 4.01$ kcal.

17. 3.14

Sol. $\frac{F}{A} = Y\frac{\Delta L}{L} \Rightarrow \frac{mg}{A} = Y(\alpha\Delta\theta)$

$$m = \frac{AY\alpha(\Delta\theta)}{g} = \frac{\pi r^2 Y\alpha(\Delta\theta)}{g}$$

$$= \frac{\pi(10^{-3})^2 \times 10^{11} \times 10^{-5} \times 10}{10} = \pi$$

18. 30.00

Sol. $f \propto \sqrt{T}$ for strings.

On increasing the tension by 1%

$f' = \sqrt{1.01\,T}$

$$\frac{f'}{f} = \frac{\sqrt{1.01\,T}}{\sqrt{T}} = (1 + 0.01)^{\frac{1}{2}} = 1 + \frac{1}{200}$$

Beat frequency, $f' - f = f\left(\frac{f'}{f} - 1\right) = 1$

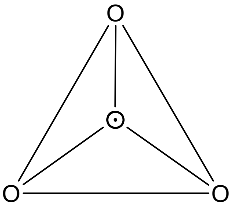
Number of beats in 30 seconds = 1 × 30 = 30.

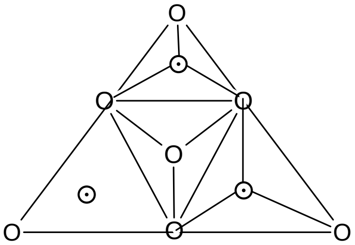
Chemistry PART – II

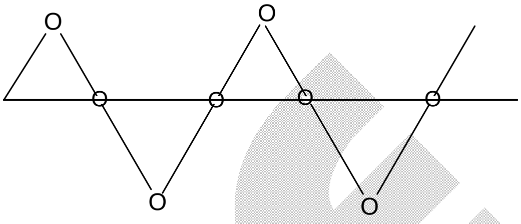
Section – A

19. A

Sol.







20. BC

Sol. $\underset{(s)}{2C} + \underset{(g)}{3H_2} \rightarrow \underset{(g)}{C_2H_6}$

$\Delta H_f^0 = \left[2 \times \Delta H_{sub}^0 + 3 \times B.E(H-H)\right] - \left[B.E.(C-C) + 6 \times B.E(C-H)\right]$

$\Rightarrow -85 = \left[(2 \times 718) + (3 \times 436)\right] - (x + 6y)$

$\therefore x + 6y = 2829$ …..1

Similarly for $C_3H_8(g)$

$2x + 8y = 4002$ …..2

Solving (1) & (2), x = 345
y = 414

21. AB

Sol. $k = Ae^{-E_a/RT}$ or $\ell nk = \ell nA \frac{-E_a}{RT}$

22. ABC

Sol. The outermost electronic configuration of Yb is $4f^{14}6s^2$

$\therefore$ Yb^{2+} has full-filled $4f^{14}$ configuration radius of $Yb^{3+} < Yb^{2+}$

23. AD

Sol. $Be_2C \xrightarrow{H_2O} Be(OH)_2 + CH_4$

$Al_4C_3 \xrightarrow{H_2O} Al(OH)_3 + CH_4$

24. ABCD

Sol. $\Delta S = \frac{\Delta H}{T} = \frac{-40,600}{373} = -108.84\,j/K$ for one mole

for $\frac{9}{18}$mole, $\Delta S = \frac{-108.84}{2} = 54.42\ j/K$

25. A

Sol. I – can undergo Nu^- substitution, elimination
II – can undergo Nu^- substitution, esterification, dehydrogenation & oxidation.
III – can undergo Nu^- addition, esterification and oxidation
IV – can undergo Nu^- substitution

26. A

Sol. Fact based

27. C

Sol. Elements having filled d-orbitals are not true transition elements.

28. B

Sol.
$$SO_3^{2-} + dil.H_2SO_4 \longrightarrow H_2O + SO_2 + SO_4^{2-}$$
$$CO_3^{2-} + dil.H_2SO_4 \longrightarrow H_2O + CO_2 + SO_4^{2-}$$
$$\overset{+}{N}H_4 + NaOH \longrightarrow Na^+ + H_2O + NH_3$$
$$S^{2-} + H_2SO_4 \longrightarrow H_2S + SO_4^{2-}$$

Section – B

29. 162.00

Sol.
$$K_f\left(\text{of camphor}\right) = \frac{R\left(T_f^o\right)^2 \times M_2}{1000 \times \Delta H_f^o} = \frac{2 \times 152 \times \left(450\right)^2}{1000 \times 1.52 \times 1000} = 40.5$$
$$\Delta T_f = i \times K_f \times m$$
$$450 - 430 = 1 \times 40.5 \times \frac{0.04 \times 1000}{M_{solute} \times 0.5}$$
$$M_{solute} = \frac{0.04 \times 1000 \times 40.5}{0.5 \times 20} = 162$$

30. 81.81

Sol.

	$NaOH$	$+ HCl$	$\longrightarrow NaCl$	$+ H_2O$
Millimoles	0.1	.001 x	0	0
	-0.001 x	-0.001x		
t = t	0.1 - .001 /x		x	

10^{-3} M NaOH have pH = 11
New pH after adding acid be 10
Hence, 10^{-4} M (100 + x) = 0.1 - .001 x

$$100 + x = \frac{0.1 - 0.001x}{10^{-4}}$$
$$\therefore\ 11x = 1000 - 100 = 900$$
$$\therefore\ x = \frac{900}{11} = 81.81\,\text{mL}$$

31. 390.55

Sol. $$\Lambda_m^0 CH_3COOH = \frac{\left(\Lambda_m^0 Ca\left(CH_3COO\right)_2 + 2\Lambda_m^0 HCl - \Lambda_m^0 CaCl_2\right)}{2}$$

$$= \frac{200.8 + 2\left(425.95\right) - 271.6}{2} = 390.55$$

32. 1.50

Sol. Vander waals equation for 1 mole of real gas, when b = 0

$$\Rightarrow \left(P + \frac{a}{V^2}\right)(V) = RT$$

$$\therefore\ PV = -a \times \frac{1}{V} + RT$$

$$y = mx + c$$

Slope = tan(π–θ) = –*a*

So, tan θ = a = $\frac{21.6 - 20.1}{3 - 2} = 1.5$

33. 11.00

Sol. The product contains three phenyl group and two multiple bonds

$\therefore$ Total number of pi-bonds = (3 × 3) + 2 = 11

34. 2920.40

Sol. Meq of MnO_4^- = Meq of Fe^{2+}

$$V \times M \times n = \frac{w}{E} \times 1000$$

$$\text{or, } 104.3 \times 1000 \times 0.1 \times 5 = \frac{w}{56/1} \times 1000$$

On solving w = 2920.4 g

35. 8.33

Sol. The average O.S of iron in $Fe_{0.96}O$ is $\frac{200}{96}$

Let the % of Fe(II) be x

$$x \times (+3) + (100 - x) \times (+2) = \frac{100 \times 200}{96}$$

3x + 200 – 2x = 208.33

$\therefore$ x = 8.33

36. 1.41

Sol. $$d = \frac{Z \times M}{N_a \times a^3}$$

$$\frac{45}{16} = \frac{z \times 27}{6.02 \times 10^{23} \times \left(4 \times 10^{-8}\right)^3}$$

$\Rightarrow$ Z = 4 (so fcc)

$$r = \frac{\sqrt{2}a}{4} = 1.41\ \overset{o}{A}$$

Mathematics PART – III

Section – A

37. AC

Sol. $V = \left|\vec{a}.\left(\vec{b}\times\vec{c}\right)\right| \le \sqrt{a_1^2+a_2^2+a_3^2}\sqrt{b_1^2+b_2^2+b_3^2}\,\sqrt{c_1^2+c_2^2+c_3^2}$ …….(i)

$\left[\left(a_1+a_2+a_3\right)\left(b_1+b_2+b_3\right)\left(c_1+c_2+c_3\right)\right]^{1/3}$ (Using A.M. $\ge$ G.M.)

$L^3 \ge \left(a_1+a_2+a_3\right)\left(b_1+b_2+b_3\right)\left(c_1+c_2+c_3\right)$

now $\left(a_1+a_2+a_3\right)^2 = a_1^2+a_2^2 = a_3^2+2\left(a_1a_2+a_2a_3+a_3a_1\right)$

$\left(a_1+a_2+a_3\right)^2 \ge a_1^2+a_2^2+a_3^2$

$\left(a_1+a_2+a_3\right) \ge \sqrt{a_1^2+a_2^2+a_3^2}$

similarly $\left(b_1+b_2+b_3\right) \ge \sqrt{b_1^2+b_2^2+b_3^2}$

$c_1+c_2+c_3 \ge \sqrt{c_1^2+c_2^2+c_3^2}$

$L^3 \ge \left[\left(a_1^2+a_2^2+a_3^2\right)\left(b_1^2+b_2^2+b_3^2\right)\left(c_1^2+c_2^2+c_3^2\right)\right]^{1/2}$

$L^3 \ge V$

38. BC

Sol. We supposed to find m and n such that $\lim\limits_{x\to\infty} 3\sqrt[3]{8x^3+mx^2} - nx = 1$ or

$\lim\limits_{x\to-\infty} \sqrt[3]{8x^3+mx} - nx = 1.$

We compute

$$\sqrt[3]{8x^3+mx^2} - nx = \frac{\left(8-n^3\right)x^3+mx^2}{\sqrt[3]{\left(8x^3+mx^2\right)^2}+nx\sqrt[3]{8x^3+mx^2}+n^2x^2}.$$

$8-n^3$ must be equal to 0

$n=2$

Now $f\left(x\right) = \dfrac{m}{\sqrt[3]{\left(8+\dfrac{m}{x}\right)^2}+2\sqrt[3]{8+\dfrac{m}{x}}+4}$.

We see that $\lim\limits_{x\to\infty} f\left(x\right) = \dfrac{m}{12}$. For this to be equal to 1, m must be equal to 12. Hence the answer to the problem is (m, n) = (12, 2).

39. ABCD

Sol. $\int \frac{x^4+1}{x^6+1}dx = \int \frac{x^4-x^2+1}{x^6+1}dx \int \frac{x^2}{x^6+1}dx = \int \frac{1}{x^2+1}dx + \int \frac{1}{3}\frac{\left(x^3\right)'}{\left(x^3\right)^2+1}dx$

$= \arctan x + \frac{1}{3}\arctan x^3.$

To write the answer in the required form we should have

$3\arctan x + \arctan x^3 = \arctan\frac{P(x)}{Q(x)}$

Applying the tangent function to both sides, we deduce

$$\frac{\frac{3x-x^3}{1-3x^2}+x^3}{1-\frac{3x-x^3}{1-3x^2}.x^3} = \tan\left(\arctan\frac{P(x)}{Q(x)}\right).$$

From here $\arctan\frac{P(x)}{Q(x)} = \arctan\frac{3x-3x^5}{1-3x^2-3x^4+x^6}$, and hence

$P(x) = 3x-3x^5, Q(x) = 1-3x^2-3x^4+x^6$. The final answer is

$\frac{1}{3}\arctan\frac{3x-3x^5}{1-3x^2-3x^4+x^6}+C.$

40. AC

Sol. Denote the value of the integral by I. With the substitution $t = \frac{ab}{x}$ we have

$$I = \int_a^b \frac{e^{\frac{b}{t}}-e^{\frac{t}{a}}}{\frac{ab}{t}}.\frac{-ab}{t^2}dt = -\int_a^b \frac{e^{\frac{t}{a}}-e^{\frac{b}{t}}}{t}dt = -I.$$

Hence, I = 0.

41. AB

Sol. $3\tan 3x = \frac{3\left(3\tan x - \tan^3 x\right)}{1-3\tan^2 x} = \frac{3\tan^3 x - 9\tan x}{3\tan^2 x - 1}$

$= \frac{8\tan x}{3\tan^2 x - 1}.$

Hence

$\frac{1}{\cot x - 3\tan x} = \frac{\tan x}{1-3\tan^2 x} = \frac{1}{8}\left(3\tan 3x - \tan x\right)$ for all $x \neq k\frac{\pi}{2}, k \in \mathbb{Z}$.

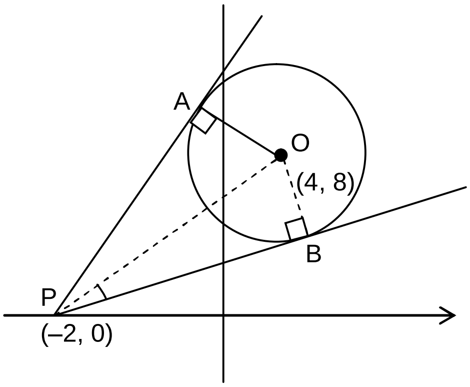
It follows that the left – hand side telescopes as

$\frac{1}{8}\left(3\tan 27^o - \tan 9^o + 9\tan 81^o - 3\tan 27^o + 27\tan 243^o - 9\tan 81^o + 81\tan 729^o - 27\tan 243^o\right)$

$$=\frac{1}{8}\left(81\tan 9^{o}-\tan 9^{o}\right)=10\tan 9^{o}.$$

42. BC

Sol.



$$\sin\theta=\frac{2\sqrt{5}}{10}=\frac{1}{\sqrt{5}}$$

Slopes of PA and PB are $\tan\left(\alpha\pm\theta\right)$ where $\tan\alpha=\frac{8}{6}=\frac{4}{3}$

$$=\frac{\frac{4}{3}+\frac{1}{2}}{1-\frac{4}{3}.\frac{1}{2}},\ \frac{\frac{4}{3}-\frac{1}{2}}{1+\frac{4}{3}.\frac{1}{2}}$$

$$=\frac{11}{2},\frac{5}{10}$$

$$\therefore\ A,B\equiv\left(4+2\sqrt{5}\left(\frac{-11}{5\sqrt{5}}\right),8+2\sqrt{5}\left(\frac{2}{5\sqrt{5}}\right)\right),$$

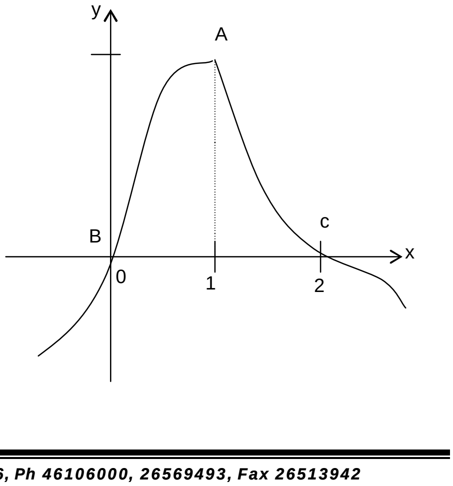
$$\left(4-2\sqrt{5}\left(\frac{-1}{\sqrt{5}}\right),\ 8-2\sqrt{5}\left(\frac{2}{\sqrt{5}}\right)\right)=\left(\frac{-2}{5},\ \frac{44}{5}\right)$$

$$=\left(6,\ 4\right)$$

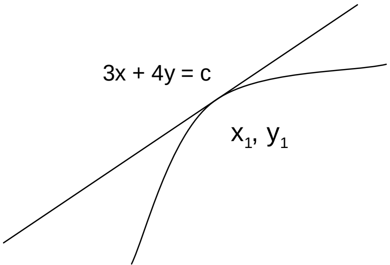
43. B

Sol. (I) A, B, C are the 3 critical points of $y=f\left(x\right)$.

$f''\left(x\right)=0$ for $x=2$ and fails to exists at x = 0.



(II) $x = \frac{1}{4}$ and 2. Make a quadratic in $\log_2 x$ and interpret the result.



(III) $\frac{dy}{dx} = -1 + 2x_1^3 = -\frac{3}{4} \Rightarrow x_1 = \frac{1}{2}$

$\Rightarrow \frac{1}{32} = \frac{1}{2} + y_1$ or $y_1 = -\frac{15}{32} \Rightarrow c = -\frac{3}{8}$

(IV) $f'(x) = 2x^3 - 3x + 1$ this is always positive in (1, 2).

$\therefore$ Increasing in [1, 2]

$\therefore$ $f(2)$ will be the greatest value.

44. D

Sol. Let $L = \lim\limits_{n\to\infty} \left(\frac{n^2}{n-1}\right)^{\tan\frac{1}{\sqrt{n}}} \left(\infty^o\right)$

$$\ln L = \lim_{n\to\infty} \tan\frac{1}{\sqrt{n}} \ln\left(\frac{n^2}{n-1}\right) = \lim_{n\to\infty} \frac{2\ln - \ln(n-1)}{\cot\left(\frac{1}{\sqrt{n}}\right)} \left(\frac{\infty}{\infty}\right)$$

Put $n = t^2 = \lim\limits_{t\to\infty} \frac{4\ln t - \ln\left(t^2-1\right)}{\cot\left(\frac{1}{t}\right)} = \lim\limits_{t\to\infty} \frac{2\left(t^2-2\right)}{t\left(t^2-1\right)\operatorname{cosec}^2\left(\frac{1}{t}\right)\left(\frac{1}{t^2}\right)}$

$$= \lim_{t\to\infty} \frac{2\left(t^2-2\right)}{t\left(t^2-1\right)} \left(\frac{\sin\frac{1}{t}}{\frac{1}{t}}\right)^2 = 0$$

$L = 1 \Rightarrow (Q)$

(III) $\sin 2x = \pm\frac{\sqrt{3}}{2}$

$2x \in (0, 4\pi)$

Hence, 8 solutions.

(IV) Since $g(x)$ is differentiable $\forall x \in R$

$\therefore$ $f(x)$ must have the factor $x(x-1)(x-2)$ atleast once.

$\therefore$ minimum 3 roots of $f(x) = 0 \Rightarrow (R)$

45. A

Sol. x b b b x c x c x c x

Number of ways $= \frac{4!}{3!} \times {}^{5}C_{4} = 20$

(II) 2b, 1b; 2c, 1c or 2b, 1b; 1c, 1c, 1c or 2b, 1b; 3c

(same way starting with c)

cbbcbc, cbcbbc

bbcccb, bcccbb

Number of ways $= 12 \times {}^{6}C_{4} = 180$

(III) bcbcbc $= {}^{7}C_{4}$

bccbcb or bcbccb $= 2 \times {}^{6}C_{3}$

bbccbc or bccbbc or bbcbcc or bcbbcc $= 4 \times {}^{5}C_{2}$

bcccbb or bbcccb $= 2 \times {}^{4}C_{1}$

bbbccc $= {}^{4}C_{4}$

Total ways $= 2(35 + 40 + 40 + 8 + 1) = 248$

(IV) bcbcbc, cbcbcb

bccbcb, cbbcbc

bcbccb, cbcbbc

bcbccb, cbcbbc

number of ways $= {}^{7}C_{1} \times 2 + 4 = 18$

46. D

Sol. (I) $P = \frac{1 \times {}^{11}C_{5}}{{}^{12}C_{6}} = \frac{1}{2}$

(II) $P = \frac{{}^{2}C_{1} \times {}^{10}C_{5}}{{}^{12}C_{6}} = \frac{6}{11}$

(III) $P = \frac{{}^{10}C_{4}}{{}^{12}C_{5}} = \frac{5}{22}$

(IV) $P = \frac{10}{11}$

Section – B

47. 252.00

Sol. $x=\left(\sqrt{3}+1\right)^{2018}$ and $y=\left(\sqrt{3}-1\right)^{2018}$

$$[x]+\{x\}+y=\left(\sqrt{3}+1\right)^{2018}+\left(\sqrt{3}+1\right)^{2018}$$

$$[x]+1=2^{1009}\left[\left(2+\sqrt{3}\right)^{1009}+\left(2-\sqrt{3}\right)^{1009}\right]$$

$$=2^{1009}\times 2\left[{}^{1009}C_0 2^{1009}+{}^{1009}C_2 2^{1007}3^1+.....+{}^{1009}C_{1006}2^3 3^{503}+{}^{1009}C_{1008}2\times 3^{504}\right]$$

$$[x]+1=2^{1011}\underbrace{\left[{}^{1009}C_0 2^{1008}+.....+{}^{1009}C_{1006}2^2 3^{503}+{}^{1009}C_{1008}3^{504}\right]}_{\text{odd}}$$

$[\because \{x\}+y\in(0,2)\Rightarrow\{x\}+y=1]$

$\Rightarrow$ N is divisible by 2^{1011}, hence divisible by $(16)^{252}$

48. 13.00

Sol. Coefficient of $x^{\frac{n(n+1)}{2}-7}=-7+(1\cdot 6+2\cdot 5+3\cdot 4)-(1\cdot 2\cdot 4)=13$

49. 18.00

Sol. We have $(\alpha+\beta+\gamma)^2=\alpha^2+\beta^2+\gamma^2+2(\beta\gamma+\gamma\alpha+\alpha\beta)$

$\Rightarrow \quad 4=6+2(\beta\gamma+\gamma\alpha+\alpha\beta)$

$\Rightarrow \quad \beta\gamma+\gamma\alpha+\alpha\beta=-1.$

Also, $\alpha^3+\beta^3+\gamma^3-3\alpha\beta\gamma$

$=(\alpha+\beta+\gamma)(\alpha^2+\beta^2+\gamma^2-\beta\gamma-\gamma\alpha-\alpha\beta)$

50. –1.59

Sol. The critical point of f are solutions to the system of equations

$$\frac{\partial f}{\partial x}(x,y)=4x^3+12xy^2-\frac{9}{4}=0,$$

$$\frac{\partial f}{\partial y}(x,y)=12x^2y+4y^3-\frac{7}{4}=0$$

divide the two equations by 4 and then add, respectively, subtract them, we obtain $x^3+3x^2y+3xy^2+y^3-1=0$ and $x^3-3x^2+3xy^3-y^3=\frac{1}{8}$. We write these as $(x+y)^3=1$ and $(x-y)^3=\frac{1}{8}$, from which we obtain $x+y=1$ and $x-y=\frac{1}{2}$. We find a unique critical point $x=\frac{3}{4},y=\frac{1}{4}$. The minimum of f is attained at this point, and it is equal to $f\left(\frac{3}{4},\frac{1}{4}\right)=-\frac{51}{32}$.

51. 126.00

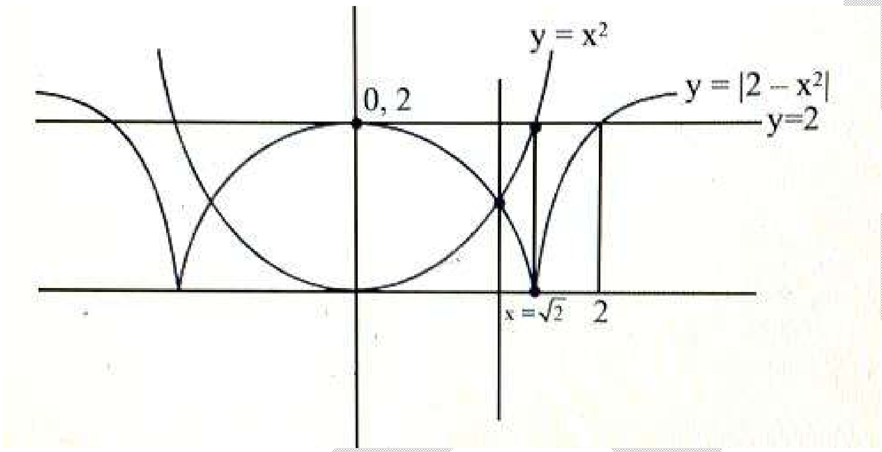
Sol. We have, $\lim\limits_{n\to\infty} gn(3) = \lim\limits_{n\to\infty} n\left(f\left(3+\frac{5}{n}\right)-f\left(3-\frac{2}{n}\right)\right)$

$$= 5\lim_{h\to 0^+}\frac{f(3+h)-f(3)}{h} + 2\lim_{h\to 0^+}\frac{f(3)-f(3-h)}{h}$$

$$= 5f'(3) + 2f'(3) = 5\times 18 + 2\times 18 = 90 + 36 = 126.$$

52. 1.01

Sol. $y = x^2$ $\qquad$ $y = \left|2-x^2\right|$ $\qquad$ $y = 2$



Required area $\int_1^{\sqrt{2}}\left[x^2-\left(2-x^2\right)\right] + \int_{\sqrt{2}}^{2}\left[2-\left(x^2-2\right)\right]dx$

$$= \frac{20}{3} - 4\sqrt{2} = 1.01$$

53. 18.00

Sol. The points (x_1, x_2) and (y_1, y_2) lie on the circle of radius $2\sqrt{2} = c$ centered at the origin. We can write $(x_1, x_2) = (c\cos\phi, c\sin\phi)$ and $(y_1, y_2) = (a\cos\theta, c\sin\theta)$. Then

$$s = 2 - c(\cos\phi + \sin\phi + \cos\theta + \sin\theta) + c^2(\cos\phi\cos\psi + \sin\phi\sin\psi)$$

$= 2 + c\sqrt{2}\left(-\sin\left(\phi+\frac{\pi}{4}\right) - \sin\left(0+\frac{\pi}{4}\right)\right) + c^2\cos(\phi-\theta)$ to 1 by choosing

$\phi = \theta = \frac{5\pi}{4}$. The maximum of S is $2 + 2c\sqrt{2} + c^2 = \left(c+\sqrt{2}\right)^2$.

54. 11.00

Sol. $\left[x-\frac{1}{2}\right]=1$ or $\left[x+\frac{1}{2=1}\right]$

$x-\frac{1}{2}\in[1,2)$ $x+\frac{1}{2}\in[1,2)$

$x\in\left[\frac{3}{2},\frac{5}{2}\right)$ ….(1) $x\in\left[\frac{1}{2},\frac{3}{2}\right)$ ……..(2)

$(1)\cup(2)$

$x\in\left[\frac{1}{2},\frac{3}{2}\right)\cup\left[\frac{3}{2},\frac{5}{2}\right)$

$x_1^2+x_2^2+x_3^2+x_4^2=\frac{1}{4}+\frac{9}{4}+\frac{9}{4}+\frac{25}{4}=11$

FIITJEE

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FULL TEST – IV
PAPER –2
TEST DATE: 08-02-2023

ANSWERS, HINTS & SOLUTIONS

Physics PART – I

Section – A

1. C

Sol. For upper portion:

$$f_1 = \frac{\mu_2 - 1}{\frac{\mu_2}{\mu_1} - 1}(f_a) = \frac{1.5 - 1}{\frac{1.5}{1.2} - 1} \times 20 = 40 \text{ cm}$$

For lower portion, $f_1 = \dfrac{\mu_2 - 1}{\frac{\mu_2}{\mu_3} - 1}(f_a)$

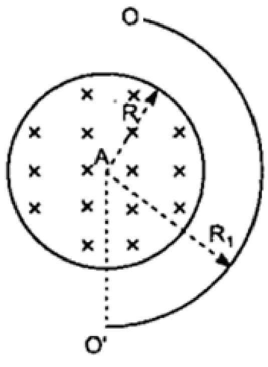
$$= \frac{1.5 - 1}{\frac{1.5}{2.5} - 1} \times 20 = -25 \text{ cm}$$

$\because$ Object is at infinity, images will be form at focal points.

Hence the distance between two images will = $40 + |-25| = 65 \text{ cm}$

2. B

Sol. $E = \dfrac{R^2}{2R_1}\left(\dfrac{dB}{dt}\right)$



e.m.f = $\dfrac{\theta}{2\pi}\dfrac{R^2}{2R_1}\left(\dfrac{dB}{dt}\right)2\pi R_1$

$= \dfrac{\theta}{2}R^2\left(\dfrac{dB}{dt}\right)$

3. D

Sol. As $\gamma > 1$

for $TV^{\gamma-1}$ = constant $\frac{dT}{dv} < 0$

and for $T^{\gamma} = KP^{\gamma-1}$

$\frac{dT}{dP} > 0$

4. A

Sol. $y = \frac{0.8}{3(x+2t)^2 + 4}$

v = 2 m/s

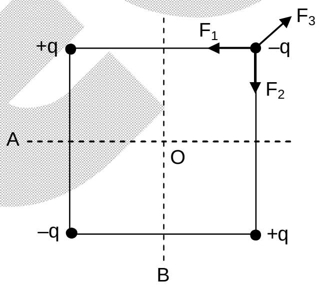
A = 0.2 m

5. AC

Sol. AOB is zero potential surface

Induce charge = –q

$F = \frac{kq^2}{a^2}\sqrt{2} - \frac{kq^2}{2a^2}$



6. AC

Sol. $I_1\left[\frac{n(n+1)}{2}r\right] + Ix = nE$ where x external resistance

$I_m\left(\frac{n(n+1)}{2}r\right) + I_x = mnE$

$I_1 + I_2 + I_3 + \ldots\ldots + I_m = I$

$\Rightarrow \quad I = \frac{\frac{n(m+1)E}{2}}{x + \frac{n(n+1)}{2m}r} = \frac{V}{x+R}$

7. CD

Sol. $\frac{dQ}{dt} = \frac{KA(\Delta T)}{x} = \frac{KA[0-(-\theta)]}{x}$; $\frac{dQ}{dt} = \frac{KA\theta}{x}$

8. ACD

Sol. y (x, t) = $-\cos kx \sin \omega t$

$y(0.05, 0.05) = -4\cos\left(\frac{2\pi}{0.4}0.05\right)\sin\left(\frac{2\pi}{0.2}0.005\right)$

$= -4\cos\left(\frac{\pi}{4}\right)\sin\left(\frac{\pi}{2}\right) = -2\sqrt{2}$ cm

$$v = f\lambda = \frac{0.4}{0.2} = 2 \text{ m/s}$$

$$\frac{\partial y}{\partial t} = -A\,\omega\cos(kx)\cos(\omega t)$$

$$= -4\left(\frac{2\pi}{0.2}\right)\cos\left(\frac{2\pi}{0.4}\frac{1}{15}\right)\cos\left(\frac{2\pi}{0.2}0.1\right)$$

$$\frac{\partial y}{\delta t} = 20\,\pi \text{ cm/sec} = \text{particle velocity}$$

9. AC

Sol. In SHM, time taken to move from x = 0 to $x = \frac{A}{2}$ is $\frac{T}{12}$ and time taken to move from extreme to $x = \frac{A}{2}$ is $\frac{T}{6}$.

If $\frac{T}{12} = 1 \Rightarrow T = 12$

If $\frac{T}{6} = 1 \Rightarrow T = 6.$

10. ABC

Sol. $E_s = \frac{-GMm}{R}$; $E_1 = \frac{-GMm}{2(2R)}$; $E_2 = \frac{-GMm}{2(3R)}$

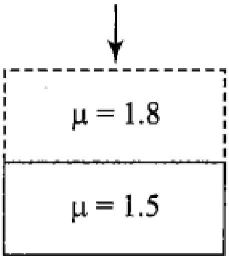
$$E_1 - E_s = \frac{3}{4}mgR$$

$$E_2 - E_1 = \frac{mgR}{12}$$

Section – B

11. 9

Sol. Path difference between rays reflected from upper and lower faces of layer = $2\mu t \cos r$ = $2\,\mu t$ (for normal incidence). But there is change in path of $\lambda/2$ of light at upper surface due to reflection from denser medium. So actual path difference is $2\,\mu t - \lambda/2$.



For constructive interference $2\,\mu t - \frac{\lambda}{2} = n\lambda$

$t = \frac{(2n+1)\lambda}{4\mu}$. For least thickness n = 0.

$$\therefore \quad t_{min} = \frac{\lambda}{4\mu} = \frac{648}{4\times 1.8}\text{nm} = 90 \text{ nm}$$

12. 5

Sol. $E_n = -\frac{mZ^2e^4}{8\varepsilon_0^2n^2h^2}$, so $hf = +\frac{mZ^2e^4}{8\varepsilon_0^2h^2}\left[\frac{1}{16}-\frac{1}{25}\right]$

$$\therefore \quad f = \frac{mZ^2e^4}{8\varepsilon_0^2h^3}\left[\frac{9}{16\times 25}\right]$$

and frequency $f_4 = \frac{Z^2e^2m}{4\varepsilon_0^2n^3h^3} = \frac{Z^2e^4m}{4\varepsilon_0^2(4)^3h^3}$

$\therefore \quad \frac{f}{f_4} = \frac{18}{25}$, so m = 5.

13. 4

Sol. When the two spheres come in contact, they exert equal and opposite impulse.

$$\int Fa\,dt = I_1(\omega_0 - \omega_1) \qquad \ldots\text{(i)}$$

$$\int Fb\,dt = I_2\omega_2 \qquad \ldots\text{(ii)}$$

Finally $\omega_1 a = \omega_2 b$ …(iii)

$$I_1(\omega_0 - \omega_1) = I_2\frac{a^2}{b^2}\omega_1$$

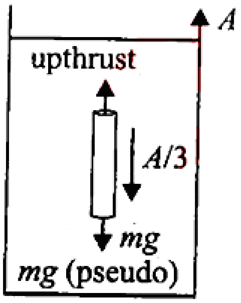
$$\omega_1 = \frac{I_1\omega_0}{I_1 + \frac{a^2}{b^2}I_2} = 4 \text{ rad/s.}$$

14. 5

Sol. Let the volume of the cylinder be V. When the cylinder is floating , upthrust = weight. Hence,

$$\rho\left(\frac{3}{4}V\right)g = mg \quad \Rightarrow \quad V = \frac{4m}{3\rho}$$

Let the acceleration of the particle vessel be A (upwards). In the reference frame of the vessel, the acceleration of the cylinder is A/3.



$$\therefore \quad mg + mA - \text{upthrust} = m\left(\frac{A}{3}\right)$$

$$mg + mA - \rho Vg' = m\left(\frac{A}{3}\right)$$

where g′ = g + A = effective value of g for upthrust.

$$\therefore \quad mg + mA - \rho V(g + A) = m\left(\frac{A}{3}\right)$$

$$\Rightarrow \quad mg - \frac{4}{3}m(g + A) = -m\frac{2}{3}A$$

$A = \left(-\frac{g}{2}\right)$ upwards

The acceleration of the vessel should be $\frac{g}{2} = \frac{10}{2}$ = 5 ms^{-2} (downwards).

15. 6

Sol. Let the pressures in wide and narrow limbs be P_1 and P_2, respectively. If R_1 and R_2 be the radii of meniscus in wide and narrow limb, pressure just below the meniscus of wide tube = $P_1 - \frac{2T}{R_1}$ and pressure just below the meniscus of narrow limb = $P_2 - \frac{2T}{R_2}$.

Therefore, difference of these pressures

$$\left(P_1 - \frac{2T}{R_1}\right) - \left(P_2 - \frac{2T}{R_2}\right) = h\,\rho\,g$$

Therefore, true pressure difference,

$$P_1 - P_2 = h\,\rho\,g - 2T\left(\frac{1}{R_2} - \frac{1}{R_1}\right)$$

For the water and glass surface, taking the angle of contact θ to be zero, we have $R_1 = \frac{r_1}{\cos\theta} = r_1$ and $R_2 = \frac{r_2}{\cos\theta} = r_2$ where r_1 and r_2 are radii of wide and narrow limbs, respectively.

$\therefore$

$$P_1 - P_2 = h\,\rho\,g - 2T\left(\frac{1}{r_2} - \frac{1}{r_1}\right) = 0.2\times10^3\times9.8 - 2\times72\times10^{-3}\times\left(\frac{1}{7.2\times10^{-4}} - \frac{1}{1.44\times10^{-3}}\right)$$

= $1.96 \times 10^3 - 0.10 \times 10^3 = 1.86 \times 10^3$ N/m^2 = 1860 N/m^2

$\therefore$ N = 6.

16. 8

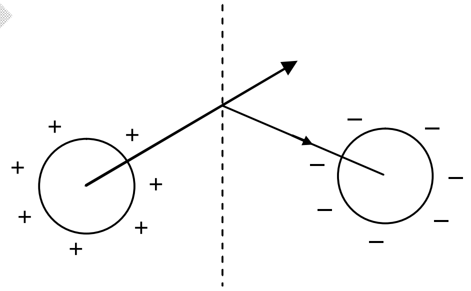
Sol. $J = \sigma E = \frac{\sigma q \ell}{2\pi\varepsilon_0 \varepsilon r^3}$

$I = \int_0^\infty J\,2\pi x dx = \frac{q}{\varepsilon_0 \varepsilon \rho}$

$\Delta V = \frac{q}{2\pi\varepsilon_0\varepsilon a} = IR$

$\Rightarrow \quad R = \frac{\rho}{2\pi a} = 0.50$

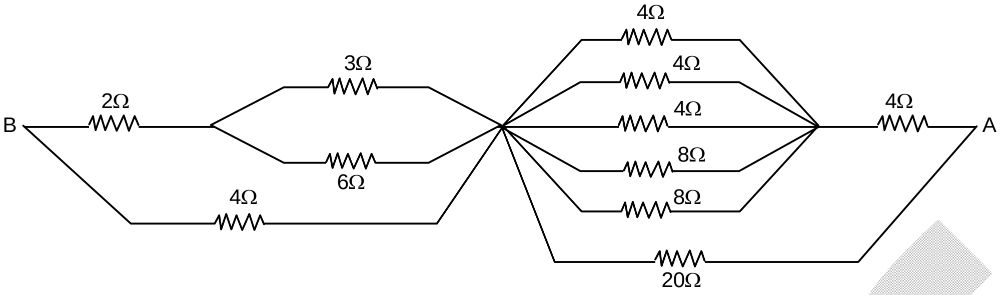
$\therefore$ n = 8.



17. 4

Sol. $$C_{eq} = \frac{2C_1C_2 + C_2C_3 + C_3C_1}{C_1 + C_2 + 2C_3} = \frac{7}{5}$$

Where $C_1 = 1$, $C_2 = 2$, $C_3 = 1$



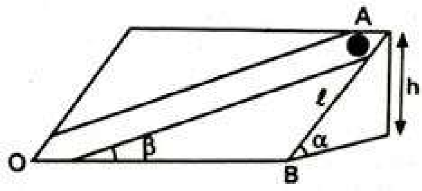
$R_{eq} = 6$

$\tau = RC = 8.4$

$\therefore$ n = 4.

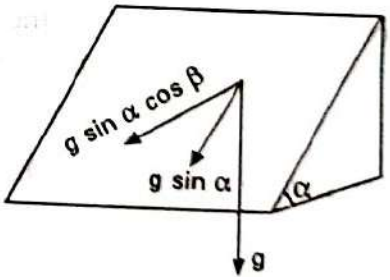
18. 2

Sol. Component of acceleration along incline is g sin α and effective acceleration along groove is a = sin α cos β.



From figure $\ell = \dfrac{h}{\sin\alpha} = OB$

OA is the groove making an angle $\beta = 45°$ with AB on the inclined surface.



From figure, $\dfrac{OB}{OA} = \cos\beta$

or $OA = \dfrac{h}{\sin\alpha\cos\beta}$

Since acceleration along groove is constant, we may use equation $s = \dfrac{1}{2}at^2$.

$\therefore$ k = 2.

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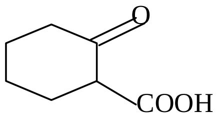
Chemistry PART – II

Section – A

19. C

Sol.

Intermediate is



Which loses CO_2 on heating (β-keto acid)

20. B

Sol. M absorbs some heat energy and prevents decomposition of O_3

21. C

Sol.

$$T_f = 4T_i$$

$$\Delta S = nC_V \ln\frac{T_f}{T_i} + nR\ln\frac{v_f}{v_1}$$

$$0 = n\times\frac{3R}{2}\ln 4 + n.R\ln\frac{v_f}{v_1}$$

$$\frac{3}{2}\log 4 = \log\frac{v_i}{v_f}$$

$$4^{3/2} = \frac{v_i}{v_f}$$

$$8v_f = v_i$$

$$0 = \Delta S = nC_p \ln\frac{T_f}{T_i} + nR.\ln\frac{Pi}{P_f}$$

$$4^{5/2} = \frac{P_f}{P_i}$$

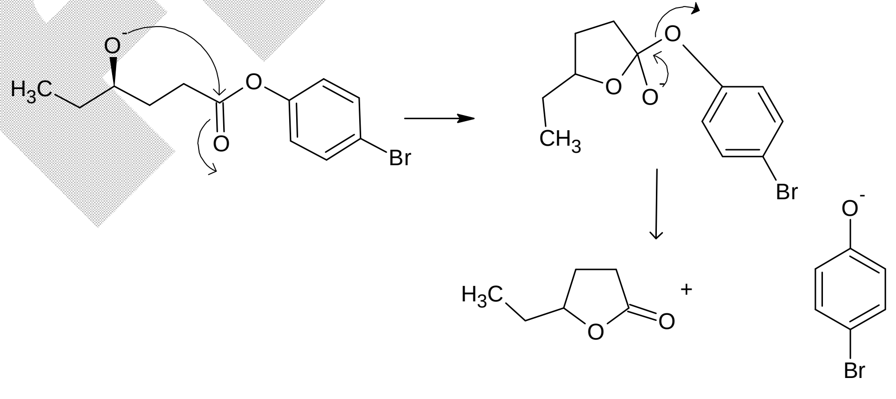
$$32P_i = P_f$$

22. D

Sol. At ¼ th and 3/4 th neutralization points the solution is buffer solution. Upon substitution we can get the ans.

23. ACD

Sol.



24. AC

Sol. Azeotropic mixture has fixed composition.

25. ABC

Sol. Rate = $k[X][Y]^0 \Rightarrow 2 \times 10^{-8} = k[0.1]\ [0.1]^0 \Rightarrow k = 2 \times 10^{-7} s^{-1}$

26. ABC

Sol.

$$CaC_2 + 2H_2O \longrightarrow Ca(OH)_2 + C_2H_2$$

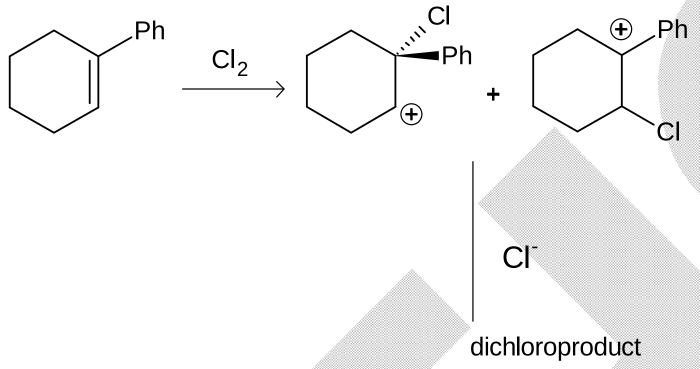
$$Mg_3N_2 + 6H_2O \longrightarrow 3Mg(OH)_2 + 2NH_3$$

$$Na_2S + 2H_2O \longrightarrow 2NaOH + H_2S$$

$$KNO_3 + H_2O \longrightarrow \text{No reaction}$$

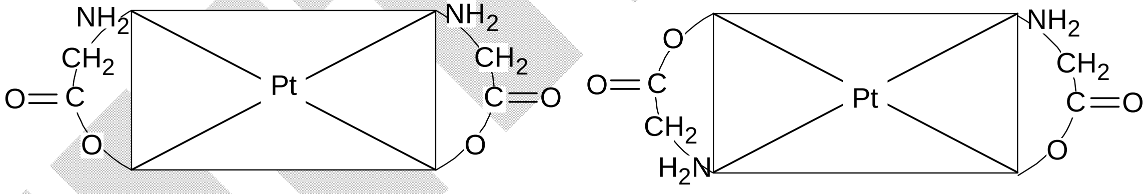
27. ABCD

Sol.


Ph
Cl2
Cl
Ph
+
Ph
Cl
Cl⁻
dichloroproduct

28. BCD

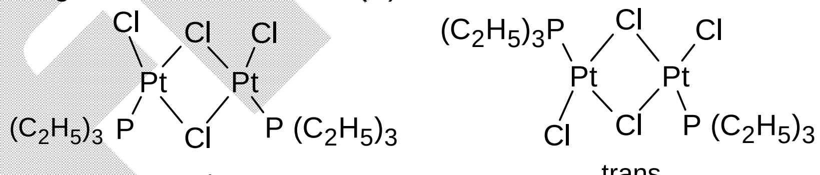
Sol. The geometrical isomers of (B) are


NH2
CH2
O=C
O
Pt
NH2
CH2
C=O
O
O
O=C
CH2
H2N
Pt
NH2
CH2
C=O
O

Cis

trans

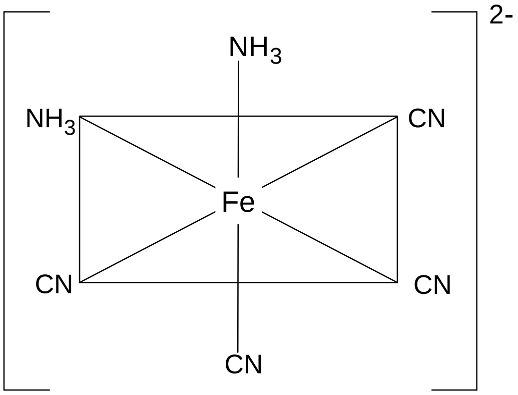
The geometrical isomers of (C) are


Cl
Cl
Cl
Pt
Pt
(C2H5)3 P
Cl
P (C2H5)3
(C2H5)3P
Cl
Cl
Pt
Pt
Cl
Cl
P (C2H5)3

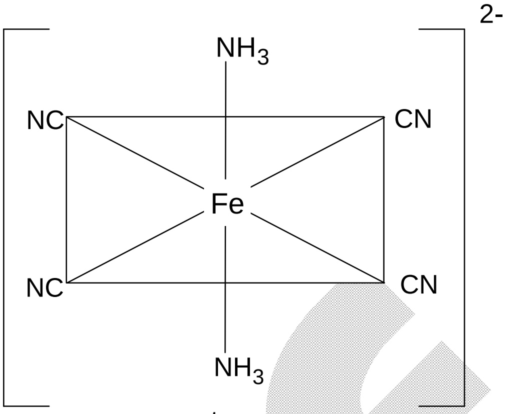
Cis

trans

The geometrical isomers of (D) are


2-
NH3
NH3
CN
Fe
CN
CN
CN

Cis

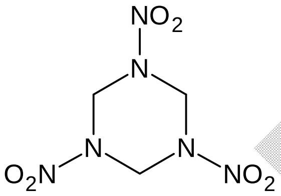

2-
NH3
NC
CN
Fe
NC
CN
NH3

trans

Section – B

29. 6

Sol. Compound (Z) is


NO2
N
N
N
O2N
NO2

30. 4

Sol. $(4n + 2)\pi e^-$ rule

31. 3

Sol. $\eta^5 C_2H_5 - 5e^-$
$2\ CO - 4e^-$
$Mo - 6e^-$
$Mo - Mo - 3e^-$

32. 3

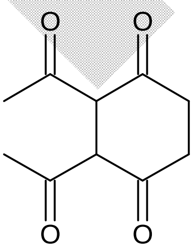
Sol. $S^{2-} + HCl \longrightarrow H_2S \xrightarrow[NaOH]{Na_2\left[Fe(CN)_5NO\right]} Na_4\left[Fe(CN)_5(NOS)\right]$

33. 5

Sol. $$\frac{25\times10^{-3}(g)}{250} = \frac{16\times10^{-3}(g)}{250 - x18}$$
X = 5

34. 4

Sol.



35. 4
Sol. (1) ala-phe-leu-gly
(2) ala-phe-gly-leu
(3) ala-leu-phe-gly
(4) ala-leu-gly-phe

36. 3
Sol. It exists in two geometrical isomeric forms in which trans isomer is optically active.

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Mathematics PART – III

Section – A

37. A

Sol. Since for two square matrices A & B the trace of AB – BA is zero.

$\therefore$ let $AB - BA = \begin{bmatrix} a & b \\ c & -a \end{bmatrix}$

$\Rightarrow$ $(AB - BA)^2 = k\, I_2$

where $k = a^2 + bc$

and odd power of AB – BA is equal to a multiple of this matrix.

i.e. odd power it can not be equal to I_2

$\therefore$ 'n' is even.

38. B

Sol. $A^2B^2 = rB^4$

$B^2A^2 = rB^4$

$\Rightarrow A^2B^2 = B^2A^2$

& $rB^2A = rAB^2 = A^3$

Multiplying $pAB + qBA = I_n$ on the right and then on the let by B, we obtain

$pAB^2 + qBAB = B$

$pBAB + qB^2A = B$

also we have $B^2A = AB^2$

on subtraction $(p - q)(AB^2 - BAB) = 0$

if $p \neq q$ then $AB^2 = BAB$

$\therefore (p + q)AB^2 = (p + q)B^2A = B$

$\Rightarrow (p + q)A^2B^2 = AB$

& $(p + q)B^2A^2 = BA$

$\Rightarrow AB = BA$

which is a contradiction

$\therefore p = q$

39. A

Sol. Integrating the given differential equation, we have $\frac{dy}{dx} = \frac{-\cos 3x}{3} + e^x + \frac{x^3}{3} + C_1$ but

$y_1(0) = 1$ so $1 = \left(\frac{-1}{3}\right) + 1 + C_1 \Rightarrow C_1 = \frac{1}{3}$.

Again integrating, we get $y = \frac{-\sin 3x}{9} + e^x + \frac{x^4}{12} + \frac{1}{3}x + C_2$

but $y(0) = 0$ so $0 = 0 + 1 + C_2 \Rightarrow C_2 = -1$. Thus $y = \frac{-\sin 3x}{9} + e^x + \frac{x^4}{12} + \frac{1}{3}x - 1$

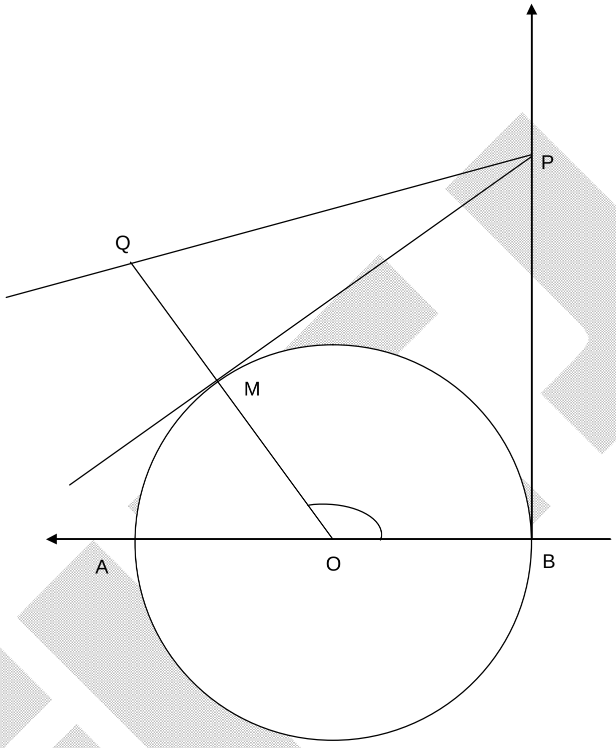
40. B

Sol. Let the radius of the circle is equal to 1. Set the origin at B with BA the positive x – semi axis and t the y – axis. If $\angle BOM = \theta,$ then $BP = PM = \tan\frac{\theta}{2}$. In triangle PQM, PQ $= \frac{\tan\frac{\theta}{2}}{\sin\theta}$. So the coordinates of Q are $\left(\frac{\tan\frac{\theta}{2}}{\sin\theta}, \tan\frac{\theta}{2}\right) = \left(\frac{1}{1+\cos\theta}, \frac{\sin\theta}{1+\cos\theta}\right)$.

The x and y coordinates are related as follows:

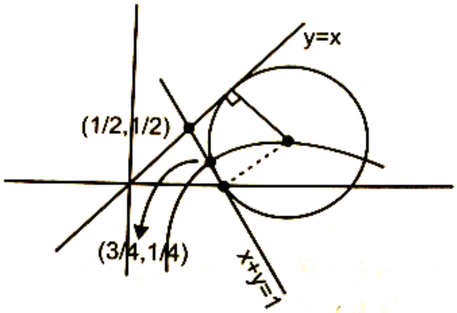
$$\left(\frac{\sin\theta}{1+\cos\theta}\right)^2 = \frac{1-\cos^2\theta}{(1+\cos\theta)^2} = \frac{1-\cos\theta}{1+\cos\theta} = 2\frac{1}{1+\cos\theta} - 1.$$

Hence the locus of Q is the parabola $y^2 = 2x - 1$.



41. BC

Sol. $4a = 2\left(\frac{|0-1|}{\sqrt{2}}\right) = \frac{2}{\sqrt{2}} = \sqrt{2}$



42. BCD

Sol. Put $\left(a - r\cos\theta, 2 - r\sin\theta\right)$ to equn. of ellipse

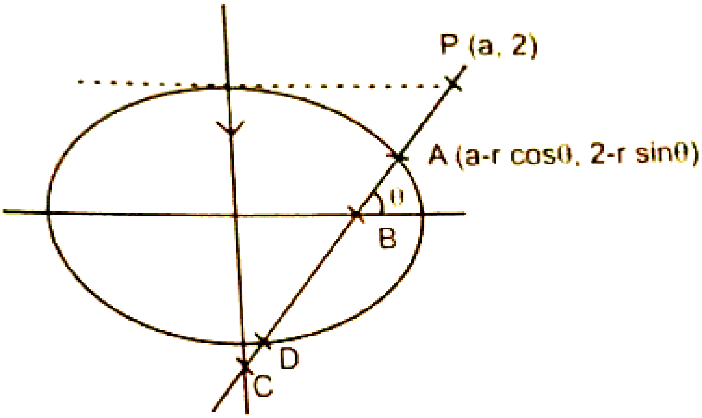
$$\Rightarrow \frac{a^2 + r^2\cos^2\theta - 2ar\cos\theta}{9}$$

$$+\frac{4 + r^2\sin^2\theta - 4r\sin\theta}{4} - 1 = 0$$

$$= \frac{4a^2}{4\cos^2\theta + 9\sin^2\theta}$$

Put $\left(a - r\cos\theta, 2 - r\sin\theta\right)$ to equation $xy = 0$

$$\Rightarrow \left(PA\right)\left(PD\right) = \frac{\frac{a^2}{9}}{\frac{\cos^2\theta}{9} + \frac{\sin^2\theta}{4}}$$



$$\Rightarrow 2a + r^2\sin\theta\cos\theta - \left(a\sin\theta + 2\cos\theta\right)r = 0$$

$$\Rightarrow \left(PB\right)\left(PC\right) = \frac{2a}{\sin\theta\cos\theta}$$

$$PA.PD = PB.PC$$

$$\Rightarrow \frac{4a^2}{4\cos^2\theta + 9\sin^2\theta} = \frac{2a}{\sin\theta.\cos\theta}$$

$$\Rightarrow a = \frac{4\cot\theta + 9\tan\theta}{2}$$

$$\Rightarrow |a| \geq \sqrt{4+9} = 6$$

$$\Rightarrow a \in \left(-\infty, -6\right] \cup \left[6, \infty\right)$$

43. CD

Sol. If α is a multiple of π, then $I(\alpha) = 0$. Otherwise, use the substitution $x = \cos\alpha + t\sin\alpha$. The indefinite integral becomes

$$\int \frac{\sin\alpha\, dx}{1 - 2x\cos\alpha + x^2} = \int \frac{dt}{1+t^2} = \text{art } \tan t + C.$$

$$\therefore I(\alpha) = \arctan\left(\frac{1-\cos\alpha}{\sin\alpha}\right) - \arctan\left(\frac{-1-\cos\alpha}{\sin\alpha}\right),$$

where the angles are to be taken between $-\frac{\pi}{2}$ and $\frac{\pi}{2}$. But

$$\frac{1-\cos\alpha}{\sin\alpha} \times \frac{-1-\cos\alpha}{\sin\alpha} = -1.$$

Hence the difference between these angles is $\pm\frac{\pi}{2}$. Notice that the sign of the integral is the same as the sign of α. Hence $I(\alpha) = \frac{\pi}{2}$ if $\alpha \in (2k\pi, (2k+1)\pi)$ and $-\frac{\pi}{2}$ if $\alpha \in ((2k+1)\pi, (2k+2)\pi)$ for some integer k.

44. AD

Sol. $k_1u - k_2v = 0$ ……….(i)

$k_1u + k_2v = 0$ ………..(ii)

$\because$ equations of bisectors of the angles formed by lines (i) and (ii) are

$$\frac{k_1u - k_2v}{\sqrt{(ak_1 - bk_2)^2 + (k_1b + ak_2)^2}} = \frac{\pm(k_1u + k_2v)}{\sqrt{(k_1a + bk_2)^2 + (k_1b - ak_2)^2}}$$

$\Rightarrow k_1u - k_2v = \pm(k_1u + k_2v)$ ………..(iii)

(i) by taking positive sign in (iii), we get

$k_1u - k_2v = k_1u + k_2v$

$2k_2v = 0 \quad \Rightarrow \quad v = 0$

(ii) by taking negative sign in (iii), we get

$u = 0$

45. BD

Sol. After we bring the function into the form $f(x)=\dfrac{\left(x-1+\dfrac{1}{x}\right)^3}{x^3-1+\dfrac{1}{x^3}}$, let $x+\dfrac{1}{x}=s$

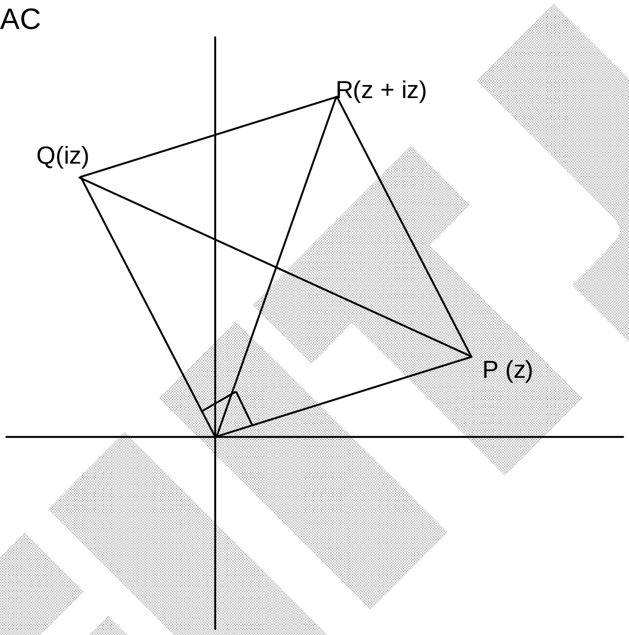
$h(s)=\dfrac{(s-1)^3}{s^3-3s-1}=1+\dfrac{-3s^2+6s}{s^3-3s-1}$ over the domain $(-\infty,-2]\cup[2,\infty)$. Setting the first derivative equal to zero yields the equation $3(s-1)(s^3-3s^2+2)=0$.

The roots are s = 1 (double root) and $s=1\pm\sqrt{3}$. Of these, only $s=1+\sqrt{3}$ lies in the domain of the function.
We compute

$$\lim_{x\to\pm\infty} h(s)=1,\ h(2)=1,\ h(-2)=9,\ h\left(1+\sqrt{3}\right)=\frac{\sqrt{3}}{2+\sqrt{3}}.$$

46. AC

Sol.



Section – B

47. 3

Sol. Equation of the chord of contact of a point $P(3\sec\theta, 2\tan\theta)$ on the hyperbola with respect to the circle is $(3\sec\theta)x+(2\tan\theta)y=9$ (1)
Let M (h, k) be the mid point of (1), then equation of (1) in terms of the mid – point is
$hx+ky=h^2+k^2$ (2)
Since (1) and (2) represent the same line.

$$\sec\theta=\frac{3h}{h^2+k^2},\ \tan\theta=\frac{9k}{2(h^2+k^2)}s$$

$\Rightarrow$ locus of (h, k) is

$$\Rightarrow \frac{9x^2}{\left(x^2+y^2\right)^2} - \frac{81y^2}{4\left(x^2+y^2\right)^2} = 1$$

or $4\left(x^2+y^2\right)^2 = bx^2 - cy^2$

$\Rightarrow \quad a = 4, b = 36, c = 81$

$a^2 + b^2 + c^2 = 16 + 1296 + 6561 = 7873$

48. 5

Sol. Let $r = \lambda b + \mu c$ and $c = \pm\left(xi + yj\right)$. Since c and b are perpendicular, we have

$4x + 3y = 0 \qquad \Rightarrow c = \pm x\left(i - \frac{4}{3}j\right)$

$\pm 1 =$ proj. of r on $b = \frac{r.b}{|b|} = \frac{(\lambda b + \mu c).b}{|b|} = \frac{\lambda b.b}{|b|}$

$[\because b.c = 0]$

$= \lambda|b| = 5\lambda$. Hence $\lambda = \frac{1}{5}$

Also, $\pm 2 =$ proj. of r on $c = \frac{r.c}{|c|}$

$$= \frac{(\lambda b + \mu c).c}{|c|} = \mu|c| = \frac{5}{3}\mu x$$

Thus, $\mu x = \pm\frac{6}{5}$. Therefore,

$$r = \frac{1}{5}(4i + 3j) + \frac{6}{5}\left(i - \frac{4}{3}j\right) = \pm(2i - j)$$

$$r = \frac{1}{5}(4i + 3j) - \frac{6}{5}\left(i - \frac{4}{3}j\right) = \pm\left(-\frac{2}{3}i + \frac{11}{5}j\right)$$

Thus there are four such vectors

$$\sum_{i=1}^{4}|r_i|^2 = 2|2i - j|^2 + 2\left|-\frac{2}{5}i + \frac{11}{5}j\right|^2 = 20$$

49. 1

Sol. Let $f(x) = \sin x + \tan x - 2x$. Then $g(x) = f'(x)$

$= \cos x + \sec^2 x - 2$

$$\Rightarrow \quad g'(x) = -\sin x + 2\sec^2 x \tan x$$

$$= \sin x\left(-1 + \frac{2}{\cos^3 x}\right)$$

$$= \sin x\left(\frac{1 - \cos^3 x + 1}{\cos^3 x}\right)$$

Since for $0 < x < \frac{\pi}{2}$, we have $0 < \cos^3 x < 1$, g is an increasing function. Hence $g(x) > g(0)$, i.e. $\cos x + \sec^2 x - 2 > 0$. Therefore f is an increasing function, so $f(x) > f(0)$ for $0 < x < \frac{\pi}{2}$. Hence $\sin x + \tan x > 2x$. Thus $g\left(\frac{\pi}{4}\right) = \frac{1}{\sqrt{2}} + 1$

50. 1

Sol. The inverse of 2 × 2 matrices C = $[C_{ij}]_{2\times2}$ with integer entries is a matrix with integer entries if and only if |c| = ± 1

$$\left\{C^{-1} = \frac{\text{adj}(C)}{|C|} \;\&\; \left|C^{-1}\right| = \frac{1}{|C|}\right\}$$

So lets take a polynomial.

$$P(x) = |A + xB|$$

as per the problem $P(0), P(1), P(2), P(3), P(4) \in \{-1, 1\}$

three of these must be same

and P(x) has degree at most 2.

$\therefore$ it is constt.

$\therefore |A + xB| = \pm 1, \forall x$

$\therefore |A + 5B| = \pm 1$

51. 2

Sol. $a_1 + a_3 + ... + a_{99} = 50$

$\Rightarrow a + (a + 2d) + (a + 4d) + ... + (a + 98d) = 50$

$\Rightarrow 50a + 2d(1 + 2 + ... + 49) = 50$

$\Rightarrow 50a + \frac{2d(50)(49)}{2} = 50$

$\Rightarrow a + 49d = 1$

$= -a_1 - a_3 + a_5 + a_7 - a_9 - a_{11} + ... + a_{93} + a_{95} - a_{97} - a_{99}$

(26 negative terms and 24 positive)

$\Rightarrow |-a_1 - a_{99}| = |-2a - 98d| \Rightarrow |-2| \Rightarrow 2$

52. 1

Sol. Given $a + b + c = 1$ ………(1)

$9a + 3b + c = 7$ ………(2)

$18 < 25a + 5b + c < 22$ ………(3)

$\Rightarrow$ From above (1), (2) and (3) $4 < 7a - b - c < 8$

$4 < 7a - b + a - 1 < 8$

$5 < 8a < 9$

$a = 1, b = -1, c = 1$

$a = 1, b = -1, c = 1$

For question (2) $h(x) = \ln(x^2 - x + 1) - x$

53. 4

Sol. Let $z_1 = z_1 e^{i\theta_1}$ and

$$z_2 = r_2 e^{i\theta_2} \Rightarrow \frac{z_1\bar{z}_2 + \bar{z}_1 z_2 + z_1 z_2 + \bar{z}_1\bar{z}_2}{\left|z_1 z_2\right|} = 2\cos\left(\theta_1+\theta_2\right) + 2\cos\left(\theta_1+\theta_2\right)$$

54. 3

Sol. $\frac{a+b+c}{b-a} = \frac{a+b-a+a+c}{b-a}$

$= 1 + \frac{2a+c}{b-a}$

Now: $f\left(x\right) = ax^2 + bx + c$

Given $f\left(x\right) \geq 0 \ \forall x \ f\left(-2\right) \geq 0$

$4a - 2b + c \geq 0$

$2a + c \geq 2\left(b-a\right)$

$\frac{2a+c}{b-a} \geq 2$

$\therefore \frac{a+b+c}{b-a} \geq 3$

FIITJEE

FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
FULL TEST – V
PAPER –1
TEST DATE: 08-02-2023

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B**.

Section – A ***(01 –06, 19 – 24, 37 – 42):*** This section contains **EIGHTEEN (18)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – A ***(07 – 10, 25 – 28, 43 – 46):*** This section contains **TWELVE (12)** Matching List Type Questions. Each question has **FOUR** statements in **List-I** entries (I), (II), (III) and (IV) and **FIVE** statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which, **ONLY ONE** of these four options is correct answer.

Section – B ***(11 – 18, 29 – 36, 47 – 54):*** This section contains **TWENTY FOUR (24)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.

MARKING SCHEME

Section – A (One or More than One Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4	If only (all) the correct option(s) is (are) chosen;
Partial Marks	:	+3	If all the four options are correct but ONLY three options are chosen;
Partial marks	:	+2	if three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks	:	+1	If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–2	In all other cases.

Section – A (Single Correct): Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+3	If ONLY the correct option is chosen.
Zero Marks	:	0	If none of the options is chosen (i.e. the question is unanswered);
Negative Marks	:	–1	In all other cases.

Section – B: Answer to each question will be evaluated according to the following marking scheme:

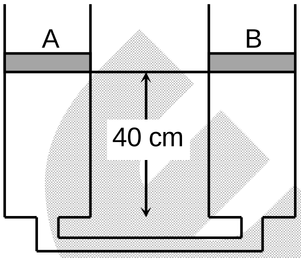
Full Marks	:	+3	If ONLY the correct numerical value is entered at the designated place;
Zero Marks	:	0	In all other cases.

Physics PART – I

Section – A (Maximum Marks: 24)

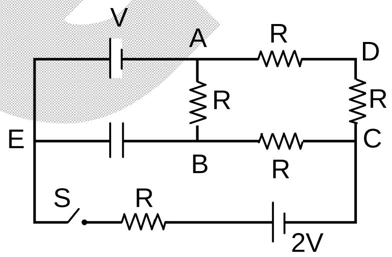
*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

1. Two vertical conducting cylinders A and B of different cross sections are connected by a thin tube as shown. An ideal gas is trapped in the cylinders by two airtight pistons of masses 1.0 kg and 2.0 kg respectively. Initially the pistons are at the same height 40cm above the base of the cylinders. If an additional mass of 10 g were gently placed on the piston in the cylinder A, which of the following statements correctly describe the new steady state ultimately reached.



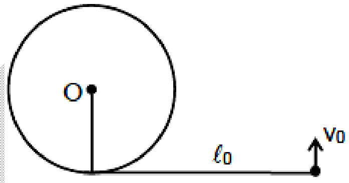
(A) Pressure of the gas has been increased.
(B) Pressure of the gas remains unchanged.
(C) Height difference between the pistons becomes 30 cm.
(D) Height difference between the pistons becomes 60 cm.

2. Five equal resistances, a capacitor and two batteries are connected in a circuit as shown in the figure. The capacitor is initially uncharged and each battery has negligible internal resistance. It is given that R = 1Ω, C = 1μF and V = 8 volt. On the basis of above information answer the following questions, if switch 'S' is closed at t = 0. (Assume $e^{-1} = 0.37$, if required)



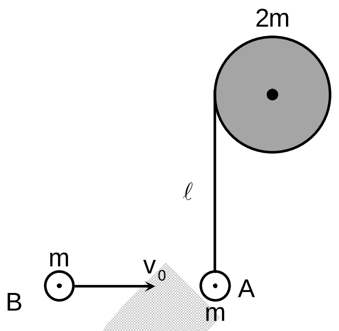
(A) Current in the branch of capacitor at t = 5/8 μs is (approximately) 6 A
(B) Current in the branch AB at t = 5/8 μs is (approximately) 1.7 A
(C) Potential difference between points A and C at t = 5/8 μs is (approximately) 2.5 V
(D) Potential difference between points A and C at t = 5/8 μs is (approximately) 6 V

3. A point mass m is attached to an ideal string, which in turns is wrapped on a vertical pole. Point mass is kept on a smooth horizontal surface and string is horizontal. A horizontal velocity is imparted to the point mass perpendicular to length of string.



(A) Speed of mass will become twice of initial value if length of string between the point mass and the pole becomes half of the original value.
(B) Kinetic energy of mass increases.
(C) Work done by tension on the point mass is zero.
(D) Energy of the mass remains constant.

4. In the adjacent figure, a uniform disc of mass 2m and radius $\ell/2$ is lying at rest on a smooth horizontal surface. A particle 'A' of mass m is connected to a light string of length ℓ, whose other end is attached to the circumference of the disc. Initially string is just taut and tangential to the disc, particle A is at rest. In the same horizontal plane another particle B of same mass m moving with velocity v_0 perpendicular to string collides elastically with A. Just after impact which of the following statements will be true



(A) Tension in the string is $\frac{2mv_0^2}{5\ell}$

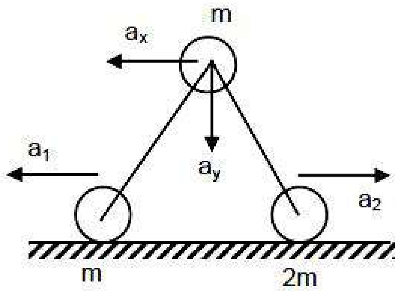
(B) Acceleration of the centre of the disc is $\frac{v_0^2}{5\ell}$

(C) Initial radius of curvature of 'A' is $\frac{5\ell}{2}$

(D) Acceleration of the centre of the disc is $\frac{2v_0^2}{5\ell}$

5. Three masses are joined using pin joints (can move freely). Length of both rods are identical and system starts from rest. Accelerations of the balls are shown in figure. Angle between the rods at this moment is 90°. The horizontal surface is smooth. Choose the correct option(s).

(A) $2a_2 = a_1 + a_x$
(B) $2a_y = a_1 + a_2$
(C) $2a_x = a_1 - a_2$
(D) $3a_1 = 5a_2$



6. A particle of mass m is subjected to two forces

$\vec{F}_1 = f(r)\frac{\vec{r}}{|\vec{r}|}$ and $\vec{F}_2 = -\alpha\vec{v}$

Where f(r) is a real valued function depends on the distance of particle from origin, $\vec{r}$ is position vector of particle and α is positive constant. If at t = 0, $\vec{v}$ vector is in x-y plane and angular momentum of the particle about the origin is L_0. Choose the correct option(s).

(A) Plane of motion of particle does not change.
(B) Angular momentum of particle about the origin is given by $L_0 e^{-\frac{\alpha t}{m}}$
(C) Angular momentum of particle about the origin is remains constant.
(D) The value of angular momentum about the origin will depend on f(r)

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (I), (II), (III) and (IV) and FIVE statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

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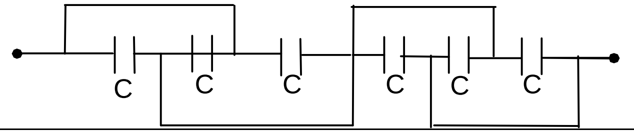
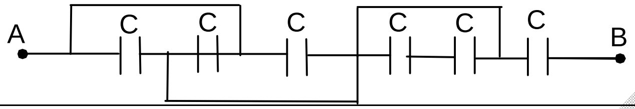
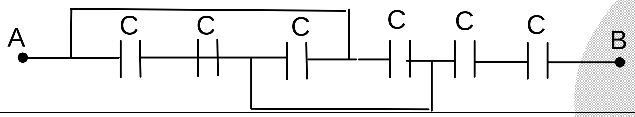
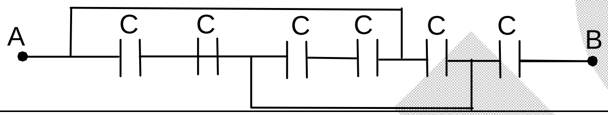
7. Match List I with List II:

List I (Circuit)		**List II (C_{eq})**	
(I)		(P)	$\frac{3C}{4}$
(II)		(Q)	$\frac{5C}{12}$
(III)		(R)	$\frac{2C}{3}$
(IV)		(S)	$\frac{3C}{2}$

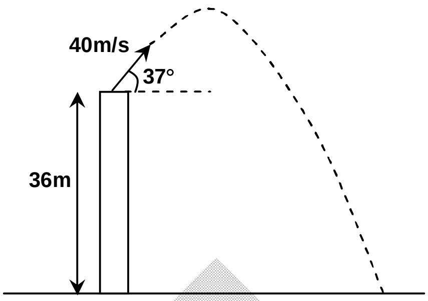
(A) I – S; II – Q; III – R; IV – P
(B) I – S; II – P; III – Q; IV – R
(C) I – S; II – P; III – R; IV – Q
(D) I – S; II – Q; III – P; IV – R

8. One mole of an ideal gas whose adiabatic exponent equals γ, undergoes a process $P = P_0 + \alpha/v$, where P_0 and α are positive constants. Its volume increases from v_1 to v_2.

List–I		**List–II**	
(I)	Heat capacity of gas as a function of its volume	(P)	$\frac{P_0(V_2 - V_1)}{\gamma - 1}$
(II)	Internal energy increment of a gas	(Q)	$\frac{P_0(v_2 - v_1)}{\gamma - 1} + \alpha \ln\frac{v_2}{v_1}$
(III)	The work performed by it	(R)	$P_0(v_2 - v_1) + \alpha \ln\frac{v_2}{v_1}$
(IV)	The amount of heat transferred	(S)	$\frac{\gamma R}{\gamma - 1} + \frac{\alpha R}{p_0 v}$

(A) I – S; II – P; III – R; IV – Q
(B) I – P; II – Q; III – R; IV – S
(C) I – P; II – S; III – R; IV – Q
(D) I – S; II – P; III – Q; IV – S

9. Consider a situation in which a projectile is fired at 40 m/s from the top of a tower in absence of air resistance t =0.



List–I		List–II	
(I)	Time at which particle moves at right angles with the initial direction	(P)	2.4 s
(II)	time at which kinetic energy is least	(Q)	6 s
(III)	Time at which it strikes the ground	(R)	20/3 s
(IV)	Time when the $\vec{v}$ make 45° with horizontal	(S)	5.6 s
		(T)	7.2 s

(A) (I) → (R); (II) → (P); (III) → (S); (IV) → (Q) (B) (I) → (P); (II) → (R); (III) → (Q); (IV) → (S)
(C) (I) → (P); (II) → (Q); (III) → (R); (IV) → (S) (D) (I) → (R); (II) → (P); (III) → (Q); (IV) → (S)

10. A neutron moving with kinetic energy K collides with a hydrogen atom at rest in ground state. Assume mass of neutron to be equal to that of hydrogen atom. Match the kinetic energy of neutron with the possible phenomena mentioned in column II. Energy of hydrogen in ground state is –13.6 ev

List– I		List–II	
(Kinetic energy of colliding neutron)			
I	K = 10.2 eV	(P)	Elastic collision may take place
II	K = 13.6 ev	(Q)	Inelastic collision may take place
III	K = 20.4 ev	(R)	Perfectly inelastic collision may take place
IV	K = 22.0 ev	(S)	Hydrogen atom may get ionised

(A) I-P; II-Q; III-R; IV-S (B) I-P; II-P; III-P, R; IV-P, Q
(C) I-P; II-P; III-P; IV-Q (D) I-P; II-P; III-R; IV-Q

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

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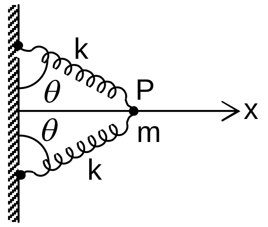
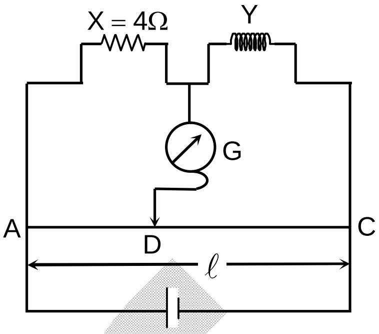
11. Two identical springs each of stiffness k are welded at a point P. If a particle of mass m is welded at P. The period of oscillation of the particle in the direction of x is $\frac{\pi}{\sin\theta}\sqrt{\frac{Ym}{k}}$. Find Y

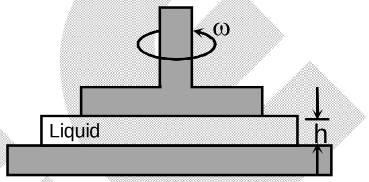


12. A body executing SHM with time period T and amplitude A. When it is at $\frac{A}{2}$ from equilibrium position moving toward right. It receives an impulse which doubles its velocity without changing direction. Time taken by the block to reach the right extreme position is $t = T\cos^{-1}\left(\frac{K}{\sqrt{13}}\right)$. Find K.

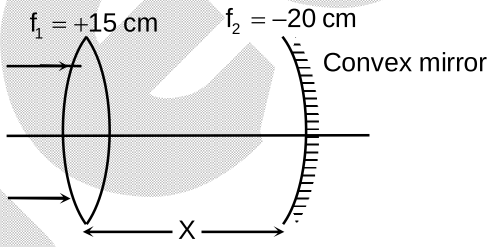
13. Figure shows a meter bridge wire AC has a uniform cross-section. The length of wire AC is 100 cm. X is a standard resistor of 4 Ω and Y is a coil. When Y is immersed in melting ice the null point is at 40 cm from point A. When the coil Y is heated to 100°C, a 12 Ω resistor has to be connected in parallel with Y in order to keep the bridge balanced at the same point.



14. A circular disc of a diameter d is slowly rotated in a liquid of large viscosity μ at a small distance h from a fixed surface. An expression for torque T necessary to maintain an angular velocity ω is $\frac{\mu\pi d^4\omega}{Xh}$. Find the value of X.



15. A set of parallel rays incident on the bi-convex lens. If after two refractions and one reflection final image formed at 15 cm left of lens, the value of $\frac{X}{9}$ is



16. Three SHM in the same direction in having same amplitude and same period are superposed. If each differ in phase from the next by 45°. Then, find the energy associated with resulting motion taking energy associated with each of given SHM as 1 J.

17. Two rods of different materials having coefficient of thermal expansion α_1, α_2 and Young's modulus Y_1, Y_2 are fixed between two massive walls. The rods are heated such that they undergo the same increase in temperature. If $\alpha_1 : \alpha_2 = 2 : 3$, then thermal stresses in rods are equal, then the ratio $Y_1 : Y_2$ is _____ .

18. A student determines a dimensionless quantity,

$$B = \frac{e^n}{Z\varepsilon_0 hc}.$$

Where, e = electric charge,
ε_0 = permittivity of vacuum,
h = Plank's constant
and c = speed of light.
Find the value of n.

Chemistry

PART – II

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

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19. An isotone of $^{76}_{32}\text{Ge}$ is
(A) $^{77}_{32}\text{Ge}$
(B) $^{77}_{33}\text{As}$
(C) $^{77}_{34}\text{Se}$
(D) $^{78}_{34}\text{Se}$

20. For a compound AB crystallises in a rock salt structure with edge length a of the unit cell,
(A) the minimum distance between A and A is $a/\sqrt{2}$
(B) the minimum distance between B and B is $a/\sqrt{2}$
(C) the minimum distance between A and B is a/2
(D) the density of the crystal is given by $\rho = \frac{4}{a^3}\frac{M_{AB}}{N_A}$

21. Which of the following statements are not correct
(A) For an ideal binary liquid solution, the plot of $1/x_A$ versus $1/y_A$ (where x_A and y_A are the mole fractions of A in liquid and vapour phases, respectively) is linear.
(B) According to Raoult's law, the relative lowering of vapour pressure is equal to the mole fraction of solvent in the solution.
(C) The crysoscopic constant K_f is property of solvent.
(D) The value of van't Hoff factor for CH_3COOH in benzene will be 2

22. Which of the following statements are correct?
(A) Linear overlap of two atomic p-orbitals leads to a sigma bond
(B) The bond angle H – N – H in NH_3 is greater than the bond angle H – As – H in AsH_3.
(C) Anhydrous HCl is a bad conductor of electricity but aqueous HCl is a good conductor
(D) o-nitrophenol is steam volatile whereas p-nitrophenol is not.

23. Which of the following reactions give an alkyne?
(A) sodium fumarate $\xrightarrow[\text{electrolysis}]{\text{Kolbe's}}$
(B) $CH_3CBr_2CHBr_2 \xrightarrow[\text{Zn/alcohol/}\Delta]{}$
(C) $CH_3CH_2CHBr_2 \xrightarrow{NaNH_3/\Delta}$
(D) $CH_3CHBr-CHBr \xrightarrow{NaNH_2}$

24. Which of the following reactions give n-propyl alcohol as the major product?
(A) $CH_3 - CH = CH_2 + H_2O \xrightarrow{H^+}$
(B) $HCHO \xrightarrow[\text{(ii)hydrolysis}]{\text{(i)}CH_3CH_2MgBr}$
(C) $CH_3 - CH = CH_2 \xrightarrow{\text{cold(aq)}KMnO_4}$
(D) $CH_2 = CH - CHO + H_2 \xrightarrow{Ni}$

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (I), (II), (III) and (IV) and FIVE statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

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25. Match the entries in List-I for the spectral series of hydrogen atom with those given in List-II. The symbols n_1 and n_2 are the quantum level in the expression

List -I		**List-II**	
(I)	Lyman series	(P)	$n_1 = 2$ and $n_2 = 3, 4, 5,\ldots$
(II)	Balmer series	(Q)	$n_1 = 4$ and $n_2 = 5, 6, 7$
(III)	Paschen series	(R)	$n_1 = 5$ and $n_2 = 6, 7,\ldots$
(IV)	Pfund series	(S)	$n_1 = 1$ and $n_2 = 2, 3, 4,\ldots$
		(T)	$n_1 = 3$ and $n_2 = 4, 5, 6,\ldots.$

Which of the following is correct match

(A) I–S; (B) II–Q

(C) III–R (D) IV – T

26. Match the list -I and List- II

List -I		**List-II**	
(I)	Electrophilic substitution	(P)	$C_6H_5N_2Cl + C_6H_5\ OH \xrightarrow{NaOH}$
(II)	Nucleophilic substitution	(Q)	Toluene + NBS $\longrightarrow$
(III)	Free radical substitution	(R)	Dow's process
(IV)	Coupling reaction	(S)	Phenol $\longrightarrow$ picric acid
		(T)	$C_6H_5ONa + CH_3Br \longrightarrow$

Which of the following is correct match

(A) I–R, (B) II–P

(C) III-Q (D) IV–T

27. Match the list -I and List- II

List -I		**List-II**	
(I)	$2p\pi - 3\ p\pi$	(P)	$F_2C = O$
(II)	$3p\pi - 3\ d\pi$	(Q)	$F_3P = O$
(III)	$2p\pi - 3\ d\pi$	(R)	$F_3P = S$
(IV)	$2p\pi - 2\ p\pi$	(S)	$F_2S = O$
		(T)	$F_2C = S$

Which of the following is correct match

(A) I–R, (B) II–T

(C) III-Q (D) IV–P

28. List-II give the values of γ (- $C_{p,\ m}/C_{V,\ m}$) at high temperature of gases which are shown in column I. Identify the gas with the corresponding γ values.

List -I		**List-II**	
(I)	Monatomic	(P)	1.154
(II)	Diatomic	(Q)	1.286
(III)	Linear Triatomic	(R)	1.167
(IV)	Nonlinear Triatomic	(S)	1.407
		(T)	1.667

Which of following is correct match

(A) I–Q (B) II–T

(C) III-P (D) IV–R

Section – B (Maximum Marks: 24)

This section contains ***EIGHT (08)*** *numerical based questions. The answer to each question is a* ***NUMERICAL VALUE.*** *If the numerical value has more than two decimal places, truncate/round-off the value to* ***TWO*** *decimal places.*

29. The ionization potential of hydrogen atom is 13.6 eV. The energy in electron volt required to remove an electron in the n = 2 state of the hydrogen atom is

30. The density of a gas is 1.5 g L^{-1} at STP. Its density at 27 °C and 1000 Torr would be

31. Ammonium chloride crystallizes in a body-centred cubic lattice with edge length of 387 pm. If the size of NH_4^+ is 154 pm, the size of Cl^- ion would be

32. A container of volume 'V' litre contains an equilibrium mixture which consists of 2 mol each of PCl_5, PCl_3 and Cl_2. The equilibrium pressure is 3 atm and temperature is 'T' kelvin. A certain amount of Cl_2 gas is now introduced into the container keeping the temperature and presence constant, until the equilibrium volume becomes '2V' litre. How many moles of Cl_2 were added?

33. The conductivity of a saturated solution of silver oxalate is 4.5×10^{-5} S cm^{-1}. If its $K_{sp} = 1.35 \times 10^{-11} M^3$, the molar conductivity of the saturated solution would be

34. How many grams of potassium perchlorate ($KClO_4$) must be mixed with 108 g of water in order to obtain a solution, which has a mole fraction of $KClO_4$ equal to $\frac{1}{7}$?

35. Calculate effective nuclear charge on last electron of Cl. (using Slater rule)

36. The number of isomers possible for complex $K_2[PtClBr_2SCN]$:

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Mathematics PART – III

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

37. A point $P\left(\sqrt{3},1\right)$ moves on the circle $x^2+y^2=4$ and after covering a quarter of the circle leaves it tangentially. The equation of a line along which the point moves after leaving the circle is

(A) $y=\sqrt{3}x+4$ (B) $\sqrt{3}y=x+4$

(C) $\sqrt{3}y=x-4$ (D) $y=\sqrt{3}x-4$

38. A chord PP' of a parabola cuts the axis of the parabola at O. The feet of the perpendiculars from P and P' on the axis are M and M' respectively. If V is the vertex then VM, VO, VM' are in

(A) AP (B) GP

(C) HP (D) none of these

39. α, β and γ are three angles given by $\alpha=2\tan^{-1}\left(\sqrt{2}-1\right),\beta$ $=3\sin^{-1}\frac{1}{\sqrt{2}}+\sin^{-1}\left(-\frac{1}{2}\right)$ *and* $\gamma=\cos^{-1}\frac{1}{3}$. Then

(A) $\alpha>\beta$ (B) $\beta>\gamma$

(C) $\alpha<\gamma$ (D) none of these

40. $\int_4^8\left(\sqrt{\sqrt{16x-64}+x}+\sqrt{x-\sqrt{16x-64}}\right)dx$

(A) $2\int_4^6\left(\sqrt{\sqrt{16x-64}+x}+\sqrt{x-\sqrt{16x-64}}\right)dx$ (B) $2\int_8^{10}\left(\sqrt{\sqrt{16x-64}+x}+\sqrt{x-\sqrt{16x-64}}\right)dx$

(C) $2\int_7^9\left(\sqrt{\sqrt{16x-64}+x}+\sqrt{x-\sqrt{16x-64}}\right)dx$ (D) 16

41. If M is the skew symmetric matrix of order n × n, then

(A) det (M – I) = det (M + I) (B) det (M – I) = – det (M + I) if n is odd

(C) det (M – I) = det (M + I) if n is even (D) det (I – M) $(I + M)^{-1}$) = 1, det (I + M) $\neq 0$

42. If the unit vectors $\vec{a}$ and $\vec{b}$ are inclined at an angle 2θ such that $\left|\vec{a}-\vec{b}\right|<1$ and $0\le\theta\le\pi$, then θ lies in the interval

(A) $[0, \pi/6)$ (B) $(5\pi/6, \pi]$

(C) $(\pi/6, \pi/2]$ (D) $[\pi/2, 5\pi/6)$

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** Matching List Type Questions. Each question has FOUR statements in **List-I** entries (I), (II), (III) and (IV) and FIVE statements in **List-II** entries (P), (Q), (R), (S) and (T). The codes for lists have choices (A), (B), (C), (D) out of which **ONLY ONE** of these four options is correct answer.*

---

43. Match the List– I & List–II

	List–I	**List–II**	
I	A straight line with negative slope passing through (1, 4) meets the coordinate axes at A and B. The minimum length of OA + OB, O being the origin, is	P	$5\sqrt{2}$
II	If the point P is symmetric to the point Q(4, –1) with respect to the bisector of the first quadrant, then the length of PQ is	Q	$3\sqrt{2}$
III	On the portion of the straight line x + y = 2 between the axis a square is constructed away from the origin, with this portion as one of its sides. If d denotes the perpendicular distance of a side of this square from the origin then the maximum value of d is	R	9/2
IV	If the parametric equation of a line is given $x = 4 + \lambda/\sqrt{2}$ and $y = -1 + \sqrt{2}\lambda$, where λ is a parameter, then the intercept made by the line on the x-axis is	S	9

(A) I → R; II →P; III → Q; IV → S (B) I → S; II →P; III → Q; IV → R

(C) I → S; II →R; III → Q; IV → P (D) I → P; II →S; III → Q; IV → R

44. Match the List–I & List–II

	List–I	**List–II**	
I	The smallest integer greater than $\frac{1}{\log_3 \pi} + \frac{1}{\log_4 \pi}$		10
II	Let $3^a = 4, 4^b = 5, 5^c = 6, 6^d = 7, 7^e = 8$, and $8^f = 9$. Then the value of the product (abcdef) is	Q	3
III	Characteristic of the logarithm of 2008 to the base 2 is	R	1
IV	If $\log_2(\log_2(\log_3 x)) = \log_2(\log_3(\log_2 y)) = 0$, then the value of (x – y) is	S	2

(A) I → R; II → S; III → P; IV → Q (B) I → S; II → Q; III → P; IV → R

(C) I → Q; II → S; III → P; IV → R (D) I → Q; II → R; III → P; IV → S

45. Match the following List-I with List–II

	List–I	**List–II**	
I	$\lim\limits_{x\to 0} \frac{1-\cos 2x}{e^{x^2} - e^x + x}$ equals to	P	1
II	If the value of $\lim\limits_{x\to 0^+} \left(\frac{(3/x)+1}{(3/x)-1}\right)^{1/x}$ can be expressed in the form of $e^{p/q}$, where p and q are relative prime, then (p + q) is equal to	Q	2
III	$\lim\limits_{x\to 0} \frac{\tan^3 x - \tan x^3}{x^5}$ equals to	R	4
IV	$\lim\limits_{x\to 0} \frac{x + 2\sin x}{\sqrt{x^2 + 2\sin x + 1} - \sqrt{\sin^2 x - x + 1}}$ equals to	S	5

(A) I → R; II → S; III → P; IV → Q (B) I → Q; II → S; III → S; IV → P

(C) I → R; II → P; III → S; IV → Q (D) I → Q; II → S; III → P; IV → R

46. Let Π be the plane parallel to y-axis and containing the points (1, 0, 1) and (3, 2, -1). $A \equiv (4, 0, 0)$ and $B \equiv (6, 0, -2)$ are two points and $P \equiv (x_0, y_0, z_0)$ is a variable point on the plane $\Pi = 0$.
Match List – I with List – II and select the correct answer using the code given below the list.

	List - I	**List - I**	
I	If the equation of the plane $\Pi = 0$ is $x + ay + bz = c$, then $\lvert a + b + c\rvert$ is	P	16
II	If (PA + PB) is minimum, then $\lvert 4x_0 + y_0 + 2z_0\rvert$ is	Q	12
III	If $\lvert PA + PB\rvert \in [0, \sqrt{N})$, then N is	R	3
IV	If the reflection of the line AB in the plane $\Pi = 0$ is $\frac{x-2}{1} = \frac{y-\alpha}{0} = \frac{z+\beta}{-1}$, then $(\alpha^4 + \beta^4)$	S	8
		T	10

(A) I → R, II → Q, III → P, IV → S (B) I → Q, II → R, III → S, IV → P
(C) I → R, II → Q, III → S, IV → P (D) I → R, II → S, III → Q, IV → P

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

47. In the coordinate plane, the region M consists of all the points (x, y) satisfying the inequalities $y \ge 0,\ y \le x$ y and $y \le 2 - x$ simultaneously. The region N, which varies with the parameter t, consists of all the points (x, y) satisfying the inequalities $t \le x \le t + 1$and $0 \le t \le 1$ simultaneously. The area of $M \cap N$ is $-k_1t^2 + k_2t + \frac{1}{2}$, then $k_1 + k_2$ is ______ .

48. The slope of the tangent to the curve represented by $x = t^2 + 3t - 8$ and $y = 2t^2 - 2t - 5$ at the point $M(2, 1)$ is $\left(\frac{\lambda}{7}\right)$, then value of λ is ?

49. Let $(1 + 3x + 4x^2) = a_0 + a_1x + a_2x^2 + .. + a_{20}x^{20}$. Then value of a_3 is –

50. Find the value of $f\left(\frac{\pi}{6}\right)$, where $f(\theta) = \begin{vmatrix} \cos^2\theta & \cos\theta\sin\theta & -\sin\theta \\ \cos\theta\sin\theta & \sin^2\theta & \cos\theta \\ \sin\theta & -\cos\theta & 0 \end{vmatrix}$

51. If α, β, γ are such that $\alpha + \beta + \gamma = 4$, $\alpha^2 + \beta^2 + \gamma^2 = 6$, $\alpha^3 + \beta^3 + \gamma^3 = 8$, then the value of $\left[\alpha^4 + \beta^4 + \gamma^4\right]$ must be equal to (where [.] denotes the greatest integer function)

52. Find the Coefficient of x^{103} in $(1 + x + x^2 + x^3 + x^4)^{199}(x - 1)^{201}$.

53. If $\left(1 + \frac{1}{x}\right)^{x+1} = \left(1 + \frac{1}{2021}\right)^{2021}$, then $\lvert x\rvert$ is equal to

54. If two events A and B are such that $P(\bar{A}) = 0.3$, $P(B) = 0.4$, $P(A \cap \bar{B}) = 0.5$, then the value of $P(B/(A \cup \bar{B}))$ is

FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2023
FULL TEST – V
PAPER –2
TEST DATE: 08-02-2023

Time Allotted: 3 Hours **Maximum Marks: 180**

General Instructions:

- The test consists of total 54 questions.
- Each subject (PCM) has 18 questions.
- This question paper contains **Three Parts.**
- **Part-I** is Physics, **Part-II** is Chemistry and **Part-III** is Mathematics.
- Each **Part** is further divided into **Two Sections**: **Section-A & Section-B**.

Section – A *(01 – 04, 19 – 22, 37 – 40)*: This section contains **TWELVE (12)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.

Section – A *(05 –10, 23 – 28, 41 – 46)*: This section contains **EIGHTEEN (18)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).

Section – B *(11 – 18, 29 – 36, 47 – 54)*: This section contains **TWENTY FOUR (24)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.**

MARKING SCHEME

Section – A (Single Correct): Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +3 If ONLY the correct option is chosen.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –1 In all other cases.

Section – A (One or More than One Correct): Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +4 If only (all) the correct option(s) is (are) chosen;
Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;
Partial marks : +2 if three or more options are correct but ONLY two options are chosen and both of which are correct;
Partial Marks : +1 If two or more options are correct but ONLY one option is chosen and it is a correct option;
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);
Negative Marks : –2 In all other cases.

Section – B: Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +3 If ONLY the correct integer is entered;
Zero Marks : 0 Question is unanswered;
Negative Marks : –1 In all other cases.

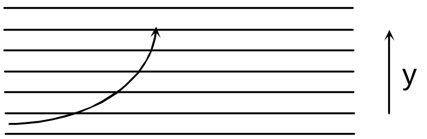
Physics

PART – I

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

1. The refractive index of the medium within a certain region, x > 0, y > 0, changes with y. A thin light ray travelling in the x-direction strikes the medium at right angles and moves through the medium along a circular arc.
How does the refractive index depend on y?
[R : Radius of path & η_0 : Initial refractive index]

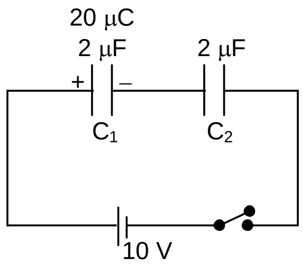


(A) $\frac{2R}{R-y}\eta_0$ (B) $\frac{R}{R-y}\frac{\eta_0}{2}$

(C) $\frac{R+y}{R}\eta_0$ (D) $\frac{R}{R-y}\eta_0$

2. A mass is suspended from a wire and is pulled along the length of wire, resulting in oscillations of time period T_1. The same mass is next attached to wire of the same material and length but double the cross-sectional area. The time period this time is T_2. Then T_1/T_2 is equal to
(A) 1 : 2 (B) 2 : 1
(C) 1 : $\sqrt{2}$ (D) $\sqrt{2}$: 1

3. Initially, C_1 is charged but C_2 is uncharged. When switch is closed, charges on C_1 and C_2 are
(A) 20 μC, 0
(B) 10 μC, 10 μC
(C) 30 μC, 10 μC
(D) 0, 20 μC



4. A standing wave is produced in a vapour of an element of atomic mass 254 (g mol^{-1}) at 400 K. Nodes are found to be 6.77 cm apart when frequency of source was 1000 Hz. The vapour used for the experiment is (R = 8.31 JK^{-1}mol^{-1})
(A) monatomic (B) diatomic
(C) polyatomic (D) none of these

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

5. A particle of mass *m* is moving in a field where the potential energy is given by $U(x) = U_0(1-\cos ax)$, where U_0 and *a* are constants and *x* is the displacement from mean position . Then (for small oscillations)

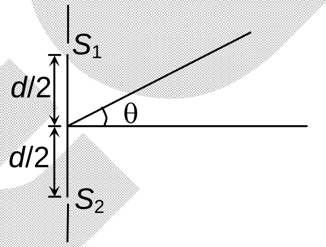
(A) the time period is $T = 2\pi\sqrt{\frac{m}{aU_0}}$

(B) the speed of particle is maximum at $x = 0$

(C) the amplitude of oscillations is $\frac{\pi}{a}$

(D) the time period is $T = 2\pi\sqrt{\frac{m}{a^2U_0}}$

6. In an interference arrangement similar to Young's double slit experiment, the slits S_1 and S_2 are illuminated with coherent microwave sources, each of frequency 10^6Hz. The sources are synchronized to have zero phase difference. The slits are separated by a distance d = 150.0 m. The intensity $I(\theta)$ is measured as a function of θ, where θ is defined as shown. If I_0 is maximum intensity, then $I(\theta)$ for $0 \le \theta \le 90°$ is given by



(A) $I(\theta) = \frac{I_0}{2}$ for $\theta = 30°$

(B) $I(\theta) = \frac{I_0}{4}$ for $\theta = 90°$

(C) $I(\theta) = I_0$ for $\theta = 0°$

(D) $I(\theta)$ is constant for all values of θ

7. A uniform square plate of mass m and edge a initially at rest starts rotating about one of the edge under the action of a constant torque τ. Then at the end of the 5th sec after start

(A) angular momentum is equal to 5τ

(B) kinetic energy is equal to $\frac{75\tau^2}{ma^2}$

(C) angular momentum is equal to 2.5τ

(D) kinetic energy is equal to $\frac{75\tau^2}{2ma^2}$

8. A particle of mass *m* start moving at *t* = 0 due to a force $F = F_0\cos\omega t$, where F_0 and ω are constant. Particle will stop first time at $t = t_0$ and distance travel in this time interval is *S*, then

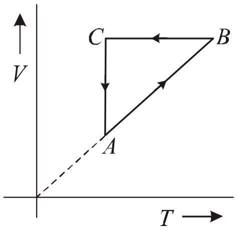
(A) $T_0 = \frac{\pi}{\omega}$

(B) $t_0 = \frac{\pi}{2\omega}$

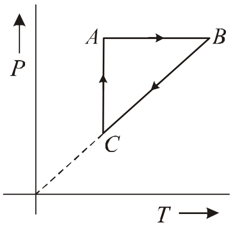
(C) $S = \frac{2F_0}{m\omega^2}$

(D) $S = \frac{F_0}{m\omega^2}$

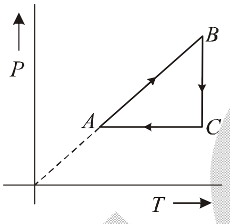
9. An ideal gas under goes a thermodynamic cycle as shown in figure. Which of the following graphs represents the same cycle ?



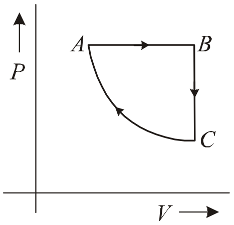
(A)



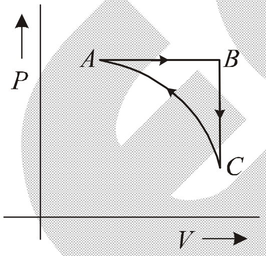
(B)



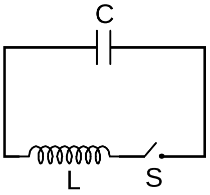
(C)



(D)



10. In the given circuit, initially the charge on capacitor is Q_0. At t = 0, the switch S is closed. Which of the following statement(s) is/are correct?



(A) Maximum current through the inductor is $\frac{Q_0}{\sqrt{LC}}$. b

(B) Charge on the capacitor is zero at $t = \frac{\pi}{2}\sqrt{LC}$.

(C) Current through the inductor is maximum at $t = \frac{\pi}{2}\sqrt{LC}$.

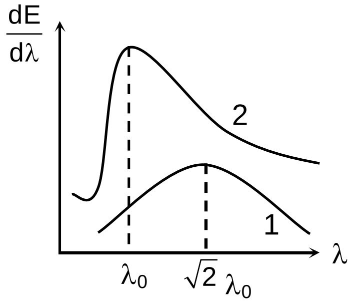
(D) Maximum magnetic energy can be stored in the inductor is $\frac{Q_0^2}{2C}$.

Section – B (Maximum Marks: 24)

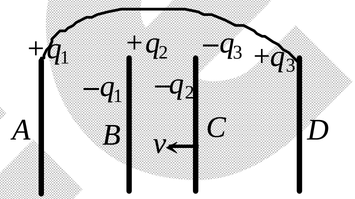
*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.***

11. A vertical hollow cylinder contains an ideal gas. The gas is enclosed by a 5 kg movable piston with area of cross-section 5×10^{-3} m^2. The gas is slowly heated from 300 K to 350 K and the piston rises by 0.1 m. The piston is now clamped at this position and the gas is cooled back to 300 K. The difference between the heat energy added during heating process and heat energy lost during cooling process is 11*x*. Find value of *x*. [Take $p_0 = 10^5$ N/m^2]

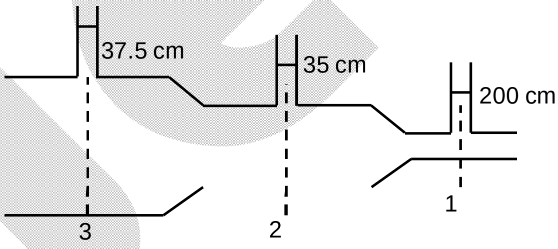
12. Graph 1 and 2 represent the spectral emissive power of a body at temperature T_1 and T_1. The ratio of area under curve 2 and curve 1 is.



13. In the diagram there are four conducting plates *A*, *B*, *C* and *D* placed parallel to each other at equal separation *L*. If plate *C* starts moving towards plate *B* with velocity *v*. Find the current (in mA) flowing in the wire connecting *A* and *D*. (assume all other plates to be fixed)
(Given: $q_2 = 2\mu C$, $q_3 = 3\mu C$, $v = 30$ m/s, $L = 0.05$ m)



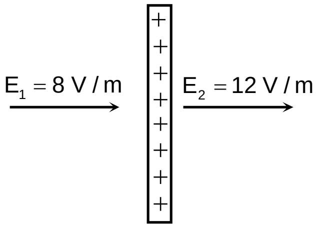
14. Water is flowing in varying cross-section pipe. The areas of cross-sections 1, 2 and 3 are 1 cm^2, 2 cm^2 and A cm^2, respectively. Water levels are shown in different vertical tubes of manometers. The speed of water at cross-section 3 is $\frac{1}{\sqrt{x}}$ m/s.
The value of x is



15. If the K_α radiation of Mo (Z = 42) has a wavelength of 0.71 Å, calculate wavelength of the corresponding radiation of Cu. i.e. K_α for Cu (Z = 29). Find the value of nearest integer value (in Å) of wavelength.

16. A particle is suspended by a light vertical inelastic string of length ℓ from a fixed support. At its equilibrium position, it is projected horizontally with a speed $\sqrt{6g\ell}$. What is the ratio of the tension in the string in its horizontal position to that in string, when the particle is vertically above the point of support?

17. The electric field on two sides of a charged plate is shown in the figure. If the charge density on the plate is $n\varepsilon_0$, then n is



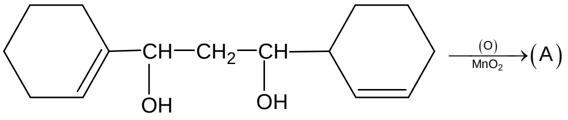
18. A hydrogen like atom (atomic number z) is in a higher excited state of quantum number n. The excited state by successively emitting two photons of energy 10.2 eV and 17.0 eV, respectively. Alternative, the atom from the same excited by successively emitting two photons of energies 4.25 eV and 5.95 eV, respectively. Determine the value of n. (Take, ionisation energy of H-atom = 13.6 eV)

Chemistry PART – II

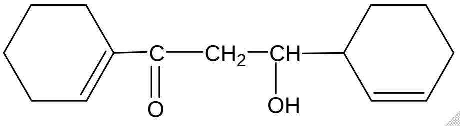
Section – A (Maximum Marks: 12)

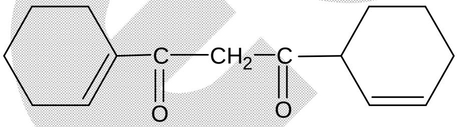
*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

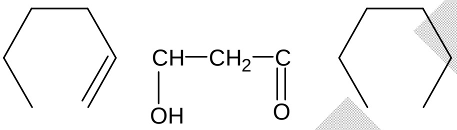
19. For $[HgI_3]^-$ ion geometry and magnetic behaviour is respectively:
(A) triangular bipyramideal, paramagnetic
(B) triangular pyramidal, diamagnetic
(C) triangular planar, paramagnetic
(D) triangular planar, diamagnetic

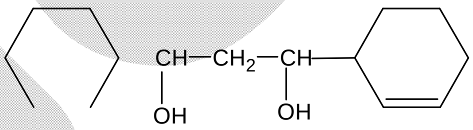
20. 

The product (A) is

(A) 

(B) 

(C) 

(D) 

21. For most reactions, rate of a reaction increases about two times when its temperature is raised by 10 K. This fact is due to
(A) increase in number of collisions per unit volume
(B) increase in number of molecules having energy E_A or more
(C) lowering of activation energy
(D) lowering of pre-exponential factor in Arrhenius equation

22. At constant volume, for a fixed amount of a gas the pressure of the gas increase with rise of temperature due to
(A) increase in average molecular speed
(B) increased rate of collision amongst molecules
(C) increase in molecular attraction
(D) decrease in mean free path

Section – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

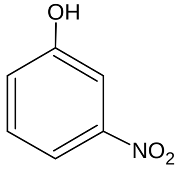
23. Which of the following statements are correct?
(A) Copper metal can reduce Fe^{2+} in acidic medium.
(B) The absolute value of standard electrode potential can be determined experimentally
(C) In a Daniell cell, electrons flow from zinc electrode to copper electrode outside the cell
(D) Cell voltage is an intensive quantity.

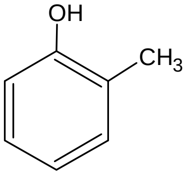
24. Which of the following show the correct order of nucleophilicity?

(A) $CH_3S^- > CH_3O^-$ (B) $(CH_3)_3N > (CH_3)_3\ddot{P}$

(C) $CN^- > Cl^-$ (D) $\overline{O}C_2H_5 > \overline{O}H$

25. Which of the following is/are more acidic than phenol?

(A)


(B)


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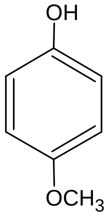

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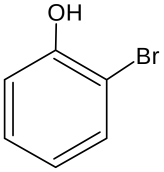
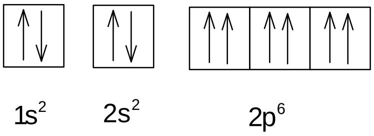
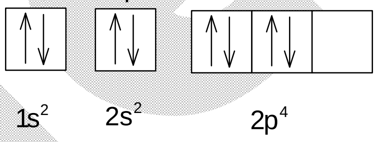


26. Select molecules(s) in which all the π-orbitals are in same plane.
(A) C_6H_6
(B) $O = C = C = C = O$
(C) $H_2C = C = CH_2$
(D) $CH_2 = CH - CH = CH_2$

27. In which of the following Pauli rule is violated?
(A) $1s^2, 2s^2, 2p^7$
(B) $1s^1, 2s^1, 2p^6$

(C)


(D)


28. Synergic bonding in metal carbonyl complexes [M = Metal]:
(A) decreases C – O bond strength
(B) increases M – C bond length
(C) increases bond order for M – C bond
(D) increases paramagnetism of complex

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.***

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29. Find the total number of electron in Cr which have ($n \times l$) = zero

30. Total number of exchanges possible for $3d^4$ electronic configuration are?

31. Total number of bonds in PCl_5 which are at 90º to each other, are

32. Consider octahydral complex $K_2[Ni(EDTA)]$.
Total no. of 5 member rings in compound = X
Total number of geometrical isomers possible for compound = Y
Represent your answer as a total of X and Y.

33. Consider a titration of potassium dichromate solution with acidified Mohr's salt solution using diphenylamine as indicator. The amount of Mohr's salt required per mole of dichromate is

34. The number of atoms in a single face-centred cubic unit cell is

35. Total no. of geometrical isomers possible for 1, 2, 4-tribormocyclohexane are?

36. Total no. of stereoisomers possible for 1, 2-dimethylcyclopropane are?

Mathematics PART – III

Section – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

37. If the area bounded by $f(x)=\sqrt{1+x^2}\,(x>0)$ the line y = x, y axis and y = –x + a(a>1) is k, then area bounded by the graph of $f^{-1}(x)$, the line y = x between the lines y = –x + 1 and y = –x + a is

(A) $\frac{k-1}{4}$ (B) $\frac{2k-1}{2}$

(C) k (D) $\frac{4k-1}{4}$

38. In a acute angle triangle ABC, the foot of the perpendicular from A divide the opposite side into two parts of length 3 and 17 units and $\tan A=\frac{22}{7}$, the $\left(\frac{\text{Area of }\Delta ABC}{22}\right)$is

(A) $\frac{5}{2}$ (B) 5

(C) 10 (D) 20

39. The digits of three digit number N are in A.P. If sum of the digits is 15 and the number obtained by reversing the digits of the number is 594 less the original number, then $\frac{1000}{N-252}$ is equal to :

(A) $\frac{5}{6}$ (B) $\frac{5}{3}$

(C) 0.06 (D) 0.03

40. A flagstaff stands vertically on a pillar, the height of the flagstaff being double the height of the pillar. A man on the ground at a distance finds that both the pillar and the flagstaff subtend equal angles at his eyes. The ratio of the height of the pillar and the distance of the man from the pillar, is

(A) $\sqrt{3}:1$ (B) 1 : 3

(C) $1:\sqrt{3}$ (D) $\sqrt{3}:2$

Section – A (Maximum Marks: 24)

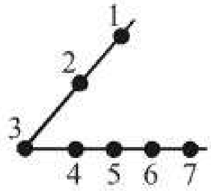
*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

41. Let $\vec{a},\vec{b},\vec{c}$ be noncoplanar vectors and $\vec{p}=\frac{\vec{b}\times\vec{c}}{\left[\vec{a}\,\vec{b}\,\vec{c}\right]}$, $\vec{q}=\frac{\vec{c}\times\vec{a}}{\left[\vec{b}\,\vec{c}\,\vec{a}\right]}$, $\vec{r}=\frac{\vec{a}\times\vec{b}}{\left[\vec{c}\,\vec{a}\,\vec{b}\right]}$ then

(A) $\vec{p}\cdot\vec{a}=1$ (B) $\vec{p}\cdot\vec{a}+\vec{q}\cdot\vec{b}+\vec{r}\cdot\vec{c}=3$

(C) $\vec{p}\cdot\vec{a}+\vec{q}\cdot\vec{b}+\vec{r}\cdot\vec{c}=0$ (D) none of these

42. 7 points are given in a plane (as shown in adjacent figure), then using these 7 points –



(A) Number of lines that can be formed is 10.
(B) Number of triangles that can be formed is 24.
(C) Number of quadrilateral that can be formed is 6.
(D) Maximum number of circles that can be formed is 24, where each circle contains atleast three of 7 points

43. The equations of four circles are $(x \pm a)^2 + (y \pm a)^2 = a^2$. The radius of a circle touching all the four circles is

(A) $\left(\sqrt{2}-1\right)a$
(B) $2\sqrt{2}a$
(C) $\left(\sqrt{2}+1\right)a$
(D) $\left(2+\sqrt{2}\right)a$

44. If f(x) is a cubic polynomial such that f(0) + 2 = 0 and $f'''(0) = 6$ & $f(x) = 0$ posses three positive integral roots then

(A) $f'(1) = 0$
(B) $2f'(0) + f''(0) = 0$
(C) $2f'(0) + f''(0) = 2$
(D) $f'(2) = 0$

45. If $x + [y] + \{z\} = 1.1$ [.] is G.I.F and {.} is fractional part

$[x] + \{y\} + z = 2.2$

$\{x\} + y + [z] = 3.3$ then

(A) $x + y + z = 3.3$
(B) $y - 2x = 1$
(C) $2(z+1) = 5y$
(D) $\{x\} + \{y\} + \{z\} = 0.3$

46. If the sides a, b & c of a triangle ABC are in G.P. then $\angle B$ can never be

(A) $\frac{\pi}{6}$
(B) $\frac{5\pi}{6}$
(C) $\frac{\pi}{4}$
(D) $\frac{2\pi}{3}$

Section – B (Maximum Marks: 24)

*This section contains **EIGHT (08)** numerical based questions. The answer to each question is a **Single Digit Integer, ranging from 0 to 9 both inclusive.***

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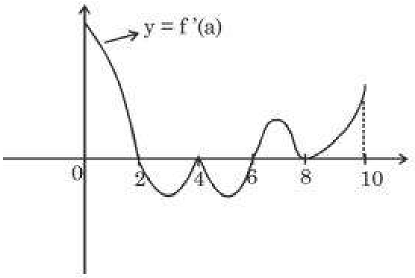
47. If $S = 3.\sqrt{9}.\sqrt{\sqrt{27}}.\sqrt{\sqrt{\sqrt{81}}}....\infty$, then sum of digits in S is

48. Let f(x) = (1 + x) $\ell n(1+x) - x - \frac{x^2}{4}, \forall x > -1$ and $f'(x) > 0 \,\forall \in x(0, \alpha)$, then value of $[\alpha]$ is (where denotes greatest integer function)

49. Let f(x) be a derivable function such that f(0) = 1, f(2) = 2, f(4) = 1 and f(6) = – 4. The graph of y $y = f'(x)$ is given below. Then find the total number of points of local maximum/local minimum of y =f (x) In (0, 10)



50. The projection length of a variable vector $x\hat{i}+y\hat{j}+z\hat{k}$ on the vector $\vec{p}=\hat{i}+2\hat{j}+3\hat{k}$ is 6. Let ℓ be the minimum projection length of the vector $x^2\hat{i}+y^2\hat{j}+z^2\hat{k}$ on the vector $\vec{p}$, then the value of $\sqrt[3]{l^2+15^2}$ is

51. Non-zero vectors $\vec{a}, \vec{b}, \vec{c}$ satisfy $\vec{a}.\vec{b}$ = 0, $(\vec{b}-\vec{a}).(\vec{b}+\vec{c})$ = 0 and $2|\vec{b}+\vec{c}|=|\vec{b}-\vec{a}|$. If $\vec{a}=\mu\vec{b}+4\vec{c}$ then the value of μ is

52. 3 couples have to be seated around a circle. Let p be the probability that no couple is together then the value of 30 p is

53. If $f(0)=1, f(2)=3, f'(2)=5$ then the value of the definite integral $\int_0^1 x\, f''(2x)\, dx$ is

54. A special die is so constructed that the probabilities of throwing 1, 2, 3, 4, 5 and 6 are (1 – k)/6, (1 + 2k)/6, (1 – k)/6, (1 + k)/6, (1 – 2k)/6 and (1 + k)/6 respectively. If two such dice are thrown and the probability of getting a sum equal to 9 lies in $\left[\frac{1}{9}, \frac{2}{9}\right]$. Then find the number of integral solutions of k.

FIITJEE
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FULL TEST – V
PAPER –1
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ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

Section – A

1. B, D

Sol. $\frac{1000}{S_1} = \frac{2000}{S_2}$ $\quad S_2 = 2S_1$

$S_1x + S_2y = (S_1 + S_2)40$

$S_1x + 2S_1y = (S_1 + 2S_1)40$

$x + 2y = 120$

2. A, B, C

Sol. time constant of capacitor $(\tau) = \frac{5RC}{8}$

Maximum charge on capacitor at steady state $(q_0) = 5CV/4$

Charge on capacitor at any time

$q = \frac{5CV}{4}\left(1 - e^{-\frac{8t}{5RC}}\right)$ .... (i)

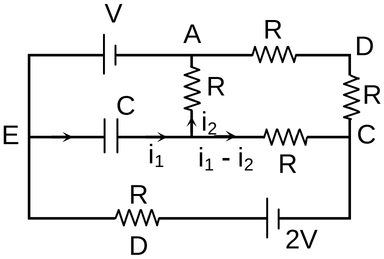
Current in the branch of capacitor at any time

$i_1 = \frac{2V}{R}e^{-\frac{8t}{5RC}}$

$i_1 = 1.7$ amp

Now, $v_A + i_2R(i_1 - i_2)R = V_C$

$V_A - v_C = 2.52$ volt



3. C, D

Sol. The force on the particle is not the central force.

4. A, B

Sol. For the disc (2m)

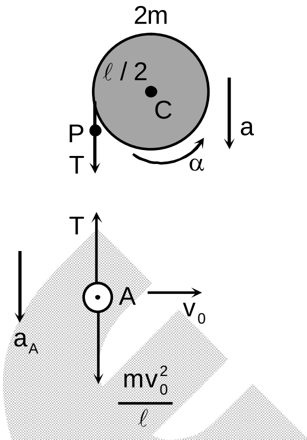
$$T = 2ma \quad ....(i)$$

$$T \times \frac{\ell}{2} = I_C\alpha \quad ....(ii)$$

For A (w.r.t. 'P')

$$T + m[a + R\alpha] = \frac{mv_0^2}{\ell}$$

Initial R.O.C. of $A = \dfrac{V_0^2}{(T/m)}$



5. A, B, C, D

Sol. $a_x + a_y = a_1$ ...(i)

$a_y - a_x = a_2$ ...(ii)

$a_{cm(x)} = 0$

$2a_2 + a_1 + a_x$ ...(iii)

6. A, B

Sol. $L = mv\theta r$ ...(i)

$$\frac{dL}{dt} = -\alpha v_\theta r$$

$$\Rightarrow \frac{dL}{dt} = -\frac{\alpha L}{m} \quad \text{from (i)}$$

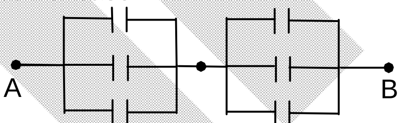
$$\Rightarrow \int_{L_0}^{L} \frac{dL}{dt} = -\frac{\alpha}{m}\int_0^t dt$$

$$L = L_0 e^{-\frac{\alpha t}{m}}$$

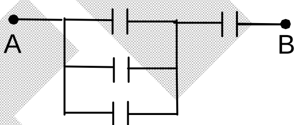
7. B

Sol. Eq. circuit of case P

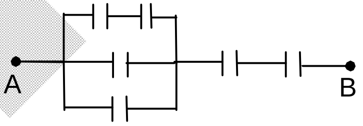
(P)



(Q)



(R)



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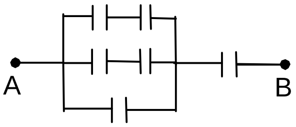


8. A

Sol. (I) C = C_v + $C_v + \frac{RT}{v}\frac{dV}{dT} = C_v + \frac{Pdv}{dT}$ (for one mole gas)

we have p = P_0 + $\frac{\alpha}{v}$, or $\frac{RT}{v} = P_0 + \frac{\alpha}{v}$

or RT = P_0v + α.

Therefore RdT = P_0dv, so, $\frac{dv}{dt} = \frac{R}{P_0}$

Hence C = C_v + $\left(P_0 + \frac{\alpha}{v}\right),\frac{R}{P_0} = \frac{R}{r-1} + \left(1 + \frac{\alpha}{P_0V}\right)R$

$= \left(R + \frac{R}{r-1}\right) + \frac{\alpha R}{P_0 v} = \frac{\gamma R}{\gamma - 1} + \frac{\alpha R}{P_0 v}$

(II) work done given by

W = $\int_{v_1}^{v_2}\left(P_0 + \frac{\alpha}{v}\right)^{dv} = P_0(v_2 - v_1) + a\ell n\frac{v_2}{v_1}$

(III) $\Delta U = C_v(T_2 - T_1) = C_v \left(\frac{P_2v_2 - P_1V_1}{R}\right) = \frac{1}{\gamma - 1}\left[p_2v_2 - p_1v_1\right]$

$= \frac{P_0(v_2 - v_1)}{\gamma - 1}$

(IV) Q = DV + W = $\frac{\gamma P_0(v_2 - v_1)}{\gamma - 1} + a\ln\frac{v_2}{v_1}$

9. D

Sol. (A) $(8-2t)\hat{j} - (8-2t)\hat{j}$

(B) $S = \frac{8\times 8}{2\times 2} = 16$

(C) $v = 8i - 8j\,,\,|v| = 8\sqrt{2}$

(D) $0 = 8t - \frac{1}{2}2t^2, t = 8$

10. B

Sol. If energy required by transition or ionization is Q then kinetic energy K required for colliding. Particle is

$$K = Q\left(1 + \frac{M_1}{M_2}\right)$$

here $M_1 = M_2$

$\therefore K = 2Q$

Minimum kinetic energy required for neutron to exite the atom = 2 × excitation energy.

Possible values of excitation energy = 10.2 ev, 12.1 ev,….

Ionisation energy = 13.6 ev

Section – B

11. 2.00

Sol. $\dfrac{\delta F}{\delta x} = k_{eff}\left(\text{numerically}\right)$

Let us find δx (static deformation of the system).
Since the particle is in equilibrium,

$$\delta F = 2\delta F_s \sin\theta$$

By Pythagoras theorem, $x^2 + y^2 = l^2$

Taking differentials of both sides, we have $2x\delta x + 2y\delta y = 2l\delta l$

Since y is constant, $\delta y = 0$

$$\delta l = \frac{x}{l}\delta x$$

$$\frac{\delta F}{\delta x} = 2k\sin^2\theta$$

$$k_{eff} = 2k\sin^2\theta$$

Substituting k_{eff}, we have $T = \dfrac{\pi}{\sin\theta}\sqrt{\dfrac{2m}{k}}$

12. 1.00

Sol. Velocity = $\omega\sqrt{A^2 - x^2}$

$$= \frac{2\sqrt{3}\pi A}{T} \text{ (doubles)}$$

$$\frac{2\sqrt{3}\pi A}{T} = \frac{2\pi}{T}\sqrt{A^2 - x^2}$$

$$A_1 = \frac{\sqrt{13}}{2}A$$

$$\cos\theta = \frac{A/2}{A_1} = \frac{1}{\sqrt{13}} \qquad \left(\theta = \cos^{-1}\left(\frac{1}{\sqrt{3}}\right)\right)$$

$$\cos^{-1}\left(\frac{1}{\sqrt{13}}\right) = \omega t$$

$$t = T\cos^{-1}\left(\frac{1}{\sqrt{13}}\right)$$

13. 1.00

Sol. According to given condition,

$$\frac{\text{i}\times 4}{\text{i}\times \text{R}_0} = \frac{\text{AD}}{\text{DC}} = \frac{40}{60} = \frac{2}{3}$$

$\Rightarrow$ R = 12

Now, $\text{R} = \text{R}_0(1+\alpha\Delta\text{T})$

$12 = 6(1+\alpha 100)$

$\Rightarrow \quad \alpha = 1\times10^{-2}$

So, $x = 1$

14. 4.00

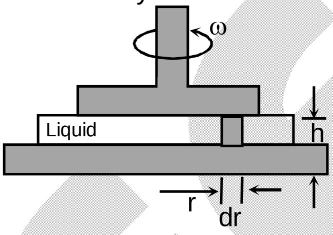
Sol. Consider an element of disc at a radius r and having a width dr.

Linearly velocity at this radius = ωr

Shear stress, $\tau = \mu\dfrac{du}{dy}$

Assuming, the gap h to be small, so that the velocity distribution may be assumed linear

$$\tau = \mu\times\frac{v}{h} = \mu\frac{\omega r}{h}$$



Viscous force, dF = $\tau\times$ Area

$= \tau\times 2\pi r dr$

Torque dT on the element,

$$dT = dF\times r = \tau 2\pi r^2 dr$$

or $$dT = \frac{\mu\omega r}{h}\times 2\pi r^2 dr = \frac{2\pi\mu\omega r^2 dr}{h}$$

Total torque,

$$T = \int_0^{d/2}\frac{2\pi\mu\omega r^3 dr}{h} = \frac{\mu\pi d^4\omega}{4h}$$

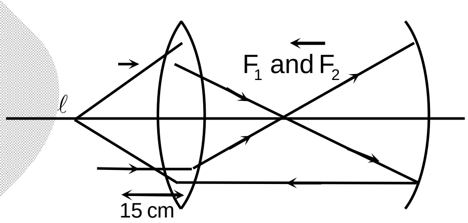
Thus, x = 4

15. 4.00

Sol. The condition is possible only when the foci of lens and mirror coincides. Then, only the final image will be at 15 cm left to lens

So, $x = 15 + 21 = 36$ cm

Hence, $\dfrac{x}{9} = \dfrac{36}{9} = 4$ cm



16. 5.82

Sol. $y_{net} = y_1 + y_2 + y_3$

$= a[\sin\omega t + \sin(\omega t + 45°) + \sin(\omega t + 90°)]$

$= (\sqrt{2}+1)a\sin(\omega t + 45°)$

Energy ratio is

$$\frac{E_{resultant}}{E_{ring}} = \left(\frac{A}{a}\right)^2 = (\sqrt{2}+1)^2$$

$$= (3 + 2\sqrt{2})$$

$\therefore \quad E_{resultant} = 5.82$ J

17. 1.50

Sol. Thermal stress = $Y\alpha\Delta\theta$

As, thermal stresses are equal

$y_1\alpha_1\Delta\theta_1 = y_2\alpha_2\Delta\theta_2$

$$\Rightarrow \quad \frac{Y_1}{Y_2} = \frac{\alpha_2}{\alpha_1} = \frac{3}{2}$$

18. 2.00

Sol. Dimension of B = $[M^0L^0T^0]$

Dimension of e = [AT]

Dimension of $\varepsilon_0 = [A^2M^{-1}L^{-3}T^4]$

Dimension of h = $[ML^2T^{-1}]$

Dimension of c = $[LT^{-1}]$

Equating,

$$[M^0L^0T^0] = \frac{[AT]^n}{[A^2M^{-1}L^{-3}T^4][ML^2T^{-1}][LT^{-1}]}$$

$$\Rightarrow \quad [M^0L^0T^0] = [A^{n-2}L^0T^{n-2}]$$

$\therefore$ n – 2 = 0 or n = 2

FIITJEE

Chemistry

PART – II

Section – A

19. B, D

Sol. Isotones have same number of neutrons

20. A, B, C, D

Sol. The d_{A-A} = d $_{B-B}$ = $\sqrt{2}$ a/2 and d_{AB} = a/2. There will be four molecules of AB in a unit cell. Hence. Its density will be given as $\rho = \dfrac{4 \times M_{AB}}{a^3 N_A}$.

21. B, D

Sol. RLVP = mole fraction of solute

Van't Hoff factor for CH_3COOH in benzene will be less than 1, because of association of CH_3COOH

22. A, B, C, D

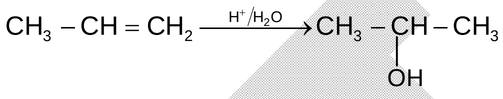
Sol. Factual

23. A, B, C, D

Sol. Factual

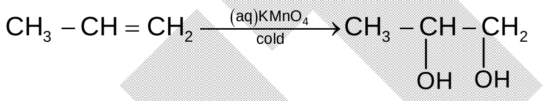
24. B, D

Sol. (A)



$$CH_3-CH=CH_2 \xrightarrow{H^+/H_2O} CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3$$

(B)



$$CH_3-CH=CH_2 \xrightarrow[\text{cold}]{\text{(aq)}KMnO_4} CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-\underset{\displaystyle OH}{\underset{|}{CH_2}}$$

25. C

Sol. Factual

26. C

Sol. Factual

27. D

Sol. Factual

28. C

Sol. Factual

Section – B

29. 3.40

Sol. I.P = $R_H Z^2$, 13.6 = R_H

$$\Delta E = R_H\left(\frac{1}{n_1^2}-\frac{1}{n_2^2}\right) = 13.6\left(\frac{1}{2^2}-\frac{1}{\infty^2}\right) = 13.6 \times \frac{1}{4} = 3.4$$

30. 1.80

Sol. $\rho = \frac{PM}{RT}$ or $M = \frac{\rho \times RT}{P} = \frac{1.5 \times R \times 273}{1}$

$$\rho = \frac{1000 \times 1.5 \times R \times 273}{760 \times R \times 300} = 1.8$$

31. 181.14

Sol. for bcc, $\sqrt{3} \times a = 2(r_+ + r_-)$

$1.732 \times 387 = 2\ (154 + r_{Cl-})$

$r_{Cl^-} \approx 181.14$

32. 6.67

Sol. $P_{PCl_5} = P_{Cl_3} = P_{Cl_2} = \frac{2}{6} \times 3 = 1$ atm

$$K_p = \frac{1 \times 1}{1} = 1$$

Let “y” mol of Cl_2 were added

	$PCl_5(g) \rightleftharpoons$	$PCl_3(g) +$	$Cl_2(g)$
Initial mol	2	2	$(2+y)$
mol of equilibrium	$(2+x)$	$(2-x)$	$(2+y-x)$

Total mol = 12, because total volume is twice of initial volume

Mol of PCl_5 + PCl_3 = 2 + x +2 –x = 4

Mol of Cl_2 = 12 – 4 = 8

$PCl_5 = \frac{(2+x) \times 3}{12} = \frac{2+x}{4}$, $P_{PCl3} = \frac{2-x}{4}$, $P_{Cl_2} = \frac{8 \times 3}{12} = 2$

$$\frac{\left(\frac{2-x}{4}\right) \times 2}{\frac{2+x}{4}} = 1.0 \Rightarrow x = \frac{2}{3}$$

$$2 + y + \frac{2}{3} = 8$$

$$y = \frac{20}{3} = 6.67$$

33. 300.00

Sol. For $Ag_2C_2O_4 \rightleftharpoons 2Ag^+ + C_2O_4^{2-}$

$$S = \left(\frac{K_{sp}}{4}\right)^{\frac{1}{3}} = \left(\frac{1.35 \times 10^{-11}}{4}\right)^{\frac{1}{3}} = \left(3.375^{-12}\right)^{\frac{1}{3}} = 1.5 \times 10^{-4}$$

$$\Lambda_m = \frac{k \times 1000}{S}$$

$$\Lambda_m = \frac{4.5 \times 10^{-5} \times 10^3}{1.5 \times 10^{-4}} = 300\ \text{S cm}^2\ \text{mol}^{-1}$$

34. 138.50

Sol. $X_{H_2O} = 1 - \frac{1}{7} = \frac{6}{7}$

$$\frac{X_{KClO_4}}{X_{H_2O}} = \frac{1}{7}\times\frac{7}{6} = \frac{1}{6} = \frac{n(KClO_4)}{n(H_2O)}$$

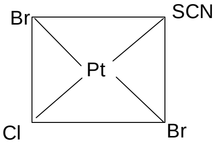
It mean 6 mol H_2O (108g H_2O) contain 1 mol $KClO_4$ = 138.5g $KClO_4$

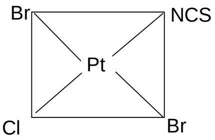
35. 6.10

Sol. Factual

36. 4.00

Sol.


Br
SCN
Pt
Cl
Br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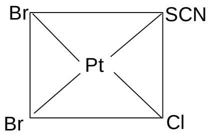
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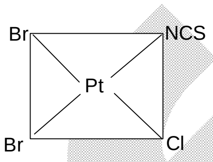
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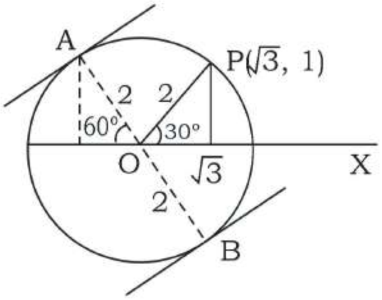
Mathematics PART – III

Section – A

37. B, C

Sol.

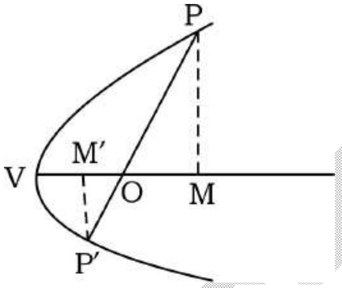


Clearly, $A=\left(-2\cos 60^\circ, 2\sin 60^\circ\right)$ *and* $B=\left(2\cos 60^\circ, -2\sin 60^\circ\right)$.

The tangent at A is $x\left(-2\cos 60^\circ\right)+y\left(2\sin 60^\circ\right)=4$ and the tangent at B is $x\left(2\cos 60^\circ\right)+y\left(-2\sin 60^\circ\right)=4$.

38. B

Sol.



Let the parabola be $y^2 = 4ax$ and $p=\left(at_1^{\,2}, 2at_1\right), P'=\left(at_2^{\,2}, 2at_2\right)$

$$\therefore \quad VM = at_1^{\,2}, VM' = at_2^{\,2} \text{ and } VO = k, \text{ where } \begin{vmatrix} a_1^2 & 2at_1 & 1 \\ a_2^2 & 2at_2 & 1 \\ k & 0 & 1 \end{vmatrix} = 0$$

$(\because \quad p, p', O \text{ are collinear})$

$$\Rightarrow \quad k + at_1t_2 = 0$$

$$\therefore \quad VM \cdot VM' = \left(at_1t_2\right)^2 = k^2 = OV^2.$$

39. B, C

Sol. $\alpha = 2\tan^{-1}\left(\sqrt{2}-1\right) = 2\tan^{1}\tan\frac{\pi}{8} = 2\times\frac{\pi}{8} = \frac{\pi}{4} = \cos^{-1}\frac{1}{\sqrt{2}}.$

$\beta = 3\cdot\frac{\pi}{4} - \frac{\pi}{6} = \frac{7\pi}{12}.$

$\therefore \quad \beta > \alpha \cdot Also\,\frac{1}{3} < \frac{1}{\sqrt{2}} \quad \Rightarrow \cos^{-1}\frac{1}{3} > \cos^{-1}\frac{1}{\sqrt{2}} = \frac{\pi}{4}.$

So $\gamma > \alpha$.

Again $\cos^{-1}\frac{1}{3}$ belongs to the first quadrant and β is in the second quadrant.

$\therefore \qquad \beta > \gamma.$

40. A, B, D

Sol. $\int_4^8 \left(\left|\sqrt{x-4}+2\right| + \left|\sqrt{x-4}-2\right|\right)dx = \int_4^8 4dx = 16$

Similarly option A = B = D = 16

41. B, C, D

Sol. $\det(M-I) = \det(M-I)^T$

$$= \det(M^T - I)$$

$$= \det(-M-I) = \begin{cases} \det(M+I), & \text{if n is even} \\ -\det(M+I), & \text{if n is odd} \end{cases}$$

42. A, B

Sol. Since, $\vec{a}$ and $\vec{b}$ are unit vectors, we have

$$\left|\vec{a}-\vec{b}\right| = \sqrt{\left(\vec{a}-\vec{b}\right)^2}$$

$$\therefore \sqrt{\left(\vec{a}\right)^2 + \left(\vec{b}\right)^2 - 2\vec{a}.\vec{b}} = \sqrt{1+1-2\cos 2\theta} = 2\left|\sin\theta\right|$$

Therefore, $\left|\vec{a}-\vec{b}\right| < 1$

$\Rightarrow \qquad 2\left|\sin\theta\right| < 1$

$$\left|\sin\theta\right| < \frac{1}{2}$$

$\Rightarrow \qquad \theta \in \left[0, \frac{\pi}{6}\right) \qquad$ or $\qquad \left(\frac{5\pi}{6}, \pi\right]$

43. B

Sol. I.

$OA = 1 + 4\cot\theta$

$OB = 4 + \tan\theta$

OA + OB = 5 + 4 cot θ + tan $\theta \geq$ 5 + $2\sqrt{4\cot\theta\tan\theta}$

$= 5 + (2\times 2) = 9$

II.

The reflection of P(4, –1) on y = x is Q (–1, 4).

Hence, PQ = $\sqrt{(4+1)^2(-1-4)^2} = \sqrt{50} = 5\sqrt{2}$.

III. AB = $2\sqrt{2}$

OC = $\sqrt{2}$

The maximum value of d is

OF = $\sqrt{2}$ + $2\sqrt{2}$ = $3\sqrt{2}$

IV.

The given line is $x = 4 + \frac{1}{\sqrt{2}}\left(\frac{y+1}{\sqrt{2}}\right)$ or $y = 2x - 9$

Hence, the intercept made by the x-axis is 9/2.

44. C

Sol. I. We have $\frac{1}{\log_3 \pi} + \frac{1}{\log_4 \pi} = \log_\pi 3 + \log_\pi 4 = \log_\pi 12$

But $\pi^2 < 12 < \pi^3$, we have $2 < \log_\pi 12 < 3$.

II. $3^a = 4; a = \log_3 4$

Similarly, $b = \log_4 5$ etc.

Hence, $abcdef = \log_3 4 . \log_4 5 . \log_5 6 . \log_6 7 . \log_7 8 . \log_8 9 = \log_3 9 = 2$

III. We have to find characteristic of $\log_2 2008$.

We know that $\log_2 1024 = 10$ and $\log_2 2048 = 11$, therefore $10 < \log_2 2008 < 11$

Hence, it has characteristic 10.

IV. $\log_2\left(\log_2\left(\log_3 x\right)\right) = 0 \Rightarrow \log_2\left(\log_3 x\right) = 1 \Rightarrow \log_3 x = 2$

$\Rightarrow x = 9$

Similarly, we have $\log_3\left(\log_2 y\right) = 1$

$\Rightarrow \log_2 y = 3$ or $y = 8$

Therefore, $x - y = 1$.

45. A

Sol. I. $I = \lim\limits_{x\to 0} \frac{e^{x^2} - 1 + x - e^x + 1}{2\frac{\sin^2 x}{x^2}.x^2} = \frac{1}{2}\left[\lim\limits_{x\to 0}\frac{e^{x^2}-1}{x^2} + \lim\limits_{x\to 0}\frac{x - e^x + 1}{x^2}\right] = \frac{1}{2}\left[1 - \lim\limits_{x\to 0}\frac{e^x - x - 1}{x^2}\right]$

II. $I = \lim\limits_{x\to 0}\left(\frac{3+x}{3-x}\right)^{1/x} = e^{\lim\limits_{x\to 0}\frac{1}{x}\left(\frac{3+x}{3-x}-1\right)} = e^{\lim\limits_{x\to 0}\frac{2x}{x(3-x)}} = e^{2/3} \Rightarrow 2 + 3 = 5$

III. $\lim\limits_{x\to 0}\frac{\left(\tan^3 x - x^3\right) - \left(\tan x^3 - x^3\right)}{x^5}$

$= \lim\limits_{x\to 0}\frac{\tan^3 x - x^3}{x^5} - \underbrace{\lim\limits_{x\to 0}\frac{\tan^3 x - x^3}{x^5}}_{\text{zero(by expansion)}}$

$== \lim\limits_{x\to 0}\frac{(\tan x - x)}{x^3}.\frac{\left(\tan^2 x + x\tan x + x^2\right)}{x^2} = \frac{1}{3}\times 3 = 1$

IV. Rationalising given

$\lim\limits_{x\to 0}\frac{(x + 2\sin x)\left[\sqrt{(x^2 + 2\sin x + 1)} + \sqrt{\sin^2 - x - x + 1}\right]}{(x^2 + 2\sin x + 1) - (\sin^2 x - x + 1)}$

$= 2.\lim\limits_{x\to 0}\frac{x + \sin 2x}{x^2 - \sin^2 x + 2\sin x + x}$

$= 2.\lim\limits_{x\to 0}\frac{1 + \frac{\sin 2x}{x}}{x - \frac{\sin^2 x}{x} + 2 + 1} = 2\left(\frac{1+2}{3}\right) = 2$

46. C

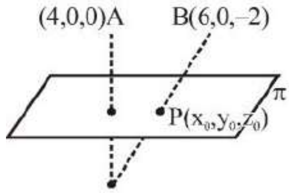
Sol. Let the plane be $\alpha x + \beta z + 1 = 0$

Pass through (1, 0, 1); (3, 2, –1)

$\therefore \alpha = -\frac{1}{2}; \beta = -\frac{1}{2}$

(I) $\pi : x + z = 2$

(II)



Both A and B are on same side of π.
Reflection of A in plane is A'(2, 0, –2)
Equation of line A'B = $\vec{r} = 6\hat{i} - 2\hat{k} + \lambda(4\hat{i})$

For P : $6 + 4\lambda + 0 - 2 = 2 \Rightarrow \lambda = \frac{-1}{2}$

$\therefore$ P(4, 2, – 2)

$\therefore \ |4x_0 + y_0 + 2z_0| = 12$

(III) Now $|PA - PB|_{min} = 0$
$|PA - PB|_{min}$ will approach
AB = $\sqrt{4+0+4} = \sqrt{8}$
$\therefore |PA - PB| \in [0, \sqrt{8})$.

(IV) Also, A' will lie on $\frac{x-2}{1} = \frac{y-\alpha}{0} = \frac{z+\beta}{-1}$.

$\Rightarrow \frac{2-2}{1} = \frac{0-\alpha}{0} = -\frac{2+\beta}{-1}$

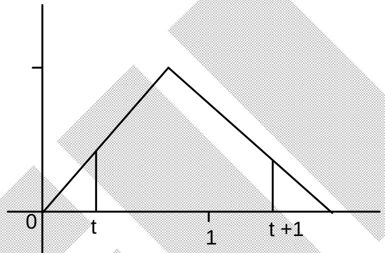
$\Rightarrow \alpha = 0, \beta = 2$

$\therefore \alpha^4 + \beta^4 = 16$

Section – B

47. 2.00

Sol. The region M is the large triangle in the diagram below, and the region N is the infinite strip between the lines $x = t$ and $x = t+1$where $0 < t < 1$



Hence $M \cap N$ is the pentagon. Its area is given by

$$\frac{1}{2}\left(\sqrt{2}^2 - t^2 - \left(2-(t+1)\right)^2\right) = -t^2 + t + \frac{1}{2}$$

48. 6.00

Sol. $t^2 + 3t - 8 = 2 \quad \Rightarrow t = 2, -5$

$2t^2 - 2t - 5 = -1 \Rightarrow t = 2, -1$

So, at $t = 2$

$$\frac{dy}{dx} = \left(\frac{\frac{dy}{dt}}{\frac{dx}{dt}}\right)_{t=2} = \frac{6}{7}$$

49. 4320.00

Sol. a_3 is coefficient of x^3

$$\frac{10!}{8!}\times 3\times 4+\frac{10!}{7!3!}\times 3^3 = 4320$$

50. 1.00

Sol. Applying $C_1 \to C_1 - \sin\theta C_3$ and $C_2 \to C_2 + \cos\theta C_3$, we get

$$f(\theta)=\begin{vmatrix} 1 & 0 & -\sin\theta \\ 0 & 1 & \cos\theta \\ \sin\theta & -\cos\theta & 0 \end{vmatrix}$$

Applying $R_3 \to R_3 - \sin\theta R_1 + \cos\theta R_2$, we get

$$f(\theta)=\begin{vmatrix} 1 & 0 & -\sin\theta \\ 0 & 1 & \cos\theta \\ \sin\theta & 0 & \sin^2\theta+\cos^2\theta \end{vmatrix}=1$$

Thus, $f\left(\frac{\pi}{6}\right)=1$

51. 7.00

Sol. We have

$$(\alpha+\beta+\gamma)^2=\alpha^2+\beta^2+\gamma^2+2(\alpha\beta+\beta\gamma+\gamma\alpha)$$

$\Rightarrow \quad 16=6+2(\alpha\beta+\beta\gamma+\gamma\alpha)$

$\therefore \quad \alpha\beta+\beta\gamma+\gamma\alpha=5$

Also, $\alpha^3+\beta^3+\gamma^3-3\alpha\beta\gamma=(\alpha+\beta+\gamma)(\alpha^2+\beta^2+\gamma^2-\alpha\beta-\beta\gamma-\gamma\alpha)$

$\Rightarrow \quad 8-3\alpha\beta\gamma=4(6-5)$

or $\quad 3\alpha\beta\gamma=4$

or $\quad \alpha\beta\gamma = 4/3$

Now, $(\alpha^2+\beta^2+\gamma^2)^2=\sum\alpha^4+2\Sigma\beta^2\gamma^2$

$$=\sum\alpha^4+2\left\{(\Sigma\beta\gamma)^2-2\alpha\beta\gamma\sum\alpha\right\}$$

$$(6)^2=\sum\alpha^4+2\left\{25-2.\frac{4}{3}.4\right\}$$

$$\sum\alpha^4=36-50+\frac{64}{3}=\frac{64}{3}-14=\frac{22}{3}$$

$\therefore \quad \left[\alpha^4+\beta^4+\gamma^4\right]=\left[\frac{22}{3}\right]=7$

52. 0.00

Sol. Coefficient of x^{103} in $(1 + x + x^2 + x^3 + x^4)^{199} (x - 1)^{201}$

Coefficient of x^{103} in $-(1 - x)^2 (1 - x^5)^{199}$

Coefficient of x^{103} in $-(1 - 2x + x^2) (1 - {}^{199}C_1 x^5 + {}^{199}C_2 x^{10} - {}^{199}C_3 x^{15} + \ldots..)$

Coefficient of $x^{103} = 0$

53. 2022.00

Sol. For x > 0 not possible

For x < 0 put x = – y

$$\left(1-\frac{1}{y}\right)^{1-y}=\left(\frac{y-1}{y}\right)^{1-y}=\left(\frac{y}{y-1}\right)^{1-y}=\left(\frac{2022}{2021}\right)^{2021}$$

$\Rightarrow y = 2022$

$x = -2022$

$|x| = 2022$

54. 0.25

Sol. $P(B)\ (A\cup \overline{B})) = \dfrac{P(B\cap(A\cup\overline{B})}{P(A\cup\overline{B})}=\dfrac{P(A)-P(A\cap\overline{B})}{P(A)+P(\overline{B})-P(A\cap\overline{B})}$

$$= \frac{0.7-0.5}{0.7+0.6-0.5}=\frac{0.2}{0.8}=\frac{1}{4}$$

FIITJEE

ALL INDIA TEST SERIES

JEE (Advanced)-2023

FULL TEST – V

PAPER –2

TEST DATE: 08-02-2023

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

Section – A

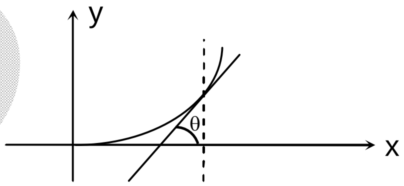
1. D

Sol. Equation of circle is

$$(x-0)^2+(y-R)^2=R^2 \qquad \ldots(1)$$

$$\frac{dy}{dx}=\tan\theta \qquad \ldots(2)$$

By Snell's law $\sin(90-\theta)\times\eta=1\times\eta_0$ …(3)



2. D

Sol. $F=-\left(\frac{Ay}{L}\right)\Delta L=K\Delta L$

$\Rightarrow \quad K=\frac{Ay}{L}$

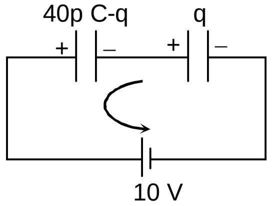
$T=2\pi\sqrt{\frac{m}{K}}$

3. A

Sol. Apply KVL

$$\frac{40-q}{2}-10-\frac{q}{2}=0$$

Solve for q



4. B

Sol. Velocity, $v=\sqrt{\frac{YRT}{M}}$

Find Y

5. B, C, D

Sol. $U = U_0(1-\cos ax)$, $F = \frac{-dU}{dx} = -aU_0 \sin ax$

$m\frac{d^2x}{dt^2} = -a^2U_0 x$ (For small oscillations)

$\Rightarrow T = 2\pi\sqrt{\frac{m}{a^2U_0}}$

Potential energy is maximum at $x = \frac{\pi}{a}$

amplitude is $\frac{\pi}{a}$

Speed of particle is maximum at $x = 0$ ($\because$ PE is minimum)

6. A, C

Sol. (i) for θ = 30

$$\lambda = \frac{c}{\nu} = \frac{3\times10^8}{10^6} = 300 \text{ m}, \ d = 150 \text{ m}$$

$$\therefore \quad \delta = \frac{2\pi}{\lambda}(d\sin\theta) = \frac{2\pi}{(300)}(150)\left(\frac{1}{2}\right) = \frac{\pi}{2}$$

$$I(\theta) = I_0\cos^2\left(\frac{\delta}{2}\right) = I_0\cos^2\left(\frac{\pi}{4}\right) = \frac{I_0}{2}$$

(ii) for θ = 90° $\Rightarrow \delta = \left(\frac{2\pi}{300}\right)(150)(1) = \pi$

$$\therefore \quad I(\theta) = I_0\cos^2\left(\frac{\delta}{2}\right)$$

$$= I_0\cos^2\left(\frac{\pi}{2}\right) = 0$$

(iii) for θ = 0°, δ = 0

$\therefore$ $I(\theta) = I_0$

7. A, D

Sol. Change in angular momentum = angular impulse

$L = 5\tau$

$I = \frac{ma^2}{3}$

$K = \frac{L^2}{2I} = \frac{75\tau^2}{2ma^2}$

8. A, C

Sol. $a = \frac{F_0}{m}\cos\omega t$, $\int_0^0 dv = \frac{F_0}{m}\int_0^{t_0} \cos\omega t \, dt$, $t_0 = \frac{\pi}{\omega}$

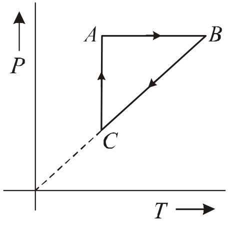
and $\int_0^v dv = \frac{F_0}{m}\int_0^t \cos\omega t \, dt$, $v = \frac{F_0}{m\omega}\sin\omega t$, $\int_0^s ds = \frac{F_0}{m\omega}\int_0^{t_0} \sin\omega t \, dt$

$$S = \frac{F_0}{m\omega^2}[-\cos\omega t]_0^{t_0} = \frac{F_0}{m\omega^2}[2] = \frac{2F_0}{m\omega^2}$$

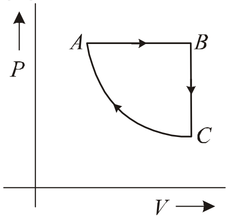
9. A, C

Sol. Using PV = nRT

(A)



(C)



10. A, B, C, D

Sol. Charge on capacitor at time t is

$q = Q_0 \cos\omega t$

Where $\omega = \frac{1}{\sqrt{LC}}$.

At $\omega t = \frac{\pi}{2}, q = 0$

$\Rightarrow \quad t = \frac{\pi}{2}\sqrt{LC}$

By conservation of energy

$\frac{Q_0^2}{2C} = \frac{1}{2}Li_{max}^2$

$\Rightarrow \quad i_{max} = \frac{Q_0}{\sqrt{LC}}$

Section – B

11. 5

Sol. $(\Delta Q)_P = nC_P\Delta T$

When piston is clamped; heat is rejected and volume becomes constant

$(\Delta Q)_V = nC_V\Delta T$

Difference = $nC_P\Delta T - nC_V\Delta T = \Delta W = P\Delta V$

$P = P_0 + \frac{Mg}{A}$ and $\Delta V = (A \times 0.1)$

$\Rightarrow (\Delta Q)_P - (\Delta Q)_V = \left(P_0 + \frac{Mg}{A}\right) \times A \times 0.1$

= 55 J

$\Rightarrow x = 5$

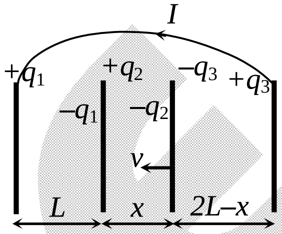
12. 4

Sol. $\sqrt{2}\,\lambda_0 T_1 = \lambda_0 T_2$

$$\frac{T_2}{T_1} = \sqrt{2} \qquad ; \qquad \frac{A_2}{A_1} = \left(\frac{T_2}{T_1}\right)^4 = 4$$

13. 1

Sol.



$$\frac{2q_1L}{2A\,\varepsilon_0} + \frac{2q_2x}{2A\,\varepsilon_0} - \frac{2q_3(2L-x)}{2A\,\varepsilon_0} = 0 \qquad \dots \text{(i)}$$

$$I = \frac{dq_1}{dt} = \frac{-dq_3}{dt} = \frac{dq_2}{dt} \qquad \dots \text{(ii)}$$

From (i), $q_1L + q_2x - 2q_3L + q_3x = 0$

$$\Rightarrow \qquad L\frac{dq_1}{dt} + x\frac{dq_2}{dt} + q_2\frac{dx}{dt} - 2\frac{dq_3}{dt}L + x\frac{dq_3}{dt} + q_3\frac{dx}{dt} = 0$$

$$\Rightarrow \qquad I = \frac{v}{3L}(q_2 + q_3) = 1 \text{ Ma}$$

14. 2

Sol. Apply Bernoulli's equations at pipe (1), (2) and (3)

$$p_3 + \frac{1}{2}\rho v_3^2 = p_2 + \frac{1}{2}\rho v_2^2 = p_1 + \rho/2v_1^2$$

$$p_0 + \rho g h_3 + \frac{1}{2}\rho v_3^2 = p_0 + \rho g h_2 + \frac{\rho}{2}v_2^2 = p_0 + \rho g h_1 + \frac{\rho}{2}v_1^2$$

$$g h_3 + \frac{v_3^2}{2} = g h_2 + \frac{v_2^2}{2} = g h_1 + \frac{v_1^2}{2} \qquad \text{...(i)}$$

$$v_3A_3 = v_2A_2$$

$$v_3 \times A = v_2 \times 2 \qquad \text{....(ii)}$$

$$v_2 \times 2 = v_1 \times 1 \qquad \text{....(iii)}$$

From Equation (i), we get

$$g h_2 + \frac{v_2^2}{2} = g h_1 + \frac{v_1^2}{2}$$

$$10 \times \frac{35}{100} + \frac{v_2^2}{2} = 10 \times \frac{20}{100} + \frac{v_1^2}{2}$$

$$\frac{15}{10} = \frac{v_1^2 - v_2^2}{2}$$

$$= \frac{4v_2^2 - v_2^2}{2}$$

$$= \frac{3v_2^2}{2}$$

$v_2 = 1$ m/s, $v_1 = 2$ m/s

From equation (i), we get

$$g h_3 + \frac{v_3^2}{2} = g h_2 + \frac{v_2^2}{2}$$

$$= 10 \times \frac{37.5}{100} + \frac{v_3^2}{2}$$

$$= 10 \times \frac{35}{100} + \frac{1}{2}$$

$$\frac{v_3^2}{2}=\frac{1}{2}+\frac{35}{10}-\frac{37.5}{10}=\frac{1}{2}-\frac{2.5}{10}=\frac{1}{2}-\frac{25}{100}$$

$$\frac{v_3^2}{2}=\frac{1}{4}\Rightarrow v_3^2=\frac{1}{2}$$

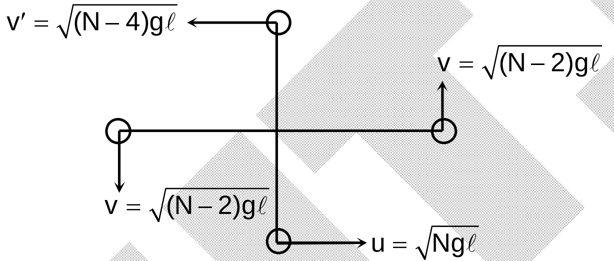
$$\Rightarrow \qquad v_3=\frac{1}{\sqrt{2}}, X=2$$

15. 2

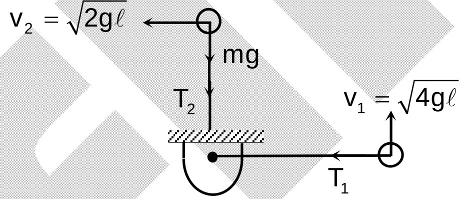
Sol.
$$\sqrt{v}=a(Z-b)$$
$$\sqrt{v}=a(Z-1)$$
$$\Rightarrow \qquad (Z-1)^2\propto \nu$$
$$\text{or} \qquad (Z-1)^2\propto \frac{1}{\lambda}$$
$$\Rightarrow \qquad \frac{(Z_{Mo}-1)^2}{(Z_{Cu}-1)^2}=\frac{\lambda_{Cu}}{\lambda_{Mo}}$$
$$\Rightarrow \qquad \lambda_{Cu}=\lambda_{Mo}\frac{(Z_{Mo}-1)^2}{(Z_{Cu}-1)^2}$$
$$=0.71\times\left(\frac{41}{28}\right)^2=1.52\text{Å}$$
$$\lambda = 2\ \text{Å}$$

16. 4

Sol. For vertical circular motion, student should always remember that



For given, $u=\sqrt{6g\ell}$



At horizontal position,

$$T_1=\frac{mv_1^2}{\ell}=4mg \qquad \ldots(i)$$

At highest point,

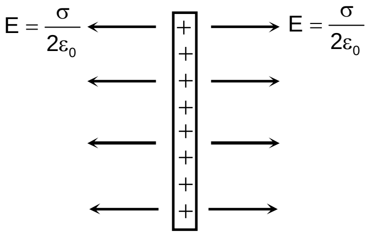
$$T_2+mg=\frac{mv_2^2}{\ell}=2\ mg$$
$$T_2=mg \qquad \ldots(ii)$$

From above equation, we get

$$\frac{T_1}{T_2}=4$$

17. 4

Sol. The electric field produced by thin charged sheet is given by $\frac{\sigma}{2\varepsilon_0}$.


$E = \frac{\sigma}{2\varepsilon_0}$
$E = \frac{\sigma}{2\varepsilon_0}$

[Where, σ = surface charge density]

$$E_0 + E = 12 \text{ V/m} \qquad \text{...(i)}$$

$$E_0 - E = 8 \text{ V/m} \qquad \text{...(ii)}$$

Solving Equations (i) and (ii), we get

$$E = 2 \text{ V/m}$$

Now, electric field due to plate $= \frac{\sigma}{2E_0} = 2$

$$s = 4e_0$$

$\therefore$ n = 4

18. 6

Sol. From the given conditions, we get

$$E_n - E_2 = (10.2 + 17)\text{eV}$$

$$= 27.2 \text{ eV} \qquad \text{...(i)}$$

$$E_n - E_3 = (4.25 + 5.95)\text{eV}$$

$$= 10.2 \text{ eV} \qquad \text{...(ii)}$$

Subtracting Equation (ii) from Eq. (i), we get

$$E_3 - E_2 = 17.0 \text{ eV}$$

$$Z^2(13.6)\left[\frac{1}{4} - \frac{1}{9}\right] = 17.0$$

$$Z^2(13.6)\left(\frac{5}{36}\right) = 17.0$$

$$Z^2 = 9 \text{ or } Z = 3$$

$$Z^2(13.6)\left[\frac{1}{4} - \frac{1}{n^2}\right] = 27.2$$

$$3^2(13.6)\left[\frac{1}{4} - \frac{1}{n^2}\right] = 27.2$$

$$\frac{1}{4} - \frac{1}{n^2} = 0.222$$

$$\Rightarrow \quad \frac{1}{n^2} = 0.0278 \Rightarrow n^2 = 36 \Rightarrow n = 6$$

Chemistry PART – II

Section – A

19. D
Sol. sp^2 hybridization of Hg and Hg^{2+} has d^{10} configuration

20. A
Sol. MnO_2 oxidise allylic alcohols

21. B
Sol. Factual

22. A
Sol. Factual

23. C, D
Sol. Factual

24. A, C, D
Sol. Down the group nucleophilicity increases

25. A, D
Sol. $–NO_2$ and –Br increases acidic character of phenol by dispersing –ve charge of phenoxide ion – OCH_3 and $–CH_3$ decreases acidic character by intensification of –ve charge of phenoxide ion.

26. A, D
Sol. Factual

27. A, C
Sol. p-subshell can have maximum 6 electron and an orbital can have maximum 2 electron with opposite spin.

28. A, C
Sol. Factual

Section – B

29. 7
Sol. for s-subshel, l = zero, hence for all electrons presente in s-orbitals, n × l = zero
$Cr = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^1$
In Cr there are 7 electrons present in s-orbitals

30. 6
Sol. Factual

31. 6
Sol. Triangular bipyramidal molecules have six, 90º angles

32. 5
Sol. edta make five rings of 5 member, x = 5 and octahydral [M(edta)] complex can not show geometrical isomerism, y = 0

33. 6

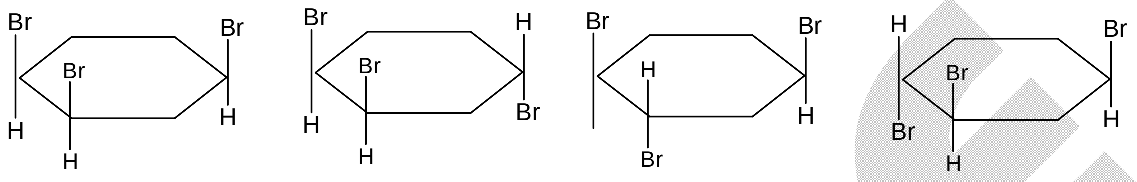
Sol. $Cr_2O_7^{2-} + 6Fe^{2+} + 14H^{+} \longrightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$

34. 4

Sol. $Z = 8\times\frac{1}{8} + 6\times\frac{1}{2} = 4$

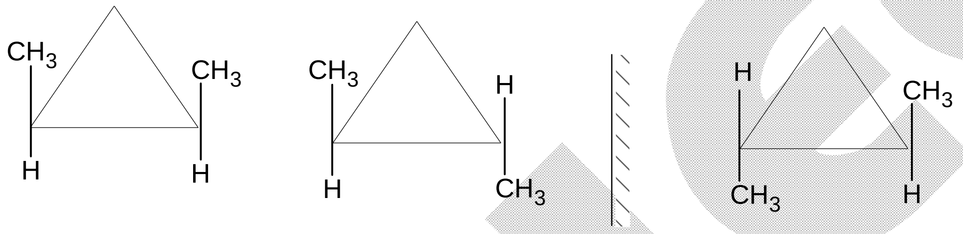
35. 4

Sol.



36. 3

Sol.

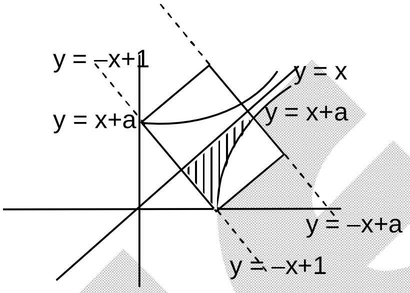


Mathematics PART – III

Section – A

37. D

Sol. Required area of shaded region is $k-\frac{1}{4}$

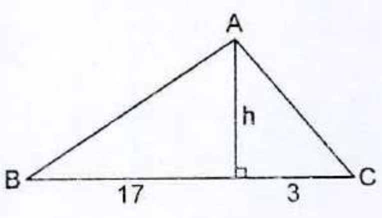


38. B

Sol. B + C = π – A

tan (B + C) = – tan A

$$\frac{h\left(\frac{1}{17}+\frac{1}{3}\right)}{1-\frac{h^2}{51}}=-\frac{22}{7}\Rightarrow\left(\frac{20h}{51-h^2}\right)=-\frac{22}{7}$$



Area of triangle ABC $\Delta=-\frac{1}{2}\times20\times11=110$

39. B

Sol. Let three digits of N be :

Hundred's digit = a – d, ten's digit = a, and unit's digit = a + d

(a – d) + a + (a + d) = 15 $\Rightarrow$ a = 5

N = 100(5 – d) + 50 + (5 + d) …(1)

Number obtained by reversing digits of N is

N_1 = 100(5 + d) + 50 + (5 – d) …(2)

Now, 594 = N – N_1 = 10(– 2d) + 2d

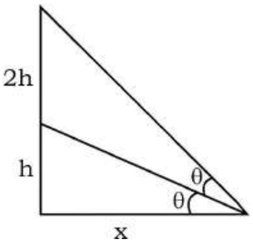
$\Rightarrow$ 2d = – 6 $\Rightarrow$ d = –3

Thus, N = 852 and $\frac{1000}{N-252}=\frac{1000}{600}=\frac{5}{3}$

40. C

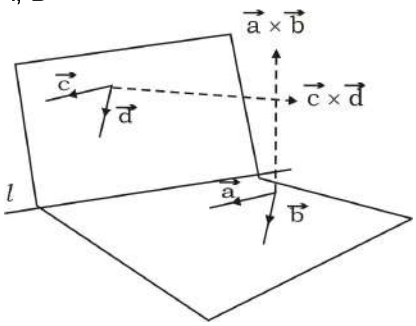
Sol. Let $\frac{h}{x}=a$. Then $\tan\theta=a, \tan2\theta=3a$.

$$\therefore\quad \frac{2a}{1-a^2}=3a \quad\Rightarrow\quad a=\frac{1}{\sqrt{3}}$$



41. A, B

Sol.



$\left(\vec{a}\times\vec{b}\right)\times\left(\vec{c}\times\vec{d}\right) =$ a vector perpendicular to $\vec{a}\times\vec{b}$ and $\vec{c}\times\vec{d}$

If l is the line of intersection of the two planes of $\vec{a},\vec{b}$ and $\vec{c},\vec{d}$ then $l \perp \vec{a}\times\vec{b}$ and $l \perp \vec{c}\times\vec{d}$.So,$\left(\vec{a}\times\vec{b}\right)\times\left(\vec{c}\times\vec{d}\right)$ is along l which is equally inclined to $\vec{a}\times\vec{b}$ and $\vec{c}\times\vec{d}$

42. A, B, C, D

Sol. (A) $^7C_2 - {}^3C_2 - {}^5C_2 + 2 = 10$

(B) $^7C_3 - {}^3C_3 - {}^5C_3 = 24$

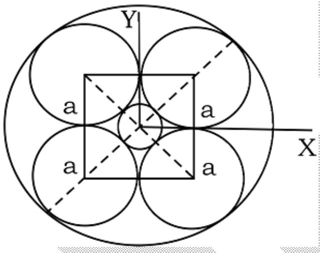
(C) There is no use of point'3'

$^6C_4 - {}^4C_4 - {}^4C_3.{}^2C_2 = 6$

(D) $^7C_3 - {}^3C_3 - {}^5C_3 = 24$

43. A, C

Sol. The four circles are as shown in the figure. The smallest circle touching all of them has the radius $= \sqrt{2}a - a$ and the greatest circle touching all of them has the radius $= \sqrt{2}a + a$.



44. A, C

Sol. Consider $f(x) = x^3 + ax^2 + bx - 2$

$\alpha\beta\gamma = 2$

$\alpha, \beta, \gamma \in N \Rightarrow$ two of them are 1 & other is 2

$\Rightarrow a = -(\alpha+\beta+\gamma) = -4 = \frac{f''(0)}{2}$

$b = (\alpha\beta + \beta\gamma + \alpha\gamma) = 5 = f'(0)$

Hence $f(x) = x^3 - 4x^2 + 5x - 2$

Again $\because$ 1 is a repeated root of f(x) = 0

$\Rightarrow \quad f'(1) = 0$

45. A, B, C, D

Sol. $x + [y] + \{z\} = 1.1$ …(1)

$[x]+\{y\}+z=2.2$ …(2)

$\{x\}+y+[z]=3.3$ …(3)

(1) + (2) + (3)

$\Rightarrow \quad 2(x+y+z)=6.6$

$\Rightarrow \quad x+y+z=3.3$ …(4)

$(4)-(1)$

$\{y\}+[z]=2.2 \quad \Rightarrow \{y\}=0.2 \ \& [z]=2$

(4) – (2)

$\{x\}+[y]=1.1 \quad \Rightarrow \{x\}=0.1,\ [y]=1$

(4) – (3)

$[x]+\{z\}=0 \quad \Rightarrow [x]=0 \ \& \ \{z\}=0$

$$\begin{cases} x=0.1 \\ y=1.2 \\ z=2 \end{cases}$$

46. B, D

Sol. $b^2=ac$

$$\cos B=\frac{a^2+c^2-b^2}{2ac}=\frac{a^2+c^2-b^2}{2b^2}$$

$$\because \quad \cos B=\frac{a^2+c^2}{2ac}-\frac{1}{2}$$

$$\Rightarrow \cos B+\frac{1}{2}=\frac{a^2+c^2}{2ac} \Rightarrow \cos B+\frac{1}{2}\ge 1 \Rightarrow \cos B\ge\frac{1}{2}$$

$B\in(0,\pi/3)$

Section – B

47. 9

Sol. $S=3.3^{2/2}.3^{3/4}.3^{4/8}.....\infty$

$S=3^{1+\frac{2}{2}+\frac{3}{4}+\frac{4}{8}+....\infty}$

$S'=1+\frac{2}{2}+\frac{3}{4}+\frac{4}{8}+....\infty$ ....(1)

$\frac{S'}{2}=\frac{1}{2}+\frac{2}{4}+\frac{3}{8}+....\infty$ ....(2)

Subtract (2) from (1)

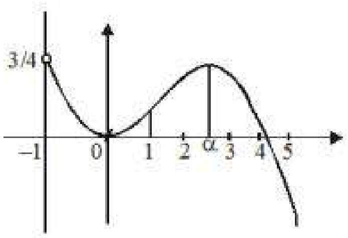
$\frac{S'}{2}=1+\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+....\infty$

$S'=$

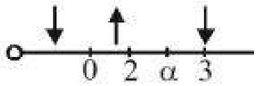
$S=3^4=81$

48. 2

Sol. $f(x)=(1+x)\ell n(1+x)-x-\frac{x^2}{4}$



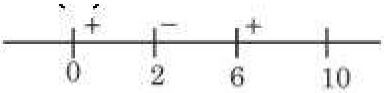
$\lim_{x\to -1} f(x) = 0 + 1 - \frac{1}{4} = \frac{3}{4}$ and $f(0) = 0$



$\Rightarrow \alpha \in (2, 3)$

49. 2

Sol.



50. 9

Sol. Projection length = $|\vec{a}.\vec{p}|$

So, $\frac{|x+2y+3z|}{\sqrt{14}} = 6$

$\Rightarrow |x + 2y + 3z| = 6\sqrt{14}$

$\Rightarrow |(x\hat{i} + \sqrt{2}y\hat{j} + \sqrt{3}z\hat{k}).(\hat{i} + \sqrt{2}\hat{j} + \sqrt{3}\hat{k})| = 6\sqrt{14}$

$\Rightarrow (x^2 + 2y^2 + 3z^2)(1 + 2 + 3)\cos^2\theta = \left(6\sqrt{14}\right)^2$

$\Rightarrow \frac{x^2 + 2y^2 + 3z^2}{\sqrt{14}} \ge 6\sqrt{14} \Rightarrow l = 6\sqrt{14}$

So, $(l^2 + 15^2)^{1/3} = (504 + 225)^{1/3} = (729)^{1/3} = 9$.

51. 0

Sol. $\vec{c} = \frac{\vec{a} - \mu\vec{b}}{4}$ and $\vec{a}.\vec{b} = 0$

Now, $\left(\vec{b} - \vec{a}\right).\left(\vec{b} + \vec{c}\right) = 0 \Rightarrow \left(\vec{b} - \vec{a}\right).\left(\vec{b} + \frac{\vec{a} - \mu\vec{b}}{4}\right) = 0$

$\Rightarrow (4 - \mu)\,b^2 = a^2$ ($\therefore$ $\mu < 4$) ... (i)

Again $4|\vec{b} + \vec{c}|^2 = |\vec{b} - \vec{a}|^2 \Rightarrow 4\left|\frac{(4-\mu)\vec{b} + \vec{a}}{4}\right|^2 = |\vec{b} - \vec{a}|^2$

$\Rightarrow 4\left(\frac{4-\mu}{4}\right)^2 b^2 + \frac{a^2}{4} = b^2 + a^2 \Rightarrow ((4 - \mu)^2 - 4)b^2 = 3a^2$ ... (ii)

(i) & (ii) we get $\frac{(4-\mu)^2 - 4}{4-\mu} = \frac{3}{1} \Rightarrow \mu^2 - 5\mu = 0$

$\Rightarrow \mu = 0$ or 5 but as $\mu < 4$, so, $\mu = 0$.

52. 8

Sol. $p = \dfrac{5! - {}^3C_1(4!).(2!) + {}^3C_2(3!).(2!).(2!) - {}^3C_3(2!).(2!).(2!).(2!)}{5!} = \dfrac{120-144+72-16}{120} = \dfrac{4}{15}$

So 30p = 8

53. 2

Sol. $$\int \underset{\text{I}}{x}\, \underset{\text{II}}{f''}(2x)\,dx = x\frac{f'(2x)}{2} - \int \frac{f'(2x)}{2}dx = x\frac{f'(2x)}{2} - \frac{f(2x)}{4}$$

$$\int_0^1 x f''(2x)\,dx = \left|\frac{xf'(2x)}{2} - \frac{f(2x)}{4}\right|_0^1 = \left(\frac{f'(2)}{2} - \frac{f(2)}{4}\right) - \left(0 - \frac{f(0)}{4}\right)$$

$$\left(\frac{5}{2} - \frac{3}{4}\right) - \left(0 - \frac{1}{4}\right) = 2$$

54. 1

Sol. Let E_1, E_2, E_3 E_4, E_5 and E_6 be the events of occurrence of 1, 2, 3, 4, 5 and 6 on the dice respectively, and let E be the event

$$\therefore P(E_1) = \frac{1-k}{6};\ P(E_2) = \frac{1+2k}{6}; P(E_3) = \frac{1-k}{6}$$

$$P(E_4) = \frac{1+k}{6};\ P(E_5) = \frac{1-2k}{6};\ P(E_6) = \frac{1+k}{6} \text{ and } \frac{1}{9} \le P(E) \le \frac{2}{9}$$

Then, $E \equiv \{(3, 6), (6, 3), (4,5), (5, 4)\}$

Hence, $P(E) = P(E_3E_6) + P(E_6E_3) + P(E_4E_5) + P(E_5E_4)$

$= P(E_3)P(E_6) + P(E_6)P(E_3) + P(E_4)P(E_5) + P(E_5)P(E_4)$

$= 2P(E_3)P(E_6) + 2P(E_4)P(E_5)$

{Since E_1, E_2, E_3, E_4, E_5 and E_6 are independent}

$$= 2\left(\frac{1-k}{6}\right)\left(\frac{1+k}{6}\right) + 2\left(\frac{1+k}{6}\right)\left(\frac{1-2k}{6}\right)$$

$$= \frac{1}{18}\left[2 - k - 3k^2\right]$$

Since, $\dfrac{1}{9} \le P(E) \le \dfrac{2}{9}$

$\therefore\ -\dfrac{1}{3} \le k \le 0$

$\therefore$ Set of integral value of k = {0}

$\therefore$ Number of integral solution of k is 1

FIITJEE RBT-1 for (JEE-Advanced)

BATCHES – Two Yr CRP2123(All)

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 1

QP Code: 100162

PAPER - 1

Time Allotted: 3 Hours **Maximum Marks: 234**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections**.
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. Each **Section** is further divided into **Two Parts**: **Part-A & B** in the OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with HB pencil for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Two Parts.

(i) **Part-A (01-07) –** Contains seven (07) multiple choice questions which have **One or More** correct answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in –**2** marks, as a wrong option is also darkened.

(i) **Part-A (08-13) –** Contains six (06) multiple choice questions which have ONLY ONE CORRECT answer Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(ii) **Part-B (01-08)** contains eight (08) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+4 marks** for correct answer and **there will be no negative marking.**

Name of the Candidate :____

Batch :______________________ **Date of Examination :**____________________

Enrolment Number :____

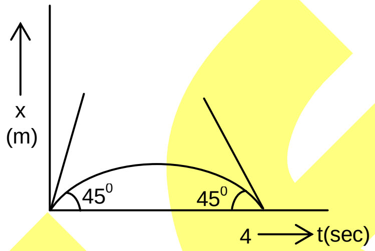
SECTION-1 : PHYSICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. A particle moves along x axis with constant acceleration and its x position depend on time 't' as shown in the following graph (parabola); then in interval 0 to 4 sec
(A) relation between x – coordinate & time is $x = t - t^2/4$
(B) maximum x – coordinate is 1 m
(C) total distance travelled is 2m
(D) average speed is 0.5 m/s

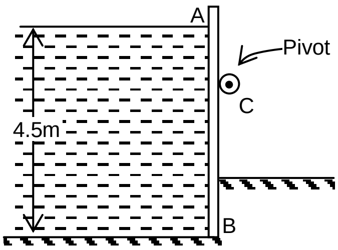


2. A vibrating string produces 2 beats per seconds when sounded with a tuning fork of frequency 256 Hz. increasing the tension in the string produces 3 beats per second. The initial frequency of the string may have been
(A) 253 Hz (B) 254 Hz (C) 258 Hz (D) 259 Hz

3. A sample of nuclei X contains 48×10^{23} nuclei at some time and reduced to 6×10^{23} nuclei in 3 minutes. The mean life of nucleus X is roughly?
(A) 0.693 min (B) 1.44 min (C) 2.079 min (D) 4.329 min

4 Air is introduced through a nozzle into a tank filled with water to form a stream of bubbles of diameter 2mm. Calculate by how much the pressure in the nozzle must exceed to that of the surrounding water? Assume surface tension of water = 0.075 N/m
(A) 133.4 Pa (B) 175.0 Pa (C) 75.0 Pa (D) 150.0 Pa

5. Figure shows a rectangular vertical board AB which is 4.5 m high and is pivoted at C. What must be the maximum height of C above B so that the vertical board will be on the verge of tipping about C when the water surface is at A?
(A) 2 m (B) 2.5 m
(C) 1.5 m (D) 3 m



Space For Rough Work

6. A convex lens made of glass (μ_g =3/2) has focal length *f* in air. The image of an object placed in front of it is inverted real and magnified. Now the whole arrangement is immersed in water (μ_w=4/3) without changing the distance between object and lens. Then
(A) the new focal length will become 4*f*
(B) the new focal length will become *f* / 4
(C) new image will be virtual and magnified
(D) new image will be real, inverted and smaller in size

7. If the potential difference of Coolidge tube producing X-ray is increased, then choose the correct option(s).
(A) the interval between $\lambda_{k\alpha}$ and $\lambda_{k\beta}$ increases
(B) the interval between $\lambda_{k\alpha}$ and λ_0 increases
(C) the interval between $\lambda_{k\beta}$ and λ_0 increases
(D) λ_0 does not change
Here λ_0 is cutoff wavelength and $\lambda_{k\alpha}$ and λ_{kB} are wavelength of k_α and k_B characteristic X-rays.

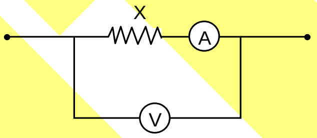
(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

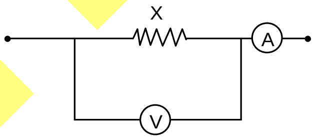
---

8. An ammeter and a voltmeter are connected in series to a battery of emf 6 V. When a certain resistance is connected in parallel with the voltmeter the reading of the voltmeter decreases n = 2 times while the reading of the ammeter increases the same number of times. Then the ratio of voltmeter resistance to the ammeter resistance will be
(A) 1 : 2 (B) 2 : 3
(C) 2 : 1 (D) None of these

9. An ammeter and a voltmeter are connected as shown in figure (1) and figure (2). In order to measure an unknown resistance which connection is to be preferred,



Circuit (1)



Circuit (2)

(A) for low resistance circuit 2 and for high resistance circuit (1).
(B) for low resistance circuit (1) and for high resistance circuit 2
(C) For an y value of resistance circuit 1.
(D) For any value of resistance circuit 2.

Space For Rough Work

10. There is a 90^0 bend in a pipe line in which water is flowing at speed v. The cross sectional area of pipe is A. The force exerted by pipe walls on water at bend is

(A) $\sqrt{3}\,A v^2\rho$ (B) $\sqrt{2}\,Av^2\rho$

(C) $Av^2\rho$ (D) $\sqrt{5}\,Av\rho$

11. Calculate the capacitance of a parallel-plate capacitor of area S, separation d and dielectric constant varying linearly form ε_1 to ε_2 ($\varepsilon_2 > \varepsilon_1$) in the direction of the applied field.

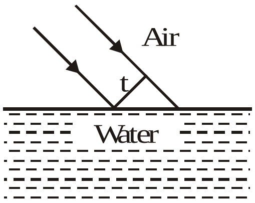
(A) $C = \dfrac{\varepsilon_o S}{d}\,\dfrac{(\varepsilon_2 - \varepsilon_1)}{\ln\left(\dfrac{\varepsilon_2}{\varepsilon_1}\right)}$ (B) $C = \dfrac{\varepsilon_o S}{d}\,\dfrac{(\varepsilon_2 + \varepsilon_1)}{\ln\left(\dfrac{\varepsilon_2}{\varepsilon_1}\right)}$

(C) $C = \dfrac{\varepsilon_o S}{2d}\,\dfrac{(\varepsilon_2 + \varepsilon_1)}{\ln\left(\dfrac{\varepsilon_2}{\varepsilon_1}\right)}$ (D) none of these

12. A hoop of mass M and radius R is placed on an absolutely smooth level surface. An insect of mass m begins to slide along the hoop from the highest point with speed V relative to the hoop. Then the velocity of the centre of the hoop after time t will be

(A) $\dfrac{v\cos\left(\dfrac{vt}{R}\right)}{1+\dfrac{m}{M}}$ (B) $\dfrac{v\sin\left(\dfrac{vt}{R}\right)}{1+\dfrac{M}{m}}$ (C) $\dfrac{v\cos\left(\dfrac{vt}{R}\right)}{1-\dfrac{M}{m}}$ (D) $\dfrac{v\cos\left(\dfrac{vt}{R}\right)}{1+\dfrac{M}{m}}$

13. A monochromatic beam of width t is incident at 45º on an air water interface as shown in the figure. The refractive index of water is μ and that of air is 1. The width of the beam in water is,



(A)$(\mu - 1)$ t (B) μ t

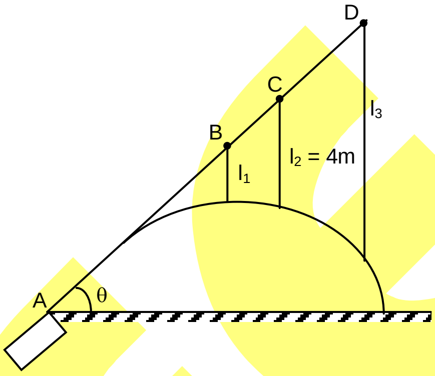
(C) $\dfrac{\sqrt{\mu^2 - 1}}{\mu}t$ (D) $\dfrac{\left(\sqrt{2\mu^2 - 1}\right)}{\mu}t$

Space For Rough Work

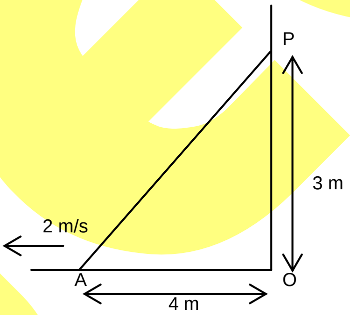
PART – B

(Numerical based)

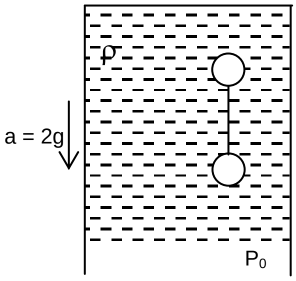
This section contains **8 Numerical based questions**, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)



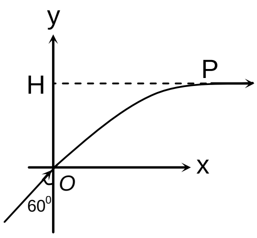
1. A stream of water coming out from a pipe at point A as shown in figure. A rod AD is along the projected velocity of stream. There are four points A,B,C,D on the rod (AB = BC = CD) from which string of length l_1, l_2, l_3 are hanging. These string are touching the trajectory of stream of water. If the length l_2 = 4m find l_3.



2. A ladder AP of length 5m is inclined to a vertical wall is slipping over a horizontal surface with velocity of 2 m/s when P is at a distance 3m from ground what is the velocity of centre of mass at this moment (in m/s) ________.



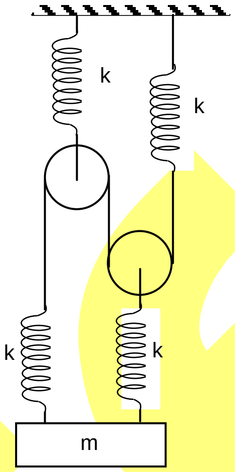
3. Two identical shaped spheres of specific gravity 0.8 & 1.6 are connected through string & placed in liquid container as shown in figure. if spheres are in equilibrium wrt container then tension in the string (take volume of each sphere v_0 = 250 CC) is xn, find the value of 'x'.



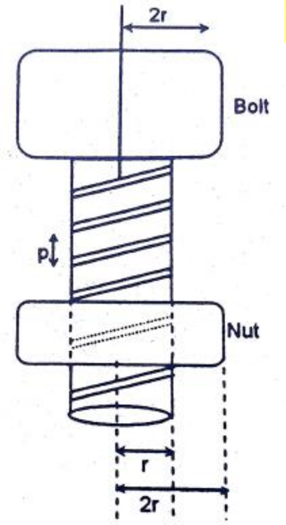
4. A system of coordinates is drawn in a medium whose refractive index varies as $\mu = \dfrac{2}{1+y^2}$, where $0 \le y \le 1$. A ray of light is incident at origin at an angle 60^0 with *y* –axis as shown in the figure. At point P ray becomes parallel to x-axis. Find the value of 'H'.

Space For Rough Work

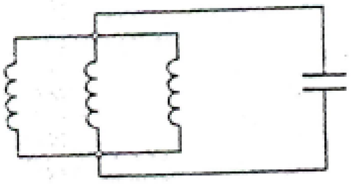
5. The refractive index for water w.r.t. air for a sound wave if the velocities of sound in water and air are 1440 ms^{-1} and 340ms^{-1}, is



6. All pulleys & ropes are ideal find out period of small oscillation of block of mass m as shown in figure. Take $\frac{M}{k} = \left(\frac{9}{10}\right)$



7. A bolt with shaft radius r has pitch of its threading equal to ρ. The nut has frictionless movement on threads. The bolt is rotated anti-clockwise while looking from top with an angular acceleration α such that the nut moves up by an acceleration g. Find α in terms of kilo radian/sec^2. (take g = 10 m/s^2 ; ρ = 2MM)



8. A circuit shown consists of three coils of inductances 1.0 H each and a 1.0 μF capacitance. At an instant, when charge on the capacitor is zero, currents of 1.0 A, 2.0 A and 4.0 A are flowing through the coils in the same direction. Find the maximum charge on the capacitor. (in MC)

Space For Rough Work

SECTION-2 : CHEMISTRY

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

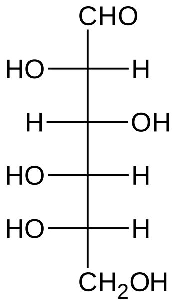
---

1. Consider the following reaction

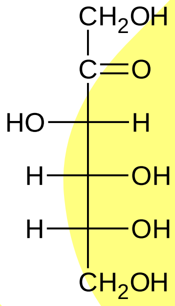
$$D-glucose \xrightarrow[\text{Cat } H^+]{PhNHNH_2 (3\text{ eq})} X$$

Among the following the compound(s) whose derivative(s) will have the same melting point as that of X is(are)

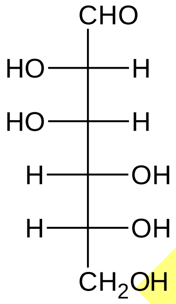
(A)



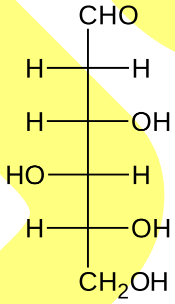
(B)



(C)



(D)



2. The type(s) of intersection(s) that hold layers of graphite together is(are)

(A) π-π stacking (B) van der Waal's

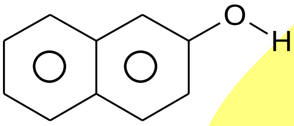
(C) hydrogen bonding (D) coulombic

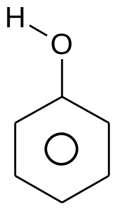
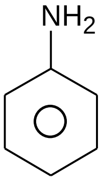
Space For Rough Work

3. Which is/are correct statement about diazo-coupling reaction?

(A) Benzene diazonium ion is a strong electrophile $\left(Ph\overset{+}{N}_2\right)$.

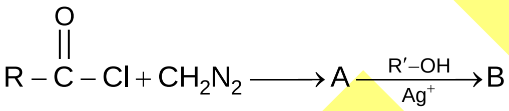
(B) For diazocoupling reaction of phenol pH optima should be slightly basic.
(C) pH diazo coupling reaction of Aniline pH optima should be slightly acidic.

(D) The colour of diazocoupling product with β-napthol  is red, with

 is orange and with  is yellow.

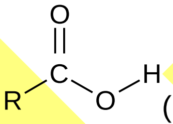
4. Which is/are correct about allotropes of carbon?
(A) Graphite is thermodynamically most stable allotrope.
(B) Molar entropy order is Fullerene > Graphite > Diamond
(C) Fullerene is aromatic
(D) Buck minister fullerene C_{60} has 12 five member and 20 six member rings

5. The intermediate formed in the reaction



$$R-\overset{\overset{O}{||}}{C}-Cl+CH_2N_2\longrightarrow A\xrightarrow[Ag^+]{R'-OH}B$$

Which is correct statements about above reaction?
(A) Intermediate involve is both carbene as well as carbanion.

(B) A can be formed by reaction of  (Carboxylic acid) with $AlPO_4$
(C) The nucleophile(CH_2N_2) is resonance stablised
(D) Final product 'B' is an ester

6. When B_2H_6 is treated with excess NH_3 at low temperature. The nature of bond present in the product is/are

(A) Ionic	(B) Covalent
(C) Co-ordinate	(D) Metallic

Space For Rough Work

FIITJEE

7. Spin isomerism is found in

(A) H_2 (B) D_2

(C) N_2 (D) F_2

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

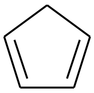
---

8 The VO_4^{3-}, CrO_4^{2-} and MnO_4^{-} ions exhibit intense ligand to metal charge transfer transition the wavelength of this transition follows the order

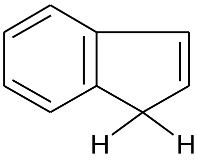
(A) $CrO_4^{2-} < VO_4^{3-} < MnO_4^{-}$ (B) $MnO_4^{-} < VO_4^{3-} < CrO_4^{2-}$

(C) $VO_4^{3-} < CrO_4^{2-} < MnO_4^{-}$ (D) $CrO_4^{2-} < MnO_4^{-} < VO_4^{3-}$

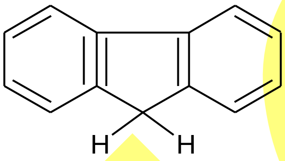
9. Correct acidic strength of



I



II



III

(A) I > II > III (B) III > II > I

(C) II > III > I (D) II > I > III

10. If EAN of metal is 36 in $[M(CO)_2(\sigma C_5H_5)(\pi C_5H_5)]$, then what is the atomic number of metal M?

(A) 23 (B) 24

(C) 25 (D) 26

11. A mineral consists of an equimolar mixture of the carbonates of two bivalent metals. One metal is present to the extent of 12.5% by mass. 2.8 g of the mineral on heating lost 1.32 g of CO_2. What is the % by mass of the other metal.

(A) 87.5 (B) 35.71

(C) 65.11 (D) 23.21

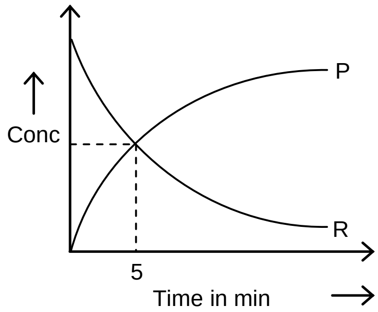
12. The CFSE for octahedral $[CoCl_6]^{4-}$ IS 18000 cm^{-1}. The CFSE for tetrahedral $[CoCl_4]^{2-}$ will be

(A) 18000 cm^{-1} (B) 16000 cm^{-1}

(C) 8000 cm^{-1} (D) 20000 cm^{-1}

Space For Rough Work

13.



For a given 1st order reaction R → 3P
What is the time required for 20% completion of reaction in minute unit?

(A) 4
(B) 2
(C) 3
(D) 5

PART – B

(Numerical based)

This section contains **8 Numerical based questions**, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

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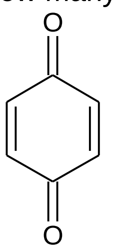
1. How many of the given molecule can show tautomerism?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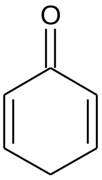
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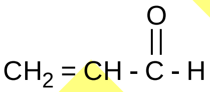
$CH_2=CH-\overset{\overset{O}{||}}{C}-H$
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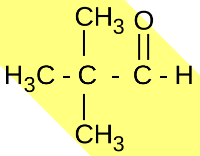
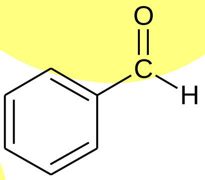

$H_3C-\underset{CH_3}{\overset{CH_3}{\overset{|}{\underset{|}{C}}}}-\overset{\overset{O}{||}}{C}-H$
,

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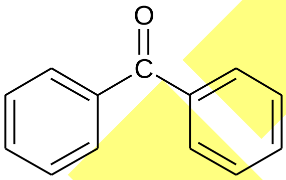
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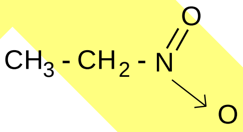
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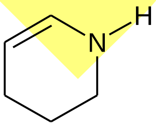
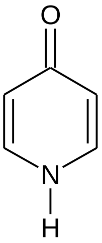

, $CH_3-\ddot{N}=O$,


2. Number of geometrical square planar complex formed when $PtCl_2$ is treated with racemic mixture of alanine is

3. The molarity of 20% w/w sulphuric acid of density 1.14g cm^{-3} is

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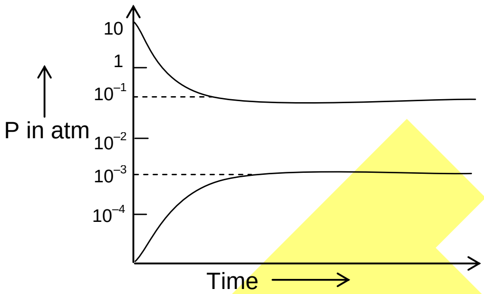
Space For Rough Work

4. How many of the given molecules have central atom sp^3 hybridized
SF_4, XeO_2F_2, $XeOF_2$, $XeOF_4$, XeO_4, CO_2, SiO_2, ClF_3, CH_3^-, CH_3^+

5. How many of the given statement(s) is/are correct?
(i) Metallic bond strength in ‘s’-block elements decreases down the group.
(ii) Metallic character increases down the group in ‘s’-block.
(iii) Reactivity of ‘s’-block elements increases down the group.
(iv) Solution of alkali metal in liquid NH_3 is blue in colour due to presence of solvated electron.
(v) The blue colour of alkali metals in liquid NH_3 slowly fades until it disappears owing to the formation of a metal amide and this reaction is catalysed by Fe or presence of impurities.
(vi) At concentrations about 3M, solution of alkali metal in liquid NH_3 are copper-bronze coloured and have a metallic lusture because metal ion clusters are formed.
(vii) Solutions of metals in liquid NH_3 conduct electricity better than any salt in any liquid and the conductivity is similar to that of pure metals
(viii) Conduction of alkali metal in liquid NH_3 is due to mainly to the presence of solvated electron.
(ix) Solutions of alkali metals in liquid NH_3 act as a powerful reducing agent and they will even reduce an aromatic ring.

6.

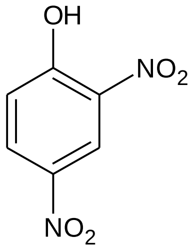


The plot of partial pressure of the product and reactant is given above. What is the value of ΔG^o in L atm unit at temperature ‘T’?
[Assume 2.303 RT = 4 L atm mol^{-1}]

Space For Rough Work

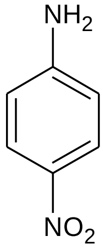
7. How many compounds can liberate CO_2 when treated with $NaHCO_3$

(a)



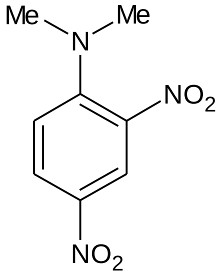
(b) $CH_3CH_2NH_2$

(c)

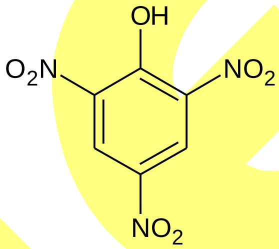


(d) CH_3COOH

(e)

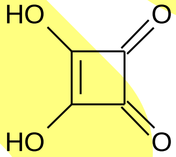

Me
Me
N
NO2
NO2

(f)

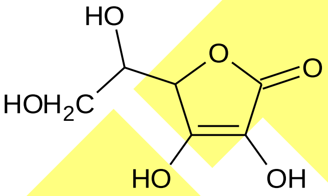

OH
O2N
NO2
NO2

(g) HCOOH

(h)

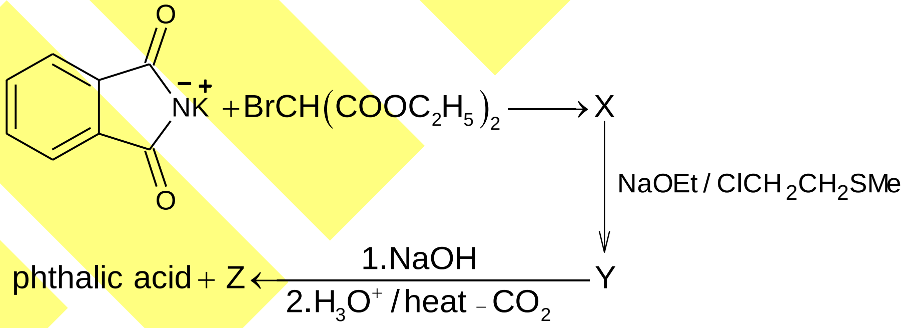


(i)


HO
HOH2C
O
O
HO
OH

(j) CH_3CONH_2

8.


O
NK
O
+BrCH(COOC2H5)2
X
NaOEt / ClCH2CH2SMe
Y
1.NaOH
2.H3O+ / heat - CO2
phthalic acid + Z

$X = \frac{1}{4}$[Sum of all atoms present in Z] + no of optically active isomers of Z. Value of X is

Space For Rough Work

SECTION-3 : MATHEMATICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

---

1. Which of the following statement(s) is (are) correct?

(A) If $\left|\vec{v}\times\vec{w}\right|=0$ for all vector $\vec{w}$, then $\vec{v}=\vec{0}$

(B) If $\vec{a}+\vec{b}+\sqrt{3}\vec{c}$ is a null vector where $\vec{a}$ and $\vec{b}$ are unit vectors such that angle between $\vec{a}$ and $\vec{b}$ is $\frac{\pi}{3}$, then the magnitude of $\vec{c}$ is 1.

(C) If $\left(\vec{u}+\vec{v}\right).\left(\vec{u}-\vec{v}\right)=0$, then $\vec{u}=\vec{v}$

(D) If $\vec{a}$ and $\vec{b}$ are two unit vectors then the maximum value of $\left|2\vec{a}+\vec{b}\right|$ is equal to 3.

2. Let $L_1:\frac{x+3}{-4}=-\frac{y-6}{3}=\frac{z}{2}$ and $L_2:\frac{x-2}{-4}=\frac{y+1}{1}=\frac{z-6}{1}$ be two lines in R^3.

Which of the following statement(s) is (are) correct?

(A) L_1, L_2 are coplanar.

(B) L_1, L_2 are skew lines

(C) Shortest distance between L_1 and L_2 is 9.

(D) $\left(\hat{i}-4\hat{j}+8\hat{k}\right)$ is a vector perpendicular to both L_1 and L_2.

3. Which of the following statement(s) is (are) correct?

(A) If $f(x)$ is differentiable $\forall x\in[0, 1]$, then $f'(x)$ must be bounded in $[0, 1]$

(B) There exist a bijective function $f:[0,1]\to[0, 1]$ which is not continuous

(C) Let $f:[-1, 2]\to R$ be defined as $f(x)=x^2-\cos\pi x+4$, then $f(c)=2\pi$ for some $c\in(-1, 2)$

(D) If $f(x)=3+x+e^x$, then $\left(f^{-1}\right)'(4)$ is equal to $\frac{1}{2}$.

4. Let $f(x)$ be twice differentiable function such that $f''(x)<0$ in $[0, 2]$. Then

(A) $f(0)+f(2)=2f(c), 0<c<2$

(B) $f(0)+f(2)=2f(1)$

(C) $f(0)+f(2)>2f(1)$

(D) $f(0)+f(2)<2f(1)$

Space For Rough Work

5. If the tangent at a point P_1 (other than (0, 0)) on the curve $ax^3 - y + b = 0$ meets the curve again at P_2. The tangent at P_2 meets the curve at P_3 and so on. If the abscissae of $P_1, P_2, P_3, ...P_n$ form a G.P. then (a, b) may be

(A) (1, 0) (B) (2, 7)
(C) (3, 5) (D) (4, 9)

6. If three planes $P_1 = 2x + y + z - 1 = 0$, $P_2 = x - y + z - 2 = 0$ and $P_3 = \alpha x - y + 3z - 5 = 0$ intersects each other at point P on XOY plane and at point Q on YOZ plane, where O is origin then identify the correct statement(s)?

(A) The value of α is 4

(B) Straight line perpendicular to plane P_3 and passing through P is $\frac{x-1}{4} = \frac{y+1}{-1} = \frac{z}{3}$.

(C) The length of projection of $\overrightarrow{PQ}$ on x – axis is 1

(D) Centroid of the triangle OPQ is $\left(\frac{1}{3}, \frac{-1}{2}, \frac{1}{2}\right)$

7. Which of the following statement is(are) true?

(A) From any point on the directrix of an ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1(a > b)$, a pair of tangents are drawn to the auxiliary circle of the ellipse. The chord of contact will pass through the corresponding focus of the ellipse.

(B) If two tangents to a parabola $y^2 = 4ax$ intersect on the line $x = a$ then their chord of contact always passes through the (–a, 0).

(C) If $P(x, y)$ is such that it moves on a hyperbola $\left|\sqrt{(x-3)^2 + (y-4)^2} - \sqrt{x^2 + y^2}\right| = k^2 + 1$, then number of possible integral values of k is equal to 3.

(D) A circle passing through 3 co – normal points on the parabola $y^2 = 4x$ also passes through (1, 0).

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

---

8. Find the locus of the centroid of an equilateral triangle inscribed in the given parabola $x^2 = 4ay$.

(A) $9y^2 = 4a(x - 8a)$ (B) $9x^2 = 4a(y - 6a)$
(C) $9x^2 = 4a(y - 8a)$ (D) $9x^2 = 4a(y + 8a)$

Space For Rough Work

9. A line through the origin divides parallelogram with vertices (10, 45), (10, 114), (28, 153) and (28, 84) into two congruent pieces. The slope of the line is

(A) $\frac{19}{99}$ (B) $\frac{99}{19}$

(C) $\frac{9}{19}$ (D) $\frac{19}{9}$

10. Equation of chord AB of circle $x^2+y^2=2$ passing through P (2, 2) such that $\frac{PB}{PA}=3$, is given by

(A) $x=3y$ (B) $x=y$

(C) $y-2=\sqrt{3}(x-2)$ (D) none of these

11. The number of ways in which 3 children can distribute 10 tickets out of 15 consecutively numbered tickets among themselves such that they get consecutive blocks of 5, 3 and 2 tickets is

(A) ${}^8C_5$ (B) ${}^5C_3 3!$

(C) ${}^8C_5(3!)^2$ (D) none of these

12. The number of ordered triplets of positive a, b, c satisfying $a+b+c=24, a^2+b^2+c^2=210$ and $abc=440$ is

(A) 3 (B) 6

(C) 9 (D) 12

13. If $\int_0^{\sin^{-1}\frac{\pi}{4}}(\pi-4\sin\theta)\sin 2\theta \ln(1+\tan(\sin\theta))d\theta$ is k, then $\frac{960k}{\pi^3 \ln 2}$ is equal to

(A) 11 (B) 10

(C) 12 (D) none of these

PART – B

(Numerical based)

This section contains **8 Numerical based questions**, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

1. A conical vessel is to be prepared out of a circular sheet of metal of unit radius. In order that the vessel has maximum volume, the sectorial area that must be removed from the sheet is A_1 and the area of the given sheet is A_2. Find $\frac{A_2}{A_1}$.

Space For Rough Work

2. Let $A = \{3,4,5,6\}$ and $B = \{1,2,3,...,10\}$ be two sets. Let a function f be defined from set A to set B such that $f(i) - f(j) \geq 2 \ \forall \ i > j,$ where $i, j \in A$. If the number of such functions is N, then the value of N is equal to

3. If $a = 1 + \frac{x^3}{3!} + \frac{x^6}{6!} + ...\infty$, $b = x + \frac{x^4}{4!} + \frac{x^7}{7!} + ...\infty$, $c = \frac{x^2}{2!} + \frac{x^5}{5!} + \frac{x^8}{8!} + ...\infty$. Find the value of $a^3 + b^3 + c^3 - 3abc =$ ___________

4. Four people sit round a circular table, and each person will roll a normal six sided die once. The probability that no two people sitting next to each other will roll the same number is $\frac{N}{1296}$. Then the value of N is

5. Let two non – collinear vectors $\vec{a}$ and $\vec{b}$ inclined at an angle $\frac{2\pi}{3}$ be such that $|\vec{a}| = 3$ and $|\vec{b}| = 4$. A point P moves so that any time t the position vector $\overrightarrow{OP}$ (where O is the origin) is given as $\overrightarrow{OP} = (e^t + t^{-t})\vec{a} + (e^t - e^{-t})\vec{b}$. If the least distance of P from origin is $\sqrt{2}\sqrt{\sqrt{a} - b}$ where $a, b \in N$ then find the value of (a + b).

6. Lot A consists of 6 good and 4 defective articles. Lot B consists of 7 good and 3 defective articles. A new lot C is formed by taking 6 articles from lot A and 4 articles from lot B. The probability that an articles chosen at random from the lot C is defective, is $\frac{k}{25}$ then k is

7. If the dependent variable y is changed to 'z' by the substitution $y = \tan z$ and the differential equation $\frac{d^2y}{dx^2} = 1 + \frac{2(1+y)}{1+y^2}\left(\frac{dy}{dx}\right)^2$ is changed to $\frac{d^2z}{dx^2} = \cos^2 z + k\left(\frac{dz}{dx}\right)^2$, then the value of $(305.33) \times k$ equals

8. Rectangle ABCD has area 200. An ellipse with area 200π passes through A and C and has foci at B and D. Let perimeter of the rectangle ABCD is P, then $103.44P$ is

Space For Rough Work

Q.P. Code: 100162

Answers

SECTION-1 : PHYSICS

PART – A

1.	ABCD	2.	BC	3.	B	4.	D
5.	C	6.	AC	7.	BC	8.	C
9.	A	10.	B	11.	A	12.	D
13.	D						

PART – B

1.	9	2.	1.67	3.	1	4.	0.39
5.	0.24	6.	6.28	7.	31.43	8.	4.04

SECTION-2 : CHEMISTRY

PART – A

1.	ABC	2.	AB	3.	BCD	4.	ABCD
5.	ABCD	6.	ABC	7.	ABCD	8.	C
9.	A	10.	D	11.	D	12.	C
13.	A						

PART – B

1.	5	2.	6	3.	2.32	4.	3
5.	9	6.	8	7.	6	8.	7

SECTION-3 : MATHEMATICS

PART – A

1.	ABD	2.	BCD	3.	BCD	4.	AD
5.	ABCD	6.	ABCD	7.	ABC	8.	C
9.	B	10.	B	11.	B	12.	B
13.	B						

PART – B

1.	5.45	2.	35.00	3.	1.00	4.	630.00
5.	72.00	6.	9	7.	610.66	8.	8275.20

Answers & Solutions

SECTION-1 : PHYSICS

PART – A

1. **ABCD**

Sol. Since the graph is like a parabola

$\therefore$ let $x(t) = At + Bt^2 + C$

From graph $x(0) = 0 \Rightarrow C = 0$

$$x(t) = Bt^2 + At$$

$$x(4) = 0 \Rightarrow 16B + 4A = 0$$

$$\left(\frac{dx}{dt}\right)_0 = 1 \Rightarrow (A + 2Bt)_{t=0} = 1$$

Put in (i), we get $B = -\frac{1}{4}$

$$x = t - \frac{t^2}{4}$$

max x coordinate = 1 (from max and min)

→ Since motion is a straight line motion

→ total distance travelled = 2 x 1 = 2 min

Average speed = $\frac{2}{4}$ = 0.5 m/sec

2. **BC**

Sol. I f – 256 | = 2.

3. **B**

Sol. Number of nuclei became $\frac{1}{8^{th}} \Rightarrow$ 3 half lives passed

$\Rightarrow 3t_{1/2} = 3\,\text{min} \Rightarrow t_{1/2} = 1\text{min}$

$\therefore t_{mean} = \frac{t_{1/2}}{\ln 2} = \frac{1}{0.693}\text{min} \approx 1.44\,\text{min}$

4. **D**

Sol. $\frac{2T}{r} = 150$ Pa

5. **C**

Sol. For critical stability, the centre of equivalent force should be at point C. So BC = $\frac{AB}{3}$ = 1.5m

6. **AC**

Sol. $\frac{1}{f} = (\mu_r - 1)\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$

7. **BC**

Sol. $\lambda_0 = \frac{hc}{eV}$

8. **C**

Sol. Use Kirchoff's loop law & Kirchhoff's junction law to make equations.

9. **A**

Sol. Voltage across resister = current × resistance.

10. **B**

Sol. $F = \frac{dp}{dt} = \left(\sqrt{2}\,V\right)\frac{dm}{dt} = \left(\sqrt{2}\,V\rho\right)\frac{d(\text{volume})}{dt} = \left(\sqrt{2}\,V\rho\right)(AV)$

11. **A**

Sol. $\frac{1}{c} = \int_0^d \frac{dx}{\varepsilon_0 S\frac{\varepsilon_1+\varepsilon_2-\varepsilon_{xy}}{d}}$

12. **D**

Sol. $V_0 = \frac{MV\cos\left(\frac{vt}{R}\right)}{M+m}$

13. **D**

Sol. Apply Snell's law and use geometry.

PART – B

1. **9**

Sol. $\frac{\ell_2}{4} = \frac{\ell_3}{9}$

2. **1.67**

Sol. about ICR

$\omega \times 3 = 2 \Rightarrow \omega = \frac{2}{3}$

$V_{cm} = \omega \times \frac{5}{2} = \frac{2}{3}\times\frac{5}{2} = \frac{5}{3}\text{m/s} = 1.67$ m/s.

3. **1**

Sol. $F_b + m_1g + T = 2m_1g$

$F_b + T = m_1g$

$F_b + m_2g = T + 2m_2g$

$F_b - T = m_2g$

$\frac{F_b+T}{F_b-T} = \frac{m_1g}{m_2g} = \frac{\rho_1}{\rho_2} = \frac{1.6}{0.8}$

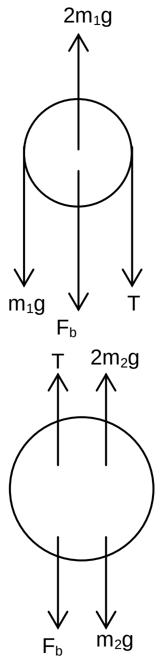
$F_b + T = 2F_b - 2T$

$3T = F_b$

$T = \frac{F_b}{3} = \frac{V\rho g}{3}$

$\rho = \frac{\rho_1+\rho_2}{2} = \frac{1.6\rho_\omega + 0.8\rho_\omega}{2} = 1.2\rho_\omega$

T = 1N



4. **0.39**

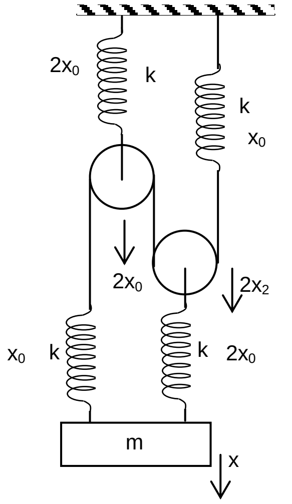
Sol. $\frac{2}{1+1+1^2} = 2\ \text{Sin}(60°)$

5. **0.24**

Sol. $\frac{\mu_w}{\mu_{air}} = \frac{340}{1440}$

6. **6.28**

Sol.



$2 \times 2x_0 + x_0 + x_0 = 2x_2 + x$

$6x_0 = 2x_2 + x$

$x - x_2 = 2x_0$

$3x = 10x_0$

$x_0 = \frac{3x}{10}$

$kx_0 + k2x_0 = k_{eq}x$

$3kx_0 = k_{eq}x$

$3k\frac{3x}{10} = k_{eq}x$

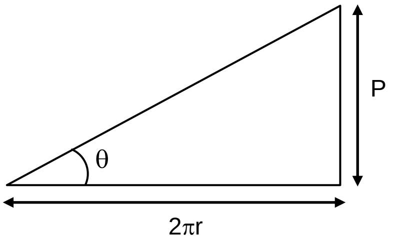
$k_{eq} = \frac{9k}{10}$

$T = 2\pi\sqrt{\frac{10m}{9k}}$

7. **31.43**

Sol. $\tan\theta = \frac{\rho}{2\pi r} = \frac{g}{r\alpha}$

$\Rightarrow \quad \alpha = \frac{2\pi g}{\rho}$



8. **4.04**

Sol. $q_{max} = 7\sqrt{\frac{CL}{3}} = \frac{7}{\sqrt{3}}\text{mA}$

SECTION-2 : CHEMISTRY

PART – A

1. **ABC**

Sol. C2-epimer and enantiomer will give osazone having same melting point.

2. **AB**

Sol. van der Waal's forces and π - π stacking.

3. **BCD**

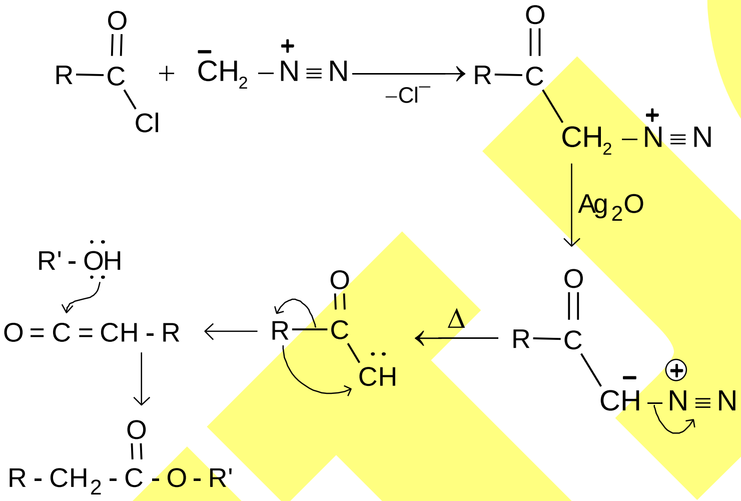
Sol. With phenol and phenol derivatives coupling occurs in weakly basic medium whereas with aniline and its derivatives it requires weakly acidic medium.

4. **ABCD**

Sol. Fact based.

5. **ABCD**

Sol.



6. **ABC**

Sol. $B_2H_6 + NH_3(\text{excess}) \xrightarrow{\text{low temp}} \left[H_3N \longrightarrow BH_2 \longleftarrow NH_3\right]^+ \left[BH_4\right]^-$

7. **ABCD**

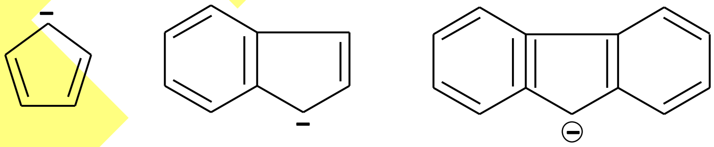
Sol.

8. **C**

Sol. Metal in high oxidation state will show efficient LMCT.

9. **A**

Sol.



Net aromatic stabilisation decreases if an aromatic ring shares aromatic character with an another ring.

10. **D**

Sol. $\left[M(CO)_2(\sigma\overset{-}{C}_2H_5)(\pi\overset{-}{C}_2H_5)\right]$

$$2\,CO \longrightarrow 4e^-$$

$$\sigma\, C_5H_5^- \longrightarrow 2e^-$$

$$\pi\, C_5H_5^- \longrightarrow 6e^-$$

This means M is in +2 oxidation state. We need 6 more electron to have 18 electrons Fe^{2+}

$$\frac{6e^-}{18e^-} = Fe(26)$$

11. **D**

Sol. Let metal are M and N

$$MCO_3 \xrightarrow{\Delta} MO + CO_2$$

$$NCO_3 \longrightarrow NO + CO_2$$

Carry out the required calculation

12. **C**

Sol. $\Delta_t = \frac{4}{3}\Delta_o$

$$\Rightarrow \Delta_t = 8000 \times \frac{4}{9}\,cm^{-1}$$

$$\Delta_t = 8000\,cm^{-1}$$

13. **A**

Sol.

$$\begin{array}{lll} & R \rightarrow & 3P \\ t = 0 & a & 0 \\ t = 5 & a - x & 3x \end{array}$$

$$K = \frac{2.303}{t}\log\frac{[A]_o}{[A]}$$

Now do the required calculation

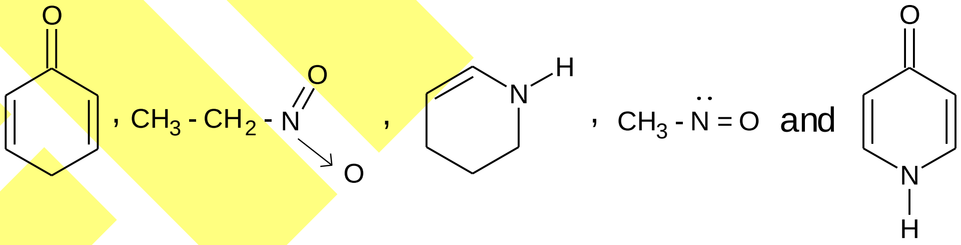
$a - x = 3x$

$x = a/4$

PART – B

1. **5**

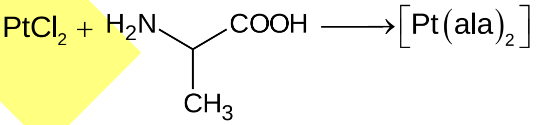
Sol.



These are the molecules which can show tautomerism.

2. 6

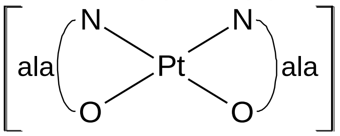
Sol.



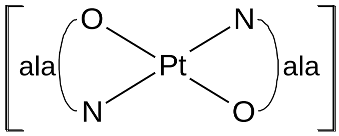
$$PtCl_2 + H_2N\text{-}CH(CH_3)\text{-}COOH \longrightarrow [Pt(ala)_2]$$

(racemic) ±

(R) and (S)



and



FIITJEE

3. **2.32**

Sol. 20 g H_2SO_4 in 100 g of solution

$$\text{Volume} = \frac{100}{1.14}\,\text{mL}$$

$$M = \frac{n_{H_2SO_4}}{V(l)}$$

4. 3

Sol. XeO_4, SiO_2, CH_3^-

5. 9

Sol. All are correct (Fact based)

6. 8

Sol. $K_P = \frac{10^{-3}}{10^{-1}} = 10^{-2}$

$\Delta G^o = -2.303\ RT\log K_P$

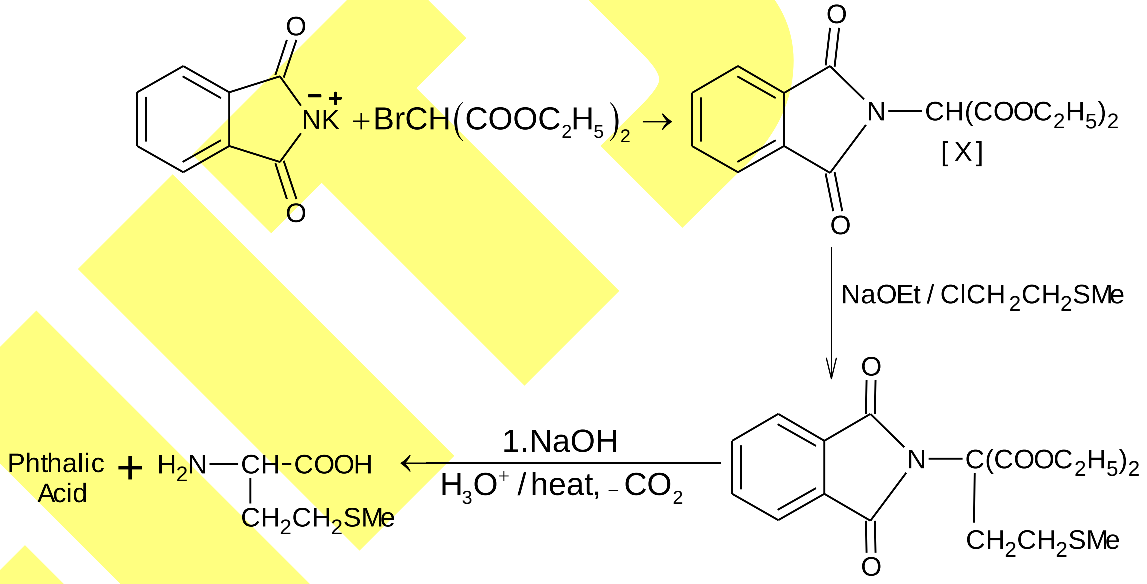
$= -2.303\ RT\log 10^{-2} = (-4)(2\ \log 10) = 8$

7. **6**

Sol. Fact based

8. **7**

Sol.



$\overset{-\ +}{NK} + BrCH(COOC_2H_5)_2 \rightarrow$
N—CH(COOC$_2$H$_5$)$_2$
[X]
NaOEt / ClCH$_2$CH$_2$SMe
N—C(COOC$_2$H$_5$)$_2$
CH$_2$CH$_2$SMe
1.NaOH
H$_3$O$^+$ / heat, – CO$_2$
Phthalic Acid + H$_2$N—CH-COOH
CH$_2$CH$_2$SMe

SECTION-3 : MATHEMATICS

PART – A

1. ABD

Sol.

(A) If $\left|\vec{v}\times\vec{w}\right| = 0\ \forall \vec{w}$ the $\vec{v}=\vec{0}$, otherwise the above relation is not possible $\Rightarrow$ True.

(B) Given, $\vec{a}+\vec{b}+\sqrt{3}\vec{c}=\vec{0}=\vec{a}+\vec{b}=-\sqrt{3}\,\vec{c}$

$$\therefore\ \left|\vec{a}+\vec{b}\right|^2 = 3\left|\vec{c}\right|^2 \Rightarrow 2+2\cos\frac{\pi}{3}=3\left|\vec{c}\right|^2$$

$$\Rightarrow \left|\vec{c}\right|^2 = 1 \Rightarrow \left|\vec{c}\right| = 1 \Rightarrow \text{True.}$$

(C) If $\left(\vec{u}+\vec{v}\right).\left(\vec{u}-\vec{v}\right)=0 \Rightarrow \left|\vec{u}\right|^2-\left|\vec{v}\right|^2=0 \Rightarrow \left|\vec{u}\right|=\left|\vec{v}\right|$

But it does not imply that $\vec{u}=\vec{v}$.

e.g. Let $\vec{u}=\hat{i}$ and $\vec{v}=\hat{j}$

Now, $\left(\hat{i}+\hat{j}\right).\left(\hat{i}-\hat{j}\right)=0$

But $\hat{i}\neq\hat{j}\Rightarrow$ False.

(D) Given, $\left|\vec{a}\right|=1=\left|\vec{b}\right|$

Let $\theta=\vec{a}\wedge\vec{b}$ where $\theta\in[0,\pi]$

Now, $\left|2\vec{a}+\vec{b}\right|^2=4\left|\vec{a}\right|^2+\left|\vec{b}\right|^2+4\vec{a}.\vec{b}=5+4(1)(1)\cos\theta=5+4\cos\theta$

$$\therefore\quad \left|2\vec{a}+\vec{b}\right|^2_{\max}=9,\ \text{when } \cos\theta=1 \text{ i.e., } \theta=0^{\circ}$$

$\Rightarrow$ Maximum value of $\left|2\vec{a}+\vec{b}\right|=3$.

2. BCD

Sol. Shortest distance $=\left|\dfrac{\left(\vec{a}_1-\vec{a}_2\right).\left(\vec{b}_1-\vec{b}_2\right)}{\left|\vec{b}_1\times\vec{b}_2\right|}\right|$

where, $\vec{a}_1=-3\hat{i}+6\hat{j},\ \vec{a}_2=2\hat{i}-\hat{j}+6\hat{k}$

$\vec{b}_1=-4\hat{i}+3\hat{j}+2\hat{k},\ \vec{b}_2=-4\hat{i}+\hat{j}+\hat{k}$

$$\therefore\ \text{S.D.}=\left|\frac{\left(-5\hat{i}+7\hat{j}-6\hat{k}\right).\left(\hat{i}-4\hat{j}+8\hat{k}\right)}{\left|\hat{i}-4\hat{j}+8\hat{k}\right|}\right|=9$$

Now, verify alternatives.

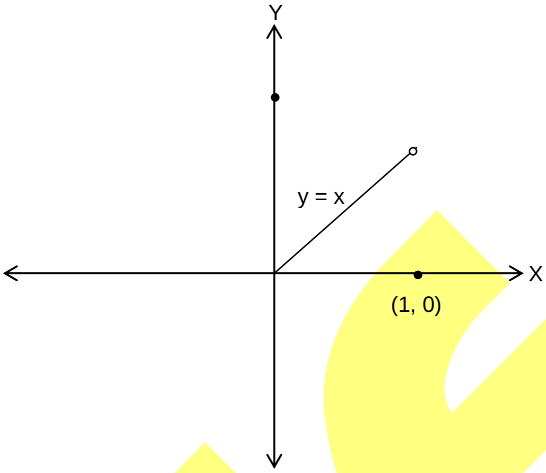
3. BCD

Sol.

(A) False, $f(x)=\begin{cases} x^2\sin\dfrac{1}{x^2} & x\neq 0\\ 0 & x=0\end{cases}$

(B) This statement is true.

For example: $f(x)=\begin{cases} x & 0<x<1 \\ 1 & x=0 \\ 0 & x=1 \end{cases}$



Graph of $f(x)$

(C) $f(x)=x^2-\cos\pi x+4$

Now $f(-1)=1-(-1)+4=6$

and $f(2)=4-1+4=7$

As f is continuous $[-1, 2]$, so $f(c)=2\pi,$ for some $c\in(-1, 2)$

(By using intermediate value theorem)

(D) $\left(f^{-1}\right)'(4)=\dfrac{1}{f'(0)}=\dfrac{1}{1+e^x}\bigg|_{x=0}=\dfrac{1}{2}$.

4. AD

Sol. By Intermediate value property

$\dfrac{f(0)+f(2)}{2}=f(c),\ 0<c<2$

By mean value theorem,

$f(1)-f(0)=f'(c_1),\quad 0<c_1<1$

$f(2)-f(1)=f'(c_2),\quad 1<c_2<2$

By subtraction

$f(0)+f(2)-2f(1)=f'(c_2)-f'(c_1)$

$=(c_2-c_1)f''(c), c_1<c<c_2 \Rightarrow f(0)+f(2)-2f(1)<0$

$\Rightarrow\quad f(0)+f(2)<2f(1)$

5. ABCD

Sol. Given curve is $ax^3-y+b=0$ $\qquad\Rightarrow y=ax^3+b$

Let point P_1 be $\left(t_1, at_1^3+b\right)$

Slope of tangent $=\dfrac{dy}{dx}\bigg|_{P_1}=3at_1^{\,2}$

$\therefore$ Equation of tangent is $y-\left(at_1^3+b\right)=3at_1^2\left(x-t_1\right)$

$\therefore$ Tangent meets curve at $P_2\left(t_2, at_2^{\,3}+b\right)$

$\therefore\ \left(at_2^{\,3}+b\right)-\left(at_1^{\,3}+b\right)=3at_1^{\,2}\left(t_2-t_1\right)$

$\Rightarrow a\left(t_2^{\,3}-t_1^{\,3}\right)=3at_1^{\,2}\left(t_2-t_1\right)$ $\qquad\Rightarrow\qquad t_2^{\,2}+t_1^2+t_2t_1=3t_1^{\,2}\quad(\because t_1\neq t_2)$

$\Rightarrow t_2^{\,2}-t_2t_1-2t_1^{\,2}=0$ $\qquad\Rightarrow\qquad (t_2+2t_1)(t_2-t_1)=0$

$\Rightarrow t_2=-2t_1$

Similarly, $t_3=-2t_2$

$\therefore$ abscissae are in G.P. for all values of a and b.

6. ABCD

Sol. There planes meet at two points it means they have infinitely many solutions, so

So, $\begin{vmatrix} 2 & 1 & 1 \\ 1 & -1 & 1 \\ \alpha & -1 & 3 \end{vmatrix} = 0 \quad \Rightarrow \quad 2(-3+1)-1(3+1)+\alpha(1+1)=0 \Rightarrow \alpha = 4$

$P_1 : 2x + y + z = 1$

$P_2 : x - y + z = 2$

$P_3 : 4x - y + 3z = 5$

P on XOY plane $= (1, -1, 0)$ (which can be obtained by putting z = 0 in any two of the given planes).

Q on YOZ plane $= \left(0, \frac{-1}{2}, \frac{3}{2}\right)$ (which can be obtained by putting x = 0 in any two of the given planes)

$\therefore$ Straight line perpendicular to plane P_3 passing through P is –

$$\frac{x-1}{4} = \frac{y+1}{-1} = \frac{z}{3}$$

$$\overrightarrow{PQ} = \hat{i} - \frac{1}{2}\hat{j} - \frac{3}{2}\hat{k}$$

Projection of $\overrightarrow{PQ}$ on x – axis $\Rightarrow \left|\frac{\overrightarrow{OP}.\hat{i}}{|\hat{i}|}\right| = 1$

Centroid of ΔOPQ is $\left(\frac{1}{3}, \frac{-1}{2}, \frac{1}{2}\right)$

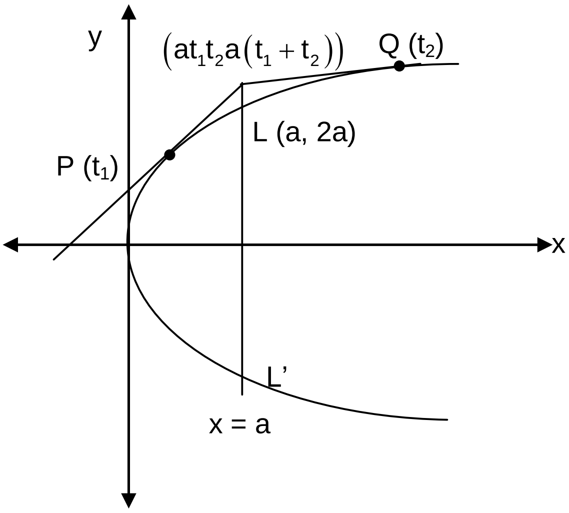
7. ABC

Sol.

(A) Let the point be $\left(\frac{a}{e}, \beta\right)$.

Chord of contact is T = 0

i.e., $x\left(\frac{a}{e}\right) + y\beta = a^2$, which is passing through (ae, 0)



(B) $T(at_1t_2, a(t_1+t_2)) \Rightarrow at_1t_2a \Rightarrow t_1t_2 = 1$

[Hence, equation of PQ is $2x - (t_1 + t_2)y + 2a = 0$

$(x + a) - \lambda y = 0$]

$\Rightarrow$ chord PQ passes (–a, 0) which is foot of directrix

$\therefore$ (B) is also true.

(C) As $|PS_1 - PS_2| = \text{constant}$

So, for hyperbola

$0 < k^2 + 1 < 5 \qquad \Rightarrow k^2 < 4 \qquad \Rightarrow -2 < k < 2$

So, number of integral values of k are 3 (i.e. k = –1, 0, 1)

8. C

Sol. Let equation of circumcircle of triangle ABC is

$x^2+y^2+2gx+2fy+c=0$ ………….(1)

Any point on the parabola is of the form $\left(2at, at^2\right)$,

Solving with (1),

$a^2t^4+2t^2a\left(f+2a\right)+4gat+c=0$.

$\sum t_1=0,\ \sum t_1t_2=\frac{2}{a}\left(f+2a\right),\ \sum t_1t_2t_3=\frac{-4g}{a},\ t_1t_2t_3t_4=\frac{c}{a^2}$

Since centriod and circumcentre coincides so

$-g=\frac{2a\left(t_1+t_2+t_3\right)}{3}=-\frac{2a}{3}t_4=\frac{3g}{2a}$ ……….(2)

$-f=\frac{a}{3}\left(t_1^2+t_2^2+t_3^2\right)=\frac{a}{3}\left(t_1^2+t_2^2+t_3^2+t_4^2-t_4^2\right)=\frac{a}{3}\left(\left(\sum t_1\right)^2-2\sum t_1t_2-t_4^2\right)$

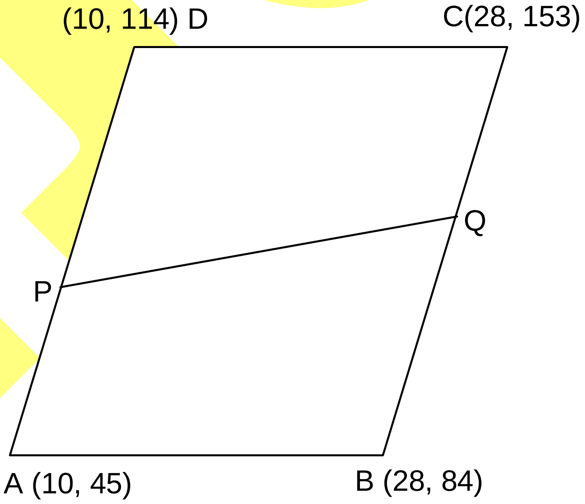
$\Rightarrow -f=\frac{a}{3}\left(0-\frac{4}{a}\left(f+2a\right)-t_4^2\right)$

Putting the value of t_4 from (2),

The required locus is $9x^2=4a\left(y-8a\right)$.

9. B

Sol. Let $AP=CQ=x$



$\Rightarrow \frac{45+x}{10}=\frac{153-x}{28}$

$\Rightarrow 1260+28x=1530-10x$

$\Rightarrow x=\frac{135}{19}$

$\Rightarrow$ slope of $PQ=\frac{45+\frac{135}{19}}{10}=\frac{99}{19}$.

10. B

Sol. Any line passing through (2, 2) will be of the form $\frac{y-2}{\sin\theta}=\frac{x-2}{\cos\theta}=r$

When this line cuts the circle $x^2+y^2=2$, $\left(r\cos\theta+2\right)^2+\left(r\sin\theta+2\right)^2=2$

$\Rightarrow r^2+4\left(\sin\theta+\cos\theta\right)r+6=0$

$\frac{PB}{PA}=\frac{r_2}{r_1}$, now if $r_1=\theta,\ r_2=3\alpha$,

then $4\alpha=-4\left(\sin\theta+\cos\theta\right), 3\alpha^2=6\Rightarrow \sin 2\theta=1\Rightarrow \theta=\frac{r}{4}$.

So required chord will be $y-2=1\left(x-2\right)\Rightarrow y=x$.

11. B

Sol. Problem is same as arranging 8 things out of which 5 identical i.e. $\frac{8!}{5!}$ which gives total number of ways of selecting block and distributing them away 3 children i.e. $\frac{8!}{5!}3!$.

12. B

Sol. $ab + bc + ca = \frac{1}{2}\left(\left(a+b+c\right)^2 - \left(a^2+b^2+c^2\right)\right) = 183$

$\Rightarrow a, b, c$ are the roots of $x^3 - 24x^2 + 183x - 440 = 0$

but it factorises as $(x-5)(x-8)(x-11) = 0$

$\Rightarrow$ there are $3!$ solutions.

13. B

Sol. Let $I = \int_0^{\sin^{-1}\frac{\pi}{4}} (\pi - 4\sin\theta)\sin 2\theta \ln(1+\tan(\sin\theta))d\theta$

put $\sin\theta = t, \cos\theta d\theta = dt$

$$I = 2\int_0^{\pi/4} (\pi - 4t)t\ln(1+\tan t)dt$$

$$= 2\int_0^{\pi/4}\left(\pi - 4\left(\frac{\pi}{4} - t\right)\right)\left(\frac{\pi}{4} - t\right)\ln\left(1+\tan\left(\frac{\pi}{4} - t\right)\right)dt$$

$$= 2\int_0^{\pi/4} t(\pi - 4t)\ln 2dt - \int_0^{\pi/4} t(\pi - 4t)\ln(1+\tan t)dt$$

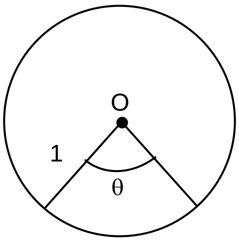
$$I = \ln 2\left[\frac{\pi}{2}.\frac{\pi^2}{16} - \frac{4}{3}\times\frac{\pi^3}{64}\right] = \frac{\pi^3}{32}\ln 2\left[1 - \frac{2}{3}\right] = \frac{\pi^3 \ln 2}{96} = k$$

$$\frac{960k}{\pi^3 \ln 2} = 10.$$

PART – B

1. 5.45

Sol. $$\frac{A_2}{A_1} = \frac{\pi r^2}{\left(\frac{2\pi - \theta}{2\pi}\right).\pi r^2} = \frac{2\pi}{2\pi - \theta}$$



$$V = \frac{\pi}{3}\left(\frac{\theta}{2\pi}\right)^2\sqrt{1^2 - \left(\frac{\theta}{2\pi}\right)^2}$$

$$\frac{dV}{d\theta} = 0 \Rightarrow \theta = \sqrt{\frac{8}{3}}\pi$$

$$\frac{A_2}{A_1} = \frac{\sqrt{3}}{\sqrt{3} - \sqrt{2}} = 3 + \sqrt{6}$$

2. 35.00

Sol. Let x_1 be the number of elements in B before $f(3)$, x_2 the number of elements between $f(3)$ and $f(4)$, x_3 the number of elements between $f(4)$ and $f(5)$, x_4 the number of elements between $f(5)$ and $f(6)$, and x_5 the number of elements after $f(6)$.

According to the conditions of the problem, $x_2, x_3, x_4 \geq 1$ and $x_1, x_5 \geq 0$.

$$x_1 + x_2 + x_3 + x_4 + x_5 = 6$$

$N = {}^{7}C_4$

3. 1.00

Sol. It is obvious

$$\frac{da}{dx} = c,\ \frac{db}{dx} = a,\ \frac{dc}{dx} = b$$

Let $f(x) = a^3 + b^3 + c^3 - 3abc$

Differentiate with respect to x on both sides

$$f'(x) = 3a^2\frac{da}{dx} + 3b^2\frac{db}{dx} + 3c\frac{dc}{dx} - 3\left(\frac{da}{dx}bc + \frac{db}{dx}ac + \frac{dc}{dx}ab\right)$$

$$= 3a^2c + 3b^2a + 3c^2b - 3\left(bc^2 + ca^2 + ab^2\right)$$

$f'(x) = 0 \Rightarrow f(x) = \lambda$ for every x

Now, $x = 0 \Rightarrow f(0) = 1 + 0 + 0 - 0 = 1$

$f(x) = 1$

4. 630.00

Sol. $n(S) = 6.6.6.6 = 6^4 = 1296$

Now A can throw die in 6 ways
B can throw only in 5 ways
D can also throw in 5 ways
Suppose C throws the same number as that of A
Hence 'C' can throw only in 1 ways.
$\therefore$ Number of ways = 6 . 5 . 5 . 1 = 150
Suppose C throws different number than A
Then A can throw in 6 ways
B can throw in 5 ways
Now C will throw different from A and B hence C can throw in 4 ways
Now D can not throws what A and C have thrown and therefore can throw in 4 ways.
$\therefore$ Number of ways = 6 . 5 . 4 . 4 = 480
Total ways = 630

5. 72.00

Sol. We have $\left(\overrightarrow{OP}\right)^2 = \left(e^t + e^{-t}\right)^2\left(\vec{a}\right)^2 + \left(e^t - e^{-t}\right)^2 + 2\left(e^t + e^{-t}\right)\left(e^t - e^{-t}\right)\left(\vec{a}.\vec{b}\right)$

$$\left(\left(\vec{a}\right)^2 = \left|\vec{a}\right|^2 = 9,\ \left(\vec{b}\right)^2 = \left|\vec{b}\right|^2 = 16 \text{ and } \vec{a}.\vec{b} = \left|\vec{a}\right|\left|\vec{b}\right|\cos\frac{2\pi}{3}\right)$$

$$\Rightarrow \left|\overrightarrow{OP}\right|^2 = 9\left(e^t + e^{-t}\right)^2 + 16\left(e^t - e^{-t}\right)^2 + 2\left(e^{2t} - e^{-2t}\right).3.4.\left(-\frac{1}{2}\right) = 13e^{2t} + 5e^{-2t} - 14$$

Now $\frac{d}{dt}\left|\overrightarrow{OP}\right|^2 = 0 \Rightarrow 26e^{2t} - 10e^{-2t} = 0 \Rightarrow e^{4t} = \frac{5}{13}$,

So $e^{2t} = \frac{\sqrt{5}}{\sqrt{13}}$

$$\therefore \left|\overrightarrow{OP}\right|^2_{\min} = 13\left(\frac{\sqrt{5}}{\sqrt{13}}\right) + 5\left(\frac{\sqrt{13}}{\sqrt{5}}\right) - 14 \Rightarrow \left|\overrightarrow{OP}\right|^2_{\min} = 2\sqrt{65} - 14$$

$$\Rightarrow \left|\overrightarrow{OP}\right|_{\min} = \sqrt{2}\sqrt{\sqrt{65} - 7} = \sqrt{2}\sqrt{\sqrt{a} - b},$$

So $a = 65,\ b = 7$

Hence $(a + b) = 72$

6. 9

Sol. Apply Total Probability

7. 610.66

Sol. Given $y = \tan z$

$$\frac{dy}{dx} = \sec^2 z.\frac{dz}{dx} \qquad (1)$$

Now $\frac{d^2y}{dx^2} = \sec^2 z.\frac{d^2z}{dx^2} + \frac{dz}{dx}.\frac{d}{dx}\left(\sec^2 z\right)$ [Using product rule]

$$= \sec^2 z.\frac{d^2z}{dx^2} + \frac{dz}{dx}.\frac{d}{dz}\left(\sec^2 z\right)\frac{dz}{dx}$$

$$\frac{d^2y}{dx^2} = \sec^2 z.\frac{d^2z}{dx^2} + \left(\frac{dz}{dx}\right)^2 .2\sec^2 z.\tan z \qquad (2)$$

Now $1 + \frac{2(1+y)}{1+y^2}\left(\frac{dy}{dx}\right)^2$

$$= 1 + \frac{2(1+\tan z)}{\sec^2 z}.\sec^4 z.\left(\frac{dz}{dx}\right)^2$$

$$= 1 + 2(1+\tan z).\sec^2 z.\left(\frac{dz}{dx}\right)^2$$

$$= 1 + 2\sec^2 z\left(\frac{dz}{dx}\right)^2 + 2\tan z.\sec^2 z\left(\frac{dz}{dx}\right)^2 \qquad (3)$$

From (2) and (3), we have RHS of (2) = RHS of (3)

$$\sec^2 z.\frac{d^2z}{dx^2} = 1 + 2\sec^2 z\left(\frac{dz}{dx}\right)^2$$

$$\Rightarrow \quad \frac{d^2z}{dx^2} = \cos^2 z + 2\left(\frac{dz}{dx}\right)^2$$

$$\Rightarrow \quad k = 2 \text{ so } (305.33)\times k = 610.66$$

8. 8275.20

Sol. $(AB)(AD) = 200$

$AB + AD = 2a$

$BD^2 = AB^2 + AD^2 = (2ae)^2$

$(AB+AD)^2 = AB^2 + AD^2 + 2(AB)(AD)$

$\Rightarrow 4a^2 = 4a^2e^2 + 400$

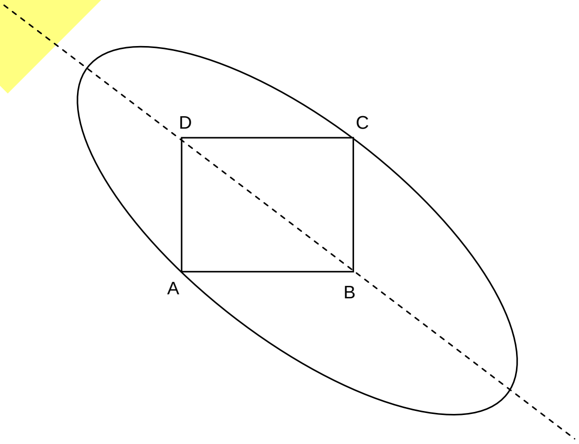
$\Rightarrow b = 10$

$\Rightarrow a^2(1-e^2) = b^2 = 100$

$\Rightarrow a = 20$

$P = 2(AB+AD) = 4a = 80$

Or 103.44P =8275.20



FIITJEE RBT-1 for (JEE-Advanced)

BATCHES – Two Yr CRP2123(All)

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 2 **QP Code: 100163** **PAPER - 2**

Time Allotted: 3 Hours **Maximum Marks: 195**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections.**
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. All the section can be filled in **PART-A** of OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with ***Blue/Black Ball Point Pen*** for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For Only One Part.

(i) **Part-A (01-07) –** Contains seven (07) multiple choice questions which have **One or More** correct answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
Negative Marks: –**2 In all other cases**.
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in –**2** marks, as a wrong option is also darkened.

(ii) **Part-A (08-14) –** Contains seven (07) multiple choice questions which have ONLY ONE CORRECT answer Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(iii) **Part-A (15-18) -** This section contains Two paragraphs. Based on each paragraph, there are Two multiple choice questions. Each question has only one correct answer and carries **+4 marks** for the correct answer and **– 2 marks** for wrong answer.

Name of the Candidate :____

Batch :____________________ **Date of Examination :**____________________

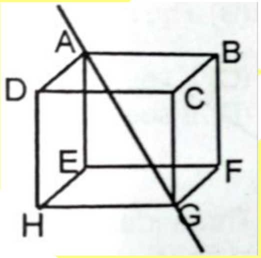
Enrolment Number :____

SECTION-1 : PHYSICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.



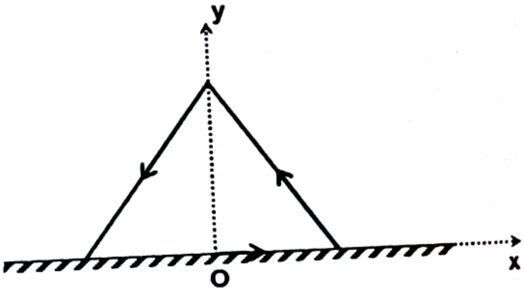
1. An infinite line charge carrying a uniform line charge of density λ is placed along the body diagonal AG of a cube of side 'a' as shown. Then
(A) The flux of the electric field of this charge through one of the sides of the cube is $\frac{\lambda a}{2\sqrt{3}\varepsilon_0}$
(B) The flux of the electric field of this charge through one of the sides of the cube is $\frac{\sqrt{3}\lambda a}{2\varepsilon_0}$
(C) The flux of the electric field of this charge through one of the sides of the cube is $\frac{\lambda a}{4\sqrt{3}\varepsilon_0}$
(D) The flux of the electric field through the face ABFE is same as that through BCGF.

2. Four waves of the equation given by
$y_1 = 5A \sin(wt - Kx + \pi/2)$
$y_2 = 2A \sin(wt - Kx + 3\pi/2)$
$y_3 = 6A \sin(wt - Kx)$
and $y_4 = 2A \sin(wt - Kx + \pi)$
(A) The resulted wave will have amplitude 5A.
(B) It will make a phase difference of 37° with y_3.
(C) Its equation will be $y = 5A \sin(wt + 37^o)$.
(D) Its equation will be $y = 5A \sin(wt - Kx + 37^o)$.

Space For Rough Work

FIITJEE

3. A conducting frame in the shape of an equilateral triangle (mass m, side a) carrying a current I is placed vertically on a horizontal rough surface (coefficient of friction is μ). A magnetic field exists such that $\vec{B} = -B_0 y\hat{i}$. Then



(A) The maximum value of B_0 so that the frame does not rotate $\frac{2\mu mg}{Ia^2}$

(B) The maximum value of B_0 so that the frame does not rotate $\frac{\mu mg}{Ia^2}$

(C) If seen from the top, the frame will have a tendency to rotate counter clockwise.

(D) If seen from the top, the frame will have a tendency to rotate clockwise.

4. A source is moving across a circle given by the equation $x^2+y^2 = R^2$, with constant speed $v = \frac{330\pi}{6\sqrt{3}}$ m/s, in anti-clockwise sense. A detector is at rest at point (2R, 0) w.r.t. the centre of the circle. If the frequency emitted by the source is f and the speed of sound, C = 330 m/s. Then

(A) the position of the source when the detector records the maximum frequency $\left(+\frac{\sqrt{3}}{2}R, -\frac{R}{2}\right)$

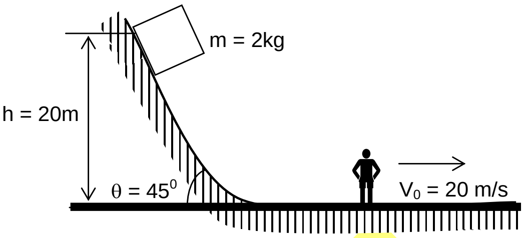
(B) the co-ordinate of the source when the detector records minimum frequency is (0, R)

(C) the maximum frequency recorded by the detector is $\frac{6\sqrt{3}}{\pi + 6\sqrt{3}} f$

(D) the minimum frequency recorded by the detector is $\frac{6\sqrt{3}}{6\sqrt{3} - \pi} f$

Space For Rough Work

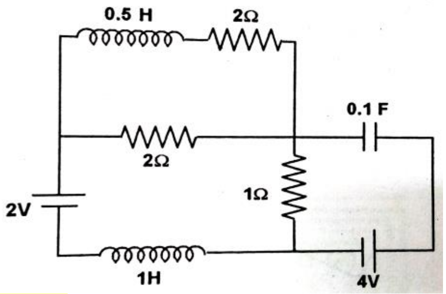
5. A block of mass m is released from top of an inclined plane of inclination $\theta = 45^0$ as shown in the figure. An observer is moving on the horizontal floor with constant velocity 20 m/s as shown, when the block reaches to horizontal floor.
(A) Velocity observed by observer will be 20 m/s
(B) Change in kinetic energy of the block will be 400J as observed by observer
(C) Work energy theorem is not applicable in moving observer frame
(D) Work done by normal reaction is – 800 J as observed by the observer



All surfaces are smooth
take $g = 10 m/s^2$

6. The kinetic energy of particle continuously increases with time :
(A) The resultant force on the particle must be parallel to the velocity at all the instant
(B) The resultant force on the particle must be at an angle less than 90^0 all the times
(C) Its height above the ground level must continuously decrease
(D) The magnitude of its linear momentum increases continuously

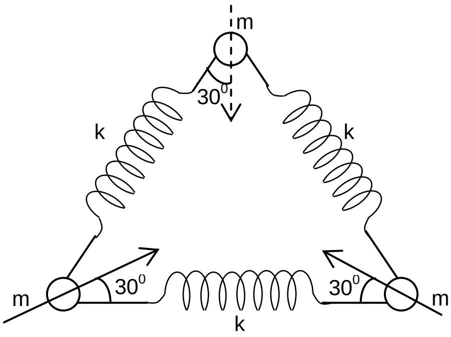
7. The circuit shown in the figure has reached its steady state.
(A) The charge on the capacitor is 0.1 C.
(B) The charge on the capacitor is 0.3 C.
(C) Power developed by the 2 Volts battery is 1 W.
(D) Power developed by the 2 Volts battery is 2 W.



(Single Correct Choice Type)

This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

8. Three identical point masses are placed at the vertices of an equilateral triangle and joined through identical spring of spring constant K. The system is placed on an smooth table. If the masses are displaced along line as shown in figure, then period of their oscillation will be
(A) $2\pi\sqrt{\frac{m}{k}}$
(B) $2\pi\sqrt{\frac{m}{3k}}$
(C) $2\pi\sqrt{\frac{m}{2k}}$
(D) $2\pi\sqrt{\frac{m}{5k}}$

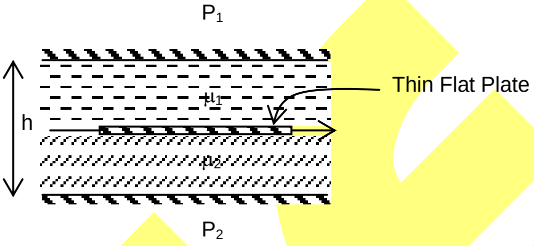


Space For Rough Work

9. A chain of length ℓ and mass M is lumped over the hole in a horizontal plate and a short length hangs down the hole when the chain is at rest. If it is released from this position, find the velocity when the last link of the chain leaves the hole

(A) $\sqrt{\frac{3}{2}g\ell}$ (B) $\sqrt{\frac{2}{4}g\ell}$ (C) $\sqrt{\frac{2}{3}g\ell}$ (D) $\sqrt{\frac{3}{4}g\ell}$

10 A thin plate is placed between two flat surfaces, h cm apart such that the viscosity of liquids on top and bottom of the plate are μ_1 and μ_2 respectively. Find the distance of the plate from the upper surface P_1 such that the viscous resistance to uniform motion of the thin plate is minimum, [Assume h to be very small] is



(A) $y = \frac{\sqrt{\mu_2}\,h}{\sqrt{\mu_1}+\sqrt{\mu_2}}$ (B) $y = \frac{\sqrt{\mu_1}\,h}{\sqrt{\mu_1}+\sqrt{\mu_2}}$

(C) $y = \frac{\sqrt{\mu_1}\,h}{\sqrt{\mu_1}-\sqrt{\mu_2}}$ (D) $y = \frac{\sqrt{\mu_2}\,h}{\sqrt{\mu_1}-\sqrt{\mu_2}}$

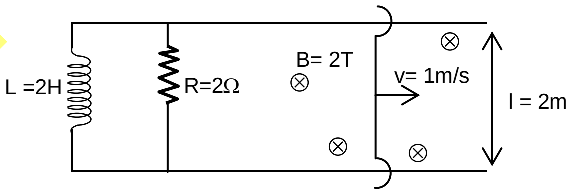
11. An a. c. source producing emf $V=V_0$ [sin ωt + cos $2\omega t$] is connected in series with a capacitor and a resistor. The current found in the circuit is $i=i_1 \sin(\omega t + \phi_1) + i_2 \cos(2\omega t + \phi_2)$. Then

(A) $i_1 = i_2$
(B) $i_1 < i_2$
(C) $i_1 > i_2$
(D) i_1 may be less than, equal to or greater than i_1

12. Two long straight wires with equal cross-sectional radii a are located parallel to each other in air at a large distance b from each other. The capacitance per unit length of the wires will be

(A) $\frac{\pi\varepsilon_0}{\ln\left(\frac{a}{b-a}\right)}$ (B) $\frac{\pi\varepsilon_0}{\ln\left(\frac{b-a}{a}\right)}$ (C) $\frac{2\pi\varepsilon_0}{\ln\left(\frac{b-a}{a}\right)}$ (D) $\frac{4\pi\varepsilon_0}{\ln\left(\frac{b-a}{a}\right)}$

13. The given figure shows an inductor and resistance fixed on a conducting wire. A movable conducting wire PQ starts moving on the fixed rails from t = 0 with constant velocity 1 m/s. The work done by the external force on the wire PQ in 2 seconds is



(A) 16 J (B) 32 J
(C) 48 J (D) 64 J

Space For Rough Work

14. A hemisphere of mass 3m and radius R is free to slide with its base on a smooth horizontal table. A particle of mass m is placed on the top of the hemisphere. If particle is displaced with a negligible velocity, then find the angular velocity of the particle relative to the centre of the hemisphere at an angular displacement θ, when velocity of hemisphere is v.

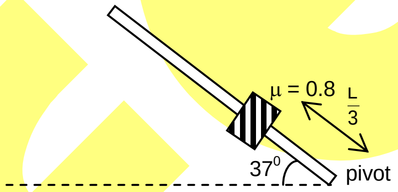
(A) $\frac{4v}{R\cos\theta}$ (B) $\frac{3v}{R\cos\theta}$ (C) $\frac{5v}{R\cos\theta}$ (D) $\frac{2v}{R\cos\theta}$

(Paragraph Type)

This section contains **2 paragraphs**. Based upon the paragraphs **2 multiple choice questions** have to be answered. Each of these questions has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph for Question no. 15 to 16

A cylindrical rod of mass m and length L is pivoted about a horizontal axis through one end and released from rest at an angle 37^0 with the horizontal. A small ring of same mass is kept on the rod as shown in figure



15. Angular velocity of rod about the pivot when it passes through horizontal position is

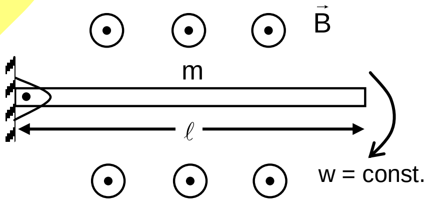
(A) $\sqrt{\frac{9g}{4L}}$ (B) $\sqrt{\frac{4g}{3L}}$ (C) $\sqrt{\frac{12g}{7L}}$ (D) $\sqrt{\frac{2g}{3L}}$

16. Tangential acceleration of CM at the instant it passes through horizontal position is

(A) $\frac{42g}{7}$ (B) $\frac{6g}{7}$ (C) $\frac{25g}{32}$ (D) $\frac{7g}{16}$

Paragraph for Question no. 17 to 18

A uniformly charged non-conducting rod of mass M and linear charge density λ(C/m) is rotating in horizontal plane in gravity free space with constant angular velocity w rad/sec. The rod is hinged at one end as shown in figure. A uniform magnetic field $\vec{B}$ exists in the region along vertically upward direction. Area of cross-section of rod is A.



17. Find out net force applied by hinge on the rod $\left(\text{when } W > \frac{B\lambda\ell}{m}\right)$

(A) $\frac{mw^2\ell}{2} - \frac{B\lambda w\ell^2}{2}$ (B) 0 (C) $\frac{B\lambda w\ell^2}{2}$ (D) $\frac{mw^2\ell}{2}$

18. Tension in the rod at the mid point of rod. When $W = \frac{B\lambda\ell}{M}$

(A) $\frac{B\lambda w\ell^2}{8A}$ (B) $\frac{w\ell}{4A}(B\lambda\ell - mw)$ (C) $\frac{mw^2\ell}{4A}$ (D) 0

Space For Rough Work

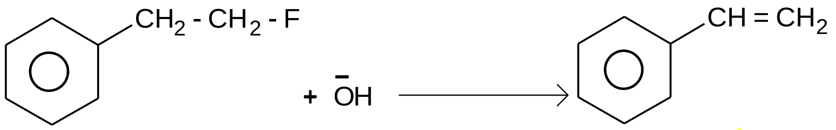
SECTION-2 : CHEMISTRY

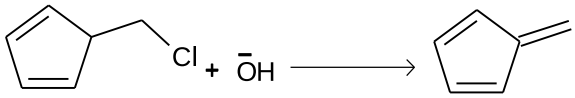
PART – A

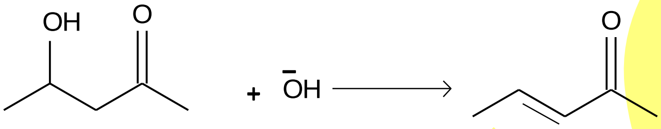
(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. Which is/are example involve E_{CB}^{1} as major mechanism?

(A)


(B)


(C)


(D) $CH_3CH_2Cl + {}^{-}OH \longrightarrow CH_2 = CH_2$

2. Which of the following statement(s) is/are incorrect if temperature is increased?
(A) pK_w increases
(B) K_w increases
(C) pH of pure water increases
(D) pOH of pure water increases

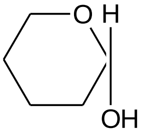
3. Which of the following is/are correct option?
(A) Tetrapeptide represents, 4 peptide bond in a molecule of polypeptide.
(B) Glucose & Fructose can be differentiated by Tollen's reagent & Fehling's solution.
(C) One mole of glucose reacts with maximum of 3 mole of phenylhydrazine.
(D) Trehalose(also known as mycose) is the disaccharide which is non-reducing in nature.

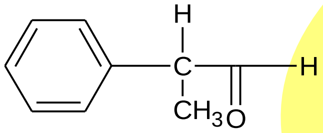
4. Which of the following statement(s) is/are false?
(A) All adiabatic processes are isoentroic(or isentropic) process
(B) When $(\Delta G_{system})_{T,P} < 0$ the reaction must be exothermic
(C) $dG = VdP - SdT$ is applicable for closed system, both PV and non-PV work
(D) The heat of vaporization of water at 100°C is 40.6 kJ.mol. When 9 g of water vapour condenses to liquid at 100°C and 1 atm, then system $\Delta S_{system} = 54.42$ J/K

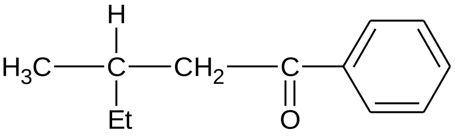
Space For Rough Work

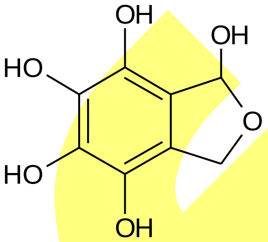
5. Which is true about Scandium compound?
(A) The Scandium carbide(ScC_2), reacts with water, liberating ethyne
(B) Oxidation number of Scandium is +3 in Scandium carbide
(C) Anhydrous $ScCl_3$ differs from $AlCl_3$ as $ScCl_3$ is monomeric while $(AlCl_3)_2$ is dimeric
(D) $2ScCl_3.7H_2O$ on heating gives anhydrous $ScCl_3$

6. In which of the following compounds, there will be either loss of optical activity or change of optical rotation, while keeping in very dilute acidic or basic aqueous solution?

(A)


(B)


(C)


(D)


7. Select the false statement(s)?
(A) Brownian motion and Tyndall effect are shown by true solution
(B) Sorption process is combinations of adsorption and absorption process
(C) Micelle formation is mainly enthalpy driven process at normal temperature
(D) Higher is the gold number greater will be the protective power of a colloid

(Single Correct Choice Type)

This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

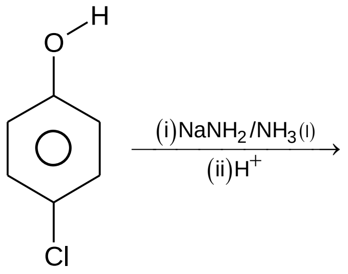
8. Correct order for relative rate of hydrolysis

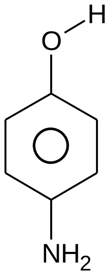
CH_3CH_2Cl	$CH_3OCH_2CH_2Cl$	$CH_3SCH_2CH_2Cl$
I	II	III

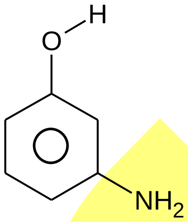
(A) I > II > III
(B) II > I > III
(C) III > II > I
(D) I > III > II

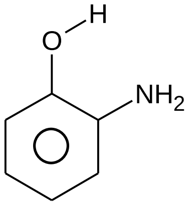
Space For Rough Work

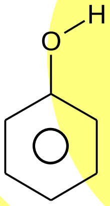
9. Major product in the given reaction is:



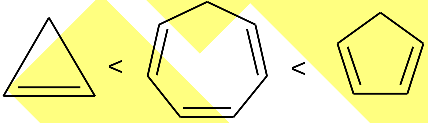
(A)


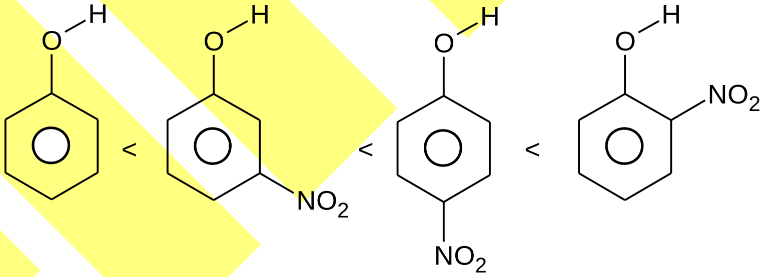
(B)


(C)


(D)


10 Cyclohexene reacts with limited amount of bromine in the presence of light to form product X (C_6H_9Br). The statement correct about X is
(A) It is racemate
(B) It is a product of an addition reaction
(C) It is formed through a cationic intermediate
(D) It is optically active

11. Which is incorrect order of acidic strength?
(A)


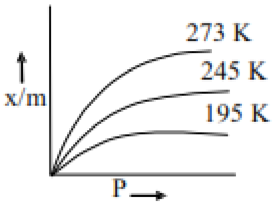
(B) $CHF_3 < CHCl_3 < CHBr_3$
(C)


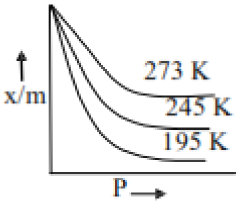
(D) $BF_3 < BCl_3 < BBr_3 < BI_3$

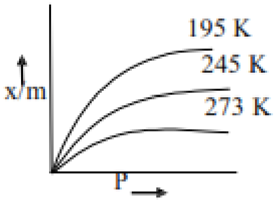
Space For Rough Work

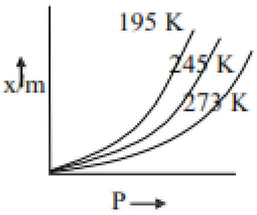
12. When an apple is cut, the exposed part begins to turn brown. Often the browning action can be arrested by adding a few drops of lemon juice to the exposed area. The basis for this treatment is
(A) lemon juice is an antioxidant
(B) denaturation of proteins of the enzymes
(C) decolourization due to lemon juice
(D) activation of decolourizing enzymes under acidic medium

13. Freundlich adsorption isotherms are properly represented as in

(A)


(B)


(C)


(D)


14. A nonapeptide in rat on hydrolysis gave the following identifiable tripeptides:
Gly-Ala-Phe, Ala-Leu-Val, Gly-Ala-Leu, Phe-Glu-His, and His-Gly-Ala, The sequence in the nonapetide is
(A) Gly-Ala-Leu-Val-Phe-Glu-His-His-Gly
(B) Ala-Phe-Leu-Val-Gly-Leu-Phe-Glu-His
(C) Gly-Ala-Phe-Glu-His-Gly-Ala-Leu-Val
(D) Phe-Ala-Leu-Val-Gly-Glu-His-Gly-Ala

Space For Rough Work

(Paragraph Type)

This section contains **2 paragraphs**. Based upon the paragraphs **2 multiple choice questions** have to be answered. Each of these questions has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph for Question no. 15 to 16

P_4O_{10} is one of very important phosphoric oxide having oxidation state of phosphorus as (+V). P_4O_{10} is having cyclic structure P_4O_{10} on hydrolysis consume 6 moles of H_2O in step wise manner involving different intermediate.

15. P_4O_{10} (1 mole) when reacts with 2 moles of H_2O gives
(A) dibasic acid
(B) tribasic acid
(C) tetrabasic acid
(D) monobasic acid

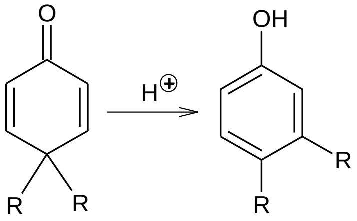
16. P_4O_{10} (1 mole) when reacts with 3 moles of H_2O gives
(A) dibasic acid
(B) tetrabasic acid
(C) hexabasic acid
(D) octabasic acid

Space For Rough Work

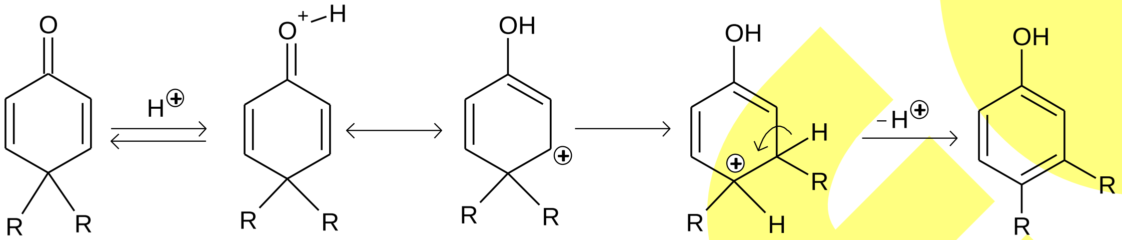
FIITJEE

Paragraph for Question no. 17 to 18

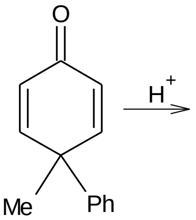
A rearrangement essentially, reversal of the pinacol/pinacolone change, a retro pinacol reaction, is the dienone-phenol rearrangement in which protonation of the initial dienone allows reattainment of the wholly aromatic condition through 1,2-migration of an alkyl group

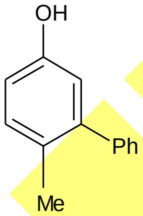


Mechanism is as follows:


O
R
R
H⊕
O
+
H
R
R
OH
⊕
R
R
OH
⊕
H
R
R
H
–H⊕
OH
R
R

17. In the reaction given below major product will be:



(A)


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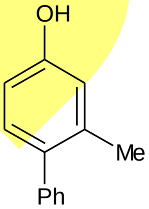

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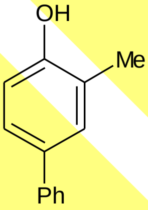

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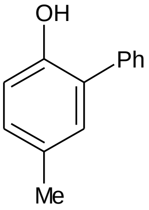
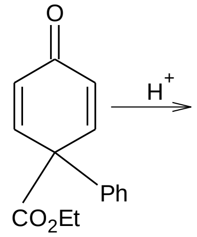
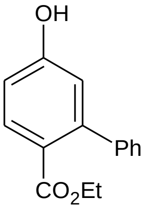
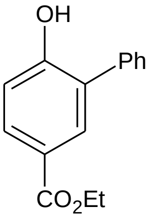


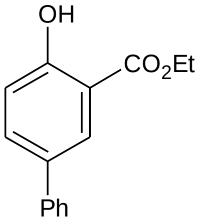
Space For Rough Work

18. In the reaction given below major product will be:



(A)


(B)


(C)


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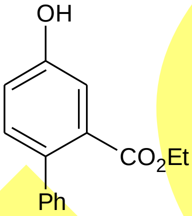

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FIITJEE

SECTION-3 : MATHEMATICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

---

1. A function $y = f(x)$ satisfies the following conditions

(i) $f(1) = 1$

(ii) The tangent at any point of the graph of $f(x)$ cuts off on the y – axis an intercept equal to the square of the abscissa of the point of tangency.
Which of the following are correct?
(A) The graph of $y = f(x)$ passes through the origin

(B) $y = f(x)$ denotes a conic where coordinates of focus are $\left(1, \frac{3}{4}\right)$

(C) The area enclosed by $f(x)$, and the line $y + 3 = 0$ is $\frac{32}{3}$.

(D) $y = f(x)$ has no maxima

2. The line of intersection of the plane $\vec{r}.\left(3\hat{i} - \hat{j} + \hat{k}\right) = 1$ and $\vec{r}.\left(\hat{i} + 4\hat{j} - 2\hat{k}\right) = 2$ is parallel to the vector

(A) $2\hat{i} + 7\hat{j} + 13\hat{k}$
(B) $-2\hat{i} + 7\hat{j} + 13\hat{k}$
(C) $-2\hat{i} - 7\hat{j} + 13\hat{k}$
(D) $2\hat{i} - 7\hat{j} - 13\hat{k}$

3. In the expansion of $(2x - 3y + z)^{10}$, then which of the following statement(s) is/are **correct**?
(A) The expansion will contain 66 terms
(B) Sum of all the coefficients is 0
(C) The coefficient of $x^2y^3z^5$ equals $\left(\frac{-10! \times 9}{5!}\right)$
(D) None of these

Space For Rough Work

4. Let $f(x)=(x^2+2x+3)^2+2(x^2+2x+3)+3$, then which of the following statement (s) is (are) correct?
(A) The equation $f(x)=0$ has no real roots.
(B) The equation $f(x)=0$ has two real roots and two imaginary roots.
(C) The minimum value of $f(x)$ equals 11
(D) The minimum value of $f(x)$ equals 12

5. If ${}^{100}C_6+4\,{}^{100}C_7+6\,{}^{100}C_8+4\,{}^{100}C_9+{}^{100}C_{10}$ has the value equal to ${}^{x}C_y$, then the value of $(x+y)$ can be
(A) 114 (B) 115 (C) 198 (D) 199

6. Which of the following is (are) correct?
(A) $\lim\limits_{n\to\infty}\left(\dfrac{2n^2-3}{2n^2-n+1}\right)^{\frac{n^2-1}{n}}$ is equal to $\sqrt{e}$.
(B) $\lim\limits_{x\to\infty} x\left(\dfrac{1}{e}-\left(\dfrac{x}{x+1}\right)^x\right)$ equal to $\dfrac{-1}{2e}$.
(C) The coefficient of x^{50} in $(1+x^2)^{25}(1+x^{25})(1+x^{40})(1+x^{45})(1+x^{47})$ is equal to $1+{}^{25}C_5$.
(D) If A, B are non – singular and symmetric matrices such that AB = BA then $A^{-1}B^{-1}$ is symmetric matrix.

7. Let the complex number $z=x+iy$ (where $x,y\in R$) satisfy
$\cot^{-1}(\log_3|2z+1|)>\cot^{-1}(\log_3|2z-1|)$, then x can be
(A) –1 (B) –2 (C) 1 (D) 2

(Single Correct Choice Type)

This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

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8. Consider two concentric circle $C_1: x^2+y^2-1=0$ and $C_2: x^2+y^2-4=0$. A parabola is drawn through the points where 'C_1' meets the x – axis and having arbitrary tangent of 'C_2' as it's directrix. Find the locus of the focus of drawn parabola.
(A) $\left(\dfrac{3}{4}\right)x^2-y^2=3$ (B) $\left(\dfrac{3}{4}\right)x^2+y^2=3$
(C) $\left(\dfrac{3}{2}\right)x^2+y^2=3$ (D) $\left(\dfrac{3}{4}\right)x^2+y^2=\dfrac{3}{2}$

Space For Rough Work

9. Let $M=\begin{bmatrix}\sin^4\theta & -1-\sin^2\theta\\ 1+\cos^2\theta & \cos^4\theta\end{bmatrix}=\alpha I+\beta M^{-1}$

Where $\alpha=\alpha(\theta)$ and $\beta=\beta(\theta)$ are real numbers, and I is the 2×2 identity matrix. If

α^* is the minimum of the set $\{\alpha(\theta):\theta\in[0,2\pi]\}$ and

β^* is the minimum of the set $\{\beta(\theta):\theta\in[0,2\pi]\}$

Then the value of $\alpha^*+\beta^*$ is

(A) $-\frac{37}{16}$ (B) $-\frac{31}{16}$ (C) $-\frac{17}{16}$ (D) $-\frac{29}{16}$

10. Given $2x-y-2z=2,\ x-2y+z=-4, x+y+\lambda z=4$ then the value of λ such that the given system of equation has NO solution, is

(A) 3 (B) 1
(C) 0 (D) –3

11. If $x=\sin\frac{2\pi}{7}+\sin\frac{4\pi}{7}+\sin\frac{8\pi}{7}$ and $y=\cos\frac{2\pi}{7}+\cos\frac{4\pi}{7}+\cos\frac{8\pi}{7}$, then x^2+y^2 is

(A) 1 (B) 2
(C) 3 (D) 4

12. The number of solutions of the equation $\sin^{-1}\left(\frac{x^2}{x^2+1}\right)+\cos^{-1}\left(\frac{x^2-1}{x^2+1}\right)=\pi$ is

(A) 1 (B) 2
(C) 0 (D) 3

13. $\sum_{r=1}^{\infty}\tan^{-1}\left(\frac{1}{r^2+5r+7}\right)$ equals to

(A) $\tan^{-1}3$ (B) $\frac{\pi}{4}$ (C) $\sin^{-1}\frac{1}{\sqrt{10}}$ (D) $\cot^{-1}2$

14. One of the sides of a triangle is divided into segments of 6 and 8 units by the point of tangency of the inscribed circle. If the radius of the circle is 4 units, then the length of the shortest side is

(A) 12 units (B) 13 units
(C) 14 units (D) 15 units

Space For Rough Work

(Paragraph Type)

This section contains **2 paragraphs**. Based upon the paragraphs **2 multiple choice questions** have to be answered. Each of these questions has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph for Question no. 15 to 16

Let z_1 and z_2 are two complex numbers satisfying the equation $3z_1^2 - 2z_1z_2 + 2z_2^2 = 0$ and also $\mathrm{Re}\left(\frac{z_1 - 2}{z_1 + 2}\right) = 0$. Also, P_1, P_2 and O are points in complex plane corresponding to z_1, z_2 and origin respectively.

15. The value of $|z_1|$ is equal to

(A) 1　　(B) $\sqrt{5}$

(C) 2　　(D) $2\sqrt{2}$

16. Area of triangle OP_1P_2 is

(A) $\sqrt{5}$　　(B) $2\sqrt{5}$

(C) $3\sqrt{5}$　　(D) $4\sqrt{5}$

Paragraph for Question no. 17 to 18

Let $P(x) = x^5 - 9x^4 + px^3 - 27x^2 + qx + r\,(p, q, r \in R)$ be divisible by x^2 and α, β and γ are the positive roots of the equation $\frac{P(x)}{x^2} = 0$.

17. The value of $(p + q + r)$ is equal to

(A) 9　　(B) 27

(C) 81　　(D) 108

18. If $\alpha - 1, \beta + 3$ and $\gamma + 7$ are the first three terms of a sequence whose sum of first n terms is given by S_n then $\sum_{n=2}^{\infty} \frac{1}{\sqrt{S_n . S_{n-1}}}$ is equal to

(A) 1　　(B) $\frac{1}{4}$

(C) $\frac{1}{2}$　　(D) 2

Space For Rough Work

Q.P. Code: 100163

Answers

SECTION-1 : PHYSICS

PART – A

1.	AD	2.	ABD	3.	AD	4.	AB
5.	BD	6.	BD	7.	BD	8.	B
9.	C	10.	B	11.	B	12.	B
13.	B	14.	A	15.	A	16.	C
17.	A	18.	D				

SECTION-1 : CHEMISTRY

PART – A

1.	ABC	2.	ACD	3.	CD	4.	ABCD
5.	ABC	6.	ABD	7.	ACD	8.	C
9.	B	10.	A	11.	C	12.	A
13.	C	14.	C	15.	C	16.	C
17.	A	18.	D				

SECTION-1 : MATHEMATICS

PART – A

1.	ABC	2.	BD	3.	ABC	4.	AC
5.	AC	6.	ABCD	7.	AB	8.	B
9.	D	10.	D	11.	B	12.	C
13.	C	14.	B	15.	C	16.	A
17.	B	18.	C				

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Answers & Solutions

SECTION-1 : PHYSICS

PART – A

1. **AD**

Sol. Use Gauss law.

2. **ABD**

Sol. Amplitude added vectorily.

3. **AD**

Sol. $\vec{\tau}=\vec{M}\times\vec{B}=\frac{IB_0a^3}{8}$

$\tau_{\text{friction}}=\frac{\mu mga}{4}$

4. **AB**

Sol. For maximum frequency velocity of source towards detector & for minimum frequency velocity of source away from detector.

5. **BD**

Sol. Use work energy theorem.

6. **BD**

Sol. For KE to increase power should be positive

$\vec{f},\vec{v}>0\Rightarrow\theta<90^0$

$P=\sqrt{2Km}\Rightarrow P\propto\sqrt{K}$

7. **BD**

Sol. Voltage across capacitor = 3 V

q_C = 3 × 0.1 = 0.3 C

$P=\frac{(2)^2}{2}$ = 2 W.

8. **B**

Sol. $3\times\frac{1}{2}k\ \ x\sqrt{3}\ \ ^2+\frac{1}{2}3\times mv^2=\text{const}$

differentiating w.r.t time

$3kx+ma=0$

$a=-\left(\frac{3k}{m}\right)x$

$T=2\pi\sqrt{\frac{m}{3k}}$

9. **C**

Sol. Use concept of variable mass system

$V=\sqrt{\frac{2gx}{3}}$

10. **B**

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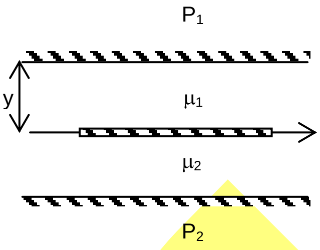
Sol. Force on both sides of the plate

$$F = v\left[\frac{\mu_1}{y} + \frac{\mu_2}{h-y}\right]A$$

Where A = area of the thin plate

For F to be minimum $\frac{dF}{dy} = 0$

$$y = \frac{\sqrt{\mu_1}\,h}{\sqrt{\mu_1} + \sqrt{\mu_2}}$$



11. **B**

Sol. $i_1 = \frac{V_o}{\sqrt{R^2 + \frac{1}{\omega^2 c^2}}}$; $i_2 = \frac{V_o}{\sqrt{R^2 + \frac{1}{4\omega^2 c^2}}}$

12. **B**

Sol. $C = \frac{\lambda}{\Delta V}$

$$C = \frac{\pi\varepsilon_0}{\ln\left(\frac{b-a}{a}\right)}$$

13. **B**

Sol. Energy stored in inductor

$= \frac{B^2V^2l^2t^2}{2L} = 16J$

energy dissipated in resistor

$= \frac{V^2B^2l^2t}{R} = 16J$

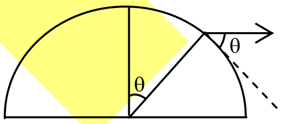
So work done by external agent = 16J + 16J = 32 J

14. **A**

Sol. By COM

$0 = 3\,mv + mv_x \quad \Rightarrow v_x = 3\,v$

wrt sphere $v_x^{'} = 4v$



15. **A**

16. **C**

Sol. By COME

$$\left[mg\left(\frac{L}{3}\right) + mg\frac{L}{2}\right] \times \frac{3}{5} = \frac{1}{2}\left[\frac{mL^2}{3} + \frac{mL^2}{9}\right]\omega^2$$

$$\Rightarrow \omega = \sqrt{\frac{9g}{4L}} = \frac{3}{2}\sqrt{\frac{g}{L}}$$

By $\tau = I\alpha$

$2mg - N = 2ma_t$

$$N\frac{5L}{12} = \left[\frac{mL^2}{12} + m\left(\frac{L}{12}\right)^2 + m\left(\frac{L}{12}\right)^2\right]\alpha$$

$$\alpha\frac{5L}{12} = a_t$$

$$\Rightarrow a_t = \frac{25g}{32} \text{ and } N = \frac{7}{16}mg$$

$$F_{ac} = (2m)\omega^2\left(\frac{5L}{12}\right) = \frac{15mg}{8}$$

Net reaction force = $= \sqrt{N^2 + F_{ac}^2} = \frac{\sqrt{949}}{16}mg$

17. **A**

Sol. $F_{Hinge} + F_{Mag} = m\omega^2 \frac{\ell}{2}$

18. **D**

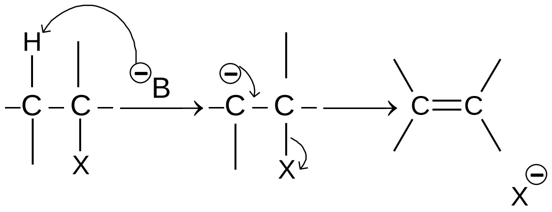
Sol. $T + F_{mag} = \frac{M}{2}\omega^2\left(\frac{3\ell}{4}\right)$

SECTION-2 : CHEMISTRY

PART – A

1. ABC

Sol.



2. ACD

Sol. $H_2O \rightleftharpoons H^+ + OH^-$ $K_w = [H^+][OH^-]$

$T\uparrow \Rightarrow K_w \uparrow$

3. CD

Sol. (A) 4 amino acids

(B) Both shows positive

(C) Osazone

(D) No free hemiacetal

4. ABCD

Sol. Theoretical

ΔS_{system} should be negative.

5. ABC

Sol. $Sc^{3+}.C_2^{2-}$ & factual

6. ABD

Sol. Enolisation & hemiacetal

7. ACD

Sol. Theoretical

8. C

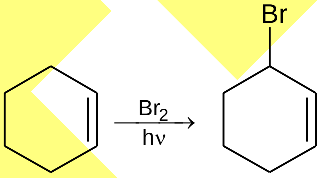
Sol. Electronegativity & nucleophilicity.

9. B

Sol. Benzyne mechanism

10. A

Sol.



11. C

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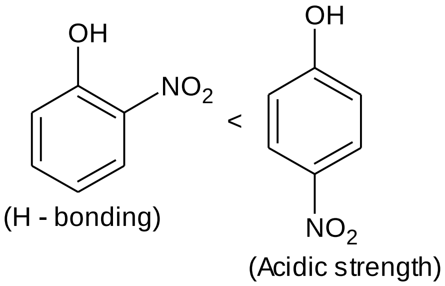
Sol.



12. A

Sol. Factual

13. C

Sol. Conceptual

$\frac{x}{m} \alpha P^{0-1}$ and $\frac{x}{m} \alpha \frac{1}{T}$

14. C

Sol. Gly-Ala-Phe-Glu-His-Gly-Ala-Leu-Val

15. C

Sol. Tetrametal Phosphoric acid $H_4P_4O_{12}$

16. C

Sol. Tetra Poly Phosphoric acid $H_6P_4O_{13}$

17. A

Sol. Migratory aptitude -Ph > -Me

18. D

Sol. –COOEt will migrate

Stability of carbocation concerned.

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SECTION-3 : MATHEMATICS

PART – A

1. ABC

Sol. $Y - y = m(X - x)$

Put $X = 0$

$Y = y - mx$

$\therefore y - mx = x^2$

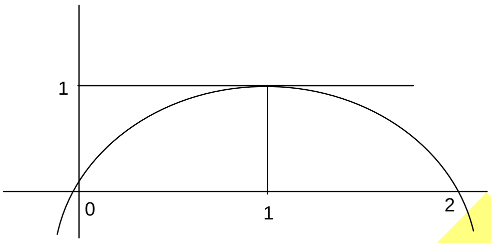
$\frac{dy}{dx} - \frac{1}{x}y = -x$ (linear DE)

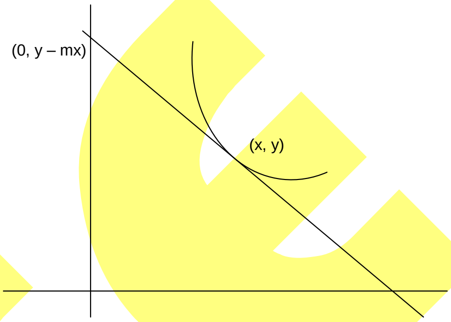
solving $y = -x^2 + cx$

$x = 1, y = 1$

$\Rightarrow \quad c = 2$

$y = 2x - x^2$





2. BD

Sol. $\vec{V} - \vec{n_1} \times \vec{n_2} = \left(3\hat{i} - \hat{j} + \hat{k}\right) \times \left(\hat{i} + 4\hat{j} - 2\hat{k}\right) = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & -1 & 1 \\ 1 & 4 & -2 \end{vmatrix}$

$= \hat{i}(2-4) - \hat{j}(-6-1) + \hat{k}(12+1) = -2\hat{i} + 7\hat{j} + 13\hat{k} \qquad \Rightarrow$ B and D

3. ABC

Sol. $(2x - 3y + z)^{10}$

General term = $\sum_{\alpha+\beta+\gamma=10} \frac{10!(2x)^{\alpha}(-3y)^{\beta}(z)^{\gamma}}{\alpha!\beta!\gamma!}$ …………(i)

$\therefore$ Number of terms $= \frac{12!}{10!2!} = \frac{12 \times 11}{2} = 66$.

Put $x = y = z = 1$ in (1), we get

Sum of all the coefficients 0.

Put $\alpha = 2, \beta = 3, \gamma = 5$ in (1),

We get coefficient of $x^2y^3z^5 = \frac{10!}{2!.3!.5!}(2)^2(-3)^2 = \frac{-10! \times 4 \times 27}{2 \times 6 \times 120} = \frac{-10! \times 9}{5!}$

4. AC

Sol. $f(x) = \left(x^2 + 2x + 3\right)^2 + 2\left(x^2 + 2x + 3\right) + 3$

$x^2 + 2x + 3 > 0 \, \forall x \in R$

$\therefore f(x) > 0 \, \forall x \in R$.

Assume $x^3 + 2x + 3 = y$

$f(x) = y^2 + 2y + 3 = (y+1)^2 + 2 \Rightarrow f(x) = \left(x^2 + 2x + 4\right)^2 + 2 \Rightarrow f(x) = \left[(x+1)^2 + 3\right]^2 + 2$

$$f(x) \geq 9 + 2 = 11 \Rightarrow f(x)\big|_{\min} = 11$$

5. AC

Sol. ${}^4C_4 . {}^{100}C_6 + {}^4C_3 . {}^{100}C_7 + {}^4C_2 . {}^{100}C_8 + {}^4C_1 . {}^{100}C_9 + {}^4C_0 . {}^{100}C_{10}$

Out of 104 students of which 100 are boys and 4 are girls, we have to select 10 students.

This can be done in ${}^{104}C_{10} = {}^{104}C_{94}$

Hence, $x+y=114$ or 198

6. ABCD

Sol.

(A) $I=e^{\lim\limits_{n\to\infty}\frac{n^2-1}{n}\left(\frac{2n^2-3}{2n^2-n+1}-1\right)}=e^{\lim\limits_{n\to\infty}\left(\frac{n-4}{2n^2-n+1}\right)\left(\frac{n^2-1}{n}\right)}=e^{\frac{1}{2}}=\sqrt{e}$

$\ln I=\frac{1}{2}$

(B) $\lim\limits_{x\to\infty}x\left(\frac{1}{e}-\left(\frac{x}{x+1}\right)^x\right)$

Let $x=\frac{1}{t}$

$$\therefore\ \lim_{t\to0}\frac{1}{t}\left(\frac{1}{e}-\left(\frac{1}{1+t}\right)^{1/t}\right)=\frac{1}{e}\lim_{t\to0}\frac{(1+t)^{1/t}-e}{t.(1+t)^{1/t}}=\frac{1}{e^2}\lim_{t\to0}\frac{e^{\frac{\ln(1+t)}{t}}-e}{t}$$

$$=\frac{1}{e}\lim_{t\to0}\frac{e^{\frac{\ln(1+t)}{t}}-1}{\left(\frac{\ell n(1+t)}{t}-1\right)}.\left(\frac{\ell n(1+t)}{t}-1\right)=\frac{1}{e}\lim_{t\to0}\frac{\ell n(1+t)-t}{t^2}=\frac{-1}{2e}$$

(C) As we are interested in coefficient of x^{50}, we shall ignore all the terms with exponent more than 50.

So, $\left(1+x^2\right)^{25}\left(1+x^{25}\right)\left(1+x^{40}\right)\left(1+x^{45}\right)\left(1+x^{47}\right)$

$=\left(1+{}^{25}C_1x^2+....+{}^{25}C_{25}x^{50}\right)\times\left(1+x^{25}+x^{40}+x^{45}+x^{47}\right)={}^{25}C_{25}+{}^{25}C_5=1+{}^{25}C_5$.

(D) $\left(A^{-1}B^{-1}\right)^T=\left(B^{-1}\right)^T\left(A^{-1}\right)^T=\left(B^T\right)^{-1}\left(A^T\right)^{-1}=B^{-1}A^{-1}=(AB)^{-1}=(BA)^{-1}=A^{-1}B^{-1}$

$\Rightarrow A^{-1}B^{-1}$ is symmetric matrix.

7. AB

Sol. $\log_3|2z+1|<\log_3|2z-1|$ (as $\cot^{-1}x$ is a decreasing function)

$\therefore\ |2z+1|<|2z-1|$

or $(2z+1)\left(2\bar{z}+1\right)<(2z-1)\left(2\bar{z}-1\right)$

$2\left(z+\bar{z}\right)<-2\left(z+\bar{z}\right)$

$z+\bar{z}<0$

$2\mathrm{Re}(z)<0$

$\therefore \mathrm{Re}(z)<0$

8. B

Sol. Clearly the parabola should pass through (1, 0) and (–1, 0). Let directrix of this parabola be, $x\cos\theta + y\sin\theta = 2$

If $S(h,k)$ be the focus of this parabola, then distance of $(\pm1, 0)$ from 'S' and from the directrix should be same.

$\Rightarrow (h-1)^2 + k^2 = (\cos\theta - 2)^2$ ………(1)

and $(h+1)^2 + k^2 = (\cos\theta + 2)^2$ ………(2)

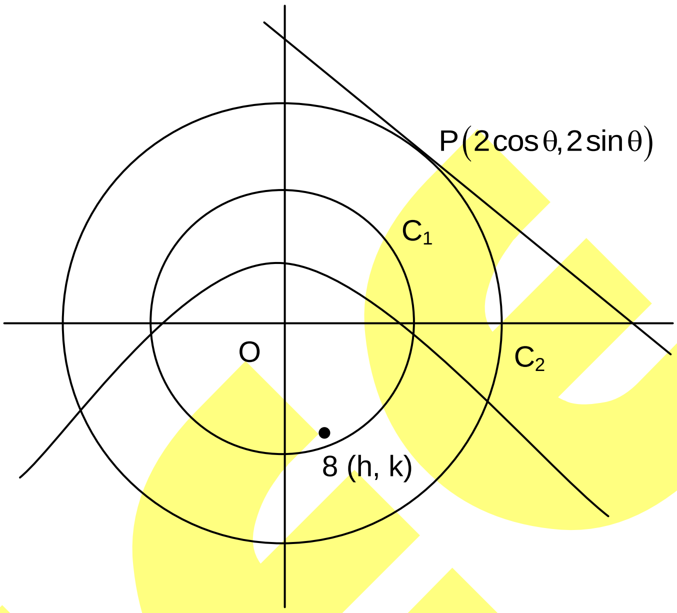
(2) – (1) gives us; $4h = 8\cos\theta$

$\Rightarrow \cos\theta = \frac{h}{2}$

(2) + (1) gives us; $2(h^2 + k^2 + 1) = 2(\cos^2\theta + 4)$

$\Rightarrow h^2 + k^2 + 1 = 4 + \frac{h^2}{4} \Rightarrow \frac{3}{4}h^2 + k^2 = 3$

Hence locus of focus is: $\left(\frac{3}{4}\right)x^2 + y^2 = 3$.



9. D

Sol. $M = \alpha I + \beta M^{-1}$

Equate trace on both sides

$$\sin^4\theta + \cos^4\theta = 2\alpha + \beta\left(\frac{\sin^4\theta + \cos^4\theta}{|M|}\right)$$

Equate sum of elements of non principal diagonal

$$\cos^2\theta - \sin^2\theta = \beta\left(\frac{\sin^2\theta - \cos^2\theta}{|M|}\right)$$

$\therefore\ \beta = -|M| = -\left[\sin^4\theta\cos^4\theta + \sin^2\theta\cos^2\theta + 2\right]$

$\alpha = \sin^4\theta + \cos^4\theta$

$\alpha^* = \alpha_{min} = \frac{1}{2}$

$\beta^* = \beta_{min} = -\frac{37}{16}$

$\therefore\ \alpha^* + \beta^* = \frac{1}{2} - \frac{37}{16} = -\frac{29}{16}$

10. D

Sol. As $\Delta_z \neq 0$, for no solution $\Delta = 0 \Rightarrow \begin{vmatrix} 2 & -1 & -2 \\ 1 & -2 & 1 \\ 1 & 1 & \lambda \end{vmatrix} = 0 \Rightarrow \lambda = -3$.

11. B

Sol. $x^2 + y^2 = 3 + 2\left(\cos\frac{2\pi}{7} + \cos\frac{4\pi}{7} + \cos\frac{6\pi}{7}\right)$

$$= 3 + \frac{2\cos\frac{4\pi}{7}\sin\frac{3\pi}{7}}{\sin\frac{\pi}{7}} = 3 - 1 = 2.$$

12. C

Sol. $\sin^{-1}\left(\frac{x^2}{x^2+1}\right)=\cos^{-1}\left(\frac{1-x^2}{1+x^2}\right)$

$=\sqrt{1-\frac{x^4}{\left(x^2+1\right)^2}}=\frac{1-x^2}{1+x^2}$.

On squaring and solving, we get, $x=0$.

13. C

Sol. $a_n=\tan^{-1}\left(\frac{1}{1+(n+3)(n+2)}\right)$

$=\tan^{-1}\left(\frac{(n+3)-(n+2)}{1+(n+3)(n+2)}\right)$

$=\tan^{-1}(n+3)-\tan^{-1}(n+2)$

$S_n=f(n)-f(0)=\tan^{-1}(n+3)-\tan^{-1}3$

$S_n=\frac{\pi}{2}-\tan^{-1}3=\cot^{-1}3=\sin^{-1}\frac{1}{\sqrt{10}}$.

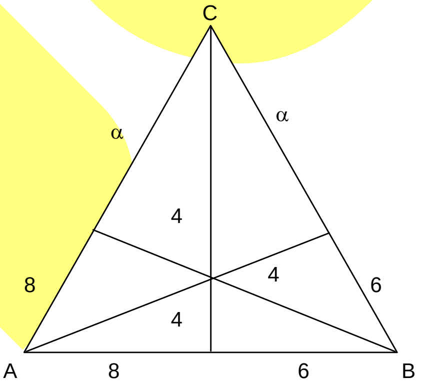
14. B

Sol. $\tan\frac{A}{2}=\frac{1}{2}$

$\tan\frac{B}{2}=\frac{2}{3}$

$\Rightarrow \tan\frac{C}{2}=\frac{4}{7}$

$\Rightarrow \alpha=7 \Rightarrow$ the shortest side is 14.



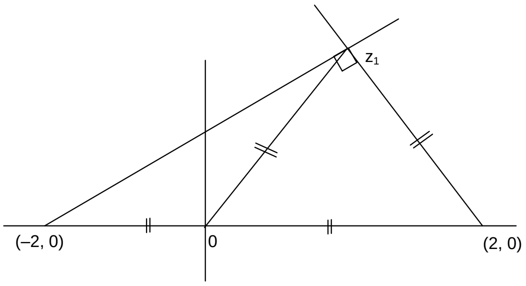
15. C

16. A

(Sol. 15 & 16)

Since $\operatorname{Re}\left(\frac{z_1-2}{z_1+2}\right)=0$

$\frac{z_1-2}{z_1+2}$ is P.I.



$\Rightarrow$ line joining (2, 0), z_1 and $(-2, 0), z_1$ are perpendicular

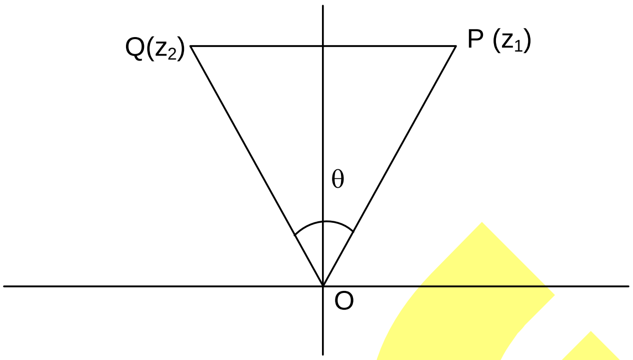
$\therefore\ |z_1|=2$

Also, $2z_2^{\ 2}-2z_1z_2+3z_1^{\ 2}=0$

$z_2=\left(\frac{1+\sqrt{5}i}{2}\right)z_1$

$\therefore |z_2|=\frac{\sqrt{6}}{2}|z_1|$.

Also, $\frac{z_2}{|z_2|}=\frac{z_1}{|z_1|}e^{i\theta}$



17. B

18. C

(Sol. 17 & 18)

$P(x)=x^5-9x^4+px^3-27x^2+qx+r$

$\because$ $P(x)$ is divisible by x^2

$\therefore q=r=0$

$P(x)=x^5-9x^4+px^3-27x^2$

$\frac{P(x)}{x^2}=x^3-9x^2+px-27=0$

$\alpha,\beta,\gamma\in R^+$

$\alpha+\beta+\gamma=9,\ \alpha\beta\gamma=27$

A.M. of $\alpha,\beta,\ \gamma=\frac{\alpha+\beta+\gamma}{3}=3$

G.M. of $\alpha,\beta,\gamma=(\alpha\beta\gamma)^{1/3}=(27)^{1/3}=3$

$\because$ A.M. $=$ G.M. $\Rightarrow\alpha=\beta=\gamma$

$\therefore 3\alpha=9\Rightarrow\alpha=3=\beta=\gamma$

$p=\alpha\beta+\beta\gamma+\gamma\alpha=27$

(i) $p+q+r=27+0+0=27$

(ii) $\alpha-1=2,\ \beta+3=6,\ \gamma+7=10$

$\therefore S_n=2+6+10+...+\text{to n terms}=2(1+3+5+...\text{to n terms})=2n^2$

Now, $\sum_{n=2}^{\infty}\frac{1}{\sqrt{S_n.S_{n-1}}}=\sum_{n=2}^{\infty}\frac{1}{\sqrt{2n^2.2(n-1)^2}}=\frac{1}{2}.\sum_{n=2}^{\infty}\frac{1}{n(n-1)}$

$=\frac{1}{2}\sum_{n=2}^{\infty}\left(\frac{1}{n-1}-\frac{1}{n}\right)$

$=\frac{1}{2}\left(\frac{1}{1}-\frac{1}{2}+\frac{1}{2}-\frac{1}{3}+...\infty\right)=\frac{1}{2}$

FIITJEE RBT-2 for (JEE-Advanced)

BATCHES – Two Yr CRP2123(All)

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 3

QP CODE: 100174

PAPER - 1

Time Allotted: 3 Hours

Maximum Marks: 204

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections.**
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. All the section can be filled in **PART-A & B** of OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with ***Blue/Black Ball Point Pen*** for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Two Parts.

(i) **Part-A (01-04) –** Contains **Four (04)** multiple choice questions which have ONLY ONE CORRECT answer Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(ii) **PART–A** (**05–12)** contains Eight (8) Multiple Choice Questions which have **One or More Than One Correct** answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
Negative Marks**: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in **–2** marks, as a wrong option is also darkened.

(iii) **PART – B (1 – 3):** This section contains **Three (03)** questions. The answer to each question is a **NON-NEGATIVE INTEGER.** Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(iv) **Part-B (4 – 8)** contains **Five (05)** Numerical based questions, the answer of which maybe positive or negative numbers or decimals **TWO** decimal places (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+3 marks** for correct answer. **There is no negative marking.**

Name of the Candidate :____

Batch :____________________ **Date of Examination :**____________________

Enrolment Number :____

SECTION – I : PHYSICS

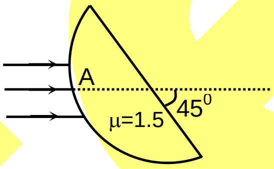
PART – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

---

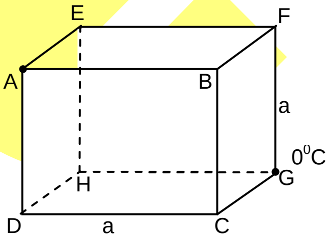
1. The diameter of a wire is measured with a screw gauge having 50 divisions on circular scale and by one complete rotation of circular scale, main scale moves 0.5 mm. If reading of screw gauge is 0.250 cm. The minimum percentage error in the reading will be
(A) 0.4 (B) 0.8 (C) 4 (D) 5

2. A parallel narrow beam of light is incident on the surface of a transparent hemisphere of radius R and refractive index μ =1.5 as shown. The distance (from A) of the image formed by refraction at the spherical surface only is



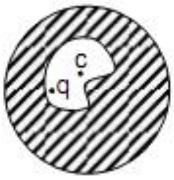
(A) $\frac{R}{2}$ (B) 3R (C) $\frac{R}{3}$ (D) 2R

3. A cubical frame is made by connecting 12 identical uniform conducting rods as shown in the figure. In the steady state the temperature of junction A is 100^0 C while that of the G is 0^0C. Then,



(A) B will be Hotter than H
(B) Temperature of F is 40^0C
(C) Temperature of D is 66.67^0C
(D) Temperature of E is 50^0C

4. The figure shows a charge q placed inside a cavity in an uncharged conductor. Now if an external electric field is switched on:
(A) only induced charges on outer surface will redistribute.
(B) only induced charges on inner surface will redistribute.
(C) both induced charges on outer and inner surfaces will redistribute.
(D) force on charge q placed inside the cavity will change.



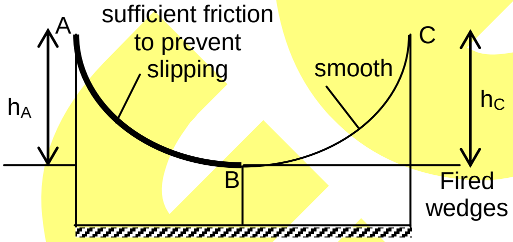
Space For Rough Work

PART – A (Maximum Marks: 32)

*This section contains **EIGHT (08)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

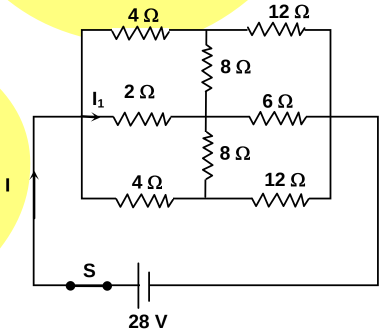
5. A sphere A moving with a speed u and rotating with an angular velocity ω, makes a head on elastic collision with an identical stationary sphere B. There is no friction between the surfaces of A and B. Disregard gravity. Then
(A) A will stop translating but continue to rotate with an angular speed ω.
(B) A will come to rest and stop rotating.
(C) B will move with a speed u without rotating.
(D) B will move with a speed u and rotate with an angular velocity ω.

6. The spherical ball is released from point A. If C be the point upto which the ball goes on smooth surface then (assuming h_A, h_C represent the height of point A and C from horizontal level B and k_A, k_C are the kinetic energies of spheres at points A and C respectively

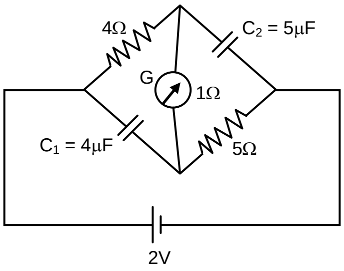


(A) $h_A > h_C$ and $k_A < k_C$
(B) $h_A > h_C$ and $k_B > k_C$
(C) $h_A = h_C$
(D) $h_A > h_C$ & $k_A > k_C$

7. In the circuit shown, the current
(A) I = 8 A
(B) I = 7 A
(C) I_1 = 3.5 A
(D) I_1 = 4 A

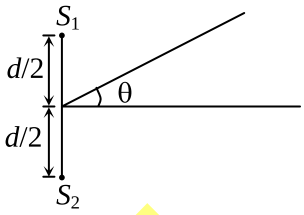


8. In the circuit shown, the cell is ideal with emf = 2V. The resistance of the coil of the galvanometer G = 1 Ω. Then in steady state
(A) No current flows in G.
(B) 0.2 A current flow in G.
(C) Potential difference across C_1 = 1.2
(D) Potential difference across C_2 = 2 V



Space For Rough Work

9. In an interference arrangement, similar to Young's double slit experiment, the slits S_1 and S_2 are illuminated with coherent microwave sources, each of frequency 10^6 Hz. The sources are synchronized to have zero phase difference. The slits are separated by distance d = 150.0 m. The intensity $I_{(\theta)}$ is measured as a function of θ, where θ is defined as shown in the figure. If I_0 is maximum intensity, then $I_{(\theta)}$ for $0 \le \theta \le 90$ is given by



(A) $I_{(\theta)} = I_0$ for $\theta = 0°$
(B) $I_{(\theta)} = (I_0 / 2)$ for $\theta = 30°$
(C) $I_{(\theta)} = (I_0 / 4)$ for $\theta = 90°$
(D) $I_{(\theta)}$ is constant for all values of θ

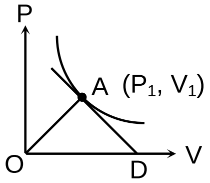
10. The electron in a hydrogen atom makes a transition $n_1 \to n_2$, where n_1 and n_2 are the principal quantum numbers of two states. Assume the Bohr model to be valid. If the time period of the electron in the initial state is eight times that in the final state then the possible values of n_1 and n_2 are

(A) $n_1 = 4, n_2 = 2$
(B) $n_1 = 8, n_2 = 2$
(C) $n_1 = 8, n_2 = 1$
(D) $n_1 = 6, n_2 = 3$

11. A string of length l is stretched along the x-axis and is rigidly clamped at x = 0 and $x = l$. Transverse vibrations are produced in the string. For nth harmonic which of the following equations may represents the shape of the string at any time t. (Assume amplitude at antinodes to be a)

(A) $y = a\cos(\omega t)\cos\left(\frac{n\pi x}{l}\right)$
(B) $y = a\sin(\omega t)\cos\left(\frac{n\pi x}{l}\right)$
(C) $y = a\cos(\omega t)\sin\left(\frac{n\pi x}{l}\right)$
(D) $y = a\sin(\omega t)\sin\left(\frac{n\pi x}{l}\right)$

12. n moles of an ideal gas undergo an isothermal process at temperature T. P-V graph of the process is as shown in the figure. A point A (P_1, V_1) is located on the P-V curve. Tangent at point A, cuts the V-axis at point D. AO is the line joining the point A to the origin O of PV diagram. Then,



(A) coordinates of points D is $\left(\frac{3V_1}{2}, 0\right)$
(B) coordinates of points D is $(2V_1, 0)$
(C) area of the triangle AOD is nRT
(D) area of the triangle AOD is $\frac{3}{4}nRT$

Space For Rough Work

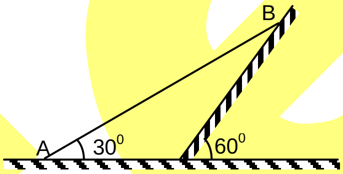
PART – B (Maximum Marks: 9)

*This section contains **THREE (03)** questions. The answer to each question is a **NON-NEGATIVE INTEGER.***

1. A bus is moving towards a huge wall with a velocity of 5 m/s. The driver sounds a horn of frequency 200Hz. The frequency of the beats heard by a passenger of the bus will be (In Hz) nearly (velocity of sound in air = $338\ \text{m/s}$)

2. An ideal gas is expanding such that PT^2 = constant. The coefficient of volume expansion of the gas is A/T where T is temperature in kelvin. Find the value of A.

3. In the figure shown, the instantaneous speed of end A of the rod is v to the left. The angular velocity of the rod of length L is equal to $n\frac{v}{\ell}$ then find the value of 'n'.

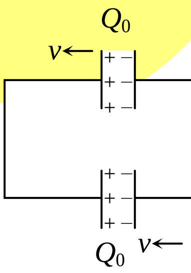


PART – B (Maximum Marks: 15)

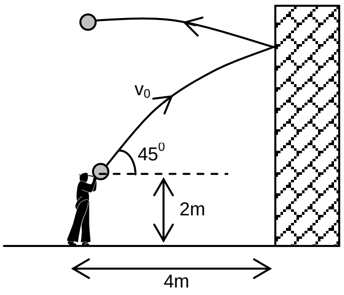
(Numerical **Type)**

This section contains ***Five (05)*** Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **TWO** decimal places (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30).

4. Two identical capacitor connected as shown and having initial charge Q_0. Separation between plates of capacitor is d_0. Suddenly the left plate of upper capacitor and right plate of lower capacitor start moving with speed v towards left while other plate of capacitor remains fixed. (given $\frac{Q_0 v}{2d}=1$ amp). Find the value of current (in amp) in the circuit.

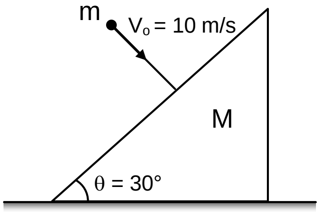


5. A boy stand l = 4 m away from a vertical wall and throws a ball. The ball leaves the boy's hand at h = 2m above the ground with initial velocity $v_0 = 10\sqrt{2}$ m/s at an angle 45^0 from the horizontal. After striking the wall elastically the ball rebounds and hit the ground at 4K (in m). Find K (take g = 9.8 m/s^2)

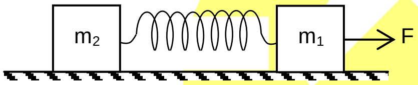


Space For Rough Work

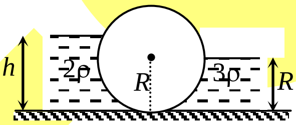
6. A ball of mass 1 kg moving with velocity 10 m/s collides perpendicularly on a smooth stationary wedge of mass 2 kg placed on smooth horizontal surface. If the coefficient of restitution is $e = 7/20$ then find the velocity of ball after the collision. [in ms^{-1}]



7. Two blocks of masses $m_1 = 1$kg and $m_2 = 2$kg are connected by a non deformed light spring. They are lying on a rough horizontal surface. The coefficient of friction between the blocks and the surface is 0.4, what minimum constant force F (in N) has to be applied in horizontal direction to the block of mass m_1 in order to shift the other block? ($g = 9.8$ m/s^2)



8. In the figure shown, the heavy cylinder (radius R) resting on a smooth surface separates two liquids of densities 2ρ and 3ρ. If the height h for the equilibrium of cylinder is equal to be $R\sqrt{x}$. Then find the value of 'x'.



Space For Rough Work

FIITJEE

SECTION – II : CHEMISTRY

PART – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

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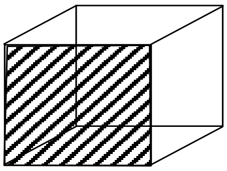
1. Copper reduces NO_3^- into NO and NO_2 depending upon concentration of HNO_3 in solution. Assuming $[Cu^{2+}]$ = 0.1 M, and $P_{NO} = P_{NO_2} = 10^{-3}$ bar, at which concentration of HNO_3, thermodynamic tendency for reduction of NO_3^- into NO and NO_2 by copper is same?

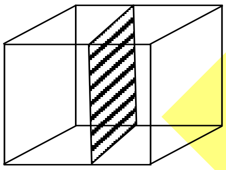
$$\left[\text{Given}: E^o_{Cu^{2+}|Cu} = +0.34 \text{ volt}, \quad E^o_{NO_3^-|NO} = +0.96 \text{ volt}, \quad E^o_{NO_3^-|NO_2} = +0.79 \text{ volt}\right]$$

(A) $10^{1.23}$ M
(B) $10^{0.56}$ M
(C) $10^{0.66}$
(D) $10^{0.12}$ M

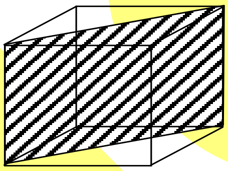
2. Following four planes (M_1, M_2, M_3, M_4) in an ideal Zinc Blend type unit cell are shown in the figure below. Consider the following statements and choose which of the following statement is incorrect



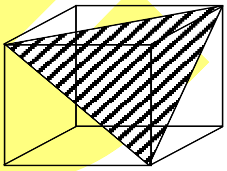
M_1



M_2



M_3



M_4

(A) Effective number of anions present on lattice sites on M_1 is 1.
(B) If ions along M_2 are removed, the formula of solid changes.
(C) All the cations are either located on lattice sites on M_3 or touches M_3.
(D) All the ions present at lattice sites on M_4 are closely packed.

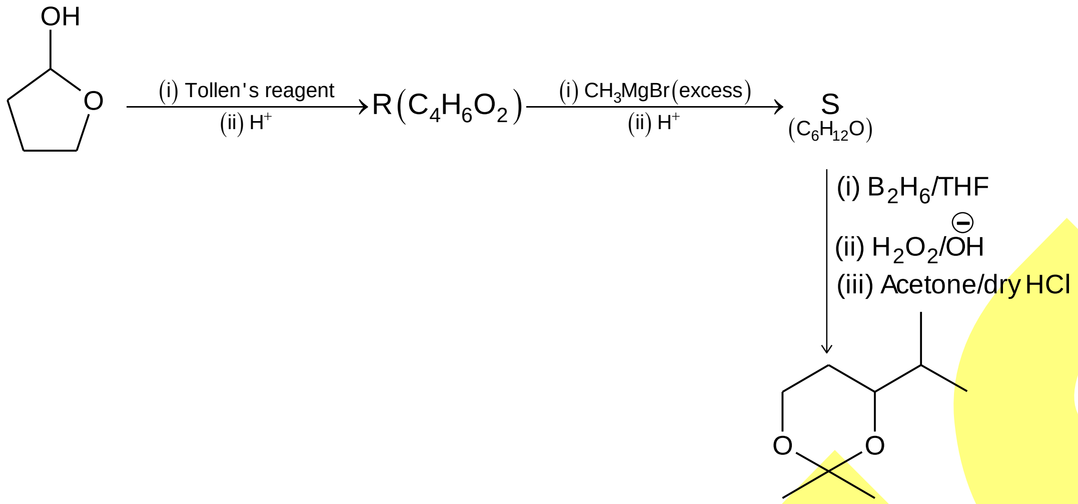
3.

$$\begin{tikzcd}
\text{Nucleic acid} \arrow[r, "Ba(OH)_2"] \arrow[d, "MgO / \Delta"] & P \\
PO_4^{3-} + Q \arrow[r, "HCl"] & R + S + \text{Sugar}
\end{tikzcd}$$

In the scheme shown above P, Q, R and S are
(A) P = purine base, (Q) = pyrimidine base, (R) = nucleotides, (S) = nucleosides
(B) P = (Q) = nucleotides, (R) = pyrimidine base, (S) = purine base
(C) P = nucleosides, (Q) = nucleotides, (R) = (S) = purine base
(D) P = nucleotides, (Q) = nucleosides, (R) = pyrimidine base, (S) = purine base

Space For Rough Work

4.



Choose the incorrect statement(s)
(A) R cannot be prepared by reacting cycloprapanone with m-CPBA.
(B) S contains 11 H-atoms bonded to sp^3-hybridized atoms
(C) Both R & S are cyclic compounds.
(D) Both R & S contains atleast one sp^2-hybridized C-atom.

PART – A (Maximum Marks: 32)

*This section contains **EIGHT (08)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

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5. An ideal gas is expanded from (p_1, V_1, T_1) to (p_2, V_2, T_2) under different conditions. The correct statement(s) among the following is(are)
(A) The work done on the gas is maximum when it is compressed irreversibly from (p_2, V_2) to (p_1, V_1) against constant pressure p_1.
(B) If the expansion is carried out freely, it is simultaneously both isothermal as well as adiabatic
(C) The work done by the gas is more when it is expanded reversibly form V_1 to V_2 under adiabatic conditions as compared to that when expanded reversible from V_1 to V_2 under isothermal conditions.
(D) The change in internal energy of the gas is (i) zero, if it is expanded reversibly with $T_1 = T_2$ and (ii) positive, if it is expanded reversibly under adiabatic conditions with $T_1 \neq T_2$.

6. When O_2 is adsorbed on a metallic surface, electron transfer occurs form the metal to O_2. The TRUE statement(s) regarding this adsorption is(are)
(A) O_2 is physisorbed
(B) heat is released
(C) occupancy of π^*_{2p} of O_2 is increased
(D) bond length of O_2 is decreased

Space For Rough Work

7. Which is/are not correctly stated about graphite?
(A) Electrical conductivity perpendicular to the planes is high.
(B) Bond order of C – C bond is 3/2.
(C) Electrical conductivity parallel to the planes increases as temperature is raised.
(D) It can act as either electron donor or an electron acceptor.

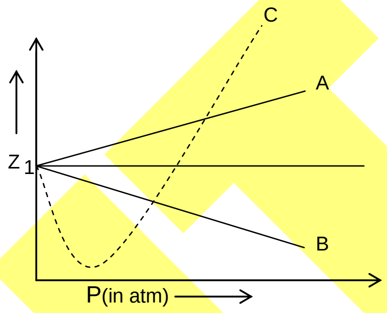
8. Which is/are correct statement?
(A) There cannot be two probabilities for an electron at any position in atom
(B) Probability cannot change abruptly form one point to the other
(C) For large distance from the nucleus probability should be smaller
(D) The total probability of electron some where in space around the nucleus approaches to1

9. When sodium is dissolved in liquor ammonia it will produce
(A) Ammoniate electron
(B) Sodium ion
(C) Amide ion
(D) Hydroxyl ion

10. When sulphur is heated with $NaOH_{(aq)}$ the compounds formed is/are
(A) Na_2SO_4
(B) Na_2S
(C) $Na_2S_2O_3$
(D) $NaHSO_3$

11. What volume of 0.1 M $KMnO_4$ in acidic medium is required for complete oxidation of 100 ml of 0.1 M FeC_2O_4 and 100 Ml of 0.1 M Ferric oxalate separately?
(A) 60 ml of $KMnO_4$ with FeC_2O_4
(B) 40 ml of $KMnO_4$ with FeC_2O_4
(C) 40 ml of $KMnO_4$ with ferric oxalate
(D) 120 ml of $KMnO_4$ with ferric oxalate

12. The given graph represents the variation of compressibility factor, Z Vs P for three real gases A, B and C at 0^oC.



Identify the correct statement.
(A) For gas A, a = 0 and its dependence on P is linear at all pressures
(B) For gas B, b = 0 and its dependence on P is linear at all pressures
(C) For gas C, neither a nor b = 0. By knowing the minima and point of intersection with Z = 1, a and b can be calculate
(D) At high pressure, the slope is positive for all real gases

Space For Rough Work

PART – B (Maximum Marks: 9)

*This section contains **THREE (03)** questions. The answer to each question is a **NON-NEGATIVE INTEGER.***

1. A decapeptide (Mol. Wt. 796) on complete hydrolysis gives glycine (Mol. Wt. 75), alanine and phenylalanine. Glycine contributes 47.0 % to the total weight of the hydrolyzed products. The number of glycine units present in the decapeptide is

2. The number of unpaired electrons in the complex [Mn(acac)$_3$] is
(Atomic number of Mn = 25)

3. The number of all possible isomers for the molecular formula C_6H_{14} is

PART – B (Maximum Marks: 15)

(Numerical **Type)**

This section contains ***Five (05)*** Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **TWO** decimal places (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30).

4. Hydrolysis of 15.45 g of benzonitrile produced 10.98 g of benzoic acid. The percentage yield of acid formed is __________

5. The total number of isomers possible for the molecular $[Co(NH_3)_4Cl(NO_2)]^+$ is _____

6. Specific rotation of the (R)-enantiomer of a chiral compound is 48. The specific rotation of a sample of this compound which contains 25% of (s)-enantiomer is

7. If the percentage of the number of coordinate-covalent bonds present in the dimer of aluminium chloride is x, what is the value of $\frac{x}{10}$?

8. Consider the complexes of manganese
$[Mn(H_2O)_6]^{2+}$ $[Mn(CN)_6]^{4-}$
(I) (II)
If a = Number of electrons present in the t_{2g} orbitals in complex(II)
b = Number of unpaired electrons of metal ion in complex(I)
& c = Number of electrons present in the e_g orbital of complex(I)
What is the value of $\frac{a+b+c}{10}$?

Space For Rough Work

SECTION – Iii : MATHEMATICS

PART – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

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1. Let function $g(x)$ be differentiable and $g'(x)$ is continuous in $(-\infty, \infty)$ with $g'(2)=14$, then $\lim\limits_{x\to 0}\dfrac{g(2+\sin x)-g(2+x\cos x)}{x-\sin x}$ is equal to:

(A) 7
(B) 14
(C) 28
(D) 56

2. $\displaystyle\int\frac{(2x+1)}{(x^2+4x+1)^{3/2}}dx$

(A) $\dfrac{x^3}{(x^2+4x+1)^{1/2}}+C$
(B) $\dfrac{x}{(x^2+4x+1)^{1/2}}+C$
(C) $\dfrac{x^2}{(x^2+4x+1)^{1/2}}+C$
(D) $\dfrac{1}{(x^2+4x+1)^{1/2}}+C$

3. Given a function g continuous on R such that $\int_0^1 g(t)dt=2$ and $g(1)=5$. If $f(x)=\dfrac{1}{2}\int_0^x (x-t)^2 g(t)dt$, then the value of $\left(f'''(1)-f''(1)\right)$ is equal to:

(A) 0
(B) 3
(C) 5
(D) 7

4. If $r,k,p \in W$, then $\sum\limits_{r+k+p=10} {}^{30}C_r \cdot {}^{20}C_k \cdot {}^{10}C_p$ is equal to

(A) $\dbinom{60}{50}$
(B) $\dbinom{60}{30}$
(C) $\dbinom{60}{20}$
(D) $\dbinom{30}{10}\dbinom{30}{20}$

Space For Rough Work

FIITJEE

PART – A (Maximum Marks: 32)

*This section contains **EIGHT (08)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

5. If sides AB, BC and CA of a triangle ABC are represented by $x+2=0$, $3x+y=0$ and $x+3y+2=0$ respectively, then identify the correct statement.

(A) $\sum \tan A = \frac{4}{3}$

(B) $\Pi \tan A = -\frac{4}{3}$

(C) $\sum \tan A \tan B = -\frac{41}{9}$

(D) $\sin^2(A+B)+\cos^2 C = \frac{5}{4}$

6. In triangle ABC, a=4 and $b=c=2\sqrt{2}$. A point P moves within the triangle such that the square of its distance from BC is half the area of rectangle contained by its distances from the other two sides. If D be the centre of locus of P, then

(A) locus of P is an ellipse with eccentricity $\sqrt{\frac{2}{3}}$

(B) locus of P is a hyperbola with eccentricity $\sqrt{\frac{3}{2}}$

(C) area of the quadrilateral ABDC=$\frac{16}{3}$sq.units

(D) area of the quadrilateral ABDC=$=\frac{32}{3}$ sq. units

7. $\vec{a},\vec{b},\vec{c}$ are three vectors such that $\vec{a}.\vec{a}=\vec{b}.\vec{b}=\vec{c}.\vec{c}=3$ and $\left|\vec{a}+\vec{b}-\vec{c}\right|^2+\left|\vec{b}+\vec{c}-\vec{a}\right|^2+\left|\vec{c}+\vec{a}-\vec{b}\right|^2=36$ then

(A) $\vec{a}.\vec{b}+\vec{b}.\vec{c}+\vec{c}.\vec{a}=\frac{9}{2}$

(B) $\vec{a},\vec{b},\vec{c}$ are co – planar

(C) $\vec{a}\times\vec{b}=\vec{b}\times\vec{c}=\vec{c}\times\vec{a}\neq 0$

(D) $\vec{a},\vec{b},\vec{c}$ represents sides of triangle

8. If $|\sin x|+|\cos x|\geq 1$ then x can lie in the interval

(A) $\left[n\pi-\frac{\pi}{4},\ n\pi\right]$

(B) $\left[n\pi,\ n\pi+\frac{\pi}{4}\right]$

(C) $\left[2n\pi,\ 2n\pi+\frac{\pi}{4}\right]$

(D) $\left[(4n+1)\frac{\pi}{4},(4n+3)\frac{\pi}{4}\right]$ where $n\in$ integer.

Space For Rough Work

9. If the sum of n terms of series $\frac{5}{1.2.3^1}+\frac{7}{2.3.3^2}+\frac{9}{3.4.3^3}+...$ is S_n then

(A) $S_3=\frac{107}{108}$

(B) $S_n=1-\frac{1}{3^n.n}$

(C) $U_{n\to\infty}S_n=1$

(D) $U_{n\to\infty}S_n=3$

10. If $f:R\to\left[-\frac{\pi}{4},\frac{\pi}{2}\right)$ is a function defined by $f(x)=\tan^{-1}\left(x^4-x^2-\frac{7}{4}+\tan^{-1}\alpha\right)$ and f is surjective then:

(A) $\cos^{-1}\left(\frac{1-\alpha^2}{1+\alpha^2}\right)=2$

(B) $\alpha+\frac{1}{\alpha}=2\operatorname{cosec}2$

(C) $\sin^{-1}\left(\frac{2\alpha}{\alpha^2+1}\right)=\pi-2$

(D) $\tan^{-1}\left(\frac{2\alpha}{\alpha^2-1}\right)=2-\pi$

11. The possible value(s) of k for which $\lim\limits_{x\to\infty}\frac{2x^3-\left(\tan^{-1}x\right)^3}{\frac{8}{\pi}x^3\cot^{-1}|kx|+k^2x^6\sin\frac{1}{x^3}-3kx^3}=\frac{1}{2}$, is:

(A) 0

(B) –1

(C) 2

(D) 4

12. Let function $y=f(x)$ satisfies the differential equation $x^2\frac{dy}{dx}=y^2e^{\frac{1}{x}}\,(x\neq 0)$ and $\lim\limits_{x\to 0^-}f(x)=1$. Identify the correct statement(s):

(A) Range of $f(x)$ is $(0,1)-\left\{\frac{1}{2}\right\}$

(B) $f(x)$ is bounded

(C) $\lim\limits_{x\to 0^+}f(x)=1$

(D) $\int_0^e f(x)dx>\int_0^1 f(x)dx$

Space For Rough Work

PART – B (Maximum Marks: 9)

This section contains ***THREE (03)*** *questions. The answer to each question is a* ***NON-NEGATIVE INTEGER.***

1. If A, B and C are angles of a triangle, then the minimum value of

$$E=\frac{\cos\left(\frac{B-C}{2}\right)}{\cos\left(\frac{B+C}{2}\right)}+\frac{\cos\left(\frac{C-A}{2}\right)}{\cos\left(\frac{C+A}{2}\right)}+\frac{\cos\left(\frac{A-B}{2}\right)}{\cos\left(\frac{A+B}{2}\right)}$$

2. Let $f(x)$ is a polynomial function and $(f(\alpha))^2+(f'(\alpha))^2=0$, then find $\lim\limits_{x\to\alpha}\frac{f(x)}{f'(x)}\left[\frac{f'(x)}{f(x)}\right]$, where [.] denotes greatest integer function, is ___________

3. α,β are roots of equation $x^2-p(x+1)-c=0$ then find the value of

$$\frac{\alpha^2+2\alpha+1}{\alpha^2+2\alpha+c}+\frac{\beta^2+2\beta+1}{\beta^2+2\beta+c}$$

PART – B (Maximum Marks: 15)

(Numerical **Type)**

This section contains ***Five (05)*** Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **TWO** decimal places (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30).

4. Let $A=\{1,2,3,4\}$ and $B=\{3,4,5,6,7\}$ are two sets. Let m is the number of one – one functions $f:A\to B$ such that $f(i)\neq i\,\forall\, i\in A$ f and n is the number of one – one functions $f:A\to B$ such that $|f(i)-i|\le 3\,\forall\, i\in A$, then find the value of $(m+n)$

5. Let $A(1,-1), B(4,-2)$ and $C(9,3)$ be the vertices of the triangle ABC. A parallelogram AFDE is drawn with vertices D, E and F on the line segments BC, CA and AB respectively. Find the maximum area of parallelogram AFDE.

Space For Rough Work

6. If the maximum area of the region enclosed by the curves $y=|x|e^{|x|}$ and the line $y=a(0\le a\le e)$ in $x\in[-1,1]$ is A, then find the value of [A].
[Note : [k] denotes greatest integer function less than of equal to k.]

7. Let $a_r=r\left({}^7C_r\right),b_r=(7-r)\left({}^7C_r\right)$ and $A_r=\begin{bmatrix} a_r & 0 \\ 0 & b_r \end{bmatrix}$. If $A=\sum_{r=0}^{7}A_r=\begin{bmatrix} a & 0 \\ 0 & b \end{bmatrix}$, then the value of $a+b$ must be $(k+895)$ then k is

8. The least possible value of a for which $\frac{x^3-6x^2+11x-6}{x^3+x^2-10x+8}+\frac{a}{30}=0$ does not have a real solution is

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Space For Rough Work

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Answers & Solutions

SECTION – I : PHYSICS

PART – A

1. **A**

Sol. $LC = \frac{0.5\,mm}{50} = 0.01\text{ mm}$

Percentage error $= \frac{0.01\times10^{-3}}{0.25\times10^{-2}}\times100$

$= 0.4$

2. **B**

Sol. $\frac{1.5}{V} - \frac{1}{-\infty} = \frac{1.5-1}{R}$

V = 3R.

3. **B**

Sol. $100°C - Ir - \frac{I}{2}r - Ir = 0°C$

$\Rightarrow \quad Ir = 40°C \quad ; \quad \therefore \; t_F = 0° + Ir = 40°C$

4. **A**

Sol. Due to electrostatic shielding.

5. **AC**

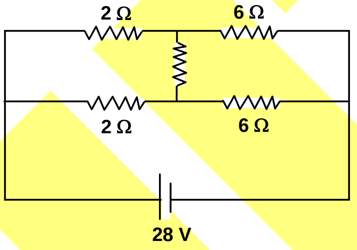
Sol. After elastic collision, translational velocities get interchanged.

6. **AB**

Sol. Apply energy conservation.

7. **BC**

Sol.



$\Rightarrow \quad i = \frac{28}{4} = 7A$

8. **B**

Sol. $i = \frac{V}{Red} = \frac{2}{10} = 0.2\text{ A}$

9. **AB**

Sol. $Cos^2\left(\frac{\phi}{2}\right), \; \phi = \frac{d\sin\theta}{\lambda}\times2\pi$

For $\theta = 0°, \phi = 0, \; I_{(\theta)} = I_0$

For $\theta = 30°, \phi = \frac{\pi}{2}, \; I_{(\theta)} = \frac{I_0}{2}$

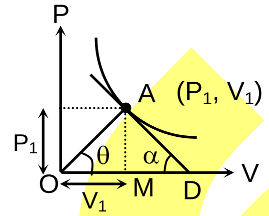
10. **AD**

Sol. $T \propto n^3$

11. **CD**

Sol. at x = 0, $\text{Sin}\left(\frac{n\pi x}{l}\right)=0$

12. **BC**



Sol. $\tan\alpha = -$ [slope at (P_1, V_1)] $=\frac{P_1}{V_1}$

$\tan\theta=\frac{P_1}{V_1}$

$\therefore\ \alpha=\theta$

$OM = MD = V_1$

$\therefore\ OD = 2V_1$

Area of triangle *AOD* $=\frac{1}{2}(AM\times OD)\ =\frac{1}{2}(P_1\times 2V_1)=P_1V_1=nRT$

PART – B

1. **6**

Sol.

2. **3**

Sol. $PT^2 = k$

$\gamma=\frac{1}{V}\left(\frac{dV}{dT}\right)$ …(i)

$\left(\frac{nRT}{V}\right)T^2=k$

$\Rightarrow\ \frac{T^3}{V}=k'$

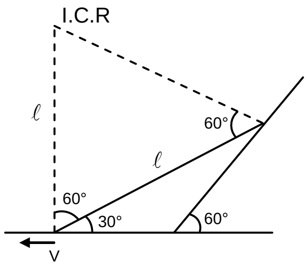
$\Rightarrow\ V=\frac{T^3}{k'}$ …(ii)

$\frac{dV}{dT}=\frac{3T^2}{K'}$ …(iii)

From (i), (ii) and (iii)

$\gamma=\left(\frac{k'}{T^3}\right)\times\left(\frac{3T^2}{k'}\right)=\frac{3}{T}$

3. **1**



Sol. $\omega=\frac{V}{L}$

4. **2**

Sol. $\frac{q_1}{C_1}=\frac{q_2}{C_2}$; $q_1+q_2=2Q_0$

$C_1=\frac{\varepsilon_0A}{d_0+vt}$; $C_2=\frac{\varepsilon_0A}{d_0-vt}$

$\frac{q_1}{q_2}=\frac{d_0-vt}{d_0+vt}$

$$q_2\left(\frac{d_0 - vt}{d_0 + vt}\right) + q_2 = 2Q_0$$

$$q_2\left[\frac{2d_0}{d_0 + vt}\right] = 2Q_0$$

$$q_2 = \frac{2Q_0}{2d_0}(d_0 + vt)$$

$$I = \frac{dq_2}{dt} = \frac{Q_0 v}{d_0} = 2 \text{ amp}$$

5. **4.50**

Sol. The velocity component at the point of projection are

$u_x = 10 m/s$, $u_y = 10 m/s$

t = 0.4 s

$v_x = 10\ m/s$, $v_y = 6.1 m/s$

h = 3.2 m

H = 5.2 m

The time taken by the ball to hit the ground

$$5.2 = -6.1T + \frac{1}{2}gT^2$$

T=1.8s

$x = v_xT = 10 \times 1.8 = 18\,m.$

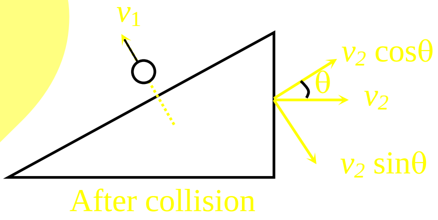
4K = 18 ; $\therefore$ K = 4.5

6. **2**

Sol. Equation of Newtons collision law

$e = \frac{\quad}{\quad}$, $\qquad e = \dfrac{v_1 + \frac{v_2}{2}}{v_0}$

$2v_1 + v_2 = 7$ … (i)



After collision

From momentum conservation

$mv \sin 30 = -mv_1 \sin 30 + mv_2$

$5 = -\frac{v_1}{2} + 2v_2$ … (ii)

Solving v_1 = 2 m/s

7. **7.64**

Sol $F.x - \mu m_1 gx - \frac{1}{2}kx^2 = 0$

kx = $\mu m_2 g$ for just shifting m_2

$$F.x - \mu m_1 gx - \frac{1}{2}\mu m_2 gx = 0$$

$$F = \mu\left(m_1 + \frac{m_2}{2}\right)g = 0.4\left(1 + \frac{2}{2}\right)(9.8) = 7.64 \text{ N}$$

8. **1.50**

Sol. ρh^2 = constant

SECTION – II : CHEMISTRY

PART – A

1. C

Sol. $Cu + 4H^+ + 2NO_3^- \longrightarrow Cu^{2+} + 2NO_2 + 2H_2O ----(1)$

$3Cu + 8H^+ + 2NO_3^- \longrightarrow 3Cu^{2+} + 2NO + 4H_2O ----(2)$

According to question

ΔG of equation (1) = ΔG of equation (2)

$\therefore E_{Cell}$(equation -1) = E_{Cell}(equation -2)

or,($E_{cathdoe}$ - E_{anode})(equ^n.1) = ($E_{cathdoe}$ - E_{anode})(equ^n.2)

$$\therefore E_{NO_3^-/NO_2} - E_{Cu^{2+}/Cu} = E_{NO_3^-/NO} - E_{Cu^{2+}/Cu}$$

$$\therefore E_{NO_3^-/NO_2} = E_{NO_3^-/NO}$$

$$\text{or, } E^0_{NO_3^-/NO_2} - \frac{0.0591}{2}\log\frac{(p_{NO_2})^2}{[H^+]^4[NO_3^-]^2} = E^0_{NO_3^-/NO} - \frac{0.0591}{6}\log\frac{(p_{NO})^2}{[NO_3^-]^2[H^+]^8}$$

$$\text{or, } 0.79 - \frac{0.0591}{2}\log\frac{(10^{-3})^2}{(x^4)(x^2)} = 0.96 - \frac{0.0591}{6}\log\frac{(10^{-3})^2}{(x^2)(x)^8}$$

On solving x = $10^{0.66}$

2. C

Sol. (A) Number of corner atoms at four corners = 4. Effective number of atoms = $4 \times \frac{1}{4} = 1$

Each corner in the plane touches four unit cells.

(B) M_2 contains the face centre ions. $\therefore$Formula will be changed.

(C) Incorrect as cations are present in tetrahedral voids.

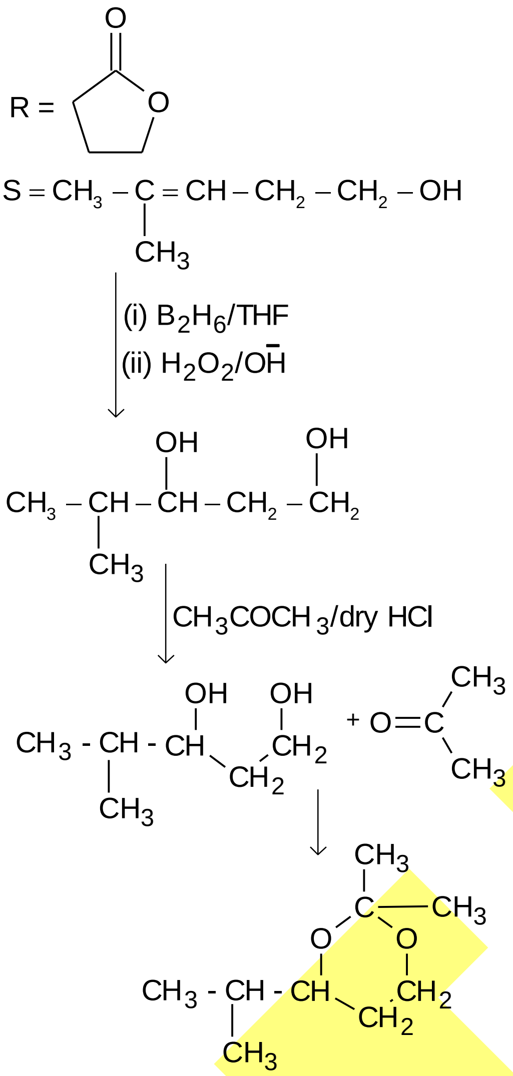
(D) Close packing takes place along face diagonals.

3. D

Sol. P is nucleotides and Q is nucleoside, R and S are bases.

4. C

Sol.


R =
O
O
S = CH3 – C = CH – CH2 – CH2 – OH
CH3
(i) B2H6/THF
(ii) H2O2/OH⁻
OH
OH
CH3 – CH – CH – CH2 – CH2
CH3
CH3COCH3/dry HCl
OH
OH
CH3 - CH - CH
CH2
CH2
CH3
+ O=C
CH3
CH3
CH3
C
CH3
O
O
CH3 - CH - CH
CH2
CH2
CH3

5. AB

Sol. $(p_1, V_1, T_1) \xrightarrow{\text{Expansion}} (p_2, V_2, T_2)$

$\therefore V_2 > V_1$ and $p_1 > p_2$

(A) $(p_2, V_2) \xrightarrow[\text{compression}]{\text{Irreversible}} (p_1, V_1)$

Work done = $-p_1(V_1 - V_2)$

Since $V_2 > V_1$, W_{irr} = +ve and $p_1 > p_2$

This is called maximum work because p_{ext} is p_1 which is larger than p_2.

$\therefore$ This is correct.

(B) For free expansion, $p_{ext} = 0$ and $W = 0$

In isothermal process

$\Delta T = 0$, $\Delta U = 0$

$\Delta U = q - W$

or, $q - W = 0$

Since q is zero for free expansion

$W = 0$, or $p_{ext}\Delta V = 0$

$\therefore\ p_{ext} = 0$

In adiabatic process

$\Delta U = q - W$

Since $q = 0$, $\Delta U = -W$

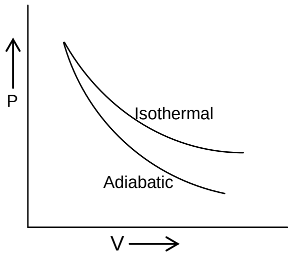
For free expansion, $\Delta U = 0$

$\therefore W = 0$

$p_{ext}\Delta V = 0$, $p_{ext} = 0$

(C) is incorrect

Work done in isothermal process is higher than that in adiabatic process



Work is area under the curve. So area under isothermal curve is higher than that in adiabatic curve.

(D) is incorrect

For isothermal process, the change in internal energy = 0 as $\Delta T = 0$

For adiabatic process, expansion of gas decreases internal energy, which is used to do work.

$\therefore \Delta U < 0$ in adiabatic process.

6. BC

Sol. Adsorption of O_2 on metal surface is called chemisorption. Since electrons are transferred from metal to oxygen, heat will be released as electron affinity of oxygen. The electrons are absorbed in the outermost molecular orbital $\left(\pi_y^*\right)$ of O_2.

7. ABC

Sol. (A) is incorrect, conduction of electricity taking place along the plane of graphite

(B) is incorrect, bond order of graphite = $\frac{4}{3}$

(C) is correct

(D) is correct, carbon can lose and accept electrons.

8. ABCD

Sol. Probability depends on distance form the nucleus. The probability is maximum(ψ^2 = 1) around the nucleus and decreases away from it.

9. BD

Sol. Liqour ammonia is aqueous solution of NH_3.

$\therefore NH_3 + H_2O \longrightarrow NH_4^+ + OH^-$ ions

$Na + NH_3 + H_2O \longrightarrow NaOH + NH_4^+ + H_2$

10. BC

Sol. Disproportionation of sulphur takes place

$S_8 \xrightarrow{OH^-} S^{2-} + S_2O_3^{2-} + H_2O$

11. AD

Sol. For FeC_2O_4(n = 3)

M_{eq} of FeC_2O_4 = M_{eq} of MnO_4^-

or, 100 × 0.1 × 3 = V × 0.1 × 5

$\therefore$ V = 60 mL

For $Fe_2(C_2O_4)_3$, n = 6

M_{eq} of $Fe_2(C_2O_4)_3$ = M_{eq} of MnO_4^-

or, 100 × 0.1 × 6 = V × 0.1 × 5

$\therefore$ V = 120 mL

12. ACD

Sol. Gas B is incorrectly represented. When a = 0, only positive deviation takes place.

PART – B

1. 6

Sol. Molar mass of decapeptide = 796 g mol^{-1}

Decapeptide contains nine peptide linkages. So one mole of decapeptide absorbs 9 moles of H_2O for hydrolysis.

$\therefore$Mass of all amino acids obtained after hydrolysis = 796 + 18(9) = 958 g mol^{-1}

Glycine contribute = 47%

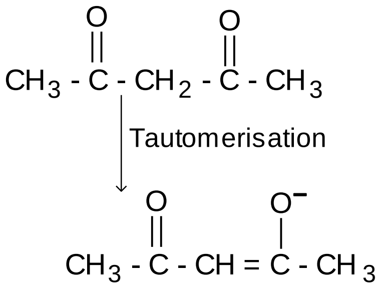
$\therefore$ Mass of glycine = $\frac{47}{100} \times 958 = 450.26$ g

Molar mass of glycine = 75 g mol^{-1}

$\therefore$ Number of glycine molecules = $\frac{450.26}{75} = 6$

2. 4

Sol. In $[Mn(acac)_3]$ the metal ion is Mn^{3+} and acac is a monodentate ligand.



$$CH_3-\overset{\overset{O}{||}}{C}-CH_2-\overset{\overset{O}{||}}{C}-CH_3 \xrightarrow{\text{Tautomerisation}} CH_3-\overset{\overset{O}{||}}{C}-CH=\overset{\overset{O^-}{|}}{C}-CH_3$$

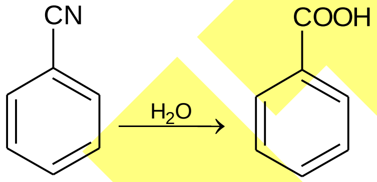
Mn^{3+} contains 7 – 3 = 4 unpaired electrons.

3. 5

Sol. C_6H_{14} has five chain isomers.

4. 60

Sol.



Molar mass of PhCN = 103

Mol. Mass of PhCOOH = 122

Moles of PhCN = $\frac{15.45}{103} = 0.15$

$\therefore$0.15 mole PhCN can produce 0.15 mole of PhCOOH

or, 15.45 g PhCN can produce(0.15 × 122) = 18.3 g PhCOOH

$\therefore$Product yield = $\frac{\text{Expt.yield}}{\text{Max.yield}} \times 100 = \frac{10.98}{18.3} \times 100 = 60\%$

5. 4

Sol. It produces two geometrical and two linkage isomers.

6. 24

Sol. Sp rotation of R-enantiomer = 48^o

Sp rotation of S-enantiomer = -48^o

25% S isomer contains 75% R isomer

$\therefore$100% R $\rightarrow 48^o$

$\therefore$75% R $\rightarrow \frac{48}{100} \times 75 = 36^o$

25% S $\rightarrow \frac{-48}{100} \times 25 = -12$

$\therefore$Sp rotation of sample = 36 - 12 = 24^{o}

7. 2.5

Sol. Total number of bonds = 8

Number of coordinate bonds = 2

$\therefore$% of coordinate bonds = $\frac{2}{8}\times 100 = 25\%$

$\frac{x}{10} = \frac{25}{10} = 2.5$

8. 1.2

Sol. a = 5, b = 5, c = 2

$\frac{a+b+c}{10} = \frac{12}{10} = 1.2$

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SECTION – Iii : MATHEMATICS

PART – A

1. C

Sol. $$\lim_{x\to 0}\left(\frac{g(2+\sin x)-g(2+x\cos x)}{\sin x - x\cos x}\right)\cdot\left(\frac{\sin x - x\cos x}{x-\sin x}\right)$$

$$= g'(2)\lim_{x\to 0}\left(\frac{\sin x - x\cos x}{x-\sin x}\right)\left(\frac{0}{0}\right)$$

$$= g'(2)\lim_{x\to 0}\left(\frac{x\sin x}{1-\cos x}\right) = 2g'(2)$$

2. B

Sol. $$\int\frac{2x+1}{\left(x^2+4x+1\right)^{3/2}}dx = \int\frac{2x+1}{x^3\left(1+\frac{4}{x}+\frac{1}{x^2}\right)^{3/2}}dx = \int\frac{2x^{-2}+x^{-3}}{\left(1+\frac{4}{x}+\frac{1}{x^2}\right)^{3/2}}dx$$

Now put $\frac{1}{x^2}+\frac{4}{x}+1=t^2$.

3. B

Sol. $$f'(x)=\frac{1}{2}\int_0^x 2(x-t)g(t)dt+\frac{1}{2}(x-x)^2 g(x)-0$$

$$=\int_0^x (x-t)g(t)dt$$

$$f''(x)=\int_0^x g(t)dt+(x-x)g(x)-0$$

$$f'''(x)=g(x)$$

$$f'''(1)-f''(1)=g(1)-\int_0^1 g(t)dt$$

$$=5-2=3$$

4. A

Sol. Required sum of coefficient of x^{10} in the expansion of $(1+x)^{30}(1+x)^{20}(1+x)^{10}$ i.e. ${}^{60}C_{10}$.

5. BC

Sol. $m_{AC}=\frac{-1}{3}=\tan\theta$

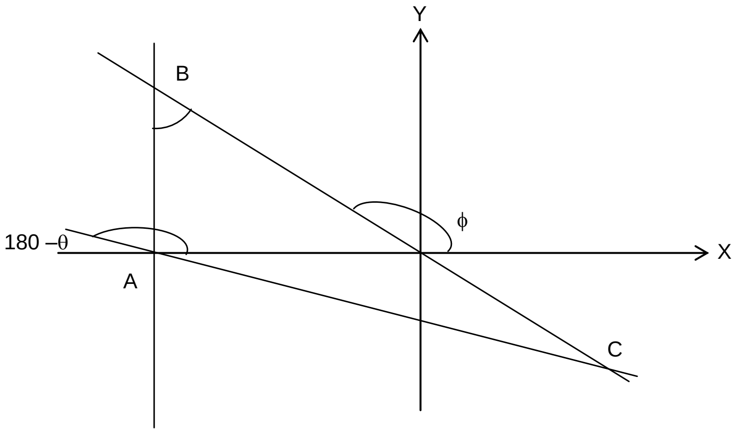
$\mathrm{Tan}\,A=\mathrm{Tan}(90+180-\theta)$

$=\mathrm{Tan}(270-\theta)=\cot\theta=-3$

……..(1)

$$\tan C=\left|\frac{m_{BC}-m_{AC}}{1+m_{BC}\,m_{AC}}\right|=\left|\frac{-3+\frac{1}{3}}{1+1}\right|=\frac{4}{3}$$

…………..(2)



$\tan\phi=-3$

$B=\phi-90^{o}$

$\mathrm{Tan}\,B=\mathrm{Tan}(\phi-90)=-\cot\phi=\frac{1}{3}$

So $\tan A+\tan B+\tan C=-3+\frac{1}{3}+\frac{4}{3}=\frac{-4}{3}$

Now check Others.

6. AC

Sol. ΔABC is isosceles right angled at A

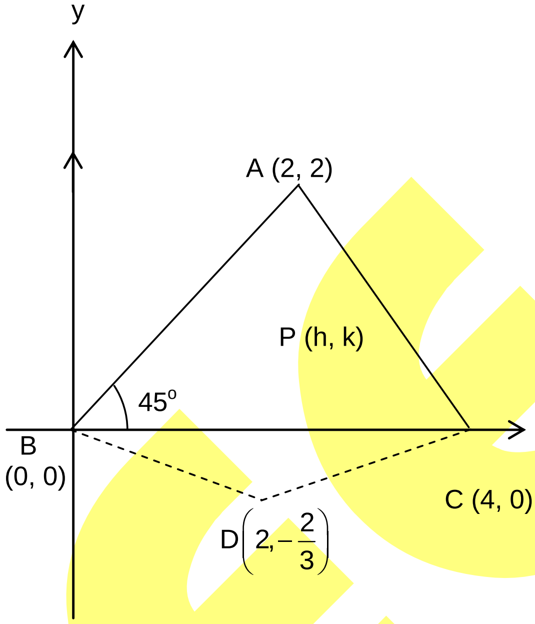
Let P be (h, k)

Let ABC be triangle as shown in figure

Equation BC : y = 0

$AB : y - x = 0$

$AC : x + y - 4 = 0$



Given condition

$$k^2 = \frac{1}{2}\frac{|h+k-4|}{\sqrt{1+1}}.\frac{|k-h|}{\sqrt{1+1}}$$

Replace (h, k) by (x, y)

$$\Rightarrow y^2 = |(x+y-4)(y-x)|$$

$$= -\frac{1}{4}(x+y-4)(x-y)$$

$$\Rightarrow 4y^2 = -\left(x^2 - y^2 - 4(x-y)\right)$$

$$x^2 + 3y^2 - 4x + 4y = 0$$

$$(x-2)^2 + 3\left(y^2 + \frac{4}{3}y + \frac{4}{9}\right) = 4 + \frac{4}{3}$$

$$(x-2)^2 + 3\left(y + \frac{2}{3}\right)^2 = \frac{16}{3}$$

$$\frac{(x-2)^2}{\frac{16}{3}} + \frac{\left(y+\frac{2}{3}\right)^2}{\frac{16}{9}} = 1$$

$$\frac{16}{9} = \frac{16}{3}\left(1 - c^2\right)$$

$$\frac{1}{3} = 1 - c^2 \Rightarrow c = \sqrt{\frac{2}{3}}$$

$$D = \left(2, \frac{-2}{3}\right)$$

$$\text{Area } = Ar(ABC) + Ar\,BCD$$

$$= \frac{1}{2}.4.2\sqrt{2} \times \frac{1}{\sqrt{2}} + \frac{1}{2} \times 4 \times \frac{2}{3}$$

$$= 4 + \frac{4}{3} = \frac{16}{3}$$

7. ABCD

Sol. $\left|\vec{a} + \vec{b} - \vec{c}\right|^2 + \left|\vec{b} + \vec{c} - \vec{a}\right|^2 + \left|\vec{c} + \vec{a} - \vec{b}\right|^2 = 36$

$$\Rightarrow 3\left(\vec{a}.\vec{a} + \vec{b}.\vec{b} + \vec{c}.\vec{c}\right) - 2\vec{a}.\vec{b} - 2\vec{b}.\vec{c} - 2\vec{a}.\vec{c} = 36$$

$$\Rightarrow 3(3+3+3) - 2\left(\vec{a}.\vec{b} + \vec{b}.\vec{c} + \vec{c}.\vec{a}\right) = 36$$

$$\Rightarrow \vec{a}.\vec{b} + \vec{b}.\vec{c} + \vec{c}.\vec{a} = \frac{-9}{2}$$

$$2\vec{a}.\vec{b} + 2\vec{b}.\vec{c} + 2\vec{c}.\vec{a} + 9 = 0$$

$$2\vec{a}.\vec{b} + 2\vec{b}.\vec{c} + 2\vec{c}.\vec{a} + \vec{a}.\vec{a} + \vec{b}.\vec{b} + \vec{c}.\vec{c} = 0$$

$$\Rightarrow \left|\vec{a} + \vec{b} + \vec{c}\right|^2 = 0$$

$$\Rightarrow \vec{a} + \vec{b} + \vec{c} = 0$$

Now verify (B), (C), (D)

8. ABCD

Sol. $|\sin x| + |\cos x| \ge 1 \forall x \in R$

Note $1 \le |\sin x| + |\cos x| < \sqrt{2}$ so $x \in R$

$\Rightarrow a, b, c, d$ all are correct.

9. AC

Sol. $$S_n = \sum_{r=1}^{n} \frac{2r+3}{r(r+1)3^r} = \sum_{r=1}^{n} \frac{3(r+1)-r}{r(r+1)3^r} = \sum_{r=1}^{n} \frac{1}{r\,3^{r-1}} - \frac{1}{(r+1)3^r}$$

$$= 1 - \frac{1}{(n+1).3^n}$$

10. ABC

Sol. $$f(x) = \tan^{-1}\left(x^4 - x^2 + \frac{1}{4} - 2 + \tan^{-1}\alpha\right) = \tan^{-1}\left(\left(x^2 - \frac{1}{2}\right)^2 + \tan^{-1}\alpha - 2\right)$$

For ‘f’ to be surjective, $\tan^{-1}\alpha - 2 = -1 \Rightarrow \alpha = \tan 1$

Now, verify the options.

11. ABD

Sol. When k = 0

$$\underset{x\to\infty}{\text{Lt}} \frac{2x^3 - \left(\tan^{-1}x\right)^3}{\frac{8}{\pi}x^3.\frac{\pi}{2} + 0 + 0} = \underset{x\to\infty}{\text{Lt}} \frac{2 - \left(\frac{\tan^{-1}x}{x}\right)^3}{4} = 2 - 1$$

$$= \frac{2-0}{4} = \frac{1}{2}$$

So k can be 0.

If $k \ne 0$ then $$\underset{x\to\infty}{\text{Lt}} \frac{2x^3 - \left(\tan^{-1}x\right)^3}{x^3\left[\frac{8}{\pi}\cot^{-1}|kx| + k^2\frac{\sin\frac{1}{x^3}}{\frac{1}{x^3}} - 3k\right]}$$

$$\underset{x\to\infty}{\text{Lt}} \frac{2 - \left(\frac{\tan^{-1}x}{x}\right)^3}{\frac{8}{\pi}\cot^{-1}(kx) + \frac{k^2\sin^{-1}\frac{1}{x^3}}{\frac{1}{x^3}} - 3k} = \frac{2-0}{\frac{8}{\pi}\times 0 + k^2 - 3k} = \frac{1}{2}$$

$\Rightarrow k^2 - 3k = 4$

$\Rightarrow k = 4, -1$

12. ABD

Sol. $$x^2\frac{dy}{dx} = y^2 e^{\frac{1}{x}} \Rightarrow \frac{dy}{y^2} = \frac{e^{\frac{1}{x}}}{x^2}dx$$

Integrating both sides,

$$\frac{-1}{y} = \int \frac{e^{\frac{1}{x}}}{x^2}dx + C \Rightarrow \text{ Putting } \frac{1}{x} = t \Rightarrow \frac{-1}{x^2}dx = dt \Rightarrow -\frac{1}{y} = -\int e^t\,dt + C \Rightarrow$$

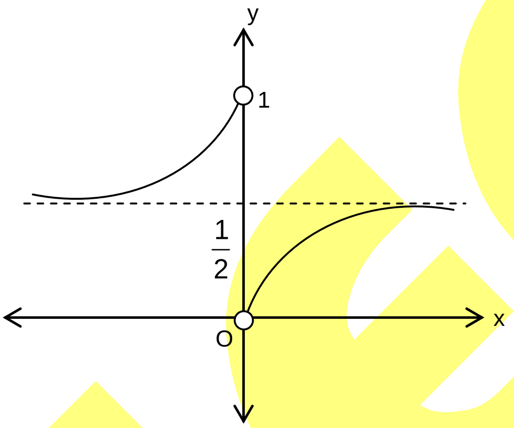
$$\frac{-1}{y}=e^{-t}+C\Rightarrow\frac{-1}{y}=-e^{\frac{1}{x}}+C$$

$$\because\ \lim_{x\to0^-}f(x)=1\Rightarrow-1=0+C\Rightarrow C=-1$$

$$\frac{-1}{y}=-e^{\frac{1}{x}}-1\Rightarrow y=\frac{1}{1+e^{\frac{1}{x}}}\Rightarrow\frac{dy}{dx}=\frac{1}{\left(1+e^{\frac{1}{x}}\right)^2}e^{\frac{1}{x}}\left(\frac{-1}{x^2}\right)=\frac{e^{\frac{1}{x}}}{x^2\left(1+e^{\frac{1}{x}}\right)^2}$$

$$\therefore\quad\frac{dy}{dx}>0\ \forall x\in R-\{0\}$$

$$\lim_{x\to\pm\infty}\frac{1}{1+e^{\frac{1}{x}}}=\frac{1}{2}\text{ and }\lim_{x\to0^+}\frac{1}{1+e^{\frac{1}{x}}}=0$$



$\therefore$ Graph of the function is
From the graph options (A) (B) and (D) are correct.

PART – B

1. 6

Sol.
$$\frac{\cos\frac{B-C}{2}.\cos\frac{A}{2}}{\cos\left(90-\frac{A}{2}\right)\cos\frac{A}{2}}+\frac{\cos\left(\frac{C-A}{2}\right)\cos\frac{B}{2}}{\cos\left(90-\frac{B}{2}\right)\cos\frac{B}{2}}+\frac{\cos\left(\frac{A-B}{2}\right)\cos\frac{C}{2}}{\cos\left(90-\frac{C}{2}\right)\cos\frac{C}{2}}$$

$$\frac{2\cos\frac{B-C}{2}\sin\frac{B+C}{2}}{2\sin\frac{A}{2}\cos\frac{A}{2}}+\frac{2\cos\left(\frac{C-A}{2}\right)\sin\left(\frac{C+A}{2}\right)}{2\sin\frac{B}{2}\cos\frac{B}{2}}+\frac{2\cos\left(\frac{A-B}{2}\right)\sin\left(\frac{A+B}{2}\right)}{2\sin\frac{C}{2}\cos\frac{C}{2}}$$

$$\frac{\sin B+\sin C}{\sin A}+\frac{\sin A+\sin C}{\sin B}+\frac{\sin A+\sin B}{\sin C}$$

$$\frac{\sin B}{\sin A}+\frac{\sin C}{\sin A}+\frac{\sin A}{\sin B}+\frac{\sin C}{\sin B}+\frac{\sin A}{\sin C}+\frac{\sin B}{\sin C}\ge6$$

2. 1

Sol. $[f(\alpha)]^2+[f'(\alpha)]^2=0$ both $f(\alpha)$ and $f'(\alpha)$ are real so $f(\alpha)=0=f'(\alpha)$

$$\underset{x\to\alpha}{\text{Lt}}\frac{f(x)}{f'(x)}\left[\frac{f'(x)}{f(x)}\right]$$

$$\underset{x\to\alpha}{\text{Lt}}\frac{f(x)}{f'(x)}\left(\frac{f'(x)}{f(x)}-\left\{\frac{f'(x)}{f(x)}\right\}\right)\qquad\{\cdot\}\text{ represents fraction part function}$$

$$=\underset{x\to\alpha}{\text{Lt}}\,1-\frac{f(x)}{f'(x)}\left\{\frac{f'(x)}{f(x)}\right\}$$

$1-0\ x$ any number is $[0,1)$

3. 1

Sol. $\alpha+\beta=p$

$$\alpha\beta = -p - c$$
$$\alpha\beta = -(\alpha+\beta) - c$$
$$\Rightarrow \alpha+\beta+\alpha\beta = -c$$
$$\alpha+\beta+\alpha\beta+1 = -c+1$$
$$\Rightarrow (\alpha+1)(\beta+1) = 1-c$$
$$\frac{(\alpha+1)^2}{(\alpha+1)^2+c-1} + \frac{(\beta+1)^2}{(\beta+1)^2+c-1}$$
$$\Rightarrow \frac{(\alpha+1)^2}{(\alpha+1)^2-(\alpha+1)(\beta+1)} + \frac{(\beta+1)^2}{(\beta+1)^2-(\alpha+1)(\beta+1)}$$
$$= \frac{\alpha+1}{\alpha-\beta} + \frac{\beta+1}{\beta-\alpha} = 1$$

4. 94

Sol. $m = {}^5C_4 . 4! = 5! =$ Total

When exactly 2 elements of A maps to itself i.e. $f(3)=3, f(4)=4$

$\therefore$ From 5, 6, 7 select any 2 in ${}^3C_2 \times 2! = 6$

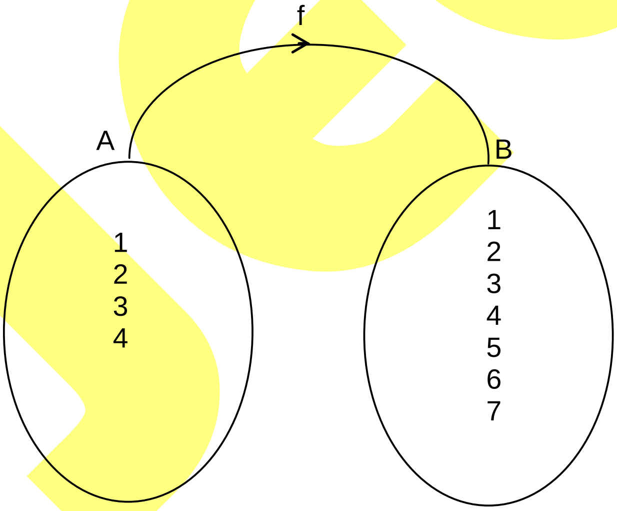
When exactly one element of A maps to itself say $f(3)=3$

Now 4 can be map in 3 ways and remaining elements $3\times 2 = 6$

$\therefore \quad {}^2C_1 \times 3 \times 6 = 36$

Total $= 36+6 = 42 \Rightarrow 5! - 42 = 78 = m$

$n = {}^2C_1 . {}^2C_1 . {}^2C_1 . {}^2C_1 = 16$



5. 5

Sol. Let AF = x = DE and AE = y = DF

As ΔCAB is ΔCED

So, $\dfrac{CE}{CA} = \dfrac{DE}{AB} \Rightarrow \dfrac{b-y}{b} = \dfrac{x}{c} \Rightarrow y = b\left(1-\dfrac{x}{c}\right)$

(Here BC = a, AC = b and AB = c)

Now, area of parallelogram AFDE

$= S = (AF)(EM) = xy \sin A \Rightarrow S = x.b\left(1-\dfrac{x}{c}\right)\sin A$

Note: $\sin A$ is fixed …(i)

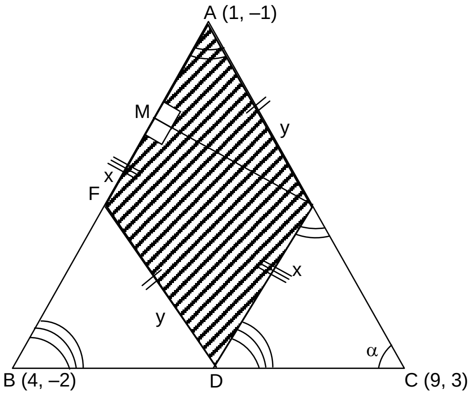
Now, differentiating both sides of equation (i) with respect to x, we get

$$\frac{dS}{dx} = \frac{b}{c}(c-2x)\sin A = 0 \Rightarrow x = \frac{c}{2}$$

Also, $\left.\dfrac{d^2S}{dx^2}\right]_{x=\frac{c}{2}} = \dfrac{-2b}{c} < 0$

So, S is maximum when $x = \dfrac{c}{2}$.

Now, $S_{max} = \dfrac{1}{4}bc \sin A$



$$=\frac{1}{2}\left(\frac{1}{2}bc\sin A\right)=\frac{1}{2}\left[\text{area}\left(\Delta ABC\right)\right]=\frac{1}{4}\left\|\begin{matrix}1 & -1 & 1\\ 4 & -2 & 1\\ 9 & 3 & 1\end{matrix}\right\|=\frac{20}{4}=5$$

(square units.)

6. 3

Sol. $f(x)=\begin{cases} xe^{x}, & x\ge 0\\ -xe^{-x}, & x\le 0\end{cases}$

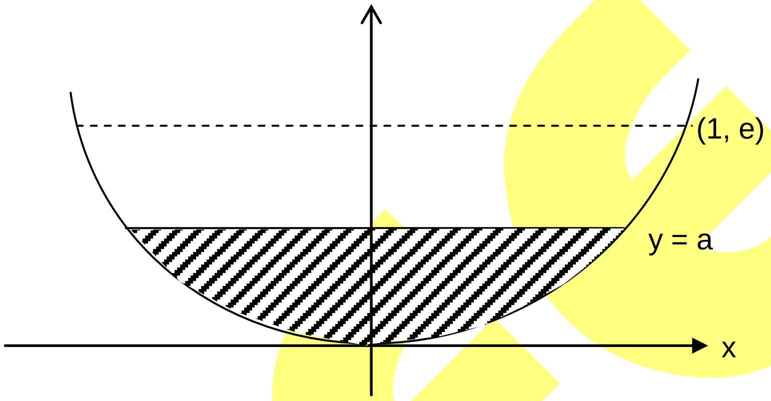
For maximum area $a=e$

$$A_{max}=2\int_0^1\left(e-xe^{x}\right)dx$$

$$=2\left[ex-\left(xe^{x}-e^{x}\right)\right]_0^1$$

$$=2(e-1)$$

Hence, $[A]=3$



7. 1

Sol. $$\sum_{r=0}^{7}A_r=\begin{bmatrix}\sum_{r=0}^{7}r\left({}^{7}C_r\right) & 0\\ 0 & \sum_{r=0}^{7}(7-r)\,{}^{7}C_r\end{bmatrix}$$

$$=\begin{bmatrix}7.2^{6} & 0\\ 0 & 7.2^{7}-7.2^{6}\end{bmatrix}$$

$$=\begin{bmatrix}7.2^{6} & 0\\ 0 & 7.2^{6}\end{bmatrix}$$

$$a+b=2.7.2^{6}=14\times 64=896$$

8. 5

Sol. $$\frac{x^3-6x^2+11x-6}{x^3+x^2-10x+8}+\frac{a}{30}=0$$

$$\frac{(x-1)(x-2)(x-3)}{(x-1)(x-2)(x+4)}+\frac{a}{30}=0$$

$$\Rightarrow\frac{x-3}{x+4}+\frac{9}{30}=0,\ x\ne 1,2$$

Above equation do no have solution then $-\frac{a}{30}$ should not belong to range of

$$y=\frac{x-3}{x+4},\ x\ne 1,\ 2$$

Range of above is $R-\left\{1,\frac{-2}{5},-\frac{1}{6}\right\}$

So, $\frac{-a}{30}=1,\ \frac{-2}{5},-\frac{1}{6}$

$\Rightarrow a=-30,\ 12,\ 5$

So least value of a = 5

$$-\frac{a}{30}=\frac{x-3}{x+4}$$

FIITJEE RBT-2 for (JEE-Advanced)

BATCHES – Two Yr CRP2123(All)

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 4

QP CODE: 100175

PAPER - 2

Time Allotted: 3 Hours **Maximum Marks: 186**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections.**
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. Each **Section** is further divided into **Two Parts**: **Part-A & B** in the OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with ***Blue/Black Ball Point Pen*** for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Two Part.

(i) **PART–A (01–08)** contains (8) Multiple Choice Questions which have **One or More Correct** answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in **–2** marks, as a wrong option is also darkened.

(ii) **Part-A (09-12) –** This section contains Two (02) List-Match Sets, each List-Match set has Two (02) Multiple Choice Questions. Each List-Match set has two lists: List-I and List-II. FOUR options are given in each Multiple Choice Question based On List-I and List-II and ONLY ONE of these four options satisfies the condition asked in the Multiple Choice Question. Each question carries **+3 Marks** for correct combination chosen and **-1 marks** for wrong options chosen.

(iii) **Part-B (01-06)** contains six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+3 marks** for correct answer. **There is no negative marking.**

Name of the Candidate :____

Batch :____________________ **Date of Examination :**___________________

Enrolment Number :____

SECTION – I : PHYSICS

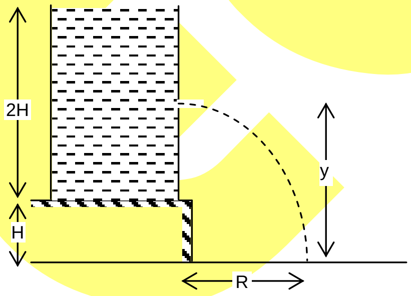
(PART – A)

(One or More Than One Options Correct Type)

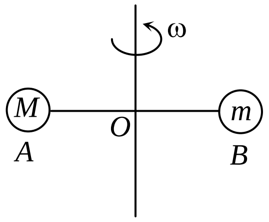
This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONE** or **MORE THAN ONE is correct.**

1. An artificial satellite is in a circular orbit around the earth. The universal gravitational constant starts decreasing at time t = 0 at a constant rate with respect to time t. Then the satellite has its
(A) path gradually spiralling out away from the centre of the earth.
(B) path gradually spiralling in towards the centre of the earth.
(C) angular momentum about the centre of the earth remains constant.
(D) potential energy increases.

2. A tank is filled upto a height 2H with a liquid and is placed on a platform of height H from the ground. The distance y from the ground where a small hole is made in the tank, to get the maximum horizontal range R is
(A) 2H
(B) 3 H/2
(C) 5 H/4
(D) H



3. Two balls of mass M = 9 g and m = 3 g are attached by massless threads AO and OB. The length AB is 1 m. They are set in rotational motion in a horizontal plane about a vertical axis at O with constant angular velocity ω. The ratio of length AO and OB $\left(\frac{AO}{OB}\right)$ for which the tension in threads are same will be

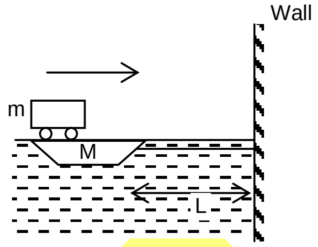


(A) $\frac{1}{3}$ (B) 3 (C) $\frac{2}{3}$ (D) $\frac{3}{2}$

4. A particle moves along positive branch of the curve $y = \frac{x}{2}$ where $x = \frac{t^3}{3}$, x and y are measured in metres and t in seconds, then:
(A) The velocity of particle at t = 1 s is $\hat{i} + \frac{1}{2}\hat{j}$
(B) The velocity of particle at t = 1 s is $\frac{1}{2}\hat{i} + \hat{j}$
(C) The acceleration of particle at t = 1 s is $2\hat{i} + \hat{j}$
(D) The acceleration of particle at t = 2 s is $\hat{i} + 2\hat{j}$

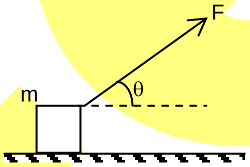
Space For Rough Work

5. A car of mass m is initially at rest on the boat of mass M tied to the wall of dock through a massless inextensible string. The car accelerates from rest to velocity v_0 in times t_0. At $t = t_0$ the car applies brake and comes to rest relative to the boat in negligible time. Neglect friction between the boat and water; the time 't' at which boat will strike the wall is



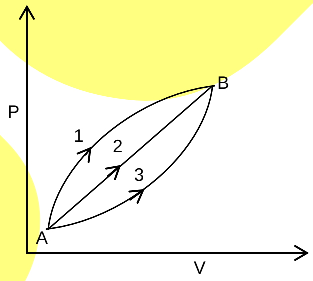
(A) $t_0 + (L/v_0)$
(B) $t_0 + \frac{L(M+m)}{mv_0}$
(C) $\frac{LM}{mv_0}$
(D) none of these

6. A force F acts on a smooth block of mass m placed on a horizontal floor at an angle θ with horizontal. On the block



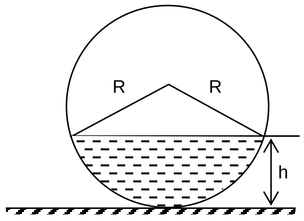
(A) the net force $= F\cos\theta$ if $F\sin\theta < mg$
(B) acceleration $= \frac{F\cos\theta}{m}$ when $F > mg\,\text{cosec}\theta$
(C) acceleration $= \frac{F}{m}$ if $F\sin\theta > mg$
(D) $N = mg - F\sin\theta$ if $F\sin\theta < mg$

7. In figure, a certain mass of gas traces three paths 1,2,3 from state A to state B. If work done by the gas along three paths are W_1, W_2, W_3 respectively, then



(A) $W_1 < W_2 < W_3$
(B) $W_1 = W_2 = W_3$
(C) $W_1 > W_2 > W_3$
(D) cannot say

8. A liquid is filled in a spherical container of radius R till a height h. At this position the liquid surface at the edges is also horizontal. The contact angle is



(A) 0
(B) $\cos^{-1}\left(\frac{R-h}{R}\right)$
(C) $\cos^{-1}\left(\frac{h-R}{R}\right)$
(D) $\sin^{-1}\left(\frac{R-h}{R}\right)$

Space For Rough Work

This section contains **2 List-Match Sets**, each List-Match set has **2 Multiple Choice Questions**. Each List-Match set has two lists: List-I and List-II. Four options are given in each Multiple Choice Question based On List-I and List-II and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

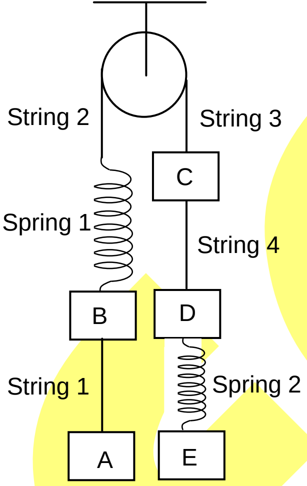
List Match Set (09-10)

The system shown below is initially in equilibrium

$m_A = m_B = 3\text{kg}$

$m_C = m_D = m_E = 2\text{kg}$

Take g = 10 m/s^2



List–I gives the four strings while List–II the value of the tension in the strings.

List – I		List – II	
(I)	String 1	(P)	10 N
(II)	String 2	(Q)	20 N
(III)	String 3	(R)	30 N
(IV)	String 4	(S)	40 N
		(T)	60 N
		(U)	0 N

9. If the spring 1 is cut, match the correct option for the tension in the strings just after the cutting.
(A) I → R, II → T, III → T, IV → P
(B) I → U, II → T, III → T, IV → P
(C) I → U, II → U, III → U, IV → P
(D) I → R, II → S, III → S, IV → P

10. If the spring 2 is cut, match the correct option for the tension in the strings just after the cutting.
(A) I → R, II → T, III → T, IV → R
(B) I → R, II → U, III → U, IV → R
(C) I → U, II → R, III → R, IV → P
(D) I → P, II → Q, III → Q, IV → R

Space For Rough Work

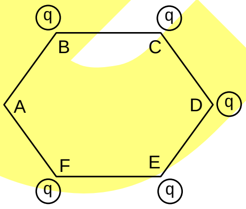
FIITJEE

List Match Set (11-12)

If some charges are place at the corners of a regular hexagon and E is the electric field due to one charge at the centre.

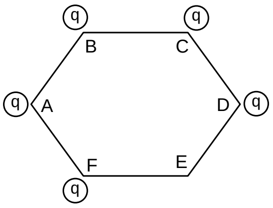
List – I		**List – II**	
(I)	If charge at B is removed, then electric field at centre become	(P)	Zero
(II)	If charge at C is removed, then electric field at centre become.	(Q)	2E
(III)	If charge at D is removed, then electric field at centre become.	(R)	$\frac{2E}{\sqrt{3}}$
(IV)	If charge at B and C both are removed, then electric field at centre become	(S)	$\sqrt{3}\,E$
		(T)	$\frac{E}{2}$
		(U)	E

11. If five charges are kept at five vertices of regular hexagon as shown, then



(A) I $\rightarrow$ S, II $\rightarrow$ U, III $\rightarrow$ Q, IV $\rightarrow$ P
(B) I $\rightarrow$ S, II $\rightarrow$ U, III $\rightarrow$ P, IV $\rightarrow$ Q
(C) I $\rightarrow$ S, II $\rightarrow$ Q, III $\rightarrow$ P, IV $\rightarrow$ U
(D) I $\rightarrow$ Q, II $\rightarrow$ U, III $\rightarrow$ P, IV $\rightarrow$ S

12. If five charges are kept at five vertices of regular hexagon as shown, then



(A) I $\rightarrow$ P, II $\rightarrow$ R, III $\rightarrow$ S, IV $\rightarrow$ U
(B) I $\rightarrow$ P, II $\rightarrow$ U, III $\rightarrow$ R, IV $\rightarrow$ S
(C) I $\rightarrow$ P, II $\rightarrow$ U, III $\rightarrow$ S, IV $\rightarrow$ U
(D) I $\rightarrow$ Q, II $\rightarrow$ U, III $\rightarrow$ S, IV $\rightarrow$ R

(PART – B)

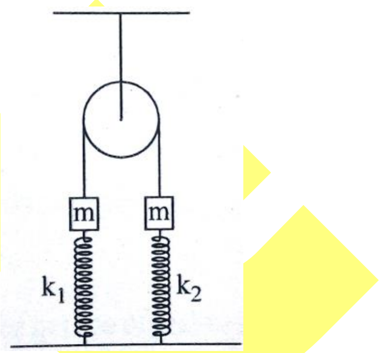
(Numerical Type)

Part-B (01-06) contains six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **Two decimals Places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)**.**

1. At a distance of 20 m from a point source, the loudness is 30 dB. After a minimum distance of $k(300\sqrt{10})$ metre the sound is inaudible. Value of 'k' is

2. A proton is fired from very far away towards a nucleus with charge = 120 e, where e is the electronic charge. It makes a closest approach of 10 fm to the nucleus. The de Broglie wavelength (in units of fm) of the proton at its start is: (take the proton mass, $m_p = (5/3) \times 10^{-27}$ kg ; $h/e = 4.2 \times 10^{-15}$ J.s./C; $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ m/F; 1 fm = 10^{-15} m)

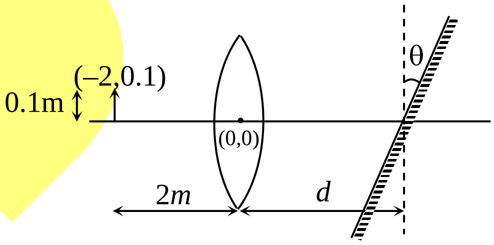
3. On the diagram, two blocks of equal mass are connected by an ideal string. The values of m = 1 kg and k_2 = 100 N/m are given. Initially, both springs are relaxed. Then the left block is slowly pulled down a distance 0.1 m and released. The maximum possible value of k_1 (in N/m) for which both blocks will have same magnitude of acceleration just after releasing, is k. Both spring have natural length of 2m. Then find the value of $\frac{k}{100}$.



4. A cube of wood supporting 200 gm mass just floats in water. When the mass is removed, the cube is raised by 2 cm. The size of the cube is 20 k cm, then the value of k is

5. Two vibrating strings of the same material but of lengths L and 2L have radii 2r and r respectively. They are stretched under the same tension. Both the strings vibrate in their fundamental modes, the one of length L with frequency f_1 and other with frequency f_2. Find the ration $\frac{f_1}{f_2}$?

6. A convex lens of focal length 1.5m is placed in a system of coordinate axis such that its optical centre is at origin and principal axis coinciding with the x-axis. An object and a plane mirror are arranged on the principal axis as shown in figure. Find the value of d (in m) so that y-coordinate of final image (after refraction and reflection) is 0.3m. (Take tan θ = 0.3)



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SECTION – II : CHEMISTRY

(PART – A)

(One or More Than One Options Correct Type)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONE** or **MORE THAN ONE is correct.**

1. Compound/s which contain 3c – 2e$^-$ bond.
(A) $(BeH_2)_n$
(B) $Al_2(CH_3)_6$
(C) B_2H_6
(D) Al_2Cl_6

2. $\psi(x, y, z)$ describe the wave function of a particle the probability of finding the particle between x and x + dx, y and y + dy, z and z + dz can be expressed as
(A) $\psi^*(x, y, z)\ \psi(x, y, z)$
(B) $|\psi(x, y, z)|^2$ dxdydz
(C) $\psi^*(x, y, z)\ \psi(x, y, z)$ dxdydz
(D) $\int_{-\infty}^{\infty} dx \int_{-\infty}^{\infty} dy \int_{-\infty}^{\infty} dz\ \psi^*(x, y, z)\ \psi(x, y, z)$

3. In water, the enthalpy of a protein in its folded state (H_f) is lower than that in its unfolded state(H_{uf}). The entropies of the folded and unfolded states are S_f and S_{uf} respectively. The condition(s) under which this protein spontaneously folds in water at a temperature T is(are)
(A) $S_{uf} < S_f$
(B) $S_{uf} = 0$
(C) $S_{uf} = S_f$
(D) $(S_f – S_{uf}) > H_f – H_{uf}/T$

4. The transition metal complex(es) with zero magnetic moment, zero dipole moment and CFSE of $-2.4\Delta_0$ is(are)
(A) $[Mn(CO)_5\ (CH_3)]$
(B) [Trans-Ni(ethylenediamine)$_2$Cl$_2$]
(C) $[trans\text{-}Co(CN)_4(H_2O)_2]^-$
(D) $[Trans\text{-}Fe(CN)_4Cl_2]^{4-}$

5. The organometallic reagent(s) among the following is/are
(A) lithium divnylcuprate
(B) lilthium disopropylamide
(C) potassium tert-butoxide
(D) isopropyl magnesiumiodide

6. The correct statement(s) among the following is/are
(A) secondary structure of a polypeptide describes the number and type of amino acid residues
(B) uracil is a pyrimidine nucleobase
(C) natural fatty acids have odd number of carbon atoms
(D) reaction of D-glucose with $Ca(OH)_2$ gives a product mixture containing(D)-fructose, D-mannose and (D)-glucose

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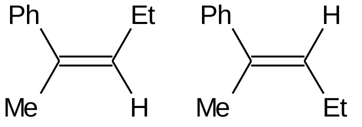
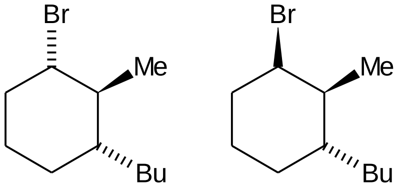
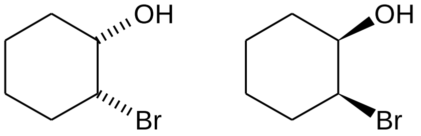
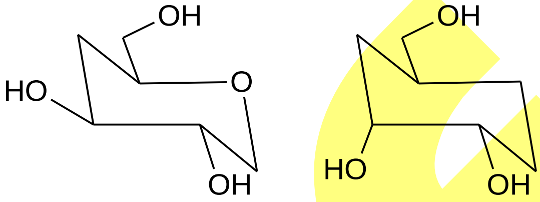
7. The diastereomeric pair(s) among the following option(s) is/are

(A)


(B)


(C)


(D)


8. With reference to the variation of molar conductivity ($\wedge_m$) with concentration for a strong electrolyte in aq. solution, the incorrect statement is

(A) the asymmetric effect contributes to decrease $\wedge_m$ whereas the electrophoretic effect contributes to increase $\wedge_m$.

(B) the asymmetric effect contributes to increase $\wedge_m$ whereas the electrophoretic effect contributes to decrease $\wedge_m$.

(C) both asymmetry effect and electrophoretic effect contribute to decrease $\wedge_m$.

(D) both asymmetry effect and electrophoretic effect contribute to increase $\wedge_m$.

This section contains **2 List-Match Sets**, each List-Match set has **2 Multiple Choice Questions**. Each List-Match set has two lists: List-I and List-II. Four options are given in each Multiple Choice Question based On List-I and List-II and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

List Match Set (09-10)

Match the lists and answer the question.

	List– I		**List – II**
(I)	One mole of nitrogen gas contained in a cylinder at 300 K is allowed to expand isothermally against an external pressure of 5 atm	(P)	w > 0
(II)	3 moles of helium gas at 1 atm are compressed reversibly and isothermally at 400 K to 5 atm pressure	(Q)	$\Delta U = 0$
(III)	An ideal gas is compressed reversibly and adiabatically from a volume of 1 dm^3 to a volume of 0.25 dm^3	(R)	$\Delta H = 0$
(IV)	One mole of liquid benzene is converted reversibly into vapour at its boiling point by heating it	(S)	$\Delta H > \Delta U$

9. Which combination is correct according to the above list?

(A) I → P
(B) II → S
(C) III → PS
(D) IV → PR

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10. Which combination is correct according to the above list?
(A) I → QR (B) II → QS (C) III → Q (D) IV → PR

List Match Set (11-12)

Match the lists and answer the question.

When we titrate sodium carbonate solution(in beaker) with hydrochloric acid

List– I		**List – II**	
(I)	At the start of titration	(P)	Buffer solution of HCO_3^- & CO_3^{2-}
(II)	Before the first equivalent point	(Q)	Buffer solution of H_2CO_3 & HCO_3^-
(III)	At the first equivalent point	(R)	Amphiprotic anion pH = $1/2\left(pK_{a_1}+pK_{a_2}\right)$
(IV)	Between the first and second equivalent points	(S)	Hydrolysis of CO_3^{2-}

11. Which combination is correct according to the above list?
(A) I → S (B) II → R (C) III → Q (D) IV → P

12. Which combination is correct according to the above list?
(A) I → P (B) II → R (C) III → S (D) IV → Q

(PART – B)

(Numerical Type)

Part-B (01-06) contains six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **Two decimals Places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)**.**

1. The enthalpy of formation for CH_4(g), C(g) and H(g) are -75, 717 and 218 kJ mol^{-1} respectively the enthalpy of the C – H bond in kJ mol^{-1} is

2. The number of P – H bonds in Hypophosphoric acid is _______

3. Number of vertices in an icosahedral doso borane is

4. The number of gauche butane-interaction(s) in cis-1, 2-dimethyl cyclohexane the following compound is ______

5. 5.3 g of benzaldehyde was reacted with excess of acetophenone to produce 5.2 g of enone product as per the reaction shown below the yield of the reaction is _______%
(round off to the nearest integer)

6. Assume that the reaction of MeMgBr with ethyacetate proceeds with 100% conversion to give tert butanol. The volume of 0.2 M solution of MeMgBr required to convert 10 mL of a 0.025 M solution of ethylacetate to tert butanol is _______mL
(Round off to one decimal place)

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SECTION – III : MATHEMATICS

(PART – A)

(One or More Than One Options Correct Type)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONE** or **MORE THAN ONE is correct.**

1. Consider the function $f(x) = xe^x + (xe^x)^{-1}$ where $x \in R - \{0\}$ then which of following statement(s) is CORRECT?
(A) $f(x)$ attains it's local maxima at $x = x_0$ where $x_0 \in (0,1)$
(B) $f(x)$ attains local minima at $x = -1$
(C) $f(x)$ attains local minima at $x = x_0$ where $x_0 \in (1,\infty)$
(D) $f(x)$ attains it's local minima at $x = x_0$ where $x_0 \in (0,1)$

2. $f : R \to R$ is one – one, onto and differentiable function and graph of $y = f(x)$ is symmetrical about the point (4, 0), then
(A) $f^{-1}(2010) + f^{-1}(-2010) = 8$
(B) $\int_{-2010}^{2018} f(x)\,dx = 0$
(C) If $f'(-100) > 0$, then roots of $x^2 - f'(10)x - f'(10) = 0$ are non real
(D) If $f'(10) = 20$, then $f'(-2) = 20$

3. The value of x in $\left(0, \frac{\pi}{2}\right)$ satisfying equation $\frac{\sqrt{5}-1}{\sin x} + \frac{\sqrt{10+2\sqrt{5}}}{\cos x} = 8$ is
(A) $\frac{\pi}{10}$ (B) $\frac{3\pi}{10}$ (C) $\frac{9\pi}{10}$ (D) $\frac{7\pi}{10}$

4. Point M moved on the circle $(x-4)^2 + (y-8)^2 = 20$. Then it broke away from it and moving along a tangent to the circle cut the x – axis at point (–2, 0). The coordinates of the point on the circle at which the moving point broke away is
(A) $\left(\frac{42}{5}, \frac{36}{5}\right)$ (B) $\left(-\frac{2}{5}, \frac{44}{5}\right)$ (C) (6, 4) (D) (2, 4)

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5. If f is an odd continuous function in [–1, 1] and differentiable in $(-1, 1)$ then which of the following statement(s) is (are) correct?
(A) $f'(a) = f(1)$ for some $a \in (-1, 0)$
(B) $f'(b) = f(1)$ for some $b \in (0, 1)$
(C) $n(f(\alpha))^{n-1} f'(\alpha) = (f(1))^n$ for some $\alpha \in (-1, 0)$ and $\forall n \in N$
(D) $n(f(\beta))^{n-1} f'(\beta) = (f(1))^n$ for some $\beta \in (0, 1)$ and $n \in N$

6. Two soldiers X and Y shoot each other. If one or both are hit then shooting is over. If both shoot miss then they repeat the process. Suppose the results of shots are independent and that each shot of X will hit Y with probability $\frac{2}{5}$ and each shot of Y will hit X with probability $\frac{1}{5}$.
(A) The probability that X is not hit is $\frac{8}{13}$
(B) The probability that X is not hit is $\frac{8}{25}$
(C) The probability that both are hit is $\frac{2}{25}$
(D) The probability that both are hit is $\frac{2}{13}$

7. Let P be the plane consisting of all points that are equidistant from A (–4, 2, 1) and B (2, –4, 3) and Q denotes the plane $x - y + Cz = 1$, where $C \in R$.
(A) If $C = \frac{1}{3}$ then plane P will be parallel to Q
(B) If C = –1 then plane P will be perpendicular to Q
(C) Volume of tetrahedron formed by plane P with coordinate planes will be $\frac{2}{81}$
(D) If line $L: \frac{x-1}{1} = \frac{y+2}{3} = \frac{z-7}{-1}$ intersect plane P at $R(\alpha, \beta, \gamma)$, then $\alpha + \beta + \gamma = 12$

8. Let $A = \begin{bmatrix} x & y & -z \\ 1 & 2 & 3 \\ 1 & 1 & 2 \end{bmatrix}$ where $x, y, z \in N$ if $|\text{adj}(\text{adj}(\text{adj}(\text{adj}\, A)))| = 4^8 . 5^{16}$ then the number of such matrix is p and value of $\int_{-\pi/2}^{\pi/2} 2^{\sin x}\, dx + \int_{5/2}^{4} \sin^{-1}(\log_2(x-2))\, dx = \frac{q\pi}{4}$, then $p + q$ is
(A) 40
(B) 41
(C) 42
(D) 44

Space For Rough Work

This section contains **2 List-Match Sets**, each List-Match set has **2 Multiple Choice Questions**. Each List-Match set has two lists: List-I and List-II. Four options are given in each Multiple Choice Question based On List-I and List-II and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

List Match Set (09-10)

Consider two circles C_1 of radius a and C_2 of radius b (b > a) both lying in the first quadrant and touching the coordinate axes. In each of conditions listed in list– I, the ratio of $\frac{b}{a}$ is given in list II

	List – I		**List – II**
(I)	C_1 and C_2 touch each other.	(P)	$2+\sqrt{2}$
(II)	C_1 and C_2 are orthogonal	(Q)	3
(III)	C_1 and C_2 intersect so that common chord is longest	(R)	$2+\sqrt{3}$
(IV)	C_1 passes through center of C_2	(S)	$3+2\sqrt{2}$
		(T)	$3-2\sqrt{2}$

9. Which is correct option?

(A) I → R
(B) II → T
(C) III → Q
(D) IV → S

Consider two circles C_1 of radius a and C_2 of radius b (b > a) both lying in the first quadrant and touching the coordinate axes. In each of conditions listed in list– I, the ratio of $\frac{b}{a}$ is given in list II

	List – I		**List – II**
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(III)	C_1 and C_2 intersect so that common chord is longest	(R)	$2+\sqrt{3}$
(IV)	C_1 passes through center of C_2	(S)	$3+2\sqrt{2}$
		(T)	$3-2\sqrt{2}$

10. Which is correct option?

(A) I → Q
(B) II → S
(C) III → T
(D) IV → P

Space For Rough Work

List Match Set (11-12)

Consider square matrices of order 2 which has it is elements 0, 1, 2 and 4. N denotes the number of such matrices all elements of which are different

	List – I		**List – II**
(I)	Possible non negative values of det (A) is	(P)	2
(II)	Sum of values of determinants corresponding to N matrices is	(Q)	4
(III)	If absolute value of (det A) is least then possible value of $\left|\left(\operatorname{adj}\left(\operatorname{adj}\left(\operatorname{adj}\right)\right)\right)\right|$ is	(R)	–2
(IV)	If $\left(\det A\right)$ is algebraically least, then possible values of $\det\left(4A^{-1}\right)$ is	(S)	0
		(T)	8

11. Which is correct option?

(A) I → Q, R
(B) II → S
(C) III → Q, P
(D) IV → T

Consider square matrices of order 2 which has it is elements 0, 1, 2 and 4. N denotes the number of such matrices all elements of which are different

	List – I		**List – II**
(I)	Possible non negative values of det(A) is	(P)	2
(II)	Sum of values of determinants corresponding to N matrices is	(Q)	4
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(IV)	If $\left(\det A\right)$ is algebraically least, then possible values of $\det\left(4A^{-1}\right)$ is	(S)	0
		(T)	8

12. Which is correct option?

(A) I → P, Q, T
(B) II → R
(C) III → P, S
(D) IV → Q

Space For Rough Work

(PART – B)

(Numerical Type)

Part-B (01-06) contains six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **Two decimals Places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)**.**

1. A 3×3 determinant has entries either 1 or –1. Let S be the set of all determinants such that the product of elements of any row or column is –1. For example $\begin{vmatrix}1&-1&1\\1&1&-1\\-1&1&1\end{vmatrix}$ is an element of S and number of elements in S is m. Let $P=\begin{bmatrix}3&-2&3\\2&-2&3\\0&-1&1\end{bmatrix}$ and trace of the matrix $\text{adj}(\text{adj}P)$ is n then find the value of $\frac{m}{n}$.

2. Let z_1 and z_2 be two complex numbers such that $|z_2|=1$ and $\frac{z_1-1}{z_1+1}=\left(\frac{z_2-1}{z_2+1}\right)^2$, then find the value of $|z_1-1|+|z_1+1|$.

3. Let $<a_n>$ is an infinite geometric sequence with first term $2\cot x$ and common ratio $\sin^2 x$ and $<b_n>$ is an infinite geometric sequence with first term $\sin 2x$ and common ratio $\sin^2 x$. If $x\in\left(0,\frac{\pi}{4}\right]$, then the minimum value of $\sum_{i=1}^{\infty}a_i-\sum_{j=1}^{\infty}b_j$ is

4. Let
$$\vec{a}=(2+\sin\theta)\hat{i}+\cos(\theta)\hat{j}+\sin(2\theta)\hat{k}$$
$$\vec{b}=\sin\left(\theta+\frac{2\pi}{3}\right)\hat{i}+\cos\left(\theta+\frac{2\pi}{3}\right)\hat{j}+\sin\left(2\theta+\frac{4\pi}{3}\right)\hat{k}$$
$$\vec{c}=\sin\left(\theta-\frac{2\pi}{3}\right)\hat{i}+\cos\left(\theta-\frac{2\pi}{3}\right)\hat{j}+\sin\left(2\theta-\frac{4\pi}{3}\right)\hat{k}$$
be three vectors where $\theta\in\left(0,\frac{\pi}{2}\right)$. Let V is the maximum volume of tetrahedron whose coterminous edges are represented by the vector $2\vec{b}\times\vec{c}, 3\vec{c}\times\vec{a}$ and $\vec{a}\times4\vec{b}$ then $\frac{V}{6}=$

Space For Rough Work

5. Considering the curve $xy = 15!$. Let n be the number of points (α, β) lying on it, where $\alpha, \beta \in I^+$ and $\text{HCF}(\alpha, \beta) = 1$ then $\left[\frac{n}{13}\right]$ equals (where $[.]$ represents G.I.F.)

6. Let $g : R - \left\{\frac{3}{2}\right\} \to R - \left\{\frac{3}{2}\right\}$ be defined as $g(x) = \frac{3x+5}{2x-3}$. If $g_{2014}(x) = \frac{px-q}{-rx+s}$, where $g_{2014}(x) = \underbrace{g(g(g(...)))(x)}_{2014 \text{ times}}$, then find the value of $(p+q+r+s)$.

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Answers & Solutions

SECTION – I : PHYSICS

(PART – A)

1. **AC**

Sol. $\frac{GMm}{r^2} = \frac{mv^2}{r}$

If G keeps decreasing, earth will attract satellite with smaller force, hence leading to spiral outward path.

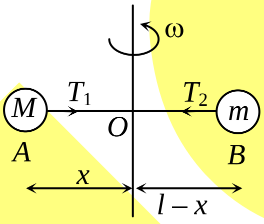
2. **B**

Sol. R to be maximum.

Y = $\frac{3H}{2} = \frac{\text{Total height}}{2}$.

3. **A**

Sol. $T_1 = T_2$



$\Rightarrow \quad M\omega^2 x = m\omega^2 (l - x)$

$x = \frac{ml}{M+m}$

$l - x = \frac{Ml}{M+m}$

$\frac{AO}{OB} = \frac{x}{l-x} = \frac{m}{M} = \frac{3}{9} = \frac{1}{3}$

4. **AC**

Sol. $\frac{dx}{dt} = t^2$ …(i)

$y = \frac{1}{2}\frac{t^3}{3}$

$\frac{dy}{dt} = \frac{t^2}{2}$ …(ii)

t = 1, $v_x = 1$, $v_y = \frac{1}{2}$; $\vec{v} = \hat{i} + \frac{1}{2}\hat{j}$

$\frac{d^2x}{dt^2} = 2t$ …(iii)

$\frac{d^2y}{dt^2} = t$ …(iv)

at t = 1 s $a_x = 2$ and $a_y = 1$

$\therefore \quad \vec{a} = 2\hat{i} + \hat{j}$.

5. **B**

Sol. After brakes applied,

Common velocity of car and boat = $\left(\frac{mv_o}{m+M}\right)$

Time taken to hit wall = $\frac{L(M+m)}{mv_o}$

6. **AD**

~~7. C~~

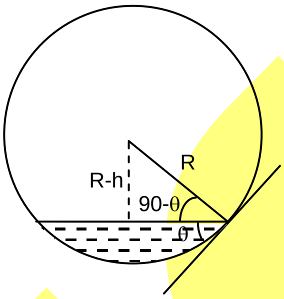
Sol. Draw F.B.D. and apply Newton's law of motion.

Sol. Work done by gas = $\int P dv$ = Area under P–V graph.

$\therefore$ $W_1 > W_2 > W_3$

8. **B**

Sol. $\sin(90-\theta) = \dfrac{R-h}{R}$



9. **C**

Sol. Just after cutting force of spring will be zero whereas the force of other spring will be unchanged.

10. **A**

Sol. Just after cutting force of spring will be zero whereas the force of other spring will be unchanged.

11. **B**

Sol. Apply principle of superposition of electric fields.

12. **C**

Sol. Apply principle of superposition of electric fields.

(PART – B)

1. **0.67**

Sol. Loudness (dB) = $10 \log_{10}\left(\dfrac{I}{I_o}\right)$ ($I_o \rightarrow$ Minimum audible intensity)

$$30 = 10 \log_{10}\left(\frac{I}{I_o}\right)$$

$$\frac{I}{I_o} = 1000$$

$\Rightarrow$ $I = (1000)I_o$

For point source, intensity $\propto \dfrac{1}{(\text{Distance})^2}$

$$(1000)I_o \propto \frac{1}{(20)^2}$$

$\Rightarrow$ $I_o \propto \dfrac{1}{(20)^2\,(1000)}$

$\Rightarrow$ Required distance = $20\sqrt{1000}$ = $200\sqrt{10}$

2. **7**

Sol. $\dfrac{P^2}{2m} = KE = \dfrac{9\times10^9\times120e^2}{10\times10^{-15}}$

$$\lambda = \frac{h}{P} = \frac{h}{e\sqrt{360\times10^{-3}}} = \frac{4.2\times10^{-15}}{0.6} = 7.$$

3. **3**

Sol. Let T be the tension in the ideal string and ‘a’ be the acceleration of the blocks at the instant of release. For the block on the left, the upward acceleration may be found from

$T + k_1x - mg = ma$

For the block on the right, the downward acceleration may be found from

$k_2x + mg - T = ma$

Adding the equations gives the acceleration of the blocks as

$a = (k_1 + k_2)x/(2m)$

However, subtracting the equations gives

$T = mg - (k_1 - k_2)x/2$

for maximum value of k_1T will be zero.

$mg = \left(\frac{k_1 - k_2}{2}\right)x$; $k_1 = 300$.

4. **0.50**

Sol. Let the length of each side of the cube is x, $x^2 \times 2 \times 1 \times g = 200 \times g$

$\Rightarrow$ x = 10 cm. $\therefore$ $k = \frac{1}{2}$.

5. **1**

Sol. $v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{T}{\pi\rho r^2}}$

$\therefore \quad \frac{v_1}{v_2} = \frac{1}{2}$; $\frac{f_1}{f_2} = \frac{v_1/2L_1}{V_2/2L_2} = \frac{v_1}{v_2} \times \frac{L_2}{L_1} = \frac{1}{2} \times 2 = 1.$

6. **5**

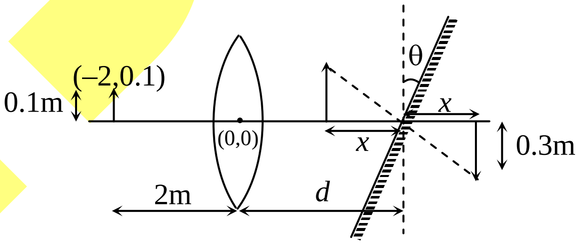
Sol. $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} - \frac{1}{-2} = \frac{1}{1.5}$; v = 6m

$m = \frac{v}{u} = -3$

$x = 6 - d$; $\tan\theta = \frac{0.3}{x}$

$\Rightarrow$ d = 5m.



FIITJEE

SECTION – II : CHEMISTRY

(PART – A)

1. ABC

Sol. Bridge bonding

$Al_2Cl_6 \Rightarrow 3c - 4e^-$ Bond

2. BC

Sol. $|\psi|^2 dv \Rightarrow 3c - 4e^-$ bond

3. ABCD

Sol. $uf \rightarrow f$

$\Delta G = \Delta H - T\Delta S$

For spontaneous ΔG = -ve

4. CD

Sol. 'VBT' with SFL pairing occur.

5. AD

Sol. Ogranometallic ⇒Carbon – Metal bond.

6. BD

Sol. Theoretical & Conceptual

7. ABD

Sol. Non-mirror images, stereoisomer.

8. ABD

Sol. "Counter ion effect + solution effect" to opposite charges electrodes.

9. C

10. A

Sol.9 & 10: $W_{Expansion} < 0$ $\Delta U = \Delta H = 0$(for isothermal process)

$W_{Compression} > 0$

11. A

12. D

Sol.12 & 13:

$CO_3^{2-} + H^+ \longrightarrow HCO_3^-$

$HCO_3^- + H^+ \longrightarrow H_2CO_3$

Before first equivalent point $\Rightarrow CO_3^{2-} + HCO_3^-$

At first equivalent point $\Rightarrow HCO_3^-$

After first equivalent point $\Rightarrow HCO_3^- + H_2CO_3$

(PART – B)

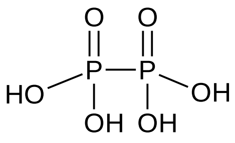
1. 416

Sol. $CH_4(g) \longrightarrow C(g) + 4H(g)$

$$\Delta H_{Rxn} = 1664,\ E_{C-H} = \frac{1664}{4} = 416$$

2. Zero

Sol.



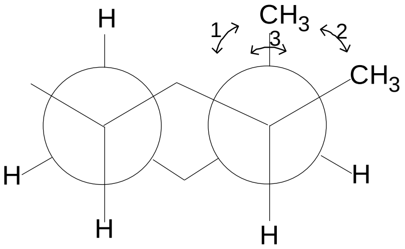
$H_4P_2O_6 \Rightarrow n_f = 4$

3. 12

Sol. $B_{12}H_{12}^{2-}$

4. 3

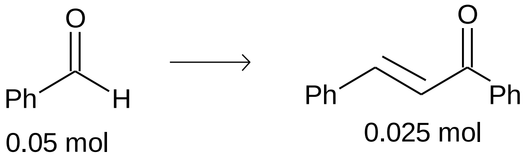
Sol.



H
CH3
CH3
H
H
H
H
H
1
2
3

5. 50

Sol.

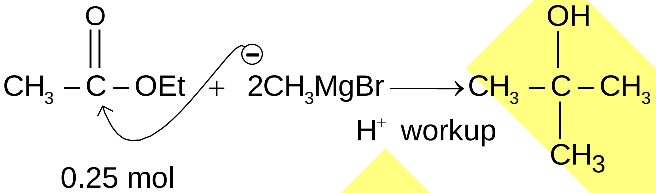


O
Ph
H
0.05 mol
O
Ph
Ph
0.025 mol

$\frac{0.025}{0.05} \times 100 = 50\%$

6. 2.5

Sol.



$$CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-OEt + 2CH_3MgBr \xrightarrow[H^+ \text{ workup}]{} CH_3-\overset{\overset{\displaystyle OH}{|}}{\underset{\underset{\displaystyle CH_3}{|}}{C}}-CH_3$$

0.25 mol

0.5 = 0.2 × V

V = 2.5 mL

SECTION – III : MATHEMATICS

(PART – A)

1. D

Sol. $f(x) = xe^x + (xe^x)^{-1}$

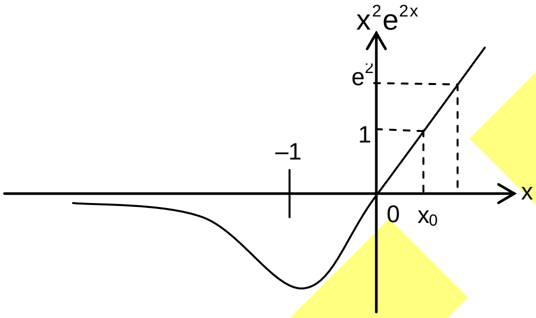
$= xe^x + \frac{1}{x}e^{-x}$

$f'(x) = (x+1)e^x - \frac{1}{x^2}e^{-x} - \frac{1}{x}e^{-x}$

$= (x+1)e^x - \frac{e^{-x}}{x^2}(1+x)$

$= \frac{(1+x)}{x^2}e^{-x}\left[x^2e^{2x} - 1\right]$

$f'(x) = 0 \Rightarrow 1 + x = 0$ or $x^2e^{2x} - 1 = 0$



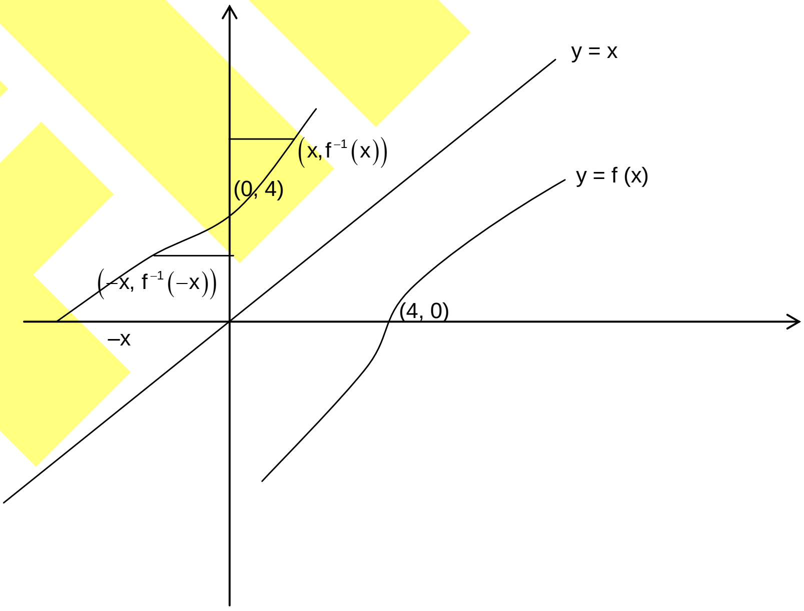
From figure $x^2e^{2x} - 1 = 0$

at $x = x_0 \in (0, 1)$

So $x = -1$ and x_0 are two points of extrema. At $x = x_0$ $x^2e^{2x} - 1$ changes sign from –ive to +ive $\Rightarrow x_0$ is point of minima. At $x = -1$ sign of $f(x)$ changes from time to + ive to –ive $\Rightarrow x = -1$ is point of maxima.

2. ABD

Sol. $f(x)$ is symmetric about (4, 0) $\Rightarrow f^{-1}(x)$ is symmetric about (0, 4)



(a) Mid point of $\left(x, f^{-1}(x)\right)$ and $\left(-x, f^{-1}(-x)\right)$ is (0, 4)

$$\Rightarrow\left(\frac{x-x}{2}, \frac{f^{-1}(x)+f^{-1}(x)}{2}\right)=(0,4)$$

$$\Rightarrow\frac{f^{-1}(x)+f^{-1}(-x)}{2}=4\Rightarrow f^{-1}(x)+f^{-1}(-x)=8$$

(b) $f(x)$ is symmetric about (4, 0)

$\Rightarrow f(4+x)=-f(4-x)$

$x\to 4-x$

$\Rightarrow f(8-x)=-f(x)$

$\Rightarrow f(x)+f(8-x)=0$ ....(1)

$I=\int_{-2010}^{2018} f(x)\,dx$ ....(2)

$iI=\int_{-2010}^{2018} f(2018-2010-x)\,dx=\int_{-2010}^{2018} f(8-x)\,dx$ ....(3)

(2) + (3)

$2I=\int_{-2010}^{2018}\left[f(x)+f(8-x)\right]dx=0$

$\Rightarrow I=0$

(c) Since $f(x)$ is one to one and $f'(-100)>0\Rightarrow f(x)$ is increasing function

So $f'(10)>0$

$D=\left(f'(10)^2-4x_1\left[-f'(10)\right]\right)=\left[f'(10)\right]^2+4f'(10)>0$

$\Rightarrow$ roots are always real.

(d) $f(x)+f(8-x)=0$

Diff. w.r.t. $\Rightarrow f'(x)-f'(8-x)=0$ ....(4)

Put $x=10$

3. AB

Sol. $$\frac{\left(\sqrt{5}-1\right)\cos x}{\sqrt{\left(\sqrt{5}-1\right)^2+10+2\sqrt{5}}}+\frac{\sqrt{10+2\sqrt{5}}\sin x}{\sqrt{\left(\sqrt{5}-1\right)^2+10+2\sqrt{5}}}=\frac{8\sin x\cos x}{\sqrt{(5-1)^2+10+2\sqrt{5}}}$$

$$\left(\frac{\sqrt{5}-1}{4}\right)\cos x+\frac{\sqrt{10+2\sqrt{5}}}{4}\sin x=\frac{8}{4}\sin x\cos x$$

$$\sin\frac{\pi}{10}\cos x+\cos\frac{\pi}{10}\sin x=\sin 2x$$

$$\sin\left(x+\frac{\pi}{10}\right)=\sin 2x$$

$$\sin 2x=\sin\left(x+\frac{\pi}{10}\right)$$

$$\Rightarrow 2x=x+\frac{\pi}{10}\text{ or }\pi-\left(x+\frac{\pi}{10}\right)$$

$$\Rightarrow x=\frac{\pi}{10}\text{ or }\frac{3\pi}{10}$$

4. BC

FIITJEE

Sol. A and B are intersection of chord of contact with circle.

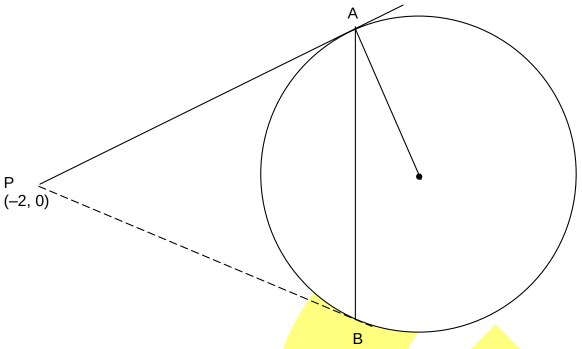
$x^2+y^2-8x-16y+60=0$ ......(1)

Equation of AB.

$-2x+0y+4(x-2)-8(y+0)+60'=0$

$-6x-8y+68=0 \Rightarrow 3x+4y-34=0$ ...(2)

Now solve (1) and (2)



5. ABD

Sol. Clearly, $f(-1)=-f(1),\ f(0)=0$

For option (A) and (B), apply LMVT for the function $y=f(x)$ in $[-1,0]$ and [0, 1] respectively

For option (D), apply LMVT to the function $y=(f(x))^n$ in $[0,1]$

6. AD

Sol. Probability that X is not hit is $=\frac{2}{5}.\frac{4}{5}+\frac{3}{5}.\frac{4}{5}.\frac{2}{5}.\frac{4}{5}+......=\frac{\frac{2}{5}.\frac{4}{5}}{1-\frac{3}{5}.\frac{4}{5}}=\frac{8}{13}$

Probability that both are hit is $=\frac{2}{5}.\frac{1}{5}+\frac{3}{5}.\frac{4}{5}.\frac{2}{5}.\frac{1}{5}+....=\frac{\frac{2}{5}.\frac{1}{5}}{1-\frac{3}{5}.\frac{4}{5}}=\frac{2}{13}$

7. AD

Sol. Clearly plane P will be perpendicular bisector of line joining A and B.

$\therefore$ It passes through (–1, –1, 2) and drs of its normal are (3, –3, 1)

$\therefore$ Equation of plane P is

$3(x+1)-3(y+1)+1(z-2)=0$

$\Rightarrow 3x-3y+z=2$ . ...(1)

(a) $\because$ P is parallel to Q

$\therefore\ \frac{1}{3}=\frac{1}{3}=\frac{C}{1} \qquad \Rightarrow \qquad C=\frac{1}{3}$

(b) If P is perpendicular to Q then $1.3-1.(-3)+1.C=0 \Rightarrow C=-6$

(c) $\because$ Plane P intersects coordinate axes at points with position vectors $\frac{2}{3}\hat{i},-\frac{2}{3}\hat{j}$ and $2\hat{k}$

$\therefore$ volume of tetrahedron $=\frac{1}{6}\left|\left[\frac{2}{3}\hat{i}\ -\frac{2}{3}\hat{j}\ \ 2\hat{k}\right]\right|=\frac{4}{27}$

(d) Point on line L can be taken as $(\lambda+1,\ 3\lambda-2,\ -\lambda+7)$

$\therefore$ It is on plane P.

$\therefore\ 3(\lambda+1)-3(3\lambda-2)+(-\lambda+7)=2$

$\Rightarrow\ 7\lambda=14 \Rightarrow \lambda=2$

$\therefore$ point of int. = (3, 4, 5)

$\therefore\ \alpha+\beta+\gamma=12$

8. B

Sol. $|A| = x + y + z$

$\left|\text{adj}\left(\text{adj}\left(\text{adj}\left(\text{adj}\right)\right)\right)\right| = |A|^{(n-1)^4} = |A|^{16}$

$|A|^{16} = 4^8.5^{16} = 2^{16}.5^{16}$

$|A| = 2 \times 5 = 10 = x + y + z$

$x + y + z = 10$

Number of natural numbers solutions $= {}^{10-1}C_{3-1} = {}^{9}C_2 = 36$

$\Rightarrow p = 36$

$\int_{-\pi/2}^{\pi/2} 2^{\sin x}\,dx + \int_{5/2}^{4} \sin^{-1}\left(\log_2\left(x-2\right)\right)dx$

sub $x - 2 = t$

$+\int_{1/2}^{2} \sin^{-1}\left(\log_2 t\right)dt$

$\int_{-\pi/2}^{\pi/2} 2^{\sin x}\,dx + \int_{1/2}^{2} \sin^{-1}\left(\log_2 x\right)dx = \frac{\pi}{2}2^{\sin\pi/2} - \left(\frac{-\pi}{2}\right)2^{\sin(-\pi/2)}$

$= \frac{\pi}{2}.2 + \frac{\pi}{2}.\frac{1}{2}$

$= \pi + \frac{\pi}{4} = \frac{5\pi}{4}$

So, $p = 36,\ q = 5$

9. C

10. D

(Sol. 9 & 10)

For C_1: Center (a, a), radius = a

C_2 : Center (b, b), radius = b

(i) $C_1C_2 = r_1r_2 \Rightarrow \sqrt{(a-b)^2 + (a-b)^2} = (a+b)$

$\Rightarrow \sqrt{2}\left(b-a\right) = a + b$

$\Rightarrow \frac{b}{a} = 3 + 2\sqrt{2}$

(ii) $C_1C_2^2 = r_1^2 + r_2^2$

$(a-b)^2 + (a-b)^2 = a^2 + b^2 \Rightarrow a^2 - 4ab + b^2 = 0$

$\Rightarrow \frac{b^2}{a^2} - \frac{4b}{a} + 1 = 0$

$\frac{b}{a} = 2 \pm \sqrt{3}$ but $\frac{b}{a} \ge 1$

$\Rightarrow \frac{b}{a} = 2 + \sqrt{3}$

(iii) Common chord is diameter of smaller circle

$x^2 + y^2 - 2bx - 2by + b^2 = 0$ ……….(i)

$x^2 + y^2 - 2ax - 2ay + a^2 = 0$ ……….(ii)

(2) – (1)

$2x + 2y = a + b$

passes through (a, a)

$2a + 2a = a + b$

$$\Rightarrow \frac{b}{a} = 3$$

(iv) $(x-b)^2 + (y-b)^2 = b^2$ passes through (a_1a)

11. B

12. A

(Sol. 11 & 12)

Total matrices $= 4! = 24$
For non negative $\det(A)$ possibilities

$$\begin{bmatrix} 1 & 0 \\ 4 & 2 \end{bmatrix} = 2, \begin{bmatrix} 1 & 0 \\ 2 & 4 \end{bmatrix} = 4, \begin{bmatrix} 2 & 0 \\ 1 & 4 \end{bmatrix} = 8$$

So, (i) P, Q, T

(iii) least absolute value of $\det A = 2$

$$|\text{adj adj adj}| = |A|^{(n-1)^3} = |A|^{(2-1)^3} = |A| = 2 \Rightarrow (P)$$

(ii) Possible value of $\det A$ are $\pm 2, \pm 4, \pm 8$
So sum = 0 $\Rightarrow (S)$

(iv) $(\det A)\text{least} = -8$ so $\det(4A^{-1}) = 4^2 \dfrac{1}{(\det A)}$

$$= \frac{16}{-8} = -2 \Rightarrow (R)$$

(PART – B)

1. 8

Sol. $\because$ Elements of determinant can be 1 or –1
$\therefore$ First two places of first row can be filled in $2 \times 2 = 4$ ways and last place can be filled in only one way to product be 1.
$\therefore$ Second row can be made in 4 ways and third row can be made in 1 way only.
$\therefore$ Number of elements in S = 16 = m

$$\because |P| = \begin{vmatrix} 3 & -2 & 3 \\ 2 & -2 & 3 \\ 0 & -1 & 1 \end{vmatrix} = \begin{vmatrix} 1 & 0 & 0 \\ 2 & -2 & 3 \\ 0 & -1 & 1 \end{vmatrix} = 1(-2+3) = 1$$

$$\because \text{adj}(\text{adj}P) = |P|^{n-2}.P = P$$

$$\Rightarrow \text{tr.}(\text{adj}(\text{adj}P)) = \text{tr}(P) = 2 = n$$

$$\therefore \frac{m}{n} = 8$$

2. 2

Sol. $\because |z_2| = 1 \Rightarrow z_2 = e^{i\theta} = \cos\theta + i\sin\theta$

$$\therefore \frac{z_2 - 1}{z_2 + 1} = \frac{\cos\theta - 1 + i\sin\theta}{\cos\theta + 1 + i\sin\theta}$$

$$= \frac{-2\sin^2\frac{\theta}{2} + i.2\sin\frac{\theta}{2}\cos\frac{\theta}{2}}{2\cos^2\frac{\theta}{2} + i.2\sin\frac{\theta}{2}\cos\frac{\theta}{2}}$$

$$=\frac{i\sin\frac{\theta}{2}}{\cos\frac{\theta}{2}}=i\tan\frac{\theta}{2}$$

$$\therefore \frac{z_1-1}{z_1+1}=-\tan^2\frac{\theta}{2}\Rightarrow\left(\frac{z_1-1}{z_1+1}\right)=-\tan^2\frac{\theta}{2}$$

$$\Rightarrow z_1=\frac{1-\tan^2\frac{\theta}{2}}{1+\tan^2\frac{\theta}{2}}=\cos\theta \text{ which is purely real and lies in } [-1, 1]$$

$$\therefore |z_1-1|+|z_1+1|=|\cos\theta-1|+|\cos\theta+1|=2$$

3. 2

Sol. $a_n=\dfrac{2\cot x}{1-\sin^2 x}=\dfrac{2\cot x}{\cos^2 x}=\dfrac{2}{\sin x\cos x}$

$b_n=\dfrac{\sin 2x}{1-\sin^2 x}=\dfrac{2\sin x\cos x}{\cos^2 x}=2\tan x$

$a_n-b_n=\dfrac{2}{\sin x\cos x}-2\tan x$

$=\dfrac{2\left(1-\sin^2 x\right)}{\sin x\cos x}=\dfrac{2\cos^2 x}{\sin x\cos x}$

$=2\cot x$

Since $\cot x\downarrow \text{in} \left(0, \dfrac{\pi}{4}\right]$

So, minimum $=2\cot\dfrac{\pi}{4}=2$

4. 2

Sol. $$\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right]=\begin{vmatrix} 2+\sin\theta & \cos\theta & \sin 2\theta \\ \sin\left(\theta+\frac{2\pi}{3}\right) & \cos\left(\theta+\frac{2\pi}{3}\right) & \sin\left(2\theta+\frac{4\pi}{3}\right) \\ \sin\left(\theta-\frac{2\pi}{3}\right) & \cos\left(\theta-\frac{2\pi}{3}\right) & \sin\left(2\theta-\frac{4\pi}{3}\right) \end{vmatrix}$$

$R_1\to R_1+R_2$

$$\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right]=\begin{vmatrix} 2+\sin\theta & \cos\theta & \sin 2\theta \\ 2\sin\theta\cos\frac{2\pi}{3} & 2\cos\theta\cos\frac{2\pi}{3} & 2\sin 2\theta\cos\frac{4\pi}{3} \\ \sin\left(\theta-\frac{2\pi}{3}\right) & \cos\left(\theta-\frac{2\pi}{3}\right) & \sin\left(2\theta-\frac{4\pi}{3}\right) \end{vmatrix}$$

$$=\begin{vmatrix} 27\sin\theta & \cos\theta & \sin 2\theta \\ -\sin\theta & -\cos\theta & -\sin 2\theta \\ \sin\left(\theta-\frac{2\pi}{3}\right) & \cos\left(\theta-\frac{2\pi}{3}\right) & \sin\left(\theta-\frac{4\pi}{3}\right) \end{vmatrix}$$

$R_1\to R_1+R_2$

$$\left[\vec{a}\ \ \vec{b}\ \ \vec{c}\right] = \begin{vmatrix} 2 & 0 & 0 \\ -\sin\theta & -\cos\theta & -\sin 2\theta \\ \sin\left(\theta.\frac{2\pi}{3}\right) & \cos\left(\theta-\frac{2\pi}{3}\right) & \sin\left(2\theta-\frac{4\pi}{3}\right) \end{vmatrix}$$

$$= 2\left(\sin 2\theta\cos\left(\theta-\frac{2\pi}{3}\right)-\cos\theta\sin\left(2\theta-\frac{4\pi}{3}\right)\right)$$

$$= 2\left(\sin 2\theta\cos\left(\theta-\frac{2\pi}{3}\right)-\cos\theta\sin\left(2\theta-\frac{4\pi}{3}\right)\right)$$

$$= 2\left\{\sin 2\theta\left[\cos\theta\left(\frac{1}{-2}\right)+(\sin\theta)\frac{\sqrt{3}}{2}\right]-\cos\theta\left[\sin 2\theta\left(-\frac{1}{2}\right)-(\cos 2\theta)\left(-\frac{\sqrt{3}}{2}\right)\right]\right\}$$

$$= \sin 2\theta\left[-\cos\theta+\sqrt{3}\sin\theta\right]-\cos\theta\left[\sqrt{3}\cos^2\theta-\sin^2\theta\right]$$

$$= \sqrt{3}\left(\sin 2\theta\sin\theta-\cos\theta\cos 2\theta\right) = -\sqrt{3}\cos 3\theta$$

$$v = \frac{1}{6}\left[2\vec{b}\times\vec{c}\quad 3\vec{c}\times\vec{a}\quad \vec{a}\times 4\vec{b}\right] = \frac{24}{6}[a,b,c]^2$$

$$= \frac{24\times 3}{6}\cos^2 3\theta$$

So, $V = 12\cos^2 3\theta$

So $V \le 12$

Hence $V_{max} = 12$

5. 4

Sol. $15! = 2^{11}.3^6.7^3.11.13$

All the powers of single prime number has two possibilities either is α or β so total pair of $(\alpha,\beta) = 2^5 = 32$

6. 2

Sol. $$gog = \frac{3\left(\frac{3x+5}{2x-3}\right)+5}{2\left(\frac{3x+5}{2x-3}\right)-3} = \frac{19x}{19} = x$$

$gogog = g(x)$, $gogogog = x$

$$\Rightarrow gogogog\_\_\_\_\text{up to n times} = \begin{cases} x, & \text{if n is even} \\ \frac{3x+5}{2x-3} & \text{if n is odd} \end{cases}$$

So, $g_{2014}(x) = x$ In comparing $p = 1, q = 0, r = 0, s = 1$

FIITJEE RBT-3 for (JEE-Advanced)

BATCHES – Two Yr CRP2123(All)

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 1

QP Code:

PAPER - 1

Time Allotted: 3 Hours **Maximum Marks: 234**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections**.
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. Each **Section** is further divided into **Two Parts**: **Part-A & B** in the OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with HB pencil for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Two Parts.

(i) **Part-A (01-07) –** Contains seven (07) multiple choice questions which have **One or More** correct answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in –**2** marks, as a wrong option is also darkened.

(i) **Part-A (08-13) –** Contains six (06) multiple choice questions which have ONLY ONE CORRECT answer Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(ii) **Part-B (01-08)** contains eight (08) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+4 marks** for correct answer and **there will be no negative marking.**

Name of the Candidate :____

Batch :____________________ **Date of Examination :**____________________

Enrolment Number :____

SECTION-1 : PHYSICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

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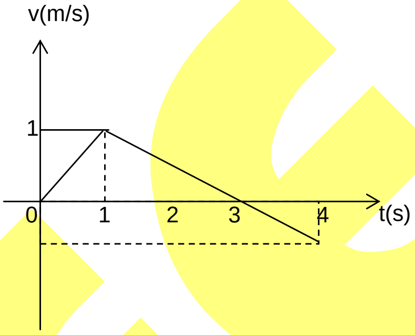
1. The velocity time graph of a particle is shown for time interval t = 0 to t = 4 sec. Choose correct options.



(A) the displacement of the particle is equal to $\frac{5}{4}$m

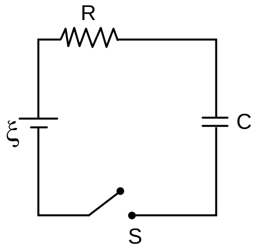
(B) the distance covered by the particle is equal to $\frac{7}{4}$m

(C) the average velocity of the particle is $\frac{1}{2}\text{m/s}$ over 4 s

(D) the motion is uniformly accelerated for 4s

2. Using screw gauge the radius of the wire is found to be 2.50 mm. The length of wire is measured by using a scale and is found to be 50.0 cm. If mass of wire is measured as 25 g, then mark the correct statement(s) [Take $\pi = 3.14$]
(A) The density has to be computed upto 2 significant digit.
(B) The least count of scale used to measure length of wire is 1 mm.
(C) The density of wire is 2.5 g/cm^3.
(D) The least count of screw gauge is 0.01 mm.

3. As situation shown in figure the maximum value of rate of energy stored in the capacitor after the switch is closed



(A) $\frac{\xi^2}{2R}$

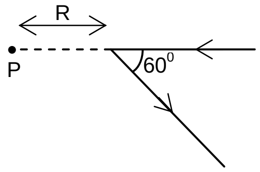
(B) $\frac{\xi^2}{4R}$

(C) $\frac{\xi^2}{8R}$

(D) none of these

4. A metal cylinder of mass 0.5 kg is heated electrically by a 12 W heater in a room at 15°C. The cylinder temperature rises uniformly to 25°C in 5 min and finally becomes constant at 45°C. Assuming that the rate of heat loss is proportional to the excess temperature over the surroundings,
(A) the rate of loss of heat of the cylinder to surrounding at 20°C is 2 W
(B) the rate of loss of heat of the cylinder to surrounding at 45°C is 12 W
(C) specific heat capacity of metal is $\frac{240}{\text{lb}(3/2)}\text{J/kg}^{o}\text{C}$
(D) none of the above

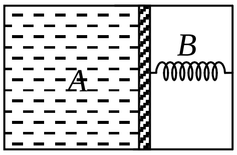
5. A long straight wire, carrying a current I is bent at its mid point to form an angle of 60^0 . AT a point P, distance R from the point of bending the magnetic field is



(A) $\frac{(\sqrt{2}-1)\mu_0 i}{4\pi R}$ (B) $\frac{(\sqrt{2}+1)\mu_0 i}{4\pi R}$

(C) $\frac{\mu_0 i}{4\sqrt{3}\pi R}$ (D) $\frac{\mu_0 i}{8R}$

6. A thermally insulated chamber of volume $2V_0$ is divided by a frictionless piston of area *S* into two equal parts *A* and *B*. Part *A* has an ideal gas at pressure P_0 and temperature T_0 and in part *B* is vacuum. A massless spring of force constant *k* is connected with piston and the wall of the container as shown. Initially spring is unstretched. Gas in chamber *A* is allowed to expand. Let in equilibrium spring is compressed by x_0. Then



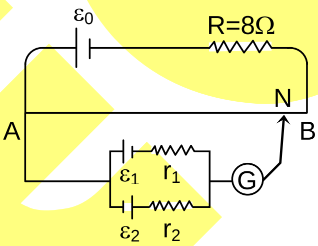
(A) final pressure of the gas is $\frac{kx_0}{S}$

(B) work done by the gas is $\frac{1}{2}kx_0^2$

(C) change in internal energy of the gas is $\frac{1}{2}kx_0^2$

(D) temperature of the gas is decreased.

7. A battery of emf $\varepsilon_0 = 12V$ is connected across a 4m long uniform wire having resistance 4Ω/m. The cells of small emfs $\varepsilon_1 = 2V$ and $\varepsilon_2 = 4V$ having internal resistance 2Ω and 6Ω respectively are connected as shown in the figure. If galvanometer shows no deflection at the point N, the distance of point N from the point A is equal to :



(A) $\frac{1}{6}m$ (B) $\frac{1}{3}m$

(C) 25 cm (D) 50 cm

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

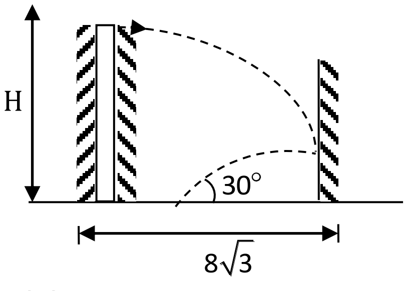
---

8. An object of mass m is thrown vertically upwards in air with an initial speed v_0. The air applies a drag force which is proportional to the instantaneous velocity of the particle in the opposite direction of the motion of ball. Then the time it takes to reach maximum height above ground is [V_T = mg/c] $\left[\vec{F} = -c(\vec{v})\right]$

(A) $\frac{V_T}{g}\ln\left[1-\frac{v_0}{g}\right]$ (B) $\frac{V_T}{g}\ln\left[1+\frac{v_0}{V_T}\right]$

(C) $\frac{V_T}{2g}\ln\left[1+\frac{2v_0}{v_T}\right]$ (D) $\frac{V_T}{g}\ln\left[1+\frac{2v_0}{V_T}\right]$

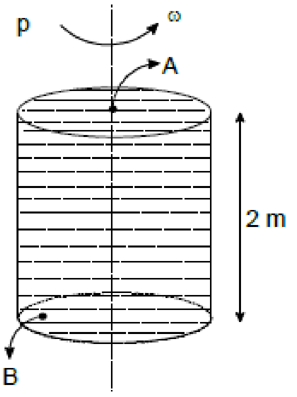
9. A ball is thrown horizontally from the top of a tower of unknown height. Ball strikes a vertical wall whom plane is normal to the plane of motion of ball. Collision is elastic and ball falls on ground at mid-point between tower and wall. Ball strikes the ground at angle of 30° with horizontal. The height of tower is



(A) 2 m (B) 4 m (C) 6 m (D) 8 m

10. A 50 Hz 20V source is connected to a resistance of 100 Ω an inductance of 1 H and a capacitance of 10μF all in series. Calculate approximate time (in sec) which the resistance (thermal capacity 2J/^{0}C) will get heated by 10^{0}C.

(A) 4 (B) 5 (C) 6 (D) 7



11. A closed tank of water is rotating about a vertical axis as shown in figure and at same time the entire tank is accelerated upward at 4 m/s^2. If the rate of rotation is 10 rad/sec. The difference in pressure between points A and B is equal to (10 × a.01) kPa. There is a point B at the bottom of the tank at a radial distance of 0.5 m from the axis of rotation and point A is at the top on the axis of rotation. Find the value of a. (take g = 9.8 m/s^2)
(A) 1 (B) 2
(C) 3 (D) 4

12. If $\overline{A} \times \overline{B} = \overline{C} + \overline{D}$, then the correct alternative is
(A) $\overline{B}$ is parallel to $(\overline{C} + \overline{D})$
(B) $\overline{A}$ is perpendicular to $\overline{C}$
(C) component of $\overline{C}$ along $\overline{A}$ = component of $\overline{D}$ along $\overline{A}$
(D) component of $\overline{C}$ along $\overline{A}$ = - component of $\overline{D}$ along $\overline{A}$

13. If θ is the angle with horizontal with which a projectile must be fired to escape from earth's gravitational pull then
(A) $0^o \le \theta < 45^o$ (B) $0^o \le \theta \le 180^o$ (C) $\theta = 90^o$ (D) $\theta = 45^o$

PART – B

(Numerical based)

This section contains **8 Numerical based questions**, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

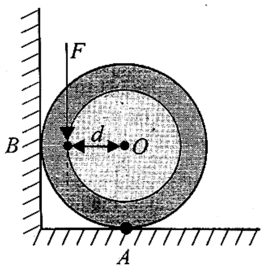
---

1. In a thermally isolated system, two boxes filled with an ideal gas are connected by a valve. When the valve is in closed position, states of the box 1 and 2, respectively, are (1 atm, V, T) and (0.5 atm, 4V, T). When the valve is opened, what is approximately the final pressure (in atm) of the system?

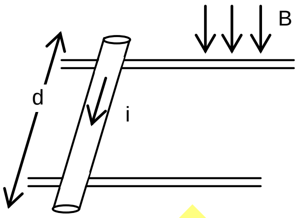
2. Three simple harmonic motions of equal amplitude 2.25m and equal time periods in the same direction combine. The phase of the second motion is 60^0 ahead of the first and the phase of the third motion is 60^0 ahead of the second. Find the amplitude of the resultant motion (in m).

3. On a horizontal frictionless frozen lake, a girl (36 kg) and a box (9 kg) are connected to each other by means of a rope. Initially they are 18 m apart. The girl exerts a horizontal force on the box, pulling it towards her. How far has the girl travelled (in m) when she meets the box?

4. A solid cylinder with r = 0.1 m and mass M = 2 kg is placed such that it is in contact with the vertical and a horizontal surface as shown in figure. The coefficient of static friction is μ = (1/3) for both the surfaces. Find the distance d (in cm) from the centre of the cylinder at which a force F = 40 N should be applied vertically so that the cylinder just starts rotating in anticlockwise direction.



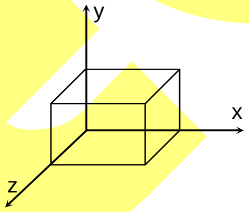
5. A cylindrical uniform rod of mass 0.72 kg and radius 6 cm rests on two parallel rails, that are d = 50 cm apart. The rod caries a current I = 48A (In the direction shown) and rolls along the rails without slipping. If it starts from rest, uniform magnetic field of magnitudes 0.25 T is directed perpendicular to the rod and the rail, then the friction force(In N) between rod and rails is



6. A wire of length L and 3 identical cells of negligible internal resistance are connected in series, when the temperature of the wire is raised by (ΔT) in time t due to the current. The same temperature rise is observed in the same time when N similar cells are connected in series with a wire of length 2L but of same material and cross-section. Find the value of N.

7 A thin wire of area of crossection $A = 10^{-2} m^2$ is used to make a ring of radius $r = 10^{-1} m$. This ring is placed on a smooth horizontal floor & is given angular velocity ω = 20 rad/s about its centre. Find out stress in the ring (mass per unit length of wire λ = 1 kg/m)

8. Electric field $\vec{E} = x\hat{i} + y\hat{j}$ exist in the region. The flux linked with the surface of cube of side 'a' as shown in the figure is ka^3 then 'k' is



Space For Rough Work

FIITJEE

SECTION-2 : CHEMISTRY

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

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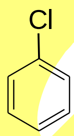
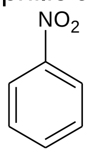
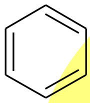
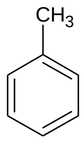
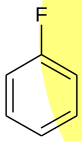
1. Which of the following compound(s) is/are more reactive than chlorobenzene  towards electrophilic attack?

(A) 

(B) 

(C) 

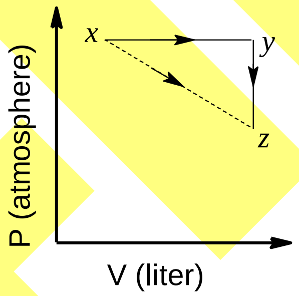
(D) 

2. For a reaction A → B, E_a for the forward reaction $(E_a)_f$ and backward reaction $(E_a)_b$ is 19 kJ/mole and 9 kJ/mole respectively. Potential energy of A is 12 kJ/mole
Find out which of the following options are correct?
(A) Heat of reaction is 10 kJ/mol
(B) It is an exothermic reaction
(C) The threshold energy of reaction is 31 kJ/mol
(D) The potential energy of product is 22 kJ/mol

3. Which of the following hydrogen halides react(s) with $AgNO_3$(aq) to give a precipitate that dissolves in $Na_2S_2O_3$(aq)?

(A) HCl	(B) HF
(C) HBr	(D) HI

4. For an ideal gas, consider only $P-V$ work in going from an initial state X to the final state Z. The final state Z can be reached by either of the two paths shown in the figure. Which of the following choice(s) is (are) correct? [Take ΔS as change in entropy and w as work done]



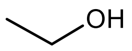
(A) $\Delta S_{x\to z} = \Delta S_{x\to y} + \Delta S_{y\to z}$	(B) $W_{x\to z} = W_{x\to y} + W_{y\to z}$
(C) $W_{x\to y\to z} = W_{x\to y}$	(D) $\Delta S_{x\to y\to z} = \Delta S_{x\to y}$

5. A salt heated with dil. H_2SO_4 and subsequently treated with few drops of dil. $KMnO_4$. The solution looses the colour of $KMnO_4$ indicates the presence of:

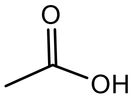
(a) Nitrite ion	(b) nitrate ion
(c) Oxalate ion	(d) sulfite ion

6. 1 mole benzene $\left(p^0_{benzene} = 42\text{mm of Hg}\right)$ and 2 mole toluene $\left(p^0_{toluene} = 36\text{mm of Hg}\right)$ will have
(A) total vapour pressure 38 mm of Hg
(B) mole fraction of vapours of benzene above liquid mixture is 7/19
(C) positive deviation from Raoult's law
(D) negative deviation from Raoult's law

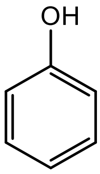
7. Correct acidity order of the following substrate in H_2O solvent.



(a)



(b)



(c)

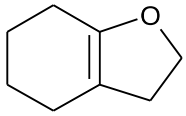
(A) b < c < a (B) b >a

(C) b >c >a (D)c >b

(Single Correct Choice Type)

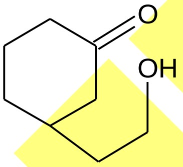
This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

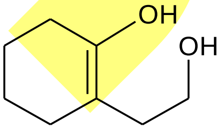
---

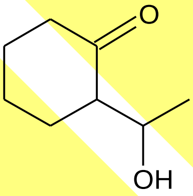
8. 

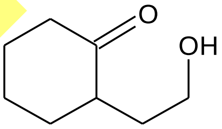
$\xrightarrow[H_2O]{H^{\oplus}}$ 'P' (major),

Identify the product 'P'

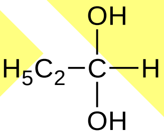
(A)


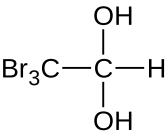
(B)


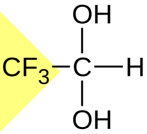
(C)


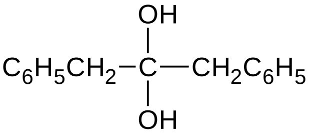
(D)


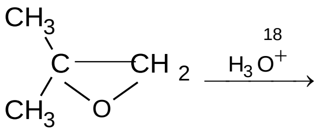
9. Which of the following 'gem' diols is stable?

(A)

$H_5C_2-\underset{OH}{\overset{OH}{\overset{|}{\underset{|}{C}}}}-H$

(B)

$Br_3C-\underset{OH}{\overset{OH}{\overset{|}{\underset{|}{C}}}}-H$

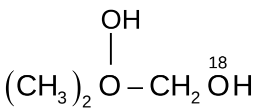
(C)

$CF_3-\underset{OH}{\overset{OH}{\overset{|}{\underset{|}{C}}}}-H$

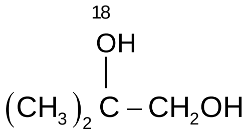
(D)

$C_6H_5CH_2-\underset{OH}{\overset{OH}{\overset{|}{\underset{|}{C}}}}-CH_2C_6H_5$

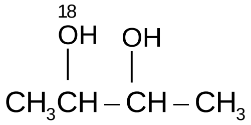
10. 

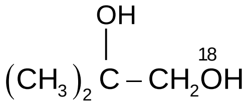
$\rightarrow A(\text{major product})$

The product (A) has the structure

(A) 
$(CH_3)_2\overset{\overset{OH}{|}}{O}-CH_2\overset{18}{O}H$

(B) 
$(CH_3)_2\overset{\overset{\overset{18}{OH}}{|}}{C}-CH_2OH$

(C) 
$CH_3\overset{\overset{\overset{18}{OH}}{|}}{C}H-\overset{\overset{OH}{|}}{C}H-CH_3$

(D) 
$(CH_3)_2\overset{\overset{OH}{|}}{C}-CH_2\overset{18}{O}H$

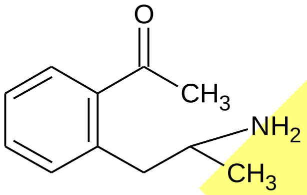
11. The flocculating power of the given ions for the specified colloidal sols will be such that:

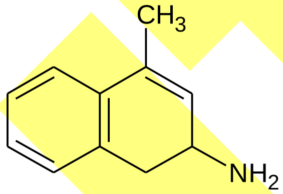
	Arsenic sulphide sol.	**Ferric hydroxide sol**
(A)	$\left[Fe(CN)_6\right]^{4-} > PO_4^{3-} > SO_4^{2-} > Cl^-$	$Al^{3+} > Ba^{2+} > Na^+$
(B)	$Al^{3+} > Ba^{2+} > Na^+$	$\left[Fe(CN)_6\right]^{4-} > PO_4^{3-} > SO_4^{2-} > Cl^-$
(C)	$Na^+ > Ba^{2+} > Al^{3+}$	$Cl^- > SO_4^{2-} > PO_4^{3-} > \left[Fe(CN)_6\right]^{4-}$
(D)	$Cl^- > SO_4^{2-} > PO_4^{3-} > \left[Fe(CN)_6\right]^{4-}$	$Na^+ > Ba^{2+} > Al^{3+}$

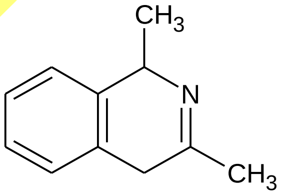
12. In an amino acid the carboxylic acid group has $K_a = 10^{-4}$ and amino group has $K_b = 10^{-5}$ at 298 K. The isoelectric point of that amino acid is

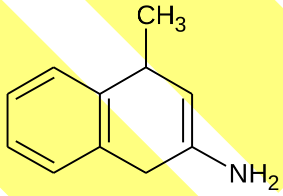
(A) 4
(B) 5
(C) 6.5
(D) 4.5

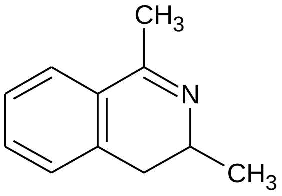
13. The compound shown below undergoes a spontaneous cyclization on long standing, the product of this intermolecular reaction is:



(A)


(B)


(C)


(D)


PART – B

(Numerical based)

This section contains **8 Numerical based questions**, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

---

1. The successive ionization energies of an s-block element are
8.6, 12.9, 1630.2, 2406.2 eV, etc
If atomic mass of the elements is 39.8 g mol^{-1}, what will be the molar mass of it's normal oxide?

2. 5 mole of a mixture of $Na_2C_2O_4$ and Na_2CO_3 required 400 mL of 0.5 M acidified $KMnO_4$ for complete oxidation. What is the mole fraction of $Na_2C_2O_4$ in the mixture?

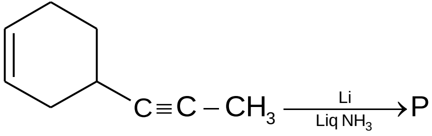
3 If the wavelength(λ) of the electronic transition n = 4 → n = 1 in a hydrogen atom is expressed as $\left(\frac{x}{y}\times10^{-7}\right)\text{m}$. What is the value of $\left(\frac{x+y}{10}\right)$?

[Rydberg constant = 10^7 m^{-1}]

4. $CH_4 \xrightarrow[h\nu]{Cl_2(\text{excess})} A + B + C + D$

If x is the molar mass of the most acidic product and y is the molar mass of the heaviest product, then what is the value of (x + y) in g mol^{-1} unit?

5. If the product(P) formed in the reaction



Has molar mass M_0 then $\frac{M_0}{4}$ is

6. pH of solution obtained by mixing 20 mL of 0.2 M NaOH with 50 mL of 0.2 M acetic acid ($K_P = 1.8 \times 10^{-5}$) is

7. 100 mL of hard water is passed through a column of the ion exchange resin RH_2. The water coming off the column requires 15.17 mL of 0.0265 M NaOH for its titration. The hardness of water as ppm of Ca^{2+} is

8.
$$\begin{tikzcd}
PhOH \arrow[r, "Na"] & (P) \arrow[r, "CH_3Br"] \arrow[d, "CH_3Br"] & (Q) \\
& (R) &
\end{tikzcd}$$

If(R) is more reactive than(Q) and both of them contain different functional groups, if the molar mass of (R) is X, what is $\frac{X}{10}$?

Space For Rough Work

SECTION-3 : MATHEMATICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. The equation $\sin^4 x + \cos^4 x = a$ has a real solution for

(A) all values of a　　(B) $a = \frac{1}{2}$

(C) $a = \frac{7}{10}$　　(D) a = 1

2. Let PQR be a triangle. Let $\vec{a} = \overrightarrow{QR}$, $\vec{b} = \overrightarrow{RP}$ and $\vec{c} = \overrightarrow{PQ}$. If $|\vec{a}| = 12$, $|\vec{b}| = 4\sqrt{3}$ and $\vec{b}.\vec{c} = 24$, then which of the following is (are) true?

(A) $\frac{|\vec{c}|^2}{2} - |\vec{a}| = 12$　　(B) $\frac{|\vec{c}|^2}{2} + |\vec{a}| = 30$

(C) $|\vec{a} \times \vec{b} + \vec{c} \times \vec{a}| = 48\sqrt{3}$　　(D) $\vec{a}.\vec{b} = -72$

3. If $\alpha = x_1x_2x_3$ and $\beta = y_1y_2y_3$ are two 3 – digit numbers, then the number of pairs of α and β can be formed so that α can be subtracted from β without borrowing, is

(A) $2! \times 10! \times 10!$　　(B) $(45)(55)^2$

(C) $3^2.5^3.11^2$　　(D) 136125

4. If all the roots of the equation $z^4 + az^3 + bz^2 + cz + d = 0$ $(a, b, c, d \in R)$ are of unit modulus, then

(A) $|a| \le 4$　　(B) $|b| \le 4$

(C) $|c| \le 4$　　(D) $|b| \le 6$

5. Which of the following statement(s) is (are) correct?

(A) The coefficient of x^2 in the expansion of $\sum_{r=0}^{100} {}^{100}C_r (x-4)^{100-r} (5)^r$ is equal to 4950.

(B) If the sixth term in the expansion of $\left(x^{\frac{-8}{3}} + x^2 \log_{10} x\right)$ is 5600, then x is equal to 1000.

(C) Let $A_n = {}^nC_0\, {}^nC_1 + {}^nC_1\, {}^nC_2 + \ldots + {}^nC_{n-1}\, {}^nC_n$ and $\frac{A_{n+1}}{A_n} = \frac{15}{4}$, then the sum of possible values of n is equal to 6.

(D) If $A_k = \frac{{}^nC_k}{{}^nC_k + {}^nC_{k+1}}$ and $\sqrt[3]{\sum_{k=0}^{n-1} A_k} = 4$, then n is equal to 128.

6. Let $f : \mathbb{R} \to \mathbb{R}$ and $g : \mathbb{R} \to \mathbb{R}$ be respectively given by $f(x) = |x| + 1$ and $g(x) = x^2 + 1$. Defined $h : \mathbb{R} \to \mathbb{R}$ by

$$h(x) = \begin{cases} \max\{f(x), g(x)\} & \text{if } x \le 0 \\ \min\{f(x), g(x)\} & \text{if } x > 0 \end{cases}$$

The number of points at which h(x) is not differentiable is

(A) more than 2
(B) more than 2 but less than 4
(C) 3
(D) less than 5

7. Identify correct statement(s) about conic $\sqrt{(x-5)^2+(y-7)^2}+\sqrt{(x+1)^2+(y+1)^2}=12$.
(A) centre is (2, 3)
(B) hyperbola with foci (5, 7) and (–1, –1)
(C) ellipse with major axis $4x-3y+1=0$
(D) eccentricity is $\frac{5}{7}$

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

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8. If $\tan\theta_1, \tan\theta_2, \tan\theta_3$ and $\tan\theta_4$ are the roots of the equation $x^4-x^3\sin 2\beta+x^2\cos 2\beta-x\cos\beta-\sin\beta=0$ then $\tan(\theta_1+\theta_2+\theta_3+\theta_4)$ is equal to
(A) $\sin\beta$
(B) $\cos\beta$
(C) $\tan\beta$
(D) $\cot\beta$

9. If a vertex of triangle is (3, 3) and the mid points of two sides through this vertex are $\left(2,\frac{2}{3}\right)$ and $\left(4,\frac{3}{2}\right)$ then the centroid of the triangle is given by
(A) (1, 3)
(B) (3, 0)
(C) (3, 4/9)
(D) (0, 3)

10. Three normals are drawn from the point (14, 7) to the parabola $y^2-16x-8y=0$. The coordinates of the feet of the normals are
(A) (0, 0), (8, –16), (3, –4)
(B) (0, 0), (8, 16), (3, –4)
(C) (0, 0), (–8, 16), (3, –4)
(D) None of these

11. For two 3×3 matrices A and B, let $A+B=2B'$ and $3A+2B=I_3$, where B's is the transpose of B and I_3 is 3×3 identity matrix. Then
(A) $10A+5B=3I_3$
(B) $5A+10B=2I_3$
(C) $3A+6B=2I_3$
(D) $B+2A+I_3$

12. If $\begin{vmatrix} x-4 & 2x & 2x \\ 2x & x-4 & 2x \\ 2x & 2x & x-4 \end{vmatrix}=(A+Bx)(x-A)^2$, then the ordered pair (A, B) is equal to:
(A) (4, 5)
(B) (–4, –5)
(C) (–4, 3)
(D) (–4, 5)

13. Let $f: R\to R$ be a continuous onto function satisfying $f(x)+f(-x)=0, \forall x\in R$. If $f(-3)=2$ and $f(5)=4$ in $[-5, 5]$, then the equation $f(x)=0$ has:
(A) exactly three real roots
(B) exactly two real roots
(C) at least five real roots
(D) at least three real roots

PART – B

(Numerical based)

This section contains **8 Numerical based questions**, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

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1. Through a given point P (5, 2),m secants are drawn to cut the circle $x^2+y^2=25$ at points $A_1(B_1), A_2(B_2), A_3(B_3), A_4(B_4)$ and $A_5(B_5)$ such that $PA_1+PB_1=5,\ PA_2+PB_2=6,\ PA_3+PB_3=7,\ PA_4+PB_4=8$ and $PA_5+PB_5=9$.

   Find the value of $\dfrac{\left(\sum_{i=1}^{5}PA_i^2+\sum_{i=1}^{5}PB_i^2\right)}{2}$.

   [Note : $A_r(B_r)$ denotes that the line passing through P (5, 2) meets the circle $x^2+y^2=25$ at two points A_r and B_r]

2. The quadratic polynomial $P(x)=ax^2+bx+c$ has two different zeroes including –2. The quadratic polynomial $Q(x)=ax^2+cx+b$ has two different zeroes including 3. If α and β be the other zeroes of P(x) and Q (x) respectively, then find the value of $\dfrac{3\alpha}{5\beta}$.

3. Let L denotes the number of surjective functions $f: A \to B$, where set A contains 4 elements and set B contains 3 elements.
   M denotes number of elements in the range of the function.
   $f(x)=\sec^{-1}(\operatorname{sgn} x)+\operatorname{cosec}^{-1}(\operatorname{sgn} x)$ where $\operatorname{sgn} x$ denotes signum function of x.
   And N denotes coefficient of t^5 in $(1+t^2)^5(1+t^3)^8$. Find the value of $1.285(LM+N)$.

4. Let $0\le\beta_r\le1$ and $\sum_{r=1}^{k}\cos^{-1}\beta_r=\dfrac{k\pi}{2}$ for any $k\ge1$ and $A=\sum_{r=1}^{k}(\beta_r)^r$, then $\lim\limits_{x\to A}\dfrac{(1+x^2)^{1/3}-(1-2x)^{1/4}}{x+x^2}$ is equal to λ, where $6.258\lambda=$

5. Given a function g continuous on R such that $\int_0^1 g(t)\,dt=2$ and $g(1)=5$. If $f(x)=\dfrac{1}{2}\int_0^x(x-t)^2g(t)\,dt$, then the value of $1.85(f'''(1)-f''(1))$ is equal to:

6. If $F(x)=\int\dfrac{(1+x)\left[(1-x+x^2)(1+x+x^2)+x^2\right]}{1+2x+3x^2+4x^3+3x^4+2x^5+x^6}dx$ then find the value of $6.76\left[F(99)-F(3)\right]$.
   [Note: [k] denotes greatest integer less than or equal to k.]

7. If $6+f''(x)+f''(x)=x^2+f^2(x)$ is the differential equation of a curve and let P be the point of minima of this curve then the number of tangents which can be drawn from P to the circle $x^2+y^2=4$ is k where 8.71k equals to

8. If a, b, c, d are distinct integers form an increasing AP such that $d=a^2+b^2+c^2$, then find the value of $8.69(a+b+c+d)$.

Space For Rough Work

FIITJEE

Q.P. Code:

Answers

SECTION-1 : PHYSICS

PART – A

1.	**AB**	2.	**ABCD**	3.	**B**	4.	**ABC**
5.	**C**	6.	**ABCD**	7.	**C**	8.	**B**
9.	**C**	10.	**B**	11.	**D**	12.	**D**
13.	**B**						

PART – B

1.	**0.60**	2.	**4.50**	3.	**3.60**	4.	**6**
5.	**2**	6.	**6.00**	7.	**400**	8.	**2.00**

SECTION-2 : CHEMISTRY

PART – A

1.	BCD	2.	ACD	3.	ACD	4.	AC
5.	ACD	6.	AB	7.	B,C	8.	D
9.	C	10.	B	11.	B	12.	C
13.	D						

PART – B

1.	55.8	2.	0.1	3.	3.1	4.	273.5
5.	30.5	6.	3.82	7.	80.40	8.	10.8

SECTION-3 : MATHEMATICS

PART – A

1.	BCD	2.	ACD	3.	BCD	4.	ACD
5.	ACD	6.	ABCD	7.	AC	8.	D
9.	C	10.	B	11.	A	12.	D
13.	D						

PART – B

1.	107.50	2.	6.60	3.	97.66	4.	3.13
5.	5.55	6.	20.28	7.	17.42	8.	17.38

Answers & Solutions

SECTION-1 : PHYSICS

PART – A

1. **AB**

Sol. Displacement = Area under v-t graph.

For distance, consider magnitude of area only.

2. **ABCD**

Sol. Based on fact of errors and significant figures.

3. **B**

Sol. $q = q_0(1 - e^{-t/RC})$

$$U = \frac{q^2}{2C} = \frac{q_0^2(1-e^{-t/RC})^2}{2C}$$

Rate = $\frac{dU}{dt}$

Rate will be maximum when $\frac{d^2U}{dt^2} = 0.$

4. **ABC**

Sol. For cylinder:

$$\left(\frac{dq}{dt}\right)_{net} = ms\frac{dT}{dt}$$

= Rate of heat inflow – Rate of heat loss to surroundings.

5. **C**

Sol. $B = \frac{\mu_0 I}{4\pi d}(\text{Sin}\,\theta_1 + \text{Sin}\,\theta_2)$

Use this formula for both straight sections.

6. **ABCD**

Sol. Final gas pressure $P = \frac{F}{A} = \frac{kx}{S}$

Work done by gas = Spring energy = $\frac{1}{2}kx_0^2$.

Temperature of gas will decrease.

7. **C**

Sol. Due to auxiliary battery E_0, find current in potentiometer wire. Then find $V_A - V_N$. This must be equal to potential difference produced by E_1 and E_2 combinely.

8. **B**

Sol. $m\frac{dV}{dt} = -mg - cv$

$$m\frac{dv}{mg + cv} = -dt$$

$$m\int_{V_0}^{0}\frac{dV}{mg + cv} = -\int_0^t dt$$

9. **C**

Sol. Assuming wall to be absent, it can be treated as standard projectile case having range

$$= 8\sqrt{3} + 4\sqrt{3}$$

$$= 12\sqrt{3}\text{ m}.$$

10. **B**

Sol. $I_{rms} = \dfrac{V_{rms}}{Z}$

$$= \frac{20}{\sqrt{(X_L - X_C)^2 + R^2}}$$

$\Delta q = C\Delta T = (I_{rms})^2 Rt$

11. **D**

Sol. Pressure difference along vertical = $\rho g_{eff} h$

$= \rho(g + a)h$

Pressure difference along horizontal = $\rho\left(\dfrac{r}{2}\omega^2\right)(r)$

12. **D**

Sol. $\vec{A} \times \vec{B} = \vec{C} + \vec{D}$

$\vec{A} \cdot (\vec{A} \times \vec{B}) = \vec{A} \cdot \vec{C} + \vec{A} \cdot \vec{D}$

$O = \vec{A} \cdot \vec{C} + \vec{A} \cdot \vec{D}$

$\vec{A} \cdot \vec{C} = -\vec{A} \cdot \vec{D}$

$\dfrac{\vec{A} \cdot \vec{C}}{A} = \dfrac{-\vec{A} \cdot \vec{D}}{A}$

$\Rightarrow$ option (D).

13. **B**

Sol. Escape speed is independent of angle of projection.

PART – B

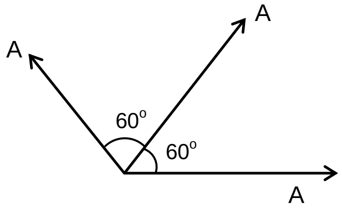
1. **0.60**

Sol. Number of moles of system remains conserved.

$$\frac{(1)V}{RT} + \frac{(0.5)(4V)}{RT} = \frac{PV}{RT} + \frac{P(4V)}{RT}$$

2. **4.50**

Sol. Use vector resultant method to find resultant amplitude.



3. **3.60**

Sol. As $F_{ext} = 0$, girl and box will meet at their centre of mass.

4. **6**

Sol. At the verge of rotation:

For translation:

$F_{net} = 0$ (Along horizontal and vertical)
$\tau_{net} = 0$ (About centre of cylinder)
Use: $f = \mu \times N$ (N → Normal reaction from adjoining surface)

5. **2**

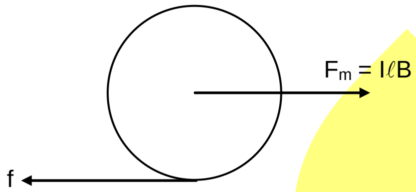
Sol. For translation:

$$I\ell B - f = ma \qquad \ldots(1)$$

For rotation about centre:

$$f(R) = \left(\frac{mR^2}{2}\right)(\alpha) \qquad \ldots(2)$$

Use $\alpha = \dfrac{a}{R}$



6. **6.00**

Sol. Only wire will contribute to heating as cells are ideal.

$$I = \frac{\text{Net E.M.F.}}{\text{Resistance}}$$

$$I^2Rt = mS\Delta T$$

7. **400**

Sol. $Td\theta = \lambda r\, d\theta \omega^2 r$

$T = \lambda r^2 \omega^2$

$$\text{Stress} = \frac{T}{A} = \frac{\lambda r^2 \omega^2}{A}$$
$$= 4$$

8. **2.00**

Sol. Flux = $2a^3$.

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SECTION-2 : CHEMISTRY

PART – A

1. BCD

Sol. Fluorine is more activating than chlorine due to greater +R effect.

2. ACD

Sol. Heat of reaction = 19 – 9 = 10(It is not a exothermic reaction)

3. ACD

Sol. $HX + AgNO_3 \rightarrow AgX \downarrow + HNO_3 \left(X = Cl, Br, I \right)$

$AgX + 2Na_2S_2O_3 \rightarrow Na_3\left[Ag\left(S_2O_3 \right)_2 \right] + NaX$

4. AC

Sol. $\Delta S_{x\rightarrow z} = \Delta S_{x\rightarrow y} + \Delta S_{y\rightarrow z} \left[\text{entropy}\left(S \right) \text{is a state function, hence additive} \right]$

$W_{x\rightarrow y\rightarrow z} = W_{x\rightarrow y} \left[\text{work done in } Y \rightarrow Z \text{ is zero as it is an isochoric process} \right]$

5. ACD

Sol. Nitrate ion is not oxidized by $KMnO_4$.

6. AB

Sol. $p = p_A^0 x_A + p_B^0 x_B$ A → Benzene, B→Toluene

$= 42 \times \frac{1}{3} + 36 \times \frac{2}{3}$

$= \frac{114}{3} = 38\text{mm}$ of Hg

Mole fraction of benzene in vapour = $\frac{p_{\text{benzene}}}{p_{\text{total}}} = \frac{42/3}{38}$ = 7/19

7. B, C

Sol. $b \rightarrow pK_a = 4.76$

$c \rightarrow pK_a = 9.95$

$a \rightarrow pK_a \approx 16 - 17$

8. D

Sol. Cleavage of ether takes place.

9. C

Sol. gem diols are stabilised by electron withdrawing groups.

10. B

Sol. Cleavage of ether takes place in acidic medium .

11. B

Sol. 1. Negatively charged arsenic sulphide solution is coagulated by higher valence of active cation.

2. Positive sol. $\left[Fe(OH)_3 \right]$ is coagulated by higher valency of active anion.

12. C

Sol. Isoelectronic point = $\frac{4+9}{2} = 6.5$

13. D

Sol. Cyclisation takes place by reaction between NH_2 group with the ketone part of the molecule.

PART – B

1. 55.8

Sol. There is a large jump from $I.E_3$ which means the atom contains two valence electron.

$\therefore$ It's valency is 2

Let the atom is M

So formula of it's oxide = Mo

Molar mass = 39.8 + 16 = 55.8 g mol^{-1}

2. 0.1

Sol. Na_2CO_3 does not react with $KMnO_4/H^+$

M_{eq} of $KMnO_4/H^+ = 400 \times 0.5 \times 5 = 1000$

$\therefore M_{eq}$ of $Na_2C_2O_4 = 1000$

$$\text{or } \frac{W}{E} \times 1000 = 1000$$

$$\therefore \frac{W}{E} = 1$$

n-factor of $Na_2C_2O_4$ is 2 as it is converted to CO_2

$$\therefore \text{Moles of } Na_2C_2O_4 = = \frac{\text{Equivalent}}{n-\text{factor}} = \frac{W/E}{2} = \frac{1}{2}$$

$$\therefore \text{ Mole fraction } = \frac{1/2}{5} = 0.1$$

3. 3.1

Sol.
$$\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\text{or, } \frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{4^2}\right] = R\left[1 - \frac{1}{16}\right] = \frac{15R}{16}$$

$$\text{or, } \lambda = \frac{16}{15R} = \frac{16}{15} \times 10^{-7} = \left(\frac{x}{y} \times 10^{-7}\right)$$

$$\therefore \frac{x+y}{10} = \frac{16+15}{10} = 3.1$$

4. 273.5

Sol. x = $CHCl_3$, y is CCl_4

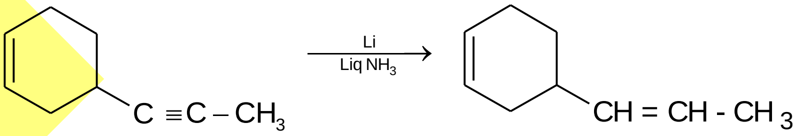
Molar mass of $CHCl_3$ = 119.5

Molar mass of y = 154

x + y = 119.5 + 154 = 273.5

5. 30.5

Sol.



$$M_o = 122, \ \frac{M_o}{4} = 30.5$$

6. 3.82

Sol. $$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$$

Initial 50×0.2 20×0.2

10 m moles 4 m moles
After Neutralization 6 –

$$pH = p^{K_a} + \log\frac{\text{Salt}}{\text{Acid}} = 4.76 + \log\frac{4}{6} = 3.82$$

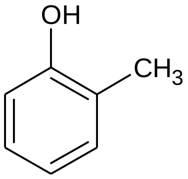
7. 80.40

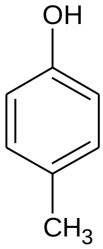
Sol. M_{eq} of Ca^{2+} = 15.17 × 0.0265 × 1 = 0.402

$$\text{Hardness of water} = \frac{0.402 \times 20}{100 \times 1000} \times 10 = 80.4$$

8. 10.8

Sol. P is PhO^-, Q is $PhOCH_3$,

R is 

or 

Molar mass of R is 10.8

SECTION-3 : MATHEMATICS

PART – A

1. BCD

Sol. We have $\sin^4 x+\cos^4 x \le \sin^2 x+\cos^2 x,$ as $|\sin x|\le 1$ and $|\cos x|\le 1$

$\Rightarrow a\le 1 \qquad (1)$

Next, $\sin^4 x+\cos^4 x = a$

$\Rightarrow \left(\sin^2 x+\cos^2 x\right)^2-2\sin^2 x\cos^2 x=a$

$\Rightarrow \frac{1}{2}\sin^2 2x = 1-a$

$\Rightarrow 1-a\le \frac{1}{2} \qquad \left[\because \sin^2 2x\le 1\right]$

$\Rightarrow \frac{1}{2}\le a \qquad (2)$

From (1) and (2) we get $\frac{1}{2}\le a\le 1$. Note that $a=\frac{1}{2}$ for $x=\frac{\pi}{4}$ and $a=1$ for $x=\frac{\pi}{2}$.

2. ACD

Sol. As $\vec{a}+\vec{b}+\vec{c}=0$

$\Rightarrow a^2=b^2+c^2+2\vec{b}.\vec{c}$

$\Rightarrow 144=48+c^2+48\Rightarrow c^2=48\Rightarrow c=4\sqrt{3}$

Again, $c^2=a^2+b^2+2\vec{a}.\vec{b}$

$\Rightarrow \vec{a}.\vec{b}=\frac{48-144-48}{2}=-72$

$\left|\vec{a}\times\vec{b}+\vec{c}\times\vec{a}\right|=\left|\vec{a}\times\vec{b}+\vec{a}\times\vec{b}\right|=2\left|\vec{a}\times\vec{b}\right|$

$=2\sqrt{a^2b^2-\left(\vec{a}.\vec{b}\right)^2}=2\sqrt{12^2.48-\left(-72\right)^2}$

$=2.12\sqrt{48-36}=2.12.\ 2\sqrt{3}=48\sqrt{3}$

3. BCD

Sol. Since, α can be subtracted from β without borrowing, if $y_i\ge x_i,$ for $i=1,2,3$

Let $x_i=\lambda$

If $i=1,$ then $\lambda=1,2,3,....9$ and if $i=2$ and 3, then $\lambda=0,1,2,3,......,9$

Hence, total number of ways of choosing the pairs α,β

$=\left(\sum_{\lambda=1}^{9}(10-\lambda)\right)\left(\sum_{\lambda=0}^{9}(10-\lambda)\right)^2=(45)(55)^2$

4. ACD

Sol. $z^4+az^3+bz^2+cz+d=0\left(a,b,c,d\in R\right)$

Let roots are z_1,z_2,z_3,z_4

$|z_1|=|z_2|=|z_3|=|z_4|=1$

$z_1+z_2+z_3+z_4=-4$

$z_1z_2+z_1z_3+z_1z_4+z_2z_3+z_2z_4+z_3z_4=b$

$z_1z_2z_3+z_1z_2z_4+z_1z_3z_4+z_2z_3z_4=-c$

$z_1z_2z_3z_4=d$

$$|z_1+z_2+z_3+z_4| \le |z_1|+|z_2|+|z_3|+|z_4|$$
$$|a| \le 4;\quad |b| \le 6;\quad |c| \le 4;\quad |d| = 1$$

5. ACD

Sol.

(a) Clearly, $E = \left((x-4)+5\right)^{100} = (1+x)^{100}$

$\therefore$ Coefficient of x^2 in $(1+x)^{100} = {}^{100}C_2 = 4950$

(b) Clearly, ${}^8C_5\left(x^{-8/3}\right)^3\left(x^2\log_{10}x\right)^5 = 5600$

$\Rightarrow x^2\left(\log_{10}x\right)^5 = 100$

$\Rightarrow x = 10$

(c) Clearly

$A_n = {}^nC_0\,{}^nC_{n-1} + {}^nC_1\,{}^nC_{n-2} + \ldots + {}^nC_{n-1}\,{}^nC_0$

$= {}^{2n}C_{n-1}$

(We can also explain by using theory of permutation).

$$\text{Now, } \frac{A_{n+1}}{A_n} = \frac{(2n+2)!}{(n)!(n+2)!} \times \frac{(n-1)!(n+1)!}{(2n)!}$$

$$= \frac{(2n+2)(2n+1)}{n(n+2)} = \frac{15}{4}$$

$\Rightarrow n = 2, 4$

Hence, Sum $= 2 + 4 = 6$

(d) As $A_k = \dfrac{{}^nC_k}{{}^{n+1}C_{k+1}} = \dfrac{k+1}{n+1}$

$$\Rightarrow \sum_{k=0}^{n-1} A_k = \frac{n}{2}$$

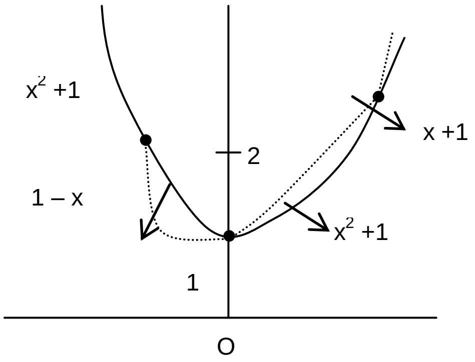
$$\text{Now, } \sum_{k=0}^{n-1} A_k = 64$$

$$\Rightarrow \frac{n}{2} = 64 \Rightarrow n = 128$$

6. ABCD

Sol.

$$h(x) = \begin{cases} x^2+1 & x \le -1 \\ |x|+1 & -1 < x < 0 \\ x^2+1 & 0 \le x < 1 \\ |x|+1 & x > 1 \end{cases}$$



Clearly 3 points of non – differentiability.

7. AC

Sol. $\sqrt{(x-5)^2+(y-7)^2} + \sqrt{(x+1)^2+(y+1)^2} = 12$

$SP + S'P = 2a \Rightarrow$ conic is ellipse

$$2ae = \sqrt{36+64}$$

$$2a = 12 \Rightarrow e = \frac{5}{6}$$

Major axis $y - 7 = \frac{7+1}{5+1}(x-5)$

$\Rightarrow 4x - 3y + 1 = 0$

8. D

Sol. From the given equation we get

$S_1 = \tan\theta_1 + \tan\theta_2 + \tan\theta_3 + \tan\theta_4 = \sin 2\beta$.

$S_2 = \sum \tan\theta_1 \tan\theta_2 = \cos 2\beta$

$S_3 = \sum \tan\theta_1 \tan\theta_2 \tan\theta_3 = \cos\beta$

and $S_4 = \tan\theta_1 \tan\theta_2 \tan\theta_3 \tan\theta_4 = -\sin\beta$

Now $\tan(\theta_1+\theta_2+\theta_3+\theta_4) = \frac{S_1 - S_3}{1 - S_2 + S_4}$.

$$= \frac{\sin 2\beta - \cos\beta}{1 - \cos 2\beta - \sin\beta} = \frac{\cos\beta(2\sin\beta - 1)}{\sin\beta(2\sin\beta - 1)} = \cot\beta$$

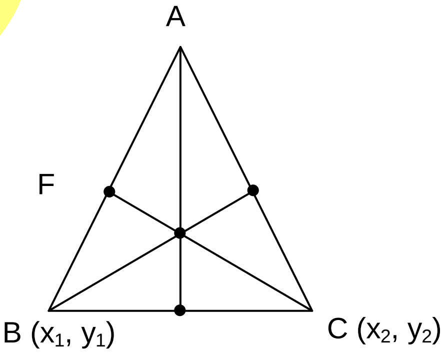
9. C

Sol. Let $A \equiv (3, 3)$

Given that $F \equiv \left(2, \frac{2}{3}\right)$ and $E \equiv \left(4, \frac{3}{2}\right)$ are mid points of AB and AC.

Let $B \equiv (x_1, y_1)$ and $C \equiv (x_2, y_2)$

Using mid point formula.



Co – ordinate of $F \equiv \left(2, \frac{2}{3}\right) = \left(\frac{3+x_1}{2}, \frac{3+y_1}{2}\right)$

$\Rightarrow \quad (x_1, y_1) = \left(1, -\frac{5}{3}\right)$

Co – ordinate of $E = \left(4, \frac{3}{2}\right) = \left(\frac{3+x_2}{2}, \frac{3+y_2}{2}\right)$

$\Rightarrow (x_2, y_2) = (5, 0)$

$\therefore$ Centroid of triangle is

$$G(x,y) = \left(\frac{3+1+5}{3}, \frac{3 - \frac{5}{3} + 0}{3}\right) = \left(3, \frac{4}{9}\right)$$

10. B

Sol. Given parabola is $y^2 - 16x - 8y = 0$ ....(1)

Let the coordinates of the feet of the normal from (14, 7) be $P(\alpha, \beta)$

Now, equation of the tangent at $P(\alpha,\beta)$ to parabola (1) is $y\beta - 8(x+\alpha) - 4(y+\beta) = 0$

Or, $(\beta - 4)y = 8x + 8\alpha + 4\beta$ ....(2)

Its slope $= \frac{8}{\beta - 4}$

Equation of normal to parabola (1) at (a, b) is $\gamma-\beta=\frac{4-\beta}{8}(x-\alpha)$.

It passes through (14, 7),

$$\therefore \quad 7-\beta=\frac{4-\beta}{8}(14-\alpha) \text{ or } \alpha=\frac{6\beta}{\beta-4} \qquad \ldots\ldots\ldots\ldots(3)$$

Also, (α,β) lies on parabola (1), $\therefore \beta^2-16\alpha-8\beta=0$

Putting the value of a from (3) in (4), we get

$$\beta^2-\frac{96\beta}{\beta-4}-8\beta=0 \qquad \Rightarrow \qquad \beta\left(\beta^2-12\beta-64\right)=0$$

$$\Rightarrow \beta(\beta-16)(\beta+4)=0$$

$$\therefore \quad \beta=0,16,-4$$

From (3), when $\beta=0, \alpha=0$

When $\beta=16, \alpha=8$ and when $\beta=-4, \alpha=3$

Hence, the feet of the normals are (0, 0), (8, 16) and (3, –4).

11. A

Sol. $A+B=2B'$

$$\Rightarrow (A+B)'=(2B')'$$

$$\Rightarrow A'+B'=2B \qquad (\because (A+B)'=A'+B')$$

$$\Rightarrow B=\frac{A'+B'}{2}$$

Now, $A+\left(\frac{B'+A'}{2}\right)=2B' \qquad [\because A+B=2B']$

$$\Rightarrow 2A+B'+A'=4B' \Rightarrow 2A+A'=3B'$$

$$\Rightarrow A=\frac{3B'-A'}{2} \qquad \ldots\ldots\ldots(1)$$

Also, $3A+2B=I_3$

$$\Rightarrow 3\left(\frac{3B'-A'}{2}\right)+2\left(\frac{A'+B'}{2}\right)=I_3$$

$$\Rightarrow \left(\frac{9B'+2B'}{2}\right)+\left(\frac{2A'-3A'}{2}\right)=I_3$$

$$\Rightarrow (11B'-A')'=(2I_3)'$$

$$\Rightarrow 11B-A=2I_3 \qquad \ldots\ldots\ldots(2)$$

Multiplying (2) by 3 and then adding (1) and (2), we get

$$35B=7I_3 \Rightarrow B=\frac{I_3}{5}$$

From (2), $11\frac{I_3}{5}-A=2I_3 \Rightarrow 11\frac{I_3}{5}-2I_3=A$

$$\Rightarrow A=\frac{I_3}{5}$$

$$\therefore 5A=5B=I_3 \Rightarrow 10A+5B=3I_3$$

12. D

Sol. $$(5x-4)\begin{vmatrix} 1 & 2x & 2x \\ 1 & x-4 & 2x \\ 1 & 2x & x-4 \end{vmatrix}$$

$$=(5x-4)\begin{vmatrix}1 & 2x & 2x\\ 0 & -(x+4) & 0\\ 0 & 0 & -(x+4)\end{vmatrix}$$

$$=(5x-4)(x+4)^2=(A+Bx)(x-A)^2$$

$$\Rightarrow \quad A=-4,\ B=5$$

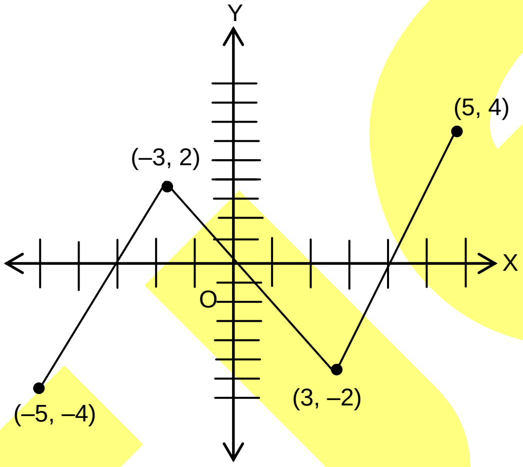
13. D

Sol. $f(x)+f(-x)=0$

$\Rightarrow f(x)$ is an odd function. Since points (–3, 2) and (5, 4) lie on the curve.

$\therefore \quad (3,-2)$ and $(-5,-4)$ will also lie on the curve

For minimum number of roots, graph of continuous function $f(x)$ is as follows.

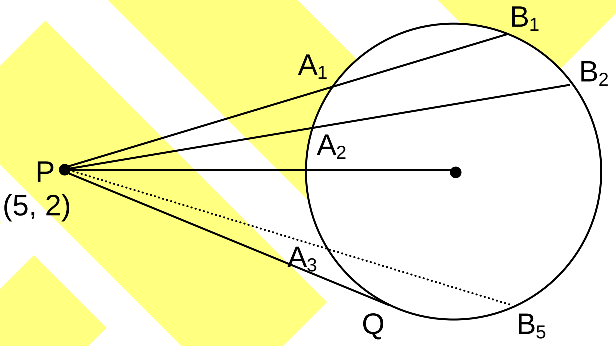


From the above graphs of $f(x)$ it is clear that equation $f(x)=0$ has at least three real roots.

PART – B

1. 107.50

Sol. PQ is tangent to circle



$PA_1.PB_1=PQ^2=4$

$PA_2.PB_2=4$

:

$PA_5.PB_5=4$

Given $PA_1+PB_1=5$

:

$PA_5+PB_5=9$

Square and Add

$\left(PA_1^2+...PA_5^2\right)+\left(PB_1^2+PB_2^2...+PB_5^2\right)$

$$= \left[5^2 + 6^2 + ... + 9^2\right] - 2\left[4+4+4+4+4\right]$$
$$= 255 - 40 = 215$$

2. 00006.60

Sol. $P(x) = ax^2 + bx + c = 0 \;\; (-2,\, \alpha)$

$Q(x) = ax^2 + cx + b = 0 \;\; (3,\, \beta)$

$S_p + P_q = 0$

$\left[S_p \rightarrow \text{sum of } P(x) \text{ and } P_q \rightarrow \text{Product of } P(x)\right]$

and $P_p + s_Q = 0$

$\therefore \quad \alpha - 2 + 3\beta = 0$

$\Rightarrow \quad \alpha + 3\beta = 2$ ....(i)

and $-2\alpha + 3 + \beta = 0$

$\Rightarrow \quad -2\alpha + \beta = -3$ .....(ii)

From equation (i) and (ii), we get

$\alpha = \dfrac{11}{7}$ and $\beta = \dfrac{1}{7}$

$$\frac{\alpha}{\beta} = \frac{11}{7}.\frac{7}{1} = 11$$

3. 97.66

Sol. $L: 3^4 - \left[{}^3C_1\left(2^4 - 2\right) + {}^3C_2\right] = 36$

$M:$ If $x > 0$, $\text{sgn}(x) = 1$

$f(x) = 0 + \dfrac{\pi}{2} = \dfrac{\pi}{2}$

For $x = 0\, f(x)$ is not defined

$\therefore$ For $x < 0$, $f(x) = \pi - \dfrac{\pi}{2} = \dfrac{\pi}{2}$

$\therefore M = 1$

N : Coefficient of $t^5 =$ coefficient of t^2 in $\left(1+t^2\right)^5 \times$ coefficient of t^3 in $\left(1+t^3\right)^8$

$= 5 \times 8 = 40$

Hence, L = 36; M = 1 and N = 40

$\Rightarrow LM + N = 36 + 40 = 76$

4. 3.13

Sol. Since maximum value of $\cos^{-1}x$ in $[0, 1] = \dfrac{\pi}{2}, \displaystyle\sum_{r=1}^{k} \cos^{-1}\beta_r = \dfrac{k\pi}{2}$ is possible if and only if

each $\cos^{-1}\beta_r = \dfrac{\pi}{2} \Leftrightarrow \beta_r = 0.$

$$A = \sum_{r=1}^{k} \left(\beta_r\right)^r = 0$$

Thus, $\displaystyle\lim_{x\to 0} \frac{(1+x)^{1/3} - (1-2x)^{1/4}}{x + x^2}$

$$=\lim_{x\to0}\frac{\left(1+\frac{x^2}{3}+0\left(x^4\right)\right)-\left(1-\frac{x}{2}+0\left(x^2\right)\right)}{x\left(1+x\right)}$$

$$=\lim_{x\to0}\frac{\frac{1}{2}+\frac{x}{3}+0\left(x^2\right)}{1+x}=\frac{1}{2}.$$

Thus the required limit is 249.

5. 5.55

Sol. $f\left(x\right)=\frac{1}{2}\left(x^2.\int_0^x g\left(t\right)dt-2x.\int_0^x t^2+\int_0^x t^2.g\left(t\right)dt\right)$

$\therefore$ Differentiate both sides with respect to x, we get

$$f'\left(x\right)=x.\int_0^x g\left(t\right)dt-\int_0^x t.g\left(t\right)dt \qquad \text{…….(i)}$$

Again differentiate both sides with respect to x, we get

$$f''\left(x\right)=\int_0^x g\left(t\right)dt \qquad \text{……(ii)}$$

$\therefore$ $f''\left(1\right)=2$

Also, $f'''\left(x\right)=g\left(x\right)$

$\Rightarrow$ $f'''\left(1\right)=g\left(1\right)=5$

6. 20.28

Sol. $F\left(x\right)=\int\frac{\left(1+x\right)\left(1+x^2\right)^2}{\left(1+x\right)^2\left(1+x^2\right)^2}dx=\ln\left(1+x\right)+c$

$\therefore$ $\left[F\left(99\right)-F\left(3\right)\right]=\left[\ln 25\right]=3$

7. 17.42

Sol. At P (x, y) for minima, $f'\left(x\right)=0,\ f''\left(x\right)>0$

$\Rightarrow x^2+f^2\left(x\right)-6>0\Rightarrow x^2+y^2>6$

(i.e., P lies outside $x^2+y^2=6$)

$\therefore$ Number of tangents to $x^2+y^2=4$ is 2

8. 17.38

Sol. Here, sum of numbers i.e. $a+b+c+d$ is not given.

Let, $b=a+D,\ c=a+2D,\ d=a+3D,\forall D\in N$

According to hypothesis,

$a+3D=a^2+\left(a+D\right)^2+\left(a+2D\right)^2$

$$\Rightarrow 5D^2+3\left(2a-1\right)D+3a^2-a=0 \qquad \text{……..(i)}$$

$$\therefore\ D=\frac{-3\left(2a-1\right)\pm\sqrt{9\left(2a-1\right)^2-20\left(3a^2-a\right)}}{10}$$

$$=\frac{-3\left(2a-1\right)\pm\sqrt{\left(-24a^2-16a+9\right)}}{10}$$

Now, $-24a^2-16a+9\geq0$

$\Rightarrow$ $24a^2+16a-9\leq0$

$\Rightarrow$ $-\frac{1}{3}-\frac{\sqrt{70}}{3}\leq a\leq-\frac{1}{3}+\frac{\sqrt{70}}{12}$

$\Rightarrow$ $a=-1,0$ $\quad\left[\because a\in I\right]$

When $a = 0$ from Equation (i), $D = 0, \frac{3}{5}$ (not possible $\because D \in N$) and for $a = -1$

From equation (i), $D = 1, \frac{4}{5}$

$\therefore \quad D = 1 \quad [\because D \in N]$

$\therefore \quad a = -1, b = 0, c = 1, d = 2$

Then $a + b + c + d = -1 + 0 + 1 + 2 = 2$

FIITJEE

FIITJEE RBT-3 for (JEE-Advanced)

BATCHES – Two Yr CRP2123(All)

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 2

QP Code:

PAPER - 2

Time Allotted: 3 Hours **Maximum Marks: 195**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections.**
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. All the section can be filled in **PART-A** of OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with ***Blue/Black Ball Point Pen*** for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For Only One Part.

(i) **Part-A (01-07) –** Contains seven (07) multiple choice questions which have **One or More** correct answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
Negative Marks: –**2 In all other cases**.
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in –**2** marks, as a wrong option is also darkened.

(ii) **Part-A (08-14) –** Contains seven (07) multiple choice questions which have ONLY ONE CORRECT answer Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(iii) **Part-A (15-18) -** This section contains Two paragraphs. Based on each paragraph, there are Two multiple choice questions. Each question has only one correct answer and carries **+4 marks** for the correct answer and **– 2 marks** for wrong answer.

Name of the Candidate :____

Batch :____________________ **Date of Examination :**____________________

Enrolment Number :____

SECTION-1 : PHYSICS

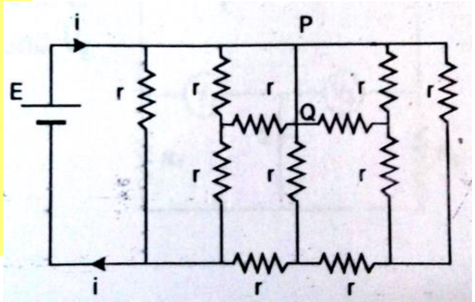
PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

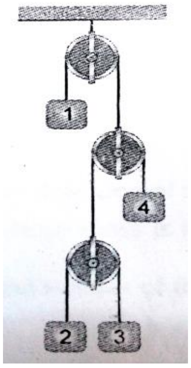
1. The electric field strength in a region is given as $\vec{E} = \frac{x\hat{i} + y\hat{j}}{x^2 + y^2}$. Then select the correct option(s).
(A) The net charge inside a sphere of radius ‘a’ with its centre at origin will be $2\pi\varepsilon_0 a$
(B) The net charge inside a sphere of radius ‘a’ with its centre at origin will be $4\pi\varepsilon_0 a$
(C) The net charge inside a sphere of radius ‘2a’ with its centre at origin will be $4\pi\varepsilon_0 a$
(D) The net charge inside a sphere of radius ‘2a’ with its centre at origin will be $8\pi\varepsilon_0 a$

2. A solution contains a mixture of two isotopes A (half life = 10 days) and B (half life = 5 days). Total activity of the mixture is 10^{10} disintegrations per second at time t = 0, the activity reduces to 20% in 20 days. Then select correct option(s).
(A) Initial activity of A is 0.73×10^{10} dps.
(B) Initial activity of B is 0.27×10^{10} dps.
(C) The ratio of initial number of their nuclei is $N_A : N_B$ is 5.4
(D) None of these



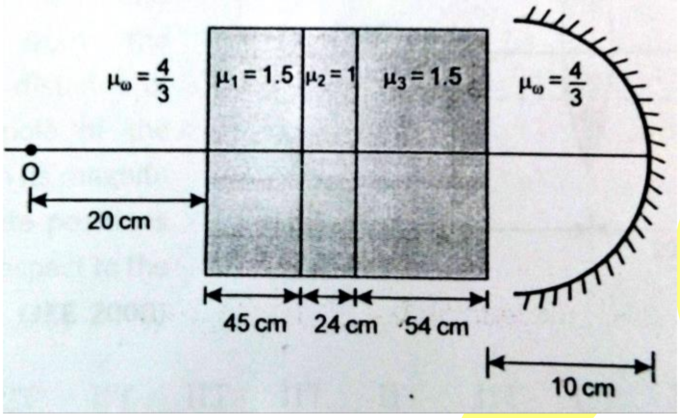
3. If r = 1 Ω and E = 10 V in the network shown in figure. Then answer the following:
(A) The value of current I is 22.85 A.
(B) The value of current I is 42.85 A.
(C) The current in branch PQ is 7.62 A.
(D) The current in branch PQ is 3.8 A.

4. An aluminium wire of cross-sectional area 10^{-6} m^2 is joined to a steel wire of the same cross-sectional area. This compound wire is stretched on a sonometer pulled by a weight of 10 kg. The total length of the compound wire between the bridges is 1.5 m of which the aluminium wire is 0.6 m and the rest is steel wire. Transverse vibrations are set up in the wire by using an external source of variable frequency. The density of aluminium is 2.6×10^3 kg/m^3 and that of steel is 1.04×10^4 kg/m^3. (g = 10 m/s^2)
(A) The lowest frequency of excitation for which standing waves are formed such that joint of wires is a node is nearly 82 Hz.
(B) The lowest frequency of excitation for which standing waves are formed such that joint of wires is a node is nearly 164 Hz.
(C) A total of 4 nodes are formed on composite wire.
(D) A total of 5 nodes are formed on composite wire.



5. In the arrangement shown in figure, all pulleys are smooth and massless. When the system is released form rest, accelerations of blocks 2 and 3 relative to 1 are 1 m/s^2 downwards and 5 m/s^2 downwards. Acceleration of block 3 relative to 4 is zero. Then
(A) The absolute acceleration of block 1 is 2 m/s^2 upward.
(B) The absolute acceleration of block 2 is 1 m/s^2 downward.
(C) The absolute acceleration of block 3 is 3 m/s^2 downward.
(D) The absolute acceleration of block 4 is 3 m/s^2 downward.

6. A composite slab consisting of different media is placed in front of a concave mirror of radius of curvature 150 cm. The whole arrangement is placed in water (μ_w = 4/3). An object O is placed at a distance 20 cm from the slab. The refractive indices are $\mu_1 = 1.5$, $\mu_2 = 1$, $\mu_3 = 1.5$. The position of final image formed is



(A) 130 cm on left of mirror
(B) 153 cm on left of mirror
(C) Final image is real
(D) Final image is virtual

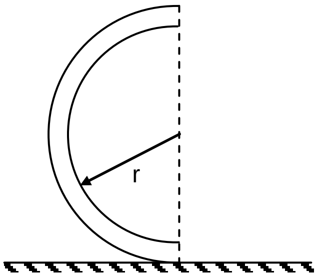
7. Two identical soap bubbles each of radius 1 cm come close to each other and join together maintaining a common surface between them.
(A) Their common surface will be curved.
(B) Their common surface will be flat.
(C) Area of their common surface will be $\frac{3\pi}{2}\text{cm}^2$
(D) Area of their common surface will be $\frac{3\pi}{4}\text{cm}^2$

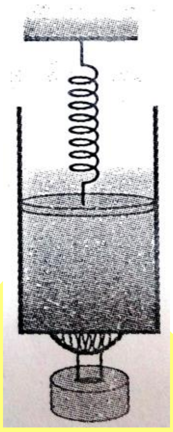
(Single Correct Choice Type)

This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

8. A ball of mass "m" moving with kinetic energy 3 J collides with a stationary ball of mass 2m in a head-on elastic collision. During collision, what will be maximum deformation potential energy stored in system?
(A) 1 J
(B) 2 J
(C) 2.5 J
(D) 1.5 J

9. A semicircular ring of mass m and radius r is released from rest in the position shown with its lower edge resting on a horizontal surface. Find the minimum coefficient of static friction μ_s which is necessary to prevent any initial slipping of the ring.
(A) 0.2
(B) 0.3
(C) 0.4
(D) 0.5





10. A gas is inside a cylinder closed by a piston. The piston is held from above by a spring whose elastic properties obey Hooke's law. If the gas is heated slowly then determine the work done by the gas in the process if volume of the gas varies from V_1 to V_2 and the pressure varies from P_1 to P_2.

(A) $(P_1 + P_2)(V_2 - V_1)$

(B) $\frac{(P_1 + P_2)(V_2 - V_1)}{2}$

(C) $\frac{(P_1 + P_2)(V_2 - V_1)}{4}$

(D) Data insufficient

11. An air sealed spherical tank of 1.2 m radius is half filled with oil of relative density 0.8. If the tank is given a horizontal acceleration of 10 m/s^2. The maximum pressure at any point on the tank is [Assume near vaccum condition]

(A) $4800\sqrt{2}\ \text{N/m}^2$

(B) 4800 N/m^2

(C) $3036\sqrt{2}\ \text{N/m}^2$

(D) 9600 N/m^2

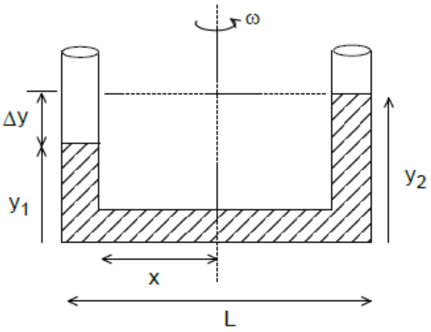
12. An U-shaped tube contains a liquid of density ρ and it rotates about an axis as shown in the figure. Given L = 2 m, Δy = 1.6 m and ω = 4 rad/s. Then the value of 'x' is

(A) 0.25 m

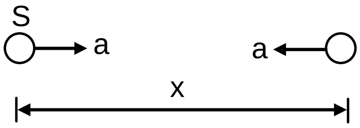
(B) 0.5 m

(C) 0.75 m

(D) 1 m



13. A source S and a detector O are initially at a distance of x = 1 km. Both start moving towards one another with same acceleration a = 10 m/s^2. Frequency of source is f = 2000 Hz. Find the frequency observed by the detector at time t = 4 second. Speed of sound in air is v = 300 m/s.



(A) 2241 Hz

(B) 2341 Hz

(C) 2441 Hz

(D) 2541 Hz

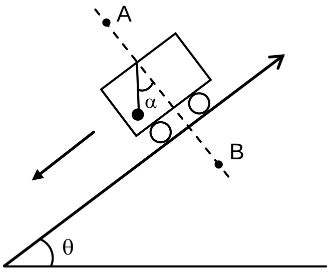
14. A pendulum hangs from roof of a cart which slides down the smooth incline as shown . Line AB is perpendicular to incline. What is angle "α" made by string of pendulum with line AB in equilibrium position?

(A) 0°

(B) θ

(C) $\frac{\theta}{2}$

(D) greater than θ

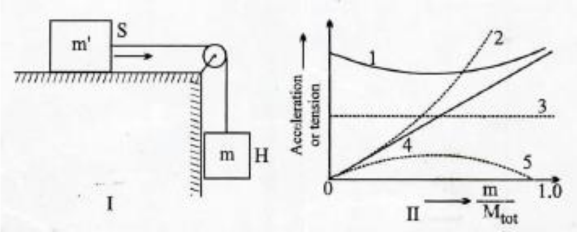


(Paragraph Type)

This section contains **2 paragraphs**. Based upon the paragraphs **2 multiple choice questions** have to be answered. Each of these questions has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph for Question no. 15 to 16

Two containers of sand S and H are arranged like the blocks in figure I. The containers alone have negligible mass; the sand in them has a total mass M_{tot}; the sand in the hanging container H has mass m. You are to measure the magnitude of the acceleration of the system in a series of experiments where m varies from experiment to experiment but M_{tot} does not; that is, you will shift sand between the containers before each trial. $\frac{m}{M_{tot}}$ is taken on the horizontal axis for all plots.



15. The plot in figure II which gives the acceleration magnitude of the containers (taken on y-axis) against ratio $\left(\frac{m}{M_{tot}}\right)$ is:

(A) 1 (B) 3 (C) 4 (D) 5

16. The curve which gives tension in the connecting string (taken on y-axis) against ratio $\left(\frac{m}{M_{tot}}\right)$ is:

(A) 1 (B) 2 (C) 4 (D) 5

Paragraph for Question no. 17 to 18

The main scale of a vernier callipers reads in millimetre and its vernier is divided into 10 divisions which coincide with 9 divisions of the main scale. When the two jaws of the instrument touch each other the seventh division of the vernier scale coincide with a main scale division and the zero of the vernier lies to the right of the zero of main scale. Furthermore, when a cylinder is tightly placed along its length between the two jaws, the zero of the vernier scale lies slightly to the left of 3.2 cm; and the fourth vernier division coincides with a scale division. Choose from following the correct option.

17. The zero error in the apparatus is

(A) –0.07 cm (B) 0.07 cm
(C) 0.03 cm (D) –0.03 cm

18. The measured value of the length of the cylinder is

(A) 3.14 cm (B) 3.24 cm
(C) 3.07 cm (D) 3.17 cm

Space For Rough Work

SECTION-2 : CHEMISTRY

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

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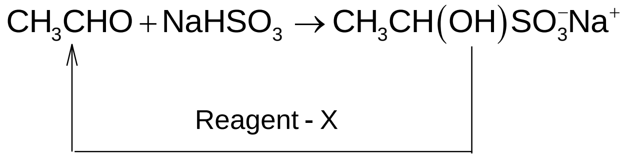
1. 

$CH_3CHO + NaHSO_3 \rightarrow CH_3CH(OH)SO_3^-Na^+$

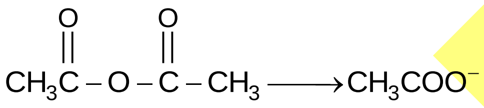
In the above change, the reagent (X) can be

(A) CCl_4 (B) HCl
(C) NaOH (D) DMF

2. Which of the following reaction(s) takes place in presence of NaOH?

(A) $CH_3CH_2CH_2OH \longrightarrow CH_3CH = CH_2 + H_2O$

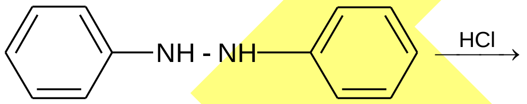
(B) $CH_3CHO + CH_3CHO \longrightarrow CH_3CH = CHCHO + H_2O$

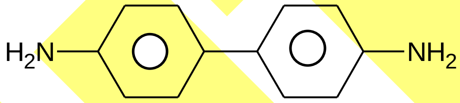
(C) 

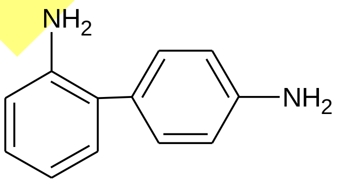
$CH_3\overset{O}{\overset{||}{C}} - O - \overset{O}{\overset{||}{C}} - CH_3 \longrightarrow CH_3COO^-$

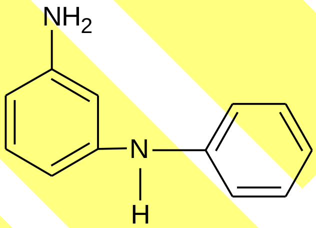
(D) $CH_3CONH_2 \longrightarrow CH_3CN + H_2O$

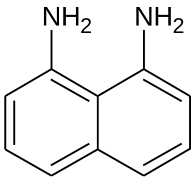
3. Find out the products which are formed by the following reaction:



(A) 

(B) 

(C) 

(D) 

4. Assuming ideal behaviour, when a solution of 1 mol of liquid A in 9 mol of liquid B is mixed at 300 K than for the solution which of the following is/are correct.

(A) $\Delta A_{mix} = 0$ (B) $\Delta S_{mix} = 27.04\, JK^{-1}$
(C) $\Delta H_{mix} = 0$ (D) $\Delta G_{mix} = -8112\, J$

5. Choose the correct statement(s):

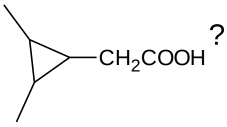
(A) Of the two isomeric liquids A and B with their normal b.p's 127°C and 27°C, respectively if the K_b for B is 6 K Kg mol^{-1} then that for A K_b almost equal to 8 k Kg mol^{-1} (K_b = molal elevation constant)

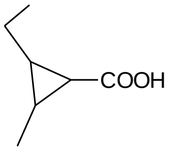
(B) At the b.p. the molar free energy of each phase must be equal

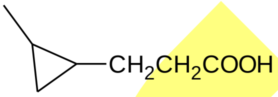
(C) For an ideal solution of two liquids, ΔS system = +Ve and ΔS surr = O

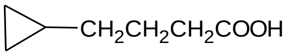
(D) Minimum boiling azeotrope results when mixture of two volatile liquids show negative deviation from Raoult's law

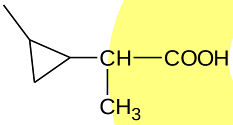
6. Which of the following statements is/are correct?
(A) Boiling point of liquid racemic mixture is same as that of pure enantiomer.
(B) Melting point of solid racemic mixture is same as that of pure enantiomer.
(C) In osmosis there is movement of solvent molecules from higher concentration (i.e. solvent) to lower concentration.
(D) In osmosis there is movement of solvent molecules from lower concentration (i.e. solute) to higher concentration.

7. Which of the following acid(s) is are more acidic than  ?

(A) 

(B) 
CH2CH2COOH

(C) 
CH2CH2CH2COOH

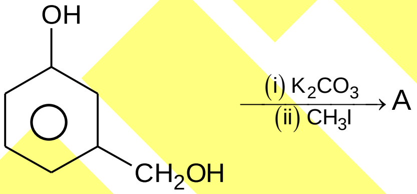
(D) 

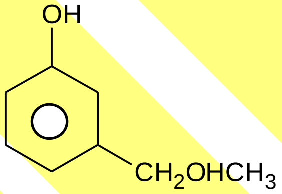
(Single Correct Choice Type)

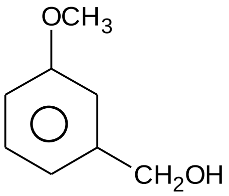
This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

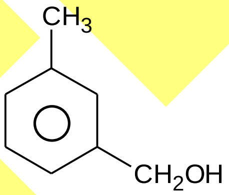
8. The compound that will react most readily with NaOH to form methanol is:-
(A) $(CH_3)_4\overset{+}{N}I^-$ (B) $CH_3 - O - CH_3$
(C) $(CH_3)_3\overset{+}{S}I^-$ (D) $(CH_3)_3C - Cl$

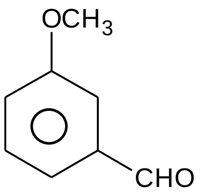
9. The product A is

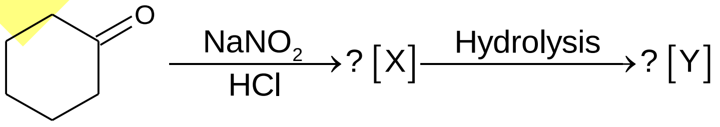

OH
CH2OH
(i) K2CO3
(ii) CH3I
A

(A) 
OH
CH2OHCH3

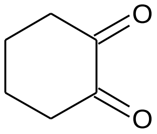
(B) 

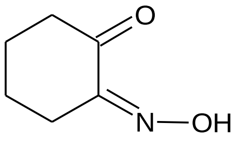
(C) 

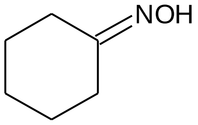
(D) 

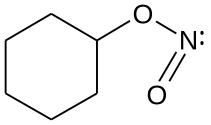
10. 
O
NaNO2
HCl
? [X]
Hydrolysis
? [Y]

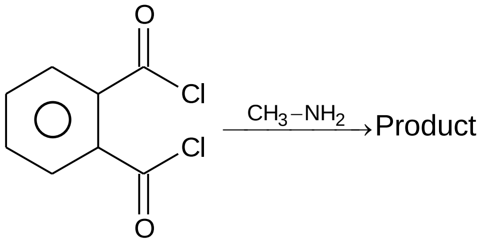
The end product [Y] is

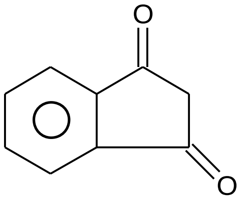
(A) 

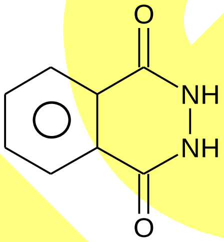
(B) 

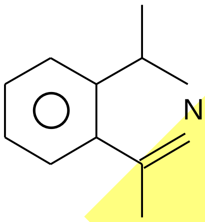
(C) 

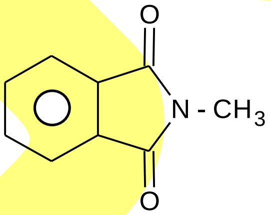
(D) 

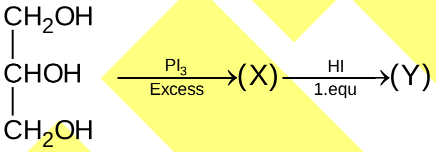
11. 

(A) 

(B) 

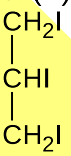
(C) 

(D) 

12. 

$$\begin{array}{l} CH_2OH \\ | \\ CHOH \\ | \\ CH_2OH \end{array} \xrightarrow[\text{Excess}]{PI_3} (X) \xrightarrow[\text{1.equ}]{HI} (Y)$$

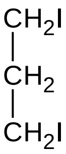
Product (Y) in the above reaction is :

(A) 

$$\begin{array}{l} CH_2I \\ | \\ CHI \\ | \\ CH_2I \end{array}$$

(B) $CH_2=CH-CH_2I$

(C) $CH_3-CH=CH_2$

(D) 

$$\begin{array}{l} CH_2I \\ | \\ CH_2 \\ | \\ CH_2I \end{array}$$

13.
$$\begin{tikzcd} CH_2=CH-CH_2-CHO \arrow[r, "NH_3(1\,eq)"] & (A) \arrow[r, "H_2/Ni"] & (B) \arrow[d] \\ & (C) & \arrow[l, "CHCl_3"', "KOH"] \end{tikzcd}$$

How many pi(π) bond(s) is/are present in one molecule of (C)?

(A) 1
(B) 2
(C) 4
(D) 3

14. Which of the following resonating structure is most stable?

(A) $\overset{\oplus}{C}H_2 - CH = CH - \overset{\ominus}{C}H_2$ (B) $CH_2 = CH - \overset{\oplus}{C}H - \overset{\ominus}{C}H_2$

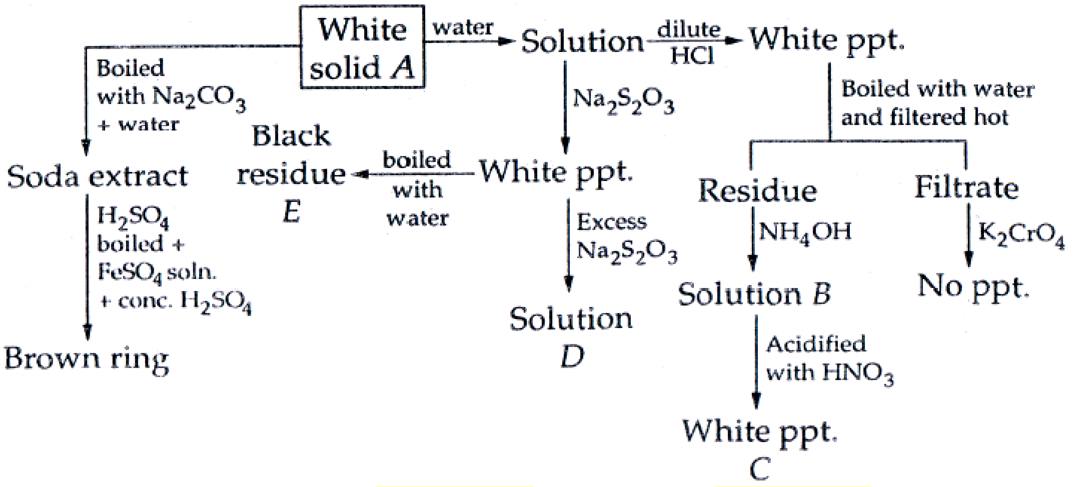
(C) $\overset{\oplus}{C}H_2 - \overset{\ominus}{C}H - CH = CH_2$ (D) $\overset{\ominus}{C}H_2 - \overset{\oplus}{C}H - \overset{\ominus}{C}H - \overset{\oplus}{C}H_2$

(Paragraph Type)

This section contains **2 paragraphs**. Based upon the paragraphs **2 multiple choice questions** have to be answered. Each of these questions has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph for Question no. 15 to 16

Consider the following sequence of reactions.


White solid A
water
Solution
dilute HCl
White ppt.
Boiled with Na_2CO_3 + water
Soda extract
H_2SO_4 boiled + $FeSO_4$ soln. + conc. H_2SO_4
Brown ring
$Na_2S_2O_3$
White ppt.
boiled with water
Black residue E
Excess $Na_2S_2O_3$
Solution D
Boiled with water and filtered hot
Residue
NH_4OH
Solution B
Acidified with HNO_3
White ppt. C
Filtrate
K_2CrO_4
No ppt.

15. The change from B to C involves the reaction

(A) $\left[Hg(NH_3)_4\right]^{2+} + 2H^+ + Cl^- \longrightarrow Hg(NH_2)Cl\downarrow + 3NH_4^+$

(B) $\left[Pb(NH_3)_4\right]^{2+} + 4H^+ + 2Cl^- \longrightarrow PbCl_2\downarrow + 4NH_4^+$

(C) $\left[Pb(OH)_4\right]^{2+} + 4H^+ + 2Cl^- \longrightarrow PbCl_2\downarrow + 4H_2O$

(D) $\left[Ag(NH_3)_2\right]^{2+} + 2H^+ + Cl^- \longrightarrow AgCl\downarrow + 2NH_4^+$

16. The white ppt. 'C' is

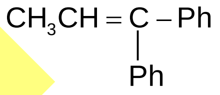
(A) $PbCl_2$ (B) $PbSO_4$ (C) AgCl (D) $BaSO_4$

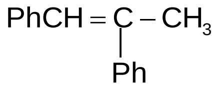
Paragraph for Question no. 17 to 18

An aromatic tertiary alcohol upon acid catalysed dehydration gives a product (I). Reductive ozonolysis of (I) forms compounds (J) and (K). Compound (J) upon reaction with NaOH gives benzyl alcohol and compound (L), whereas (K) on heating with NaOH gives only (M)

Answer the following questions on the basis of the above write up.

17. The structure of the compound (I) is:

(A)

$CH_3CH = \underset{\displaystyle Ph}{C} - Ph$

(B)

$PhCH = \underset{\displaystyle Ph}{C} - CH_3$

(C) $PhCH = CH - CH_3$ (D) $PhCH_2CH = CH(Ph)$

18. The structure of compounds J, K and L respectively are:

(A) PhCHO, $PhCH_2CHO$ and $PhCH_2COONa$

(B) PhCHO, $PhCOCH_3$ and PhCOONa

(C) PhCHO, $PhCOCH_3$ and $PhCH_2COONa$

(D) PhCHO, PhCOPh and PhCOONa

Space For Rough Work

SECTION-3 : MATHEMATICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

---

1. A line L passing through the point P (1, 4, 3), is perpendicular to both the lines $\frac{x-1}{2}=\frac{y+3}{1}=-\frac{z-2}{4}$ and $\frac{x+2}{3}=\frac{y-4}{2}=\frac{z+1}{-2}$.

If the position vector of point Q on L is (a_1, a_2, a_3) such that $(PQ)^2 = 357$, then $\left(a\ + a_2 + a_3\right)$ can be:

(A) 16 (B) 15

(C) 2 (D) 1

2. If $\lim\limits_{x\to 0}\frac{a\sin x - bx + cx^2 + x^3}{2x^2\log(1+x) - 2x^3 + x^4}$ exists and is finite, then

(A) a = b (B) c = 0

(C) a = 6 (D) c = 2

3. Which of the following definite integral(s) vanishes?

(A) $\int_0^{\pi/2}\ln(\cot x)\,dx$ (B) $\int_0^{2\pi}\sin^3 x\,dx$

(C) $\int_{1/e}^{e}\frac{dx}{x(\ln x)^{1/3}}$ (D) $\int_0^{\pi}\sqrt{\frac{1+\cos 2x}{2}}\,dx$

4. Let f be a real valued function satisfying $f\left(\frac{x}{y}\right)$ = f(x) – f(y) and $\lim\limits_{x\to 0}\frac{f(1+x)}{x}$ = 3. The area bounded by the curve y = f(x), the y – axis and the line y = 3 is

(A) e (B) 2e

(C) 3e (D) 4e

5. Let $f(x) = \begin{cases} x^3 - x^2 + 10x - 5, & x \le 1 \\ -2x + \log_2\left(b^2 - 2\right), & x > 1 \end{cases}$. If $f(x)$ has greatest value at $x = 1$, then $\left[b^2 \in (2, \lambda)\right]$. Then, λ is

(A) multiple of 13 (B) even number

(C) divisible by 5 (D) odd number

6. The area of the region bounded by the curve $y = \frac{16 - x^2}{4}$ and $y = \sec^{-1}\left[-\sin^2 x\right]$ where [.] denotes the greatest integer function) is

(A) $\frac{1}{3}(4-\pi)^{3/2}$ (B) $8(4-\pi)^{3/2}$

(C) $\frac{8}{3}(4-\pi)^{3/2}$ (D) $\left(\frac{3}{8(4-\pi)^{\frac{3}{2}}}\right)^{-1}$

7. If $x = 2 + 5i$ (where $i^2 = 1$) and $2\left(\frac{1}{1!-9!}+\frac{1}{3!7!}\right)+\frac{1}{5!5!}=\frac{2^a}{b!}$, then the value of $\left(x^3 - 5x^2 + 33x - 19\right)$ is equal to:

(A) a + 1
(B) b
(C) a – b + 11
(D) a + b – 9

(Single Correct Choice Type)

This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

---

8. A square, of each side 2, lies above the x – axis and has one vertex at the origin. If one of the sides passing through the origin makes an angle 30^o with the positive direction of the x – axis, then the sum of the x – coordinates of the vertices of the square is

(A) $\sqrt{3}-2$
(B) $2\sqrt{3}-1$
(C) $\sqrt{3}-1$
(D) $2\sqrt{3}-2$

9. All the chords of the hyperbola $3x^2 - y^2 - 2x + 4y = 0$ subtending a right angle at the origin pass through the fixed points

(A) (1, –2)
(B) (–1, 2)
(C) (1, 2)
(D) none of these

10. The sum of two natural numbers n_1 and n_2 is known to be equal to 100. The probability that their product being greater than 1600, is equal to:

(A) $\frac{20}{33}$
(B) $\frac{58}{99}$
(C) $\frac{13}{33}$
(D) $\frac{59}{99}$

11. The reflection of the complex number $\frac{4+3i}{1+2i}$, in the straight line $iz = \bar{z}$ is

(A) $2+i$
(B) $2-i$
(C) $1+2i$
(D) $1-2i$

12. Let a, b, c be distinct positive numbers such that each of the quadratics $ax^2 + bx + c$, $bx^2 + cx + a$ and $cx^2 + ax + b$ is non – negative for all $x \in R$. If $R = \frac{a^2+b^2+c^2}{ab+bc+ca}$, then

(A) $1 \le R < 4$
(B) $1 < R \le 4$
(C) $1 \le R \le 4$
(D) $1 < R < 4$

13. Let $P = \begin{bmatrix} (-z)^r & z^{2s} \\ z^{2s} & z^r \end{bmatrix}$, where $r, s \in \{1, 2, 3\}$ and $z = \frac{-1+i\sqrt{3}}{2}$. If $P^2 = -I_2$, then total number of ordered pairs (r, s) is

(A) 0
(B) 1
(C) 2
(D) 3

14. Let $S_n = \cot^{-1}\left(3x + \frac{2}{x}\right) + \cot^{-1}\left(6x + \frac{2}{x}\right) + \cot^{-1}\left(10x + \frac{2}{x}\right) + ... + n$ terms, where $x > 0$. If $\lim_{n\to\infty} S_n = 1$, then x equals

(A) $\frac{\pi}{4}$
(B) 1
(C) $\tan 1$
(D) $\cot 1$

(Paragraph Type)

This section contains **2 paragraphs**. Based upon the paragraphs **2 multiple choice questions** have to be answered. Each of these questions has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph for Question no. 15 to 16

Let f be an even function satisfying $f(x-2)=f\left(x+\left[\frac{6x^2+13}{x^2+2}\right]\right)\forall x\in R$ and

$$f(x)=\begin{cases}3x, & 0\le x<1\\ 4-x, & 1\le x\le 4\end{cases}$$

[Note : [y] denotes greatest integer function of y.]

15. The area bounded by the graph of $f(x)$ and the x – axis from x = –1 to x = 9 is:

(A) $\frac{31}{2}$ (B) 15

(C) 12 (D) $\frac{15}{2}$

16. The value of $f(-89)-f(-67)+f(46)$ is equal to :

(A) 4 (B) 5

(C) 6 (D) 7

Paragraph for Question no. 17 to 18

Let a differentiable function 'f' satisfies the functional rule

$f(xy)=f(x)+f(y)+xy-x-y\,\forall x,y>0$ and $f'(1)=4$.

17. If $f(x_0)=0$, then x_0 lies in the interval

(A) $(0, 1)$ (B) $(1, e)$

(C) (e, e^2) (D) (e^2, e^3)

18. If $\int e^{f(x)}dx=e^x(ax^2+cx+d)+\lambda$, then the value of $(a+b+c+d)$ is equal to:

(A) –1 (B) –2

(C) 3 (D) 6

Space For Rough Work

Q.P. Code:

Answers

SECTION-1 : PHYSICS

PART – A

1.	BD	2.	ABC	3.	AC	4.	BD
5.	ACD	6.	BC	7.	BD	8.	B
9.	C	10.	B	11.	C	12.	B
13.	B	14.	A	15.	C	16.	D
17.	B	18.	C				

SECTION-1 : CHEMISTRY

PART – A

1.	BC	2.	BC	3.	AB	4.	BCD
5.	ABC	6.	ACD	7.	BC	8.	A
9.	B	10.	A	11.	D	12.	C
13.	B	14.	B	15.	B	16.	A
17.	B	18.	B				

SECTION-1 : MATHEMATICS

PART – A

1.	BD	2.	ABC	3.	ABC	4.	C
5.	ABC	6.	CD	7.	ABCD	8.	D
9.	B	10.	D	11.	D	12.	D
13.	B	14.	D	15.	B	16.	A
17.	A	18.	B				

Answers & Solutions

SECTION-1 : PHYSICS

PART – A

1. **BD**

Sol. At a point P(x, y, z) on sphere of radius 'a' unit vector ⊥ to surface:

$$\hat{n} = \frac{x}{a}\hat{i} + \frac{y}{a}\hat{j} + \frac{z}{a}\hat{k}$$

$$\vec{E} = \frac{x\hat{i} + y\hat{j}}{x^2 + y^2}$$

$$\vec{E}\cdot\hat{n} = \frac{1}{a} = \text{Independent of point P.}$$

$$\Rightarrow \quad \phi = \frac{1}{a} \times 4\pi a^2 = \frac{q}{\varepsilon_0}$$

2. **ABC**

Sol. Initial activities:

$$A_{O1} + A_{O2} = 10^{10}$$

After 20 days:

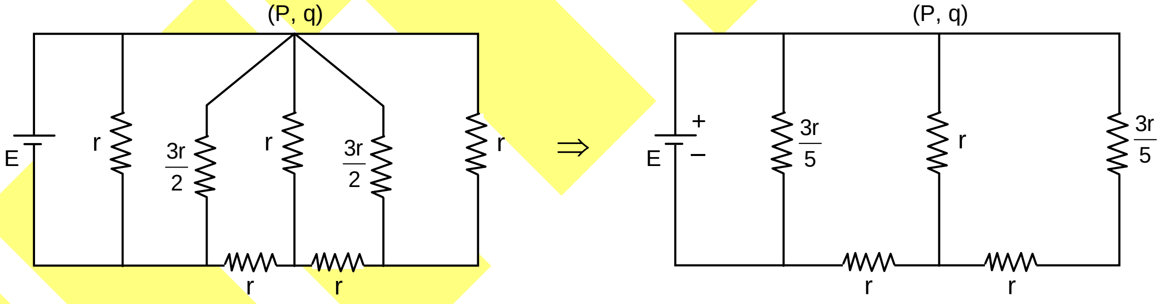
$$A_1 = \left(\frac{1}{2}\right)^2 A_{O1},$$

$$A_2 = \left(\frac{1}{2}\right)^4 A_{O2}$$

$A_1 + A_2 = 0.2 \times 10^{10}$.

3. **AC**

Sol. Circuit simplification:



4. **BD**

Sol. Let $n_a \longrightarrow$ Number of loops on Al wire.

$N_s \longrightarrow$ Number of loops on steel wire.

$$f_a = f_s$$

$$n_a\left(\frac{V_a}{2\ell_a}\right) = n_s\left(\frac{Vs}{2\ell_s}\right)$$

$$\Rightarrow \quad \frac{n_a}{n_s} = \left(\frac{V_s}{V_a}\right)\left(\frac{\ell_a}{\ell_s}\right) \quad ; \quad \frac{V_s}{V_a} = \sqrt{\frac{\rho_a}{\rho_s}} \qquad \left(\text{Using } V = \sqrt{\frac{T}{\mu}}\right)$$

5. **ACD**

Sol. String constrains and $\sum_{i=1}^{n} \vec{T}_i \cdot \vec{a}_i = 0$

6. **BC**

Sol. Shift produced by three slabs:

$$\Delta x_1 = \left(1-\frac{\mu_w}{\mu_1}\right)(45) = 5 \text{ cm}$$

$$\Delta x_2 = \left(\frac{\mu_w}{\mu_2}-1\right)(24) = 8 \text{ cm}$$

$$\Delta x_3 = \left(1-\frac{\mu_w}{\mu_3}\right)(54) = 6 \text{ cm}$$

$(\Delta x_1, \Delta x_3) \longrightarrow$ Towards mirror

$\Delta x_2 \longrightarrow$ Away from mirror.

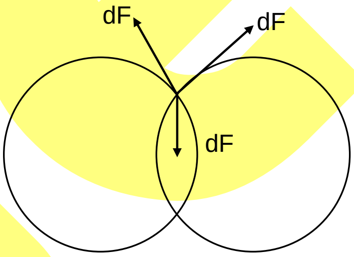
Net shift = 5 + 6 – 8 = 3 cm

Now, solution can be proceeded with.

7. **BD**

Sol. As pressure on both sides of common surface is equal, hence it will be flat.

By symmetry of surface tension forces (dF) on common interface, angle between any two surfaces will be 120°.



8. **B**

Sol. Conservation of momentum:

mu = (3 m)V

$V = \frac{u}{3}$ = Common speed at maximum deformation.

Maximum deformation energy = Maximum loss of kinetic energy during impact.

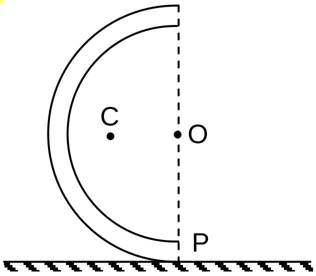
$$= \frac{1}{2}mu^2 - \frac{1}{2}(3\,m)V^2$$

9. **C**

Sol. As there is no slipping I.C.R is at point P.

C $\longrightarrow$ Centre of mass

$OC = \frac{2r}{\pi}$



10. **B**

Sol. When piston moves up by distance Δx:

Gas pressure = $P = P_0 + \frac{mg}{A} + \frac{k\Delta x}{A}$

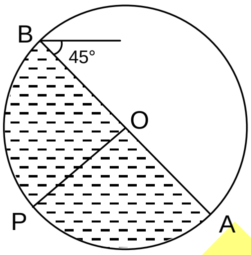
$$P = P_0 + \frac{mg}{A} + \frac{k}{A^2}(V - V_i)$$

Draw P-V graph which will be straight line.

Work done = Area under P-V graph.

11. **C**

Sol. In frame of reference of tank, g_{eff} will be along OP where OP ⊥ AB. Maximum pressure will be at point P.



12. **B**

Sol. Centrifugal force on horizontal liquid makes the liquid rise in vertical section.

13. **B**

Sol. Let t be the time when sound in emitted which is received at t = 4 sec.

Then: $\frac{1}{2}at^2 + \frac{1}{2}a(4)^2 + v(4-t) = 1000$

$$\frac{1}{2}(10)t^2 + \frac{1}{2}(10)(16) + (300)(4-t) = 1000$$

t = 0.95 sec.

Hence, pulse emitted at 0.95 sec will be received at t = 4 sec.

14. **A**

Sol. Due to effect of pseudo force, g_{eff} in frame of cart will be along line AB. Hence, $\alpha = 0°$.

15. **C**

Sol. Let acceleration of system = a

mg – T = ma …(1)

(M – m)a = T …(2)

16. **D**

Sol. As in problem 15, tension (T) can also be calculated.

17. **B**

Sol. Zero error = M.S.R + (V.S.R) (L.C) (with closed scale)

$$= 0 + (7)\left(\frac{1}{10}\text{mm}\right)$$

= 0.07 cm.

18. **C**

Sol. Length = M.S.R + (V.S.R) (L.C) – (Z.E.)

= 3.1 cm + 4 × (0.01 cm) – (0.07) cm

Length = 3.07 cm.

SECTION-2 : CHEMISTRY

PART – A

1. BC

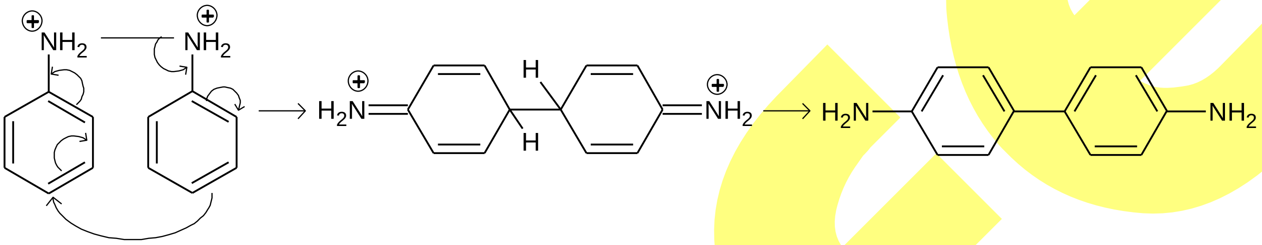
Sol. Hydrolysis in acidic or basic medium.

2. BC

Sol. Aldol &I hydrolysis

3. AB

Sol.



4. BCD

Sol. $\Delta S_{mixing} = -n_{total} \ell \sum \chi_i \ell n \chi_i$

$= -10 \times 8.314 \times (-0.23 - 0.0948) = -0.32 \times 10 \times 9.314 = 27\ JK^{-1}$

5. ABC

Sol. $K_f = \dfrac{MR\left(T_b^o\right)^2}{\Delta H_{vap}}$, at equilibrium $\Delta G = 0$

6. ACD

Sol. Theoretical

7. BC

Sol. Acidic strength α Stability of conjugate base.

8. A

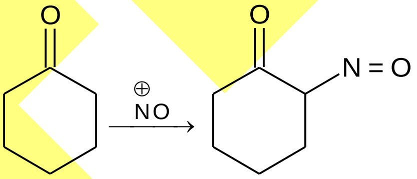
Sol. Good leaving group & electronegativity.

9. B

Sol. Acidity Phenol > Alcohol

10. A

Sol.



11. D

Sol. $S_{N_{AE}}$ of acid halide.

12. C

Sol. $\underset{(X)}{CH_2 = CH - CH - I} \xrightarrow{HI} \underset{(Y)}{CH_3 - CH = CH_2}$

13. B

Sol. $CH_3 - CH_2 - CH_2 - N \equiv C$(imine followed by reduction followed by carbylomine)

14. B

Sol. Theoretical, opposite charge close

15. D

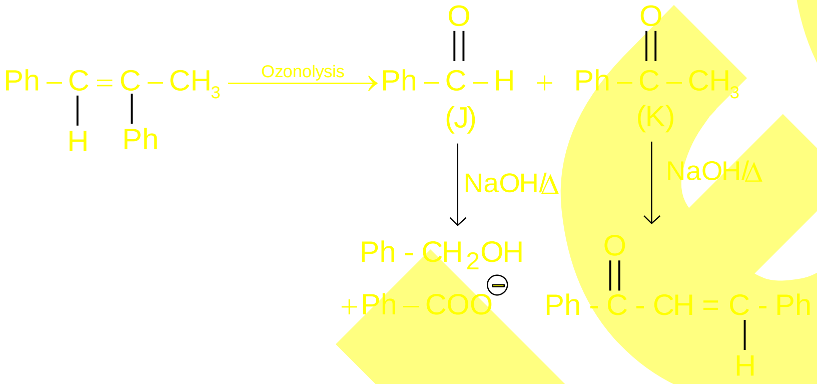
16. C

Sol for 15 & 16. A = $AgNO_3$, B = $[Ag(NH_3)_2]^+$, C = $AgCl\downarrow$, D = $[Ag(S_2O_3)_2]^{3-}$, E = Ag_2S

17. B

18. B

Sol for 17 & 18.


Ph – C = C – CH3
H
Ph
Ozonolysis
Ph – C – H
O
(J)
+
Ph – C – CH3
O
(K)
NaOH/Δ
NaOH/Δ
Ph - CH2OH
+ Ph – COO⊖
Ph - C - CH = C - Ph
O
H

FIITJEE

SECTION-3 : MATHEMATICS
PART – A

1. BD

Sol. Equation of the line passing through P(1, 4, 3) is: $\frac{x-1}{a}=\frac{y-4}{b}=\frac{z-3}{c}$ …….(i)

Since equation (i) is perpendicular to $\frac{x-1}{2}=\frac{y+3}{1}=\frac{z-2}{4}$ and $\frac{x+2}{3}=\frac{y-4}{2}=\frac{z+1}{-2}$

Hence $2a+b+4c=0$ and $3a+2b-2c=0$

$$\therefore \quad \frac{a}{-2-8}=\frac{b}{12+4}=\frac{c}{4-3}$$

$$\Rightarrow \quad \frac{a}{-10}=\frac{b}{16}=\frac{c}{1}$$

Hence the equation of the lines is $\frac{x-1}{-10}=\frac{y-4}{16}=\frac{z-3}{1}$ ………(ii)

Now any point Q on (2) can be taken as $(1-10\lambda, 16\lambda+4, \lambda+3)$

$\therefore$ Distance of Q from P (1, 4, 3) $=(10\lambda)^2+(16\lambda)^2+\lambda^2=357$

$\Rightarrow \quad (100+256+1)\lambda^2=357$

$\Rightarrow \quad \lambda=1$ or -1

$\therefore$ Q is $(-9,20,4)$ or $(11,-12,2)$

Hence $a_1+a_2+a_3=15$ or 1

2. ABC

Sol.
$$\lim_{x\to 0}\frac{a\left(x-\frac{x^3}{6}+\frac{x^5}{120}-...\right)-bx+cx^2+x^3}{2x^2\left(x-\frac{x^2}{2}+\frac{x^3}{3}-...\right)-2x^3+x^4}$$

$$=\lim_{x\to 0}\frac{(a-b)x+cx^2+(1-a/6)x^3+ax^5/120+...}{2x^2/3-x^6/2+...}$$

For this limit to exist we must have $a-b=0$, $c=0$, and $1-a/6=0$, that is, a = b = 6 and c = 0

3. ABC

Sol.

(A) $I=\int_0^{\pi/2}\ln(\cot x)dx \Rightarrow I=\int_0^{\pi/2}\ln(\tan x)dx$

$I=-\int_0^{\pi/2}\ln(\cot x)dx \Rightarrow I=-I \Rightarrow I=0$

(B) $I=\int_0^{2\pi}\sin^3 x\,dx=-\int_0^{2\pi}\sin^3 x\,dx \Rightarrow I=0$

(C) $I=\int_e^{1/e}\frac{-\left(\frac{1}{t^2}\right)dt}{\frac{-1}{t}(\ln t)^{1/3}}=\int_{1/e}^{e}\frac{dt}{t(\ln t)^{1/3}}$

$I=-I$

$I=0$

(D) $\sqrt{\frac{1+\cos 2x}{2}} > 0$

$$\int_0^{\pi}\sqrt{\frac{1+\cos 2x}{2}}\,dx > 0$$

4. C

Sol. Given $f\left(\frac{x}{y}\right) = f(x) - f(y)$ …(1)

Putting x = y = 1, we get $f(1) = 0$

Now, $f'(x) = \lim\limits_{h\to 0}\frac{f(x+h)-f(x)}{h} = \lim\limits_{h\to 0}\frac{f\left(1+\frac{h}{x}\right)}{h}$ (From (1))

$$= \lim_{h\to 0}\frac{f\left(1+\frac{h}{x}\right)}{\left(\frac{h}{x}\right)x}$$

$\Rightarrow f'(x) = \frac{3}{x}$ $\left\{\text{since } \lim\limits_{x\to 0}\frac{f(1+x)}{x} = 3\right\}$

$\Rightarrow f(x) = 3\ln x + c$

Putting x = 1

$\Rightarrow c = 0$

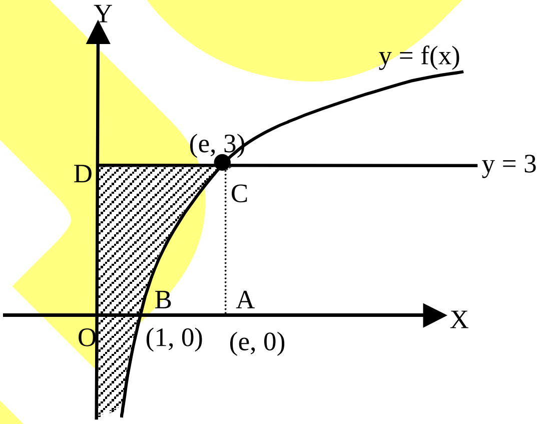
$\Rightarrow f(x) = 3\ln x = y$ (say)

$\therefore$ Required area $= \int_{-\infty}^{3} x\,dy$

$= \int_{-\infty}^{3} e^{y/3}dy$

$= 3\left[e^{y/3}\right]_{-\infty}^{3}$

$= 3(e - 0)$



5. ABC

Sol. For $x \le 1$ $f'(x) = 3x^2 - 2x + 10$

$$= 3\left\{\left(x-\frac{1}{3}\right)^2 + \frac{29}{9}\right\} > 0$$

$\therefore f(x)$ is increasing function for $x \le 1$ Now, for $x > 1$,

$f'(x) = -2 < 0$

So, $f(x)$ is decreasing function, for $x > 1$

Now, $f(x)$ will have greatest value at x = 1 if

$\Rightarrow \lim\limits_{x\to 1^+} f(x) \le f(1)$

$\Rightarrow \lim\limits_{h\to 0} f(1+h) \le 5$

$\Rightarrow \lim\limits_{h\to 0} -2(1+h) + \log_2\left(b^2-2\right) \le 5$

$\Rightarrow -2 + \log_2\left(b^2-2\right) \le 5$

$\Rightarrow \log_2\left(b^2-2\right) \le 7$

$\Rightarrow \quad b^2 - 2 \le 2^7$

$\Rightarrow \quad b^2 \le 130$

but $\quad b^2 - 2 > 0$

$\therefore \quad 2 < b^2 \le 130$

Hence, $\lambda = 130$

6. CD

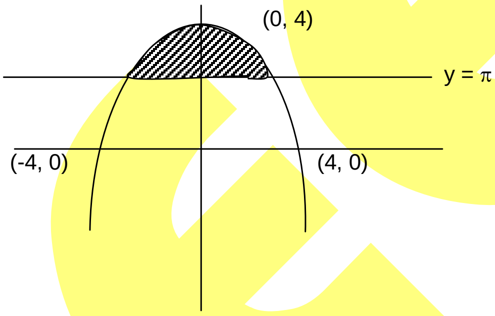
Sol. $0 \le \sin^2 x \le 1$

$\Rightarrow -1 \le -\sin^2 x \le 0$

$\therefore \left[\sin^2 x\right] = 0$ or -1

but sec^{-1}(0) is not defined

hence $y = \sec^{-1}\left[-\sin^2 x\right] = \sec^{-1}(-1) = \pi$



now $\pi = \dfrac{16 - x^2}{4}$

$\Rightarrow x^2 = 16 - 4\pi = 4(4 - \pi)$

$x = \pm 2\sqrt{(4 - \pi)}$

The required area =

$$\int_{-2\sqrt{4-\pi}}^{2\sqrt{4-\pi}} \left(\frac{16 - x^2}{4} - \pi\right) dx = \frac{8}{3}(4 - \pi)^{3/2}$$

7. ABCD

Sol. $2\left(\dfrac{1}{1!9!} + \dfrac{1}{3!7!}\right) + \dfrac{1}{5!5!} = \dfrac{2^n}{b!}$

$\Rightarrow \dfrac{2}{1!9!} + \dfrac{2}{3!7!} + \dfrac{1}{5!5!} = \dfrac{2^a}{b!}$

$\Rightarrow \dfrac{1}{10!}\left(\dfrac{2!10!}{1!9!} + \dfrac{2!10!}{3!7!} + \dfrac{10!}{5!5!}\right) = \dfrac{2^a}{b!}$

$\Rightarrow \dfrac{1}{10!}\left(2.{}^{10}C_1 + 2.{}^{10}C_3 + {}^{10}C_5\right) = \dfrac{2^a}{b!}$

$\Rightarrow \dfrac{1}{10!}\left({}^{10}C_1 + {}^{10}C_1 + {}^{10}C_3 + {}^{10}C_3 + {}^{10}C_5\right) = \dfrac{2^a}{b!}$

$\Rightarrow \dfrac{1}{10!}\left({}^{10}C_1 + {}^{10}C_9 + {}^{10}C_3 + {}^{10}C_7 + {}^{10}C_5\right) = \dfrac{2^a}{b!}$

$\Rightarrow \dfrac{1}{10!}\left({}^{10}C_1 + {}^{10}C_3 + {}^{10}C_5 + {}^{10}C_7 + {}^{10}C_9\right) = \dfrac{2^a}{b!}$

$\Rightarrow \dfrac{2^{10-1}}{10!} = \dfrac{2^a}{b!}$

$\therefore a = 9,\ b = 10$

Also, $x = 2 + 5i$

$\therefore (x - 2)^2 = (5i)^2$

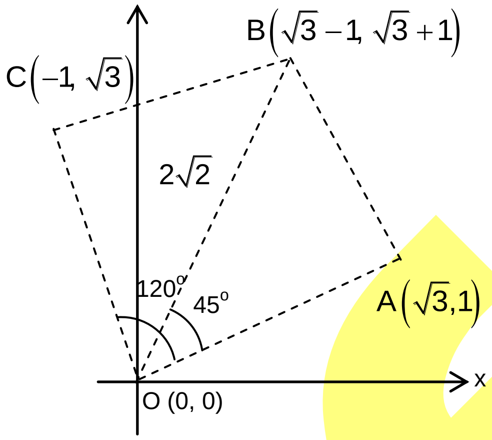
$\Rightarrow x^2 - 4x + 29 = 0$

$\therefore x^3 - 5x^2 + 33x - 19 = (x - 1)\left(x^2 - 4x + 29\right) + 10$

$= 0 + 10 \qquad \left(\because x^2 - 4x + 29 = 0\right)$

$= 10 = b$

8. D


$B\left(\sqrt{3}-1, \sqrt{3}+1\right)$
$C\left(-1, \sqrt{3}\right)$
$2\sqrt{2}$
120^o
45^o
$A\left(\sqrt{3},1\right)$
O (0, 0)
x

Sol. Side of square = 2

$$\frac{x}{\cos 30^o} = \frac{y}{\sin 30^o} = 2$$

$$\Rightarrow x = \frac{2\sqrt{3}}{2} = \sqrt{3} \text{ and } y = 1$$

$$\frac{x}{\cos 120^o} = \frac{y}{\sin 120^o} = 2$$

$$\Rightarrow x = -1, \ y = \sqrt{3}$$

$$\frac{x}{\cos 75^o} = \frac{y}{\sin 75^o} = 2\sqrt{2}$$

$$\Rightarrow \quad x = \sqrt{3}-1 \text{ and } y = \sqrt{3}+1$$

$\therefore$ Required sum $= 0 + \sqrt{3} + \sqrt{3} - 1 + (-1)$

$= 2\sqrt{3} - 2$

9. B

Sol. Let $ax + by = 1$ be the chord (1)

Making the equation of hyperbola homogeneous using (1),
We get

$$3x^2 - y^2 + (-2x + 4y)(ax + by) = 0$$

or, $(3-2a)x^2 + (-1+4b)y^2 + (-2b+4a)xy = 0$

Since the angle subtended at the origin is a right angle, so, coefficient of $x^2 +$ coefficient of $y^2 = 0$

$$\Rightarrow (3-2a) + (-1+4b) = 0 \Rightarrow a = 2b + 1$$

$\therefore$ The chords are $(2b+1)x + by - 1 = 0$

Or, $b(2+y) + (x-1) = 0$,

which, clearly, pass through the fixed point (1, –2)

10. D

Sol. Total number of ways in which $n_1 + n_2 = 100$ is equal to 99.

Now, $n_1.n_2 > 1600$

$\Rightarrow n_1(100 - n_1) > 1600$

$\Rightarrow n_1^2 - 100n + 1600 < 0$

$\Rightarrow (n_1 - 80)(n_1 - 20) < 0$

$\Rightarrow 20 < n_1 < 80$

$\Rightarrow 21 \le n_1 \le 79$

Thus, number of favourable ways
= 79 – 21 + 1 = 59

Hence, required probability $= \frac{59}{99}$,

11. D

Sol. We have,

$$z_1 = \frac{4+3i}{1+2i} = \frac{(4+3i)(1-2i)}{(1+2i)(1-2i)}$$

$= \frac{10-5i}{5} = 2 - i$ which represents the point whose coordinates are (2, –1)

Also, we have,

$iz = \bar{z}$

$\Rightarrow i(x+iy)-(x-iy)=0$ [Putting $z = x+iy$]

$\Rightarrow i(x+y)-(x+y)=0$

$\Rightarrow (i-1)(x+y)=0$ which represents the line $y=-x$

Hence, reflection of the point (2, –1) in the line $y=-x$ gives the point (1, –2) which is equivalent to 1 – 2i in the argand plane.
The correct option is (D)

12. D

Sol. Given, $b^2 \le 4\text{ ac}, c^2 \le 4ab$ and $a^2 \le 4ac$
Equality cannot hold simultaneously
[∵ a, b, c are different]

$\therefore \quad a^2+b^2+c^2 < 4(ab+bc+ca) \Rightarrow R < 4$

Also, $a^2+b^2+c^2-ab-bc-ca$

$\Rightarrow \frac{1}{2}\left[(b-c)^2+(c-a)^2+(a-b)^2\right] > 0 = \Rightarrow R > 1$

The correct option is (D)

13. B

Sol. $z=\omega$

$$P^2 = \begin{bmatrix} (-\omega)^r & \omega^{2s} \\ \omega^{2s} & \omega^r \end{bmatrix}\begin{bmatrix} (-\omega)^r & \omega^{2s} \\ \omega^{2s} & \omega^r \end{bmatrix} = \begin{bmatrix} \omega^{2r}+\omega^{4s} & \omega^{r+2s}\left(1+(-1)^r\right) \\ \omega^{r+2s}\left(1+(-1)^r\right) & \omega^{2r}+\omega^{4s} \end{bmatrix} = -I_2$$

$\Rightarrow 1+(-1)^r = 0 \Rightarrow r = 1 \text{ or } 3$ and $\omega^{2r}+\omega^{4s} = -1$ ....(i)

Possible options are (r, s) = (1, 1), (1, 2), (1, 3), (3, 1), (3, 2), (3, 3) of which one (1, 1) satisfies (i).

14. D

Sol. As, $T_n = \cot^{-1}\left[\frac{(n+1)(n+2)}{2}x+\frac{2}{x}\right]$

$\Rightarrow T_n = \tan^{-1}\left(\frac{2x}{(n+2)(n+1)x^2+4}\right)$

$\therefore T_n = \tan^{-1}\left(\left(\frac{n+2}{2}\right)x\right)-\tan^{-1}\left(\left(\frac{n+1}{2}\right)x\right)$

So, $S_n = \tan^{-1}\left(\left(\frac{n+2}{2}\right)x\right)-\tan^{-1}x$

$\Rightarrow \lim_{n\to\infty} S_n = \frac{\pi}{2}-\tan^{-1}x$

$=\cot^{-1}x = 1$ (given)

$\Rightarrow \quad x = \cot 1$

15. B

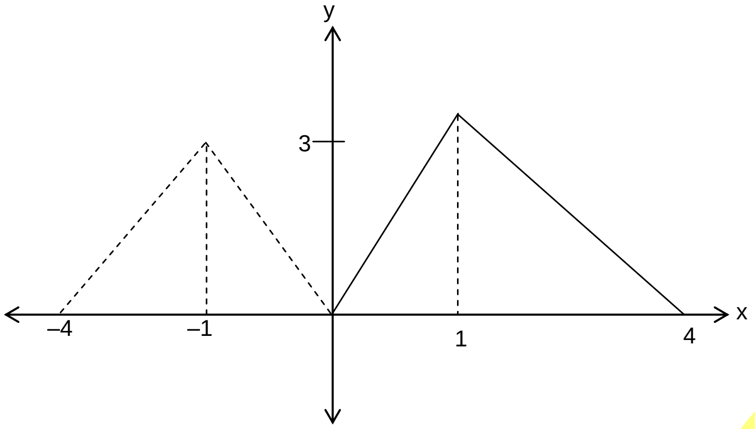
Sol. Required area $= 2\times\frac{1}{2}\times4\times3+2+2\times\frac{1}{2}\times1\times3 = 15$

16. A

Sol. $f(-89)-f(-67)+f(46) = f(-1)-f(-3)+f(-2)$

$= 3-1+2 = 4$

$$f(x-2)=f(x+6)$$
$$\Rightarrow\ f(x)=f(x+8)$$



17. A

18. B

(Sol. 17 to 18)

$$f(xy)=f(x)+f(y)+xy-x-y$$

Partially differentiating w.r.t. y (taking x as a constant)

$$f'(xy).x=f'(y)+x-1$$

Putting $y=1$

$$f'(x)=x=f'(1)+x-1$$
$$f'(x).x=3+x$$
$$f'(x)=\frac{3}{x}+1$$

Integrating both sides.

$$f(x)=3\ln x+x+c$$

From the given functional rule

$$x=y=1,\ f(1)=1$$
$$f(x)=3\ln x+x+c$$
$$\therefore\ f(x)=3\ln x+x$$

(i) $f(x)=0\Rightarrow 3\ln x+x=0$

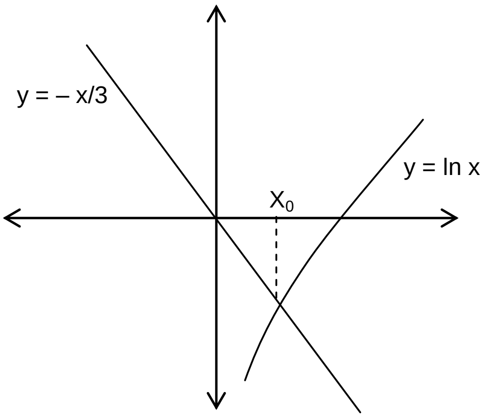
$$\Rightarrow\ \ln x=\frac{-x}{3}$$

Clearly, x_0 lies in the interval (0, 1).

(ii) $\int e^{f(x)}dx=e^{x}\left(ax^{3}+bx^{2}+cx+d\right)+\lambda$

$\Rightarrow$

$$\int e^{3\ln x+x}\,dx=e^{x}\left(ax^{3}+bx^{2}+cx+d\right)+\lambda$$



< 3

FIITJEE RBT-4 for (JEE-Advanced)

BATCHES – Two Yr CRP2123(All)

PHYSICS, CHEMISTRY & MATHEMATICS

QP Code: 100182 **Paper-1**

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections**.
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. Each **Section** is further divided into **Two Parts**: **Part-A & B** in the OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with HB pencil for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **PART – A *(01 – 04)*:** This section contains Four **(04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer. Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

PART – A *(05 – 10)*: This section contains **Six (06)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in –**2** marks, as a wrong option is also darkened.

(ii) **PART – B *(1 – 3)*:** This section contains **Three (03)** questions. The answer to each question is a **NON-NEGATIVE INTEGER.** Each question carries **+4 marks** for correct answer and **there will be no negative marking.**

(iii) **PART – B *(4 – 9)*:** This section contains Six **(06)** question stems. There are **TWO (02)** questions corresponding to each question stem. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places. Each question carries **+2 marks** for correct answer and **there will be no negative marking.**

Name of the Candidate :____

Batch :____________________ **Date of Examination :**____________________

Enrolment Number :____

SECTION – I : PHYSICS

PART – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

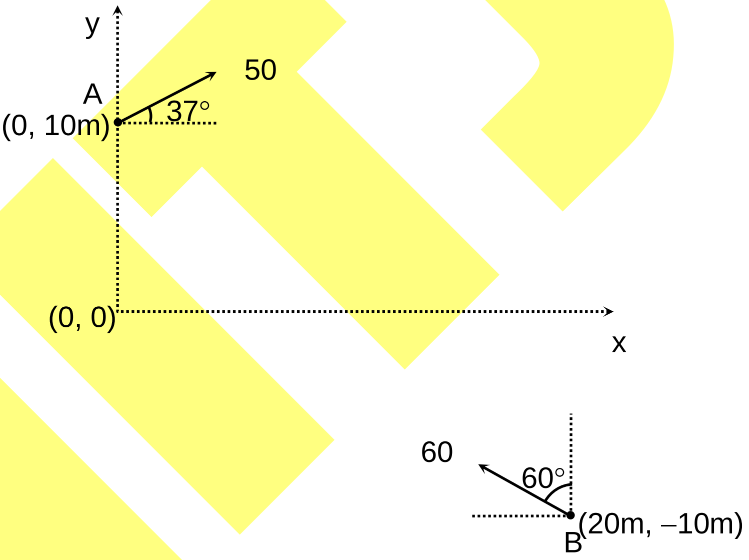
---

1. A circular disc of radius R caries surface charge density $\sigma(r) = \sigma_0\left(1-\frac{r^2}{R^2}\right)$, where σ_0 is a constant and r is the distance from the centre of the disc. Assume that disc is in xz-plane and its axis is y-axis. We have an imaginary hollow sphere of radius R and centre at $\left(0, \frac{3}{5}R, 0\right)$. What is the flux of electric field through this imaginary sphere?

(A) $\frac{408}{625}\left(\frac{\sigma_0\pi R^2}{\varepsilon_0}\right)$ (B) $\frac{272}{625}\left(\frac{\sigma_0\pi R^2}{\varepsilon_0}\right)$

(C) $\frac{544}{625}\left(\frac{\sigma_0\pi R^2}{\varepsilon_0}\right)$ (D) $\frac{136}{625}\left(\frac{\sigma_0\pi R^2}{\varepsilon_0}\right)$

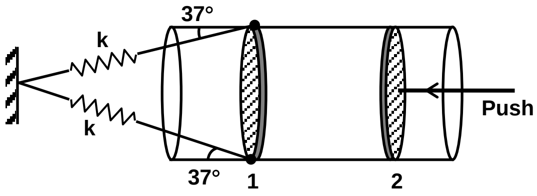
2. Two particles A and B are projected in the vertical plane with velocity 50 m/s at an angle of 37° with horizontal and with velocity 60 m/s at an angle of 60° with vertical respectively as shown in the figure. Find the minimum distance between the particles A and B during the motion? (Take g = 10 m/s^2 and $\tan 37° = \frac{3}{4}$)



(A) 10 m (B) 15 m

(C) 20 m (D) 8 m

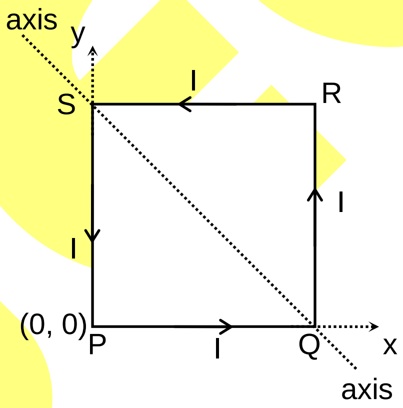
Space For Rough Work



3. A long container has air enclosed inside at room temperature and atmospheric pressure 10^5 N/m^2 between two movable pistons. It has a volume 20,000 cc. The area of cross section is 100 cm^2 and force constant of springs is k = 781.25 N/m^2. Now push the right piston isothermally and slowly till it reaches the original position of the left piston-1 which is movable. What is the final length of air column. Assume that spring is initially relaxed and length of spring is very large as compare to separation between two piston.

(A) 100 cm
(B) 75 cm
(C) 50 cm
(D) 200 cm

4. A uniform rigid, square loop of mass 'm' and side 'ℓ' is free to rotate about an axis in xy plane passing through two corner as shown in figure. A constant current I is flowing in the loop. In space magnetic field $\vec{B}(x) = B_0\left(1+\frac{x}{\ell}\right)(\hat{i}+\hat{k})$ is present. Initially loop is held at rest in xy-plane. On releasing its instantaneous angular acceleration will be (space is gravity free space)



(A) $\frac{9IB}{\sqrt{2}m}$
(B) $\frac{5IB}{2\sqrt{2}m}$
(C) $\frac{9IB}{2\sqrt{2}m}$
(D) $\frac{5\sqrt{2}IB}{2m}$

Space For Rough Work

PART – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

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5. A gaseous mixture at 300 K and 2 × 10^5 N/m^2 pressure contains 6g of H_2 and 8g of He. The mixture is expanded four times its initial volume, through an isobaric heating process. Then it is **isochoricaly** cooled unit its temperature again becomes 300 K. After that the gas mixture is isothermally compressed to its original volume. Choose the correct option(s). (take $\ell n2 = 0.695$)

(A) Ratio of molar specific heat (γ) of the mixture is $\frac{31}{21}$

(B) Ratio of heat absorb in isobaric expansion to that of heat rejected in isochoric cooling is $\frac{31}{21}$

(C) Heat rejected in isothermal compression is more than the heat rejected in isochoric cooling.

(D) Efficiency of the complete cycle is $\frac{161}{930}$.

6. An electron, initially at rest, is released far away from a proton (fixed in space). The de-broglie wavelength of the electron when it is at distance r from proton is λ. The ratio of its Kinetic energy at this distance with the kinetic energy of the electron in ground state of hydrogen atom (Bohr model) with the radius of its orbit being r, is μ. Pick the correct option(s).

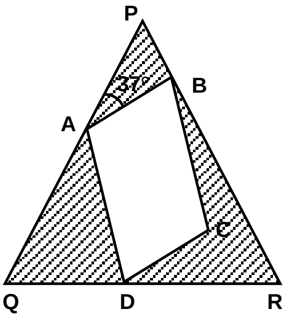
(A) $\lambda \propto \sqrt{r}$

(B) $\lambda \propto \frac{1}{r}$

(C) $\mu = \frac{1}{2}$

(D) $\mu = 2$

7. A rectangular cavity ABCD is carved inside an equilateral prism PQR of refractive index $\left(\frac{8}{5}\right)$ as shown in figure. If δ_{min} is the deviation in a ray entering at face PQ and emerging at face PR, without passing through AB or CD, then which of the following is/are correct.



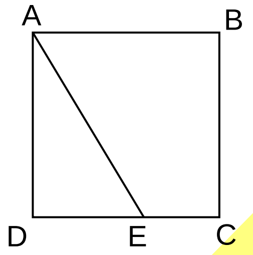
(A) There is no effect of cavity of the value of δ_{min}.

(B) The minimum deviation $\delta_{min} = 46°$

(C) If the cavity is filled with water ($\mu_W = 4/3$), the $\delta_{min} = 46°$

(D) If the cavity is filled with a liquid of refractive index $\mu = 2$, then $\delta_{min} = 23°$

Space For Rough Work



8. ABCD is square as shown in figure, resistance of side AB, BC, CD and DA are 8Ω, 2Ω, 14Ω and 22Ω respectively. A point E lies on the CD such that a uniform wire of resistance 32Ω is connected across AE and constant potential difference is applied across A and C then B and E are equipotential. Choose the correct option(s).

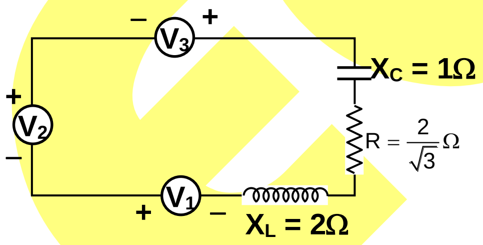
(A) Resistance of DE is 10Ω

(B) Resistance of EC is 10Ω

(C) Equivalent resistance across AC is $\frac{20}{3}\Omega$

(D) Equivalent resistance across AC is 10Ω

9. Three alternating voltage sources $V_1 = 3\sin\omega t$, $V_2 = 5\sin(\omega t + 30°)$ and $V_3 = 5\sin(\omega t - 127°)$ volt connected across a resistor, inductor and capacitor as shown in the figure, then choose the correct option(s)



(A) The maximum current in the resistors is 3 ampere.

(B) The maximum current in the resistor is 2 ampere.

(C) Effective impedance of the circuit is $\sqrt{\frac{7}{3}}\Omega$

(D) Maximum potential of the three AC source is $\sqrt{21}$ volts.

10. Two vernier calipers A and B both have M.S.D. of 1 mm. 10 vernier scale division have same length as 7 main scale division of vernier A and 8 vernier scale division have same length as 3 main scale division for vernier B.

(A) The least count of vernier A is more than the vernier B.

(B) The least count of vernier A is less than the vernier B.

(C) The least count of vernier B is 0.125 mm.

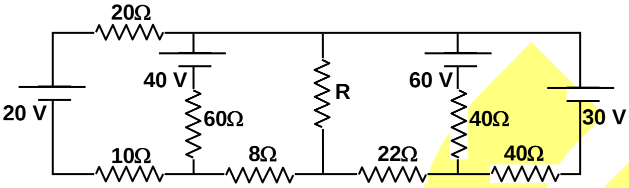
(D) The magnitude of difference in least count of vernier A and vernier B is 0.025 mm.

Space For Rough Work

PART – B (Maximum Marks: 12)

*This section contains **THREE (03)** questions. The answer to each question is a **NON-NEGATIVE INTEGER.***

1. In the given circuit, the value of R so that thermal power generated in R will be maximum is 4.2mΩ. Find the value of m.



2. Velocity of an object in rectilinear motion is given as function of time by $v = 4t - 3t^2$, where v is in m/s and t is in seconds. Its average speed over the time interval from t = 0 second to t = 2 seconds, is $\frac{8K}{27}$ m/s. Find the value of K.

3. An open pipe 68.48 cm long and a closed pipe 58.4 cm long, both having same diameter, are producing their second overtone, and these are in unison. Determine the end correction in centimeter of these pipes.

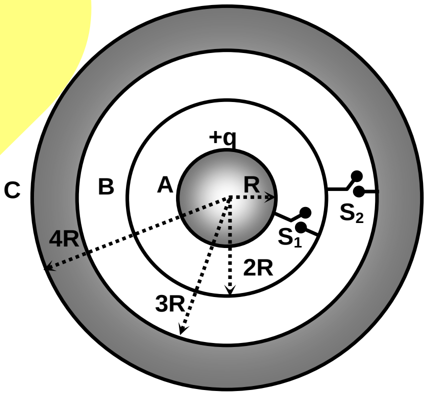
PART – C (Maximum Marks: 12)

*This section contains **THREE (03)** question stems. There are **TWO (02)** questions corresponding to each question stem. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

Question Stem for Question Nos. 4 and 5

Question Stem

Three conducting bodies A(solid sphere), B (spherical shell) and C(hollow sphere with thickness R) are arranged as shown in the figure. A charge q is given to the inner sphere. When S_1, S_2 both are open capacity of the system is C_1 and when S_1 is closed but S_2 is open capacity is C_2, then $(C_2 - C_1) = \frac{X\pi\varepsilon_0 R}{55}$. When S_2 is closed but S_1 is opened capacity is C_3 and When both S_1 and S_2 are closed capacity is C_4 then $(C_4 - C_3) = \frac{Y\pi\varepsilon_0 R}{3}$.



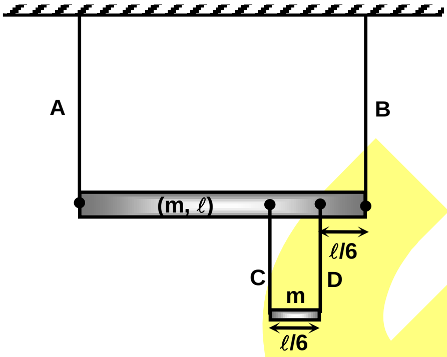
4. The value of X is ………..

5. The value of Y is ………..

Space For Rough Work

Question Stem for Question Nos. 6 and 7

Question Stem



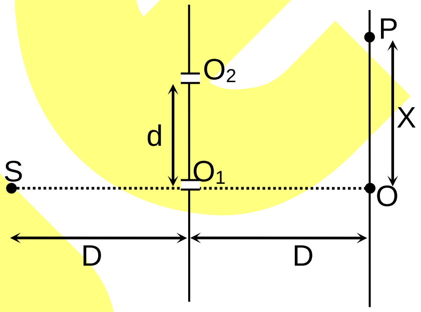
A uniform rod of mass ‘m=10kg’ and length ‘ℓ=20m’ is held horizontally by two vertical strings of negligible mass and another rod of mass ‘m’ is also held by two strings with the rod as shown in the figure. The tension in the string ‘A’ immediately after the string B and D is cut is X newton and the tension in the string ‘A’ immediately after the string B and C is cut is Y newton. (Take g = 10 m/s^2)

6. The value of X is ………..

7. The value of Y is ………..

Question Stem for Question Nos. 8 and 9

Question Stem



A monochromatic light source is kept at S having wavelength λ in a modified YDSE setup. The minimum value of d so that there is a dark fringe at O is $d_{min} = \sqrt{\frac{D\lambda}{M}}$. For the value of d_{min}, the distance of the 2nd nearest bright fringe from O is X(as shown) = $Kd_{min.}$

8. The value of M is………………

9. The value of K is……………….

Space For Rough Work

SECTION – II : CHEMISTRY

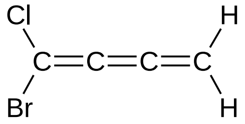
PART – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

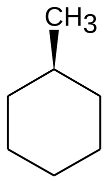
---

1. Optically active is

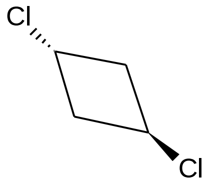
(A)


Cl
H
C=C=C=C
Br
H

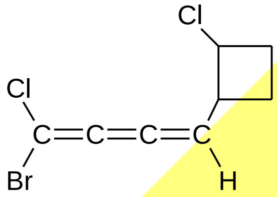
(B)



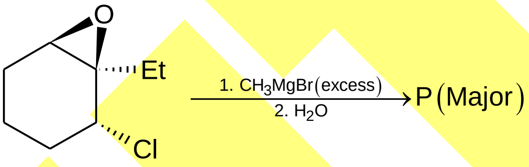
(C)



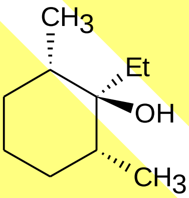
(D)


Cl
Cl
C=C=C=C
Br
H

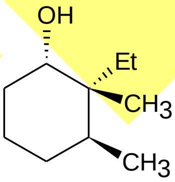
2.


O
Et
Cl
1. CH3MgBr(excess)
2. H2O
P(Major)

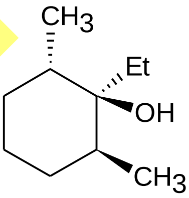
(A)

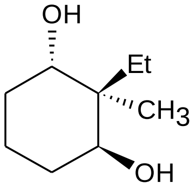

CH3
Et
OH
CH3

(B)


OH
Et
CH3
CH3

(C)


CH3
Et
OH
CH3

(D) 

3. 4 mole of a mixture O_2 and O_3 is reacted with excess of acidified solution of KI. The liberated iodine require 1 L of 2 M hypo solution for complete reaction. The mole percent of O_3 in the initial sample is

(A) 25
(B) 30
(C) 75
(D) 50

4. Square pyramidal shape is

(A) XeF_2
(B) ICl_4^-
(C) XeF_5^+
(D) XeF_5^-

Space For Rough Work

FIITJEE

PART – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

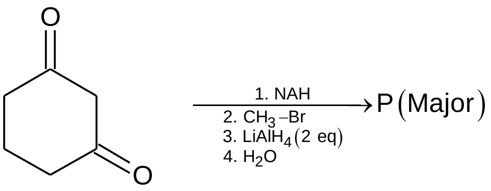
---

5. High spin complex is/are

(A) $\left[Fe(H_2O)_6\right]^{2+}$ (B) $\left[FeF_6\right]^{3-}$

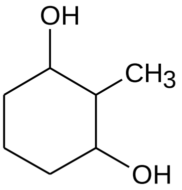
(C) $\left[Fe(CN)_6\right]^{3-}$ (D) $\left[Co(H_2O)_6\right]^{3+}$

6.



Choose correct option is/are

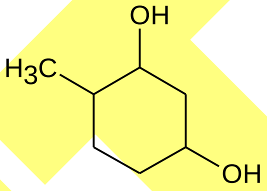
(A) P is



(B) Number stereo isomers in P is 4

(C) Number of stereo isomer in P is 3

(D) P is



7. The correct statement for $2p_z$ orbital is/are

(A) $\psi_{n,\ell,m} \propto \left(\frac{Z}{a}\right)^{3/2}\left(\frac{Zr}{a}\right)e^{-2r/2a}\cos(\theta)$

(B) $\psi_{n,\ell,m} \propto \left(\frac{Z}{a}\right)^{3/2}\left(2-\frac{Zr}{a}\right)e^{-2r/2a}$

(C) xy plane is nodal plane

(D) $2p_z$ ungerade orbital

Space For Rough Work

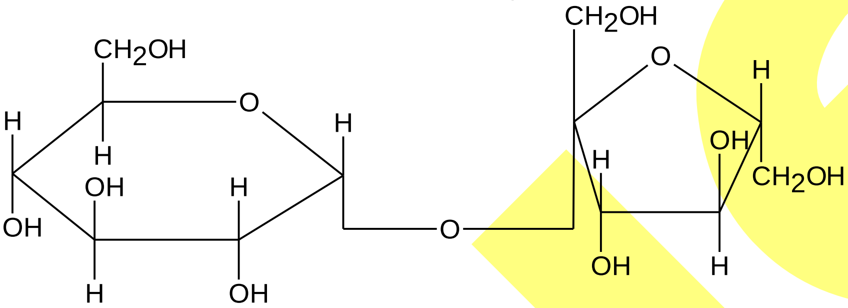
8. Which of the following complexes is/are shows the co-ordination isomerism?

(A) $\left[Pt(NH_3)_4\right]\left[PtCl_4\right]$
(B) $\left[CO(en)_3\right]\left[Cr(CN)_6\right]$
(C) $\left[Ag(NH_3)_2\right]\left[AgCl_2\right]$
(D) $\left[CO(NH_3)_6\right]\left[CO(NO_2)_6\right]$

9. Choose homopolymer:

(A) Butadiene-styrene (Buna-S)
(B) Polythene
(C) Polypropene
(D) Nylon 6, 6

10. Which statement are correct about following

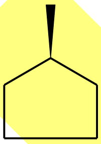


(A) Due to presence of Hemiacetal linkage it is non reducing sugar
(B) It is sucrose
(C) Due to absence of Hemiacetal group it can't give Tollen's test
(D) Left side is a $\alpha-D-\text{Glucose}$ and right side unit is $\beta-D-$fructose

PART – B (Maximum Marks: 12)

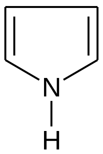
*This section contains **THREE (03)** questions. The answer to each question is a **NON-NEGATIVE INTEGER.***

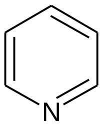
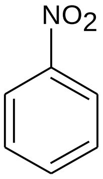
1. Number of monohalogen derivative (excluding stereo isomers) for the following is

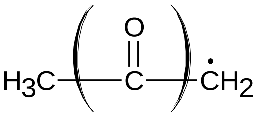
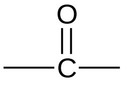


Space For Rough Work

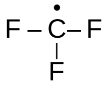
2. Total number of correct statement among the following is

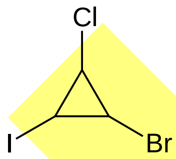
(A)  is aromatic

(B)  is more reactive than  for EAS reaction

(C) In  $H_3C-\overset{O}{\overset{||}{C}}-\dot{C}H_2$ the presence of  $-\overset{O}{\overset{||}{C}}-$ group stabilise the radical

(D) Adiabatic irreversible expansion for ideal gas, $[\Delta S]_{system} = 0$

(E) In  $F-\underset{F}{\underset{|}{\dot{C}}}-F$ the state of hybridization of radical is sp^3

3. Total number of diastereomeric pair for  is x then value of $\frac{x}{6}$ is

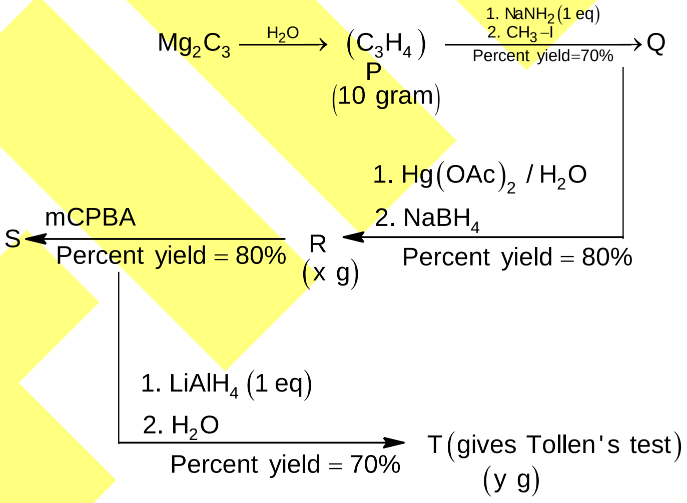
PART – C (Maximum Marks: 12)

*This section contains **THREE (03)** question stems. There are **TWO (02)** questions corresponding to each question stem. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

Question Stem for Question Nos. 4 and 5

Question Stem

For the following reaction scheme, percentage yields are given along the arrow



Mg_2C_3
H_2O
(C_3H_4)
P
(10 gram)
1. $NaNH_2$ (1 eq)
2. CH_3-I
Percent yield=70%
Q
1. $Hg(OAc)_2$ / H_2O
2. $NaBH_4$
Percent yield = 80%
R
(x g)
mCPBA
Percent yield = 80%
S
1. $LiAlH_4$ (1 eq)
2. H_2O
Percent yield = 70%
T (gives Tollen's test)
(y g)

If mass of R and T are x and y g respectively then

4. The value of x is_______

5. The value of y is_______

Question Stem for Question Nos. 6 and 7

Question Stem

When 2 mole of P(g) is introduced in a closed rigid 1 litre vessel maintained at constant temperature. Following equilibrium are established

$\text{P}(g) \rightleftharpoons \text{Q}(g) + \text{R}(g), \quad K_{C_1} = \text{W mole / litre}$

$\text{R}(g) \rightleftharpoons \text{S}(g) + \text{Q}(g), \quad K_{C_2} = \text{Z mole / litre}$

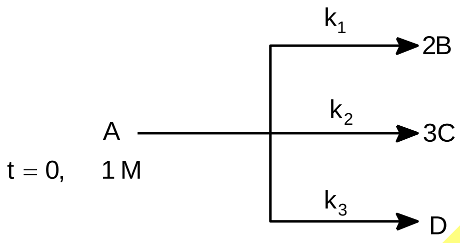
If pressure at equilibrium is twice the initial pressure and $\dfrac{[\text{R}]_{eq}}{[\text{Q}]_{eq}} = \dfrac{1}{5}$

6. The value of W is_________mol/L

7. The value of Z is_________mol/L

Question Stem for Question Nos. 8 and 9

Question Stem



$k_1 = 0.1 \text{ min}^{-1}$

$k_2 = k_3 = 0.2 \text{ min}^{-1}$

If C_t, D_t at $t = 4.606 \text{ min}^{-1}$ are W and Z mol/L

8. The value of W is __________

9. The value of Z is __________

Space For Rough Work

SECTION – III : MATHEMATICS

PART – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

---

1. $\int_0^2 \left(\sqrt{1+x^3}+\sqrt[3]{x^2+2x}\right)$ is equal to

(A) 4

(B) 5

(C) 6

(D) 7

2. Assume that P = {(x, y) : $x^2 + 2y^2 = 10$} and Q = {(x, y) : y = mx + c}. If P ∩ Q = ϕ for all m ∈ [–1, 1], then minimum positive integral value of c is

(A) 3

(B) 4

(C) 5

(D) 10

3. The locus of the centre of the circle which touches the circle $(x – 1)^2 + y^2 = 9$ and the line x = 6 is a curve whose directrix is

(A) x = 1

(B) y = 9

(C) y = –4

(D) x = 9

4. If f(x) is a 4 degree polynomial satisfying $f(x)=\frac{x}{x+1}$ for x = 0, 1, 2, 3, 4, then f(6) is

(A) $\frac{12}{7}$

(B) 0

(C) 1

(D) –6

Space For Rough Work

PART – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

5. The value of definite integral $\int_{-\infty}^{k} \frac{\left(\sin^{-1}e^{x}+\sec^{-1}e^{-x}\right)}{\left(\tan^{-1}e^{k}+\tan^{-1}e^{x}\right)\left(e^{x}+e^{-x}\right)}dx$ (where $k \in R$) is

(A) $\frac{\pi}{2}\ln 2\left(2\tan^{-1}e^{k}\right)$

(B) independent of k

(C) dependent on k

(D) $\frac{\pi}{2}\ln 2$

6. Let g(x) be a cubic polynomial with leading coefficient unity such that the roots of g(x) = 0 are the squares of the roots of $x^3 + x + 1 = 0$, then

(A) g(3) is a prime number

(B) last two digit of $(g(1))^{50}$ are 49

(C) when $(g(2))^{2022}$ is divided by 5, remainder is 2

(D) g(x) = 0 has all 3 roots real

7. Let P and Q be two square matrix of order 3, then which of the following statement is/are always CORRECT?

(A) PQP^T is symmetric matrix

(B) PQ – QP is skew symmetric matrix

(C) If $Q = |P|P^{-1}$, $|P| \neq 0$, then $\text{adj}(P^T) - Q$ is skew symmetric matrix

(D) If $Q + P^T = 0$ and P is skew symmetric matrix and Q^{15} is also skew symmetric matrix

Space For Rough Work

FIITJEE

8. A tangent L_1 is drawn to the curve $x^2 - 4y^2 = 16$ at point A in first quadrant whose abscissa is 5. Another tangent L_2 parallel to L_1 meets the curve at B. L_3 and L_4 are normal to the curve at A and B lines L_1, L_2, L_3, L_4 forms a rectangle, then

(A) equation of normal at B is $12x + 10y + 75 = 0$

(B) area of rectangle $L_1 L_2 L_3 L_4$ is $\frac{2400}{61}$

(C) radius of largest circle inscribed in the rectangle is $\frac{32}{\sqrt{61}}$

(D) radius of the circle circumscribing the rectangle is $\frac{\sqrt{109}}{2}$

9. The integral point satisfying $|z - 1| + |z + 1| \le 6$ in the argand plane for which $||z + \omega^2| - |z + \omega||$ is minimum (where ω is complex root of unity) is/are

(A) (2, 0)

(B) (1, 2)

(C) (–3, 0)

(D) (0, 2)

10. Let for $x \in [1, \infty)$, $\int_1^x f(x)dx = \left(\frac{x^2+1}{2x}\right)\left(f(x) - x + \frac{2x}{x^2+1}\right) = \ln 2$, then for $x \in [1, \infty)$ which of the following is are TRUE?

(A) $f(1) = \ln 2$

(B) Range of $g(x) = \frac{xf'(x) - f(x)}{x}$ is [0, 2]

(C) $\lim_{x\to 3}\left[\frac{f(x)}{x}\right] = 2$

(D) $h(x) = \frac{f(x)}{x}$ is an odd function

(where [.] denotes greatest integer function)

Space For Rough Work

PART – B (Maximum Marks: 12)

*This section contains **THREE (03)** questions. The answer to each question is a **NON-NEGATIVE INTEGER.***

1. If P is the number of ways in which a person can walk up a stairway which has 11 steps if he can take 1 or 2 steps up the stairs at a time, then $\frac{P}{16}$ is equal to

2. In a triangle ABC, side AC = 4 units and sin A sin B + sin B sin C + sin C sin A = $\frac{9}{4}$. If A is the area or the triangle ABC, then $\frac{A}{\sqrt{3}}$ is equal to

3. If p is the least positive integer which satisfies the equation $|x - 2| + |x^2 - 9x + 20| = |x^2 - 8x + 18|$ and q is the minimum value of $\sin^2 x + \sin x + 1$ and α is the only positive root of $\left((2021)^{2022} - 1\right)x^2 + \left(p - (2021)^{2022}\right)x = 1$, then the value of $\left(\alpha^{2022} - 1\right)p^2 + \left(p - 1 - \alpha^{2017}\right)pq + 8q$ is

PART – C (Maximum Marks: 12)

*This section contains **THREE (03)** question stems. There are **TWO (02)** questions corresponding to each question stem. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

Question Stem for Question Nos. 4 and 5

Question Stem

Let $A_n = [A_{ij}]$ be a n × n matrix such that $A_{ij} = \begin{cases} k & ; \quad i = j \\ 1 & ; \quad |i - j| = 1 \\ 0 & ; \quad \text{otherwise} \end{cases}$. Let B_n denote the determinant of matrix A_n

4. If k = 2, then B_{2022} is equal to

5. If k = 1, then $\sum_{p=1}^{2022} |B_p|$ is equal to (where |.| denotes absolute value function

Space For Rough Work

Question Stem for Question Nos. 6 and 7

Question Stem

Let A_1, A_2, A_3, ….. A_{12} be a regular polygon of 12 sides whose centre is origin. Let the complex numbers representing vertices A_1, A_2, A_3, ….. A_n be z_1, z_2, z_3, ….. z_{12} respectively. Let $OA_1 = OA_2 = OA_3 = ….. OA_{12} = 1$ (where O is origin)

6. The value of $|A_1 A_2| \times |A_1 A_3| \times |A_1 A_4| \times ….. |A_1 A_{12}|$ is equal to

7. The value of $|A_1 A_2|^2 + |A_1 A_3|^2 + ….. |A_1 A_n|^2$ is

Question Stem for Question Nos. 8 and 9

Question Stem

Suppose 12 students of a class are asked a question successively in a random order and exactly 4 of them known the answer. Assume that none of them are aware of the answers given by other students, answer the following

8. If the probability that 6th student to be asked the question is the first one to know the answer is k, then 99k is equal to

9. If the probability that 1st and 12th student knows the answer is k, then 99k is equal to

---

Space For Rough Work

FIITJEE

Q. P. Code: 100182

ANSWERS

SECTION-1 : PHYSICS

PART – A

1.	B	2.	C	3.	A	4.	A
5.	A, B, D	6.	A, D	7.	A, B, C	8.	A, C
9.	A, C, D	10.	B, C, D				

PART – B

1.	4	2.	4	3.	2	4.	288.00
5.	32.00	6.	25.00	7.	25.00	8.	02.00
9.	03.00						

SECTION – 2 : CHEMISTRY

PART – A

1.	D	2.	A	3.	A	4.	C
5.	A, B	6.	A, B	7.	A, C, D	8.	A, B, D
9.	B, C	10.	B, C, D				

PART – B

1.	4	2.	3	3.	4	4.	10.08
5.	03.44	6.	01.00	7.	04.00	8.	01.08
9.	00.36						

SECTION – 3 : MATHEMATICS

PART – A

1.	C	2.	B	3.	D	4.	B
5.	B, D	6.	A, B	7.	C, D	8.	A, B, C, D
9.	A, C	10.	A, B, C				

PART – B

1.	9	2.	4	3.	6	4.	2023.00
5.	1348.00	6.	12.00	7.	24.00	8.	04.00
9.	09.00						

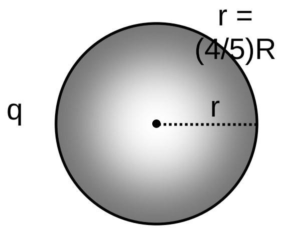
Answers & Solutions

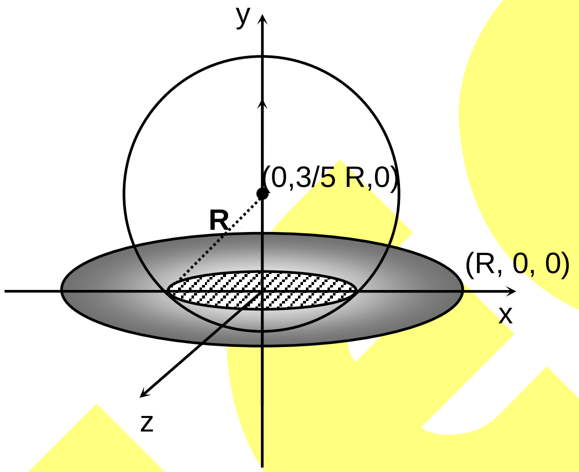
SECTION-1 : PHYSICS

PART – A

1. B

Sol.





Charge on circular part

$$q = \int \sigma(r)\cdot 2\pi r \cdot dr$$

$$= \int_0^{(4/5)R} 2\pi\sigma_0\left(r - \frac{r^3}{R^2}\right)dr = \frac{272}{625}\left(\sigma_0 \pi R^2\right)$$

$$\phi = \frac{q}{\varepsilon_0} = = \frac{272}{625}\left(\frac{\sigma_0 \pi R^2}{\varepsilon_0}\right)$$

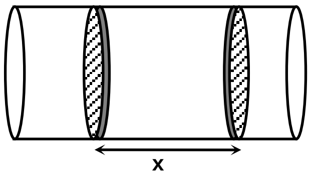
2. C

Sol. The path of projectile motion as observed by the other projectile motion is a straight line. The vertical component 30 m/s will get cancelled. Hence B will travel horizontal with respect to A. Hence minimum separation = 20 m.

3. A

Sol. $P_1V_1 = P_2V_2$

$$(10^5)\,(20{,}000 \times 10^{-6}) = \left\{10^5 + \frac{(2k\cos^2 37^\circ)x}{100\times 10^{-4}}\right\}(100\times 10^{-4})x$$



$x^2 + x - 2 = 0$

$x = 1$ m = 100 cm

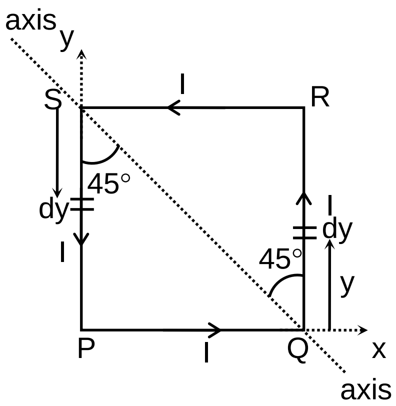
4. A

Sol. Torque on the loop due to magnetic field

$$\tau = \int_0^{\ell} (I2B_0 dy)\frac{y}{\sqrt{2}} + \int_0^{\ell} (IB_0 dy)\frac{y}{\sqrt{2}}$$

$$I\alpha = \frac{3IB_0\ell^2}{2\sqrt{2}}$$

$$\frac{1}{6}m\ell^2\alpha = \frac{3IB_0\ell^2}{2\sqrt{2}} \Rightarrow \alpha = \left(\frac{9IB_0}{\sqrt{2}m}\right)$$



5. A, B, D

Sol. $f = \frac{n_1f_1 + n_2f_2}{n_1 + n_2} = \frac{3\times5+2\times3}{3+2} = \frac{21}{5}$

$\gamma = 1 + \frac{2}{f} = \frac{31}{21}$

Let initial volume and pressure are V_0 and P_0 respectively

Heat absorb in isobaric expansion

$Q_1 = \frac{\gamma}{\gamma-1}(3P_0V_0) = 9.3P_0V_0$

Heat rejected in isochoric cooling

$Q_2 = \frac{1}{\gamma-1}(3P_0V_0) = 6.3P_0V_0$

Heat rejected in isothermal compression $Q_3 = nRT_0\ell n4 = P_0V_0\ell n4$

Efficiency = $\frac{Q_1 - Q_2 - Q_3}{Q_1} = \left(\frac{161}{930}\right)$

6. A, D

Sol. $\frac{1}{2}mu^2 - \frac{ke^2}{r} = 0$

$\Rightarrow u = \sqrt{\frac{2k}{mr}}e$

$\lambda = \frac{h}{mu} \propto \frac{1}{u} \propto \sqrt{r}$

$KE_1 = \frac{1}{2}mu^2 = \frac{ke^2}{r}$

For Bohr model, $\frac{1}{2}mv^2 = \frac{ke^2}{2r} = KE_2$

$\Rightarrow \mu = \frac{KE_1}{KE_2} = 2$

7. A, B, C

Sol. The deviation produced by ABCD is zero. Hence the cavity will not have any effect on the deviation.

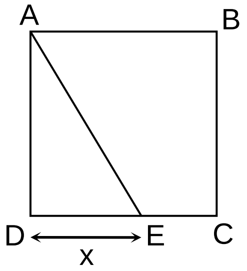
$$\mu = \frac{\sin\left(\frac{\delta_{min}+A}{2}\right)}{\sin\left(\frac{A}{2}\right)} = \frac{8}{5}$$

$$\sin\left(\frac{\delta_{min}+A}{2}\right) = \left(\frac{8}{5}\right)\sin\left(\frac{60^\circ}{2}\right)$$

$\delta_{min} = 46^\circ$

8. A, C

Sol. Equivalent resistance between A and E



$y = \frac{x+22}{x+22+32}$

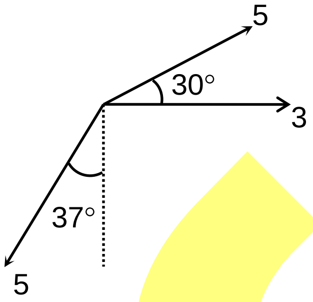
For B and E to be equipotential

$\frac{R_{AE}}{R_{AR}} = \frac{R_{EC}}{R_{RC}}$

$\Rightarrow \frac{(22+x)\times32}{(54+x)\times(14-x)} = \frac{8}{2} = 4$

Solve to get : $x = 10\ \Omega$

9. A, C, D



Sol. $z = \sqrt{(2-1)^2 + \left(\frac{2}{\sqrt{3}}\right)^2} = \sqrt{\frac{7}{3}}\Omega$

$V_1 = 3\sin\omega t,\ V_2 = 5\sin(\omega t + 30°),\ V_3 = 5\sin(\omega t - 127°)$

$V_{max} = \sqrt{21}$ volts

$I_{max} = \frac{V_{max}}{z} = \frac{\sqrt{21}}{\sqrt{\frac{7}{3}}} = 3$ amp

10. B, C, D

Sol. For A, $1V = \frac{7S}{10} = 0.7$ mm

Least count of A = 5 – 0.7 × 7 = 0.1 mm

For B, 1V = $\frac{3S}{8}$ = 0.375 mm

Least count of B = 2 – 0.375 × 5 = 0.125

Difference = 0.125 – 0.1 = 0.025 mm

PART – B

1. 4

Sol. $R = \frac{28 \times 42}{70} = 16.8\Omega$

2. 4

Sol. v = 4t – 3t^2

S = 2t^2 – t^3 + C

When v = 0, ⇒ t = 0 and t = 4/3

S(t = 0) = C, $S\left(t = \frac{4}{3}\right) = \frac{32}{27} + C$, S(t = 2) = 0

Distance traveled = $\frac{32}{27} + \frac{32}{27} = \frac{64}{27}$

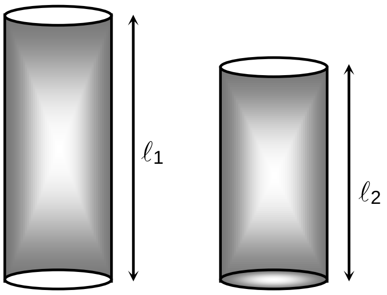
Average speed = $\frac{64}{27 \times 2} = \frac{32}{27}$ m/s

3. 2

Sol. $\frac{3v}{2\ell_1} = \frac{5v}{4\ell_2}$

$\frac{3v}{2(\ell_1 + 2e)} = \frac{5v}{4(\ell_2 + e)}$

$e = \frac{12\ell_2 - 10\ell_1}{8} = 2\,\text{cm}$



4. 288.00

5. 32.00

Sol. **(for Q.4-5):**

When S_1, S_2 both are open capacity of the system is C_1. Then C_1.

$$C_1 = \frac{\frac{4\pi\varepsilon_0(3R)(R)}{(3R-R)}(4\pi\varepsilon_0 4R)}{\frac{4\pi\varepsilon_0(3R)(R)}{(3R-R)} + 4\pi\varepsilon_0 4R}$$

$$C_1 = \frac{(4\pi\varepsilon_0 R)\left(\frac{3}{2}\right)(4)}{\left(\frac{3}{2}+4\right)} = \frac{(4\pi\varepsilon_0 R)(3.4)}{11}$$

$$C_1 = \frac{48\pi\varepsilon_0 R}{11}$$

When S_1 is closed but S_2 is open capacity is C_2. Find C_2.

$$C_2 = \frac{\frac{4\pi\varepsilon_0(3R)(2R)}{(3R-2R)}(4\pi\varepsilon_0.4R)}{\frac{4\pi\varepsilon_0(3R)(2R)}{(3R-2R)} + 4\pi\varepsilon_0 4R} = \frac{(4\pi\varepsilon_0 R)(6)(4)}{(6+4)} = \frac{48\pi\varepsilon_0 R}{5}$$

When S_2 is closed but S_1 is opened capacity is C_3. Find C_3

$$C_3 = \frac{\frac{4\pi\varepsilon_0(2R)(R)}{(2R-R)}(4\pi\varepsilon_0 4R)}{\frac{4\pi\varepsilon_0(2R)(R)}{(2R-R)} + 4\pi\varepsilon_0 4R} = \frac{4\pi\varepsilon_0 R\cdot 2\cdot 4}{6} = \frac{16\pi\varepsilon_0 R}{3}$$

When both S_1 and S_2 are closed. Capacity is C_4 is . Then C_4 is equal to

$C_4 = 4\ \pi\varepsilon_0 4R$

$C_4 = 16\ \pi\varepsilon_0 R$

6. 25.00

7. 25.00

Sol. **(for Q.6-7):**

When B and D is cut

mg – T = ma

taking torque about mid point of rod

$$T\cdot\frac{\ell}{2} = \frac{m\ell^2}{12}\times\frac{a}{\ell/2}$$

T = mg/4

8. 02.00

9. 03.00

Sol. **(for Q.8-9):**

There is a dark fringe at O if path difference = $\lambda/2$

$$\Delta x = SO_2O - SO_1O = \frac{\lambda}{2}$$

$$2\sqrt{D^2+d^2} - 2D = \frac{\lambda}{2}$$

$$2D\left(1+\frac{d^2}{2D^2}\right) - 2D = \left(\frac{\lambda}{2}\right)$$

$$d_{min} = \sqrt{\frac{D\lambda}{2}}$$

The bright fringe is formed at P if the path differnece = λ

$\Delta x = SO_1P - SO_2P = \lambda$

$$\left\{\left(D+\sqrt{D^2+X^2}\right) - \left(\sqrt{D^2+d^2} + \sqrt{D^2+(x-d)^2}\right)\right\} = \lambda$$

$$D + D\left(1 + \frac{x^2}{2D^2}\right) - D\left(1 + \frac{d^2}{2D^2}\right) - D\left(1 + \frac{(x-d)^2}{2D^2}\right) = \lambda$$

$$\frac{x^2}{2D} - \frac{d^2}{2D} - \frac{(x-d)^2}{2D} = \lambda$$

$$x = 2\sqrt{\frac{\lambda D}{2}} = 3\,d_{min}$$

SECTION – 2 : CHEMISTRY

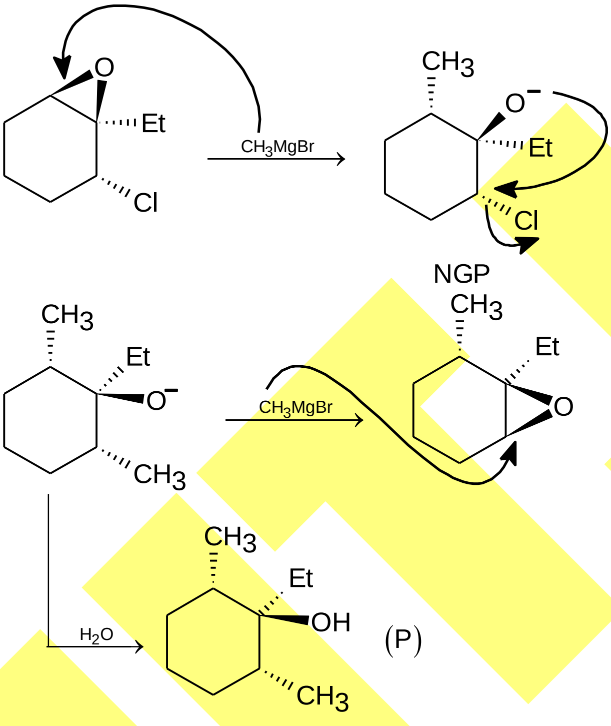
PART – A

1. D

Sol. Due to absence of plane of symmetry. Option (D) is optically active.

2. A

Sol.



O
Et
Cl
CH3MgBr
CH3
O⁻
Et
Cl
NGP
CH3
Et
O⁻
CH3
CH3MgBr
CH3
Et
O
H2O
CH3
Et
OH
CH3
(P)

3. A

Sol. $KI + O_3 \longrightarrow KOH + I_2 + O_2$

$I_2 + Na_2S_2O_3 \longrightarrow NaI + Na_2S_4O_6$

Law of chemical equivalence,

$(ne)_{I_2} = (ne)_{Na_2S_2O_3} = (ne)_{O_3}$

$\therefore (ne)_{Na_2S_2O_3} = (ne)_{O_3}$

$\Rightarrow 2 \times 1 = 2 \times [mole]_{O_3}$

$[mole]O_3 = 1$

Mole of % $O_3 = \frac{1}{4} \times 100 = 25\%$

4. C

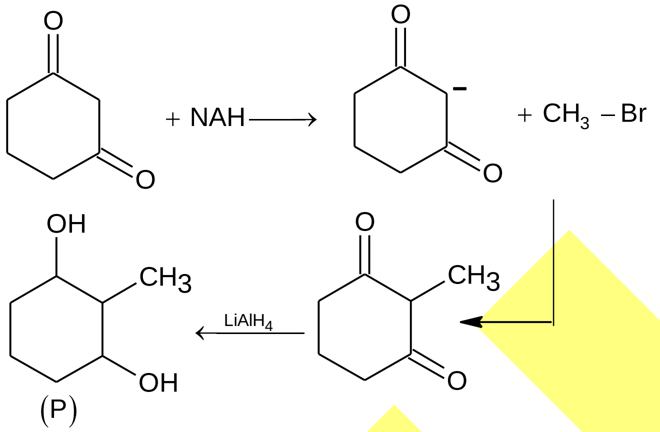
Sol. $XeF_2 \longrightarrow$ linear
$ICl_4^- \longrightarrow$ square planar
$XeF_5^+ \longrightarrow$ square pyramidal
$XeF_5^- \longrightarrow$ pentagonal planar

5. A, B

Sol. A and B are high spin complex [NO pairing] C and D are low spin complex.

6. A, B

Sol.



(P)

Number of stereo isomers in P is 4.

7. A, C, D

Sol. $\psi_{n,\ell,m} \propto \left(\frac{Z}{a}\right)^{3/2}\left(\frac{Zr}{a}\right)e^{-2r/2a}\cos(\theta)$ and xy plane is nodal plane

Number of nodal plane = 1
$2p_z$ is ungerade orbital.

8. A, B, D

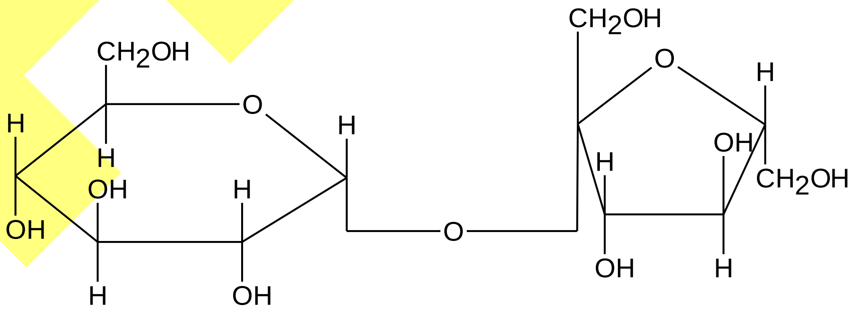
Sol. $\left[Ag(NH_3)_2\right]\left[AgCl_2\right]$ will not show the co-ordination isomerism.

9. B, C

Sol. Polythene and polypropene are homopolymer.

10. B, C, D

Sol.

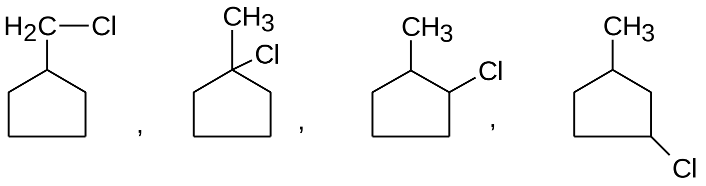


Structure is of sucrose which is non reducing sugar due to absence of Hemiacetal group.

PART – B

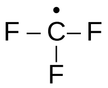
1. 4

Sol.

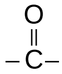

H2C—Cl
CH3
Cl
CH3
Cl
CH3
Cl

2. 3

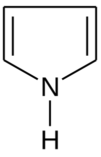
Sol.



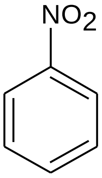
$\dot{C}F_3$: $F-\underset{F}{\underset{|}{\dot{C}}}-F \rightarrow$ hybridization sp^3.



$-\overset{O}{\overset{||}{C}}-$ group stabilize the radical.



⟶ Aromatic



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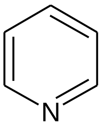


⟶ For EAS reaction

$[\Delta S]_{system} > 0$ for adiabatic irreversible process.

3. 4

Sol. Number of diastereomeric pair $8_{C_2 - 4}$

$= \frac{\lfloor 8}{\lfloor 2 \lfloor 6} - 4$

$= \frac{7 \times 8}{2} - 4$

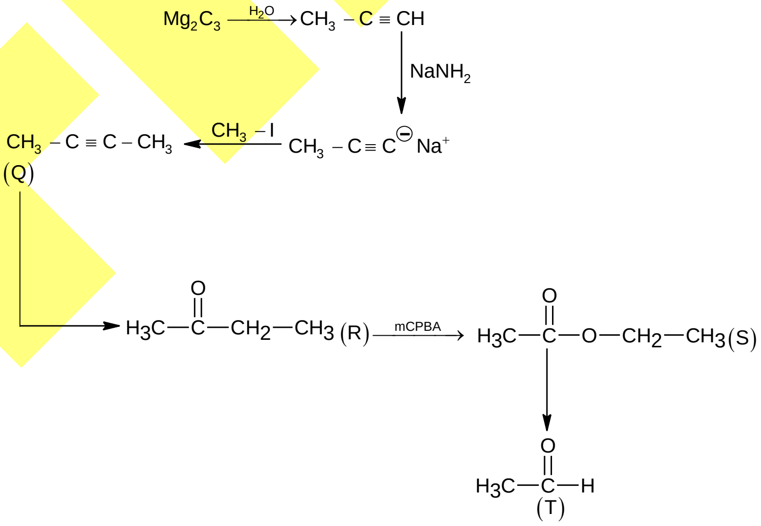
$x = 24$

$\therefore \frac{x}{6} = 4$

4. 10.08

5. 03.44

Sol. **(for Q. 4 to 5):**


Mg2C3
H2O
CH3 – C ≡ CH
NaNH2
CH3 – C ≡ C⊖ Na+
CH3 – I
CH3 – C ≡ C – CH3
(Q)
H3C—C(=O)—CH2—CH3 (R)
mCPBA
H3C—C(=O)—O—CH2—CH3(S)
H3C—C(=O)—H
(T)

$\because [Mass]_{CH_3-C\equiv C-H} = 10,\ [M]_{CH_3-C\equiv C-H = 40\ gram/mole}$

$$\therefore [\text{Mole}]_{CH_3-C\equiv CH} = \frac{10}{40} = \frac{1}{4}$$

$$\therefore \text{Mole of Q} = \frac{1}{4} \times \frac{70}{100} = \frac{7}{40}$$

$$\therefore \text{Mole of R} = \frac{7}{40} \times \frac{80}{100}$$

$$\therefore \text{Mass of R} = \frac{7}{40} \times \frac{80}{100} \times [72]$$

$$x = 10.08\,g$$

$$\text{Mass of T} = \frac{7}{40} \times \frac{80}{100} \times \frac{80}{100} \times \frac{70}{100} \times [44]$$

6. 01.00

7. 04.00

Sol. **(for Q. 6 to 7):**

$$\begin{array}{lll} P \rightleftharpoons & Q \;+ & R \\ 2 & 0 & 0 \\ 2-x & x+y & x-y \end{array}$$

$$\begin{array}{lll} R \rightleftharpoons & S \;+ & Q \\ x & 0 & 0 \\ x-y & y & y+x \end{array}$$

$$2-x+x+y+x-y+y=4$$

$$x+y=2$$

$$\frac{x-y}{x+y} = \frac{1}{5}; y = \frac{2}{3}x$$

Hence, $x = 1.2$

$y = 0.8$

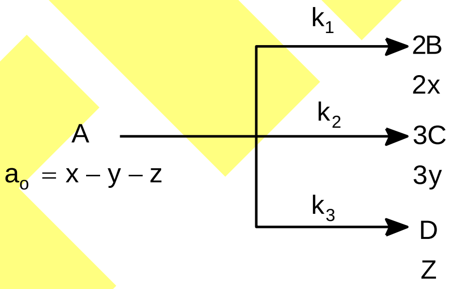
$$K_{C_1} = W = \frac{(x-y)(x+y)}{2-x} = \frac{2\times 0.4}{0.8} = 1$$

$$K_{C_2} = Z = \frac{(x+y)(y)}{x-y} = \frac{2\times 0.8}{0.4} = 4$$

8. 01.08

9. 00.36

Sol. **(for Q. 8 to 9):**



$$A_t = a_o \times e^{-[k_1+k_2+k_3]t}$$

$$= 1 \times e^{-[0.5]4.606}$$

$$\therefore A_t = [10]^{-1} = \frac{1}{10} = 0.1\,M$$

$$\frac{k_1}{k_2} = \frac{x}{y} \Rightarrow \frac{1}{2} = \frac{x}{y} \qquad \ldots (1)$$

$\frac{k_2}{k_3} = \frac{y}{z} \Rightarrow y = z$ … (2)

$A_t = a_o - [x + y + z]$

$0.1 = 1 - [x + y + z]$

$x + y + z = 1 - 0.1 = 0.9$ … (3)

$A_t = 0.1\,M,\ B_t = 2x = 0.36\,M$

$C_t = 3y = 1.08\ M,\ D_t = 0.36\ M$

SECTION – 3 : MATHEMATICS

PART – A

1. C

Sol. Let $(x^2 + 2x)^{\frac{1}{3}} = y \Rightarrow x^2 + 2x + 1 = y^3 + 1 \Rightarrow x = -1 + (y^3 + 1)^{\frac{1}{2}} \Rightarrow f^{-1}(x) = -1 + (x^3 + 1)^{\frac{1}{2}}$

$\int_0^2 (f^{-1}(x) + 1 + f(x))dx \Rightarrow \int_0^2 f^{-1}(x)dx$

Let $f^{-1}(x) = t \Rightarrow x = f(t) \Rightarrow \frac{dx}{dt} = f'(t)$; $\int tf'(t)dt = tf(t) - \int_0^2 f(t) = 2f(2) - \int_0^2 f(x)dx$

$\Rightarrow \int_0^2 (f^{-1}(x) + 1 + f(x))dx = 2f(2) - \int_0^2 f(x)dx + \int_0^2 1dx + \int_0^2 f(x)dx = 2f(2) + 2 = 2 \times 2 + 2 = 6$

2. B

Sol. $10\,m^2 + 5 - c^2 < 0$

Thus $c^2 > 15$

3. D

Sol. $C_1C_2 = r_1 + r_2 \Rightarrow \sqrt{(h-1)^2 + k^2} = r + 3$ and $h = 6 - r$

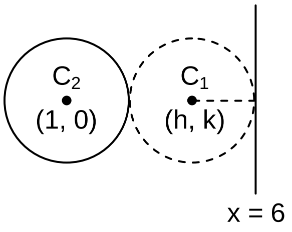
$\Rightarrow r = 6 - h$; $(h - 1)^2 + k^2 + r^2 + 9 + 6r$

$\Rightarrow h^2 + 1 - 2h + k^2 = (6 - h)^2 + 9 + 6(6 - h)$

$\Rightarrow h^2 + 1 - 2h + k^2 = 36 + h^2 - 12h + 9 + 36 - 6h$

$\Rightarrow k^2 = 16h + 80 \Rightarrow y^2 = -16(x - 5)$

Equation of directrix is $x - 5 = 4 \Rightarrow x = 9$



4. B

Sol. Let $g(x) = f(x)(x + 1) - x \Rightarrow g(0) = g(1) = g(2) = g(3) = g(4) = 0$

$\therefore g(x) = f(x)(x + 1) - x = kx(x - 1)(x - 2)(x - 3)(x - 4)$

Put $x = -1 \Rightarrow 1 = kx - 1x - 2x - 3x - 4x - 5 \Rightarrow k = -\frac{1}{120}$

$\therefore f(x)(x+1) - x = -\frac{x(x-1)(x-2)(x-3)(x-4)}{120}$

Put $x = 6 \Rightarrow f(6) \times (7 - 6) = -\frac{6 \times 5 \times 4 \times 3 \times 2}{120} \Rightarrow f(6) = 0$

5. B, D

Sol. $\int_{-\infty}^{k} \frac{(\sin^{-1} e^x + \cos^{-1} e^x)}{(\tan^{-1} e^k + \tan^{-1} e^x)} \frac{e^x}{e^{2x} + 1}$. Let $\tan^{-1} e^x = t$

$\frac{\pi}{2} \int_0^{\tan^{-1}(e^k)} \frac{1}{(t + \tan^{-1} e^k)} dt$

6. A, B

Sol. $\alpha^2 = x \Rightarrow \alpha = \sqrt{x}$ replace x by $\sqrt{x}$ in $x^3 + x + 1 = 0$. We get $g(x) = x^3 + 2x^2 + x - 1$

$\Rightarrow g(3) = 47 \Rightarrow g(1) = 3 \Rightarrow 3^{50} = (10-1)^{25} = {}^{25}C_0 10^{25} + ... {}^{25}C_{23}10^2 + {}^{25}C_{24}10 - 1$

$\Rightarrow g'(x) > 0\ \forall x \in R \therefore g(x)$ has only 1 real root

7. C, D

Sol. $(PQP^T)^T = PQ^TP^T \Rightarrow PQP^T$ is not symmetric

$(PQ - QP)^T = Q^TP^T - P^TQ^T$

$Q = |P|\dfrac{\text{adj } P}{|P|} \Rightarrow Q = \text{adj } P$

$\Rightarrow (\text{adj }(P^T) - Q)^T = (\text{adj }(P^T) - \text{adj } P)^T = \text{adj } P - \text{adj } P^T$

and $Q = -P^T \Rightarrow Q = P \Rightarrow Q$ is also skew symmetric

8. A, B, C, D

Sol. Equation of L_1

$5x - 4 \times y \times \dfrac{3}{2} = 16$

$5x - 6y = 16$

$\therefore$ Equation of tangent of B

$5x - 6y = -16$

$\therefore$ Equation of normal at A

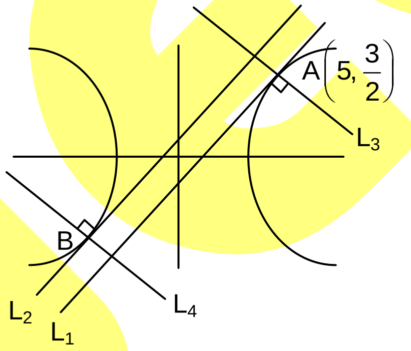
$6x + 5y = \dfrac{75}{2}$

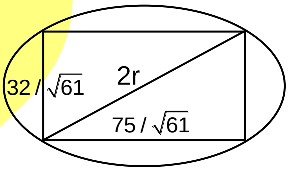
$\therefore$ Equation of normal at B is

$6x + 5y = -\dfrac{75}{2}$

Distance between tangents $\dfrac{32}{\sqrt{61}}$

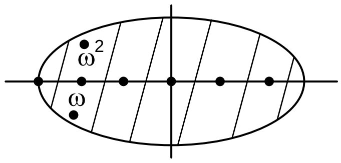
Distance between normals $\dfrac{75}{\sqrt{61}}$





9. A, C

Sol. $||z + \omega^2| - |z + \omega||$ is minimum when z lies on the major axis of the ellipse



$\dfrac{x^2}{a} + \dfrac{y^2}{8} \le 1$

10. A, B, C

Sol. $\displaystyle\int_1^x f(x)dx = \frac{f(x)}{2}\left(x + \frac{1}{x}\right) - \frac{x^2+1}{2} + 1$ using Leibnitz Rule

$f(x) = \dfrac{f'(x)}{2}\left(x + \dfrac{1}{x}\right) + \dfrac{f(x)}{2}\left(1 - \dfrac{1}{x^2}\right) - x \Rightarrow \dfrac{xf'(x) - f(x)}{x^2} = \dfrac{2x}{x^2+1}$

Integrating both sides, we get $\dfrac{f(x)}{x} = \ln(x^2+1)$

PART – B

1. 9

Sol. Let x_1 be the number of times he took 1 step up the staircase

Let x_2 be the number of times he took 2 step up the staircase

$x_1 + 2x_2 = 11$

			Number of ways
$x_1 = 1$	$x_2 = 6$	1, 2, 2, 2, 2, 2	$\frac{6!}{1!\,5!} = 6$
$x_1 = 3$	$x_2 = 4$	1, 1, 1, 2, 2, 2, 2	$\frac{7!}{3!\,4!} = 35$
$x_1 = 5$	$x_2 = 3$	1, 1, 1, 1, 1, 2, 2, 2	$\frac{8!}{3!\,4!} = 56$
$x_1 = 7$	$x_2 = 2$	1, 1, 1, 1, 1, 1, 1, 2, 2	$\frac{9!}{2!\,7!} = 36$
$x_1 = 9$	$x_2 = 1$		$\frac{10!}{9!\,1!} = 10$
$x_1 = 11$	$x_2 = 0$		1
			144

$\therefore$ P = 144

2. 4

Sol. $2\sin A\sin B + 2\sin B\sin C + 2\sin C\sin A = \frac{9}{2}$

$\cos(A-B) - \cos(A+B) + \cos(B-C) - \cos(B+C) + \cos(C-A) - \cos(C+A) = \frac{9}{2}$

$\Rightarrow \cos(A-B) + \cos(B-C) + \cos(C-A) + \cos A + \cos B + \cos C = \frac{9}{2}$

$\Rightarrow \cos(A+B) + \cos(B-C) + \cos(C-A) = \frac{9}{2} - (\cos A + \cos B + \cos C) \geq \frac{9}{2} - \frac{3}{2} \geq 3$

$\Rightarrow \cos(A-B) + \cos(B-C) + \cos(c-A) = 3$

$\Rightarrow A = B = C \;\therefore\; A = \frac{\sqrt{3}}{4} \times 16 = 4\sqrt{3}$

3. 6

Sol. $(x-2)(x^2 - 9x + 20) \geq 0 \Rightarrow x \in [2, 4] \cup [5, \infty)$

$\therefore$ p = 2

$\Rightarrow \left(\sin x + \frac{1}{2}\right)^2 + \frac{3}{4}$, least value is $\frac{3}{4}$ $\therefore$ $q = \frac{3}{4}$

$\Rightarrow$ x = 1 satisfies it $\therefore$ $\alpha = 1$ and other root is $\frac{-1}{(2021)^{2022} - 1}$

$\therefore \alpha = 1,\; q = \frac{3}{4},\; p = 2$

4. 2023.00

5. 1348.00

Sol. **(for Q.4.-5):**

$A_1 = [k] \Rightarrow B_1 = k$; $A_2 = \begin{bmatrix} k & 1 \\ k & 1 \end{bmatrix} \Rightarrow B_2 = k^2 - 1$; $A_3 = \begin{bmatrix} k & 1 & 0 \\ 1 & k & 1 \\ 0 & 1 & k \end{bmatrix} \Rightarrow B_3 = KB_2 - 1B_1$

Similarly, $A_4 = \begin{bmatrix} k & 1 & 0 & 0 \\ 1 & k & 1 & 0 \\ 0 & 1 & k & 1 \\ 0 & 0 & 1 & k \end{bmatrix} \Rightarrow B_4 = kB_3 - B_2$

Thus, $B_n = KB_{n-1} - B_{n-2}$. If k = 2, $B_1 = 2$, $B_2 = 3$, $B_3 = 4$, $B_4 = 5$

Thus, $B_{2022} = 2023$

If k = 1, $B_n = B_{n-1} - B_{n-2}$; $B_1 = 1$, $B_2 = 0$, $B_3 = B_2 - B_1 = -1$, $B_4 = B_3 - B_2 = -1$

$B_5 = B_4 - B_3 = 0$; $B_6 = 1$ and it goes on

$B_{6n+1} = 1$; $B_{6n+2} = 0$; $B_{6n+3} = -1 \Rightarrow B_{6n-4} = -1$; $B_{6n+5} = 0$; $B_{6n} = 1$

Thus, $\sum\limits_{k=1}^{2022} |B_p| = \frac{4}{6} \times 2022 = 1348$

6. 12.00

7. 24.00

Sol. **(for Q. 6.-7):**

$z_1, z_2, z_3, \ldots\ldots z$ are also the roots of $z^{12} = 1$ i.e. 12th roots of unity

$z^{12} - 1 = (z - z_1)(z - z_2)(z - z_3) \ldots\ldots (z - z_{12})$

$$\frac{z^{12} - 1}{z - 1} = (z - z_2)(z - z_3)(z - z_4)\ldots\ldots(z - z + 2)$$

$1 + z + z^2 + \ldots\ldots z^{11} = (1 - z_1)(1 - z_3)(1 - z_4) \ldots\ldots (1 - z_{12})$

Put z = 1, $12 = |1 - z_2|\ |1 - z_3|\ |1 - z_4| \ldots\ldots |1 - z_{12}|$

$\Rightarrow |z_2 - z_1|^2 = |z_1|^2\ |(e^{i2\pi/12} - 1)|^2 = 2^2 \sin^2 \frac{\pi}{12} \Rightarrow |A_1 A_2|^2 + |A_1 A_3|^2 + \ldots\ldots |A_1 A_{12}|^2$

$$= 4\left[\sin^2 \frac{\pi}{12} + \sin^2 \frac{2\pi}{12} + \sin \frac{3\pi}{12} + \ldots\ldots \sin^2 \frac{11\pi}{12}\right] = 2\left[11 - \left(\cos \frac{2\pi}{12} + \cos \frac{4\pi}{12} + \ldots\ldots \cos^2 \frac{2\pi}{12}\right)\right]$$

$= 2(11 - (-1)) = 24$

8. 04.00

Sol. $\frac{4}{7} \times \frac{{}^{8}C_5}{{}^{12}C_5}$

9. 09.00

Sol. $\frac{4}{12} \times \frac{3}{11} = \frac{1}{11}$

3

FIITJEE RBT-4 for (JEE-Advanced)

BATCHES – Two Yr CRP2123(All)

PHYSICS, CHEMISTRY & MATHEMATICS

QP Code: 100183 **Paper-2**

Time Allotted: 3 Hours **Maximum Marks: 180**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections**.
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. Each **Section** is further divided into **Two Parts**: **Part-A & B** in the OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with HB pencil for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Three Parts.

(i) **PART – A *(01 –06)***: This section contains SIX **(06)** questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in **–2** marks, as a wrong option is also darkened.

PART – A *(07 –10)*: This section contains TWO **(02) paragraphs.** Based on each paragraph, there are **TWO (02)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer. Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(ii) **PART – B *(1 – 3)*:** This section contains **THREE (03)** questions. The answer to each question is a **NON-NEGATIVE INTEGER.** Each question carries **+4 marks** for correct answer and **there will be no negative marking.**

(iii) **PART – B (4 – 9):** This section contains **SIX (06)** questions stems. There are **TWO (02)** questions corresponding to each question stem. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places. Each question carries **+2 marks** for correct answer and **there will be no negative marking.**

Name of the Candidate :____

Batch :____________________ **Date of Examination :**____________________

Enrolment Number :____

SECTION – I : PHYSICS

PART – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

---

1. Two stars S_1 and S_2 of mass M each are moving in circular orbits about their common centre of mass ‘O’ due to mutual gravitational force of attraction. The separation between them is 4R. An asteroid of mass m(m <<M) is in a coplaner circular orbit about same centre ‘O’. It is observed that the asteroid is also moving in a circular orbit with same angular speed. Neglect size of stars and asteroid compared with R. Then choose the correct option(s).

(A) Time period of revolution of stars and asteroid is $8\pi\sqrt{\frac{2R^3}{GM}}$

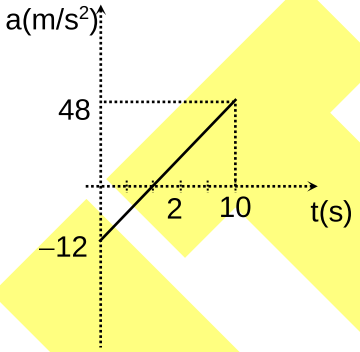
(B) Radius of the circle traced by asteroid is $2\sqrt{3}\,R$

(C) The total energy of the asteroid is $\frac{-5GMm}{16R}$

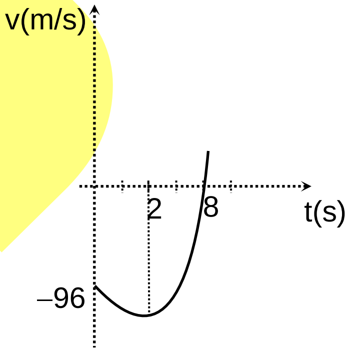
(D) Radius of the circle traced by the star S_1 is 2R.

2. The position of a particle which moves along a straight line is defined by the relation $x = t^3 - 6t^2 - 96t + 37$, where x is expressed in meters and t is in seconds. Which of the graph(s) represent(s) the motion of the particle?

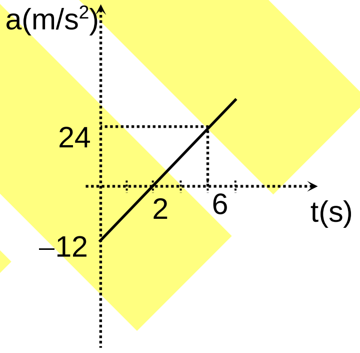
(A)



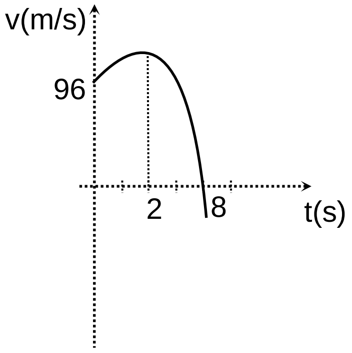
(B)



(C)



(D)



3. A flat circular annular disc of mass M, outer radius a and inner radius b. The measured value of M, a and b are, M = (0.30 kg ± 0.0003 kg), a = (4 cm ± 0.001 cm) and b = (2 cm ± 0.001 cm). Then,

(A) Percentage error in the calculation of a and b are in ratio 1 : 2.

(B) Percentage error in the calculation M is 0.1%

(C) Percentage error in the calculation of moment of inertia of the disc about an axis passing through the centre and perpendicular to the plane of disc is 0.16%

(D) Percentage error in the calculation of moment of inertia of the disc about an axis passing through the centre and perpendicular to the plane of disc is 1.6%

4. When a yellow light of wavelength 6000 Å from a sodium lamp falls on a certain photocell, a negative potential of 0.30 volt is needed to stop all the electrons from reaching the collector. Then choose correct option(s).

(A) Work function of the given photocell is 2.5 eV (approximately).

(B) Work function of the given photocell is 1.78 eV (approximately).

(C) A negative potential of 0.6 Volt will be needed to stop all the electrons if light of wavelength λ = 4000 Å is used

(D) A negative potential of 1.32 Volt (approximately) will be needed to stop all the electrons if light of wavelength λ = 4000 Å is used

5. 10g of ice at 0°C is mixed with 5g of steam at 100°C. If latent heat of fusion of ice is 80 cal-g^{-1} and latent heat of vaporization of 540 cal-g^{-1}. When thermal equilibrium is reached then which of the following is/are correct?

(A) Temperature of the mixture is 0°C

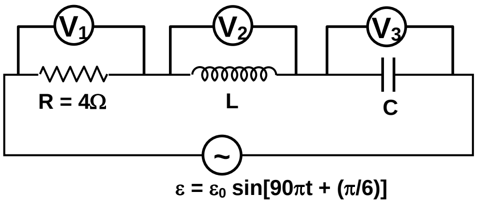
(B) Temperature of mixture is 100°C

(C) Mixture contains 13.3 g of water and 1.67 g of steam

(D) Mixture contains 5.3 g of ice and 9.7 g of water

Space For Rough Work

FIITJEE



6. In the figure shown the reading of voltmeter are V_1 = 80 V, V_2 = 90 V and V_3 = 30 V. Then choose the correct option(s).

(A) The peak value of current is $20\sqrt{2}$ ampere.
(B) The peak value of emf is $100\sqrt{2}$ volts.
(C) The value of L, is $\frac{1}{20\pi}$H
(D) The value of C for which the circuit will produce maximum heat is $\frac{1}{405\pi}$F

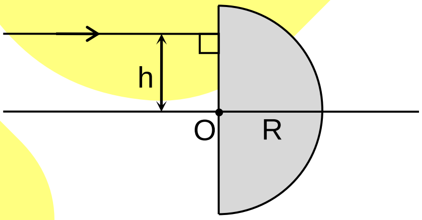
PART – A (Maximum Marks: 12)

*This section contains **TWO (02) paragraphs.** Based on each paragraph, there are **TWO (02)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.*

Paragraph for Question Nos. 07 and 08

A semi-cylinder made of a transparent plastic has a refractive index of μ = 5/3 and radius of R = 30 cm lies in vacuum. There is a narrow incident light ray perpendicular to the flat side of the semi-cylinder at height ‘h’ from the axis of symmetry. (take tan37° = 3/4)

Now answers the following questions.



7. What is the maximum value of ‘h’ so that the light ray can still leave the other side of the semi-cylinder?

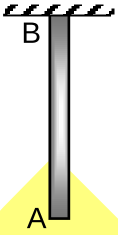
(A)	12 cm	(B)	8 cm
(C)	18 cm	(D)	24 cm

8. When the refractive index of transparent plastic is $\mu = \sqrt{2}$, the value of ‘h’ is chosen such that total internal reflection just takes place, then time for which light remains inside the cylinder, is

(A)	10^{-9} s	(B)	2×10^{-9} s
(C)	4×10^{-9} s	(D)	8×10^{-9} s

Space For Rough Work

Paragraph for Question Nos. 09 and 10



Consider a rope AB of non-uniform density as shown in the figure. If we consider direction A to B as the direction of increasing y, with y = 0, at A. The linear mass density of rope is given by $\mu = \left(\frac{y}{\ell}\right)^3 \mu_0$, where μ_0 is a positive constant and ℓ is length of the rope. Now one pulse is produced at the lower end A. Then answer the following questions

9. The time to move the pulse from A to B.

(A) $\sqrt{\frac{\ell}{g}}$ (B) $2\sqrt{\frac{\ell}{g}}$

(C) $3\sqrt{\frac{\ell}{g}}$ (D) $4\sqrt{\frac{\ell}{g}}$

10. Acceleration of the pulse when $y = \ell/4$.

(A) g/4 (B) g/2

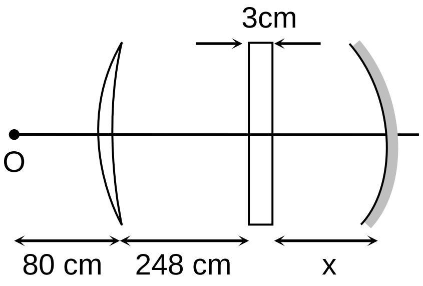
(C) g (D) g/8

PART – B (Maximum Marks: 12)

*This section contains **THREE (03)** questions. The answer to each question is a **NON-NEGATIVE INTEGER.***

1. Two rods each of length L_1 and one rod of length L_2 form isosceles triangle having base of length L_2. Co-efficient of linear expansion of base is 4×10^{-6} /°C while for rod of length L_1 is 25×10^{-6} /°C. Find the ratio $\left(\frac{L_2}{L_1}\right)$, if the length of latitude remains same when the temperature of the system is increased by 10°C.

2. A concavo-convex lens made of glass of refractive index 1.5 has surfaces of radii 20 cm and 60 cm. A concave mirror of radius of curvature 20 cm is placed co-axially to the lens. A glass slab of thickness 3 cm and refractive index 1.5 is placed close to the mirror in the space between the mirror and lens as shown in the figure. The distance of the nearest surface of the slab from lens is 248 cm. An object is placed 80 cm to the left of the lens. If the final position of the image formed after the refraction from lens, refraction from slab, reflection from mirror, refraction from the slab and lens is at the object O, find the distance x (in cm) of the mirror from nearer surface of slab.



Space For Rough Work

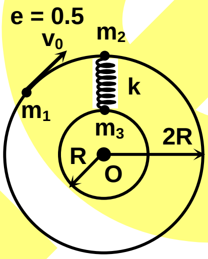
3. A train moving towards a hill at a speed 144 km/hr, sounds whistle of frequency 300 Hz. Wind is blowing from the hill with a velocity 360 km/hr at an angle of 53° with the railway track. If the speed of sound in air is $\frac{400}{3}$ m/s, then find the frequency (in Hz) heard by a man on the hill.

PART – B (Maximum Marks: 12)

*This section contains **THREE (03)** question stems. There are **TWO (02)** questions corresponding to each question stem. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

Question Stem for Question Nos. 4 and 5

Three particles each of mass ‘m’ can slide on fixed frictionless circular track in the same horizontal plane as shown in the figure. Particle m_1 moves with velocity v_0 and hits particle m_2, the coefficient of restitution being e = 1/2. Assume m_2 and m_3 are initially in rest and lie along a radial line before impact and the spring is initially unstretched. The velocity of m_3 when extension in the spring is maximum, is X m/s and the maximum extension in the spring is Y meter. (Take v_0 = 20 m/s and $\frac{m}{k} = 5$ kg/(N/m))

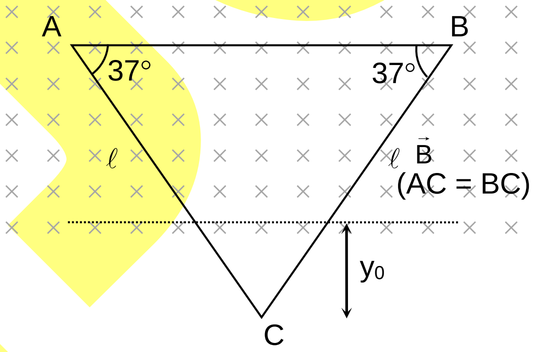


4. The value of X is ………..

5. The value of Y is ………..

Question Stem for Question Nos. 6 and 7

A current carrying loop is in the shape of isosceles triangle of mass m lies in the vertical plane. There exists uniform horizontal magnetic field B in the region as shown in the figure. The current in the loop is i. The value of y_0 is X meter when loop is in equilibrium. If the loop is displaced slightly in its plane perpendicular to its side AB from its equilibrium position and released, then time period of its oscillation is Y sec. (neglect the induced emf in the loop, take $\frac{mg}{iB} = \frac{80}{3}$, π = 3.14 and g = 10 m/s²)

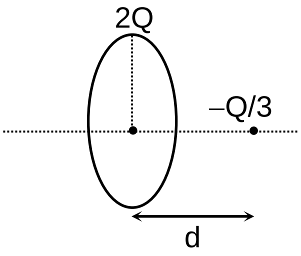


6. The value of X is……………….

7. The value of Y is……………….

Question Stem for Question Nos. 8 and 9

A ring of mass 2M, radius R and charge 2Q is placed as shown in the figure. A point charge $-\frac{Q}{3}$ and mass M is placed on the axis of ring at a distance d from the centre of the ring as shown in the figure. (d<<R). When system is released it performs oscillations. The energy of oscillation of the system is $\frac{Q^2}{m\pi\varepsilon_0 R^n}$ and the time period of oscillation is $T = \sqrt{\frac{X\pi^3\varepsilon_0 MR^3}{YQ^2}}$.



8. The value of |m – n| is ………..

9. The value of |X – Y| is ………..

Space For Rough Work

SECTION – II : CHEMISTRY

PART – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

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1. Among the following intensive properties are

(A) E^{o}_{cell}

(B) E_{cell}

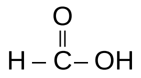
(C) Normality

(D) Entropy

2. Which of the following solution is/are hypertonic at constant T with 0.4 M NaCl showing 80% dissociation?

(A) 0.7 M glucose

(B) 0.3 M Na_3PO_4 showing 90% dissociation

(C) 
$1\ M\ H-\overset{\overset{O}{\|}}{C}-OH$ showing 30% association

(D) 0.5 M $MgCl_2$ showing 20% dissociation

3. In isothermal compression of ideal gas

(A) W is +ve

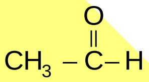
(B) ΔH is zero

(C) ΔS_{gas} is – ve

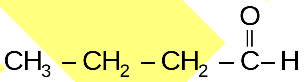
(D) ΔE is zero

4. Tautomer of which of the following can show geometrical isomerism

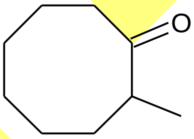
(A)


$CH_3-\overset{\overset{O}{\|}}{C}-H$

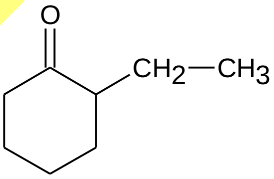
(B)


$CH_3-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-H$

(C)

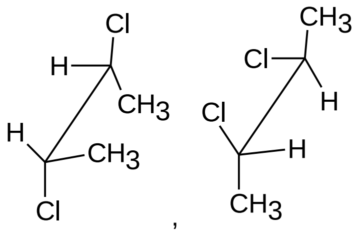


(D)

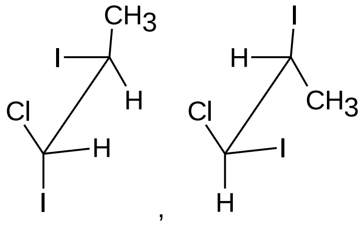


5. Which of the following pairs of compounds is/are identical?

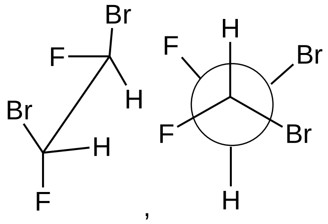
(A)


Cl
H
CH3
H
CH3
Cl
,
CH3
Cl
H
Cl
H
CH3

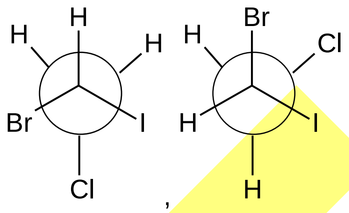
(B)


CH3
I
H
Cl
H
I
,
I
H
CH3
Cl
I
H

(C)


Br
F
H
Br
H
F
,
H
F
Br
F
Br
H

(D)


H
H
H
Br
I
Cl
,
Br
H
Cl
H
I
H

6. Which set of quantum numbers is/are not consistent with the theory?

(A) $n = 2, \ell = 0, m = -1, s = +\frac{1}{2}$

(B) $n = 2, \ell = 0, m = 0, s = -\frac{1}{2}$

(C) $n = 1, \ell = -1, m = 0, s = -\frac{1}{2}$

(D) $n = 3, \ell = 3, m = -3, s = +\frac{1}{2}$

Space For Rough Work

PART – A (Maximum Marks: 12)

*This section contains **TWO (02) paragraphs.** Based on each paragraph, there are **TWO (02)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.*

Paragraph for Question Nos. 07 and 08

An orange solid (A) on heating gives a green residue (B), a colourless gas (C) and water vapours. The dry gas (C) on passing over heated Mg gave a white solid (D). (D) on reaction with water gave a gas (E) which formed black precipitate with mercurous nitrate solution.

7. Select the incorrect statement

(A) The central atom (s) of the anion of solid (A) has sp^3 hybridization.

(B) The orange solid (A) is diamagnetic in nature.

(C) The anion of orange solid (A) is oxidizing in nature.

(D) All metal oxygen bond lengths are equal in anion of solid (A).

8. Which of the following is false for the gas (E)?

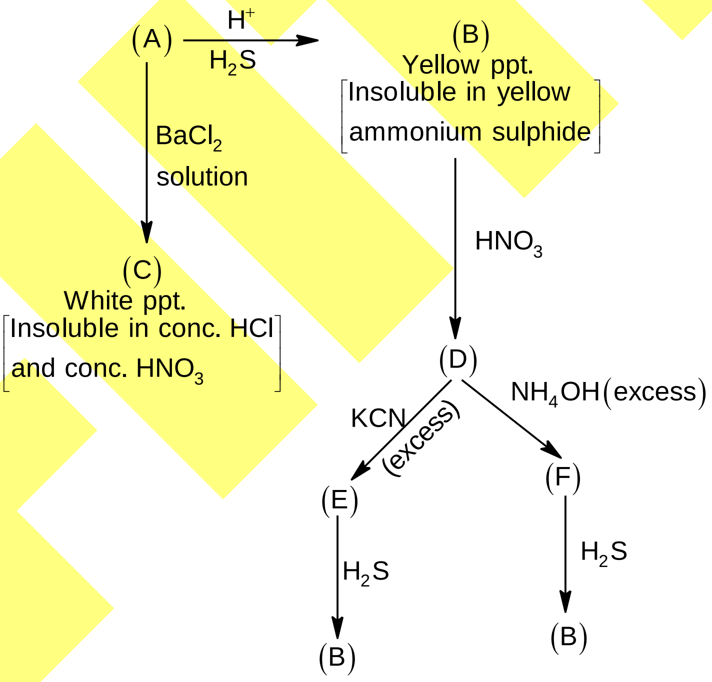
(A) It gives a deep blue colouration with $CuSO_4$ solution.

(B) It is oxidized to a colourless gas (neutral oxide) at 1200 K in presence of a catalyst Pt/Rh in air.

(C) It gives the same gas (C) with potassium permanganate solution.

(D) It gives black precipitate with $HgCl_2$.

Paragraph for Question Nos. 09 and 10


(A)
H⁺
H₂S
(B)
Yellow ppt.
[Insoluble in yellow ammonium sulphide]
BaCl₂ solution
(C)
White ppt.
[Insoluble in conc. HCl and conc. HNO₃]
HNO₃
(D)
KCN (excess)
NH₄OH (excess)
(E)
(F)
H₂S
(B)
H₂S
(B)

9. What is "C"?

(A) $PbCl_2$ (B) $BaSO_4$

(C) $BaSO_3$ (D) $PbSO_4$

10. What is “B”?

(A) CdS (B) $PbCrO_4$

(C) HgO (D) $K_3\left[Co(NO_2)_6\right]$

PART – B (Maximum Marks: 12)

*This section contains **THREE (03)** questions. The answer to each question is a **NON-NEGATIVE INTEGER.***

---

1. Number of co-ordination isomerism for the complex $\left[\overset{II}{Pt}(NH_3)_4\right]\left[\overset{II}{Pt}Cl_4\right]$ is (including itself)

2. Number of stereo isomers in the complex $[Ma_2b_2c_2]$ [where a, b, c are monodentate ligand]

3. The following equilibrium are established in mixing of two gases x_2 and y in sealed container at constant temperature T.

$$3x_2(g) \rightleftharpoons x_6(g), \qquad K_p = 1.6\ \text{atm}^{-2}$$
$$x_2(g) + y(g) \rightleftharpoons x_2y(g), \ K_P = z\ \text{atm}^{-1}$$

When $x_2(g)$ and $y(g)$ are mixed in 2 : 1 molar ratio, the total pressure of gases at equilibrium is found to be 1.4 atm and partial pressure of $x_6(g)$ is 0.2 atm. The value of 6W is.

PART – B (Maximum Marks: 12)

*This section contains **THREE (03)** question stems. There are **TWO (02)** questions corresponding to each question stem. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

Question Stem for Question Nos. 4 and 5

A reaction is said to be first order if it’s rate is proportional to the concentration of reactant. Let us consider a reaction

	$A(g) \longrightarrow$	$B(g) +$	$C(g)$
At $t = 0$	a	0	0
At time t	$a - x$	x	x

The rate of reaction is given by the expression $\frac{dx}{dt} = k(a-x)$ and integrated rate equation for given reaction is represented as $k = \frac{1}{t}\ell n\left(\frac{a}{a-x}\right)$ where a = initial concentration and (a – x) = concentration of A after time t.

4. Thermal decomposition of compound A is a first order reaction. If 75% of A is decomposed in 100 min. How long will it take for 90% of the compound to decompose?
[Given: log2 = 0.30]

5. Consider a reaction $A(g) \longrightarrow 3B(g) + 2C(g)$ with rate constant $1.386 \times 10^{-2}\ \text{min}^{-1}$. Starting with 2 moles of A in 12.5 litre vessel initially, if reaction is allowed to takes place at constant pressure and at 298 K then find the concentration of B after 100 min? $\left[e^{-1.386} = 0.25\right]$

Space For Rough Work

Question Stem for Question Nos. 6 and 7

0.257 g of an organic compound is analysed for nitrogen by Kjeldahl's method. The ammonia evolved was absorbed in 50 mL of 0.1 M HCl which required 23.2 ml of $\frac{N}{10}$ NaOH for the complete neutralization.

6. What is percentage of 'N' in the compound?

7. In Carius method of estimation of halogen, 0.15 g of an organic compound gave 0.12 g of AgBr. What is % of Bromine in the compound?
[Take : $M_{AgBr} = 188\ g/mol;\ M_{Br} = 80\ g/mol$]

Question Stem for Question Nos. 8 and 9

EMF of a cell corresponding to the reaction:

$$Zn(s) + 2H^{+}(aq) \longrightarrow Zn^{2+}(aq)[0.10\ M] + H_2(g) \mid [1.0\ atm]$$

is 0.61 V at $25^{o}C$. Also, at $25^{o}C$, $E^{o}_{Zn^{2+}/Zn} = -0.76\ V$. $\left[\frac{2.303RT}{F} = 0.06\right]$

8. The pH of solution in cathode chamber is………

9. ΔG of the above cell reaction is y,' then the value of |y| in kJ? (Given 1F = 96500)

Space For Rough Work

FIITJEE

SECTION – III : MATHEMATICS

PART – A (Maximum Marks: 24)

*This section contains **SIX (06)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).*

---

1. If the value of limit ; $\lim\limits_{n\to\infty}\left(n+1-\sum\limits_{i=2}^{n}\sum\limits_{k=2}^{i}\frac{k-1}{k!}\right)$ is L, then (where [.] denotes greatest integer function)

(A) $\left[\frac{[L]+2L}{[L]}\right]=3$

(B) $\left[\frac{[L]+2L}{[L]}\right]=4$

(C) $\left[\frac{[L]+[L-1]}{2[L]}\right]=0$

(D) $\left[\frac{[L]+[L-1]}{2[L]}\right]=1$

2. Suppose that the function f : R → R and g : R → R satisfy the relation $f(x + g(y)) = 2x + y + 5$, then if function $g(x + f(y)) = k_1(x) + k_2(y) + k_3$, then

(A) $2k_1 + k_2 = 1$

(B) $2k_1 + k_2 = 2$

(C) $k_3 - k_1 = 0$

(D) $k_3 - k_1 = 2$

3. ${}^{m}C_1\cdot{}^{n}C_m - {}^{m}C_2\cdot{}^{2n}C_m + {}^{m}C_3\cdot{}^{3n}C_m$ ..... is equal to

(A) coefficient of x^n in $(1 - (1 + (1 - x)^n)^m)$

(B) coefficient of x^n in $(1 - (1 - (1 + x)^n)^m)$

(C) coefficient of x^m in $(1 - (1 - (1 + x)^n)^m)$

(D) coefficient of x^m in $(1 - (1 + (1 - x)^n)^m)$

4. Given an alphabet with three letters a, b, c, then the number of words of n letter which contain even number of a's?

(A) $2^n\left(\left(1+\frac{1}{2}\right)^n+\left(1-\frac{1}{2}\right)^n\right)$

(B) $2^{n-1}\left(\left(1+\frac{1}{2}\right)^n+\left(1-\frac{1}{2}\right)^n\right)$

(C) $\frac{1}{4}\left(3^n+1\right)$

(D) $\frac{1}{2}\left(3^n+1\right)$

Space For Rough Work

5. For each integer $n \geq 1$. Let $a_n = 1 + \frac{1}{2} + \frac{1}{3} ..... \frac{1}{n} - \log n$ and $b_n = a_n - \frac{1}{n}$, then

(A) $a_{n+1} > a_n$ (B) $a_{n+1} < a_n$

(C) $b_{n+1} > b_n$ (D) $b_{n+1} < b_n$

6. Let point A is taken on line x + y – 9 = 0 and B and C are taken on circle $2x^2 + 2y^2 - 8x - 8y - 1 = 0$ such that line AB passes through centre of circle and $\angle BAC = 45°$, then range of x coordinate of point A is superset of which of the following?

(A) [3, 4] (B) [2, 4]

(C) $\left[\pi, \frac{3\pi}{2}\right]$ (D) $[\pi, 5]$

PART – A (Maximum Marks: 12)

*This section contains **TWO (02) paragraphs.** Based on each paragraph, there are **TWO (02)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.*

Paragraph for Question Nos. 7 and 8

N dice are rolled once, then the probability of getting sum t is expressed as $P_d(t, N)$. Where dice is a d sided dice with face marked 1, 2, 3, 4, ... d.

7. Which of the following is an **incorrect** combination?

(A) $P_6(14, 3) = P_6(14, 5)$ (B) $P_3(5, 2) = P_3(5, 3)$

(C) $P_3(10, 4) = P_3(10, 5)$ (D) $P_4(9, 3) = P_4(9, 4)$

8. The value of $P_9(15, 2)$ is equal to

(A) $\frac{4}{71}$ (B) $\frac{4}{81}$

(C) $\frac{8}{81}$ (D) $\frac{8}{71}$

Space For Rough Work

Paragraph for Question Nos. 09 and 10

Let consider lines $\frac{x-3}{3}=\frac{y-8}{-1}=\frac{z-3}{1}$ and $2x + 5y - z + 47 = 0 = 2x + y + z + 7$

9. The shortest distance between both given line is

(A) $2\sqrt{30}$

(B) $3\sqrt{30}$

(C) $\sqrt{30}$

(D) $\sqrt{75}$

10. Equation of plane parallel to both of lines and which lies midway between the lines

(A) $2x + 5y - z + 2 = 0$

(B) $2x - 5y + z - 2 = 0$

(C) $2x + 5y - z - 2 = 0$

(D) $2x - 5y - z - 2 = 0$

PART – B (Maximum Marks: 12)

*This section contains **THREE (03)** questions. The answer to each question is a **NON-NEGATIVE INTEGER.***

---

1. Let R be the circum-radius of triangle ABC and let G and H be its centroid and orthocentre respectively. Let F be the midpoint of GH, then if $AF^2 + BF^2 + CF^2 = kR^2$, then k is equal to

2. In the coordinate plane, the area of the region bounded by the line passing through (1, 2) with the slope α and the parabola $y = x^2$ is denoted by $S(\alpha)$ where α varies in the range of $0 \le \alpha \le 6$, then find the value of α such that $S(\alpha)$ is minimized

3. Given a triangle ABC, let a, b, c denotes the length of its sides and m, n, p the length of its medians. For every positive real α, let $\lambda(\alpha)$ be the real number satisfying
$a^\alpha + b^\alpha + c^\alpha = (\lambda(\alpha))^\alpha \{m^\alpha + n^\alpha + p^\alpha\}$, then of value of $\lambda(2)$ is k, then [k] is
(where [.] denotes the greatest integer function)

Space For Rough Work

PART – B (Maximum Marks: 12)

*This section contains **THREE (03)** question stems. There are **TWO (02)** questions corresponding to each question stem. The answer to each question is a **NUMERICAL VALUE.** If the numerical value has more than two decimal places, truncate/round-off the value to **TWO** decimal places.*

Question Stem for Question Nos. 4 and 5

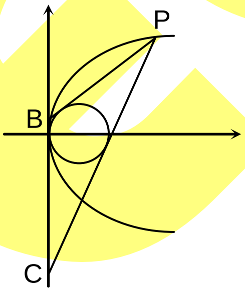
If the abscissa and the ordinate of on equilateral triangle are the roots of $a_1x^3 + b_1x + c_1 = 0$ and $a_2x^3 + b_2x + c_2 = 0$, then if $k_1\left[\frac{b_1}{a_1}+\frac{b_2}{a_2}\right]+k_2R^3=0$ (where R is the circumradius of triangle ABC); k_1 and k_2 are coprime to each other), then

4. Value of k_1 is

5. Value of k_2 is

Question Stem for Question Nos. 6 and 7

As is shown in figure, $P(x_0, y_0)$ is a moving point on the parabola $y^2 = 2x$, point B and C are on y-axis, and the sides of triangle PBC touches the circle $(x – 1)^2 + y^2 = 1$.



6. The minimum value of area of triangle PBC is _____ (in sq. unit)

7. The value of x_0 when the area of ΔPBC is minimum

Question Stem for Question Nos. 8 and 9

The largest area of rectangle whose

8. Base is on x-axis and upper two vertices lies on parabola $y = 12 – x^2$

9. Base is along with x-axis and inscribed in equilateral triangle having base as x-axis and side length 20 unit

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Space For Rough Work

QP Code: 100183

ANSWERS

SECTION-1 : PHYSICS

PART – A

1.	A, B, C, D	2.	A, B, C	3.	A, B, C	4.	B, D
5.	B, C	6.	A, B, C, D	7.	C	8.	C
9.	D	10.	D				

PART – B

1.	5	2.	10	3.	2100	4.	06.00
5.	15.00	6.	10.00	7.	06.28	8.	09.00
9.	15.00						

SECTION – 2 : CHEMISTRY

PART – A

1.	A, B, C	2.	B, C	3.	A, B, C, D	4.	B, C
5.	A	6.	A, C, D	7.	D	8.	D
9.	B	10.	A				

PART – B

1.	2	2.	6	3.	9	4.	166.67
5.	00.07	6.	17.72	7.	34.04	8.	03.00
9.	117.73						

SECTION – 3 : MATHEMATICS

PART – A

1.	A, C	2.	B, D	3.	C	4.	B, D
5.	B, C	6.	A, C, D	7.	C	8.	B
9.	B	10.	A				

PART – B

1.	3	2.	2	3.	1	4.	02.00
5.	03.00	6.	08.00	7.	04.00	8.	32.00
9.	86.50 (Range 86.50 to 86.60)						

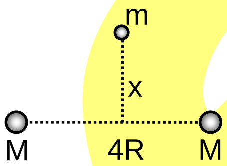
Answers & Solutions

SECTION-1 : PHYSICS

PART – A

1. A, B, C, D

Sol. For the stars



$$\frac{GM^2}{(4R)^2} = M(2R)\omega^2$$

$$\omega = \sqrt{\frac{GM}{32R^3}} \qquad \ldots(i)$$

The asteroid should be equidistant from both the stars.

$$\frac{2GMmX}{\left[(X^2+(2R)^2\right]^{3/2}} = mX\omega^2 \qquad \ldots(ii)$$

From (i) and (ii)

$$X = 2\sqrt{3}R$$

Total energy = $-\frac{2GMm}{4R}+\frac{1}{2}m\left(2\sqrt{3}R\sqrt{\frac{GM}{32R^3}}\right)^2 = -\frac{5GMm}{16R}$

2. A, B, C

Sol. $x = t^3 - 6t^2 - 96t + 37$ …(i)
$v = 3t^2 - 12t - 96$ …(ii)
$a = 6t - 12$ …(iii)
at t = 0, v = – 96 m/s
when v = 0, t = 8 sec
and when v is maximum t = 2 sec.

3. A, B, C

Sol. Percentage error in a, b and M are $\frac{\Delta a}{a}\times 100 = \frac{0.001}{4}\times 100 = 0.025\%$

$$\frac{\Delta b}{b}\times 100 = \frac{0.001}{2}\times 100 = 0.05\%$$

$$\frac{\Delta M}{M}\times 100 = \frac{0.0003}{0.3}\times 100 = 0.1\%$$

Moment of Inertia

$$I = \frac{M}{2}(a^2+b^2)$$

$$\frac{\Delta I}{I} = \frac{\Delta M}{M} + \frac{2a\cdot\Delta a + 2b\cdot\Delta b}{a^2+b^2}$$

$$\frac{\Delta I}{I} = 0.001 + \frac{2(4)(0.001)+2(2)(0.001)}{20}$$

$$\frac{\Delta I}{I} = 0.001 + \frac{0.008+0.004}{20} = 0.0016$$

$$\frac{\Delta I}{I}\times 100 = 0.16\%$$

4. B, D

Sol. As we know that,

FIITJEE

$\frac{hC}{\lambda} = \phi + K \Rightarrow \frac{12400}{\lambda} = \phi + v_s$, where ϕ is in electron Volt and λ is in Å

When light of wavelength λ = 6000 Å is used

$\frac{12400}{6000} = \phi + 0.3 \Rightarrow \phi$ = 1.77 ≈ 1.78 eV (approximately)

When light with wavelength λ = 4000 Å is used

$\frac{12400}{4000} = \phi + eV$

$\Rightarrow$ eV = (3.1 – 1.78) e volt = 1.32 eV

$\Rightarrow$ V = 1.32 Volt

5. B, C

Sol. Heat gain by ice to melt = mL_f = 10 × 80 = 800 cal

Heat gain by 10 g water to raise its temperature from 0°C to 100°C = 10 × 1 × 100 = 1000 cal

Total heat gain = 1800 cal

Mass of stem converted into water

$\therefore$ 1800 = m × 540 $\Rightarrow$ m = 3.33 g

$\therefore$ equilibrium temperature 100°C

Amount of water = 10 + 3.33 = 13.33 g

Amount of steam = 5 – 3.33 = 1.67 g

6. A, B, C, D

Sol. (A) $i_{rms} = \frac{80}{4} = 20\text{ amp},\ i_{peak} = 20\sqrt{2}\text{ amp}$

(B) $\varepsilon_{rms} = \sqrt{(40)^2 + (40-10)^2} = 100\text{V}$, ε_0 = $100\sqrt{2}$V

(C) $\omega L i_{rms} = 90 \Rightarrow L = \frac{90}{10 \times 90\pi} = \frac{1}{20\pi}\text{H}$

(D) For maximum heat, current through the circuit will be maximum $\omega L = \frac{1}{\omega C}$

$C = \frac{1}{405\pi}\text{F}$

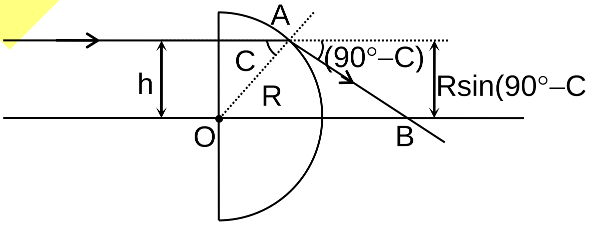
7. C

Sol. $\frac{5}{3}\sin C = 1\sin 90°$

sin C = 3/5 (C → critical angle)

C = 37°

h = R sin 37° = $\frac{3}{5}R = \frac{3}{5}(30) = 18\text{ cm}$



8. C

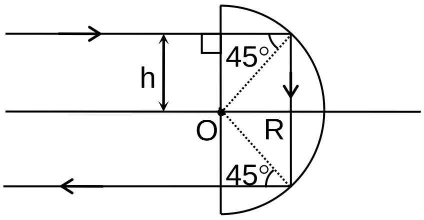
Sol. when μ = $\sqrt{2}$

$\sqrt{2}\ \sin C = 1$ (C → critical angle)

C = 45°

Total distance travel in semi-cylinder

= $\left(\frac{R}{\sqrt{2}}\right)4 = 2\sqrt{2}R = (2\sqrt{2})(30) = 60\sqrt{2}$ cm

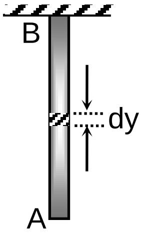


Time $= \frac{60\sqrt{2}}{C_m} \times 10^{-2} = \frac{60\sqrt{2} \times 10^{-2}}{\left(\frac{3 \times 10^8}{\sqrt{2}}\right)} = \frac{120 \times 10^{-2}}{3 \times 10^8} = 4 \times 10^{-9}$ s (C_m → speed of light in the medium)

9. D

10. D

Sol. **(for Q. 9-10):**



dm = μdy

$$m = \int_0^y \mu_0 \left(\frac{y}{\ell}\right)^3 dy = \left(\frac{\mu_0}{\ell^3}\right)\left(\frac{y^4}{4}\right)$$

Velocity of wave

$$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{gy}{4}}$$

$$\frac{dy}{dt} = \frac{\sqrt{gy}}{2}$$

$$\int_0^{\ell} \frac{dy}{\sqrt{y}} = \frac{\sqrt{g}}{2}\int_0^t dt$$

$$t = \left(4\sqrt{\frac{\ell}{g}}\right)$$

$$v = \frac{\sqrt{gy}}{2}$$

$$v^2 = \frac{gy}{4}$$

$$2v\frac{dv}{dy} = \frac{g}{4}$$

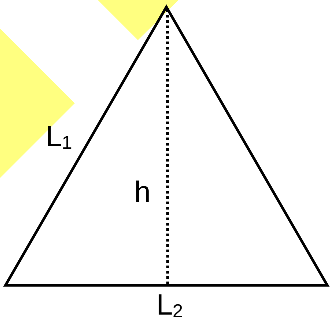
$$v\frac{dv}{dy} = \left(\frac{g}{8}\right)$$

a = g/8

PART – B

1. 5

Sol. $h^2 = L_1^2 - \frac{L_2^2}{4}$



Differentiating and using dL=L α Δt

$$0 = 2L_1\alpha_1 L_1 \Delta t - \frac{1}{4}2L_2\alpha_2 L_2 \Delta t$$

$$L_1 L_1 \alpha_1 \Delta t = \frac{1}{4}L_2 L_2 \alpha_2 \Delta t$$

$$\Rightarrow \frac{L_2}{L_1} = 2\sqrt{\frac{\alpha_1}{\alpha_2}} = 2\sqrt{\frac{25\times10^{-6}}{4\times10^{-6}}} = 5$$

2. 10

Sol. For lens, $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

Here, R_2 = +60 cm and R_1 = 20 cm

$$\frac{1}{f} = (1.5-1)\left(\frac{1}{20} - \frac{1}{60}\right)$$

$$\Rightarrow \frac{1}{60} = \frac{1}{v} + \frac{1}{80}$$

v = 240

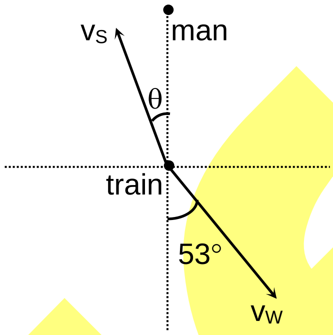
Shift due to slab, $s = 2\left[1 - \frac{1}{1.5}\right] = 1\,\text{cm}$

For final image to form at O, ray should retrace its path after reflection from mirror. So, I_2 should be at centre of curvature of mirror i.e.

$7 + 3 + x = 20$
$x = 10$ cm

3. 2100

Sol. $v_W \to$ velocity of wind
$v_S \to$ velocity of sound
$v_S.\sin\theta = v_W \sin 53°$



$$\sin\theta = \frac{v_W}{v_S}\left(\frac{4}{5}\right) = \frac{100}{(400/3)} \times \frac{4}{5} = \frac{3}{5}$$

$\theta = 37°$

$$f' = f\left(\frac{v_S\cos\theta - v_W\cos 53°}{v_S\cos\theta - v_W\cos 53° - v_T}\right) = 300 \times 7 = 2100 \text{ Hz}$$

4. 06.00

5. 15.00

Sol. **(for Q. 4-5):**
By the conservation of linear momentum between m_1 and m_2 and by using coefficient of restitution velocity m_2 just after collision $\frac{3v_0}{4}$.
After the collision, the maximum extension in the spring occurs when angular velocity of m_2 and m_3 about O become same. Now by conservation of angular momentum about 'O' and energy conservation

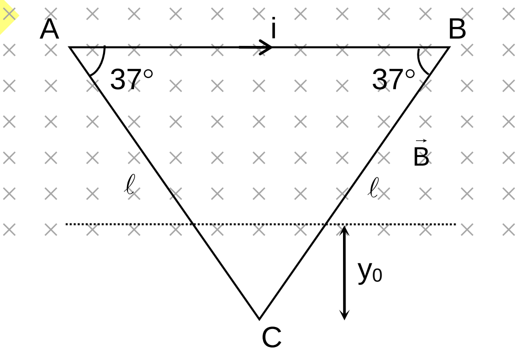
Velocity of $m_2 = 2R\omega = \frac{3}{5}v_0$

Velocity of $m_3 = R\omega = \frac{3}{10}v_0$ and Δx maximum = $\frac{3}{4}v_0\sqrt{\frac{m}{5k}}$

6. 10.00

7. 06.28

Sol. **(for Q. 6-7):**



$$i\left(\frac{8y_0}{3}\right)B = mg$$

$$y_0 = \frac{3mg}{8iB}$$

$y_0 = 10$

If loop is displaced by small y downward. Then,

$$ma = mg - iB\left[\frac{8}{3}(y + y_0)\right]$$

$$a = -\left(\frac{8iB}{3m}\right)y$$

$$\omega = \sqrt{\frac{8iB}{3m}}$$

$$T = \frac{2\pi}{\omega} = 2\pi$$

8. 09.00

9. 15.00

Sol. **(for Q. 8-9):**

Difference of potential energy of two configuration when point charge is at rest at a distance d to when it passes through centre.
The energy of oscillation system

$$E = \frac{2KQ^2}{3\sqrt{R^2+d^2}} - \frac{2KQ^2}{3R} = \frac{Q^2d^2}{12\pi\varepsilon_0 R^3}$$

|m – n| = 12 – 3 = 9
Force between the ring and the charge particle

$$F = -\left(\frac{2KQ^2}{3R^3}\right)d$$

$$M_{eq} = \frac{2}{3}M$$

Hence time period of oscillation is $T = \sqrt{\frac{16\pi^3\varepsilon_0 MR^3}{Q^2}}$

SECTION – 2 : CHEMISTRY

PART – A

1. A, B, C

Sol. E^o_{cell}, E_{cell} and normality are intensive property, where as entropy is extensive property.

2. B, C

Sol. $\left[\pi_{obs}\right]_{0.4\text{ M NaCl}} = i \times C \times R \times T$

$= i \times 0.4 \times R \times T$

$= \left[1+(n-1)\alpha\right] \times 0.4 \times R \times T$

$= \left[1+0.8\right] \times 0.4 \times R \times T$

$= 1.8 \times 0.4 \times R \times T$

= 0.72 RT

$\left[\pi_{obs}\right]_{0.3\text{ M }Na_3PO_4} = \left[1+(4-1)\times 0.9\right] \times 0.3 \times R \times T$

= 1.11 RT

$\left[\pi_{obs}\right]_{0.7\text{ M Glucose}} = 0.7 \times R \times T$

= 0.7 RT

$\left[\pi_{obs}\right]_{1MH-\overset{\overset{O}{\|}}{C}-OH} = \left[1+(2-1)0.3\right] \times R \times T$

$= 1.3 \times R \times T$

$\left[\pi_{obs}\right]_{0.5\text{ M }MgCl_2} = 0.5 \times R \times T\left[1+(2)\times 0.2\right]$

$= R \times T \times 0.5\left[1.4\right]$

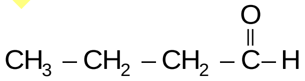
= 0.7 RT

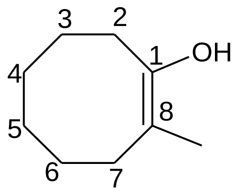
Here only option (B) and (C) have greater osmotic pressure then given solution.

3. A, B, C, D

Sol. In isothermal ideal gas compression as volume decrease. Hence, W is +ve, ΔH is zero, ΔS_{gas} is – ve and ΔE is zero

4. B, C

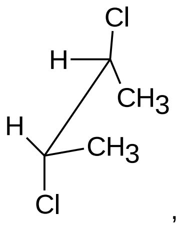
Sol. 
$CH_3-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-H$ will show geometrical isomerism.



will show geometrical isomerism

5. A

Sol.



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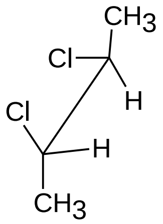


are identical.

6. A, C, D

Sol. (A) $\ell = 0$, then $m \neq 1$. Hence, (A) is incorrect.

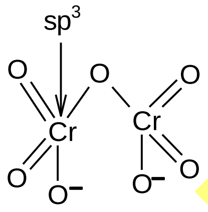
(B) It is the correct set.

(C) If n = 1, then $\ell = -1$. Hence, (C) is not correct.

(D) If n = 3, then $m \neq 3$. Hence, (D) is also incorrect.

7. D

Sol.



, all electrons are paired. So, diamagnetic ($3d^0 4s^0$)

$Cr_2O_7^{2-}$ acts as strong oxidizing agent in acidic medium.

8. D

Sol. (E) = NH_3

(A) $Cu^{2+} + 4NH_3 \longrightarrow \left[Cu(NH_3)_4\right]^{2+}$ (deep blue colouration)

(D) $HgCl_2 + NH_3 + H_2O \longrightarrow HgO.Hg(NH_2)Cl \downarrow$ (white)

9. B

10. A

Sol. **(for Q. 9 to 10):**

$A \xrightarrow{H^+/H_2S} B$ (Yellow ppt.)

Only CdS and As_2S_3 are yellow

CdS insoluble in Yellow Ammonium Sulphide

As_2S_3 soluble in Yellow Ammonium Sulphide

So, B is CdS

$A \xrightarrow{BaCl_2} C$ (White ppt.)

$BaSO_4$ are white ppt.

$BaSO_4$ Insoluble in mineral acids

$BaSO_3$ soluble in mineral acids

So, C is $BaSO_4$

$\therefore$ A is $CdSO_4$

$$CdS[B]\xrightarrow{HNO_3}\underbrace{Cd^{2+}(aq.)+S\downarrow+NO_3^{1-}(aq)}_{D}$$

$$Cd^{2+}(aq)\xrightarrow{KCN(excess)}K_2\left[Cd(CN)_4\right]$$

$[D]$

PART – B

1. 2

Sol. $\left[Pt(NH_3)_4\right][PtCl_4]$ and $\left[Pt(NH_3)_3\,Cl\right][PtCl_3NH_3]$

2. 6

Sol. Number of stereo isomers for the complex is 6.

3. 9

Sol.

$$\begin{array}{lcl} 3x_2(g) & \rightleftharpoons & x_6(g),\ K_p=1.6\ atm^{-2} \\ 2a-x-z & & \dfrac{x}{3} \end{array}$$

$$\begin{array}{lllll} x_2(g)\ + & y(g) \rightleftharpoons & x_2y(g), & & K_P = W\ atm^{-1} \\ 2a-x-z & a-z & z & & \end{array}$$

$$\frac{x}{3}=0.2\Rightarrow x=0.6$$

$$1.6=\frac{P_{x_6}}{\left[P_{x_2}\right]^3}\Rightarrow\left[P_{x_2}\right]^3=\frac{0.2}{1.6}$$

$$P_{x_2}=\frac{1}{2}=0.5\ atm$$

Now, 0.5 + 0.2 + a – z + z = 1.4

a = 0.7

2a – x – z = 0.5

$\Rightarrow 2\times0.7-0.6-0.5=z$

$z=0.3$

$$K_P=W=\frac{0.3}{0.5\times[0.7-0.3]}=1.5$$

Hence, 6W = 6 × 1.5 = 9

4. 166.67

Sol. 1st order kinetic

$$t=\frac{2.303}{k}\log\frac{a_o}{a_t}$$

$$\frac{0.6932}{50}=\frac{2.303}{t}\log\frac{100}{10}$$

5. 00.07

Sol.

$$\begin{array}{llll} & A(g) & \longrightarrow\ 3B(g) & +\ 2C(g) \\ t=0 & \left[\dfrac{2}{12.5}\right] & 0 & 0 \\ t=t & \dfrac{2-x}{V} & \dfrac{3x}{V} & \dfrac{2x}{V} \end{array}$$

Now, $t=\dfrac{2.303}{K}\log\dfrac{a_0}{a_t}$

$$\Rightarrow 100 = \frac{2.303}{1.386\times10^{-2}}\log\frac{2/12.5}{a_t}$$

$$\Rightarrow at = 0.04$$

Now, $\frac{2-x}{V} = 0.04$ … (1)

And as the P, T constant

$\frac{2}{12.5} = \frac{2+4x}{V}$ ... (2)

On solving Eq. (1) and (2), we get

$[B_t] = 0.07$ M

6. 17.72

Sol. Meq. of NH_3 = Meq. of HCl – Meq. of NaOH

$$\frac{W\times1000}{17} = 5-2.32 = 2.68$$

$$W = \frac{17\times2.68}{1000} = 0.4556$$

$$\%N = \frac{0.04556}{0.257}\times100$$

= 17.72%

7. 34.04

Sol. $\%Br = \frac{80}{188}\times\frac{0.12}{0.15}\times100 = 34.04\%$

8. 03.00

Sol. $E = 0.61 = 0.76 - \frac{0.06}{2}\log\frac{[Zn^{2+}]}{[H^+]^2}$

$$\Rightarrow \log\frac{(0.1)}{[H^+]^2} = \frac{0.76-0.61}{0.03}$$

$$\Rightarrow pH = 3$$

9. 117.73

Sol. $\Delta G = -nFE_{cell}$

$$|\Delta G| = \frac{2\times0.61\times96500}{1000}\text{kJ}$$

$$= 117.73 \text{ kJ}$$

SECTION – 3 : MATHEMATICS

PART – A

1. A, C

Sol. $\lim_{n\to\infty}\left(n+1-\sum_{i=2}^{n}\sum_{k=2}^{i}\frac{k-1}{k!}\right)=\lim_{n\to\infty}\left(n+1-\sum_{i=2}^{n}\sum_{k=2}^{i}\left\{\frac{1}{(k-1)!}-\frac{1}{k!}\right\}\right)$

$L=\lim_{n\to\infty}\left(n+1-\sum_{i=2}^{n}\left(1-\frac{1}{i!}\right)\right)$; $L=\lim_{n\to\infty}\left(2+\sum_{i=2}^{n}\frac{1}{i!}\right)$

$\therefore L = e$

2. B, D

Sol. Let g(0) = c then put x = x and y = 0 in functional equation f(x + g(y)) = 2x + y + 5
$\Rightarrow$ f(x + c) = 2x + 5 $\Rightarrow$ f(x) = 2x + 5 – 2c
$\Rightarrow$ f(x + g(y)) = 2x + 2(g(y)) – 2c + 5 compare with give equation
$\Rightarrow g(y)=\frac{y}{2}+c \Rightarrow g(x+f(y))=\frac{x+f(y)}{2}+c \Rightarrow g(x+f(y))=\frac{x+2y-2c+5}{2}+c = \frac{x+2y+5}{2}$

3. C

Sol. ${}^{m}C_1\cdot{}^{n}C_m-{}^{m}C_2\cdot{}^{2n}C_m+{}^{m}C_3\cdot{}^{3n}C_m \,.....\, (-1)^{m-1}\cdot{}^{m}C_m\cdot{}^{mn}C_n$
$\Rightarrow$ Coefficient of x^m in expression
${}^{m}C_1\cdot(1+x)^n-{}^{m}C_2\cdot(1+x)^{2n}+{}^{m}C_3\cdot(1+x)^{3n} \,.....\, {}^{m}C_m\cdot\left((1+x)^{mn}\right)\cdot(-1)^{m-1}$
$\Rightarrow {}^{m}C_0-\left[{}^{m}C_0-{}^{m}C_1\cdot(1+x)^n+{}^{m}C_2\cdot(1+x)^{2n}-{}^{m}C_3\cdot(1+x)^{3m} \,.....\, {}^{m}C_m\cdot(-1)^{mn}\cdot(1+x)^{mn}\right]$
$\Rightarrow$ Coefficient of x^m in ${}^{m}C_0-\left(1-(1+x)^n\right)^m$ $\Rightarrow$ Coefficient of x^m in $\left(1-\left(1-(1+x)^n\right)^m\right)$

4. B, D

Sol. If there is 2k occurrence of a then this can be done by ${}^{n}C_{2k}$ ways and remaining positions can be filled in 2^{n-2k} ways. So total number of ways are $\sum_{k=0}^{n}{}^{n}C_{2k}\,2^{n-2k} = \frac{1}{2}\left(3^n+1\right)$

5. B, C

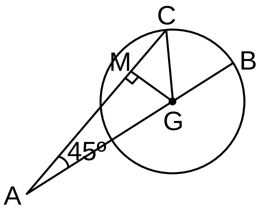
Sol. Let $f(x)=\frac{1}{1+x}$, then $\frac{1}{n}\left(\frac{1}{1+\frac{1}{n}}\right)<\int_0^{\frac{1}{n}}f(x)\,dx<\frac{1}{n}$, $\frac{1}{1+n}<\ln\left(1+\frac{1}{n}\right)<\frac{1}{n}$

Now, $a_n-a_{n+1}=-\log n-\frac{1}{n+1}+\log(n+1) = \log\left(1+\frac{1}{n}\right)-\frac{1}{n+1}>0$

$b_{n+1}-b_n=a_{n+1}-a_n-\frac{1}{n+1}+\frac{1}{n} = \frac{1}{n+1}-\log\left(1+\frac{1}{n}\right)-\frac{1}{n+1}+\frac{1}{n} = -\log\left(1+\frac{1}{n}\right)+\frac{1}{n}>0$

6. A, C, D

Sol. Let coordinate of A(a, 9 – a), then the distance of the centre of circle
$x^2 + y^2 - 4x - 4y - \frac{1}{2} = 0$ from AC will be
= |AG| sin 45°
$= \sqrt{(a-2)^2+(7-a)^2}\cdot\frac{1}{\sqrt{2}}$



Now, $d \le \sqrt{\frac{17}{2}} \Rightarrow \sqrt{(a-2)^2+(7-a)^2} \cdot \frac{1}{\sqrt{2}} \le \sqrt{\frac{17}{2}}$

$\Rightarrow a^2 - 9a + 18 \le 0 \Rightarrow a \in [3, 6]$

7. C

8. B

Sol. **(for Q. 7 & 8):**

We can determine the value of $P_d(t, N)$ as = $\dfrac{\text{coefficient of } x^t \text{ in } \left(x^1+x^2+x^3.....x^d\right)^N}{d^N}$

The value of $P_3(5, 2) = P_3(5, 3) = \frac{2}{9}$; $P_9(15, 2) = \frac{4}{81}$

$P_6(14, 3) = P_6(14, 5) = \frac{5}{72}$; $P_3(10, 4) = P(10, 6) = \frac{10}{81}$

$P_4(9, 3) = P_4(9, 4) = \frac{5}{32}$

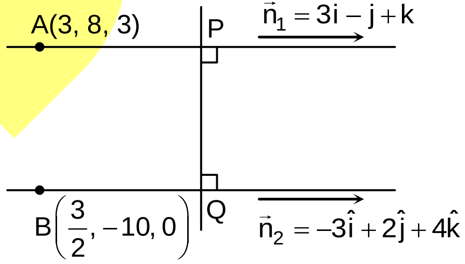
9. B

10. A

Sol. **(for Q. 9 & 10):**

Equation of line-1 ≡ $\frac{x-3}{3} = \frac{y-8}{-1} = \frac{z-3}{1}$

Equation of line-2 ≡ $2x + 5y - z + 47 = 2x + y + z + 7 = 0$ in symmetric form $\dfrac{x-\frac{3}{2}}{-3} = \frac{y+10}{2} = \frac{z}{4}$


A(3, 8, 3)
P
$\vec{n}_1 = 3\hat{i} - \hat{j} + \hat{k}$
$B\left(\frac{3}{2}, -10, 0\right)$
Q
$\vec{n}_2 = -3\hat{i} + 2\hat{j} + 4\hat{k}$

Shortest distance between both line

$= \left|\dfrac{\overrightarrow{AB} \cdot (\vec{n}_1 \times \vec{n}_2)}{|\vec{n}_1 \times \vec{n}_2|}\right| = 3\sqrt{30}$

Now, P is point on AP ⇒ P = (3 + 3r, 8 – r, 3 + r)

Q is point of BQ = $Q = \left(\frac{3}{2} - 3r', -10 + 2r', 4r'\right)$

Now, $\overrightarrow{PQ} \parallel (\vec{n}_1 \times \vec{n}_2)$

$\Rightarrow \dfrac{\frac{3}{2} + 3r + 3r'}{-2} = \dfrac{19 - r - 2r'}{-5} = \dfrac{3 + r - 4r'}{1} \Rightarrow r = 0 \text{ and } r' = \frac{3}{2}$

∴ P = (3, 8, 3) and Q = (–3, –7, 6) midpoint of PQ = $\left(0, \frac{1}{2}, \frac{9}{2}\right)$,

so required plane 2x + 5y – z + 2 = 0

PART – B

1. 3

Sol. Let vertices $\vec{A}, \vec{B}, \vec{C}$ and circumcentre as origin, then

$\vec{H}$ (orthocentre) = $\vec{A} + \vec{B} + \vec{C}$

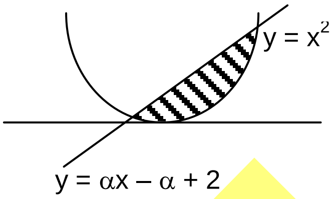
$\vec{G}$ (centroid) = $\frac{\vec{H}}{3}$

$\vec{F} = \frac{\vec{G} + \vec{H}}{2} = \frac{2\vec{H}}{3}$

Now, $AF^2 + BF^2 + CF^2 = (\vec{A} - \vec{F})(\vec{A} - \vec{F}) + (\vec{B} - \vec{F})(\vec{B} - \vec{F}) + (\vec{C} - \vec{F})(\vec{C} - \vec{F})$

$= \vec{A} \cdot \vec{A} + \vec{B} \cdot \vec{B} + \vec{C} \cdot \vec{C} - 2(\vec{A} + \vec{B} + \vec{C}) \cdot \vec{F} + 3\vec{F} \cdot \vec{F} = 3R^2 - \vec{F} \cdot \left(2(\vec{A} + \vec{B} + \vec{C}) - 3\vec{F}\right) = 3R^2$

2. 2



Sol. Let point of intersection of line
$y = \alpha x - \alpha + 2$ with $y = x^2$ are $x = x_1$ and $x = x_2$
Then, $x_1 + x_2 = \alpha$; $x_1x_2 = \alpha - 2$

$$S(\alpha) = \int_{x_1}^{x_2} \left((\alpha x - \alpha + 2) - x^2\right)dx$$

For area to minimized $\frac{d(S(\alpha))}{d\alpha} = 0$

$$\Rightarrow \frac{d(S(\alpha))}{d(\alpha)} = \frac{d}{d\alpha}\int_{x_1}^{x_2}\left((\alpha x - \alpha + 2) - x^2\right)dx = \int_{x_1}^{x_2}\frac{d}{d\alpha}\left(\alpha x - \alpha + 2 - x^2\right)dx$$

$$= \int_{x_1}^{x_2}(x-1)dx = (x_2 - x_1)\left(\frac{x_1 + x_2}{2} - 1\right) = 0 \Rightarrow x_1 + x_2 = 2 \Rightarrow \alpha = 2$$

3. 1

Sol. $m = \frac{1}{2}\sqrt{2b^2 + 2c^2 - a^2}$; $n = \frac{1}{2}\sqrt{2a^2 + 2c^2 - a^2}$; $p = \frac{1}{2}\sqrt{2a^2 + 2b^2 - c^2}$

$\Rightarrow a^2 + b^2 + c^2 = (\lambda(2))^2\{m^2 + n^2 + p^2\}$

$\Rightarrow a^2 + b^2 + c^2 = (\lambda(2))^2\left\{\frac{1}{4}\left\{(2b^2 + 2c^2 - a^2) + (2(a^2) + 2c^2 - b^2) + (2a^2 + 2b^2 - c^2)\right\}\right\}$

$\Rightarrow \lambda(2) = \frac{2}{\sqrt{3}}$

4. 02.00

5. 03.00

Sol. **(for Q. 4.-5):**
Let the vertices of triangle ABC are (x_1, y_1), (x_2, y_2), (x_3, y_3)
Then x_1, x_2, x_3 are root of $a_1x^3 + b_1x + c_1 = 0$

$\Rightarrow x_1 + x_2 + x_3 = 0$ and $\sum x_1x_2 = \frac{b_1}{a_1}$.

Similarly $y_1 + y_2 + y_3 = 0$ and $\sum y_1y_2 = \frac{b_2}{a_2}$

⇒ Circumcentre is at origin

$\Rightarrow x_1^2 + y_1^2 = x_2^2 + y_2^2 = x_3^2 + y_3^2 = R^2 \Rightarrow x_1^2 + x_2^2 + x_3^2 + y_1^2 + y_2^2 + y_3^2 = 3R^2$

$\Rightarrow (x_1 + x_2 + x_3)^2 - 2\sum x_1x_2 + (y_2 + y_2 + y_3)^2 - 2\sum y_1y_2 = 3R^2$

$\Rightarrow -2\left[\sum xx_2 + \sum y_1y_2\right] = 3R^2 \Rightarrow -2\left[\frac{b_1}{a_1} + \frac{b_2}{a_2}\right] = 3R^2$

6. 08.00

7. 04.00

Sol. Let point B(0, b) and C(0, c) and assume b > c

The equation of PB is $y - b = \frac{y_0 - b}{x_0}(x)$

$\Rightarrow (y_0 - b)x - x_0y + x_0b = 0$ as its tangent of circle $(x - 1)^2 + y^2 = 1$

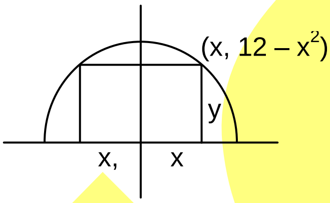
$\Rightarrow 1 = \left|\frac{y_0 - b + x_0b}{\sqrt{(y_0 - b)^2 + x_0^2}}\right| \Rightarrow (x_0 - 2)b^2 + 2y_0b - x_0 = 0$ similarly $(x_0 - 2)c^2 + 2y_0c - x_0 = 0$

$\Rightarrow b+c=\dfrac{-2y_0}{x_0-2}$ and $bc=\dfrac{-x_0}{x_0-2} \Rightarrow (b-c)^2=\dfrac{4x_0^2+4y_0^2-8x_0}{(x_0-2)^2} \Rightarrow b-c=\dfrac{2x_0}{x_0-2}$ (as $y_0^2=2x_0$)

Now, area of $\Delta PBC = \dfrac{1}{2}(b-c)x_0 = \dfrac{x_0^2}{x_0-2} = (x_0-2)+\dfrac{4}{(x_0-2)}+4 \geq 8$

8. 32.00

Sol. $A = 2x(12 - x^2)$



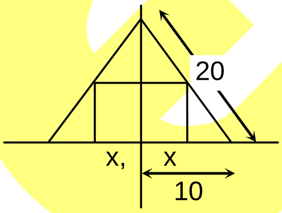
$\dfrac{dA}{dx} = 2\left(12-x^2+\left(-2x(2x)\right)\right) = 24-6x^2$

For maximum x = 2, A = 32 sq units

9. 86.50

(Range 86.50 to 86.60)

Sol. $A = 2x\sqrt{3}(10-x)$



$\dfrac{dA}{dx} = 2\sqrt{3}(10-2x)$

Maximize when x = 5

$A = 50\sqrt{3}$

< 3

FIITJEE RBT-5 for (JEE-Advanced)

BATCHES – Two Yr CRP2123(All)

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 3

QP CODE: 100187

PAPER - 1

Time Allotted: 3 Hours **Maximum Marks: 204**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections.**
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. All the section can be filled in **PART-A & B** of OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with ***Blue/Black Ball Point Pen*** for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Two Parts.

(i) **Part-A (01-04) –** Contains **Four (04)** multiple choice questions which have ONLY ONE CORRECT answer Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(ii) **PART–A (05–12)** contains Eight (8) Multiple Choice Questions which have **One or More Than One Correct** answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in **–2** marks, as a wrong option is also darkened.

(iii) **PART – B (1 – 3):** This section contains **Three (03)** questions. The answer to each question is a **NON-NEGATIVE INTEGER.** Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(iv) **Part-B (4 – 8)** contains **Five (05)** Numerical based questions, the answer of which maybe positive or negative numbers or decimals **TWO** decimal places (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+3 marks** for correct answer. **There is no negative marking.**

Name of the Candidate :____

Batch :____________________ **Date of Examination :**____________________

Enrolment Number :____

SECTION – I : PHYSICS

PART – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

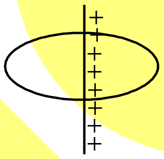
---

1. A paper ball (assumed to be carried easily by wind) is to be thrown in a trash can located $\frac{6\sqrt{3}}{5}$ m north of the point of projection. Wind is blowing towards east with speed 2 m/s. The paper ball is thrown at an angle 37° with the horizontal and it falls on the trash can. What is the speed with which it was thrown?

(A) 4 m/s (B) 5 m/s (C) 6 m/s (D) 7 m/s

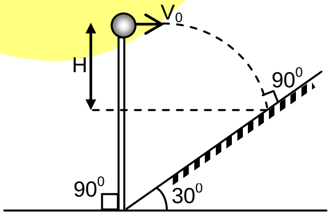
2. A very long uniformly charged rod falls with a constant velocity V through the center of a circular loop making an angle 37° with axis of loop. Then the magnitude of induced emf in loop is

(charge per unit length of rod = λ)



(A) $\frac{\mu_0}{2\pi}\lambda V^2$ (B) $\frac{\mu_0}{2}\lambda V^2$ (C) $\frac{\mu_0}{2\lambda}V$ (D) zero

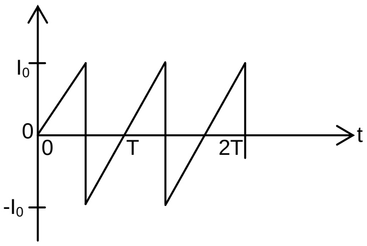
3. In the given figure, the angle of inclination of the inclined plane is 30^0. The horizontal velocity V_0 so that the particle hits the inclined plane perpendicularly is



(A) $v_0 = \sqrt{\frac{2gH}{3}}$ (B) $V_0 = \sqrt{\frac{2gH}{7}}$

(C) $V_0 = \sqrt{\frac{gH}{5}}$ (D) $V_0 = \sqrt{\frac{gH}{7}}$

4. For a circuit, current variation with time is shown in figure, corresponding rms current is



(A) I_0 (B) $I_0/\sqrt{2}$

(C) $I_0/\sqrt{3}$ (D) $I_0/2$

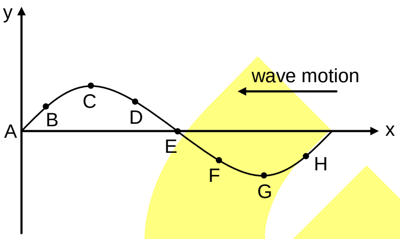
Space For Rough Work

PART – A (Maximum Marks: 32)

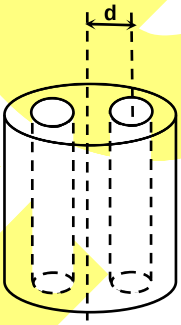
This section contains ***EIGHT (08)*** *questions. Each question has* ***FOUR*** *options (A), (B), (C) and (D).* ***ONE OR MOER THAN ONE*** *of these four option(s) is (are) correct answer(s).*

---

5. A transverse wave is travelling along a stretched string from right to left. The figure shown represents the shape of the string (snap shot) at a given instant. At this instant:
(A) the particles at A, B and H have upward velocity.
(B) the particles at D, E and F have downward velocity.
(C) the particles at C, E and G have zero velocity.
(D) the particles at A and E have maximum velocity.



6. An infinitely long cylindrical conductor of radius R contains current of uniform density J along axis of the cylinder. Two infinitely long cylindrical holes of radius r are drilled symmetrically throughout the length of the cylinder. The axes of the holes are parallel to the axis of cylinder and at distance d from it in the same plane.



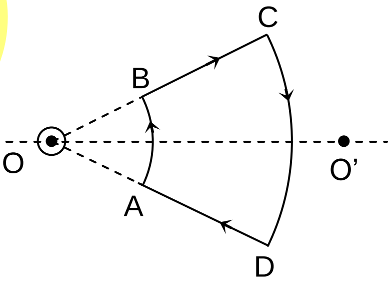
(A) Magnetic field on the axis of one of the hole will be $\frac{\mu_0 J}{2}\left(d-\frac{r^2}{2d}\right)$

(B) Magnetic field on the axis of one of the hole will be $\frac{\mu_0 J}{2}\left(d-\frac{r^2}{d}\right)$

(C) Magnetic field on the axis of cylinder will be $\frac{\mu_0 J}{2}\frac{r^2}{d}$

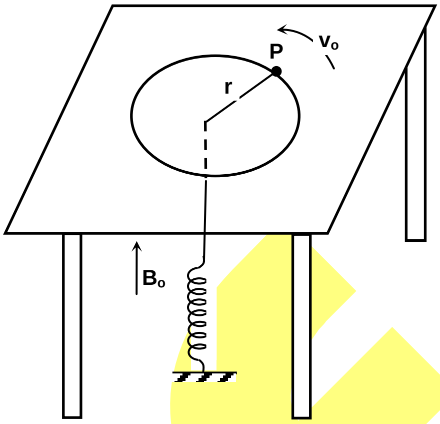
(D) Magnetic field on the axis of cylinder will be zero

7. An infinite current carrying wire coming outward passes through point O and in perpendicular to the plane containing a current carrying loop ABCD as shown in the figure. Choose the correct option(s).
(A) net force on the loop is zero
(B) Net torque on the loop is zero
(C) As seen from O, the loop rotates clockwise
(D) As seen from O, the loop rotates anticlockwise



Space For Rough Work

8. A particle mass m charge q is moving on a circular path on the surface of a frictionless table with speed v_o where a magnetic field B_o exists uniformly over the whole region. It is attached by a string which passes through a hole in the table to a spring as shown. The spring is stretched by x_o. If now the magnetic field is increased slowly to $2B_o$,
(A) The extension in the spring will increase
(B) The speed of the particle will increase
(C) The speed of the particle will decrease
(D) The kinetic energy of the particle will decrease

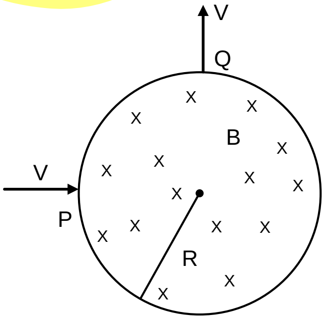


9. Two projectile are thrown at the same time from two different points. The projectile thrown from the origin has initial velocity $3\hat{i}+3\hat{j}$ with respect to earth. The projectile has initial velocity $a\hat{i}+b\hat{j}$ with respect to earth thrown from the point (10, 5). ($\hat{i}$ is a unit vector along horizontal, $\hat{j}$ along vertical). If the projectile collides after two second, then the

(A) value of a is -2
(B) value of a is $\frac{1}{2}$
(C) value of b is $\frac{1}{2}$
(D) value of b is –2

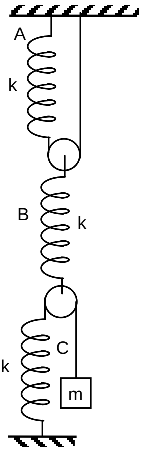
10. A particle of charge q mass m enters normally (at point P) in a region of magnetic field with speed v. It comes out normally from Q after time T as shown in figure. The magnetic field B is present only in region of radius R and is constant and uniform. Initial and final velocities are along radial direction and they are perpendicular to each other. For this to happen, which of the following expression(s) is/are correct?

(A) $B < \frac{2mv}{qR}$ (B) $T < \frac{\pi m}{Bq}$ (C) $T = \frac{\pi m}{2Bq}$ (D) $B < \frac{mv}{2qR}$



11. In the given figure, the block is attached with a system of three ideal springs A, B, C. The block is displaced by a small distance x from its equilibrium position vertically downwards and released. T represents the time period of small vertical oscillations of the block. Then (pulleys are ideal)

(A) $T = 2\pi\sqrt{\frac{11m}{2k}}$
(B) the deformation of the spring A is (2/11) times the displacement of the block.
(C) the deformation of the spring C is (1/11) times the displacement of the block.
(D) the deformation of the spring B is (4/11) times the displacement of the block.



Space For Rough Work

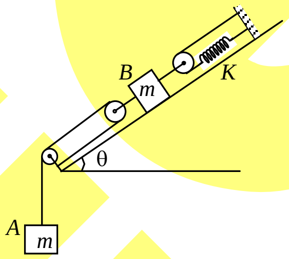
12. The distance between a screen and an object is 120 cm. A convex lens is placed closed to the object and is moved along the line joining object and screen, towards the screen. Two sharp images of the object are found on the screen. The ratio of magnification of two real images is 1 : 9. Then,
(A) focal length of the lens is 22.5 cm.
(B) smaller image is brighter than the larger one.
(C) larger image is brighter than the smaller one.
(D) brightness of both the images is same.

PART – B (Maximum Marks: 9)

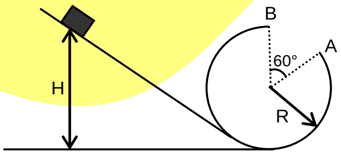
*This section contains **THREE (03)** questions. The answer to each question is a **NON-NEGATIVE INTEGER.***

---

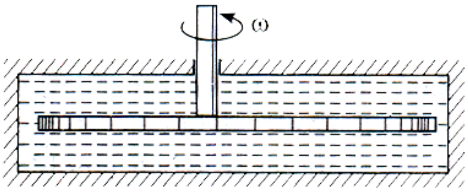
1. Two blocks *A* and *B*, each of mass *m* are connected by means of a pulley-spring system on a smooth inclined plane of inclination θ as shown in the figure. All the pulleys and spring are ideal. Now, *B* is slightly displaced from its equilibrium position. It starts to oscillate. Time period of oscillation of *B* is $n\pi$, then find n. (Take $m = 4$ kg, $K = 5$ N/m, $\pi = 3.14$)



2. A small particle slides from height H = 45 cm as shown and then loops inside the vertical loop of radius R from where a section of angle $\theta = 60°$ has been removed. If R = (1/N) meter, such that after losing contact at A and flying through the air, the particle will reach at the point B. Find N. Neglect friction everywhere.



3. A thin circular disc of radius R is made to rotate with a constant angular speed ω within a oil filled (coeff. of viscosity η) cylindrical box as shown in the figure. The clearance between the disc & the horizontal planes of the cylindrical box is very small & is equal to h. Considering that the vertical side of the cylindrical box is almost in contact with the disc, the power to be supplied to the system to maintain the constant angular speed is $\frac{\pi\eta\omega^x R^y}{h}$. Then x + y is



Space For Rough Work

PART – B (Maximum Marks: 15)

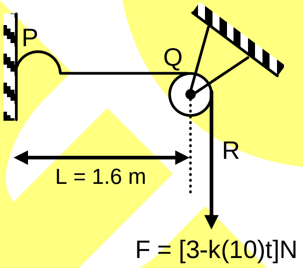
(Numerical **Type)**

This section contains ***Five (05)*** Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **TWO** decimal places (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30).

4. A ring of mass 3.15 kg is rolling without slipping with linear velocity 1 m/sec on a smooth horizontal surface. A rod of same mass is fitted along its one diameter. Find total kinetic energy of the system (in J).

5. Potential energy of a particle moving along x-axis is given by U = $\frac{x^3}{3} - \frac{9x^2}{2} + 20x$. Find out position of stable equilibrium state.

6. As shown in figure light string PQR is stretched by force F = (3 – 10kt) N, where k is a constant and t is time in second. At time t = 0, a pulse is generated at the end P of the string. For the value of k (in N/s) if the value of force becomes zero as the pulse reaches point Q. Given mass per unit length of string is 0.03 kg/m.



7. In a moving coil galvanometer, torque on the coil can be expressed as $\tau \propto i$, where i is current through the wire. The rectangular coil of the galvanometer having number of turns N, area A and moment of inertia I is placed in magnetic field B. The torsion constant of spring in the galvanometer is C and charge Q is passed through the coil almost instantaneously. If the maximum angle through which coil deflected is $\frac{KNABQ}{\sqrt{3CI}}$. (Ignore the damping in mechanical oscillations). Then the value of K is

8. 2 kg of ice at –22.5^{0}C is mixed with 2.5 kg of water at 25^{0}C in an insulating container. If the specific heat of ice and water are 0.5 cal/gm°C and 1 cal/gm°C respectively. Latent heat of fusion of ice = 80 cal/gm. Find the amount of water present in the container (In kg).

Space For Rough Work

SECTION – II : CHEMISTRY

PART – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

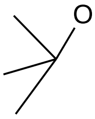
---

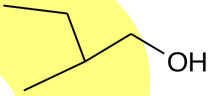
1. Choose correct statement from the following
(A) Bond angle: $OCl_2 > BCl_3 > NCl_3$
(B) Strength of backbonding: $BCl_3 > OCl_2 > NCl_3$
(C) Bond order: $NCl_3 > OCl_2 > BCl_3$
(D) Dipole moment: $NCl_3 > BCl_3 > OCl_2$

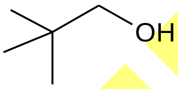
2. $R-C\equiv C-R' \xrightarrow{LiAlH_4} RCH=CHR'$
In the above reaction, R and R' should be
(A) R = CHO and $R' = CH_3$
(B) $R = CH_3$ and $R' = CH_2OH$
(C) $R = C_2H_5$ and R' = CO
(D) $R = CH_3$ and R' = COOH

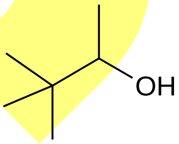
3. The S – O bond order of SOF_2 is greater than that of $SOCl_2$. This is due to
(A) polarity of O – F bond is greater than that of O – Cl bond
(B) the O → S back bond in SOF_2 is stronger than that in $SOCl_2$
(C) the S → O back bond in SOF_2 is stronger than that in $SOCl_2$
(D) the $\angle$FSF is greater than $\angle$ClSCl

4. Which alcohol can't be formed by acidic hydration of any alkene?

(A)


(B)


(C)


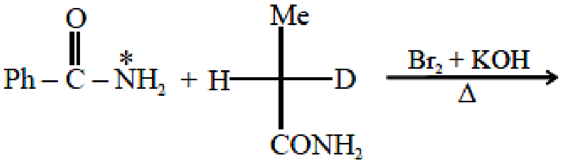
(D)


Space For Rough Work

PART – A (Maximum Marks: 32)

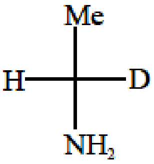
This section contains ***EIGHT (08)*** *questions. Each question has* ***FOUR*** *options (A), (B), (C) and (D).* ***ONE OR MOER THAN ONE*** *of these four option(s) is (are) correct answer(s).*

5.

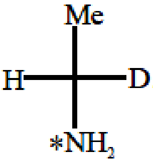


$Ph-\overset{O}{\overset{||}{C}}-\overset{*}{N}H_2 + H-\overset{Me}{\underset{CONH_2}{C}}-D \xrightarrow[\Delta]{Br_2 + KOH}$

Which of the following statement(s) is/are correct regarding the given reaction?

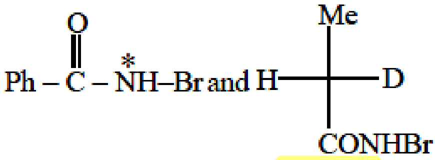
(A) $Ph\overset{*}{N}H_2$ and  D are produced.

$H-\overset{Me}{\underset{NH_2}{C}}-D$

(B) Cross over products $PhNH_2$ and  D are also produced.

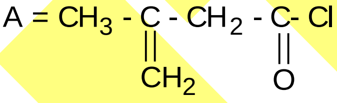
$H-\overset{Me}{\underset{*NH_2}{C}}-D$

(C) Migration of –R(alkyl group or aryl) of R–$CONH_2$ takes place with retention of configuration.

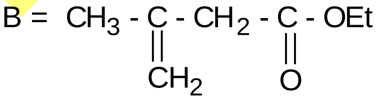
(D)  are the intermediates formed.

$Ph-\overset{O}{\overset{||}{C}}-\overset{*}{N}H-Br$ and $H-\overset{Me}{\underset{CONHBr}{C}}-D$

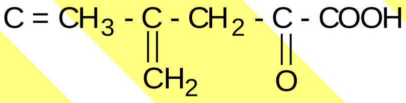
6. Compound A(C_5H_7OCl) reacts rapidly with ethanol and catalytic amount of acid to form a pleasant smelling substance B($C_7H_{12}O_2$). A also reacts with H_2O to form C with neutralization equivalent of 100. A, B and C all react with Br_2 water. Acid C, which can also be obtained by acidic hydrolysis of B is oxidized to new acid D($C_4H_6O_3$) and CO_2. D on heating with soda lime gives acetone. Identify A to D.

(A) 

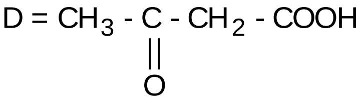
$A = CH_3-\underset{\underset{CH_2}{||}}{C}-CH_2-\underset{\underset{O}{||}}{C}-Cl$

(B) 

$B = CH_3-\underset{\underset{CH_2}{||}}{C}-CH_2-\underset{\underset{O}{||}}{C}-OEt$

(C) 

$C = CH_3-\underset{\underset{CH_2}{||}}{C}-CH_2-\underset{\underset{O}{||}}{C}-COOH$

(D) 

$D = CH_3-\underset{\underset{O}{||}}{C}-CH_2-COOH$

7. Choose the correct statement

(A) d_{yz} orbital lies in the xz plane

(B) p_z orbital lies along the x axis

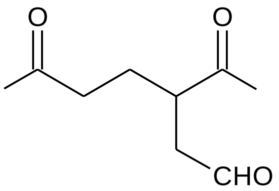
(C) lobes of $d_{x^2-y^2}$ orbital are at 90° with the z axis

(D) lobes of d_{xy} orbital are at 90° with the z axis

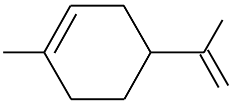
Space For Rough Work

8. The spectra of which complex(s) is/are spin forbidden as well as Laporte forbidden?
(A) $[Mn(H_2O)_6]^{2+}$
(B) $[Fe(H_2O)_6]^{3+}$
(C) $[Co(CN)_6]^{3-}$
(D) $[Cr(NH_3)_6]^{3+}$

9. A hydrocarbon X ($C_{10}H_{16}$) upon catalytic hydrogenation gives 4-methyl-1-isopropyl cyclohexane. Also (X) upon ozonolysis followed by hydrolysis in the presence of Zn gives CH_2O and



The correct statement(s) concerning (X) is/are
(A) Structure of (X) is



(B) (X) has two chiral carbon.
(C) (X) has one chiral carbon.
(D) With excess of HCl, (X) gives racemic dichloride.

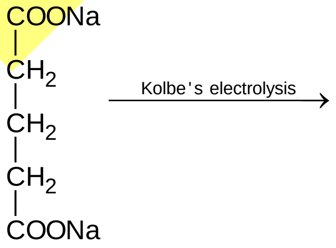
10. Which of the following reactant(s) produce(s) racemic mixtures when treated with HBr?
(A) Cis-2-butene
(B) Trans-2-butene
(C) 1-butene
(D) Isobutene

11. Which of the following increases by increasing the temperature of a chemical reaction?
(A) Rate constant
(B) Half-time
(C) Rate of reaction
(D) Temperature coefficient

12. Which reaction produces cyclic products?

(A) $CH_3COCH_3 \xrightarrow[\text{Heat}]{\text{Conc.}H_2SO_4}$

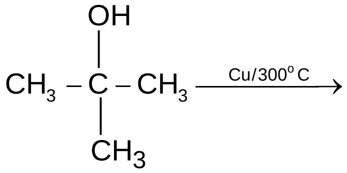
(B)



$$\begin{array}{l} COONa \\ | \\ CH_2 \\ | \\ CH_2 \\ | \\ CH_2 \\ | \\ COONa \end{array} \xrightarrow{\text{Kolbe's electrolysis}}$$

(C) $C_6H_5COONa \xrightarrow[\text{Heat}]{\text{Soda lime}}$

(D)



$$CH_3-\overset{\overset{\displaystyle OH}{|}}{\underset{\underset{\displaystyle CH_3}{|}}{C}}-CH_3 \xrightarrow{\text{Cu/300}^{\circ}\text{C}}$$

Space For Rough Work

PART – B (Maximum Marks: 9)

*This section contains **THREE (03)** questions. The answer to each question is a **NON-NEGATIVE INTEGER.***

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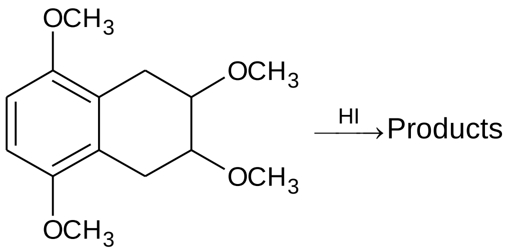
1. 

If x moles of HI can be completely consumed by one mole of the above compound, what is the value of x?

2. $FeCl_3 + K_4[Fe(CN)_6] \rightarrow Fe_4[Fe(CN)_6]_3$
If ‘x’ moles of KSCN will be completely consumed by one mole of product in above reaction, to produce blood red colouration, what is the value of x/3?

3. If the pH of 0.1 M aqueous solution of NH_4NO_3 is x, what is the value of x? [K_b of $NH_4OH = 10^{-5}$]

PART – B (Maximum Marks: 15)

(Numerical **Type)**

This section contains ***Five (05)*** Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **TWO** decimal places (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30).

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4. 2.5 mole of KCl is added to one Kg of water at 1 atm. At what temperature in kelvin unit will the water boil if the degree of dissociation of KCl is 0.8? [K_b of H_2O = 0.52 K kg mol^{-1}]

5. 14 g of a metal oxide of formula MO is added to a container containing 500 mL of 1.25 M HCl solution. After complete reaction, the reaction mixture is treated with 250 mL of 0.5 M NaOH to neutralize the excess acid. If the atomic mass of M is expressed as (2x + 15). What is x?

6. The successive ionization energies of a s-block element are
8.6, 12.9, 1630.2, 2406.2 eV, etc
If atomic mass of the elements is 39.8 g mol^{-1}, what will be the molar mass of it’s normal oxide?

Space For Rough Work

7. The molecular mass of a polyhydric aliphatic alcohol, increases by 252 unit if it reacts with $CH_3COCl/(CH_3CO)_2O$. if the number of OH groups present in the alcohol is x, what is the value of $\frac{x}{4}$?

8. $A_2(g) \longrightarrow A(g) + A(g)$

The heat of reaction of above decomposition of a diatomic molecule A_2(g), into monoatomic gases A(g) is 40.5 kJ mol^{-1} at 320 K. What will be the enthalpy change of the reaction at 330 K in kJ mol^{-1} unit?

[C_P of monoatomic gases = $\frac{5R}{2}$]

[C_P of diatomic gases = $\frac{7R}{2}$]

[R = 8.3 J K^{-1} mol^{-1}]

Space For Rough Work

FIITJEE

SECTION – Iii : MATHEMATICS

PART – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

1. Let $a, b, p, q \in \mathbb{Q}$ and suppose that $f(x) = x^2 + ax + b = 0$ and $g(x) = x^3 + px + q = 0$ have a common irrational root, then

(A) $f(x)$ divides $g(x)$
(B) $g(x) \equiv xf(x)$
(C) $g(x) \equiv (x - b - q)f(x)$
(D) none of these

2. If $x = \left(7 + 4\sqrt{3}\right)^{2n} = [x] + f$, then $x(1 - f)$is equal to

(A) 1
(B) 2
(C) 3
(D) 4

3. Consider the points $P = \left(-\sin(\beta - \alpha), -\cos\beta\right), Q = \left(\cos(\beta - \alpha), \sin\beta\right)$ and $R = \left(\cos(\beta - \alpha + \theta), \sin(\beta - \theta)\right)$, where $0 < \alpha, \beta < \frac{\pi}{4}$ then

(A) P lies on the line segment RQ
(B) Q lies on the line segment PR
(C) R lies on the line segment QP
(D) P, Q, R are non – collinear

4. For $a > b > c > 0$, the distance between (1, 1) and the point of intersection of the lines $ax + by + c = 0$ and $bx + ay + c = 0$ is less than $2\sqrt{2}$. Then

(A) $a + b - c > 0$
(B) $a - b + c < 0$
(C) $a - b + c > 0$
(D) $a + b - c < 0$

PART – A (Maximum Marks: 32)

*This section contains **EIGHT (08)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

5. The number of triangles that can be formed with the sides of lengths a, b and c where a, b, c are integers such that $a \le b \le c$ is

(A) $\frac{1}{4}(c+1)^2$ when c is odd
(B) $\frac{1}{2}c(c+1)$ when c is odd
(C) $\frac{1}{4}c(c+2)$ when c is even
(D) $\frac{1}{4}c^2$ when c is even

Space For Rough Work

6. If $x \in R$, and $S = 1 - C_1 \frac{1+x}{1+nx} + C_2 \frac{1+2x}{(1+nx)^2} - C_3 \frac{1+3x}{(1+nx)^3} + ... + ..$upto $(n+1)$ terms then S

(A) equals x^2
(B) equals 1
(C) equals 0
(D) is independent of x

7. A and B are two points on the x – axis and y – axis respectively. Two circles are drawn passing through the origin and having centre at A and B.

(A) Equation of the common chord is $ax - by = 0$
(B) mid – point of the common chord is $\left(\frac{ab^2}{a^2+b^2} \cdot \frac{a^2b}{a^2+b^2}\right)$
(C) AB bisect the common chord.
(D) AB is perpendicular to the common chord.

8. The equation $\frac{b\cos x}{2\cos 2x - 1} = \frac{b + \sin x}{(\cos^2 x - 3\sin^2 x)\tan x}$ posses a solution if

(A) $b < \frac{1}{2}$
(B) $0 < b < \frac{1}{2}$
(C) $b < 0$
(D) $b = \frac{1}{2}$

9. Normals are drawn from the point P (15, 12) to the parabola $y^2 = 4x$. If the feet of the normal form a ΔABC, then which of the following is/are true.

(A) Centroid of ΔABC is $\left(\frac{26}{3}, 0\right)$
(B) Centroid of ΔABC is $\left(\frac{22}{3}, 0\right)$
(C) Area of triangle formed by tangents to the parabola at A, B and C is 35 sq. units
(D) Area of triangle formed by tangents to the parabola at A, B and C is 140 sq. units

10. Let z_1 lies on $|z| = 1$ and z_2 lies on $|z| = 2$, then which of the following is/are true?

(A) maximum value of $|z_1 + z_2|$ is 3
(B) minimum value of $|2z_1 - z_2|$ is 0
(C) maximum value of $|2z_1 + z_2|$ is 4
(D) minimum value of $|2z_1 - 3z_2|$ is 5

11. If pair of tangents are drawn from centre C of the circle $x^2 + y^2 - 5x = 0$ to the nearer branch of the hyperbola $\frac{x^2}{25} - \frac{y^2}{16} = 1$ to touch it at point A and B, then

(A) product of the slopes of lines CA and CB is $\frac{-64}{75}$
(B) product of the slopes of lines CA and CB is $\frac{-32}{25}$
(C) circumcentre of ΔABC lies inside the ΔABC.
(D) circumcentre of ΔABC lies outside the ΔABC.

Space For Rough Work

12. If $a+b+c=4$ and $a^2+b^2+c^2+3(ab+bc+ac)=21$ where $a,b,c\in\mathbb{R}$, then which of the following is/are true
(A) minimum value of $(a+b)(b+c)(a+c)$ is 18
(B) minimum value of $(a+b)(b+c)(a+c)$ is 24
(C) maximum value of $(a+b)(b+c)(a+c)$ is $\frac{490}{27}$
(D) maximum value of $(a+b)(b+c)(a+c)$ is $\frac{471}{27}$

PART – B (Maximum Marks: 9)

*This section contains **THREE (03)** questions. The answer to each question is a **NON-NEGATIVE INTEGER.***

1. Consider the number $N=10!$. If the number of positive divisors of N is λ, then $\frac{\lambda}{30}$ equals

2. Let L_1, L_2 and L_3 be the length of tangents drawn from a point P to the circles $x^2+y^2=4$, $x^2+y^2-4x=0$ and $x^2+y^2-4y=0$ respectively. If $L_1^4=L_2^2L_3^2+16$, then locus of P are the curves C_1 (a straight line) and C_2 (a circle). Let the circumcentre of the triangle formed by C_1 and other two lines which are inclined at an angle of 45^o with C_1 and is tangent to C_2 is (α,β), then $(\alpha+2\beta)$ equals

3. Let $S_n=\sum_{r=1}^{n} r.2^{2^{\frac{r}{2}\left(1+(-1)^r\right)}}.3^{2^{\frac{r}{2}(1-(-1)r)}}$. If $S_{20}=\alpha.3^{21}+\beta.2^{22}+\frac{391}{288}$, then the value of $\left[\frac{32\alpha-9\beta}{4}\right]$ is (where [.] denotes the greatest integer function)

PART – B (Maximum Marks: 15)

(Numerical **Type)**

This section contains ***Five (05)*** Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **TWO** decimal places (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30).

4. If $[16\cos x+12\sin x]=4k+10$, then the maximum value of k is ________________

Space For Rough Work

5. The length of the semi – major axis of an ellipse is 8 and the eccentricity is $\frac{1}{2}$. If Δ denotes the area of the rectangle formed by joining the vertices of the latera recta of the ellipse then the value of $\frac{\Delta}{120}$ is equal to

6. The centres of two circles C_1 and C_2 each of unit radius are at a distance of 6 units from each other. Let P be the mid point of the line segment joining the centres of C_1 and C_2 and C be a circle touching C_1 and C_2 externally. If a common tangent to C_1 and C passing through P is also a common tangents to C_2 and C_1, then the one fifth of the radius of the circle C is

7. Value of x if x satisfies the equation $\log_{1-x}(3)-\log_{1-x}(2)=\frac{1}{2}$ is

8. The sum of all the integral roots of $(\log_5 x)^2+\log_{5x}\left(\frac{5}{x}\right)=1$ is ________________

Space For Rough Work

FIITJEE

QP Code: 100187

Answers

SECTION – I : PHYSICS

PART – A

1.	**B**	2.	**D**	3.	**A**	4.	**C**
5.	**ABD**	6.	**AD**	7.	**AC**	8.	**ACD**
9.	**AC**	10.	**ABC**	11.	**ABCD**	12.	**AB**

PART – B

1.	**2**	2.	**5**	3.	**6**	4.	**5.25**
5.	**5**	6.	**1.25**	7.	**1.73**	8.	**3**

SECTION – II : CHEMISTRY

PART – A

1.	B	2.	B	3.	B	4.	C
5.	**ACD**	6.	**ABD**	7.	**CD**	8.	AB
9.	AC	10.	ABC	11.	ACD	12.	ABC

PART – B

1.	7	2.	4	3.	5
4.	375.34 (Range 375.2 to 375.4)			5.	12.5 (Range12.4 to 12.6)
6.	55.8(Range 55.7 to 55.9)			7.	1.5
8.	40.62(Range 40.6 – 40.7)				

SECTION – III : MATHEMATICS

PART – A

1.	A	2.	A	3.	D	4.	A
5.	AC	6.	CD	7.	ABCD	8.	ABC
9.	AC	10.	ABC	11.	AC	12.	AC

PART – B

1.	9	2.	0	3.	4	4.	2.50
5.	0.8	6.	1.6	7.	–1.25	8.	6

FIITJEE

Answers & Solutions

SECTION – I : PHYSICS

PART – A

1. **B**

Sol. From range:

$$\frac{2u_xu_y}{g} = \frac{6\sqrt{3}}{5} \qquad u_xu_y = 6\sqrt{3} \quad \ldots(1)$$

Resultant of 2 and u_x $\Rightarrow$ $\sqrt{4+u_x^2}$

Whose resultant with u_y makes an angle 37°.

So, $$\frac{u_y^2}{4+u_x^2} = \frac{9}{16} \quad \ldots(2)$$

Solving (1) + (2), we will get $u_x = 2\sqrt{3}, u_y = 3$ & $u_z = 2\,m/s$

So net $\Rightarrow$ $\sqrt{u_x^2+u_y^2+u_z^2}$ = 5 m/s.

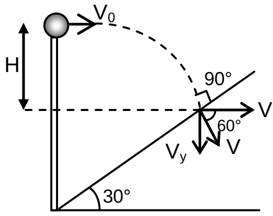
2. **D**

Sol. $\phi_B = 0$

$\because$ $\vec{B} \perp \vec{S}$; $\therefore$ $\frac{d\phi_B}{dt} = 0$

3. **A**

Sol. $v_y = \sqrt{2gH}$



$$\frac{v_y}{v_x} = \frac{\sqrt{2gH}}{v_o} = \tan 60^o = \sqrt{3}$$

$$v_0 = \sqrt{\frac{2gH}{3}}$$

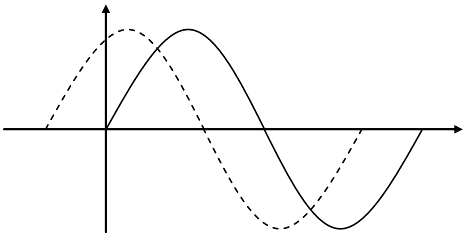
4. **C**

Sol. $i = \frac{2I_o}{T}t$ [0 < t < t/2]

$$i_{rms} = \frac{\frac{2I_o}{T}\sqrt{\int_0^{T/2} t^2dt}}{\sqrt{T/2}} = \frac{I_o}{\sqrt{3}}.$$

5. **ABD**

Sol. Results can be obtained by looking at shape of string after a short time (shown dotted). Also, each particle of string executes SHM about mean position which is on x-axis.



6. **AD**

Sol. Use ampere`s law to find magnetic field due to solid cylinder current = $\mu_0 Jd/2$

Due to cylinder on its own axis is 0

Applying superposition principle we can get the required answers.

7. **AC**

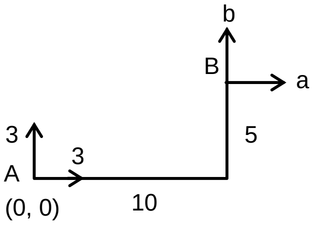
Sol. Force on branch BC is coming out of the plane of paper and force on AD is going into the plane of paper and net force on the loop is zero.

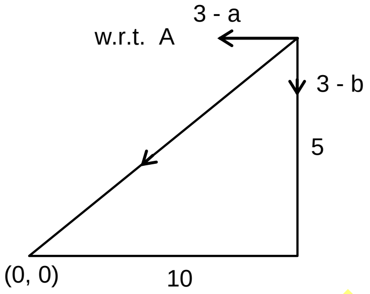
8. **ACD**

Sol. $\vec{F}_m = q\left(\vec{v} \times \vec{B}\right)$ and apply Newton's second law of motion.

9. **AC**

Sol.





In vertical direction $\left(s = \frac{d}{t}\right)$

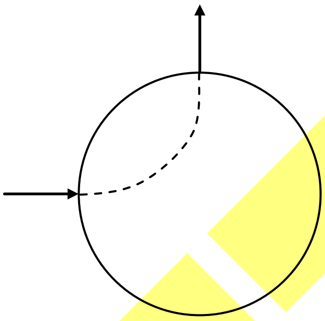
$3 - b = \frac{5}{2} \rightarrow b = \frac{1}{2}$

In horizontal direction

$3 - a = \frac{10}{2} \rightarrow a = -2.$

10. **ABC**

Sol.



So, its radius is also R.

So, $R = \frac{mv}{qB} \rightarrow B = \frac{mv}{qR}$

$T = \frac{2\pi M}{4qB} = \frac{\pi m}{2qB}$

So, A, B & C are correct.

11. **ABCD**

Sol. Let elongation in spring A, B and C be x_1, x_2 and x_3 respectively.

Considering spring forces and constraint relations

$x_2 = 4x_3$ …(i)

$x_2 = 2x_1$ …(ii)

and $x_1 + 2x_2 + x_3 = x$ …(iii)

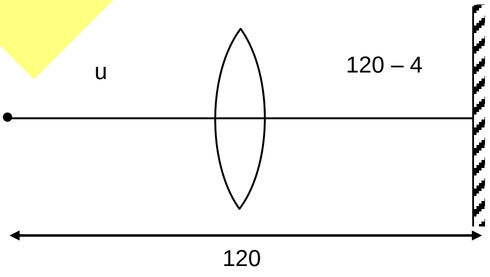
$\Rightarrow x_1 = \left(\frac{2}{11}\right)x \; ; \; x_2 = \left(\frac{4}{11}\right)x \; ; \; x_3 = \left(\frac{1}{11}\right)x$

Also, F = $2K\left(\frac{x}{11}\right)$

$\Rightarrow T = 2\pi\sqrt{\frac{11m}{2k}}$

12. **AB**

Sol.



For two different positions of lens

$1 = \frac{u}{120 - u} \; ; \; 9 = \frac{120 - u}{u}$

$\frac{1}{9} = \frac{u^2}{(120 - u)^2} \rightarrow \frac{1}{3} = \frac{u}{120 - u}$

u = 30 ; v = 90

$$\frac{1}{f}=\frac{1}{v}-\frac{1}{u}=\frac{1}{90}+\frac{1}{30}$$

$$P = 22.5$$

PART – B

1. **2**

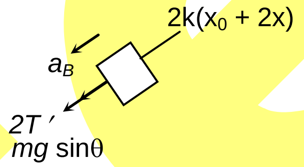
Sol. Let elongation of spring be x_0 in equilibrium. Then,

$$2T+mg\sin\theta=2kx_0 \qquad \text{...(i)}$$

and $T=mg$ ...(ii)

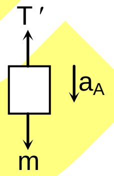
Let Block B is displaced by x down the inclination

F.B.D. of B



$$-ma_B=2k(x_0+2x)-2T'-mg\sin\theta \qquad \text{...(iii)}$$

F.B.D. of *A*



$mg - T' = ma_A$

Also, $a_A=2a_B$

$$T'=mg-2ma_B$$

$$-ma_B=2kx_0+4kx-2mg+4ma_B-mg\sin\theta$$

$$-ma_B=4kx+4ma_B$$

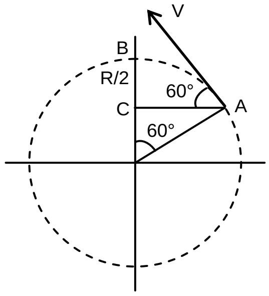
$$a_B=-\frac{4k}{5m}x$$

$$\therefore \qquad T=2\pi\sqrt{\frac{5m}{4k}}$$

T = 6.28 s.

2. **5**

Sol. Conservation of mechanical energy



$$mgH = mgh + \frac{1}{2}mv^2$$

$$0.45\ mg = 3mg\frac{R}{2}+\frac{1}{2}mv^2$$

$$9 - 30R = v^2 \qquad \text{...(i)}$$

$$AC = \frac{R\sqrt{3}}{2}$$

. For reaching at B let particle takes t sec.

$$\frac{v}{2}\times t=\frac{R\sqrt{3}}{2} \qquad \text{...(ii)}$$

$$\frac{v\sqrt{3}}{2}t-\frac{1}{2}\times g\times t^2=\frac{R}{2} \qquad \text{...(iii)}$$

On solving, $v^2 = 15R$ by eq. (i)

$$9 - 30R = 15R \qquad \Rightarrow \qquad R = \frac{9}{45}\times 100 = 20\text{ cm}$$

= 1/5 meter.

3. **6**

Sol. $dF=\left[\eta(2\pi rdr)\frac{\omega r}{h}\right]2$

dP = dF. V

$$= \frac{4\eta\pi}{h}(\omega r)^2 r\,dr$$

$$\int_o^P dP = \frac{4\eta\pi\omega^2}{h}\int_o^R r^3 dr = \frac{\eta\pi\omega^2 R^4}{h}$$

$x + y = 6$

4. **5.25**

Sol. K.E. = $\frac{1}{2}mv^2 + \frac{1}{2}mv^2 + \frac{1}{2}\frac{m(2r)^2}{12}w^2 + \frac{1}{2}mr^2w^2$ = 5.25.

5. **5**

Sol. At stable equilibrium, U is minimum.

$\frac{dU}{dx}$ = 0 and $\frac{d^2U}{dx^2}$ > 0

$$= \frac{1}{dx}\left(\frac{x^3}{3} - \frac{ax^2}{2} + 20x\right) = 0.$$

$\Rightarrow$ $x^2 - 9x + 20 = 0$. $\Rightarrow$ $(x - 5)(x - 4) = 0$.

x = 5 and x = 4 are points of equilibrium.

And U minimum when $\frac{d^2U}{dx^2}$ > 0. i.e. at x = 5.

6. **1.25**

Sol. For pulse $\frac{dx}{dt} = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{3-10kt}{\mu}}$

$$\Rightarrow \int_o^L dx = \int_o^{t_0}\sqrt{\frac{3-10\,kt}{\mu}}\,dt$$

And $3 - 10\,k\,t_o = 0$

7. **1.73**

Sol. τ = NIAB = Cθ

$$\theta = \frac{NABQ}{C}$$

So, $K = \sqrt{3}$

K = 1.73

8. **3**

Sol. 2000 × 15 × 0.5 + m × 80 = 2500 × 25 × 1

m = 500 gm

Water = 2.5 kg + 0.5 kg = 3 kg.

SECTION – II : CHEMISTRY

PART – A

1. B

Sol. Back bonding in BCl_3 is easier as it is electron deficient compound. Between OCl_2 and NCl_3 the electronegative difference between atoms in OCl_2 is greater than between atoms in NCl_3. $\therefore OCl_2$ forms stronger back bond than NCl_3.

2. B

Sol. R or R′ can't be CHO, CO, COOH as they are reduced by $LiAlH_4$.

3. B

Sol. The $O \rightarrow S$ back bond in SOF_2 is stronger than $O \rightarrow S$ in $SOCl_2$. Since F is more electronegative than Cl, the S atom in SOF_2 strongly attract the lone pair of oxygen to form $p\pi$ - $d\pi$ back bond.

4. C

Sol. No alkene can produce the alcohol in (C) because loss of H_2O can't form any alkene.

5. **ACD**

Sol. This is Hoffmann's bromamide reaction.

6. **ABD**

Sol. The alkene part of the carboxylic acid derivatives reacts with Br_2/H_2O.

7. **CD**

Sol. $d_{x^2-y^2}$ lie along X- and Y- axis, which are perpendicular to Z-axis.

8. AB

Sol. Due to $t_{2g}^3 e_g^2$ crystal field electronic configuration of Mn^{2+} and Fe^{3+} ions

9. AC

Sol. Cleavage of C = C bond takes place during ozonolysis.

10. ABC

Sol. Racemic mixture is formed from compounds containing chiral carbon atom.

11. ACD

Sol. $t_{1/2}$ only decreases by increasing temperature.

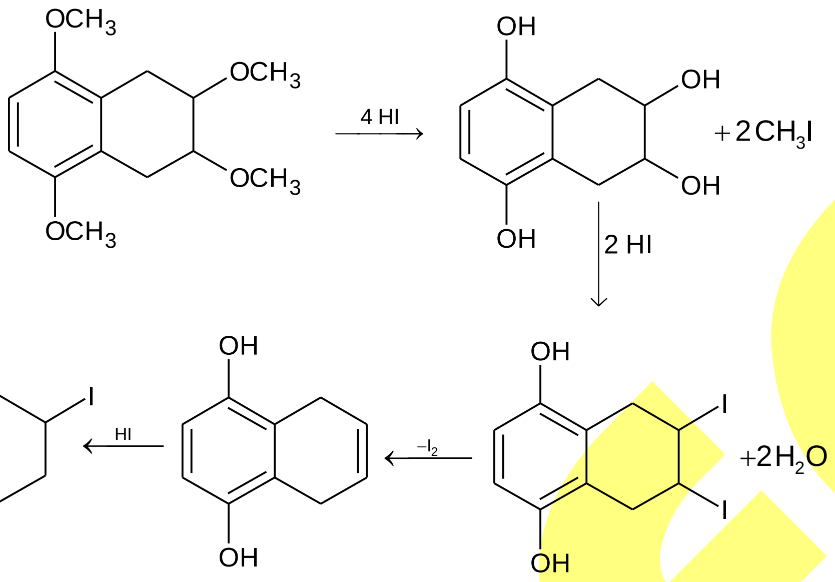
12. ABC

Sol. In A, B and C the products are mesitylene, cyclohexane and benzene respectively.

PART – B

1. 7

Sol.



2. 4

Sol. $4Fe^{3+} + 12SCN^{-} \longrightarrow 4[Fe(SCN)_3]$

One mole Fe^{3+} consumes three moles of SCN^{-} ion. Four moles of Fe^{3+} will consume 4 × 3 = 12 moles $Fe(SCN)_3$.

$\therefore$ x = 4

3. 5

Sol. $pH = \frac{1}{2}\left[p^{k_w} - p^{k_b} - \log C\right] = \frac{1}{2}\left[14 - 5 - \log 10^{-1}\right] = \frac{1}{2} \times 10 = 5$

4. 375.34 (Range 375.2 to 375.4)

Sol. $\Delta T_b = iK_b m = 1.8 \times 0.52 \times 2.5 = 2.34$

$\therefore T_b - T_b^0 = 2.34$

or $T_b - 100^\circ C = 2.34$

$\therefore T_b = 102.34^\circ C = 375.34$ K

5. 12.5 (Range12.4 to 12.6)

Sol. M_{eq} of HCl added = 500 × 1.25 = 625

M_{eq} of NaOH used = 250 × 0.5 = 125

M_{eq} of HCl reacted with MO = 625 – 125 = 500

$500 = M_{eq}$ of MO $= \frac{W}{E} \times 1000 = \frac{14}{E} \times 1000 \Rightarrow E = 28, \text{molar mass} = 28 \times 2 = 56$

$\therefore$At weight of MO = 56 – 16 = 40

$\therefore$ 2x + 15 = 40

$\therefore$ x = 12.5

6. 55.8(Range 55.7 to 55.9)

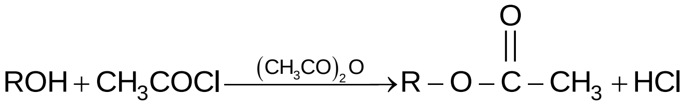
Sol. The atom contains two unpaired electrons.

$\therefore$ Formula of oxide = MO

Molar mass = 39.8 + 16 = 55.8

7. 1.5

Sol.



$$ROH + CH_3COCl \xrightarrow{(CH_3CO)_2O} R - O - \overset{\overset{O}{||}}{C} - CH_3 + HCl$$

For one OH group ($OH \rightarrow OCOCH_3$), loss of one H and gain of $COCH_3$ takes place.

$\therefore$ For one OH group, the mass increases by 42 units.

$\therefore$ Number of OH group = $\frac{252}{42} = 6 = x$

$\therefore \frac{x}{4} = \frac{6}{4} = 1.5$

8. 40.62(Range 40.6 – 40.7)

Sol. $\Delta H_2 = \Delta H_2 + n\Delta C_P dT$

$= 40.5 + n\Delta C_P \int_{320}^{330} dT$

$= 40.5 + 0.1(1.5\ R)\ (330\text{-}320)$

$= 40.5 + 1.5R \times 10 = 40.5 + 15R$

$= 40.5 + 15 \times 8.3 = 40.62$

FIITJEE

SECTION – III : MATHEMATICS

PART – A

1. A

Sol. Let $\alpha \in \mathbb{R}-\mathbb{Q}$ be a common root of $f(x)=0$ and $g(x)=0$. Then $\alpha^2=-a\alpha-b$. Substituting this in $\alpha^3+p\alpha+q=0$, we get $\left(a^2-b+p\right)\alpha+ab+q=0$

As α is irrational and $a,b,p,q \in \mathbb{Q}$, $p=b-a^2$, $q=-ab$. This gives, $g(x)=(x-a)f(x)$.

2. A

Sol. We have $7-4\sqrt{3}=\dfrac{1}{7+4\sqrt{3}}$

$\therefore 0<7-4\sqrt{3}<1 \Rightarrow 0<\left(7-4\sqrt{3}\right)^{2m}<1$

Let $F=\left(7-4\sqrt{3}\right)^{2n}$.

Then $x+F=\left(7+4\sqrt{3}\right)^{2n}+\left(7-4\sqrt{3}\right)^{2n}$

$$=2\left[{}^{2n}C_0 7^{2n}+{}^{2n}C_2 7^{2n-2}\left(4\sqrt{3}\right)^2+{}^{2n}C_4 7^{2n-4}\left(4\sqrt{3}\right)^4+\ldots+{}^{2n}C_{2n}\left(4\sqrt{3}\right)^{2n}\right]$$

$=2m$, where m is some positive integer.

$\Rightarrow [x]+f+F=2m \Rightarrow f+F=2m-[x]$

Since $0\le f<1$ and $0<F<1$, we get $0<f+F<2$. Also, since $f+F$ is an integer, we must have $f+F=1$. Thus, $x(1-f)=xF=\left(7+4\sqrt{3}\right)^{2n}\left(7-4\sqrt{3}\right)^{2n}$

$=(49-48)^{2n}=1^{2n}=1.$

3. D

Sol. Put $\beta-\alpha-\phi$ and consider the determinant $\Delta=\begin{vmatrix}-\sin\phi & -\cos\beta & 1\\ \cos\phi & \sin\beta & 1\\ \cos(\phi+\theta) & \sin(\beta-\theta) & 1\end{vmatrix}$

Using $R_3 \to R_3-\cos\theta R_2-\sin\theta R_1$

$$\Delta=\begin{vmatrix}-\sin\phi & -\cos\beta & 1\\ \cos\phi & \sin\beta & 1\\ 0 & 0 & 1-\cos\theta-\sin\theta\end{vmatrix}$$

$=(1-\cos\theta-\sin\theta)\cos(\phi+\beta)$

$=(1-\cos\theta-\sin\theta)\cos(2\beta-\alpha)$

$=\left[1-\sqrt{2}\sin\left(\theta+\dfrac{\pi}{4}\right)\right]\cos(2\beta-\alpha)$

As $0<\theta<\dfrac{\pi}{4} \Rightarrow \dfrac{\pi}{4}<\theta+\dfrac{\pi}{4}<\dfrac{\pi}{2}$

$\Rightarrow \dfrac{1}{\sqrt{2}}<\sin\left(\theta+\dfrac{\pi}{4}\right)<1$ and $0<\alpha,\beta<\dfrac{\pi}{4} \Rightarrow \dfrac{-\pi}{4}<2\beta-\alpha<\dfrac{\pi}{2}$

$\Rightarrow \cos(2\beta-\alpha)\neq 0$

Thus $\Delta\neq 0$ and the points *P*, *Q*, *R* are non – collinear.

4. A

Sol. The lines $ax+by+c=0$ and $bx+ay+c=0$ intersect in $\left(\dfrac{-c}{a+b},\dfrac{-c}{a+b}\right)$.

Distance between (1, 1) and $\left(\frac{-c}{a+b},\frac{-c}{a+b}\right)$

$$=\sqrt{2}\left|1+\frac{c}{a+b}\right|=\sqrt{2}\,\frac{a+b+c}{a+b}.$$

As $\sqrt{2}\,\frac{a+b+c}{a+b}<2\sqrt{2}$, we get $a+b+c<2(a+b)$

$\Rightarrow a+b-c>0$.

5. AC

Sol. Let $c=2m+1$ where m is a positive integer. Since $c<a+b$ and $a\le b$, we get $c<2b\Rightarrow b>\frac{1}{2}c=m+\frac{1}{2}$. Thus, b can take values from $m+1$ to $2m+1$.

If $b=2m+1$, a can be $1,2,......(2m+1)$. Thus, there are $(2m+1)$ values.

If $b=2m$, a can be 2, 3,….2m. In this case a can take $(2m-1)$ values. And so on. When $b=m+1$, a can take just one value viz. $(m+1)$. Thus, there are $(2m+1)+(2m-1)+....+1=(m+1)^2$.

6. CD

Sol. Putting $\frac{1}{1+nx}=y$, we can write $S=\left[C_0-C_1y+C_2y^2-...+(-1)^nC_ny^n\right]$

$$-xy\left[C_1-2C_2y+3C_2y^2-...+(-1)^{n-1}nC_ny^{n-1}\right]$$

$$=(1-y)^n+xy\frac{d}{dt}\left\{(1-t)^n\right\}_{t=y}$$

$$=(1-y)^n-nxy(1-y)^{n-1}$$

$$=(1-y)^{n-1}[1-y-nxy]$$

$$=(1-y)^{n-1}\left[1-(1+nx)y\right]=0.$$

7. ABCD

Sol. Let OA = a and OB = b (figure), so that the equation of the line AB is $\frac{x}{a}+\frac{y}{b}=1$. Equations of the circles passing through the origin and having centres at A (a, 0) and B (0, b) are, respectively.

$$x^2-2ax+y^2=0 \qquad (1)$$

and $x^2-2by+y^2=0$ (2)

so that the equation of the common chord OP is

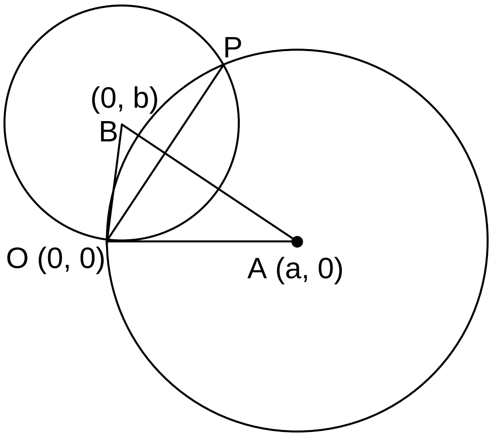
$ax-by=0$ (3)

which is perpendicular to AB

This has one end at the origin O and the other end P is given by solving (2) and (3).

$$\left(\frac{b}{a}y\right)^2-2by+y^2=0$$

$$\Rightarrow y=\frac{2a^2b}{a^2+b^2}\Rightarrow x=\frac{2ab^2}{a^2+b^2}$$



Therefore, the mid – point of the common chord OP is $\left(\frac{ab^2}{a^2+b^2}, \frac{a^2b}{a^2+b^2}\right)$ which lies on AB

8. ABC

Sol. The conditions for the existence of a solution are

1. $2\cos 2x - 1 \neq 0 \Rightarrow \cos 2x \neq \frac{1}{2} \Rightarrow 2x \neq \frac{\pi}{6}$

2. $\tan x \neq 0 \Rightarrow x \neq \pm\frac{\pi}{2}$

3. $\cos^2 x - 3\sin^2 x \neq 0 \Rightarrow \tan^2 x \neq \frac{1}{3} \Rightarrow x \neq \pm\frac{\pi}{6}$

As $2\cos 2x - 1 = 2\left(\cos^2 x - \sin^2 x\right) - 1$

$$= 2\left(\cos^2 x - \sin^2 x\right) - \left(\cos^2 x + \sin^2 x\right)$$

$$= \cos^2 x - 3\sin^2 x$$

So the given equation can be written as $b\sin x = b + \sin x$

$\Rightarrow \qquad \sin x = \frac{b}{b-1}$

Which is possible if $-1 \leq \frac{b}{b-1} \leq 1$

$\Rightarrow \qquad \frac{2b-1}{b-1} \geq 0$ and $\frac{1}{b-1} \leq 0$

$\Rightarrow \qquad 2b - 1 \leq 0 \Rightarrow b \leq \frac{1}{2}$

But for $b = \frac{1}{2}, \sin x = -1$ which is not possible as $x \neq \frac{-\pi}{2}$.

Hence equation has a solution if $b < \frac{1}{2}$.

9. AC

Sol. $tx + y = 2t + t^3$ passes through (13, 12) $t^3 - 13t - 12 = 0$

$\Rightarrow t^2(t+1) - t(t+1) - 12(t+1) = 0$

$(t+1)(t-4)(t+3) = 0$

A, B, C $= \left(t^2, 2t\right)$

$A(1, -2); B(16, 8); C(9, -6)$

Centroid $= \left(\frac{26}{3}, 0\right)$, Area $= \frac{1}{2}\begin{vmatrix} 1 & -2 & 1 \\ 16 & 8 & 1 \\ 9 & -6 & 1 \end{vmatrix}$

$A = 70$

Area of triangle formed by tangents $=\frac{70}{2}=35$.

10. ABC

Sol. $|z_1|=1$ and $|z_2|=2$

(A) $|z_1+z_2|\le|z_1|+|z_2|\le 3$

(B) $|2z_1-z_2|\ge\big|2|z_1|-|z_2|\big|\ge 0$

(C) $|2z_1+z_2|\le 2|z_1|+|z_2|\le 4$

(D) $|2z_1-3z_2|\ge\big|2|z_1|-3|z_2|\big|\ge 4$

11. AC

Sol. centre: $\left(\frac{5}{2},0\right)$; $y=mx\pm\sqrt{25m^2-16}$

$\frac{5}{2}m=\pm\sqrt{25m^2-16}\Rightarrow\frac{25m^2}{4}=25m^2-16$

$\frac{75m^2}{4}=16\Rightarrow m^2-\frac{64}{65}=0$, product of slopes of CA . CB is $-\frac{64}{75}$ circumcentre of ΔABC lies inside the ΔABC

12. AC

Sol. $(a+b)+(b+c)+(a+c)=8$

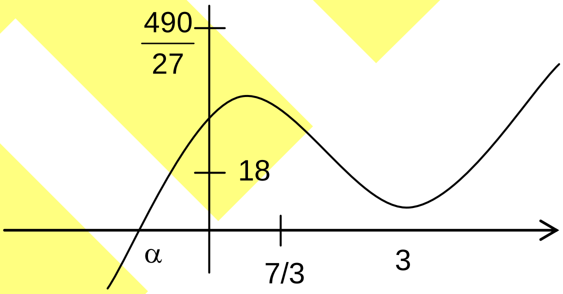
Let $a+b=\alpha, b+c=\beta, a+c=\gamma$

$\Rightarrow\alpha+\beta+\gamma=8$

$\Rightarrow\alpha\beta+\beta\gamma+\gamma\alpha=a^2+b^2+c^2+3(ab+bc+ac)$

= 21

$\Rightarrow x^3-8x^2+21x-\lambda=0$ where $\lambda=(a+b)(b+c)(a+c)$ these equations have 3 real roots.

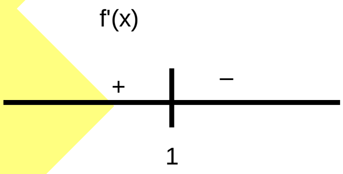


$f(x)=xe^{-x}$, $f'(x)=-(x-1)e^{-x}$, $f''(x)=e^{-x}(x-2)$

$g(x)=xe^{x}$, $g'(x)=(x+1)e^{x}$, $g''(x)=(x+2)e^{x}$

$p(x)=x^3-3x$, $p'(x)=3x^2-3$, $p''(x)=6x$

$q(x)=x^4-2x^2+3$, $q'(x)=4x(x-1)(x+1)$, $q''(x)=12x^2-4$



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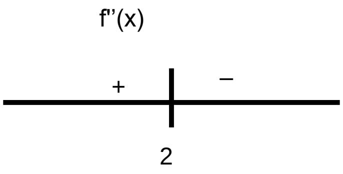

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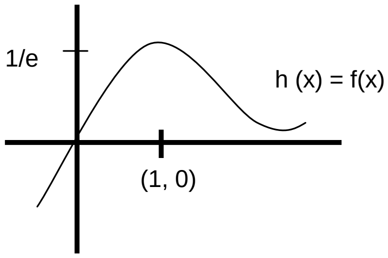

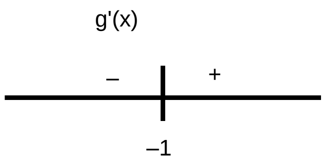

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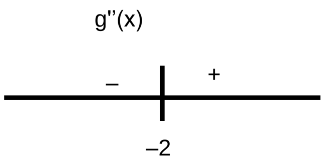

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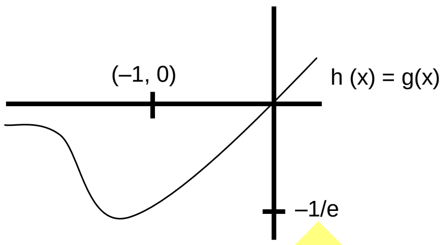

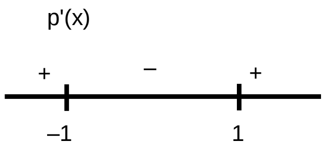

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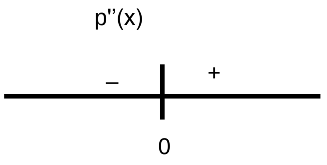

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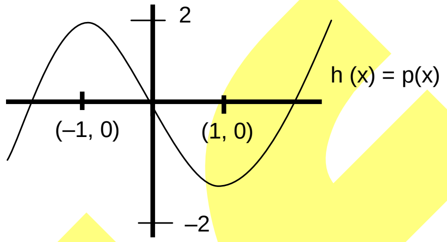
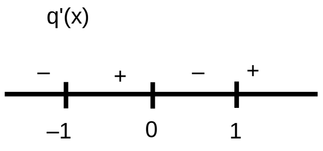

2
h (x) = p(x)
(–1, 0)
(1, 0)
–2



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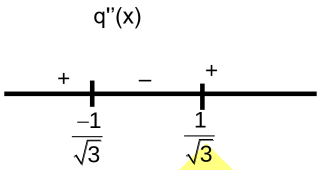
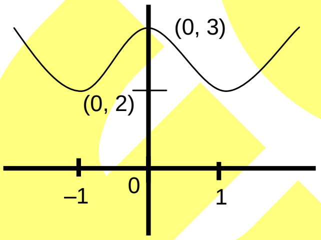

q''(x)
+
–
+
$\frac{-1}{\sqrt{3}}$
$\frac{1}{\sqrt{3}}$

,



(I), (i) (iv), (R)
(II), (i) (iv), (R, S)
(III), (ii) (iv), (P, Q, R)
(IV), (ii) (iii), (P, S)

PART – B

1. 9

Sol. $10! = 2^8.3^4.5^2.7$

Number of divisors $= 9\times5\times3\times2 = 270 = \lambda$

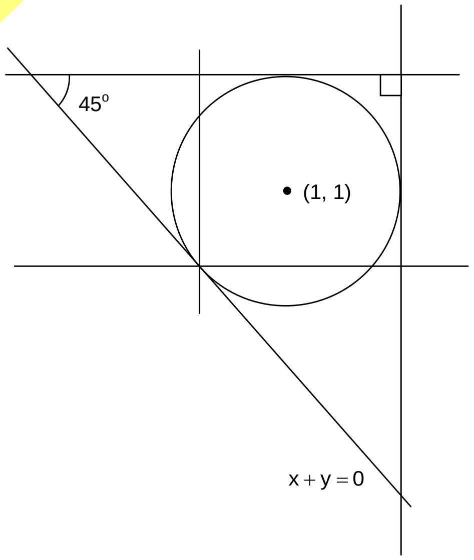
2. 0

Sol. $\left(h^2+k^2-4\right)^2 = \left(h^2+k^2-4h\right)\left(h^2+k^2-4k\right)+16$

$\Rightarrow (h+k)\left(h^2+k^2-2h-2k\right)=0$ circle

$C_1 : x^2+y^2-2x-2y=0$ and

$C_2 : x+y=0$ circumcentre will be mid point of hypotenuse in right angle triangle $(\alpha,\beta)=(0, 0)$



3. 4

Sol. $S_n = 1.3 + 2.2^2 + 3.3^3 + 4.2^4 + ... + \text{upto n} - \text{terms}$

$S_n = \left(1.3+3.3^3+5.3^5+...\right)+\left(2.2^2+4.2^4+6.2^6+...\right)$

$S_1 = 1.3+3.3^3+5.3^5+...+$ upto 10 – terms, $S_1 = \frac{15}{32}\left(5.3^{21}+1\right)$

$S_2 = 2.2^2+4.2^4+6.2^6+...+$ upto 10 – terms, $S_2 = \frac{58.2^{22}+8}{9}$

$$S_{20} = S_1 + S_2 = \frac{15}{32}\left(5.3^{21}+1\right) + \left(\frac{58.2^{22}+8}{9}\right)$$

$$= \frac{75}{32}.3^{21} + \frac{58}{9}.2^{22} + \frac{391}{288}$$

4. 2.50

Sol. $16\cos x + 12\sin x = \sqrt{16^2+12^2}\cos(x-\alpha), \alpha = \tan^{-1}\left(\frac{3}{4}\right)$.

5. 0.8

Sol. Let the equation of the ellipse be $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ where $a^2 = 8^2$ and $b^2 = 8^2\left(1-\frac{1}{4}\right)$

Vertices of the letra recta are $\left(\pm ae, \pm\frac{b^2}{a}\right)$

So $\Delta = 2ae \times \frac{2b^2}{a} = 4b^2e$

$$= 4\times 8^2 \times \frac{3}{4}\times\frac{1}{2} = 12\times 8$$

$$\Rightarrow \frac{\Delta}{120} = 0.8$$

6. 1.6

Sol. Let A_1, A_2 and M be the centres of the circles C_1, C_2 and C respectively. Let the common tangent through P to C_1 and C touch C_1 at B_1, C at B_2 and C_2 also at B_2.

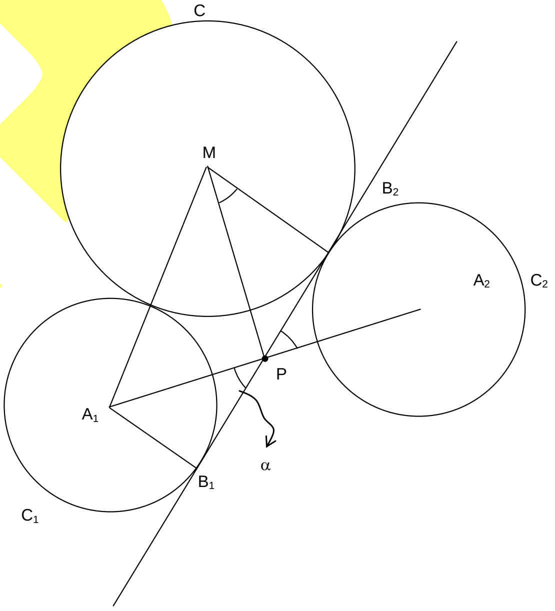
From right angled triangle A_1B_1P if

$$\angle A_1PB_1 = \alpha, \sin\alpha = \frac{A_1B_1}{A_1P} = \frac{1}{3}$$

$$\Rightarrow \cos\alpha = \frac{2\sqrt{2}}{3} \Rightarrow PB_1 = 2\sqrt{2} = PB_2$$

From triangle MPB_2, $\tan\alpha = \frac{PB_2}{MB_2} = \frac{2\sqrt{2}}{r}$

$$\Rightarrow \frac{1}{2\sqrt{2}} = \frac{2\sqrt{2}}{r} \Longrightarrow r = 8.$$



7. –1.25

Sol. $1-x>0,\ 1-x\neq 1 \Rightarrow x<1,\ x\neq 0$

Also, $\log_{1-x}\left(\frac{3}{2}\right) = \frac{1}{2} \Rightarrow \frac{3}{2} = (1-x)^{1/2}$

$$\Rightarrow \frac{9}{4} = 1-x \Rightarrow x = 1-\frac{9}{4} = \frac{-5}{4}.$$

$\Rightarrow -4x = 5$

$\Rightarrow x = -1.25$

8. 6

Sol. Clearly $x>0$ and $x\neq\frac{1}{5}$

$$\log_{5x}\left(\frac{5}{x}\right)=\frac{\log_5 5-\log_5 x}{\log_5 5+\log_5 x}$$

Putting $\log_5 x=t,$ then equation (1) becomes

$$t^2+\frac{1-t}{1+t}=1\Leftrightarrow t^3+t^2-2t=0$$

$$\Leftrightarrow t(t-1)(t+2)=0\Leftrightarrow t=0,1,-2$$

So integral roots of (1) are 1 and 5.

FIITJEE

FIITJEE RBT-5 for (JEE-Advanced)

BATCHES – Two Yr CRP2123(All)

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 4

QP CODE: 100188

PAPER - 2

Time Allotted: 3 Hours **Maximum Marks: 186**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections.**
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. Each **Section** is further divided into **Two Parts**: **Part-A & B** in the OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with ***Blue/Black Ball Point Pen*** for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Two Part.

(i) **PART–A (01–08)** contains (8) Multiple Choice Questions which have **One or More Correct** answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in **–2** marks, as a wrong option is also darkened.

(ii) **Part-A (09-12) –** This section contains Two (02) List-Match Sets, each List-Match set has Two (02) Multiple Choice Questions. Each List-Match set has two lists: List-I and List-II. FOUR options are given in each Multiple Choice Question based On List-I and List-II and ONLY ONE of these four options satisfies the condition asked in the Multiple Choice Question. Each question carries **+3 Marks** for correct combination chosen and **-1 marks** for wrong options chosen.

(iii) **Part-B (01-06)** contains six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+3 marks** for correct answer. **There is no negative marking.**

Name of the Candidate :____

Batch :____________________ **Date of Examination :**____________________

Enrolment Number :____

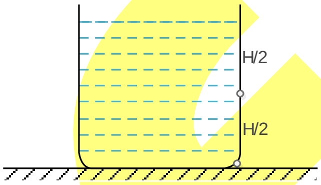
SECTION – I : PHYSICS

(PART – A)

(One or More Than One Options Correct Type)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONE** or **MORE THAN ONE is correct.**

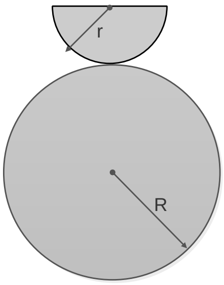
1. There is a cylindrical container of height H and base area A. It is filled with a fluid and two small holes of area a each are made at mid-height and at bottom of the container. $\frac{A}{a}\sqrt{\frac{H}{g}} = 600\,s$. Then



(A) Time taken to half-empty the tank lies between 150 s and 160 s
(B) Time taken to half-empty the tank lies between 155 s and 170 s
(C) Time taken to empty the tank lies between 760 s and 775 s
(D) Time taken to empty the tank lies between 755 s and 770 s

2. Choose the correct statement about X-rays
(A) Probability of K_α radiation is more than K_β radiation.
(B) A K_α photon is more energetic than a K_β photon.
(C) A photon of cutoff wavelength is least energetic.
(D) As we move down the periodic table, the energy of K_α X-ray photon goes on decreasing.

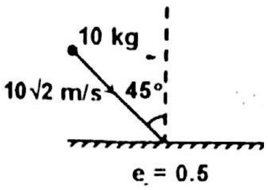
3. A solid hemisphere of radius r = 20 cm is placed on top of a fixed, very rough sphere of radius R in equilibrium such that curved surface of hemisphere is in contact with fixed sphere. There may not be any slipping between the surfaces. A very slight angular displacement is given to the hemisphere. Then



(A) Hemisphere cannot oscillate if $\frac{r}{R} < 0.2$
(B) Hemisphere cannot oscillate if $\frac{r}{R} > 0.6$
(C) If $\frac{r}{R} = 0.2$ then time period of oscillation is $0.24\pi\,s$
(D) If $\frac{r}{R} = 0.5$ then time period of oscillation is $\pi\,s$

Space For Rough Work

4. A ball of mass 10 Kg hits a smooth horizontal surface with a speed of $10\sqrt{2}\,m/s$ at an angle 45° as shown in figure. The co-efficient of restitution between the ball and the surface is 0.5 and the ball remains in contact with the surface for 0.1 s. $\vec{F}$ is the instantaneous force exerted by the surface on the ball at any time t during the collision.



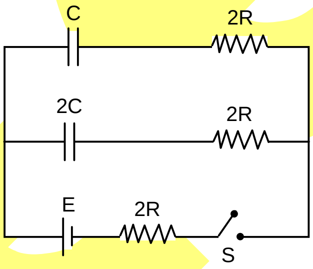
(A) The speed with which ball rebounds is $\sqrt{125}\,m/s$

(B) During collision $|\vec{F}|$ may be less than or equal to 1800 N

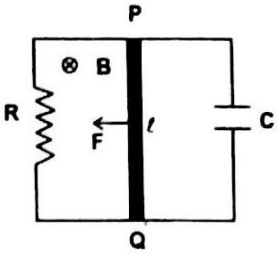
(C) During collision $|\vec{F}|$ may be less than or equal to 100 N

(D) The average force exerted by ground during collision is 1600 N

5. In the circuit shown in figure, switch S is closed at time t = 0. Select the correct statement(s)
(A) rate of increase of charge is same in both capacitors at t = 0
(B) ratio of charge stored in C to that in 2C at any instant is 1:2
(C) time constant of both the capacitors are equal
(D) steady state charge in capacitors C and 2C are in ratio 1:2



6. A conducting rod PQ of length l and mass m is dragged with a constant force F along two parallel smooth rails separated by a distance l. There is a magnetic field B in the region as shown in the adjacent figure. Then choose the correct statement(s). [Also, $m = B^2L^2C$ and at t = 0, velocity = 0].



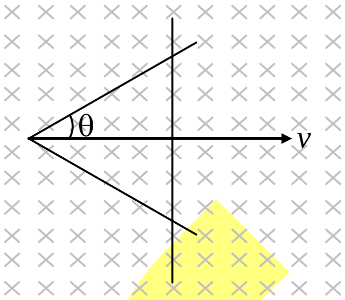
(A) terminal velocity of rod, $V_T = \dfrac{2FR}{B^2l^2}$

(B) terminal velocity of rod, $V_T = \dfrac{FR}{B^2l^2}$

(C) Maximum charge on the capacitor, $q_{max} = \dfrac{FCR}{Bl}$

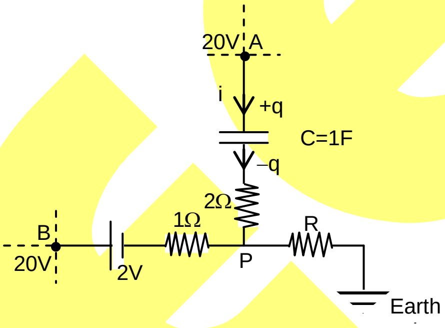
(D) At t = 2RC, current through rod is $\dfrac{F}{B\ell}\left(1-\dfrac{1}{2e}\right)$

7. Two straight conducting rails form a right angle where their ends are joined. A conducting bar in contact with the rails start at the vertex at $t = 0$ and moves with a constant velocity *v* along them as shown. A magnetic field *B* is directed into the page. The induced emf in the circuit at any time *t* is proportional to



(A) t^0
(B) t
(C) v
(D) v^2

8. The network shown in the figure is part of some bigger circuit. Charge on capacitor (C = 1 F) at any time t is q = 3(1 - e^{-t}) in coulombs. If at t = 0 the potentials of point A and B is 20 V, then at t = 0 match the following.
(A) current in branch AP is 3A
(B) current through R is 7A
(C) value of R is 2Ω
(D) value of R is 1Ω



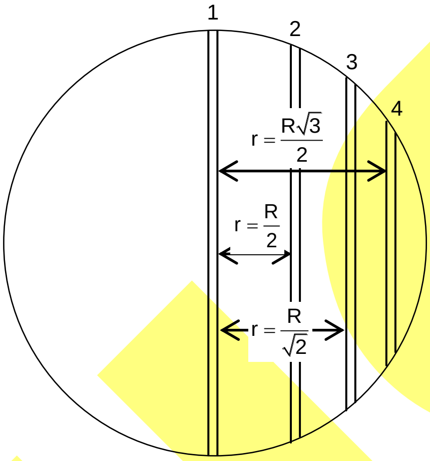
Space For Rough Work

FIITJEE

This section contains **2 List-Match Sets**, each List-Match set has **2 Multiple Choice Questions**. Each List-Match set has two lists: List-I and List-II. Four options are given in each Multiple Choice Question based On List-I and List-II and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

List Match Set (09-10)

Consider a planet of radius R having density ρ. The four tunnels (1, 2, 3 and 4) are dug side at the distances from its centre are r = 0, $r = \frac{R}{2}$, $r = \frac{R}{\sqrt{2}}$ and $r = \frac{R\sqrt{3}}{2}$ respectively as shown. Four objects each of mass 1 kg are dropped inside the tunnel from the surface of plant at t = 0.



List-I gives the above four tunnels while List-II the magnitude of some quantity.

List – I		**List – II**	
(I)	Tunnel '1'	(P)	0
(II)	Tunnel '2'	(Q)	$\frac{2\pi G\rho R}{3}$
(III)	Tunnel '3'	(R)	$\frac{2\sqrt{2}\pi G\rho R}{3}$
(IV)	Tunnel '4'	(S)	$\frac{2\pi G\rho R}{\sqrt{3}}$
		(T)	$\frac{4\pi G\rho}{3}R$

9. The normal reaction between objects and mid of tunnels, the correct match is
(A) I → P, II → Q, III → R, IV → S (B) I → S, II → R, III → Q, IV → P
(C) I → Q, II → P, III → R, IV → S (D) I → P, II → Q, III → S, IV → R

10. The magnitude of maximum acceleration of the objects in the tunnels
(A) I → T, II → S, III → R, IV → Q (B) I → S, II → T, III → R, IV → Q
(C) I → T, II → S, III → S, IV → R (D) I → Q, II → R, III → S, IV → T

Space For Rough Work

List Match Set (11-12)

11. A ball is attached to a string and moves in vertical circle. There is no resistive force. Match the column-I to column-II.

List – I		List – II	
(I)	Minimum	(P)	Tension in the string when ball is at the lowest point.
(II)	Maximum	(Q)	Tension in the string when ball is at the highest point.
(III)	Towards the centre	(R)	The angle between tension and weight of ball when string becomes horizontal.
(IV)	Perpendicular	(S)	The direction of tension in the string
		(T)	Magnitude of tangential acceleration when string becomes horizontal.
		(U)	Magnitude of centripetal acceleration when string becomes horizontal.

(A) I → Q, II → P, III → U, IV → RS (B) I → T, II → R, III → SU, IV → Q
(C) I → Q, II → PT, III → SU, IV → R (D) I → Q, II → PT, III → S, IV → U

12. A small bob of mass m = 0.01 kg is hanging from the roof of a moving car in equilibrium making angle θ with vertical. If initial velocity of car was zero and acceleration of car is $a = 2\ m/s^2$.

List – I		List – II	
(I)	Work done by tension in ground frame in first 10 second	(P)	20 m/s
(II)	Work done by tension in the frame of car in first 10 second	(Q)	2J
(III)	Velocity of bob in ground frame after 10sec	(R)	0J
(IV)	Work done by gravity	(S)	–ve
		(T)	+ve
		(U)	10 m/s

(A) I → QT, II → R, III → PT, IV → R (B) I → QR, II → S, III → PT, IV → Q
(C) I → Q, II → P, III → S, IV → T (D) I → U, II → P, III → S, IV → R

Space For Rough Work

FIITJEE

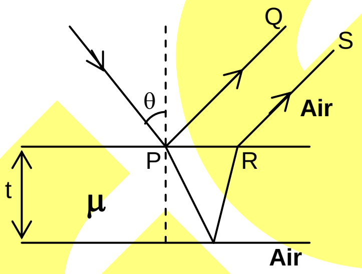
(PART – B)

(Numerical Type)

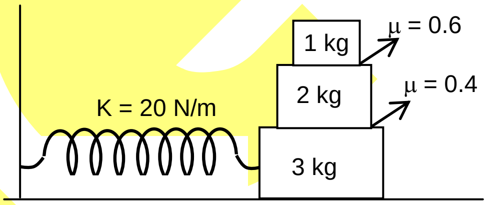
Part-B (01-06) contains six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **Two decimals Places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)**.**

1. Two spherical bodies A (of radius 6 cm) and B (of radius 36 cm) are at temperatures T_1 and T_2 respectively. The maximum intensity in the emission spectrum of A is at 500 nm and in that of B is at 1500nm. Considering them to be black bodies, the ratio of the rate of total energy radiated by A and B will be

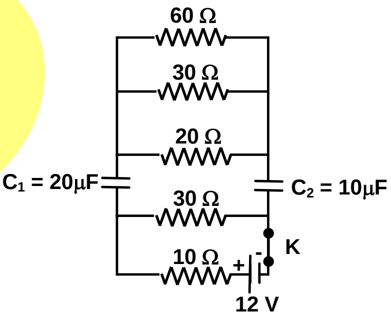
2. Rays PQ and RS (Wavelength λ) interfere constructively for small θ and corresponding minimum thickness of the slab is $\dfrac{n\lambda}{12\mu}$,then n =



3. What can be the maximum amplitude (in m) of the system so that there is no slipping between any of the blocks

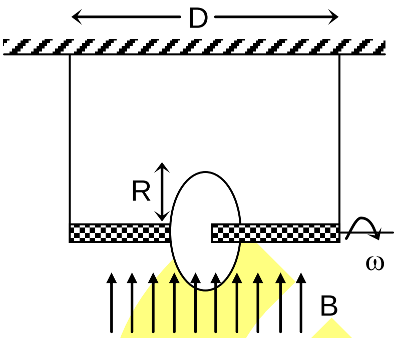


4. For the circuit arrangement shown in the figure, find the potential difference (in V) across C_2 in the steady state condition.

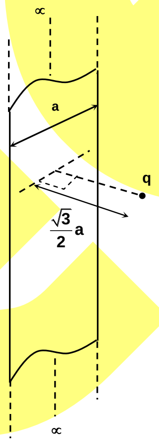


Space For Rough Work

5. The axle of a circular wheel of radius R is held horizontally by two identical strings of equal lengths separated by a distance D. The tension in each string is T_0. The rim of the wheel carries a total charge + Q distributed uniformly on it. The wheel is vertical and is kept in a uniform vertical magnetic field $\vec{B}$. It is now rotated at an angular speed ω. The string break at a tension of $3T_0/2$. If the maximum possible value of ω at which the wheel can be rotated without breaking a string is $\frac{4KT_0D}{5QR^2B}$. Then find the value of K.



6. There is an infinite long straight surface having width ‘a’. A point charge q is placed at a perpendicular distance $\frac{\sqrt{3}}{2}a$ from the surface symmetrically as shown in the figure. If the flux linked with this infinitely long surface due to charge q is $\frac{q}{k\varepsilon_0}$. Then find the value of k.



Space For Rough Work

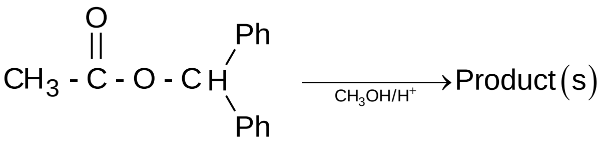
SECTION – II : CHEMISTRY

(PART – A)

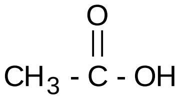
(One or More Than One Options Correct Type)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONE** or **MORE THAN ONE is correct.**

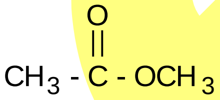
1. Which statements about corrosive sublimate($HgCl_2$) are correct?
(A) It is prepared by heating mercury in chlorine
(B) It oxidizes stannous chloride
(C) It is highly poisonous
(D) It sublimes on heating

2. 

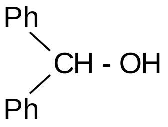
$$CH_3-\overset{\overset{\displaystyle O}{||}}{C}-O-CH(Ph)_2 \xrightarrow[CH_3OH/H^+]{} \text{Product(s)}$$

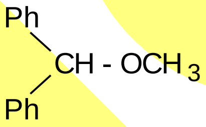
(A) 

$CH_3-\overset{\overset{O}{||}}{C}-OH$

(B) 

$CH_3-\overset{\overset{O}{||}}{C}-OCH_3$

(C) 

(D) 

3. Select the correct match
(A) $Fe^{3+} + [Fe(CN)_6]^{4-} \rightarrow$ Blue colour ppt.
(B) $Fe^{3+} + [Fe(CN)_6]^{3-} \rightarrow$ Red Brown colouration
(C) $Fe^{2+} + [Fe(CN)_6]^{3-} \rightarrow$ Blue colour ppt.
(D) $Fe^{2+} + [Fe(CN)_6]^{4-} \rightarrow$ Red Brown colouration

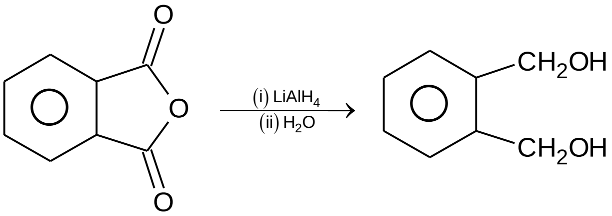
4. Let the height of hcp unit cell is ‘h’. The height of octahedral voids form the base is
(A) $\frac{h}{2}$
(B) $\frac{h}{3}$
(C) $\frac{h}{4}$
(D) $\frac{3h}{4}$

5. The significance of Heisenberg uncertainty principle in the atom is/are
(A) it rules out the concept of orbit
(B) it rules out the existence of nucleus
(C) it introduces the probability of position and momentum of an electron in an atom
(D) it introduces the probability of finding e^- in a given orbit

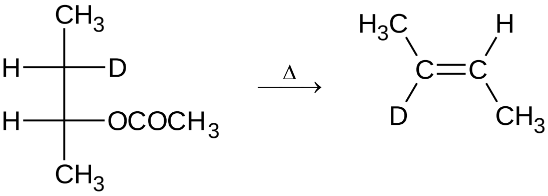
Space For Rough Work

6. Which of the following is(are) incorrect?

(A)

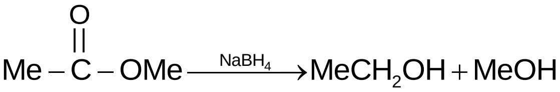


(B)



(C) $Ph-CH=CH-CHO \xrightarrow{LiAlH_4} PhCH=CH-CH_2OH$

(D)



$Me-\overset{\overset{\displaystyle O}{\|}}{C}-OMe \xrightarrow{NaBH_4} MeCH_2OH + MeOH$

7. Select correct statement(s)
(A) liquefication of gases in a continuous transition
(B) Boyle temperature $T_B = \frac{2a}{Rb}$
(C) van der Waal's equation is not very accurate near the critical states
(D) for an ideal gas $T_C = 0$

8. Which of the following factors is/are responsible for the extent of positive deviation?
(A) Difference in polarity of the molecules
(B) Difference in the length of hydrocarbon chain in case of their solution
(C) Difference in intermolecular forces of attraction
(D) Association of either of the constituent in the liquid state

Space For Rough Work

This section contains **2 List-Match Sets**, each List-Match set has **2 Multiple Choice Questions**. Each List-Match set has two lists: List-I and List-II. Four options are given in each Multiple Choice Question based On List-I and List-II and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

List Match Set (09-10)

Match the Lists and answer the following question.

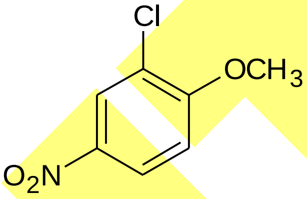
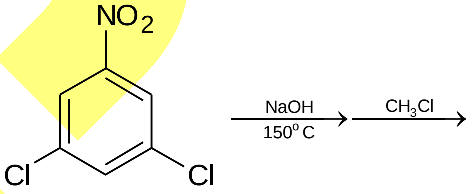
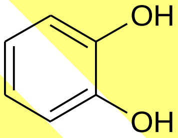
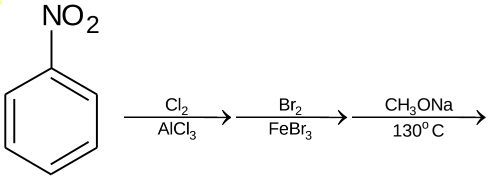
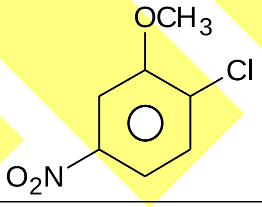
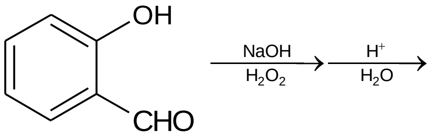
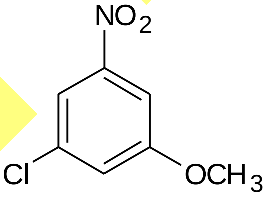
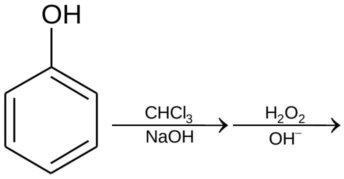
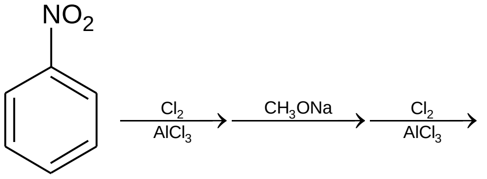
List – I		**List – II**	
(I)	Cubic	(P)	$a = b \neq c \quad \alpha = \beta = \gamma = 90^o$
(II)	Tetragonal	(Q)	$a = b = c \quad \alpha = \beta = \gamma = 90^o$
(III)	Orthorombic	(R)	$a \neq b \neq c \quad \alpha = \gamma = 90^o, \beta \neq 90^o$
(IV)	Monoclinic	(S)	$a \neq b \neq c \quad \alpha = \beta = \gamma = 90^o$

9. Which combination is correct according to the above list?
(A) I → Q
(B) II → S
(C) III → R
(D) IV → P

10. Which combination is correct according to the above list?
(A) I → S
(B) II → Q
(C) III → P
(D) IV → R

List Match Set (11-12)

Match the Lists and answer the following question.

List – I		**List – II**	
(I)		(P)	 NO2 Cl Cl NaOH 150° C CH3Cl
(II)		(Q)	 NO2 Cl2 AlCl3 Br2 FeBr3 CH3ONa 130° C
(III)		(R)	 OH CHO NaOH H2O2 H+ H2O
(IV)		(S)	 OH CHCl3 NaOH H2O2 OH−
		(T)	 NO2 Cl2 AlCl3 CH3ONa Cl2 AlCl3

11. Which combination is correct according to the above list?
(A) I → ST (B) II → RS (C) III → PQ (D) IV → RT

12. Which combination is correct according to the above list?
(A) I → RS (B) II → Q (C) III → PQ (D) IV → P

(PART – B)

(Numerical Type)

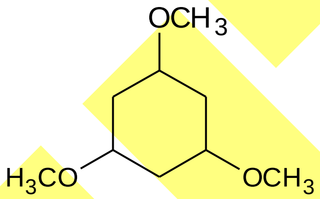
Part-B (01-06) contains six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **Two decimals Places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30).

1. pH of 0.1 M $NH_4^+HCO_3^-$ solution, given $K_b = 1.8 \times 10^{-5}$ K_1 of $H_2CO_3 = 4.2 \times 10^{-7}$ M and $K_2\left(HCO_3^{-1}\right) = 4.8 \times 10^{-11}$

2. Which of the following cations can form soluble complex when treated with conc.NaOH(excess)
Cu^{2+}, Pb^{2+}, Zn^{2+}, Ni^{2+}, Al^{3+}, Fe^{3+}, Sn^{2+}, Cd^{2+}, Co^{2+}

3. 3.24 g of mercuric nitrate is dissolved in 1 kg of water, the freezing point of the solution is found to be -0.0558ºC. Sum of degree of dissociation and van't Hoff factor for mercuric nitrate is
(Given: $K_{f_{H_2O}}$ = 1.86 mol^{-1} K kg; molecular mass of mercuric nitrate = 324.6)

4. In the following reactions,
$Na_2SO_3 + S \xrightarrow{\text{boiling water}} [X]$ (Colorless Solid)
$AgBr \xrightarrow{\text{excess}[X]} [Y]$ (soluble Complex)
$X + Cl_2 + H_2O \longrightarrow [Z] + HCl$
Sum of sulphur atoms in compound [X], [Y] and [Z]

5.


How many maximum moles of HI is needed for complete reaction of one mole of the above compound?

6. 9 gm oleum completely neutralizes 100 mL 2 M NaOH. Percentage oleum is

Space For Rough Work

SECTION – III : MATHEMATICS

(PART – A)

(One or More Than One Options Correct Type)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONE** or **MORE THAN ONE is correct.**

1. If $y = f(x)$ is a solution of $\dfrac{dy}{d(x^2)} + \dfrac{y}{x^2} = \dfrac{\sin^{-1} x}{2x^2}$ and $f(0) = 0$, then

(A) $f(1) = \dfrac{\pi}{8}$
(B) $f(-1) = -\dfrac{\pi}{8}$
(C) $f\left(\dfrac{1}{2}\right) = \dfrac{\sqrt{3}}{4} - \dfrac{\pi}{6}$
(D) $x^2 f(x) = \dfrac{1}{2}(2x^2 - 1)\sin^{-1} x + \dfrac{1}{4} x\sqrt{1 - x^2} + \dfrac{1}{4}$

2. If $f(x) = \begin{vmatrix} 5 + \sin^2 x & \cos^2 x & 4\sin 2x \\ \sin^2 x & 5 + \cos^2 x & 4\sin 2x \\ \sin^2 x & \cos^2 x & 5 + 4\sin 2x \end{vmatrix}$, then which of the following is/are correct

(A) $f(x)$ is a non – monotonic function
(B) $f(x) = 0$ has no real roots
(C) $f'(x)$ has infinitely many maxima and minima
(D) Number of integers in the range of $f(x)$ is 201

3. If $\cos\dfrac{2\pi}{2019}.\cos\dfrac{4\pi}{2019}.\cos\dfrac{6\pi}{2019}...\cos\dfrac{2018\pi}{2019}$ is 2^{-k} where $k = \dfrac{p}{q}, p, q \in \mathbb{N}$ and p and q are relatively prime, then

(A) $(p + q)$ is a 4 – digit number
(B) sum of the digits in $(p + q)$ is 2
(C) $(p + q)$ is a 3 – digit number
(D) number of divisors of p is 8

4. For the curve $\sin x + \sin y = 1$, $\lim\limits_{x \to 0}\left(x^{\alpha}\right)\dfrac{d^2y}{dx^2}$ exists then α can be

(A) $\dfrac{3}{2}$
(B) 2
(C) $\dfrac{5}{2}$
(D) 1

Space For Rough Work

5. A point P moves inside a square with vertices A (1, 1), B (–1, 1), C(–1, –1) and D (1, –1) such that minimum $\{PA, PB, PC, PD\} \le 1$. If the area bounded by the curve traced out by moving point P is λ, then which of the following is/are correct

(A) λ is a rational number

(B) $[\lambda] = 3$ (where [.] represents greatest integral function)

(C) λ is an irrational number

(D) $[\lambda] = 0$ (where [.] represents greatest integral function)

6. $\lim\limits_{x \to 0} \dfrac{x^2 \sin \beta x}{\tan \alpha x - \sin x} = 4$ where $\alpha, \beta \in \mathbb{R}$, then which of the following is/are correct

(A) $\alpha = 1$ (B) $\beta = 2$

(C) $\alpha = 2$ (D) $\beta = 1$

7. Let A and B be two matrices different from *I* such that $AB = BA$ and $A^n - B^n$ is invertible for some positive integer *n*. If $A^n - B^n = A^{n+1} - B^{n+1} = A^{n+2} - B^{n+2}$, then

(A) $I - A$ is singular (B) $I - B$ is singular

(C) $A + B = AB + I$ (D) $(I - A)(I - B)$ is non – singular

8. $a, b \in \mathbb{R}, |a| \le 1, |b| \le 1$, let $I(a,b) = \int_0^{\pi} (a \sin x + b \cos x)^3 \, dx$ then

(A) $I(a,b)$ is independent of a (B) $I(a,b)$ is independent of b

(C) Maximum value of $I(a,1)$ is $\dfrac{10}{3}$ (D) minimum value of $I(-1, b)$ is $\dfrac{-10}{3}$

Space For Rough Work

FIITJEE

This section contains **2 List-Match Sets**, each List-Match set has **2 Multiple Choice Questions**. Each List-Match set has two lists: List-I and List-II. Four options are given in each Multiple Choice Question based On List-I and List-II and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

List Match Set (09-10)

	List – I		**List – II**
(I)	If $(n-1)(2n-1)$ is the total number of odd numbers less than 1000 formed by using 0, 3, 5 and 7 (repetition of digits not allowed), then n is	(P)	8
(II)	Number of triangles formed by the vertices of the regular polygon of 10 sides is n and no side of the polygon is the sides of the triangle then $\frac{n}{10}$ is	(Q)	7
(III)	If five – digit numbers divisible by 4 can be formed by digit 1, 2, 3, 4 and 5 (the digits cannot be repeated in the same number) is $(n+2)(n-3)$, then n is	(R)	6
(IV)	A student writes 4 quizes of 4 marks each. If the number of ways of getting total 8 marks is n, then $\left[\frac{n}{16}\right]$ is ([.] denotes greatest integer function)	(S)	5
		(T)	4

9. Which of the following is the correct combination?
(A) I → T (B) I → Q (C) II → Q (D) II → U

10. Which of the following is the correct combination?
(A) I → Q (B) II → S (C) III → R (D) IV → T

List Match Set (11-12)

	List – I		**List – II**
(I)	A vector perpendicular to the line $x=2t+1, y=t+2$ and $z=-t-3$	(P)	$7\hat{i}+3\hat{j}+5\hat{k}$
(II)	A vector parallel to the planes $x+y+z-3=0$ and $2x-y+3z=0$	(Q)	$4\hat{i}-\hat{j}-3\hat{k}$
(III)	A vector along which the distance between the lines $\frac{x}{2}=\frac{y}{-3}=\frac{z}{-1}$ and $\vec{r}=(3\hat{i}-\hat{j}+\hat{k})+t(\hat{i}+\hat{j}-2\hat{k})$ is the shortest	(R)	$-11\hat{i}+7\hat{j}+5\hat{k}$
(IV)	A vector normal to the plane $\vec{r}=-\hat{i}+4\hat{j}-6\hat{k}+\lambda(\hat{i}+3\hat{j}-2\hat{k})+\mu(-\hat{i}+2\hat{j}-5\hat{k})$	(S)	$\hat{i}+3\hat{j}+\hat{k}$
		(T)	

11. Which of the following is not the correct combination?
(A) II → Q (B) I → P (C) III → P (D) IV → R

12. Which of the following is the correct combination?
(A) I → R (B) II → R (C) III → P (D) IV → S

(PART – B)

(Numerical Type)

Part-B (01-06) contains six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **Two decimals Places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)**.**

1. If the differential equation of all straight lines which are at a fixed distance of 10 units from origin is $\left(y - xy_1\right)^2 = 400A\left(1 + y_1{}^2\right)$then A is equal to ________units.

2. There are n different objects, *1, 2, 3,……, n*, distributed at random in n places marked 1, 2, 3….,n. If p is the probability that at least three of the objects occupy places corresponding to their number, then 6p is equal to

3. If $\int_0^{\pi/2} \sin\theta \log\sin\theta\, d\theta = \log\left(\frac{5A}{e}\right)$ then A is equal to

4. If p_1, p_2 are respectively the perpendicular distances of the points with position vectors $a = 3i - 5j + 8k$ and $b = 2i - 41j + 21k$ from the plane $r.\left(2i + 2j - k\right) = 12$, then $\frac{p_2}{37} + \frac{p_1}{32}$ is equal to

5. A variable plane at a unit distance fom the origin cuts the coordinate axes at points A, B, C. If the centroid (x, y, z) of the triangle ABC satisfies the equation $x^{-2} + y^{-2} + z^{-2} = k$, then the value of $\frac{k}{4}$ is

6. Let $p(x)$ be a polynomial of degree 4 having extremum at $x = 1, 2$ and $\lim_{x \to 0}\left(1 + \frac{p(x)}{x^2}\right) = 2$. Then the value of $p(2)$ is

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Space For Rough Work

QP Code: 100188

Answers

SECTION – I : PHYSICS

(PART – A)

1.	**BCD**	2.	**A**	3.	**BC**	4.	**ABD**
5.	**AD**	6.	**BCD**	7.	**BD**	8.	**ABC**
9.	**A**	10.	**A**	11.	**C**	12.	**A**

(PART – B)

1.	**2.25**	2.	**3**	3.	**1.20**	4.	**6**
5.	**1.25**	6.	**6**				

SECTION – II : CHEMISTRY

(PART – A)

1.	**ABCD**	2.	**AD**	3.	**ABC**	4.	**CD**
5.	**AC**	6.	**BCD**	7.	**CD**	8.	**ABCD**
9.	**A**	10.	**D**	11.	**B**	12.	**D**

(PART – B)

1.	7.83	2.	4	3.	4	4.	**7**
5.	**6**	6.	108.8				

SECTION – III : MATHEMATICS

(PART – A)

1.	AB	2.	ABCD	3.	AB	4.	ABC
5.	BC	6.	AB	7.	ABC	8.	CD
9.	A	10.	B	11.	B	12.	C

(PART – B)

1.	0.25	2.	0.17	3.	0.4	4.	1.25
5.	2.25	6.	0				

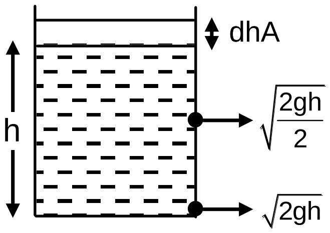
Answers & Solutions

SECTION – I : PHYSICS

(PART – A)

1. **BCD**

Sol.



Liquid coming out = $\sqrt{2g\frac{h}{2}}\,a.\,dt + \sqrt{2gh}\,adt$

A(–dh) = $\sqrt{gh}\,adt + \sqrt{2gh}\;\;adt$

2. **A**

Sol. Probability of K_α radiation is more than K_β radiation.

3. **BC**

Sol. 10 r > 6R

$\frac{r}{R} > \frac{6}{10};\frac{r}{R} > 0.6$ cannot oscillate & if $\frac{r}{R} = 0.2$

$\Rightarrow$ T = 0.24 π.

4. **ABD**

Sol. Apply in impulse momentum equation.

$$\int_0^{0.1}(N - m_y)dt = mv_{yf} - mv_{y1}$$

$$\int_0^{0.1}Ndf = \frac{10\times 10}{2} + 10\times 10 + 10\times 10\times 0.1$$

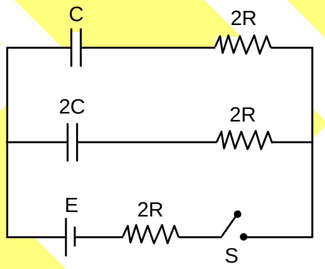
$$\Rightarrow \quad \int_0^{0.1}Ndt = 160$$

<N> $\Rightarrow$ $160 = \frac{\int Ndt}{0.1}$

$\Rightarrow$ 1600

5. **AD**

Sol.



$$q = q_{max}\left(1 - e^{-\frac{t}{CR_{eq}}}\right)$$

Q_{max} → Max. charge at t = ∞

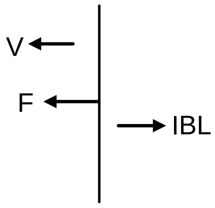
R_{eq} = Net resistance about capacitor keeping battery as short circuit.

6. **BCD**

Sol. At any instant motional emf = BVI

Charge on capacitor $\Rightarrow$ q = C(BIV)

Current I in rod = $\frac{d_q}{dt} + \frac{BVI}{R}$



when terminal velocity achieved F = IBL

$$F=\left(\frac{dq}{dt}+\frac{BVI}{R}\right)BL$$

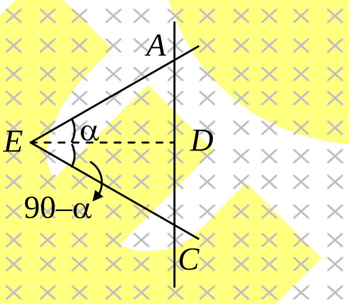
$$F=\left(\frac{CB|dV}{dt}+\frac{BVI}{R}\right)BL$$

$$\frac{dV}{dt}=0$$

$$F=\frac{B^2VI^2}{R}\quad ; \quad V_t=\frac{FR}{B^2I^2}$$

7. **BD**

Sol. At time t, the distance traveled by the rod is



$$ED=vt$$

$$\tan\alpha=\frac{AD}{ED}\text{ or }AD=ED\tan\alpha$$

$$AD=vt\tan\alpha$$

$$\tan(90-\alpha)=\frac{DC}{ED}\text{ or }DC=at\cot\alpha$$

So, $AC=AD+DC=vt(\tan\alpha+\cot\alpha)$

Induced emf = $BvI=Bv(AC)$

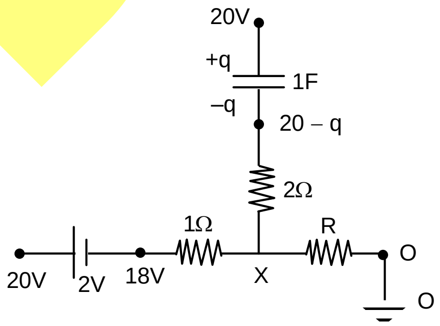
$=Bv.vt(\tan\alpha+\cot\alpha)$

Induced emf $=Bv^2t(\tan\alpha+\cot\alpha)$

Hence, Induced emf $\propto t$ and v^2

Therefore, choices (B) and (D) are correct and choices (A) and (C) are wrong.

8. **ABC**



Sol. $$\frac{x}{R}+\frac{x}{2}-10+\frac{q}{2}+x-18=0$$

$$\frac{x-0}{R}+\frac{x-20+q}{2}+\frac{x-18}{1}=0$$

$$x\left(\frac{3}{2}+\frac{1}{R}\right)+\frac{q}{2}=28$$

$$x=\frac{28-\frac{q}{2}}{\frac{3}{2}+\frac{1}{R}}$$

Current in AP = $\frac{20-q-(x)}{2}$ = 3A

Current through R = $\frac{x}{R}=7A$ + R = 2Ω.

9. **A**

10. **A**

11. **C**

Sol. $$T-mg=\frac{mv_A^2}{R}\quad ; \quad T+mg=\frac{mv_B^2}{R}$$

12. **A**

Sol. (P) → Work done = Fs cosθ = (F cosθ) × s = 0.01 × 2 × ½ × 2 × 10^2 = 2 J

(Q) → Work done = 0 as bob is not getting displaced relative to car
(R) → v = u + at = 0 + 2 × 10 = 20
(S) → Work done = 0 as bob is not getting displaced in vertical direction

(PART – B)

1. **2.25**

Sol. $\lambda_m = \frac{b}{T}$

$\Rightarrow \; 500 = \frac{b}{T_A}$

And $1500 = \frac{b}{T_B}$

$\Rightarrow \; \frac{T_A}{T_B} = 3$

$\frac{U_A}{U_B} = \frac{\sigma(4\pi r_A^2)T_A^4}{\sigma(4\pi r_B^2)T_B^4} = \frac{9}{4}$ = 2.25

2. **3**

Sol. $\mu.2\frac{n\lambda}{12u} = \frac{\lambda}{2}$

$\Rightarrow$ n = 3

3. **1.20**

Sol. $\omega = \sqrt{\frac{k}{m_1 + m_2 + m_3}} = \sqrt{\frac{24}{1+2+3}} = 2$

$0.4 \times g = \omega^2 A_{max}$, $A_{max} = 1$.

4. **6**

Sol. Current through 30 Ω is $\frac{12}{40}$ and apply loop rule then charge on the capacitor C_2 is 60 μC.

5. **1.25**

Sol. $B\int_0^R \frac{\omega}{2\pi} Q \frac{2\pi r}{\pi R^2} dr \, \pi r^2 = \frac{T_0 D}{2}$

$\Rightarrow \; \omega = \frac{T_0 D}{QR^2 B}$.

6. **6**

Sol. Consider five more identical surfaces, such that a Hexagonal prism is formed with point charge at the centre. Flux will be equally divided between these surfaces.

SECTION – II : CHEMISTRY

(PART – A)

1. **ABCD**

Sol. $HgCl_2 + SnCl_2 \longrightarrow Hg_2Cl_2 \downarrow \longrightarrow Hg$

2. **AD**

Sol. Stable alkyl carbocation

3. **ABC**

Sol. Theoretical

4. **CD**

Sol. Conceptual

5. **AC**

Sol. Heisenberg contradict Bohr

6. **BCD**

Sol. Conceptual

7. **CD**

Sol. $T_B = \dfrac{a}{Rb}$

$T_C = \dfrac{8}{27}\dfrac{a}{Rb}$

8. **ABCD**

Sol. Positive deviation

$$\begin{pmatrix} A----A \\ B----B \end{pmatrix} > (A---B)$$

9. **A**

10. **D**

Sol. 9 & 10: 7 crystal system

11. **B**

12. **D**

Sol. 11 & 12: General organic reaction

(PART – B)

1. 7.83

Sol. pH = $pH = 7 + \dfrac{1}{2}\left(p_{K_a} - p_{K_b}\right)$

2. 4

Sol. Amphoteric

3. 4

Sol. $-\Delta T_f = iK_fm \Rightarrow i = 1, \alpha = 1$

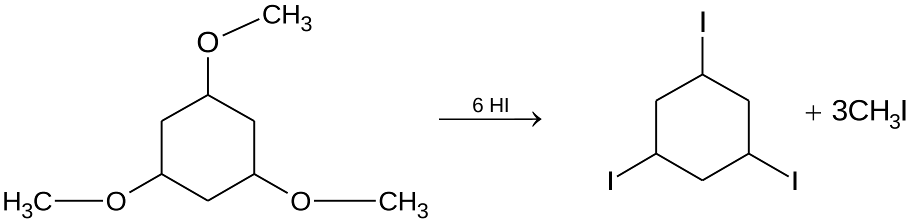
4. **7** $\Rightarrow i + \alpha = 4$

FIITJEE

Sol. $Na_2S_2O_3$, $[Ag(S_2O_3)_2]^{3-}$, Na_2SO_4

5. **6**

Sol.



6. 108.8

Sol. % SO_3 = 39.5

$$\%SO_3 = (\%\ oleum - 100) \times \frac{80}{18}$$

%oleum = 108.88

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SECTION – III : MATHEMATICS

(PART – A)

1. AB

Sol. $\frac{dy}{2x\,dx}+\frac{y}{x^2}=\frac{\sin^{-1}x}{2x^2}$

$\Rightarrow \frac{dy}{dx}+\left(\frac{2}{x}\right)y=\frac{\sin^{-1}x}{x}$

I.F. $e^{\int\frac{2}{x}dx}=e^{2\ell nx}=x^2$

Solution is given by $y\times x^2=\int\frac{\sin^{-1}x}{x}\times x^2dx$

$\Rightarrow y\times x^2=\frac{1}{2}\left(2x^2-1\right)\sin^{-1}x+\frac{1}{4}x\sqrt{1-x^2}+C$

2. ABCD

Sol. $f\left(x\right)=\begin{vmatrix}5+\sin^2x & \cos^2x & 4\sin2x\\ \sin^2x & 5+\cos^2x & 4\sin2x\\ \sin^2x & \cos^2x & 5+4\sin2x\end{vmatrix}$

Apply $C_1\to C_1+C_2+C_3$

$=\left(6+4\sin2x\right)\begin{vmatrix}1 & \cos^2x & 4\sin2x\\ 1 & 5+\cos^2x & 4\sin2x\\ 1 & \cos^2x & 5+4\sin2x\end{vmatrix}$

Apply $R_3\to R_3+R_1$

$=\left(6+4\sin2x\right)\begin{vmatrix}1 & \cos^2x & 4\sin2x\\ 1 & 5+\cos^2x & 4\sin2x\\ 0 & 0 & 5\end{vmatrix}$

$=\left(6+4\sin2x\right)5\times5=25\times\left(6+4\sin2x\right)$

$\left[50,\ 250\right]$

3. AB

Sol. $A=\cos\theta.\cos2\theta.\cos3\theta......\cos\left(n-1\right)\theta$

$B=\sin\theta.\sin2\theta.\sin3\theta.....\sin\left(n-1\right)\theta$ where $\theta=\frac{2\pi}{2019}$

$n=2019$

$2^{1009}\times A\times B=\left(2\sin\theta.\cos\theta\right)\left(2\sin2\theta.\cos2\theta\right)$

$.....\left(2\sin\left(n-1\right)\theta.\cos\left(n-1\right)\theta\right)$

$=\sin2\theta.\sin4\theta\sin6\theta......\sin\left(2n-2\right)\theta$

$\Rightarrow 2^{1009}\times A\times B=B$

$A=\frac{1}{2^{1009}}=2^{1009}$

$\frac{p}{q}=\frac{1009}{1}\Rightarrow p+q=1010$

4. ABC

Sol. $\sin x+\sin y=1$

$$\Rightarrow \cos x + \cos y\frac{dy}{dx} = 0 \Rightarrow \frac{dy}{dx} = -\frac{\cos x}{\cos y}$$

$$\Rightarrow -\sin x - (\sin y)\left(\frac{dy}{dx}\right)^2 + (\cos y)\frac{d^2y}{dx^2} = 0$$

$$\Rightarrow \frac{d^2y}{dx^2} = \frac{\sin x + \sin y\left(-\frac{\cos x}{\cos y}\right)^2}{\cos y}$$

$$= \frac{\cos^2 y.\sin x + \sin y.\cos^2 x}{(\cos y)^3}$$

Put $\sin x = t, \sin y = 1 - t, \cos y = \sqrt{2t - t^2}$

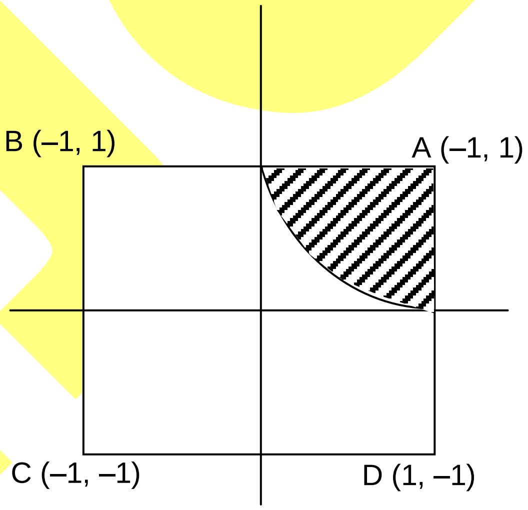
$$\lim_{x\to 0} x^{\alpha}\frac{d^2y}{dx^2} = \lim_{t\to 0}\frac{t^n\left[\left(2t-t^2\right)t + (1-t)\left(1-t^2\right)\right]}{\left(\sqrt{2t-t^2}\right)}$$

exists $\Rightarrow \alpha \geq \frac{3}{2}$

5. BC

Sol. Required area = 4 × area in quadrant 1

$$= 4 \times \left(1 - \frac{\pi}{4}\right) = 4 - \pi$$



6. AB

Sol. $$\lim_{x\to 0}\frac{x^2\frac{\sin\beta x}{\beta x}\times\beta x}{\alpha n + \frac{(\alpha x)^3}{3} + \ldots - \left(x - \frac{x^3}{3} + \ldots\right)} = 4$$

$$\Rightarrow \lim_{x\to 0}\frac{x^3\times\beta}{x(\alpha-1) + \left(\frac{\alpha^3}{3} + \frac{1}{3!}\right)x^3 + \ldots} = 4$$

$$\Rightarrow \alpha = 1 \text{ and } \frac{\beta}{\frac{1}{3} + \frac{1}{3!}} = 4$$

$$\Rightarrow \beta = 4 \times \left(\frac{1}{3} + \frac{1}{6}\right)$$

$$= 4 \times \frac{1}{2} = 2$$

7. ABC

Sol. $A^{n+2}-B^{n+2}=(A+B)\left(A^{n+1}-B^{n+1}\right)-AB\left(A^{n}-B^{n}\right)$

$\Rightarrow A^{n}-B^{n}=(A+B)\left(A^{n}-B^{n}\right)-AB\left(A^{n}-B^{n}\right)$

$\Rightarrow I=A+B-AB$ [$\because A^{n}-B^{n}$ is invertible]

$\Rightarrow (I-A)(I-B)=O$.

As $A,B\neq I$, we get $I-A$ and $I-B$ are singular matrices.

8. CD

Sol. $I(a,b)=a^{3}I_{1}+3a^{2}bI_{2}+3ab^{2}I_{2}+b^{3}I_{3}$ where

$$I_{1}=\int^{\pi}\sin^{3}x\,dx=2\int_{0}^{\pi/2}\sin^{3}dx=\frac{4}{3}$$

$$I_{2}=\int_{0}^{\pi}\sin^{2}x\cos x\,dx=0$$

$$I_{3}=\int_{0}^{\pi}\sin x\cos^{2}x\,dx=-\frac{1}{3}\cos^{3}x\Big]_{0}^{\pi}=\frac{2}{3}$$

$$I_{4}=\int_{0}^{\pi}\cos^{3}x\,dx=0$$

Thus, $I(a,b)=\frac{4}{3}a^{3}+2ab^{2}$

$I(a,1)=\frac{4}{3}a^{3}+2a\leq\frac{4}{3}+2=\frac{10}{3}=I(1,1)$

and $I(-1,b)=\frac{-4}{3}+2b^{2}\geq\frac{-10}{3}=I(-1,1)$

9. A

10. B

Sol. (9 to 10)

(I) Odd numbers:

One – digit number $\boxed{\ }\to 3$

Two – digit numbers $\boxed{\text{two choices not zero}}\boxed{\text{(Choices 3, 5, 7)}}\to 3\times 2=6$

Three – digit number $\boxed{\text{two non zero choices}}\boxed{\text{two choices}}\boxed{\text{Choices}=3,5,7}\ 3\times 2\times 2=12$

$(n-1)(2n-1)=3+6+12=21\Rightarrow 2n^{2}-3n-20=0$

$\Rightarrow n=4$, (Option S)

(II) Number of triangles $={}^{10}C_{3}-(10+10\times 6)$

n = 50 (option – S)

(III) $$\underbrace{\boxed{}\boxed{}\boxed{}}_{3!}\boxed{\begin{matrix}12, & 52\\ 32, & 24\end{matrix}}\to 4\text{ choices}$$

{3! (Last two digits)

$(n+2)(n-3)=4\times 3!=24\Rightarrow n^{2}-n-30=0\Rightarrow n=6$

Option (R)

(IV) Assumption: Each question carries one mark for correct and zero for other cases.

$x_{1}+x_{2}+x_{3}+x_{4}=8$ $\quad(0\leq x_{1},x_{2},x_{3}\leq x_{4}\leq 4)$.

Number of non – negative solutions = Coefficient of x^{8} in

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$$(1+x+x^2+x)^4 = \left(\frac{1-x^5}{1-x}\right)^4 = \left(1+x^{10}-2x^5\right)^2(1-x)^{-4}$$

$$=\left(x^{20}+4x^{10}-4x^{15}-4x^5+2x^{10}+1\right)(1-x)^{-4}$$

Coefficient of $x^8 = (-4)\,{}^{3+4-1}C_{4-1} + {}^{8+4-1}C_8 = {}^{11}C_8 - 4\,{}^6C_3 = 85$

$$n = 85.\left[\frac{n}{16}\right] = \left[\frac{85}{16}\right] = 5.$$

11. B

12. C

Sol. (11 & 12)

(I) Vector along the line is $2\hat{i}+\hat{j}-\hat{k}$

None of the vectors from (P) (Q) (R) (S) are perpendicular to $2i+\hat{j}-\hat{k}$

(II) Vectors perpendicular to the planes are

$\overrightarrow{n_1} = \hat{i}+\hat{j}+\hat{k}$ (Plane $x+y+z-3=0$)

$\overrightarrow{n_2} = 2\hat{i}-\hat{j}+3\hat{k}$ (Plane $2x-y+3z=0$)

Vector parallel to both planes is along $\overrightarrow{n_1}\times\overrightarrow{n_2}$.

$$\overrightarrow{n_1}\times\overrightarrow{n_2} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 1 & 1 \\ 2 & -1 & 3 \end{vmatrix} = 4\hat{i}-\hat{j}-3\hat{k}.\ \text{[Option (Q)]}$$

(III) $\frac{x}{2} = \frac{y}{-3} = \frac{z}{-1}$ (line – 1)

$\frac{x-3}{1} = \frac{y+1}{1} = \frac{z-1}{-2}$ (line – 2)

Vectors along the lines are $2\hat{i}-3\hat{j}-\hat{k}$ and $\hat{i}+\hat{j}-2\hat{k}$.

Vector along the shortest distance : $\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -3 & -1 \\ 1 & 1 & -2 \end{vmatrix} = 7\hat{i}+3\hat{j}+5\hat{k}$ (Option P)

(IV) Vector normal to the plane is $\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 3 & -2 \\ -1 & 2 & -5 \end{vmatrix} = -11\hat{i}+7\hat{j}+5\hat{k}$ (Option R)

(I) → none, (II) → (Q), (III) → (P) (IV) → (R)

(PART – B)

1. 0.25

Sol. The given family of lines can be represented by the equation

$x\cos\alpha + y\sin\alpha = 10$ ……..(1)

where α is an arbitrary constant. Differentiating we have

$\cos\alpha + \sin\alpha\, y_1 = 0$ ……….(2)

Multiplying (2) by x and subtracting it from (1)

$$y\sin\alpha - x\sin\alpha\frac{dy}{dx} = 10$$

$\Rightarrow$ $(y-xy_1)\sin\alpha = 10$ ……..(3)

Multiplying (1) by y_1 and (2) by y and subtract

$$\Rightarrow \quad xy_1\cos\alpha - y\cos\alpha = 10y_1 \qquad \text{........(4)}$$

Square and add (3) and (4) we get, $(y-xy_1)^2 = 100\left(1+y_1^2\right)$.

2. 0.17

Sol. Let E_i denote the event that the ith object goes to the ith place.

We have $P\left(E_i \cap E_j \cap E_k\right) = \frac{(n-3)!}{n!}$ for $i<j<k$

Since we can choose 3 places out of n in ${}^nC_3$ ways, the probability of the required event is

$$p = {}^nC_3 \cdot \frac{(n-3)!}{n!} = \frac{n!}{3!(n-3)!}\,\frac{(n-3)!}{n!} = \frac{1}{6}.$$

3. 0.4

Sol. Putting $t=\cos\theta,$ we get $\int_0^{\pi/2}\sin\theta\log\sqrt{1-\cos^2\theta}\;d\theta$

$$= \frac{1}{2}\int_0^{\pi/2}\sin\theta\log\left(1-\cos^2\theta\right)d\theta$$

$$= -\frac{1}{2}\int_1^0\log\left(1-t^2\right)dt$$

$$= \frac{1}{2}\int_0^1\left[\log(1-t)+\log(1+t)\right]dt$$

$$= \frac{1}{2}\int_0^1\log\left[1-(1-t)\right]dt + \frac{1}{2}\int_0^1\log(1+t)\,dt$$

$$= \frac{1}{2}\int_0^1\left[\log t+\log(1+t)\right]dt$$

$$= \frac{1}{2}\left(t\log t\Big|_0^1 - \int_0^1 dt + t\log(1+t)\Big|_0^1 - \int_0^1\frac{1+t-1}{1+t}dt\right)$$

$$= \frac{1}{2}(-1+\log 2-1+\log 2) = \log 2-\log e$$

$$= \log\left(\frac{2}{e}\right).$$

4. 1.25

Sol. $$p_1 = \frac{\left|12-(3i-5j+8k).(2i+2j-k)\right|}{\left|2i+2j-k\right|}$$

$$= \left|\frac{12-(6-10-8)}{\sqrt{4+4+1}}\right| = \frac{24}{3} = 8$$

Similarly, $p_2 = \frac{1}{3}\left|12-(4-82-21)\right| = \frac{111}{3} = 37$.

5. 2.25

Sol. Let the equation of the plane be $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=1$

$$\Rightarrow A(a,0,0), B(0,b,0)\,C(0,0,c)$$

$$\Rightarrow (x,y,z) = \left(\frac{a}{3},\frac{b}{3},\frac{c}{3}\right)$$

$$k = x^{-2}+y^{-2}+z^{-2} = 9\left(a^{-2}+b^{-2}+c^{-2}\right)$$

Since the distance of the plane from the origin is 1

$$\left|\frac{-1}{\sqrt{\left(\frac{1}{a}\right)^2+\left(\frac{1}{b}\right)^2+\left(\frac{1}{c}\right)^2}}\right|=1\Rightarrow a^{-2}+b^{-2}+c^{-2}=1$$

Hence k = 9.

6. 0

Sol. $\lim\limits_{x\to0}\left(1+\frac{p(x)}{x^2}\right)=2\Rightarrow\lim\limits_{x\to0}\left(\frac{p(x)}{x^2}\right)=1$

Let $p(x)=a_0x^4+a_1x^3+a_2x^2+a_3x+a_4$. The given limit is finite is possible only if $a_3=a_4=0$ and is 1 if $a_2=1$. Thus $p(x)=a_0x^4+a_1x^3+x^2p(x)$ has extremum at $x=1,2$ if $p'(1)=0, p'(2)=0\Rightarrow 4a_0+2a_1=-2, 32a_0+12a_1=-4$.

Solving we get, $a_0=\frac{1}{4}, a_1=-1$

$$\therefore p(x)=\frac{1}{4}x^4-x^3+x^2\Rightarrow p(2)=\frac{1}{4}(16)-8+4=0.$$

FIITJEE RBT-6 for (JEE-Advanced)

BATCHES – Two Yr CRP2123(All)

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 1

QP Code: 100191

PAPER - 1

Time Allotted: 3 Hours **Maximum Marks: 234**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections**.
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. Each **Section** is further divided into **Two Parts**: **Part-A & B** in the OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with HB pencil for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Two Parts.

(i) **Part-A (01-07) –** Contains seven (07) multiple choice questions which have **One or More** correct answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in –**2** marks, as a wrong option is also darkened.

(i) **Part-A (08-13) –** Contains six (06) multiple choice questions which have ONLY ONE CORRECT answer Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(ii) **Part-B (01-08)** contains eight (08) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+4 marks** for correct answer and **there will be no negative marking.**

Name of the Candidate :____

Batch :____________________ **Date of Examination :**___________________

Enrolment Number :____

SECTION-1 : PHYSICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

---

1. If the dimensions of length are expressed as $G^x\, c^y\, h^z$; where G, c and h are the universal gravitational constant, speed of light and Planck's constant respectively, then

(A) $x = \frac{1}{2}, y = \frac{1}{2}$ (B) $x = \frac{1}{2}, z = \frac{1}{2}$

(C) $y = \frac{1}{2}, z = \frac{3}{2}$ (D) $y = -\frac{3}{2}, z = \frac{1}{2}$

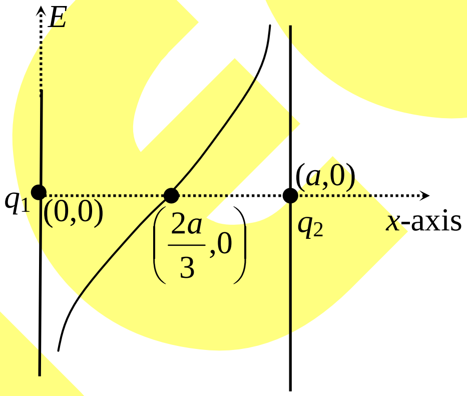
2. If the electric field *E* is plotted, with distance from q_1 along the line joining of two, then (*E* is positive along +ve *x*-axis) it looks as shown in figure. From the plot we can say that

(A) q_1 and q_2 both are negative

(B) $\left|\frac{q_1}{q_2}\right| = 4$

(C) q_1 is positive and q_2 is negative

(D) $\left|\frac{q_1}{q_2}\right| = \frac{1}{4}$



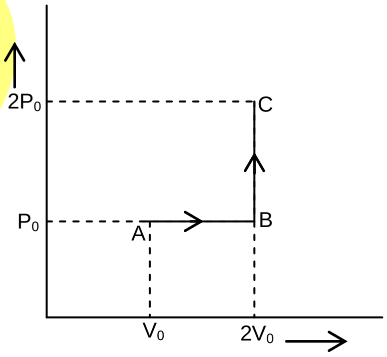
3. One mole of an ideal monoatomic gas is taken from A to C along the path ABC. The temperature of the gas at A is T_0. For the process ABC (where R is gas constant)

(A) Heat absorbed by the gas is $\frac{11}{12}RT_0$

(B) Heat absorbed by the gas is $\frac{11}{2}RT_0$

(C) Work done by the gas = RT_0

(D) Change in internal energy of gas is $\frac{9}{2}RT_0$



4. The threshold wavelength for photoelectric mission from a material is 5200 Å. Photoelectrons will be emitted when this material is illuminated with monochromatic radiation from a:

(A) 50 watt infrared lamp (B) 20 watt infrared lamp

(C) 50 watt ultraviolet lamp (D) 20 watt ultraviolet lamp

Space For Rough Work

5. A capacitor is charged to a potential of V_0. It is connected with an inductor through a switch S. The switch is closed at time t = 0. Which of the following statements are correct?

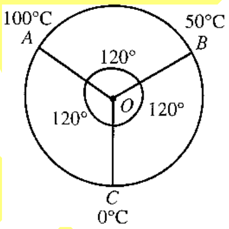
(A) The maximum current in the circuit is $V_0\sqrt{\frac{C}{L}}$

(B) Potential across capacitor becomes zero for the first time at time t = $\pi\sqrt{LC}$

(C) Energy stored in the inductor at time $t = \frac{\pi}{2}\sqrt{LC}$ is $\frac{1}{4}CV_0^2$

(D) Maximum energy stored in the inductor is $\frac{1}{2}CV_0^2$

6. A circular ring (centre O) of radius a, and of uniform cross section is made up of three different metallic rods AB, BC & CA joined together at the points A, B and C in pairs) of thermal conductivities α_1, α_2 and α_3, respectively (see diagram). The junction A, B and C are maintained at the temperatures 100°C, 50°C and 0°C, respectively. All the rods are of equal lengths and cross sections. Under steady state conditions, assume that no heat is lost from the sides of the rods. Let Q_1, Q_2 and Q_3 be the rates of transmission of heat along the three rods AB, BC and CA. Then which of the following is/are correct?



(A) $Q_1 = Q_2 = Q_3$ and all are transmitted in the clockwise sense
(B) Q_1 and Q_2 flow in clockwise sense and Q_3 in the anticlockwise sense
(C) $Q_1 : Q_2 : Q_3 : : \alpha_1 : \alpha_2 : 2\alpha_3$
(D) $\frac{Q_1}{\alpha_1} + \frac{Q_2}{\alpha_2} = \frac{Q_3}{\alpha_3}$

7. A 10 m long horizontal stainless steel wire AB of mass 1 kg whose end A is fixed, is connected to a massless string BC passing over a smooth pulley. String BC is connected to a container of mass 2 kg at end C. Water (density = 1×10^3 kg/m^3) is poured in the container at a constant rate of 2.25 litre/sec at t = 0. Also at t = 0, a pulse is generated at end A. Choose from the following the correct option(s).
(A) Time taken by the pulse to reach point B is 0.612 sec
(B) Time taken by the pulse to reach point B is 0.212 sec
(C) Tension in the string at this moment is 33.77 N
(D) Tension in the string at this moment is 24.77 N

Space For Rough Work

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

---

8. A dipole of dipole moment *p* is kept at the centre of a ring of radius *R* and charge *q*. The dipole moment has direction along the axis of the ring. The resultant force on the ring due to the dipole is

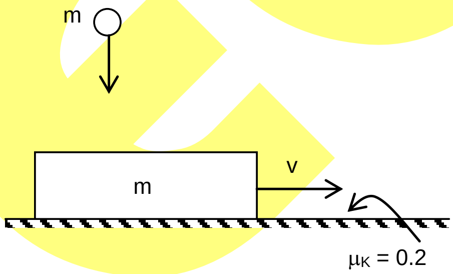
(A) zero

(B) $\frac{pq}{4\pi\varepsilon_0 R^3}$

(C) $\frac{pq}{2\pi\varepsilon_0 R^3}$

(D) $\frac{pq}{4\pi\varepsilon_0 R^3}$ only if the charge is uniformly distributed on the ring.

9. A ball of mass m falls vertically from a height h and collides with a block of equal mass m moving horizontally with a velocity v on a surface. The coefficient of kinetic friction between the block and the surface is $\mu_k = 0.2$, while the coefficient of restitution (e) between the ball and the block is 0.5. There is no friction acting between the ball and the block. The velocity of the block just after the collision decreases by



(A) $0.5\sqrt{2gh}$ (B) 0 (C) $0.1\sqrt{2gh}$ (D) $0.3\sqrt{2gh}$

10. Consider elastic collision of a particle of mass m moving with a velocity u with another particle of the same mass at rest. After the collision the projectile and the struck particle move in direction making angle θ_1 and θ_2 respectively with the initial direction of motion. The sum of the angle $\theta_1 + \theta_2$ is

(A) 45^0 (B) 90^0 (C) 135^0 (D) 180^0

11. A ball is dropped from a height of 20 m above the surface of water in a lake. The refractive index of water is 4/3. A fish inside the lake, in the line of fall of the ball, is looking at the ball. At an instant when the ball is 12.8 m above the water surface the fish see the speed of ball as

(A) 9 m/s (B) 12 m/s (C) 16 m/s (D) 21.33 m/s

12. In Bohr model of the hydrogen atom, let R, V and E represent the radius of the orbit, speed of the electron and the total energy of the electron respectively. Which of the following quantities are proportional to the quantum number n:

(A) VR (B) RE (C) V (D) $\frac{R}{E}$

Space For Rough Work

13. A particle of mass m and charge q is projected in a region where an electric field is existing and given by $\vec{E} = E_0\hat{i}$, with a velocity $v_0\hat{j}$ from the origin at time t = 0, then choose the correct statement (assuming $m^2v_0^2 = 2qE_0mx_0$).
(A) radius of curvature of the particle when its x-coordinate becomes x_0 is $2x_0$.
(B) radius of curvature of the particle when its x-coordinate becomes x_0 is $4\sqrt{2}\,x_0$.
(C) speed of the particle when its x-coordinate becomes x_0 is v_0.
(D) speed of the particle when its x-coordinate becomes x_0 is $2v_0$.

PART – B

(Numerical based)

This section contains **8 Numerical based questions**, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

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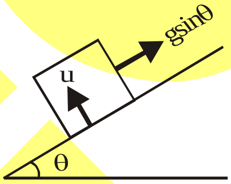
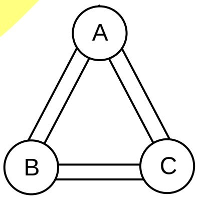
1. A cabin is moved up the inclined plane with constant acceleration g sinθ. A particle is projected with some velocity in a direction perpendicular to the inclined plane. If maximum height attained by particle perpendicular to inclined plane is same as range of particle with respect to the cabin parallel to plane then calculate values of cotθ.



2. Three metallic blocks A, B and C have masses m, m and 2m respectively. Specific heat of A, B and C are C, 2C and C respectively. Initial temperature of A, B and C are 10°C, 5°C and 5°C respectively. Now the blocks are connected by 3-identical rods as shown. Find the final temperature of block A on Celsius scale (Neglect any heat loss due to radiation).



3. In an AC circuit the phase difference between emf and current is $\pi/3$ then the power factor of the circuit is n. Find 'n'.

4. A thin uniform rod of mass 'm', length 'ℓ' rotates uniformly about a vertical axis ω, form a conical pendulum, the upper end of the rod is hinged and θ is angle between rod and vertical. If the change of angular momentum of the rod about hinge is $\frac{m\ell^2}{x}\omega^2\sin 2\theta$ then the value of 'x' will be

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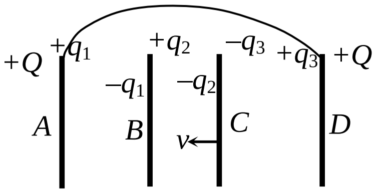
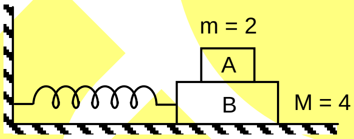
Space For Rough Work



5. In the diagram there are four conducting plates A, B, C and D placed parallel to each other at equal separation L. If plate C starts moving towards plate B with velocity v. The current (in mA) flowing in the wire connecting A and D is '2y'. Find 'y'. (assume all other plates to be fixed) (Given: $q_2 = 5\mu C$, $q_3 = 10\mu C$, v = 10 m/s, L = 0.05 m)

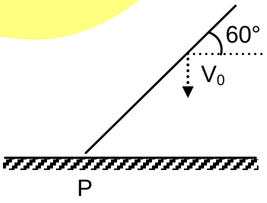
6. A mono-atomic gas undergo a process such that $P \propto \frac{1}{T^2}$. If final temperature is twice that of initial temperature of the gas in given process and molar heat capacity for this process is $\frac{nR}{2}$ then value of 'n' is

7. Block B of mass 4 kg resting on a frictionless horizontal surface and connected with spring of spring constant K = 10 as shown in figure.



Another block A of mass 2 kg is placed on the top of block B. Co-efficient of friction between the blocks is $\mu = 0.5$. Body B is displaced and released such that both bodies are moving together and perform simple harmonic motion. Maximum oscillation amplitude that permits body A and B to move together without slipping between the surfaces in contact of body A and B. (Consider g = 10 m/sec^2).

8. A rod of length $\ell = \frac{6}{7}$ meter forming an angle 60° with horizontal strikes a frictionless floor at point P with its velocity v_0 = 2 meter/second in downward direction and no angular velocity. Assume that collision at point P is perfectly elastic then angular velocity of the rod just after collision is



Space For Rough Work

SECTION-2 : CHEMISTRY

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

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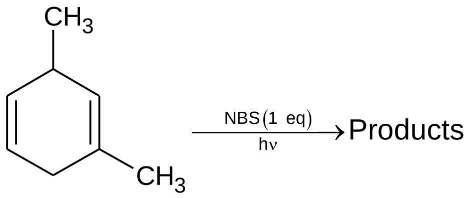
1. Which order is/are correct for OCl_2, NCl_3 and BF_3 molecules?
(A) Tendency to form back π-bond: $BF_3 > OCl_2 > NCl_3$
(B) Polarity of covalent bond: $B - F > O - Cl > N - Cl$
(C) Dipole moment: $BF_3 > OCl_2 > NCl_3$
(D) Hydrolysis: $BF_3 > OCl_2 > NCl_3$

2.



The characteristic(s) of the major product of above reaction is
(A) it is a conjugated cyclic diene.
(B) an α-keto acid is one of it's oxidation product.
(C) it contains five allylic hydrogen atoms.
(D) it forms an ether when reacts with aq. KOH

3. Which of the following are colourless or pale colour complexes?
(A) $[Mn(H_2O)_6]^{2+}$ (B) $[Mn(CN)_6]^{4-}$
(C) $[FeF_6]^{3-}$ (D) $[Fe(CN)_6]^{3-}$

4. Choose the incorrect statement(s) regarding the face centred cubic unit cell of a metal lattice?
(A) The metal atoms are present at the lattice points as well as voids.
(B) The metal atoms touch each other along the face diagonal.
(C) The body diagonal contains a relative number of $\frac{5}{4}$ atoms.
(D) The interatomic attraction force is uniform through out the crystal.

Space For Rough Work

5. $\left[Cr(H_2O)_6\right]^{3+} + 6NH_3 \longrightarrow \left[Cr(NH_3)_6\right]^{3+} + 6H_2O$

Which reaction(s) is/are thermodynamically more favourable then the one given above

(A) $\left[Cr(NH_3)_6\right]^{3+} + 3\,en \longrightarrow \left[Cr(en)_3\right]^{3+} + 6NH_3$

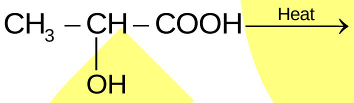
(B) $CrCl_3 \xrightarrow[\text{Reducing agent}]{CO} Cr(CO)_6$

(C) $\left[Cr(NH_3)_6\right]^{3+} + 2\,dien \longrightarrow \left[Cr(dien)_2\right]^{3+} + 6NH_3$

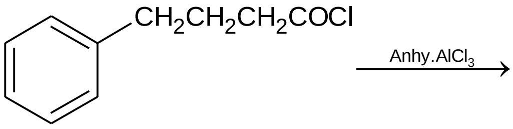
(D) $Cr(OH)_3 + OH^- \longrightarrow \left[Cr(OH)_4\right]^-$

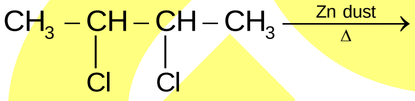
6. The product(s) of which reaction(s) show geometrical isomerism?

(A) $CH_3-CH=CH-C_2H_5 + CH_2N_2 \xrightarrow{\text{Heat}}$

(B) 

$CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-COOH \xrightarrow{\text{Heat}}$

(C) 

(D) 

$CH_3-\underset{\displaystyle Cl}{\underset{|}{CH}}-\underset{\displaystyle Cl}{\underset{|}{CH}}-CH_3 \xrightarrow[\Delta]{\text{Zn dust}}$

7. Which of the following solutions mixtures show identical colligative properties? [Assume complete dissociation of salts]

(A) 0.2 M $CaCl_2$ and 0.3 M KCl
(B) 0.4 M $C_6H_{12}O$ and 0.2 NaCl
(C) 0.1 M $AlCl_3$ and 0.1 M NH_2CONH_2
(D) 0.4 M $K_4[Fe(CN)_6]$ and 0.5 M $K_3[Fe(CN)_6]$

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

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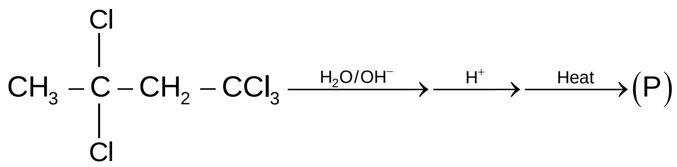
8. The incorrect statement regarding $Fe(CO)_5$ is
(A) it has trigonal bipyramidal structure
(B) both sigma donation and pi-acceptance takes place by the CO ligands
(C) on heating the complex, the oxidation number of Fe decreases as CO is a reducing agent
(D) the CO bond length in the complex increases as compared to the free CO

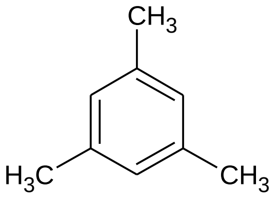
9. Which is correct statement for an ideal solution?
(A) The mole fraction of solute should be less than that of the solvent.
(B) The entropy of the system increases and that of the surrounding does not change
(C) $\Delta H_{mix} > 0$
(D) $\Delta G_{mix} = 0$

Space For Rough Work

10. 

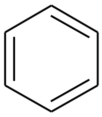
$$CH_3-\overset{\overset{\displaystyle Cl}{|}}{\underset{\underset{\displaystyle Cl}{|}}{C}}-CH_2-CCl_3\xrightarrow{H_2O/OH^-}\xrightarrow{H^+}\xrightarrow{Heat}(P)$$

Which is a characteristic of (P)?

(A)  is formed when (P) reacts with hot conc. H_2SO_4

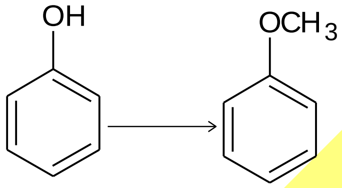
(B) in aqueous solution(P) remains in four different forms

(C) reaction of (P) with CH_3MgBr, forms secondary alcohol

(D) when heated in Al-tube,(P) forms 

11. How many elements of the fourth period of periodic table, contains 10 electrons in their orbitals, which azimuthal quantum number is 2?

(A) 10 (B) 5 (C) 6 (D) 8

12. 

Which reagent can’t be used for above reaction?

(A) CH_2N_2/Δ (B) KOH and CH_3Cl

(C) CH_3Br and Na (D) Cl_2/H_2O and CH_3OH

13. $(NH_4)_2Cr_2O_7(s)\xrightarrow{Heating}P(s)+Q(g)+H_2O$

Select the incorrect statement

(A) the equivalent mass of $(NH_4)_2Cr_2O_7$ in above reaction is $\frac{M}{6}$

M = Molar mass of $(NH_4)_2Cr_2O_7$ in g mol^{-1} unit

(B) Q(g) is NH_3

(C) P(s) is a green solid

(D) P(s) is dissolve in HCl

Space For Rough Work

PART – B

(Numerical based)

This section contains **8 Numerical based questions**, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

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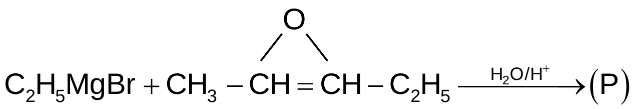
1. One mole of an ideal gas at 0.1 atm and 300 K, was heated to 320 K at constant pressure, this results in expansion of the gas. What is the entropy change of this reversible process in JK^{-1} mol^{-1} unit?

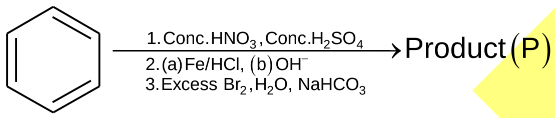
   $[\ell n(1.066) = 0.064, R = 8.3\ J\ K^{-1}\ mol^{-1}, C_P = \frac{5}{2}R]$

2. 

   $C_2H_5MgBr + CH_3 - \overset{O}{CH = CH} - C_2H_5 \xrightarrow{H_2O/H^+} (P)$

   If x = Number of chiral carbon atoms in organic product P
   and y = Number of optical isomers possible for P

   What is the value of $\frac{x+y}{4}$?

3. 

   $\xrightarrow[\text{2.(a) Fe/HCl, (b) } OH^- \quad \text{3. Excess } Br_2, H_2O, NaHCO_3]{\text{1. Conc.} HNO_3, \text{Conc.} H_2SO_4}$ Product (P)

   If the molar mass of the product(P) is expressed as (120x + 30) g mol^{-1}, what is the value of x? [At mass of Br = 80 g mol^{-1}]

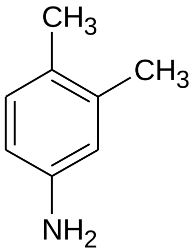
4. One litre of a buffer solution contains 0.5 mole of CH_3COONa and 0.3 mole of CH_3COOH. The pH of the solution is x. Now 0.1 mole of H^+ is added to the buffer solution, the pH changes to y. What is the value of |x – y}?

   $[K_a \text{ of } CH_3COOH = 10^{-5}][\log \frac{0.5}{0.3} = 0.22]$

5. The octacarbonyl of Scandium does not involve back donation from metal to ligand. So the complex is weaker than that of other 3d-series metal. If the oxidation number of scandium in the carbonyl is +x, what is the value of x?

Space For Rough Work

6. Reaction of an organic compound(P) with Br_2 and KOH form an amine having the following structure.



$$P \xrightarrow{H_2O/H^+} Q \xrightarrow{MnO_4^-/H^+} R$$

If the sum of the number of oxygen atoms present in(P), (Q) and (R) is expressed as 10x, what is the value of 'x'?

7. The specific conductance or conductivity of an electrolyte AB is 4×10^{-3} $ohm^{-1}cm^{-1}$. What will be the degree of dissociation of the electrolyte in 0.1 M aqueous solution, if the limiting molar conductance Λ_m^0 is 100 ohm^{-1} cm^2mol^{-1}

8. The molecular formula of an octahedral complex is $CrN_6H_{18}Cl_3$. it shows cis- and trans isomerism and ionise in aqueous solution. If one mole of the complex is dissolved in water. How much gram of $AgNO_3$ is needed to produce sufficient amount of AgCl precipitate?

Space For Rough Work

SECTION-3 : MATHEMATICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. The solution of $\frac{dy}{dx} = \sqrt{y-x}$ is given by

   (A) $x + C = 2\sqrt{y-x} + 2\log\left(\sqrt{y-x} - 1\right)$ (B) $x^2 + C = 2\sqrt{y-x} + \log\left(\sqrt{y-x} - 1\right)$

   (C) $x + C = (y-x)^2 + \log(y-x-1)$ (D) $\sqrt{y-x} - 1 = C'\,e^{x/2-\sqrt{y-x}}$

2. If n objects are arranged in a row, then the number of ways of selecting three of these objects so that no two of them are next to each other is

   (A) $\frac{1}{6}(n-2)(n-3)(n-4)$ (B) ${}^{n-2}C_3$

   (C) ${}^{n-3}C_3 + {}^{n-3}C_2$ (D) none of these

3. A four digit number (numbered from 0000 to 9999) is said to be lucky if the sum of first two digits is equal to the sum of its last two digits. If a four digit number is picked up at random, then the probability that it is lucky is

   (A) > 0.065 (B) < 0.068

   (C) 0.066 (D) 0.067

4. If $\sum_{k=1}^{n}\left(\sum_{m=1}^{k} m^2\right) = an^4 + bn^3 + cn^2 + dn + e$, then

   (A) $a = \frac{1}{12}$ (B) $b = \frac{1}{16}$

   (C) $d = \frac{1}{6}$ (D) $e = 0$

5. The function $f : R \to R$ satisfies $f\left(x^2\right)f''(x) = f'(x)f'\left(x^2\right)\ \forall x \in R$, given that $f(1) = 1$ and $f'''(1) = 8$, then

   (A) $f'(1) = 2$ (B) $f''(1) = 4$

   (C) $f'(1) = 4$ (D) $f''(1) = 2$

Space For Rough Work

6. Which of the following are CORRECT?

(A) If A and B are symmetric matrices of order 3 then $|AB-BA|=0$

(B) If A and B are square matrices of order 'n' such that $AB=I_n$, then $BA=I_n$.

(C) The matrix $A=\begin{bmatrix}9017 & 5148 & 7220\\ 1234 & 2117 & 4848\\ 4320 & 3648 & 1179\end{bmatrix}$ is non-invertible.

(D) If two square matrices A and B of same order commute, then all positive integral powers of A and B commute.

7. Let solutions of the equation $(z-1-2i)^4=1$ be $\omega_1, \omega_2, \omega_3, \omega_4$ such that $|\omega_1|>|\omega_2|>|\omega_3|>|\omega_4|$. If $\arg\left(\dfrac{z-\omega_i}{z-\omega_j}\right)=\pm\dfrac{\pi}{2}$ represents a circle, then for different values of i, j where $i, j\in\{1, 2, 3, 4\}$, $i\neq j$ the number of different circles is λ, where λ lies in

(A) $\left[\dfrac{42\pi}{22}, \dfrac{49\pi}{22}\right]$ (B) $\left[\dfrac{35\pi}{22}, \dfrac{42\pi}{22}\right]$ (C) $\left[\dfrac{31\pi}{22}, \dfrac{37\pi}{22}\right]$ (D) $\left[\dfrac{29\pi}{22}, \dfrac{3\pi}{2}\right]$

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

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8. The number of values of k for which the equation $x^3-3x+k=0$ has two distinct roots lying in the interval (0, 1) is

(A) three (B) two

(C) infinitely many (D) zero

9. Let $a, b, p, q\in Q$ and suppose that $f(x)=x^2+ax+b=0$ and $g(x)=x^3+px+q=0$ have a common irrational root, then

(A) $f(x)$ divides $g(x)$ (B) $g(x)=x\,f(x)$

(C) $g(x)=(x-b-q)f(x)$ (D) none of these

10. The focal chord to $y^2=16x$ is tangent to $(x-6)^2+y^2=2$, then the possible value of the slope of this chord, are

(A) $\{-1, 1\}$ (B) $\{-2, 2\}$ (C) $\left\{-2, \dfrac{1}{2}\right\}$ (D) $\left\{2, \dfrac{-1}{2}\right\}$

Space For Rough Work

11. Consider parabola $y^2 = 40x$, A circle $S = 0$ is drawn taking one of its focal chord as diameter. The extremeties of the focal chord being P_1 and P_2 . A point 'P' is taken on the circumference of S = 0, then
   (A) $\angle P_1PP_2 = \frac{\pi}{4}$
   (B) x = 10 is a tangent to S = 0
   (C) Combined equation of the tangents at P_1 and P_2 has $\left(\text{coeff. } x^2\right) + \left(\text{coeff. } y^2\right) = -2$
   (D) Orthocenter of ΔP_1PP_2 lies on it

12. If $\cos^{-1}p + \cos^{-1}q + \cos^{-1}r = \pi$. Then value of $p^2 + q^2 + r^2 + 2pqr + 4$ is equal to
   (A) 1 (B) 0
   (C) 5 (D) 3

13. If $x_{n+1} = \sqrt{\frac{1}{2}(1 + x_n)}$, then $\cos\left[\frac{\sqrt{1 - x_0^2}}{x_1x_2x_3\text{......to infinite}}\right](-1 < x_0 < 1)$ is equal to
   (A) –1 (B) 1
   (C) x_0 (D) $\frac{1}{x_0}$

PART – B

(Numerical based)

This section contains **8 Numerical based questions**, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

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1. The integer n for which $\lim\limits_{n \to \infty} \frac{(\cos x - 1)(\cos x - e^x)}{x^n}$ is a finite non – zero number, then $\frac{1}{n}$ is

2. The sum of the products of the ten numbers $\pm 1, \pm 2, \pm 3, \pm 4$, and ± 5 taking two at a time is x, then $|x| =$

3. The circles having radii 1, 2, 3 touch each other externally then find the radius of the circle which cuts the three circles orthogonally.

4. If $x + \frac{1}{x} = 2\cos 20^\circ$, then the value of $\frac{1}{\left(x^3 + \frac{1}{x^3}\right)^{-1} + 1}$ is equal to

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Space For Rough Work

5. Let $A = \{3,4,5,6\}$ and $B = \{1,2,3,...,10\}$ be two sets. Let a function f be defined from set A to set B, such that $f(i) - f(j) \geq 2\ \forall i > j$, where $i, j \in A$. If the number of such functions is N, then the value of $\frac{N}{5}$ is

6. In a scalene triangle ABC, the value of $\Delta\left[\frac{\tan\frac{A}{2}}{(a-b)(a-c)} + \frac{\tan\frac{B}{2}}{(b-a)(b-c)} + \frac{\tan\frac{C}{2}}{(c-a)(c-b)}\right]$ is (all notations are standard)

7. Let $a_1, a_2, a_3 ....., a_{4001}$ are in A.P such that $\frac{1}{a_1 a_2} + \frac{1}{a_2 a_3} + ... + \frac{1}{a_{4000} a_{4001}} = 10$ and $a_2 + a_{4000} = 50$ then $\frac{10}{|a_1 - a_{4001}|}$ is equal to

8. If CF is perpendicular from the centre C of the ellipse $\frac{x^2}{49} + \frac{y^2}{25} = 1$ on the tangent at any point P, and G is the point where the normal at P meets the minor axis, then $(C.F.\ PG)^2$ is equal to $(40 + \lambda)^2$ then $\lambda =$

Space For Rough Work

FIITJEE

Q.P. Code: 100191

Answers

SECTION-1 : PHYSICS

PART – A

1.	**BD**	2.	**AB**	3.	**BCD**	4.	**CD**
5.	**AD**	6.	**BCD**	7.	**AC**	8.	**B**
9.	**D**	10.	**B**	11.	**C**	12.	**A**
13.	**B**						

PART – B

1.	**8**	2.	**6**	3.	**0.5**	4.	**6**
5.	**0.5**	6.	**9**	7.	**3**	8.	**8**

SECTION-2 : CHEMISTRY

PART – A

1.	AB	2.	ABC	3.	AC	4.	AC
5.	AC	6.	ABD	7.	ABD	8.	C
9.	B	10.	A	11.	D	12.	D
13.	B						

PART – B

1.	1.33 (Range 1.3 to 1.4)			2.	1.5	3.	2.5
4.	0.22[Range 0.2 to 0.3]			5.	3	6.	0.9
7.	0.4	8.	170				

SECTION-3 : MATHEMATICS

PART – A

1.	AD	2.	ABC	3.	ABD	4.	ACD
5.	AB	6.	ABD	7.	BD	8.	D
9.	A	10.	A	11.	D	12.	C
13.	C						

PART – B

1.	0.33	2.	55	3.	1	4.	0.5
5.	7	6.	1	7.	0.33	8.	9

FIITJEE

Answers & Solutions

SECTION-1 : PHYSICS

PART – A

1. **BD**

Sol. Length $\propto G^x c^y h^z$

$$L=\left[M^{-1}L^3T^{-2}\right]^x\left[LT^{-1}\right]^y\left[ML^2T^{-1}\right]^z$$

By comparing the power of M, L and T in both sides we get

$-x+z=0, 3x+y+2z=1$ and $-2x-y-z=0$

By solving above three equations we get

$$x=\frac{1}{2}, y=-\frac{3}{2}, z=\frac{1}{2}$$

2. **AB**

Sol. q_1 and q_2 both are negative and $\dfrac{kq_1}{\left(\frac{2a}{3}\right)^2}=\dfrac{kq_2}{\left(\frac{a}{3}\right)^2}\Rightarrow\dfrac{q_1}{q_2}=4$.

3. **BCD**

Sol. f = 3, n = 1 $P_0V_0=nRTo$

$$H_{AB}=P_o\left(2V_o-V_0\right)+\frac{3}{2}P_o\left(2V_o-V_o\right)=\frac{5}{2}P_oV_o=\frac{5RT_0}{2}$$

$$H_{BC}=\frac{fn}{2}R\left(T_c-T_B\right)=\frac{3}{2}\left(2P_o2V_o-P_o2V_o\right)=3P_oV_o=3RTo$$

$$H_{AB-c}=\frac{5}{2}RT_O+3RT_O=\frac{11}{2}RT_O$$

$$W_{AB-C}=P_oV_o+0=RT_O$$

$$\Delta UA-B-C=H_{ABC}-W_{ABC}=\frac{9}{2}RT_O$$

4. **CD**

Sol. Threshold frequency is independent of intensity.

5. **AD**

Sol. $\dfrac{1}{2}Li_{max}^2=\dfrac{1}{2}CV_o^2$

6. **BCD**

Sol. The flow of heat will always be in the direction of the temperature gradient from higher to lower temperature. Hence Q_1 in rod AB, Q_2 in rod BC will both be in clockwise sense while Q_3 in CA will be in anti-clockwise sense. Also, we have if L is the length of each rod and A its area of cross-section,

$$Q_1=\frac{\alpha_1A\left(100-50\right)}{L}=\left(50\alpha_1\right)\frac{A}{L}$$

$$Q_2=\frac{\alpha_2A\left(50-0\right)}{L}=\left(50\alpha_2\right)\frac{A}{L}$$

$$Q_3=\frac{\alpha_3A\left(100-0\right)}{L}=\left(100\alpha_3\right)\frac{A}{L}$$

Hence, $Q_1 : Q_2 : Q_3 :: \alpha_1 : \alpha_2 : 2\alpha_3$

Also,

$$\frac{Q_1}{\alpha_1}+\frac{Q_2}{\alpha_2}=\left(50\frac{A}{L}\right)+\left(50\frac{A}{L}\right)=\frac{100A}{L}=\frac{Q_3}{\alpha_3}$$

7. **AC**

Sol. Mass per unit length of the wire = 0.1 kg/m.
At any instant, tension in the string is (2 + 2.25 t) g N

$$v=\sqrt{\frac{(2+2.25\,t)g}{0.1}}$$

$$\int_0^{10} dx=10\int_0^t \sqrt{2+2.25\,t}\,dt$$

t = 0.612 s

$$T=(2+2.25\times0.612)\times10=33.77\text{ N}$$

8. **B**

Sol. The electric field due to the dipole on the circumference of the ring $E=\frac{p}{4\pi\varepsilon_0R^3}$ and it is directed normal to the plane of charged ring.

Hence force on the charged ring $F=qE=\frac{pq}{4\pi\varepsilon_0R^3}$

9. **D**

Sol. $\int Ndt=\frac{3MV}{2}$; $\frac{\int \mu Ndt}{m}=\Delta V$

10. **B**

Sol. Property of perfectly elastic collision.

11. **C**

Sol. $V=\frac{4}{3}\sqrt{2\times10\times7.2}=16$

12. **A**

Sol. $Vr=\frac{nh}{2\pi m}$, $rV\propto n$; $r\propto n^2$

$E\propto 1/n^2$ and $V\propto 1/n$

13. **B**

Sol. $v^2=v_0{}^2+2\left(\frac{qE_0}{m}\right)x_0$

$v=\sqrt{2}v_0$

$$a_n=\frac{qE_0}{m}\frac{v_0}{\sqrt{v_x^2+v_0^2}}$$

$$R=\frac{v^2}{a_n}\ \mathbf{=}\ \frac{[m^2v_0^2+2qE_0mx_0]^{\frac{3}{2}}}{qE_0v_0m^2}=4\sqrt{2}\,x_0$$

PART – B

1. **8**

Sol. Maximum height = $\frac{u^2}{2g\cos\theta}$ …(i)

Range = $\frac{1}{2}\times 2g\sin\theta\times\left(\frac{2u}{g\cos\theta}\right)^2$ …(ii)

From (i) and (ii) cot θ = 8.

2. **6**

Sol. mc (10 – T) = m 2c (T–5) + 2mC (T-5)
T = 6°C.

3. **0.5**

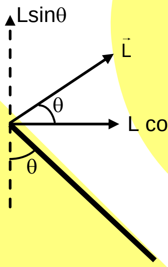
Sol. Power factor = cos ϕ = cos $\pi/3$ = 1/2.

4. **6**

Sol. $\left|\frac{d\vec{L}}{dt}\right| = L\cos\theta\omega$

$= \frac{m\ell^2}{3}\omega\sin\theta\cos\theta\omega$

$= \frac{m\ell^2}{3}\omega^2\sin\theta\cos\theta$



5. **0.5**

Sol. $\frac{2q_1L}{2A\varepsilon_0}+\frac{2q_2x}{2A\varepsilon_0}-\frac{2q_3(2L-x)}{2A\varepsilon_0}=0$ … (i)

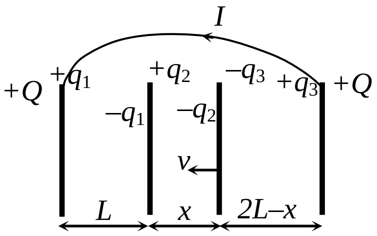
$I=\frac{dq_1}{dt}=\frac{-dq_3}{dt}=\frac{dq_2}{dt}$ … (ii)

From (i),

$q_1L+q_2x-2q_3L+q_3x=0$

$\Rightarrow \quad L\frac{dq_1}{dt}+x\frac{dq_2}{dt}+q_2\frac{dx}{dt}-2\frac{dq_3}{dt}L+x\frac{dq_3}{dt}+q_3\frac{dx}{dt}=0$

$\Rightarrow \quad I=\frac{v}{3L}(q_2+q_3)$ = 1 mA



6. **9**

Sol. $P\propto\frac{1}{T^2}$. $\Rightarrow$ PT^2 = constant

$P\left(\frac{PV}{nR}\right)^2$ = constant

P^3V^2 = constant

$PV^{2/3}$ = constant

Molar heat capacity $C=C_V+\frac{R}{1-x}$

$C=C_V+\frac{R}{1-\frac{2}{3}}=\frac{3R}{2}+3R=\frac{9R}{2}$

7. **3**

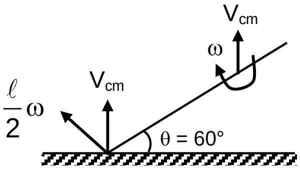
Sol. $m\omega^2 A \le \mu mg$

$$A \le \frac{\mu g}{\left[\frac{K}{(m+M)}\right]}$$

$$A \le \frac{0.5\times 10}{\left(\frac{10}{6}\right)} \le 3$$

8. **8**

Sol.



Impulse $I = m(V_{cm} + V_0)$ …(1)

Angular Impulse $I\left(\frac{\ell}{2}\cos\theta\right) = \frac{m\ell^2}{12}\omega$ …(2)

$\because$ $e = 1$

$\Rightarrow$ $V_0 = V_{cm} + \frac{\ell}{2}\omega\cos\theta$ …(3)

From equation (1) and (2)

$$m(V_{cm} + 2)\frac{\ell}{2}\cos\theta = \frac{m\ell^2}{12}\omega$$

$$(V_{cm} + 2)\frac{3}{\ell} = \omega$$

$\Rightarrow$ $V_{cm} = \frac{\omega\ell}{3} - 2$ …(4)

From equation (3) and (4)

$$2 = \frac{7\omega\ell}{12} - 2$$

$\Rightarrow$ $\omega = 8.$

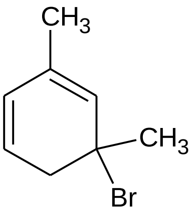
SECTION-2 : CHEMISTRY

PART – A

1. AB

Sol. Back bond is stronger in BF_3 as compared to OCl_2 due to energy difference between overlapping orbitals. NCl_3 does not form back π-bond due to less electronegativity difference between N and Cl.

2. ABC

Sol. The major product is 

3. AC

Sol. Due to $t_{2g}^3 e_g^2$ configuration of Mn^{2+} and Fe^{3+} in their respective weak field complexes.

4. AC

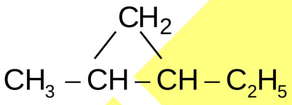
Sol. Close packing takes place along the face diagonal. No atom occupy the voids, as voids can hold smaller atoms or ions.

5. AC

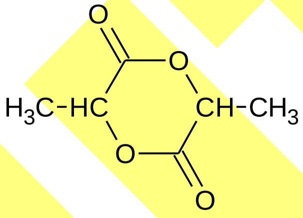
Sol. In (A) and (C) entropy of solution increases.

6. ABD

Sol. (A)



(B)



(C) $CH_3 – CH = CHCH_3$

7. ABD

Sol. Colligative properties depend on the number of solute particles.
0.2 M$CaCl_2$ has 0.2 × 3 = 0.6 mole particles.
0.3 MKCl has 0.3 × 2 = 0.6 mole particles
Similarly, B and D contain same number of particles

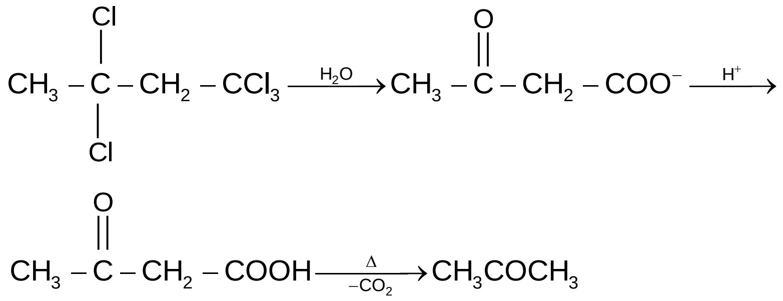
8. C

Sol. Oxidation number of iron remains zero even after heating.

9. B

10. A

Sol.



$$CH_3-\overset{Cl}{\underset{Cl}{C}}-CH_2-CCl_3 \xrightarrow{H_2O} CH_3-\overset{O}{\overset{||}{C}}-CH_2-COO^- \xrightarrow{H^+} CH_3-\overset{O}{\overset{||}{C}}-CH_2-COOH \xrightarrow[-CO_2]{\Delta} CH_3COCH_3$$

11. D

Sol. The elements are
Cu, Zn, Ga, Ge, As, Se, Br and Kr

12. D

Sol. Reagents in A,B,C convert phenol to anisole.

13. B

Sol. Q(g) is N_2

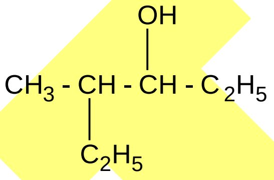
PART – B

1. 1.33 (Range 1.3 to 1.4)

Sol. $\Delta S(\text{adiabatic}) = nC_p \ell n\frac{T_2}{T_1}$

2. 1.5

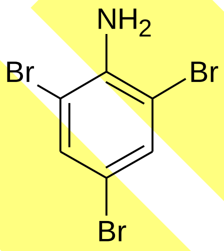
Sol. The product(P) is



$CH_3-\underset{C_2H_5}{CH}-\overset{OH}{CH}-C_2H_5$

3. 2.5

Sol. P is



4. 0.22[Range 0.2 to 0.3]

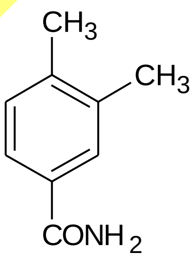
Sol. $p^H = p^{K_a} + \log\frac{[CH_3COONa]}{[CH_3COOH]}$

5. 3

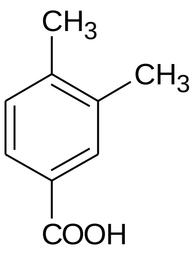
Sol. Sc^{3+} contains no d-electron. So back donation does not take place.

6. 0.9

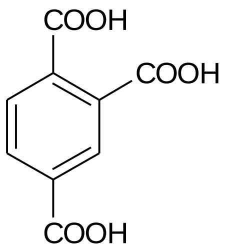
Sol. (P) is



, (Q) is



(R) is



7. 0.4

Sol. $K = 4 \times 10^{-3}$ ohm^{-1} cm^2

$$\Lambda_m = K \times \frac{1000}{M}$$

$$= 4 \times 10^{-3} \times \frac{1000}{0.1} = 40 \text{ ohm}^{-1} \text{ cm}^2\text{mol}^{-1}$$

$$\alpha = \frac{\Lambda_m}{\Lambda_m^0} = \frac{40}{100} = 0.4$$

8. 170

Sol. The complex is $[Cr(NH_3)_4Cl_2]Cl.2NH_3$

FIITJEE

SECTION-3 : MATHEMATICS

PART – A

1. AD

Sol. Let $\sqrt{y-x}=t$

$$y-x=t^2$$

$$\frac{dy}{dx}=2t\frac{dt}{dx}+1$$

$$2t\frac{dt}{dx}+1=\sqrt{t}$$

$\dfrac{2t}{\sqrt{t}-1}dt=dx$ which leads A and D as solutions

2. ABC

Sol. Let x_0 be the number of objects to the left of the first object chosen, x_1 the number of objects between the first and the second, x_2 the number of objects between the second and the third and x_3 the number of objects to the right of the third object. We have

$x_0, x_3 \ge 0,\ x_1, x_2 \ge 1$ and $x_0+x_1+x_2+x_3=n-3$ (1)

Put $x_1=y_1+1$ and $x_2=y_2+1$. Then (1) reads as

$x_0+y_1+y_2+x_3=n-5$ (2)

where $x_0, y_1, y_2, x_3 \ge 0$

The number of non – negative integral solution of (2) is ${}^{n-5+3}C_3={}^{n-2}C_3$

We have ${}^{n-2}C_3=\frac{1}{6}(n-2)(n-3)(n-4)$

Also, ${}^{n-3}C_3+{}^{n-3}C_2={}^{n-2}C_3$

3. ABD

Sol. The total number of ways of choosing the ticket is 1000. Let the four digits number on the ticket is 1000.

Let the four digits number on the ticket be $x_1x_2x_3x_4$.

Note that $0\le x_1+x_2\le 18$ and $0\le x_3+x_4\le 18$.

Also, the number of non – negative integral solutions of $x+y=m$ (with $0\le x,\ y\le 9$) is $m+1$ if $0\le m\le 9$ and is 19 – m if $10\le m\le 18$.

Thus, the number of favourable ways

$$=1\times1\times1+2\times2+.......+10\times10+9\times9+8\times8+.............+1\times1$$

$$=2\left\{\frac{9\times10\times19}{6}\right\}+100=670$$

$\therefore$ Probability of required event $=\dfrac{670}{1000}=0.067$

Note that $0.067>0.065$ and $0.067<0.068$.

4. ACD

Sol. $\displaystyle\sum_{k=1}^{n}\left(\sum_{m=1}^{k}m^2\right)=an^4+bn^3+cn^2+dn+e$

$$\Rightarrow\sum_{k=1}^{n}\left[\frac{k(k+1)(2k+1)}{6}\right]=an^4+bn^3+cn^2+dn+e$$

$$\Rightarrow\frac{1}{6}\left\{2\sum_{k=1}^{n}k^3+3\sum_{k=1}^{n}k^2+\sum_{k=1}^{n}k\right\}=an^4+bn^3+cn^2+dn+e$$

$$\Rightarrow \frac{1}{6}\left\{\frac{k^2(k+1)^2}{2}+\frac{k(k+1)(2k+1)}{2}+\frac{k(k+1)}{2}\right\}:$$

$an^4+bn^3+cn^2+dn+e$

$$\Rightarrow \frac{n^4}{12}+\frac{n^3}{3}+\frac{5n^2}{12}+\frac{n}{6}=an^4+bn^3+cn^2+dn+e$$

Therefore, $a=\frac{1}{12}; b=\frac{1}{3}; c=\frac{5}{12}; d=\frac{1}{6}; e=0$

5. AB

Sol: Let $f'(1)=a$ and $f''(1)=b$, putting x = 1 in the given equation we get $b=a^2$.
Differentiating the equation and putting x = 1 gives
$2ab+8=ab+2ab \Rightarrow ab=8 \Rightarrow a=2, b=4$

6. ABD

Sol: AB-BA is skew symmetric. Also in option C, $|A| \neq 0$. Rest are obvious.

7. BD

Sol: $(z-(1+2i))^4=1 \Rightarrow z=1^{1/4}+1+2i$

$z_1=1+2i+1=2+2i=\omega_2$

$z_2=1+2i-1=2i=\omega_3$

$z_3=1+2i+i=1+3i=\omega_1$

$z_4=1+2i-i=1+i=\omega_4$

$\lambda=5$ (circle on $\omega_1-\omega_4$ and $\omega_3-\omega_2$ will overlap)

8. D

Sol: Let there be a value of k for which $x^3-3x+k=0$ has two distinct roots between 0 and 1. Let a, b be two distinct roots of $x^3-3x+k=0$ lying between 0 and 1 such that $a<b$. Let $f(x)=x^3-3x+k$. Then $f(a)=f(b)=0$. Since between any two roots of a polynomial f(x) there exist at least one root of its derivative $f'(x)$. Therefore $f'(x)=3x^2-3$ has at least one root between a and b. But $f'(x)=0$ has two roots equal to ±1 which do not lie between a and b. Hence $f(x)=0$ has no real roots lying between 0 and 1 for any value of k.

9. A

Sol. Let $\alpha \in R-Q$ be a common root of $f(x)=0$ and $g(x)=0$.

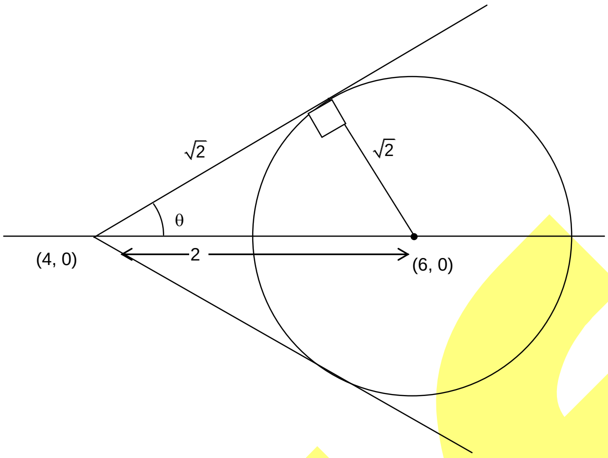
Then $\alpha^2=-a\alpha-b$. Substituting this in $\alpha^3+p\alpha+q=0$, we get $(a^2-b+p)\alpha+ab+q=0$

As α is irrational and $a,b,p,q \in Q$, $p=b-a^2$, $q=-ab$. This gives, $g(x)=(x-a)f(x)$.

10. A

Sol. From diagram, $\theta = 45^{o}$

$\Rightarrow$ Slope $= \pm 1$,



11. D

Sol. $x = -10$ is the directrix of the given parabola. Hence the circle S = 0 will touch it. P_1P_2 is the diameter. So $\angle P_1P\,P_2 = 90^{o}$ and hence ΔP_1PP_2 is right angled and its orthocentre is point P. Tangents at extremeties of focal chord are perpendicular. Hence in their combined equation (coefficient x^2) + (coefficient y^2) = 0.

12. C

Sol. Let $\cos^{-1}p = \alpha,\ \cos^{-1}q = \beta,\ \cos^{-1}r = \gamma$

$$\cos\alpha = p$$
$$\cos\beta = q$$
$$\cos\gamma = r$$
$$\alpha + \beta + \gamma = \pi$$
$$\Rightarrow \cos(\alpha + \beta) = \cos(\pi - \gamma)$$
$$\Rightarrow \cos\alpha\cos\beta - \sin\alpha.\sin\beta = -\cos\gamma$$
$$\Rightarrow pq - \sqrt{1-p^2}\ \sqrt{1-q^2} = -r$$
$$\Rightarrow pq + r = \sqrt{1-p^2}\ \sqrt{1-q^2}$$
$$2pqr + p^2q^2 + r^2 = (1-p^2)(1-q^2)$$
$$p^2 + q^2 + r^2 + 2pqr = 1$$

13. C

Sol. Let $x_0 = \cos\theta$, then $x_1 = \sqrt{\frac{1}{2}(1+\cos\theta)} = \cos\frac{\theta}{2},\ x_2 = \cos\left(\frac{\theta}{2^2}\right),\ x_3 = \cos\left(\frac{\theta}{2^3}\right)$.... and so on.

So that $\left[\dfrac{\sqrt{1-x_0^2}}{x_1x_2x_3\text{.......to infinite}}\right]$

$$= \frac{\sin\theta}{\cos\frac{\theta}{2}\cos\frac{\theta}{2^2}\text{......}\cos\frac{\theta}{2^n}\text{......infinite}}$$

$$= \frac{2\sin\frac{\theta}{2}\cos\frac{\theta}{2}}{\cos\frac{\theta}{2}\cos\frac{\theta}{2^2}\text{.....}\cos\frac{\theta}{2^n}\text{.....infinite}}$$

$$= \frac{2^2\sin\frac{\theta}{2^2}\cos\frac{\theta}{2^2}}{\cos\frac{\theta}{2^2}\cos\frac{\theta}{2^3}\text{.......}\cos\frac{\theta}{2^n}\text{.....infinite}}$$

$$= \lim_{n\to\infty} \frac{2^n \sin\frac{\theta}{2^n}}{\cos\frac{\theta}{2^{n+1}}}$$

$$= \lim_{n\to\infty} \theta \left(\frac{\sin\frac{\theta}{2^n}}{\frac{\theta}{2^n}}\right) \frac{1}{\cos\frac{\theta}{2^{n+1}}} = \theta$$

So that $\cos\left[\frac{\sqrt{1-x_0^2}}{x_1 x_2 .....\text{inf}}\right] = \cos\theta = x_0$

PART – B

1. 0.33

Sol. $\lim_{n\to\infty} \frac{(\cos x - 1)(\cos x - e^x)}{x^n}$

Limit $= \lim_{x\to 0} \frac{2\sin^2\frac{x}{2}}{2^2\left(\frac{x}{2}\right)^2} \frac{e^x - \cos x}{x^{n-2}} = \frac{1}{2}\lim_{x\to 0} \frac{e^x - \cos x}{x^{n-2}}$

$(n \neq 1$ for then the limit = 0)

$= \frac{1}{2}\lim_{x\to 0} \frac{e^x + \sin x}{(n-2)x^{n-3}}$.

So, if $n = 3$, the limit is $\frac{1}{2(n-2)}$ which is finite.

If $n = 4$, the limit is infinite.
Answer is 0.33.

2. 55

Sol. $(1-1+2-2+...+5-5)^2 =$

$1^2 + 1^2 + 2^2 + 2^2 + ... + 5^2 + 5^2 + 2S$.

3. 1

Sol. $\Delta = \sqrt{s(s-a)(s-b)(s-c)} = 6$

$\therefore r = \frac{\Delta}{s} = 1$

Answer is 1.

4. 0.5

Sol. Cubing on both sides apply
$\cos 3\theta = 4\cos^3\theta - 3\cos\theta$

5. 7

Sol. The problem corresponds to a selection of 4 non-consecutive integers out of first 10 natural numbers. Therefore $N = {}^7C_4$.

6. 1

Sol: Given expression $= \frac{(s-b)(s-c)}{(a-b)(a-c)} + \frac{(s-a)(s-c)}{(b-a)(b-c)} + \frac{(s-a)(s-b)}{(c-a)(c-b)} = 1$

7. 0.33

Sol: $\frac{4000}{a_1a_{4001}} = 10 \Rightarrow a_1a_{4001} = 400$

also $a_1 + a_{4001} = 50$

$\Rightarrow |a_1 - a_{4001}|^2 = 2500 - 1600$

$\Rightarrow |a_1 - a_{4001}| = 30$

8. 9

Sol. Equation of the tangent at P $(7\cos\theta, 5\sin\theta)$ on the ellipse is $\frac{x}{7}\cos\theta + \frac{y}{5}\sin\theta = 1$

then $(CF)^2 = \frac{7^2 \times 5^2}{5^2\cos^2\theta + 7^2\sin^2\theta}$

$= \frac{25 \times 49}{25\cos^2\theta + 49\sin^2\theta}$

Equation of the normal at P is $\frac{7x}{\cos\theta} - \frac{5y}{\sin\theta} = 7^2 - 5^2$

Coordinates of G are $\left(0, \frac{-24\sin\theta}{5}\right)$

$(PG)^2 = (7\cos\theta)^2 + \left(5\sin\theta + \frac{24\sin\theta}{5}\right)^2$

$= \frac{49}{25}\left(25\cos^2\theta + 49\sin^2\theta\right)$

So $(CF\,.\,PG)^2 = (49)^2 = 2401$

FIITJEE

FIITJEE RBT-6 for (JEE-Advanced)

PHYSICS, CHEMISTRY & MATHEMATICS

BATCHES – Two Yr CRP2123(All)

Pattern – 1

QP Code: 100191

PAPER - 1

Time Allotted: 3 Hours **Maximum Marks: 234**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections**.
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. Each **Section** is further divided into **Two Parts**: **Part-A & B** in the OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with HB pencil for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Two Parts.

(i) **Part-A (01-07) –** Contains seven (07) multiple choice questions which have **One or More** correct answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in –**2** marks, as a wrong option is also darkened.

(i) **Part-A (08-13) –** Contains six (06) multiple choice questions which have ONLY ONE CORRECT answer Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(ii) **Part-B (01-08)** contains eight (08) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+4 marks** for correct answer and **there will be no negative marking.**

Name of the Candidate :____

Batch :____________________ **Date of Examination :**____________________

Enrolment Number :____

SECTION-1 : PHYSICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

---

1. If the dimensions of length are expressed as $G^x c^y h^z$; where G, c and h are the universal gravitational constant, speed of light and Planck's constant respectively, then

(A) $x = \frac{1}{2}, y = \frac{1}{2}$ (B) $x = \frac{1}{2}, z = \frac{1}{2}$

(C) $y = \frac{1}{2}, z = \frac{3}{2}$ (D) $y = -\frac{3}{2}, z = \frac{1}{2}$

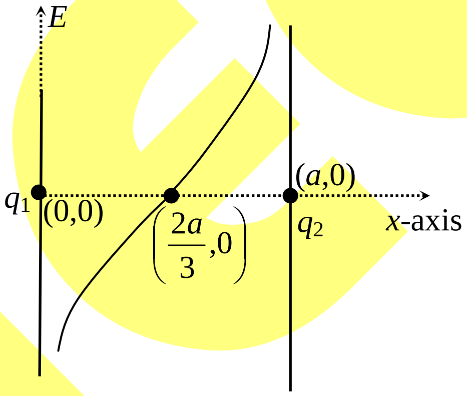
2. If the electric field *E* is plotted, with distance from q_1 along the line joining of two, then (*E* is positive along +ve *x*-axis) it looks as shown in figure. From the plot we can say that

(A) q_1 and q_2 both are negative

(B) $\left|\frac{q_1}{q_2}\right| = 4$

(C) q_1 is positive and q_2 is negative

(D) $\left|\frac{q_1}{q_2}\right| = \frac{1}{4}$



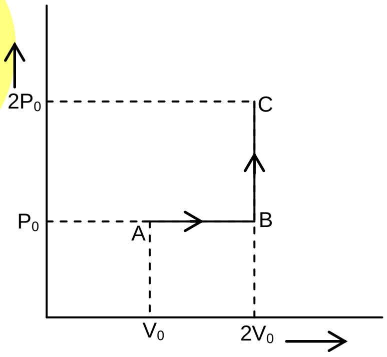
3. One mole of an ideal monoatomic gas is taken from A to C along the path ABC. The temperature of the gas at A is T_0. For the process ABC (where R is gas constant)

(A) Heat absorbed by the gas is $\frac{11}{12}RT_0$

(B) Heat absorbed by the gas is $\frac{11}{2}RT_0$

(C) Work done by the gas = RT_0

(D) Change in internal energy of gas is $\frac{9}{2}RT_0$



4. The threshold wavelength for photoelectric mission from a material is 5200 Å. Photoelectrons will be emitted when this material is illuminated with monochromatic radiation from a:

(A) 50 watt infrared lamp (B) 20 watt infrared lamp

(C) 50 watt ultraviolet lamp (D) 20 watt ultraviolet lamp

Space For Rough Work

5. A capacitor is charged to a potential of V_0. It is connected with an inductor through a switch S. The switch is closed at time t = 0. Which of the following statements are correct?

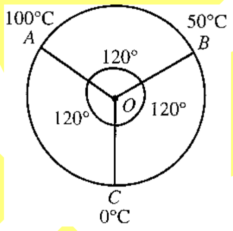
(A) The maximum current in the circuit is $V_0\sqrt{\dfrac{C}{L}}$

(B) Potential across capacitor becomes zero for the first time at time t = $\pi\sqrt{LC}$

(C) Energy stored in the inductor at time $t = \dfrac{\pi}{2}\sqrt{LC}$ is $\dfrac{1}{4}CV_0^2$

(D) Maximum energy stored in the inductor is $\dfrac{1}{2}CV_0^2$

6. A circular ring (centre O) of radius a, and of uniform cross section is made up of three different metallic rods AB, BC & CA joined together at the points A, B and C in pairs) of thermal conductivities α_1, α_2 and α_3, respectively (see diagram). The junction A, B and C are maintained at the temperatures 100°C, 50°C and 0°C, respectively. All the rods are of equal lengths and cross sections. Under steady state conditions, assume that no heat is lost from the sides of the rods. Let Q_1, Q_2 and Q_3 be the rates of transmission of heat along the three rods AB, BC and CA. Then which of the following is/are correct?



(A) $Q_1 = Q_2 = Q_3$ and all are transmitted in the clockwise sense
(B) Q_1 and Q_2 flow in clockwise sense and Q_3 in the anticlockwise sense
(C) $Q_1 : Q_2 : Q_3 :: \alpha_1 : \alpha_2 : 2\alpha_3$
(D) $\dfrac{Q_1}{\alpha_1} + \dfrac{Q_2}{\alpha_2} = \dfrac{Q_3}{\alpha_3}$

7. A 10 m long horizontal stainless steel wire AB of mass 1 kg whose end A is fixed, is connected to a massless string BC passing over a smooth pulley. String BC is connected to a container of mass 2 kg at end C. Water (density = 1×10^3 kg/m^3) is poured in the container at a constant rate of 2.25 litre/sec at t = 0. Also at t = 0, a pulse is generated at end A. Choose from the following the correct option(s).
(A) Time taken by the pulse to reach point B is 0.612 sec
(B) Time taken by the pulse to reach point B is 0.212 sec
(C) Tension in the string at this moment is 33.77 N
(D) Tension in the string at this moment is 24.77 N

Space For Rough Work

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

8. A dipole of dipole moment *p* is kept at the centre of a ring of radius *R* and charge *q*. The dipole moment has direction along the axis of the ring. The resultant force on the ring due to the dipole is

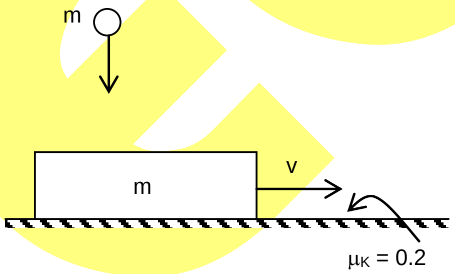
(A) zero

(B) $\frac{pq}{4\pi\varepsilon_0 R^3}$

(C) $\frac{pq}{2\pi\varepsilon_0 R^3}$

(D) $\frac{pq}{4\pi\varepsilon_0 R^3}$ only if the charge is uniformly distributed on the ring.

9. A ball of mass m falls vertically from a height h and collides with a block of equal mass m moving horizontally with a velocity v on a surface. The coefficient of kinetic friction between the block and the surface is $\mu_k = 0.2$, while the coefficient of restitution (e) between the ball and the block is 0.5. There is no friction acting between the ball and the block. The velocity of the block just after the collision decreases by



(A) $0.5\sqrt{2gh}$ (B) 0 (C) $0.1\sqrt{2gh}$ (D) $0.3\sqrt{2gh}$

10. Consider elastic collision of a particle of mass m moving with a velocity u with another particle of the same mass at rest. After the collision the projectile and the struck particle move in direction making angle θ_1 and θ_2 respectively with the initial direction of motion. The sum of the angle $\theta_1 + \theta_2$ is

(A) 45^0 (B) 90^0 (C) 135^0 (D) 180^0

11. A ball is dropped from a height of 20 m above the surface of water in a lake. The refractive index of water is 4/3. A fish inside the lake, in the line of fall of the ball, is looking at the ball. At an instant when the ball is 12.8 m above the water surface the fish see the speed of ball as

(A) 9 m/s (B) 12 m/s (C) 16 m/s (D) 21.33 m/s

12. In Bohr model of the hydrogen atom, let R, V and E represent the radius of the orbit, speed of the electron and the total energy of the electron respectively. Which of the following quantities are proportional to the quantum number n:

(A) VR (B) RE (C) V (D) $\frac{R}{E}$

Space For Rough Work

13. A particle of mass *m* and charge *q* is projected in a region where an electric field is existing and given by $\vec{E} = E_0\hat{i}$, with a velocity $v_0\hat{j}$ from the origin at time *t* = 0, then choose the correct statement (assuming $m^2v_0^2 = 2qE_0mx_0$).
(A) radius of curvature of the particle when its *x*-coordinate becomes x_0 is $2x_0$.
(B) radius of curvature of the particle when its *x*-coordinate becomes x_0 is $4\sqrt{2}\,x_0$.
(C) speed of the particle when its *x*-coordinate becomes x_0 is v_0.
(D) speed of the particle when its *x*-coordinate becomes x_0 is $2v_0$.

PART – B

(Numerical based)

This section contains **8 Numerical based questions**, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

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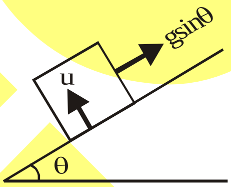
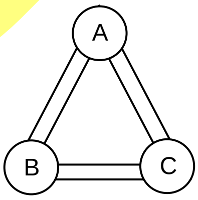
1. A cabin is moved up the inclined plane with constant acceleration g sinθ. A particle is projected with some velocity in a direction perpendicular to the inclined plane. If maximum height attained by particle perpendicular to inclined plane is same as range of particle with respect to the cabin parallel to plane then calculate values of cotθ.



2. Three metallic blocks A, B and C have masses m, m and 2m respectively. Specific heat of A, B and C are C, 2C and C respectively. Initial temperature of A, B and C are 10°C, 5°C and 5°C respectively. Now the blocks are connected by 3-identical rods as shown. Find the final temperature of block A on Celsius scale (Neglect any heat loss due to radiation).



3. In an AC circuit the phase difference between emf and current is π/3 then the power factor of the circuit is n. Find ‘n’.

4. A thin uniform rod of mass ‘m’, length ‘ℓ’ rotates uniformly about a vertical axis ω, form a conical pendulum, the upper end of the rod is hinged and θ is angle between rod and vertical. If the change of angular momentum of the rod about hinge is $\frac{m\ell^2}{x}\omega^2\sin 2\theta$ then the value of ‘x’ will be

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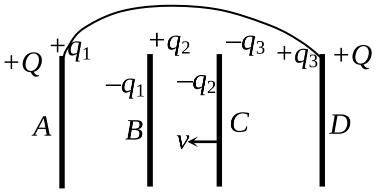
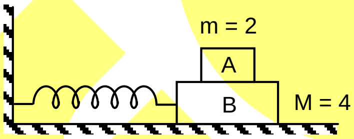
Space For Rough Work

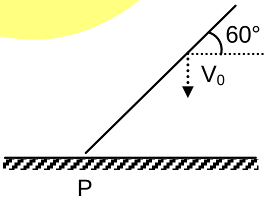


5. In the diagram there are four conducting plates A, B, C and D placed parallel to each other at equal separation L. If plate C starts moving towards plate B with velocity v. The current (in mA) flowing in the wire connecting A and D is ‘2y’. Find ‘y’. (assume all other plates to be fixed) (Given: $q_2 = 5\mu C$, $q_3 = 10\mu C$, v = 10 m/s, L = 0.05 m)

6. A mono-atomic gas undergo a process such that $P \propto \frac{1}{T^2}$. If final temperature is twice that of initial temperature of the gas in given process and molar heat capacity for this process is $\frac{nR}{2}$ then value of ‘n’ is



7. Block B of mass 4 kg resting on a frictionless horizontal surface and connected with spring of spring constant K = 10 as shown in figure. Another block A of mass 2 kg is placed on the top of block B. Co-efficient of friction between the blocks is $\mu = 0.5$. Body B is displaced and released such that both bodies are moving together and perform simple harmonic motion. Maximum oscillation amplitude that permits body A and B to move together without slipping between the surfaces in contact of body A and B. (Consider $g = 10\ m/sec^2$).



8. A rod of length $\ell = \frac{6}{7}$ meter forming an angle 60° with horizontal strikes a frictionless floor at point P with its velocity v_0 = 2 meter/second in downward direction and no angular velocity. Assume that collision at point P is perfectly elastic then angular velocity of the rod just after collision is

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Space For Rough Work

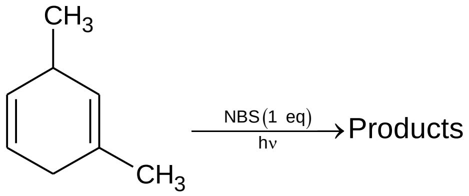
SECTION-2 : CHEMISTRY

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. Which order is/are correct for OCl_2, NCl_3 and BF_3 molecules?
(A) Tendency to form back π-bond: $BF_3 > OCl_2 > NCl_3$
(B) Polarity of covalent bond: $B – F > O – Cl > N – Cl$
(C) Dipole moment: $BF_3 > OCl_2 > NCl_3$
(D) Hydrolysis: $BF_3 > OCl_2 > NCl_3$

2. 

The characteristic(s) of the major product of above reaction is
(A) it is a conjugated cyclic diene.
(B) an α-keto acid is one of it's oxidation product.
(C) it contains five allylic hydrogen atoms.
(D) it forms an ether when reacts with aq. KOH

3. Which of the following are colourless or pale colour complexes?
(A) $[Mn(H_2O)_6]^{2+}$ (B) $[Mn(CN)_6]^{4-}$
(C) $[FeF_6]^{3-}$ (D) $[Fe(CN)_6]^{3-}$

4. Choose the incorrect statement(s) regarding the face centred cubic unit cell of a metal lattice?
(A) The metal atoms are present at the lattice points as well as voids.
(B) The metal atoms touch each other along the face diagonal.
(C) The body diagonal contains a relative number of $\frac{5}{4}$ atoms.
(D) The interatomic attraction force is uniform through out the crystal.

Space For Rough Work

5. $\left[Cr(H_2O)_6\right]^{3+} + 6NH_3 \longrightarrow \left[Cr(NH_3)_6\right]^{3+} + 6H_2O$

Which reaction(s) is/are thermodynamically more favourable then the one given above

(A) $\left[Cr(NH_3)_6\right]^{3+} + 3\,en \longrightarrow \left[Cr(en)_3\right]^{3+} + 6NH_3$

(B) $CrCl_3 \xrightarrow[\text{Reducing agent}]{CO} Cr(CO)_6$

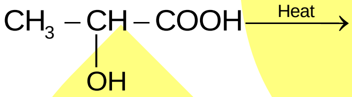
(C) $\left[Cr(NH_3)_6\right]^{3+} + 2\,dien \longrightarrow \left[Cr(dien)_2\right]^{3+} + 6NH_3$

(D) $Cr(OH)_3 + OH^- \longrightarrow \left[Cr(OH)_4\right]^-$

6. The product(s) of which reaction(s) show geometrical isomerism?

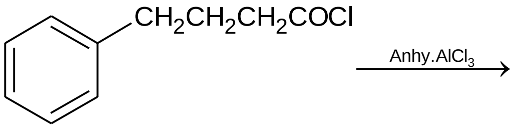
(A) $CH_3-CH=CH-C_2H_5 + CH_2N_2 \xrightarrow{\text{Heat}}$

(B)

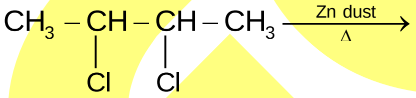


$CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-COOH \xrightarrow{\text{Heat}}$

(C)



(D)



$CH_3-\underset{\displaystyle Cl}{\underset{|}{CH}}-\underset{\displaystyle Cl}{\underset{|}{CH}}-CH_3 \xrightarrow[\Delta]{\text{Zn dust}}$

7. Which of the following solutions mixtures show identical colligative properties? [Assume complete dissociation of salts]

(A) 0.2 M $CaCl_2$ and 0.3 M KCl
(B) 0.4 M $C_6H_{12}O$ and 0.2 NaCl
(C) 0.1 M $AlCl_3$ and 0.1 M NH_2CONH_2
(D) 0.4 M $K_4[Fe(CN)_6]$ and 0.5 M $K_3[Fe(CN)_6]$

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

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8. The incorrect statement regarding $Fe(CO)_5$ is

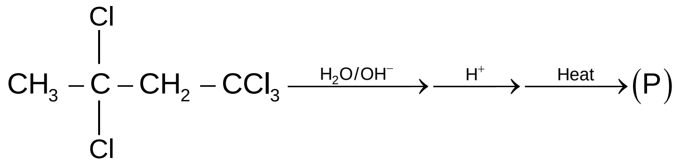
(A) it has trigonal bipyramidal structure
(B) both sigma donation and pi-acceptance takes place by the CO ligands
(C) on heating the complex, the oxidation number of Fe decreases as CO is a reducing agent
(D) the CO bond length in the complex increases as compared to the free CO

9. Which is correct statement for an ideal solution?

(A) The mole fraction of solute should be less than that of the solvent.
(B) The entropy of the system increases and that of the surrounding does not change
(C) $\Delta H_{mix} > 0$
(D) $\Delta G_{mix} = 0$

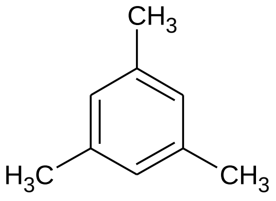
Space For Rough Work

10.



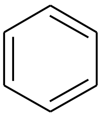
$$CH_3-\overset{\overset{Cl}{|}}{\underset{\underset{Cl}{|}}{C}}-CH_2-CCl_3 \xrightarrow{H_2O/OH^-} \xrightarrow{H^+} \xrightarrow{Heat} (P)$$

Which is a characteristic of (P)?

(A)  is formed when (P) reacts with hot conc. H_2SO_4

(B) in aqueous solution(P) remains in four different forms

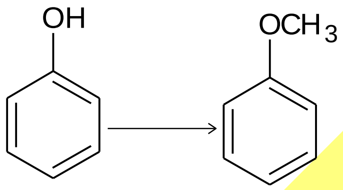
(C) reaction of (P) with CH_3MgBr, forms secondary alcohol

(D) when heated in Al-tube,(P) forms 

11. How many elements of the fourth period of periodic table, contains 10 electrons in their orbitals, which azimuthal quantum number is 2?

(A) 10 (B) 5 (C) 6 (D) 8

12.



Which reagent can't be used for above reaction?

(A) CH_2N_2/Δ

(B) KOH and CH_3Cl

(C) CH_3Br and Na

(D) Cl_2/H_2O and CH_3OH

13. $(NH_4)_2Cr_2O_7(s) \xrightarrow{Heating} P(s) + Q(g) + H_2O$

Select the incorrect statement

(A) the equivalent mass of $(NH_4)_2Cr_2O_7$ in above reaction is $\frac{M}{6}$

M = Molar mass of $(NH_4)_2Cr_2O_7$ in g mol^{-1} unit

(B) Q(g) is NH_3

(C) P(s) is a green solid

(D) P(s) is dissolve in HCl

Space For Rough Work

PART – B

(Numerical based)

This section contains **8 Numerical based questions**, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

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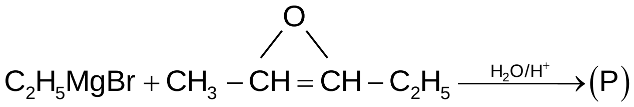
1. One mole of an ideal gas at 0.1 atm and 300 K, was heated to 320 K at constant pressure, this results in expansion of the gas. What is the entropy change of this reversible process in JK^{-1} mol^{-1} unit?

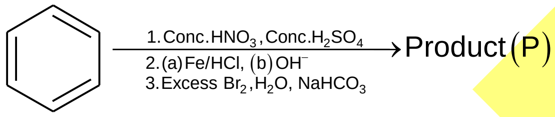
   [$\ell n(1.066) = 0.064$, $R = 8.3\ J\ K^{-1}\ mol^{-1}$, $C_P = \frac{5}{2}R$]

2. 

   $C_2H_5MgBr + CH_3 - \overset{O}{CH = CH} - C_2H_5 \xrightarrow{H_2O/H^+} (P)$

   If x = Number of chiral carbon atoms in organic product P
   and y = Number of optical isomers possible for P

   What is the value of $\frac{x+y}{4}$?

3. 

   1. Conc. HNO_3, Conc. H_2SO_4
2. (a) Fe/HCl, (b) OH^-
3. Excess Br_2, H_2O, $NaHCO_3$
Product (P)

   If the molar mass of the product(P) is expressed as (120x + 30) g mol^{-1}, what is the value of x? [At mass of Br = 80 g mol^{-1}]

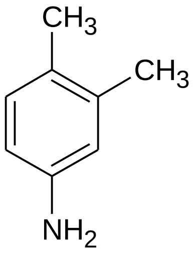
4. One litre of a buffer solution contains 0.5 mole of CH_3COONa and 0.3 mole of CH_3COOH. The pH of the solution is x. Now 0.1 mole of H^+ is added to the buffer solution, the pH changes to y. What is the value of |x – y}?

   [K_a of $CH_3COOH = 10^{-5}$][log $\frac{0.5}{0.3}$ = 0.22]

5. The octacarbonyl of Scandium does not involve back donation from metal to ligand. So the complex is weaker than that of other 3d-series metal. If the oxidation number of scandium in the carbonyl is +x, what is the value of x?

Space For Rough Work

6. Reaction of an organic compound(P) with Br_2 and KOH form an amine having the following structure.



$P \xrightarrow{H_2O/H^+} Q \xrightarrow{MnO_4^-/H^+} R$

If the sum of the number of oxygen atoms present in(P), (Q) and (R) is expressed as 10x, what is the value of ‘x’?

7. The specific conductance or conductivity of an electrolyte AB is 4×10^{-3} $ohm^{-1}cm^{-1}$. What will be the degree of dissociation of the electrolyte in 0.1 M aqueous solution, if the limiting molar conductance Λ_m^0 is 100 ohm^{-1} cm^2mol^{-1}

8. The molecular formula of an octahedral complex is $CrN_6H_{18}Cl_3$. it shows cis- and trans isomerism and ionise in aqueous solution. If one mole of the complex is dissolved in water. How much gram of $AgNO_3$ is needed to produce sufficient amount of AgCl precipitate?

Space For Rough Work

FIITJEE

SECTION-3 : MATHEMATICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

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1. The solution of $\frac{dy}{dx}=\sqrt{y-x}$ is given by

(A) $x+C=2\sqrt{y-x}+2\log\left(\sqrt{y-x}-1\right)$
(B) $x^2+C=2\sqrt{y-x}+\log\left(\sqrt{y-x}-1\right)$
(C) $x+C=(y-x)^2+\log(y-x-1)$
(D) $\sqrt{y-x}-1=C'\,e^{x/2-\sqrt{y-x}}$

2. If n objects are arranged in a row, then the number of ways of selecting three of these objects so that no two of them are next to each other is

(A) $\frac{1}{6}(n-2)(n-3)(n-4)$
(B) ${}^{n-2}C_3$
(C) ${}^{n-3}C_3+{}^{n-3}C_2$
(D) none of these

3. A four digit number (numbered from 0000 to 9999) is said to be lucky if the sum of first two digits is equal to the sum of its last two digits. If a four digit number is picked up at random, then the probability that it is lucky is

(A) >0.065
(B) <0.068
(C) 0.066
(D) 0.067

4. If $\sum_{k=1}^{n}\left(\sum_{m=1}^{k}m^2\right)=an^4+bn^3+cn^2+dn+e$, then

(A) $a=\frac{1}{12}$
(B) $b=\frac{1}{16}$
(C) $d=\frac{1}{6}$
(D) $e=0$

5. The function $f:R\to R$ satisfies $f\left(x^2\right)f''(x)=f'(x)f'\left(x^2\right)\ \forall x\in R$, given that $f(1)=1$ and $f'''(1)=8$, then

(A) $f'(1)=2$
(B) $f''(1)=4$
(C) $f'(1)=4$
(D) $f''(1)=2$

Space For Rough Work

6. Which of the following are CORRECT?

(A) If A and B are symmetric matrices of order 3 then $|AB - BA| = 0$

(B) If A and B are square matrices of order 'n' such that $AB = I_n$, then $BA = I_n$.

(C) The matrix $A = \begin{bmatrix} 9017 & 5148 & 7220 \\ 1234 & 2117 & 4848 \\ 4320 & 3648 & 1179 \end{bmatrix}$ is non-invertible.

(D) If two square matrices A and B of same order commute, then all positive integral powers of A and B commute.

7. Let solutions of the equation $(z-1-2i)^4 = 1$ be $\omega_1, \omega_2, \omega_3, \omega_4$ such that $|\omega_1| > |\omega_2| > |\omega_3| > |\omega_4|$. If $\arg\left(\frac{z-\omega_i}{z-\omega_j}\right) = \pm\frac{\pi}{2}$ represents a circle, then for different values of i, j where $i, j \in \{1, 2, 3, 4\}$, $i \neq j$ the number of different circles is λ, where λ lies in

(A) $\left[\frac{42\pi}{22}, \frac{49\pi}{22}\right]$ (B) $\left[\frac{35\pi}{22}, \frac{42\pi}{22}\right]$ (C) $\left[\frac{31\pi}{22}, \frac{37\pi}{22}\right]$ (D) $\left[\frac{29\pi}{22}, \frac{3\pi}{2}\right]$

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

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8. The number of values of k for which the equation $x^3 - 3x + k = 0$ has two distinct roots lying in the interval (0, 1) is
(A) three (B) two
(C) infinitely many (D) zero

9. Let $a, b, p, q \in Q$ and suppose that $f(x) = x^2 + ax + b = 0$ and $g(x) = x^3 + px + q = 0$ have a common irrational root, then
(A) $f(x)$ divides $g(x)$ (B) $g(x) = x\, f(x)$
(C) $g(x) = (x - b - q) f(x)$ (D) none of these

10. The focal chord to $y^2 = 16x$ is tangent to $(x-6)^2 + y^2 = 2$, then the possible value of the slope of this chord, are
(A) $\{-1, 1\}$ (B) $\{-2, 2\}$ (C) $\left\{-2, \frac{1}{2}\right\}$ (D) $\left\{2, \frac{-1}{2}\right\}$

Space For Rough Work

11. Consider parabola $y^2 = 40x$, A circle $S = 0$ is drawn taking one of its focal chord as diameter. The extremeties of the focal chord being P_1 and P_2. A point 'P' is taken on the circumference of S = 0, then

(A) $\angle P_1PP_2 = \frac{\pi}{4}$

(B) x = 10 is a tangent to S = 0

(C) Combined equation of the tangents at P_1 and P_2 has $\left(\text{coeff. } x^2\right) + \left(\text{coeff. } y^2\right) = -2$

(D) Orthocenter of ΔP_1PP_2 lies on it

12. If $\cos^{-1}p + \cos^{-1}q + \cos^{-1}r = \pi$. Then value of $p^2 + q^2 + r^2 + 2pqr + 4$ is equal to

(A) 1 (B) 0

(C) 5 (D) 3

13. If $x_{n+1} = \sqrt{\frac{1}{2}(1+x_n)}$, then $\cos\left[\frac{\sqrt{1-x_0^2}}{x_1x_2x_3\text{......to infinite}}\right]\left(-1 < x_0 < 1\right)$ is equal to

(A) –1 (B) 1

(C) x_0 (D) $\frac{1}{x_0}$

PART – B

(Numerical based)

This section contains **8 Numerical based questions**, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

1. The integer n for which $\lim\limits_{n\to\infty} \frac{(\cos x - 1)\left(\cos x - e^x\right)}{x^n}$ is a finite non – zero number, then $\frac{1}{n}$ is

2. The sum of the products of the ten numbers $\pm 1, \pm 2, \pm 3, \pm 4$, and ± 5 taking two at a time is x, then $|x| =$

3. The circles having radii 1, 2, 3 touch each other externally then find the radius of the circle which cuts the three circles orthogonally.

4. If $x + \frac{1}{x} = 2\cos 20^{\circ}$, then the value of $\frac{1}{\left(x^3 + \frac{1}{x^3}\right)^{-1} + 1}$ is equal to

Space For Rough Work

5. Let $A=\{3,4,5,6\}$ and $B=\{1,2,3,...,10\}$ be two sets. Let a function f be defined from set A to set B, such that $f(i)-f(j)\ge 2\ \forall i>j$, where $i,j\in A$. If the number of such functions is N, then the value of $\frac{N}{5}$ is

6. In a scalene triangle ABC, the value of $\Delta\left[\frac{\tan\frac{A}{2}}{(a-b)(a-c)}+\frac{\tan\frac{B}{2}}{(b-a)(b-c)}+\frac{\tan\frac{C}{2}}{(c-a)(c-b)}\right]$ is (all notations are standard)

7. Let $a_1,a_2,a_3.....,a_{4001}$ are in A.P such that $\frac{1}{a_1a_2}+\frac{1}{a_2a_3}+...+\frac{1}{a_{4000}a_{4001}}=10$ and $a_2+a_{4000}=50$ then $\frac{10}{|a_1-a_{4001}|}$ is equal to

8. If CF is perpendicular from the centre C of the ellipse $\frac{x^2}{49}+\frac{y^2}{25}=1$ on the tangent at any point P, and G is the point where the normal at P meets the minor axis, then $(C.F.\ PG)^2$ is equal to $(40+\lambda)^2$ then $\lambda=$

Space For Rough Work

Q.P. Code: 100191

Answers

SECTION-1 : PHYSICS

PART – A

1.	**BD**	2.	**AB**	3.	**BCD**	4.	**CD**
5.	**AD**	6.	**BCD**	7.	**AC**	8.	**B**
9.	**D**	10.	**B**	11.	**C**	12.	**A**
13.	**B**						

PART – B

1.	**8**	2.	**6**	3.	**0.5**	4.	**6**
5.	**0.5**	6.	**9**	7.	**3**	8.	**8**

SECTION-2 : CHEMISTRY

PART – A

1.	AB	2.	ABC	3.	AC	4.	AC
5.	AC	6.	ABD	7.	ABD	8.	C
9.	B	10.	A	11.	D	12.	D
13.	B						

PART – B

1.	1.33 (Range 1.3 to 1.4)			2.	1.5	3.	2.5
4.	0.22[Range 0.2 to 0.3]			5.	3	6.	0.9
7.	0.4	8.	170				

SECTION-3 : MATHEMATICS

PART – A

1.	AD	2.	ABC	3.	ABD	4.	ACD
5.	AB	6.	ABD	7.	BD	8.	D
9.	A	10.	A	11.	D	12.	C
13.	C						

PART – B

1.	0.33	2.	55	3.	1	4.	0.5
5.	7	6.	1	7.	0.33	8.	9

Answers & Solutions

SECTION-1 : PHYSICS

PART – A

1. **BD**

Sol. Length $\propto G^x c^y h^z$

$$L = \left[M^{-1}L^3T^{-2}\right]^x \left[LT^{-1}\right]^y \left[ML^2T^{-1}\right]^z$$

By comparing the power of M, L and T in both sides we get

$-x + z = 0, 3x + y + 2z = 1$ and $-2x - y - z = 0$

By solving above three equations we get

$$x = \frac{1}{2}, y = -\frac{3}{2}, z = \frac{1}{2}$$

2. **AB**

Sol. q_1 and q_2 both are negative and $\dfrac{kq_1}{\left(\frac{2a}{3}\right)^2} = \dfrac{kq_2}{\left(\frac{a}{3}\right)^2} \Rightarrow \dfrac{q_1}{q_2} = 4$.

3. **BCD**

Sol. f = 3, n = 1 $\quad P_0V_0 = nRTo$

$$H_{AB} = P_o\left(2V_o - V_0\right) + \frac{3}{2}P_o\left(2V_o - V_o\right) = \frac{5}{2}P_oV_o = \frac{5RT_0}{2}$$

$$H_{BC} = \frac{fn}{2}R\left(T_c - T_B\right) = \frac{3}{2}\left(2P_o2V_o - P_o2V_o\right) = 3P_oV_o = 3RTo$$

$$H_{AB-c} = \frac{5}{2}RT_O + 3RT_O = \frac{11}{2}RT_O$$

$$W_{AB-C} = P_oV_o + 0 = RT_O$$

$$\Delta UA - B - C = H_{ABC} - W_{ABC} = \frac{9}{2}RT_O$$

4. **CD**

Sol. Threshold frequency is independent of intensity.

5. **AD**

Sol. $\frac{1}{2}Li_{max}^2 = \frac{1}{2}CV_o^2$

6. **BCD**

Sol. The flow of heat will always be in the direction of the temperature gradient from higher to lower temperature. Hence Q_1 in rod AB, Q_2 in rod BC will both be in clockwise sense while Q_3 in CA will be in anti-clockwise sense. Also, we have if L is the length of each rod and A its area of cross-section,

$$Q_1 = \frac{\alpha_1 A\left(100 - 50\right)}{L} = \left(50\,\alpha_1\right)\frac{A}{L}$$

$$Q_2 = \frac{\alpha_2 A\left(50 - 0\right)}{L} = \left(50\,\alpha_2\right)\frac{A}{L}$$

$$Q_3 = \frac{\alpha_3 A\left(100 - 0\right)}{L} = \left(100\,\alpha_3\right)\frac{A}{L}$$

Hence, $Q_1 : Q_2 : Q_3 :: \alpha_1 : \alpha_2 : 2\alpha_3$

Also,

$$\frac{Q_1}{\alpha_1}+\frac{Q_2}{\alpha_2}=\left(50\frac{A}{L}\right)+\left(50\frac{A}{L}\right)=\frac{100A}{L}=\frac{Q_3}{\alpha_3}$$

7. **AC**

Sol. Mass per unit length of the wire = 0.1 kg/m.
At any instant, tension in the string is (2 + 2.25 t) g N

$$v=\sqrt{\frac{(2+2.25\,t)g}{0.1}}$$

$$\int_0^{10} dx = 10\int_0^t \sqrt{2+2.25\,t}\,dt$$

$t = 0.612$ s

$$T=\left(2+2.25\times 0.612\right)\times 10 = 33.77\text{ N}$$

8. **B**

Sol. The electric field due to the dipole on the circumference of the ring $E=\dfrac{p}{4\pi\varepsilon_0 R^3}$ and it is directed normal to the plane of charged ring.

Hence force on the charged ring $F = qE = \dfrac{pq}{4\pi\varepsilon_0 R^3}$

9. **D**

Sol. $\int N dt = \dfrac{3MV}{2}$; $\dfrac{\int \mu N dt}{m} = \Delta V$

10. **B**

Sol. Property of perfectly elastic collision.

11. **C**

Sol. $V=\dfrac{4}{3}\sqrt{2\times 10\times 7.2}=16$

12. **A**

Sol. $Vr=\dfrac{nh}{2\pi m}$, $rV \propto n$; $r \propto n^2$

$E \propto 1/n^2$ and $V \propto 1/n$

13. **B**

Sol. $v^2 = v_0{}^2 + 2\left(\dfrac{qE_0}{m}\right)x_0$

$v=\sqrt{2}v_0$

$$a_n=\frac{qE_0}{m}\,\frac{v_0}{\sqrt{v_x^2+v_0^2}}$$

$$R=\frac{v^2}{a_n}=\frac{[m^2v_0^2+2qE_0mx_0]^{\frac{3}{2}}}{qE_0v_0m^2}=4\sqrt{2}\,x_0$$

PART – B

1. **8**

Sol. Maximum height = $\frac{u^2}{2g\cos\theta}$ …(i)

Range = $\frac{1}{2}\times 2g\sin\theta\times\left(\frac{2u}{g\cos\theta}\right)^2$ …(ii)

From (i) and (ii) cot θ = 8.

2. **6**

Sol. mc (10 – T) = m 2c (T–5) + 2mC (T-5)
T = 6°C.

3. **0.5**

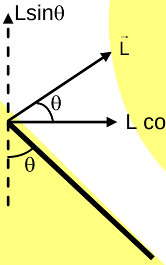
Sol. Power factor = cos ϕ = cos π/3 = 1/2.

4. **6**

Sol. $\left|\frac{d\vec{L}}{dt}\right| = L\cos\theta\omega$

$= \frac{m\ell^2}{3}\omega\sin\theta\cos\theta\omega$

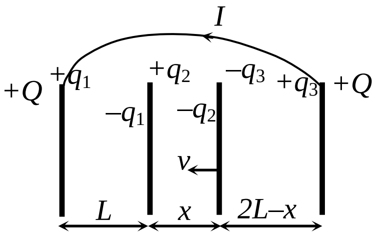
$= \frac{m\ell^2}{3}\omega^2\sin\theta\cos\theta$



5. **0.5**

Sol. $\frac{2q_1L}{2A\varepsilon_0}+\frac{2q_2x}{2A\varepsilon_0}-\frac{2q_3(2L-x)}{2A\varepsilon_0}=0$ … (i)

$I=\frac{dq_1}{dt}=\frac{-dq_3}{dt}=\frac{dq_2}{dt}$ … (ii)



From (i),

$q_1L+q_2x-2q_3L+q_3x=0$

$\Rightarrow \quad L\frac{dq_1}{dt}+x\frac{dq_2}{dt}+q_2\frac{dx}{dt}-2\frac{dq_3}{dt}L+x\frac{dq_3}{dt}+q_3\frac{dx}{dt}=0$

$\Rightarrow \quad I=\frac{v}{3L}(q_2+q_3)$ = 1 mA

6. **9**

Sol. $P\propto\frac{1}{T^2}$. ⇒ PT^2 = constant

$P\left(\frac{PV}{nR}\right)^2$ = constant

P^3V^2 = constant

$PV^{2/3}$ = constant

Molar heat capacity $C=C_V+\frac{R}{1-x}$

$C=C_V+\frac{R}{1-\frac{2}{3}}=\frac{3R}{2}+3R=\frac{9R}{2}$

7. **3**

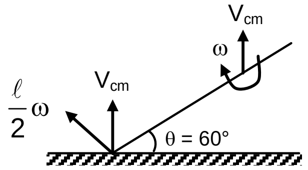
Sol. $m\omega^2 A \le \mu mg$

$$A \le \frac{\mu g}{\left[\frac{K}{(m+M)}\right]}$$

$$A \le \frac{0.5\times 10}{\left(\frac{10}{6}\right)} \le 3$$

8. **8**

Sol.



Impulse $I = m(V_{cm} + V_0)$ …(1)

Angular Impulse $I\left(\frac{\ell}{2}\cos\theta\right) = \frac{m\ell^2}{12}\omega$ …(2)

$\because$ e = 1

$\Rightarrow$ $V_0 = V_{cm} + \frac{\ell}{2}\omega\cos\theta$ …(3)

From equation (1) and (2)

$$m(V_{cm} + 2)\frac{\ell}{2}\cos\theta = \frac{m\ell^2}{12}\omega$$

$$(V_{cm} + 2)\frac{3}{\ell} = \omega$$

$\Rightarrow$ $V_{cm} = \frac{\omega\ell}{3} - 2$ …(4)

From equation (3) and (4)

$$2 = \frac{7\omega\ell}{12} - 2$$

$\Rightarrow$ $\omega = 8$.

SECTION-2 : CHEMISTRY

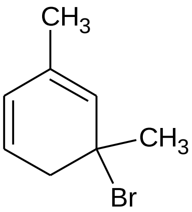
PART – A

1. AB

Sol. Back bond is stronger in BF_3 as compared to OCl_2 due to energy difference between overlapping orbitals. NCl_3 does not form back π-bond due to less electronegativity difference between N and Cl.

2. ABC

Sol. The major product is



3. AC

Sol. Due to $t_{2g}^{3}e_{g}^{2}$ configuration of Mn^{2+} and Fe^{3+} in their respective weak field complexes.

4. AC

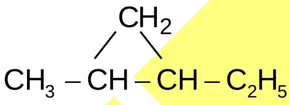
Sol. Close packing takes place along the face diagonal. No atom occupy the voids, as voids can hold smaller atoms or ions.

5. AC

Sol. In (A) and (C) entropy of solution increases.

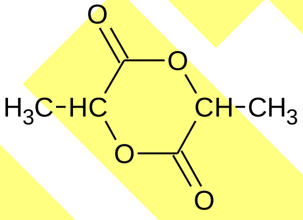
6. ABD

Sol. (A)



$CH_3-\overset{CH_2}{CH-CH}-C_2H_5$

(B)



(C) $CH_3-CH=CHCH_3$

7. ABD

Sol. Colligative properties depend on the number of solute particles.

0.2 $MCaCl_2$ has $0.2 \times 3 = 0.6$ mole particles.

0.3 MKCl has $0.3 \times 2 = 0.6$ mole particles

Similarly, B and D contain same number of particles

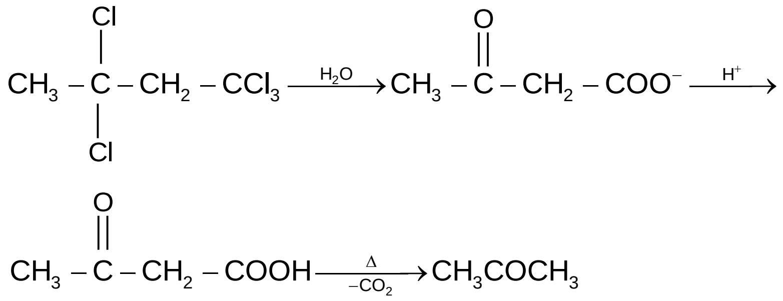
8. C

Sol. Oxidation number of iron remains zero even after heating.

9. B

10. A

Sol.



$$CH_3-\overset{\overset{Cl}{|}}{\underset{\underset{Cl}{|}}{C}}-CH_2-CCl_3 \xrightarrow{H_2O} CH_3-\overset{\overset{O}{\|}}{C}-CH_2-COO^- \xrightarrow{H^+}$$

$$CH_3-\overset{\overset{O}{\|}}{C}-CH_2-COOH \xrightarrow[-CO_2]{\Delta} CH_3COCH_3$$

11. D

Sol. The elements are
Cu, Zn, Ga, Ge, As, Se, Br and Kr

12. D

Sol. Reagents in A,B,C convert phenol to anisole.

13. B

Sol. Q(g) is N_2

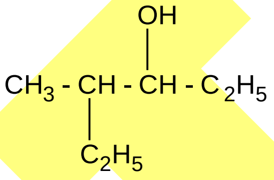
PART – B

1. 1.33 (Range 1.3 to 1.4)

Sol. $\Delta S(\text{adiabatic}) = nC_p \ell n \frac{T_2}{T_1}$

2. 1.5

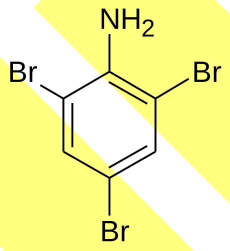
Sol. The product(P) is



$$CH_3-\underset{\underset{C_2H_5}{|}}{CH}-\overset{\overset{OH}{|}}{CH}-C_2H_5$$

3. 2.5

Sol. P is



4. 0.22[Range 0.2 to 0.3]

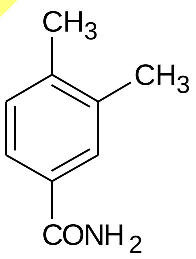
Sol. $p^H = p^{K_a} + \log\frac{[CH_3COONa]}{[CH_3COOH]}$

5. 3

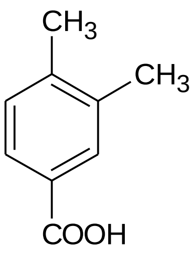
Sol. Sc^{3+} contains no d-electron. So back donation does not take place.

6. 0.9

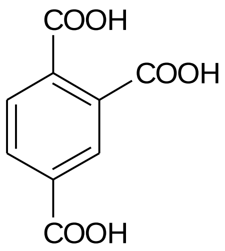
Sol. (P) is



, (Q) is



(R) is



7. 0.4

Sol. K = 4 × 10^{-3} ohm^{-1} cm^2

$$\Lambda_m = K \times \frac{1000}{M}$$

$$= 4 \times 10^{-3} \times \frac{1000}{0.1} = 40\ ohm^{-1}\ cm^2 mol^{-1}$$

$$\alpha = \frac{\Lambda_m}{\Lambda_m^0} = \frac{40}{100} = 0.4$$

8. 170

Sol. The complex is $[Cr(NH_3)_4Cl_2]Cl.2NH_3$

FIITJEE

SECTION-3 : MATHEMATICS

PART – A

1. AD

Sol. Let $\sqrt{y-x}=t$

$$y-x=t^2$$

$$\frac{dy}{dx}=2t\frac{dt}{dx}+1$$

$$2t\frac{dt}{dx}+1=\sqrt{t}$$

$\frac{2t}{\sqrt{t}-1}dt=dx$ which leads A and D as solutions

2. ABC

Sol. Let x_0 be the number of objects to the left of the first object chosen, x_1 the number of objects between the first and the second, x_2 the number of objects between the second and the third and x_3 the number of objects to the right of the third object. We have

$x_0, x_3 \ge 0,\ x_1, x_2 \ge 1$ and $x_0+x_1+x_2+x_3=n-3$ (1)

Put $x_1=y_1+1$ and $x_2=y_2+1$. Then (1) reads as

$x_0+y_1+y_2+x_3=n-5$ (2)

where $x_0, y_1, y_2, x_3 \ge 0$

The number of non – negative integral solution of (2) is ${}^{n-5+3}C_3={}^{n-2}C_3$

We have ${}^{n-2}C_3=\frac{1}{6}(n-2)(n-3)(n-4)$

Also, ${}^{n-3}C_3+{}^{n-3}C_2={}^{n-2}C_3$

3. ABD

Sol. The total number of ways of choosing the ticket is 1000. Let the four digits number on the ticket is 1000.

Let the four digits number on the ticket be $x_1x_2x_3x_4$.

Note that $0 \le x_1+x_2 \le 18$ and $0 \le x_3+x_4 \le 18$.

Also, the number of non – negative integral solutions of $x+y=m$ (with $0 \le x, y \le 9$) is $m+1$ if $0 \le m \le 9$ and is 19 – m if $10 \le m \le 18$.

Thus, the number of favourable ways

$=1\times1\times1+2\times2+.......+10\times10+9\times9+8\times8+.............+1\times1$

$=2\left\{\frac{9\times10\times19}{6}\right\}+100=670$

$\therefore$ Probability of required event $=\frac{670}{1000}=0.067$

Note that $0.067>0.065$ and $0.067<0.068$.

4. ACD

Sol. $\sum_{k=1}^{n}\left(\sum_{m=1}^{k}m^2\right)=an^4+bn^3+cn^2+dn+e$

$$\Rightarrow \sum_{k=1}^{n}\left[\frac{k(k+1)(2k+1)}{6}\right]=an^4+bn^3+cn^2+dn+e$$

$$\Rightarrow \frac{1}{6}\left\{2\sum_{k=1}^{n}k^3+3\sum_{k=1}^{n}k^2+\sum_{k=1}^{n}k\right\}=an^4+bn^3+cn^2+dn+e$$

$$\Rightarrow \frac{1}{6}\left\{\frac{k^2(k+1)^2}{2}+\frac{k(k+1)(2k+1)}{2}+\frac{k(k+1)}{2}\right\}:$$

$$an^4+bn^3+cn^2+dn+e$$

$$\Rightarrow \frac{n^4}{12}+\frac{n^3}{3}+\frac{5n^2}{12}+\frac{n}{6}=an^4+bn^3+cn^2+dn+e$$

Therefore, $a=\frac{1}{12};\ b=\frac{1}{3};c=\frac{5}{12};d=\frac{1}{6};e=0$

5. AB

Sol: Let $f'(1)=a$ and $f''(1)=b$, putting x = 1 in the given equation we get $b=a^2$.
Differentiating the equation and putting x = 1 gives
$2ab+8=ab+2ab \Rightarrow ab=8 \Rightarrow a=2,\ b=4$

6. ABD

Sol: AB-BA is skew symmetric. Also in option C, $|A|\neq 0$. Rest are obvious.

7. BD

Sol: $(z-(1+2i))^4=1 \Rightarrow z=1^{1/4}+1+2i$

$z_1=1+2i+1=2+2i=\omega_2$

$z_2=1+2i-1=2i=\omega_3$

$z_3=1+2i+i=1+3i=\omega_1$

$z_4=1+2i-i=1+i=\omega_4$

$\lambda=5$ (circle on $\omega_1-\omega_4$ and $\omega_3-\omega_2$ will overlap)

8. D

Sol: Let there be a value of k for which $x^3-3x+k=0$ has two distinct roots between 0 and 1. Let a, b be two distinct roots of $x^3-3x+k=0$ lying between 0 and 1 such that $a<b$. Let $f(x)=x^3-3x+k$. Then $f(a)=f(b)=0$. Since between any two roots of a polynomial f(x) there exist at least one root of its derivative $f'(x)$. Therefore $f'(x)=3x^2-3$ has at least one root between a and b. But $f'(x)=0$ has two roots equal to ±1 which do not lie between a and b. Hence $f(x)=0$ has no real roots lying between 0 and 1 for any value of k.

9. A

Sol. Let $\alpha\in R-Q$ be a common root of $f(x)=0$ and $g(x)=0$.

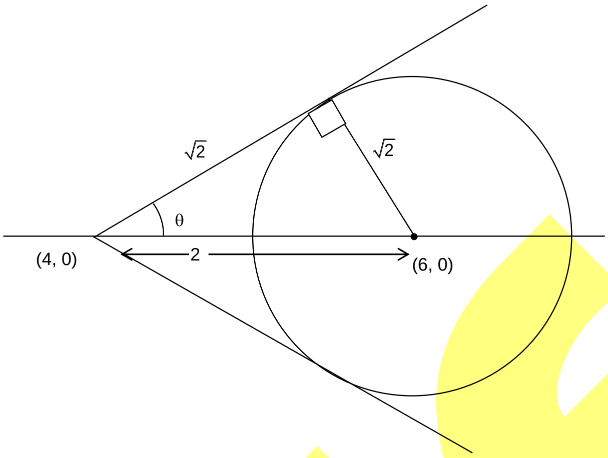
Then $\alpha^2=-a\alpha-b$. Substituting this in $\alpha^3+p\alpha+q=0$, we get $(a^2-b+p)\alpha+ab+q=0$

As α is irrational and $a,b,p,q\in Q$, $p=b-a^2$, $q=-ab$. This gives, $g(x)=(x-a)f(x)$.

10. A

Sol. From diagram, $\theta = 45^o$

$\Rightarrow$ Slope $= \pm 1$,



11. D

Sol. $x = -10$ is the directrix of the given parabola. Hence the circle S = 0 will touch it. P_1P_2 is the diameter. So $\angle P_1P\,P_2 = 90^o$ and hence ΔP_1PP_2 is right angled and its orthocentre is point P. Tangents at extremeties of focal chord are perpendicular. Hence in their combined equation (coefficient x^2) + (coefficient y^2) = 0.

12. C

Sol. Let $\cos^{-1}p = \alpha,\ \cos^{-1}q = \beta,\ \cos^{-1}r = \gamma$

$\cos\alpha = p$

$\cos\beta = q$

$\cos\gamma = r$

$\alpha + \beta + \gamma = \pi$

$\Rightarrow \cos(\alpha + \beta) = \cos(\pi - \gamma)$

$\Rightarrow \cos\alpha\cos\beta - \sin\alpha.\sin\beta = -\cos\gamma$

$\Rightarrow pq - \sqrt{1-p^2}\ \sqrt{1-q^2} = -r$

$\Rightarrow pq + r = \sqrt{1-p^2}\ \sqrt{1-q^2}$

$2pqr + p^2q^2 + r^2 = (1-p^2)(1-q^2)$

$p^2 + q^2 + r^2 + 2pqr = 1$

13. C

Sol. Let $x_0 = \cos\theta$, then $x_1 = \sqrt{\frac{1}{2}(1+\cos\theta)} = \cos\frac{\theta}{2},\ x_2 = \cos\left(\frac{\theta}{2^2}\right),\ x_3 = \cos\left(\frac{\theta}{2^3}\right)$.... and so on.

So that $\left[\dfrac{\sqrt{1-x_0^2}}{x_1x_2x_3\text{.......to infinite}}\right]$

$$= \frac{\sin\theta}{\cos\frac{\theta}{2}\cos\frac{\theta}{2^2}\text{......}\cos\frac{\theta}{2^n}\text{......infinite}}$$

$$= \frac{2\sin\frac{\theta}{2}\cos\frac{\theta}{2}}{\cos\frac{\theta}{2}\cos\frac{\theta}{2^2}\text{.....}\cos\frac{\theta}{2^n}\text{.....infinite}}$$

$$= \frac{2^2\sin\frac{\theta}{2^2}\cos\frac{\theta}{2^2}}{\cos\frac{\theta}{2^2}\cos\frac{\theta}{2^3}\text{.......}\cos\frac{\theta}{2^n}\text{.....infinite}}$$

$$= \lim_{n\to\infty} \frac{2^n \sin\frac{\theta}{2^n}}{\cos\frac{\theta}{2^{n+1}}}$$

$$= \lim_{n\to\infty} \theta \left(\frac{\sin\frac{\theta}{2^n}}{\frac{\theta}{2^n}} \right) \frac{1}{\cos\frac{\theta}{2^{n+1}}} = \theta$$

So that $\cos\left[\frac{\sqrt{1-x_0^2}}{x_1 x_2 .....\text{inf}}\right] = \cos\theta = x_0$

PART – B

1. 0.33

Sol. $\lim\limits_{n\to\infty} \frac{(\cos x - 1)(\cos x - e^x)}{x^n}$

Limit $= \lim\limits_{x\to 0} \frac{2\sin^2\frac{x}{2}}{2^2\left(\frac{x}{2}\right)^2} \frac{e^x - \cos x}{x^{n-2}} = \frac{1}{2} \lim\limits_{x\to 0} \frac{e^x - \cos x}{x^{n-2}}$

$(n \ne 1$ for then the limit = 0)

$= \frac{1}{2} \lim\limits_{x\to 0} \frac{e^x + \sin x}{(n-2)x^{n-3}}$.

So, if $n = 3$, the limit is $\frac{1}{2(n-2)}$ which is finite.

If $n = 4$, the limit is infinite.
Answer is 0.33.

2. 55

Sol. $(1-1+2-2+...+5-5)^2 =$

$1^2 + 1^2 + 2^2 + 2^2 + ... + 5^2 + 5^2 + 2S$.

3. 1

Sol. $\Delta = \sqrt{s(s-a)(s-b)(s-c)} = 6$

$\therefore r = \frac{\Delta}{s} = 1$

Answer is 1.

4. 0.5

Sol. Cubing on both sides apply
$\cos 3\theta = 4\cos^3\theta - 3\cos\theta$

5. 7

Sol. The problem corresponds to a selection of 4 non-consecutive integers out of first 10 natural numbers. Therefore $N = {}^7C_4$.

6. 1

Sol: Given expression $= \frac{(s-b)(s-c)}{(a-b)(a-c)} + \frac{(s-a)(s-c)}{(b-a)(b-c)} + \frac{(s-a)(s-b)}{(c-a)(c-b)} = 1$

7. 0.33

Sol: $\frac{4000}{a_1a_{4001}} = 10 \Rightarrow a_1a_{4001} = 400$

also $a_1 + a_{4001} = 50$

$\Rightarrow |a_1 - a_{4001}|^2 = 2500 - 1600$

$\Rightarrow |a_1 - a_{4001}| = 30$

8. 9

Sol. Equation of the tangent at P $(7\cos\theta, 5\sin\theta)$ on the ellipse is $\frac{x}{7}\cos\theta + \frac{y}{5}\sin\theta = 1$

then $(CF)^2 = \frac{7^2 \times 5^2}{5^2\cos^2\theta + 7^2\sin^2\theta}$

$= \frac{25 \times 49}{25\cos^2\theta + 49\sin^2\theta}$

Equation of the normal at P is $\frac{7x}{\cos\theta} - \frac{5y}{\sin\theta} = 7^2 - 5^2$

Coordinates of G are $\left(0, \frac{-24\sin\theta}{5}\right)$

$(PG)^2 = (7\cos\theta)^2 + \left(5\sin\theta + \frac{24\sin\theta}{5}\right)^2$

$= \frac{49}{25}\left(25\cos^2\theta + 49\sin^2\theta\right)$

So $(CF\,.\,PG)^2 = (49)^2 = 2401$

BATCHES – Two Yr CRP2123(All)

FIITJEE RBT-6 for (JEE-Advanced)

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 2

QP Code: 100192

PAPER - 2

Time Allotted: 3 Hours **Maximum Marks: 195**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections.**
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. All the section can be filled in **PART-A** of OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with ***Blue/Black Ball Point Pen*** for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For Only One Part.

(i) **Part-A (01-07) –** Contains seven (07) multiple choice questions which have **One or More** correct answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
Negative Marks: –**2 In all other cases**.
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in –**2** marks, as a wrong option is also darkened.

(ii) **Part-A (08-14) –** Contains seven (07) multiple choice questions which have ONLY ONE CORRECT answer Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(iii) **Part-A (15-18) -** This section contains Two paragraphs. Based on each paragraph, there are Two multiple choice questions. Each question has only one correct answer and carries **+4 marks** for the correct answer and **– 2 marks** for wrong answer.

Name of the Candidate :____

Batch :____________________ **Date of Examination :**____________________

Enrolment Number :____

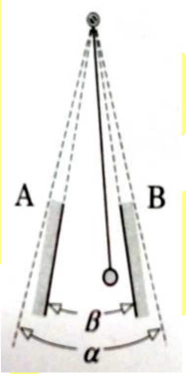
SECTION-1 : PHYSICS

PART – A

(Multi Correct Choice Type)

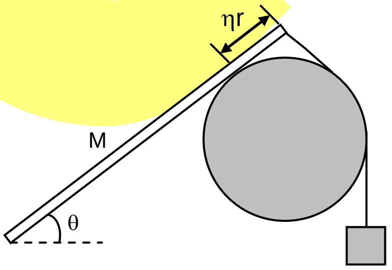
This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. A simple pendulum initially oscillating simple harmonically with angular amplitude α and period T_0 is symmetrically confined between two rigid fixed planes A and B making angle $\beta < \alpha$ with each other as shown in the figure.



(A) If collisions at both the walls are elastic, period is $T_0(1 - \beta/\alpha)$.
(B) If collisions at both the walls are inelastic, period is T_0.
(C) If collision at one wall is elastic and at the other is inelastic, the period is T_0.
(D) If collision at one wall is elastic and at the other is inelastic, the period is less then T_0.

2. A load is suspended from one end of a uniform rod of mass m = 10 kg and length ℓ with the help of a light inextensible thin cord and the arrangement is placed on a fixed horizontal frictionless cylinder of radius r as shown in the figure. In equilibrium, the rod stays at angle $\theta = 30°$ with the horizontal and distance between point of contact of the rod with the cylinder and top end of the rod is $\eta = 1/\sqrt{2}$ times the radius of the cylinder. Then



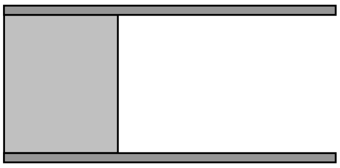
(A) ratio of length of the rod to the radius of the cylinder = $\dfrac{4+\sqrt{6}}{\sqrt{3}}$

(B) ratio of length of the rod to the radius of the cylinder = $\dfrac{4+\sqrt{3}}{\sqrt{6}}$

(C) mass of the load = 15 kg
(D) mass of the load = 10 kg

Space For Rough Work

3. A parallel palate capacitor of capacitance C_0 is charged to a voltage V and then the battery is disconnected. A dielectric covering one-third area of each plate is now inserted as shown in the figure. If charges on the capacitor plates get redistributed such that the portions covered with dielectric and not covered with the dielectric share equal amounts of charge, which of the following statements is/are true?



(A) Dielectric constant of the dielectric is 2.0.
(B) Charge appearing due to polarization on the surface of the dielectric is $0.25\ C_0V$.
(C) Force of electrostatic interaction between portions of the plates covered with dielectric is equal to that between uncovered portions.
(D) Force of electrostatic interaction between the plates after insertion of the dielectric becomes 9/8 times of its value before insertion of the dielectric.

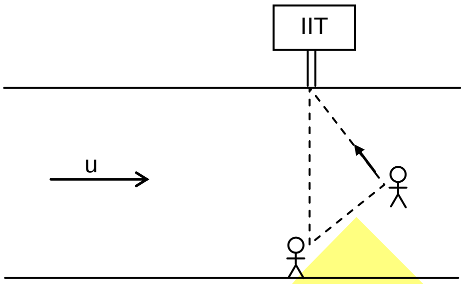
4. Four waves of the equation given by
$y_1 = 5A \sin(wt - Kx + \pi/2)$
$y_2 = 2A \sin(wt - Kx + 3\pi/2)$
$y_3 = 6A \sin(wt - Kx)$
and $y_4 = 2A \sin(wt - Kx + \pi)$
(A) The resulted wave will have amplitude 5A.
(B) It will make a phase difference of 37^o with y_3.
(C) Its equation will be $y = 5A \sin(wt + 37^o)$.
(D) Its equation will be $y = 5A \sin(wt - Kx + 37^o)$.

5. During an experiment, an ideal gas is found to obey a condition $\frac{P^2}{\rho}$ = constant [ρ = density of the gas]. The gas is initially at temperature T, pressure P and density ρ. The gas expands such that density changes to $\rho/2$
(A) The pressure of the gas changes to $\sqrt{2}P$.
(B) The temperature of the gas changes to $\sqrt{2}T$.
(C) The graph of the above process on the P–T diagram is parabola.
(D) The graph of the above process on the P–T diagram is hyperbola.

Space For Rough Work

FIITJEE

6. There is a board on which 'IIT' is written. It is situated on the opposite side of a river while IIT-JEE aspirant swim the river such that he/she always approach the IIT board [i.e. he/she always try to swim towards the board]. If speed of river and speed of aspirants w.r.t. river are same and width of river is d.



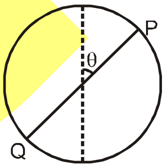
(A) drift suffered by the aspirant will be $\frac{d}{4}$

(B) drift suffered by the aspirant will be $\frac{d}{2}$

(C) If IIT board is taken away from the bank by distance 'd' in perpendicular direction of river flow then drift suffered will be $\frac{4d}{3}$

(D) If IIT board is taken away from the bank by distance 'd' in perpendicular direction of river flow then drift suffered will be $\frac{3d}{4}$

7. A bead is sliding down a smooth, massless rod PQ attached on the circumference of a vertical circle of radius R. The bead starts from rest from P:



(A) Time taken by bead to go from P to Q is $2\sqrt{\frac{R\cos\theta}{g}}$

(B) Time taken by bead to go from P to Q is $2\sqrt{\frac{R}{g\cos\theta}}$

(C) The velocity of bead when it reaches centre of circle is $\sqrt{2gR\cos\theta}$

(D) The velocity of bead when it reaches centre of circle is $2\sqrt{gR\cos\theta}$

(Single Correct Choice Type)

This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

8. The pair(s) of physical quantities that do not have the same dimensions, is
(A) Reynolds number and coefficient of friction
(B) Latent heat and gravitational potential
(C) Curie and frequency of a light wave
(D) Planck's constant and torque

Space For Rough Work

9. In a LR decay circuit, the current at t = 0 is 10 A. After 5 s it reduces to 9 A then incorrect statement is

(A) The time constant is $\dfrac{5}{\ln\left|\dfrac{10}{9}\right|}$

(B) The time constant is $5\ln\left|\dfrac{10}{9}\right|$

(C) At t = 10 s, the current will be 8.1 A

(D) At t = 15 s, the current will be 7.3 A

10. A ball of mass m projected horizontally from the top of a tower with kinetic energy K flies in the air for a time interval τ before it hits the horizontal ground. If force of air drag is proportional to the speed, and the proportionality constant is k_0, find horizontal range of the ball.

(A) $\dfrac{\sqrt{Km}}{k_0}\left\{1-e^{\frac{-k_0\tau}{m}}\right\}$

(B) $\dfrac{\sqrt{2Km}}{k_0}\left\{1-e^{\frac{-k_0\tau}{m}}\right\}$

(C) $\dfrac{\sqrt{Km}}{2k_0}\left\{1-e^{\frac{-k_0\tau}{m}}\right\}$

(D) $\dfrac{\sqrt{4Km}}{k_0}\left\{1-e^{\frac{-k_0\tau}{m}}\right\}$

11. Find suitable expression for the moment of inertia of a uniform ring of mass m and radius r about an axis that passes through the centre of the ring and makes an angle θ with the plane of the ring.

(A) $\dfrac{mr^2}{2}$

(B) $\dfrac{mr^2}{2}(\sin^2\theta)$

(C) $mr^2(1+\sin^2\theta)$

(D) $\dfrac{mr^2}{2}(1+\sin^2\theta)$

12. If electric field in a region is radially outward with magnitude E = Ar. The charge contained in a sphere of radii r_0 centered at origin is

(A) $\dfrac{4\pi\varepsilon_0 A}{r_0^3}$

(B) $\dfrac{A}{4\pi\varepsilon_0 r_0^3}$

(C) $4\pi\varepsilon_0 r_0^3 A$

(D) $2\pi\varepsilon_0 r_0^3 A$

13. A ball is dropped from a height h above a massive platform that is moving upward with a constant speed u. If the ball collides with the platform elastically, find height above its initial position the ball will rebound. Acceleration of free fall is g.

(A) $\dfrac{2u\sqrt{u^2+gh}}{g}$

(B) $\dfrac{u\sqrt{u^2+2gh}}{g}$

(C) $\dfrac{2u\sqrt{u^2+2gh}}{g}$

(D) $\dfrac{u\sqrt{u^2+2gh}}{2g}$

Space For Rough Work

14. A person walking at the rate of 3km/hour, the rain appears to fall vertically when he increase his to speed 6 km/hr it appears to meet him at angle of 45^0 with vertical. The speed of rain is

(A) $3\sqrt{2}$ km/hr (B) $\frac{3}{\sqrt{2}}$ km/hr

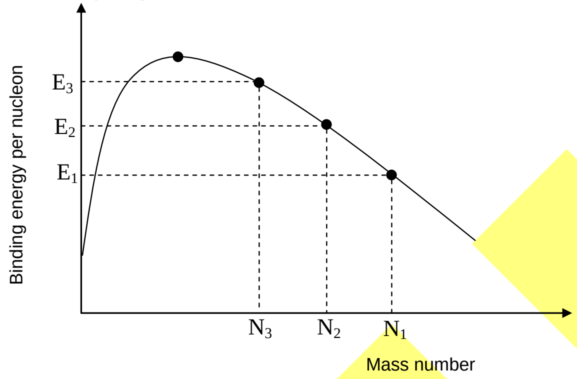
(C) $6\sqrt{2}$ km/hr (D) $2\sqrt{3}$ km/hr

(Paragraph Type)

This section contains **2 paragraphs**. Based upon the paragraphs **2 multiple choice questions** have to be answered. Each of these questions has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph for Question no. 15 to 16

Consider the nuclear fission reaction W → X + Y. Using the graph given, answer the following equations:



15. What is the Q value of the reaction?

(A) $E_1N_1-(E_2N_2+E_3N_3)$ (B) $(E_2N_2+E_3N_3-E_1N_1)$

(C) $E_2N_2+E_1N_1+E_1N_1-E_3N_3$ (D) $E_1N_1+E_3N_3-E_2N_2$

16. If M_W is the mass of W, M_X is mass of X and M_Y is mass of Y nucleus, choose correct statement.

(A) $\frac{M_W}{N_1}>\frac{M_Y}{N_2}>\frac{M_X}{N_3}$ (B) $\frac{M_W}{N_1}<\frac{M_Y}{N_2}<\frac{M_X}{N_3}$

(C) $\frac{M_W}{N_1}<\frac{M_Y}{N_2}>\frac{M_X}{N_3}$ (D) $\frac{M_W}{N_1}>\frac{M_Y}{N_2}>\frac{M_X}{N_3}$

Space For Rough Work

Paragraph for Question no. 17 to 18

A rectangular rigid fixed block has a long horizontal edge. A solid homogeneous cylinder of radius R is placed horizontally at rest. Its length is parallel to the edge such that the axis of the cylinder and the edge of the block are in the same vertical plane. There is sufficient friction present at the edge so that a very small displacement causes the cylinder to roll off the edge without slipping

17. The angle θ through which the cylinder rotates before it leaves contact with the edge is

(A) $\tan^{-1}\frac{4}{7}$ (B) $\cos^{-1}\frac{7}{4}$ (C) $\cos^{-1}\frac{4}{7}$ (D) $\tan^{-1}\frac{7}{4}$

18. The speed of the centre of mass of the cylinder before leaving contact with the edge is

(A) $\sqrt{\frac{gR}{7}}$ (B) $\sqrt{\frac{4gR}{7}}$ (C) $\sqrt{\frac{9gR}{7}}$ (D) $\sqrt{\frac{3gR}{7}}$

Space For Rough Work

FIITJEE

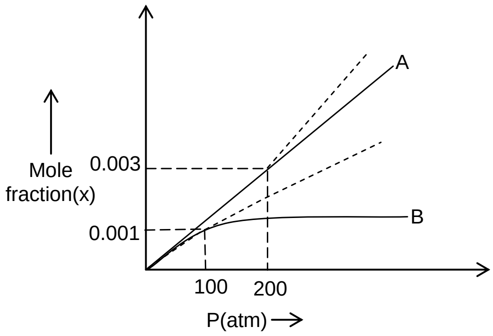
SECTION-2 : CHEMISTRY

PART – A

(Multi Correct Choice Type)

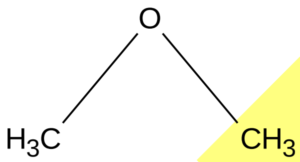
This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1.

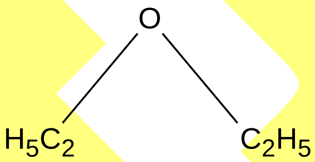


The solubility of two gases A and B in water at 50°C is plotted above. The variation of mole fraction and partial pressure of the gases is given in above graph.
Choose the correct statements
(A) Gas ‘A’ follows Henry’s law upto 200 atm
(B) The Henry’s law constant for gas B is 10^{-5} atm^{-1}
(C) Gas ‘A’ is more soluble than gas ‘B’
(D) Gas ‘B’ does not follow ideal gas behaviour after 100 atm

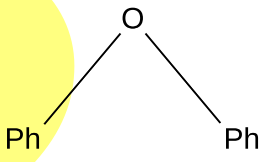
2.



(I)



(II)



(III)

Choose correct statements
(A) the dipole moment of (I) is higher than that of (II)
(B) (II) is stable in basic medium whereas(III) is stable in acid as well as basic medium
(C) (I) is more reactive than (III) towards Cl_2 in presence of sunlight
(D) (II) is more reactive than (III) towards electrophilic substitution reaction

3. Which of the following oxo fluoride(s) is/are formed by the following reaction?

$$XeO_3 + XeF_6 \longrightarrow$$

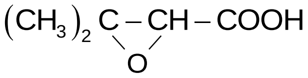
(A) XeO_2F_2
(B) $XeOF_4$
(C) $XeOF_2$
(D) XeO_3F_2

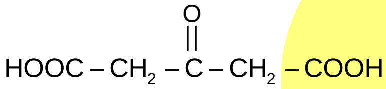
Space For Rough Work

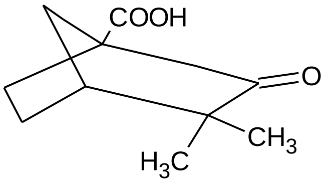
4. An aqueous solution of 50 mL of a weak dibasic acid H_2A of concentration 0.02 M is titrated with 0.1 M NaOH solution $K_{a_1} = 10^{-2}$, $K_{a_2} = 10^{-5}$

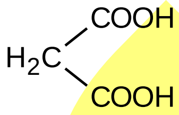
Choose the correct statement [Assume $1 - \alpha = 1$]
(A) the pH of the solution before titration is approx 2
(B) the pH of solution at first equivalence point is 3.5
(C) the volume of NaOH solution consumed in complete titration is 180 mL
(D) the degree of dissociation of HA^- is greater than that of H_2A

5. Which of the following compound(s) undergo(es) decarboxylation on heating?

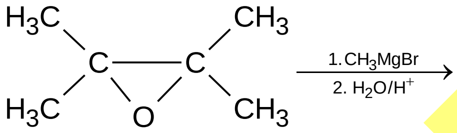
(A)

$(CH_3)_2\underset{\diagdown\ O\ \diagup}{C-CH}-COOH$

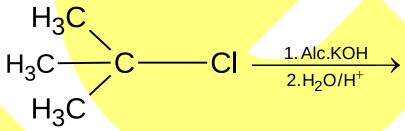
(B)

$HOOC-CH_2-\overset{\overset{O}{||}}{C}-CH_2-COOH$

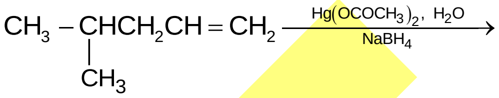
(C)


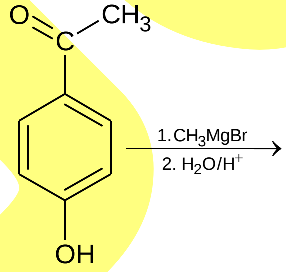
(D)


6. Which of the following reaction(s) produce(s) tertiary alcohol?

(A)


(B)


(C)

$CH_3-\underset{\underset{CH_3}{|}}{C}HCH_2CH=CH_2 \xrightarrow[NaBH_4]{Hg(OCOCH_3)_2,\ H_2O}$

(D)


7. Which of the following statement(s) is/are correct for zinc blend structure of ZnS?
(A) The Zn^{2+} ions occupy half of the tetrahedral voids of the unit cell.
(B) Pure ZnS fluorescences when light falls on it.
(C) If the sulphide ions of ZnS are replaced by, X^{4-} ions, two cationic vacancy will be created
(D) It is more stable than the wurtzite structure of zinc sulphide.

Space For Rough Work

(Single Correct Choice Type)

This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

---

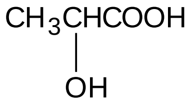
8. Reaction of an aqueous solution of $Hg(NO_3)_2$ with an aqueous solution of KNO_2 forms an eight-coordinate complex which is obtained as a yellow crystal. The correct statement for the complex is

(A) it contains Hg – Hg bond
(B) it contains eight NO_3^- ligands
(C) the oxidation state of Hg is +8
(D) it contains NO_2^- as a bidentate ligand

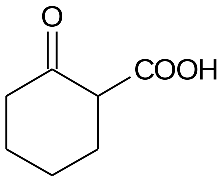
9. Ag(s) | AgCl(s), KCl(0.2 M) || KBr(0.001 M), AgBr(s) | Ag(s)
K_{sp} of AgCl = 2.8×10^{-10}
K_{sp} of AgBr = 3.3×10^{-13}
What is the emf of the cell?

(A) -0.41 V
(B) -0.037 V
(C) 0.037 V
(D) +0.41 V

10. Which of the following substance undergoes dehydration on heating?

(A) 
$CH_3\underset{\displaystyle OH}{\underset{|}{C}}HCOOH$

(B) $CH_3CH = NOH$

(C) 

(D) CH_3CH_2OH

11. Which of the following substance is not needed in order to elucidate the open chain structure of glucose?

(A) Br_2/H_2O
(B) $(CH_3CO)_2O$/catalyst
(C) Conc.HI/red 'P'
(D) $LiAlH_4$/ether

12. $XY_2(s) \rightleftharpoons X(g) + 2Y(g)$

Above reaction takes place by taking only XY_2 in container. The reaction attains equilibrium at 1.2 atm.
Choose the correct statement

(A) if the reaction quotient Q_P is 0.12 atm^3, then the forward reaction will take place
(B) if the partial pressure of X(g) is doubled then the partial pressure of Y(g) will change to $\dfrac{p_y}{2\sqrt{2}}$
(C) if the reaction takes place in a larger container at constant temperature then the equilibrium constant K_p will decrease
(D) addition of XY_2 favours forward reaction

Space For Rough Work

13. $Co_2(CO)_8 \xrightarrow{NO} (X) + CO$

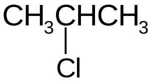
In above reaction 'X' may be

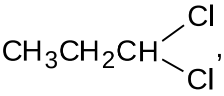
(A) $Co(NO)_2(CO)_2$ (B) $Co(NO)(CO)_3$
(C) $Co(NO)_3(CO)_2$ (D) $Co(NO)(CO)_4$

14. $CH_3CH_2CH_2Cl \xrightarrow[\text{Heat}]{\text{Anhy.}AlCl_3} \text{Product}$

The product and type of above reaction is

(A) $CH_3CH_2CH_2CH_2CH_2CH_3$, dimerisation

(B) 
$CH_3\underset{\underset{Cl}{|}}{C}HCH_3$, isomerisation

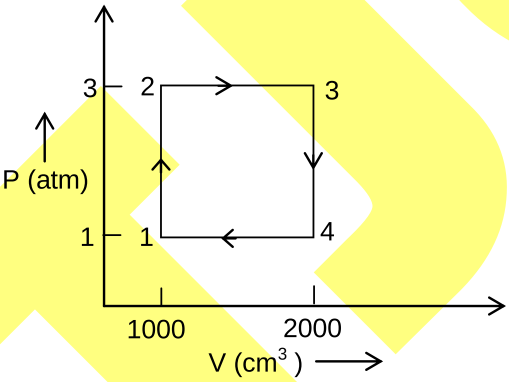
(C) 
$CH_3CH_2CH\begin{matrix}Cl\\Cl\end{matrix}$, nucleophilic substitution

(D) CH_3CH_2Cl, CH_3Cl, pyrolysis

(Paragraph Type)

This section contains **2 paragraphs**. Based upon the paragraphs **2 multiple choice questions** have to be answered. Each of these questions has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph for Question no. 15 to 16



0.1 mole of an ideal gas having $C_{V,M} = \frac{3R}{2}$ (independent of temperature) undergoes a reversible cyclic process 1 → 2 → 3 → 4 as shown above. Each step is accompanied with either constant P or constant V.

Answer the following questions on the basis of above write up.

15. How much work is done for the complete cycle in Joule unit?

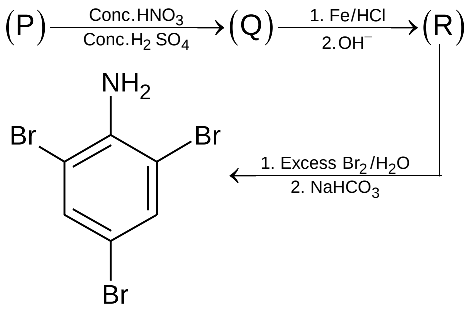
(A) -281 (B) -408 (C) -203 (D) -513

Space For Rough Work

16. What is the sum of the heat absorbed in the steps 1 → 2 and 2 → 3 ($q_{1-2} + q_{2\to 3}$) in joule unit?

(A) 1218 (B) 1120 (C) 1065 (D) 975

Paragraph for Question no. 17 to 18



$$(R) \xrightarrow[\text{Cold}]{NaNO_2/HCl} (S) \xrightarrow[\Delta]{H_2O} (T)$$

$$(U) \xleftarrow[\text{2. t–BuNH}_2]{\text{1. Excess } Br_2/H_2O} (T)$$

Answer the following question on the basis of above write up

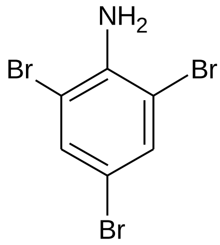
17. Which of the following reaction is accompanied with formation of aromatic side products?

(A) $(S) \xrightarrow[\Delta]{H_2O} (T)$

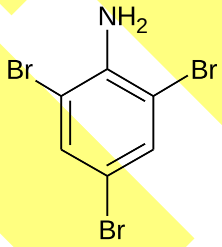
(B) $(Q) \xrightarrow[\text{2. } OH^-]{\text{1. Fe/HCl}} (R)$

(C) $(T) \xrightarrow[\text{2. t–BuNH}_2]{\text{1.Excess } Br_2/H_2O} (U)$

(D) $(R) \xrightarrow[\text{2. } NaHCO_3]{\text{1.Excess } Br_2/H_2O}$



18. $(R) \xrightarrow[\text{2. } NaHCO_3]{\text{1.Excess } Br_2/H_2O}$



Which of the following change(s) is/are observed if $NaHCO_3$ is not used in the reaction?
(I) Rate of reaction will decrease
(II) Meta orientation products are formed
(III) Nucleophilic substitution will take place
(IV) Dehydrogenation reaction will take place
The correct answer(s) is/are

(A) II, III (B) I, II (C) I, II, III (D) III, IV

Space For Rough Work

SECTION-3 : MATHEMATICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

---

1. The sum of two non-negative numbers is 2a. If P is the probability that the product of these numbers is not less than m times their greatest possible product, then

(A) $P=\frac{2}{3}, m=\frac{4}{5}$ (B) $P=\frac{1}{3}, m=\frac{3}{5}$

(C) $P=\frac{1}{2}, m=\frac{3}{4}$ (D) $P=\frac{3}{4}, m=\frac{7}{16}$

2. If $\theta\in\left[-\frac{\pi}{9},-\frac{\pi}{36}\right]$, such that $f(\theta)=\tan\left(\theta+\frac{5\pi}{18}\right)+\cos\left(\theta+\frac{5\pi}{18}\right)-\tan\left(\theta+\frac{7\pi}{9}\right)$ has maximum and minimum values as a and b respectively, then

(A) $a=\frac{11}{\sqrt{3}}$ (B) $b=\frac{-3+2\sqrt{2}}{2}$

(C) $b=\frac{2\sqrt{2}+1}{\sqrt{2}}$ (D) $a=\frac{11}{2\sqrt{3}}$

3. If $a_0=\sqrt{2}-\sqrt{3}+\sqrt{6}$ and $a_n=\tan\left(\frac{2^{n-3}\pi}{3}\right)+2$ then the value of

$$M=\sum_{n=0}^{3}\tan\left(\frac{2^{n-3}\pi}{3}\right).\sec\left(\frac{2^{n-2}\pi}{3}\right)$$ is equal to

(A) a_4-a_0 (B) a_3-a_1

(C) a_1-a_0 (D) a_1-a_0-2

Space For Rough Work

4. Let $f : R \to R$ be defined as

$$f(x) = \begin{cases} \lim\limits_{n\to\infty}\left(\dfrac{[x]}{1+n^2}+\dfrac{3[x]}{2+n^2}+\dfrac{5[x]}{3+n^2}+.....+\dfrac{(2n-1)[x]}{n+n^2}\right) & x \neq \dfrac{\pi}{2} \\ 1, & x = \dfrac{\pi}{2} \end{cases}$$, where [.] denotes GIF, then

which of the following statement(s) is (are) correct?

(A) $f(x)$ is injective but not surjective

(B) $f(x)$ is non – differentiable at $x = \dfrac{\pi}{2}$

(C) $f(x)$ is discontinuous at all integers and continuous at $x = \dfrac{\pi}{2}$

(D) $f(x)$ is unbounded function.

5. If $x \in R$, then the roots of the equation $x^4 + 4x^3 - 8x^2 + k = 0$ with respect to the values of k, $(k \in [0, 2014])$, are:

(A) for $k \in [0, 3]$: 4 real and distinct roots

(B) for $k \in (3, 128)$: two real and two imaginary roots

(C) for $k \in (128, 583)$: no real root

(D) for $k \in (0, 3)$: four real and distinct roots

6. If $f(x) = \int_0^x \frac{\sin t}{t}\,dt,\ x > 0$ then

(A) $f(x)$ has a local maxima at $x = n\pi\left(n = 2k,\ k \in I^+\right)$

(B) $f(x)$ has a local minima at $x = n\pi\left(n = 2k,\ k \in I^+\right)$

(C) $f(x)$ has neither maxima nor minima at $x = n\pi\left(n \in I^+\right)$

(D) $f(x)$ has local maxima at $x = n\pi\left(n = 2k - 1,\ k \in I^+\right)$

7. Consider the planes $3x - 6y + 2z + 5 = 0$ and $4x - 12y + 3z = 3$. The plane $67x - 162y + 47z + 44 = 0$ bisects the angle between the given planes which

(A) contains the origin
(B) is acute
(C) is obtuse
(D) none of these

Space For Rough Work

(Single Correct Choice Type)

This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

8. The maximum value of n for which the quadratic equation $a_{n+1}x^2 - 2x\sqrt{\sum_{k=1}^{n+1} a_k^{\ 2}} + \sum_{k=1}^{n} a_k = 0$ has real roots for every choice of real numbers $a_1, a_2, ..., a_{n+1}$ is

(A) 2 (B) 3
(C) 4 (D) 5

9. Let $f : R \to R - \{3\}$ be a function which satisfies $f(x+10) = \dfrac{f(x)-5}{f(x)-3}$, then $\int_{10}^{20} f(x)dx$ is equal to

(A) $\int_{100}^{110} f(x)dx$ (B) $\int_{110}^{120} f(x)dx$
(C) $\int_{120}^{130} f(x)dx$ (D) $\int_{130}^{140} f(x)dx$

10. C the centre of the hyperbola $\dfrac{x^2}{a^2} - \dfrac{y^2}{b^2} = 1$. The tangents at any point P on this hyperbola meets the straight lines $bx - ay = 0$ and $bx + ay = 0$ in the points Q and R respectively. Then CQ. CQ . CR =

(A) $a^2 + b^2$ (B) $a^2 - b^2$
(C) $\dfrac{1}{a^2} + \dfrac{1}{b^2}$ (D) $\dfrac{1}{a^2} - \dfrac{1}{b^2}$

11. The ratio of the areas of two regions in which the curve $C_1 \equiv 4x^2 + \pi^2 y^2 = 4\pi^2$ is divided by the curve $C_2 \equiv y = -\left(\text{sgn}\left(x - \dfrac{\pi}{2}\right)\right)\cos x$ is equal to (where sgn denotes signum function)

(A) $\dfrac{\pi^2 - 2}{\pi^2 + 2}$ (B) $\dfrac{\pi^2 + 4}{\pi^2 - 2\sqrt{2}}$
(C) $\dfrac{\pi^2 + 3\sqrt{2}}{\pi^2 + 6}$ (D) $\dfrac{\pi^2 - \sqrt{2}}{\pi^2 + 1}$

Space For Rough Work

12. The plane $\frac{x}{1}+\frac{y}{2}+\frac{z}{3}=1$ intersects x-axis, y-axis and z-axis at points A, B and C respectively. The distance between origin and orthocentre of ΔABC is equal to

(A) $\frac{1}{\sqrt{7}}$ units (B) $\frac{6}{\sqrt{7}}$ units

(C) $\frac{6}{7}$ units (D) none of these

13. If the equation $4x^4 - ax^3 + bx^2 - cx + 6 = 0,\ a,b,c \in R^+$ has four distinct real roots say $x_1 < x_2 < x_3 < x_4$ such that $\frac{1}{x_1}+\frac{2}{x_2}+\frac{3}{x_3}+\frac{4}{x_4}=8$, then $\frac{x_4}{x_1}$ is equal to

(A) 2 (B) 3

(C) 4 (D) 6

14. The perpendicular bisectors $x+y+2=0$ and $x-y-1=0$ of sides AB and AC of a triangle ABC intersect them at $(-1,-1)$ and $(2,1)$ respectively. If the midpoint of side BC is P, then the distance of P from the orthocentre of triangle ABC is

(A) $\sqrt{85}$ (B) $\sqrt{41}$

(C) $\sqrt{13}$ (D) none of these

(Paragraph Type)

This section contains **2 paragraphs**. Based upon the paragraphs **2 multiple choice questions** have to be answered. Each of these questions has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph for Question no. 15 to 16

Consider the equation $x^2-[x^2]=(x-[x])^2$ where [.] denotes Greatest integer function. For $n \in N$, let $f(n)$ denote the number of roots of the above equation in the interval $1 \le x \le n$. Answer the following questions:

15. The number of solutions of the equation $f(n)=n$ is

(A) 0 (B) 1

(C) 2 (D) none of these

Space For Rough Work

16. The value of $\lim\limits_{n\to\infty}\left(\sqrt{f(n)}-\left[\sqrt{f(n)}\right]\right)$ (where [.] denotes GIF) is

(A) 1
(B) $\frac{1}{4}$
(C) $\frac{1}{2}$
(D) none of these

Paragraph for Question no. 17 to 18

Let $\vec{a},\vec{b},\vec{c}$ and $\vec{d}$ be unit vectors such that $\vec{a}.\vec{b}=\vec{b}.\vec{c}=\vec{c}.\vec{a}=\cos\theta$ and $\vec{d}.\vec{a}=\vec{d}.\vec{b}=\vec{d}.\vec{c}=\cos\alpha$.

17. If $\theta=\frac{\pi}{3}$ then α is equal to

(A) $\frac{\pi}{4}$
(B) $\cos^{-1}\left(\frac{1}{\sqrt{3}}\right)$
(C) $\cos^{-1}\left(\sqrt{\frac{2}{3}}\right)$
(D) $\frac{\pi}{2}$

18. If $\theta=\cos^{-1}\left(\frac{1}{4}\right)$ then α is equal to

(A) $\frac{\pi}{4}$
(B) $\cos^{-1}\left(\frac{1}{\sqrt{3}}\right)$
(C) $\cos^{-1}\left(\sqrt{\frac{2}{3}}\right)$
(D) $\frac{\pi}{2}$

Space For Rough Work

FIITJEE

Q.P. Code: 100192

Answers

SECTION-1 : PHYSICS

PART – A

1.	BC	2.	AC	3.	ABD	4.	ABD
5.	BD	6.	BD	7.	BC	8.	D
9.	B	10.	B	11.	D	12.	C
13.	C	14.	A	15.	B	16.	A
17.	C	18.	B				

SECTION-1 : CHEMISTRY

PART – A

1.	ABCD	2.	ABC	3.	AB	4.	AB
5.	ABD	6.	AB	7.	AD	8.	D
9.	B	10.	A	11.	D	12.	A
13.	B	14.	B	15.	C	16.	C
17.	A	18.	B				

SECTION-1 : MATHEMATICS

PART – A

1.	CD	2.	CD	3.	AD	4.	CD
5.	BCD	6.	BD	7.	AB	8.	C
9.	D	10.	A	11.	A	12.	C
13.	C	14.	C	15.	B	16.	C
17.	C	18.	A				

FIITJEE

Answers & Solutions

SECTION-1 : PHYSICS

PART – A

1. **BC**

Sol. If collisions at both the walls are inelastic, period is T_0.
If collision at one wall is elastic and at the other is inelastic, the period is T_0.

2. **AC**

Sol. $\frac{\ell}{r} = \frac{4+\sqrt{6}}{\sqrt{3}}$

Mass of load = $\frac{m(1+\eta^2)}{(1-\eta^2)}\sin\theta$ = 15 kg.

3. **ABD**

Sol. Dielectric constant = $\frac{\ell - \frac{\ell}{3}}{\frac{\ell}{3}}$ = 2.

Charge appearing due to polarization on the surface of the dielectric is 0.25 C_0V.

4. **ABD**

Sol. Resultant amplitude = $\sqrt{(5A-2A)^2+(6A-2A)^2} = 5A$

$\tan\phi = \frac{3A}{4A}$; $\phi = 37°$

Resultant wave = 5A sin (ωt – kx + 37°)

5. **BD**

Sol. PT = constant

$P_f = P\sqrt{\frac{\frac{\rho}{2}}{\rho}} = \frac{P}{\sqrt{2}}$

$T_f = T\sqrt{\frac{\rho}{\frac{\rho}{2}}}$ = $T\sqrt{2}$

6. **BD**

Sol. Drift = $\frac{d}{2}$, when board at bank of river.

Say drift = x, when board taken away from bank by a distance ‘d’.

$2d - x = \sqrt{d^2+x^2}$

$4d^2 + x^2 - 4dx = d^2 + x^2$

$4dx = 3d^2$

$x = \frac{3d}{4}$

7. **BC**

Sol. PQ = 2R

a = g cos θ

$u^2 = 2(g\cos\theta)(2R)$

$u = 2\sqrt{gR\cos\theta}$

$$t = \frac{u}{a} = \frac{2\sqrt{gR\cos\theta}}{g\cos\theta} = 2\sqrt{\frac{R}{g\cos\theta}}$$

In reaching upto centre.

$$u^2 = 2\,(g\cos\theta).\ R = \sqrt{2gR\cos\theta}\,.$$

8. **D**

Sol. Reynolds number and coefficient of friction are dimensionless.

Latent heat and gravitational potential both have dimension $\left[L^2T^{-2}\right]$

Curie and frequency of a light wave both have dimension $\left[T^{-1}\right]$. But dimensions of Planck's constant is $\left[ML^2T^{-1}\right]$ and torque is $\left[ML^2T^{-2}\right]$.

9. **B**

Sol. $I = I_o\left(e^{-Rt/L}\right)$

10. **B**

Sol. $$x = \frac{\sqrt{2Km}}{k_0}\left\{1 - e^{\frac{-k_0\tau}{m}}\right\}$$

At $t = \tau$, $x = R$

$$R = \frac{\sqrt{2Km}}{k_0}\left\{1 - e^{\frac{-k_0\tau}{m}}\right\}$$

11. **D**

Sol. $$I = \frac{mr^2}{2} + \frac{mr^2\sin^2\theta}{2}$$

$$= \frac{mr^2}{2}(1 + \sin^2\theta)$$

12. **C**

Sol. $$\oint \bar{E}.d\bar{s} = \frac{q_{en}}{\varepsilon_0}$$

$$Ar_0 \;\; 4\pi r_0^2 = \frac{q}{\varepsilon_0}$$

$$q = 4\pi\varepsilon_0 A\, r_0^3$$

13. **C**

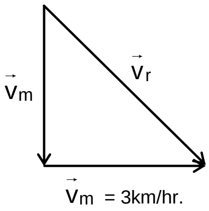
Sol. $$H = \frac{\left(u + \sqrt{u^2 + 2gh}\right)^2}{2g} - h + \frac{\sqrt{u^2 + 2gh} - u}{g}$$

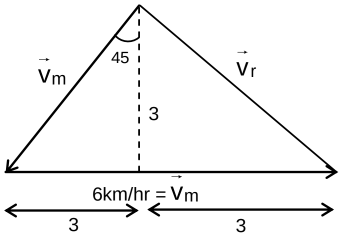
$$= \frac{2u\sqrt{u^2 + 2gh}}{g}$$

14. **A**

Sol. $\vec{v}_r$ should be same in both the situations.

Thus, $|\vec{v}_r| \;\; 3\sqrt{2}$ km/hr.





15. **B**

Sol. W correspond to N_1, X and Y correspond to N_2 and N_3 and Q value = $E_2N_2 + E_3N_3 - E_1N_1$

16. **A**

Sol. Binding energy per nucleon for N_1 is least hence mass of nucleus of W is greatest.

17. **C**

Sol. $\frac{3}{4}MV^2 = mgr(1 - \cos\theta)$ and $Mg\cos\theta = \frac{MV^2}{r} \Rightarrow \cos\theta = \frac{4}{7}$

18. **B**

Sol. $V = \sqrt{gR\cos\theta} = \sqrt{\frac{4}{7}gR}$

FIITJEE

SECTION-2 : CHEMISTRY

PART – A

1. ABCD

Sol. Henry's law is followed by ideal gas for which mole fraction is directly proportional to partial pressure.

$x = K_H P$

$$\therefore k_h = \frac{x}{p} = \frac{10^{-3}}{100} = 10^{-5}\,\text{atm}^{-1}$$

2. ABC

3. AB

Sol.
$$2\,XeO_3 + XeF_6 \xrightarrow{\quad} 3\,XeO_2F_2$$
$$XeO_3 + 2\,XeF_6 \xrightarrow{\quad} 3\,XeOF_4$$

4. AB

Sol. Before titration, the pH of acid is calculates as

$[H^+] = C\alpha = 0.02 \times 0.5 = 0.01$

$\therefore pH = 2$

At first equivalence point the solution contains HA^-

So pH = $\frac{1}{2}\left(p^{K_{a_1}} + p^{K_{a_2}}\right) = \frac{1}{2}(2+5) = 3.5$

5. ABD

Sol. (A) forms aldehyde on decarboxyaltion reaction (C) does not undergo decarboxylation as six-membered ring is not formed.

6. AB

Sol. In (C) 3^o-alcohol is not formed

(D) CH_4 is formed

7. AD

Sol. Zn^{2+} ions are present in half of the tetrahedral voids which are present on body diagonals.

Pure ZnS does not fluoresce it does so in presence of impurities like Ag^+ and Cd^{2+}

Anionic vacancy will be created not cationic vacancy.

8. D

Sol. The complex is:

$K_2[Hg(NO_2)_4].KNO_3$

9. B

Sol.
$$E = E^o - \frac{0.0591}{1}\log\frac{\left[Ag^+\right]_{LHS}}{\left[Ag^+\right]_{RHS}}$$
$$= 0 - 0.0591\log\frac{\left(2.8\times10^{-10}\right)/0.2}{\left(3.3\times10^{-13}\right)/10^{-3}} = -0.03\ V$$

10. A

Sol. α-hydroxy acids undergoes dehydration on heating to form a cyclic compound.

11. D

Sol. Br_2/H_2O confirms CHO group

$(CH_2CO)_2O$ confirms OH group

Conc. HI/red P confirm six membered carbon chain

12. A

Sol. $P_{equ^m} = 1.2$ atm

$\therefore p_x + p_y = 1.2$ atm

or, $p_x + 2px = 1.2$ atm

$\therefore p_x = 0.4$ atm

$$K_p = p_x \times p_y^2 = 0.4 \times (0.8)^2 = 0.256$$

$Q_p < K_p$, so forward reaction takes place

$$K_p = p_x \times p_y^2 = 2p_x \times p_y'^2$$

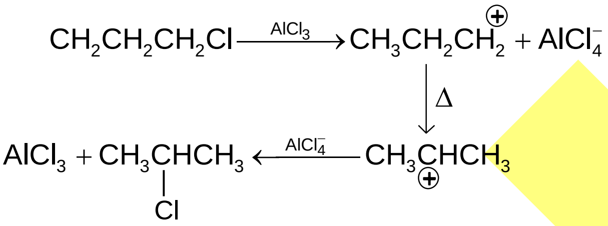
$$p_y'^2 = \frac{p_y^2}{2} \Rightarrow p_y' = \sqrt{\frac{p_y^2}{2}} = \frac{p_y}{\sqrt{2}}$$

13. B

Sol. One NO can substituted three CO groups.

14. B

Sol.



$$CH_2CH_2CH_2Cl \xrightarrow{AlCl_3} CH_3CH_2\overset{\oplus}{C}H_2 + AlCl_4^- \xrightarrow{\Delta} CH_3\underset{\oplus}{C}HCH_3 \xrightarrow{AlCl_4^-} AlCl_3 + CH_3\underset{Cl}{\underset{|}{C}}HCH_3$$

15. C

Sol. $W_T = W_{1\to2} + W_{2\to3} + W_{3\to4} + W_{4\to1}$

$$= 0 + \left[-\int_2^3 Pdv\right] + 0 + \left[-\int_4^1 Pdv\right]$$

= 0 + (-304 J) + 0 + 101 J = -203 J

16. C

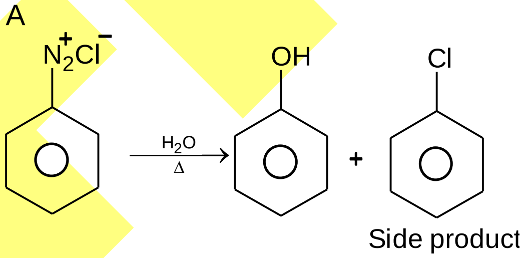
Sol. $q_{1\to2} = \int_1^2 C_v dT = nC_{V,\,M}\int_1^2 (T_2 - T_1) = 304$ J

$q_{2\to3} = \int_2^3 C_P dT = nC_{P,m}\int_2^3 (T_3 - T_2) = 761$ J

$\therefore q_T = 304 + 761 = 1065$ J

17. A

Sol.



18. B

Sol. HBr will be formed during reaction. It is consumed by $NaHCO_3$. Unless it is consumed, 'H$^+$' will change $-NH_2$ group to $-\overset{+}{N}H_3$ which decreases the reaction rate and direct meta substitution.

SECTION-3 : MATHEMATICS

PART – A

1. CD

Sol: Let numbers be x and y and let $z = xy$

$z_{max} = a^2$

Now, $P\left(xy \geq ma^2\right) = P\left(x(2a-x) \geq ma^2\right) \Rightarrow x^2 - 2ax + ma^2 \leq 0$

For $m = \frac{3}{4}, P = \frac{1}{2}$, and for $m = \frac{7}{16}, P = \frac{3}{4}$.

2. CD

Sol: Let $A = \theta + \frac{5\pi}{18} \Rightarrow A \in \left[\frac{\pi}{6}, \frac{\pi}{4}\right]$

$f(A) = \tan A + \cos A + \cot A \Rightarrow a = \frac{11}{2\sqrt{3}}, b = \frac{2\sqrt{2}+1}{\sqrt{2}}$

3. AD

Sol: $M = \sum_{n=0}^{3} \tan\left(\frac{2^{n-3}\pi}{3}\right).\sec\left(\frac{2^{n-2}\pi}{3}\right)$

$$= \frac{\sin\left(\frac{\pi}{12} - \frac{\pi}{24}\right)}{\cos\frac{\pi}{24}.\cos\frac{\pi}{24}} + ... + \frac{\sin\left(\frac{2\pi}{3} - \frac{\pi}{3}\right)}{\cos\frac{\pi}{3}.\cos\frac{2\pi}{3}}$$

$= \tan\frac{2\pi}{3} - \tan\frac{\pi}{24}$

$= -\sqrt{3} - \sqrt{2} + \sqrt{3} + 2 - \sqrt{6}$

$M = 2 - \sqrt{2} - \sqrt{6}$

$a_0 = \sqrt{2} - \sqrt{3} - \sqrt{6}$

$a_1 = \tan\frac{\pi}{12} + 2 \quad = 4 - \sqrt{3}$

$a_4 = \tan\left(\frac{2\pi}{3}\right) + 2 = 2 - \sqrt{3}$

then $a_1 - a_0 - 2 = 2 - \sqrt{2} - \sqrt{6}$ and $a_4 - a_0 = 2 - \sqrt{2} - \sqrt{6}$

4. CD

Sol:
$$f(x) = \begin{cases} \lim\limits_{n\to\infty}\left(\frac{1}{1+n^2} + \frac{3}{2+n^2} + ... + \frac{(2n-1)}{n+1^2}\right)[x], & x \neq \frac{\pi}{2} \\ 1, & x = \frac{\pi}{2} \end{cases}$$

$$\because \frac{1}{n+n^2} + \frac{3}{n+n^2} + ... + \frac{(2n-1)}{\left(n+n^2\right)} < \frac{1}{1+n^2} + \frac{3}{2+n^2} + ... + \frac{(2n-1)}{\left(n+n^2\right)} < \frac{1}{1+n^2} + \frac{3}{1+n^2} + ... + \frac{(2n-1)}{1+n^2}$$

$$\Rightarrow \quad \frac{n^2}{n+n^2} < \frac{1}{1+n^2} + \frac{3}{2+n^2} + ... + \frac{(2n-1)}{n+n^3} < \frac{n^2}{1+n^2}$$

$$\because \quad \lim_{n\to\infty}\frac{n^2}{n+n^2}=1 \text{ and } \lim_{n\to\infty}\frac{n^2}{1+n^2}=1$$

$$\therefore \quad \lim_{n\to\infty}\left(\frac{1}{1+n^2}+\frac{3}{2+n^2}+......+\frac{(2n-1)}{n+n^2}\right)=1$$

$$\therefore f(x)=\begin{cases}[x], & x\neq\frac{\pi}{2}\\ 1, & x=\frac{\pi}{2}\end{cases}\Rightarrow f(x)=[x]\,\forall\, x\in R.$$

Hence range of f(x) is set of all integers.

$\Rightarrow f(x)$ is unbounded.

Now, at $x=\frac{\pi}{2}$

Clearly, L.H.L= R.H.L = 1 = $f\left(\frac{\pi}{2}\right)$

But $f(x)$ is discontinuous at all integers as $[x]$ is discontinuous at integers.

5. BCD

Sol:

$$x^4+4x^3-8x^2=-k$$

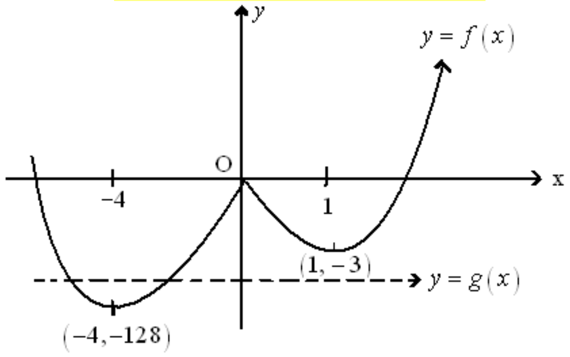
$$\Rightarrow \quad f(x)=-k$$

Where

$$f(x)=x^4+4x^3-8x^2=x^2\left(x^2+4x-8\right)$$

Let $g(x)=-k$

From the graph the following cases arise :



1. When $-3\le -k\le 0,\Rightarrow 0\le k\le 3$

In this case, $y=-k$ intersect at four points.

2. When $-4\le -k<-3,\Rightarrow 3<k\le 4$

In this case, $y=-k$ intersect at two points, the given equation has two real roots.

3. When $k<0,\Rightarrow -k>0$

In this case, there are two points of intersection. So, the equation has two real roots.

6. BD

Sol. $f'(x)=\frac{\sin x}{x}$

For $f'(x)=0,\frac{\sin x}{x}=0\Rightarrow x=n\pi\,(n\in I,\, n\neq 0)$

$$f''(x)=\frac{x\cos x-\sin x}{x^2}$$

$f''(n\pi)=\frac{\cos n\pi}{n\pi}<0$ if $n=2k-1$ and >0 if $n=2k,\ k\in I^+$

Hence, $f(x)$ has local maxima at $x=n\pi$, where $n=2k-1$ and local minima at $x=n\pi, n=2k$, where $k\in I^+$.

7. AB

Sol: $3x-6y+2z+5=0$

$-4x+12y-3z+3=0$

Bisectors are $\frac{3x-6y+2z+5}{\sqrt{9+36+4}}=\pm\frac{-4x+12y-3z+3}{\sqrt{16+144+9}}$

The plane which bisects the angle between the planes that contains the origin is

$13(3x-6y+2z+5)=7(-4x+12y-3z+3)$

$67x-162y+47z+44=0$

Further, $3x(-4)+(-6)(12)+2\times(-3)<0$

Hence, the origin lies in the acute angle.

8. C

Sol: Clearly $D_{min}=4a_{n+1}^{2}\left[1-\frac{n}{4}\right]$

For real roots, $D_{min}\geq 0\Rightarrow n\leq 4$.

9. D

Sol: f(x) is periodic with period 40.

10. A

Sol. P is $(a\sec\theta, b\tan\theta)$

Tangent at P is $\frac{x\sec\theta}{a}-\frac{y\tan\theta}{b}=1$

It meets $bx-ay=0$ i.e. $\frac{x}{a}=\frac{y}{b}$ in Q

$\therefore$ Q is $\left(\frac{a}{\sec\theta-\tan\theta},\frac{-b}{\sec\theta-\tan\theta}\right)$

It meets $bx+ay=0$ i.e. $\frac{x}{a}=-\frac{y}{b}$ in R.

$\therefore$ R is $\left(\frac{a}{\sec\theta+\tan\theta},\frac{-b}{\sec\theta+\tan\theta}\right)$

$\therefore CQ.CR=\frac{\sqrt{a^2+b^2}}{(\sec\theta-\tan\theta)}\cdot\frac{\sqrt{a^2+b^2}}{(\sec\theta+\tan\theta)}$

$=a^2+b^2,(\because\sec^2\theta-\tan^2\theta=1)$.

11. A

Sol: The areas of the regions are respectively π^2-2 and π^2+2.

12. C

Sol: Orthocentre is the foot of perpendicular from origin to the plane.

13. C

Sol: All roots are positive. Applying $AM\geq GM$ on $\frac{1}{x_1},\frac{2}{x_2},\frac{3}{x_3},\frac{4}{x_4}$ we get $x_1=\frac{1}{2}$ and $x_4=2$.

14. C

Sol: Triangle is right angled. Distance AP is equal to distance between $(-1,-1)$ and $(2,1)$ which is equal to $\sqrt{13}$.

15. B

16. C

Sol: **(15 & 16)**

It is obvious that $x = n$ is a required root. Let $1 \le \alpha < n$ be another root of the given equation. Let $m = [\alpha]$ and $t = \{\alpha\}$. Then the equation becomes: $2mt - \left[2mt + t^2\right] = 0$.

Therefore 2mt is a non-negative integer, i.e. $t = 0, \frac{1}{2m}, \frac{2}{2m}, \ldots, \frac{2m-1}{2m}$ for $m = 1, 2, 3, \ldots, n-1$. Hence the number of required roots is

$$f(n) = 2\left[1+2+3+\ldots+(n-1)\right]+1 = n^2 - n + 1$$

17. **C**

18. **A**

Sol 17 & 18:

Obviously, $\vec{d} \parallel \left(\vec{a}+\vec{b}+\vec{c}\right)$ and since $\vec{d}$ is a unit vector $\therefore \vec{d} = \frac{\vec{a}+\vec{b}+\vec{c}}{\left|\vec{a}+\vec{b}+\vec{c}\right|}$

Now, $\left|\vec{a}+\vec{b}+\vec{c}\right| = \sqrt{3+6\cos\theta}$

And $\vec{d}\cdot\vec{a} = \frac{\vec{a}\cdot\vec{a}+\vec{a}\cdot\vec{b}+\vec{a}\cdot\vec{c}}{\sqrt{3+6\cos\theta}}$

$$\Rightarrow \frac{1+2\cos\theta}{\sqrt{3+6\cos\theta}} = \cos\alpha$$

$$\Rightarrow \cos\alpha = \frac{1}{\sqrt{3}}\sqrt{1+2\cos\theta}$$

$\therefore \theta = \frac{\pi}{3} \Rightarrow \alpha = \cos^{-1}\sqrt{\frac{2}{3}}$ and $\theta = \cos^{-1}\frac{1}{4} \Rightarrow \alpha = \frac{\pi}{4}$

FIITJEE RBT-7 for (JEE-Advanced)

BATCHES – Two Yr CRP2123(All)

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 3

QP CODE: 100202

PAPER - 1

Time Allotted: 3 Hours **Maximum Marks: 204**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections.**
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. All the section can be filled in **PART-A & B** of OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with ***Blue/Black Ball Point Pen*** for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Two Parts.

(i) **Part-A (01-04) –** Contains **Four (04)** multiple choice questions which have ONLY ONE CORRECT answer Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(ii) **PART–A** (**05–12)** contains Eight (8) Multiple Choice Questions which have **One or More Than One Correct** answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
Negative Marks**: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in **–2** marks, as a wrong option is also darkened.

(iii) **Part-B (1 – 8)** contains Eight **(08)** Numerical based questions, the answer of which maybe positive or negative numbers or decimals **TWO** decimal places (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+3 marks** for correct answer. **There is no negative marking.**

Name of the Candidate :____

Batch :____________________ **Date of Examination :**____________________

Enrolment Number :____

SECTION – I : PHYSICS

PART – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

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1. A ball is projected from a point in one of the two smooth parallel vertical walls against the other in a plane perpendicular to both. After being reflected at each wall impinge again on the second at a point in the same horizontal plane as it started from. If “e” is the coefficient of restitution, “a” is the distance between the walls and “R” is the free range on horizontal surface, then which of the following is correct?

(A) $Re^3 = a(1 + e + e^2)$
(B) $Re = a(1 + e^2 + e^3)$
(C) $Re^2 = a(1 + e + e^2)$
(D) $R = a(1 + e + e^2)$

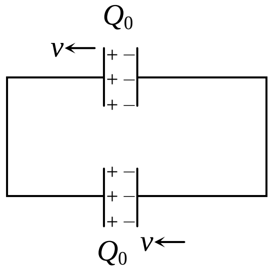
2. A hemisphere rests in equilibrium on a rough ground and against an equally rough wall, if the equilibrium is limiting, then the inclination θ of the base to the horizontal is

(A) $\theta = \sin^{-1}\left[\frac{3}{8}\left\{\frac{\mu+\mu^2}{1+\mu^2}\right\}\right]$
(B) $\theta = \sin^{-1}\left[\frac{8}{3}\left\{\frac{\mu+\mu^2}{1+\mu^2}\right\}\right]$
(C) $\theta = \cos^{-1}\left[\frac{8}{3}\left\{\frac{\mu+\mu^2}{1+\mu^2}\right\}\right]$
(D) $\theta = \cos^{-1}\left[\frac{3}{8}\left\{\frac{\mu+\mu^2}{1+\mu^2}\right\}\right]$

3. A cubical container of side ‘a’ and wall thickness x (x << a) is suspended in air and filled n moles of diatomic gas (adiabatic exponent γ) in a room where room temperature is T_0. If at time t = 0 gas temperature is T_1 ($T_1 > T_0$), the temperature of gas ‘T’ at time ‘t’ is

(A) $T = T_0 + T_1 e^{-\frac{6ka^2(\gamma-1)}{nRx}t}$
(B) $T = T_0 - (T_1 - T_0)e^{-\frac{6ka^2(\gamma-1)}{nRx}t}$
(C) $T = T_0 + (T_1 + T_0)e^{-\frac{6ka^2(\gamma+1)}{nRx}t}$
(D) $T = T_0 + (T_1 - T_0)e^{\frac{6ka^2(\gamma-1)}{nRx}t}$

4. Two identical capacitor connected as shown and having initial charge Q_0 each. Separation between plates of capacitor is d. Suddenly the left plate of upper capacitor and right plate of lower capacitor start moving with speed v towards left while other plate of capacitor remains fixed. The current in the circuit is



(A) $\frac{Q_0 v}{2d}$
(B) $\frac{Q_0 v}{d}$
(C) $\frac{Q_0 vt}{2d}$
(D) zero

Space For Rough Work

PART – A (Maximum Marks: 32)

*This section contains **EIGHT (08)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

5. A strip of wood of mass M and length ℓ is placed on a smooth horizontal surface. An insect of mass m starts at one end on the strip and walks to the other end in time t, moving with a constant speed.

(A) the speed of the insect as seen from the ground is $< \frac{\ell}{t}$.

(B) the speed of the strip as seen from the ground is $\frac{\ell}{t}\left(\frac{M}{M+m}\right)$

(C) the speed of the strip as seen from the ground is $\frac{\ell}{t}\left(\frac{m}{M+m}\right)$

(D) the total kinetic energy of the system is $\frac{1}{2}(m+M)\left(\frac{\ell}{t}\right)^2$

6. When photons of energy 4.25 eV strike the surface of a metal A, the ejected photoelectrons have maximum kinetic energy T_A eV and de-Broglie wavelength λ_A. The maximum kinetic energy of photoelectrons liberated from another metal B by photons of energy 4.70 eV is $T_B = (T_A - 1.50)$ eV. If the de-Broglie wavelength of these photoelectrons is $\lambda_B = 2\lambda_A$ then

(A) the work function of A is 2.25 eV
(B) the work function of B is 4.20 eV
(C) $T_A = 2.00$ eV
(D) $T_B = 2.75$ eV

7. A tube of length *l* and radius R carries a steady flow of fluid whose density is ρ and viscosity is η. The fluid flow velocity depends on the distance r from the axis of the tube as $v = v_0\left(1-\frac{r^2}{R^2}\right)$. Choose the correct option(s) from the following.

(A) the volume of the fluid flowing across the section of the tube per unit time is $\frac{1}{2}\pi^2 v_0 R^2$

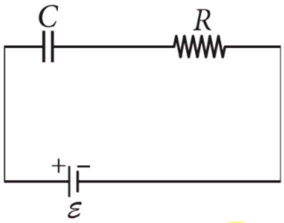
(B) the kinetic energy of the fluid within the tube's volume is $\frac{1}{6}\pi\ell R^2\rho v_0^2$

(C) the friction force exerted on the tube the fluid is $\frac{4\pi\eta\ell}{v_0}$

(D) the pressure difference at the ends of the tube is $\frac{4\eta\ell v_0}{R^2}$

Space For Rough Work

8. In the following $R-C$ circuit, the capacitor is in the steady state. The initial separation of the capacitor plates is x_0. If at $t=0$, the separation between the plates starts changing so that a constant current flows through R, find the velocity of the moving plates as a function of time. The plate area is A.



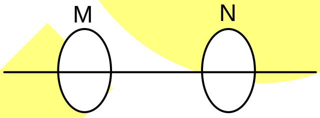
(A) $\left(\frac{I/\varepsilon_0 A}{IR-\xi}\right)\left[\left(\frac{I/\varepsilon_0 A}{\xi-/IR}\right)^2 t+\frac{1}{x_0}\right]^{-2}$

(B) $\left(\frac{I/\varepsilon_0 A}{IR-\xi}\right)\left[\left(\frac{I/\varepsilon_0 A}{\xi-IR}\right)t+\frac{1}{x_0}\right]^{-2}$

(C) $\left(\frac{I/\varepsilon_0 A}{IR-\xi}\right)\left[\left(\frac{I/\varepsilon_0 A}{\xi-IR}\right)t+\frac{1}{x_0}\right]^{2}$

(D) $\left(\frac{I/\varepsilon_0 A}{IR-\xi}\right)\left[\left(\frac{I/\varepsilon_0 A}{\xi-IR}\right)^{-1} t+\frac{1}{x_0}\right]^{2}$

9. Two identical circular coils M and N are arranged coaxially as shown in the figure. Separation between the coils is large as compared to their radii. The arrangement is viewed from left along the common axis. The sign convention adopted is that currents are taken to be positive when they appear to flow in clockwise direction. Then



(A) if M carries a constant positive current and is moved towards N, a positive current is induced in N
(B) if M carries a constant positive current and N is moved towards M, a negative current is induced in N
(C) if a positive current in M is switched off, a positive current is momentarily induced in N
(D) if both coils carry positive currents, they will attract each other

10. An external magnetic field is decreased to zero due to which a current is induced in a circular wire loop of radius r and resistance R placed in the field. This current will not become zero.
(A) at the instant when external magnetic field stops changing $(t=0)$, the current in the loop as a function of time for $t>0$ is given by $i_0 e^{-2Rt/\mu_2 \pi F}$
(B) at the instant when B stops changing $(t=0)$, the current in the loop as a function of time $t>0$ is given by $\frac{\mu_0 IR}{2r}$
(C) the time in which current in loop decreases to $10^{-3} I_0 (\text{from} t=0)$ for $R=100\Omega$ and and $r=5$ cm is given by $\frac{3\pi^2 \ln 10}{10^{10}}$
(D) the time in which current in loop decreases to $10^3 I_0$ (from $t=0$)for $R=100\Omega$ and $r=5\text{cm}$ is given by $\frac{3\pi^2}{10^6}\text{s}$

Space For Rough Work

11. In the series L – C – R circuit, the voltage across resistance, capacitance and inductance are 30V each at frequency $f = f_0$.
(A) It the inductor is short-circuited, the voltage across the capacitor will be $30\sqrt{2}$ V.
(B) If the capacitor is short-circuited, the voltage drop across the inductor will be $\frac{30}{\sqrt{2}}$ V.
(C) If the frequency is changed to $2f_0$, the ratio of reactance of the inductor to that of the capacitor is 4 : 1.
(D) If the frequency is changed to $2f_0$, the ratio of the reactance of the inductor to that of the capacitor is 1 : 4.

12. A wave disturbance in a medium is described by

$$y(x, t) = 0.02 \cos (50 \pi t + \pi/2) \cos (10 \pi x),$$

where ‘x’ and ‘y’ are in metre and ‘t’ in seconds.
(A) A node occurs at x = 0.15 m
(B) An antinode occurs at x = 0.3 m
(C) The speed of the component wave is 5.0 m/s
(D) The wavelength is 0.2 m.

PART – B (Maximum Marks: 24)

(Numerical Type)

This section contains ***Eight (08)*** Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **TWO** decimal places (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30).

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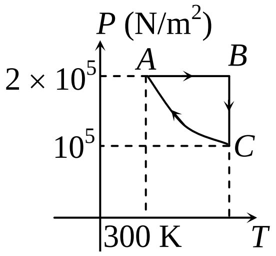
1. A machine is blowing spherical soap bubbles of different radii filled with helium gas. It is found that if the bubbles have a radius smaller than 1 cm, then they sink to the floor in still air. Larger bubbles float in the air. Assume that the thickness of the soap film in all bubbles is uniform and equal. Assume that the density of soap solution is same as that of water (=1000 kg m^{-3}). The density of helium inside the bubbles and air are 0.18 kg m^{-3} and 1.23 kg m^{-3}, respectively. If d is the thickness (in μm) of the soap film of the bubbles which are just floating, find the value of 2d.

2. Find the mass ratio M_D/M_H of deuterium and hydrogen (in near integer value) if their Hα lines have wavelengths of 6561.01 Å and 6562 Å respectively.

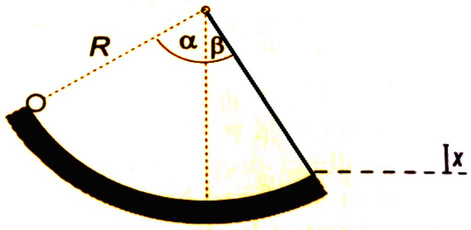
3. Two moles of a monatomic ideal gas is taken through a cyclic process shown on pressure(P) - temperature(T) diagram in figure. Process CA is represented as PT = Constant. If efficiency of given cyclic process is $1-\frac{3x}{12\ln 2+15}$, then find the value of ‘x’.



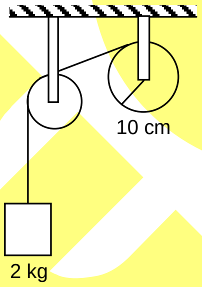
Space For Rough Work

4. A solid sphere of radius R = 0.2 m and of negligible mass is swimming in the water tank of base surface area A = 0.5 m^2. The depth of the water in the tank is h = 1 m. Determine the work (in joules) needed to push to push the sphere down the bottom of tank. (Assume that no water flows out of the tank. The density of water is ρ = 1000 kg/m^3 and g = 9.81 m/s^2).

5. A small wheel, initially at rest, rolls down a ramp in the shape of a quarter circle without slipping. The radius of the circle is R = 1 m and $\alpha = 60°$, $\beta = 30°$. Find the height ‘x’ (in cm) reached by the wheel after leaving the track.

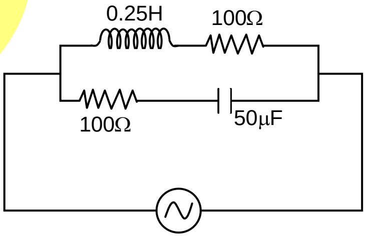


6. A string is wrapped on a wheel of moment of inertia 0.20 kg m^2 and radius 10 cm and goes through a light pulley to support a block of mass 2.0 kg as shown in figure. Find the acceleration of the block. (in m/s^2)



7. A battery is made by joining identical cells in m rows each row having m cells. The current flowing in an external resistance R is i_1. Now if the number of rows ‘m’ and number of cells in each row ‘n’ are interchanged, the current in external resistance is i_2. If $\frac{m}{2} = 2$ and $\frac{R}{r} = 4$ then the value of $\frac{i_2}{i_1}$ is

8. In the given Ac circuit, what is the power developed in watts?



220 V, 200 rad/s

Space For Rough Work

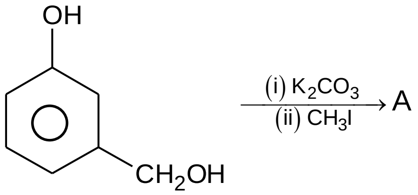
SECTION – II : CHEMISTRY

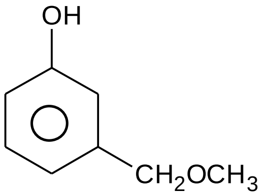
PART – A (Maximum Marks: 12)

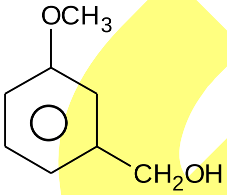
*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

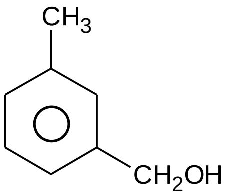
---

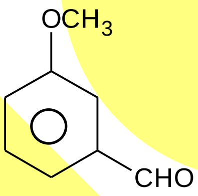
1. The product A is

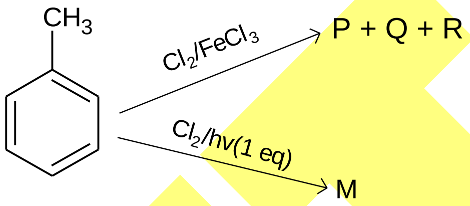

OH
CH2OH
(i) K2CO3
(ii) CH3I
A

(A)


(B)


(C)


(D)


2.

CH3
Cl2/FeCl3
P + Q + R
Cl2/hv(1 eq)
M

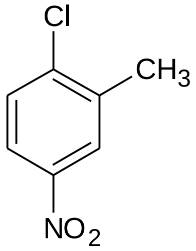
Which product can easily undergoes nucleophilic substitution reaction(S_N1 and S_N2 with equal ease).

(A) P
(B) Q
(C) R
(D) M

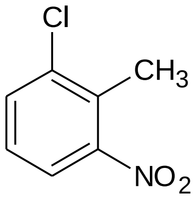
Space For Rough Work

3. Which is most reactive towards aromatic nucleophilic substitution reaction towards NaOH?

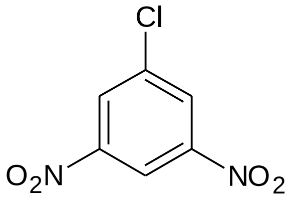
(A)



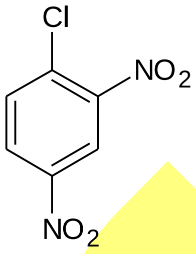
(B)



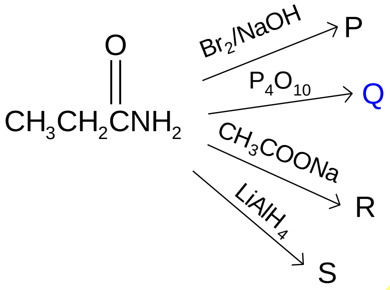
(C)



(D)



4.



Choose correct statement

(A) (P) and (S) are chain isomers

(B) hydrolysis of (Q) produces carboxylic acid

(C) (R) is obtained by the fastest reaction

(D) (S) contains four carbon atom

PART – A (Maximum Marks: 32)

This section contains ***EIGHT (08)*** *questions. Each question has* ***FOUR*** *options (A), (B), (C) and (D).* ***ONE OR MOER THAN ONE*** *of these four option(s) is (are) correct answer(s).*

5. Choose incorrect statements:

(A) $AlCl_3$ undergoes hydrolysis to form $\left[Al(H_2O)_6\right]^{3+}$

(B) Amalgamated Al reacts with cold water to liberate H_2

(C) The ash formed on burning magnesium in air fumes on wetting and exposing to HCl

(D) B^{3+} ion can exist in aqueous solution in the hydrated form

Space For Rough Work

6. Given $\Delta H_f^0(C_2H_6, g) = -85\,kJ/mole$,

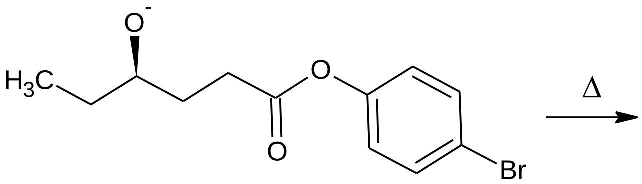
$\Delta H_f^0(C_3H_8, g) = -104\,kJ/mole$,

$\Delta H_{sub}^0(C, s) = 718\,kJ/mole\ \&\ B.E.\ of\ (H-H) = 436$ kJ/mole.

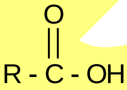
Then, in kJ/mole, the

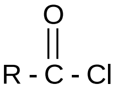
(A) C – C bond enthalpy is 218
(B) C – H bond enthalpy is 414
(C) C – C bond enthalpy is 345
(D) C – H bond enthalpy is 448

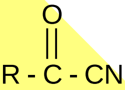
7.

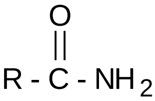


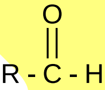
Which of the statements regarding the product formed in the above reaction is/are correct?
(A) If Br is replaced with NO_2 rate of reaction increases
(B) Inversion of configuration takes place.
(C) Nucleophillic acyl substitution takes place.
(D) Configuration at chiral carbon does not change

8. Which of the following compounds are more reactive than  $R-\overset{O}{\overset{||}{C}}-OH$ towards attack of nucleophile?

(A)  $R-\overset{O}{\overset{||}{C}}-Cl$

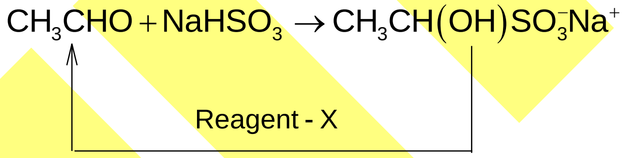
(B)  $R-\overset{O}{\overset{||}{C}}-CN$

(C)  $R-\overset{O}{\overset{||}{C}}-NH_2$

(D)  $R-\overset{O}{\overset{||}{C}}-H$

9. Compound/s which contain 3c – $2e^-$ bond.
(A) $(BeH_2)_n$
(B) $Al_2(CH_3)_6$
(C) B_2H_6
(D) Al_2Cl_6

10.



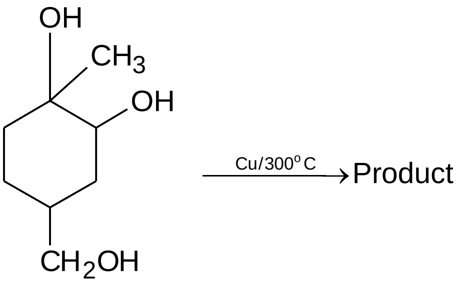
$$CH_3CHO + NaHSO_3 \rightarrow CH_3CH(OH)SO_3^-Na^+$$

In the above change, the reagent (X) can be
(A) CCl_4
(B) HCl
(C) NaOH
(D) DMF

Space For Rough Work

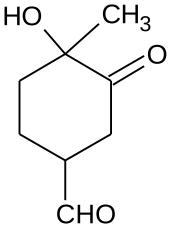
11. Acetone can form an aromatic compound when treated with conc. H_2SO_4. Which of the following reaction(s) do(es) not take place?
(A) oxidation
(B) dehydration
(C) sulphonation
(D) dehydrogenation

12.

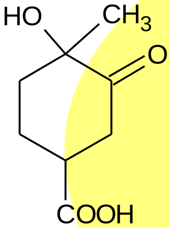


Which of the following(s) is/are minor product(s) or product(s) that are not formed at all?

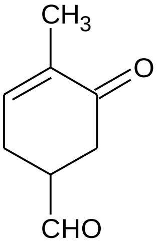
(A)



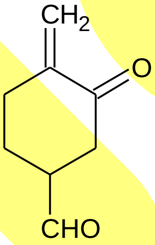
(B)



(C)



(D)



PART – B (Maximum Marks: 24)

(Numerical **Type)**

This section contains ***Eight (08)*** Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **TWO** decimal places (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30).

1. 4 moles of a liquid A (V.P = 100 mm of Hg) was mixed with 6 moles of B(V.P = 400 mm of Hg). If the mole fraction of A in the vapour above the solution is expressed as $\frac{x}{y}$, what is the value of (x + y)?

2. How many moles of O_2 gas can be produced by passing eight Faraday of electricity into sufficient water?

Space For Rough Work

3. $NH_4NO_3 \longrightarrow N_2O + 2H_2O$

What is the n-factor of NH_4NO_3 in above reaction?

4. An organic compound(X) upon ozonolysis reaction, produces 2-heptanone and formaldehyde. Reaction of (X) with HCl forms major product(Y) and minor product (Z). Reaction of (Y) with sodium metal in presence of dry ether(Wurtz reaction) forms the only product(P).

If x = the number of quartenary carbon atoms present in (P)
y = the number of monochloro products formed by (P) excluding stereoisomers
z = number of allylic hydrogen atoms present in (X)?

What is the value of $\left(\frac{x+y+z}{10}\right)$?

5. 11.7 g of NaCl solid is added to 176.4 g of H_2O. The degree of dissociation of NaCl in the solution is 0.8. If the relative lowering of vapour pressure of water in the solution is expressed as $x \times 10^{-2}$, what is the value of x?

6. In a mixed metallic oxide, the oxide ion forms the hexagonal close packing(hcp) lattice. The M^{2+} ions occupy ½ of the octahedral voids and the N^{3+} ions occupy 1/6th of the tetrahedral voids. If the formula of the solid is written as $M_xN_yO_z$, what is the value of $\left(\frac{x+y+z}{10}\right)$?

7. A 0.5 M aqueous solution of $Al_2(SO_4)_3$ is isotonic to a 0.2 M aqueous solution of glucose. If the solute undergoes completely ionization, then the ratio of their osmotic pressure is expressed as x : y. What is the value of $\frac{x}{y}$ in decimal form?

8. 5.35 g of a salt of a strong acid and weak base is dissolved in water to make one litre solution. The pH of the solution is found to be 5. The crystal of the salt contains NaCl type unit cell. What is the mass of one mole of unit cell of the salt in gram unit?
[K_b of the weak base = 10^{-5}]

Space For Rough Work

FIITJEE

SECTION – Iii : MATHEMATICS

PART – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

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1. A varying parabola ‘S’ of latus rectum ‘4a’ touches $y^2 = 4ax$, the axis of ‘S’ being parallel to x – axis. The locus of vertex of ‘S’ is

(A) $x + y + a = 0$ (B) $y^2 = 16ax$

(C) $x + y - a = 0$ (D) $y^2 = 8ax$

2. On the open interval (–c, c), where c is a positive real number, y(x) is an infinitely differentiable solution of the differential equation $\frac{dy}{dx} = y^2 - 1 + \cos x$, with the initial condition $y(0) = 0$. Then which one of the following is correct?

(A) $y(x)$ has a local maximum at the origin

(B) $y(x)$ has a local minimum at the origin.

(C) $y(x)$ is strictly increasing on the open interval $(-\delta, \delta)$ for some positive real number δ

(D) $y(x)$ is strictly decreasing on the open interval $(-\delta, \delta)$ for some positive real number δ.

3. Let $f:(0, \infty) \to (0, \infty)$, $f(1) = \sqrt{2}$ be a twice differentiable function such that $f'\left(\frac{1}{x}\right) = \frac{1}{f(x)}$ for all x in given domain, then $f(3) =$

(A) $\sqrt{2}$ (B) $\sqrt{10}$

(C) $3\sqrt{3}$ (D) $\sqrt{3}$

4. The values that ‘a’ can take so that the function $f:R \to R\ f(x) = x^3 + x^2 + a\cos x$ is injective

(A) $a \in \left(\frac{1}{3}, \infty\right)$ (B) $a \in \left(-\infty, -\frac{1}{3}\right)$

(C) $a = 2$ (D) No value of a

Space For Rough Work

PART – A (Maximum Marks: 32)

*This section contains **EIGHT (08)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

5. Equation of ellipse E is $\frac{x^2}{16}+\frac{y^2}{4}=1$. Suppose C be a circle concentric with E intersecting the ellipse in four points. Let A be a point on E and B be a point on C such that line joining A and B is common tangent of ellipse E and circle C. If ℓ be maximum value of length AB and m be its corresponding slope, then

(A) $\ell=2$ (B) $m=\sqrt[\pm]{2}$

(C) $\ell=6$ (D) $m=\frac{\pm1}{\sqrt{2}}$

6. Let $S=\{w_1,w_2,....\}$ be a sample space associated to a random experiment. Let $P(w_n)=\frac{P(w_{n-1})}{2}, n\geq 2$. Let $A=\{2k+3\ell : k,\ell\in N\}$ and $B=\{w_n : n\in A\}$. Then

(A) $P(w_n)=\frac{1}{2^{n-1}}$ (B) $P(B)=\frac{3}{32}$

(C) $P(w_n)=\frac{1}{2^n}$ (D) $P(B)=\frac{3}{64}$

7. If $|2z+3|=|3z+4|$, then

(A) $|z|_{min}=2$ (B) $|z|_{max}=\frac{7}{5}$

(C) $|z|_{max}=2$ (D) $|z|_{min}=1$

8. Let $f:X\to Y$ be a function. If $P\subset X$ and $Q\subset Y$, define $f(p)=\{f(x):x\in P\}$ and $f^{-1}(Q)=\{x:f(x)\in Q\}$. Then the true statement(s) is/are:

(A) $f\left(f^{-1}(Q)\right)=Q$ (B) $f^{-1}(Q)\cup f^{-1}(R)=f^{-1}(Q\cup R)$

(C) $f^{-1}\left(f(P)\right)=P$ (D) $f^{-1}(Q)\cap f^{-1}(R)=f^{-1}(Q\cap R)$

9. Consider function $f:A\to\bar{B}$ and $g:B\to C(A,B,C\subseteq R)$ such that $(gof)^{-1}$ exists then

(A) f is ONTO and g is ONE – ONE (B) f is ONE – ONE

(C) g is ONTO (D) f and g are both ONTO

Space For Rough Work

10. The function $f(x)$ is differentiable, continuous and $f(x) \neq 0$ for all x on the interval $[4, 8]$. Also $f(4) = \frac{1}{4}$, $f(8) = \frac{1}{2}$ and $\int_4^8 \frac{(f'(x))^2}{(f(x))^4} dx = 1$. Find $f(6)$.

(A) $f(6) = \frac{1}{9}$
(B) $f(6) = \frac{1}{3}$
(C) $f(5) = \frac{2}{7}$
(D) $f(5) = 3$

11. A relation R on the set of complex numbers is defined by $z_1 R\ z_2$ if and only if $\frac{z_1 - z_2}{z_1 + z_2}$ is real. Then

(A) R is reflexive relation
(B) R is symmetric relation
(C) R is transitive relation
(D) R is equivalence relation

12. Consider 4 persons A, B, C, D

(A) If A, B, C, D each have four houses then number of ways in which they can enter these houses so that none of them enter their own house is **9**
(B) If A has two houses whereas B, C, D have one house each then number of ways in which they can enter these houses such that no one enters their own house is **44**
(C) If A, B, C, D each have four houses then number of ways in which they can enter these houses so that none of them enter their own house is **16**
(D) If A has two houses whereas B, C, D have one house each then number of ways in which they can enter these houses such that no one enters their own house is **42**

PART – B (Maximum Marks: 24)

(Numerical **Type)**

This section contains ***Eight (08)*** Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **TWO** decimal places (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30).

---

1. If number of arrangements of letters of the word MISSISSIPPI in which the first S precedes the first I equals α, then $\frac{\alpha}{10}$ equals

2. For all real numbers x, $f(x)$ is an increasing function that is differentiable and satisfies the following conditions

(i) $f(1) = 1, \int_1^2 f(x) dx = \frac{5}{4}$

(ii) Let $g(x)$ be inverse of $f(x)$, then for all $x \geq 1, g(2x) = 2f(x)$.

If $\int_1^8 x f'(x) dx = \frac{p}{q}$; $HCF(p, q) = 1$, then $p + q =$

Space For Rough Work

3. The value of $\left[\dfrac{\sum\limits_{n=1}^{99}\sqrt{10+\sqrt{n}}}{\sum\limits_{n=1}^{99}\sqrt{10-\sqrt{n}}}\right]$ is equal to (here [.] represents greatest integer function) is equal to

4. If the length of the shortest distance between any two opposite edges of the tetrahedron formed by the planes whose equations are $y+z=0,\ z+x=0,\ x+y=0$ and $x+y+z=\sqrt{3}$ is λ, then the value of 2λ is equal to

5. f is differentiable function such that $f(f(x))=x$ where $x\in[0,1]$. Also, $f(0)=1$. Then the value of $2024\int_0^1 (x-f(x))^{2023}\,dx$ is

6. Let positive vector of points A, B and C of triangle ΔABC respectively be $\hat{i}+\hat{j}+2\hat{k},\ \hat{i}+2\hat{j}+\hat{k}$ and $2\hat{i}+\hat{j}+\hat{k}$. Let l_1, l_2 and l_3 be the lengths of perpendiculars drawn from the orthocenter ‘O’ on the sides AB, BC and CA, then $(l_1+l_2+l_3)$ equals.

7. Let $f(x)=\frac{1}{2}x\sin x-(1-\cos x)$. The smallest positive integer k such that $\lim\limits_{x\to 0}\frac{f(x)}{x^k}\neq 0$ is

8. Consider the real valued function $h:\{0,1,2,\ldots\ldots,100\}\to R$ such that $h(0)=5,\ h(100)=20$ and satisfying $h(i)=\frac{1}{2}(h(i+1)+h(-1))$ for every $i=1,2,\ldots\ldots.,99$. Then the value of h(1) is

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Space For Rough Work

Q. P. Code: 100202

Answers

SECTION – I : PHYSICS

PART – A

1.	C	2.	B	3.	D	4.	B
5.	AC	6.	ABC	7.	BCD	8.	B
9.	BCD	10.	AC	11.	BC	12.	ABCD

PART – B

1.	7	2.	2	3.	7	4.	274.00
5.	4.58	6.	0.89	7.	1.50	8.	629.20

SECTION – II : CHEMISTRY

PART – A

1.	B	2.	D	3.	D	4.	B
5.	AD	6.	BC	7.	ACD	8.	ABD
9.	ABC	10.	BC	11.	ACD	12.	ABD

PART – B

1.	8	2.	2	3.	4	4.	1.4
5.	3.6	6.	1.1	7.	12.5	8.	214

SECTION – III : MATHEMATICS

PART – A

1.	D	2.	D	3.	B	4.	C
5.	AD	6.	CD	7.	BD	8.	BD
9.	BC	10.	BC	11.	ABCD	12.	AD

PART – B

1.	924	2.	143	3.	2	4.	2.82
5.	1	6.	1.22	7.	4.00	8.	5.15

Answers & Solutions

SECTION – I : PHYSICS

PART – A

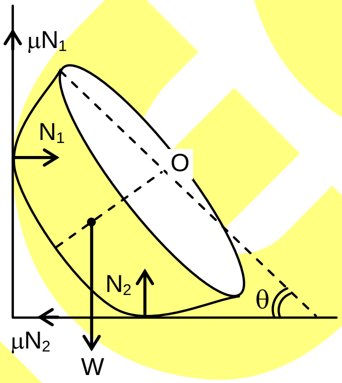
1. **C**

Sol. $\frac{a}{u_x}+\frac{q}{eu_x}+\frac{a}{e^2u_x}=\frac{2u_y}{g}$ ...(1)

Horizontal range:

$$R=\frac{2.u_xu_y}{g} \quad ...(2)$$

2. **B**



Sol. $N_1 = \mu N_2$ ...(1)

$W = \mu N_1 + N_2$ ...(2)

By (1) and (2)

$N_1=\frac{\mu W}{1+\mu^2}$ ...(2)

Balancing torque about 'O'

$\mu N_1 \times R + \mu N_2 \times R = W\times\frac{3R}{8}\sin\theta$

$\text{Sin }\theta=\frac{8}{3}\left[\frac{\mu+\mu^2}{1+\mu^2}\right]$

3. **D**

Sol. $\frac{dQ}{dt}=\frac{K(6a^2)(T-T_0)}{x}=n\left(\frac{R}{\gamma-1}\right)\frac{dT}{dt}$

$\int_{T_1}^{T}\frac{dT}{T-T_0}=\frac{6Ka^2(\gamma-1)}{nRx}\int_{o}^{t}dt$

$T=T_0+(T_1-T_0)e^{\frac{6Ka^2(\gamma-1)t}{nRx}}$

4. **B**

Sol. $\frac{q_1}{C_1}=\frac{q_2}{C_2}$ **;** $q_1+q_2=2Q_0$

$C_1=\frac{\varepsilon_0A}{d_0+vt}$; $C_2=\frac{\varepsilon_0A}{d_0-vt}$

$\frac{q_1}{q_2}=\frac{d_0-vt}{d_0+vt}$

$q_2\left(\frac{d_0-vt}{d_0+vt}\right)+q_2=2Q_0$

$q_2\left[\frac{2d_0}{d_0+vt}\right]=2Q_0$

$q_2=\frac{2Q_0}{2d_0}(d_0+vt)$

$I=\frac{dq_2}{dt}=\frac{Q_0v}{d_0}$

5. **AC**

Sol. Velocity of insect w.r.t. strip = $\frac{\ell}{t}$

Let strip moves with speed v

Initial momentum was 0

$$\Rightarrow \quad 0 = m\left(\frac{\ell}{t} + v\right) + Mv$$

$$v = -\frac{m\ell / t}{M + m} \text{ i.e. } \frac{m\ell / t}{M + m} \text{ toward left}$$

$\therefore$ Velocity of insect w.r.t. ground = $\frac{\ell}{t} - \frac{m\ell / t}{M+m} < \frac{\ell}{t}$.

6. **ABC**

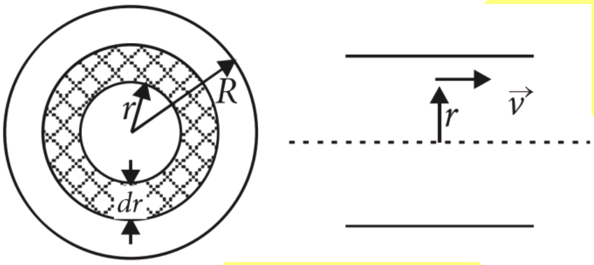
Sol. KE = hν – ϕ

7. **BCD**

Sol. Let dV be the volume flowing per second through the cylindrical shell of thickness dr then,

$dV = (2\pi r dr)v_0\left(1 - \frac{r^2}{R^2}\right) = 2\pi v_0\left(r - \frac{r^3}{R^2}\right)dr$ and the total volume,

$$V = 2\pi v_0 \int_0^R \left(r - \frac{r^3}{R^2}\right)dr = 2\pi v_0 \frac{R^2}{4} = \frac{\pi R^2 v_0}{2}$$



Let, dK be the kinetic energy, within the above cylindrical shell. Then

$$dK = \frac{1}{2}(dm)v^2 = \frac{1}{2}(2\pi r \ell \rho)v^2 dr$$

$$= \frac{1}{2}(2\pi \ell \rho) r v_0^2 \left(1 - \frac{r^2}{R^2}\right) dr$$

$$= \pi l \rho v_0^2 \left[r - \frac{2r^3}{R^2} + \frac{r^5}{R^4}\right] dr$$

Hence, kinetic energy of the fluid,

$$K = \pi l \rho v_0^2 \int_0^R \left(r - \frac{2r^3}{R^2} + \frac{r^5}{R^4}\right) dr = \frac{\ell \pi R^2 \rho v_0^2}{6}$$

Hence frictional force is the shearing force on the tube, exerted by the fluid, which equals $-\eta S \frac{dv}{dr}$, where S is the surface area of tube.

Given, $v = v_0\left(1 - \frac{r^2}{R^2}\right)$ So $\frac{dv}{dr} = -2v_0 \frac{r}{R^2}$

and at $r = R, \frac{dv}{dr} = -\frac{2v_0}{R}$

Then, viscous force is given by,

$$dF = -\eta(2\pi R l)\left(\frac{dv}{dr}\right)_{r=R}$$

$$= -2\pi R \eta l\left(-\frac{2v_0}{R}\right) = 4\pi \eta l v_0$$

Taking a cylindrical shell of thickness dr and radius r Viscous force, $F = -\eta(2\pi r l)\frac{dv}{dr}$, Let, ΔP be the pressure difference, the net force on the element $= \Delta P\pi r^2 + 2\pi\eta l r\frac{dv}{dr}$

But, since the flow is steady, $F_{net} = 0$

$$\text{or } \Delta P = \frac{-2\pi l\eta r\frac{dv}{dr}}{\pi r^2} = \frac{2\pi l\eta r\left(2v_0\frac{r}{R^2}\right)}{\pi r^2} = \frac{4\eta l v_0}{R^2}$$

8. **B**

Sol. Let q be the instantaneous charge on the capacitor when a steady current I flows through the circuit. Appling KVL on the circuit, we have

$$\xi = \frac{q}{C} + IR \text{ or } \xi = \frac{qx}{\varepsilon_0 A} + IR\left(\because C = \frac{\varepsilon_0 A}{x}\right) \qquad .....(i)$$

Differentiating eqn. (i) with respect to time, we get

$$0 = \frac{q}{\varepsilon_0 A}\left(\frac{dx}{dt}\right) + \frac{Ix}{\varepsilon_0 A} + 0 \qquad (\because q = It)$$

$$\text{or } q = -\frac{Ix}{(dx/dt)}\left(\text{where}\frac{dx}{dt} = \text{velocity}\right) \qquad .....(ii)$$

From equationn (ii) substituting the value of q in equation (i). we have

$$\xi = -I\frac{x^2}{\varepsilon_0 A(dx/dt)} + IR$$

$$\text{or } \frac{dx}{dt} = v = \left(\frac{-I/\varepsilon_0 A}{\xi - IR}\right)x^2 \qquad ....(iii)$$

$$\text{or } -\frac{dx}{x^2} = \left(\frac{I/\varepsilon_0 A}{\xi - IR}\right)dt \qquad ....(iv)$$

Integrating the above expression w.r.t. time, we get

$$\frac{1}{x} - \frac{1}{x_0} = \left(\frac{I/\varepsilon_0 A}{\xi - IR}\right)t \qquad ....(v)$$

From eqn (iii) and (v), we get

$$v = \left(\frac{I/\varepsilon_0 A}{IR - \xi}\right)\left[\left(\frac{I/\varepsilon_0 A}{\xi - IR}\right)t + \frac{1}{x_0}\right]^{-2}$$

9. **BCD**

Sol. Apply Faraday law for direction of induced current.

10. **AC**

Sol. Flux linked with loop due to its own magnetic field,

$$\phi = \frac{\mu_0 I}{2r}(\pi r^2) = \frac{\mu_0 \pi r I}{2}$$

emf induced $= \frac{d\phi}{dt} = \varepsilon = -\frac{\mu_0 \pi r}{2}\frac{dI}{dt}$

$$I = \frac{\varepsilon}{R} = -\frac{\mu_0 \pi r}{2R}\frac{dI}{dt}$$

$$\int_{I_0}^{1}\frac{dI}{I} = -\int_0^t \frac{2R}{\mu_0 \pi r}.dt; I = I_0 e^{-2Rt/\mu_0 \pi r}$$

Now, $10^{-3}I_0 = I_0 e^{-\frac{2Rt}{\mu_0 \pi r}} = i_0 e^{-2Rt/\mu_0 \pi r}$

which gives $t = \frac{3\pi^2 \ln 10}{10^{10}}$s.

11. **BC**

$v_L = v_C = v_R;$

$\Rightarrow x_L = x_C = R$

when inductor is short circuited

$$Z = \sqrt{R^2 + x_C^2} = \sqrt{2}R$$

$$\therefore I = \frac{30}{Z} = \frac{30}{\sqrt{2}R}$$

$$\therefore V_L = ix_L = \frac{30}{\sqrt{2}R} \times R = \frac{30}{\sqrt{2}}$$

∴ (A) is incorrect and with similar calculations (B) will be correct.

Here f_0 is the resonance frequency as $v_L = v_C$

$$\omega_0 = 2\pi f_0 = \frac{1}{\sqrt{LC}}$$

$$\frac{x_L}{x_C} = \frac{\omega L}{1/\omega C} = \omega^2 LC$$

Given $f = 2f_0$

$\Rightarrow \quad \omega = 2\omega_0$

$$\therefore \quad \frac{x_L}{x_C} = 4$$

∴ (C) is also correct.

12. **ABCD**

Sol. y = 2a cos (ωt + ϕ) cos (Kx) comparison with given equation gives

$$K = \frac{2\pi}{\lambda} = 10\pi \Rightarrow \lambda = \frac{1}{5}\text{m}$$

$\omega = 2\pi f = 50\pi \Rightarrow f = 25$ Hz

∴ $v = 5\ \text{ms}^{-1}$

at x = 0.15 m

cos (10 π × 0.15) = cos (1.5π)

= –1 for all t

at x = 0.3

cos (10 π × 0.3) = cos 3π = – 0 for all t

PART – B

1. **7**

Sol. For equilibrium of bubble.

$$4\pi R^2 d\,\rho_{sol} g + \frac{4}{3}\pi R^3\,\rho_{He} g = \frac{4}{3}\pi R^3 \rho_{air} g$$

d → Thickness of soap solution.

∴ d = 3.5 μm.

2. **2**

Sol. Use formula in terms of reduced mass

$$\frac{1}{\lambda} = \frac{R_\infty z^2}{\left(1+\frac{m}{M}\right)}\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\therefore \quad \frac{\lambda_D}{\lambda_H} = \frac{1+\frac{m}{M_D}}{1+\frac{m}{M_H}}$$

$$\frac{M_D}{M_H} \approx 2.0$$

3. **7**

Sol. For process AB $T_A = 300\text{ K},\ T_B = 600\text{ K}$

$$W = nR\Delta T = nR(T_B - T_A) = 300\text{ nR } = 600R.$$

$$Q = n\,Cp\,\Delta T = 2\times\frac{5}{2}R\ (300) = 1500R.$$

For process BC $W = nRT\ln\frac{v_f}{v_c} = nRT\ln\frac{p_i}{p_f} = nRT\ln 2 = 1200R\ln 2$

$$Q = W = 1200R\ln 2$$

For process CA $W = \int P\,dV = \int_{600}^{300}\frac{K}{T}\frac{2nRT}{K}dT.$

$$= -2nR(300) = -1200R.$$

$$Q = nC_V\ \Delta\ T + W$$

$$= 2\times\frac{3}{2}R(-300) - 1200R.$$

$$= -900R - 1200R = -2100R$$

$$\eta = \frac{600R + 1200R\ln 2 - 1200R}{1500R + 1200R\ln 2}$$

$$= 1 - \frac{21}{12\ln 2 + 15} \quad \Rightarrow x = 7.$$

4. **274.00**

Sol. $W = \frac{4}{3}\pi R^3\rho g\left[h - R + \frac{x}{2}\right] = \frac{4}{3}\pi R^3\rho g\left[h - R + \frac{\frac{4}{3}\pi R^3}{2A}\right]$

5. **4.58**

Sol. h = (R – r) [cos 30° – cos 60°]

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}mr^2\omega^2$$

$$x = \frac{v^2\sin^2 30^o}{2g}$$

6. **0.89**

Sol. $2g - T = 2a$ …(i)

$TR = I\alpha$ …(ii)

$a = R\alpha$ …(iii)

From (ii) and (iii) $T = \frac{Ia}{R^2}$

$$\therefore\quad 2g = a\left(2 + \frac{I}{R^2}\right)$$

$$\Rightarrow\quad a = \frac{2g}{\left(2 + \frac{I}{R^2}\right)} = \frac{2\times 9.8}{2 + \frac{0.2}{0.01}} = \frac{9.8}{11} \approx 0.89\text{ m/s}^2$$

7. **1.50**

Sol. $i_1 = \frac{E}{\frac{r}{m} + \frac{R}{n}}$ & $i_2 = \frac{E}{\frac{r}{n} + \frac{R}{m}}$

$$\frac{i_2}{i_1} = \frac{\frac{r}{m} + \frac{R}{n}}{\frac{r}{n} + \frac{R}{m}} = \frac{1 + \frac{m}{n}\cdot\frac{R}{r}}{\frac{m}{n} + \frac{R}{r}} = \frac{3}{2} = 1.5$$

8. **629.20**

Sol. $X_L = 50\ \Omega$, $X_C = 100\ \Omega$

$Z_1 = 100 - 50\ I$; $Z_2 = 100 + 100\ i$ $(i = \sqrt{-1})$

$$Z = \frac{Z_1 Z_2}{Z_1 + Z_2} = \frac{100}{17}(13 + i)$$

$$|Z| = \frac{100}{17}\sqrt{170}\ ;\ \cos\theta = \frac{13}{\sqrt{170}}$$

$$P = \frac{V^2}{|Z|}.\cos\phi\ = 629.20$$

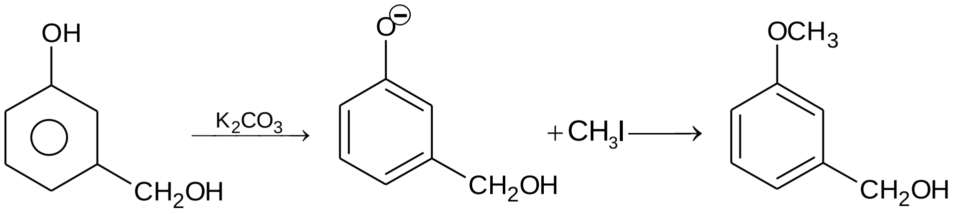
FIITJEE

SECTION – II : CHEMISTRY

PART – A

1. B

Sol.



2. D

Sol. P, Q and R are formed by EAS reaction M is formed by free radical chlorination.

3. D

Sol. Electron withdrawing groups favour nucleophilic substitution when they are ortho and para to leaving group.

4. B

Sol. P = $CH_3CH_2NH_2$, Q = CH_3CH_2CN, R = Not formed, S = $CH_3CH_2CH_2NH_2$.

5. AD

Sol. $AlCl_3 + 3H_2O \xrightarrow{\text{Hydrolysis}} Al(OH)_3 + 3HCl$

B^{3+} cannot exist in aqueous media

6. BC

Sol. $\underset{(s)}{2C} + \underset{(g)}{3H_2} \rightarrow \underset{(g)}{C_2H_6}$

$\Delta H_f^0 = \left[2\times\Delta H_{sub}^0 + 3\times B.E(H-H)\right] - \left[B.E.(C-C) + 6\times B.E(C-H)\right]$

$\Rightarrow -85 = \left[(2\times718) + (3\times436)\right] - (x+6y)$

$\therefore x + 6y = 2829$ …..1

Similarly for $C_3H_8(g)$

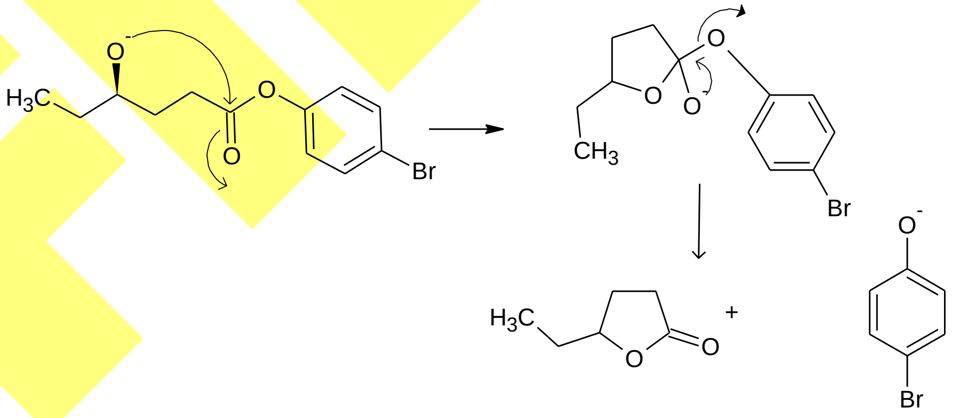
$2x + 8y = 4002$ …..2

Solving (1) & (2), x = 345

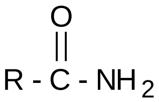
y = 414

7. ACD

Sol.



8. ABD



Sol. $R-\overset{\overset{\displaystyle O}{\|}}{C}-NH_2$ has least +ve charge density among all of the given compound.

9. ABC

Sol. Bridge bonding

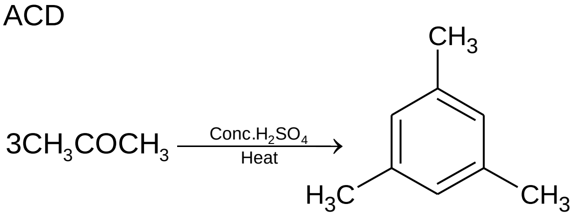
$Al_2Cl_6 \Rightarrow 3c - 4e^-$ Bond

10. BC

Sol. Original carbonyl compound can be generated from product by weak acid or base treatment.

11. ACD

Sol.



12. ABD

Sol. Dehydrogenation reaction takes place.

PART – B

1. 8

Sol. $P_T = p_A^0 x_A + p_B^0 x_B = 100 \times \left(\frac{4}{6+4}\right) + 400 \times \left(\frac{6}{6+4}\right)$ = 280 mm of Hg

$p_A = y_A P_T$

or, $p_A^0 x_A = y_A P_T$ or, $100 \times 0.4 = y_A \times 280$

or, $y_A = \frac{40}{280} = \frac{1}{7}$

$\therefore \frac{x}{y} = \frac{1}{7}$

so, (x + y) = 8

2. 2

Sol. $2O^{2-} \longrightarrow O_2 + 4e^-$

One mole of O_2 produced by passing 4F electricity.

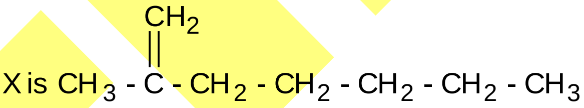
$\therefore$ Two moles of O_2 will be produced by passing 8F electricity.

3. 4

Sol. The oxidation number of N changes from -3 to +1 and +5 to +1.

4. 1.4

Sol. x = 2, y = 7, z = 5



X is $CH_3 - \overset{\overset{\Large CH_2}{||}}{C} - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$

5. 3.6

Sol. $\frac{p^o - p}{p^o} = iX_{solute} = (1+\alpha)\left(\frac{0.2}{10}\right)$

= (1 + 0.8) (0.02) = 0.036

$\therefore x \times 10^{-2} = 0.036 = 3.6 \times 10^{-2}$

$\therefore$ x = 3.6

6. 1.1

Sol. Formula of solid $M_3N_2O_6$

$\therefore \frac{x+y+z}{10} = \frac{3+2+6}{10} = 1.1$

7. 12.5

Sol. π of $Al_2(SO_4)_3$ = π of glucose

or, $iC_1RT = C_2RT$

or, $iC_1 = C_2$

or, $5 \times 0.5 = 0.2$

Ratio = $\frac{5 \times 0.5}{0.2} = 12.5$

8. 214

Sol. $pH = \frac{1}{2}\left[p^{k_w} - p^{k_b} - \log C\right] = \frac{1}{2}\left[14 - 5 - \log C\right] = 5$

or logC = -1 or C = $10^{-1} = 0.1$ M

Mass of 0.1 mole of salt = 5.35 g

Mass of one mole of salt = 53.5 g

NaCl unit cell contains 4 units of NaCl

The unit cell of the salt contains 4 units of the salt

Mass of one mole of unit cell = 53.5 × 4 = 214

FIITJEE

SECTION – III : MATHEMATICS

PART – A

1. D

Sol. Let the vertex he (h, k).

So, 'S' can be assumed as $(y-k)^2=-4a(x-h)$

Solving with $y^2=4ax$

$$y^2-2ky+k^2=-y^2+4ah$$

$$\Rightarrow 2y^2-2ky+k^2-4ah=0$$

Disc. = 0 ($\because$ the parabolas touch each other)

$$4k^2-8\left(k^2-4ah\right)=0$$

$$-k^2+8ah=0$$

$$\Rightarrow y^2=8ax$$

2. D

Sol. $y(0)=y'(0)=y''(0)=0$

$$y'''(0)=-1$$

$\Rightarrow y'''(x)$ is negative in the neighbourhood of $x=0$

$\Rightarrow y''(x)$ is a decreasing function in the neighbourhood of x = 0.

$\Rightarrow$ For $x>0$	For $x<0$
$y''(x)<y''(0)$	$y''(x)>y''(0)$
$\Rightarrow y''(x)<0$	$y''(x)>0$

Clearly, the concavity of curve changes from positive to negative across x = 0

So $x=0$ is point of inflection

So the answer should therefore be (D).

Also, by n – th derivative test if $f^n(c)\neq 0$ (n is odd) then $x=c$ is neither point of maxima nor minima.

3. B

Sol. $f'\left(\frac{1}{x}\right)f(x)=1$

Replace x by $\frac{1}{x}$, we get $f'(x)f\left(\frac{1}{x}\right)=1$

Differentiating $f''(x)f\left(\frac{1}{x}\right)+f'(x)f'\left(\frac{1}{x}\right)\left(-\frac{1}{x^2}\right)=0$

$$\frac{f''(x)}{f'(x)}-\frac{f'(x)}{f(x)}\cdot\frac{1}{x^2}=0$$

$$\Rightarrow \frac{f''(x)f(x)}{\left(f'(x)\right)^2}f(x)dx=\int\frac{1}{x^2}dx$$

$$-\frac{1}{f'(x)}f(x)-\int\left(-\frac{1}{f'(x)}\right)f'(x)dx=-\frac{1}{x}+c$$

$$-\frac{f(x)}{f'(x)}+x=-\frac{1}{x}+c$$

Put $x=1\Rightarrow-\frac{f(1)}{f(1)}+1=-1+c\Rightarrow c=2-\frac{\sqrt{2}}{\frac{1}{\sqrt{2}}}=2-2=0$

$$\Rightarrow \frac{f(x)}{f'(x)} = x + \frac{1}{x}$$

$$\Rightarrow \frac{f'(x)}{f(x)} = \frac{x}{x^2+1} \Rightarrow \ell n(f(x)) = \frac{1}{2}\ell n(1+x^2) + c'$$

$$\ell n\sqrt{2} = \frac{1}{2}\ell n 2 + c' \Rightarrow c' = 0$$

$$\Rightarrow f(x) = \sqrt{1+x^2} \Rightarrow f(3) = \sqrt{10}$$

4. C

Sol. $f'(x) = 3x^2 + 2x - a\sin x;\ f''(x) = 6x + 2 - a\cos x$

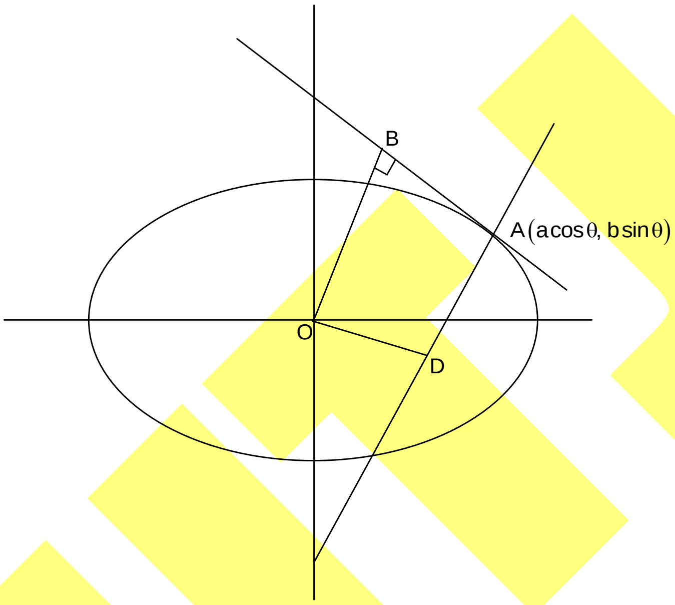
Clearly $f'(0) = 0$

So, for f to be injective $f'(x)$ must attain minima at $x = 0$

$\Rightarrow f''(0) = 0 \Rightarrow 6(0) + 2 - a = 0 \Rightarrow a = 2$

5. AD

Sol.



AD is normal to ellipse at A ⇒ Equation of AD is $a\sec\theta - by\operatorname{cosec}\theta = a^2 - b^2$

$$\Rightarrow AB = OD = \frac{a^2-b^2}{\sqrt{a^2\sec^2\theta + b^2\operatorname{cosec}^2\theta}} = \frac{a^2-b^2}{\sqrt{(a+b)^2 + (a\tan\theta - b\cot\theta)^2}} \le \frac{a^2-b^2}{a+b}$$

$$\Rightarrow AB \le a-b \Rightarrow AB \le 4-2 \Rightarrow AB \le 2 \Rightarrow \ell = 2$$

$\ell = 2$ happens when $a\tan\theta - b\cot\theta = 0 \Rightarrow \tan^2\theta = \frac{b}{a} = \frac{1}{2} \Rightarrow \tan\theta = \frac{1}{\sqrt{2}}$

Slope of tangent at A $= -\frac{\cot\theta}{2} = -\frac{1}{\sqrt{2}}$

6. CD

Sol. Since P is a probability distribution, we have $\sum_{n=1}^{\infty} P(w_n) = 1$

$$P(w_n) = \frac{1}{2}(w_{n-1}) = \frac{1}{2^2}P(w_{n-2}) = \ldots = \frac{1}{2^{n-1}}P(w_1)$$

$$\sum_{n=1}^{\infty} P(w_n) = 1 \Rightarrow \sum_{n=1}^{\infty}\frac{1}{2^{n-1}}P(w_1) = 1 \Rightarrow P(w_1)\sum_{n=1}^{\alpha}\frac{1}{2^{n-1}} = 1 \Rightarrow P(w_1)(2) = 1$$

So, $P(w_1)=\frac{1}{2}$

Clearly, the set A contains all natural numbers greater than 4 (excluding 6)

So, $P(B)=1-\{P(w_1)+P(w_2)+P(w_3)+P(w_4)+P(w_6)\}$

$=1-\left\{\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+\frac{1}{16}+\frac{1}{64}\right\}=\frac{3}{64}$

7. BD

Sol. $|2z+3|^2=|3z+4|^2 \Rightarrow 4|z|^2+9+6(z+\bar{z})=9|z|^2+16+12(z+\bar{z})$

$\Rightarrow 5|z|^2+7=-6(z+\bar{z})=-12\text{Re}(z)\le 12|z|$

$\Rightarrow 5|z|^2-12|z|+7\le 0 \Rightarrow (5|z|-7)(|z|-1)\le 0 \Rightarrow 1\le |z|\le \frac{7}{5}$

8. BD

Sol.

(B) If $x\in f^{-1}(Q)\cup f^{-1}(R) \Rightarrow x\in f^{-1}(Q)$ OR $x\in f^{-1}(R) \Rightarrow f(x)\in Q$ OR $f(x)\in R$

$\Rightarrow f(x)\in Q\cup R \Rightarrow x\in f^{-1}(Q\cup R)$

If $x\in f^{-1}(Q\cup R) \Rightarrow f(x)\in Q$ or $f(x)\in R \Rightarrow x\in f^{-1}(Q)$ or $x\in f^{-1}(R) \Rightarrow x\in \left(f^{-1}(Q)\cup f^{-1}(R)\right)$

$\Rightarrow f^{-1}(Q)\cup f^{-1}(R)=f^{-1}(Q\cup R)$

(D) If $x\in f^{-1}(Q)\cap f^{-1}(R)$ then $x\in f^{-1}(Q)$ and $x\in f^{-1}(R) \Rightarrow f(x)\in Q$ and $f(x)\in R$.

$\Rightarrow f(x)\in Q\cap R \Rightarrow x\in f^{-1}(Q\cap R)$

If $x\in f^{-1}(Q\cap R)$ then $f(x)\in Q\cap R \Rightarrow f(x)\in Q$ and $f(x)\in R \Rightarrow x\in f^{-1}(Q)$ and $x\in f^{-1}(R)$

$\Rightarrow x\in \left(f^{-1}Q\right)\cap f^{-1}(R)$

$\Rightarrow f^{-1}(Q)\cap f^{-1}(R)=f^{-1}(Q\cap R)$

(A) Consider $f:\{1,2,3\}\to\{1,2,3\}$

where $f(1)=f(2)=f(3)=1$

If $y\in f\left(f^{-1}(Q)\right)$

the $f^{-1}(\gamma)\in f^{-1}(Q)$

not possible for $y=2,3$

If $y\in Q$

then $f^{-1}(\gamma)$ is not possible

since f is not surjective

(C) Same counter example as in A can be used

9. BC

Sol. If $(gof)^{-1}$ exists then gof must be one – one and onto

gof is one – one $\Rightarrow$ f is one – one

gof is onto $\Rightarrow$ g is onto

Consequently, since $(gof)^{-1}$ exists, then gof is one – one and onto, hence f is one – one and g is onto

Claim 1: gof if one – one $\Rightarrow$ f is one – one

Proof Let a_1 and a_2 be two elements of the set A.

$f(a_1)=f(a_2)\Rightarrow gof(a_1)=gof(a_2)$ since gof is one – one we get that $a_1=a_2$

So, we have proved that $f(a_1)=f(a_2)$ implies f is one – one

Claim 2 : gof is ONTO $\Rightarrow$ g is ONTO

Proof Since gof is onto, it follows that for any $c\in C$, there exists $a\in A$ such that $gof(a)=c$

Consequently, for any $c\in C$ there exists $b=f(a)\in B$ such that $g(b)=gof(a)=c$

Hence g is ONTO

10. BC

Sol. Let $g(x)=\frac{f'(x)}{(f(x))^2}\Rightarrow\int g(x)\,dx=-\frac{1}{f(x)}+c$

$$\Rightarrow\int_4^8 g(x)\,dx=-\frac{1}{f(8)}+\frac{1}{f(4)}=-2+4=2$$

Also, $\int_4^8 (g(x))^2\,dx=1$

$$\Rightarrow\int_4^8\left(g(x)-\frac{1}{2}\right)^2=0$$

$$\Rightarrow g(x)=\frac{1}{2}$$

$$\Rightarrow\frac{f'(x)}{(f(x))^2}=\frac{1}{2}$$

$$\Rightarrow-\frac{1}{f(x)}=\frac{x}{2}+d$$

$\Rightarrow d=-6$ using $f(4)=\frac{1}{4}$

$$\Rightarrow f(x)=\frac{2}{12-x}$$

$$\Rightarrow f(6)=\frac{1}{3}$$

11. ABCD

Sol. $z_1Rz_1\Rightarrow\frac{z_1-z_2}{z_1+z_2}=0=$ a real number $\Rightarrow R$ is reflexive

If z_1Rz_2 holds i.e. $\frac{z_1-z_2}{z_1+z_2}$ is real then clearly $\frac{z_2-z_1}{z_2+z_1}=-\left(\frac{z_1-z_2}{z_1+z_2}\right)$ is also real

$\Rightarrow$ R is symmetric

If $\frac{z_1-z_2}{z_1+z_2}$ is real i.e. $\frac{z_1-z_2}{z_1+z_2}=\frac{\bar{z}_1-\bar{z}_2}{\bar{z}_1+\bar{z}_2}$

$$z_1\bar{z}_1+z_1\bar{z}_2-\bar{z}_1z_2-z_2\bar{z}_2=z_1\bar{z}_1-z_1\bar{z}_2+\bar{z}_1z_2-z_2\bar{z}_2$$

$$z_1\bar{z}=\bar{z}_1z_2$$

$$\Rightarrow\frac{z_1}{\bar{z}_1}=\frac{z_2}{\bar{z}_2}$$

So, if $\frac{z_2-z_3}{z_2+z_3}$ is real, in same manner we have $\frac{z_2}{\bar{z}_2}=\frac{z_3}{\bar{z}_3}$

$\Rightarrow\frac{z_1}{\bar{z}_1}=\frac{z_2}{\bar{z}_2}=\frac{z_3}{\bar{z}_3}\Rightarrow R$ is transitive.

12. AD

Sol. Derangement of 4 persons in 4 houses $=D_4=9$ ways. Hence option A.

If A has two houses. Then let there be a hypothetical person E. So that A, B, C, D, E have one house each now.

Among the total derangements $(D_5 = 44)$. A is equally likely to go to B, C, D, E houses. So

A does not go to E's house in $\frac{1}{4}D_5$ ways.

$\therefore$ Number of ways $= D_5 - \frac{1}{4}D_5 = 44 - \frac{1}{4}(44) = 33$ ways

But it is OK, for E to go to A'C house, it means one of A's houses is occupied.

So, number of derangements in this case $= D_4 = 9$

$\therefore$ Required number of ways $= 33 + 9 = 42$ ways

PART – B

1. 924

Sol. Consider the first S, I, P

* S * I * P *

The second P can only be placed in the last gap and hence we have * S * I * P *

The three I's can be placed only in the last three gaps.

Choosing the places for I's is put 3 identical object into 3 boxes i.e.

${}^{3+3-1}C_{3-1} = {}^{5}C_2 = 10$ ways $(x_1 + x_2 + x_3 = 3)$

We have so far placed 7 letters. We have to put 3S's in the gaps created by these. However, for placing the 3 – S's, we cannot choose the gap before the first S and hence we have 7 – gaps to choose from

This can be done in ${}^{7+3-1}C_{2-1} = {}^{9}C_6 = 84$ ways.

Only, the letter M remains to be placed. M can go in any of these 11 – gaps.

$\Rightarrow$ Required number of ways $= 10 \times 84 \times 11 = 9240$

2. 143

Sol. $f(2) = g(2), f(4) = g(4), f(8) = g(8)$

$$\int_1^8 x f'(x) = x f(x)\Big|_1^8 - \int_1^8 f(x)dx = 8f(8) - f(1) = 63 - \int_1^8 f(x)dx$$

$$\int_1^2 f(x)dx = \int_1^2 \frac{g(2x)}{2}dx = \int_2^4 \frac{g(t)}{4}dt \quad (t = 2x)$$

$$\int_1^2 f(x)dx = \frac{5}{4} \Rightarrow \frac{5}{4} = \frac{1}{4}\int_2^4 g(t)dt \Rightarrow \int_2^4 g(x)dx = 5$$

$$\int_2^4 f(x)dx + \int_2^4 g(x)dx = 16 - 4 = 12 \Rightarrow \int_2^4 f(x)dx = 7$$

$$\int_2^4 \frac{g(2x)}{2}dx = 7 \Rightarrow \int_2^4 \frac{g(t)}{4}dt = 7 \Rightarrow \int_4^8 g(x)dx = 28$$

$$\Rightarrow \int_4^8 f(x)dx + \int_4^8 g(x)dx = 64 - 16 = 48$$

$$\Rightarrow \int_4^8 f(x)dx = 48 - 28 = 20$$

$$\Rightarrow \int_1^8 x f'(x)dx = 63 - \left[\int_1^2 f(x)dx + \int_2^4 f(x)dx + \int_4^8 f(x)dx\right]$$

$$= 63 - \left[\frac{5}{4} + 7 + 20\right] = \frac{139}{4} = \frac{p}{q}$$

$$\Rightarrow p+q=143$$

3. 2

Sol. $A=\sqrt{10+\sqrt{1}}+\sqrt{10+\sqrt{2}}+......+\sqrt{10+\sqrt{99}}$

$$B=\sqrt{10-\sqrt{1}}+\sqrt{10-\sqrt{2}}+......+\sqrt{10-\sqrt{99}}$$

$$\frac{A}{B}=1+\frac{A-B}{B}$$

$$A-B=\sum_{I=1}^{99}\left(\sqrt{10+\sqrt{i}}-\sqrt{10-\sqrt{i}}\right)$$

Consider, for each i

$$\left(\sqrt{10+\sqrt{i}}-\sqrt{10-\sqrt{i}}\right)^2=10+\sqrt{i}+10-\sqrt{i}-2\sqrt{10^2-i}$$

$$=20-2\sqrt{100-i}$$

$$\therefore\sqrt{10+\sqrt{i}}-\sqrt{10-\sqrt{i}}=\sqrt{20-2\sqrt{100-i}}=\sqrt{2}\sqrt{10-\sqrt{100-i}}$$

$$A-B=\sum_{i=1}^{99}\left(\sqrt{10+\sqrt{i}}-\sqrt{10-\sqrt{i}}\right)=\sqrt{2}\sum_{i=1}^{99}\sqrt{10-\sqrt{100-i}}=\sqrt{2}\sum_{i=1}^{99}\sqrt{10-\sqrt{i}}=B\sqrt{2}$$

$$\frac{A-B}{B}=\sqrt{2}$$

4. 2.82

Sol. The equation of two edges can be taken to be

$$\frac{x-0}{1}=\frac{y-0}{1}=\frac{z-0}{-1}\text{ and }\frac{x-0}{1}=\frac{y-0}{-1}=\frac{z-\sqrt{3}}{0}$$

The shortest distance between them is $\sqrt{2}$.

5. 1

Sol. $x=f(t)\Rightarrow dx=f'(t)dt$

$$I=\int_1^0 (f(t)-t)^{2023}f'(t)dt$$

$$=-\int_0^1 (t-f(t))^{2023}f'(t)dt$$

$$=-\int_0^1 (t-f(t))^{2023}(-1+f'(t)+1)dt$$

$$=+\int_0^1 (t-f(t))^{2023}(1-f'(t))dt-I$$

$$2I=\int_0^1 (t-f(t))^{2023}(1-f'(t))dt=\left.\frac{(f-f(t))^{2024}}{2024}\right|_0^1=\frac{2}{2024}$$

6. 1.22

Sol. Clearly, triangle formed by the given points $\hat{i}+\hat{j}+2\hat{k}$, $\hat{i}+2\hat{j}+\hat{k}$ and $2\hat{i}+\hat{j}+\hat{k}$ is equilateral as $AB=BC=AC=\sqrt{2}$.

$\therefore$ Distance of orthcentre 'O' from the sides is equal to inradius of the triangle.

$$\therefore l_1 = l_2 = l_3 = \text{inradius } = r = \frac{\Delta}{s} = \frac{\frac{\sqrt{3}}{4}\left(\sqrt{2}\right)^2}{\frac{4}{2}\left(\sqrt{2}\right)} = \frac{1}{\sqrt{6}}$$

$$\Rightarrow \qquad \left(l_1 + l_2 + l_3\right) = \frac{3}{\sqrt{6}} = \frac{\sqrt{6}}{2}$$

7. 4.00

Sol. $\lim\limits_{x\to 0} \frac{f(x)}{x^k} = \lim\limits_{x\to 0} \frac{\frac{1}{2}x\sin x - 1 + \cos x}{x^k}$

$= \lim\limits_{x\to 0} \frac{\frac{1}{2}\sin x + \frac{1}{2}x\cos x - \sin x}{k\,x^{k-1}}$

$= \lim\limits_{x\to 0} \frac{\frac{1}{2}\cos x + \frac{1}{2}\cos x - \frac{1}{2}\times\sin x - \cos x}{k(k-1)x^{k-2}}$

$= \lim\limits_{x\to 0} \frac{-\frac{1}{2}\sin x}{k(k-1)x^{\kappa-3}}$

If $k-3=1$ i.e. $k=4$, $\lim\limits_{x\to 0} \frac{f(x)}{x^k} = \frac{-\frac{1}{2}}{4\times 3} = \frac{-1}{24}$

8. 5.15

Sol. Clearly $h(i)$ is an A.P.

$h(100) = h(0) + 100d \Rightarrow 100d = 20 - 5 = 15 \Rightarrow d = 0.15$

$\Rightarrow h(1) = 5.15$

FIITJEE RBT-7 for (JEE-Advanced)

BATCHES – Two Yr CRP2123(All)

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 4

QP CODE: 100203

PAPER - 2

Time Allotted: 3 Hours **Maximum Marks: 186**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections.**
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. Each **Section** is further divided into **Two Parts**: **Part-A & B** in the OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with ***Blue/Black Ball Point Pen*** for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Two Part.

(i) **PART–A (01–08)** contains (8) Multiple Choice Questions which have **One or More Correct** answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in **–2** marks, as a wrong option is also darkened.

(ii) **Part-A (09-12) –** This section contains Two (02) List-Match Sets, each List-Match set has Two (02) Multiple Choice Questions. Each List-Match set has two lists: List-I and List-II. FOUR options are given in each Multiple Choice Question based On List-I and List-II and ONLY ONE of these four options satisfies the condition asked in the Multiple Choice Question. Each question carries **+3 Marks** for correct combination chosen and **-1 marks** for wrong options chosen.

(iii) **Part-B (01-06)** contains six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+3 marks** for correct answer. **There is no negative marking.**

Name of the Candidate :____

Batch :____________________ **Date of Examination :**___________________

Enrolment Number :____

SECTION – I : PHYSICS

(PART – A)

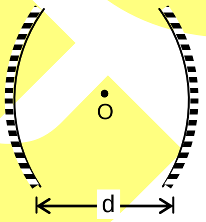
(One or More Than One Options Correct Type)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONE** or **MORE THAN ONE is correct.**

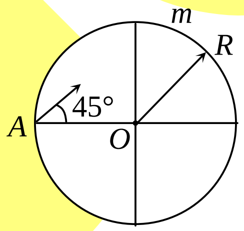
---

1. The potential energy φ in joule of a particle of mass 1 kg moving in the x – y plane, obeys the law $\varphi = 3x + 4y$, where (x, y) are the coordinate of the particle in metre. If the particle is at rest at (6, 4) at time t = 0, then (only conservative force are acting on particle).
(A) the particle has constant acceleration
(B) the work done by the conservative forces from position of rest of the particle to the instant of the particle crossing x axis is 25 J
(C) the speed of the a particle when it crosses the y axis is 10 ms^{-1}
(D) the coordinates of the particle at time t = 4s are (–18, –28)

2. The distance d between two identical concave mirrors of radius of curvature R. So, as to coincide the image I on the object O itself, which is placed at the mid point can be
(A) R (B) 2R
(C) 3R (D) R/2



3. A ring of mass m and radius R is placed on a frictionless horizontal surface. A particle of mass m is projected from point A with velocity v at an angle of 45° with AO as shown. The correct statements are



(A) The particle reaches the same point A on the ring after time $\frac{4R\sqrt{2}}{v}$.

(B) Magnitude of impulse transformed during first collision is $\frac{mv}{\sqrt{2}}$.

(C) Magnitude of impulse transformed during second collision is $\frac{mv}{\sqrt{2}}$.

(D) Particle reaches diametrically opposite point on the ring in time $\frac{2R}{v}$.

Space For Rough Work

4. A point moves with deceleration along the circle of radius R so that at any time its tangential and normal acceleration are equal in magnitude. At the initial moment t =0, the velocity of the point is v_0. The velocity of the point will be

(A) $v = \dfrac{v_0}{1+\dfrac{v_0 t}{R}}$ at t second

(B) $v = v_0 e^{-S/R}$ where s is path travelled on circle

(C) $v = v_0 e^{-SR}$ where s is path travelled on circle

(D) $v = \dfrac{v_0}{1-\dfrac{v_0 t}{R}}$ at t second

5. A horizontal disc rotates freely about a vertical axis through its centre. A ring, having the same mass and radius as the disc, is now gently placed on the disc. After some time, they rotate with a common angular speed.

(A) some friction exists between the disc and the ring.

(B) the angular momentum of the disc plus ring is conserved.

(C) the final common angular speed is $\frac{2}{3}$ rd of the initial angular velocity of the disc.

(D) $\frac{2}{3}$ rd of the initial kinetic energy changes to heat.

6. If the potential difference of Coolidge tube producing X-ray is increased, then choose the correct option(s).

(A) the interval between $\lambda_{k\alpha}$ and $\lambda_{k\beta}$ increases

(B) the interval between $\lambda_{k\alpha}$ and λ_0 increases

(C) the interval between $\lambda_{k\beta}$ and λ_0 increases

(D) λ_0 does not change

Here λ_0 is cutoff wavelength and $\lambda_{k\alpha}$ and $\lambda_{k\beta}$ are wavelength of k_α and k_β characteristic X-rays.

7. A coil of radius r(r << R) and mass m carries current i_2. Planes of two coils are mutually perpendicular and both the coils are free to rotate about common diameter.

Choose the correct statement/statements.

(A) The maximum Kinetic energy of smaller coil when both the coils are released, is

$$K_{max} = \frac{\mu_0 \pi r^2 i_1 i_2 MR}{2(MR^2 + mr^2)}$$

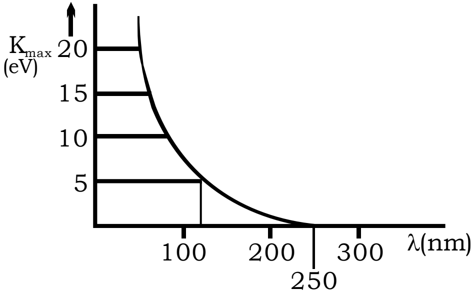
(B) Total energy of both the coils remains constant.

(C) Total angular momentum of both the coils remains constant.

(D) The potential energy of the system will be minimum when both the coils are in same plane and current in them are in same direction.

Space For Rough Work

8. In a photoelectric effect experiment, the maximum kinetic energy of the ejected photoelectrons is measured for various wavelengths of the incident light. Figure shows a graph of this maximum kinetic energy K_{max} as a function of the wavelength λ of the light falling on the surface of the metal. Which of the following statements is/are correct?



(A) Threshold frequency for the metal is 1.2×10^{15} Hz
(B) Work function of the metal is 4.968 eV.
(C) Maximum kinetic energy of photoelectrons corresponding to light of wavelength 100 nm is nearly 7.4 eV.
(D) Photoelectric effect takes place with red light.

This section contains **2 List-Match Sets**, each List-Match set has **2 Multiple Choice Questions**. Each List-Match set has two lists: List-I and List-II. Four options are given in each Multiple Choice Question based On List-I and List-II and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

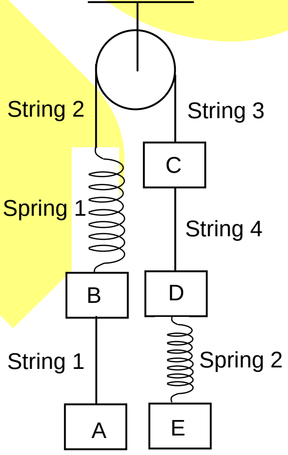
List Match Set (09-10)

The system shown below is initially in equilibrium

$m_A = m_B = 3kg$

$m_C = m_D = m_E = 2kg$

Take g = 10 m/s^2



List–I gives the four strings while List–II the value of the tension in the strings.

List – I		**List – II**	
(I)	String 1	(P)	10 N
(II)	String 2	(Q)	20 N
(III)	String 3	(R)	30 N
(IV)	String 4	(S)	40 N
		(T)	60 N
		(U)	0 N

9. If the spring 1 is cut, match the correct for the tension in the strings just after the cutting.
(A) I → R, II → T, III → T, IV → P
(B) I → U, II → T, III → T, IV → P
(C) I → U, II → U, III → U, IV → P
(D) I → R, II → S, III → S, IV → P

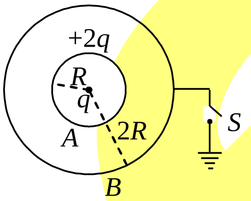
Space For Rough Work

10. If the spring 2 is cut, match the correct for the tension in the strings just after the cutting.
(A) I → R, II → T, III → T, IV → R
(B) I → R, II → U, III → U, IV → R
(C) I → U, II → R, III → R, IV → P
(D) I → P, II → Q, III → Q, IV → R

List Match Set (11-12)

Match the List-I with the List-II for question no. 11 and 12.

Two concentric conducting shells *A* and *B* have radii *R* and 2*R*. A charge *q* is placed at the centre of the shells and a charge 2*q* is given to shell *A*.



List – I		List – II	
(I)	Charge on inner surface of shell *A*	(P)	$-3q$
(II)	Charge on inner surface of shell *B*	(Q)	Zero
(III)	Charge on outer surface of shell *A*	(R)	$-q$
(IV)	Charge on outer surface of shell *B*	(S)	$3q$
		(T)	$2q$
		(U)	$-2q$

11. When switch is open
(A) I → R, II → P, III → S, IV → S
(B) I → T, II → P, III → S, IV → Q
(C) I → P, II → R, III → S, IV → T
(D) I → S, II → R, III → T, IV → U

12. When switch is closed
(A) I → P, II → R, III → S, IV → Q
(B) I → R, II → P, III → S, IV → Q
(C) I → T, II → U, III → R, IV → P
(D) I → P, II → Q, III → R, IV → S

(PART – B)

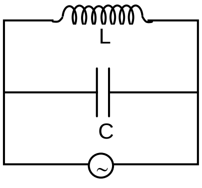
(Numerical Type)

Part-B (01-06) contains six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **Two decimals Places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)**.**

1. A sphere of radius 0.1 m and mass 8π kg is attached to the lower end of a steel wire of length 5 m and diameter 10^{-3} m. The wire is suspended from 5.22 m high ceiling of a room. When the sphere is made to swing as a simple pendulum, it just grazes the floor at its lowest point. Calculate the velocity of the sphere at the lowest position (in m/s). Young's modulus of steel is 1.994×10^{11} N/m^2.

Space For Rough Work

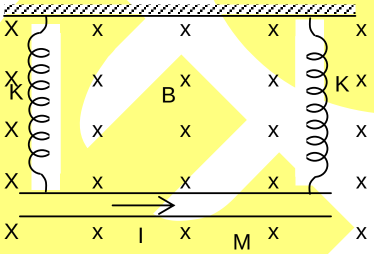
2. For the circuit shown in the figure, the current through the inductor is 0.6 A, while the current through the capacitor is 0.4 A. Find the current (in A) drawn from the generator



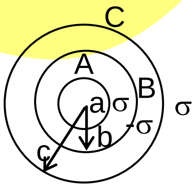
Generator

3. An ice cube of mass 0.1 kg at 0^0C is placed in an isolated container which is at 227^0C. The specific heat s of the container varies with temperature T according to the empirical relation $s = A + BT$, where $A = 100\ \text{cal kg}^{-1}K^{-1}$ and $B = 2\times10^{-2}\ \text{cal kg}^{-1}K^{-2}$. The final temperature of the container is 27^0C, the mass of the container is $x \times 10^{-1}$ kg. What is the value of x? (Latent heat of fusion of water $= 8\times10^4\ \text{cal kg}^{-1}$, Specific heat of water $= 10^3\ \text{cal kg}^{-1}K^{-1}$).

4. A metal rod of mass 10gm and length 25 cm is suspended on two springs as shown in figure. The springs are extended by 4 cm. When a 20 ampere current passes through the rod it rises by 1 cm. The magnetic field is x × 10^{-2} T (g = 10 m/s^2). Find the value of 2x.



5. The adjacent figure shows charged spherical shells A, B and C having charge densities σ, $-\sigma$, σ and radii a, b, c respectively. If $V_A = V_c$ then c is equal to (in m) (assuming a = 0.10 m, b = 0.20 m)



6. In YDSE experiment if the screen is shifted by a distance of 0.5 m away from the slit, 3rd maxima is shifted by 3×10^{-4} m. The slit width is 2×10^{-3}m. If the wavelength (in 100 nm) used in the experiment is ‘k’, find the value of ‘k’.

Space For Rough Work

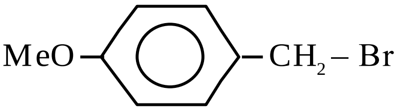
SECTION – II : CHEMISTRY

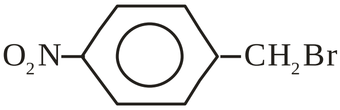
(PART – A)

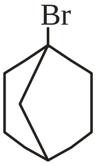
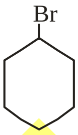
(One or More Than One Options Correct Type)

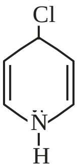
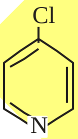
This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONE** or **MORE THAN ONE is correct.**

1. Consider the following statements and pick up the correct statements:

(A)  will react more readily than

 for S_N1 reaction

(B)  will react more readily than  for S_N1 reaction

(C)  will react more readily than  for S_N1 reaction

(D) Generally S_N1 reaction occurs in polar protic solvent

2. Which of the following statement(s) is/are correct for PCl_5?

(A) Phosphorus undergoes sp^3d hybridization.

(B) Two sets of P–Cl bond length are observed in the molecule

(C) It's solid contains $[PCl_4]^+$ and $[PCl_6]^-$ ions

(D) The maximum value of $\angle ClPCl$ angle is 120°.

3 The standard electrode potential of a metal-metal ion $(Ag \mid Ag^+)$ and metal-sparingly soluble salt anion $(Ag|AgCl|Cl^-)$ are not related as

(A) $E^0_{Ag^+|Ag} = E^0_{Cl^-|Agcl|Ag} + \frac{RT}{F}\ln K_{sp}$

(B) $E^0_{Ag^+|Ag} = E^0_{Cl^-|Agcl|Ag} + \frac{RT}{F}\ln K_{sp}$

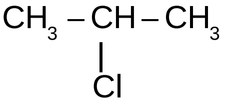
(C) $E^0_{Cl^-|AgCl|Ag} = E^0_{Ag^+|Ag} - \frac{RT}{F}\ln\frac{[Cl^-]}{K_{sp}}$

(D) $E^0_{Cl^-|AgCl|Ag} = E^0_{Ag^+|Ag} - \frac{RT}{F}\ln\frac{K_{sp}}{[Cl^-]}$

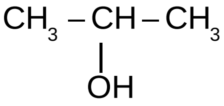
Space For Rough Work

4. A ($C_5H_{12}O$) ether, on reaction with PCl_5 form alkyl chloride B and C. B and C both on reaction with aqueous KOH form alcohol D and E. Both D and E give iodoform test. Identify correct answers.

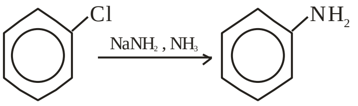
(A) A is $CH_3CH_2-O-CH(CH_3)_2$

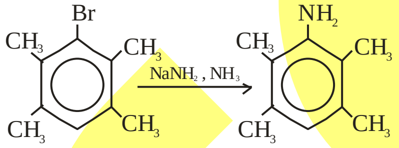
(B) C is 
$CH_3-\underset{\underset{Cl}{|}}{CH}-CH_3$

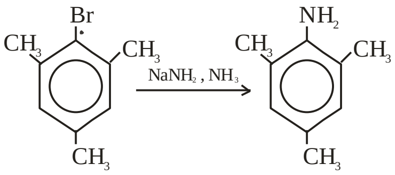
(C) C is $CH_3CH_2CH_2Cl$

(D) E is 
$CH_3-\underset{\underset{OH}{|}}{CH}-CH_3$

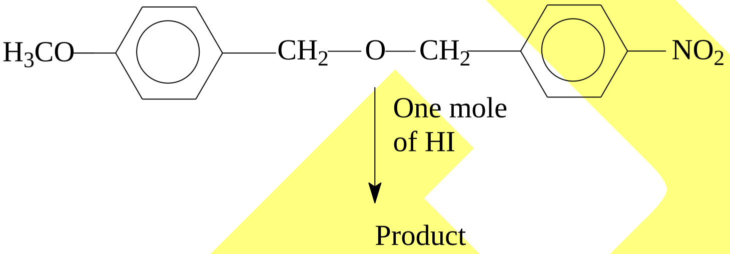
5. Which of the following reactions are not feasible?

(A) 
Cl
NaNH₂ , NH₃
NH₂

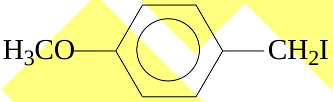
(B) 
Br
CH₃
CH₃
CH₃
CH₃
NaNH₂ , NH₃
NH₂
CH₃
CH₃
CH₃
CH₃

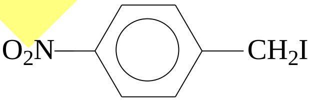
(C) 
Br
CH₃
CH₃
CH₃
NaNH₂ , NH₃
NH₂
CH₃
CH₃
CH₃

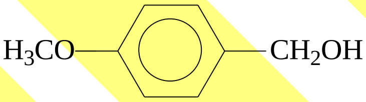
(D) $R-OH+NaOH\rightarrow R-\bar{O}Na^{+}+H_2O$
(R = Aliphatic alcohol)

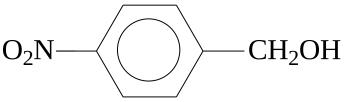
6. 
H₃CO
CH₂
O
CH₂
NO₂
One mole of HI
Product

Major products are

(A) 

(B) 

(C) 

(D) 

7. For a non-ideal solution with a negative deviation

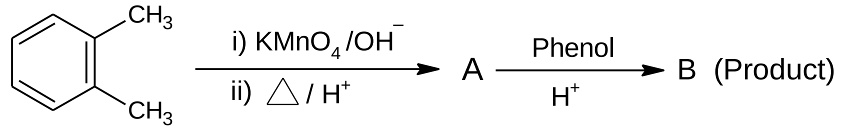
(A) $\Delta H_{mix} = -ve$

(B) $\Delta V_{mix} = -ve$

(C) $\Delta S_{mix} = -ve$

(D) $\Delta G_{mix} = -ve$

Space For Rough Work

8. 

Which of the following is correct regarding product 'B'?
(A) 'B' is colourless in acidic medium
(B) 'B' is pink colour in basic medium
(C) 'B' has Benzenoid form in Basic medium
(D) 'B' exists in Ionic form in Basic medium

This section contains **2 List-Match Sets**, each List-Match set has **2 Multiple Choice Questions**. Each List-Match set has two lists: List-I and List-II. Four options are given in each Multiple Choice Question based On List-I and List-II and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

List Match Set (09-10)

Match the reversible reactions mentioned in List – I with the effect of Le – Chatelier principles on them mentioned in List - II and answer the question.

	List – I		**List - II**
(I)	$N_2(g)+O_2(g) \rightleftharpoons 2NO(g); \Delta H=+ve$	(P)	The concentration of NO_2 increases by increasing temperature.
(II)	$2NO(g)+O_2(g) \rightleftharpoons 2NO_2(g); \Delta H=+ve$	(Q)	The concentration of NO_2 increases by decreasing temperature
(III)	$N_2O_3(g) \rightleftharpoons NO_2(g)+NO(g); \Delta H=+ve$	(R)	The concentration of NO_2 increases by increasing the volume of reaction vessel.
(IV)	$2NO_2(g) \rightleftharpoons N_2O_4(g); \Delta H=-ve$	(S)	The concentration of NO_2 increases by increasing pressure.
		(T)	Inert gas addition does not have any result at constant pressure or at constant volume.

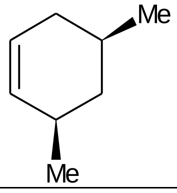
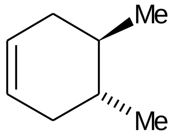
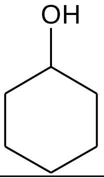
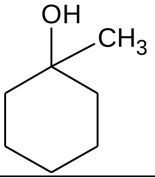
9. The correct matching according to List-I & List-II is
(A) I → PQ
(B) II → T
(C) III → P
(D) IV → Q

10. The correct matching according to List-I & List-II is
(A) I → R
(B) II → Q
(C) III → T
(D) IV → S

Space For Rough Work

List Match Set (11-12)

Match the compound(s) mentioned in column-I with their properties mentioned in column-II.

	List – I		List– II
(I)		(P)	Shows optical isomerism before hydrogenation with H_2/Ni
(II)		(Q)	Shows optical isomerism after hydrogenation with H_2/Ni
(III)		(R)	Shows optical isomerism before dehydration
(IV)		(S)	Shows optical isomerism after dehydration
		(T)	Shows optical isomerism before addition of HBr
		(U)	Shows optical isomerism after addition of HBr

11. The correct matching according to above list is

(A) I → Q
(B) II → U
(C) III → R
(D) IV → T

12. The correct matching according to above list is

(A) I → P
(B) IV → S
(C) III → U
(D) IV → R

Space For Rough Work

(PART – B)

(Numerical Type)

Part-B (01-06) contains six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **Two decimals Places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)**.**

1. How many of them are correctly matched for purification process(refining of metal)?
(a) Liquation – Sn
(b) Distillation – Zn
(c) Parke's process – Pb
(d) Zone refining – Ge
(e) Cupellation – Cu
(f) Mond's process – Ni
(g) Electrolytic refining – Ag
(h) Baeyer's process – Al
(i) Parting process – Au
(j) Poling process – Cu

2. A dipositive metal ion is oxidized to it's tripositive ion by acidified permangante solution $\left(MnO_4^- / H^+\right)$. A solution containing 134.04 g of dipositive ion, required 1.2 L of 0.4 M acidified solution of MnO_4^- for complete oxidation. What is the ionic mass of the ion?

3. Which of the following is/are correctly matched?

	Drugs used for treatment	**Class of drug**
(a)	Ranitidine	Antacid
(b)	Histamine	Antacid
(c)	Seldane	Anti histamines
(d)	Seretonin	Tranquilizers
(e)	Aspirin	Analgasic & antipyretic
(f)	Heroin	Analgasic(Narcotic)
(g)	Pencillin	Antibiotics(Bactericidal)
(h)	1% Phenol	Antiseptic
(i)	Norethindrone	Antifertility

4. A radiation travels with an uniform velocity of 2116.52 × 10^4 m s^{-1}. What is the wavelength of the radiation in nm unit if it's energy is 3.3 × 10^{-20} Joule?

5. $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
A container contains 6 moles of PCl_5 and 4 moles of PCl_3. On heating, PCl_5 decomposes to PCl_3 and Cl_2 according to above reaction. The total number of gaseous moles present at equilibrium is 14. What will be the volume of the reaction container in liter unit, if the equilibrium constant, K_C is $\frac{1}{35.45}$ mol L^{-1}.

6. What is the maximum limit of NO_3^-(Nitrate ion) in drinking water prescribed, otherwise excess nitrate in drinking water can cause disease Methemoglobinemia(Blue Baby Syndrome)
[Give answer in ppm or mg dm^{-3}]

Space For Rough Work

SECTION – III : MATHEMATICS

(PART – A)

(One or More Than One Options Correct Type)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONE** or **MORE THAN ONE is correct.**

1. Let a and b be two complex numbers such that $|a+b|=20$ and $|a^2+b^2|=16$ then

(A) maximum value of $|a^3+b^3|$ is 4480
(B) minimum value of $|a^3+b^3|$ is 2022
(C) minimum value of $|a^3+b^3|$ is 3520
(D) maximum value of $|a^3+b^3|$ is 4044

2. If $y=\alpha x^2+\alpha x+\frac{1}{24}$ and $x=\alpha y^2+\alpha y+\frac{1}{24}$ are tangent to each other, then

(A) $\alpha=\frac{2}{3}$
(B) $\alpha=\frac{3}{2}$
(C) $\frac{13-\sqrt{601}}{12}$
(D) $\frac{13+\sqrt{601}}{12}$

3. A parabola touches x – axis at A (4, 0) and y – axis at B (0, 3)

(A) Equations of directrix is $4x+3y=0$
(B) Co – ordinates of focus are $\left(\frac{36}{25},\frac{48}{25}\right)$
(C) Equation of directrix is $3x+4y=0$
(D) Co – ordinates of focus are $\left(\frac{48}{25},\frac{36}{25}\right)$

4. If $8\sin x=\frac{\sqrt{3}}{\cos x}+\frac{1}{\sin x}$ then x = _____

(A) $n\pi\pm\frac{\pi}{4}$
(B) $n\pi\pm\frac{\pi}{6}$
(C) $n\pi+\frac{\pi}{6}$
(D) $\frac{n\pi}{2}-\frac{\pi}{12}$

5. Let a_n be the number of non-empty subsets of $S=\{1,2,3,4....,n-1,n\}$ such that there are no two consecutive numbers in the same set, then

(A) $a_n=a_{n-1}+a_{n-2}$
(B) $a_n=a_{n-1}+a_{n-2}+1$
(C) $a_7=33$
(D) $a_7=21$

Space For Rough Work

6. Suppose ***100*** students appeared for IIT Genius Test. The test carries a maximum of ***100*** marks and there is no negative marking. The arithmetic mean of their scores is ***40*** with standard deviation ***20***. Let p be the number of students who have scored marks equal to or more than ***80***. Then the possible value(s) of p can be

(A) 10
(B) 20
(C) 22
(D) 18

7. If ΔABC, let G be the centroid, and let I be the centre of the inscribed circle. If IG be parallel to AB and $\tan\frac{B}{2}=\frac{1}{3}$. Then

(A) ΔABC is obtuse angled
(B) ΔABC is right angled but not isosceles
(C) $3c=4b$
(D) $5b=3a$

8. Let $a_1, a_2, a_3, \ldots\ldots, a_n$ be first 'n' terms of a G.P. with first term 'a' and common ratio 'r' then

(A) $$\frac{1}{a_1^2-a_2^2}+\frac{1}{a_2^2-a_3^2}+\ldots\ldots+\frac{1}{a_{n-1}^2-a_n^2}=\frac{\left(1-r^{2n}\right)}{a^2r^{2n-4}\left(1-r^2\right)^2}$$

(B) $$\frac{1}{a_1^2-a_2^2}+\frac{1}{a_2^2-a_3^2}+\ldots\ldots+\frac{1}{a_{n-1}^2-a_n^2}=\frac{\left(1-r^{2n-2}\right)}{a^2r^{2n-4}\left(1-r^2\right)^2}$$

(C) $$\frac{1}{a_1^m+a_2^m}+\frac{1}{a_2^m+a_3^m}+\ldots..+\frac{1}{a_{n-1}^m+a_n^m}=\frac{\left(r^{mn-m}-1\right)}{a^m\left(1+r^m\right)\left(r^{mn-m}-r^{mn-2m}\right)}$$

(D) $$\frac{1}{a_1^m+a_2^m}+\frac{1}{a_2^m+a_3^m}+\ldots..+\frac{1}{a_{n-1}^m+a_n^m}=\frac{\left(r^{mn-m}-1\right)}{a^m\left(1-r^m\right)\left(r^{mn-m}-r^{mn-2m}\right)}$$

Space For Rough Work

This section contains **2 List-Match Sets**, each List-Match set has **2 Multiple Choice Questions**. Each List-Match set has two lists: List-I and List-II. Four options are given in each Multiple Choice Question based On List-I and List-II and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

List Match Set (09-10)

Three players A, B and C alternatively throw a die in that order, the first player to throw a being deemed the winner. A's die is fair whereas B and C throw dice with probabilities p_1 and p_2 respectively, or throwing a 6.

Column-I		Column-II	
(I)	If $p_1 = \frac{1}{5}, p_2 = \frac{1}{4}$ and probability that A wins the game is $\frac{1}{\lambda_1}$, then λ_1 is divisor of	(P)	6
(II)	If $p_1 = \frac{1}{5}$, $p_2 = \frac{1}{4}$ and probability that C wins the game is $\frac{1}{\lambda_2}$, then λ_2 is divisor of	(Q)	8
(III)	If P (A wins) = P (B wins) and $\frac{1}{p_1} = \lambda_3$, then λ_3 is divisor of	(R)	12
(IV)	If game is equiprobable to all the three players and $\frac{1}{p_1} = \lambda_4$, then λ_4 is divisor of	(S)	15

9. Which of the following is the correct combination?
(A) I → Q
(B) II → PRS
(C) III → R
(D) IV → P

10. Which of the following is the correct combination?
(A) I → PQS
(B) II → Q
(C) III → S
(D) IV → P

Space For Rough Work

List Match Set (11-12)

Matching Type Questions

Column-I		Column-II	
(I)	If number of dissimilar terms in the expansion of $(x+2y+3z)^n\,(n \in N)$ is am^2+bn+c, then	(P)	$a+b+c=3$
(II)	If number of dissimilar terms in the expansion of $(x+y+z)^{2n+1}-(x+y-z)^{2n+1}\,(n \in N)$ is an^2+bn+c, then	(Q)	$a+b+c=4$
(III)	If number of dissimilar terms in the expansion $(x-y+z)^n+(x+y-z)^n\,(n \in$ is even natural number) is an^2+bn+c, then	(R)	$a+b=2c$
(IV)	If number of dissimilar terms in the expansion of $\left(\frac{x^2+1+x^4}{x^2}\right)^{\sum n}$ $(n \in N)$ is an^2+bn+c, then	(S)	$b+c=8a$

11. Which of the following is the correct combination?

(A) I $\rightarrow$ RS
(B) I $\rightarrow$ PRS
(C) II $\rightarrow$ P
(D) IV $\rightarrow$ PR

12. Which of the following is the correct combination?

(A) I $\rightarrow$ QS
(B) I $\rightarrow$ R
(C) II $\rightarrow$ Q
(D) III $\rightarrow$ Q

(PART – B)

(Numerical Type)

Part-B (01-06) contains six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **Two decimals Places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)**.**

1. Let A and B be two square matrices having real elements satisfying $A^2+B^2=2AB$ then value of $\det(AB-BA)=$

2. If $p(t)=\frac{t(t-1)\ldots(t-2023)}{2023!}$, then the value of

$$\int_0^1\left(\frac{1}{t+1}+\frac{1}{t+2}+\ldots+\frac{1}{t+2024}\right)p(-t-1)\,dt=k^2$$ then k – 2000 equals

Space For Rough Work

3. If $\cot k^\circ = \tan 78^\circ + \tan 72^\circ + \tan 60^\circ$ then k=

4. 6 given points on a circle are joined by line segments of which no three are concurrent. The number of triangles inside the circle equals ___________

5. The number of continuous functions $f:\left[0, \frac{3}{2}\right] \to (0, \infty)$ satisfy the equation $4\int_0^{3/2} f(x)dx + 125\int_0^{3/2} \frac{dx}{\sqrt{f(x)+x^2}} = 108$ is ____________.

6. If $S = \frac{1}{1.2.3} + \frac{1}{5.6.7} = \frac{1}{9.10.11} + \ldots$ (value of $\ell n 2 \approx 0.693$) then value of S = __________

Space For Rough Work

FIITJEE

Q. P Code: 100203

Answers

SECTION – I : PHYSICS

(PART – A)

1.	ABCD	2.	AB	3.	ABC	4.	AB
5.	ABD	6.	BC	7.	ABCD	8.	ABC
9.	C	10.	A	11.	A	12.	B

(PART – B)

1.	8.74	2.	0.20	3.	4.95	4.	3
5.	0.30	6.	4				

SECTION – II : CHEMISTRY

(PART – A)

1.	ACD	2.	ABD	3.	ACD	4.	ABD
5.	BC	6.	AD	7.	ABD	8.	ABD
9.	C	10.	D	11.	B	12.	A

(PART – B)

1.	8	2.	55.85 (Range 55 to 56)			3.	7
4.	423.30 (Range 421 to 425)			5.	567.2(range 566 to 568)		
6.	50 (Range 49 to 51)						

SECTION – III : MATHEMATICS

(PART – A)

1.	AC	2.	ABCD	3.	AB	4.	CD
5.	BC	6.	ABD	7.	BCD	8.	BC
9.	B	10.	C	11.	D	12.	C

(PART – B)

1.	0	2.	24	3.	6	4.	111
5.	1	6.	0.17				

Answers & Solutions

SECTION – I : PHYSICS

(PART – A)

1. **ABCD**

Sol. $\vec{F} = 3\hat{i} - 4\hat{j},\ W_{con.f} = U_i - U_f = 34 - 9 = 25 \ \&\ \frac{1}{2}mv^2 - 16 = 34$

2. **AB**

Sol. $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

3. **ABC**

Sol. Assume x-axis along OA and y-axis perpendicular to it in the plane of ring.
After 1st collision

Velocity of particle = $\frac{v}{\sqrt{2}}$ along x-axis

And velocity of ring = $\frac{v}{\sqrt{2}}$ along y-axis

After second collision velocity of ring = $\frac{v}{\sqrt{2}}\hat{i} + \frac{v}{\sqrt{2}}\hat{j}$

Velocity of particle = 0

Time to return at point A = $4 \times \frac{R\sqrt{2}}{v}$

4. **AB**

Sol. $-\frac{dv}{dt} = \frac{v^2}{R} \ \&\ -v\frac{dv}{ds} = \frac{v^2}{R}$

5. **ABD**

Sol. By conservation of angular momentum,

$I_1\omega_i = (I_1 + I_2)\omega_f$

$\omega_f = \omega_1 / 3$

$E_i = \frac{1}{2}I_1\omega_i^2$

$E_f = \frac{1}{2}(I_1 + I_2)\omega_f^2$

Ratio of the heat produced to initial kinetic energy $= \frac{E_i - E_f}{E_i} = \frac{2}{3}$

6. **BC**

Sol. As $\lambda_0 = \frac{hc}{eV}$ and as V increases. λ_0 decreases but characteristic wavelengths do not change so interval between $\lambda_{k\alpha} \ \&\ \lambda_0$ increases and the same for the interval between $\lambda_{k\beta} \ \&\ \lambda_0$

7. **ABCD**

Sol. MB(cos 0° – Cos 90°) = $\frac{1}{2}I_1\omega_1^2 + \frac{1}{2}I_2\omega_2^2$ …(1)

By (1) and (2) we get

Also, $I_1\omega_1 = I_2\omega_2$ …(2)

$$K_{max} = \frac{\mu_0 \pi r^2 i_1 i_2 MR}{2(MR^2 + mr^2)}$$

8. **ABC**

Sol. From graph,

$$\lambda_{th} = 250 \text{ nm}$$

$$f_{th} = \frac{C}{\lambda_{th}} = \frac{3\times10^8 \text{m/s}}{250\times10^{-9}\text{m}} = 1.2\times10^{15}\text{Hz}$$

Work function ϕ $= \frac{\lambda f_{th}}{e}(eV)$

$$= 4.968\, eV$$

$$K.E_{max} = hv - hv_{th}(\phi)$$

$$= 7.4\, eV$$

9. **C**

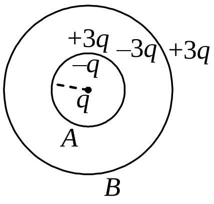
Sol. Just after cutting force of cut spring will be zero whereas the force of other spring will be unchanged.

10. **A**

Sol. Just after cutting force of cut spring will be zero whereas the force of other spring will be unchanged.

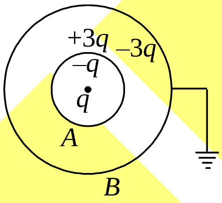
11. **A**

Sol. When switch is open



12. **B**

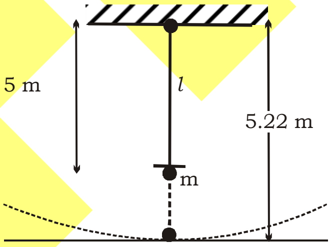
Sol. When switch is closed



(PART – B)

1. **8.74**

Sol.



$$T = mg + \frac{mv^2}{R} \qquad v = \sqrt{\left(\frac{T}{m} - g\right)R}$$

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$$\frac{mv^2}{R} = T - mg$$

$$mv^2 = TR - mgR$$

$$v^2 = \frac{TR}{m} - gR$$

$$v^2 = \left(\frac{T}{m} - g\right)R$$

$$v = \sqrt{(24.925 - 10)5.12}$$

$$= 8.74\, m/s$$

$$\frac{T}{m} = \frac{yA\Delta L}{mL}, g = 10$$

$$R = 5.22 - 0.1$$

$$(R = 5.12)$$

$$\frac{T}{m} = \frac{1.994\times10^{11}}{1000\ 8A} \times \frac{A\times10^{-6}}{4} \times \frac{0.02}{5100}$$

$$= \frac{1994}{84} \times \frac{2}{20}$$

$$\frac{T}{m} = \frac{1994}{80}$$

2. **0.20**

Sol. I_L and I_C will be in opposite phases.

$I_{net} = I_L - I_C$

$= 0.6 - 0.4 = 0.2$ A

3. **4.95**

Sol. Heat last by contains $= msdt.$

$$fdQ = \int_{500}^{300} m(A + Bt)dt$$

$$-Q = m\left[AT + \frac{BT^2}{\alpha}\right]_{500}^{300}$$

$$+Q = m[+21600]cal$$

Heat gained by ice at 0^o $Q_1 = mL$

$Q_1 = 8000 cal$

Heat gained by water to raise temp. $= ms\Delta 7$

$$Q_2 = 0.1\times1000\times27$$

$$= 2700$$

Total heat gained $= Q_1 + Q_2$

$$= 8000 + 2700$$

$$= 10700\, cal$$

Heat lost = Heat gained

$$m21600 = 10700$$

$$m = 0.495\, kg. = 4.95\times10^{-1} kg$$

4. **3**

Sol. Initially the rod will be in equilibrium if

$2T_o = Mg$ with $T_o = kx_o$ …(i)

when the current I is passed through the rod, it will experience a force F = BIL vertically up,

In equilibriums

2T + BIL = Mg with T = kx …(ii)

from (i) & (ii)

$$\frac{T}{T_o} = \frac{Mg - BIL}{Mg} \text{ i.c. } \frac{x}{x_o} = 1 - \frac{BIL}{Mg}$$

$$\text{or, } B = \frac{Mg(x_o - x)}{I\ \ L\ \ x_0}$$

Putting the values we get $B = 1.5\times10^{-2}$ T.

5. **0.30**

Sol. $V_A=V_C$

$c=a+b$

6. **4**

Sol. Here 3rd maxima is shifted by 3×10^{-4} m. It indicates fringe width increases by 1×10^{-4} m.

Hence $\beta = \frac{\lambda(D+0.5)}{d} = \frac{\lambda D}{d} + 1\times10^{-4}$

or $\frac{0.5\lambda}{d} = 1\times10^{-4}\,\text{m}$ or $\lambda = \frac{2\times10^{-3}\times1\times10^{-4}}{0.5} = 4\times10^{-7}\,\text{m} = 400$ nm.

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SECTION – II : CHEMISTRY

(PART – A)

1. ACD

Sol. S_N1 Rate α Steric α Stability of C^+

$$S_N 2 \text{ Rate } \alpha \frac{1}{\text{Steric}}$$

2. ABD

Sol. Basic hybridization.

3. ACD

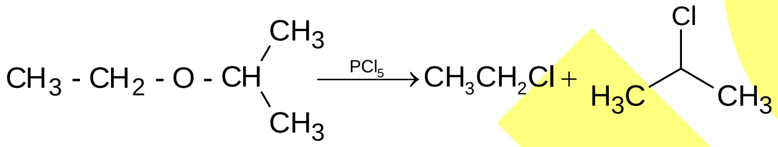
Sol. $$E^0_{AgCl/Ag} = E^0_{AgCl/Ag} + \frac{RT}{F}\ell n\left[Cl^-\right]$$

$$AgCl + e^- \longrightarrow Ag + Cl^-$$

$K_{sp} = [Ag^+][Cl^-]$

4. ABD

Sol.



5. BC

Sol. Benzyne mechanism, $K_{eq} < 1$

6. AD

Sol. S_N1 mechanism

7. ABD

Sol. Conceptual

8. ABD

Sol. A = Pthalic anhydride
B = Phenol/ohthalien

9. C

Sol. $\Delta H = +ve$, T↑ = K_{eq}↑

10. D

Sol. P↑ = Conc^n↑

11. B

Sol. Chiral centre generated, without symmetry.

12. A

Sol. $$\left.\begin{array}{l}\text{POS X}\\ \text{COS X}\end{array}\right\}\text{Optically active}$$

(PART – B)

1. 8

Sol. Refining of metals

2. 55.85 (Range 55 to 56)

Sol. $\frac{134.04}{M} \times 1 = 1.2 \times 0.4 \times 5$

3. 7

Sol. Theoretical

4. 423.30 (Range 421 to 425)

Sol. Speed = $\lambda\nu$

5. 567.2(range 566 to 568)

Sol. $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

$$\begin{array}{llll} 6 & 4 & - & \\ 6 - x & 4 + x & x & = 14 \end{array}$$

x = 4

$\frac{1}{35.45} = \frac{8.4}{2} . \frac{1}{V} \Rightarrow V = 567.2$

6. 50 (Range 49 to 51)

Sol. Theoretical

SECTION – III : MATHEMATICS

(PART – A)

1. AC

Sol. $|a+b|=20 \Rightarrow a+b=20e^{i\theta}$

Assume $a+b=20$ (Coordinate axes can be related so that $\theta=0$)

$|a^2+b^2|=16 \Rightarrow a^2+b^2=16e^{i\alpha}$

$$|a^3+b^3|=\left|(a+b)^3-3ab(a+b)\right|$$

$$=\left|(a+b)^3-\frac{3}{2}\left\{(a+b)^2-(a^2+b^2)\right\}(a+b)\right|$$

$$=\left|\frac{3}{2}(a^2+b^2)(a+b)-\frac{1}{2}(a+b)^3\right|$$

$$=\left|480e^{i\alpha}-4000\right|$$

$$=160\left|3e^{i\alpha}-25\right|$$

$$=160\sqrt{634-150\cos\alpha}$$

$$=4480(\cos\alpha=-1) \text{ and } 3520(\cos\alpha=1)$$

2. ABCD

Sol. Let (x, y) be point common to both parabolas at point of tangency.

$$y-x=\alpha(x^2-y^2)+\alpha(x-y)$$

$$\Rightarrow (x-y)\{\alpha(x+y)+\alpha+1\}=0$$

Either x = y OR $\alpha(x+y)+\alpha+1=0$

Solving $y=x$ with $y=\alpha x^2+\alpha x+\frac{1}{24}$

$$x=\alpha x^2+\alpha x+\frac{1}{24} \Rightarrow \alpha x^2+(\alpha-1)x+\frac{1}{24}=0$$

Since the curves touch $\Rightarrow$ above quadratic should have one root only

$$\Rightarrow \text{Disc}=0 \Rightarrow (\alpha-1)^2-4\alpha\left(\frac{1}{24}\right)=0 \Rightarrow 6\alpha^2-13\alpha+6=0$$

$$\Rightarrow \alpha=\frac{2}{3},\frac{3}{2}$$

Solving $\alpha(x+y)+\alpha+1=0$ and $y=\alpha x^2+\alpha x+\frac{1}{24}$

$$\alpha x^2+(\alpha+1)x+\frac{\alpha+1}{\alpha}+\frac{1}{24}=0$$

$$\Rightarrow \text{Disc.}=0 \Rightarrow (\alpha+1)^2-4\alpha\left(\frac{25}{24}+\frac{1}{\alpha}\right)=0 \Rightarrow \alpha=\frac{13\pm\sqrt{601}}{12}$$

3. AB

Sol. By default, x – axis and y – axis (both tangents) are perpendicular

$\Rightarrow$ Origin lies on the directrix

Also, line joining point of intersection of tangents at A and B and mid – point of chord AB is parallel to axis or perpendicular to directrix.

$$\Rightarrow \text{midpoint of AB} \equiv \left(2, \frac{3}{2}\right) \equiv M$$

$$\Rightarrow \text{slope of OM} = \frac{\frac{3}{2}-0}{2-0} = \frac{3}{4} \Rightarrow \text{slope of directrix x} = \frac{-4}{3}$$

$$\Rightarrow \text{Equation of directrix : } y = \frac{-4}{3}x \text{ i.e. } 4x + 3y = 0$$

Line segment joining point of contact (0, 3) and (0, 0) subtend a right angle at focus (h, k)

$$\text{Slope of AB(focal chord)} = -\frac{3}{4}$$

$$\text{Slope of OS} = \frac{4}{3} = \frac{k-0}{h-0} \Rightarrow k = \frac{4}{3}h$$

Since tangents at A and B are perpendicular AB $\left(\frac{x}{4}+\frac{y}{3}=1\right)$ is the focal chord so

$$\frac{h}{4}+\frac{k}{3}=1$$

Solving for h and k, we get $h = \frac{36}{25}, k = \frac{48}{25}$

4. CD

Sol.
$$8\sin^2 x\cos x = \sqrt{3}\sin x + \cos x$$
$$4\sin 2x\sin x = \sqrt{3}\sin x + \cos x$$
$$2(\cos x - \cos 3x) = \sqrt{3}\sin x + \cos x$$
$$2\cos 3x = \cos x - \sqrt{3}\sin x$$
$$\cos 3x = \cos x\frac{1}{2} - \sin x.\frac{\sqrt{3}}{2}$$
$$\cos 3x = \cos\left(x + \frac{\pi}{3}\right)$$
$$3x = 2n\pi \pm \left(x + \frac{\pi}{3}\right)$$
$$\Rightarrow x = n\pi + \frac{\pi}{6} \text{ or } x = \frac{n\pi}{2} - \frac{\pi}{12}$$

5. BC

Sol. a_n = Number of sets containing the element ‘n’ + Number of sets that do not contain ‘n’

Number of subsets containing ‘n’= set containing ‘n’ itself + number of subsets to be chosen from $\{1, 2, 3, 4....,n-2\}$

$$= 1+a_{n-2}$$

Number of subsets not containing 'n'= subset to be chosen from $\{1, 2, 3, 4....,n-2, n-1\}$

$$= a_{n-1}$$

So, $a_n = (1+a_{n-2})+a_{n-1}$

6. ABD

Sol. Let $\bar{x} = 40$ be the mean of the scores and let $x_1, x_2, ..., x_p$ be the scores higher than or equal to 80. Then

$$(\bar{x}-x_{p+1})+(\bar{x}-x_{p+2})+...+(\bar{x}-x_{100}) = (x_1-\bar{x})+...+(x_p-\bar{x}) \ge (80-40)p = 40p$$

$$100.20^2 = (x_1-\bar{x})^2+...+(x_p-\bar{x})^2+(x_{p+1}-\bar{x})^2+...+(x_{100}-\bar{x})^2$$

By RMS $\ge$ AM inequality $\sqrt{\dfrac{a_1^2+a^2{}_2+...+a^2_n}{n}} \ge \dfrac{a_1+a_2+...+a_n}{n}$

We have

$$\sqrt{\frac{(\bar{x}-x_{p+1})^2+(\bar{x}-x_{p+2})^2+...+(\bar{x}-x_{100})^2}{100-p}} \ge \frac{(\bar{x}-x_{p+1})+(\bar{x}-x_{p+2})+...+(\bar{x}-x_{100})}{100-p} \ge \frac{(40-0)p}{100-p}$$

So $(x_{p+1}-\bar{x})^2+(x_{p+2}-\bar{x})^2+...+(x_{100}-\bar{x})^2 \ge \dfrac{(40p)^2}{100-p}$

Similarly,

$$\sqrt{\frac{(x_1-\bar{x})^2+(x_2-\bar{x})^2+...+(x_p-\bar{x})^2}{p}} \ge \frac{(x_1-\bar{x})+(x_2-\bar{x})+...+(x_p-\bar{x})}{p} \ge \frac{(80-40)p}{p} = 40$$

$$(x_1-\bar{x})^2+(x_2-\bar{x})^2+...+(x_p-\bar{x})^2 \ge (40)^2 p$$

$$100.20^2 = (x_1-\bar{x})^2+...+(x_p-\bar{x})^2+(x_{p+1}-\bar{x})^2+...+(x_{100}-\bar{x})^2 \ge (40)^2 p + \frac{(40p)^2}{100-p}$$

On simplifying we get

$100-p \ge 4p$

$p \le 20$

7. BCD

Sol. Let AB lie along the x – axis.

Let $A \equiv (0,0)$

$\tan\dfrac{B}{2} = \dfrac{1}{3} \Rightarrow \tan B = \dfrac{3}{4}$

Assume, $B \equiv (4+x_1, 0)$, so that

$\tan B$ can be equal to $\dfrac{3}{4}$

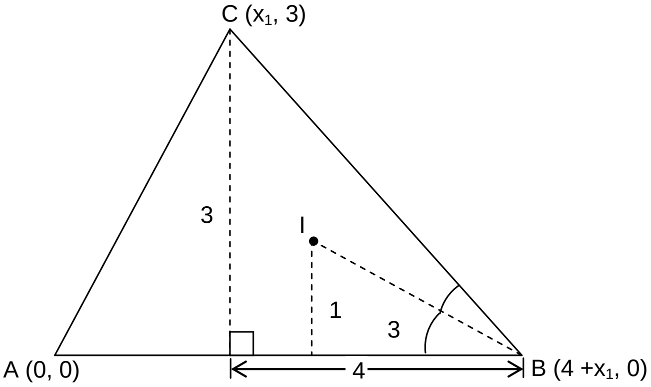
and $C \equiv (x_1, 3)$

Centroid $\equiv \left(\dfrac{4+2x_1}{3}, 1\right)$

Since $IG \parallel AB$, we have inradius, r = 1

$r = \dfrac{\Delta}{s}$

$\Rightarrow \Delta = S$



$$\Rightarrow \frac{1}{2}(3)(4+x_1)$$

$$= \frac{(4+x_1)+5+\sqrt{9+x_1^2}}{2}$$

$$\Rightarrow 3x_1^2+12x_1=0$$

$\Rightarrow x_1=0$ (–4 is rejected otherwise area of triangle will become zero) .

So the foot of perpendicular from C on AB coincides with A

$$\Rightarrow \angle CAB=90^o$$

$$\Rightarrow \sin B=\frac{b}{a}=\frac{3}{5};\ \tan B=\frac{3}{4}=\frac{b}{c}$$

8. BC

Sol. (B) $\frac{1}{a^2(1-r^2)}\left[1+\frac{1}{r^2}+\frac{1}{r^4}+......\frac{1}{r^{2(n-2)}}\right]=\frac{1-\frac{1}{r^{2(n-1)}}}{\left(1-\frac{1}{r^2}\right)a^2(1-r^2)}$

$$=\frac{(1-r^{2n})}{a^2(1-r^2)^2r^{2n-4}}$$

(C) $\frac{1}{a^m(1+r^m)}\left[1+\frac{1}{r^m}+\frac{1}{r^{2m}}+.....+\frac{1}{r^{(n-2)m}}\right]=\frac{\left(1-\frac{1}{r^{(n-1)m}}\right)}{\left(1-\frac{1}{r^m}\right)a^m(1+r^m)}$

$$=\frac{(1-r^{mn-m})}{(1-r^m)(r^{mn-m}-r^{mn-2m})}$$

9. B

10. C

Sol.

(I) Let $q_1=1-p_1$ and $q_2=1-p_2$

∵ A can win the game at the 1st , 4th, 7th… trials.

∴ P (A wins) $=\frac{1}{6}+\frac{5}{6}(q_1)(q_2)\left(\frac{1}{6}\right)+\left(\frac{5}{6}\right)^2(q_1)^2(q_2)^2\left(\frac{1}{6}\right)+...$

$$=\frac{\frac{1}{6}}{1-\frac{5}{6}q_1q_2}=\frac{1}{6-5q_1q_2}=\frac{1}{6-5\left(\frac{4}{3}\right)\left(\frac{3}{4}\right)}=\frac{1}{\lambda_1}\text{ [given]}$$

$$\therefore \lambda_1=3$$

(II) P (C wins) $=\frac{5}{6}.q_1.p_2+\left(\frac{5}{6}\right)^2.q_1^2.q_2\,p_2+...$

$$=\frac{\frac{5}{6}q_1.p_2}{1-\frac{5}{6}.q_1q_2}=\frac{5q_1p_2}{6-5q_1q_2}=\frac{5\times\frac{4}{5}\times\frac{1}{4}}{6-5\times\frac{4}{5}\times\frac{3}{4}}=\frac{1}{3}$$

$=\frac{1}{\lambda_2}$ [given]]

$\therefore \lambda_2=3$

(III) $\because$ P (A wins) = P (B wins)

$\Rightarrow \frac{1}{6-5q_1q_2}=\frac{5p_1}{6-5q_1q_2}$

$\therefore \quad p_1=\frac{1}{5}=\frac{1}{\lambda_3}$ [given]

$\therefore \quad \lambda_3=5$

(IV) P (Q wins) = P (B wins) = P (C wins)

$\Rightarrow \quad \frac{1}{6-5q_1q_2}=\frac{5p_1}{6-5q_1q_2}=\frac{5q_1p_2}{6-5q_1q_2}$

$\Rightarrow \quad 1=5p_1=5q_1p_2$

$\Rightarrow \quad p_1=\frac{1}{5},\frac{1}{p_2}=5q_1=5\left(1-\frac{1}{5}\right)=4=\lambda_4$ [given]

$\therefore \quad \lambda_4=4$

11. D

12. C

(I) Number of dissimilar terms in the expansion of $(x+2y+3z)^n\ (n\in N)$

$={}^{n+3-1}C_{3-1}={}^{n+2}C_2=\frac{1}{2}n^2+\frac{3}{2}n+1$

$\therefore \quad a=\frac{1}{2},\ b=\frac{3}{2},c=1$

Hence, $a+b+c=\frac{1}{2}+\frac{3}{2}+1=3$ and $a+b=\frac{1}{2}+\frac{3}{2}=2=2c$

(II) We have $(x+y+z)^{2n+1}=\{(x+y)+z\}^{2n+1}$

$=(x+y)^{2n+1}+{}^{2n+1}C_1(x+y)^{2n}z+{}^{2n+1}C_2(x+y)^{2n-1}z^2+{}^{2n+1}C_3(x+y)^{2n-2}z^3+\ldots$

${}^{2n+1}C_{2n}(x+y)z^{2n}+{}^{2n+1}C_{2n+1}z^{2n+1}$ and $(x+y-z)^{2n+1}=\{(x+y)-z\}^{2n+1}$

$=(x+y)^{2n+1}-{}^{2n+1}C_1(x+y)^{2n}z+{}^{2n+1}C_2(x+y)^{2n-1}z^2$

$-{}^{2n+1}C_3(x+y)^{2n-2}z^3+\ldots+{}^{2n+1}C_{2n}(x+y)z^{2n}-{}^{2n+1}C_{2n+1}z^{2n+1}$

$\therefore (x+y+z)^{2n+1}-(x+y-z)^{2n+1}$

$=2\left\{{}^{2n+1}C_1(x+y)^{2n}z+{}^{2n+1}C_3(x+y)^{2n-2}z^3+\ldots+z^{2n+1}\right\}$

$\therefore$ The number of dissimilar terms in the expansion of $(x+y+z)^{2n+1}-(x+y-z)^{2n+1}$

$=(2n+1)+(2n-1)+(2n-3)+\ldots5+3+1$

$=\frac{(n+1)}{2}(2n+1+1)=(n+1)^2$

$=n^2+2n+1$

$\therefore\ a=1, b=2, c=1$

Hence, $a+b+c=1+2+1=4$

(III) We have, $(x-y+z)^n=\{x-(y-z)\}^n$

$= x^n - {}^nC_1x^{n-1}(y-z)+{}^nC_2x^{n-2}(y-z)^2+{}^nC_3x^{n-3}(y-z)^3$

$+\ldots-{}^nC_{n-1}x(y-z)^{n-1}+{}^nC_n(y-z)^n$ and $(x+y-z)^n=(x+y-z)^n$

$= x^n + {}^nC_1x^{n-1}(y-z)+{}^nC_2x^{n-2}(y-z)^2+{}^nC_3x^{n-3}(y-z)^3+\ldots+{}^nC_{n-1}x(y-z)^{n-1}+(y-z)^n$

$\therefore\ (x+y+z)^n+(x+y-z)^n$

$=2\left[x^n+{}^nC_2x^{n-2}(y-z)^2+{}^nC_4x^{n-4}(y-z)^n+\ldots+(y-z)^n\right]$

$\therefore$ The number of dissilmilar terms in the expansion of

$(x-y+z)^n+(x+y-z)^n=1+3+5+\ldots+(n+1)$

$$=\frac{\frac{(n+2)}{2}}{2}(1+n+1)=\frac{(n+2)^2}{4}=\frac{1}{4}(n^2+n+1)$$

$\therefore\ a=\frac{1}{4}, b=1, c=1$

Hence, $b+c=1+1=2=8a$

(IV) $\because \left(\frac{x^2+1+x^4}{x^2}\right)^{\sum n}$

$$=\frac{a_0+a_2x^2+a_4x^4+\ldots+a_{2n(n+1)}x^{2n(n+1)}}{x^{n(n+1)}}$$

$\therefore$ Number of terms $=\frac{1}{2}.2n(n+1)+1=n^2+n+1$

$\therefore\ a=1, b=1, c=1$

Hence, $a+b+c=1+1+1=3$ and $a+b=1+1=2=2c$

(PART – B)

1. 0

Sol. Assume $\det(AB-BA)\neq 0$

Since $A^2+B^2=2AB$ we have $A^2+B^2-AB-BA=2AB-AB-BA$

$\Rightarrow (A-B)^2=AB-BA$

$\Rightarrow \det(A-B)^2=\det(AB-BA)\neq 0$

$\Rightarrow \det(A-B)\neq 0 \Rightarrow A-B$ is invertible.

Also, if $A^2+B^2=2AB$

then $A^2-AB=AB-B^2$

$A(A-B)=(A-B)B$

$\Rightarrow A(A-B)(A-B)^{-1}=(A-B)B(A-B)^{-1}$

$\Rightarrow A=(A-B)B(A-B)^{-1}$

Subtracting B from both sides.

$\Rightarrow A-B=(A-B)B(A-B)^{-1}-B$

$\Rightarrow (A-B)^{-1}(A-B)=(A-B)^{-1}(A-B)B(A-B)^{-1}-(A-B)^{-1}B$

$\Rightarrow I=B(A-B)^{-1}-(A-B)^{-1}B$

$\text{trace}(I)=\text{trace}\left\{B(A-B)^{-1}-(A-B)^{-1}B\right\}$

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$$\Rightarrow \text{trace}(I) = \text{trace}\left\{B(A-B)^{-1}\right\} - \text{trace}\left\{(A-B)^{-1}B\right\}$$

$$\Rightarrow \text{trace}(I) = 0 \qquad (\because \text{trace}(AB) = \text{trace}(BA))$$

which is a contradiction.

Hence, $\det(AB - BA) = O$

2. 24

Sol. $p(-t-1) = \dfrac{(-t-1)(-t-1-1)(-t-1-2)\ldots(-t-1-2023)}{2023!}$

$= \dfrac{(t+1)(t+2)(t+3)\ldots(t+2024)}{2023!}$

$\displaystyle\int_0^1 \left\{\frac{1}{t+1} + \frac{1}{t+2} + \ldots + \frac{1}{t+2024}\right\} \frac{(t+1)(t+2)(t+3)\ldots(t+2024)}{2023!}\, dt$

$= \dfrac{1}{2023!} \left|(t+1)(t+2)(t+3)\ldots.(t+2024)\right|_0^1$

$= \dfrac{1}{2023!} 2025! - 2024!$

$= \dfrac{(2024)!}{2023} \{2025 - 1\}$

$= (2024)^2$

$\Rightarrow k = 2024$

3. 6

Sol. $\tan 78^\circ + \tan 72^\circ + \tan 60^\circ$

$= \dfrac{1}{2\cos 72^\circ \cos 75^\circ} + \cot 30^\circ$

$= \dfrac{2\cos 36^\circ}{\cos 78^\circ} + 2\cos 30^\circ \qquad 2\cos 72^\circ = 2\sin 18^\circ = \dfrac{\sqrt{5}-1}{2}$

$\qquad = \dfrac{2}{\sqrt{5}+1}$

$= \dfrac{2\cos 36^\circ + 2\cos 30^\circ \cos 78^\circ}{\cos 78^\circ} \qquad = \dfrac{1}{2\cos 36^\circ}$

$= \dfrac{2\cos 36^\circ + \cos 108^\circ + \cos 48^\circ}{\cos 78^\circ}$

$= \dfrac{2\cos 36^\circ - \cos 72^\circ + \cos 48^\circ}{\cos 78^\circ} \qquad \cos 36^\circ - \cos 72^\circ = \dfrac{\sqrt{5}+1}{4} - \dfrac{\sqrt{5}-1}{4} = \dfrac{1}{2}$

$= \dfrac{1 + \cos 72^\circ + \cos 48^\circ}{\cos 78^\circ} = \dfrac{1 + 2\cos 60^\circ \cos 12^\circ}{\sin 12^\circ} = \dfrac{1 + \cos 12^\circ}{\sin 12^\circ} = \cot 6^\circ$

$\Rightarrow k = 6$

4. 111

Sol. In general, number of triangles is ${}^{n}C_3 + 4\left({}^{n}C_4\right) + 5\left({}^{n}C_5\right) + {}^{n}C_6$

So, putting $n = 6$, number of triangles is 111

5. 1

Sol. $4\displaystyle\int_0^{\pi/2} \left(f(x) + x^2\right) dx + 125 \int_0^{3/2} \frac{dx}{\sqrt{f(x) + x^2}} = \frac{225}{2}$

Let $g(x)=f(x)+x^2$

$$4\int_0^{3/2} g(x)\,dx+125\int_0^{3/2}\frac{1}{2\sqrt{g(x)}}dx+125\int_0^{3/2}\frac{1}{2\sqrt{g(x)}}dx$$

$$\geq 3\int_0^{3/2}\left(4g(x).\frac{125}{2\sqrt{g(x)}}.\frac{125}{2\sqrt{g(x)}}\right)^{1/3}dx$$

$$=\frac{225}{2}$$

Equality occurs if $4g(x)=\dfrac{125}{2\sqrt{g(x)}}\Rightarrow\left(g(x)\right)^{\frac{3}{2}}=\left(\dfrac{5}{2}\right)^3$

$$\Rightarrow g(x)=\frac{25}{4}$$

6. 0.17

Sol. $S=\sum\limits_{i=0}^{\infty}\int\limits_0^1\left(x^{4i}-2x^{4i+1}+x^{4i+2}\right)dx=\dfrac{1}{2}\int\limits_0^1\left(\dfrac{1}{1-x^4}-\dfrac{2x}{1-x^4}+\dfrac{x^2}{1-x^4}\right)dx=\dfrac{1}{2}\int\limits_0^1\dfrac{(1-x)^2}{1-x^4}dx\,]$

So, $S=\dfrac{1}{2}\int\limits_0^1\left(\dfrac{1}{1+x}-\dfrac{x}{1+x^2}\right)dx=\dfrac{\ln 2}{4}$

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FIITJEE RBT-8 for (JEE-Advanced)

BATCHES – Two Yr CRP2123(All)

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 1

QP Code: 100204

PAPER - 1

Time Allotted: 3 Hours

Maximum Marks: 234

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections**.
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. Each **Section** is further divided into **Two Parts**: **Part-A & B** in the OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with HB pencil for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Two Parts.

(i) **Part-A (01-07) –** Contains seven (07) multiple choice questions which have **One or More** correct answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in –**2** marks, as a wrong option is also darkened.

(i) **Part-A (08-13) –** Contains six (06) multiple choice questions which have ONLY ONE CORRECT answer Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(ii) **Part-B (01-08)** contains eight (08) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+4 marks** for correct answer and **there will be no negative marking.**

Name of the Candidate :____

Batch :____________________ **Date of Examination :**___________________

Enrolment Number :____

SECTION-1 : PHYSICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

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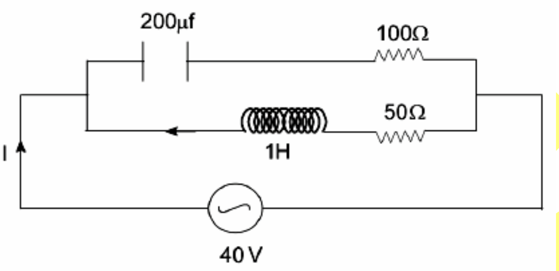
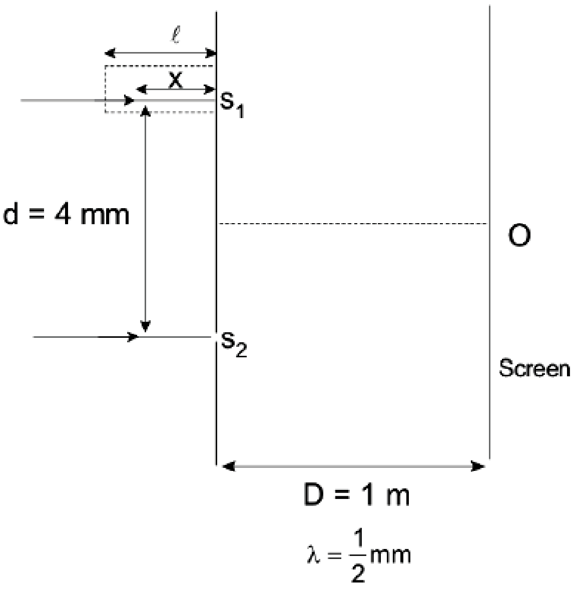
1. In the given cirucit, the AC source has ω = 50 rad/s considering the inductor and capacitor to be ideal, the correct choice(s) is/are



(A) The voltage across 100 Ω resistor = 20.
(B) The voltage across 50 Ω resistor = 20.
(C) The current through the circuit is $I = \frac{\sqrt{5}}{\sqrt{2}}A$
(D) the current through the cirucit is I = 1.2A

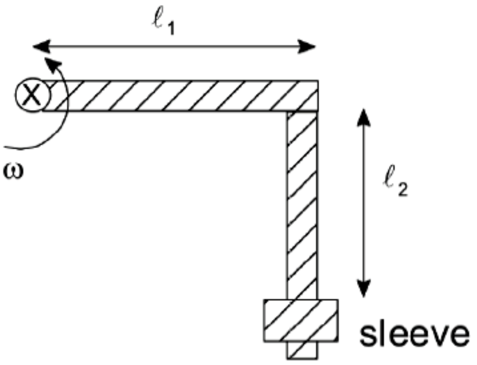
2. In YDSE, D = 1 m, d = 4 mm and $\lambda = \frac{1}{2}$mm in the figure shown, a parallel beam of light incident on the plane of the slits of YDSE. Light incidnet on the slit S_1, passes through a medium of variable refractive index $\mu = (2x + 1)$ (where x is the idstance from the plane of slits in mm) up to a distnace ℓ = 1 mm before falling on s_1. Rest of the space filled with air. Then choose the correct option(s):



(A) Position of central bright frindge is at a distace $y = \frac{1}{\sqrt{3}}$m above the central line.
(B) Position of central bright fringe is at a distance $y = \frac{1}{2}$m above the central line.
(C) Number of maxima obtaining on the screening is 7.
(D) Number of maxima obtaining on the screening is 8.

Space For Rough Work

3. A rough L – shaped rod is located in a horizontal plane and a sleeve of mass m is inserted in the rod. The rod is rotated with a cosntant angular velocity ω in the horizontal plane. The lengths ℓ_1 and ℓ_2 are shown in figure. The normal reaction and frictional force acting on the sleeve when it starts slipping are (μ: coefficient of friction between rod and sleeve).



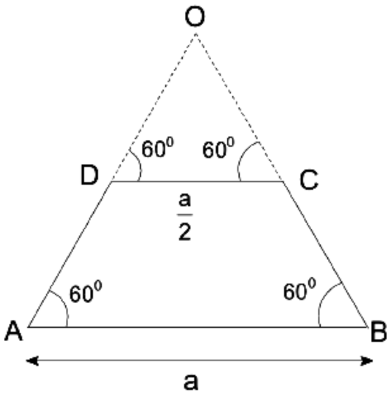
(A) $N = m\omega^2\ell_1$

(B) $\omega^4 = \dfrac{\mu^2 g^2}{\ell_2^2 - \mu^2\ell_1^2}$

(C) $N = m\sqrt{g^2 + \omega^4\ell_1^2}$

(D) $f = \mu N$

4. Consider a uniformly charged sheet ABCD, which is a part of an equilateral triangluar sheet of a side a as shown in the figure. Choose the correct options regarding the electric field E at point O due to this sheet.



(A) Magnitude of $\vec{E}$, increases with the increase in ‘a’ (Keeping charge density same)

(B) Magnitude of E, decreases with the increase in ‘a’ (Keeping total charge same)

(C) If charge desnity is σ and a = 1 m, magnitdue of E is equal to $\dfrac{7\sigma}{44\varepsilon_0}\ln\sqrt{2}$

(D) If charge desnity is σ and a = 2 m, magnitdue of E is equal to $\dfrac{7\sigma}{22\varepsilon_0}\ln\sqrt{2}$

5. Which of the folliwng statements is/are correct for mechanical standing wave on a stretched wire?

(A) Elastic potential energy of a small element at antinode is constant and minimum.

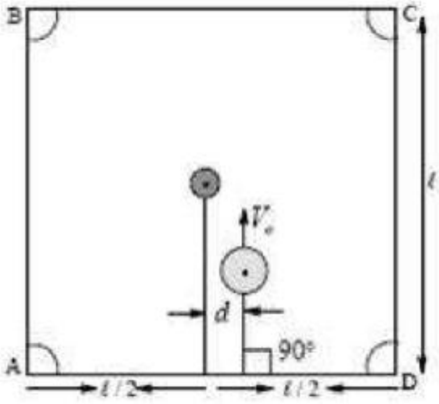
(B) Elastic potential energy of a small element at node is constant and maximum.

(C) Eleastic potential energy of a small element at node is constant and maximum.

(D) Total kinetic energy between two consecutive nodes become maximum twice in one-time period.

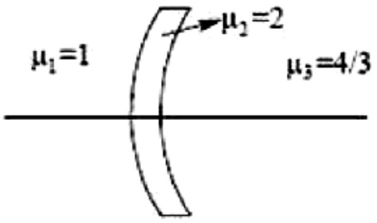
Space For Rough Work

6. The queen is put at the centre of a perfectly smooth carom board (square with side ℓ). The striker strikes the queen with a speed V_e as shown in the figure. Radius of the queen is $\sqrt{10}$ cm and that of the striker is $2\sqrt{10}$ cm. Coefficient of restitution for the collision between the qaueen and the striker is $\frac{1}{2}$ and that for the collision between the queen and the walls of the board is 1. (Assume ℓ >>> radius of queen)



(A) The value of 'd' for which the queen gets in the hole A is 3 cm.
(B) The value of 'd' for whcih the queen gets in the hole A is 2 cm.
(C) The value of 'd' depends on the coefficient of restitution between the queen and the striker.
(D) The value of 'd' independent on the coefficient of restitution between the queen and the striker.

7. A thin lens of same radius of curvature 20 cm is haivng two different medium on its two sides extending upto infinity as shown in the figure. Then



(A) it may behave as a converging lens of focal length 60 cm.
(B) it may behave as a diverging lens of focal elgnth 60 cm.
(C) it may behave as a converging lens of focal length 80 cm.
(D) it may behave as a diverging lens of focal length 80 cm.

Space For Rough Work

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

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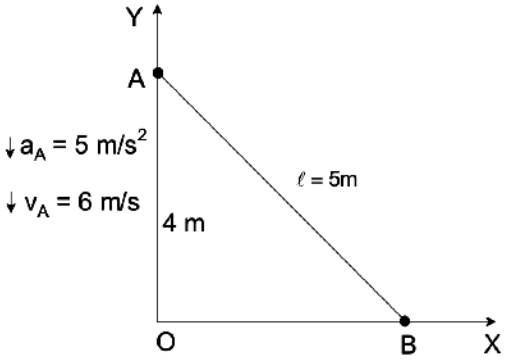
8. Point A on the rod AB has an acceleration of 5 m/s^2 and a veloicity of 6 m/s at an instant as shown in the figure. The acceleratin of the end B at the same moment is:


Y
A
$\downarrow a_A = 5\ \text{m/s}^2$
$\downarrow v_A = 6$ m/s
$\ell = 5$m
4 m
O
B
X

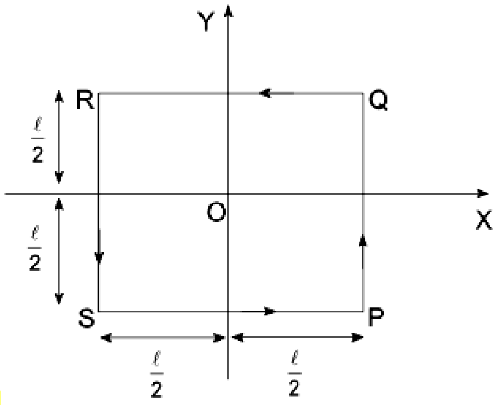
(A) $-\frac{80}{3}\hat{i}\ \text{m/s}^2$

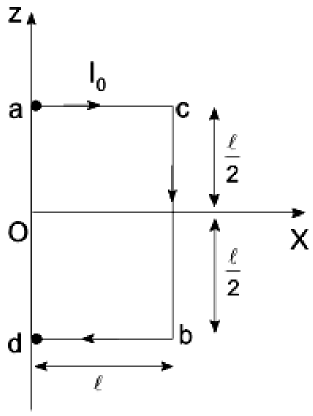
(B) $\frac{80}{3}\hat{i}\ \text{m/s}^2$

(C) $-\frac{40}{3}\hat{i}\ \text{m/s}^2$

(D) $-\frac{75}{6}\hat{i}\ \text{m/s}^2$

9. Current I_0 is flowing through a bent wire a → b → c → d in z – x plane as shown in figure, then $\oint \vec{B}.\vec{d\ell}$ over the loop PQRS lying in the X-Y plane as shown in figure, due to the bent wire abcd


Y
R
Q
$\frac{\ell}{2}$
$\frac{\ell}{2}$
O
X
S
P
$\frac{\ell}{2}$
$\frac{\ell}{2}$

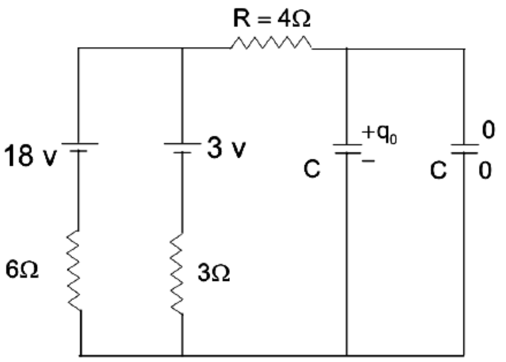

z
I_0
a
c
$\frac{\ell}{2}$
O
X
$\frac{\ell}{2}$
d
b
ℓ

(A) $\frac{\mu_0 I_0}{8}$ (B) $\frac{\mu_0 I_0}{7}$ (C) $\frac{\mu_0 I_0}{5}$ (D) $\frac{\mu_0 I_0}{3}$

Space For Rough Work

10. The circuit is completed at t = 0, then heat loss in R = 4Ω resistance, till the capacitor gets fully charged:

(A) 64 μJ
(B) 384 μJ
(C) 320 μJ
(D) 576 μJ



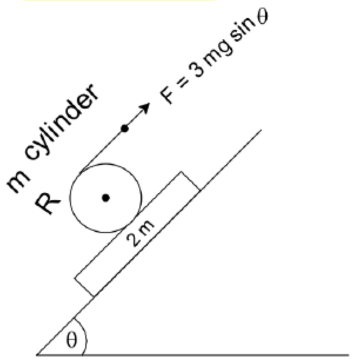
$C = 16\ \mu F$
$q_0 = 64\mu C$

11. A simple harmonic plane progressive wave is travelling along the +ve x-axis having amplitude A and ω = π rad/s. At t = 1 sec, particle at x = 2 m and x = 3 m are moving in downward and upward direction respectively at the position $y = +\frac{A}{2}$. The time when maximum power transfer will takes place at $x = \frac{11}{4}m$?

(A) $\frac{5}{4}$sec (B) $\frac{5}{3}$sec (C) $\frac{7}{4}$sec (D) $\frac{7}{5}$sec

12. There is sufficient friciton between long plank of mass 2 m and cylinder of mass m and radius R to prevent slipping. Whole system is placed on the smooth inclined surface. Now, force F = 3 mg sin θ is applied on the ideal string wrapped over the cylinder as shown in figure. Choose correct option:

(A) If the plank moves down a distance of S m, work done by the applied force F on the string is 5 mg sin θ S.
(B) If the plank moves down a distance of S m, work done by the applied force F on the string is 6 mg sin θ S.
(C) If the plank moves down a distance of S m, work done by the applied force F on the sstring is 12 mg sinθ S.
(D) If the plank moves down a dsitane of S m, work done by the applied force F on the string is 15 mg sinθ S.



Space For Rough Work

13. A vertical thermally insulated cylinder of volume V contain n moles of an ideal monoatomic gas under a weightless piston. A load of weight W is placed on the piston as a result of which the piston is displaced. If the initial temperature of the gas is 300 K, area of piston is A and atmospheric pressure P_0. (take W = P_0A). Determine the value of final temperature of the gas.

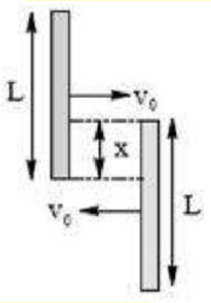
(A) 375 K	(B) 425 K
(C) 475 K	(D) 515 K

PART – B

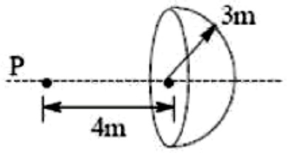
(Numerical based)

This section contains **8 Numerical based questions**, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

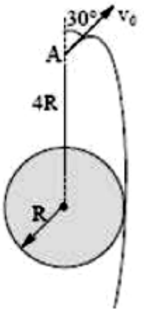
1. Two identical rigid rods, each of mass 1 kg & length $\sqrt{3}$ m, are moving opposite to each other without rotation on a smooth horizontal table as shwon. For what maximum vlue of 'x' (after rouding off), the direciton of motion of each rod would not change after collision, irrespective of the type of collision. Assume no sticking.



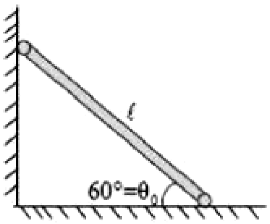
2. A point source of power 'P' is placed on th axis of a thin hemispherical shell as shown. The shell has a radius of 3m and behaves like a perfect black body. If the steady state temperature of shell is T. Find T^4 (after rounding off). (Take P = 2400π σ W, σ = Stefan's constant)



3. A particle is projected from point 'A', that is at a distance 4R from the centre of the Earth, with speed V_0 as shwon. If the particle passes grazing the earth's surface, then it is found that V_0 = 100 × N. Find the value of N (after rounding off). [Take $\frac{GM}{R} = 6.4\times10^7 m^2/s^2, \sqrt{2} = 1.414$]

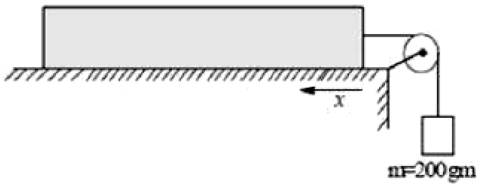


Space For Rough Work

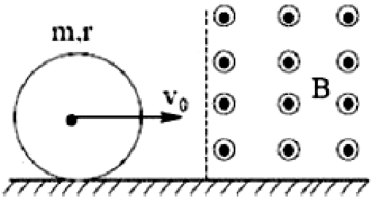


4. A ladder of mass m and length ℓ stands against a frictionless wall with its feet on a fricitonless floor. If it is let go at an initial angle $\theta_0 = 60°$ then the angle ‘θ’ at which the ladder loses contact with the wall is given as $\sin^{-1}\left(1/\sqrt{N}\right)$, find 'N'.

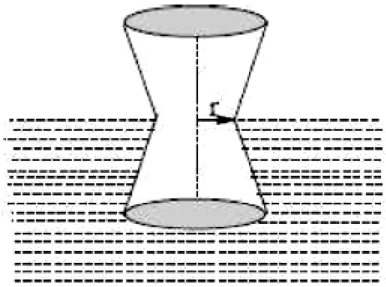
5. An electric charge distribution produces an electric field $\vec{E} = C(1-e^{-\alpha r})\frac{\hat{r}}{r^2}$ where $C = \frac{1}{4\pi\varepsilon_0}$ and α are constant. If the net charge within the radius $r = \frac{1}{\alpha}$ is $(1 - e^{-N})$, then find the value of ‘N’?



6. Uniform rope of mass = 5 kg and length 1 meter is lying on a rough horizontal surface. Coefficient of static friciton varies from right end of the rope as $\mu = \mu_0 x$ where $\mu_0 = 0.5$ per meter. A block of mass 200 gm is hanging from an ideal string which passes over an ideal pulley as shown in the figure. The minimum value of x (in cm) for which tension at some cross-section of rope becomes zero is 10 × N. Find the value of ‘N’.



7. A ring of mass m and radius r is made of an insulating material carries uniformly disturbed charge. Initially it rests on a fricionless horizontal table top with its plane vertical. The charge on the ring, such that it starts rolling on entering completely into the region of the magnetic field, is $\frac{\sqrt{N}\,mv_0}{rB}$, then the value of ‘N’.



8. A solid object of mass $\frac{22}{7}$kg is in the shape of pellet drum its half submerged in water of density 1000 kg/m^3 with dimensions as shown in the figure. Find the time period (in seconds) of small vertical oscillations of the drum. [Take $r = \frac{22}{7}$cm]

Space For Rough Work

SECTION-2 : CHEMISTRY

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

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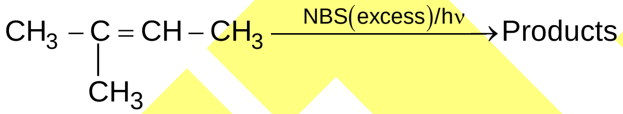
1. The correct statement(s) regarding the wave function $\psi_{4,1,-1}$ is/are
   (A) it represent the 4p-subshell
   (B) orbital associated with the wave function has one nodal plane and two radial nodes
   (C) the energy of this orbital is higher than that of 3s orbital
   (D) arsenic(Z = 33) contains one electron in this orbital

2. The correct statement(s) regarding a complex ion $[MnCl_4]^{2-}$ is/are that
   (A) according to crystal field theory, the electronic configuration of the 3d-orbital of Mn^{2+} in the complex is $e^2t_2^3$.
   (B) it is a square planar complex
   (C) the Cl^- ions acts as weak field ligands
   (D) Mn^{2+} undergoes sp^3-hybridization in the complex

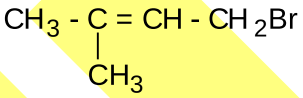
3. The solubility product constant(K_{sp}) of $Be(OH)_2$ is 5×10^{-10} at 298K.
   Choose correct statement(s)
   (A) the concentration of it's saturated solution is 5×10^{-4} mol L^{-1}
   (B) it's solubility increases in a buffer of pH > 11 and decreases in a buffer of pH < 11
   (C) addition of NH_4Cl increase it's solubility
   (D) addition of NaCl does not affect solubility

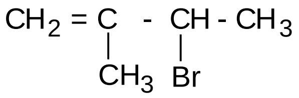
4. The product(s) of the given reaction

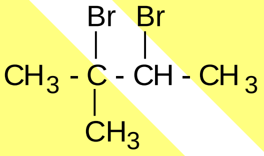


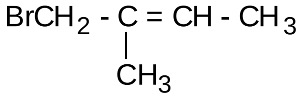
$$CH_3-\underset{\underset{CH_3}{|}}{C}=CH-CH_3 \xrightarrow{NBS(excess)/h\nu} Products$$

is/are

(A)

$CH_3-\underset{\underset{CH_3}{|}}{C}=CH-CH_2Br$

(B)

$CH_2=\underset{\underset{CH_3}{|}}{C}-\underset{\underset{Br}{|}}{CH}-CH_3$

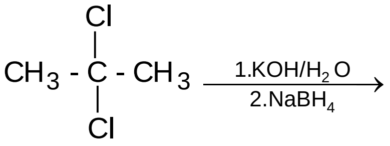
(C)

$CH_3-\overset{\overset{Br}{|}}{\underset{\underset{CH_3}{|}}{C}}-\overset{\overset{Br}{|}}{CH}-CH_3$

(D)

$BrCH_2-\underset{\underset{CH_3}{|}}{C}=CH-CH_3$

Space For Rough Work

5. Which reaction(s) produce(s) secondary alcohol(s)?

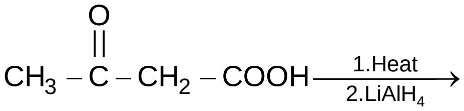
(A)



$CH_3-C(Cl)_2-CH_3 \xrightarrow[2.NaBH_4]{1.KOH/H_2O}$

(B) $CH_3-CH_2-CHO \xrightarrow{CH_3MgBr/H_3O^+}$

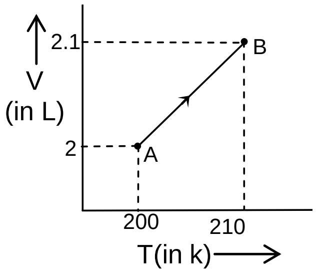
(C)



$CH_3-\overset{O}{\overset{||}{C}}-CH_2-COOH \xrightarrow[2.LiAlH_4]{1.Heat}$

(D) $CH_3COOC_2H_5 \xrightarrow{LiAlH_4}$

6.



One mole of an ideal gas undergoes above thermodynamic process. C_P of the gas is $\frac{5R}{2}$.

[R = 8.3 J K^{-1} mol^{-1}]

Choose correct statement(s) $\left[\ell n\frac{21}{20}=0.048\right]$

(A) The irreversible work done along path A $\rightarrow$ B is -83 J mol^{-1}.

(B) The system absorbs 207.5 J mol^{-1} heat from the surrounding.

(C) The entropy[ΔS(system)] change along the path A $\rightarrow$ B in reversible way is 0.996 J K^{-1} mol^{-1}.

(D) The internal energy of the system will increase to 124.5 J mol^{-1}.

7. The correct hydrolysis order of the given compound(s) is/are

(A) $SiCl_4 > SiF_4$ (B) $NCl_3 > CCl_4$

(C) $BI_3 > BF_3$ (D) $BBr_3 > BCl_3$

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

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8. $BeCl_2$ undergoes polymerization and BCl_3 undergo dimerisation because

(A) $BeCl_2$ is more electron deficient than BCl_3

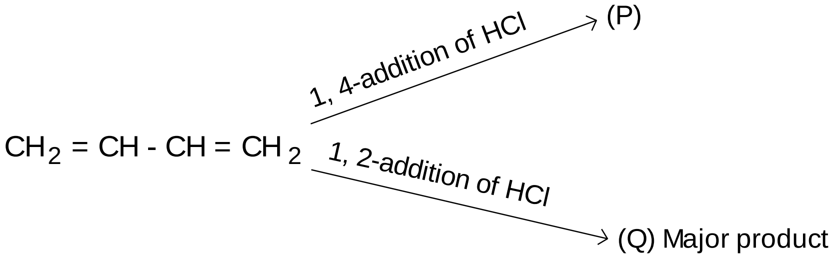
(B) $BeCl_2$ is linear and BCl_3 is angular

(C) Electronegativity different between Be and Cl is higher than that between B and Cl

(D) $BeCl_2$ is less covalent than BCl_3 molecule

Space For Rough Work

9.

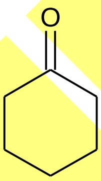


Which statement is correct regarding properties of P and Q?
(A) Reactivity with aq.KOH (S_N1 path) P > Q
(B) Number of stereoisomers: P = Q
(C) Rate of reaction with alc.KOH: P > Q
(D) Heat of hydrogenation: P > Q

10. Which solubility order is incorrect?
(A) LiI > NaI > KI > RbI
(B) $BeSO_4 > MgSO_4 > CaSO_4 > SrSO_4$
(C) $Be(OH)_2 > Mg(OH)_2 > Ca(OH)_2 > Sr(OH)_2$
(D) LiF < NaF < KF < RbF

11. Which forms the most stable complex with carbon monoxide?
(A) Fe
(B) Fe^{2+}
(C) Fe^{3+}
(D) $Fe^{+8/3}$

12. Gases having which of the following value of ‘a’ and ‘b’(van der Waal’s constant) can be liquefied easily?
[a in atm L^2 mol^{-2}, b in L mol^{-1}]
(A) a = 0.04, b = 0.03
(B) a = 0.08, b = 0.4
(C) a = 0.06, b = 0.03
(D) a = 0.004, b = 0.04

13. Two moles of  forms a single product when they react with
(A) $LiAlH_4$
(B) Zn-Hg/Conc.HCl
(C) NaOH
(D) $C_6H_5NH - NH_2$

Space For Rough Work

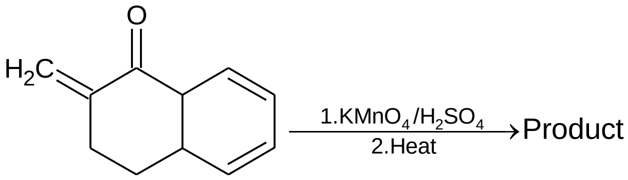
FIITJEE

PART – B

(Numerical based)

This section contains **8 Numerical based questions**, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

1.



How many maximum number of CO_2 molecule(s) is/are formed in the above reaction?

2. A container contains 200 mL of 0.5 M NH_4NO_3 solution. 200 mL of 0.4 M NaOH solution was added to it. What is the pH of the resulting solution?
[K_b of $NH_4OH = 10^{-5}$] [log 0.25 = -0.6]

3.

$$\begin{tikzcd} CH_3COCl + CH_3COONa \arrow[r, "-NaCl"'] & (P) \arrow[r, "H_2O"] & (Q) \arrow[d, "\Delta"', "NaOH\ CaO"] \\ & & (R) \end{tikzcd}$$

$$(R) + Cl_2 \xrightarrow[-HCl]{h\nu} S + T + U + V$$

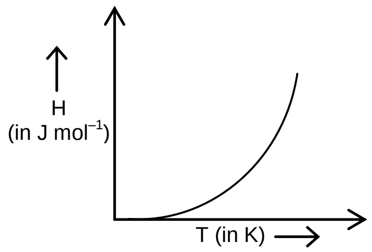
Order of molar mass = S < T < U < V
Let x = The number of chlorine atoms present in 'T'.
y = Number of hydrogen atoms present in 'U'
What is the value of $\left(\frac{x+y}{10}\right)$?

4. The crystal field stabilization energy of $[Fe(CN)_6]^{3-}$ is -xΔ_o and that of $[Fe(CN)_6]^{4-}$ is -yΔ_o. What is the value of (x + y)?

5. In a first order reaction $A(g) \longrightarrow \text{Product}$. What is the value of $\frac{[A_t]}{[A_o]}$ after two half-lives.

Space For Rough Work

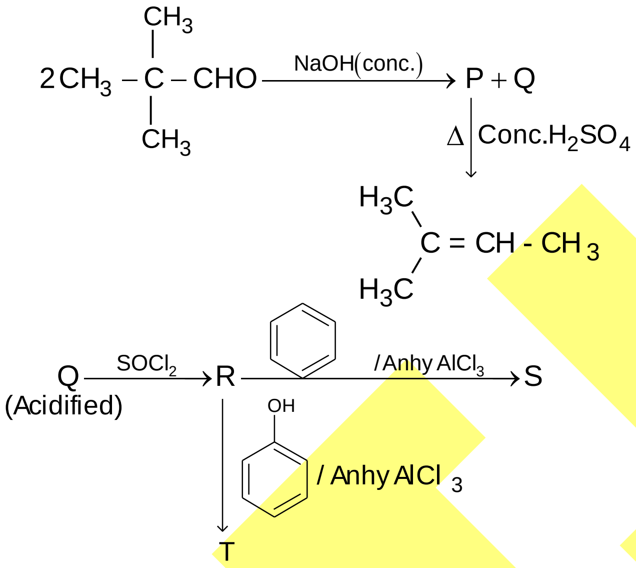
6.



If the slope of the above curve is 20.75 J K^{-1} mol^{-1}, what is the value of C_v in J K^{-1} mol^{-1} unit? [R = 8.3 J K^{-1} mol^{-1}]

7. A tetrahedral chloro complex of cobalt contains same number of electrons in the 'e' and t_2 orbitals according to crystal field theory. If the oxidation number of cobalt in the complex is +x, what is the value of $\frac{x}{2}$ is

8.


$2CH_3-C(CH_3)_2-CHO$
NaOH(conc.)
P + Q
Δ Conc.H_2SO_4
H_3C
C = CH - CH_3
H_3C
Q
(Acidified)
$SOCl_2$
R
/ Anhy $AlCl_3$
S
OH
/ Anhy AlCl $_3$
T

If the molar mass difference between the organic product S and T is X, what is $\frac{X}{10}$?

Space For Rough Work

SECTION-3 : MATHEMATICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

---

1. Consider the equation $z^6+6z+20=0$, Then which of following can be true?
   (A) The number of the roots in the first quadrant can be 1or 2
   (B) The number of the roots in the second quadrant can be 1or 2
   (C) The number of the roots in the third quadrant can be 1or 2
   (D) The number of the roots in the fourth quadrant can be 1or 2

2. A function f from integers to integers is defined as

$$f(x) = \begin{cases} n+3 & n \in \text{odd} \\ n/2 & n \in \text{even} \end{cases}$$

suppose k $\in$ odd and f(f(f(k))) = 27 then

(A) k can be 45
(B) sum of the digit of k is 6
(C) sum of the digit of k is 9
(D) k can be 105

3. Let α and $f(\alpha)$ be the eccentricity of the ellipse $\frac{x^2}{3b^2-2a^2}+\frac{y^2}{2b^2-a^2}=1,\left(3b^2>2a^2\right)$ and $\frac{x^2}{2b^2-a^2}+\frac{y^2}{b^2}=1,\left(2b^2>a^2\right)$ then

(A) $f(\alpha)=\frac{\alpha}{\sqrt{1-\alpha^2}}, b\in R-\{0\}$

(B) $\int_0^{1/2} ffff(\alpha)d\alpha=\frac{1}{4}$

(C) $\int e^{\alpha}\left(f(\alpha)-f''(\alpha)\right)d\alpha=e^{\alpha}\left[\frac{\alpha}{\sqrt{1-\alpha^2}}-\frac{1}{\left(1-\alpha^2\right)^{3/2}}\right]+C$

(D) $f(\alpha)=\frac{\alpha}{2\sqrt{1-\alpha^2}}, b\in R-\{0\}$

Space For Rough Work

4. If $f(x)=(a^2+a+1)x^2+bx+c$ and $f(x)$ is symmetrical about the line x = 1, then

(A) $f(1-\sqrt{3})<f(\sqrt{3})<f(2+\sqrt{3})<f(4)$

(B) $f(\sqrt{3})<f(1-\sqrt{3})<f(2+\sqrt{3})<f(4)$

(C) $f(2+\sqrt{3})>f(4)>f(\sqrt{3})>f(1-\sqrt{3})$

(D) $f(4)>f(2+\sqrt{3})>f(-\sqrt{2})>f(\sqrt{2})$

5. If $\int_0^1 (4x^3-f(x))f(x)\,dx=\frac{4}{7}$, then which of the following is/are true

(A) $f(x)$ has a point of inflexion

(B) $\left|f(x)-\frac{1}{4}\right|$ has exactly one point of non-differentiability

(C) area bounded by $y=f(x)$, x – axis, x = 1 and x =2 is $\frac{15}{2}$

(D) The function $f(x)$ is concave upward for $\forall x\in R$

6. In triangle ABC, a=4 and $b=c=2\sqrt{2}$. A point P moves with the triangle such that the square of its distance from BC is half the rectangle contained by its distances from the other two sides. If D be the centre of P, then

(A) locus of P is an ellipse with eccentricity $\sqrt{\frac{2}{3}}$

(B) locus of P is a hyperbola with eccentricity $\sqrt{\frac{3}{2}}$

(C) area of the quadrilateral ABCD=$\frac{16}{3}$sq.units

(D) area of the quadrilateral ABCD=$=\frac{32}{3}$ sq. units

7. If $f:R\to[2,4]$ be a periodic function such that the equation $f(x)=g(x)$ has a unique solution, if $g(x)=1-\cos\pi x$ then period of $f(x)$ can be

(A) e

(B) $\sqrt{3}$

(C) π

(D) 2020

Space For Rough Work

(Single Correct Choice Type)

This section contains **6 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

---

8. A boy have 32 cards out of which 10 cards, each of blue, green and red colours, have denominations as $\left\{2^1, 2^2, \ldots\ldots\ldots\ldots, 2^{10}\right\}$ and one black and one white each has value unity. The number of ways in which the boy can get a sum of 2012 if he can choose any number of cards, is

(A) $(1001)^2$ (B) $(1002)^2$

(C) $(1007)^2$ (D) $(1111)^2$

9. The minimum value of $(\sin\alpha - \cot\beta)^2 + (\tan\beta - \cos\alpha)^2$ for all admissible real Values of α and β is

(A) $3 - 2\sqrt{2}$ (B) 0

(C) $3 + 2\sqrt{2}$ (D) $2 - 3\sqrt{3}$

10. On the circle $\left|z - i\sqrt{3}\right| = 1$ points z_1, z_2, z_3 are so located that $3z_1 = 2z_2 + 2z_3 - i\sqrt{3}$. Then which is true ?

(A) $\left|z_1 - z_2\right| = \frac{1}{\sqrt{2}}$

(B) $\left|z_2 - z_3\right| = \frac{\sqrt{7}}{4}$

(C) The value of $\frac{z_2 - i\sqrt{3}}{z_3 - i\sqrt{3}} = \frac{\mathbf{1 \pm i\sqrt{63}}}{\mathbf{4}}$

(D) $\left|z_2 - z_3\right| = \frac{\sqrt{7}}{2}$

11. If f(x) be a positive, continuous and differentiable on the interval (a,b). If $\lim\limits_{x \to a^+} f(x) = 1$ and $\lim\limits_{x \to b^-} f(x) = 3^{1/4}$. Also $f'(x) + \frac{1}{f(x)}$, then

(A) $b - a \geq \frac{\pi}{24}$ (B) $b - a \leq \frac{\pi}{24}$

(C) $b - a = \frac{\pi}{12}$ (D) none of these

Space For Rough Work

12. If P be a point inside and equilateral triangle ABC such that PA=3,PB=4 and PC=5, then the side length of the equilateral triangle ABC is

(A) $\sqrt{25-12\sqrt{3}}$ (B) 13

(C) $\sqrt{25+12\sqrt{3}}$ (D) 17

13. If $f(x)$ is continuous function and satisfying $f(x)+f(1+x)=|2^x-1|+|x-1|$ in $0\le x\le 2$, then the value of $\int_0^2 f(x)dx$ is equal to

(A) $\frac{1}{\ln 2}-\frac{1}{2}$ (B) $\frac{1}{\ln 2}-1$

(C) $\frac{2}{\ln 2}-1$ (D) none of these

PART – B

(Numerical based)

This section contains **8 Numerical based questions**, the answer of which maybe positive or negative numbers or decimals to **two decimal places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)

---

1. Let f be a continuous function and $f(x)=f(2x),\ x\in R$. If f(x) = 3 then

$$\int_{-1}^{+1} f(f(f(x)))\,dx$$ is equal to

2. The number of ordered triplet (x,y,z) such that LCM(x,y)=3375,

LCM(y,z)=1125, LCM(z,x)=3375 is equal to

3. Let $A=\begin{bmatrix}1 & 0 & 2\\ 2 & 0 & 1\\ 1 & 1 & 2\end{bmatrix}$, then find the value of determinant $\left((A-I)^3-4A\right)$. [Note I is an identity matrix of order 3] .

Space For Rough Work

4. A biased coin shows head with probability of $\frac{3}{4}$ and tail with a probability of $\frac{1}{4}$. Let ‘A’ be the event that three or more heads occurs in four tosses and ‘B’ be the event that three heads do not occur in first three tosses. If $P\left(\frac{A}{B}\right)=\frac{m}{n}$ where m, n $\in$ N then find the least value of (m + n – 225) .

5. Let foci of the conic represented by the equation $ax^2+2\left(a+2\right)xy+ay^2+2fy=0$, where $a<-1$ and $f\neq 0$ be $F_1\left(\alpha,-3\right)$ and $F_2\left(\beta,-5\right)$. If the feet of perpendicular from F_1 and F_2 upon x-axis be M & N and accentricity of the conic given by the equation $\sqrt{10}\,e^2-7e+\sqrt{10}=0$ then the square of the radius of director circle of the conic is

6. If [sinx]+[cosx]+2=0, then number of integral values in the range of f(x)=sinx-cosx+3, corresponding to the solution set of the given equation is (where [.] denotes the greatest integer function)

7. $f\left(n\right)\sum_{r=1}^{n}\left[r^2\left({}^{n}C_r-{}^{n}C_{r-1}\right)+\left(2r+1\right)\left({}^{n}C_r\right)\right]$, then f(30) is

8. If p is a positive integer and ‘f’ be a function defined for positive numbers and attains only positive values such that $f(xf(y))=x^py^4$, then p=

Space For Rough Work

Q.P. Code: 100204

Answers

SECTION-1 : PHYSICS

PART – A

1.	ABC	2.	AD	3.	BCD	4.	BC
5.	AD	6.	AD	7.	AC	8.	A
9.	D	10.	B	11.	B	12.	D
13.	A						

PART – B

1.	0.73	2.	8.89	3.	56.56	4.	3.00
5.	1.00	6.	4.00	7.	2.00	8.	2.00

SECTION-2 : CHEMISTRY

PART – A

1.	BCD	2.	ACD	3.	ACD	4.	ABCD
5.	ABC	6.	ABCD	7.	ABCD	8.	A
9.	C	10.	C	11.	A	12.	C
13.	C						

PART – B

1.	4	2.	9.6	3.	0.3	4.	4.4
5.	0.25	6.	12.45	7.	1.5	8.	4.4

SECTION-3 : MATHEMATICS

PART – A

1.	ABCD	2.	BD	3.	ABC	4.	BD
5.	ABC	6.	AC	7.	ABC	8.	C
9.	A	10.	A	11.	B	12.	C
13	A						

PART – B

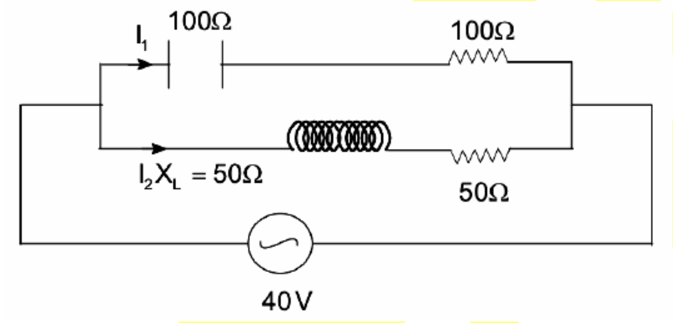
1.	6	2.	50	3.	8	4.	4
5	40	6.	1	7.	960	8.	2

Answers & Solutions

SECTION-1 : PHYSICS

PART – A

1. **ABC**


I_1
100Ω
100Ω
$I_2X_L = 50\Omega$
50Ω
40 V

Sol. $I_1 = \frac{20}{z_1} \times 2$

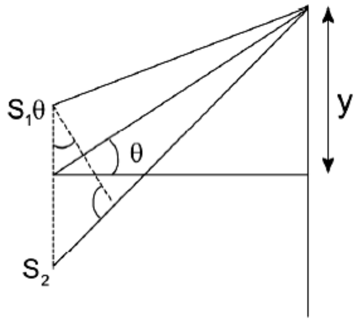
$= \frac{2}{5\sqrt{2}}$ A at 45° leading

$I_2 = \frac{20}{z_2} = \frac{\sqrt{2}}{5}$ A at 45° lagging

$I_{1_{RMS}} = \frac{1}{5}$A

$I_{2_{RMS}} = \frac{2}{5}$A

2. **AD**


$S_1\theta$
θ
S_2
y

Sol. For central fringe

$d \sin\theta = 2$ mm

4 mm $\sin\theta = 2$ mm

$\theta = 30°$

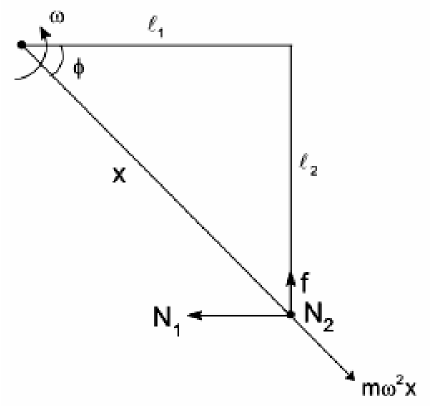
$\tan 30° = \frac{y}{2}$

$y = \frac{1}{\sqrt{3}}$m

For bright fringe $(d \sin\theta \pm 2) = n\lambda$

Whre n is 0, 1, 2, 3 ....

3. **BCD**


ω
ℓ_1
φ
ℓ_2
x
f
N_1
N_2
$m\omega^2x$

Sol. $N_1^2 + N_2^2 = N^2$

$N_2 = mg$

$m\omega^2 \times \sin\phi = f$

$f = m\omega^2\ell_2$

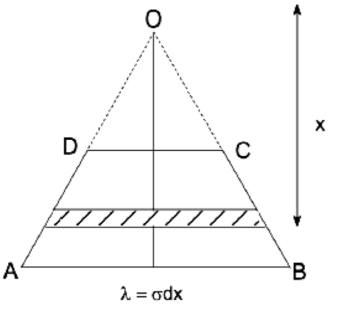
$N_1 = m\omega^2\ell_1$

4. **BC**

Sol. $dE = 2\left(\frac{1}{4\pi\varepsilon_0}\right)\frac{\sigma dx}{x}\left(\frac{1}{2}\right)$

$dE = \frac{\sigma}{4\pi\varepsilon_0}\frac{dx}{x}$

$E = \frac{7\sigma}{44\varepsilon_0}\ln\sqrt{2}$



5. **AD**

Sol. Elastic potential energy $\propto \left(\frac{\partial y}{\partial x}\right)^2$, kinetic enegy $\propto \left(\frac{\partial y}{\partial t}\right)^2$. So for antinoe elastic potential energy is constant & minimum. $\frac{\partial y}{\partial x}$ always changes for all other points.

6. **AD**

Sol. Let's assume, time taken by the queen to get into the hole is t

$t = \frac{\ell}{2V\sin\theta}$ & also $t = \frac{\ell}{2V\cos\theta} + \frac{\ell}{eV\cos\theta}$

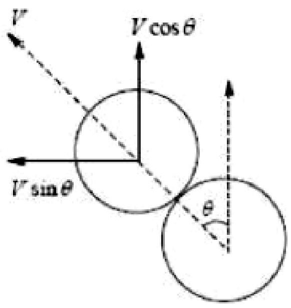
Therefore

$\frac{\ell}{2V\sin\theta} = \frac{\ell}{2V\cos\theta} + \frac{\ell}{eV\cos\theta}$

$\therefore \quad \tan\theta = \frac{1}{3}$

$\therefore \quad \frac{d}{\sqrt{(r_1+r_2)^2 - d^2}} = \frac{1}{3}$

$d^2 = 9 \Rightarrow d = 3$ cm.



7. **AC**

Sol. When parallel light falls from left side

$\frac{\mu_3}{f} = \frac{(\mu_3 - \mu_2)}{R} + \frac{(\mu_2 - \mu_1)}{R}$

$\frac{4/3}{f_1} = \frac{(4/3 - 2)}{R} + \frac{(2-1)}{R} \Rightarrow f_1 = 80\text{ cm}$

When parallel light falls from right side

$\frac{1}{f_2} = \frac{(1-2)}{-R} + \frac{(2-4/3)}{-R} \Rightarrow f_2 = 60\text{ cm}$

8. **A**

Sol. $\overrightarrow{a_B} = \overrightarrow{a_A} + \left(\vec{\alpha} \times \overrightarrow{r_{B,A}}\right) - \omega^2\overrightarrow{r_{B,A}}$

$= -5j + 4\alpha i + 3\alpha j - (12i - 16j)$

A_B along y-axis should be zero.

$\Rightarrow \quad 11 + 3\alpha = 0$

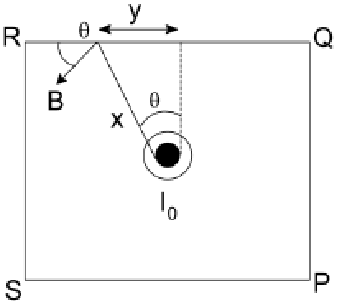
$\Rightarrow \quad \alpha = -\frac{4}{3}\text{rad}/s^2$

$a_B = (4\alpha - 12)i = \frac{80}{3}i\, m/s^2$

9. **D**

Sol. $y = \frac{\ell}{2}\tan\theta$

$dy = \frac{\ell}{2}\sec^2\theta d\theta$



$$8\int_0^{\frac{\pi}{4}} Bdy\cos\theta + \oint_{a\to b\to c\to d} \vec{B}\cdot\vec{d\ell} = \mu_0 I_0$$

$$\int_0^{\frac{\pi}{4}} \frac{8\mu_0 I_0}{4\pi x}\cdot\frac{2\frac{\ell}{2}}{x^2+\frac{\ell^2}{4}}\cdot\frac{\ell}{2}\sec^2\theta\cos\theta + \oint_{a\to b\to c\to d} \vec{B}\cdot\vec{d\ell} = \mu_0 I_0$$

$$\frac{2}{3}\mu_0 I_0 + \oint_{a\to b\to c\to d} \vec{B}\cdot\vec{d\ell} = \mu_0 I_0$$

$$\oint_{a\to b\to c\to d} \vec{B}\cdot\vec{d\ell} = \mu_0 I_0 - \frac{2}{3}\mu_0 I_0 = \frac{\mu_0 I_0}{3}$$

10. **B**

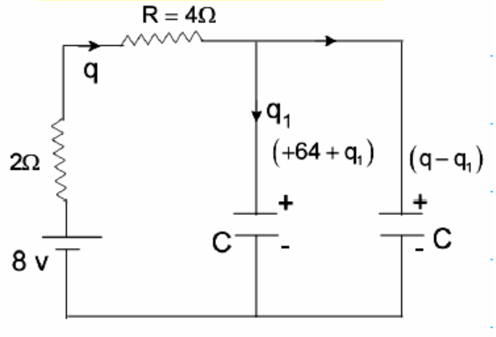
Sol. Let R + 2 = R_1

$$q(t) = \frac{3CE}{2}\left(1 - e^{\frac{t}{2R_1C}}\right)$$

$$I = \frac{dq}{dt} = \frac{3E}{4R_1}e^{-\frac{1}{2R_1C}}$$

Heat loss in $R_1 = \int I^2 R_1 dt = 576\ \mu J$

So, heat kloss in R = 4Ω is = $576 \times \frac{2}{3} = 384\ \mu J$.



11. **B**

Sol. Maximum power transfer will takes place when v_P is maximum.

12. **D**

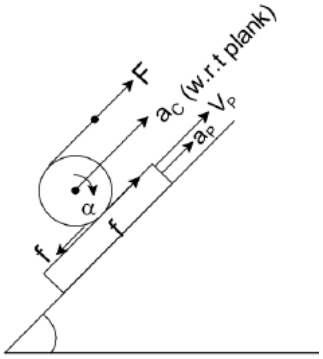
Sol. $a_C = R\alpha$ (for no slipping)

$V_c = R\omega$ (V_C is the speed of cylinder w.r.t plank)

$a_C + 3a_P = 0$

$V_C + 3V_P = 0$

$S_C + 3S_P = 0$



13. **A**

Sol. Let T_1 and T_2 be the initial and final temperature, then

$P_0V = nRT_1$ …(i)

$\left(P_0 + \frac{W}{A}\right)(V - Ah) = nRT_2$ …(ii)

Where h is the displacement of piston.

Also, work done on gas $-\Delta U$

$$Wh = nC_v\Delta T = \frac{3}{2}nR(T_2 - T_1) \qquad \ldots(iii)$$

From equation (i), (ii) and (iii)

$$\frac{2}{3}Wh = \frac{WV}{A} - Wh - P_0Ab$$

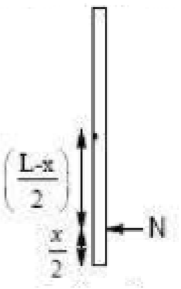
$$\text{or,} \quad Ah = \frac{WV}{P_0A + \frac{5}{3}W}$$

$$T_2 - \left(P_0 + \frac{W}{A}\right)\left(V - \frac{W_v}{P_0A + \frac{5}{3}W}\right)$$

PART – B

1. **0.73**

Sol. Impulse due to ‘N’ would act at the centre of the colliding parts.



Applying impulse momentum theorem

$$-\int N\,dt = M(\nu - \nu_0) \qquad ...(1)$$

& Applying angular impulse, angular momentum theorem

$$\int N\left(\frac{L-x}{2}\right)dt = \frac{ML^2}{12}\omega \qquad ...(2)$$

$$\text{Also } e = \frac{\omega\left(\frac{L-x}{2}\right) - \nu}{\nu_0} \qquad \ldots(3)$$

From (1), (2) & (3)

$$\nu\left[1 + 3\left(\frac{L-x}{2}\right)^2\right] - \nu_0\left[3\frac{(L-x)^2}{L^2} - e\right]$$

$\therefore$ for $\nu > 0$

$$x < L\left[1 - \sqrt{\frac{e}{3}}\right]$$

For inequality to hold true for all ‘e’

$$x < L\left[1 - \frac{1}{\sqrt{3}}\right]$$

or $x < (\sqrt{3} - 1)$, $\therefore\ x_{max} = 0.732$

2. **8.89**

Sol. Power absorbed by shell

$$\Rightarrow \quad \frac{P \times 2\pi(1 - \cos 37)}{4\pi}$$

$$\Rightarrow \quad \frac{P}{10}$$

For equilibrium

$$\Rightarrow \quad \frac{P}{10} = 3\pi R^2\sigma T^4$$

$$\therefore \quad T^4 = \frac{P}{30\pi R^2\sigma} = \frac{2400\,\sigma\pi}{30\pi \times 9 \times \sigma} \Rightarrow 8.89.$$

3. **56.56**

Sol. Applying conservation of angular momentum w.r.t. the centre of earth,

$4R \times mv_0 \sin 30 = mvR$, $v = 2v_0$

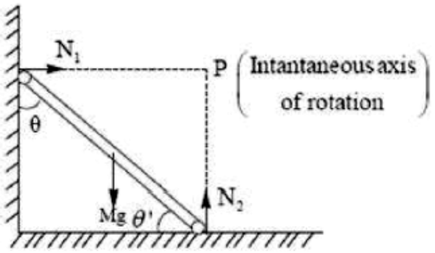
Applying energy conversation

$$\frac{1}{2}m(2v_0)^2 - \frac{GMm}{R} = -\frac{GMm}{4R} + \frac{1}{2}mv_0^2$$

$$\therefore \quad x = 40\sqrt{2} \Rightarrow 56.56$$

4. **3.00**

Sol. x coordinate of centre of mass of the rod



$$x = \frac{\ell}{2}\sin\theta$$

$$v_x = \frac{\ell}{2}\cos\theta\,\omega \text{ and } a_x = \frac{\ell}{2}(\cos\theta\alpha - \sin\theta\omega^2)$$

When $N_1 = 0 \Rightarrow \cos\theta\,\alpha = \sin\theta\,\omega^2$ ...(1)

Using COME:

$$mg\frac{\ell}{2}(\cos\beta - \cos\theta) = \frac{1}{2}m\frac{\ell^2}{4}\omega^2 + \frac{1}{2}m\frac{\ell^2}{12}\omega^2$$

$$\left[v = \frac{\ell}{2}\omega \text{ from IAOR}\right]$$

$$\omega^2 = \frac{3g}{\ell}(\cos\beta - \cos\theta) \quad \ldots(2)$$

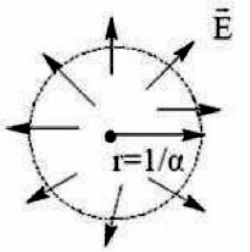
$$\alpha = \frac{3g}{2\ell}\sin\theta \quad \ldots(3)$$

Substituting the value of ω^2 and α in equation (1) gives

$$\Rightarrow \cos\theta = \frac{2}{3}\cos\beta \Rightarrow \cos\theta = \frac{1}{\sqrt{3}} \Rightarrow \sin\theta = \frac{1}{\sqrt{3}} \text{ So } N = 3.$$

5. **1.00**

Sol. As the electric field is radial, by applying gauss law, we can write



$$\int \vec{E}\cdot\vec{ds} = \frac{Q}{\varepsilon_0}$$

For $r = \frac{1}{\alpha}$, $\vec{E} = C(1 - e^{-a\times 1/\alpha})\frac{\hat{r}}{(1/\alpha)^2}$

$$\therefore \oint \vec{E}\cdot\vec{ds} = C(1 - e^{-1})\alpha^2 \times 4\pi(1/\alpha)^2$$

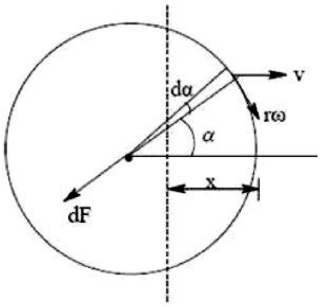
$$\Rightarrow \frac{Q}{\varepsilon_0} = 4\pi C(1 - e^{-1}) \Rightarrow Q = (1 - e^{-1}) \Rightarrow \therefore N = 1$$

6. **4.00**

Sol. $$\int_0^{x_{min}} 0.5x\frac{mg}{\ell}dx = 2$$

$\Rightarrow \quad x_{min} = 40$ cm.

7. **2.00**



x=r-rcosθ

dx=rsinθdθ

Sol. $mr^2\beta = \int_0^\theta \frac{2q}{2\pi} d\alpha\, \nu Br\cos\alpha$

$\beta = \frac{dw}{dt} = \frac{q\nu B\sin\theta}{\pi\ mr}$ ...(1)

$-ma = \int_0^\theta 2\frac{q}{2\pi} d\,\alpha r\omega B\cos\alpha$

$a = \frac{dv}{dt} = \frac{qr\omega B\sin\theta}{\pi m}$ ...(2)

$= \frac{d\omega}{d\nu} = \frac{\nu}{r^2\omega} \Rightarrow r^2\int_0^\omega wd\omega = -\int_{\nu_0}^{\nu}\nu d\nu$

$\Rightarrow \quad \nu = \frac{\nu_0}{\sqrt{2}}$

$\frac{\nu d\nu}{dx} = \frac{qr\omega B\sin\theta}{\pi m}$; $\int_{v_0}^{v_0/\sqrt{2}} \frac{\nu d\nu}{\sqrt{\nu_0^2-\nu^2}} = \frac{qrB}{m\pi}\int_0^\pi \sin^2\theta d\theta$

$\Rightarrow \quad q = \frac{\sqrt{2}\, mv_0}{Br}$

8. **2.00**

Sol. For slight displacement $(\pi r^2 x)\rho g = ma$

$\Rightarrow \quad T = 2\pi\sqrt{\frac{m}{\pi r^2\rho g}}$

$\Rightarrow$ T = 2 sec.

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SECTION-2 : CHEMISTRY

PART – A

1. BCD

Sol. $\psi_{4,1,-1}$ is an orbital of 4p-subshell. It may be $4p_x$ or $4p_y$ or $4p_z$.

2. ACD

Sol. $[MnCl_4]^{2-}$ is a tetrahedral complex.

3. ACD

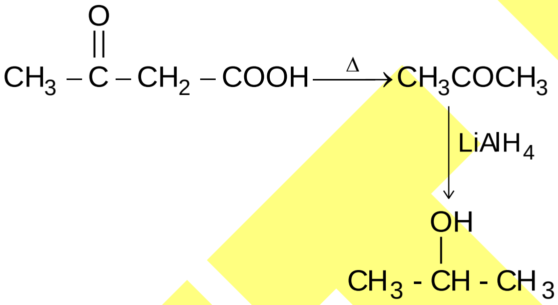
Sol. $K_{sp} = 4s^3 = 5 \times 10^{-10}$
$\therefore s = 5 \times 10^{-4}$
$\therefore$ Conc. of saturated solution = 5×10^{-4} M
pOH of saturated solution = $-\log[OH^-]$
$= -\log[2 \times 5 \times 10^{-4}] = -\log 10^{-3} = 3$
$\therefore$ pH = 14 – 3 = 11
$\therefore$ Solubility decreases in a solution of pH > 11 and increases in a solution of pH < 11.

4. ABCD

Sol. With excess of NBS, addition as well as allylic substitution reactions take place.

5. ABC

Sol.



$$CH_3-\overset{\overset{\displaystyle O}{||}}{C}-CH_2-COOH \xrightarrow{\Delta} CH_3COCH_3 \xrightarrow{LiAlH_4} CH_3-\overset{\overset{\displaystyle OH}{|}}{CH}-CH_3$$

$CH_3COOC_2H_5$ forms primary alcohols.

6. ABCD

Sol. It is an isobaric process(pressure remains constant)
$W_{irr} = -P(V_2 - V_1)$
$q = nC_P\Delta T$
$\Delta S = nC_P \ln\frac{T_2}{T_1}$
$\Delta U = nC_v\Delta T$

7. ABCD

8. A

Sol. $BeCl_2$ and BCl_3 remove electron deficiency by forming polymers and dimers respectively.

9. C

Sol. P will show geometrical isomerism(cis and trans) and Q will show optical isomerism (R and S).

10. C

Sol. For group-1 iodides and fluorides, mismatch of ionic radius favours solubility.

11. A
C

Sol. Metals in lower oxidation state forms stable complexes with CO.

12.

Sol. $T_C = \frac{8a}{27Rb}$

$\therefore$ Liquification α $\frac{a}{b}$ ratio.

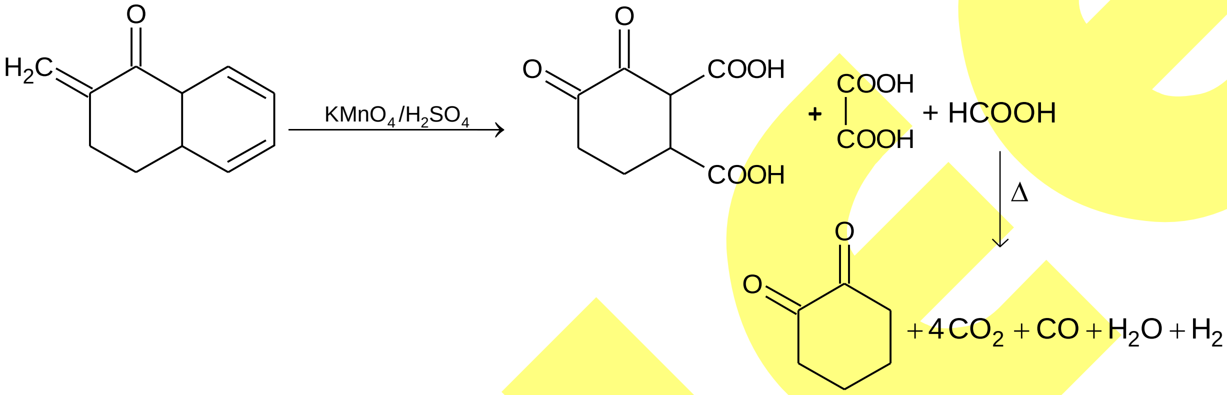
13. C

Sol. Aldol condensation will take place.

PART – B

1. 4

Sol.



2. 9.6

Sol. $NH_4NO_3 + NaOH \rightleftharpoons NH_4OH + NaNO_3$

	NH_4NO_3	NaOH	NH_4OH	$NaNO_3$
Before reac^n M_{eq}	200×0.5 = 100	200×0.4 = 80	0	0
After reac^n M_{eq}	100 – 80 = 20	80 – 80 = 0	80	80

$$\therefore pOH = p^{K_b} + \log\frac{[NH_4NO_3]}{[NH_4OH]}$$

$$= 5 + \log\frac{20}{80} = 5 - 0.6 = 4.4$$

pH = 14 – 4.4 = 9.6

3. 0.3

Sol. R = CH_4, x = 2, y = 1

4. 4.4

Sol. $Fe^{3+}\left(t_{2g}^5 e_g^0\right)$: CFSE = 5 × -0.4$\Delta_o$ = -2Δ_o

$Fe^{2+}\left(t_{2g}^6 e_g^0\right)$: CFSE = 6 × -0.4$\Delta_o$ = -2.4Δ_o

$\therefore$ x + y = 2 + 2.4 = 4.4

5. 0.25

Sol. $[A_t] = [A_o](½)^n$

or, $\frac{[A_t]}{[A_o]} = \left(\frac{1}{2}\right)^2 = \frac{1}{4} = 0.25$

6. 12.45

Sol. Slope = C_P = 20.75 JK^{-1} mol^{-1}.

$C_P - C_V = R$

$\therefore$ $C_V = C_P - R$ = 20.75 – 8.3 = 12.45

7. 1.5

Sol. The oxidation number of cobalt in the complex is +3.

8. 4.4

Sol. Cannizzaro Reaction takes place

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SECTION-3 : MATHEMATICS

PART – A

1. ABCD

Sol. Consider a function f(x)= $x^6 + 6x + 20$ and then use monotonicity to plot the graph and nature of the function

2. BD

Sol. $\therefore k \in \text{odd}\,(\text{even})$

f(k) = k + 3

$$f(f(k)) = \frac{k+3}{2}$$

$$\text{if } \frac{k+3}{2} \in \text{odd} \Rightarrow 27 = \frac{k+3}{2} + 3 \Rightarrow k = 45 \text{ not possible}$$

$$\text{Now let } \frac{k+3}{2} \in \text{even}$$

$$\therefore 27 = f(f(f(k))) = f\left(\frac{k+3}{2}\right) = \frac{k+3}{4}$$

$$\therefore k = 105$$

verifying $f(f(f(105))) = f(f(108)) = f(54) = 27$

3. ABC

Sol: eliminate a and b by using the formulae for eccentricity

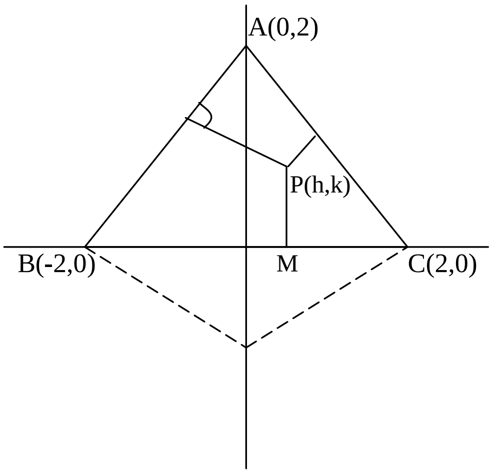
4. BD

Sol f(x) is vertical upward parabola & is sym.about its axis x=1 , so points situated at greater distance from axis have greater outputs

5. ABC

Sol Make integrand perfect square

6. AC



Sol. PM=k

Equation of $AB \equiv -x + y = 2$

Equation of $AC \equiv x + y = 2$

According to question

$$\left(\frac{2-h-k}{\sqrt{2}}\right)\left(\frac{2+h+k}{\sqrt{2}}\right) = 2k^2$$

$$\Rightarrow h^2 + 3k^2 + 4k = 4$$

$$\Rightarrow h^2 + 3\left(k^2 + \frac{4}{3}k + \frac{4}{9}\right) = 4 + \frac{4}{3}$$

$$\Rightarrow h^2 + 3\left(k + \frac{2}{3}\right)^2 = \frac{16}{3}$$

$$\Rightarrow \frac{h^2}{16/3} + \frac{\left(k + \frac{2}{3}\right)^2}{16/9} = 1$$

$\Rightarrow$ellipse with e= $\sqrt{\frac{2}{3}}$ and $D \equiv \left(0, -\frac{2}{3}\right)$

7. ABC

Sol. Period of f(x) must be rational

8. C

Sol. Coefficient of x^{2012} in $(1+x)^2\left((1+x^2)\ldots\ldots\ldots\ldots.(1+x^{2^{10}})\right)^3$

$$\Rightarrow \text{Coefficient of } x^{2012} \text{ in } \frac{\left(1-x^{2^{11}}\right)^3}{(1+x)(1-x)^3}$$

Coefficient of x^{2012} in $(1+x^2+x^4+\ldots\ldots)(1+2x+3x^2+\ldots..)$

$\Rightarrow 1.(2013)+1.(2011)+1.(2009)+\ldots\ldots\ldots.+1$

$\Rightarrow 2k+1=2013 \Rightarrow k=1006$

We know that $1+3+5+\ldots\ldots.+(2k+1)=(k+1)^2$

9. A

Sol. Minimise the distance btw a circle and rectangular hyp which is along the common normal

10. A

Sol. The mid – point of z_2 & z_3 divides the line joining the points z_1 & $i\sqrt{3}$ in the ratio 1:3 internally.

11. B

Sol. Since $f'(x) \ge f^3(x)+\dfrac{1}{f(x)}$

$$f(x)f'(x) \ge f^4(x)+1 \Rightarrow \frac{f(x)f'(x)}{1+f^4(x)} \ge 1$$

On integrating w.r.t.x from x=a to b

$$\frac{1}{2}\left(\tan^{-1} f^2(x)\right)_a^b \ge b-a$$

Or $b-a \le \dfrac{1}{2}\left[\lim\limits_{x\to b^-} \tan^{-1}\left(f^2(x)\right) - \lim\limits_{x\to a^+} \tan^{-1}\left(f^2(x)\right)\right]$ or $b-a \le \dfrac{\pi}{24}$

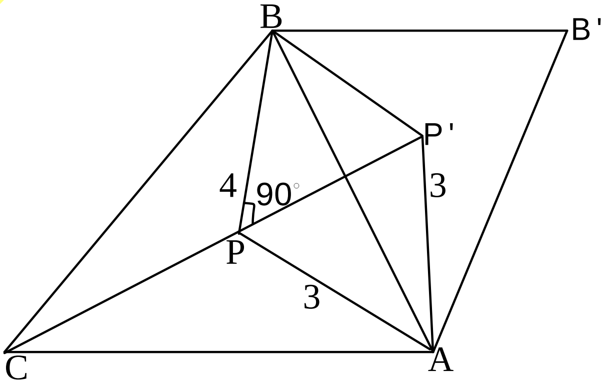
12. C

Sol. Rotate the triangle in clockwise direction through an angle 60°. Let the points A,B,C and P will be A,B', B and P' respectively after the rotation.

We have PA=P'A=3

And $\angle PAP' = 60^\circ \Rightarrow PP' = 3$

Also CP=BP'=5



So $\Delta BPP'$ is right angle triangle which $\angle BPP' = 90^\circ$.

Now apply cosine rule in triangle BPA because

$\angle BPA = 90^\circ + 60^\circ = 150^\circ$, PA=3 and BP=4, we can get AB

13 A

Sol. Use $\int_0^2 f(x)dx = \int_0^1 f(x)dx + \int_1^2 f(x)dx = \int_0^1 f(x)dx + \int_0^1 f(x+1)dx$

PART – B

1. 6

Sol. $f(2x) = f(x) = f(x/2) = f\left(x/2^2\right) = f\left(\frac{x}{2^n}\right)$

f is continuous, when $n \to \infty,\ f(2x) = f(0)$

$\Rightarrow \quad f(x)$ is constant

2. 50

Sol. $1125 = 5^3.3^2, 3375 = 5^3.3^3$

Clearly 3^3 is a factor of x and 3^2 is a factor of atleast one of y and z. This can be done in 5 ways. Also 5^3 is a factor of atleast two of the numbers x,y,z which can be done in $\left({}^3C_2 \times 4 - 2\right) = 10$

3. 8

Sol. We have $|A - \lambda I| = 0$

$$\Rightarrow \begin{vmatrix} 1-\lambda & 0 & 2 \\ 2 & -\lambda & 1 \\ 1 & 1 & 2 \end{vmatrix} = 0$$

$\Rightarrow \lambda^3 - 3\lambda^2 - \lambda - 3 = 0$

So, $A^3 - 3A^2 - A = 3I_3$

Now $\left|(A - I)^3 - 4A\right|$

$= \left|A^3 - 3A^2 + 3A - I - 4A\right|$

$= \left|A^3 - 3A^2 - A - I\right| = |2I_3| = 8$

4. 4

Sol $$P\left(\frac{A}{B}\right) = \frac{P(A \cap B)}{P(B)} = \frac{{}^3C_1.\frac{1}{4}\left(\frac{3}{4}\right)^2.\frac{3}{4}}{1 - \left[\left(\frac{3}{4}\right)^4.\frac{1}{4} + \left(\frac{3}{4}\right)^4\right]}$$

$= \frac{81}{148}$

$(m+n)_{\text{least}} = 81 + 148 = 229$

5 40

Sol. Given conic is an ellipse and x – axis being the tangent to it.

6. 1

Sol. $[\sin x] + [\cos x] + 2 = 0$ is possible only when

$[\sin x] = -1$ and $[\cos x] = -1$

Or $-1 \le \sin x < 0$ and $-1 \le \cos x < 0 \Rightarrow x \in \left(\pi, \frac{3\pi}{2}\right)$,

Now f(x)=sinx-cpsx+3= $\sqrt{2}\sin\left(x - \frac{\pi}{4}\right) + 3$

For $x \in \left(\pi, \frac{3\pi}{2}\right), \sin\left(x - \frac{\pi}{4}\right) \in \left(-\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)$

$$\Rightarrow y = f(x) = \sqrt{2}\sin\left(x - \frac{\pi}{4}\right) + 3, \text{then } f(x) \in (2,4)$$

7. 960

Sol. $f(n)\sum_{r=1}^{n}\left[r^2\left({}^nC_r - {}^nC_{r-1}\right) + (2r)^n C_r + {}^n C_r\right] = \sum_{r=1}^{n}\left[\left(r^2 + 2r + 1\right)^n C_r - r^2\ {}^nC_{r-1}\right]$

$= \sum_{r=1}^{n}\left[(r+1)^2\ {}^nC_r - r^2\ {}^nC_{r-1}\right] = \sum_{r=1}^{n}\left[V_{r+1} - V_r\right]$

$= V_2 - V_1 + V_3 - V_2 + ... + V_{n+1} - V_n$

$V_{n+1} - V_1 = (n+1)^2\ {}^nC_{n+1} - 1 = n^2 + 2n$

8. 2

Sol. $f(x(y)) = x^p y^4$, put $x = \frac{1}{f(y)}$

$f(1) = \left(\frac{1}{f(y)}\right)^p y^4 = \frac{y^4}{(f(y))^p}$ for $y = 1, f(1) = \frac{1}{(f(1))^p} \Rightarrow f(1) = 1$

So $f(y) = y^{4/p}$ ….(1)

Hence $f\left(xy^{4/p}\right) = x^p y^4$

Put $y = z^{p/4}$

$f(xz) = x^p z^p \Rightarrow f(x) = x^p$ …(2)

From (1) and (2) $\frac{4}{p} = p \Rightarrow p = 2$

FIITJEE RBT-8 for (JEE-Advanced)

BATCHES – Two Yr CRP2123(All)

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 2

QP Code: 100205

PAPER - 2

Time Allotted: 3 Hours **Maximum Marks: 195**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections.**
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. All the section can be filled in **PART-A** of OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with ***Blue/Black Ball Point Pen*** for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For Only One Part.

(i) **Part-A (01-07) –** Contains seven (07) multiple choice questions which have **One or More** correct answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
Negative Marks: –**2 In all other cases**.
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in –**2** marks, as a wrong option is also darkened.

(ii) **Part-A (08-14) –** Contains seven (07) multiple choice questions which have ONLY ONE CORRECT answer Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(iii) **Part-A (15-18) -** This section contains Two paragraphs. Based on each paragraph, there are Two multiple choice questions. Each question has only one correct answer and carries **+4 marks** for the correct answer and **– 2 marks** for wrong answer.

Name of the Candidate :____

Batch :____________________ **Date of Examination :**____________________

Enrolment Number :____

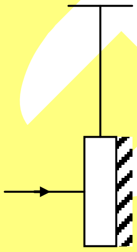
SECTION-1 : PHYSICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. A small mirror is suspended by a thread as shown in figure. A short pulse of monochromatic light rays is incident normally on the mirror and gets reflected. Which of the following statements are correct?



(A) mirror will starts oscillating

(B) wavelength of reflected rays will be greater than that of incident rays

(C) wavelength of reflected rays may be less than that of incident rays

(D) mirror will be at rest after some time

2. A particle of mass m is moving in a field where the potential energy is given by $U(x) = U_0(1 - \cos ax)$, where U_0 and a are constants and x is the displacement from mean position . Then (for small oscillations)

(A) the time period is $T = 2\pi\sqrt{\frac{m}{aU_0}}$

(B) the speed of particle is maximum at $x = 0$

(C) the amplitude of oscillations is $\frac{\pi}{a}$

(D) the time period is $T = 2\pi\sqrt{\frac{m}{a^2U_0}}$

3. Two different coils have self inductances $L_1 = 8$ mH and $L_2 = 2$ mH. The current in one coil is increased at a constant rate. The current in the second coil is also increased at the same constant rate. At a certain instant of time, the power given to the two coils is the same. At this time the current, the induced voltage and the energy stored in the first coil are i_1, V_1 and U_1 respectively. Corresponding values for the second coil at the same instant are i_2, V_2 and U_2 respectively. Then

(A) $\frac{i_1}{i_2} = \frac{1}{4}$ (B) $\frac{i_1}{i_2} = 4$ (C) $\frac{U_2}{U_1} = 4$ (D) $\frac{V_2}{V_1} = \frac{1}{4}$

Space For Rough Work

FIITJEE watermark

4. The magnetic field perpendicular to the plane of conducting ring of radius *r* changes at the rate $\frac{dB}{dt} = \alpha$. Then

(A) Emf induced in the ring is $\pi r^2 \alpha$

(B) Emf induced in the ring is $2\pi r \alpha$

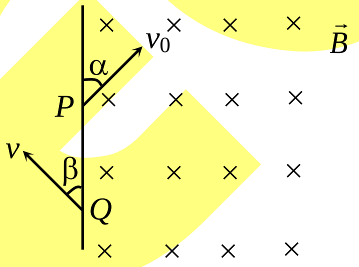
(C) the potential difference between diametrically opposite points on the ring is half of induced emf

(D) all points on the ring are at same potential

5. When photons of energy 4.25 eV strike the surface of a metal A, the ejected photoelectrons have maximum kinetic energy T_A eV and de-Broglie wavelength λ_A. The maximum kinetic energy of photoelectrons liberated from another metal B by photons of energy 4.70 eV is $T_B = (T_A - 1.50)$ eV. If the de-Broglie wavelength of these photoelectrons is $\lambda_B = 2\lambda_A$ then

(A) the work function of A is 2.25 eV
(B) the work function of B is 4.20 eV
(C) $T_A = 2.00$ eV
(D) $T_B = 2.75$ eV

6. A particle of charge –*q* and mass *m* enters a uniform magnetic field $\vec{B}$ (perpendicular to paper inwards) at *P* with a velocity v_0 at an angle α and leaves the field at *Q* with velocity *v* at angle β as shown in the figure. Then



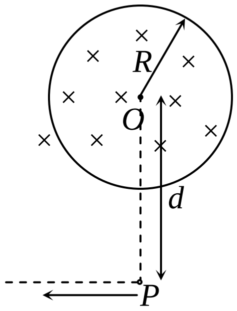
(A) $\alpha = \beta$

(B) $v = v_0$

(C) $PQ = \frac{2mv_0 \sin\alpha}{Bq}$

(D) particle remains in the field for time $t = \frac{2m(\pi - \alpha)}{Bq}$

7. In a cylindrical region of radius *R*, there exists a time varying magnetic field *B* such that $\frac{dB}{dt} = k(>0)$. A charged particle having charge q is placed at the point *P* at a distance *d* (> R) from its centre O. Now, the particle is moved in the direction perpendicular to OP (see figure) by an external agent upto infinity so that there is no gain in kinetic energy of the charged particle. Choose the correct statement/s.



(A) Work done by external agent is $\frac{q\pi R^2}{4}k$ if d = 2R

(B) Work done by external agent is $\frac{q\pi R^2}{8}k$ if d = 4R

(C) Work done by external agent is $\frac{q\pi R^2}{4}k$ if d = 4R

(D) Work done by external agent is $\frac{q\pi R^2}{4}k$ if d = 6R

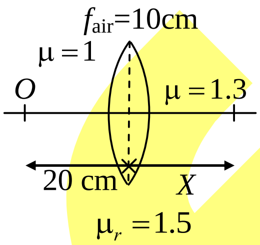
(Single Correct Choice Type)

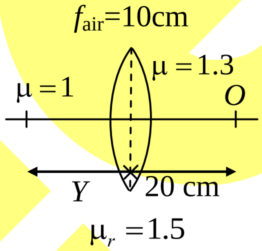
This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

8. A diatomic molecule having atoms of masses m_1 and m_2 has its potential energy function about the equilibrium position r_0 as given by $U(r) = -A + B(r - r_0)^2$ where A and B are constants. When the atom vibrate at high temperature condition, the square of angular frequency of vibration will be

(A) $\frac{2B}{m_1}$ (B) $\frac{2B}{m_2}$ (C) $\frac{2B(m_1 + m_2)}{m_1 m_2}$ (D) $\frac{B(m_1 + m_2)}{2m_1 m_2}$

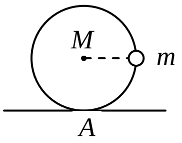
9. An equiconvex lens made up of a material of refractive index 1.5 has focal length of 10 cm when placed in air as shown in the figure. One side of the medium is replaced by another medium of refractive index 1.3. If X and Y are the image distances when the object is placed at a distance of 20cm from optical centre in the medium with refractive index 1 and 1.3 respectively, then





(A) $X > 1.3Y$ (B) $X < 1.3Y$
(C) $X = 1.3Y$ (D) cannot be determined

10. A uniform body of mass M of radius R has a small mass m attached at edge as shown in the figure. The system is placed on a perfectly rough horizontal surface such that mass m is at the same horizontal level as the centre of body. It is assumed that there is no slipping at point A. If I_A is the moment of the inertia of combined system about point of contact A then the normal reaction at point A just after the system is released from rest is (M = 6 kg, m = 2 kg, I_A = 4 kg m^2, R = 1 m, g = 10 m/s^2)



(A) 60 N (B) 80 N (C) 75 N (D) 70 N

11. A circuit consists of a capacitor and a resistor having resistance R = 220 Ω connected in series. When an alternating e.m.f. of peak voltage $V_0 = 220\sqrt{2}$ V is applied to the circuit, the peak current in steady state is observed to be I_0 = 1A. The phase difference between the current and the voltage is

(A) 30° (B) 45° (C) 60° (D) 90°

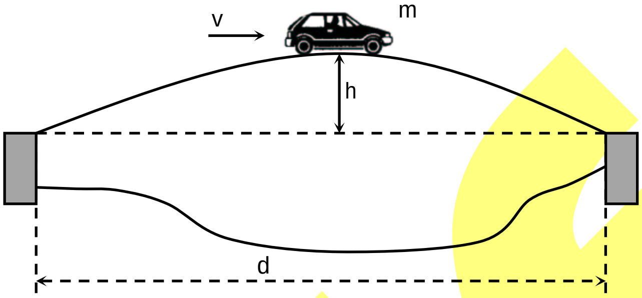
Space For Rough Work

12. A stone of mass m tied to one end of thread of length ℓ. The diameter of thread is ‘d’ and it is suspended vertically. The stone is now rotated in horizontal plane and makes an angle ‘θ’ with vertical. The increase in length of wire is (young’s modulus of wire is y)

(A) $\frac{4mg\ell}{\pi d^2 y\cos\theta}$ (B) $\frac{4mg\ell}{\pi d^2 y\sin\theta}$

(C) $\frac{4mg\ell}{\pi d^2 y}$ (D) $\frac{4mg\ell}{\pi d^2 y\sec\theta}$

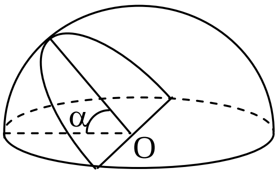
13. There is a parabolic-shaped bridge across a river of width 100 m. The highest point of the bridge is 5 m above the level of the banks. A car of mass 1000 kg is crossing the bridge at a constant speed of 20 ms^{-1}.



Using the notation indicated in the figure, find the force exerted on the bridge by the car when it is at the highest point of the bridge (Ignore air resistance and take g as 10 ms^{-2}.)

(A) 6.4 KN (B) 7.2 KN
(C) 8.4 KN (D) 9.2 KN

14. The strength of the electric field produced by charges uniformly distributed over the surface of a hemisphere at its centre O is E$_0$. A part of the surface is isolated from this hemisphere by two planes passing through the same diameter and forming an angle α with each other. Determine the electric field strength E produced at the same point O by the charges located on the isolated surface (on the “mericarp”).



(A) $\frac{E_0}{2}\sin\frac{\alpha}{2}$ (B) $\frac{2E_0}{3}\sin\frac{\alpha}{2}$ (C) $E_0\sin\frac{\alpha}{2}$ (D) $2E_0\sin\frac{\alpha}{2}$

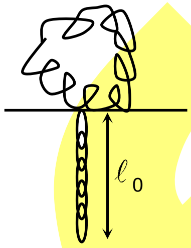
Space For Rough Work

(Paragraph Type)

This section contains **2 paragraphs**. Based upon the paragraphs **2 multiple choice questions** have to be answered. Each of these questions has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph for Question no. 15 to 16

A rope of mass m, length 'ℓ' in lying on a table with ℓ_0 length lying outside a hole on the table on which it is kept. It is kept at t = 0. Answer the following questions:



15. Speed of the free end of the chain when it is at a distance of 'y' from the table is?

(A) $v(y) = \sqrt{\frac{2g}{3}\left(y - \frac{\ell_0^3}{y^2}\right)}$

(B) $v(y) = \sqrt{\frac{g}{3}\left(y - \frac{2\ell_0^3}{y^2}\right)}$

(C) $v(y) = \sqrt{2g\left(y - \frac{\ell_0^3}{y^2}\right)}$

(D) $v(y) = \sqrt{g\left(y - \frac{2\ell_0^3}{y^2}\right)}$

16. If $\ell_0 = 0$, the time in which the entire rope will slip off the table is?

(A) $\sqrt{4\ell / g}$

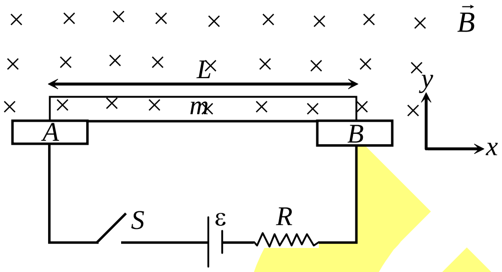
(B) $\sqrt{12\ell / g}$

(C) $\sqrt{\frac{6\ell}{g}}$

(D) $\sqrt{\frac{2\ell}{g}}$

Space For Rough Work

Paragraph for Question no. 17 to 18



In a vertical plane, a metal rod of length *L* and mass *m* is placed over two conducting platforms *A* and *B*. A region of magnetic field $\vec{B} = -B_0\hat{k}$ starting from line joining *A* and *B* and lying over it, is switched on. Now, at *t* = 0 switch *S* is closed such that the charge *q* is passes through the rod in time *dt* due to which magnetic field exert an impulsive force which causes the rod to jump with certain velocity and since the gravitational field is present the rod comes back to *AB* after some time and collides inelastically and the process is repeated.

17. The maximum height reached by the rod is

(A) $\frac{2q^2L^2B_0^2}{m^2g}$ (B) $\frac{q^2L^2B_0^2}{2m^2g}$

(C) $\frac{q^2L^2B_0^2}{m^2g}$ (D) $\frac{q^2L^2B_0^2}{4m^2g}$

18. The maximum emf induced in the rod is

(A) $\frac{B_0^2L^2q}{m}$ (B) $\frac{B_0^2L^2q}{2m}$

(C) $\frac{2B_0^2L^2q}{m}$ (D) $\frac{4B_0^2L^2q}{m}$

Space For Rough Work

FIITJEE

SECTION-2 : CHEMISTRY

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

1. Which one of the following reactions of Xenon compounds is/are feasible ?

(A) $XeO_3 + 6HF \longrightarrow XeF_6 + 3H_2O$

(B) $3XeF_4 + 6H_2O \longrightarrow 2Xe + XeO_3 + 12HF + 1.5O_2$

(C) $2XeF_2 + 2H_2O \longrightarrow 2Xe + 4HF + O_2$

(D) $XeF_6 + RbF \longrightarrow Rb[XeF_7]$

2. Which of the following reactions form racemic mixture?

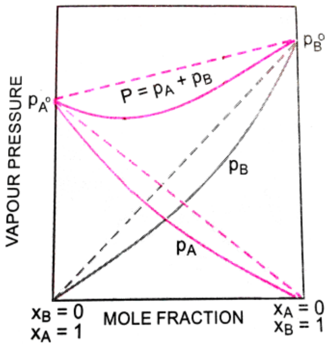
(A) $CH_3CH_2CH = CH_2 \xrightarrow{Br_2/CCl_4}$

(B) $CH_3CH_2CHO \xrightarrow[NaOH]{HCN}$

(C) $CH_3CH_2CH = CH_2 \xrightarrow[CCl_4]{HCl}$

(D) $CH_3CH_2CHO \xrightarrow{NH_2OH/H^+}$

3.



Which of the following statement(s) is/are correct for a solution of liquid A and B as given in the above figure?

(A) Enthalpy change of mixing of A with B(ΔH_{mix}) < 0

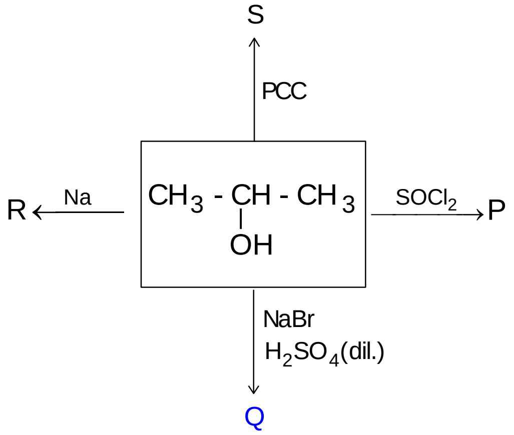
(B) Volume of mixing(ΔV_{mix}) < 0

(C) $p < p_A^0$

(D) Entropy of mixing $\Delta S_{mixing} < 0$

Space For Rough Work

4.



P, Q, R and S are the organic products of above reactions. Choose correct statements.

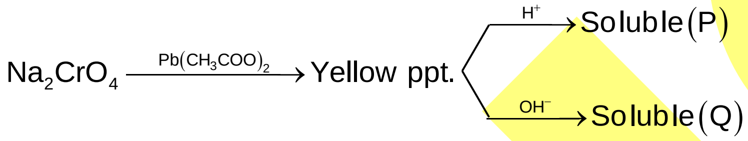
(A) ‘P’ is less reactive than ‘Q’ towards dehydrohalogenation reaction in presence of alcoholic KOH through E_1 path.

(B) Formation of ‘R’ is accompanied with emission of H_2 gas.

(C) Reaction of ‘S’ with CH_3MgBr/H_3O^+ forms a tertiary alcohol.

(D) ‘R’ is more soluble in water than ‘P’.

5.



The anions present in the soluble compounds of (P) and (Q) in the above reaction is/are

(A) $[Pb(OH)_4]^{2-}$

(B) $Cr_2O_7^{2-}$

(C) $[Pb(CrO_4)_2]^{2-}$

(D) PbO_4^{2-}

6. $FeTiO_3$ contains Fe^{2+}, Ti^{4+} and O^{2-} ions. It’s crystal contains hcp unit cells in which O^{2-} form the hcp array.

Choose the correct statements

(A) Fe^{2+} ions occupy $\frac{1}{3}^{rd}$ of octahedral voids

(B) Ti^{4+} ions occupy $\frac{1}{3}^{rd}$ of octahedral voids

(C) It’s colour is due to only Fe^{2+} ions

(D) It is a paramagnetic substance

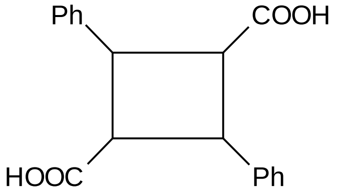
Space For Rough Work

7. The value of $\Delta H_{transition}$ of C (graphite) $\longrightarrow$ C (diamond) is 1.9 kJ/mol at 25°C entropy of graphite is higher than entropy of diamond. This Implies that :
(A) C (diamond) is more thermodynamically stable than C (graphite) at 25°C
(B) C (graphite) is more thermodynamically stable than C (diamond) at 25°C
(C) diamond will provide more heat on complete combustion at 25°C
(D) $\Delta G_{transition}$ of C (diamond) $\longrightarrow$ C (graphite) is –ve

(Single Correct Choice Type)

This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

8. How many geometrical isomers are possible for the following compound?



(A) 3 (B) 4
(C) 5 (D) 6

9. $SO_4^{2-} \xrightarrow{BaCl_2} \underset{\text{White ppt.}}{(P)\downarrow}$

$(P)\downarrow \xrightarrow[\text{(ii) } Na_2CO_3]{\text{(i) Carbon}} (Q)$

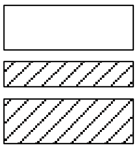
Compound (Q) containing sulphur is
(A) Na_2SO_4 (B) Na_2S
(C) Na_2SO_3 (D) CS_2

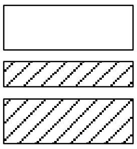
10. A solution of ‘P’ and ‘Q’ with 30 mole percent of ‘P’ is in equilibrium with its vapour which contains 60 mole percent of ‘P’. The solution and the vapour behave ideally. If the ratio of vapour pressure of pure ‘P’ to pure ‘Q’ is expressed as x : y, the value of x + y is
(A) 3.5 (B) 9
(C) 18 (D) 7

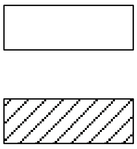
11. A mixture of NaOH and Na_2CO_3 requires 100 mL of 3 M HCl for complete reaction upto phenolphthalein indicator. How many gram of NaOH is present in the mixture which contains 10.6 g of Na_2CO_3?
(A) 8 g (B) 12 g
(C) 4 g (D) 12 mg

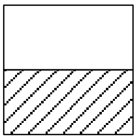
Space For Rough Work

12. The bond structure of n-type semiconductor is

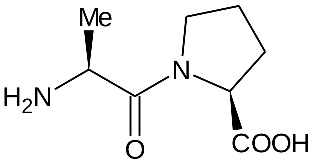
(A) 

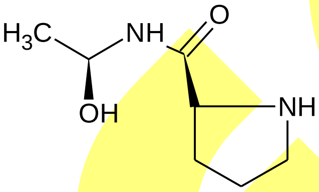
(B) 

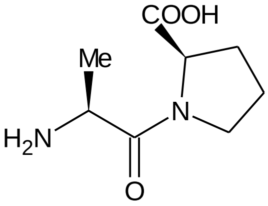
(C) 

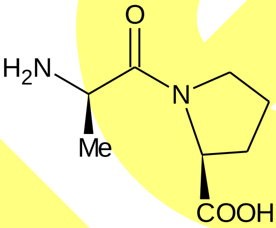
(D) 

13. The structure of dipeptide "Ala-Pro" derived from Natural amino acid is

(A) 

(B) 

(C) 

(D) 

14. In the isoelectronic series VO_4^{3-}, CrO_4^{2-} & MnO_4^-, all members have CT transition. The incorrect statement is

(A) CT transition attributed to excitation of electrons from ligand to metal

(B) MnO_4^- exhibits charge transfer at shortest wavelength among three

(C) CT transition lapporte & spin allowed transition

(D) Charge on metal nucleus increases in order : $VO_4^{3-} < CrO_4^{2-} < MnO_4^-$

Space For Rough Work

(Paragraph Type)

This section contains **2 paragraphs**. Based upon the paragraphs **2 multiple choice questions** have to be answered. Each of these questions has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph for Question no. 15 to 16

Lucas test is used to distinguish the different types of alcohols i.e., the primary, secondary and tertiary alcohols. Lucas reagent is anhydrous $ZnCl_2$ and conc.HCl. The alcohols are converted to alkyl chlorides in this test. The alcohols are distinguished through the rate of their reactions with HCl. Anhydrous $ZnCl_2$ is used as a catalyst. It removes the alcoholic OH to form a carbocation. The speed or rate of reaction of the different alcohols is

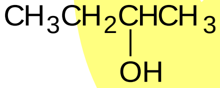
$3^o > 2^o > 1^o$

Formation of alkyl chlorides by the alcohols is observed due to formation of white turbidity.

Answer the following questions on the basis of above write up.

15. Which alcohol can form the white turbidity instantaneously?

(A) $CH_3CH_2CH_2CH_2OH$

(B) 
$CH_3CH_2\underset{\displaystyle OH}{\underset{|}{C}}HCH_3$

(C) $(CH_3)_3COH$

(D) CH_3CH_2OH

16. Which alcohol mostly require the catalyst anhy. $ZnCl_2$ to form the corresponding alkyl chloride?

(A) CH_3CH_2OH (B) $PhCH_2OH$ (C) $(CH_3)_2CHOH$ (D) $(CH_3)_3COH$

Paragraph for Question no. 17 to 18

Silicates are the oxo-anions of silicon, which contains Si – O sigma bonds. The anions are associated with metal cations. So, they are called ionic crystals. The silicate anions are very simple like ortho silicates SiO_4^{4-} and complex like cyclic or sheet silicates. The SiO_4^{4-} has no sharing oxygen atoms. The higher silicate contain shared oxygen atoms. For example $Si_2O_7^{6-}$ is called pyrosilicate in which one oxygen atom is shared. $(Si_3O_9)^{6-}$ is called cyclic silicate in which three oxygen atoms are shared.

Answer the following questions on the basis of above write up.

17. How many oxygen atom(s) is/are shared in the silicate anion $(Si_6O_{15})^{6-}$?

(A) 3 (B) 6 (C) 9 (D) 8

18. How many O^- ions per tetrahedra are present in pyrosilicate?

(A) 2 (B) 3 (C) 1 (D) 4

Space For Rough Work

SECTION-3 : MATHEMATICS

PART – A

(Multi Correct Choice Type)

This section contains 7 **multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE OR MORE** may be correct.

---

1 If $I_1 \equiv (1, -2)$ and $I_2 = (-3, 2)$ are the ex-centers of ΔABC and ex-centre I_3 lies on the circle $x^2 + y^2 + 3x + y - 6 = 0$, then

(A) locus of in-centre of ΔABC is given by $x^2 + y^2 + x - y - 5 = 0$

(B) locus of in-centre of ΔABC is given by $x^2 + y^2 + x - y + 5 = 0$

(C) locus of locus lies on the line y = -x

(D) origin lies inside the locus

2. Let N be the number of 7-digit numbers the sum of whose digits is even.
(A) The number of positive divisors of N is 126
(B) The number of positive divisors of N of the form 4k+1 , k ≥ 0 is 14
(C) The number of positive divisors of N of the form 4k+2 , k ≥ 1 is 9
(D) The number of positive divisors of N of the form 4k+2 , k ≥ 0 is 12

3. Consider $f(x) = a_5x^5 + a_4x^4 + a_3x^3 + 3x^2 + 2x + 1 = 0, a_5, a_4, a_3 \in R - \{0\}$ .Then
(A) f(x)=0 will have atlest one non-real root
(B) f(x)=0 will have atleast one real root
(C) for $a_5 = 2021$ and $a_3 = 2019$, f(x)=0 has atleast one positive root
(D) for $a_5 = 1, a_4 = 9$ and $a_3 = 16$, the above equation has atleast one negative root

4. If A and B are different matrices satisfying $A^3 = B^3$, $A^2B = B^2A$ then which of the following is/are incorrect.

(A) $|A^2 + B^2| = 0$ (B) $|A - B| = 0$

(C) $|A^2 + B^2|$ and $|A - B|$ must be zero (D) At least $|A^2 + B^2|$ or $|A - B|$ must be zero

---

Space For Rough Work

5. Let f : R → R, g : R → R and h : R → R be differentiable functions such that f(x) = $x^3 + 3x + 2$, g(f(x)) = x and h(g(g(x))) = x for all x ∈ R. Then

(A) $g'(2) = \frac{1}{3}$ (B) $h'(1) = 666$

(C) h(0) = 16 (D) h(g(3)) = 38

6. If lines x + y – 3 = 0 and y = x + 1 are two tangents to the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$; then angle between the pair of tangents drawn from point $P\left(4, -\sqrt{5}\right)$ to the curve $\frac{x^2}{3a^2 + b^2} + \frac{y^2}{a^2 + 3b^2} = 1$ can be

(A) $\frac{\pi}{3}$ (B) $\frac{\pi}{6}$

(C) $\frac{2\pi}{3}$ (D) $\frac{5\pi}{6}$

7. Given that f is a real valued differentiable function such that f(x).f'(x) ≤ 0, for all real x, there exists 'a' such that f'(x) ≠ 0 ∀ x ∈ [a, ∞) then it follows that:
(A) $f^2(x)$ is non-decreasing function
(B) $f^2(x)$ is non-increasing function
(C) f(x) has no point of local maxima or minima
(D) f(x) = 0 does not have any real root

(Single Correct Choice Type)

This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

---

8 If $(x_1, y_1), (x_2, y_2)$ and (x_3, y_3) are three points on the parabola $y^2 = 4ax$ the normals at which meet in a point, then $\frac{x_1 - x_2}{y_3} + \frac{x_2 - x_3}{y_1} + \frac{x_3 - x_1}{y_2}$ is equal to

(A) 4 (B) 8

(C) 0 (D) 1

9. Let P(x) be a polynomial with integer coefficients. It is known that P(x) takes the value 2015 for four distinct integers. Then the number of integral values of x for which P (x) equals 2022
(A) 1 (B) 7
(C) 2011 (D) 0

Space For Rough Work

10. If α is a root of the equation $x^2 - 3x + 1 = 0$, then $\dfrac{2\alpha^5 - 5\alpha^4 + 2\alpha^3 - 8\alpha^2}{\alpha^2 + 1}$ is

(A) –1 (B) –3

(C) $\dfrac{2}{3}$ (D) 1

11. If the points of intersection of the curves $x^2 - y^2 = a^2$ and $y = x^2$ lie on a unique circle, and S is the set of all such values of a, then S contains

(A) (–1, 1) (B) (0, 1)

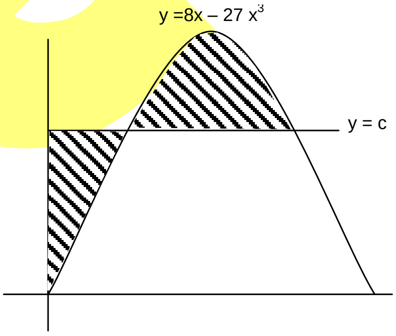
(C) (–1, 0) (D) $\left(-\dfrac{1}{2}, \dfrac{1}{2}\right)$

12. A fair coin is repeated by tossed. If the probability that the first time heads is tossed, twice in a row, is on the 9th and 10th toss, is

(A) $\dfrac{17}{512}$ (B) $\dfrac{15}{512}$

(C) $\dfrac{11}{512}$ (D) $\dfrac{1}{2}$

13. The value of c such that areas of shaded region are equal.



(A) $\dfrac{32}{27}$ (B) $\dfrac{1}{7}$

(C) $\dfrac{16}{9}$ (D) none of these

14. If p, q are two real numbers satisfies the relations $2p^2 - 3p - 1 = 0$ and $q^2 + 3q - 2 = 0$ and $pq \neq 1$, then the value of $\dfrac{1 + 2p + pq}{q}$ is

(A) $\dfrac{-3}{4}$ (B) $\dfrac{\left(12 + \sqrt{17}\right)\left(3 + \sqrt{17}\right)}{24}$

(C) 1 (D) $\dfrac{1}{2}$

Space For Rough Work

(Paragraph Type)

This section contains **2 paragraphs**. Based upon the paragraphs **2 multiple choice questions** have to be answered. Each of these questions has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

Paragraph for Question no. 15 to 16

Tangents are drawn to the parabola $y^2 = 4x$ from the point P(6, 5) to touch the parabola at Q and R. C_1 is a circle which touches the parabola at Q and C_2 is a circle which touches the parabola at R. Both the circles C_1 and C_2 pass through the focus of the parabola.

15. Area of the ΔPQR equals
(A) $\frac{1}{2}$ (B) 1
(C) 2 (D) $\frac{1}{4}$

16. Radius of the circle C_2 is
(A) $5\sqrt{5}$ (B) $5\sqrt{10}$
(C) $10\sqrt{2}$ (D) $\sqrt{210}$

Paragraph for Question no. 17 to 18

If $f(x) = (x-\alpha)^n g(x)$, then $f(\alpha) = f'(\alpha) = f''(\alpha) = ... = f^{n-1}(\alpha) = 0$ where f(x) and g(x) are polynomials for a polynomial f(x) with rational coefficients, answer the following questions

17. If f(x) touches x-axis at only one point, then the point of touching is
(A) always a rational number (B) may or may not be a rational number
(C) never a rational number (D) none of these

18 $f(\alpha) = f'(\alpha) = f''(\alpha) = 0, f(\beta) = f'(\beta) = f''(\beta) = 0$ and f(x) is a polynomial of degree 6, then
(A) atleast three roots of f”(x)=0 are always real
(B) atleast two roots of f”(x)=0 are always real
(C) exactly two roots of f”(x)=0 are real
(D) none of these

Space For Rough Work

Q.P. Code: 100205

Answers

SECTION-1 : PHYSICS

PART – A

1.	AB	2.	BCD	3.	ACD	4.	AB
5.	ABC	6.	ABCD	7.	ACD	8.	C
9.	B	10.	D	11.	B	12.	A
13.	C	14.	C	15.	A	16.	B
17.	B	18.	A				

SECTION-1 : CHEMISTRY

PART – A

1.	BCD	2.	ABC	3.	AB	4.	ABCD
5.	AB	6.	ABCD	7.	BCD	8.	C
9.	B	10.	B	11.	A	12.	A
13.	A	14.	B	15.	C	16.	A
17.	C	18.	B				

SECTION-1 : MATHEMATICS

PART – A

1	ACD	2.	ABCD	3.	ABD	4.	ABC
5.	ABCD	6.	AB	7.	BCD	8.	C
9.	D	10.	A	11.	D	12.	A
13.	A	14.	D	15.	A	16.	B
17.	A	18.	B				

Answers & Solutions

SECTION-1 : PHYSICS

PART – A

1. **AB**

2. **BCD**

Sol. $F = -\dfrac{\partial U}{\partial x}$

3. **ACD**

Sol. $U = \dfrac{1}{2}Li^2$

4. **AB**

Sol. $-\int \vec{E}\,d\vec{l} = -\dfrac{dB}{dt}$

5. **ABC**

Sol. $h\nu = \phi + KE$

6. **ABCD**

Sol. $R = \dfrac{mv}{qB}$

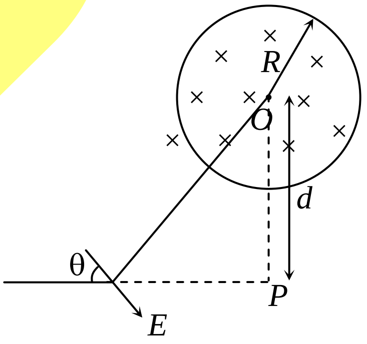
7. **ACD**

Sol. $\int \vec{E}\cdot d\vec{l} = A\dfrac{dB}{dt}$

$E2\pi\sqrt{x^2+d^2} = \pi R^2 k$

$E = \dfrac{\pi R^2 k}{2\sqrt{x^2+d^2}}$

$W_{ext} = \int_0^{\infty} q\vec{E}\cdot dx = \dfrac{q\pi R^2}{4}k$



8. **C**

Sol. $F = -\dfrac{\partial U}{\partial r}$

9. **B**

Sol. $\dfrac{\mu_2}{v'} - \dfrac{\mu_1}{u} = \dfrac{\mu_2-\mu_1}{R}$, $\dfrac{\mu_3}{v} - \dfrac{\mu_2}{v'} = \dfrac{\mu_3-\mu_2}{-R}$ $\Rightarrow$ $\dfrac{\mu_3}{v} - \dfrac{\mu_1}{u} = \dfrac{2\mu_2-\mu_1-\mu_3}{R}$

for Ist case: $\mu_3 = 1.3$, $\mu_2 = 1.5$, $\mu_1 = 1$, $u = -20$, $v = X$

we get $\dfrac{1.3}{X} + \dfrac{1}{20} = \dfrac{0.7}{R}$ … (i)

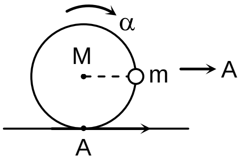
for IInd case: $\mu_3 = 1$, $\mu_2 = 1.5$, $\mu_1 = 1.3$, $u = -20$, $v = Y$

$\dfrac{1}{Y} + \dfrac{1.3}{20} = \dfrac{0.7}{R}$ … (ii)

From (i) and (ii), $1.3Y > X$

10. **D**

Sol. $(A_{CM})_x = \frac{mA + MA}{m + M} = A$



$(A_{CM})_y = \frac{M \times 0 + mR\alpha}{m + M} = \frac{mR\alpha}{m + M}$

$f = (M + m)A$ … (i)

$(M + m)g - N = (M + m)(A_{CM})_y$ … (ii)

$mgR = I_A\alpha$ … (iii)

$A = R\alpha$ … (iv)

$\therefore$ N = 70 N

11. **B**

12. **A**

Sol. $y = \frac{T\ell}{A\Delta\ell}, \Delta L = \frac{T\ell}{Ay} = \frac{mg\ell}{Ay\cos\theta}$

13. **C**

Sol. $mg - N = \frac{mv^2}{R}$

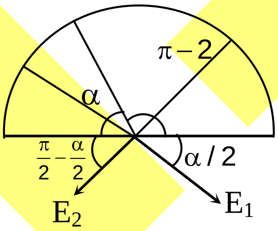
'R' can be measured by $\frac{\left[1 + \left(\frac{dy}{dx}\right)^2\right]^{3/2}}{d^2y/dx^2}$

14. **C**

Sol. $E_1 \cos\frac{\alpha}{2} = E_2 \sin\frac{\alpha}{2}$ …(i)

$E_1 \sin\frac{\alpha}{2} + E_2 \cos\frac{\alpha}{2} = E_0$ …(ii)

Solving we get E_1



15. **A**

Sol. $V_{cm} = \frac{yv}{\ell}$

$\lambda yg - \lambda v^2 = \lambda\ell.\frac{d}{dt}(V_{cm})$

$\frac{dy}{dt} = v.$

16. **B**

17. **B**

Sol. $H_{\max} = \frac{v^2}{2g} = \frac{q^2L^2B_0^2}{2m^2g}$

18. **A**

Sol. $E_{\max} = B_0Lv = \frac{B_0^2L^2q}{m}$ $(\because v_{\max} = v)$

FIITJEE

SECTION-2 : CHEMISTRY

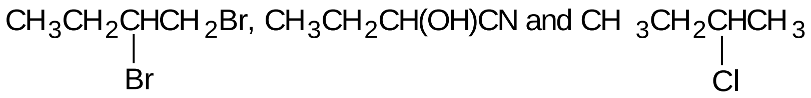
PART – A

1. BCD

Sol. All fluorides of 'Xe' undergo hydrolysis. Perxenate ion is formed by XeF_6.

2. ABC

Sol.



$CH_3CH_2\underset{\substack{|\\ Br}}{C}HCH_2Br$, $CH_3CH_2CH(OH)CN$ and $CH_3CH_2\underset{\substack{|\\ Cl}}{C}HCH_3$

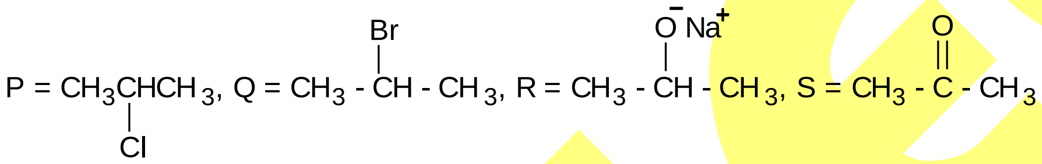
contains chiral carbon atoms. So they form a pair of enantiomers.

3. AB

Sol. Negative deviation takes place.

4. ABCD

Sol.



$P = CH_3\underset{\substack{|\\ Cl}}{C}HCH_3$, $Q = CH_3 - \overset{\substack{Br\\ |}}{C}H - CH_3$, $R = CH_3 - \overset{\substack{\bar{O}\,Na^{+}\\ |}}{C}H - CH_3$, $S = CH_3 - \overset{\substack{O\\ ||}}{C} - CH_3$

contains chiral carbon atoms. So they form a pair of enantiomers.

5. AB

Sol. $P = Cr_2O_7^{2-}$ and $Q = Pb\left(OH\right)_4^{2-}$

6. ABCD

Sol. Formula(empirical) = $FeTeO_3$

As there are six oxide ions per hcp unit cell. The molecular formula will be $Fe_2Ti_2O_6$.

7. BCD

Sol. Graphite is thermodynamically more stable than diamond.

8. C

Sol. Five isomers are possible.

9. B

Sol. P = $BaSO_4$ and Q = Na_2S

10. B

Sol.
$$\frac{X_P p_P^o}{X_Q p_Q^o} = \frac{y_P P_T}{y_Q P_T}$$
$$\frac{0.3\ p_P^o}{0.7\ p_Q^o} = \frac{0.6}{0.4}$$
$$\frac{p_P^o}{p_Q^o} = \frac{0.6}{0.4} \times \frac{0.7}{0.3} = \frac{7}{2} = \frac{x}{y}$$
$\therefore x + y = 9$

11. A

Sol. M_{eq} of HCl = M_{eq} of NaOH + M_{eq} of Na_2CO_3(n = 1)

12. A

13. A

Sol. The conduction band contains more electrons than that of p-type semiconductor.

Sol. The amino acids are alanine and proline.

14. B

Sol. MnO_4^- exhibit charge transfer band at longer wavelength that that of the other three.

15. C

Sol. Reactivity of alcohols towards Lucas test is $3^o > 2^o > 1^o > CH_3$

16. A

Sol. Primary alcohols can't remove the OH group as water easily by HCl along. So they forms a co-ordinated complex with $ZnCl_2$ which fascilate the removal of OH group and form the carbocation, which then forms the alkyl chloride.

17. C

Sol. $(Si_6O_{15})^{6-}$ shares nine oxygen atoms.

18. B

Sol. In pyrosilicate $Si_2O_7^{6-}$ contain one sharing oxygen atom. So other three atom oxygen per tetrahedra carries 6-charge. Therefore per tetrahedral three O^- ions are present.

FIITJEE

SECTION-3 : MATHEMATICS

PART – A

1 ACD

Sol. Clearly $x^2+y^2+3x+y-6=0$ is circumcircle of $\Delta I_1I_2I_3$ and in-centre of ΔABC is orthocenter of $I_1I_2I_3$ let (h,k)

As mirror image of orthocenter about any side of triangle lies on the circumcircle. Hence required locus is $x^2+y^2+x-y-5=0$

2. ABCD

Sol. The seven digit numbers are 1000000, 1000001, ……. 9999999

The sums of their digits are odd, even, odd, even, ….etc.

$$\therefore \quad N=\frac{9\times 10^6}{2}=2^5\,3^2\,5^6$$

Required no.number of divisors of N is 1.2.7=14

3. ABD

Sol. If x_1,x_2,x_3,x_4,x_5 be the five roots, then $\sum\frac{1}{x_i^2}=-2$

So, the equation has atleast one complex root and since it is an odd degree polynomial equations with coefficients real always have atleast one real root

4. ABC

Sol. $A^3-A^2B=B^3-B^2A$

$A^2(A-B)+B^2(A-B)$

$(A^2+B^2)(A-B)=0$

$\therefore$ Either $A^2+B^2=0$ or $A-B=0$

5. ABCD

Sol. $g'(2)=\frac{1}{f'(0)}=\frac{1}{3}$

h(g(g(x))) = x   let g(g(x)) = y

h(y) = f(f(y))   g(x) = f(y)

h'(y) = f'(f(x)).f'(y)   x = f(f(y))

h(0) = 16,   h'(1) = 666

6. AB

Sol. Tangents are perpendicular ⇒ their point of intersection (1, 2) lies on director circle $x^2+y^2=a^2+b^2 \Rightarrow a^2+b^2=5$

Equation of director circle of ellipse $x^2+y^2=4(a^2+b^2)=20$

Clearly point $(4,-\sqrt{5})$ lies outside the director circle

⇒ Angle is acute

7. BCD

Sol. Case possible f(x) > 0 and f(x) decreasing or f(x) < 0, f(x) increasing and f(x) and f'(x) have to change sign simultaneously to maintain the condition which is not possible also $(f^2(x))'=2f(x).f'(x)\le 0$

8. C

Sol. $\frac{x_1-x_2}{y_3}+\frac{x_2-x_3}{y_1}+\frac{x_3-x_1}{y_2}$

$$=\frac{a\left(t_1^2-t_2^2\right)}{2at_3}+\frac{a\left(t_2^2-t_3^2\right)}{2at_1}+\frac{a\left(t_3^2-t_1^2\right)}{2at_2}$$

$$=\frac{\left(t_1-t_2\right)\left(-t_3\right)}{2t_3}+\frac{\left(t_2-t_3\right)\left(-t_1\right)}{2t_1}+\frac{\left(t_3-t_1\right)\left(-t_2\right)}{2t_2}=0$$

9. D

Sol. $P(x)-2015=q(x)(x-x_1)(x-x_2)(x-x_3)(x-x_4)$

Let $P(\alpha)=2022$

$\Rightarrow P(\alpha)-2015=q(\alpha)(\alpha-x_1)(\alpha-x_2)(\alpha-x_3)(\alpha-x_4)$

$\Rightarrow 7=q(\alpha)(\alpha-x_1)(\alpha-\alpha_2)(\alpha-\alpha_3)(\alpha-\alpha_4)$

Impossible since 7 is prime

10. A

Sol. α is a root of $x^2-3x+1=0$

$\Rightarrow \alpha^2-3\alpha+1=0$, yields

$\alpha^2+1=3\alpha\,(\alpha\neq 0)$

Now $\frac{2\alpha^5-5\alpha^4+2\alpha^3-8\alpha^2}{\alpha^2+1}=\frac{\left(\alpha^2-3\alpha+1\right)\left(2\alpha^3+\alpha^2+3\alpha\right)-3\alpha}{\alpha^2+1}$

$=\frac{-3\alpha}{\alpha^2+1}=\frac{-3\alpha}{3\alpha}=-1$

11. D

Sol. The points of intersection lies on $(x^2-y^2-a^2)+\lambda(x^2-y)=0$

It represents a circle if $\lambda=-2$

$\therefore$ equation of circle is $x^2+(y-1)^2=1-a^2$

$\Rightarrow 1-a^2>0\Rightarrow a\in(-1,1)$

But both curves will intersect in real points if $y^2-y+a^2=0$ for some real y

i.e. $a\in\left(-\frac{1}{2},\frac{1}{2}\right)$.

12. A

Sol. All 8 tails | T | T | T | T | T | T | T | T H H $\Rightarrow$ 1 way

Exactly 7 tails | T | T | T | T | T | T | T H H $\Rightarrow$ $^7C_1=7$ ways

7 gaps and one to be selected for a head

Exactly 6 tails | T | T | T | T | T | T H H $\Rightarrow$ $^6C_2=15$ ways

6 gaps and 2 to be selected for heads

Exactly 5 tails | T | T | T | T | T H H $\Rightarrow$ $^5C_1=10$ ways

5 gaps and 3 to be selected for heads

Exactly 4 tails | T | T | T | T H H $\Rightarrow$ $^4C_4=1$ ways

Total ways = 34

$\therefore$ Required probability $=\frac{34}{1024}\ \frac{17}{512}\equiv\frac{p}{512}\Rightarrow p=17.$

13. A

Sol. $\int_0^a\left(c-\left(8x-27x^3\right)\right)dx=\int_a^b\left(\left(8x-27x^3\right)-c\right)dx$

$O=4b^2-27b^4-bc$

$O=4b^2-\frac{27}{4}-b\left(8b-27b^3\right)$

$b^4\left(\frac{81}{4}b^2-4\right)=0$

$b > 0 \;\; b^2 = \frac{4^2}{81} \qquad b = \frac{4}{81}$

$C = 8b - 27b^3$

$= \frac{32}{27}$

14. D

Sol. We can write the 2nd equation in form $2\left(\frac{1}{q}\right)^2 - 3\left(\frac{1}{q}\right) - 1 = 0$

then it is found that p and $\frac{1}{q}$ are both roots of equation $2x^2 - 3x - 1 = 0, \; (pq \ne 1)$ from viete

$p + \frac{1}{q} = \frac{3}{2}$ and $\frac{p}{q} = \frac{-1}{2}$

so, $\frac{1 + 2p + pq}{q} = \frac{1}{q} + p + \frac{2p}{q} = \frac{3}{2} - \frac{2}{2} = \frac{3}{2} - 1 = \frac{1}{2}$

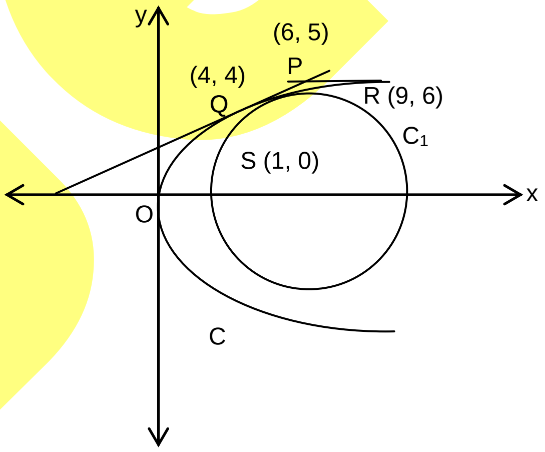
15. A

16. B

Sol. **(15 to 16)**

Equation of tangent of slope m to $y^2 = 4x$ is

$y = mx + \frac{1}{m} \qquad \text{….(1)}$



(i) As (1) passes through P(6, 5), so $5 = 6m = \frac{1}{m}$

$\Rightarrow 6m^2 - m + 1 = 0 \Rightarrow m = \frac{1}{2}$ or $m = \frac{1}{3}$

Points of contact are $\left(\frac{1}{m_1^2}, \frac{2}{m_1}\right)$ and $\left(\frac{1}{m_2^2}, \frac{2}{m_2}\right)$

Hence P (4, 4) and Q (9, 6)

Area of $\Delta PQR = \frac{1}{2}\begin{vmatrix} 6 & 5 & 1 \\ 4 & 4 & 1 \\ 9 & 6 & 1 \end{vmatrix} = \frac{1}{2} \Rightarrow (A)$

(ii) $y = \frac{1}{2}x + 2 \Rightarrow x - 2y + 4 = 0 \qquad \text{….(2)}$

And $y = \frac{1}{3}x + 3 \Rightarrow x - 3y + 9 = 0$

Now equation of circle C_2 touching x – 3y + 9 = 0 at (9, 6), is

$(x - 9)^2 + (y - 6)^2 + \lambda(x - 3y + 9) = 0$

As above circle passes through (1, 0), so

$64 + 36 + 10\lambda = 0 \quad \Rightarrow \quad \lambda = -10$

Circle C_2 is $x^2 + y^2 - 28x + 18y + 27 = 0 \qquad \text{….(3)}$

Radius of C_2 is

r_2^2 = 196 + 81 – 27 = 277 – 27 = 250 ⇒ $r_2 = 5\sqrt{10}$ ⇒ (B)

17. A

Sol. If f(x) touches x-axis at only one irrational point, then $f(x) = (x-\alpha)^2 g(x)$, where α is irrational

⇒ coefficient of f(x) cant be rational

⇒ for f(x) with rational coefficient , then point of touching is rational

18. B

Sol. $f(x) = (x-\alpha)^3 (x-\beta)^3$

$\Rightarrow f'(x) = f(x-\alpha)^2 (x-\beta)^2 (2x-(\alpha+\beta))$

$\Rightarrow f''(x)$ has roots α, β and a root between $\left(\alpha, \frac{\alpha+\beta}{2}\right)$ and $\left(\frac{\alpha+\beta}{2}, \beta\right)$

FIITJEE

FIITJEE RBT-9 for (JEE-Advanced)

BATCHES – Two Yr CRP2123(All)

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 3

QP CODE: 100215

PAPER - 1

Time Allotted: 3 Hours **Maximum Marks: 204**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections.**
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. All the section can be filled in **PART-A & B** of OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with ***Blue/Black Ball Point Pen*** for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Two Parts.

(i) **Part-A (01-04) –** Contains **Four (04)** multiple choice questions which have ONLY ONE CORRECT answer Each question carries **+3 marks** for correct answer and **-1 marks** for wrong answer.

(ii) **PART–A** (**05–12**) contains Eight (8) Multiple Choice Questions which have **One or More Than One Correct** answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in –**2** marks, as a wrong option is also darkened.

(iii) **Part-B (1 – 8)** contains Eight **(08)** Numerical based questions, the answer of which maybe positive or negative numbers or decimals **TWO** decimal places (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+3 marks** for correct answer. **There is no negative marking.**

Name of the Candidate :____

Batch :____________________ **Date of Examination :**____________________

Enrolment Number :____

SECTION – I : PHYSICS

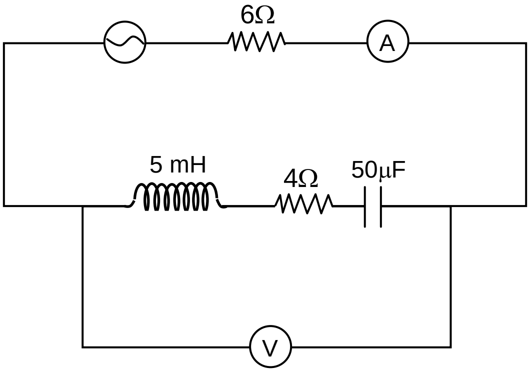
PART – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

1. A particle moves along the y-axes of a coordinate system, with a force component $F_y = (2\ \text{N/m}^3)y^3$ acting on it. As the particle moves from the origin to y = 3 m, how much work is is done on it by the force?

(A) 0 J (B) 40.5 J
(C) –40.5 J (D) 162 J

2. In the circuit shown in given below figure, the AC source gives a voltage V = 20 cos (2000 t). Neglecting source resistance, the voltmeter and ammeter reading will be: (approximately)



(A) 0 V, 0.47 A (B) 1.68 V, 0.47 A
(C) 0 V, 1.4 A (D) 5.6 V, 1.4 A

3. Two coils X and Y are placed in a circuit such that a current change of 3 A in coil X causes the change in magnetic flux by 1.2 Wb in coil Y. The value of mutual inductance of the coil is:

(A) 0.2 H (B) 0.4 H
(C) 0.6 H (D) 3.6 H

4. The temperature gradient in a rod of 0.5 m length is 80°C/m. If the temperature of hotter end of the rod is 30°C, then the temperature of the cooler end is:

(A) 40°C (B) –10°C
(C) 10°C (D) 0°C

Space For Rough Work

PART – A (Maximum Marks: 32)

*This section contains **EIGHT (08)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

5. Two particles A and B, each carrying a charge Q, are held fixed with a separation d between them. A particle C having a mass m and charge –q, is kept at the middle point of line AB. It displaced through a distance x perpendicular to AB. Assume x << d. Then choose the correct option(s).
(A) Force experienced by C is proportional to x
(B) Force experienced by C is proportional to d
(C) Particle C may execute SHM with time period $\left(\frac{m\pi^3\varepsilon_0 d^3}{qQ}\right)^{1/2}$
(D) Particle C may execute SHM with time period $\left(\frac{m\pi^2\varepsilon_0 d^2}{qQ}\right)^{1/2}$

6. The equivalent resistance of a group of resistances is R. If another resistance is connected in parallel to the group, its new equivalent becomes R_1 and if it is connected in series to the group, its new equivalent becomes R_2 we have:
(A) $R_1 > R$
(B) $R_1 < R$
(C) $R_2 > R$
(D) $R_2 < R$

7. Radiations of monochromatic waves of wavelength 400 nm are made incident on the surface of metals Zn, Fe and Ni of work functions 3.4 eV, 4.8 eV and 5.9 eV respectively. Which of the following is (are) correct?
(A) Maximum KE associated with photoelectrons from the surface of any metal is 0.3 eV.
(B) No photoelectron are emitted from the surface of Ni.
(C) If the wavelength of source of radiation is doubled then KE of photoelectrons is also doubled.
(D) Photoelectrons will be emitted from the surface of all the three metals if the wavelength of incident radiations < 200 nm.

8. A diverging lens of focal length f_1 is placed in front of and coaxially with a concave mirror of focal length f_2. Their separation is d. A parallel beam of light incident on the lens returns as a parallel beam from the arrangement.
(A) The beam diameters of the incident and reflected beam must be the same.
(B) $d = 2\,|f_2| - |f_1|$
(C) $d = 2\,|f_1| - |f_2|$
(D) If the entire arrangement is immersed in water, the conditions will remain unaltered.

Space For Rough Work

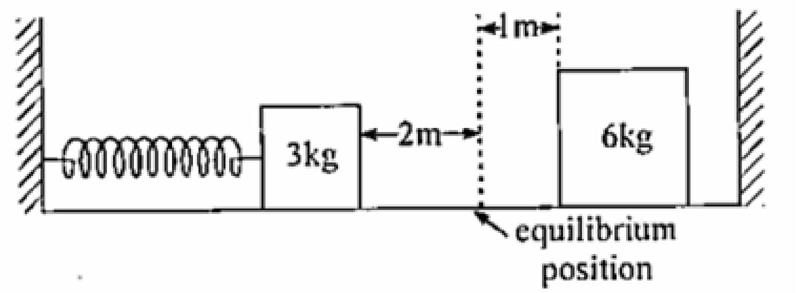
9. A positive charge is passing through an electromagnetic field in which $\vec{E}$ & $\vec{B}$ are directed towards y-axis and z-axis respectively. If a charge particle passes through the region undeviated, then its velocity may be represented by (here a, b & c are constant)

(A) $\vec{v} = \frac{E}{B}\hat{i} + a\hat{j}$
(B) $\vec{v} = \frac{E}{B}\hat{i} + b\hat{k}$
(C) $\vec{v} = \frac{E}{B}\hat{i} + c\hat{i}$
(D) $\vec{v} = \frac{E}{B}\hat{i}$

10. An ideal gas undergoes a process such that $P \propto \frac{1}{T}$. The molar heat capacity of this process is 33.24 J/mol K. For one mole, choose correct options. (R = 8.31)

(A) The work done by the gas is $2R\Delta T$
(B) Degree of freedom of the gas is 4.
(C) Degree of freedom of the gas is 3.
(D) $\gamma = \left(\frac{C_P}{C_V}\right)$

11. Two blocks of masses 3 kg and 6 kg rest on a horizontal smooth surface. The 3 kg block is attached to a spring with a force constant k = 900 Nm^{-1} which is compressed 2 m from the equilibrium position as shown in given below figure. The 6 kg mass is at rest at 1 m from mean position. 3 kg mass strikes the 6 kg mass and the two stick together:



(A) Velocity of the combined masses immediately after the collision is 10 ms^{-1}
(B) Velocity of the combined masses immediately after the collision is 5 ms^{-1}
(C) Amplitude of the resulting oscillation is $\sqrt{2}$ m.
(D) Amplitude of the resulting oscillation is $\sqrt{5/2}$ m.

12. If x, v and a denote displacement, velocity and acceleration of a particle executing simple harmonic motion of time period T, then, which of the following does not change with time?

(A) $aT + 2\pi v$
(B) $\frac{aT}{v}$
(C) $a^2T^2 + 4\pi^2v^2$
(D) $\frac{aT}{x}$

Space For Rough Work

PART – B (Maximum Marks: 24)

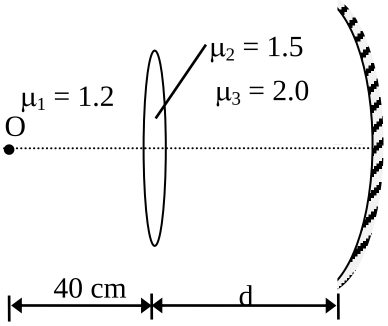
(Numerical **Type)**

This section contains ***Eight (08)*** Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **TWO** decimal places (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30).

1. A gas containing hydrogen like ions with atomic number Z, emits photons in transition n + 2 → n, where n = Z. There photons fall on a metallic plate and eject electrons having minimum de-Broglie wavelength λ of 5000 Å. Find the value of 'Z' (nearest integer value) if the work function of metal is 4.2 eV.

2. Potential energy of a particle moving along x-axis is given by $U = \frac{x^3}{3} - \frac{9x^2}{2} + 20x$. Find out position (value of x) of stable equilibrium state.

3. The figure shows an arrangement of a equi-convex lens and a concave mirror. A point object O is placed on the principal axis at a distance 40 cm from the lens such that the final image is also formed at the position of the object. If the radius of curvature of the concave mirror is 80 cm. The distance d comes out to be 10 n cm. Find n. The focal length of the lens in air is 20 cm.



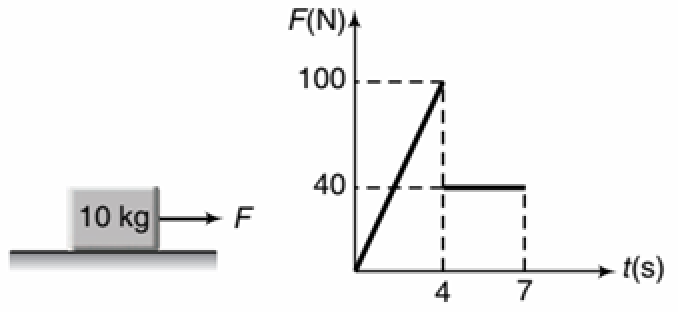
4. A ring of mass 3.15 kg is rolling without slipping with linear velocity 1 m/sec on a smooth horizontal surface. A rod of same mass is fitted along its one diameter. Find total kinetic energy of the system (in J).

5. A source of sound is travelling towards a stationary observer. The frequency of sound heard by the observer is three times of the original frequency. The velocity of sound v = 332.25 m/sec.

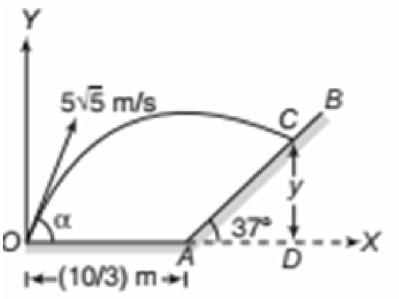
6. A light inextensible thread is wound round a solid cylindrical reel of mass m = 1.5 kg and radius a = 10 cm. The end of the string is held fixed and the reel is allowed to fall so that the thread unwinds. If the axis of the reel remains horizontal and tension is 20 n, value of 'n' is ($g = 10\ m/sec^2$)

Space For Rough Work

7. The 10 kg block is resting on the horizontal surface when the force F is applied to it for 7s. The variation of F with time is shown. Calculate the maximum velocity reached by the block during which the block is in motion. The coefficients of static and kinetic friction are both 0.50. ($g = 9.8\ m/s^2$)



8. A particle is projected from point O on the ground with velocity $u = 5\sqrt{5}\ m/s$ at angle $\alpha = \tan^{-1}(0.5)$. It strikes at a point C on a fixed smooth plane AB having inclination of 37° with horizontal as shown in figure. If the particle does not rebound, calculate maximum height from the ground to which the particle rises. ($g = 10\ m/s^2$).



Space For Rough Work

SECTION – II : CHEMISTRY

PART – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

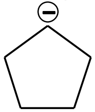
1. Under which condition, the internal energy of a substance may be zero?

(A) -273°C, 0.01 atm (B) 273°C, 1 atm

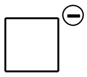
(C) 298 K, 10^{-4} atm (D) None of these

2. The strongest base out of the following is

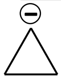
(A)



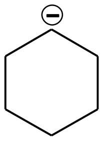
(B)



(C)



(D)



3. At constant volume, one mole of an ideal monoatomic gas was heated from 1400 to 1420 K.

$$\left[C_v = \frac{3R}{2}, R = 8.3\,JK^{-1}\,mol^{-1}\right]$$

Choose the incorrect statement

(A) ΔU or ΔE = 249 J mol^{-1} (B) Q = 249 J mol^{-1}

(C) Change in kinetic energy = 249 J mol^{-1} (D) Entropy change = 249 J K^{-1} mol^{-1}

4. The product of which reaction can form a conjugated diene when it is treated with alcoholic KOH?

(A) $CH_3CH_2CH = CH \xrightarrow{Cl_2/CCl_4}$ (B) $CH_3CH = CHCH_3 \xrightarrow{HCl}$

(C) $CH_3CH_2CH = CHCH_3 \xrightarrow{Cl_2/CCl_4}$ (D) $CH_3CH_2CH = CHCH_3 \xrightarrow{HCl}$

PART – A (Maximum Marks: 32)

*This section contains **EIGHT (08)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

5. Which property(s) of NH_3 and NF_3 is/are given in correct order?

(A) Dipole moment: $NH_3 > NF_3$

(B) Bond angle: $NH_3 > NF_3$

(C) Lewis basicity: $NH_3 > NF_3$

(D) Number of hydrogen bonds formed with H_2O: $NH_3 > NF_3$

Space For Rough Work

6. Crystal field theory is not applied on complex(es) like

(A) $[Ni(CO)_4]$
(B) $[Fe(CO)_5]$
(C) $[Zn(NH_3)_4]CO_3$
(D) $K_4[Fe(CN)_6]$

7. The boiling point of water in which aqueous solution(s) is/are higher than 100°C?

(A) 0.2 M $Al_2(SO_4)_3$
(B) 1 M CH_3OH in water
(C) 0.1 M NaCl
(D) 1 M $NaCONH_2$

8. The first ionization enthalpies of two elements P and Q respectively are 8.1 and 10.2 eV. The electron gain enthalpies of P and Q are respectively -3.1 and -6.6 eV respectively. The percentage ionic character of the covalent bond P – Q is given as

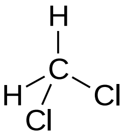
% ionic character = $16(END) + 3.5(END)^2$

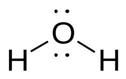
Where END is the electronegativity difference **in Mulliken scale** between P and Q.

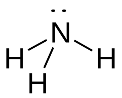
Choose correct statements

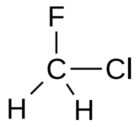
(A) The electronegativity of P is 1.05
(B) Q is more electronegative than P
(C) percentage covalent character of P – Q bond is 80.5
(D) P – Q bond is purely covalent with 100% covalent character

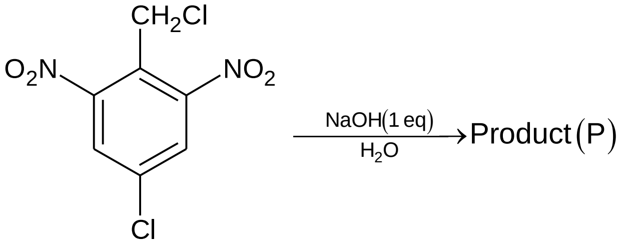
9. In which of the following molecule(s) the bond containing H and the central atom contains more than 25% s-orbital character?

(A)


(B)


(C)


(D)


10.


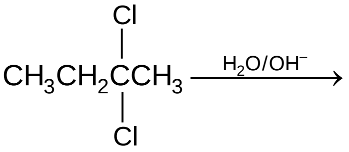
Correct statement(s) regarding product(P) is

(A) it is an alcohol
(B) it is a phenol
(C) the longer C – Cl bond breaks in the reaction
(D) the NO_2 groups favours substitution of benzylic chloride

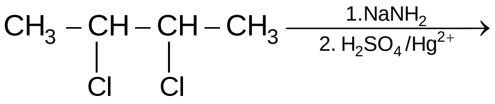
Space For Rough Work

11. Which of the following reactions produce(s) a ketone?

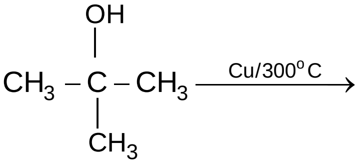
(A) $CH_3COOH \xrightarrow[2.\text{Heat}]{1.\ Ca(OH)_2}$

(B) 

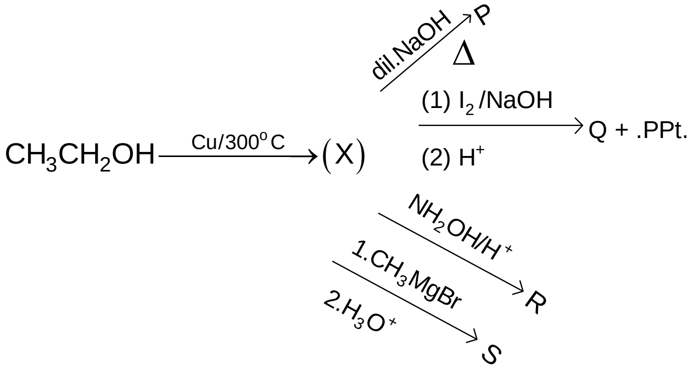
$$CH_3CH_2\overset{\overset{Cl}{|}}{\underset{\underset{Cl}{|}}{C}}CH_3 \xrightarrow{H_2O/OH^-}$$

(C) 

$$CH_3-\underset{\underset{Cl}{|}}{CH}-\underset{\underset{Cl}{|}}{CH}-CH_3 \xrightarrow[2.\ H_2SO_4/Hg^{2+}]{1.NaNH_2}$$

(D) 

$$CH_3-\overset{\overset{OH}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_3 \xrightarrow{Cu/300^oC}$$

12. 

Correct statement(s) regarding products of above reaction(s) is/are

(A) P, Q and R contain pi-bonds

(B) P and R exhibit geometrical isomerism

(C) R and S show optical isomerism

(D) The ppt. is yellow colour

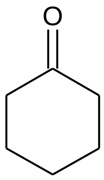
PART – B (Maximum Marks: 24)

(Numerical **Type)**

This section contains ***Eight (08)*** Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **TWO** decimal places (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30).

1. A dicarboxylic acid(P) forms a white precipitate when reacts with aqueous $Ca(OH)_2$ solution. If (P) is the simplest dicarboxylic acid. How many moles of gases are evolved when one mole of (P) is heated at 85°C.

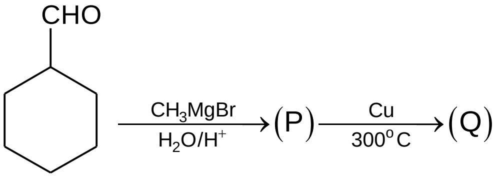
Space For Rough Work

2. Two moles of  reacts with dilute NaOH to produce one mole of product(P). Heating of (P) forms (Q). Reaction of (Q) with Zn-Hg/Conc.HCl(excess) forms product(R)

If x = Number of C – C sigma bonds present in (R)
y = Number of C = C bonds present in (R)
z = Number of 3^o-carbon atoms present in (R), then the value of (x + y + z) is

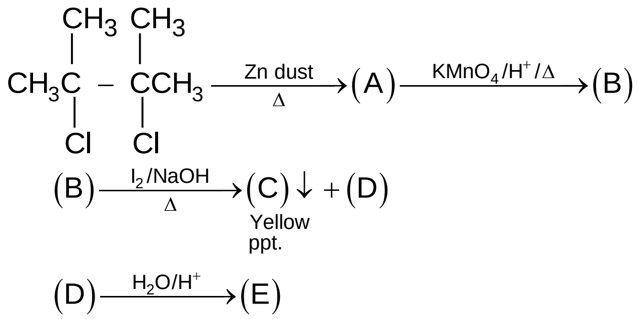
3. A vessel contains equal number of moles of CH_4 and SO_2 gases at a particular temperature. If the ratio of rates of effusion of CH_4 to SO_2 through an orifice made on the vessel, is expressed as x : y, the value of (x + y) is:

4. The p^{K_a} of the α-COOH, α-NH_2 and side chain COOH groups of an α-amino acid are respectively 2.1, 9.82 and 3.86. What is the pI of the amino acid?

5. 

CHO
$\xrightarrow[H_2O/H^+]{CH_3MgBr}$ (P) $\xrightarrow[300^oC]{Cu}$ (Q)

If the number of hydrogen atom(s) is/are present in a molecule of (Q) is X. What is $\frac{X}{10}$?

6. 

If the number of oxygen atom(s) are present in (E) is y, what is the value of $\frac{y}{10}$?

7. The depression in freezing point of an aqueous solution of NaCl is 18.6. How many moles of NaCl is present in 200 g of solvent(water)?
[K_f of water = 1.86 K kg mol^{-1}]
[Assume complete dissociation of NaCl]

8. A metal crystallized in b.c.c unit cell. What will be the diameter of the metal atoms in pm unit if the edge-length of the unit cell is $\sqrt{3}$ pm?

Space For Rough Work

SECTION – Iii : MATHEMATICS

PART – A (Maximum Marks: 12)

*This section contains **FOUR (04)** questions. Each question has **FOUR** options. **ONLY ONE** of these four options is the correct answer.*

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1. If $f(x) = x^4 \tan(x^3) - x \ln(1 + x^2)$, then the value of $\frac{d^4(f(x))}{dx^4}$ at x = 0 is

(A) 0 (B) 6

(C) 12 (D) 24

2. Let $\vec{a}, \vec{b}$ and $\vec{c}$ be three vectors having magnitudes 1, 1 and 2 respectively. If $\vec{a}\times\left(\vec{a}\times\vec{c}\right)+\vec{b}=0$, then incorrect statement is

(A) $\vec{b}$ is in the plane of $\vec{a}$ and $\vec{c}$ (B) $\vec{b}$ is parallel to $\vec{a}\times\vec{c}$

(C) angle between $\vec{a}$ and $\vec{c}$ is 30^o (D) angle between $\vec{a}$ and $\vec{c}$ is 150^o

3. Let a, b, c are distinct real numbers, not equal to one. If $ax+y+z=0$, $x+by+z=0$ and $x+y+cz=0$ has a non – trivial solution, then the value of $\frac{1}{1-a}+\frac{1}{1-b}+\frac{1}{1-c}$ is equal to:

(A) –1 (B) 1

(C) zero (D) none of these

4. The volume enclosed by the planes $|3x-4|+|2y-3|+|z+4|=3$ is

(A) 4 (B) 6

(C) 8 (D) None of these

PART – A (Maximum Marks: 32)

*This section contains **EIGHT (08)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MOER THAN ONE** of these four option(s) is (are) correct answer(s).*

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5. The solution of the differential equation $\frac{d^2y}{dx^2}=\sin 3x+e^x+x^2$ when $y_1(0)=1$ and $y(0)=0$ is

(A) $\frac{-\sin 3x}{9}+e^x+\frac{x^4}{12}+\frac{1}{3}x-1$ (B) $\frac{-\sin 3x}{9}+e^x+\frac{x^4}{12}+\frac{1}{3}x$

(C) $\frac{-\cos 3x}{3}+e^x+\frac{x^4}{12}+\frac{1}{3}x+1$ (D) none of these

Space For Rough Work

6. If A and B are two events such that $P(A)=3/4$ and $P(B)=5/8$, then

(A) $P(A\cup B)\geq 3/4$ (B) $P(A'\cap B)\leq 1/4$

(C) $3/8\leq P(A\cap B)\leq 5/8$ (D) $3/8\leq P(A\cap B)\leq 5/8$

7. If $f(x)=2x-\sin x$ and $g(x)=\sqrt[3]{x}$, then

(A) range of gof is R (B) gof is one – one

(C) both f and g are one – one (D) both f and g are onto

8. $\lim\limits_{x\to\infty}\sqrt{x}\left(\sqrt{x+1}-\sqrt{x}\right)$ equals

(A) $\lim\limits_{x\to 0}\frac{\ln(1+x)-x}{x^2}$ (B) $\lim\limits_{x\to 0}\frac{1-\cos x}{x^2}$

(C) $\lim\limits_{x\to 0}\frac{\sqrt{1+x}-1}{x}$ (D) $\lim\limits_{x\to 0}\frac{\sqrt{x}}{\sqrt{x+\sqrt{x^2+2x}}}$

9. The solution/s of the equation $9\cos^{12}x+\cos^2 2x+1=6\cos^6 x\cos 2x+6\cos^6 x-2\cos 2x$ is/are

(A) $x=n\pi+\frac{\pi}{2},\ n\in I$ (B) $x=n\pi\pm\cos^{-1}\sqrt[4]{\frac{2}{3}},n\in I$

(C) $x=n\pi\pm\cos^{-1}\sqrt{\frac{2}{3}},n\in I$ (D) $x=n\pi,\ n\in I$

10. If a straight line through a point $P(\alpha,2),\alpha\neq 0$, meets the ellipse $\frac{x^2}{9}+\frac{y^2}{4}=1$ at A and D and x – and y–axes at B and C respectively such that $PA\times PD=PB\times PC$, then 'α' can lie in the interval

(A) $[7,\infty)$ (B) $(-12,-8)$

(C) $(-5,0)$ (D) $(10,\infty)$

11. Tangent drawn at point P(1, 3) of a parabola intersects its tangent at vertex at M(–1, 5) and cuts the axis of parabola at T. If R(–5, 5) is a point on SP; where S is focus of the parabola, then

(A) slope of axis is –3

(B) radius of circumcircle of ΔSMP is $\sqrt{\frac{5}{2}}$ units

(C) $(ST)^2-(SM)^2=(PM)^2$

(D) tangent cuts the axis of parabola at T (–3, 7)

Space For Rough Work

12. Suppose that f(x) is a differentiable invertible function, $f(x) \neq 0$ and $h(x) = \int_1^x f(t)dt$. Given that $f(1) = f'(1) = 1$ and g(x) is inverse of f(x).,
Let G(x) = x^2g(x) –xh(g(x)) $\forall x \in R$. Which of the following are correct:
(A) G'(1) = 2
(B) G'(1) = 3
(C) G"(1) = 2
(D) G"(1) = 3

PART – B (Maximum Marks: 24)

(Numerical **Type)**

This section contains ***Eight (08)*** Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **TWO** decimal places (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30).

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1. Let $A = \begin{bmatrix} 2 & 0 \\ 0 & -3 \end{bmatrix}, B = \begin{bmatrix} 0 & 1 \\ 3 & 0 \end{bmatrix}$ and $x = \begin{bmatrix} \cos x & -\sin x \\ \sin x & \cos x \end{bmatrix}$. If $P = AXB, Q = BX^T A$ and $\text{Tr.}\left((PQ)^{10}\right) = a^{10} + b^{10}$, where $a < b$, then find the value of $b - 2a$______
(Tr (M) denotes trace of Matrix M and M^T denotes transpose of matrix M)

2. Let $\beta = \int_0^1 \frac{2 + 3x + 4x^2}{2\sqrt{x^2 + x + 1}}$, then find the value of β^2.

3. Suppose that the circle $x^2 + y^2 - 4ax - 2ay + 4a^2 = 0 \left(a > 0\right)$ touches the lines $y = mx$ at A and B such that AB = 3. Then the value of $\frac{4a}{\sqrt{5}}$ is

4. If |z – 3| = Re z, |w – 3| = Re w and $\arg\left(z - w\right) = \frac{\pi}{4}$, then find the value of $\text{Im}\left(z + w\right)$.

5. The smallest value of 'a' for which the inequality $\left(a-1\right)x^2 - \left(a+1\right)x + \left(a-1\right) \geq 0$ holds for all $x \geq 2$ is k then the value of $\frac{3k}{14}$ is

6. If roots of $x^3 + ax^2 + bx - \frac{1}{9} = 0$ are in A.P. the $\frac{121}{16}\left(2a^3 - 9ab + 1\right)$ is _______.

7. If $\sum_{k=0}^{100}\left(\frac{k}{k+1}\right){}^{100}C_k = \frac{a\left(2^{100}\right) + b}{c}$ where $a, b, c \in N$, then find the least value of $\frac{\left(a + b + c\right)}{670}$.

8. A straight line cuts the x-axis at point $A\left(1, 0\right)$, and y-axis at point B, such that $\angle OAB = \alpha\left(\alpha > \frac{\pi}{4}\right)$. C is middle point of AB and B' is a mirror image of point B with respect to line OC and C' is a mirror image of point C with respect to line BB', then the ratio of the areas of triangles ABB' and BB'C' is equal to

Q. P. Code: 100215

Answers

SECTION – I : PHYSICS

PART – A

1.	B	2.	D	3.	B	4.	B
5.	AC	6.	BC	7.	BD	8.	AB
9.	BD	10.	ABD	11.	AC	12.	CD

PART – B

1.	2	2.	5	3.	3	4.	5.25
5.	221.50	6.	0.25	7.	5.2	8.	4.45

SECTION – II : CHEMISTRY

PART – A

1.	D	2.	D	3.	D	4.	C
5.	ABCD	6.	AB	7.	ACD	8.	BC
9.	AD	10.	ACD	11.	ABC	12.	ABD

PART – B

1.	2	2.	15	3.	3	4.	2.98
5.	1.4	6.	0.2	7.	1	8.	1.5

SECTION – III : MATHEMATICS

PART – A

1.	A	2.	B	3.	B	4.	B
5.	A	6.	ABCD	7.	ABCD	8.	BC
9.	AB	10.	ABD	11.	ABCD	12.	AD

PART – B

1.	3	2.	3	3.	3	4.	6
5.	0.50	6.	30.25	7.	0.30	8.	2.00

Answers & Solutions

SECTION – I : PHYSICS

PART – A

1. **B**

Sol. $W = \int_0^3 F dy = 2\int_0^3 y^3 dy = \frac{1}{2}\left[y^4\right]_0^3 = \frac{81}{2} = 40.5$

2. **D**

Sol. Circuit impedance for series RLC circuit is given as

$$Z = \sqrt{(R)^2 + (X_L - X_C)^2}$$

$R = 10\Omega$, $X_L = \omega L = 2000 \times 5 \times 10^{-3} = 10\ \Omega$.

$$X_C = \frac{1}{\omega_C} = \frac{10^6}{2000 \times 5}$$

As $X_L = X_C$ so circuit is in resonance and current in circuit is given as

$$i_0 = \frac{V_0}{Z} = \frac{20}{10} = 2A$$

$$\Rightarrow\ i_{rms} = \frac{2}{\sqrt{2}} = 1.41\,A$$

Voltmeter reading is equal to the voltage across the resistance as at resonance phasor voltage of capacitor and inductor gets cancelled out

$$V_{rms} = i_{rms} R = 4 \times 1.41 = 5.64\ V$$

3. **B**

Sol. Flux change in coil Y is related to current change in coil X as

$$\phi = Mi$$

$$\Rightarrow\ d\phi = M\, di$$

$$\Rightarrow\ M = \frac{d\phi}{di}$$

$$\Rightarrow\ M = \frac{1.2}{3} = 0.4\ H$$

4. **B**

Sol. Temperature gradient

$$\frac{dT}{dx} = 80°C/m$$

$$\Rightarrow\ \int_{30}^{T} dT = -80\int_0^{0.5} dx$$

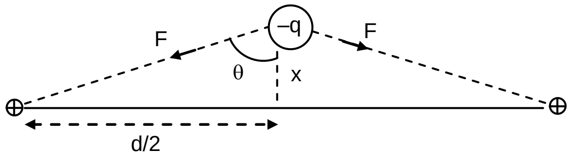
$$\Rightarrow\ T - 30 = -80(0.5)$$

$$\Rightarrow\ T - 30 = -40$$

$$\Rightarrow\ T = -10°C$$

5. **AC**

Sol.



$$F_{net} = 2F\cos\theta = 2\frac{k\,Qqx}{\left(\frac{d^2}{4}+x^2\right)^{\frac{3}{2}}}$$

If x << d

Acceleration $\bar{a} = -\frac{2\,kQq}{m\left(\frac{d}{2}\right)^3}\bar{x}$

$$T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{md^3}{16}\frac{4\pi\varepsilon_0}{Q\,q}} = \left(\frac{m\pi^3\varepsilon_0 d^3}{q\,Q}\right)^{\frac{1}{2}}$$

6. BC

Sol. Suppose resistance connected is r.

R2 = R + r > R

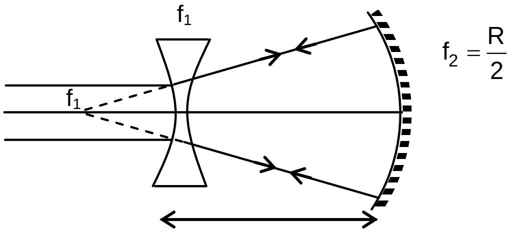
7. **BD**

Sol. $\Delta E = \frac{hc}{\lambda} = \frac{12375}{4000}$ = 3.09375 ≃ 3.1 eV.

For photoelectric effect, ΔE should be greater than work function.

8. **AB**

Sol.



|R| = d + |f$_1$|

d = |2f$_2$| – |f$_1$|

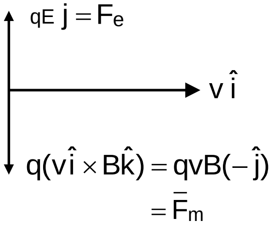
9. **BD**

Sol. $q\bar{E} + q(\bar{v}\times\bar{B}) = 0$

For, $\bar{E}, \bar{v}, \bar{B}$ mutually perpendicular.

qE = –qvB

$v = \frac{E}{B}$


$qE\,\hat{j} = \bar{F}_e$
$v\,\hat{i}$
$q(v\hat{i}\times B\hat{k}) = qvB(-\hat{j})$
$= \bar{F}_m$

$$q\bar{E}\,\hat{j} + q\left[(v_x\hat{i}+v_y\hat{j}+v_z\hat{k})\times B(\hat{k})\right] = 0$$

$\Rightarrow \quad q(E - v_xB)\hat{j} + v_yBq\,\hat{i} = 0$

$\Rightarrow \quad v_x = \frac{E}{B}$ and $v_y = 0$

$\therefore \quad \bar{v} = \frac{E}{B}\hat{i} + b\,\hat{k}$

10. **ABD**

Sol. Given PT = Constant

and $PV = nRT$

⇒ $P^2V = \text{constant}$

⇒ $PV^{1/2} = k$

From first law of thermodynamics

$$\Delta Q = \Delta U + \Delta W$$

⇒ $C = C_V + \left(\frac{R}{1-x}\right)$

$$C = C_V + 2R$$

$$33.24 = \frac{R}{\gamma - 1} + 2R$$

⇒ $\gamma = 1.5$

and $\gamma = 1 + \frac{2}{f}$

⇒ $f = 4$.

11. **AC**

Sol. Just before collision

$$v = \omega\sqrt{A^2 - x^2}$$

$$v = \sqrt{\frac{k}{m}}\sqrt{A^2 - x^2} = \sqrt{\frac{900}{3}}\left[\sqrt{(4-1)}\right] = 30$$

COM

$3 \times 30 = 9v'$

⇒ $v = 10$ (velocity just after collision)

When 3 kg mass is released the amplitude of its oscillation is 2 m and at a distance 1 m from the equilibrium position we can find the speed of it using the relation $v = [(k/m)(A^2 - x^2)]^{1/2}$ then by conservation of momentum we can find the resulting speed of the combined mass and the new amplitude using the above relation which gives options (A) and (C) are correct.

12. **CD**

Sol. $a = -\omega^2 x,\ v = \omega\sqrt{A^2 - x^2}$

$$a^2T^2 + 4\pi^2v^2 = \omega^4x^2T^2 + 4\pi^2\omega^2(A^2 - x^2)$$

$$= \frac{4\pi^2}{T^2}\omega^2x^2T^2 + 4\pi^2\omega^2(A^2 - x^2)$$

$$= 4\pi^2\omega^2A^2 = \text{constant}$$

$$\frac{aT}{x} = -\frac{\omega^2 xT}{x} = -\omega^2 T = \text{constant.}$$

PART – B

1. **2**

Sol. $\Delta E = 4.2 + \frac{12375}{5000} = 6.675$

$$\because\ \Delta E = 13.6\, Z^2\left(\frac{1}{n^2} - \frac{1}{(n+2)^2}\right) = 13.6\left[1 - \frac{1}{\left(1 + \frac{2}{Z}\right)^2}\right]$$

$$\Rightarrow \ \frac{1}{2} \simeq \left[1-\frac{1}{\left(1+\frac{2}{Z}\right)^2}\right] \Rightarrow \ \frac{1}{\left(1+\frac{2}{Z}\right)^2} = \frac{1}{2} \ \Rightarrow \ 1+\frac{2}{Z} = \sqrt{2}$$

$$\Rightarrow \ \frac{2}{Z} = 0.41 \Rightarrow \ Z = \frac{2}{0.41} \simeq 5.$$

2. **5**

Sol. At stable equilibrium, U is minimum.

$$\frac{dU}{dx} = 0 \text{ and } \frac{d^2U}{dx^2} > 0$$

$$\Rightarrow \frac{1}{dx}\left(\frac{x^3}{3} - \frac{9x^2}{2} + 20x\right) = 0.$$

$\Rightarrow \quad x^2 - 9x + 20 = 0. \ \Rightarrow \ (x - 5)(x - 4) = 0.$

x = 5 and x = 4 are points of equilibrium.

And U minimum when $\frac{d^2U}{dx^2} > 0$. i.e. at x = 5.

3. **3**

Sol. $$\frac{\mu_3}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R_1} + \frac{\mu_3 - \mu_2}{R_2}$$

$$\frac{2}{-(80-d)} - \frac{1.2}{-40} = \frac{1.5-1.2}{20} + \frac{2-1.5}{-20}$$

$$\Rightarrow \quad \frac{2}{-(80-d)} + \frac{1.2}{40} = \frac{0.3}{20} + \left(\frac{-0.5}{20}\right)$$

$$\frac{1.2}{40} + \frac{0.2}{20} = \frac{2}{(80-d)}$$

$$\frac{1.6}{40} = \frac{2}{(80-d)}$$

80 – d = 50

d = 30

$\Rightarrow$ n = 3.

4. **5.25**

Sol. $$k = \frac{1}{2}mv_{cm}^2 + \frac{1}{2}(mr^2)\left(\frac{v}{r}\right)^2 + \frac{1}{2}\left\{\frac{m(2r)^2}{12}\right\}\left(\frac{v}{r}\right)^2 + \frac{1}{2}mv_{rod}^2$$

$$= \frac{1}{2}mv_{cm}^2 + \frac{1}{2}mv_{cm}^2 + \frac{1}{2}mv_{cm}^2 \times \frac{1}{3} + \frac{1}{2}mv_{cm}^2$$

$$= \frac{1}{2} \times 3.15 \times 1\left[1+1+1+\frac{1}{3}\right] = \frac{3.15}{2} \times \frac{10}{3} = 5.25$$

5. **221.50**

Sol. We use

$$n' = n\left(\frac{v}{v - v_s}\right)$$

$$\Rightarrow$$

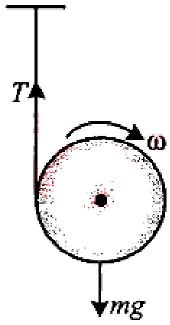
$$\frac{n'}{n} = \frac{v}{v - v_s}$$

$$\Rightarrow \quad \frac{v}{v - v_s} = 3$$

$$\Rightarrow \quad v_s = \frac{2v}{3}.$$

6. **0.25**

Sol. Let T be the tension in the thread and f, the linear acceleration of the reel as it falls.



For the downward translation,

$(mg - T) = mf$ …(1)

For the rotational motion of the reel, angular acceleration is

$$Ta = \frac{ma^2}{2}\alpha$$

$$T = \frac{ma\alpha}{2} = \frac{mf}{2} \quad \text{…(2)}$$

From equation (1) and (2)

$\Rightarrow$ 3T = mg

$$\therefore \quad T = \frac{mg}{3} = 1.5 \times \frac{10}{3} = 5 \text{ N.}$$

7. **5.2**

Sol. Block will start moving at, F = μ mg

or 25t = (0.5) (10) (9.8) = 49 N

$\therefore$ t = 1.96 s

Velocity is maximum at the end of 4 second.

$$\therefore \quad \frac{dv}{dt} = \frac{25t - 49}{10} = 2.5t - 4.9$$

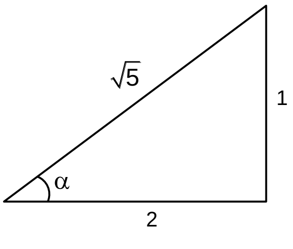
$$\therefore \quad \int_0^{v_{max}} dv = \int_{1.96}^{4} (2.5\,t - 4.9)dt$$

$\therefore$ v_{max} = 5.2 m/s

8. **4.45**

Sol. Let, (x, y) be the coordinates of point C

x = OD = OA + AD



$$\therefore \quad x = \frac{10}{3} + y\cot 37^o = \frac{10 + 4y}{3} \quad \text{…(i)}$$

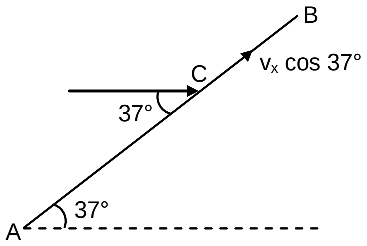
As point C lies on the trajectory of a parabola, we have

$$y = x\tan\alpha - \frac{gx^2}{2u^2}(1 + \tan^2\alpha) \quad \text{…(ii)}$$

Given that, tan α = 0.5 = $\frac{1}{2}$

Solving equations (i) and (ii), we get x = 5 m and y = 1.25 m.

Hence, the coordinates of point C are (5 m, 1.25 m).



Let v_y be the vertical component of velocity of the particle just before collision at C.

Using $v_y = u_y + a_y t$, we have

$v_y = u \sin \alpha - g\,(x/u \cos \alpha)$ ($\because$ $t = x/u \cos \alpha$)

$$= \frac{5\sqrt{5}}{\sqrt{5}} - \frac{10 \times 5}{(5\sqrt{5} \times 2/\sqrt{5})} = 0$$

Thus, at C, the particle has only horizontal component of velocity

$$v_x = u \cos \alpha = 5\sqrt{5} \times \left(\frac{2}{\sqrt{5}}\right) = 10\ \text{m/s}$$

Given, that the particle does not rebound after collision. So, the normal component of velocity (normal to the plane AB) becomes zero. Now, the particle slides up the plane due to tangential component $v_x \cos 37^o = (10)\left(\frac{4}{5}\right) = 8\ \text{m/s}$

Let h be the further height raised by the particle. Then

$$mgh = \frac{1}{2} m(8)^2 \quad \text{or} \quad h = 3.2\ \text{m}$$

Height of the particle from the ground = y + h

$\therefore$ H = 1.25 + 3.2 = 4.45 m

SECTION – II : CHEMISTRY

PART – A

1. D

Sol. The internal energy never becomes zero. Because even at 0 K, the vibration motions of the ideal solids exist.

2. D

Sol. Larger the bond angle of the cycloalkanes, stronger is their basic strength. Because the p-orbital character of carbon atom increases, if the bond angle increases. So due to less s-orbital character, the carbon atom can't strongly attract the negative charge or electron cloud.

3. D

Sol. $\Delta V = 0, \therefore W = 0$

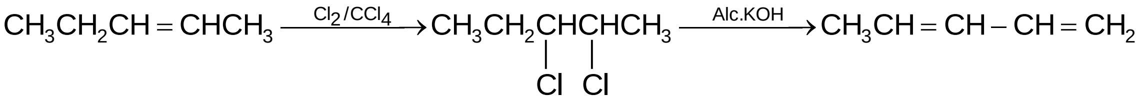
So, $\Delta U = q = nC_v\Delta T = 1\times\frac{3R}{2}\times(1420-1400) = 249\,\text{J mol}^{-1}$

$\Delta K.E = \frac{3}{2}nR(\Delta T) = \frac{3}{2}\times 1\times 8.3\times 20 = 249\ \text{J mol}^{-1}$

$\Delta S = nCv\ \ell n\frac{T_2}{T_1} = 0.176\ \text{J K}^{-1}\ \text{mol}^{-1}$

4. C

Sol.



$$CH_3CH_2CH=CHCH_3 \xrightarrow{Cl_2/CCl_4} CH_3CH_2\underset{Cl}{\underset{|}{C}}H\underset{Cl}{\underset{|}{C}}HCH_3 \xrightarrow{\text{Alc.KOH}} CH_3CH=CH-CH=CH_2$$

5. ABCD

Sol. In NH_3, bond pair dipole-moment and lone-pair dipole moment are along same direction. In NF_3, they are in opposite direction.

6. AB

Sol. CFT based on electrostatic interaction between metal ions and ligands. In the given metal carbonyls, neither metal nor ligand carry charges. Though CO carries partial positive charge, but the metal carries no charge, hence no electrostatic attraction takes place between them.

7. ACD

Sol. The boiling point of water increases by adding non-volatile solutes.

8. BC

Sol. E.N of P = $\frac{8.1+3.1}{5.6} = 2$

E.N of Q = $\frac{10.2+6.6}{5.6} = 3$

% ionic character = $16(3 - 2) + 3.5(3 - 2)^2 = 19.5$

% covalent character = 100 – 19.5 = 80.5

9. AD

Sol. $\text{Cos}\theta = \frac{S}{S-1}$

Where θ = bond angle containing hydrogen and central atom

S = % s-orbital character.

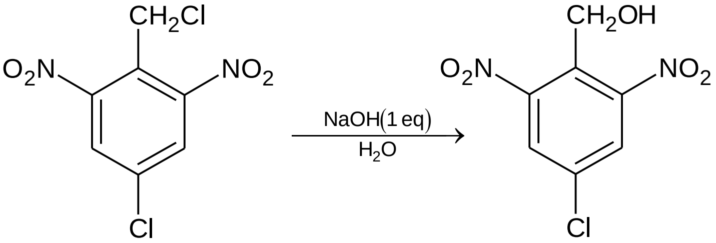
In H_2O, $\theta = 104.5^o$

$\text{Cos } 104.5^o = -0.25 = \frac{S}{S-1}$

On solving S = 0.2, hence the O – H bond contain 20% s-orbital character and 80% p-orbital character.
$\therefore$ (B) is not correct similarly (C) will not be correct.

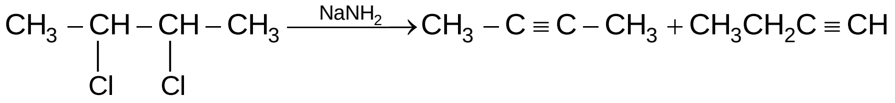
10. ACD

Sol.



11. ABC

Sol. $CH_3COOH + Ca(OH)_2 \longrightarrow Ca(CH_3COO)_2 \xrightarrow{\Delta} CH_3COCH_3 + CaCO_3$



$$\underset{\substack{|\\Cl}}{CH_3 - CH} - \underset{\substack{|\\Cl}}{CH} - CH_3 \xrightarrow{NaNH_2} CH_3 - C \equiv C - CH_3 + CH_3CH_2C \equiv CH$$

Both product will give $CH_3COCH_2CH_3$ upon hydrolysis with H_2SO_4/Hg^{2+}.

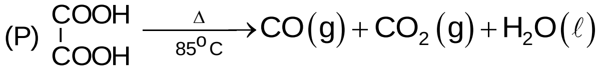
12. ABD

Sol. X = CH_3CHO
P = $CH_3 – CH = CH – CHO$
Q = HCOOH, PPt. = CHI_3
R = $CH_3 – CH = NOH$
S = CH_3COCH_3

PART – B

1. 2

Sol. (P)



$$\begin{matrix}COOH\\|\\COOH\end{matrix} \xrightarrow[85^0 C]{\Delta} CO(g) + CO_2(g) + H_2O(\ell)$$

2. 15

Sol. x = 13, y = 0, z = 2

3. 3

Sol. When the moles are same

$$\frac{r_{CH_4}}{r_{SO_2}} = \sqrt{\frac{M_{SO_2}}{M_{CH_4}}} = \sqrt{\frac{64}{16}} = \sqrt{4} = 2$$

$\therefore$ x : y = 2 : 1 $\Rightarrow$ x + y = 3

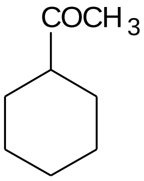
4. 2.98

Sol. $$pI = \frac{1}{2}\left(p^{Ka_1} + p^{Ka_2}\right)$$

$$= \frac{1}{2}(2.1 + 3.86) = 2.98$$

5. 1.4

Sol. Q is



6. 0.2

Sol. (A) is $(CH_3)_2C = C(CH_3)_2$

(B) is CH_3COCH_3
(C) = CHI_3
(D) = CH_3COONa
(E) = CH_3COOH

7. 1

Sol. $\Delta T_f = iK_f m = iK_f n \times \frac{1000}{W}$

or, $18.6 = 2 \times 1.86 \times n \times \frac{1000}{200}$

$\therefore$ n = 1

8. 1.5

Sol. $\sqrt{3}a$ = 4r = 2d

or, $\left(\sqrt{3}\right)\left(\sqrt{3}\right)$ = 2d

or, d = 3/2 = 1.5 pm

SECTION – III : MATHEMATICS

PART – A

1. A

Sol. As, f (x) = $x^4\tan(x^3) - x\ln(1+x^2)$ is odd, $\dfrac{d^4f(x)}{dx^4}=0$ at x = 0.

2. B

Sol. On expanding we get $\left(\vec a.\vec c\right)\vec a-\left(\vec a.\vec a\right)\left(\vec c\right)=-\vec b$

$\Rightarrow \vec c-\left(\vec a.\vec c\right)\vec a=\vec b$

$\Rightarrow$ (a) is correct and (b) is ruled out.

$\Rightarrow \left|\vec c-\left(\vec a.\vec c\right)\vec a\right|^2=\left|\vec b\right|^2$

If θ is the angle between $\vec a$ and $\vec c$ then

$4+\left(2\cos\theta\right)^2-2\left(2\cos\theta\right)^2=1$

$\Rightarrow \cos\theta=\pm\dfrac{\sqrt3}{2} \Rightarrow \theta=30^o;150^o$

3. B

Sol. Since the system has non – trivial solution, therefore $\begin{vmatrix}a&1&1\\1&b&1\\1&1&c\end{vmatrix}=0$

Applying $R_1\to R_1-R_2, R_2\to R_2-R_3$, we get $\Delta=\begin{vmatrix}a-1&1-b&0\\0&b-1&1-c\\1&1&c\end{vmatrix}=0$

$\Rightarrow (a-1)(b-1)c-(1-c)+(1-b)(1-c)=0$

$\Rightarrow (1-a)(1-b)c+(1-c)+(1-b)(1-c)=0$

Dividing throughout by $(1-a)(1-b)(1-c)$, we get $\dfrac{c}{1-c}+\dfrac{1}{1-b}+\dfrac{1}{1-a}=0$

$\Rightarrow -1+\dfrac{1}{1-c}+\dfrac{1}{1-b}+\dfrac{1}{1-a}=0$

$\Rightarrow \dfrac{1}{1-c}+\dfrac{1}{1-a}+\dfrac{1}{1-b}=1.$

4. B

Sol. The volume is invariant under translation.

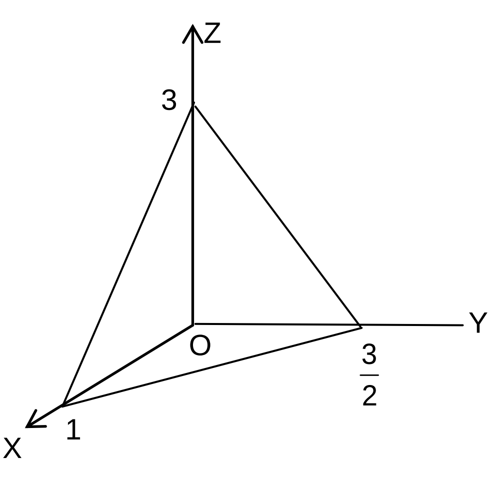
If $X=x-\dfrac43,\ Y=y-\dfrac32,\ Z=z+4,$ then the planes become $3|X|+2|Y|+|Z|=3$

The plane $3X+2Y+Z=\pm3, -3X+2Y+Z=\pm3.$

$3X+2Y-Z=\pm3$, $3X+2Y-Z=\pm3$ form an octahedron.

The plane $3X+2Y+Z=3$ forms a tetrahedron with coordinate planes in the positive octant of volume $\dfrac16.1.\dfrac32.3=\dfrac34$

Total volume $=8\times\dfrac34=6$



5. **A**

Sol. Integrating the given differential equation, we have $\frac{dy}{dx}=\frac{-\cos 3x}{3}+e^x+\frac{x^3}{3}+C_1$ but $y_1(0)=1$

so $1=\left(\frac{-1}{3}\right)+1+C_1 \Rightarrow C_1=\frac{1}{3}$.

Again integrating, we get $y=\frac{-\sin 3x}{9}+e^x+\frac{x^4}{12}+\frac{1}{3}x+C_2$

but $y(0)=0$ so $0=0+1+C_2 \Rightarrow C_2=-1$. Thus $y=\frac{-\sin 3x}{9}+e^x+\frac{x^4}{12}+\frac{1}{3}x-1$

6. ABCD

Sol. $A\subseteq A\cup B$

$\Rightarrow P(A)\le P(A\cup B)\Rightarrow P(A\cup B)\ge \frac{3}{4}$

Also,

$P(A\cap B)=P(A)+P(B)-P(A\cup B)$

$\ge P(A)+P(B)-1$

$=\frac{3}{4}+\frac{5}{8}-1=\frac{3}{8}$

Now,

$A\cap B\subseteq B$

$\Rightarrow P(A\cap B)\le P(B)=\frac{5}{8}$

$\therefore \quad \frac{3}{8}\le P(A\cap B)=\frac{5}{8}$

and

$P(A\cap B')=P(A)-P(A\cap B)$

$\Rightarrow \frac{3}{4}-\frac{5}{8}\le P(A\cap B')\le \frac{3}{4}-\frac{3}{8}$

$\Rightarrow \frac{1}{8}\le P(A\cap B')\le \frac{3}{8}$

$\therefore\ P(A\cap B)=P(B)=P(A'\cap B)$ [Using Equation (1)]

$\Rightarrow \frac{3}{8}\le P(B)-P(A'\cap B)\le \frac{5}{8}$

$\Rightarrow 0\le P(A'\cap B)\le \frac{1}{4}$

7. ABCD

Sol. $(gof)(x)=(2x-\sin x)^{1/3}$

Range of (gof) (x) is R.

8. BC

Sol. $\lim\limits_{x\to\infty}\sqrt{x}\left(\sqrt{x+1}-\sqrt{x}\right)$

$=\lim\limits_{x\to\infty}\frac{\sqrt{x}}{\sqrt{x+1}+\sqrt{x}}=\lim\limits_{x\to\infty}\frac{1}{\sqrt{1+\frac{1}{x}}+1}=\frac{1}{2}$

Option (A): $\lim\limits_{x\to 0}\frac{\ln(1+x)-x}{x^2}=\lim\limits_{x\to 0}\frac{\left(x-\frac{x^2}{2}+\frac{x^3}{3}-...\right)-x}{x^2}=-\frac{1}{2}$

Option (B): $\lim\limits_{x\to 0}\dfrac{1-\cos x}{x^2}=\lim\limits_{x\to 0}\dfrac{2\sin^2\frac{x}{2}}{4\times\left(\frac{x}{2}\right)^2}=\dfrac{1}{2}$

Option (C): $\lim\limits_{x\to 0}\dfrac{\sqrt{1+x}-1}{x}=\lim\limits_{x\to 0}\dfrac{(1+x)^{1/2}-(1)^{1/2}}{(1+x)-1}=\dfrac{1}{2}$

Option (D): $\lim\limits_{x\to 0}\dfrac{\sqrt{x}}{\sqrt{x+\sqrt{x^2+2x}}}=\lim\limits_{x\to 0}\dfrac{1}{\sqrt{1+\sqrt{1+\frac{2}{x}}}}=\dfrac{1}{\sqrt{2}}$

9. AB

Sol. $9\cos^{12}x+\cos^2 2x+1-6\cos^6 x\cos 2x-6\cos^6 x+2\cos 2x=0$

$\Rightarrow \quad (3\cos^6 x-1-\cos 2x)^2=0$

$\Rightarrow \quad \cos^2 x(3\cos^4 x-2)=0$

$\Rightarrow \quad \cos x=0$

$x=n\pi+\dfrac{\pi}{2},\ n\in I$

or $\quad \cos^4 x=\dfrac{2}{3}$

$\cos x=\pm\sqrt[4]{\dfrac{2}{3}}$

$x=m\pi\pm\cos^{-1}\sqrt[4]{\dfrac{2}{3}},\ m\in I$

10. ABD

Sol. Let any point on the line through P be $x=\alpha+r\cos\theta,\ y=2+r\sin\theta$.

Put this in $\dfrac{x^2}{9}+\dfrac{y^2}{4}=1$ and $xy=0$.

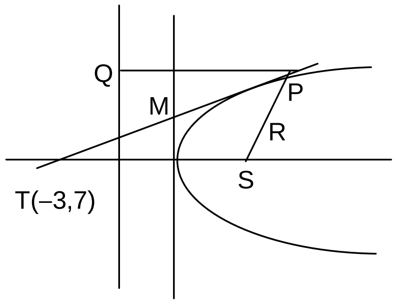
$PA\times PD=PB\times PC$

$\Rightarrow 2\alpha\sin 2\theta+5\cos 2\theta=13$

$\Rightarrow 13\le\sqrt{4\alpha^2+25}$

$\Rightarrow |\alpha|\ge 6$

11. ABCD



Sol. Equation of tangent at P is x+y=4

Clearly mirror image of R(–5,5) lies on line PQ.

Now mirror image R′ or R

$\Rightarrow\dfrac{\alpha'+5}{1}=\dfrac{\beta'-5}{1}=\dfrac{-2(-5+5-4)}{2}=4$

$\Rightarrow (\alpha',\beta')\equiv(-1,9)$

Let PM cuts the axis at T; As M is midpoint of PT

$\Rightarrow$ T is (–3, 7)

We know that SP = ST and $\angle$SMP= $\dfrac{\pi}{2}$

Equation SP $\equiv y-3=-\dfrac{1}{3}(x-1)$

$\Rightarrow x + 3y–10 = 0$

Let S $\equiv (10-3\beta,\ \beta)$

Again TS || PQ $\Rightarrow \frac{\beta-7}{13-3\beta}=\frac{9-3}{-1-1}=-3$

$\therefore$ focus is (–2, 4)

12. AD

Sol. h'(x) = f(x) $\Rightarrow$ h"(x) = f'(x)

h(1) = 0, f(1) = f'(1) = h'(1) = h"(1) = g(1)

f(g(x)) = x

f' (g(x)). g'(x) = 1

f' (g(1)). g'(1) = 1 $\Rightarrow$ g' (1) = 1

G(x) = x^2.g(x) – x. h(g(x))

G'(x) = x^2 g'(x) + 2x. g(x) – h(g(x)) – x. h'(g(x)). g'(x)

= 2x.g(x) – h(g(x))

G"(x) = 2.g(x) + x.g'(x)

G'(1) = 2g(1) – h (g(1)) = 2g(1) – h(1) = 2

G"(1) = 2.g(1) + g'(1) = 3

PART – B

1. 3

Sol. $XX^T=I$; Find PQ then $(PQ)^{10}$

2. 3

Sol. $\beta=\int_0^1\frac{2x+3x^2+4x^3}{2\sqrt{x^4+x^3+x^2}}dx$

Put $\left(x^2+x^3+x^4\right)=t \quad \Rightarrow \quad \left(2x+3x^2+4x^3\right)dx=dt$

$\beta=\int_0^3\frac{dt}{2\sqrt{t}}$

$\beta=\left[\sqrt{t}\right]_0^3=\sqrt{3} \qquad \Rightarrow \qquad \beta^2=3$

3. 3

Sol. $y=mx$ touches circle

$\Rightarrow D=0$ for $\left(m^2+1\right)x^2-2a\left(m+2\right)x+4a^2=0$

$\Rightarrow 4a^2\left(m+2\right)^2=4\left(m^2+1\right)\left(4a^2\right)$

$\Rightarrow m=0,\frac{4}{3}$

Let $A:\left(x_1,m_1x_1\right),B:\left(x_2,m_2x_2\right)$

$AB^2=9\Rightarrow\left(x_1-x_2\right)^2+\left(m_1x_1-m_2x_2\right)^2=9$ where

$x_1=\frac{\left(m_1+2\right)}{m_1^{\ 2}+1}a,\ x_2=\frac{\left(m_2+2\right)}{m_2^{\ 2}+1}a,\ m_1=0,\ m_2=\frac{4}{3}$

get $a=\frac{3\sqrt{5}}{4}$

4. 6

Sol. Let $z=x_1+iy_1,w=x_2+iy_2$

$\therefore |z-3|=\text{Re}\,z\Rightarrow(x_1-3)^2+y_1^2=x_1^2$ ....(i)

$|w-3|=\text{Re}\,w\Rightarrow(x_2-3)^2+y_2^2=x_2^2$ ...(ii)

$\arg(z-w)=\frac{\pi}{4}\Rightarrow\frac{y_1-y_2}{x_1-x_2}=\tan\frac{\pi}{4}=1$ ...(iii)

By solving (i), (ii) and (iii) we get

$$\Rightarrow \frac{y_1 - y_2}{x_1 - x_2} = \frac{6}{y_1 + y_2}$$

From (iii) $y_1 + y_2 = 6$

5. 0.50

Sol. $a\left(x^2 - x + 1\right) - \left(x^2 + x + 1\right) \ge 0$

$$\Rightarrow\ a \ge \frac{x^2 + x + 1}{x^2 - x + 1} \text{ or } a \ge \frac{\left(x^2 - x + 1\right) + 2x}{x^2 - x + 1}$$

$$\Rightarrow\ a \ge 1 + \frac{2x}{x^2 - x + 1} \text{ or } a \ge 1 + \frac{2}{\left(x + \frac{1}{x}\right) - 1}$$

Now, for $x \ge 2$, the minimum value of $x + \frac{1}{x}$ is $\frac{5}{2}$.

$$\Rightarrow\ a \ge \frac{7}{3}$$

6. 30.25

Sol. Let $\alpha - d,\ \alpha, \alpha + d$ are roots

$\therefore 3\alpha = -a$ (1)

$3\alpha^2 - d^2 = b$ (2)

$\alpha\left(\alpha^2 - d^2\right) = \frac{1}{9}$ (3)

From (1) and (2), $d^2 = \frac{a^2}{3} - b$

Put d^2 in (3) to get

$2a^3 - 9ab + 1 = 4$

7. 0.30

Sol. Let $S = \sum_{k=0}^{100}\left(\frac{k}{k+1}\right)\ {}^{100}C_k$

$$= \sum_{k=0}^{100}\frac{\left((k+1) - 1\right)}{(k+1)}\ {}^{100}C_k = \left(\sum_{k=0}^{100}\ {}^{100}C_k\right) - \sum_{k=0}^{100}\frac{{}^{100}C_k}{k+1}$$

$$= 2^{100} - \frac{1}{101}\sum_{k=0}^{100}\left(\frac{101}{k+1}\ {}^{100}C_k\right)$$

$$= 2^{100} - \frac{1}{101}\sum_{k=0}^{100}\ {}^{101}C_{k+1}$$

$$2^{100} - \left(\frac{2^{101} - 1}{101}\right) = \frac{(101)2^{100} - 2^{101} + 1}{101} = \frac{99\left(2^{100}\right) + 1}{101}$$

$$= \frac{a\left(2^{100}\right) + b}{c} \quad \text{(Given)}$$

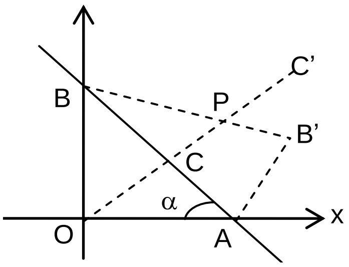
So, $a = 99,\ b = 1,\ c = 101$

Hence, $(a + b + c)_{\text{least}} = 99 + 1 + 101 = 201.$

8. 2.00

Sol. $A \equiv (1,0)$, $B = \equiv (0, tan\alpha)$, $C \equiv \left(\frac{1}{2}, \frac{tan\alpha}{2}\right)$, $B' = \left(\frac{2tan^2\alpha}{1 + tan^2\alpha}, \frac{tan^3\alpha - tan\alpha}{1 + tan^2\alpha}\right)$

$$\frac{\Delta ABB'}{\Delta BB'C}=2$$



FIITJEE RBT-9 for (JEE-Advanced)

BATCHES – Two Yr CRP2123(All)

PHYSICS, CHEMISTRY & MATHEMATICS

Pattern – 4

QP CODE: 100216

PAPER - 2

Time Allotted: 3 Hours **Maximum Marks: 186**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.
- You are not allowed to leave the Examination Hall before the end of the test.

1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains **Three Sections.**
3. **Section-I** is Physics, **Section-II** is Chemistry and **Section-III** is Mathematics.
4. Each **Section** is further divided into **Two Parts**: **Part-A & B** in the OMR.
5. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
6. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet

1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with ***Blue/Black Ball Point Pen*** for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Two Part.

(i) **PART–A** (**01–08**) contains (8) Multiple Choice Questions which have **One or More Correct** answer.
Full Marks: **+4** If only the bubble(s) corresponding to all the correct options(s) is (are) darkened.
Partial Marks: **+1** For darkening a bubble corresponding **to each correct option,** provided NO incorrect option is darkened.
Zero Marks: **0** If none of the bubbles is darkened.
***Negative Marks*: –2 In all other cases.**
For example, if **(A), (C) and (D)** are all the correct options for a question, darkening all these three will result in **+4 marks**; darkening only **(A) and (D)** will result in **+2 marks**; and darkening **(A) and (B)** will result in –**2** marks, as a wrong option is also darkened.

(ii) **Part-A (09-12) –** This section contains Two (02) List-Match Sets, each List-Match set has Two (02) Multiple Choice Questions. Each List-Match set has two lists: List-I and List-II. FOUR options are given in each Multiple Choice Question based On List-I and List-II and ONLY ONE of these four options satisfies the condition asked in the Multiple Choice Question. Each question carries **+3 Marks** for correct combination chosen and **-1 marks** for wrong options chosen.

(iii) **Part-B (01-06)** contains six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30) and each question carries **+3 marks** for correct answer. **There is no negative marking.**

Name of the Candidate :____

Batch :____________________ **Date of Examination :**____________________

Enrolment Number :____

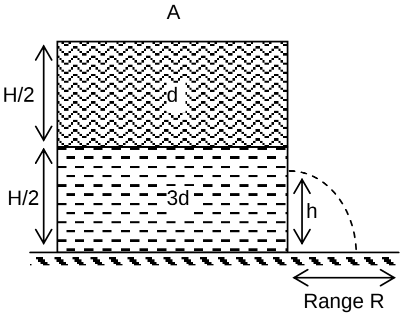
SECTION – I : PHYSICS

(PART – A)

(One or More Than One Options Correct Type)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONE** or **MORE THAN ONE is correct.**

1. A container of large uniform cross sectional area A resting on a horizontal surface holds two immiscible non viscous and incompressible liquids of density d and 3d, each of height H/2. The lower density liquid is open to the atmosphere having pressure P_0. A tiny hole of area a(a<<A) is punched to the vertical side of lower container at a height h (0<h<H/2) for which range is maximum.



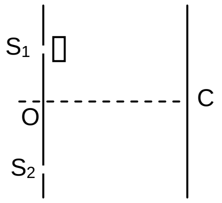
(A) $h = H/3$

(B) Range $R = \frac{2H}{3}$

(C) Range $R = \frac{3H}{2}$

(D) Velocity of efflux $v = \sqrt{\frac{2}{3}gH}$

2. A YDSE is performed in a medium of refractive index μ_1. In front of one of the slits say S_1 as shown, thin glass slab of refractive index $\mu_2 (< \mu_1)$ is kept. If initially the central maxima was formed on the central line OC then



(A) central maxima will shift upwards

(B) central maxima will shift downwards

(C) the waves reaching on the screen at C from S_1 will lead the waves reaching from S_2

(D) the waves reaching C from S_1 will lag from the waves reaching from S_2

3. Two projectile are thrown at the same time from two different points. The projectile thrown from the origin has initial velocity $3\hat{i} + 3\hat{j}$ with respect to earth. The projectile has initial velocity $a\hat{i} + b\hat{j}$ with respect to earth thrown from the point (10, 5). ($\hat{i}$ is a unit vector along horizontal, $\hat{j}$ along vertical). If the projectile collides after two second, then the

(A) value of a is -2

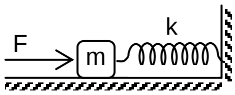
(B) value of a is $\frac{1}{2}$

(C) value of b is $\frac{1}{2}$

(D) value of b is –2

Space For Rough Work

4. A constant force F is applied on a spring block system as shown in figure. The mass of the block is m and spring constant is k. The block is placed over a smooth surface. Initially the spring was unstretched. Choose the correct alternative (s)

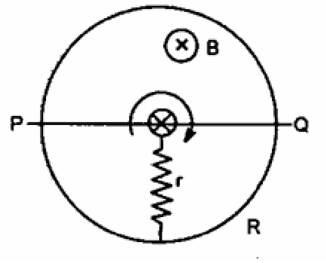


(A) the block will execute SHM
(B) amplitude of oscillation is F/2k
(C) time period of oscillation is $2\pi\sqrt{\frac{m}{k}}$
(D) the maximum speed of block is $\sqrt{\frac{2Fx - kx^2}{m}}$
(here x = F/k)

5. A particle is taken from point A to point B under the influence of a force field. Now it is taken back from B to A and it is observed that the work done in taking the particle from A to B is not equal to the work done in taking it from B to A. If W_{nc} and W_c is the work done by non conservative forces and conservative forces present in the system respectively,ΔU is the change in potential energy, Δ k is the change is kinetic energy, then
(A) $W_{nc} - \Delta U = \Delta k$
(B) $W_c = -\Delta U$
(C) $W_{nc} + W_c = \Delta k$
(D) $W_{nc} - \Delta U = -\Delta k$

6. A particle of charge q and mass m moves rectilinearly under the action of an electric field E = $\alpha - \beta x$. Here, α and β are positive constants and x is the distance from the point where the particle was initially at rest. Then,
(A) the motion of the particle is oscillatory.
(B) the amplitude of the particle is $\left(\frac{\alpha}{\beta}\right)$
(C) the mean positron of the particle is at $x = \left(\frac{\alpha}{\beta}\right)$
(D) the maximum acceleration of the particle is $\frac{q\alpha}{m}$

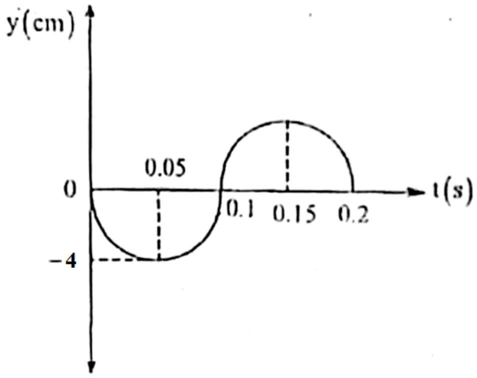
7. In figure, R is a fixed conducting ring of negligible resistance and radius a. PQ is a uniform rod of resistance r. It is hinged at the centre of the ring and rotated about this point in clockwise direction with a uniform angular velocity ω. There is a uniform magnetic field of strength B pointing inward and r is a stationary resistance. Then:



(A) current through r is zero.
(B) current through r is $\frac{2B\omega a^2}{5r}$
(C) direction of current in external resistance r is from centre to circumference.
(D) direction of current in external resistance r is from circumference to center.

Space For Rough Work

8. For a certain transverse standing wave on a long string, an antinode is formed at x = 0 and next to it, a node is formed at x = 0.10 meter, the displacement y(t) of the string particle at x = 0 is shown in figure.



(A) Transverse displacement of the particle at x = 0.05 m and t = 0.05 sec is $-2\sqrt{2}$ cm

(B) Transverse displacement of the particle at x = 0.04 m and t = 0.025 sec is $-2\sqrt{2}$ cm

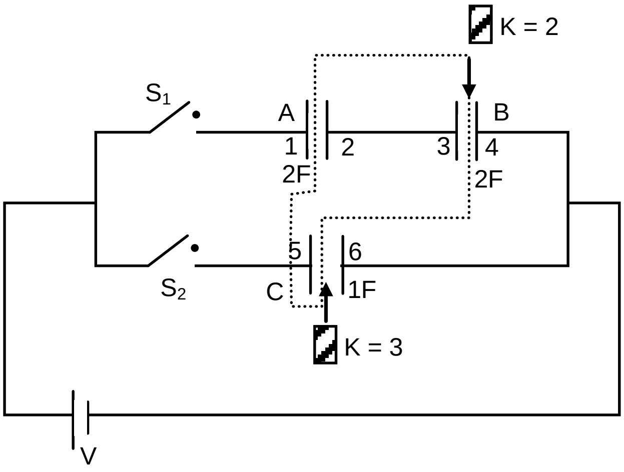
(C) Speed of travelling wave that interfere to produce this standing wave is 2 m/s.

(D) The transverse velocity of the string particle at $x = \frac{1}{15}$m and t = 0.1 sec is 20π cm/sec.

Space For Rough Work

This section contains **2 List-Match Sets**, each List-Match set has **2 Multiple Choice Questions**. Each List-Match set has two lists: List-I and List-II. Four options are given in each Multiple Choice Question based On List-I and List-II and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

List Match Set (09-10)



Change in quantities between initial and final situation is given in list-I and its numerical value in list-II.

List-I		List-II	
(I)	|Change in amount of + charge on capacitor|	(P)	0
(II)	|Change in energy|	(Q)	$\frac{1}{3}$
(III)	|Change in potential difference|	(R)	$\frac{1}{36}$
(IV)	|Final charge inside closed surface inclosing plate 2, 3 and 5 of different capacitor.|	(S)	$\frac{1}{6}$
		(T)	$\frac{1}{2}$

9. S$_1$ is closed and S$_2$ open, and V = 1 volt. In initial situation capacity are given. When capacitors are fully charged then dielectric of dielectric constant shown in figure is inserted in capacitor B to fill space between plates completely for final situation. Then for capacitor B. Choose correct option

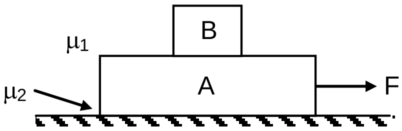
(A) I $\rightarrow$ Q, II $\rightarrow$ R, III $\rightarrow$ S, IV $\rightarrow$ P
(B) I $\rightarrow$ P, II $\rightarrow$ Q, III $\rightarrow$ R, IV $\rightarrow$ S
(C) I $\rightarrow$ R, II $\rightarrow$ S, III $\rightarrow$ Q, IV $\rightarrow$ P
(D) I $\rightarrow$ Q, II $\rightarrow$ S, III $\rightarrow$ P, IV $\rightarrow$ R

10. Now switch S$_2$ is also closed and V = 1/6 volt. In initial situation, capacitor C is completely charged then in final situation, di electric is inserted completely as shown in figure. For capacitor C.

(A) I $\rightarrow$ Q, II $\rightarrow$ R, III $\rightarrow$ T, IV $\rightarrow$ S
(B) I $\rightarrow$ P, II $\rightarrow$ Q, III $\rightarrow$ T, IV $\rightarrow$ R
(C) I $\rightarrow$ Q, II $\rightarrow$ R, III $\rightarrow$ P, IV $\rightarrow$ T
(D) I $\rightarrow$ R, II $\rightarrow$ S, III $\rightarrow$ T, IV $\rightarrow$ P

Space For Rough Work

List Match Set (11-12)



List-I		List-II	
(I)	Acceleration of A or B	(P)	$\frac{4}{3}$
(II)	Normal reaction between blocks	(Q)	$\frac{2}{3}$
(III)	Frictional force between blocks f_1	(R)	20
(IV)	Frictional force on surface f_2	(S)	0
		(T)	1

11. F = 4 Newton, $m_A = 4$, $m_B = 2$, $\mu_1 = 0.1$ and $\mu_2 = 0$, frictional force between blocks is f_1 and between surface and block A is f_2 ($g = 10$ m/sec^2)
(A) I → Q, II → P, III → R, IV → S
(B) I → Q, II → S, III → P, IV → R
(C) I → S, II → R, III → Q, IV → P
(D) I → Q, II → R, III → P, IV → S

12. F = 4 Newton, $m_A = 4$, $m_B = 2$, $\mu_1 = 0$ and $\mu_2 = \frac{1}{45}$
(A) I → QS, II → R, III → S, IV → P
(B) I → QS, II → RS, III → S, IV → T
(C) I → QR, II → P, III → R, IV → Q
(D) I → QS, II → S, III → P, IV → R

(PART – B)

(Numerical Type)

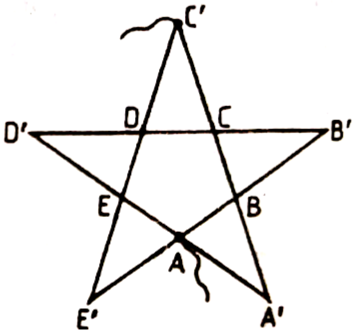
Part-B (01-06) contains six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **Two decimals Places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)**.**

1. Toluene liquid of volume 300 cm^3 at 0°C is contained in a beaker. Another quantity of toluene of volume 110 cm^3 at 100°C is in another beaker. (the combined volume is 410 cm^3). ΔV cm^3 is change in volume of the mixture of the toluene liquids when they are mixed together. Given the coefficient of volume expansion $\gamma = 0.001$/C and all forms of heat losses can be ignored. Value of ΔV is

Space For Rough Work

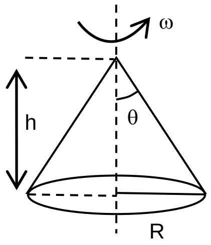
2. Two tuning forks with natural frequencies 340 Hz each move relative to a stationary observer. One fork moves away from the observer while the other moves towards him at the same speed. The observer hears beats of frequency 3 Hz. Find the speed of the tuning fork. Velocity of tuning fork is small in comparison to velocity of sound. (velocity of sound in air is 340 m/s).

3. A five-pointed regular star has been formed from a uniform wire. Calculate the equivalent resistance between points A and C′. Take sin 18° = 1/3 and the resistance of the sections AA′ = A′B = BB′ = …. = r = $\frac{1}{2}\Omega$.



4. Three concentric thin spherical shells are of radii a, b and c (a < b < c). The first and third are connected by a fine wire through a small hole in the second. The second is connected to earth. Find the capacity of the condenser formed in μF. (a : b : c = 1 : 2 : 3, $\frac{1}{4\pi\varepsilon_0} = 9\times10^9$, a = 90 m)

5. ‘Q’ charge is uniformly distributed over the curve surface of a right circular cone of semi-vertical angle θ and height h. The cone is uniformly rotated about its axis at angular velocity ω. Magnetic moment associated with the cone is found to be $nQ\omega h^2\tan^2\theta$ where value of ’n’ is



6. In an experiment of photoelectric effect light of wavelength 400 nm is incident on a metal plate at the rate of 5W. the potential of the collector plate is made sufficiently positive with respect to emitter so that the current reaches the saturation value. Assuming that on the average one out of every 10^6 photons is able to eject a photoelectron, find the photocurrent in the circuit. (in micro ampere)

Space For Rough Work

SECTION – II : CHEMISTRY

(PART – A)

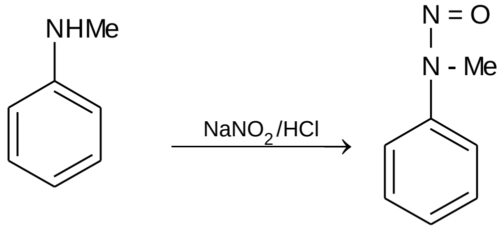
(One or More Than One Options Correct Type)

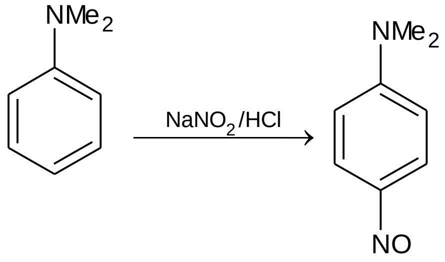
This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONE** or **MORE THAN ONE is correct.**

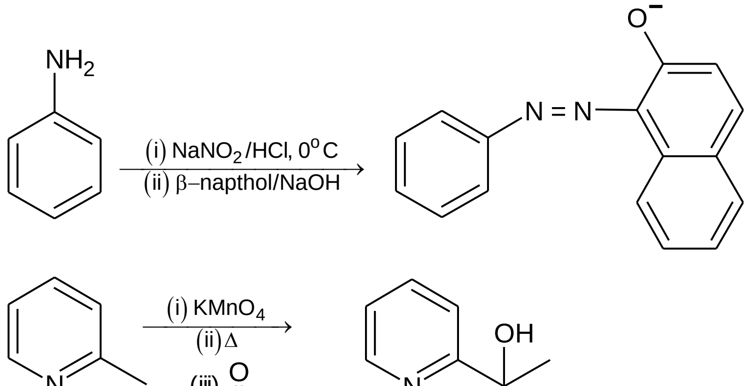
1. Which of the following pairs produce same gas?
(A) (Ca_3N_2 + dil. HCl) and (NH_4NO_2 on heating)
(B) [$(NH_4)_2Cr_2O_7$ on heating] and (NH_4NO_2 on heating)
(C) (NH_4NO_3 on heating) and [$Hg(NO_3)_2$ on heating]
(D) (NH_4Cl on heating) and [$NaNO_3$ + Zn + $NaOH_{(aq.)}$ on heating]

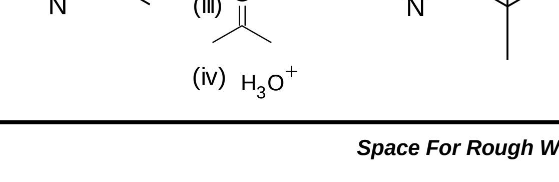
2. A current is passed through 500 mL of an aqueous solution of CaI_2. After sometime, it is observed that 50 millimoles of I_2 have been formed. Which of the following statements is(are) correct?
(A) The number of faradays of charge passed through the solution is 0.10 F.
(B) The volume of dry H_2 at STP that has been formed during electrolysis is 1120 mL.
(C) The pH of the solution is nearly 0.7.
(D) The mass of calcium produced is 2.0 g.

3. Products of which of the following reactions is/are correctly represented.

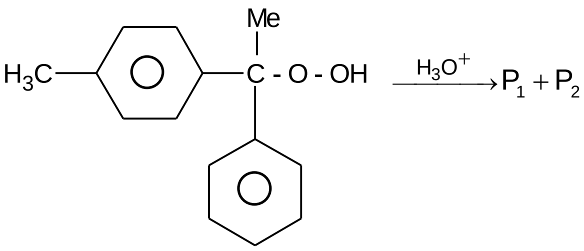
(A)


(B)


(C)


(D)


Space For Rough Work

4. 

P_2 + $FeCl_3$ → Violet Colour
P_1 + NaOI → P_3↓ + P_4
yellow

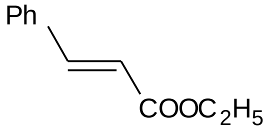
The correct statement/s for the above sequence is/are
(A) P_3 on reaction with Ag gives acetylene
(B) P_4 on reaction with sodalime gives toluene
(C) P_4 on reaction with sodalime gives benzene
(D) P_1 on reaction with $LiAlH_4$ gives a compound which gives blue colour in Victor Meyer test

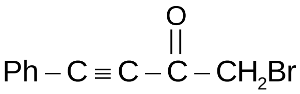
5. During the production of iron and steel.
(A) The oxide ore is primarily reduced to iron by solid coke according to the reaction.
$$2Fe_2O_3 + 3C \longrightarrow 4Fe + 3CO_2$$
(B) The oxide ore is reduced by the carbon monoxide according to the reaction
$$Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$$
(C) Major silica impurities are removed as calcium silicate slag by addition of a fluxing agent lime stone.
(D) The converter slag containing phosphorus is used as a fertilizer.

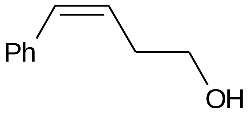
6. Select the correct statement(s)
(A) the value of rate constant cannot exceed the value of Arrhenius factor
(B) molecularity of multiple step reaction can be obtained from mechanism
(C) half life of a fourth order reaction is linearly dependent on initial concentration of reactant
(D) reactions with order ≥ 1 cannot get complete infinite time interval

7. $$Ph \equiv H \xrightarrow[\text{2.BrCH}_2\text{COOC}_2\text{H}_5]{\text{1.MeMgBr}} P \xrightarrow[H_2]{Pd/BaSO_4} Q \xrightarrow[\text{dry ether}]{LiAlH_4} R$$

Select correct compound/s

(A) 'Q' is 

(B) 'P' is 
$Ph-C\equiv C-\overset{\overset{O}{||}}{C}-CH_2Br$

(C) 'R' is 

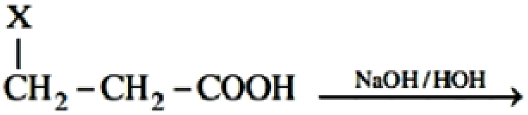
(D) 'P' is $Ph-C\equiv C-CH_2-COOC_2H_5$

Space For Rough Work

8. Which of the following reactions will have α-hydroxy acid as a product?

(A) $CH_3\text{–}CHO \xrightarrow[(ii)\,H_2O/H^{\oplus}/\Delta]{(i)\,NaCN/HCl}$

(B) $CH_3\text{–}CHO + Br\text{–}CH_2\text{–}COOC_2H_5 \xrightarrow[(ii)\,NH_4Cl/HOH \;\; (iii)\,HOH/H^{\oplus}/\Delta]{(i)\,Zn}$

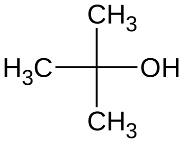
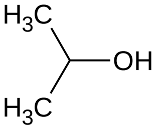
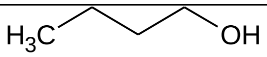
(C) 
$\overset{X}{\overset{|}{CH_2}} - CH_2 - COOH \xrightarrow{NaOH/HOH}$

(D) $CH_3CH_2Br \xrightarrow[(ii)\,Red P/Br_2 \;\; (iii)\,NaOH]{(i)\,NaCN\ followed\ by\ hydrolysis}$

This section contains **2 List-Match Sets**, each List-Match set has **2 Multiple Choice Questions**. Each List-Match set has two lists: List-I and List-II. Four options are given in each Multiple Choice Question based On List-I and List-II and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

List Match Set (09-10)

Match the lists and answer the following question.

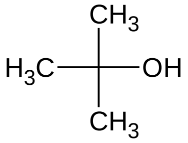
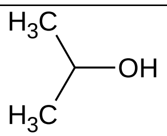
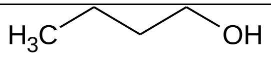
List – I		List – II	
Alcohols subjected to Lucas reagent		Observation	
(I)		(P)	White turbidity after boiling only
(II)	$PhCH_2OH$	(Q)	Turbidity instantaneously
(III)		(R)	Appearance of turbidity after 5-10 minutes of addition of reactants
(IV)		(S)	No visible change observed
		(T)	Red colour is obtained

9. Which combination is correct according to the above list?

(A) I → R
(B) II → Q
(C) III → S
(D) IV → T

Space For Rough Work

Match the lists and answer the following question.

List – I		List – II	
Alcohols subjected to Lucas reagent		Observation	
(I)		(P)	White turbidity after boiling only
(II)	PhCH$_2$OH	(Q)	Turbidity instantaneously
(III)		(R)	Appearance of turbidity after 5-10 minutes of addition of reactants
(IV)		(S)	No visible change observed
		(T)	Red colour is obtained

10. Which combination is correct according to the above list?

(A) I → R (B) II → S

(C) III → Q (D) IV → P

List Match Set (11-12)

Match the Lists and answer the following question.

List– I		List – II	
(I)	Neso Silicate	(P)	$\left(SiO_3\right)_n^{2n-}$
(II)	Soro Silicate	(Q)	$\left(Si_2O_5\right)_n^{2n-}$
(III)	Cyclic Silicate	(R)	$\left(Si_2O_7\right)^{6-}$
(IV)	Phyllo Silicate	(S)	None of the O atom is shared
		(T)	All oxygen atoms are shared

11. Which combination is correct according to the above list?

(A) I → Q (B) II → S

(C) III → P (D) IV → P

Space For Rough Work

Match the Lists and answer the following question.

List– I		List – II	
(I)	Neso Silicate	(P)	$\left(SiO_3\right)_n^{2n-}$
(II)	Soro Silicate	(Q)	$\left(Si_2O_5\right)_n^{2n-}$
(III)	Cyclic Silicate	(R)	$\left(Si_2O_7\right)^{6-}$
(IV)	Phyllo Silicate	(S)	None of the O atom is shared
		(T)	All oxygen atoms are shared

12. Which combination is correct according to the above list?
(A) I → S
(B) II → P
(C) III → Q
(D) IV → T

(PART – B)

(Numerical Type)

Part-B (01-06) contains six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **Two decimals Places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)**.**

1. 3.64 g of silver salt of an organic dibasic acid yields, on strong heating, 2.16 g of silver. If the weight percentage of carbon in acid 8 times the weight percentage of hydrogen and one-half the weight percentage of oxygen, if the molecular formula of the acid is written as $C_xH_yO_z$. Then find x + y + z = ?
[Atomic weight of Ag = 108]

2. How many of the following statements are incorrect?
(a) Spontaneous adsorption of gases on solid surface is an endothermic process as entropy decreases during adsorption.
(b) Formation of micelles takes place when temperature is below Kraft Temperature (T_k) and concentration is above critical micelle concentration (CMC).
(c) A colloid of $Fe(OH)_3$ is prepared by adding a little excess [required to completely precipitate Fe^{3+} ions as $Fe(OH)_3$)] of NaOH in $FeCl_3$ solution the particles of this sol will move towards anode during electrophoresis.
(d) According to Hardy-Schulze rule for the coagulation of As_2S_3 sol flocculation value of Fe^{3+} ion will be more than Ba^{2+} or Na^+.
(e) In Micelle formation of ionic soap, entropy decreases

3. How many of following is/are paramagnetic in nature?
$[NiCl_4]^{2-}$, $[Ni(CO)_4]$, $[PtCl_4]^{2-}$, $[Cu(NH_3)_4]^+$, $[Co(H_2O)_6]^{2+}$, $K_2[NiF_6]$, $[Ni(NH_3)_6]^{2+}$, $[Co(CN)_6]^{3-}$, $[Ti(H_2O)_6]^{3+}$, $[Cr(CN)_6]^{4-}$, $[Fe(NH_3)_6]^{2+}$, $[PtCl_6]^{2-}$

Space For Rough Work

4. Na_2HPO_4 and NaH_2PO_4 on heating at high temperature produce a chain sodium pentaphosphate quantitatively of ideal molar ratio of Na_2HPO_4 to NaH_2PO_4 is x : y & total charge on pentaphosphate anion is z then calculate value of $\frac{x}{y} \times z$.

5. 10 g Neon initially at a pressure of 506.625 KPa and temperature of 473 K expand adiabatically to a pressure of 202.65 KPa. Calculate entropy change (in JK^{-1}) of universe of expansion is a free expansion.

6. The value of rate constant for the gas phase reaction $2NO_2 + F_2 \longrightarrow 2NO_2F$ is 38 dm^3 $mol^{-1}s^{-1}$ at 300 K. the order of reaction is ______?
Write "1000" if the order cannot be predicated with given information

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Space For Rough Work

SECTION – III : MATHEMATICS

(PART – A)

(One or More Than One Options Correct Type)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D), out of which **ONE** or **MORE THAN ONE is correct.**

1. If $f(x)=\begin{vmatrix}\sec^2 x & 1 & 1\\ \cos^2 x & \cos^2 x & \operatorname{cosec}^2 x\\ 1 & \cos^2 x & \cot^2 x\end{vmatrix}$ then

(A) $\int_{-\pi/4}^{\pi/4} f(x)\,dx=\frac{1}{16}(3\pi+8)$ (B) $f'\left(\frac{\pi}{2}\right)=0$

(C) Maximum value of $f(x)$ is 1 (D) Minimum value of $f(x)$ is 0.

2. If $A(\alpha,\beta)=\begin{bmatrix}\cos\alpha & \sin\alpha & 0\\ -\sin\alpha & \cos\alpha & 0\\ 0 & 0 & e^{\beta}\end{bmatrix}$, then

(A) $A(\alpha,\beta)'=A(-\alpha,\beta)$ (B) $A(\alpha,\beta)^{-1}=A(-\alpha,-\beta)$

(C) $\text{Adj}(A(\alpha,\beta))=e^{\beta}A(-\alpha,-\beta)$ (D) $A(\alpha,\beta)'=A(\alpha,-\beta)$

3. If n objects are arranged in a row, then the number of ways of selecting three of these objects so that no two of them are next to each other is

(A) $\frac{1}{6}(n-2)(n-3)(n-4)$ (B) ${}^{n-2}C_3$

(C) ${}^{n-3}C_3+{}^{n-3}C_2$ (D) None of these

4. Let $\alpha(n)=1-\frac{1}{2}+\frac{1}{3}-............+(-1)^{n-1}\frac{1}{n}$

(A) $\frac{1}{n+1}+\frac{1}{n+2}+.......+\frac{1}{2n}=\alpha(2n)$ (B) $\alpha(2n)<1\forall n$

(C) $\alpha(2n)\ge 0.5\forall n$ (D) $0.5<\alpha(n)<1\forall n$

5. If $\int_0^{\alpha}\frac{dx}{1-\cos\alpha\cos x}=\frac{A}{\sin\alpha}+B(a\ne 0)$. Then possible values of A and B are

(A) $A=\frac{\pi}{2}, B=0$ (B) $A=\frac{\pi}{4}, B=\frac{\pi}{4\sin\alpha}$

(C) $A=\frac{\pi}{6}, B=\frac{\pi}{\sin\alpha}$ (D) $A=\pi, B=\frac{\pi}{\sin\alpha}$

Space For Rough Work

6. The solution of $\frac{dy}{dx} = \sqrt{y-x}$ is given by

(A) $x + C = 2\sqrt{y-x} + 2\log\left(\sqrt{y-x} - 1\right)$
(B) $x^2 + C = 2\sqrt{y-x} + \log\left(\sqrt{y-x} - 1\right)$
(C) $x + C = (y-x)^2 + \log(y-x-1)$
(D) $\sqrt{y-x} - 1 = C' \, e^{x/2-\sqrt{y-x}}$

7. If sines of the angle A and B of a triangle ABC satisfy the equation $c^2x^2 - c(a+b)x + ab = 0$, then the triangle

(A) is acute angled
(B) is right angled
(C) is obtuse angled
(D) satisfies $\sin A + \cos A = \frac{(a+b)}{c}$

8. In the expansion of $\left(x^2 + 1 + \frac{1}{x^2}\right)^n$, $n \in N$,

(A) number of terms is $2n+1$
(B) coefficient of constant term is $2^n - 1$
(C) coefficient of x^{2n-2} is n
(D) coefficient of x^2 is n

This section contains **2 List-Match Sets**, each List-Match set has **2 Multiple Choice Questions**. Each List-Match set has two lists: List-I and List-II. Four options are given in each Multiple Choice Question based On List-I and List-II and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

List Match Set (09-12)

9. Match the following

List – I		**List – II**	
(I)	The radical axis of two circles	(P)	Subtends a right angle at a point of intersection.
(II)	The common tangent to two intersecting circles of equal radii	(Q)	Is perpendicular to the line joining the centres.
(III)	The common chord of two intersecting circles	(R)	Is parallel to the line joining the centres.
(IV)	The line joining the centres of two circles intersecting orthogonally	(S)	Is bisected by the line joining the centres.
		(T)	Is parallel to common normals

Which is correct option?

(A) I →Q
(B) II → P
(C) III →R
(D) IV →S

Space For Rough Work

10. Match the following

	List - I		List – II
(I)	$f(x)=x\,\operatorname{sgn}(x-1)$	(P)	$\lim\limits_{x\to1} f(x)$ does not exist
(II)	$f(x)=\dfrac{\sin\left(\sin\left(\tan\left(\dfrac{x^2}{2}\right)\right)\right)}{\log\cos 3x}$	(Q)	$\lim\limits_{x\to0} f(x)$ doesn't exist
(III)	$f(x)=\dfrac{\sqrt[3]{1+\tan^{-1}3x}-\sqrt[3]{1-\sin^{-1}3x}}{\sqrt{1-\sin^{-1}2x}-\sqrt{1+\tan^{-1}2x}}$	(R)	$\lim\limits_{x\to0} f(x)=\dfrac{-1}{9}$
(IV)	$f(x)=\dfrac{e^{1/x}-1}{e^{1/x}+1}$	(S)	$\lim\limits_{x\to0} f(x)=-1$
		(T)	$\lim\limits_{x\to0} f(x)=2$

Which is correct option?

(A) I → S
(B) II → R
(C) III → Q
(D) IV → P

11. Match the sequence $a_1, a_2, a_3, \ldots\ldots\ldots$ whose nth term is given on the left with properties of the sequence on the right .

	List - I		List – II
(I)	$a_n=\int_0^{\pi/2}\dfrac{1-\cos 2nx}{1-\cos 2x}\,dx$	(P)	$a_1, a_2, a_3\ldots\ldots$ are in A.P.
(II)	$I_n=\int_0^{\pi/4}\tan^n x\,dx$ and $a_n=\dfrac{1}{I_{n+1}+I_{n+3}}$	(Q)	$a_1, a_2, a_3, \ldots\ldots.$ are in G.P.
(III)	$I_n=\int_0^{\pi/4}\dfrac{\sin^2 nx}{\sin x}\,dx\ \forall n\ge 0$ and $a_n=I_n-I_{n-1}\forall n\ge 1$	(R)	$a_1, a_2, a_3, \ldots\ldots$ are in H.P.
(IV)	$b_n=\int_0^{\pi/2}\dfrac{\sin^2 nx}{\sin^2 x}\,dx,\ a_n=b_n-b_{n-1}\ \forall n\ge 1$	(S)	$a_1, a_2, a_3, \ldots\ldots$ is constant sequence.
		(T)	$a_{n+1}=a_n+a_n^2$

Which is correct option?

(A) I → Q
(B) II → T
(C) III → R
(D) IV → S

Space For Rough Work

12. Lines $y^2 - xy = 0$ make Intercepts on curve given on R.H.S of Matrix.

List – I		List – II	
(I)	2	(P)	$\frac{x^2}{3} + y^2 = 1$
(II)	4	(Q)	$x^2 + \frac{y^2}{3} = 1$
(III)	$\sqrt{6}$	(R)	$x^2 + y^2 = 4$
(IV)	$2\sqrt{3}$	(S)	$y^2 = 2\sqrt{2}x$
		(T)	$x^2 - y^2 = 2$

Which is correct option?

(A) I $\rightarrow$Q
(B) II $\rightarrow$ P
(C) III $\rightarrow$S
(D) IV $\rightarrow$R

(PART – B)

(Numerical Type)

Part-B (01-06) contains six (06) Numerical based questions, the answer of which maybe positive or negative numbers or decimals to **Two decimals Places** (e.g. 6.25, 7.00, -0.33, -.30, 30.27, -127.30)**.**

1. If $f:[0,1] \to R$ is a continuous function satisfying $\int_0^1 f(x)dx = \frac{1}{3} + \int_0^1 \left(f\left(x^2\right)\right)^2 dx$, then the reciprocal of $\frac{1}{8} f\left(\frac{1}{4}\right)$ is __________

2. Any chord of conic $x^2 + y^2 + xy = 1$ passing through origin is bisected at point (p, q), then $\frac{(p+q+1)}{8}$ equals __________

3. Compute the square of the value of the expression $\frac{4 + \sec 20^o}{\operatorname{cosec} 20^o}$

4. Let $f(x) = x - \frac{1}{x}$. Then find the number of different solutions to the equation $f(f(f(x))) = 1$.

5. If the total number of selections that can be made from n different books each having 5 copies taking at least 2 copies of each book is 256, then n =

6. The positive integral value of n such that $1.2^1 + 2.2^2 + 3.2^3 + 4.2^4 + ...n.2^n = 2 + 2^{n+5}$, is

Space For Rough Work

Q. P Code:

Answers

SECTION – I : PHYSICS

(PART – A)

1.	ABD	2.	BC	3.	AC	4.	ACD
5.	ABC	6.	ABCD	7.	BD	8.	ACD
9.	A	10.	C	11.	D	12.	A

(PART – B)

1.	0.75	2.	1.50	3.	0.50	4.	0.11
5.	0.25	6.	1.6 (Range: 1.60 to 1.62)				

SECTION – II : CHEMISTRY

(PART – A)

1.	BD	2.	AB	3.	ABCD	4.	ACD
5.	BCD	6.	AD	7.	CD	8.	AD
9.	B	10.	D	11.	C	12.	A

(PART – B)

1.	16	2.	4	3.	6		
4.	-4.66(Range-4.6 to -4.7)			5.	3.81 JK^{-1} (Range 3.7 to 3.9)		
6.	2						

SECTION – III : MATHEMATICS

(PART – A)

1.	ABCD	2.	ABC	3.	ABC	4.	ABC
5.	AB	6.	AD	7.	BD	8.	AC
9.	A	10.	A	11.	C	12.	A

(PART – B)

1.	0.25	2.	0.125	3.	3.00	4.	1.00
5.	4.00	6.	17.00				

Answers & Solutions
SECTION – I : PHYSICS

(PART – A)

1. **ABD**

Sol. Bernoulli's Theorem for an orifice at depth 'x' in liquid '3d'.

$$P_o + \left(dg\frac{H}{2} + 3dg.x\right) = P_o + \frac{1}{2} \times 3d \times v^z \quad \ldots(1)$$

$$\frac{H}{2} - x = \frac{1}{2}gt^2 \quad \ldots(2)$$

$$R = Vt \quad \ldots(3)$$

Solve for R and apply maxima/minima.

2. **BC**

Sol. Introduction of sheet decrease optical path length.

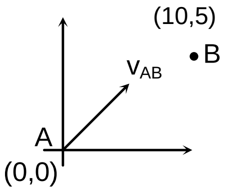
3. **AC**

Sol. $\vec{v}_{AB} = (3-a)\hat{i} + (3-b)\hat{j}$

$\vec{a}_{AB} = \vec{o}$

$(3-a) \times 2 = 10$ and $(3-b) \times 2 = 5$

a = –2 and b = $\frac{1}{2}$



4. **ACD**

Sol. $Fx - \frac{1}{2}kx^2 = \frac{1}{2}mv^2$

$\Rightarrow \sqrt{\frac{2Fx - kx^2}{m}} = v$

Where $x = \frac{F}{k}$

5. **ABC**

Sol. Using work energy theorem $W_C + W_{nc} = \Delta K$

Where $W_k = -\Delta U$.

6. **ABCD**

Sol. $a = \frac{F}{m} = \frac{qE}{m} = \frac{q}{m}(\alpha - \beta x) \quad \ldots(1)$

a = 0 at $x = \frac{\alpha}{\beta}$

i.e., force on the particle is zero at $x = \frac{\alpha}{\beta}$

So, mean position of the particle is at $x = \frac{\alpha}{\beta}$

Equation (1) can be written as $v\frac{dv}{dx} = \frac{q}{m}(\alpha - \beta x)$

$\therefore \int_0^v vdv = \frac{q}{m}\int_0^x (\alpha - \beta x)\, dx$

$\underline{\therefore}$

$$v = \sqrt{\frac{2qx}{m}\left(\alpha - \frac{\beta}{2}x\right)}$$

$$v = 0 \text{ at } x = 0 \text{ and } x = \frac{2\alpha}{\beta}$$

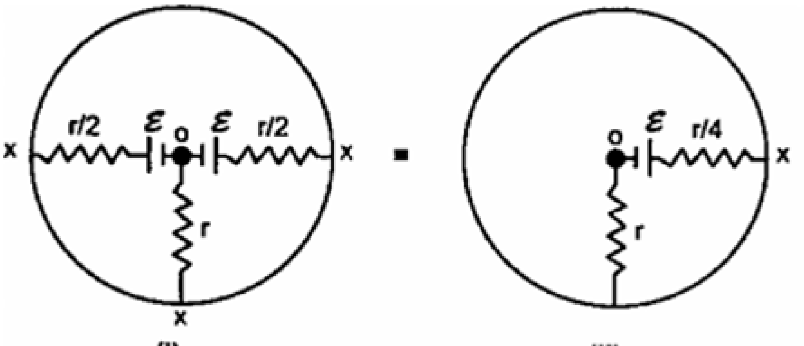
So, the particle oscillates between x = 0 and $x = \frac{2\alpha}{\beta}$

with mean position at $x = \frac{\alpha}{\beta}$.

Maximum acceleration of the particle is at extreme positions (at x = 0 or x = $2\alpha/\beta$) and $a_{max} = q\,\alpha/m$ [from equation (1)].

7. **BD**

Sol. Equivalent circuit:



(i) (ii)

Induced e.m.f. $\varepsilon = \left(\frac{B\omega a^2}{2}\right)$ ($\because$ radius = a)

By nodal equation:

$$4\left(\frac{x-\varepsilon}{r}\right) + \left(\frac{x-0}{r}\right) = 0$$

$$5x = 4\varepsilon$$

$$\Rightarrow \qquad x = \frac{4\varepsilon}{5} = \frac{2B\omega a^2}{5}$$

and $I = \frac{x}{r} = \frac{2B\omega a^2}{5r}$

Also direction of current in (i) will be toward negative terminal, i.e., from rim to origin alternating, by equivalent of cells figure.

$$I = \frac{\varepsilon}{r + \frac{r}{4}} = \frac{4\varepsilon}{5r} = \frac{2B\omega a^2}{5r}$$

8. **ACD**

Sol. y(x, t) = – cos kx sinωt

$$Y(0.05, 0.05) = -4\cos\left(\frac{2\pi}{0.4}0.05\right)\sin\left(\frac{2\pi}{0.2}0.05\right)$$

$$= -4\cos\left(\frac{\pi}{4}\right)\sin\left(\frac{\pi}{2}\right) = -2\sqrt{2}\text{ cm}$$

$$v = f\lambda = \frac{0.4}{0.2} = 2 \text{ m/s}$$

$$\frac{\partial y}{\partial t} =\sim A\omega\cos(kx)\cos(\omega t)$$

$$= \sim 4\left(\frac{2\pi}{0.2}\right)\cos\left(\frac{2\pi}{0.4}\frac{1}{15}\right)\cos\left(\frac{2\pi}{0.2}0.1\right)$$

$\frac{\partial y}{\delta t} =$ 20π cm/sec = particle velocity.

9. **A**

Sol. C_{eq} = 1 F of capacitors A and B before inserting dielectric. Final C_{eq} of A and B = $\frac{4}{3}F$.

$$\therefore \quad \Delta Q = (\Delta C)V = \left(\frac{4}{3}-1\right)\times 1 = \left(\frac{1}{3}\right)$$

$$\Delta U = \left|\frac{\left(\frac{4}{3}\right)^2}{2\times 4} - \frac{(1)}{2\times 2}\right| = \left|\frac{2}{9}-\frac{1}{4}\right| = \frac{1}{36}$$

$$\Delta V = \left|\frac{q_2}{C_2}-\frac{q_1}{C_1}\right| = \left|\frac{\left(\frac{4}{3}\right)}{4}-\frac{1}{2}\right| = \left|\frac{1}{3}-\frac{1}{2}\right| = \frac{1}{6}$$

10. **C**

Sol. $C_{initial} = 1F$

$C_{final} = 3F$

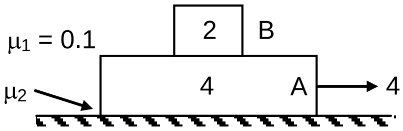
$\Delta Q = (C_f - C_i)V = 2\times\frac{1}{6} = \frac{1}{3}$

$$\Delta U = \frac{1}{2}C_f V^2 - \frac{1}{2}C_i V^2 = \frac{1}{2}\times 2\times\frac{1}{36} = \frac{1}{36}$$

$Q_{final} = C_{final}\ V = 3\times\frac{1}{6} = \frac{1}{2}$

11. **D**

Sol.



If both block have together, their common acceleration

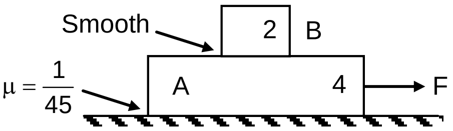
$$a = \frac{4}{6} = \left(\frac{2}{3}\right)$$

Maximum possible acceleration of block B = μg = 1 which is greater than common acceleration. Therefore both block will move together.

$$f_1 = ma = 2\times\frac{2}{3} = \frac{4}{3}$$

12. **A**

Sol.



$$a = \frac{F-f}{4} = \frac{4-\left(\frac{1}{45}\right)60}{4} = \frac{2}{3}$$

B will be at rest

$$f = \mu(2+6)g = \frac{60}{45} = \frac{4}{3}$$

(PART – B)

1. **0.75**

Sol. $m_1 = \rho_0 \times 300$

$m_2 = \rho_{100} \times 110$

Suppose final temp = T

$m_1S(T - 0) = m_2S(100 - T)$

$\rho_0 \times 300\ T = \rho_{100} \times 110(100 - T)$

$$300\ \rho_0 T = \frac{\rho_0 \times 110}{(1+\gamma\times 100)} \times (100 - T)$$

$$300\ T = \frac{110}{1.1} \times (100 - T)$$

$3T = 100 - T$

$\Rightarrow \quad T = 25°$

$V_{final} = 300(1+ 0.001 \times 25) + 110(1 - 0.001 \times 75)$

$= 410 + 7.5 - 8.25 = 409.25\ cm^3$

Change = 0.75 cm^3.

2. **1.50**

Sol. Given: $f_1 - f_2 = 3$

or $$\left(\frac{v}{v - v_s}\right)f - \left(\frac{v}{v + v_s}\right)f = 3$$

or $$\left[\frac{1}{\left(1 - \frac{v_s}{v}\right)} - \frac{1}{\left(1 + \frac{v_s}{v}\right)}\right]f = 3$$

or $$\left[\left(1 - \frac{v_s}{v}\right)^{-1} - \left(1 + \frac{v_s}{v}\right)^{-1}\right]f = 3$$

or $$\left[\left(1 + \frac{v_s}{v}\right) - \left(1 - \frac{v_s}{v}\right)\right]f = 3$$

or $$\frac{2v_s f}{v} = 3$$

or Speed of tuning fork $v_s = \dfrac{3v}{2f}$

Substituting the values, we get

$$v_s = \frac{(3)(340)}{(2)(340)} = 1.5\ m/s$$

3. **0.50**

Sol. Each of angle A′, B′, C′, … is 36°.

$\therefore$ Resistance of AB = 2 × r sin 18° = $2r \times \frac{1}{3} = \frac{2}{3}r$

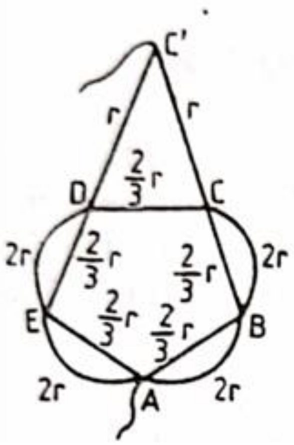


Fig. (a)

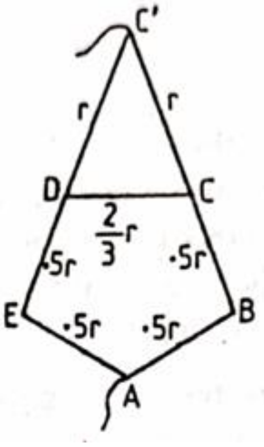


Fig. (b)

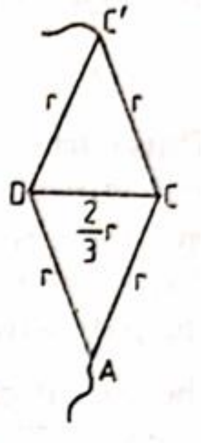


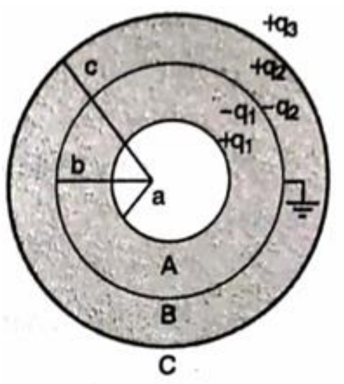
Fig. (c)

AA′ and A′B are in series and so they sum up to 2r. Similarly BB′ and B′C, DD′ and D′E, and EE′ and E′A sum up to 2r. This is shown in figure (a). In each side 2r and $\frac{2r}{3}$ in parallel sum up to 0.5 r, this is shown in figure b. The next reduction is shown if figure (c). D and C are equipotential points and hence DC′ and CC′ are in parallel and they sump up to $\frac{r}{2}$; AD and AC are in parallel and they sum up to $\frac{r}{2}$. So the required resistance is r.

4. **0.11**

Sol. If a charge q is given to the outermost sphere C, some of the charge will go to the outer surface of sphere A. Some will go to the inner surface of C and the rest will go to the outer surface of C. The charge q_1 on sphere A will induce a charge $-q_1$ on the inner surface of sphere B. Charge q_2 on the inner surface of sphere C will induce a charge $-q_2$ on the outer surface of sphere B.

In this way three capacitors are formed. One between the outer surface of A and inner surface of B. Second between the outer surface of B and inner surface of C and third by the outer surface of C.



Their capacities are

$$C_1 = 4\pi\varepsilon_0 \frac{ab}{b-a} \;;$$

$$C_2 = 4\pi\varepsilon_0 \frac{bc}{c-b} \quad \text{and} \quad C_3 = 4\pi\varepsilon_0 c$$

Hence the combined capacity is

$$C = C_1 + C_2 + C_3$$

$$C = 4\pi\varepsilon_0\left[\frac{ab}{b-a} + \frac{bc}{c-b} + c\right] - 4\pi\varepsilon_0\left[\frac{ab}{b-a} + \frac{c^2}{c-b}\right]$$

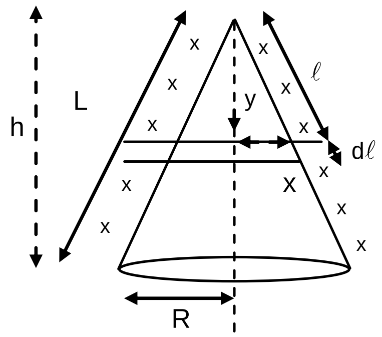
5. **0.25**

Sol. Charge on ring = $q' = \frac{Q}{\pi RL} 2\pi x d\ell$

Magnetic moment due to ring = $\frac{q'\omega}{2\pi}\pi x^2$

$$= \left(\frac{Q\,2xd\ell}{RL}\right)\frac{\omega x^2}{2}$$

$$= \frac{Q\,\omega d\ell}{RL}\left(\frac{R}{L}\ell\right)^3$$



$$\frac{x}{\ell} = \frac{R}{L}$$

$$\frac{R}{h} = \tan\theta$$

$$= \frac{Q\,\omega R^2}{L^4}\ell^3 d\ell$$

Total magnetic moment = $\frac{Q\omega R^2}{L^4}\int_0^L \ell^3 d\ell = \frac{Q\omega R^2}{4}$

$$= \frac{Q\omega h^2 \tan^2\theta}{4}$$

$= 0.25\ Q\omega h^2 \tan^2\theta$

6. **1.6 (Range: 1.60 to 1.62)**

Sol. $E = \frac{12375}{4000}$ = 3.1 eV

Number of photoelectrons emitted per second,

$$n = \left(\frac{1}{10^6}\right)\left(\frac{5}{3.1 \times 1.6 \times 10^{-19}}\right)$$

$= 1.0 \times 10^{13}$ per second

∴ $i = ne$

$= 1.0 \times 10^{13} \times 1.6 \times 10^{-19}$

$= 1.6 \times 10^{-6}$ A

$= 1.6\ \mu$A

SECTION – II : CHEMISTRY

(PART – A)

1. BD

Sol. The gases formed in the options are
(A) NH_3 and N_2
(B) N_2 and N_2
(C) N_2O and O_2
(D) NH_3 and NH_3

2. AB

Sol. $2I^- \longrightarrow I_2 + 2e^-$

$\therefore$ One mole I_2 needs 2F of electricity.

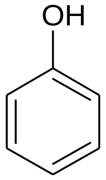
3. ABCD

Sol. $NaNO_2 + HCl \longrightarrow NaCl + HNO_2$

$$H - \overset{\frown}{O} - N = O + H^+ \longrightarrow \underset{\text{Attacking species}}{NO^+} + H_2O$$

4. ACD

Sol. $P_1 = CH_3COCH_3$

$P_2 =$ 

$P_4 = CH_3COONa$

5. BCD

Sol. The correct reaction in (A) is $Fe_2O_3 + C \longrightarrow 2FeO + CO$

6. AD

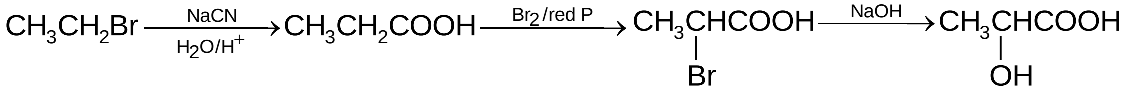
Sol. All zero order reactions complete in two half lives.

7. CD

Sol. Q is Ph – CH = $CHCH_2COOC_2H_5$(Cis-)

8. AD

Sol. $CH_3CHO \xrightarrow[\text{(ii) } H_2O/H^+/\Delta]{\text{(i) NaCN/HCl}} CH_3CH(OH)COOH$



$$CH_3CH_2Br \xrightarrow[H_2O/H^+]{NaCN} CH_3CH_2COOH \xrightarrow{Br_2/\text{red P}} \underset{\displaystyle Br}{CH_3\overset{}{C}HCOOH} \xrightarrow{NaOH} \underset{\displaystyle OH}{CH_3CHCOOH}$$

9. B

Sol. $PhCH_2OH$ forms benzyl carbocation Ph^+CH_2 which is more stable and gives instantaneous result.

10. D

Sol. 1°-alcohols are less reactive than 2°- and 3°-alcohol.

11. C

Sol. Cyclic silicates contain $(SiO_3)_n^{2n-}$ units.

Sol. Meso silicates are not polymer. So they do not share any oxygen ato m.

~~12.~~ A

(PART – B)

1. 16

Sol. $x = 4, y = 6, z = 6$

2. 4

Sol. Statements a, c, d & e are incorrect.

3. 6

Sol. There are six paramagnetic complexes.

4. -4.66(Range-4.6 to -4.7)

Sol. $2Na_2HPO_4 + 3NaH_2PO_4 \longrightarrow Na_7P_5O_{16} + 4H_2O$

$Z = -7, x = 2, y = 3$

5. 3.81 JK^{-1} (Range 3.7 to 3.9

Sol. $nC_v(T_2 - T_1) = -Pdv$

6. 2

Sol. Since the unit of rate constant is $dm^3\ mol^{-1}\ s^{-1} = L\ mol^{-1}\ s^{-1}$

The reaction is second order.

SECTION – III : MATHEMATICS

(PART – A)

1. ABCD

Sol. Applying $C_2 \to C_1 - \cos^2 x C_1$, we get $f(x) = \begin{vmatrix} \sec^2 x & 0 & 1 \\ \cos^2 x & \cos^2 x - \cos^4 x & \cos ec^2 x \\ 1 & 0 & \cot^2 x \end{vmatrix}$

$= \left(\cos^2 x - \cos^4 x\right)\left(\sec^2 x \cot^2 x - 1\right)$ [expending along C_2]

$= \cos^2 x \sin^2 x \left(\operatorname{cosec}^2 x - 1\right)$

$= \cos^2 x \sin^2 x \cot^2 x = \cos^4 x$

$= \frac{1}{4}\left(3 + 4\cot 2x + \cos 4x\right)$

Thus $\int_{-\pi/4}^{\pi/4} f(x)\,dx$

$= \frac{1}{4}\left(3x + 2\sin 2x + \frac{1}{4}\sin 4x\right)\Big|_0^{\pi/4} = \frac{1}{16}\left(3\pi + 8\right)$

It can be easily checked that each of (b), (c) and (d) also holds.

2. ABC

Sol. We have $A(\alpha,\beta)' = \begin{bmatrix} \cos\alpha & -\sin\alpha & 0 \\ \sin\alpha & \cos\alpha & 0 \\ 0 & 0 & e^{\beta} \end{bmatrix}$

$= \begin{bmatrix} \cos(-\alpha) & \sin(-\alpha) & 0 \\ -\sin(-\alpha) & \cos(-\alpha) & 0 \\ 0 & 0 & e^{\beta} \end{bmatrix} = A(-\alpha, \beta)$

Also, $A(\alpha,\beta)A(-\alpha,-\beta)$

$= \begin{bmatrix} \cos\alpha & \sin\alpha & 0 \\ -\sin\alpha & \cos\alpha & 0 \\ 0 & 0 & e^{\beta} \end{bmatrix}\begin{bmatrix} \cos\alpha & -\sin\alpha & 0 \\ \sin\alpha & \cos\alpha & 0 \\ 0 & 0 & e^{-\beta} \end{bmatrix}$

= I

$\Rightarrow A(\alpha,\beta)^{-1} = A(-\alpha, -\beta)$

Next, $\operatorname{Adj}(\alpha,\beta) = \left|A(\alpha,\beta)\right| A(\alpha, \beta)^{-1}$

$= e^{\beta} A(-\alpha, -\beta)$

3. ABC

Sol. Let x_0 be the number of objects to the left of the first object chosen, x_1 the number of objects between the first and the second, x_2 the number of objects between the second and the third and x_3 the number of objects to the right of the third object. We have

$x_0, x_3 \ge 0,\ x_1, x_2 \ge 1$ and $x_0 + x_1 + x_2 + x_3 = n - 1$ (1)

Put $x_1 = y_1 + 1$ and $x_2 = y_2 + 1$. Then (1) reads as $x_0 + y_1 + y_2 + x_3 = n - 5$ (2)

where $x_0, y_1, y_2, y_3 \ge 0$

The number of non – negative integral solution of (2) is ${}^{n-5+3}C_3 = {}^{n-2}C_3$

We have ${}^{n-2}C_3 = \frac{1}{6}(n-2)(n-3)(n-4)$.

Also, ${}^{n-3}C_3 + {}^{n-3}C_2 = {}^{n-2}C_3$

4. ABC

Sol. $\frac{1}{n+1}+\frac{1}{n+2}+......+\frac{1}{2n}$

$=\left(1+\frac{1}{2}+\frac{1}{3}+......+\frac{1}{2n}\right)-\left(1+\frac{1}{2}+.....+\frac{1}{n}\right)$

$=\left(1+\frac{1}{3}+.......+\frac{1}{2n-1}\right)$

$+\frac{1}{2}\left(1+\frac{1}{2}+......+\frac{1}{n}\right)-\left(1+\frac{1}{2}+.....+\frac{1}{n}\right)$

$=1-\frac{1}{2}+\frac{1}{3}-\frac{1}{4}-.....+\frac{1}{2n-1}-\frac{1}{2n}$

$\alpha(2n)<\underbrace{\frac{1}{n}+\frac{1}{n}+......+\frac{1}{n}}_{\text{n times}}=1$ and $\alpha(2n)\geq\frac{1}{2n}\geq\frac{1}{2}\forall n$

(D) is not correct as $\alpha(1)=1$

5. AB

Sol. $I=\int_0^\alpha\frac{dx}{1-\cos\alpha\cos x}$

$=\int_0^\alpha\frac{dx}{\left(\cos^2\frac{x}{2}+\sin^2\frac{x}{2}\right)-\cos\alpha\left(\cos^2\frac{x}{2}-\sin^2\frac{x}{2}\right)}$

$=\int_0^\alpha\frac{dx}{(1-\cos\alpha)\cos^2\frac{x}{2}+(1+\cos\alpha)\sin^2\frac{x}{2}}$

$=\int_0^\alpha\frac{dx}{2\sin^2\frac{\alpha}{2}\cos^2\frac{x}{2}+2\cos^2\frac{\alpha}{2}\sin^2\frac{x}{2}}$

$=\frac{1}{2}\int_2^\alpha\frac{\left(\sec^2\frac{\alpha}{2}\right)\sec^2\frac{x}{2}}{\tan^2\frac{\alpha}{2}+\tan^2\frac{x}{2}}dx$

Put $\tan\frac{x}{2}=t$, we have

$I=\int_0^{\tan\frac{\alpha}{2}}\frac{\sec^2\frac{\alpha}{2}dt}{t^2+\tan^2\frac{\alpha}{2}}$

$=\sec^2\frac{\alpha}{2}\cot\frac{\alpha}{2}\left[\tan^{-1}\left(\frac{t}{\tan\frac{\alpha}{2}}\right)\right]_0^{\tan\frac{\alpha}{2}}$

$=\frac{2}{\sin\alpha}.\frac{\pi}{4}=\frac{\pi}{2\sin\alpha}$

Thus $\frac{A}{\sin\alpha}+B=\frac{\pi}{2\sin\alpha}$. $A=\frac{\pi}{2}$, $B=0$ and $A=\frac{\pi}{4}$,

$B=\frac{\pi}{4\sin\alpha}$ satisfy the last equation.

6. AD

Sol. Let $\sqrt{y-x}=t$

$$y - x = t^2$$
$$\frac{dy}{dx} = 2t\frac{dt}{dx} + 1$$
$$2t\frac{dt}{dx} + 1 = \sqrt{t}$$
$\frac{2t}{\sqrt{t}-1}dt = dx$ which leads A and D as solutions

7. BD

Sol. $\sin A + \sin B = \frac{a+b}{c} = \frac{\sin A + \sin B}{\sin C} \Rightarrow \sin C = 1$

$\Rightarrow C = 90^o$

$A + B = 90^o \Rightarrow \cos A = \sin B$

8. AC

Sol. $\left(x^2 + 1 + \frac{1}{x^2}\right)^n$

$= {}^nC_0 + {}^nC_1\left(x^2 + \frac{1}{x^2}\right) + {}^nC_2\left(x^2 + \frac{1}{x^2}\right)^2 + ... + {}^nC_n\left(x^2 + \frac{1}{x^2}\right)^n$

This contains each of the term $x^0, x^2, x^4, ...x^{2n}, x^{-2}, x^{-4}, ...x^{-2n}$

Coefficient of constant term

$= {}^nC_0 + \left({}^nC_2\right)(2) + \left({}^nC_4\right)\left({}^4C_2\right) + \left({}^nC_6\right)\left({}^6C_3\right) + ...$

$\neq 2^n - 1$

Coefficient of x^{2n-2} in ${}^nC_{n-1} = n$

Coefficient of x^2 is ${}^nC_1 + \left({}^nC_3\right)\left({}^3C_1\right) + \left({}^nC_5\right)\left({}^5C_2\right) + ... > n$

9. **A**

Sol. Let the equations of the circles be $x^2 + y^2 + 2g_1x + 2f_1y + c_1 = 0$ and $x^2 + y^2 + 2g_2x + 2f_2y + c_2 = 0$.

(I) Equation of the radical axis is $2(g_1 - g_2)x + 2(f_1 - f_2)y + c_1 - c_2 = 0$

Slope of the radical axis $= \frac{g_1 - g_2}{f_1 - f_2}$

Slope of the line joining the centres $= \frac{f_1 - f_2}{g_1 - g_2}$ So, the radical axis is perpendicular to the line joining the centre

(II) Common tangent to the intersecting circles of equal radii is at the same distance from the centres of the two circles and hence is parallel to the line joining the centres.

(III) Since the line joining the centres of the circles to the mid – point of the common chord is perpendicular to the chord, it bisects the chord.

(IV) The line joining the centre of one to a point of intersection of tangent to the other circle. So by definition of orthogonality, they are perpendicular.

10. A

Sol. For function f in (a) $f(x) = \begin{cases} x, & x > 1 \\ 0, & x = 1 \\ -x, & x < 1 \end{cases}$ so $\lim_{x \to 1} f(x)$ does not exist.

$$\lim_{x\to0}\frac{\sin\left(\sin\left(\tan\left(\frac{x^2}{2}\right)\right)\right)}{\log\cos 3x}$$

$$=\lim_{x\to0}\frac{\sin\left(\sin\left(\tan\left(\frac{x^2}{2}\right)\right)\right)}{\sin\left(\frac{\tan x^2}{2}\right)}\times\frac{\sin\left(\sin\left(\tan\left(\frac{x^2}{2}\right)\right)\right)}{\sin\left(\frac{\tan x^2}{2}\right)}\times\frac{\sin\left(\tan\frac{x^2}{2}\right)}{\tan\frac{x^2}{2}}\times\frac{\tan\left(\frac{x^2}{2}\right)}{\frac{x^2}{2}}\times\frac{\frac{x^2}{2}}{\log\cos 3x}$$

$$=\frac{1}{2}\lim_{x\to0}\frac{2x}{-3\tan 3x}=-\frac{1}{9}$$

$$\lim_{x\to0}\frac{\sqrt[3]{1+\tan^{-1}3x}-\sqrt[3]{1+\sin^{-1}3x}}{\sqrt{1-\sin^{-1}2x}-\sqrt{1+\tan^{-1}2x}}$$

$$=\lim_{x\to0}\frac{\left(1+\frac{1}{3}\tan^{-1}3x+.......\right)-\left(1-\frac{1}{3}\sin^{-1}3x+........\right)}{\left(1-\frac{1}{2}\sin^{-1}2x-...\right)-\left(1+\frac{1}{2}\tan^{-1}2x+......\right)}$$

$$=\lim_{x\to0}\frac{\frac{1}{3}\frac{\tan^{-1}3x}{x}+\frac{1}{3}\frac{\sin^{-1}3x}{x}+\frac{1}{x}\left(\text{highest power of }\sin^{-1}3x\text{ and }\tan^{-1}3x\right)}{-\frac{1}{2}\frac{\sin^{-1}2x}{x}-\frac{1}{2}\frac{\tan^{-1}2x}{x}+\frac{1}{x}\left(\text{higher power of }\sin^{-1}x\text{ and }\tan^{-1}2x\right)}$$

$$=\frac{1+1}{-1-1}=-1$$

$$\lim_{x\to0}\frac{e^{1/x}-1}{e^{1/x}+1}=-1\text{ and }\lim_{x\to0^+}\frac{e^{1/x}-1}{e^{1/x}+1}=1$$

11. C

Sol.

(I) $a_1=\int_0^{\pi/2}dx=\frac{\pi}{2},\ a_2=\pi$

Also, $a_{n+2}+a_n-2a_{n+1}$

$$=\int_0^{\pi/2}\frac{2\cos(2n+2)x-\cos(2n+4)x-\cos(2nx)}{1-\cos 2x}dx$$

$$=\int_0^{\pi/2}\frac{2\cos(2n+2)x-2\cos(2n+2)x\cos 2x}{1-\cos 2x}dx$$

$$=\int_0^{\pi/2}2\cos(2n+2)x\,dx$$

$$=\frac{2}{2n+2}\sin(2n+2)x\Big]_0^{\pi/2}=0$$

$\therefore a_1,a_2,a_3,...$ are in A.P.

(II) $I_{n+1}+I_{n+3}$

$$=\int_0^{\pi/4}\tan^{n+1}x\sec^2x\,dx$$

$$=\frac{1}{n+2}\tan^{n+2}x\Big]_0^{\pi/4}=\frac{1}{n+2}$$

$\therefore a_n=n+2$

$\Rightarrow a_1,\ a_2,......$ are in A.P.

(III) $I_n - I_{n-1} = \int_0^{\pi/2} \frac{\sin^2(nx) - \sin^2(n-1)x}{\sin x} dx$

$= \int_0^{\pi/2} \frac{\sin(2n-1)x \sin x}{\sin x} dx$

$= -\frac{1}{2n-1}\cos(2n-1)x\Big]_0^{\pi/2} = \frac{1}{2n-1}$

$\Rightarrow a_1, a_2, a_3, ...$ are in H.P.

(IV) $b_n = \int_0^{\pi/2} \frac{1-\cos 2nx}{1-\cos 2x} dx = \frac{n\pi}{2}\left[\text{see}(a)\right]$

$a_n = \frac{\pi}{2} \forall\ n.$

$\therefore\ a_1, a_2, a_3, ...$ area in A.P. , G.P. and H.P.

Also $a_1, a_2, a_3......$ is a constant sequence.

12. A

Sol.

(I) The given lines are $y = x$ and $y = 0$. The line $y = x$ meets $\frac{x^2}{3} + y^2 = 1$ at the points $x = \pm\frac{\sqrt{3}}{2},\ y = \pm\frac{\sqrt{3}}{2}$. So the required intercept is $\sqrt{2\left(\frac{\sqrt{3}}{2} + \frac{\sqrt{3}}{2}\right)^2} = \sqrt{6},$ intercept on $y = 0$ is $2\sqrt{3}$

(II) Required intercepts are $\sqrt{6}$ and 2.

(III) $y = x$ and $y = 0$ are diameters of the circle and hence the required intercepts is equal to the diameter of the circle which is 4.

(IV) $y = x$ meets the parabola $y^2 = 2\sqrt{2}x$ at points where $x = 0,\ 2\sqrt{2}$.

So that the points of intersection of the line and the parabola are (0, 0) and $\left(2\sqrt{2},\ 2\sqrt{2}\right)$ and the required intercept is 4. Intercept on $y = 0$ is 0.

For T, $x = \pm\sqrt{2},$ and $0 = 2$ which is not possible hence no intercept or intercept $= 2\sqrt{2}$

(PART – B)

1. **0.25**

Sol. Given $\int_0^1 f(x)dx = \frac{1}{3} + \int_0^1 \left(f\left(x^2\right)\right)^2 dx$

Consider, $I_1 = \int_0^1 \left(f\left(x^2\right)\right)^2 dx$

Put $x^2 = t \Rightarrow 2x\,dx = dt$

$I_1 = \frac{1}{2}\int_0^1 \frac{\left(f(t)\right)^2}{\sqrt{t}} dt$

$\therefore$ Equation (1) becomes

$$\int_0^1 \frac{t}{2\sqrt{t}} dt + \int_0^1 \frac{\left(f(t)\right)^2 - 2\sqrt{t}\,f(t)}{2\sqrt{t}} dt \Rightarrow \int_0^1 \left(f(t) - \sqrt{t}\right)^2 dt = 0$$

$\therefore f(t) = \sqrt{t}$

So, $f\left(\frac{1}{4}\right)=\frac{1}{2}$

So, reciprocal of $f\left(\frac{1}{4}\right)=2$

2. **0.125**

Sol. Given curve is ellipse having centre (0, 0). All chords of ellipse through origin are bisected at origin

$\Rightarrow p=q=0$

3. 3.00

Sol. We have $\frac{4+\sec 20^o}{\operatorname{cosec} 20^o}=\frac{\sin 20^o}{\cos 20^o}\left(4\cos 20^o+1\right)$

$$=\frac{2\sin 40^o+\sin 20^o}{\cos 20^o}$$

$$=\frac{\sin 40^o+\left(\sin 40^o+\sin 20^o\right)}{\cos 20^o}$$

$$=\frac{\sin 40^o+2\sin 30^o\cos 10^o}{\cos 20^o}$$

$$=\frac{2\sin 60^o\cos 20^o}{\cos 20^o}=2\times\frac{\sqrt{3}}{2}=\sqrt{3}$$

Hence square of the value of expression = 3

4. 1.00

Sol. Note that for the x interval $(-\infty,0), f(x)$ is strictly increasing and has range $(-\infty, \infty)$. For the x interval $(0,\infty)$, again, $f(x)$ is strictly increasing and has range $(-\infty, \infty)$.

Hence for all a, there is exactly one positive and one negative solution to $f(x)=a$.

Thus, there are 2^n solutions to $f^n(x)=a$, and the answer is $2^3=8$

5. 4.00

Sol. 2 or 3 or 4 or 5 copies of each book out of 5 identical copies can be selected in 4 ways. Since number of books is n, therefore, total number of selections = 4^n

Given $4^n=256\Rightarrow n=4$

6. 17.00

Sol. Let $S_n=1.2^1+2.2^2+3.2^3+4.2^4+\text{.........}+n.2^n$ ....(1)

$\Rightarrow \quad 2.S_n=1.2^2+2.2^3+\text{......}+(n-1)2^n+n.2^{n+1}$ ....(2)

$\therefore$ On Subtracting, we get

$\Rightarrow \quad -S_n=\left(2^1+2^2+2^3+\text{.......}+2^n\right)-n.2^{n+1}$

$\quad =2\left(2^n-1\right)-n.2^{n+1}$

$\therefore\ S_n=n.2^{n+1}-2\left(2^n-1\right)=n.2^{n+1}-2^{n+1}+2=2+(n-1)2^{n+1}$

But $2+(n-1)2^{n+1}=2+2^{n+5}$ (given)

$\Rightarrow \quad n-1=2^4$

$\therefore \quad n=17$